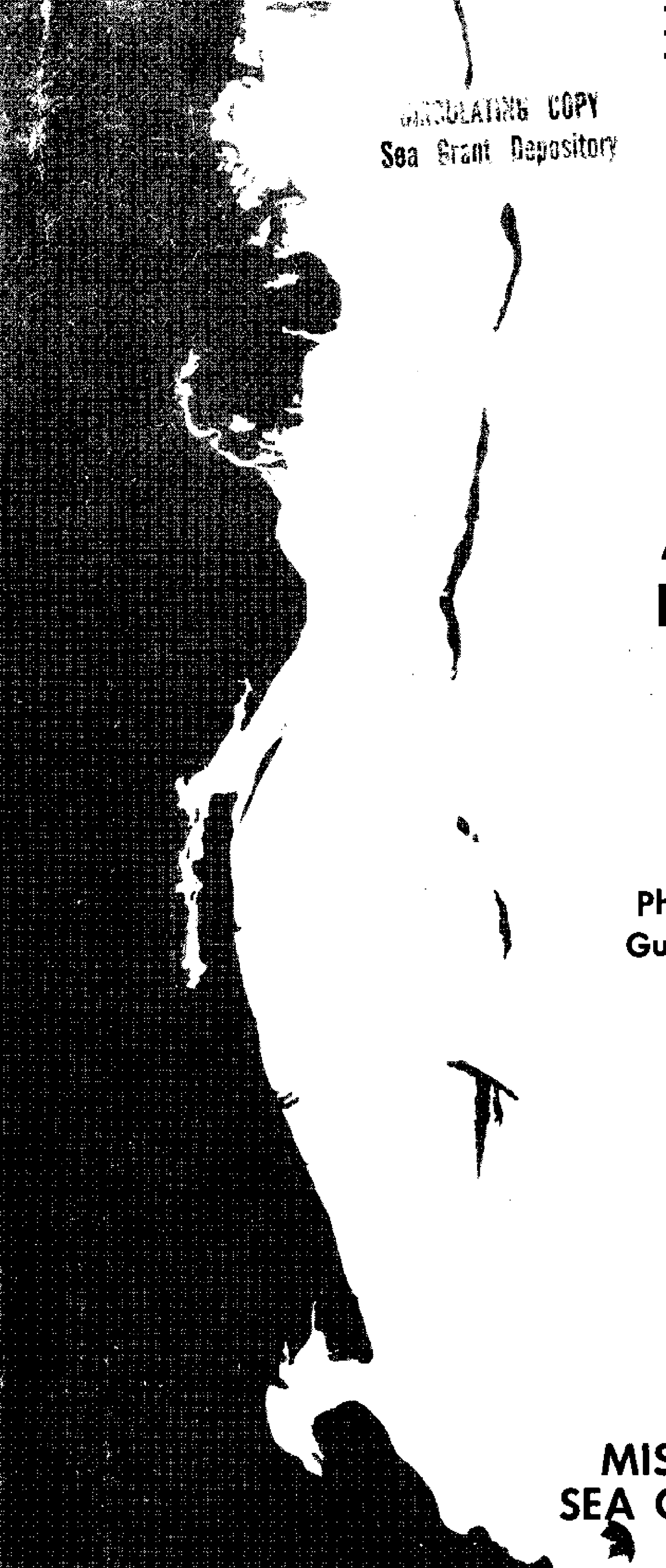


MISSISSIPPI SOUND

SALINITY DISTRIBUTION AND INDICATED FLOW PATTERNS

Charles K. Eleuterius
Physical Oceanography Section
Gulf Coast Research Laboratory
Ocean Springs, Mississippi

MISSISSIPPI-ALABAMA
SEA GRANT CONSORTIUM
MASGP - 76 - 023

MISSISSIPPI SOUND SALINITY DISTRIBUTION AND INDICATED FLOW PATTERNS

by

Charles K. Eleuterius
Physical Oceanography Section
Gulf Coast Research Laboratory
Ocean Springs, Mississippi 39564

Prepared for

MISSISSIPPI-ALABAMA SEA GRANT CONSORTIUM
Ocean Springs, Mississippi

Sea Grant Publication MASG-76-023

This work is a result of research sponsored in part by NOAA Office of Sea Grant, Department of Commerce, under Grant # 04-5-158-54. The U. S. Government is authorized to produce and distribute prints for governmental purposes notwithstanding any copyright notation that may appear hereon.

ACKNOWLEDGMENTS

Thanks are due the staff of Gulf Coast Research Laboratory's Computer Center for the efficient and timely manner in which requests for data processing services were handled.
Miss Dianne Jones, (Acting) Director of the Mississippi-Alabama Sea Grant Consortium, has been most helpful since the initiation of the project. Her willing assists were appreciated.

Special thanks go to Messrs. Chris Moran, Glen Messer, Francis Powell, James French, Dennis Stapp and George Higgins. Their conscientious attitude and perseverance, often under somewhat less than ideal conditions, are to be commended.

To Mrs. Joyce Randall Edwards I am indebted because of the many burdensome tasks that she handles with such efficiency and expertise. My personal thanks are due here for her efforts in organizing, restructuring, typing and collating this report.

Any errors appearing within are reserved for the author.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF PHOTOGRAPHS

INTRODUCTION

Mississippi Sound (Figure 1), located on the northeastern Gulf of Mexico, is an elongate water body with its major axis oriented parallel to the Gulf. A series of barrier islands mark the seaward boundary of the Sound. Some of these islands: Dauphin, Petit Bois, Horn, and Ship, are a part of the Gulf Islands National Seashore. The western boundary bisects Halfmoon Island, formerly known as Grand Island. Narrow peninsulas and shallow shell reefs connecting Dauphin Island to the mainland separate the Sound from Mobile Bay on the east.

The tides of Mississippi Sound are diurnal with an average range of 1.8 feet at Biloxi Bay. The two principal diurnal components of the tide are K_1 and O_1 with periods of 23.93 and 25.84 hours, respectively. The tides are modified by the bathymetry, geometry of the basin, river discharge and winds. Sustained south and southeast winds push water into the Sound piling it against the mainland. North winds have the opposite effect, driving the water out.

The Sound is a relatively shallow basin with an average depth of 9.9 feet. The greater depths, caused by tidal scouring action, are located at the immediate western tips of the islands. A second, shallower cut is found about midway of the pass between Horn and Ship islands. With the exception of these deep cuts, the passes are predominantly shoal areas. In the Sound west of Cat Island is an extensive area of both live and dead oyster reefs.

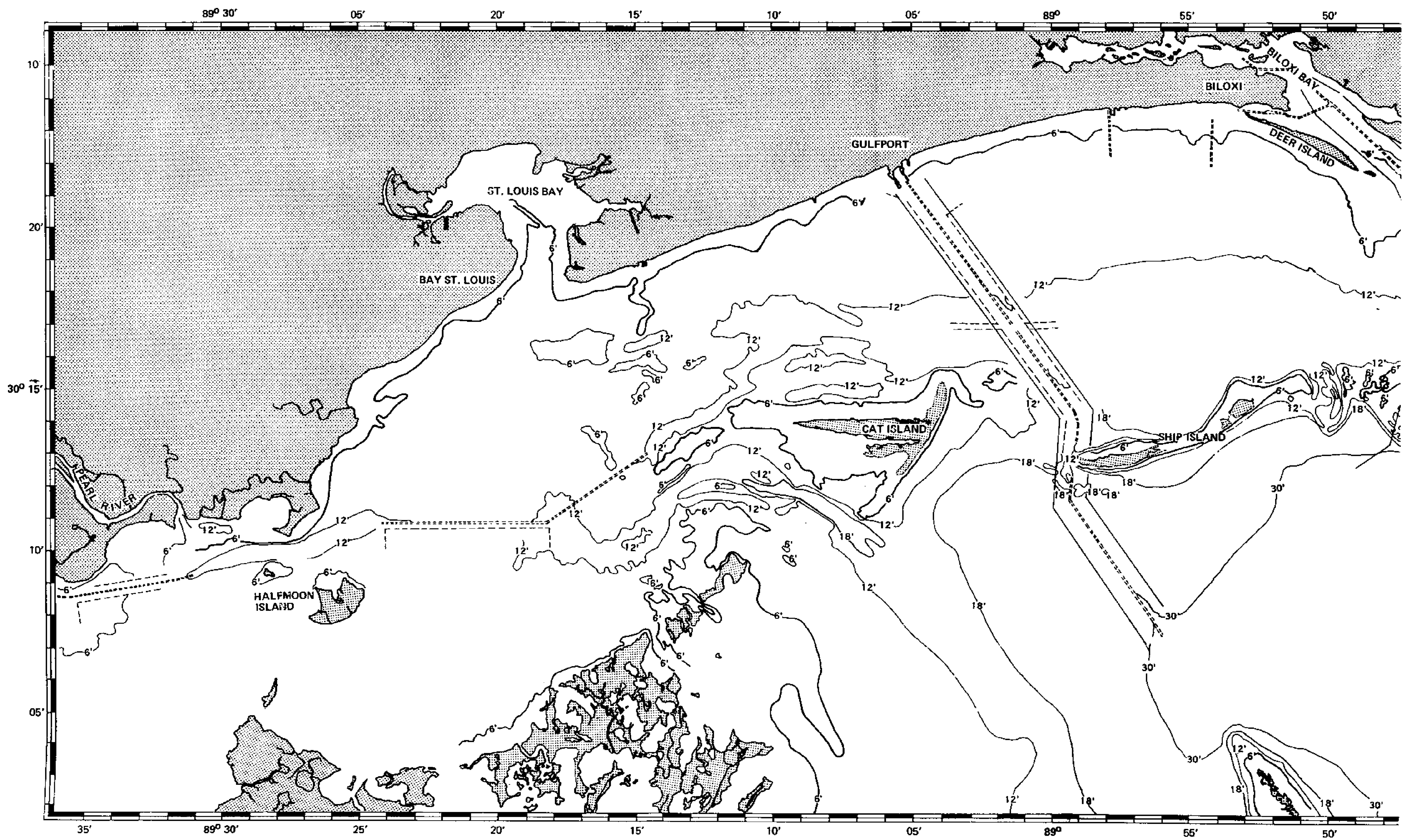
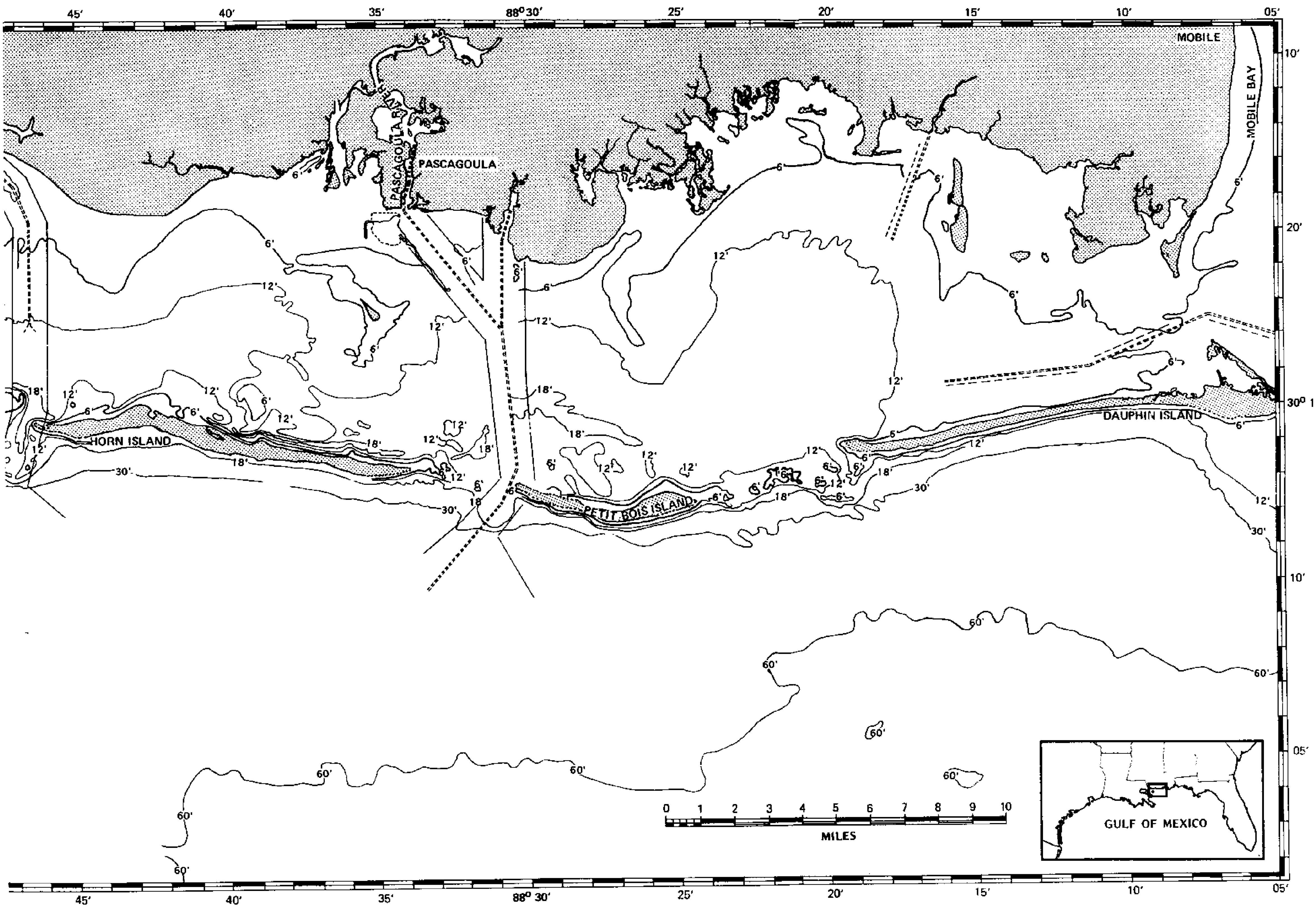


Figure 1. Map of Study Area: Missis


45′
40′
35′
88° 30′
25′
20′
15′
10′
05′
MOBILE
MOBILE BAY
PASCAGOULA BAY
PASCAGOULA
HORN ISLAND
PETIT BOIS ISLAND
DAUPHIN ISLAND
30° 15′
GULF OF MEXICO
0 1 2 3 4 5 6 7 8 9 10
MILES

sippi Sound.

Three channels traverse Mississippi Sound from the Gulf to the mainland. The ports at Pascagoula and Gulfport have deep water access by two of these channels with authorized depths of 40 and 32 feet, respectively. The third, Biloxi Channel, used primarily by barge, commercial fishing fleet and pleasure craft, has an authorized depth of 12 feet. A fourth channel, the Intracoastal Waterway, spans the east-west length of the Sound. Since the natural bathymetry along the waterway is greater than the authorized depth of 12 feet except in the area west of Cat Island and east of the west tip of Dauphin Island, dredging is necessary only in these shallower areas. The customary practice of disposal of dredge spoil from maintenance dredging operations in this area has been placement of the spoil alongside the channel.

Pascagoula River empties directly into the Sound with an average flow of 13,369.4 cubic feet per second. The Biloxi and Tchoutacabouffa rivers with average flows of 493.5 CFS and 436.6 CFS, respectively, reach the Sound via Biloxi Bay. The Jourdan and Wolf rivers empty into St. Louis Bay with average flows, respectively, of 1,535.4 CFS and 705.9 CFS. The mouth of the Pearl River is located on Lake Borgne approximately 3.5 miles west of the boundary where the lake and Sound waters merge indistinguishably. Pearl River has an average flow of 11,580.3 CFS. It has been estimated (Austin 1954) that one-fifth of the discharge from Mobile Bay is diverted into Mississippi Sound mainly via Grants Pass. Besides rainfall and direct runoff, additional fresh water is contributed to the Sound by numerous tidal bayous.

Mississippi Sound, an estuarine system, is an integral part of what Gunter (1963) described as the "Fertile Fisheries Crescent." This name refers to the area encompassed by a figurative arc extending into the Gulf of Mexico from Pascagoula, Mississippi, to Port Arthur, Texas. Since the area inscribed produced over 20 percent of the total fishery landings of the United States in 1961 and 1962, the name is appropriate. The same area now produces an even larger percentage of landings. A recent look at the State of Mississippi mainland coastline (Gunter 1976) shows "that this state lands more commercial fishery products per mile of shoreline than any other state in the nation."

The Mississippi coast became well established as a resort area in the latter part of the nineteenth century. Tourism has continued to flourish and represents a notable portion of the economy. The development of the Mississippi coastal area has been rapid and largely confined to a band approximately five miles wide spanning almost the entire shoreline. This concentration of population and industry has had associated with it many of the well-known environmental problems of pollution, dredging, coastal construction, conflicting uses of resources, alteration, and in some instances, destruction of the marine environment.

The Sound is the eventual recipient of the accumulative effluents from activities throughout the drainage basin and is further altered by other direct actions such as dredging and construction. In order to assess the effect of present and future development on the hydrography of the Sound, it is necessary to ascertain the descriptive norms and dynamics that characterize the Sound. Knowledge of the hydrography of the estuarine system is essential to the intelligent planning and design of coastal development, navigation, the supply and disposal of municipal and industrial waters, and in interpretation of biotic studies. Prior to the Mississippi Sound study, the results of which are to be reported in part here, very little information on the hydrography of the Sound existed.

Hydrographic measurements of Mississippi Sound waters made before 1971 were usually taken in connection with biological or geological investigations. Sampling techniques rightly designed for solving problems falling within the realm of those particular disciplines were limited in furthering knowledge of the hydrography. The areal and temporal constraints of such investigations render the value of the hydrographic data to general baseline conditions.

Gunter (Christmas 1973) made monthly measurements of surface and bottom salinity in Mississippi Sound during 1946-1947. In surveying hurricane damage to Mississippi oyster reefs, Engle (1948) made salinity determinations in November 1947. From these measurements he noted a decrease in salinity from east to west through the Sound. Dr. A. E. Hopkins (Demoran 1975) reportedly collected daily readings of water temperature and salinity at Biloxi, Mississippi, for the years 1947 through 1949. Gunter (1950), in a report on the effects of the 1950 opening of the Bonnet Carré Spillway on Mississippi's oyster reefs, included considerable surface salinity data for the western portion of the Sound.

In comparison of salinity levels between mainland and barrier island sites, Christmas, Gunter and Musgrave (1966) reported that lower average values prevailed near the mainland but with much greater variation. They also noted the general longitudinal decline in salinity in the Sound from east to west. It was suggested that the common occurrence of lower salinity waters west of the estuaries was possibly due to the effect of Coriolis force.

A study (Upshaw, Creath and Brooks 1966) of the microfauna and sediments of an area that included the Sound produced a set of water temperature and salinity measurements made near the bottom. A bacteriological study of Mississippi oyster bottoms (Cook 1969) yielded measurements of salinity, water temperature and pH along four north-south transects of the Sound.

Christmas and Eleuterius (1973) published the results of the hydrographic phase of a three-year survey of Mississippi's estuarine waters. The hydrological measurements were made in connection with and limited to the biological sampling effort. The data from stations within "zones" were pooled to produce general time trends of levels of water temperature, salinity, pH, nitrite, nitrate, orthophosphate and total phosphate for surface and bottom waters. The western portion of the Sound consistently showed a more uniform water column.

Construction of bimonthly temperature and salinity charts from averaging pooled data showed some of the larger, more permanent circulatory features. The westward deflection of the outflow from the west mouth of the Pascagoula River was apparent from the charts.

Decreasing salinity westward across the St. Louis Bay entrance implicated Coriolis force as influencing the circulation in that area.

A remote sensing study (Atwell 1973a) of Mississippi Sound was initiated in April 1971 by NASA Earth Resources Laboratory. While its primary objective was the test and development of remote sensing techniques, considerable information was gained on the hydrography of surface waters. It must be mentioned that the infrared sensors used measure only the upper 0.02 mm of the water and this proved to be nonrepresentative of the upper few inches. The western portion of the Sound was identified as being an area of low salinity with little variation in temperature and low water clarity. These characteristics were attributed to the restricted communication between this area and the Gulf of Mexico. Atwell described this area as being "the most quiescent" of Mississippi Sound.

A more comprehensive analysis and interpretation of these and other data were reported by Atwell (1973b). Among the variables discussed in these two reports were surface salinity, chlorophyll, water transparency and surface water temperature. Of particular significance was the discovery that Sound waters are traceable over ten miles out into the Gulf of Mexico. The flow patterns implied by the spatial distribution of temperature and salinity were generally in agreement with those presented earlier by Christmas and Eleuterius (1973). On the basis of data collected remotely and by conventional means, it was suggested that the Sound could be divided into three hydrologic regimes: the eastern portion dominated by Mobile Bay water inflow and related dynamics of Petit Bois Pass; the central portion defined mainly by the flux through the island passes; and the western portion described as "quiescent."

On 1 January 1973 the Physical Oceanography Section of Gulf Coast Research Laboratory initiated a three-year investigation of the hydrography of Mississippi Sound funded by the National Oceanic and Atmospheric Administration's Sea Grant Program and administered through Mississippi's Universities Marine Center (Mississippi-Alabama Sea Grant Consortium). The primary objectives of the Mississippi Sound research effort were to provide a description of flow patterns; determine the salinity and temperature characteristics; and to ascertain the temporal and spatial distribution of nutrients. The results, due to the scope of the project, will be reported in several technical reports and scientific journals.

METHODS

Sampling stations were established throughout Mississippi Sound (Figure 2) with their locations being determined, first, on the basis of the probable value of the hydrographic information they would provide; and second, on the ability to reoccupy those sites under various weather conditions. With the accuracy of Loran-A within the Sound being unacceptable and use of alternate navigation systems too costly, it was necessary to locate stations by means of landmarks, buoys and day markers. Station sitings constrained by the second criterion precluded an arrangement of stations that would have yielded more definitive information.

Initially, eighty-five station sites were selected and numbered using the odd integers not assigned to sites in previous investigations. When preliminary analysis indicated the need for additional stations to clarify circulation patterns in an area, they were established and assigned even integer numbers.

The number of stations and the vastness of the area precluded the possibility of covering the entire Sound in a single cruise. The Sound was divided into three overlapping segments that can best be described by their east-west linear extents as follows: the eastern segment extended from the west tip of Dauphin Island to the east tip of Ship Island; the middle section covered the area from the west end of Horn Island to near the west end of Cat Island; the

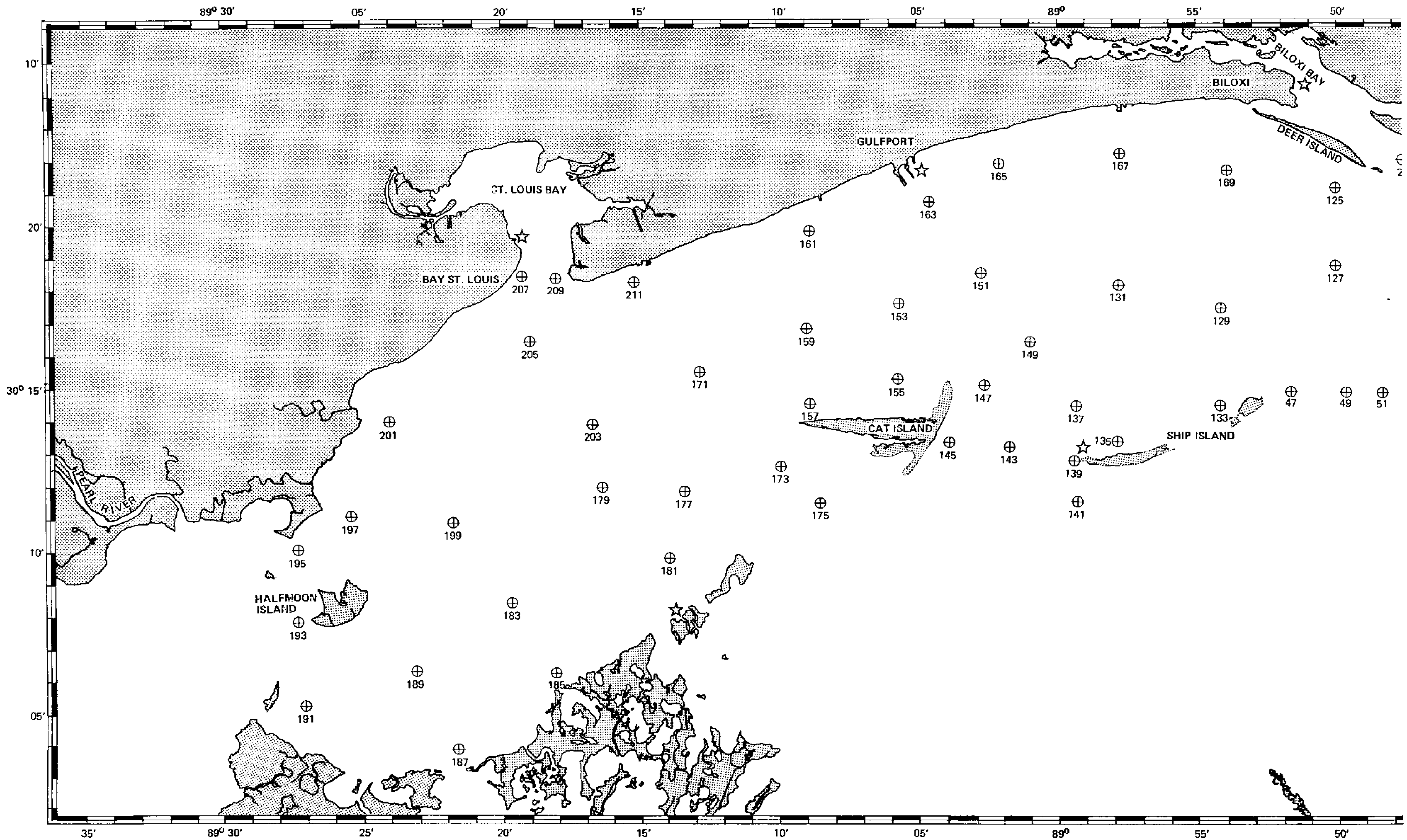
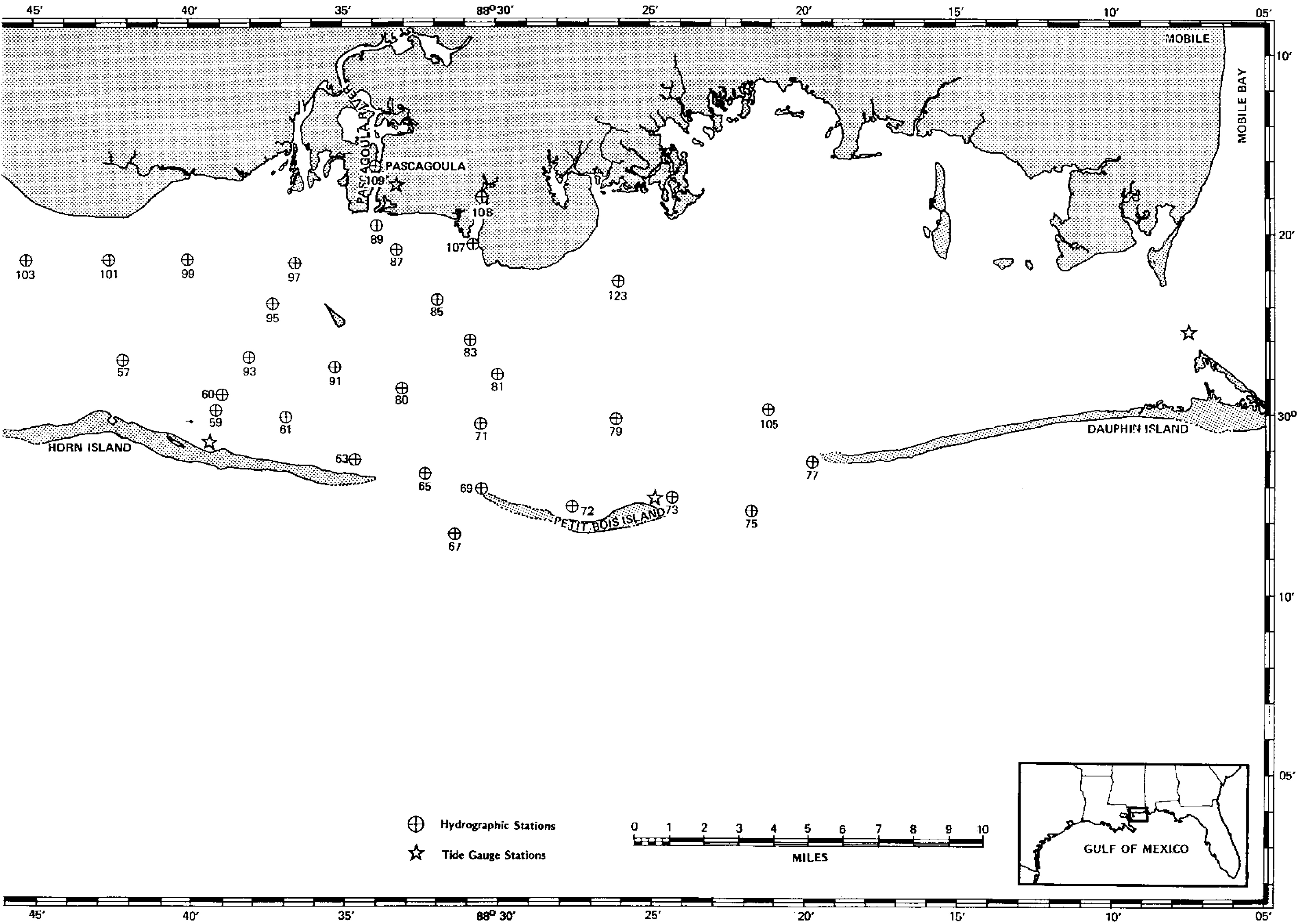


Figure 2. Locations of Hydrographic and Ti


45'
40'
35'
88° 30'
25'
20'
15'
10'
05'
MOBILE
MOBILE BAY
PASCAGOULA RIVER
PASCAGOULA
HORN ISLAND
PETIT BOIS ISLAND
DAUPHIN ISLAND
30° 15'
20'
10'
05'
Hydrographic Stations
Tide Gauge Stations
MILES
GULF OF MEXICO

ge Stations.

western section extended fron near the west end of Cat Island to just west of Half Moon Island. The three sections were overlapping in that stations on boundaries common to adjacent sections were occupied when cruises were conducted in either of the adjacent areas. Cruises rotated among the three areas except during the first year when work was confined to the eastern section on recommendation of the local Sea Grant office.

In order to obtain additional information on the tidal current regime of the Sound, four tide gauge stations were established near the mainland side of the barrier islands. Installation of these stations entailed considerable labor in the construction of platforms and stilling wells. Photographs of these tide gauge stations appear elsewhere in this report. The stations were instrumented with Leupold-Stevens, type A, water level recorders. Time entered on the strip charts initially and at approximately two-week intervals was furnished by a quartz crystal clock set to WWV time. Records from these stations supplement those from mainland gauges maintained by the U. S. Army Corps of Engineers.

The research vessel, Seiche, is a twenty-nine foot, aluminum alloy, single-screw offshore survey boat powered by a 6v-53 General Motors diesel engine. The boat, specially designed to satisfy the requirements of the oil industry's offshore operations, proved to be ideally suited for the demands of hydrographic research. The boat was equipped with a Johnson citizen's band radio, Ray Jefferson VHF radio, Decca model 050 radar and an Apelco depth recorder.

A Martek, model II, water quality analyzer, modified by a member of the Laboratory staff, was used in obtaining measurements of temperature, conductivity, pH and dissolved oxygen through the water column. Readings were taken near the surface (< 1 foot) and descending depths at multiples of the interval of five feet with respect to the surface. If the distance between the bottom and the last reading taken was greater than one-half of the standard interval (5 feet), a reading was obtained for that depth. The accuracy of the instrument is reported to be: temperature, ± 0.5C; conductivity, ±0.2 mmho/cm; pH, ±0.1; dissolved oxygen, ±0.5 ppm. The instrument was tested and recalibrated, if necessary, before each cruise. The reason for adopting this particular interval (5 feet) was to enable the comparison with and utilize data formerly collected using this procedure.

Samples of surface waters were collected at each station and from near-bottom at select stations. Surface water was taken by bucket while a Van Dorn sampler was used to obtain bottom water. The waters were transferred to Whirl Pak sample bags and immediately placed on ice. Determinations for levels of nitrite-nitrogen, nitrate-nitrogen, orthophosphate and total phosphate were later made. The results and interpretations of the occurrence and distribution of these nutrients will be reported separately.

A Bendix psychrometer was used to obtain air temperature and dew point. A GM precision bucket thermometer was employed to verify water temperature readings from the Martek by comparison of near-surface values. A salinity determination of surface water was also made, post cruise, by means of a Plessey precision salinometer and using Copenhagen standard seawater to confirm the validity of the Martek conductivity readings.

All measurements and observations were entered directly onto specially designed computer coding forms with the exception of nutrients which were entered upon receiving the results of the chemical analysis. Coded data were submitted to the GCRL Computer Center for keypunching. The encoded data were verified and processed.

Several computer programs were written for the Laboratory's IBM 1130, model 2B, computer by the principal investigator to process the hydrographic data. Programs employing the on-line Houston Electronics incremental plotter generated trend charts and isopleth work sheets. Descriptive statistics for each station for all hydrographic variables were also computed.

The computer-generated isohaline work sheets consisted of the positions of specified salinity levels arrived at by linear interpolation between stations. From these computer plots, separate charts of isohalines were constructed for the surface and depths of 5, 10 and 15 feet wherever feasible. To provide a more informative picture of the relationship, both laterally and vertically, of the flow and salinity distribution at these depths, composites of the individual charts were made. The convention used in constructing the salinity distribution charts was limiting the isohalines constructed to 2.0 ppt intervals beginning with 0.0 ppt. This convention permitted the configuration of flow to be illustrated while avoiding too great a density of isohalines which make the charts illegible. Furthermore, it facilitated comparison of conditions throughout the study period in this highly variable estuary. The isopleths are coded as indicated in the chart legends in order to distinguish between the particular depths.

Flow rates of rivers affecting Mississippi Sound hydrography and for which data were available for the period of the study are shown in Figures 3, 4, 5 and 6.

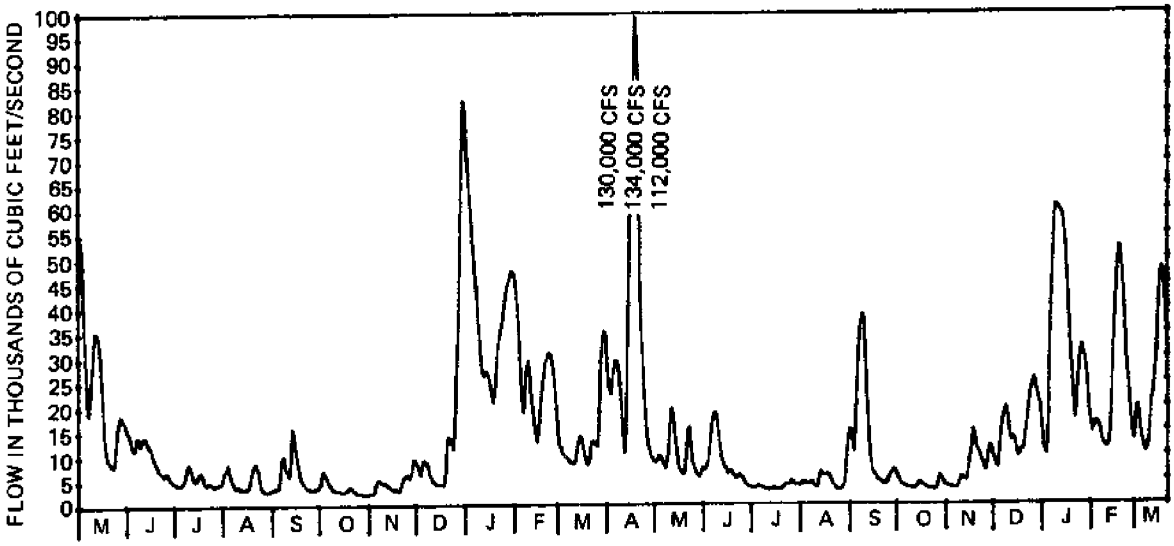


Figure 3. Flow of Pascagoula River at Merrill, Mississippi from 1 May 1973 through March 1975.

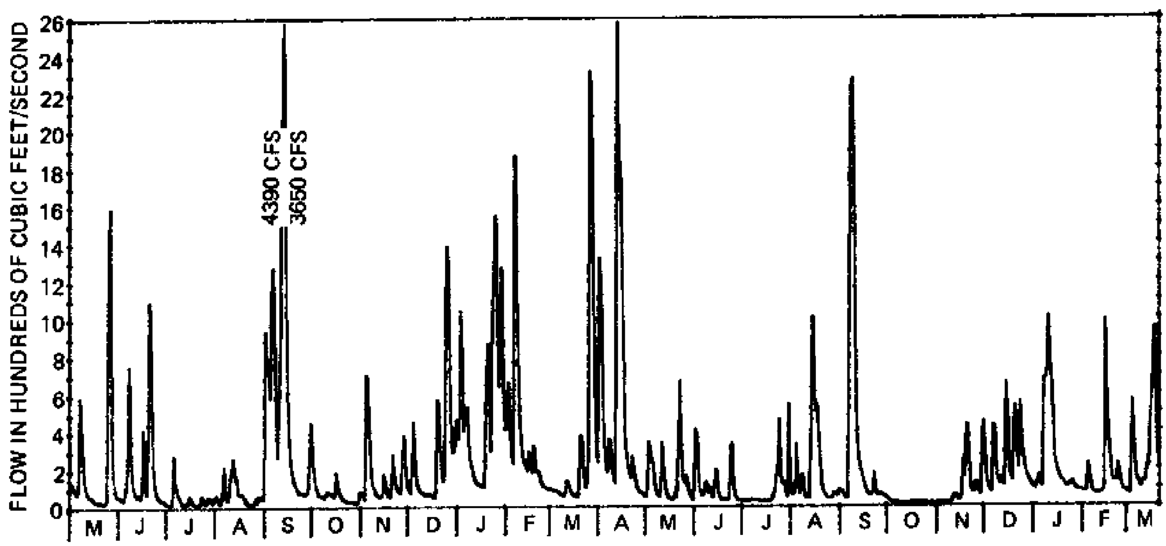


Figure 4. Flow of Biloxi River at Wortham, Mississippi from 1 May 1973 through March 1975.

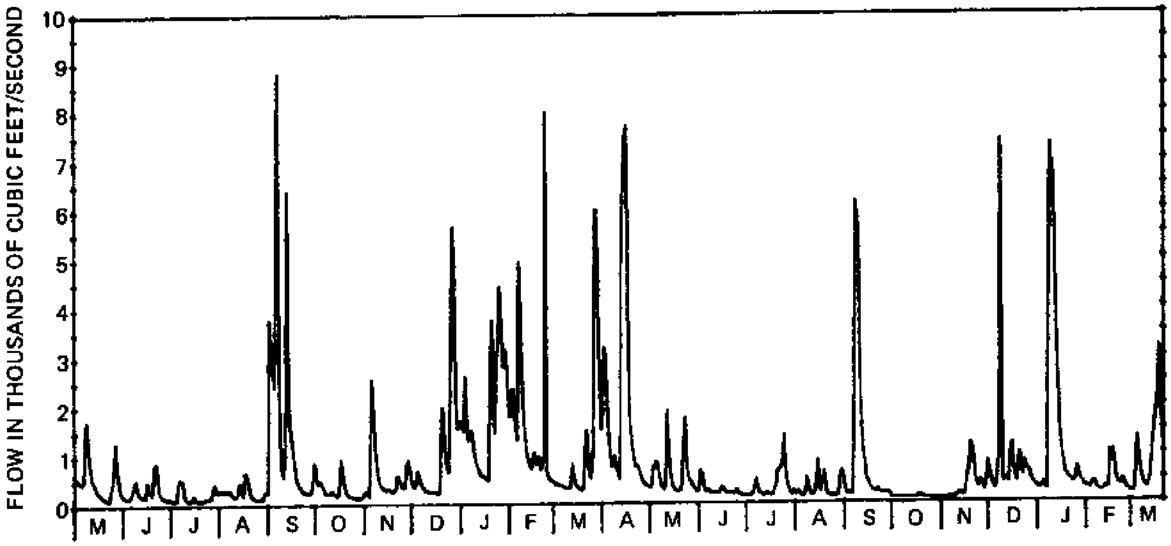


Figure 5. Flow of Wolf River at Landon, Mississippi from 1 May 1973 through March 1975.

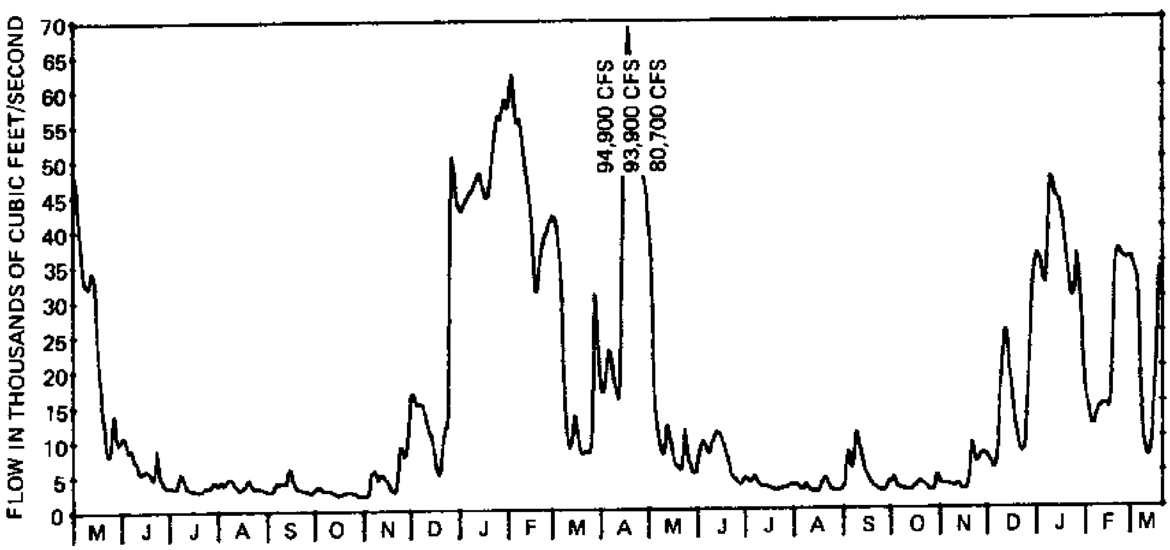
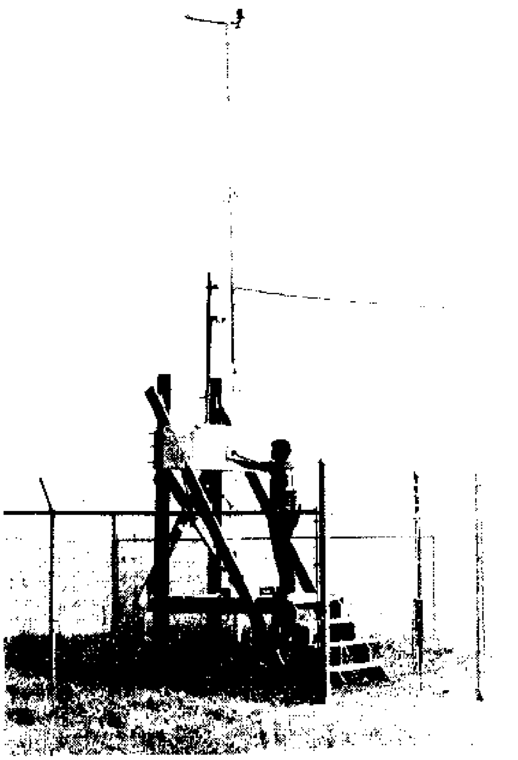


Figure 6. Flow of Pearl River near Bogalusa, Louisiana from 1 May 1973 through March 1975.



