ALABAMA MARINE RESOURCES BULLETIN

NUMBER 11

Alabama Marine Resources Laboratory

Dauphin Island, Alabama 36528

JUNE 1976

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HOLOCENE SEDIMENTS OF MOBILE BAY, ALABAMA[1]

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ABSTRACT

Mobile Bay was a deep river valley until rising sea level from melting of the last major glaciation began to form the present estuary about 10,000 years ago. Subbottom borings, probes and radiocarbon dates show that Holocene sediment in Mobile Bay averages about 20 meters in thickness and has been deposited at different rates during the past 10,000 years in response to changes in sea level and possibly runoff. The rate of sedimentation at the present delta front was 70 centimeters per century between 10,000 and 9,500 years ago. Between 9,500 and 7,500 years B.P. the rise in sea level was interrupted by the Cochrane glacial readvance and little sedimentation or erosion of the basin occurred. During this period modern terrestrial plants were deposited between about –14 and –16 meters, after which the rise in sea level resumed and sediment was deposited at 43 centimeters per century between 7,500 B.P. and 6,500 B.P. About 6,500 years ago the average rate of sedimentation at the present delta front slowed to 20 centimeters per century. Throughout the open bay the rate varied from 3 to 12 centimeters per century.

The barrier islands began to effectively influence estuarine salinity between 3,000 and 4,000 years ago but they likely began to form earlier in response to a slowdown in the marine transgression. Dated archaelogical sites on Holocene sediment are about 4,000 years old or less.

The concentration of natural trace metals increase with depth in response to variations in particle size distribution associated with different depositional environments. Clay mineralogy is remarkedly uniform with depth. Surface lead and zinc concentrations in a limited area near the city of Mobile may have been increased above natural levels anthropogenically. Natural levels of trace metals in sediment are not known to pose a threat to water quality or biota whether sediment is left undisturbed or resuspended by man or nature.

INTRODUCTION

Recognition of the importance of estuarine sedimentology has increased since federal regulatory agencies have recently considered sediment as an environmental quality standard in relation to dredging and other activities. In developing criteria for determining whether sediment may be dredged safely there has been a problem of recognizing what is natural and what is polluted by man. Trace metals have been assumed to be major pollutants in estuarine sediment because of the potential toxicity of some forms when dissolved in water although there is little information on their natural occurrence. Estuarine biological cycles and water quality are interrelated with the chemical and physical properties of sediments but little is known about biological uptake of chemicals from sediment. The role of many trace metals as essential nutrients and the degree of metal release or dissolution into water by sediment resuspension has been generally over-

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1 This study was done in cooperation with the U. S. Department of Commerce, N.O.A.A., National Marine Fisheries Service P.L. 88-309 (Project 2-216-R), U. S. Army Corps of Engineers, Mobile District, and the Alabama Highway Department.

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looked.

Failure to apply available knowledge to this environmental problem has partially resulted in a general assumption that resuspended sediments are pollutants. In contrast, the fact is plain that sediment is exposed to water naturally. Estuarine areas which receive the most fresh water and its alluvium, rich in trace metals and organic matter, are the most productive biologically.

This paper partially describes the properties of Holocene sediments in Mobile Bay, particularly as related to the past 10,000 years of glacial and eustatic events. The sediment composition and history of deposition compliment what is known from other areas of the Gulf coast (Shepard and Moore, 1960; Rusnak, 1960; van Andel, 1960; Curray, 1965). Consideration is given to the stratification of trace metals as a function of deposition rate and mineralogy. The environmental significance of sediment resuspension is discussed.

Different aspects of the geology of the Alabama coastal area have been described by Smith, Johnson and Langdon (1894); Richard (1939); Carlston (1950); Marsh (1966); Copeland (1968); Ryan (1969); Isphording and Lamb (1971); Reed (1971 a;b); Ryan and Goodell (1972); Isphording and Riccio (1972); Riccio, Isphording and Gazzier (1972); Otvos (1973); and others.

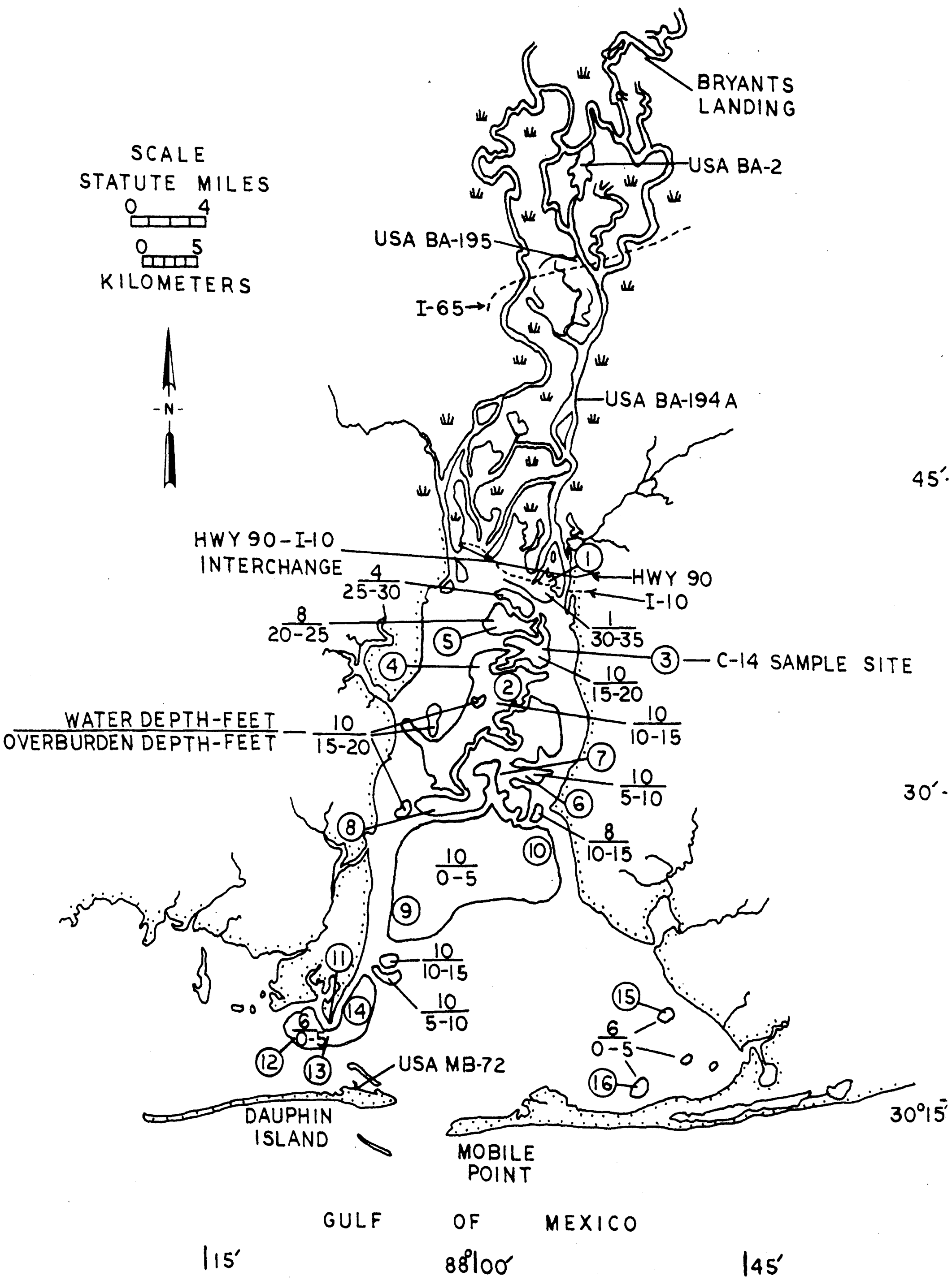
METHODS AND AREA OF INVESTIGATION

The Mobile River system drains approximately 114,000 square kilometers and is second in discharge only to the Mississippi River system along the eastern and southern coasts of the United States. The river terminus is Mobile Bay which is about 50 kilometers long and 14 to 18 kilometers wide in the northern two-thirds and about 38 kilometers wide in the lower reaches. The bay opens to the west into Mississippi Sound. Both water bodies are bordered on their seaward margins by barrier islands or spits. An extensive delta merges with the flood plains of the Alabama and Tombigbee rivers about 48 kilometers north of the upper end of the bay (Figure 1).

Extensive subsurface investigations were done by Shelby tube borings in conjunction with the proposed bridge crossings of interstate highways I-65 in the delta and I-10 at the delta front by the Alabama Highway Department. Radiocarbon dates were obtained from several stations near the proposed Highway 90 and I-10 interchange and from the I-65 right-of-way. A continuous profile of dates was obtained at one station near the centerline of the intersection of the two highways from the surface to a depth of 20 meters and were used to interpret sedimentation rates. Samples of large oyster shells were dated from a deposit in the Gulf of Mexico in 38 meters at 29°40′ north latitude and 88°23′ west longitude. Most mineralogical and engineering analyses of core and surface samples as done by the Alabama Highway Department. Trace metal analyses were done by the Alabama Highway Department and the Corps of Engineers Waterways Experiment Station using atomic absorption spectrophotometry (Environmental Protection Agency, 1969). Clay mineralogy was done at Auburn University using X-ray defraction and differential thermal analysis.

Radiocarbon analyses were done by Teledyne Isotopes, Westwood, New Jersey under contract with the U. S. Army Corps of Engineers, Mobile, Alabama.

FIGURE 1. The Mobile Bay delta estuarine system showing locations of radiocarbon dates and the distribution of buried oyster shell deposits in relation to depth of overburden.



Total organic carbon from 15-to 30-centimeter long sediment cores was analyzed after treatment for removal of carbonates. Wood, charcoal, or shell was present in most core segments. Shell from a small section of the core was used in most samples. All shell was acid-washed before dating the remainder. Samples of buried shell from deposits in the bay were collected in 1969 by May (1971). Additional dates were reported by Ryan (1969).

Much of the data in this study was provided through the cooperation of Edward Eiland and Don Horn with the Alabama Highway Department and Don Conlon with the Mobile District, Corps of Engineers. Ben Hajek, Auburn University, did the clay mineralogy and R. John Taylor, Southeastern State University, Durant, Oklahoma, identified macrofossil plant material. Bobby Taylor, Dauphin Island, collected oyster shells in the Gulf.

LATE PLEISTOCENE AND HOLOCENE HISTORY OF MOBILE BAY

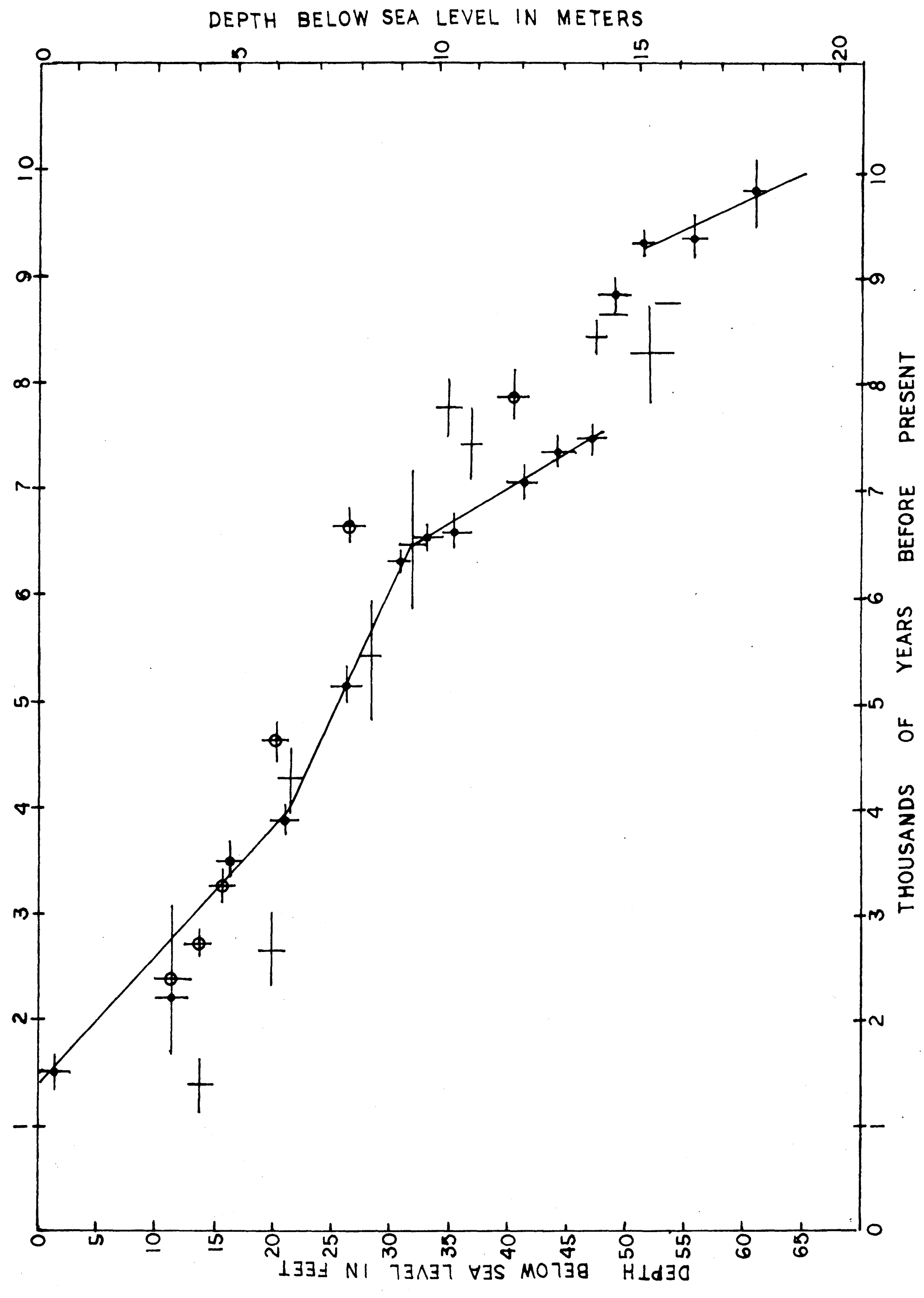
The formation of Mobile Bay and the present coastline was a function of a rise in sea level from the low of the last glacial maximum to its present height and associated meteorological conditions which influenced runoff. The late-Wisconsin glaciations achieved a maximum extent about 18,000 years ago and sea level is thought to have been as low as –122 meters below its present stand. After this last major glacial advance the glaciers began a nonuniform retreat and sea level began to rise in response to world-wide glacial melting.

The rise in sea level was interrupted by two and possibly three temporary regressions (Curray, 1965). The Valders readvance occurred around 11,800 years B.P. (before present) and sea level was again lowered. This glacial readvance was followed by a rapid retreat about 11,500 B.P. and a resumption in sea level rise (Broecker, 1965). The most significant interruption in the rise of sea level was between 9,500 and 7,500 B.P. and correlates with the Cochrane readvance in Ontario, Canada (Karlstrom and Rubin, 1955; Curray, 1960; Flint, 1963). The overall trend in sea level was a rapid rise with temporary interruptions until a pronounced slowing occurred around 7,000 B.P. It is not known with certainty whether the present stand was reached 3,000 to 5,000 years ago or only recently (Curray, 1965).

Knowledge of sea level height and Holocene sedimentation in estuaries is based on radiocarbon dates of coastal deposits which have known relationship to sea level such as mollusk shells and peat deposits. Literature on sea level fluctuation reflects the incomplete data and the complexity of the events of this period. Uncertainties in the actual relationship of deposits to sea level, different subsidence and compaction of sediments and other sources of error have caused uncertainties among geologists as to the exact position of sea level with time but the overall process is fairly well known.

In addition to sea level position, climatic changes have pronounced affects on sedimentation. Very little is known of the paleo-climatic conditions of the Mobile Bay drainage system (Morris, 1965; Szabo, 1972). Nevertheless, the variations in deposition of sediments in Mobile Bay fit well into the time intervals proposed for climatic changes in other areas of the United States (Brooks, 1949; Deevey, 1949; Parker, 1960; Broecker, 1965; Curray, 1960; 1961; Broecker and Kaufman, 1965;

FIGURE 2. Sedimentation rate curve for Mobile Bay at the proposed interchange of Highway 90 and I-10 (Figure 1) based on radiocarbon dates of wood, charcoal and shells. Line connects dotted samples taken from same hole. Other dates are from nearby holes except those circled are from I-65. Vertical lines are depth range of sample. Horizontal lines are statistical variability of dates.



Martin and Mehringer, 1965; Meier, 1965; Morrison, 1965; Schumn, 1965; Smith, 1965; Whitehead, 1965 and others).

Mobile Bay began to form when rising sea level drowned a deep river valley which was eroded by the Pleistocene river system. Since the beginning of this process about 10,000 years ago the eroded valley has become about 85 percent filled with sediment in reference to present sea level. The bathymetry on the continental shelf off Alabama shows evidence of relic shorelines such as mounds along the 18-meter contour, submerged deltas or alluvial fans and possibly river channels inside the 55-meter contour. Similar features also occur off the coast of Texas (Curray, 1960; 1961).

SEDIMENTATION RATE

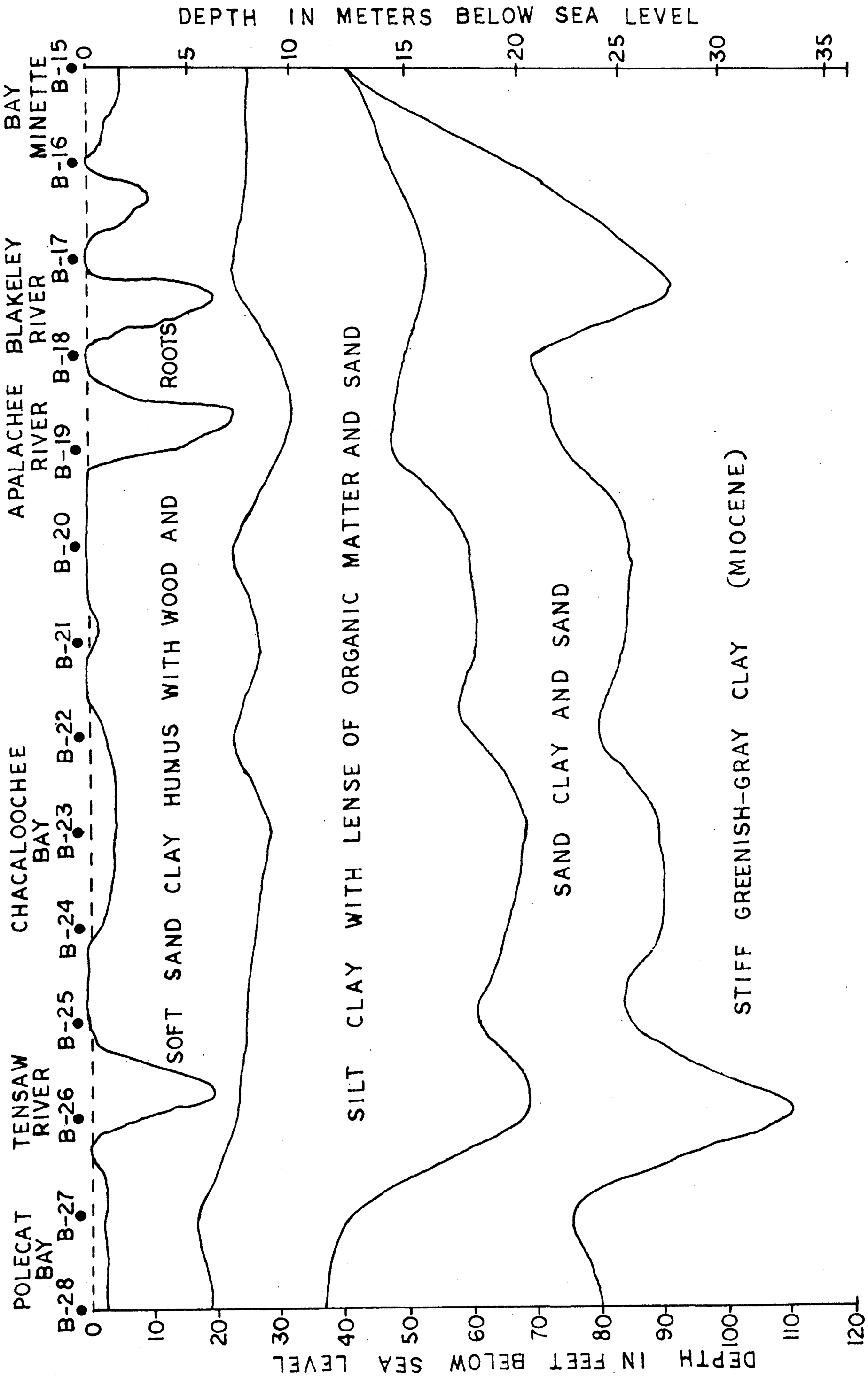
The sedimentary history of the present bay and delta is mostly confined to within the past 10,000 years. For a practical discussion of sedimentation in Mobile Bay, four periods of sea level fluctuation need to be considered; before 9,500 B.P.; from 9,500 to 7,500 B.P.; from 7,500 to 6,500 B.P.; and since 6,500 B.P. The position of sea level is inferred and discussed from the sedimentation rate curve (Figure 2) but the data represent the bay bottom, not height of sea level. Sea level was above or near the curve shown in Figure 2 except between 9,500 and 7,500 B.P. The line in Figure 2 connects samples from the same hole which are represented by a dot in the center.

Before 9,500 B.P.

During lower sea level the Mobile River became deeply entrenched in a broad valley with the river mouth perhaps 100 kilometers seaward of the present mouth of the bay. Much of the Pleistocene sediments previously deposited in the valley were removed by erosion and coarse sand and gravel was deposited on stiff clays of predominantly Miocene age (Riccio et al., 1972). The top of the extremely stiff clay exposed during the Pleistocene occurs at various depths at the delta front from about –12 to –33 meters and most frequently at about –24 meters below present sea level. Although detailed coring throughout all the bay and delta has not been done, numerous probes with a water jet hit an impenetrable clay at about –18 meters or less over most of the open bay. Within the buried river channel the clay occurs at –36 meters in the lower bay (K. R. McLain, personal communication). The river channels formed during lower sea level are well defined in coring profiles across the delta front at the I-10 crossing (Figure 3 A&B) and across the delta 27 kilometers northward at the I-65 crossing (Figure 4).

As rising sea level advanced into what is now Mobile Bay, the deep river channel and the adjoining valley began to flood and fill with sediment before about 10,000 B.P. The transgressional erosion and alluvial sedimentation deposited silt-clay and very little sand at a rate of around 70 centimeters per century until about 9,500 B.P. when sea level apparently regressed from a position of about –16 meters. This interruption in the rise of sea level caused much of the previously inundated basin to become subaerially exposed until the rise resumed. Oyster shells collected in 38 meters from the Gulf of Mexico, 76 kilometers south-southwest of Mobile Bay, had an average age of 9,585 years B.P. (9230 ± 150; 9940 ± 150). River channels formed during this regression and deposition of sediment on the Texas shelf suggested to Curray

FIGURE 3. Vertical cross-sectional profile of sediments near the present delta front at stations shown in Figure 6.



