COASTAL PROCESSES FIELD TRIP: KIAWAH ISLAND, SEABROOK ISLAND, AND EDISTO BEACH STATE PARK

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RESEARCH PLANNING, INC. AND CAROLINA GEOLOGICAL SOCIETY

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FIELD TRIP GUIDEBOOK

18-19 SEPTEMBER 2010

COASTAL PROCESSES FIELD TRIP: KIAWAH ISLAND, SEABROOK ISLAND, AND EDISTO BEACH STATE PARK

DATE: 18 and 19 September 2010.

TRIP LEADERS: Miles O. Hayes,[1] Jacqueline Michel,[1] and Tim Kana[2]

SUMMARY:

This is a day and a half field trip to view the tidal inlets, barrier islands, and beaches of the beautiful South Carolina Coast. On Day 1, the first two stops will be on Kiawah Island, a drumstick-shaped, prograding barrier island eight miles long. The trip also includes visits to two tidal inlets - Captain Sams and North Edisto - where inlet dynamics will be illustrated and discussed, including the impact of relocating Captain Sams Inlet several thousand feet to the north (twice since 1983). On Day 2, we will visit Edisto Beach State Park in order to examine and discuss the geomorphology and stratigraphy of a transgressive (landward migrating) barrier island. Beach cusps and beach nourishment issues will also be covered on this day. These two field trips will be led by a team that has been conducting geomorphologic and sedimentologic research on the South Carolina Coast since 1974.

DAY ONE (SATURDAY – 18 SEPTEMBER 2010)

SCHEDULE AND LOGISTICS:

(1) Board the buses at 0800 for transportation to the Fort Johnson Marine Laboratory. At that facility, the trip leaders will give a one-hour lecture to introduce the trip participants to the general geomorphology and coastal processes of the South Carolina Coast, with specific information on the four areas to be visited during the two days.

(2) After the lecture, we will drive to the north end of Kiawah Island (located on Figure 1), a privately owned island that graciously allows geologists and engineers like us to pay the island a visit from time to time (the trip leaders have carried out several research projects on this island since 1974), and go out onto the beach at the golf course on the north end of the island (Ocean Course). With the aid of detailed graphic maps and charts, at this location we will discuss the stratigraphy of the island, historic shoreline changes, etc. The evolution of islands of this type is illustrated in Figure 2, and their stratigraphic makeup is illustrated in Figure 3 (lower tier). On the beach, several trenches will be available for inspection. The types of sedimentary structures to be seen in the trenches are illustrated in Figure 4. Along this walk, some spectacular examples of both erosion and deposition are always present. Efforts to curtail erosion of the golf course will also be discussed. Low tide is around 11:14 am (+1.01), so we will be viewing the beach at the north end of Kiawah Island at low tide. The predicted tidal range on this day is a little over 5 ft.

(3) From the first stop, we will drive to the south end of Kiawah Island and visit Beachwalker Park (a Charleston County Park), which is located at the neck of a recurved spit positioned to the north of a southward migrating tidal inlet (Captain Sams Inlet). The historical record of the migration of this inlet at the rate of around 200 ft per

year is illustrated in Figure 5. About every 40/50 years, the over-extended spit is truncated at the neck, probably as a result of the storm surge of a hurricane.

(4) Lunch (box lunches and non-alcoholic beverages) will be available at the Park, which we should reach around noon.

(5) After lunch, we will take a long walk down the beach along the spit front, where a variety of issues will be discussed, such as the sedimentary structures visible in a couple of large trenches, the well developed and vegetated foredunes, beach accretion, infauna in the beach sediment (e.g., ghost crabs and ghost shrimp), birds present, etc.

(6) After leaving Beachwalker Park, we go to the Seabrook Island (located on Figure 1), another privately owned island that graciously allows geologists and engineers like us to pay the island a visit from time to time (the trip leaders have carried out several research projects on this island since the early 1980s). At Seabrook Island, which we hope to reach about 2:45 pm, we will first view the North Edisto Inlet, one of the largest inlets on the South Carolina Coast, and discuss the dynamic coastal processes of the Inlet, which is illustrated in Figure 6, along with the general model for ebb-tidal deltas. Next, we will visit the open beach on Seabrook Island that has accreted seaward over a thousand feet as a result of relocating Captain Sam's Inlet to the north in 1983 and again in 1996. Figure 7 illustrates the original relocation project.

(7) Return to the Hotel. Probably be back around 5:30 pm.

DAY TWO (SUNDAY) – 18 SEPTEMBER 2010)

SCHEDULE AND LOGISTICS:

(1) Board the buses at 0800 for transportation to Edisto Beach State Park, which is located in Figure 8. This is a popular park with its 1,255-acres of dense maritime forest, expansive salt marsh, and beach. This is about the only place in the state where you can drive to and walk on a landward-migrating (transgressive) barrier island.

(2) We will go first to a groin located near the southern boundary of the Park. The beachface is usually fairly steep at this location, because of the abundance of shells in the sediment. At least a part of that shell material came from the offshore material dredged during the many beach nourishment projects (some of which will be discussed). The relatively steep offshore area makes for larger waves here than you normally see on the South Carolina Coast. As a result, the big waves sometimes reflect from the beachface, creating beach cusps, and this is the one of the few places on the South Carolina Coast accessible by automobile where we (Hayes and Michel) have observed rip currents (Kana reports that they are fairly common in the Myrtle Beach area). Beach cusps are evenly spaced triangular projections of coarser-grained sediment (called horns), typically composed of shells in this area, that project out from near the high-tide line and are separated by eroded out bays, shaped like a half circle, open to the water. In this area, they typically have a spacing of about 20 feet. Cusps are thought to form by the same mechanism as rip currents (reflecting waves that generate edge waves). Beach cusps are very common on beaches with coarse sediment, such as the Great Lakes, California, Maine, and Alaska, but this is one of the few places they commonly occur in South Carolina. Also, do not be too surprised if they are not there on the day of our visit,

because they are ephemeral features that come and go in response to changing wave conditions. A trench will be dug in this steep beach so that its internal sedimentary structures can be examined.

(3) After viewing the trench, we will walk north of the camping area (beyond the end of the trees) for a few hundred yards and walk right across a shell-rich washover terrace (compare this area with the diagram in Figure 9). Because we will be there near low tide, which occurs at 12:05 pm (+0.93 ft), you may be able to see the exposed eroding marsh at the toe of the beach face. If not, the back-barrier sediments will be uncovered in another trench. This is a great place to see a landward-migrating barrier island. Why is it migrating landward? Rising sea level? Not in this case, it is moving landward because the sand supply was cut off naturally in the mid-1800s (as will be discussed in the field).

MORE DETAILED GUIDEBOOK

A book titled - A COAST FOR ALL SEASONS: A NATURALIST'S GUIDE TO THE COAST OF SOUTH CAROLINA (2008) – written by co-leaders Hayes and Michel includes a lot of details on the areas to be visited during these field trips. This book, which normally sells for $40 in bookstores, will be available to field-trip participants for a reduced price of $20.

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Pierce, J.W. and D.J. Colquhoun, 1970. Holocene evolution of a portion of the North Carolina coast, *Geol. Soc. Am. Bull.*, 81, 3697-3714.

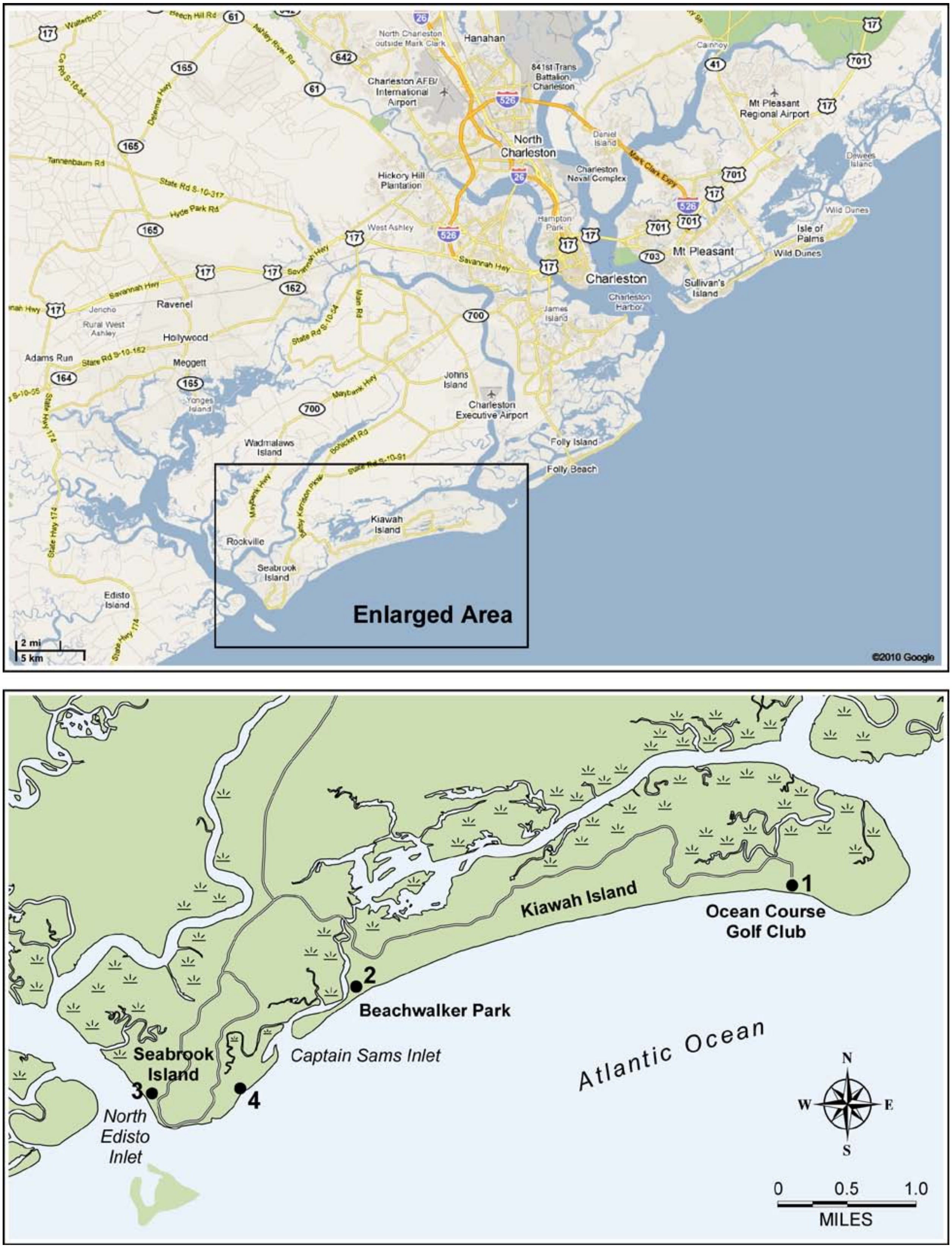


Figure 1. General location map for Seabrook and Kiawah Islands showing the track of the field trip on Day 1.

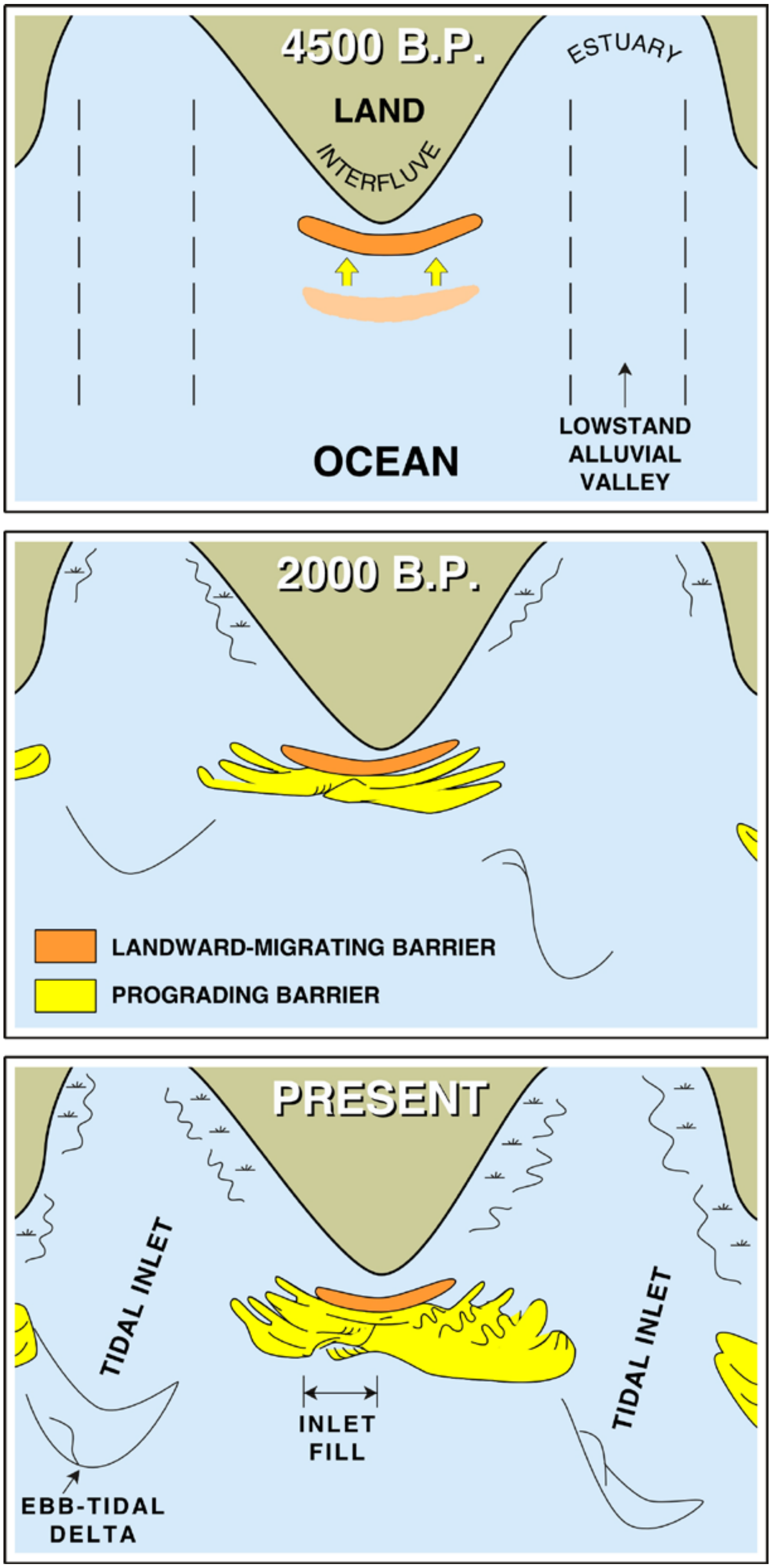


Figure 2. Model for the origin of the prograding barrier islands on the South Carolina Coast – *transgressive-regressive interfluve hypothesis*. Based on Pierce and Colquhoun (1970) and Moslow (1980).

