INLET DYNAMICS

Tidal inlets — Floridians often call them passes, especially on the west coast — are the most dynamic and visible features of Southwest Florida's boating geography. Inlets are points of entry and egress between the Gulf of Mexico and inland waterways. They are also a challenge to navigate, because of their shifting nature, strong ebb and flood currents, and changing wave action. Waves propagating into an opposing current in inlets increase in height and decrease in length. The result is steeper waves that are more difficult to navigate.

Offshore shoals continually shift because of the moving beach sand, so it is challenging to keep markers in the best water. Local watermen often leave the buoyed channel, guided by knowledge of local conditions that enables them to pick the best water and avoid uncharted obstructions. A basic understanding of how inlets come into being and evolve can aid all mariners to cope with the seeming vagaries of Florida's vital passes.

Rotonda West (circular shape on left side of photo), view south with Stump Pass in foreground, Gasparilla Pass in upper right, Charlotte Harbor in background.

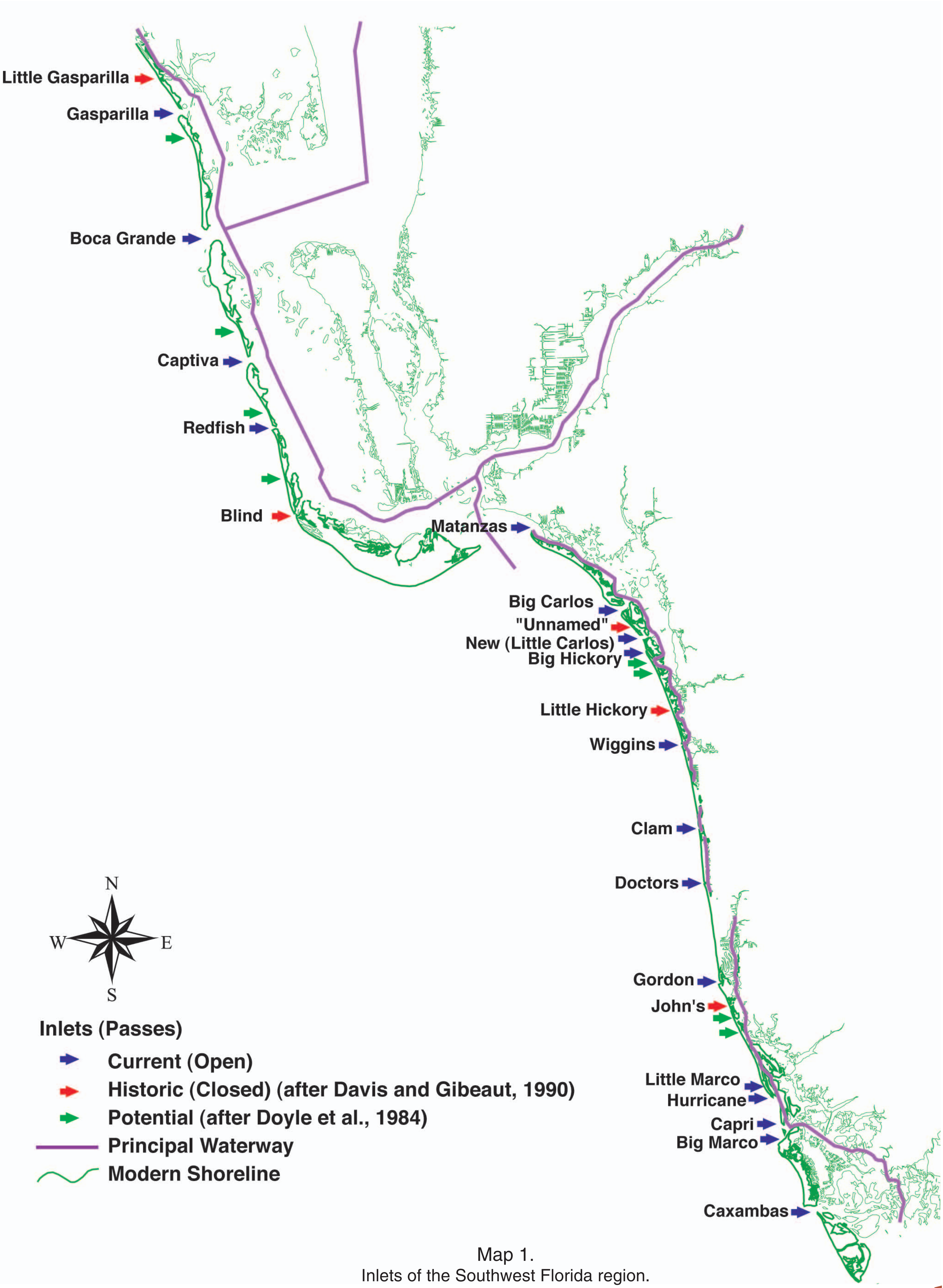
Inlet Locations and Status

Fifteen inlets are currently used by boaters to transit between Gulf and bay waters in this Southwest Florida region: Gasparilla, Boca Grande, Captiva, Redfish, Matanzas, Big Carlos, New, Big Hickory, Wiggins, Clam, Doctors, Gordon, Big Marco, Capri, and Caxambas Passes (Map 1). Table 1 lists distances for traversing the outside (Gulf of Mexico) and inside (Intracoastal and Inland Waterways) routes, as well as the intervening access channels. Outside route distances for mariners are longer, but travel time under favorable conditions is usually less, especially for high-performance cruisers. An exception to the distance rule is from Gordon Pass to Caxambas Pass, where the inside route is considerably longer due to running the Gordon River. Cruising sailboats often choose the outside route for better winds and to avoid bridges with restricted openings.

Boca Grande, Matanzas, Gordon, Capri, and Big Marco Passes are federally authorized navigation inlets, periodically surveyed and dredged by the Army Engineers, in cooperation with the West Coast Inland Navigation District (WCIND), Lee and Collier Counties, and the City of Naples. Though not generally navigable, Big Hickory Pass was dredged once, in the late 1970s, to increase tidal flushing. Wiggins, and Doctors Passes are maintenance dredged for navigation by Collier County and the City of Naples. Another four inlets–Redfish, Blind (currently closed), Clam, and Caxambas have been dredged either as a by product of beach renourishment or for water quality improvement. The remaining inlets — Gasparilla, Captiva, Big Carlos, New, Little Marco, and Hurricane — are natural, unimproved passes. Aids to navigation are maintained at all the inlets, except Gasparilla, Captiva, Big Hickory, Clam, Little Marco, Hurricane, and Big Marco. New and Big Hickory Passes have fixed–span bridges near their mouths, and Big Carlos has a lift bridge that opens on demand between 8 a.m. and 7 p.m., but is otherwise locked down.

Five inlets have closed during the past century on this reach of the Southwest Florida coast: Little Gasparilla, Blind, Un-named (south of Big Carlos), Little Hickory, and John's (Map 1). Current and historic inlets have formed, closed, and reopened, due to natural processes as well as human intervention. Such events directly affect the amount of water flowing through an inlet during a tidal cycle, referred to as a tidal prism. Dredging inlet "*A*" can rob some of the tidal prism from inlet "*B*", situated several miles down the coast. Similarly, the tidal prism of an inlet may be affected by changing the area of the bay adjacent to it; an inlet may close due to an abundance of sediment and strong longshore drift coupled with a small tidal prism.

Considerable debate continues regarding the effects on tidal prism and the related closing of inlets caused by the dredging and filling of mangrove and marsh environments along bay margins. Little disagreement exists, however, about the potential for storm overwash of the barrier islands and the creation of new inlets. Eight sites along this stretch of the coast are particularly vulnerable to storm overwash (the "potential" inlet sites on Map 1). They are prone to overwash because of the narrow width of the barrier island, low elevation, and orientation to storm-wave attack.



Map 1.
Inlets of the Southwest Florida region.

Route distances between inlets.

a. Gulf of Mexico (outside) route to inlet (sea buoy) entrance (distances in statute miles).

Pass/Inlet	Stump	Gasparilla	Boca Grande	Captiva	Redfish	Matanzas	Big Carlos	New (Little Carlos)	Big Hickory	Wiggins	Clam	Doctors	Gordon	Capri	Big Marco	Caxambas
Stump (Volume One)		7.0	16.1	24.7	27.3	51.8	59.4	60.7	62.4	67.3	72.1	75.3	81.0	89.9	92.2	95.7
Gasparilla	7.0		9.1	17.7	20.3	44.8	52.4	53.7	55.4	60.3	65.1	68.3	74.0	82.9	85.2	88.7
Boca Grande	16.1	9.1		8.6	11.2	35.7	45.3	44.6	46.3	51.2	56.0	59.2	64.9	73.8	76.1	79.6
Captiva	24.7	17.7	8.6		2.6	27.1	34.7	36.0	37.7	42.6	47.4	50.6	56.3	65.2	67.5	71.0
Redfish	27.3	20.3	11.2	2.6		24.5	32.1	33.4	35.1	40.0	44.8	48.0	53.7	62.6	64.9	68.4
Matanzas	51.8	44.8	35.7	27.1	24.5		7.6	8.9	10.6	15.5	20.3	23.5	29.2	38.1	40.4	43.9
Big Carlos	59.4	52.4	43.3	34.7	32.1	7.6		1.3	3.0	7.4	12.7	15.9	21.6	30.5	32.8	36.3
New (Little Carlos)	60.7	53.7	44.6	36.0	33.4	8.9	1.3		1.7	6.6	11.4	14.6	20.3	29.2	31.5	35.0
Big Hickory	62.4	55.4	46.3	37.7	35.1	10.6	3.0	1.7		4.9	9.7	12.9	18.6	27.5	29.8	33.3
Wiggins	67.3	60.3	51.2	42.6	40.0	15.5	7.9	6.6	4.9		4.8	8.0	13.7	22.6	24.9	28.4
Clam	72.1	65.1	56.0	47.4	44.8	20.3	12.7	11.4	9.7	4.8		3.2	8.9	17.8	20.1	23.6
Doctors	75.3	68.3	59.2	50.6	48.0	23.5	15.9	14.6	12.9	8.0	3.2		5.7	14.6	16.9	20.4
Gordon	81.0	74.0	64.9	56.3	53.7	29.2	21.6	20.3	18.6	13.7	8.9	5.7		8.9	11.2	14.7
Capri	89.9	82.9	73.8	65.2	62.6	38.1	30.5	29.2	27.5	22.6	17.8	14.6	8.9		2.3	5.8
Big Marco	92.2	85.2	76.1	67.5	64.9	40.4	32.8	31.5	29.8	24.9	20.1	16.9	11.2	2.3		3.5
Caxambas	95.7	88.7	79.6	71.0	68.4	43.9	36.3	35.0	33.3	28.4	23.6	20.4	14.7	5.8	3.5	

b. Intracoastal waterway (inside) route to inlet access channel (distances in statute miles).

Pass/Inlet	Stump	Gasparilla	Boca Grande	Captiva	Redfish	Matanzas	Big Carlos	New (Little Carlos)	Big Hickory	Wiggins
Stump (Volume One)		7.5	15.5	23.0	28.0	47.7	55.1	57.6	60.0	65.8
Gasparilla	7.5		8.0	15.5	20.5	40.2	47.6	50.1	52.5	58.3
Boca Grande	15.5	8.0		7.5	12.5	32.2	39.6	42.1	44.5	50.3
Captiva	23.0	15.5	7.5		5.0	24.7	32.1	34.6	37.0	42.8
Redfish	28.0	20.5	12.5	5.0		19.7	27.1	29.6	32.0	37.8
Matanzas	47.7	40.2	32.2	24.7	19.7		7.4	9.9	12.3	18.1
Big Carlos	55.1	47.6	39.6	32.1	27.1	7.4		2.5	4.9	10.7
New (Little Carlos)	57.6	50.1	42.1	34.6	29.6	9.9	2.5		2.4	8.2
Big Hickory	60.0	52.5	44.5	37.0	32.0	12.3	4.9	2.4		5.8
Wiggins	65.8	58.3	50.3	42.8	37.8	18.1	10.7	8.2	5.8	

c. Inland waterway (inside) to access channel (distances in statute miles).

Pass/Inlet	Gordon	Capri	Big Marco	Caxambas
Gordon		10.6	10.9	21.9
Capri	10.6		0.3	11.3
Big Carlos	10.9	0.3		11.0
Caxambas	21.9	11.3	11.0	

d. Inlet and access channels from Gulf to Intracoastal (distances in statute miles).

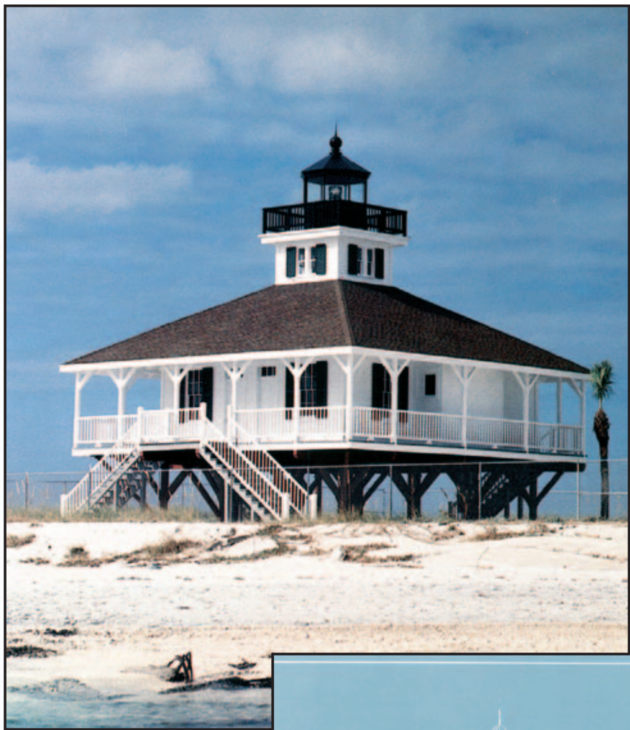
Pass/Inlet	Inlet Channel	ICW/IW Access	Total
Stump (Vol.1)	1.5	0.8	2.3
Gasparilla	0.9	1.2	2.1
Boca Grande	4.3	0.8	5.1
Captiva	2.5	1.2	3.7
Redfish	1.1	1.9	3.0
Matanzas	1.1	0.0	1.1
Big Carlos	1.8	0.0	1.8
New (Little Carlos)	0.9	0.4	1.3
Big Hickory	0.6	0.5	1.1
Wiggins	0.6	0.0	0.6
Clam	0.2		0.2
Doctors	0.3		0.3
Gordon	0.8	1.0	1.8
Capri	0.7	0.0	0.7
Big Marco	2.1	0.0	2.1
Caxambas	1.4	5.4	6.8

e. Outside route, including runs from and to the ICW/IW (distances in statute miles).																
Pass/Inlet	Stump	Gasparilla	Boca Grande	Captiva	Redfish	Matanzas	Big Carlos	New (Little Carlos)	Big Hickory	Wiggins	Clam	Doctors	Gordon	Capri	Big Marco	Caxambas
Stump (Volume One)		11.4	23.5	30.7	32.6	55.2	63.5	64.3	65.8	70.2	74.6	77.9	85.1	92.9	96.6	104.8
Gasparilla	11.4		16.3	23.5	25.4	48.0	56.3	57.1	58.6	63.0	67.4	70.7	77.9	85.7	89.4	97.6
Boca Grande	23.5	16.3		17.4	19.3	41.9	50.2	51.0	52.5	56.9	61.3	64.6	71.8	79.6	83.3	91.5
Captiva	30.7	23.5	17.4		9.3	31.9	40.2	41.0	42.5	46.9	51.3	54.6	61.8	69.6	73.3	81.5
Redfish	32.6	25.4	19.3	9.3		28.6	36.9	37.7	39.2	43.6	48.0	51.3	58.5	66.3	70.0	78.2
Matanzas	55.2	48.0	41.9	31.9	28.6		10.5	11.3	12.8	17.2	21.6	24.9	32.1	39.9	43.6	51.8
Big Carlos	63.5	56.3	50.2	40.2	36.9	10.5		4.4	5.9	10.3	14.7	18.0	25.2	33.0	36.7	44.9
New (Little Carlos)	64.3	57.1	51.0	41.0	37.7	11.3	4.4		4.1	8.5	12.9	16.2	23.4	31.2	34.9	43.1
Big Hickory	65.8	58.6	52.5	42.5	39.2	12.8	5.9	4.1		6.6	11.0	14.3	21.5	29.3	33.0	41.2
Wiggins	70.2	63.0	56.9	46.9	43.6	17.2	10.3	8.5	6.6		5.6	8.9	16.1	23.9	27.6	35.8
Clam	74.6	67.4	61.3	51.3	48.0	21.6	14.7	12.9	11.0	5.6		3.7	10.9	18.7	22.4	30.6
Doctors	77.9	70.7	64.6	54.6	51.3	24.9	18.0	16.2	14.3	8.9	3.7		7.8	15.6	19.3	27.5
Gordon	85.1	77.9	71.8	61.8	58.5	32.1	25.2	23.4	21.5	16.1	10.9	7.8		11.4	15.1	23.3
Capri	92.9	85.7	79.6	69.6	66.3	39.9	33.0	31.2	29.3	23.9	18.7	15.6	11.4		5.1	13.3
Big Marco	96.6	89.4	83.3	73.3	70.0	43.6	36.7	34.9	33.0	27.6	22.4	19.3	15.1	5.1		12.4
Caxambas	104.8	97.6	91.5	81.5	78.2	51.8	44.9	43.1	41.2	35.8	30.6	27.5	13.3	13.3	12.4	

