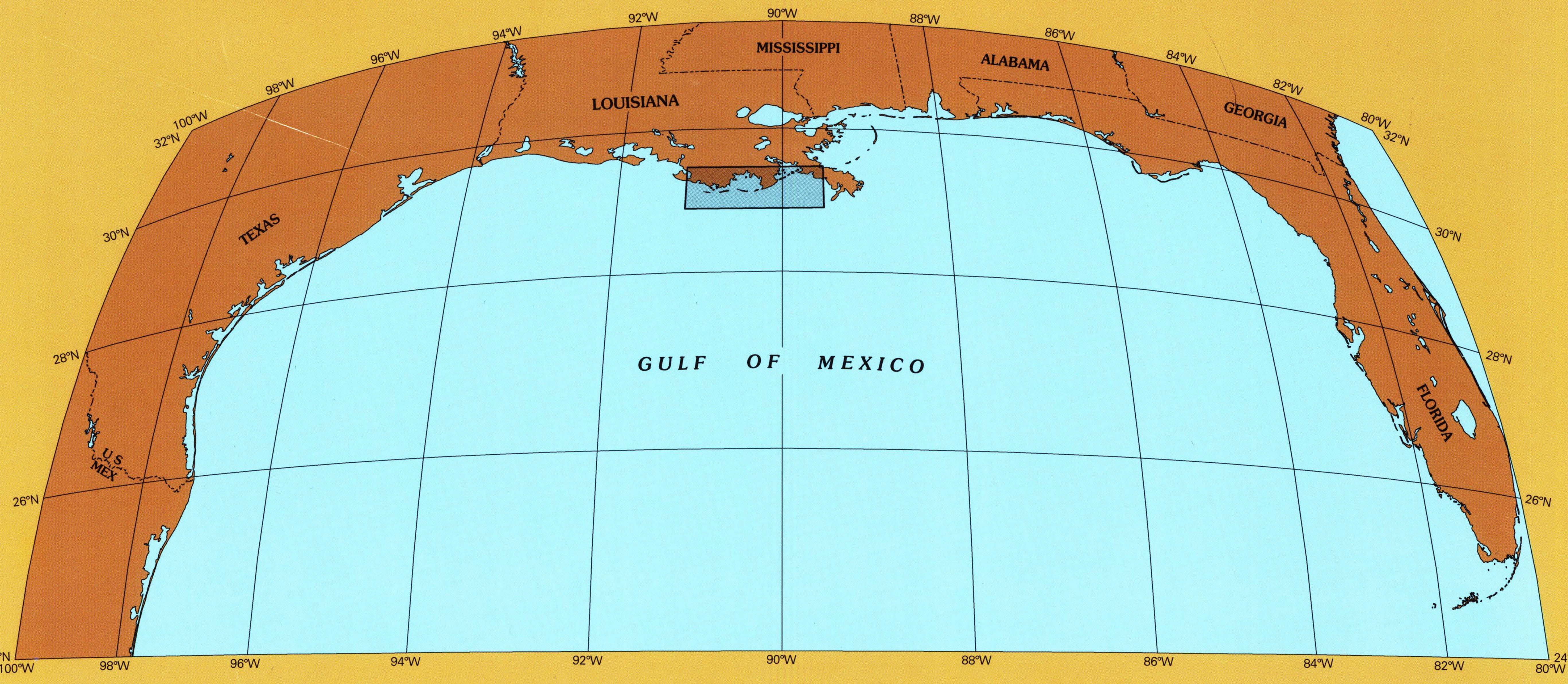
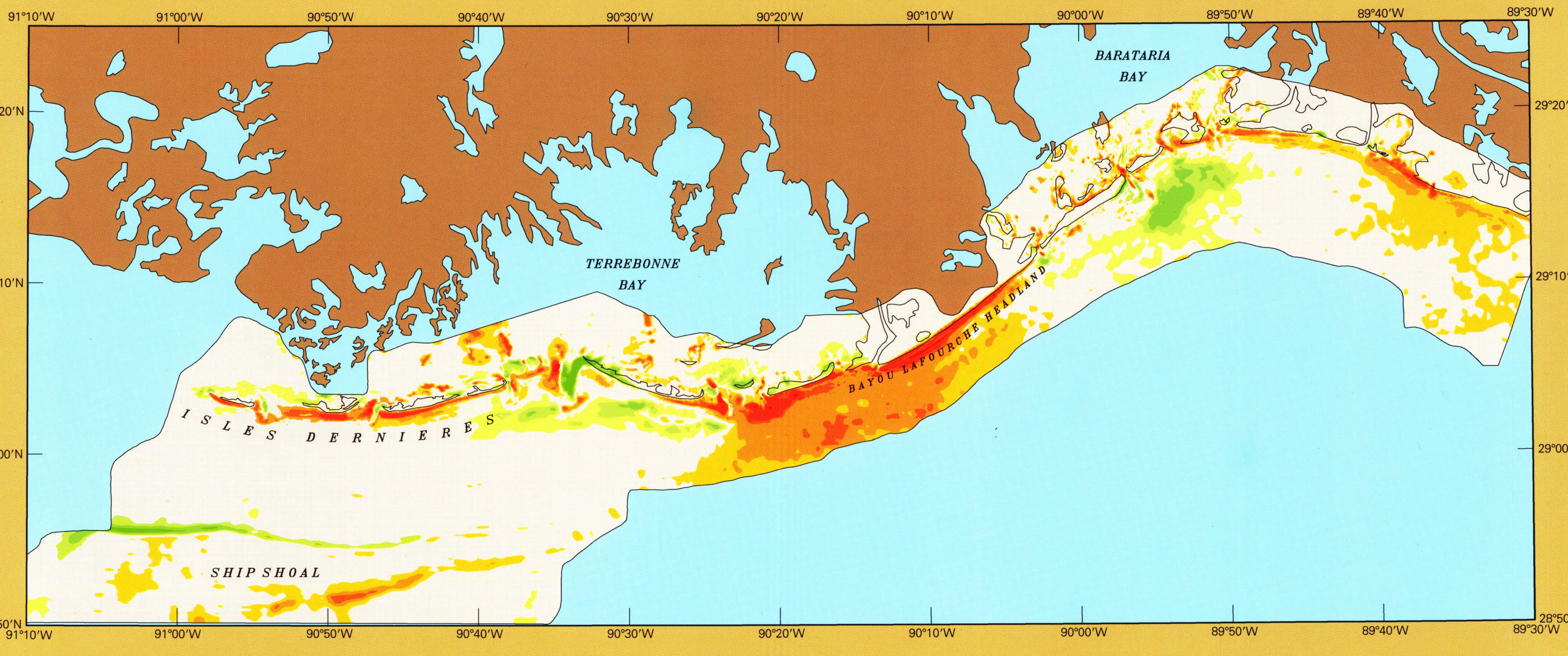
Louisiana Barrier Island Erosion Study

Atlas of Sea-Floor Changes from 1878 to 1989





U.S. Geological Survey

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Louisiana Barrier Island Erosion Study: Atlas of sea-floor changes from 1878 to 1989

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An examination of the processes and geological conditions
responsible for the widespread erosion of Louisiana's delta-plain coast

Prepared in cooperation with
LOUISIANA STATE UNIVERSITY

U.S. Geological Survey
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FOREWORD

It is with pleasure that we present this Atlas of Sea-floor Changes. This atlas is one of many products of the Louisiana Barrier Island Erosion Study, conducted jointly by the U.S. Geological Survey and Louisiana State University. It demonstrates the positive results that are possible when Federal and State agencies work together to solve problems that concern many segments of the population.

The erosion of our Nation's coasts and the degradation and loss of valuable wetlands affect all of us. Coastal businesses and homeowners endure the immediate consequences. But when one individual suffers, many suffer indirectly through higher prices, insurance premiums, and taxes. Diminished coasts and wetlands also affect those who value them as wildlife habitat, as abundant food resources, and as recreational areas.

Cooperative efforts such as the Louisiana Barrier Island Erosion Study allow the pooling of knowledge and resources. As a result, planners and decisionmakers, who must determine courses of remedial action, receive critical information expeditiously. This atlas is a small but important contribution to the information transfer process. We trust that it will provide not only evidence of the dramatic effects of coastal erosion and wetland loss in Louisiana but also understanding to those who must deal with mitigation approaches that will benefit society as a whole.

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Executive Director
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INTRODUCTION

The barrier islands of Louisiana are eroding at alarming rates; in many areas the long-term erosion rate exceeds 20 meters (m) per year (McBride and others, 1991a). Within the past 100 years, these barrier islands have decreased in area by more than 40 percent, and some islands have lost 90 percent of their area. A few of the islands are predicted to disappear within the next two decades (McBride and others, 1989). Although considerable controversy exists, many scientists believe that the disappearance of these barrier islands will result in a greatly increased rate of wetlands loss, and the conversion of highly productive estuarine habitat to the less productive, open Gulf of Mexico environment.

The physical processes causing barrier island erosion are complex, varied, and not well understood. There is much debate in the technical and academic community about which of the many contributing processes, both natural and human-induced, are the most significant (Penland and others, 1990). Furthermore, controversy surrounds most of the measures that are being proposed to alleviate barrier island erosion. Much of the debate is focused on the reliability of predicted results of a given technique for management, restoration, or erosion mitigation. With better understanding of the processes causing barrier island erosion, such predictions will become more accurate, and clearer consensus is likely to appear on how to reduce and mitigate land loss.

In response to this need for better information on the causes of barrier island erosion, the U.S. Geological Survey (USGS) began a five-year study in 1985 to further our knowledge of the geologic framework, historical changes, and modern processes affecting the barrier islands of Louisiana (Sallenger and others, 1987). As final products of this study, two atlases have been designed to give a comprehensive overview of the shoreline and sea-floor evolution. Atlas I–2150–A, entitled *Atlas of shoreline changes in Louisiana from 1853 to 1989* (Williams and others, 1992), describes the geologic history of the study area, and provides a detailed series of shoreline maps with accompanying data analysis documenting the evolution of the barrier island systems since the first shoreline surveys in 1853.

This atlas, I–2150–B, documents changes in sea-floor elevation along a 157-kilometer (km) section of deltaic-plain coast immediately west of the modern Mississippi River delta. This area, shown in figure 1, covers approximately 3000 km^2 of sea floor and extends from about 7 km landward of the barrier islands offshore to water depths of about 13–18 m in the Gulf of Mexico. The motivation for the sea-floor change analysis presented here is straightforward: the patterns of sea-floor erosion and accretion provide clues to the large-scale processes of sediment transport, and allow for better predictions of future conditions. Combined with the shoreline change analysis and geologic history provided by the companion atlas, this information is vital for managing one of our country's most rapidly changing coastlines.

Bathymetric surveys from three time periods are considered: 1878–1906 (referred to as the 1880's), 1933–36 (the 1930's), and 1986–89 (the 1980's). Maps depicting sea-floor erosion, accretion, and relatively stable areas are presented for two time intervals, the 1880's to 1930's and the 1930's to 1980's. These maps are presented at two scales: 1:250,000, showing the entire study area in an overview; and 1:100,000, focusing on four overlapping regions. Additionally, sea-floor changes along 23 profiles are presented, giving another view of the rapid evolution of the study area.

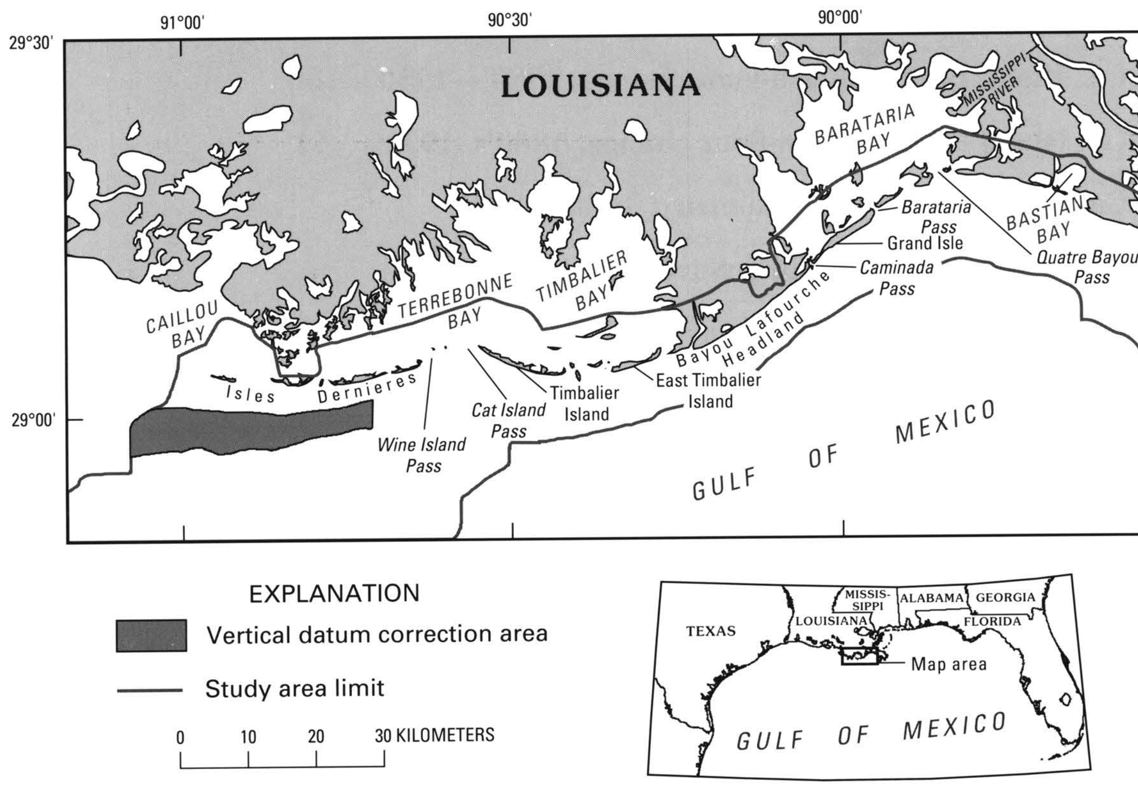

Figure 1—Map showing the geographic extent of the study area, significant features in it, and area used to determine the vertical datum correction between different survey years.

DATA COLLECTION

Data for the bathymetric comparisons presented here were obtained from diverse sources with a variety of densities. These data sets are described below for the 1880's, 1930's, and 1980's composite years, and are shown on pages 10–15. Throughout the atlas, bathymetric and shoreline data are not to be used for navigational purposes.

1880's Surveys

A total of 63,909 soundings were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic smooth sheets from the years 1878, 1883, 1886, 1888, 1889, 1891, and 1906. The locations of these soundings are shown on pages 10 and 11. The 1906 survey covered a small area behind the eastern part of Isles Dernieres, which was not surveyed during the 1880's and 1890's. Horizontal positioning for the soundings on these charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. The horizontal datum used for digitizing was the North American Datum of 1927 (NAD27), for which control points were added to the hydrographic sheets by the USCGS in the 1930's.

Soundings were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used (Shalowitz, 1964). The vertical datum is mean low water (MLW) during the period of the survey, based on tide records from local gauges deployed specifically for the bathymetric survey. Because of the short-term nature of the tide records, the resulting vertical datum may have been strongly influenced by annual or wind-induced variations in sea level. Thus the MLW datum for any one of the 1880's surveys is not likely to be equivalent to the MLW datums used for the 1930's and 1980's bathymetric surveys.

Sounding errors for the 1880's surveys arise from numerous sources, including various types of measurement error and inequalities in the vertical datum used for different surveys. One measure of sounding error is the magnitude of the elevation discrepancies between tracklines at crossing points (where two tracklines intersect). On the average, this discrepancy was about 3 percent of the water depth, resulting in a maximum of about 45 centimeters (cm) in 15 m of water. When considering the mean elevation of large areas of sea floor, however, this type of error should cancel out due to its small spatial scale of variability. Nevertheless, this type of error analysis indicates that deeper water areas will have a larger error than shallow water areas.

A more significant source of sounding error may arise from vertical datum inequalities between separate surveys of the 1880's composite bathymetry. As noted above, the vertical datum was determined from short-term tide gauge deployments during each survey. Depending on meteorological conditions, this datum may have varied significantly between surveys (Jaffe and others, 1991). In one perhaps worst-case situation, historical notes describe extraordinarily high tides produced by strong southerly winds; bathymetric comparisons for this survey suggest a datum inconsistency of as much as 40 cm.

Shoreline data for the 1880's surveys were digitized from USCGS topographic sheets from the years 1883, 1884, 1886, 1887, and 1906. The 1906 data include back-barrier and mainland shorelines behind the eastern end of Isles Dernieres; these shorelines were not covered during the 1880's surveys. All shorelines were measured by planetable and alidade ground surveys, and are labeled in the atlas as the mean high water (MHW) line following the historical charts and Shalowitz (1964). However, as indicated by Anders and Byrnes (1991), this shoreline really represents the high water line (HWL) at the time of the surveys. Nevertheless, for the purposes of processing the bathymetric data in the atlas, it is assumed that the shorelines represent the approximate position of the MHW line, or about 0.5 m above the MLW datum of the bathymetric data. Because of the very low tidal range in the study area (mean diurnal range of about 0.4 m), this introduces negligible error. As with the sounding data, the horizontal datum used for digitizing shorelines was NAD27.

Further information on the 1880's surveys and their horizontal and vertical datums may be found in Jaffe and others (1988, 1991).

1930's Surveys

A total of 315,856 soundings were used in constructing the 1930's bathymetry. These soundings, shown on pages 12 and 13, were obtained in digital form from the National Geophysical Data Center in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA) from USCGS hydrographic smooth sheets from the years 1933, 1934, 1935, and 1936. Horizontal positioning for the soundings on these charts was accomplished by means of radio acoustic ranging (RAR), which involved the deployment of buoys emitting radio signals (sonu-buoys) throughout the study area (Jaffe and others, 1988). The horizontal datum used for the 1930's data set was NAD27.

Depths were measured with precision fathometers utilizing newly developed echo-sounding technology. Both the RAR and echo-sounding methods had only recently been employed by the USCGS, following advances in acoustic instrumentation stimulated by World War I. As in the 1880's surveys, these soundings were reduced to a MLW datum by applying sea-level corrections obtained from tide stations deployed solely for the surveys.

Sounding errors for the 1930's surveys were evaluated similarly to those for the 1880's data. Trackline intersection discrepancies were about 3 percent of the depth for offshore areas and 10 percent of the depth in back-barrier bays. Again, this type of randomly distributed error should largely cancel out when considering large sea-floor areas. Vertical datum inconsistencies were not obvious between different 1930's surveys, but may still be present.

The 1930's shoreline data were digitized from USCGS topographic sheets. Shorelines were interpreted by the USGS from aerial photography taken in 1932 and 1933, supplemented by planetable surveys in selected areas following a hurricane in 1934. As in the 1880's data, the shorelines represent the approximate position of the MHW line, or about 0.5 m above the MLW datum of the bathymetric data. The 1930's surveys are also described in Jaffe and others (1988, 1991).

1980's Surveys

The 1980's bathymetry was constructed from 232,289 soundings obtained in digital form from hydrographic surveys conducted in 1986, 1988, and 1989 by companies under contract to the USGS (p. 14 and 15). The 1986 survey, conducted by Geodetic International, Inc., utilized a Sercel Syledis, UHF-type radio positioning system for horizontal control and a Krupp-Atlas, model 20, high-precision, dual-frequency fathometer for soundings. The 1988 and 1989 surveys, conducted by Gulf Ocean Services, Inc., utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings. All horizontal positioning was in reference to NAD27. Reported nominal accuracies for all these systems were much smaller than the observed data error, as obtained from trackline crossing discrepancies (see below).

Following the surveys, the sounding data were post-processed to remove vertical variations due to tidal and other water-level fluctuations. Water-level recordings obtained at hourly intervals from the NOAA tide gauge at Grand Isle, La., were used to reduce the measured water depth to mean lower low water (MLLW), a datum determined from the Grand Isle gauge over an 18-year period from 1960 to 1978. Corrections were also made for predicted time and water-level differences between the Grand Isle gauge and other zones within the study area. The MLLW datum is virtually identical to a MLW datum for this area. Also, due to local subsidence, the MLLW datum is only 0.05 m below the National Geodetic Vertical Datum (NGVD), which was a mean-sea-level datum for the area when it was determined in 1929.

Sounding errors for the 1980's surveys were evaluated similarly to those for the earlier surveys. The average trackline intersection discrepancy was 17 cm for 518 observations. Again, this type of error should cancel out over large sea-floor areas due to its inherently random nature. Datum inconsistencies should be minimal for the 1980's surveys due to the use of a common MLLW datum. However, tide correction errors are likely to be present due to the use of the Grand Isle tide gauge for the entire study area. This error is difficult to quantify without detailed predictions of sea-surface variations forced by wind and waves.

The shorelines for the 1980's surveys were obtained from aerial photography taken in 1986 and 1989. The 1986 photographs, taken by Gulf Coast Aerial Mapping Co., Inc., were black and white images covering the Isles Dernieres section of the study area at a scale of 1:4,800. The approximate position of the MHW shoreline was digitized directly from these photographs, and was then rectified to the geographic coordinates of 1950's USCGS topographic sheets at scale 1:20,000. The 1989 photographs were high-altitude color infrared stereopairs taken by the National Aeronautics and Space Administration (NASA) at a scale of 1:65,000. The approximate position of the MHW shoreline was interpreted on mylar overlays, rectified to the 1:24,000-scale 7.5-minute USGS topographic quadrangles from 1979, and then digitized. As in the 1880's and 1930's, the 1980's shoreline was assumed to represent the MHW level, or about 0.5 m above the MLLW datum of the bathymetric data. Further details of the 1986 bathymetric survey may be found in Williams and others (1989).

DIGITAL PROCESSING TECHNIQUES AND ERROR ASSESSMENT

Maps in the atlas were produced by digital means. This section gives an overview of the methods used to process sounding data into contours, to generate sea-floor change data, and to produce thematic-map film negatives using these contours. More detailed descriptions of the digital techniques employed can be found in a series of USGS Open-File Reports, including Jaffe and others (1991), Hopkins and List (1991a,b), and Hopkins and others (1991).

Generation of Surface Grids

The first step in digital processing was the conversion of raw hydrographic data to a set of regularly spaced elevation values known as the surface grid. The surface grid, stored on the computer as a two-dimensional array, represents a best-fit surface through the sounding data. Surface grids were calculated using the Dynamic Graphics, Inc., software package, Interactive Surface Modeling (ISM), version 6.93B, with input data consisting of the hydrographic data described above, as well as numerous shoreline points having an elevation of 0.5 m derived from the digital shorelines. In general, a grid-point spacing of 135 m was used for the bathymetric surface grids for all survey years. The choice of this and other gridding parameters, as well as the many special problems encountered in gridding sounding data for this project, are described in Hopkins and others (1991).

We evaluated the accuracy of our final bathymetric grids by comparing the elevation of all original sounding values with grid-predicted elevations at the same locations. In general, the mean absolute difference between grid and sounding elevations was less than 15 cm, and the standard deviation of this difference was less than 30 cm. Errors tended to be somewhat larger for the earlier survey years than for the later survey years. Discrepancies between the grid and sounding data arise from numerous sources, including difficulties in making surface models of rapidly changing depths very close to shorelines, and the presence of erroneous sounding values that were not detected during the gridding process (Hopkins and others, 1991). However, these errors tend to be randomly distributed, with plus and minus errors summing to zero over areas of a size considered for bathymetric change in the atlas. Problem areas do occur nevertheless in some inlets, especially Barataria Pass, where slopes are too great for accurate surface modeling at the 135-m spacing determined to be necessary for efficient processing of the large study area considered. These areas should be viewed with caution throughout the atlas.

Surface grids are used for several purposes. ISM generates contour lines from grids, as presented in this atlas. Bathymetric grids from different years are also subtracted to give the patterns of erosion and accretion, as described below.

Sea-floor Change Calculation

Patterns of sea-floor erosion and accretion were determined between two time periods, the 1880's to 1930's and the 1930's to 1980's. The procedure for making these sea-floor comparisons is conceptually straightforward: bathymetric grids from different years are subtracted in ISM, creating a new grid of elevation-difference values. Contours are then generated from these difference grids; the resulting color-filled maps show the levels of erosion and accretion in the overlapping areas between years.

Several problems complicated this otherwise simple procedure. Relative sea level has risen by about 1 cm/yr during the study period, largely due to compaction and subsidence of the underlying deltaic sediments (Ramsey and Moslow, 1987; Penland and Ramsey, 1990). Without a correction for this relative sea-level rise, bathymetric comparisons would be strongly biased toward erosion. The determination of this sea-level-rise, or vertical datum, correction was one of the major challenges of this study, as described by Jaffe and others (1991). Traditional sources of information used to determine the vertical datum correction, such as continuous tide gauge or geodetic leveling data, were not available for the study area. An alternate method was developed using an area of sea floor that appears to be sedimentologically inactive, that is, showing no apparent significant erosion or accretion. This sea-floor region, labeled "datum correction area" in figure 1, was used to calculate a spatially averaged water-depth change between the 1880's and 1930's and between the 1930's and 1980's. These changes are presumed to be direct measures of the vertical datum change between survey years. Sea-floor change grids representing levels of erosion and accretion were derived by subtracting the earlier year's bathymetric grid from the later year's bathymetric grid (both measured negatively below the MLW datum) and adding the datum correction: 0.27 m for the 1880's to 1930's, and 0.33 m for the 1930's to 1980's. Further details of the derivation and application of this datum correction are given by Jaffe and others (1991).

A second difficulty in conducting this bathymetric comparison concerns the elevations of land areas, which were not available in historical or recent surveys. Because the study area includes large regions where land has been converted to open water through shoreline transgression and submergence, we made assumptions about the land elevation in order to facilitate the bathymetric comparisons. Specifically, it was assumed that land areas had a constant elevation of +0.55 m above the MLW datum of each year's bathymetry. This elevation is approximately the elevation of the low, frequently inundated marshes that compose the majority of the land surface in the study area. Although small, low-relief dune complexes are present in several areas (Ritchie and Penland, 1988), historical and recent observations support the conclusion that very limited land relief has existed, and that a constant land-elevation assumption will lead to a relatively small error in terms of volumetric calculations of erosion and (or) accretion.

This and several other elevation assumptions permitted a graphical representation of the sea-floor changes in areas associated with the transgression of the open coast over land and inland water bodies, such as lakes and bayous. Table 1 summarizes all the possible combinations of year 1 (earlier year) and year 2 (later year) surface area descriptions, the assumptions made (if any), and the result in terms of sea-floor change. By far the largest surface area for which an elevation assumption was made was for case 4, in which land of unknown elevation in year 1 is converted to open water with sounding data in year 2. Other cases, including the one in which shallow, inland water (lakes or bayous) lacking sounding data is converted to open water with sounding data (case 5), are of minor areal extent. These assumptions add a degree of uncertainty to bathymetric change calculations which is difficult to quantify. However, because of the desire for continuous coverage in the nearshore zone, these assumptions were accepted with the realization that the accuracies of change volumes were decreased somewhat by this problem.

Table 1—Determination of sea-floor change
[MLW, mean low water]

Case	Year 1 area description	Year 2 area description	Elevation assumptions	Sea-floor change result
1*	Sea floor, bathymetry known.	Sea floor, bathymetry known.	None	Sea-floor change known
2*	Open water, bathymetry known.	Open water, bathymetry unknown.	None	No data
3*	Land, elevation unknown.	Land, elevation unknown.	Land elevation is 0.55 m above MLW datum for year 1 and for year 2.	Elevation change is equal to vertical datum correction.
4*	Land, elevation unknown.	Sea floor, bathymetry known.	Land elevation is 0.55 m above MLW datum.	Sea-floor change known
5	Inland water, bathymetry unknown.	Open water, bathymetry known.	Elevation of inland water is 0.50 m below MLW datum.	Sea-floor change known
6	Land, elevation unknown.	Inland water, bathymetry unknown.	Elevation of inland water is 0.55 m above MLW datum.	Elevation change is equal to vertical datum correction.
7*	Inland water, bathymetry unknown.	Inland water, bathymetry unknown.	Inland water is 0.55 m above MLW datum.	Elevation change is equal to vertical datum correction.
8	Inland water, bathymetry unknown.	Land, elevation unknown.	Land is 0.55 m above MLW datum; inland water is 0.50 m below MLW datum.	1.05 m of accretion

*Situation is reversible.

DEFINITIONS

Inland water: areas of sea floor enclosed or mostly enclosed by land, such as lakes and bayous.
Open water: areas of sea floor not enclosed by land, such as in the Gulf of Mexico or in the larger bays.
Sea floor: areas submerged at mean low water, including inland and open waters.
Land: areas exposed at mean low water.

Sea-floor Change Error

The total error associated with sea-floor change calculations is a complex combination of many potential sources of error, including sounding measurement error, tidal correction problems, vertical and horizontal datum inconsistencies, computer gridding errors, and the elevation assumptions just mentioned. Added to this is the uncertainty of to what degree these errors may cancel out over the variably sized areas of sea floor considered in this atlas. It is clear that our most easily quantified errors, including trackline intersection discrepancies and gridding errors, should have little influence over large areas due to their inherently random nature.

On the other hand, tidal correction problems, datum inconsistencies, and elevation assumption errors are very difficult to quantify, but are likely to have more impact due to their larger scale of variation. One major source of uncertainty is the use of the vertical datum correction derived from the sea-floor area shown in figure 1 for the entire study area. This assumes the rate of subsidence is the same throughout this coastal reach. Though this assumption is supported to some degree by short-term tide gauge records (Jaffe and others, 1991), the spatial and temporal scales of subsidence variability are not well known. However, because no region in the eastern part of the study area was suitable for deriving a vertical datum change, the corrections obtained from the datum correction area shown in figure 1 were used for the entire study area.

Because of these problems in determining the various error contributions, we were not able to quantitatively assign error bounds for sea-floor change values. As a qualitative approach, we examined sea-floor change results to see how fine a difference in seabed elevation could be distinguished in terms of large-scale, coherent patterns of erosion and accretion. When the range of sea-floor change from −0.5 to +0.5 m was considered a no-significant-change zone (as shown in this atlas), patterns were coherent and interpretable from a geologic standpoint. Patterns of sea-floor change associated with individual tracklines or groups of tracklines were also minimized, suggesting that the error arising from the numerous potential sources mentioned above fell within the ±0.5 m range. A test with ±0.25 m as the no-significant-change zone displayed similar patterns of erosion and accretion, but also showed a greatly increased level of random, or trackline-associated, error.

Another test with a doubled sea-level datum correction showed a decreased level of random error in the back-barrier bays of the eastern half of the study area, but an increased level in the western half. This suggests that the datum correction derived in the western half of the study area may apply only to the eastern half, to within about 30 cm.

Taken together, this empirical evidence suggests that our sea-floor change data are valid to a degree somewhat better than ±0.5 m, as a conservative estimate. The true error is likely to vary widely as a function of the size of the sea-floor area considered (more spatial averaging, less error), the distance from the datum correction area (more distance, more error), and the years considered in the bathymetric comparisons (1880's–1930's, more error than 1930's–1980's). In interpreting the results of this atlas, the reader is cautioned to view the ±0.5 m error as only a rough guideline to the uncertainty, with the true error likely to be less for most areas considered.

Cartographic Production

The maps and profiles in this atlas were produced by digital means. In order to meet all our cartographic demands, three geographically oriented packages were integrated as shown in figure 2. As described above, ISM was used to process sounding data to surface-modeled grids, and to create sea-floor change grids through the subtraction of different years' bathymetric grids. At this point, all contours were in the desired form for final publication. However, ISM version 6.93B could not be used for digital map production, for several reasons: ISM's map annotation and linework did not meet USGS cartographic standards, ISM could not color-fill contour intervals, and a driver was not available for sending digital information from ISM directly to a machine producing film negatives.

Two other software packages were employed to meet these requirements. ARC/INFO (Environmental Systems Research Institute, Inc.) was used for contour color-fill and to generate color-separated film negatives on a Scitex Response-280 system. MAPGEN (USGS in-house software; see Evenden and Botbol, 1985) was used to create lines and text and to generate film negatives for this information via the Gerber photo-plotter. (The Gerber plotter produced film positives from which negatives were made.)

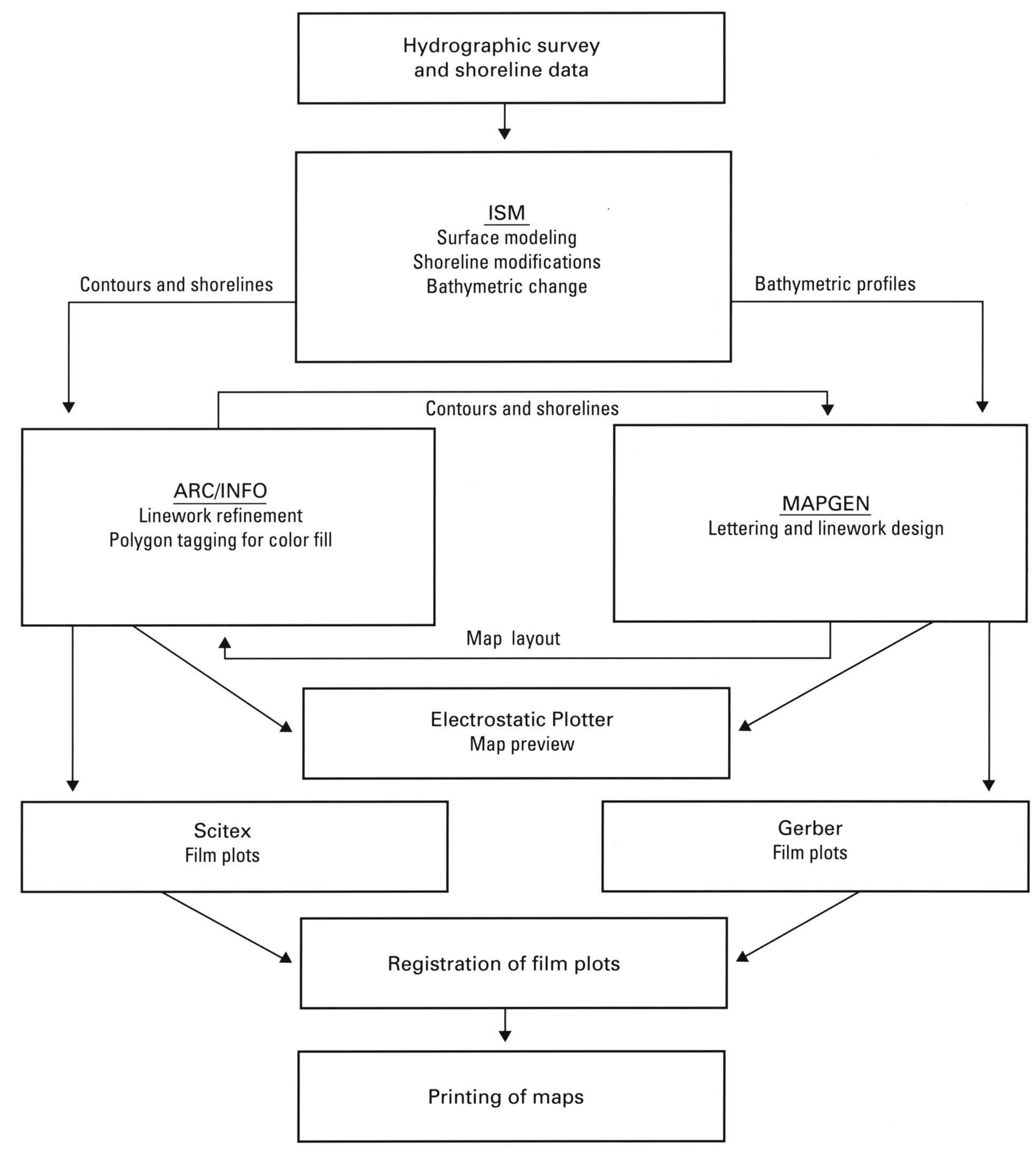

Figure 2—Processing scheme for the cartographic production of the atlas.

ATLAS FORMAT AND DATA PRESENTATION

Map Scales and Coverage Area

Two scales were selected for presentation of map data in the atlas. A small-scale series at 1:250,000 displays the entire study area on two facing atlas pages. This scale shows the patterns of sounding locations for the three study periods (p. 10–15) and gives an overview of the bathymetric and sea-floor change results (p. 16–25). A larger-scale series at 1:100,000 divides the study area into four overlapping regions, shown in figure 3. These regions were chosen to highlight the changes occurring within specific geologic systems. From the west, the Isles Dernieres area (p. 36–45) shows the evolution of Ship Shoal and the Isles Dernieres barrier

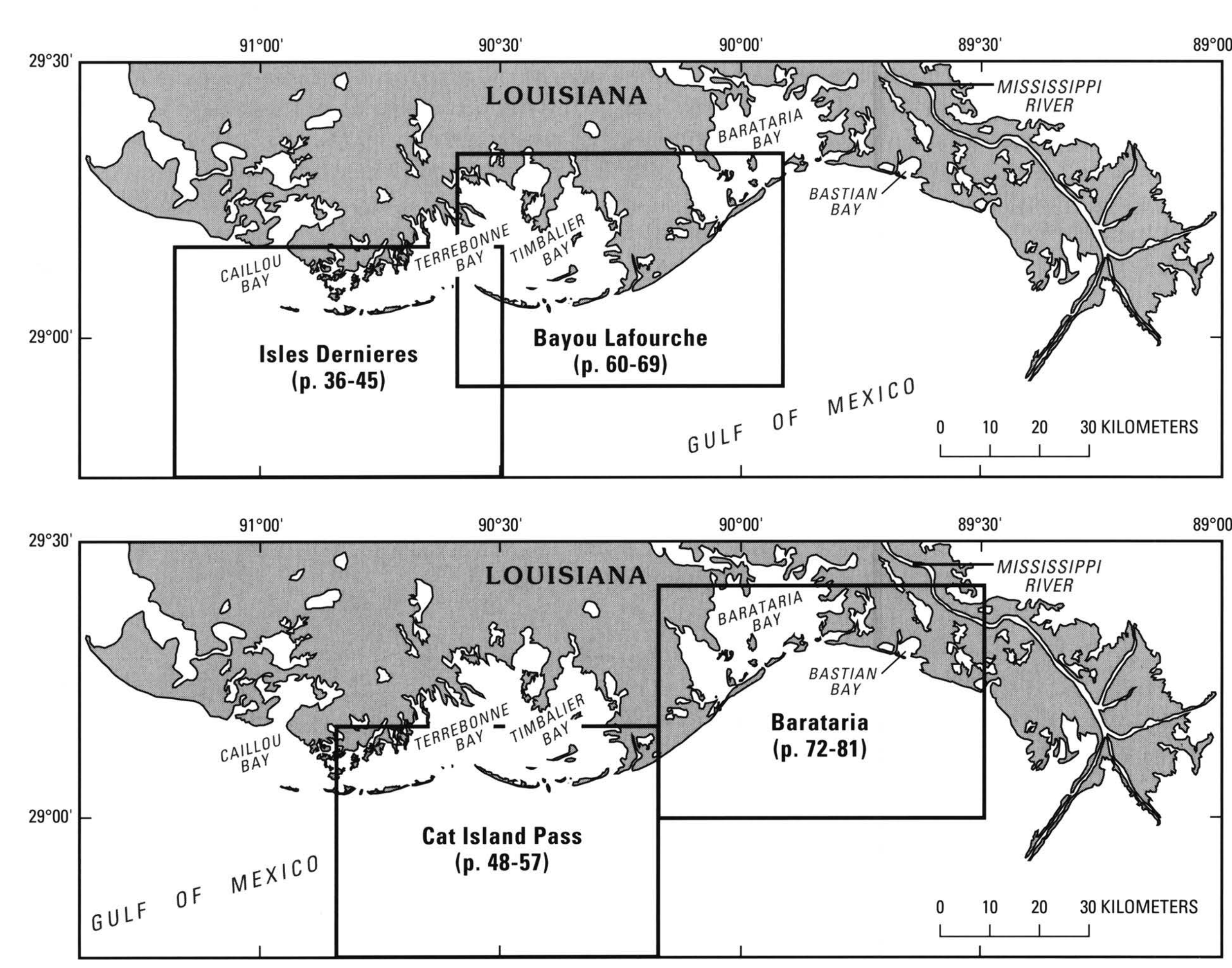

Figure 3—Geographic areas shown in the atlas at a scale of 1:100,000.

island system. The Cat Island Pass area (p. 48–57) documents the transport of sediment between the Bayou Lafourche headland and the Isles Dernieres across the broad inlet area including Cat Island and Wine Island Passes. The Bayou Lafourche area (p. 60–69) shows the changes to the headland and flanking barrier islands of the Bayou Lafourche delta lobe (Penland and others, 1988). Finally, the Barataria area (p. 72–81) completes the study area and highlights the sediment accumulations offshore from inlets connecting the Gulf of Mexico to Barataria Bay.

Both the large-scale and small-scale map series are presented in a sequence from the 1880's bathymetry to the 1980's bathymetry, with sea-floor change maps located between the associated years of bathymetry. This permits the reader to easily reference both the "before" and "after" bathymetry associated with each sea-floor change map. Page size limitations required the areas shown in both the 1:250,000- and 1:100,000-scale maps to be divided into western and eastern halves. Differences in margin text between these halves reflect differences in the data composing the respective areas.

Soundings

Pages 10–15 show the location of the soundings used for the generation of bathymetric grids. Each dot represents one sounding location. However, because of the close spacing of the soundings, the individual points may not be resolvable. For the 1980's surveys, the spacing between soundings was only about 30 m.

Bathymetric Contours

Bathymetric contours are shown at a 1-m interval, with heavy contours every 5 m, for both the 1:250,000- and 1:100,000-scale maps throughout the atlas. The 1:100,000-scale maps color-code these contours with different shades of blue in the 0–2 m, 2–5 m, 5–10 m, 10–15 m, and >15 m intervals. The 1:250,000-scale maps show the same color scheme, except that the 0–2 m and 2–5 m intervals are combined. The contours are in reference to different MLW datums for each study period, and as such are not directly comparable without a datum change correction. The shorelines on these maps represent the approximate MHW position relative to each survey's vertical datum.

Profiles

The sea-floor profiles on pages 28–33 are from the locations shown on the 1:250,000-scale bathymetric maps. These locations, which have an arbitrary horizontal datum, are the same for each survey year. The profiles are shown at a vertical exaggeration of 1:200, and are 20 km in length unless they extend into a region of no data, in which case they are truncated. Because these profiles were derived from digital surface elevation data in grid form, the length of each profile line is only as accurate as the grid spacing. Thus the profile lengths vary randomly by as much as 135 m, the grid spacing.

As noted above, elevations from different surveys are not directly comparable without a vertical datum correction. This correction was determined to be 0.27 m between the 1880's and 1930's study years and 0.33 m between the 1930's and 1980's study years (Jaffe and others, 1991). Profile elevations were cumulatively adjusted for this correction, with the 1980's profile elevations receiving no adjustment, 0.33 m subtracted from the 1930's profile elevations, and 0.60 m subtracted from the 1880's profile elevations. This results in a 1980's MLW datum for all profiles. Elevation differences between profiles thus indicate the degree of accretion or erosion, as shown on the sea-floor change maps which employ the same vertical datum correction.

As described above, land areas were assumed to have a constant elevation of +0.55 m relative to the MLW vertical datum of the bathymetry. This is reflected in the profiles by the leveled appearance of land areas. As a result of the datum correction, this constant maximum profile elevation occurs at 0.55 m for the 1980's, 0.22 m for the 1930's, and −0.05 m for the 1880's.

Sea-floor Change and Volumetric Analysis

For the 1:100,000-scale maps, sea-floor change was depicted by six shades of orange (orange to dark red) for erosion and six shades of green for accretion. As described above, the range from 0.5 m of erosion to 0.5 m of accretion was considered a zone of no significant change. This zone, shaded gray, also shows the area of overlap between the two survey periods in the sea-floor change comparison. An exception to this occurs in some of the offshore areas in the 1880's–1930's comparison, which were removed from consideration due to the sparse and inaccurate nature of the 1880's data.

Both the earlier and later years' shorelines are shown on the 1:100,000-scale change maps for reference and to allow the reader to relate sea-floor changes to island changes. For both the 1880's–1930's and 1930's–1980's comparisons, the earlier period is shown by a blue line, while the later period is shown by a black line.

The 1:250,000-scale sea-floor change maps are similar to the 1:100,000-scale maps, except for a simplified color scheme and the elimination of the later years' shoreline. In addition, areas enclosed by blue lines and described as "volumetric polygons" delineate features for which the volumes of erosion or accretion are provided in table form on the maps. These polygons were usually defined by the erosional and accretional features themselves. However, in some cases, especially near inlets, complex patterns of erosion and accretion were grouped into one polygon on the basis of bathymetric contours from either the earlier or later years' surveys.

In the tables, the term "area number" refers to these numbered polygons. The term "gross area" refers to the total surface area within a polygon, excluding the gray area assigned to the no-significant-change zone. The term "net volume gain" or "net volume loss" refers to the volume of sediment either deposited or eroded within a polygon, again excluding the gray areas of no significant change. The net volume change for a polygon is calculated by adding the total accretional volume (positive number) and the total erosional volume (negative number) for that area. Depending on the sign of the outcome, the result is tabled under either "erosional areas" or "accretional areas." Finally, the term "average vertical change" is simply the net volume divided by the gross area.

The volumes reported thus exclude any areas within the range of −0.5 to 0.5 m of sea-floor change. Although this has the effect of reducing the erosional or accretional magnitudes, this method was adopted because the sea-floor change features of interest are defined by the graphical presentation of the data with a ±0.5-m zone of no significant change. Attempts to define sea-floor change features by means of the zero-change contour failed because of the often very irregular nature of this accretion/erosion boundary.

Assuming that the ±0.5-m range also represents the uncertainty associated with sea-floor change data, as described above, an error can be calculated for each of the net volume gains or losses reported on the 1:250,000-scale maps. This error, which is simply the gross area multiplied by the ±0.5-m uncertainty, is given in tables 2 and 3 for the 1880's–1930's and 1930's–1980's comparisons, respectively. Note that for large areas with small levels of sea-floor change, the reported error may be larger than the volume change itself. As noted previously, this error can only be considered a rough estimate of the maximum level of uncertainty, which will vary with the size of the area considered.

RESULTS AND INTERPRETATION

This section begins with an overview of the study area's geologic framework and physical setting, as a basis for interpreting the results of the sea-floor change analysis. This is followed by a description of the changes occurring within each of the four overlapping study regions (see fig. 3) shown in the 1:100,000-scale series. Finally, the results are interpreted with respect to the large-scale evolution of the entire study area, with implications for the prediction of future coastal changes.

Geologic and Physical Setting

The geology of the Louisiana coast, including the 157-km section of coast in the study area (fig. 1), is closely associated with the Holocene history of the Mississippi River. Throughout the Holocene, the Mississippi River has episodically changed course, each time depositing a new sequence of sediments that are subsequently re-worked and eroded by waves and coastal currents (Fisk, 1944; Kolb and Van Lopik, 1958; Scruton, 1960; Bernard and LeBlanc, 1965; Frazier, 1967; Coleman, 1988). Penland and others (1988) describe this cycle of deposition and erosion in terms of a multi-stage geomorphic model (fig. 4). This model begins with the deposition of a sedimentary lobe as part of an active delta complex. After the abandonment of the distributary channel, an erosional headland forms with the concurrent development of flanking barrier islands through the littoral drift of sand-size sediment (stage 1). Stage 2, a detached barrier-island arc fronting a tidal lagoon, is formed through the inundation and erosion of the marshes landward of the headland through a process that is poorly understood, but probably relates to a lack of sediment supply in a rapidly subsiding environment, combined with wave-induced erosion. Finally, an inner-shelf shoal forms when the vertical accretion and landward migration of the transgressive barrier-island arc fails to keep pace with the relative sea-level rise rate and is submerged as a remnant sand body (stage 3).

Most of the subaerial and subaqueous morphology in the study area reflects some stage of this idealized "transgressive-Mississippi-delta barrier model," with no appreciable modern input of sediment. In the west, Ship Shoal (fig. 5 and p. 24) is thought to represent a stage-3 inner-shelf shoal associated with the Maringouin/Teche delta complex, abandoned about 5,000 years before present (B.P.) (Frazier, 1967, Penland and others, 1986b, 1988, 1989a). This shoal, located 15 km offshore of the Isles Dernieres, is a massive sand deposit averaging 5–6 m thick over its 50-km length (Penland and others, 1989a), making it the largest sand body in the study area.

In contrast, the Isles Dernieres barrier island chain (fig. 5) is a sand-deficient system, with only a narrow littoral band of sand (1–2 m thick) overlying marsh sediments in some areas (Dingler, 1989). This island chain fits the model of a stage-2 barrier, formed after the abandonment of the Bayou Petit Caillou delta lobe of the Lafourche delta complex some 400 years B.P. (Penland and others, 1988). Shoreline maps from 1853 suggest that this barrier chain has undergone the detachment process within the last 150 years, although this conclusion is uncertain due to the reconnaissance nature of the early historical maps. Over the last 100 years, the Isles Dernieres have evolved from a nearly continuous barrier to a chain of four islands separated by tidal inlets (compare p. 16 and 24). Concurrently, the islands have narrowed through erosion and overwash on the sandy seaward side and submergence and erosion of marshes on the lagoonal side (McBride and others, 1989, 1991a,b).

Table 2—Error estimates for 1880's–1930's net-volume-loss and -gain calculations (p.18–19)

[Estimates are derived from the gross area multiplied by the ±0.5-m uncertainty factor]

STUDY AREA WEST			
EROSIONAL AREAS		ACCRETIONAL AREAS	
Area number	Error (±) in net volume ($m^3 \times 10^6$)	Area number	Error (±) in net volume ($m^3 \times 10^6$)
1	32.2	2	19.6
4a	1.1	3	1.2
5	1.5	4b	3.6
6a	5.1	6b	6.6
7	1.5	10	1.2
8a	5.6	12	2.4
8b	5.2	13b	1.4
9	12.0	14	1.8
11	1.7	15b	6.2
13a	1.6	16b	1.0
15a	5.2	18b	3.9
16a	4.6	19	12.2
17	5.4	20	1.9
18a	6.2	21	3.4
22	7.3	23.1	12.0
25.1	24.4	24	1.0
Combined areas	120.6	Other	68.0
		Combined areas	147.4

STUDY AREA EAST			
EROSIONAL AREAS		ACCRETIONAL AREAS	
Area number	Error (±) in net volume ($m^3 \times 10^6$)	Area number	Error (±) in net volume ($m^3 \times 10^6$)
25.2	137.8	23.2	19.8
27a	.6	26	3.1
28	4.9	27b	2.0
31a	1.6	29	14.0
32	6.6	30	86.5
33	1.9	31b	1.3
35	90.3	34	2.8
Combined areas	243.7	36	2.5
		37	2.6
		Other	5.0
		Combined areas	139.6

Table 3—Error estimates for 1930's–1980's net-volume-loss and -gain calculations (p.22–23)

[Estimates are derived from the gross area multiplied by the ±0.5-m uncertainty factor]

STUDY AREA WEST			
EROSIONAL AREAS		ACCRETIONAL AREAS	
Area number	Error (±) in net volume ($m^3 \times 10^6$)	Area number	Error (±) in net volume ($m^3 \times 10^6$)
1a	41.0	1b	19.7
2	2.2	4b	3.2
3	2.8	5b	4.9
4a	2.0	9b	2.1
5a	4.8	10b	3.8
6a	8.4	12	34.8
6b	5.0	14b	4.0
7	9.2	16	7.4
8	2.7	18.1	.6
9a	1.7	Other	8.2
10a	5.2	Combined areas	88.7
11	1.4		
13	1.6		
14a	3.8		
15	8.4		
17	8.0		
19.1	26.6		
Combined areas	134.8		

STUDY AREA EAST			
EROSIONAL AREAS		ACCRETIONAL AREAS	
Area number	Error (±) in net volume ($m^3 \times 10^6$)	Area number	Error (±) in net volume ($m^3 \times 10^6$)
19.2	111.0	18.2	5.8
21	1.6	20	3.4
22	9.8	24	56.6
23	7.8	27b	.6
25	1.3	29	.9
26	8.0	Combined areas	67.3
27a	2.2		
28	2.6		
30	2.8		
31	78.4		
Other	5.3		
Combined areas	230.8		

TRANSGRESSIVE MISSISSIPPI DELTA BARRIER MODEL

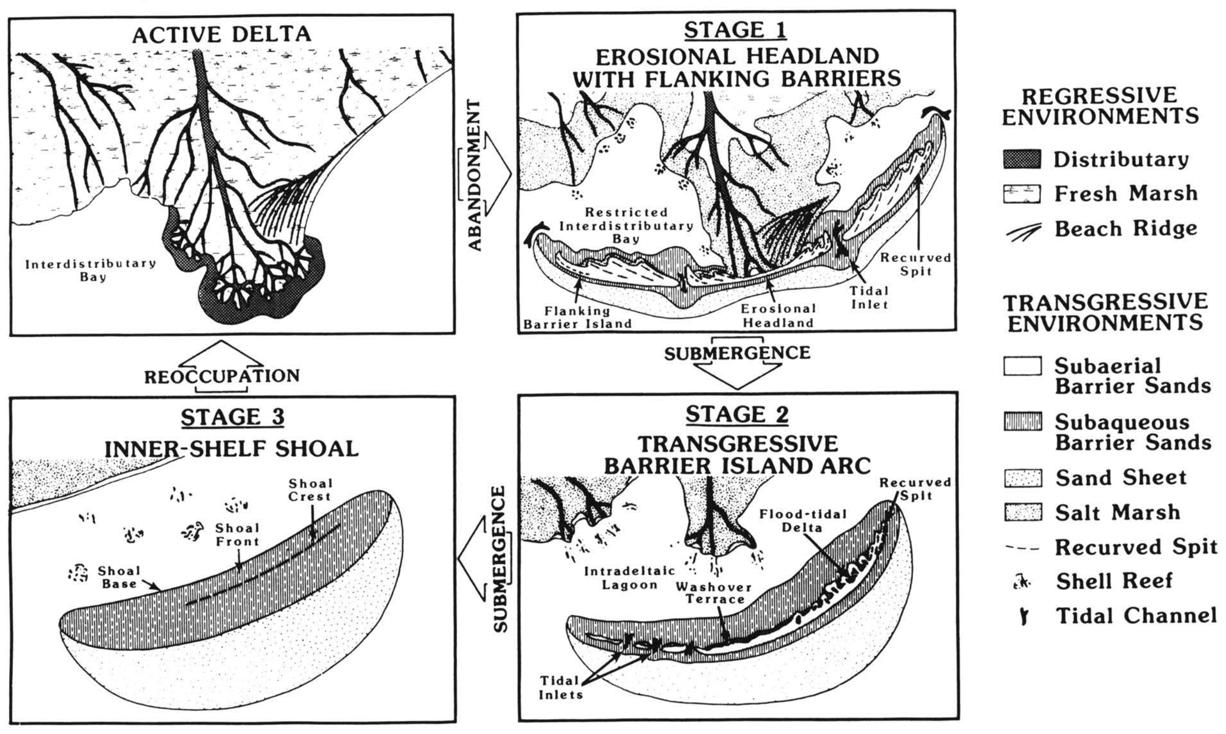

Figure 4—Idealized cycle of Mississippi River delta building and erosion. Redrawn and adapted, with permission, from Penland and Boyd (1981, p. 211); © 1981 by The Institute of Electrical and Electronics Engineers, Inc.

