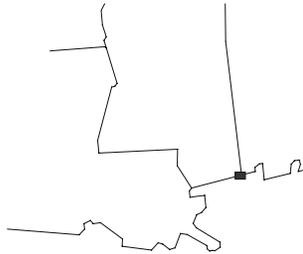


Shoreline Erosion Analysis of Grand Bay Marsh

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By Keil Schmid, Mississippi Department of Environmental Quality, Office of Geology, Jackson, MS 39289

Erosion of marsh shoreline in the Grand Bay National Estuarine Research Reserve (NERR) has been occurring steadily throughout the past several hundred to thousands of years, since the pirating of the Escatawpa River by the Pascagoula River (Otvos, 1985). The Grand Bay NERR is located in the southeast corner of Mississippi and borders Alabama. This natural process is driven by relative sea-level rise (combination of sea-



level rise and land subsidence) (Figure 1) and wave attack, and is offset somewhat by the conversion of upland areas to wetlands. Today, however, the process of upland conversion is limited, and in many cases reversed, by development, making marsh erosion more problematic. The importance of marsh to the coastal ecosystem has been well documented (Mitsch and Gosselink, 1986, among others).

This update on shoreline position, high erosion areas, and area loss in the Grand Bay NERR marsh system (Figure 2) is meant to highlight recent trends associated with coastal erosion.

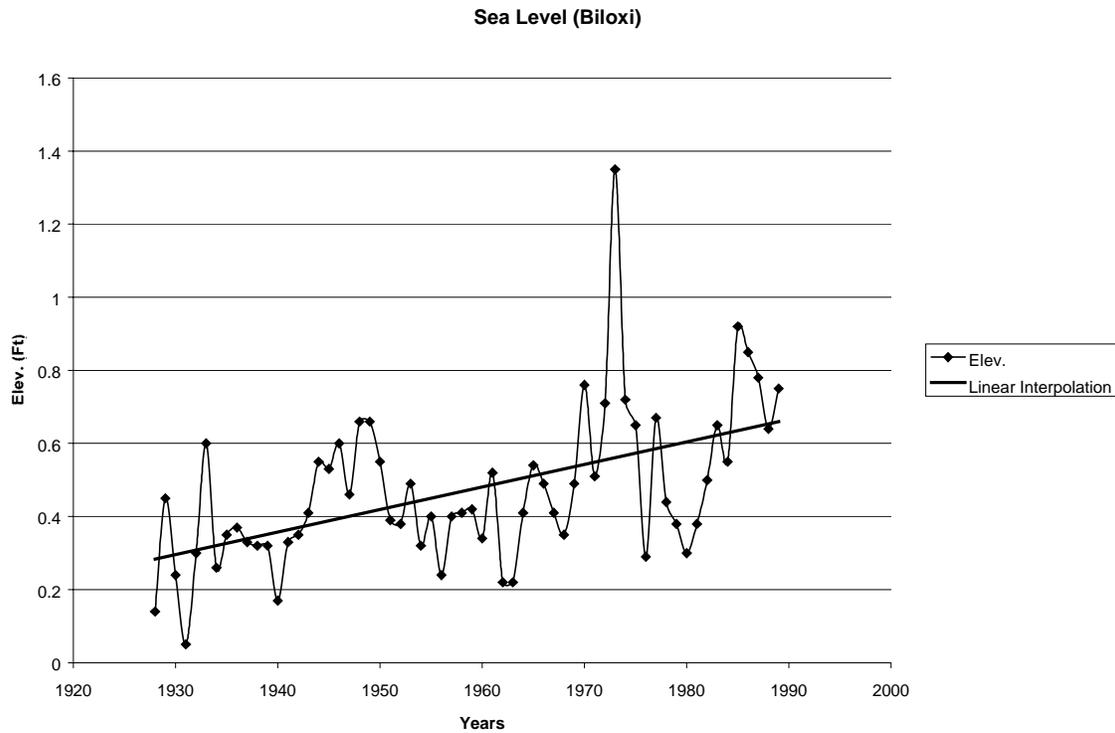


Figure 1. Sealevel rise in Mississippi (from W.W. Burdin, 1990).

