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Appraisal Report on Beach Conditions in Florida

U.S. Army Engineer District, Jacksonville Corps of Engineers

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APPRAISAL REPORT
ON
BEACH CONDITIONS IN FLORIDA

ENGINEERING DIVISION
WALTER DRAVN

OFFICE COPY
WALTER DRAVN



U. S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
JANUARY 1965

APPRAISAL REPORT
ON
BEACH CONDITIONS IN FLORIDA

Prepared in cooperation with
the Florida Board of Conservation

U. S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
JANUARY 1965

SUMMARY

This appraisal study and report on beach conditions in Florida are for the purpose of developing a comprehensive and orderly approach to the serious beach erosion problems of Florida. The study and report evaluate the problems in general terms, and establish a suggested sequence of future studies, along with the estimated costs of those studies. Approximations of the costs of possible future projects, and the degree of possible Federal participation in those projects are developed.

APPRAISAL REPORT ON BEACH CONDITIONS IN FLORIDA

TABLE OF CONTENTS

Subject	Paragraph	Page	Subject	Paragraph	Page
I. INTRODUCTION			B. KEY WEST TO APALACHEE BAY		
Authority	1	1	Physical characteristics	68	12
Scope and purpose	2	1	Collier County	70	13
Coordination with other agencies	3	1	Lee County	71	13
II. DESCRIPTION OF SHORES			Charlotte County	72	13
A. FLORIDA-GEORGIA LINE TO KEY WEST			Sarasota County	73	13
Physical characteristics	4	1	Manatee County	74	14
Nassau County	6	2	Pinellas County	75	14
Duval County	8	2	Pasco County		
St. Johns County	11	3	to Apalachee Bay	78	15
Flagler County	14	3	Problem Areas	79	15
Volusia County	15	3	Present and Future Development	80	15
Brevard County	18	4	Collier County	81	16
Indian River County	20	4	Lee County	82	16
St. Lucie County	21	4	Charlotte County	83	16
Martin County	24	4	Sarasota County	84	17
Palm Beach County	27	5	Manatee County	85	17
Broward County	33	6	Pinellas County	86	17
Dade County	38	7	Pasco County	87	17
The Florida Keys			Hernando County	88	17
(Monroe County)	45	8	Citrus County	89	17
Problem areas	49	8	Levy County	90	17
Present and future development	54	9	Dixie County	91	17
Nassau County	55	10	Taylor County	92	18
Duval County	56	10	Jefferson County	93	18
St. Johns County	57	11	C. APALACHEE BAY TO PERDIDO BAY		
Flagler County	58	11	Physical characteristics	94	18
Volusia County	59	11	East of Ochlockonee Bay	95	18
Brevard County	60	11	The coast of Apalachee Bay	96	18
Indian River County	61	11	Ochlockonee Bay—		
St. Lucie County	62	11	Lighthouse Point	97	18
Martin County	63	12	Alligator Point		
Palm Beach County	64	12	to Turkey Point	98	18
Broward County	65	12	Dog Island	99	19
Dade County	66	12	St. George Island	100	19
Monroe County	67	12	St. Vincent Island	101	19
			Indian Peninsula	102	20

TABLE OF CONTENTS (continued)

Subject	Paragraph	Page	Subject	Paragraph	Page
Westward from			Studies authorized but not started	126	28
Money Bayou	103	20	a. Collier County		28
Mainland opposite			b. Lee County		28
St. Joseph Spit	104	20	c. Sarasota County		28
Hurricane Island	106	21	Studies for which authority is		
West of Panama City Beach	107	21	being sought	127	28
Santa Rosa Island	109	22			
Problem Areas	111	22	C. APALACHEE BAY TO		
Present and Future Development	118	24	PERDIDO BAY		28
			IV. IMPROVEMENT COSTS		
III. STATUS OF PROJECTS AND STUDIES			A. FLORIDA-GEORGIA LINE		
A. FLORIDA-GEORGIA LINE TO KEY			TO KEY WEST		28
WEST			B. KEY WEST TO		
Authorized projects	120	25	APALACHEE BAY		29
a. Palm Beach County from Mar-			C. APALACHEE BAY TO		
tin County line to Lake Worth			PERDIDO BAY		29
Inlet and from South Lake					
Worth Inlet to Broward Coun-			V. LITTORAL DRIFT		
ty line		25	A. FLORIDA-GEORGIA LINE		
b. Palm Beach County from Lake			TO KEY WEST		
Worth Inlet to South Lake			General	132	31
Worth Inlet		26	B. KEY WEST TO		
c. Virginia Key and Key Biscayne		26	APALACHEE BAY		31
d. Key West		26	C. APALACHEE BAY TO		
Studies completed or underway	121	26	PERDIDO BAY		31
a. Amelia Island		26	General	134	31
b. Duval County		26	Predominant directions	135	32
c. St. Johns County		27	Annual volume	136	32
d. Brevard County		27			
e. Fort Pierce		27	VI. ESTIMATED STUDY COSTS		
f. Jupiter Island		27	A. FLORIDA-GEORGIA LINE TO		
g. Broward County		27	KEY WEST		
h. Dade County		27	General	137	33
Studies authorized but not started	122	27	Estimates of cost	138	33
Studies for which authority					
is being sought	123	28	B. KEY WEST TO APALACHEE BAY		
			General	139	33
B. KEY WEST TO APALACHEE BAY			Estimated study costs	140	33
Authorized projects	124	28			
Studies completed or underway	125	28			
a. Mullet Key		28			
b. Pinellas County		28			

TABLE OF CONTENTS (continued)

Subject	Paragraph	Page	Title	Figure	Follows page
C. APALACHEE BAY TO PERDIDO BAY	33		Miami to Key West	5	9
VII. SUGGESTED PRIORITY OF FUTURE STUDIES			Yearly sea level, Atlantic Coast	6	5
FLORIDA-GEORGIA LINE TO FLORIDA-ALABAMA LINE			Sanibel Island to Anclote Key	7	13
Basis for priority	142	34	LIST OF TABLES		
Priorities	143	34	Title	Table	Page
VIII. A FEASIBLE SCHEDULE OF FUTURE STUDIES			Population, Florida east coast	1	10
FLORIDA-GEORGIA LINE TO FLORIDA-ALABAMA LINE			Population, Florida gulf coast	2	16
Schedule	144	35	Population statistics for eight coastal counties between Apalachee Bay and Alabama state line	3	25
IX. ROUGH ESTIMATE OF PROJECT COSTS			Improvement costs	4	30
Bases for estimates	145	35	Estimated net littoral drift rate	5	31
Estimates of project costs	146	35	Estimated littoral drift rate and direction	6	31
X. ROUGH ESTIMATE OF FEDERAL PARTICIPATION IN FUTURE PROJECTS			Estimated study costs (Florida-Georgia line to Key West)	7	33
Basis for Federal participation	147	35	Estimated study costs (Key West to Apalachee Bay)	8	33
XI. BASE FOR FINANCIAL SUPPORT OF PROJECTS			Estimated study costs (Apalachee Bay to Perdido Bay)	9	33
Existing conditions	149	36	Suggested priority and schedule of future studies and rough estimate of project costs	10	34
Other States	150	36	Rough estimate of Federal participation in future projects	11	36
XII. ZONING CONSIDERATIONS			LIST OF PLATES (Plates follow text)		
Existing conditions	151	36	Title		Plate
XIII. CONCLUSIONS			Status map		1
Conclusions	152	37	Problem areas		2
FIGURES			Proposed future studies of shorelines		3
Title	Figure	Follows page	LIST OF APPENDIXES		
Florida-Georgia line to St. Johns River	1	2	Title		Appendix
St. Johns River to Titusville	2	5	State participation in local shore protection projects		I
	Figure	Follows figure	Zoning legislation in other areas		II
Titusville to Winter Beach	3	2	Photographic survey of shoreline		III
Vero Beach to Miami Beach	4	3			

U. S. ARMY ENGINEER DISTRICT, JACKSONVILLE
OFFICE OF THE DISTRICT ENGINEER
CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

January 1965

APPRAISAL REPORT ON BEACH CONDITIONS IN FLORIDA

I. INTRODUCTION

1. **Authority.**—This report was prepared in cooperation with the State of Florida, represented by the State Board of Conservation, under authority of section 2 of the River and Harbor Act approved July 3, 1930, as amended and supplemented. The report was initiated by request of the Florida Board of Conservation dated May 6, 1963, for a cooperative report, the cost of which to be shared equally by the State of Florida and the Federal Government. The request was approved August 13, 1963 by the Chief of Engineers.

2. **Scope and purpose.** — The report is an appraisal of beach conditions along the entire State of Florida coastline from the Georgia-Florida line on the Atlantic Ocean to the Alabama-Florida line on the Gulf of Mexico. The report appraises the overall coastal situation on a comprehensive basis. It defines the problem areas, and includes the status of existing Corps of Engineers shore protection projects and studies, and includes the need, cost, and relative priority of future studies for shore protection projects.

3. **Coordination with other agencies.**—Appraisal of the Florida gulf coast west of Jefferson County (Jacksonville-Mobile District boundary) was made by the U. S. Army Engineer District, Mobile. Coordination was maintained with the Florida Board of Conservation and other State agencies, including officials and engineers of the various coastal counties. Reports and publications of the Department of Coastal Engineering of the University of Florida (formerly the Coastal Engineering Laboratory) were used freely.

II. DESCRIPTION OF SHORES

A. FLORIDA-GEORGIA LINE TO KEY WEST

4. **Physical characteristics.**—The east coast of Florida from the Florida-Georgia line to the Florida Keys, a distance of more than 500 miles, consists of a series of sandy barrier islands, broken here and there by inlets. The barrier islands, which are generally backed by a low tidal marsh or lagoon, separate the mainland from the Atlantic Ocean. That type of shoreline is typical of young shorelines of emergence. According to one geological theory, the barrier bar has been built during recent times from material cut from the sea floor by wave action in front of the bar and to a lesser extent by deposition of sand from the southward moving currents. Another theory holds that the bar was formed as an offshore bar during a time of higher sea level and became dry land upon lowering of the sea level with respect to land. The underlying material of practically all the beaches contains a large proportion of a sand and shell mixture of loose or unconsolidated sedimentary form which was deposited during the later stages of emergence. The general effect of the southward movement of sand by shore currents and wave action has been to provide and to maintain the supply of siliceous material generally forming the dunes and beaches, and at places to cover the calcareous materials that were deposited when the area was under water.

5. The beach barrier islands of the east coast vary considerably in length, width, elevations, and development. The ocean beaches of the islands vary from wide and flat beaches to narrow, steep strips fronting seawalls, and from the

hard fine sand at some locations to the soft sands and coquina outcrops on the south Florida beaches. Physical characteristics of the ocean beaches in all the coastal counties within this reach, from north to south, are presented in the following paragraphs. A photographic survey of the entire shoreline of the state is presented in appendix III.

6. **Nassau County.**—The ocean frontage of Nassau County is about 13 miles of sandy beach on Amelia Island; shown on figure 1. Amelia Island is bounded on the north by St. Marys Entrance into Cumberland Sound and on the south by Nassau Sound. St. Marys Entrance is an improved navigation channel with twin stone jetties. The north jetty is about 19,150 feet long with a crest width of 8 feet at the shore and 15 feet at the outer end and a height to mean high water (+5.8)*. The south jetty is 11,200 feet long and rises to mean high water for 7,500 feet out from the shore end and to 5 feet below low water out to the outer end. Nassau Sound is a natural opening about 14,000 feet wide at the seaward edge and 3,500 feet wide at the narrowest point. Depths in the sound vary considerably—from mean low water to 35 feet.

7. From the north end of Amelia Island, the ocean shore curves southward in a slightly concave arc. The maximum width of the island is about 2 miles. The beaches are low and gently sloping, and, due to an almost 6-foot tide range, are very wide at low tide (300-400 feet). At the north end, the beach is backed by a low ridge behind which is a sandy plain. Along the inner edge of this plain are the main shore dunes, 30 to 40 feet high and irregularly shaped. The beach at the south end slopes directly to the main dune ridge which is generally narrow and parallel to the shore. Median diameters of surface sand samples tested in connection with a 1960 study by the Corps of Engineers Savannah District ranged from 0.08 to 0.51 millimeter. Analysis also indicated an average calcium carbonate content of about 16 percent.

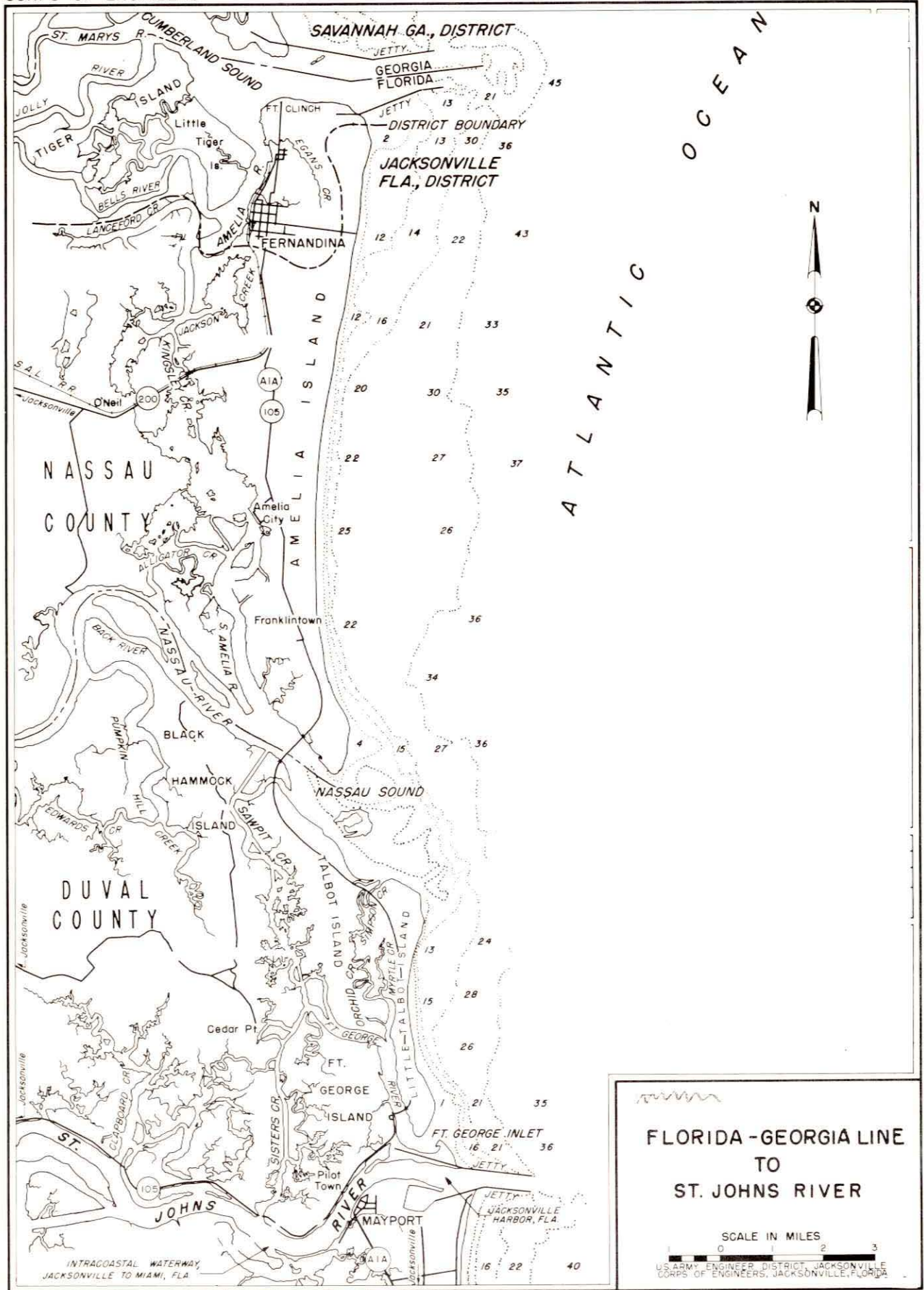
8. **Duval County.**—The ocean frontage of Duval County is about 16 miles. It is bounded on the north by Nassau Sound and interrupted in

the north-south direction by Fort George Inlet and the mouth of St. Johns River. The Duval County ocean frontage is comprised of Little Talbot Island, a small peninsula of Fort George Island, the ocean frontage of the United States Naval Station at Mayport, an unincorporated area south of Mayport and the towns of Atlantic Beach, Neptune Beach, and Jacksonville Beach; see figures 1 and 2. Fort George Inlet is an unimproved natural inlet located immediately north of the mouth of St. Johns River. The hydrography of the inlet, which is characterized by large shoals and breakers, changes continuously. The throat of the inlet is generally about 1,000 feet wide, with depths ranging from 1 to 13 feet. St. Johns River is an improved navigation project with a 42-foot channel depth at the entrance and two parallel rubblestone jetties. The north jetty is 14,300 feet long, and the south jetty is 11,183 feet long.