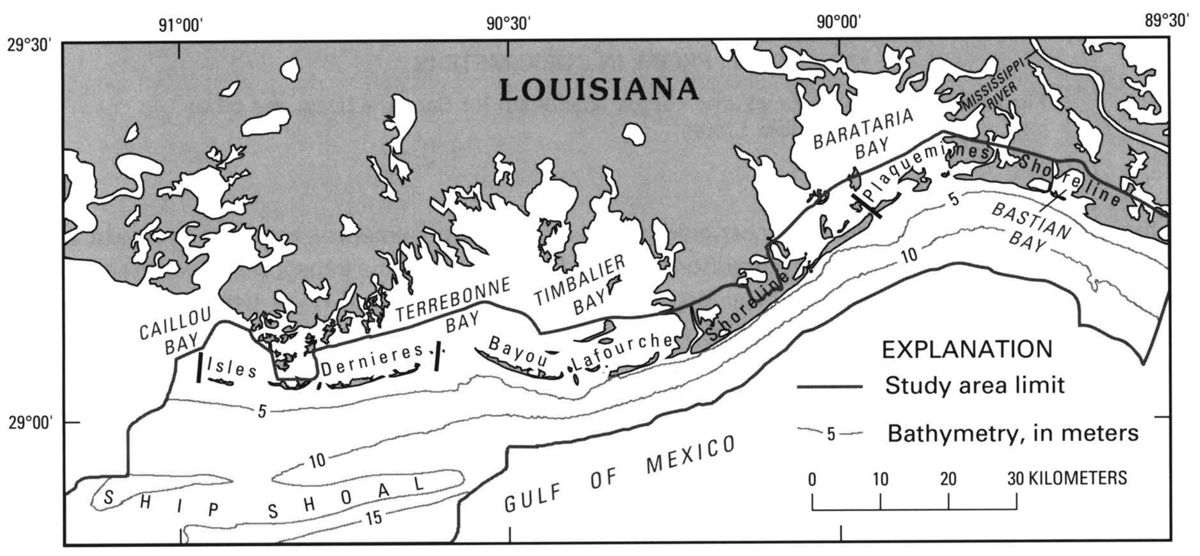

Figure 5—Physiographic and bathymetric place names. Short black bars separate the Isles Dernieres, Bayou Lafourche shoreline, and Plaquemines shoreline, which are discussed in the section, "Geologic and physical setting."

A geologic cross section, A–A′ (location given in fig. 6), extending along the strike of the Isles Dernieres chain, is shown in figure 7. This section shows that the islands are largely underlain by prodelta muds, with a deposit of beach-ridge sand underlying the eastern part of the islands. Overlying these delta deposits are back-barrier marsh deposits that are overlain by the active, transgressive barrier sands. These sands form a thin washover veneer in the central islands, but thicken at both the tidal inlet areas and the recurved spits on the western and eastern ends of the island chain.

The central part of the study area consists of an erosive headland and flanking barriers of the Bayou Lafourche delta lobe of the Lafourche delta complex, abandoned about 300 years B.P. (Penland and others, 1986a). This system, a stage 1 example (see fig. 4), is similar in cross section to the Isles Dernieres, and has a headland composed of prodelta muds and beach ridge sands, as shown in figure 8. These sediments are overlain by thin transgressive sands in the central headland, which thicken greatly under the flanking barrier islands toward the west at Timbalier and East Timbalier Islands and toward the east at Grand Isle.

Over the last 100 years, the central Bayou Lafourche shoreline has experienced some of the highest erosion rates in the study area, with up to 2 km of shoreline erosion (see p. 63 and 67). The flanking barrier islands on the west side of the Bayou Lafourche headland, including Timbalier and East Timbalier Islands, have also undergone extensive changes (see p. 62 and 66). East Timbalier Island retreated landward at a higher rate than the headland, until engineering protection of the shoreline began in the late 1950's. Timbalier Island has migrated rapidly to the west through spit growth, while at the same time the eastern end of the island has eroded, resulting in an overall westward translation of the island by about 8 km. By comparison, the eastern flanking barrier, Grand Isle, has been fairly stable over the last 100 years.

The remainder of the study area, east of the Bayou Lafourche shoreline, is described as the Plaquemines shoreline (fig. 5) after the Plaquemines distributary network of the Holocene delta complex, of which the present-day Mississippi delta is a part. This area consists of several small deltaic headlands with flanking barrier islands in various states of development. The largest barrier consists of the Grand Terre Islands (p. 72, 76, and 80), which formed from westward littoral drift from the erosion of the Bayou Robinson and Grand Bayou headlands following abandonment about 400 years B.P. (Penland and others, 1988).

A much more detailed description of the geologic framework and recent morphologic evolution of the Louisiana barrier islands can be found in Williams and others (1992).

The barrier islands in the study area enclose several large and many small bays. Tidal inlets to these bays have developed between barrier islands from adjacent headlands, as well as through numerous storm-induced breaches in the barriers. Although the tidal regime can be classified as microtidal (mean diurnal range of about 0.4 m [National Ocean Service, 1987]), the large and rapidly expanding bays (expanding through wetlands loss) and corresponding increase in tidal prism have produced large ebb-tidal deltas (Howard, 1983; Shamban and Moslow, 1991). For a coastal system that is generally sand deficient, these ebb-tidal deltas have a large sand-storage capacity.

In addition to tides, other important sources of energy for reshaping the coast include waves, storm surges, and non-tidal coastal currents (Boyd and Penland, 1981; Roberts and others, 1987). Although the modal wave height in the region is only 1 m, with a 5- to 6-second period (Boyd and Penland, 1984), larger waves and currents from cold fronts, hurricanes, and extra-tropical storms have major impacts on the morphologic development of the area (Debusschere and others, 1991). Storms also generate a superelevation of water levels which may far exceed the astronomical tide even during minor events (Ritchie and Penland, 1988). The surge associated with hurricanes may inundate large parts of the study area, and, in conjunction with associated waves and currents, may produce very rapid changes in coastal morphology (Penland and others, 1989b).

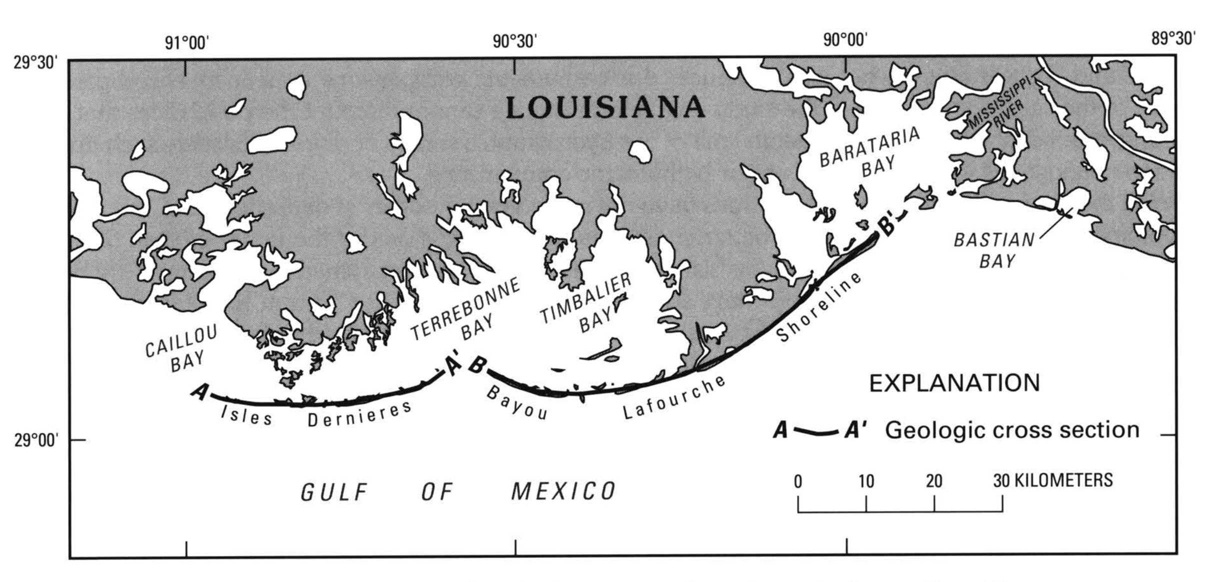

Figure 6—Location of geologic cross sections shown in figures 7 and 8.

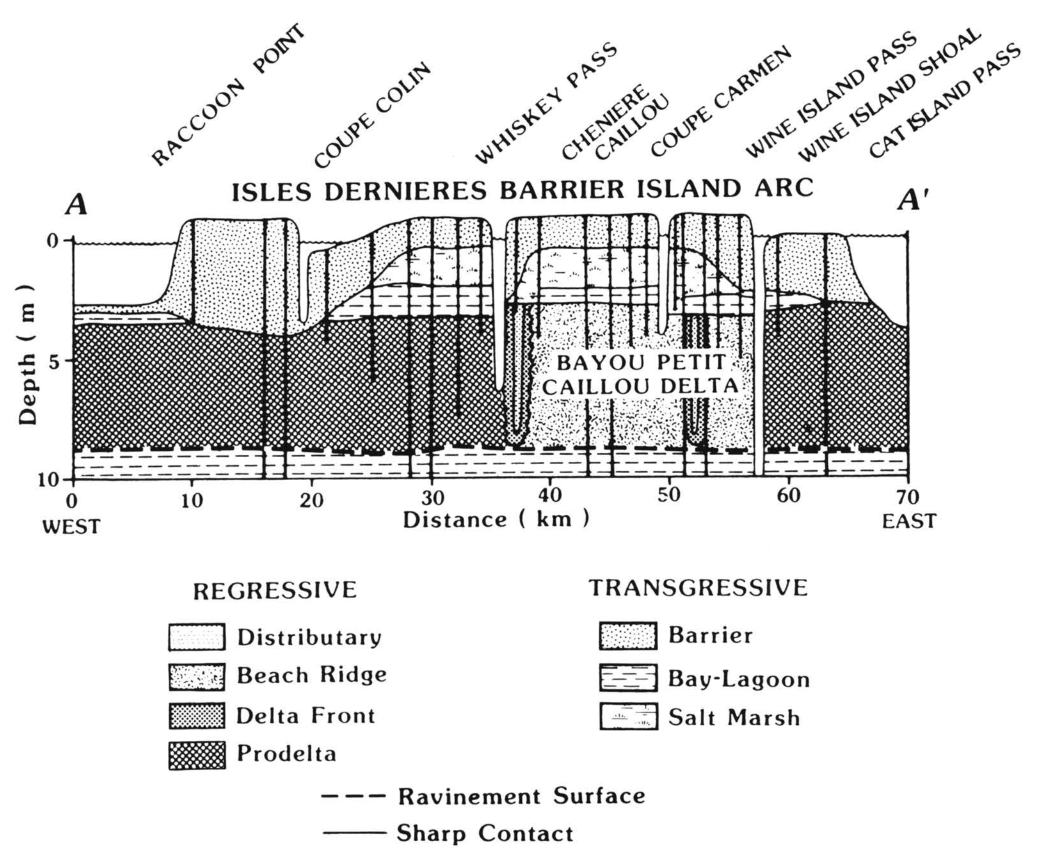

Figure 7—Geologic cross section A–A′, extending along the strike of the Isles Dernieres barrier-island chain. Location shown in figure 6. Reprinted from Penland and others (1988, p. 938) and published with permission.

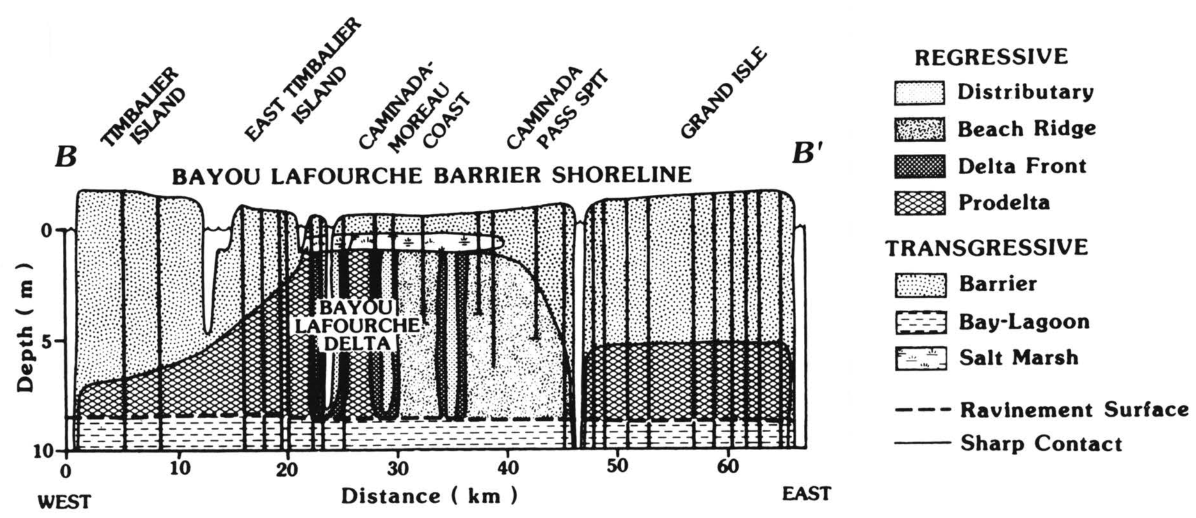

Figure 8—Geologic cross section B–B′, extending along the strike of the Bayou Lafourche shoreline. Location shown in figure 6. Reprinted from Penland and others (1988, p. 936) and published with permission.

Regional Sea-floor Changes

In this section, sea-floor changes are described and interpreted within each of the four regional areas: Isles Dernieres, Cat Island Pass, Bayou Lafourche, and Barataria. Reference will be made primarily to the 1:100,000-scale maps showing sea-floor change, for which geographic place names are shown on the 1:100,000-scale bathymetric maps preceding and following each sea-floor change map. Additional reference is made to the bathymetric profiles and to the 1:250,000-scale sea-floor change maps for volumetric information.

Isles Dernieres

Several large-scale features characterize sea-floor changes within the Isles Dernieres region. At a distance of about 15 km offshore from the islands, the large sand body known as Ship Shoal has experienced erosion on its seaward side and deposition on the landward side. This is shown most clearly in the 1930's to 1980's comparison on pages 42 and 43, and bathymetric profile A–A′ on page 28. Volumetric calculations on page 22 show that between the 1930's and 1980's, 62.1×10^6 m^3 of sediment were removed from the seaward-sloping side of the shoal (area 1a) and 43.3×10^6 m^3 were deposited on the landward-sloping side of the shoal (area 1b). Within the error inherent in these two estimates (table 3), these values indicate a materials balance between erosion and accretion. This suggests that Ship Shoal is acting as a massive sand bar that is migrating landward under the action of waves and currents. The profiles on page 28 do show, however, that the shoal crest is not accreting vertically; as the water depth over the shoal increases with relative sea-level rise, the rate of landward migration is likely to decrease due to a reduction in the intensity of wave action at the seabed.

The Isles Dernieres barrier island chain has also experienced major changes over the last 100 years. The island morphology has evolved from one, nearly continuous barrier in the 1880's (p. 36–37) to a series of four islands separated by inlets varying from 400 m to 6 km wide in the 1980's (p. 44–45; see also McBride and others, 1991a). Concurrent with this inlet breaching and expansion process, the Gulf shoreline, nearshore zone, and shoreface have retreated over 1,000 m during the last 100 years. (Here the nearshore zone is defined as the region of breaking waves, and the shoreface is roughly defined as the region seaward of the nearshore zone, out to the limit of wave-induced sediment transport.) This retreat is reflected in the sea-floor change maps by a continuous zone of erosion along the Gulf shoreline in the 1880's–1930's comparison (p. 38–39), and by an inlet-interrupted zone of erosion in the 1930's–1980's comparison (p. 42–43). Unlike the sandy Ship Shoal system, the Isles Dernieres system does not show volumes of sediment deposited on the landward side that are comparable to the volume eroded from the Gulf side. In the 1880's–1930's comparison, approximately 44.7×10^6 m^3 were eroded from the shoreface (p. 18, areas 4a, 6a, and 8a), while only about 13.2×10^6 m^3 can be identified in bayside and spit deposits (p. 18, areas 4b and 6b). In the 1930's–1980's comparison, 42.6×10^6 m^3 were eroded from the shoreface (p. 22, areas 4a, 5a, and 6a), while only 10.4×10^6 m^3 can be identified in bayside and spit deposits (p. 22, areas 4b, 5b, and 6b).

This discrepancy between eroded and accreted volumes can be explained by the relatively small percentage of sand present in the deposits composing the eroding shoreface. Core logs and stratigraphic interpretations (fig. 7) suggest that only about 30 percent of the eroding shoreface sediments are of sand size. The silt- and mud-size fractions are likely to be widely dispersed along the coast, offshore, and into the marshes, with only the sand-size material transported through overwash, inlet processes, and spit accretion into concentrated deposits that can be identified through these bathymetric comparisons.

One apparent result of this paucity of sand-size sediment in the Isles Dernieres arc is that only very small parts of the islands are migrating landward through overwash of sand into the shallow bayside waters. Along the majority of the Isles Dernieres, overwash, in the form of a thin veneer of sand, extends only a short distance landward into the marshes that compose the majority of the islands' surface area (Dingler and Reiss, 1990). In most cases where Gulf-side erosion has intersected the bayside marsh shoreline, the barrier has disappeared due to a shortfall of sand necessary to maintain the islands' height above the bottom of the bay.

As a result, the Isles Dernieres are narrowing as the inlets widen. Concurrently, subaqueous deposits of sand are accumulating, such as in areas 4b and 6b on page 18 and areas 4b and 5b on page 22. Thus there is some indication that the Isles Dernieres are evolving toward a stage-3 sand shoal within the context of the barrier-island evolution model shown in figure 4 (Penland and others, 1988). However, erosion of the Isles Dernieres is likely to result in a subaqueous sand body having at least an order of magnitude less sand than Ship Shoal.

Cat Island Pass

The Cat Island Pass map sheets, pages 48–57, highlight changes to Cat Island and Wine Island Passes, as well as the redistribution of sediment between the Bayou Lafourche area to the east and the Isles Dernieres area to the west. Strongly influencing most features in the Cat Island Pass area is the predominant westward transport of sediment. This is manifest by bathymetric changes along both the nearshore path of longshore transport and at greater depths along the shoreface.

In the nearshore zone, Timbalier Island has migrated westward nearly 8 km over the last 100 years through updrift erosion and downdrift spit accretion. As a result of this island migration, Caillou Pass (p. 49) has been infilled and deactivated while Cat Island Pass has migrated 3 km west through the deposition of sediment into the channel at the west end of Timbalier Island. Volumetrically, this westward transport delivered 60.9×10^6 m^3 of sediment between the 1880's and 1930's (areas 15b, 18b, and 19, p. 18), and 34.0×10^6 m^3 between the 1930's and 1980's (areas 10b and 14b, p. 22). The reason for this significant decrease in transport between these two time periods is unclear, but it may relate to a natural shift in the transport pathway to an offshore location, as described below.

Sea-floor change maps also document a significant westward transport of sediment at shoreface depths. As described by Jaffe and others (1989), this transport takes the form of unusual lobes of deposition. These lobes emanate in shallow water from erosional areas to the east, and extend directly west, cutting across bathymetric contours that curve north toward Cat Island Pass. In the 1880's–1930's comparison two small lobes are evident, having volumes of 3.0×10^6 m^3 and 6.6×10^6 m^3, respectively (areas 20 and 21, p. 18). In the 1930's–1980's comparison, these small lobes are replaced by a single, massive band of deposition that follows the 4–6 m depth contours from the eastern end of Timbalier Island to the eastern end of the Isles Dernieres chain. This lobe contains 59.6×10^6 m^3 of sediment (area 12, p. 22), surpassing the volume of sediment transported along the nearshore zone of Timbalier Island as described above.

The mechanism by which these depositional lobes are formed is unknown. Examination of sediment cores collected by the Louisiana Geological Survey (Suter and Penland, 1987) shows an interbedding of sand and mud in the sediments composing the eastern end of the 1930's–1980's lobe, suggesting an episodic, perhaps storm-related, origin. Cores through the western part of the 1930's–1980's lobe, however, generally show clean, massive sands, which suggest this area is influenced by ebb-tidal delta processes associated with Wine Island and Cat Island Passes. Although patterns of erosion and accretion associated with the westward migration of Cat Island Pass clearly show that sediments in this area are being modified by inlet processes, the surplus sediment must originate from erosional areas to the east; local erosional sources (for example, Cat Island Pass) are insufficient to account for the volume of sediment deposited.

At least two transport pathways are potential candidates for delivering sediment to the western part of the 1930's–1980's depositional lobe. Sand may be transported west by the same, poorly understood process responsible for emplacement of the eastern part of the lobe. Alternatively, sand may be derived from littoral transport along Timbalier Island, emplacement in Cat Island Pass, and offshore transport by ebb currents.

Regardless of the mechanism by which sand is reaching the western part of the 1930's–1980's depositional lobe, the development of this lobe has resulted in sand bypassing Cat Island and Wine Island Passes. Jaffe and others (1989) have suggested that this has resulted in reduced erosion rates along East Island, the easternmost island of the Isles Dernieres chain.

Bayou Lafourche

Eastward, in the Bayou Lafourche region (p. 60–69), erosional and depositional patterns assume a much larger scale. The dominant feature in this area is the massive erosion of the Bayou Lafourche shoreface from the eastern end of Timbalier Island to Caminada Pass. This erosion extends to at least the 13-m depth contour offshore, and reaches a maximum of over 6 m of vertical change seaward of Bay Champagne. In the 1880's–1930's comparison, 439.4×10^6 m^3 of sediment were eroded (area 25.1, p. 18; and area 25.2, p. 19). Similarly, in the 1930's–1980's comparison, 461.3×10^6 m^3 of sediment were eroded (areas 17 and 19.1, p. 22; and area 19.2, p. 23). Profiles J–J′ through N–N′ (p. 30–31) document the rapid erosion of this shoreface and the concurrent extreme rates of shoreline retreat—nearly 30 m/yr in some areas.

Patterns of accretion suggest several pathways of sediment transport away from this rapidly eroding headland. Farthest west are the depositional features that were described in the Cat Island Pass section above. These suggest westward transport in both the littoral zone along Timbalier Island and at shoreface depth seaward of Timbalier Island.

Landward of a line connecting Little Pass Timbalier and Belle Pass lies another depositional region; this is associated with the landward migration of both East Timbalier Island and the spit extending west from Belle Pass. In the 1880's–1930's comparison, this deposition totaled 59.4×10^6 m^3 (area 23.1, p. 18; and area 23.2, p. 19), while in the 1930's–1980's comparison only 24.5×10^6 m^3 were observed (areas 16 and 18.1, p. 22; and area 18.2, p. 23). Concurrent with the marked decrease in the amount of deposition between these two time periods, the rate of retreat of East Timbalier Island decreased from over 30 m/yr between the 1880's and 1930's to a nearly negligible rate between the 1930's and 1980's. Much of this apparent stabilization is likely due to the emplacement of a rubble-mound seawall along the entire length of East Timbalier Island (p. 68) starting in the late 1950's (Mossa and others, 1985). Although the shoreface in front of the seawall continued to erode and steepen (profile K–K′, p. 30), the onshore migration of sediments and of the island itself were much less in the 1930's–1980's comparison than in the 1880's–1930's comparison (compare p. 62 and 66).

Another area of deposition derived at least in part from the erosion of the Bayou Lafourche headland is located to the east, on the shoreface between Caminada and Quatre Bayoux Passes. This depositional region is described below.

Barataria

The changes within the Barataria region, pages 72–81, are dominated by one very large-scale pattern: erosion of headland areas and deposition on the shoreface adjacent to tidal inlets connecting the Gulf of Mexico to Barataria Bay. These headlands include the Bayou Lafourche headland to the west, described above, and the coast between Quatre Bayoux Pass and Bay Coquette to the east.

The depositional area that lies offshore from the inlets connecting Barataria Bay to the Gulf of Mexico (area 30, p. 19 for the 1880's–1930's comparison and area 24, p. 23 for the 1930's–1980's comparison) contains the largest volume of deposited sediment in the study area (147.4×10^6 m^3 for the earlier period and 112.0×10^6 m^3 for the latter period). In the 1930's–1980's comparison, this depositional body is spatially coincident, roughly, with what appear to be a series of large, coalesced ebb-tidal deltas between Barataria and Quatre Bayoux Passes (compare p. 23 and 25; also compare p. 78 and 80). List and others (1991) investigated the volume of sediment stored in these ebb-tidal deltas using the method of Dean and Walton (1975). They found that changes in ebb-tidal delta volume over the last 100 years closely correspond with changes in the Barataria Bay tidal prism (fig. 9), according to the empirically derived relation of Walton and Adams (1976).

Despite this evidence that depositional area 24 (p. 23) lies within the region of ebb-tidal deltas in equilibrium with the local tidal prism, visual estimates of grain size from sediment cores taken by the Louisiana Geological Survey preliminarily indicate that this deposit may contain only a small fraction of sand, being composed mostly of silt- and clay-size material. Although additional cores are needed and more sand may be present than is discernible from a visual estimate, we infer that the depositional processes within area 24 are different from those generally assumed for sandy coast systems in which sand is cycled between the ebb-tidal delta and littoral zone by a combination of wave-induced and tidal currents (see Oertel, 1988).

The deposition seaward of the Barataria Bay inlets is thus one of the interesting enigmas of this study. Volumetrically, the material could have been derived from the massive erosion of adjacent headlands, although no mechanism, even of a conceptual nature, is known by which such fine material could have been eroded from these headlands and deposited in the ebb-tidal delta region. Another potential source, the erosion of adjacent shorelines and the deepening of nearby inlet channels, must be largely discounted due to the lack of a sufficient volume of sediment (in the 1930's–1980's comparison, for example, a total of only 23.5×10^6 m^3 was eroded from areas 21, 23, 25, 27a, and 28, p. 23). Another source may be fine sediment flushed from Barataria Bay on the ebb-tidal flow. However, this assumes a net export of sediment from Barataria Bay, and, again, a mechanism by which such fine sediment could be deposited in the form of an ebb-tidal delta. Clearly, research is needed on the transport and deposition of fine-grained sediment in this area.

Large-scale Coastal Evolution

At the largest scale, the sea-floor change patterns suggest a redistribution of sediment through a simple coastal straightening process: headlands are eroding and relative embayments are the loci of deposition (p. 22 and 23). However, traditional littoral processes—whereby wave energy is focused on headlands and breaking waves drive a sediment transport gradient toward the embayments—are hard to evoke as the responsible mechanism. Bathymetric comparisons suggest that the bulk of the transport has occurred in water depths greater than usually influenced by breaking waves (greater than 4–7 m here). Another set of processes, working at shoreface depths and resulting in a net transport gradient over long spatial and temporal scales, must be active.

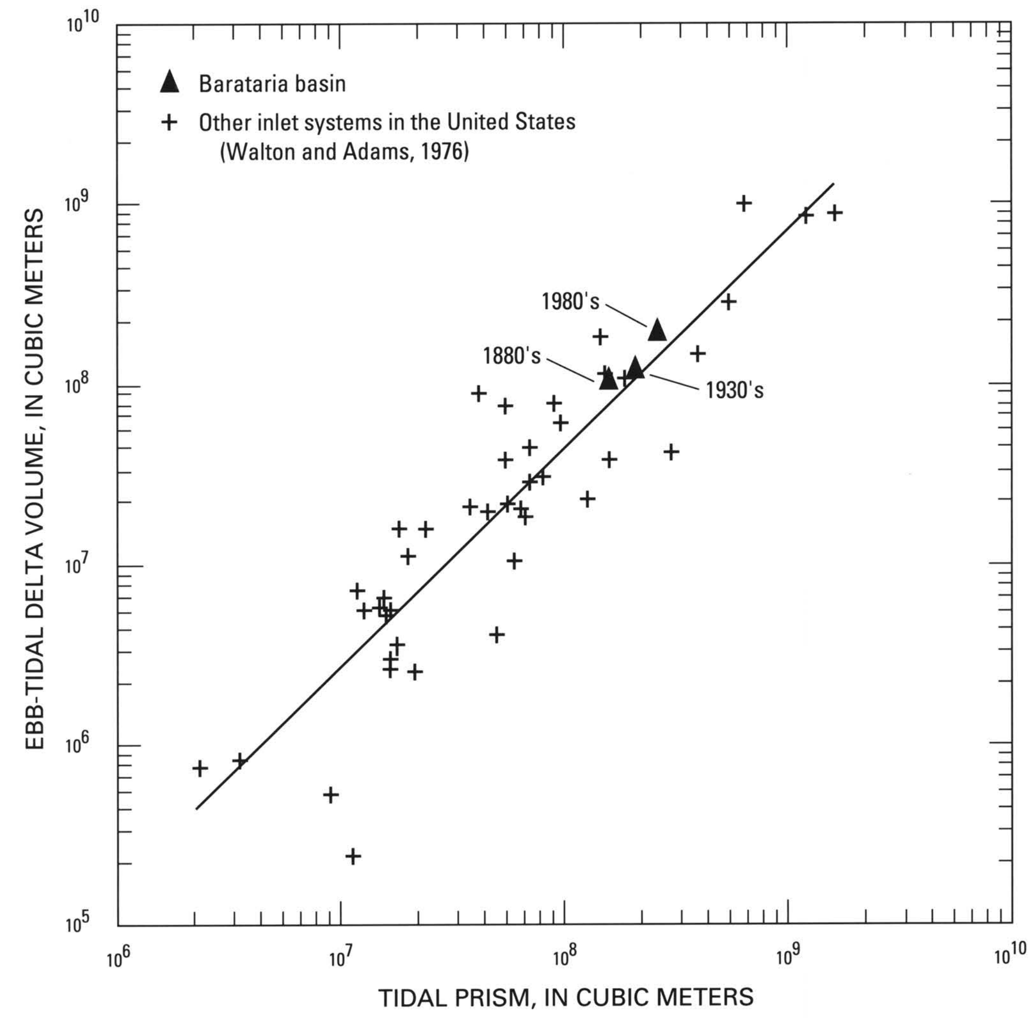

Figure 9—Ebb-tidal delta volume versus tidal prism for Barataria basin and other inlet systems in the United States.

It is clear that a greatly improved knowledge of processes at shoreface depths is required to make accurate long-term predictions of the study area's coastal changes. However, by considering the region's evolution in terms of several simpler approaches, the bathymetric comparisons may be used to further our understanding of the region's long-term evolution. These approaches, based on geomorphology and the sediment budget, are considered below.

Geomorphic Approach

In the section on the geologic and physical setting above, the study area is described in terms of a three-stage model of barrier island evolution following abandonment of Mississippi delta lobes (Penland and others, 1988; fig. 4 here). The sea-floor change results support this model in some areas, but suggest modifications in others.

The Isles Dernieres barrier-island chain is a clear stage-2 example—a barrier island that has become separated from its headland by a widening bay. The Isles Dernieres also show signs of a transition to a stage-3 inner-shelf shoal; large sections of island are converting to sandy, subaqueous shoals. However, as described previously, future erosion is likely to result in a shoal containing at least an order of magnitude less sand than Ship Shoal, which is thought to be classic example of a stage-3 inner-shelf shoal. In fact, given the very small volume in the sand deposits associated with the erosion of the Isles Dernieres, it is doubtful that these islands will ever transform to a continuous and active sand shoal similar to Ship Shoal. Whether this implies an origin for Ship Shoal that is different from the submergence of a barrier island or perhaps a much more sand-rich source during the deposition of the Maringouin/Teche delta complex is unclear.

Toward the east, the Bayou Lafourche headland and flanking barrier islands (Timbalier and East Timbalier to the west and Grand Isle to the east) are a stage-1 example. Interestingly, between the 1880's–1930's and 1930's–1980's comparisons a shift occurred from deposition of eroding headland sediments along flanking barrier islands (0–2 m water depth) to deposition of sediments on the shoreface (4–7 m water depth). Also, as shown on pages 22 and 23, much of the shoreface erosion is now along sections of coast that were once actively developing barriers. Thus the process by which flanking barrier islands develop seems to be reaching a near-terminal stage. Concurrently, expanding inland lakes and bayous (p. 69) suggest that the Bayou Lafourche headland may be evolving to a stage-2 detached barrier island system.

As mentioned above, sediment transport at shoreface depths appears to be a mechanism by which sand from the eroding Bayou Lafourche headland is bypassing Cat Island and Wine Island Passes and nourishing the eastern part of the Isles Dernieres arc (p. 54). If this continues, the volume of sand within the Isles Dernieres system may greatly increase, improving the chance it will eventually be transformed into a sandy shoal resembling Ship Shoal. Conversely, the removal of sand from the Bayou Lafourche headland and flanking barrier islands may decrease the chance that this area east of the Isles Dernieres will evolve toward the sand shoal stage.

In the far eastern part of the study area, the geomorphology is harder to fit into the framework of the idealized three-stage barrier-evolution model, due to the complexity of the multiple abandoned deltaic lobes composing the area. However, along the stretch of coast between Bastian Bay and Bay Coquette (p. 81), barrier islands have become detached from adjacent marshlands in only the last 100 years. Sea-floor change maps show that this area has the character of a rapidly eroding headland similar to the Bayou Lafourche headland. Thus this appears to be a good example of a stage-1 headland that has very recently evolved to a stage-2 series of barrier islands. Again, the volume of sand stored in these barrier islands is small; a terminal stage-3 sand body, if formed, would contain at least an order of magnitude less sand than Ship Shoal.

Sediment Budget Approach

The sea-floor change data presented in this atlas are well suited for examining coastal evolution in terms of the balance or budget of eroding and accreting sediments. Overall, we observed only 35 percent as much deposition (293×10^6 m^3) as erosion (834×10^6 m^3) throughout the study area in the 1930's–1980's comparison. However, sediment cores suggest that only about 31 percent of the eroding sediment was of sand size, whereas most of the deposited sediment is sand size except for the material deposited in area 24 (p. 23). Estimating (roughly) that deposition in area 24 was 20 percent sand whereas other depositional bodies were 100 percent sand, there was a net sand deposition of 203.8×10^6 m^3 versus a net erosion of 258.5×10^6 m^3 (31 percent of total erosional volume). Within the error estimated for volumetric calculations (tables 2 and 3), this gives a net sand balance; our bathymetric comparisons appear to encompass the majority of the sea-floor changes in the study area. However, we cannot discount the possibilities that sand was transported offshore beyond the depth limit of our hydrographic survey or dispersed widely such that the elevation change was within the error of our bathymetric comparisons.

With the assumption that our comparisons have not missed major bodies of deposited sand, the patterns and volumes of deposits can be used to better understand and perhaps predict the future erosion of certain coastal reaches. This approach was taken by List and others (1991), who examined the erosion of the Bayou Lafourche shoreline in terms of an equilibrium shoreface profile following the "Bruun Rule" (Bruun, 1962) and a modified Bruun Rule (Everts, 1985). In summary, the Bruun Rule states that if the shoreface profile retains the same form (the equilibrium assumption) during shoreline retreat (as in profile M–M′, p. 31), and if the profile maintains a constant elevation in relation to a rising sea level, then the rate of shoreline retreat can be predicted from the sea-level rise during a certain time period.

For the Bayou Lafourche shoreline, List and others (1991) showed that despite an extremely high rate of relative sea-level rise in the study area (approximately 1 cm/yr; Ramsey and Moslow, 1987), only about one-third of the observed shoreline retreat was directly attributable to sea-level rise. The difference could be made up by accounting for the sediment removed in the longshore direction as determined through our sediment budget analysis.

The equilibrium profile approach of hindcasting shoreline erosion works well in other highly erosive headland areas, such as along the Isles Dernieres, but does not work where deposition occurs on the shoreface, such as between Grand Isle and Quatre Bayoux Pass. In these areas, where the shoreface is being nourished and yet the shoreline is still eroding, the equilibrium assumption fails. Clearly a more process-based approach will be required to hindcast shoreline erosion in these areas.

Predictions of shoreline erosion with changing future conditions can also be made for headland areas using the equilibrium approach. List and others (1991) predict that a 100 percent increase in the relative sea-level rise along the Bayou Lafourche headland would increase the shoreline erosion by only about 35 percent. However, this prediction assumes that the rate of longshore sand removal from the headland will remain constant under the scenario of a doubled sea-level-rise rate, which currently cannot be verified.

Conclusions

Historical sea-floor comparisons have led to results that could not have been anticipated from an examination of shoreline changes alone. Although the rapid relative sea-level rise experienced by the region is a contributing factor, it has been shown that much of the coastal retreat is driven by the redistribution of sand in the longshore direction. Overall, there is a large-scale pattern of headland erosion and embayment deposition. While this fits, in general, a simple model of littoral-drift-induced coastal straightening, the bulk of the transport has occurred at shoreface depths, deeper than normally assumed for breaking-wave processes. The responsible shoreface-depth transport processes are poorly defined, but appear to be of primary importance in controlling the long-term coastal evolution. Predictions of future coastal changes, whether based on geomorphic, sediment budget, or processes approaches, must account for this redistribution of sediment.

The sediment budget results suggest a balance of sand-size material, that is, no net loss within the area of our bathymetric comparisons. However, the small amount of sand that is liberated by erosion of muddy headlands is deposited mostly in areas where it cannot protect these headlands, or flanking barrier islands, from further erosion. One exception to this, and possibly the only positive note along this coast, is that sand eroding from the Bayou Lafourche headland now appears to be nourishing the eastern part of the Isles Dernieres. Still, the overall result is continued rapid erosion of headland areas.

Thus the sea-floor comparisons do not support much optimism for the future of Louisiana's barrier island coast. Areas having rapidly retreating shorelines, such as along the Bayou Lafourche headland, show massive shoreface erosion that has been occurring since at least the late 1800's. This long-term continuity of change indicates a cause rooted in natural processes and implies that similarly massive erosion will be experienced in the future.

One goal of the Louisiana Barrier Island Erosion Study was to provide coastal engineers and planners with the information needed to make better decisions regarding erosion mitigation and management. It is hoped that the sea-floor change maps and volumetric information presented here will have this effect. Although ultimately an improved understanding of processes will provide the most reliable information, the analysis of historical sea-floor changes is an important first step toward understanding the natural system and determining the feasibility of any human attempts to modify it.

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List, J.H., Jaffe, B.E., Sallenger, A.H., Jr., Williams, S.J., McBride, R.A., and Penland, Shea, 1994, Louisiana Barrier Island Erosion Study: Atlas of sea-floor changes from 1878 to 1989: U.S. Geological Survey Miscellaneous Investigations Series I–2150–B, 82 p., scale 1:250,000 and 1:100,000.

STUDY AREA OVERVIEWS
1:250,000-SCALE MAPS

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

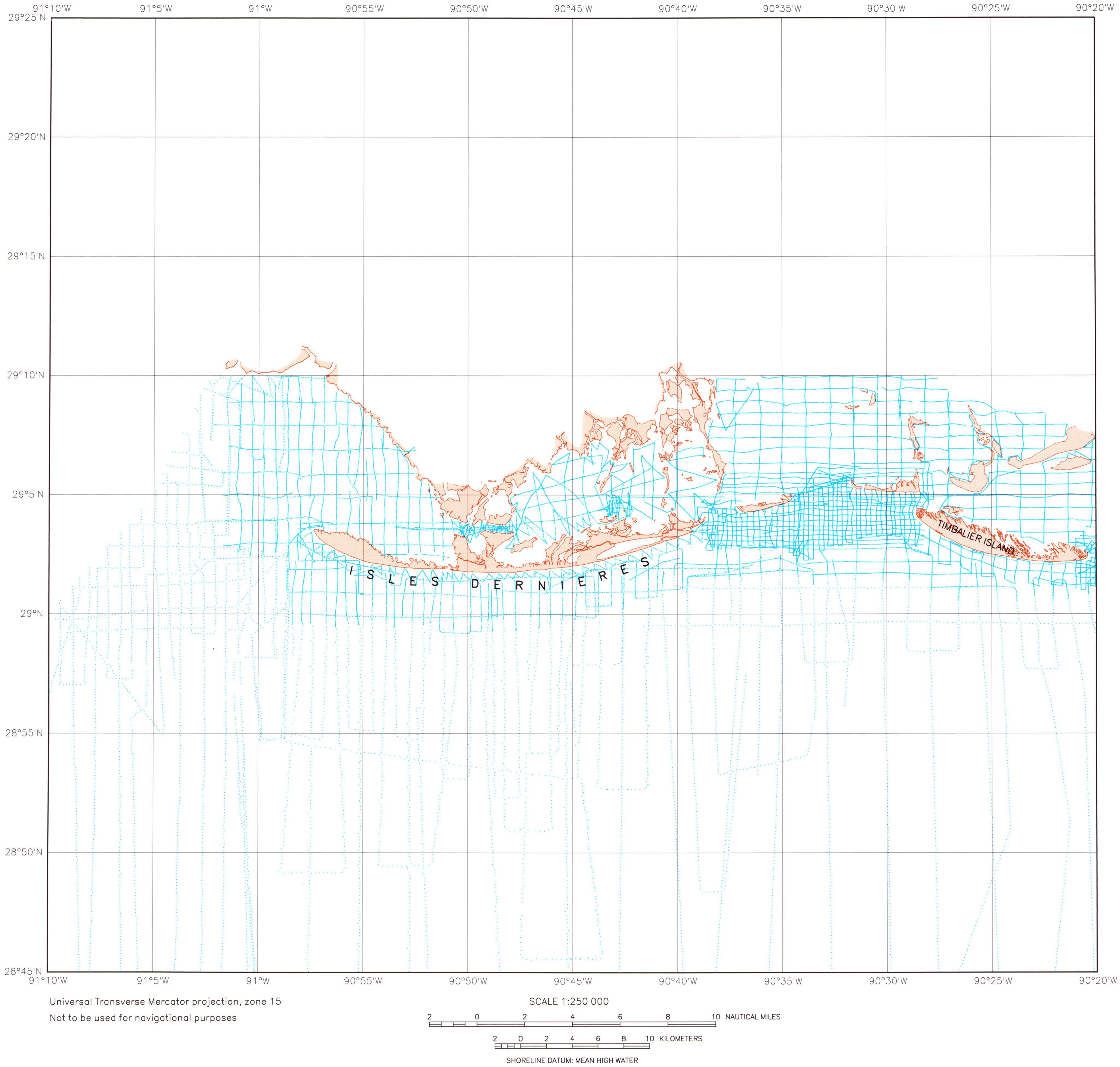
Bathymetric Data

The points on this page represent the locations of the depth soundings used to construct the 1880's bathymetric contour maps shown in the atlas. The 37,024 soundings on this page were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic smooth sheets from the years 1888, 1889, 1891, and 1906. The 1906 survey covered a small area behind the eastern part of Isles Dernieres, which had been missed during the 1888, 1889, and 1891 surveys. Horizontal positioning for the soundings on these charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

These soundings were reduced to a mean low water (MLW) datum by applying sea-level corrections obtained from tide stations deployed solely for the hydrographic surveys. The MLW datum was derived from these temporary tide stations during a period of several months prior to each survey. Thus the 1880's MLW datum is only an approximation of the true MLW datum for that time period. There is also some evidence that the MLW datum may vary between different surveys included in the 1880's data.

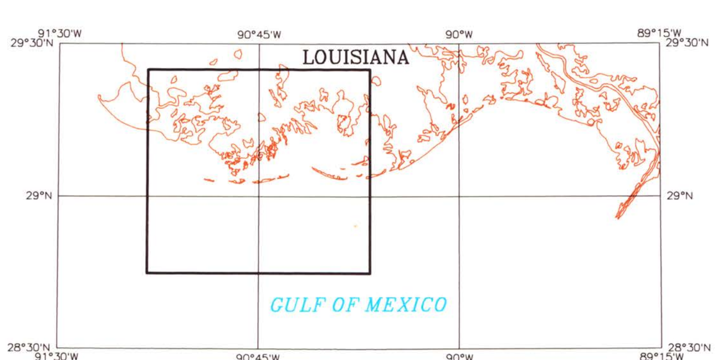
Shoreline Data

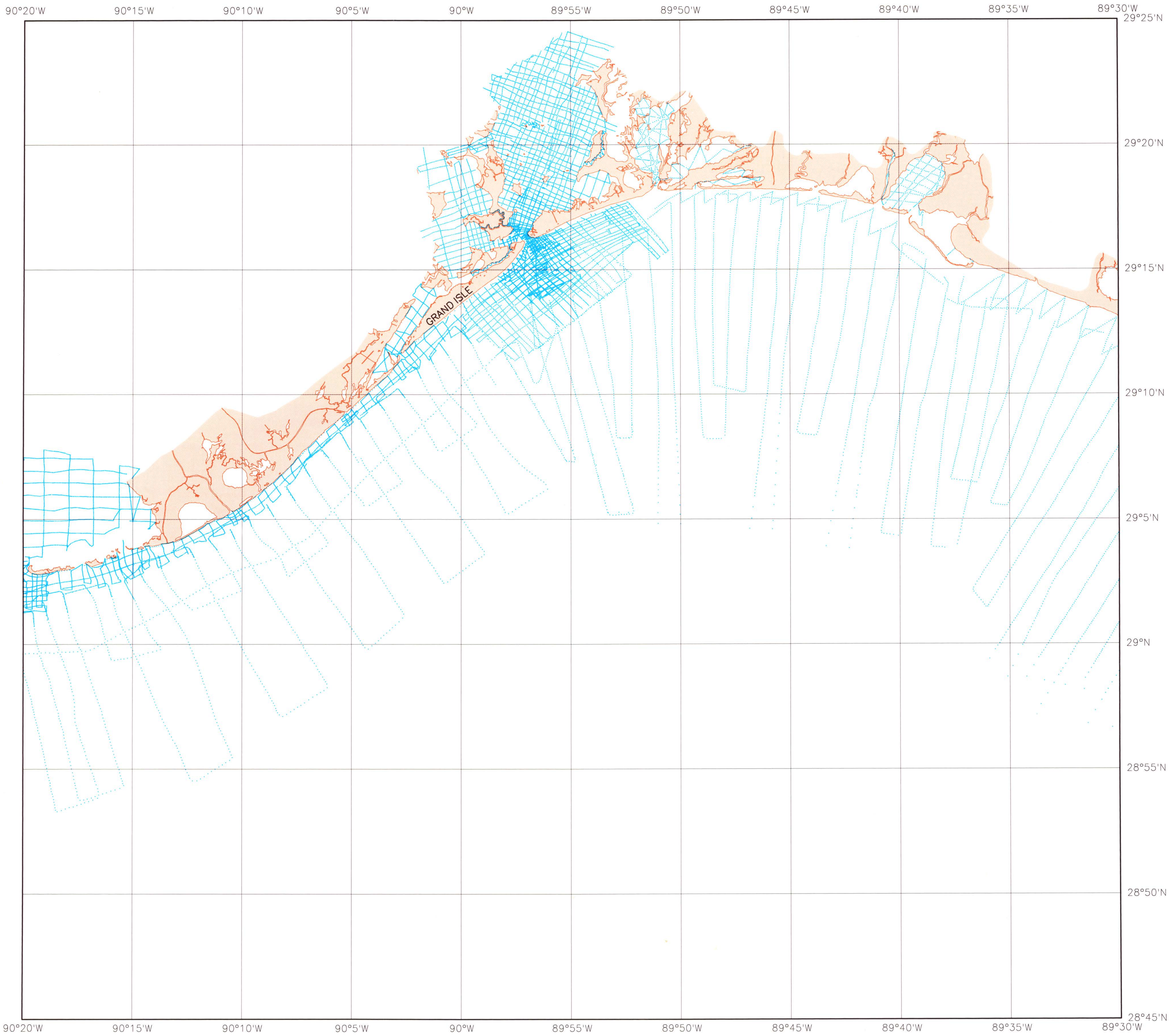
Shoreline data on this map were digitized from USCGS topographic sheets from the years 1886, 1887, and 1906. The 1906 data include back-barrier and mainland shorelines behind the eastern end of Isles Dernieres; these shorelines were not covered during the 1886 and 1887 surveys. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, or about 0.5 m above the MLW datum of the bathymetric data.



STUDY AREA WEST SOUNDING LOCATIONS, 1880's

INDEX MAP





SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

2 0 2 4 6 8 10 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

STUDY AREA EAST SOUNDING LOCATIONS, 1880's

Bathymetric Data

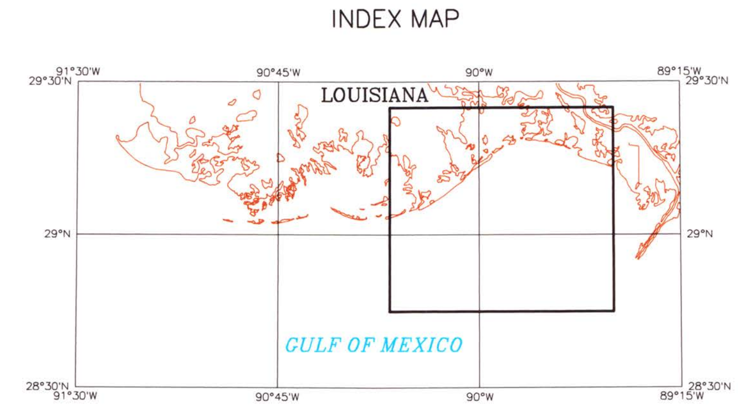
The points on this page represent the locations of the depth soundings used to construct the 1880's bathymetric contour maps shown in the atlas. The 26,885 soundings on this page were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic smooth sheets from the years 1878, 1883, 1886, and 1891. Horizontal positioning for the soundings on these charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

These soundings were reduced to a mean low water (MLW) datum by applying sea–level corrections obtained from tide stations deployed solely for the hydrographic surveys. The MLW datum was derived from these temporary tide stations during a period of several months prior to each survey. Thus the 1880's MLW datum is only an approximation of the true MLW datum for that time period. There is also some evidence that the MLW datum may vary between different surveys included in the 1880's data.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1883, 1884, 1886, and 1887. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, or about 0.5 m above the MLW datum of the bathymetric data.

INDEX MAP



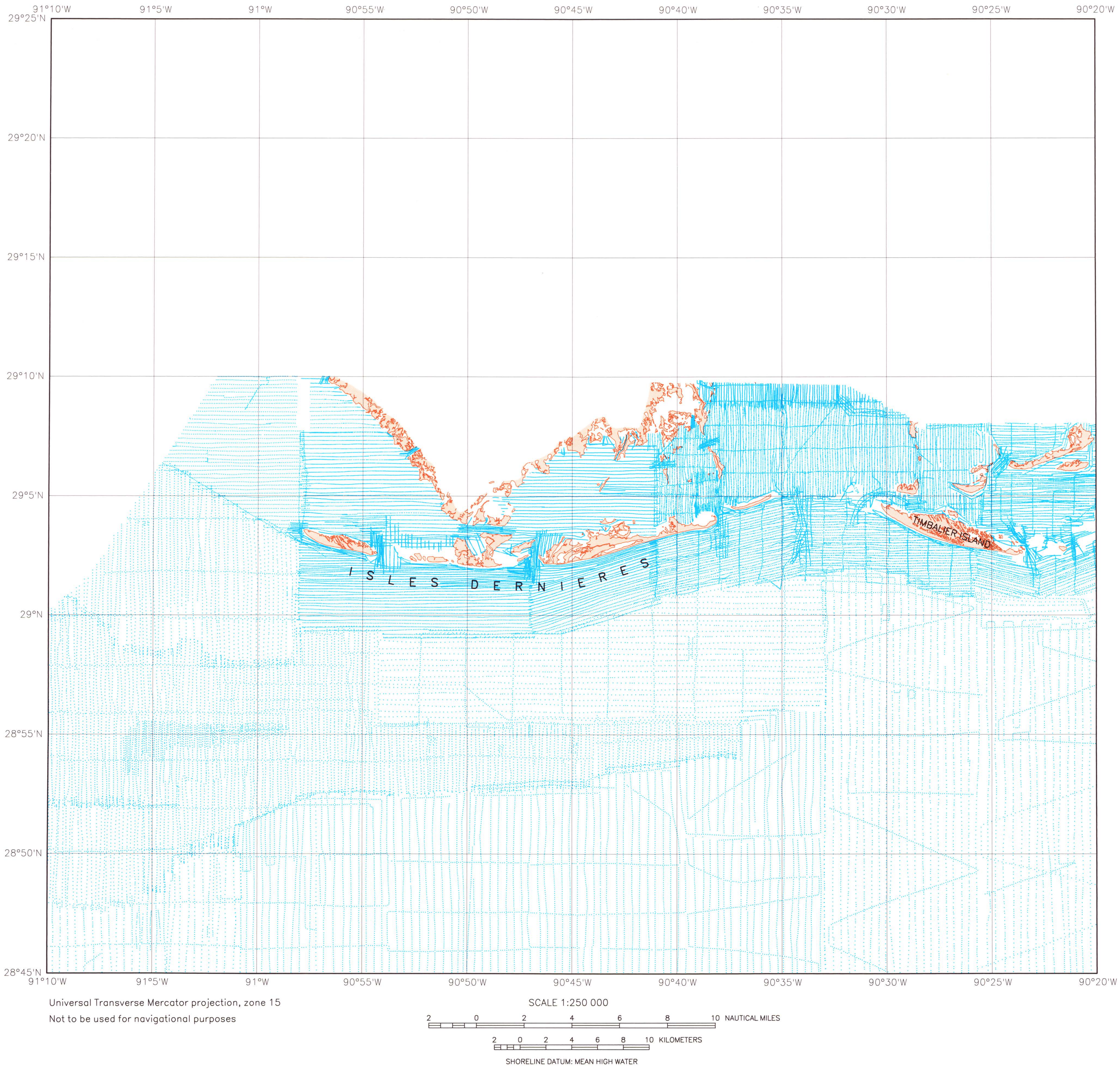
Bathymetric Data

The points on this page represent the locations of the depth soundings used to construct the 1930's bathymetric contour maps shown in the atlas. The 188,932 soundings on this page were obtained in digital form from the National Geophysical Data Center in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the National Ocean Service of the National Oceanic and Atmospheric Administration from U.S. Coast and Geodetic Survey (USCGS) hydrographic smooth sheets from the years 1934, 1935, and 1936. Horizontal positioning for the soundings on these charts was accomplished with radio acoustic ranging (RAR), which involved the deployment of a series of radio sonu−buoys throughout the study area. Depths were measured with precision fathometers utilizing newly developed echo−sounding technology. Both the RAR and echo−sounding methods had only recently been employed by the USCGS, following advances in acoustic instrumentation stimulated by World War I.