Wind gauge station at Point Cadet, Biloxi, Mississippi.

Chris Moran taking readings of water temperature, conductivity, pH, and dissolved oxygen.

Francis Powell obtaining water samples for chemical analysis.

Joyce Edwards, Physical Oceanography Section, consults with David Boyes, computer programmer.

EAST MISSISSIPPI SOUND

The hydrographic investigation of the area of Mississippi Sound from the west end of Dauphin Island to the east end of Ship Island was conducted from June 1973 through June 1974. The salinity regime of this area is determined largely by the influx of Gulf waters through Petit Bois, Horn Island and Dog Keys passes; inflow of Mobile Bay waters entering the east end of the area; outflow of the East and West Pascagoula rivers; and the discharge from Biloxi Bay. The short-duration altering of the horizontal and vertical salinity structure by direct precipitation was not considered in this study.

The horizontal and vertical distributions of salinity in the east Sound area for each cruise date are shown in Figures 7-24. For the sake of brevity, the author restricts remarks to describing the general circulatory features, seasonal variations in salinity and particular subtle but pertinent situations. For more detailed information on the salinity distribution and circulation, one's attention is directed to the illustrations, statistics in the Appendix and forthcoming papers.

The outflow from the west passage of Pascagoula River is one of the most important factors dictating the salinity regime in the Sound leeward of Horn Island. Because the outflow from the east passage of the Pascagoula River is guided directly seaward by dredge spoil placed along the west side of the channel, the outflow from the west passage is the major source of freshwater in this area.

The core of the discharge from the west passage of Pascagoula River, except during high flow periods, follows the shoreline westward past Graveline Bayou where the shoreline turns southwest. At this point the flow moves toward the southwest and exits through Dog Keys Pass. When the Biloxi and Tchoutacabouffa rivers reach high flow stages, part of the outflow exits through Biloxi Bay's east entrance between Deer Island and Marsh Point. This discharge from Biloxi Bay merges with that from Pascagoula River's west passage south of Bellefontaine Beach. Incoming tides through Dog Keys Pass act to deflect the Pascagoula west passage outflow into a more southerly route across the Sound.

The channel that transects the Sound from Horn Island Pass (passage between Petit Bois and Horn islands) to the east passage of Pascagoula River evolved into the 40-foot deep (authorized depth), 350-foot wide ship channel in stages. Continual lateral deposition of dredge spoil from construction and periodic maintenance dredging operations has created an almost unbroken ridge paralleling the channel. This "spoil" ridge, greater than mean sea level for approximately two miles, reaches heights in excess of 15 feet. The ridge continues further seaward but only slightly submerged. The presence of this weir prevents the near-shore westward spreading of the outflow. Instead, that portion of the river outflow that would move westward is guided approximately two miles toward the southeast by the "dredge spoil" weir before it is permitted to move freely to the west.

The channel permits the intrusion of waters, high in salinity, into Mississippi Sound from the Gulf than would otherwise occur. However, this study shows that the channel waters located below the natural depth of the contiguous Sound are largely confined to the channel. An abrupt increase (10.0 ppt) in salinity was often encountered at a depth of 10 to 13 feet at stations located within the channel. This well-defined interface (1.0 to 1.5 feet) was also reflected in a pronounced drop in dissolved oxygen (7.0 to 1.0 ppm) and, less markedly, in temperature.

Except for periods of high flow rates, the influence of Pascagoula River's east passage is reduced by rapid mixing within the lower river. For example, at the heaviest river flow (134,000 CFS) by Pascagoula River during this study, the 6.0 ppt surface isohaline was located less than two miles from the river mouth. The usual surface salinity at the river mouth was about 11.6 ppt.

There was an insufficient number of stations north of Petit Bois Pass (passage between Dauphin Island and Petit Bois Island) to adequately describe the salinity regime in that area. However, the stations in and just north of the pass were sufficient to indicate an aperiodic occurrence of a salinity gradient across the pass. The discharge of Mobile Bay enters Mississippi Sound, mainly through Grants Pass, and exits, apparently in its entirety, through the east side of Petit Bois Pass.

The deepest portion of the Sound, excepting the island passes, is located approximately along a line two-thirds of the distance from the mainland. This bathymetric feature facilitates the lateral spreading of the high salinity waters within the Sound.

The Sound showed a relatively uniform vertical structure of salinity during periods of low river flow with the normal range in the upper 10 feet being less than 2.0 ppt. During periods of accelerated flow, the increase in salinity with depth became more pronounced with as much as 6.0 ppt change over an interval of 5 feet. As pointed out previously, in the lower reach of the river a sharp salinity interface was often encountered at a depth of 10 to 13 feet. The abrupt increase in salinity was always accompanied by a drop in the level of dissolved oxygen.

The horizontal difference in surface salinity within the Sound was as little as 5.0 ppt and as much as 20.0 ppt. With increasing depth the horizontal difference in salinity levels diminished. The statistics on salinity appearing in the Appendix clearly show the increasing salinity and decreasing variability with increasing depth.

The presence of the Middle Ground, a broad, shallow bar approximately one mile north of the center of Horn Island, has consistently been depicted in charts dating from about 1709. The permanence of this bathymetric feature might be explained, in part, by its location. It appears that the Middle Ground is situated in an area of convergence. Tide waves that enter the Sound through Horn Island and Dog Keys meet in this vicinity. While this suggested cause and its degree of influence cannot be substantiated at present, existing current and tidal records appear to warrant its further consideration.

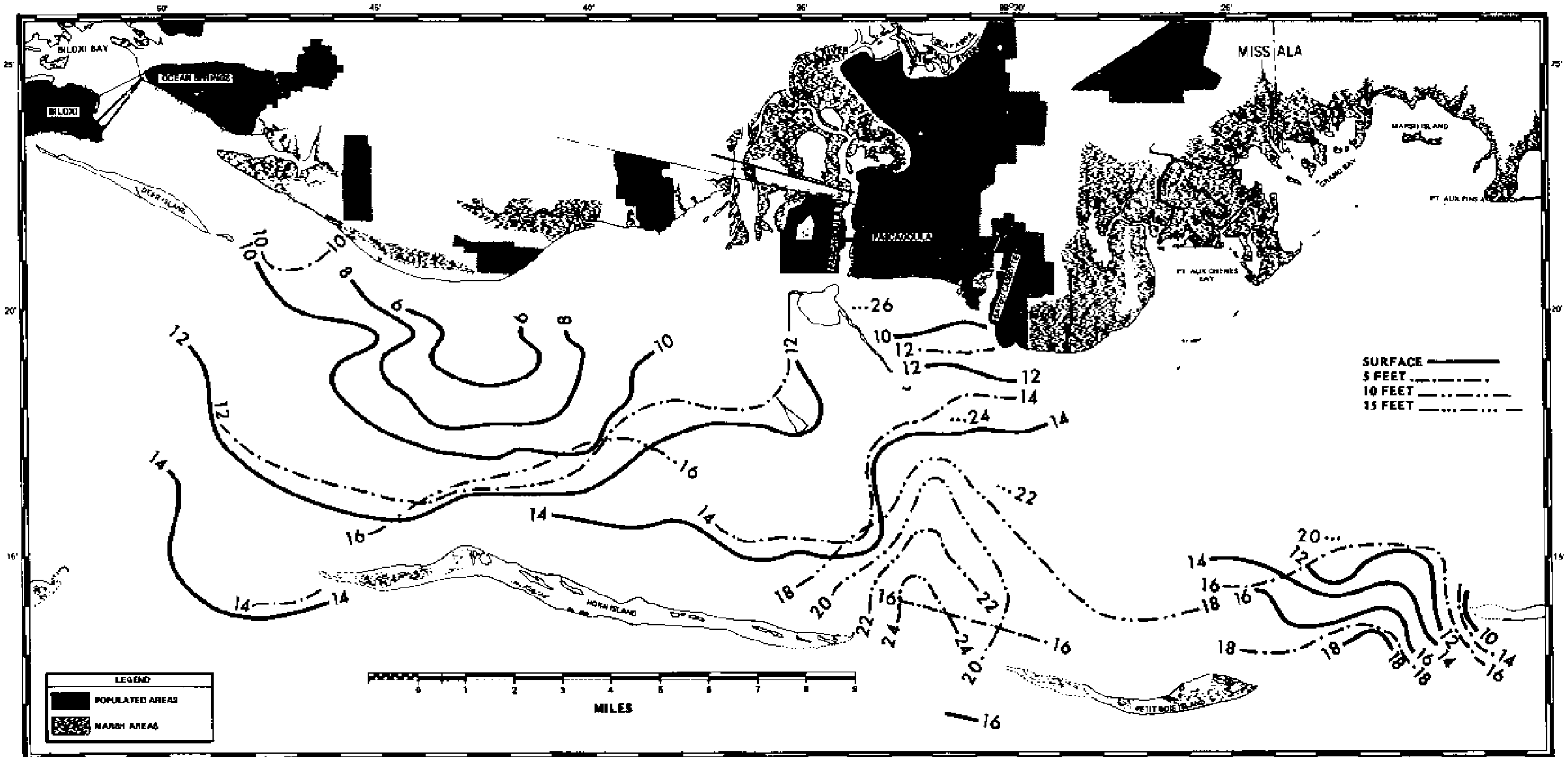


Figure 7. Salinity (‰) distribution 14 June 1973.

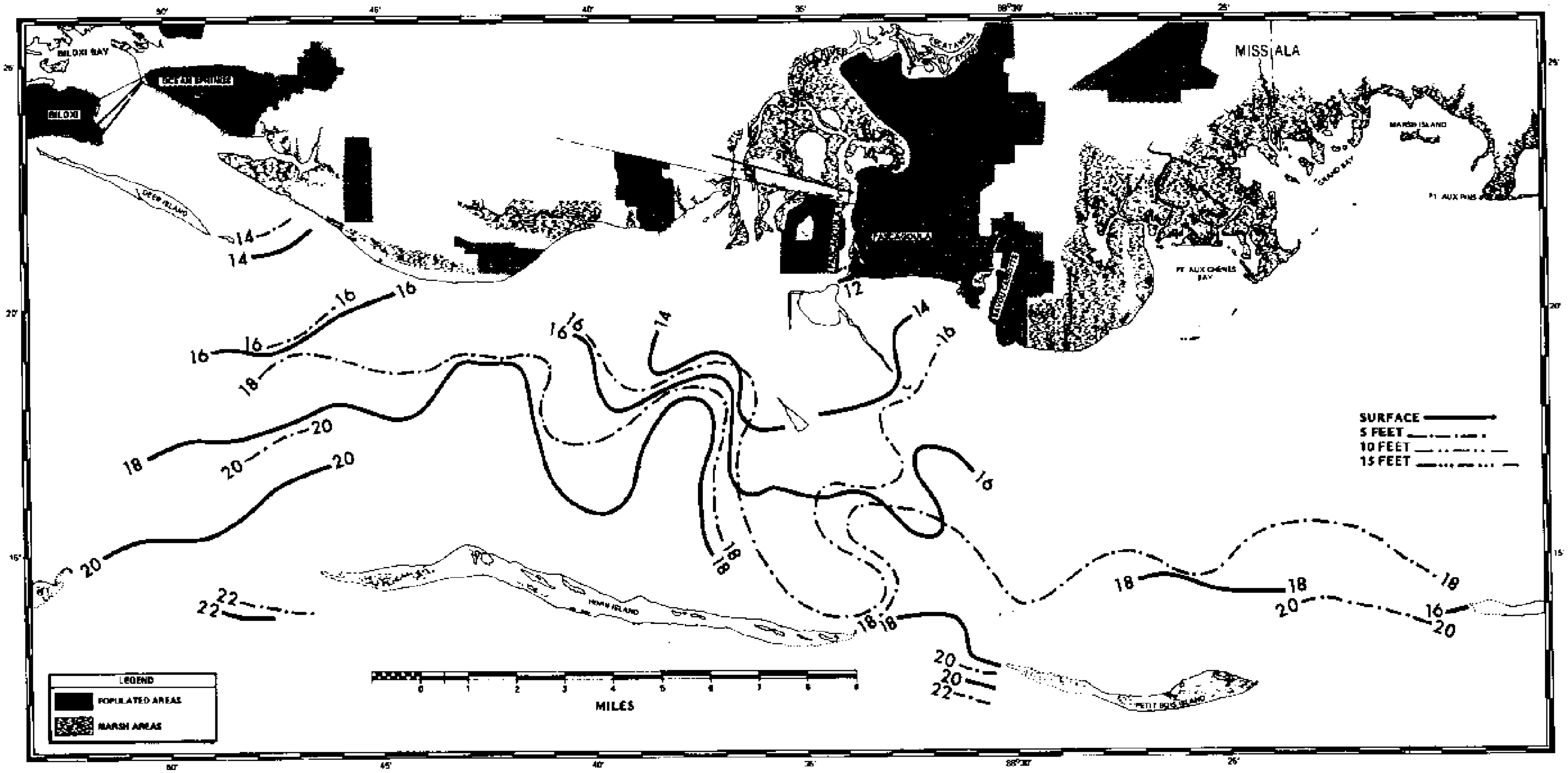


Figure 8. Salinity (‰) distribution 26 June 1973.

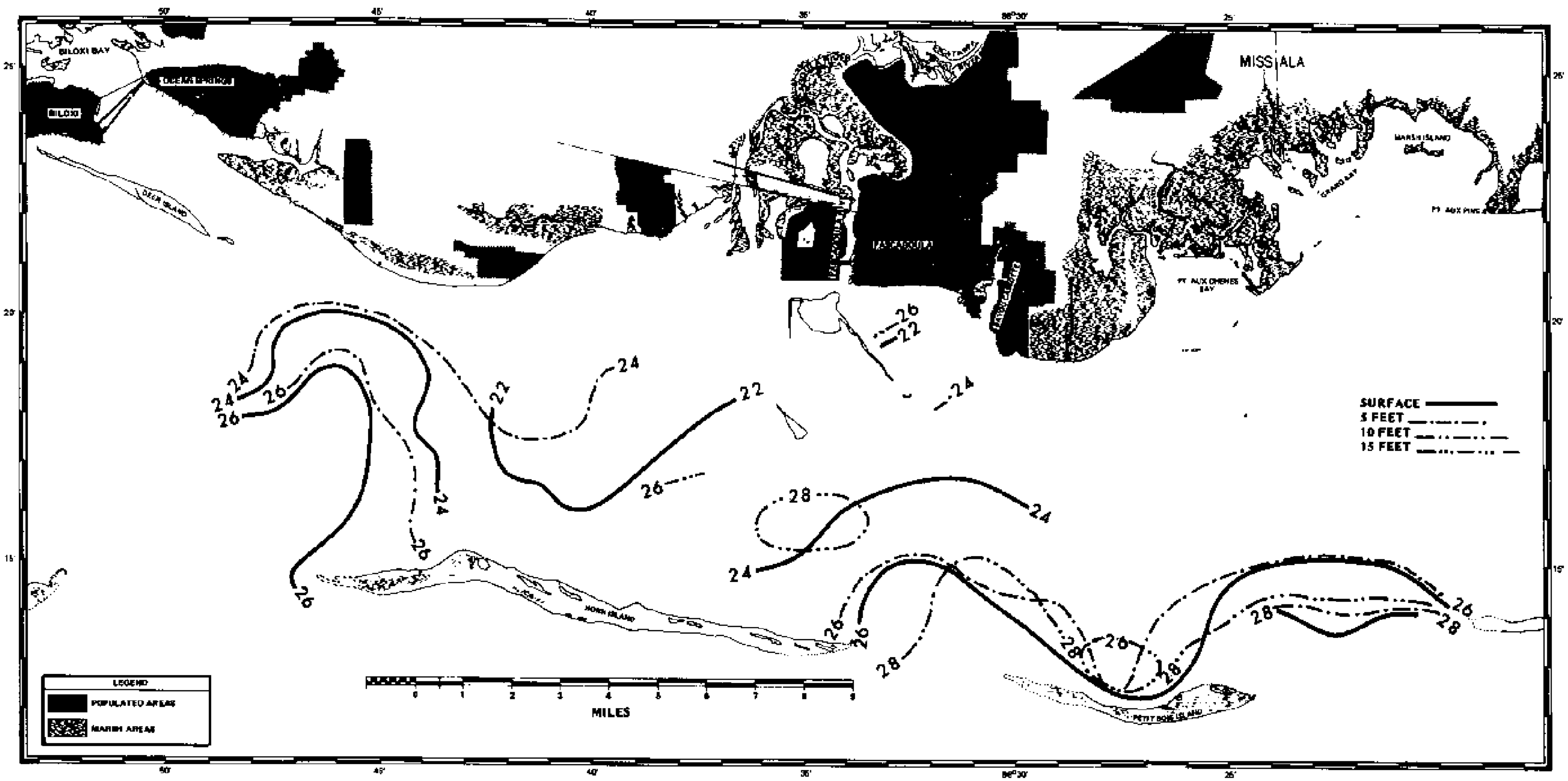


Figure 9. Salinity (‰) distribution 31 July 1973.

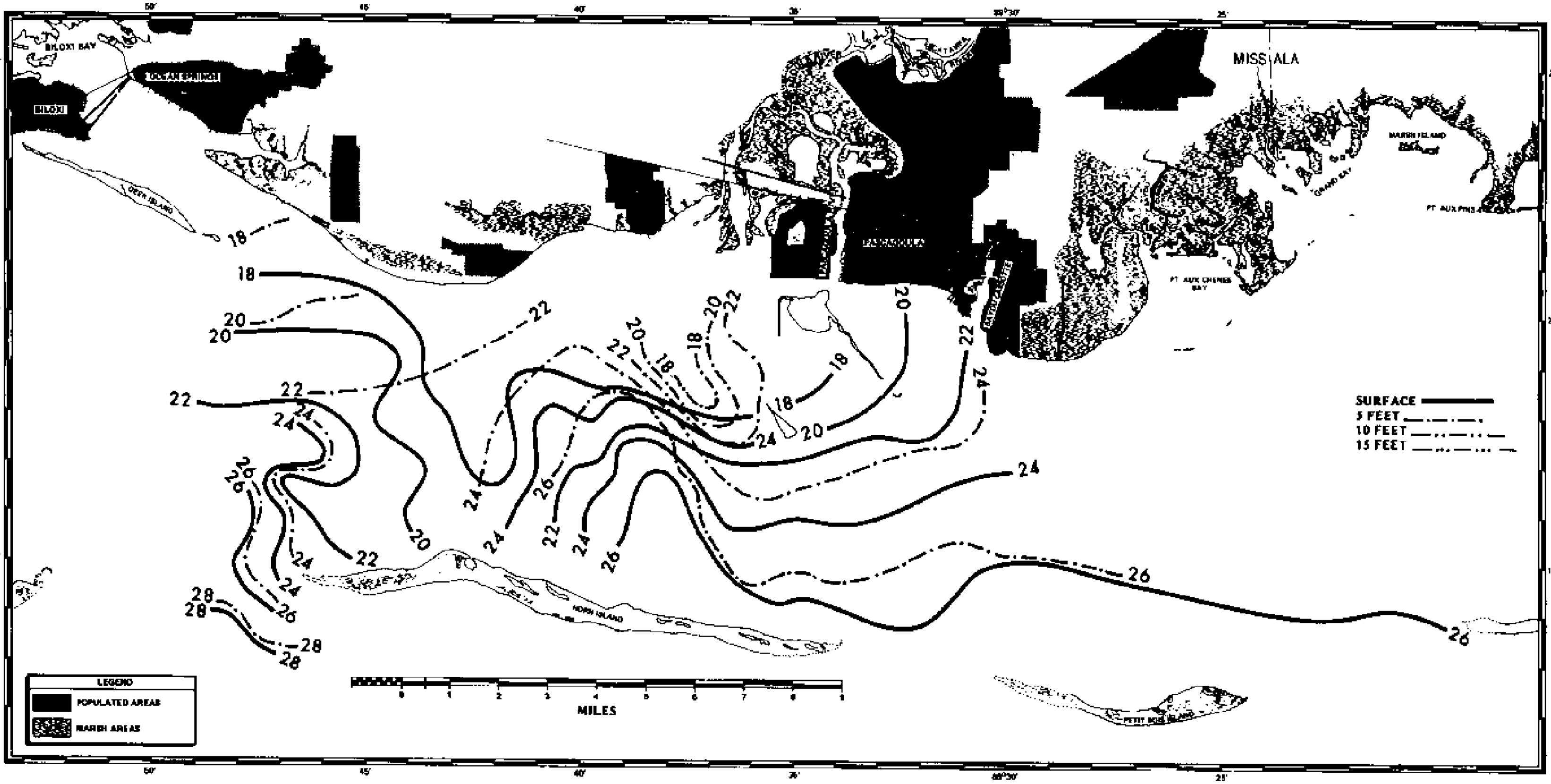


Figure 10. Salinity (‰) distribution 14 August 1973.

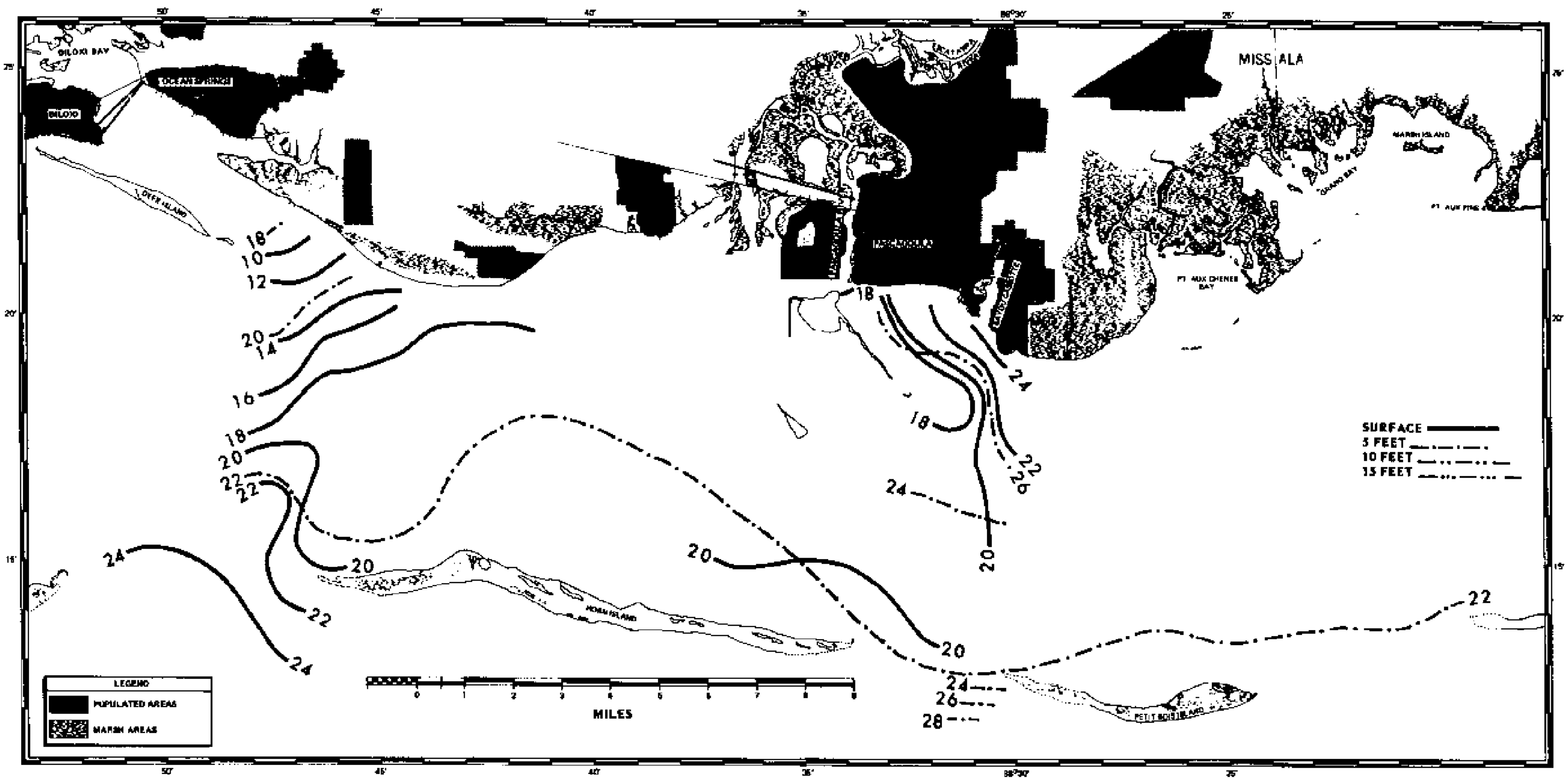


Figure 11. Salinity (‰) distribution 12 September 1973.

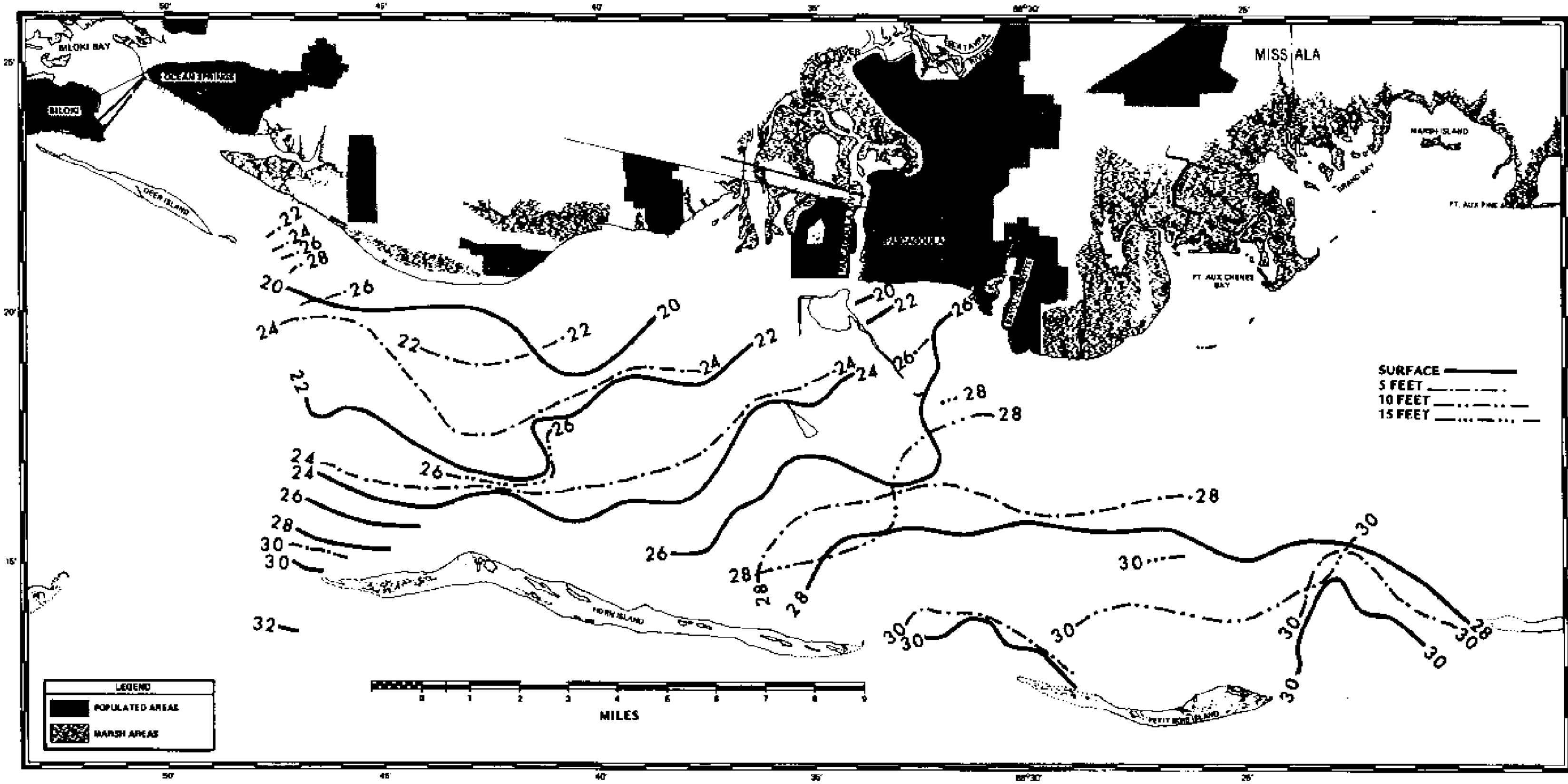


Figure 12. Salinity (‰) distribution 7 November 1973.

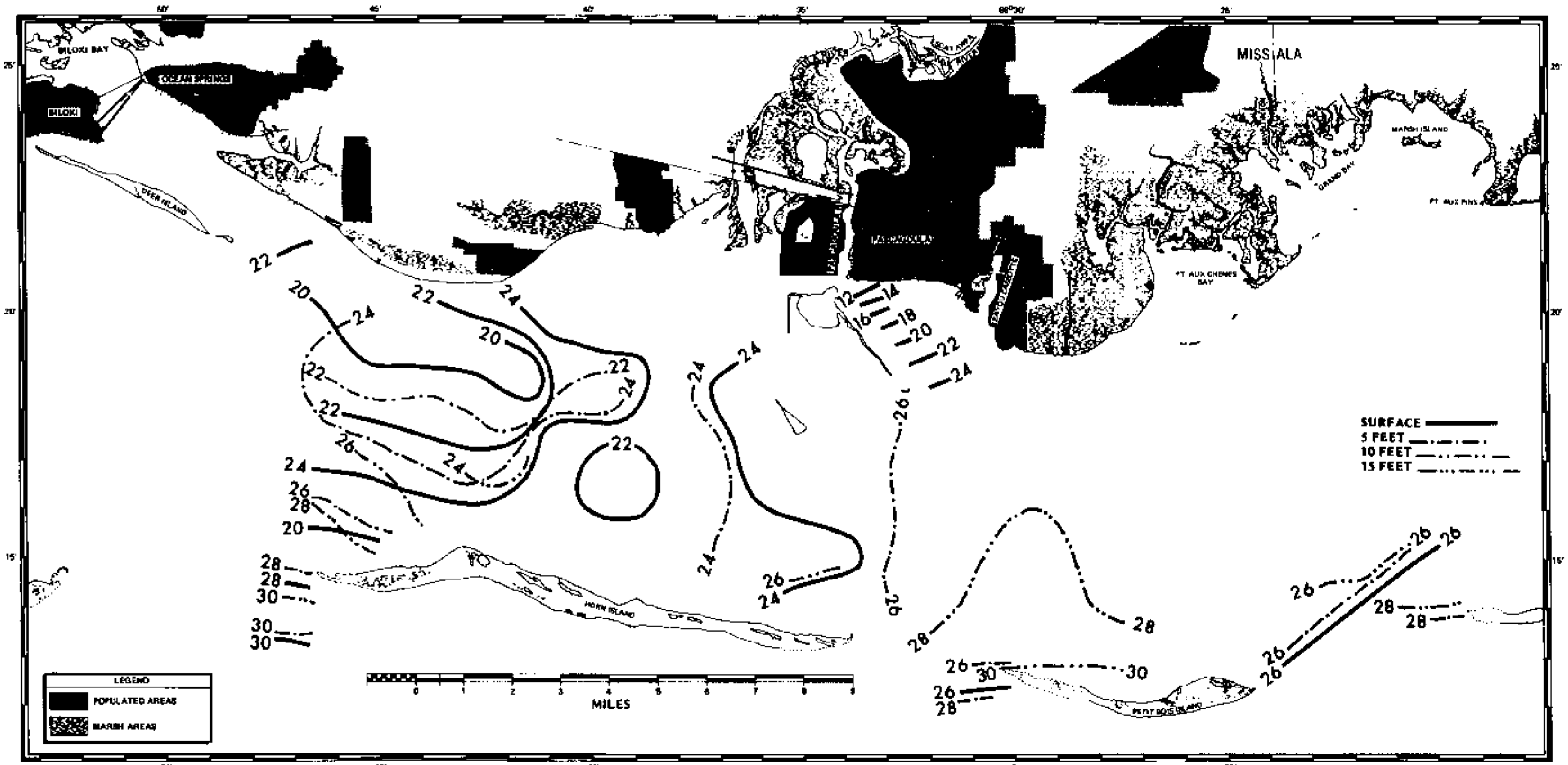


Figure 13. Salinity (‰) distribution 28 December 1973.

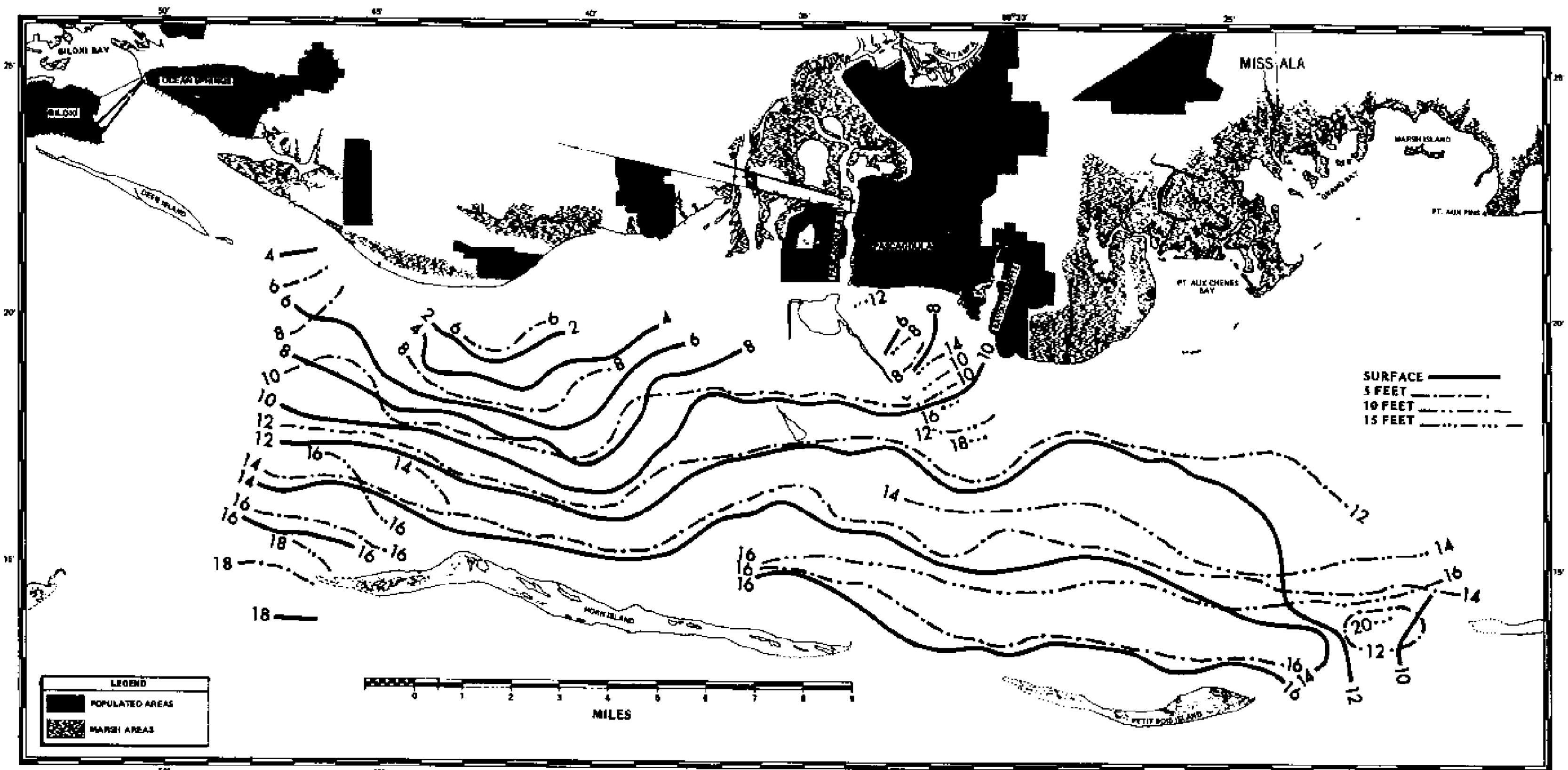


Figure 14. Salinity (‰) distribution 24 January 1974.

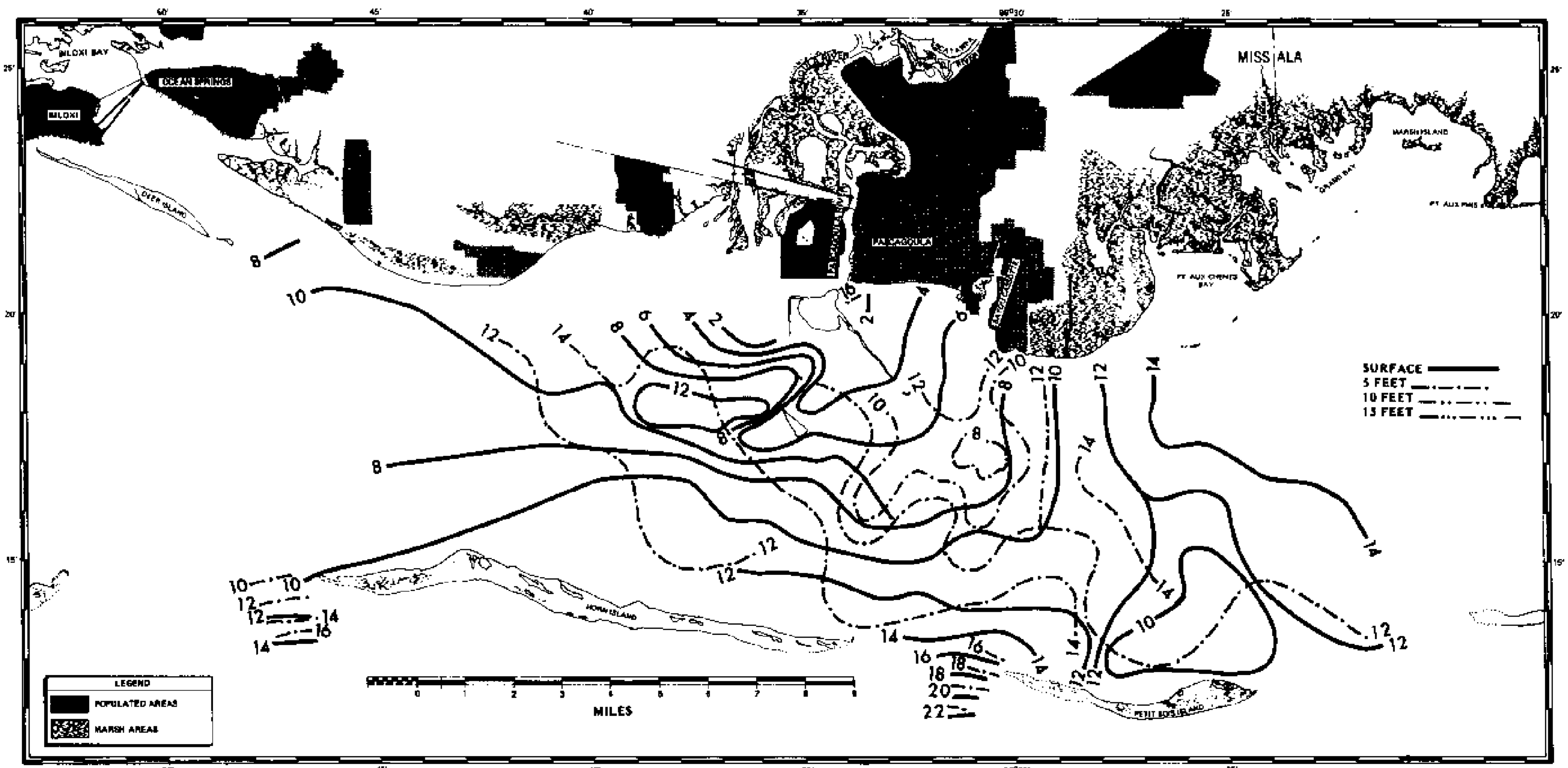


Figure 15. Salinity (‰) distribution 11 February 1974.

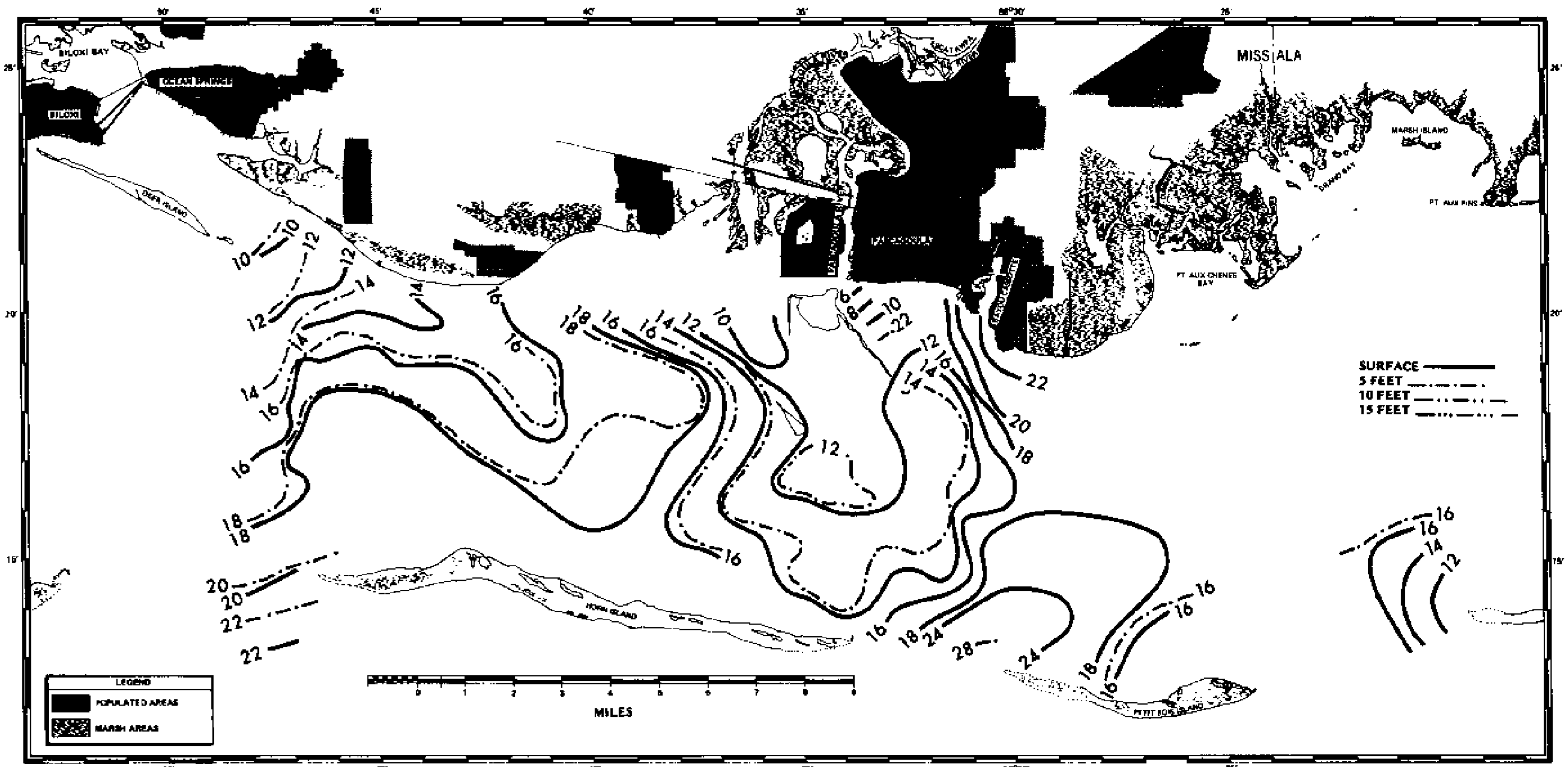


Figure 16. Salinity (‰) distribution 25 February 1974.