9. Little Talbot Island, a State Park, occupying about 2,500 acres, is of irregular shape with widths of about 2,000 to 4,000 feet and a length from north to south of about 5 miles. The ocean shoreline is crescent shaped; the point of maximum indentation is near the middle of the island. South of Little Talbot Island is Fort George Inlet and a small peninsula of Fort George Island formed by the north jetty at the mouth of St. Johns River. The beach at Little Talbot Island is low and wide (300-500 feet) and is backed by a series of dune ridges varying in elevation from 10 to over 20 feet. The beach is composed of fine sand with an average median diameter of 0.10 to 0.28 millimeter.

10. The barrier island south of St. Johns River ranges in width from about 3,000 feet to about 13,000 feet and in elevation from about 10 to 30 feet. In the northern part the beach is narrow and flat. The dune line is nearly continuous and the seaward face of the dunes is a nearly vertical scarp. In Atlantic Beach, Neptune Beach and Jacksonville Beach, the beach in front of the nearly continuous seawall is narrow at high tide and at times nonexistent. At low tide the beach is relatively wide and flat. Recent storms have narrowed the beach considerably. The beach is composed of fine, hard sand with a minimum of shell content which, when damp, compacts

*Unless otherwise indicated, all stages and elevations throughout this report refer to mean low water datum.



**FLORIDA - GEORGIA LINE
TO
ST. JOHNS RIVER**

SCALE IN MILES
0 1 2 3

U.S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

FIGURE I

into a hard, smooth surface excellent for motor-ing, especially at low tide.

11. **St. Johns County.**—The ocean frontage of St. Johns County is about 41 miles; see figure 2. For the northern 6 miles, the beach ridge is about 3 miles wide, with dune elevations ranging from 15 to 25 feet. For the next 12 miles the ocean is separated from the mainland by two ridges and two low marshes. The most easterly ridge is 500 to 1,500 feet wide, with a near continuous dune line ranging in elevation from 15 to 44 feet. For the next 7 miles to St. Augustine Inlet, the beach ridge is about 1,000 to 2,000 feet wide with dune elevations at 15 feet. The beach in this part of the county shore (north of St. Augustine Inlet) is relatively wide and is backed by high dunes. St. Augustine Inlet is an im-proved navigation project. The project generally provides for a channel 16 by 200 feet along the best natural alinement across the bar; a groin on the north side 1,880 feet long and a jetty on the south side 3,695 feet long.

12. Conch Island, which lies immediately south of St. Augustine Inlet, is about 3 miles long and 500 to 4,000 feet wide. The entire island is a sand beach and is the present formation of numerous former shoals and islands. Salt Run, a remnant of a former course of the old natural St. Au-gustine Inlet was recently reopened at its south-erly end by natural forces during storms. Anastasia Island, the northern part of which is a State park, varies in width from about 2 miles at the northern end to 1,000 feet at the southern end at Matanzas Inlet. Elevations on Anastasia Island range from 10 to 30 feet. The beach width on Anastasia Island varies considerably; it is low and narrow in some places and wide at others. At St. Augustine Beach there is no beach at high tide, the water coming up to the seawall or face of dune. The beach ridge from Matanzas Inlet to the south county line is very narrow, with elevations ranging from 5 to 10 feet. The beach is low and almost nonexistent due to ero-sion. Matanzas Inlet is an unimproved natural inlet about 1,000 feet wide at its narrowest point. Limited survey data indicate depths in the inlet range from 10 to 16 feet.

13. Average median diameter of beach sand in St. Johns County ranges from 0.08 to 1.90 mil-

limeters. The beaches of St. Johns County con-tain a large quantity of coquina shell. Prominent outcroppings of coquina are found on Anastasia Island (the Anastasia formation).

14. **Flagler County.**—The ocean frontage of Flagler County is about 18 miles. The beach ridge varies in width from a few hundred feet to over a mile. Elevations on the beach ridge range from 5 to 20 feet. The beach in the northern part of the county is relatively narrow (30-50 feet) and steep and includes a very high coquina shell content. Moderate dunes slope uniformly down to the beach. The beaches in the southern part of the county widen and become flatter, and the dune-berm definition is greater. The coquina shell content in the beach decreases rapidly in the southern part of the county, especially at Flagler Beach. See figure 2 for a map of the Flag-ler County coastline.

15. **Volusia County.**—The length of the Volu-sia County ocean front is about 49 miles. The coastline area is generally comprised of Ormond-by-the-Sea, Ormond Beach, Daytona Beach, Wil-bur-by-the-Sea, and New Smyrna Beach; see figure 2. Ponce de Leon Inlet breaks the north-south continuity of the longest wide beach area on the east coast. The inlet is a natural waterway connecting the Atlantic Ocean with Halifax River and Indian River North. A fan-shaped sand bar lies across the ocean entrance. The channel across the bar changes frequently in depth, width, position, and alinement.

16. The beach ridge in Volusia County varies from 3,000 feet to about 300 feet in the extreme south end. The beach ridge is generally com-prised of a series of parallel sand dunes ranging in elevation from 10 to over 20 feet. The beaches of Volusia County are very wide, especially at low tide and are very flat. At Daytona Beach the beach is about 500 feet wide at low tide with a gentle slope and comparatively straight aline-ment. Immediately landward of the beach is the beginning of the dune lines or, in many cases, sea-walls. A considerable part of the Volusia County shore is protected by vertical seawalls. Although the beach is wide, it is low and susceptible to overwash during storm tides.

17. The beach sand in Volusia County for the most part is clean and fine, and under wave ac-

tion packs hard. From the north county line to Ormond Beach the shell particles content of the beach diminishes in volume and the beach is almost pure quartz sand at the latter point. From Ormond Beach through Daytona Beach to Ponce de Leon Inlet, 18 miles, the beach is at times entirely free of shell particles in any noticeable amounts. It is that absence of shell particles and the firmness and gentle slope of the beach sand that make the beaches of Volusia County suitable for motor vehicles.

18. **Brevard County**—The ocean shoreline of Brevard County is about 72 miles. The northerly 32 miles of the county shore, from Canaveral Harbor north, is occupied by agencies involved in the Federal space program. See figures 2 and 3 for a map of the area. The beach ridge in Brevard County varies from the narrowest on the east coast, about 300 feet, to the widest, about 10 miles. Beach and dune characteristics vary considerably along this long coastline. North of Cape Kennedy, dune elevations range from 10 to 15 feet, slightly lower near the north and south ends. The beach is narrow and appears steep. Cape Kennedy is a massive dune formation consisting of numerous ridges of varying elevations generally parallel to each other. The beach in the vicinity is wide.

19. South of Cape Kennedy and Canaveral Harbor the dune line is rather uniform, with elevations ranging from 10 to 15 feet. The seaward face of the dune is rather steep at many places. The beach width is generally under 100 feet, seaward of the toe of dune or seawall. The beach composition in Brevard County contains a high percentage of shell particles.

20. **Indian River County**—The length of ocean shore in Indian River County is about 22 miles. Sebastian Inlet, at the Brevard-Indian River county line, is about 600 feet wide. The beach ridge is very narrow (about 300 feet) and low (elevations 5 to 8 feet) for the northernmost 3 miles. The beach is also narrow and low. Over the middle portion of the county shore the beach ridge is wider and higher. The width varies from 1,500 to 5,000 feet and the dune elevation ranges from 8 to about 15 feet. The beach in this region, near Vero Beach, is very narrow and steep. The seaward face of the dune is steep. Near the south

end the beach ridge is narrow and dune elevations are low. The beach, however, is wider than that at Vero Beach. Figures 3 and 4 contain a map of the area. The beaches of Indian River County have a relatively high shell content.

21. **St. Lucie County**—The length of ocean shore in St. Lucie County is about 22 miles. The beach ridge north of Fort Pierce Inlet, about 6 miles in length, varies in width from 3,000 to 700 feet. Dune elevations vary from 15 feet near the north county line to 10 feet north of Fort Pierce Inlet. The beach immediately north of the inlet is about 200-300 feet wide; however, it is very low. The beach farther north to the county line steepens and narrows considerably. The seaward face of the dune is steep and in places water is up to the vegetation line.

22. Fort Pierce Inlet is an improved deep-draft navigation channel. The channel is 200 to 350 feet wide and 27 feet deep. The inlet is protected by two rubblestone jetties and revetments. The north jetty and revetment is about 3,500 feet long and the south jetty and revetment is about 3,200 feet long.

23. Hutchinson Island extends from Fort Pierce Inlet to St. Lucie Inlet in Martin County. The island varies in width from 200 feet to about 1 mile. The dune line and beach within the northernmost mile are nonexistent due to erosion. The dune line begins to appear at a point one mile south of Fort Pierce Inlet. Dune elevations are low, slightly over 5 feet at the north end and gradually increasing to about 15 feet at the extreme south end. The seaward face of the dune is steep and the beach is low. The beaches of St. Lucie County are composed of sand and fine shell particles. Median diameters of some surface sand samples from the beach at Fort Pierce ranged from 0.07 to 0.85 millimeter.

24. **Martin County**—The ocean shoreline of Martin County is about 21 miles. St. Lucie Inlet, which separates Hutchinson Island from Jupiter Island, is about 7 miles south of the St. Lucie-Martin county line; see figure 4. St. Lucie Inlet is an artificial cut, opening into the Atlantic Ocean through the barrier strip. A stone jetty 3,325 feet long protects the inlet along the north side. The barrier strip between the north county

line and St. Lucie Inlet is narrow and low. The beach is low and has no dune.

25. The barrier ridge at Jupiter Island varies in width from a few hundred feet to nearly a mile. At the north end near St. Lucie Inlet, the ground level is very low. Grass and other vegetation is growing very nearly to the high-water line. Farther to the south the beach is generally straight and the ground elevation rises rapidly. The dunes reach an elevation of 24 feet above mean low water in the southern part of Jupiter Island. The seaward face of the dune is either protected by a seawall (vertical or sloping) or has a near vertical scarp down to the beach. The beach width varies, but is generally narrow. At some places, extreme high water is at or near the vegetation line or seawall; at others, the beach is wide. The north-south alinement and indentation of seawalls cause considerable variations in beach widths.

26. Part of the shore of Jupiter Island is protected to a limited extent by outcroppings of coquina rock. Jupiter Island is underlain by the Anastasia formation, which varies in composition and texture from coarse sandstone composed of consolidated macerated shells to a compact mass of only slightly worn shells. A major outcropping of this coquina rock appears near the south end of Jupiter Island. It also appears in numerous reefs from 1 to 9 feet below mean low water at numerous places along the coast. Coquina is easily weathered and eroded and does not form rocky headlands as do harder rocks. These coquina outcroppings furnish a large volume of shell fragments. Consequently, the beach at Jupiter Island contains a large percentage of shell fragments.

27. **Palm Beach County.**—The ocean shoreline of Palm Beach County is 45 miles. The shoreline is broken by four inlets—Jupiter Inlet, Lake Worth Inlet, South Lake Worth Inlet, and Boca Raton Inlet; see figure 4. The coastal barrier strip from the north county line to Lake Worth Inlet varies in width from about 300 to 7,500 feet and in height up to about 50 feet. Palm Beach Island, which is the barrier strip between Lake Worth Inlet and South Lake Worth Inlet, varies in width from 250 feet to about 3,600 feet and in height up to about 25 feet.

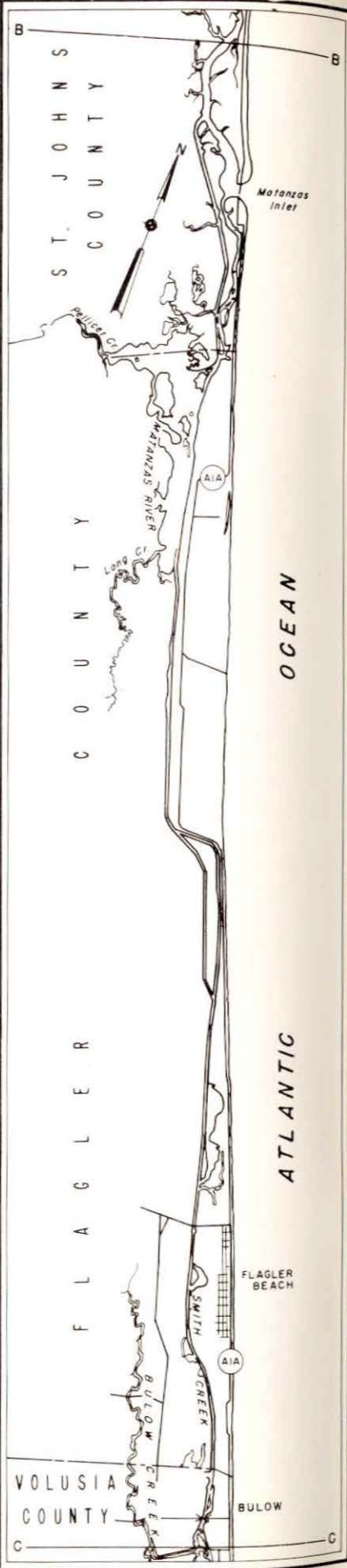
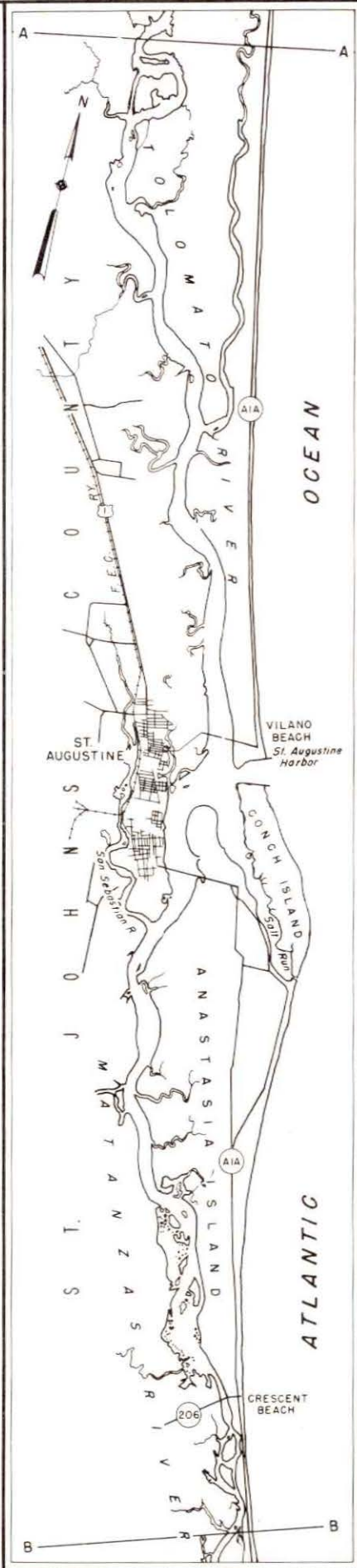
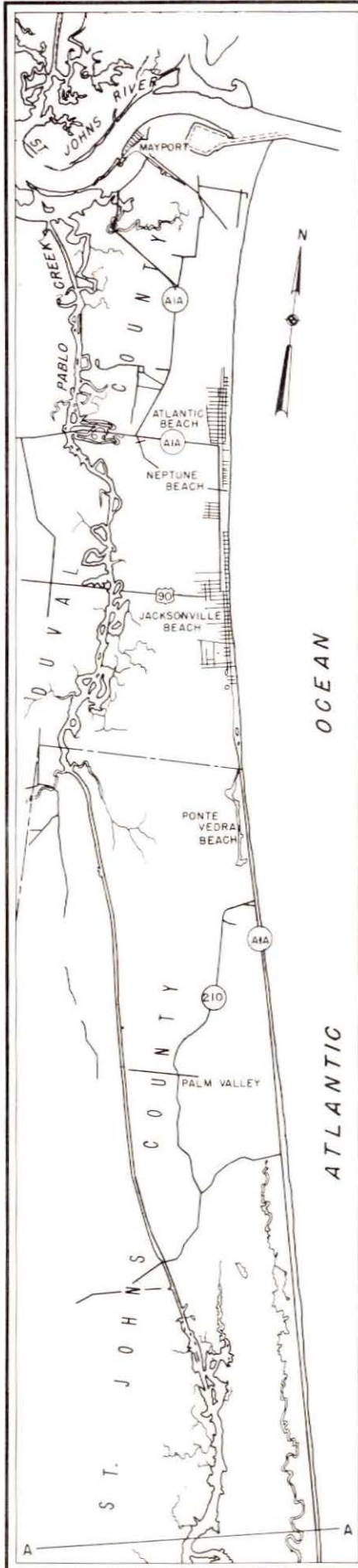
28. Jupiter Inlet, about 2 miles south of the Martin-Palm Beach county line, is a natural opening through the barrier strip. In 1922, a channel was dredged and two rock jetties, about 350 feet apart and 400 feet long, were constructed. The north jetty was extended to a length of 600 feet and the south jetty to a length of 475 feet. Two timber groins were constructed on the north side of the channel and a steel-sheet-pile groin was constructed at the seaward end of the south jetty in 1940. In 1956, a 300-foot concrete-capped steel-sheet-pile jetty was constructed parallel to and about 100 feet north of the original north jetty. Jupiter Inlet has had a long history of opening and closing.