Methods

Shoreline positions of the wave-exposed marsh shorelines were surveyed using Global Positioning System (GPS) techniques in 1993 and 1999. In both 1993 and 1999 the high tide position was surveyed. Additionally, the position of the entire 1986 shoreline was digitized from aerial photographs and maps by the Mississippi Office of Geology and NOAA Coastal Service Center. The 1993 and 1999 GPS data cover the area from west of Point aux Chenes to the interior of Point aux Chenes Bay, and along the southern shore of South Rigolets Island. All of the data were added to a Geographic Information System (GIS) and analyzed to determine erosion trends. Accuracies of both methods are better than 5 m (16 ft.). Erosion thresholds of more than 15 meters were used to highlight critical areas between 1993 and 1999, and 40 meters between 1986 and 1999. These values are significantly large to minimize over-estimating critical erosion areas. With an estimation technique, which uses buffers created to highlight critical erosion, the total area loss from shoreline erosion has also been computed for the shoreline mapped in 1999.

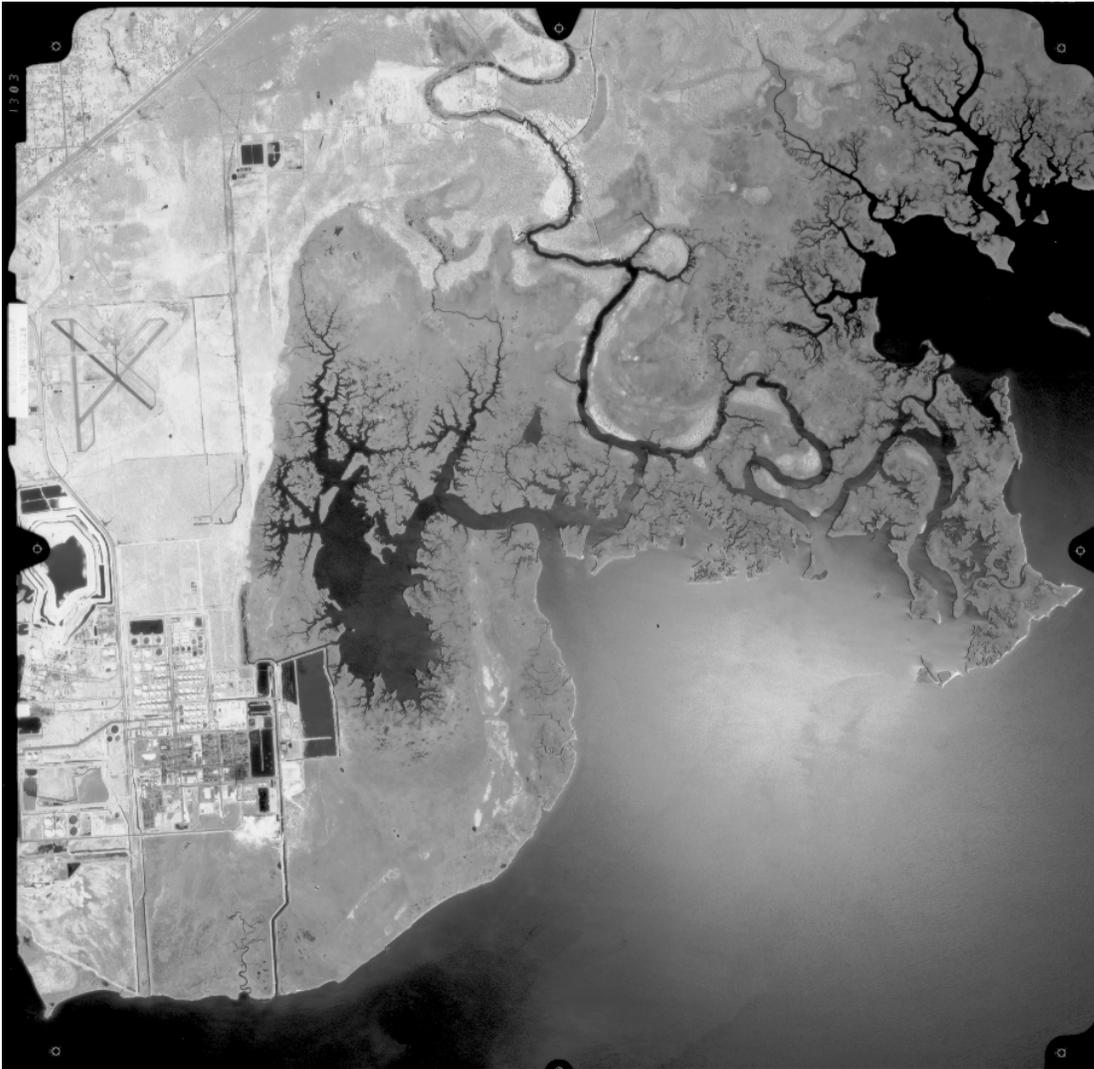


Figure 2. High-altitude aerial photograph of the Grand Bay marshes; north is up.

Results

1993-1999

Areas of the 1999 surveyed shoreline with more than 2.5 m/yr. (8 ft./yr.) of erosion, which totals 15 m (50 ft.), are highlighted in Map 1. Of the 11.3 kilometers surveyed, nearly 55%, or 6 km, had erosion of at least 15 m (50 ft.) over the period. Of these areas, the southwestern shoreline of South Rigolets Island has the highest rates, which average 50 m over the six-year period (8 m/yr., 27 ft./yr.). From the data, it is clear that erosion is occurring on all of the south to southeast facing shoreline open to the Mississippi Sound; the specific magnitude appears to be determined primarily by wave conditions and possibly, although to a lesser extent, by morphology and underlying geology.

Areal loss during this period is 202,300 square meters or 50 acres. It should be noted that this includes 2 km of shoreline to the west of Point aux Chenes, but does not include any portion of the eastern Point aux Chenes Bay shoreline nor the western shore of Grand Bay. Therefore, this estimate falls short of the actual loss. However, using the average loss of 4 acres per 1 km of wave-exposed shoreline and a total wave-exposed shoreline of roughly 18 km yields a conservative estimate of 80 acres of erosion from 1993 to 1999. This is a rate of 13.3 acres per year.