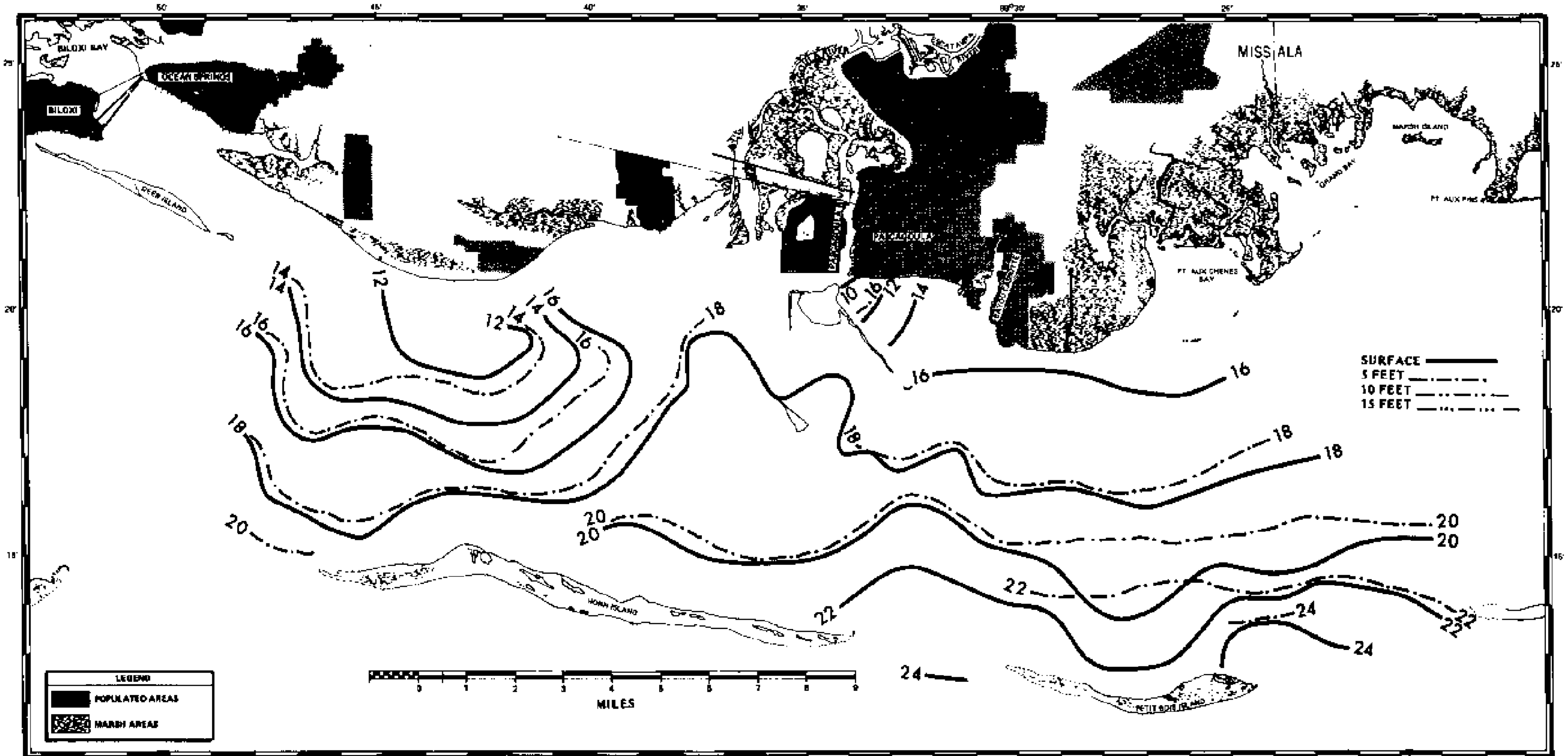


Figure 17. Salinity (‰) distribution 15 March 1974.

Figure 18. Salinity (‰) distribution 9 April 1974.

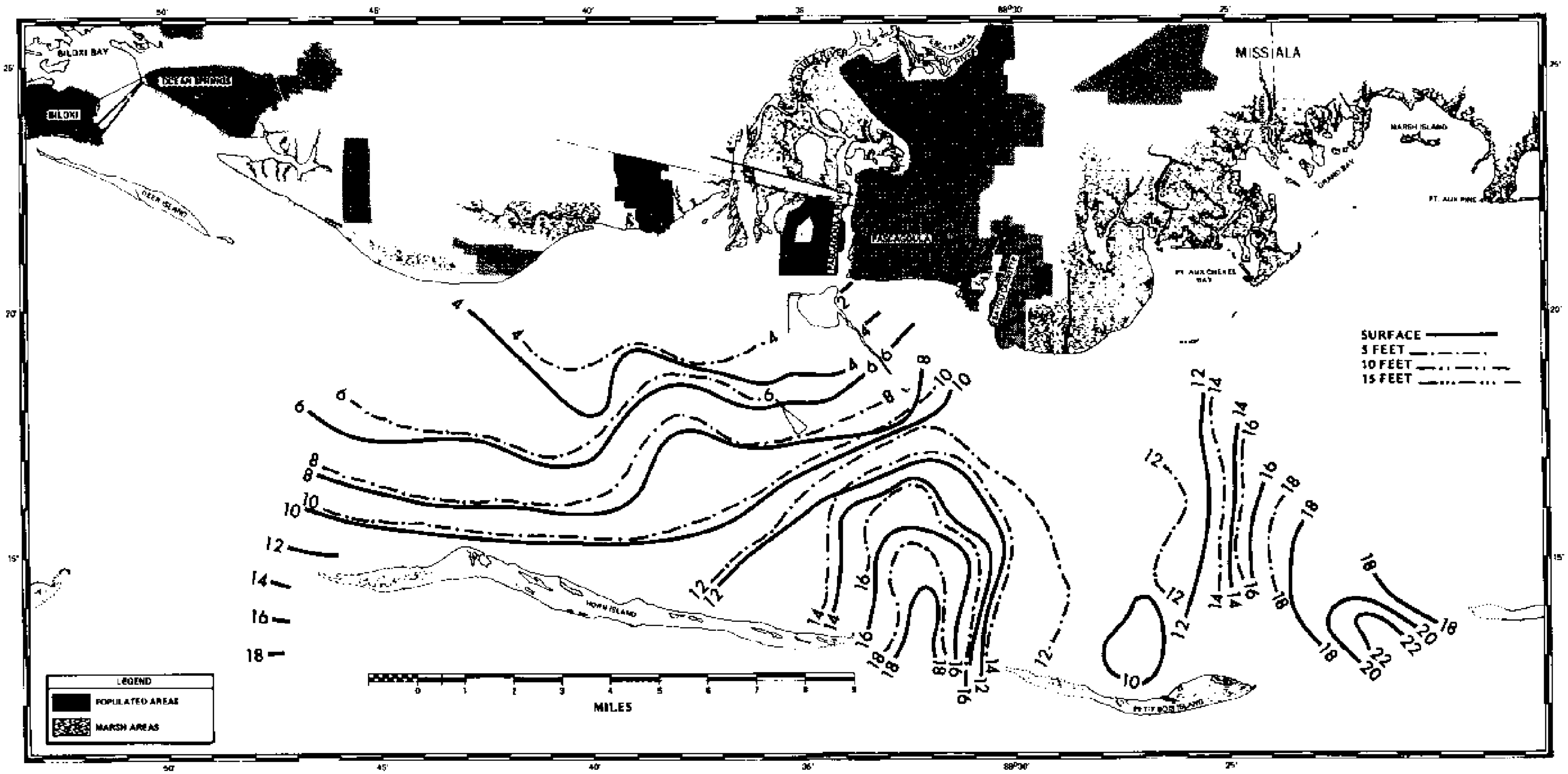


Figure 19. Salinity (‰) distribution 25 April 1974.

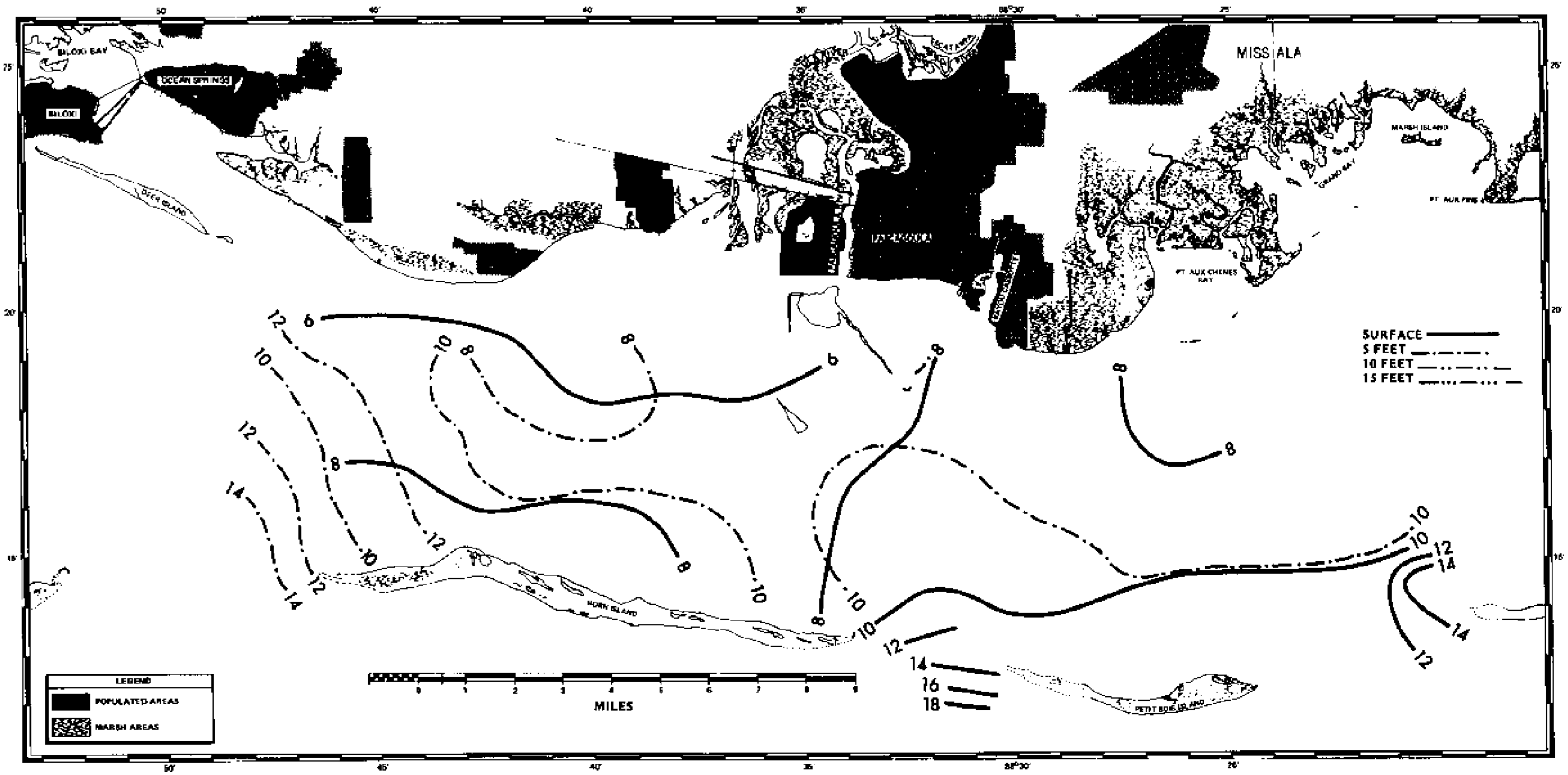


Figure 20. Salinity (‰) distribution 6 May 1974.

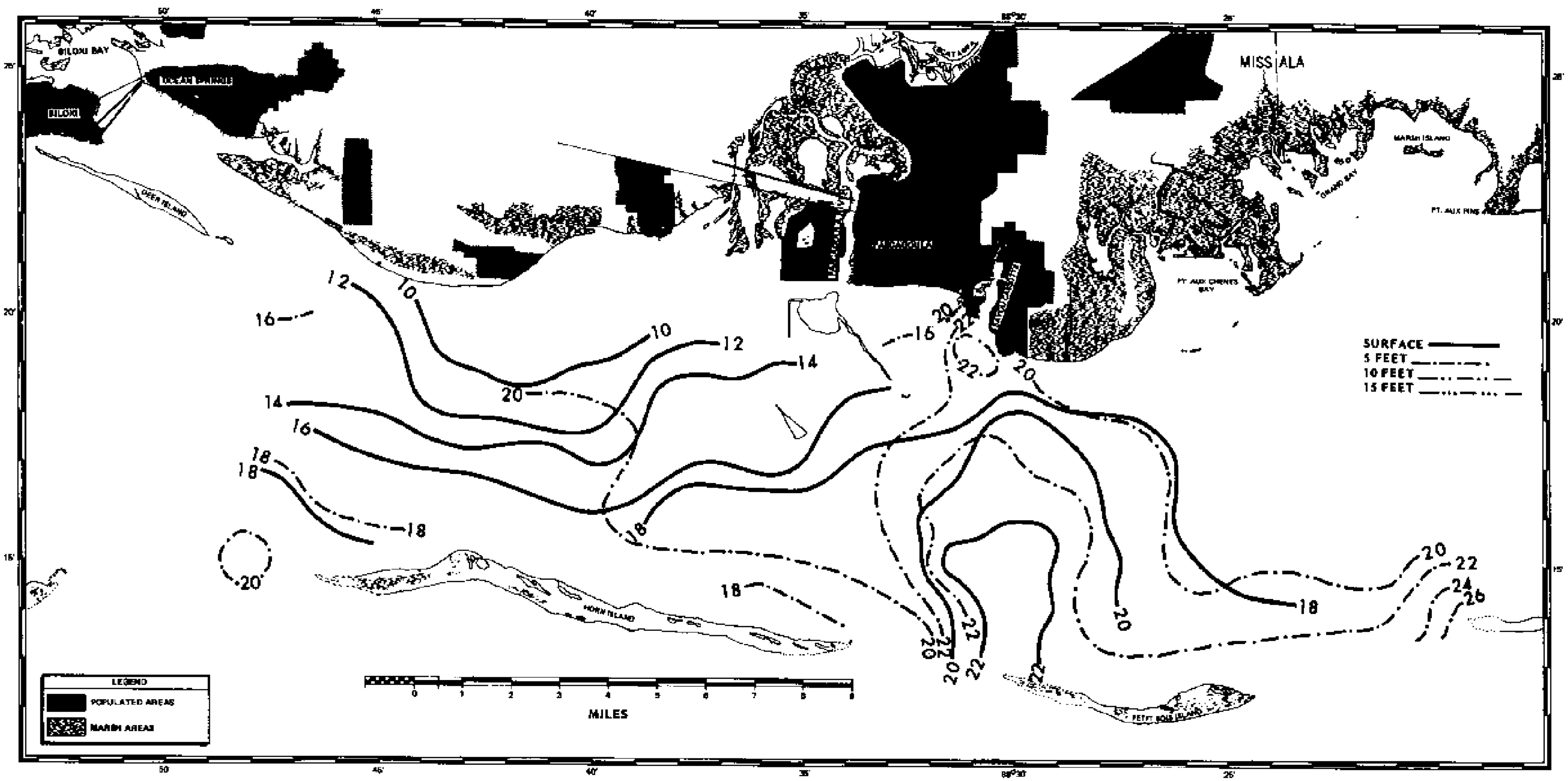


Figure 21. Salinity (‰) distribution 24 May 1974.

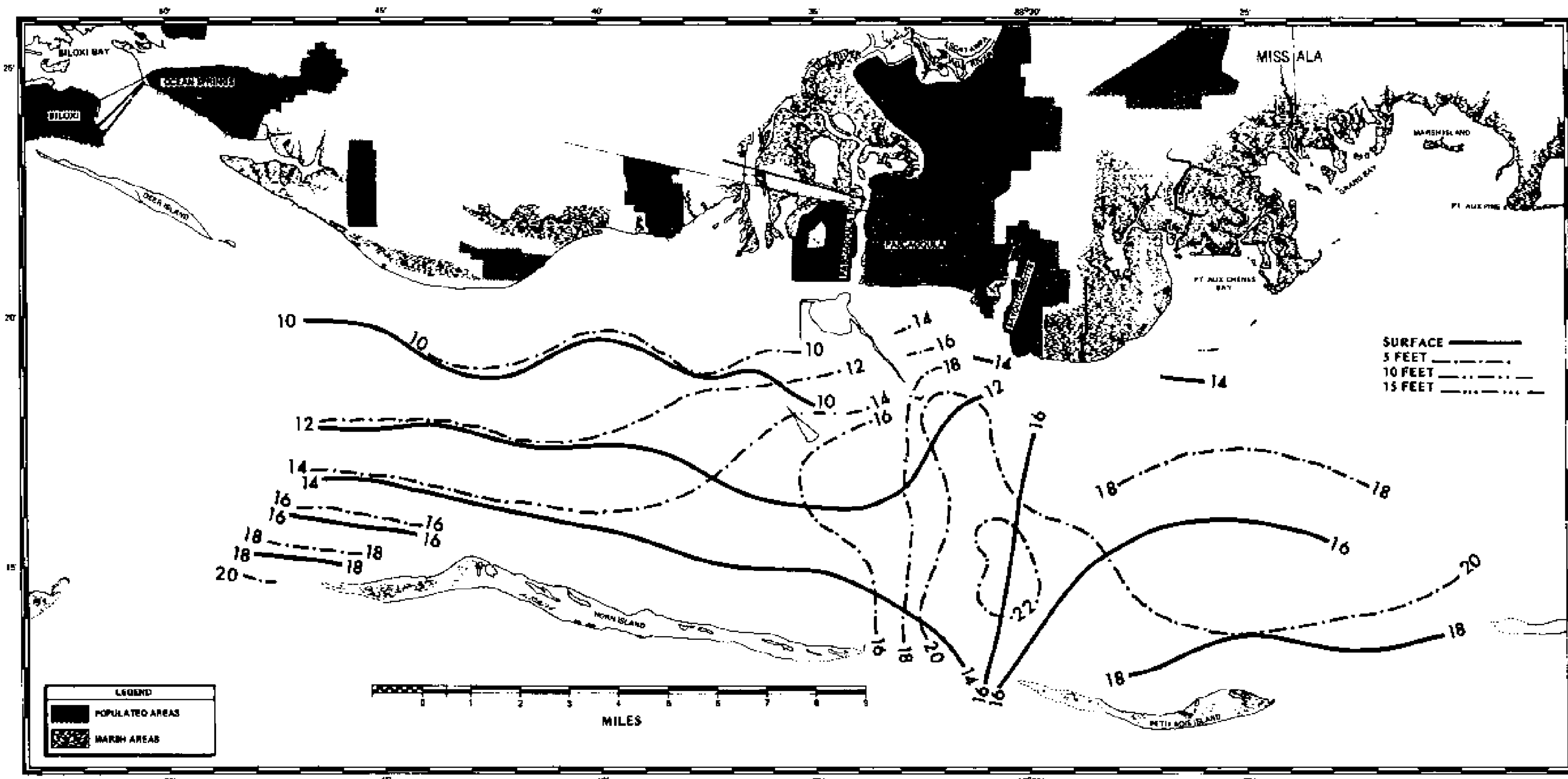


Figure 22. Salinity (‰) distribution 4 June 1974.

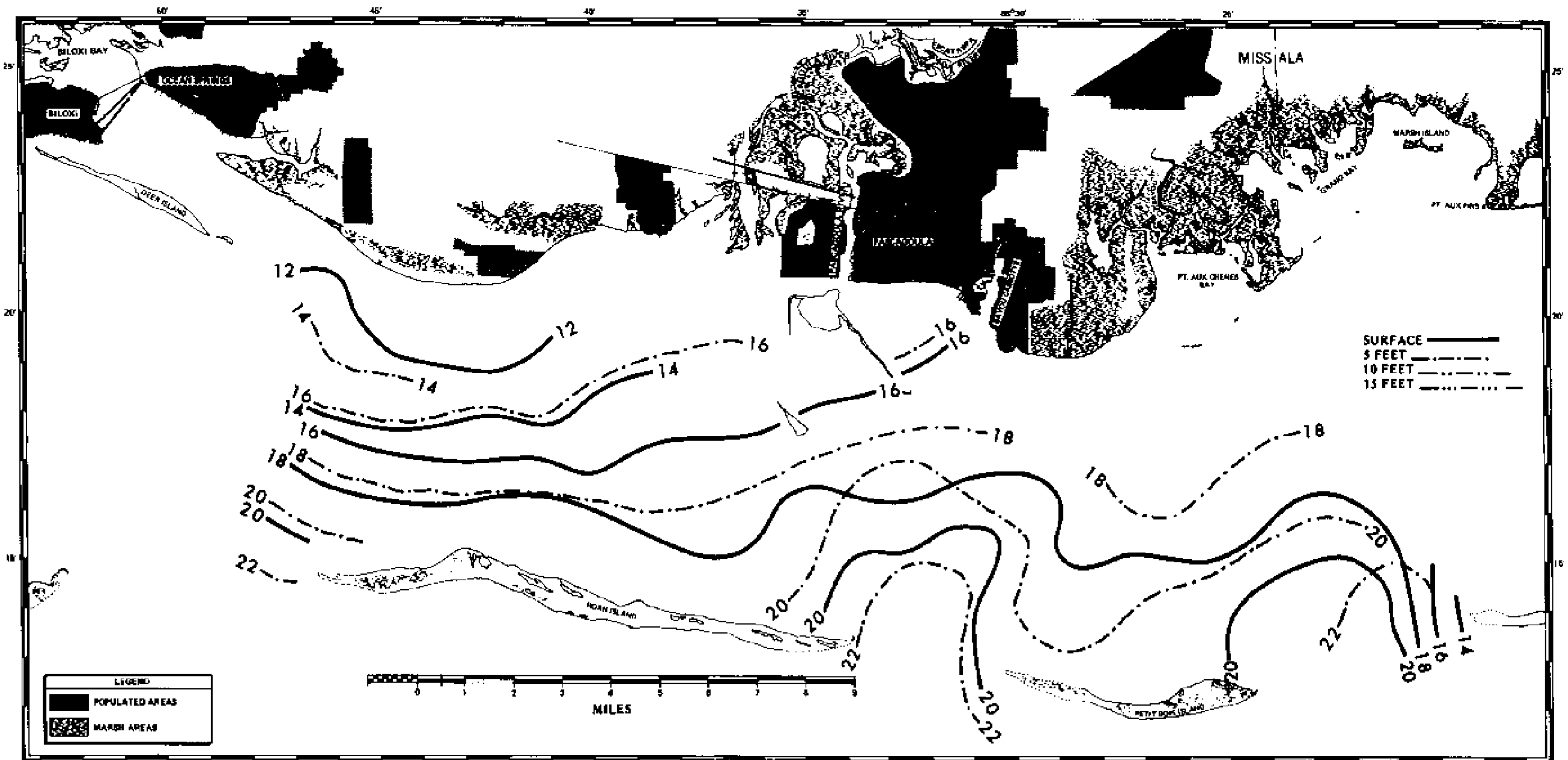


Figure 23. Salinity (‰) distribution 20 June 1974.

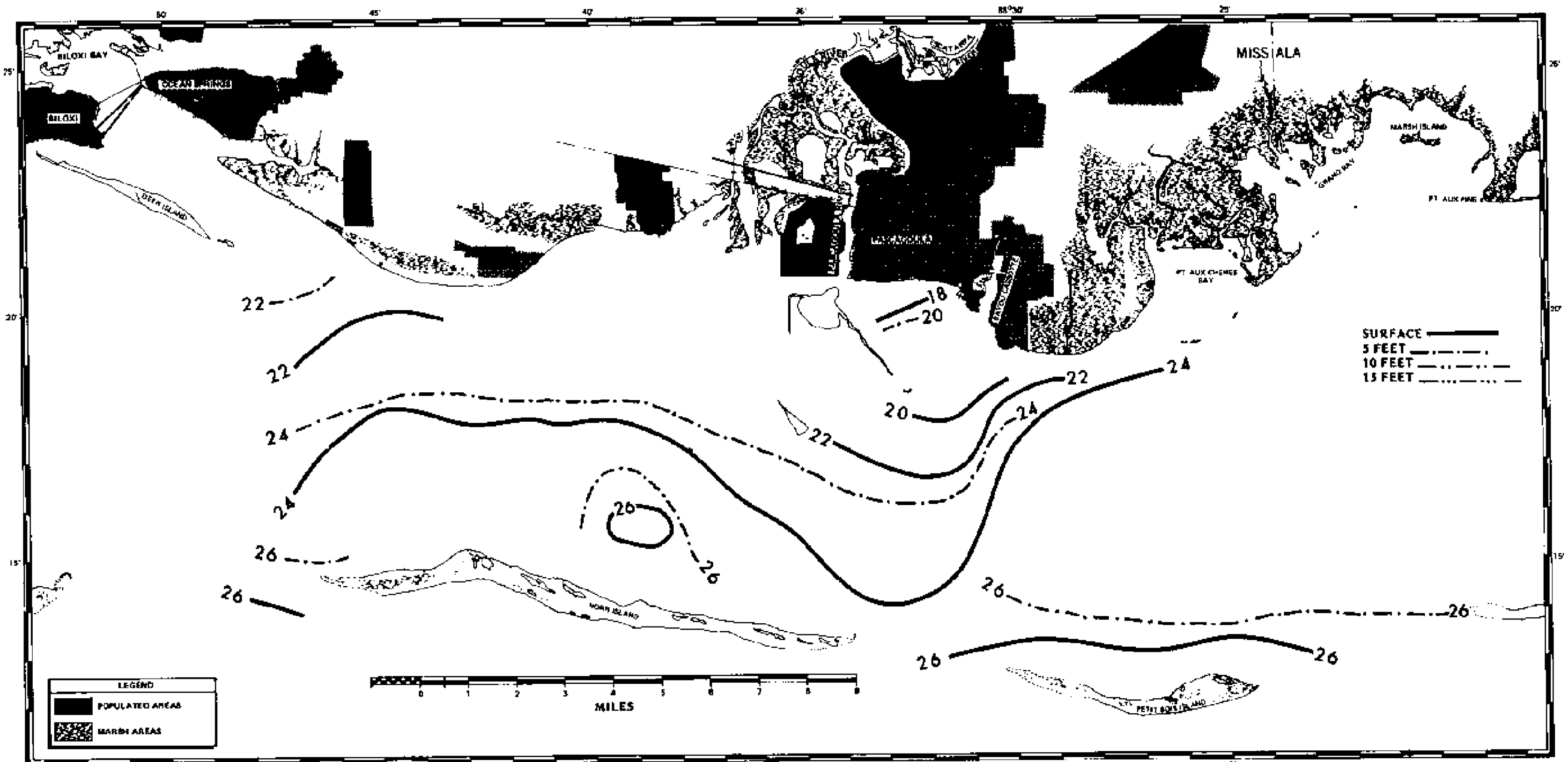
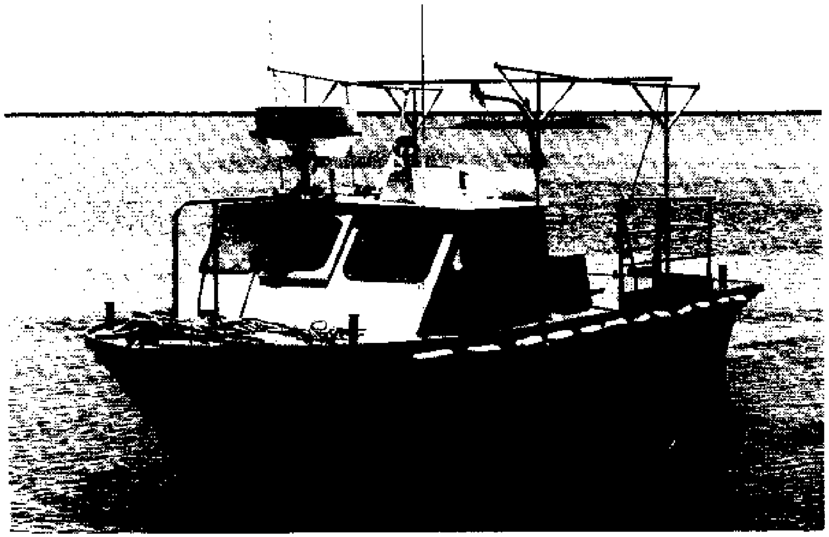
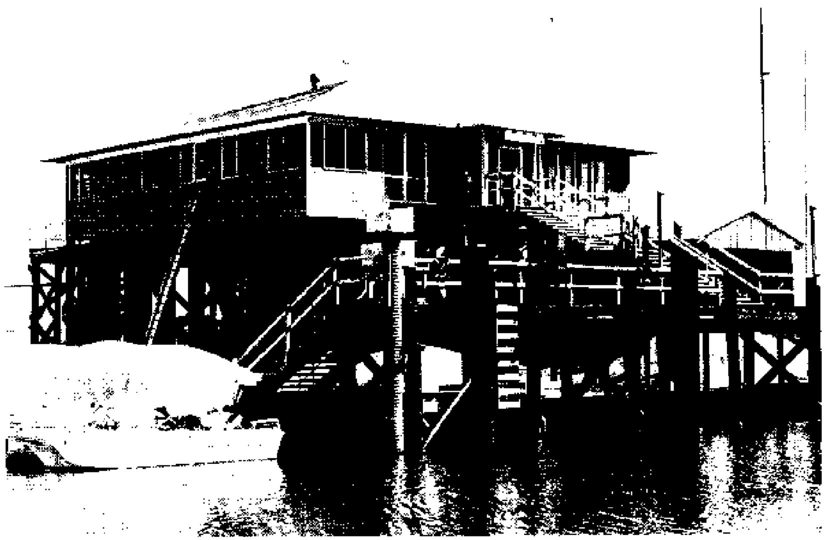


Figure 24. Salinity (‰) distribution 1 July 1974.



Seiche, a 29-foot, 5081 aluminum alloy, diesel powered, single screw research vessel.

The Seiche is equipped with CB radio, VHF radio, radar, and depth recorder.



Project tide gauge station at Louisiana Fish and Wildlife Grand Pass Camp, Louisiana.

Patsy Browning, Water Analysis Section, using spectrophotometer.

CENTRAL MISSISSIPPI SOUND

The hydrographic study of the central portion of Mississippi Sound was conducted during the period 5 February 1974 through 25 February 1975 (Figures 25 - 49). Circulation in this area can be attributed largely to the tidal flux through Dog Keys and Ship Island passes. Normally, the primary source of low-salinity water in this area is Biloxi Bay; the other sources being direct runoff and Pearl River during periods of peak flow. Occasionally, when the Bonnet Carré Spillway is opened to alleviate flood conditions along the lower Mississippi River, the outflow can be traced as far as the east end of Ship Island.

There exist two natural channels through the passage between Horn Island and Ship Island. Because of the difference in their depth and breadth, they are locally termed "Dog Keys" and "Little Dog Keys." The term "Dog Keys" also refers to the passage as a whole. The main channel of the passage is located at the immediate west end of Horn Island and has a natural depth of 25 feet at MLW. The major portion of the water entering the Sound through this passage spreads radially in the northeast quadrant. The waters passing into the Sound through Little Dog Keys flow, with lateral spreading, toward the northwest.

The influence of the Biloxi Bay outflow on the salinity regime of Mississippi Sound from both east and west passages was in evidence. However, because of the normal low input of freshwater into upper

Biloxi Bay, its influence is only sharply apparent during periods of peak flow.

The channel of Ship Island Pass lies at the immediate west end of Ship Island. Periodic dredging artificially maintains the channel at a set location preventing its natural tendency to migrate westward with Ship Island. This passage and the Gulfport Ship Channel that traverses it are maintained at a depth of 30 feet. The channel permits the intrusion of higher salinity water into and across the Sound.

Water entering the Sound through Ship Island Pass spreads, roughly, in a radial manner. The occurrence of lower salinity waters toward the west is due to the flow of the Jourdan and Wolf rivers through St. Louis Bay, Pearl River, and, during this study, the diversion of Mississippi River waters through the Bonnet Carré Spillway. Special notice should be taken, as will be evident in the discussion of the west section of Mississippi Sound, that Ship Island Pass is responsible for contributing the largest amount of high salinity water to the area between Gulfport and Bay St. Louis.

In 1969, Ship Island was bisected by Hurricane Camille. The maximum depth of this channel was initially about six feet but has been filling in slowly. This new passage, "Camille Cut," provides another source of high salinity water to this section of the Sound.

A zone of convergence is shown in several of the salinity distribution charts. The semi-radial spreading of waters entering the Sound through Dog Keys and Ship Island passes converges along a line from about Camille Cut north to the mainland. A study of selected charts illustrating salinity distributions under different tidal conditions supports the proposal that this is a permanent circulatory feature. The combination of no existing sources of fresh or low salinity waters between Biloxi Bay and St. Louis Bay and this zone of convergence results in higher salinity waters being carried close to the mainland. In the portion of Mississippi Sound studied under this grant, this area of the Mississippi mainland coast consistently has the highest salinities.

The degree of influence the freshwater input from Pearl River and the Mississippi River, via the Bonnet Carré Spillway, has on the salinity and thus circulation is clearly shown in Figures 29, 47, 48 and 49. During periods of peak freshwater inflow, the salinity has been sharply reduced in a west to east direction. The eastern extent of this influence is a line of longitude passing through the east end of Ship Island. The alignment of the isohalines throughout the water column shows a definite change in the circulation patterns from those prevalent during periods of average freshwater input.

The vertical salinity structure shows greater variability, as one would expect, in the area of Ship Island Pass. During "dry periods" of little freshwater input, the vertical salinity structure of the entire area becomes more uniform. On two occasions, "pockets" of higher salinity water were detected in the same area west of the Gulfport Ship Channel. These were apparently left from previous tidal excursions.

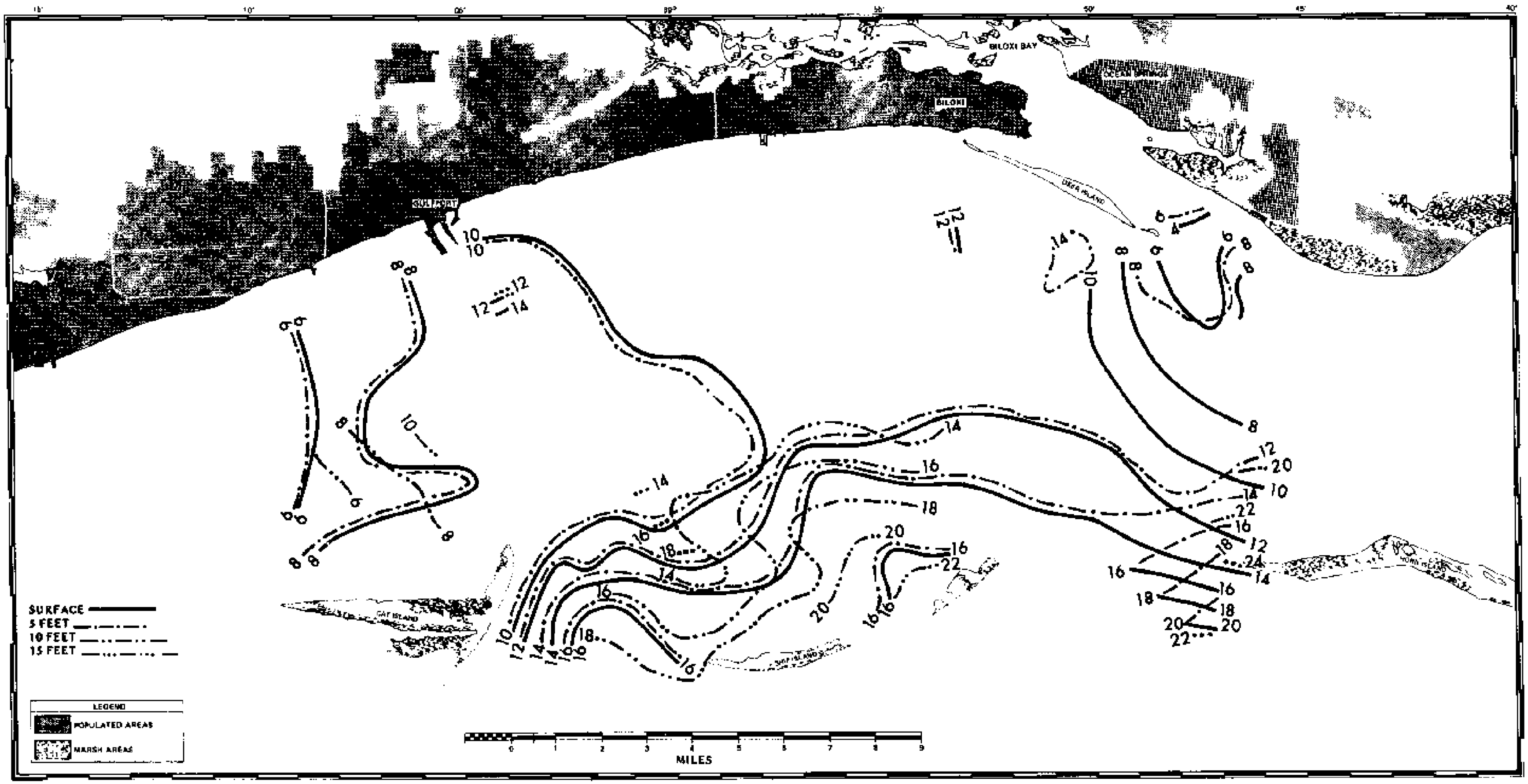


Figure 25. Salinity (‰) distribution 5 February 1974.

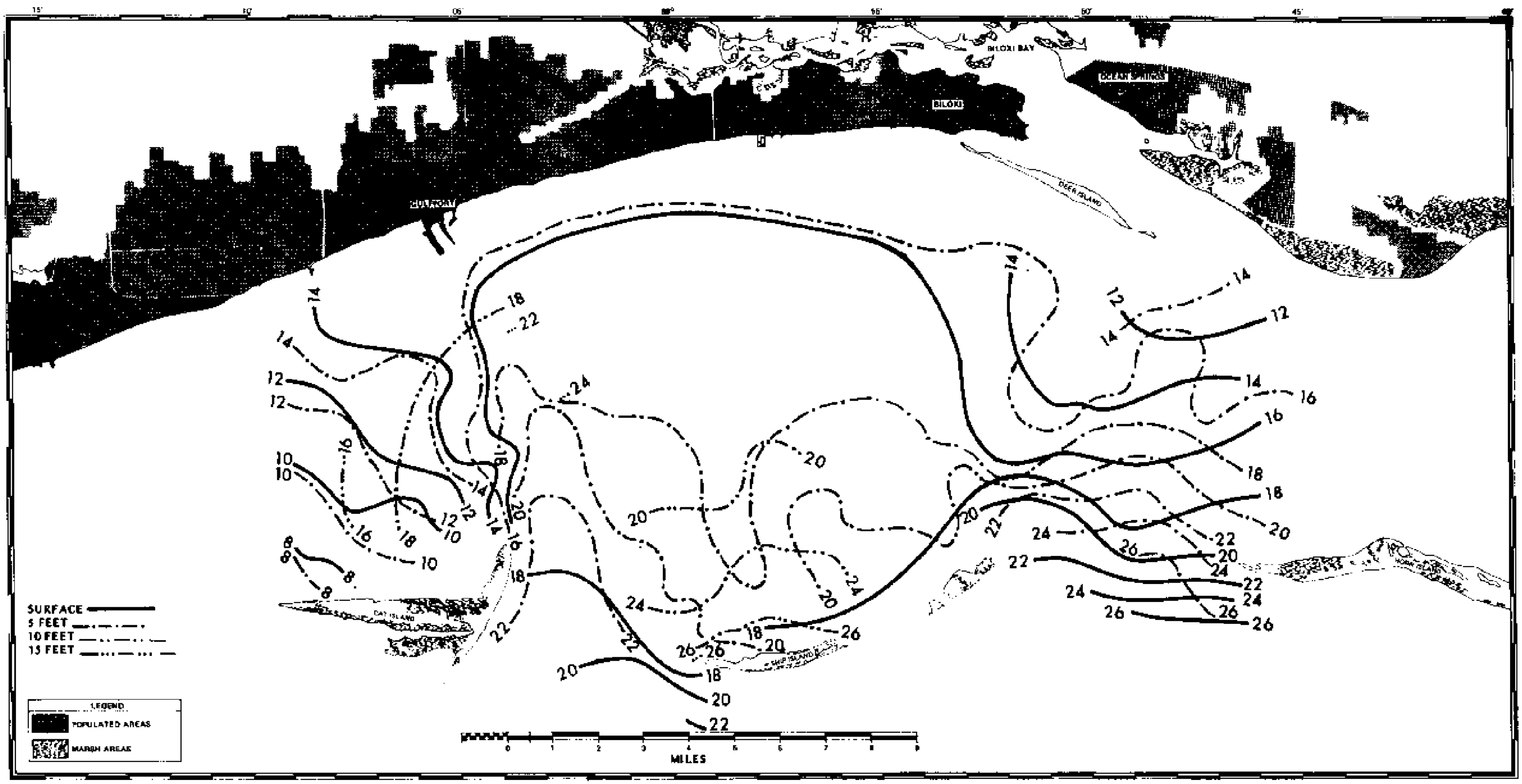


Figure 26. Salinity (‰) distribution 27 February 1974.