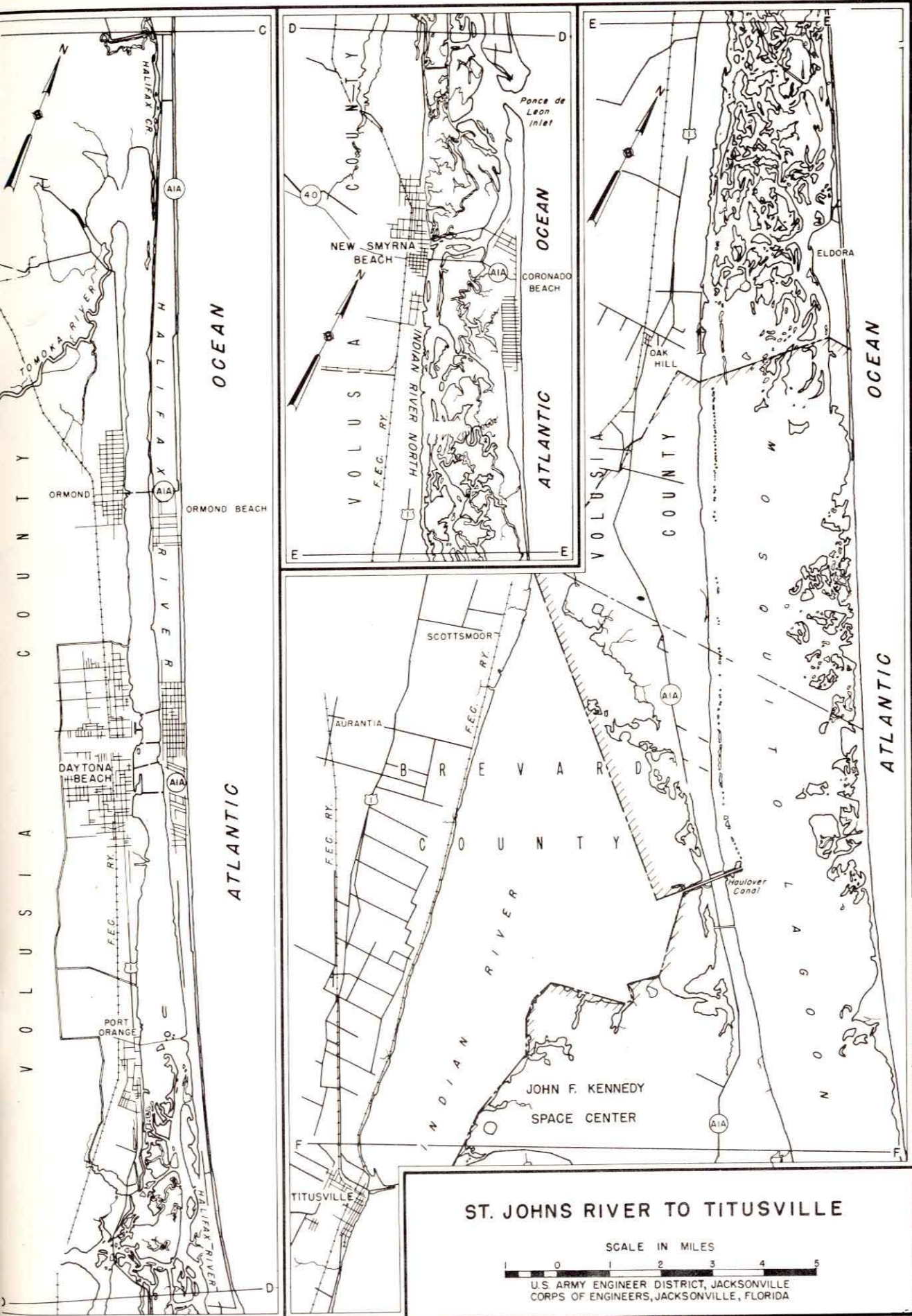
29. Lake Worth Inlet was dredged through the barrier and two jetties were constructed between 1918 and 1925. The inlet is now about 800 feet wide with the sides revetted. The two jetties are concrete capped. The entrance channel, which is part of an authorized navigation project, is 35 feet deep. A sand-transfer plant on the north jetty continuously, conditions permitting, pumps sand from the north side of the inlet to the beaches on the south side.

30. South Lake Worth Inlet was dredged through the barrier in 1927. The channel is protected by two jetties about 310 feet long. The heights of the north and south jetties are 12 feet and 9 feet respectively. A sand-transfer plant was built on the north jetty in 1937 to pump sand across the inlet and thereby nourish the beaches to the south.

31. Boca Raton Inlet, located near the south end of the county, is an improved natural inlet first improved in 1925. The inlet is protected by short, parallel, native-stone jetties 200 feet apart. Usual depths in the inlet are shallow; however, dredging is undertaken by local people from time to time.

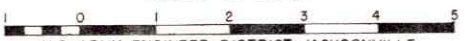
32. The beaches of Palm Beach County vary considerably in physical characteristics. Numerous protective structures and the four inlets have had varying effects on the beaches. The Anastasia formation appearing as rock reefs, usually submerged and paralleling the shoreline, has added a considerable amount of shell fragments to the beach sand. North of Jupiter Inlet, there is a major coquina outcropping. The beach is





