Louisiana Barrier Island Comprehensive Monitoring Program (BICM)
Volume 3: Bathymetry and Historical Seafloor Change 1869-2007
Part 3: Southern Chandeleur Islands and Western Chenier Beaches, Bathymetry Maps

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Final Report

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INTRODUCTION

It is widely recognized and well documented that barrier islands and deltaic headland shorelines of the Louisiana Coastal Zone are rapidly retreating landward and degrading (e.g. LCA, 2005). High rates of delta plain subsidence, ongoing eustatic sea-level rise, sediment starvation, and processes such as storm impacts collectively contribute to this shoreline loss as shoreline sediment is eroded or becomes inundated by marine waters (Penland and Ramsey, 1990). The amount of shoreline retreat along coastal Louisiana has been shown to be as much as 25 m/yr locally (Williams et al., 1992; Martinez et al., 2009), and has been a contributing factor to the more than 100 km^2 of annual land loss that has been documented for some select historic time frames across the region (Barras et al., 2004).

PURPOSE

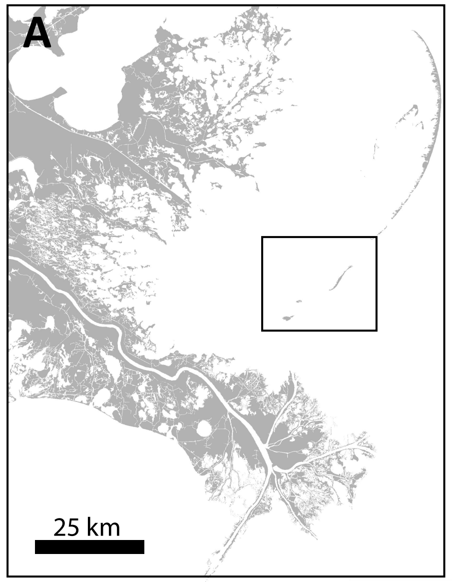
To more effectively identify the magnitude, rates, and processes of shoreline change a Barrier Island Comprehensive Monitoring program (BICM) has been developed by the Louisiana Department of Natural Resources (LDNR), and implemented by LDNR, University of New Orleans-Pontchartrain Institute for Environmental Sciences (UNO-PIES), and the U.S. Geological Survey (USGS) as a framework for a coast-wide monitoring effort. A significant component of this effort includes documenting the historically dynamic morphology of the Louisiana nearshore, shoreline, and backshore zones. This aspect of the program is designed to complement other more area-specific monitoring programs that are currently underway through the support of agencies such as the Louisiana Department of Natural Resources and U.S. Army Corp of Engineers.

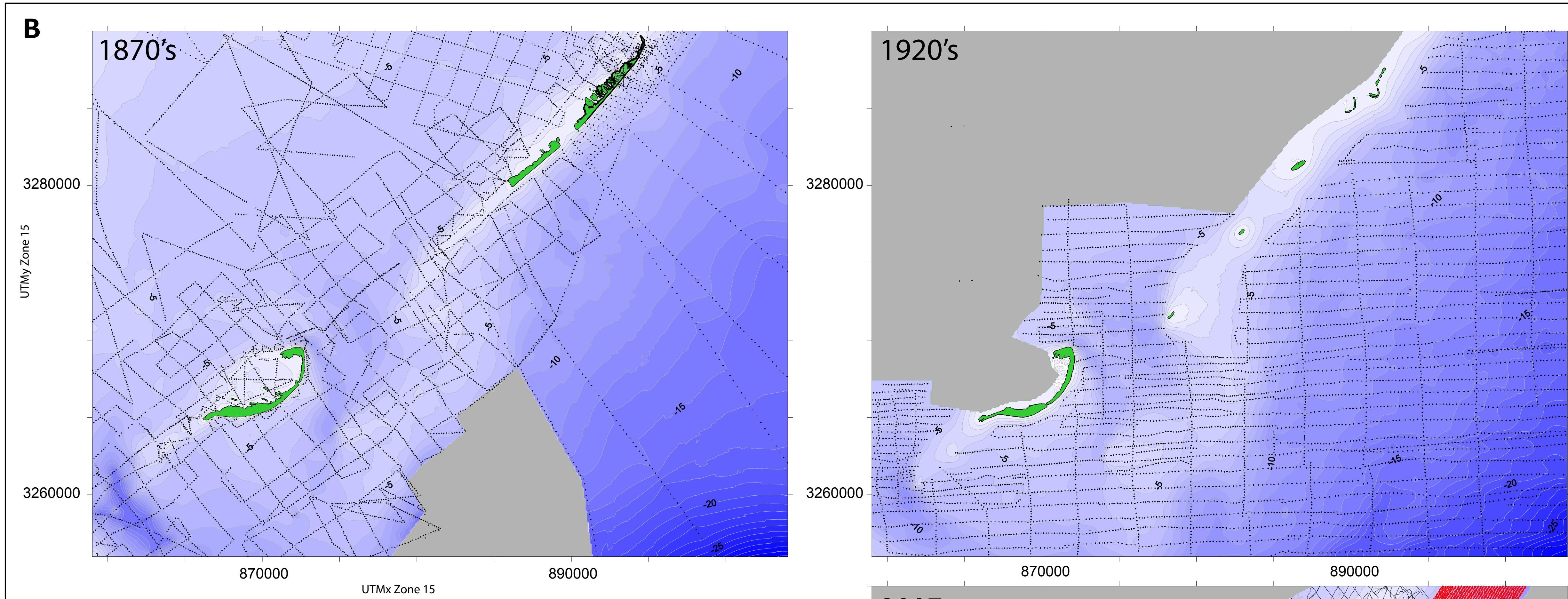
The advantage of BICM over current project-specific monitoring efforts is that it will provide long-term morphological datasets on all of Louisiana's barrier islands and shorelines; rather than just those islands and areas that are slated for coastal engineering projects or have had construction previously completed. BICM additionally specifically provides a larger proportion of unified, long-term datasets that will be available to monitor constructed projects, plan and design future barrier island projects, develop operation and maintenance activities, and assess the range of impacts created by past and future tropical storms. The development of coastal models, such as those quantifying littoral sediment budgets, and a more advanced knowledge of mechanisms forcing large-scale coastal evolution becomes increasingly feasible with the availability of BICM regional datasets. These factors constitute critically important elements of any effort that is aimed at effective coastal restoration, sediment nourishment, or management.