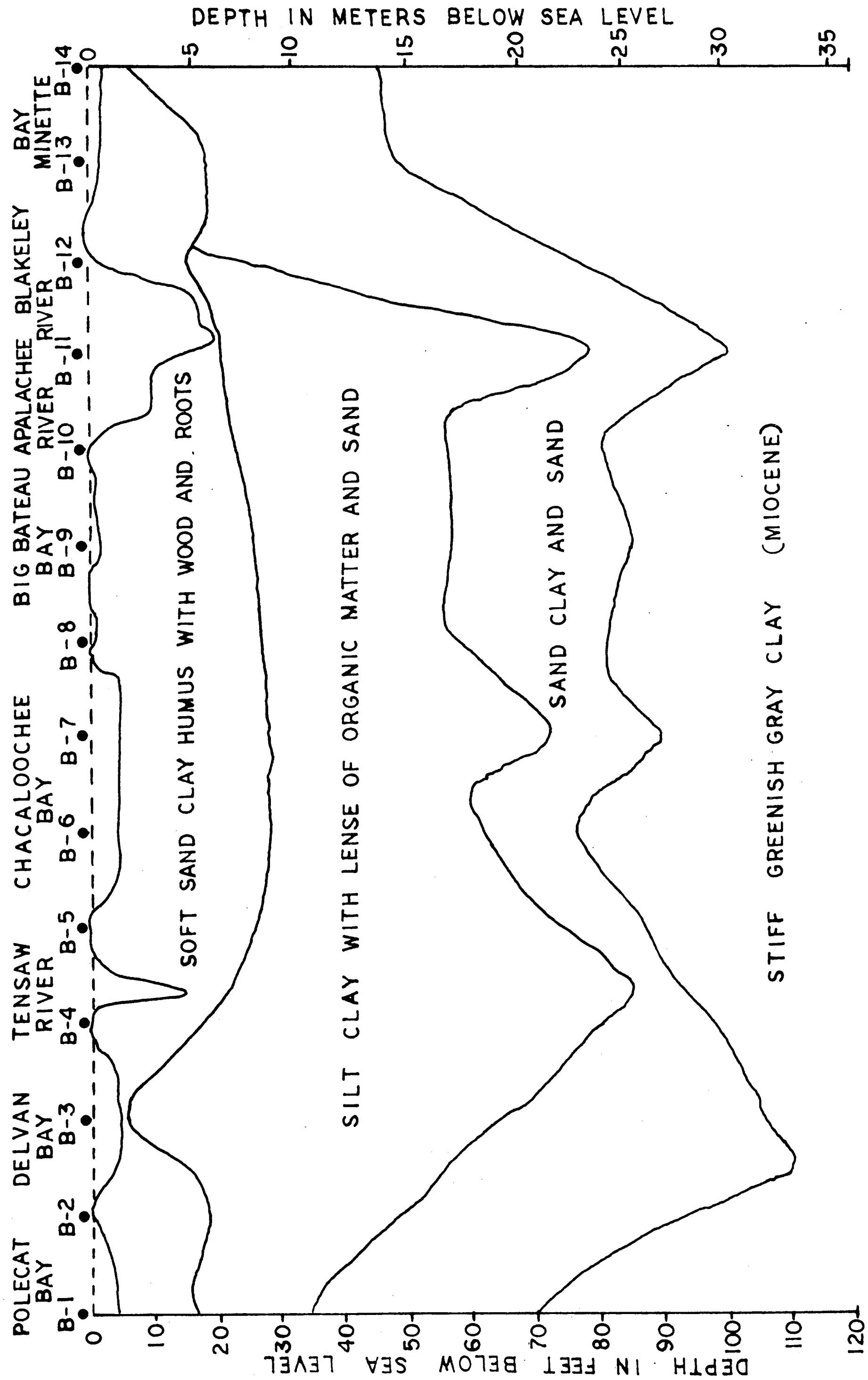
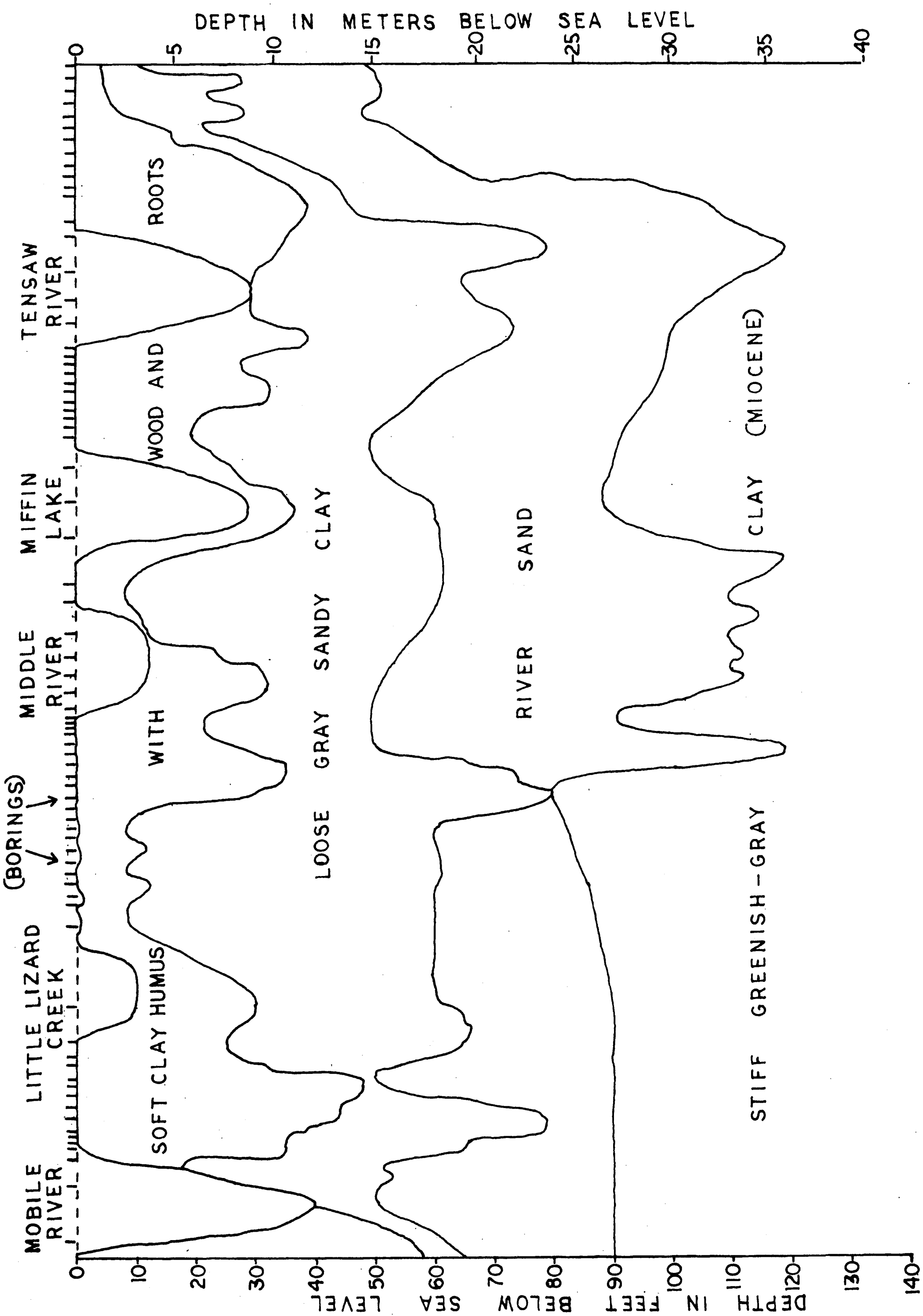

DEPTH IN METERS BELOW SEA LEVEL
0
-5
-10
-15
-20
-25
-30
-35
DEPTH IN FEET BELOW SEA LEVEL
0
10
20
30
40
50
60
70
80
90
100
110
120
POLECAT BAY
B-1
B-2
DELVAN BAY
B-3
TENSAW RIVER
B-4
B-5
CHACALOOCHEE BAY
B-6
B-7
B-8
BIG BATEAU BAY
B-9
B-10
APALACHEE RIVER
B-11
BLAKELEY RIVER
B-12
B-13
BAY MINETTE
B-14
SOFT SAND CLAY HUMUS WITH WOOD AND ROOTS
SILT CLAY WITH LENSE OF ORGANIC MATTER AND SAND
SAND CLAY AND SAND
STIFF GREENISH GRAY CLAY (MIOCENE)

FIGURE 4. Vertical cross-sectional profile along proposed I-65 delta crossing 27 kilometers north of the delta front. Location shown in Figure 1.



(1960) that sea level fell to –38 meters and then rose to and remained at about –17 meters until the transgression resumed. Acoustic subsurface profiles of Holocene sediment in South America were interpreted by van Andel and Sachs (1964) as showing the regression was from about –20 meters to a low of –37 meters.

The apparent lack of significant erosion of the soft bay deposits and continued clay deposition during this interval indicate a minor or very temporary increase in gradient. Shepard (1964) reported a salt marsh peat with a C-14 age of 8,000 years at –21 meters in a submarine canyon in California which he felt was a stable area. Some additional dates from this period are reported by Curray (1960) and Shepard (1960a) but none exceed 30 meters in depth. Additional work in lower Mobile Bay and on the Alabama shelf could likely help establish this sequence with certainty.

9,500 to 7,500 B.P.

This period is marked at the present delta front by an absence of estuarine sedimentation and aquatic mollusk shells and the presence of a muddy, woody peat-like deposit and soil-like zone between about –14 and –16 meters. Sediments are sandy, silty clay. In eroded channels, undated wood is found to depths of –18 to –21 meters but in most places the woody zone overlies sediments which contain mollusk shell. Evidence of this terrestrial stage is found near this depth in cores throughout much of the lower delta and it is analogous with similar organic layers of the same age found elsewhere along the northern Gulf coast (Rehkemper, 1969). The muddy condition and degree of preservation of the material suggest its deposition in water, possibly by inundation. The narrow age range of the plant material suggests there were times during this period, especially after 8,500 B.P., which were unfavorable for growth or preservation.

Plant macrofossils in the muddy layer –14 ot –16 meters below present sea level in the continuous profile consisted of wood, seeds, leaves, stems, roots and grass. Much of the material was fairly well preserved and identifiable. Radiocarbon dates of wood from 11 samples of this deposit at different stations and depths ranged from 8,340 ± 380 to 9,380 ± 180 years B.P. with most dates between 8,400 and 8,900 B.P. In Figure 2 the date of 8,640 B.P. at a depth of –14.2 to –15.2 meters is an average of six dates within that depth: 8480 ± 350; 8665 ± 365; 8500 ± 430; 8480 ± 280; 8860 ± 420 and 8860 ± 170. The date 8770 B.P. at –15.8 to –16.5 meters is an average of 8900 ± 450 and 8640 ± 145. A thin soil-like zone overlying the deposit occupied a period from 8,300 B.P. to 7,500 B.P.

In the bottom layers of the organic zone a freshwater diatom *Stephanodiscus* and eastern red cedar were abundant. Cedar became less abundant and disappeared in the upper layers. Throughout the deposit, typical bottomland species were present; tupelo, sycamore, river birch, American beech, waxmyrtle, black haw, lichens and grasses or sedges. These species are identical to those found along streams in the area today and whose common range presently extend from the southeastern Gulf coast as far north as southern Illinois and Indiana. Oaks and pines common on the present upland are currently rare in the lower delta just as in the period sampled.

7,500 to 6,500 B.P.

A resumption in the rise of sea level covered the subaerial zone at –14 meters 7,500 years ago. Sedimentation was rapid until about 6,500 B.P. (about 43 centimeters per century) after which sedimentation rate slowed (Figure 2). There is an inconsistancy between dates from different stations within this period which may represent differences in elevations of the bottom before deposition. The two older dates at the same depth tend to weight the slowing in the sedimentation rate curve for the continuous profile to a point nearer 7,000 B.P. Unfortunately, the compositional character of these two samples was not observed.

The sediment from this zone (–10 to –14 meters) is silt-clay with almost no sand. Cores have a lenticular, crumbly structure when broken and contain very few mollusk shells and little organic matter which may be a function of rapid sedimentation. The structure of the cores may be related to flocculation in relatively high salinity. Sediment yield by the rivers during this period may have been considerably greater than since that time although shore erosion due to rising sea level may have been a significant source of sediment.

Since 6,500 B.P.

After 6,500 B.P. sediments at the present delta front were sandy with lesser amounts of silt and clay and the rate of sedimentation slowed to an average of 20 centimeters per century. There is an indication from the continuous profile that sedimentation rate may have been slightly less (14 centimeters) between 6,000 and 4,000 years ago. Bedload from delta progradation may have contributed to the apparent increase since 4,000 B.P. and dates from other stations tend to flatten the curve (Figure 2) to a rate similar to the 6,000 to 4,000 B.P. rate. Sediment is mostly bypassing the center of the bay now (Ryan, 1969) and a similar situation may have existed earlier at the present delta front causing the variations in rate.

The pronounced slowing in sedimentation rate about 6,500 B.P. correlates with a hypothesized slowing in rate of sea level rise about that time (Curray, 1965). There is a lack of concensus on sea level position or rate of rise but most authors infer that since about 7,000 B.P. there has been a slow rise of sea level to its present stand. In any case, the last 6,500 years have been a period of relative stability of the sedimentation rate within the estuary.

Presently, the bulk of sediment deposited in the estuary is received during seasonal high river discharge and little is deposited during low or normal flow. The river system entering Mobile Bay delivers an average of 4.3 million dry weight metric tons of sediment annually. During the large flood of 1961, 4.7 million metric tons of the total 7.5 million metric tons for that year, entered the bay between January and March (Ryan, 1969). During a longer flood from 17 December 1972 to 24 June 1973, I estimated that 8.0 million metric tons entered the bay. A daily average of over 107,000 metric tons of sediment is suspended naturally in Mobile Bay, which has an area of about 107,000 hectares. Over 569,000 metric tons of suspended solids have been estimated from measurements taken during a 25-knot wind and the amount is higher during storms.

The rate of sedimentation is not uniform throughout the delta-bay system and varies from the average determined at the present delta front. Buried oyster shell samples from the open bay (average water depth 3 meters) show deposition of overburden ranges from 3 to 21 centimeters per century (average 12) which is in agreement with the rate reported for Mississippi Sound (12) by Rainwater (1964). The highest rates are in Bon Secour Bay in the lower estuary due to salinity flocculation of clay in the upper bay (18 to 21 centimeters per century) due to delta progradation (Figure 1 and Table 1).

TABLE 1. Radiocarbon dates of oyster shell deposits buried at various depths.

Sample Location Fig. 1	Lab No.	Below MSL (m)	H_2O Depth (m)	OB* Depth (m)	OB Over Sample (m)	C-14 Age	Sed. Rate of OB cm/century
1	FSU 192	9.5	0	9.2	9.5	5680 ± 50	16.46
2 top	R-3857	7.6	3.7	4.0	3.9	5550 ± 210	7.01
2 bot	R-3858	11.6	3.7	—	7.9	5710 ± 220	13.72
3 top	R-4228	7.3	3.4	4.0	3.9	5260 ± 200	7.60
3 bot	R-4227	11.3	3.4	—	7.9	4820 ± 190	16.46
4	FSU 167	7.6	3.1	4.3	4.5	3910 ± 75	19.51
5	I-7143	9.5	3.4	4.3	6.1	5330 ± 110	11.28
6	R-4225	6.1	4.3	0.6	1.8	1430 ± 140	12.80
8 top	R-3855	4.0	3.4	0.6	0.6	2200 ± 140	2.74
8 bot	R-3856	6.4	3.4	—	3.0	3120 ± 160	9.76
11	FSU 195	3.7	0	3.7	3.7	2245 ± 35	16.16
12	I-7166	4.0	1.8	0.3	2.2	2410 ± 85	8.84
13	I-7165	4.0	2.1	0	1.9	1400 ± 85	13.11
14	I-7161	4.9	2.7	0	2.2	2750 ± 85	7.62
10	I-7164	4.6	2.4	0.6	2.2	2330 ± 85	9.14
9	I-7160	5.5	3.4	0	2.1	1100 ± 85	20.42
15	I-7163	4.9	2.7	0.3	2.2	1070 ± 85	19.81
16	I-7162	3.7	2.1	0	1.6	2050 ± 85	7.32
7	I-7682	6.4	3.4	2.1	3.0	1450 ± 85	21.03

* Overburden

Carbon-14 dates and sediment profiles from the upper delta at the I-65 crossing show that delta growth north of the bay apparently kept pace with sea level rise during the past 10,000 years and the bay probably never extended much farther up the valley than now. The profile in Figure 4 shows that mostly sandy clay or sand was deposited in the upper delta except above –6 to –9 meters where organic clay predominates. The data do not indicate that tectonic subsidence or compaction is greater than in the lower delta. The C-14 dates from I-65 are circled in Figure 2. The two older dates from the upper delta are much shallower than similar dates from the lower delta. The oldest date was from wood and the next oldest was from tree roots in growth position. The four shallower dates were at the same depth as samples from the lower delta and were of marsh grass and wood. No mollusk shells were found in the cores.

Lack of indication of differential subsidence of the deeper sediment compared to the lower delta and the presence of a marsh peat between about –4 and –7 meters suggests that sea level and rate of rise may have been very near the sedimentation rate curve in Figure 2 since 7,500 B.P. and that sea level did not reach its present height until fairly recently. It may still be rising (Hicks and Crosby, 1975). However, compaction of the upper sediment, which does occur to some degree, precludes an absolute interpretation of sea level position.

Russell (1967) mentioned a regional subsidence of 11 centimeters per century based on a 3.3 meter subsidence of Indian mounds in the delta during the past 3,000 years although he gave no supporting data. In order for the delta to have remained subaerially exposed in relation to sea level if subsiding at that rate, a sediment accumulation of 37 centimeters per century would have had to occur. This rate is similar to Galveston Bay where 4.6 meters of subsidence has been assumed (Rehkemper, 1969). Shephard and Moore (1960) found subsidence increased northward in the Guadalupe Delta, Texas indicating a faster deposition rate up the river. However, my data show a sedimentation rate of only about 12 centimeters per century in the Mobile Delta.

It seems reasonable to assume that sediment accumulation during the past 150 years could be greater than before due to lumbering, agriculture and physical modifications within the bay and this may be true in local areas of the system. Ryan (1969) calculated a baywide sedimentation rate of 56 centimeters during the past 100 years from bathymetry changes in Mobile Bay. Whether this estimate based on decreases in depths reflects a significant increase in recent sedimentation rate for the entire system is uncertain. Ryan determined a dry weight density of 0.57 grams per cubic centimeter for surface sediments in the Bay which is about half the average density (1.1 grams per cubic centimeter) reported from cores 0.5 to 1 meter deep (May, 1973). Deeper cores are still more dense. After the surface sediments, which contain a large amount of water, consolidate further with time the density of the surface sediments will probably approach that of deeper sediments on which the long term rates were based. Likewise, the long-term rate does not consider compaction and the material deposited before 6,500 B.P. must have had a much greater temporary shoaling rate than is reflected by the long-term sedimentation rate.

In summary, Mobile Bay like other bays, is a transient geological feature. Ultimately it will be filled with sediment and the delta will prograde into the Gulf if sea level does not fluctuate significantly. At a rate of 20 centimeters per century the bay will be filled with alluvial sediment in less than 1,500 years. Bedload from delta progradation will shorten this time to about 10 centuries.

The delta is growing into the upper bay at a rate in excess of 0.3 kilometer per century. Progradation was estimated by Ryan (1969) to be 0.6 kilometer during the last century. The interdistributary bays in the lower Mobile Delta are rapidly filling. Within about two centuries or less these small bays will be mostly filled and replaced by new bays formed between new distributary terraces seaward of the present river mouths. A detailed understanding of these dynamic processes would be highly beneficial when developing plans for disposal of dredged sediment. It has not been generally recognized that material dredged to maintain the Port of Mobile and other ports on major rivers would enter the open water portion of the upper bay naturally if dredging was not done. A logical solution to problems of disposal of maintenance spoil from both a practical and environmental standpoint may be to put the spoil in open water in a manner that is compatible with what would happen naturally. A detailed field study of the biological, sedimentological and hydrological characteristics of the delta front and adjacent wetlands is a prerequisite to a solution of dredged material disposal problems in upper Mobile Bay.

BARRIER ISLAND FORMATION

The formation of the sand barriers, Mobile Point Peninsula and Dauphin Island, in their present position at the mouth of the bay was a particularly significant event in the sedimentary history of Mobile Bay. The sand base of these barriers and other islands to the west is generally separated from the surface exposed during the Pleistocene by several feet of Holocene mud. Depth of the sand is variable because different parts formed at different times and the islands have migrated thus obscuring some of the conditions of their original formation.

Using acoustic-reflection, Curray and Moore (1963) found the base of the sand between Cat, Ship and Horn islands in Mississippi Sound to be 9 to 12 meters below sea level. This correlated with borings which showed that sand extended to not over –12 meters overlying marine clay (Shephard, 1969b). Texas barrier sands lie on the Pleistocene surface in some cases and in other cases overlie bay deposits at about –8 to –12 meters below sea level. In most places the sand bodies are bordered on both sides by muddy sediments (Shephard, 1960b). Physical probes and acoustic profiles in Bon Secour Bay proceeding toward the middle of Mobile Point Peninsula showed barrier sand overlying mud at about –9 to –11 meters below sea level (May and McLain, 1970). Mobile Point is, in part, a relic Pleistocene ridge (Kwon, 1969; Otvos, 1973). Recent borings in Dauphin Island by E. G. Otvos (Gulf Coast Research Laboratory, Mississippi) found that eastern Dauphin Island is a relic Pleistocene ridge, veneered over by recent beach and dune sediments.

The depth of the barrier sand in relation to previous sea level indicates that the barriers started forming near their present position when the rate of rise of sea level slowed and upbuilding kept pace with the slower rise (Curray and Moore, 1963). Otvos (1970a;b) discussed the development and migration of barrier formation by aggradation of submerged shoals. He felt that most present Gulf coast barrier islands started to form about 5,000 to 3,500 years ago when the Holocene sea level transgression had slowed down or stopped altogether. Much of the literature on barrier formation is reviewed by Kwon (1969).

In the present state of knowledge it is not known whether these bars were exposed above sea level when they first began to form. Shephard and Moore (1960) presented evidence for existence of barrier islands seaward of their present position during the early development of San Antonio Bay. Rehkemper (1969) reported cemented beachrock seaward of the present barriers near Galveston Bay which indicated emergence of earlier barriers. The presence of two distinct buried oyster reef developments in Galveston Bay separated by a continuous mud layer containing no shell material indicated marine incursion by submersion of previously formed barriers about 6,000 B.P. He felt that the present barriers formed between 2,000 and 4,000 years ago. Deep multiple reef facies of unknown significance are also present in upper Mobile Bay but layered reefs are more numerous at shallower depths at a later time. Mobile Bay is a long, narrow river estuary and oyster reef development in the upper bay could have occurred independent of barrier formation. This could be true since oysters began growing soon after the rate of sedimentation and, presumably, rate of sea level rise slowed. There was a significant increase in Formanifera, clam shells *(Mulinia* and *Rangia)* and the first appearance of oyster shells *(Crassostrea virginica)* about 6,500 B.P. when the bay bottom in the area of the present delta front was about 11 meters below present sea level.

For all practical purposes, the oyster *C. virginica* is restricted to estuaries and is usually prolific only within the 15 to 25 ppt salinity range. It is most abundant in areas where the salinity averages 20 ppt. It is highly probable that salinity averaged close to 20 ppt at places in the bay or Gulf where large accumulations of oyster shells were deposited.

Oyster shell deposits have not been found below about –11 meters MSL or at ages older than 6,500 years in the bay or delta. No old deposits have been found by deep probing in the lower bay indicating that extensive oyster reef development did not migrate up the present bay with advancing sea level. Extensive oyster shell deposits have not been found north of the present delta front indicating that sufficient saltwater penetration from increased water depth has not occurred beyond that point. When oysters first grew in the upper bay, if a similar relationship existed between distance from the river mouths, rainfall and abundant oyster growth as exists now, the delta front at that time would have been about 40 kilometers northward or the bay much deeper. However, there is no evidence that either condition existed. A near surface C-14 date of the Little Lizzard Creek Midden near I-65 indicates that the elevation of the delta in that area has remained relatively stable for the past 2,500 years. If the delta front was not considerably farther north when oysters first began growing or the bay was not deep, then the winter and spring climate would have had to been much dryer or the barriers not emergent, both of which are possibilities.