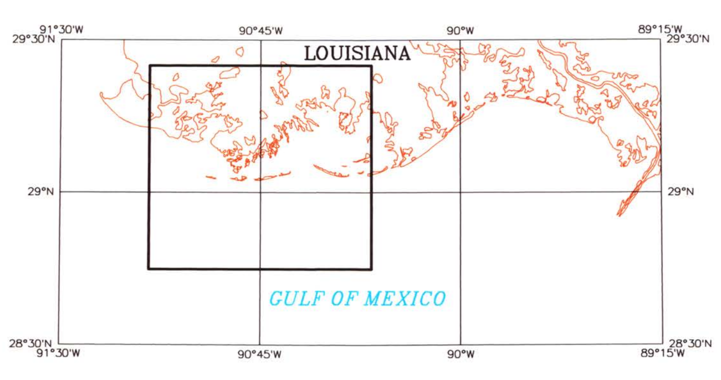
These soundings were reduced to a mean low water (MLW) datum by applying sea−level corrections obtained from tide stations deployed solely for the 1930's surveys. The MLW datum was derived from these temporary tide stations during a period of several months prior to the surveys. Thus the 1930's MLW datum is only an approximation of the true MLW datum for that time period.

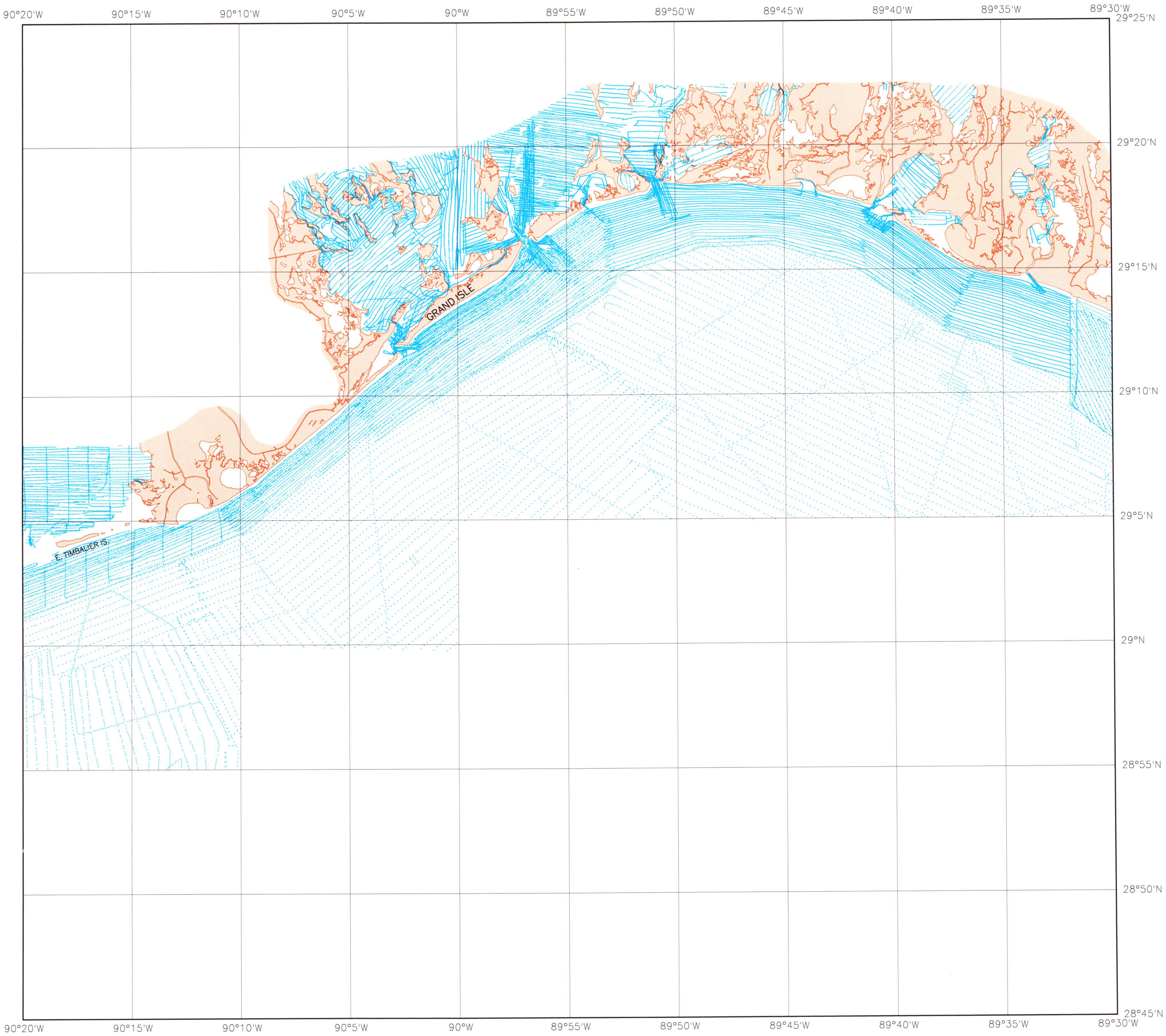
Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets. Shorelines for these USCGS maps were interpreted from aerial photography taken in 1932, supplemented by planetable surveys in selected areas following a hurricane in 1934. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data.



STUDY AREA WEST SOUNDING LOCATIONS, 1930's





SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

2 0 2 4 6 8 10 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

STUDY AREA EAST SOUNDING LOCATIONS, 1930's

Bathymetric Data

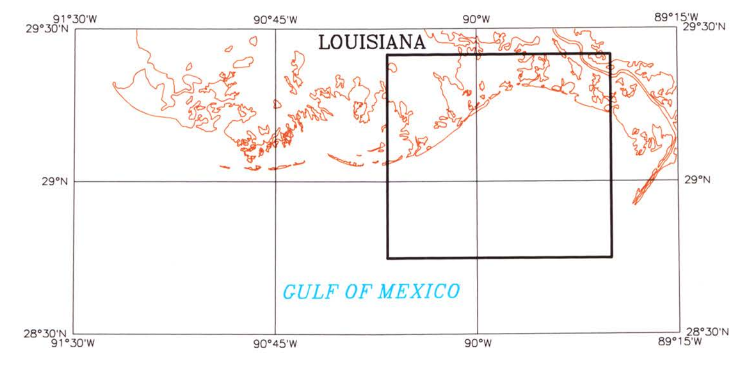
The points on this page represent the locations of the depth soundings used to construct the 1930's bathymetric contour maps shown in the atlas. The 126,924 soundings on this page were obtained in digital form from the National Geophysical Data Center in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the National Ocean Service of the National Oceanic and Atmospheric Administration from U.S. Coast and Geodetic Survey (USCGS) hydrographic smooth sheets from the years 1933, 1934, and 1936. Horizontal positioning for the soundings on these charts was accomplished with radio acoustic ranging (RAR), which involved the deployment of a series of radio sonu–buoys throughout the study area. Depths were measured with precision fathometers utilizing newly developed echo–sounding technology. Both the RAR and echo–sounding methods had only recently been employed by the USCGS, following advances in acoustic instrumentation stimulated by World War I.

These soundings were reduced to a mean low water (MLW) datum by applying sea–level corrections obtained from tide stations deployed solely for the 1930's surveys. The MLW datum was derived from these temporary tide stations during a period of several months prior to the surveys. Thus the 1930's MLW datum is only an approximation of the true MLW datum for that time period.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets. Shorelines for these USCGS maps were interpreted from aerial photography taken in 1932 and 1933, supplemented by planetable surveys in selected areas following a hurricane in 1934. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data.

INDEX MAP



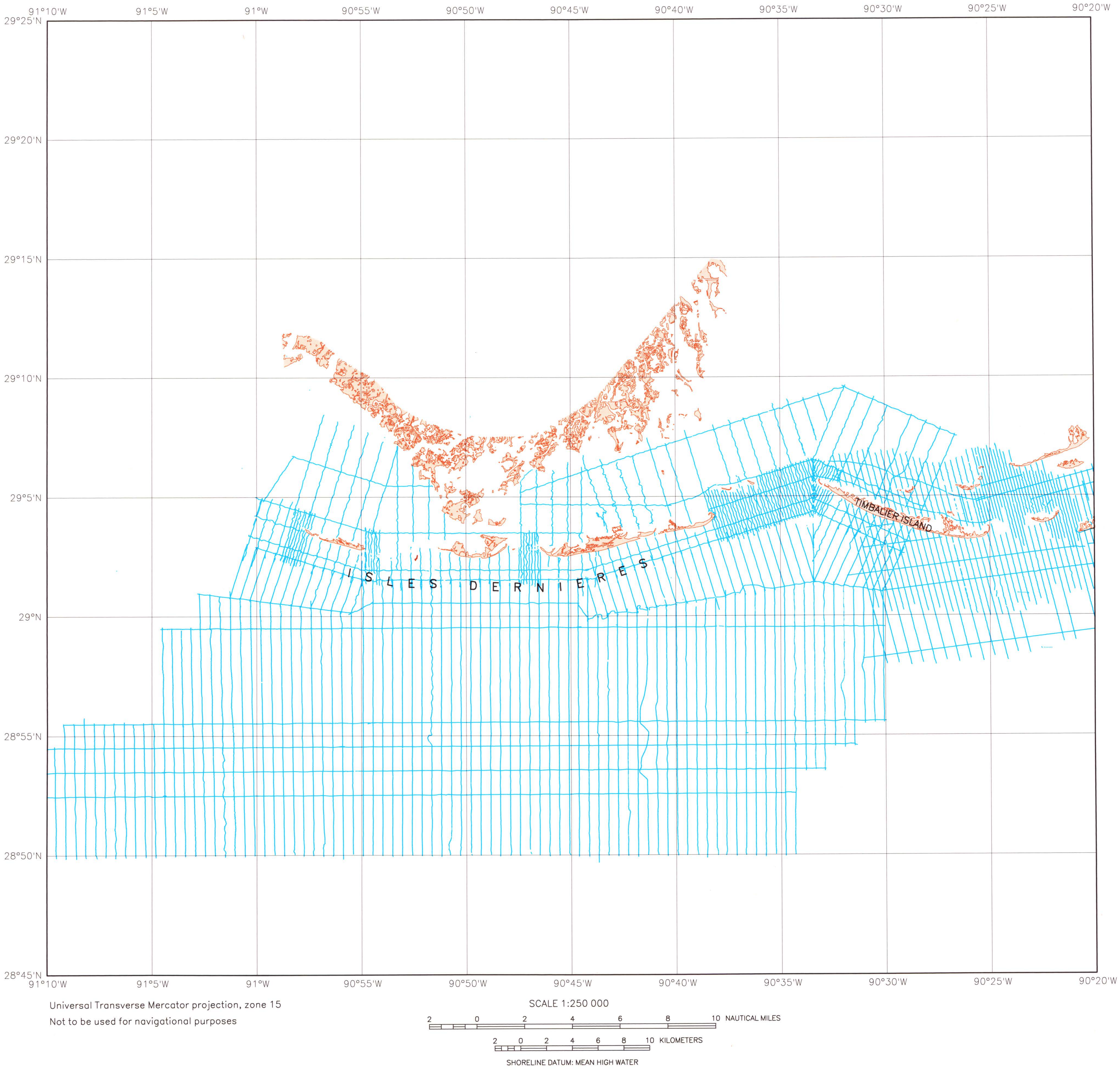
Bathymetric Data

The points on this page represent the locations of the depth soundings used to construct the 1980's bathymetric contour maps shown in the atlas. The 134,125 soundings on this page have a spacing of approximately 30 m along tracklines, giving these points the appearance of continuous lines. These soundings, consisting of latitude, longitude, and depth values, were obtained in digital form from hydrographic surveys conducted in 1986, 1988, and 1989 by companies under contract to the USGS. The 1986 survey, conducted by Geodetic International, Inc., utilized a Sercel Syledis, UHF-type radio positioning system for horizontal control and a Krupp-Atlas, model 20, high-precision, dual-frequency fathometer for soundings. The 1988 and 1989 surveys, conducted by Gulf Ocean Services, Inc., utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings.

Following the surveys, the sounding data were post-processed to remove vertical variations due to tidal and other water-level fluctuations. Water-level recordings obtained at hourly intervals from the National Oceanic and Atmospheric Administration tide gauge at Grand Isle were used to reduce the measured water depth to a mean lower low water (MLLW) datum determined from the tidal epoch from 1960 to 1978. Corrections were also made for predicted time and water-level differences between the Grand Isle gauge and other zones within the study area.

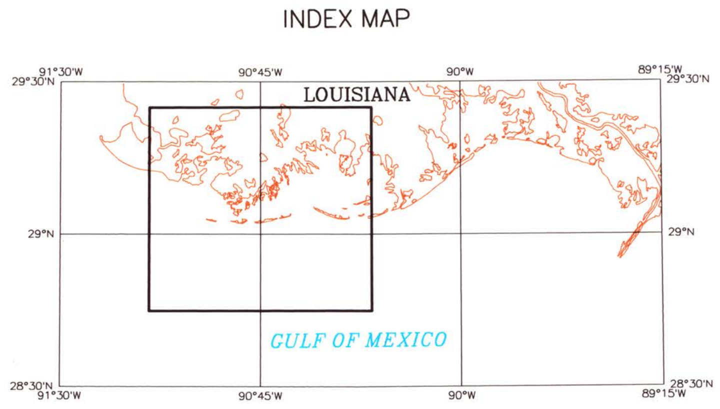
Shoreline Data

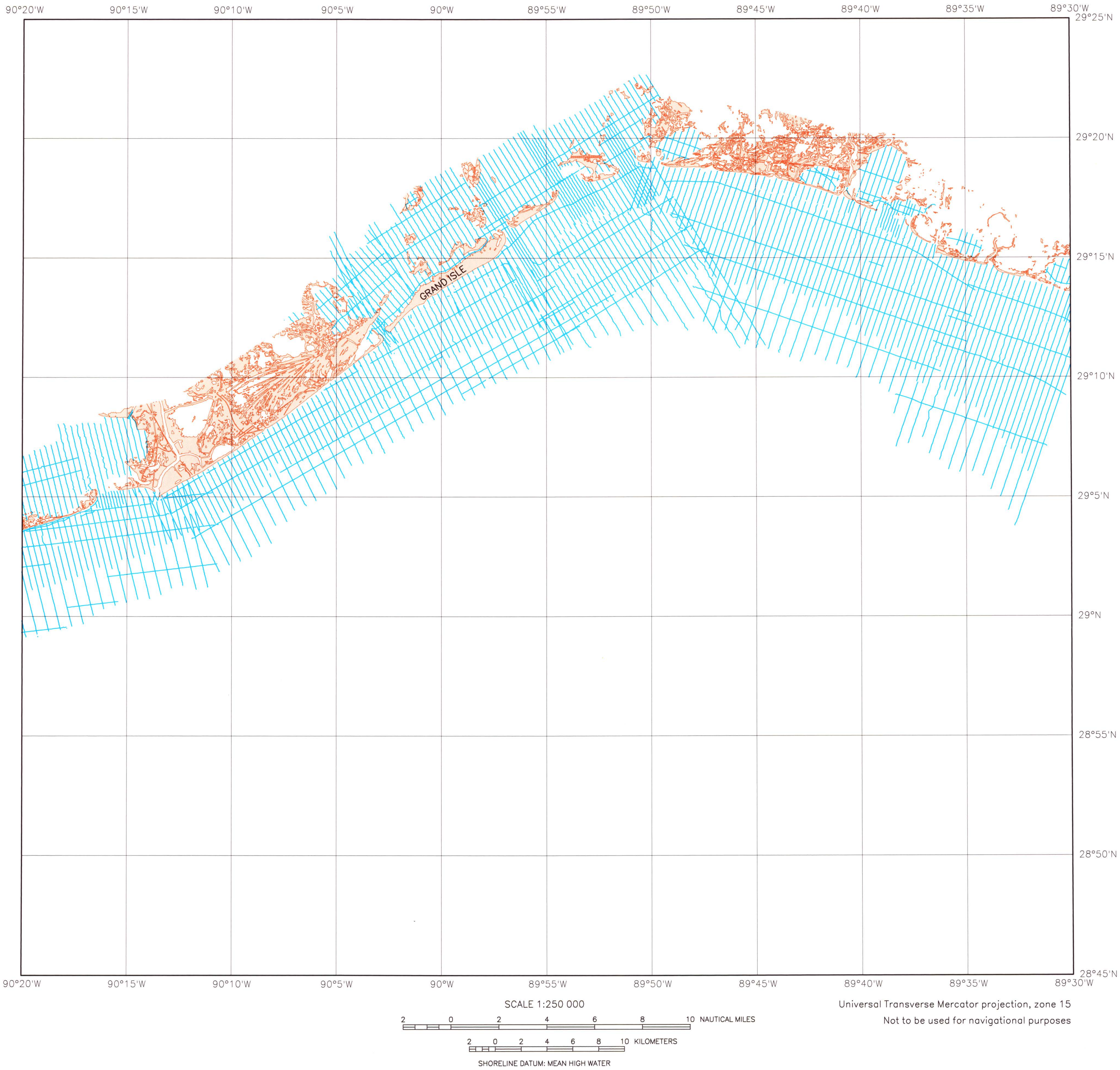
The shorelines shown on this map were obtained from aerial photography taken in 1986 and 1989. The 1986 photographs were taken by Gulf Coast Aerial Mapping Co., Inc. These black and white photographs covered the Isles Dernieres section of the study area at a scale of 1:4,800. The approximate position of the mean high water (MHW) shoreline was digitized directly from these photographs, and was then rectified to the geographic coordinates of 1950's USCGS topographic sheets at scale 1:20,000. The 1989 photographs were high-altitude color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the MHW shoreline was interpreted on mylar overlays, rectified to the 1:24,000-scale 7.5-minute USGS topographic quadrangles, and then digitized. The MHW shoreline for both years' shorelines is approximately 0.5 m above the MLLW datum of the bathymetric data.



STUDY AREA WEST SOUNDING LOCATIONS, 1980's

INDEX MAP





STUDY AREA EAST SOUNDING LOCATIONS, 1980's

Bathymetric Data

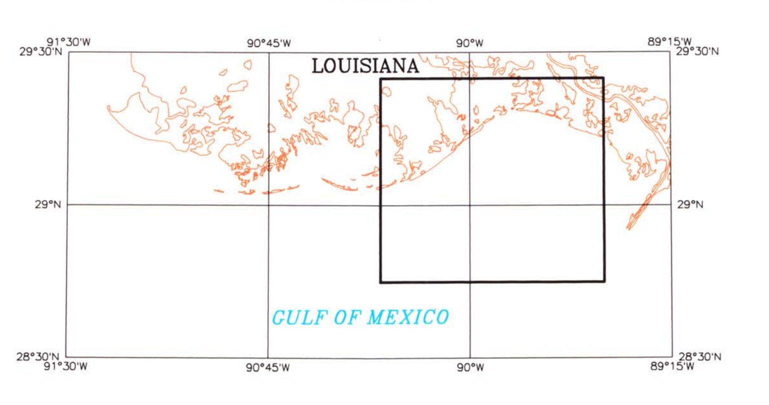
The points on this page represent the locations of the depth soundings used to construct the 1980's bathymetric contour maps shown in the atlas. The 98,164 soundings on this page have a spacing of approximately 30 m along tracklines, giving these points the appearance of continuous lines. These soundings, consisting of latitude, longitude, and depth values, were obtained in digital form from hydrographic surveys conducted in 1988 and 1989 by Gulf Ocean Services, Inc., under contract to the USGS. These surveys utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings.

Following the surveys, the sounding data were post–processed to remove vertical variations due to tidal and other water–level fluctuations. Water–level recordings obtained at hourly intervals from the National Oceanic and Atmospheric Administration tide gauge at Grand Isle were used to reduce the measured water depth to a mean lower low water (MLLW) datum determined from the tidal epoch from 1960 to 1978. Corrections were also made for predicted time and water–level differences between the Grand Isle gauge and other zones within the study area.

Shoreline Data

The shorelines shown on this map were obtained from high–altitude aerial photography taken in 1989. The photographs were color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the mean high water (MHW) shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.

INDEX MAP



EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–5
- 5–10
- 10–15
- >15

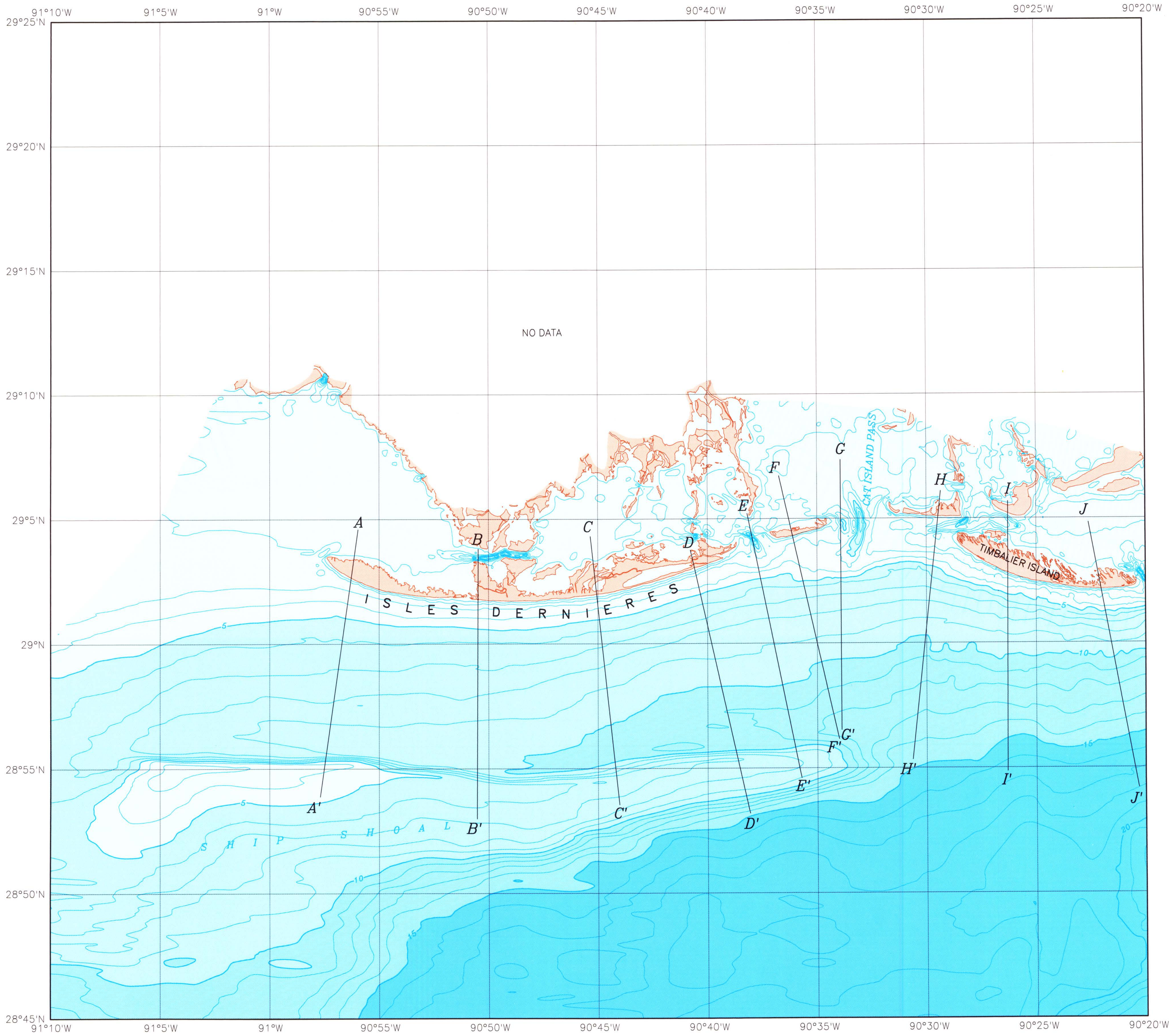
Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1888, 1889, 1891, and 1906. The 1906 survey covered a small area behind the eastern part of the Isles Dernieres, which had been missed during the 1888, 1889, and 1891 surveys. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1886, 1887, and 1906. The 1906 data include back–barrier and mainland shorelines behind the eastern end of Isles Dernieres; these shorelines had not been covered during the 1886 and 1887 surveys. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

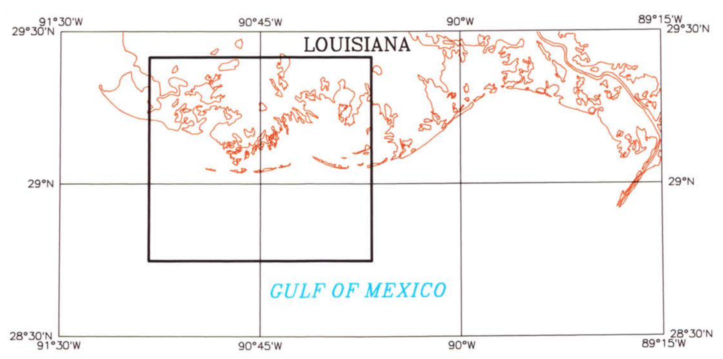
2 0 2 4 6 8 10 KILOMETERS

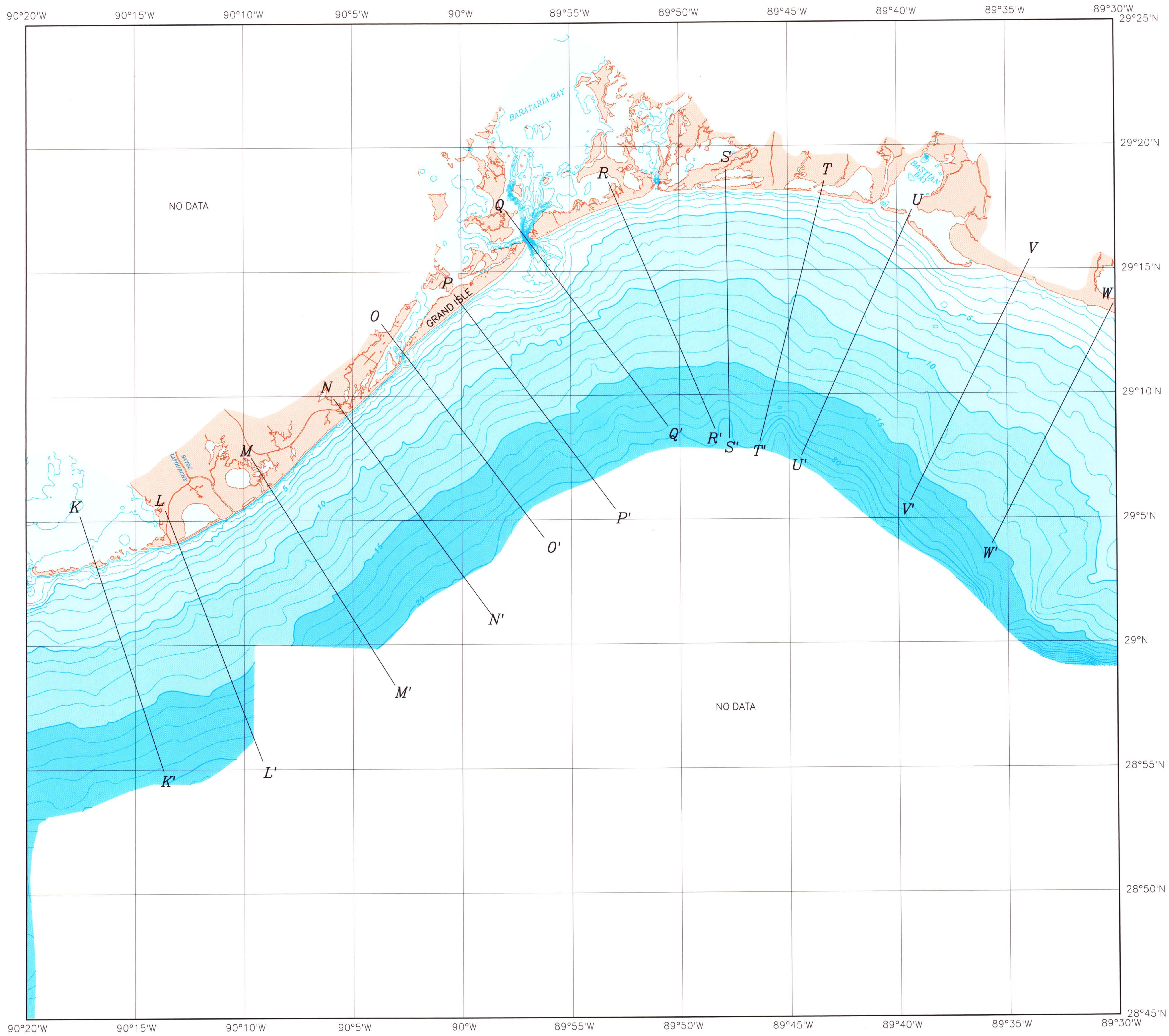
BATHYMETRIC CONTOUR INTERVAL 1 METER

DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

STUDY AREA WEST BATHYMETRY, 1880's
SHOWING THE LOCATIONS OF PROFILES *A–A'* THROUGH *J–J'*

INDEX MAP





SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

2 0 2 4 6 8 10 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER

DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

STUDY AREA EAST BATHYMETRY, 1880's

SHOWING THE LOCATIONS OF PROFILES *K–K'* THROUGH *W–W'*

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–5

5–10

10–15

>15

Bathymetric Data

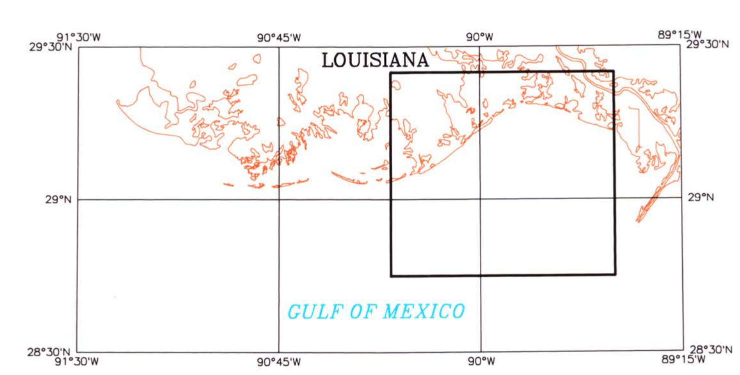
Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1878, 1883, 1886, and 1891. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

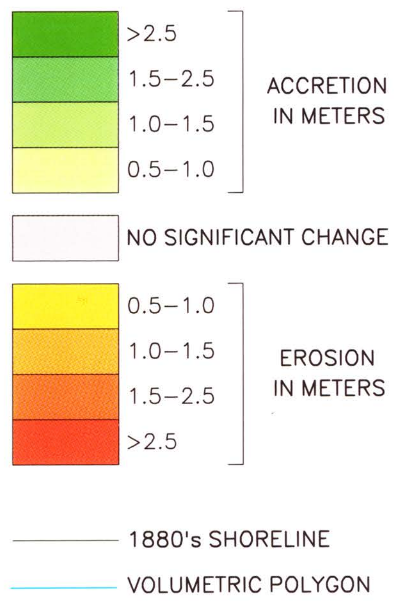
Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1883, 1884, 1886, and 1887. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



EXPLANATION OF MAP COLORS



Sea-floor Change Data

Areas of vertical sea-floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry, with a correction of 0.27 m for the relative sea-level rise and vertical datum difference between the two time periods. This correction is explained in the discussion section of the atlas.

Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

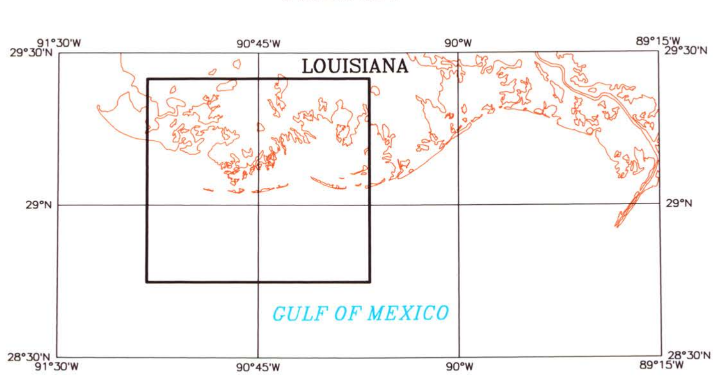
Elevation of Land Areas

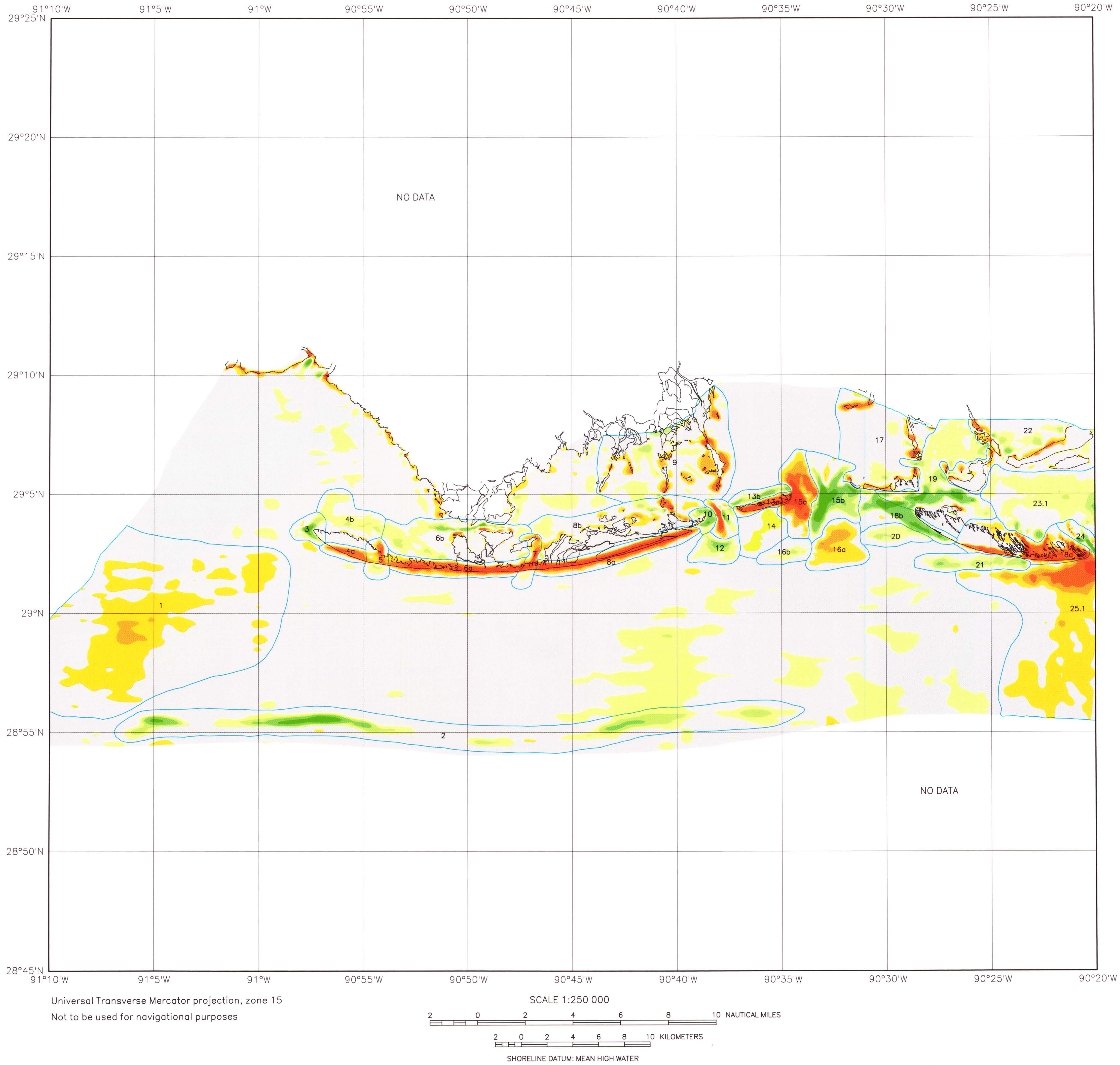
As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the actual land elevation in the 1880's is not known. The justification for this and other assumptions used to determine zones of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

Volumetric Analysis

The tables below give the volume of sediment eroded or deposited in the areas enclosed by blue lines on this map. Areas numbered with an a or b, such as 13a and 13b, represent regions that may be coupled through sediment transport or hydrodynamic processes. Areas 23.1 and 25.1 are continued on the following page in areas 23.2 and 25.2, respectively. The values reported in the "gross area" column in the tables below represent the surface areas within the regions enclosed by the blue lines, excluding the gray areas of no significant change. Volumes represent the net sediment volume change within these areas. The volume given for "other significant change areas" includes the erosional or accretional areas outside the blue-bordered regions, again excluding the areas of no significant change.

INDEX MAP





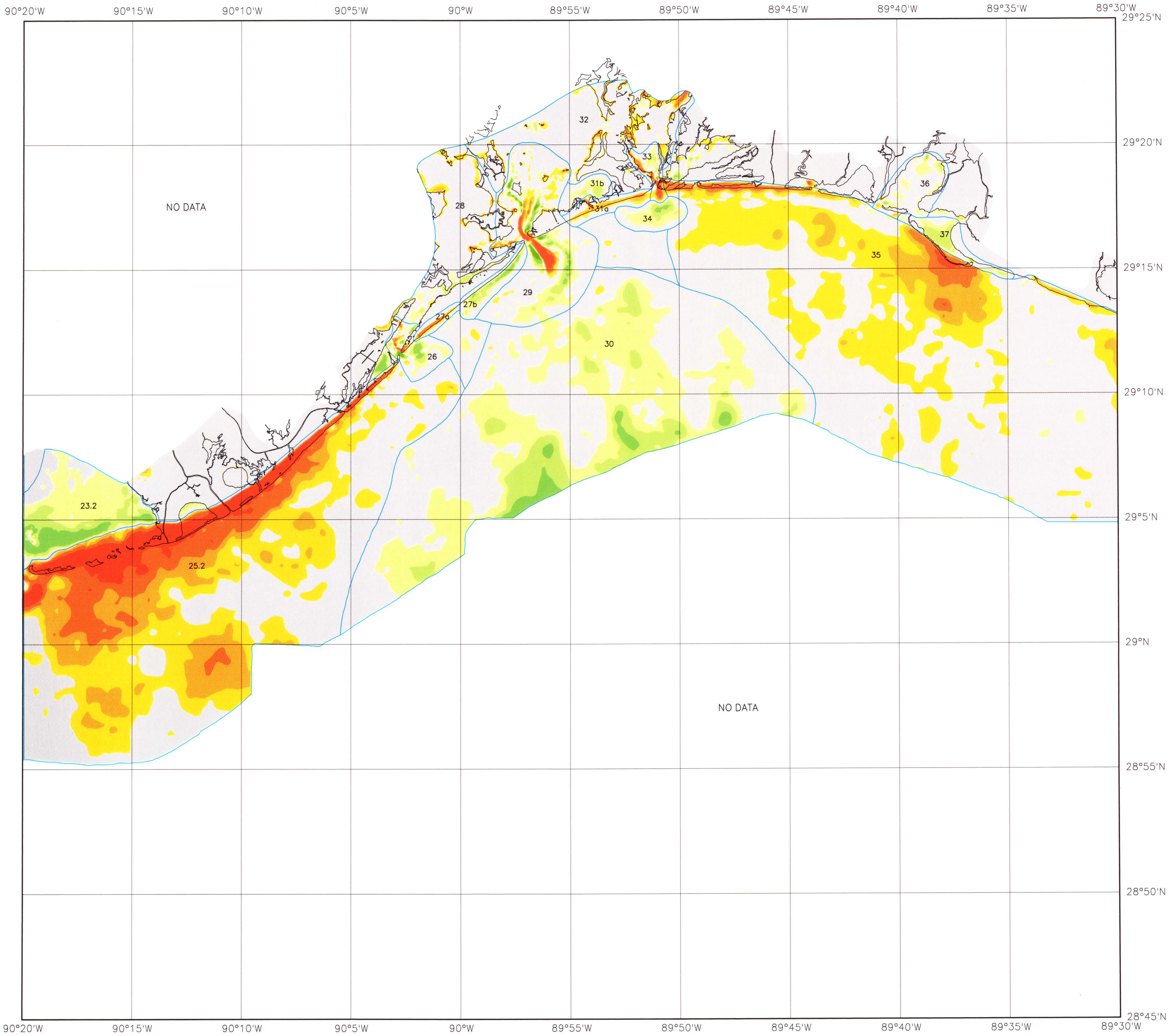
EROSIONAL AREAS

Area number	Description	Gross area (km^2)	Net volume loss ($m^3 \times 10^6$)	Average vertical change (m)
1	Westernmost part of study area	64.5	−43.2	−0.7
4a	Raccoon Island shoreface	2.2	−3.7	−1.7
5	Coupe Colin inlet area	3.0	−2.2	−.7
6a	Whiskey Island shoreface	10.2	−18.1	−1.8
7	Whiskey Pass area	3.0	−3.9	−1.3
8a	Trinity Island shoreface	11.3	−22.9	−2.0
8b	Trinity Island back barrier	10.5	−2.5	−.2
9	Islands in Lake Pelto	24.0	−7.0	−.3
11	Wine Island Pass	3.4	−2.2	−.6
13a	Wine Island, 1880's location	3.3	−7.0	−2.1
15a	Cat Island Pass, 1930's location	10.5	−17.3	−1.6
16a	Cat Island Pass ebb tidal delta, 1880's location	9.2	−7.6	−.8
17	Timbalier Bay: Caillou Island	10.7	−4.6	−.4
18a	Timbalier Island, 1880's location	12.5	−21.7	−1.7
22	Timbalier Bay: Brush and Casse-Tete Islands	14.6	−1.3	−.1
25.1	Bayou Lafourche headland	48.7	−43.1	−.9
	Total	241.6	−208.3	−0.9

ACCRETIONAL AREAS

Area number	Description	Gross area (km^2)	Net volume gain ($m^3 \times 10^6$)	Average vertical change (m)
2	Ship Shoal	39.1	42.5	1.1
3	Raccoon Island spit	2.5	3.2	1.3
4b	Raccoon Island back barrier	7.3	4.6	.6
6b	Whiskey Island back barrier	13.2	8.6	.7
10	Trinity Island spit	2.3	3.0	1.3
12	Wine Island Pass, ebb tidal delta	4.7	4.2	.9
13b	Wine Island, 1930's location	2.8	3.2	1.1
14	Wine Island shoreface	3.7	2.5	.7
15b	Cat Island Pass, 1880's location	12.4	21.2	1.7
16b	Cat Island Pass ebb tidal delta, 1930's location	2.0	1.5	.8
18b	Timbalier Island, 1930's location	7.8	14.5	1.9
19	Timbalier Bay channel infilling	24.4	25.2	1.0
20	Timbalier Island shoreface, west	3.8	3.0	.8
21	Timbalier Island shoreface, east	6.8	6.6	1.0
23.1	East Timbalier Island and Timbalier Bay	24.1	18.4	.8
24	Little Pass Timbalier	1.9	2.0	1.1
	Other significant change areas	136.0	67.0	.5
	Total	294.8	231.2	0.8

STUDY AREA WEST SEA-FLOOR CHANGE, 1880's–1930's



SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

2 0 2 4 6 8 10 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

EXPLANATION OF MAP COLORS

ACCRETION IN METERS: >2.5; 1.5–2.5; 1.0–1.5; 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS: 0.5–1.0; 1.0–1.5; 1.5–2.5; >2.5

1880's SHORELINE

VOLUMETRIC POLYGON

Sea-floor Change Data

Areas of vertical sea-floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry, with a correction of 0.27 m for the relative sea-level rise and vertical datum difference between the two time periods. This correction is explained in the discussion section of the atlas.

Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the actual land elevation in the 1880's is not known. The justification for this and other assumptions used to determine zones of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

Volumetric Analysis

The tables below give the volume of sediment eroded or deposited in the areas enclosed by blue lines on this map. Areas numbered with an a or b, such as 27a and 27b, represent regions that may be coupled through sediment transport processes. Areas 23.2 and 25.2 are continued on the previous page in areas 23.1 and 25.1, respectively. The values reported in the "gross area" column in the tables below represent the surface areas within the regions enclosed by the blue lines, excluding the gray areas of no significant change. Volumes represent the net sediment volume change within these areas. The volume given for "other significant change areas" includes the erosional or accretional areas outside the blue-bordered regions, again excluding the areas of no significant change.

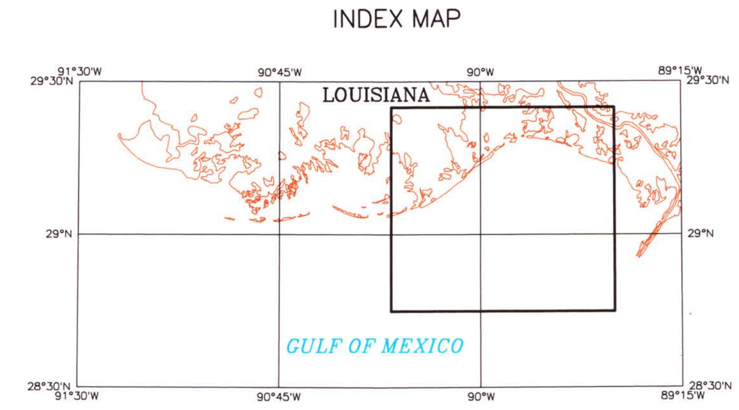
EROSIONAL AREAS

Area number	Description	Gross area (km^2)	Net volume loss (m$^3\times10^6$)	Average vertical change (m)
25.2	Bayou Lafourche headland	275.5	−396.3	−1.4
27a	Grand Isle, west	1.3	−1.8	−1.4
28	Bay Des Ilettes	9.8	−2.7	−.3
31a	Grand Terre Island	3.3	−3.7	−1.1
32	Barataria Bay	13.1	−9.1	−.7
33	Quatre Bayoux Pass	3.8	−3.9	−1.0
35	Shoreface east of Quatre Bayoux Pass	180.6	−153.5	−.8
	Total	487.4	−571.0	−1.2

ACCRETIONAL AREAS

Area number	Description	Gross area (km^2)	Net volume gain (m$^3\times10^6$)	Average vertical change (m)
23.2	East Timbalier Island and Timbalier Bay	39.5	41.0	1.0
26	Caminada Pass	6.2	3.0	.5
27b	Grand Isle, east	4.0	4.4	1.1
29	Barataria Pass	27.9	1.9	.1
30	Barataria basin shoreface	173.0	147.4	.9
31b	Grand Terre Island	2.6	2.1	.8
34	Quatre Bayoux Pass, ebb tidal delta	5.6	5.0	.9
36	Bastian Bay	5.0	2.6	.5
37	Shell Island	5.2	5.0	1.0
	Other significant change areas	10.1	1.1	.1
	Total	279.1	213.5	0.8

INDEX MAP



STUDY AREA EAST SEA-FLOOR CHANGE, 1880's–1930's

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–5

5–10

10–15

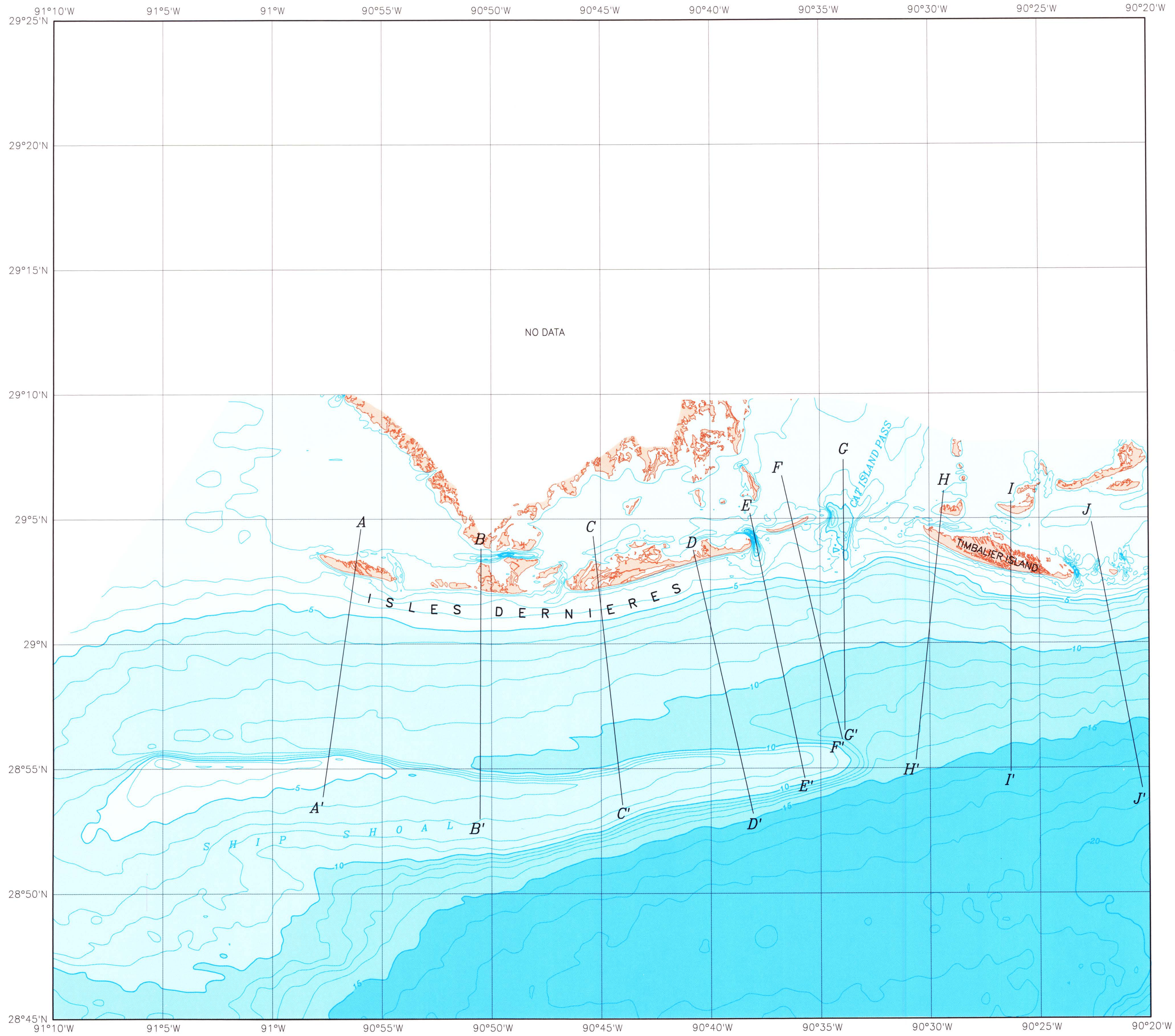
>15

Bathymetric Data

Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1934, 1935, and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from the years 1932 and 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.



Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

2 0 2 4 6 8 10 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER

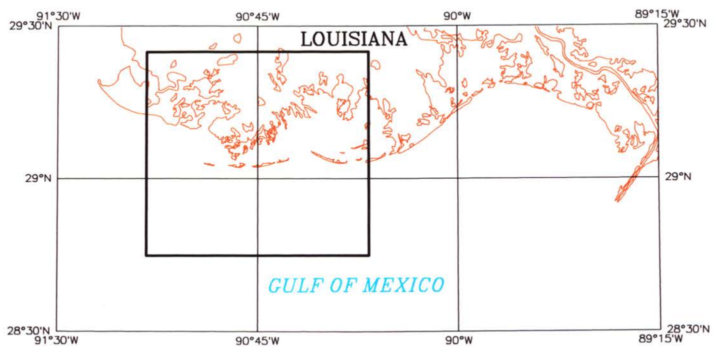
DATUM: MEAN LOW WATER

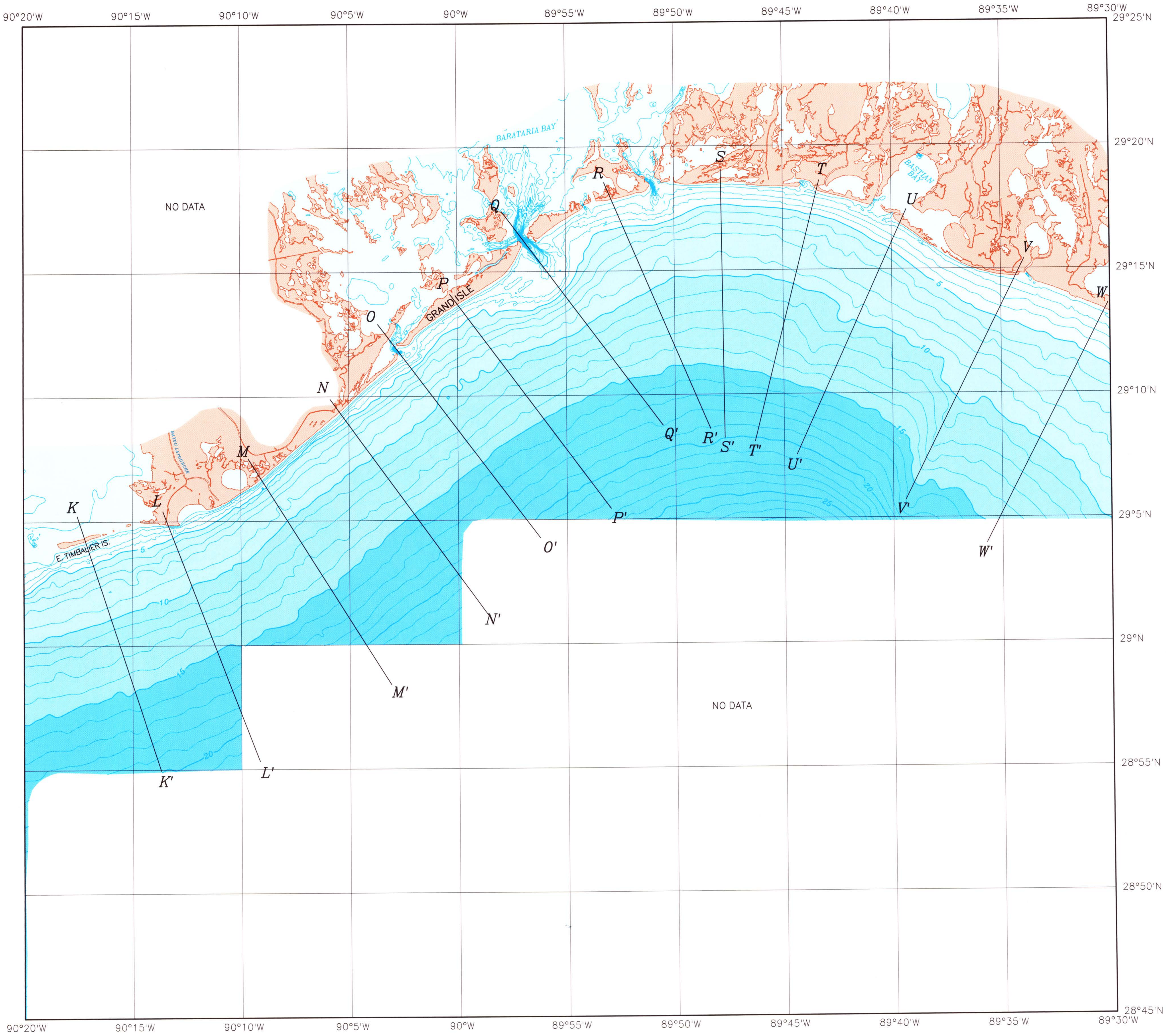
SHORELINE DATUM: MEAN HIGH WATER

STUDY AREA WEST BATHYMETRY, 1930's

SHOWING THE LOCATIONS OF PROFILES *A–A'* THROUGH *J–J'*

INDEX MAP





SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

2 0 2 4 6 8 10 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER

DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

STUDY AREA EAST BATHYMETRY, 1930's
SHOWING THE LOCATIONS OF PROFILES *K–K'* THROUGH *W–W'*

EXPLANATION OF MAP COLORS

- Land
- DEPTH IN METERS
  - 0–5
  - 5–10
  - 10–15
  - >15

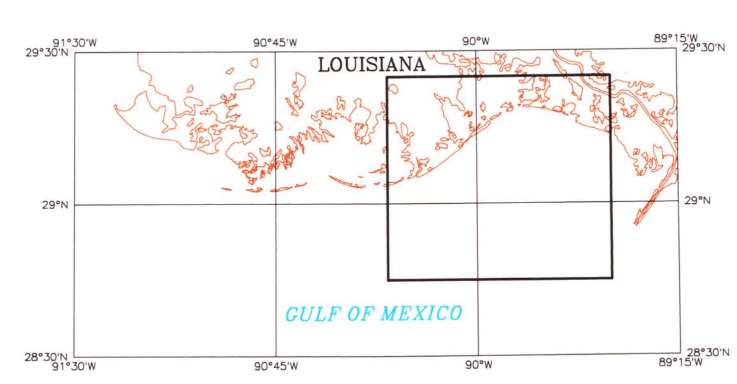
Bathymetric Data

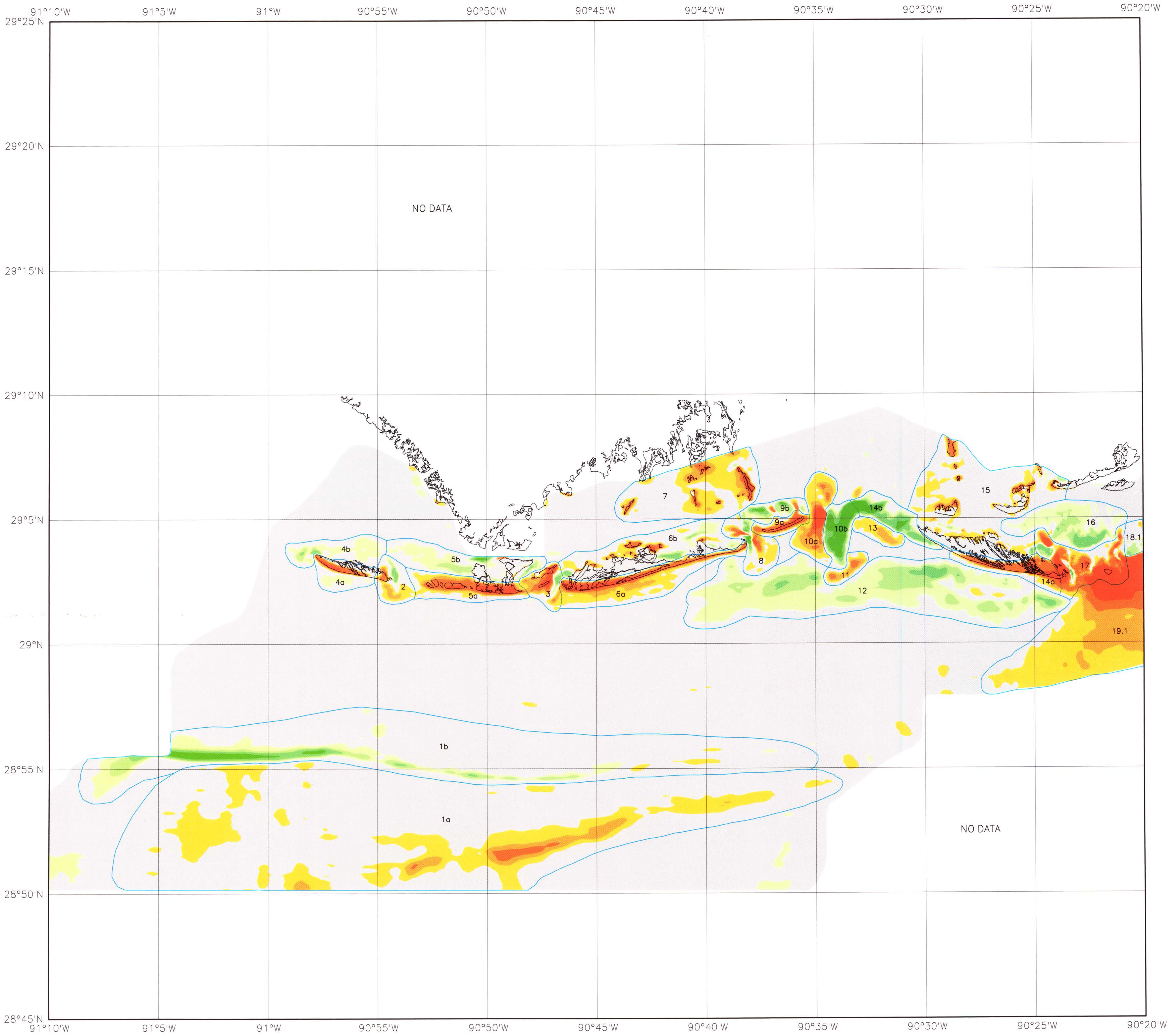
Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1933, 1934, and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from the years 1932, 1933, and 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP





Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

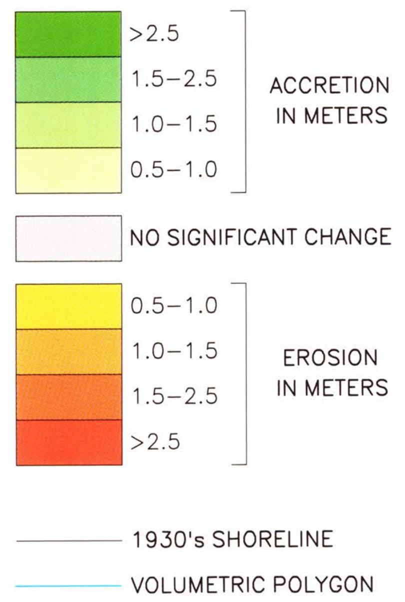
SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

2 0 2 4 6 8 10 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

EXPLANATION OF MAP COLORS



Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry, with a correction of 0.33 m for the relative sea–level rise and vertical datum difference between the two time periods. This correction is explained in the discussion section of the atlas.

Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map. The gray zone also defines the area of overlap between the 1930's and 1980's surveys.

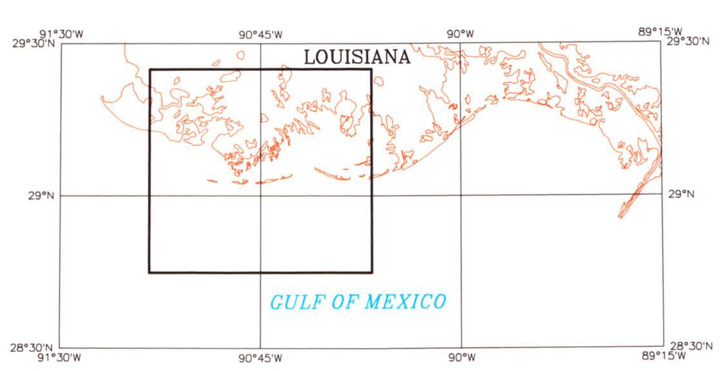
Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the actual land elevation in the 1930's is not known. The justification for this and other assumptions used to determine zones of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

Volumetric Analysis

The tables below give the volume of sediment eroded or deposited in the areas enclosed by blue lines on this map. Areas numbered with an a or b, such as 1a and 1b, represent regions that may be coupled through sediment transport or hydrodynamic processes. Areas 18.1 and 19.1 are continued on the following page in areas 18.2 and 19.2, respectively. The values reported in the "gross area" column in the tables below represent the surface areas within the regions enclosed by the blue lines, excluding the gray areas of no significant change. Volumes represent the net sediment volume change within these areas. The volume given for "other significant change areas" includes the erosional or accretional areas outside the blue–bordered regions, again excluding the areas of no significant change.

INDEX MAP



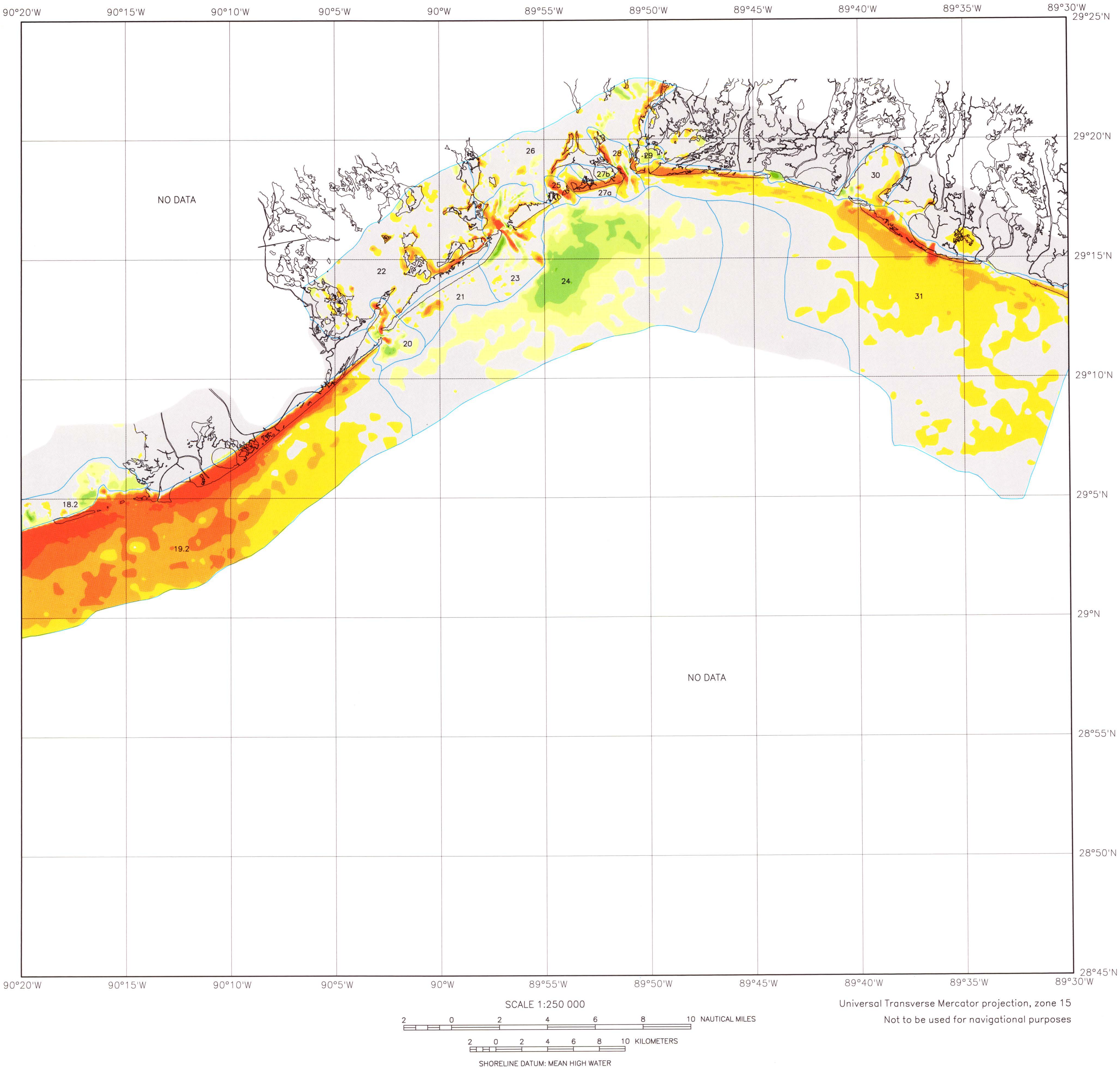
EROSIONAL AREAS

Area number	Description	Gross area (km^2)	Net volume loss ($m^3 \times 10^6$)	Average vertical change (m)
1a	Ship Shoal, seaward side	82.0	−62.1	−0.8
2	Coupe Colin inlet area	4.3	−1.9	−.4
3	Whiskey Pass area	5.6	−7.6	−1.4
4a	Raccoon Island shoreface	4.1	−3.1	−.8
5a	Whiskey Island shoreface	9.6	−15.8	−1.6
6a	Trinity and East Islands shoreface	16.7	−23.7	−1.4
6b	Trinity and East Islands back barrier	10.1	−2.0	−.2
7	Islands in Lake Pelto	18.5	−19.0	−1.0
8	Wine Island Pass	5.4	−2.2	−.4
9a	Wine Island, 1930's location	3.4	−6.4	−1.9
10a	Cat Island Pass, 1980's location	10.5	−15.2	−1.4
11	Cat Island Pass, ebb tidal delta	2.7	−3.0	−1.1
13	Timbalier Island shoreface	3.3	−2.9	−.9
14a	Timbalier Island, 1930's location	7.7	−15.7	−2.0
15	Timbalier Bay islands	16.7	−12.7	−.8
17	Little Pass Timbalier	15.9	−33.0	−2.1
19.1	Bayou Lafourche headland	53.2	−70.3	−1.3
	Total	269.7	−296.6	−1.1

ACCRETIONAL AREAS

Area number	Description	Gross area (km^2)	Net volume gain ($m^3 \times 10^6$)	Average vertical change (m)
1b	Ship Shoal, landward side	39.4	43.3	1.1
4b	Raccoon Island back barrier	6.5	4.9	.8
5b	Whiskey Island back barrier	9.8	7.5	.8
9b	Wine Island, 1980's location	4.2	3.9	.9
10b	Cat Island Pass, 1930's location	7.6	19.5	2.6
12	Timbalier Island to Isles Dernieres shoreface	69.6	59.6	.9
14b	Timbalier Island, 1980's location	7.9	14.5	1.8
16	Little Pass Timbalier shoals	14.8	14.2	1.0
18.1	East Timbalier Island	1.2	.9	.8
	Other significant change areas	16.4	.2	0.0
	Total	177.4	168.5	0.9

STUDY AREA WEST SEA–FLOOR CHANGE, 1930's–1980's



EXPLANATION OF MAP COLORS

ACCRETION IN METERS: >2.5; 1.5–2.5; 1.0–1.5; 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS: 0.5–1.0; 1.0–1.5; 1.5–2.5; >2.5

1930's SHORELINE

VOLUMETRIC POLYGON

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry, with a correction of 0.33 m for the relative sea–level rise and vertical datum difference between the two time periods. This correction is explained in the discussion section of the atlas.

Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map. The gray zone also defines the area of overlap between the 1930's and 1980's surveys.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the actual land elevation in the 1930's is not known. The justification for this and other assumptions used to determine zones of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

Volumetric Analysis

The tables below give the volume of sediment eroded or deposited in the areas enclosed by blue lines on this map. Areas numbered with an a or b, such as 27a and 27b, represent regions that may be coupled through sediment transport or hydro–dynamic processes. Areas 18.2 and 19.2 are continued on the previous page in areas 18.1 and 19.1, respectively. The values reported in the "gross area" column in the tables below represent the surface areas within the regions enclosed by the blue lines, excluding the gray areas of no significant change. Volumes represent the net sediment volume change within these areas. The volume given for "other significant change areas" includes the erosional or accretional areas outside the blue–bordered regions, again excluding the areas of no significant change.

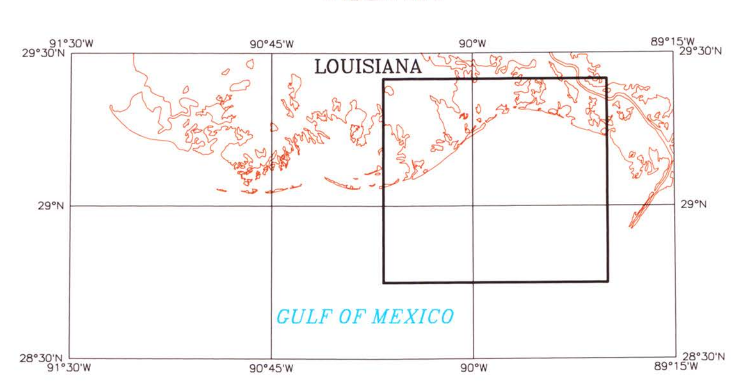
EROSIONAL AREAS

Area number	Description	Gross area (km²)	Net volume loss ($m^3 \times 10^6$)	Average vertical change (m)
19.2	Bayou Lafourche headland	222.0	−358.0	−1.6
21	Grand Isle shoreface	3.2	−1.7	−.5
22	Caminada Bay	19.5	−15.4	−.8
23	Barataria Pass	15.7	−5.2	−.3
25	Pass Abel	2.6	−3.6	−1.4
26	Barataria Bay	16.0	−6.4	−.4
27a	East Grand Terre Island, 1930's location	4.3	−6.7	−1.6
28	Quatre Bayoux Pass	5.2	−6.3	−1.2
30	Bastian Bay	5.7	−2.6	−.5
31	Shoreface east of Quatre Bayoux Pass	156.9	−131.1	−.8
	Other significant change areas	10.6	−.3	0.0
	Total	461.7	−537.3	−1.2

ACCRETIONAL AREAS

Area number	Description	Gross area (km²)	Net volume gain ($m^3 \times 10^6$)	Average vertical change (m)
18.2	East Timbalier Island	11.5	9.4	0.8
20	Caminada Pass	6.8	1.0	.1
24	Barataria basin shoreface	113.2	112.0	1.0
27b	East Grand Terre Island, 1980's location	1.2	1.0	.8
29	Islands near Quatre Bayoux Pass	1.8	1.5	.8
	Total	134.5	124.9	0.9

INDEX MAP



STUDY AREA EAST SEA–FLOOR CHANGE, 1930's–1980's

EXPLANATION OF MAP COLORS

- Land
- DEPTH IN METERS
  - 0–5
  - 5–10
  - 10–15
  - >15

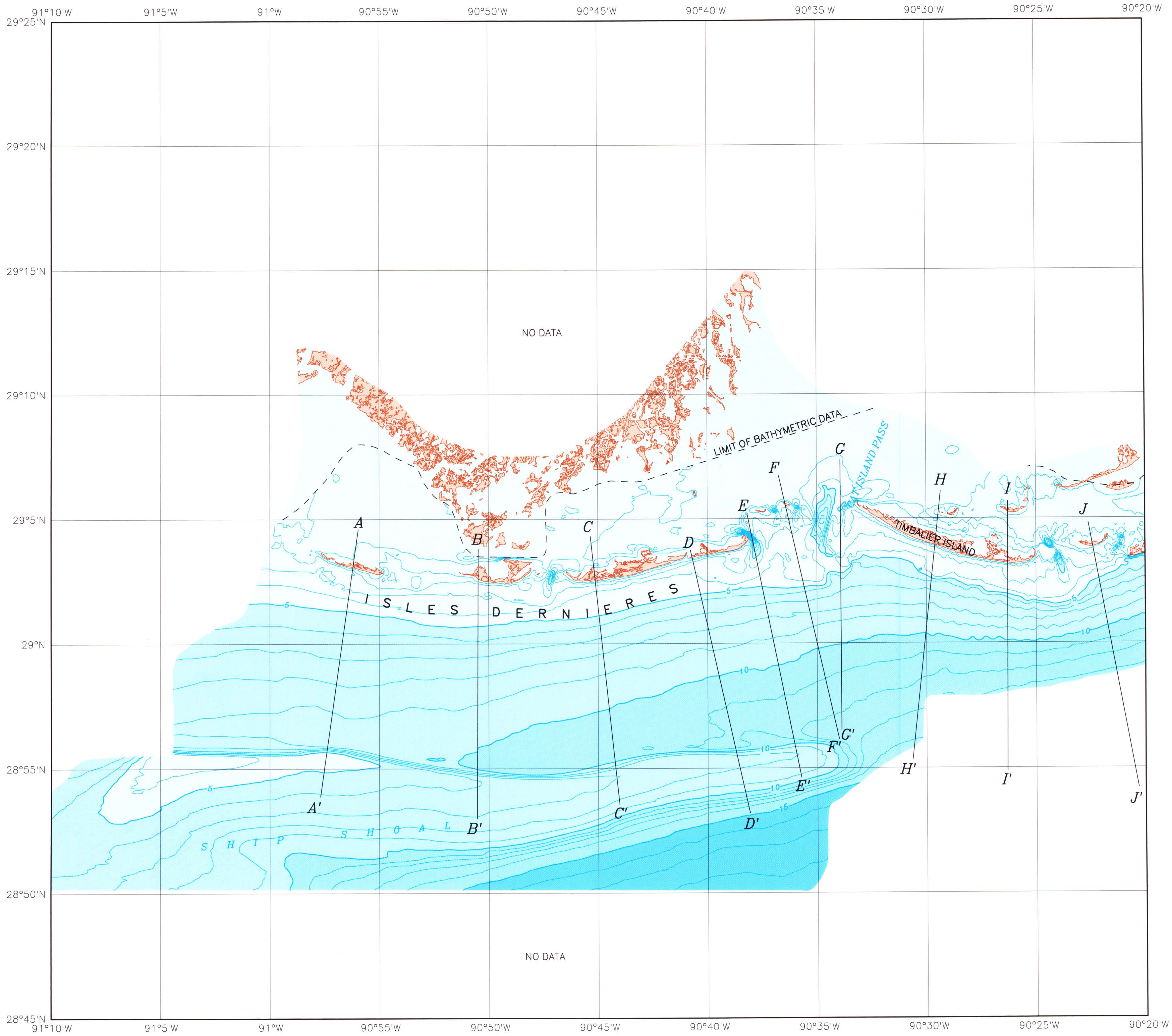
Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from hydrographic surveys conducted in 1986, 1988, and 1989 by companies under contract to the USGS. The 1986 survey, conducted by Geodetic International, Inc., utilized a Sercel Syledis, UHF–type radio positioning system for horizontal control and a Krupp–Atlas, model 20, high–precision dual–frequency fathometer for soundings. The 1988 and 1989 surveys, conducted by Gulf Ocean Services, Inc., utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. Other open–water areas, for which bathymetric data are lacking, are also shown in blue. These areas, which fall outside dashed lines labeled "limit of bathymetric data," include land features that both serve as a reference for offshore areas and allow a comparison with maps from other years in the atlas.

Shoreline Data

The shorelines shown on this map were obtained from aerial photography taken in 1986 and 1989. The 1986 photographs were taken by Gulf Coast Aerial Mapping Co., Inc. These black and white photographs covered the Isles Dernieres section of the study area at a scale of 1:4,800. The approximate position of the mean high water (MHW) shoreline was digitized directly from these photographs, and was then rectified to the geographic coordinates of 1950's U.S. Coast and Geodetic Survey topographic sheets at scale 1:20,000. The 1989 photographs were high–altitude color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the MHW shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

SCALE 1:250 000

2 0 2 4 6 8 10 NAUTICAL MILES

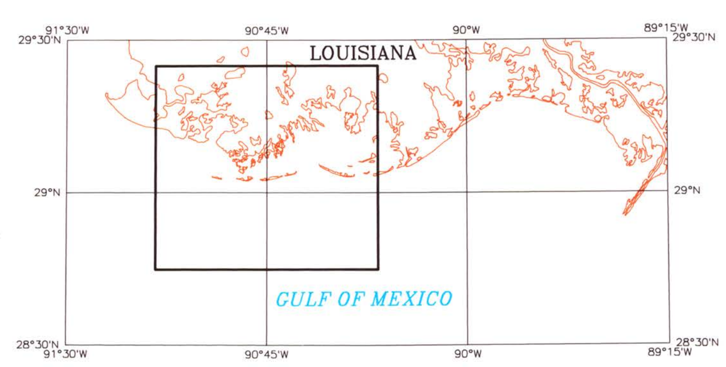
2 0 2 4 6 8 10 KILOMETERS

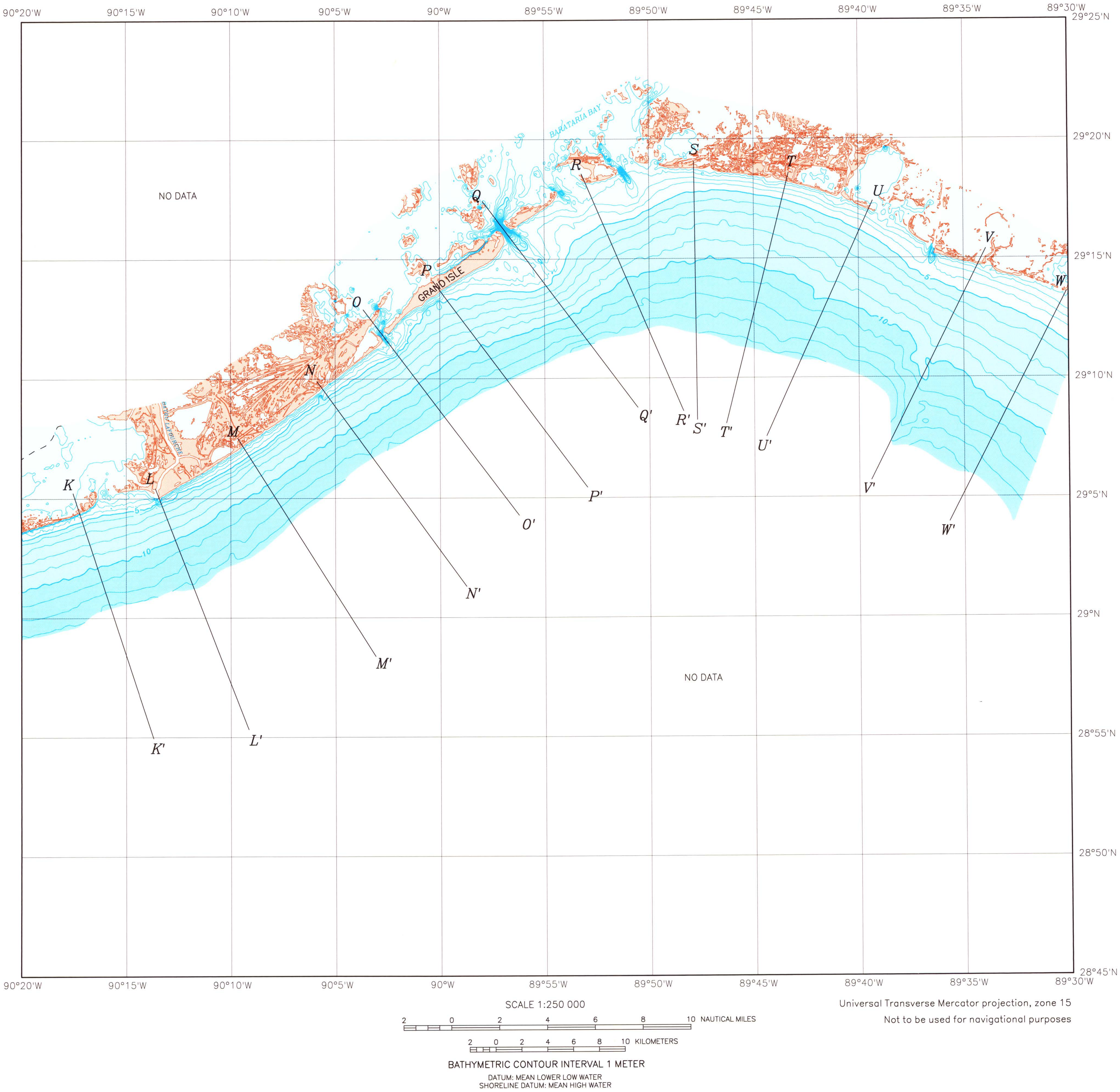
BATHYMETRIC CONTOUR INTERVAL 1 METER

DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

STUDY AREA WEST BATHYMETRY, 1980's
SHOWING THE LOCATIONS OF PROFILES *A–A'* THROUGH *J–J'*

INDEX MAP





EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–5
- 5–10
- 10–15
- >15

Bathymetric Data

Depth-sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from hydrographic surveys conducted in 1988 and 1989 by Gulf Ocean Services, Inc. under contract to the USGS. These surveys utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

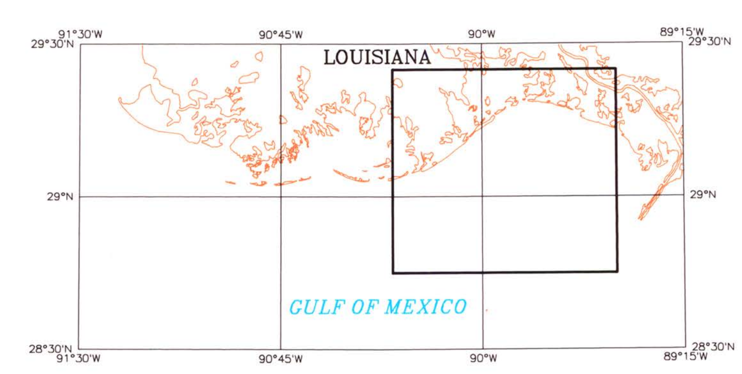
Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. However, several inland shipping channels known to be deep are shown blank (no data), to prevent implying that these areas are shallow, as are most inland bodies of water. Bathymetric data are also lacking for the small open-water area north of the dashed line at the western edge of the map.

Shoreline Data

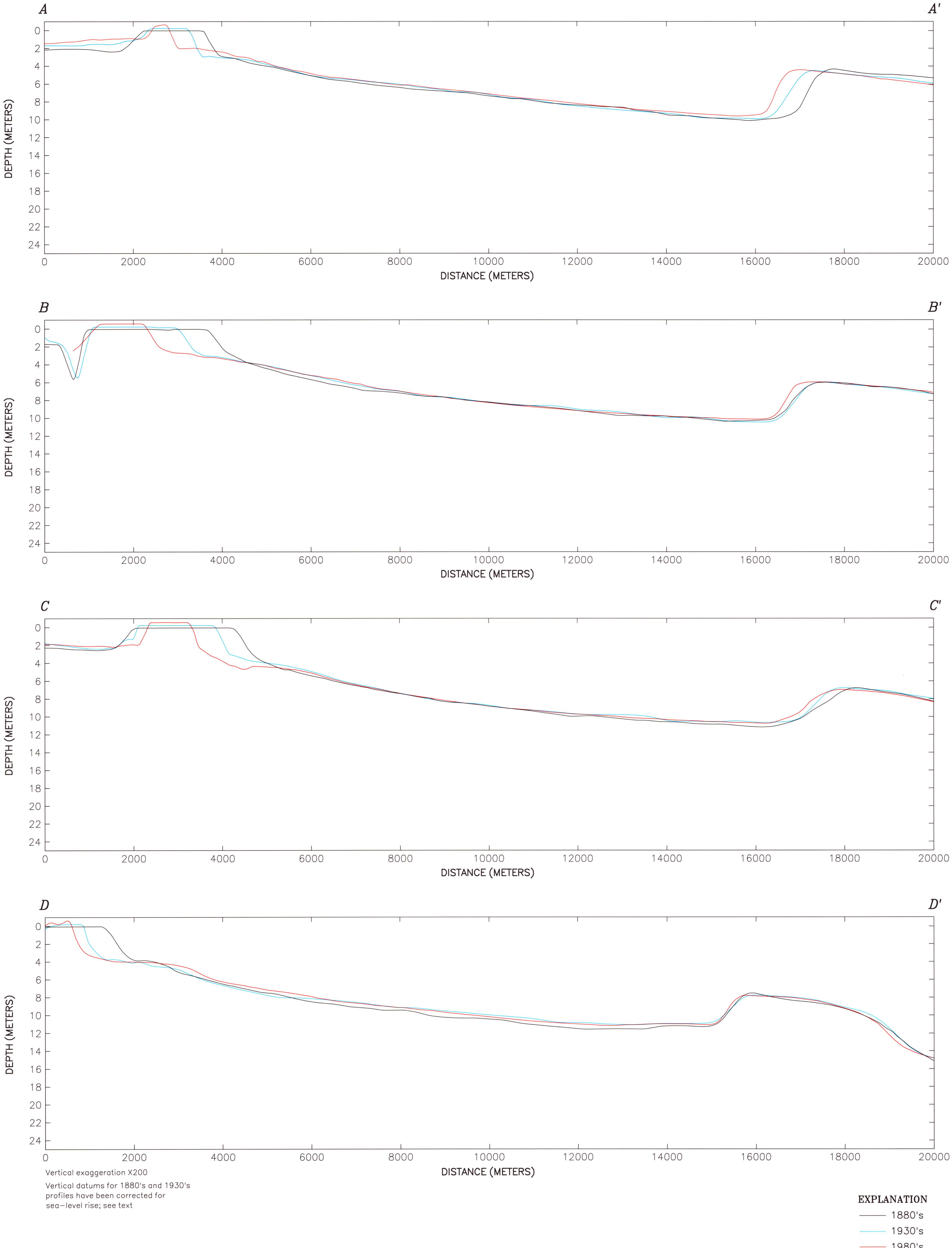
The shorelines shown on this map were obtained from high-altitude aerial photography taken in 1989. The photographs were color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the mean high water (MHW) shoreline was interpreted on mylar overlays, rectified to the 1:24,000-scale 7.5-minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.

STUDY AREA EAST BATHYMETRY, 1980's
SHOWING THE LOCATIONS OF PROFILES *K–K'* THROUGH *W–W'*

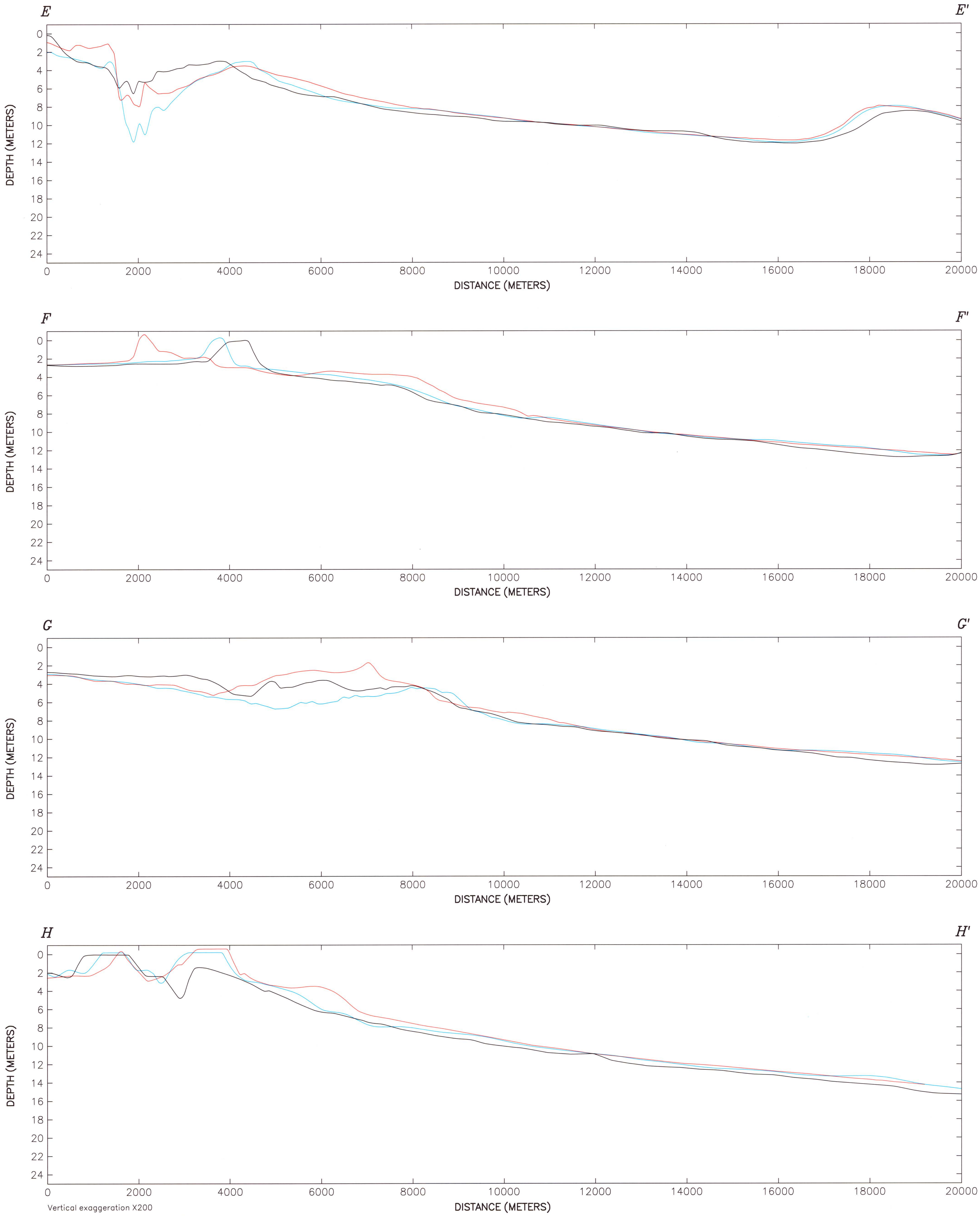
INDEX MAP



BATHYMETRIC PROFILES



BATHYMETRIC PROFILES *A–A′* THROUGH *D–D′*



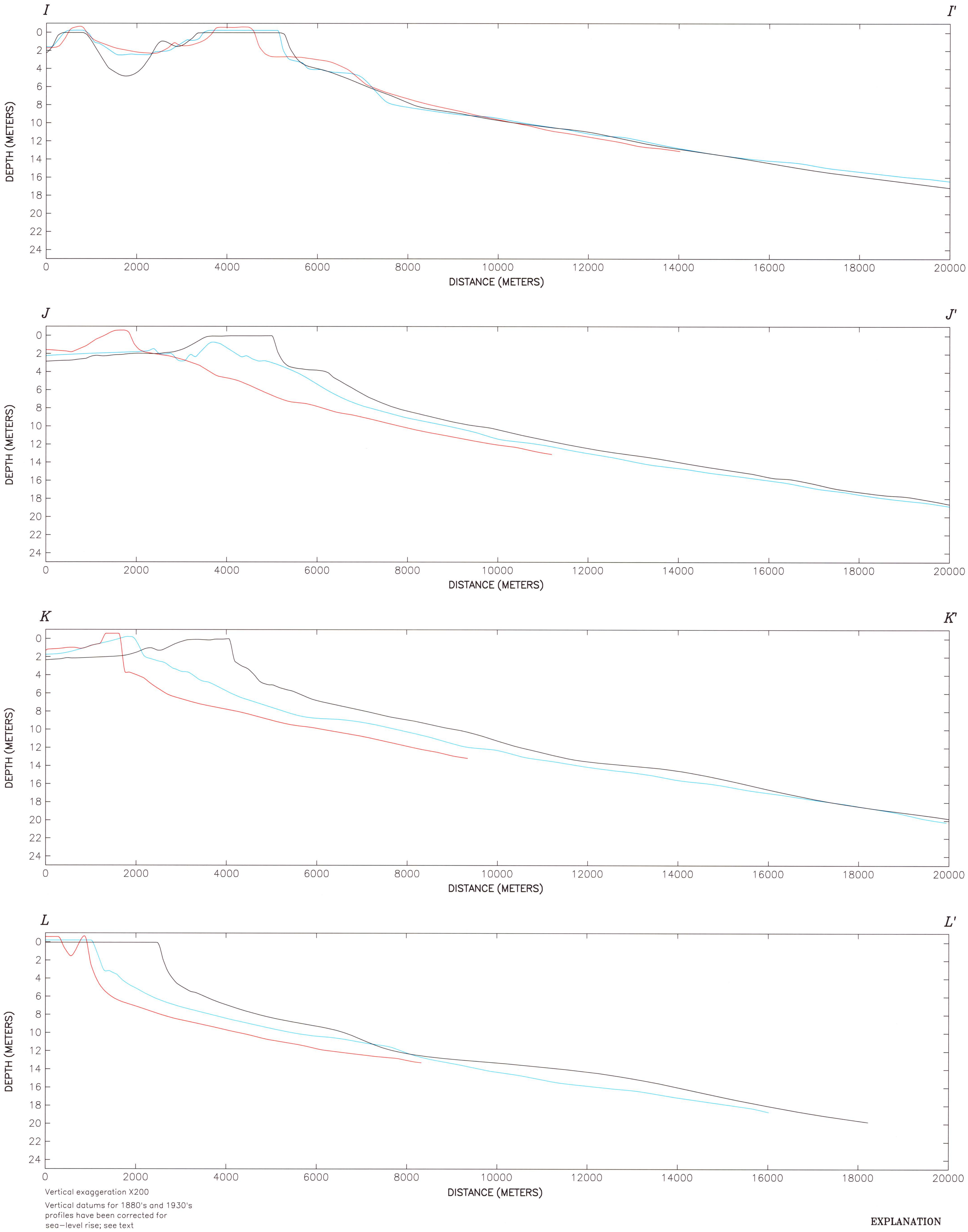
Vertical exaggeration X200

Vertical datums for 1880's and 1930's profiles have been corrected for sea–level rise; see text

EXPLANATION

- 1880's
- 1930's
- 1980's

BATHYMETRIC PROFILES *E–E'* THROUGH *H–H'*



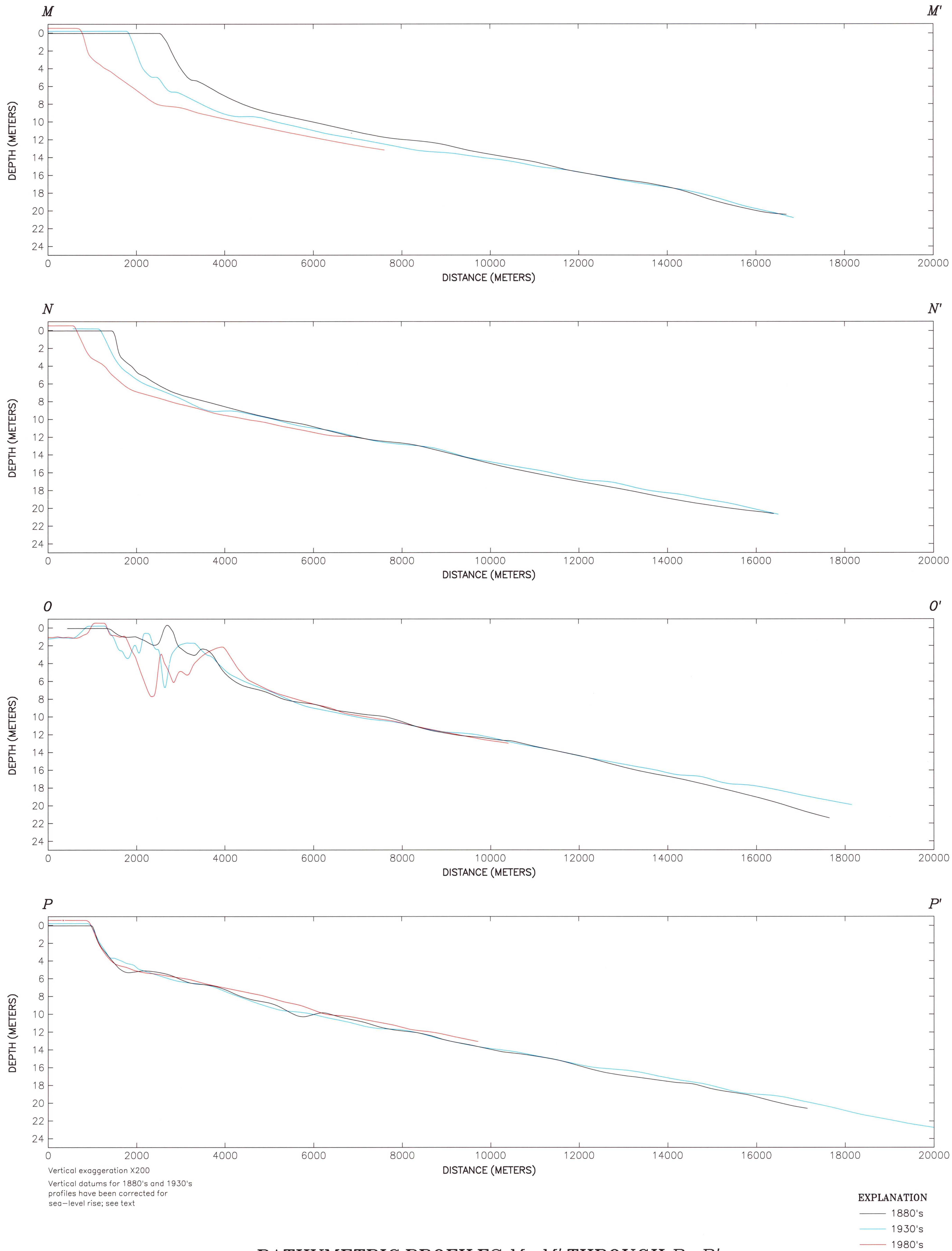
EXPLANATION

1880's

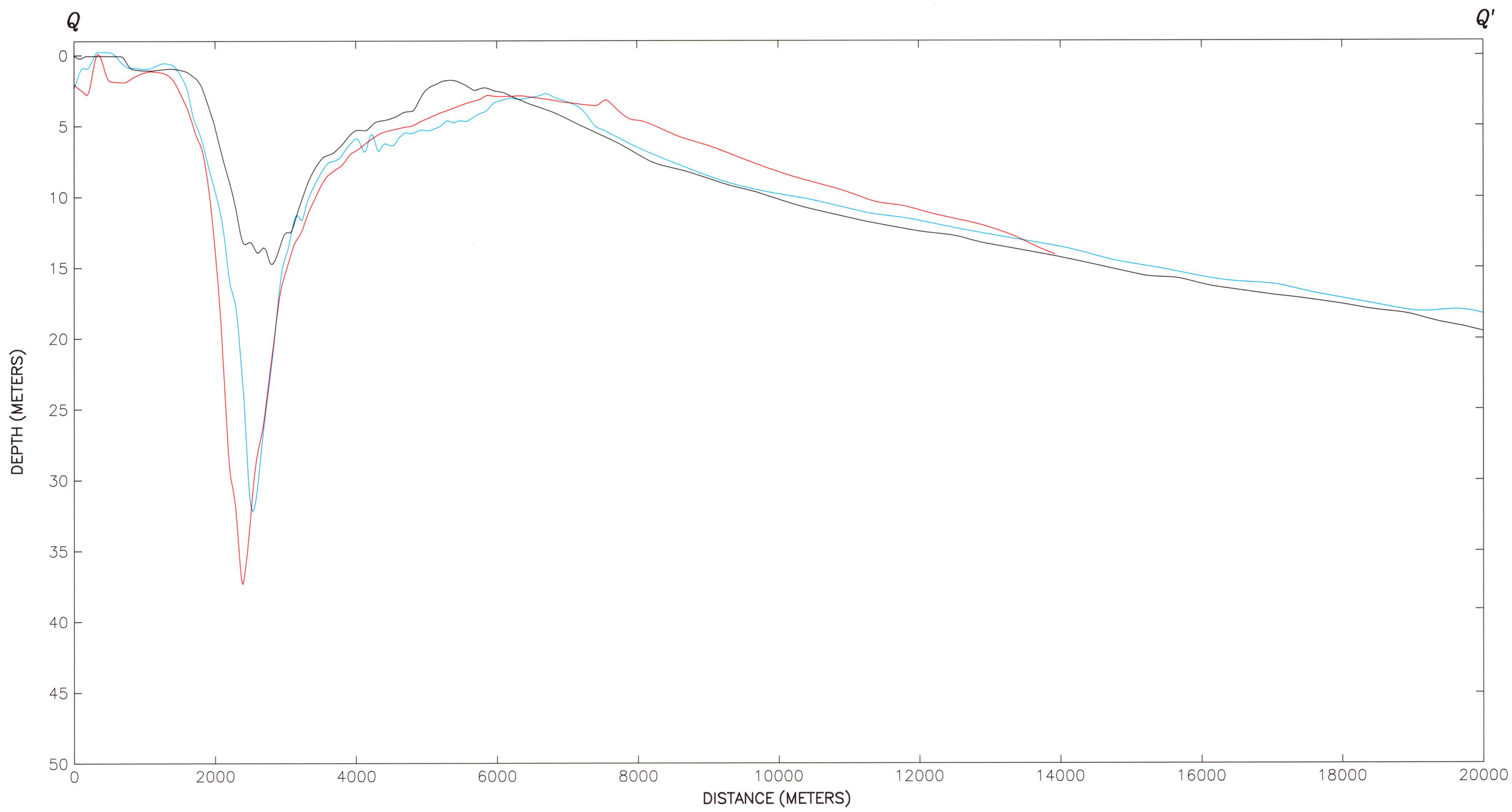
1930's

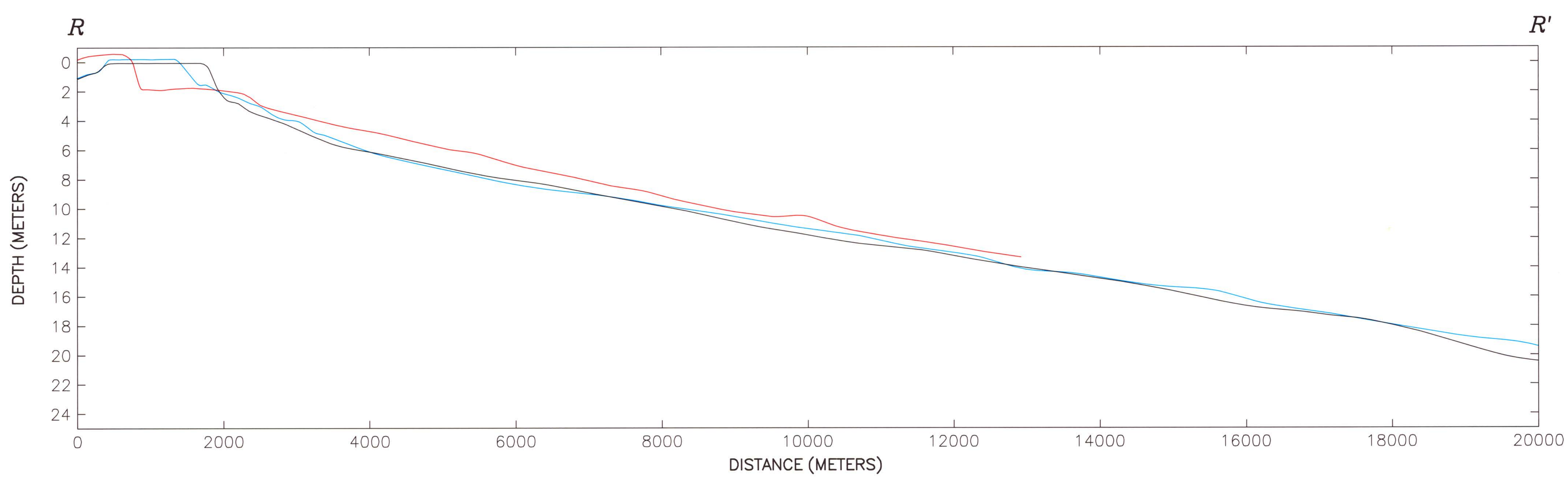
1980's

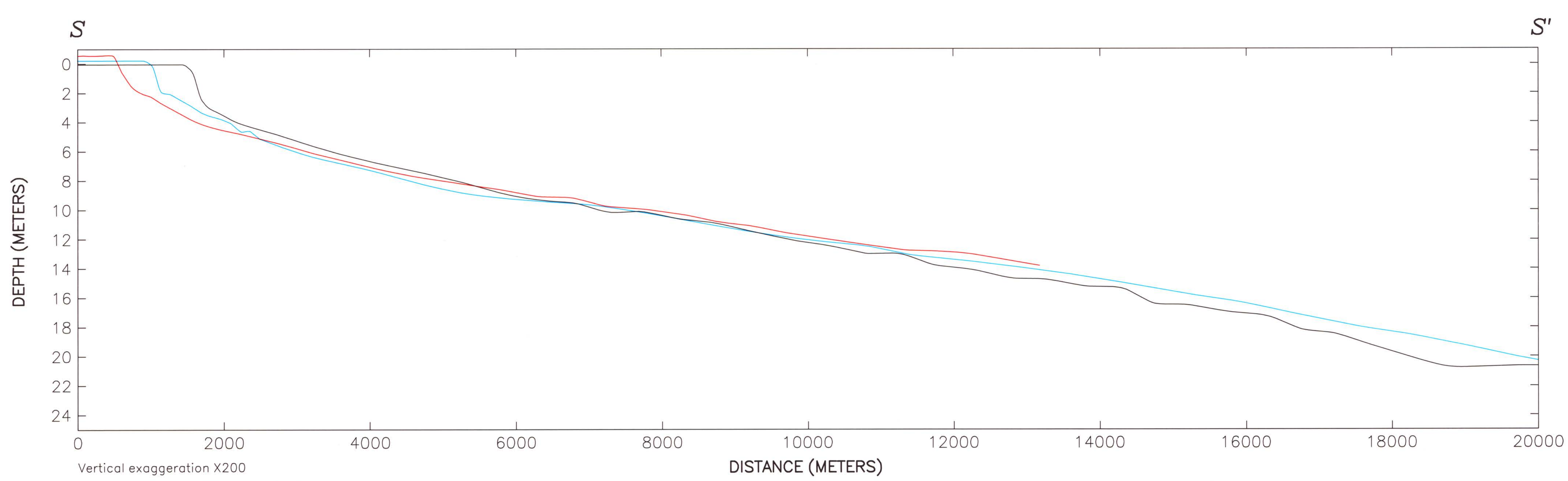
BATHYMETRIC PROFILES I–I' THROUGH L–L'