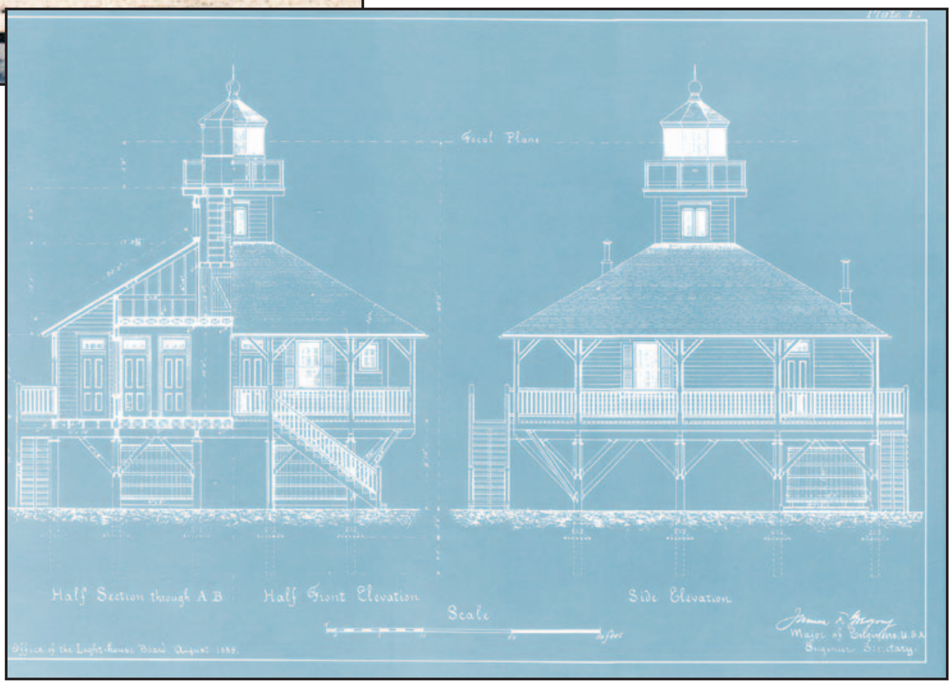
Table 1. (a-e)

In 1890, in order to illuminate the last dark spaces of the Florida coast, a lighthouse was lit on the southernmost tip of Gasparilla Island. Called Old Port Boca Grande Lighthouse, it served as a guidepost to Charlotte Harbor and was a square, house-type sentinel perched on steel stilts to protect it from the gnawing surf. In 1927, the iron pile Gasparilla Island Rear Range Lighthouse was constructed north of the old lighthouse to serve as an additional aid for harbor-bound traffic. Like its sister sentinel at Sanibel Island, its open framework design allowed wind and water to pass through unobstructed, and its lightweight piles were more easily anchored in the Gulf Coast's erosive shore than a masonry foundation.

—Elinor DeWire, *Guide to Florida Lighthouses* *© 1987.*



Old Port Boca Grande Lighthouse was abandoned in 1967 and fell victim to vandals and the elements. Local residents felt the elder sentinel should be preserved and had it transferred from federal to county ownership in 1972 for inclusion in a park. It was placed on the National Register of Historic Places in 1980. Late in 1985, the Gasparilla Island Conservation and Improvement Association assumed the responsibility of restoring the rapidly deteriorating structure. The project was successfully completed in November 1986. Through the assistance of the U.S. Coast Guard, the original imported French Fresnel lens was reinstalled. On November 21 of that year the beacon was ceremoniously relit and the Old Boca Grande Lighthouse is again an active federal aid to navigation.



Inlet Features

Inlets are natural or manmade channels connecting the coastal waters of the Gulf of Mexico to estuaries. A key feature of inlets is strong tide-induced currents that build up and modify supplies of sand, called shoals, adjacent to their channels. Inlets may migrate, stabilize, open, or close in response to changes in sediment supply, wave climate, tidal regime, back-bay filling or dredging. Changes in inlets occur on different time scales, ranging from hours during severe storm events to decades or even centuries.

For the mariner running an inlet, the most recognizable feature is the steep groundswell that builds across the inlet mouth, caused by waves interacting with the sea bottom where onshore swells encounter shoaling water. Figure 1 illustrates tide-generated and wave-generated features in a typical Southwest Florida inlet system. Sediment transport along the beach face, referred to as longshore or littoral drift, occurs on the Gulf side of barrier islands. It is generally north to south in Southwest Florida, although localized reversals are common. Figure 2 shows the elements of a typical inlet system; not all of the features illustrated may be present or well developed in all inlets.

Sand is deposited as shoals just inside and outside the inlet due to the reduction of current speed in these areas. Ebb-tidal deltas are created at the seaward margin-outside-of the inlet and retreat or bend in response to interaction with incoming waves and ebb tides. Large inlets, like Boca Grande and Big Marco, build extensive ebb-tidal deltas that may contain millions of cubic yards of sand. The sediment sources include material from the bay, material eroded from the main ebb channel, or longshore drift-deposited sand, that moves along the shore between the beach and the outer edge of the breaker zone due to waves approaching the shore at an angle.

Material brought out on the ebb tide is deposited on the swash platform. The breaking waves that the mariner experiences at the inlet entrance are a dominant feature on swash platforms and help create swash bars. Marginal channels may develop along the ends of barrier islands where incoming (flood) tidal flow is enhanced by wave-generated currents; the swash channel at Boca Grande is a good example of this feature. These channel features, at boat deck level, appear to have the smoothest water surface and absence of breakers and, under favorable weather, may offer the mariner a short route through an inlet.

Spits occur where there is a high rate of longshore sediment transport coupled with a small tidal prism in the estuary. Spit growth may restrict tidal flow in the main channel and cause downdrift migration or closure of the inlet. Migration of barrier island spits along this reach of the Florida coast is generally southward, in the direction of historic net longshore transport. The extension of Captiva Island, closure of Blind Pass, and migration of Little Marco Pass are illustrative of this process.

Flood (incoming) tidal currents transport sediment landward through the inlet via the main channel, producing a similar shallow water, delta-like feature on the bay (inner) side of the pass. The interplay of ebb and flood tides on this flood tidal delta creates spits and spill-over lobes where flood currents run strong. This dynamic process at Redfish Pass has caused shoaling within the dredged channel to South Seas Resort. Flood tidal deltas are less prone to change than ebb tidal deltas in Southwest Florida. They may become stabilized by seagrasses and mangroves over time, serving as nurseries for juvenile fish and important fishing grounds.

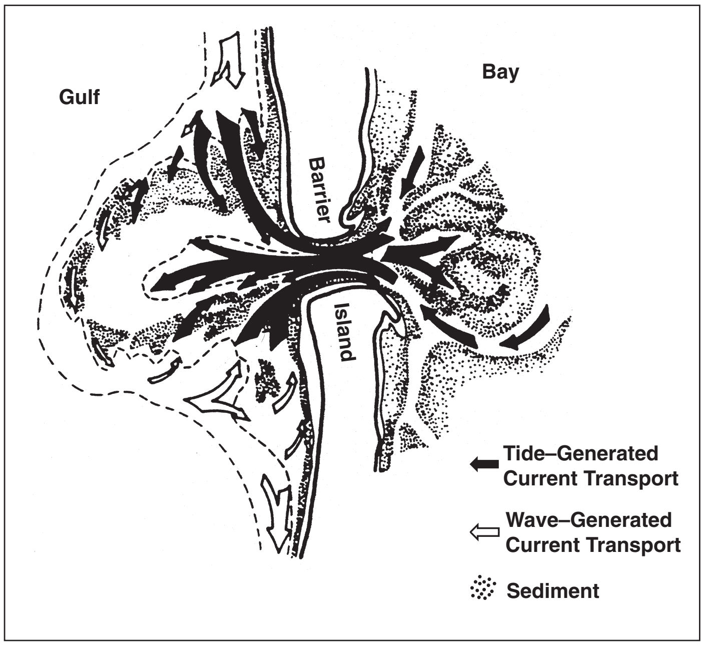


Figure 1.
Tide-generated and wave-generated transport features in a representative inlet system (from Smith, 1984).

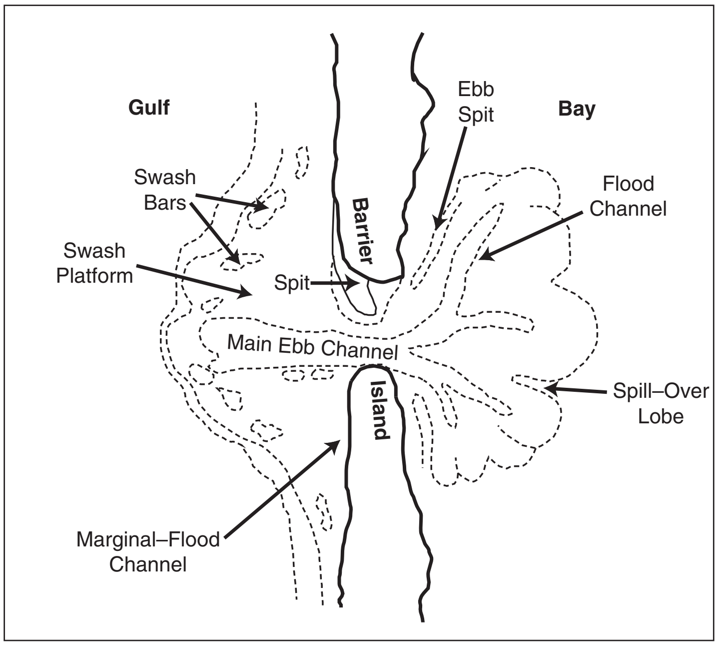


Figure 2.
Tidal inlet features (from Smith, 1984).

Types of Inlets

The form of seaward-flowing, ebb-tidal deltas is determined by tidal and wave energies. The mix of these two forces determines the movement and deposition of sediments. The character of an inlet — its shape, dynamics, and navigability — evolves over time as the inlet adjusts to changes caused by the interaction of tides and waves. Since Southwest Florida is a low wave energy coastline and the mean tidal range is relatively small (generally no more than 3 feet), a delicate balance exists between tide- and wave-dominated conditions. A slight decrease in tidal prism (e.g., due to bayside filling) may cause an inlet to change from tide-dominated to wave-dominated. Likewise, a change in wave energy reaching the inlet due to sediment accumulation and spit development along the beach face may offset the alignment of the ebb delta to the inlet.

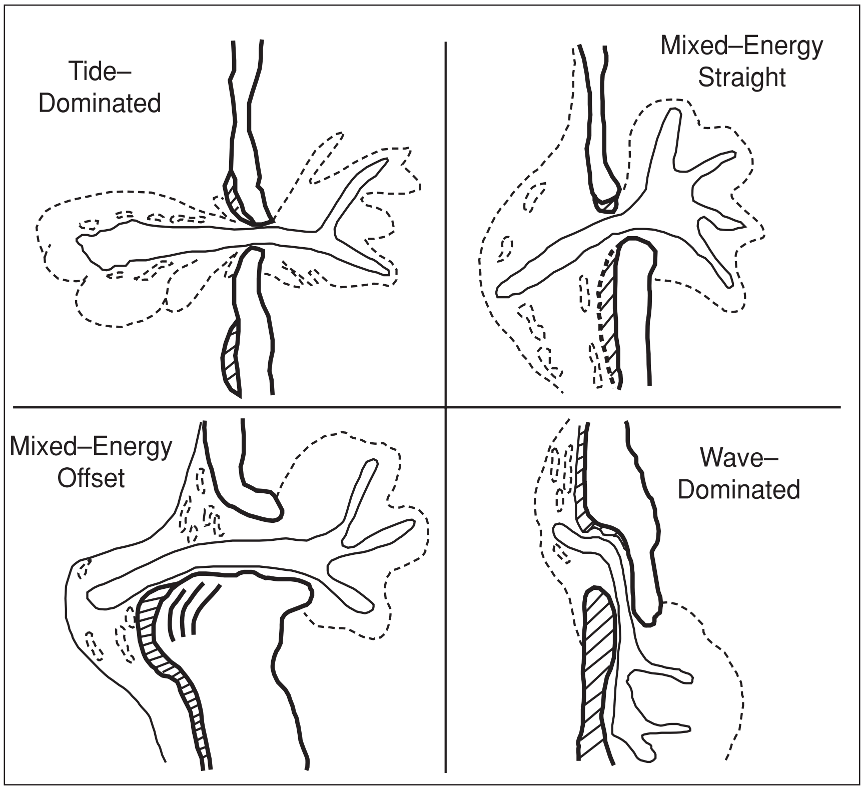
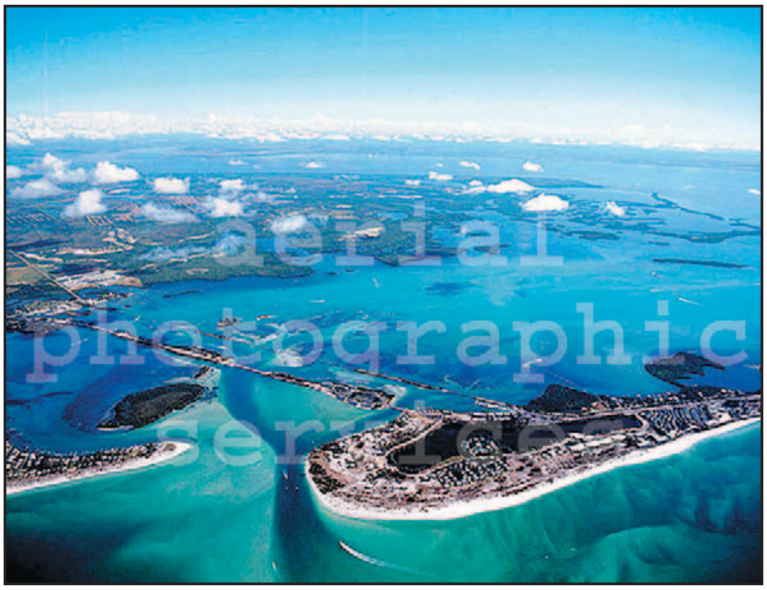


Figure 3.
Inlet types along the Southwest Florida Coast (from Davis Jr. and Gibeaut, 1990).



Gasparilla Pass, looking southeast past the causeway and abandoned railroad trestle to Gasparilla Sound with Charlotte Harbor in distance.

In addition to these natural forces, shoreline engineering through construction of groins, jetties, and bulkheads — features designed to stabilize the shoreline by holding beach sand in one place — can dramatically alter the supply of sediment and the course of development and shape of an inlet. Another factor leading to inlet alteration is caused by beach renourishment, which can contribute to pass shoaling as added sand moves via longshore drift.

Figure 3 depicts four types of inlets found in Southwest Florida, based on the shape of ebb-tidal deltas: tide-dominated, wave-dominated, mixed-energy with straight shape, and mixed-energy with offset shape. The Gulf is to the left side of the diagram and the bay side is to the right, as in Figures 1 and 2.

The signature feature of tide-dominated inlets is a well-defined main ebb channel with deposits of beach sand on adjacent Gulf shores. Boca Grande and Redfish Pass are good examples. These inlets have relatively stable ebb tidal deltas. Mariners should exercise caution in approaching tide-dominated inlets from the Gulf during falling tides because maximum ebb current velocities can be high. A combination of strong on-shore winds and peak ebb tide can be especially hazardous due to the wave amplitude and steepness.

Wave-dominated inlets are very unstable and prone to migration along the coastline. As wave-dominated inlets migrate, the main channel lengthens and becomes hydraulically inefficient for tidal exchange. Big Hickory is an example of such a "wild" inlet. Wave-dominated inlets are susceptible to closure by the formation of new, more hydraulically efficient inlets when storms breach spits on the updrift side. Such an event occurred when a hurricane formed Redfish Pass in 1921 and, over subsequent years, captured the tidal prism of Blind Pass and closed it for extended periods.

Mixed-energy inlets have ebb-tidal (Gulf side) deltas shaped by a combination of tidal and wave forces. Maximum ebb and flood tidal current velocities tend to be equal and have a lower magnitude in mixed-energy inlets than other inlet types. The main ebb channel may shift its location due to drifting beach sediment. Where littoral drift is pronounced, a channel offset may occur.

Gordon Pass is an example of a mixed-energy inlet with a straight ebb-delta shape. Its main ebb channel is periodically dredged on an alignment perpendicular to the shore (east-west heading). Net littoral drift, from north to south, builds a shoal over the swash platform.

Big Marco, Captiva and Gasparilla inlets are mixed-energy systems with an offset alignment. The approach from the Gulf to the main ebb channel in these inlets is from the south, off the north end of the southern barrier islands. Once inshore of the swash bar shoals, the channel parallels the curved north shore.