The distribution of buried oyster shell deposits (May, 1971) indicates that the process of oyster shell deposition has not been greatly interrupted within the past 6,500 years. Progressively younger shell deposits with less overburden are found proceeding southward from the delta (Figure 1 and Table 1). The area of favorable salinity and oyster shell deposition has rather uniformly shifted southward by a complex interaction of delta progradation, sedimentation, sea level rise, barrier formation and possibly an increase in rainfall. Oysters did not grow in the lower half of the bay until about 3,000 years ago and many of these reefs are still exposed with oysters growing on them. No extensive reefs formed in the upper half of the bay since about 4,000 B.P. The period between 4,000 and 3,000 B.P. when salinity favorable for oyster growth shifted from the upper half of the bay to the lower half is marked in the midbay by numerous multiple reef facets. The tops of the lower deposits are at about –6 meters MSL (ca. 4,000 B.P.) and the bottoms of the upper deposits are at about –4.6 (ca. 3,000 B.P.). Since oysters could not have grown in the lower bay if they had been exposed to the open Gulf, the barriers were well established and emergent by 3,000 B.P. However, an increase in runoff since 4,000 years ago which is suggested from the sedimentation rate could have strongly influenced oyster distribution and favored growth in the lower bay. Carbon-14 dates and depths of oyster shell deposits indicate that the salinity system within Mobile Bay has been fairly well balanced and somewhat similar to the present for the past 3,000 years with only a moderate reduction in favorable salinity conditions (freshening) in the middle bay due to delta progradation.

ARCHAEOLOGICAL RELATIONSHIPS

Dated occupation sites of aboriginal man are important indicators of the deposition and stability of coastal and deltic sediments. Knowledge of coastal Indians in Alabama dates only to 4,000 B.P. Correlations based on pottery sherds place several Alabama sites in the late Archaic (ca. 4,000 B.P.) and Early Woodland (ca. 3,000 B.P.) but few have been radiocarbon dated. Reports of C-14 dates from archaeological excavations in coastal Alabama, Louisiana, northwest Florida and Mississippi are given by Wimberly (1960), Lazarus (1965) and Otvos (1973). The earliest dated occupations range from 4,000 to 3,000 B.P. in surrounding states with 3,000 years or less more common. Trickey (1958) and Trickey and Holmes (1971) established a ceramic chronoligical framework for the Mobile Bay area. The river bottom sites tend to date late in the chronology with the earlier sites found on the periphery of the flood plain.

The Bryants Landing site in the upper Mobile Delta (Figure 1) has conflicting reports of supposedly the same C-14 date of 3,500 B. P. and 2,540 ± 200 B. P. reported by Wimberly (1960) and Lazarus (1965). More recent dates from the site range from 1,080 ± 150 to 4,100 ± 250 years (Trickey and Holmes, 1974). They interpreted the sites stratigraphy to indicate sea level oscillations, but there is no substantiative evidence in Alabama or elsewhere for a recent stand of sea level higher than its present position (Shephard, 1964).

Radiocarbon dates of clam or oyster shell from Dauphin Island middens and three other Mississippian Period middens in the delta (Figure 1) are reported in Table 2. Some of the sites

TABLE 2. Radiocarbon dates from Indian shell middens associated with Holocene sediments.

Sample No.	Location Figure 1	Description	Age In Years B.P.
I-7656A	USA Ba-2	**Rangia** 1 meter pit in midden 30 meters NW of Temple Mound	1,440 ± 85
I-7656B	USA Ba-2	**Rangia** 1 meter pit in Midden, base Temple Mound	1,440 ± 85
I-7141	USA Ba-2	**Rangia** 1 meter pit near Temple Mound	1,090 ± 85
I-7655	USA Ba-195	**Rangia** 1 meter in midden, Little Lizard Creek	2,520 ± 85
I-7539	USA Ba-194A	**Rangia** 1 meter pit in site, Maritime Administration, Blakeley River	1,150 ± 80
I-7654	USA MB-72	Oyster 1 meter above ground level in midden	360 ± 80
I-7658	USA MB-72	Oyster near ground level base of midden	515 ± 80
I-7657	USA MB-72	Oyster near ground level base of midden	550 ± 80
I-7142	USA MB-72	Oyster 1 meter pit top midden	520 ± 80

are probably older than these dates. The most significant to sedimentology is the date of 2,520 ± 85 B.P. from 1 meter deep in the Little Lizzard Creek site about one-half mile north of the I-65 crossing. The character of the site which forms a small but noticeable mound suggests little change in surroundings since the Early Woodland Period and very little subsidence.

Commercially dredged buried shell deposits in Mobile Bay only extend to about –11 meters below sea level and are not Indian middens since the basin was inundated at the time of their deposition. However it is possible that there are buried sites in the delta or at greater depths in the bay on the Pleistocene surface. Man was present in northern Alabama and other coastal states in the Paleo-Indian and Archaic periods over 8,000 years ago (Miller, 1957; Wormington, 1957; Williams and Stoltman, 1965). The coastal area and river valleys may very well have been inhabited when sea level was lower and evidence may lie buried in the sediments or seaward of the present coastline. Underwater sites over 5,000 years old have been located by diving off the coast of California (Shephard, 1964) and in a coastal spring in Florida which dated 10,200 ± 145 B.P. (W. A. Cockrell, personal communication).

TRACE METAL GEOCHEMISTRY

Subsurface trace metal concentrations in the bay sediments are stratified and increase with depth (Figure 5). Lowest levels are found in the upper 6 meters (ca. 1,500-4,000 B.P.). Concentrations increase between –6 and –9 meters (ca. 4,000-6,000 B.P.) and are at a higher level between –9 and –17 meters (ca. 6,000-9,500 B.P.). Concentration between –17 and –20 meters (ca. 9,500-10,000 B.P.) are similar to the –6 to –9 meter levels.

The stratification corresponds to differences in sediment particle size distribution and organic matter as a result of varying depositional environments of the sediments with depth. The sediments at the I-10 site are predominantly silty clay and sand-silt-clay. The sand facet overlying the Miocene clay

DEPTH IN METERS BELOW SEA LEVEL	ZINC			CADMIUM			CHROMIUM			LEAD			MERCURY		
	AVE	RANGE	N	AVE	RANGE	N	AVE	RANGE	N	AVE	RANGE	N	AVE	RANGE	N
0 to -6	31.4	16.4-86.8	20	.58	.2-1.6	20	13.4	5.8-41.5	20	8.7	2.0-24.1	20	.014	>.01-.03	18
-6 to -9	51.4	11.0-72.1	24	1.09	.3 5.6	24	22.2	3.2-31.1	24	15.8	4.1-26.7	24	.014	>.01-.03	23
-9 to -17	77.0	30.2-101.0	56	1.42	.3-9.5	56	32.1	18.4-41.7	56	25.8	9.3-43.3	56	.019	>.01-.05	56
-17 to -20	58.5	26.0-69.0	15	.73	.2-2.1	15	25.4	16.5-34.3	15	22.5	7.7-34.9	15	.019	>.01-.03	14

FIGURE 5. Subsurface trace metal concentrations with depth (ppm) from borings near the proposed Highway 90 - I-10 interchange (Figure 1).

was not analyzed. The clay minerals are remarkedly uniform with depth (Table 3). The upper 6 meters are loose and contain over 60 percent sand and about equal amounts of silt and clay with some humus. From –6 to –9 meters is a transition zone with the sediment becoming more consolidated. From –9 to about –14 meters the sediments are silt-clay with almost no sand. Between –14 and –17 meters there is abundant organic matter and about 40 percent sand. Below about –17 meters the sediment is stiff silt-clay with very little sand. The silt-clay sediments overlie several meters of river sand and pea gravel down to the hard Pleistocene surface. The Miocene clay consists of illite and kaolinite with lesser amounts of montmorillonite and chlorite (Riccio et al., 1972). Eleven borings in the undated hard clay from the west side of the Mobile River along I-65 contained an average of 36.1 ppm zinc, 0.25 ppm cadium, 10.4 ppm chromium, 17.7 ppm lead and 0.08 ppm mercury.

The adsorption capacity of sediment is well known. There is a definite relation between the percentage and kind of clay and the metallic concentrations. The cation exchange capacity of different sediment minerals vary greatly. The capacity of montmorillonite to adsorb metallic cations is about five times greater than illite and eighteen times greater than kaolinite which in turn is about five times greater than quartz (Nelson, 1962). Surface sediment types (Ryan, 1969) and trace metal concentrations vary areally within Mobile Bay and between various bays throughout the Gulf of Mexico (May, 1973).

The type of clay in sediments is a function of the clay minerals in the soils from which they were derived and the manner in which they were deposited. The Mobile River basin is currently supplying a clay mineral suit intermediate between the predominantly montmorillontic Mississippi River sediments to the west and the kaolinitic sediments of the eastward Apalachicola River (Griffin, 1962; Ryan, 1969). Montmorillonite composes about 47 percent of the clay mineral fraction with illite 22 percent and 29 percent kaolinite. Variable clay mineralogy with depth has been reported for borings from Mobile Bay (Ryan and Goodell, 1972) and in northwestern coastal Florida (Schnable and Goodell, 1968) but was not found in this study.

In addition to physical manner of

TABLE 3. Particular size distribution and clay mineral composition of Mobile Bay sediments at I-10.

Sample	Depth (m)	Particle Size Distribution[2] Sand 2-.05 mm	Silt .05-.002 mm	Clay .002 mm	Clay Mineralogy[1] Kaolinite	Montmorillonite	Illite
		%			%		
1	1.0	72.4	13.8	13.8	22	49	18
2	4.0	60.9	30.8	8.8	30	50	20
3	7.4	61.8	27.0	11.2	26	51	23
4	8.5	60.9	11.3	27.8	32	45	23
5	10.0	3.4	51.5	45.1	28	46	26
6	13.0	3.4	51.8	44.8	35	44	21
7	14.5	42.8	13.4	43.8	27	50	23
8	19.8	5.4	42.3	52.3	31	41	28

[1] Percent of clay fraction based on X-ray diffraction, DTA, and TGA
[2] Percent of total sediments

deposition, variations in pH, salinity, organic matter, gases, and many other factors influence the rate of uptake or exchange of metallic cations by sediment (Smith and Bader, 1960; Nelson, 1962; and Lee, 1970). Furthermore the chemical analyses may not represent the original composition of the sediment when it was deposited since pore water space is gradually replaced by secondary mineral accumulation in the dewatering and compaction process (Ho and Coleman, 1969). Variations in the degree of acid digestion in laboratory analyses can also influence values since some chemical forms are more tightly bound in sediment than others. Most of the trace metals in sediment cannot be normally measured by standard spectrophotometric techniques without prior treatment with acid (Cross, Duke and Willis, 1970) which partially attests to why basic estuarine sediments do not release significant amounts of cations when resuspended. In surface mud from Delaware Bay where illite and chlorite are the dominant clays, trace metals are reported at much higher levels than in Mobile Bay (Strom et al., 1973). This may be due to their use of more rigorous digestion procedures of sediment samples.

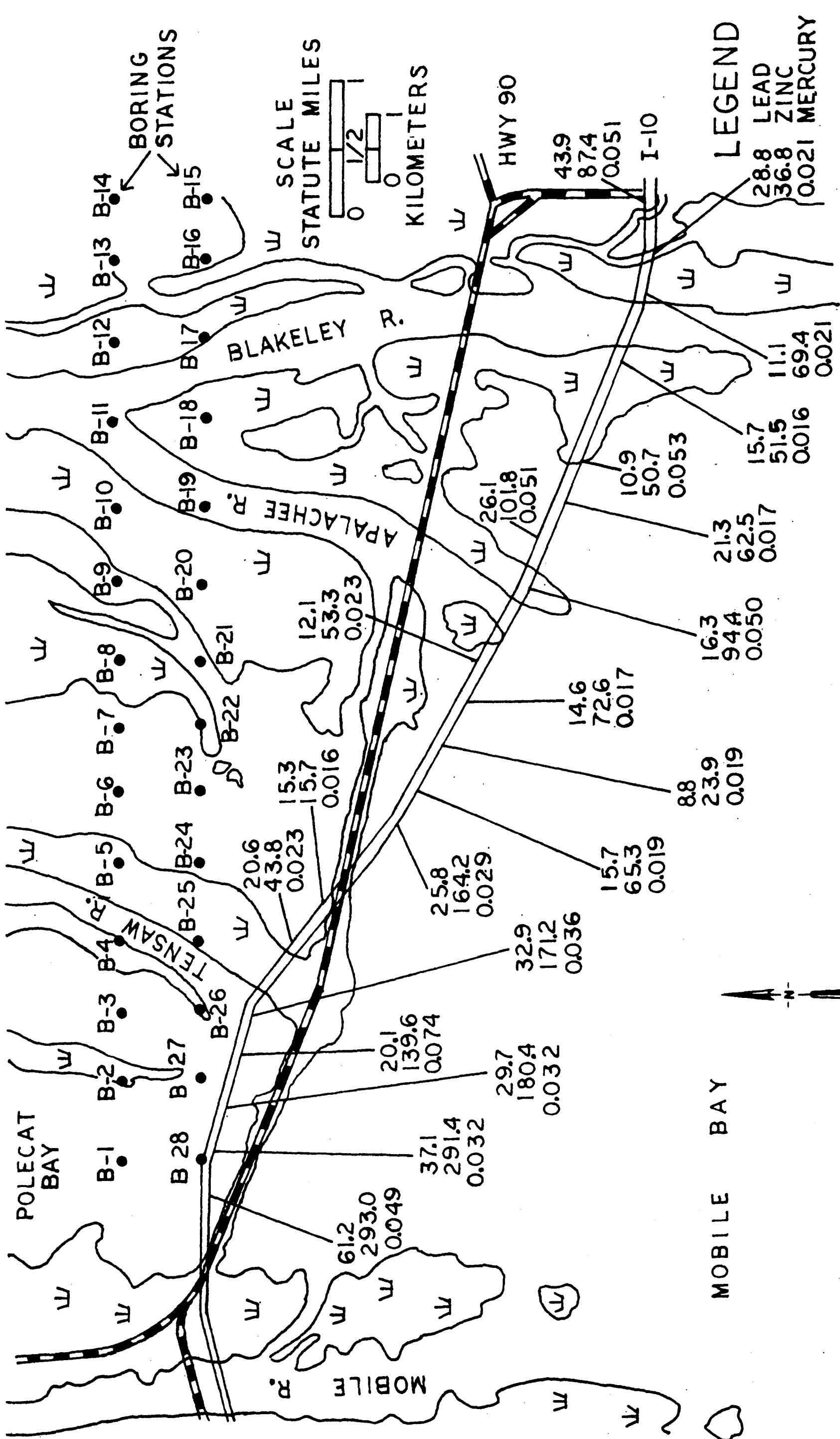
A relatively major source of heavy metal input by man near the delta front has been lead from automobile emissions but it has created no apparent environmental hazard. The Highway 90 causeway which crosses the lower delta near the I-10 site was opened to traffic in 1927. Estimates from continuous toll records indicate that approximately 200 million motor vehicles traveled the seven miles before 1974 and emitted about 93 tons of lead during the time lead has been widely used in gasoline. Like other metals, lead is rapidly adsorbed by sediment. About 75 percent of the 2.1 to 1.5 grams of lead per gallon of gasoline exits automobile exhaust mostly in the form of relatively soluble halid salts which are rapidly converted to less soluble forms in soil (Zimdahl and Arvik, 1973). Many studies cited by the above authors have reported decreases of lead in soil with distance from highways with the marked effect being limited to very near the highway and highest levels on the lee side from prevailing winds.

Lead concentrations in surface sediments east of the Tensaw River may be slightly higher near the causeway but not significantly so (Figure 6). All but one sample were below the 28.5 ppm average for surface sediment in the bay (May, 1973). The average concentration of lead east of the Tensaw River was slightly higher than the average for deeper sediment. Surface lead, zinc and mercury west of the Tensaw nearer the city of Mobile were higher than to the east. Mercury values were within the natural range but average lead and zinc concentrations were higher than in the open bay (May, 1973) or in the sediments with depth (Figure 5) which suggested that there may be an anthropogenic source for the higher levels. There is no evidence that metals at their present levels adversely affect the biota.

Very little of the lead in soils is in a form available for uptake by plants, and the highest levels found here are below those commonly found in soil (Zimdahl and Arvik, 1973). Lead in fish may be higher near an atmospheric pollution source (Alley, Brown and Kawasaki, 1974) and lead may be accumulated by mollusks when it is present in water (Chipman, Rice and Price, 1958).

Sediment dominates the reversible cycling of zinc and other metals in

FIGURE 6. Surface trace metal concentrations along the centerline of proposed I-10 mear the present delta front and locations of boring stations shown in Figure 3.



estuaries and smaller amounts of metals are recycled by the biota depending on the chemical form and aquatic concentration of the element (Wolf and Rice, 1972; Duke, Willis and Price, 1966). No relationship was found between sediment concentrations of trace metals and levels in aquatic animals (Cross, Duke and Willis, 1970). The presence of sediment reduces metal uptake by estuarine fishes (Hoss and Baptist, 1973). Sediment acts as a buffer on aquatic concentrations (Lee, 1970) and quickly removes excess cations from water (Duke, 1967). Biological uptake of metals is affected by the chemical state of the element in the water (Duke and Rice, 1966). Most metals in an oxidated state are insoluble. Some are limiting nutrients in estuaries (Fournier, 1966). The transfer of metals from sediment back to water is slight as shown by consistantly lower dissolved concentrations compared to levels in sediment (May, 1973).

Trace metals vary naturally depending on the watershed and the manner of deposition which influences sediment mineralogy. Aquatic and sediment concentrations can be increased by man's activity and conceivably pose a threat to biota at unusually high concentrations if in a biologically available form. However, it has not been demonstrated that natural levels of metals in estuarine sediment, even at high levels, have any harmful effect whether the sediment is left undisturbed or temporarily suspended by currents or man. Trace elements in sediment do not become dissolved into the water at high levels if at all as a result of resuspension of sediment by dredging regardless of sediment concentrations (Windom, 1972; May, 1973; 1974; Lee and Plumb, 1974).

Natural trace metals and other sediment components are frequently lumped with man-made pesticides as being sediment pollutants even though there is no evidence for their toxicity in sediment and several are biological essential nurtients. The assumption that the presence of stable isotopes of trace metals in sediment always represent pollution is unfounded. Even high concentrations cannot be qualified without knowledge of the composition of the sediment and a comparison of possible sources of contamination with other parts of the estuary. The essential role of many metals and organic matter in estuarine biological cycles leads to the belief that it would be best to develop a broader understanding of the role of sediment constituents in aquatic ecosystems and at least consider the present knowledge before sediments are declared by bureaucratical decree to be grossly polluted and unfit for man nor beast.

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ANALYSIS OF COMMERCIAL FISHERIES CATCH DATA FOR ALABAMA[1]

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INTRODUCTION

The commercial marine fishing industry of Alabama is located in Mobile and Baldwin counties. Most of the seafood is landed in Mobile County at Bayou La Batre which ranked as the tenth port in the nation in value of seafood landed during the last few years. Other Alabama ports include Mobile, Coden, Gulf Shores, Bon Secour, Alabama Port, Heron Bay and Fairhope.

The number of processing and wholesale seafood plants ranged between 56 and 71 during the period 1964 through 1971 (Table 1). The number of persons employed by these plants during this period doubled while the value of processed products tripled reaching $20.9 million in 1971.

The commercial landings have increased from 8,458,000 pounds in 1961 to 33,944,000 pounds in 1974, a four-fold increase (Table 2). During this period the dockside value of the seafood increased from $1,991,000 to $16,579,000, an eight-fold increase.

The economic value of the seafood industry to the local economy of south Alabama is estimated in excess of $70 million while the economic value to the state and nation exceeds $120 million.

The Alabama seafood industry is characterized by progress and expansion and the fishing fleet is among the most modern in the nation. The fishing fleet based in the two counties land seafood caught throughout the Gulf of Mexico from Florida to Texas and from as far away as the coast of Central America. Most of the catch, however, is from the offshore waters of Alabama westward to the mouth of the Mississippi River and from the estuarine waters of Alabama.

The number of fishermen engaged in the fishery between 1964 and 1971 ranged between 1,733 and 2,290 (Table 3). Most of the increase has been in the shrimp fishery while declines occurred in other fisheries.

The National Marine Fisheries Service (NMFS) has been collecting data which lists the catch by species from each specific water body and off-shore area. The following discussion is based on these data for the period 1964-1972 for Alabama waters and landings. Catch of a species from any body of water is a function of the size of the harvestable annual crop and the fishing effort directed toward harvest of that species. The annual harvestable crop of a species fluctuates from year to year depending primarily on the environmental conditions, but is essentially stable consistant with the fertility of that body of water.

A total of 106 species of fish and

[1] This study was done in cooperation with the U. S. Department of Commerce, N.O.A.A., National Marine Fisheries Service under P.L. 88-309 (Project Number 2-238-R).

TABLE 1. Summary of wholesale and processing plants and employment in Alabama for the period 1964-1971.[1]

	Processing			Wholesale			Total			(x 1000) Value Processed Products
		Employment Avg.			Employment Avg.			Employment Avg.		
Year	Plants	Season	Year	Plants	Season	Year	Plants	Season	Year	
1964	—	—	—	—	—	—	57	1,135	650	$ 7,434
1965	—	—	—	—	—	—	58	1,070	699	6,838
1966	—	—	—	—	—	—	66	1,343	820	9,613
1967	—	—	—	—	—	—	68	1,643	999	13,390
1968	—	—	—	—	—	—	71	1,726	1,013	15,373
1969	—	—	—	—	—	—	67	1,673	1,009	17,616
1970	43	1,383	875	13	423	186	56	1,806	1,061	20,575
1971	48	1,590	1,018	14	592	229	62	2,182	1,247	20,908

1 From **Fisheries Statistics of the United States**

TABLE 2. A summary of commercial fishes landed in Alabama during the period 1961-1974.[1]

	Quantity — Thousands of Pounds[2]								% Increase In Quantity From Previous Year	Thousands of Dollars[3]	% Increase In Value From Previous Year
Year	Shrimp	Oysters	Crabs	Red Snapper	Mullet	Flounder	Other	Total Pounds			
1961	3,525	509	838	1,784	897	98	807	8,458	—	1,991	—
1962	3,748	443	634	1,893	1,447	98	818	9,081	7.4	2,509	26.0
1963	7,760	995	1,297	2,315	1,390	107	1,024	14,888	63.9	3,714	48.0
1964	7,215	1,005	1,762	2,393	1,072	162	1,458	15,067	1.2	3,975	7.0
1965	9,624	492	1,812	2,495	1,508	301	1,556	17,789	18.1	4,986	25.4
1966	10,608	1,304	2,183	2,701	1,697	383	1,686	20,562	15.6	6,807	36.5
1967	14,456	2,088	2,353	2,288	3,169	480	1,578	26,412	28.4	8,300	21.9
1968	15,450	1,212	1,980	1,214	2,840	533	3,432	26,661	0.9	9,617	15.9
1969	14,977	481	1,920	1,163	3,193	540	6,242	28,547	7.1	10,557	9.8
1970	15,031	279	1,407	983	3,111	780	8,030	29,601	3.7	9,925	—6.0
1971	16,709	249	1,997	939	2,361	951	11,028	34,234	15.7	13,810	39.1
1972	17,548	1,069	1,612	1,051	1,513	1,169	12,080	36,042	5.3	17,728	28.4
1973	12,019	590	2,098	960	2,786	708	17,583	36,744	0.8	17,667	—0.3
1974	13,922	733	1,826	890	2,013	916	13,644	33,944	—7.6	16,579	—6.1

1 From **Alabama Landings**

2 Shrimp weights are heads-on weight, oyster weights are reported in pounds of oyster meat (8.75 pounds per gallon)

3 Dockside wholesale value

TABLE 3. Number of fishermen by gear operating in Alabama during the period 1964-1971.[1]

Year	Shrimp Trawls	Crab Pots	Gill Nets	Trammel Nets	Oyster Tongs	Oyster Dredges	Hand Lines	Fish Gigs	Crab Trot Lines	Long Lines	Haul Seines	Lobster Pots	Total[2]
1964	989	66	10	104	681	13	225	36	18	—	18	—	1,733
1965	1,075	60	10	94	756	7	230	50	14	—	15	—	1,854
1966	1,236	67	8	90	776	13	254	56	8	—	—	—	2,084
1967	1,291	85	6	89	795	13	211	44	—	—	4	—	2,130
1968	1,458	104	8	102	642	14	152	38	—	—	—	—	2,195
1969	1,539	85	18	117	639	13	145	47	—	—	—	—	2,290
1970	1,394	94	18	100	536	13	116	58	—	13	—	—	2,042
1971	1,401	88	18	95	459	13	126	45	—	—	—	5	1,958

[1] From **Fisheries Statistics of the United States**
[2] Exclusive of duplication

11 species of invertebrates are classified as commercial species in Alabama by Swingle (1971); however, only 36 species are consistantly landed for the commercial market in Alabama. Many of these, such as shrimp, flounders, and groupers, are grouped in the landing statistics of the National Marine Fisheries Service. For simplicity, these data are discussed under four major categories as shrimp fishery, finfish fishery, crab fishery and oyster fishery.

