

MONITORING OF ESTUARINE SHORELINE CHANGES ON CUMBERLAND
ISLAND, GEORGIA: A PRELIMINARY REPORT

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Operation of a TRIDENT submarine base at Kings Bay, GA requires a 23-mile long channel to be dredged the length of Cumberland Sound, through St. Marys Inlet to the Atlantic. The dredging project is expected to affect the shoreline of Cumberland Island near where the channel passes. Monitoring of estuarine shoreline erosion was suggested by the Georgia Department of Natural Resources and a proposal to the National Park Service was funded to establish a monitoring project on the southwestern edge of Cumberland Island National Seashore. Geomorphological research in conjunction with the mapping of pre-historic shoreline changes using archeological dating of sea level rise, historical cartography and air photo interpretation is being conducted. Study sites have been selected in areas of known erosion and survey stakes have been placed to monitor current shoreline change. Preliminary erosion data collected at the three sites indicate differential rates of change based on a variety of geomorphologic, geographic and even biologic factors. The collection of weather data will determine the effect of single storm events on shoreline change while a photo index is being made to document how the various estuarine shoreline features respond to shoreline processes of subsidence, submergence and weather as well as to changes caused by channel dredging.

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Description of the Kings Bay Project

The US Navy is currently constructing a TRIDENT submarine base at Kings Bay, a naturally occurring feature of Cumberland Sound in Camden County, Georgia. The Navy project includes dredging a 23-mile long channel from the construction site down Cumberland Sound and through St. Marys Entrance between the southern end of Cumberland Island and the northern end of Amelia Island, Florida. The existing St. Marys Entrance channel will be widened and deepened for 7.5 miles into the Atlantic. (Fig. 1)

An estimated 30 million cubic yards of material is expected to be removed during channel dredging. Maintenance dredging is expected to remove an additional 500,000 cubic yards of spoil material each year for the duration of the operation of the facility.

A recent Georgia Geological Survey report indicates that a section of the southwestern shoreline of Cumberland Island is experiencing erosion for the first time since jetty construction in the 1880's. This erosion follows a century of accretion at the south end of Cumberland Island. (1)

The proposed dredging for the TRIDENT submarine base will widen the floor of the St. Marys Entrance channel to 500 feet and establish a -47 foot depth. It will alter the Cumberland Sound channel to 400 feet on the bottom and -44 feet deep mlw.

Alteration in channel alignment will be necessary at the turn from St. Marys Entrance channel into Cumberland Sound to remove the sharp angle. The dredge channel will pass along the perimeter of the southwestern edge of Cumberland Island.

Historical Shoreline Change Studies

The monitoring of Georgia's barrier island shoreline changes has been going on for some time. One substantial study was concluded in 1977 Nash in his master's thesis. (2) Nash established that although several of the barrier islands have undergone relatively slight net erosion in the past three decades, there has been a net gain of land above the mean high water shoreline since the mid-1800's of which over 80 percent occurred in a small area adjacent to the St. Marys Entrance.

The construction of rock jetties in 1881 caused intensified accretion on the southern end of Cumberland Island and on the northern end of Amelia Island. The two large jetties extend 4.1 and 2.4 km seaward from St. Marys Entrance.

Changes in the nearshore bathymetry during the 120-year period for which data is available indicate southerly migration of the shoal and channel systems of the ebb-tidal deltas. This conforms to Hoyt and Henry's proposal of a southerly extension of the barrier islands as a result of north end erosion and south end accretion due to migration of tidal channels under the influence of predominantly southward littoral currents. (3)

The major influence on barrier island and tidal inlet migration is sea level rise. Georgia tide gauges indicate an average sea level rise of nearly one tenth of an inch per year, or about nine and a half inches per century, the lowest rate for the US Atlantic coast. With regard to long term coastal shoreline change (hundreds of years) this relatively gradual rise is the single most important agent of shoreline retreat. (2)

The Georgia Geological Survey study of historical shoreline changes reported findings nearly identical to those of Nash. During the last half century the Georgia coast was characterized by dynamic stability, the slight

erosion of some barrier islands was offset by slight deposition on others, though most of the barrier islands maintained equilibrium. (1)

Impact of Channel Dredging

Mention of the Kings Bay project is made in both shoreline change studies. (1, 2) This project will significantly increase the disequilibrium in sediment source and sink caused by the dredging in the St. Marys Entrance channel and in Cumberland Sound. Nash speculated that as a result of the Kings Bay dredging project, the estuarine shoreline adjacent to the St. Marys Entrance would undergo increased erosion. (2)

That prediction was evidenced by the Georgia Geological Survey overlay maps of shoreline change. Although both mapping projects were primarily concerned with beach shoreline changes, they both showed the southwestern tip of Cumberland Island undergoing erosion.