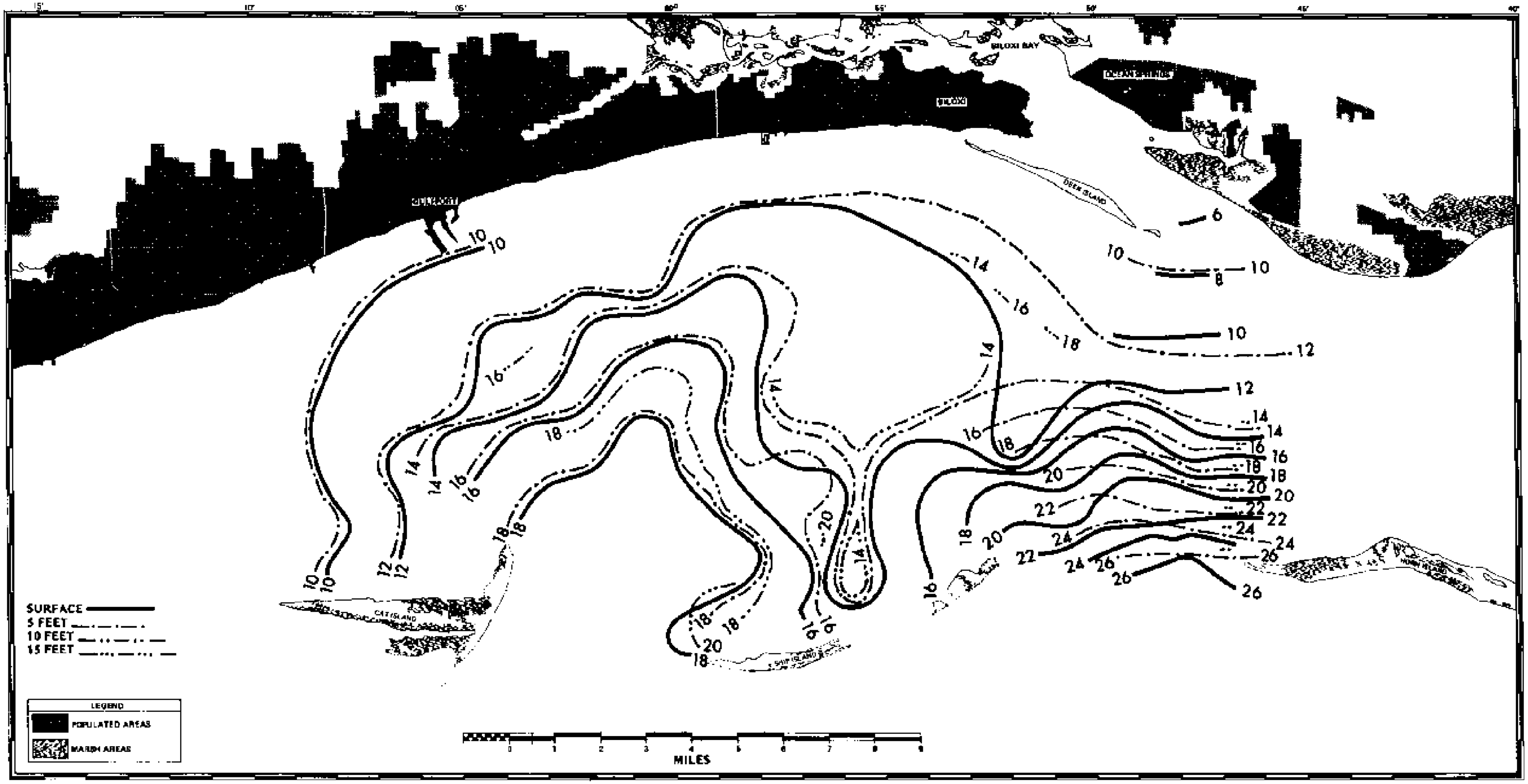


Figure 27. Salinity (‰) distribution 13 March 1974.

Figure 28. Salinity (‰) distribution 16 April 1974.

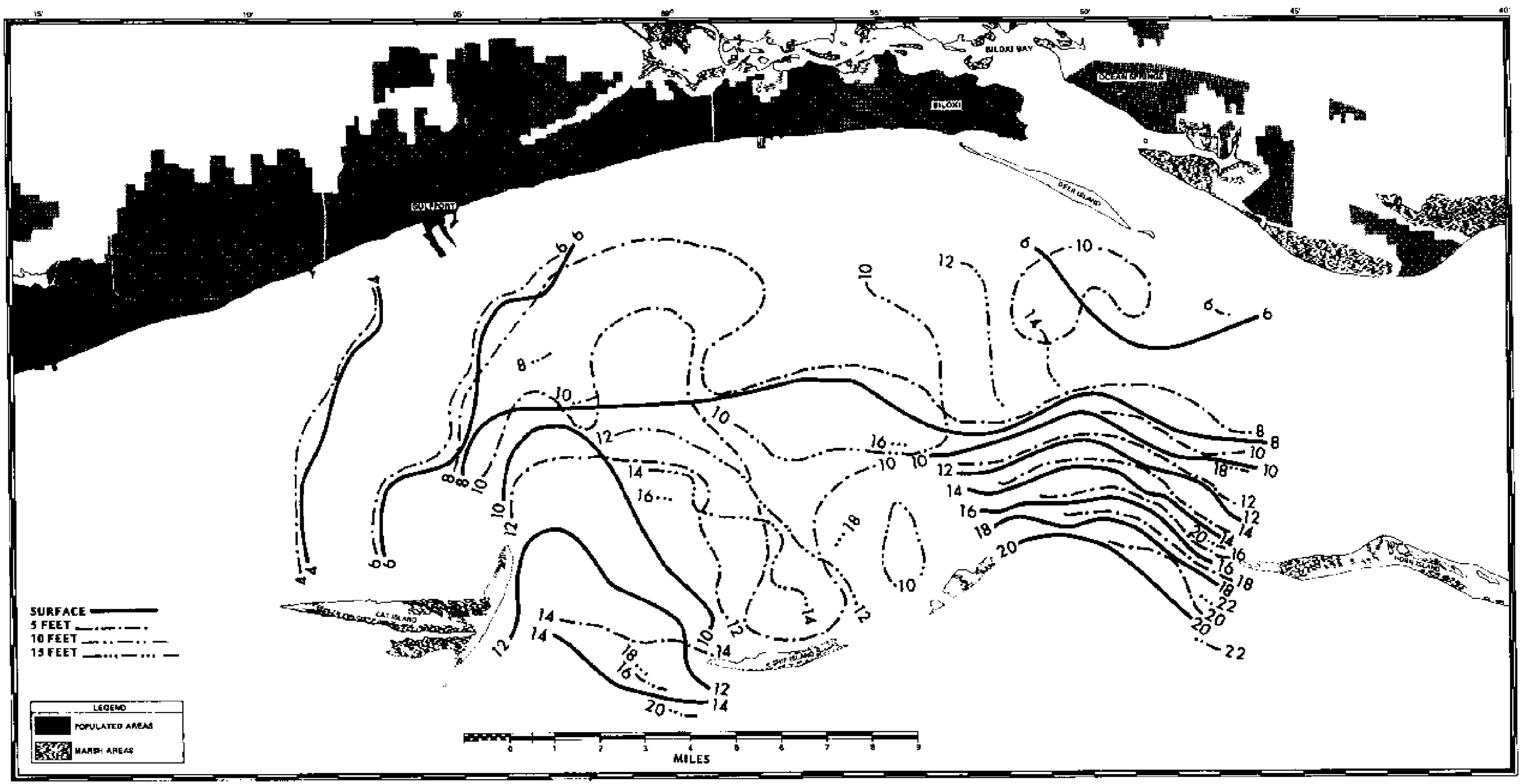


Figure 29. Salinity (‰) distribution 24 April 1974.

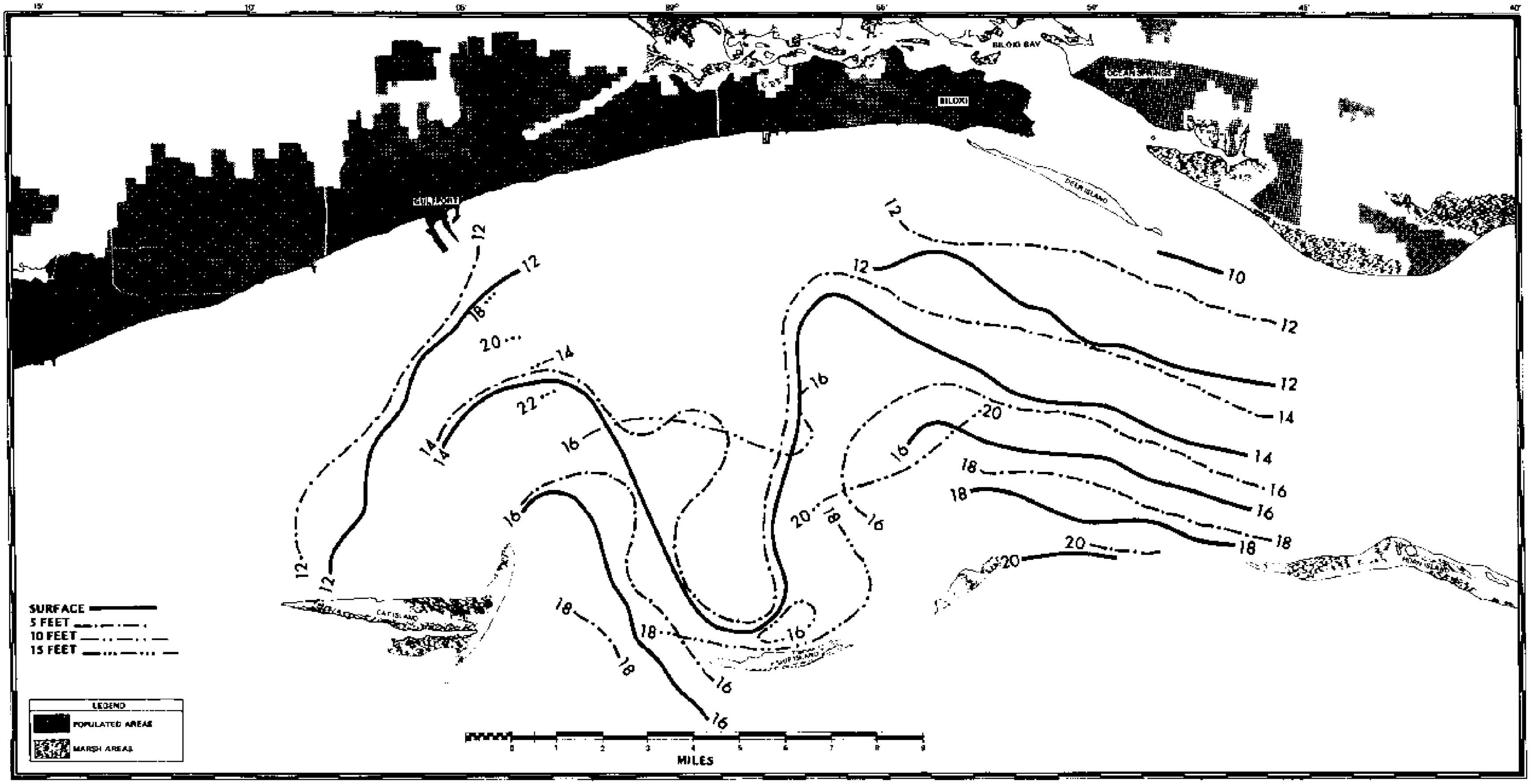


Figure 30. Salinity (‰) distribution 8 May 1974.

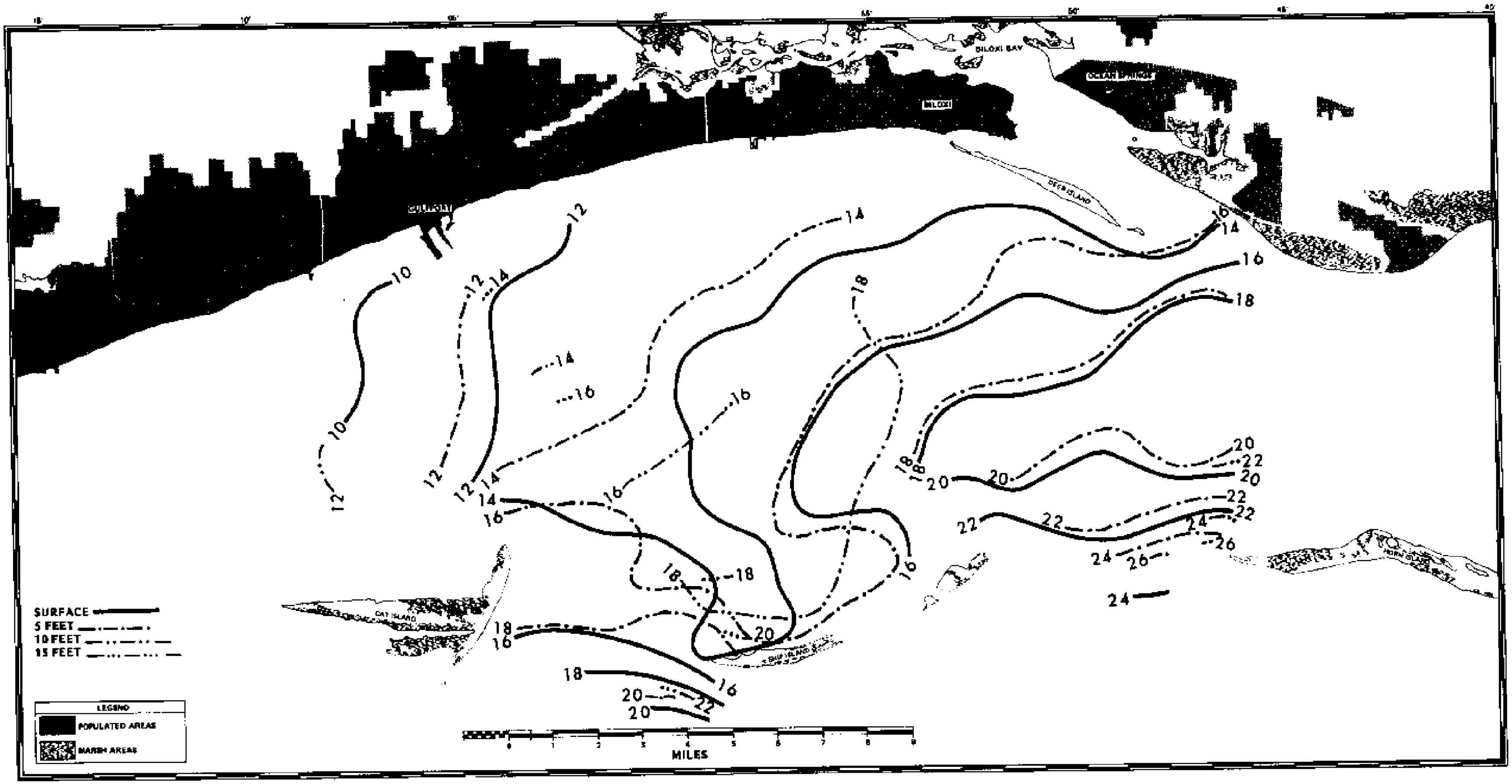


Figure 31. Salinity (‰) distribution 23 May 1974.

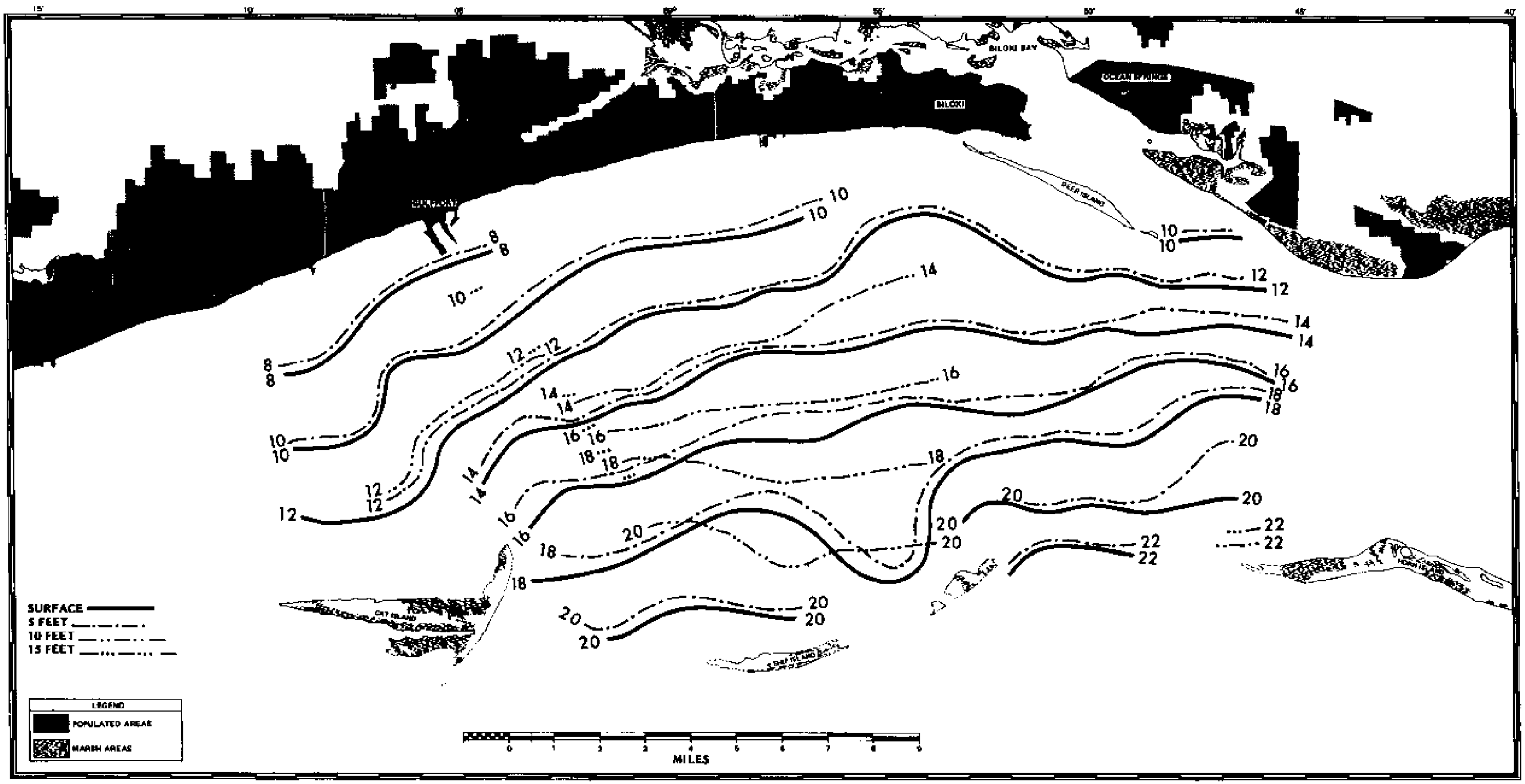


Figure 32. Salinity (‰) distribution 6 June 1974.

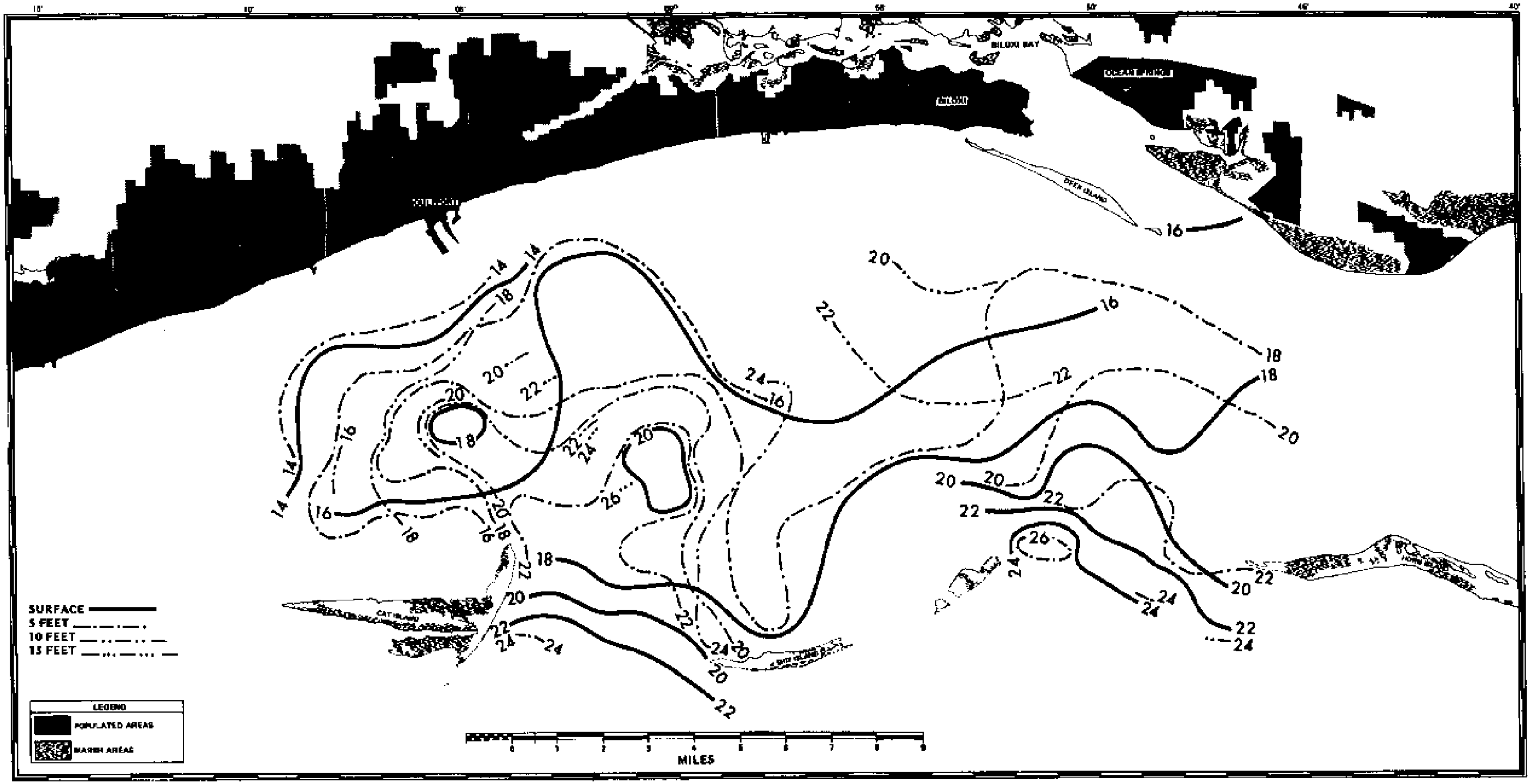


Figure 33. Salinity (‰) distribution 18 June 1974.

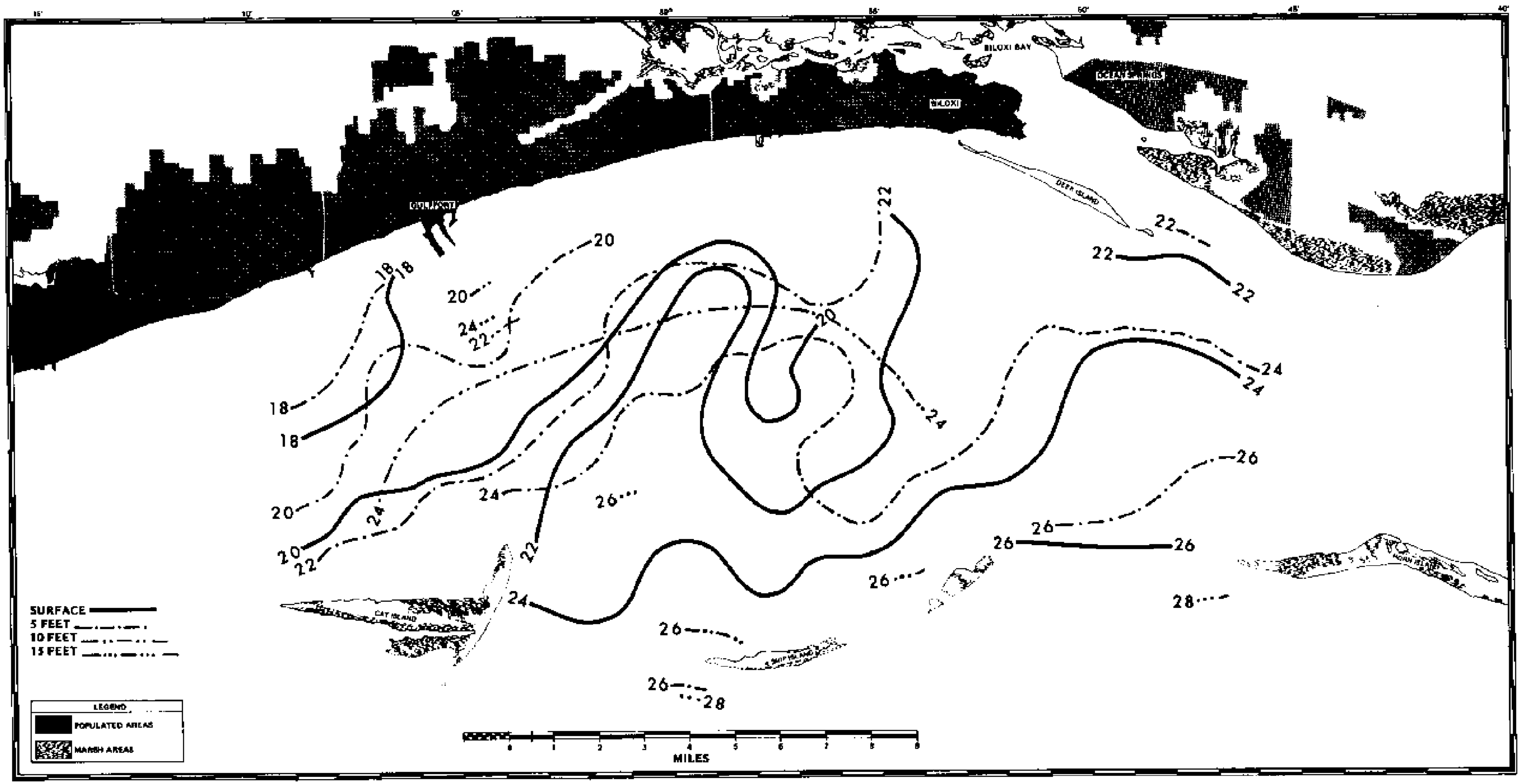


Figure 34. Salinity (‰) distribution 2 July 1974.

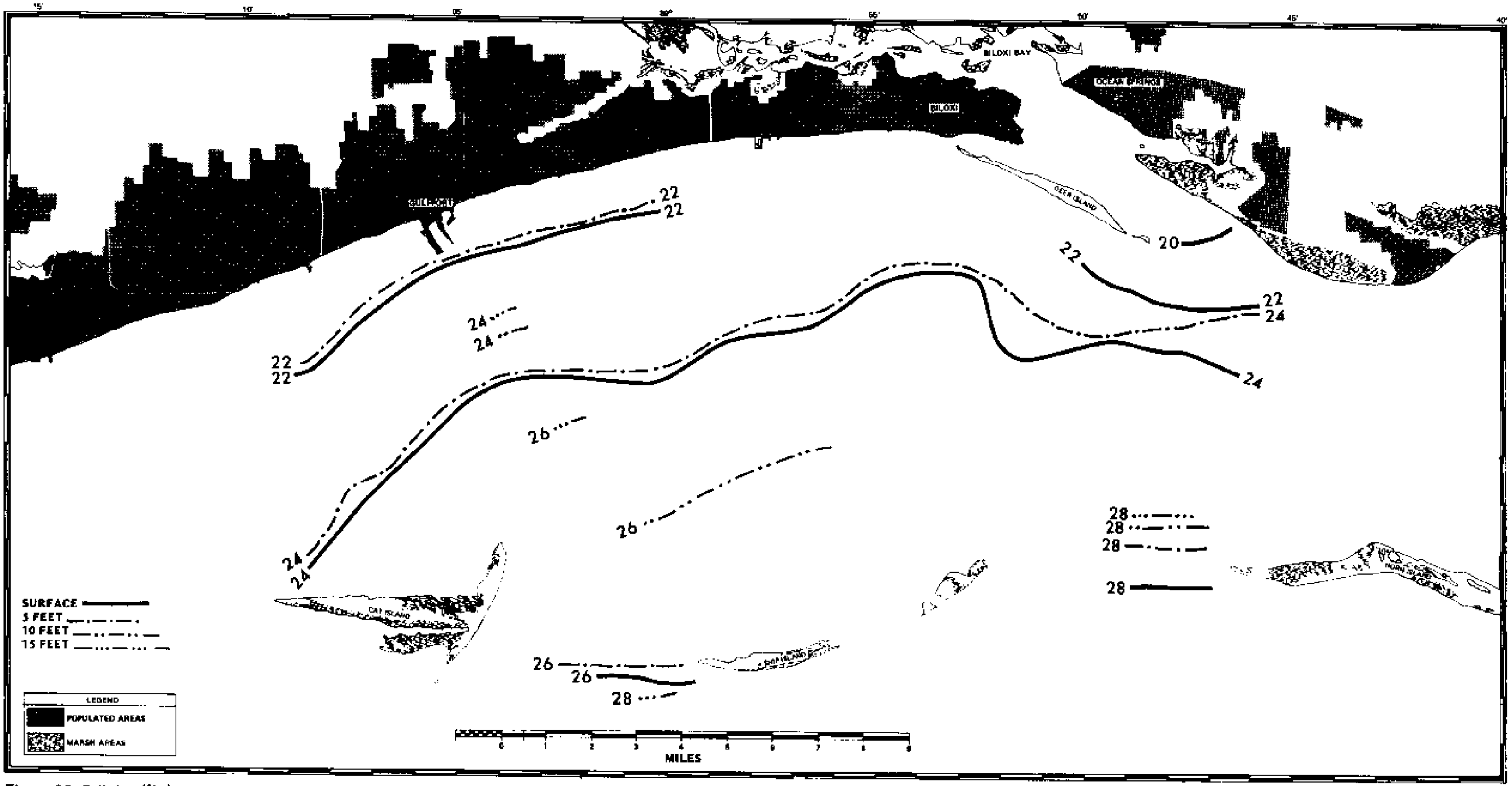


Figure 35. Salinity (‰) distribution 15 July 1974.

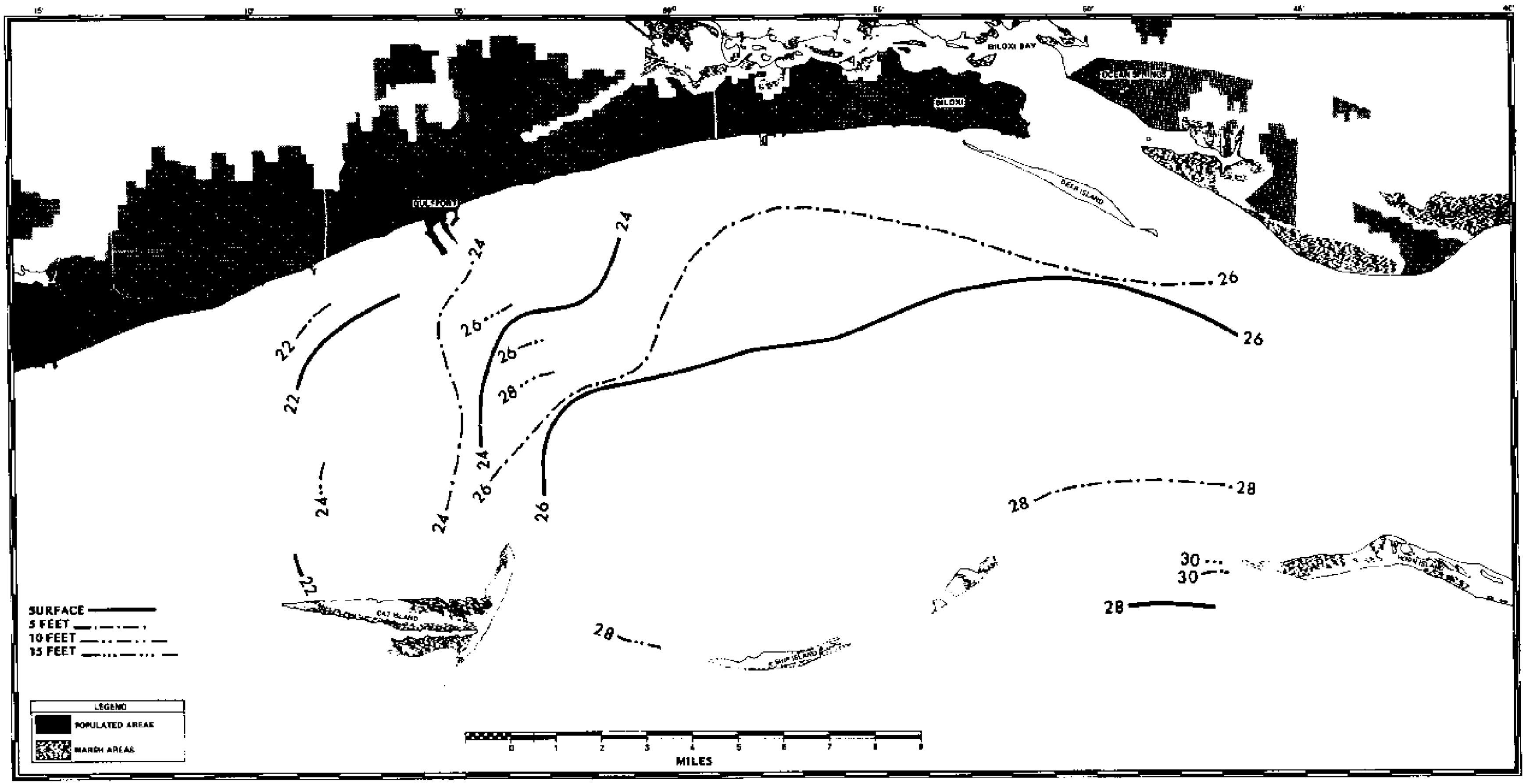


Figure 36. Salinity (‰) distribution 31 July 1974.

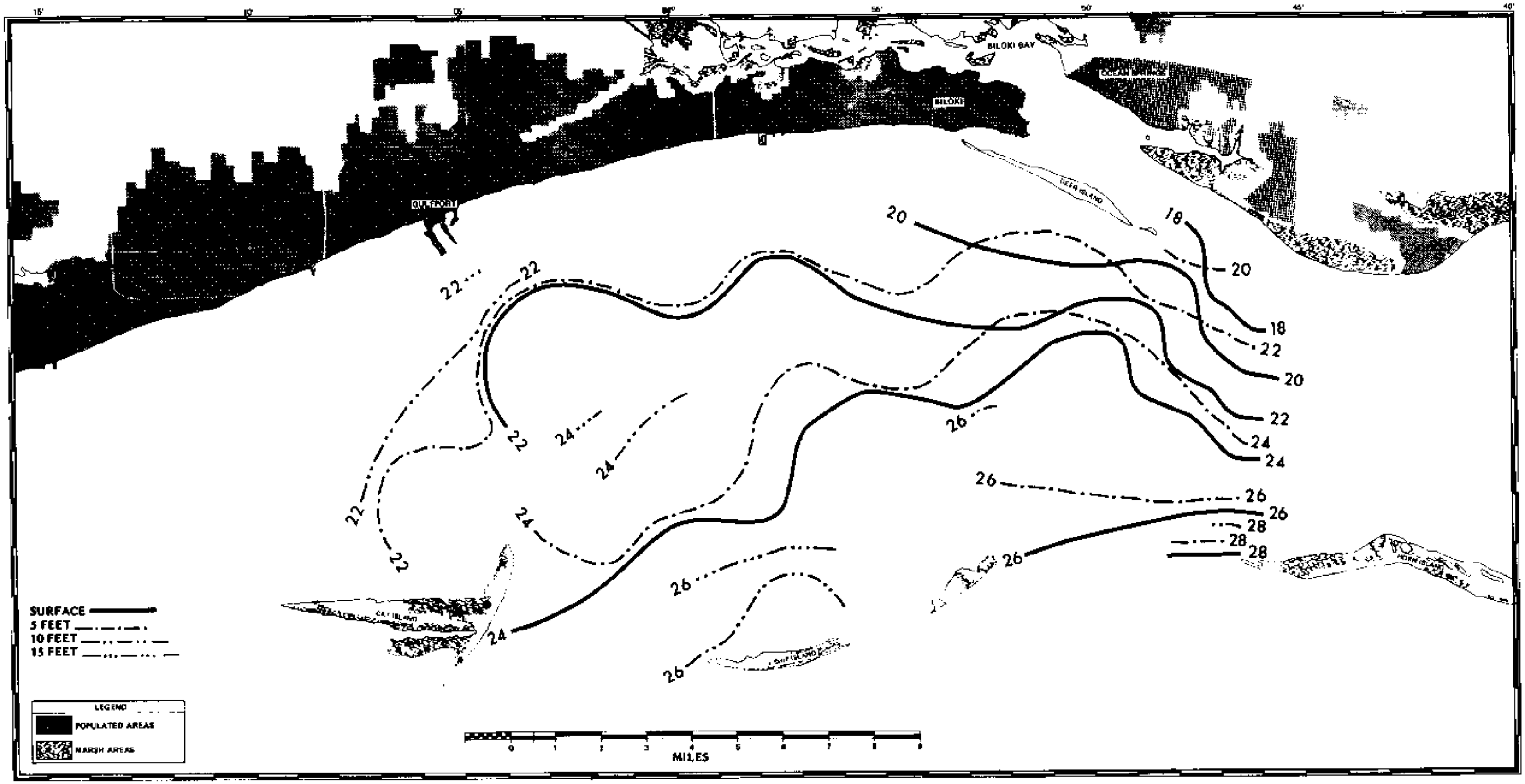


Figure 37. Salinity (‰) distribution 13 August 1974.

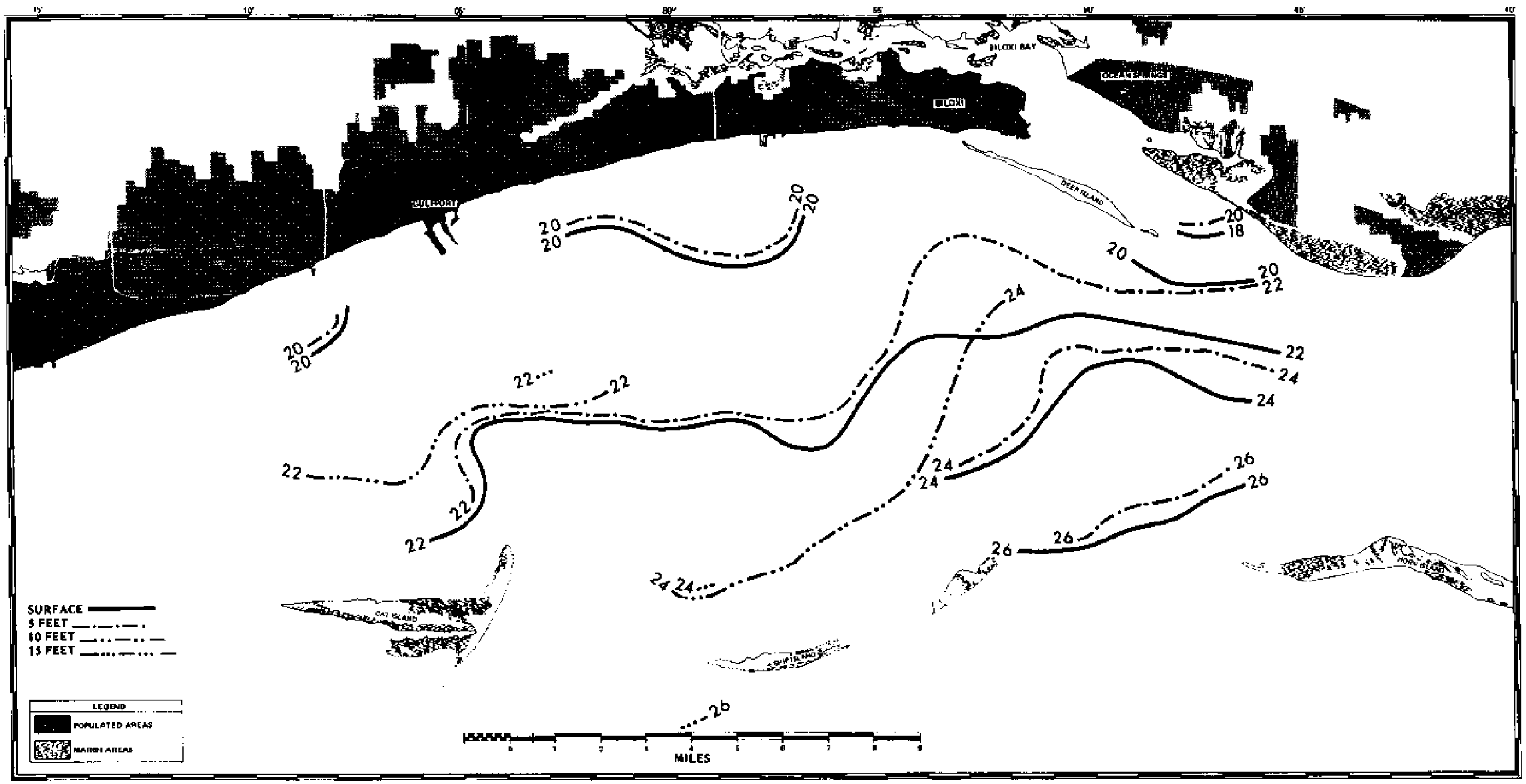


Figure 38. Salinity (‰) distribution 28 August 1974.

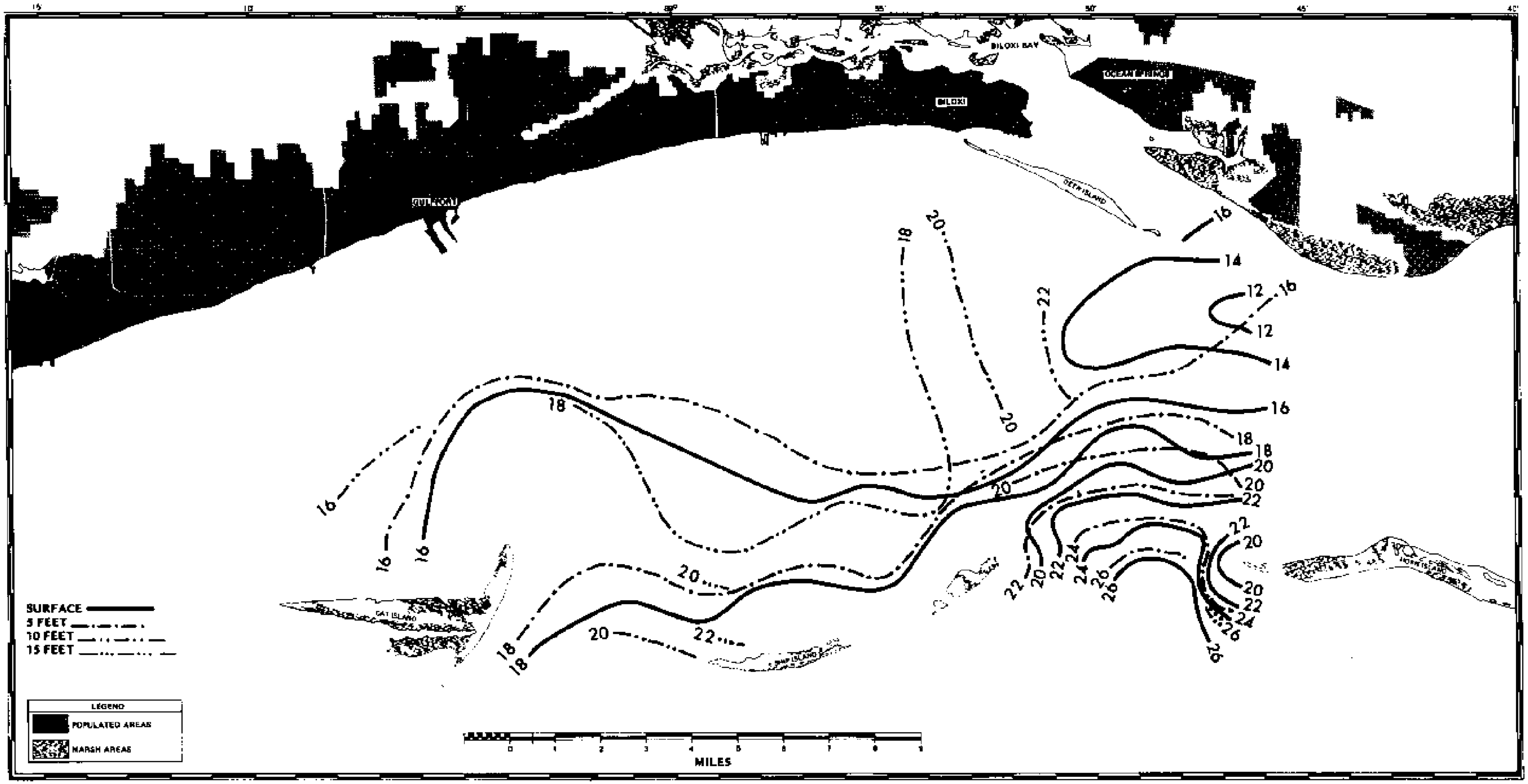


Figure 39. Salinity (‰) distribution 16 September 1974.