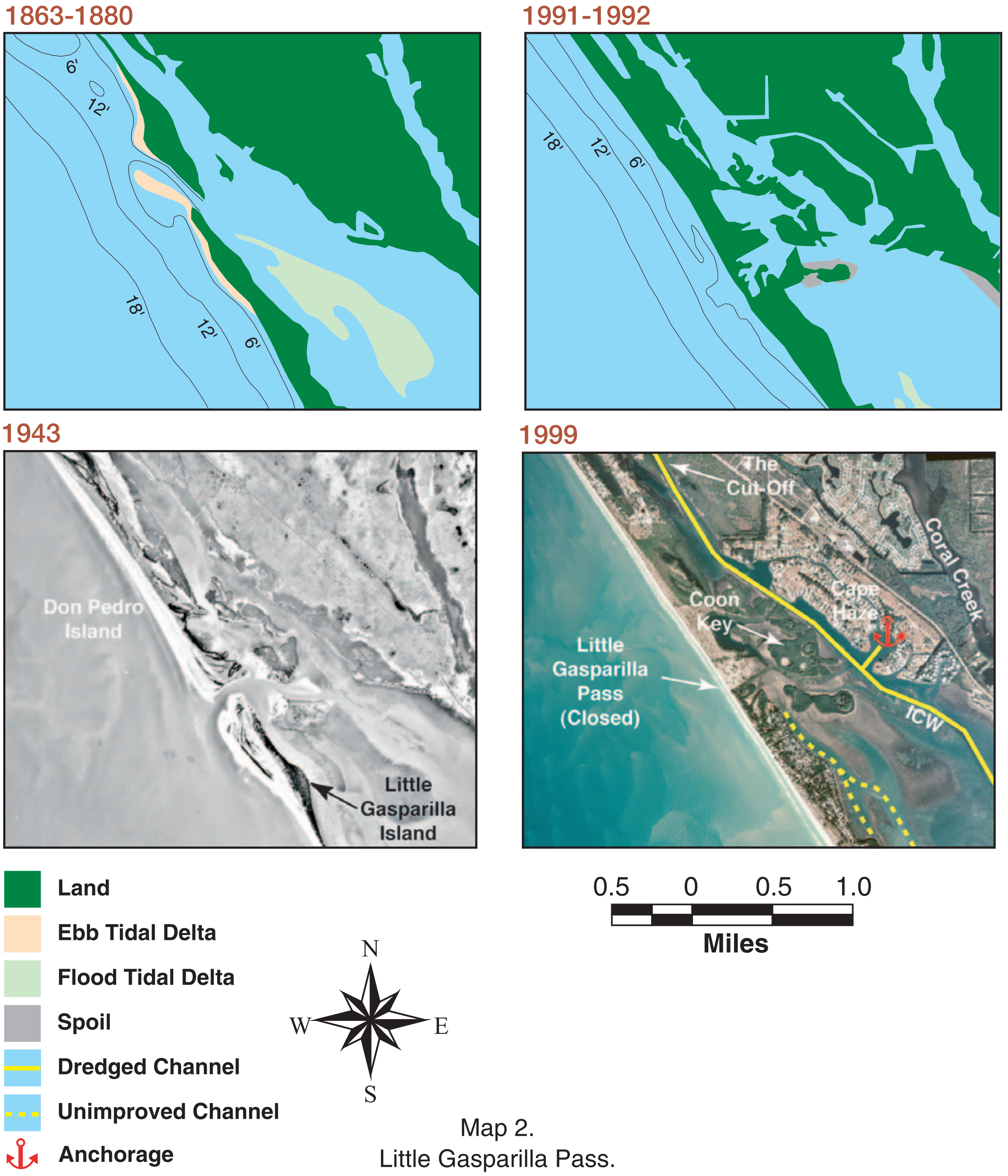
Historical Changes

Changes in inlets are revealed by historic charts and aerial photographs that provide an indelible image of the location and shape of these highly dynamic, visible features of the region's boating geography. The following section offers a description of these changes as seen through a selection of maps that recreate antecedent inlet features, along with historic and contemporary aerial photographs illustrating changing inlet conditions.

Little Gasparilla (Boca Nueva) Pass

This inlet existed in the 1880s about 1 mile south of Bocilla Pass (Historical Geography of Southwest Florida, Volume One) and 2 miles north of Gasparilla Pass (Map 3). The inlet was closed naturally by 1957. Pre–development conditions in Little Gasparilla Pass (1863-80 Map) show a mixed-energy ebb delta. The spit at the mouth of the inlet indicates a northward net littoral drift, opposite that of Bocilla Pass to the north and Gasparilla Pass to the south. The 1943 photograph shows that the main ebb channel within the inlet throat had been realigned more east-west and a marginal flood channel had developed along the north shore of Little Gasparilla Island. At that time, the ebb delta had a slight downdrift (south) orientation. There are remnants of a large flood-tidal delta which, with the inlet's closure and a reduction in the tidal exchange, have become stabilized with seagrasses.

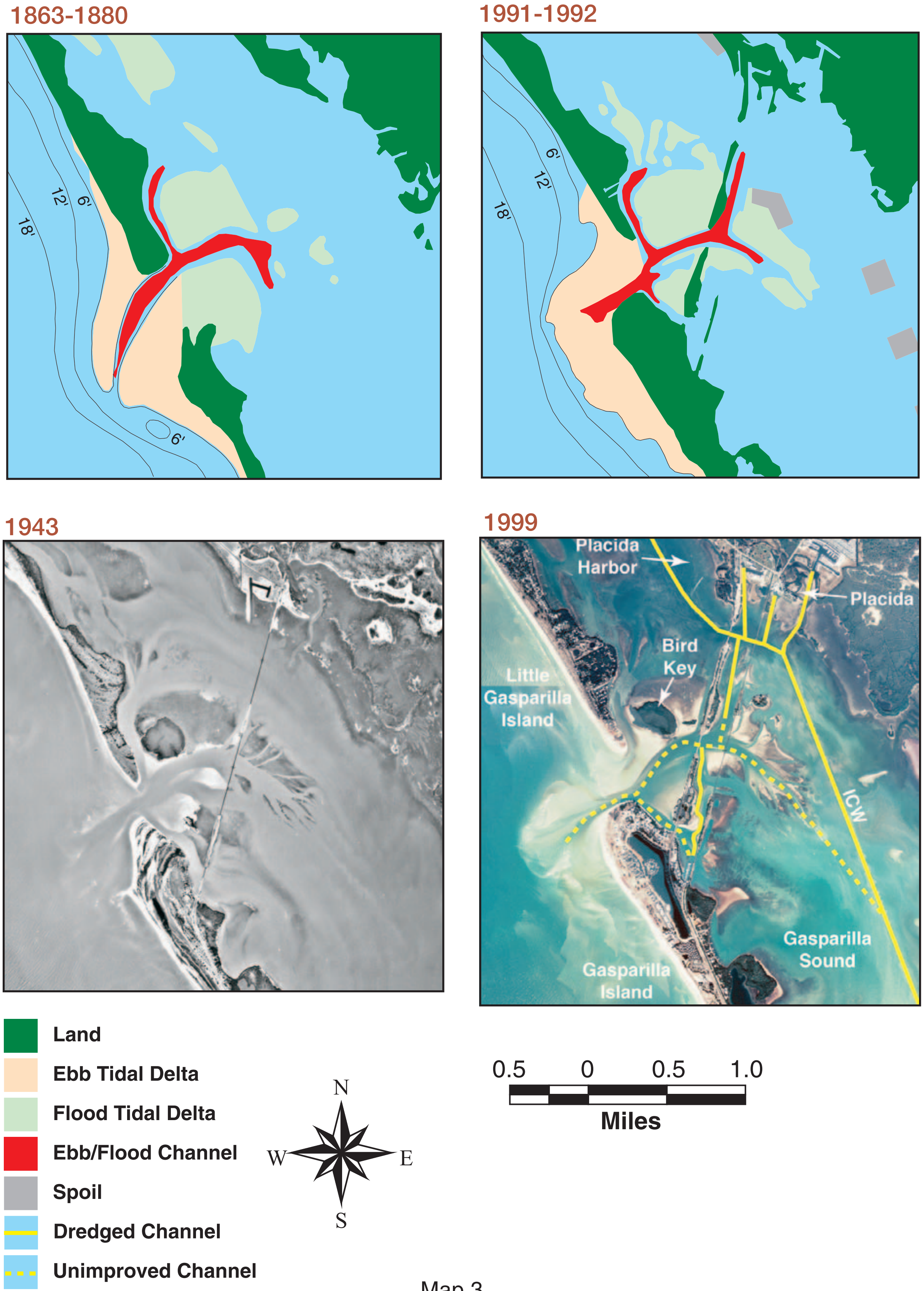
The bayside geography, shown in the 1991-92 map, has been drastically altered by land development on the Cape Haze peninsula and dredge-and-fill associated with the Gulf Intracoastal Waterway (ICW). Coon Key has spoil deposits from the ICW dredging of the 1960s. An anchorage, popular with boaters cruising the ICW, is situated in a dredged basin, adjoining a residential community, on the mainland (1999 photo).



Map 2.
Little Gasparilla Pass.

Gasparilla Pass

This is a large inlet, stable since the 1860s (Map 3). The ebb-tidal delta exhibits a mixed energy offset configuration (1863-80 map). The notable change since the 1860s has been a large increase in its downdrift, southward orientation (1991-92 map). Though Gasparilla is an unimproved inlet, dredge-and-fill associated with construction of the bayside causeways has modified the flood tidal delta (1943 photo). Bird Key has developed on flood deltaic sediments. A dredged channel south of the road causeway leads to a popular marina on the north end of Gasparilla Island (1999 photo). Ebb-flood channels are well developed and deep; boaters use them when running the inlet between the Gulf and Gasparilla Sound.



Map 3.
Gasparilla Pass.

Boca Grande

Boca Grande is the primary inlet serving Charlotte Harbor. Because of its size, width and large tidal prism, the inlet has been stable over time and — uniquely — has no flood-tidal delta (Map 4). The main inlet channel is deep (exceeding 70 feet in the throat), but abruptly shoals to less than 6 feet along the north lobe of the ebb-tidal delta (1863-80 and 1991-92 maps). Tarpon fishermen work this edge during the season.

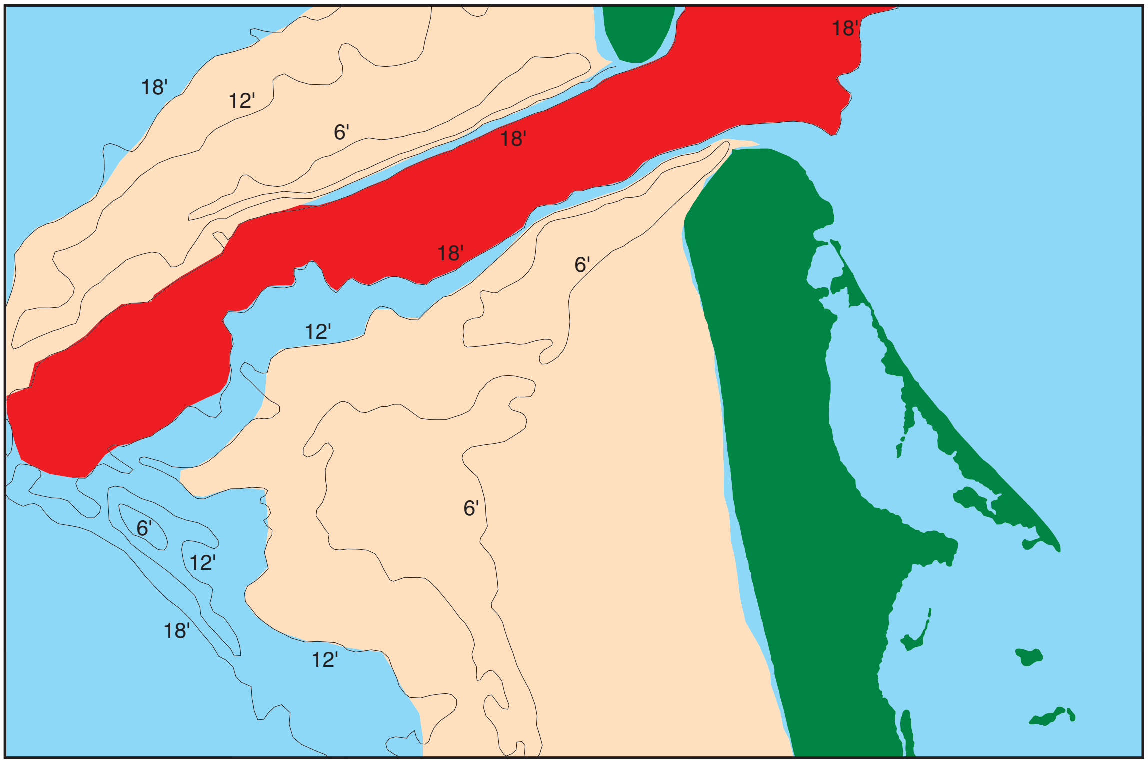
This is a federally maintained inlet. Port Boca Grande, at the south end of Gasparilla Island, once served as the terminus and storage facility for phosphate, shipped by rail from inland quarries and across the causeway at Placida (see Gasparilla Inlet photo in Map 3). The tide-dominated ebb delta is extremely large and asymmetrical. There is a narrow, 2.5-mile-long northern lobe containing spot

...Click went the reel, down went his thumb on the leather brake, and with a long, steady movement he swung his rod to the vertical position, when he took most of the pressure off the brake. Whiz! went the reel with lightning speed in the fraction of a second. Then, with a glorious leap, out sprang the king of game fish. His tail was three feet above the water, his head perhaps eight, while his six feet of polished silver side flashed in the sun.

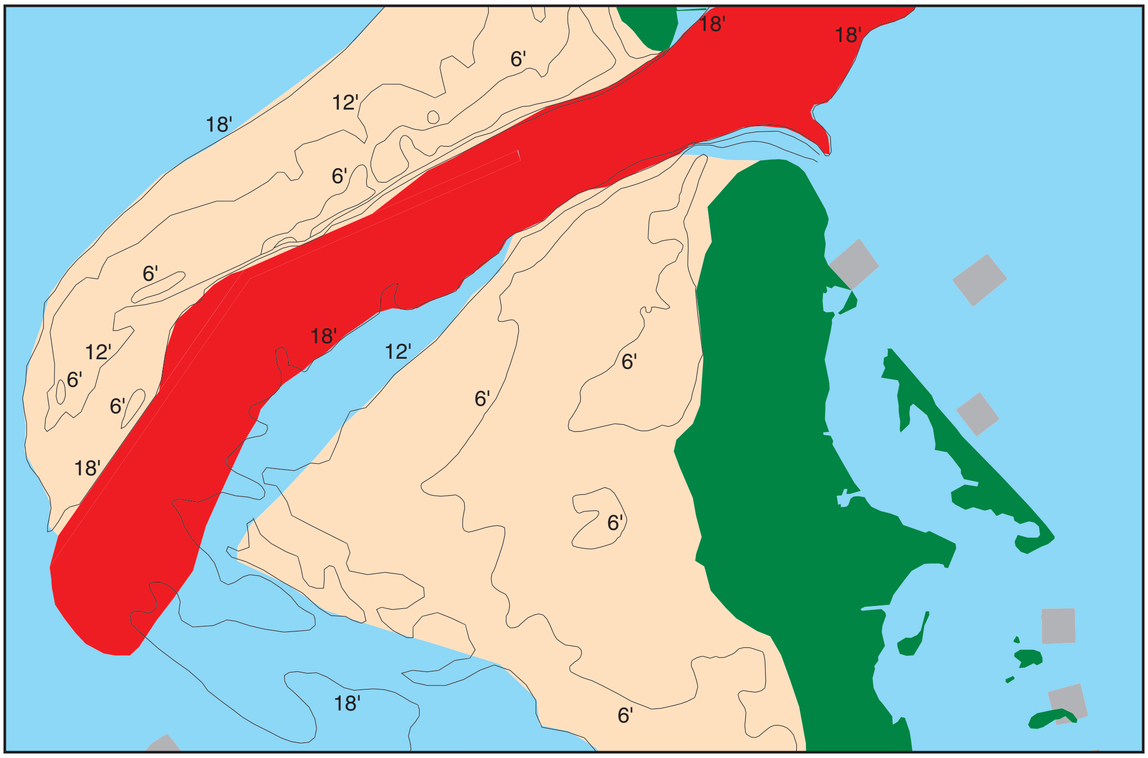
—O.A. Mygatt, "A Good Day's Tarpon Fishing" 1890

—*Tales of Old Florida* ©1987.

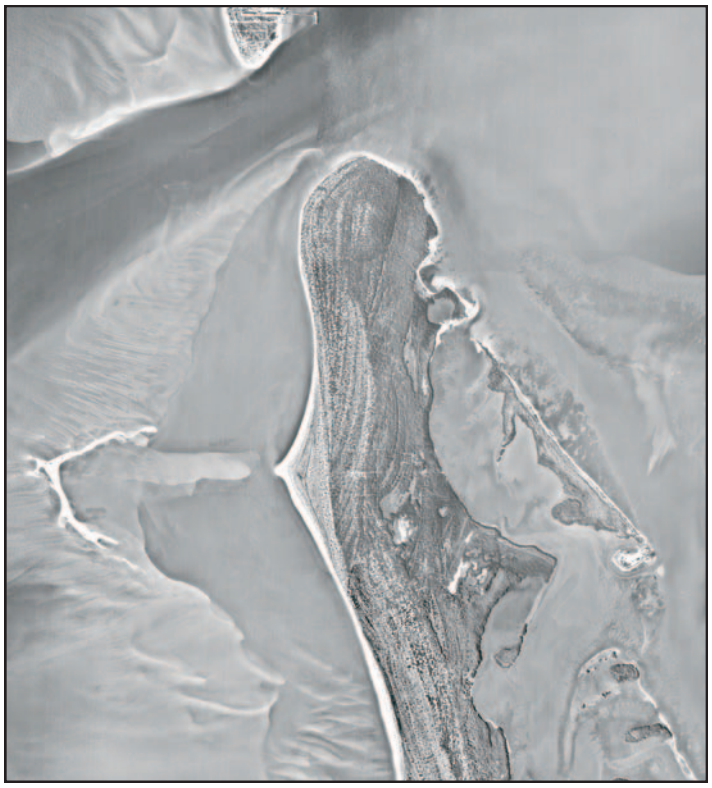
1863-1880



1991-1992



1944

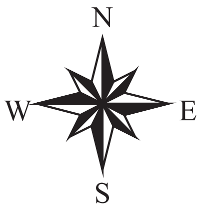


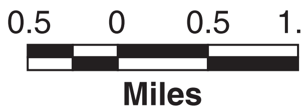
1999

Map 4.
Boca Grande.