A Final Environmental Impact Statement for the Kings Bay Submarine Support Base was prepared by Environmental Science and Engineering, Inc. in 1980. (5) A letter from the Georgia Department of Natural Resources published in the EIS Supplement expressed concern that the Kings Bay Project and the dredging of Cumberland Sound and St. Marys Entrance channel would have a detrimental effect of the shoreline of Cumberland Sound. The DNR recommend that the estuarine shoreline be monitored to gauge the erosion rate.

Perhaps the most important feature of the proposed dredging for the Kings Bay project may be its impact on the saltmarshes of Cumberland Sound. These estuarine ecosystems are considered to be the most productive regions in the world in terms of biomass production.

Research in Shoreline Changes

While Georgia's saltmarshes have been studied in great detail by biologists and ecologists, little work has been done in mapping of the saltmarsh areas. The objective of this study is to monitor the rate of estuarine shoreline changes and to determine both the historical and recent shoreline changes.

A proposal was made to the National Park Service in January of this year to establish a monitoring project at the southwestern tip of Cumberland Island, a national seashore. The project was approved and survey plots were chosen using air photos and ground reconnaissance.

An understanding of estuarine shoreline changes must begin with the analyzing of geomorphological data to determine barrier island processes in geologic time. Additionally, archeological data may be used to determine sea level rise and shoreline change in pre-historic time. Historical cartography is used to determine more recent shoreline change, while overlay mapping of aerial photographs are used to chart shoreline changes in recent time. These research techniques are then combined with field surveying to monitor current shoreline changes, in conjunction with the collecting of weather data and documentation by photo indexing.

Three study sites were chosen in areas of known accelerated erosion and were surveyed in the Spring. A geographic description of the three sites, all located on the southwestern edge of Cumberland Island, illustrates the variety of features on an estuarine shoreline.

Nightingale Bluff (Site 1) (Fig. 2) is a two-meter high sand dune overlying a Pleistocene substrate as evidenced by relict cypress stumps revealing an estuarine fresh-water origin. Pre-historic Indian shell middens line the the study site and archeological evidence is strewn along the face of the bluff.

Raccoon Keys (Site 2) (Fig. 2) are relict beach ridges or cheniers now rising one meter above the surrounding saltmarsh. The sound-side of the ridge is covered with the pre-historic shell middens and contains the remains of an archaic period shell ring now partly eroded into the sound.

The third site (Fig. 2) is located at the mouth of Beach Creek, a large, meandering tidal creek which drains a 500-acre marsh. The creek once broke through to the oceanside during a hurricane and was blocked by a rock dike in 1898. Beach Creek is being encroached upon at its eastern boundary by a large unvegetated migrating sand dune. Beach Creek marsh is owned by the Army Corps of Engineers and is scheduled to be used as a dredge spoil disposal site. (5)

Much research into barrier island origin and migration was conducted in the 1960's. University of Georgia geology professor John Hoyt emerged as a proponent of sea level rise as the cause of barrier island formation and migration. (4)

Establishing rates of sea level rise over geologic time, and even during historic time has been complicated by the geomorphological processes of subsidence and submergence, because either or both processes at work on Georgia's barrier islands.

The presence of Indian shell middens along the length of Nightingale Bluff and on the shoreline of Raccoon Keys may prove to be a useful technique for determining sea level rise. Work being conducted by anthropologist Chester DePratter and oceanographer James Howard involves using fiber-tempered and sand-tempered pottery shards dating 4,000 to about 2,500 years ago to establish a time period for occupation of these sites. (6) Work by Smithsonian anthropologist Jerald Milanich establishes the time periods for occupation of

Nightingale Bluff while studies by archeologist John Ehrenhard have been conducted at Raccoon Keys. (7, 10)

Copies of historical maps have been collected beginning with the LeMoyne maps of 1562. Several French and Spanish maps dating from the 1700's have been copied, the first to show soundings in Cumberland Sound being the "Boca y Barra Del Rio Santa Maria" of 1750. The Fuller map of 1770, and a map entitled "St. Marys Inlet" circa 1775 also give soundings for Cumberland Sound. Several other maps of the 1700's also outline Beach Creek and give soundings for Cumberland Sound. A map dated 1802 by John McKinnon shows Raccoon Keys, Nightingale Bluff and a fairly detailed outline of Beach Creek. The most detailed early map of the south end of Cumberland Island was produced in 1843 which gave soundings not only for Cumberland Sound but also for Beach Creek.