THIS REPORT

This report is the third part of BICM Volume 3, a series focusing on the bathymetry and seafloor change for the Louisiana Coastal Zone. Part 3 specifically focuses on the historical and 2007 bathymetry for the Southern Chandeleur Islands (Figure 1) and the Western Chenier Beaches (Figure 2). It is not intended to be used as a stand-alone reference without a complete understanding of the methodology detailed in Part 1 of Volume 3. Contained within this volume are the results of a three-year-long effort to: 1) assimilate into one database an array of known historical bathymetric datasets for the study areas, 2) develop the most regionally comprehensive, up-to-date, high-resolution bathymetric dataset available for the study areas, and 3) shift bathymetric data from various time periods into a common vertical and horizontal datum so that all of the data for different time periods are comparable. The approach, methods, quality control and uncertainty analysis results are described in detail within Part 1 of Volume 3 and uncertainty analysis results that are specific to the data with this report are presented below. Part 1 also documents the sources of pre-2007 bathymetric data and the methods used to create, from these sources, digital data that is based on common vertical and horizontal reference frames. A subsequent report (Volume 3, Part 4) will employ the historical and 2006-2007 datasets to derive patterns and rates of seafloor change (erosion and accretion), calculate volumes of sediment erosion or accretion, and interpret regional coastal evolution trends within the study areas. Shorelines used in this report were generated for BICM Volume 2, *Shoreline Change Analysis, 1800's to 2005* by Martinez et al. (2009). A detailed account of the methods and data sources for the shorelines can be found in Martinez et al. (2009).

1870’s to 2007 Bathymetric Survey Coverage: Southern Chandeleur Islands





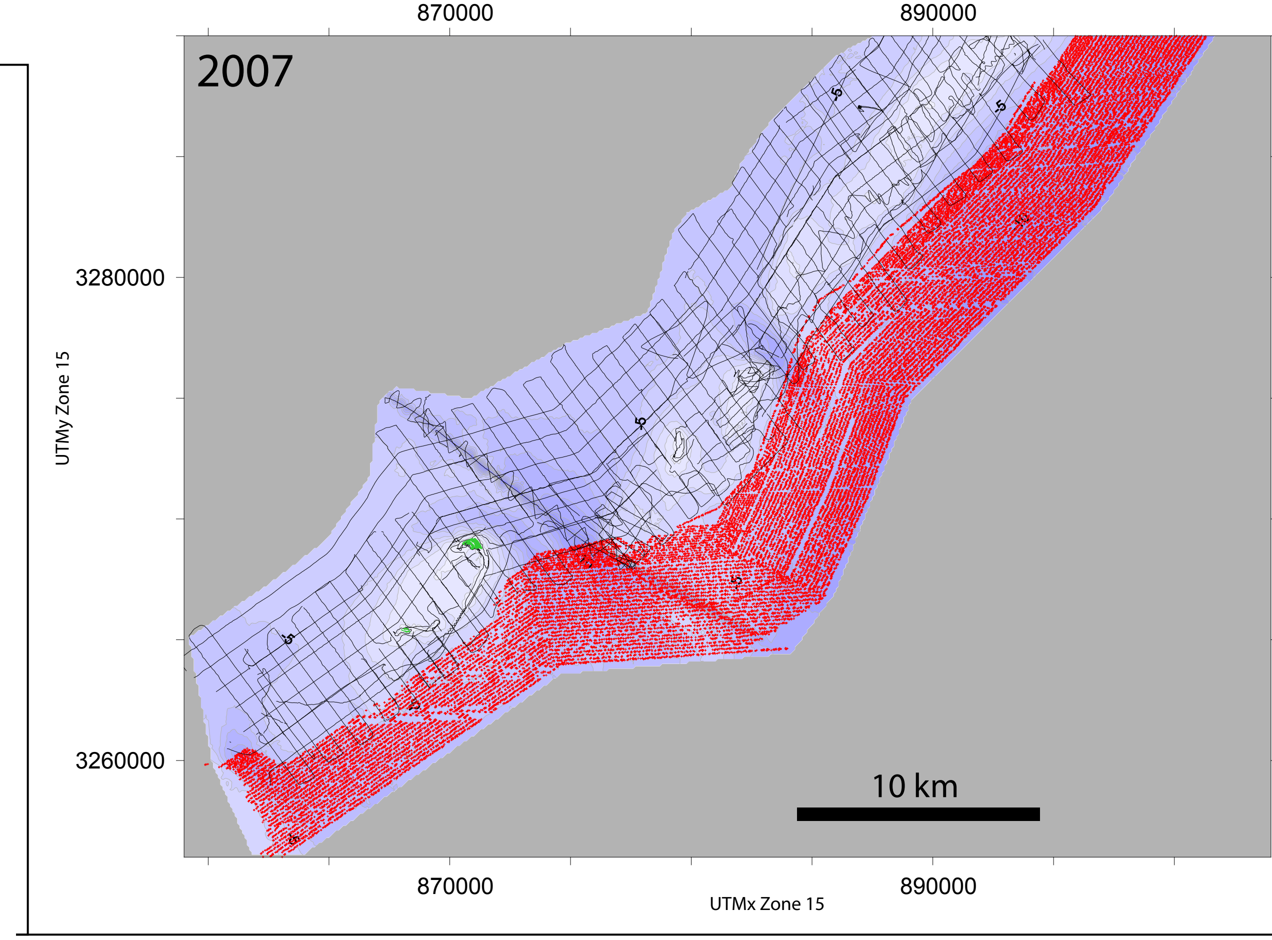
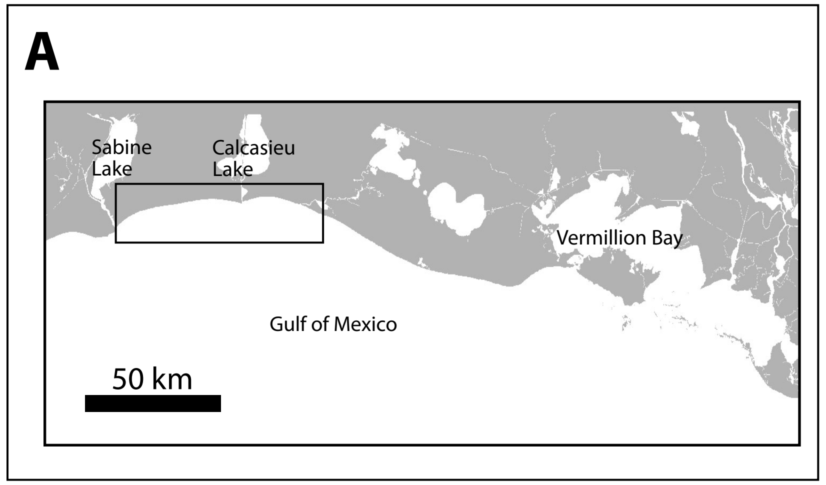


Figure 1. A. Regional map of southeastern Louisiana. The Southern Chandeleur Islands study area is indicated by the rectangle.
B. Bathymetric data coverage for the study area 1870’s to 2007. On 2007 bathymetric data coverage map black transects indicate single-beam bathymetric data and red transects indicate swath bathymetric data coverage.
C. U.S. Coast and Geodetic Survey (USCGS) Hydrographic Survey Smooth Sheets (H-Sheets) used for historical bathymetric data sources. 2007 bathymetric data were collected by the University of New Orleans Pontchartrain Institute for Environmental Sciences and the U.S. Geological Survey.