BATHYMETRIC PROFILES M–M' THROUGH P–P'







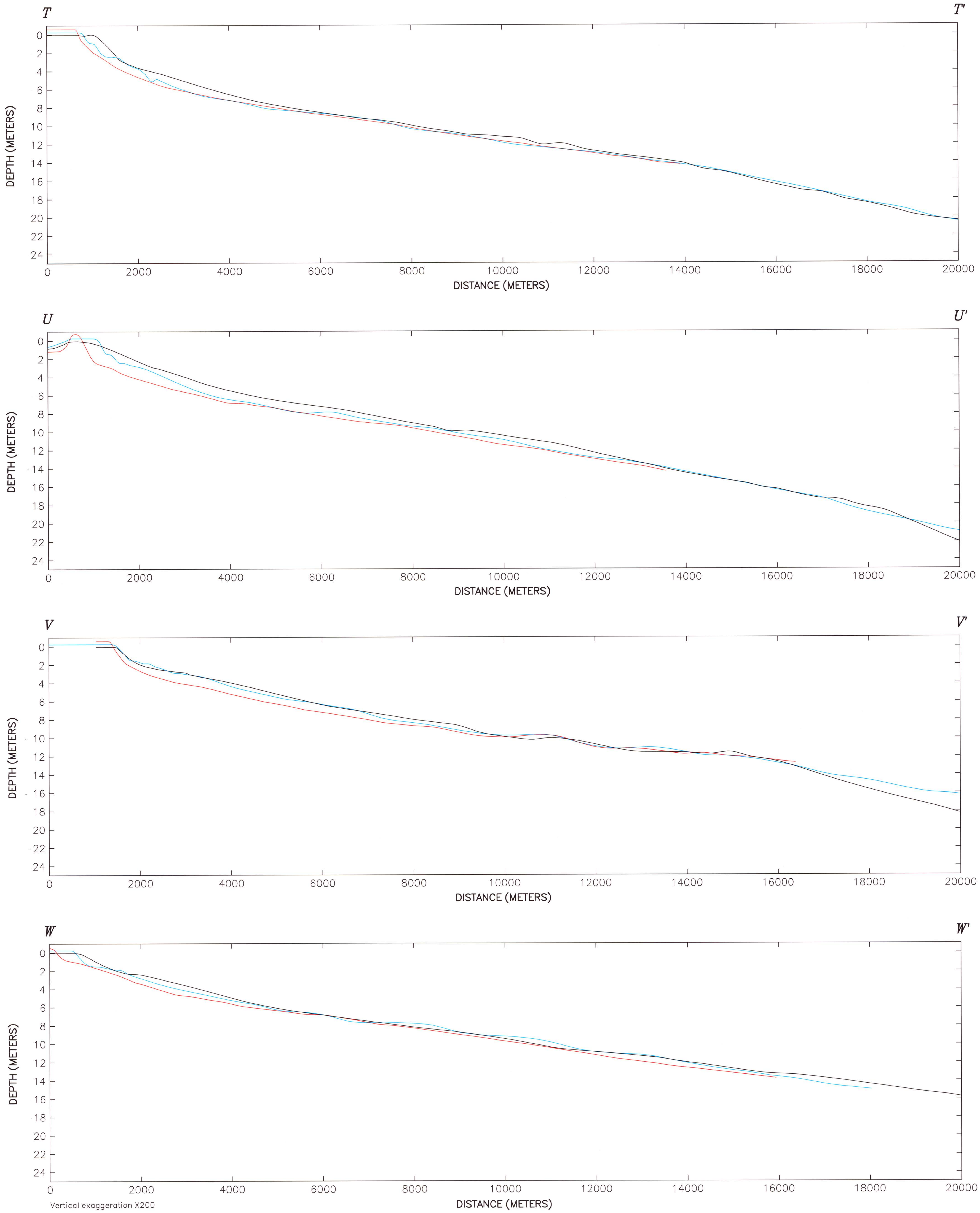
Vertical exaggeration X200

Vertical datums for 1880's and 1930's profiles have been corrected for sea–level rise; see text

EXPLANATION

- 1880's
- 1930's
- 1980's

BATHYMETRIC PROFILES *Q–Q'* THROUGH *S–S'*



Vertical exaggeration X200
Vertical datums for 1880's and 1930's profiles have been corrected for sea–level rise; see text

EXPLANATION
- 1880's
- 1930's
- 1980's

BATHYMETRIC PROFILES *T–T'* THROUGH *W–W'*

ISLES DERNIERES AREA
1:100,000-SCALE MAPS

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2
2–5
5–10
10–15
>15

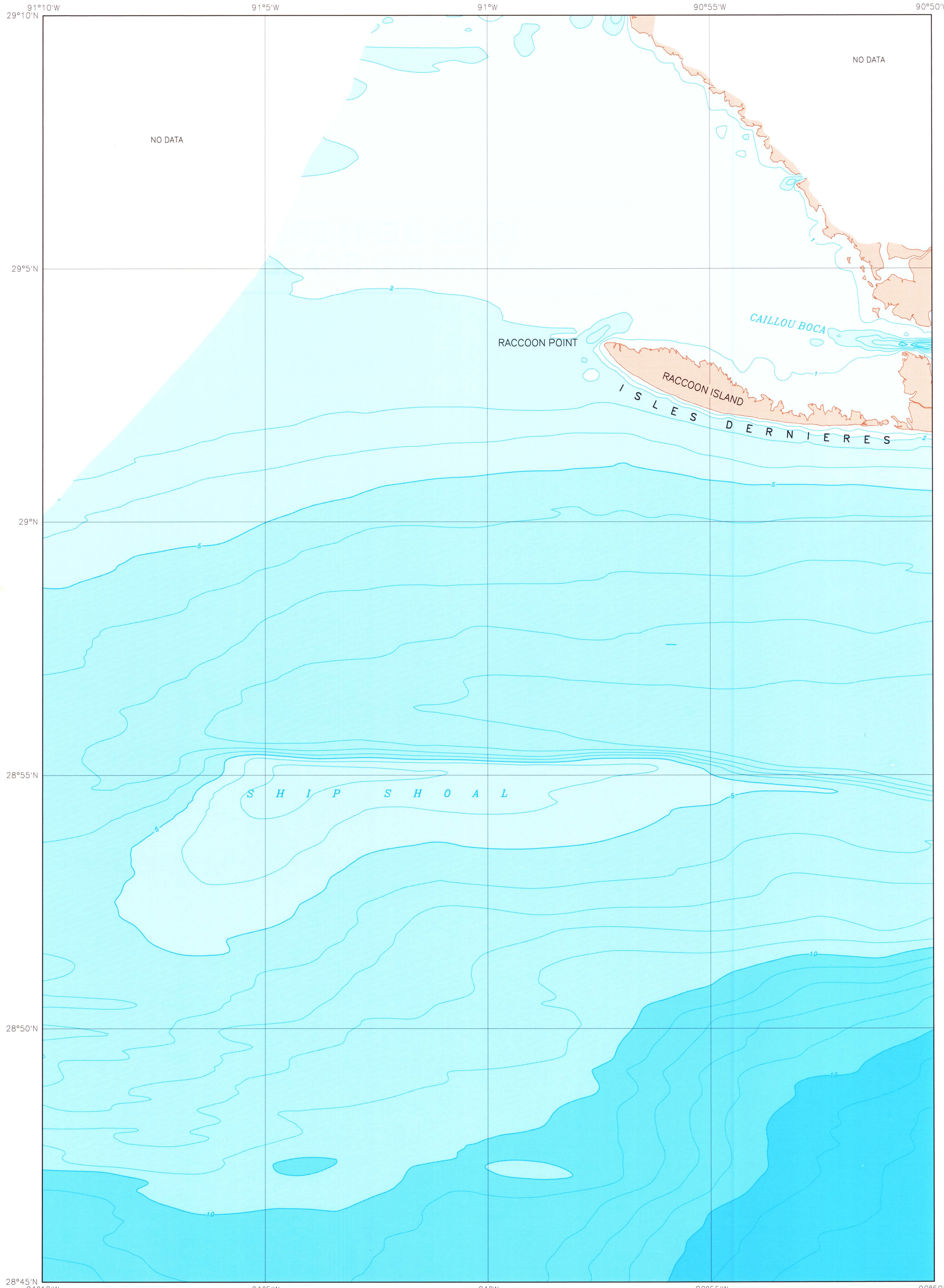
Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1888 and 1889. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1886 and 1887. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

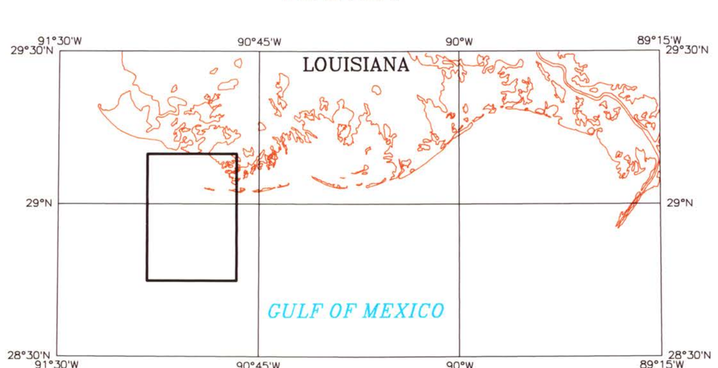
SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

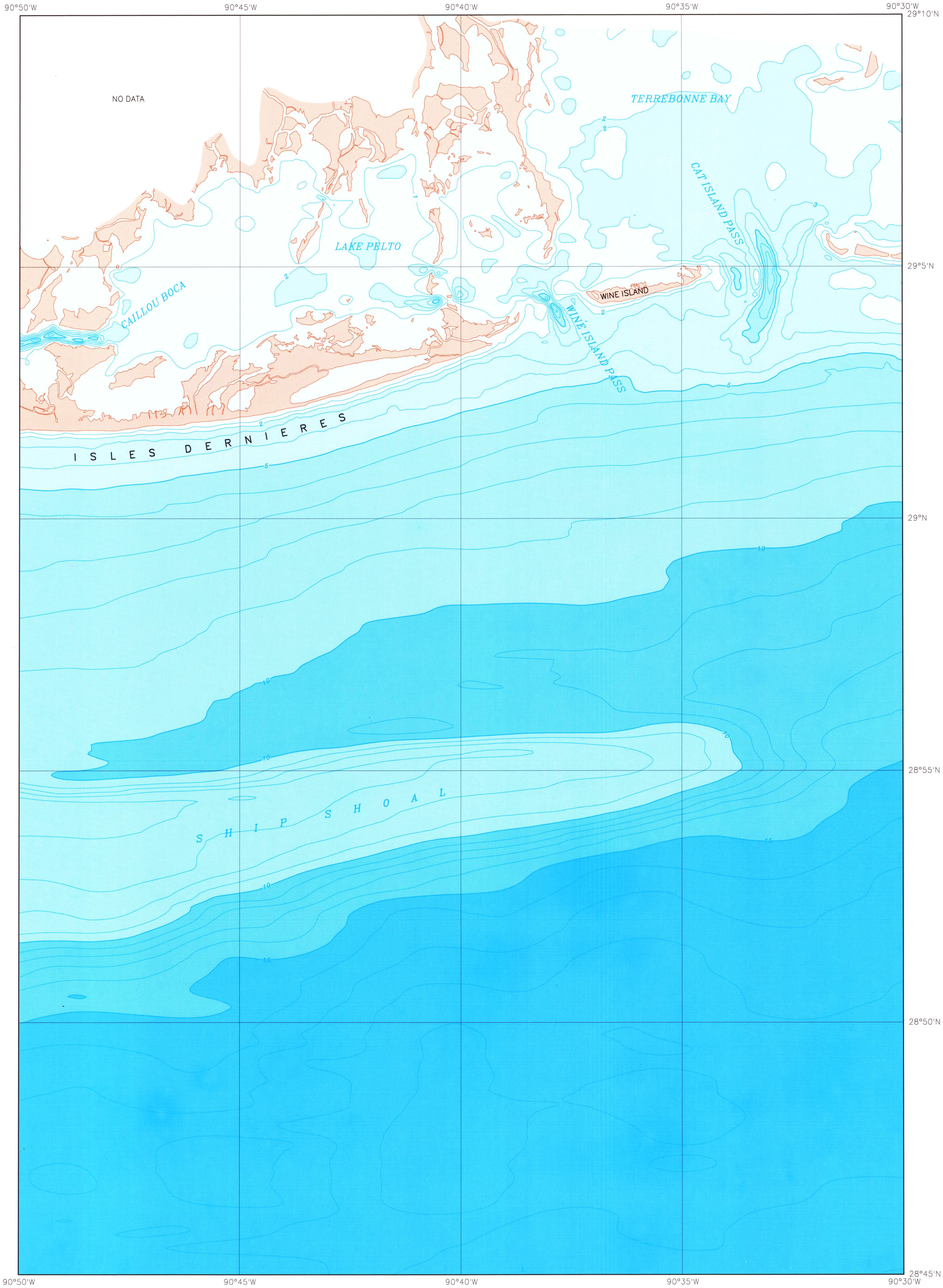
1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

INDEX MAP



ISLES DERNIERES WEST BATHYMETRY, 1880's



EXPLANATION OF MAP COLORS

	Land
DEPTH IN METERS	
	0–2
	2–5
	5–10
	10–15
	>15

Bathymetric Data

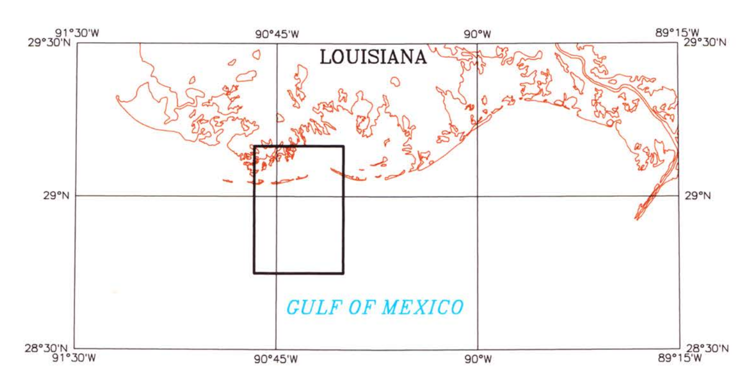
Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1889, 1891, and 1906. The 1906 survey covered a small area behind the eastern part of Isles Dernieres, which had been missed during the 1889 and 1891 surveys. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1887 and 1906. The 1906 data include back–barrier and mainland shorelines behind the eastern end of Isles Dernieres; these shorelines had not been covered during the 1887 survey. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

ISLES DERNIERES EAST BATHYMETRY, 1880's

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1880's SHORELINE

1930's SHORELINE

Sea-floor Change Data

Areas of vertical sea-floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry. Because of relative sea-level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.27 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea-level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea-floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea-floor change documented throughout the study area.

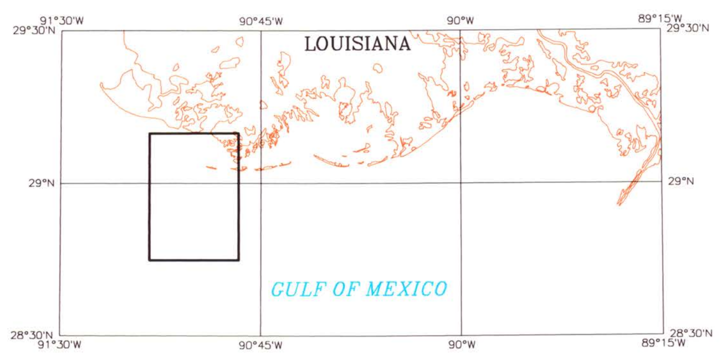
Accuracy of Results

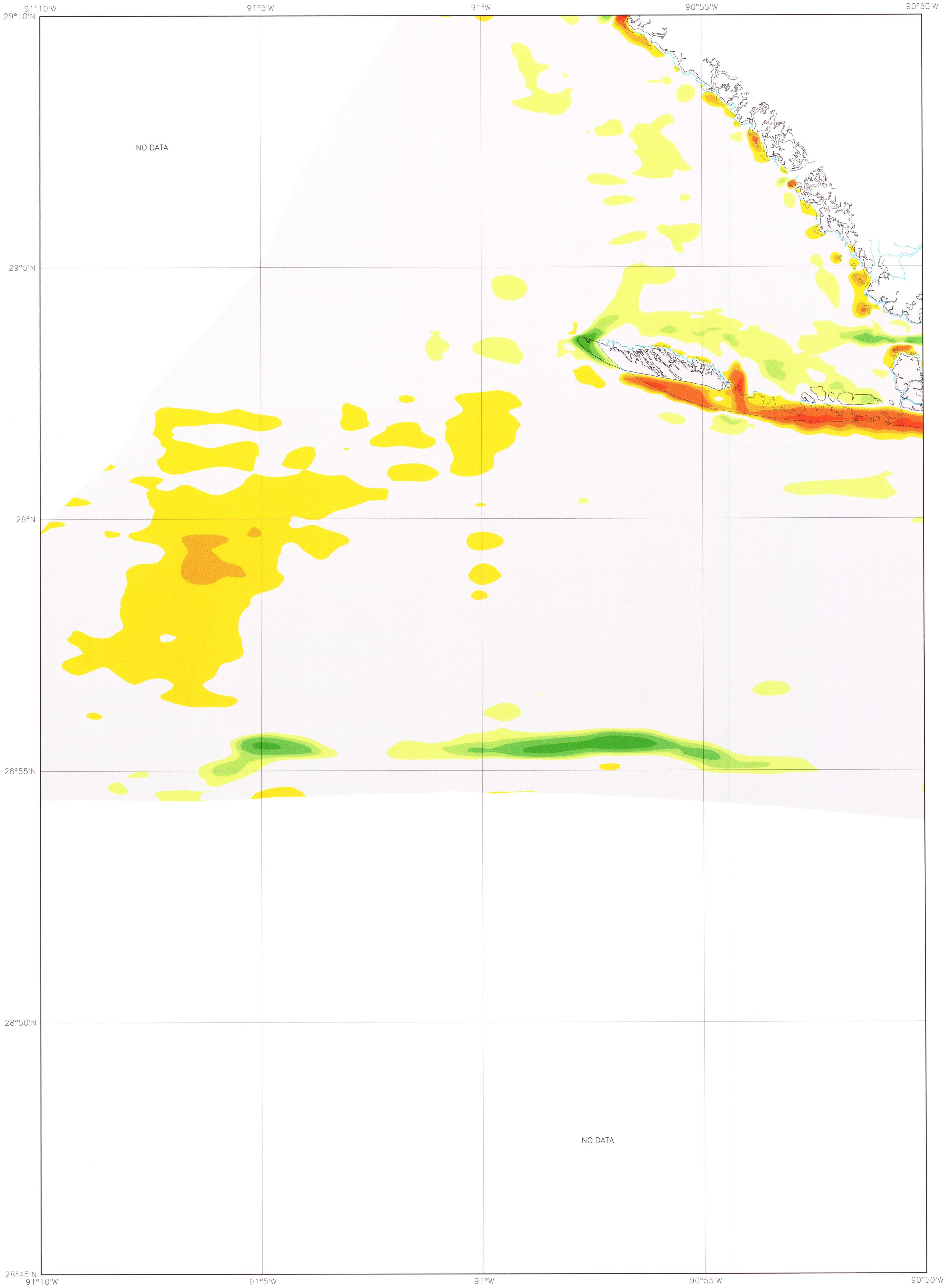
Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character did not change between the 1880's and 1930's. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the precise land elevation in the 1880's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP





Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

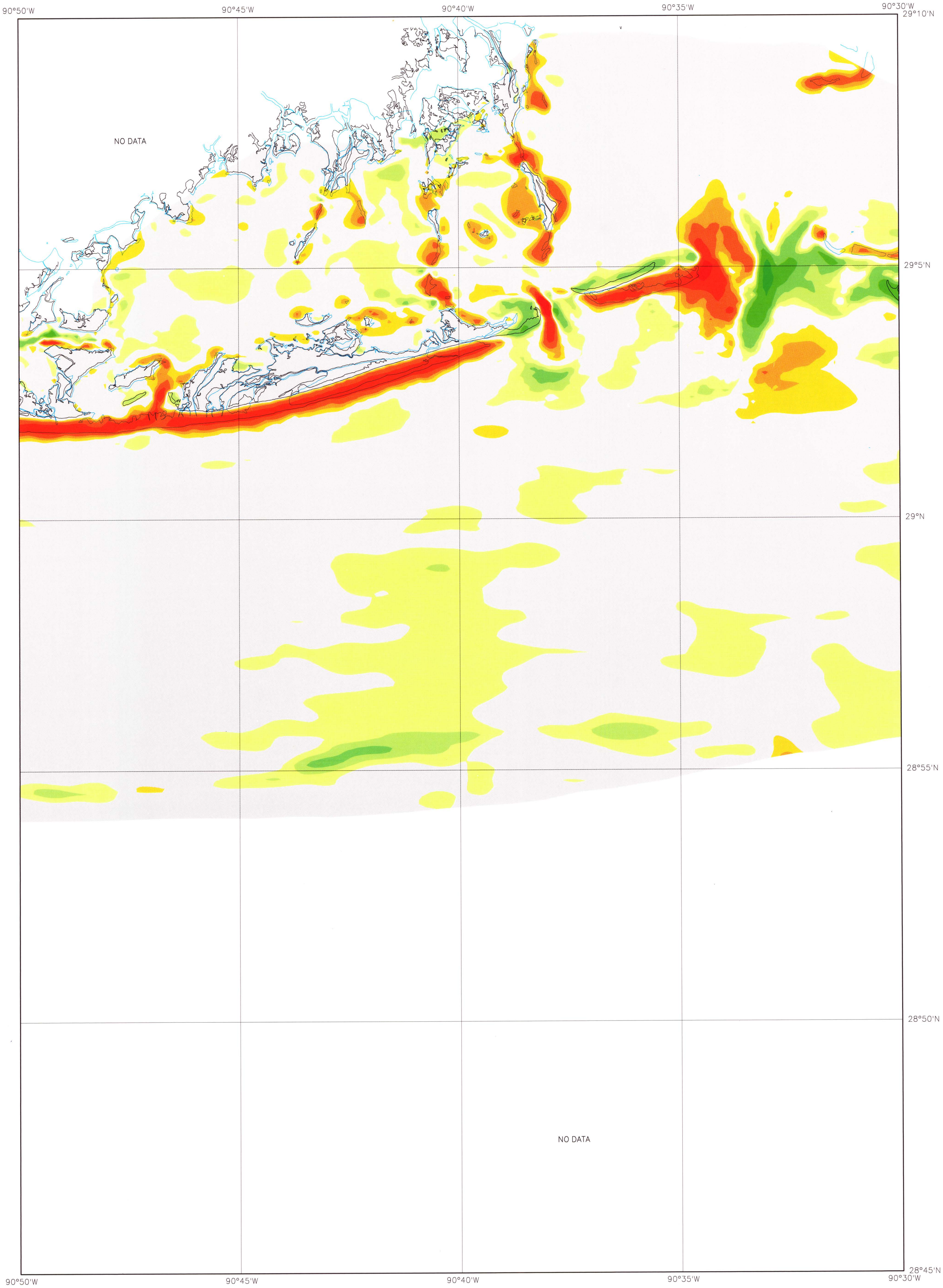
SCALE 1:100 000

NAUTICAL MILES

KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

ISLES DERNIERES WEST SEA–FLOOR CHANGE, 1880's–1930's



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

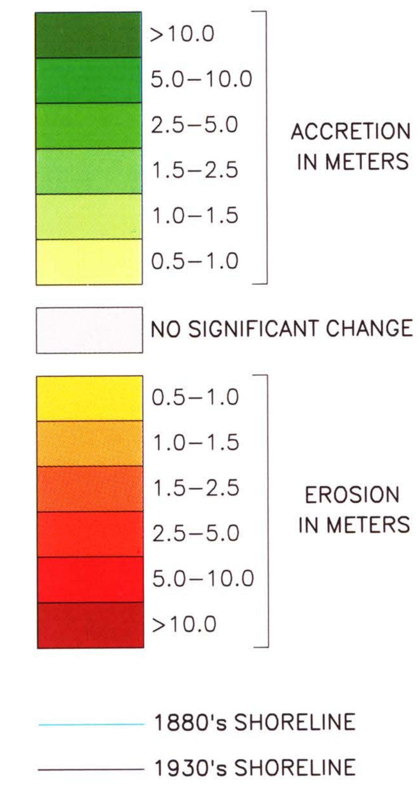
1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

EXPLANATION OF MAP COLORS



Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.27 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

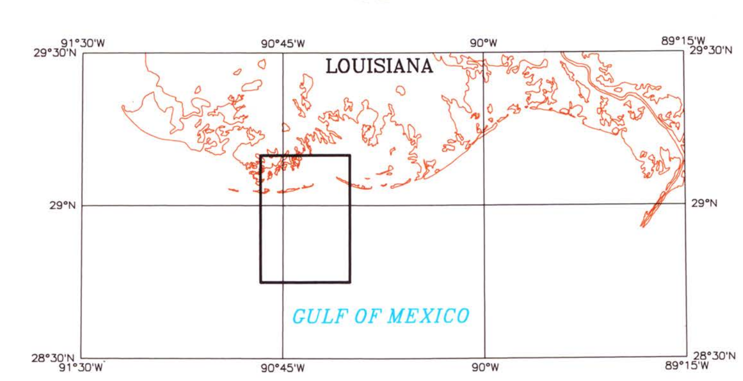
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character did not change between the 1880's and 1930's. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the precise land elevation in the 1880's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



ISLES DERNIERES EAST SEA–FLOOR CHANGE, 1880's–1930's

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

EXPLANATION OF MAP COLORS

(tan)	Land

DEPTH IN METERS

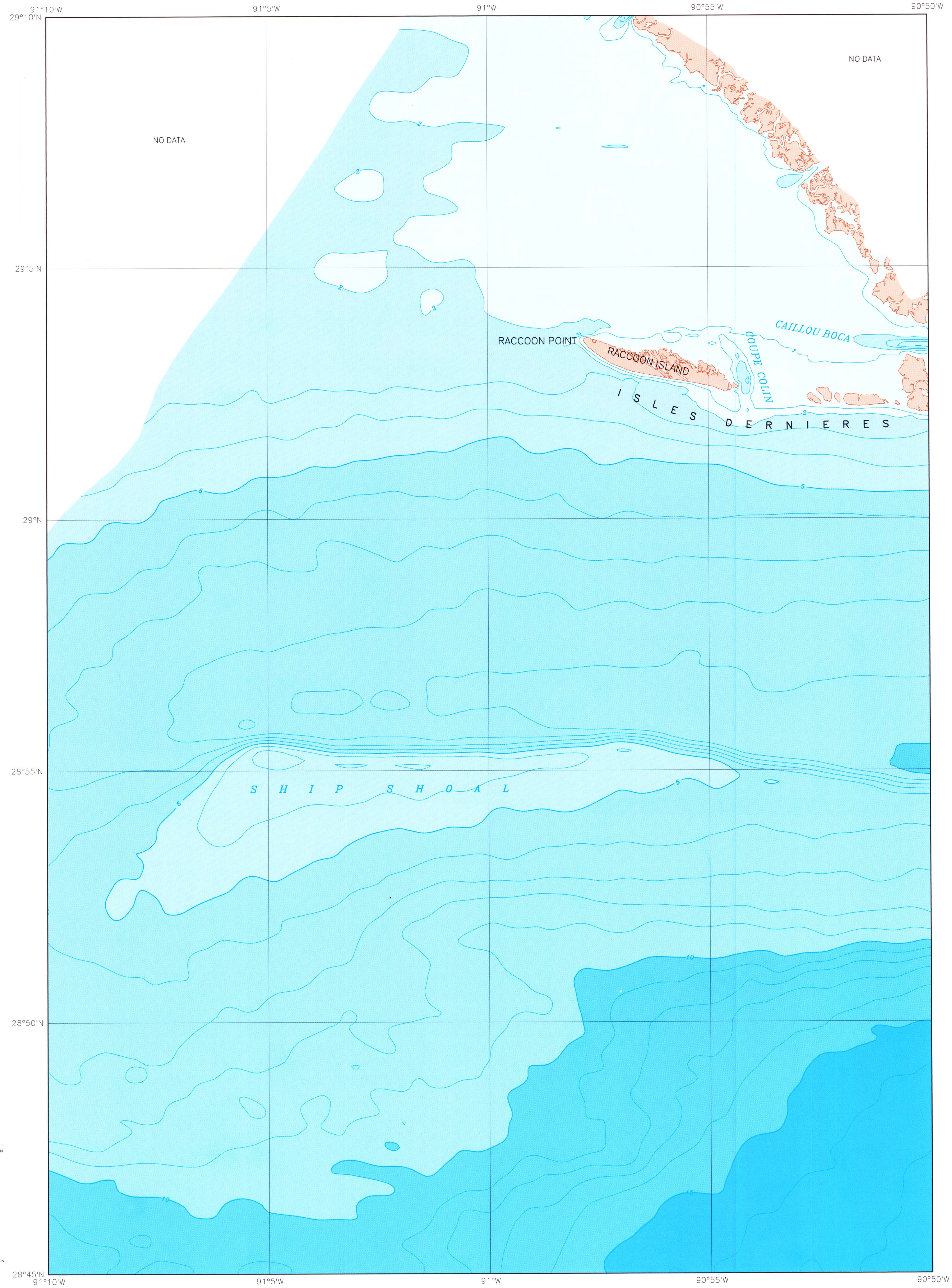
(white)	0–2
(lightest blue)	2–5
(light blue)	5–10
(medium blue)	10–15
(dark blue)	>15

Bathymetric Data

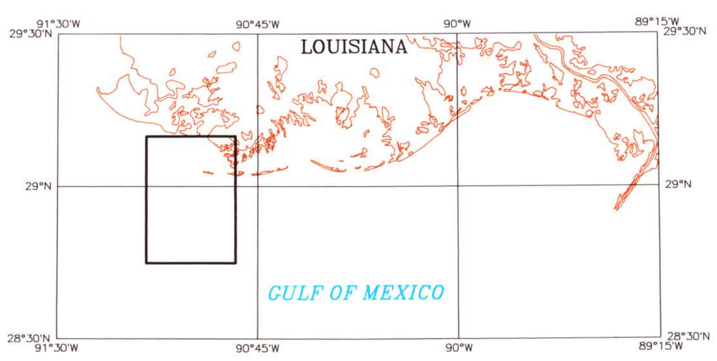
Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1934, 1935, and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from the years 1932 and 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.



INDEX MAP



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

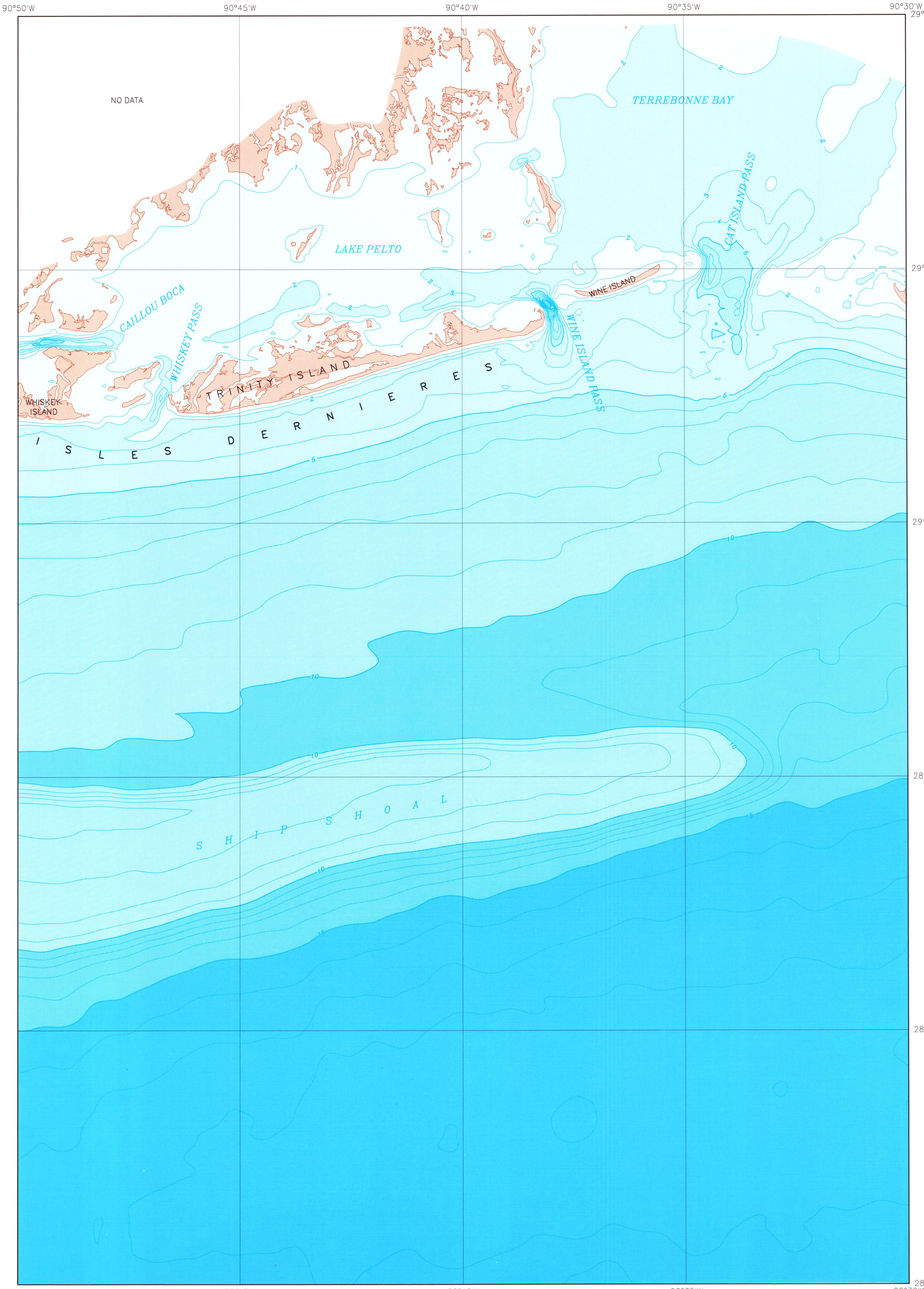
SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

ISLES DERNIERES WEST BATHYMETRY, 1930's



EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2

2–5

5–10

10–15

>15

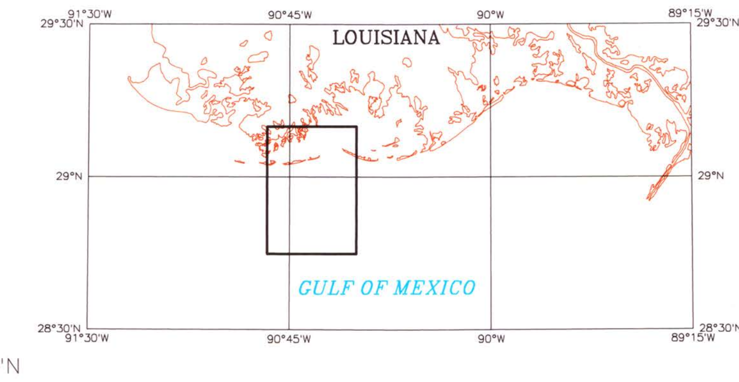
Bathymetric Data

Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1934, 1935, and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from the years 1932 and 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

ISLES DERNIERES EAST BATHYMETRY, 1930's

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1930's SHORELINE
1980's SHORELINE

Sea-floor Change Data

Areas of vertical sea-floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry. Because of relative sea-level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.33 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea-level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea-floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea-floor change documented throughout the study area.

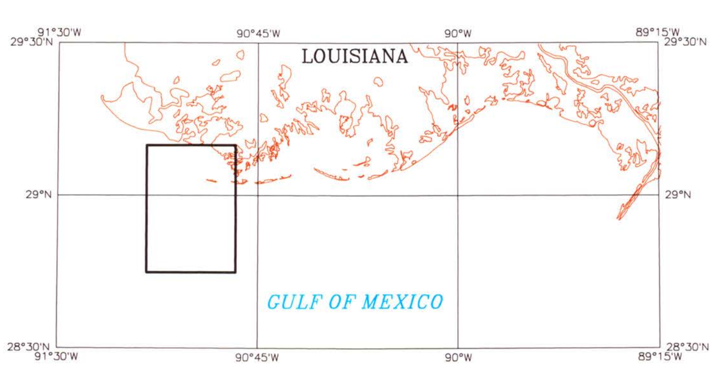
Accuracy of Results

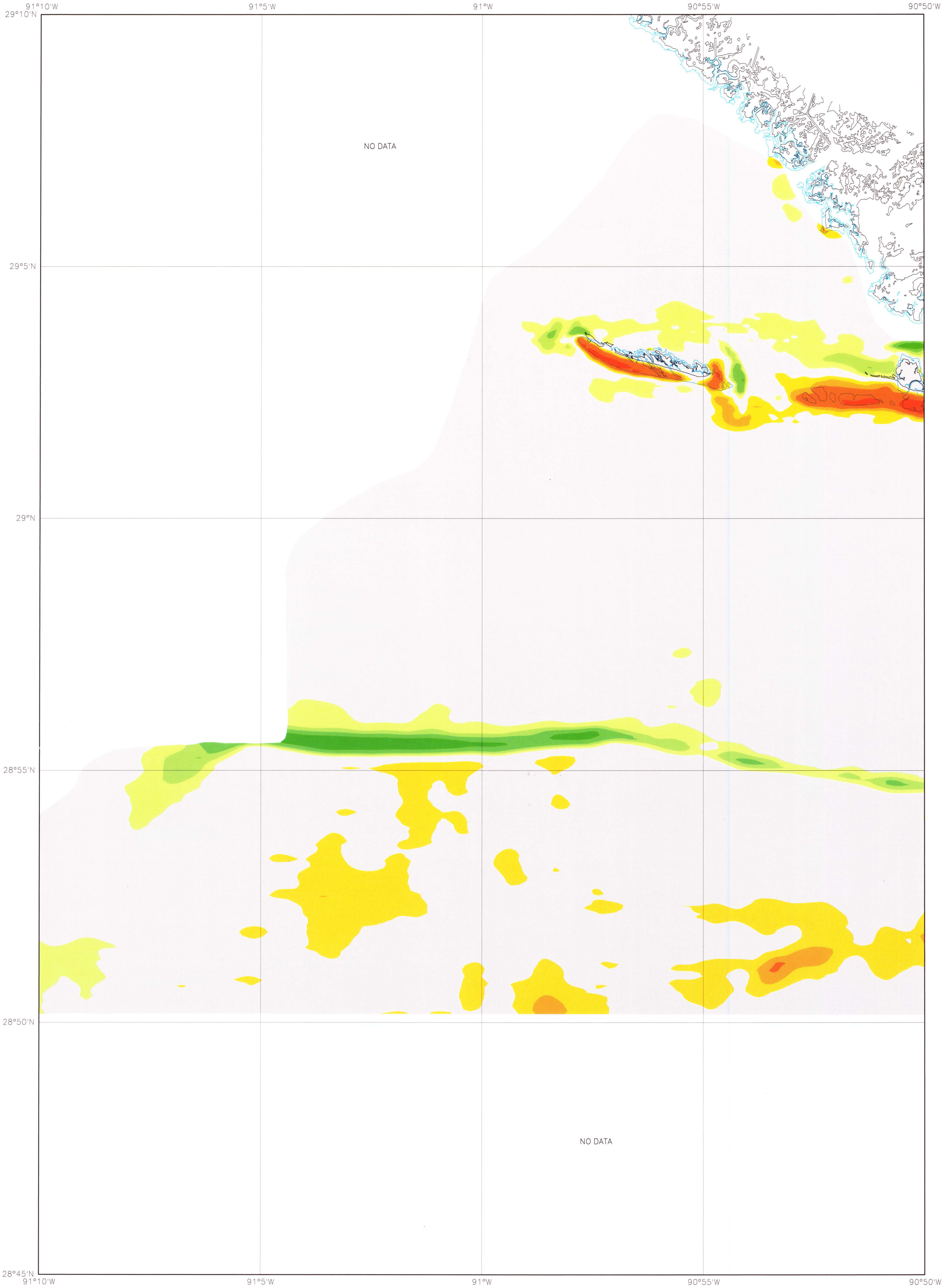
Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character has not changed since the 1930's. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the precise land elevation in the 1930's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP





Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

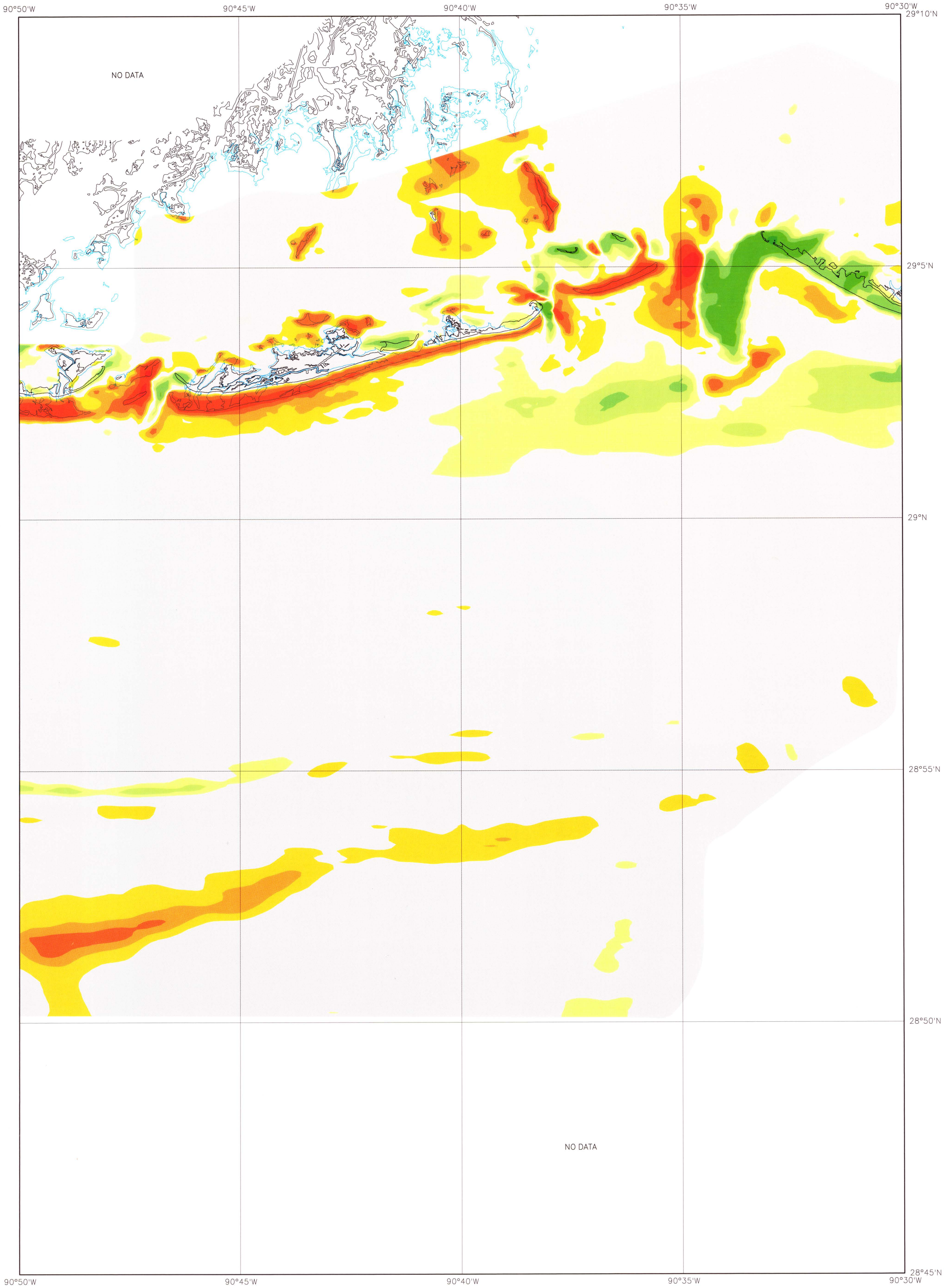
SCALE 1:100 000

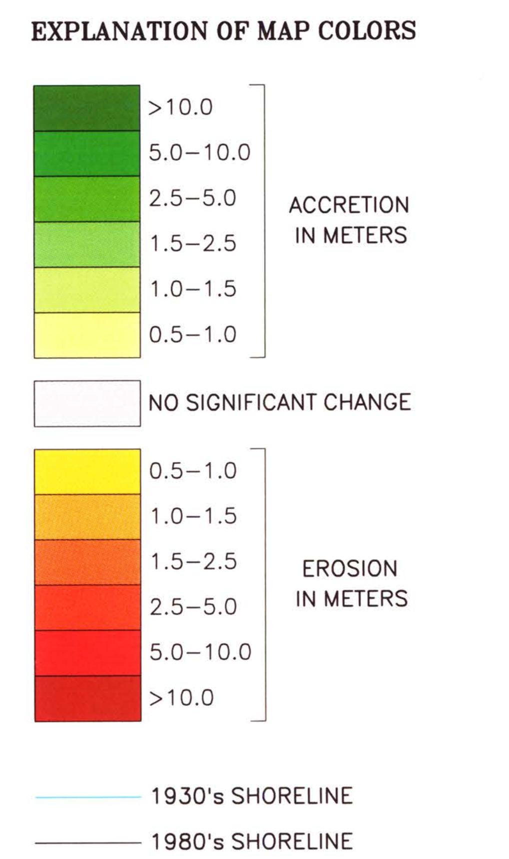
1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

ISLES DERNIERES WEST SEA-FLOOR CHANGE, 1930's–1980's





SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.33 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

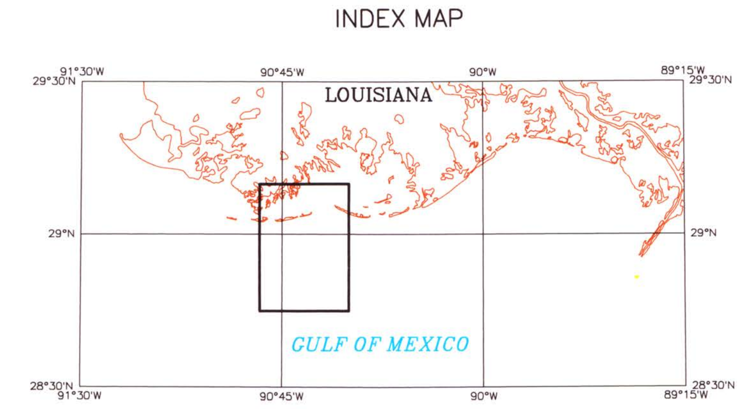
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character has not changed since the 1930's. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the precise land elevation in the 1930's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



ISLES DERNIERES EAST SEA–FLOOR CHANGE, 1930's–1980's

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2
2–5
5–10
10–15
>15

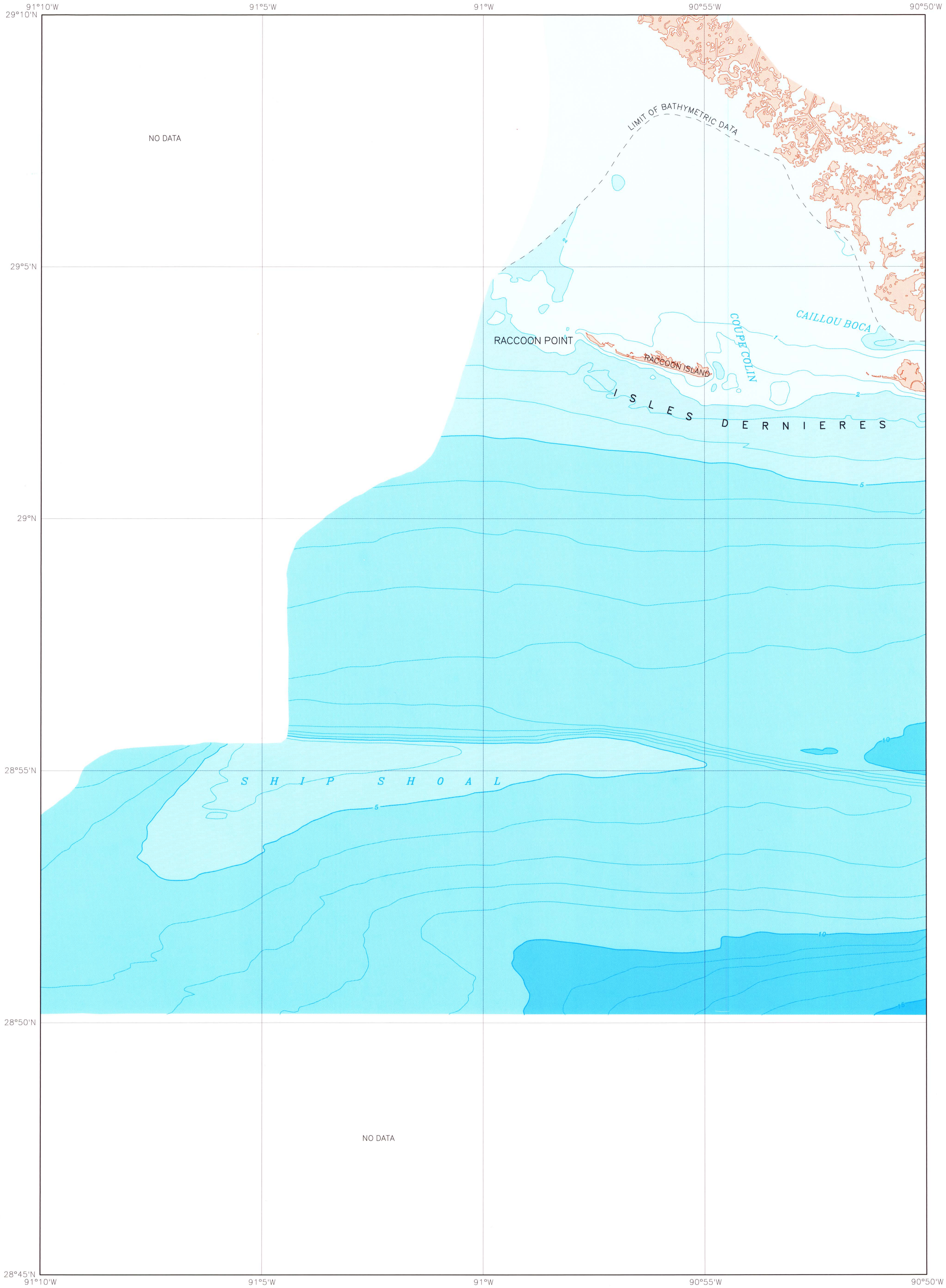
Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from a hydrographic survey conducted in 1986 by Geodetic International, Inc., under contract to the USGS. This survey utilized a Sercel Syledis, UHF–type radio positioning system for horizontal control and a Krupp–Atlas, model 20, high–precision dual–frequency fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

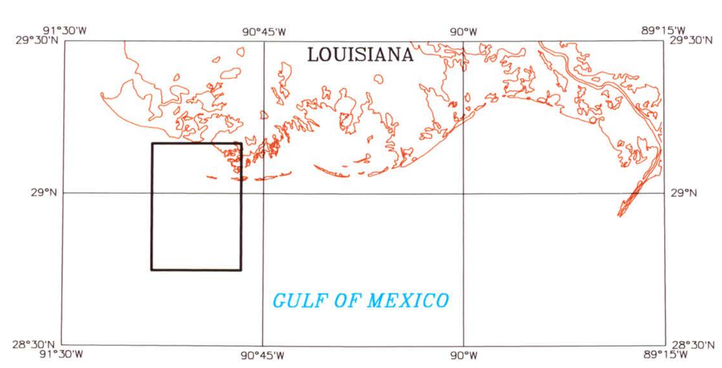
Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. Other open–water areas, for which bathymetric data are lacking, are also shown in blue. These areas, which fall outside the dashed line labeled "limit of bathymetric data," include land features that both serve as a reference for offshore areas and allow a comparison with maps from other years in the atlas.

Shoreline Data

The shorelines shown on this map were obtained from aerial photography taken in 1986 and 1989. The 1986 photographs were taken by Gulf Coast Aerial Mapping Co., Inc. These black and white photographs covered the Isles Dernieres section of the study area at a scale of 1:4,800. The approximate position of the mean high water (MHW) shoreline was digitized directly from these photographs, and was then rectified to the geographic coordinates of 1950's U.S Coast and Geodetic Survey topographic sheets at scale 1:20,000. The 1989 photographs were high–altitude color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the MHW shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.



