CHAPTER 7
RECENT SHORELINE EROSION AND VERTICAL ACCRETION PATTERNS, ST. CATHERINES ISLAND

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Significant erosion rates on the north and east sides of St. Catherines Island have long been evident, most notably shown by standing dead trees and patches of relict marsh mud on the beaches. McClain (1980) began a series of measurements in 1974 at markers located at prominent and accessible places on the island, particularly in the northern and northeastern areas. In a few locations, notably at the north end of Engineers Road (East) and at Picnic Bluff (fig. 7.1), his rusty metal rebar stakes are still present. Since the initiation of the University of the South's Island Ecology Program in 1987, the distances from the bars to erosional scarps have been annually monitored by Sewanee students and professors. Additional stakes have been installed over the past two decades in an effort to more precisely monitor rates of scarp retreat near the western extension of Engineers Road (West) in the northwestern part of the island, along the northern shore between Engineers Road (East), and the now-eroded USGS benchmarks along the northeast shore, along the Yellow Banks Bluff from the Picnic Area to the Ramp, and along South Beach from Beach Pond to the southern tip of the island. In addition to these Atlantic shoreline areas, two marsh-edge areas inland from the shoreline but subject to cut-bank erosion of tidal inlets have also been monitored, one on Wamassee Creek south of the mission site (fig. 7.2) and one at Seaside Inlet north of Seaside dock (fig. 7.3). The important long-term role of tidal creek cut-banks in eroding marsh-edge bluffs is particularly evident in aerial photographs and even USGS 7.5 minute quadrangles of St. Catherines eastern marsh drained by Seaside and McQueen inlets (along King New Ground Scarp of Bishop et al., 1997); large arcuate boundaries up to 1 km long such as the forest edge north of King New Ground dock (fig. 7.1) are obvious and appear by the regularity of their shape to indicate relatively young (Holocene) meander scars.

Monitoring along the periphery of St. Catherines Island has been expanded in the past 12 years, particularly along the Yellow Banks Bluff north of Seaside ramp and along the stretch of beach from South Beach entrance to Flag Lagoon, a freshwater pond formerly situated west of the beach, that was breached in March 1993 and now is inundated by daily tides, forming the lagoon.

In addition to shoreline and scarp retreat we have documented three areas that show various aspects of erosion and accretion: the bluff along the south margin of St. Catherines Sound in the northeast portion of the island where a recently eroded benchmark appeared on maps (fig.7.4), the small hammock in Seaside Marsh 0.5 km southwest of the ramp entrance on North Beach, and the roughly circular marsh immediately south of McQueen Inlet that is bordered by dunes on the north, east, and south. The benchmark location shows vertical accretion between the installation of 1913 and 1933 benchmarks by the U.S. Coast and Geodetic Survey. Our interest in the Seaside Marsh hammock has been the relative timing of hammock sand deposition versus marsh formation. In the dune-ringed marsh at McQueen Inlet the volume of fresh groundwater has increased and the water table has risen as eolian sand has accumulated on its outer edges.

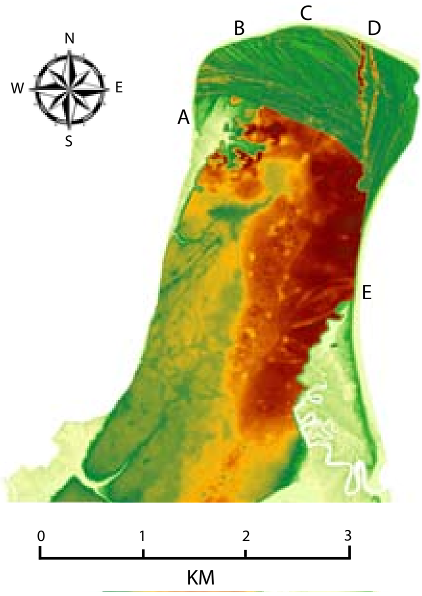

Fig. 7.1. Lidar map of the northern end of St. Catherines Island, with measurement sites (A–E) documenting shoreline retreat. Image created by Brian K. Meyer.