The Coastal Surveys of the 1850's provide accurate depiction of the south end of Cumberland Island and Cumberland Sound. The Geodetic Surveys of the 1930's and recent topographic sheets and coast charts are used to determine recent shoreline changes. While early mapping efforts may have been crude, a record of soundings by a half dozen surveyors may offer clues to shoreline changes during the historic period.

Air photos are available from various agencies beginning with the Soil Conservation Service photos of Camden County taken in 1943. A great number of flights were made in the 1960's and 70's as planning for the Kings Bay project began.

Photogrammetric techniques suggested by Dolan, et al. will permit the measuring of shoreline changes in the Cumberland Sound area. (9) Single-scale base maps are being created to be used by enlarging or reducing historical maps and air photos. Best-fit adjustments will be made in conjunction with

a grid-address system to correct for distortion and to determine shoreline change.

Field Survey Methodology

While the historical and recent shoreline changes are being calculated, the main focus of the project is ground surveying to monitor shoreline change. Initial field surveys were conducted in the Spring of this year for the three study sites.

A survey grid system was established for each site by placing parallel rows of stakes adjacent to the shoreline. The stakes were placed 30 meters apart and the rows set 15 meters apart. The survey stakes were placed to last for the duration of the one year study period.

The Raccoon Keys site was surveyed in March, the Nightingale Bluff site in April and the Beach Creek site in June. A re-measurement was made in September of this year which offers preliminary erosion data. (Table 1)

Data for the Nightingale Bluff site is the most complete. From April to September, the bluff experienced slight erosion, though the rate for each transect in the grid varies greatly.

Preliminary shoreline change data presents evidence that the shoreline does not change at a uniform rate. Where an oyster bed occurs along the shoreline, for example, it seems to stabilize that section and erosion is slowed or reduced. A low, unprotected marsh does not seem to erode at the same rate as a sand bluff. The marsh's ability to withstand higher waves contrasts with the high, forested bluff's inability to withstand equal waves. Once the sand bank is undercut, the trees begin to topple, pulling out larger chunks of the shoreline, whereas in the saltmarsh, an eroding bank may repair itself and even begin accreting sediments.

In addition to the field surveying, a photo index is being made to document in visual images each of the sites during the period of measurement. The photo index may help in determining the kinds of shorelines being monitored and how they change over time.

Storm data is also being collected and re-measurements of the sites will be conducted following storm events. The September measurement was performed one day after the passage of Hurricane Diana, although no impact was thought to have occurred. With the past storm monitoring of the study sites, shoreline changes occurring in single storm events can be measured and separated from other causes of shoreline change such as sea level rise, subsidence, or even channel dredging.

Conclusions

An understanding of the geographic variability of an estuarine shoreline, both spatially and temporally can be accomplished only through a thorough examination of the geomorphological processes of subsidence and submergence, as well as a complete study of historical records in cartography and air photos and through intensive field surveying to determine differential rates of change in a variety of shoreline features. The survival of the estuarine biotic community of fish, shrimp, crabs, dolphins, sea turtles, as well as the saltmarsh grasses and fauna creating detritus and the rest of the ecological community of the Georgia estuaries will depend on the protection of the saltmarshes. A study of the natural processes at work in estuaries must be joined to the geographic variability studies as presented in this monitoring program to form a more complete understanding of the role of estuaries in the ecosystem and how they can be affected by man's activities.