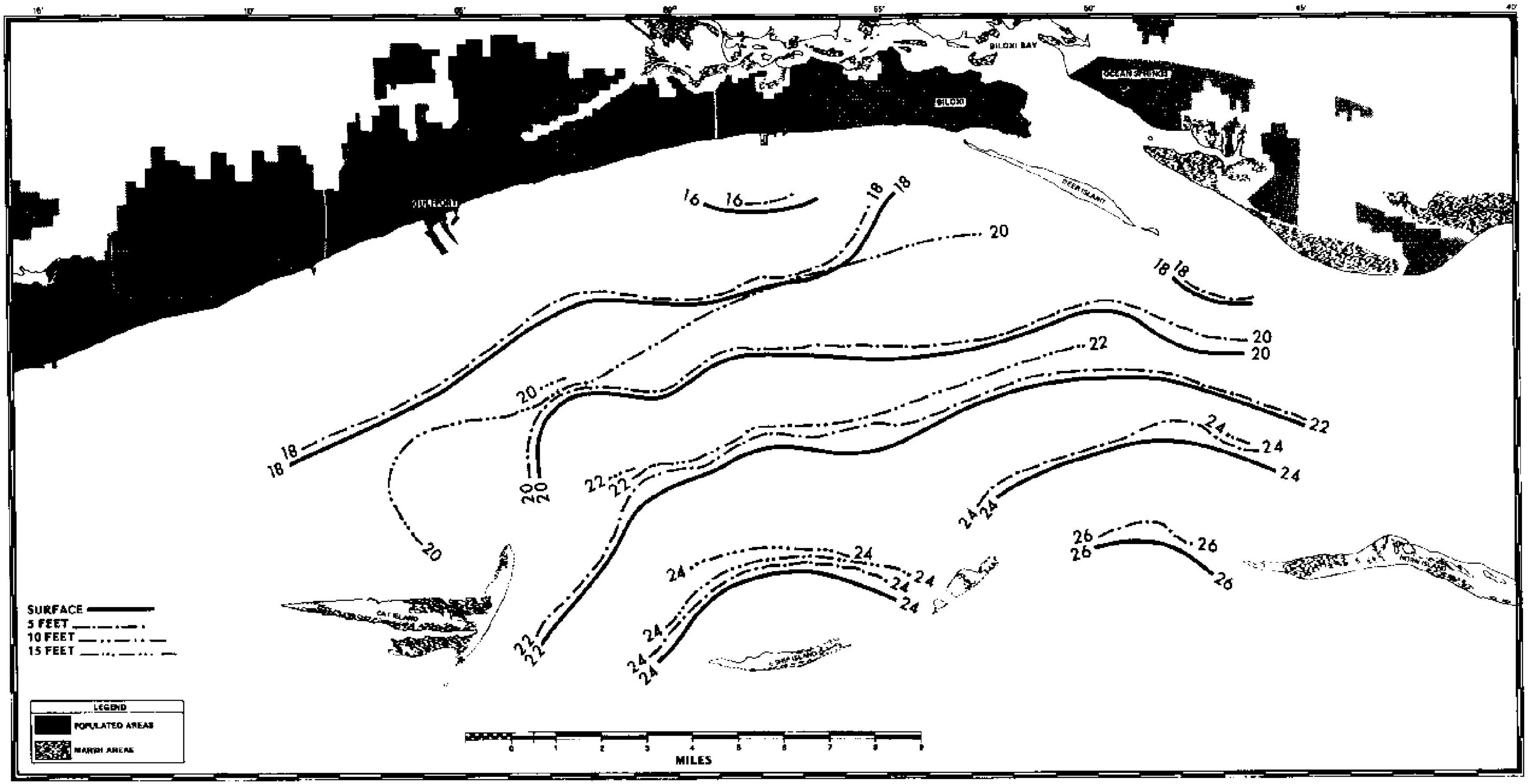


Figure 40. Salinity (‰) distribution 25 September 1974.

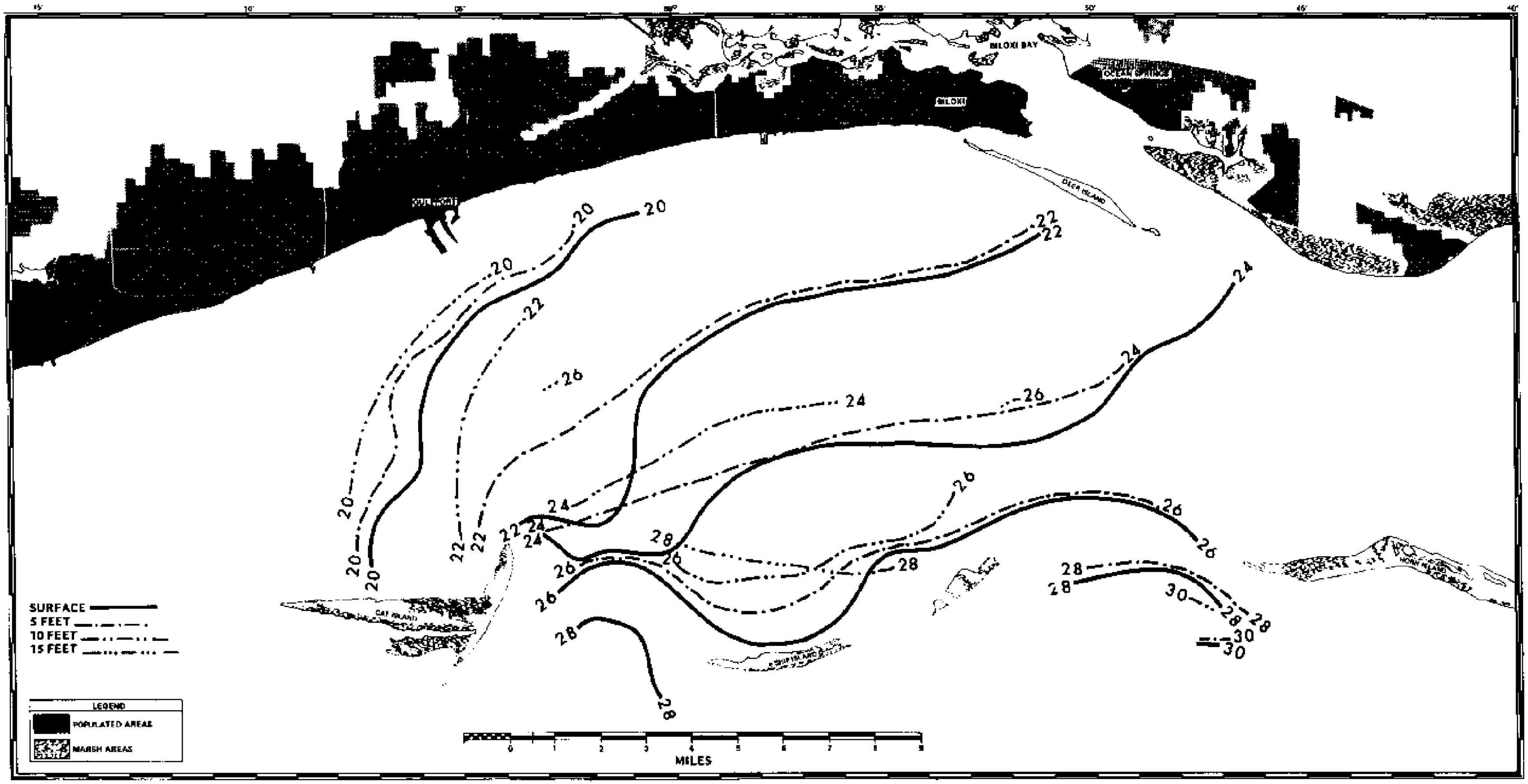


Figure 41. Salinity (‰) distribution 9 October 1974.

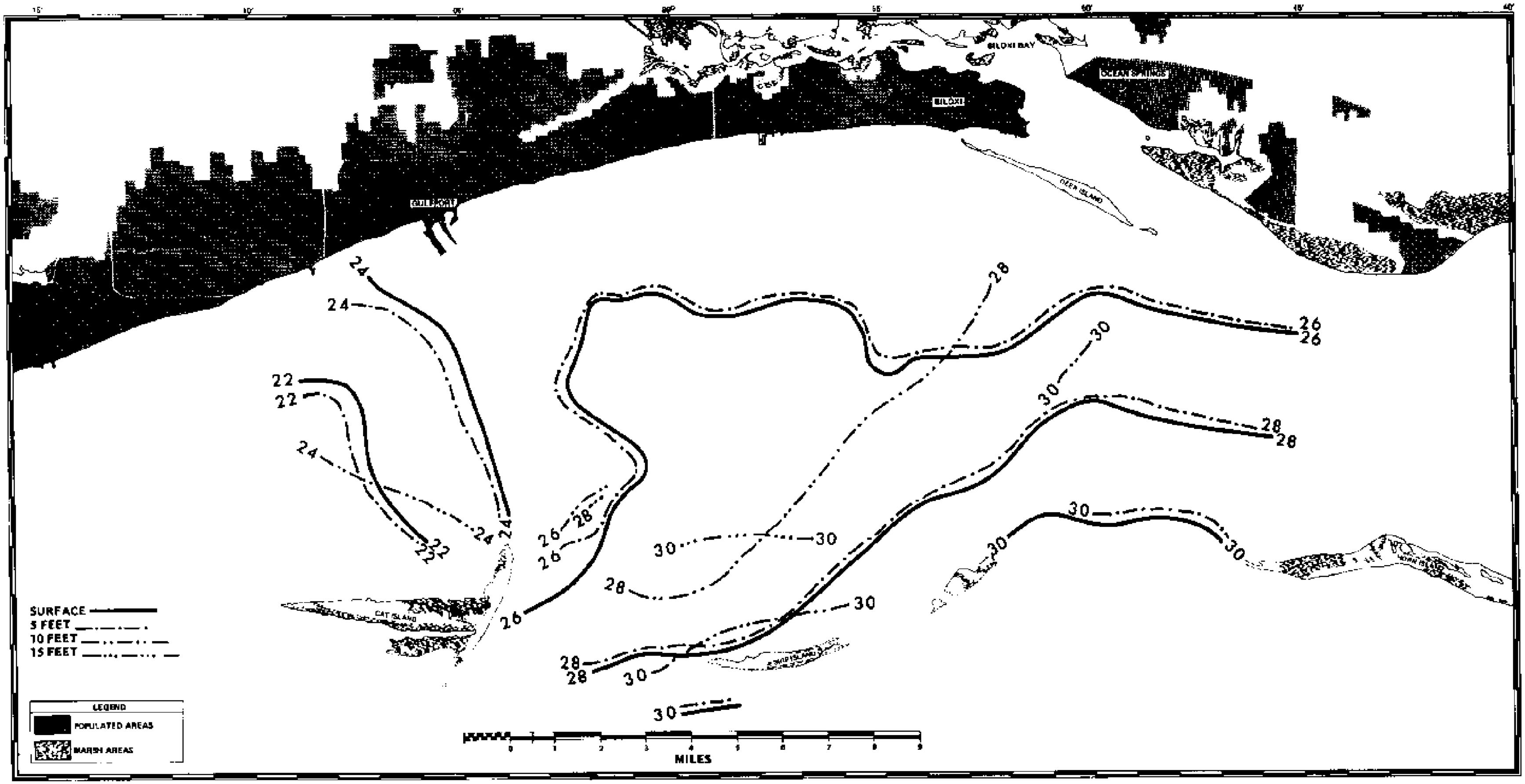


Figure 42. Salinity (‰) distribution 25 October 1974.

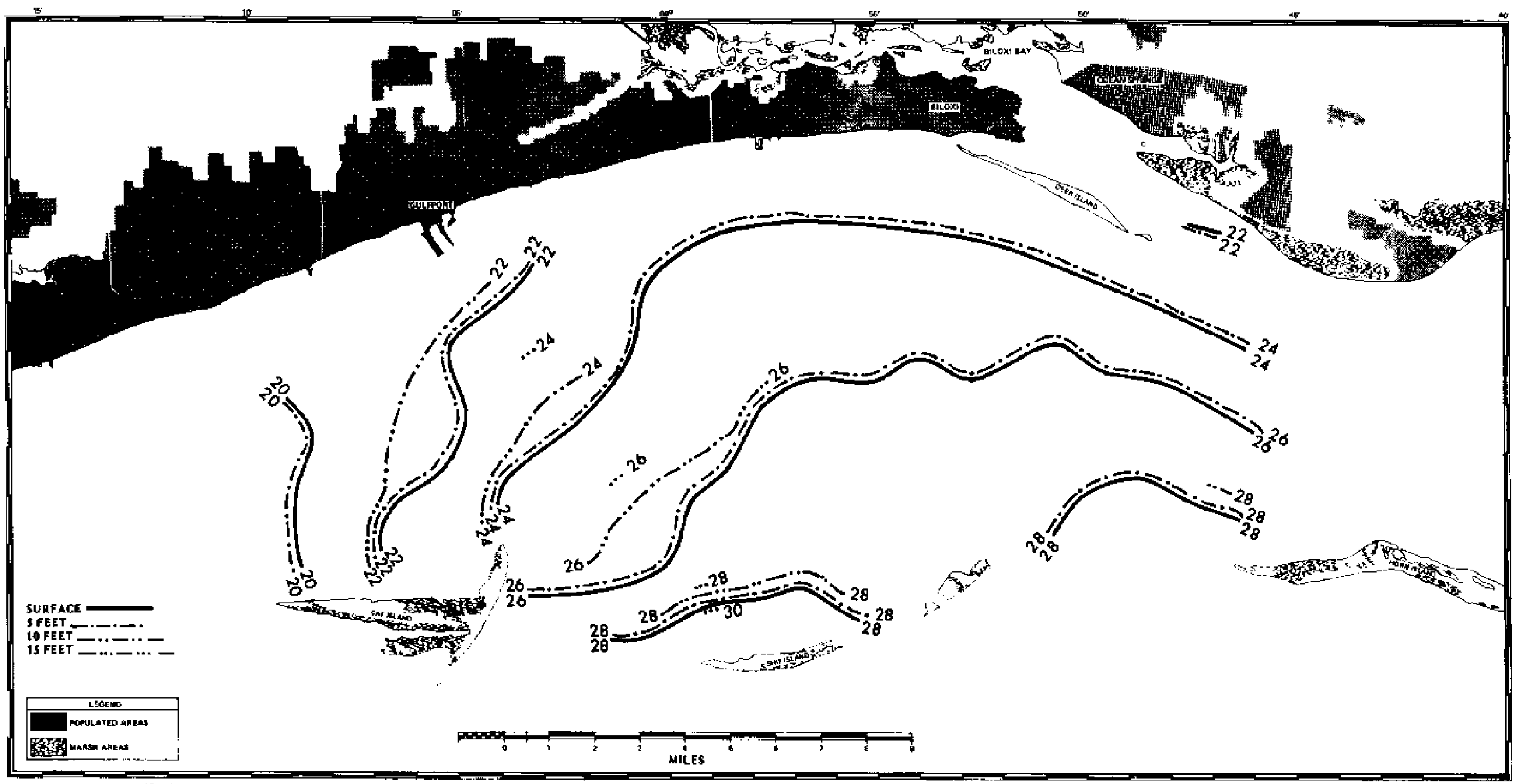


Figure 43. Salinity (‰) distribution 12 November 1974.

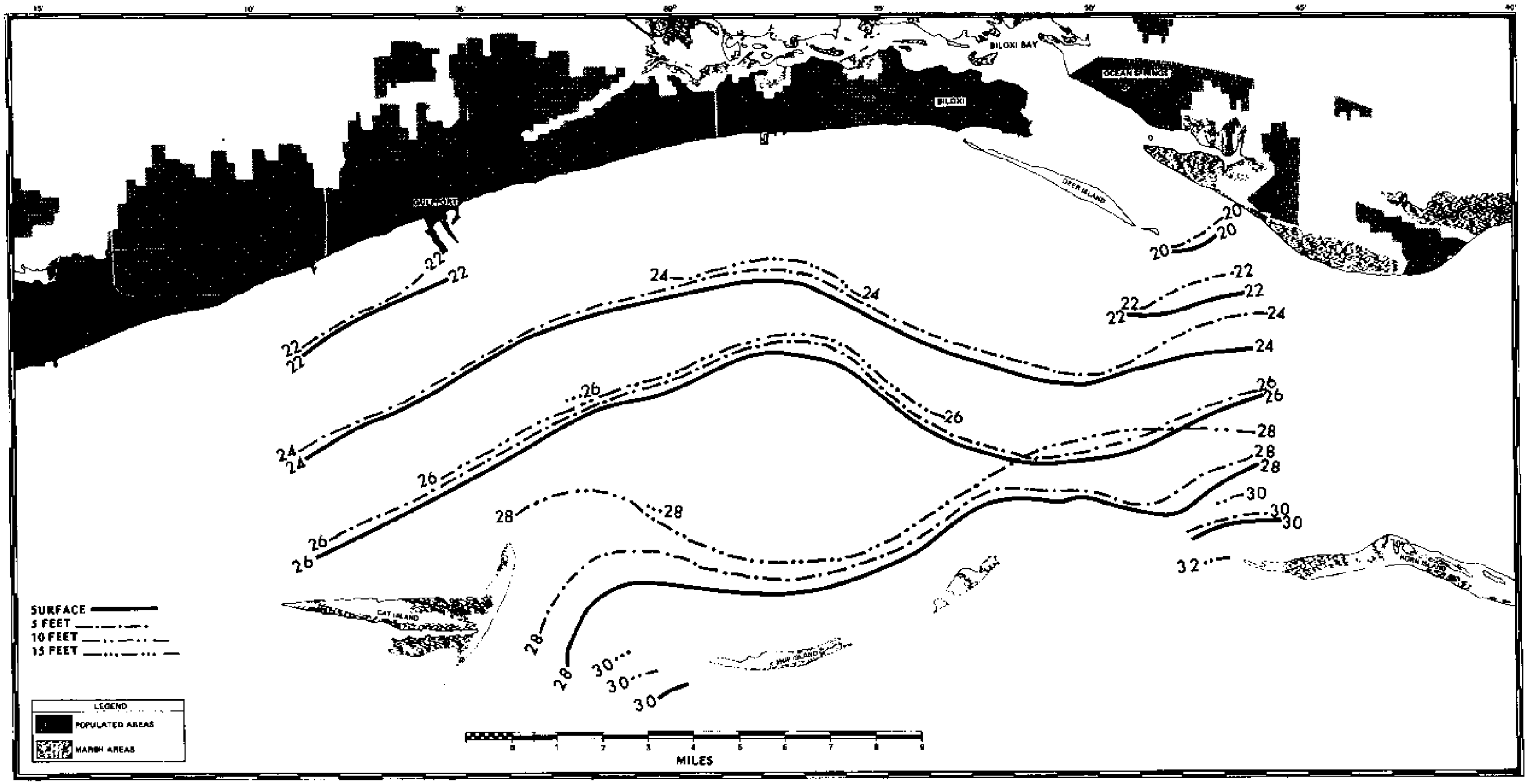


Figure 44. Salinity (‰) distribution 26 November 1974.

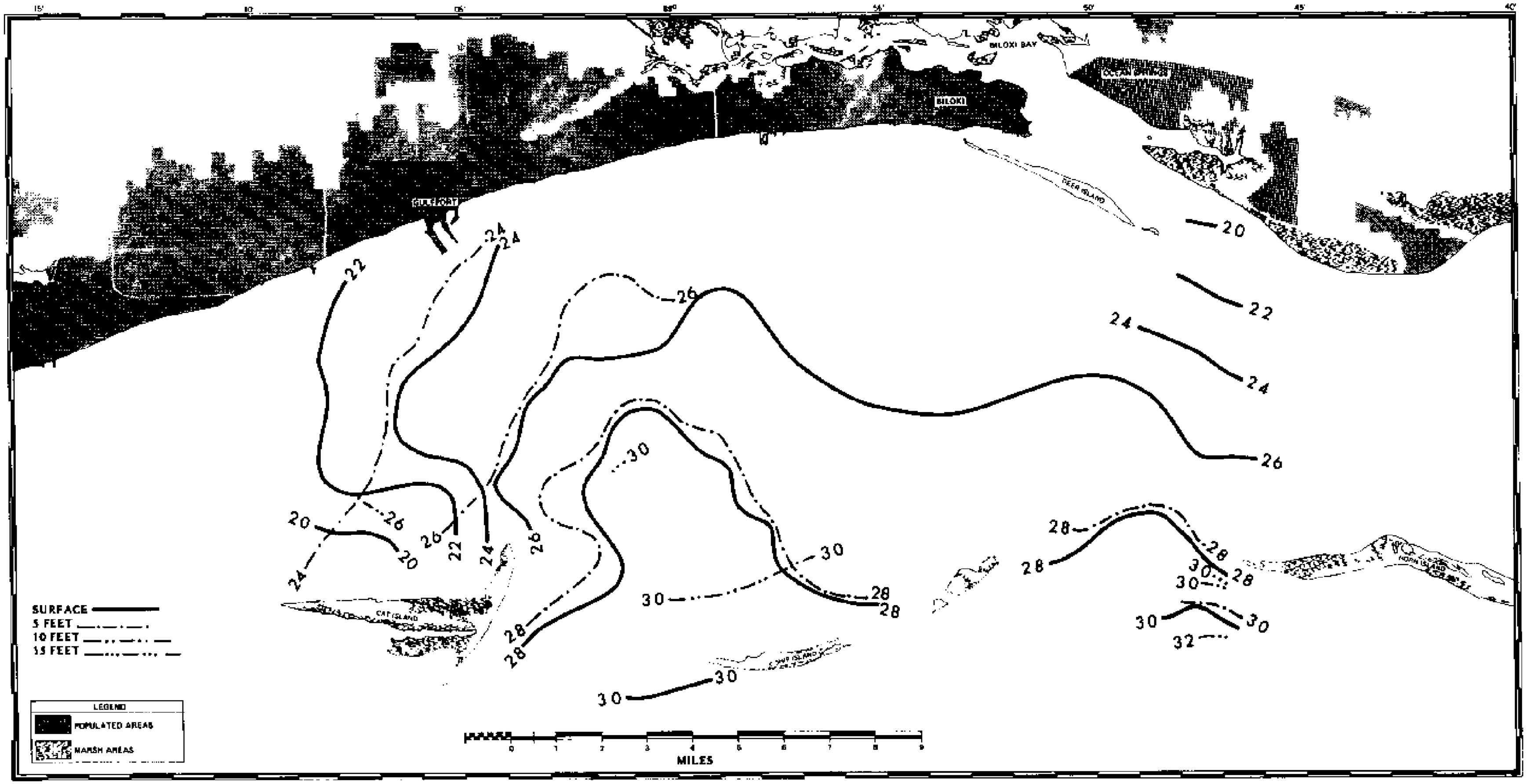


Figure 45. Salinity (‰) distribution 5 December 1974.

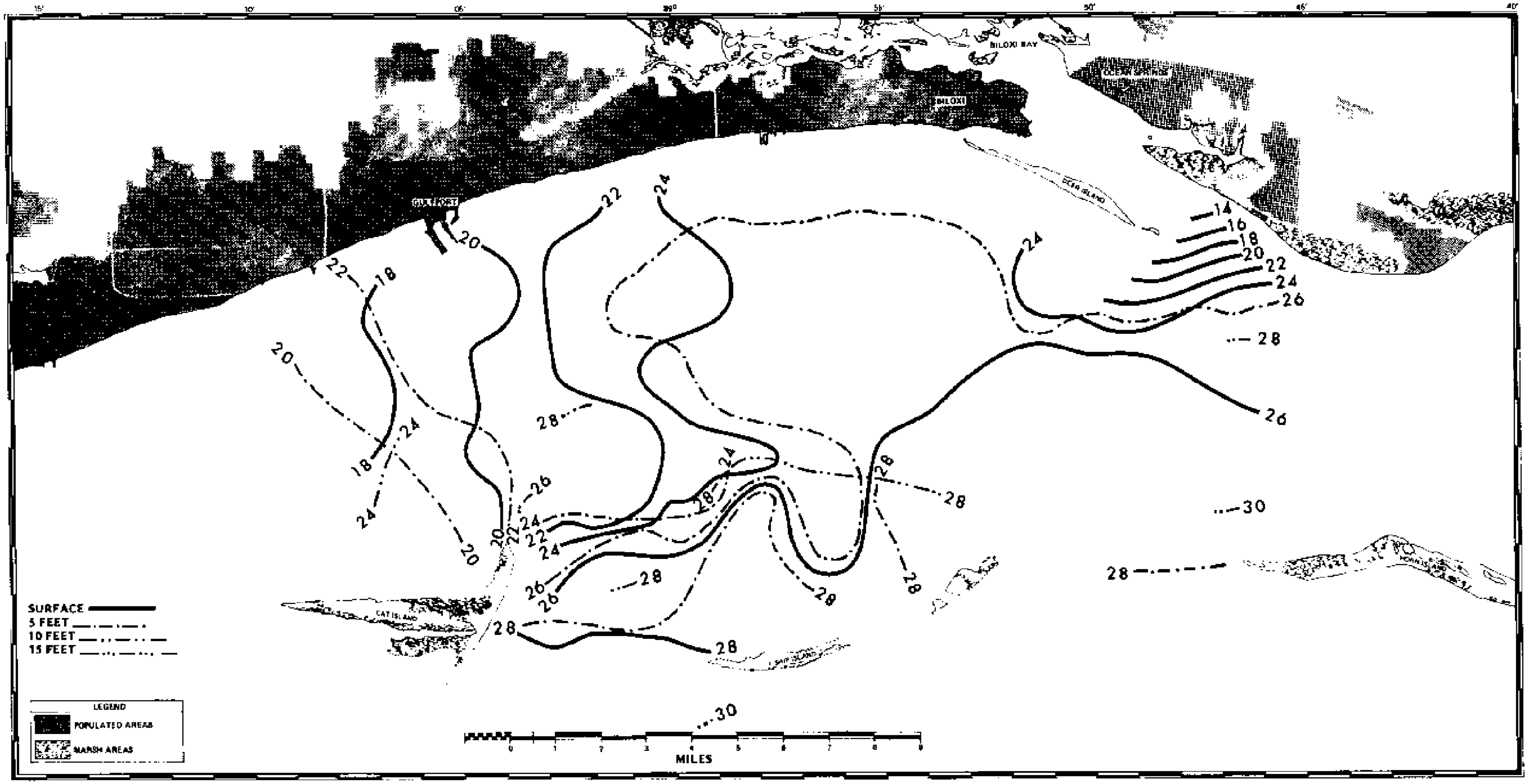


Figure 46. Salinity (‰) distribution 18 December 1974.

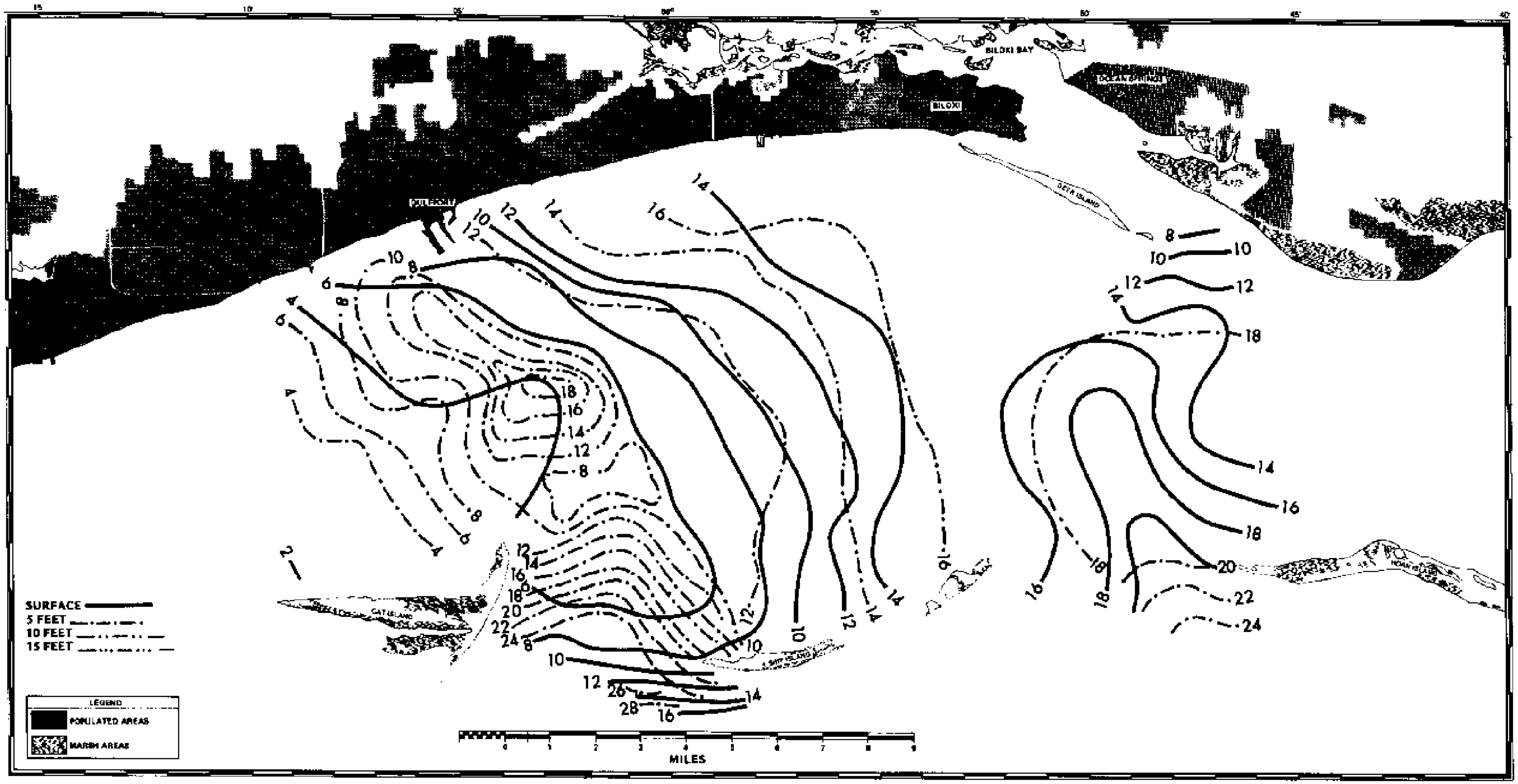


Figure 47. Salinity (‰) distribution 15 January 1975.

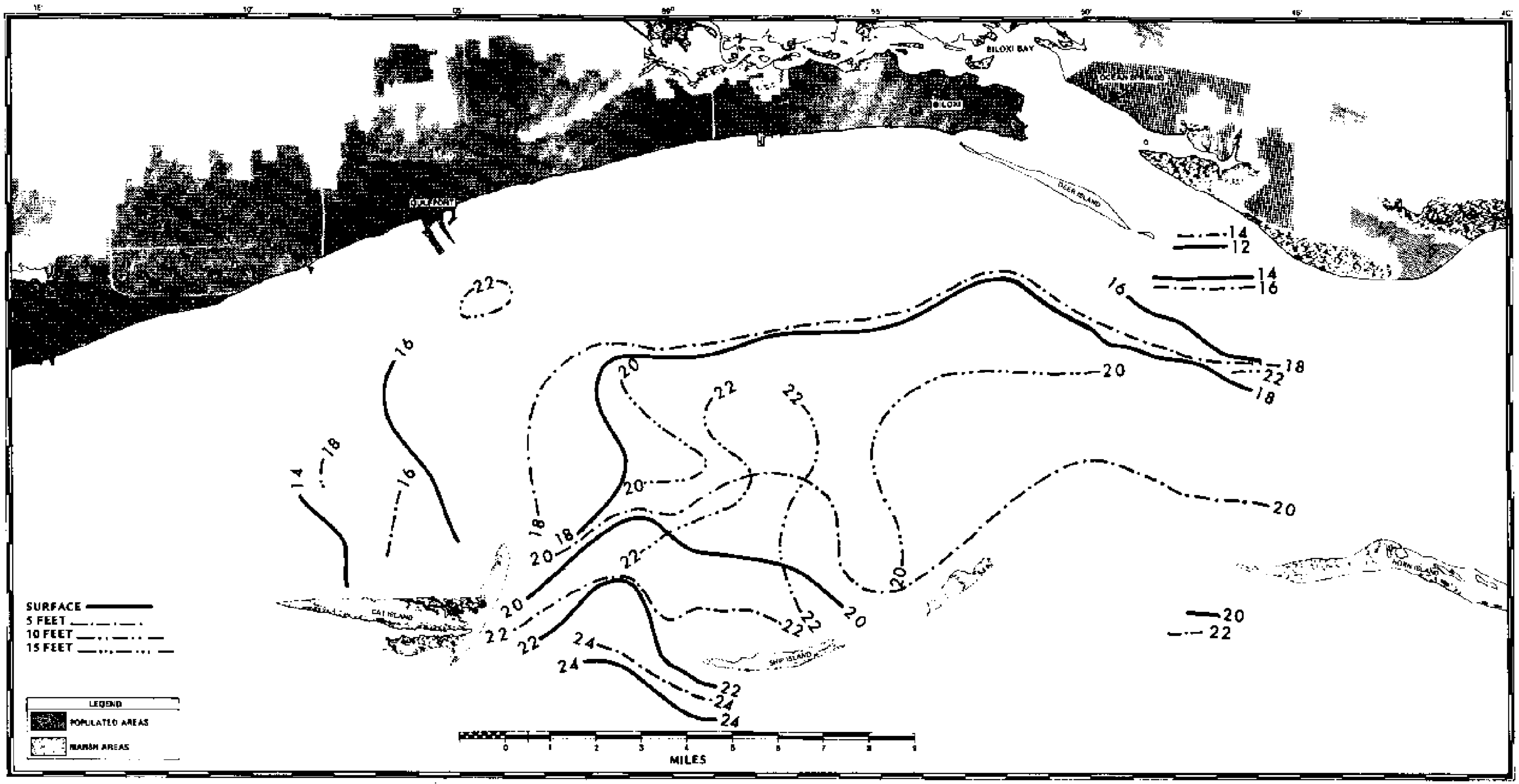


Figure 48. Salinity (‰) distribution 13 February 1975.

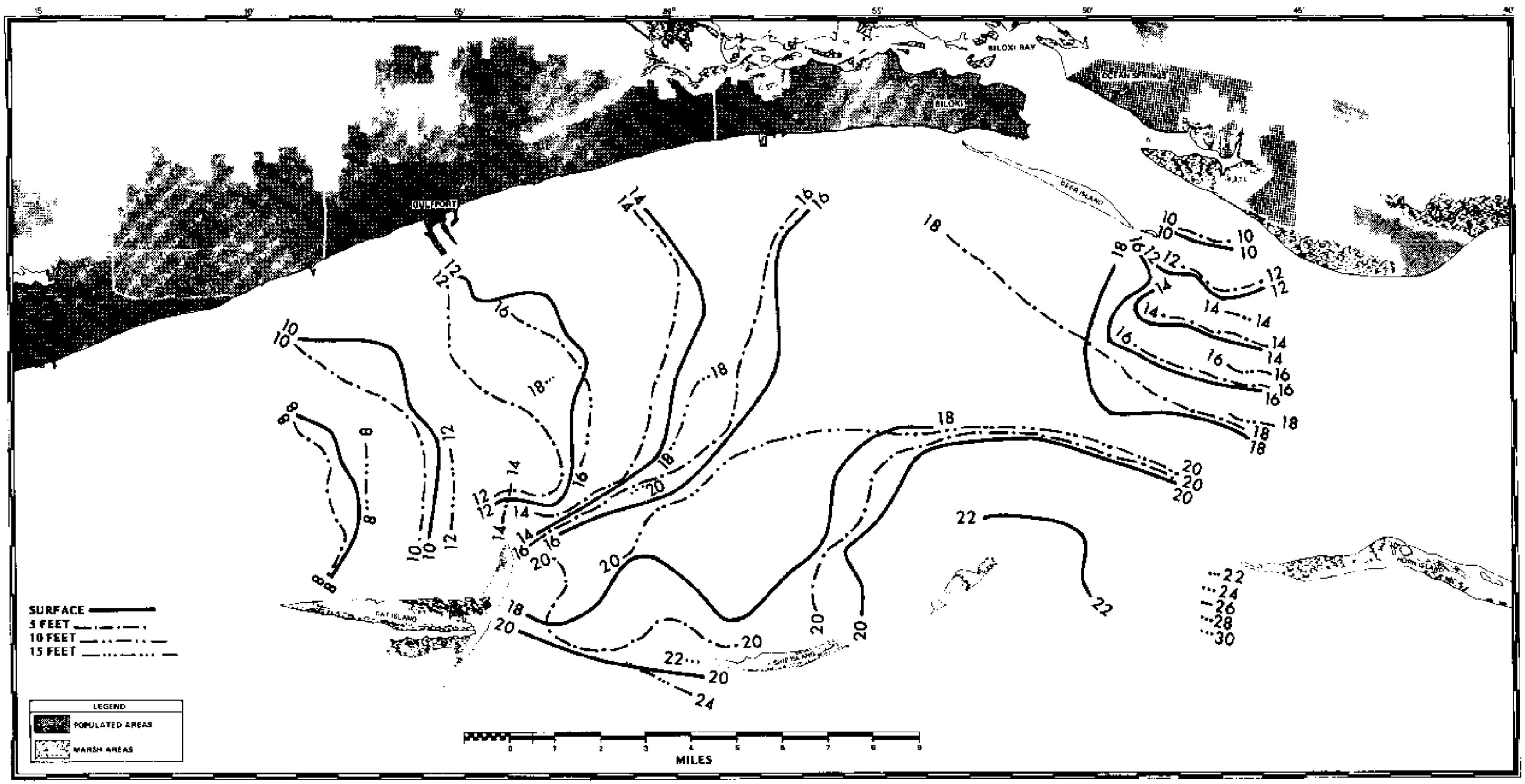
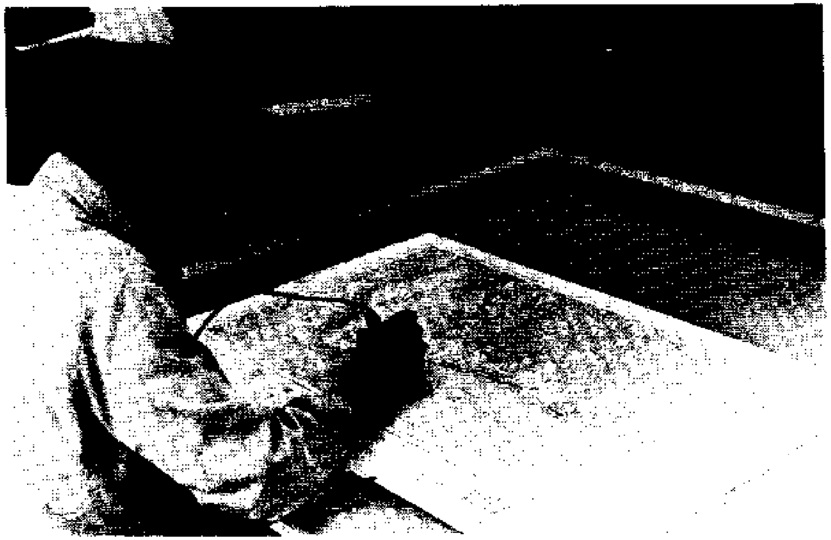
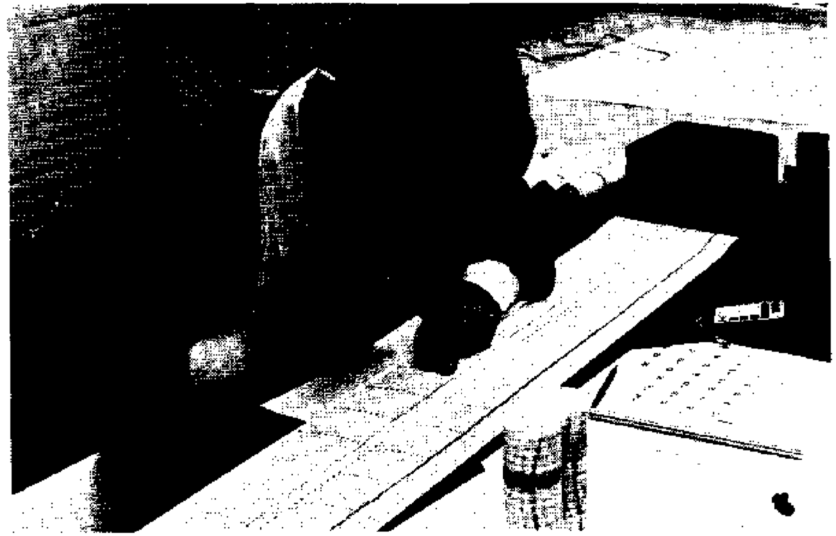


Figure 49. Salinity (‰) distribution 25 February 1975.



Dennis Stapp using digitizer to obtain coordinates of shoreline.



Francis Powell entering wind data on computer coding forms.

Chris Moran analyzing tide gauge records.

James French using precision salinometer to determine conductivity of seawater sample.

WEST MISSISSIPPI SOUND

The hydrographic study of west Mississippi Sound was conducted during the period March 1974 through February 1975 (Figures 50 - 74). West Mississippi Sound is defined here as that area lying west of a line drawn from Long Beach, Mississippi, to near the west end of Cat Island. Atwell (1973b) described this area as the most "quiescent" of the Sound.

Unlike the other island passes, the deepest portion of Cat Island Pass (passage between Cat Island and the Isle of Pitre) is centrally located. While the greatest depth of this passage is 50 feet, the predominant depth is less than 12 feet. The thalweg of the passage follows a rather sinuous path through shallow bars and oyster reefs. The highest salinity recorded in the Sound-end of the passage was 30 ppt at a depth of 10 feet. The waters exchanged through Cat Island Pass are primarily those of Mississippi and Chandeleur sounds and are therefore already measurably diluted. This restricted exchange of waters with the open Gulf plays a major role in dictating the area's salinity regime. It will be necessary to first understand the current regime of Chandeleur Sound and the near Gulf of Mexico before one can accurately ascertain the water renewal rates in the west Sound.

Le Petit Pass is a narrow (< half mile), deep (> 40-foot) passage between Le Petit Pass Island and the Louisiana marshland to the south. The amount of flow through this pass is unknown but maintenance of its depth by bottom scour implies high rates. The influence of this pass on the hydrography was not determined during this study but should be considered in any future work.

Pearl River empties into Lake Borgne approximately four miles west of the narrowest width of St. Joe Pass. The river water flows via St. Joe Pass into Mississippi Sound. The core of the river outflow was observed to take two distinct routes. One; the river outflow often passing through St. Joe Pass turned to the northeast, probably deflected by winds and/or incoming tides. Two; the flow, while spreading radially, turns to the southeast toward Cat Island Pass.

