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ABSTRACT

Coastal survey data from the 1700's to the present indicate progressive loss of Alabama coastal shoreline and wetlands. Alabama coastal shoreline/wetland environments include those of bays, estuaries, Mississippi Sound, lagoons, lakes, fluvial deltas and Gulf barrier. Areas showing the highest rates of loss include Mississippi Sound north shoreline and islands, Mobile Bay west shoreline, Gulf shoreline of Dauphin Island, and north shoreline of Morgan Peninsula. Other areas showing progressive substantial loss are Mobile Bay east shoreline, Perdido Bay, and Perdido estuary. The relationship between erosional loss and accretionary gain of Gulf barrier shoreline in Baldwin County (from Mobile Point to Alabama Point) is complex but this shoreline appears to be generally stable with isolated short segments of erosional as well as accretionary beach. Negative economic results of shoreline/wetland loss include shoreline property devaluation, costs associated with erosion protection, and loss of wetlands supportive of fishery species reproduction. Accretionary gain of land areas appears to be negligible. Although no new wetlands appear to be developing along Mississippi Sound shoreline exposed to erosional affects of waves and currents, it is postulated that subsidence and drowning of terrane adjacent to Mississippi Sound is resulting in some new upland swamp and bayou areas. The balance between loss and gain of wetlands has not been estimated. General descriptions are given for the unique combinations of factors postulated as contributory to loss of specific shoreline/wetland. Primary factors associated with shoreline loss are wave, current and tidal parameters, local subsidence, sea level rise, position and character of natural barriers, position and nature of shoreline protection structures, anthropogenic affects, local bathymetry, shoreline orientation, local sediment budgets, and morphological and physical character of shoreline/wetland.

INTRODUCTION

The purpose of this discussion is to provide an overview of trends in Alabama coastal shoreline loss and to offer comment on regimes related to this loss. In Alabama the coastal environments that are subject to change through shoreline loss are diverse. Regimes associated with this loss generally involve a number of factors, including wind and associated wave factors, tidal affects, sediment transport systems, bathymetry, shoreline sediment character, topography, shoreline flora, fluvial delta sediment consolidation and resulting subsidence, sea level rise, and anthropogenic factors such as channelization and various modifications of shoreline. The relative importance of any of these factors for a specific shoreline varies. Although wind induced wave systems together with sediment transport regimes would appear to be the essential systems, the other factors have critical influence. Coastal environments currently showing shoreline loss include those of bays, Mississippi Sound, Gulf barriers, lagoons, lakes, estuaries and the lower Mobile delta. Estimates of total coastal shoreline range from 500 to over 800 miles. Computer techniques utilizing satellite imagery (Hardin and others, 1976) place the estimate in the upper range.

GULF BARRIERS

Alabama barrier beach aggregates about 50 miles, including beach on Dauphin Island and Sand Island in Mobile County, and Gulf beach along southern Baldwin County (Fig. 1). Baldwin County barrier beach extends from the Alabama-Florida line to Mobile Point, a distance of about 31 miles. Gulf shoreline of Dauphin and Sand Islands lies west of the Mobile Bay tidal pass and includes about 19 miles. Knowledge of natural systems affecting Gulf barrier beaches in Alabama is only rudimentary. Beach profile stations were established along most of this beach during 1988-90 and periodic measurement of these stations is continuing.

Erosion was reported as averaging –78 feet (about 1.4 feet per year) on Baldwin County beach for the period 1917-1974 (Hardin and others, 1976), with higher erosion rates given (5 to 10 feet per year) for shore immediately west of Perdido Pass. Measurements based on 1955, 1960 and 1987 air photos imply general stability for most of the Baldwin County barrier beach with isolated short segments of erosional as well as accretionary beach. The highest erosion rates inferred from 1960 and 1987 imagery (up to 5 feet per year) appear to be along shoreline south of Little Lagoon, particularly the shoreline adjacent to and west of an engineered pass to Little Lagoon.