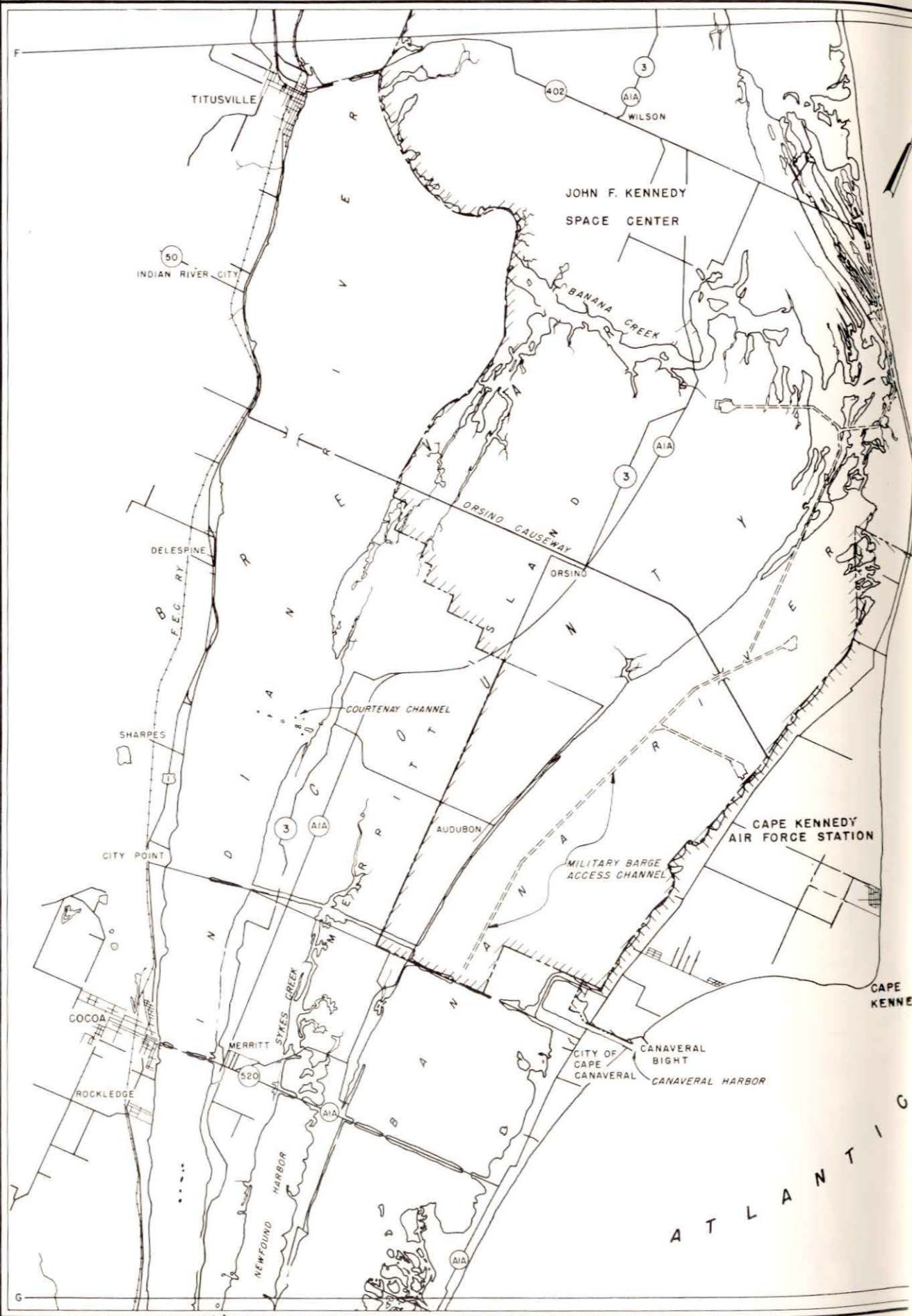
ST. JOHNS RIVER TO TITUSVILLE

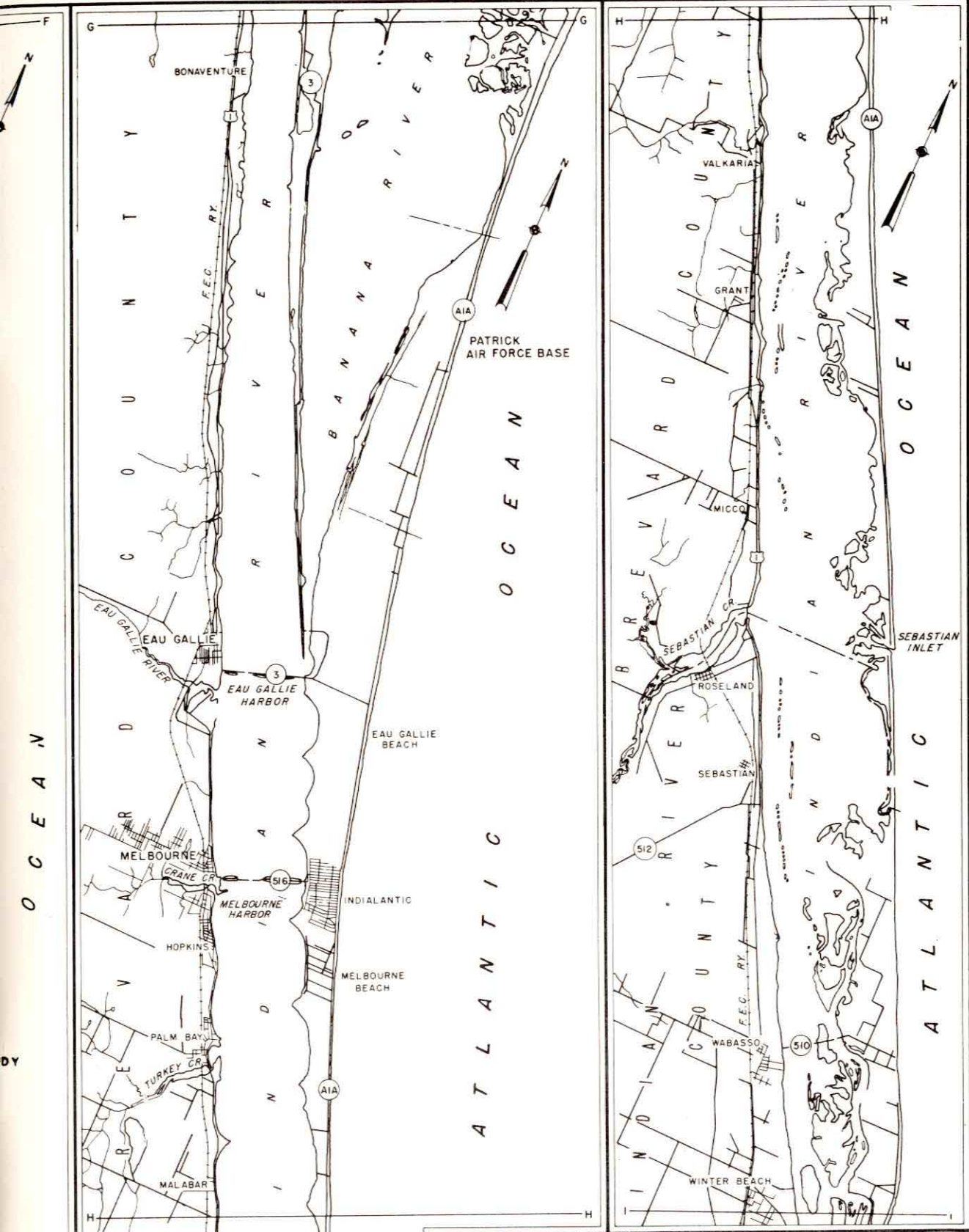
SCALE IN MILES



U. S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

FIGURE 2





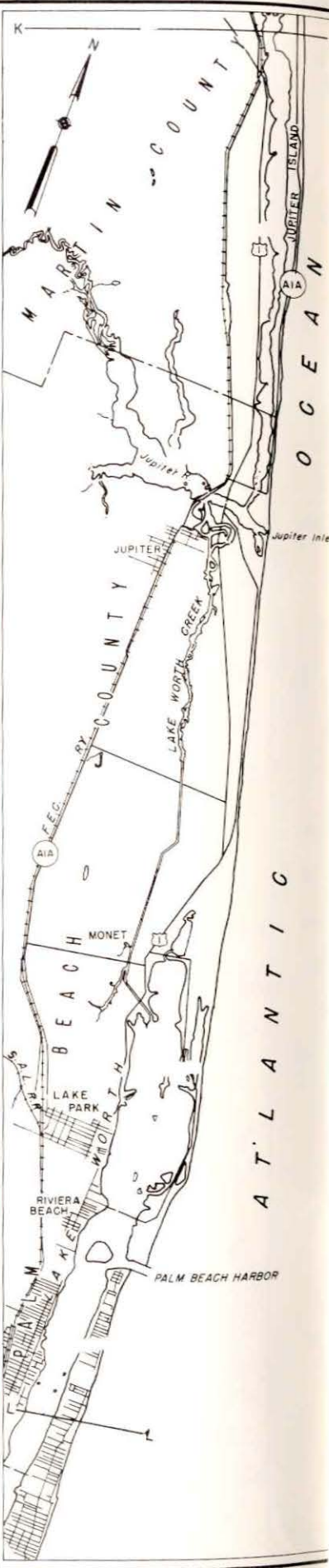
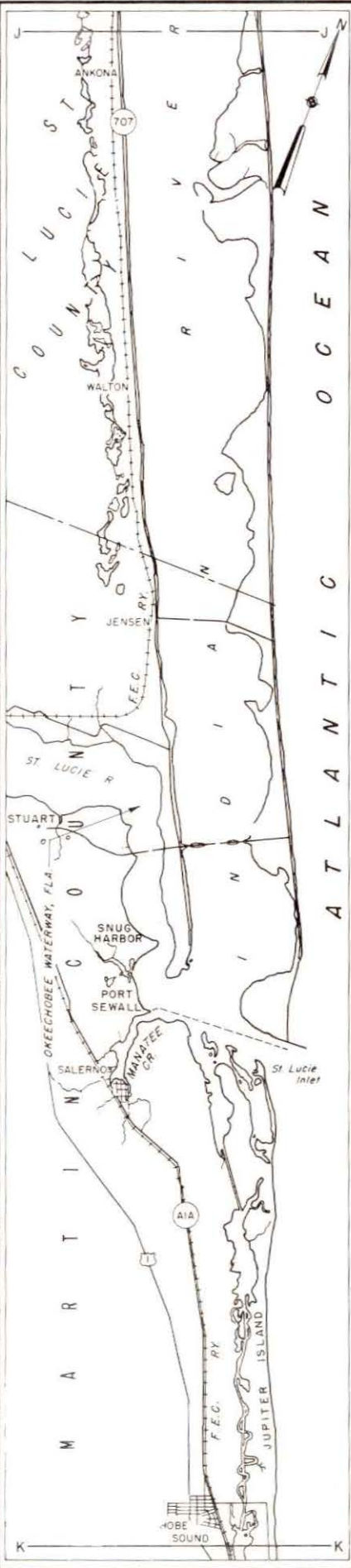
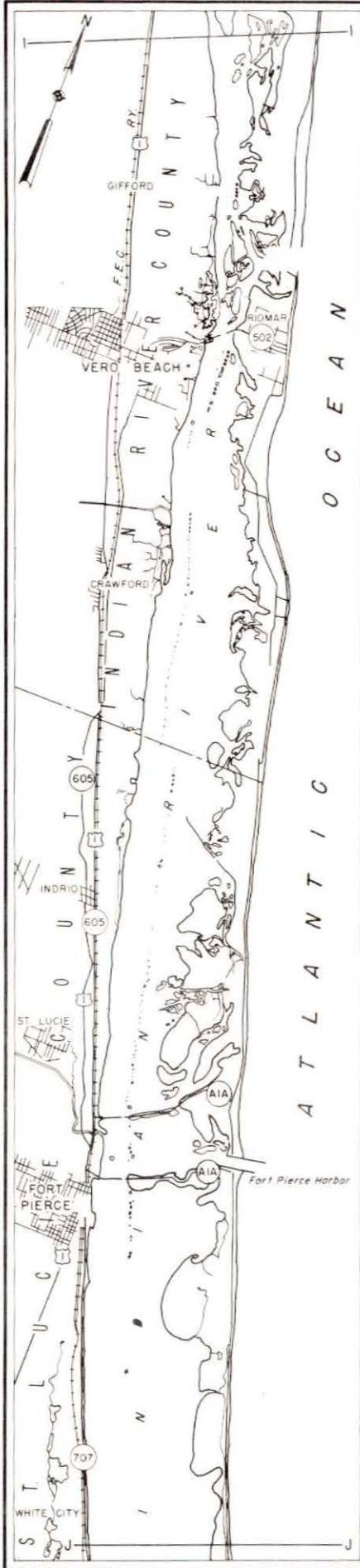
TITUSVILLE TO WINTER BEACH

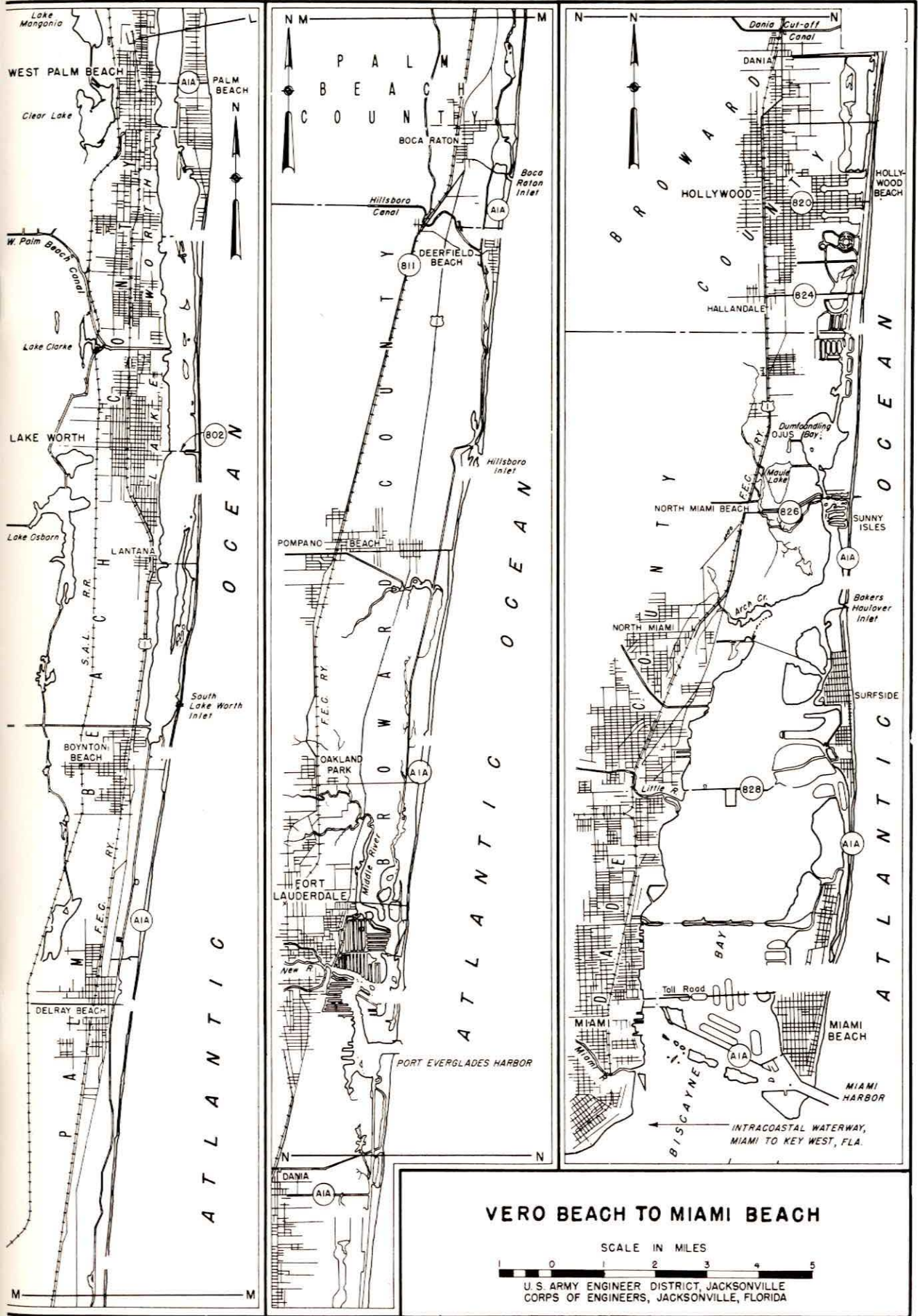
SCALE IN MILES



U. S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

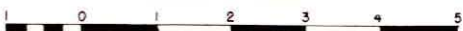
FIGURE 3





VERO BEACH TO MIAMI BEACH

SCALE IN MILES



U. S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

FIGURE 4

low, narrow (about 20 to 70 feet wide) and rather steep with slopes of 1 on 20 or steeper. The seaward face of the dune is also steep. Between Jupiter Inlet and Lake Worth Inlet there are a few coquina outcrops that are generally submerged. The beach width varies from 0 to 200 feet, and the slope is generally flatter than 1 on 20. The seaward face of the dunes are steep. At Palm Beach Island there are less coquina outcrops than at the shores to the north and south. The width of beach is between 0 and 150 feet. There are many protective structures on the shore of Palm Beach Island, including groins and seawalls of timber, steel, or concrete construction in various designs, shapes and elevations. Seawalls on Palm Beach Island are generally higher in elevation than are seawalls on the rest of the county shore. The sand-transfer plant at Lake Worth Inlet partially nourishes the north end of Palm Beach Island. The beaches between South Lake Worth Inlet and Boca Raton Inlet vary in width between 0 and 100 feet at times, and slope generally from 1 on 20 to 1 on 30. The dunes in this reach are relatively high (above 20 feet). The sand-transfer plant at South Lake Worth Inlet partially nourishes about 2 to 3 miles of shore at the north end of the reach. There are numerous groins in the reach. From Boca Raton Inlet to the south county line the dunes are relatively high with a steep face. The beach is lower and flatter than it is to the north, and varies in width from 0 to 100 feet. There are numerous groins in this reach, mostly of the adjustable timber and concrete type. The groins are generally anchored into the face of the dune or seawall.

33. **Broward County.**—The ocean shoreline of Broward County is about 24 miles. The shoreline is crossed by Hillsboro Inlet and Port Everglades Harbor; see figure 4. Hillsboro Inlet is a natural inlet over a rock reef. Part of that reef is exposed and the remainder is submerged and generally parallels the coastline. Port Everglades is a deep-draft navigation harbor with a 40-foot-deep entrance channel. The channel is protected by two rubble-mound stone jetties and two converging submerged breakwaters north and south of the jetties. The coastal barrier strip of Broward County varies in width from about 300 to

4,500 feet. Natural ground elevation is about 15 feet or lower except north of Hillsboro Inlet where it is as high as 23 feet.

34. Deerfield Beach and Hillsboro Beach occupy the ridge north of Hillsboro Inlet. The northern part of Deerfield is protected by a vertical seawall and the beach is nonexistent. South of the seawall a considerable amount of revetment and groins with rubble mounds protect the shore. The beach is narrow and low. The face of the bank is very steep. Hillsboro Beach has no protective structures. The beach is narrow, about 50 feet, and is backed by very steep-faced dunes over 20 feet high.

35. The beaches between Hillsboro Inlet and Port Everglades vary considerably in physical characteristics. At Pompano Beach, immediately south of Hillsboro Inlet, the beach is narrow and steep. There is about 1 mile of seawalls in Pompano Beach and the adjacent area to the south, and the walls are mostly vertical. The beach berm in front of the walls varies from 0 to about 75 feet and is generally low. The beach is generally slightly wider in the area with no seawall and is backed by a low bank with a moderately steep face. There are numerous short, adjustable, concrete and timber groins in the Pompano Beach area. South of Pompano Beach, at Lauderdale-by-the-Sea and Fort Lauderdale, the beach becomes considerably wider and flatter. The beach at Fort Lauderdale, which is within the influence of the Port Everglades jetties, varies in width from about 50 feet to over 300 feet. The beach is very flat and low, with slopes of 1 on 30 and flatter, and elevations under 10 feet. There are generally no dunes behind the beach and the coastal highway is flooded with water and sand during storms.

36. The beaches south of Port Everglades are generally narrow and steep. The entire reach, except for the extreme south end at Hallandale, is devoid of dunes. At the county public beach immediately south of Port Everglades, there is very little beach between high water and the vegetation line except at clearings. Farther south at Dania public beach, the beach is slightly wider and also very low. At Hollywood, the beach width varies from 0 to about 75 feet. It is generally low and ranges in slope from 1 on 20 to

1 on 30. The beach in long continuous reaches is backed by a concrete and asphalt paved walk that is only slightly higher than the beach. There are numerous evenly spaced timber groins in the Hollywood area. Dunes of 10- to 12-foot elevation begin to appear near the south end of the reach.

37. The beaches of Broward County are composed of a mixture of sand and shell in varying proportions. Median diameter of numerous surface sand samples collected throughout the shore-front and offshore zone ranged from 0.24 to 2.4 millimeters.

38. **Dade County.**—The length of ocean shoreline in Dade County is about 21 miles to the south end of Key Biscayne, plus about 14 additional miles comprised of numerous narrow sandy keys. See figures 4 and 5 for a map of the area. From the Broward-Dade county line to Bakers Haulover Inlet the barrier strip varies in width from about 400 feet to about 2,500 feet. Elevations of the strip range from 5 to 15 feet. The topography and areal extent of the barrier strip have been considerably altered by bulk-heading and man-made fill. At Golden Beach the beach varies from 50 to 150 feet in width. The beach slope is about 1 on 20 or steeper. There is a slight dune at about elevation 10. At Sunny Isles the beach between mean high water and the seawalls is narrow; the width generally ranges from 20 to 50 feet. The beach is very steep between the tidal range. Vertical seawalls are almost continuous and there are numerous low, short, timber groins. Highest elevations in the reach are found at Haulover Beach Park, where the dune is at elevation 15. The beach at the park was naturally very narrow and steep. After partial restoration by Dade County, the beach is considerably wider and somewhat flatter. At the north and south ends of the park the beach is 100 to 150 feet wide. At the central portion the beach is 50 to 100 feet wide. The beach slope between mean high water and mean low water is very steep.

39. Bakers Haulover Inlet is an artificial cut across the barrier. The inlet was originally constructed in 1925. A Federal navigation project was recently completed at Bakers Haulover Inlet. The project provided for, among other

things, reconstruction of the existing jetties, protection of inlet shores, and a channel 11 feet deep and 200 feet wide at the entrance.

40. The barrier strip between Bakers Haulover Inlet and Government Cut, occupied by Miami Beach and several other coastal communities, varies in width from 0.2 to 1.5 miles; average width is about 0.5 mile. Elevations of the strip range from about 5 to 10 feet. The higher elevations occur generally along the oceanside; the ground surface slopes downward toward the bay. The average elevation along the oceanside is about 10 feet. The width and elevation of the barrier have been changed materially due to numerous land fills.

41. The shoreline of Miami Beach, Surfside, and Bal Harbour is almost a continuous line of seawalls with abutting groins. There are about 40,000 linear feet of seawall fronting the ocean between Government Cut and Bakers Haulover Inlet, about half of which have little or no beach. Many of the walls have water against them during normal tides, and are subjected to direct wave action at times. The Miami Beach shoreline is very irregular. Some seawalls project seaward as much as 100 feet from adjacent property. Therefore, the beach widths in front of the seawalls vary considerably and range generally from 0 to about 75 feet. The beach is considerably wider at public beaches and parks, due to landward setback of development and facilities. The beach at the extreme south end of Miami Beach is relatively wide due to the accretion fillet of the north jetty at Government Cut. The slope of the beach in front of seawalls, where a dry beach exists, is usually steep—1 on 20 or steeper. Generally speaking, the beach slope in the reach becomes flatter from north to south and the beach becomes lower.

42. Government Cut is the ocean entrance to Miami Harbor. The channel is 30 feet deep and 500 feet wide from the ocean to near the outer end of the north jetty, thence 30 feet deep and 400 feet wide through the entrance cut and across Biscayne Bay. The entrance cut is protected by two parallel rubblestone jetties, 1,000 feet apart and 3,000 and 2,750 feet long, and rubblestone revetment on both sides of the entrance cut.

43. Virginia Key and Key Biscayne are low sandy islands with heavy mangrove growth on parts of them, especially the western side. Average elevation is about 5 feet. The beach on Virginia Key is very narrow, ranging in widths from 20 to 60 feet except at a clearing for a public park and beach. The beach slope from the berm to mean low water is about 1 on 15 or steeper. There are no dunes. The beach on Key Biscayne is very narrow at the north and south ends—about 50 feet or less. However, near the middle of the island at Crandon Park the shoreline projects seaward to form a cape about 2,000 feet long in a north-south direction and 200 feet wide. Opposite that point, is an offshore sand bar approximately 1,000 feet long and about 500 feet from shore. The beach on Key Biscayne is steep and low—berm at elevation 5.