METHODOLOGY

The method of monitoring retreat has been to install PVC pipe driven ~45.7 cm (18 in.) into the sand at known locations, to be used as reference points from which distance to the erosional scarp may be measured along a given bearing. Latitude and longitude are recorded and the stakes are labeled with a letter and number (i.e., SB 1 for South Beach #1). Notable landmarks are also occasionally used and are typically large trees that can be identified on aerial photographs. For example, a tall magnolia with striking bronze-colored leaves standing 7.9 m from the bluff in 1996 (and the namesake of Magnolia Bluff, the current picnic site) was used as a reference along Yellow Banks Bluff north of Seaside ramp until it eroded onto North Beach in 2000.

Aerial photographs have been an important resource for establishing historical rates of erosion. Careful scaling from the photograph gives a reasonable estimate of distance between the shore and known locations that include small hammocks, the edge of Flag Pond, and identifiable large trees. Comparison of the map distance from a given year with the present distance (determined with a tape measure) allows calculation of yearly erosion averages.

A more recent method involves walking the erosional scarp or high tide line with a high-accuracy GPS unit. These tracks are compared to those of subsequent years.

The first method, installing PVC pipes and monitoring the locations regularly, is the most precise and labor-intensive. Relatively frequent replacement of lost pipes is an inevitable consequence of natural erosion, heavy equipment use near roads and the human use of nearshore areas. The installation of backup PVC markers, typically 10 m farther from the scarp than the original markers, has allowed fewer interruptions in data collection in several of our most critical sites.

Study of the vertical accretion at the northern benchmark has included measurement of charcoal horizon elevations with tape and auger. Fresh erosion scarps have been photographed, measured, and sketched. Increment borings in pines have yielded minimum ages of both trees and corresponding forest floors, and have also provided growth-disturbance patterns. Metal probes have been used to determine whether trees are rooted at the present land surface or a lower surface. Typically the pines have a set of horizontal roots along the surface on which they grow, and buried trees can be identified by trunks without this set of roots.

At Seaside Marsh south of the ramp, vibracoring from dune sands to below marsh level has given a clearer understanding of the relative ages of marsh and hammock. In the McQueen Marsh immediately south of the inlet, observation of water table height, salinity, and freshwater flora have helped to monitor yearly variation.

RESULTS

Erosional retreat rates are presented here for locations in the northwest, north, and eastern portions of the island, working in a clockwise direction. The overall pattern in the northern part of the island, with the exception of 1.5 km north of Yellow Banks (Picnic) Bluff, is retreat. Four representative locations, listed clockwise from the northwest, define the pattern for the northern tip of the island (fig. 7.1): a large dune immediately north of the northwest marsh (fig. 7.1, location A), dunes at the western extension of Engineers Road (B), the shore at the northern extension of

Fig. 7.2. Aerial photograph of the southwestern side of St. Catherines Island. Wamassee Creek forms an active cut bank immediately south of Mission Santa Catalina de Guale. Photograph by Digital Globe, March 8, 2008.

Engineers Road (C), and the 1933 benchmark (D) (see table 7.1).

Rates for North Beach were measured along the 4 m high Pleistocene Yellow Banks Bluff (Bishop et al., 2007) extending 800 m north from the North Beach ramp (fig. 7. 1, location E). Table 7.2 shows the average rates of retreat from 1996 through 2008 from north to south along this stretch. Average retreat for the 12 markers in this area was 1.82 m/yr (Potter, Padgett, and Trimble, 2007; Potter, fieldnotes, 2008).