THE SHRIMP FISHERY

The shrimp fishery is the most important fishery economically. During recent years shrimp have accounted for one-half to one-third of the total pounds landed and about 80 to 85% of the dockside value of landings. In addition to the shrimp, the major portion of the finfish landings is taken by trawl.

Table 4 summarizes the shrimp catch landed in Alabama from estuarine and offshore areas. Nearly all the shrimp taken in Mobile Bay are landed in Alabama, whereas the majority of shrimp taken from Perdido Bay are landed in Florida. Alabama landings from Mississippi Sound (NMFS area from Mobile Bay to Gulfport Ship Channel) have declined from 45% of the total catch in 1964 to 19% in 1972, whereas Alabama's share of the offshore catch from statistical zones 10 and 11 (Figure 1) increased from 46% to 73% during the same period. Table 5 illustrates why this has occurred. The number of bay boats has substantially declined while the number of large offshore shrimp vessels has more than doubled. This also accounts for the increased catches from Louisiana and Florida waters.

The decreased catch from Mobile Bay appears to be related to changes in fishing effort (Table 6). Because of the

TABLE 4. Pounds (heads on) of shrimp caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile[1] Bay	Perdido Bay	Mississippi Sound	Little Lagoon	Offshore[2]	Florida	Louisiana	Mexico	Total Landings
1964	1,222,500 (100)	—	904,000 (45)	2,800	4,560,800 (46)	26,700	497,200	700[3]	7,214,700 (4)*
1965	1,085,600 (100)	—	955,500 (39)	23,500	6,903,400 (50)	181,700[4]	473,800	—	9,623,500 (5)
1966	1,027,800 (100)	—	1,007,700 (40)	6,400	7,094,500 (55)	13,300	1,458,000	500	10,608,200 (6)
1967	1,726,300 (100)	8,800 (100)	1,419,400 (30)	—	9,566,900 (67)	900	1,413,200	320,000[5]	14,455,500 (6)
1968	1,394,300 (100)	—	1,490,300 (30)	5,100	10,447,100 (62)	37,500	1,689,600	380,700	15,444,600 (8)
1969	954,300 (95)	—	930,800 (31)	—	11,284,600 (63)	—	1,622,700	178,300	14,970,700 (7)
1970	696,000 (96)	6,200 (31)	993,900 (28)	—	10,338,400 (62)	129,500	2,842,000	25,000	15,031,000 (7)
1971	543,200 (97)	5,100 (38)	914,900 (28)	—	12,938,900 (69)	78,500	2,229,700	2,500	16,712,800 (7)
1972	722,300 (98)	4,400 (10)	527,400 (20)	—	9,497,300 (73)	250,000	6,526,900	20,500	17,548,800
1973	[6]								12,018,700 [7]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] From off Texas (Zone 19)
[4] Includes 164,300# from Pensacola Bay
[5] From off Mexico
[6] Data on catch from specific waters not presently available
[7] Preliminary data subject to revision
* Percentage of total Gulf landings

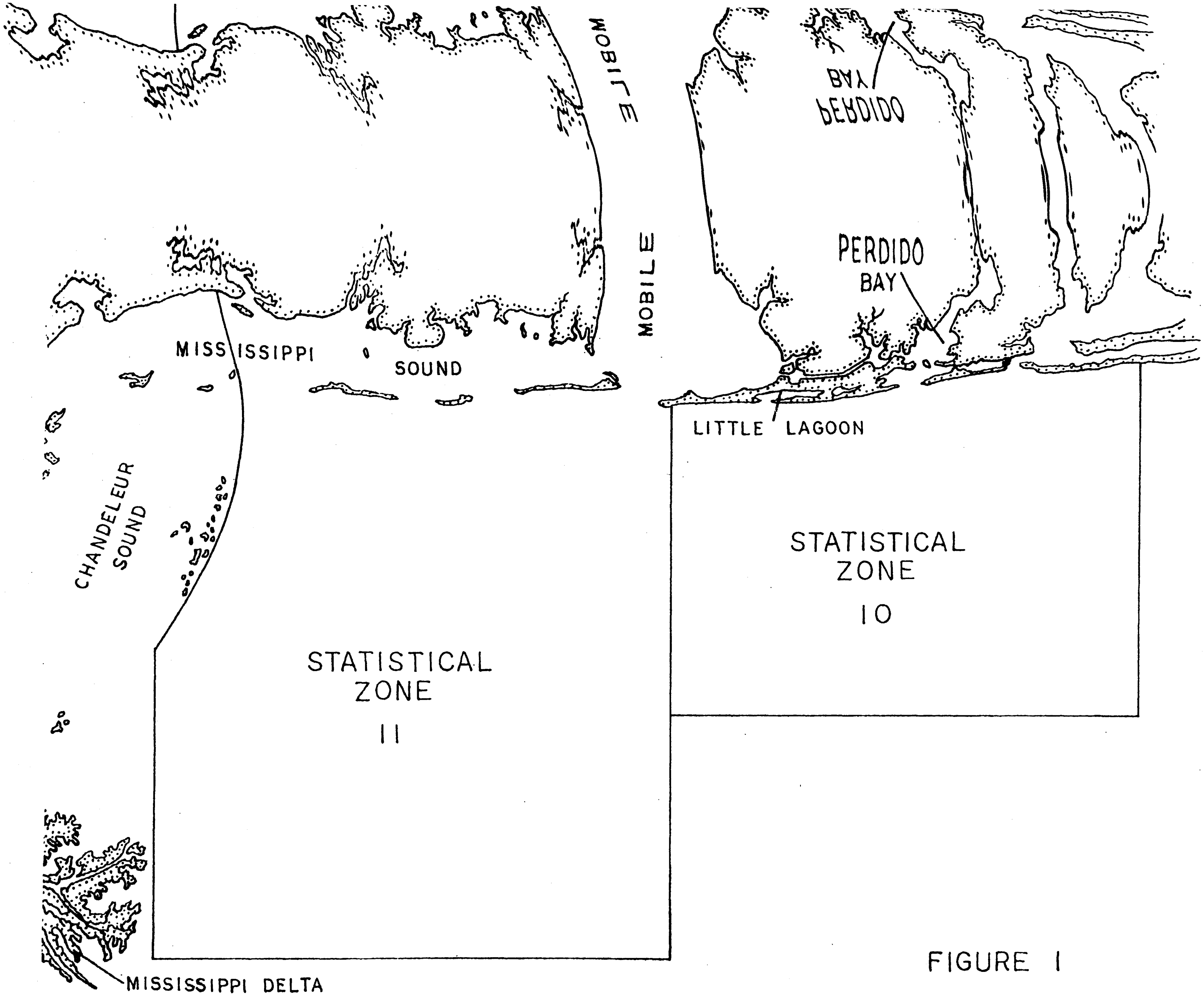
MOBILE
PERDIDO BAY
MOBILE
PERDIDO
BAY
MISSISSIPPI SOUND
LITTLE LAGOON
CHANDELEUR SOUND
STATISTICAL ZONE 10
STATISTICAL ZONE 11
MISSISSIPPI DELTA

FIGURE 1

TABLE 5. Number of Alabama shrimp fishermen and number of boats and vessels operating in Alabama during the period 1964-1971. (From **Fisheries Statistics of the United States.**)

Year	Shrimp Boats Under 5 Tons	Fishermen On Boats	Shrimp Vessels Over 5 Tons	Fishermen On Vessels	Vessel Gross Tonnage	Average Gross Tonnage of New Boats Added to Fleet
1964	231	380	230	582	8,225	35.7
1965	206	335	295	706	9,547	20.3
1966	203	311	366	882	14,050	63.3
1967	174	279	397	961	17,413	108.5
1968	139	227	467	1,164	23,718	90.1
1969	129	188	506	1,283	27,487	96.6
1970	149	174	448	1,143	24,904	—
1971	169	171	456	1,160	26,434	—

TABLE 6. Catch of shrimp and number of fishing trips by all fishermen in Mobile Bay during the period 1964-1972. (From **Gulf Coast Shrimp Data** published by National Marine Fisheries Service.)

Year	Catch (Lbs. Heads Off)	Percent Change From Previous Year	Number of Trips By Shrimp Boats	Percent Change From Previous Year	Average Catch Per Trip (Lbs. Heads Off)	Percent Change From Previous Year
1964	775,246	—	2,144.0	—	361.6	—
1965	683,913	—11.8%	2,158.8	+0.7%	316.9	—12.4%
1966	640,310	—6.4%	1,742.0	—19.4%	367.6	+16.0%
1967	1,080,067	+68.7%	2,247.0	+29.0%	480.7	+27.6%
1968	873,436	—19.1%	2,077.5	—7.5%	420.4	—12.5%
1969	632,929	—27.5%	2,112.0	+1.7%	299.7	—28.7%
1970	459,637	—27.4%	1,565.0	—25.9%	293.7	—2.0%
1971	353,970	—22.9%	975.0	—37.7%	363.0	+23.6%
1972	462,127	+30.6%	1,159.0	+18.9%	398.7	—9.8%
Average Yearly Percent Change		—2.0%		—5.0%	366.9	+2.7%

reduction in the number of bay boats the number of trips declined from 2,144 in 1964 to 1,159 in 1972. The catch declined by a yearly average of 2.0%, whereas the number of trips declined by an average of 5.0% yearly. The catch per trip increased by an average of 2.7% yearly. In addition, by the years 1972-74 sport trawlers were taking between 15 and 25% of the shrimp caught from the inshore waters of Alabama (Swingle, Bland and Tatum, 1976).

Brown shrimp (*Penaeus aztecus*) constituted by far the largest percentage of Alabama landings followed by white shrimp (*Penaeus setiferus*), pink shrimp (*Penaeus duorarum*), royal red shrimp (*Hymenopenaeus robustus*) and seabob (*Xiphopeneus kroyeri*) in decreasing order. Table 7 summarizes the pounds of each of these species caught from statistical zone 11. By comparing this table to Table 4 it is obvious that only a small portion of the offshore catch comes from statistical zone 10. This is particularly true of the more recent years. Mobile Bay is about the eastern limit of the productive shrimp grounds of the northern Gulf. White shrimp production is extremely variable ranging from about 1 million to 4 million pounds annually from zone 11 (Table 7). The same variability is characteristic of the catches from Mississippi Sound[2] (Table 8).

[2] Unless stated otherwise Mississippi Sound refers to the area of the sound between Mobile Bay and Gulfport Ship Channel.

TABLE 7. Pounds of the various species of shrimp (heads on) caught from Statistical Zone 11 by all fishermen and the catch and the percentage of the total catch landed in Alabama as compiled from the statistical records of the National Marine Fisheries Service.

Year	Brown	Pink	White	Royal Red	Sea Bob	Total Catch	Alabama Landings Catch	Alabama Landings Percent of Total Catch
1964	6,327,686	84,073	2,124,851	4,244	468	8,541,324	4,487,000	52.5%
1965	11,685,180	52,452	1,931,099	15,075	500	13,684,306	6,825,900	49.8%
1966	11,680,841	70,451	1,110,424	—	—	12,861,716	8,055,900	62.6%
1967	12,717,338	238,350	1,308,742	9,068	—	14,273,498	9,566,800	67.0%
1968	15,254,671	279,190	1,189,488	88,864	—	16,812,213	10,442,700	62.1%
1969	13,322,054	595,416	3,788,367	58,642	—	17,764,479	11,281,900	63.5%
1970	13,112,018	296,569	3,279,996	6,665	—	16,695,248	10,338,300	61.9%
1971	15,706,878	283,556	2,851,970	7,380	—	18,849,784	12,938,900	68.6%
1972	11,247,836	199,916	1,669,620	4,179	28,245	13,149,796	9,497,300	72.2%

TABLE 8. Pounds (heads on) of the various species of shrimp caught from Mississippi Sound[1] by all fishermen and the catch and the percentage of the total catch landed in Alabama as compiled from the statistical records of the National Marine Fisheries Service.

Year	Brown	Pink	White	Total	Alabama Landing Catch	Alabama Landing Percentage of Catch
1964	1,714,142	46,057	233,496	1,993,695	904,000	45.3
1965	2,166,958	2,124	299,870	2,468,952	955,500	38.7
1966	2,345,670	1,179	153,214	2,500,063	1,007,700	40.3
1967	4,338,694	27,731	363,152	4,729,577	1,419,400	30.0
1968	4,571,456	50,779	287,279	4,909,514	1,490,300	30.3
1969	2,453,234	46,416	549,923	3,049,573	930,800	30.5
1970	3,083,895	11,708	469,941	3,565,494	993,900	27.8
1971	3,039,535	13,955	216,502	3,269,992	914,900	27.9
1972	2,402,340	78,406	131,766	2,612,512	527,400	20.0

[1] Mobile Bay to Gulfport Ship Channel

There is some speculation that offshore trawling is hurting the spawning success of white shrimp in the near shore waters.

Alabama's percentage of the total Gulf shrimp landings increased from 4% in 1964 to 8% in 1968 and have remained at 7% since that time (Table 4). Since Alabama's landings more than doubled during this period, it indicates a substantial increase in the total Gulf landings through 1968 and then a more or less stabilized catch which probably approaches maximum sustainable yield. With the possible exception of white shrimp, there is little evidence to suggest that the stocks are being overexploited. It appears that a sufficient number of spawners from the brown shrimp populations are escaping capture so that there is presently little danger of overexploitation, particularly as the shrimp spawn within the year they are vulnerable to capture. At some point before the spawning population is seriously reduced it becomes uneconomical to harvest them. However, there does exist the possibility that if an extensive fishery develops for the offshore groundfish the incidental catch of brown shrimp could substantially reduce the spawning population. In this case, the economic restraint against catching the scattered brown shrimp spawners would be removed because the economics would depend on the success of the groundfish fishery.

By 1972, only 7% of the commercial shrimp landings were harvested from Alabama inshore or estuarine waters compared to 30% in 1964. The major increase in landings has been from the waters offshore of our coast and that of Mississippi and Louisiana.

THE FINFISH FISHERY

The fishery for finfish consists of three distinct major fisheries as classified by gear type. The trawl fishery is the largest producer and one in which many of the fish are caught incidental to shrimp harvest operations. The major exception is the croaker fishery in which trawls are fished specifically for this species with shrimp catches being incidental. The other two major fisheries are the gill-trammel net fishery and the handline fishery for snapper, grouper and jewfish.

The number of fishermen in the trawl fishery increased by 30% from 1964 through 1971 (Table 3). The major increases in finfish landings during this period came primarily from the offshore trawl fishery.

The number of participants in the gill-trammel net fishery have remained essentially stable over this period while the number of fishermen in the handline or snapper fishery have declined by 44% (Table 3). This decrease is primarily the result of the sale of the Bayou La Batre snapper fleet to a Mississippi firm in 1967.

Three other types of gear were used to take fish (Table 3). Gigs or spears were used to take flounder, haul seines were used to take several species from 1964 to 1967, and long lines were used to take swordfish in 1970. The fish from the latter operation were impounded by the Food and Drug Administration because of high mercury concentrations and swordfishing has been of minor importance in Alabama since that time.

Table 9 summarizes the catch of all fish from each of the estuarine areas and offshore for the period 1964 through 1972. The catches from Mobile Bay have been cyclic varying from 1 to 3 million pounds, whereas the catches from the Mobile Delta and Lit-

TABLE 9. Pounds of fish caught by Alabama fishermen from the coastal waters during the years 1964-1973 as compiled from the statistical records of the Natural Marine Fisheries Service.

Year	Mobile[1] Bay	Mobile Delta	Little Lagoon	Mississippi Sound	Offshore[2]	Louisiana	Other	Total Landings
1964	1,071,500	138,500	83,000	132,800	748,700	167,300	2,739,200[3]	5,081,000
1965	1,436,600	165,000	69,700	248,800	967,000	51,200	2,916,800[4]	5,855,100
1966	1,409,500	82,800	62,200	456,500	1,267,100	363,800	2,818,300[4]	6,460,200
1967	2,965,200	81,400	47,300	368,700	1,314,900	377,000	2,356,800[5]	7,511,300
1968	2,837,700	53,600	3,900	297,300	2,990,200	555,200	1,272,700[5]	8,010,600
1969	2,984,200	48,800	2,500	432,700	5,483,700	790,300	1,300,900[5]	11,043,100
1970	2,930,300	19,000	500	518,800	6,667,200	1,637,200	1,120,400[5]	12,893,200
1971	2,178,300	—	100	534,700	8,592,300	3,110,700	730,100[5]	15,146,200
1972	1,326,700	400	400	375,000	8,687,700	4,390,200	1,009,800[5]	15,790,200
1973	[6]							22,025,000[7]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Primarily snapper and grouper from Mexico
[4] Primarily snapper and grouper from Mexico and Central America
[5] Primarily snapper and grouper from Mexico, Texas and Central America
[6] Data for catches from specific locations are not presently available
[7] Preliminary data subject to revision

tle Lagoon have drastically declined as a result of decreased effort by commercial fishermen.

The delta was closed to commercial fishing for several years because of a "mercury scare" and commercial fishermen were forced to seek other employment. Little Lagoon is only periodically open to the sea and restrictive netting regulations, instituted at the request of sportfishermen and property owners, contributed to reduced fishing effort by commercial fishermen.

Catches of fish from offshore increased more than eight-fold reaching 8.7 million pounds by 1972. Catches from Louisiana waters increased from 167,300 pounds in 1964 to 4,390,200 pounds in 1972. Catches from both of these areas reflect primarily the increased landings of croaker.

The total landings of fish have increased from 5 million pounds in 1964 to 22 million pounds in 1973. These landings and areas of capture are discussed by species or species groups.

Atlantic croaker (Micropogon undulatus)

Alabama's catch of croaker has increased dramatically from 3,200 pounds or 4% of the total Gulf landings in 1964 to 8,383,800 pounds or 82% of the total Gulf landings in 1971 (Table 10). By 1973, the catch had reached 13.3 million pounds or about one-third of the total Alabama landings. This is a result of the development of a market for the Gulf croaker on the East Coast of the United States. The market developed in or about 1968 for croaker of one-half pound and larger (Gutherz et al., 1975).

Croaker are caught primarily from the offshore waters of Alabama, Mississippi and Louisiana. Some of Alabama's fleet fish almost exclusively for croaker, others fish for croaker when shrimp catches are poor, and a large number of croaker are caught while shrimping. The majority of large croaker caught in the inshore waters is by gill and trammel net. During 1971, 51% of the inshore catch were taken in entangling nets. The catch from

TABLE 10. Pounds of Atlantic croaker caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	1,500 (100)	—	1,200	400 (100)	100	3,200 (4)*
1965	2,400 (100)	1,500 (100)	—	11,200 (100)	—	15,100 (23)
1966	6,600 (100)	1,500 (47)	10,500	27,800 (29)	5,800	52,200 (17)
1967	4,200 (100)	10,800 (100)	500	67,100 (71)	21,800	104,400 (14)
1968	5,200 (100)	14,700 (100)	—	1,322,500 (97)	223,800	1,566,200 (46)
1969	13,900 (100)	2,300 (100)	—	3,236,400 (99)	434,700	3,687,300 (70)
1970	15,000 (100)	26,300 (100)	—	4,502,400 (98)	1,147,100	5,690,800 (77)
1971	23,200 (100)	24,800 (95)	—	6,217,100 (99)	2,117,600[5]	8,383,796 (82)
1972	12,000 (100)	6,200 (51)	—	6,378,500 (99)	3,047,800[6]	9,444,500
1973	[3]					13,299,500[4]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Data on catch from specific waters not presently available
[4] Preliminary data subject to revision
[5] Includes 500 pounds from Pensacola Bay
[6] Includes 3,500 pounds from Mexico
* Percentage of total Gulf landings

the inshore waters is negligible in comparison to the offshore catch; however, it has increased significantly since the market developed.

White seatrout (Cynoscion arenarius and C. nothus)

Most of the white seatrout landed in Alabama (Table 11) are *C. arenarius* which is the predominant species offshore. Alabama catch of white seatrout has increased from 33% of the total Gulf landings in 1964 to 63% in 1972. The catch was 1.5 million pounds in 1973. Catches from the offshore area and Louisiana have accounted for the increase in production. Almost all of the seatrout are taken by trawls during shrimping operations. Less than 1% was taken by gill or trammel nets during 1971. White seatrout ranks second in pounds of fish landed by Alabama fishermen.

Flounder (Paralichthys spp.)

The founders landed in Alabama are mostly *P. lethostigma* and *P. albigutta.* Alabama's landings of flounder increased from 18% of the total Gulf landings in 1964 to 43% in 1971 (Table 12). More than 95% of the flounder are caught in shrimp trawls. A negligible amount is caught in gill or trammel nets and as much as 4 to 5% are taken by fish gigs or spears at night.

Most of the flounders are caught offshore in zones 10 and 11. The second largest catch was taken off Louisiana west of the Mississippi River with catches from the three areas totaling as high as 1 million pounds. Catches from the inshore waters ranged from 25 to 80 thousand pounds.

Whiting (Menticirrhus spp.)