C

H-Sheet ID	Year	Location
1870’s		
H00999	1869	Breton Offshore
H01000	1869	Breton Sound
H01171	1873	Chandeleur Sound
H01654	1885	Chandeleur Offshore
1920’s		
H04171	1920	Chandeleur Offshore
H04212	1921-22	Breton Offshore
H04219	1922	Breton Sound
H04223	1922	Breton Offshore and Sound

1880's to 2007 Bathymetric Survey Coverage: Western Chenier Beaches



C

H-Sheet ID	Year	Location
1880's		
H01596A	1884	Sabine Pass to Johnson Bayou
H01596B	1884	Sabine Pass
H01645	1885	Johnson Bayou to East of Mermentau
H01647	1885	Mermentau Delta
H01648	1885	Calcasieu Pass
1920's		
H04332	1922-23	Sabine Pass to Constance Beach
H04365	1923-24	Constance Beach to Calcasieu Pass
H04372	1924	Calcasieu Pass to Mermentau River

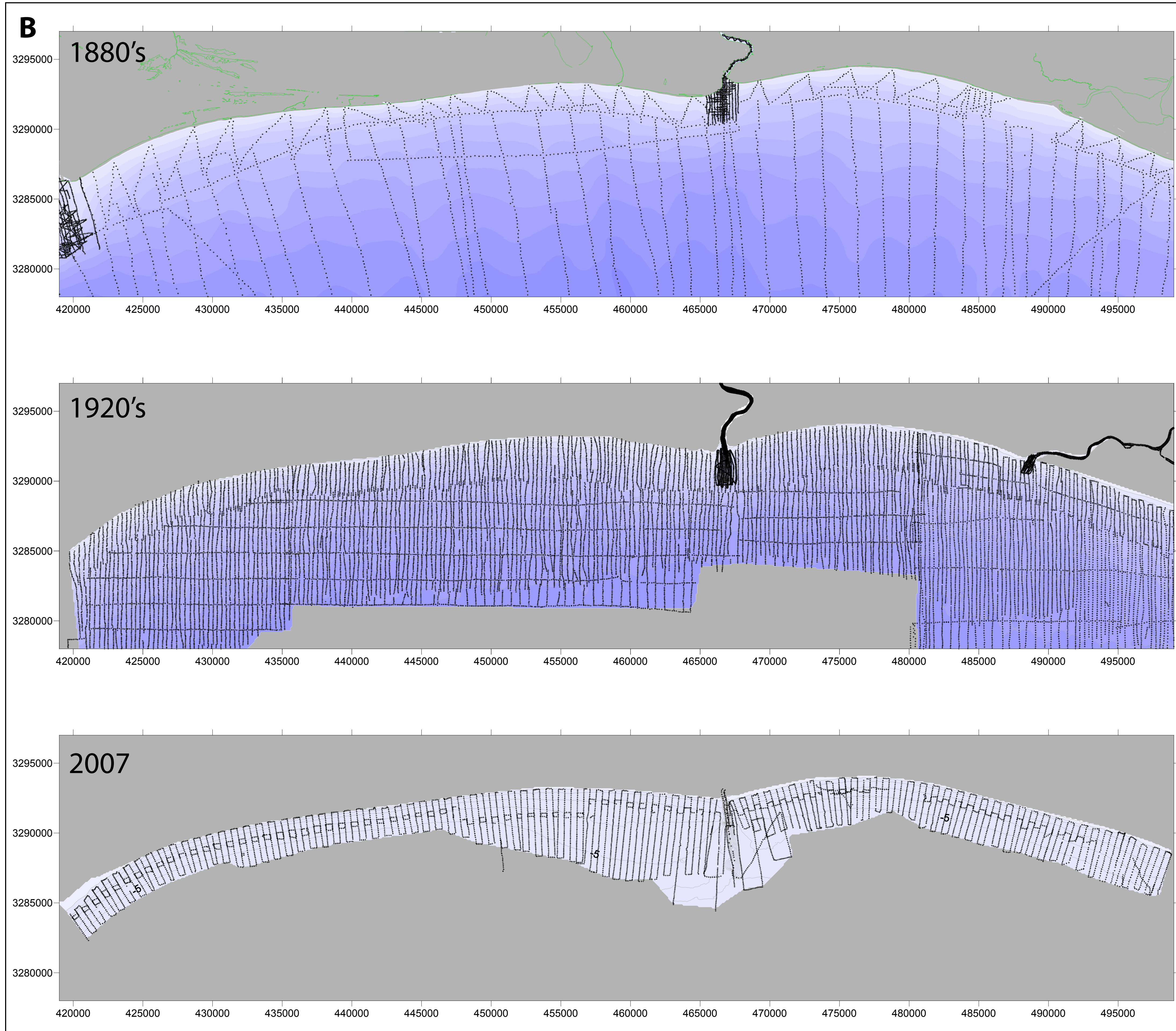


Figure 2. A. Regional map of southwestern Louisiana. The Western Chenier Beaches study area is indicated by the rectangle.
B. Bathymetric data coverage for the study area 1880's to 2007.
C. U.S. Coast and Geodetic Survey (USCGS) Hydrographic Survey Smooth Sheets (H-Sheets) used for historical bathymetric data sources. 2007 bathymetric data were collected by the University of New Orleans Pontchartrain Institute for Environmental Sciences and the U.S. Geological Survey.

UNCERTAINTY ANALYSIS RESULTS FOR 2007 BATHYMETRIC DATA

The methods employed to conduct uncertainty analysis for the 2006-2007 bathymetric data are detailed in Part 1 of BICM Volume 3. Here we present a summary of the methods and the results of our uncertainty analysis for the 2007 data.

During the survey, shore-parallel lines trending perpendicular to the shore-perpendicular transects were surveyed, providing an opportunity to assess consistency of elevation measurement throughout the study. At each location where a survey vessel crossed itself or another survey vessel, the difference in elevation (DZ) is calculated. Ideally, the processed elevation at any given crossing point should be identical (DZ=0). However, this is rarely the case. An ideal crossing would have two boat paths acquiring a measurement at the exact same position (Northing and Easting). However, this was also rarely, if ever, the case, so comparative elevation measurements were conducted by proximity. A script is then run to: 1) identify all crossings, 2) interpolate the elevation for each survey line at the XY location of that crossing, and 3) calculate the DZ between survey lines. The general mechanics of this script are described below.

For a crossing analysis run, each survey line was compared against all others. If the paths crossed, an intersection point was interpolated from the four nearest survey measurements: two from each line. From the interpolated crossing position, a representative elevation measurement was interpolated for each boat path using an average of the measured Z (elevation) within a given search radius of 5 m. This local averaging technique was employed in order to remove any exaggerated DZ discrepancy that could result from an erratic Z measurement associated with any of the four survey points used to determine the crossing position.