Eight markers were installed on South Beach between Beach Pond and Flag Pond in 2000. Yearly erosion rates for this stretch range from 0.9 to 2.9 m/yr, with an average rate of 1.63 m/yr. Single yearly rates measured over the span from 1987 to the present are as high as 10.4 m/yr, recorded in the winter of 1992–1993 when

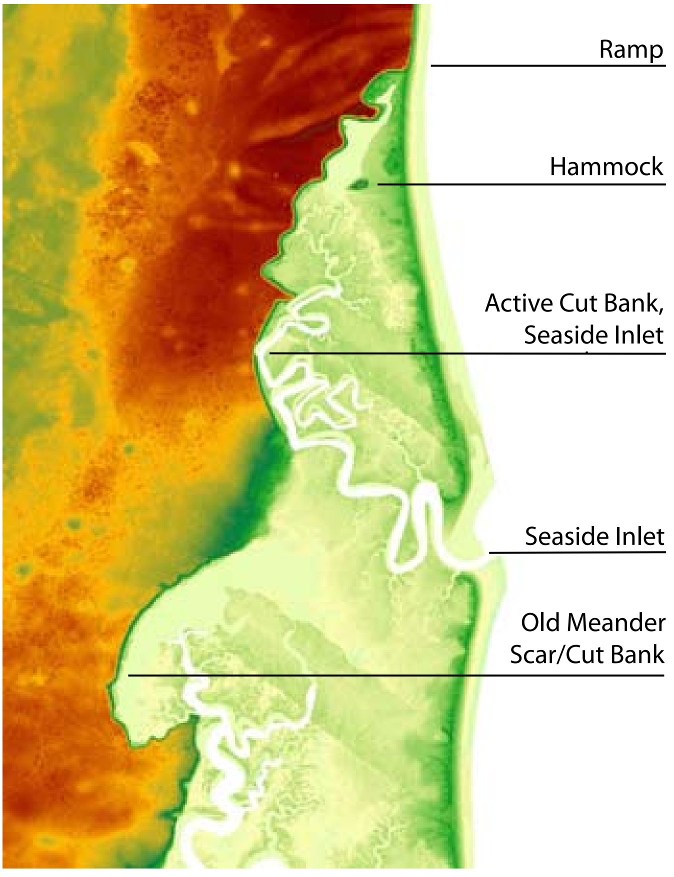

Fig. 7.3. Lidar map of the Seaside Marsh portion of St. Catherines Island. Note the large meander scar south of Seaside Inlet. A new scar is shown where the present inlet cuts the Pleistocene bluff. The small hammock south of the ramp predates the marsh that surrounds it. Image created by Brian K. Meyer.

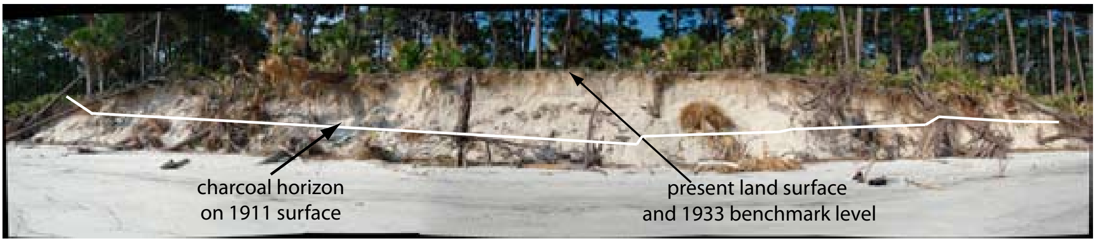

Fig. 7.4. View of Benchmark Bluff, looking southward. The bluff is 4–5 m in height. The white line represents the surface on which the 1911 benchmark was placed; it is now marked by a charcoal-rich horizon. A pine with horizontal roots at the 1911 level is left of center. The 1933 benchmark was placed on the present wooded surface and was undercut and eroded in the summer of 2007. Several of the living trees in this view are rooted at the lower horizon (photograph by Mike Brady, taken June 2007).

the 1.22 m high narrow forested ridge of sand between North Beach and Flag Pond was eroded (Potter, fieldnotes, 1992 and 1993).

The highest erosion rates on St. Catherines Island are south of Flag Pond. At least 10 of our markers have been eroded over the period since 1987, and retreat has been estimated using 1951 and 1972 aerial photographs. Erosion rates based on the photographs are 2.3 m/yr from 1972 to 2008 in the Flag Pond area and 5.4 m/yr from 1951 to 2008 in the marsh immediately south of the last large forested hammock on South Beach at latitude 31°33′50″N.