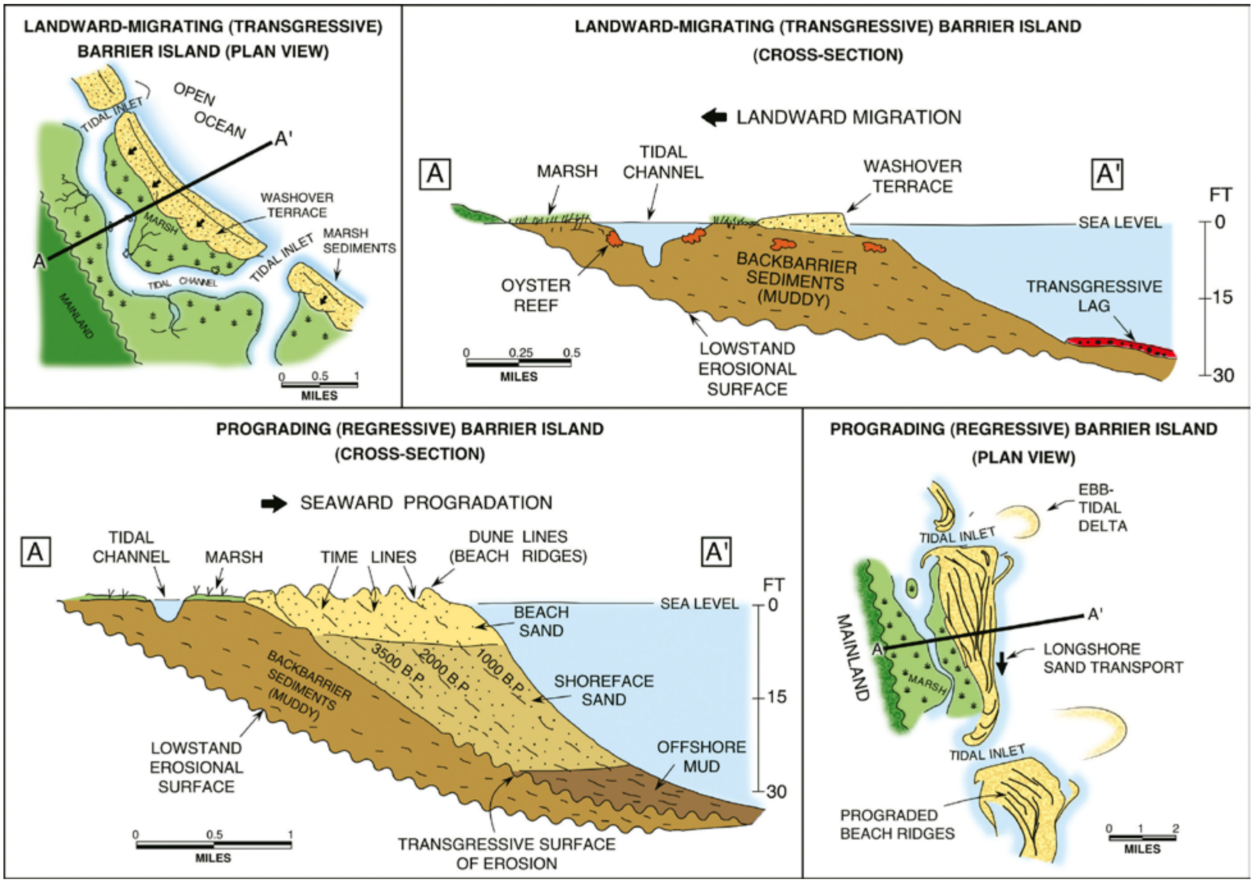


Figure 3. Morphology and subsurface three-dimensional configuration (stratigraphy) of prograding (regressive) barrier islands, in the top row; and landward-migrating (transgressive) barrier islands in the bottom row. The cross-sections (A-A') are located in each of the plan view maps.

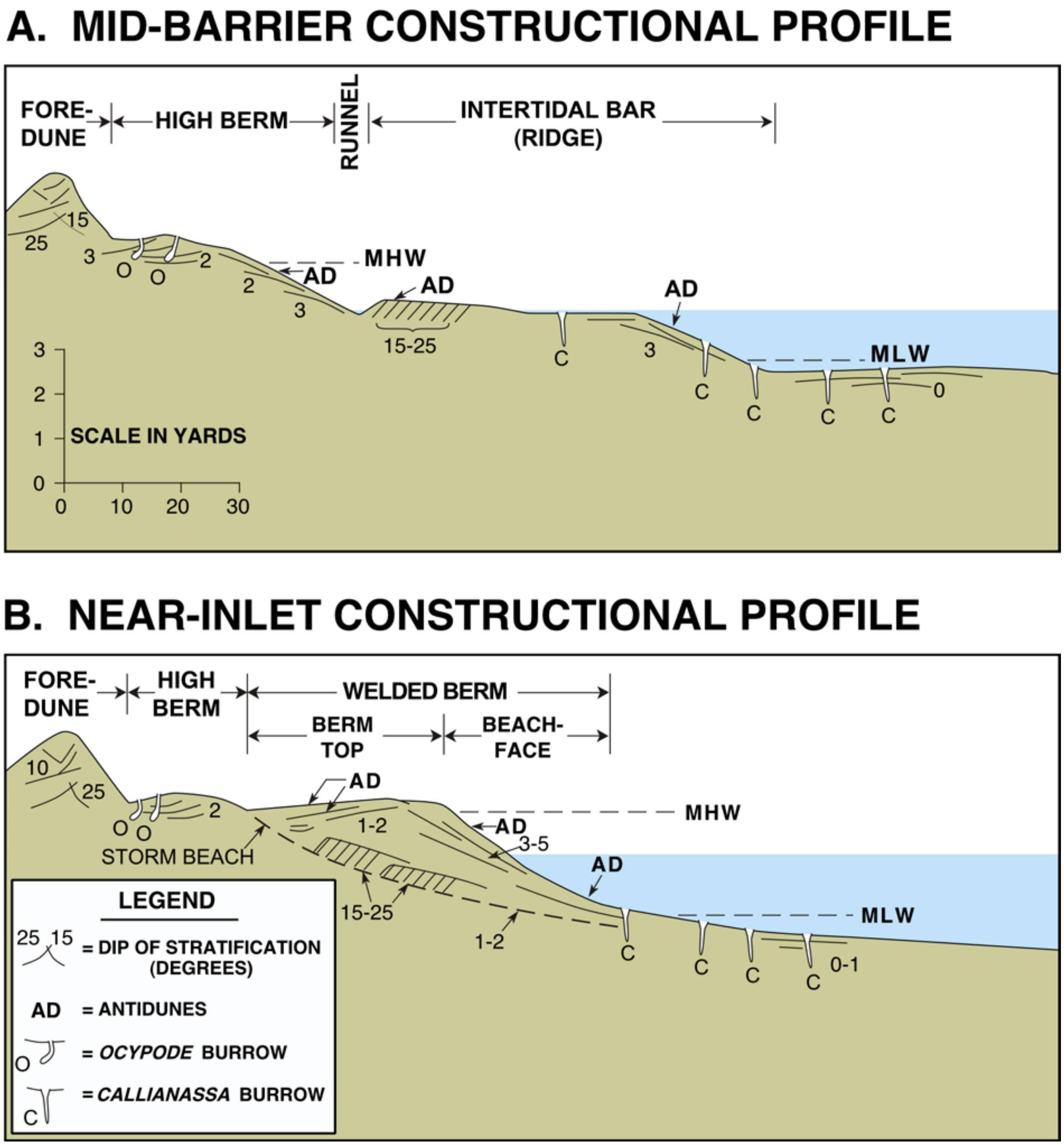


Figure 4. Representative morphology and sedimentary features occurring on the beaches of the prograding, mixed-energy barrier islands of South Carolina. Based on inspection of hundreds of beach trenches. (A) Features found on a typical mid-barrier beach in a constructional mode (modified after Hoyt and Weimer 1963). (B) Features found on beaches near tidal inlets in a late constructional mode.

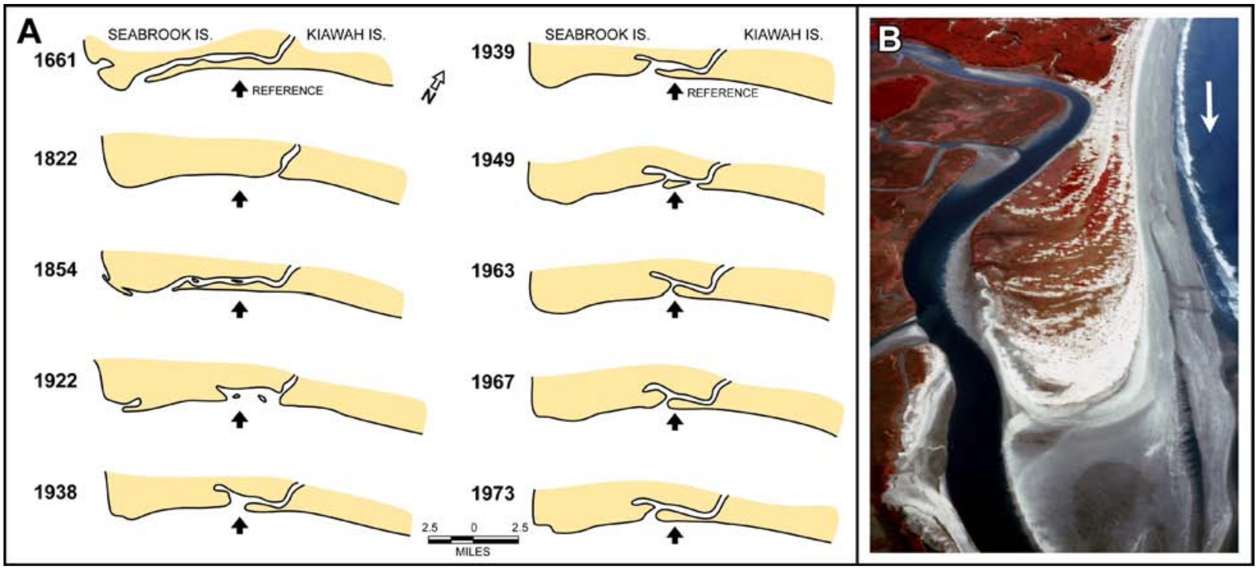


Figure 5. The Kiawah Island recurved spit and Captain Sams Inlet. (left) Historic changes of Captain Sams Inlet between 1661 and 1973, based on a combination of historical charts and aerial photographs. These maps and photos indicate three periods of breaching of the spit: 1822, 1922, and 1949. Breaches occurred at numerous other times, of course, at intervals estimated to be about every 40-50 years. From Hayes (1976). (right) The recurved spit at the southern end of Kiawah Island, S. C. at low tide on 10 June 1976 (from infrared photograph by Dennis K. Hubbard). Because of the consistent movement of sand along the shore from northeast to southwest (see arrow; view looks northeast), the tidal inlet just beyond the bottom of the photo (Captain Sams Inlet) is forced to migrate to the south at rates of around 60 m/yr (200 ft/yr), as is indicated in the left diagram. Probably in 1947, a new inlet channel was formed at the narrow neck of the recurved spit, after which the inlet resumed its unceasing migration to the southwest. Therefore, the entire spit form shown in this photograph, which was more than 1,500 m (5,000 ft) long at that time, had formed in the previous 28 years.

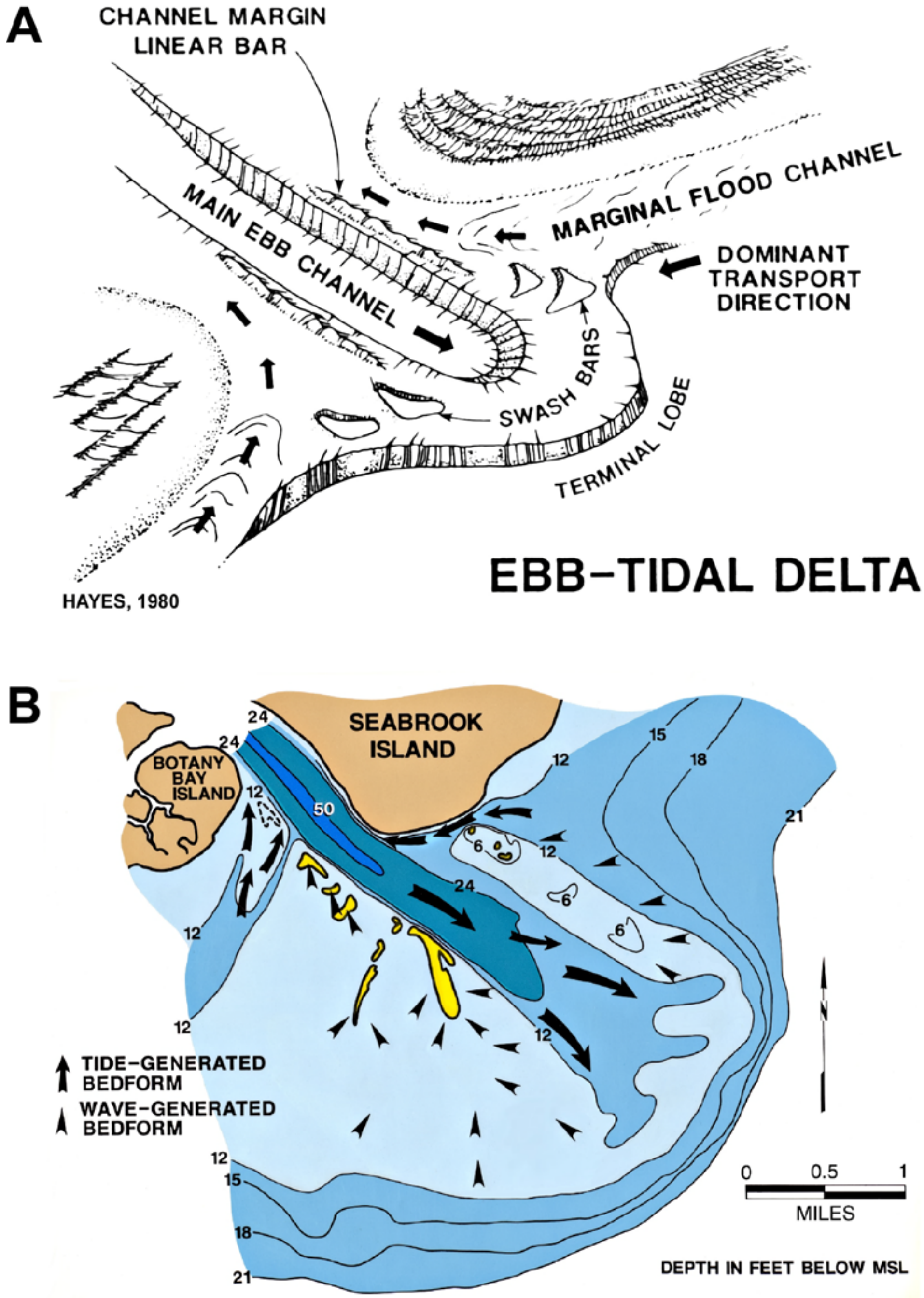


Figure 6. Ebb-tidal deltas. (A) Typical morphology of ebb-tidal deltas in mesotidal settings (after Hayes 1980). Arrows indicate dominant direction of tidal currents. This model was derived for the ebb-tidal deltas of the New England area, but it applies equally well to the inlets of South Carolina and other barrier-island systems around the world. (B) North Edisto Inlet, South Carolina. Arrows indicate the dominant orientation of bedforms generated by tidal currents (e.g., megaripples) and wave-generated currents (e.g., ripples). Compare this diagram with the general model given in A. Note the dominance of landward-directed sand transport in the marginal flood channels and seaward-directed transport in the main ebb channel. Arrows are based on actual field observation through several tidal cycles (Imperato, Sexton, and Hayes 1988).

