Land Use and Land Cover Changes Along the Shoreline

Late 19th century mariners sailing along Southwest Florida's shore encountered few settlements. Population was sparse on the barrier islands, the eastern shore of Charlotte Harbor, Estero Bay, and Naples Bay and in the Caloosahatchee valley. Prior to the arrival of the railroad in Punta Gorda (1886) and the Big Freeze of 1892, only a few dozen persons lived on the islands and along the shore in this region.

Range cattle roamed freely over wide areas from the Myakka River south. During the Civil War, Southwest Florida was a prime source of beef for the Confederate army. Afterwards, and until about 1878, the primary market was Cuba. Cattle were shipped from Punta Gorda and Punta Rassa.

During the pre–development period, bay and Gulf fishing was in the hands of Cubans who often employed Native Americans as deckhands and established seasonal fish camps on islands all along this stretch of the Gulf coast: Lacosta, Mondongo, Pelau, Punta Blanca, Useppa, Captiva, Sanibel, Estero, Mound, Black, Little Hickory, and Marco. Cuban fishermen dried and salted mullet for the Cuban market, living in "ranchos" or palmetto-thatched houses. These fishing stations existed for more than three centuries, beginning in the late 1600s. The arrival of the railroad at Punta Gorda in 1886 and establishment of an ice factory there in 1893 opened up the domestic United States fresh fish market to local fishermen. More than 20 icehouses, from Charlotte Harbor to Estero Bay, were built to hold the day's fresh catch, which was collected by run boats and transported to Punta Gorda for shipment north. The local fisher-folk culture gradually changed as Cubans either assimilated into local Florida families or returned permanently to Cuba.

Production of naval stores and logging were other important local industries that followed the railroads into the region. Turpentine camps, or "stills," operated from remote locations, oftentimes using forced, convict laborers.

The 1890s witnessed the rapid introduction of the citrus industry as north Florida growers reestablished groves in the region below the frost-free line, producing citrus in the Caloosahatchee valley, along the shores of Estero Bay and Naples Bay, and on Marco Island. Before railroads, getting products to market and providing settlers with supplies meant reliance on inland water transport. Steamers and sailing schooners hauled fruit and vegetables north to Punta Gorda and returned south with grain and other supplies.

The arrival of the railroad in 1904 at Ft. Myers caused a boom in the local economy. Ft. Myers became the distribution and commercial center for Southwest Florida. The railroad offered northern tourists unrestricted access to winter vacation locales. Guest homes and hotels were established in the major towns. By the turn of the century, Punta Gorda and Ft. Myers each had between 1,200 and 1,500 inhabitants. The sparsely settled conditions and extensive land use during this pre–development period are reflected in Map 1–A, C, E, G, and I.

There is a striking difference between the pre–development waterfront use of the 1858-1944 period and that of the bayside and barrier islands in the 1990s (Map 1–B, D, F, H, and J). Table 1 summarizes the major changes in land use and land cover bordering this 253-square-mile shoreline area from pre–development to modern eras. The most dramatic change visible on Map 1A-J is the phenomenal urban development: the 1-square-mile aggregate urban area of the 1890s grew to 81 square miles by the 1990s, an 8,100-percent increase. Another discernible change during this period is the decline in vegetated uplands (forest, shrub, and brushland), a 76-percent decrease from 46 to 28 square miles.

Land use and land cover bordering the Southwest Florida shoreline: Pre–development era and 1990s.

Land Use and Land Cover	Pre-development+		Contemporary		Change
	(miles)*	(percent)	(miles)**	(percent)	(percent)
Wetland and Mangroves	129	51	135	53	+4
Vegetated Upland	117	46	28	11	-76
Agriculture	2	1	6	2	+200
Barren	4	2	3	1	-25
Urban	1	0	81	32	+8100
Total	253	100	253	99	

Table 1.

Sources:

* U.S. Coast and Geodetic Survey, T-Sheets No. 693, 738, 739, 853, 854, 855, 856, 1048, 1554a, 1554b, 2122, 2123, 2126, 4289, H/T-Sheets No. 5067, 5072, and 1944 aerial photography covering Estero Bay.

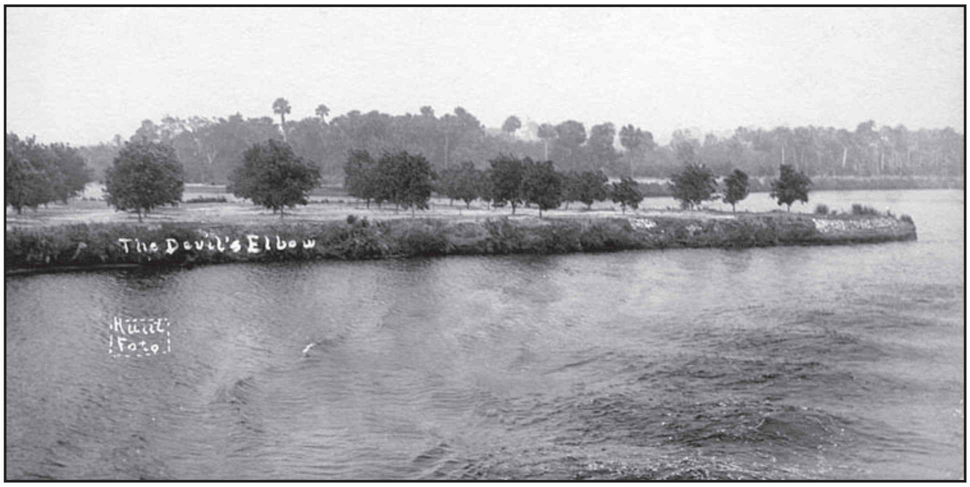
** South Florida Water Management District and Southwest Florida Water District, 1995.

\+ Pre–development Time Span: Charlotte Harbor (including Gasparilla Sound, Pine Island Sound, Matlacha Pass and San Carlos Bay):1858-1867, Caloosahatchee:1882-1883, Estero Bay: 1944, Naples-Marco: 1930.

Southwest Florida once shared a heritage of natural resources as bountiful and awe-inspiring as any region of America. Its heritage reflects the geological history, geographic location and biological evolution of the United States' only humid and sub-tropical peninsula. Coastal waters abounded with fish, rumored to impede the progress of sailing ships and rowboats. Birds were so numerous as to eclipse the sun when their flocks took wing. Naval stores of pine, cypress and oak seemed without limit. Not that the region was a benign Eden. Mosquitoes swarmed after sudden rains in numbers sufficient to kill livestock. Wild cats, venomous snakes, alligators, bears, sharks and other wildlife were elements of everyday life for explorers and settlers.

Clam factory of Marco Island, circa 1910.

Grande Bayou, Boca Grande in the early 1900s.



The Caloosahatchee before development.

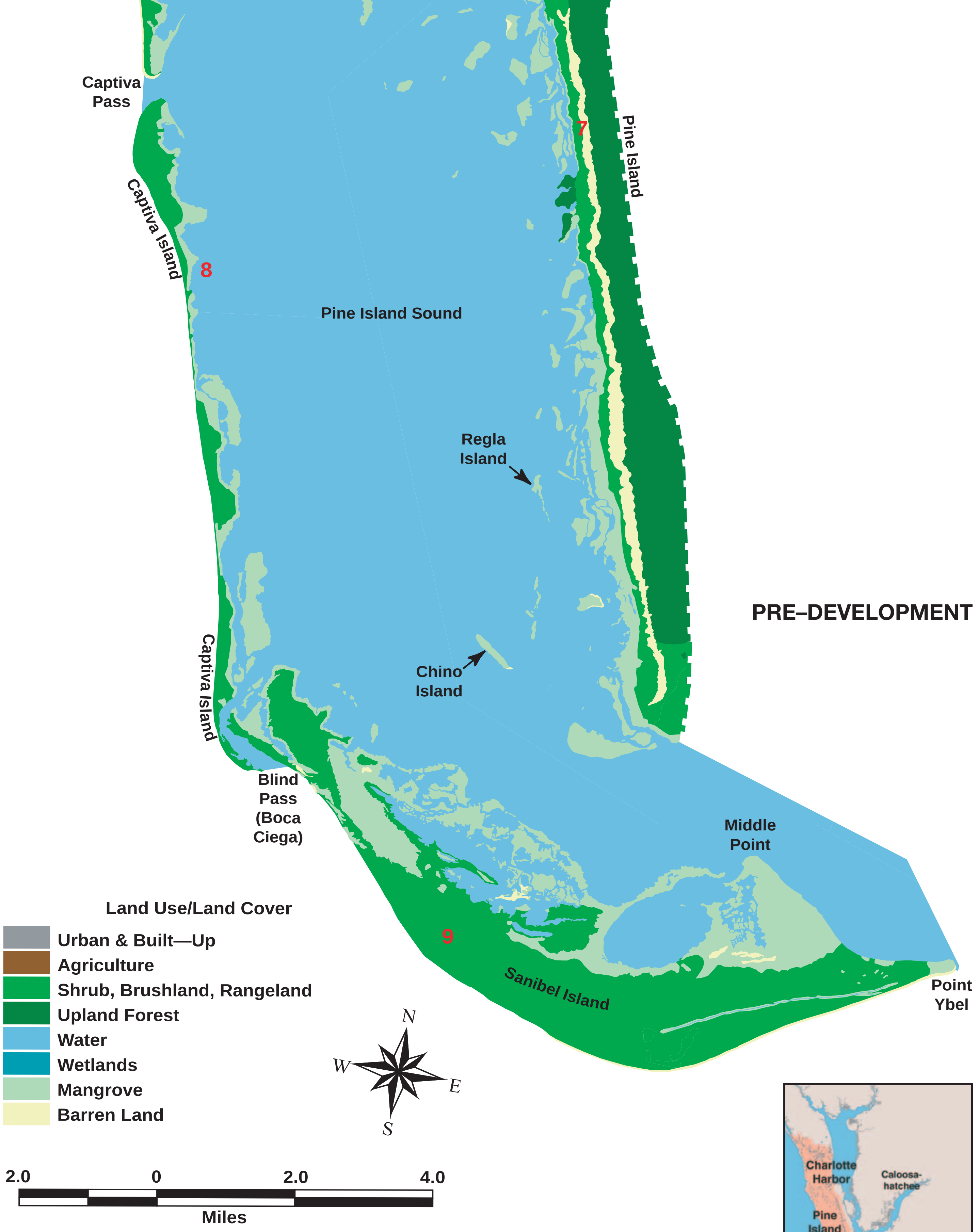
1. **Placida** is the Spanish word for "placid," an apt term to describe Placida Harbor, located at the mouth of Coral Creek and at the north end of Gasparilla Sound, with access to the Gulf through Gasparilla Pass. The town originated with a bunkhouse of the Charlotte Harbor & Northern Railroad — locals called it the "Cold, Hungry and Naked" line — later supplemented by relocation of the Gasparilla fishing village. It has been a major commercial fishing center for decades. Today, with the impact of the commercial fishing gill net ban in 1995, most of the fishing activities in the area have been curtailed and many of the stores closed, although some shops and a restaurant are still in operation.

2. **Cayo Pelau** is a 140-acre island west of Bull Bay and fronting Charlotte Harbor. The island's settlement dates to the Calusa Indian period. It was occupied by Cuban fishermen during the 19th century. An 1832 expedition describes a Spanish-speaking (Cuban) settlement "…from 60 to 70 inhabitants who keep an abundance of hogs, dogs innumerable." The term "Pelau" is West Indian Spanish jargon for "bald spot," aptly describing the center of the island's wet–dry marsh, surrounded by gumbo limbo and mangrove trees.

3. **Gasparilla Island** is bounded on the north by Gasparilla Pass, on the east by Gasparilla Sound, on the south by Boca Grande (Pass) and on the west by the Gulf of Mexico. The island was sparsely settled by fishing families until the late 19th century. The federal government in 1848 established a military reservation at Boca Grande, including both the southern end of Gasparilla Island and the northern end of Lacosta Island. A lighthouse was built and placed in operation in 1890.

Construction began on a port facility and railroad spur to receive and ship phosphate ore mined in the Peace River Valley in 1905. The railroad provided access to the outside world. Fish houses were established along the rail line, which brought in ice from the mainland (Punta Gorda) and shipped out fresh fish. The fish house at the north end of the island developed into Gasparilla Village. The railroad also attracted land investors. The Gasparilla Inn opened in 1911 as a resort hotel, and Boca Grande was on its way to become an upscale community catering to affluent winter visitors and sports fishermen. Homes on Gilchrist and Park Avenues date back to this early development period. Storm-induced beach recession in the 1920s required the railroad to be shifted eastward. Fill dredged from the bay bottom along the east shore created Loomis Key. Boaters now use the dredged channel when transiting north from Grande Bayou to Gasparilla Sound. The Boca Grande Causeway, providing road connection to Placida, was built in 1958. In the late 1970s, the Port Boca Grande docks and storage facilities were found in need of extensive repairs and were abandoned in favor of shipping ore from the Peace River mines directly by rail to Tampa. The Boca Grande rail spur right of way became a bicycle path, and Port Boca Grande became an oil storage depot.

The lighthouse was retired from service in 1966 when automated channel navigation lights were installed. The old lighthouse became a site on the National Register of Historic Places in 1980. The U.S. Coast Guard recommissioned the light in 1986, and the Florida Department of Environmental Protection manages the park facilities. The lighthouse is now the location of a historical museum.



Map 1-A.
Pre–development conditions along the barrier islands.

Useppa Island was the first land purchased in Southwest Florida by New York advertising millionaire Barron Collier. Later, he was to purchase more Florida land than any other one person, including much of Lee County.

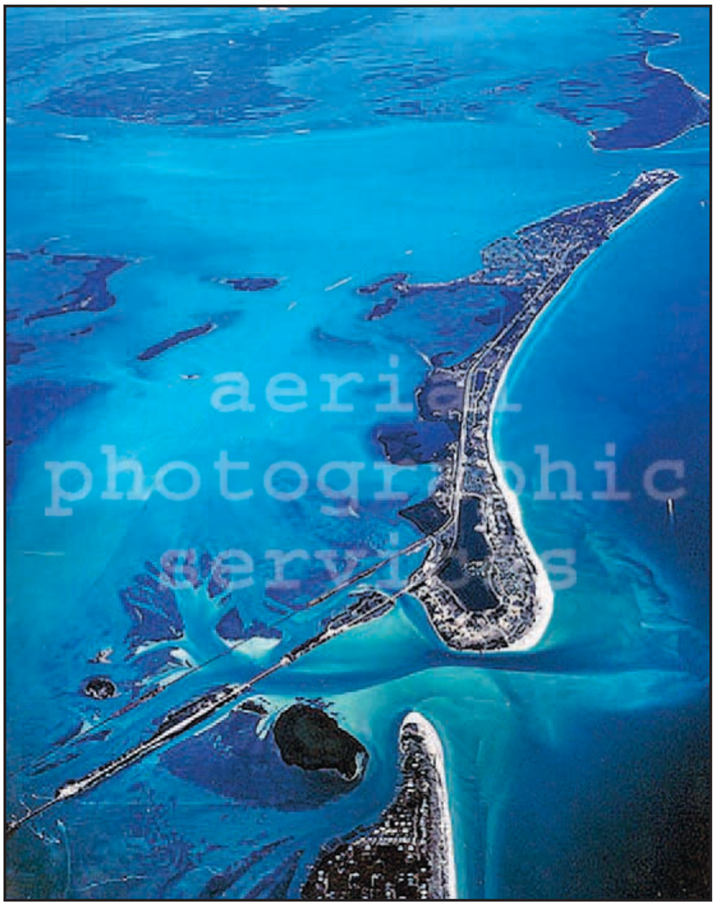
4. **Lacosta Island (Cayo Costa)** is a barrier island situated south of Boca Grande and north of Captiva Pass. The number of Indian shell mounds on the island indicate human habitation dates far back in the pre-Discovery period. The island was used periodically by Cubans during the 19th century as a base for fishing in Charlotte Harbor and nearby Gulf waters. In 1880, the original (1848) land parcel acquired as a military reservation by the federal government (see Gasparilla Island note above) was modified, and a limited area along the Boca Grande shore was set aside for military purposes, a pilot station, and a marine hospital. The federal government relinquished control of this property in 1938. Lacosta Island retained a quasi-clandestine reputation, even when ostensibly under federal control. It was a base for smuggling operations, especially rum from Cuba during the Prohibition, and is reported to have had a house of ill fame frequented by fishermen and sailors from the many Cuban fishing smacks that frequented the harbor at the turn of the century.

The feral hogs on the island were vestige of the island's past and accounted for the numerous trails through the impenetrable cabbage-palm forest. A number of residences remain on the island: some are in an abandoned state, others are maintained as fishing retreats. Lee County, in 1959, established a park on the northern 640 acre parcel. This park was turned over to the Florida Department of Environmental Protection in the early 1980s.

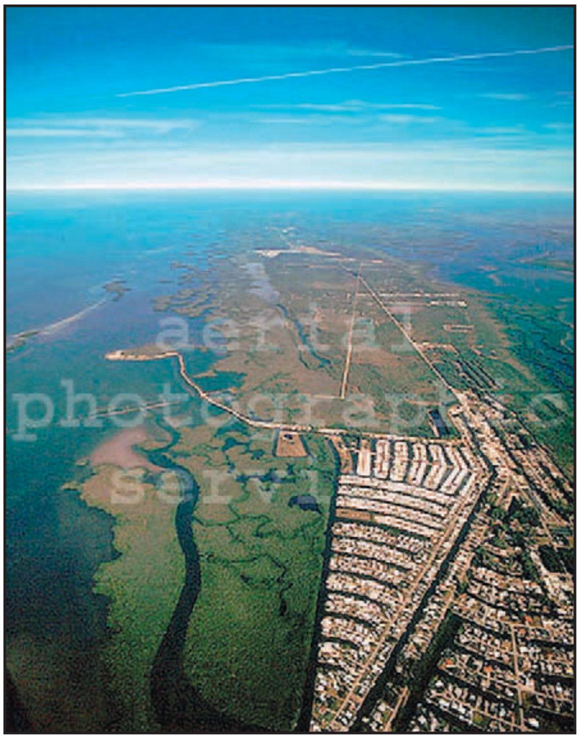
5. **Useppa Island** was settled by the ancestors of Calusa Indians thousands of years ago. Fort Casey was established here during the Seminole Wars, but was short-lived. A fishing community, called "Guiseppe," later developed on the island. During the Civil War, a Union naval station garrisoned here to protect refugees and curtail the smuggling of provisions to the Confederacy. Useppa's modern post-19th century history stems from its purchase by John Roach, president of the Chicago Street Railway Company, who built a home and small hotel, the Useppa Inn, where he entertained friends and business associates Henry Ford and Thomas Edison by fishing for tarpon during the winter months. Barron Collier bought the property in 1911 for his Florida residence. Today, the former Collier Mansion is the site of the Useppa Island Club and the island has been developed into an exclusive residential community.

6. **Cabbage Key** This island in Pine Island Sound, just west of Useppa, is 100 acres upon which is a resort, marina and restaurant. The resort is built atop a 38-foot-high Native American shell mound. The island is easy to locate because of the tall water tower, which provides visitors and guests a panoramic view of the bays and Gulf of Mexico. The resort was once the home of novelist Mary Roberts Rinehart. Contemporary novelist Randy Wayne White describes Cabbage Key as having "an oasis feel to it, sitting out there all by itself, like it could have been Abaco or Tangiers or Caicos, soaking up the sun through the decades while travelers tromped up the shell path to the old house on the mound."

Useppa Island, looking south towards the barrier islands.



Gasparilla Pass with causeway to Placida in foreground, looking south, down Gasparilla Island to Boca Grande, Lacosta Island (Cayo Costa) at upper right and Pine Island at upper left.



South Pine Island, looking northeast, St. James City in foreground.

7. Pine Island consists of three settlements. At the north tip of the island is Bokeelia, on the south shore of Charlotte Harbor; Pineland is to the south on the east shore of Pine Island Sound; and St. James City at the southern tip of the island abuts San Carlos Bay. Pineland is home to the Randell Research Center — devoted to learning and teaching the archaeology, history, and ecology of Southwest Florida — owes this distinction in part to Calusa Indian shell mounds or middens (ancient Indian garbage dumps) located along the island's shore overlooking Pine Island Sound. There are remnants of an aboriginal canoe canal, dug by the Calusa or their ancestors, probably 500 to 1,000 years ago. The "haul-over" canal had its western terminus at Pineland and extended eastward to Matlacha Pass, ending at Indian Field. In 1912, when Army Engineers visited the region, Pineland town consisted of a post office and three or four houses, but no streets or roads. The early 20th century settlement developed from turpentine stills and sawmills on north Pine Island. Today, all three communities provide recreational, sport fishing, eco-tourism, agricultural, and residential services.

Safety Harbor on North Captiva Island, looking south, towards Redfish Pass in midground.

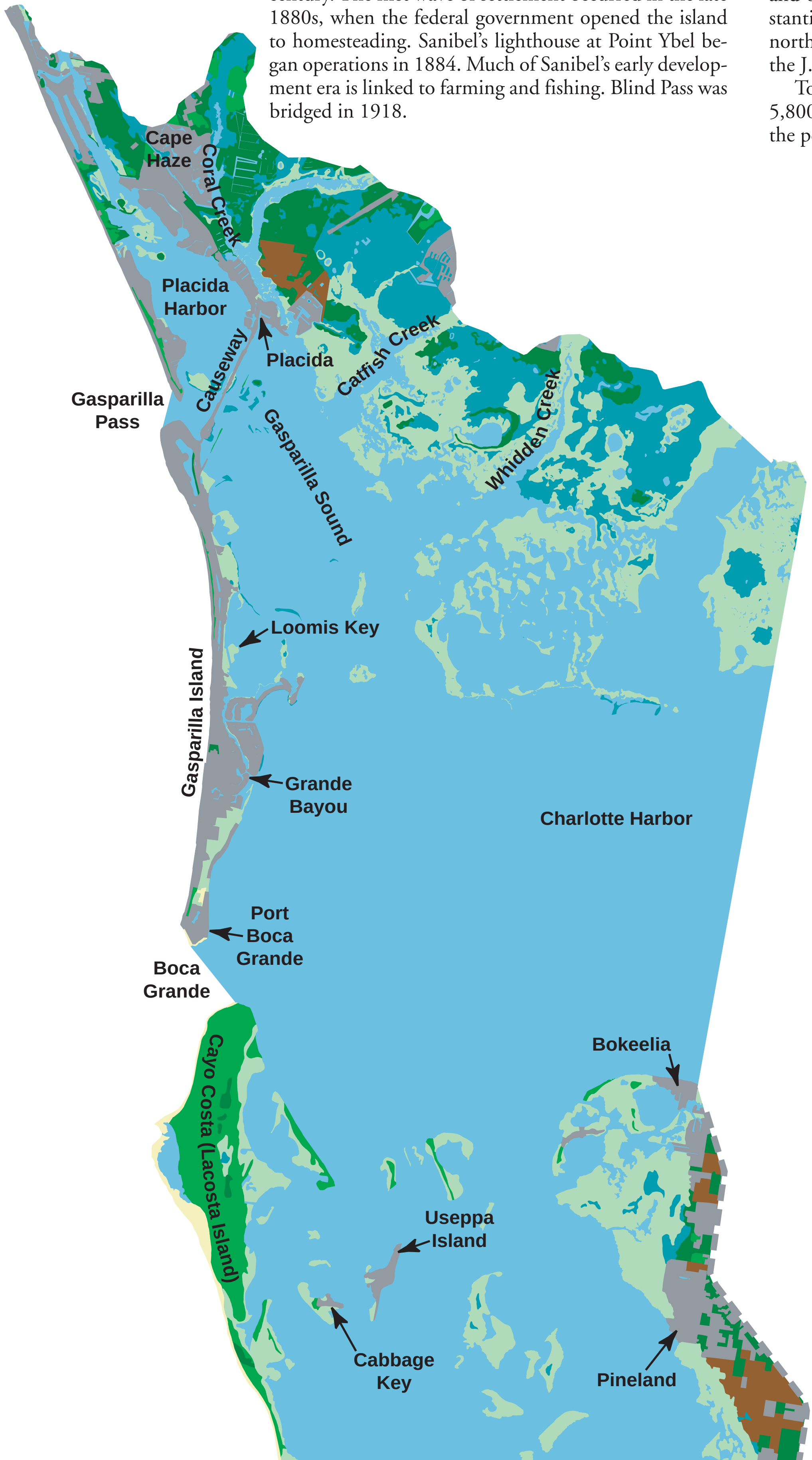
8. North Captiva and Captiva Islands were one island prior to the 1921 hurricane and the creation of Redfish Pass. Major storms in the 1920s, '30s, and '40s overtopped the low, narrow southern end of North Captiva. Safety Harbor, the small embayment inside Captiva Pass, was a fish camp during the pre–development period. A surge of vacation-home construction, beginning in the 1960s, along with finger-canal construction, has occurred on North Captiva Island. The State of Florida in 1975 acquired about half of the island, which has been designated a Barrier Island Preserve. South Seas, a destination marina and golfing resort, is at the north end of Captiva Island. The town of Captiva is at the center, adjacent to Roosevelt Channel, a present-day popular anchorage and relict inlet channel to Blind Pass. It is hard to imagine that the town claimed only 45 inhabitants just prior to World War II.

Gaspar the Pirate: Fact or Fiction?
Legend and myth surround the name and a claim that a supposed pirate "Jose Gaspar" maintained a lair in these waters during the 18th and early 19th centuries. Some say the myths were invented about 1900 by a fishing guide, Juan Gomez, to entertain customers. Historians suspect the name refers to a 'Friar Gaspar.' Boca Gasparilla (Inlet) appears on a late 18th century chart of the region.

9. Sanibel Island, "…the piece of coast that trends E and W, is the beach of an island called Sanybel, this place is further remarkable for a great number of pine-trees without tops standing at the bottom of the bay (San Carlos Bay), there is no place like to it, in the whole extent of this coast" (from the sailing directions for the Dry Tortugas to Pensacola, Bernard Romans, 1775). An attempt at establishing an agricultural colony failed in the early 19th century. The first wave of settlement occurred in the late 1880s, when the federal government opened the island to homesteading. Sanibel's lighthouse at Point Ybel began operations in 1884. Much of Sanibel's early development era is linked to farming and fishing. Blind Pass was bridged in 1918.

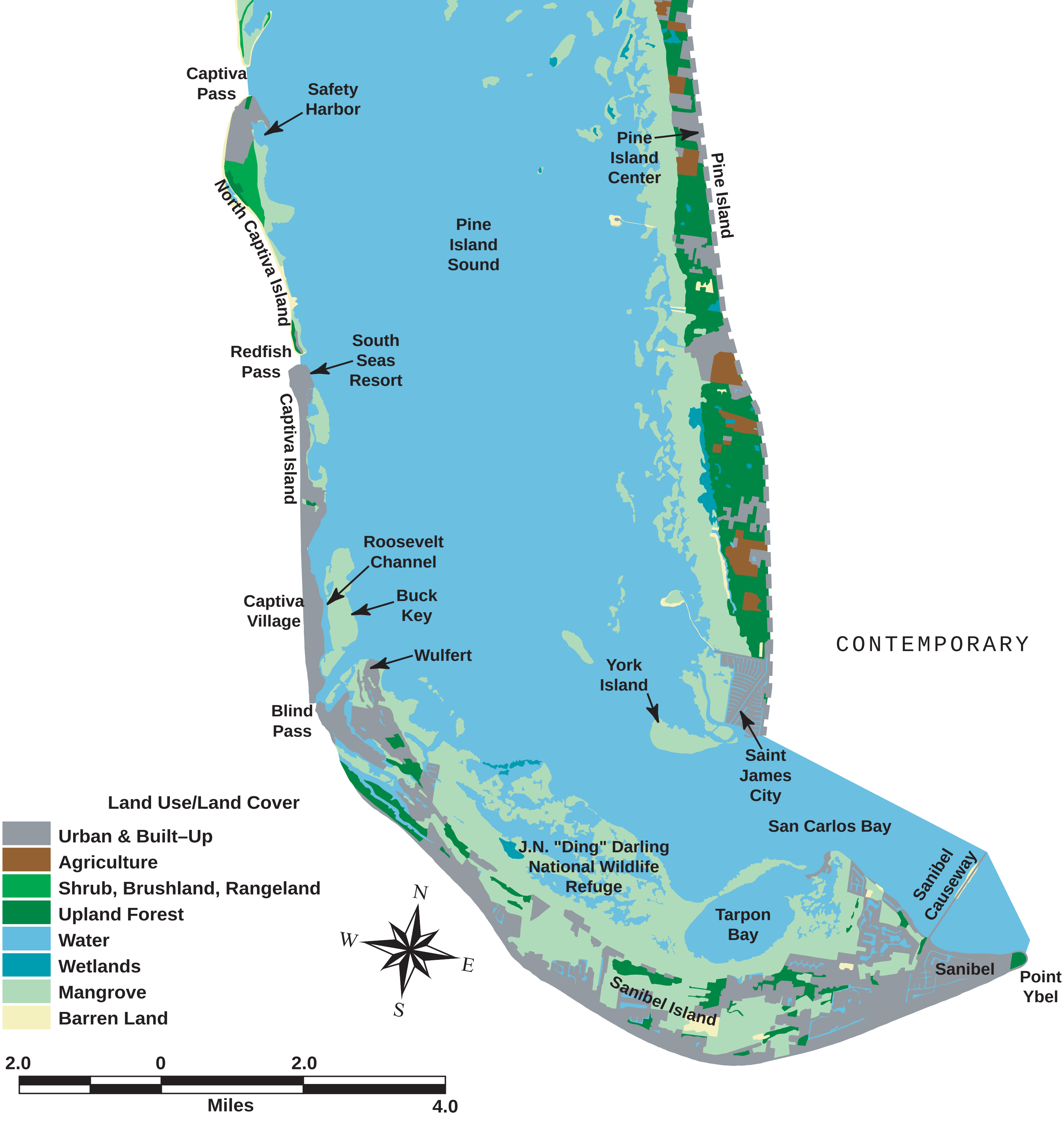
The island's fame developed as a world-class paradise for shelling and wildlife observation during the early 20th century. Writers and artists came for the isolation and quiet beauty. In 1939, Sanibel's population was 100, and Wulfert had 10 residents. A concrete structure replaced the Blind Pass Bridge in 1954. (The pass closed in the early 1990s). But it was the Sanibel Causeway, built in 1963, that provided direct road access to the mainland and opened the island to a development boom. A substantial, 4,975-acre, undeveloped area, mainly along the northern Pine Island Sound side, has been retained as the J. N. "Ding" Darling National Wildlife Refuge.

Today, Sanibel has an annual population of more than 5,800 people which swells to more than 20,000 during the peak tourism season.



Boca Grande Pass during tarpon season with boats fishing along edge of channel with 50 foot depth range, view north with Gasparilla Sound on right.

North Captiva Island in foreground, Captiva and Sanibel Islands in distance, looking southeast, Pine Island Sound on left and Gulf of Mexico on right.



Map 1-B.
Contemporary conditions along the barrier islands.

Sanibel Island in foreground, looking north across San Carlos Bay towards St. James City (south Pine Island) and Cape Coral.

10. **El Jobean** was named after Joel Bean, a Boston lawyer, who in 1924 filed a town plan consisting of six wards, each with its own civic center bordering a circular plaza. Construction stopped with the stock market crash of 1929, and only a remnant of El Jobean remains today. Much of the subdivision is now within the Riverwood Development of Regional Impact.

11. **Charlotte Harbor** (**Town**), settled in 1862, first called Live Oak Point and later Hickory Bluff, was the site of a cattle dock built to ship beef, first to the Confederacy, and later to Cuba. The bluff was leveled for building lots during the land boom period of the 1920s.

12. **Peace River**, or Peas Creek on pre–development maps, is named for black-eyed peas, which grew in the region.

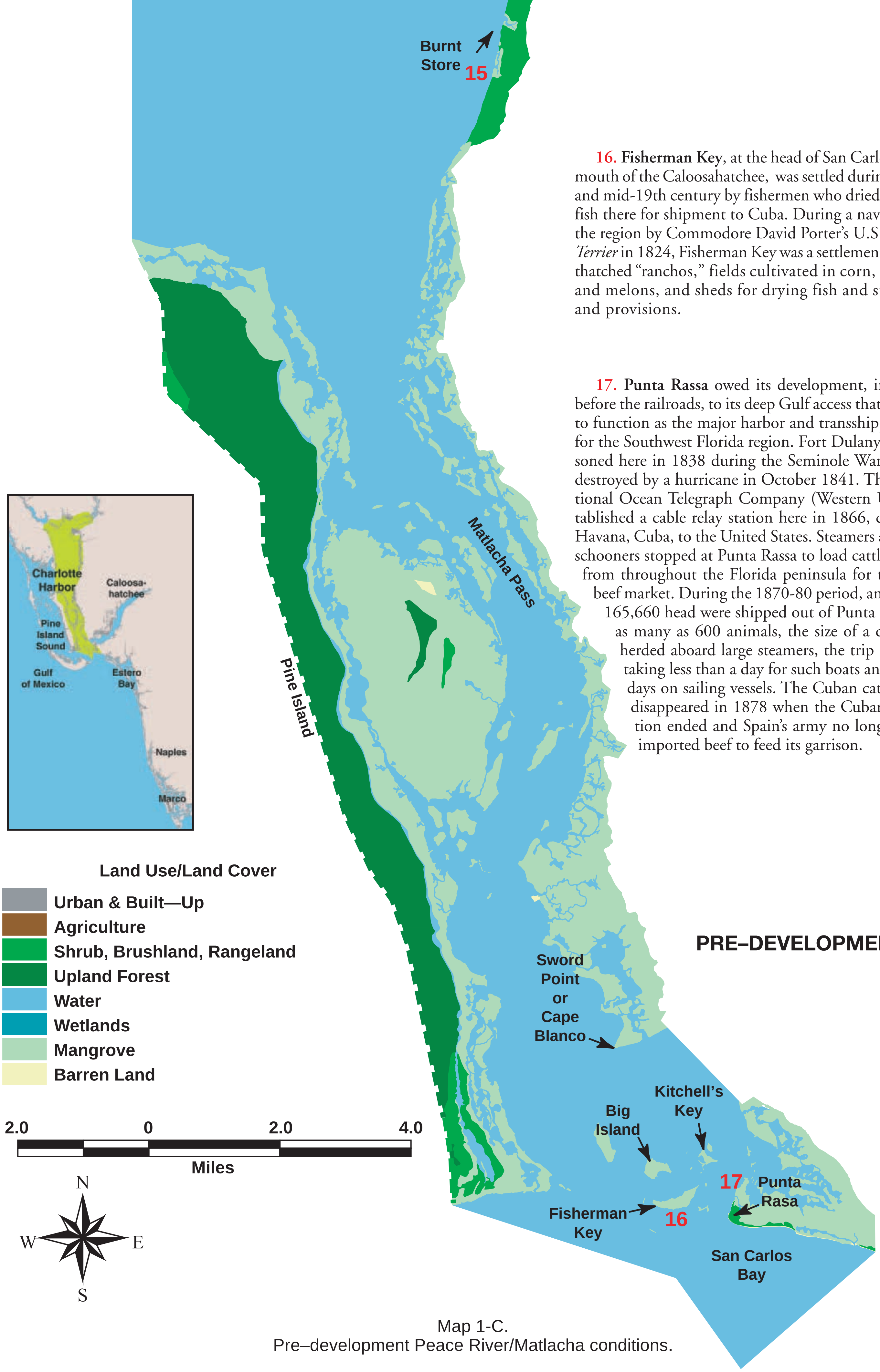
13. **Punta Gorda** became an important shipping hub in 1886 with the arrival of the Florida Southern Railroad and the telegraph. An ice factory built in 1893 transformed the fishing industry in the harbor by making the shipment of fresh fish possible. Small stilt fish houses and houseboats, called lighters, were set up throughout Charlotte Harbor, managed by fish companies which operated "run boats" that delivered ice and supplies to the outlying fishermen and picked up the catch for transport back to Punta Gorda. The salt fisheries that operated in the harbor throughout the early pre–development period were absorbed by this new enterprise.

14. **Punta Gorda Isles**, today an upscale residential waterfront community, was shrub, brushland, and rangeland in the pre–development period, where cattle roamed freely.

15. **Burnt Store** on the east shore of Charlotte Harbor, was a trading post that the Seminoles burned in 1845. Today, Burnt Store Marina and Country Club is a destination resort complex, featuring a 400-plus-slip (and dry-storage) marina, a golf course, and tennis courts, with condominium and upscale single-family homes.