During low flow periods, the river outflow is not sharply defined but is manifested only in the progressively lower salinities toward St. Joe Pass. High rates of freshwater inflow into the Sound from the west alter the normal circulatory patterns. The water column approaches uniformity with depressed salinity levels and the isosals oriented approximately north-south indicating an eastward flow. The eastern extent of this influence was pointed out in the section dealing with central Mississippi Sound as being a line of longitude crossing the east end of Ship Island.

St. Louis Bay contributes low salinity water to the area. Two rivers, Jourdan and Wolf, empty into St. Louis Bay. While little information on circulation within the bay exists (Eleuterius 1973), it is well established that a salinity gradient exists across the entrance with the low salinity outflow consistently occurring on the west side. Furthermore, from this study, it appears that the low salinity water exiting on the west side continues to follow the shoreline westward for some distance. Spatial resolution dictated by station locations does not permit a more definitive accounting.

Overall, the water column was usually fairly uniform. However, on several occasions (Figures 50, 60 and 71) the horizontal distribution of salinity at the surface and at a depth of 5 feet indicated different flow patterns existed. While it normally shares with Cat Island Pass in supplying higher salinity water to the Pass Christian area, Ship Island Pass becomes the primary source of saline water to the area during periods of high river flow.

The influence of the freshwater inflow on the salinity levels in the area is clearly shown in Figures 50, 53 and 72. Salinity reached a peak in October 1974 (Figure 66) when Pearl, Jourdan and Wolf rivers simultaneously approached their lowest rate of flow. Surface salinity reached 16 ppt in St. Joe Pass at that time. The greatest salinity gradient across the Sound spanned 18 ppt (6 - 24 ppt).

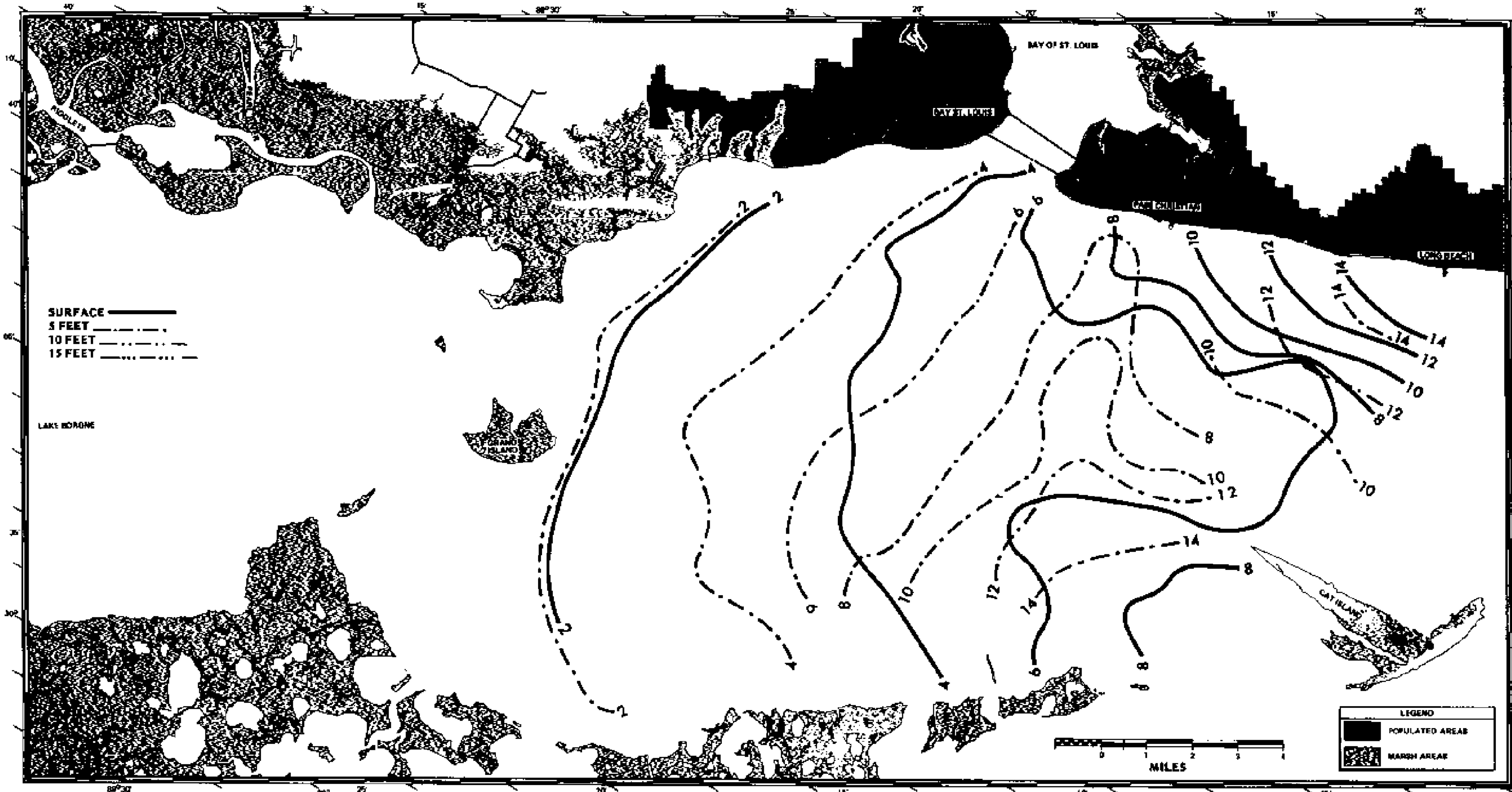


Figure 50. Salinity (‰) distribution 1 March 1974.

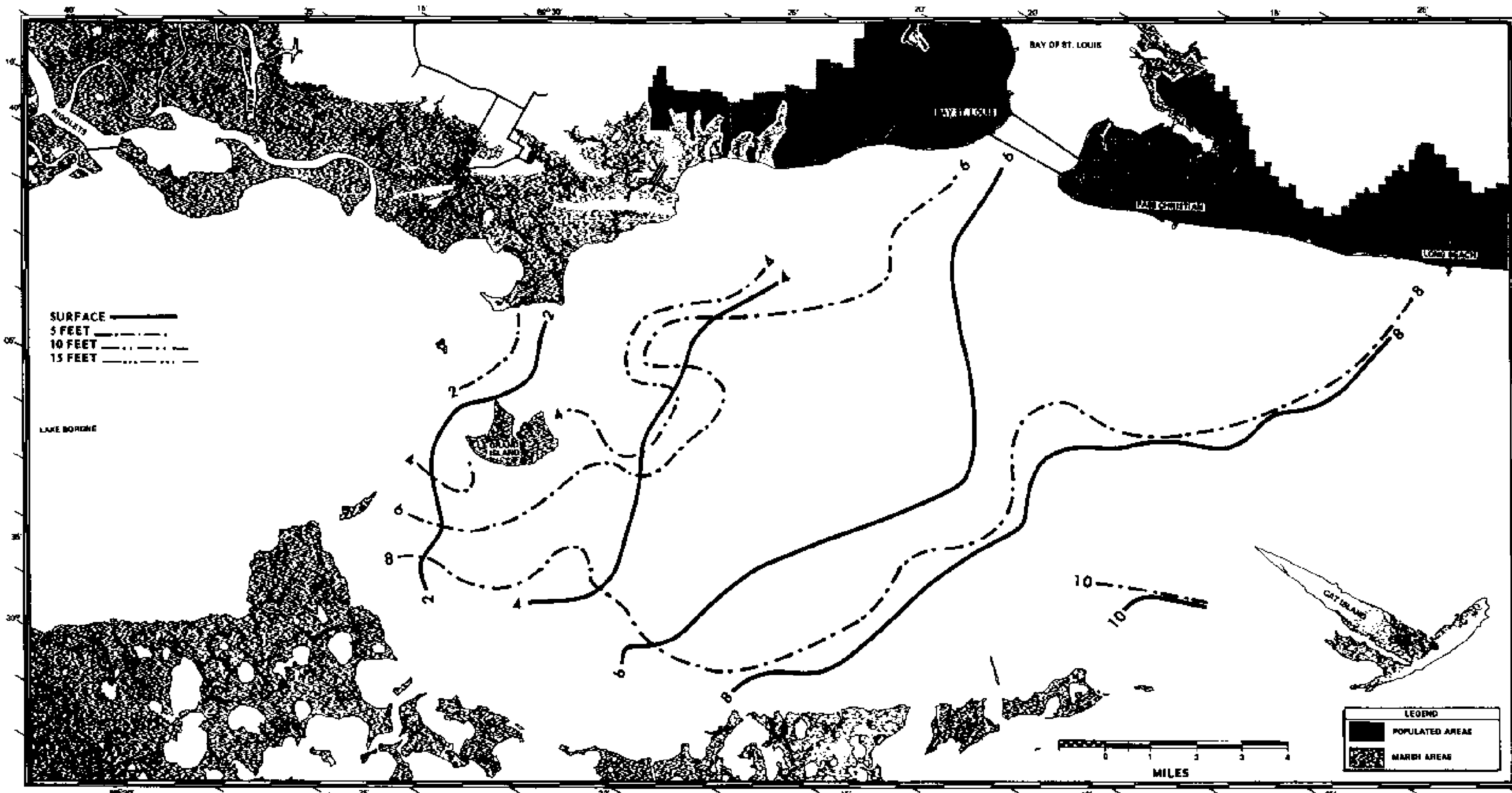


Figure 51. Salinity (‰) distribution 11 March 1974.

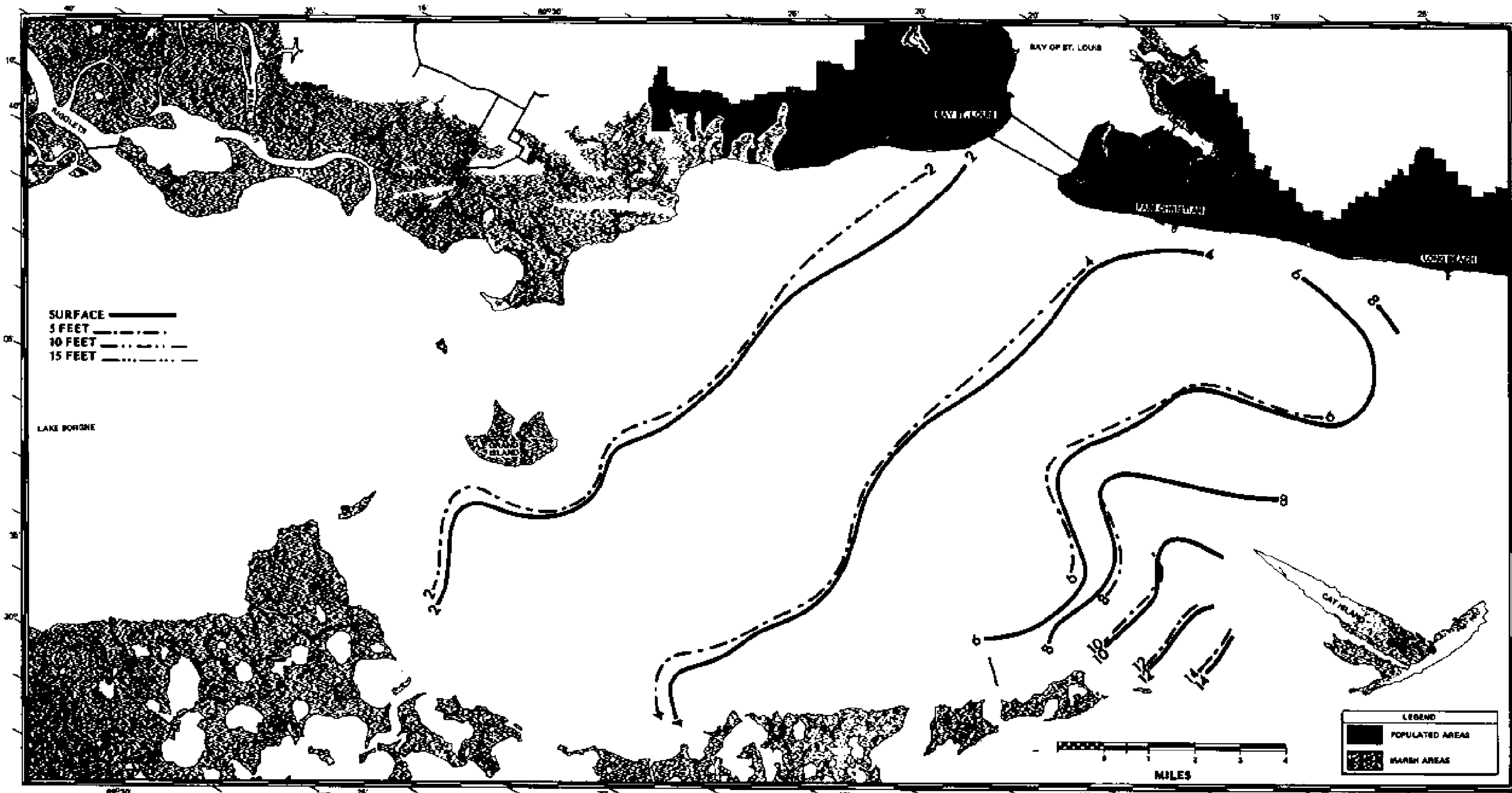


Figure 52. Salinity (‰) distribution 17 April 1974.

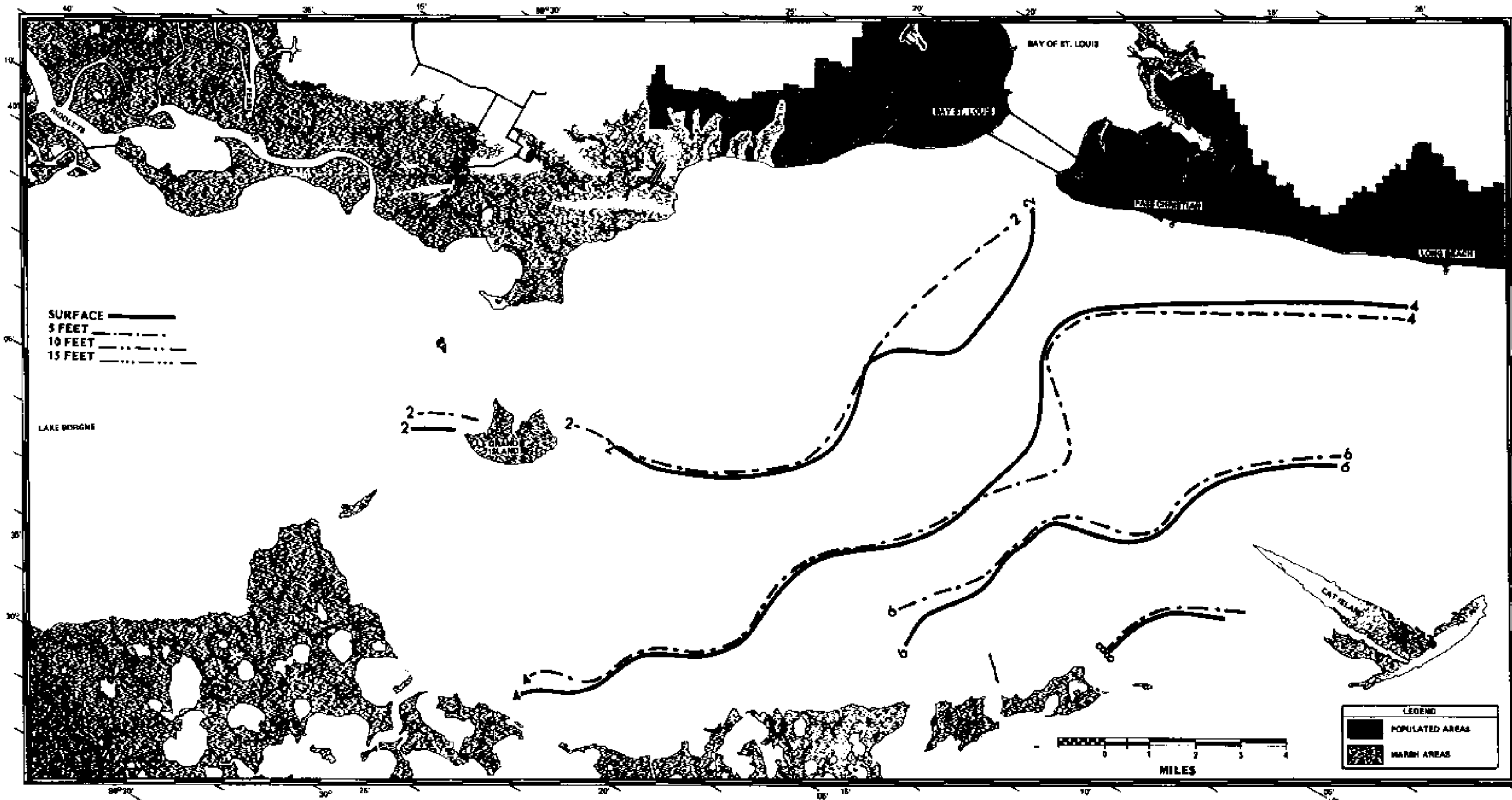


Figure 53. Salinity (‰) distribution 23 April 1974.

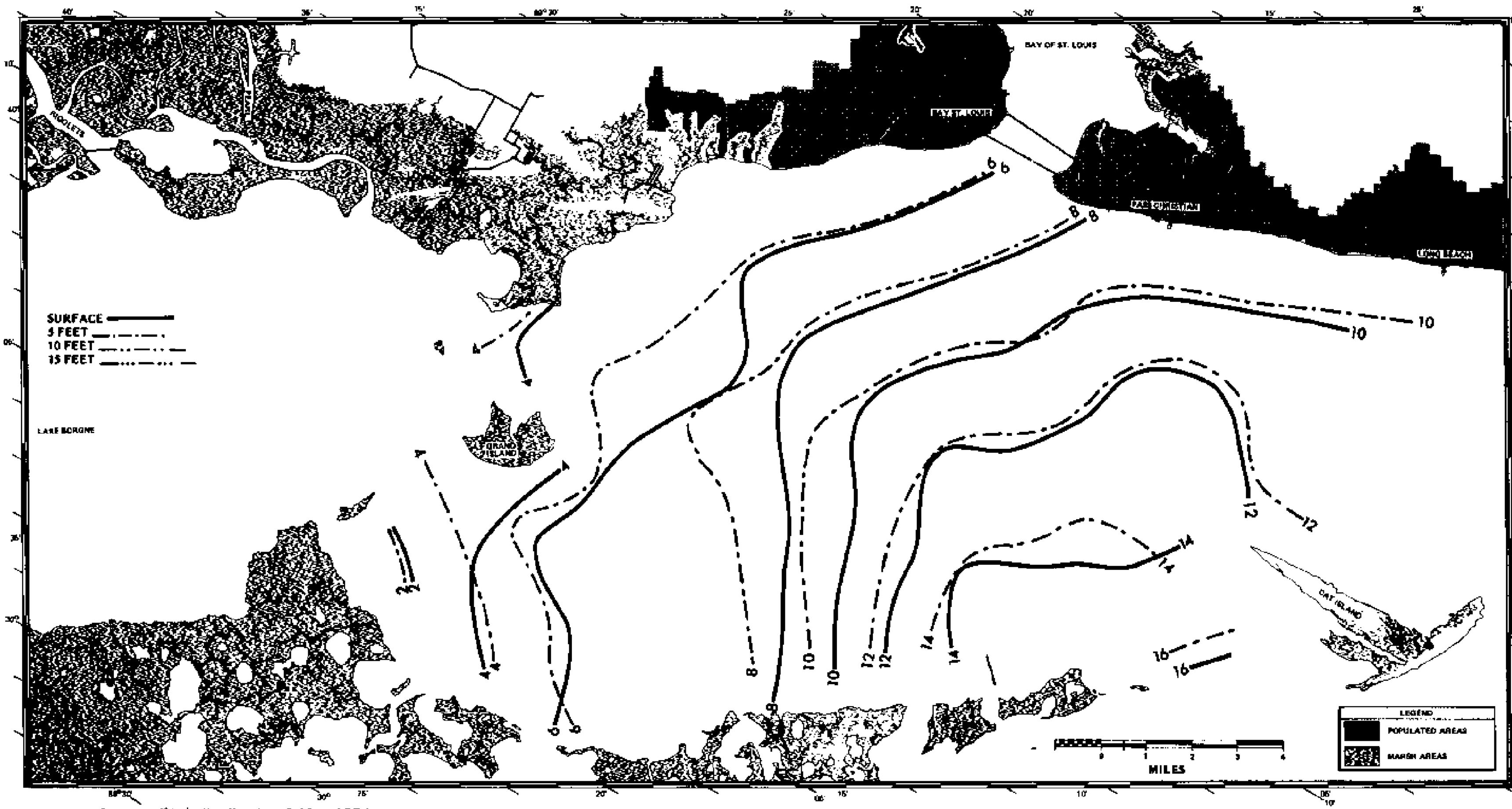


Figure 54. Salinity (°/₀₀) distribution 9 May 1974.

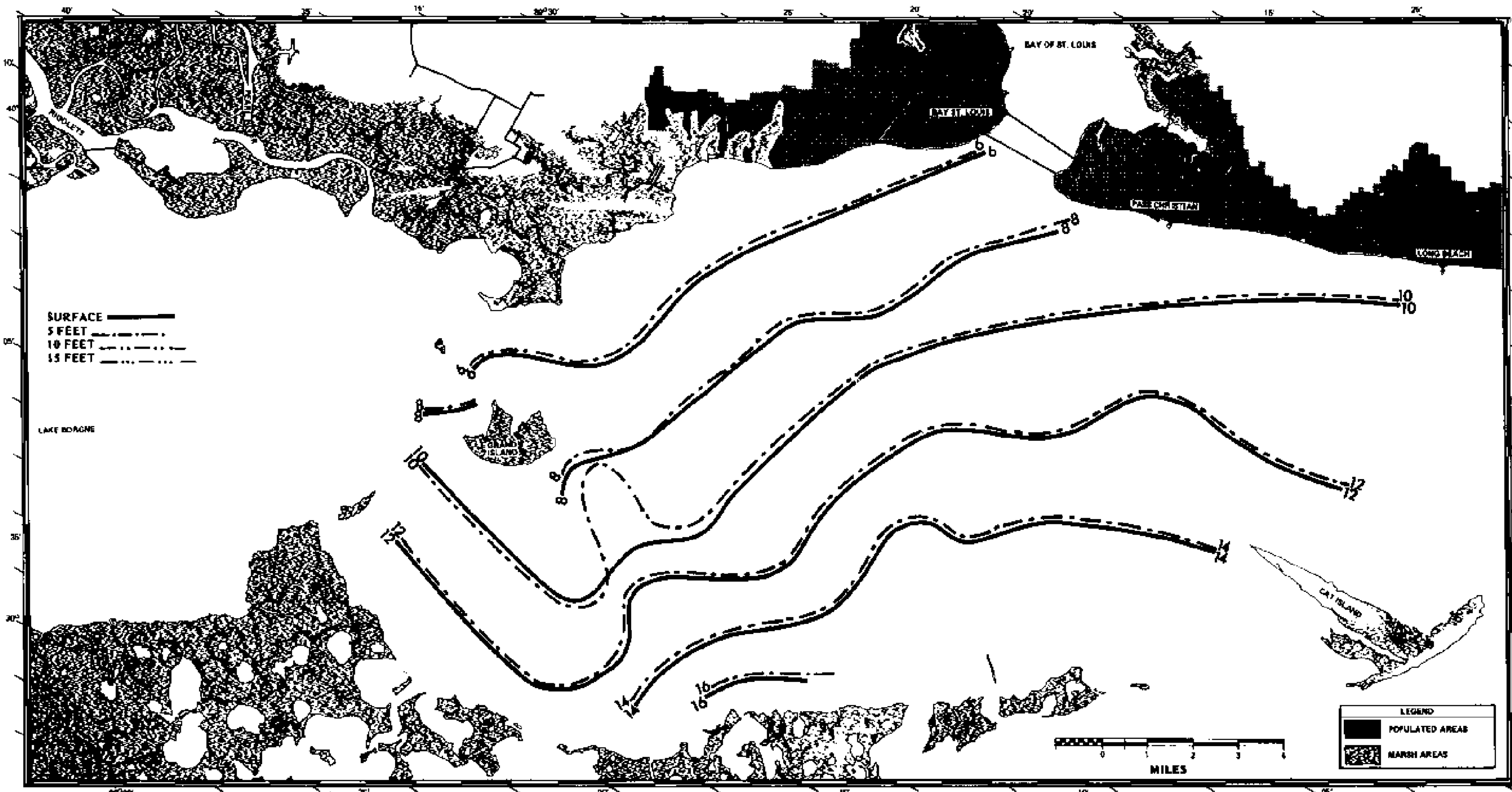


Figure 55. Salinity (‰) distribution 20 May 1974.

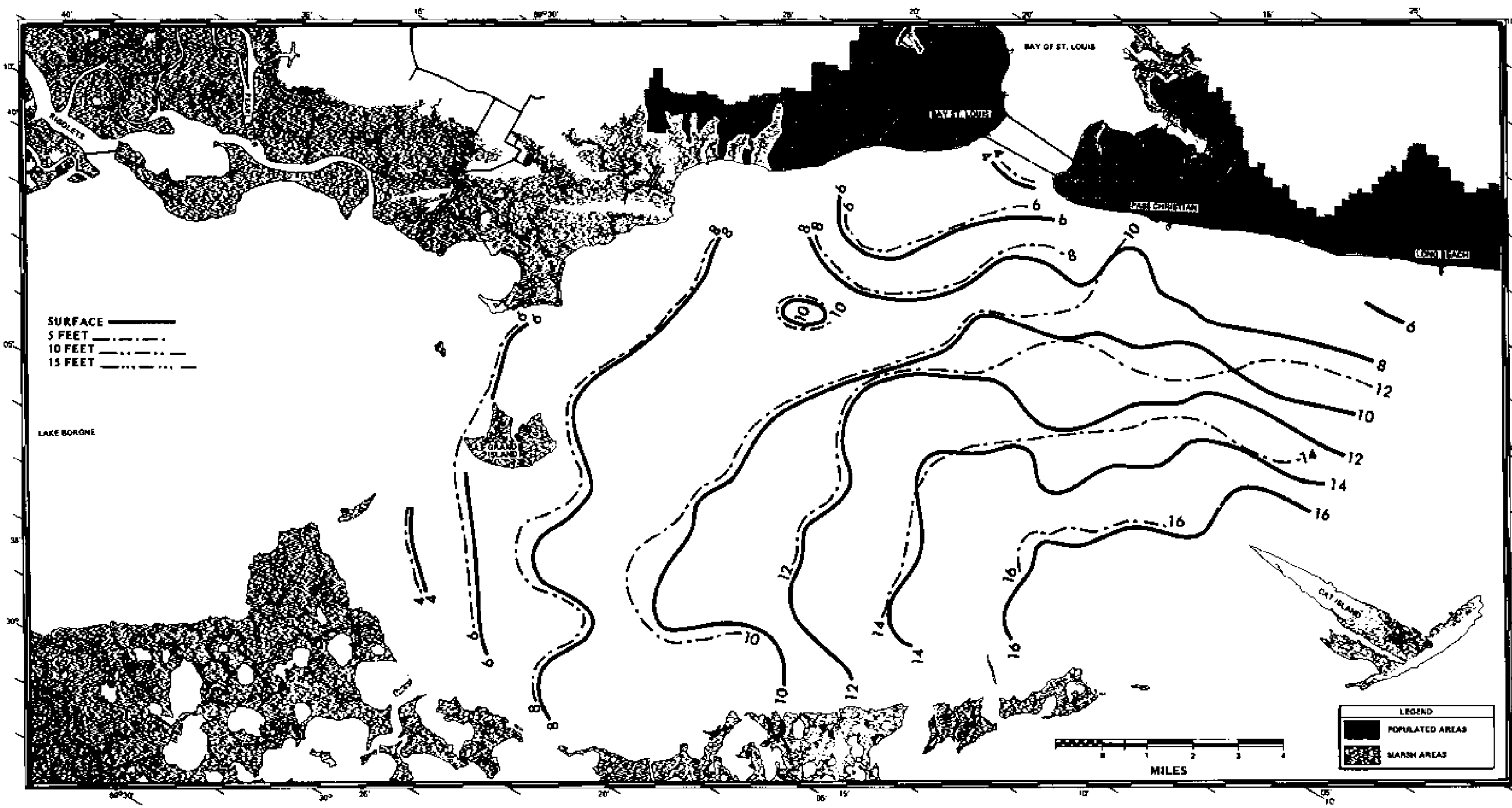


Figure 56. Salinity (‰) distribution 10 June 1974.

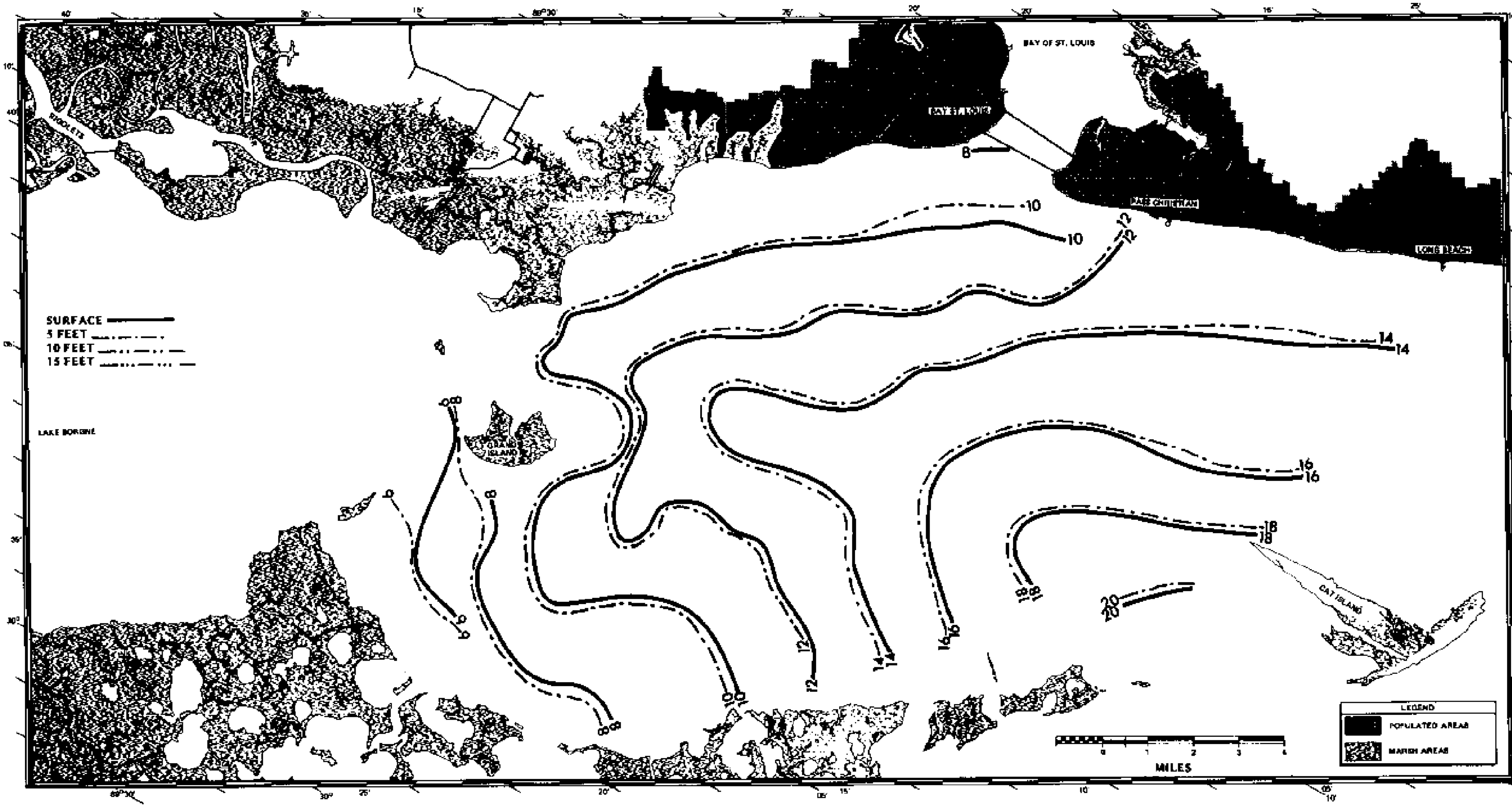


Figure 57. Salinity (‰) distribution 17 June 1974.

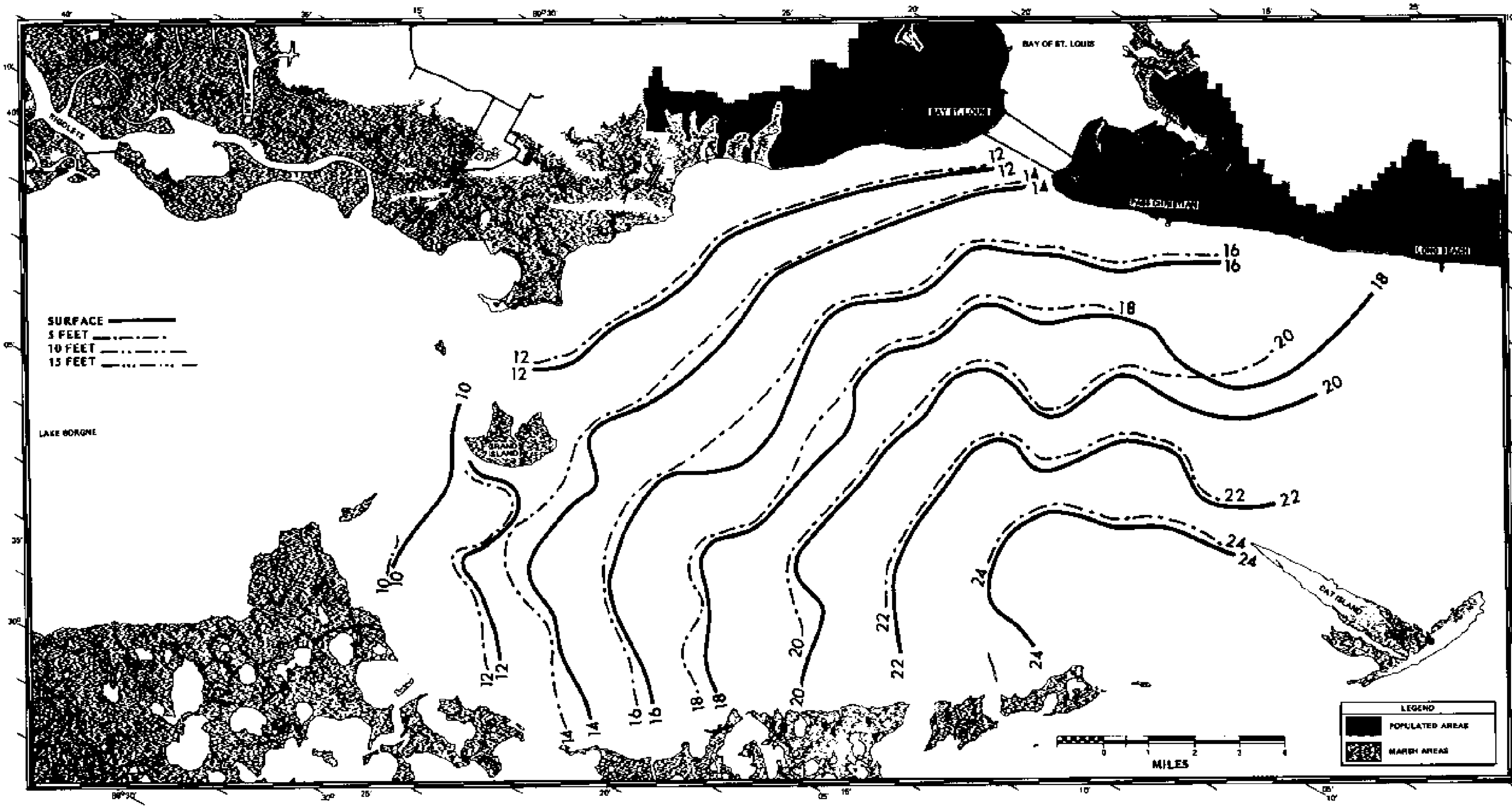


Figure 58. Salinity (‰) distribution 3 July 1974.

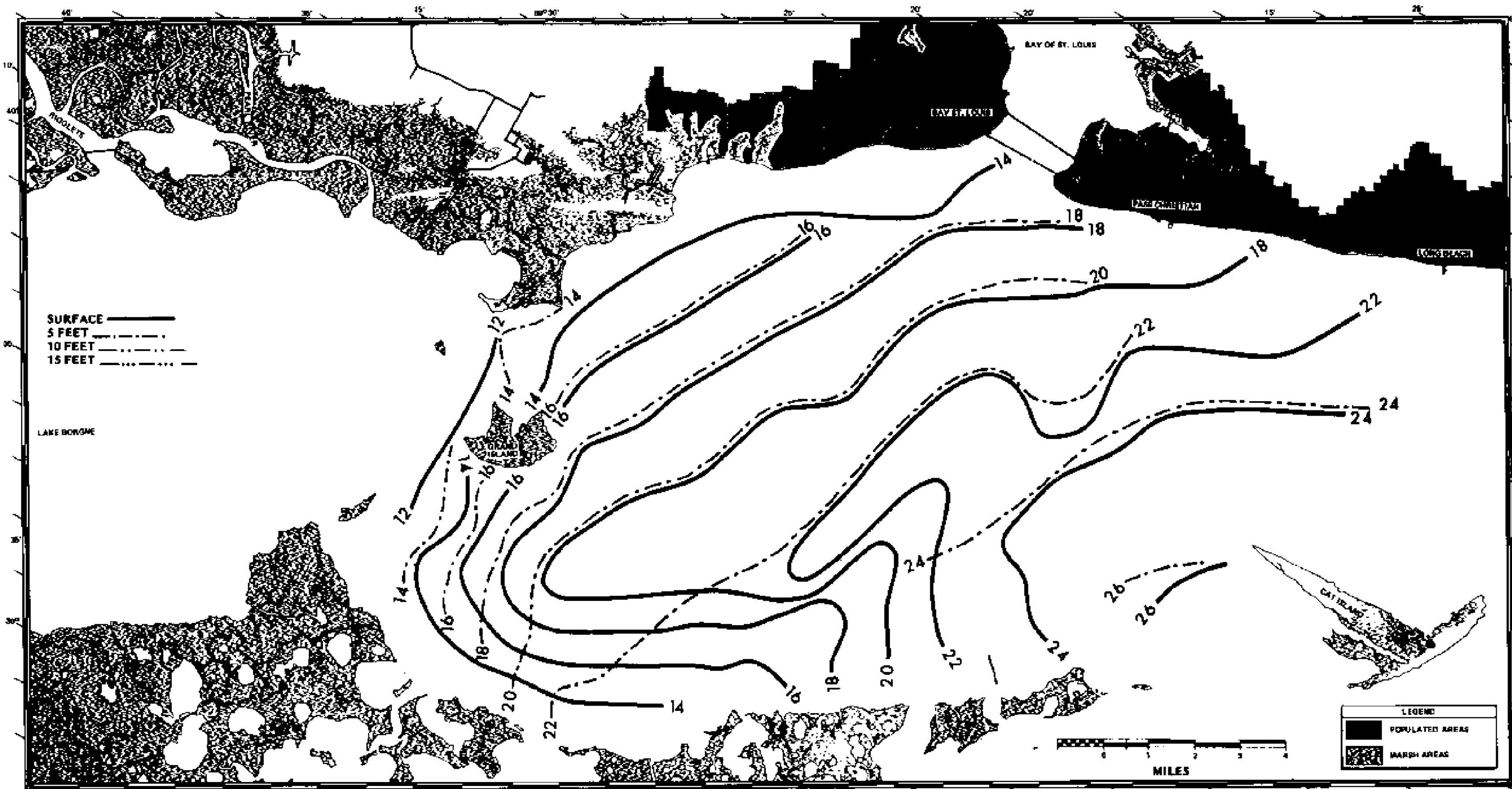


Figure 59. Salinity (‰) distribution 16 July 1974.

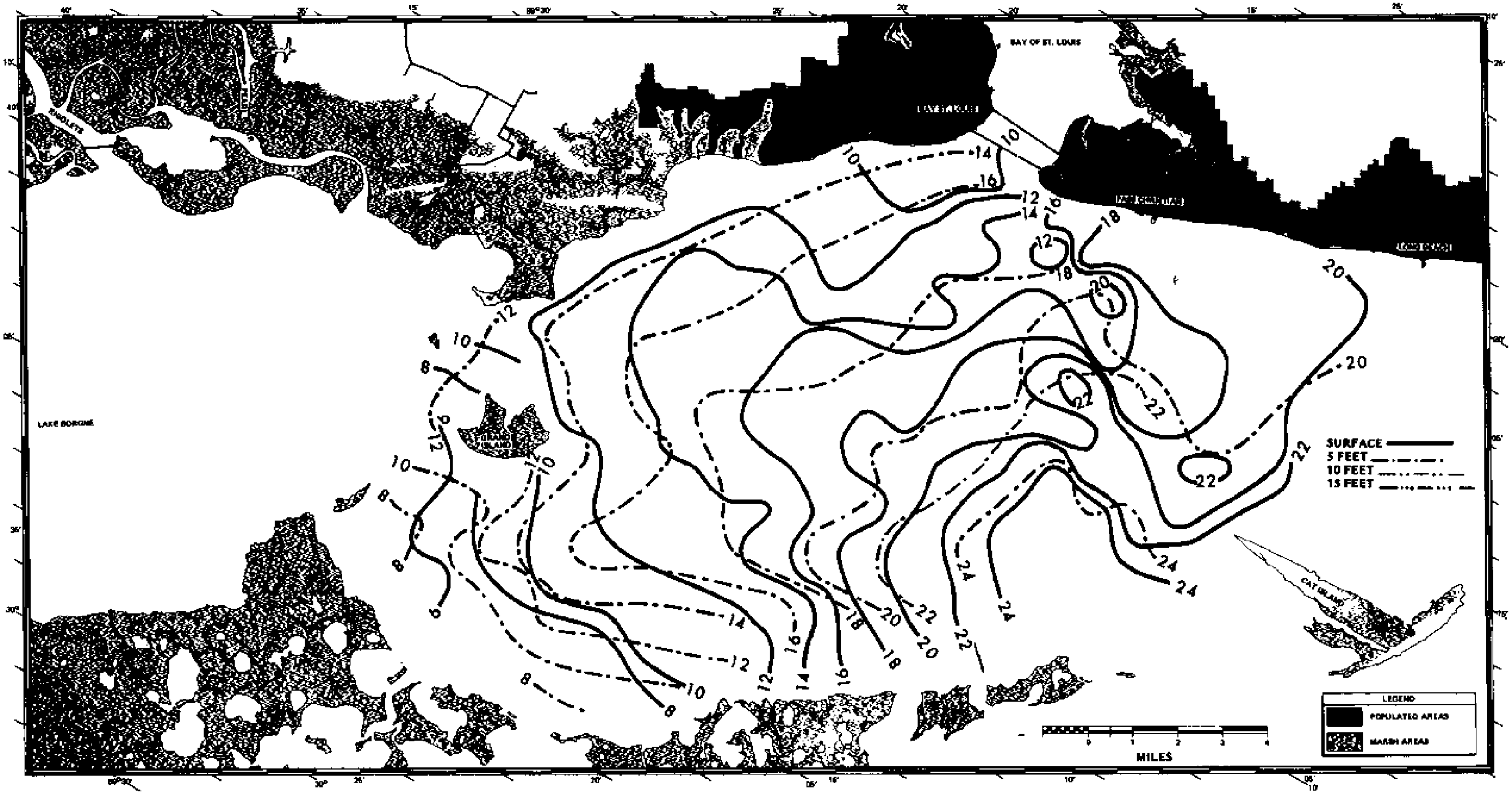


Figure 60. Salinity (‰) distribution 29 July 1974.