44. The beaches in Dade County are composed generally of fine sand and shell fragments. Average median diameter of numerous surface sand samples collected from throughout the area ranged from 0.13 to 0.84 millimeter.

45. **The Florida Keys (Monroe County).**—The Florida Keys form a reef of rock and sand islands extending from Key Biscayne southward and westward a distance of nearly 200 miles; see figure 5. The islands are connected by extensive and very shallow sand flats, underlain by soft oolitic limestone, whose disintegration furnishes in large measure the sand of which the flats are constituted. The keys are low islands and are generally covered with mangrove growth. A few of the keys also have pine and coconut groves. The average natural ground elevation throughout the keys ranges from 4 to 6 feet. There is a shallow coastal shelf along the seaward side of the keys that is about 5 miles wide.

46. There are very few sandy beaches along the Florida Keys, and no indications that measurable amounts of littoral material enter the area. Most, if not all, of the sand available on the beaches is not due to natural processes or accumulation, but was artificially placed. It is either natural silica sand brought from elsewhere or manufactured sand (crushed lime-rock screenings). At the north end of Key Largo there is about a 300-foot beach 0 to 50 feet wide. At Pennekamp Coral Reef Park, there is a very

small beach about 50 feet long and 30 feet wide. At Tavernier there is a 100-foot beach that is about 20 feet wide. A 200-foot strip of sand 10 feet wide exists on Plantation Key. At Islamorada there is a strip of sand 0 to 50 feet wide and about 100 feet long. A beach 10 to 50 feet wide parallels the highway for about 2,000 feet at Marathon. Bahia Honda State Park on Bahia Honda Key contains a narrow sandy beach 10 to 50 feet wide and about a half mile in length.

47. At Key West all the natural beaches were exposed rock. Some of the rocky beaches have been covered. A Federal beach erosion control project was authorized for the city-owned beach at Key West in 1958. The length of the beach is 6,200 linear feet. The project provides for restoration and nourishment of the beach by placing a beach core of native rock and covering it with a 2-foot-thick blanket of suitable material. The beach was to be 100 feet wide at elevation 4 with an approximate slope of 1 on 20 seaward. About half of the beach (3,000 feet) has been restored. The restored beach is functioning well and appears to be stable.

48. The Florida Keys contain all the sandy beach within Monroe County. The mainland shore of Monroe County is within the Everglades and is comprised of marshes and swamp.

49. **Problem areas.**—Erosion problem areas on the Florida east coast between the Georgia-Florida line and Key West are numerous. The beaches of Florida are composed generally of fine sand and shell fragments, and, in some locations exposed rock. The sand and shell fragments are easily moved by littoral currents and by wave action. The rock outcrops somewhat alter the effect of shore processes. Littoral drift is predominantly southward.

50. The east coast of Florida is in a zone subjected to tropical storms of hurricane intensity. The east coast is also subjected to relatively frequent coastal storms from the northeast (extra-tropical). Both hurricanes and northeast storms have caused great damage and erosion to beaches and ocean-front property along practically the entire east coast of Florida. On an eroding beach, the material is carried away by wave action, tidal currents, or littoral currents. Because of the configuration and bearing of the

shoreline on the east coast, ocean waves and swells approaching from the north and northeast cause a southerly movement of material; waves and swells from the south and southeast cause a northerly movement. Waves and swells from the east approach the coast normal to the shoreline and probably create very little north-south movement. The result of the severity and intensity of waves from the north and northeast is noticeable throughout the east coast. The southeast coast of Florida is afforded some protection from severe northeast waves by the Bahama Banks.

51. The behavior of the shore is directly influenced by all the inlets along the east coast, whether improved or unimproved. Erosion problem areas are usually concentrated and more severe on the downdrift (south) side of the inlets. The inlets generally constitute littoral barriers in varying degrees of effectiveness in intercepting the southerly drifting sand along the east coast beaches. The effectiveness of an inlet as a littoral barrier depends upon its stability and migration, upon the inlet channel depth and current velocity, upon the offshore bar, and if protected by jetties, upon the length, height, and impermeability of the jetties.

52. Another important factor on the erosion situation of the Florida east coast is the level of the sea. Figure 6 shows the changes in sea level along the Atlantic coast with respect to the land. From this evidence alone it cannot be concluded whether the sea is rising or the land is lowering, and so far as the effect on the beaches is concerned, there is no difference. Indications are that the sea level along the Atlantic Coast in general has been rising at the rate of 0.011 foot per year. Changes in sea level have great ramifications in flat coastal regions. An increase in the level of the ocean along the flat beaches of the Florida east coast, though very small vertically, would move the shoreline landward a noticeable distance due to the flat beach slope. Changes in the position of the mean-high-water shoreline, besides having effects on the erosion

situation, are of considerable importance in this State. In Florida, title to riparian property extends to the mean or ordinary high-water line. The beaches seaward of that line are in custody of the State of Florida. The State of Florida and the Federal Government, represented by the Coast and Geodetic Survey, are making a concerted effort to better define, clarify, or physically establish the mean-high-water shoreline throughout the state.

53. The erosion problem areas along the east coast are shown on Plate 2. It may be noted that at least one problem area exists in each of the coastal counties on the east coast. The problem in those areas includes some or all of the following: Severe shoreline and dune recession, loss of recreation beaches and upland property, damage to or destruction of seawalls and other structures, and damage to development and facilities.

54. **Present and future development.**—At the present time development is most heavily concentrated in three areas—Duval County, Volusia-Brevard Counties, and Palm Beach-Broward-Dade Counties. Population forecasts indicate that those general areas will continue to represent the most highly developed areas of the east coast during the foreseeable future. Projections indicate that in 50 years the lower east coast will have a population of from 6 to 8 million persons, while the other two complexes will each be approaching the 1-million mark. Other populous areas would be Indian River, St. Lucie, and Martin Counties. Table 1 below shows the population by counties and their principal cities from 1920 through 1960, and includes a projected figure for the year 2010. The projected figure is based on a graphical extrapolation of actual population growth through 1960 and does not integrate all the economic, physiographic, sociologic, and technological parameters required for first-order population forecasts. Such forecasts are considered to be beyond the scope of this study. Discussion of the individual counties is presented in more detail in the following paragraphs.



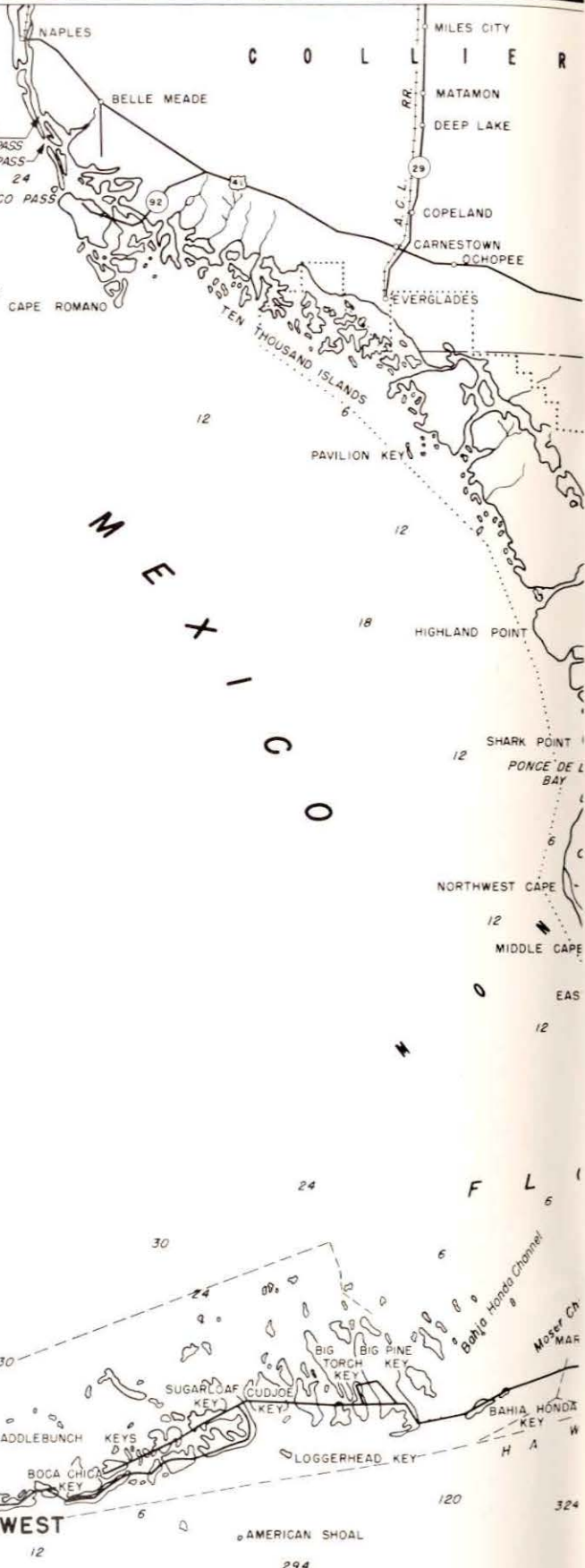
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CHANNEL FROM NAPLES
TO GORDON PASS AND BIG MARCO PASS
GORDON PASS
BIG MARCO PASS

MILES CITY
MATAMON
DEEP LAKE

COPELAND
CARNESTOWN
OCHOPEE

EVERGLADES

HIGHLAND POINT

SHARK POINT
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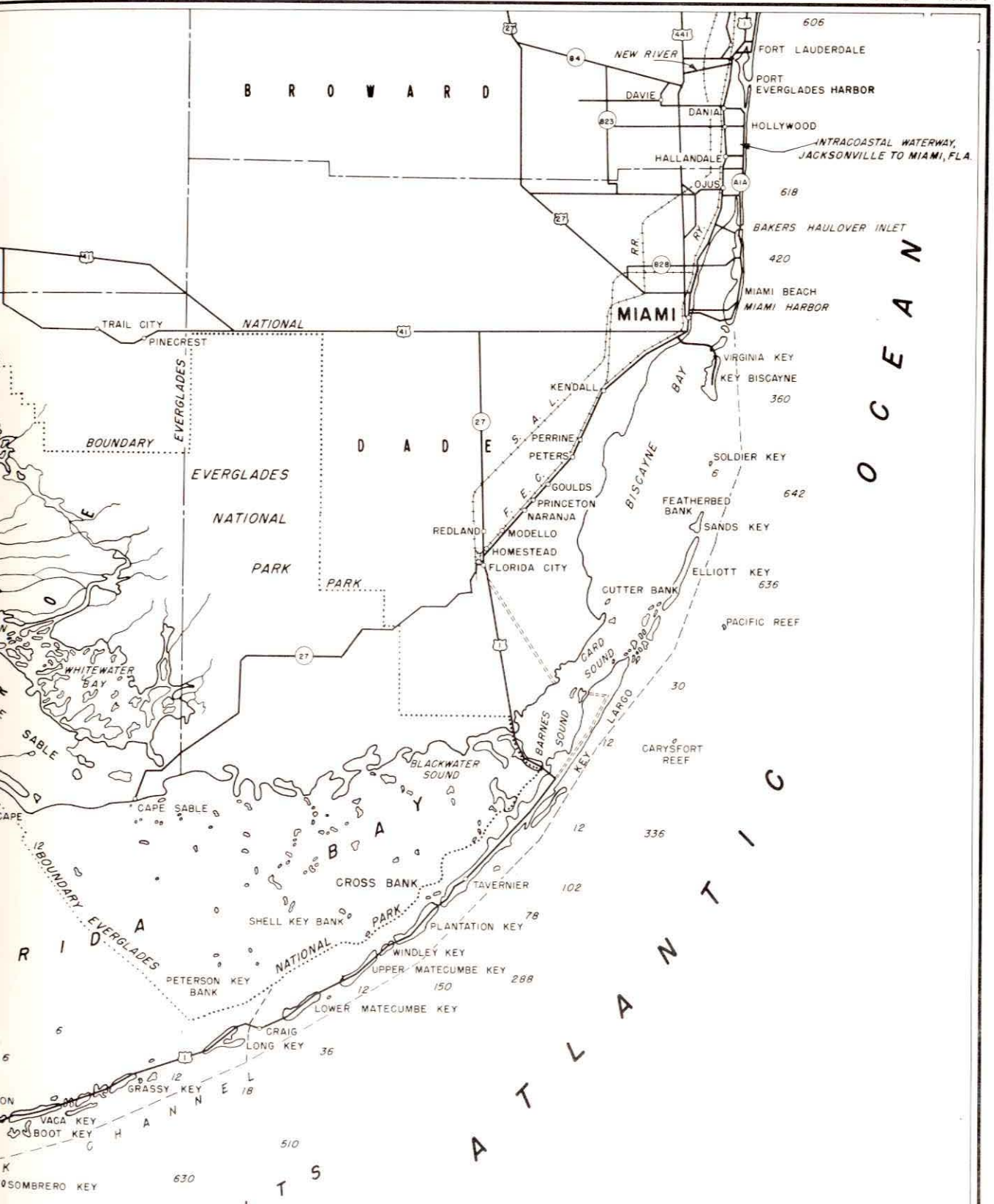
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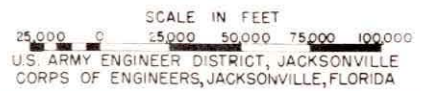
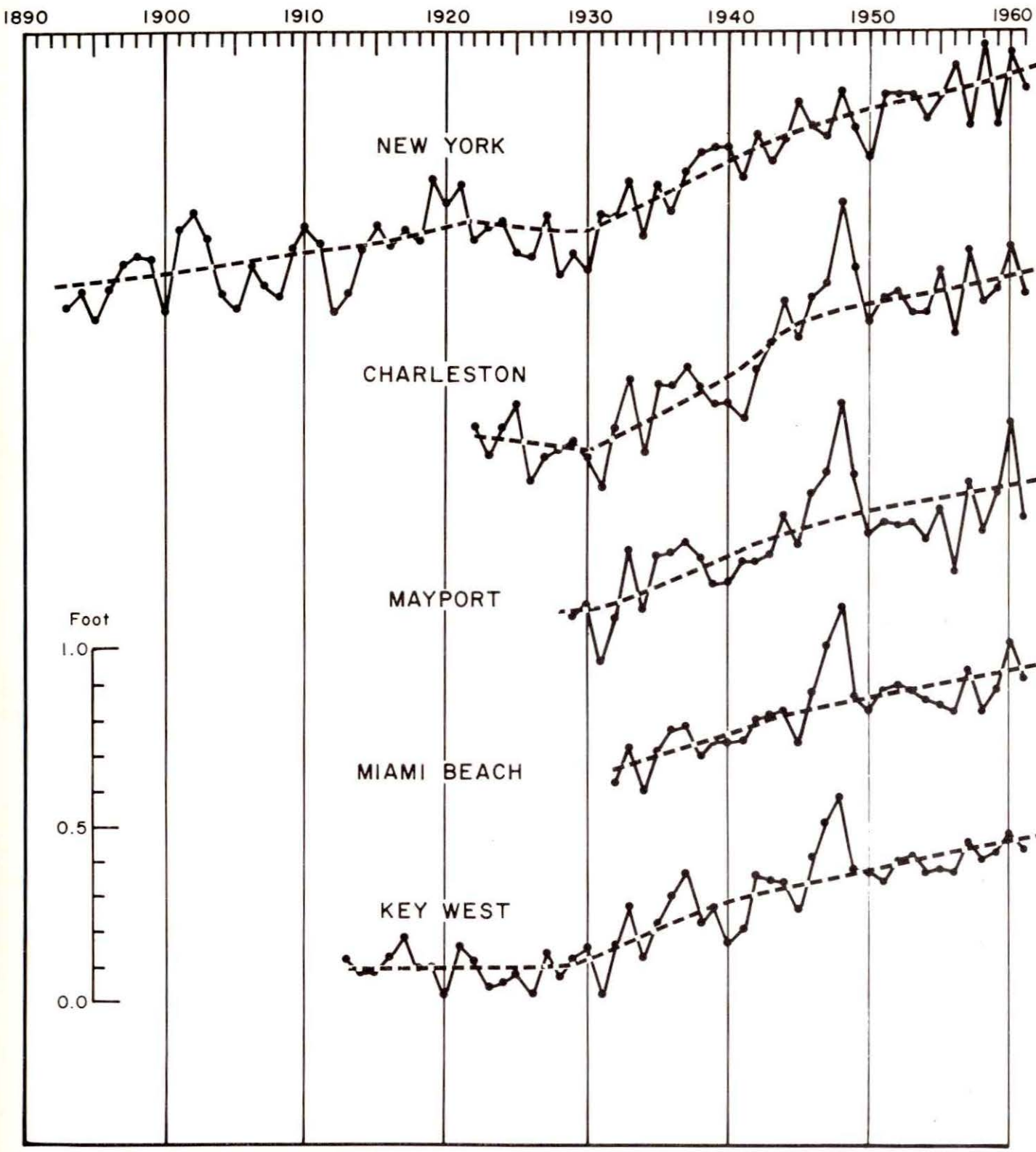


FIGURE 5



YEARLY SEA LEVEL, ATLANTIC COAST

Data to 1950 obtained from article entitled "Changes in Sea Level Determined From Tide Observations" by H. A. Marmer, Proceedings of Second Conference on Coastal Engineering, Houston, Texas 1951; Data from 1951 to 1961, incl, furnished by U. S. Coast and Geodetic Survey.

