CHAPTER 9
DRAINAGE CHANGES AT OSSABAW, ST. CATHERINES, AND SAPELO SOUNDS AND THEIR INFLUENCE ON ISLAND MORPHOLOGY AND SPIT BUILDING ON ST. CATHERINES ISLAND

Timothy M. Chowns[1]

In a recent paper, Chowns and others (2008) suggest that estuaries on the Georgia coast have recently been straightened as a consequence of the Holocene transgression. Abandoned channels preserved beneath Holocene marsh show that inlets formerly debouched south of their present locations, presumably in response to southerly longshore transport. Ossabaw, St. Catherines, and Sapelo sounds are prime examples of inlets that appear to have been modified during this process. All these inlets are fed by tidal distributaries and marshes that may be subject to avulsion when large volumes of water are trapped behind the barrier islands by a combination of storm runoff, onshore winds, and high tides. Circumstantial evidence for changes in inlet location is mainly geomorphic (fig. 9.1) including evidence of:

(1) Breaching supplied by truncation and cross-cutting relations adjacent to modern channels,

(2) Abandoned channels preserved beneath modern marsh,

(3) Detached spits that originally formed the northern, seaward margin of abandoned inlets,

(4) New spits formed by rapid progradation into abandoned inlets.

All four criteria were documented in the diversion of Brunswick River from the south to the north end of Jekyll Island and proved by vibracoring and radiometric dating (Chowns et al., 2008).

In the present case Ossabaw Sound provides the clearest evidence of recent breaching, Blackbeard and Guale marshes are possible abandoned channels, Blackbeard and Guale islands are good candidates for dissected spits, and St. Catherines Spit represents abandoned inlet fill. In order to assess the evidence, relative timing is critical.

The breaching of an inlet, dissection of a spit, abandonment of a former channel, and growth of a new spit are clearly related events. Thus a program of vibracoring, and dating by ^{14}C and optically stimulated luminescence (OSL) using quartz sand, has been initiated to establish the age of the inlets, dates of abandonment and infilling, and the ages of dune ridges that make up the spits (table 9.1). All new ^{14}C dates are conventional ages corrected for isotopic fractionation by Beta Analytic and are based on plant debris (confidence limit 1σ). Calendar dates are calibrated according to conventions cited in the preface to this volume (Bishop, Rollins, and Thomas). Only preliminary results are available so far but they generally support the hypothesis and provide a provisional time line.

The study area lies at the center of the Georgia Bight subject to a mixed wave and tidal regime, although dominated by tidal processes (Davis and Hayes, 1984; Davis, 1994; Hayes, 1994). Currently, tidal energy increases toward the head of the Georgia Bight, while wave energy decreases. In response to mesotidal conditions and suppressed wave energy the Georgia Sea Islands are relatively short drumstick-shaped islands separated by deep inlets formed by strong tidal currents (especially ebb tidal currents; Oertel, 1975b, 1977; Oertel, Henry, and Foyle, 1991). By contrast, in the Carolinas the combination of larger waves and microtidal conditions leads to longer islands with inlets that tend to close as a result of longshore transport (Davis and Hayes, 1984; Davis, 1994; Hayes, 1994). The processes by which barrier islands form and migrate have been described by Hoyt (1967) and Hoyt and Henry (1967). The

most important origin is through the flooding of dune ridges during transgression, but a secondary cause is the dissection of spits.

Although eustatic sea level has risen progres-

sively during the Holocene (Fleming et al., 1998, Peltier, 2002) the relative rate of rise varies locally as a consequence of vertical land movements. On the U.S. Atlantic coast, variations are primari-
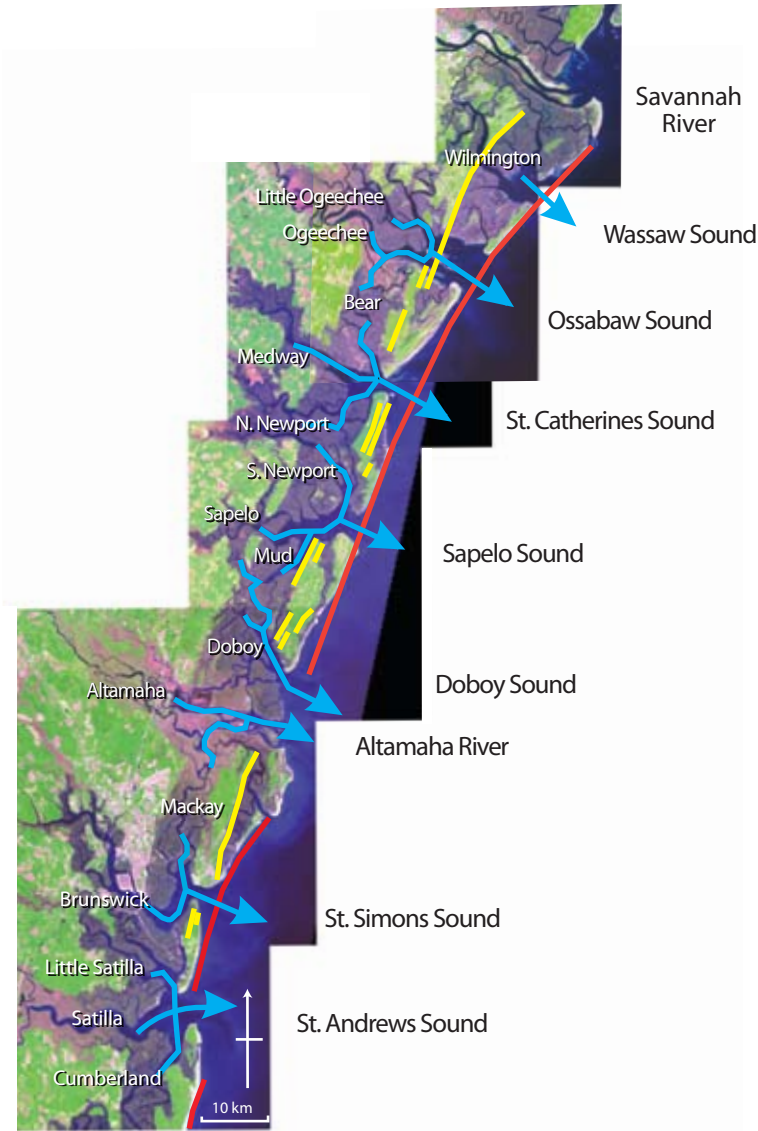

Fig. 9.1. Satellite image of the Georgia coast showing the location of modern estuaries and their principal distributaries. Yellow lines show the continuity of strand lines that make up the Silver Bluff barrier. Red lines suggest the Holocene strand prior to the beaching of major inlets. Note the progradation of the modern strand immediately south of the Savannah and Altamaha, the largest rivers. All inlets take relatively direct routes to the Atlantic without evidence of displacement due to longshore transport and spit building. This configuration is believed to be a consequence of the modern marine transgression, which favors tidal over wave processes.

TABLE 9.1
**Preliminary Ages for Dune Lines on St. Catherines Spit Based
on Optically Stimulated Luminescence and ^{14}C Dates**

Locations[a]	OSL ka	^{14}C yr B.P.	cal B.P.
Southern tip of spit (XVI–XVII) (Irene phase and later)	(9) 0.5 ± 0.3	—	—
Beach Pond–Flag Pond (XIII–XV), St. Catherines phase	(10) 1.0 ± 0.1	(Beta-217246) 1010 ± 50	830–570
	—	(Beta-217245) 1170 ± 50	960–720
	(11) 0.7 ± 0.1	—	—
	—	(Beta-115910) 1210 ± 40	1260–1010
Jungle Road ridge (X–XII) (Wilmington phase)	(7) 0.3 ± 0.1	—	—
	(6) 0.9 ± 0.1	—	—
	(5) 1.2 ± 0.1	—	—
	(8) 0.5 ± 0.1	—	—
	(3) 1.5 ± 0.3	—	—
Western spit, older part (V–IX) (Refuge-Deptford phases)	—	(Beta-183630) 1350 ± 60	1190–910
	—	(Beta-183629) 1390 ± 50	1120–950
	—	(Beta-183637) 1500 ± 50	1290–1060
	(4) 1.2 ± 0.3	(Beta-20829) 1700 ± 60	1520–1310
	(2) 1.3 ± 0.5	(Beta-262151) 1720 ± 50	1780–1520
Cracker Tom Hammock (I–IV) (St. Simons phase)	—	[(UGA 6442) 3590 ± 50	3820–3490
	—	(USGS #WW-1260) 4450 ± 50	4950–4620

[a]For locations, see figures 9.5 and 9.9. Beta-262151 is reported here for the first time; all other ^{14}C dates are from Thomas (2008, tables 29.1. and 15.2; see also appendix 1, this volume). Paired OSL and ^{14}C dates are from related beach ridges and should be of similar age. OSL dates provided by Dr. George Brook, University of Georgia Luminescence Dating Lab, based on assumed water content of 20 ± 5% and cosmic rate 150 ± 30 (μGY/yr).

ly related to glacial isostatic adjustments. The depression created by the Laurentide Ice Sheet was matched by the development of a forebulge that is currently collapsing concomitant with deglaciation and isostatic uplift in Canada (Engelhart et al., 2009). On the Georgia-Carolina coast, several workers (DePratter and Howard, 1981; Gayes et al., 1992; Scott et al., 1995; Colquhoun, Brooks, and Stone, 1995) identify a relative lowstand of sea level (estimated around 3600 cal B.P.) that may be related to the presence of this bulge. It has important implications for the evolution of the coast and its aboriginal inhabitants.