INDEX MAP



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

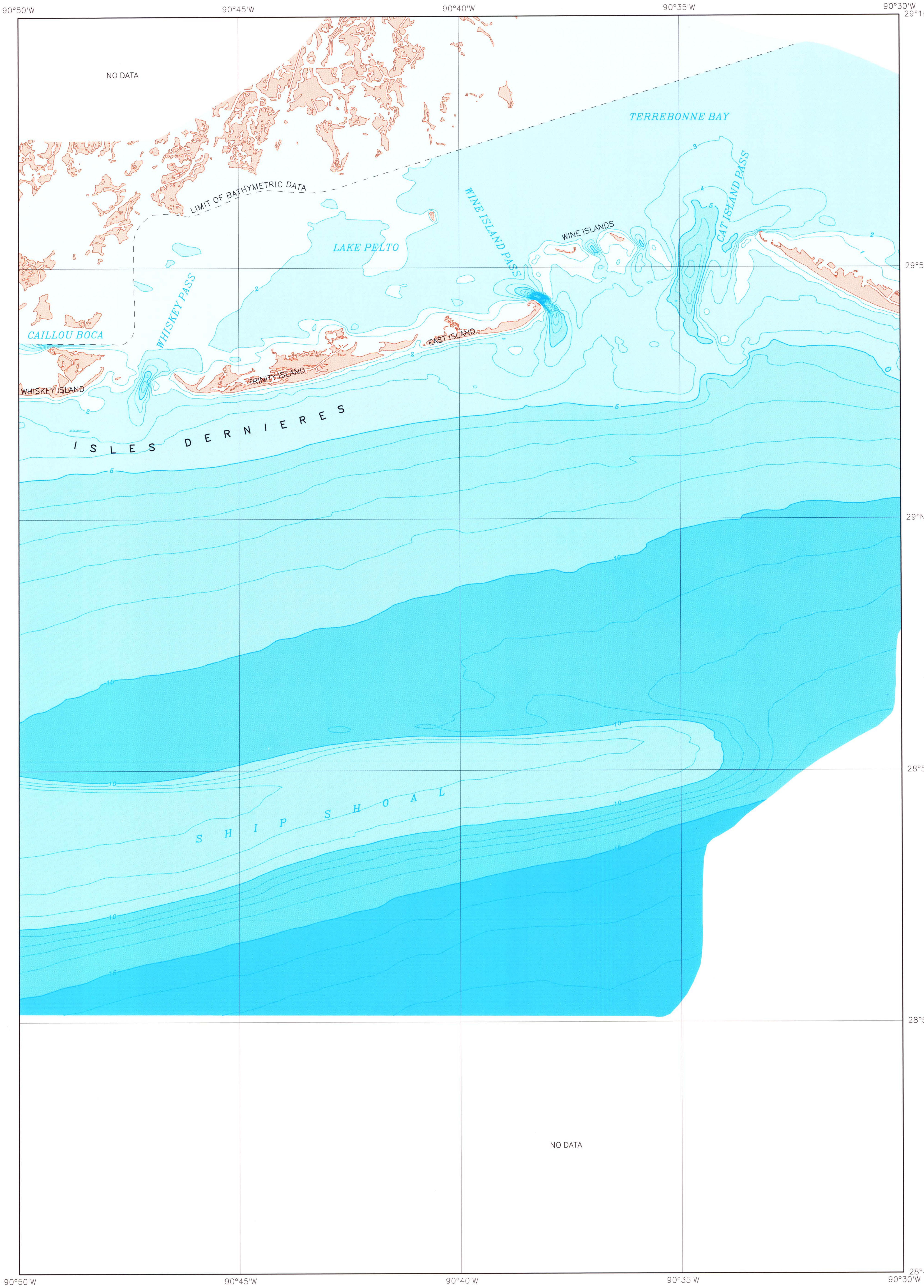
SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

ISLES DERNIERES WEST BATHYMETRY, 1980's



EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–2
- 2–5
- 5–10
- 10–15
- >15

Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from a hydrographic survey conducted in 1986 by Geodetic International, Inc., under contract to the USGS. This survey utilized a Sercel Syledis, UHF–type radio positioning system for horizontal control and a Krupp–Atlas, model 20, high–precision dual–frequency fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

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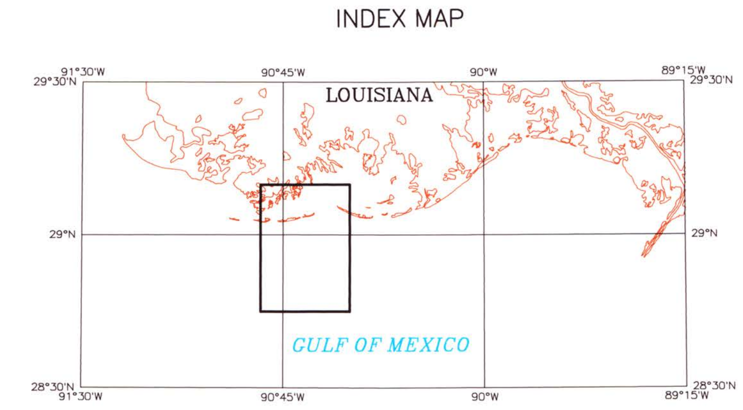
The shorelines shown on this map were obtained from aerial photography taken in 1986 and 1989. The 1986 photographs were taken by Gulf Coast Aerial Mapping Co., Inc. These black and white photographs covered the Isles Dernieres section of the study area at a scale of 1:4,800. The approximate position of the mean high water (MHW) shoreline was digitized directly from these photographs, and was then rectified to the geographic coordinates of 1950's U.S Coast and Geodetic Survey topographic sheets at scale 1:20,000. The 1989 photographs were high–altitude color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the MHW shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.

INDEX MAP



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

ISLES DERNIERES EAST BATHYMETRY, 1980's

CAT ISLAND PASS AREA
1:100,000-SCALE MAPS

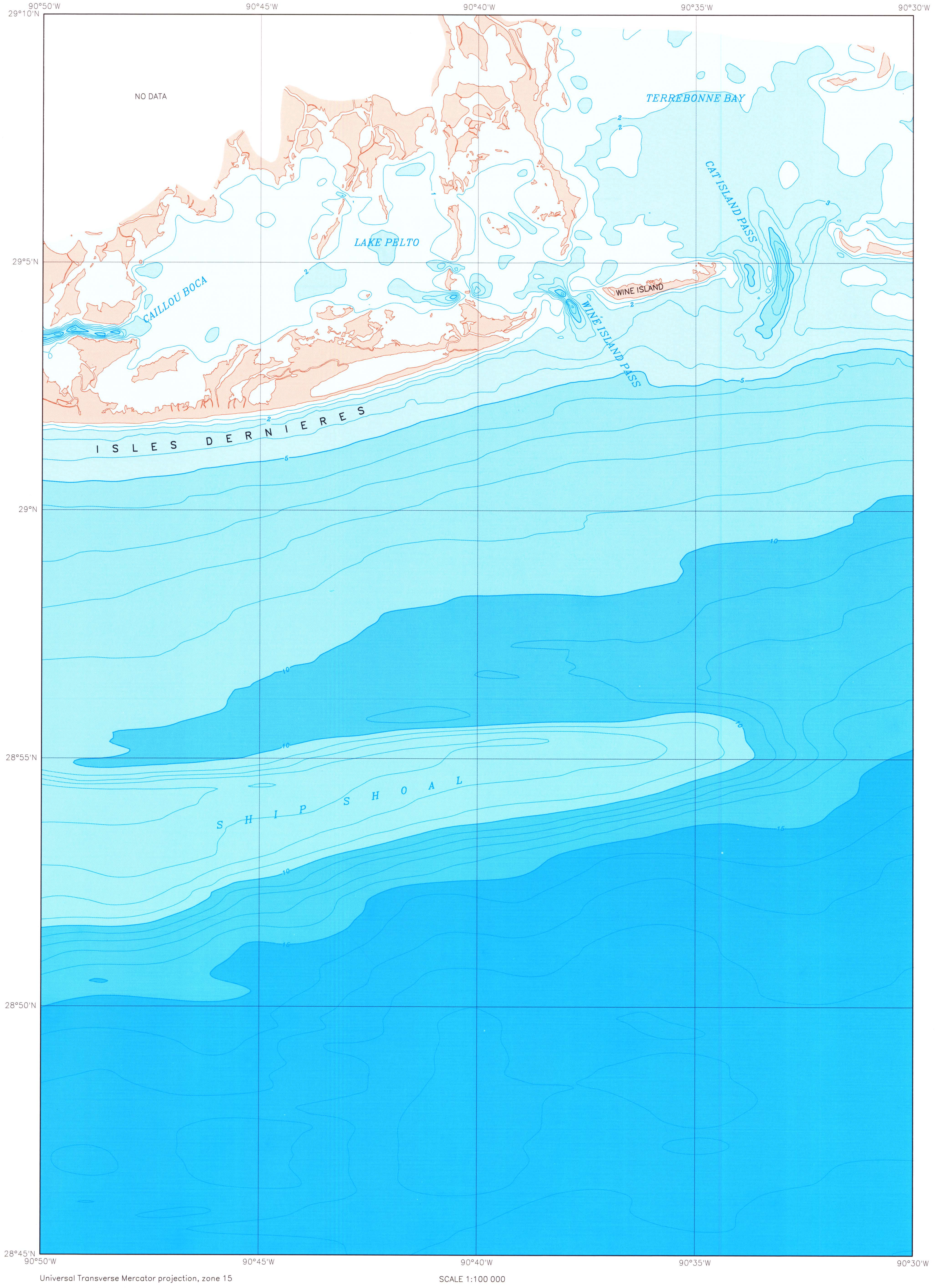
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–2
- 2–5
- 5–10
- 10–15
- >15



Bathymetric Data

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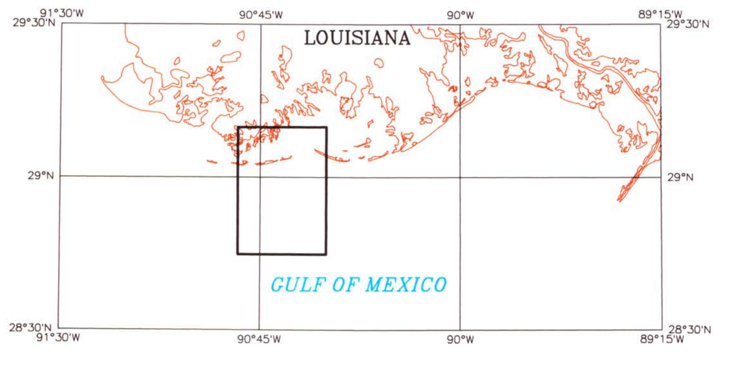
INDEX MAP



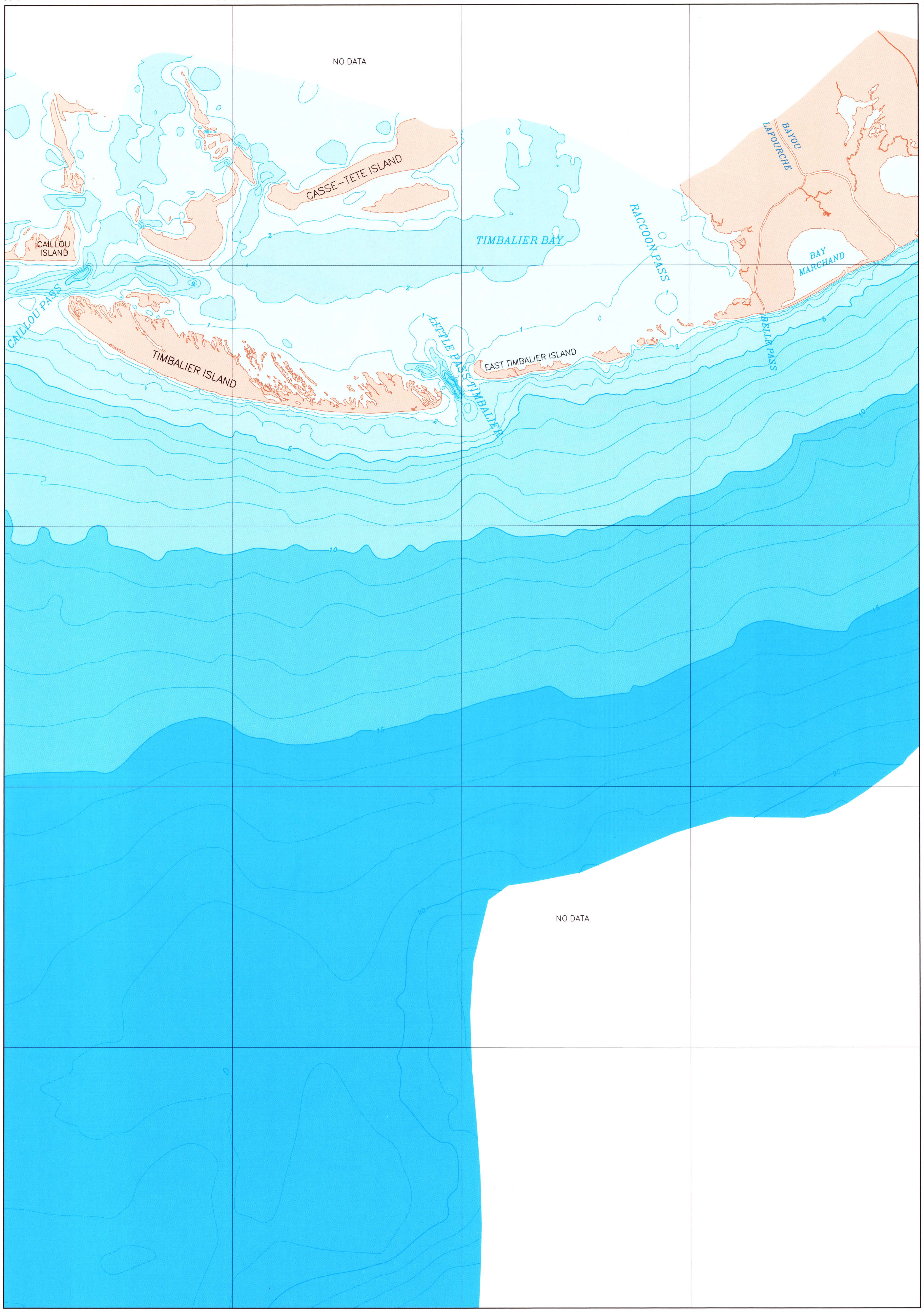
Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES
1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

CAT ISLAND PASS WEST BATHYMETRY, 1880's



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2
2–5
5–10
10–15
>15

Bathymetric Data

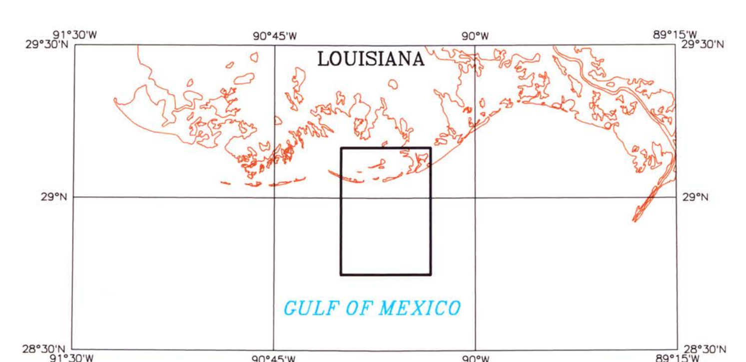
Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from 1891. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1886 and 1887. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



CAT ISLAND PASS EAST BATHYMETRY, 1880's

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1880's SHORELINE

1930's SHORELINE

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.27 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

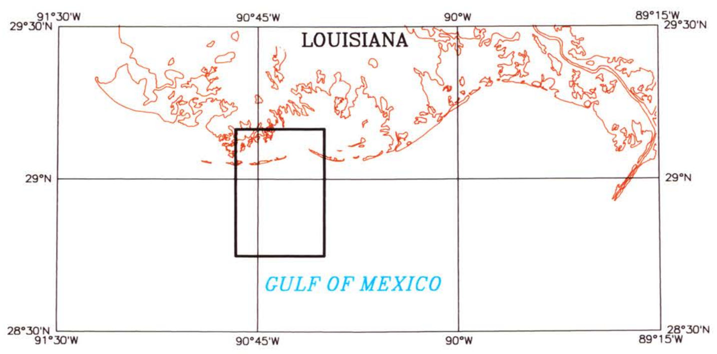
Accuracy of Results

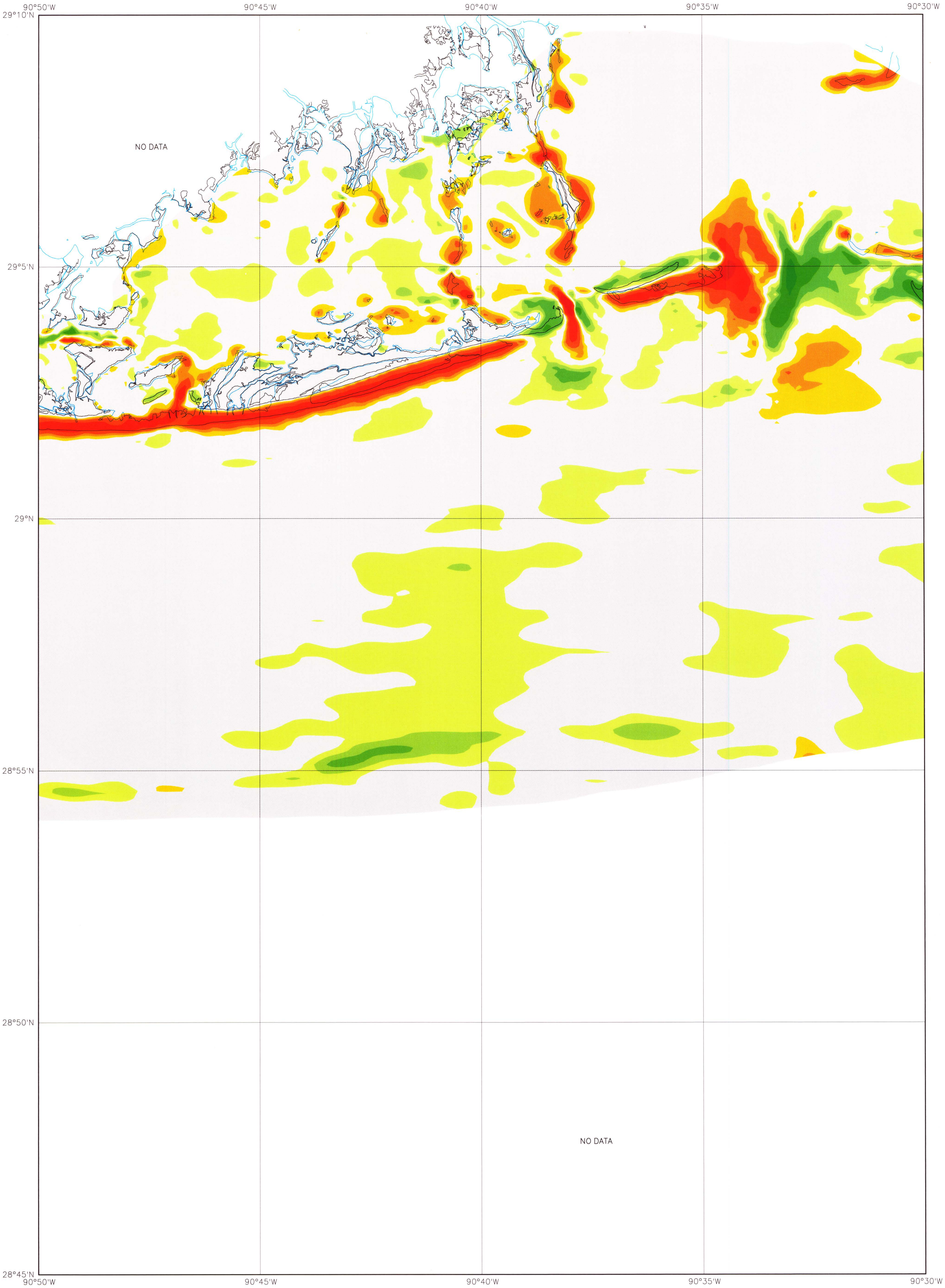
Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character did not change between the 1880's and 1930's. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the precise land elevation in the 1880's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP





Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

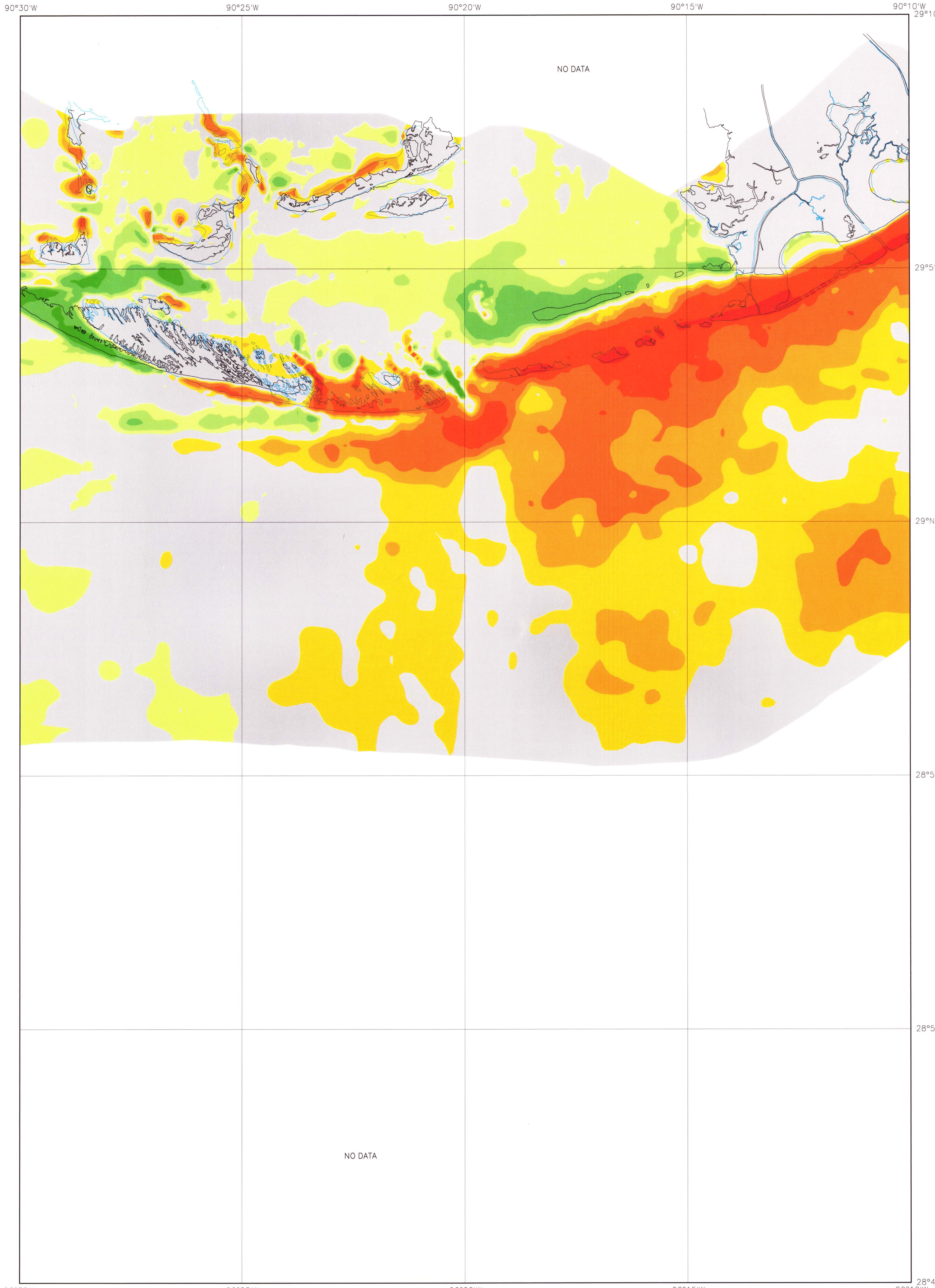
SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

CAT ISLAND PASS WEST SEA–FLOOR CHANGE, 1880's–1930's



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1880's SHORELINE

1930's SHORELINE

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.27 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

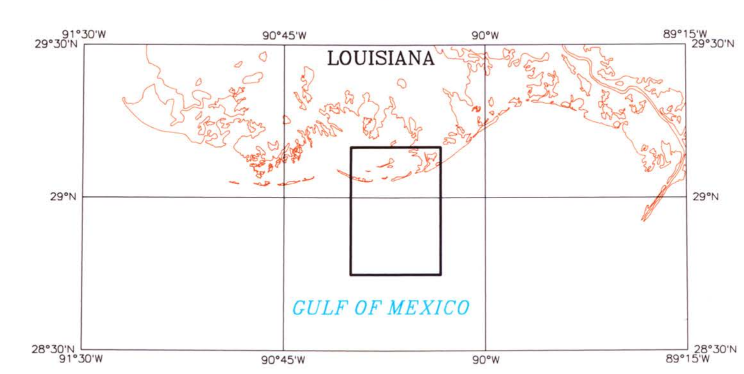
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character did not change between the 1880's and 1930's. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the precise land elevation in the 1880's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



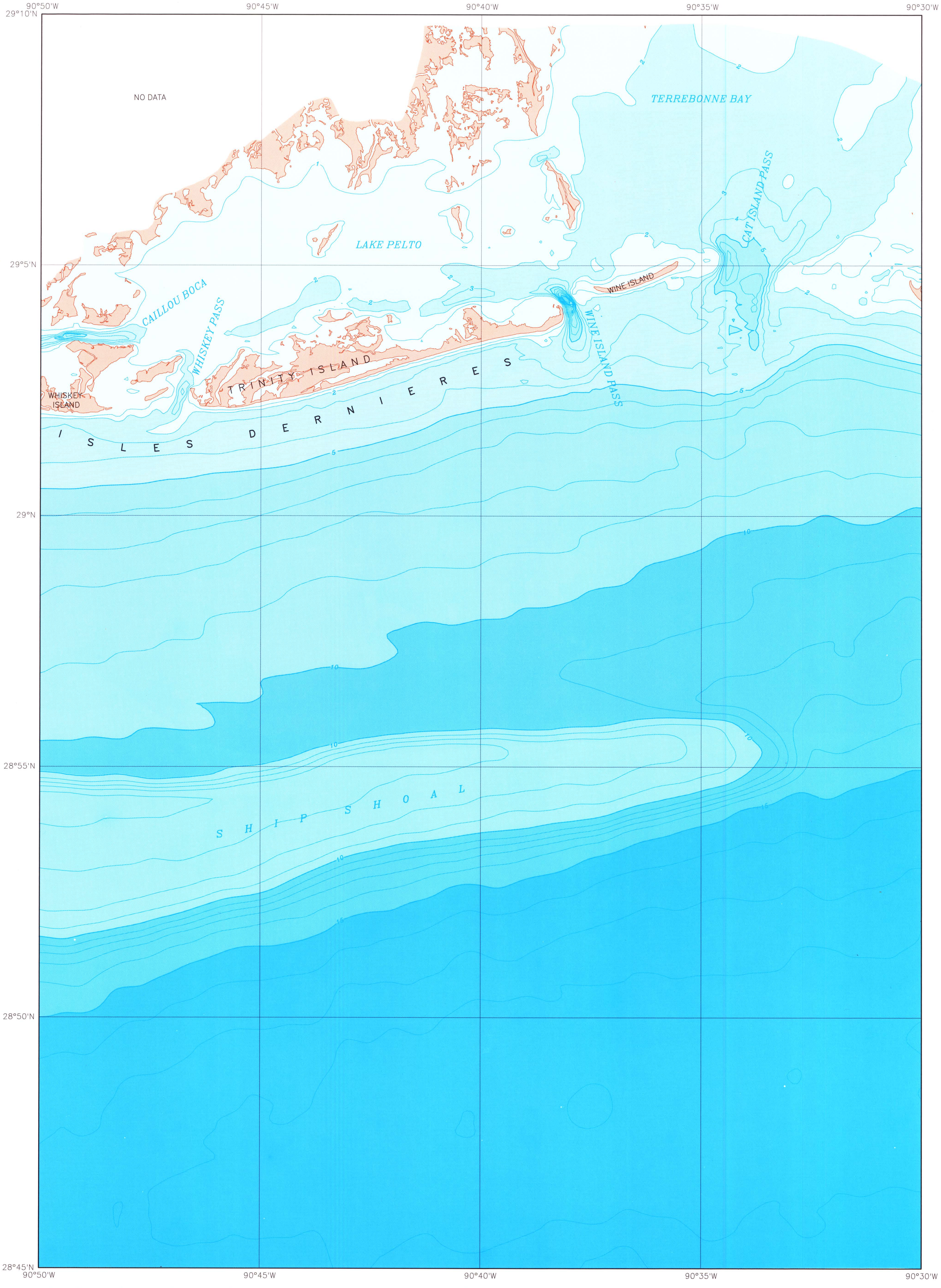
CAT ISLAND PASS EAST SEA–FLOOR CHANGE, 1880's–1930's

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2
2–5
5–10
10–15
>15



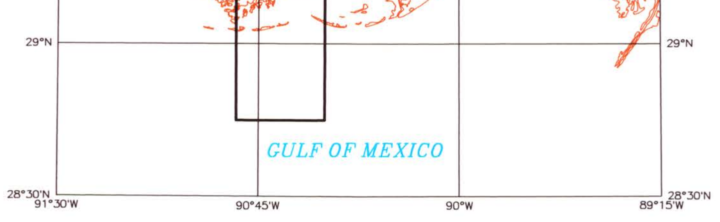
Bathymetric Data

Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1934, 1935, and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from the years 1932 and 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

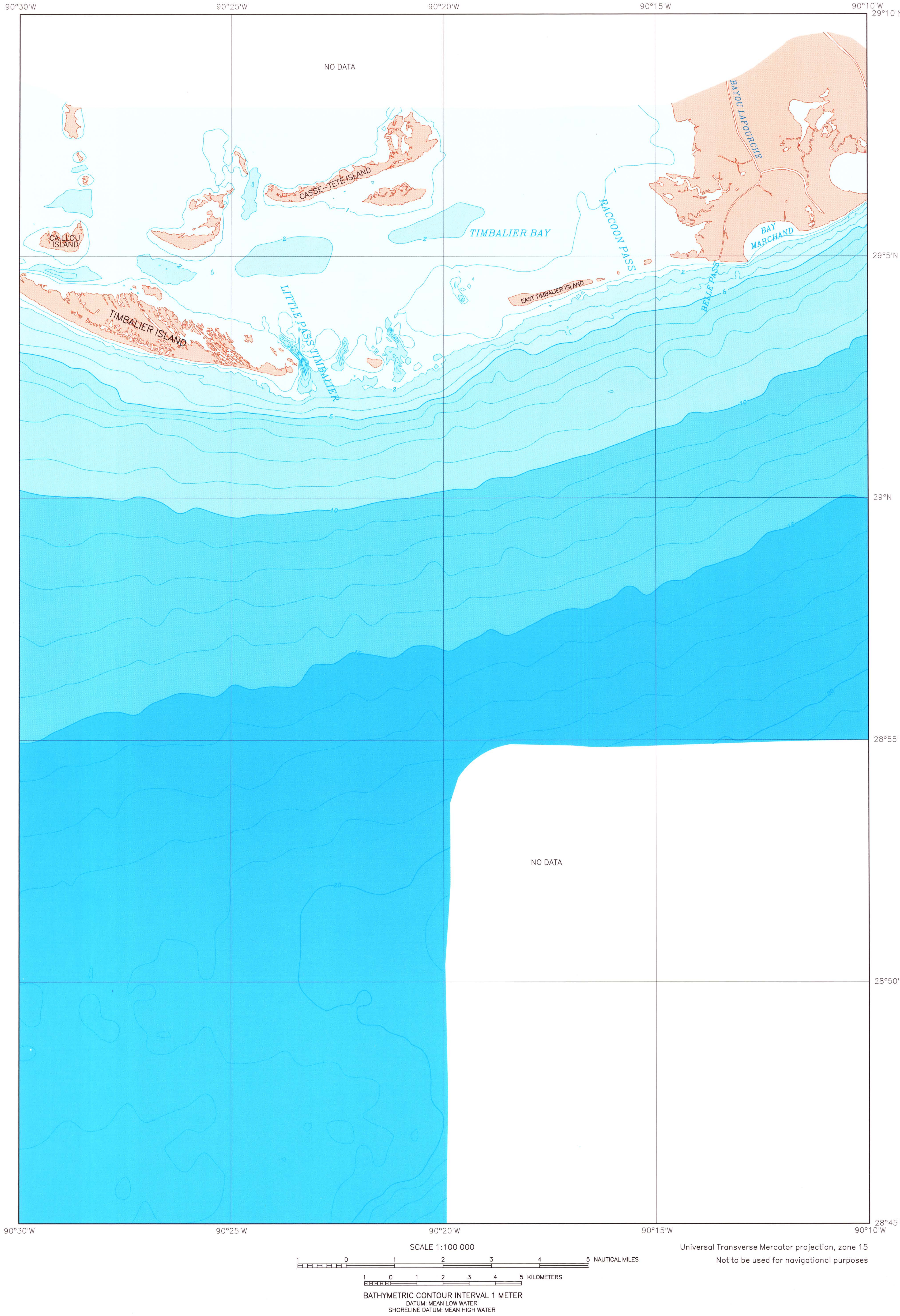
1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER

DATUM: MEAN LOW WATER

SHORELINE DATUM: MEAN HIGH WATER

CAT ISLAND PASS WEST BATHYMETRY, 1930's



EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2
2–5
5–10
10–15
>15

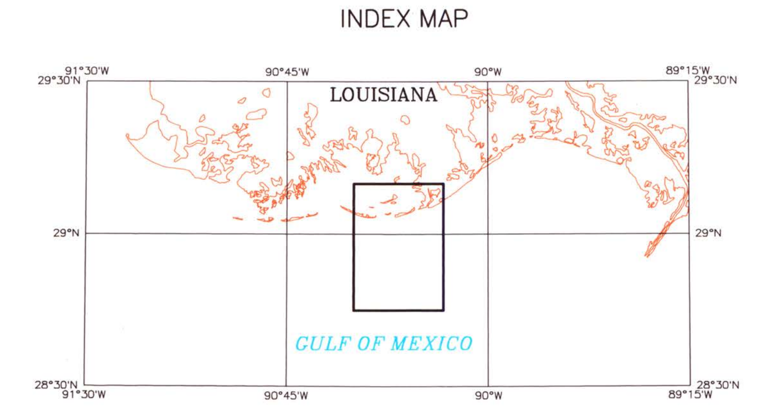
Bathymetric Data

Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1934, 1935, and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

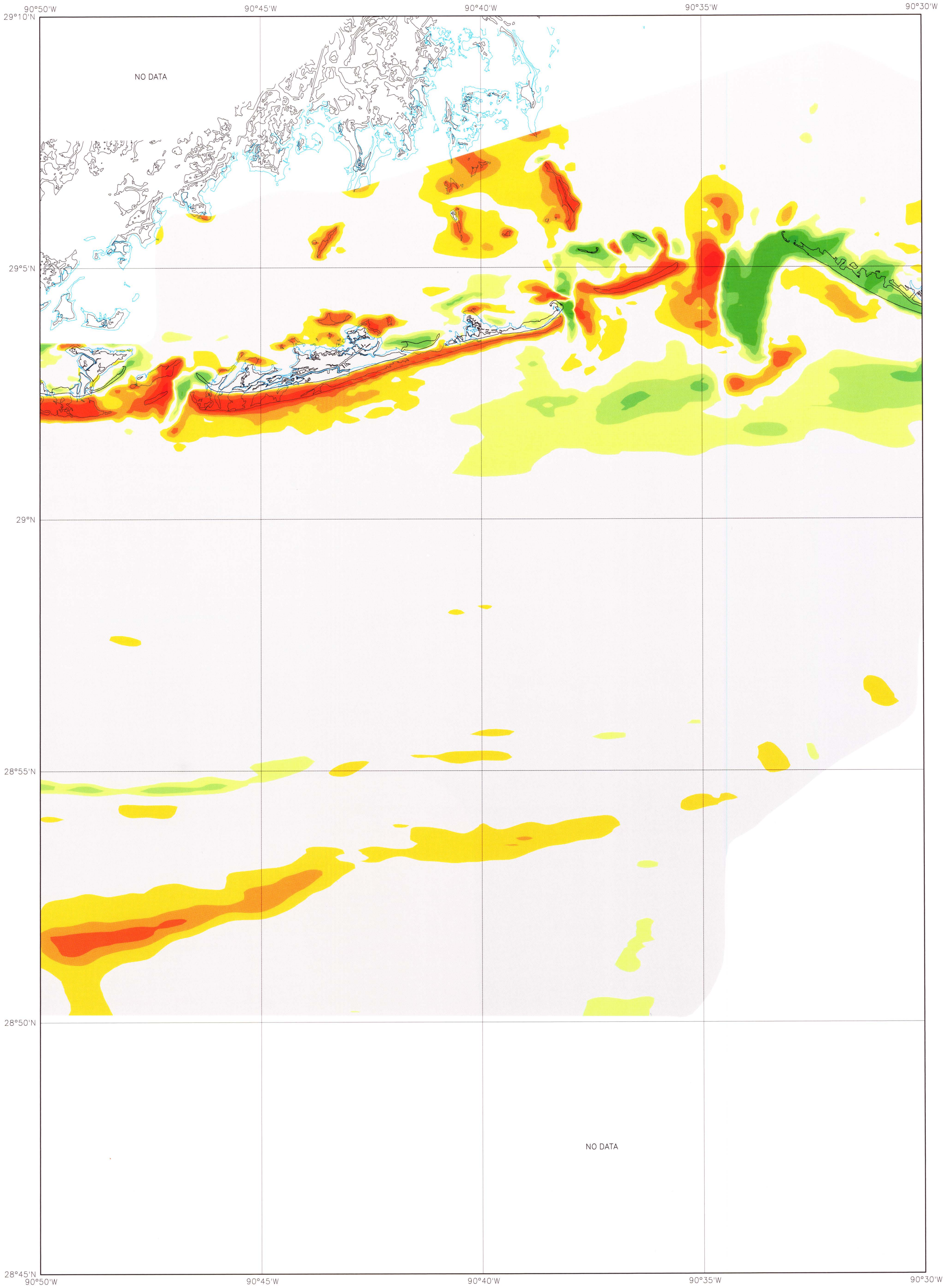
Shoreline data were digitized from USCGS topographic sheets from the years 1932 and 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



CAT ISLAND PASS EAST BATHYMETRY, 1930's

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1930's SHORELINE

1980's SHORELINE

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.33 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

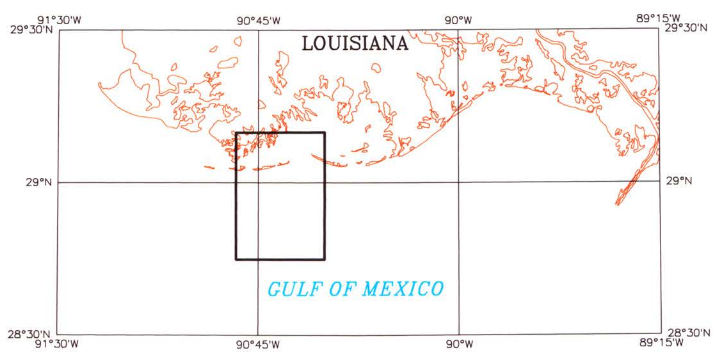
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character has not changed since the 1930's. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the precise land elevation in the 1930's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

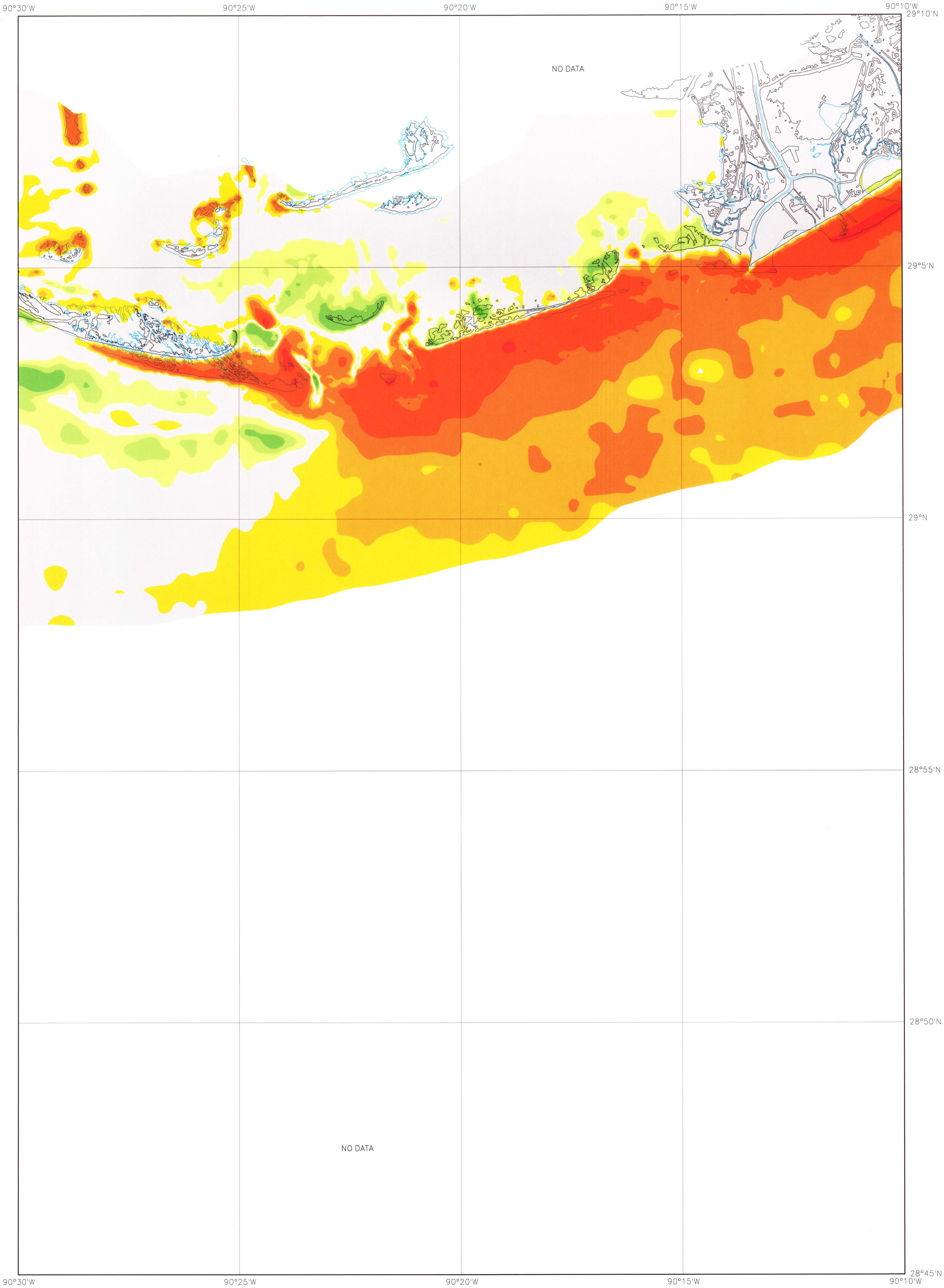
SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

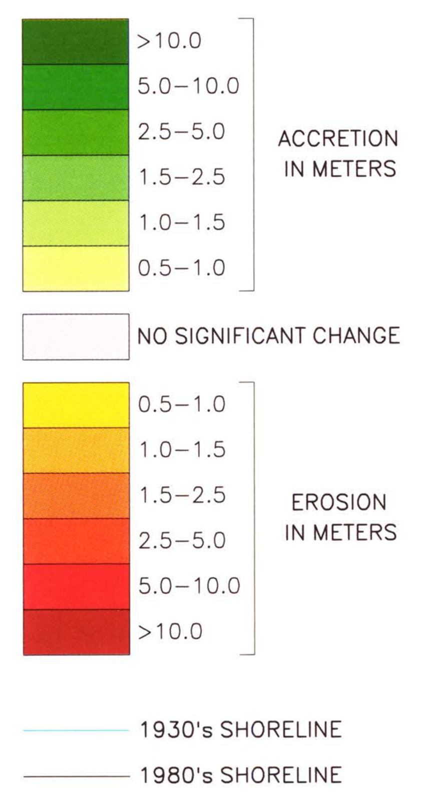
1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

CAT ISLAND PASS WEST SEA–FLOOR CHANGE, 1930's–1980's



EXPLANATION OF MAP COLORS



Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.33 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

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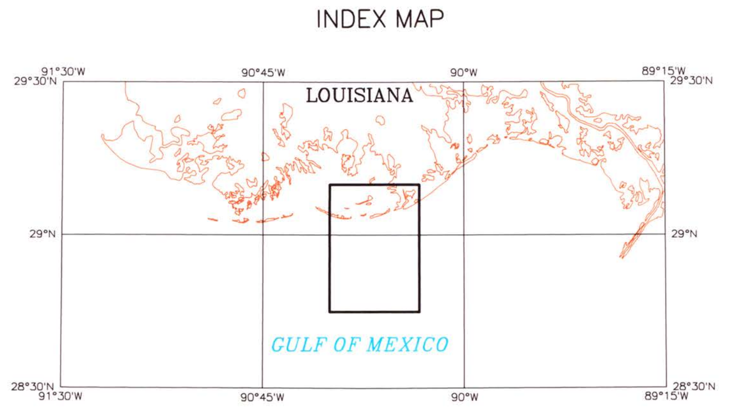
Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character has not changed since the 1930's. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the precise land elevation in the 1930's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



SCALE 1:100 000

NAUTICAL MILES

KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

CAT ISLAND PASS EAST SEA–FLOOR CHANGE, 1930's–1980's

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2
2–5
5–10
10–15
>15

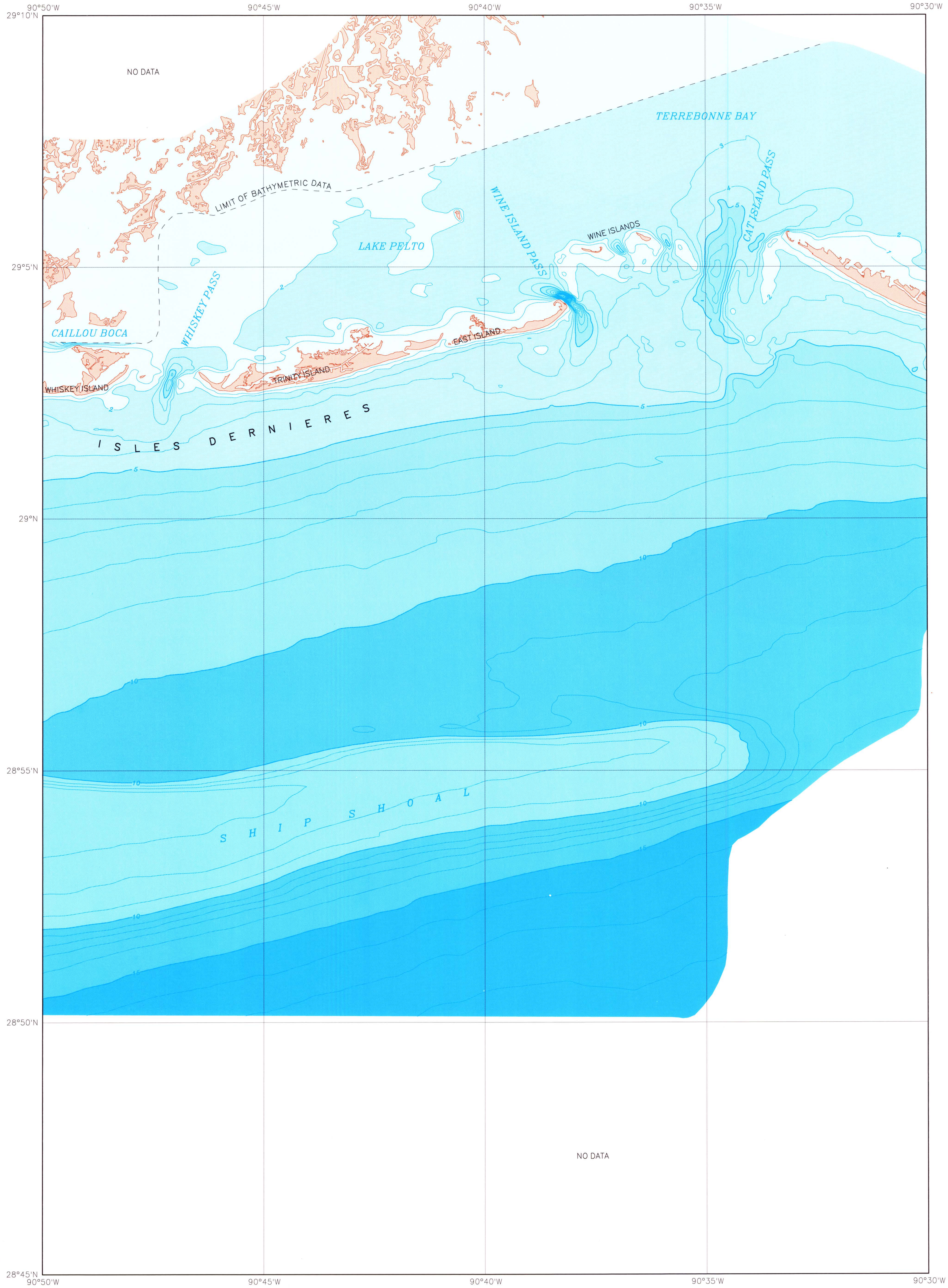
Bathymetric Data

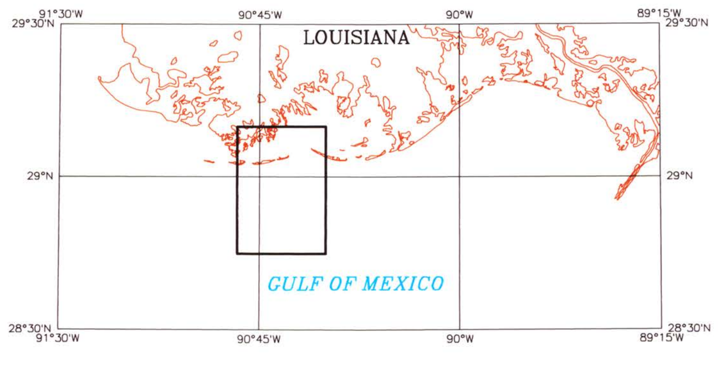
Depth–sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from a hydrographic survey conducted in 1986 by Geodetic International, Inc., under contract to the USGS. This survey utilized a Sercel Syledis, UHF–type radio positioning system for horizontal control and a Krupp–Atlas, model 20, high–precision dual–frequency fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. Other open–water areas, for which bathymetric data are lacking, are also shown in blue. These areas, which fall outside the dashed line labeled "limit of bathymetric data," include land features that both serve as a reference for offshore areas and allow a comparison with maps from other years in the atlas.

Shoreline Data

The shorelines shown on this map were obtained from aerial photography taken in 1986 and 1989. The 1986 photographs were taken by Gulf Coast Aerial Mapping Co., Inc. These black and white photographs covered the Isles Dernieres section of the study area at a scale of 1:4,800. The approximate position of the mean high water (MHW) shoreline was digitized directly from these photographs, and was then rectified to the geographic coordinates of 1950's U.S Coast and Geodetic Survey topographic sheets at scale 1:20,000. The 1989 photographs were high–altitude color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the MHW shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.





Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

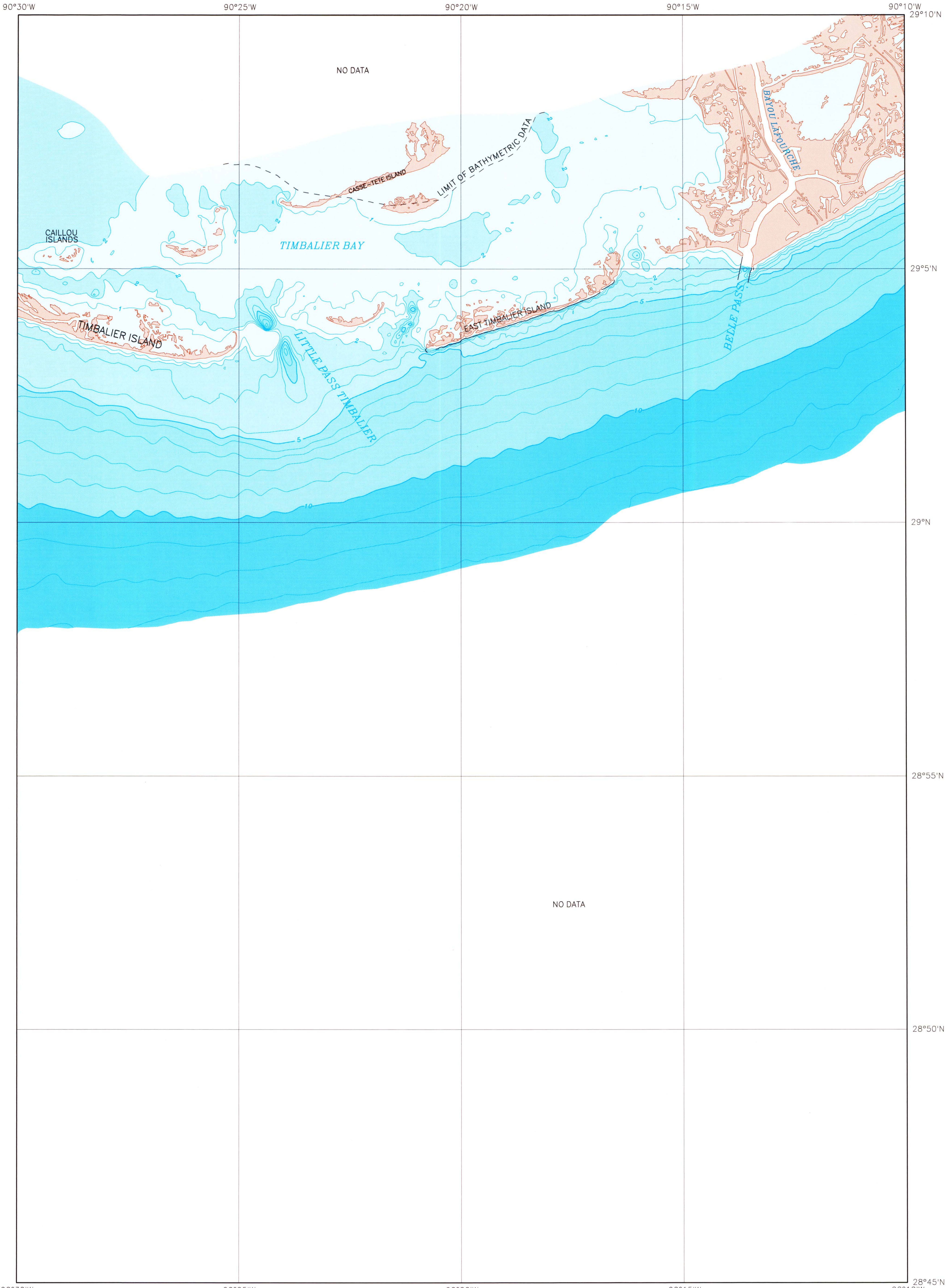
SCALE 1:100 000

NAUTICAL MILES

KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

CAT ISLAND PASS WEST BATHYMETRY, 1980's



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

EXPLANATION OF MAP COLORS

- Land
- DEPTH IN METERS
  - 0–2
  - 2–5
  - 5–10
  - 10–15
- Breakwater or jetty

Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from hydrographic surveys conducted in 1988 and 1989 by Gulf Ocean Services, Inc., under contract to the USGS. These surveys utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

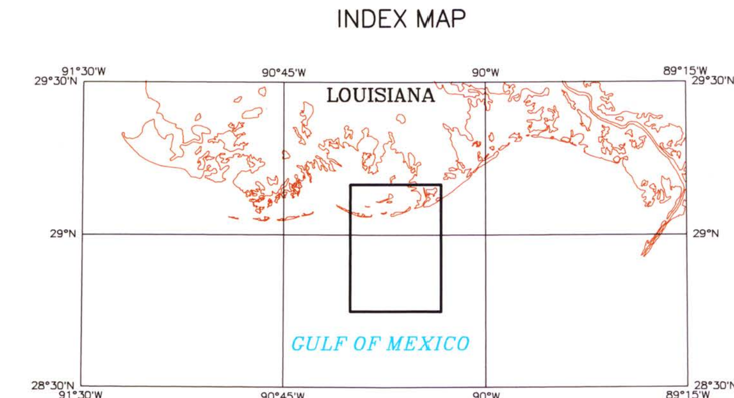
Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. However, an inland shipping channel known to be deep is shown blank (no data), to prevent implying that it is shallow, as are most inland bodies of water. Also, several open–water areas, for which bathymetric data are lacking, are shown in blue. These areas, which fall outside the dashed line labeled "limit of bathymetric data," include land features that both serve as a reference for offshore areas and allow a comparison with maps from other years in the atlas.