TABLE 1
Population, Florida east coast
(Nassau-Monroe Counties)

County (1)	Population (1,000's)					
	1920	1930	1940	1950	1960	2010
Nassau	11.3	9.4	10.8	12.8	17.2	50.0
(Fernandina Beach)	3.1	3.0	3.5	4.4	7.3	
Duval	113.5	155.5	210.1	304.0	442.0	850.0
(Jacksonville)	91.6	129.5	173.1	204.5	201.0	
St. Johns	13.1	18.7	20.0	25.0	30.0	100.0
(St. Augustine)	6.2	12.1	12.1	13.6	14.7	
Flagler	2.4	2.5	3.0	3.4	4.6	40.0
(Bunnell)	0.7	0.7	1.0	1.3	1.9	
Volusia	23.4	42.8	53.7	74.2	125.3	350.0
(Daytona Beach)	0.8	16.6	22.6	30.2	37.4	
Brevard	8.5	13.3	16.1	23.7	111.3	550.0
(Cocoa)	1.4	2.2	3.1	4.2	12.3	
Indian River	Not	6.7	9.0	11.9	25.4	160.0
(Vero Beach)	available	2.3	3.1	4.7	8.8	
St. Lucie	7.9	7.1	11.8	20.2	39.3	200.0
(Fort Pierce)	2.1	4.8	8.0	13.5	25.3	
Martin	Not	5.1	6.3	7.8	16.9	200.0
(Stuart)	available	1.9	2.4	2.9	4.8	
Palm Beach	18.7	51.8	80.0	114.7	228.1	1,100.0
(West Palm Beach)	8.7	26.6	33.7	43.2	56.2	
Broward	5.1	20.1	39.8	83.9	334.0	1,700.0
(Fort Lauderdale)	2.1	8.7	18.0	36.3	83.6	
Dade	42.8	143.0	267.7	495.1	935.0	3,800.0
(Miami)	29.6	110.7	172.2	249.3	291.7	
Monroe	19.6	13.6	14.1	30.0	47.9	150.0
(Key West)	18.8	12.8	12.9	26.4	34.0	

NOTE: (1) Principal city of county is shown in parenthesis.

55. **Nassau County.**—Amelia Island represents the part of the county which fronts on the Atlantic Ocean. The city of Fernandina Beach is near the north end of the island. Fort Clinch State Park occupies the northerly 4,000 feet of shore on Amelia Island. The 1960 population of Fernandina Beach was about 7,300 persons, an increase of 65 percent over the 1950 population. The principal source of income in the area is based on the production of paper and related products. The area has only recently felt the

effects of commercial development of beach facilities with a view to attracting the tourist trade. The beach area is rapidly expanding its accommodations for summer visitors, a trend which is expected to continue in the future.

56. **Duval County.** — Little Talbot Island, north of St. Johns River, is a State park. South of St. Johns River, the shore is occupied by the United States Mayport Naval Station, an unincorporated county area, and the resort municipalities of Atlantic Beach, Neptune Beach, and

Jacksonville Beach. Most of the population of Duval County is represented by metropolitan Jacksonville, which has an industrial base. However, the population along the shore is increasing rapidly, and the 1960 population of about 18,000 persons represented an increase of about 85 percent over the 1950 population. It is expected that the growth along the shore will continue to accelerate in the future.

57. **St. Johns County.** — Shorefront development in St. Johns County is relatively sparse except in the St. Augustine area and, to a lesser degree, in the Ponte Vedra Beach area. Throughout the remainder of the county shorefront the development is limited to one or two rows of buildings along the ocean-front road. St. Augustine and St. Augustine Beach, the most populous areas of the county, are tourist oriented. St. Augustine, as the oldest permanent white settlement in the country, derives its livelihood from year-round tourist trade. St. Augustine Beach is largely dependent on summer tourism; that is, recreational use of the beaches. Winter temperatures discourage swimming during fall and winter seasons. The population of St. Augustine increased by about 8 percent in the decade from 1950 to 1960. However, greater future growth of the entire tributary area is expected to increase the demand for public beaches.

58. **Flagler County.**—Coastal development in the county is largely concentrated at Flagler Beach, which had a 1960 population of 970 persons. The 1950 population of Flagler Beach was 374 persons. In addition, the small town of Marineland, with a permanent population of only 9 persons, represents a significant item of shore development by virtue of the world famous aquarium located there.

59. **Volusia County.**—Development along the county shore is concentrated at the Ormond Beach-Daytona Beach area and at New Smyrna Beach. Between 1950 and 1960 the population of Ormond Beach increased from 3,418 to 8,658, an increase of about 150 percent. In the same period the population of Daytona Beach increased from 30,187 to 37,395, an increase of about 23 percent. New Smyrna Beach increased in population from 5,775 to 8,781, during that decade, an increase of about 52 percent. The coastal communities

normally have a very large tourist trade, but, as in the case of St. Augustine Beach, it is greatest during the warm season of the year. Most of the winter tourists who stop there are en route to south Florida. Future growth of the area will be increased by expansion related to the Cape Kennedy activities.

60. **Brevard County.** — Development in this county since about 1950 has been largely a reflection of the space program located there. By way of example, the county population increased by almost 400 percent between 1950 and 1960. Individual communities along the shore increased by about the same ratio, and new communities came into being. The shore north of Canaveral Harbor is occupied by Federal agencies, and 4 miles of the shore between Cocoa Beach and Melbourne Beach is occupied by Patrick Air Force Base. While some leveling of the extreme growth rate should be expected in the future, a very substantial increase in population will continue.

61. **Indian River County.**—Sebastian, Gifford, and Vero Beach represent the most significant development along the county shore, and Vero Beach, with a 1960 population of 8,849, included about one-fourth of the entire county population. Vero Beach is about the most northerly of the coastal communities which enjoys a healthy year-round tourist season. Many high-class motels are located along the oceanfront. The county more than doubled in population between 1950 and 1960. This growth was influenced to some degree by overflow from Brevard County, but was largely a normal growth induced by the attractive environment. Continued growth is expected.

62. **St. Lucie County.** — Shorefront development in this county is concentrated at Fort Pierce. Fort Pierce, which includes a federally maintained harbor, is largely agriculturally (truck farming) oriented, but is working hard to establish a healthy tourist foundation. Development along the oceanfront has been less intense than at Vero Beach, but is expected to increase when the very severe beach erosion problem there is relieved. The population of Fort Pierce doubled between 1950 and 1960, and is expected to continue to grow at a rapid rate.

63. **Martin County.**—The shorefront of this county contains the south end of Hutchinson Island and most of Jupiter Island. While the population of the county is not great (about 17,000 in 1960) the residential development along parts of the shore of Jupiter Island is of the highest order. The Town of Jupiter Island is an exclusive resort community inhabited in the winter by people from all parts of the country. Because of the nature of the development, future growth will probably be limited. A higher rate of growth is expected for the remaining coastal part of the county.

64. **Palm Beach County.**—This is a fast growing county which includes a wide cross-section of development. Palm Beach Island, in the center of the county, is a winter resort community of the highest class. To the north of the island the development is of a lesser order, but is still typical of a first class tourist environment. South of Palm Beach, the town of Delray Beach and many smaller communities dot the shore. The county population doubled between 1950 and 1960. Continued future growth is expected, and the shore of the county should be solidly developed by the year 2010.

65. **Broward County.**—The shore of Broward County is largely developed at the present time. Principal coastal communities are Deerfield Beach, Pompano Beach, Fort Lauderdale, Hollywood, and Hallandale. The area has developed into a thriving tourist area and includes tourist facilities which are unsurpassed. The population of the county increased about 300 percent between 1950 and 1960. Continued development will consist of replacement and upgrading of some older facilities, and occupation of the few areas not now developed. Complete development of the shore is expected to occur in the relatively near future.

66. **Dade County.**—Development of the county shores north of Key Biscayne can be considered to be complete. Future development would take the form of continuing improvement and replacement. The shore between Government Cut and Bakers Haulover Inlet probably represents the most highly concentrated tourist center in the country. The northerly end of the Florida Keys projects into Dade County. Future new

development along the shore will have to occur there. Large scale planning for such development has been under way for a number of years. It is considered only a matter of time before it takes place.

67. **Monroe County.**—Development here has been historically concentrated at Key West. However, since World War II, development of the chain of keys has been occurring at an accelerated rate. It is expected that the prospects for future development of the county are largely in the keys between Key West and Dade County. By way of example, the population of Key West increased by 30 percent between 1950 and 1960; the population of the entire county increased by 60 percent during the same period.

B. KEY WEST TO APALACHEE BAY

68. **Physical characteristics.**—The entire Gulf of Mexico shore of Florida from Key West north to Apalachee Bay is characteristically a mangrove swamp or marsh, with sandy beach areas occurring from place to place. Most of the gulf shore from the southern tip of the State northward to Anclote Key on the Pinellas-Pasco county line is composed of offshore barrier islands. These offshore barrier islands begin with the Ten Thousand Islands at the south and extend northerly almost continuously for more than 150 miles. The shore is very intricate and scattered mangrove swamps are found, particularly in the southerly part of the region. The offshore barrier islands or keys are separated from the mainland by generally shallow tidal lagoons, and from each other by shallow natural passes. Many of those passes have been improved for navigation purposes. The beaches in this lower region, where they exist, are composed of fine white sand and contain a considerable amount of shell.

69. The gulf coast of Florida from Anclote Key to Apalachee Bay, a distance of some 180 miles, is almost devoid of barrier beaches. Between those points the shore consists entirely of a sinuous strip of low, flat, salt marshes. The water off the coast in this region is very shallow for a considerable distance gulfward. Physical characteristics of the gulf coast counties are presented in the following paragraphs.

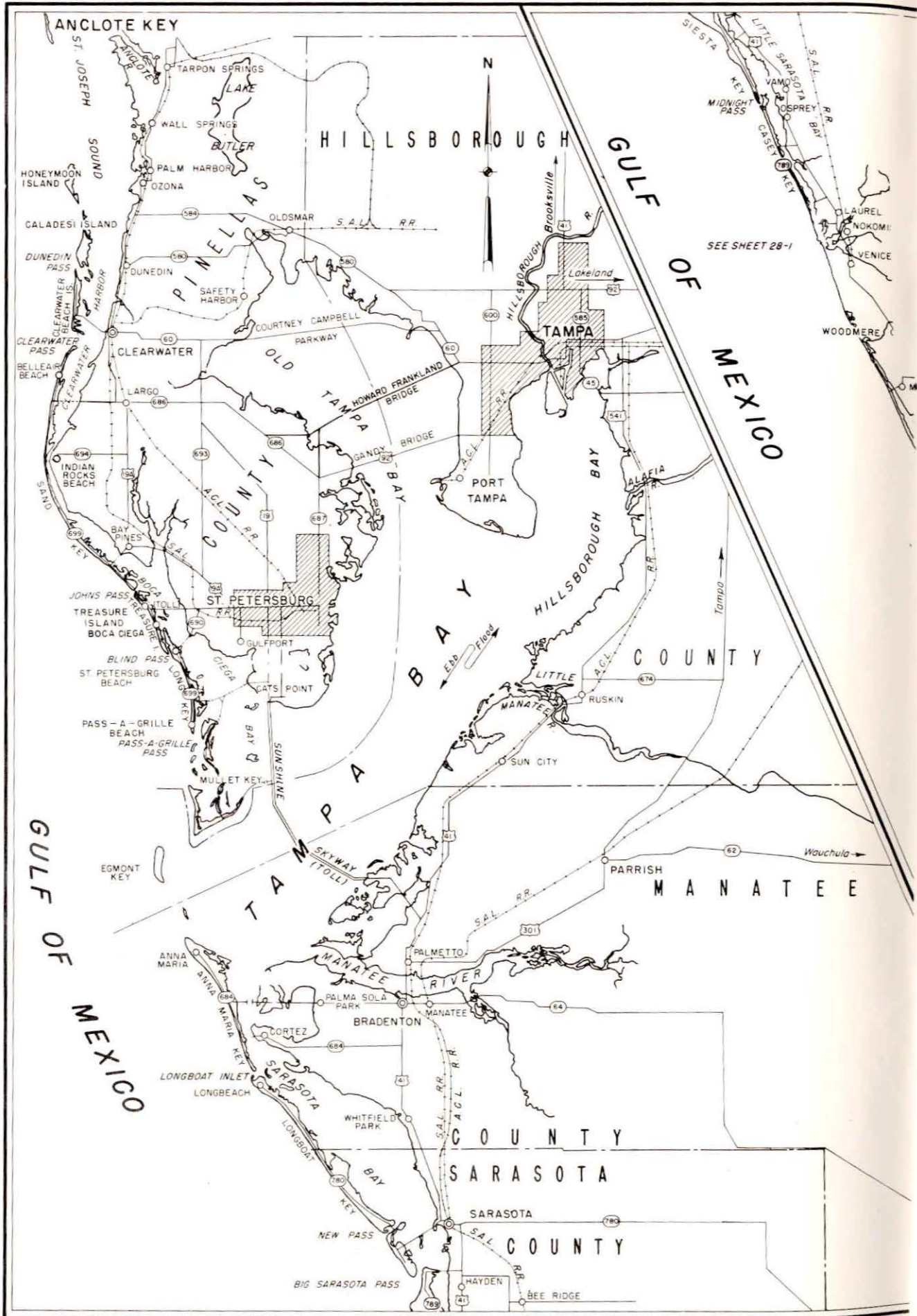
70. **Collier County.** — The total length of shoreline is about 50 miles, of which the northerly 30 miles are constituted of sandy beaches. The remainder, from Cape Romano south, consists of numerous low flat islands covered with mangrove growth. Within the area of sand beaches two principal inlets exist—Big Marco Pass and Gordon Pass. In addition, Hurricane Pass and Little Marco Pass cross the barrier islands between Big Marco and Gordon Passes. Federal navigation projects have been authorized for Gordon Pass and Big Marco Pass. A channel 6 by 70 feet is authorized for the latter and has been provided; a channel 12 by 150 feet is authorized for the former but has not yet been provided. Beaches in the sandy area are 80 to 100 feet wide. Elevations are low, ranging from 3 to 6 feet. In the Naples area there are a number of seawalls and groins; additional structures existed prior to Hurricane Donna in 1960 but were destroyed or so severely damaged that their effectiveness was destroyed.