Chowns, Schultz, and Griffin (2006) and Chowns et al. (2008) argue that marine transgression tends to favor tidal over wave processes by trapping sediment in the estuaries and also flooding the marshes, thereby increasing the volume of the tidal prism. On the other hand, stillstand (or minor regression) is expected to release more sand into the longshore transport system and decrease the volume of the tidal prism, thus favoring wave over tidal processes. In other words, stillstand favors spit building and the diversion of inlets while transgression encourages inlet straightening and the dissection of spits.

This chapter investigates the evidence for breaching at Ossabaw, St. Catherines, and Sapelo sounds, the possible timing of the breaches, and their influence on the distribution of erosion and accretion, especially on St. Catherines Island.

SILVER BLUFF STRANDLINES

During the Pleistocene with sea levels down around 100 m, the coastline lay close to the shelf edge (Hoyt, Henry, and Weimer, 1968; Hoyt and Hails, 1974; Fleming et al., 1998; Rollins and Thomas, this volume, chap. 16). Radiometric ages from buried marsh sediments and cypress

swamps indicate that sea level first reached the modern shoreline between 5500 and 4500 ^{14}C yr B.P. (DePratter and Howard, 1977, 1980, 1981; Thomas, Rollins, and DePratter, 2008: chap 29), reoccupying an earlier Silver Bluff strandline, questionably dated between 35 and 50 ^{14}C ka (Hoyt, Henry, and Weimer, 1968; Hoyt and Hails, 1974; Vento and Stahlman, this volume, chap. 4). In this process, the old dunes were converted to barrier islands, the low country behind the dunes was inundated to form marshes, and inlets opened at river mouths (Hoyt, 1967). St. Catherines Island was isolated from the mainland around 4000 B.P. (Linsley 1993; Linsley, Bishop and Rollins, 2008; Thomas, 2008: chap 4; Rollins and Thomas, this volume, chap. 16). As sea level rose with deglaciation, barrier islands initiated on the shelf migrated landward, and presumably southward with longshore transport, and eventually merged with the old Silver Bluff dunes to form the modern Sea Islands with a Pleistocene core fronted by dunes and marshes accreted during the Holocene (Bishop et al., chap. 3, this vol.). Satellite images of the Silver Bluff islands show lineations representing old wave-cut strandlines that form a rather continuous arc between the Savannah and Altamaha rivers (fig. 9.1). In spite of intervening inlets, lineaments project from one island to another as if the islands were once continuous. This continuity is especially obvious across Wassaw and Ossabaw sounds leading to the crosscutting relationship illustrated by Alexander and Henry (2007). These same lineaments may also project to St. Catherines Island, raising the possibility that the scarp that forms the southeastern boundary of the Silver Bluff barrier on Ossabaw Island is the same feature as the King New Ground Scarp on St. Catherines (Bishop et al., 2007; Linsley, Bishop, and Rollins, 2008). There is a long gap between Silver Bluff deposits on St. Catherines and the north end of Sapelo Island but the trends are similar. The first noticeable change occurs at the south end of Sapelo where the trend that extends from Wilmington and Skidaway islands is truncated by a younger set of cuspate beach lineaments. Overall, beach ridges on the Silver Bluff barrier seem to be more continuous than the Holocene beach ridges. If inlets were present between Skidaway, Ossabaw, and St. Catherines islands they must have been relatively small. The only possible interruption for a larger inlet along this stretch of coast during Silver Bluff

time was at Sapelo Sound. The implication is that Wassaw, Ossabaw, St. Catherines, and possibly even Sapelo Sound, all postdate the Silver Bluff shoreline and were thus breached or significantly enlarged during the Holocene transgression. One possibility, which needs further investigation, is that the low country between the Silver Bluff and Princess Anne beach ridges represents the former valley of the Ogeechee at a time when it was tributary to the Altamaha.

OSSABAW SOUND

Ossabaw Sound seems to be the most recent breach within the Georgia Sea Islands (fig. 9.2). The inlet is relatively narrow and clearly transects both Silver Bluff strandlines and Holocene marshes seaward of this barrier (Alexander and Henry, 2007). At first inspection it appears that marshes and sand hammocks dated by archaeological artifacts (DePratter and Howard, 1981) and OSL (Alexander and Henry, 2007) to be as young as 1.5–1.0 ka are truncated. However, peat associated with inlet fill close to Torreys Landing on the south side of Ossabaw Sound (fig. 9.3) shows that this part of the inlet is older than 1880 ± 40 ^{14}C yr B.P. (Beta 263588; 1900–1710 cal B.P.; 2σ interval; see appendix 1; i.e., Deptford or older). Nevertheless, Ossabaw Sound still appears to be one of the youngest inlets between the Sea Islands with no sign of abandoned channels as in the case of older inlets at St. Catherines and Sapelo sounds and only a small spit intruding from Wassaw Island.

Because the Holocene marsh is almost 5 km wide, the Silver Bluff barrier cannot have been breached by erosion from the seaward margin. Rather it must have resulted from erosion by the Ogeechee. In fact, aerial photographs suggest the possibility of a large meander in the vicinity of the confluence of the Little Ogeechee with the main trunk of the Ogeechee, which may have initiated the breach (fig. 9.2). Erosion on the outside cut-bank of such a meander would be expected to eat away the western margin of the Silver Bluff barrier, ultimately allowing communication with the marsh west of the Holocene barrier. Most likely the avulsion occurred as a consequence of excess discharge and flooding on the lower reaches of the Ogeechee. Combinations of storm rainfall (hurricane or nor'easter), onshore winds, and high spring tides are precisely the kinds of conditions required.
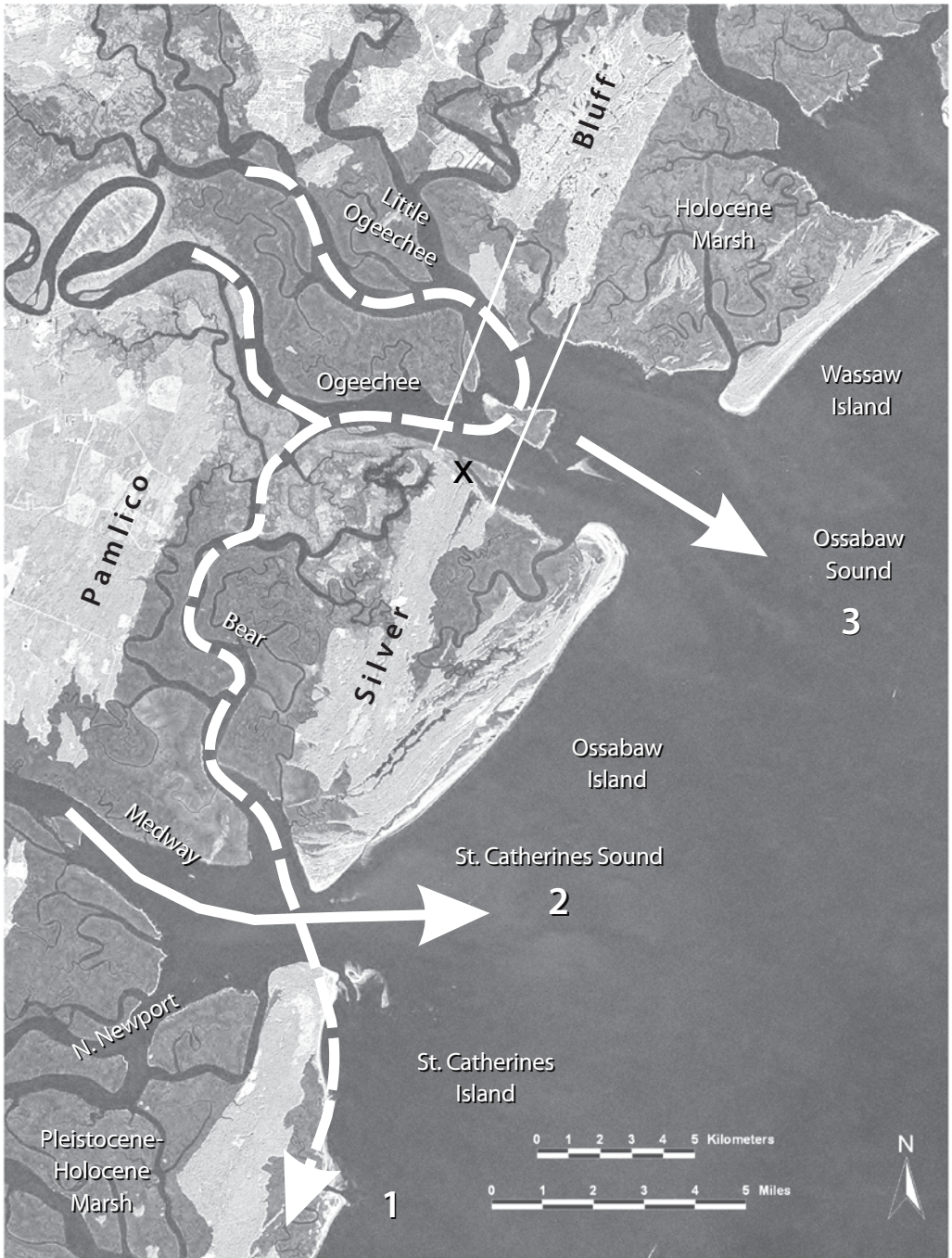
Fig. 9.2. Satellite imagery of Ossabaw Island showing the proposed displacement in the mouth of the Ogeechee from St. Catherines Sound to Ossabaw Sound resulting from erosion and avulsion at an old meander at the confluence with the Little Ogeechee. Numbers indicate the relative ages of inlets based on crosscutting relations. Number 1 is Guale Inlet. Cross marks the location of Torreys Landing (fig. 9.3) (updated from Chowns et al., 2008).
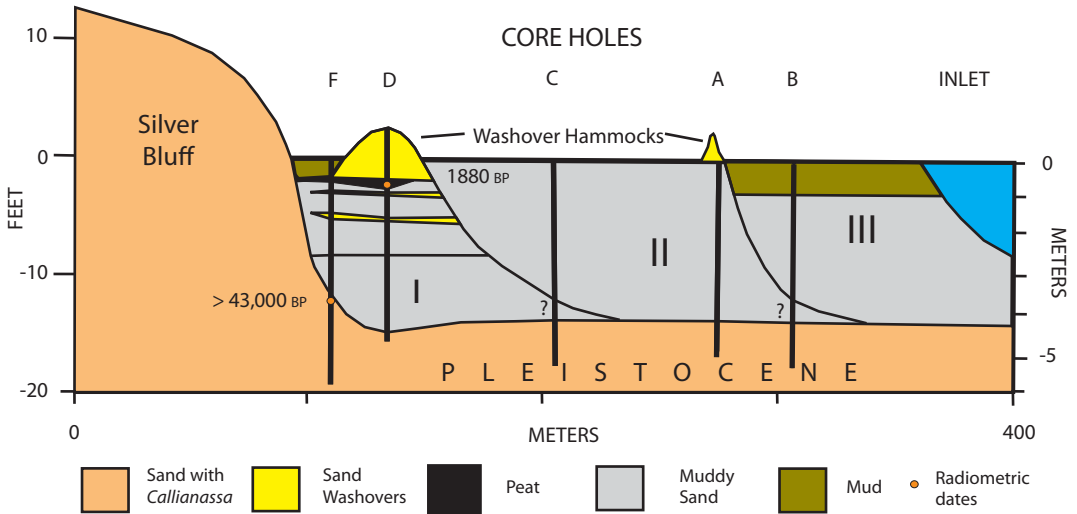
Fig. 9.3 Stratigraphic cross section constructed from vibracores (A–D, F) across channel bars (I, II, and III) near Torreys Landing on the south side of Ossabaw Sound (see fig. 9.2 for location). Radiometric dates show that the inlet predates 1880 ± 40 ^{14}C yr B.P. (1900–1710 cal B.P.; 2σ interval).