Johnson Shoals, 1981.

- Land
- Ebb Tidal Delta
- Ebb/Flood Channel
- Spoil
- Dredged Channel
- Unimproved Channel
- Anchorage



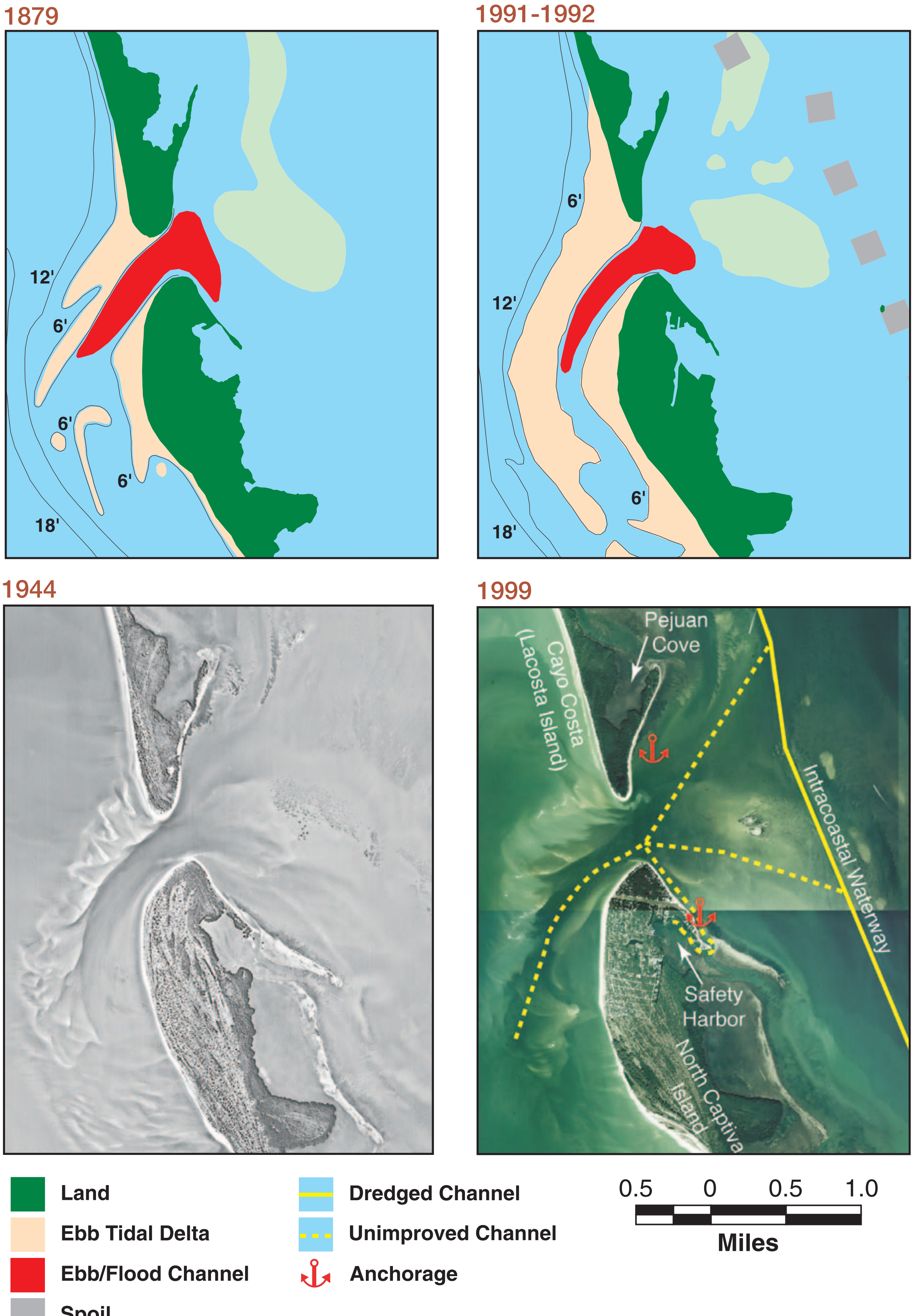


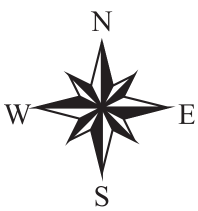
shoals less than 2 feet deep. The broad southern lobe that covers an extensive offshore area, Johnson Shoals, nourishes beach development on Cayo Costa, as sand is accreted and beach ridges are formed and move shoreward. Murdoch Point is a cuspate headland where erosion is taking place (1999 photo). The 1944 aerial photograph shows the parallel beach ridges on Cayo Costa.

Johnson Shoals is a dynamic shoreline feature that in 1944 was an offshore bar. By 1999, it had migrated east and was attached to Cayo Costa barrier island. At times, this shoal has become stabilized and vegetated, as shown in the 1981 oblique aerial; when this occurs, Johnson Shoals is a prime fair-weather destination for recreational boaters.

Captiva Pass

Captiva Pass (Map 5) retains much of its pre–development form (1879 map and 1944 aerial photograph), with a large flood-tidal delta on the bayside and a mixed energy ebb-tidal delta, distinctly asymmetric and south drift-tending, on the Gulf side (1991 map). Both deltas are large, and the bayside form has many lobes, relatively deep water, and an extensive seagrass cover. The Gulf side ebb delta is similar in form to Big Sarasota Pass, with a main inlet channel that curves south and runs parallel to the North Captiva Island shore. This inlet is unmarked and requires local knowledge, but is a popular boating destination with anchorages adjoining the bayside inlet shore. Some amenities for boaters are available at Safety Harbor (1999 photo).





Map 5.
Captiva Pass.

Redfish Pass

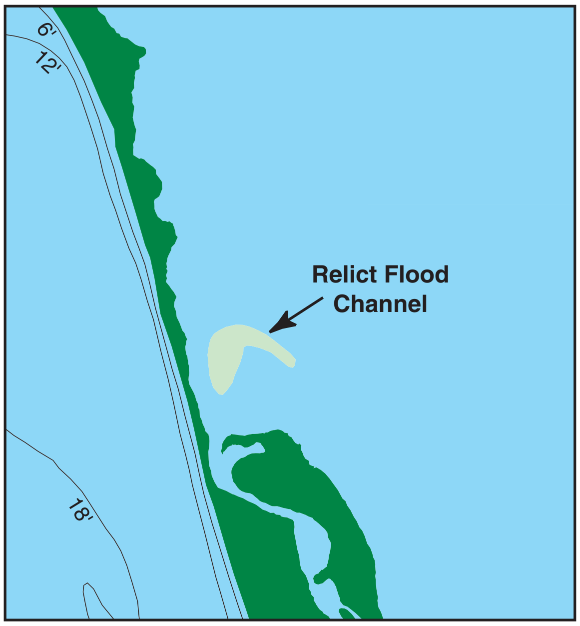
The hurricane of 1921 created Redfish Pass, which separates Captiva and North Captiva Islands (Map 6). Not surprisingly, the 1879 map shows a relict flood channel of an antecedent inlet. This narrow ribbon of barrier island is subject to overwash of storm waves from the Gulf to the bayside, as occurred in 1960 (see aerial and ground photos). The pass has distinctive flood- and ebb-tidal deltas and a pronounced, deep water, ebb/flood channel in the inlet throat (1944 photo and 1991-92 map).

The Captiva Erosion Prevention District removed sediment from the offshore bar on the ebb-tidal (Gulf side) delta to renourish the beach on Captiva Island in 1981 and 1988. A dredged channel, which leads from the Intracoastal Waterway to South Seas Resort, a destination at the north end of Captiva Island, crosses the apron of the flood-tidal delta near the inlet (1999 photo). This approach channel is subject to shoaling because of strong tidal currents that transport and redeposit sediment from the Gulf beach. The inlet has a tide-dominated ebb delta with nearly symmetrical north and south-side depositional lobes and channel margin bars. Redfish Pass competes directly with Blind Pass, located 5 miles south, for water to flush Pine Island Sound. Since the emergence of Redfish Pass in 1921, the inlet's large tidal prism has been a contributing factor to the demise of Blind Pass.

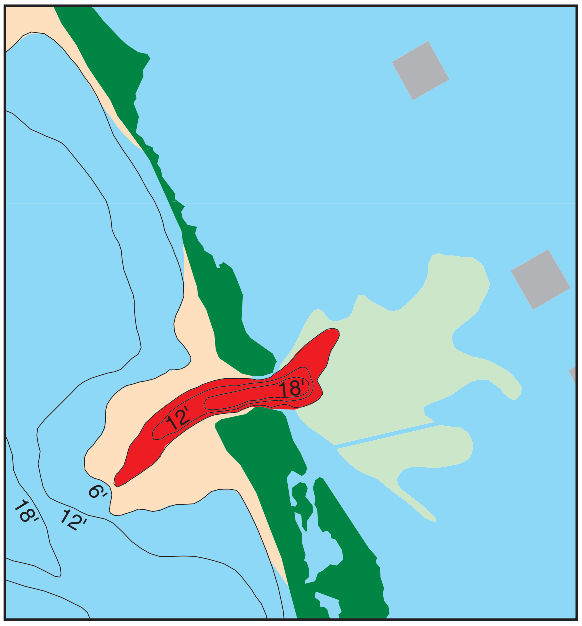
Ground view of overwash.

1960 aerial view of overwash.

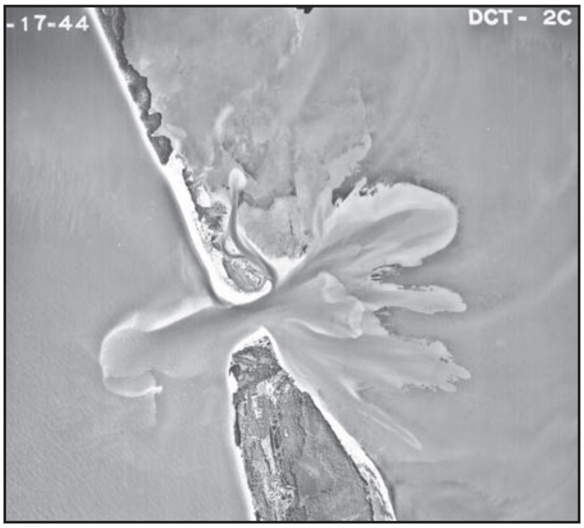
1879



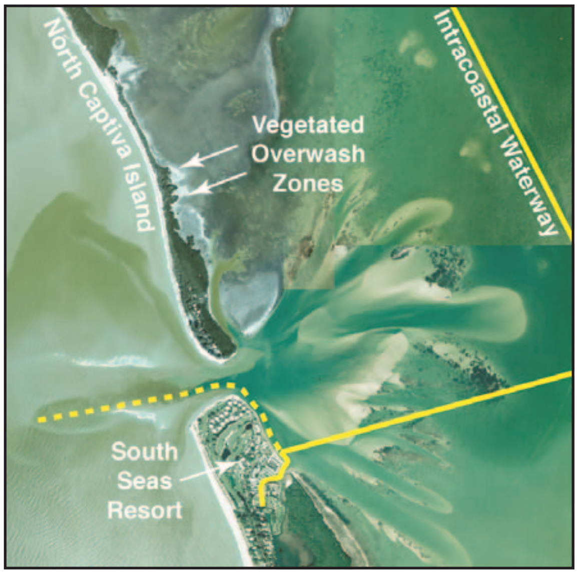
1991-1992

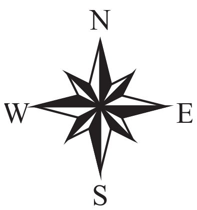


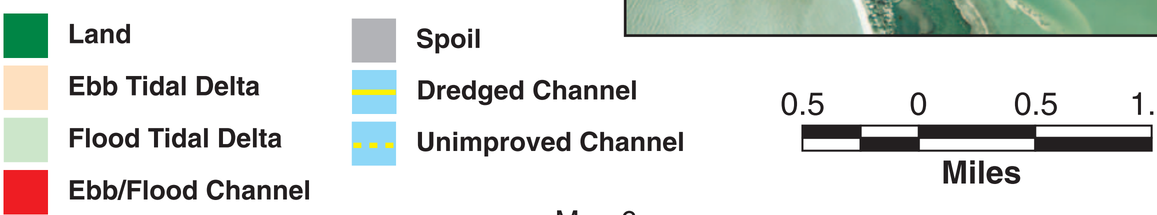
1944



1999





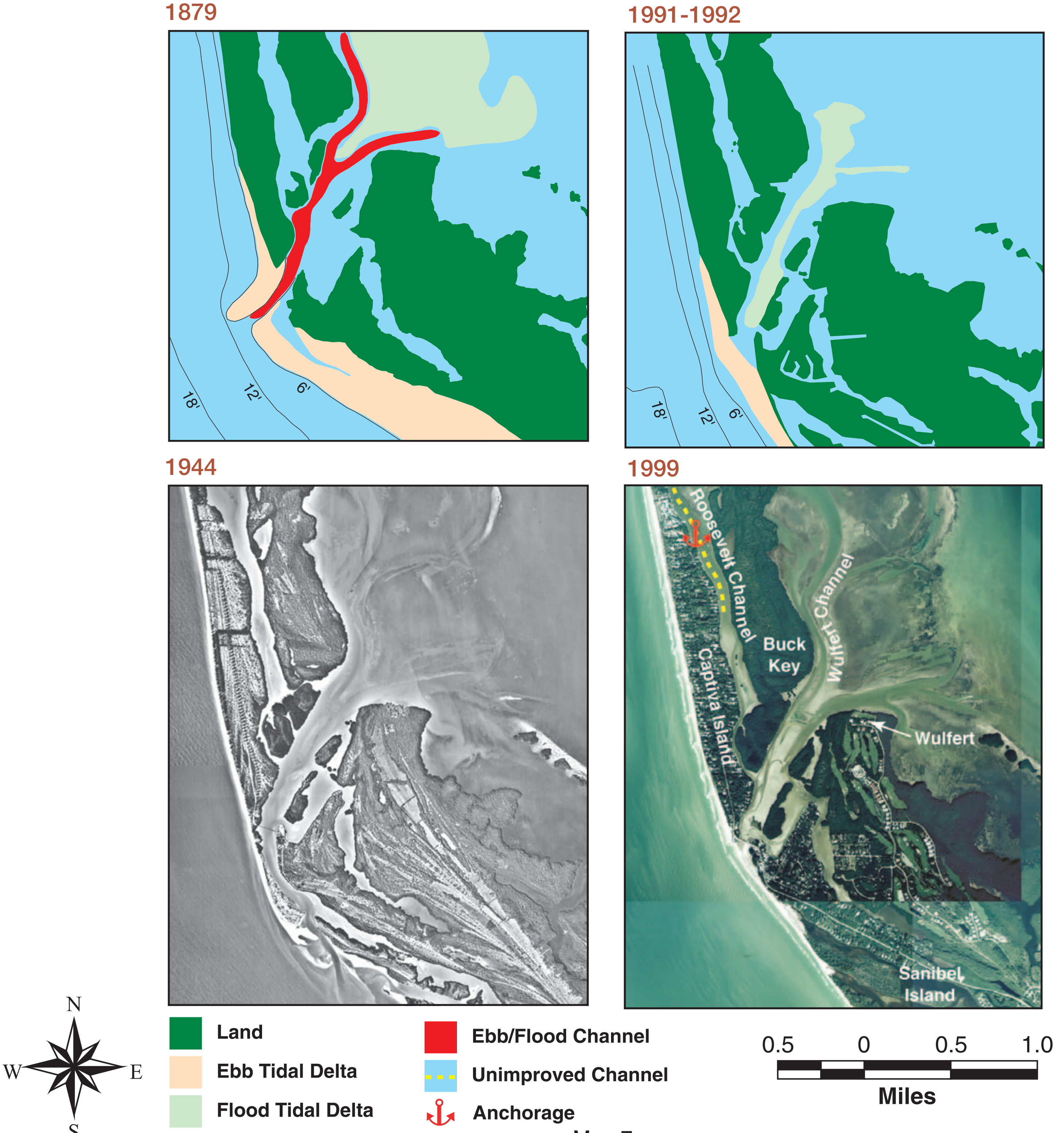


Map 6.
Redfish Pass.