Measurements and observations of the three selected vertical accretion study areas are briefly summarized here.

(1) The bluff at the 1933 benchmark site is more than 120 m long in an E-W direction and approximately 5 m high. A charcoal-rich horizon 0.75 to 1 m above high tide level marks the level of land surface at the time the 1913 benchmark was placed on the island. A longleaf pine rooted at this horizon 3.6 m downward from the modern forested dune surface was exposed in the erosion scarp in the summer of 2007. Increment boring 4.5 m above the charcoal layer and base of the tree showed a burn scar on rings 9 and 10; there were 93 rings in total. Probing with a steel bar to depths of 0.5 m around the circumference of pines within 3 m of the bluff showed several to be rooted below the present forest horizon.

(2) At the Seaside Marsh hammock located 0.5 km SW of the North Beach ramp a vibracore was taken in the west slope about 1.5 m above marsh level. No marsh mud or other indications of marsh sedimentation were identified in a 3 m core. Sand samples from the hammock and Yellow Banks Bluff 0.16 km to the west compare closely in texture and in their light brown color (Iralu, Serene, and Potter, 2008).

(3) Informal observations in the past few summers at the marsh immediately south of McQueen Inlet indicate increasing freshwater and higher water tables in the past few summers on the inner-facing slopes of the dune-ringed depression.

DISCUSSION

Significant erosion of the northern and eastern shore of St. Catherines Island is a long-standing reality evidenced by dead standing trees on the beach, steep erosional scarps where dunes or more ancient sands are adjacent to the beach, conspicuous washover fans in the eastern-facing salt marshes, and cohesive marsh deposits exposed on the beach face. For island residents and visitors, the retreat has also been made obvious by the rerouting of Seaside Road near Yellow Banks Bluff and the multiple relocations of Seaside ramp, and by bounding scarps around the periphery of St. Catherines Island, including the cut banks in Wamassee Creek, south of Mission Santa Catalina de Guale (fig. 7.2).

Measurement of this retreat would appear to be a simple matter of installing and monitoring fixed markers, but the process has been complicated by irregular monitoring and the lack of anticipation of rapid erosion rates that have caused the loss of many markers. In the past 12 years we have been more vigilant in our monitoring and in the placement of backup markers. This time-consuming process is more precise than aerial

TABLE 7.1
Erosion Rates at the Northern End of St. Catherines Island, 1977–2008

Marker Location	Year Measurements Began	Average Retreat, m/yr
Northwest Marsh	1977	0.20 m/yr
W. End Engineers Rd.	1999	2.38 m/yr
N. End Engineers Rd.	1979	1.65 m/yr
1933 Benchmark	1993	1.03 m/yr

TABLE 7.2
Erosion Rates on Yellow Banks Bluff, North Beach, 1996–2008

Location on bluff	Retreat, m/yr[a]
Northern third	0.53
Middle third	1.61
Southern third	2.69

[a]Average rate.

photograph scaling and GPS measurements, although the latter may soon offer enough precision to be a standard method. For calculating erosion over longer spans of time the aerial photographs methods are indispensable.

For calculating erosion of the north tip of St. Catherines, the older McClain markers established three decades ago are the most reliable for longer-term trends. Given the protection of the northern tip of the island, it is no surprise that the dune 0.7 km south of the western extension of Engineers Road (fig. 7.1, location A) exhibits an erosion rate of 0.2 m/yr (table 7.1). Engineers Road (West) on St. Catherines Sound shows a corresponding increase in erosion; the 2.38 m/year rate is anomalously high in comparison to other north shore sites, but only 10 years of data are available. The marker here was in a clump of five tightly clustered live oaks that were undermined by storm waves in the winter of 2006–2007, and the relatively horizontal rooting pattern allowed the entire mass to tip seaward. Erosion at the northern end of Engineers Road (East) (fig. 7. 1, location C) has been relatively steady over the years. McClain established the marker at 62 m from the scarp in 1979 (McClain, 1980); it was at 38.1 m in 1990, 27.2 m in 2004, and 14.1 m in 2008 (Potter, fieldnotes, 1997–2008).