SAPELO SOUND
AND BLACKBEARD ISLAND

The original location of Sapelo Sound is known from the development of beach ridges at the south end of St. Catherines Island (figs. 9.4 and 9.5). The oldest Holocene beach ridges in the vicinity of Cracker Tom Hammock (terrains I–IV) were evidently shaped by wave action on the Atlantic strand. They are concave toward the ocean, having accreted against a bulwark of Pleistocene deposits along Back Creek Scarp. Figure 9.5 illustrates the major accretionary terrains that make up St. Catherines Spit south of Cracker Tom Hammock. In addition to progradation (purple lines) there were periodic episodes of wave erosion from the Atlantic beach (green lines) and the tip of the spit was frequently trimmed by storm waves crossing Sapelo Sound (yellow lines). The red line labeled Zapala Scarp indicates dissection by a tidal channel and is interpreted as the original limit of Sapelo Sound (Bishop et al., 2007).

The first evidence of a spit (terrain V) occurs immediately south of Zapala Scarp, which truncates Cracker Tom Hammock seaward of South Newport River (Bishop et al., 2007). While Cracker Tom Hammock overlies Pleistocene de-

posits at shallow depth (Booth and Rich, 1999; Booth, Rich, and Bishop, 1999), south of Zapala Scarp the spit rests on inlet fill (Linsley, Bishop, and Rollins, 2008).. Radiometric dates from roots in a paleosol within terrain V suggest that the spit was initiated sometime before 1720 ± 50 ^{14}C yr B.P. (Beta 262151; 1780–1520 cal B.P.; fig. 9.6) possibly around 2700 cal B.P. or even 3000 B.P., based on the occurrence of early Refuge ceramics on terrain VII (Thomas, Rollins, and DePratter, 2008: chap. 29). A small composite sample of plant debris deposited with the sand of terrain V was submitted for dating (Beta 261351; 6330 ± 60 ^{14}C yr B.P.; 7420–7160 cal B.P.) but proved excessively old probably as a result of contamination with reworked fossil wood.[2]

The southern shore of Sapelo Sound is formed by Blackbeard Island and the question then arises as to whether, prior to the erosion of Zapala Scarp, this island may have been a part of St. Catherines Island. The suggestion that Blackbeard Island originated as a spit at the southern end of St. Catherines Island rests on similarities to the beach ridges on Cracker Tom Hammock and overall morphology (figs. 9.5 and 9.7). Like Cracker Tom Hammock, Blackbeard Island consists mainly of beach ridges that are concave to the Atlantic and quite unlike
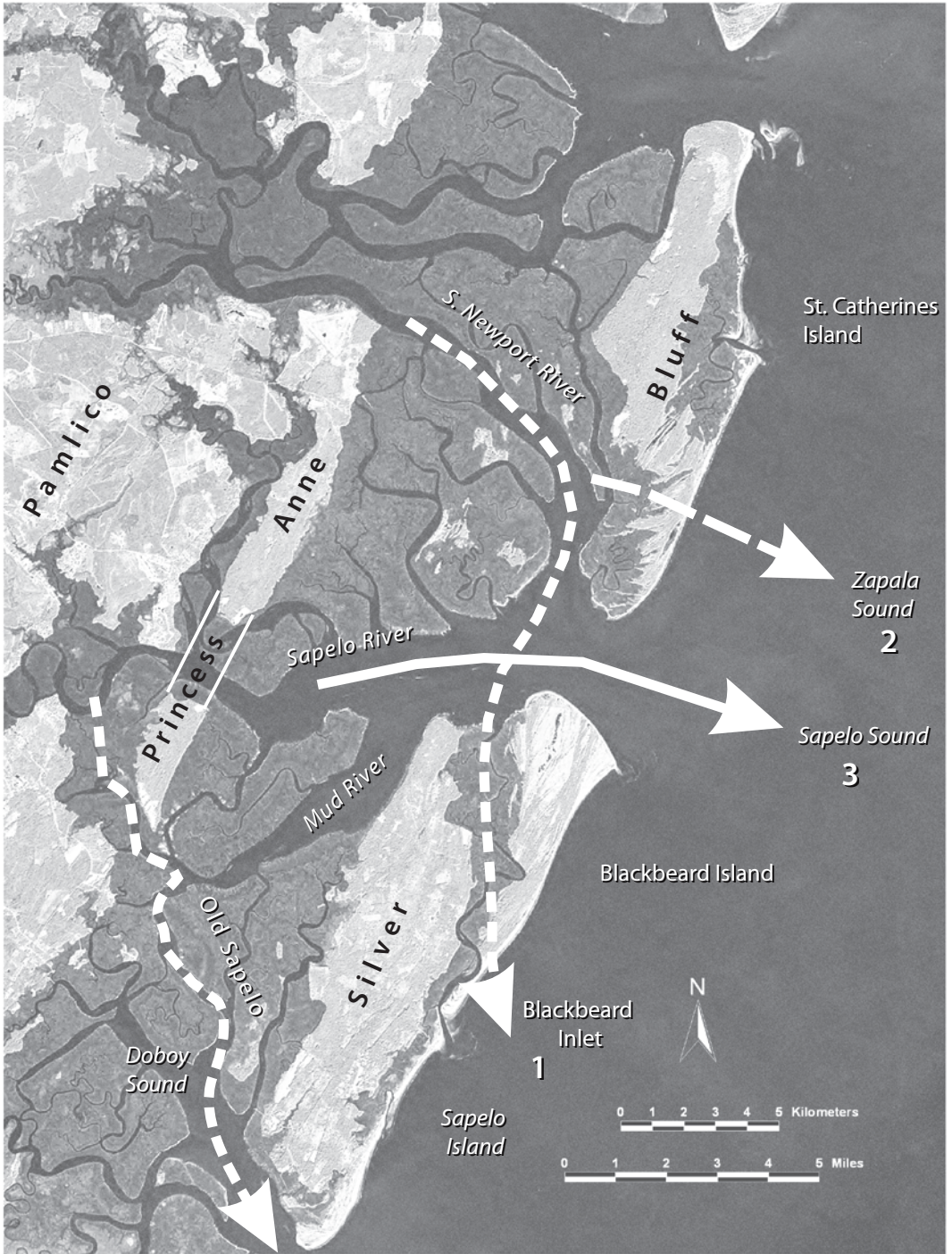
Fig. 9.4. Satellite imagery of St. Catherines and Sapelo islands suggesting the original course of S. Newport River prior to the breaching of Zapala (Sapelo) Sound and isolation of the southern part of St. Catherines Spit to form Blackbeard Island. Based on crosscutting relations Blackbeard Inlet (1) predates Zapala Sound (2) and Sapelo Sound (3). Sapelo River originally drained into Doboy Sound (updated from Chowns et al., 2008).
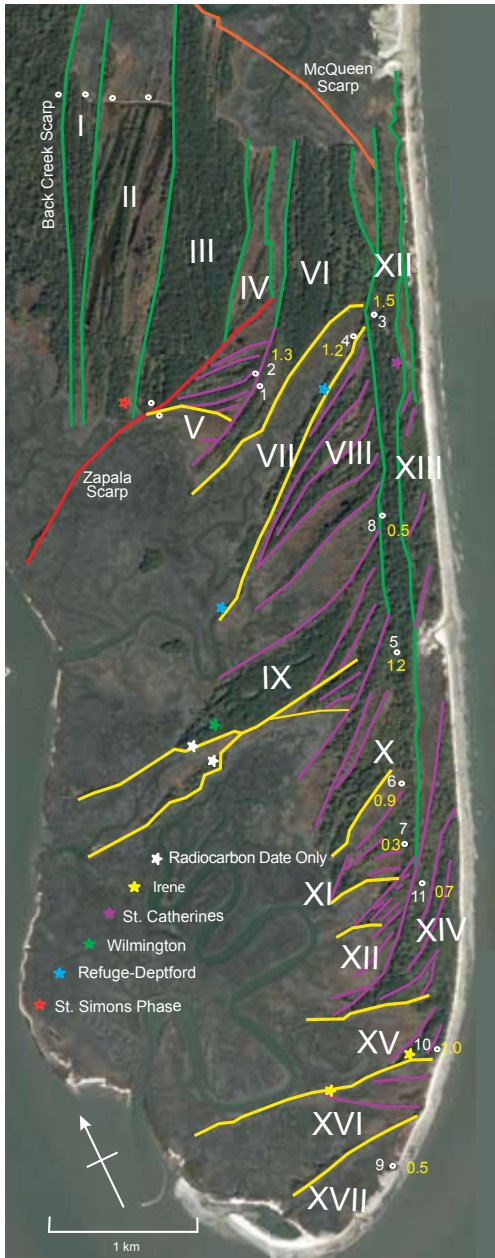
the convex dune lines that form the modern tip of St. Catherines. Both sets of beach ridges are similarly aligned and generally prograde to the east except at the southern end of Blackbeard where progradation is to the south, culminating in the spit at Cabretta Inlet (Oertel, 1975b). If we assume for the sake of argument that Sapelo Sound has maintained a constant width during the progradation of St. Catherines Spit, then the north end of Blackbeard Island may have lost around 6 km to erosion since about 2700 cal B.P. This is sufficient to span the modern sound and overlap the southern third of the spit (fig. 9.8). Blackbeard Marsh is entirely consistent with an abandoned tidal inlet. At the northern end it matches the dimensions and alignment of South Newport River while to the south it narrows as a result of overwash from the younger part of Blackbeard Island.