Blind Pass

Blind Pass separates Captiva Island from Sanibel Island, though someone traveling overland would be hard-pressed to see where one island ends and the other begins (Map 7). Since Redfish Pass was formed by the hurricane of 1921, Blind Pass's future has been sealed: it lost most of Pine Island Sound's tidal prism, which led to its becoming a wave-dominated, "wild" inlet. An active beach renourishment program that provides a source of sediments to the Gulf shore of Captiva Island has continued to feed the existing south-trending spit, more than 1 mile in extent. Continued spit growth and placement of beach sand on northern Sanibel Island in 1996 contributed to the most recent closure of the inlet (1991-92 map). Its recent history is varied: the inlet closed in 1960, opened in 1972, closed again in 1977, only to open in 1982 and close again in 2000. The Captiva Erosion Prevention District dredged gulfward from the bridge to open the pass in 2000, not for navigation, but to provide some flushing for lower Pine Island Sound. The pass reclosed within a year.

Before Redfish Pass opened, Blind Pass was an inlet with a mixed-energy downdrift offset form (1879 map). The flood-tidal delta, developed under those pre-Redfish Pass conditions, was large and well-defined. Over the years, with the demise of the pass, this bayside feature has become stabilized with an extensive seagrass community. Boat access, from the Gulf to Pine Island Sound, in the pre–development period (1944 aerial), was through Wulfert and Roosevelt Channels. No longer a thoroughfare, Roosevelt Channel today is a popular boating destination, adjoining the town of Captiva, and a secure anchorage (1999 photo).

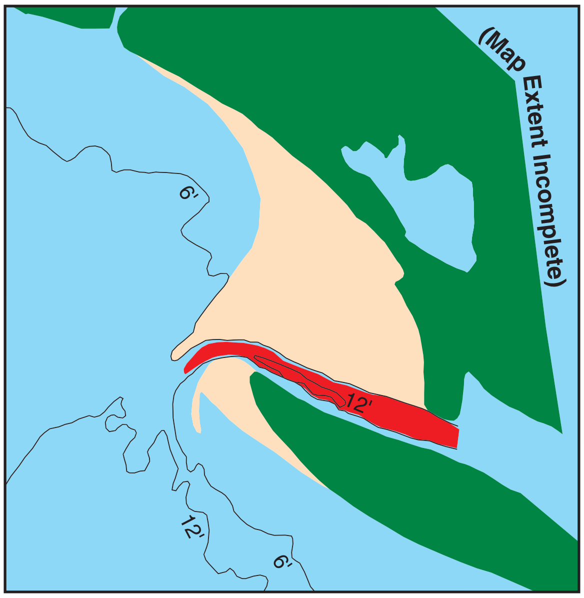


Map 7.
Blind Pass.

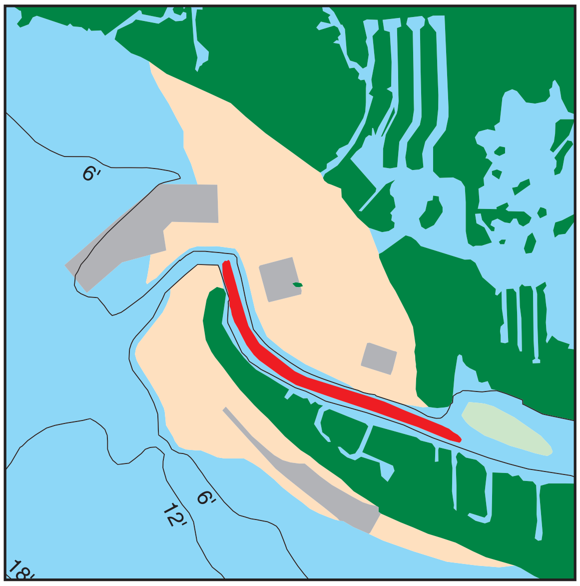
Matanzas Pass

Matanzas Pass has been remarkably stable over the past century (Map 8). It has a tide-dominated ebb delta due to its sheltered location from northerly winds in the lee of Sanibel Island and San Carlos Bay (1928 map). It has been federally maintained since 1961; spoil taken from the inlet has been placed on the north tip of Estero Island (1991-92 map). A small flood-tidal delta is situated inshore from the bridge connecting Ft. Myers Beach and San Carlos Island, immediately north of the anchorage (1944 and 1999 photographs).

1928



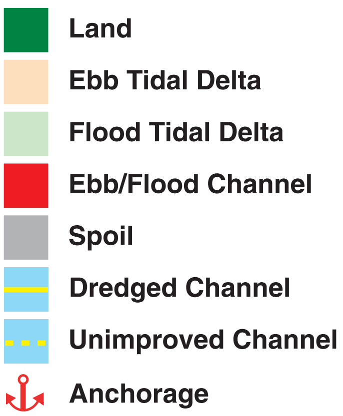
1991-1992

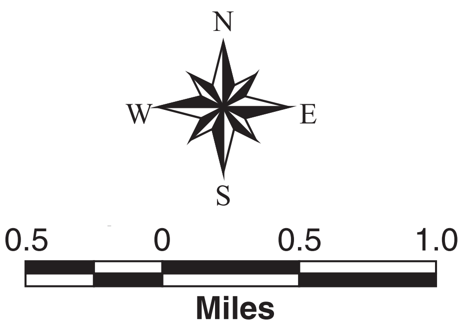


1944

1999

The toll bridge over Matanzas Pass, linking Estero Island with the mainland by means of a single-lane, rutted road, cost 54 cents in 1921. With the opening of the wooden drawbridge, the beach boomed and got a new identity, as historic Estero Island became Fort Myers Beach. A hurricane in 1926 washed out the narrow bridge, which was then temporarily rebuilt; two years later a new, shorter highway and a new bridge replaced everything.





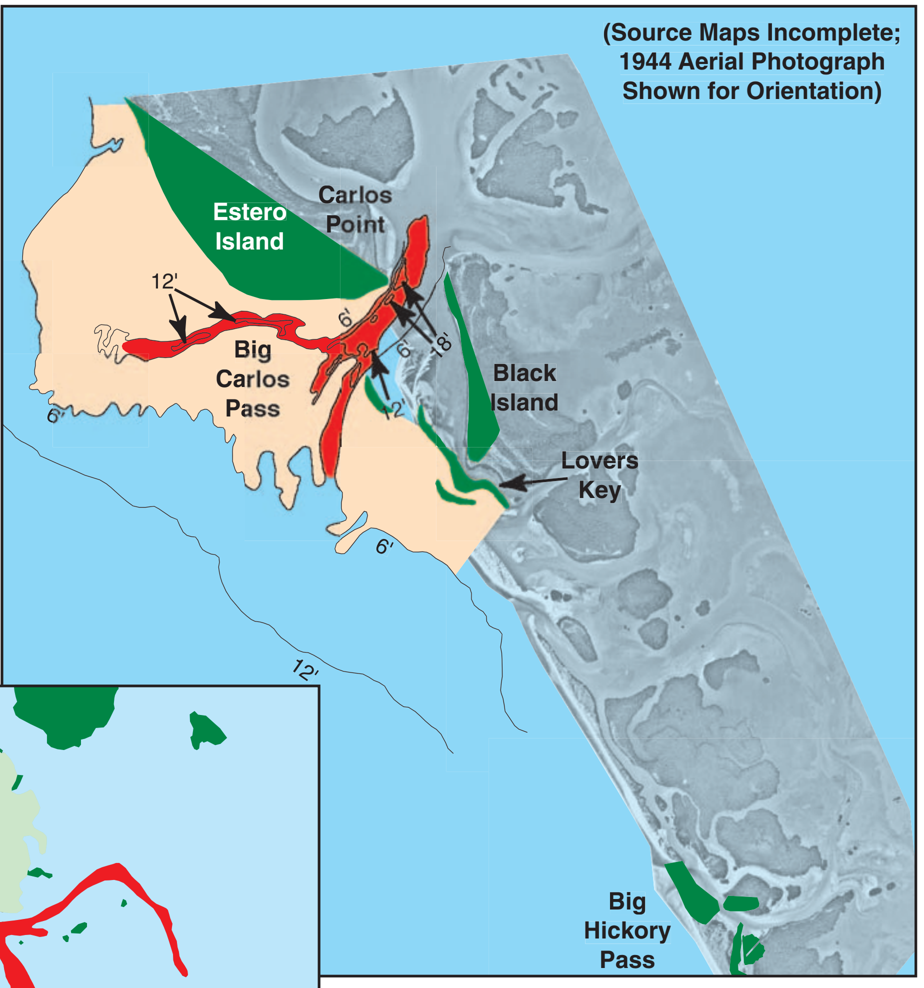
Map 8.
Matanzas Pass.

Estero Bay Passes: Big Carlos, Un–named, Little Carlos, Big Hickory

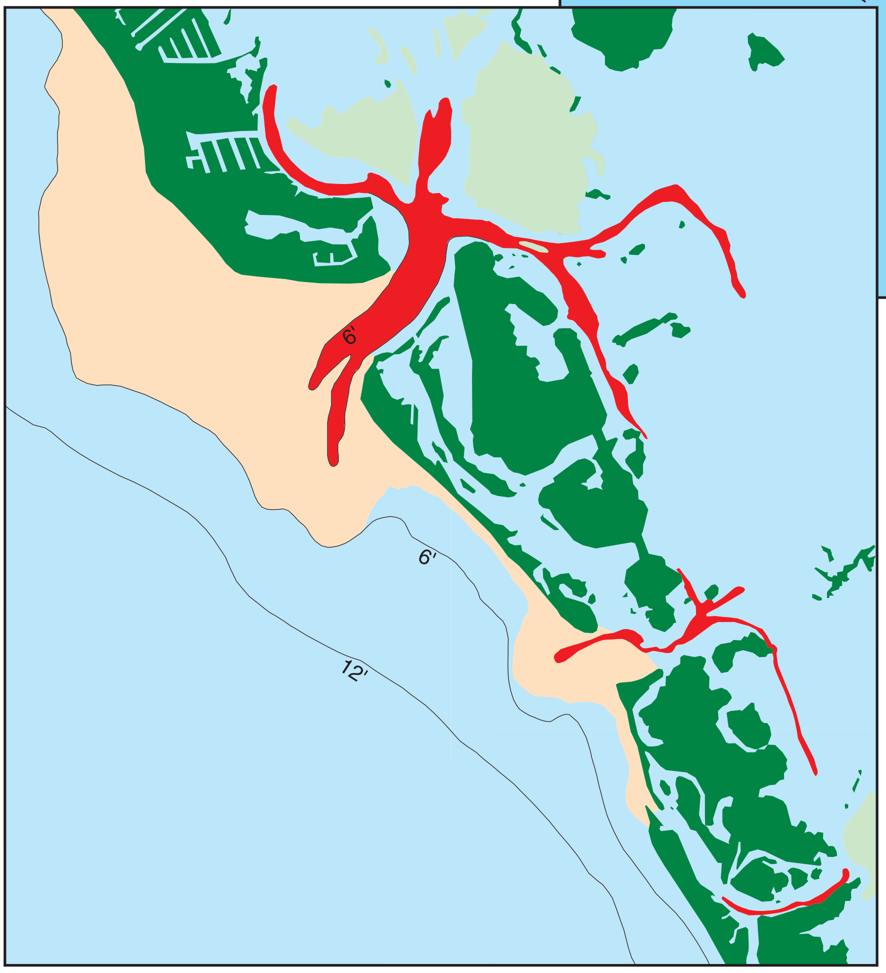
Tidal flushing for Estero Bay occurs through multiple inlets along a 3-mile stretch of the coast, south of Estero Island and north of Little Hickory Island (Map 9). Big Carlos Pass, the largest of these inlets, with a deep, wide channel, has remained essentially unchanged over the past century (1908-28 and 1991-92 maps). It has a tide-dominated ebb delta, due to the large prism and the low wave energy along this reach of the coast, sheltered from northerly storm waves by the coastline offset at Sanibel Island. Historically, there has been accretion of spits and beach ridges on both sides of Big Carlos Pass.

Pre–development era charts show Little Carlos Pass between Big Carlos and Big Hickory Passes; New Pass was nonexistent during the pre–development period. The 1944 aerial photograph shows the location of Little Carlos and New Pass. Development of New Pass appears to have resulted from hurricanes during the 1944-47 period. New Pass in 1944 shows a small ebb-tidal delta, but this has changed in recent years, as a substantial lobe has developed off the Gulf side.

1908-1928

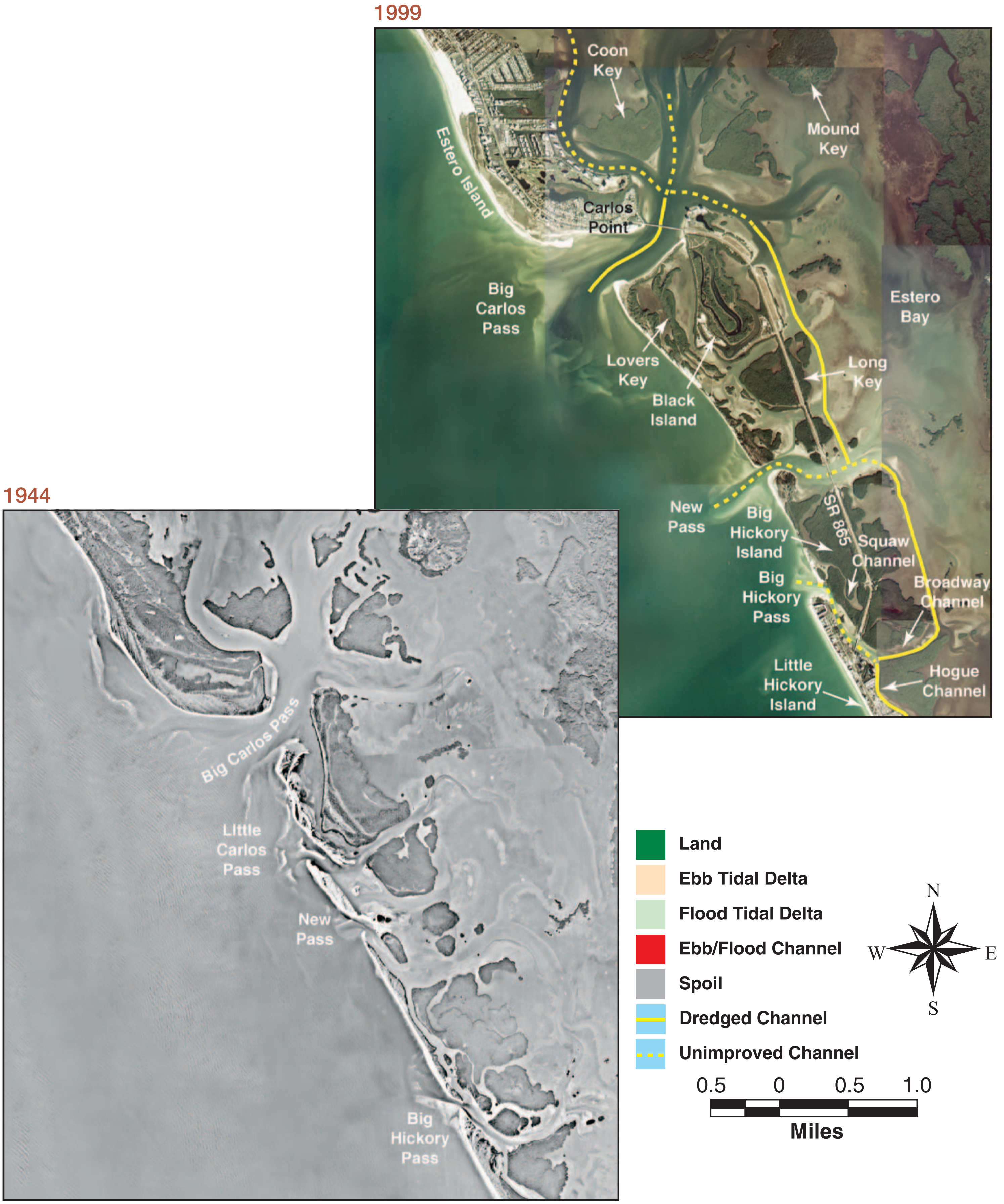


1991-1992



Because of the low energy wave climate, tide-dominated conditions prevail along the shoreline. Big Hickory Pass is a small, "wild" inlet that has migrated in a northerly direction over the past century. It was named for adjacent Big Hickory Island, not for the size of the inlet. Its history is marked by periodic openings and closings. Little or no ebb delta is present, though occasionally a small shoal builds from the south side and trends northwestward across the inlet mouth. Large, stable flood-tidal deltas developed bayside of these inlets over the past century, and large portions are covered with dense mangrove islands and seagrass communities.

Construction of the Route 865 causeway in the mid-1960s, linking Ft. Myers Beach (Estero Island) and Bonita Beach (Little Hickory Island), significantly altered inlet dynamics south of Big Carlos Pass. The causeway closed several tidal channels between Black Island and Little Hickory Island. With these closures, the islands west of Long Key emerged and attached themselves to Lovers' Key.