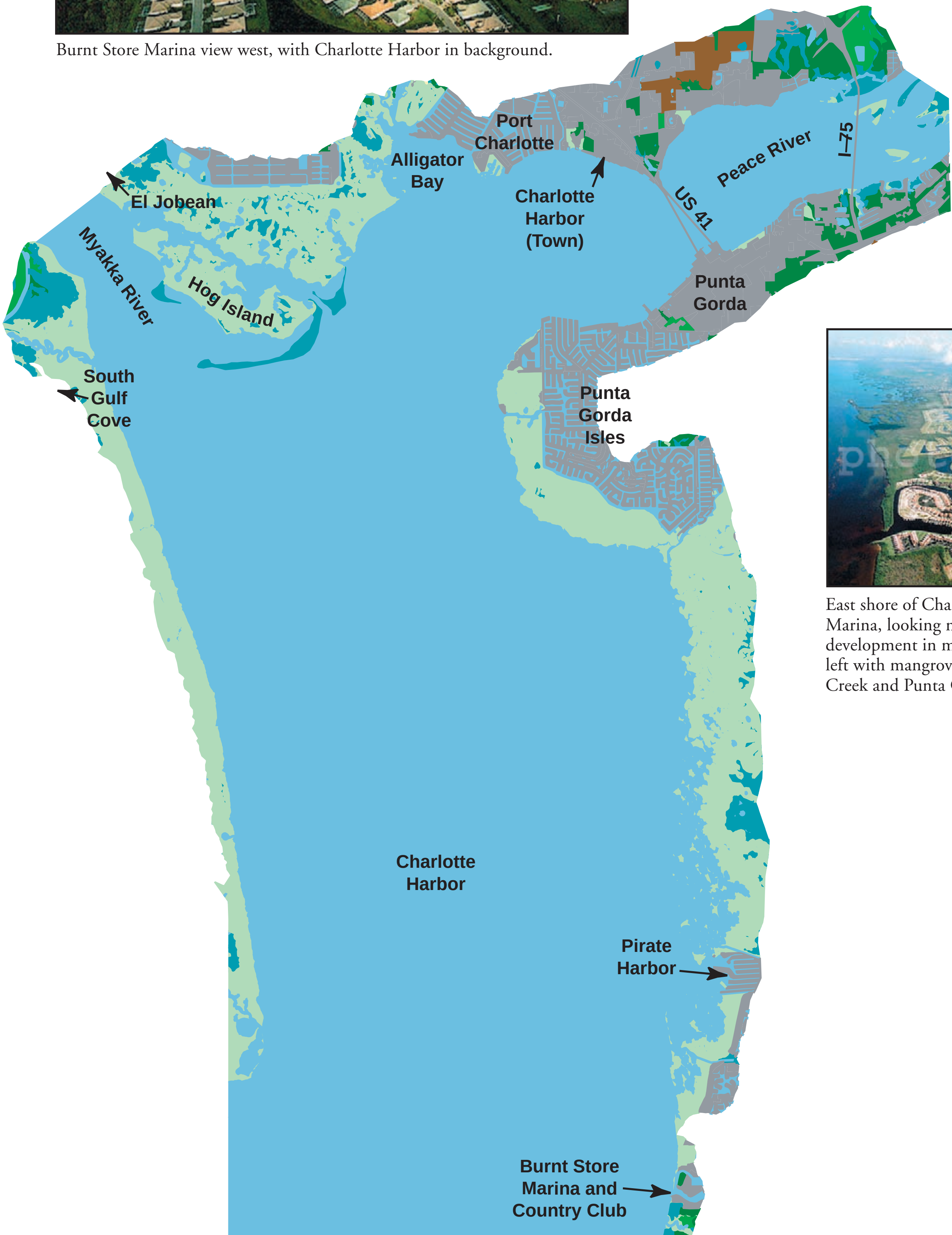
16. **Fisherman Key**, at the head of San Carlos Bay and mouth of the Caloosahatchee, was settled during the early and mid-19th century by fishermen who dried and salted fish there for shipment to Cuba. During a naval sortie in the region by Commodore David Porter's U.S. Schooner *Terrier* in 1824, Fisherman Key was a settlement with nine thatched "ranchos," fields cultivated in corn, pumpkins and melons, and sheds for drying fish and storing salt and provisions.

17. **Punta Rassa** owed its development, in the days before the railroads, to its deep Gulf access that enabled it to function as the major harbor and transshipping point for the Southwest Florida region. Fort Dulany was garrisoned here in 1838 during the Seminole Wars, but was destroyed by a hurricane in October 1841. The International Ocean Telegraph Company (Western Union) established a cable relay station here in 1866, connecting Havana, Cuba, to the United States. Steamers and sailing schooners stopped at Punta Rassa to load cattle, brought from throughout the Florida peninsula for the Cuban beef market. During the 1870-80 period, an estimated 165,660 head were shipped out of Punta Rassa, and as many as 600 animals, the size of a drive, were herded aboard large steamers, the trip to Havana taking less than a day for such boats and up to 10 days on sailing vessels. The Cuban cattle market disappeared in 1878 when the Cuban insurrection ended and Spain's army no longer needed imported beef to feed its garrison.



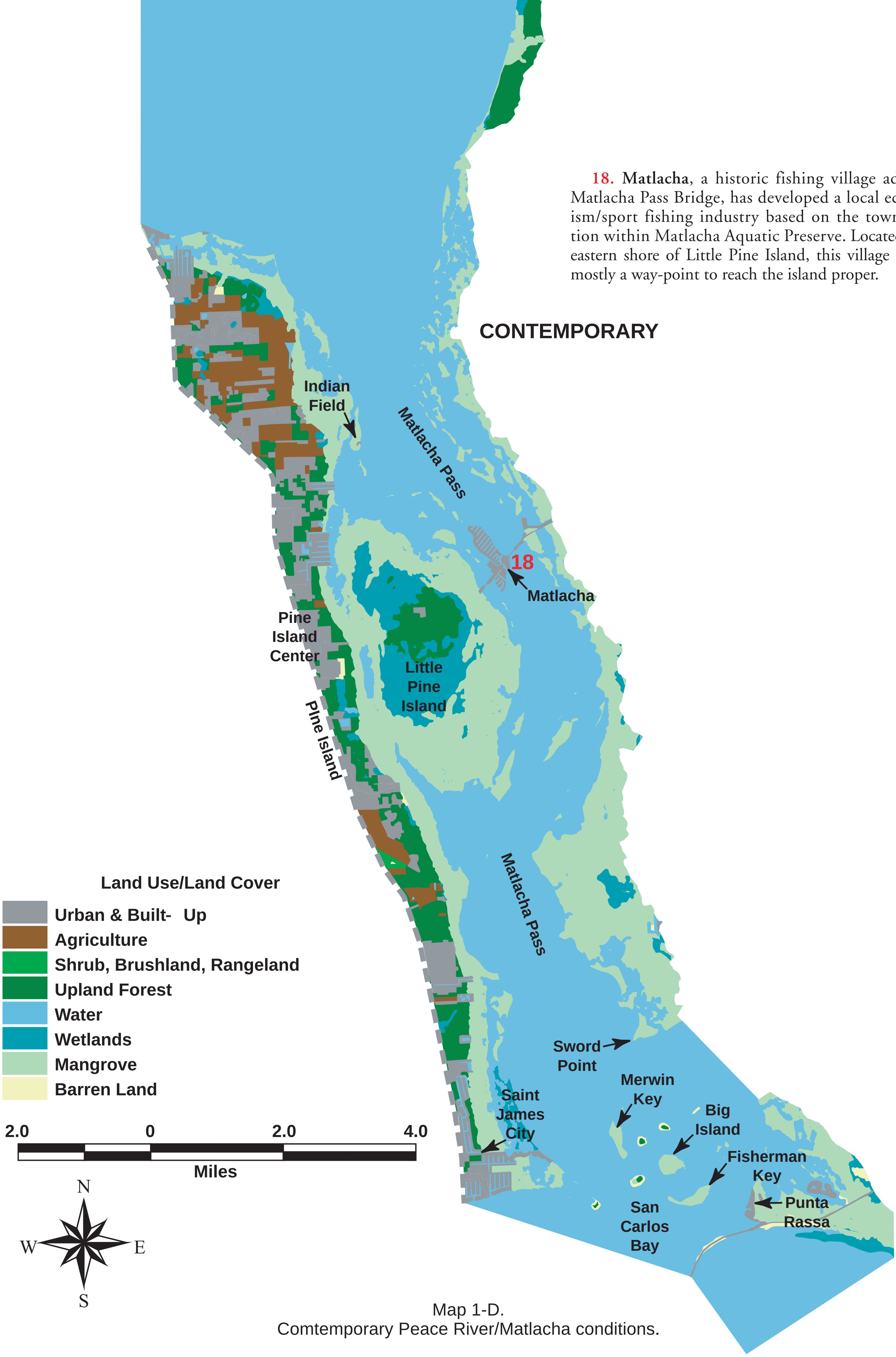
Map 1-C.
Pre–development Peace River/Matlacha conditions.

Burnt Store Marina view west, with Charlotte Harbor in background.



East shore of Charlotte Harbor from Burnt Store Marina, looking north, Burnt Store Lakes development in midground, Key Point on upper left with mangrove islands reaching to Alligator Creek and Punta Gorda Isles in distance.

18. **Matlacha**, a historic fishing village adjoining Matlacha Pass Bridge, has developed a local eco-tourism/sport fishing industry based on the town's location within Matlacha Aquatic Preserve. Located on the eastern shore of Little Pine Island, this village is today mostly a way-point to reach the island proper.



Map 1-D.
Comtemporary Peace River/Matlacha conditions.

19. **Ft. Myers** served as an army supply depot during the Seminole and Civil Wars. By 1879, the town had a population of 150 and included four stores that supplied goods and medicines to the sparse population of the Caloosahatchee Valley. The town's population grew to 349 by 1885. The following year Ft. Myers became the seat of newly formed Lee County. The railroad arrived in 1904, and later a large tourist trade developed. The lower Caloosahatchee attracted hundreds of fishermen and sportsmen annually. Waterborne commerce — steamers and trading schooners — declined in the face of competition by the railroad. Ft. Myers, during the 20th century preceding World War II, became the distribution center for a large and rapidly developing region, and its commerce increased accordingly.

The Ft. Myers waterfront today is undergoing a resurgence of development. Hotels, condominiums and single-family homes line the riverfront east and west of downtown proper. The downtown waterfront is the focus of a redevelopment study that will blend the historic structures with new growth. There is thriving nightlife in the core of the city today that city officials hope to spread throughout the daytime hours. One element that should spur downtown redevelopment was the creation in the late 1990s of a terminal to allow daily high-speed boat trips from the city to Key West. Operation of a high-speed catamaran is expected to begin by 2003.

Map 1-F.
Pre–development Caloosahatchee conditions.

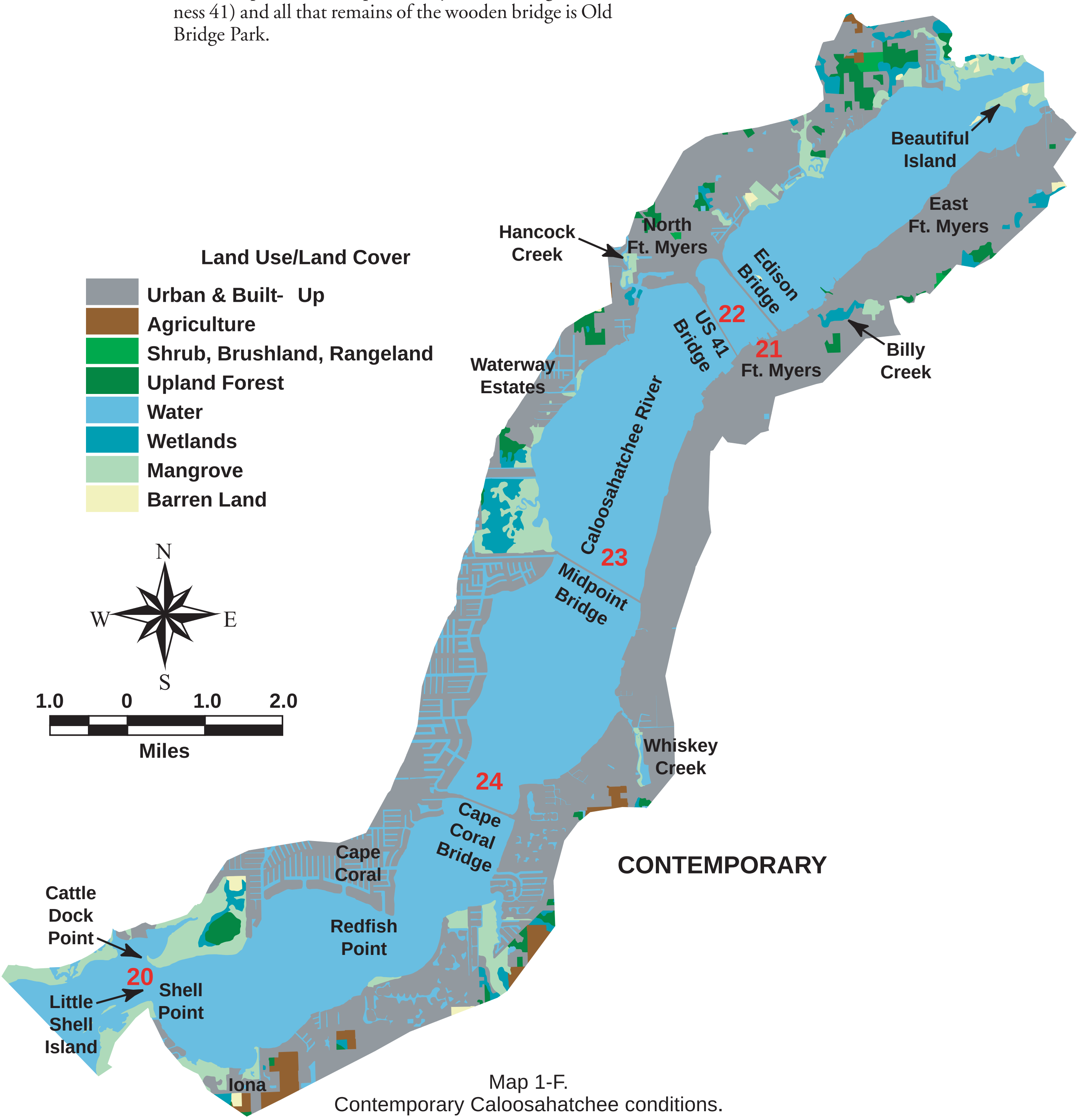
20. Little Shell Island, at the mouth of the Caloosahatchee, provided a place for boaters to go for great hamburgers during the 1950s. Today, the burgers are gone and the island is mostly deserted except for weekend boaters.

21. Ft. Myers Yacht Basin and Waterfront Park was built in 1937 as a WPA (Works Progress Administration) project, the New Deal relief and recovery program of the Depression that employed tens of thousands of people on public works projects, such as building roads, bridges, and parks.

22. Ft. Myers (downtown) Bridge The first bridge across the Caloosahatchee was a wooden structure built in 1924 that burned in the early 1940s. The bridge crossed the river upstream of the present day Edison Bridge (Business 41) and all that remains of the wooden bridge is Old Bridge Park.

23. Midpoint Bridge This span opened to vehicular traffic in October 1997. It is a four-lane facility with a 55-foot clearance for boats at the center of the channel. Construction of the bridge was first discussed in the 1960s; the issue came before the Lee County Board of County Commissioners in 1975 and was defeated by a 3-2 vote. It eventually was constructed.

24. Cape Coral Bridge A two-lane bridge first opened to vehicular traffic in 1964. A twin span was added in 1989, creating a total of four lanes of traffic. The bridge has a clearance for vessels of 55 feet at the center of the channel.

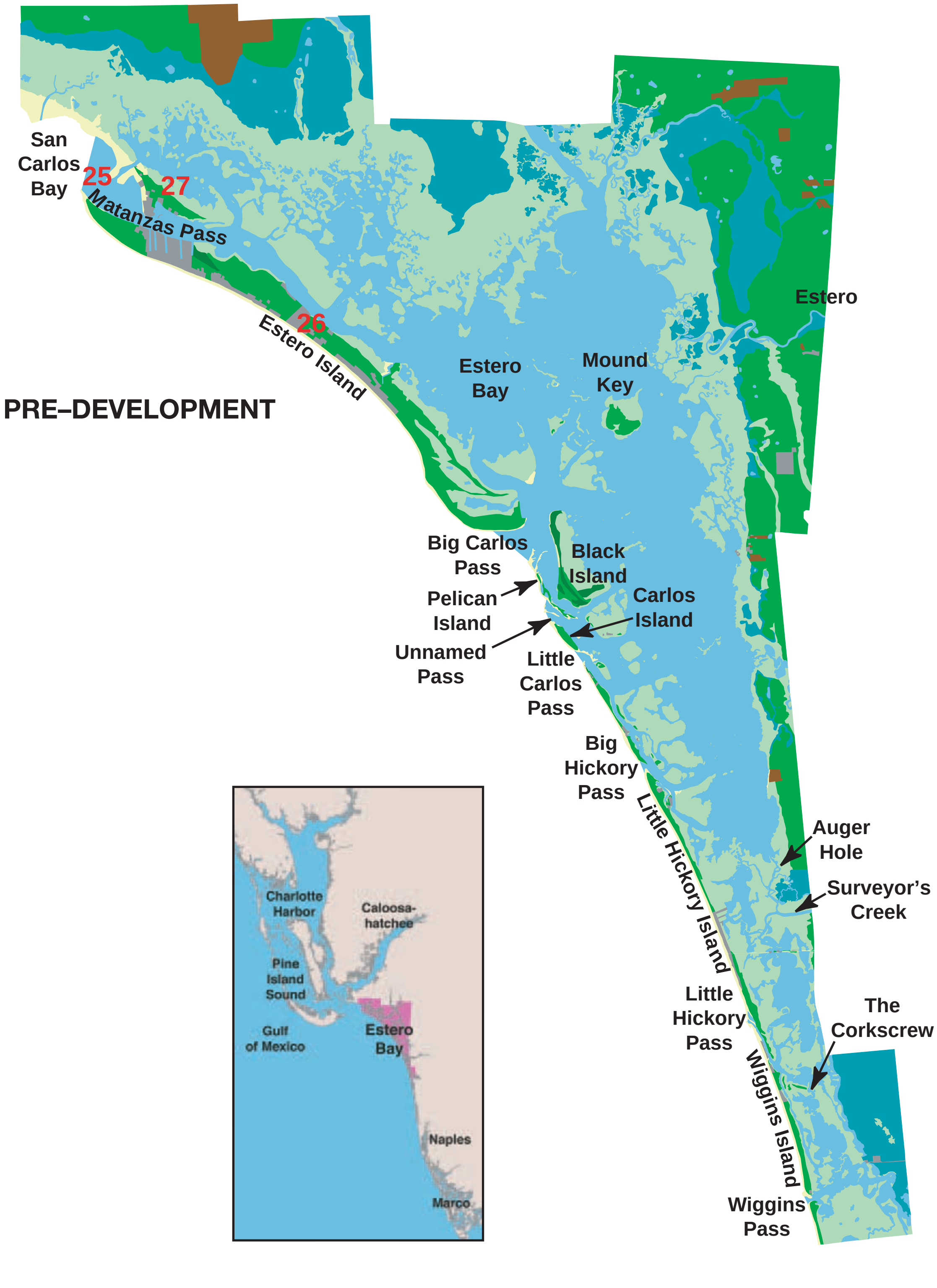


Map 1-F.
Contemporary Caloosahatchee conditions.

25. **Matanzas (Pass),** from the Spanish word for "slaughter," probably commemorates the 1566 death of Carlos, Chief of the Calusa Indians, at the hands of a Spanish expedition under Pedro Menendez. This Indian chief undoubtedly lent his name to Big and Little Carlos Passes and Carlos Island.

26. **Ft. Myers Beach (Estero Island)**, called Crescent Beach in earlier times, was homesteaded in the 1890s. During those years, before road and bridge linked the island to the mainland, most supplies reached Estero Island by a boat operated by the Koreshan Unity (a communal pioneer society), which made regular trips from Ft. Myers to Estero. The hurricane of September 1926 destroyed a wooden bridge connecting Estero and San Carlos Islands. A swing bridge replaced it in 1928 and functioned until 1979, when the "Sky Bridge" was built. The first "finger-island" canals on Ft. Myers Beach were dredged in 1924, and by 1934, a large number of canal lots had been dredged and filled, facing Matanzas Pass, and sold for $35 each. By 1940, the island's population was 473. The pace of development accelerated after World War II, spurred by tourism and a growing demand for permanent waterfront living. There were more than 700 island residents in 1950, and the population jumped to 2,500 by 1960. A bridge spanning Big Carlos Pass and a causeway running from the south end of Estero Island to Bonita Beach were built in 1965. Today, Ft. Myers Beach is an incorporated town with an annual population of 14,000 which doubles during the winter tourist season.

27. **San Carlos Island** developed into one of the largest shrimp ports in the United States in 1950 with the discovery of "pink gold" in the Dry Tortugas, off Key West. As these beds became depleted, other shrimp grounds were discovered off Sanibel in the Gulf and as far away as Campeche, Mexico. During the peak production in 1996, 4.2 million pounds of heads-off shrimp were unloaded at San Carlos Island. Landings fell the next year to 2.7 million pounds, but still produced a dockside value of almost $14 million. It has been estimated that the shrimping industry on the island, on average, generates an economic base of more than $21 million and employs 600 people. However, the vagaries of the industry may cause those figures to change dramatically from year to year.



Map 1-G.
Pre–development Estero Bay conditions.

28. Lovers Key, once an offshore shoal, owes its emergence and growth to Hurricane Donna, the 1960 storm that devastated the Southwest Florida coast. Floyd Lucky, a local developer, laid claim to the newly formed island and began building and dredging. Wetland and bay bottom habitats were altered to uplands. The state purchased the island in 1983 and merged it with its acquisition of county-owned lands on Black Island, Long Key, and Inner Key in 1996 to create the Lovers Key State Park, a multi-use marine recreation area.

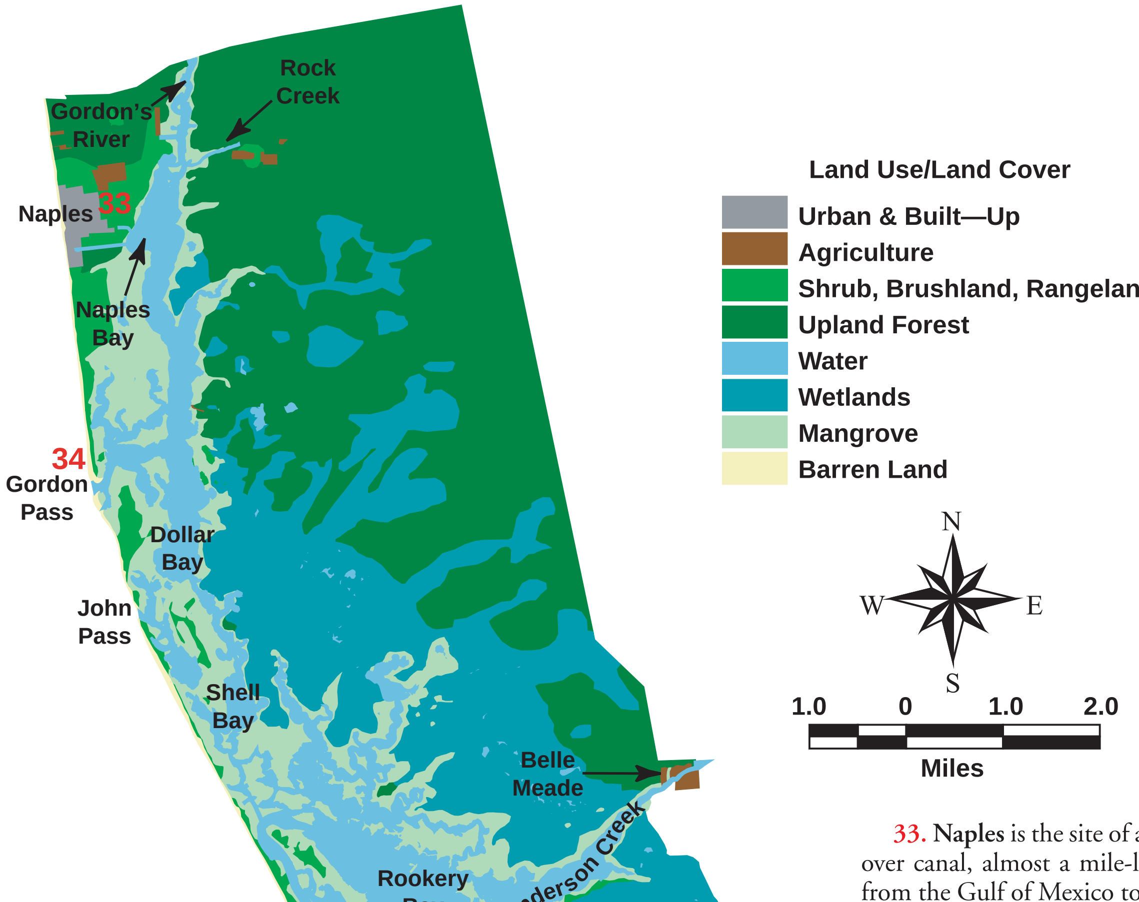
29. Black Island, a former Koreshan homesite and fish camp where fishermen and their families lived from the turn of the century until the 1950s, is now part of the Lovers Key State Park. Koreshan was a religious sect founded by Dr. Cyrus Teed. Koreshans believed the world was round, but concave rather than convex. The church followers also adhered to strict rules of celibacy and, by the end of World War II, the religion was mostly extinct.

30. Estero, on the banks of the Estero River, was founded in 1894 by the Koreshan Unity. When the Army Engineers conducted a river survey in 1903, about 500 persons lived in the community and its vicinity. The Army Engineers reported that the town, incorporated by the Koreshans on a tract of 70,000 acres, included a post office, small store, machine shop and "…one of the largest printing establishments in Florida." The religion published its beliefs in "The Flaming Sword," a religious magazine, "The American Eagle," a newspaper, and in Koresh's private writings published through Guiding Star Publishing House. The Unity operated a large orange grove (185 acres) nine miles above the mouth of the river; they also colonized Mound Key and Black Island. Membership declined through the early 20th century and the land was deeded to the state in 1961. It is now the Koreshan State Historic Site.

31. Mound Key, almost 30 feet in height, owes its elevation to the thousands of years of shelling and building of middens by the Calusa and their predecessors. Mound Key is believed by researchers to be Carlos, the town where King Carlos of the Calusas met with Spanish Governor Pedro Menendez in 1566. Cuban fishermen settled on Mound Key in the 1800s, and by the early 1900s the island was home to members of the Koreshan Unity. The Koreshans deeded Mound Key to the state in 1961 to preserve the island's historic and archaeological character.

32. Wiggins Pass is named for Joe Wiggins, who homesteaded and operated a trading post in the area. Just south of the pass is the Delnor Wiggins Pass State Recreation Area.

Map 1-G.
Contemporary Estero Bay conditions.



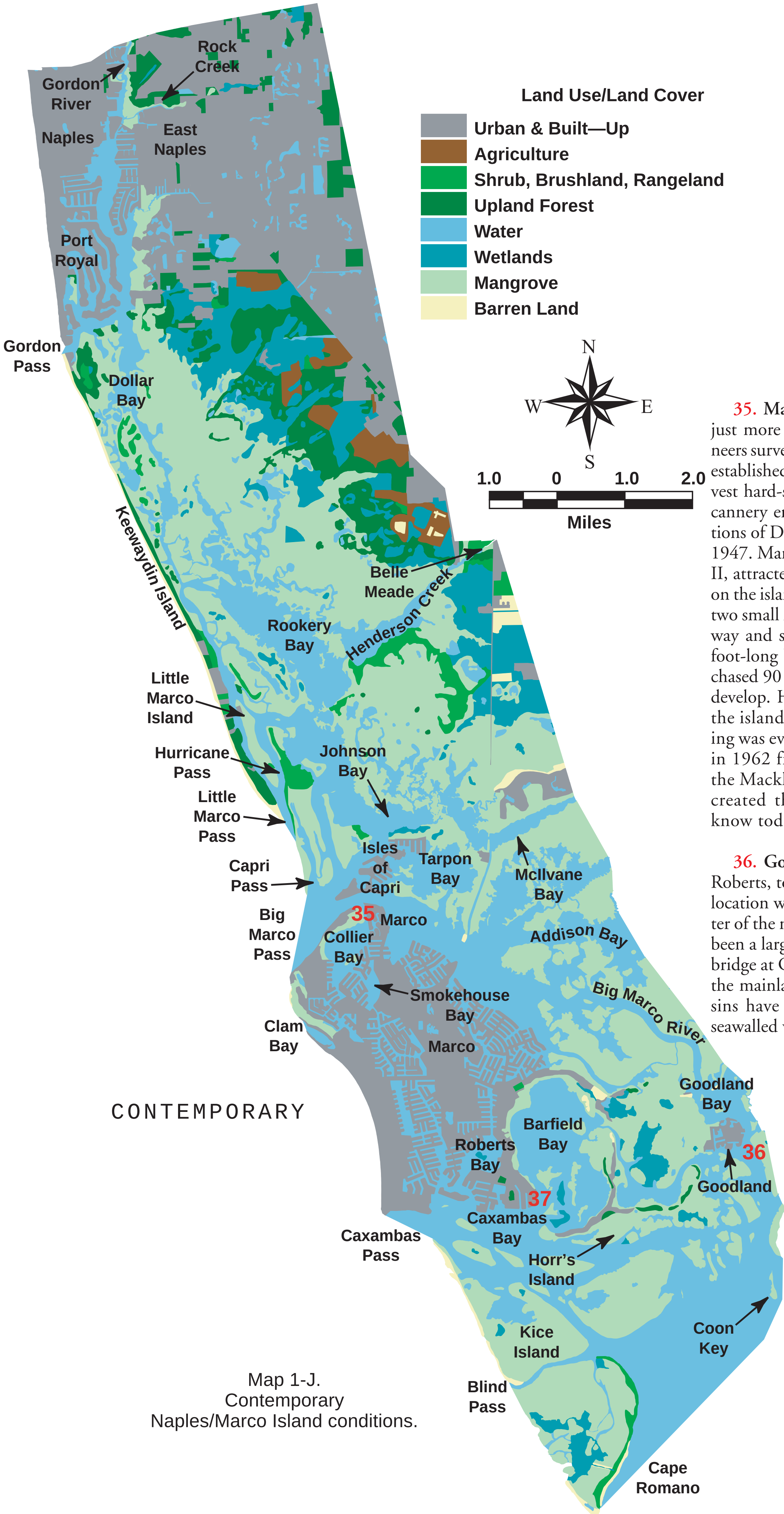

33. **Naples** is the site of a Calusa settlement and haul-over canal, almost a mile-long, deep canoe passageway from the Gulf of Mexico to Naples Bay. The earliest settlers were squatters who came to the area in the 1870s. With the arrival of the railroad at Punta Gorda and later extension to Ft. Myers, Naples, by the turn of the century, attracted increasing numbers of tourists, principally sportsmen, who fished and hunted during the winter season and made their residence aboard yachts or at local hotels. Naples retained its small-town ambiance until the early 1950s, when major dredge-and-fill developments created a maze of waterways and waterfront communities that lined the Gordon River and Naples Bay.

34. **Gordon Pass** is named for Roger Gordon, who operated a fishing camp there in the 1870s.

PRE–DEVELOPMENT

Clam Pass and Outer Clam Bay in middle foreground, looking east, with Seagate Drive trending east-west, and US 41 (Tamiami Trail) running north-south.

Map 1-I.
Pre–development
Naples/Marco Island conditions.



Map 1-J.
Contemporary
Naples/Marco Island conditions.

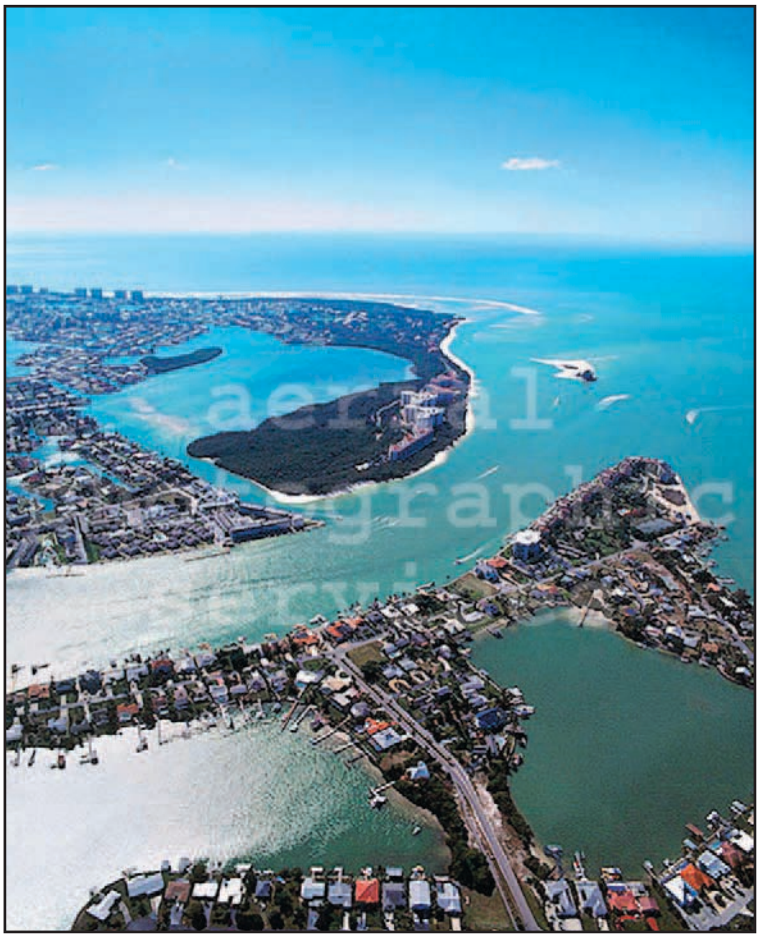
South Marco Island from Caxambas Pass, looking north, showing Marco's cresent-shaped Gulf beach and complex canal system.

35. **Marco** was a small fishing village in 1913, with just more than 100 inhabitants, when the Army Engineers surveyed the pass and inland waterway. J. H. Doxsee established a clam cannery at the village in 1910 to harvest hard-shell clams in the Ten Thousand Islands. The cannery employed as many as 150 people. Five generations of Doxsees operated the cannery before it closed in 1947. Marco Village, during the years before World War II, attracted sportsmen who fished for tarpon or hunted on the island and nearby mainland. They stayed at one or two small hotels on the island. At the time, a marine railway and shipyard were capable of accommodating 60-foot-long boats. In the early 1920s, Barron Collier purchased 90 percent of Marco Island, which he planned to develop. He even began to clear land in the middle of the island at a location named Collier City, but nothing was ever completed. Marco was totally transformed in 1962 from its sleepy, idyllic old Florida setting by the Mackle brothers when their Deltona Corporation created the residential canal resort community we know today.

36. **Goodland** was named by its first settler, Jonnie Roberts, to describe the fertile, well-drained soil and the location with abundant fishing available in the deep water of the nearby Marco River. Goodland had historically been a large Calusa settlement. The county built a swing bridge at Goodland in 1939, Marco's only connection to the mainland until 1969. Finger canals and borrow basins have transformed the mangrove shoreline into a seawalled waterfront residential community.

37. **Caxambas** (sometimes spelled "Caximbas"), one of the oldest place names on the Southwest Florida coast, is of West Indian (Arawak) origin, from the word "casimba" or "cacimba," which refers to a drinking hole or "well" which was probably a shallow freshwater depression in the beach used by explorers and fishermen in the pre–development period. Shell mounds attest to earlier Calusa settlement. There was a small agricultural and fishing settlement here during the 19th century. The E.S. Burnham Packing Company established a clam factory at Caxambas in 1904. The town was moved in 1949 to Goodland, preceding the Collier family's attempt to develop Marco Island.

South Marco Island and Roberts Bay in foreground, looking southwest out Caxambas Pass.



View south from the Isles of Capri, across the Big Marco River to Marco Island, Coconut Island separating Capri Pass from Big Marco Pass on right.