The Little Lagoon pass structure consists of a concrete weir through the lagoon barrier and concrete jetties extending into the Gulf. Shortly after construction of the pass structure, beach accretion took place on the eastern side, and erosion began on the western (downdrift) side, resulting in seas under some beach houses under some surf conditions. While it is possible that the systems associated with the engineered pass are now near equilibrium, erosion related to the pass structure appears to have narrowed the barrier by an estimated 250 feet. This, coupled with the tendency of this area to erode (Hardin and

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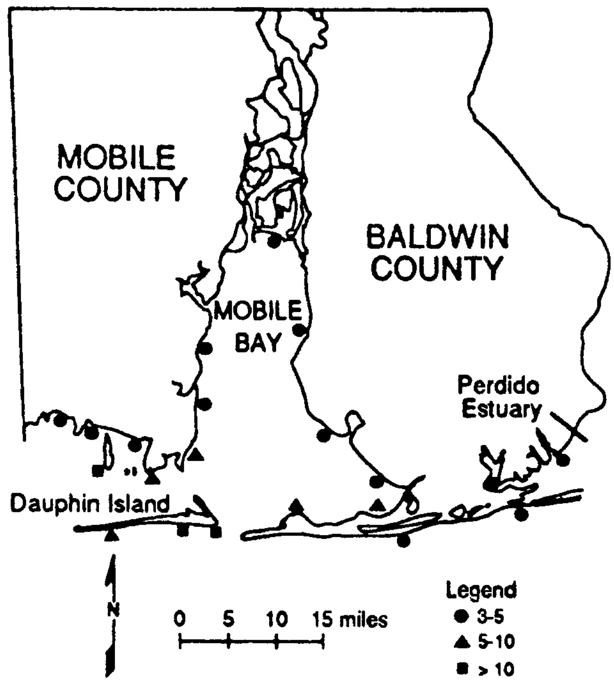

Figure 1. Coastal Mobile and Baldwin Counties, Alabama, showing shoreline loss rates for selected areas (feet per year).

others, 1976), increases the likelihood of future hurricane breaching of the lagoon barrier.

A generally westward longshore current persists along the Gulf barriers. Temporary erosional current systems also impinge on the Baldwin County shoreline and in some cases appear to migrate along the shoreline, resulting in temporary shoreline loss or gain at some localities. Some segments of this beach have shown unusual stability over many years—for example, the salient or cusp south of Shelby Lakes and the barrier curvature beginning at the western end of Little Lagoon. The Shelby Lakes structure as well as the Little Lagoon feature may be relics of tidal pass complexes. Erosion of Little Lagoon and Shelby Lakes shoreline behind the Baldwin County barrier appears to be concentrated along northern shores, where erosion rates are estimated to be generally less than 1 foot per year.

Perdido Pass in Baldwin County is now modified by an engineered structure consisting of a concrete weir and rip rap jetties. Hurricane Frederic (1979) partially destroyed the easternmost jetty. The pass structure results in net erosion for the downdrift (western) shoreline near the pass, but occasional bypass pumping of sand has been used to control erosion of this shoreline. Recent pumpage to the downdrift side of the pass (1989-90) has created a very wide (more than 600 feet) beach and backbeach area, but erosion is now proceeding rapidly along this new beach face.

The State fishing pier at Gulf Shores presents some resistance to westward littoral drift, resulting in erosional tendency for the beach immediately to the west of the structure. It is not known if this section of shoreline is now stable.

Alabama Gulf barrier erosion is most extensive along Dauphin Island, Mobile County. Erosion rates up to 5 feet per year were estimated for the period 1917-74 for southeastern shoreline, with rates exceeding 10 feet per year estimated for this period along western island shoreline (Hardin and others, 1976).

Comparison of 1955 and 1985 air photos and observations involving beach profile stations indicate that erosion is currently active along most of Dauphin Island Gulf beach. Erosion may be particularly intense along the 5 to 6 mile section of beach near the island's western end (where the 1917-74 erosion rates were estimated to be 5 to 10 feet per year). Whereas the western half of the island is undeveloped, erosion on the island's southeastern shoreline is resulting in loss of public and private property. Several groins along the southeastern end of the island have been flanked and are now isolated from the shoreline. Orientation of several of these groins is such that they tend to focus southeasterly wave energy to specific areas of the shoreline and currents transport sediment westward from the groin area. Beach at the Dauphin Island Park features erosional cuts into barrier core sediments (Pleistocene barrier sands and marsh). Exposed tree stumps and undermining of park beach structures are other manifestations of active erosion at this locality. The fishing pier at the state park appears to localize some erosion of adjacent (downdrift) shoreline; however, the structure probably does not exacerbate the total erosional loss from the island.