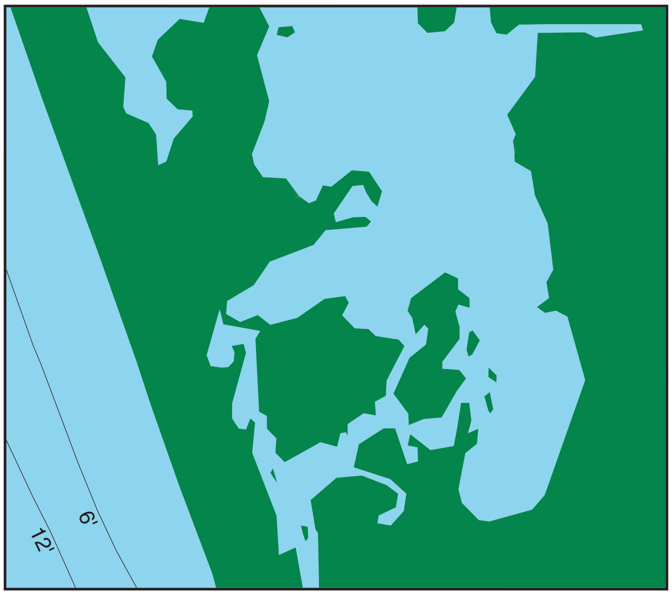


Map 9.
Estero Bay Passes.

Little Hickory Pass

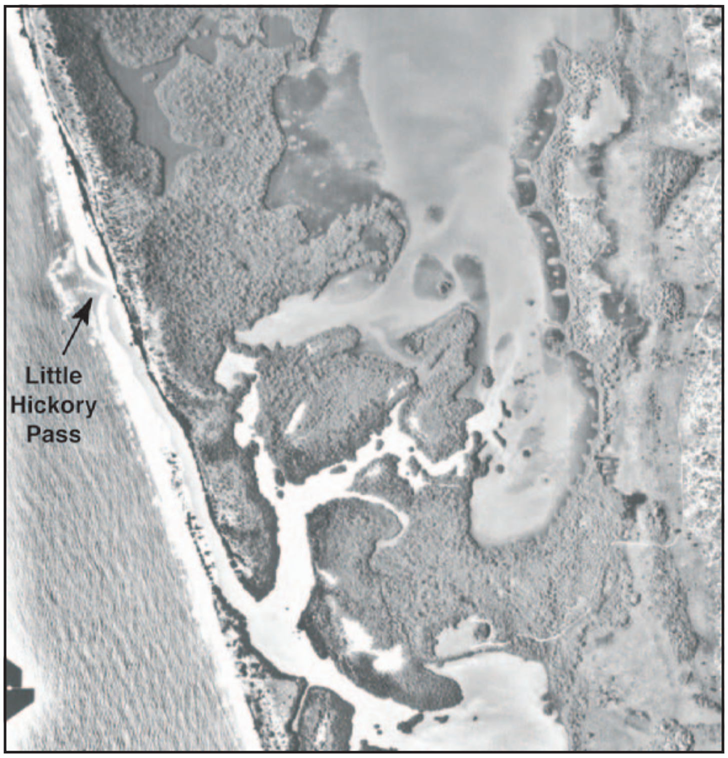
Little Hickory Pass is a closed inlet that ceased to exist in the early 1960s when developers closed the inlet in order to build an access road to beachfront properties. (Map 10). The 1944 aerial photograph shows the "wild" inlet, with tide-dominated conditions, no ebb or flood tidal deltas, and a prograding (growing) northward-trending spit at the pass entrance. The inlet's closure, coupled with construction of the causeway connecting the mainland and Little Hickory Island at Bonita Beach, has decreased water circulation within Little Hickory Bay (1991-92 map and 1999 photo).

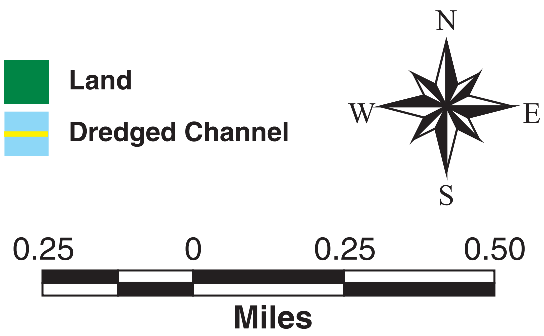
1991-1992



1999

1944

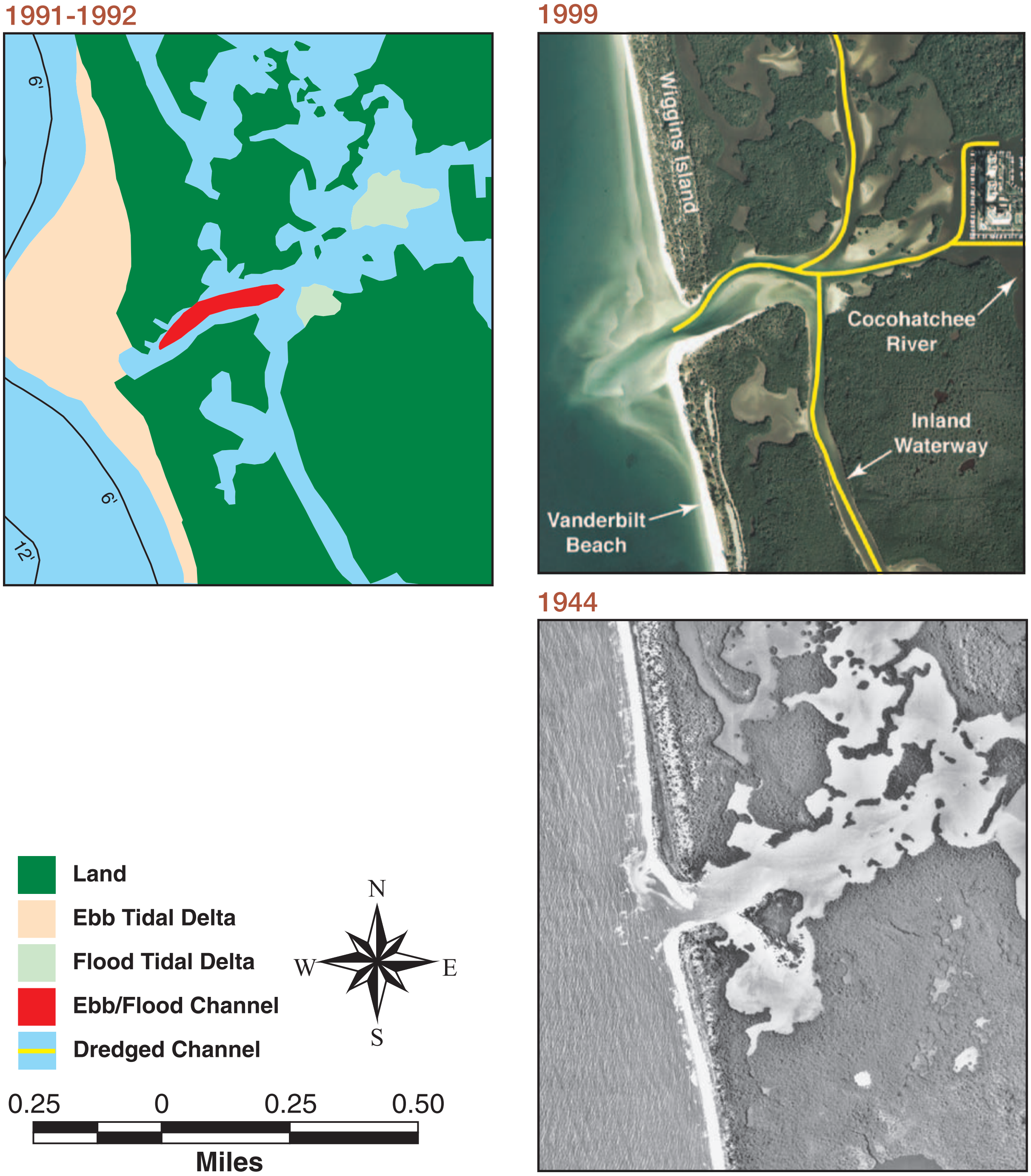




Map 10.
Little Hickory Pass.

Wiggins Pass

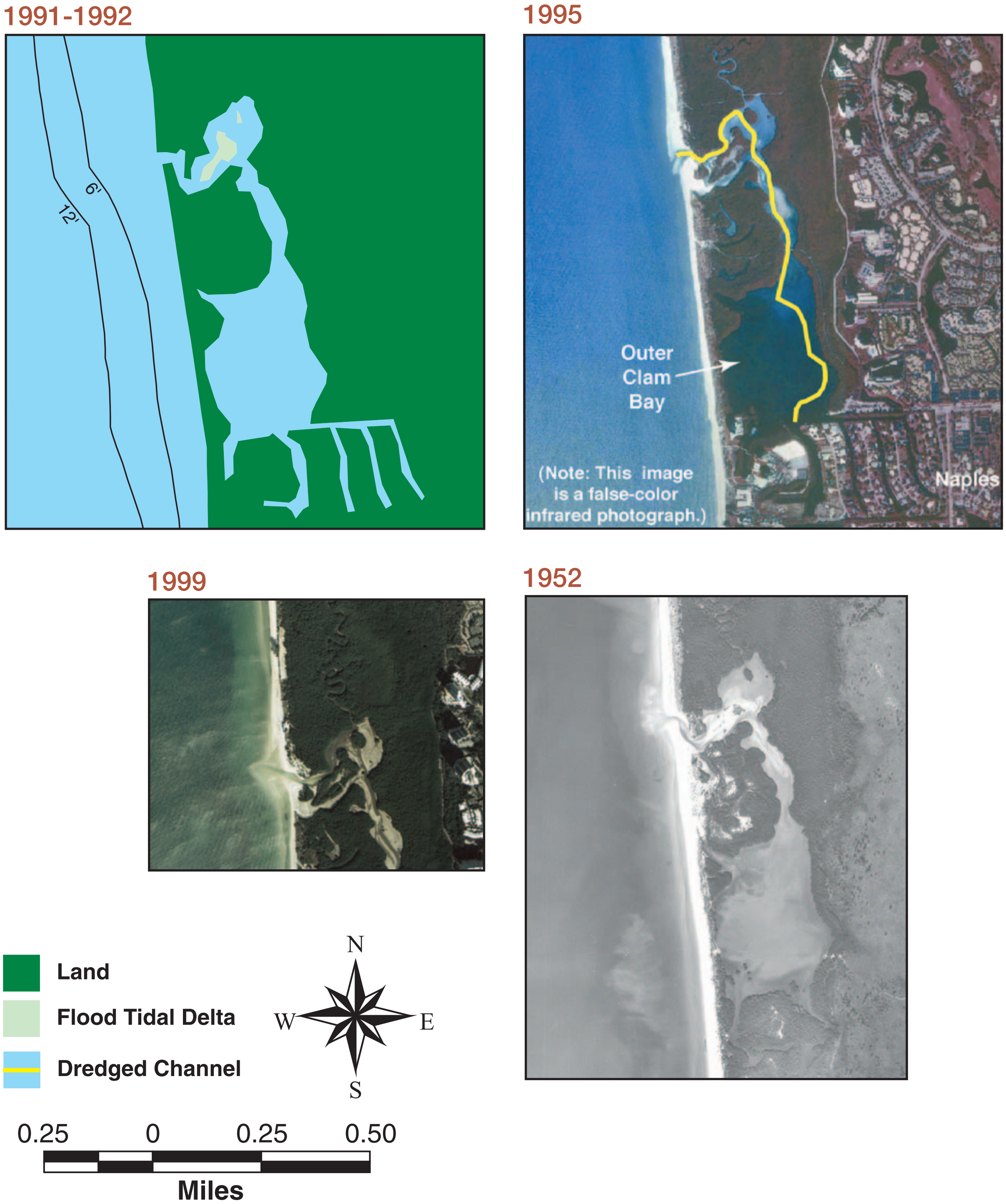
Wiggins Pass is a small inlet that was subject to periodic closings prior to 1952, when it was dredged for the first time (Map 11). The ebb-tidal delta at the mouth of the inlet shows modest accretion north and south of the entrance channel (1991-92 map). The small flood tidal shoals are partially vegetated (1944 photograph). The dredging that occurred since 1952 at the inlet and along the inland waterway south of Bonita Beach and north from Naples Park, as well as the closure of Little Hickory Pass two miles north, contributed to increasing the tidal prism and maintaining depths in the ebb-flood channel (1999 photograph).



Map 11.
Wiggins Pass.

Clam Pass

Clam Pass does not appear on the pre-development era charts. It is a very small inlet with an estuary and wetlands of limited extent (Map 12). The inlet mouth, which shifts seasonally and closes periodically, has been dredged (1952 and 1999 photos). A small flood-tidal delta is covered with mangroves (1991-92 map). Sand shoals build at the inlet mouth as do small spits (1995 photo). The 1999 color aerial photograph shows the emergence of a small ebb-tidal delta. Recent dredging has removed a portion of the flood shoal, which has increased the tidal prism.

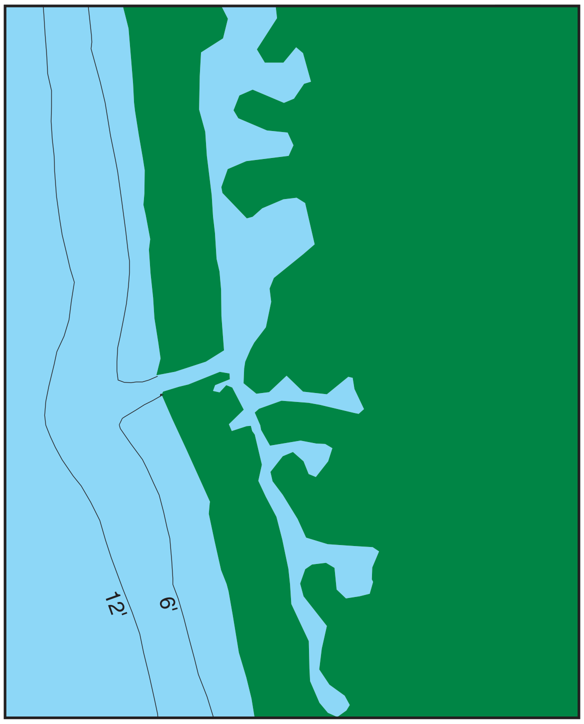


Map 12.
Clam Pass.

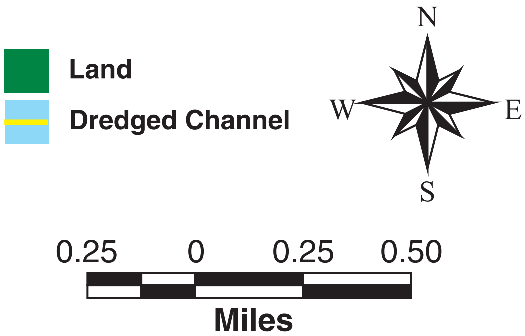
Doctors Pass

Doctors Pass provides access to the Moorings Bay system, formally called inner and outer Doctors Bays, in the City of Naples (Map 13). The 1945 aerial photograph shows a mixed-energy inlet with a prograding spit on the north, and submerged shoals extending across the mouth to the south. The pass was dredged in 1984 by the developers of the Moorings Bay Subdivision (1991-92 map). Jetties were constructed in 1960 (1995 photo).

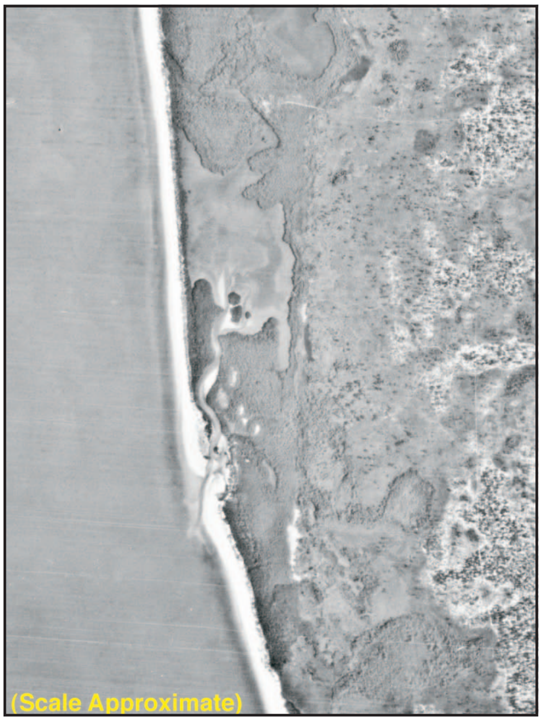
1991-1992



1995



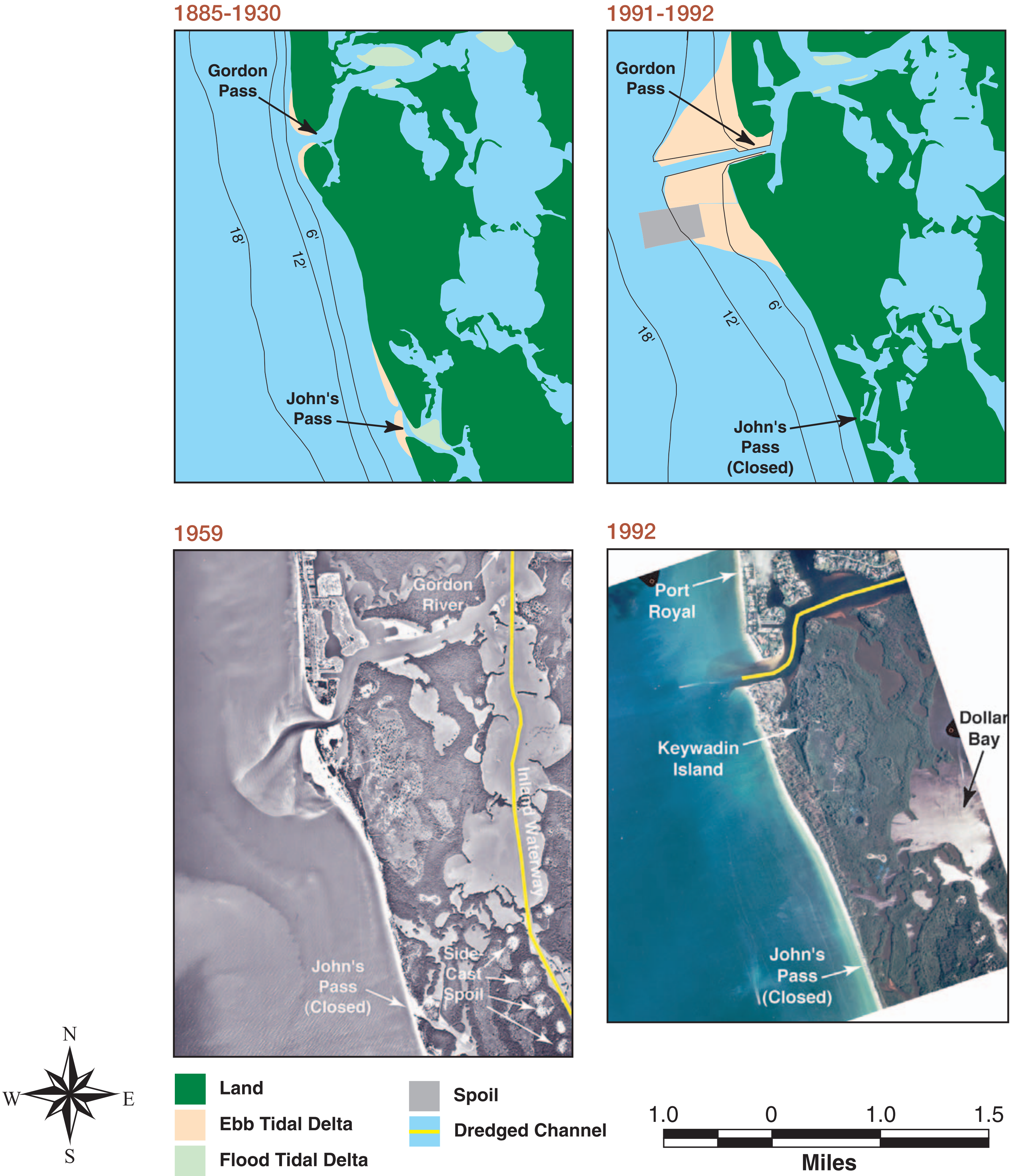
1945



Map 13.
Doctors Pass.