1986-1999

The same 1999 surveyed shoreline with more than 40 m (130 ft.) of shoreline loss since 1986, which equals 3 m/yr. (10 ft./yr.), is highlighted in Map 2. Of the 11.8 km surveyed, 3.8 km had more than 3 m/yr. of loss over a 13-yr. period. This is a long record, including several severe storms (hurricanes). The highlighted long-term erosion areas are associated with the most wave-exposed orientations, notably Point aux Chenes and South Rigolets Island.

Areal loss from 1986 to 1999 is 84 acres; however, like mentioned above, this does not include the entire shoreline. Using the same estimation method suggests that a total of 133 acres has been lost to erosion since 1986. This is a rate of 10.2 acres per year.

Discussion

Wave erosion is one of the primary causes of wetland loss in Mississippi, although it pales in comparison to human modification. However, wave erosion on the surveyed shores of the Grand Bay marsh is widespread, both in terms of area and length, and may, given the recent National Estuarine Research Reserve status, rival human modification in this wetland system. A comparison of this data with values from the Hancock County marsh (Coastal Division, Mississippi Office of Geology) highlights the wave-dominated character of Grand Bay. The Grand Bay marsh had 4 times the percentage of surveyed shoreline with erosion of more than 2.5 m/yr. since 1993, and the area lost per length of surveyed shoreline is twice of that in the Hancock County marsh during the same period.

Diversion of the Escatawpa River sometime prior to 1854 (Kramer, 1990) and the change in barrier island configuration, starting prior to 1784 (Hutchins, 1784), are likely causes for the high rates of erosion. The timing of the Escatawpa River's capture by the Pascagoula River is not well known, but would have signaled the start of the erosive

phase of the delta. The separation of Petit Bois Island from Dauphin Island, prior to 1784, and the subsequent loss of protection to the mainland shore occurred rapidly between 1854 and 1917 (Map 3). During this period, the Grande Batture Islands shrank from 8 km long to 5.5 km long and the Point aux Chenes area eroded at a rate of approximately 1-2 m/yr., which is slightly less than the present rate.