Boat crossing analysis is an iterative process whereby the crossing results are analyzed. Analysis suggests problems with parts of the dataset, i.e. a miss-edited survey day, and in turn, a way to amend this problem. The cycle of crossing analysis repeats until the data set has desirable statistical qualities, that is, a mean DZ near 0 m and a narrow standard deviation, as this provides an estimate of overall error in the survey point elevations. Generally, crossings identify problems at three levels: the gross scale and the boat scale. The gross scale identifies large discrepancies, those where the DZ at crossing is greater than 1 meter. These errors are generally the result of missed edits and the like. At the boat scale, survey boat pairs have a single mode in their DZ values; however, this value is not zero. At this scale, static shifts are applied to the Z values in the dataset per each boat such that the DZ modes of boat pairs all approach zero. The results of the crossings analysis are presented in Table 1 below.

Study Area	mean DZ (m)	std DZ (m)	number of crossings
Southern Chandeleur Islands	-0.003	0.06	1680
Western Chenier Beaches	0.03	0.06	802

Table 1. Uncertainty analysis final results for the 2007 bathymetric data. The standard deviation (std) of the difference in elevation (DZ) at survey line crossings is the estimated vertical uncertainty for each study area. In this case the vertical uncertainty for both study areas is +/- 0.06 m. Note that this uncertainty is for the processed bathymetric data (soundings) and not for the interpolated grid surfaces that were used to generate contour maps in this report.

VERTICAL ADJUSTMENT OF HISTORICAL DATA TO NAVD88

In order to conduct seafloor change in the Western Chenier Plain, historical data were shifted from mean lower low water (MLLW) at the time of the survey to NAVD88. Prior to the datum shift (MLLW to NAVD88), a correction for relative sea-level rise must be applied. Daily water level data from the Calcasieu Pass tide gauge were analyzed to determine relative sea level rise (RSLR). The data span a range from 1943 to 1994, and are shown in Figure 3. A linear fit of the daily sea level data indicated a relative sea level rise rate of 0.0049 m/yr. This rate was applied to the data over the time span between the two historical data periods in the Western Chenier Plain, the 1880's and 1920's, and the BICM 2007 surveys. While the tide gauge data overlap surveys from the 1920's, it was assumed to be constant enough in recent history such that it was backwards extrapolated and applied to the 1880's bathymetric data as well. The shifts applied for relative sea level rise were -0.6m for the 1880's data, and -0.41m for the 1920's data. After applying a shift to account for RSLR, the historical data were then shifted from MLLW to NAVD88. For this, the tide gauge at Lake Charles (Station ID: 8767816) was used where the National Geodetic Survey has published that NAVD88 is 0.149m below MLLW. Table 2 shows a summary of the shifts applied to all datasets. Note the 2007 survey data were collected recently in NAVD88, and therefore required no RSLR correction or datum shift.