It is clear that Blackbeard is a late addition to Sapelo Island. Depending on the development of inlets, it must have originated as an independent island or as part of St. Catherines Island. If it is a segment of St. Catherines, the older parts of Blackbeard should match (or postdate) terrains around Cracker Tom Hammock and predate terrains south of Zapala Scarp. Once again, radiometric dating is necessary to test which hypothesis is feasible. Current archaeological sites and limited ^{14}C dating indicate that Cracker Tom Hammock predates 4000 ^{14}C yr B.P. (4480 cal B.P.; St. Simons phase or older) while St. Catherines spit is younger than ~2700 cal B.P. (Refuge and younger, per Thomas, 2008: table 15.3). The oldest archaeological sites on the west side of Blackbeard Island date to the Deptford period (C. DePratter, V. Thompson, personal commun., 2008), which ranges from 2180 to 1690 ^{14}C yr (2300–1600 cal B.P.) in the St. Catherines Island chronology (Thomas, 2008: chap. 15; this volume, table 1.1); the island, of course, may be much older. Preliminary ^{14}C dates from the west side of the island range from 3090 ± 40 B.P. (3330-2750 cal B.P.; Beta-282469) to 2110 ± 40 B.P. (2290-2270 and 2160-1990 cal B.P.; Beta-

Fig. 9.5. Beach ridges that make up St. Catherines Spit illustrating episodes of progradation (purple lines) interrupted by erosion; wave erosion on the Atlantic beach (green), and southern tip of the spit (yellow) as well as erosion by tidal inlets (red). Numbered circles show the locations of sample sites providing OSL dates (table 9.1). Asterisks, color coded to date, represent archaeological sites from Thomas (2008): Irene (yellow), cal A.D. 1300–1580; St. Catherines (violet), cal A.D. 800–1300; Wilmington (green), cal A.D. 350–800; Refuge-Deptford (blue), cal 1000 B.C.–A.D. 350; and St. Simons Phase (red), cal 3000–1000 B.C.
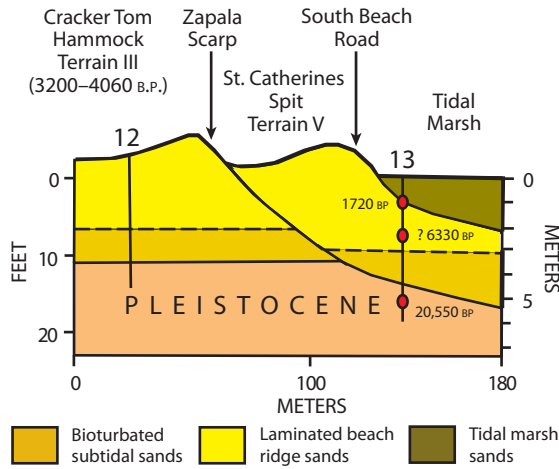
Fig. 9.6. Stratigraphic cross section across Zapala Scarp showing locations of dated samples (all expressed in ^{14}C yr B.P.). Dates prove that terrain V predates 1720 ± 50 ^{14}C yr B.P. (1780–1520 cal B.P.). Estimate of 6330 ± 60 ^{14}C yr B.P. (7420–7160 cal B.P.) was from a composite sample of plant debris and is most likely contaminated by fossil material. See figure 9.9 for location of vibracores. Dates for Cracker Tom Hammock are based on Booth, Rich, and Bishop, 1999.

282468) (St. Simons to Deptford) as predicted.

The alignment of Blackbeard Marsh with South Newport River suggests that the location of Sapelo Sound was formerly controlled mainly by the South Newport and that it was the breaching of Zapala Scarp that led to the abandonment of the inlet beneath Blackbeard Marsh. This also suggests that formerly Sapelo and Mud rivers may have debouched further south at Doboy Sound.

ST. CATHERINES SOUND AND GUALE ISLAND

According to Linsley (1993), Linsley, Bishop, and Rollins (2008), and Bishop et al. (2007), St. Catherines Island was, until recently, accompanied by a doublet similar to the Blackbeard-Sapelo doublet. The reconstructions of those authors show an unusual geometry with a seaside marsh protected by north and south prograding spits. As an alternative interpretation, it is possible that, as in the case of Blackbeard Island, "Guale Island" originated as a spit at the southern end of Ossabaw Island and was dissected due to a change in the position of St. Catherines Sound. In this case Seaside-McQueen (Guale) Marsh, like Blackbeard Marsh, is the remnant of the old inlet (fig. 9.8).

Prior to the breaching of Ossabaw Sound the Ogeechee probably entered St. Catherines Sound via Bear River and possibly occupied the channel beneath Guale Marsh. Bishop et al. (2007) record more than 9.1 m of marsh mud at the northern end of Seaside (Guale) Marsh, a minimum depth for the channel. Radiocarbon dates from other cores in the same vicinity indicate an active channel between 4290 and 3100 ^{14}C yr B.P. (4840–3350 cal B.P.) giving way to tidal marsh around 1720 ^{14}C yr B.P. (1580 cal B.P.; Linsley, 1993; Linsley, Bishop, and Rollins, 2008; Thomas, Rollins, and DePratter, 2008: table 29.1; see also this volume, appendix 1). Guale Inlet may have been abandoned with the loss of discharge from the Ogeechee or possibly earlier as a result of other drainage changes or erosion at the shoreline. Loss of the Ogeechee would increase the importance of the Medway and South Newport rivers and change the trajectory of the inlet, possibly leading to abandonment of Guale Inlet and the breaching of a spit attached to Ossabaw to form Guale Island. This is a similar scenario to that described at St. Simons Inlet following a change in trajectory due to the capture of Brunswick River (Chowns et al., 2008). Accretion north and south of the modern inlet (Oertel, 1975b) is most likely a response to the loss of discharge and

narrowing of the channel, which is now controlled mainly by the Medway.

ST. CATHERINES SPIT

Any changes in inlet geometry, and especially those involving the Ogeechee, would have a major effect on sand supply to Ossabaw, St. Catherines, and Sapelo islands. In the case of Sapelo and St. Catherines, a recent displacement in the Ogeechee would remove the islands from a proximal to a distal position relative to sand supply from this river. It is very likely that changes in erosion and progradation both on Guale Island and the southern spit may be related to such changes in sand supply (Bishop et al., 2007). Figure 9.9 shows estimated ages of the accretionary terrains that make up the spit. Approximate ages