Accompanying erosion of Dauphin Island Gulf beach is accretion on the western end of the island and erosion on the north side of the island (Mississippi Sound). Thus, the general trend for the island is to become narrower, particularly in areas of lower elevations west of the developed area. This trend enhances the probability of island breaching during a hurricane or major storm.

Regimes responsible for Dauphin Island erosional trends have not been thoroughly defined. Following some hurricane events, particularly Hurricane Frederic in 1979, island erosion during the storm event appears to have been fostered by partial destruction of the Sand Island barrier bar complex. In recent years, Sand Island has increased in length toward the northwest and depths of Pelican Bay have diminished, indicating significant accumulation of sand west of the tidal pass. This may support erosional trends on the island's Gulf side through at least two mechanisms: (1) the body of sand that has accumulated west of the tidal pass, of which Sand Island is a part, possibly is a barrier to westward and northward transport of sand to the island, and (2) the sand body may be promoting channelization of currents closer to and parallel to the island (via Pelican passage), promoting westward to offshore transport of sediment eroded from the island's Gulf beach.

MISSISSIPPI SOUND

The Alabama portion of Mississippi Sound lies north of the Dauphin Island barrier and is bounded on the north by a wetland shoreline of low topographic relief that includes the state's primary marsh area. This shoreline has exhibited erosion ranging from 3 to 12 feet per year for the period 1955 to 1985 (Smith, 1989). Aggregate loss of shoreline, including that of islands, exceeds 40 acres per year, a significant economic loss, inasmuch as no new marsh is being created, and the area serves as a major nutrient source for several commercial fishery species. The nature and rate of loss by a specific segment of Sound shoreline is related to intensity and direction of sustained winds (waves), a general lack of sediment contribution from fluvial systems, tidal currents and associated eddies that remove sediment eroded from shoreline, shifts in size and position of Petit Bois Pass, and subsidence/sea level rise.

Wave systems of the Gulf now have access to Sound north shoreline via Petit Bois Pass. An early chart (about 1717) infers a continuous barrier across the Alabama Mississippi Sound (Dauphin Island). Petit Bois Pass developed at some time prior to 1848 by breaching of the apparently continuous barrier, creating Petit Bois Island. It appears probable that accelerated erosion of the Grand Batture and Rigoletes Islands has been closely related to position, width and bathymetry of the pass. As depicted on the earliest charts (1860's), the Grand Batture Islands appear as islands that developed above wave base from a system of bars offshore of an eroding relict fluvial delta. The Grand Batture Islands now have been reduced to shallow bars offshore of an eroding relict delta terrane (Rigoletes Islands).

Most of the Mississippi Sound north shoreline presents a drowned appearance, possibly related to subsidence of the region, or more specifically to consolidation and subsidence of fluvial delta sediment associated with the Escatawpa-Pascagoula River drainage corridors. A fluvial delta origin of the Rigoletes Islands appears plausible, and it is possible that much of the Mississippi Sound north shoreline and some of the islands in the Sound originated as fluvial delta terrane and are showing significant subsidence. No estimates of local subsidence rates have been made, to the knowledge of the writer. It is possible that accompanying subsidence and loss of wetland areas is the development of new upland swamp and bayou areas, but no data have been developed in evidence of such a system.

MOBILE BAY

Loss of Mobile Bay shoreline is often the focus of public attention primarily because of economic factors associated with maintaining shoreline property. Such efforts vary in their success, but ultimately the shoreline recedes, erosion abatement expense continues, and the shoreline, with its uncoordinated series of bulkheads, groins, jetties and other structures, assumes an unnatural character. Almost all bay shoreline is eroding and at rates ranging to more than 12 feet per year.