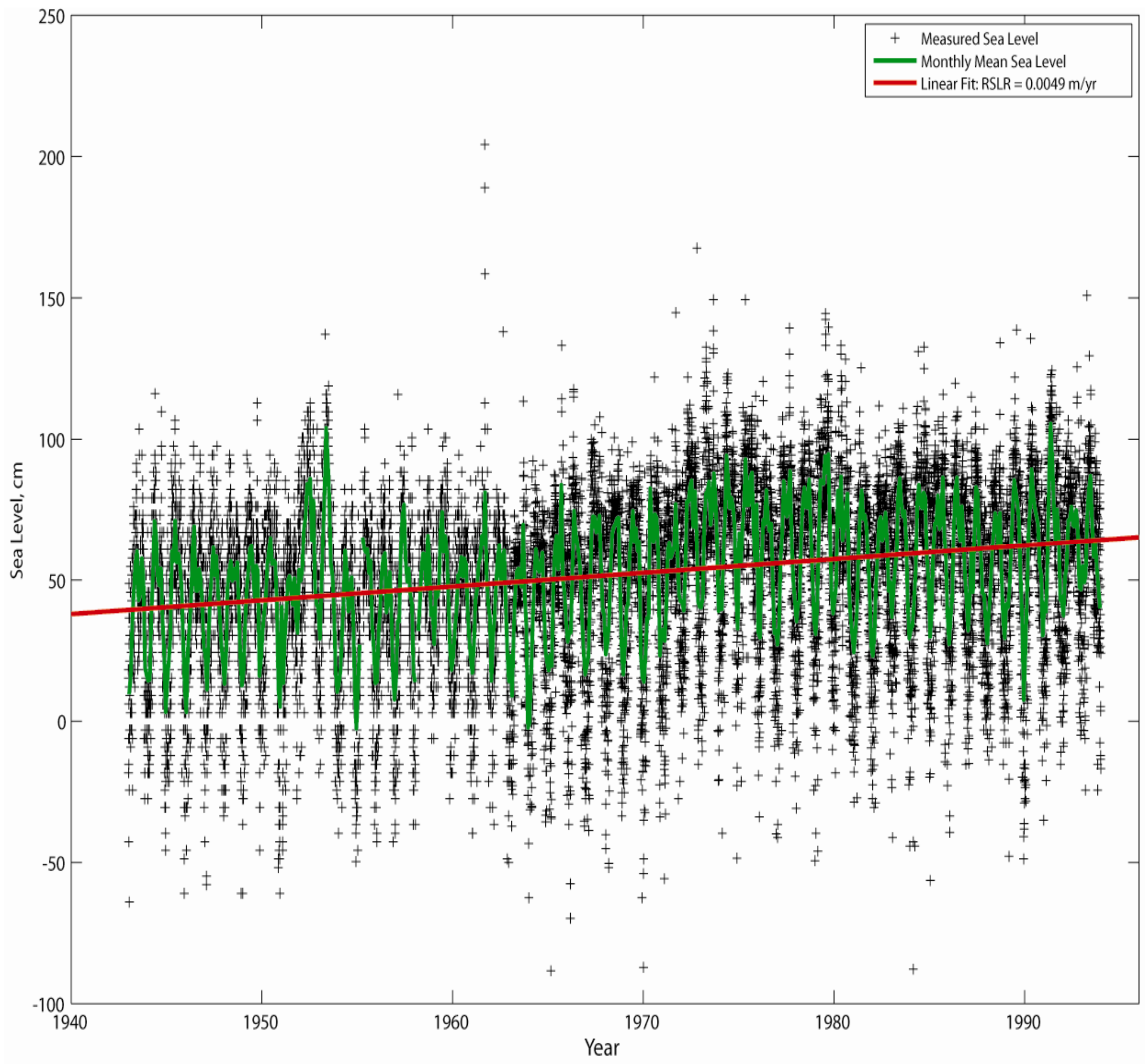


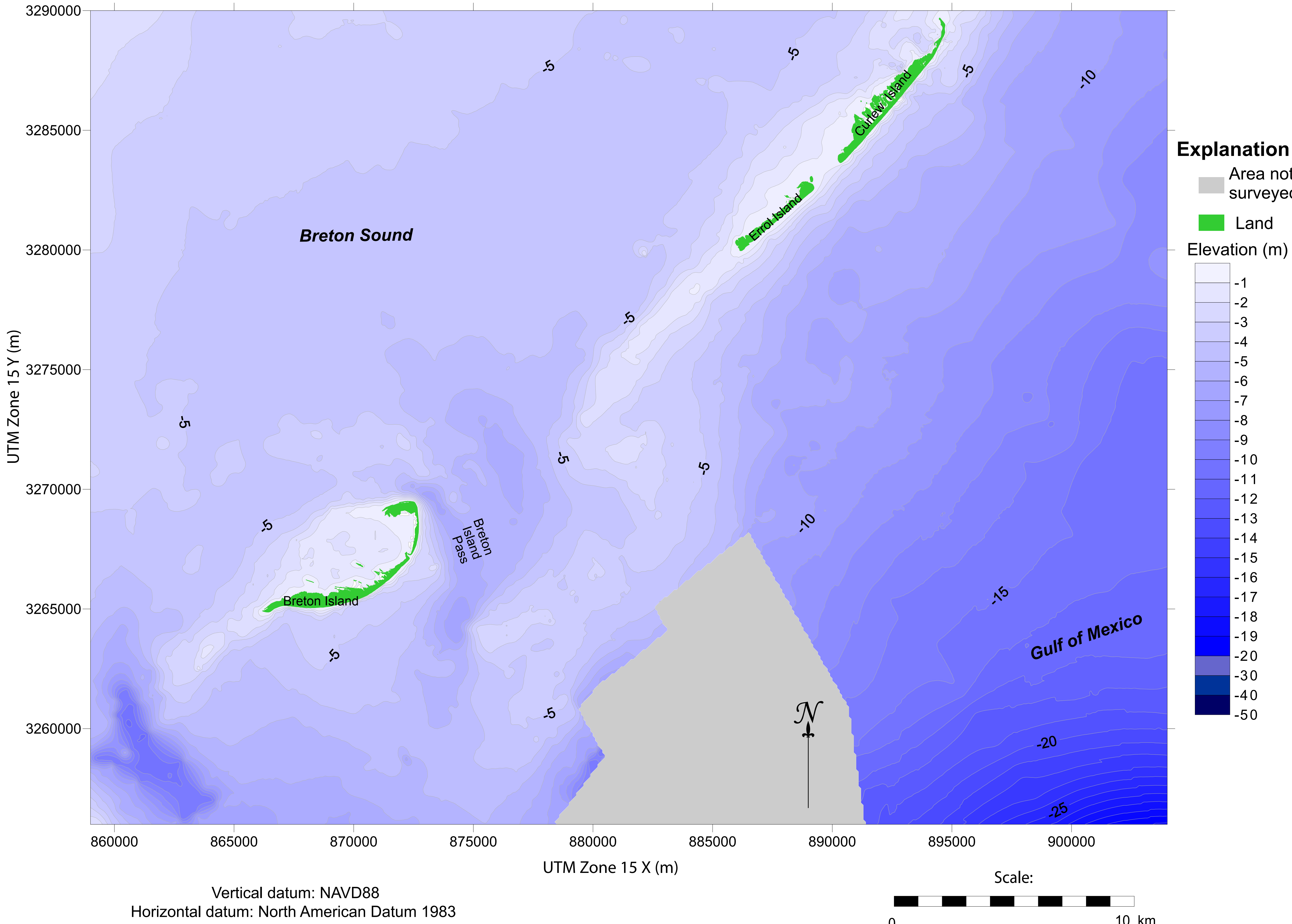
Figure 3. Daily sea level measurements from the Calcasieu Pass tide gauge are shown in black, with the monthly means sea level shown in green. The red line shows the linear fit of the data. The slope of this line was to determine the rate of relative sea level rise to be 0.0049 m/yr for this region. (Note: The vertical scale is in cm.)

Time Period	RSLR (1988-2006, tide gauge)	MLLW to NAVD88	Total Adjustment
1880's	-0.6 m	-0.149 m	-0.749 m
1920's	-0.41 m	-0.149 m	-0.559 m
2007	na	0 m	0 m

Table 2. Adjustments made to historical bathymetric data for seafloor change analysis. Note that a negative value results in an increased depth because the bathymetry is expressed as an elevation relative to NAVD88.

For the Southern Chandeleur Islands, each of the historical datasets was shifted to MLW for the modern tidal epoch by applying a 0.5 cm/yr RSLR correction. Because there are no local sea level rise data that exist for the Chandeleur Islands for the period of study, a value had to be estimated based on tide gauge records in the region. Studies of subsidence-induced sea-level rise in Louisiana have shown that there is a direct correlation between RSLR rates and thickness of the Holocene substrates (Kolb and Van Lopik, 1958; Penland and Ramsey, 1990; Kulp, 2000; Meckel et al., 2006; Tornqvist et al., 2006; 2008). Based on these findings, sea-level rise rates for the Chandeleurs and associated range of uncertainty were estimated by relating RSLR values from tide gauges in the region (0.92 cm/yr at Grand Isle, Louisiana; 0.56 cm/yr at Delacroix, Louisiana; and 0.29 cm/yr at Dauphin Island, Alabama) to thickness of Holocene substrate at each location and based on this relationship, the value for the Chandeleur Islands RSLR was interpolated.