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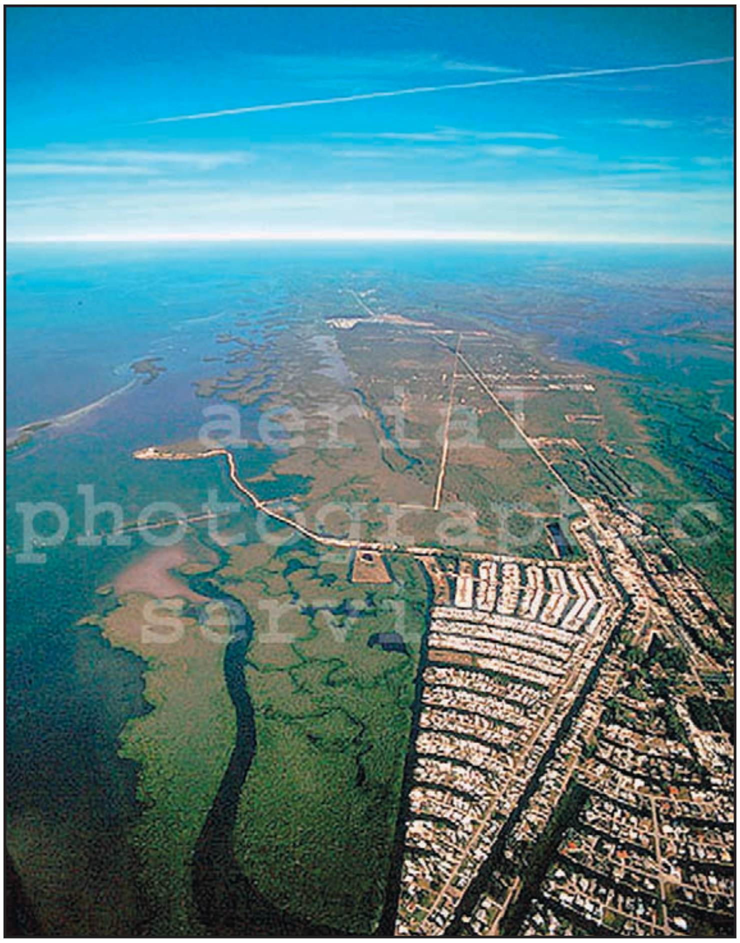


South Pine Island, looking northeast, St. James City in foreground, road to Galt Island with McKeever Keys fronting on Pine Island Sound on the left midground and Matlacha Pass on right.

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.

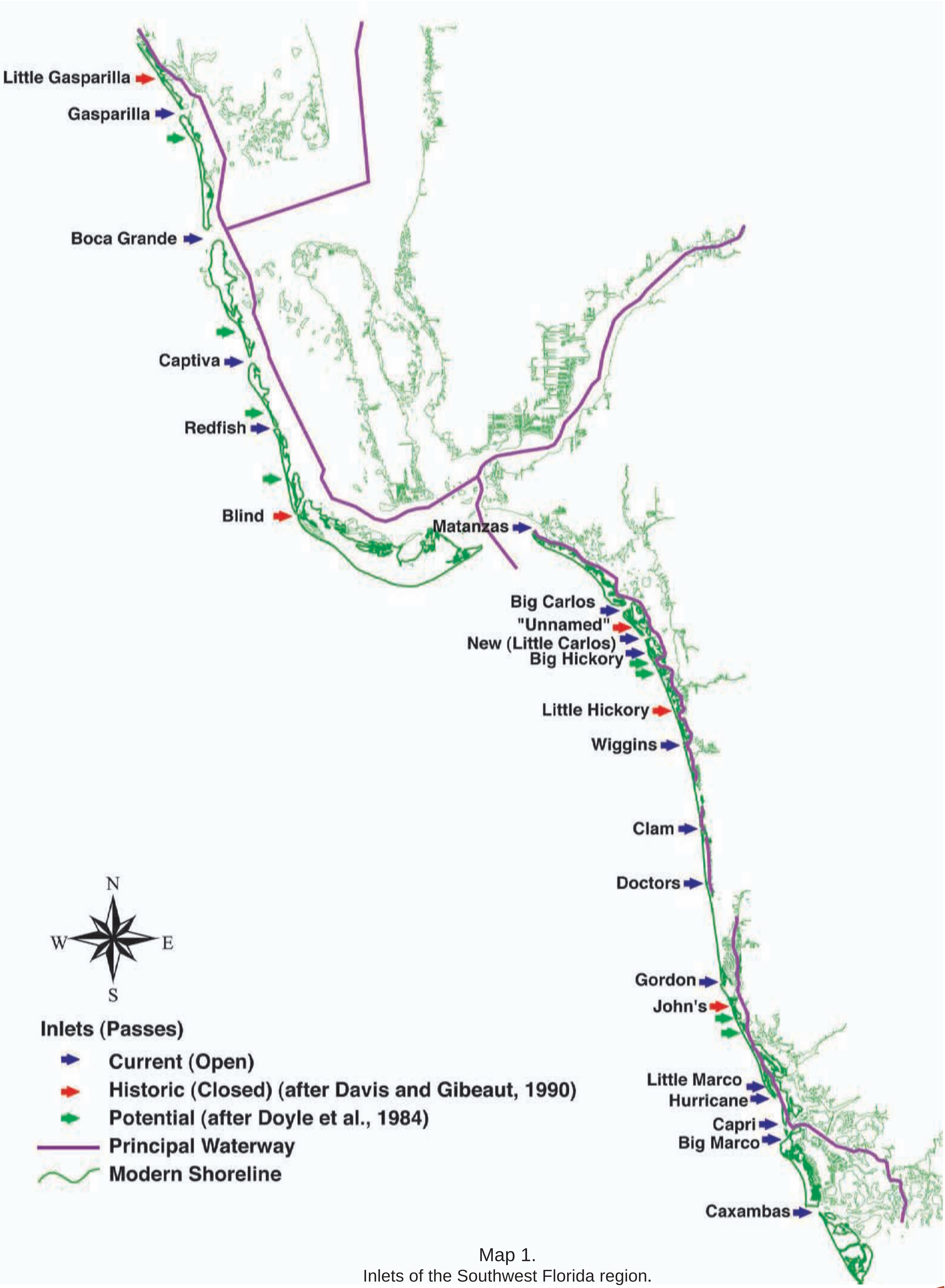
Inlet Locations and Status

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

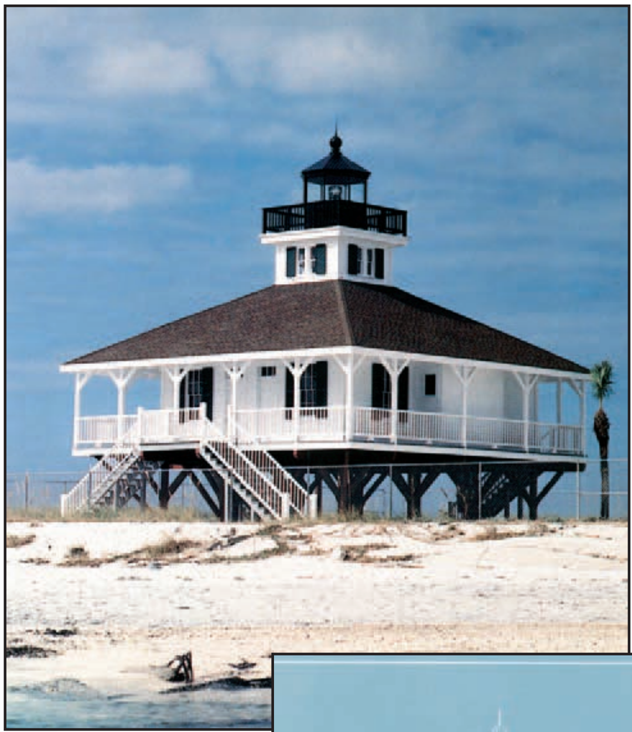
e. Outside route, including runs from and to the ICW/IW (distances in statute miles).

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	

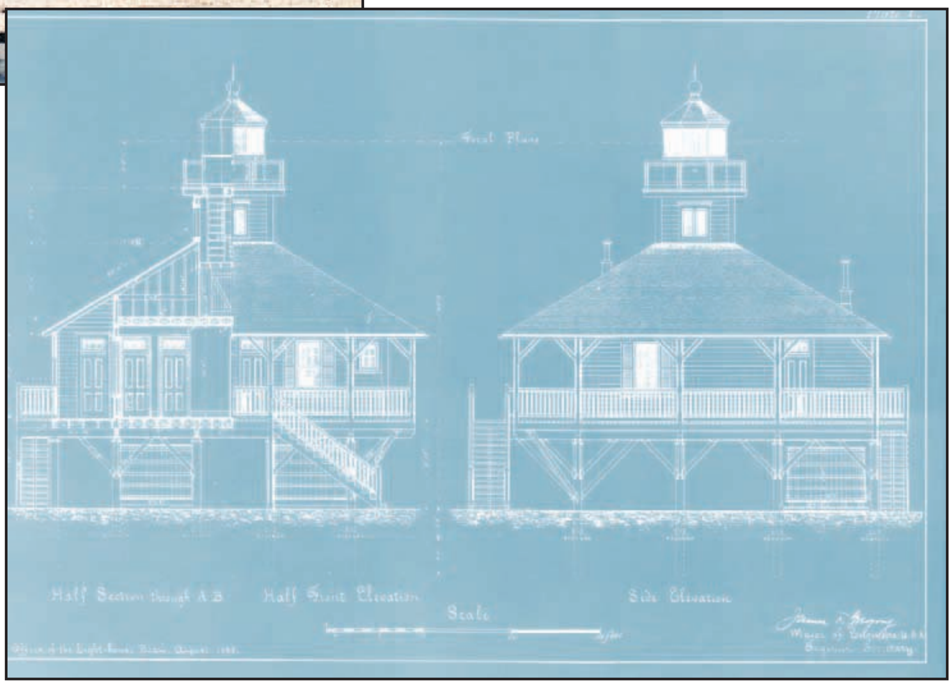
Table 1. (a-e)

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.

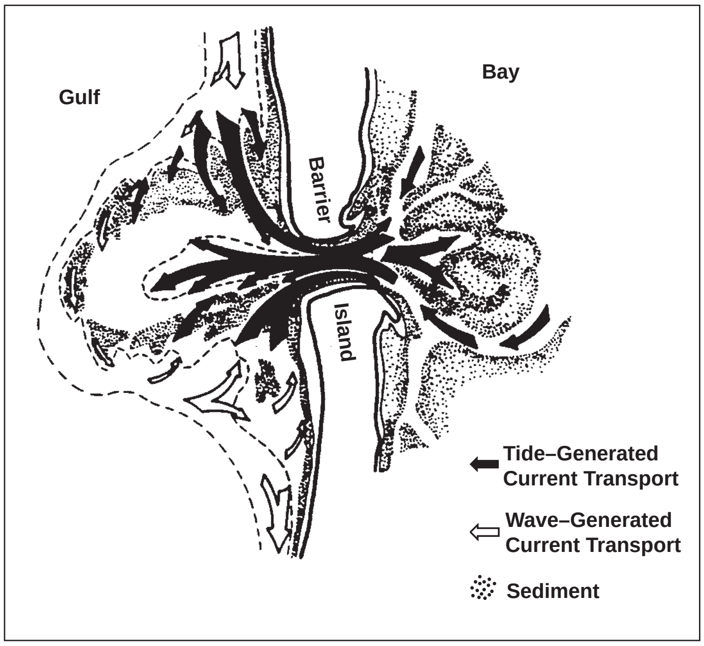


Figure 1.
Tide-generated and wave-generated transport features in a representative inlet system (from Smith, 1984).

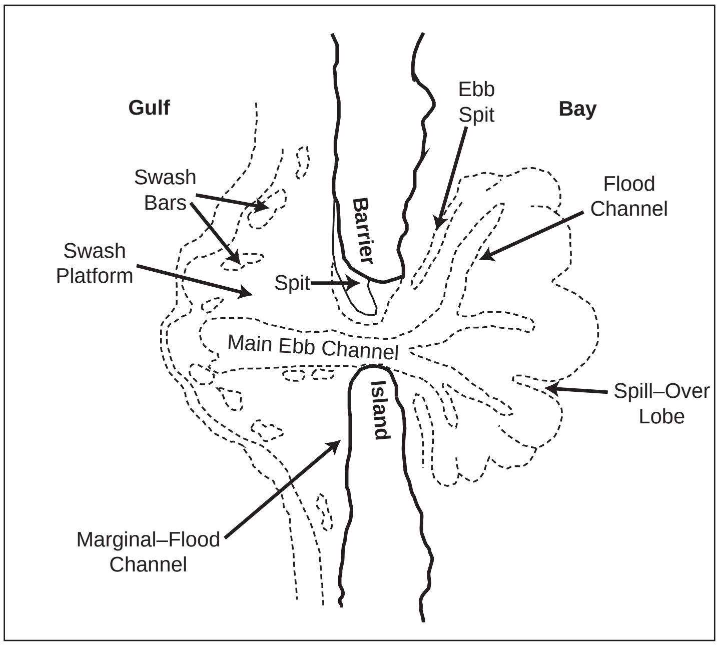


Figure 2.
Tidal inlet features (from Smith, 1984).

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.

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.

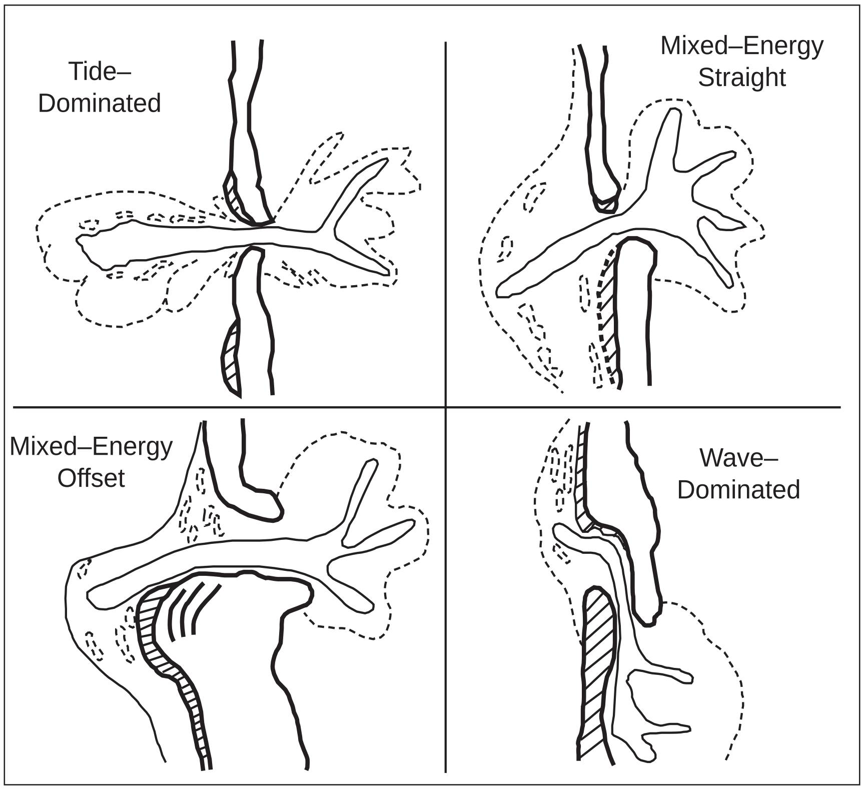
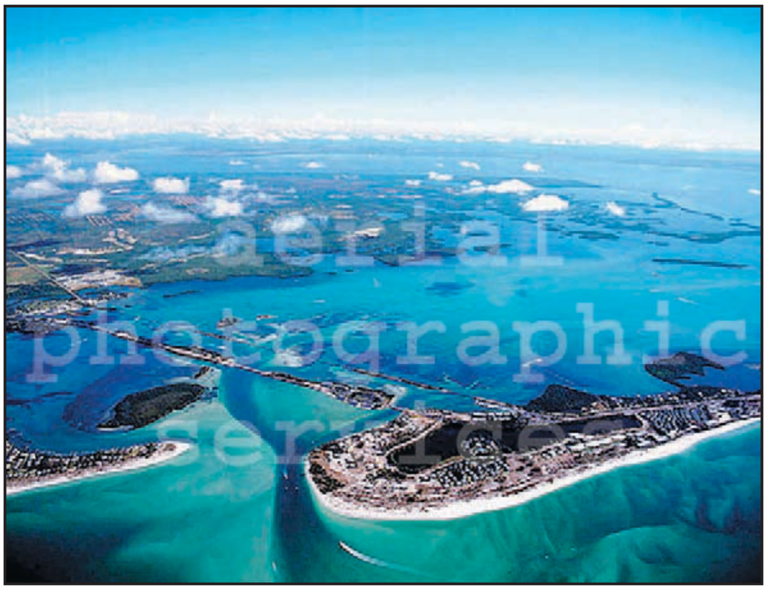


Figure 3.
Inlet types along the Southwest Florida Coast (from Davis Jr. and Gibeaut, 1990).



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

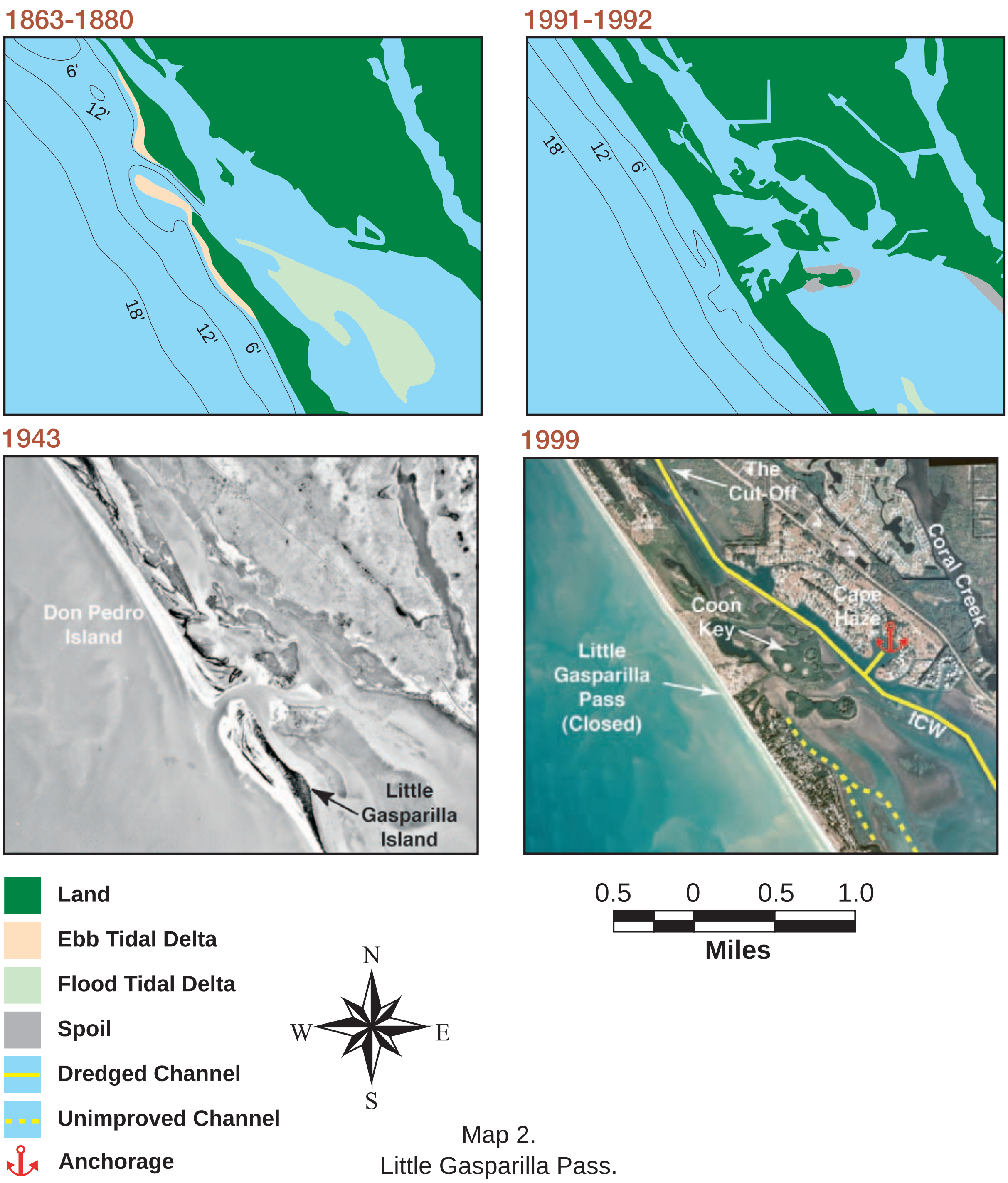
Historical Changes

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.

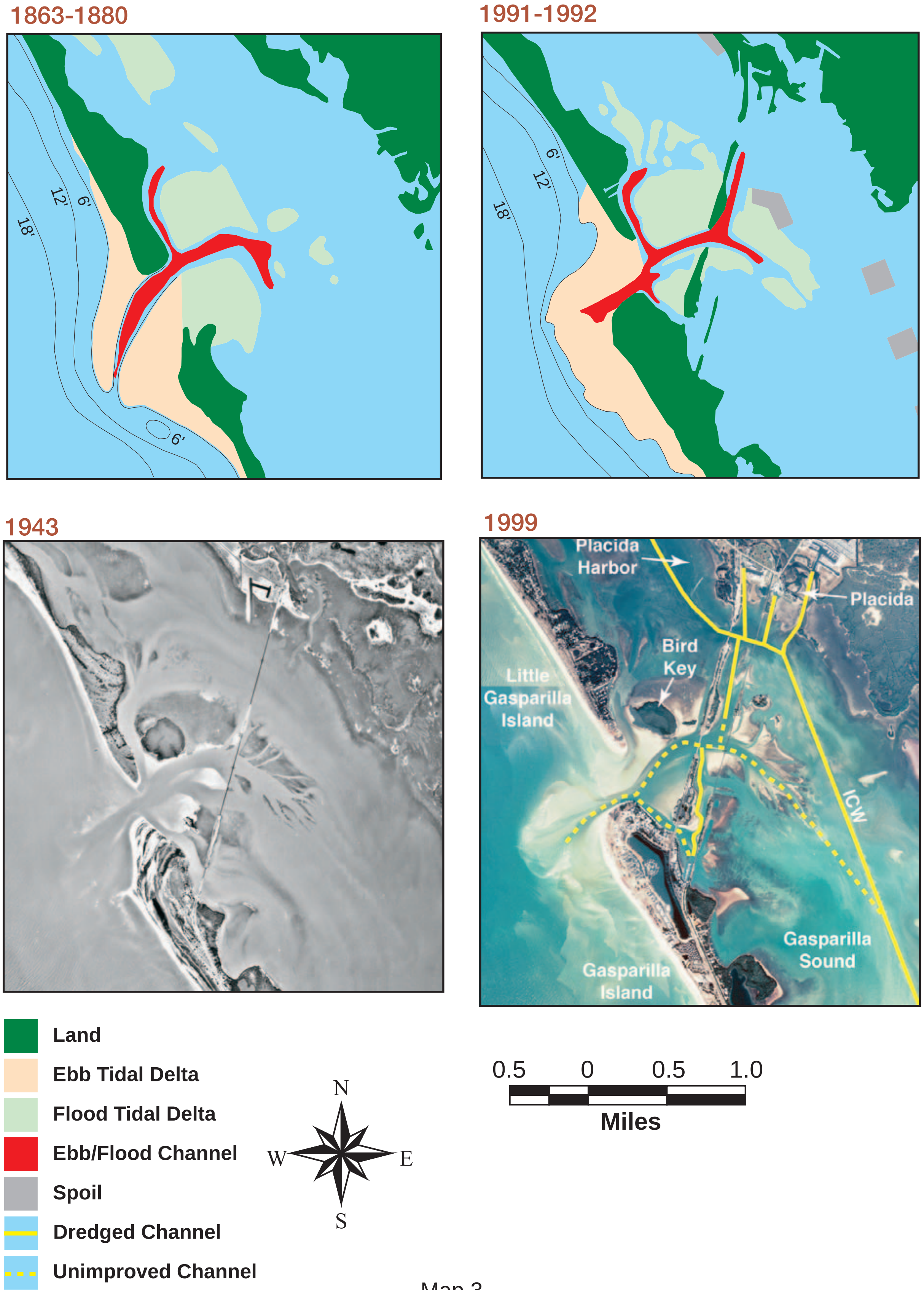
The bayside geography, shown in the 1991-92 map, has been drastically altered by land development on the Cape Haze peninsula and dredge-and-fill associated with the Gulf Intracoastal Waterway (ICW). Coon Key has spoil deposits from the ICW dredging of the 1960s. An anchorage, popular with boaters cruising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



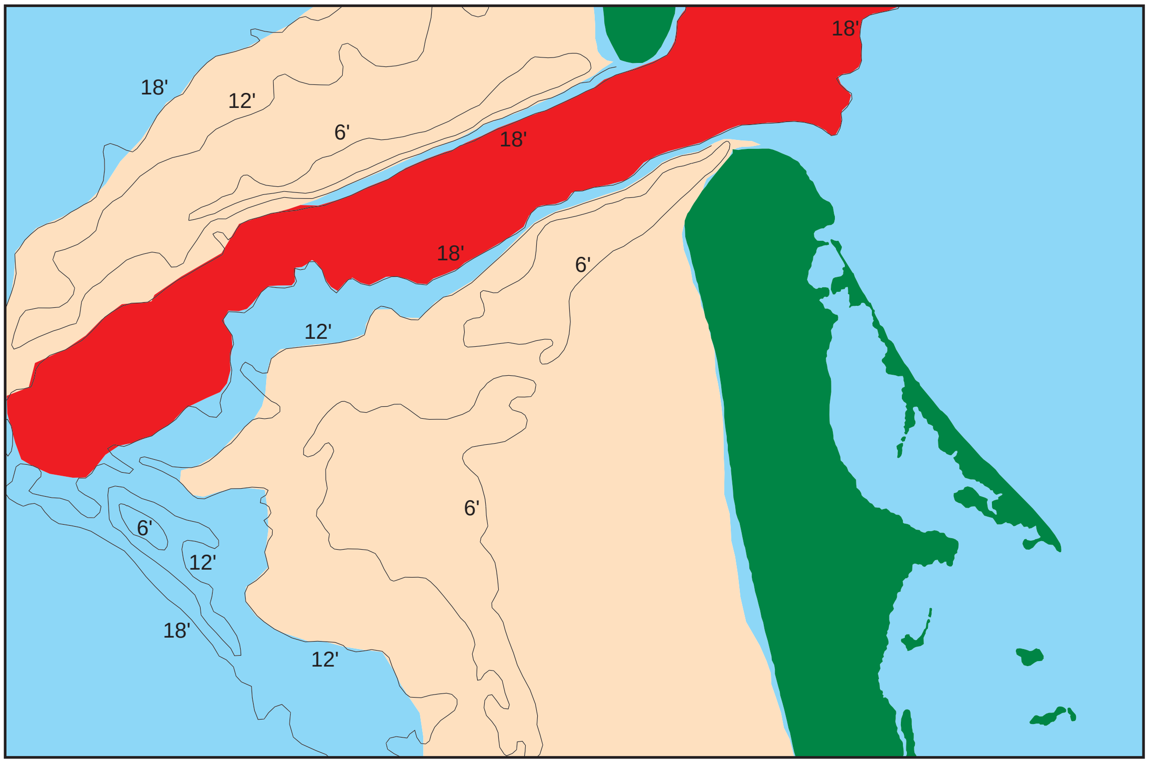
Map 3.
Gasparilla Pass.

Boca Grande

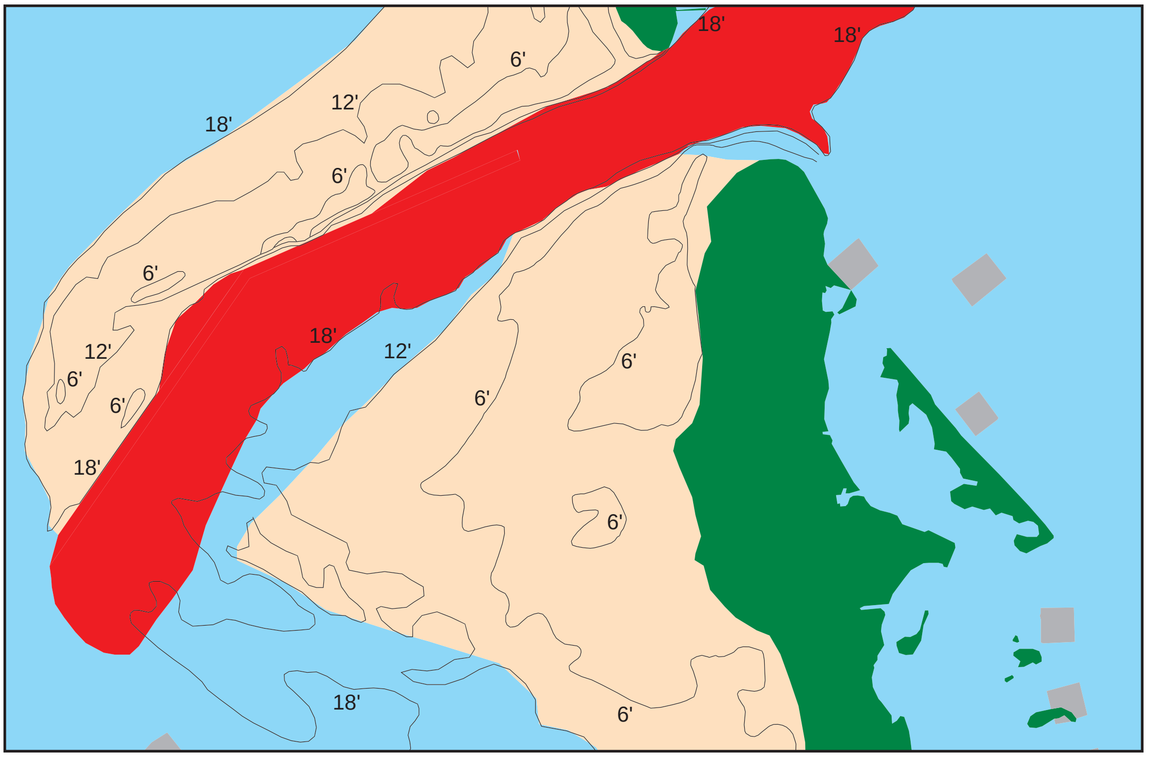
Boca Grande is the primary inlet serving Charlotte Harbor. Because of its size, width and large tidal prism, the inlet has been stable over time and — uniquely — has no flood-tidal delta (Map 4). The main inlet channel is deep (exceeding 70 feet in the throat), but abruptly shoals to less than 6 feet 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

1863-1880



1991-1992

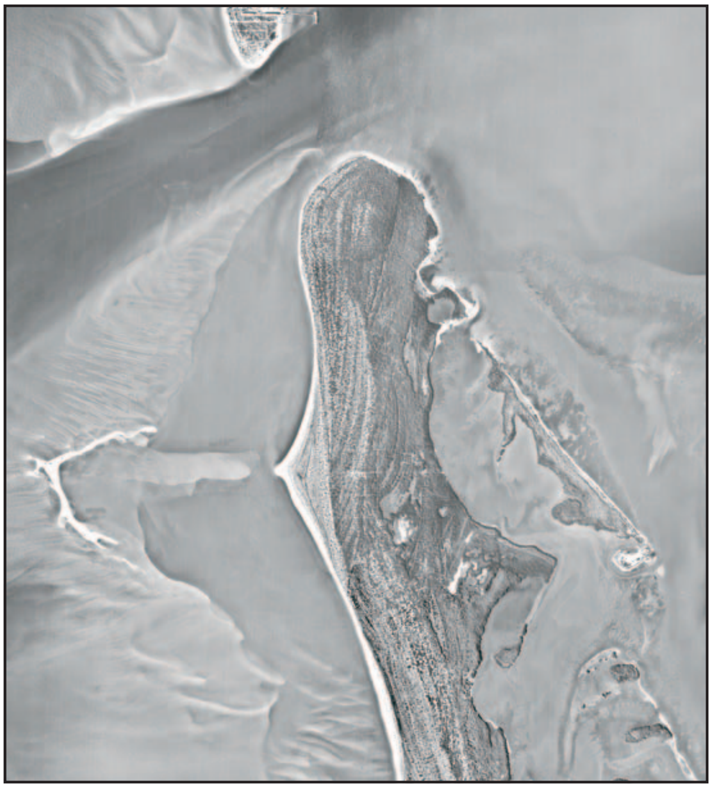


...Click went the reel, down went his thumb on the leather brake, and with a long, steady movement he swung his rod to the vertical position, when he took most of the pressure off the brake. Whiz! went the reel with lightning speed in the fraction of a second. Then, with a glorious leap, out sprang the 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.

1944

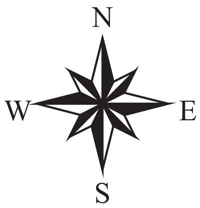


1999

Map 4.
Boca Grande.

Johnson Shoals, 1981.

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



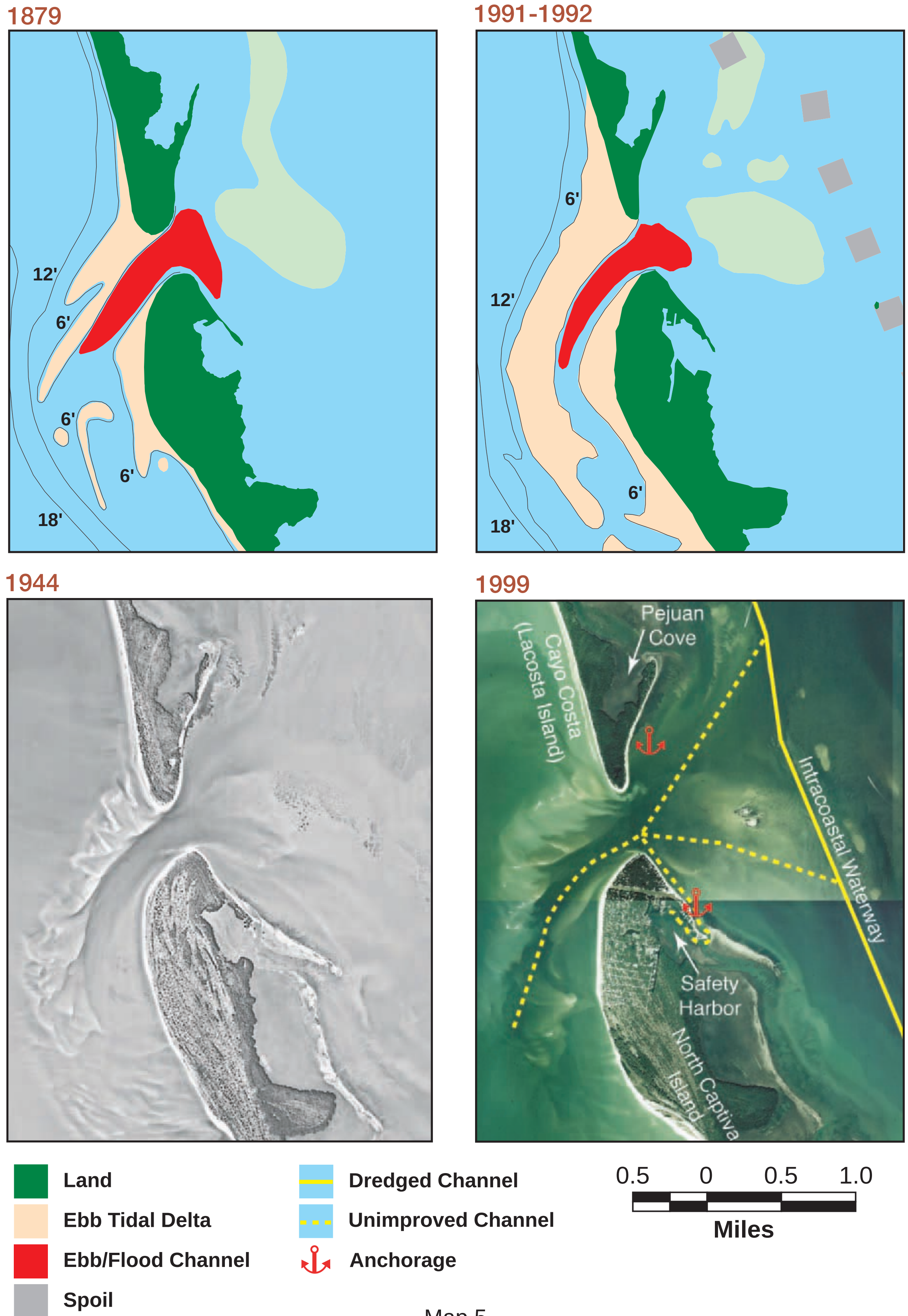
0.5 0 0.5 1.0
Miles

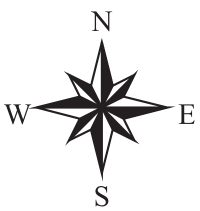
shoals less than 2 feet deep. The broad southern lobe that covers an extensive offshore area, Johnson Shoals, nourishes beach development on Cayo Costa, as sand is accreted and beach ridges are formed and move shoreward. Murdoch Point is a cuspate headland where erosion is taking place (1999 photo).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

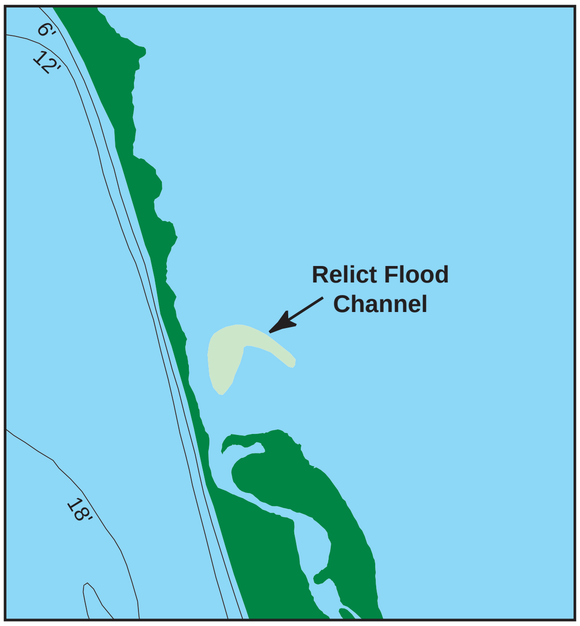
The hurricane of 1921 created Redfish Pass, which separates Captiva and North Captiva Islands (Map 6). Not surprisingly, the 1879 map shows a relict flood channel of an antecedent inlet. This narrow ribbon of barrier island is subject to overwash of storm waves from the Gulf to the bayside, as occurred 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.