Shoreline Data

The shorelines shown on this map were obtained from high–altitude aerial photography taken in 1989. The photographs were color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the mean high water (MHW) shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.

Breakwaters or jetties, indicated by black lines, are shown where they have a significant influence on the shoreline configuration or bathymetry

INDEX MAP



CAT ISLAND PASS EAST BATHYMETRY, 1980's

BAYOU LAFOURCHE AREA
1:100,000-SCALE MAPS

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–2
- 2–5
- 5–10
- 10–15
- >15

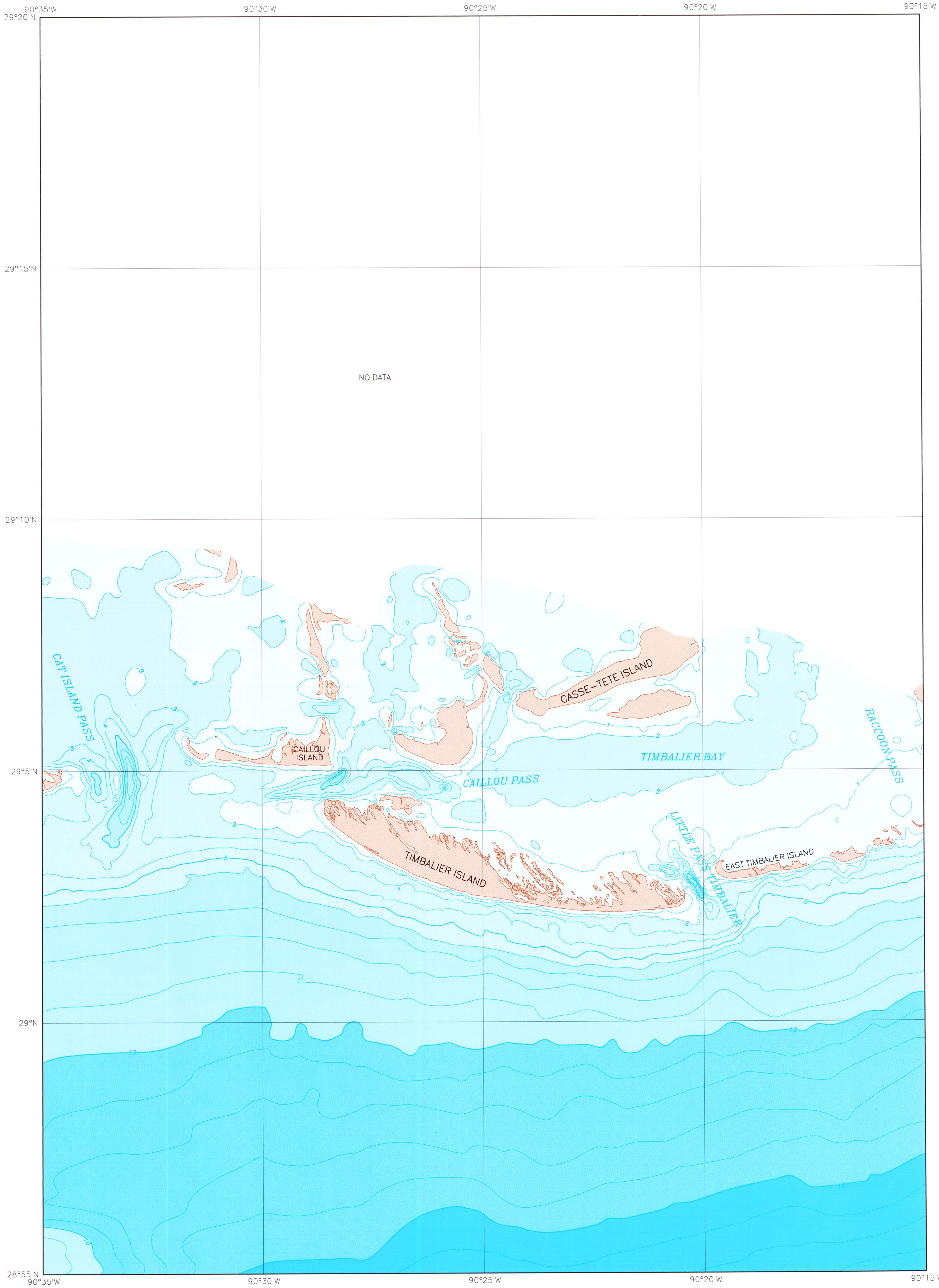
Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from 1891. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

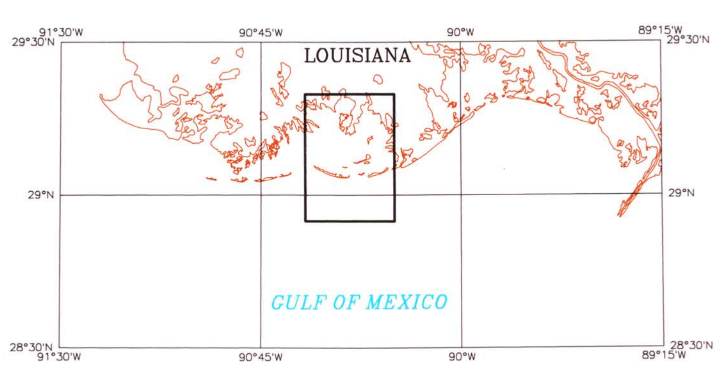
The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1886 and 1887. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.



INDEX MAP



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

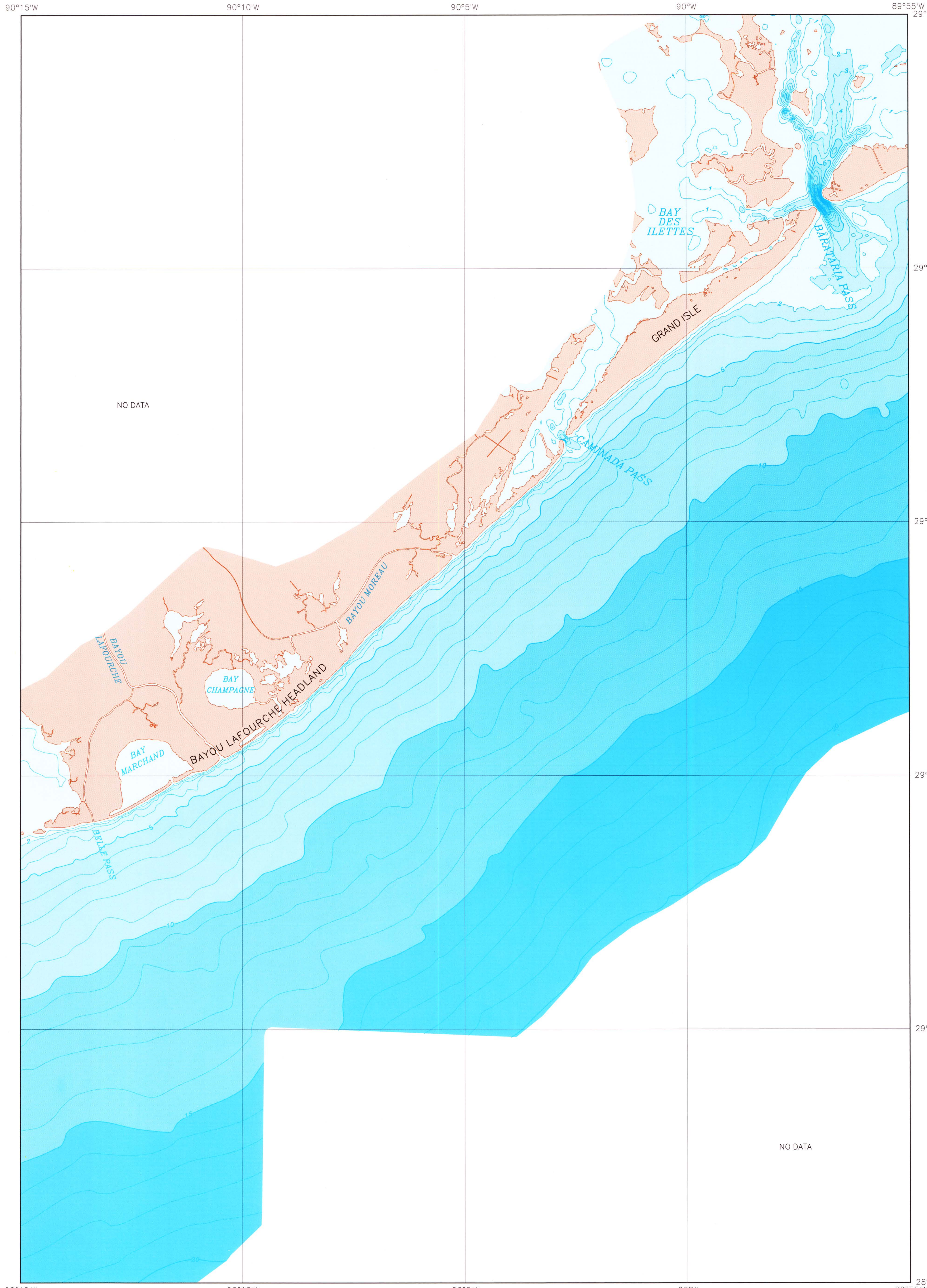
SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

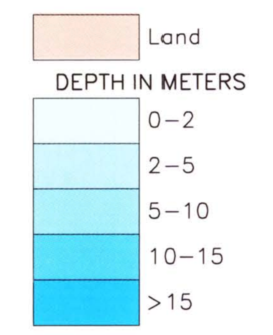
1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

BAYOU LAFOURCHE WEST BATHYMETRY, 1880's



EXPLANATION OF MAP COLORS



Bathymetric Data

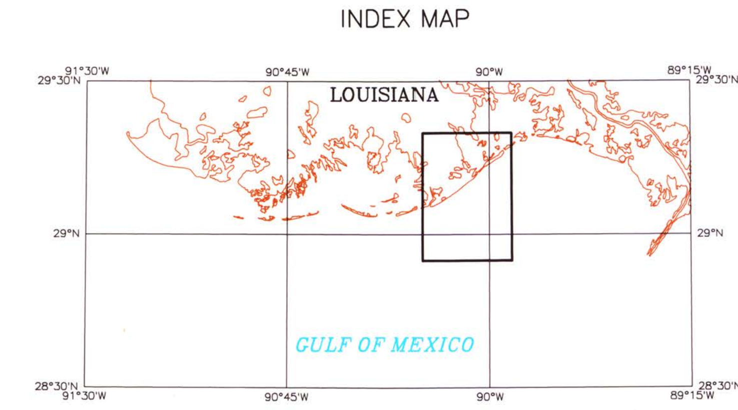
Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1878, 1886, and 1891. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1886 and 1887. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

BAYOU LAFOURCHE EAST BATHYMETRY, 1880's

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

EXPLANATION OF MAP COLORS

>10.0	ACCRETION IN METERS
5.0–10.0	
2.5–5.0	
1.5–2.5	
1.0–1.5	
0.5–1.0	
NO SIGNIFICANT CHANGE	
0.5–1.0	EROSION IN METERS
1.0–1.5	
1.5–2.5	
2.5–5.0	
5.0–10.0	
>10.0	

1880's SHORELINE
1930's SHORELINE

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.27 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

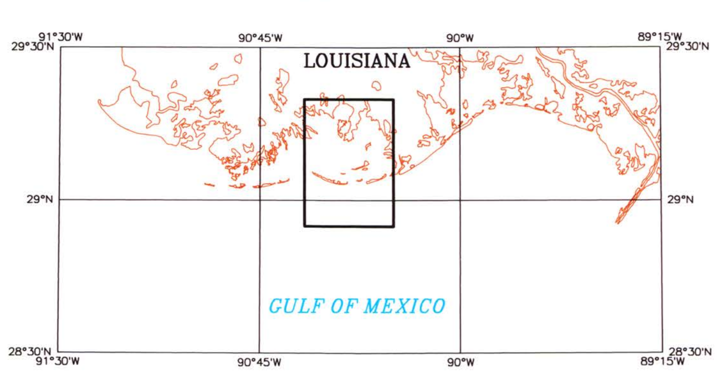
Accuracy of Results

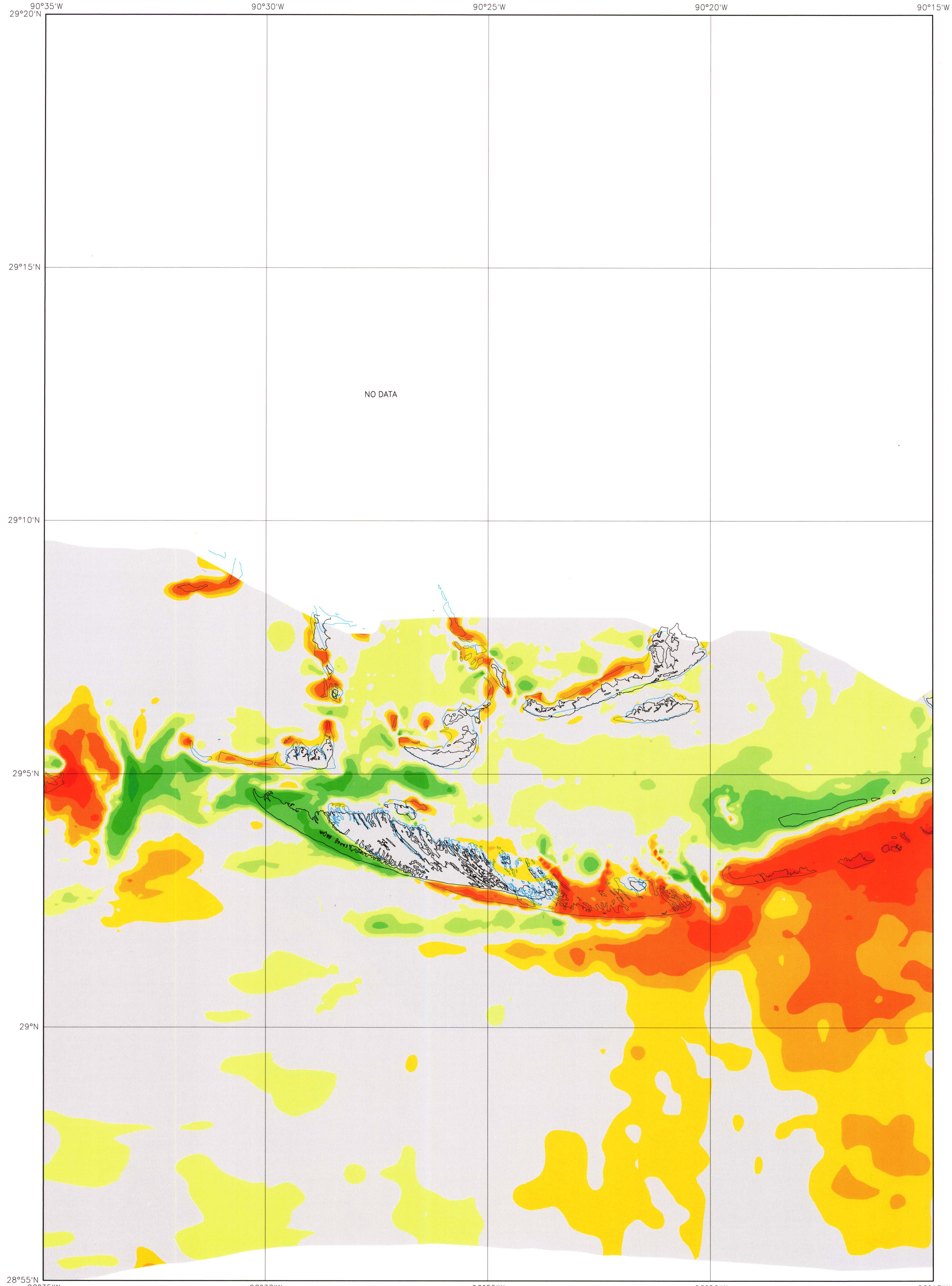
Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character did not change between the 1880's and 1930's. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the precise land elevation in the 1880's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



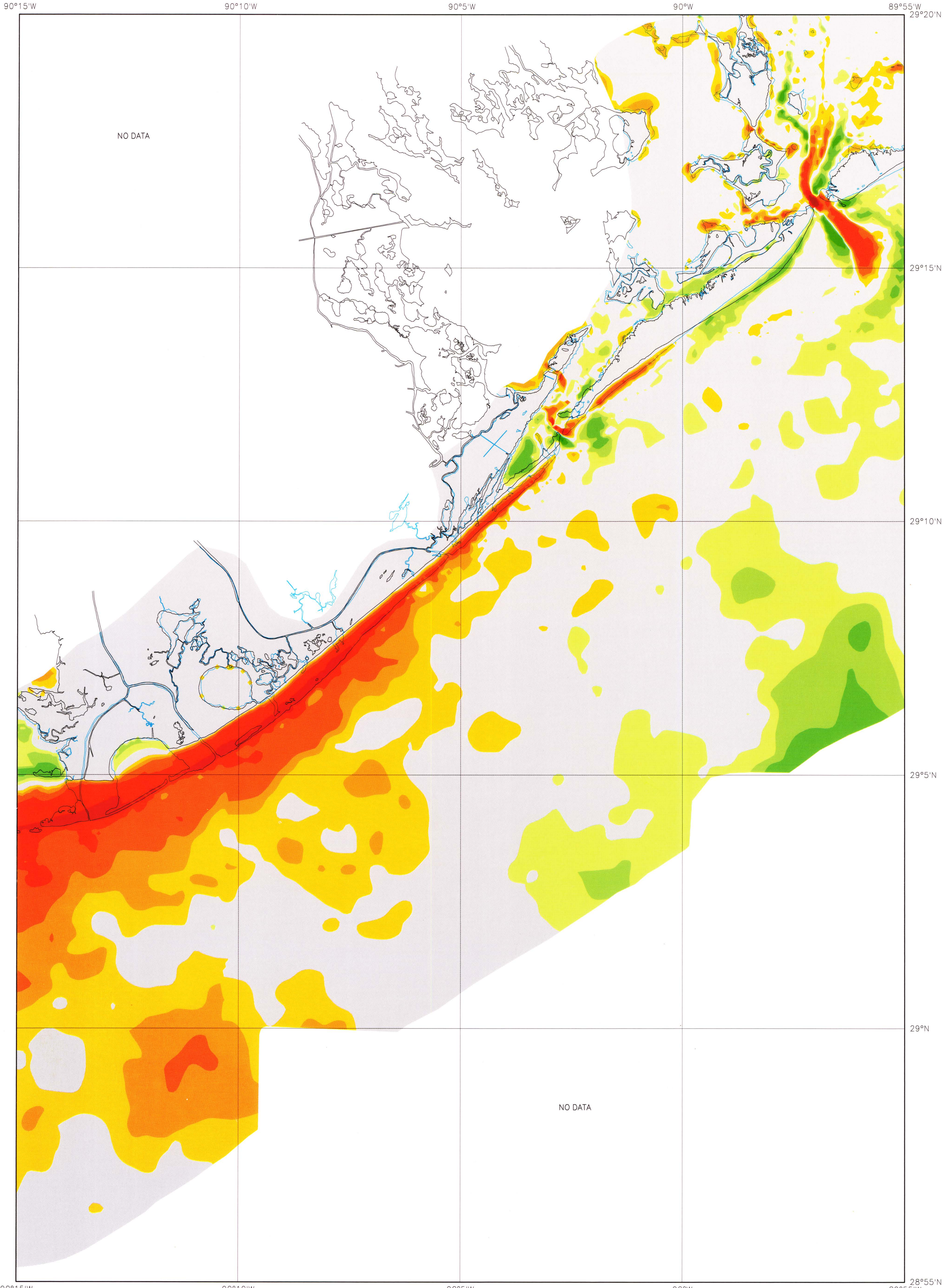


Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES
1 0 1 2 3 4 5 KILOMETERS
SHORELINE DATUM: MEAN HIGH WATER

BAYOU LAFOURCHE WEST SEA–FLOOR CHANGE, 1880's–1930's



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1880's SHORELINE

1930's SHORELINE

Sea-floor Change Data

Areas of vertical sea-floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry. Because of relative sea-level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.27 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea-level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea-floor change shown on this map does not reach the maximum accretional level given in the explanation of map colors, which shows the entire range of sea-floor change documented throughout the study area.

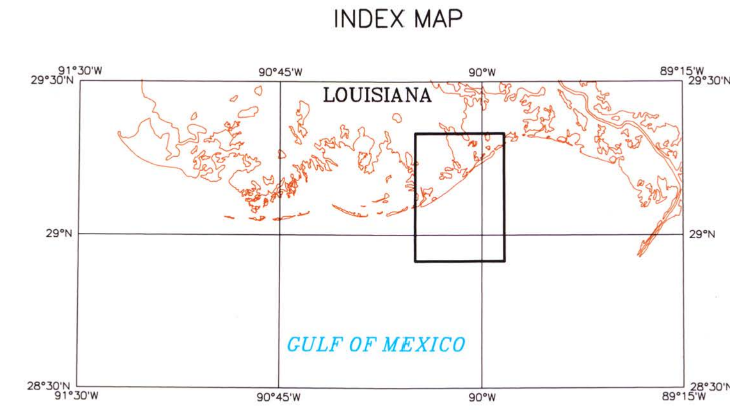
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character did not change between the 1880's and 1930's. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the precise land elevation in the 1880's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



BAYOU LAFOURCHE EAST SEA-FLOOR CHANGE, 1880's–1930's

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

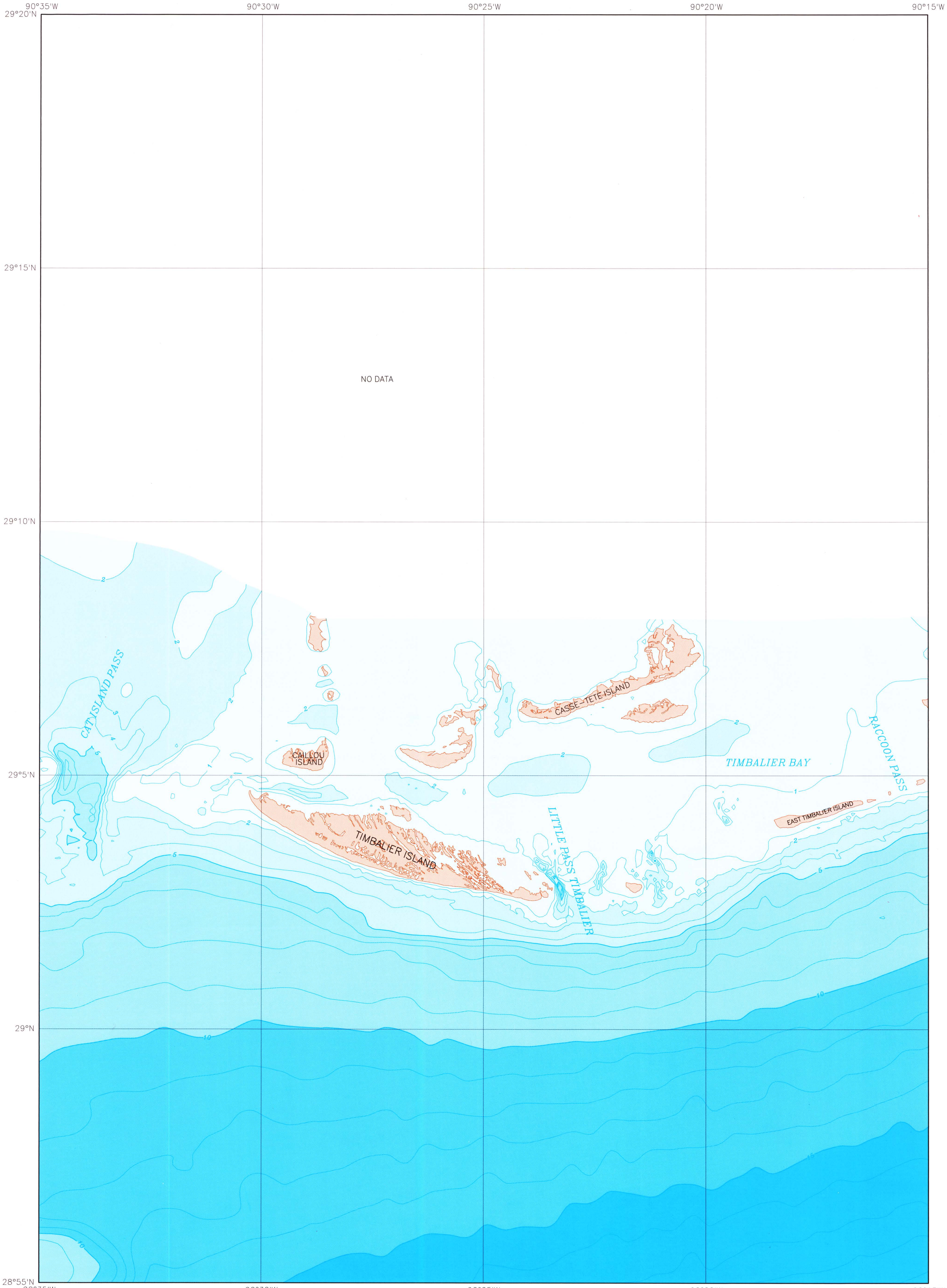
0–2

2–5

5–10

10–15

>15



Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER

DATUM: MEAN LOW WATER

SHORELINE DATUM: MEAN HIGH WATER

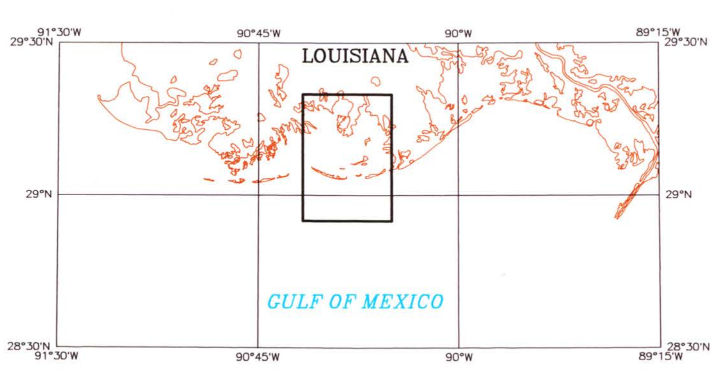
Bathymetric Data

Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1934 and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

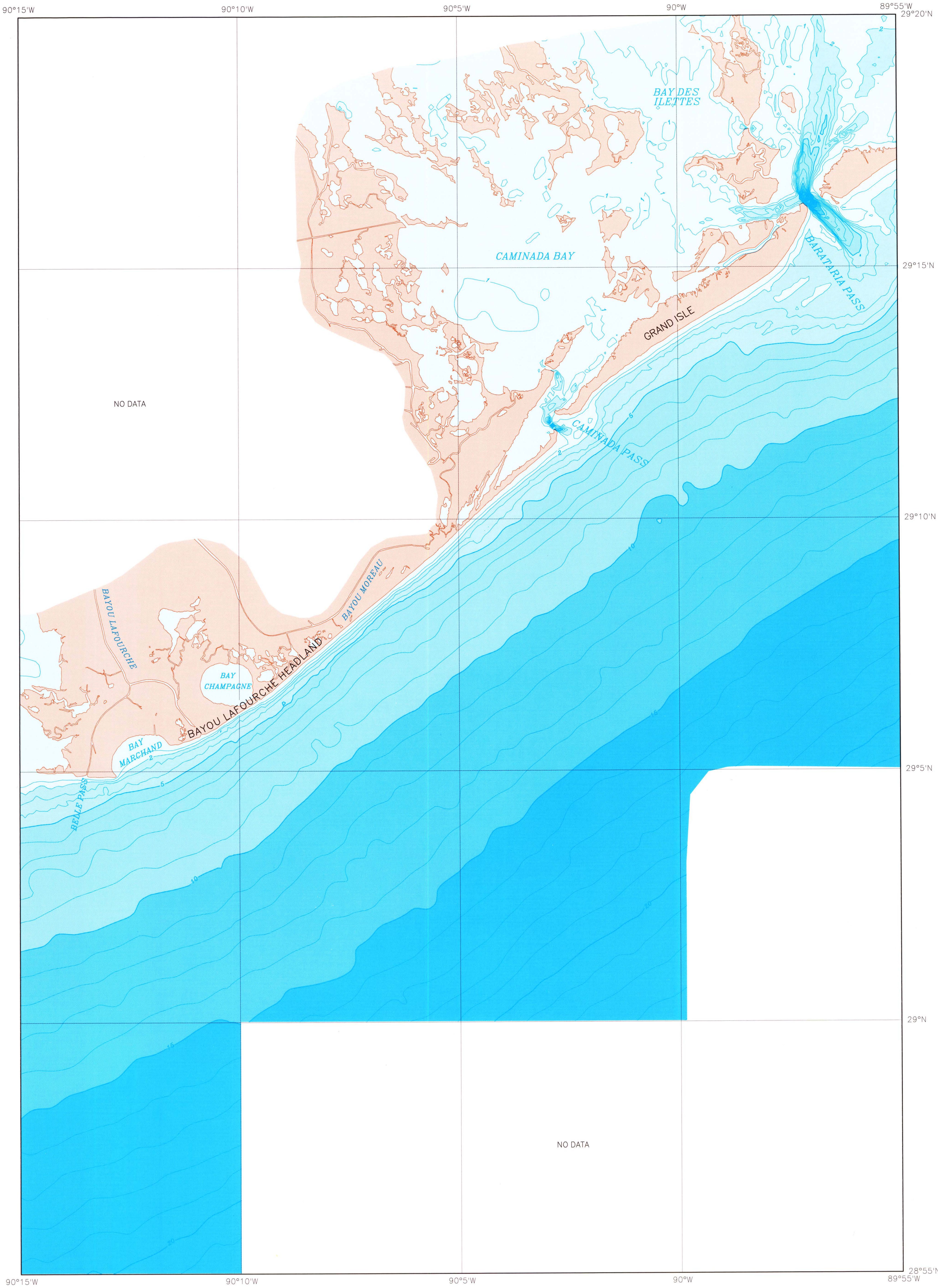
Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from the years 1932 and 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



BAYOU LAFOURCHE WEST BATHYMETRY, 1930's



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–2
- 2–5
- 5–10
- 10–15
- >15

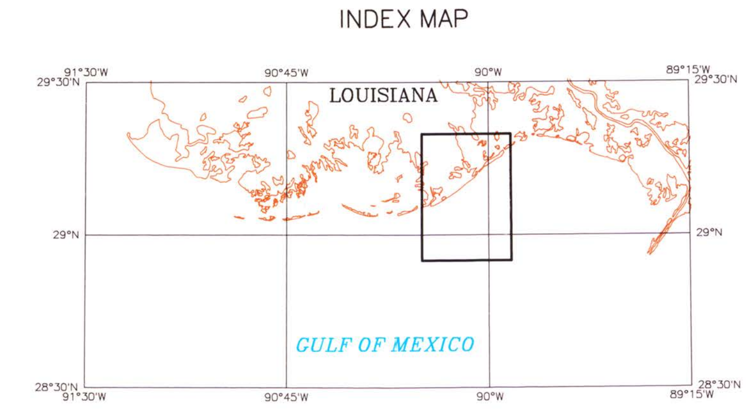
Bathymetric Data

Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1933, 1934, and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

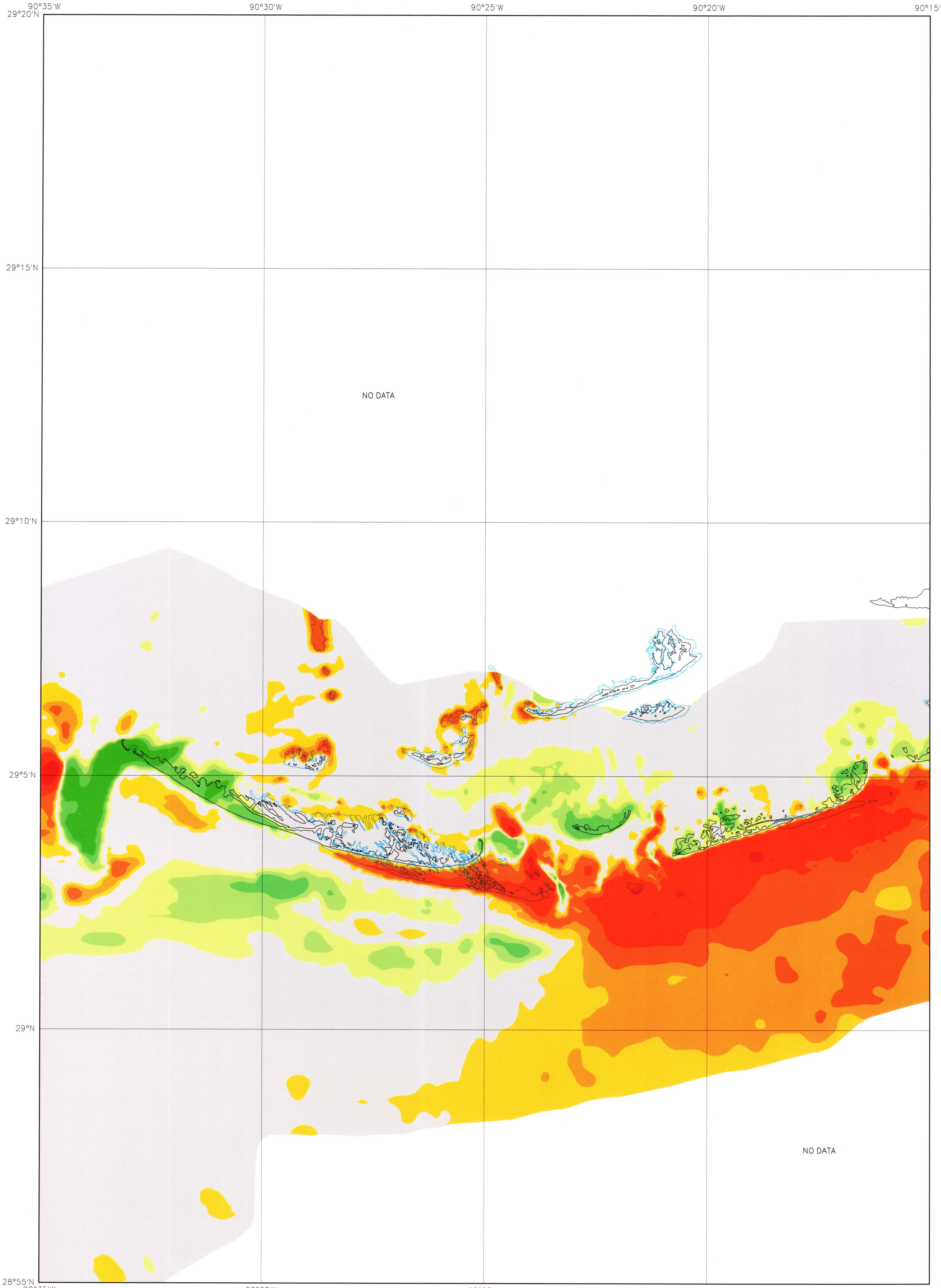
Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



BAYOU LAFOURCHE EAST BATHYMETRY, 1930's



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

SCALE 1:100 000
1 0 1 2 3 4 5 NAUTICAL MILES
1 0 1 2 3 4 5 KILOMETERS
SHORELINE DATUM: MEAN HIGH WATER

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1930's SHORELINE
1980's SHORELINE

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.33 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

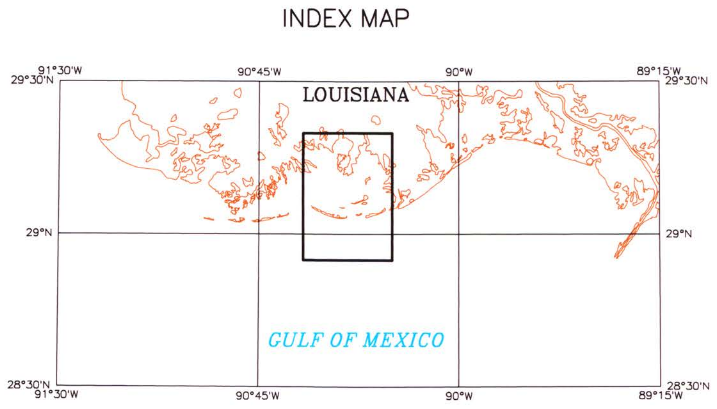
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

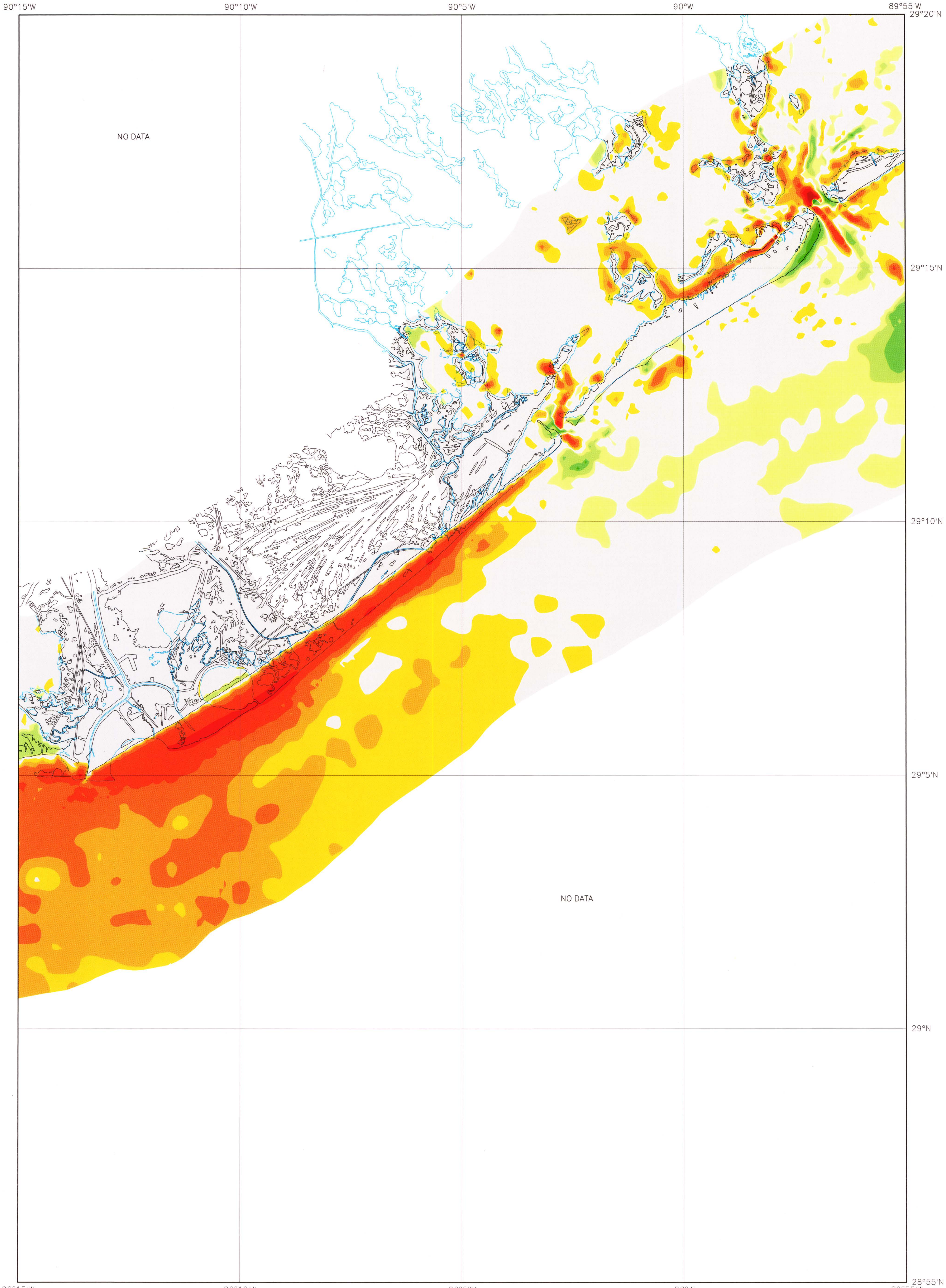
Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character has not changed since the 1930's. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the precise land elevation in the 1930's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



BAYOU LAFOURCHE WEST SEA–FLOOR CHANGE, 1930's–1980's



SCALE 1:100 000

NAUTICAL MILES 1 0 1 2 3 4 5

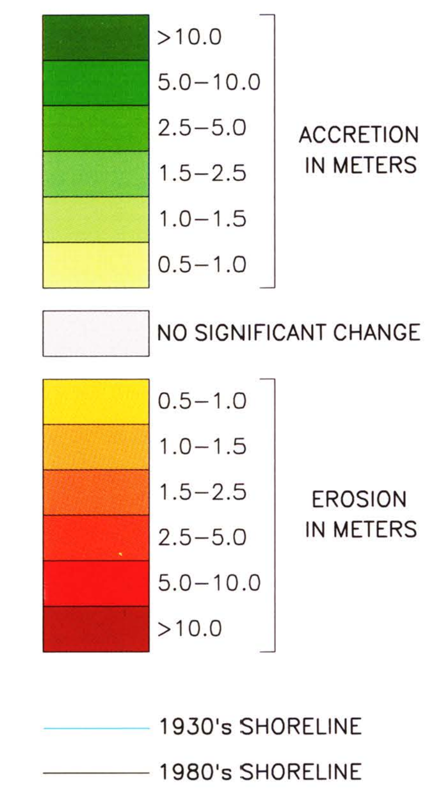
KILOMETERS 1 0 1 2 3 4 5

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

EXPLANATION OF MAP COLORS



Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.33 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

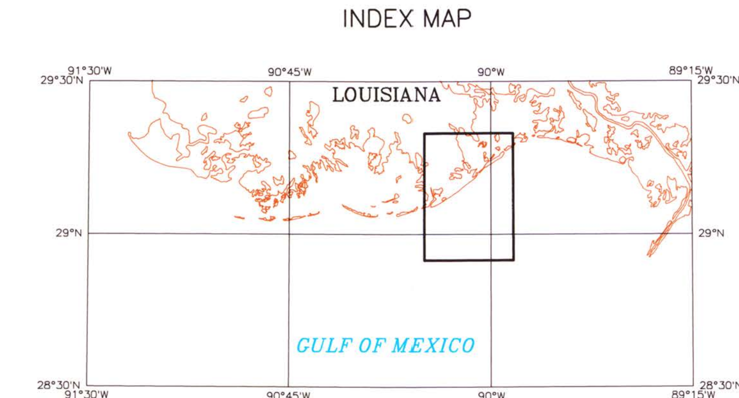
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character has not changed since the 1930's. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the precise land elevation in the 1930's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



BAYOU LAFOURCHE EAST SEA–FLOOR CHANGE, 1930's–1980's

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2

2–5

5–10

10–15

Breakwater or jetty

Bathymetric Data

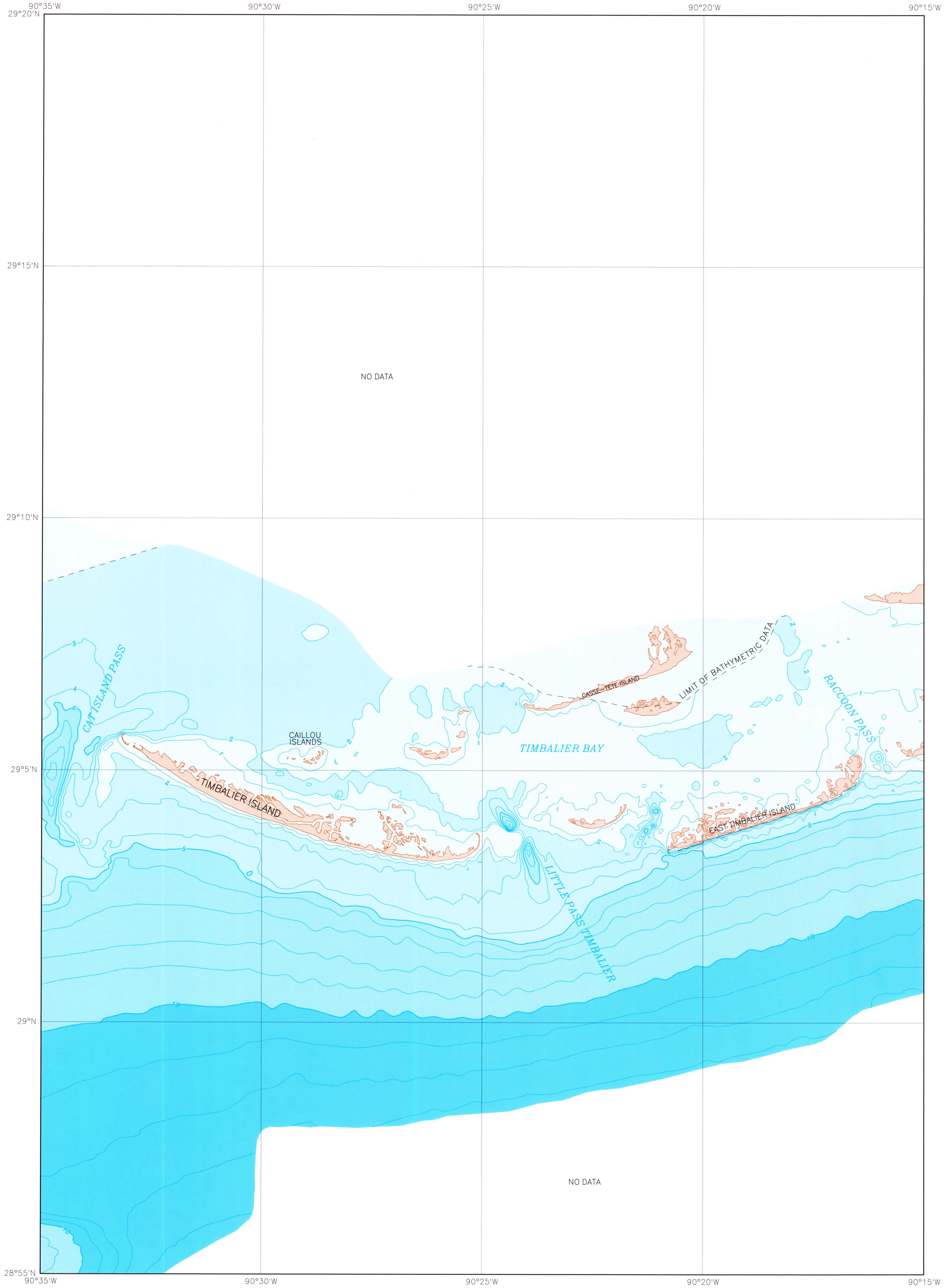
Depth–sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from hydrographic surveys conducted in 1986, 1988, and 1989 by companies under contract to the USGS. The 1986 survey, conducted by Geodetic International, Inc., utilized a Sercel Syledis, UHF–type radio positioning system for horizontal control and a Krupp–Atlas, model 20, high–precision dual–frequency fathometer for soundings. The 1988 and 1989 surveys, conducted by Gulf Ocean Services, Inc., utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW) determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. Other open–water areas, for which bathymetric data are lacking, are also shown in blue. These areas, which fall outside the dashed line labeled "limit of bathymetric data," include land features that both serve as a reference for offshore areas and allow a comparison with maps from other years in the atlas.

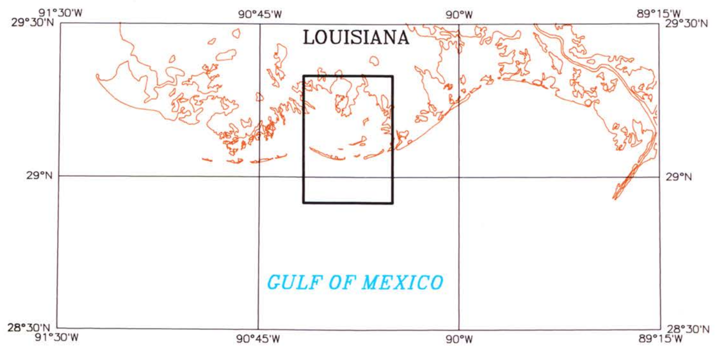
Shoreline Data

The shorelines shown on this map were obtained from high–altitude aerial photography taken in 1989. The photographs were color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the mean high water (MHW) shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.

Breakwaters or jetties, indicated by black lines, are shown where they have a significant influence on the shoreline configuration or bathymetry.



INDEX MAP



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

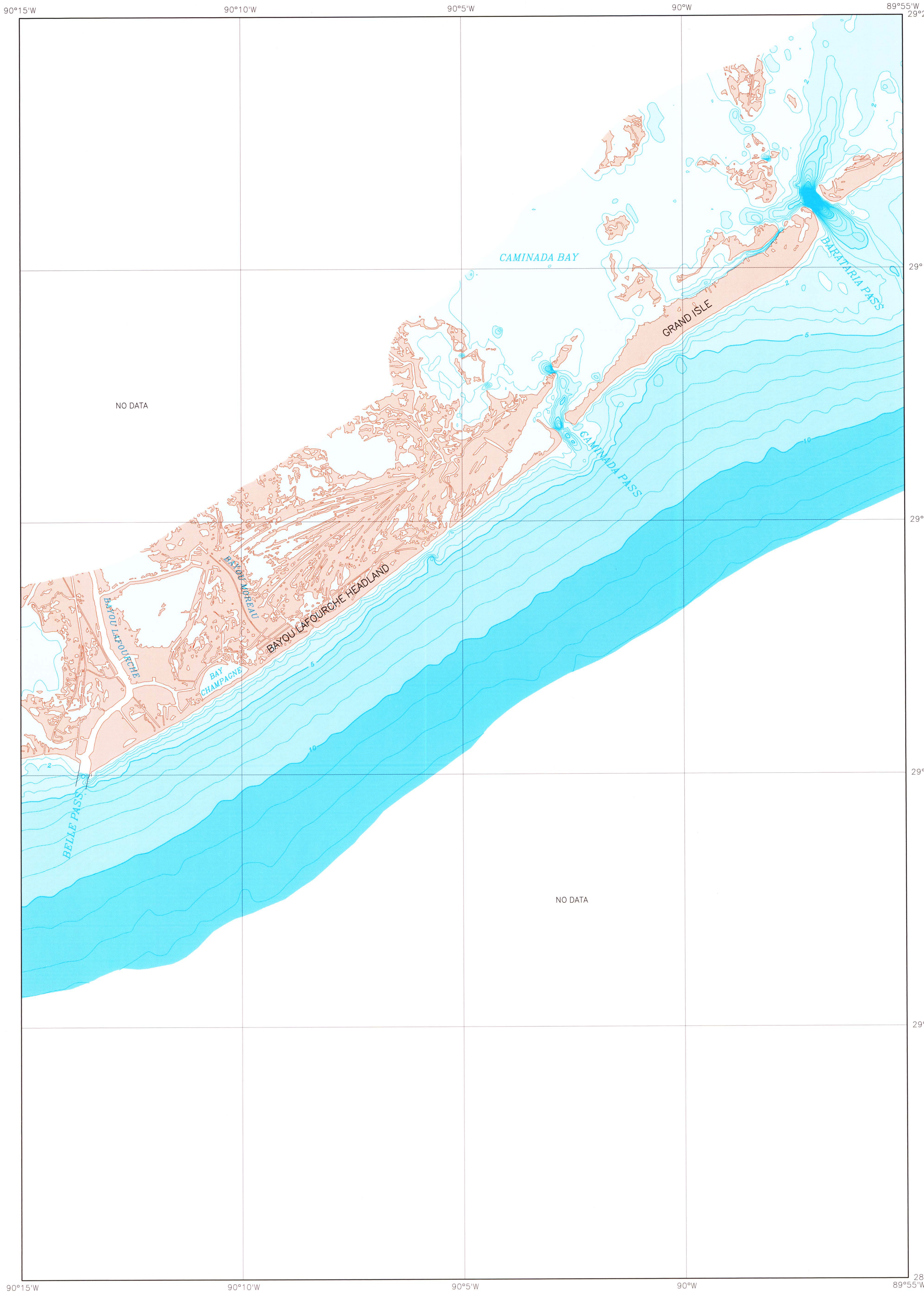
SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

BAYOU LAFOURCHE WEST BATHYMETRY, 1980's



EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2

2–5

5–10

10–15

>15

Breakwater or jetty

Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from hydrographic surveys conducted in 1988 and 1989 by Gulf Ocean Services, Inc., under contract to the USGS. These surveys utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

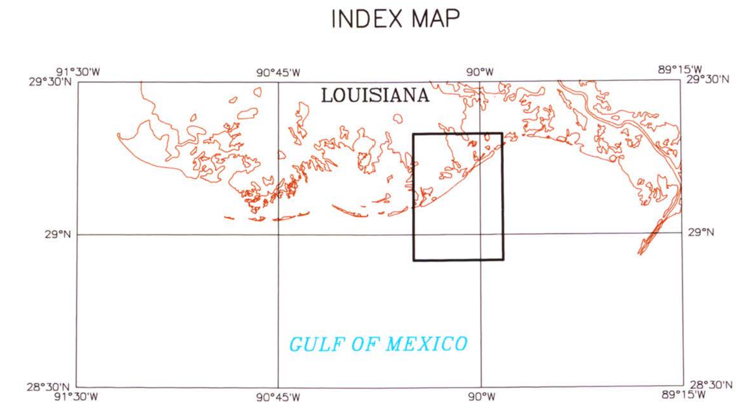
Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. However, an inland shipping channel known to be deep is shown blank (no data), to prevent implying that it is shallow, as are most inland bodies of water.

Shoreline Data

The shorelines shown on this map were obtained from high–altitude aerial photography taken in 1989. The photographs were color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the mean high water (MHW) shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.

Breakwaters or jetties, indicated by black lines, are shown where they have a significant influence on the shoreline configuration or bathymetry.