Southern Chandeleur Islands 1870’s Bathymetry



Vertical datum: NAVD88
Horizontal datum: North American Datum 1983

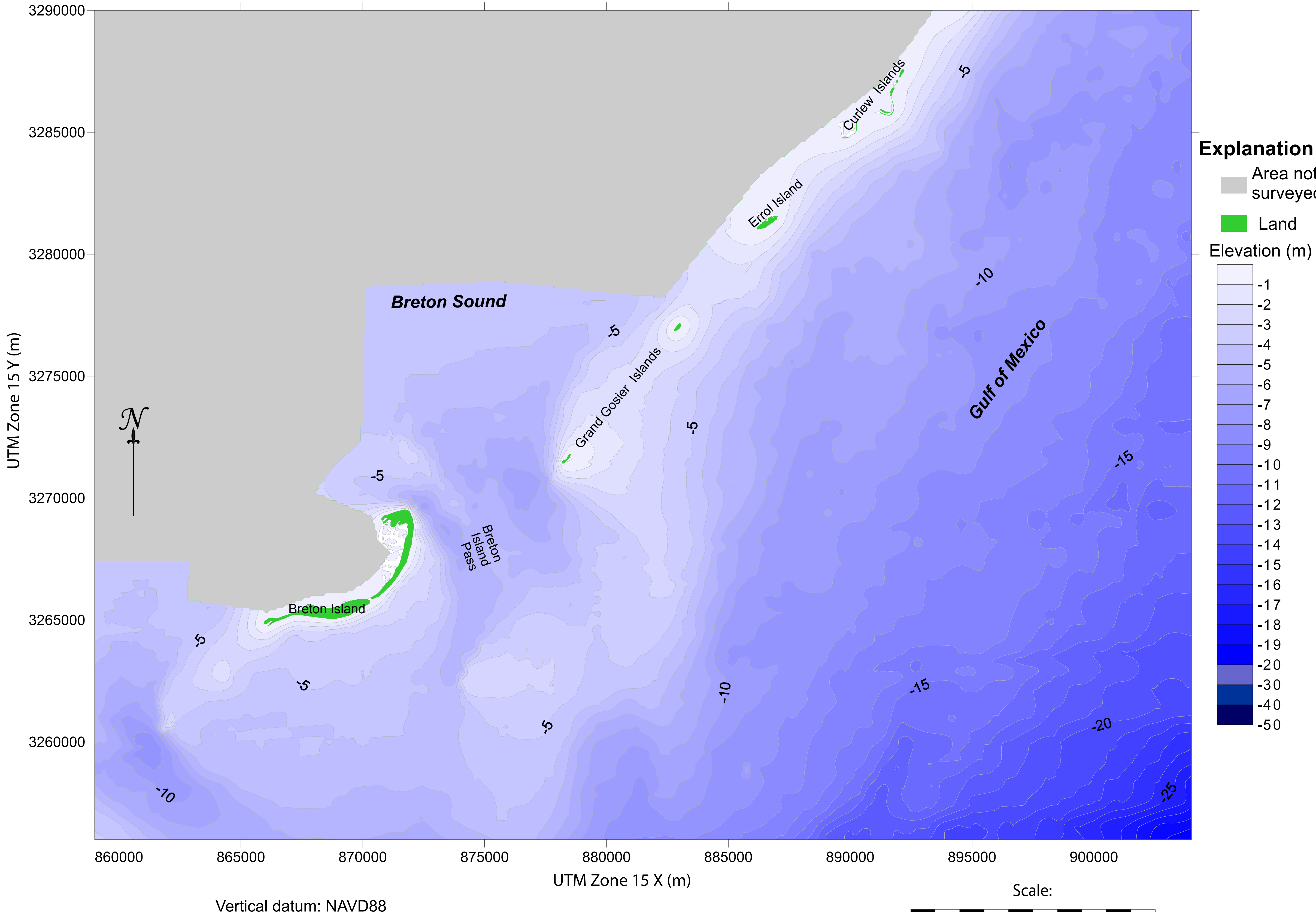
Bathymetric Data

The bathymetric data on this map were acquired during hydrographic surveys conducted by the USCGS in 1869. Depths are given relative to North American Vertical Datum 1988 and were converted from mean low water (MLW) at the time of the survey for comparison to other time periods within a common vertical datum. See details in Parts 1 an 3 of this report for vertical datum coversion methodology.

Supratidal Areas

Shoreline data from 1869 were derived from T-Sheets scanned into digital format at a scale of 1:20,000 by UNO-PIES. For details on shoreline processing methodology see Martinez et al. (2009). Note that shorelines were delineated at mean high water for the time of the topographic survey and the bathymetric data is referenced to NAVD88.

Southern Chandeleur Islands 1920's Bathymetry



Vertical datum: NAVD88
Horizontal datum: North American Datum 1983

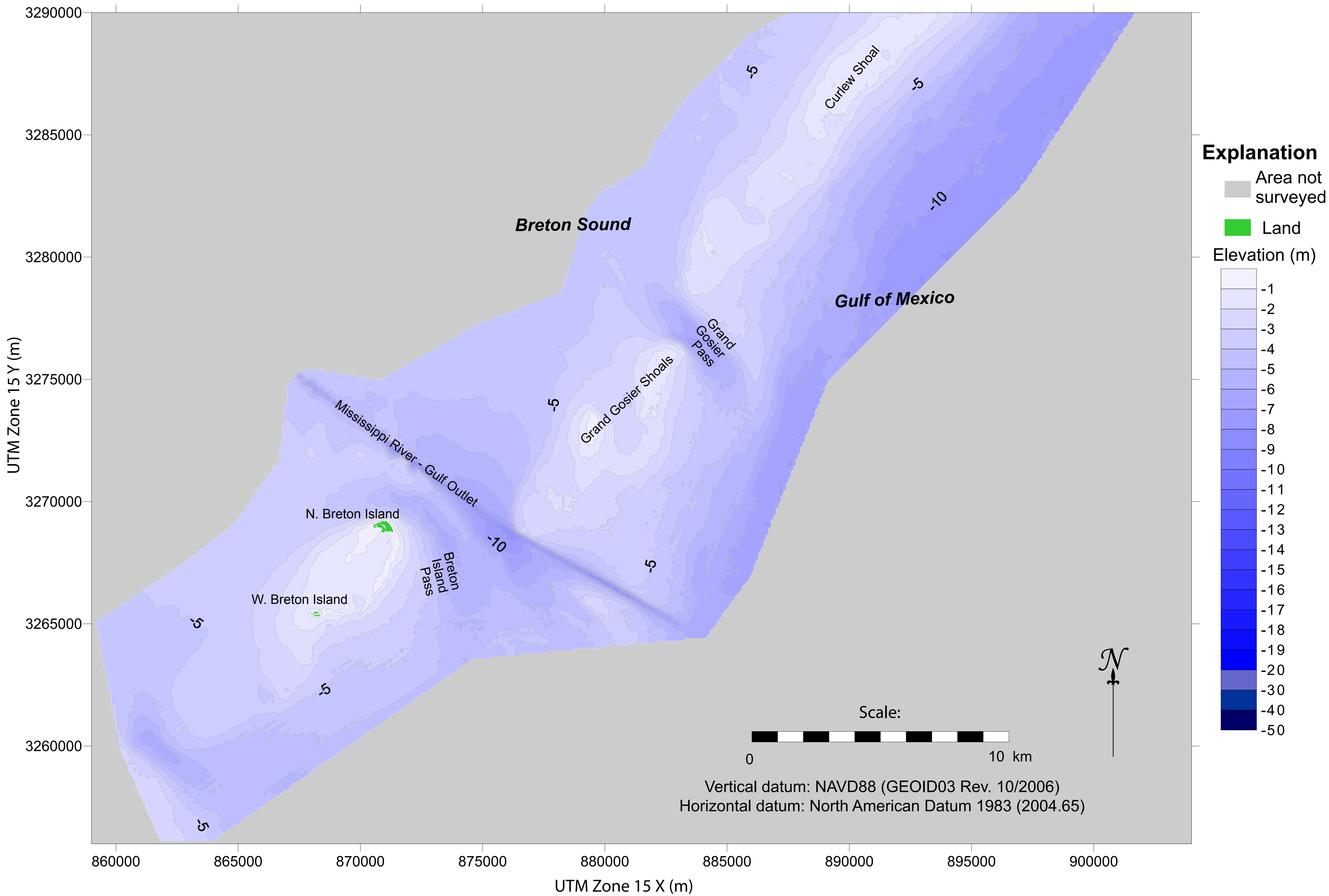
Bathymetric Data

The bathymetric data on this map were acquired during hydrographic surveys conducted by the USCGS from 1921-1922. Depths are given relative to North American Vertical Datum 1988 and were converted from mean low water (MLW) at the time of the survey for comparison to other time periods within a common vertical datum. See details in Parts 1 and 3 of this report for vertical datum coversion methodology.