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NIGHTINGALE BLUFF, SITE 1

BEACH CREEK, SITE 2RACCOON KEYS, SITE 3

Stake #	1	2	3	4	5	6	7	8	9	10
March *	.5	GS	GS	GS	1.7	2.	GS	GS	GS	4.
September	.5	10.9	14.7	GS	2.3	2.4	GS	1.4	4.6	5.4
CHANGE	NC	ND	ND	NC	-.6	-.4	NC	ND	ND	-1.4

*All measurements taken from stake to eroding bluff, in meters
 GS - Grassy slope, no bluff ND - No data NC - No change
 / - Indicates bluff edge in front of stake, not behind stake

Fig. 1. Cumberland Island, Georgia

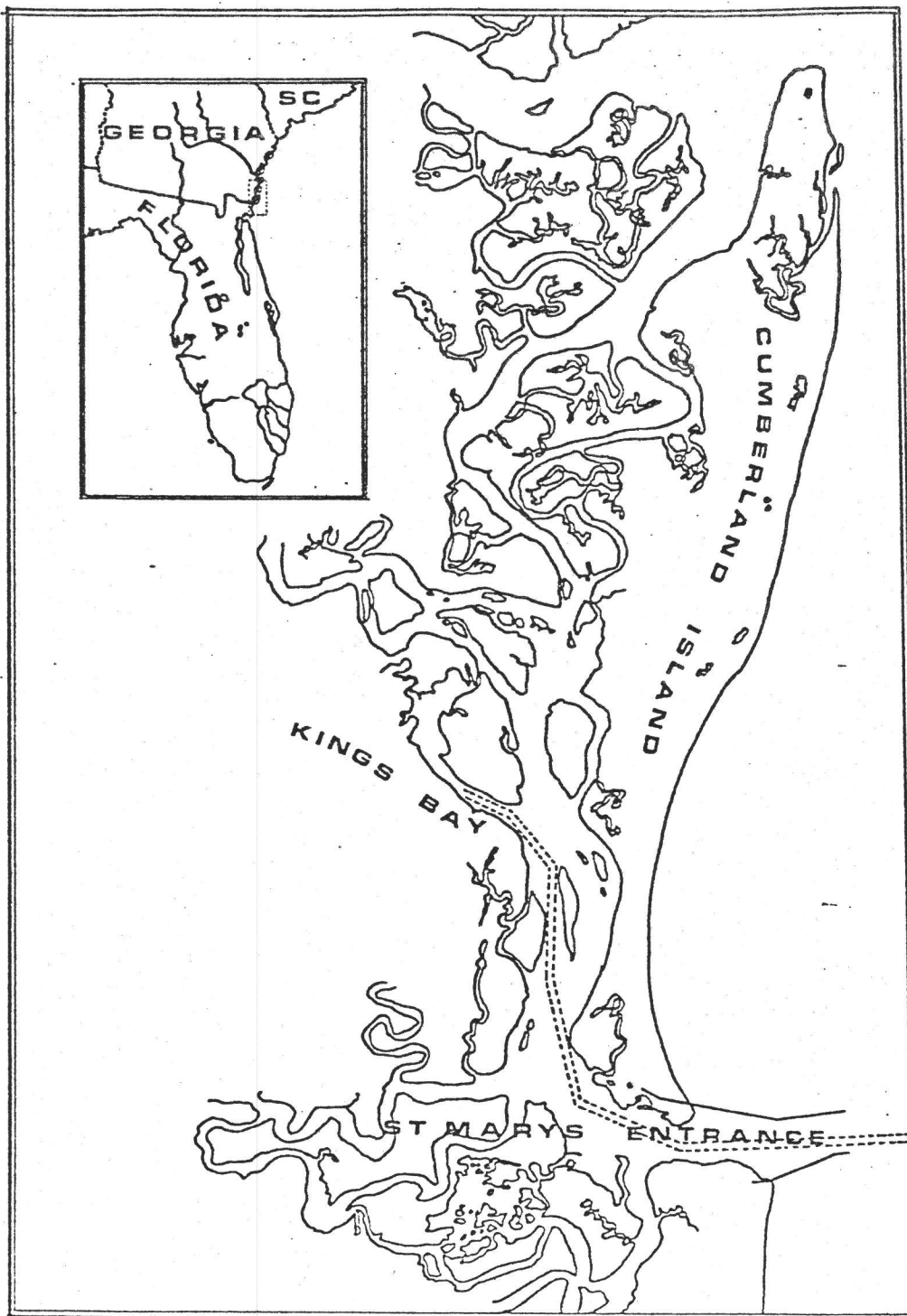


Fig. 2. Study Sites