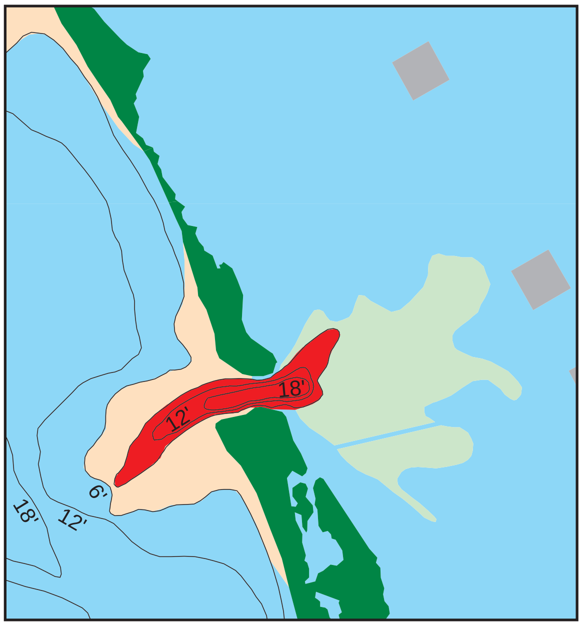
Ground view of overwash.

1960 aerial view of overwash.

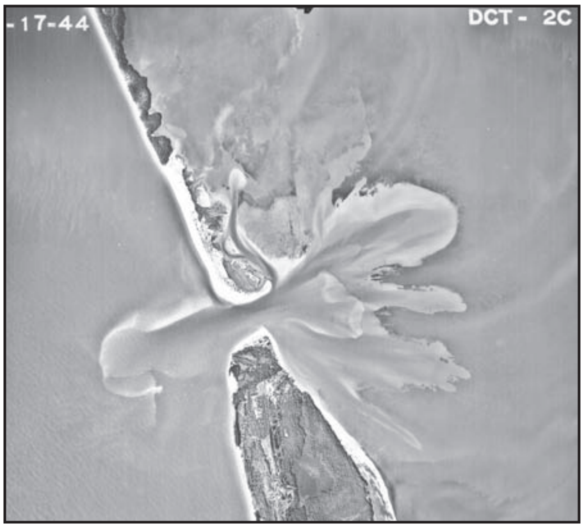
1879



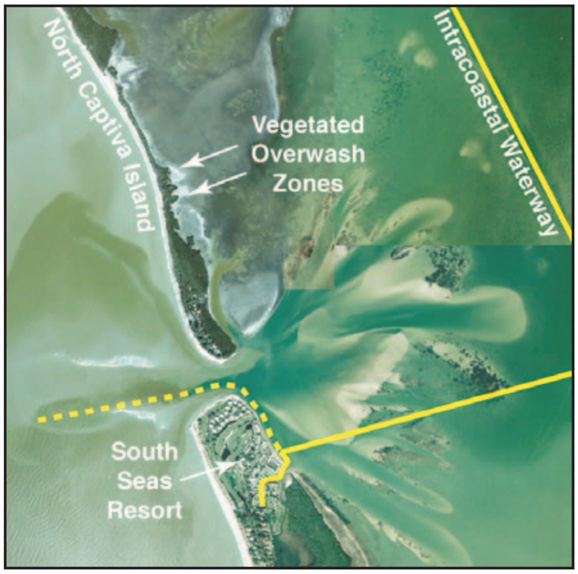
1991-1992

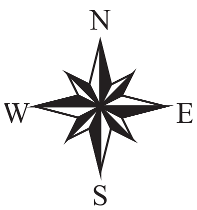


1944

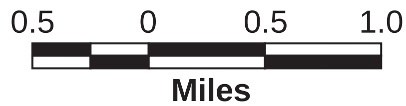


1999





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

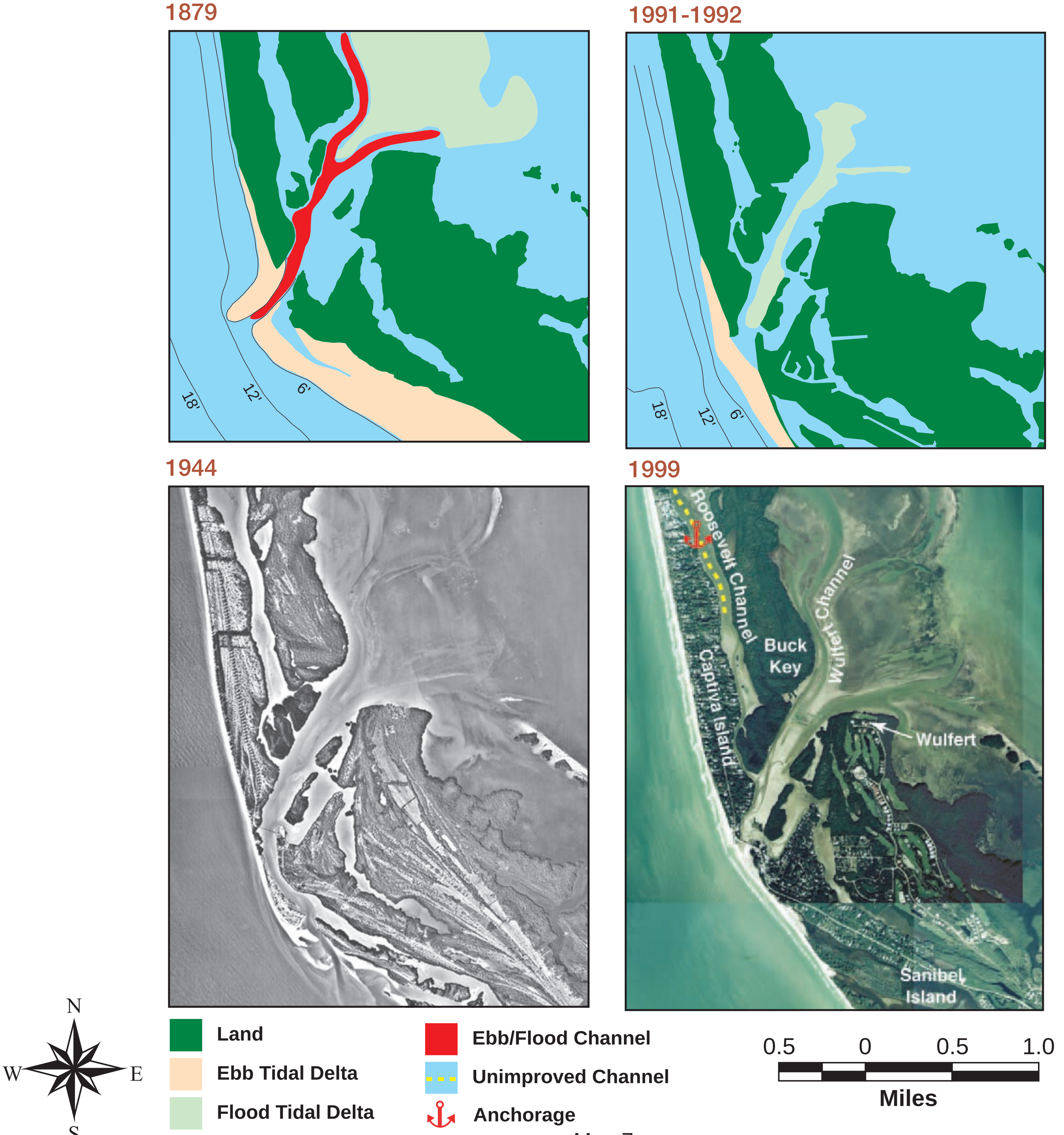


Map 6.
Redfish Pass.

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).

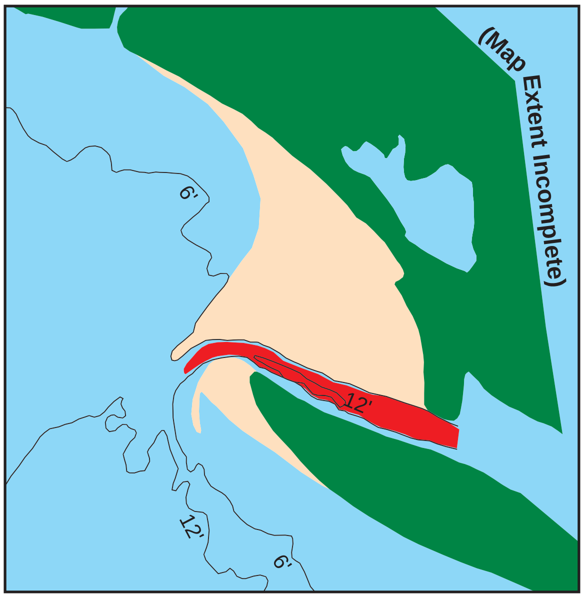


Map 7.
Blind Pass.

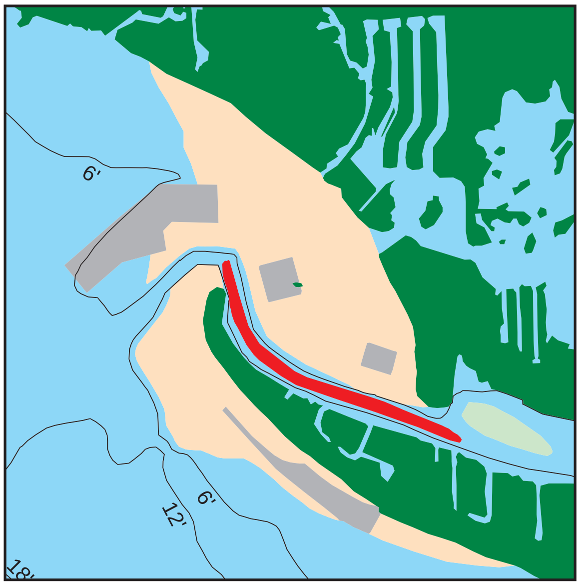
Matanzas Pass

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

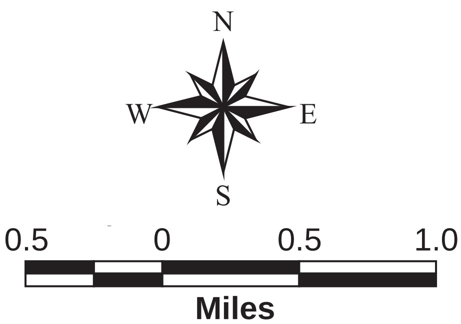


1991-1992



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.

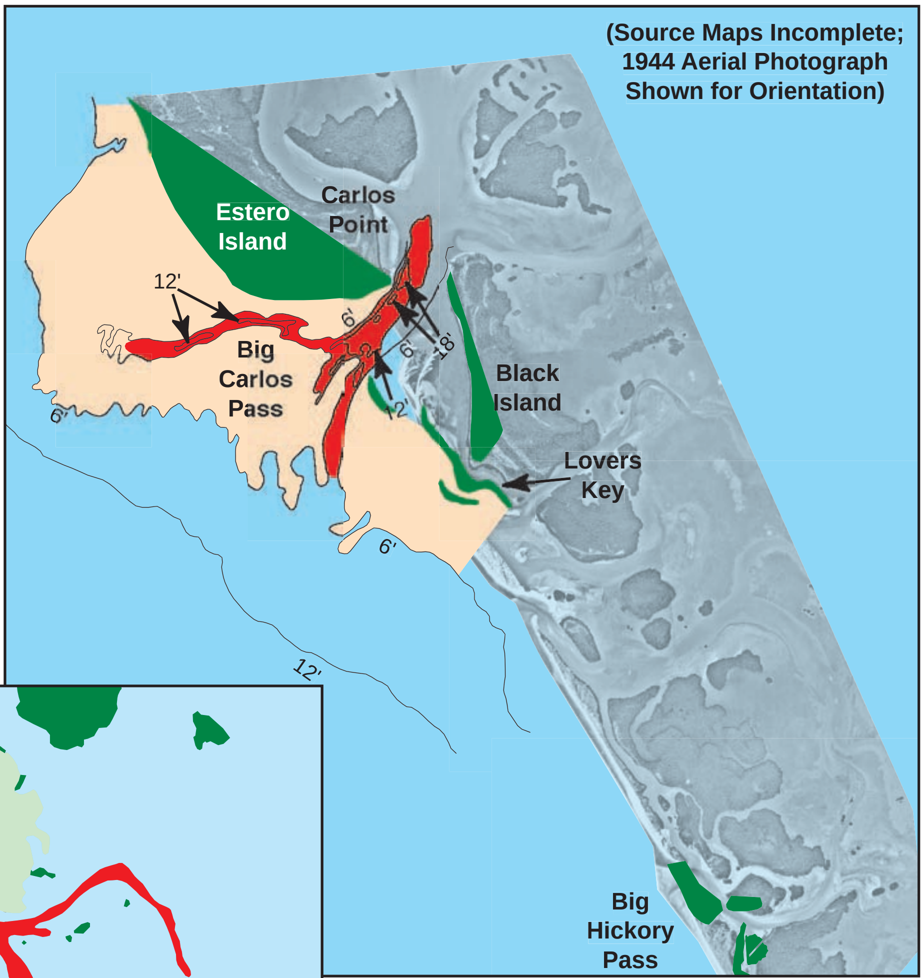
Map 8.
Matanzas Pass.

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

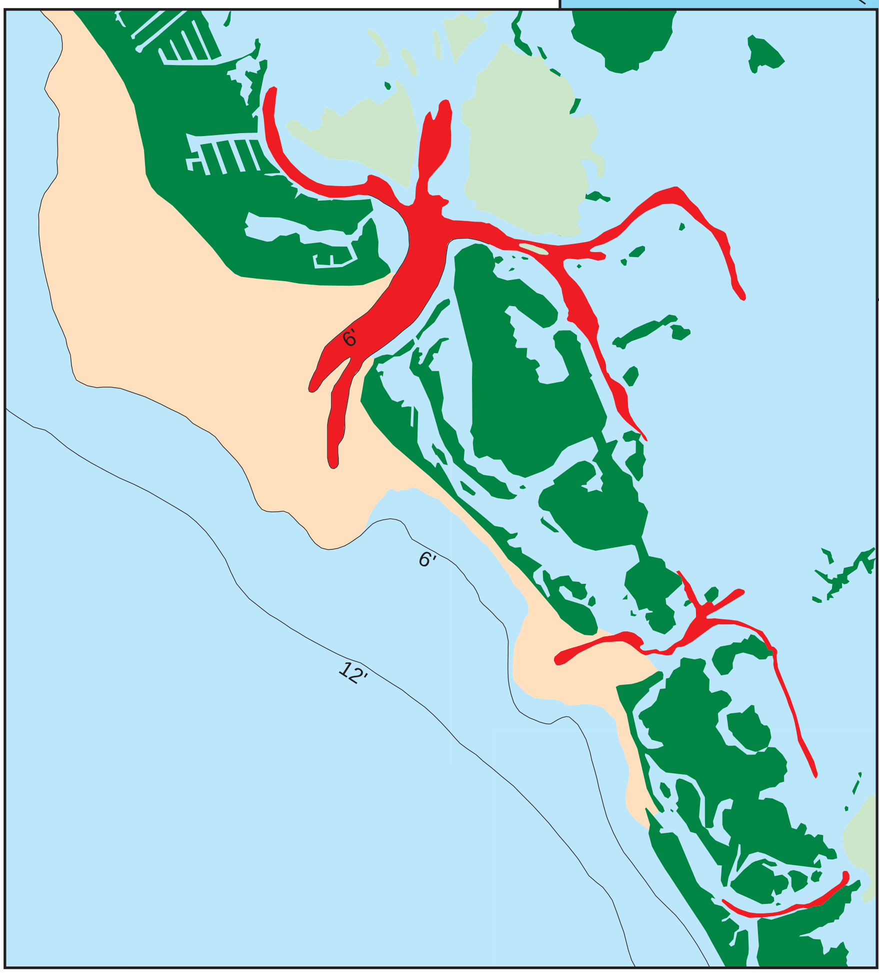
Tidal flushing for Estero Bay occurs through multiple inlets along a 3-mile stretch of the coast, south of Estero Island and north of Little Hickory Island (Map 9). Big Carlos Pass, the largest of these inlets, with a deep, wide channel, has remained essentially unchanged over the past century (1908-28 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

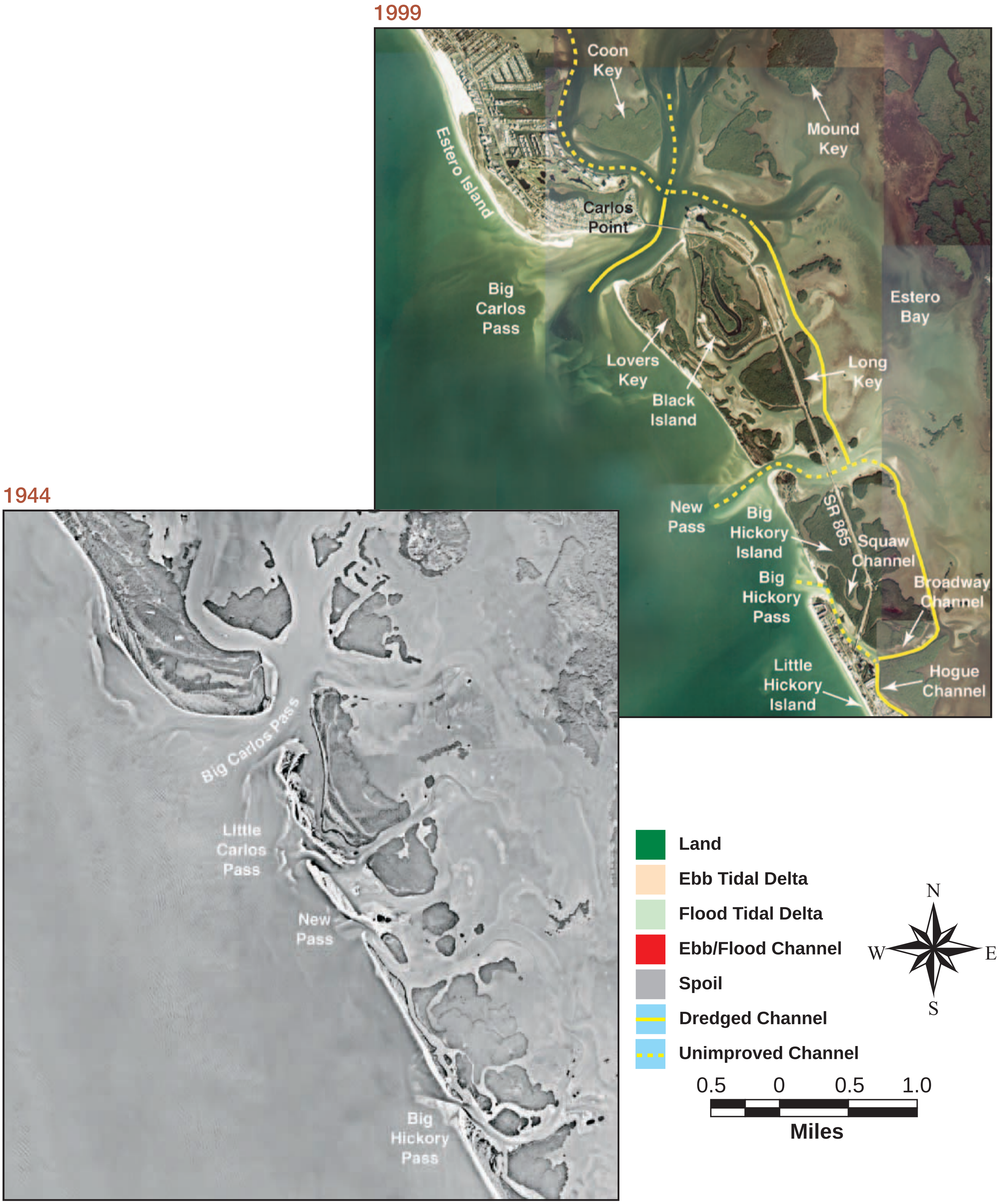


1991-1992



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.

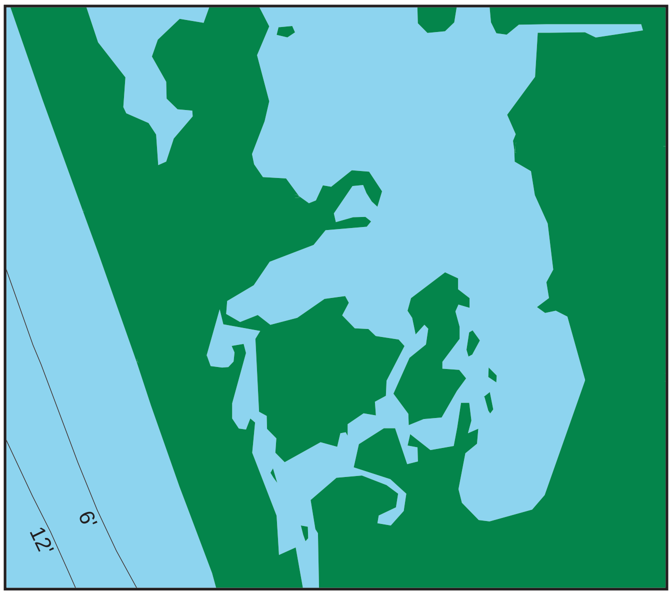


Map 9.
Estero Bay Passes.

Little Hickory Pass

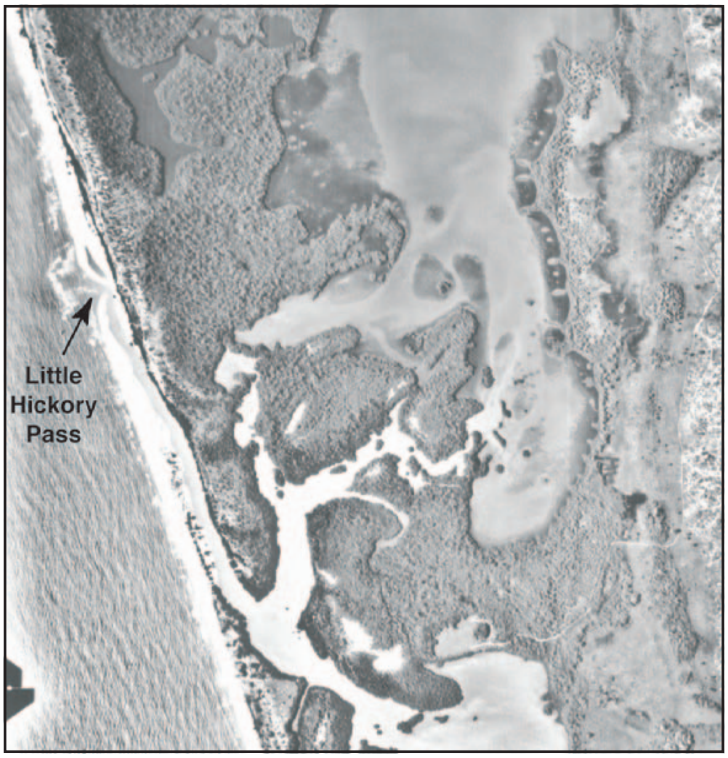
Little Hickory Pass is a closed inlet that ceased to exist in the early 1960s when developers closed the inlet in order to build an access road to beachfront properties. (Map 10). The 1944 aerial photograph shows the "wild" inlet, with tide-dominated conditions, no ebb or flood tidal deltas, and a prograding (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).

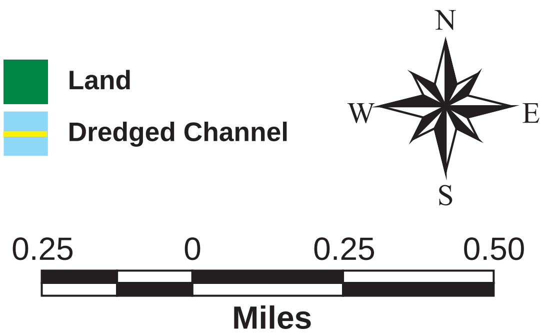
1991-1992



1999

1944



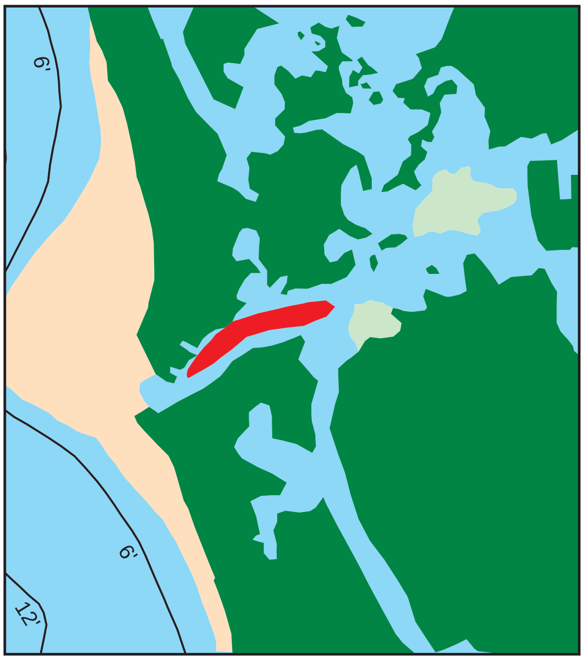


Map 10.
Little Hickory Pass.

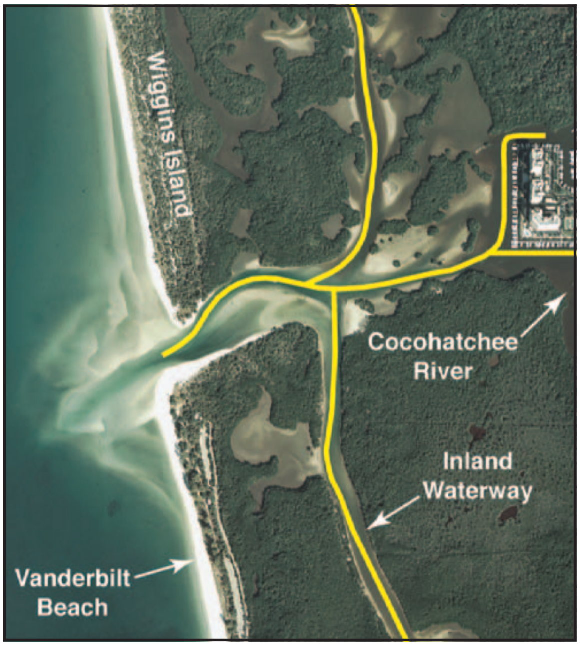
Wiggins Pass

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).

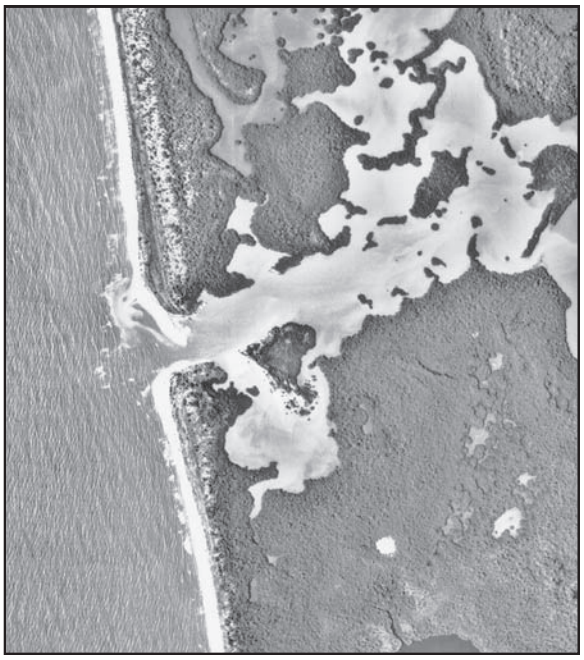
1991-1992

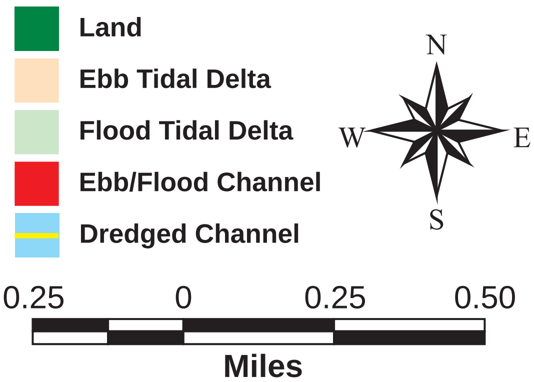


1999



1944

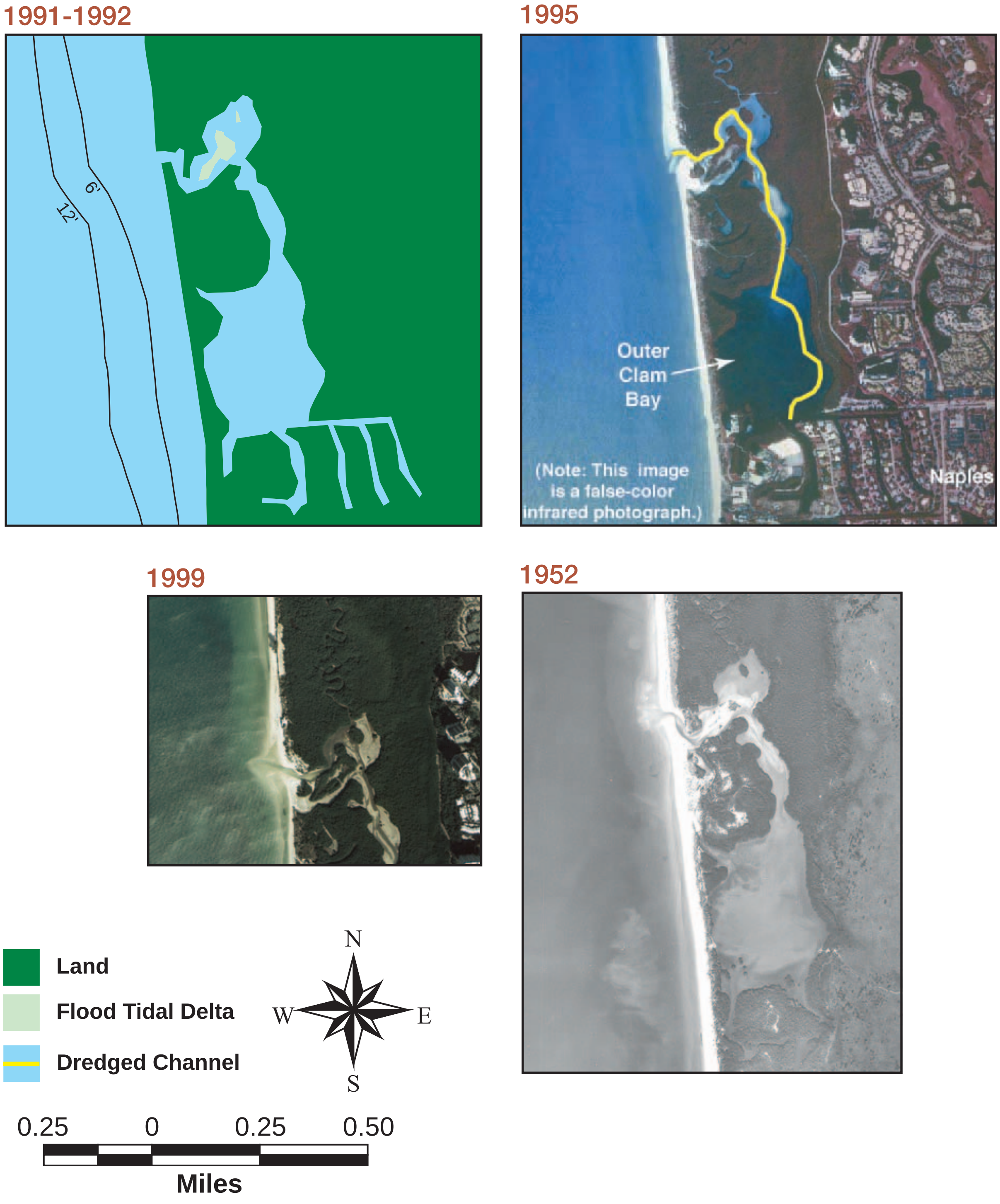




Map 11.
Wiggins Pass.

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.

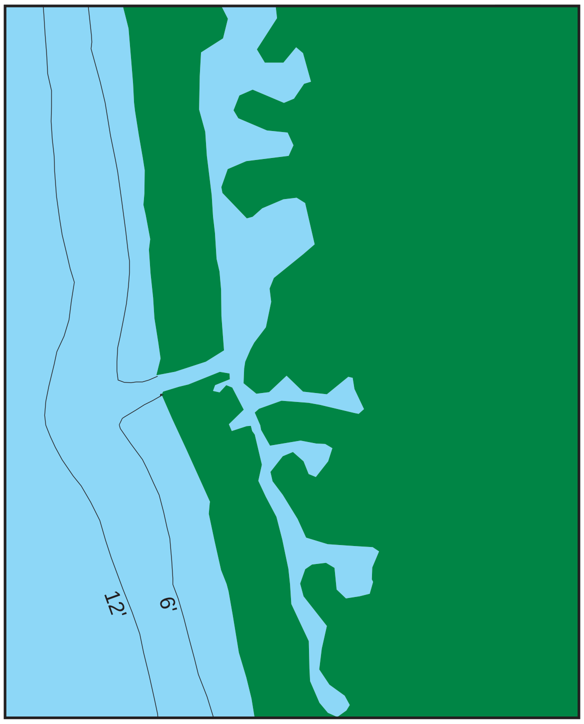


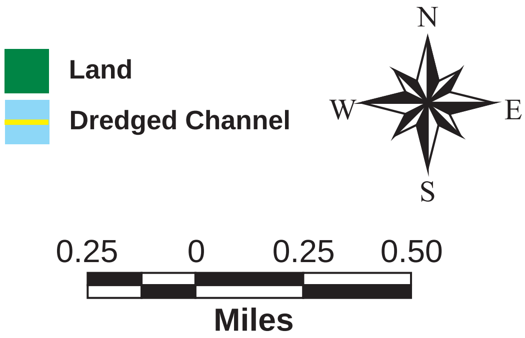
Map 12.
Clam Pass.

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).