Gordon and John's Passes

Gordon Pass is the largest inlet between Big Carlos and Big Marco Passes (Map 14). The ebb-tidal delta is indicative of mixed energy conditions. Prior to dredging in 1962 and the placement of the north groin and south jetty, the ebb delta had a pronounced southward drift (1959 aerial). The entrance channel subsequently has been straightened (1991-92 map). Several deposits of flood-deltaic sediments are situated within the estuary and at its juncture with the Gordon River (1885-1930 map). Vegetated uplands and mangrove now cover these sites. John's Pass, a wave-dominated, "wild" inlet, was located 2.5 miles to the south in the pre–development period, but closed between 1938 and 1941 (1992 photo).

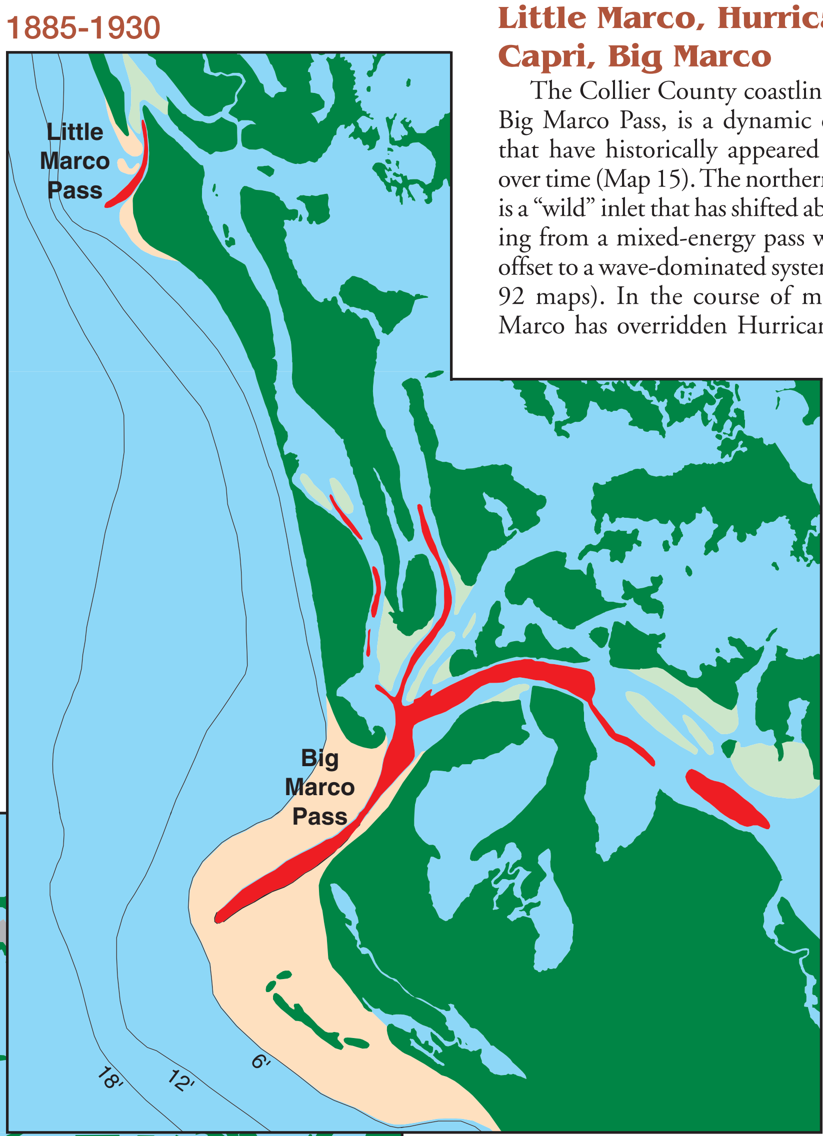


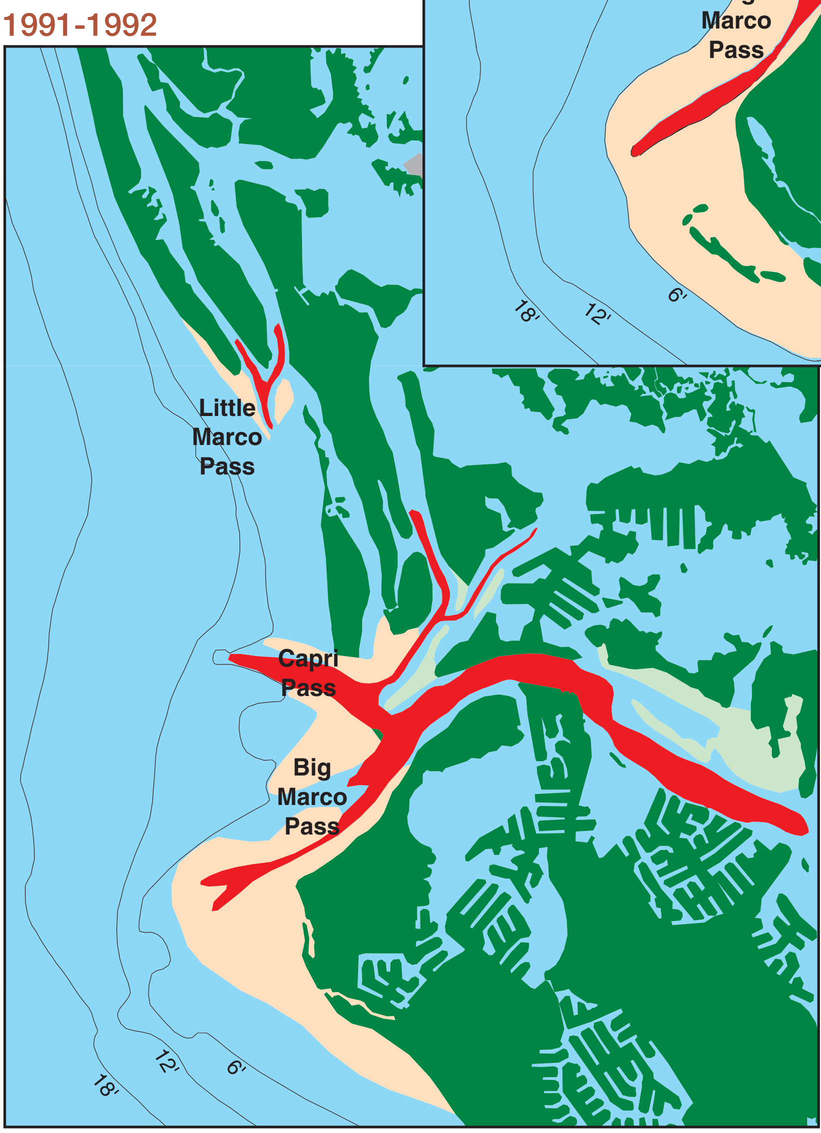
Map 14.
Gordon and John's Passes.

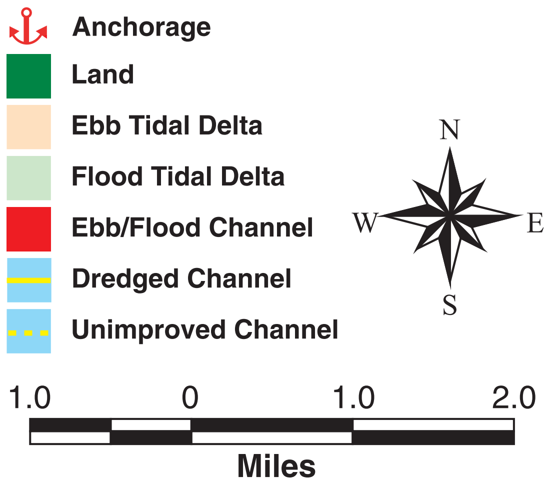
North Marco Island Passes: Little Marco, Hurricane, Capri, Big Marco

The Collier County coastline, from Gordon's Pass to Big Marco Pass, is a dynamic environment with inlets that have historically appeared and closed or migrated over time (Map 15). The northernmost inlet, Little Marco, is a "wild" inlet that has shifted about 2 miles south, changing from a mixed-energy pass with a distinct downdrift offset to a wave-dominated system (1885-1930 and 1991-92 maps). In the course of moving southward, Little Marco has overridden Hurricane Pass (1952 and 1992 photos). Today, there is a small, ephemeral sand shoal at the inlet mouth.

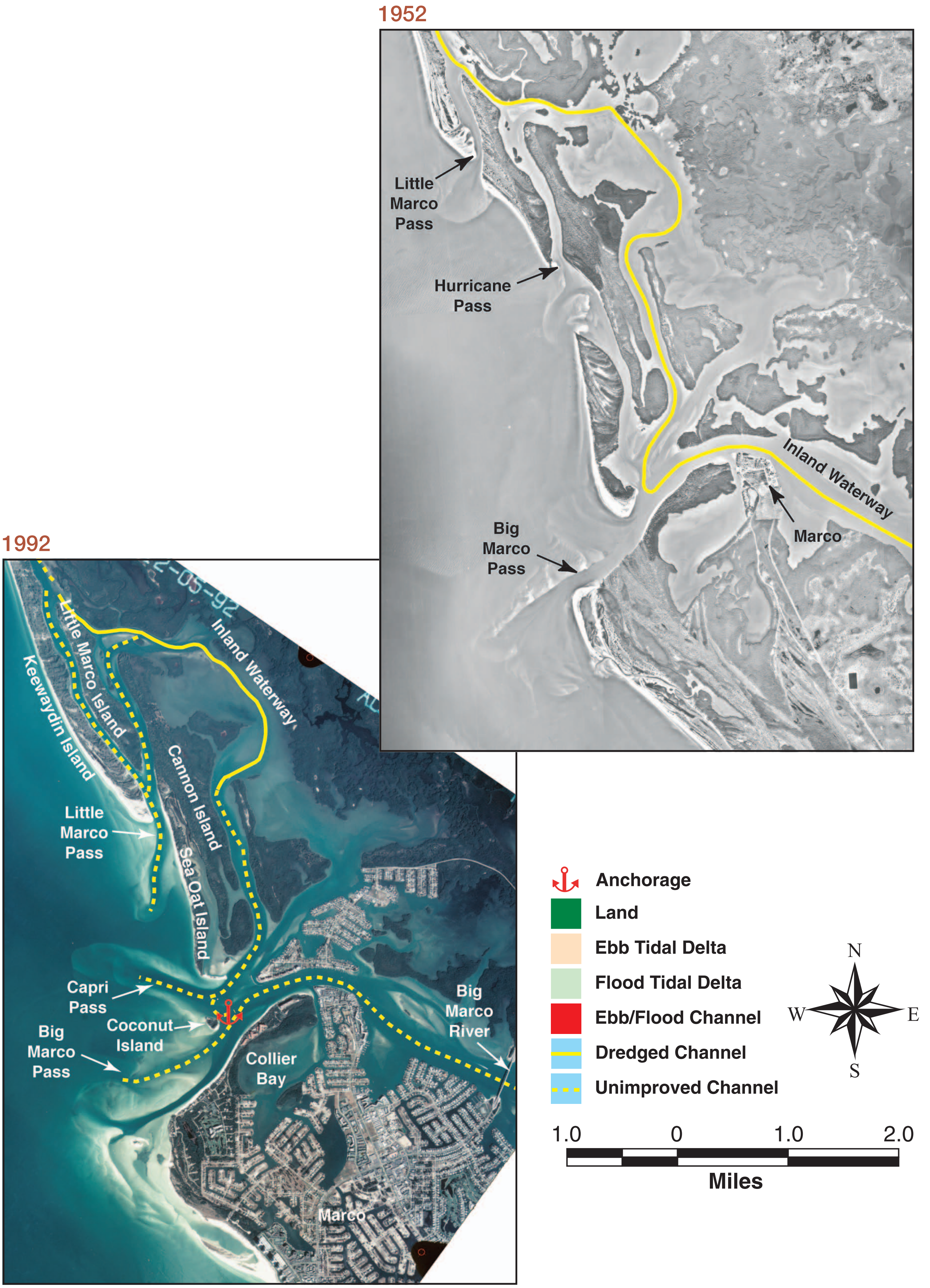
Big Marco Pass is one of the largest inlets along the Southwest Florida coastline. Sometime between 1962 and 1973, the narrow barrier island to the north, Sea Oat Island, was breached and Capri Pass was formed. Coconut Island was created by this process, which separates Big Marco and Capri Passes. Much of the tidal prism that historically flowed through Big Marco Pass now is channeled into Capri Pass. Capri is the main entrance channel from the Gulf to Marco Island (1992 photo). There is a popular fair-weather day anchorage on the bay side. The ebb–tidal delta at Big Marco Pass has the mixed-energy offset shape, with lobes north and south of its ebb-flood channel. The large, shallow-water shoal on the south side has contributed shoreward-migrating sand bars that have produced beach ridges and ponds on the north end of Marco Island (1952 photo).







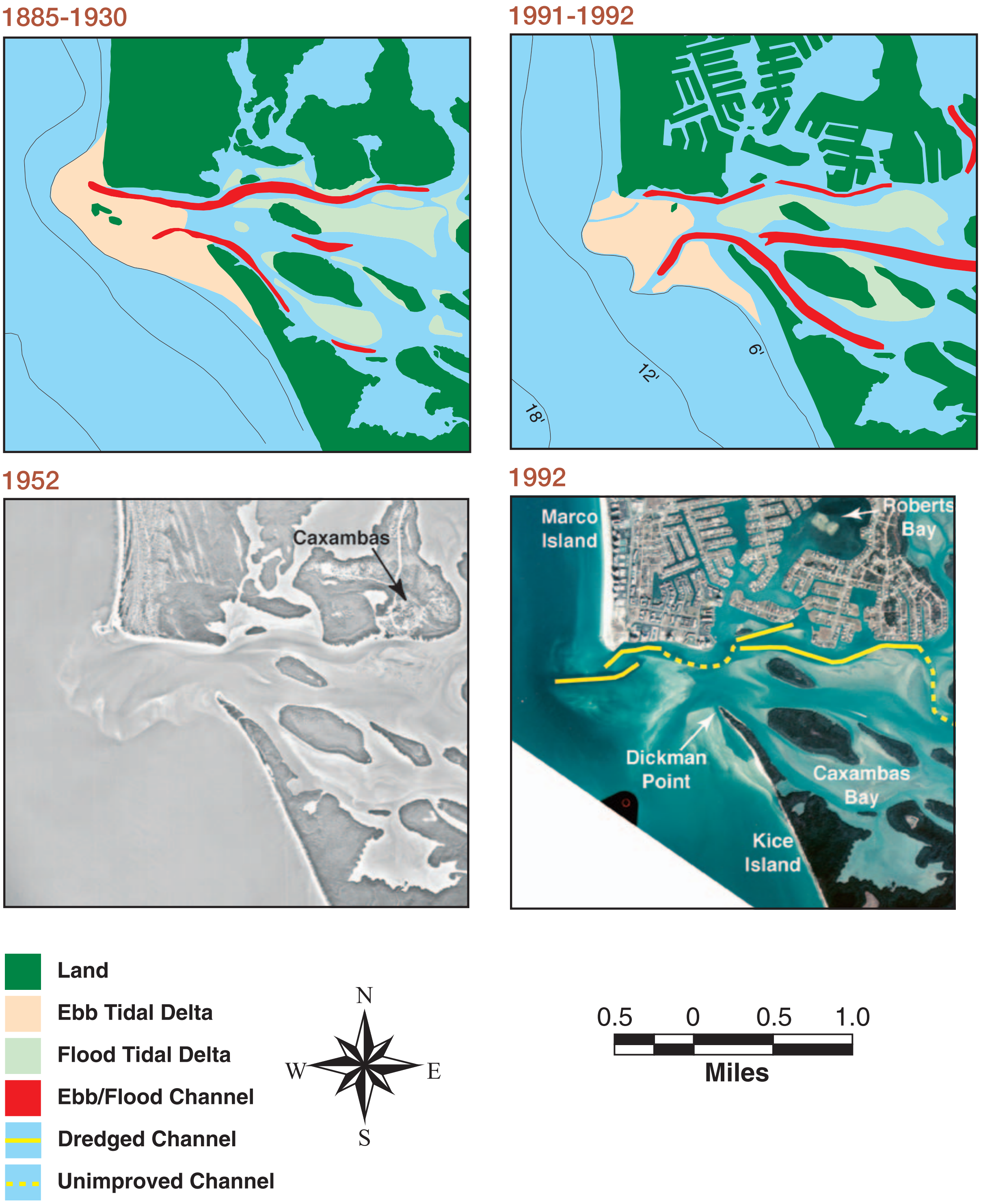
Map 15 (part 1).
North Marco Island Passes.