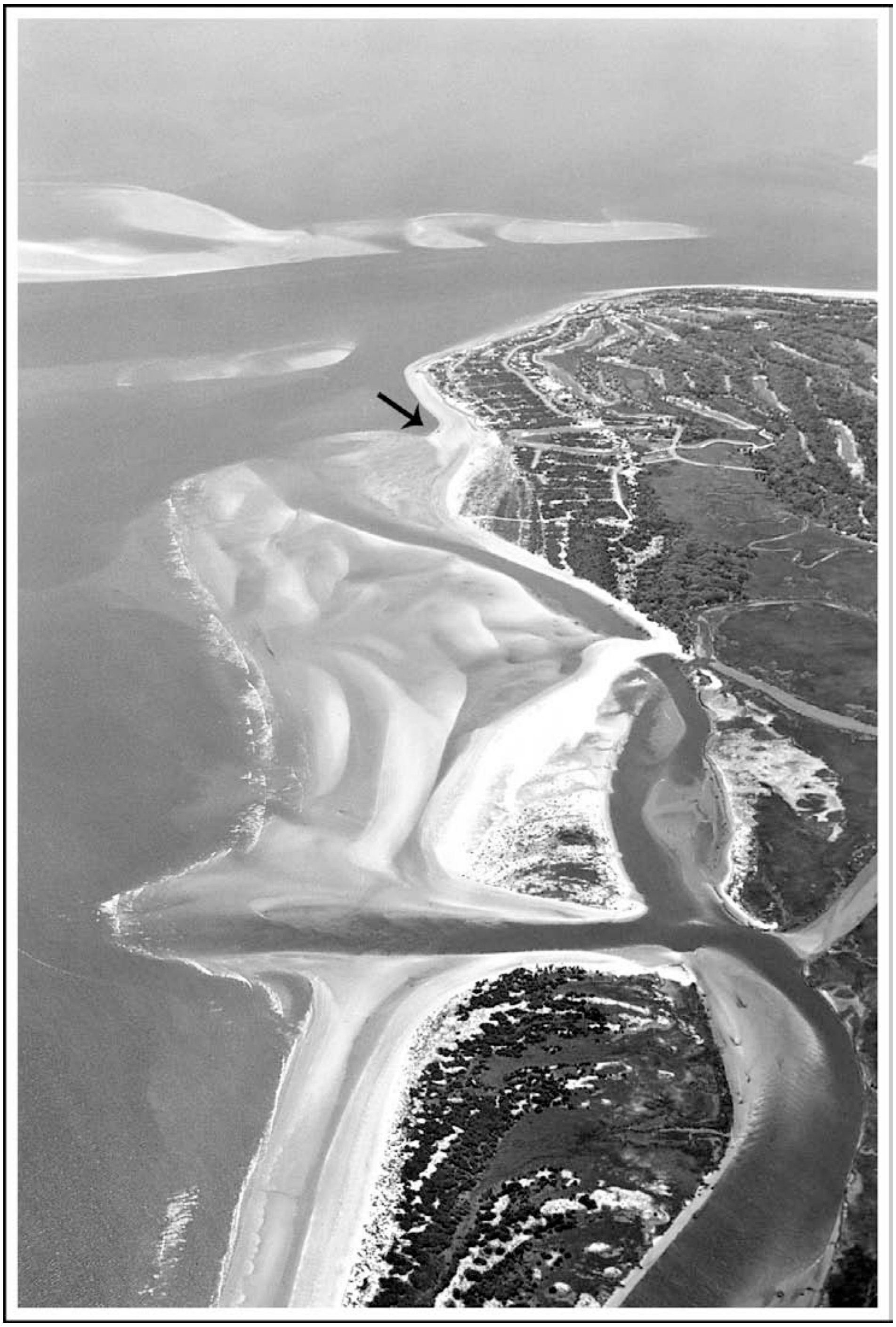


Figure 7. Relocated Captain Sams Inlet on 23 April 1983, only two months after the new inlet was cut. The shoals of the abandoned ebb-tidal delta eventually welded to the downdrift beach, alleviating the severe erosion in that locality. The inlet was relocated again in 1996, and the new sediment added to the beach as a result of the two projects built the beach out over 300 m (1,000 ft) by February 2006 (at the location indicated by the arrow). Photograph by T. W. Kana.

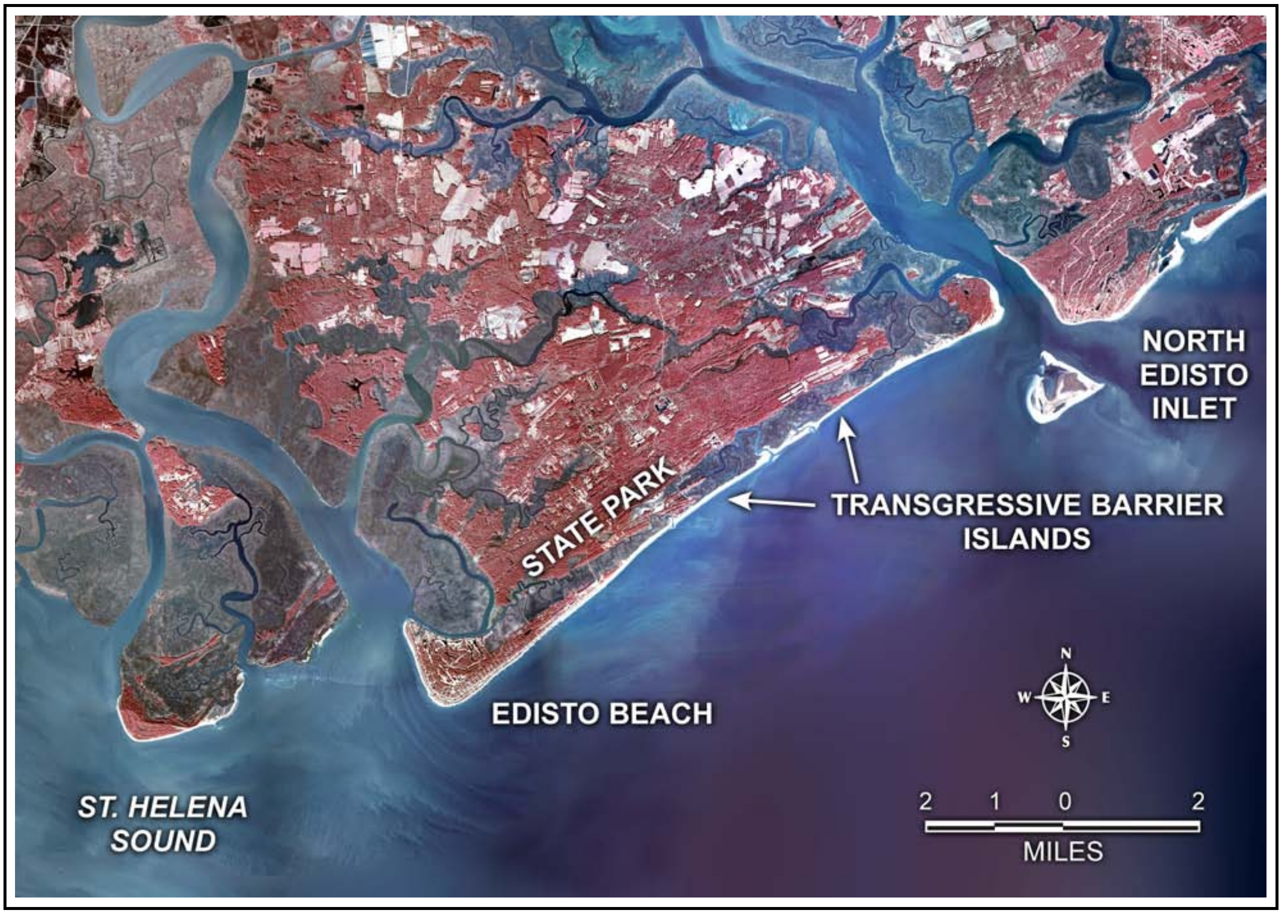


Figure 8. Vertical infrared image of the Edisto Beach area. Image acquired in 2006. Courtesy of SCDNR.

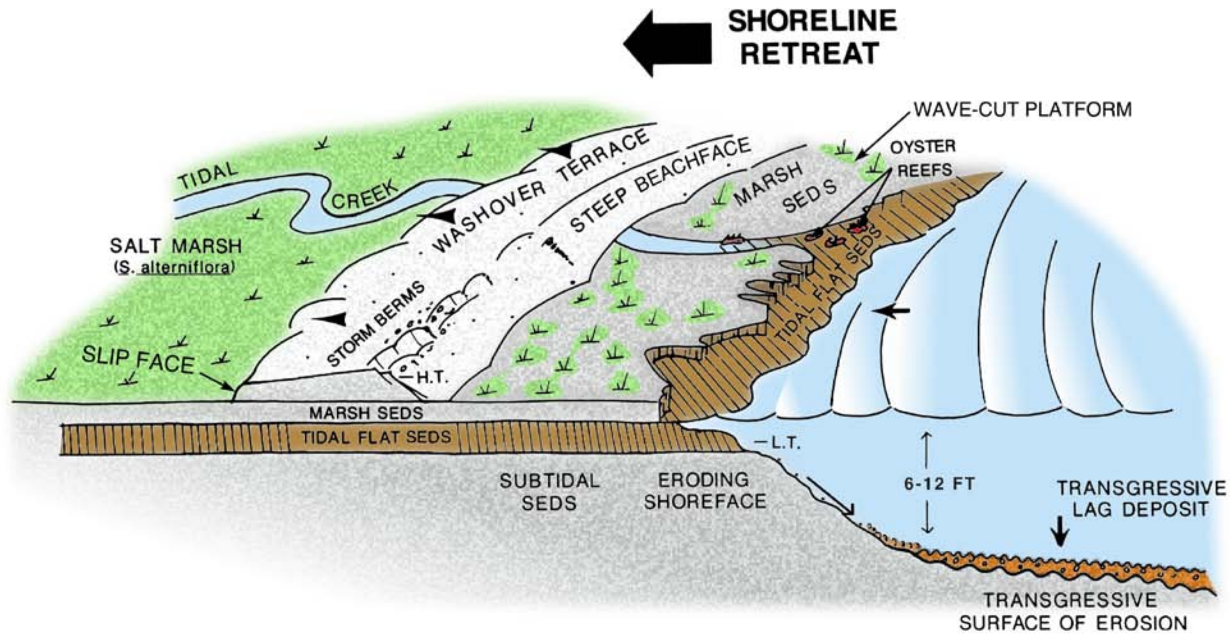
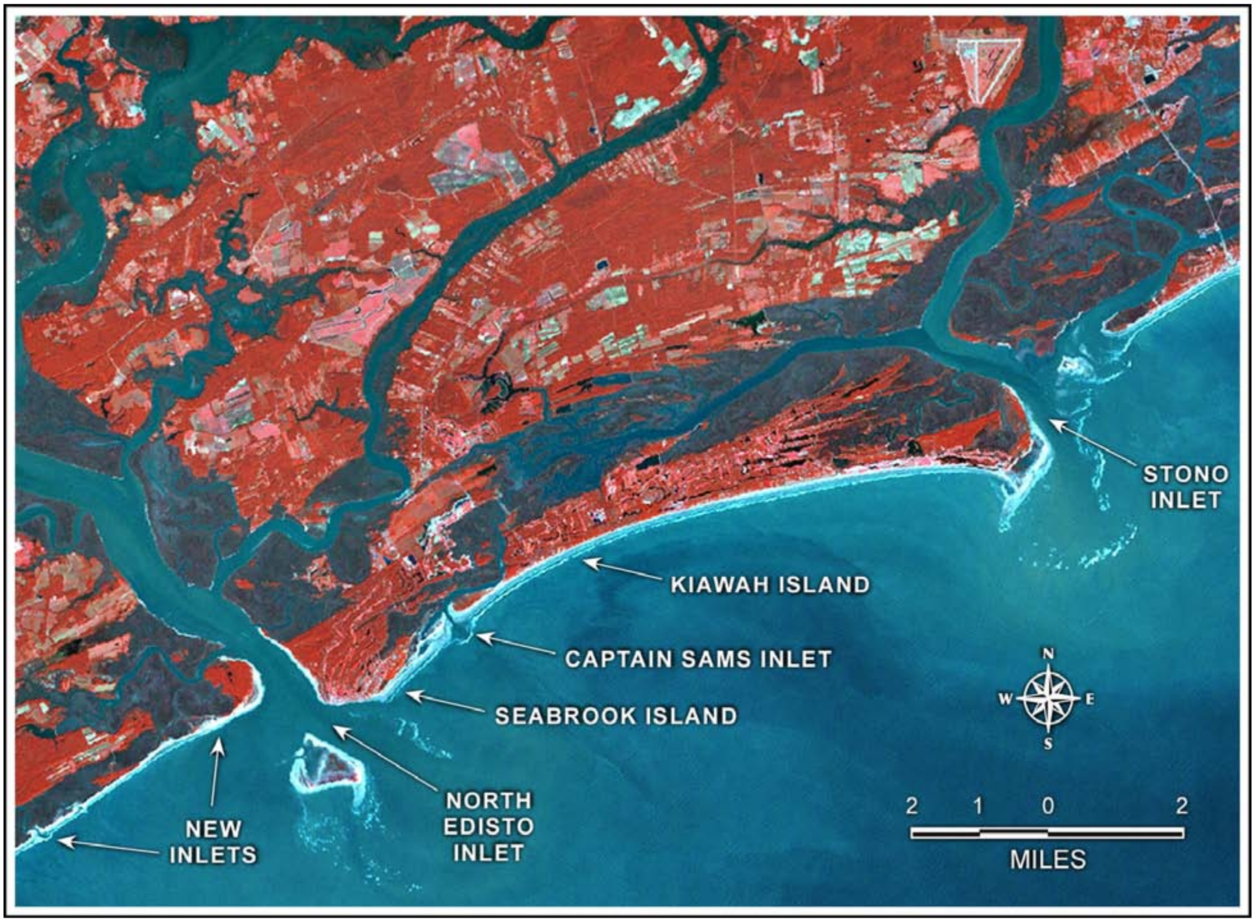


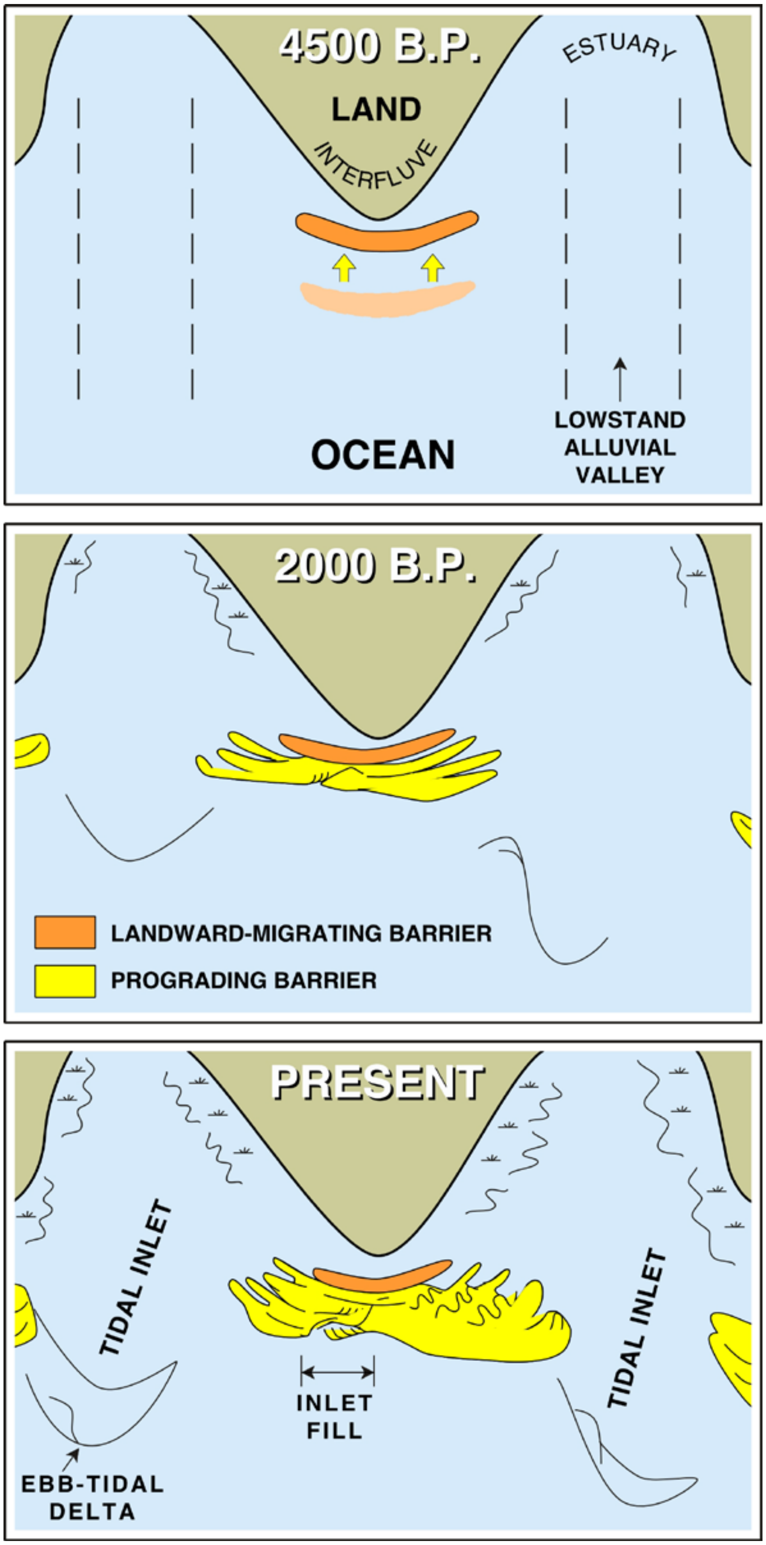
Figure 9. Typical low-tide morphology and stratigraphy of a landward-migrating (transgressive) barrier island, such as the one you will visit at Edisto Beach State Park. This particular example is based on detailed studies of a transgressive barrier island on the southwest end of Cape Romain, S.C. See also the upper tier in Figure 3.