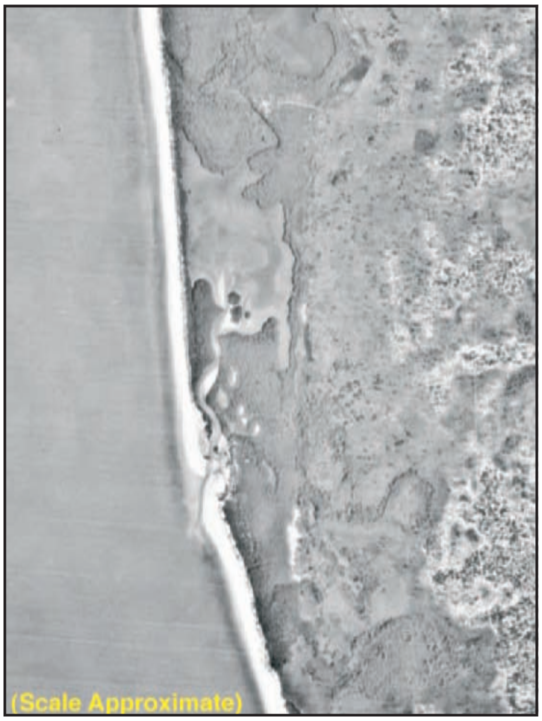
1991-1992





1995

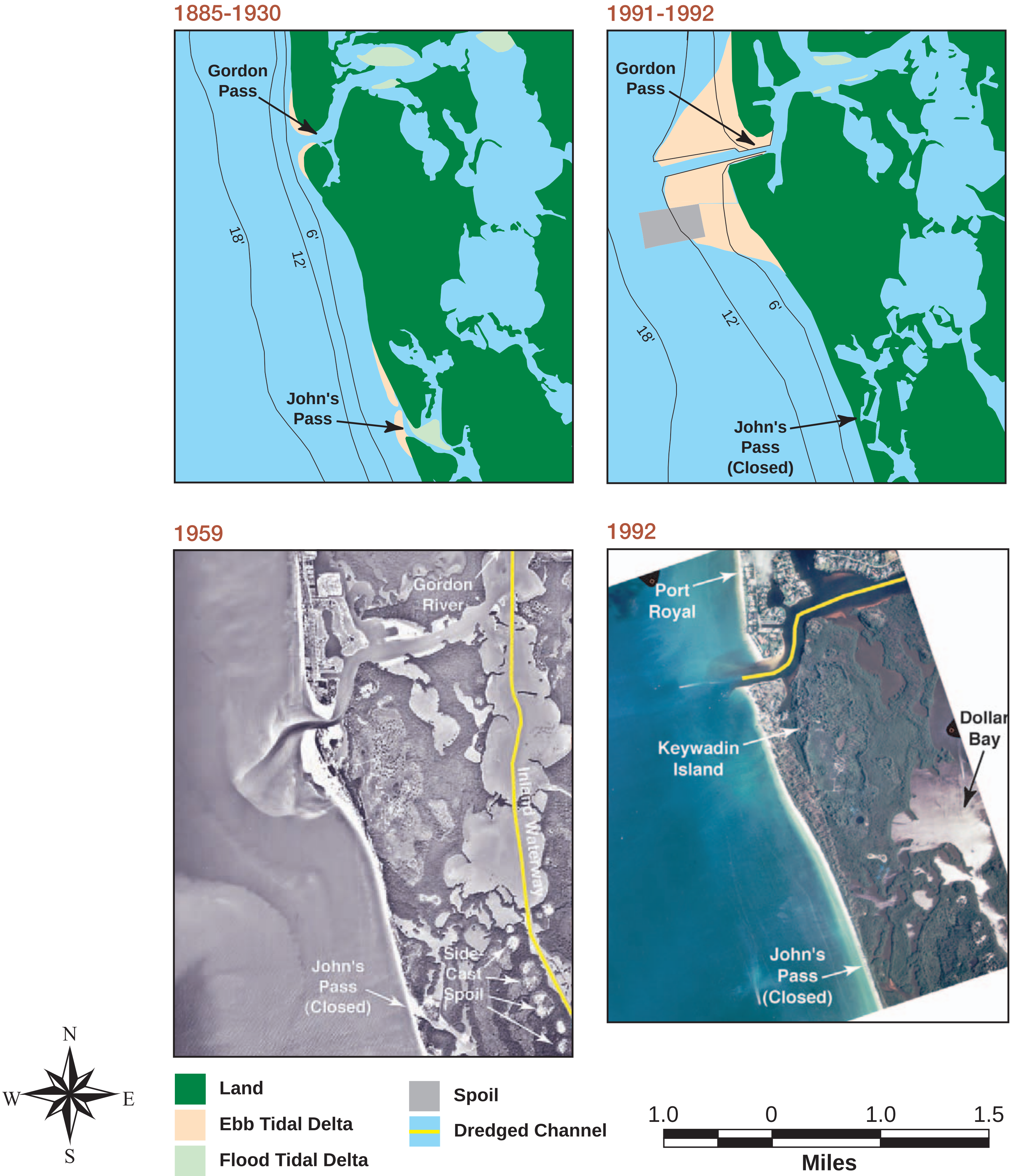
1945



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).

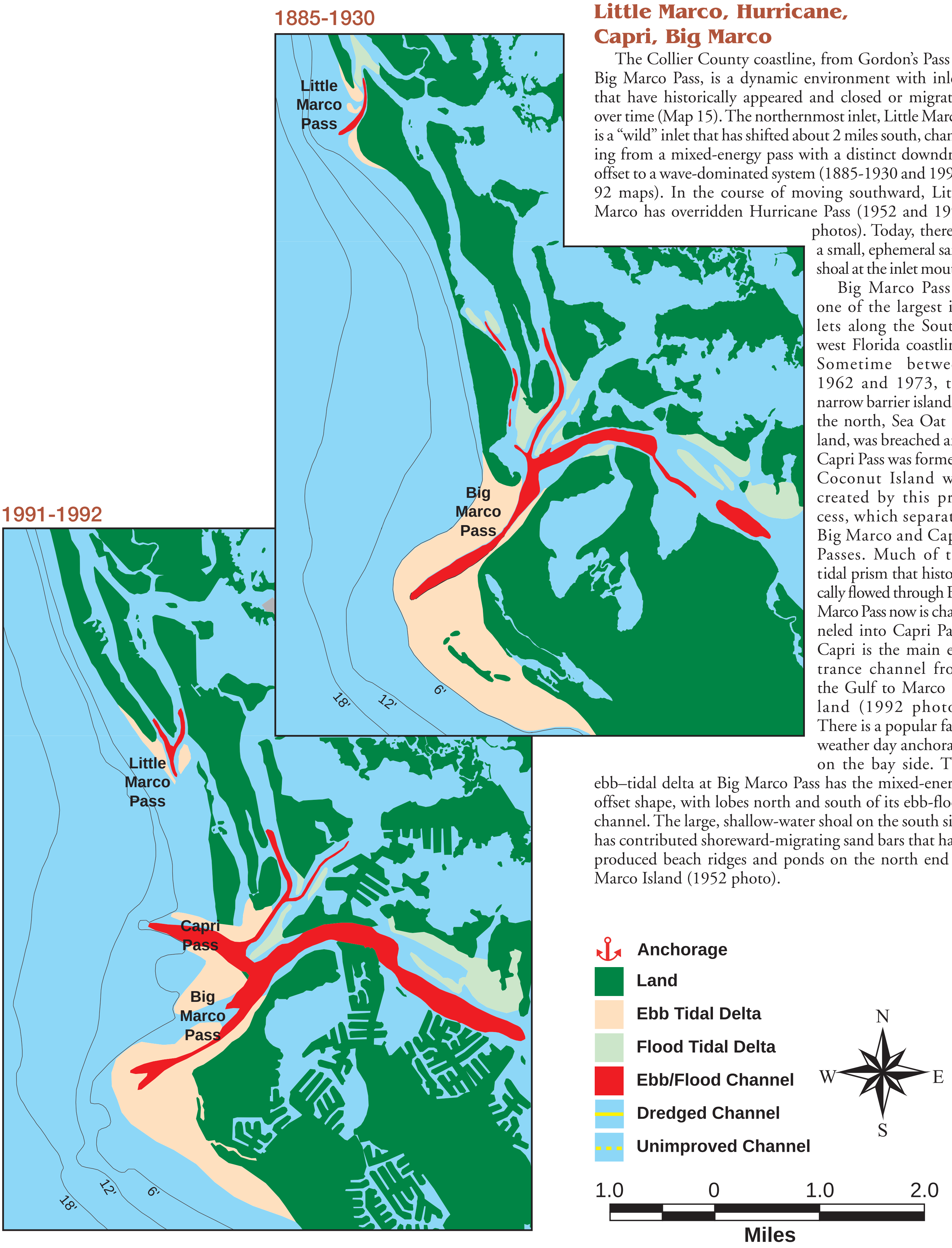


Map 14.
Gordon and John's Passes.

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

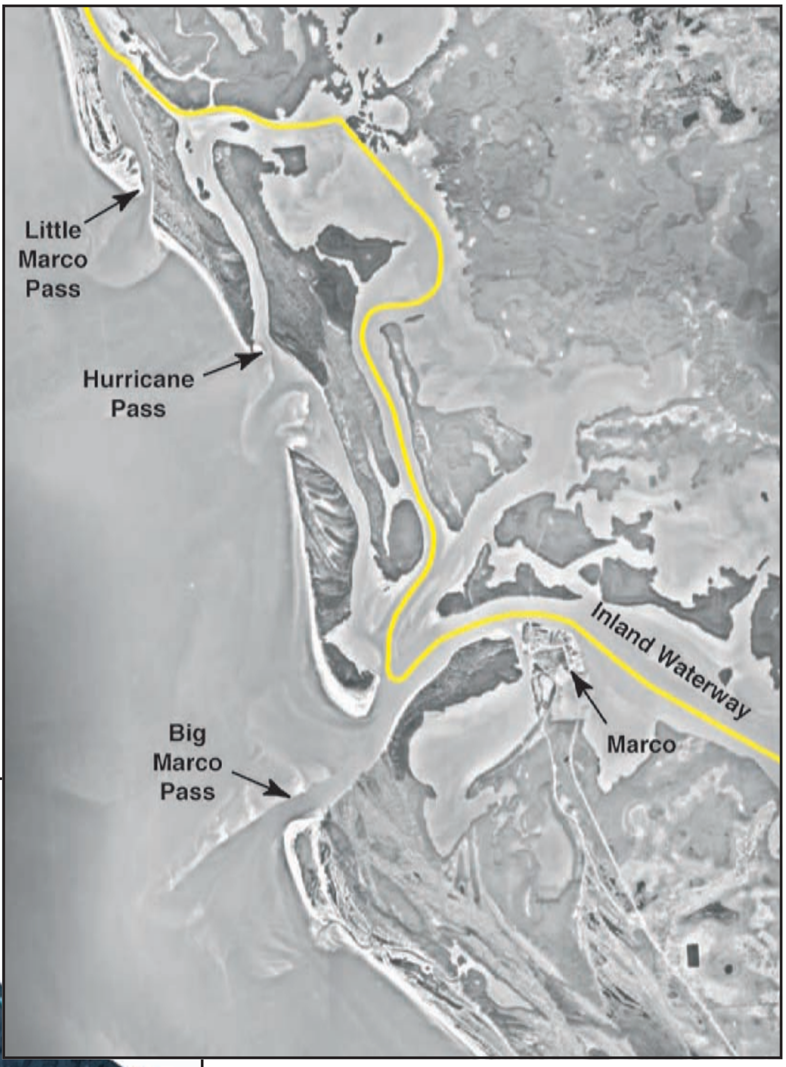
The Collier County coastline, from Gordon's Pass to Big Marco Pass, is a dynamic environment with inlets that have historically appeared and closed or migrated over time (Map 15). The northernmost inlet, Little Marco, is a "wild" inlet that has shifted about 2 miles south, changing from a mixed-energy 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).

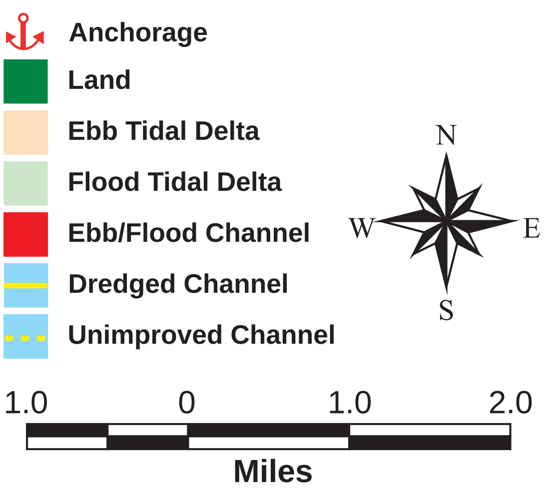


Map 15 (part 1).
North Marco Island Passes.

1952



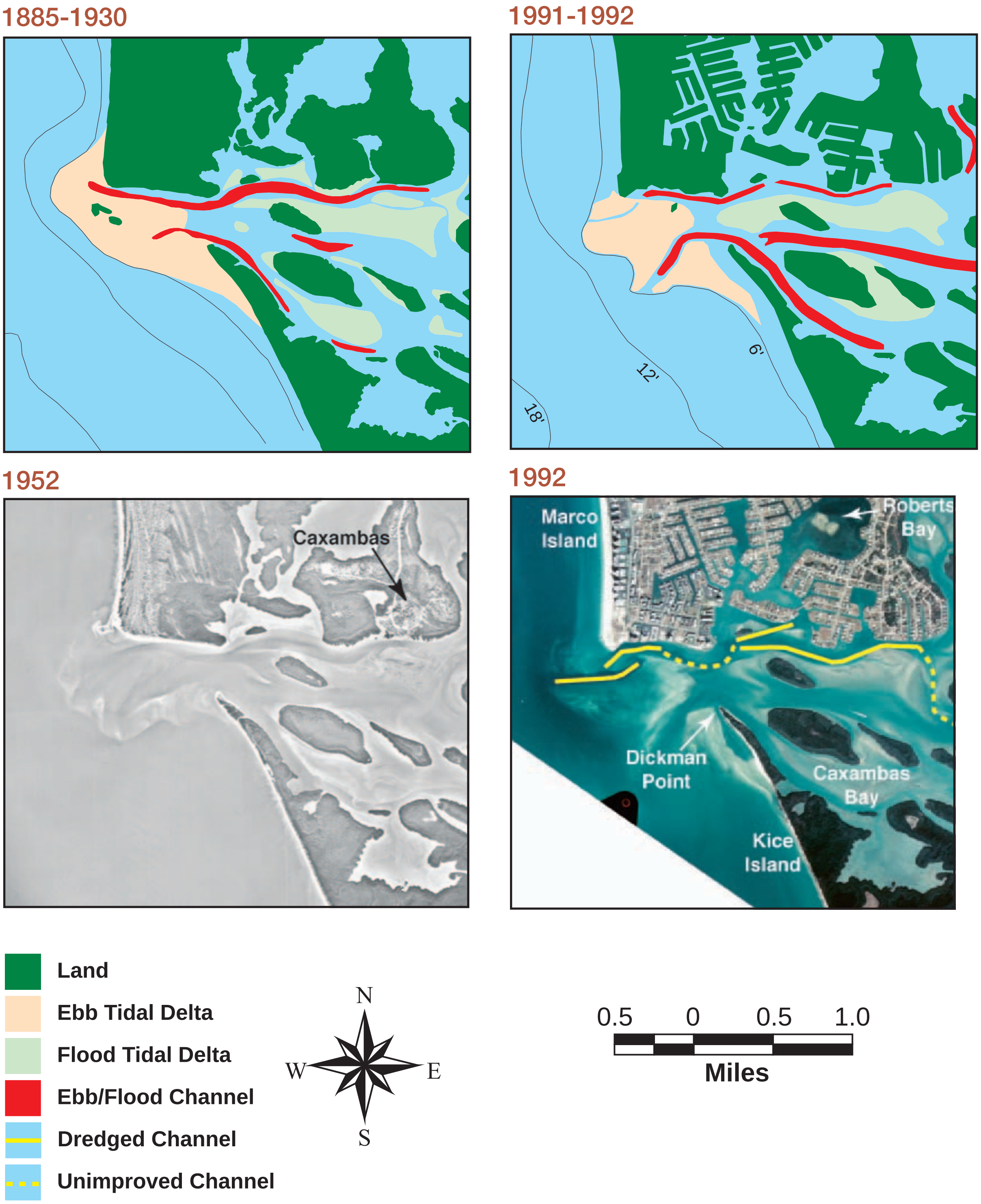
1992



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.

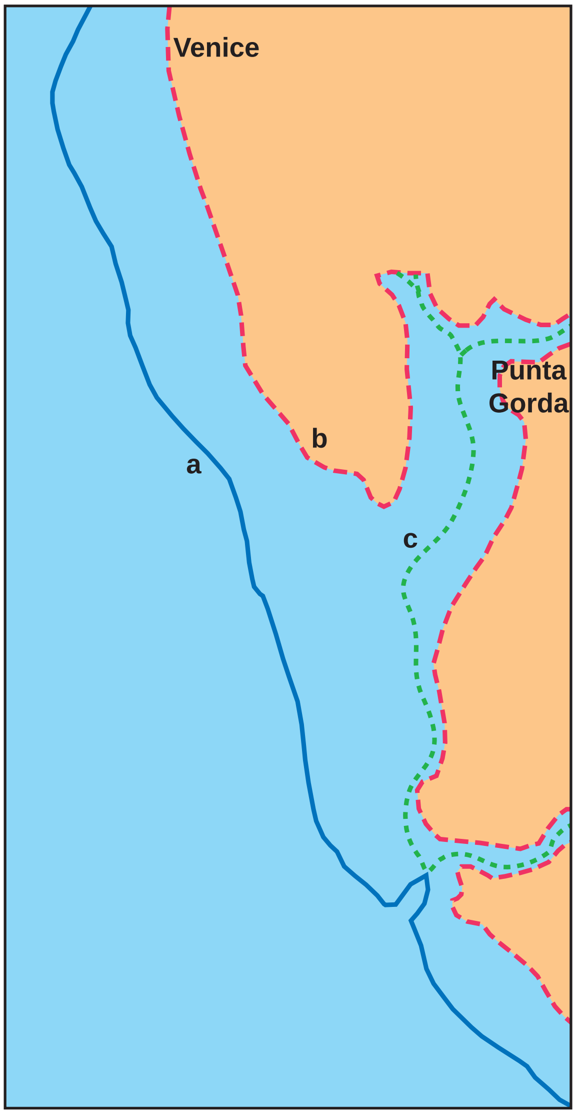


Figure 4. Charlotte Harbor shoreline in the Pleistocene Glacial Period.

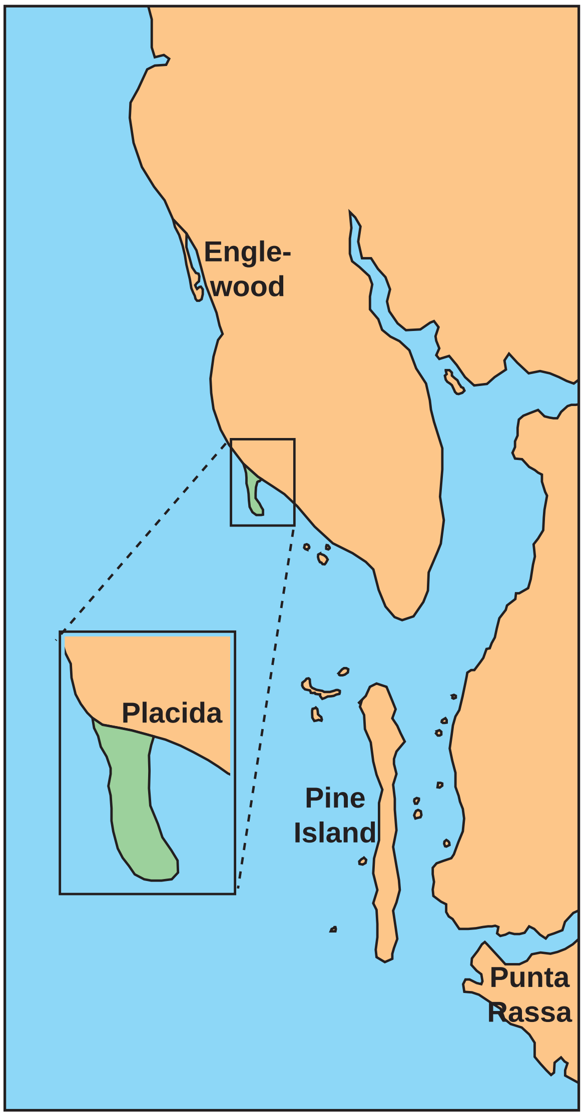


Figure 5. Charlotte Harbor shoreline approximately 5000 years ago.

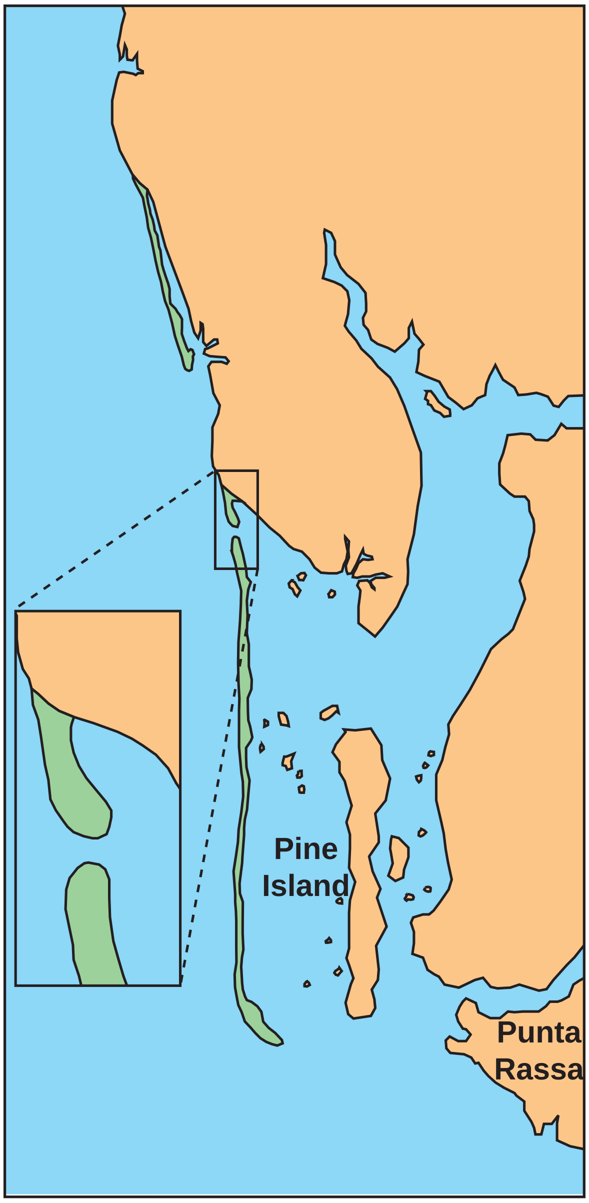


Figure 6. Charlotte Harbor showing intermediate stages of barrier island development.

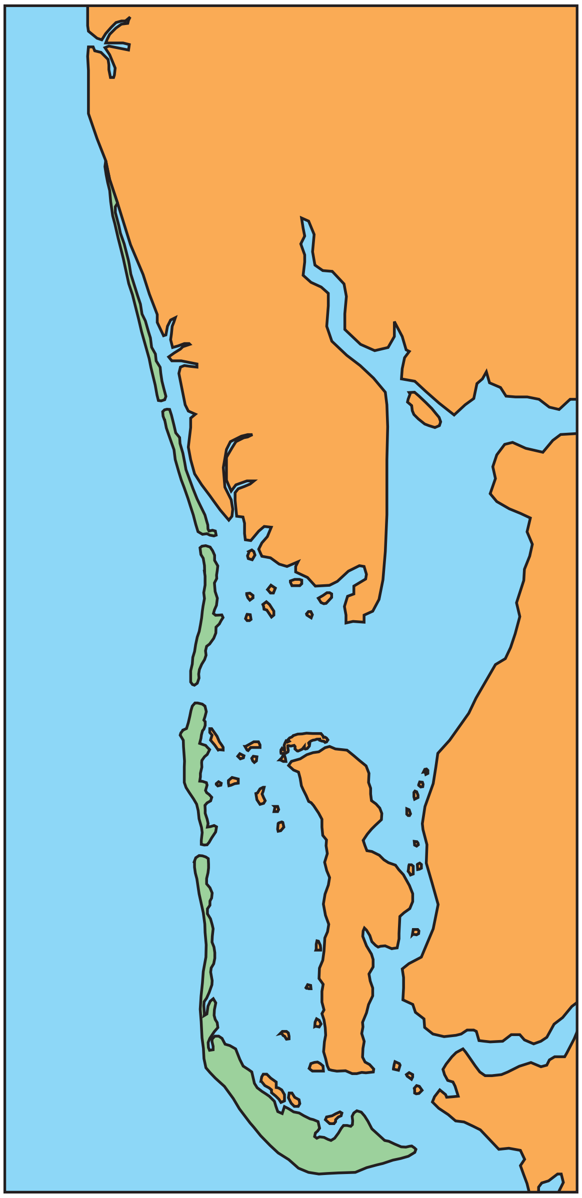


Figure 7. Modern shoreline of Charlotte Harbor and barrier islands.

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

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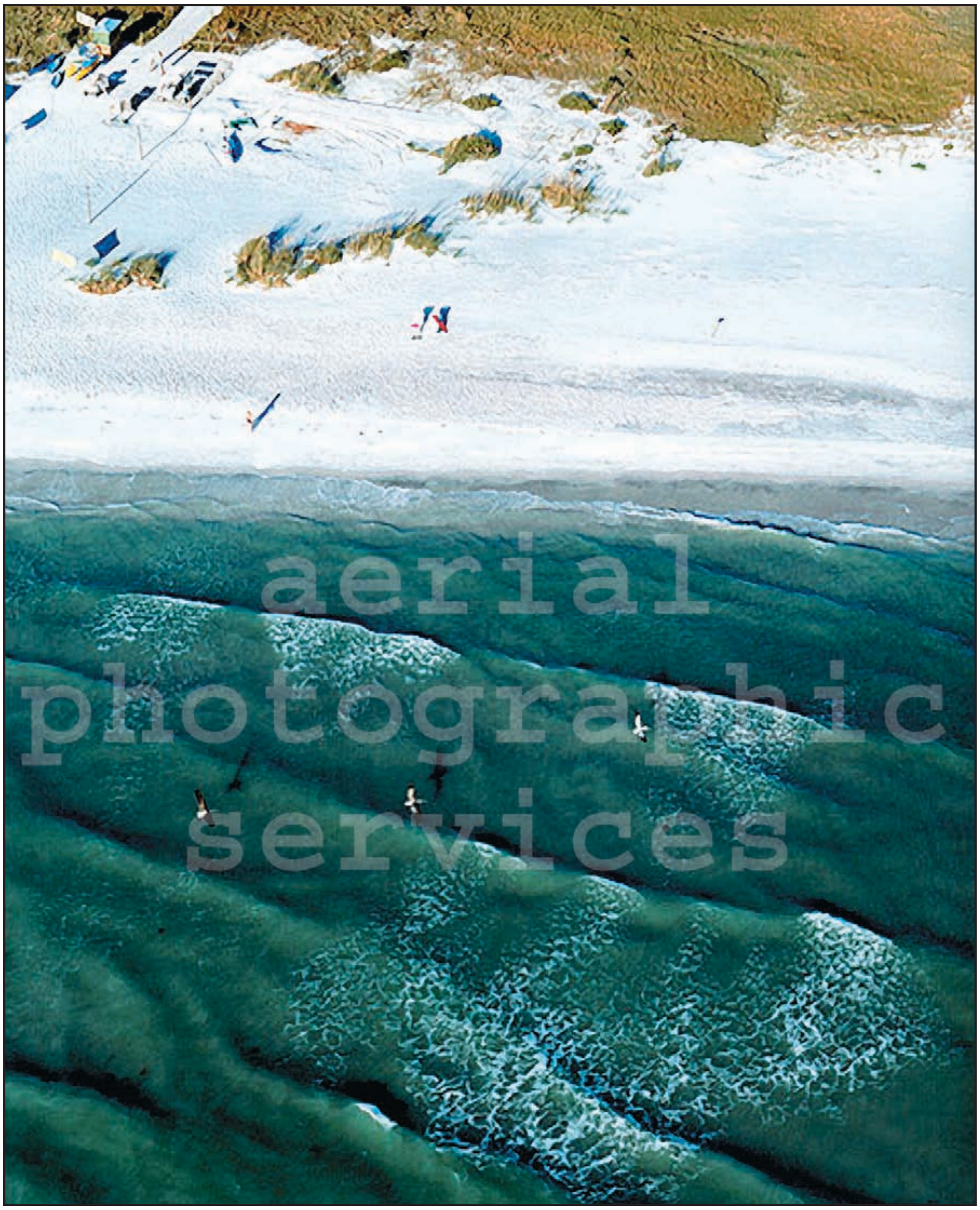


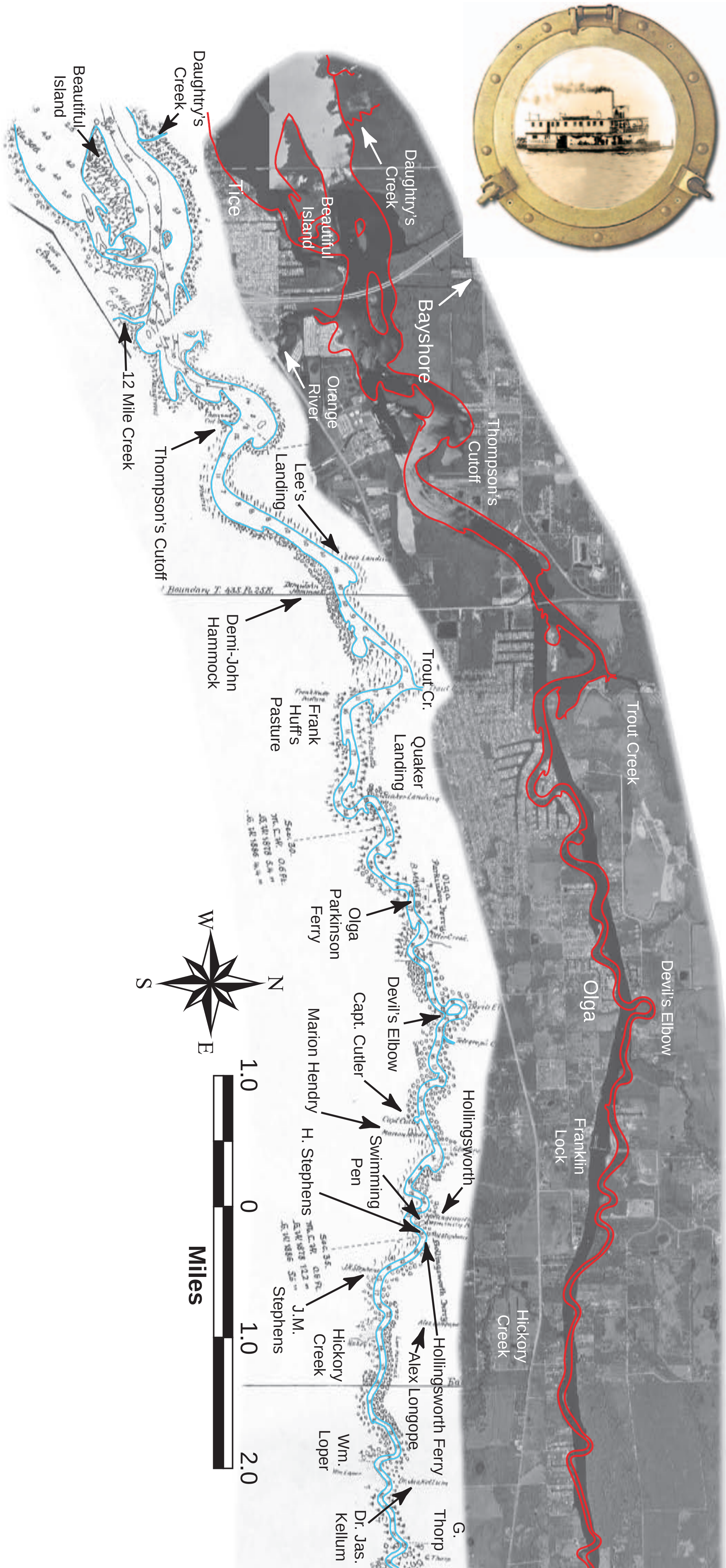
Waves refracting along Little Gasparilla Island, longshore current runs from left to right, carrying sand in the direction, parallel to the shoreline.

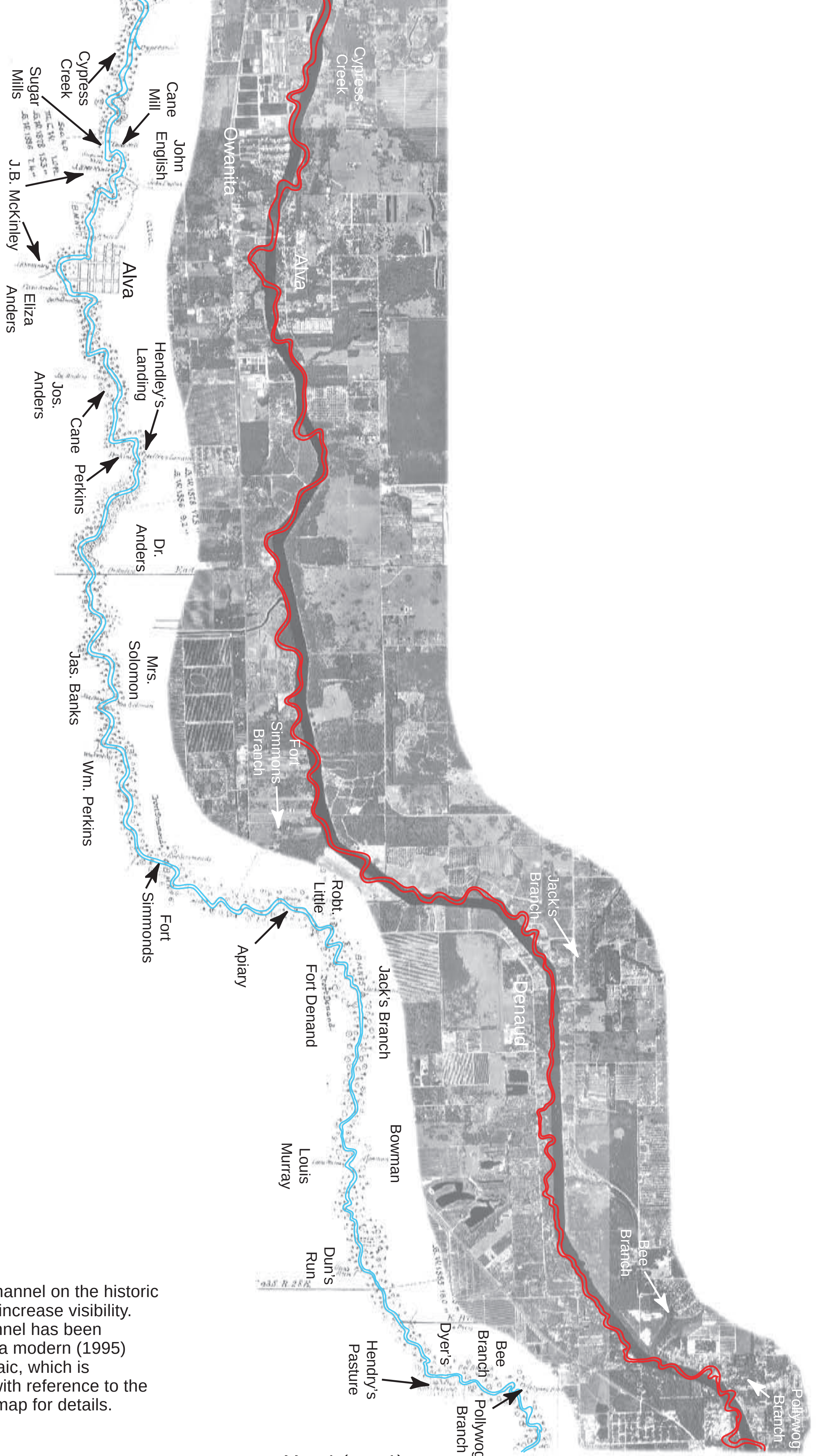
ALTERING THE CALOOSAHATCHEE FOR LAND AND WATER DEVELOPMENT

The Caloosahatchee [Caloosa = indigenous Native Americans who inhabited Southwest Florida, Hatchee = Seminole for 'river'] is a microcosm of Southwest Florida's waterways, in which multiple interests — striving to develop waterfront real estate, to create new land from formerly overflowed swamplands, and to increase and improve the navigable waterways — have propelled development in many profound ways.The river between Lake Okeechobee (on the east) and Beautiful Island (on the west) has been selected to illustrate the effects, both latent and direct, of land drainage and waterway construction policies on waterfront and waterway uses.