Fig. 9.7. Pattern of beach ridges on Blackbeard Island showing progradation to the east and south over time. Green lines between major terrains mark intervals of wave erosion on the Atlantic foreshore; yellow lines indicate erosion at the tip of a spit, and red lines are channel margins. Note the overall cuspate geometry (similar to Cracker Tom Hammock) formed by deposition against a bulwark of older deposits.
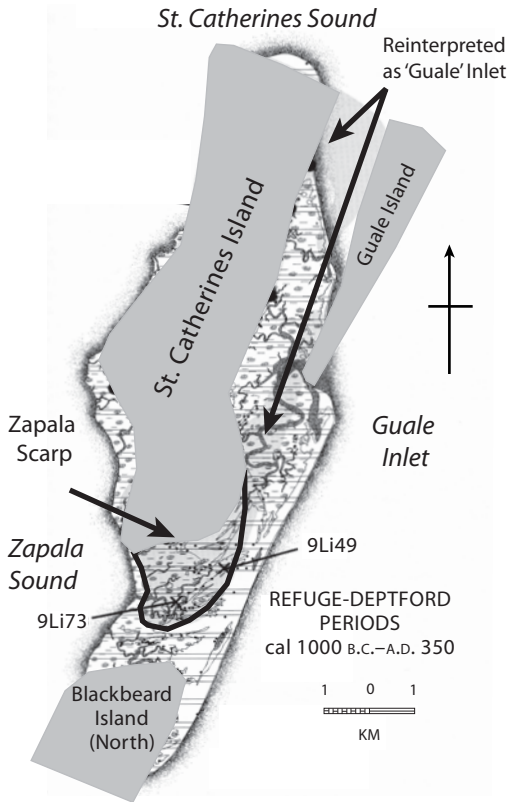
Fig. 9.8. Reconstruction of St. Catherines Island around 2700 ^{14}C yr B.P. (2770 cal B.P.; early Refuge Period) showing Guale Island, Guale Inlet, and Zapala Scarp with the inferred location of Blackbeard Island (modified from Linsley, 1993; Thomas and others, 2008). Timing is shortly after the breaching of both Zapala (Sapelo) and St. Catherines sounds. Sites 9Li49 and 9Li73 are Refuge sites (9Li49 early Refuge) on the spit south of Zapala scarp showing that the scarp must have been eroded prior to 2500 B.P. ^{14}C yr B.P. (2610 cal B.P.).

are given based on ^{14}C dates and archaeological sites, mainly from Thomas (2008: tables 13.4 and 29.1), supplemented by preliminary dates from optically stimulated luminescence (OSL) of quartz sands making up the dune ridges (table 9.1). Since beach ridges may have been reoccupied over a considerable range of time, it is clearly the older archaeological ages that are most significant for dating the progradation of the spit. In general the OSL dates fall in the correct order and

are consistent with ^{14}C dates but younger than expected from archaeological determinations. There are no radiometric ages older than 1720 ^{14}C yr B.P. (1580 cal B.P.) and yet archaeological sites date back to the early Refuge period (2850–2500 cal B.P.). This is a problem previously noted by Thomas (2008, chap. 16, and personal commun., 2010). Some OSL dates are anomalously young, possibly as a result of exposure to blowouts, superposition of younger dunes, or bioturbation after original deposition.

The spit may be divided into four distinct sectors characterized by different styles of accretion and separated by pronounced erosional discontinuities (fig. 9.9). The oldest sector includes terrains I–IV and lies immediately east of Back Creek Scarp. It is bounded on all sides by erosional discontinuities but evidently formed due to eastward progradation of the Atlantic beach. The beach ridges are distinctly cuspate because sand accumulated against a bulwark of older beach ridges. Radiometric ages from Cracker Tom Causeway (Booth, Rich, and Bishop, 1999; Thomas, 2008: table 29.1) indicate that deposition commenced sometime before 4450 ± 50 ^{14}C yr B.P. (4950–4620 cal B.P.), which is in accord with the occurrence of St. Simons period artifacts resting on terrain II.

The second sector includes terrains V–IX with the first evidence of an inlet and recurved spit in terrain V. The resulting discontinuity with terrains I–IV is identified as Zapala Scarp (Bishop et al., 2007) and appears to connect with the Atlantic beach to the north (between intervals IV and VI) and with the remnants of an overwash hammock further west. Terrain VI also records the southern tip of the island with a recurved spit turning north into Atlantic beach ridges. This is the last unit that prograde markedly to the east. Terrain VII consists of Long Marsh and an associated overwash-sand hammock to the southeast. The sand hammock is especially significant because two archaeological sites (9Li49, and 9Li73 of Thomas, 2008, chaps. 20 and 28; Thomas, Rollins, and DePratter, 2008, chap. 29: fig. 9.8) have yielded Refuge artifacts (early Refuge in the case of 9Li49). This would indicate that the shoreline must have prograded south of terrain VII by the end of Refuge times (around 2300 cal B.P.; see table 1.1) and that ^{14}C (1720 ± 50 ^{14}C yr B.P.; 1780–1520 cal B.P.) and OSL (1.3 ± 0.5 ka) dates from terrain V are too young. Subsequent to terrain VII, progradation was mainly southward, periodically interrupted

by erosion from waves crossing Sapelo Sound. The position of the Atlantic beach was apparently stationary through terrains VIII–IX with ^{14}C dates ranging from 1500 ± 50 (1290–1060 cal B.P.) yr B.P. to 1350 ± 60 yr B.P. (1190–910 cal B.P.). One archaeological site dates to the Wilmington period (9Li 164), but terrains VIII–IX might be older, possibly even Refuge.

Terrains X–XII continue to build to the south but an important discontinuity is evident at the north end. Here X–XII are amalgamated into a single ridge that truncates older terrains, in particular terrain VI and McQueen Scarp. Evidently, the remnant of Guale Inlet north of McQueen Scarp was blocked at this time. OSL dates within this sector show a scatter ranging from 0.3 ± 0.1 to 1.5 ± 0.3 ka possibly due to the superposition of younger dunes on top of the X–XII ridge. There is only one significant archaeological site (9Li128) yielding sherds of St. Catherines age (Thomas, 2008: chap 20; Thomas, Rollins, and DePratter, 2008: chap. 29). Most likely this ridge dates to the Wilmington period but, once again, may be older. The last important break (along Jungle Road Scarp) occurs between terrains XII and XIII immediately east of Jungle Road. Terrains X–XII were abandoned at this stage and a new foreshore XIII–XVII was constructed further east. It was the progradation of this new succession of beach ridges that impounded first Beach Pond (1210 ^{14}C yr B.P.; 1260–1010 cal B.P.; Booth et al., 1999) and later Flag Pond. Radiometric ages indicate the southern tip of the island at terrain XV by 1090 ^{14}C yr B.P. (cal 1000 B.P.;[3] 1.0 ± 0.1 ka OSL). To the north terrains XIII–XV are mainly St. Catherines age while further south (XVI–XVII) they are probably Irene. The Jungle Road hiatus between units XII and XIII is probably late Wilmington (prior to 1210 ± 40 ^{14}C yr B.P.; 1260–1010 cal B.P.).

The southern tip of the island has been undergoing rapid erosion for at least 150 years (Griffin and Henry, 1984) and the location of the strandline is currently controlled by the position of the headland at McQueen Inlet.

AGE RELATIONS

More work is needed to prove the ages of Ossabaw, St. Catherines, and Sapelo sounds but some idea of relative age may be gained from existing dates and from geomorphic preservation (table 9.1; figs. 9.9 and 9.10). The relative ages of these inlets as well as of Blackbeard and Guale inlets are critical to the question of the

segmentation of the Ogeechee, which will be discussed later.

The breaching of Sapelo Sound along the line of Zapala Scarp probably occurred during the early Refuge archaeological period (perhaps around 2700 cal B.P.) or sometime around the St. Simons–Refuge boundary (3000 cal B.P.) and has since been obscured by the renewed progradation of St. Catherines Spit. Prior to the Refuge period, between about 4300 and 3600 cal B.P. or perhaps a little later (Gayes et al., 1992; Scott, Gayes, and Collins, 1995), sea level fell by around 2 m leading to a significant gap in the archaeological record. This may have been due to abandonment of the island or to the drowning and erosion of Refuge sites during subsequent sea level rise (DePratter and Howard, 1981; Thomas, 2008; this volume, chap. 4; chap. 1, this vol.). The eastward progradation of Cracker Tom Hammock (I–IV) may be a record of higher sedimentation rates during the lowstand, while Zapala Scarp was cut during the early stages of transgression. Eastward progradation was resumed in terrains V–VII possibly due to the proximity of the Ogeechee at Guale Inlet.

In the case of St. Catherines Sound, a presumed doublet, Guale Island, has apparently been consumed by wave erosion and the inlet has been narrowed both to the north and south by accretion. The age of breaching of the modern inlet may be approximated from the date that Guale Inlet was abandoned; sometime before 1720 ^{14}C B.P. (Pitt-723; 2200 cal B.P.) during the Deptford period based on vibracores (Linsley, 1993; Linsley, Bishop, and Rollins, 2008).