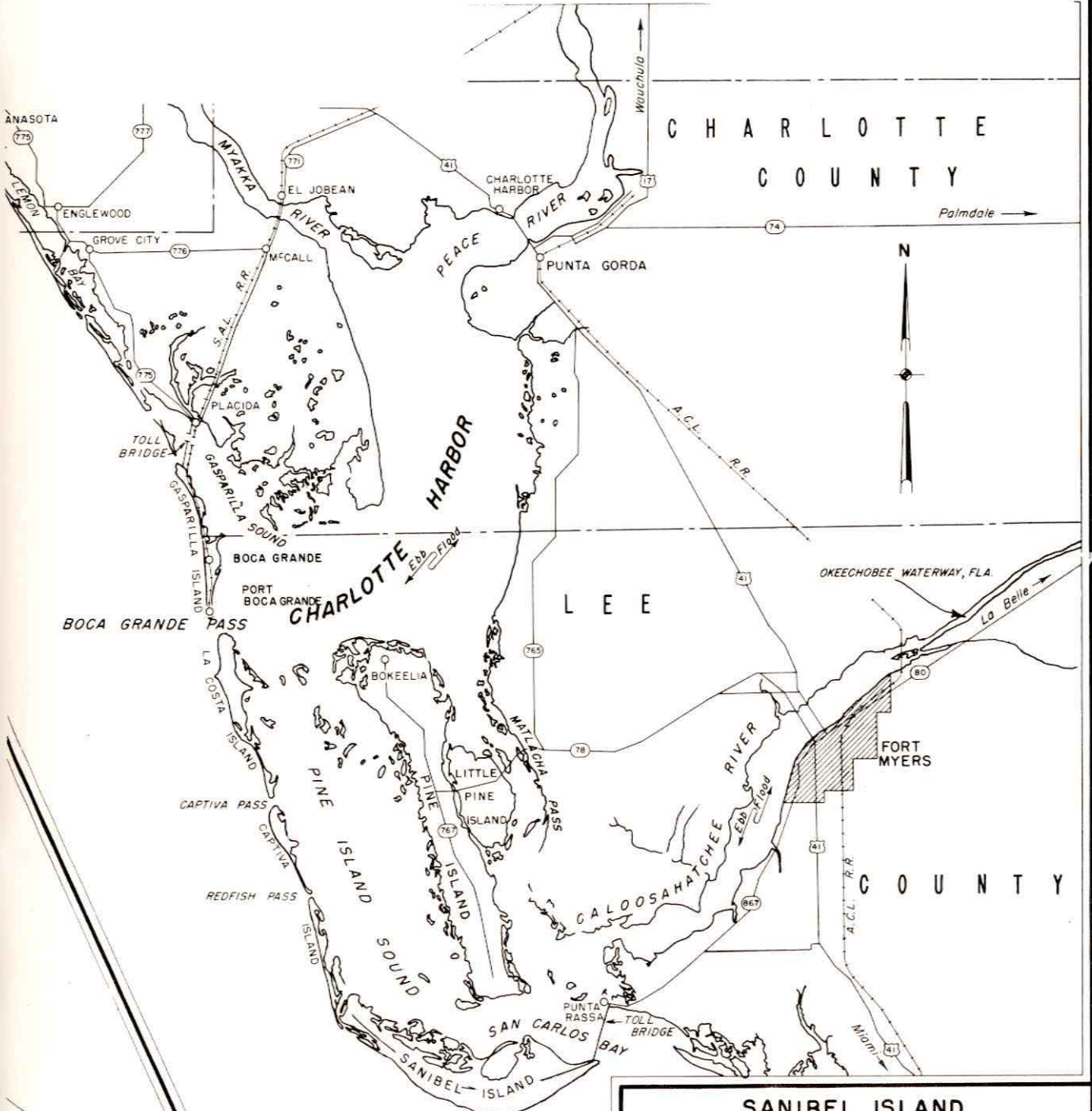
71. **Lee County.**—The total length of shoreline is about 44 miles. In the southern part of the county there are numerous low mangrove covered islands having elevations of about 4 feet. Proceeding northward to Estero Island (Fort Myers Beach), the beaches become characteristically sandy. Estero Island is about 7 miles long and ranges in width from 400 to 3,000 feet. The beach is generally 30 to 50 feet wide at the north end; it is normally somewhat wider at the center and south ends. Beach elevations range from 4 to 6 feet, and inhabitants generally build their residences on extended piling. Sanibel and Captiva Islands (north and south) occupy about the next 22 miles of Lee County shore. The islands range in width from less than 100 feet to about 1.1 miles. Numerous permeable groins have been installed on Captiva Island (south) in an effort to control erosion. Beach elevations are generally 5 to 8 feet. The beaches of Sanibel Island are relatively wide, ranging up to 100 feet. La Costa Island is about 7 miles long and varies in width from a few feet to about 1.2 miles. The beaches are narrow, unstable, and steep. Elevations are about 5-6 feet. La Costa Island is separated from Gasparilla Island by Boca Grande Pass, which is about 2,000 feet wide

and serves as passageway into Charlotte Harbor. The approach channel to the harbor is 32 by 300 feet. The southerly 2.5 miles of Gasparilla Island is in Lee County. Beach elevations are about 5 feet. In the town of Boca Grande there are a number of impermeable groins and a seawall. See figure 7.

72. **Charlotte County.**—The gulf coastline of Charlotte County is about 14 miles long. The barrier islands in Charlotte County range in width from 200 to 2,000 feet. Elevations on the barrier range from 5 to 8 feet, with the average being slightly above 5 feet. At Punta Gorda Beach near the north county line, the beach is about 75 feet wide. Stump Pass, a natural opening in the barrier, is about 2 miles south of Punta Gorda Beach. South of Stump Pass on Don Pedro and Little Gasparilla Islands the beach is very low and somewhat flat. The beach width ranges from 50 to 70 feet. Across Gasparilla Pass, which is a natural shallow opening about 1,200 feet wide, the beach on the north end of Gasparilla Island is very low and only about 50 feet wide. The beaches of Charlotte County are composed of sand and shell fragments.

73. **Sarasota County.** — The total length of shoreline is about 35 miles. The shoreline is made up of a number of sandy barrier islands separated by tidal inlets. The islands vary in width from about 400 feet to about 2 miles. The northern part of Manasota Peninsula occupies the southern 8 miles of the county. Elevations there are 4 to 6 feet. The beach width is 0 to 75 feet. Between Woodmere and Venice Inlet there are no barrier islands, but the shoreline resembles that of the islands. Venice Inlet is a jettied inlet improved for navigation by provision of a channel 9 by 100 feet. The beaches south of the inlet are generally narrow, though the public beach at Venice is sometimes about 100 feet wide. Some seawalls have been provided at Venice. North of Venice Inlet is Casey Key, about 7 miles long. This key is long and narrow, averaging about 400 feet in width, with beaches ranging in width from a few feet to about 100 feet. Some groin systems have been installed on the key. Midnight Pass, small and unimproved, separates Casey Key from Siesta Key, which is about 7 miles long. The beaches at the south end of Siesta Key





SANIBEL ISLAND TO ANCLOTE KEY

SCALE IN MILES

U. S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

FIGURE 7

are wide but low and unstable. The remainder of the key has beaches ranging from 0 to 300 feet in width, but nearly all are low. Some protective structures, seawalls and groins, have been provided. A stabilizing rock outcrop exists at Point O'Rocks. Big Sarasota Pass separates Siesta Key from Lido Key, which is about 2½ miles long. The unimproved pass is wide and deep, and produces eroding currents against the north shore of Siesta Key. Lido Key is somewhat crescent shaped. The beach at the south end is wide and low; some believe that it profits from material eroded from the recessed center part of the key, where the beach is 40 to 60 feet wide and has a berm elevation of about 5 feet. New Pass separates Lido Key from Longboat Key, the southern half of which (4½ miles) is in Sarasota County. New Pass has been improved for navigation, and has a 10- by 150-foot entrance channel and an 8- by 100-foot inner channel. Just north of the pass, Longboat Key beaches are wide (200 feet) and stable. From there north to the county line the beach deteriorates. At the county line the beach is steep and 25 to 50 feet wide.

74. **Manatee County.**—The gulf shore of Manatee County is about 12 miles long and is comprised of Anna Maria Key and the approximate northern half of Longboat Key. Anna Maria Key is immediately south of Tampa Bay. Longboat Pass separates Anna Maria Key from Longboat Key. See figure 7. Anna Maria Key varies in width from 1,200 to 6,000 feet. Natural ground elevations along the gulf coast of the key range from 4 to 8 feet. The beach at the north end of the key is only about 40 to 50 feet wide and is scarped. At the Manatee County public beach, a varying-permeability-type pier-groin has been installed recently. The beach in that area is 60 to 80 feet wide and is relatively flat. South of that area the beach is generally narrow and at places nonexistent. There are numerous seawalls, rock groins, and revetments. The beach immediately north of Longboat Pass is wide and flat. Longboat Pass is about 2,000 feet wide and is of variable depth. There is a large middle ground shoal at the gulf end of the pass. South of the pass the beach has been nearly completely eroded. The beach is either very narrow and steep

or nonexistent. Many vertical seawalls have collapsed. Near the south county line the beach is about 75 to 100 feet wide. The sandy beaches of Manatee County have a very high shell content.

75. **Pinellas County.**—The shore of Pinellas County extends northerly about 39 miles from the main entrance to Tampa Bay to the vicinity of the Anclote Key. The Pinellas County coast consists of numerous keys or barrier islands, running generally northwest-southeast in the southern half, and almost north-south in the northern half of the county. The keys approach nearest to the mainland at Indian Rocks Beach, where the lagoon through the Narrows is only 200 to 300 feet wide. The Narrows connects Boca Ciega Bay on the south with Clearwater Harbor and St. Josephs Sound on the north. See figure 7 for a map of the area. The main keys and intervening passes within Pinellas County, from north to south, are as follows:

Keys	Passes
Honeymoon Island	Hurricane Pass
Caladesi Island	Dunedin Pass
Clearwater Beach	Clearwater Pass
Island	Johns Pass
Sand Key	Blind Pass
Treasure Island	Pass-a-Grille Pass
Long Key	Bunces Pass
Cabbage, Pine, and	Egmont Channel (main
Shell Keys and	entrance to Tampa
adjacent small keys	Bay)
Mullet Key	

76. The above keys and islands are of various lengths, widths, and elevations. The beach on Honeymoon Island is very narrow and steep at the northern half of the island and is backed by a 5-foot scarp. The beach on the southern half is slightly wider—about 50 to 100 feet wide. The northern half of Caladesi Island has no sandy beach, as erosion has cut into the vegetation. The beach near the center of the island is about 50 to 60 feet wide. Both Honeymoon and Caladesi Islands are very low. The beach on Clearwater Beach Island varies from 0 to 200 feet. There are numerous seawalls and groins throughout the island.

77. The beaches on Sand Key vary considerably in width. At the north end, many parts of the shore have little or no beach at all. There are

numerous vertical seawalls in the area. At the center part of the key the beach width varies from 20 to 100 feet. The beach is low and eroding. At the south end of the key the beaches are very narrow, ranging in width from 0 to 50 feet. The beaches in this area are very narrow. The beaches of Treasure Island range from 75 to 200 feet at the northern half and 0 to 50 feet at the southern half. The beaches of Long Key vary in width from 0 to about 200 feet. The beach on Mullet Key is very low and very narrow, averaging about 30 feet.

78. Pasco County to Apalachee Bay. — The shoreline between Pasco County and Apalachee Bay is comprised of salt marshes and mud flats. There are some artificially created beaches in Pasco County, generally about 30 feet wide and very low. There are also some artificial beaches in Hernando County, comprised of crushed rock. There is a very small accumulation of sand in the Cedar Keys area in Levy County. Another natural accumulation of sand is in Dixie County at Shired Island, that has formed a small beach about 40 feet wide. Keaton Beach in Taylor County has an artificially placed beach about 100 feet wide. At Dekle Beach and Jug Island in Taylor County there are some very narrow flat sand and mud beach strips. The above comprise generally all usable beaches in this reach.

79. Problem areas.—The problem areas on the gulf coast of Florida between Key West and

Apalachee Bay are shown on Plate 2. The general shore alinement, the numerous man-made structures and development, the numerous passes and inlets, the storm waves, tides and currents, and the low rate of littoral drift material entering the area have combined to produce the erosion problem areas in the reach.

80. Present and future development.—At the present time development is most heavily concentrated in the Pinellas-Hillsborough Counties area. Population forecasts indicate that those counties will continue to be the most highly developed areas of the gulf coast of peninsular Florida during the foreseeable future. Hillsborough County has no gulf frontage, but its large population provides a significant demand for gulf access and recreation. Projections indicate that the Pinellas-Hillsborough Counties complex will, by 2010, have a population total of about 3 million persons. Other populous areas would be Sarasota, Manatee, and Lee Counties, in that order. Population figures for the coastal counties of this reach are shown in table 2. Values through 1960 are from United States Censuses; the values for the year 2010 are based on graphical extrapolation of the census figures, and, as stated in paragraph 54, do not integrate all the techniques and parameters required for the most accurate population forecasting. The individual counties are discussed in more detail in the following paragraphs.

TABLE 2
Population, Florida gulf coast
(Collier-Jefferson Counties)

County (1)	Population (1,000's)					
	1920	1930	1940	1950	1960	2010
Collier	Not	2.9	5.1	6.5	15.6	120.0
(Naples)	available	0.4	1.3	1.5	4.7	
Lee	9.5	15.0	17.5	23.4	54.5	220.0
(Fort Myers)	3.4	9.1	10.6	13.2	22.5	
Charlotte	Not	4.0	3.7	4.3	12.6	100.0
(Punta Gorda)	available	1.8	1.9	1.9	3.2	
Sarasota	Do.	12.4	16.1	28.8	76.9	400.0
(Sarasota)	2.1	8.4	11.1	18.9	34.1	
Manatee	18.7	22.5	26.1	34.7	69.2	320.0
(Bradenton)	3.9	6.0	7.4	13.6	19.4	
Pinellas	28.3	62.1	91.9	159.3	375.0	1,200.0
(St. Petersburg)	14.3	40.4	60.8	96.7	181.3	
Pasco	8.8	10.6	14.0	20.5	36.8	100.0
(Dade City)	1.3	1.8	2.6	3.8	4.8	
Hernando	4.5	4.9	5.6	6.7	11.2	40.0
(Brooksville)	1.0	1.4	1.6	1.8	3.3	
Citrus	5.2	5.5	5.8	6.1	9.3	30.0
(Inverness)	1.1	1.2	1.1	1.5	1.9	
Levy	9.9	12.5	12.6	10.4	10.4	20.0
(Bronson)	—	0.7	0.8	0.6	0.7	
Dixie	Not	6.4	7.0	3.9	4.5	20.0
(Cross City)	available	1.1	1.9	1.5	1.9	
Taylor	11.2	13.1	11.6	10.4	13.2	30.0
(Perry)	2.0	2.7	2.7	2.8	8.0	
Jefferson	14.5	13.4	12.0	10.4	9.5	15.0
(Monticello)	1.7	1.9	2.0	2.3	2.5	

NOTE: (1) Principal city of county shown in parenthesis.

81. **Collier County.** — Development in this county is concentrated at Everglades and at Naples. In recent years some increased development has taken place at Big Marco Island. Much of the county frontage is virgin territory, and has never been cleared. The population of Naples and of the entire county about tripled during the period 1950-1960. Future development is expected to occur north, and to a more limited degree, south of Naples.

82. **Lee County.** — The population of Lee County is concentrated at Fort Myers and Fort

Myers Beach. However, the barrier islands of Captiva and Sanibel have been recently connected to the mainland and an acceleration of growth there should occur, followed by development of La Costa Island to the north. It is expected that increased development at Bonita Beach will occur in the next decade. The population of Lee County in 1960 was about 230 percent of what it was in 1950.

83. **Charlotte County.**—Coastal development in this county has lagged behind that of its neighbors to the north and south. Punta Gorda,

with a 1960 population of about 3,200, is the largest community in the county. Englewood, with a 1960 population of about 1,000, is the most populous coastal community. It is expected that future growth of the county shore will increase as the shores of Lee County and Sarasota County become more nearly saturated.

84. **Sarasota County.**—Sarasota and Venice are the principal towns of the county. A chain of barrier islands separates most of the mainland from the ocean. The most highly developed of these are Lido Key and Siesta Key. Development of Casey Key and the part of Longboat Key which is in Sarasota County is increasing. Some severe erosion problems have probably retarded development at many locations along the county shore. Relief of those problems would result in accelerated growth throughout most of the county shore. The population of the county increased from about 29,000 in 1950 to about 77,000 in 1960.