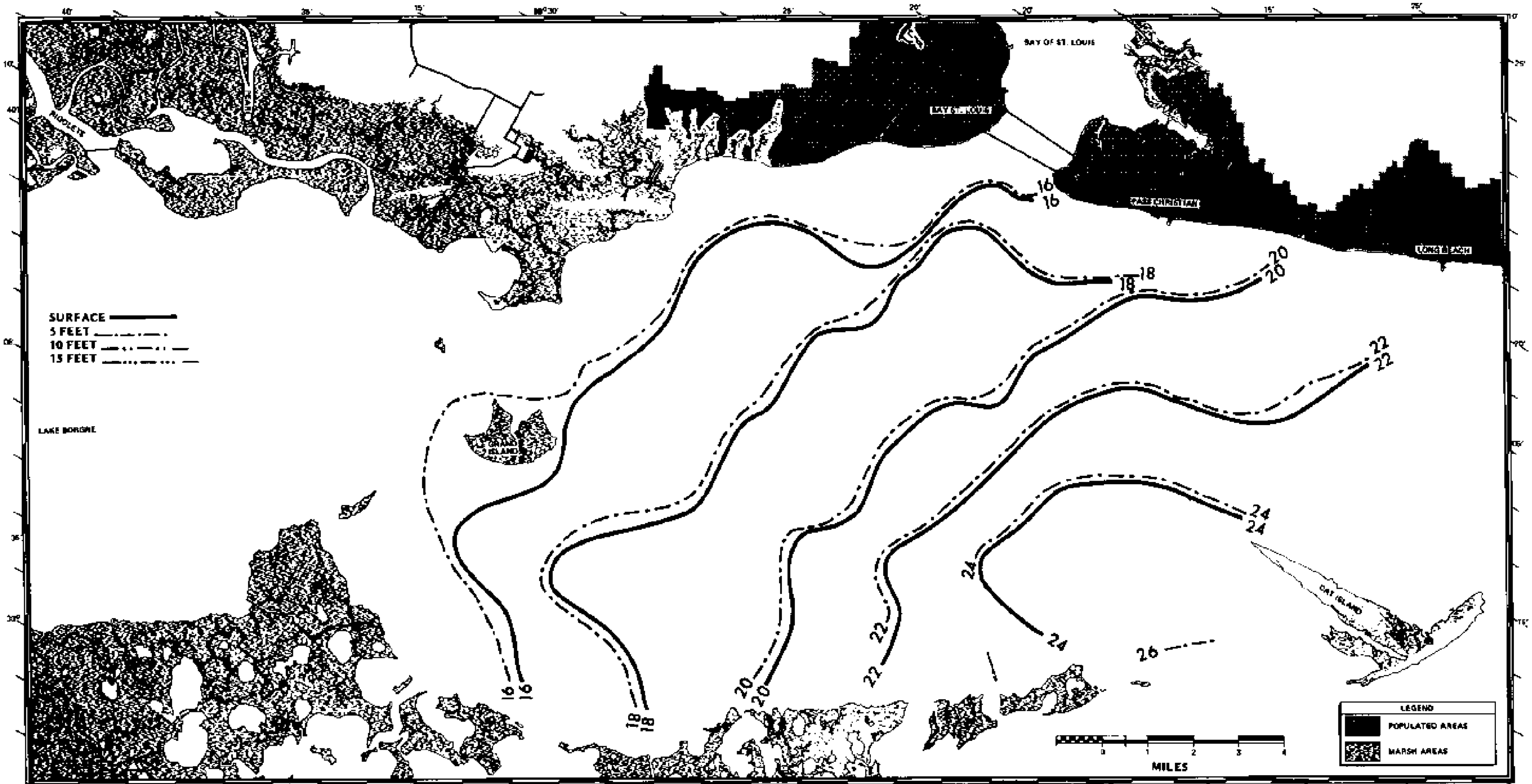


Figure 61. Salinity (‰) distribution 14 August 1974.

Figure 62. Salinity (‰) distribution 27 August 1974.

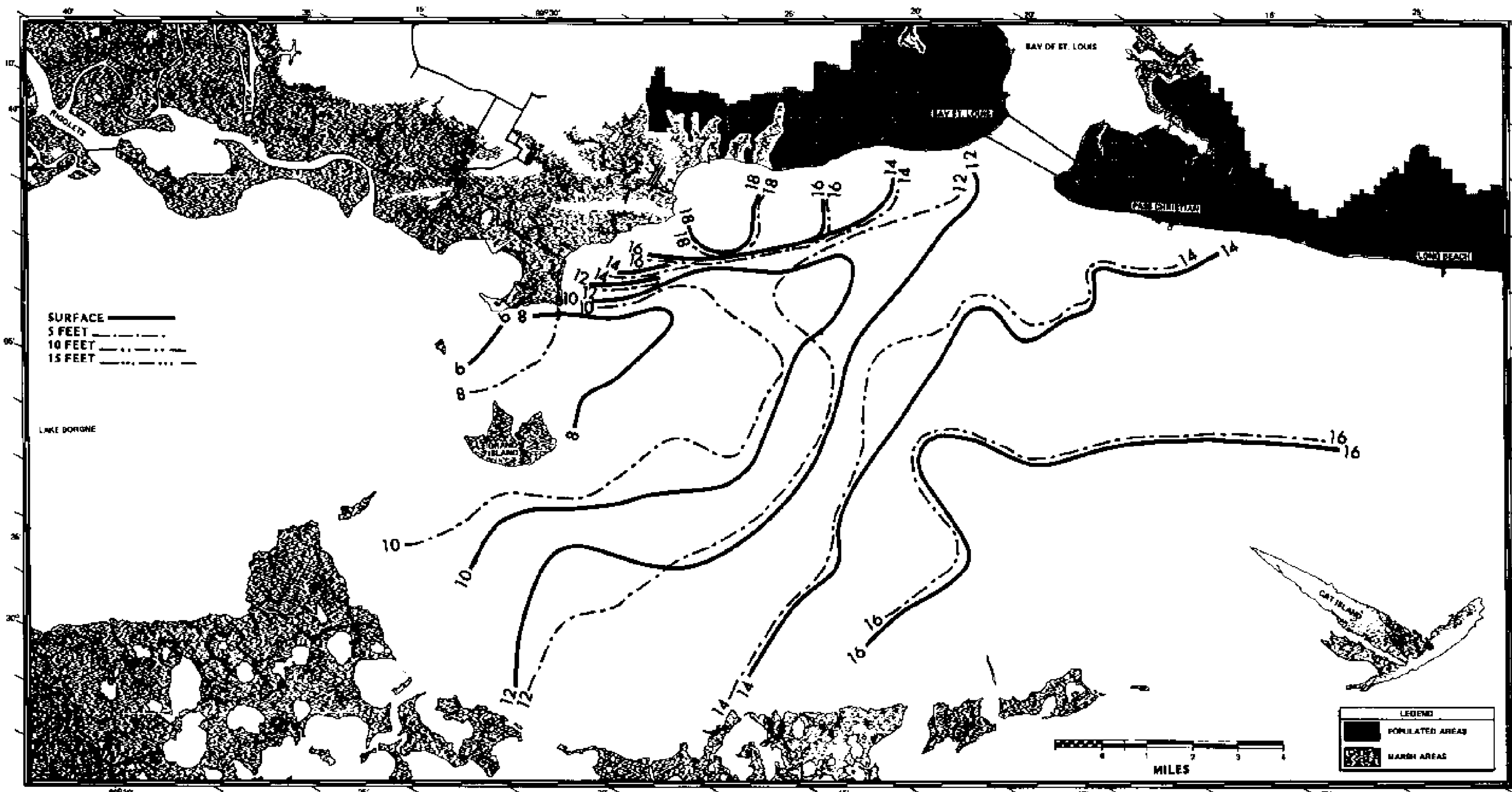


Figure 63. Salinity (‰) distribution 17 September 1974.

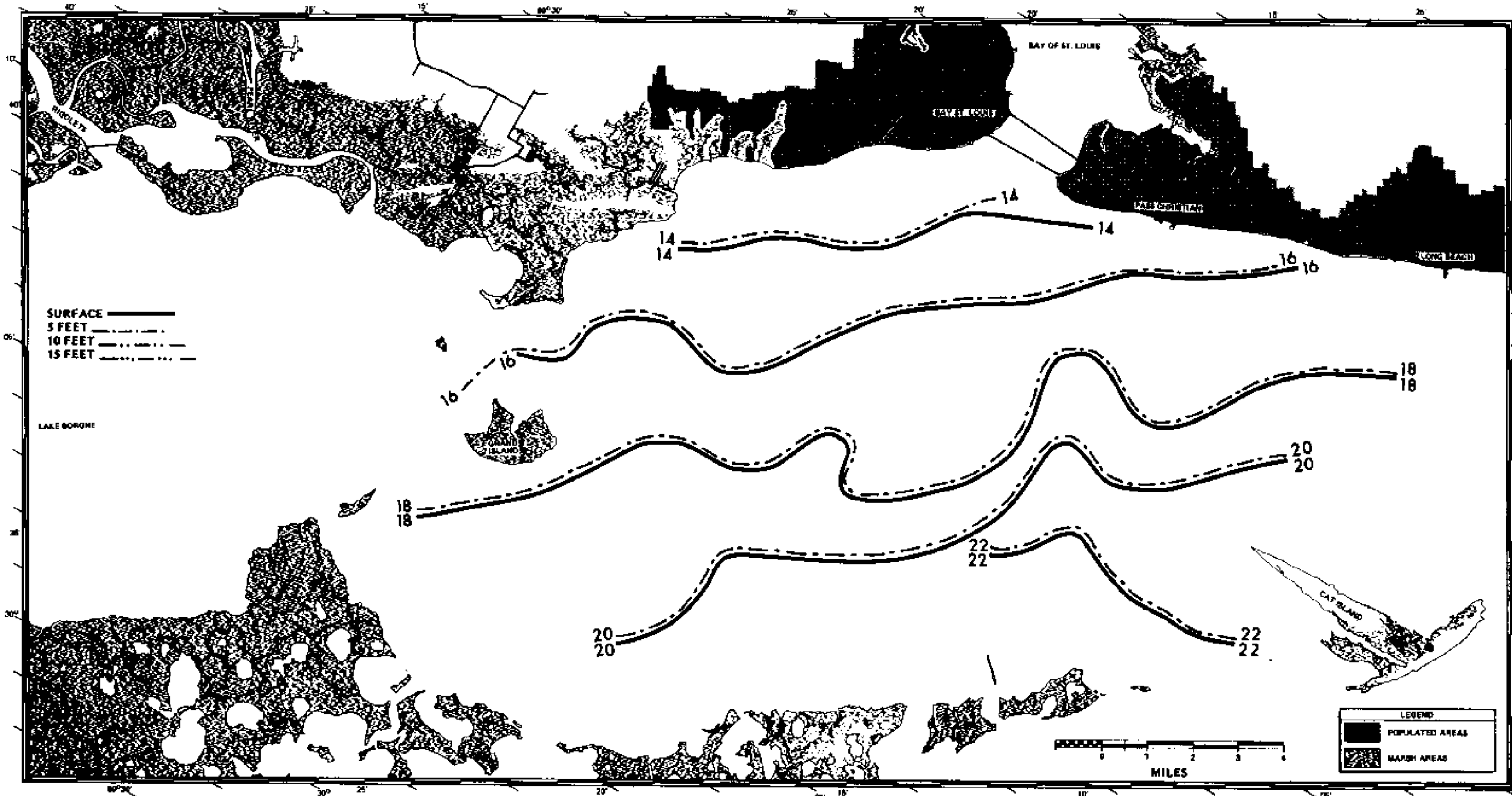


Figure 64. Salinity (‰) distribution 24 September 1974.

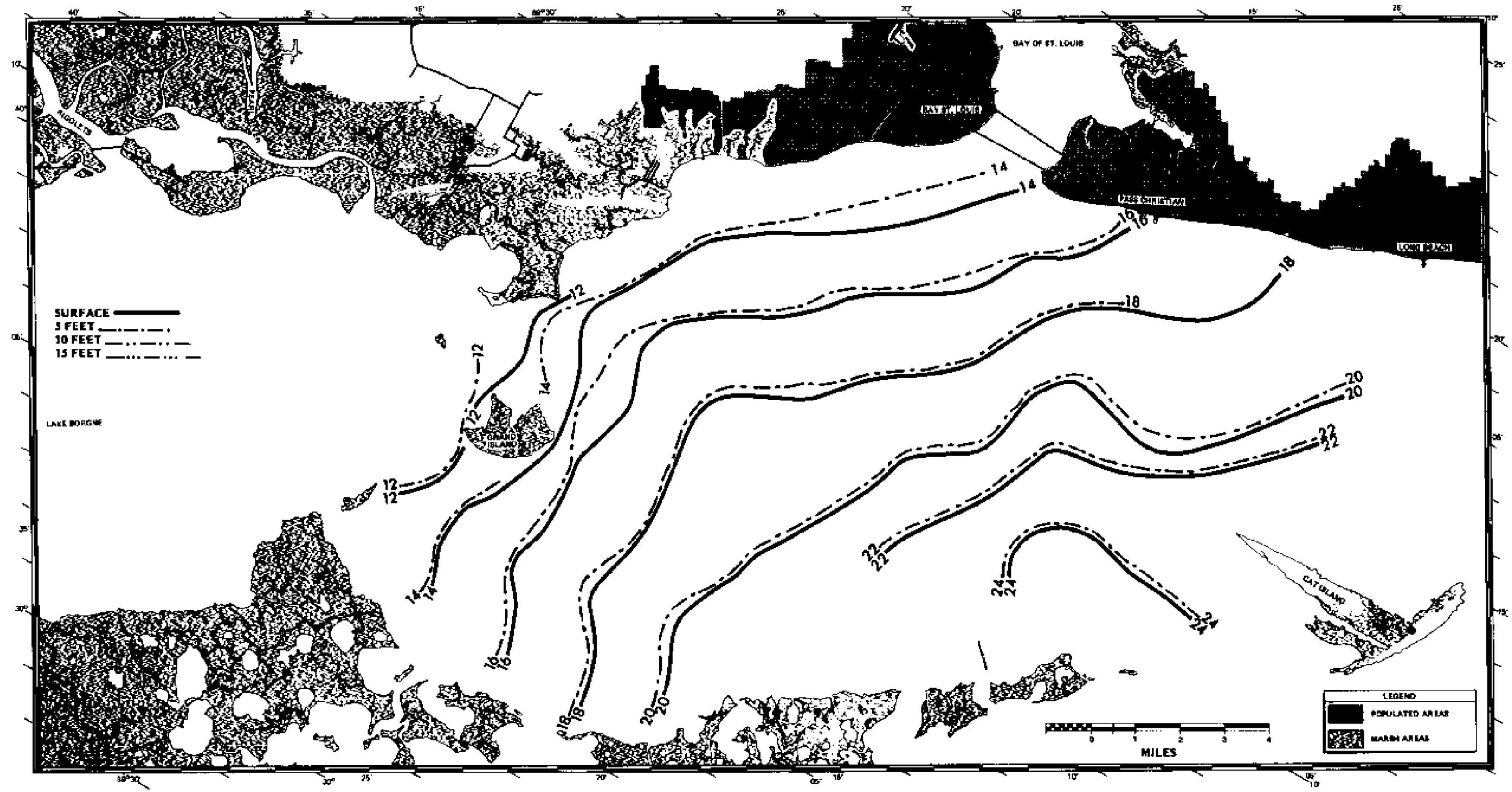


Figure 65. Salinity (‰) distribution 10 October 1974.

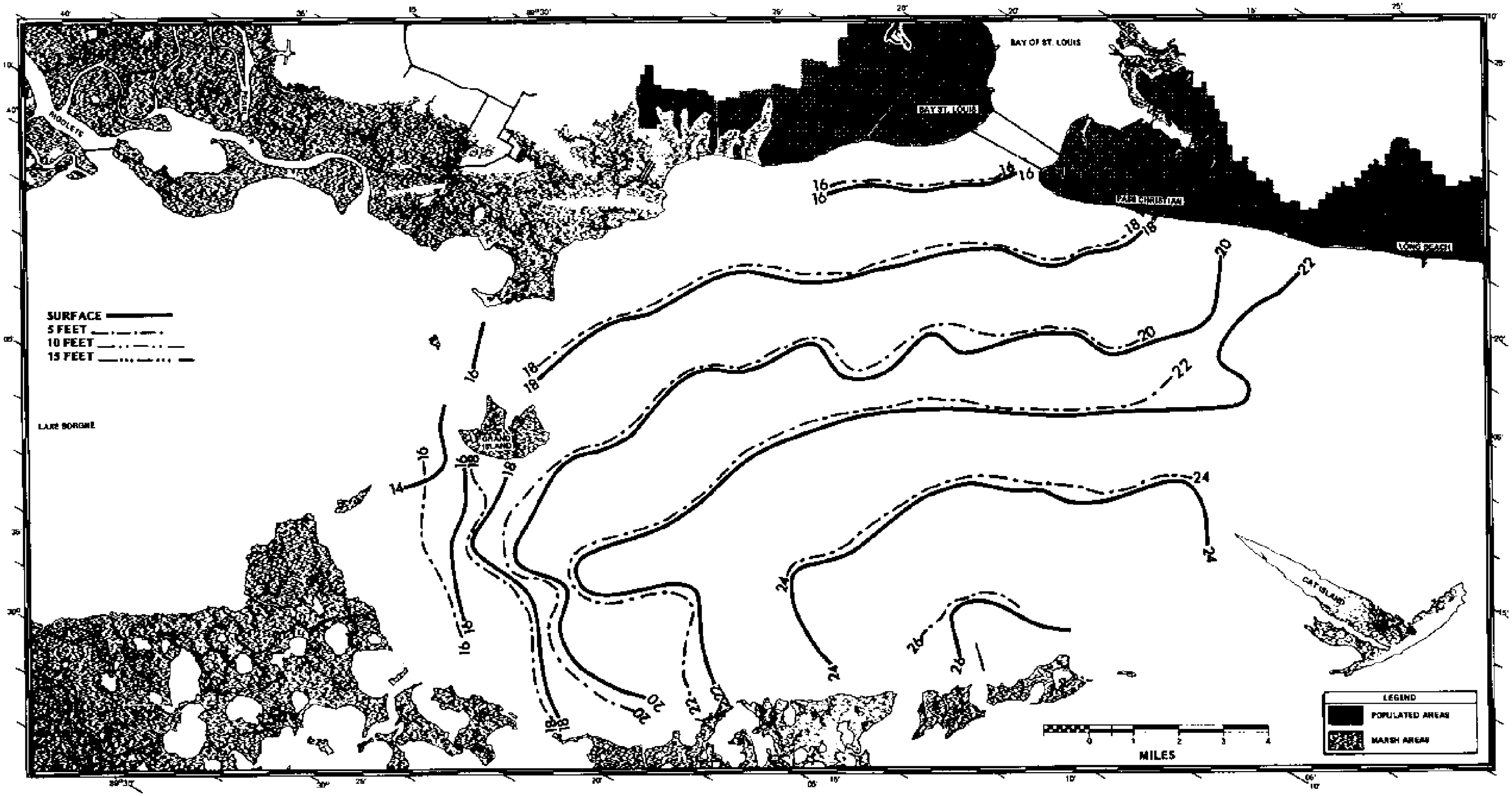


Figure 66. Salinity (‰) distribution 24 October 1974.

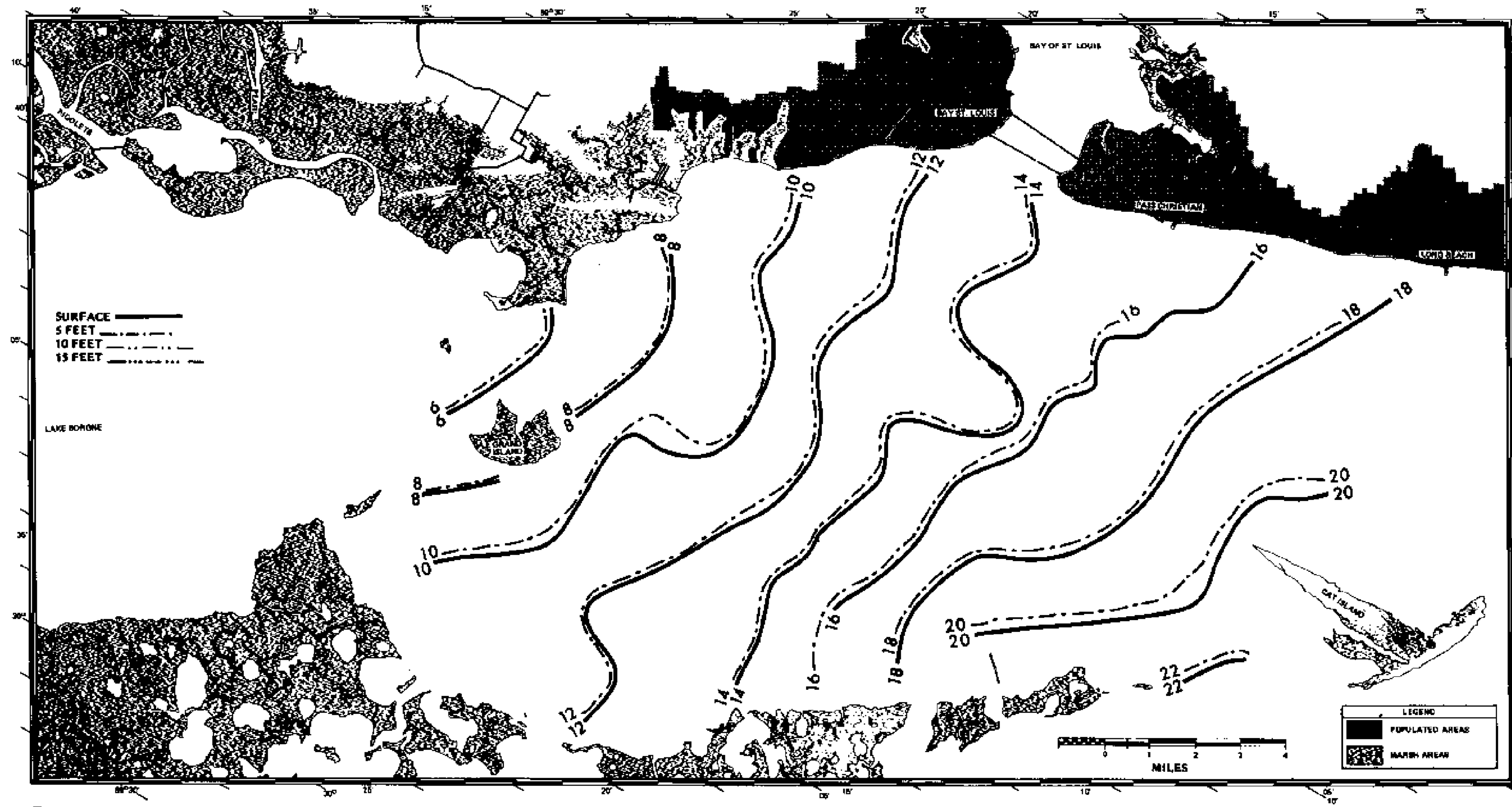


Figure 67. Salinity (‰) distribution 14 November 1974.

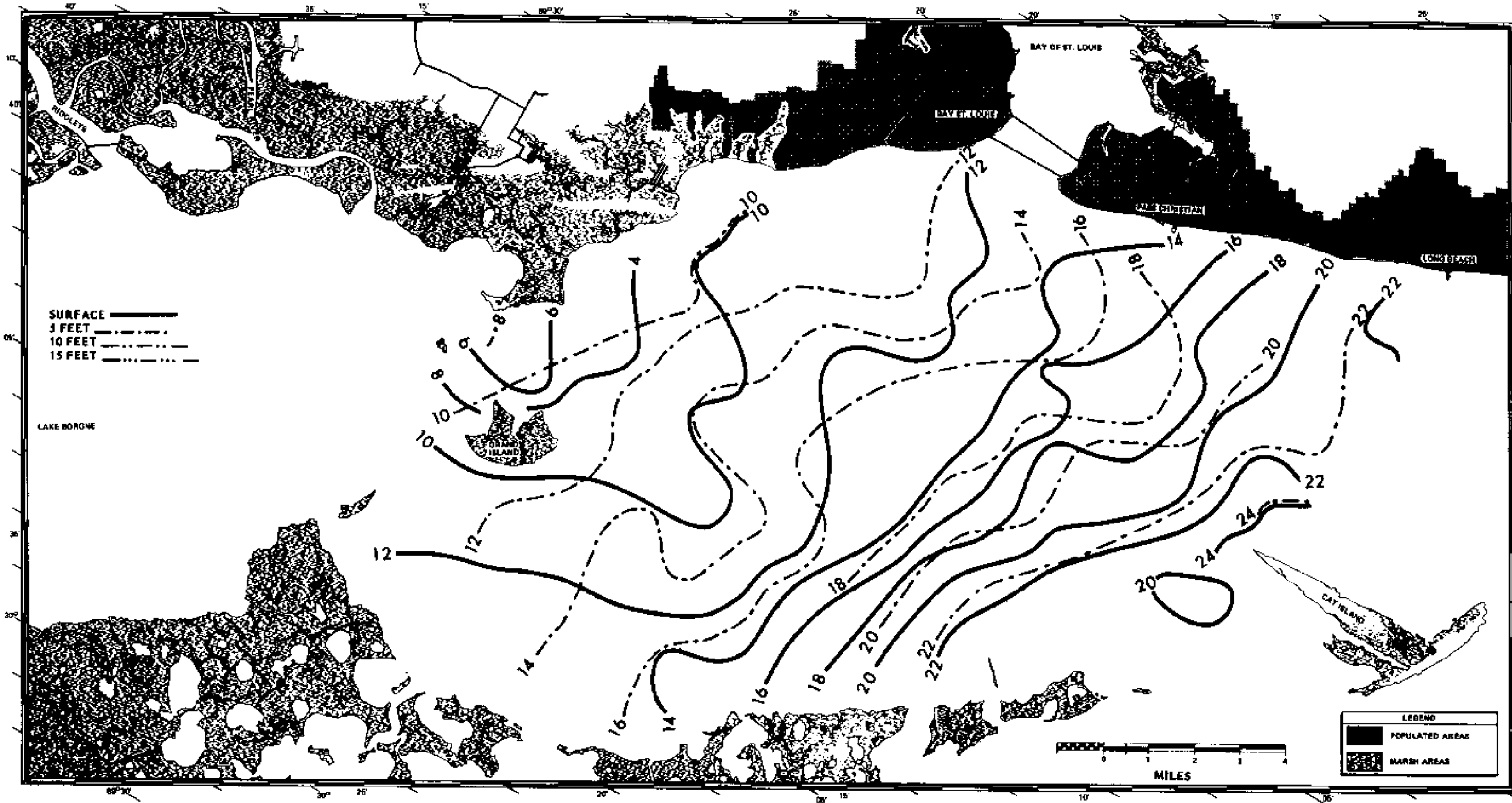


Figure 68. Salinity (‰) distribution 27 November 1974.

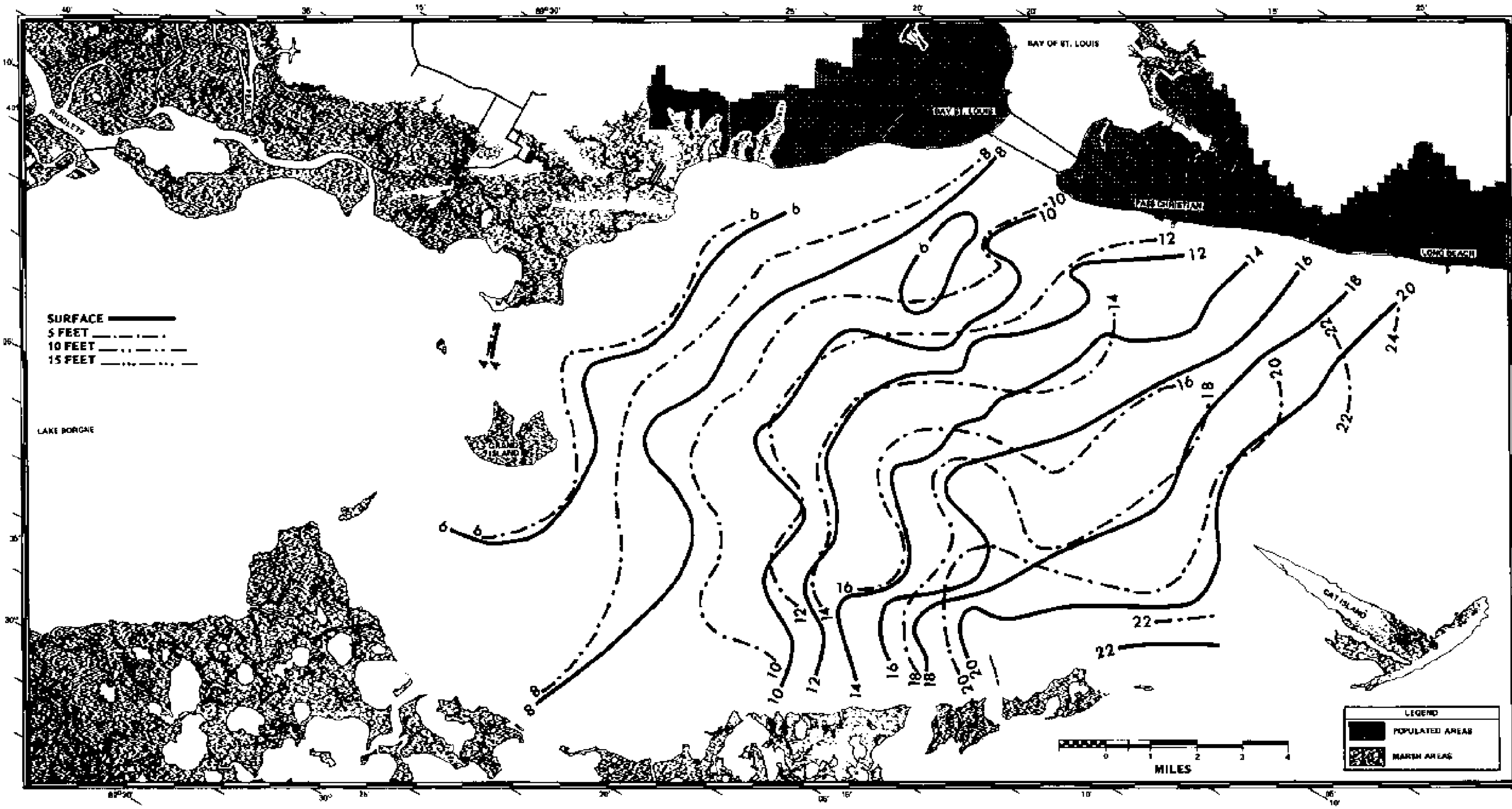


Figure 69. Salinity (‰) distribution 4 December 1974.

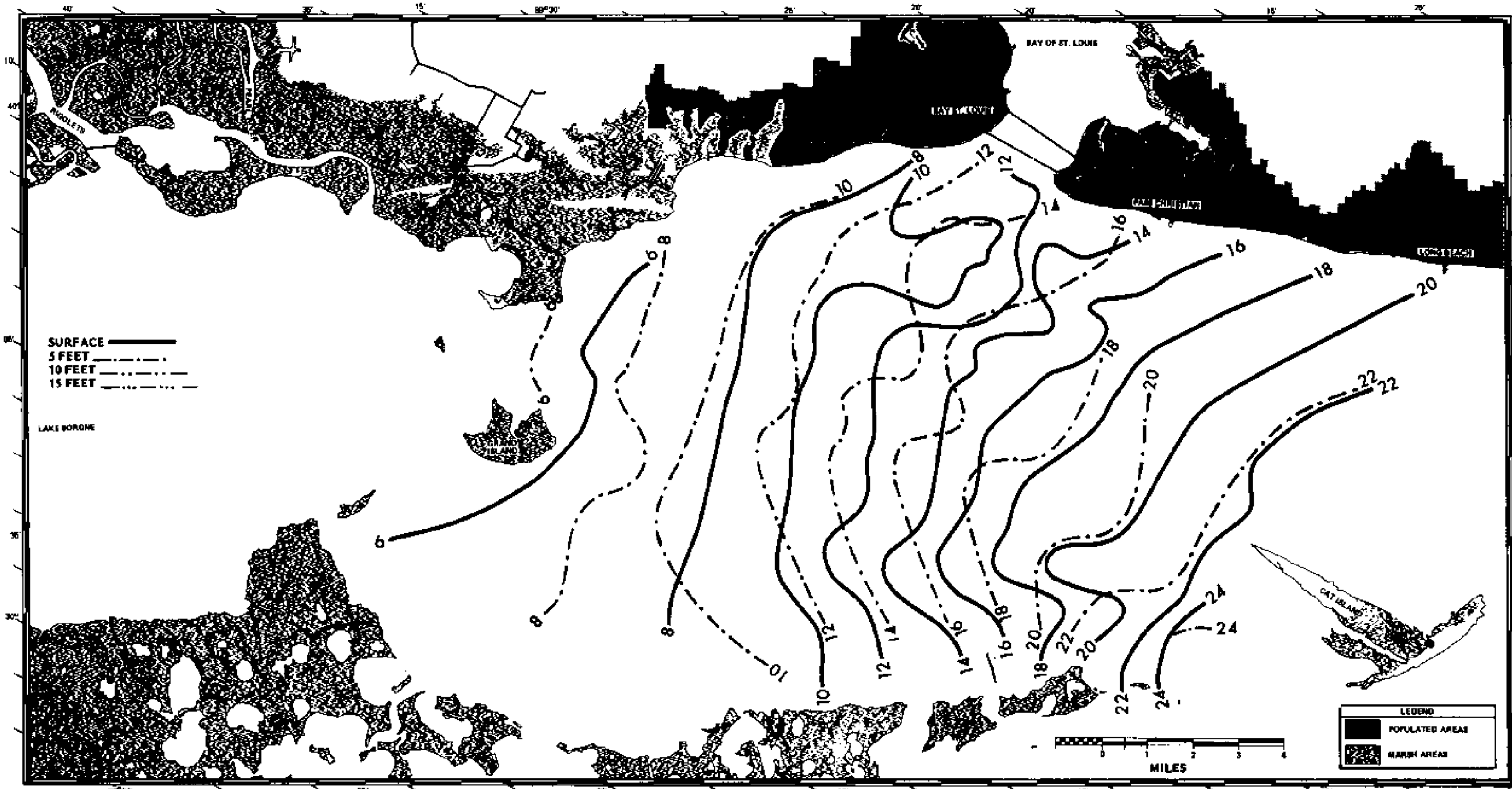


Figure 70. Salinity (‰) distribution 19 December 1974.

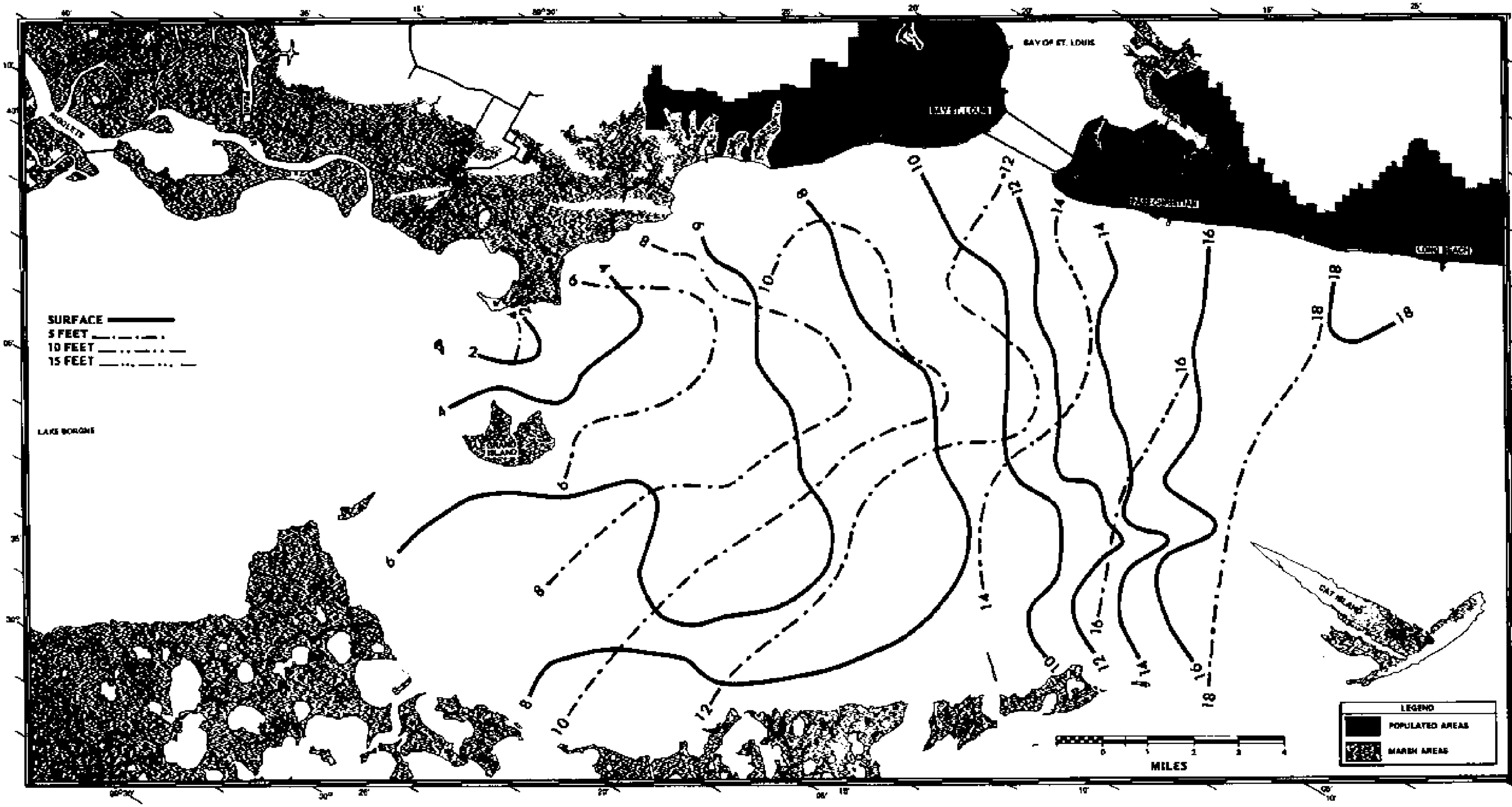


Figure 71. Salinity (‰) distribution 6 January 1975.

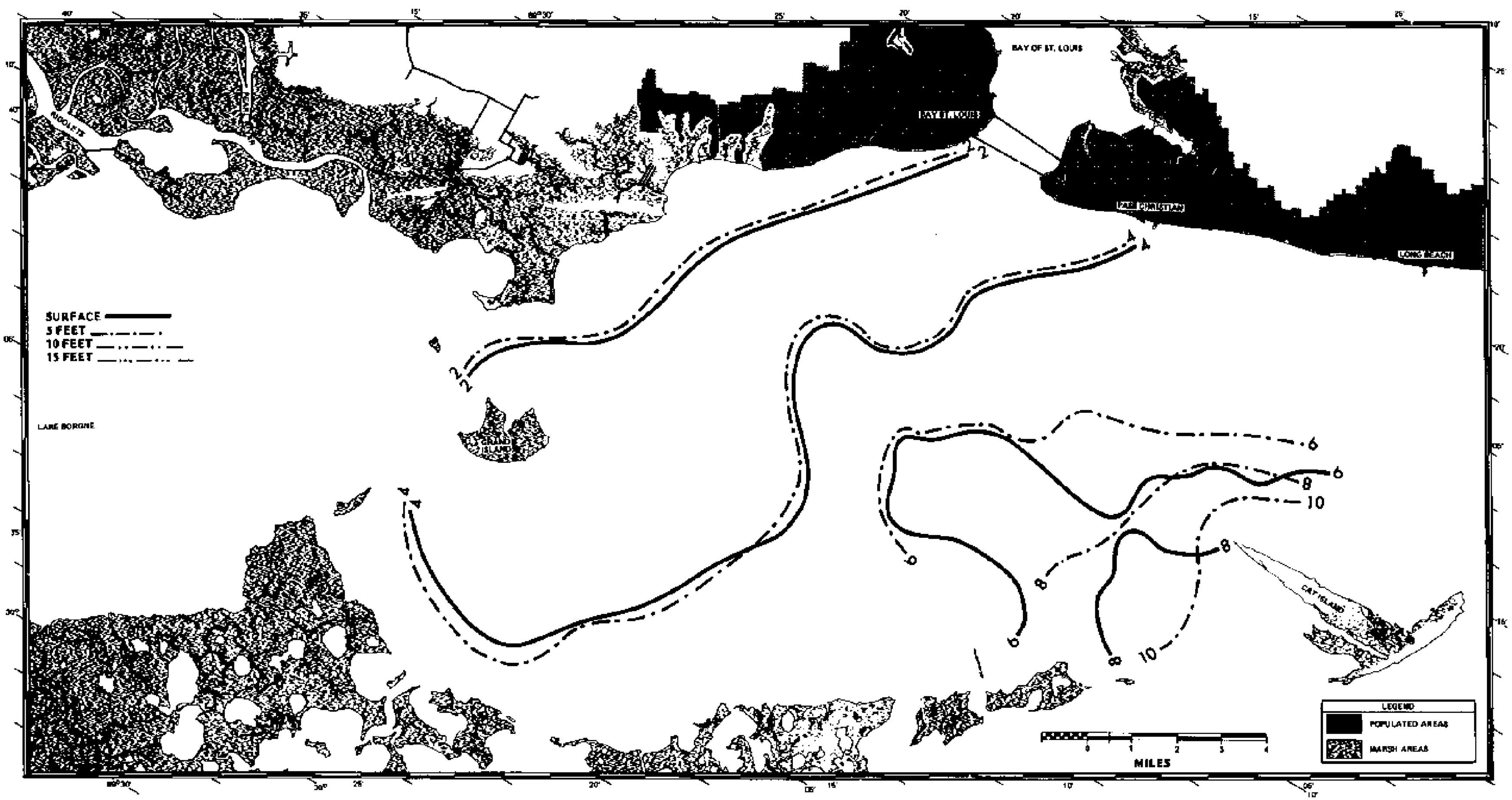


Figure 72. Salinity (‰) distribution 17 January 1975.