Although erosion has been relatively constant at the northernmost part of the island at Engineers Road (East), the bluff in the benchmark area has varied from a fresh scarp in the late 1980s to an inactive slope bordered to the north by low dunes and young pines formed as accretion occurred below the bluff in the 1990s. There was no measured retreat of the benchmark bluff area from 1992 to 1996 (Potter, fieldnotes, 1992, 1996). A renewed cycle of erosion in the past five years resulted in retreat of the bluff that resulted in erosion of the 1933 and 1913 benchmarks onto the beach in 2007. The more recent benchmark, a brass cylinder in a concrete cube (labeled "U.S. Coast and Geodetic Survey, no.2, 1913 1933; 22.242"), was found in the surf below the high-tide mark in June 2007. Smaller concrete blocks found within a few meters may have been parts of the 1913 marker eroded from the charcoal horizon.

The charcoal horizon with the live pine rooted along it approximately halfway up the present 5 m bluff has shed light on a long-standing discussion among the University of the South faculty members. In 1987, founding staff members Keith-Lucas, Ramseur, Toll, and Potter found two closely spaced live oaks at the top of the highest dune on the island, 200 m south of the benchmark. These appeared to be branches of a single buried tree, and the discussion centered around the tree's potential ability to keep growing when buried to a significant depth. Erosion in early 2007, exposing the charcoal layer and its living pine with a lower trunk buried 3.6 m deep, confirmed the two-decade-old speculation that St. Catherines Island's highest dunes formed in at least two stages.

The accretion of new dune lines north of Yellow Banks Bluff beginning in the early 1990s has coincided with the growth of a large bar (part of St. Catherines Sound ebb delta) off the northeast tip of the island, now protected by the Georgia Department of Natural Resources for nesting birds. Growth of the bar has lessened the erosional effect of storm waves and caused an eastern extension of the beach between the bar and Sand Pit Road. Modest vertical accretion in the northernmost portion of Yellow Banks Bluff has stabilized erosion at what had been one of McClain's more active sites from 1974 to 1979 (McClain, 1980). Increasing rates of erosion farther south along North Beach and Yellow Banks Bluff, with the highest rates of 2.69 m/year occurring in the area of Seaside ramp correspond to increasing distance from the protective influence of the bar.

Nowhere else on the island is the march of erosion more obvious than along South Beach. Active washover fans into low-relief palm and live oak forests, as well as east-facing marshes, are the rule. The loss of so many naively placed markers in the Flag Pond area and farther south was due in part to erosional rates ranging from 2.3 m/year to 5.4 m/year that are best measured by markers established far back from the beach or by the use of historical aerial photographs. Corps of Engineers (1971) studies indicate that the recession of the southernmost part of South Beach is "greater than 2,400 feet" in the period from 1857–1860 to 1951–1952.

In the case of the small hammock in Seaside Marsh south of the ramp, the lack of marsh sediments correlative with the marsh deposits of Seaside Marsh in the vibracore taken there suggests that the hammock is a remnant of the nearby Pleistocene sands exposed in the bluff to the west and that the hammock was isolated by inlet migration.

Very preliminary work on vertical accretion in the small marsh south of McQueen Inlet has been done, with recent GPS data providing a framework that was lacking in earlier student studies. If windblown sand from nearby dunes continues to accumulate in this erosion-vulnerable are, we may be able to document the transition to a more freshwater-dominated marsh.

CONCLUSIONS

The documentation of shoreline retreat along the St. Catherines coast is more systematic than in the earliest years of the University of the South's Island Ecology Program but is in the process of being expanded and refined. Studies of further change in established study areas will be augmented by denser arrays of markers, and the areas south of Flag Pond characterized by high historical rates of erosion will receive renewed attention. As the accuracy of GPS systems improves, they will become a more important component of data collection. Documentation of the erosion of the island will remain important as sea level continues to rise.