Erosion ranges up to 8 feet per year along some sections of west Mobile Bay shoreline. Erosion along this west shore may be attributed generally to winds (waves) with some eastern component, land area of low relief and resultant low volume of sediment locally contributed to the bay, uncoordinated erosion control measures, relatively steep erosional banks with little vegetative cover, and sediment transport current systems (including those related to effluent from the Mobile-Tensaw River system).

Although shoreline loss rates do not appear to be as great along Mobile Bay eastern shore as along the bay's western shore, almost all of the eastern shore is showing some erosion, ranging up to 3 to 5 feet per year. Erosion causes include waves (winds), with some western component, low volume of sediment from uplands (although possibly higher than for west shore), and uncoordinated erosion control structures.

The lower part of eastern Mobile Bay (Bon Secour and St. Andrews Bays) now shows erosion rates ranging from 3 to 5 feet per year on most eastern shoreline, to more than 12 feet per year on Morgan Peninsula at the fan (or salient of beach ridge terrane).

Bon Scour Bay shoreline includes unique terrane, such as the National Wildlife Sanctuary, coastal swamp, and the Morgan Peninsula beach ridge area. A significant segment of bay shoreline on Morgan Peninsula is private property upon which a variety of erosion protection structures have been erected. Some of this property is on elevated terrane (+10 to +20 feet) resulting in low bluffs facing Bon Secour Bay. The erosion of this terrane threatens structures consisting mostly of beach houses. Northerly winds coupled with heavy flotsam such as logs, are highly destructive to erosion protection structures in this area. Groins that retain some longshore-transported sediment are effective erosion control devices along some of Bon Secour Bay south shoreline.

The upper part of Mobile Bay or the lower part of the Mobile delta features tidal flats, fluvial channels and banks, and floodbasins. Much of the shoreline loss in this area may be attributed to delta subsidence/sea level rise (Smith, 1988). The floodbasins with associated levees and splay channels exhibit a distinct drowned appearance. Quantification of shoreline changes in this area using available air photos is unreliable owing to low relief of terrane and water level variation related to tides, winds, atmospheric pressure and fluvial drainage. Erosion is active along the fluvial channels, with cypress trees of former channel banks commonly isolated from present banks. It has been suggested that construction of the several dams upstream of the Mobile delta may have diminished the supply of sediment to the delta wetland, thereby hastening erosion. The writer has found no evidence in support of this and suggests that such effect is unlikely, as the alluvial plain of the delta downstream of these dams holds an abundance of sediment for reentrainment and redistribution during flood.

PERDIDO ESTUARY

The Perdido estuary shows erosion along most shoreline, apparently ranging up to 3 feet per year on some open, unprotected shoreline. Erosion is most evident on shoreline receiving southerly and southeasterly winds and associated wave systems. Perdido Bay exhibits several linear shorelines apparently related to these systems (Smith, 1986).

SUMMARY AND CONCLUSIONS

Progressive loss of Alabama coastal shoreline is indicated by data from the 1700's to the present. The primary loss areas are the Gulf side of Dauphin Island, Mississippi Sound north shore and islands, and western, eastern and southern shoreline of Mobile Bay. Regimes responsible for shoreline loss include wind induced waves and sediment redistribution currents as primary factors, but other factors are involved. Subsidence of fluvial delta terrane and sea level rise may be significant factors for some areas in Mississippi Sound and upper Mobile Bay.

REFERENCES CITED

Hardin, J. D., Sapp, C. D., Emplaincourt, J. L., and Richter, K. E., 1976, Shoreline and bathymetric changes in the coastal area of Alabama: Alabama Geological Survey Information Series 50, 125 p.

Smith, W. E., 1986, Geomorphology of coastal Baldwin County, Alabama: Alabama Geological Survey Bulletin 124, 86 p.

Smith, W. E., 1988, Geomorphology of the Mobile delta: Alabama Geological Survey Bulletin 132, 133 p.

Smith, W. E., 1989, Mississippi Sound north shoreline changes in Alabama, 1955-85: Alabama Geological Survey Information Series 67, 34 p.