APPENDEX

PROPS SHOWN IN THE FIELD



1. Vertical infrared image of Kiawah Island and vicinity acquired on 23 October1999, courtesy of Earth Science Data Interface (ESDI) at the Global Land Cover Facility. The locations of inlets originating by three different mechanisms are shown on this image. Captain Sams Inlet was cut most likely during a hurricane storm surge in the middle to late 1940s. Stono and North Edisto Inlets were formed by barrier islands converging over lowstand valleys. A number of small tidal inlets were formed south of North Edisto Inlet as a result of landward-migrating barrier islands moving across major tidal channels.



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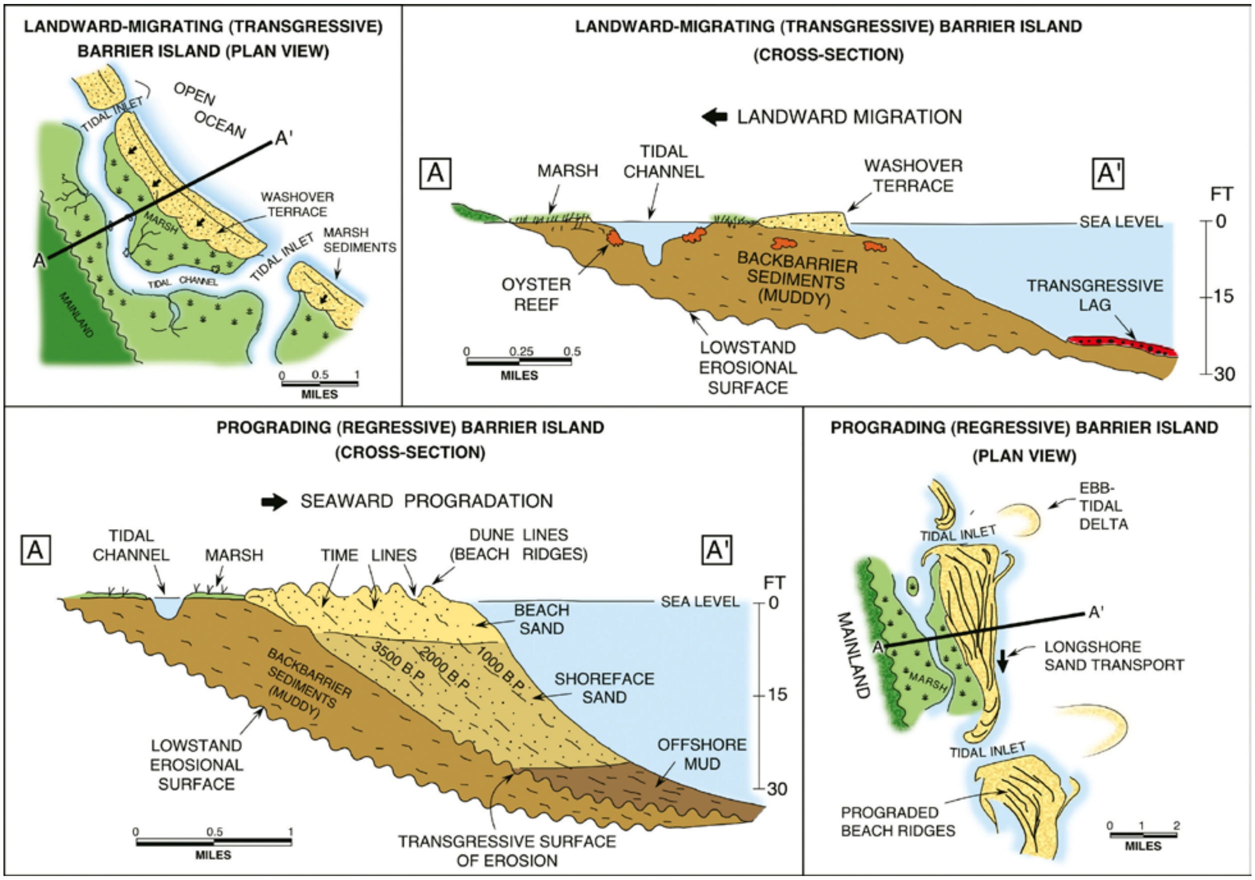
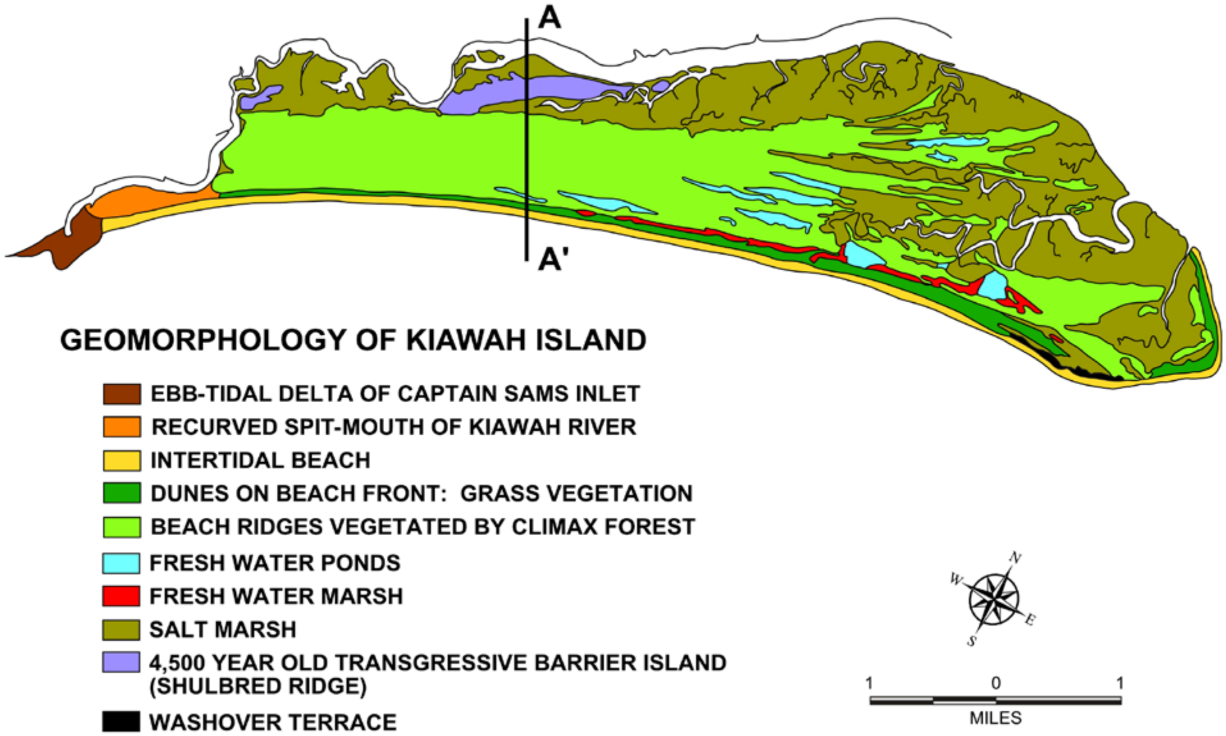
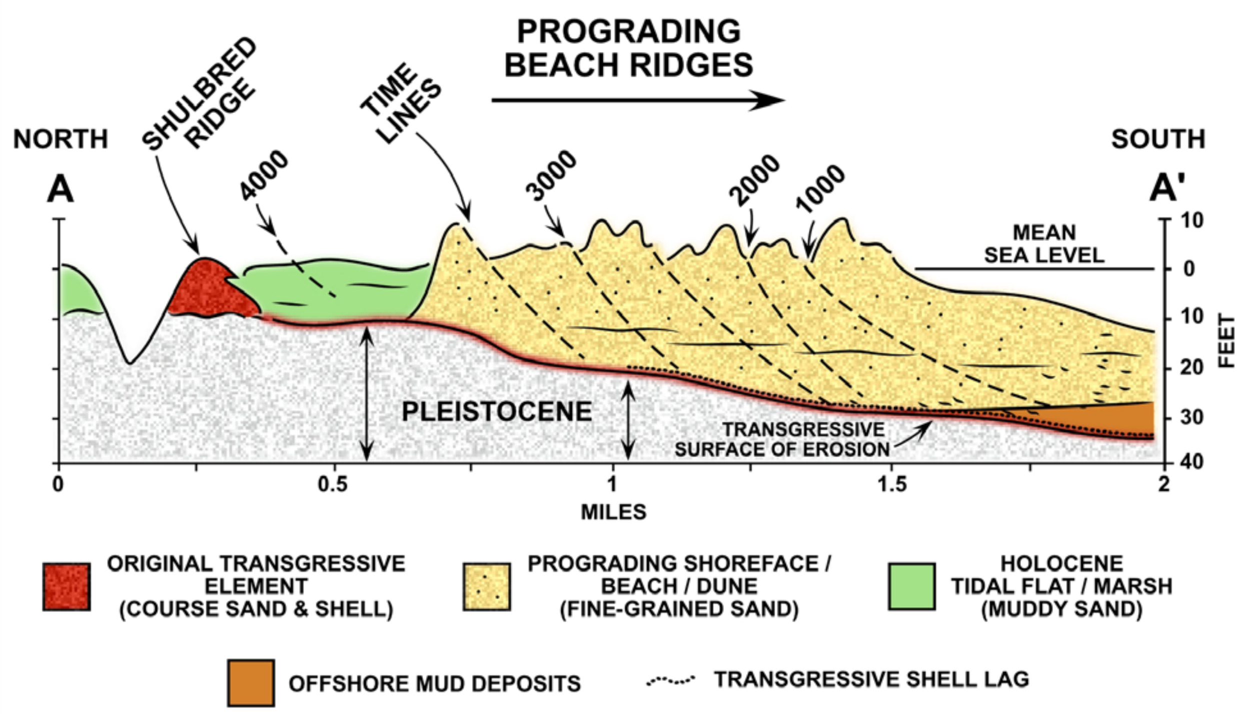


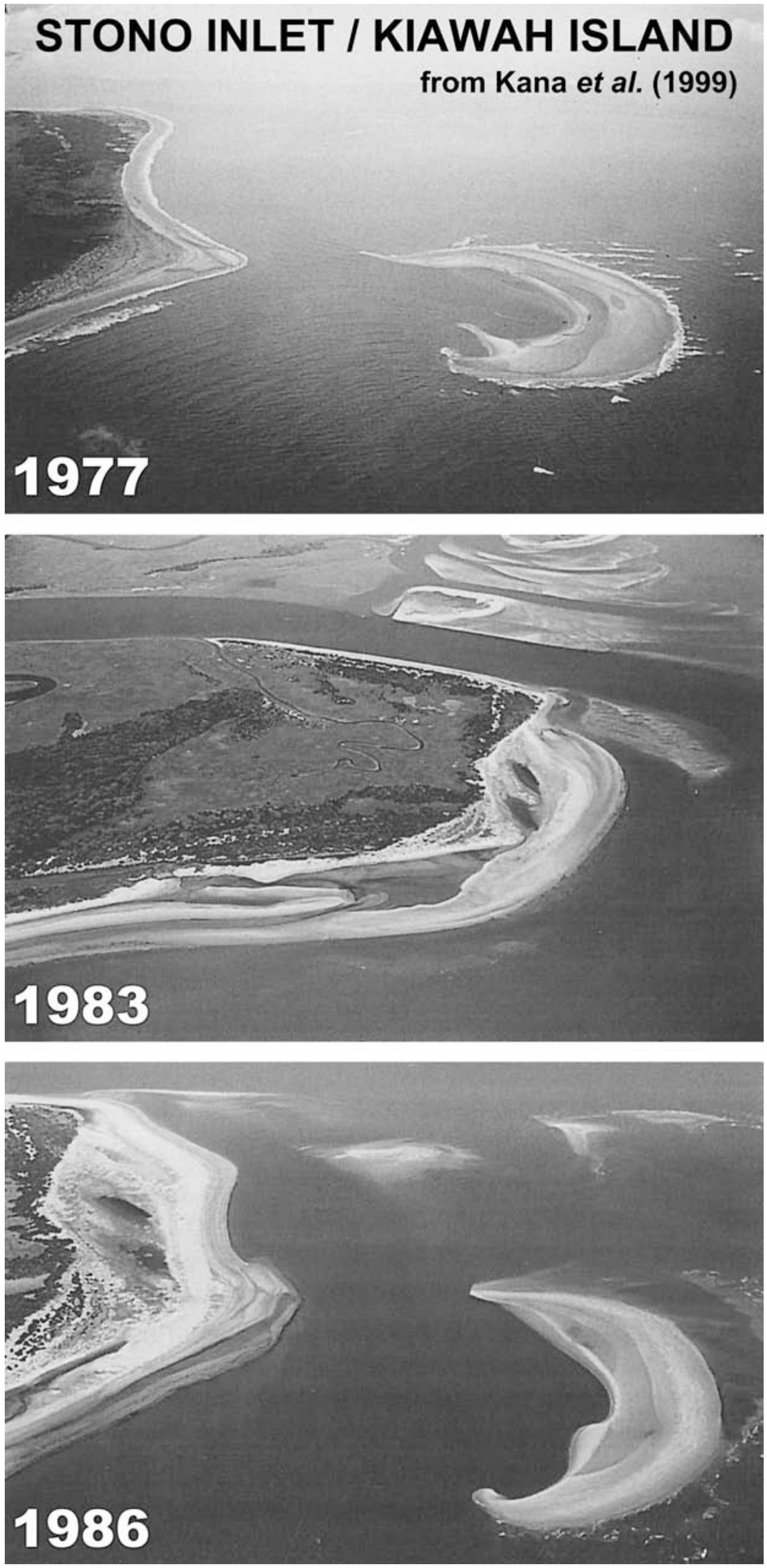
3. Morphology and subsurface three-dimensional configuration (stratigraphy) of prograding (regressive) barrier islands, in the bottom row; and landward-migrating (transgressive) barrier islands in the top row. The cross-sections (A-A') are located in each of the plan view maps.