The whiting, kingfish or ground mullet landed in Alabama consist primarily of *M. littoralis* and *M. americanus.* Also included in the catch is *M. focaliger.*

Alabama's catch has ranged between 31 and 38% of the total Gulf landings with no significant changes in pounds landed (Table 13). The catch from Mo-

TABLE 11. Pounds of white seatrout caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	300 (100)	—	—	43,000 (72)	21,800[3]	65,100 (33)*
1965	2,600 (100)	1,700 (60)	—	81,300 (78)	22,400	108,000 (30)
1966	1,700 (100)	2,600 (40)	200	49,900 (30)	47,200	101,600 (19)
1967	2,600 (100)	7,900 (46)	—	108,900 (74)	29,900	149,300 (24)
1968	3,300 (100)	7,400 (45)	—	260,800 (92)	54,200	325,700 (37)
1969	3,800 (100)	6,900 (40)	—	710,300 (96)	95,000	816,000 (69)
1970	12,900 (100)	10,500 (64)	—	580,600 (92)	146,600	750,600 (60)
1971	14,600 (100)	17,400 (69)	—	718,400 (95)	229,600[6]	980,000 (63)
1972	9,800 (100)	2,800 (14)	—	624,900 (96)	298,700[7]	936,200
1973	[4]					1,522,460[5]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Includes 100 pounds from Florida waters
[4] Data on catch from specific waters not presently available
[5] Preliminary data subject to revision
[6] Includes 100 pounds from Pensacola Bay
[7] Includes 600 pounds from Mexico
* Percentage of total Gulf landings

TABLE 12. Pounds of flounder caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Perdido Bay	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	36,500 (100)	—	5,300 (35)	1,300	107,400 (72)	11,600[3]	162,100 (18)*
1965	36,700 (100)	—	15,500 (71)	5,500	237,400 (81)	5,700[3]	300,800 (25)
1966	20,800 (100)	—	16,200 (73)	2,500	331,800 (80)	112,100	483,400 (33)
1967	16,300 (100)	--	17,700 (61)	1,800	355,600 (84)	88,100	479,500 (34)
1968	13,300 (100)	—	11,700 (55)	3,800	428,500 (93)	75,700	533,000 (35)
1969	26,400 (100)	—	11,000 (51)	2,500	446,000 (88)	53,900	539,800 (35)
1970	52,300 (100)	100 (3)	25,900 (76)	500	560,000 (86)	141,900	780,700 (39)
1971	42,200 (100)	—	25,300 (62)	100	688,900 (94)	194,400	950,900 (43)
1972	30,300 (100)	700 (2)[7]	6,300 (30)	400	796,800 (94)	335,300[6]	1,169,800
1973	[4]						708,700[5]

1 Includes Bon Secour Bay
2 Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
3 Includes 100 pounds from Pensacola Bay
4 Data on catch from specific water not presently available
5 Preliminary data subject to revision
6 Includes 6,100 pounds from Mexico
7 Includes 600 pounds from Pensacola Bay
* Percentage of total Gulf landings

TABLE 13. Pounds of ground mullet or kingfish caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Perdido Bay	Mississippi Sound	Little Lagoon	Offshore[2]	Other[3]	Total Landings
1964	76,400 (100)	—	38,100 (46)	—	407,500 (61)	52,800	574,800 (31)*
1965	38,100 (100)	—	64,000 (66)	300 (100)	488,700 (70)	16,600	607,700 (32)
1966	32,100 (100)	—	51,200 (61)	—	433,000 (64)	152,200	668,500 (31)
1967	30,600 (100)	—	66,800 (53)	21,800 (100)	398,000 (76)	95,900	613,100 (28)
1968	39,100 (100)	—	59,700 (51)	—	512,400 (86)	89,400	700,500 (36)
1969	12,700 (100)	—	30,800 (42)	—	543,400 (81)	73,800	660,700 (38)
1970	19,600 (100)	200 (7)	42,200 (57)	—	412,000 (73)	90,900	564,900 (35)
1971	12,500 (100)	—	36,100 (52)	—	364,500 (78)	103,700	516,800 (33)
1972	15,700 (100)	100 (8)	22,900 (23)	—	364,600 (68)	154,800[6]	558,100
1973	[4]						532,200[5]

1 Includes Bon Secour Bay
2 Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
3 Over 99% from Louisiana waters
4 Data on catch from specific waters not presently available
5 Preliminary data subject to revision
6 Includes 200 pounds from Mexico
* Percentage of total Gulf landings

bile Bay has declined over the period 1964 through 1972. This is probably due to decreased shrimping effort (Table 6). Alabama boats take about 50 to 60% of the whiting caught from Mississippi Sound and about 70 to 80% of the offshore catch.

Sheepshead (Archosargus probatocephalus)

Alabama landings of sheepshead increased from 5% of the total Gulf landings in 1964 to 82% in 1971 (Table 14). By 1973, the landings had exceeded 500 thousand pounds. Catches from Mobile Bay and Mississippi Sound have remained essentially the same with the major portion of the increase in catch coming from the offshore area. Most of the catch was taken by shrimp trawl with less than 1,000 pounds taken by gill or trammel nets in 1971.

Gafftopsail catfish (Bagre marinus)

Alabama catches of catfish increased from 3% of the total Gulf landings in 1964 to 30% in 1971 (Table 15). The maximum poundage landed was 119,400 which occurred in 1970. Between 80 and 90% of the catch were taken by shrimp trawl with the remainder being caught in gill and trammel nets. Most of the catch was harvested offshore.

TABLE 14. Pounds of sheephead caught from the coastal waters by Alabama fishermen during the period 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	14,400 (100)	1,000 (6)	200	12,400 (54)	6,700	34,700 (5)*
1965	7,900 (100)	1,700 (30)	—	4,800 (53)	1,000	15,400 (3)
1966	3,300 (100)	2,500 (22)	—	4,900 (60)	900	11,600 (2)
1967	7,200 (100)	3,600 (9)	100	16,100 (86)	6,400	33,400 (5)
1968	13,300 (72)	7,400 (23)	—	39,600 (100)	7,900	68,200 (8)
1969	9,400 (86)	6,400 (28)	—	119,400 (94)	18,600	153,800 (13)
1970	9,800 (100)	3,500 (35)	—	140,500 (82)	28,100[3]	181,900 (20)
1971	9,700 (100)	11,100 (77)	—	207,200 (98)	92,600	320,600 (82)
1972	8,200 (100)	2,800 (41)	—	85,700 (88)	47,800	144,500
1973	[4]					532,200[5]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Includes 700 pounds caught in Florida
[4] Data on catch from specific waters not presently available
[5] Preliminary data subject to revision
* Percentage of total Gulf landings

TABLE 15. Pounds of gafftopsail catfish caught from the coastal waters by Alabama fishermen during the period 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Florida	Total Landings
1964	5,700 (100)	—	400	3,600 (20)	400	2,700	12,800 (3)*
1965	3,300 (100)	800 (10)	900	13,500 (40)	100	900	19,500 (6)
1966	5,100 (100)	3,000 (100)	—	15,600 (15)	4,400	300	28,400 (7)
1967	4,200 (100)	3,300 (46)	—	25,000 (46)	4,000	—	36,500 (7)
1968	9,900 (100)	3,600 (78)	—	30,400 (65)	6,900	—	50,800 (13)
1969	11,800 (100)	3,500 (70)	—	84,900 (87)	17,800	—	118,000 (28)
1970	12,400 (100)	8,000 (96)	—	81,300 (80)	17,600	100	119,400 (29)
1971	7,900 (100)	4,200 (84)	—	60,000 (59)	18,800	200[3]	91,100 (30)
1972	8,700 (100)	4,000 (100)	—	43,500 (50)	12,100	300[3]	68,600
1973	[4]						80,400[5]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] From Perdido Bay
[4] Data on catch from specific waters not presently available
[5] Preliminary data subject to revision
* Percentage of total Gulf landings

Spot (Leiostomus xanthurus)

Alabama landings of spot increased from 4% of the total Gulf landings in 1964 to 16% in 1971 (Table 16). By 1973, the landings had reached 191 thousand pounds. More than 60% were caught in shrimp trawls with most of the catch coming from offshore.

Cobia (Rachycentron canadus)

The cobia or ling is a choice game fish taken off the Alabama coast. Commercial landings of this species ranged from 100 pounds in 1964 to 14,500 pounds in 1972 (Table 16). All of the cobia landed from 1964 to 1971 were caught by trawl incidental to shrimping operations. Since cobia often feed on crabs this is not surprising.

Pompano (Trachinotus carolinus)

Few pompano are caught commercially. During the period 1964 through 1973 landings of pompano ranged from

TABLE 16. Pounds of spot caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Other	Total Landings
1964	9,400 (100)	—	4,100	200 (6)	—	13,700 (4)
1965	7,200 (100)	600 (50)	2,400	4,700 (78)	—	14,900 (4)
1966	4,800 (100)	600 (20)	20,100	1,400 (26)	200	27,100 (7)
1967	6,500 (100)	1,200 (80)	1,100	4,100 (84)	3,300	16,200 (5)
1968	9,600 (100)	4,900 (100)	100	27,500 (96)	3,700	45,700 (12)
1969	18,400 (100)	6,100 (92)	—	15,700 (94)	2,800	43,000 (12)
1970	14,100 (100)	4,200 (100)	—	20,500 (92)	4,800	43,600 (13)
1971	13,200 (100)	6,700 (78)	—	53,600 (98)	15,300	88,800 (16)
1972	11,000 (100)	4,600 (100)	—	66,200 (99)	18,800	100,600
1973	[3]					191,200[4]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Data on catch from specific waters not presently available
[4] Preliminary data subject to revision
* Percentage of total Gulf landings

TABLE 17. Pounds of ling or cobia caught from the coastal waters by Alabama fishermen during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Inshore	Offshore[1]	Louisiana	Other	Total Landings
1964	—	100 (8)	—	—	100
1965	—	300 (17)	—	—	300
1966	—	1,000 (5)	300	—	1,300 (3)*
1967	100	3,600 (81)	300	—	4,000 (10)
1968	—	11,200 (82)	1,100	—	12,300 (15)
1969	200	8,400 (82)	400	—	9,000 (13)
1970	—	11,000 (91)	1,900	100[2]	13,000 (12)
1971	—	7,100 (95)	800	—	7,900 (8)
1972	—	11,500 (95)	3,200	—	14,500
1973	[3]				14,000[4]

[1] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[2] From Mexico
[3] Data on catch from specific waters not presently available
[4] Preliminary data subject to revision
* Percentage of total Gulf landings

1,400 pounds to 13,300 pounds (Table 18). During 1971 about 80% of the pompano were caught in shrimp trawls with the remainder being caught in gill and trammel nets.

TABLE 18. Pounds of pompano caught from the coastal waters by Alabama fishermen during the period 1964-1973 as compiled from the statistical records of the National Marine Fisheries Service.

Year	Inshore	Offshore[1]	Louisiana	Landings
1964	300	1,300	—	1,600
1965	100	1,700	—	1,800
1966	—	1,300	100	1,400
1967	200	1,700	100	2,000
1968	200	1,800	500	2,500
1969	100	3,300	200	3,600
1970	—	2,000	100	2,100
1971	100	4,700	400	5,200
1972	200	3,500	800	4,500
1973	[2]			13,300[3]

[1] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[2] Data on catch from specific waters not presently available
[3] Preliminary data subject to revision

Red snapper (Lutjanus spp.)

Alabama landings of red snapper have declined from 18% of the total Gulf landings in 1964 to about 11% in 1971 (Table 19). This resulted primarily because the Bayou La Batre snapper fleet was sold to a Mississippi firm in 1967. In earlier years (1964-67) nearly all the snapper were taken from Mexico and Central America by the snapper fleet. More recently (1967-72) the fleet has shifted to fishing grounds off Texas and Louisiana and has continued with a more limited effort off Central America and Mexico.

Over the years a higher percentage of the catch has been taken by shrimp trawl. In 1964, 18,700 pounds of snapper were taken by trawls and by 1971 the poundage had increased to 181,600 pounds. An unknown amount is sold by anglers.

Groupers (Epinephelus spp. and Mycteroperca spp.)

Alabama landings of grouper have remained about 3 to 4% of the total Gulf landings (Table 20); however, the pounds landed have declined indicating an overall decline in Gulf landings. Nearly all grouper are caught with hand lines by the snapper fleet. In 1964, 600 pounds were taken by shrimp

TABLE 19. Pounds of red snapper caught by Alabama fishermen during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Offshore[1]	Inshore	Louisiana	Texas	Mexico	Central America	Total Landings
1964	72,500 (15)	—	1,800	—	2,318,600	—	2,392,900 (18)*
1965	88,600 (18)	—	5,600	—	2,269,500	131,300	2,495,000 (19)
1966	274,200 (46)	100	34,400	—	1,853,800	538,600	1,701,100 (14)
1967	267,800 (44)	300	30,300	234,700	1,512,900	242,400	2,288,400 (19)
1968	283,000 (51)	200	58,200	490,400	382,000	—	1,213,800 (11)[2]
1969	204,900 (40)	—	26,900	181,700	281,100	551,300	1,245,900 (13)
1970	204,900 (40)	—	43,200	297,200	285,100	152,800	983,200 (12)
1971	167,100 (35)	900	206,600	348,200	24,000	192,400	939,200 (11)
1972	186,100 (30)	—	153,100	393,800	305,500	12,000	1,050,500
1973	[3]						960,400[4]

[1] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[2] Bayou La Batre snapper fleet sold
[3] Data on catches from specific waters not presently available
[4] Preliminary data subject to revision
* Percentage of total Gulf landings

trawl and by 1971 the trawl catch had increased to only 6,900 pounds.

Jewfish (Epinephelus itajara)

In the years 1964 through 1966 the Alabama snapper fleet landed between 60 and 70% of all the jewfish caught from the Gulf of Mexico (Table 21). By 1971, the catch had declined to 22% of the Gulf landings. All of the fish were caught by hand lines.

Mullet (Mugil cephalus)

M. curema does occur occasionally in the catch. Mullet is the mainstay of the trammel net fishery. The number of fishermen has been essentially stable at about 100 over the period 1964 through 1971 (Table 3).

Alabama landings of mullet increased from 3% of the total Gulf landings in 1964 to 9% in 1971 (Table 22). During many years more mullet are avail-

TABLE 20. Pounds of grouper caught by Alabama fishermen during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Offshore[1]	Inshore	Louisiana	Texas	Mexico	Central America	Total Landing
1964	4,100 (3)	—	100	—	300,300	—	304,500 (4)*
1965	4,000 (3)	—	100	—	269,900	14,500	388,500 (4)
1966	39,300 (37)	400	500	—	321,200	21,400	382,800 (5)
1967	21,200 (25)	—	300	33,700	253,200	9,800	318,200 (5)
1968	12,300 (25)	—	1,000	160,800	131,900	—	306,000 (4)[2]
1969	8,000 (10)	—	300	67,300	62,000	111,200	247,400 (3)
1970	11,700 (14)	—	900	152,700	71,700	28,500	265,500 (4)
1971	7,500 (8)	—	50,800	85,000	2,300	34,400	180,000 (3)
1972	7,100 (6)	—	21,000	135,500	64,000	1,200	228,800
1973	[3]						197,700[4]

[1] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[2] Snapper fleet based in Bayou La Batre sold to Pascagoula, Mississippi firm
[3] Data on catch from specific waters not presently available
[4] Preliminary data subject to revision
* Percentage of total Gulf landings

TABLE 21. Pounds of jewfish caught by Alabama fishermen from the coastal waters during the period 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Offshore[1]	Louisiana	Texas	Mexico	Central America	Total Landings
1964	1,900 (95)	—	—	116,500	—	118,400 (57)*
1965	3,800 (100)	200	—	125,800	4,400	134,200 (68)
1966	12,600 (95)	5,000	—	80,200	2,500	100,300 (70)
1967	6,700 (100)	200	2,100	67,500	—	76,500 (53)
1968	6,200 (94)	1,800	62,500	45,100	—	115,600 (54)
1969	3,300 (100)	300	39,400	—	6,900	49,900 (32)
1970	6,600 (100)	400	37,400	28,900	—	73,300 (35)
1971	2,700 (96)	13,100	21,500	3,000	1,200	41,500 (22)
1972	4,400 (100)	9,200	43,900	22,500	—	80,000
1973	[2]					59,200[3]

[1] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[2] Data on catch from specific waters not presently available
[3] Preliminary data subject to revision
* Percentage of total Gulf landings

able than can be sold locally and the price paid to the fisherman has dropped as low as $0.03 per pound. Because of this it is difficult to evaluate whether the fluctuations in catch are due to environmental conditions or economic conditions.

Alabama fishermen caught nearly all the mullet taken from Mobile Bay and up to 85% of those landed from Mississippi Sound. Very few mullet were caught from offshore. Total landings have fluctuated between 1 and 3 million pounds annually (Table 22). Mullet were taken almost exclusively by trammel net with a small amount being taken by gill net (700 pounds in 1971) and even a smaller amount taken by trawl.

Spotted seatrout (Cynoscion nebulosus)

Spotted or speckled trout are considered the leading sport fish in the inshore waters of Alabama. Some sportsmen feel that commercial net fishermen are taking ever increasing numbers of speckled trout from Alabama waters. However, Table 3 indicates that the number of net fishermen has remained relatively stable over the period 1964 through 1971. Table 23

TABLE 22. Pounds of mullet caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	874,200 (100)	81,700 (32)	67,200	4,400 (3)	44,500	1,072,000 (3)*
1965	1,292,900 (100)	156,000 (55)	57,500	2,100 (1)	—	1,508,500 (5)
1966	1,295,800 (100)	369,500 (49)	27,700	3,500 (1)	300	1,696,800 (6)
1967	2,861,900 (76)	231,600 (25)	21,600	9,300 (6)	45,200	3,169,600 (11)
1968	2,676,100 (84)	156,300 (30)	—	2,500 (2)	5,000	2,839,900 (12)
1969	2,831,900 (97)	347,100 (69)	—	8,400 (14)	1,100	3,188,500 (11)
1970	2,722,300 (99)	385,400 (85)	—	2,500 (1)	1,300	3,111,500 (12)
1971	1,974,500 (100)	384,200 (83)	—	1,200 (1)	1,200	2,361,100 (9)
1972	1,176,500 (100)	308,300 (76)	—	11,100 (5)	17,400	1,513,300
1973	[3]					2,785,703[4]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Data on catch from specific waters not presently available
[4] Preliminary data subject to revision * Percentage of total Gulf landings

TABLE 23. Pounds of spotted seatrout caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Perdido Bay	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	33,200 (100)	—	4,000 (7)	7,400	5,300 (56)	14,700	64,600 (1)*
1965	38,800 (100)	—	6,700 (33)	2,700	5,600 (36)	—	53,800 (1)
1966	31,600 (100)	—	7,000 (27)	700	8,200 (55)	—	47,500 (1)
1967	20,500 (98)	—	21,000 (24)	200	4,600 (60)	44,600	90,900 (2)
1968	52,100 (90)	—	25,700 (29)	100	4,800 (53)	18,100	100,800 (2)
1969	48,800 (97)	—	15,900 (38)	—	2,900 (43)	30,800	98,400 (2)
1970	64,900 (100)	—	11,400 (34)	—	7,000 (72)	1,200	81,500 (2)
1971	59,400 (100)	—	22,300 (69)	—	12,300 (28)	43,300	137,300 (3)
1972	34,200 (100)	200 (4)	14,300 (66)	—	7,700 (75)	163,800	220,200
1973	[3]						351,600[4]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Data on catch from specific waters not presently available
[4] Preliminary data subject to revision
* Percentage of total Gulf landings

shows that the catch did not increase substantially until 1971 when the commercial fishermen began to fish extensively in Louisiana waters. By 1972, 74% of Alabama's landings were caught from Louisiana waters.

Alabama commercial landings increased from 1% of the total Gulf landings in 1964 to 3% in 1971 (Table 23). Catches from Mobile Bay have ranged from 20,500 pounds to 64,000 pounds. Alabama's percentage of the catch from Mississippi Sound increased from 7% in 1964 to 66% in 1972. The offshore catches have ranged from 2,900 pounds to 12,300 pounds.

Table 24 summarizes the catch of speckled trout by gear. Trammel nets are responsible for the majority of the catch, which ranged from 33,800 pounds to 120,000 pounds. Trammel nets are also used to catch mullet and many speckled trout are caught incidental to this fishery. Nets are fished specifically for speckled trout during certain periods of the year.

TABLE 24. Catch of spotted seatrout (pounds)by gear during the period 1964-1974.[1]

Year	Trawl	Gill Net	Trammel Net	Hook & Line	Haul Seines
1964	400	—	43,000	10,500	10,700
1965	—	100	44,000	9,700	—
1966	300	1,300	33,800	12,100	—
1967	200	1,000	85,200	4,400	100
1968	100	—	94,600	6,100	—
1969	300	16,100	81,600	400	—
1970	2,700	300	76,900	4,600	—
1971	2,900	9,000	120,000	5,400	—

[1] From **Fisheries Statistics of the United States**

Fish taken by anglers was second in pounds harvested after trammel nets. Angling catches ranged from 400 pounds to 12,100 pounds. Gill net catches ranged from zero to 16,100 pounds. Catches by trawl increased significantly in 1970 and 1971.

Data on the sport fishery catches of speckled trout and other marine game fish are being collected for Alabama waters during 1975 (P.L. 88-309, Project 2-251-R). These data will be available in 1976.

TABLE 25. Pounds of Spanish mackeral caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Perdido Bay	Mississippi Sound	Little Lagoon	Offshore[2]	Other	Total Landings
1964	1,000 (100)	—	—	100	73,000 (26)	—	74,100 (2)*
1965	900 (100)	—	—	100	13,300 (7)	—	14,300 (.3)
1966	700 (100)	—	100 (100)	—	52,900 (16)	300	54,000 (.8)
1967	3,000 (100)	—	—	—	19,200 (6)	3,000	25,200 (.4)
1968	4,600 (100)	—	2,000 (29)	—	31,200 (11)	900	38,700 (.5)
1969	1,200 (100)	—	500 (19)	—	79,600 (30)	3,900	85,200 (1)
1970	1,000 (100)	—	300 (100)	—	56,400 (25)	68,200[3]	125,900 (1)
1971	1,000 (100)	100 (100)	200 (50)	—	38,200 (36)	16,300[4]	55,800 (.7)
1972	1,600 (100)	—	—	—	22,300 (20)	66,900[4]	90,800
1973	[5]						75,900[6]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Mainly from Texas
[4] From Louisiana waters
[5] Data on catch from specific waters not presently available
[6] Preliminary data subject to revision
* Percentage of total Gulf landings

Spanish mackerel (Scomberomorus maculatus)

Spanish mackerel are also considered a choice game fish by the offshore fishermen. Alabama's commercial landings of spanish mackerel have decreased from 2% of the total Gulf landings in 1964 to 0.7% in 1971 (Table 25). The total landings increased from 74 thousand pounds in 1964 to 126 thousand pounds in 1970 and then decreased to 76 thousand pounds in 1973. The catches were primarily from offshore.

Gill nets are the most effective gear used in the mackerel fishery (Table 26). Catches with gill nets ranged from 2,600 pounds to 54,600 pounds. The catch of mackerel by trawls increased from 200 pounds in 1964 to 28,600 pounds in 1971. The angling and handline catch entering the commercial landings ranged from 100 pounds to 64,800 pounds. The catches by trammel nets were small and probably incidental to their use in other fisheries.

TABLE 26. Pounds of spanish mackerel caught by each type of gear during the period 1964-1971.[1]

Year	Trawl	Gill Net	Trammel Net	Haul Seine	Hook & Line
1964	200	11,300	900	60,900	800
1965	2,500	2,600	800	6,900	1,500
1966	2,300	50,900	600	—	200
1967	11,200	7,100	3,200	3,600	100
1968	14,000	19,200	5,400	—	100
1969	29,500	54,600	1,000	—	100
1970	25,100	34,800	1,200	—	64,800
1971	28,600	25,200	1,500	—	500

[1] From **Fisheries Statistics of the United States**

Red drum (Sciaenops ocellata)

The commercial catches of red drum or redfish have increased from 19,300 in 1964 to 172,200 pounds in 1973 (Table 27). The significant increases in catch occurred in 1972 and 1973. The catch from Alabama inshore waters has declined or remained about stable and increases have been from offshore and Louisiana waters. Most of the redfish taken commercially are caught by nets and the remainder by hook and line.

TABLE 27. Pounds of redfish or red drum caught from the coastal waters by Alabama fishermen during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Other	Total Landings
1964	8,000 (100)	1,100 (6)	400	1,000 (30)	8,800[3]	19,300 (1)*
1965	2,700 (100)	300 (4)	100	600 (55)	—	3,700 (.2)
1966	2,100 (100)	1,500 (12)	300	2,200 (67)	—	6,100 (.3)
1967	2,600 (56)	2,400 (4)	—	2,200 (76)	2,000[4]	9,200 (.4)
1968	4,100 (44)	2,100 (4)	—	7,500 (100)	2,700[4]	16,400 (.6)
1969	2,200 (69)	900 (8)	—	36,500 (88)	13,700[4]	53,300 (2)
1970	2,100 (100)	600 (7)	—	27,000 (69)	5,500[4]	35,200 (1)
1971	2,500 (100)	1,500 (32)	—	17,900 (92)	9,800[4]	31,700 (.9)
1972	5,400 (100)	1,700 (33)	—	43,100 (88)	26,800[4]	77,000
1973	[5]					172,200[6]

[1] Includes Bon Secour Bay
[2] NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] From Louisiana and 100 lbs. from Texas
[4] From Louisiana
[5] Data on catch from specific waters not presently available
[6] Preliminary data subject to revision
* Percentage of total Gulf landings

Black drum (Pogonias cromis)

Alabama landings of black drum increased from 1% of the total Gulf landings in 1964 to 2% in 1971 (Table 28). Inshore catches have been stable to declining. Offshore catches have increased significantly ranging from 700 to 29,100 pounds. While most of the drum are taken by trammel nets, a fairly high percentage have been taken by trawl in recent years. In 1971, the percentages were 54% by trammel nets and 45% by trawls as compared to 73% by trammel nets and 9% by trawls during 1964.