Pre–development Geography

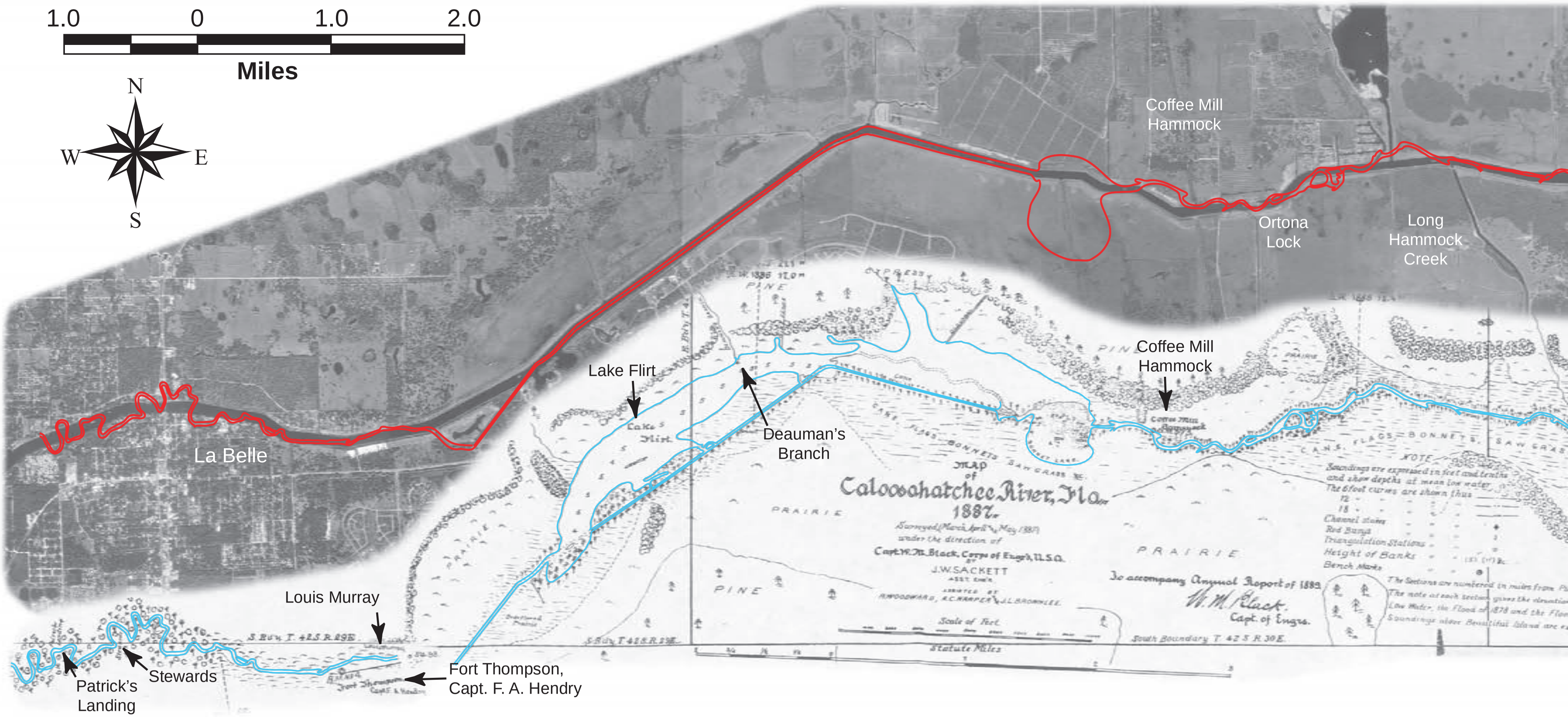
It is hard to recognize from today's Okeechobee Waterway — with its abruptly cut banks and straight-lined, flood-controlled, navigation-optimized, dredged channel — the once meandering, shifting, rope-bending, snag-laden course of the Caloosahatchee. Today, the Caloosahatchee is the western portion of the Okeechobee Waterway, which stretches from Stuart, on the Atlantic Ocean, to San Carlos Bay and the Gulf of Mexico. The route crosses the state via the St. Lucie River and Canal, Lake Okeechobee, and the Caloosahatchee (see Map 1 in the Dredging History chapter). Map 1 in the present chapter shows the antecedent river course superimposed on the present waterway.



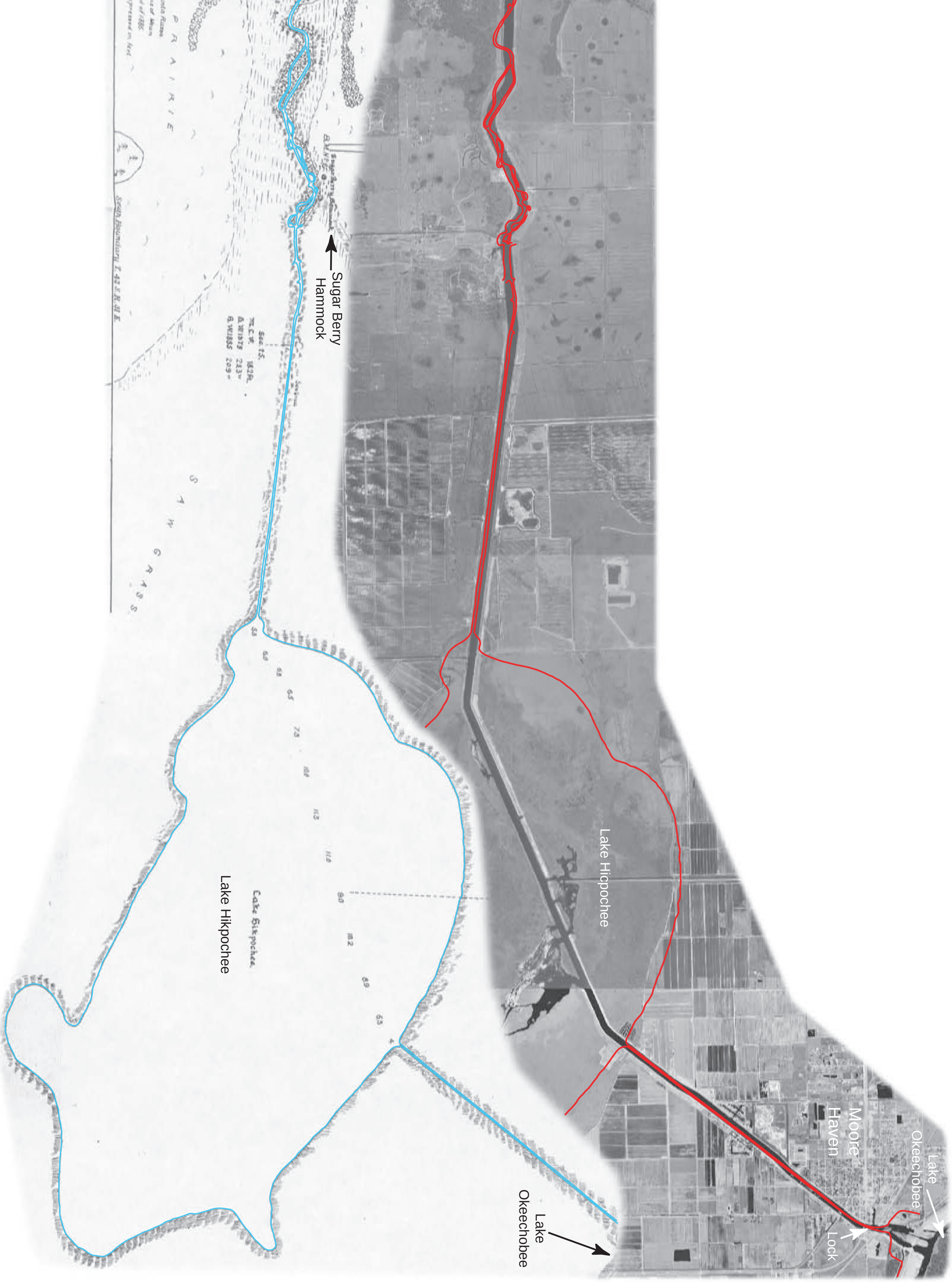


Note: The main river channel on the historic map is colored blue to increase visibility. The same historic channel has been interpreted in red over a modern (1995) aerial photograph mosaic, which is positionally accurate, with reference to the 1887 Army Engineers map for details.

Map 1 (part 1).
Caloosahatchee Channel, 1887 and 1995.



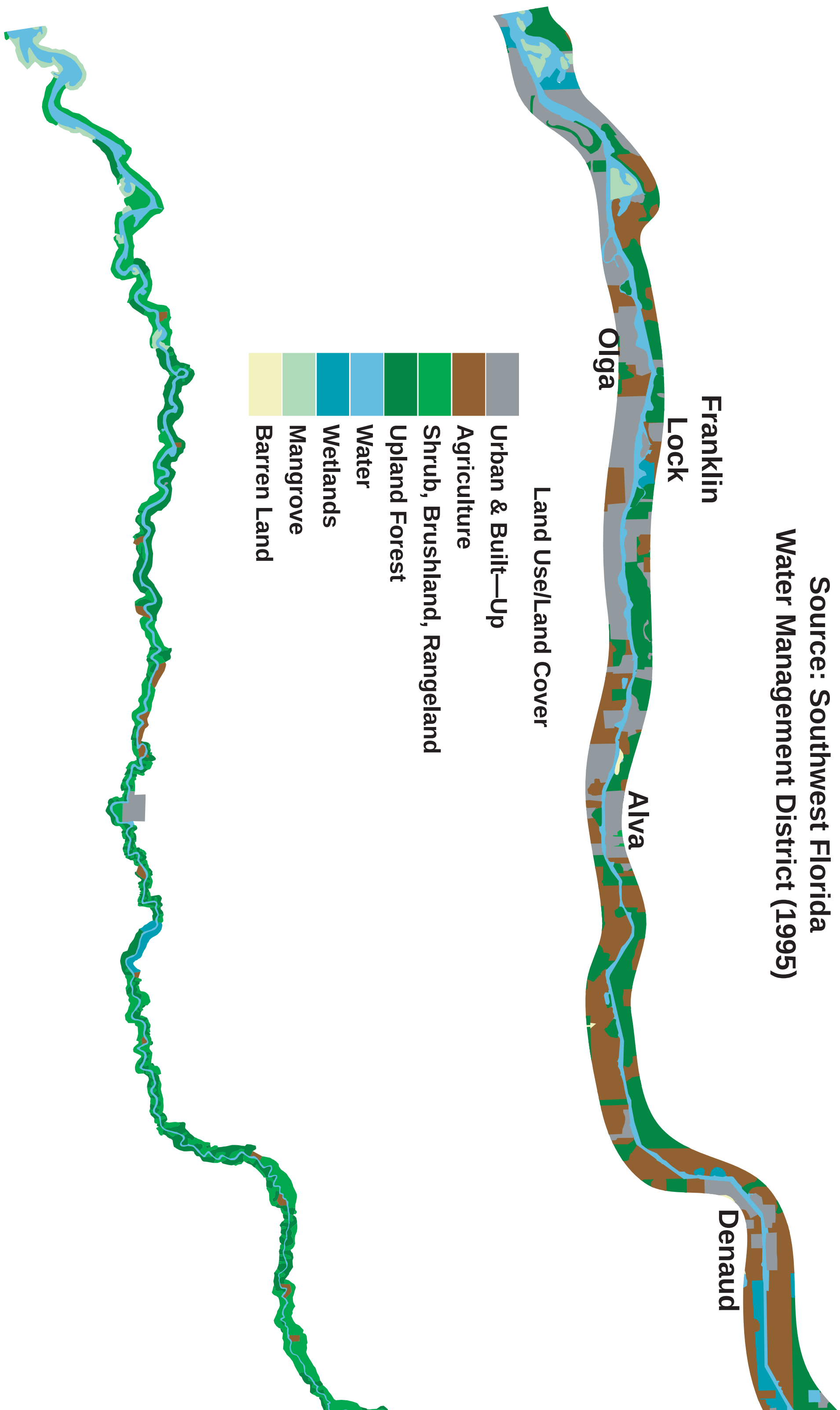
1.0
0
1.0
2.0
Miles
N
W
E
S
La Belle
Coffee Mill Hammock
Ortona Lock
Long Hammock Creek
Lake Flirt
Deauman's Branch
Coffee Mill Hammock
Louis Murray
Patrick's Landing
Stewards
Fort Thompson, Capt. F. A. Hendry
Map of Caloosahatchee River, Fla. 1887.
Surveyed March, April & May 1887
under the direction of
Capt. W. M. Black, Corps of Engrs. U.S.A.
J. W. SACKETT
PRAIRIE
PINE
To accompany Annual Report of 1889
W. M. Black
Capt. of Engrs.
Scale of Feet
Statute Miles

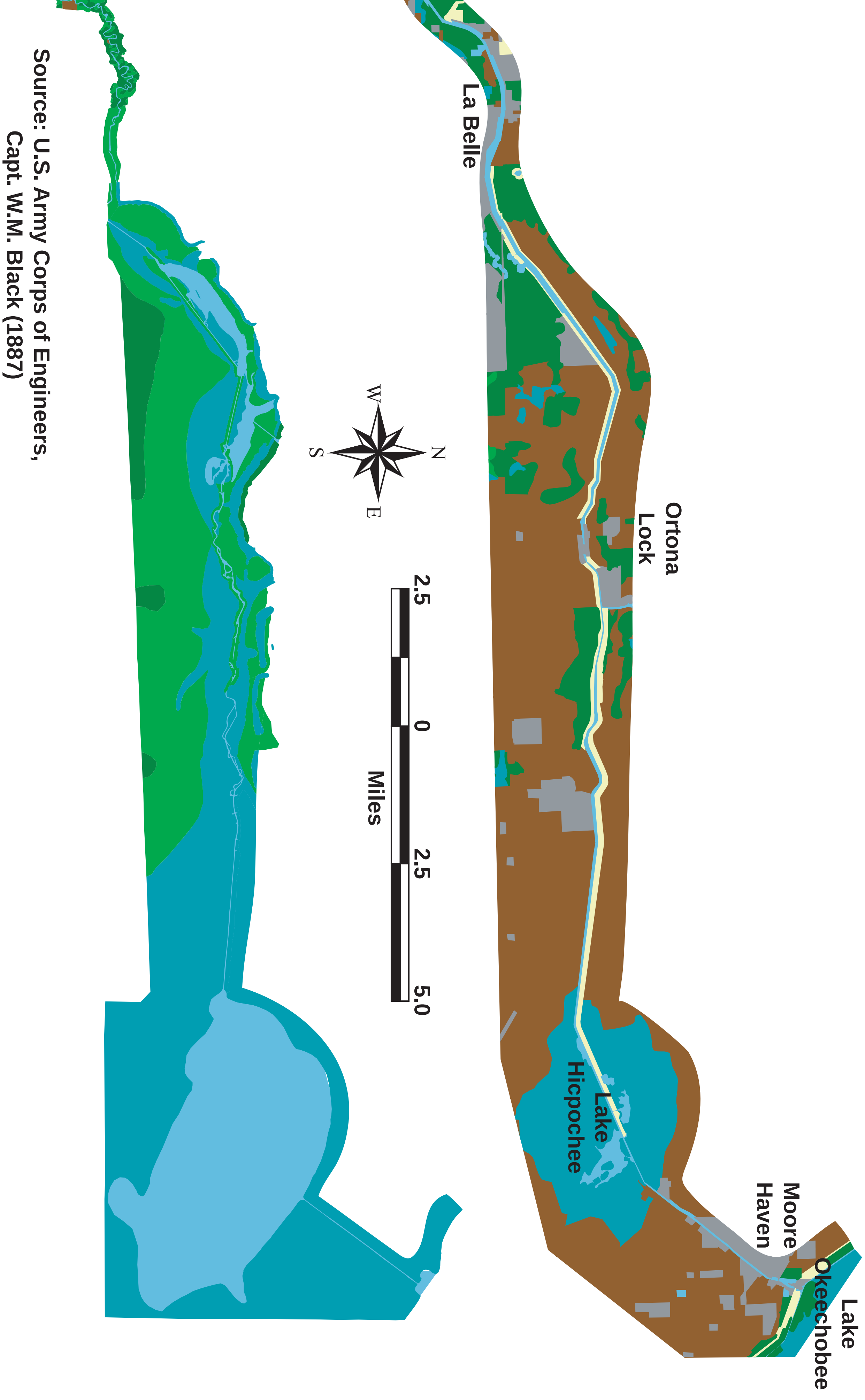


Map 1 (part 2).
Caloosahatchee Channel, 1887 and 1995.

Before human intervention, the Caloosahatchee originated in a geologic basin known as Lake Flirt, located at Ft. Thompson, approximately 2 miles east of La Belle. The formation was perched 4–10 feet (varying with seasonal water levels) above the western Caloosahatchee valley, creating 0.9-mile-long rapids that fed the Caloosahatchee. To the east, ephemeral marshes seasonally connected a series of lakes. In the wet season (May–October), high water would spill out of the shallow boundary of Lake Okeechobee and sheet flow through the ephemeral marshes and swamp forest to collect in several smaller lakes–Hicpochee (9,000 acres), Bonnet (500 acres) and Flirt (1,000 acres)–before spilling over the rapids and flowing into the Caloosahatchee and to the Gulf of Mexico. The Ft. Thompson Rapids set the head of navigation. The lower portion of Map 2, from the Black survey of 1887, shows land use and land cover before major development occurred.

During the dry season (November–April), the region of marshes surrounding Lake Hicpochee and the riverbed from that lake to the foot of Ft. Thompson Rapids would dry up so much that a horse could be ridden in the channel. Normal high water would raise the water level downstream by 2 feet at Ft. Thompson, 3 feet at Ft. Denaud (La Belle) and Alva, 2 feet at Olga and 1 foot at Ft. Myers. Freshets caused by continuous heavy precipitation increased the water level to historic heights above mean water of as much as 12 feet at Ft. Thompson, 17 feet at Ft. Denaud, 14 feet at La Belle, 13 feet at Alva, and 6 feet at Ft. Myers.





Map 2.
Land use/land cover along the Caloosahatchee, 1887 and 1995.

Distance and number of river bends between pre–development and contemporary conditions along the Caloosahatchee/Okeechobee waterway.

	Beautiful Island/Olga		Olga/Alva		Alva/La Belle		La Belle/Moore Haven		Total	
	Miles	River-Bends	Miles	River-Bends	Miles	River-Bends	Miles	River-Bends	Miles	River-Bends
Pre–development River	9.5	5	8.7	19	19.0	58	26.7	20	63.9	102
Okeechobee Waterway	7.7	3	7.0	2	14.0	10	27.0	11	55.7	26
Difference	-1.7	-2	-1.7	-17	-2.0	-48	+0.3	-9	-8.2	-76

Table 1.

Figure 1. Four-point rope bend.

Figure 2. Water wheel irrigation.

These extreme, cyclical variations in stream flow contributed to the Caloosahatchee's meandering course. There were 102 river-bends in the 64-mile stretch from Beautiful Island to Lake Okeechobee in the pre–development period (Table 1). Navigating the river was especially difficult at the low-water stage. Some of the sharper meanders required the larger vessels to "warp-around," that is, to run their bow up on shore, attach a spring line to trees, back down to a second point, swing around and go ahead at the next point, and so on until the bends were passed (Figure 1).

Torrential rains during the wet season dramatically increased the volume of discharge and sediment load, leading to channel scouring and flooding of adjacent lowlands. During this period, coarser-textured sediments were deposited both as point-bars on the inside of the meanders and along the banks of the natural levees. Channel deepening occurred on the outer bends, and fresh, fine-textured alluvium was deposited on the adjoining floodplain. At these high water stages, the meandering Caloosahatchee in places cut across the necks of the meander spurs, shortened its course, and created abandoned meanders or oxbows.

Land and waterway developments were slow to occur during the 19th century. The Seminole Wars and the Civil War were major deterrents to settlement expansion. Extensive cattle grazing was a common land use. Small settlements did evolve along the river, usually occupying former military outposts. Ft. Thompson was an important up-river location because of the ford where cattle drives crossed the rapids en route to the shipping pier at Punta Rassa. The land cover along much of the river's course south of Ft. Thompson was in upland forest, scrub, grassland, and some homesteads with small agricultural farms (Map 2). The lower portion of Map 1 highlights the names of some of the homesteaders. Rudimentary waterwheel-type irrigation systems permitted farming during the dry season (Figure 2).

The winter freezes of 1892 and 1899 prompted North Florida citrus growers to reestablish their groves south of the freeze line and in the Caloosahatchee Valley. Citrus production increased rapidly in subsequent years and the transport of fruits and shipment of supplies became dependent on riverboat transport (Figure 3). Large catches of fish were brought down the river from Lake Okeechobee, although the business did not become extensive until after the railroad entered Ft. Myers, in 1904.

The 1880-90s was a period wherein the upper river valley represented the backbone of potential growth that resided in its agricultural resources, but communities there depended on the lower river course for transport and communication with service centers downstream. The key to sustainable regional growth rested on creating a scheme to manage the floods, which drove the early settlers from their homes, damaged farmlands, and discouraged agricultural development.

Figure 3. SS *City of Athens,* 1910.

Land Reclamation or River Navigation?

The development history of the Caloosahatchee is a record of competing and conflicting interests, some wanting to control flooding by upland drainage and others striving to build an inland waterway for pleasure boating and commercial use.

The record of government intervention by the State of Florida and federal agencies had its origins in the 1880s, with attempts to drain the overflowed lands adjoining Lake Okeechobee and to reduce and maintain water levels in the river. By 1887, the Atlantic and Gulf Coast Canal and Okeechobee Land Company of Hamilton Disston had opened a channel, with a minimum cross-section of 22 feet by 5 feet, from Lake Okeechobee to the headwaters of the Caloosahatchee at the western end of Lake Flirt. The Disston dredges were brought up-river from Ft. Myers. Four of the most severe river bends west of Ft. Thompson were straightened in order to move the dredges upstream. The 4-mile stretch of rock-floored outcrops, including the Ft. Thompson Rapids west of Lake Flirt, was dynamited in order to deepen the channel. A provisional dam was built every few miles to the rear of the dredge to obtain sufficient water to float the equipment (Figure 4). Disston's work was not intended to benefit navigation. Indeed, since the contract with the state included the drainage of the Caloosahatchee Valley and confining the river to its banks, the dredged channel was to have been closed and a levee extended north–south just west of Lake Hicpochee. Nearly 2 miles of this levee was constructed when the company ceased operations and the channel was never closed.

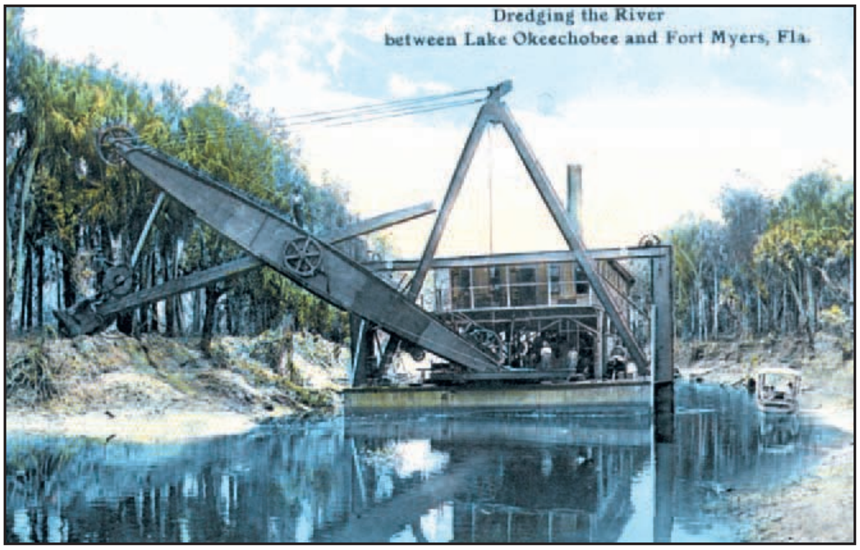


Figure 4. River dredge.

The net incidental result of Disston's dredging operation was to open up a water route for steamers some 300 miles long from the Gulf of Mexico to the interior of Florida via the Caloosahatchee and Lake Okeechobee to Kissimmee (Figure 5). But the dredged channel between Ft. Thompson and Lake Okeechobee was not maintained and shoals quickly appeared; boats drawing a mere 4 to 6 inches grounded repeatedly in Bonnet Lake and Lake Flirt. More significantly, during the wet season, floodwaters from Lake Okeechobee rushed unrestricted down the channel and caused severe flooding of the farms and citrus groves in the lower valley.

The dilemma facing the Caloosahatchee Valley at that time, much as it is today, was to devise a scheme that would coordinate land drainage with river navigation. Residents in 1913, for example, believed that floodwaters could be mitigated by straightening the river's course and navigation could be improved by deepening the channel, though attempts to straighten the river above Alva would probably require building levees well back from the river banks which would deprive a greater part of the citrus groves along the river from protection. The heated battle between land drainage and river navigation sometimes raged beyond the rule of law. Makeshift dams built by private interests across the canal between Lake Hicpochee and Bonnet Lake were blown up by unknown parties. In 1902, the state approved an application to close the canal but held Lee County responsible for all damages. The Army Engineers, at that time, agreed with local and state government that navigation interests were insufficient to warrant federal waterway improvements.

By 1913, however, drainage operations by the state elsewhere in central Florida had lowered the water level in Lake Okeechobee so much that navigation in the upper Caloosahatchee was seriously impaired and settlements were being abandoned. In 1914, the river at its junction with the lake dried out and at La Belle there was only 1.5 feet of water, not enough to allow the passage of commercial river traffic. The State of Florida dredged a 5-foot-deep by 40-foot-wide channel from Lake Okeechobee to La Belle. The seesawing of natural events–flooding of river lowlands followed by shoaling of navigation chan-

Figure 5. Tow steamer *Corona*.

1966 -
The Necessity to Understand the Sea

"But the influence of the sea on man's daily life and on his future well-being is so great and still so poorly comprehended that the sea must be explored, studied, and understood so that it can be taken into account more intelligently whenever man is faced with any problem relating to his physical environment."

—H. B. Stewart, "In Deep Challenge," 1966.

—Published by Van Nostrand, NJ. p. 17.

nels–fostered ambivalent public policies and created a laissez-faire attitude which resulted in little prescriptive action or long-term planning.

Disastrous floods in 1922, 1923, 1926, and 1928 caused the loss of many lives and considerable property damage in the Lake Okeechobee region. The federal government authorized the Army Engineers in 1927 to survey the Caloosahatchee drainage area and work with the state's Flood Control District (now the South Florida Water Management District) to improve both flood protection and navigation. This decision led to construction of the Hoover Dike around Lake Okeechobee as well as the dredging and channel straightening of the Caloosahatchee. The 1930s was a period of river dredging and construction of drainage canals, navigation locks at Moore Haven and Ortona and pumping stations to remove excess water from adjoining river bottomlands.

As a result of this work, the Caloosahatchee upstream from Beautiful Island was forever changed from the picturesque, meandering river which existed prior to 1881. It took on a new form, that of vertical-banked and straight-lined, flood-controlled, navigation-designed, dredged channel. It was also transformed into the federally authorized, Army Engineers-maintained Okeechobee Waterway (C-43 Canal), an intrinsic western component of the Cross-State Ship Channel that links the Gulf of Mexico to the Atlantic Ocean.

The Okeechobee Waterway was again modified in the mid-1950s. The channel was enlarged to an 8-foot depth and 250-foot width. Bridge crossings were modernized. An additional lock and dam structure was built in 1962 at Olga to assure a freshwater supply for Lee County and to prevent saltwater intrusion upstream.

In 1969, the structure was re-dedicated as the W.P. Franklin Lock in honor of Walter Prospect Franklin, a local entrepreneur and concerned member of the Okeechobee Waterway Association. This lock artificially sets the eastern limit of the Gulf's tidal influence for the estuary, which historically extended to Ft. Denaud. The waterway was dredged again in the 1960s, but following passage of the Clean Water Act in 1972, the Army Engineers has restricted its functions to operation and annual maintenance of the locks at Moore Haven, Ortona, and Franklin.

The Caloosahatchee today is still in serious need of management and maintenance. It faces many of the same varied challenges of its past development and use, including competing demands for water by municipalities, agriculture, commercial and recreational boating activities, and the functional requirements of the natural aquatic system. In times of flooding, the Caloosahatchee is used as a conduit for discharge with little regard for the downstream impacts of water quality and water volumes. In times of drought, water releases from Lake Okeechobee often do not maintain minimum flows necessary to support the critical productive functions of natural systems nor do they retain necessary water depths in the federal navigation channel of Lake Okeechobee.

Resource managers with the South Florida Water Management District view and treat this waterway as a drainage and storage component of Lake Okeechobee and the multi-billion-dollar Comprehensive Everglades Restoration Project. Their concerns and program objectives are regional in scope and focus predominantly on water management functions, primarily flood control and water supply. Stakeholders and organizations concerned about the condition of the waterway have recently called for federal assistance from the Army Engineers to address its navigation and water-based eco-tourism needs by promoting coordinated management and sustainable use.

Does history repeat itself? Can we learn from past mistakes? Is there hope that both objectives–flood control and navigation–can be realized in the 21st century to provide for sustainable management that protects the resources and allows for use by all citizens who live, work and recreate along this waterway?

Contemporary Geography

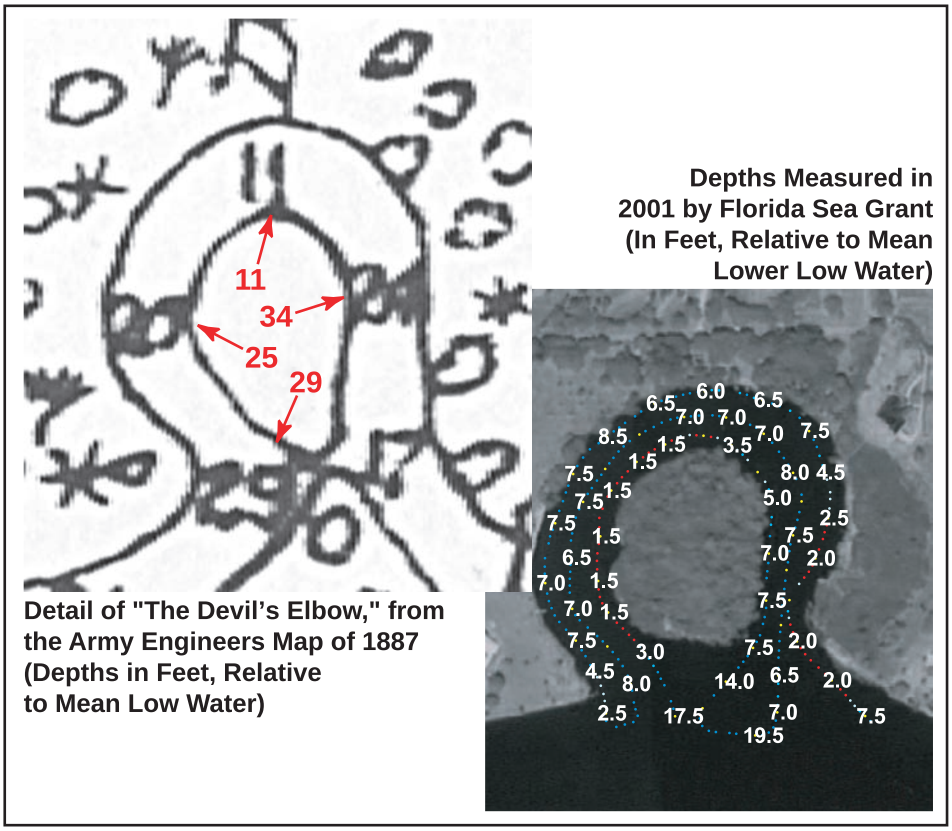
The scenic Caloosahatchee, the historic waterway that fostered settlement of interior Southwest Florida, functions today as a thoroughfare for transiting recreational boat traffic and a conduit for excess stormwater flows. Where once the river meandered, it is now a series of straight legs interrupted by 26 gentle bends (Map 1 and Table 1). Although one still, rarely, may encounter some tugs and barges, heavy commercial traffic of the past eras is gone. Both the form and function of the river have changed.

The Okeechobee Waterway and former vestiges of the Caloosahatchee lie side by side. About 35 abandoned meanders are situated between Olga and La Belle and another seven are in the estuarine portion of the river downstream from the Franklin Lock. The dichotomy of this landscape is striking: a straight-line, deep waterway with artificially configured banks, punctuated by intriguing side loops, heavily vegetated, shoaled, and snag-laden. A comparison of spot soundings from the years 1887 and 2002 shows the striking differences in water depths as channeled river discharge bypassed the meanders (Map 3). Today, nearly half of the meanders along the river are not fully navigable because of siltation caused by reduced water flow through the bends. Shoreline residences and boat docks are found on some, while others are quite pristine (see Changes on the Waterway and Along the Waterfront).

Lake Hicpochee, now approximately 215 acres of open water, is a mere relict of its past extent. Lake Flirt no longer exists, though the area is being studied to determine the feasibility of creating an above-ground reservoir with a total storage capacity of approximately 160,000 acre-feet (about 7 billion cubic feet). This proposed reservoir would be part of the Comprehensive Everglades Restoration Plan, a multi-billion dollar federal project to correct water flow problems created by dredging and channelizing the Okeechobee–Kissimmee–Everglades region.

There are recreational boat facilities along the Okeechobee Waterway. Some towns, like Moore Haven and La Belle, provide downtown docking for transient vessels. In-the-water boat storage is available at various locations within the freshwater section of the waterway; boats from northern states are left here during the summer season protected from coastal storms.

The land use and cover that confronts the passing boater has been dramatically altered from the historic past. Major riverine forest tracts are gone, replaced by agriculture and urban built-up uses. High levees run parallel to the waterway from Lake Hicpochee to the historic Ft. Thompson area, just east of La Belle (Map 2).



Map 3.
Detailed plans showing water depths in the Devil's Elbow in 1887 and 2001.

Ft. Myers riverfront.

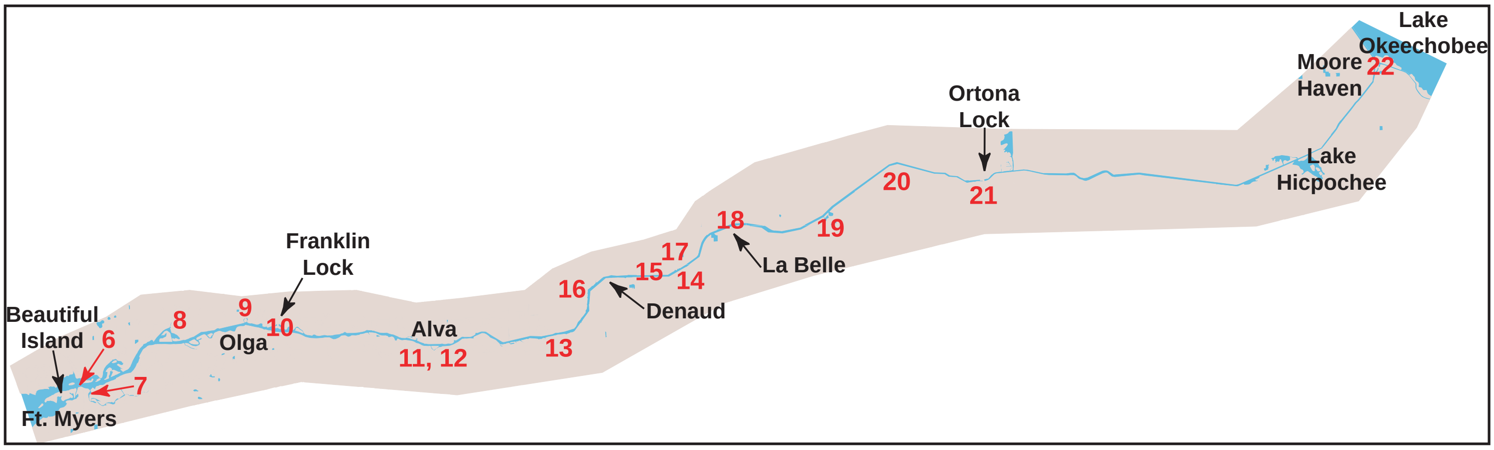

Stabilized Oxbow Slopes, Denaud.


Orange grove, packing house and the Caloosahatchee at Alva in 1912.

Changes on the Waterway and Along the Waterfront

The history of waterway changes is reflected in a record of past and contemporary photographs referenced to specific sites along the stretch of the river from Beautiful Island to Moore Haven and the western rim of Lake Okeechobee (Map 4).

The view from the railroad trestle span at Beautiful Island is very much the same today as in yesteryears (Figures 6a, b). Shoreline land use on the Orange River, however, has changed dramatically from citrus groves to residential use (Figures 7a, b). Photo 8 shows the mouth of Trout Creek and Figure 9 captures the Devil's Elbow on the north shore. Located opposite the historic settlement of Olga, the Devil's Elbow was an extremely tight river meander to navigate (thus its name), which required warping by larger vessels in order to pass through the tight rope-bend. Water depths there, once 11-34 feet, have been reduced to 7-9 feet as a result of waterway channeling that bypassed this meander. Devil's Elbow today is a favored "hurricane hole" because of its relatively deep water, minimal fetch and protected location.



Map 4.
Locations of photographs along the river.

Figure 6a. Old railroad trestle at Beautiful Island.

Figure 6b. Contemporary trestle at Beautiful Island.

Figure 7a. Steamer on the Orange River.

Figure 7b. Contemporary Orange River shore.

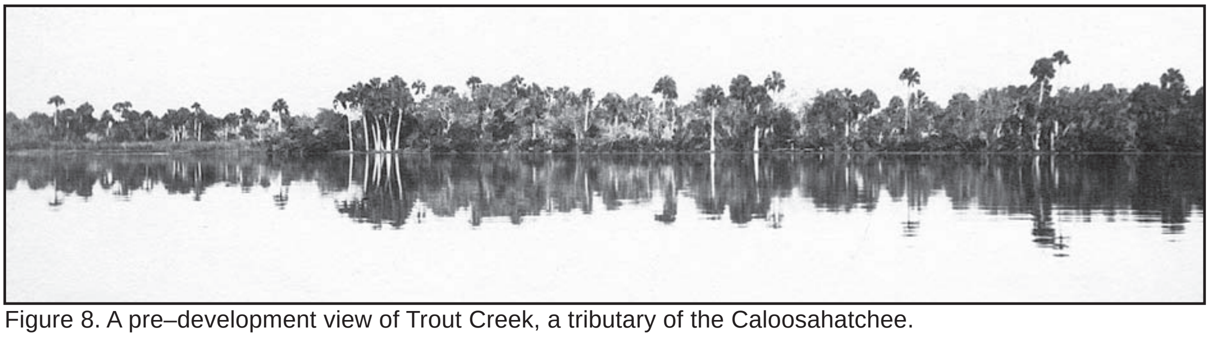


Figure 8. A pre–development view of Trout Creek, a tributary of the Caloosahatchee.