4. Map of the geomorphology of Kiawah Island, using a 1971 aerial photograph as a base. The line labeled A-A' gives the approximate location of the stratigraphic section shown in Prop 17.

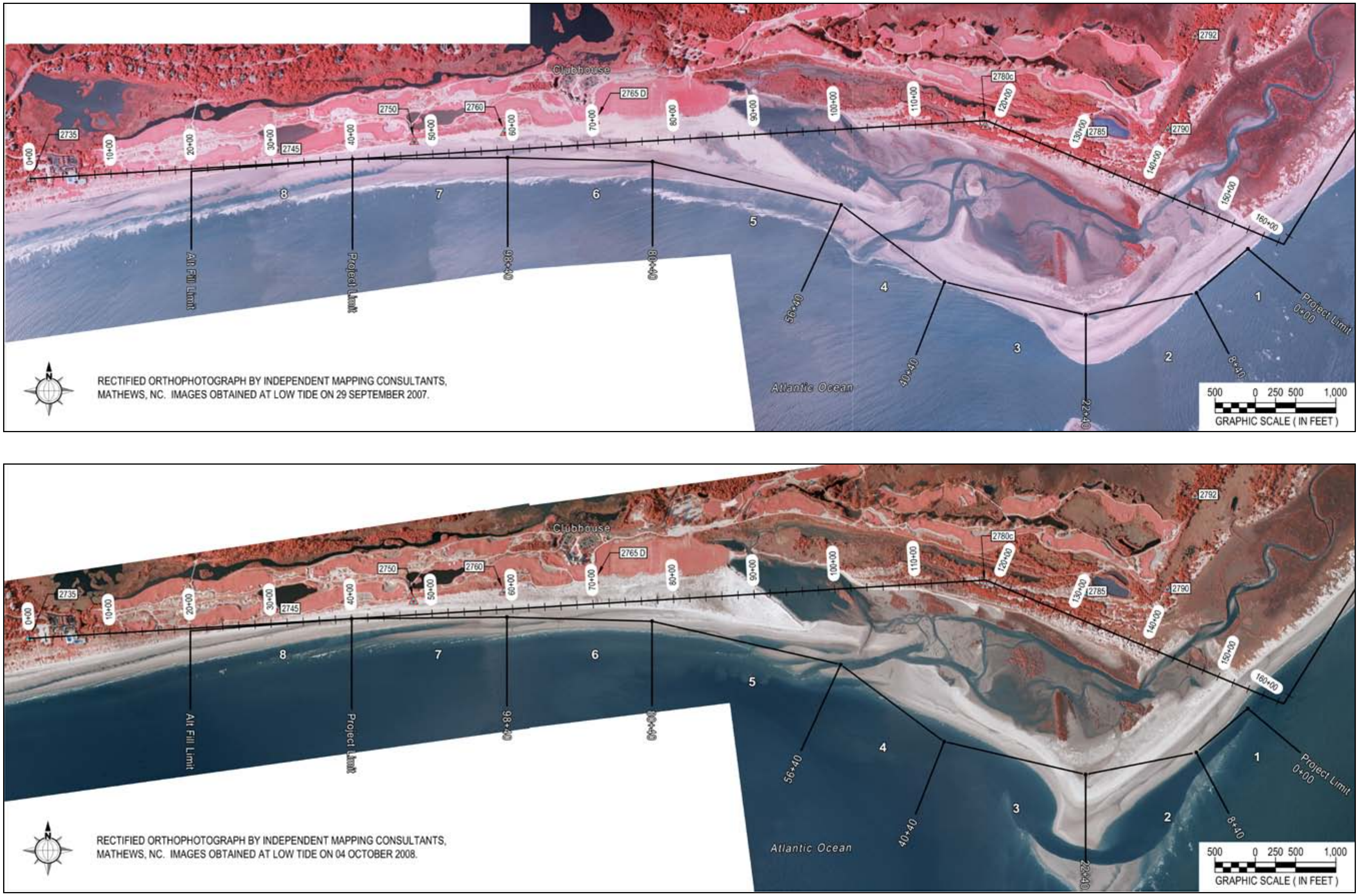


5. Generalized stratigraphy of Kiawah Island. Modified after Moslow (1980). This cross-section is located (approximately) on Prop 4.

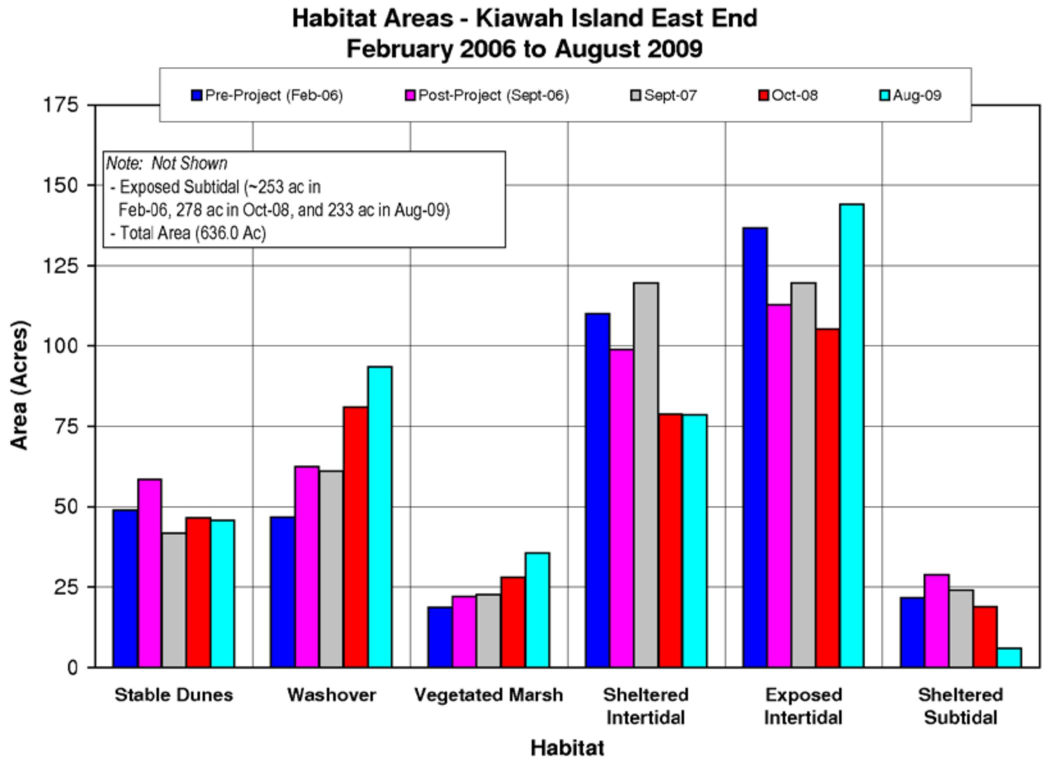


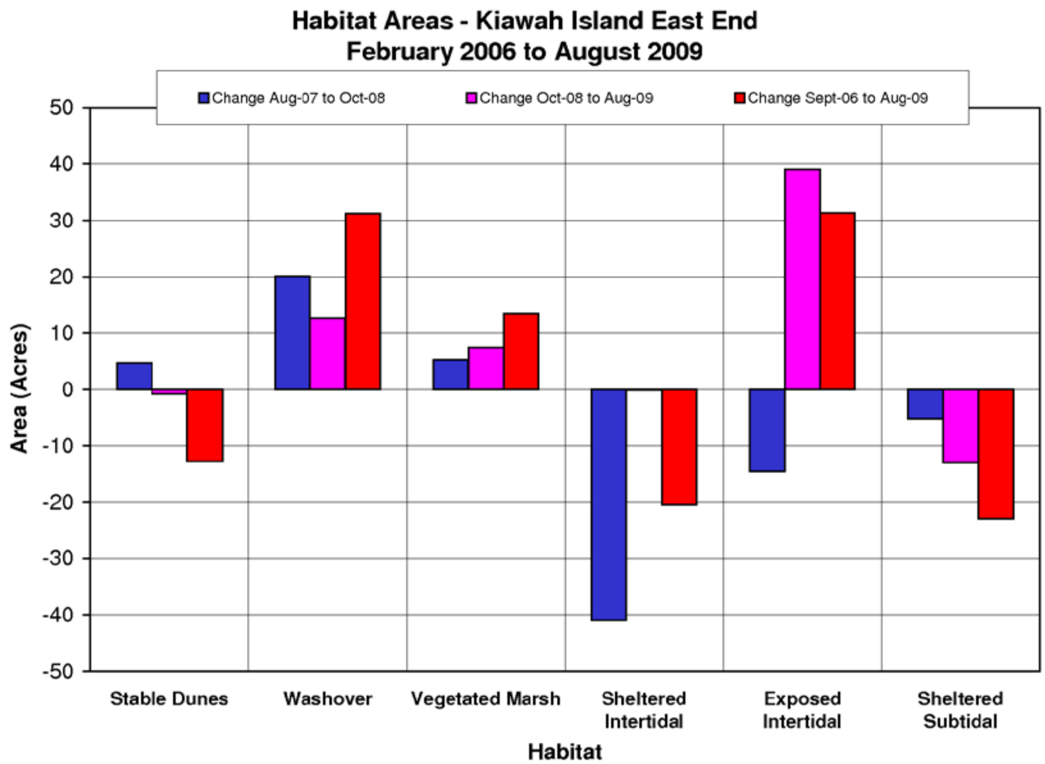
6. Northeast end of Kiawah Island.

7. The eastern end of Kiawah Island in December 1989 (upper) and February 2005 (lower). Note the 1989 shoreline situated well inland from the outer beach. Shoals 1 and 2 added upward of 5 million cubic yards to Kiawah in the 1990s. As waves pushed the new sand shoreward, an incipient barrier island/lagoon/marsh formed. The new lagoon was flushed via a channel at the western end of the accreted beach. [From CSE 2007]

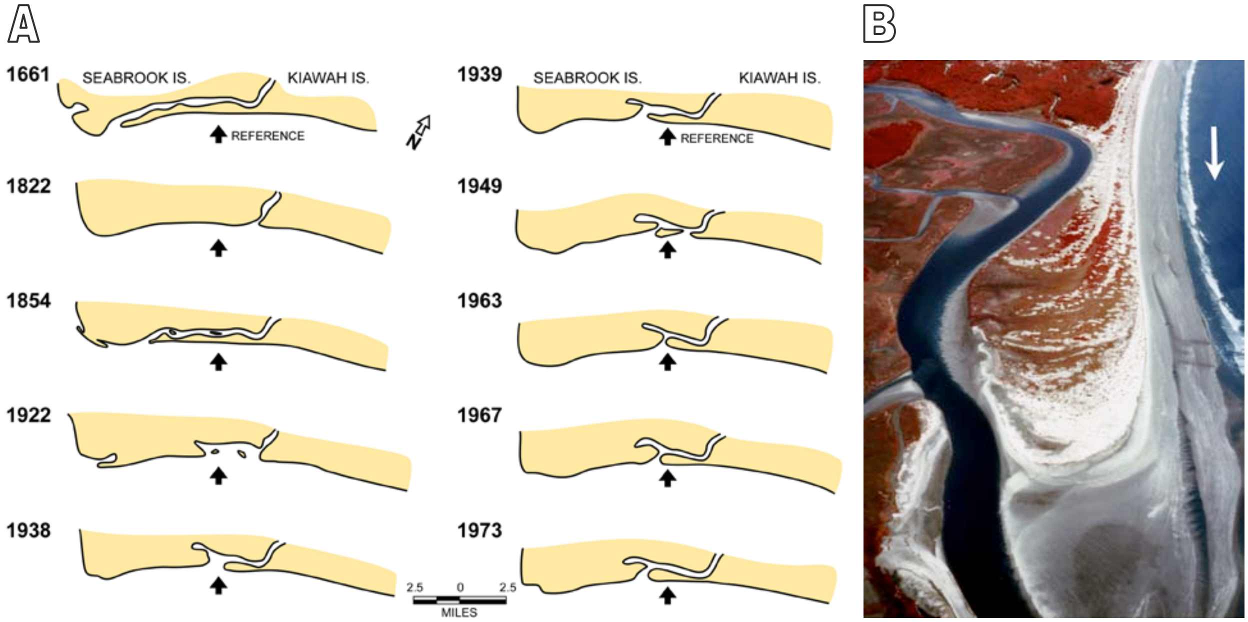


8. Aerial Images of the eastern end of Kiawah Island ~1 year (upper) and ~2 years (lower) after the restoration project. Note in the lower figure, an offshore shoal is almost attached to the outer beach. Construction (seaward) and monitoring (landward) baselines are shown.