Supratidal Areas

Shoreline data from 1922 were derived from T-Sheets scanned into digital format at a scale of 1:20,000 by UNO-PIES. For details on shoreline processing methodology see Martinez et al. (2009). Note that shorelines were delineated at mean high water for the time of the topographic survey and the bathymetric data is referenced to NAVD88.

Southern Chandeleur Islands 2007 Bathymetry



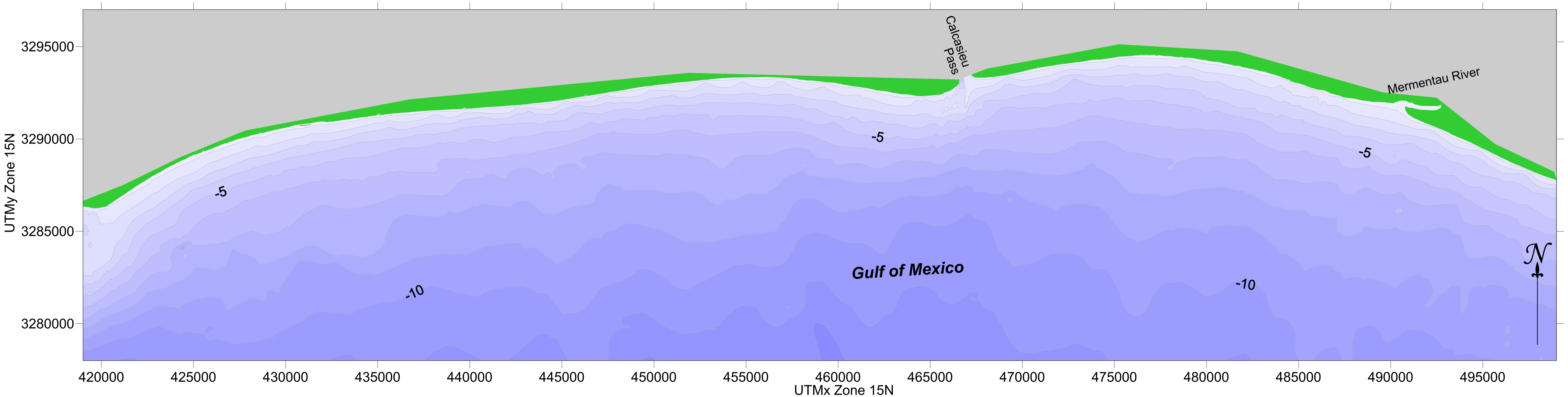
Bathymetric Data

The bathymetric data on this map was acquired from bathymetric surveys conducted in 2007 by UNO-PIES and USGS. Depths are given relative to North American Vertical Datum 1988 (NAVD88). Not to be used for navigation purposes.

Supratidal Areas

The areas shown in green were assigned an elevation value of 0.5 meters. Shoreline data from 2005 were derived from a combination of Digital Ortho-Quarter Quads (DOQQs) and Digital Globe Quickbird satellite imagery obtained by UNO-PIES. The shorelines were derived from thematic land/water classifications produced from these image datasets and subsequent GIS editing by UNO-PIES. Details on shoreline data can be found in Martinez et al. (2009).

Western Chenier Beaches 1880's Bathymetry



Supratidal Areas

Shoreline data from 1880 were derived from T-Sheets scanned into digital format at a scale of 1:20,000 by UNO-PIES. For details on shoreline processing methodology see Martinez et al. (2009). Note that shorelines were delineated at mean high water for the time of the topographic survey and the bathymetric data is referenced to NAVD88.

Bathymetric Data

The bathymetric data on this map was acquired during hydrographic surveys conducted by the USCGS from 1884-1885 Depths are given relative to North American Vertical Datum 1988 and were converted from mean low water (MLW) at the time of the survey for comparison to other time periods within a common vertical datum. See details in Parts 1 and 3 of this report for vertical datum coversion methodology.

Scale:

0 10 km

Vertical datum: NAVD88
Horizontal datum: North American Datum 1983

Explanation

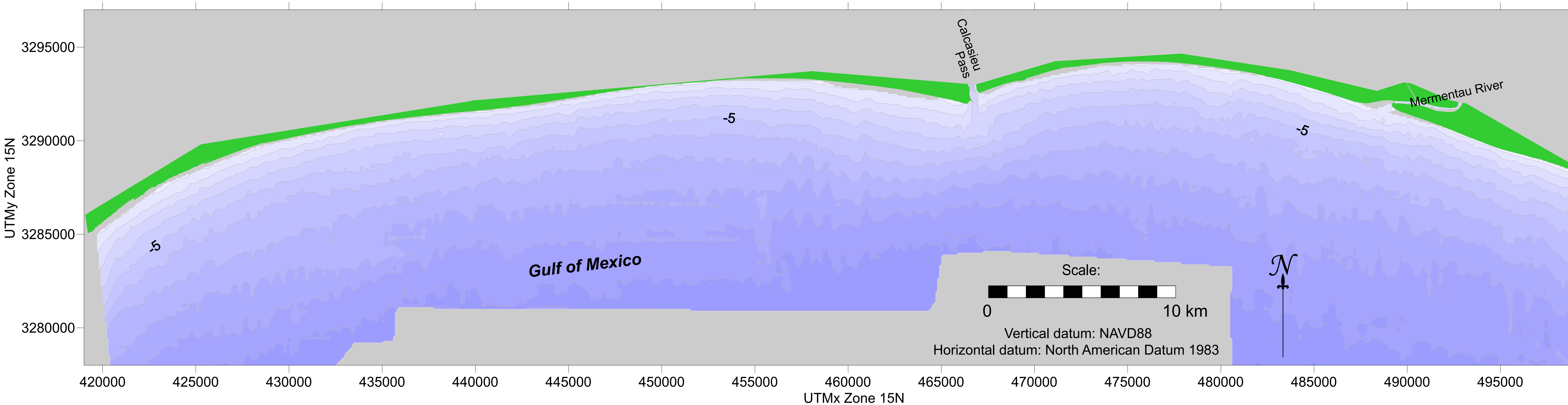
-20 -19 -18 -17 -16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0

Elevation (m)