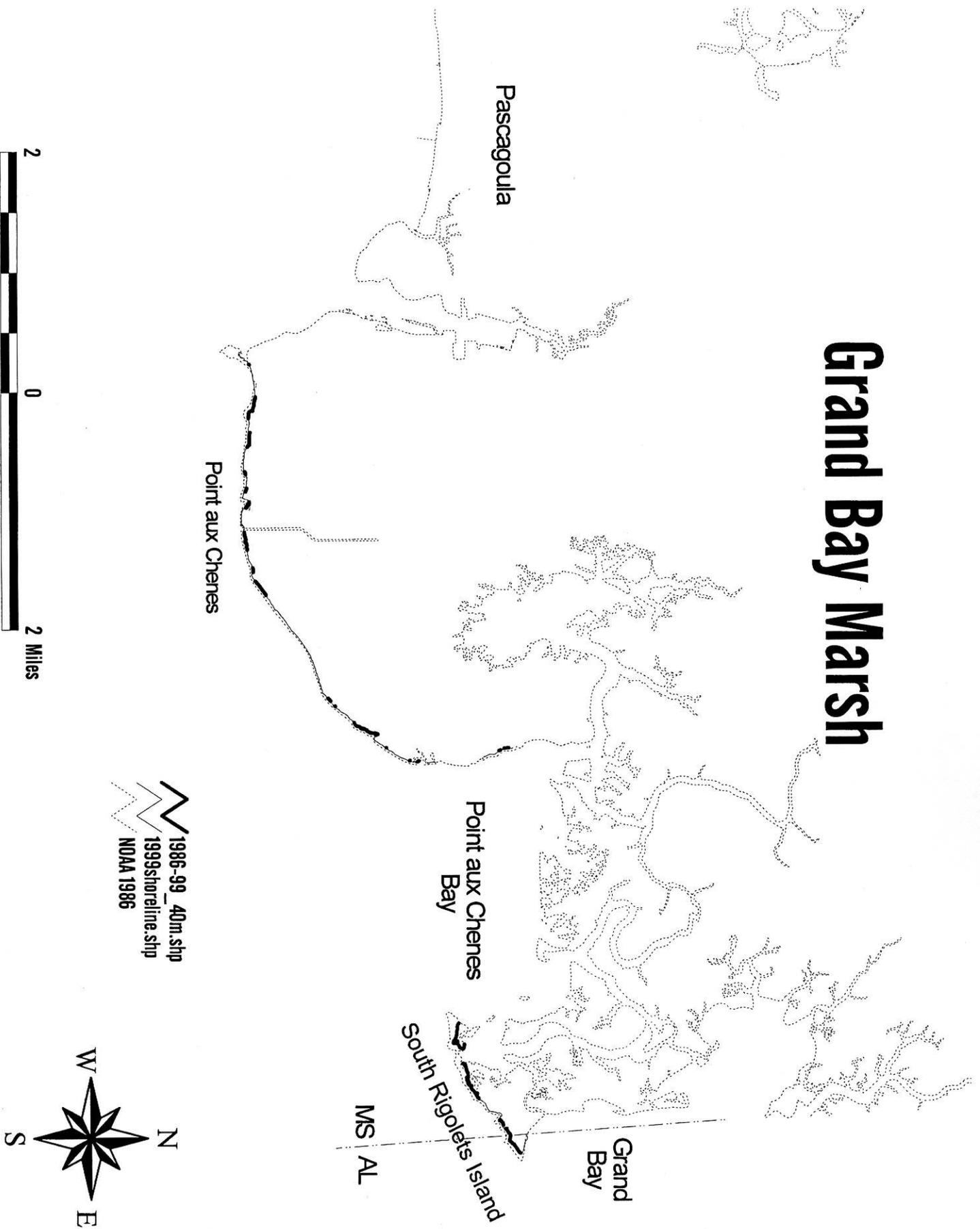
Although the process of marsh loss appears to be linked with the start of the diversion of the Escatawpa and evolution of the barrier islands, many questions remain. The short list would include: 1) the timing of the river diversion; 2) the source of sand feeding the ancient Grande Batture Islands, which in 1784 were only shoals and no similar islands have formed at the mouth of the Pascagoula; 3) erosion rates prior to and after the migration of Petit Bois island past the area; 4) rates of sedimentation vs. rates of subsidence now occurring in the marsh; 5) bathymetry prior to and following large storms; and 6) the record of human influence. Kramer (1990) began to answer some of these questions; however, more work is need to provide a detailed history and make projections about the future evolution of the Grand Bay marsh area.