INDEX MAP



SCALE 1:100 000

NAUTICAL MILES

KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

BAYOU LAFOURCHE EAST BATHYMETRY, 1980's

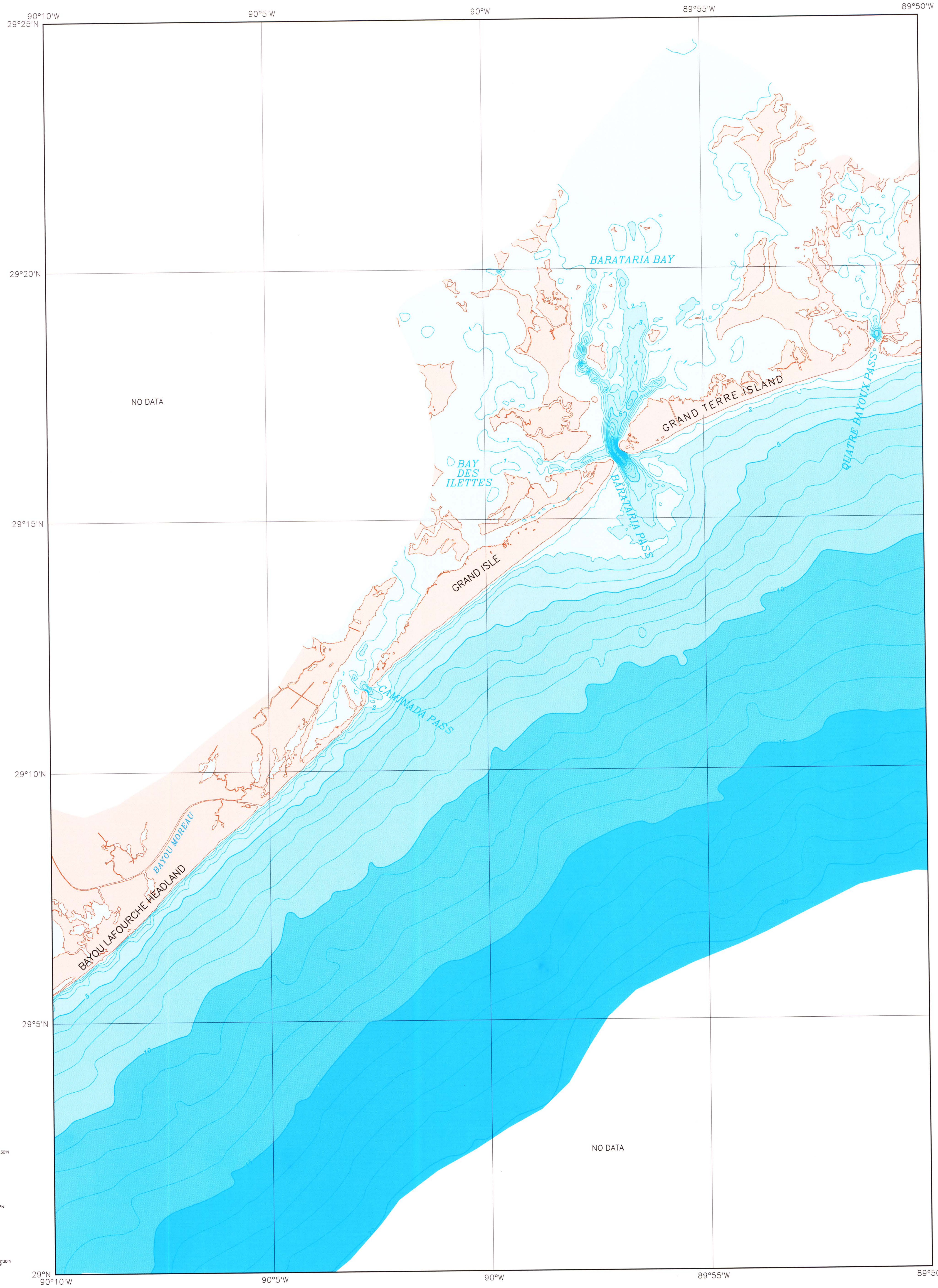
BARATARIA AREA
1:100,000-SCALE MAPS

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2
2–5
5–10
10–15
>15



Bathymetric Data

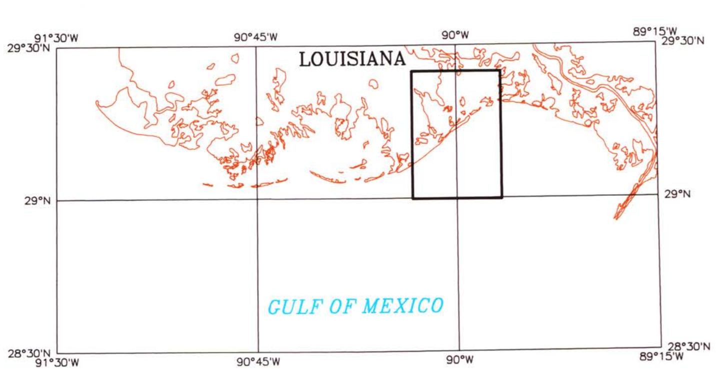
Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1878, 1883, 1886, and 1891. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1886 and 1887. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

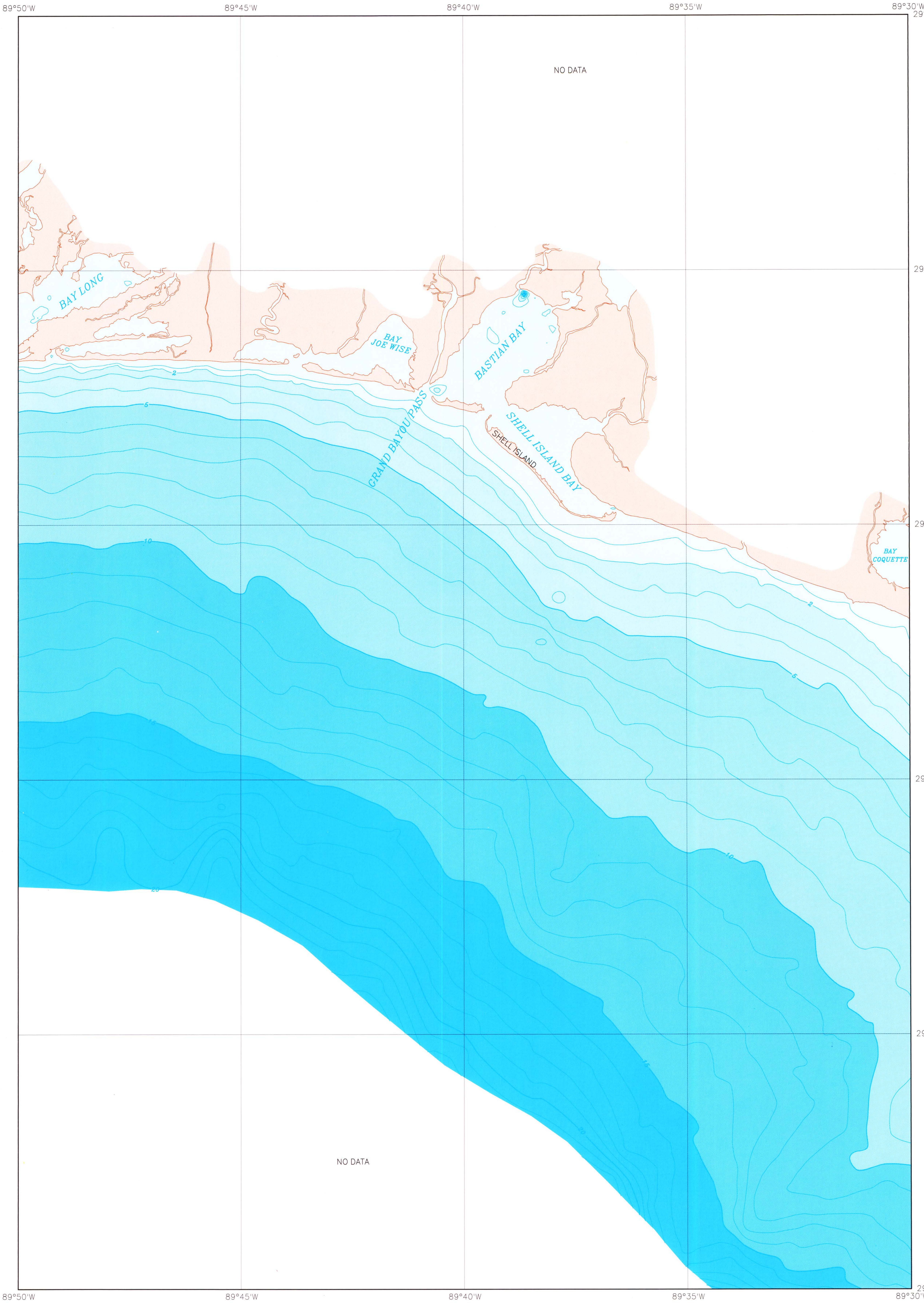
SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

BARATARIA WEST BATHYMETRY, 1880's



EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–2
- 2–5
- 5–10
- 10–15
- >15

Bathymetric Data

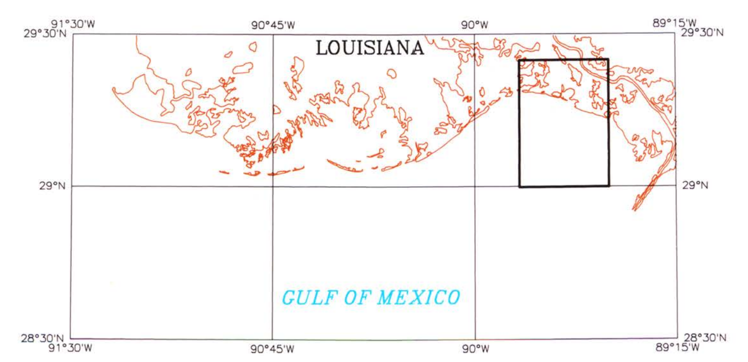
Depth–sounding data, consisting of latitude, longitude, and depth values, were digitized from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1878, 1883, and 1886. Horizontal positioning for the soundings on these USCGS charts was accomplished through various manual techniques, including recording sextant angles from the ship to known landmarks, recording theodolite angles to the survey vessel from shoreline positions, and dead reckoning (estimation of position based on ship's speed and heading) for some of the points beyond the visual range of the shoreline. Soundings also were taken with manual techniques. For depths up to 5 m, soundings were measured with a graduated pole; in deeper water a line with an attached lead weight was used.

The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data on this map were digitized from USCGS topographic sheets from the years 1883, 1884, and 1887. All shorelines were measured by planetable and alidade ground surveys. They represent the approximate position of the mean high water line, which is about 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



SCALE 1:100 000

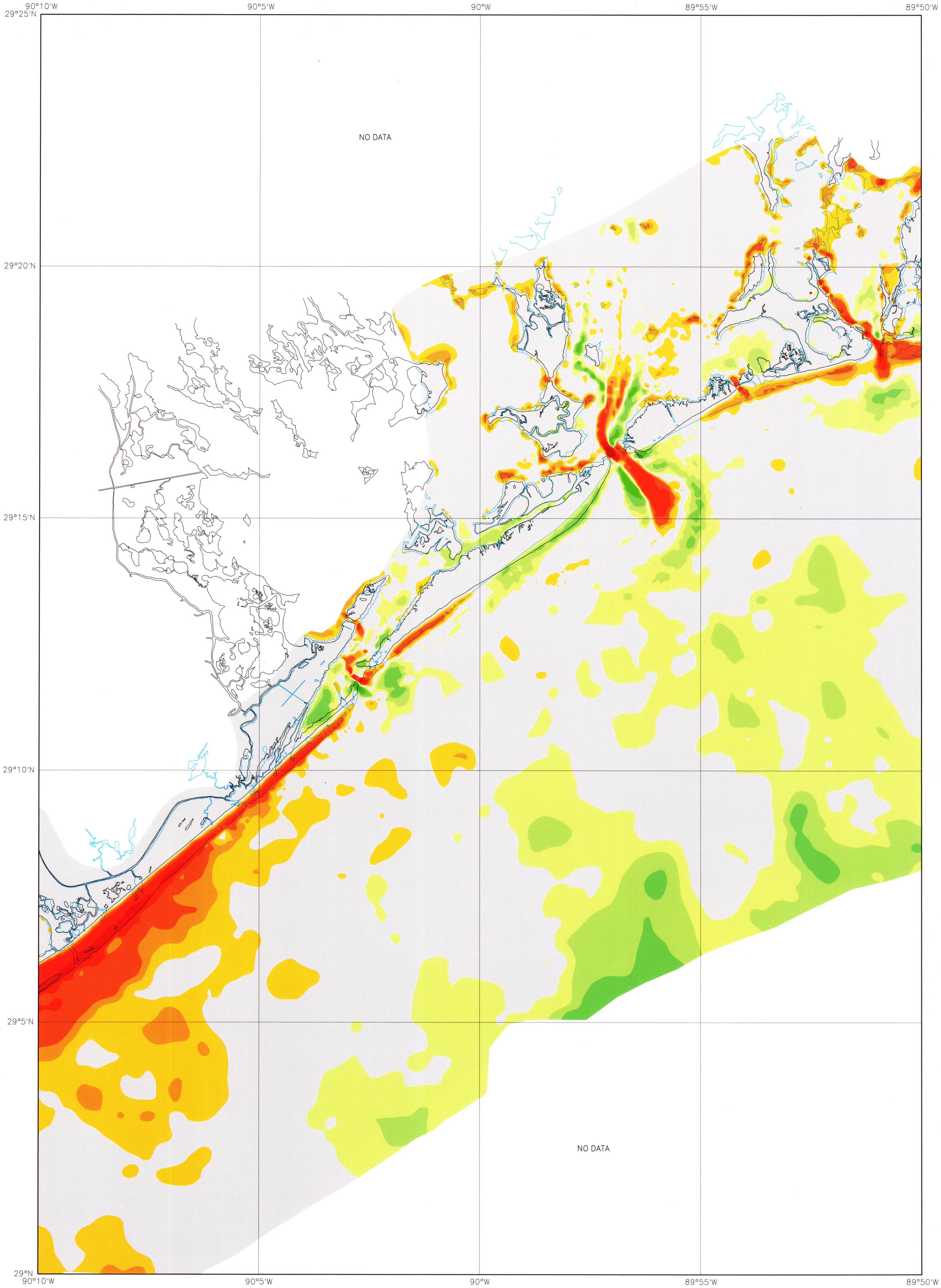
1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

BARATARIA EAST BATHYMETRY, 1880's



Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

SCALE 1:100 000
1 0 1 2 3 4 5 NAUTICAL MILES
1 0 1 2 3 4 5 KILOMETERS
SHORELINE DATUM: MEAN HIGH WATER

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1880's SHORELINE
1930's SHORELINE

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.27 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum accretional level given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

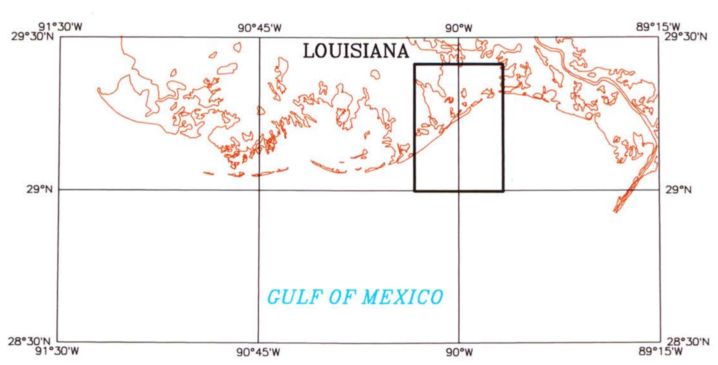
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

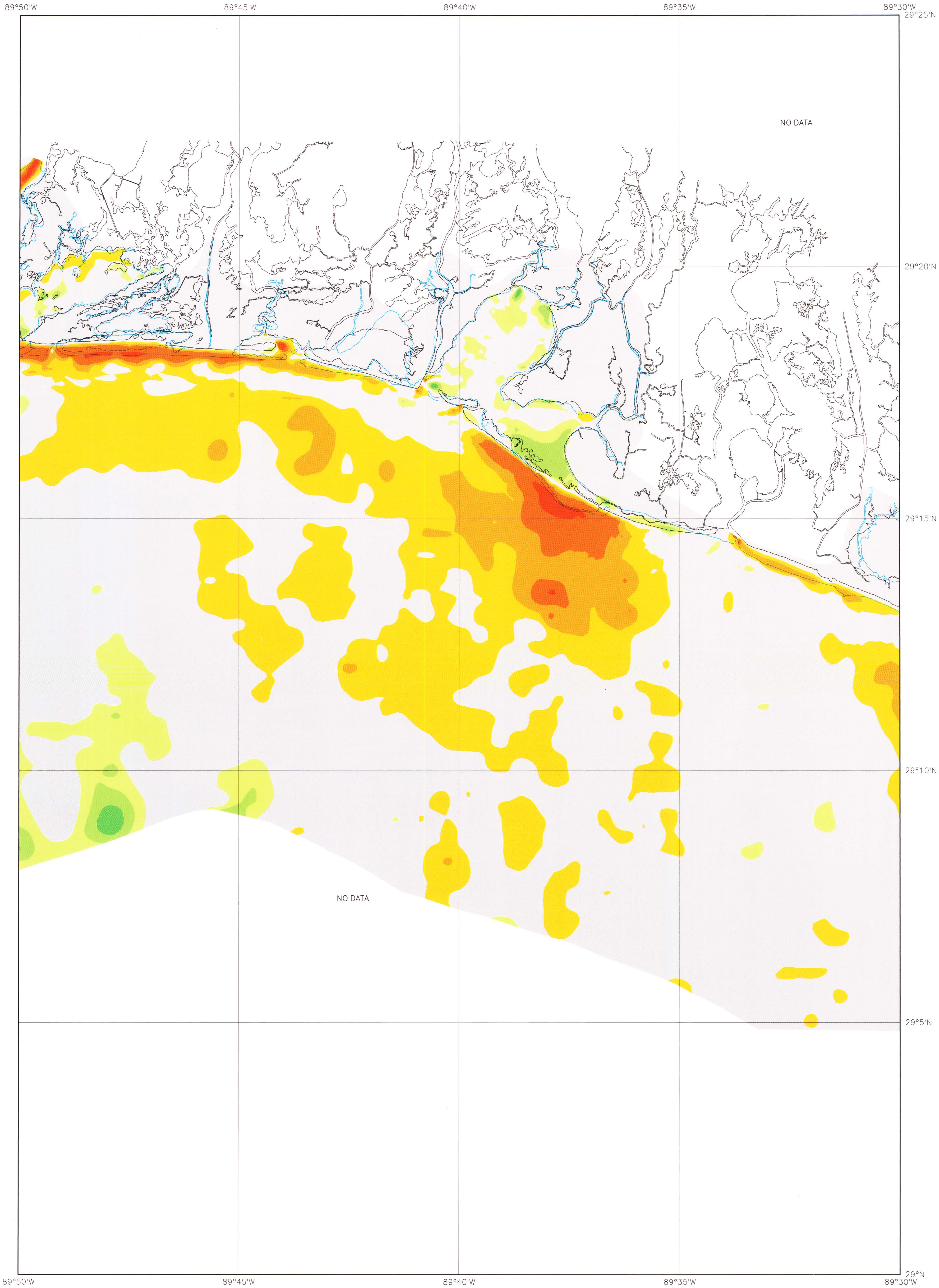
Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character did not change between the 1880's and 1930's. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the precise land elevation in the 1880's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



BARATARIA WEST SEA–FLOOR CHANGE, 1880's–1930's



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1880's SHORELINE

1930's SHORELINE

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1880's and 1930's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.27 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea–floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea–floor change documented throughout the study area.

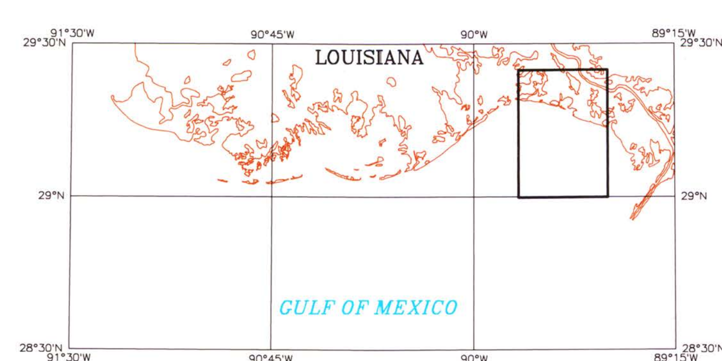
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1880's eroded to become open water in the 1930's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character did not change between the 1880's and 1930's. Thus, areas showing a transition from land in the 1880's to open water in the 1930's are shown as erosional zones, even though the precise land elevation in the 1880's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



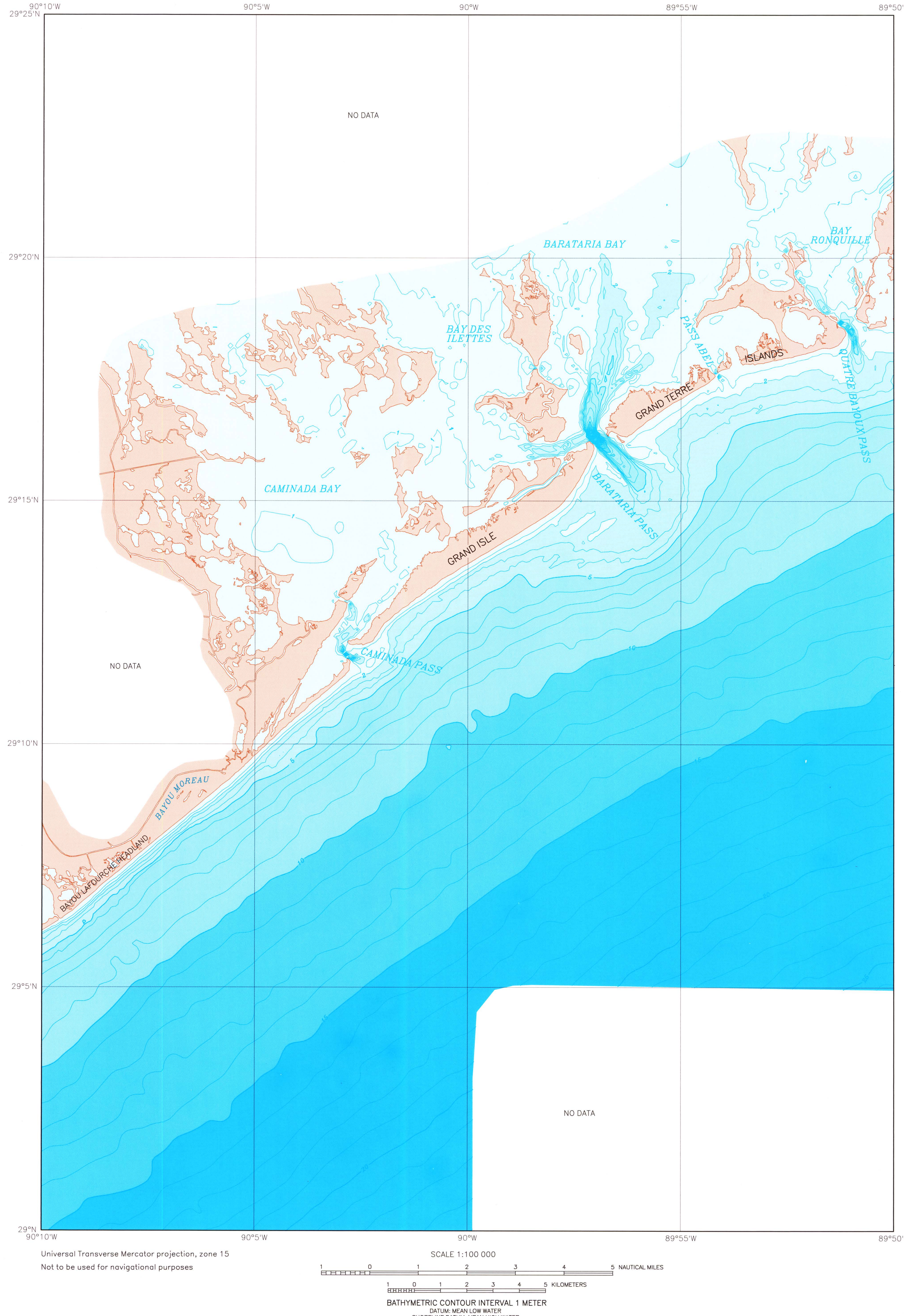
BARATARIA EAST SEA–FLOOR CHANGE, 1880's–1930's

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2
2–5
5–10
10–15
>15



Bathymetric Data

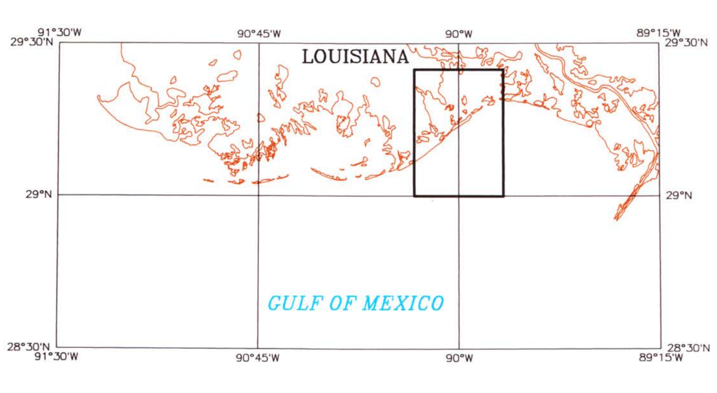
Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1933, 1934, and 1936. Soundings for these charts were collected using then-newly-developed echo-sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas.

Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. In addition, a small channel at the eastern end of the Grand Terre Islands has been left blank due to an inability to depict the very dense contours of this part of Quatre Bayoux Pass.

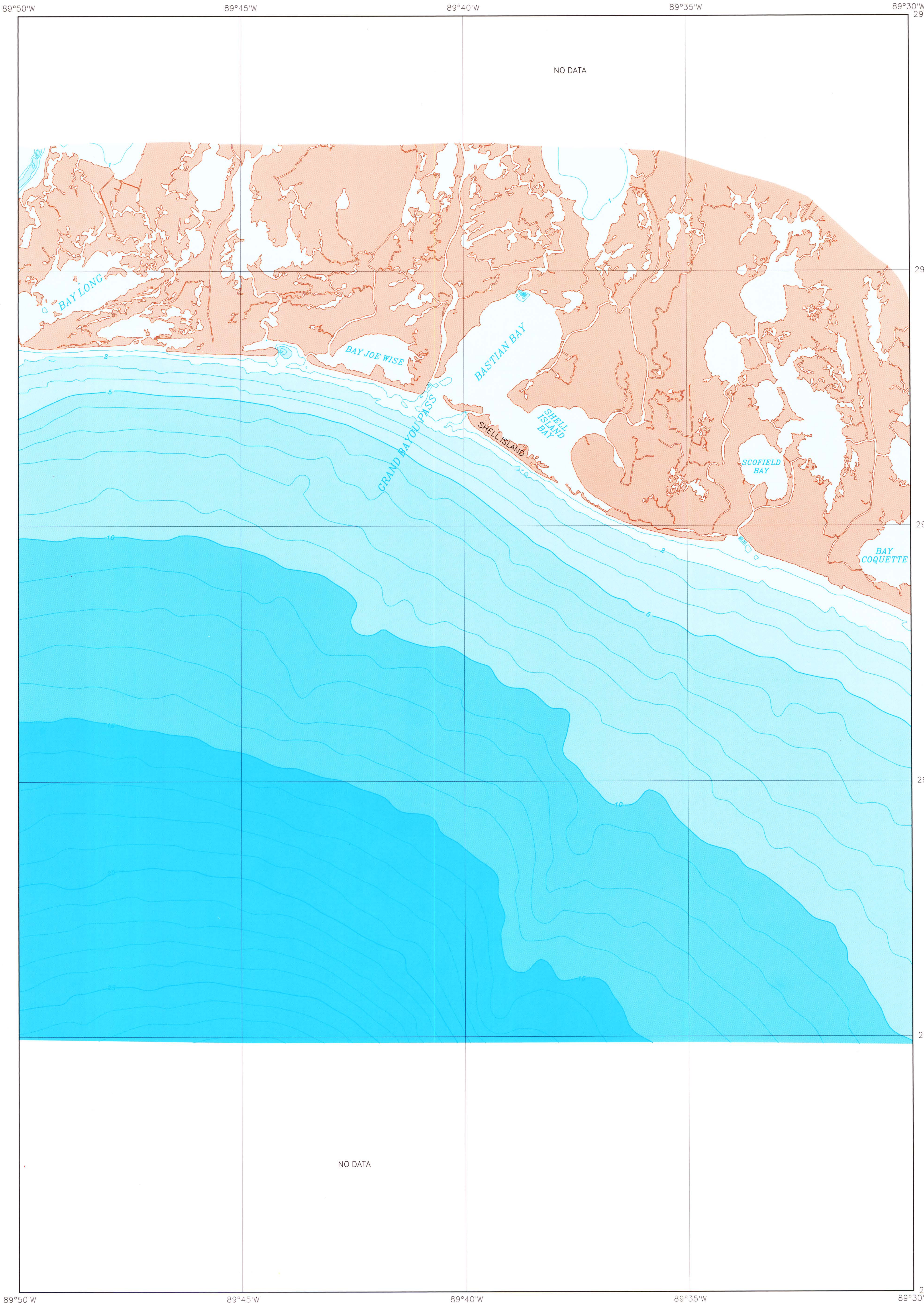
Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



BARATARIA WEST BATHYMETRY, 1930's



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–2
- 2–5
- 5–10
- 10–15
- >15

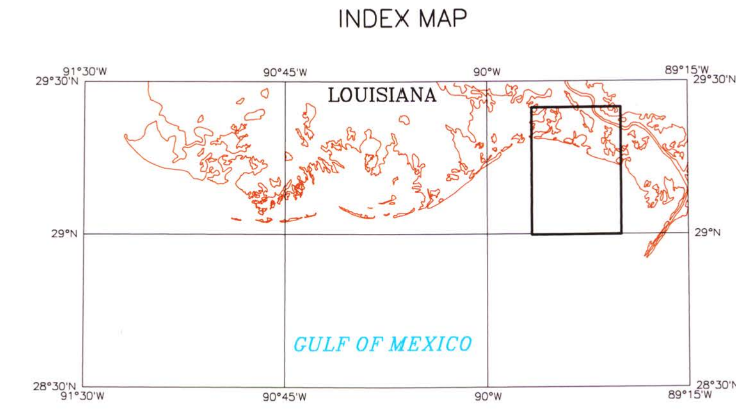
Bathymetric Data

Depth soundings in digital form were obtained from the National Ocean Service (NOS), National Geophysical Data Center, in Boulder, Colo. This data set, consisting of latitude, longitude, and depth values, was digitized by the NOS from U.S. Coast and Geodetic Survey (USCGS) hydrographic sheets from the years 1934 and 1936. Soundings for these charts were collected using then–newly–developed echo–sounding and radio acoustic ranging equipment. The vertical datum is mean low water (MLW) during the period of each hydrographic survey; it is not directly comparable to the vertical datum used for other years in the atlas. Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

Shoreline data were digitized from USCGS topographic sheets from the years 1932, 1933, and 1934. Shorelines for these USCGS maps were interpreted from aerial photography, supplemented by planetable surveys in selected areas. The shorelines represent the approximate position of the mean high water line. This elevation is approximately 0.5 m above the MLW datum of the bathymetric data. Some shoreline positions were modified to reflect changes indicated by subsequent hydrographic surveys.

INDEX MAP



BARATARIA EAST BATHYMETRY, 1930's

EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1930's SHORELINE
1980's SHORELINE

Sea–floor Change Data

Areas of vertical sea–floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry. Because of relative sea–level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.33 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea–level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

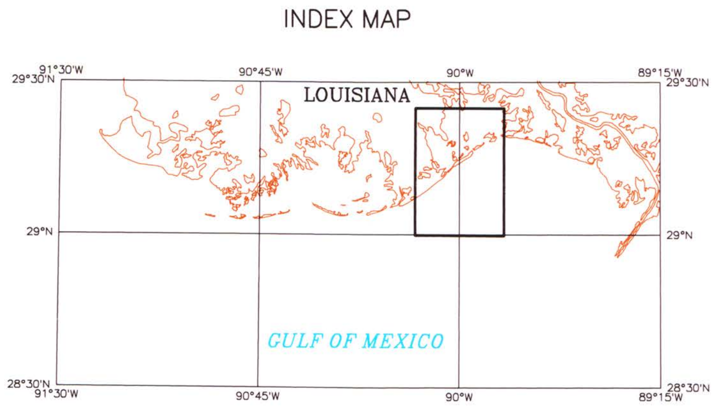
Accuracy of Results

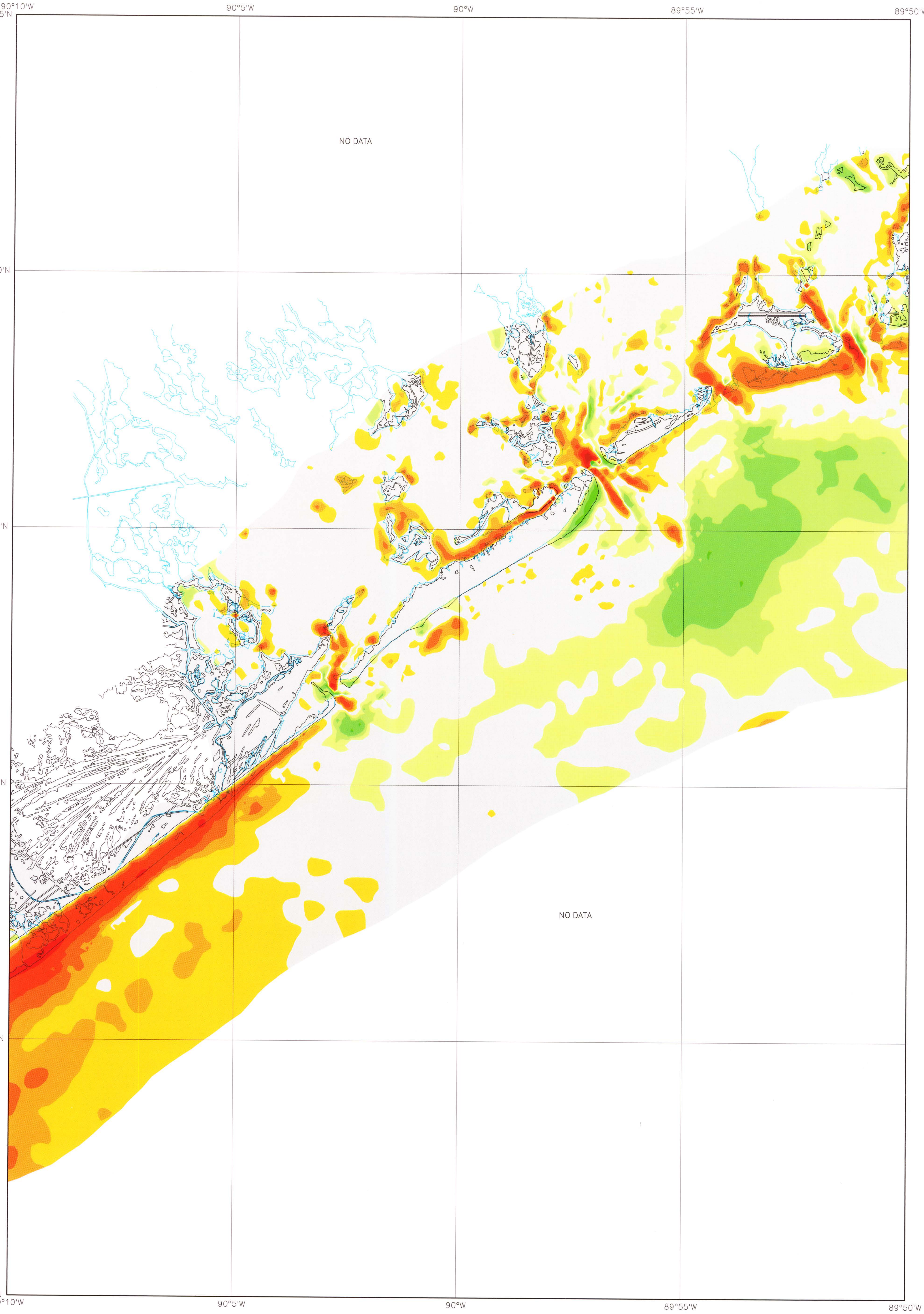
Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character has not changed since the 1930's. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the precise land elevation in the 1930's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP

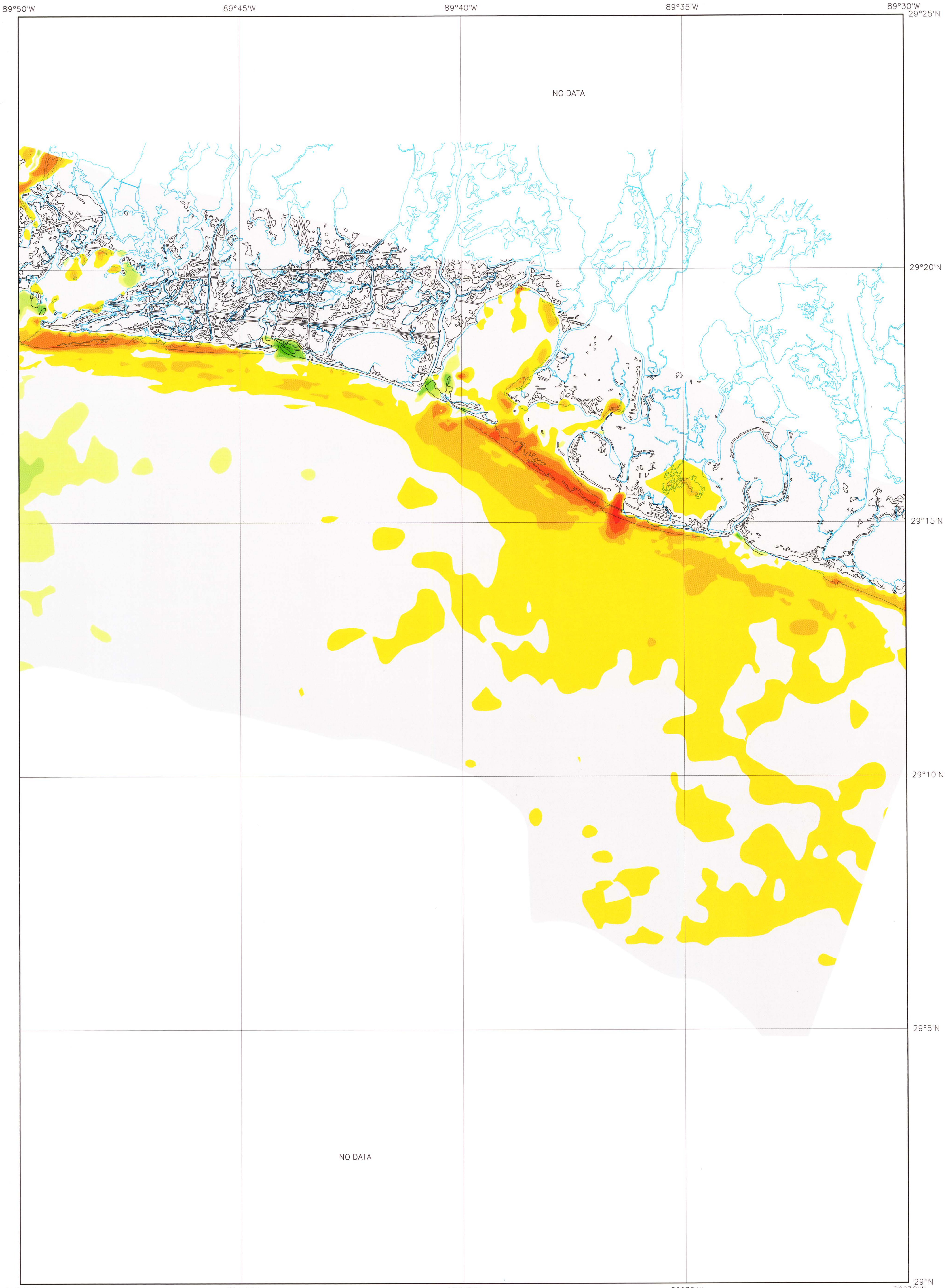




Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

SCALE 1:100 000
1 0 1 2 3 4 5 NAUTICAL MILES
1 0 1 2 3 4 5 KILOMETERS
SHORELINE DATUM: MEAN HIGH WATER

BARATARIA WEST SEA–FLOOR CHANGE, 1930's–1980's



EXPLANATION OF MAP COLORS

ACCRETION IN METERS
- >10.0
- 5.0–10.0
- 2.5–5.0
- 1.5–2.5
- 1.0–1.5
- 0.5–1.0

NO SIGNIFICANT CHANGE

EROSION IN METERS
- 0.5–1.0
- 1.0–1.5
- 1.5–2.5
- 2.5–5.0
- 5.0–10.0
- >10.0

1930's SHORELINE

1980's SHORELINE

Sea-floor Change Data

Areas of vertical sea-floor erosion and accretion were defined through a numerical comparison of surface grids representing the 1930's and 1980's bathymetry. Because of relative sea-level rise and vertical datum differences between these two time periods, a vertical datum correction of 0.33 m was applied to the results. With this correction, areas of accretion and erosion represent changes in seabed elevation through sediment transport processes, without the influence of sea-level changes and datum inconsistencies. The vertical datum correction is explained in further detail in the discussion section of the atlas.

The sea-floor change shown on this map does not reach the maximum levels given in the explanation of map colors, which shows the entire range of sea-floor change documented throughout the study area.

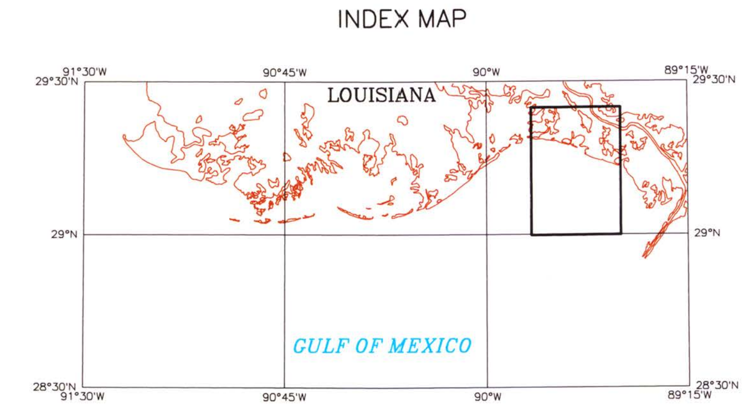
Accuracy of Results

Numerous sources of error are present in the methodologies and data associated with a historical bathymetric comparison of this type. The range of potential errors is explained in the discussion section. Based on an evaluation of these errors, a zone of no significant change is defined here as ranging from 0.5 m of erosion to 0.5 m of accretion, shown in gray on this map.

Elevation of Land Areas

As noted on the bathymetric maps in the atlas, the elevation of land areas is not known. However, since areas of particular importance include regions where land in the 1930's eroded to become open water in the 1980's, land areas were assumed to have a constant elevation of 0.55 m above the mean low water datum for each year in order that the vertical change could be evaluated in these areas. This is a reasonable assumption because the land in the study area is almost uniformly low, frequently inundated marsh, and because historical descriptions support the assumption that this basic character has not changed since the 1930's. Thus, areas showing a transition from land in the 1930's to open water in the 1980's are shown as erosional zones, even though the precise land elevation in the 1930's is not known. A full explanation of the methods and assumptions used to determine areas of erosion, accretion, and no significant change can be found in the discussion section of the atlas.

INDEX MAP



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

BARATARIA EAST SEA-FLOOR CHANGE, 1930's–1980's

EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

- 0–2
- 2–5
- 5–10
- 10–15
- >15

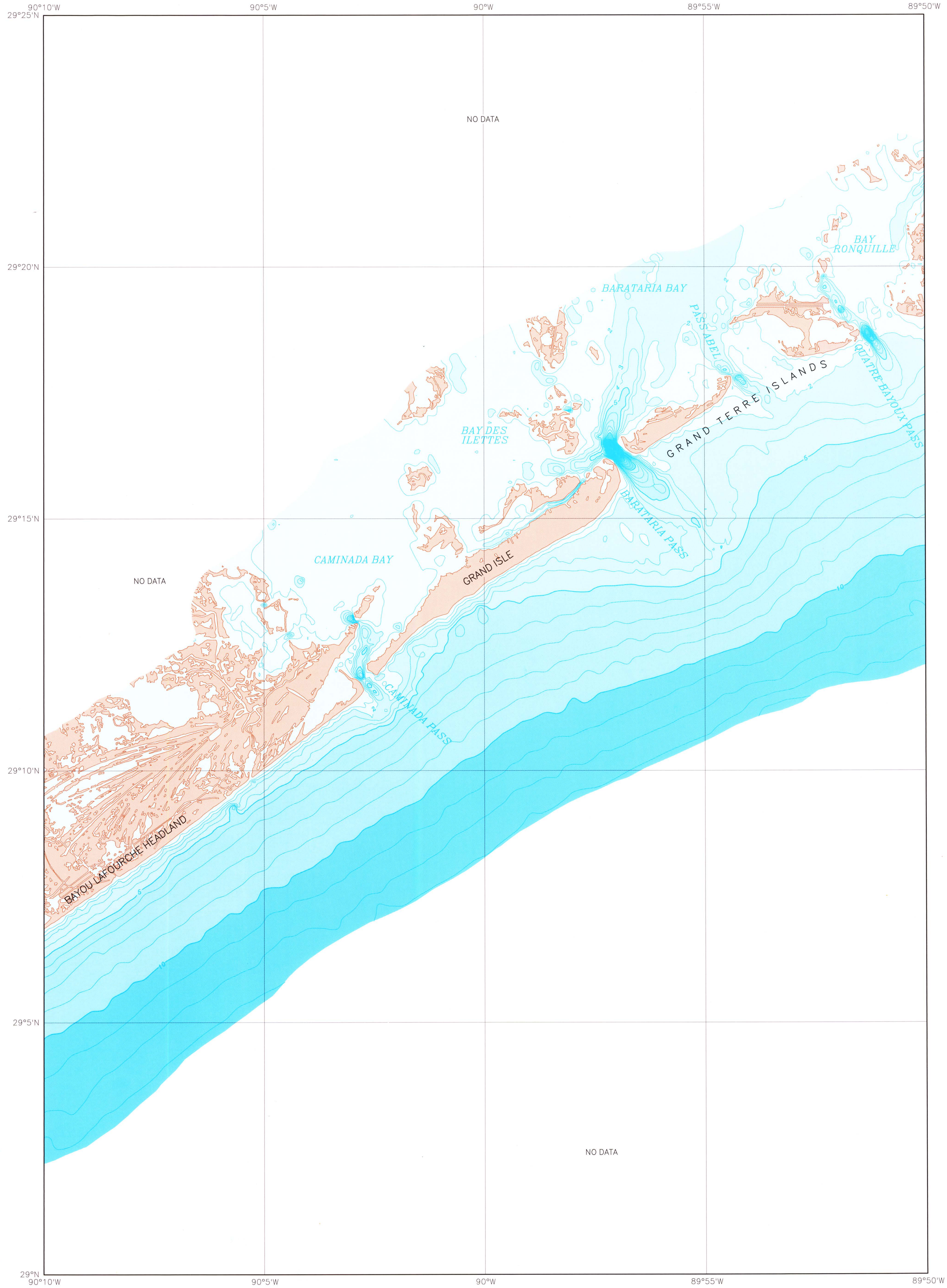
Bathymetric Data

Depth–sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from hydrographic surveys conducted in 1988 and 1989 by Gulf Ocean Services, Inc., under contract to the USGS. These surveys utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

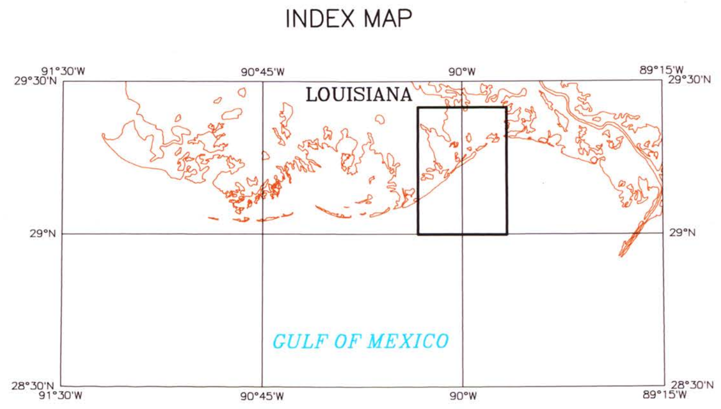
Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map.

Shoreline Data

The shorelines shown on this map were obtained from high–altitude aerial photography taken in 1989. The photographs were color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the mean high water (MHW) shoreline was interpreted on mylar overlays, rectified to the 1:24,000–scale 7.5–minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.



INDEX MAP



Universal Transverse Mercator projection, zone 15

Not to be used for navigational purposes

SCALE 1:100 000

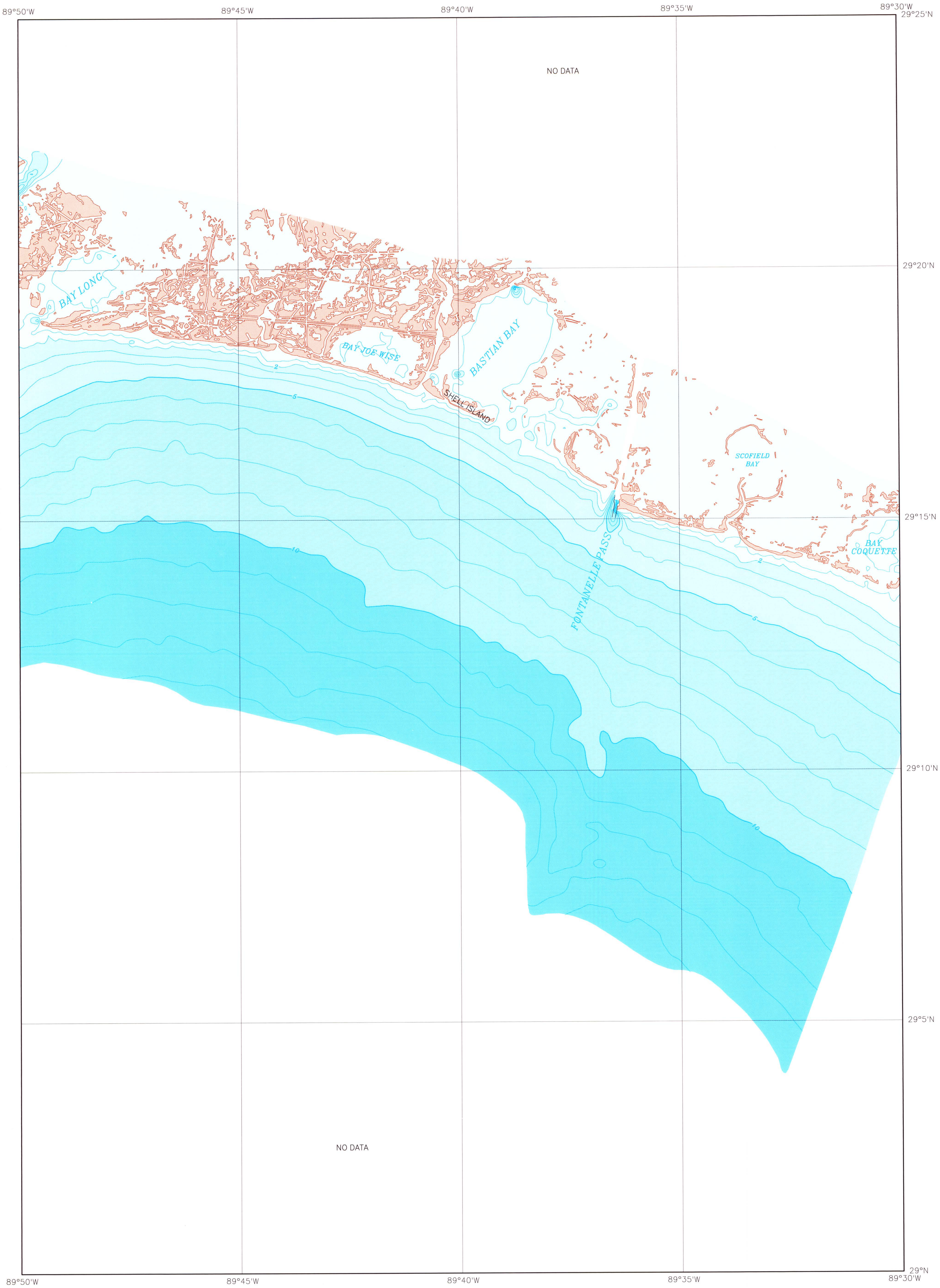
1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER

DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

BARATARIA WEST BATHYMETRY, 1980's



EXPLANATION OF MAP COLORS

Land

DEPTH IN METERS

0–2

2–5

5–10

10–15

Breakwater or jetty

Bathymetric Data

Depth-sounding data, consisting of latitude, longitude, and depth values, were obtained in digital form from a hydrographic survey conducted in 1989 by Gulf Ocean Services, Inc., under contract to the USGS. This survey utilized a Del Norte model 520 microwave Trisponder for horizontal control and an Echotrac fathometer for soundings. The vertical datum for these soundings is mean lower low water (MLLW), determined from the Grand Isle tide gauge from 1960 to 1978; it is not directly comparable to the vertical datum used for other years in the atlas.

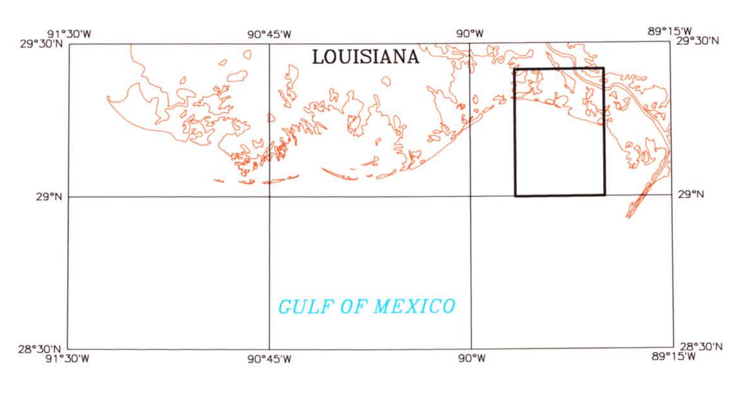
Depths for inland bodies of water, such as bayous and small lakes, were not processed here, although these areas are shown in blue to improve the visual quality of the map. However, an inland shipping channel known to be deep is shown blank (no data), to prevent implying that it is shallow, as are most inland bodies of water.

Shoreline Data

The shorelines shown on this map were obtained from high-altitude aerial photography taken in 1989. The photographs were color infrared stereopairs taken by the National Aeronautics and Space Administration at a scale of 1:65,000. The approximate position of the mean high water (MHW) shoreline was interpreted on mylar overlays, rectified to the 1:24,000-scale 7.5-minute USGS topographic quadrangles, and then digitized. The MHW shoreline is approximately 0.5 m above the MLLW datum of the bathymetric data.

Breakwaters or jetties, indicated by black lines, are shown where they have a significant influence on the shoreline configuration or bathymetry.

INDEX MAP



SCALE 1:100 000

1 0 1 2 3 4 5 NAUTICAL MILES

1 0 1 2 3 4 5 KILOMETERS

BATHYMETRIC CONTOUR INTERVAL 1 METER
DATUM: MEAN LOWER LOW WATER
SHORELINE DATUM: MEAN HIGH WATER

Universal Transverse Mercator projection, zone 15
Not to be used for navigational purposes

BARATARIA EAST BATHYMETRY, 1980's