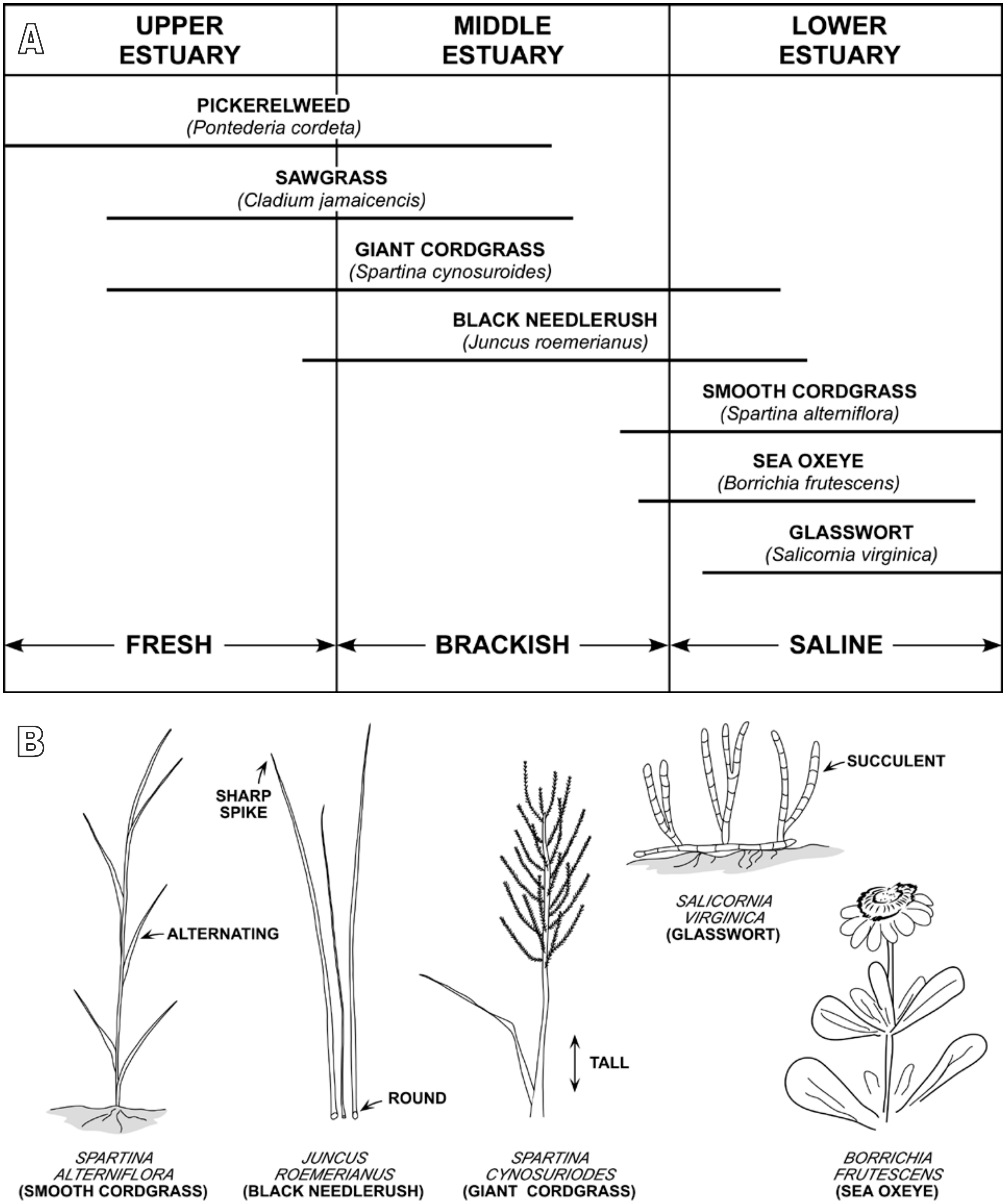




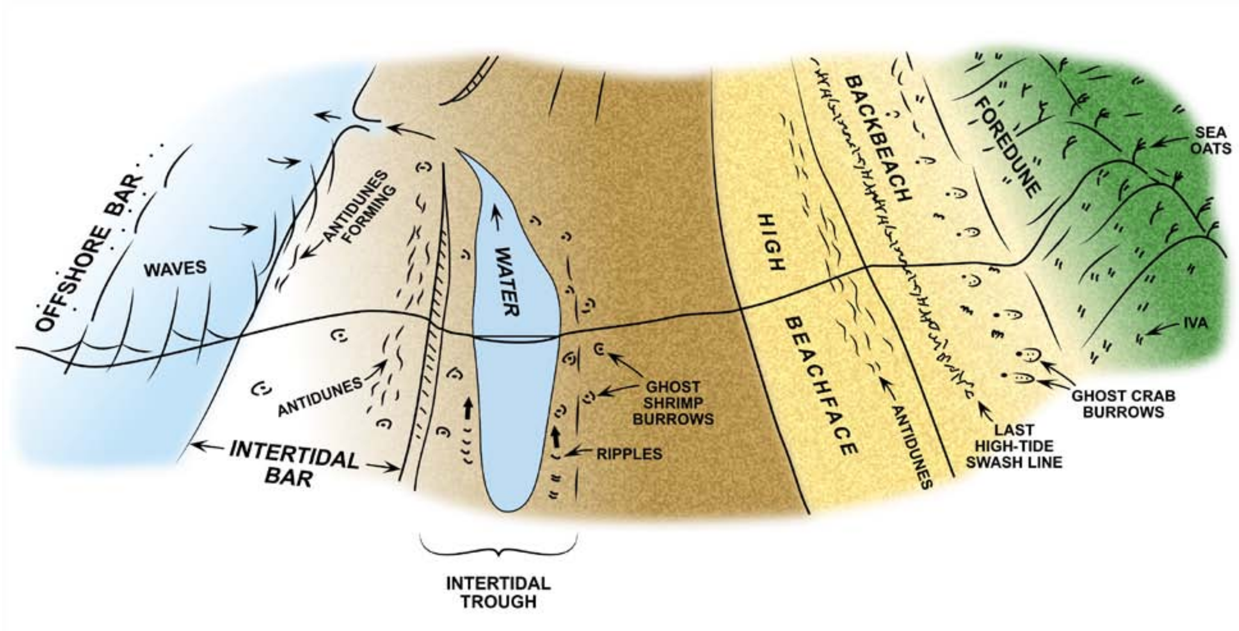
9. **(Upper)** Habitat areas before and after the East End Beach Restoration Project. **(Lower)** Change in habitat areas between August 2007 and October 2008, October 2008 and August 2009, and post-project (September 2006) and August 2009.



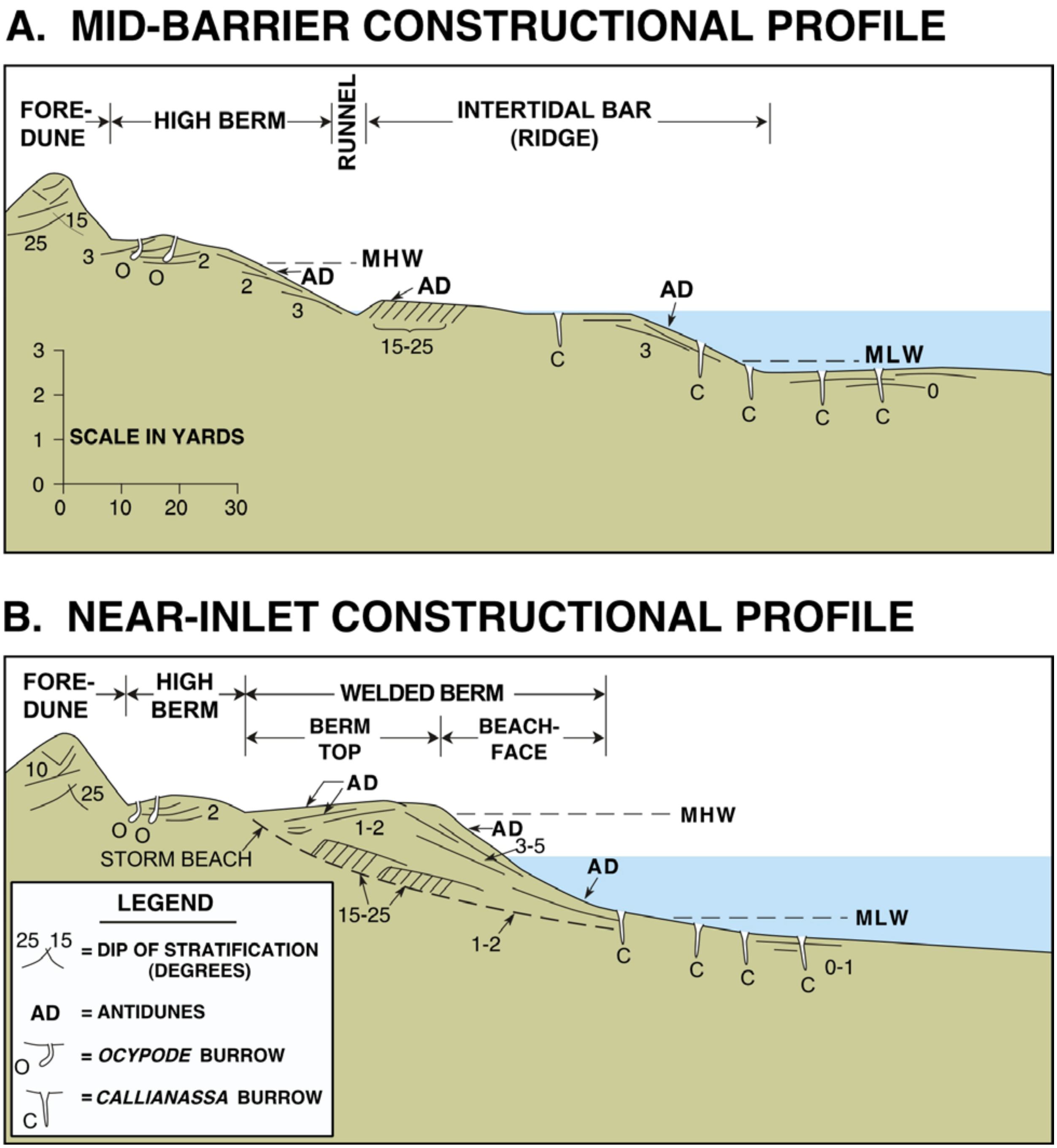
10. (A) Historic changes Captain Sams Inlet between 1661 and 1973, based on a combination of historical charts and aerial photographs. These maps and photos show three periods of breaching of the spit: 1822, 1922, and 1949. Breaches occurred at numerous other times, of course, at intervals we estimate to be about every 40-50 years. From Hayes et al. (1976). (B) The recurved spit at the southern end of Kiawah Island, S. C. at low tide on 10 June 1976 (infrared photograph by Dennis K. Hubbard). Because of the consistent movement of sand along the shore from northeast to southwest (see arrow; view looks northeast), the tidal inlet just beyond the bottom of the photo (Captain Sams Inlet) is forced to migrate to the south at rates of around 200 feet/year. As a result, the waves moving sand along the beach and into the inlet produce a curve in the beach that extends much of the way around the end of the island on the inside of the inlet. As this pulsating process continues, the spit continues to migrate to the southwest with the curving beach ridges marking the different stages of this advancement. Around 1948, a new inlet channel was formed at the narrow neck of the recurved spit, after which the inlet resumed its unceasing migration to the southwest. Therefore, the entire spit form shown in this photograph, which was more than 5,000 feet long at that time, had formed in the previous 28 years.



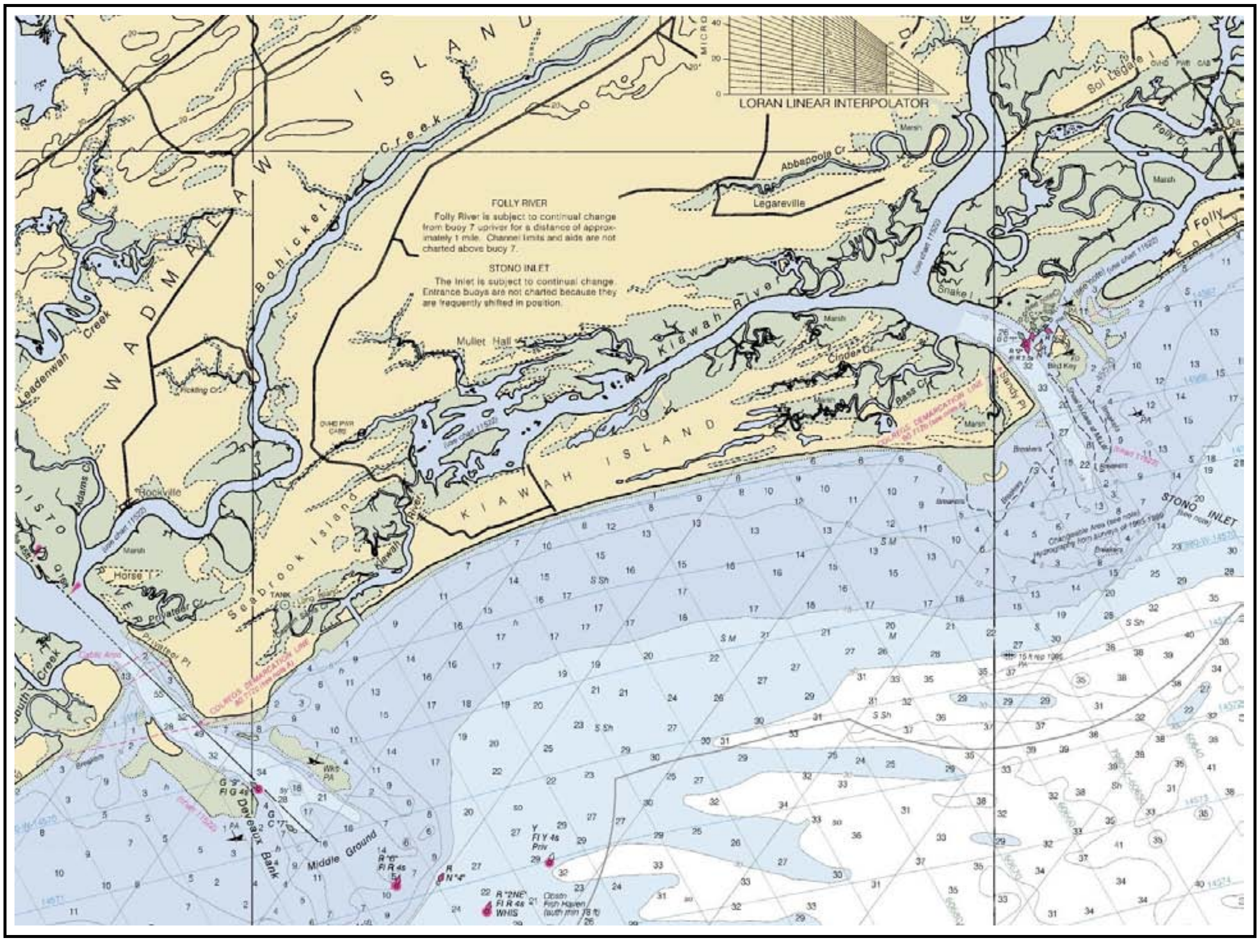
11. Marsh plants. (A) Occurrence of the most conspicuous plants in the marshes of the upper (fresh), middle (brackish), and lower (saline) parts of the estuaries of South Carolina. Modified after Stalter (1974). (B) Sketches of some of the more common marsh plants in South Carolina.



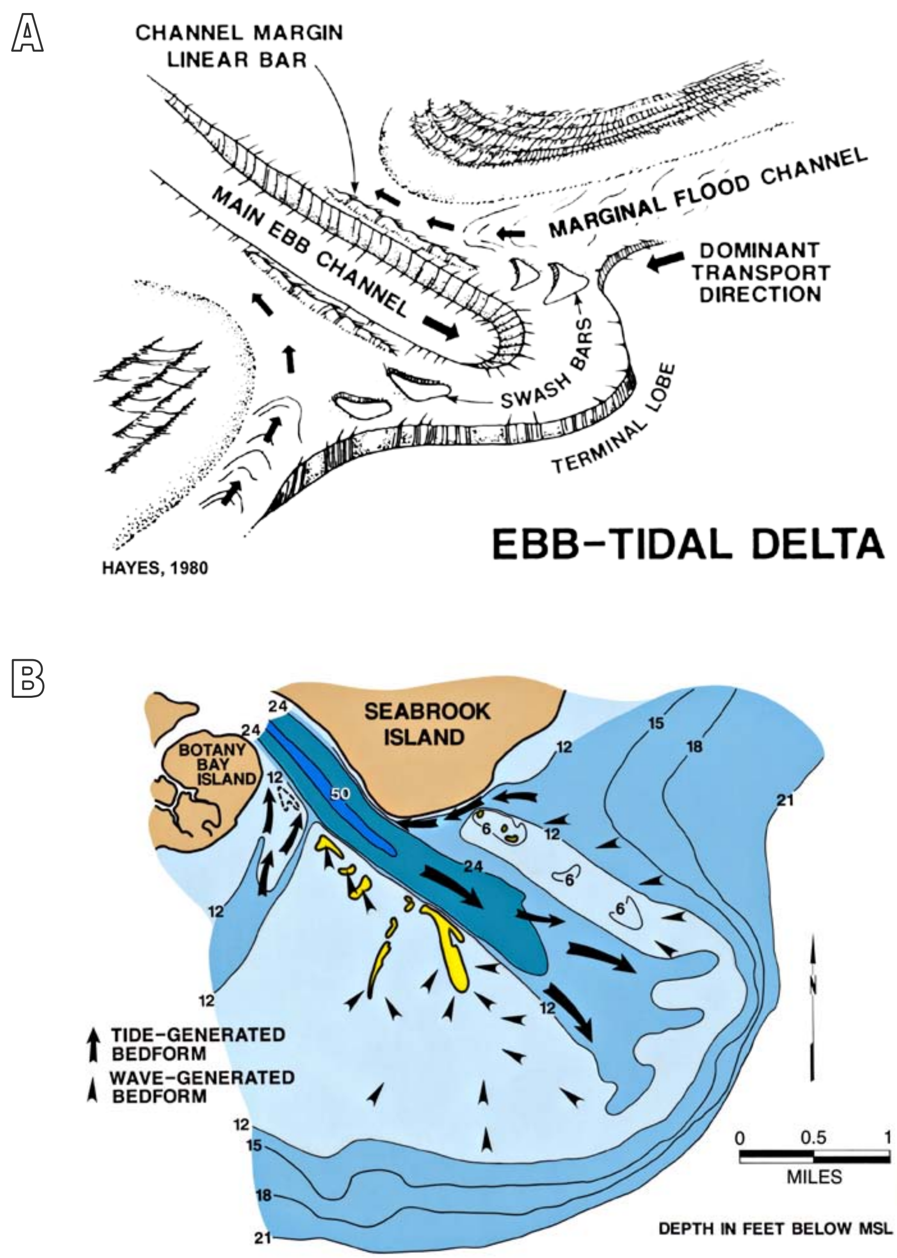
12. Sketch showing the different aspects of the beach exposed at low tide on the recurved spit on the south end of Kiawah Island.