Bluefish (Pomatomus saltatrix)

Alabama landings of bluefish increased from 11,000 pounds in 1964 to 27,100 pounds in 1973 (Table 29). Most of the catch was taken by gill nets although in recent years up to 25% of the catch was from trawls.

TABLE 28. Pounds of black drum caught from the coastal waters by Alabama fishermen during the period 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	10,000 (100)	1,100 (9)	400	700 (18)	5,100	17,300 (1)*
1965	2,300 (100)	—	—	800 (53)	—	3,100
1966	1,900 (100)	200 (2)	200	1,800 (78)	300	4,400
1967	3,300 (100)	1,900 (8)	200	1,000 (40)	1,200	7,600
1968	5,400 (47)	1,700 (7)	—	5,600 (100)	3,800	16,500 (1)
1969	3,200 (56)	800 (13)	—	29,100 (82)	9,400	42,500 (3)
1970	3,500 (100)	400 (7)	—	16,900 (39)	3,200	24,000 (2)
1971	8,300 (100)	800 (80)	—	11,700 (90)	10,400	31,200 (2)
1972	3,400 (100)	600 (100)	—	16,100 (98)	23,800	43,900
1973	[3]					79,400[4]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Data on catch from specific waters not presently available
[4] Preliminary data subject to revision
* Percentage of total Gulf landings

TABLE 29. Pounds of bluefish caught from the coastal waters by Alabama fishermen during the period 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	600 (100)	500 (10)	300	9,600 (20)	—	11,000 (1)*
1965	700 (100)	—	100	4,600 (4)	—	5,400
1966	2,800 (100)	100 (0.6)	—	5,700 (6)	—	8,600 (1)
1967	100 (100)	500 (5)	—	2,000 (3)	500	3,700
1968	1,000 (100)	—	—	2,400 (2)	500	3,900
1969	400 (100)	300 (5)	—	22,500 (35)	8,400	31,600 (5)
1970	400 (100)	100 (100)	—	20,800 (32)	600	21,900 (3)
1971	900 (100)	—	—	11,400 (32)	600	12,900 (2)
1972	1,700 (100)	500 (20)	—	14,600 (20)	5,500	22,300
1973	[3]					27,100[4]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] Data on catch from specific waters not presently available
[4] Preliminary data subject to revision
* Percentage of total Gulf landings

THE OYSTER FISHERY

May (1971) described the oyster fishery, the oyster resources and mapped the reefs. Oyster production in Alabama is very cyclic because of the unique environmental fluctuations associated with Mobile Bay and the drainage system (Table 2). Mobile Bay receives the fourth largest river discharge in the United States which drastically alters the salinity levels on the reefs (Crance, 1971) and periodically results in mortalities (May, 1972). During 1973, more than 44.8 million oysters were killed by floodwaters.

Mobile Bay also has the "jubilee" phenomenon that periodically results in low dissolved oxygen in the bottom waters affecting spawning success and periodically killing the oysters on the reefs in the middle of the bay (May, 1973). This is caused by large depressions in the bottom which resulted largely from submerged dikes created by shoaling and spoil material left from construction of navigation channels. Water in these depressions stratify and the dissolved oxygen becomes deficient in large areas over the bottom. Periodically this water mass with low dissolved oxygen moves over the upper reefs killing oysters. This occurred in 1968 and 1971 on Klondike and Point Clear Reefs.

The catch statistics from the reefs (Table 30) are further complicated by the extended closures of the reefs as a result of high coliform bacteria levels. In 1973, for example, the reefs were closed from the first week in January to the first week in June. The total catch shown in Table 30 represents a 4-month fishing effort in September through December.

During the period 1964 through 1972, the catch from Mobile Bay was the lowest in 1965 when only 20,900 pounds were harvested (Table 30). The largest harvest occurred in 1967 when the previous administration of the Marine Resources Division allowed undersized oysters to be taken for the canning factories in Mississippi. In addition to the 2 million pounds of meats landed in Alabama that year, approximately 1.3 million pounds were landed in Mississippi which is the highest harvest on record since statistics were first tak-

TABLE 30. Pounds (meats) of oysters caught by Alabama fishermen from the coastal waters during the years 1964-1973 as compiled from the statistical records of the National Marine Fisheries Service.

Year	Mobile Bay	Bon Secour Bay	Mississippi Sound	Other Locations	Total Landings
1964	349,400	129,800	526,100	—	1,005,300
1965	20,900	179,800	291,700	—	492,400
1966	236,700	232,700	831,700	3,400[2]	1,304,500
1967	663,600	266,200	1,157,600	—	2,087,400[4]
1968	275,200	214,100	722,500	—	1,211,800
1969	71,500	191,500	289,200	—	552,200
1970	42,300	56,100	181,000	—	279,400
1971	52,500	23,200	173,800	—	249,400
1972	239,200	10,000	820,300	—	1,069,500
1973	[3]				590,118[5]

1 Alabama waters
2 From Graveline Bay, Mississippi
3 Data on catch from specific waters not presently available
4 An dditional 1.3 million pounds were landed in Mississippi from Alabama reefs
5 Preliminary data subject to revision

en in 1880. Harvesting undersized oysters was apparently a mistake as the following annual harvests suffered as a result. Whitehouse Reef has not been productive since that time and Buoy and Kings Bayou reefs have been poor producers.

The catch trend was approximately the same for Mississippi Sound and Mobile Bay because the major productive reef, Cedar Point Reef, lies in both bodies of water (Table 30). Bon Secour Bay which is the southeast corner of Mobile Bay has most of the private oyster bottoms. Catches from these bottoms have significantly declined because there has been almost no seed oysters (small oysters transferred from public reefs) available for private beds since 1967-68 with the exception of 3,400 barrels in 1971. Table 31 lists the pounds and percentages of the total landings caught from private beds during 1964-72.

TABLE 31. Pounds and percentage of the total landings of oysters caught from private beds during the period 1964-1972.

		Private Beds	
Year	Total Landings	Pounds	Percentage
1964	1,005,300	74,600	7.4
1965	492,400	62,000	12.6
1966	1,304,500	111,000	8.5
1967	2,087,400	117,600	5.6
1968	1,211,800	116,200	9.6
1969	552,200	82,800	14,9
1970	279,400	33,800	12.1
1971	249,400	13,600	5.5
1972	1,069,500	3,600	0.3
Average	916,877	68,356	7.4

Freshwater flows and low oxygen in some areas resulted in poor or no spat set during 1968 through 1971 with the exception of July 1970. This set was responsible for producing the oysters harvested in 1972 and 1973. The poor spat sets and closure of the reefs for 171 days resulted in the harvest of 1971 being the smallest on record.

The spring and summer of 1972 were very dry periods and thus the salinity was higher in the estuarine areas which resulted in the best spat set in years. The 382,419 Alabama barrels (69,531 yd^3) of shell planted by the state between 1968 and 1972 had good spat set; however, extended floodwaters during 1973 resulted in the mortality of most of these young oysters.

Spat set in Bon Secour Bay has always been low, but in recent years it has almost been nonexistant (Hoese, Nelson and Beckert, 1972). Even in 1972 when good spat set occurred in Mobile Bay and Mississippi Sound, spat set did not occur in Bon Secour Bay.

A history of Alabama's oyster industry and management was compiled by Swingle and Hughes (1976). Table 3 shows the number of participants in the fishery which has declined in recent years. The oyster harvest will continue to be cyclic due to environmental conditions. However, production can be increased by a continuing program of shell planting and good management and by efforts to develop better criteria for closing shellfish harvesting areas to protect the public health.

THE CRAB FISHERY

Alabama's catch of blue crabs *(Callinectes sapidus)* has ranged between 4 and 8% of the total Gulf landings (Table 32). Catches from Mobile Bay have ranged between 534 thousand pounds in 1970 and 991 thousand pounds in 1968. Total state landings ranged between 1.4 million pounds and 2.3 million pounds. Alabama fishermen take about one-half of all the crabs harvested from Mississippi Sound. The offshore catch increased significantly in 1971 (Table 32) as did the inshore and offshore catches by trawl although the majority of catch was taken by crab pot or trap (Table 33). Prior to 1960, most of the catch was taken by baited trotline; however, this method of harvest was discontinued in 1966. The number of pot fishermen and number of pots have varied considerably over the period 1964-1971; however, despite recent declines both the numbers of pots and fishermen remained significantly higher in 1971 than in 1964. The catch per unit effort (pounds per pot) was highest in 1964 at 275 pounds per pot annually. By 1970, the annual catch per pot had declined to about 1/3 this amount. These data indicate that the fishery is near or at the maximum sustainable yield; however, the interpretation of the landing statistics are complicated by the fact that occasionally in recent years more crabs are caught than can be processed. Mechanized crab processing is needed in the industry.

Stone crabs *(Menippe mercenaria)* are taken only occasionally and do not enter the commercial crab fishery.

Squid (Lolliguncula brevis)

Occasionally, *Loligo pealei* is included in the catch. All squid were caught by trawl. Those 3-6 inches in length are

TABLE 32. Pounds (live weight) of blue crabs caught by Alabama fishermen from the coastal waters during the years 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay	Bon Secour Bay	Mississippi Sound*	Offshore[1]	Other Locations	Total Landings
1964	613,700 (100)	25,800 (100)	1,018,500 (48)	103,700 (100)	—	1,701,700 (7)**
1965	674,700 (100)	36,800 (100)	1,093,300 (41)	7,300 (25)	100[2]	1,812,200 (5)
1966	728,300 (100)	105,000 (100)	1,344,000 (55)	5,100 (10)	200[3]	2,182,600 (7)
1967	962,400 (100)	126,800 (100)	1,243,100 (60)	3,900 (100)	17,200[4]	2,353,400 (9)
1968	991,000 (97)	3,300 (100)	971,300 (53)	9,000 (100)	—	1,979,600 (8)
1969	679,900 (100)	102,700 (100)	1,105,500 (41)	31,900 (80)	—	1,920,000 (6)
1970	534,900 (100)	52,000 (100)	818,700 (30)	1,700 (7)	—	1,407,300 (4)
1971	643,400 (100)	7,500 (100)	1,105,400 (51)	240,300 (90)	—	1,996,600 (6)
1972	596,000 (100)	8,000 (100)	951,300 (50)	52,000 (100)	5,300[5]	1,612,600
1973	[6]					2,098,500[7]

[1] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[2] From Little Lagoon, Alabama
[3] From Pensacola Bay, Florida and Louisiana coast
[4] From Perdido Bay (300#), Little Lagoon (15,000#) and Chandeleur Sound, Louisiana
[5] From Perdido Bay
[6] Data for catch from specific waters not presently available
[7] Preliminary data subject to revision
* Includes all of Mississippi Sound
** Percentage of the total Gulf landings

TABLE 33. Catch of blue crabs by Alabama fishermen using various types of gear for the years 1964-1971 (From **Fisheries Statistics of the United States**).

Year	Catch (Pounds) By: Shrimp Trawl	Crab Pots	Trotline	Total Landings	Number of Fishermen	Number of Pots
1964	117,900	1,584,800	59,000	1,761,700	66	6,400
1965	36,100	1,760,300	15,800	1,812,200	60	8,400
1966	8,800	2,165,400	8,400	2,186,600	67	10,540
1967	10,300	2,343,100	—	2,353,400	85	12,520
1968	46,300	1,933,300	—	1,979,600	104	17,347
1969	103,300	1,816,700	—	1,920,000	85	13,490
1970	2,200	1,405,100	—	1,407,300	94	14,100
1971	441,300	1,556,000	—	1,997,300	88	14,425

sold for bait but most squid caught are discarded by the shrimp fishermen as the landings are never particularly high (Table 34). Swingle (1971) found *L. brevis* to be the tenth most abundant species in trawl collections in Alabama estuaries. Alabama's percentage of the total Gulf landings increased from 9% in 1964 to 17% in 1971 which indicates stable landings for the Gulf of Mexico as Alabama's landings doubled during this period.

SUMMARY OF THE TOTAL CATCH FROM ALABAMA'S COASTAL WATERS

Table 35 summarizes the total catch of all commercial species by all fishermen from the estuarine waters of Alabama and the waters adjoining the Alabama coast from 1964 through 1972. Catches of seafood in Mobile Bay increased from 3.4 million pounds in 1964 to 8 million pounds in 1967 and then declined to 3.1 million pounds by 1972. The decline in fishing effort by the shrimp fleet (Table 6) and in oyster production (Table 30) are believed to be largely responsible for this decline in the total catch from Mobile Bay.

The catch from Perdido Bay has increased from 46 thousand pounds in 1967 to 265 thousand pounds in 1972. Most of the catch is landed in Florida. The reported seafood catch from Little Lagoon declined from 94 thousand pounds in 1965 to 100 pounds in 1971 and then increased to 110 thousand pounds in 1972.

Catches from Mississippi Sound ranged from 39 million pounds to 131 million pounds (Table 35). Most of the catch consists of menhaden which is landed in Mississippi. Menhaden fishing is prohibited in all Alabama inside waters except the western two-thirds of Mississippi Sound and all offshore waters east of a line at the approximate center of Dauphin Island. The seafood catches from Mississippi Sound ranged from 5 million pounds to 9.4 million pounds. Mississippi Sound seafood catches showed the same trend as Mobile Bay catches, ie., increasing from 1964 to 1967 and then decreasing to about the 1964 level by 1972. This was

TABLE 34. Pounds of squid caught from the coastal waters by Alabama fishermen during the period 1964-1973. (Number in parenthesis is the percent of the total catch from the area taken by Alabama fishermen.)

Year	Mobile Bay[1]	Mississippi Sound	Little Lagoon	Offshore[2]	Louisiana	Total Landings
1964	2,900	200	—	1,100	—	4,200 (9)*
1965	300	300	300	4,700	300[3]	5,900 (11)
1966	1,000	1,600	—	4,100	800	7,500 (12)
1967	—	2,200	—	2,400	200	4,800 (10)
1968	200	1,500	—	7,100	100	8,900 (10)
1969	400	700	—	5,400	200	6,700 (12)
1970	300	700	—	6,600	100	7,700 (14)
1971	200	200	—	7,900	400	8,700 (17)
1972	200	1,400	—	2,100	—	3,700
1973	[4]					10,400[5]

[1] Includes Bon Secour Bay
[2] Includes NMFS Statistical Zones 10 & 11 which adjoin the Alabama coast
[3] From Florida
[4] Data on catch from specific waters not presently available
[5] Preliminary data subject to revision
* Percentage of total Gulf landings

TABLE 35. Pounds of menhaden, industrial fish and seafood caught from Alabama's coastal waters by all commercial fishermen during the years 1964-72.

Year	Type	Mobile Bay[1]	Perdido Bay	Little Lagoon	Mississippi Sound[2]	Statistical Zone 10	Statistical Zone 11
1964	Menhaden	—	—	—	95,199,700	—	—
	Industrial Fish	—	—	—	—	200	50,000,000
	Seafood	3,415,600	—	85,800	4,945,600	1,036,700	11,197,200
	Total	3,415,600	—	85,800	100,145,300	1,036,900	61,197,200
1965	Menhaden	—	—	—	102,890,500	—	2,318,500
	Industrial Fish	—	—	—	—	15,545,200	26,647,500
	Seafood	3,434,800	—	93,600	5,149,500	1,015,600	15,191,000
	Total	3,434,800	—	93,600	108,040,000	16,560,800	44,157,000
1966	Menhaden	—	—	—	63,109,500	—	—
	Industrial Fish	—	—	—	—	4,000,100	31,054,900
	Seafood	3,741,000	—	68,600	6,950,400	1,085,400	14,949,700
	Total	3,741,000	—	68,600	70,059,900	5,085,500	46,004,600
1967	Menhaden	—	—	—	66,500,000	100	—
	Industrial Fish	—	—	—	—	10,000,000	34,494,100
	Seafood	8,082,600	46,300	62,300	9,453,000	975,700	16,064,700
	Total	8,082,600	46,300	62,300	75,953,000	10,975,800	50,558,800
1968	Menhaden	—	—	—	31,073,900	—	—
	Industrial Fish	—	—	—	—	11,000,100	31,000,000
	Seafood	6,238,200	68,600	42,400	7,925,600	676,100	20,250,200
	Total	6,238,200	68,600	42,400	38,999,500	11,676,200	51,250,200
1969	Menhaden	—	—	—	83,393,300	1,700	—
	Industrial Fish	—	—	—	—	64,015,700	—
	Seafood	5,044,700	104,300	2,500	5,906,267	866,600	23,754,500
	Total	5,044,700	104,300	2,500	89,299,600	64,884,000[3]	23,754,500
1970	Menhaden	—	—	—	76,316,000	—	—
	Industrial Fish	—	—	—	—	—	—
	Seafood	4,351,200	210,000	500	6,046,700	1,069,000	24,179,300
	Total	4,351,200	210,000	500	82,362,700	1,069,000	24,179,300
1971	Menhaden	—	—	—	126,080,400	—	—
	Industrial Fish				—	4,007,200	30,000,000
	Seafood	3,459,200	196,900	100	5,680,500	784,500	28,098,900
	Total				131,760,900	4,791,700	58,098,900
1972	Menhaden	—	—	—	88,048,300	—	—
	Industrial Fish	—	—	—	—	7,000,000	25,741,000
	Seafood	3,099,000	264,600	110,600	5,651,800	901,700	22,360,900
	Total	3,099,000	264,600	110,600	93,700,100	7,901,700	48,101,900

[1] Includes Bon Secour Bay
[2] From Mobile Bay to Gulfport Ship Channel
[3] Data for industrial fish is probably an error in NMFS data and represents the catch from zones 10 and 11

largely in response to changes in fishing effort by the Alabama shrimp fleet.

Catches from statistical zone 10 have ranged from 1 million pounds to 16.6 million pounds. Most of the catch was industrial fish which was landed in Mississippi for pet food processing. The catch consists primarily of mixed groundfish such as croaker, spot, catfish, etc. Seafood catches from this zone have remained fairly consistant ranging from 0.7 to 1 million pounds. The majority of the seafood is landed in Florida.

Catches from statistical zone 11 have ranged from 24 million pounds to 61 million pounds. The highest percentage was industrial fish landed in Mississippi. Catches of seafood from this zone have increased from 11 million pounds in 1964 to 22 million pounds in 1972. Alabama boats landed most of the seafood.

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SURVEY OF THE 16-FOOT TRAWL FISHERY OF ALABAMA[1]

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ABSTRACT

Of the 19,120 owners of Class I and II boats registered in Mobile and Baldwin counties in 1972, 5,727 or 30% owned a 16-foot shrimp trawl. During 1972, 1973 and 1974 the estimated shrimp catch by these 16-foot trawls was 277,051, 204,577 and 290,541 pounds (heads-on), respectively, which ranged between 15 and 25 percent of the total catch from the inside waters of Alabama

INTRODUCTION

Shrimp is the most widely accepted seafood nationwide and the demand has not been satisfied by the domestic fishing fleet for many years. Historically, all coastal states made provisions under state laws whereby citizens could harvest shrimp for personal consumption. Some states require licenses and all have restrictions on method and time of harvest, quantity taken or seasons. Under Alabama law citizens can take shrimp for bait throughout the year although restrictions are slightly different during the closed and open commercial seasons. During the closed commercial season 5 pounds per person is allowed (15 pounds per boat containing three or more persons) with no size count restrictions. During the open commercial season 25 pounds per person is allowed but shrimp must be at least 68 (heads-on) per pound. A license is not required for nets 16 feet or less in width provided the shrimp are not sold.

Swingle (1972) estimated that the 24 bona fide live bait shrimp dealers operating in Alabama in 1968 sold approximately 50,000 pounds of live and dead bait shrimp during that year. The catch by bait dealers during a brief trial period in the permanently closed waters of the Mobile Delta was reported by Loesch (1957). The noncommercial catch by 16-foot trawls has not been documented previously.

METHODS

Nonpersonal Contacts

Cards were mailed to 10% of the owners of Class I and II boats (boats 26 ft. or less in length) registered in Mobile and Baldwin counties. Names were randomly selected by taking every fifth name from boatowner registration records at the courthouse in each county. The postage-paid returnable portion of the card requested information on whether the boatowner owned a 16-foot shrimp trawl, the number of trips made during 1972, the estimated catch per trip, months trips were made and the area most frequented during the shrimping trips. The returnable portion of the card was numbered to correspond with the addressee in order to determine the names and addresses of trawl owners in the two counties for follow-up contacts to provide data for

[1] This study was made in cooperation with the U. S. Department of Commerce, NOAA, NMFS, Under P. L. 88-309 (Proj. 2-208-R).

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1973 and 1974. We assumed that all sport shrimp trawls were owned by boatowners and that all sport shrimping was done from boats 26 feet or less in length. A total of 1,384 cards were mailed to boatowners in Mobile County and 504 were mailed to Baldwin County boatowners on 6 June 1973. A second mailing was made on 23 July to persons not responding to the first mailing and a follow-up nighttime telephone interview was made later with a random sample of 10% of the remaining nonrespondents in each county (Table 1).

In January 1974, cards were mailed to the 247 boatowners in Mobile County and 130 boatowners in Baldwin County known to have owned trawls in 1972 to determine shrimping effort during 1973. Cards were mailed 60% of these boatowners in December 1974 to determine effort during 1974. Only a single mailing was made in each of these two years.

Personal Contacts

A creel census of 16-foot trawl users was started in June 1973 to collect completed trip data on total catch and species composition, trawling time, disposition of catch, number of persons per boat and trip expenses. A creel census clerk was stationed at selected marinas and boat ramps 5 days per week (2/5 effort on weekends and holidays) from 16 June through 31 August 1973, 2 days per week (½ effort on weekends and holidays) from 1 September to 31 October, 1 day per week (½ effort on weekends and holidays) from 1 November 1973 to 31 April 1974, 2 days per week (1/3 effort on weekends and holidays) from 1 May to 31 August and 1 day per week (all on weekends and holidays) from 1 September to 31 October 1974. The marina or boat ramp was selected based upon estimated relative utiliza-

TABLE 1. Mobile and Baldwin County Class I and II boatowners response to two card mailings and one telephone interview concerning ownership of 16-foot shrimp trawls during 1972.

	Mobile County (13,850 boats)			Baldwin County (5,270 boats)		
	First[1]	Second[2]	Telephone[3]	First[4]	Second[5]	Telephone[6]
Own trawl—shrimped in 1972	(138)30.1%	(51)25.2%	(8)16.0%	(91)45.7%	(25)33.8%	(8)26.7%
Own trawl—did not shrimp in 1972	(37) 8.1%	(21)10.4%	(0) —	(10) 5.0%	(4) 5.4%	(0) —
Do not own trawl—						
shrimped with friend	(8) 1.7%	(4) 1.9%	(1) 2.0%	(9) 4.5%	(4) 5.4%	(1) 3.3%
Do not own trawl—do not shrimp	(275)60.0%	(126)62.4%	(41)82.0%	(89)44.7%	(41)55.4%	(21)70.0%
Addressee unknown	(19)	(13)		(10)	(6)	
Response	(458)33.1%	(202)22.3%	(50)	(199)39.5%	(74)25.1%	(30)
Total Response		(660)47.7%			(273)54.2%	

1 6 June 1973—1384 cards
2 23 July 1973—907 cards
3 4 January 1974
4 6 June 1973—504 cards
5 23 July 1973—295 cards
6 21 December 1973

tion. Shrimping effort is not uniformly distributed in Alabama due to seasonal variation in shrimp distribution. From late spring through late summer greater effort is expended in the lower portion of the estuaries when brown shrimp is the principal species taken. During fall and early winter more effort is expended in the upper estuary where white shrimp makes up the largest portion of the catch. Our sampling sites were selected with forehand knowledge of this in an attempt to interview as many persons as possible. The creel clerk arrived at the selected area at approximately 8 a.m. and left about 5 p.m. Only during the peak of the shrimping season (June-August) was this procedure efficient enough to be recommended. During most of the year the clerk's time would have been better utilized by cruising the area by boat and passing out returnable postage-paid data cards to persons shrimping, although this method likely would have provided less reliable data on total catch and species composition than actual measurements by the clerk. Collection of creel data was terminated after October 1974.