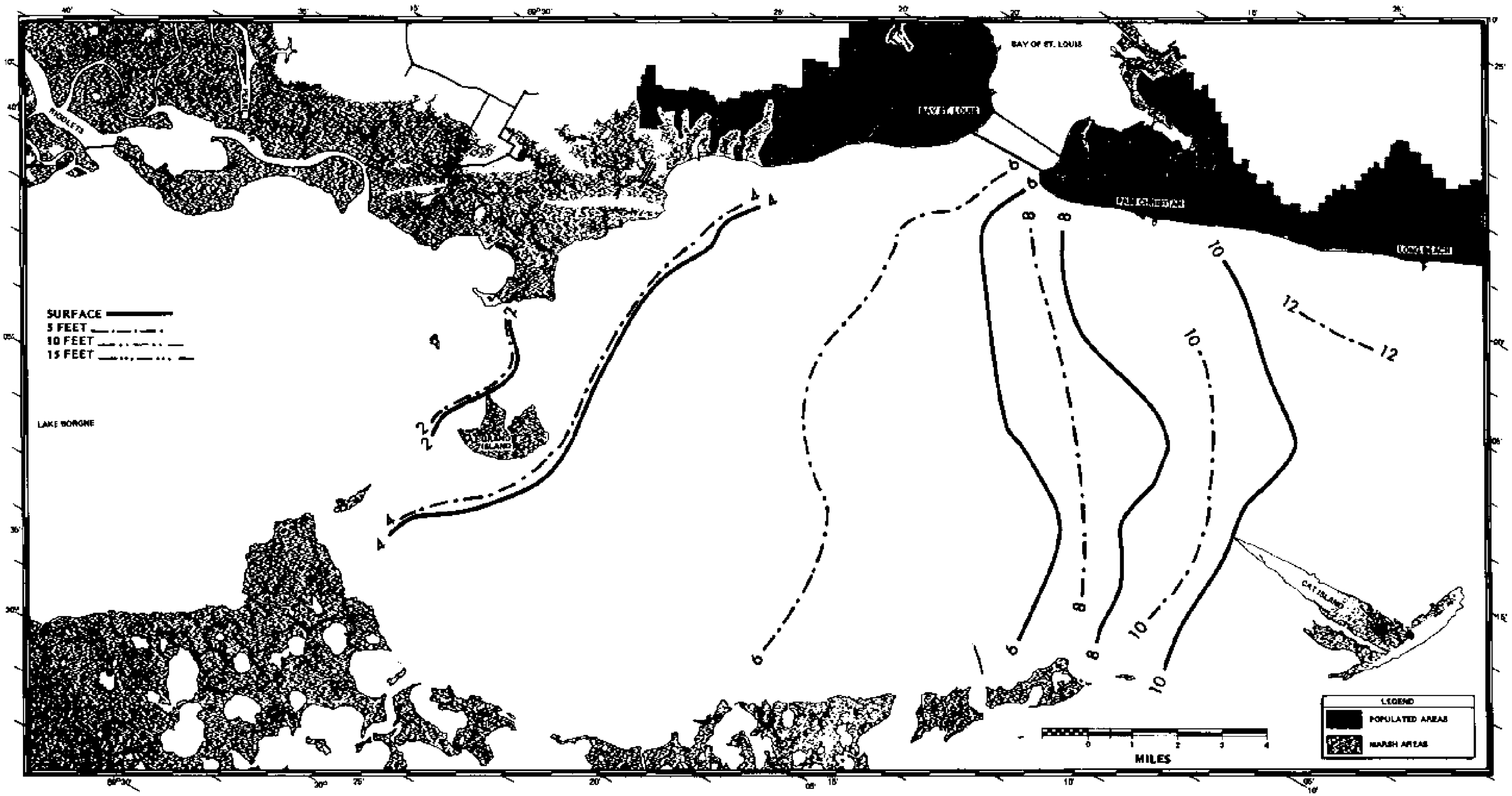


Figure 73. Salinity (‰) distribution 5 February 1975.

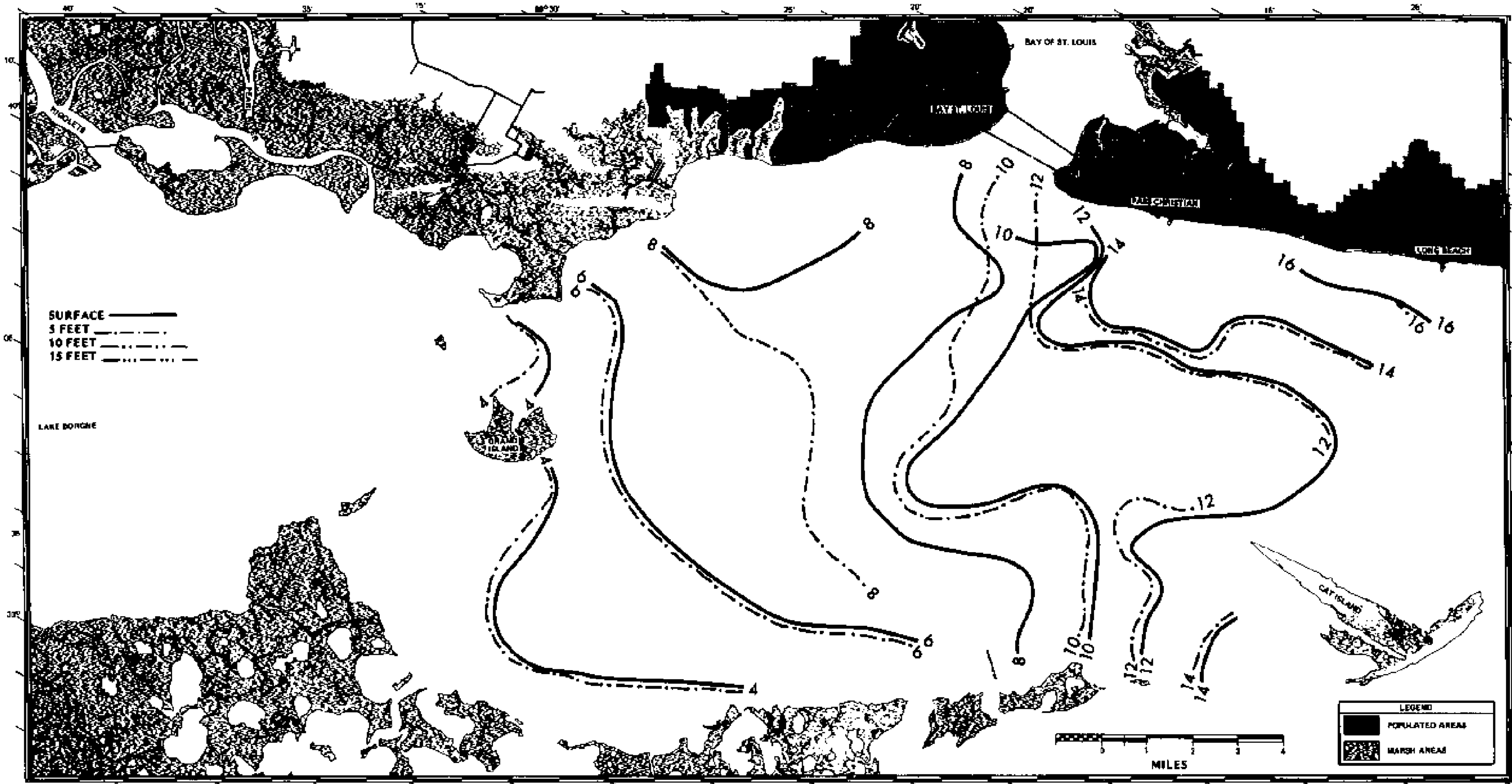
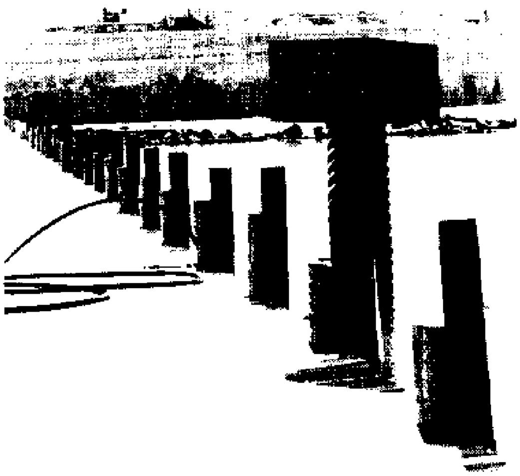
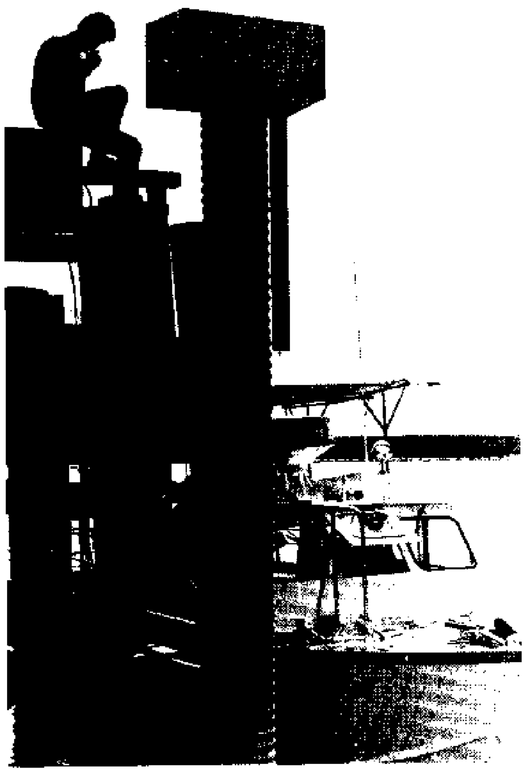


Figure 74. Salinity (‰) distribution 19 February 1975.

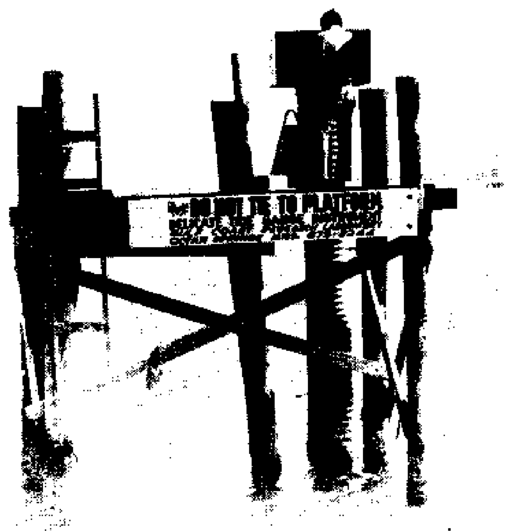


Tide gauge station at Ship Island, Mississippi.

Tide gauge station at Petit Bois Island, Mississippi.



Tide gauge station at Louisiana Fish and Wildlife Grand Pass Camp, Louisiana.



Tide gauge station at Horn Island, Mississippi.

DISCUSSION AND SUMMARY

Multiple passages between Mississippi Sound and the Gulf of Mexico permit the intrusion of higher salinity water. A number of fresh or low salinity water sources are irregularly located along the mainland and, while generally agreeing in overall seasonal trends, vary independently on a short term basis. When the effects of geometry, bathymetry and wind, the primary agent for mixing in such shallow estuaries, are also considered, it becomes obvious that circulation within the Sound is complex.

This study of the circulation and salinity regime of Mississippi Sound describes the general patterns of flow indicated by the horizontal distribution of salinity at selected depth levels and the variability of salinity through the year. To facilitate the use of this report in decision making by various agencies and other interests, an appendix containing tables of salinity statistics for each station has been included. Particular attention was given to certain areas or situations that the author felt warranted it in view of various activities planned or ongoing in the Sound including those associated with disposal of domestic waste, dredging, fisheries, heavy industry and biological studies.

In east Mississippi Sound, it was indicated that the entire contribution to the Sound from Mobile Bay exits, in its entirety, through Petit Bois Pass. Austin (1954) estimated this inflow to be one-fifth of total Mobile Bay discharge. However, remote sensing imagery discussed by Atwell (1973b) indicates that additional work is needed to confirm or recalculate this value.

The outflow from the east passage of Pascagoula River is prevented from spreading to the west by an unbroken ridge of dredge spoil placed alongside the channel. This ridge, above mean sea level for a distance of approximately two miles, continues shallowly submerged for several more miles. The "spoil" acts to direct the outflow seaward delaying its free movement to the west for several miles from the mainland. A sharp interface at a depth of 10 - 13 feet was often detected in the Pascagoula Ship Channel. The interface was manifested in an abrupt increase in salinity and an associated drop in dissolved oxygen. The east passage outflow mixes rapidly and was never detected exiting the Sound in an unmixed state.

The outflow from the west passage of Pascagoula River follows the coastline westward to Bellefontaine Beach where it turns to the southwest and exits through Dog Keys Pass. Because the bathymetry from the river mouth is shallow (< 4 feet) and no deep channel is in close proximity, the outflow influences a greater area of the Sound than that of the east passage.

The Middle Ground, a broad, shallow sandy bar appears to be situated in the area where the tide entering separately through Horn Island and Dog Keys passes meet. This could account, in part, for the existence and stability of this bathymetric feature.

Circulation and thus salinity distribution in central Mississippi Sound is largely attributable to the tidal flux through Dog Keys and

Ship Island passes. The tides entering through the two passes converge approximately along a north-south line bisecting Camille Cut. Since there exists no fresh or low salinity water sources between Biloxi Bay and St. Louis Bay, this convergence zone brings higher salinity water closer to the mainland than anywhere else in the study area.

Upon opening of the Bonnet Carré Spillway, the eastern extent of the area influenced by the freshwater introduction was approximately a line of longitude intersecting the east end of Ship Island.

West Mississippi Sound, overall, displays a consistently lower salinity regime than the other sections. The water column is usually very uniform but occasionally during periods of moderate flow, it displays a pronounced halocline. During periods of high river flow, Ship Island Pass becomes the primary source of higher salinity water to the Sound area near Pass Christian. The direct exchange of west Sound waters with the open Gulf is practically nonexistent. Waters exchanged through Cat Island Pass are largely those of Chandeleur and Mississippi sounds. The highest salinity water observed entering the west Sound area was 30.0 ppt at a depth of 10 feet.

A salinity gradient across the entrance to St. Louis Bay exists, the lower salinity water exiting the bay on the west.

The observation that Engle (1948) made that there existed an east to west decline in salinity was, as a general assessment, valid. However, a more accurate depiction is an irregular pattern of areas that alternate between high and low salinity.

The present practice of dredge spoil disposal in Mississippi Sound needs to be carefully scrutinized with particular attention to the alteration of flow patterns and the salinity regime. The change in either flow patterns or salinity regime affects the physical, chemical and biological environment.

With the construction of reservoirs on rivers that contribute freshwater input to Mississippi Sound and the changes in the watershed character throughout the drainage basins because of development, both the freshwater volume and the time interval over which the Sound receives it has been altered. In order to properly manage the marine environment by assuring the continuation of the proper freshwater input, a freshwater budget for the Sound should be ascertained.

REFERENCES CITED

Atwell, B. H. 1973a. Mississippi Sound remote sensing study. National Aeronautics and Space Administration, Earth Resources Laboratory, Technical Report No. 048.

Atwell, B. H. 1973b. Mississippi Sound remote sensing study II. National Aeronautics and Space Administration, Earth Resources Laboratory, Technical Report No. 091.

Austin, G. B., Jr. 1954. On the circulation and tidal flushing of Mobile Bay, Alabama. Texas A&M College Project 24. 28 pp.

Christmas, J. Y., Gordon Gunter and Patricia Musgrave. 1966. Studies of annual abundance of postlarval penaeid shrimp in the estuarine waters of Mississippi, as related to sebsequent commercial catches. Reprinted from Gulf Research Reports, 2(2):177-212.

Christmas, J. Y. 1973. Phase I: Area description. Pages 1-71 in Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi. Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Christmas, J. Y. and Charles K. Eleuterius. 1973. Phase II: Hydrology. Pages 73-121 in Cooperative Gulf or Mexico Estuarine Inventory and Study, Mississippi. Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Cook, David W. 1969. A study of coliform bacteria and *Escherichia coli* on polluted and unpolluted oyster bottoms of Mississippi and a study of depuration by rebedding. Completion Report, Bureau of Commercial Fisheries Federal Aid Project 2-28-R (PL 88-309). Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Demoran, W. J. 1975. Personal communication.

Engle, J. B. 1948. Investigations of the oyster reefs of Mississippi, Louisiana, and Alabama following the hurricane of September 19, 1947. Fish and Wildlife Serv. Spec. Sci. Rept. No. 59.

Gunter, Gordon. 1950. The relationship of the Bonnet Carré Spillway to oyster beds in Mississippi Sound and the "Louisiana Marsh" with a report on the 1950 opening and a study of beds in the vicinity of the Bohemia Spillway and Baptiste Collette Gap. Rep. prepared for the Dist. Eng., New Orleans Dist. Corps of Engineers, U. S. Army. August 1950.

Gunter, Gordon. 1963. The fertile fisheries crescent. Journal of the Mississippi Academy of Sciences, Vol. 9, pp. 286-290.

Gunter, Gordon. 1976. Notes on the length of the Mississippi seacoast and some comparisons with other states. (In press).

Upshaw, Charles F., Wilgus B. Creath and Frank L. Brooks. 1966. Sediments and microfauna off the coasts of Mississippi and adjacent states. Mississippi Geological Economic and Topographical Survey. Bull. 106.

APPENDIX A

Hydrographic Station Locations

TABLE 1. Hydrographic Station Locations.

STATION NUMBER	LATITUDE	LONGITUDE
27	30° 21.8'	88° 47.5'
39	30° 20.9'	88° 46.8'
41	30° 19.8'	88° 46.5'
43	30° 18.6'	88° 46.5'
45	30° 17.3'	88° 46.5'
47	30° 14.7'	88° 51.6'
49	30° 14.7'	88° 49.6'
51	30° 14.6'	88° 48.3'
53	30° 14.6'	88° 47.0'
55	30° 13.0'	88° 47.3'
57	30° 16.6'	88° 42.1'
59	30° 15.3'	88° 39.1'
60	30° 15.6'	88° 38.9'
61	30° 15.0'	88° 36.8'
63	30° 13.8'	88° 34.5'
65	30° 13.5'	88° 32.2'
67	30° 11.8'	88° 31.4'
69	30° 13.0'	88° 30.6'
71	30° 14.8'	88° 30.5'
72	30° 12.6'	88° 27.5'
73	30° 12.8'	88° 24.2'
75	30° 13.4'	88° 21.6'
77	30° 13.8'	88° 19.6'
79	30° 14.9'	88° 26.1'
80	30° 15.9'	88° 33.0'
81	30° 16.2'	88° 29.9'
83	30° 17.1'	88° 30.8'
85	30° 18.2'	88° 31.8'
87	30° 19.6'	88° 33.1'
89	30° 20.4'	88° 33.9'
91	30° 16.4'	88° 35.2'
93	30° 16.7'	88° 38.1'
95	30° 18.2'	88° 37.3'
97	30° 19.4'	88° 36.5'
99	30° 19.4'	88° 40.0'
101	30° 19.4'	88° 42.5'
103	30° 19.4'	88° 45.2'
105	30° 15.3'	88° 21.0'
107	30° 19.8'	88° 30.8'
108	30° 21.1'	88° 30.4'
109	30° 22.0'	88° 33.9'
123	30° 18.8'	88° 26.0'
125	30° 20.9'	88° 50.0'
127	30° 18.6'	88° 50.0'

TABLE 1. Continued

STATION NUMBER	LATITUDE	LONGITUDE
129	30° 17.3'	88° 54.2'
131	30° 18.0'	88° 57.8'
133	30° 14.3'	88° 54.2'
135	30° 13.2'	88° 57.8'
137	30° 14.3'	88° 59.3'
139	30° 12.6'	88° 59.4'
141	30° 11.3'	88° 59.3'
143	30° 13.0'	89° 01.8'
145	30° 13.2'	89° 03.9'
147	30° 14.9'	89° 02.7'
148	30° 15.7'	89° 02.7'
149	30° 16.2'	89° 00.9'
151	30° 18.3'	89° 02.7'
153	30° 17.4'	89° 05.7'
155	30° 15.1'	89° 05.8'
157	30° 14.4'	89° 08.9'
159	30° 16.7'	89° 08.9'
161	30° 19.7'	89° 08.9'
163	30° 20.5'	89° 04.6'
165	30° 21.8'	89° 02.1'
167	30° 22.0'	88° 57.8'
169	30° 21.6'	88° 54.1'
171	30° 15.4'	89° 13.0'
173	30° 12.5'	89° 10.0'
175	30° 11.4'	89° 08.6'
177	30° 11.7'	89° 13.5'
179	30° 11.9'	89° 16.5'
181	30° 09.6'	89° 14.0'
183	30° 08.3'	89° 19.8'
185	30° 06.1'	89° 18.2'
187	30° 03.8'	89° 21.7'
189	30° 06.2'	89° 23.3'
191	30° 05.1'	89° 27.1'
193	30° 07.7'	89° 27.4'
195	30° 10.0'	89° 27.4'
197	30° 11.1'	89° 25.6'
199	30° 10.8'	89° 21.9'
201	30° 13.9'	89° 24.1'
203	30° 13.7'	89° 16.8'
205	30° 16.4'	89° 19.0'
207	30° 18.3'	89° 19.3'
209	30° 18.3'	89° 18.1'
211	30° 18.2'	89° 15.3'

APPENDIX B

Salinity Statistics

TABLE 2. Station 27 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	49	12.6	1.5	24.5	23.0	6.32
5	49	14.5	2.3	26.6	24.3	6.41
10	10	14.4	3.3	28.0	24.7	8.18

TABLE 3. Station 39 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	22	12.1	1.4	22.5	21.1	5.88
5	18	14.4	3.7	28.3	24.6	6.72

TABLE 4. Station 41 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	47	15.6	1.7	26.6	24.9	6.59
5	32	16.7	5.8	26.1	20.3	6.37
10	4	22.2	13.7	27.4	13.7	6.40

TABLE 5. Station 43 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	22	14.2	3.2	26.3	23.1	6.56
5	22	16.1	5.4	26.3	20.9	6.26

TABLE 6. Station 45 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	47	18.3	4.2	28.0	23.8	6.84
5	47	19.2	6.1	28.1	22.0	6.43
10	38	22.4	8.6	30.3	21.7	5.43

TABLE 7. Station 47 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	32	22.6	7.3	30.7	23.4	5.81
5	4	22.3	7.9	30.7	22.8	10.00
10	1	15.7	15.7	15.7	0.0	0.00

TABLE 8. Station 49 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	34	22.6	8.8	30.6	21.8	5.89
5	34	23.2	10.2	30.6	20.4	5.38
10	34	24.3	13.6	30.6	17.0	4.53
15	33	25.6	14.3	30.6	16.3	4.07
20	30	27.0	19.1	32.3	13.1	3.56
25	20	27.3	19.5	34.0	14.5	3.86
30	8	26.5	19.9	32.8	12.9	4.26
35	1	19.9	19.9	19.9	0.0	0.00

TABLE 9. Station 51 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	44	21.9	7.8	30.7	22.9	5.75
5	20	20.9	8.4	27.9	19.5	5.64

TABLE 10. Station 53 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	48	20.7	6.7	31.0	24.3	6.37
5	48	22.2	9.5	31.6	22.1	5.33
10	48	24.3	14.5	32.0	17.5	4.34
15	48	25.4	16.4	31.8	15.4	4.00
20	46	26.0	17.9	32.4	14.5	3.92
25	33	25.8	18.3	32.2	13.9	3.96
30	16	26.6	18.9	32.4	13.5	3.76
35	1	32.4	32.4	32.4	0.0	0.00

TABLE 11. Station 55 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	44	22.7	10.1	32.8	22.7	5.75
5	44	23.7	14.0	31.7	17.7	4.79
10	44	25.1	14.3	33.3	19.0	4.61
15	42	25.7	14.3	33.1	18.8	4.45
20	40	27.1	14.8	33.6	18.8	4.43
25	25	29.4	22.1	33.9	11.7	3.01
30	1	31.2	31.2	31.2	0.0	0.00

TABLE 12. Station 57 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	19	15.7	6.6	24.9	18.3	5.43
5	19	16.7	6.6	25.7	19.1	6.02
10	12	21.3	13.8	28.2	14.3	4.99

TABLE 13. Station 59 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	20	17.5	8.6	26.2	17.6	5.84

TABLE 14. Station 60 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	11	15.0	8.6	25.7	17.1	5.34
5	11	15.9	8.8	26.6	17.8	5.40

TABLE 15. Station 61 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	19	17.0	7.1	27.3	20.2	5.88
5	19	17.6	8.3	27.5	19.2	5.88
10	15	19.2	10.7	27.7	17.0	5.23

TABLE 16. Station 63 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	19	17.8	8.1	28.6	20.5	6.09
5	19	18.1	8.1	29.3	21.2	6.14
10	17	19.9	11.7	29.8	18.1	5.67
15	5	24.2	20.0	30.1	10.1	4.13

TABLE 17. Station 65 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	19	20.5	12.2	30.2	18.0	6.11
5	19	21.4	12.4	30.4	18.0	5.52
10	10	24.6	17.6	30.3	12.7	4.39
15	3	28.6	27.3	30.2	2.8	1.46

TABLE 18. Station 67 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	23.1	13.8	32.0	18.2	5.08
5	18	24.7	16.3	31.9	15.6	4.40
10	18	26.4	16.9	31.8	14.9	3.74
15	18	27.9	17.4	32.7	15.3	3.74
20	18	29.2	24.3	34.1	9.8	2.85
25	17	30.1	24.3	34.5	10.2	2.57
30	16	30.4	24.3	34.1	9.8	2.30
35	13	30.9	28.2	34.1	5.9	1.70
40	2	32.2	30.3	34.2	3.9	2.75

TABLE 19. Station 69 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	20	21.1	8.8	30.4	21.6	6.61
5	20	21.8	11.3	30.4	19.1	6.06
10	20	25.0	16.7	31.0	14.3	4.50
15	20	28.1	23.9	31.3	7.4	2.40
20	20	29.3	23.9	33.4	9.5	2.49
25	20	29.8	24.3	33.8	9.5	2.48
30	18	30.2	25.2	33.9	8.6	2.38
35	16	30.9	27.6	33.9	6.2	2.03
40	16	31.1	27.7	34.0	6.3	2.00
45	12	31.6	27.8	34.4	6.5	2.29
50	6	32.9	29.5	34.5	5.0	1.81
55	2	33.9	33.4	34.5	1.1	0.77

TABLE 20. Station 71 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	21	19.5	9.1	29.4	20.3	5.89
5	21	20.4	12.0	29.3	17.3	5.45
10	21	23.4	14.0	29.6	15.6	4.74
15	21	26.5	20.4	30.3	9.9	2.98
20	20	28.9	25.4	33.1	7.7	2.25
25	20	29.9	26.1	33.8	7.6	2.10
30	18	30.1	27.0	34.1	7.0	1.91
35	13	30.1	27.0	33.3	6.2	1.84

TABLE 21. Station 72 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	16	19.3	8.1	29.6	21.5	6.49
5	16	19.9	8.3	29.6	21.3	6.19
10	8	21.5	13.0	29.6	16.6	6.29
15	1	28.7	28.7	28.7	0.0	0.00

TABLE 22. Station 73 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	19.5	8.8	29.7	20.9	6.17
5	18	20.1	8.9	29.7	20.8	6.14
10	18	22.3	10.6	30.8	20.2	4.98

TABLE 23. Station 75 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	20.5	10.2	31.3	21.1	6.17
5	14	21.3	11.6	31.3	19.7	5.36
10	12	22.9	12.0	31.3	19.3	6.08

TABLE 24. Station 77 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	18.5	9.3	27.7	18.4	6.21
5	18	21.9	13.2	30.0	16.8	5.20
10	18	24.7	13.5	31.3	17.8	4.73
15	13	26.3	19.3	31.3	12.0	4.08

TABLE 25. Station 79 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	18.7	8.9	28.2	19.3	6.01
5	18	19.3	9.4	28.3	18.9	5.73
10	18	22.0	13.7	29.0	15.3	4.58
15	3	25.1	21.0	29.6	8.6	4.30

TABLE 26. Station 80 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	11	14.7	7.6	23.3	15.7	5.10
5	11	17.0	11.3	24.2	12.8	4.57
10	10	22.4	14.7	27.1	12.4	3.86

TABLE 27. Station 81 Salinity Statistics

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	21	18.5	8.6	28.7	20.1	6.04
5	21	19.5	10.2	28.7	18.5	6.13
10	21	23.0	13.8	28.7	14.8	4.97

TABLE 28. Station 83 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	22	17.7	7.3	28.0	20.7	6.19
5	22	18.6	7.3	27.9	20.6	6.37
10	22	22.5	13.2	29.3	16.1	4.84
15	22	26.1	18.8	30.5	11.7	3.34
20	22	27.6	22.6	32.9	10.2	3.00
25	22	28.8	25.1	33.1	8.0	2.43
30	22	29.6	26.0	33.6	7.5	2.16
35	20	29.7	26.1	33.2	7.0	1.88

TABLE 29. Station 85 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	22	15.9	6.1	27.1	21.0	6.12
5	22	17.7	8.4	27.2	18.8	6.14
10	21	22.7	11.3	29.2	17.9	5.00
15	21	25.4	16.3	29.6	13.3	4.03
20	21	27.2	19.8	32.5	12.7	3.30
25	21	28.9	25.2	33.5	8.3	2.14
30	20	29.7	26.6	33.7	7.0	2.01
35	13	29.5	27.1	32.3	5.1	1.88

TABLE 30. Station 87 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	22	13.8	3.3	24.0	20.7	5.96
5	22	17.0	6.1	27.9	21.8	6.62
10	21	22.3	7.3	28.5	21.2	5.14
15	21	25.1	12.4	30.1	17.7	4.55
20	21	27.4	19.3	30.7	11.3	2.73
25	21	28.8	25.6	32.6	7.0	2.07
30	18	29.6	27.0	33.1	6.0	1.77
35	7	29.5	27.5	33.2	5.6	2.08

TABLE 31. Station 89 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	21	11.6	1.1	21.3	20.2	6.01
5	21	16.7	6.3	26.9	20.6	6.27
10	21	21.9	6.8	28.7	21.9	5.38
15	21	24.9	11.9	29.6	17.7	4.50
20	21	27.4	20.1	31.5	11.4	2.82
25	21	28.6	25.1	32.4	7.2	2.00
30	18	28.8	25.9	32.7	6.8	1.95
35	5	29.7	27.5	32.8	5.2	2.61

TABLE 32. Station 91 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	19	16.5	6.0	27.0	21.0	6.25
5	10	18.6	10.9	27.8	16.9	6.18
10	1	15.2	15.2	15.2	0.0	0.00

TABLE 33. Station 93 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	16.9	7.3	26.1	18.8	5.98
5	18	18.1	8.6	29.3	20.7	6.09
10	5	22.1	16.1	26.0	9.9	4.13

TABLE 34. Station 95 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	19	15.8	6.0	24.1	18.1	5.65
5	19	17.0	7.7	25.0	17.3	5.52
10	1	25.9	25.9	25.9	0.0	0.00

TABLE 35. Station 97 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	13.1	0.4	24.1	23.7	7.51
5	1	18.5	18.5	18.5	0.0	0.00

TABLE 36. Station 99 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	13.9	2.7	25.1	22.4	6.87
5	3	20.2	16.8	24.5	7.7	3.90

TABLE 37. Station 101 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	12.7	1.2	22.6	21.4	6.69
5	7	14.4	4.5	23.2	18.7	6.48

TABLE 38. Station 103 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	14.5	5.1	24.9	19.8	5.93
5	9	16.3	5.4	24.9	19.5	6.17

TABLE 39. Station 105 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	18	18.2	8.2	26.9	18.7	5.93
5	18	19.6	10.3	29.0	18.7	5.53
10	18	22.6	13.8	30.5	16.7	5.28
15	4	24.8	19.6	28.2	8.6	3.85

TABLE 40. Station 107 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	20	19.1	7.6	29.1	21.5	6.40
5	20	20.9	10.6	29.2	18.6	5.44
10	20	23.6	15.8	29.3	13.5	3.98
15	20	25.4	20.0	29.6	9.6	3.10
20	20	27.0	21.6	31.9	10.3	2.55
25	19	28.4	24.6	32.3	7.6	2.08
30	17	29.0	25.2	32.8	7.5	1.98
35	16	29.3	26.0	33.1	7.0	2.01

TABLE 41. Station 108 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	16	20.0	11.8	28.8	17.0	5.92
5	16	22.0	12.8	29.4	16.6	4.96
10	16	23.9	15.2	29.9	14.7	4.26
15	16	26.0	19.9	30.2	10.3	3.31
20	16	27.3	20.8	30.6	9.8	2.92
25	16	28.3	24.0	32.1	8.1	2.44
30	16	28.9	24.3	32.7	8.4	2.21
35	15	29.4	25.3	32.9	7.5	2.09

TABLE 42. Station 109 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	21	8.1	0.2	18.1	17.9	5.34
5	21	13.5	0.4	26.3	25.9	8.37
10	21	21.0	3.9	29.1	25.2	7.25
15	21	24.4	4.5	29.7	25.2	5.62
20	21	26.8	21.9	30.8	8.9	2.71
25	21	27.7	23.7	32.2	8.5	2.43
30	21	28.4	24.4	32.6	8.2	2.20
35	8	28.7	27.2	31.6	4.4	1.61

TABLE 43. Station 123 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	12	16.5	7.7	26.6	18.9	6.16
5	7	19.3	7.8	27.5	19.7	7.44

TABLE 44. Station 125 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	18.1	5.7	28.0	22.3	6.27
5	21	19.7	10.8	26.4	15.6	5.03

TABLE 45. Station 127 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	19.5	6.4	27.7	21.3	6.33
5	24	20.4	6.4	27.7	21.3	5.78
10	7	24.9	20.0	29.9	9.8	3.54

TABLE 46. Station 129 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	19.9	8.1	26.7	18.6	5.60
5	25	20.1	8.5	27.3	18.8	5.50
10	22	21.3	8.8	28.5	19.7	5.04

TABLE 47. Station 131 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	19.3	8.2	27.1	18.9	5.93
5	25	19.7	8.2	27.1	18.9	5.89
10	18	21.1	8.3	30.6	22.3	6.11

TABLE 48. Station 133 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	21.1	8.8	29.4	20.6	5.86
5	25	21.3	8.3	29.4	21.1	5.84
10	24	22.6	9.4	31.0	21.6	5.65
15	1	21.7	21.7	21.7	0.0	0.00

TABLE 49. Station 135 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	20.7	8.2	29.7	21.5	6.51
5	25	21.1	9.1	29.7	20.6	6.39
10	25	23.1	10.7	31.0	20.3	5.47
15	24	25.3	19.3	31.5	12.2	3.81
20	12	26.4	19.5	31.5	12.0	3.76

TABLE 50. Station 137 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	20.5	5.1	29.0	23.9	6.55
5	25	21.2	10.6	29.5	18.9	5.71
10	25	23.2	12.5	29.5	17.0	4.54
15	25	24.3	17.0	30.5	13.5	4.23
20	25	25.4	17.1	30.8	13.7	4.08
25	22	26.2	17.2	31.7	14.5	4.15
30	5	29.0	26.2	32.5	6.3	2.47

TABLE 51. Station 139 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	24	21.0	6.8	29.4	22.6	6.29
5	25	23.1	15.0	30.3	15.3	4.72
10	25	24.5	17.4	31.3	13.9	4.32
15	25	25.2	18.3	31.4	13.1	3.94
20	25	26.0	19.8	31.7	11.8	3.54
25	25	26.6	20.1	32.1	12.0	3.44
30	18	27.5	20.4	32.4	12.0	3.75
35	1	25.7	25.7	25.7	0.0	0.00

TABLE 52. Station 141 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	22	23.2	15.8	31.1	15.3	4.62
5	22	24.0	16.1	31.1	15.0	4.29
10	22	24.9	16.5	31.1	14.6	4.46
15	22	25.7	19.3	31.1	11.8	4.01
20	22	26.5	20.4	31.5	11.1	3.78
25	19	27.3	20.9	31.5	10.6	3.27
30	3	30.1	28.2	32.3	4.0	2.05

TABLE 53. Station 143 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	22.2	6.5	30.2	23.7	5.46
5	25	23.5	15.2	30.4	15.2	4.44
10	25	24.2	15.5	30.9	15.3	4.24
15	20	24.9	16.2	30.9	14.7	4.26

TABLE 54. Station 145 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	20.7	6.5	28.4	21.9	5.85
5	25	22.0	10.4	28.5	18.1	4.80
10	1	28.5	28.5	28.5	0.0	0.00

TABLE 55. Station 147 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	20.2	6.2	28.8	22.6	5.65
5	12	22.2	17.1	27.2	10.1	3.75

TABLE 56. Station 148 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	9	20.1	4.4	28.1	23.7	7.81
5	9	21.1	6.5	28.6	22.1	7.44
10	4	18.5	13.9	25.6	11.7	5.15
15	1	26.8	26.8	26.8	0.0	0.00

TABLE 57. Station 149 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	19.5	4.6	29.0	24.4	6.55
5	25	20.1	7.0	29.1	22.1	6.03
10	25	22.0	12.5	29.2	16.7	4.85
15	25	23.7	13.5	30.3	16.8	4.50
20	23	25.1	16.7	30.7	14.0	4.14
25	18	26.2	20.0	31.5	11.5	3.34
30	2	24.5	23.1	25.9	2.7	1.97

TABLE 58. Station 151 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	17.7	3.9	26.2	22.3	6.28
5	25	18.6	7.4	26.3	18.9	5.63
10	25	20.2	8.3	28.5	20.2	5.62
15	24	22.4	12.7	28.8	16.1	4.53
20	19	24.9	13.7	30.0	16.3	3.98
25	7	27.0	19.3	30.4	11.1	3.85

TABLE 59. Station 153 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	16.9	3.9	25.1	21.2	6.13
5	25	17.3	5.5	25.0	19.5	6.17
10	8	14.4	6.9	20.1	13.2	4.74

TABLE 60. Station 155 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	16.2	2.7	26.8	24.1	6.45
5	25	16.8	3.8	26.8	23.0	6.60
10	10	17.1	7.3	24.9	17.6	5.88

TABLE 61. Station 157 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	50	15.6	2.0	26.1	24.1	6.34
5	37	15.5	3.0	24.7	21.7	6.21
10	2	9.5	8.9	10.2	1.2	0.91

TABLE 62. Station 159 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	50	15.0	2.2	24.3	22.1	6.37
5	50	15.5	2.4	24.3	21.9	6.28
10	40	17.1	4.8	25.8	21.0	6.18

TABLE 63. Station 161 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	52	14.6	2.7	24.1	21.4	6.20
5	47	15.1	2.7	24.1	21.4	5.80

TABLE 64. Station 163 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	16.5	5.6	25.2	19.6	5.81
5	25	17.3	5.6	25.6	20.0	5.56
10	25	18.8	7.0	28.6	21.6	5.75
15	25	21.1	9.7	29.7	20.0	5.21
20	12	24.9	18.4	30.3	11.9	3.87
25	3	27.6	26.6	29.0	2.4	1.23

TABLE 65. Station 165 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	17.1	7.5	25.4	17.9	5.43
5	25	17.4	7.5	25.6	18.1	5.62

TABLE 66. Station 167 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	17.6	6.9	26.5	19.6	5.37
5	25	17.8	6.9	27.1	20.2	5.53

TABLE 67. Station 169 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	18.5	6.6	27.1	20.5	5.49
5	24	18.9	6.6	27.3	20.7	5.42
10	3	19.3	12.9	26.3	13.4	6.71

TABLE 68. Station 171 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	14.2	2.5	23.8	21.3	6.21
5	25	14.8	3.8	23.8	20.0	5.99
10	13	16.6	5.7	24.0	18.3	5.58

TABLE 69. Station 173 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	17.5	7.3	26.2	18.9	5.96
5	25	18.1	7.4	26.3	18.9	5.83
10	20	21.2	9.6	30.0	20.4	5.62
15	3	22.0	21.7	22.5	0.8	0.41

TABLE 70. Station 175 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	18.9	9.0	25.9	16.9	5.97
5	25	19.4	9.1	26.1	17.0	5.70
10	25	20.6	9.5	29.1	19.6	5.41
15	25	21.7	10.3	31.7	21.4	5.73
20	25	22.2	10.7	32.0	21.3	5.63
25	25	22.6	10.9	32.1	21.2	5.57
30	24	23.3	10.9	32.2	21.3	5.25
35	23	23.4	10.9	32.2	21.3	5.06
40	14	23.3	11.1	32.2	21.1	5.91

TABLE 71. Station 177 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	16.2	4.8	25.7	20.9	7.34
5	25	17.0	4.8	25.8	21.0	6.81
10	25	19.1	6.5	26.5	20.0	5.70
15	24	20.9	7.9	30.1	22.2	5.89

TABLE 72. Station 179 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	13.8	2.8	23.6	20.8	6.27
5	25	14.7	2.9	23.7	20.8	6.05
10	5	17.1	3.9	22.9	19.0	8.06

TABLE 73. Station 181 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	15.7	4.4	26.2	21.8	7.48
5	22	16.4	4.4	26.2	21.8	7.33
10	1	26.9	26.9	26.9	0.0	0.00

TABLE 74. Station 183 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	11.0	2.5	23.1	20.6	6.56
5	25	11.9	3.1	23.1	20.0	6.31

TABLE 75. Station 185 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	11.5	1.8	22.5	20.7	6.44
5	23	12.5	2.8	23.1	20.3	6.86

TABLE 76. Station 187 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	9.6	0.9	18.9	18.0	5.24
5	18	11.4	3.6	22.3	18.7	5.77

TABLE 77. Station 189 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	10.1	2.3	21.8	19.5	5.92
5	24	10.7	2.3	21.8	19.5	6.02

TABLE 78. Station 191 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	24	7.8	1.5	18.7	17.2	4.94
5	4	9.1	1.5	14.7	13.2	5.81

TABLE 79. Station 193 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	23	7.3	1.6	15.9	14.3	4.48
5	3	11.6	2.3	16.4	14.1	8.08

TABLE 80. Station 195 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	24	6.8	0.5	16.6	16.1	5.25
5	24	7.3	0.5	16.6	16.1	5.27
10	24	7.7	0.8	17.0	16.2	5.40
15	24	7.9	1.1	17.2	16.1	5.50
20	24	8.2	1.1	17.5	16.4	5.60
25	24	8.6	1.2	18.3	17.1	5.61
30	1	19.0	19.0	19.0	0.0	0.00

TABLE 81. Station 197 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	7.7	0.1	17.6	17.5	5.56
5	25	8.0	0.1	17.6	17.5	5.64

TABLE 82. Station 199 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	9.9	1.1	20.7	19.6	6.28
5	24	10.7	1.1	20.8	19.7	6.38

TABLE 83. Station 201 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	8.8	0.4	19.4	19.0	5.49
5	23	8.8	0.5	17.1	16.6	5.21

TABLE 84. Station 203 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	12.6	1.7	22.5	20.8	6.09
5	20	12.6	1.8	22.5	20.7	6.53

TABLE 85. Station 205 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	9.9	1.2	19.2	18.0	5.42
5	7	7.7	4.9	15.4	10.5	3.47

TABLE 86. Station 207 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	8.7	1.3	15.1	13.8	4.27
5	4	11.6	6.0	15.0	9.0	3.88

TABLE 87. Station 209 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	8.9	0.6	16.3	15.7	4.83
5	7	8.9	3.8	15.4	11.6	4.64

TABLE 88. Station 211 Salinity Statistics.

DEPTH (FEET)	NUMBER OBSERVATIONS	MEAN	MINIMUM	MAXIMUM	RANGE	STANDARD DEVIATION
0	25	11.8	1.7	18.6	16.9	5.21
5	5	13.0	9.4	17.5	8.1	3.45