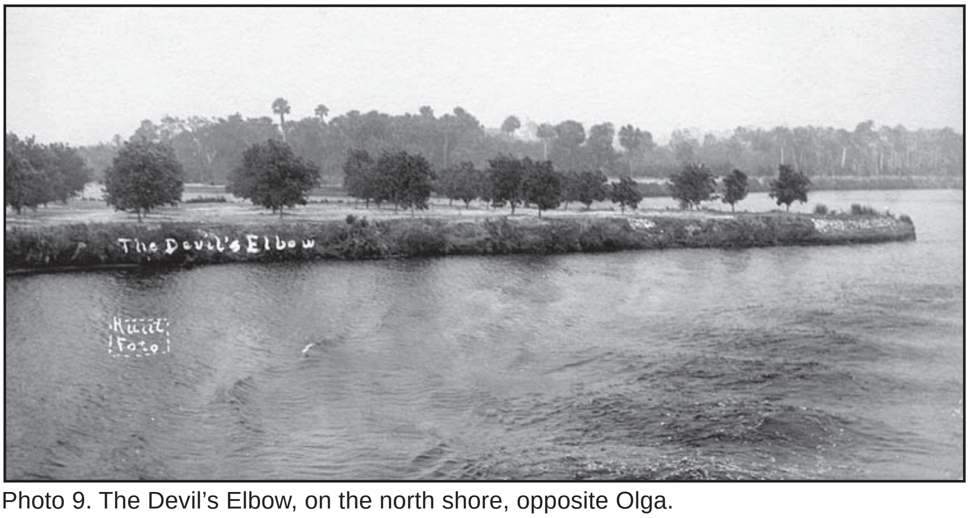


Photo 9. The Devil's Elbow, on the north shore, opposite Olga.

W. P. Franklin Lock is the western line of protection limiting storm surge from the Gulf and saltwater intrusion (Figure 10). The river scene looking west from Alva hasn't changed much (Figure 11a, b), though the view years ago of the town with its historic swing bridge (Figure 12a) is different from its appearance today (Figure 12b).

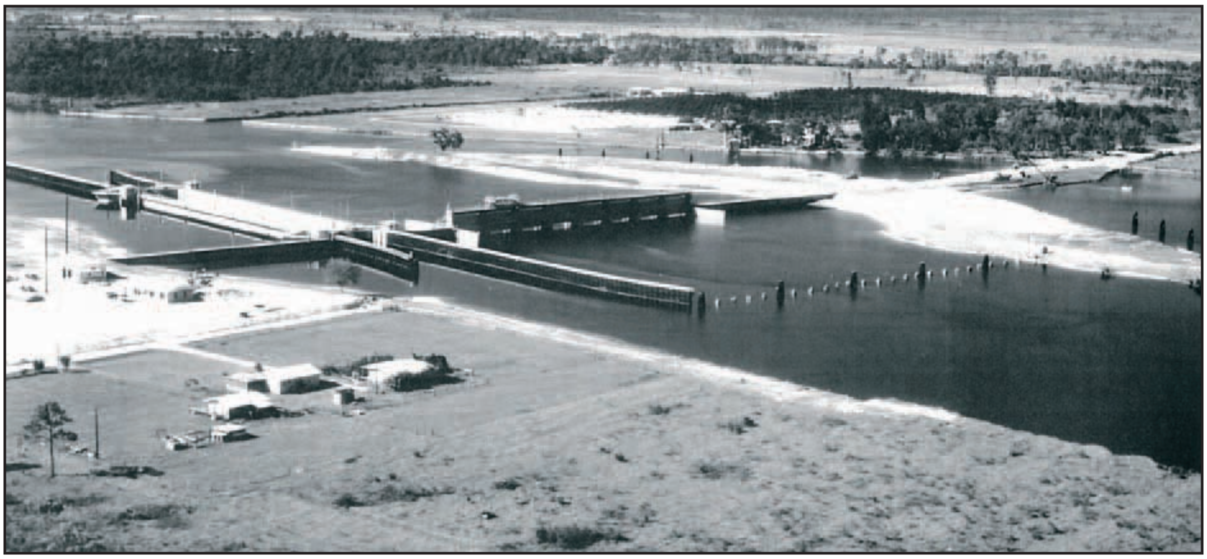


Figure 10. W.P. Franklin Lock, 1968.

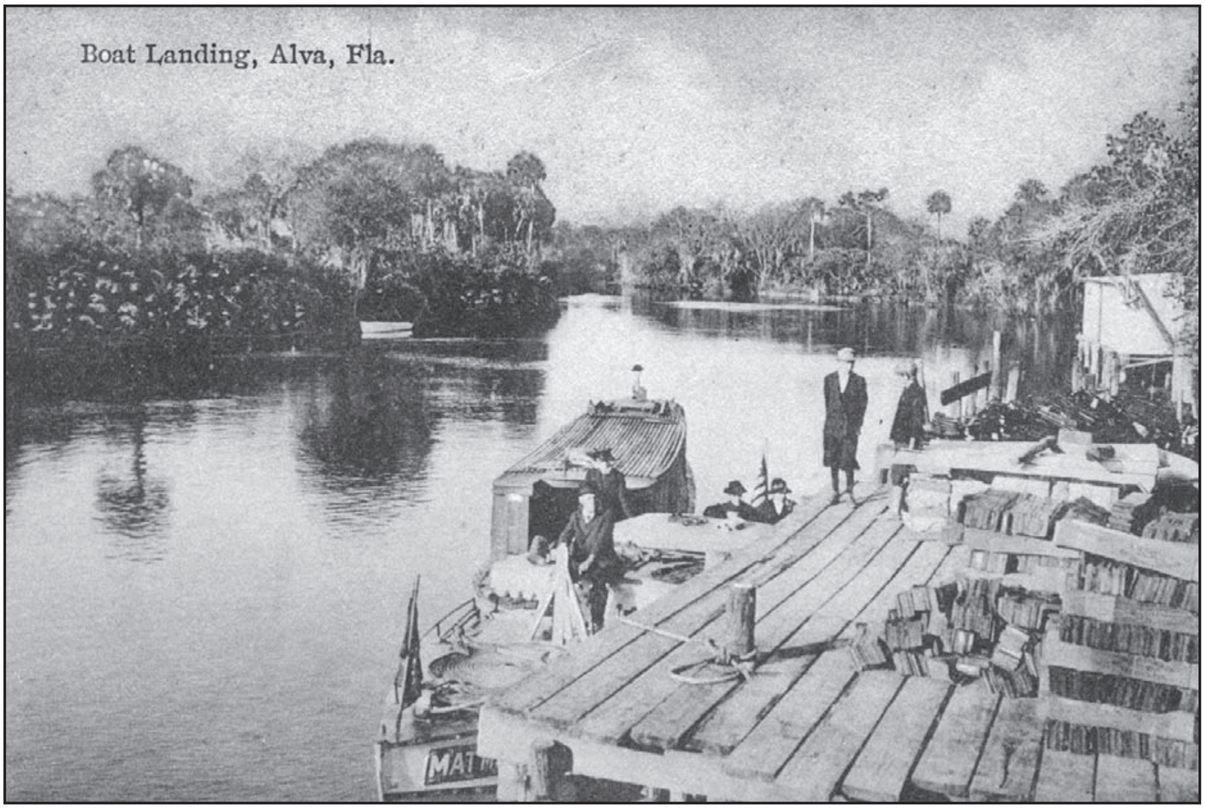


Figure 11a. Former boat landing at Alva.

Figure 11b. Today's contemporary boat landing at Alva.

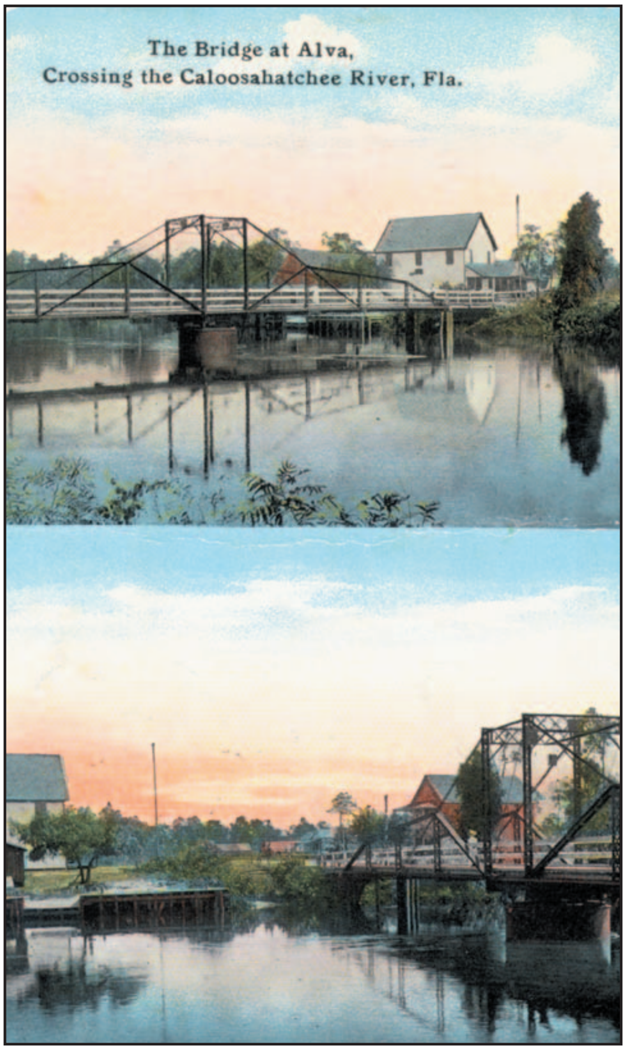


Figure 12a. Historic Alva bridge, view to west.

Figure 12b. Alva bridge, 2001.

A boat trip into segments of the old Caloosahatchee, where the old riverine forest has been retained (Figures 13a, b), or where old homes, such as the Terrell House at Turners' Landing have been preserved (Figures 14a, b), is a step back in time. In some cases, however, large homes and boat docks line the former river bends (Figure 15) or the rim of the present waterway. Dredged spoil, side-cast on the north bank, appears near Rialto (Figure 16).

Figure 13a. Historic river near Ft. Denaud.

Figure 13b. Contemporary view of Oxbow, West of Denaud.

Figure 14a. Dr. Terrell house, Turners Landing today.

Figure 14b. Turners Landing in the early 1900s.


Figure 15. Rialto Oxbow (residential use).


Figure 16. Side cast spoil along waterway at Rialto.

La Belle, a historic river town, retains much of the character from bygone days especially along the waterfront (Figure 17a, b), though the old swing bridge has been replaced by a bascule bridge (Figure 17c, d). Nothing remains from Ft. Thompson although a historic marker has been erected at its location; Ft. Thompson was probably destroyed by dredging and portions of the settlement buried under spoil along the south bank of the waterway. Figure18a shows the flooded riverbanks years ago near Ft. Thompson, and Figure 18b is the cattle crossing at the Rapids. Lake Flirt no longer exists, but a number of dredged basins in that locale now harbor wet storage facilities (Figure 19).

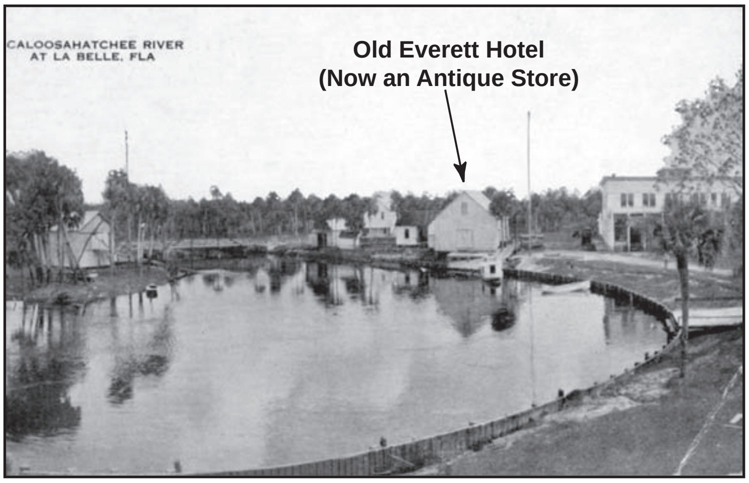


Figure 17a. La Belle riverfront (then).

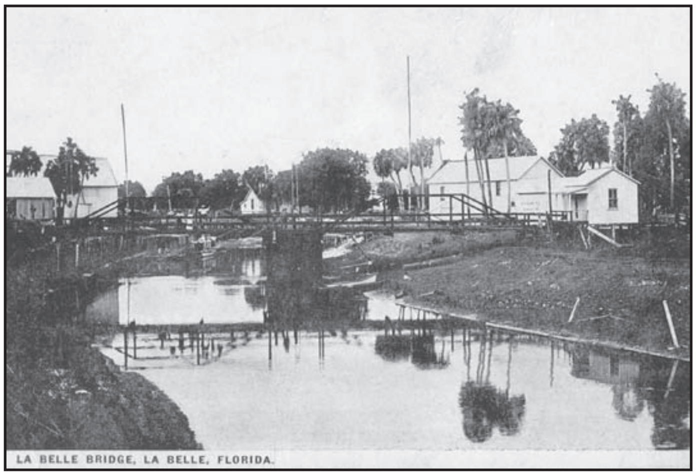


Figure 17c. La Belle swing bridge (then).

Figure 17b. La Belle Town dock (now).

Figure 17d. La Belle bridge (now).

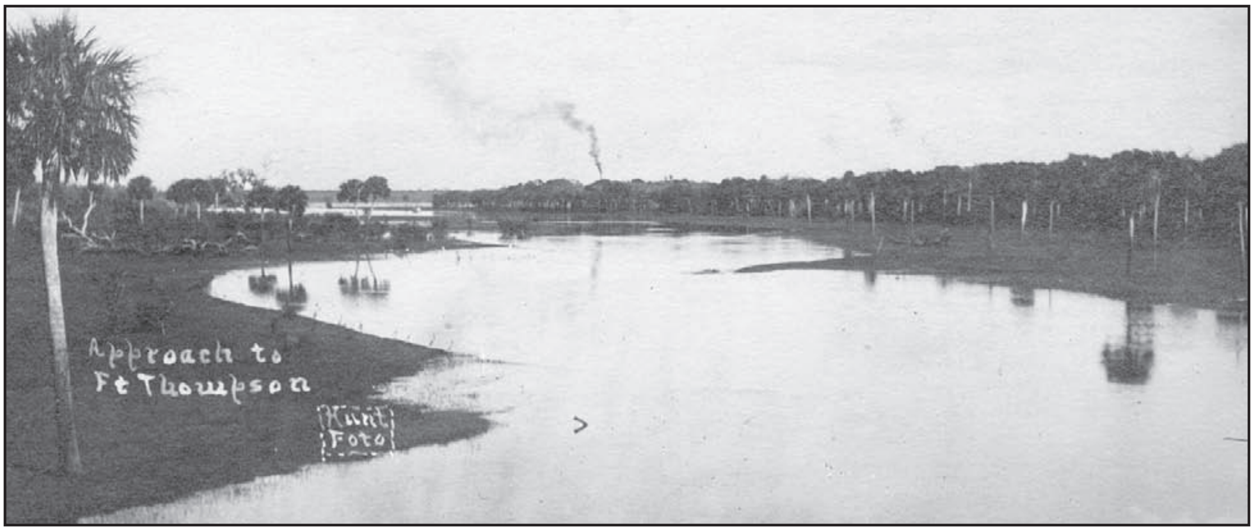


Figure 18a. River at Ft. Thompson.

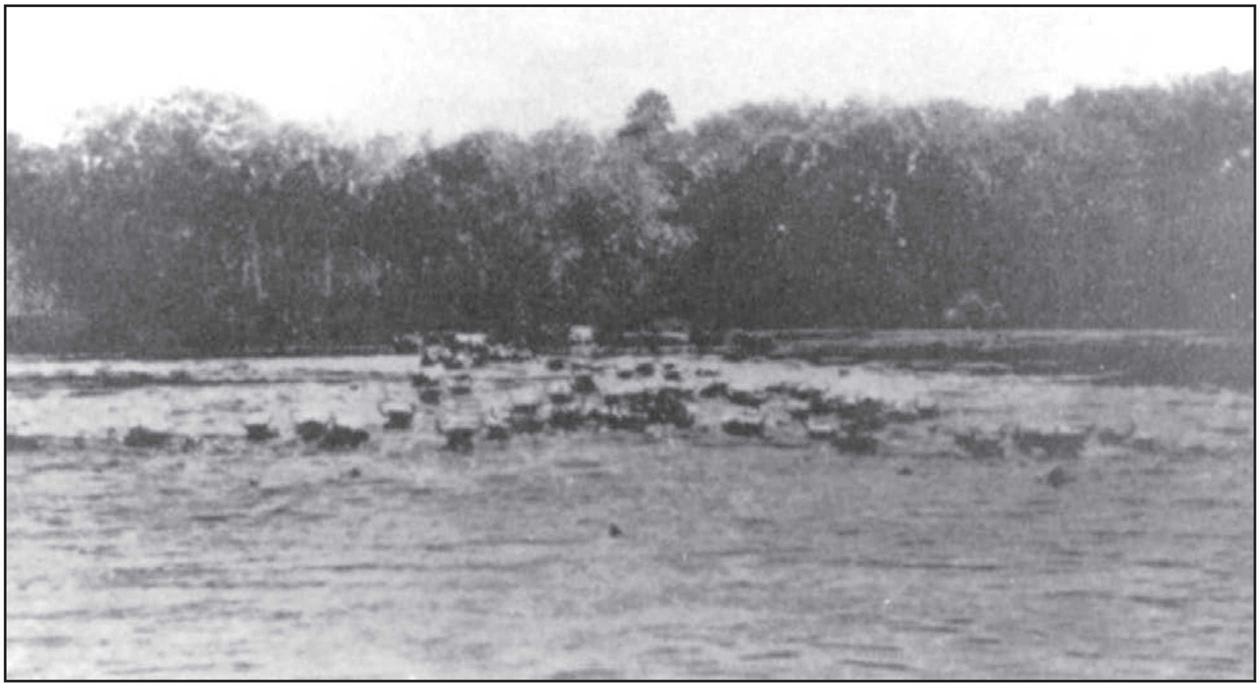


Figure 18b. Cattle crossing at Ft. Thompson.

Ortona Lock, near former Coffee Mill Hammock and west of the levee partially completed by Disston in the 1880s, is a major feature of the Okeechobee Waterway (Figure 20). For many years an important landmark guiding mariners across Lake Okeechobee, a sentinel cypress, known as *The Lone Cypress*, marked the eastern entrance to the Caloosahatchee and became a fixture of Moore Haven at the lock's location (Figures 21a, b).

Figure 19. Boats near former Lake Flirt.

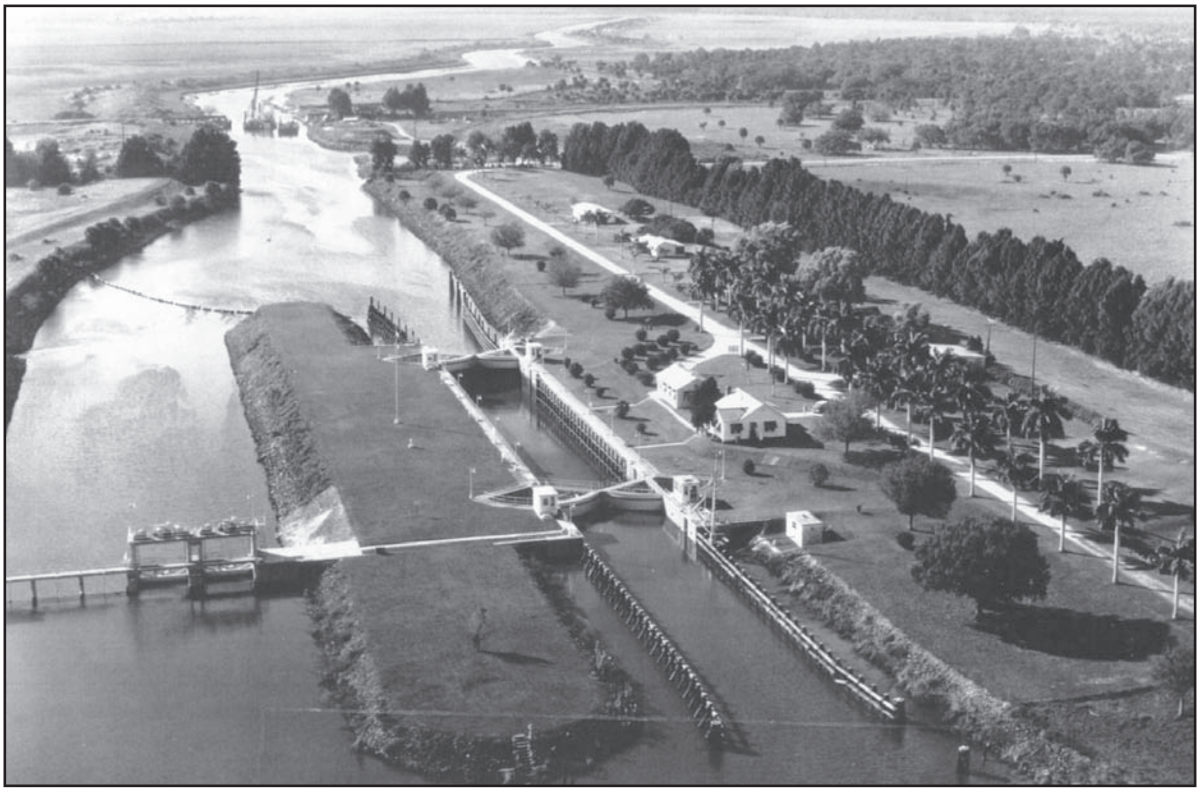


Figure 20. Ortona Lock.

Figure 21a. Lone cypress at the lake and canal junction.

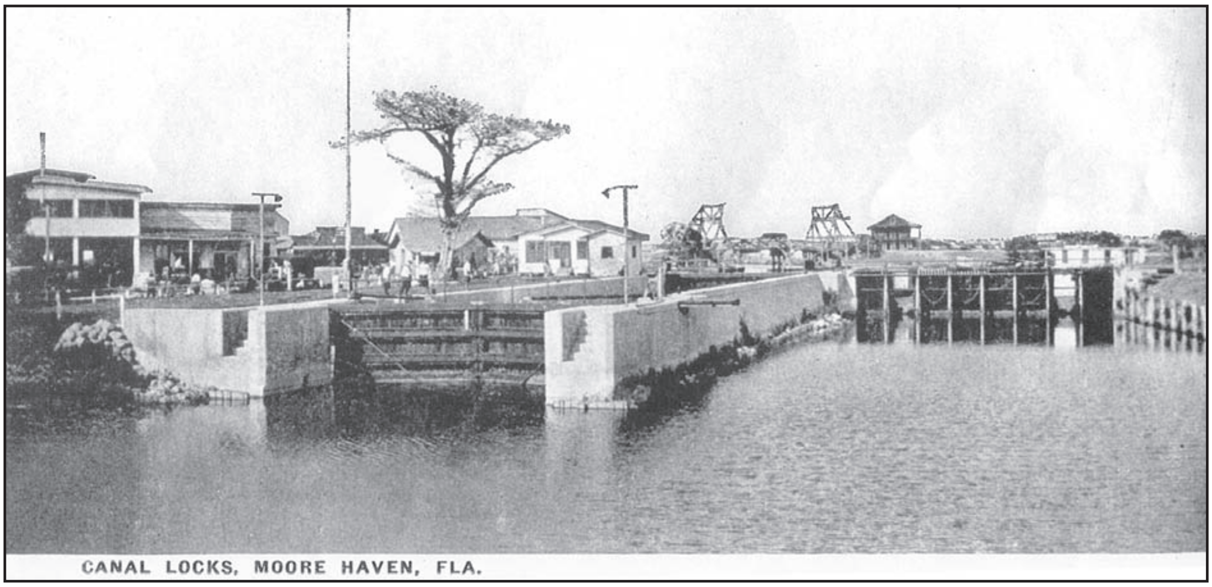
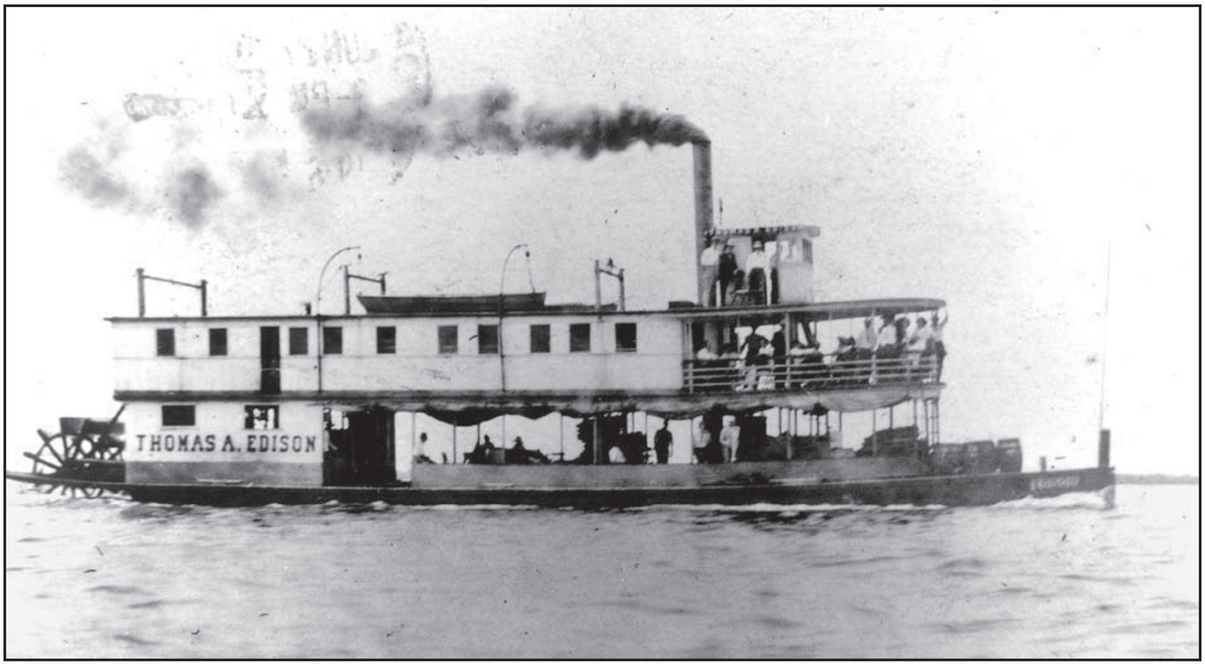


Figure 21b. Moore Haven lock.

Epilogue

Caloosahatchee history is the extreme case of altering land and water for coastal development in Southwest Florida. The river's form and function over the past 100 years have irrevocably changed. The historic river, which was relied upon by pioneers as a commercial artery for transporting goods and services, had a meandering, shifting course subjected to flood and drought conditions. Today, it is the straight-channel, dredged, Okeechobee Waterway, used by resource managers for flood control and by boaters transiting between the Eastern Seaboard and Gulf Coast. Hidden behind the waterway's artificially configured banks are isolated remnants of the Caloosahatchee's meanders, some pristine, others altered by development pressures from residential, agricultural and recreational uses. The dichotomy of waterway and river remain coupled by geography and history. The question of how this historic river and its water will be managed and provided to sustain the rich historical and ecological balance, which drives our current coastal economy, is a vexing enigma to this day.



Steamer *Thomas A. Edison* on a run up the Caloosahatchee to Ft. Myers during the early 1900s.

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For Your Information...

Physical Features of Southwest Florida Rivers and their Influence on Shoreline Use and Navigation

Rivers, such as the Caloosahatchee, Estero, Imperial, and Cocohatchee, share a number of common physical features that affect navigation and land use along their shorelines.

Viewed from the air, these streams display floodplains with a meandering river course. During the pre–development period, when flood-control structures were uncommon, overbank flooding occurred during the rainy season as the meandering river would leave its existing channel and inundate part or all of its floodplain. Early settlers described such events, wherein the increased flow kept the sediment load suspended, with the river channel oftentimes indistinguishable because of the floodwater's turbidity.

The meandering habit of these rivers alternately cuts and fills the valley floor, depositing sediments on the inside of bends and cutting away its banks on the outside, and in this process, the whole meander migrates down-valley. The Black map (1887) displays many of the Caloosahatchee's floodplain features of the pre–development period, downstream from Ft. Thompson (Figure 22). In time, the meanders develop narrow necks (Figure 22, a), and, in flood stages, the river may abandon, or cut-off, a meander loop (Figure 22, b). An oxbow lake forms (Figure 22, c) when the river deposits sediments across the ends of the abandoned channel.

In the active meanders, water pools along the outside bend because the river undercuts the bank, which results in caving that allows the meander radius to grow. Depths become shallow where the river crosses from one bend to the next and creates shifting sand bars known as riffles. Riverboat captains during the heydays of 20th century development were familiar with these channel characteristics as they navigated through the shifting shoals and sought the deepwater pools in the outer bends. Larger vessels were required to warp-around the tight rope-bends. Present day mariners seek out the remaining deepwater pools as storm havens or "hurricane holes."

Today, the lower Caloosahatchee, downstream from Beautiful Island, is an estuary (subject to tidal influence), but, in essence, it is a drowned river valley, inundated during the post-glacial rise in sea level. Many of its former river meanders are clearly visible along the shoreline (Figure 23, red dashed line).

Relict Meanders East of the Franklin Lock.

Figure 22. Meanders in the Caloosahatchee, 1887.

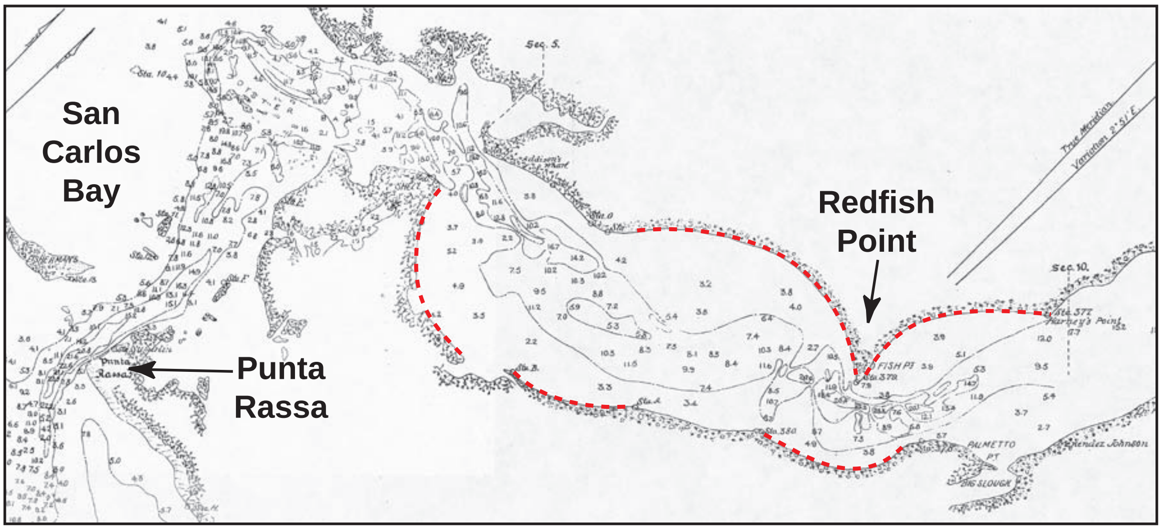


Figure 23. Drowned River Valley features.

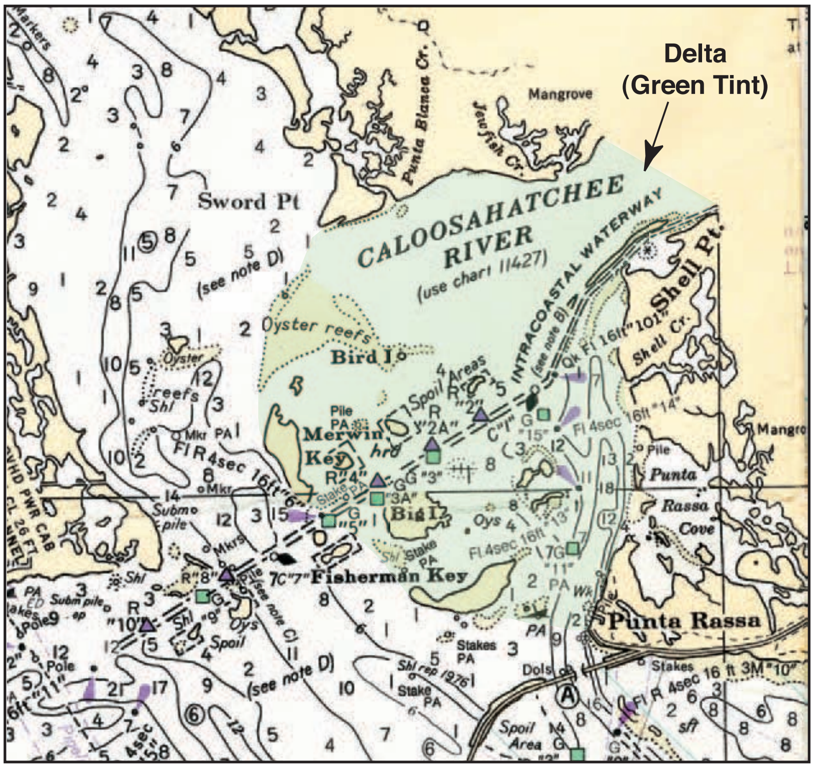


Figure 24. Chart of the Caloosahatchee delta.

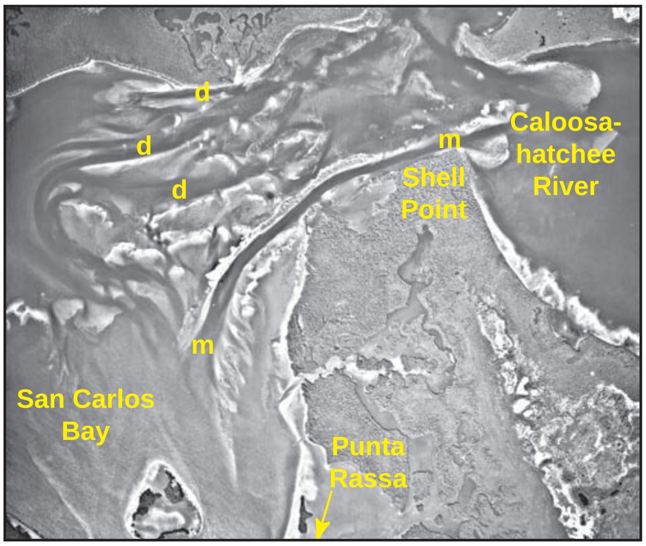


Figure 25. Caloosahatchee delta, 1944.

Figure 26. Imperial River delta, 1999.

Another feature of these rivers is the delta formed where the velocity of the stream rapidly decreases as it flows into a body of standing water. Distributary, intersecting, secondary channels form where the main river channel divides and pushes out into the bay. The configuration of the shoreline influences the shape of the delta. The Caloosahatchee delta, delineated by Shell Point at the apex (on the east) and a line drawn between Sword Point and Punta Rassa (on the west), has the characteristic *delta*-shape and is influenced by tidal currents flowing between Matlacha Pass and San Carlos Bay (Figure 24). Indeed, much of the shifting, shoaling character of the "Miserable Mile" segment of the Gulf Intracoastal Waterway through this area is attributable to tidal currents redistributing the river's delta deposits. The aerial photograph in Figure 25 predates the Gulf Intracoastal Waterway and clearly shows the many distributary channels ("d") in this area. The main, navigable channel through the delta ("m" in Figure 25) shows the side-cast spoil placed along the north bank of the channel. This is a federally-maintained channel that was first dredged by the Army Engineers in 1882.

The Imperial River's delta (Figure 26) extends across lower Estero Bay and abuts the barrier island. This delta has proved to be an effective barrier to navigation. Shallow-draft coastal vessels used one of the distributary channels, the "Auger Hole," during the early development period. In 1955, a private developer dredged a north-south channel across the delta in order to provide boat access between Estero Bay and Wiggins Pass.

CHARTING WATERWAY CHANGES

Coast Survey nautical charts, piloting tools used by skippers of coastal vessels include fine examples of Nineteenth Century cartography. Unfortunately, when compiling source maps of the land and water features for this historical geography series, the authors were unable to acquire nautical charts covering the entire study area.

The Coast Survey carefully preserved "compilation smooth sheets," the final working draft source maps — both hydrographic (water) "H-sheets" and topographic (land) "T-sheets" — which provided the baseline information for portraying bathymetric, shoreline, and land conditions on the charts. (In Volume 1, "Charting Sarasota Bay" described the fieldwork and cartographic processes in the creation of nautical charts.) The H-sheets portrayed soundings and depth contours derived from them. The T-sheets provided information on shore features of interest to navigators, generally showing terrain and landmarks to the inland extent visible from vessels. Therefore, for parts of our coast where the published pre–developement era nautical charts are no longer readily obtainable, the archived H- and T-sheets are an invaluable resource. This is the case for Southwest Florida.