13. Representative morphology and sedimentary features occurring on the beaches of the prograding, mixed-energy barrier islands of South Carolina. Based on inspection of hundreds of beach trenches. (A) Features found on a typical mid-barrier beach in a constructional mode (modified after Hoyt and Weimer, 1963). (B) Features found on beaches near tidal inlets in a late constructional mode.



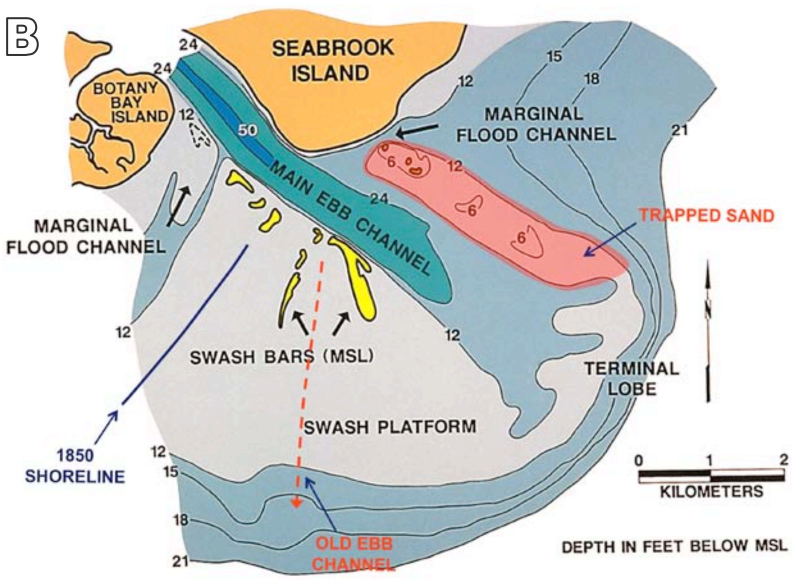
14. Nautical Chart of Seabrook and Kiawah Islands showing the North Edisto Inlet in the bottom left corner.



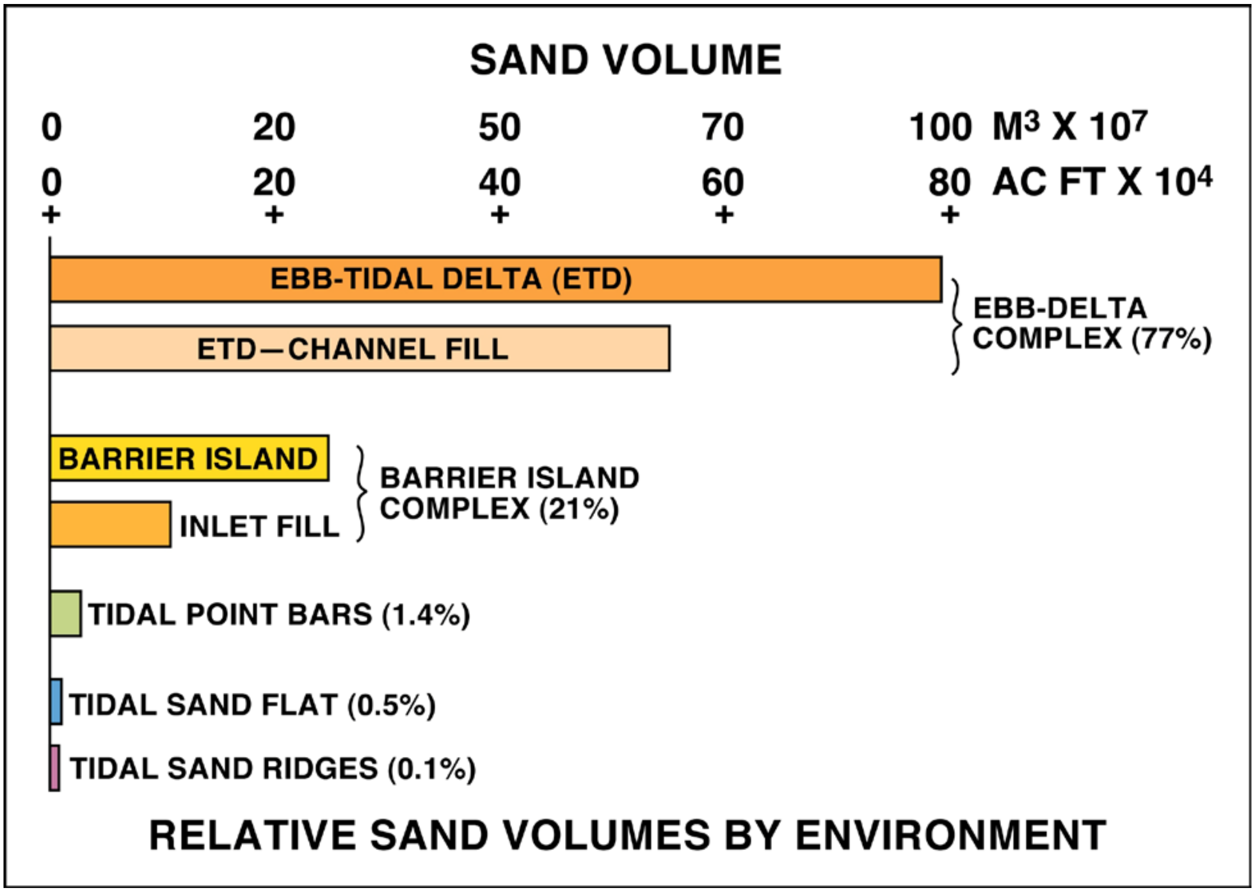
15. Examples of ebb-tidal deltas on the South Carolina coast. (A) Typical morphology of ebb-tidal deltas in mesotidal settings (after Hayes, 1980). Arrows indicate dominant direction of tidal currents. This model was derived for the ebb-tidal deltas of the New England area, but it applies equally well to the inlets of South Carolina and other barrier-island systems around the world. (B) North Edisto Inlet. Arrows indicate the dominant orientation of bedforms generated by tidal currents (e.g., megaripples) and wave-generated currents (e.g., ripples). Compare this diagram with the general model given in (A). Note the dominance of landward–directed sand transport in the marginal flood channels and seaward-directed transport in the main ebb channel. Arrows are based on actual field observation through several tidal cycles (Imperato, Sexton and Hayes, 1988).

A

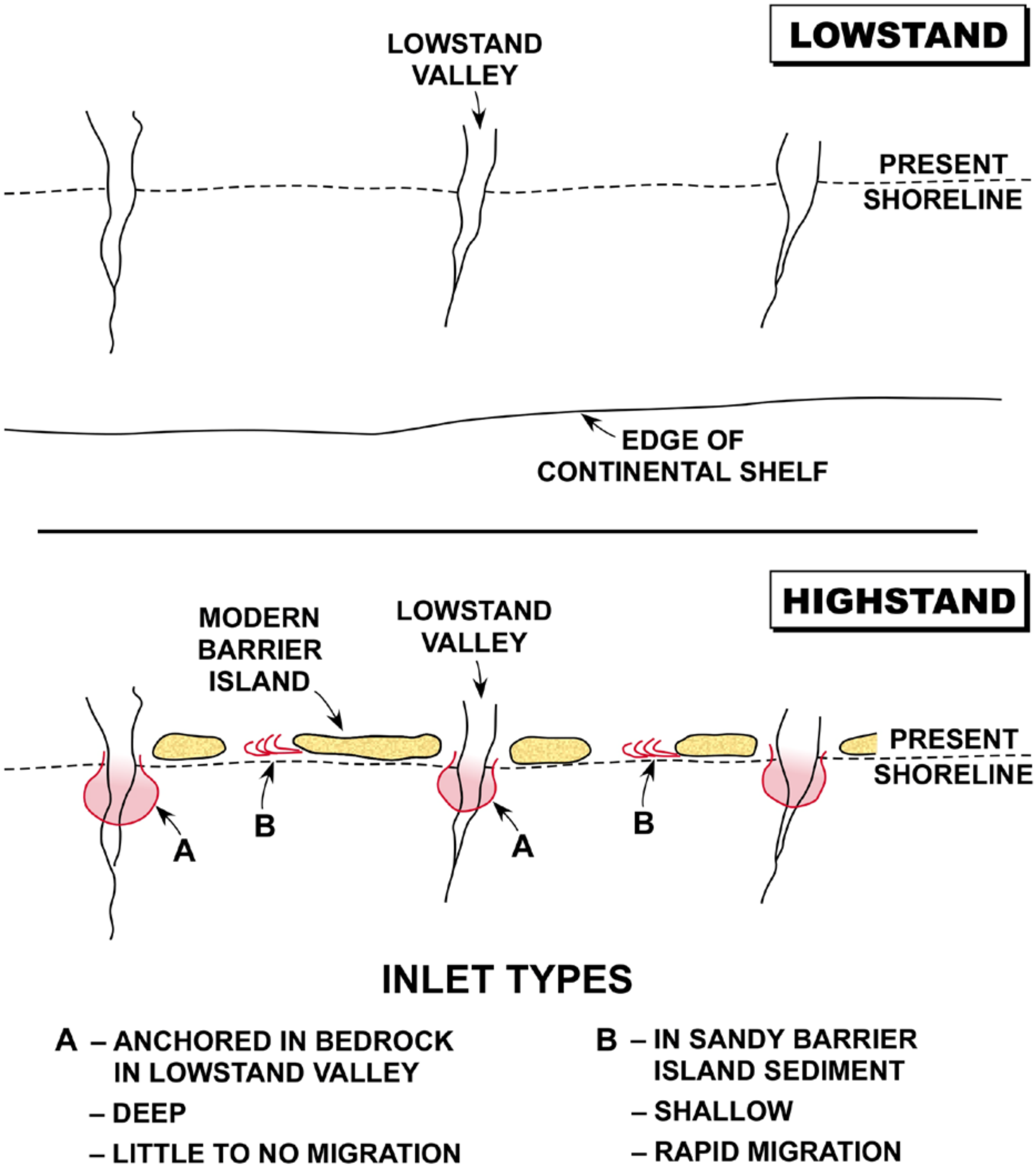
B



16. (A) Landward-migrating (transgressive) barrier islands at Edingsville Beach, South Carolina. This shoreline has retreated almost a mile since the 1850s because of the trapping of sand on the major ebb-tidal delta located north of the area. Note the new tidal inlet that was created by the intersection of the retreating washover terrace with a tidal channel (arrow). Photograph by M. F. Stephen taken in October 1974. (B) North Edisto Inlet flood-tidal delta showing: 1) 1850 shoreline; 2) approximate location of the main ebb channel in1850; and 3) new lobe of sand (pink) trapped by the new main ebb channel.

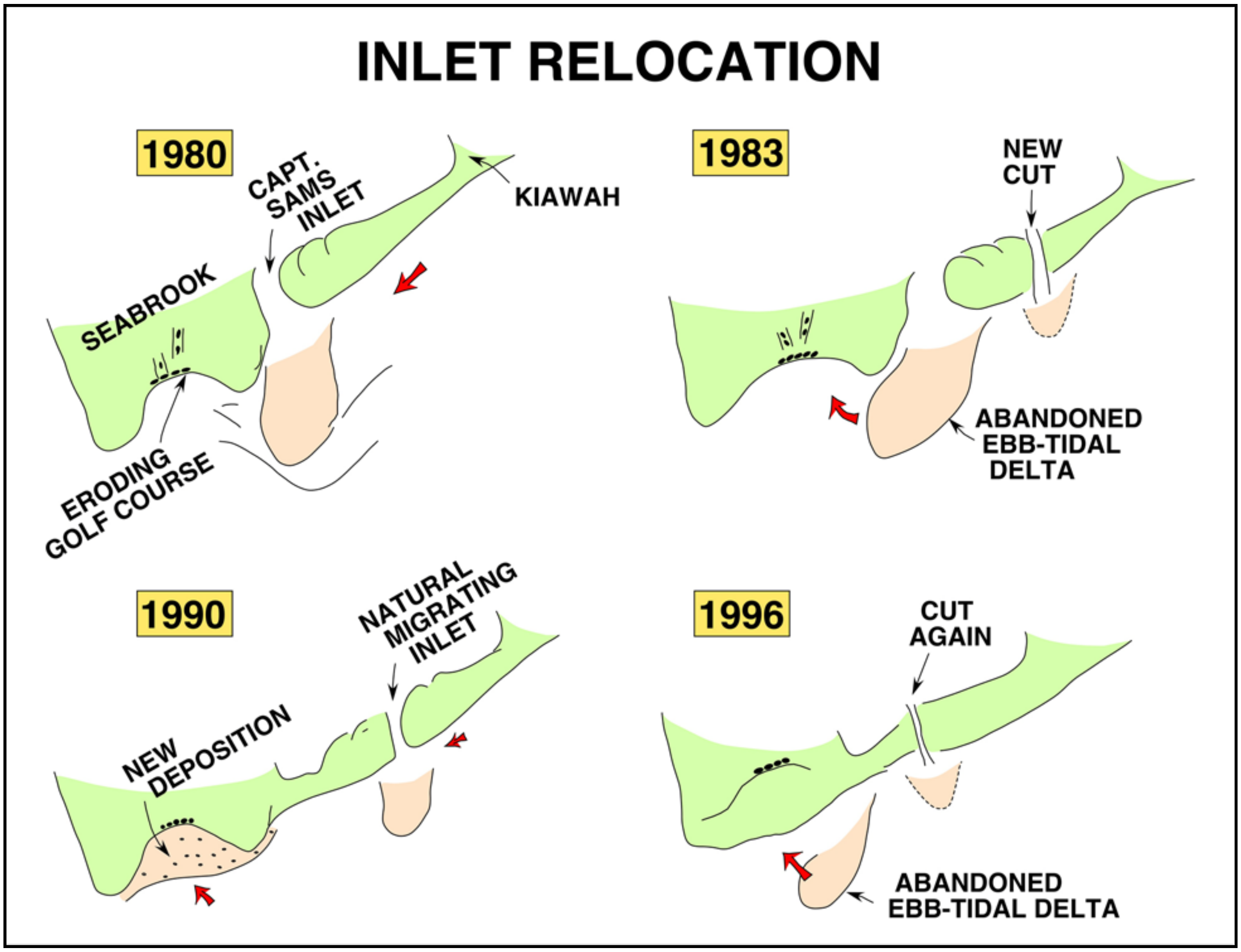


17. Holocene sand deposits on the central coast of South Carolina.



18. Inlet migration styles

19. The Seabrook Island shoreline from Beach Club Villas (lower edge of image) to Camp St. Christopher at low tide on 31 May 2008. Peican Watch Villas were originally aligned with the shoreline when built in the 1970s. Dotted red line marks approximate shoreline in 1980. Photos by TW Kana.