This report is meant to update and consolidate some of the pertinent survey information gathered by the Mississippi Office of Geology. The most recent GPS shoreline data are, unfortunately, sparse in coverage for the area. This is problematic; consequently, the area is targeted for a more complete survey in 2000.

References

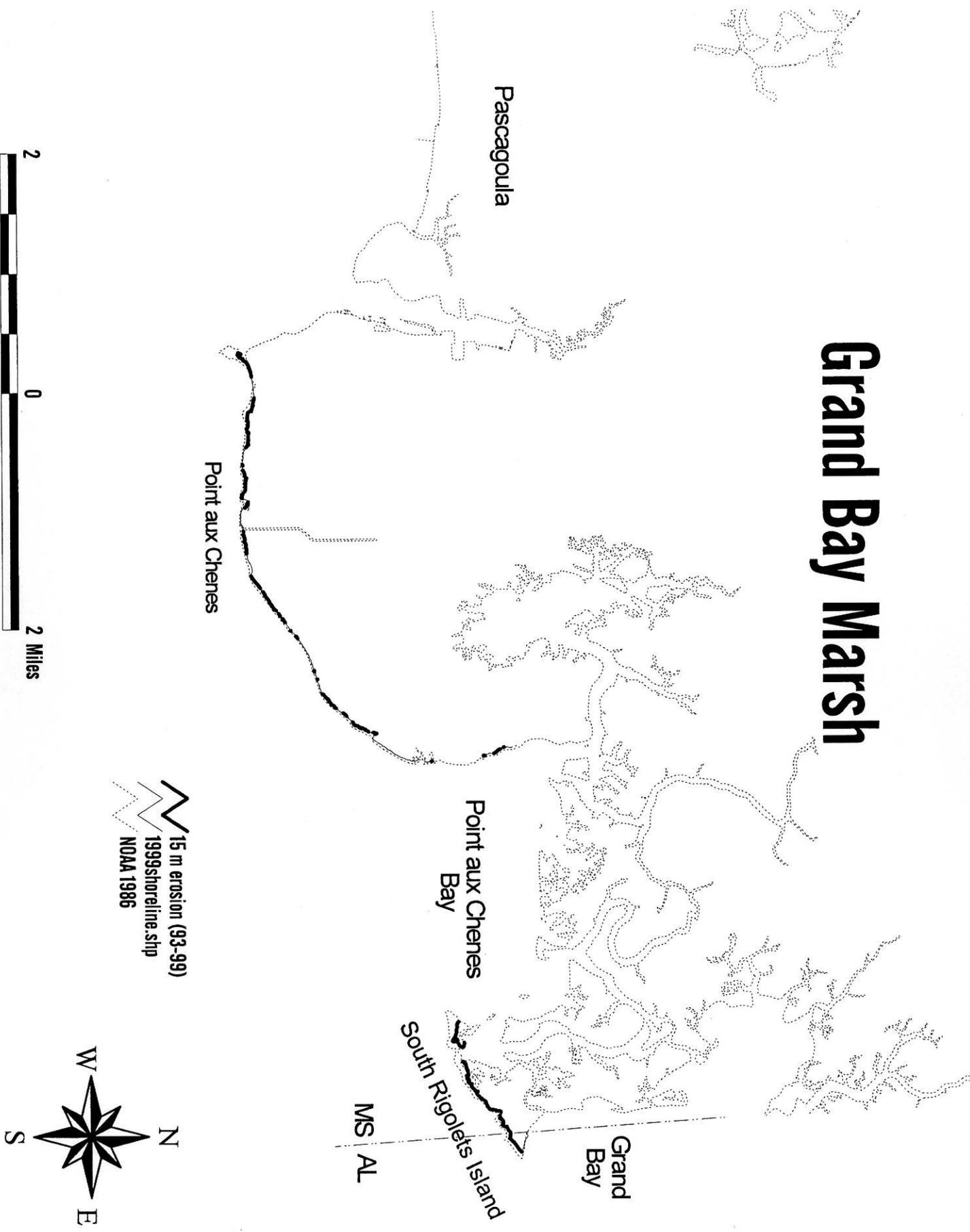
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Grand Bay Marsh