Although St. Catherines Spit continued to advance southward, apparently during the Deptford and/or Wilmington periods (2180–1170 cal B.P.), the Atlantic shoreline remained fixed through terrains VIII–XII, as the sedimentation rate was balanced by the creation of accommodation space. Terrain XII crosscuts and is superposed on McQueen Scarp, indicating that Guale Inlet was closed, allowing sand from the erosion of Guale Island to pass directly along the strand to feed the spit. Prior to this time the location of the southern strandline was controlled by the promontory south of Guale Inlet whereas afterward it was controlled by Guale Island. As an apparent result the shoreline was twice trimmed by erosion (prior to XII and again prior to XIII) and then repaired (during XII and later during XIII–XIV). Erosion may have occurred with the
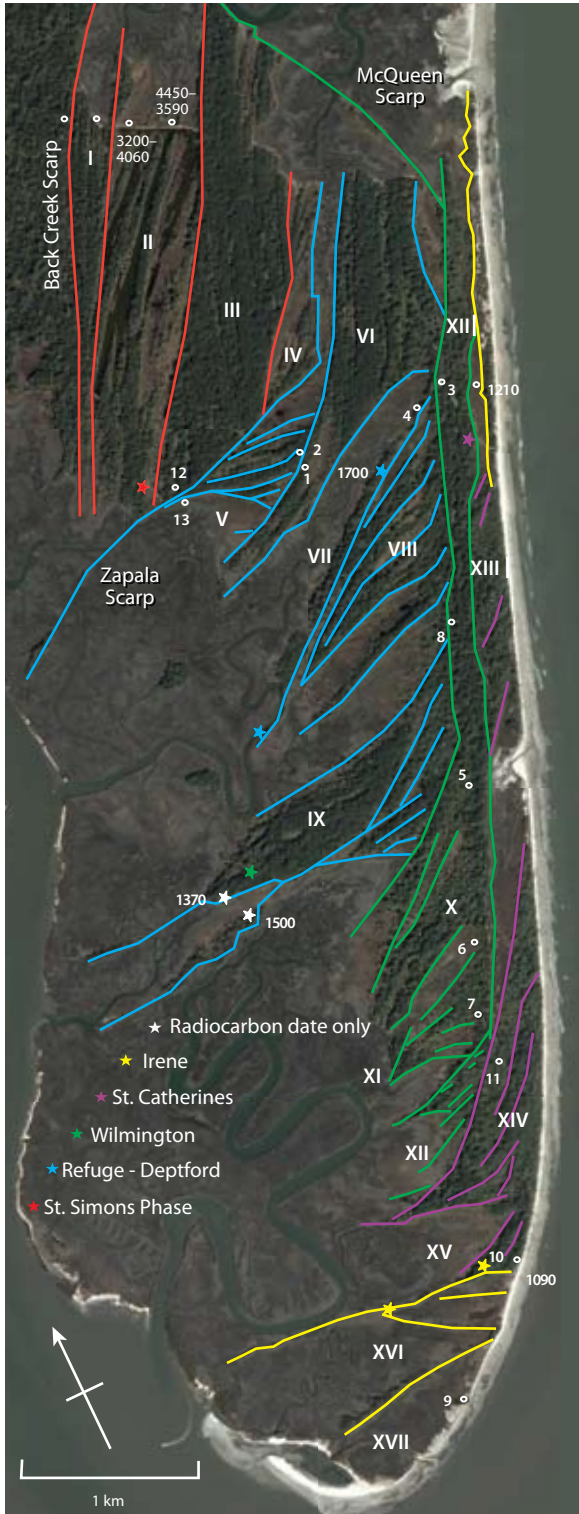
Fig. 9.9. Tentative subdivision by age of accretionary terrains on St. Catherines Spit, based mainly on ^{14}C dates (expressed in cal B.C./A.D. estimates) as well as the distribution of archaeological sites and dated artifacts: Irene (yellow), cal A.D. 1300–1580; St. Catherines (violet), cal A.D. 800–1300; Wilmington (green), cal A.D. 350–800; Refuge-Deptford (blue), cal 1000 B.C.–A.D. 350; and St. Simons Phase (red), cal 3000–1000 B.C. Numbered circles show the location of sample sites including vibracores where ^{14}C dates were obtained. Asterisks represent archaeological sites from Thomas (2008).
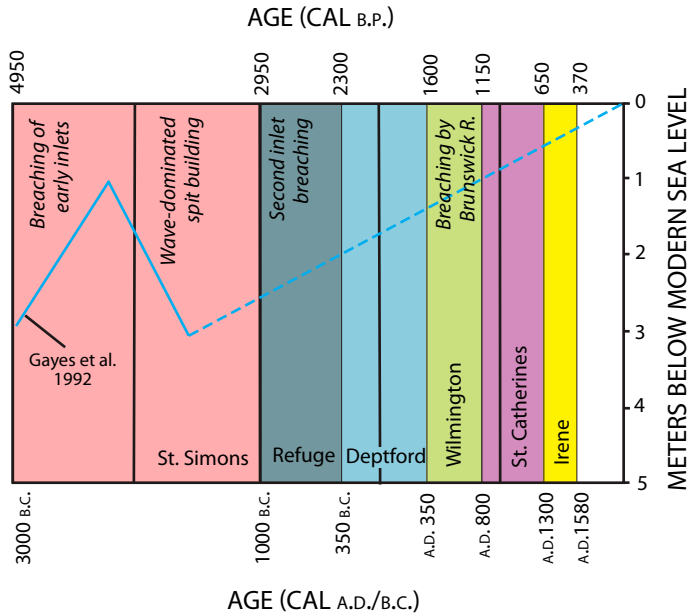
Fig. 9.10. Chronostratigraphic diagram showing relationship between archaeological phases, sea level, and breaching of inlets. Archaeological boundaries are approximate and based on Thomas (2008, chap. 15). Early inlets include the ancestral Blackbeard and Guale inlets. Sapelo Sound, St. Catherines Sound, and Ossabaw Sound are secondary inlets. Blackbeard and Guale islands are relics of spits constructed during an interval of wave dominance related to a minor regression.

loss of sand supply from Guale Inlet and repair occurred when supply was reestablished from St. Catherines Sound or even Ossabaw Sound.

Ossabaw Sound was breached sometime before 1880 ± 40 ^{14}C yr B.P. (Beta-263588: 1900–1710 cal B.P.; see appendix 1) and appears to be the youngest of the three major inlets. As noted earlier, it is markedly crosscutting and without evidence of old abandoned channels. If there is a record of this breach preserved as a hiatus in the progradation of St. Catherines Spit, it should appear somewhere in the Deptford section. The discontinuities between terrains IX and X and XII and XIII most likely date to the Wilmington period, too young to support a connection. However, there is much uncertainty in the assignment of radiometric dates and a correlation remains a possibility. It is possible that these discontinuities record the relocation of the Ogeechee first to St. Catherines Sound and later to Ossabaw Sound. In each case erosion was repaired once sand supply was reestablished by longshore

transport. Alternatively, they may merely reflect changes in erosion on nearby Guale Island.

Within the limitations of the available radiometric ages, it seems that all three inlets, Sapelo (Zapala), St. Catherines, and Ossabaw may have opened around the same time (fig. 9.10), sometime around 2700 cal B.P. in the case of Zapala, between 3100 and 1720 ^{14}C yr B.P. (3350–1570 cal B.P.) for St. Catherines, and perhaps shortly before 1880 ^{14}C yr B.P. (1870 cal B.P.) in the case of Ossabaw Sound. All may date to the Refuge-Deptford period and be attributable to rising sea levels following a forced regression during late St. Simons time. Further south, the breach at St. Simons Sound occurred around 1480 ^{14}C yr B.P. (1390 cal B.P.), during the Wilmington period (Chowns et al., 2008). At all of these localities southeasterly flowing inlets were abandoned and infilled by marsh: Blackbeard Marsh on Sapelo, Guale Marsh on St. Catherines, and Clam Creek Marsh on Jekyll. While Blackbeard Marsh is still protected by the spit that formed

its seaward boundary, both Guale Marsh and Clam Creek Marsh are currently exposed to wave erosion.

BLACKBEARD AND GUALE INLETS

The abandoned inlets beneath Blackbeard and Guale marshes predate younger inlets at Sapelo, St. Catherines, and Ossabaw sounds. Evidently they originated prior to the lowstand responsible for the construction of the spits that eventually gave rise to Blackbeard and Guale islands. This is confirmed in the case of Guale Inlet by inlet facies giving radiometric dates between 4290 ± 80 (Pitt-734) and 3100 ± 50 (Pitt-736) ^{14}C yr B.P. (3440–3170 cal B.P. and 5210–4570 cal B.P.; Linsley, Bishop, and Rollins, 2008, Thomas, 2008: 835–858, table 29.1). They are therefore the earliest inlets preserved, remnants of older breaches in the Silver Bluff barrier, perhaps dating to the 4300 ^{14}C cal B.P. highstand identified by Gayes et al. (1992) and Scott, Gayes, and Collins (1995). Of course, these radiometric dates record the final positions of these inlets at the time they were abandoned; the inlets probably originated further north up the longshore transport system and migrated south over time.

MECHANISM OF BREACHING

Several mechanisms are possible for the development of the breaches described above. In the case of Ossabaw Sound the Silver Bluff barrier was eroded, allowing a connection between the Ogeechee and the marshes behind the Holocene beach ridge. These marshes may have already drained to the Atlantic via a small inlet that was taken over after the avulsion of the Ogeechee. Wilmington River seems to be an example of a small tidal estuary that has breached the Silver Bluff barrier, possibly by headward erosion. Similar small inlets may have been utilized in other breaches. It is also possible that both Silver Bluff and Holocene beach ridges were eroded by meandering back-barrier tidal distributaries without the necessity of an existing inlet. This certainly seems to be likely where S. Newport River impinges on Holocene beach ridges at the southern end of St. Catherines Island and may also apply at St. Catherines Sound. As a third possibility, some breaches may occur directly as a result of wave erosion. This could have occurred at St. Catherines Sound during the destruction of Guale

Island. Finally, it may be that some sounds are longstanding features with minor changes in size and trajectory taking place in response to local changes in their tidal distributaries (inlet jumping, Chowns, Schultz, and Griffin, 2002). As examples, Sapelo River was probably diverted from Doboy Sound at some time, while North and South Newport rivers might easily switch positions between Sapelo and St. Catherines sounds.

As argued previously for Brunswick River (Chowns et al., 2008), the tendency for inlets to straighten is a predictable consequence of the modern marine transgression. As sea level rises, back-barrier environments are flooded and sediment is trapped upstream in the estuaries. This has the dual effect of increasing the size of the tidal prism and reducing the supply of sand to the longshore transport system. The end result is to favor tidal over wave processes and to break the longshore transport system down into a series individual inlet sediment cells (Oertel, 1975b), in other words, to favor inlet-straightening over spit-building. It is significant that, with the exception of Blackbeard and Guale inlets, all the breaches described in this chapter have occurred during a period when the Georgia Bight has experienced approximately 3–4 m of sea level rise (DePratter and Howard, 1981: Gayes et al., 1992, Scott, Gayes, and Collins, 1995; Colquhoun, Brooks, and Stone, 1995). Conversely, Blackbeard and Guale islands with their associated marshes are interpreted to be the relics of spits and diverted inlets formed at a time, between about 4300 and 3600 cal B.P. (Thomas, 2008: chap. 4; this volume, chap. 1) when wave processes were favored by a minor regression (fig. 9.10). This was also a period of increased sedimentation rates as judged by the progradation of Cracker Tom Hammock on St. Catherines Island. It was also an interval of major cultural change and perhaps abandonment on the island (Thomas, 2008, chap.16; this volume, chap. 1).