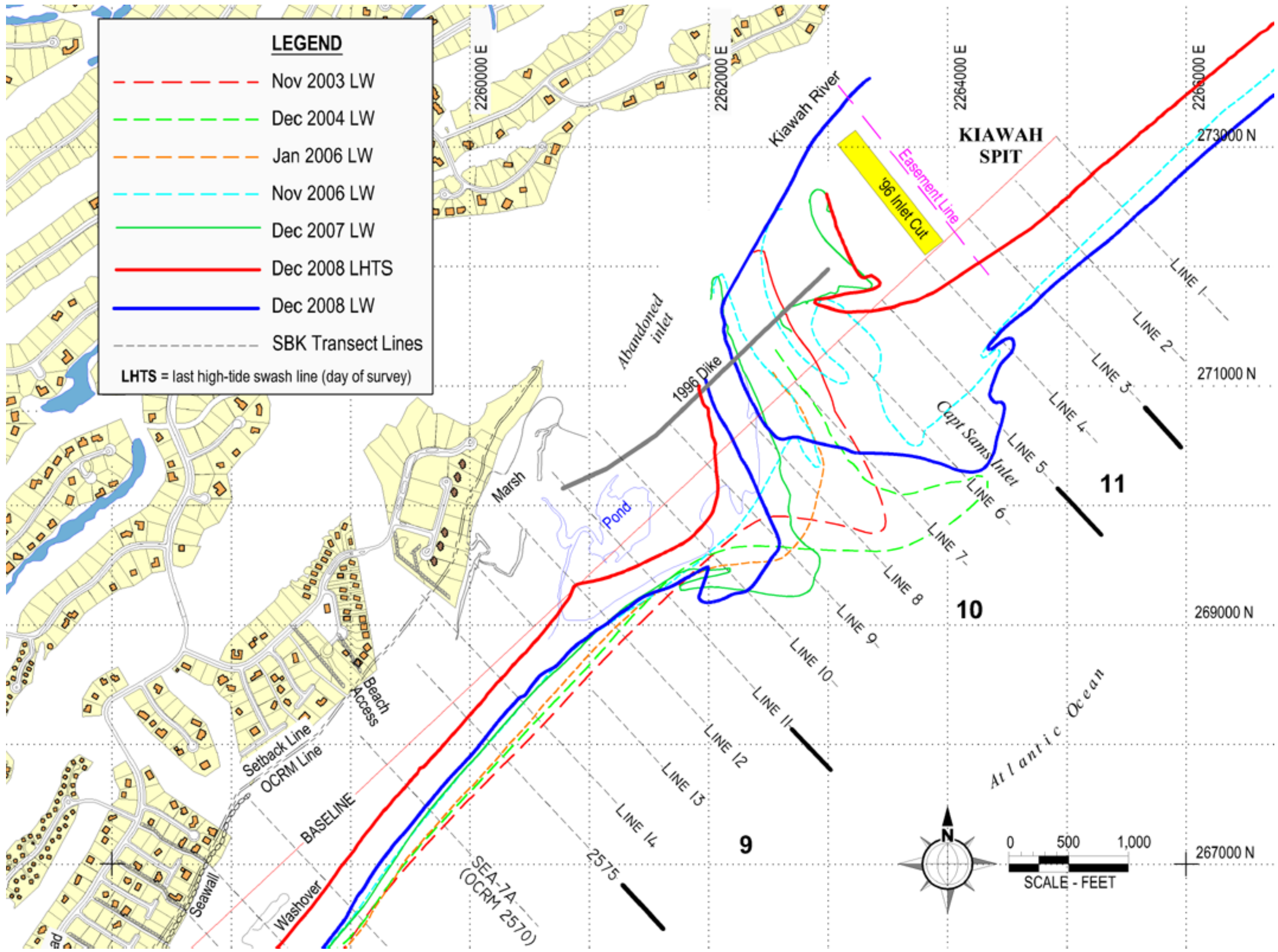


20. Captain Sams Inlet relocation.

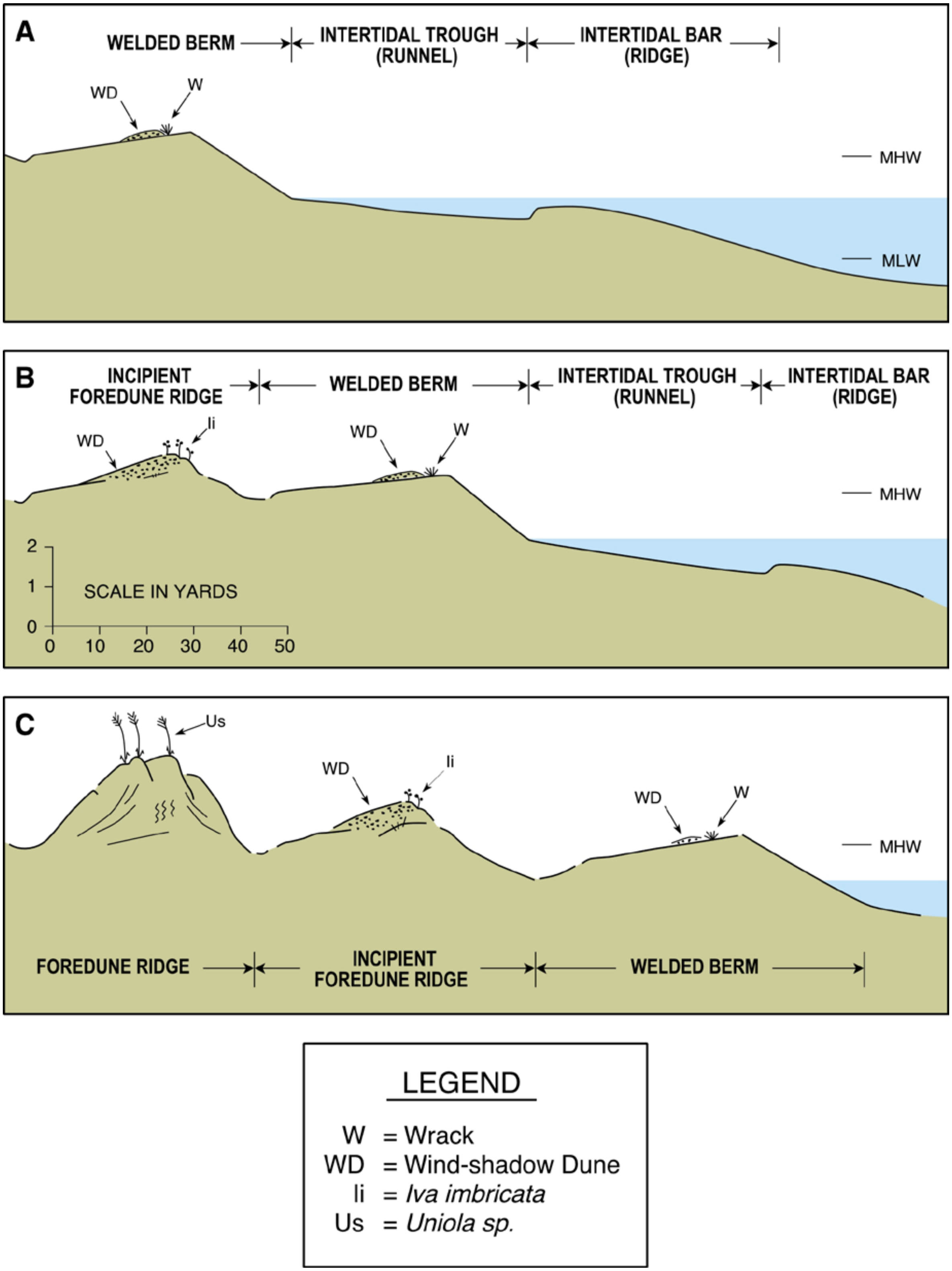
21. Vertical image of the relocated Captain Sams Inlet on 28 March 1983. Relocation of the new inlet was completed 24 days earlier, on 4 March 1983.

22. Sand added to Seabrook Island as result of relocating Captain Sams Inlet in 1983. (A) Photograph of Seabrook Island by Tim Kana taken at low tide on 25 February 1986, two years and eleven months after Captain Sams Inlet was relocated. Note the welding and landward migration of swash bars composed of sand released from the abandoned ebb-tidal delta after the inlet was relocated. (B) Photograph by Tim Kana taken on 10 February 2006. The beach in front of the golf course had built out 985 feet in the 23 years since the inlet was originally relocated. It was relocated again in the spring of 1996. Note the position of the 1983 shoreline.

23. **(Left)** Aerial Photo of Kiawah-Seabrook Islands taken in 1982 (before restoration).
(Right) Aerial Photo of Kiawah-Seabrook Islands taken 28 April 2010. (after restoration).



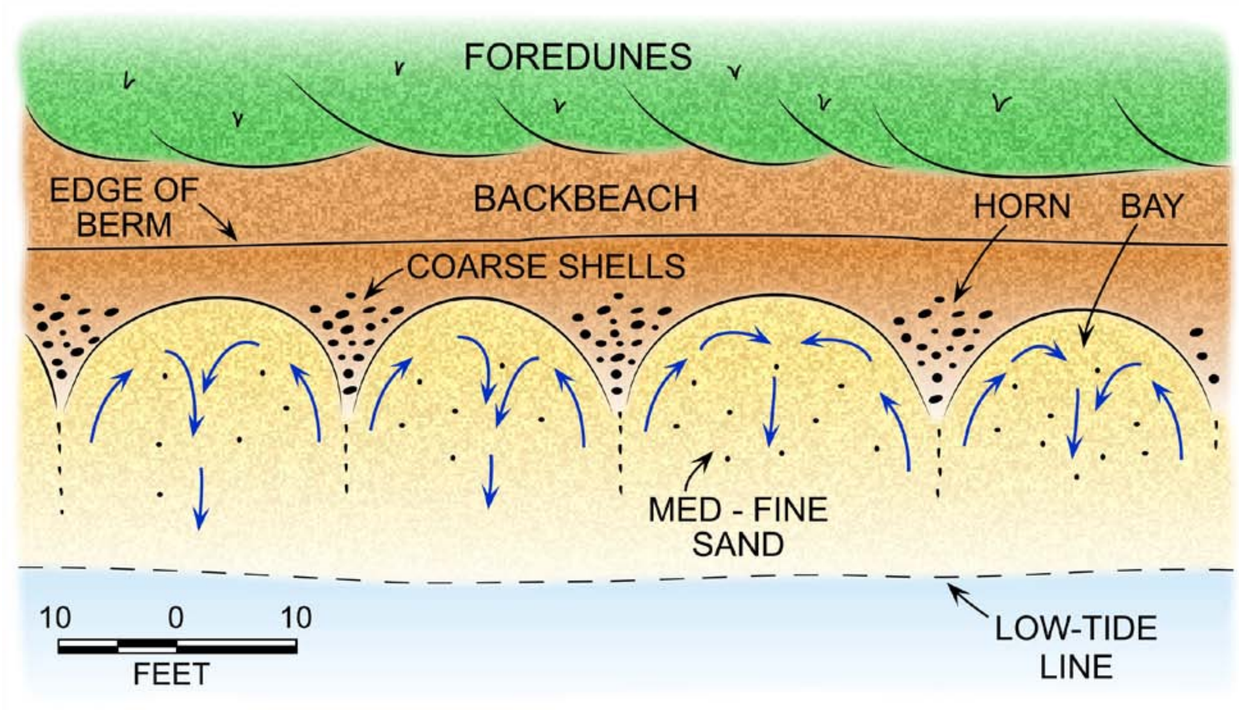
24. Survey baseline and beach profiles north of Oystercatcher beach access (near SEA 7A) along with recent shorelines. LHTS equals last high-tide swash line which is typically at (~)+4 ft NAVD along the open coast. LW equals low-tide swash line or (~)-2.5 ft NAVD (typical). Note inlet migration to line 8 in 2008. Shoals of Captains Sams Inlet migrate with the channel and now account for a buildup between lines 10 and 11. Meanwhile, erosion is occurring at lines 12-15 as North Beach takes on more curvature between Captains Sams Inlet and Renken Point.



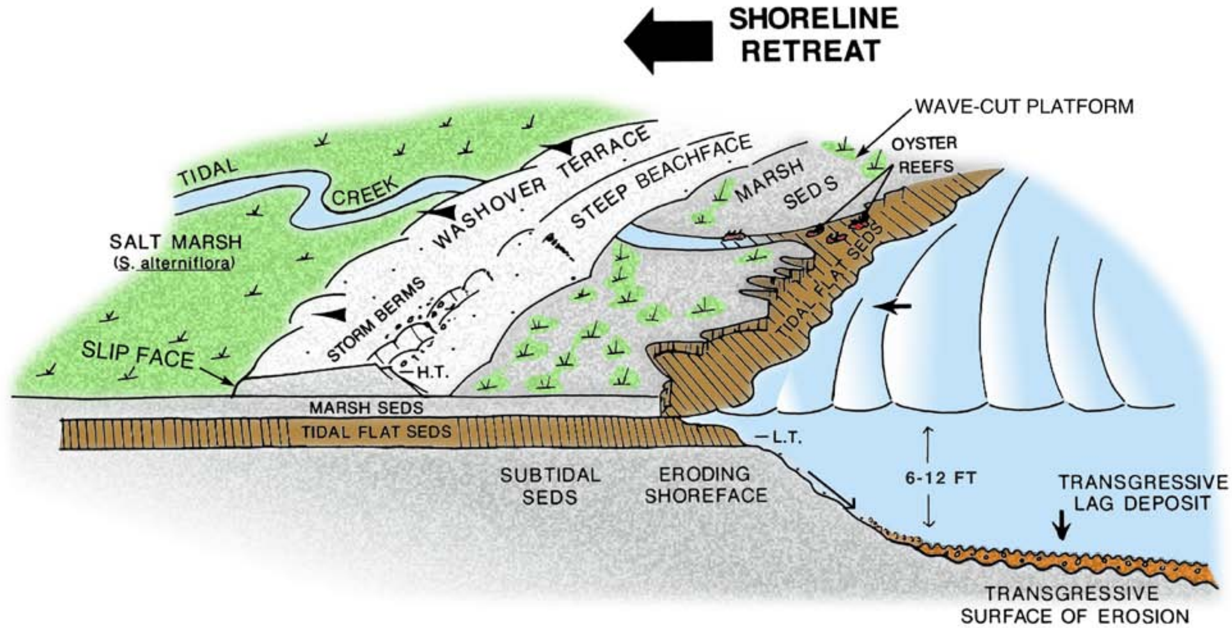
25. Model for evolution of foredune ridges on a prograding, recurved spit in South Carolina (see photograph of Kiawah Island recurved spit in Prop 7B).

26. Vertical infrared image of Edisto Beach subcompartment. Image acquired in 2006. Courtesy of SCDNR.

27. Aerial views of Edisto Beach taken on 10 February 2006 (A) before a major beach nourishment project and after it in June 2006 (B). Note how the nourished sand had buried many of the groins. Photographs by Tim Kana.



28. General pattern of beach cusps. Arrows show the patterns of flowing water (during high stages of the tide) in the bays between the horns of the cusps.



29. Low-tide morphology of the landward-migrating (transgressive) barrier island on the southwest end of Cape Romain at Sandy Point, based on observations made during the late 1990s. At that time, a wide wave-cut platform composed of salt-marsh sediments was exposed at low tide. A scarp displaying a remarkable array of erosional features was eroded into the outer edge of the exposed salt-marsh sediments. As the shoreline retreated, tidal creeks and oyster reefs were exposed along the eroding platform. The beach face was steep, because of an abundance of coarse-grained shell material in the beach sediment, and the washover terrace was terminated in a 3 foot high slip face on top of the living marsh surface. Steep storm berms composed mostly of oyster shells were present in places along the top of the beach face. According to Walter J. Sexton, this landward-migrating barrier island at Sandy Point was nearly gone in 2007, the sediments being deposited into the deep tidal channel on its landward side.