DISCUSSION

All 1972 data were derived from two mailings and a follow-up telephone interview. A total of 47.7% of the 1,384 boatowners contacted in Mobile County and 54.2% of the 504 in Baldwin County responded to the first and second mailings (Table 1.) A greater percentage of trawl owners responded to the first mailing than to the second mailing and the response from both mailings was significantly different from the telephone interview. The estimated total number of trawls owned in 1972 in each county was obtained by combining separate estimates from the three contacts (Table 1) as shown in the following for the 13,850 boatowners in Mobile County:

1st mailing: $0.382 \times \frac{477}{1384} \times 13{,}850 = 1{,}799$

2nd mailing: $0.356 \times \frac{215}{1384} \times 13{,}850 = 789$

Telephone: $0.160 \times \frac{692}{1384} \times 13{,}850 = 1{,}108$

trawls owned 3,696

The estimated number of 16-foot trawls actually used in Mobile County was calculated as shown below:

1st mailing: $0.301 \times \frac{477}{1384} \times 13{,}850 = 1{,}417$

2nd mailing: $0.252 \times \frac{215}{1384} \times 13{,}850 = 558$

Telephone: $0.160 \times \frac{692}{1384} \times 13{,}850 = 1{,}108$

trawls used 3,083

The estimated number of 16-foot trawls owned and used in Baldwin County in 1972 (Table 2) was calculated by the same method. An estimated 26.5% of the Mobile County and 35.3% of the Baldwin County owners of Class I and II boats owned 16-foot shrimp trawls in 1972. An estimated 4,961 of the 5,727 trawls were used in 1972 to catch 277,051 pounds of shrimp (heads on) during 45,930 trips in Alabama coastal waters.

The total number of trips made during 1973 was estimated from returns of cards mailed in January 1974 to the 247 persons in Mobile County and the 130 persons in Baldwin County who reported that they owned trawls during 1972. Forty-nine percent of the Mobile County and 48% of the Baldwin County cards were returned. We did not resample the population of boatowners to determine the change in trawls owned from 1972 to 1973, but based our catch estimate on the 5,727 trawls owned in 1972. The commercial shrimp harvest during 1973 was the

TABLE 2. Summary of card survey for 1972, 1973 and 1974 and creel data* for 1973 and 1974 in Mobile (M) and Baldwin (B) counties, Alabama.

Trawls owned	1972	1973	1974
Mobile County	3,696	Data are based on 5,727	
Baldwin County	2,031	trawls owned in 1972	
	5,727		
Trawls used			
Mobile County	3,083	2,983	3,049
Baldwin County	1,878	1,801	1,702
	4,961	4,784	4,751
Average trips/year			
Mobile County	9.6	9.1	9.9
Baldwin County	8.7	9.5	8.8
Total trips/year			
Mobile County	29,520	27,145	30,185
Baldwin County	16,410	17,110	14,978
	45,930	44,255	45,163
Catch/trip (lbs. heads-on)			
Mobile County	5.8 lbs.	3.9 (4.7*)	6.8 (6.4*)
Baldwin County	6.5	4.7 (4.5*)	6.3 (6.5*)
Card total catch estimate			
Mobile County	171,160 lbs.		
Baldwin County	105,891		
	277,051 lbs.		
***Creel data total catch estimate**			
Mobile County		127,582 lbs.	193,184 lbs.
Baldwin County		76,995	97,357
		204,577 lbs.	290,541 lbs.
***Trawling time (hr./trip)**		M-2.6 B-2.9	M-1.8 B-1.3
***Catch (lbs. heads-on /hr)**		M-1.8 B-1.6	M-3.6 B-5.0
***Number persons/boat**		M-2.7 B-2.4	M-2.6 B-2.5
***Expenditures/trip**		M-$11.72 B-$7.72	M-$12.50 B-$9.67
***Roundtrip mileage**		M-48.0 B-55.1	M-48.6 B-48.6
***Disposition of catch**			
Bait		M-50.3% B-11.3%	M-66.3% B-24.0%
Food		M-49.7% B-88.7%	M-33.7% B-76.0%
***Opinion on closed season**			
For		M-79.3% B-82.4%	M-43.5% B-73.0%
Against		M- 4.7% B-10.2%	M-30.4% B-27.0%
No opinion		M-16.0% B- 7.4%	M-26.1% B-
***Opinion of license**			
For		M-41.6% B-68.2%	M-34.8% B-27.0%
Against		M-50.6% B-28.9%	M-43.5% B-70.3%
No opinion		M- 7.8% B- 2.9%	M-21.7% B- 2.7%
***Man-hours expended shrimping**			
Mobile County		190,557.9	141,265.8
Baldwin County		119,085.6	48,678.5
		309,643.5	189,944.3
***Total trip expenditures**			
Mobile County		$318,139	$377,312
Baldwin County		132,089	144,837
		$450,228	$522,149

*Based on creel data

lowest in several years due to flooding of the river systems of the northern Gulf of Mexico. The lower catch per trip during 1973 (Table 2) was shown in response to the card survey, as well as catch data collected by the creel census which began in June 1973. Even though the catch was down, almost as many trips were made during 1973 as during 1972.

The 1972-trawl owners were contacted again in November 1974 to determine the number of trawls used and the number of trips made during 1974 (Table 2.) The estimated total catch increased to slightly above that of 1972. Considerably less man-hours were expended in 1974 as the catch per hour more than doubled that of 1973. The creel census was terminated in October 1974 as only about 2% of the annual trawling effort is expended after October (Table 3).

TABLE 3. Monthly distribution of 16-foot trawl effort.

Jan	0.2%	Jul	27.4%
Feb	0.3	Aug	26.3
Mar	0.6	Sep	12.9
Apr	0.8	Oct	5.7
May	4.4	Nov	1.4
Jun	19.2	Dec	0.8

During early spring trawling is concentrated in the lower estuaries and during late fall most of the effort is in upper Mobile Bay. During the peak of the season (late June through August) effort is fairly well distributed over all coastal water although certain areas (Table 4) are preferred.

Many Mobile County residents trawl in Baldwin County but few Baldwin County residents trawl in Mobile County. More than 34% of the Mobile County residents indicated that they trawled one or more times in Baldwin County but only 3% of the Baldwin County residents trawled in Mobile County during 1973. Of the 181 parties interviewed by the census clerk in Baldwin County during 1973, 62.9% were Baldwin County residents, 24.9% were from Mobile County, 5.5% from Escambia County, 0.6% were from Conecuh County, 0.6% from Monroe County and 5.5% were from Escambia County, Florida. All persons interviewed at Mobile County ramps and Marinas during 1973 were Mobile County residents. Creel data showed no difference in the catch per hour between the two counties during 1973, but the hourly catch was considerably higher in Baldwin County during 1974 (Table 2).

TABLE 4. Percent of respondents reporting launching boats "most often" in localized areas during 1972-1974.

Area	Percent
Weeks Bay—Mullet Point	16.9
Orange Beach—Terry Cove—Cotton Bayou	16.1
Dog River—Deer River	14.7
Dauphin Island—Heron Bay	13.2
Wolf Bay—Bay La Launch—Arnica Bay	9.2
Bon Secour—Oyster Bay—Gulf Shores	7.2
Battleship Parkway	6.7
Daphne—Fairhope—Pt. Clear	6.2
East Fowl River	3.9
Little Lagoon	2.7
Ft. Morgan Peninsula	1.7
Bayou La Batre	1.4

The commercial catch from Mobile Bay during 1973 was composed of 54% brown, 45% white and 1% pink shrimp (U. S. Dep. Comm., 1974b). The 1973 catch by 16-foot trawls in Mobile Bay was 71% brown, 28% white and 1% pink. The difference in composition of the commercial and the sport catch is due to the fact that little sport trawling is done in the early spring and late fall when white shrimp are most abundant. Pink shrimp are of little consequence to the sport fishery except in Perdido Bay where they make up about 5% of the catch. There is a considerable difference in the species composition of the catch in the lower and upper parts of Mobile Bay. Brown shrimp made up approximately 80% of the catch near Dauphin Island but only about 31% in the upper bay near Dog River.

A point of friction between the commercial and sport shrimper is the size and amount of shrimp taken by the unlicensed sport shrimper prior to opening of the commercial season. Our creel data were all obtained from completed-trip interviews and in many instances shrimp had been used up during fishing when the party returned to dock. We were also unable to determine the amount of culling or discards of shrimp by the party so our data are not quantitative for the percent of shrimp taken that are under the legal commercial size. Under the bait shrimping law, however, shrimp do not have to be of commercial count (68 heads-on/lb.) until the commercial season is opened. We did interview some parties which returned with shrimp smaller than 68 count but they usually had only a few pounds. The true bait fisherman certainly catches a considerable amount of small shrimp but in most instances these are utilized solely for bait which is the intent of the bait shrimping law. Persons catching shrimp for food in most instances are not interested in catching shrimp smalled than 68 count. A greater percentage of parties shrimping in Baldwin County utilized their shrimp for food and also favored a closed season restricting use of 16-foot trawls to the commercial shrimping season (Table 2). Persons catching shrimp, as well as croakers and other small fish, solely for bait were largely against a closed season as the closed commercial shrimp season (usually mid-May through the middle of June) coincides with the peak of the spotted seatrout fishing in the lower bays and around the Gulf beaches.

The commercial shrimp catch from the inside waters of Alabama is not known precisely because the statistical areas used by the National Marine Fisheries Service in reporting shrimp catch *(Gulf Coast Shrimp Data)* include portions of Florida and Mississippi with Alabama. Alabama waters make up about one-third of statistical area 011.1 which extends from Mobile Bay to Gulf Port, Mississippi and about one-half of statistical area 010.3 (Perdido Bay). Assuming shrimp are equally distributed within areas, one-third of the catch from area 011.1 and one-half of the catch from areas 010.3 is here considered as taken from Alabama waters. Estimated catch (pounds heads-on) during 1972, 1973 and 1974 is presented below:

	1972	1973	1974
commercial catch	1,621,073	855,012	1,009,300
16-foot trawl catch	277,051	204,577	290,541

Sales by the live bait shrimp dealers was approximately 50,000 pounds during 1968 (Swingle, 1972). The catch has likely increased by 5-10% since 1968 although the demand for bait shrimp is dependent largely upon spotted seatrout fishing success. We estimate that the catch by 16-foot trawls is between 15% and 25% of the total shrimp catch from the inside waters of Alabama.

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[illegible]EVIEW OF THE OYSTER FISHERY OF ALABAMA [1]

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ABSTRACT

[illegible] data on the Alabama oyster fishery are presented. Legislation affecting [illegible] since 1852 and management and research activities during the 1900's are [illegible]

[illegible]NTRODUCTION

[illegible] have been a significant part [illegible] along the Alabama coast [illegible] first Indians visited the area [illegible] years ago but were a local [illegible] until improvements in transportation systems and construction of [illegible] in the late 1800's and early [illegible] Early management of state [illegible] consisted solely of re[illegible] harvest methods. The first [illegible] Oyster Commission (1909- [illegible] the second Alabama Oyster [illegible] (1935-1939) established [illegible] Legislature were the first [illegible] concerned solely with [illegible] management. Both commissions [illegible] harvest methods, established [illegible] state bottoms and had ex[illegible] planting programs. Both com[illegible] were apparently unpopular [illegible] were abolished by the legis[illegible] after their creation. The [illegible] Department of Conservation [illegible] Resources assumed author[illegible] oysters in 1919, but activities [illegible] primarily regulatory in function [illegible] late 1940's. Oyster manage[illegible] been a major activity of the [illegible] Marine Resources Division since

HISTORY OF THE FISHERY

Prehistoric Indian cultures harvested oysters from the coastal waters of Alabama over 3,500 years ago (May, 1971). Numerous middens consisting almost entirely of oyster shells located along the shores of Bon Secour Bay, Mississippi Sound and Dauphin Island indicate the importance of oysters in the diet of these early cultures. Early Spanish and French explorers and settlers made use of the abundant oysters along our coast as early as the 16th century. By 1732, what is now known as Cedar Point had been named Oyster Point because of the large reef there. It is the major reef fished today. Oysters have had a significant influence on inhabitants of coastal Alabama, having provided a readily accesible and stable source of food and income since man first settled in the area.

Methods of Harvest

Throughout the history of the oyster fishery hand tongs have been the only legal method of taking oysters from the public reefs with the exception of a period between 1909 and 1915 when dredging was allowed on White House, Point Clear and Klondike Reef in the

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[1] [illegible]dy was made in cooperation with the U.S. Department of Commerce, NOAA, [illegible] under P.L. 88-309 (Project 2-216-R)

mid-region of Mobile Bay, from 1933 to 1939 and a brief period during the 1950's. Legislation permitting dredging was established by the first Alabama Oyster Commission (1909-1915), the Department of Game and Fisheries, and the second Alabama Oyster Commission (1935-1939) and was apparently very unpopular with the majority of fishermen as the acts were repealed when the Commissions were abolished by the State Legislature. Dredging is now allowed only for taking seed oysters for replanting under supervision of the Department of Conservation and Natural Resources and for harvest on private beds.

Harvest Statistics

Statistics on the Alabama oyster fishery have been collected by federal agencies since 1880 but are complete only from 1948 (Table 1). Annual fluctuation in harvest is common to the fishery due to both natural and man-made reasons. The average harvest per decade since 1880 based on available records has been about 1 million pounds of meats annually (May, 1971). During the early 1880's records indicate that harvest was only about 300 thousand pounds of meats annually, most of which was presumably consumed locally although oyster canneries were in operation in Mississippi at this time. Only Alabama citizens could engage in the fishery from 1882 until legislation was passed in 1901 allowing nonresidents fishing privileges but only if they sold to Alabama canneries. Legislation in 1915 repealed this, allowing only citizens fishing rights. In 1919, nonresidents were again given fishing rights after paying a double license fee.

Legislation regulating out-of-state shipment of oysters in the shell was passed 1891. This act allowed out-of-state shipment only from the middle of December to the middle of January, which coincided with the start of the oyster canning season in Mississippi. In 1909, legislation prohibited all out-of-state sale of raw oysters unless Alabama canneries paid less than the price paid in neighboring states. Legislation in 1919 allowed out-of-state shipment only to states allowing Alabama fishermen to take and transport oysters from that state.

TABLE 1. Alabama Oyster Landings.

Year	Pounds of Meats	Year	Pounds of Meats
1880	327,085	1950	2,070,300
1888	238,271	1951	2,191,400
1889	1,372,270	1952	1,842,000
1890	1,505,749	1953	1,449,700
1897	798,316	1954	739,300
1902	1,087,550	1955	1,580,600
1908	1,677,680	1956	769,900
1911	1,162,592	1957	1,291,200
1918	376,360	1958	457,600
1923	729,559	1959	894,800
1927	520,804	1960	1,169,300
1928	1,886,104	1961	508,500
1929	178,823	1962	442,700
1930	286,794	1963	995,400
1931	768,721	1964	1,005,300
1932	859,217	1965	492,400
1934	391,800	1966	1,304,500
1936	991,800	1967	2,087,900
1937	1,235,200	1968	1,211,800
1938	1,358,700	1969	480,700
1939	1,357,700	1970	279,000
1940	936,000	1971	250,000
1945	1,605,700	1972	1,069,515
1948	1,531,200	1973	590,118
1949	1,585,800	1974	732,776

In 1891, legislation set the oyster season from 1 September to 30 April, the "r-months" common elsewhere. This was in effect for many years. The Department of Conservation and Natural Resources presently sets the season by regulation.

In 1901, catchers were restricted to 3,500 barrels of oysters per week which had to be at least 2½ inches in length. Legal size was changed to 3 inches and

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HISTORY OF MANA

Responsibility for man
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Company, Grahams Seafood Company, Hidenheim Company, McPhillips Packing Company, Marco Skremetti, Coffee Island, and others operated at Bayou La Batre or Coden. In 1926, there were five companies in Bayou La Batre packing shrimp and oysters (Ann. Rep. 1922-1926) but by 1938 only two were in operation in Alabama (U. S. Dep. Interior, 1941). According to Fisheries Statistics of the U. S., there were three canneries in operation in the 1950's and two in 1960. One operated through 1967 with the exception of 1965 and 1966. Some companies canned vegetables as well as seafood. A typical operation would can oysters from January until May, vegetables (beans and potatoes) during the late spring and summer and shrimp from August through late fall or early winter depending upon their availability. Crab meat was canned also by some canneries.

In 1923, a survey made of raw oyster consumption in Birmingham, Montgomery and Mobile stated that 100%, 97% and 90% of the raw oysters consumed in the respective cities came from out of state (Dep. Game and Fisheries, 1930). The canneries were apparently consuming the bulk of the Alabama harvest. The decline of the canneries from their peak years of the 1920's was largely due to loss of productive oyster bottoms in Portersville Bay. Periodic closure of the reefs by the Alabama Department of Health since 1952 and restrictions on harvesting oysters from leased and riparian beds also contributed to their demise.

HISTORY OF MANAGEMENT

Responsibility for management of Alabama's oyster fishery and enforcement of laws and regulations has been under various agencies since the 1800's when the first legislation concerning oysters was enacted by the State Legislature. The agencies and periods of responsibilities follow:

18??-1891	County Law Enforcement Agents
1891-1909	Oyster Inspector appointed by Governor
1909-1915	First Alabama Oyster Commission
1915-1919	Secretary of State through the Chief Inspector
1919-1923	Department of Conservation through the Chief Oyster Inspector
1923-1935	Department of Game and Fisheries through the Chief Oyster Inspector
1935-1939	Department of Conservation of Game, Fish and Seafoods through the Second Alabama Oyster Commission
1939-1951	Department of Conservation through the Division of Game, Fish and Seafoods
1951-1971	Department of Conservation through the Seafoods Division
1971-	Department of Conservation and Natural Resources through the Marine Resources Division

The Department of Game and Fish was established by the State Legislature on 27 February 1907 but did not assume responsibility over the oyster fishery and other seafoods until 1919 when the name of the department was changed.

State management during the 1800's consisted solely of laws passed by the legislature. There was no state agency in any way concerned with oyster management, and enforcement of the few laws concerning oysters was by the county sheriff. The earliest law at hand concerning oysters, dated 1852, made it unlawful to take oysters from any waters of the state by any methods other than hand tongs and authorized the sheriff of any county "bordering the waters of this state" to confiscate boats and equipment of persons violating this law. Legislation in 1872, amended in 1879, granted riparian owners the right to plant and harvest oysters for a maximum distance of 600 yards offshore as long as it did not interfere with navigation. In 1882, the State Legislature passed a law regulating buying and selling oysters in the shell in measurements other than described by law. This one-third barrel was described as being 16 inches across the bottom, 18 inches across the top and 9½ inches high. In 1887, a culling law was passed by the State Legislature. All oysters "that are too small or unfit for market" were required to be returned to the reef from which they were taken.

The first oyster management legislation was passed in February 1891. An Oyster Inspector and Deputy Inspector appointed by the Governor for a two-year term were authorized to enforce a new culling law (2½ inches), seasons for taking oysters from public and private reefs (September - May) and restrictions on out-of-state shipment of oysters in the shell (restricted to the middle of December to the middle of January). Oystering on private beds was excluded from the season restriction only if oysters were taken for the owners use. Sheriffs, constables and other police officers were also authorized enforcement agents under this legislation. The Oyster Inspector and Probate Judge of Mobile County were authorized to collect oyster boat licenses based on $0.10 per barrel capacity and a tax of $0.10 per barrel of oysters taken from both public and private beds. All receipts were deposited with the State Treasurer. Only citizens of Alabama were allowed fishing privileges. The Oyster Inspector was required to live either on Dauphin Island or at Cedar Point and the Deputy Inspector was required to live in Mobile, unless filling the duties of the inspector. The two officials were actually under the control of the Mobile County Grand Jury which was given authority by the Governor for their dismissal.

Legislation in 1892 and amended in 1894 provided that the Oyster Inspector live in Mobile and that one deputy live in Mobile County and an additional deputy live in Baldwin County. The inspectors enforced the culling laws, collected taxes and patrolled the reefs during the closed season. In 1902, a law was passed limiting weekly catch to 3,500 barrels.

Although the Department of Game and Fish was established by the legislature in 1907, the oyster fishery was still controlled by the Oyster Inspector.

The first oyster and shell planting in Alabama by other than private individuals was done by the first Alabama Oyster Commission about 1910. This commission was established by the State Legislature in August 1909 and was the first attempt at management of the public reefs. The commission received no appropriations from the state and expenses prior to collection of annual oyster taxes, licenses, lease fees and other revenue were advanced by members of the commission. Between 1909 and February 1915, when the commission was abolished by the State Legislature, the commission planted 35,000 barrels of shell at a cost of $1,559.56 and transported an unreported number of seed oysters at a cost of $1,147.50 to an experimental plot in Portersville

Bay to demonstrate oyster management. When the federal government dredged Pass aux Herons channel, *ca.* 1912, the commission persuaded the government to change the course of the channel and to deposit the spoil some distance away to minimize damage to Cedar Point Reef. The present ½-barrel measure was established in 1909. In 1910, the commission obtained the services of Dr. H. F. Moore (1913), U. S. Bureau of Fisheries to survey the oyster reefs and the potential oyster bottoms and to make recommendations on oyster management. The shell and seed oysters planted by the commission were not successful and the commission obtained the services of T. C. Nelson in 1914 to determine the cause of mortality on planted areas in Portersville Bay. Nelson (1914) found that many of the planted areas were on soft mud or on unstable bottoms. The Alabama Oyster Commission was attempting a scientific approach to oyster management but was abolished by the State Legislature in February 1915 before it became truly effective. The Secretary of State assumed control of the oyster fishery from 1915 to 1919.

In 1919, the Department of Game and Fish was changed to the Department of Conservation and assumed jurisdiction over the oyster fishery and other saltwater species. This legislative act also established the Game and Fish Protection Fund and the Oyster Fund. A one dollar oyster license was established. The Oyster Fund consisting of licenses and taxes on both oysters and shrimp paid the salaries and expenses of the Chief Oyster Inspector and two Assistant Inspectors. Receipts of the Oyster Fund during FY 1920 totaled $5,662.00 of which $2,880.42 was spent on salaries and expenses. The Chief Oyster Inspector was under the direct supervision of the Commissioner of the Department of Conservation. Oyster management consisted solely of law enforcement.

In 1923, the Department of Conservation was renamed the Department of Game and Fisheries. During 1925, the Department planted 35,000 barrels of seed oysters on public reefs which was the first plantings on public reefs since the planting by the first Alabama Oyster Commission in 1910. During 1926, 10,000 barrels of seed oysters were planted. During 1923, legislation was passed allowing dredging of oysters by the Department north of a line from Alabama Port in Mobile County eastward to Mullet Point in Baldwin County. This provided a more readily available supply of seed oysters to the state. The legislation was very unpopular among most fishermen. During the period 1923-1926 receipts of the Oyster Fund varied annually from $6,658.51 (1924) to $9,466.26 (1925), about two-thirds of which was spent on salaries and expenses of the Chief Oyster Inspector and three assistants. During 1933 and 1934, federal funds under Civil Works Administration and Federal Emergency Relief Administration programs were used to plant 41,000 barrels of seed oysters and shells in Isle of Dames, Portersville and Dauphin Island bays. Approximately 350 acres were planted with 26,795 barrels of seed oysters obtained from Mississippi Sound, Bayou La Batre and Bayou Coden (Dep. Game and Fisheries, 1934). Legislation in 1933 allowed dredging on Cedar Point Reef, King's Bayou Reef, Buoy Reef, White House Reef and Fowl River Reef and gave riparian owners broader privileges in developing private beds.

In August 1935, the Department of Game and Fisheries was reorganized.