Any new breach within the barrier islands implies changes in the coastal drainage system. Some of these changes involve only the local switching of inlets, while others may have regional implications. The relocation of Brunswick River from St. Andrews Sound to St. Simons Sound is an example of local inlet jumping (Chowns, Schultz, and Griffin, 2002; Chowns et al., 2008). While the more recent changes at St. Catherines and Sapelo sounds are probably local, the older breaches at Blackbeard and Guale inlets

Savannah River

Guale Inlet

Blackbeard Inlet

Altamaha-Ogeechee Confluence

Brunswick Inlet

KM

0   10
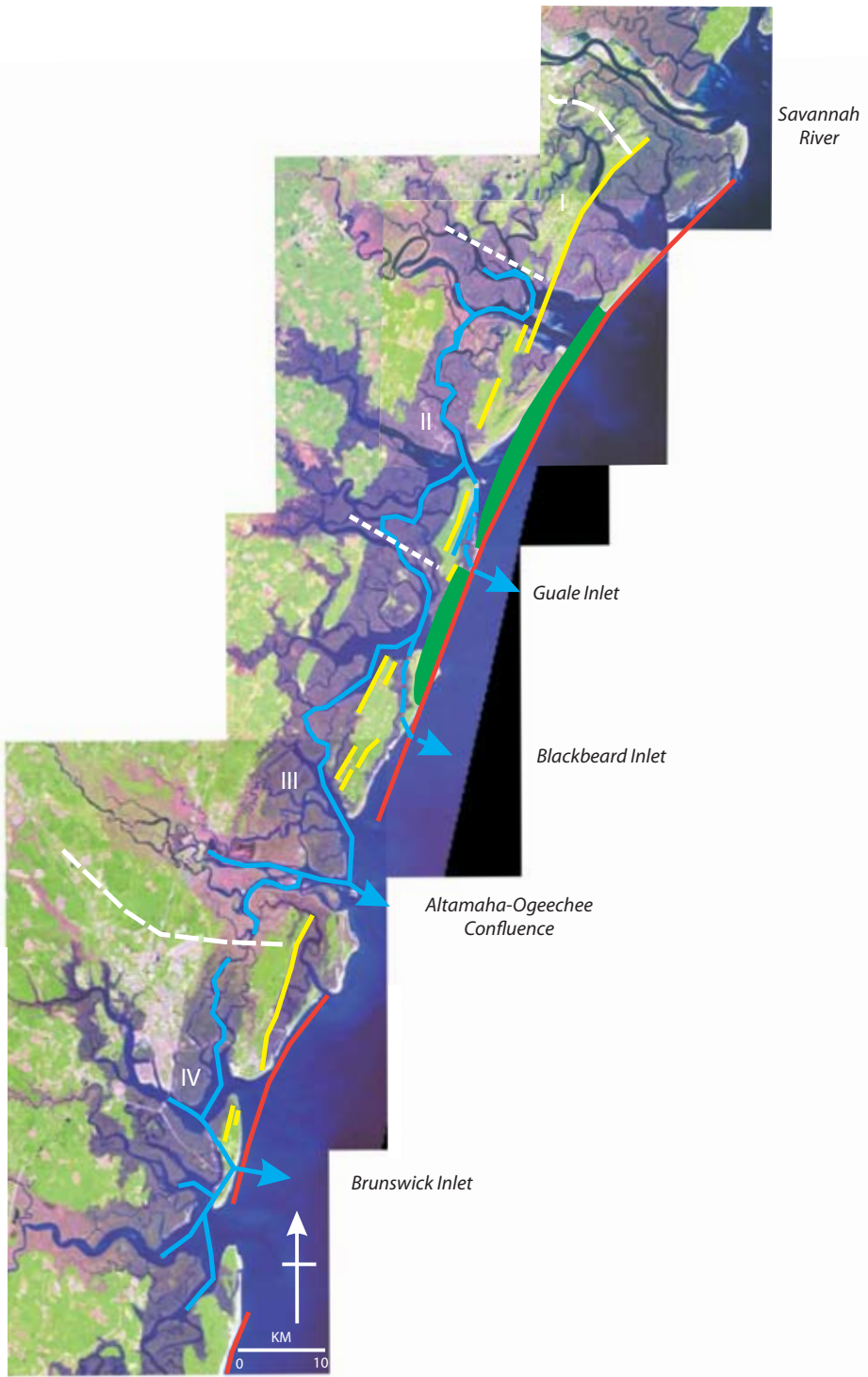
may be related to more significant changes in the drainage of the Ogeechee.

THE OGEECHEE

All the estuaries on the Georgia coast make a relatively direct connection with the Atlantic, perpendicular to the coast. This is somewhat surprising given the longshore transport system and led Chowns et al. (2008) to suspect that southeasterly flowing channels had been abandoned in favor of more easterly channels; a consequence of Holocene transgression. The Ogeechee provides one of the best examples, with St. Catherines Sound being the most logical place for a former outlet. If the Ogeechee has been displaced, its former course must have followed the low country southward between the Princess Anne and Silver Bluff barriers, the approximate location of modern Bear River.

The low country between the Silver Bluff and Princess Anne barriers may be divided into four different sectors (fig. 9.11). The northernmost sector (sector I), between the Savannah River and Ossabaw Sound, is mainly Pleistocene with only narrow Holocene marshes. Within this area Pamlico, Princess Anne, and Silver Bluff barriers are preserved and there is no evidence of a major alluvial channel (Henry, Giles, and Woolsey, 1973; Alexander and Henry, 2007). Despite low elevation, this sector forms the drainage divide between the Savannah and Ogeechee rivers. In the middle sectors (II and III), between Ossabaw Sound and the Altamaha, the Holocene marshes expand to a width of around 8 km at the expense of either Princess Anne or Silver Bluff barriers. Between the Medway and S. Newport rivers (sector II) erosion is concentrated on the northwest side, and Princess Anne deposits are entirely absent. Further south, between the S. Newport

and Altamaha (sector III), erosion switches to the southeast and the Silver Bluff is drastically trimmed. In a fourth sector south of the Altamaha, the Holocene marshes narrow and Princess Anne and Pamlico barriers are well preserved. Once again this constriction, landward of St. Simons Island, is a significant (although porous) drainage divide.

Given that the Ogeechee formerly occupied the low country behind Ossabaw Island, it may be argued that the entire middle sector between drainage divides on the south side of the Savannah and south side of the Altamaha is likely the valley of the Ogeechee at a time when it was a major tributary of the Altamaha. The breaching of Blackbeard and Guale inlets, and later Ossabaw Sound, would have segmented this valley and allowed its tributaries (e.g., the Medway, Newport, and Sapelo rivers) direct access to the Atlantic. Depending on the relative ages of Blackbeard and Guale inlets, the mouth of the Ogeechee may have shifted progressively north over time (figs. 9.11 and 9.12). One possible objection to this scenario is the lack of meander scars sculpting the putative valley bluffs. However, much of the valley is now obscured by marsh deposits laid down during transgression, and until about 15 ka the Ogeechee was a braided river (Leigh, Srivastava, and Brook, 2004; Leigh, 2006). The bluffs overlooking the lower reaches of the Savannah and Altamaha are similarly lacking in meander scars.

One unusual characteristic that may be explained by the breaching of inlets through the avulsion of meanders is the bowlike shape, and pairing of tidal distributaries. Thus at Ossabaw Sound it was the shape of the confluence between the Little Ogeechee and Ogeechee that first suggested avulsion. St. Catherines Sound

Fig. 9.11 (*left*). Reconstruction of the Ogeechee valley behind the Silver Bluff (yellow) and Sea Island (red) strand lines prior to the breaching of Blackbeard and Guale inlets. Note the relic meanders in the pattern of distributaries in the low country behind the Silver Bluff barrier; also the way in which the restoration of the Blackbeard–St. Catherines and Guale-Ossabaw spits helps define an earlier wave-dominated shoreline possibly related to an interval of forced regression between 4300 and 3600 cal B.P. Dashed white lines separate sectors I–IV within the low country behind the Silver Bluff barrier. Sector IV shows drainage to the Brunswick River described by Chowns et al. (2008).

is complicated by the combination of three es-
tuaries (Bear, Medway, and N. Newport) but
the Bear and N. Newport show a similar pair-
ing, while Sapelo Sound is formed by the pair-
ing of the S. Newport and Mud rivers (com-
plicated by Sapelo River). Further south, the
original confluence of the Ogeechee (Doboy
Sound) and Altamaha has been obscured by
transgression.