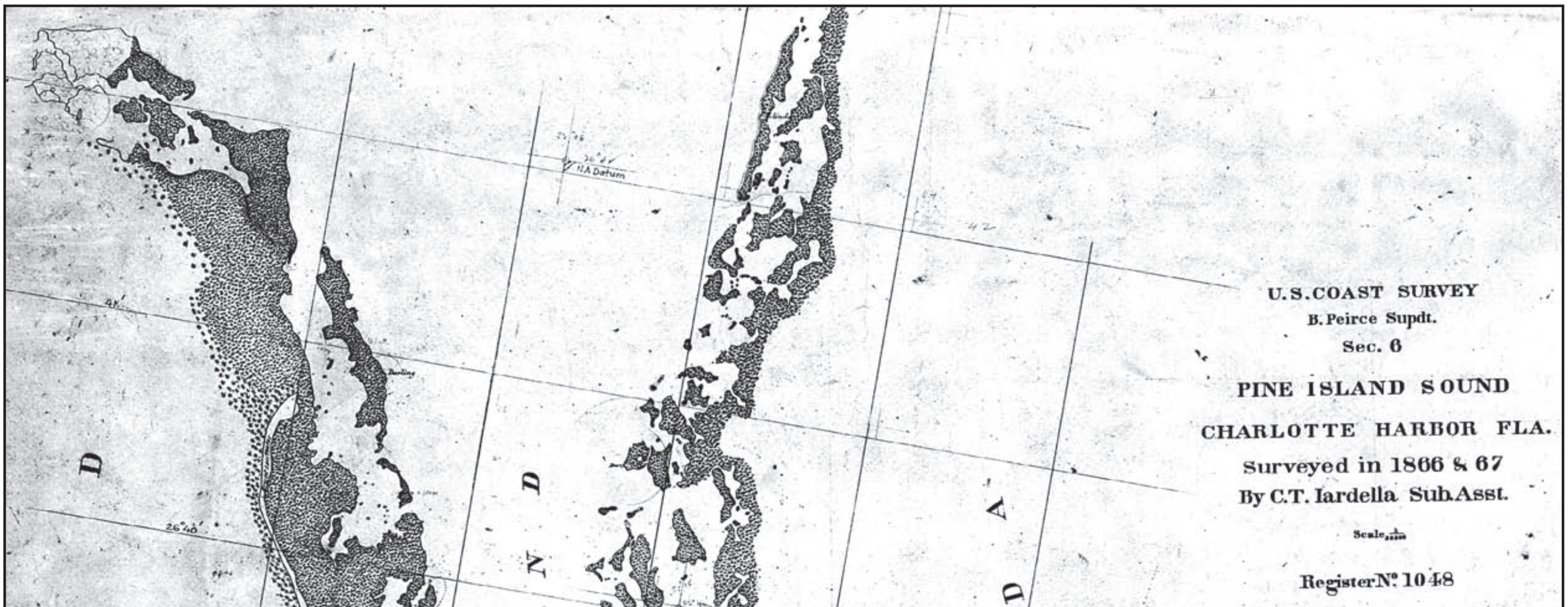
Figure 1 is a T-sheet, with an enlarged inset showing the amount of detail drawn to indicate land cover, here mostly mangrove forest. This map shows what is today known as Matlacha Pass, between Pine Island and the mainland near Cape Coral; the T-sheet, dated 1886-87, labels the pass "Pine Island Sound."

In every bay, estuary, and navigable river along Florida's Gulf of Mexico coast, the hydrographic surveys produced thousands of individual depths, each carefully measured by a sounding pole or a lead line heaved from a boat. Surveying techniques, based on sextant or transit sightings to or from shore stations, established a location for each sounding. Recording tide gauges allowed correction for the tidal variations. Shore parties performed the topographic surveys, mapping shorelines and other natural features, as well as roads, homesteads, farms, townships, and prominent buildings. Boundaries between land cover communities (mangrove, scrub, brushland, fresh and saltwater marshes, other wetlands, upland forests, etc.) were carefully drawn. The H- and T-sheets preserve abundant data on the state of water and land.

Today, Geographic Information System (GIS) computer programs facilitate quantitative analysis of change in shorelines, bathymetry, land use, etc., both among earlier eras and from historic to modern times. A printed historic map may be used as a data source, when input into a GIS via a file made by scanning either the paper map or a photograph of it. The GIS also needs the geographic coordinates of at least a few identifiable mapped features in order to relate all parts of the map to the coordinate system. Otherwise, the file is simply a picture or graphic, not a *georeferenced* map.

In low-energy coastal areas, away from inlets or other features subject to significant change due to storm events, scour, sedimentation, etc., it is often possible to identify presently existing natural or manmade features on historic maps. They can serve as *ground control points* (GCPs) for georeferencing. However, in Southwest Florida, especially near the barrier island passes, few natural or manmade features have survived unchanged since the mid- to late -1800s. The distinctive shoreline shapes and many small islands visible on historic maps, which might serve as GCPs if identifiable on modern maps or aerial photographs, usually reflect mangrove forest boundaries, which may have changed substantially in the intervening years.

Fortunately, historic T-sheets were drawn with accurate geographic grids, the familiar lines of latitude and longitude. Using visible grid intersections with known geographic coordinates as control points, georeferencing map scans is straightforward. Once the coordinates of selected grid intersections (or other ground control points) are associated with the corresponding pixel coordinates in the image file, the GIS then transforms all pixel coordinates to geographic ones. In addition, this process can *rectify* the image, correcting source map inaccuracies, as well as removing distortions induced in the paper maps over decades of storage and handling or introduced in the scanning process. Sophisticated mathematical operations (algorithms) start with the map coordinates of the GCPs and interpolate new positions for all other pixels in the image.



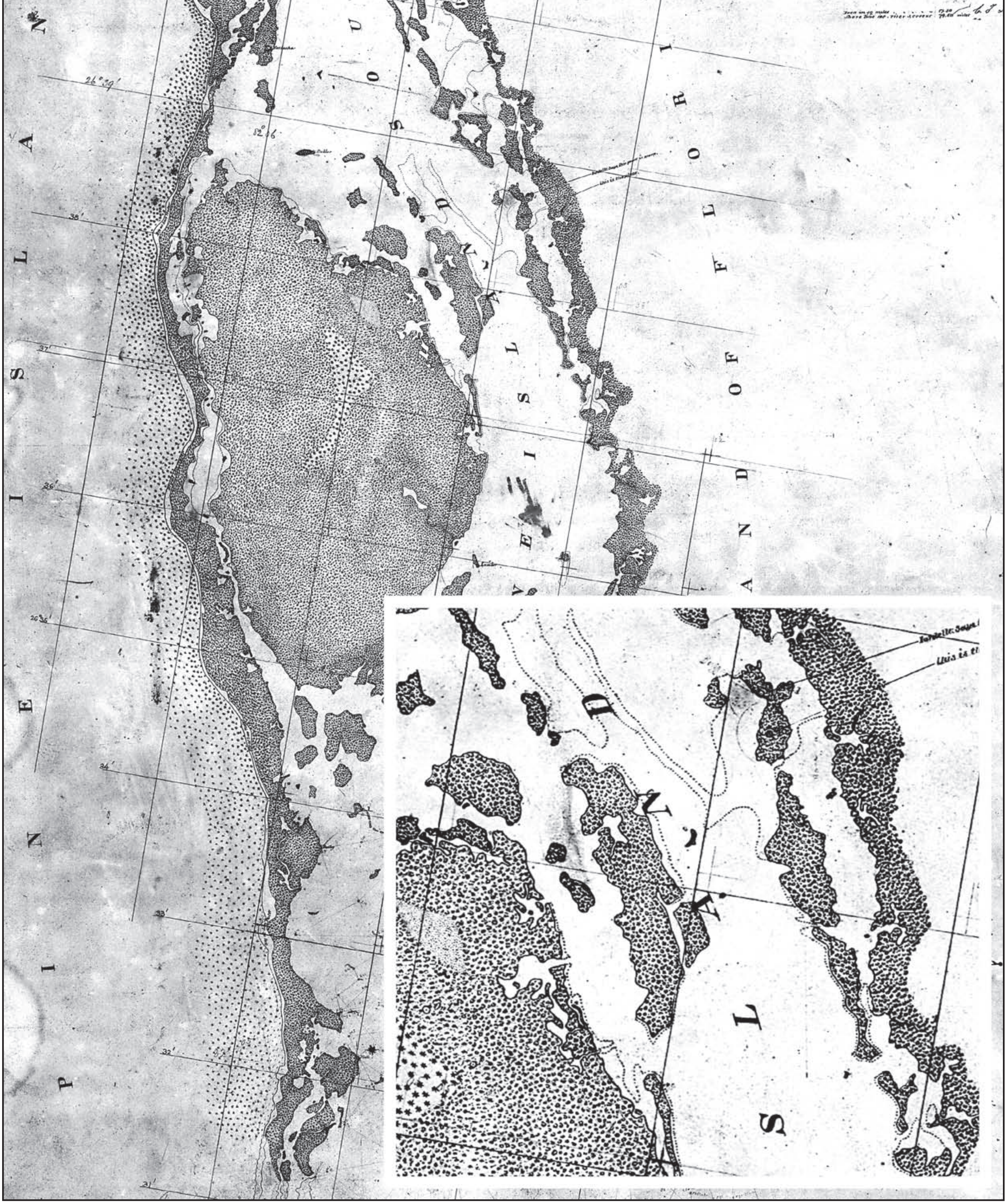


Figure 1. Example terrestrial smooth sheet (T-Sheet).

Many of the H-sheet scans do not show geographic grids, which may have been drawn so lightly that the scan process failed to capture them. Also, the cartographers often drew H-sheet shorelines in a simplified fashion, omitting small, distinctive features. However, H-sheets (and the T-sheets) show the shoreline *triangulation stations*, used for position determination in both the topographic and hydrographic surveys. Figure 2 is a small portion of an H-sheet scan, showing station "Annie," near the south end of Captiva Island. The scan shows no trace of a geographic grid, but the triangulation stations are visible, if only barely, as are parts of colored depth contours. The green line is the 6-foot contour.

Triangulation stations were points of precisely known location, distributed along the barrier island and mainland shorelines, often on prominent points. A few occupied small bay islands or oyster reefs. The survey crews selected sites that maximized views of the open water, performed careful surveys to determine their positions, and thoroughly documented each station's important characteristics.

The National Ocean Service provided the T-sheets as high-quality photographic negatives; thus, Figure 1 retains most of the detail visible on the original map. For the H-sheets, obtained as scans of much lower resolution, we plotted the scans onto paper at full size and then *digitized* depth contours, either tracing the original contours or interpolating between the point soundings. This process requires an operator to trace each contour with an electronic "puck" on a special table, following rigid rules of contour construction. Of the 95 control points used in the shoreline and depth contour mapping, 52 were triangulation stations. (The T-sheets and some better quality H-sheets also served as sources for land use/land cover interpretation. The operator did "heads up" digitizing on a computer screen, rather than moving a puck over a paper plot.)

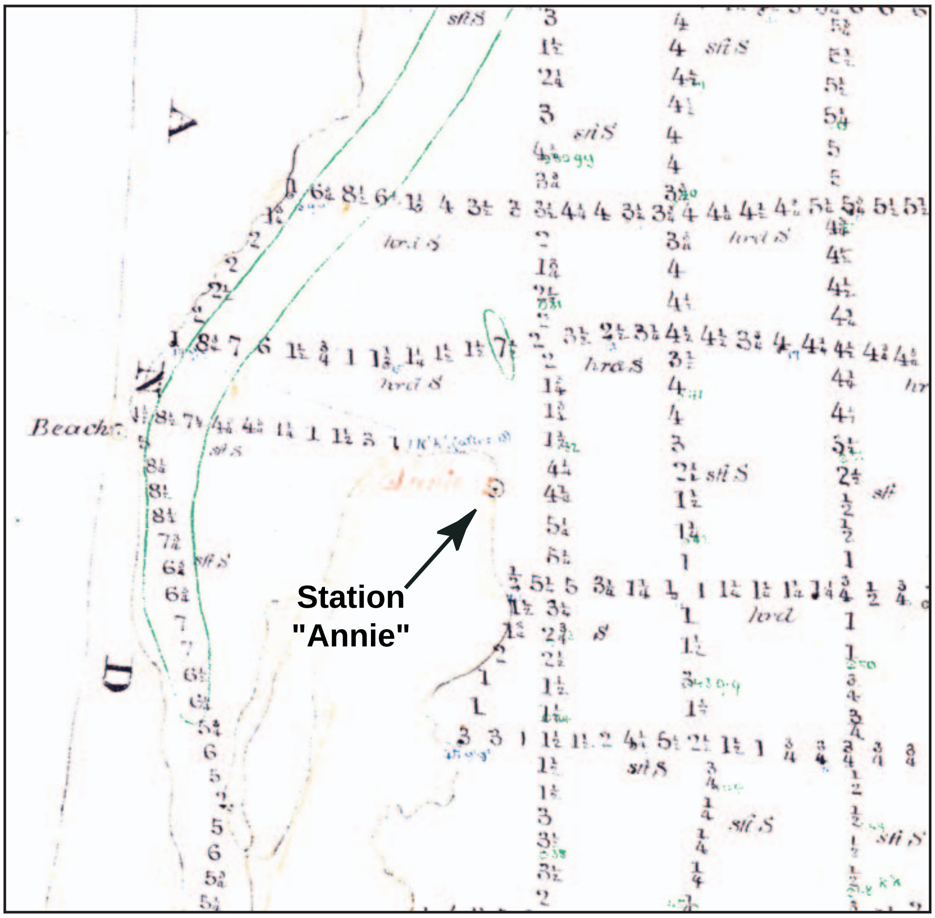


Figure 2. Detail of hydrographic smooth sheet (H-Sheet) scan.

Two source documents provide the coordinates of the triangulation stations in our study area. The *Report to the Superintendent of the United States Coast Survey, Showing the Progress of the Survey during the Year 1868*, tabulates some of them. These positions used the *Bessel ellipsoid*. An ellipsoid is a representation of the Earth's shape; improved knowledge of the true shape of the planet allows definition and adoption of more accurate ellipsoids (also called *spheroids*).

Another document, *Triangulation along the West Coast of Florida*, by Clarence H Swick, provided most of the station positions and descriptions. Station coordinates were based on the "Old North American" *datum* (mathematical model that fits the earth to an ellipsoid or spheroid); this datum used the Clarke 1866 spheroid, which succeeded the Bessel ellipsoid. Swick also discusses the Old North American Datum. In 1901, the Coast Survey adopted a single datum, the *United States Standard Datum*. This was made possible by analysis ("a very heavy piece of work") of data from the transcontinental triangulation of the United States, completed in 1899. Canada and Mexico adopted the new datum in 1913, and its name became the North American Datum. Later, the *North American Datum of 1927* (NAD27) became the standard, and the previous datum came to be referred to as the "Old North American Datum."

To summarize, converting historic source maps into forms usable for Geographic Information System analyses required transforming map coordinates of ground control points from the Old North American Datum (based on either of two obsolete spheroids) to the NAD27 Datum. The next step was conversion of the coordinates from NAD27 latitude and longitude degrees into modern *projected* systems that use meters or feet for units and yet other spheroids. (Projection displays the Earth's curved surface as a flat representation, such as a paper map. Unprojected coordinates are satisfactory for a globe, but not good for flat maps.)

The National Geodetic Survey generously supplied the triangulation station reference documents and provided formulas to transform coordinates from Bessel ellipsoid to Clarke 1866 spheroid-based coordinates, as well as from the "Old North American Datum" to NAD27. These transformations all vary from place to place; *Datum Differences: Gulf and Pacific Coasts*, published by the Coast and Geodetic Survey in 1936, specifies the corrections needed for the NAD27 transformation in Southwest Florida.

Table 1 is an example of the coordinate transformation steps. Transforming the Bessel-ellipsoid coordinates of station "Annie" to the Clarke 1866 spheroid required subtracting 3.32 arc-seconds from the original latitude (26 30 58.09 became 26 30 54.77) and adding 10.65 to the longitude (82 10 42.07 became 82 10 52.72). Then, to convert the Old NA coordinates to NAD27, latitude decreased by another 0.250 arc-second, and longitude increased by 0.039. The projection changed the degree-minute-second lat/lon coordinates to Annie's X-Y Albers coordinates: 580951.343/280297.497meters. Not shown is the conversion of degrees-minutes-seconds to decimal degrees, required for the projection operation. Each of the 95 ground control points required careful execution of these steps.

Example of geographic coordinate transformations.

Example Map Triangulation Station	Geographic Coordinates						Albers Projection	
	NA Datum		NA Datum		NAD27		NAD83	
	(Bessel Ellipsoid)		(Clarke 1866 Spheroid)		(Clarke 1866 Spheroid)		(GRS80 Spheroid)	
	Lat (DMS)	Lon (DMS)	Lat (DMS)	Lon (DMS)	Lat (DMS)	Lon (DMS)	X (m)	Y (m)
Mistake			26 37 43.030	82 10 44.200	26 37 42.780	82 10 44.239	581000.298	292887.974
Boca Captiva			26 36 40.539	82 13 28.750	26 36 40.289	82 13 28.789	576486.397	290895.047
Oyster Shell	26 32 46.57	82 07 23.10	26 32 43.25	82 07 33.75	26 32 43.000	82 07 33.789	586398.834	283724.254
Annie	26 30 58.09	82 10 42.07	26 30 54.77	82 10 52.72	26 30 54.520	82 10 52.759	580951.343	280297.497
Havelock			26 30 05.720	82 06 10.078	26 30 05.470	82 06 10.117	588784.823	278902.973
New Year	26 28 4.61	82 07 39.09	26 28 1.29	82 07 49.74	26 28 1.040	82 07 49.779	586089.004	275024.823
		Bessel Ellipsold to Clarke 1866 Spheroid: lat -3.32” lon +10.65”		NA Datum to NAD27: lat -0.250” lon + 0.039”		Geographic Coordinates to Albers Conic Equal-Area Projection		

Table 1.

How well did the process work? Figure 3 shows the pre–development bathymetry map of Matlacha Pass, with depth contours interpreted from an H-sheet, displayed in the GIS program. A recent (1999) georeferenced aerial photograph overlies the map. In places, the shoreline neatly continues from the photograph onto the map, indicating little change from the late 1800s to 1999. Other parts of the shoreline do not line up as well, suggesting change has occurred, either from natural processes, such as variation in mangrove coverage, or by the influence of man. At the upper and lower edges of the photograph, changes in the water depth — indicated by color variation, mostly due to sea grass beds — correlate well with the depth contours visible on the map. Matlacha Pass is a relatively low-energy waterway, not subject to the dramatic changes wrought by storm events at the barrier island Gulf passes, so the lack of major variation is not surprising.

Geographic Information System computer programs allow researchers to compare old and new maps, in a common reference frame, in order to visualize and quantify changes that occur over time. Many of the maps in this book required this capability in their creation. Traditional methods could have produced similar maps and even allowed simplified change analyses, but the time, expense, and limitations associated with those older techniques would have precluded our embarking on the task.

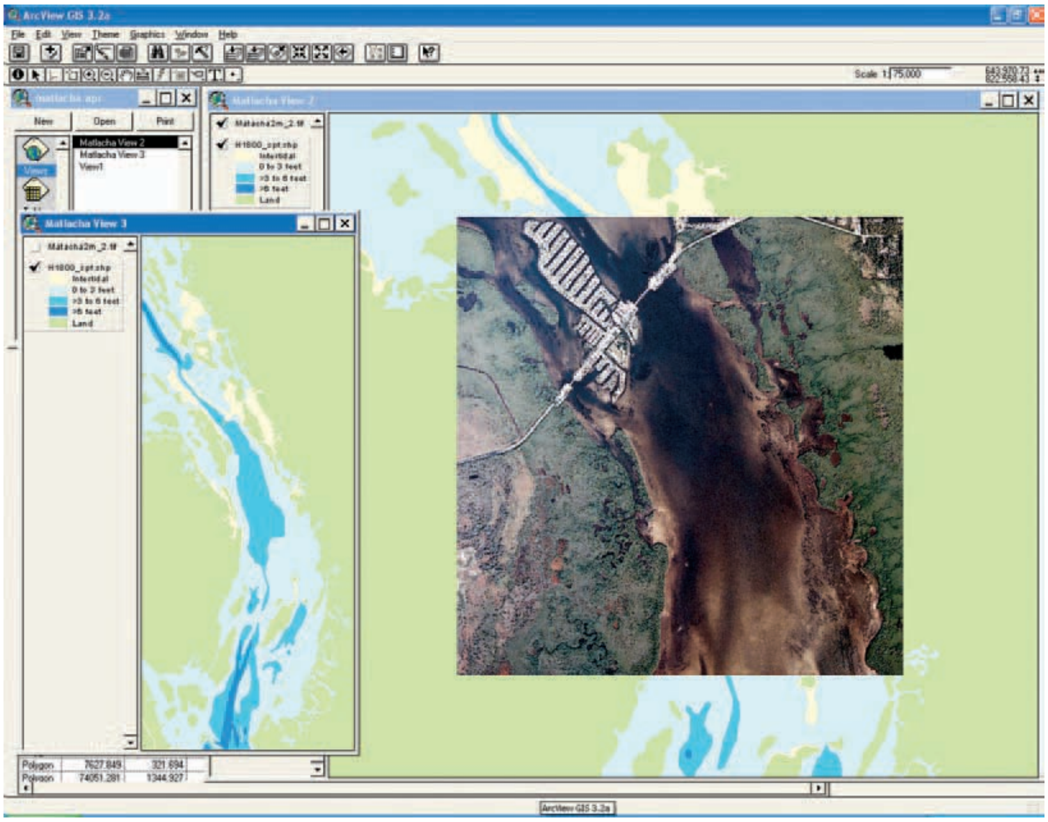


Figure 3.
Map of pre–development era bathymetry with modern aerial photograph.

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Published Reports

“Datum Differences: Gulf and Pacific Coasts,” 1936. U. S. Department of Commerce, Coast and Geodetic Survey, Washington, D.C.

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GLOSSARY OF TERMS

bascule bridge — A drawbridge with a counterbalanced span that lifts to allow passage of vessels.

benthic (organisms) — Living on or at the floor of a body of water.

chloropleth map — A map using varying colors to show the differences in the average value of a parameter among defined areas.

cuspate headland — A land mass, roughly triangular, jutting into a body of water.

downdrift — Moving in the direction of longshore currents; used especially with regard to inlet migration.

dredge-and-fill — Creation of land by deposition of material (spoil) dredged from nearby waterways.

ebb-flood channel — The principal channel in an inlet, maintained by scouring of sediments by tidal currents.

ebb-tidal delta — Mostly underwater sediment mass deposited seaward of inlets by tidal currents as the tide ebbs (falls) (cf., flood-tidal delta).

finger canals — Canals (often straight and parallel) branching from a common canal.

flood-tidal delta — Mostly underwater sediment mass deposited landward of inlets by tidal currents as the tide floods (rises) (cf., ebb-tidal delta).

georeference — Locate with respect to a geographic (map) coordinate system.

groin — A structure projecting from a beach to intercept sediment being transported by longshore currents.

groundswell — Increase in the height of waves entering shallow water.

intertidal — Land alternately covered with water and then exposed due to the rise and fall of tides.

jetty — A structure projecting from the shore to stabilize an inlet by intercepting sediment being transported by longshore current.

longshore drift — Movement of sediment (especially, sand) by wave-induced currents parallel to the shore.

marginal channel — A channel formed by currents along the ends of barrier islands, which may offer safe, deep passage through an inlet.

mixed-energy — Inlets subject to both wave and tidal influences where neither dominates.

overwash — Storm-driven waves flowing across a barrier island; the erosional/deposition features resulting from such flow.

oxbow — A crescent-shaped lake formed in an abandoned channel of a river.

prograding — Land growing seaward by deposition of sediment.

prop wash — Turbulent water flow generated by a boat's propeller.

renourishment — Addition of sand to a beach by artificial means.

run boat — A vessel that delivered supplies to fishermen and transported their catch back to processing or shipping facilities.

spill-over lobe — Local enlargement of a flood-tidal delta caused by sediment deposition.

snag boat — A vessel designed and equipped to remove obstacles, such as overhanging or fallen trees, from a waterway.

spit — Finger-like body of sediment projecting into deeper water, usually at an inlet.

swash platform — The zone of a beach or ebb-tidal delta, immediately shoreward of the breaker zone, where water from broken waves flows shoreward in low-energy sheets.

tidal prism — The volume of water flowing through an inlet during a tidal cycle.

tide-dominated inlet — Channel depths and shape subject to the effects of tides more than to wave effects (cf., wave-dominated).

wave-dominated inlet — Channel depths and shape subject to the effects of waves more than to tidal effects (cf., tide-dominated).

"wild" inlet — A wave-dominated, unstable, migrating inlet with varying shape and depth.

Wide-angle view southeast, above Useppa Island and Cabbage Key (middle foreground), down Pine Island Sound, Barrier island chain on right and Pine Island on left.

SCIENTIFIC, TECHNICAL, AND BOATING-RELATED INFORMATION ON THE WATERWAYS OF SOUTHWEST FLORIDA

The references listed below result from a decade-long Urban Boating Bay Water Management Research and Extension Program, sponsored by the National Oceanographic and Atmospheric Administration (NOAA), through Florida Sea Grant College Program, Coastal Services Center and The Marine Charting Division, and by the West Coast Inland Navigation District. Designed to help Florida boaters, residents, communities, and businesses achieve sustainable, self-regulated use of coastal waters, the program's goals are eliminating the need for costly and onerous regulation of boating citizens, enhancing the boating experience, and reversing the decline in quality of coastal waters. The program focuses on anchorage and waterway management, operating under the aegis of formalized agreements with the Florida Department of Environmental Protection.

Detailed resource inventories, scientific and technical investigations, and extension education publications (maps and guide materials) are some of the results of this ongoing effort. Copies of these materials can be examined at or obtained from the agencies referred to by number in ( ) below.

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(3) Boaters' Action & Information League, 5835 Wildwood Ave., Sarasota, FL 34231.

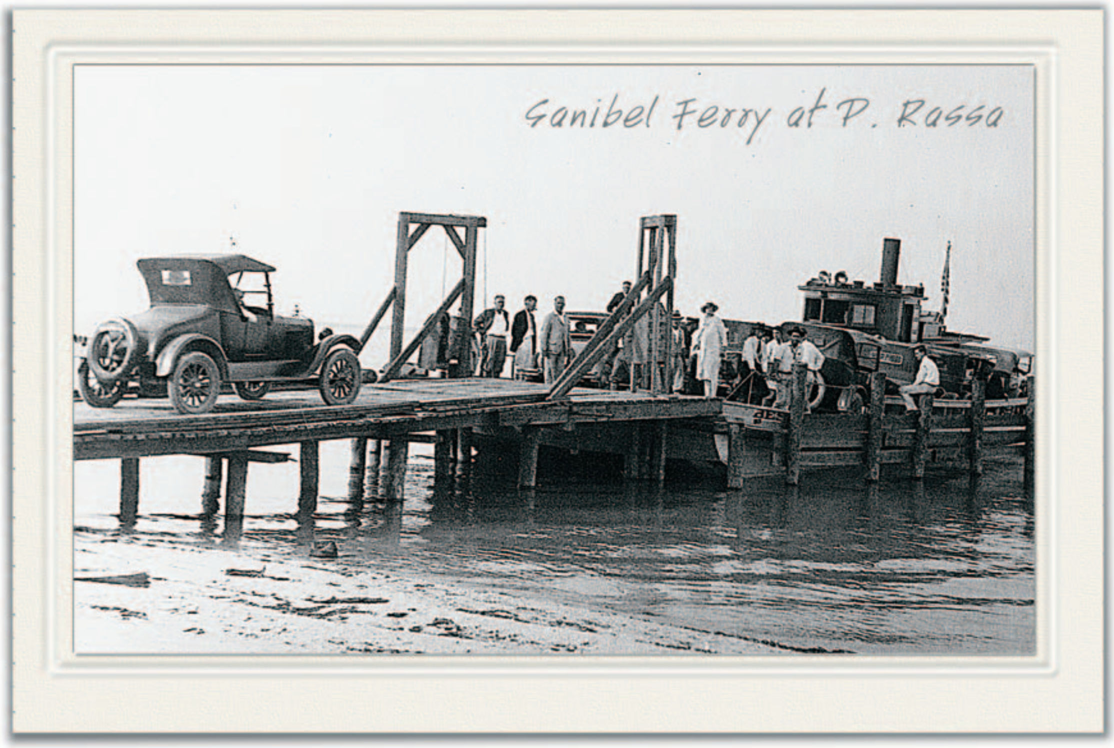
(4) Lee County, Marine Program, Natural Resources Division, P.O. Box 398, Ft. Myers, FL 33902-0398. http://www.lee-county.com/naturalresources/

(5) Charlotte County Planning Dept., 18500 Murdock Circle, Pt. Charlotte, FL 33948-1094.

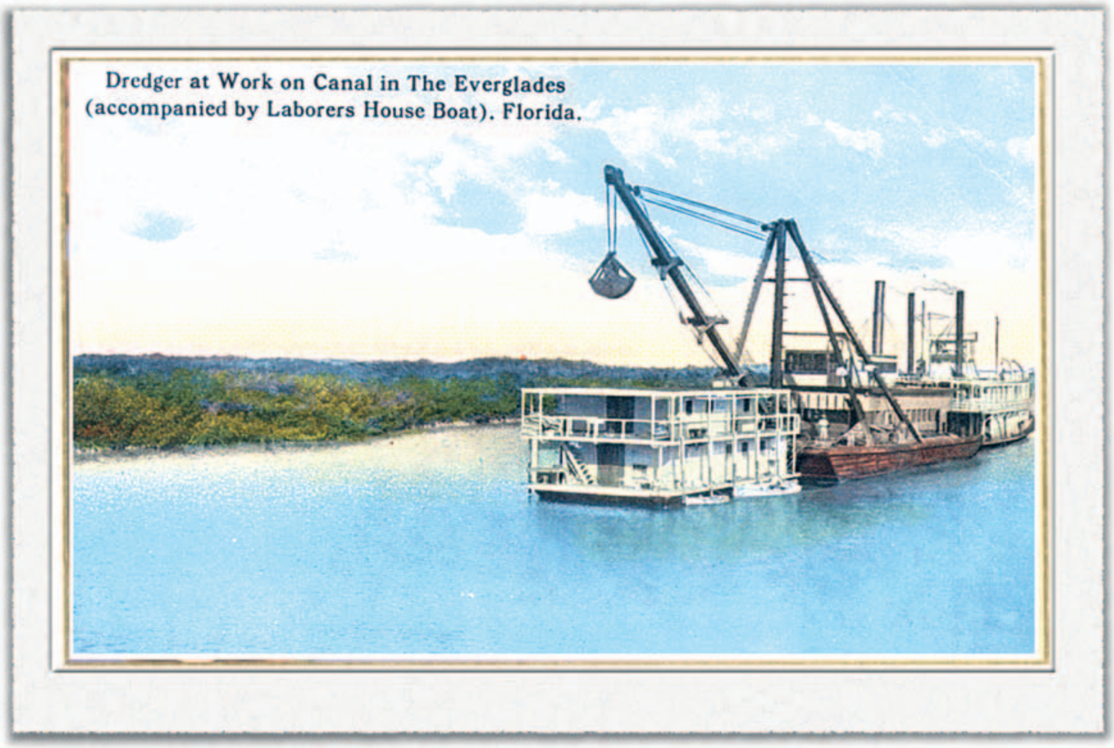
Boca Grande Town.

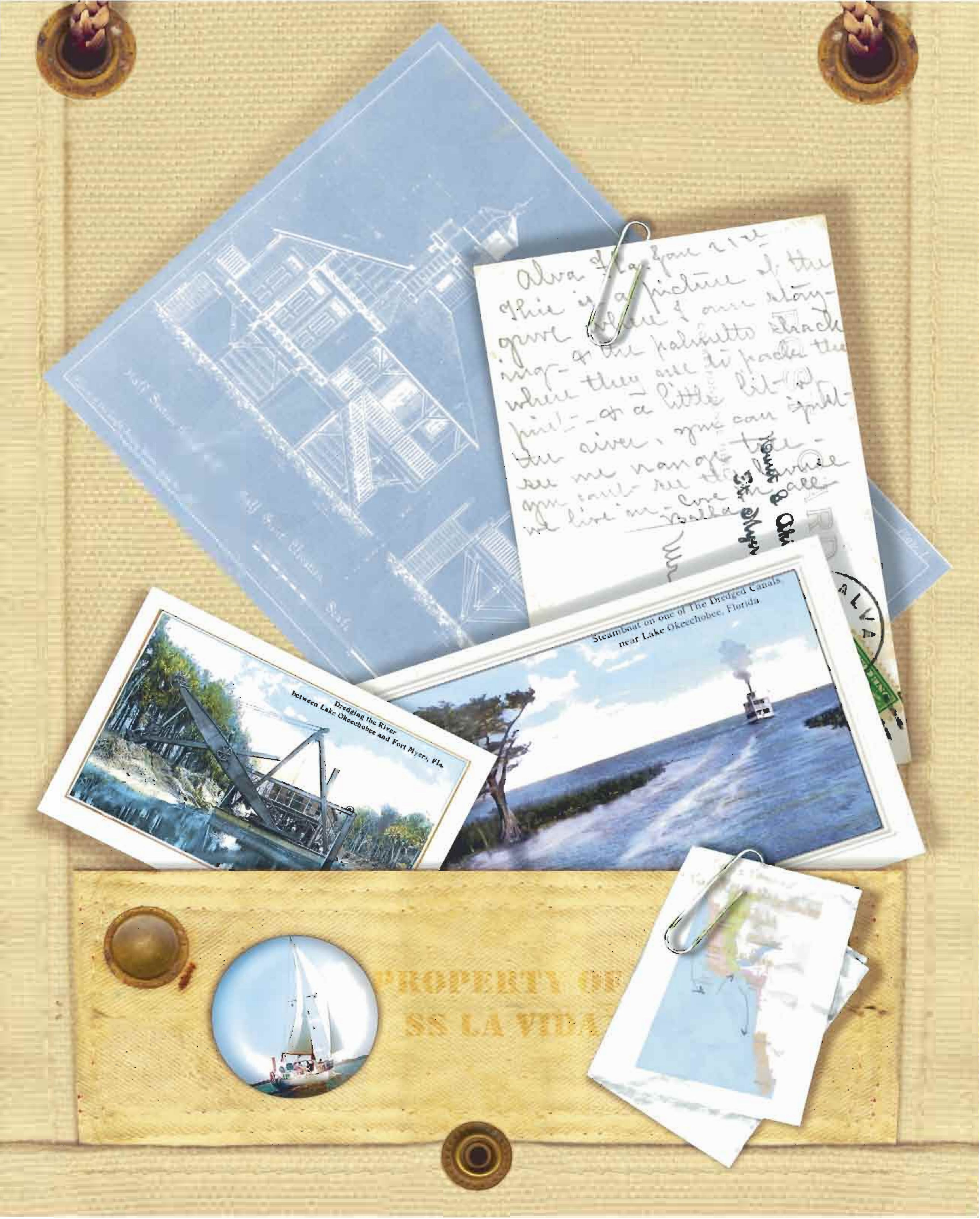

An Orange Packing House, Fort Myers, Fla.


Marco, Florida


Sanibel Ferry at P. Rassa


A THATCHED HOUSE ON THE BANKS OF THE UPPER CALOOSAHATCHEE RIVER, FLA.


Dredger at Work on Canal in The Everglades
(accompanied by Laborers House Boat). Florida.



Dredging the River
between Lake Okeechobee and Fort Myers, Fla.
Steamboat on one of The Dredged Canals
near Lake Okeechobee, Florida
ALVA
PROPERTY OF
SS LA VIDA


Punta Gorda
Lake Okeechobee
Inlets (Passes)
Current (Open)
Historic (Closed) (after Davis and Gibeaut, 1990)
Potential (after Doyle et al., 1984)
Little Gasparilla
Gasparilla
Charlotte Harbor
Boca Grande
Caloosahatchee River
•Finger Canal or Basin
•Multiple Canal System
•Individual Shoreline Canal
•Shoreline Channel Linked to Finger Canal
•Stream or Tidal Creek
•Access Channel
Cape Coral
Captiva
Pine Island Sound
Redfish
Ft. Myers
Blind
Matanzas
Gulf of Mexico
N
W
E
S
Big Carlos
"Unnamed"
New (Little Carlos)
Big Hickory
Estero Bay
Little Hickory
Wiggins
Clam
Doctors
Naples
Gordon
John's
Little Marco
Hurricane
Capri
Big Marco
Marco Island
Caxambas
WCIND
Gulf Intracoastal Waterway
Sea Grant
Florida
SGEB56