The Swift Act created the Department of Conservation of Game, Fish and Seafoods; created a State Conservation Board advising the Commissioner; and made the office of Commissioner an appointee by the Governor rather than an elected official as it had been since 1907. The McPhaul Act (July 1935) created the second Alabama Oyster Commission. The Alabama Oyster Commission obtained a federal grant of $92,365 and $17,635 state funds and equipment for oyster reef rehabilitation. The members of the commission were N. J. Gonzales of Mobile, A. B. McPhaul of Seminole, C. H. Wakefield of Bon Secour, and A. L. Staples of Mobile. Mr. I. T. Quinn the Conservation Commissioner was Chairman of the Oyster Commission. The state, through the Oyster Commission was empowered to buy and sell property, conduct economic surveys of the seafood industry, lease oyster bottoms, plant and remove seed oysters and shells and purchase seed oysters and shell for planting. The Chief Enforcement Officer and assistants enforced the regulations of the Oyster Commission. The annual report of 1936 was the first to mention a "Seafoods Division", which consisted of the Chief Enforcement Officer, the Chief Oyster Inspector and two Assistant Inspectors. The 1938 annual report listed the following divisions of the Department of Conservation of Game, Fish and Seafoods: Division of Fish Culture, Division of Law Enforcement, Division of Research and Statistics, Division of Game Propagation, Division of Game Management, and Division of Seafoods. The Division of Seafoods consisted of the Chief Enforcement Officer and four assistants which enforced regulations of the Alabama Oyster Commission. Oyster planting was done by the federal Works Progress Administration (WPA) and by the Alabama Oyster Commission. Total receipts of the Oyster Fund during FY 1937 was $11,262.02.

In March 1939, the Department of Conservation of Game, Fish and Seafoods was reorganized into the Department of Conservation which consisted of the Game, Fish and Seafoods Division; Forestry Division; Parks, Monuments and Historical Sites Division; and Statistical Division. The legislation abolished the Alabama Oyster Commission, Forestry Commission, Alabama Conservation Board, Office of State Forester, and the Alabama Monument Commission. It established the present Conservation Advisory Board and changed the title of department head to Director, replacing Commissioner used since 1907. The seafoods branch of the Division of Game, Fish and Seafoods consists of Chief Enforcement Officer and five assistants who were responsible for enforcement of seafood laws and collecting license and taxes on seafoods. No shell planting was done by the Division during its first year of existance. Revenue from the oyster fishery during FY 1938 was $140.25 from oyster leases and $455.31 from oyster taxes. Seafoods ranked such low importance that it was omitted in two instances from the Division of Game, Fish and Seafoods in the Department of Conservation annual report of FY 1939; being referred to on page 64 of the report as "The seafoods unit of the Game and Fish Division" and on page 7 being omitted completely from the Division title. Through the effort of WPA, Alabama oyster canneries and local oyster fishermen a total of 60,000 barrels of shell were planted on public reefs. The receipts from seafood industry totaled

$12,583.34 during FY 1940 or slightly more than twice that received during FY 1910. Little oyster management was done by the Division of Game, Fish and Seafoods until FY 1943 when general fund appropriations allowed planting of 92,426 barrels of shell on the public reefs. The Division of Game, Fish and Seafoods had separate accounts for receipts from seafoods and receipts from fishing and hunting until FY 1945 and receipts from seafoods was always insufficient for enforcement and much needed management and research.

Legislation in FY 1944 allowed oysters of any size to be dredged from private oyster reefs for the first time. The Mobile Bay Seafood Union directed seed oyster planting of 6,000 barrels in FY 1944. The union was composed of members of the crew of the vessel that dredged seed oysters from Buoy Reef for the state and was apparently the first unofficial advisory committee. During FY 1945 the Division of Game, Fish and Seafoods had a budget carry-over to FY 1946 of more than $216 thousand. Even with this surplus no shell was reported planted in the annual report of that year.

The FY 1946 annual report separated the Division of Game and Fish and the Division of Seafoods into staff divisions although the two divisions were not separated by legislature until 1951. The Division of Game, Fish and Seafoods contracted with McPhillips Packing Company of Bayou La Batre for planting 40,000 barrels of seed oysters in Mobile Bay and Bon Secour Bay. Land was purchased in Bayou La Batre for construction of a seafood office, dock, boathouse and warehouse. Arrangements were made with the University of Alabama to provide biological services in matters dealing with seafoods. Attempts were made to obtain reciprocal fishing agreements with Mississippi and Louisiana similar to the one obtained with Florida in 1946. The revenue from the new shell dredging contract ($5,443.26) was used for seafoods management.

During FY 1947 biological studies of the oyster reefs were made by the Geological Survey of Alabama and the Alabama Museum of Natural History at the request of the Department of Conservation. The "Seafoods Division" became self-sustaining for the first time in history with revenues of $135 thousand composed of $47 thousand from shell dredging, $45 thousand from a legislative appropriation and the remaining $43 thousand from seafood revenue. The State Ecologist with the Alabama Museum of Natural History made recommendations for management of seafoods and the enforcement personnel were increased to eleven. Air patrols were made to check shrimp and oyster fishermen for violations. The activities of the "Seafoods Division" covered eight pages in the annual report of FY 1947, or more than the total coverage for the past decade or more. Recommendations for more research, hiring a full time marine biologist, construction of a seafoods laboratory and installation of laboratory equipment and a larger patrol force were made by the Chief Oyster Inspector. Legislation was passed in 1947 authorizing formation of the Gulf States Marine Fisheries Commission. The organization meeting was held in Mobile on 16 July 1949 and Governor Folsom of Alabama was the first to sign the compact and Mr. Bert Thomas, Director, Alabama Department of Conservation, became the first Chairman.

In January 1950, the Marine Laboratory at Heron Bay Cutoff was officially opened. The laboratory provided office and laboratory space for Senior Biologist F. X. Leuth and some enforcement personnel. Studies of oyster spat set, oyster growth and survival were initiated on planted areas and hydrological data were collected to improve management techniques. The receipts of the Game, Fish and Seafoods Fund during FY 1949 was slightly over $900 thousand.

On 1 October 1951, upon recommendation of the Director of Conservation, legislation was signed separating the Division of Seafoods from the Division of Game, Fish and Seafoods. The Game, Fish and Seafoods Fund was separated with seafood revenues and revenue from dredging buried reef shells going to the new Seafoods Division. Receipts from 1 October 1951 to 30 September 1952 totaled $256 thousand. The Division moved to a new office building in Bayou La Batre on 15 May 1952. Enforcement consisted of six officers, three boats, and one amphibian airplane. Shell and seed oysters were planted by the Division and by packers and dealers which were required to return 30% of the shells back to the reefs under the supervision of the Seafoods Division. The Division dredged a 9-foot channel into Bon Secour to aid the seafood industry of that area.

During the early 1950's, injunctions were placed against the Division prohibiting the opening of public reefs for seed oysters. One such decision went as far as the Alabama Supreme Court where it was reversed in 1955. After this ruling seed oysters were made available from reefs located in water too deep for tonging. During the early 1950's the biological staff consisted of one division biologist and consultant biologists from Texas A & M, Mississippi and the federal laboratory at Gulf Breeze, Florida. The Department of Conservation Annual Report for FY 1959 stated that "The Seafoods Division was completely re-organized during the past year. A new division director was appointed, together with new enforcement men". Biological work was now contracted to the Biology Department, University of Alabama, and Dr. Gordon Gunter of Mississippi. The Division had apparently become ineffective during the late 1950's as the report stated that "there was very little activity in the form of constructive development, enforcement, research or administration". The oyster shell dredge was shut down during 1959 causing financial distress within the Division which received as much as 89% of its revenue from this single source. After the reorganization the Division renewed shell and seed oyster planting efforts.

Financing through the Mobile Area Public Higher Education Foundation, Inc. permitted construction of the present Alabama Marine Resources Laboratory on Dauphin Island which was completed in 1963. The facility originally provided office space for the Division Chief and enforcement personnel of the Seafoods Division and office and laboratory space for biological and teaching staff of the University of Alabama which did research under contract for the Seafoods Division. The Division of Seafoods began to obtain its own biological staff in 1966, hiring a laboratory director and a biologist to work on oyster management. The contract with the University of Alabama was terminated in 1967 and university personnel moved into facilities at Point aux Pins. When the 1971 State Legislature changed the name of Department of Conservation to Department of Conservation and Natural Resources and the Seafoods Division to Marine Resources Division, the Division staff consisted of Division Director, Chief Biologist, 5 biologists, 14 enforcement officers, 3 biologist aides, 4 laborers and 5 clerk typists. Offices were maintained at Dauphin Island, Bayou La Batre and Gulf Shores. From 1967 oyster management has consisted of intensified oyster research and shell planting. Approximately 40% of the 1,899,351 barrels of shell planted between 1910 and 1975 (Table 2) were

TABLE 2. Barrels[1] of oyster shells and seed oysters planted on public reefs in Alabama since 1910.

Year	Oyster Shells	Seed Oysters	Year	Oyster Shells	Seed Oysters
1910-1914	35,000	—0—	1955	97,707	—0—
1925	—0—	35,000	1956	—0—	40,000
1926	—0—	10,000	1957	—0—	50,000
1928	—0—	30,000	1958	—0—	59,860
1929	—0—	10,000	1959	—0—	—0—
1932	33,382	—0—	1960	23,534	15,000
1936	189,554	[2]	1961	70,000	—0—
1937	20,045	[2]	1962	115,000	39,839
1940	60,000	—0—	1963	60,000	30,000
1942	25,000	—0—	1964	65,000	36,000
1944	92,426	—0—	1965	60,000	65,698
1945	—0—	6,000	1966	50,000	60,000
1946	12,743	19,040	1967	11,400	8,660
1947	15,000	18,950	1968	46,470	—0—
1948	25,000	40,000	1969	105,325	—0—
1949	63,215	33,409	1970	51,296[3]	—0—
1950	—0—	40,713	1971	61,982	—0—
1951	40,000	—0—	1972	117,346[3]	—0—
1952	17,749	54,000	1973	3,157[3]	—0—
1953	2,431	—0—	1974	167,330[3]	5,451
1954	—0—	7,500	1975	162,259[3]	—0—

TOTAL — Oyster Shells — 1,899,351
TOTAL — Seed Oysters — 715,120

[1] An Alabama barrel = 4.9 ft.^{3} or 3.9 U. S. Standard bushels

[2] Figure for seed oysters combined with that for oyster shells this year

[3] Combined figure for oyster shells and clam shells

planted from 1967 to 1975. Revenue is presently obtained from the seafood industry, oyster shell dredging (since 1946), marine gas tax (1962), Commercial Fisheries Research and Development Act, P.L. 88-309 (1966), Anadromous Fish Act P.L. 89-304 (1967) and, rarely, appropriations from the State General Fund. Revenue has not increased significantly since the mid 1960's and the greatest source of revenue (shell dredging) is a nonrenewable resource which will eventually become depleted.

HISTORY OF RESEARCH

The prehistoric Indian cultures were aware of the locations of Alabama oyster reefs more than 3,500 years ago as evidenced by the numerous shell middens in coastal Alabama. The Spanish expedition of 1519 led by Pineda possibly explored the Alabama coastal area and recorded the position of some oyster reefs. The first U.S. Coast Survey map of coastal Alabama published in 1851 showed locations of certain reefs although the first specific effort to map the oyster reef was done by Boudouquie in 1883 (May, 1971).

In 1894, Homer P. Ritter (1896), Assistant, U. S. Coast and Geodetic Survey, made a survey of the oyster reefs from Cedar Point eastward to Bon Secour Bay and northward throughout Mobile Bay. Besides mapping the oyster reefs he described the general areas and recorded water temperatures, densities, depths, bottom types and the quality of oysters. Having begun the survey on February 10 during a period of freshets, he returned in December to take additional water densities under low flow conditions. Ritter obtained the approximate locations of reefs from oystermen but used triangulation points established by the Coast Survey records during mapping. The extent of the reefs were determined by dragging a chain over the reefs. He found the northern limits of oyster growth in Mobile Bay to be along a east-west line from Great Point Clear to East Fowl River. The oyster reefs along the eastern shore were few in number and Ritter concluded that depletion of these reefs was probably due to excessive fishing. He mapped 3,105 acres of oyster bottoms in Mobile Bay, Bon Secour Bay and extreme eastern portion of Mississippi Sound. He did not map the reefs in Mississippi Sound but stated "oysters were growing in all parts" of the northern portion of the sound west to the Mississippi line.

During 1910-1911, Dr. H. F. Moore (1913) of the U. S. Bureau of Fisheries examined the oyster bottoms of Mobile Bay and Mississippi Sound. His study was done at the request of the newly appointed Alabama Oyster Commission created by the Alabama Legislature on August 27, 1909. Moore used chains dragged behind a boat to locate the reefs. A launch tonged oysters for counting and measurement. Grabs were also taken to determine the density of oysters. The survey covered 93,000 acres including 4,000 acres of oyster beds. A general summary of all the beds were made in terms of relative productivity. More than 24,000 acres surveyed were considered suitable for oyster culture and Moore recommended removal of small oysters from crowded bottoms to other suitable areas.

In July 1914, Thurlow C. Nelson (1914) of the University of Wisconsin came to Alabama at the request of Mr. Joullian, Secretary of the Alabama Oyster Commission, to study mortality of planted seed oysters in Alabama waters, principally those in Portersville Bay. He examined both private leases and public reefs recording dates and amounts planted, condition of oysters and other data. He concluded that in every area where oysters died the bottom was either too soft or that the bottom was unstable or shifting in nature and that oysters planted on suitable bottoms were not affected by the mortality observed during February and March 1914. He completely dismissed the oyster drill as playing any part in the mortality.

In May 1929, Dr. Paul Galtsoff (1930) of the U. S. Bureau of Fisheries made a study of the oyster reefs of Alabama following the 1929 flood. He used oyster dredges to sample the reefs to determine mortality. His study showed that between 55% and 100% of the oysters on the reefs in Mobile Bay and Mississippi Sound were destroyed by the flood. He concluded that all commercially important oyster bottoms in Mobile Bay were destroyed and that the reefs could be rehabilitated only by establishing "spawning beds", planting shell near the spawning beds and planting seed oysters. He recommended that state law prohibit leasing of public oyster bottoms and that development of public reefs should be a state responsibility.

During November and December 1943, James B. Engle (1945) of the U. S. Fish and Wildlife Service made a survey of the oyster bottoms of Alabama to determine the conditions of the reefs to improve rehabilitation of depleted reefs and improve cultivation methods. This survey followed an examination of the reefs by the Department of Conservation in 1941-1942 which revealed heavy mortality. Engle recommended planting shell and seed oysters and enforcement of the culling law. During December 1947 Engle (1948) made another survey following the hurricane of 1947. He found damage restricted mostly to the northern area of Mississippi Sound where oysters had been covered by soft mud to depths up to 1 foot. Most of the producing bottoms in Mobile Bay were unaffected. He recommended that bottoms in much of the Mississippi Sound area were too soft to support oysters or shell and that plantings should be done only on suitable bottoms. He also observed that considerable damage to oysters was caused by oyster drills along the northern shores of Mississippi Sound. Ritter (1896) had commented upon the freshness of the waters of the northern portion of the Sound. In an addendum to Ritter's paper, a note by Mr. John J. Delchamps stated that "whelks" have become a problem and that "This is the first year (1894?) that I have heard complaints of their destructiveness". Increased salinity and oyster drill activity apparently became prevalent between the early 1900's and the 1940's presumably due to migration and widening of the pass between Dauphin and Petit Bois islands.

Bell (1952) surveyed the oyster reefs during the summer of 1951 in fulfilling requirements of a M.S. thesis for Texas A & M University. He surveyed 5,912 acres of public oyster beds of which 3,284 acres were considered to contain a fishable density. The oyster beds were found generally to be in good condition with good spat set. He encouraged increasing the area under private lease.

May (1971) surveyed both the public oyster reefs and the buried shell deposits during 1968 and 1969. He surveyed 3,064 acres of natural oyster bottoms. He stated that there were 924 acres of leased bottoms and 1,050 acres of riparian bottoms which ocassionally produced oysters. He did extensive sampling on the reefs using scuba to determine the density of oysters, spat, boxes, mud crabs and oyster drills and presented data on the commercial fishery and factors affecting oyster production. Oyster density was considerably lower in 1969 than during earlier surveys and he concluded that there were about 60 thousand acres of bottoms in Alabama which are firm enough to support oysters. The buried shell deposits totaled more than 93 million cubic yards of which approximately 46 million were recoverable. He contributed significantly to the knowledge of the Alabama oyster fishery in papers dealing with summer oyster mortalities (May, 1968), oyster culture (May, 1969), oyster survival (May and Bland, 1970), surveying oyster deposits (May and McLain, 1970), effect of floodwaters (May, 1972a), oyster fishery (May, 1972b), diseases (Beckert, Bland and May, 1972), dredging (May, 1973a), oxygen depletion (May, 1973b) and mud crab abundance on oyster reefs (May, 1974).

Other research concerning oysters in Alabama include Casper et al. (1969), Engle (1936), Gallagher et al. (1969), Hoese, Nelson and Beckert (1972), and McClellan (1965).

PROBLEMS IN OYSTER MANAGEMENT

Biological and socioeconomic problems have plagued the oyster fishery during historical times. Spring floods, pollution, low dissolved oxygen, oyster predators and diseases together with insufficient funding, indifferent fishermen and administration, and bi-county bickering have all had effects on the fishery.

A total of 73,584 acres of Alabama waters are permanently closed to shellfish harvest (May, 1971) and almost all of the remainder is temporarily closed due to bacterial contamination during winter and spring flood periods. While there are only two small reefs within the permanently closed areas, the temporary closures of the major reefs caused an estimated loss to the fishermen of $2,000 per day or an estimated total of $282 thousand during 1968 and 1969 (May, 1971). Closures last from a few weeks to 4 months or longer depending upon the magnitude of the winter and spring flooding. Winter floods have also caused extensive oyster mortalities in Alabama. During the 1929 flood, mortalities ranged from 100% in upper Mobile Bay and from 54% to 84% in the lower bay (Galtsoff, 1930). Other extensive mortalities were recorded in 1912, 1953, 1961 and in 1973 when 42% of all oysters in the state were killed (Hughes and May, 1975).

Within limits decreased salinity is beneficial in that the oyster drill, *Thais haemostoma*, is salinophilic. In the spring and summer of 1967, 80 to 95% of the oysters less than 2 inches were killed on some Alabama reefs by drills (May, 1971). Spat set in Alabama is highest in the saline waters of Mississippi Sound but survival is negligible due to oyster drills (Hoese, Nelson and Beckert, 1972). The number of drills on some Alabama reefs outnumber oysters and spat combined (May, 1971). Mud crabs are also predators on small oysters and spat and may transmit oyster diseases. May (1974) found that the number of mud crabs ranged from none per acre on some of the more northern reefs to 62,000 per acre in the lower bay. Low salinities also inhibit development of *Labyrinthomyxa marina*, a parasitic fungus affecting oysters (Ray, 1954).

The effects of small amounts of pesticides upon oysters is not fully understood. Levels of certain pesticides as low as 10 parts per billion (ppb) may inhibit growth of oysters (Butler, 1969) and oysters can concentrate pesticides within the tissues to levels much higher than found in surrounding waters (Butler, 1966). The levels of DDT residues in mollusks, however, has declined markedly in most estuaries (Butler, 1973) and residues in Alabama oysters are far below levels considered harmful from a public health standpoint (Casper et al., 1969).

Low dissolved oxygen in certain areas of Mobile Bay has caused oyster mortalities as high as 100% and is responsible for poor spat set (May, 1973b). During 1967, approximately 1,000 acres of oysters valued at $500 thousand were lost due to low dissolved oxygen and during 1971 more than 2.6 million oysters were lost due to the same cause (May, 1973b). Reefs in the middle portion of Mobile Bay and Bon Secour Bay have a long history of poor spat set (Ritter, 1896; Bell, 1952) which is likely due in part to low dissolved oxygen (May, 1973b). This low dissolved oxygen phenomenon has been known locally for more than a century as "jubilees" (Loesch, 1960; May, 1973b). Other contributing factors to poor spat set are thought to be spring freshets (May, 1972a) and existing current patterns (Hoese, Nelson and Beckert, 1972).

Current patterns have changed somewhat due to spoil deposition adjacent to the Mobile Ship Channel. The channel has also caused saltwater penetration inland from the Gulf (Ryan, 1969). May (1971) considered changes in salinity and current patterns more detrimental to oyster resources than siltation or physical destruction due to channel construction. Physical destruction of oysters has occurred during construction of Grants Pass in 1838, Pass aux Herons (ca. 1912) and the Gulf Intracoastal Waterway in the late 1930's. Spoil from these channels was placed in some instances on nearby oyster reefs. Increased salinity in Portersville Bay resulting from the natural westward migration of Dauphin and Petit Bois islands has destroyed the oyster resources in Portersville Bay. The width of the pass between the two islands has increased from 1.5 nautical miles in 1851 to about 5 nautical miles (May, 1971) increasing the salinity throughout Mississippi Sound.

Socioeconomic problems also affect the industry. Overfishing was mentioned by Ritter (1896) as the cause of depletion of certain reefs in Alabama. Nelson (1914), Galtsoff (1930) and Engle (1936) also considered overfishing of the more accessible reefs, failure to return shells to the reefs, and use of oyster dredges as major factors in depletion of the reefs. These conclusions must be considered; however, many biological factors affecting oysters were unknown at those times. While the effects of high fishing pressure is not fully understood, continued fishing of the more accessible reefs and little or no utilization of less accessible reefs is a poor method of exploiting a resource. At least 90% of the fishing pressure is expended on Cedar Point Reef even though less accessible reefs such as Sand Reef, Buoy Reef, King's Bayou and others periodically have oyster densities equally as high. One valid example of overfishing was during the 1966-1967 steam oyster season. The size of legal oysters was reduced and thousands of barrels of small oysters were taken to the canneries in Mississippi. The oyster harvest was considerably reduced for several years following the steam season (May, 1971).

Bickering between oyster fishermen of Baldwin and Mobile counties and among fishermen within each county sometimes has hampered effective management and improvement of the fishery. The eastern shore historically has had a poor oyster set (Ritter, 1896; Hoese, Nelson and Beckert, 1972) and production there is sporatic. The Mobile County fishermen greatly resent attempts by Baldwin County fishermen to obtain seed oysters from reefs in Mobile County. This led to an armed confrontation between the two groups in the 1960's. Also, most shell planting by the state has historically been on the better producing reefs of Mobile County which has caused resentment among the Baldwin County fishermen. During 1975, seed oysters in two locations in Mobile County were made available to a small group of Mobile County fishermen for planting on their leased bottoms. Both areas were in polluted, permanently closed areas and considerable effort was made by the Marine Resources Division to obtain authorization from the Department of Health to move these oysters. The lessees were indifferent to obtaining oysters from one location and permission to obtain oysters from the other was withdrawn after a petition was circulated by other Mobile County fishermen objecting to removal of oysters from public bottoms (even though permanently closed) to a private lease.

The oyster fishery itself contributes almost nothing to reef improvement and, as in all coastal states, is heavily subsidized by the state. During the period from 1960 to 1968 the Marine Resources Division planted 454,934 barrels of shell and 254,499 barrels of seed oysters on the public reefs of Alabama. During this same time revenue received from the oyster fishery amounted to about $9,000 per year, or 2% of the dockside value of the fishery (May, 1971). During 1968, 1970, 1972, 1974 and 1975 a total of $396 thousand was spent by the Marine Resources Division to plant shell following extremely high mortalities on the oyster reefs. These funds were made available by the U. S. Department of Commerce under Public Law 88-309, Section 4(b) for fisheries disaster relief. Were these funds not available, it would have been impossible for the state to fund shell planting programs of this scope. Lack of funds historically has been a cause of little development of suitable bottoms, but it is questionable whether governmental subsidies except following natural disasters are the solution. Lack of seed oysters has reduced interest in developing leases and riparian bottoms but the recent development in producing cultchless seed oysters in hatcheries may provide needed stimulation to private development of the fishery. However, closures due to pollution have become more frequent and of longer duration since the 1950's and have certainly decreased interest in extensive development of the fishery by either private enterprise or governmental agencies.

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