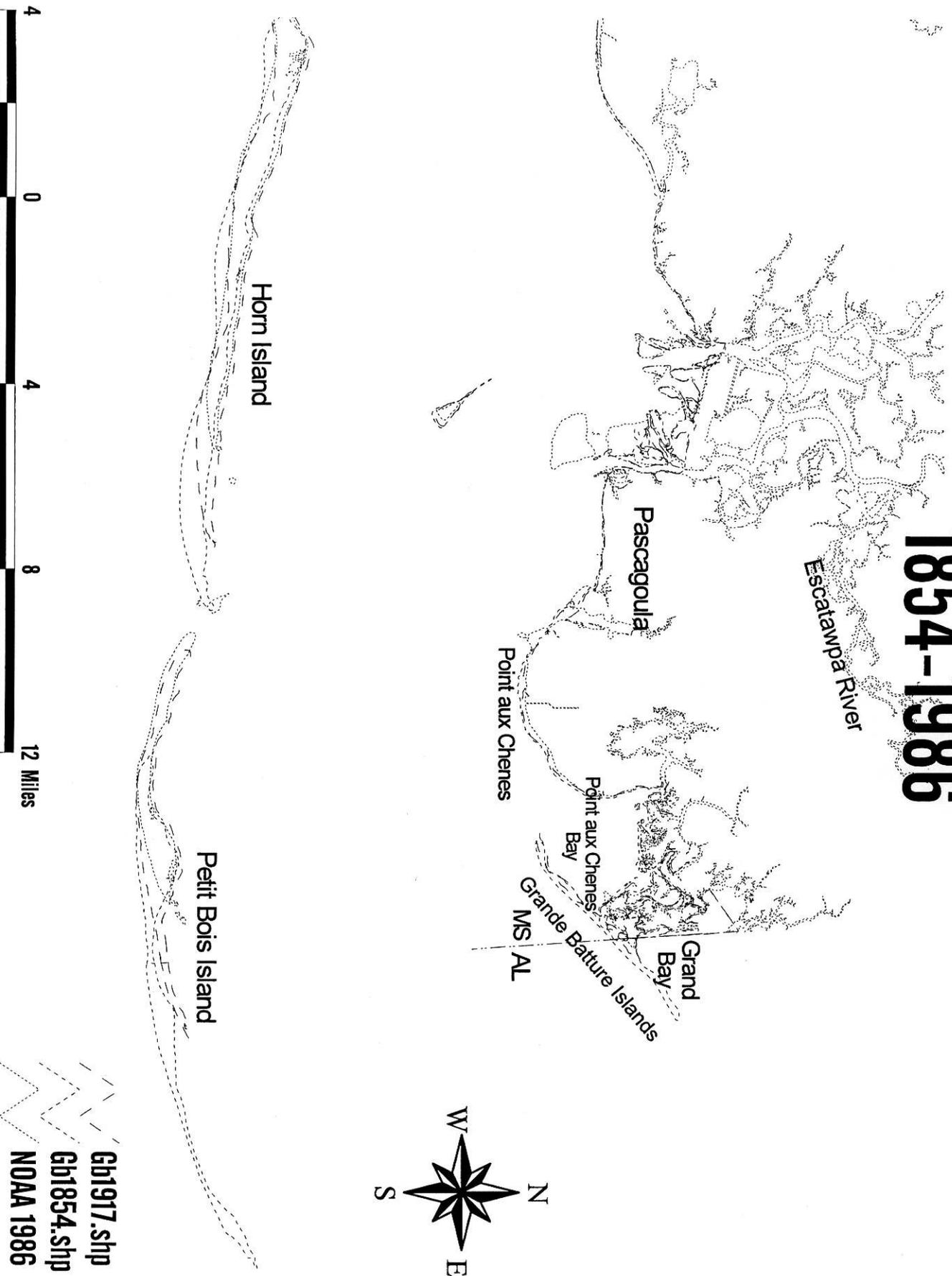
Map 2. Shoreline erosion of more than 3 m/yr between 1986 and 1999

Grand Bay Marsh



Map 1. Shoreline erosion of more than 2.5 m/yr between 1993 and 1999

1854-1986



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NOAA 1986

Map 3. 1854 to 1986 shoreline configuration