A possible means of testing the original
course of the Ogeechee is to check the distri-
bution of micaceous sands within the channel
fills encased beneath the marshes. Barring the

Savannah and Altamaha, the Ogeechee is the
only southeasterly flowing river likely to carry
significant mica from the Piedmont since all
other rivers rise on the coastal plain. The Alta-
maha also carries much mica but it is unlikely
to have flowed northeast in a direction opposed
to longshore transport. Based on the abundance
of mica in Pleistocene valley fill behind Jekyll
Island, Chowns et al. (2008) propose that the
Altamaha was diverted to the south at one time
and also occupied the low country between the
Princess Anne and Silver Bluff barriers. How-
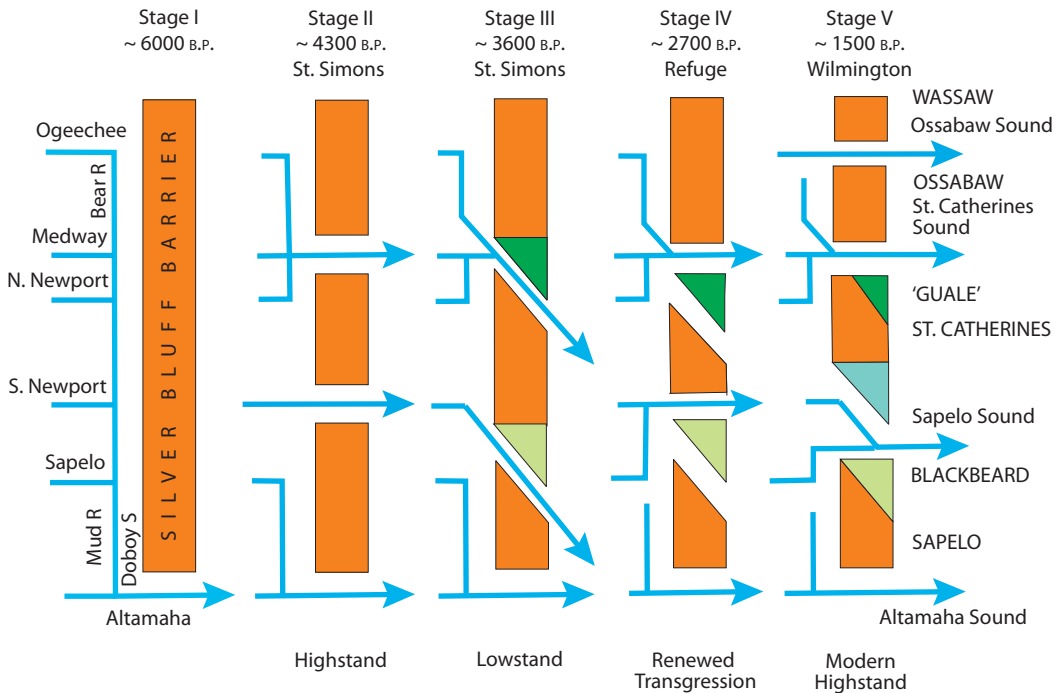ever, this was at a period (dated around 32 ka)

Fig. 9.12. Diagram illustrating the proposed succession of changes during the breaching of the Sea Islands
and segmentation of the low-country portion of the Ogeechee valley. Green triangles are spits: Guale (dark
green), St. Catherines (cyan), and Blackbeard (light green). Islands are indicated in capital letters; rivers and
inlets in lower case. Stage I illustrates the Silver Bluff barrier and low-country valley of the Ogeechee prior to
flooding by the Holocene transgression. Stage II coincides with the breaching of the first inlets during a highstand
around 4300 ^{14}C cal B.P. During stage III a minor regression (~3600 cal B.P.) encouraged spit building and
diversion of inlets. When transgression resumed in stage IV (~2700 cal B.P.) inlets were straightened and spits
breached. Stage V shows accretion of the dissected spits (Blackbeard and Guale islands) to the next adjacent
island down the longshore transport direction. This is essentially the modern condition except that Guale Island
has been lost to erosion.

when sea level was much lower and the valley was narrower and more deeply incised—alluvial rather than estuarine. Farrell, Henry, and Cofer-Shabica (1993a) record no trace of mica in estuarine fill behind Cumberland Island (dated between about 3000 and 1000 ^{14}C yr B.P.; cal 3210–930 cal B.P.), suggesting that this connection may also have been severed during the 5300–4300 cal B.P. highstand (Gayes et al., 1992; Scott, Gayes, and Collins, 1995; Thomas, 2008: chap. 4).

If the Ogeechee originally joined the Altamaha or opened into Doboy Sound, this would imply a diversion of around 55 km parallel to the coast. By comparison, the Pee Dee River is displaced by about 35 km behind the Grand Strand of South Carolina (Baldwin et al., 2006). In its most extreme version this scenario would require the welding of the Georgia Sea Islands into a continuous strand, like that in South Carolina—a possibility supported by the apparent continuity of the Silver Bluff strandline between the Savannah and Altamaha rivers (fig. 9.11). Thus, it is possible that the Ogeechee was diverted into the low country seaward of the Princess Anne barrier by the development of the Silver Bluff strandline. Depending on the age assigned to the Silver Bluff barrier, this might coincide with the time the Pee Dee River was diverted by the Myrtle Beach barriers (marine isotope stage Q3b according to Baldwin et al., 2006).

Assuming that the inlets between the Savannah and Altamaha were closed or much reduced in size around 3600 ^{14}C yr. B.P. (3910 cal B.P.), it is possible to approximate an equilibrium shoreline (fig. 9.11). This reconstruction assumes a wave-dominated coast with longshore transport of sand unimpeded by large tidal deltas or other promontories. The resulting arcuate curve forms a tangent with beach ridges on Wassaw, St.Catherines Spit, and Blackbeard Island but is markedly discordant with the southern parts of Tybee, Ossabaw, and Sapelo islands and the northern part of St. Catherines Island. It suggests that Tybee, Ossabaw, and Sapelo islands have all rotated clockwise, perhaps as a result of increased tidal velocities and sediment starvation. It is significant that much of the loss from St. Catherines Sound may be restored by the reconstruction of Guale Island, especially if the island originated as a spit at the southern end of Ossabaw.

CONCLUSIONS

From a combination of basic stratigraphic principles (crosscutting relations and superposition) combined with absolute dating by ^{14}C and optically stimulated luminescence, it is hoped to be able to elucidate recent shoreline changes in the vicinity of St. Catherines Island and relate them to the archaeological landscape. From preliminary studies I hypothesize that:

(1) Ossabaw Sound is the youngest of the major inlets on the Georgia coast and was formed when the Ogeechee was diverted from St. Catherines Sound to its present location sometime before 1880 ^{14}C yr. B.P. (1640 cal B.P. Deptford period).

(2) Sapelo and St. Catherines sounds were formed by the modification of earlier inlets, which lie south of the modern channels and are now abandoned and infilled by marsh; Blackbeard Marsh in the case of Sapelo Sound and Guale Marsh in the case of St. Catherines Sound. Guale Inlet was active between 4290 and 3100 ^{14}C yr (4870–3350 cal B.P.) and both inlets may date from the transgression between about 5300 and 4300 cal B.P. (St. Simons period).

(3) Blackbeard and Guale islands originated as spits formed through longshore transport on the north sides of their respective inlets. They probably developed during a minor regression or stillstand between about 4300 and 3600 cal B.P.; St. Simons period). It is argued that wave-driven processes and spit building are favored by the reduction in the volume of the tidal prism during periods of regression.

(4) The breaching of Sapelo Sound and the isolation of Blackbeard Island are recorded as a prominent discontinuity (Zapala Scarp) at the north end of St. Catherines Spit. Radiometric dating shows that this scarp was cut prior to 1720 ^{14}C yr B.P. (1610 cal B.P.), while archaeological sites suggest that it was cut earlier, during the early Refuge period (~2700 cal B.P.) as the Holocene transgression resumed.

(5) A similar island, called Guale Island (Bishop et al., 2007), formerly existed northeast of St. Catherines Island and was likely formed in the same way, by the severing of a spit from Ossabaw Island. Although this island has now been lost to erosion, part of Guale Inlet survives beneath Seaside Marsh. Radiometric dating indicates that this inlet was abandoned sometime between 3100 and 1720 ^{14}C yr (3350–1580 cal

B.P.; Refuge-Deptford periods), presumably as a result of loss of discharge due to the breaching of St. Catherines Sound.

(6) The modern estuaries at Ossabaw, St. Catherines, and Sapelo sounds all seem to date to Refuge-Deptford times. All led to the straightening of inlets, which is interpreted to be the result of increased tidal current velocities as a consequence of the inundation of low-country marshes during renewed transgression. Breaching was most likely triggered by avulsion following storm flooding in the tangle of distributaries clustered around the inlets.

(7) Because the Ogeechee is the proximal source of sand for St. Catherines Island, it is possible that the spit preserves a record of the breaching of St. Catherines and Ossabaw sounds. Two prominent discontinuities, east and west of Jungle Road, record episodes of erosion and rebuilding that may be related to these breaches, but limited radiometric dates fail to support this conclusion at present.

(8) The straightening of these estuaries has diverted drainage from the low country behind the Silver Bluff beach ridge. It is posited that this was once the valley of the Ogeechee, originally a tribu-

tary of the Altamaha, but now segmented as another consequence of the Holocene transgression.

(9) The interpretation presented here emphasizes the importance of fundamentally deltaic processes in the construction of the Georgia coast. The waterways tangled between the Princess Anne and Silver Bluff beach ridges are tide-dominated distributaries. Within this low country, divides are highly "porous" and liable to significant changes due to avulsion.

NOTES

2.The 2700 cal B.P. date cited throughout this chapter is an estimate based on the span of early Refuge (2850–2500 cal B.P.) and particularly the occurrence of early Refuge ceramics at 9Li49. But in truth, this estimate could easily range from about 2500 cal B.P. to even 3000 cal B.P.

3. This estimate is an average of 1170 ± 50 and 1010 ± 50 (Beta-217245 and Beta-217246).