Map 15 (part 2).
North Marco Island Passes.

Caxambas Pass

Caxambas Pass is a mixed-energy inlet with a distinct northward offset (Map 16). Its ebb-tidal delta extends about 0.5 mile offshore (1885-1930 map). The seawall constructed at the south end of Marco Island in 1958 contributed to major changes in the inlet (1991-92 map). The ebb-tidal delta has been used as a sand source for the Marco Island Beach Nourishment Project, which included construction of two terminal groins slightly north of the pass. Sand recovery from the delta has deepened the pass for navigation (1992 map).



Map 16.
Caxambas Pass.

Long-Term Shoreline Change and Barrier Island Development

The Southwest Florida shoreline, where the saltwater of the Gulf meets freshwater and contacts the solid land base of the Florida peninsula, is a constantly changing boundary that has been influenced not only by short-term events, but also by long-term sea level fluctuations. Expansion and contraction of continental ice sheets during the Late-Cenozoic Ice Age (last 2 million years) have had a profound effect on the continental margins.

Imagine what would occur if the ice held on Antarctica melted along with all other glacial ice: the sea level rise of some 200 feet would inundate most of Florida. On the other hand, the growth of ice sheets would withdraw vast quantities of seawater from water bodies and a decline in sea level would occur.

In Figure 4, the shoreline of Charlotte Harbor during the Pleistocene glacial period is shown as a solid line (a) and the present shoreline as a dashed line (b). The green dotted line (c) represents the former coastal valleys of the Myakka, Peace, and Caloosahatchee Rivers. The mouth of the Peace River, at that time, extended through present-day Matlacha Pass, to reach the more distant shoreline.

As sea level rose, the same streams were forced to deposit alluvium and fill their valleys. In Figure 5, the flooded river mouths have led to creation of Charlotte Harbor and adjacent waters. Pine Island, part of the original mainland, is an eroded remnant. As sea level rise slowed at about 5000 before present, shoaling occurred along the headlands, such as north of Placida (see inset) and at Englewood. When post-glacial rise ebbed, longshore processes began to exert a force contributing to emergence, coastal deposition and spit or barrier island growth.

South-setting longshore currents produced elongated spits, bars, and barrier islands, extending from north of Englewood and from Placida (Figure 6). Storms periodically breached the barrier spits, creating inlets and islands. Continued progradation of the recurved barrier spit eastward towards Punta Rassa, along with growth of Little Pine Island, restricted discharge from the Myakka and Peace Rivers through Matlacha Pass and forced the outflow to seek a new route by way of the emerging barrier island inlets at Boca Grande and Captiva. This present condition of the Charlotte Harbor barrier island chain is shown in Figure 7.

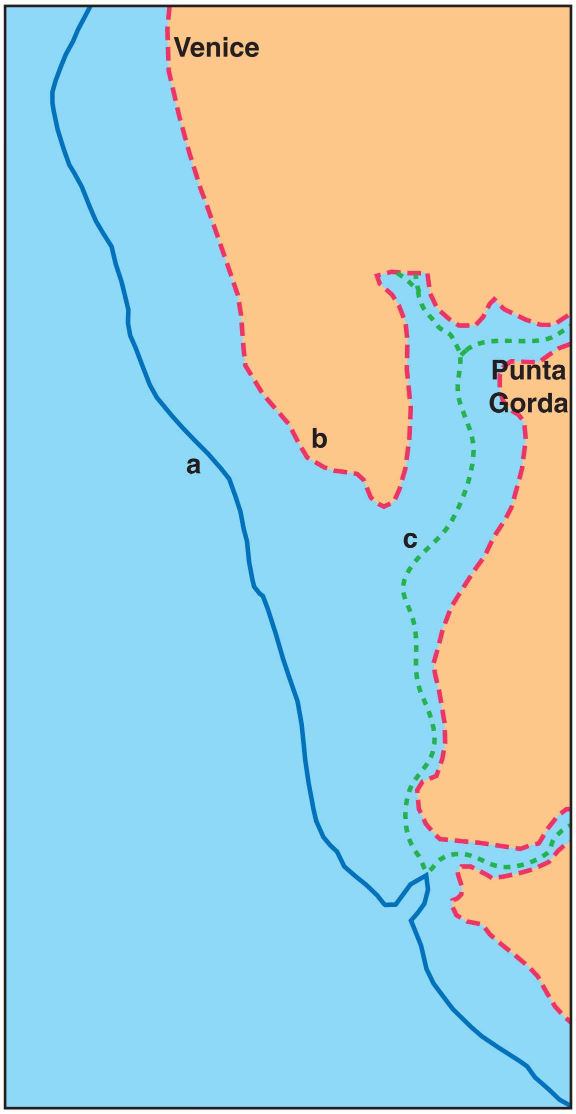


Figure 4. Charlotte Harbor shoreline in the Pleistocene Glacial Period.

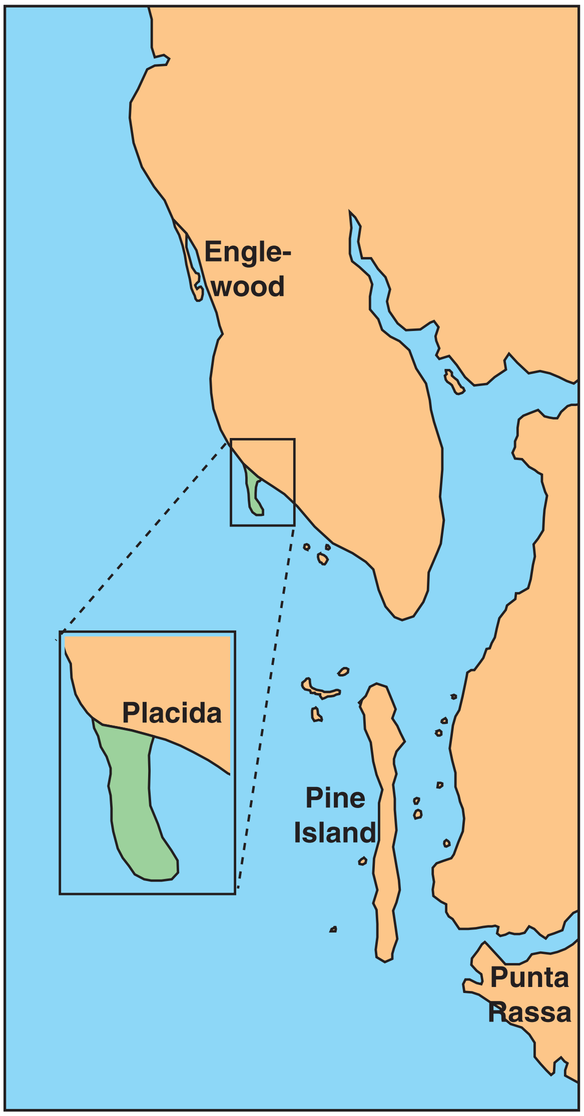


Figure 5. Charlotte Harbor shoreline approximately 5000 years ago.

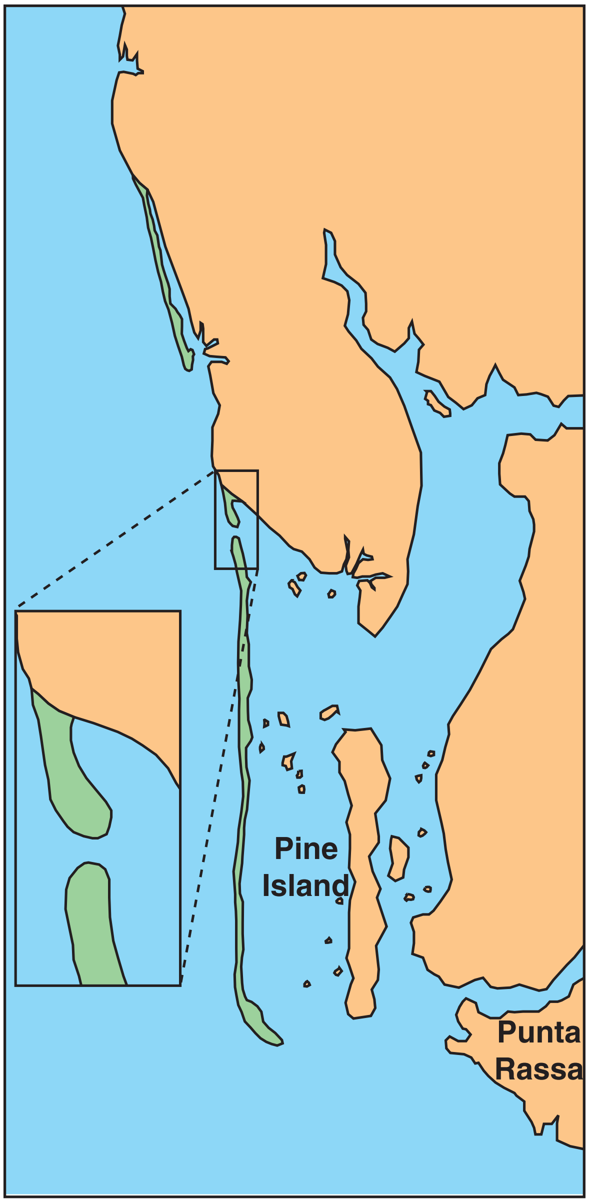


Figure 6. Charlotte Harbor showing intermediate stages of barrier island development.

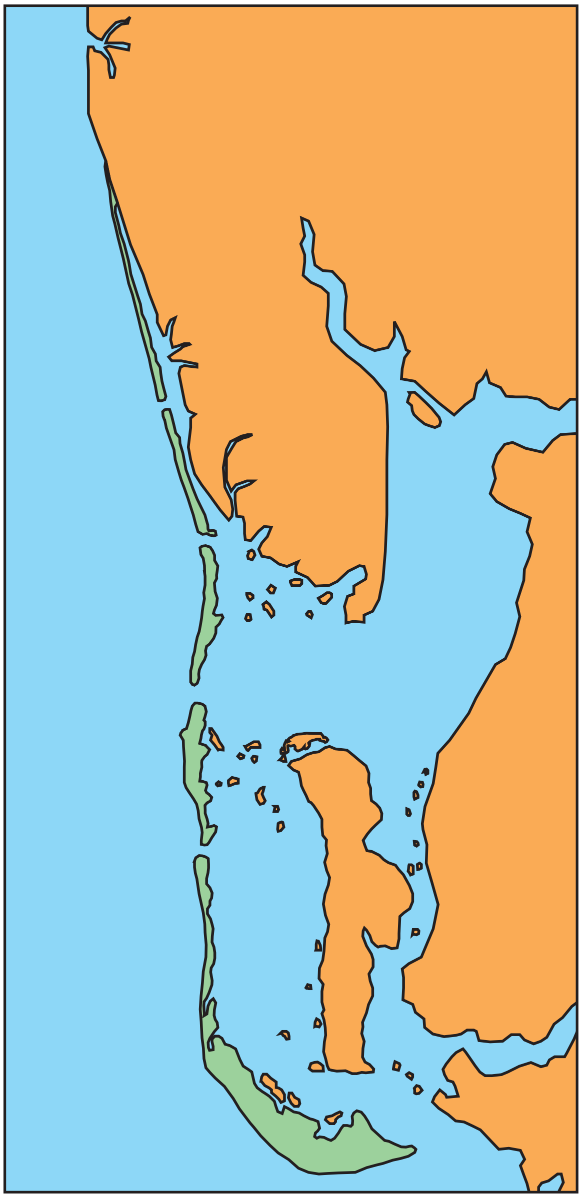


Figure 7. Modern shoreline of Charlotte Harbor and barrier islands.

Adapted from Stanley Herwitz, 1977, The Natural History of Cayo-Costa Island, New College Environmental Studies Program, Sarasota, Florida.

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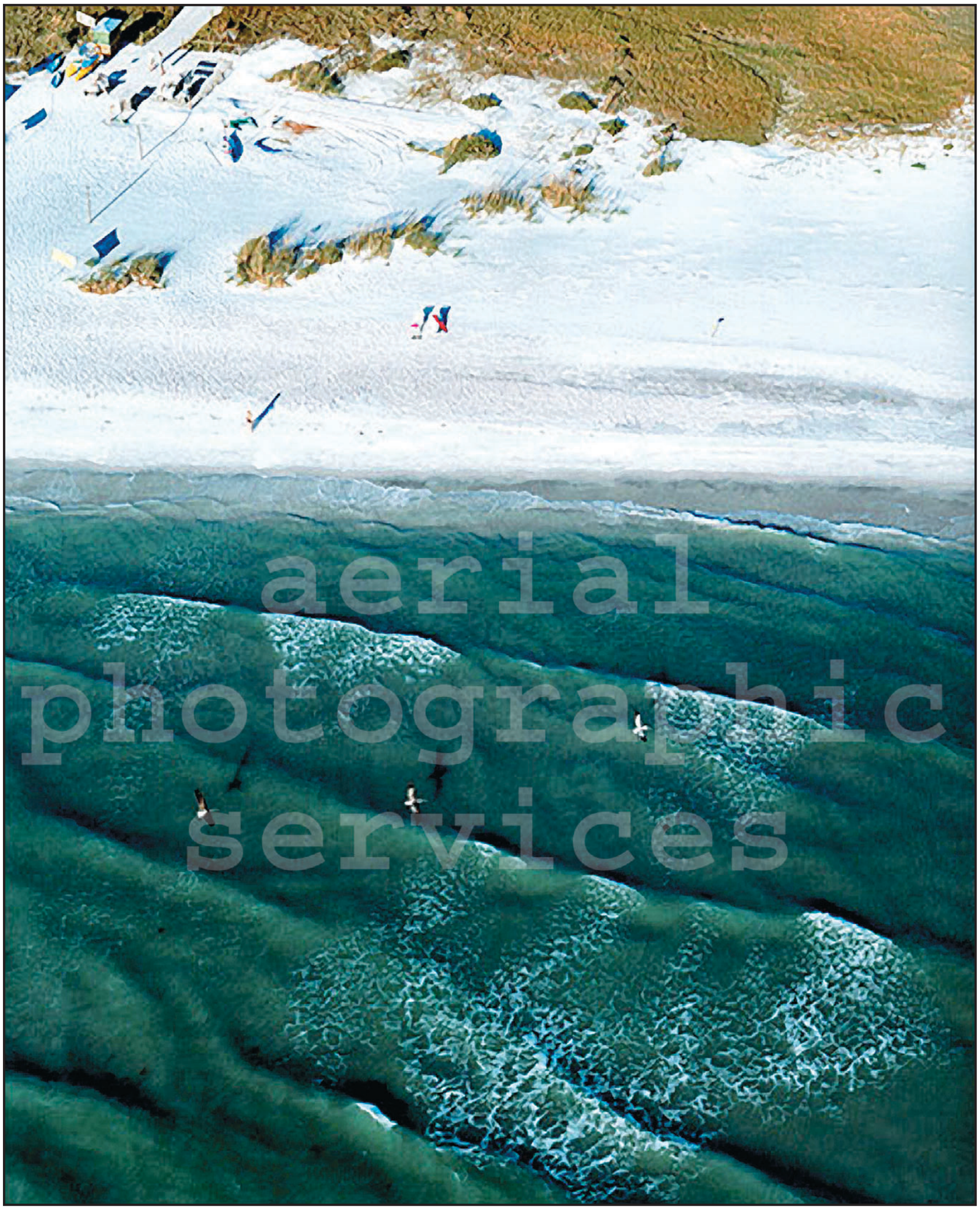

Waves refracting along Little Gasparilla Island, longshore current runs from left to right, carrying sand in the direction, parallel to the shoreline.