Area not surveyed

Land

Western Chenier Beaches 1920's Bathymetry

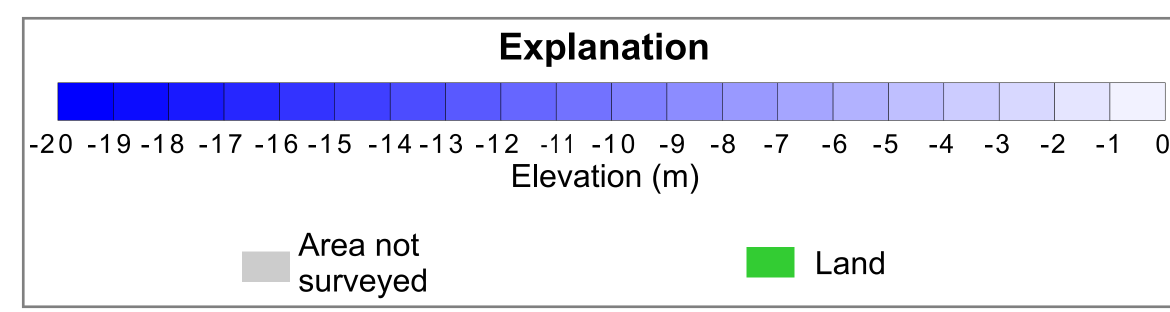


Supratidal Areas

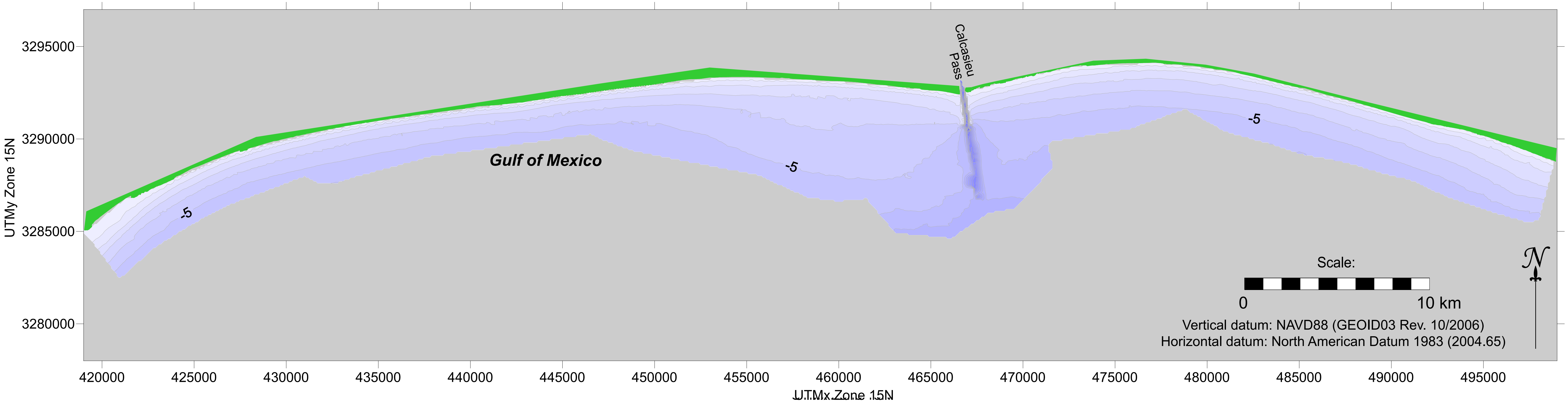
Shoreline data from 1930 were derived from T-Sheets scanned into digital format at a scale of 1:20,000 by UNO-PIES. For details on shoreline processing methodology see Martinez et al. (2009). Note that shorelines were delineated at mean high water for the time of the topographic survey and the bathymetric data is referenced to NAVD88.

Bathymetric Data

The bathymetric data on this map was acquired during hydrographic surveys conducted by the USCGS from 1922-1924 Depths are given relative to North American Vertical Datum 1988 and were converted from mean low water (MLW) at the time of the survey for comparison to other time periods within a common vertical datum. See details in Parts 1 and 3 of this report for vertical datum coversion methodology.



Western Chenier Beaches 2007 Bathymetry

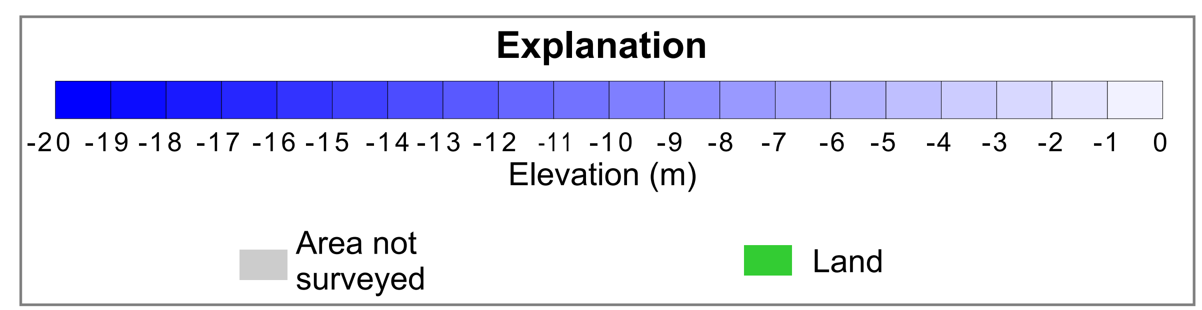


Supratidal Areas

The areas shown in green were assigned an elevation value of 0.5 meters. Shoreline data from 2005 were derived from a combination of Digital Ortho-Quarter Quads (DOQQs) and Digital Globe Quickbird satellite imagery obtained by UNO-PIES. The shorelines were derived from thematic land/water classifications produced from these image datasets and subsequent GIS editing by UNO-PIES see Martinez et al. (2009) for more details about shoreline data.

Bathymetric Data

The bathymetric data on this map was acquired from hydrographic surveys conducted in 2007 by UNO-PIES and USGS. Depths are given relative to North American Vertical Datum 1988 (NAVD88). Not to be used for navigation purposes.



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APPENDIX: BICM 2007 Base Station Geometry and Vertical Error Estimate

Base ID	Latitude NAD83			Longitude NAD83			Ellipsoid (GRS80)	Orthometric (m) Geoid03	Vertical Error
BRET	29	29	38.41803	89	10	29.42099	-23.713	0.908	+/- 1.9cm
GRIG	29	36	48.00490	89	4	55.26548	-23.385	1.738	+/- 1.6 cm
MARK	29	57	12.68450	88	49	38.39671	-25.711	0.889	+/- 1.4cm
MNKY	29	47	23.17218	88	52	0.99811	-25.200	0.707	+/- 1.5cm

Table A1. Base station final geometry and vertical error estimate for Southern Chandeleur Islands

Base ID	Latitude NAD83			Longitude NAD83			Ellipsoid (GRS80)	Orthometric (m) Geoid03	Vertical Error
CALC	29	46	9.25722	93	20	24.98136	-25.399	1.332	+/- 0.5cm
CS1A	29	46	4.61594	93	30	54.47842	-25.494	1.347	+/- 2.1cm
G213	29	47	6.03110	93	5	56.92453	-25.687	0.895	+/- 2.2cm
JONB	29	45	1.19780	93	39	53.57032	-25.243	1.666	+/- 2.0cm

Table A2. Base station final geometry and vertical error estimate for Western Chenier Beaches