85. **Manatee County.**—Anna Maria Island and the northern half of Longboat Key occupy the gulf shore of this county. Principal communities along the shore are the City of Anna Maria, with a 1960 population of 690, and Bradenton Beach, with a 1960 population of 1,124. The county is taking positive measures to control erosion. If those measures are successful it is expected that future growth of the islands would be accelerated, as the county population increased from about 35,000 in 1950 to about 69,000 in 1960.

86. **Pinellas County.**—This is one of the fastest growing counties in the State. The barrier islands of Clearwater Beach, Sand Key, Treasure Island, and Long Key have matched the development of the county, which increased in population from about 160,000 in 1950 to about 375,000 in 1960. Erosion problems exist at many locations, and it is considered that relief of those problems would result in a higher utilization of much of the gulf-shore frontage of the county. The projected population of the county in the year 2010 is 1,200,000 persons, and there should be a great demand for stable shores if that population projection is realized.

87. **Pasco County.**—Shorefront development in this county is sparse except in New Port

Richey area and, to a lesser degree in the Port Richey area. The population of New Port Richey in 1960 was about 135 percent of what it was in 1950. The population along the coastal shorefront is increasing; however, the county population of about 37,000 persons in 1960 represented an increase of about 85 percent over the 1950 population. The population of Dade City (county seat) in 1960 was about 25 per cent of what it was in 1950. It is expected the growth along the shore will continue to grow as the shores of Pinellas County and Hillsborough County become more nearly saturated.

88. **Hernando County.** — The population of Hernando County is concentrated at Brooksville, the county seat. Coastal development has lagged behind that of its neighbor county to the south. The population of Hernando County in 1960 was about 170 percent of what it was in 1950. It is expected that the growth along the shore will continue in the future.

89. **Citrus County.**—The coastal development in this county has lagged behind that of its neighbor to the south. The population of Citrus County increased about 50 percent in the decade from 1950 to 1960. The population of Citrus County is concentrated at Crystal River and Inverness. However, the barrier islands of St. Martins Keys have been recently open to the public for development. It is expected that the future growth of the county will increase as St. Martins Keys develop with completion of the Cross-Florida Barge Canal.

90. **Levy County.**—Shorefront development in this county is concentrated at Cedar Key. Cedar Key is largely a seafood industrial center, but local interests are working hard to establish a tourist trade. Generally, the remainder of county shorefront is undeveloped. The population of Levy County has remained between 10,000 and 13,000 for the past 30 years. However, with the Suwannee River and the Cross-Florida Barge Canal, when completed, offering outdoor recreation, it is expected that growth along the shore will increase in the future.

91. **Dixie County.**—The shorefront development in Dixie County is sparse and probably will remain so until the Intracoastal Waterway is con-

structed. However, the shoreline is being developed and will continue to grow because Shired Island beach, Horseshoe beach and Suwannee and Steinhatchee Rivers provide outdoor recreation such as boating, swimming, and sunbathing.

92. **Taylor County.**—Shorefront development in this county is concentrated at Keaton Beach, Tug Island, Dekle Beach and Adams Beach. Throughout the remainder of the county shorefront is undeveloped. The population of Taylor County increased by about 30 percent in the decade from 1950 to 1960. The beach area is rapidly expanding its accommodations for summer visitors, a trend which is expected to continue in the future.

93. **Jefferson County.**—The shorefront is undeveloped and the future growth of the Jefferson County waterfront will probably remain unchanged because this area is in a National Wildlife Refuge. The population of Jefferson County has decreased by about 10 percent in the decade from 1950 to 1960.

C. APALACHEE BAY TO PERDIDO BAY

94. **Physical characteristics.**—The gulf coast between Apalachee Bay and the Alabama state line, a distance of about 250 miles, is comprised of the eight coastal counties of Wakulla, Franklin, Gulf, Bay, Walton, Okaloosa, Santa Rosa, and Escambia.

95. **East of Ochlockonee Bay,** which indents the western shore of Apalachee Bay, the coast can be generally classified as a tidal marsh with elevations at about mean high water. From Ochlockonee Bay westward to the Alabama state line, the coast is characterized by relatively straight shorelines and wide sandy beaches, backed by dune lines with elevations ranging generally from 10 to 15 feet above mean sea level. Most of the beach material along this reach is medium white sand composed of about 98 percent quartz. The near surface deposits were laid down as marine and estuarine terrace deposits in the late Pleistocene age, probably during the Sangamon and Mid-Wisconsin (Pamlico) interglacial stages. The Pamlico formation is composed almost entirely of sand, though it may include some local bodies of clay and shell. In northwest Florida this formation is about 20 feet thick and is overlain unconformably by "Recent"

deposits of similar composition. The coast is indented by six practically landlocked bays of appreciable size; from east to west these are Apalachicola Bay, St. Joseph Bay, St. Andrew Bay, Choctawhatchee Bay, Pensacola Bay, and Perdido Bay. The state boundary between Alabama and Florida passes through Perdido Bay. About 150 miles of the coastline is composed of a series of barrier sand islands and sandspits which separate the mainland from the Gulf of Mexico. More detailed descriptions of the shores from Apalachee Bay westward to the Alabama state line, including shoreline changes, are given in the following paragraphs.

96. **The coast of Apalachee Bay** east of Ochlockonee Bay is characterized by an irregular shoreline bordered by low, swampy land dissected by numerous tidal streams. Sandy beaches are uncommon and, where present, are generally narrow and poorly developed. A broad, very shallow bank offshore probably renders this reach free of all but the smallest waves. There is a marked absence of signs of erosion, both in the form of the shore and in the composition of the beach. The shape of the coast indicates that the marshy shore is very slowly building out as the tidal marsh spreads.

97. **From Ochlockonee Bay southward to Lighthouse Point** on the extreme southwest shore of Apalachee Bay, the shoreline is fairly regular and is backed by sandy beaches averaging about 50 feet in width. The toe of the dunes averages 5 to 6 feet, m.s.l., in elevation and the crest of the foredunes 8 to 12 feet. The reach is about evenly divided between areas of accretion and areas of erosion, the northern portion of the shore having advanced eastward and the southern portion having receded westward. The amount of both these movements between the earliest and latest surveys of record (1855-60 and 1934-35) is less than 300 feet. A long sandspit extends westward from Lighthouse Point to Alligator Point. During the same period, erosion predominated along most of the southern shore of the spit. Accretion on the western end of the sandspit has resulted in a westward growth and the formation of a narrow sandbar, which is exposed at low tide and almost seals off Alligator Harbor.

98. **Along the mainland from Alligator Point to Turkey Point,** little change in the shoreline is

apparent. West of Turkey Point, a reach of the shore is well protected by a long complex sand-bar which parallels the coast about a mile offshore. The bar is exposed at low tide and a small island occurs at about the midpoint. Formerly, this bar may have been a barrier island but most of the surface is now reduced to below mean sea level.

99. **Dog Island**, the first of the barrier islands, lies south of the mainland opposite Carrabelle and separates the eastern portion of St. George Sound from the Gulf of Mexico. It is about 7 miles long and varies from 600 to 2,500 feet in width. The mean high-water shoreline has receded steadily except at the two ends, where accretion has resulted in elongating the island both eastward and westward. Most of the island is adequately duned, having toe elevations of 5 to 6 feet, m.s.l., and foredune elevations of 8 to 12 feet. In the west central area, the dunes attain elevations of up to 35 feet, m.s.l. Over much of the island, the 45- to 50-foot wide sand beaches are backed by an escarpment cut into the foredunes by wave action. The dune line has been heavily attacked near the west end of the island, where the receding shoreline has left stumps protruding in the breaker zone and along the narrow beach.

100. **St. George Island**, lying west of Dog Island, separates the greater portion of Apalachicola Bay and the western portion of St. George Sound from the Gulf of Mexico. It is 29 miles long and varies in width from about 1,000 feet at its narrowest section to 6,000 feet at Cape St. George. A navigation channel, 10 feet deep and 100 feet wide, has been cut through the island opposite Apalachicola to connect Apalachicola Bay with the Gulf of Mexico. Its 200-foot wide entrance channel from the Gulf is stabilized by twin rubble-mound jetties. The seaward side of most of the island is characterized by a sand ridge 10 to 20 feet in elevation above mean sea level. Back of the sand ridge, elevations vary from mean sea level to about 5 feet above, and the surface is fairly heavily covered by pine trees and scrub palmettos. Accretion during the period from 1855-1935 extended the eastern end of the island for a distance of about one mile. There is evidence, however, of steady erosion over the eastern third of the island, amounting to 300 to

400 feet during the period of record referred to above. The beaches over the greater part of the eastern end of the island are 100 to 125 feet wide. The central portion of the island, opposite the ferry landing to the mainland, has fairly stable beaches, which are about 70 to 80 feet wide and rise to an elevation of about 6 feet, m.s.l., at the toe of the dunes. Westward for 3 miles to the present navigation channel, there are signs of continuous erosion and in some places tree stumps protrude from the beach and in the surf zone. At the time of the 1855-60 survey an inlet existed about 1.5 miles west of the present channel. By the time of the 1934-35 survey this inlet had closed naturally, and although the shoreline was landward from that of 1855-60 survey, it has been classified as advancing because the closure of the inlet created a new shoreline. There is also evidence of steady erosion along the shore for a distance of about 4 miles east of St. George Lighthouse. The southernmost point along Cape St. George has migrated in a southwesterly direction for a distance of approximately 1,600 feet. Along the extreme western portion of St. George Island, which extends in a northwesterly direction from Cape St. George, the mean high-water shore moved seaward from 1855-60 to 1934-35. In 1852, a breach midway of this reach formed an inlet. A shoreline survey in 1902 revealed that this inlet had closed. The relative location of the high-water shorelines of 1902 and 1934-35 in the vicinity of the former inlet indicated erosion, but both these shorelines were gulfward from the 1855-56 shoreline.

101. **St. Vincent Island** is separated from the western end of St. George Island by West Pass, a tidal inlet approximately 2,200 feet wide. The island forms the western boundary of Apalachicola Bay and separates St. Vincent Sound from the Gulf of Mexico. It is roughly triangular in shape, being about 3 miles wide at its eastern end and extending 8 miles westward to a point at Indian Pass. The most significant change in St. Vincent Island between 1856 and 1902 was the formation of a cape or peninsula extending about 3,000 feet into the gulf about 3 miles west of West Pass. Prior to the survey of 1934-35, this peninsula had disappeared entirely. During the period 1856-57 and 1934-35, erosion was active along 2.5 miles of the bay shore along the eastern

end of St. Vincent Island. From this point gulfward through West Pass, and for about 6.2 miles along the gulf shore, accretion advanced the shoreline except for two short reaches where erosion occurred. These exceptions, located at distances of 2.4 miles and 3.5 miles west of West Pass, extended for about 1,800 and 900 feet, respectively. Erosion predominated along the westernmost 9,500 feet of the island, receding the shoreline up to about 100 feet.

102. **Indian Peninsula**, west of Indian Pass, consists of a narrow sandspit extending eastward from the mainland. The shore at the end fronting Indian Pass has eroded, and the mean high-water shoreline moved landward for a distance of about 100 feet during the period from 1855-60 to 1934-35. Accretion predominated along the gulf beaches westward to Money Bayou during the same period. Beaches along the peninsula are 90 to 100 feet wide within 0.5 mile of Indian Pass. The mainland beaches westward to Money Bayou are about 200 feet wide and are backed by dunes with toe elevations of 6 to 7 feet, m.s.l. The dunes are low at the base of Indian Peninsula but reach elevations of 30 feet, m.s.l., eastward.

103. **Westward from Money Bayou** to a point about 2.5 miles east of Cape San Blas on St. Joseph spit, the shoreline moved gulfward as a result of general accretion between 1855-60 and 1934-35. In the 2.5 miles reach east of Cape San Blas, erosion predominated during this period, with the greatest amount occurring prior to 1902. Since 1902 there has been some gulfward movement of the shoreline at the western end; but the 1934-35 shoreline is still landward of the shoreline as it existed in 1868-72. The beaches are about 200 feet wide along this reach and the dune line elevation is 7 to 8 feet, m.s.l., at the toe. At Cape San Blas, St. Joseph spit makes an abrupt turn to the north and extends in that direction for its remaining length of about 15 miles. Erosion is evident over most of this extension. It is interesting to note that even though erosion has predominated both to the east and to the north of Cape San Blas, which is the southernmost point of the spit, the cape itself has grown seaward. The latest aerial photographs of the Cape San Blas area (December 1959) show further extension of the cape to the south and growth of a spit to the east from its southernmost point.

North of the cape, severe erosion has occurred over a distance of approximately 2.5 miles, causing the high-water shoreline to recede about 2,300 feet during the period of record. About midway of this reach elevations between the gulf and St. Joseph Bay are only 3 to 4 feet, m.s.l., and stumps protrude in the breaker zone. Northward to a point about 4 miles from the cape, the shoreline has receded 200 to 300 feet, and northward from that point to a point about 5 miles south of the end of the spit; the shoreline has receded 100 to 200 feet. From that point northward for about 0.5 mile, the shoreline has been stable during the period of record (1868-72 to 1934-35), but north of this reach erosion has occurred again along a 2.5-mile reach. In the northernmost 2 miles of the spit, there has been accretion and a northward growth of the peninsula amounting to about 2,500 feet during the 65 years of record.

104. **On the mainland opposite St. Joseph spit**, a concrete revetment along the shore of St. Joseph Bay northwest of Port St. Joe protects the embankment of U. S. Highway 98 from erosion. Westwardly along the mainland to the base of Crooked Island, the high-water shoreline has advanced gulfward between 200 and 300 feet during the period 1855-60 to 1934-35. Along this reach, the elevation of the toe of the dunes averages about 6 feet above mean sea level and that of the crest of the dunes averages 8 to 12 feet. At Mexico Beach a rock jetty has recently been constructed updrift from the mouth of a small boat channel, which extends inland. The jetty forms a littoral barrier, which has caused some erosion along the beach downdrift of the channel. West of Mexico Beach to the base of Crooked Island accretion has predominated and the high-water shoreline advanced gulfward 200 to 300 feet. Along the easternmost four miles of the island accretion has advanced the high-water shoreline about 1,500 feet. Westward, for the next two miles, Crooked Island has been eroding and the high-water shoreline has moved landward approximately 500 feet. Accretion for the next 1.5 miles has advanced the shoreline gulfward for about 500 feet. The remaining 9,000 feet of Crooked Island has changed considerably between the surveys of 1855-60 and 1934-35. The 1855 survey shows the island continuing to the

west about 1.5 miles offshore. By 1934-35 the western end of the island had migrated landward as much as 4,000 feet and a long slender spit had formed toward the mainland. Since the earliest survey there has been a 9,300-foot recession of the western end of Crooked Island and the entrance to St. Andrew Sound has been reduced to a width of about 500 feet.

105. The area between the western end of Crooked Island and the eastern end of Hurricane Island is unique in that this is probably a nodal zone which is subjected to littoral drift arriving from both the east and the west. Notwithstanding the withdrawal of the western end of Crooked Island to the southeast, it is known that the drift is to the north in the vicinity of St. Joseph spit because of the northward extension of the spit and the drift is continuous to the north and to the west around Crooked Island. On the other hand the extension to the east of Hurricane Island has been continuous over the period of record indicating drift to the east. The reach between these two islands has been one of accretion and gulfward migration of the mean high water shoreline. At the same time small arcuate islands have appeared, disappeared, and reappeared in this reach. The magnitude of the gulfward migration of the shoreline in this reach between 1855-60 and 1945 is of the order of 1,000 feet to 1,500 feet. Immediately to the west is a small area some 4,000 feet in length which has been subjected to erosion and landward migration of the mean high water shoreline.

106. **Hurricane Island**, also called Shell Island, is actually a peninsula extending eastward about 11 miles from the mainland coast at Panama City Beach inclosing St. Andrew Bay. The Federal Government maintains a deep-draft entrance channel from the Gulf of Mexico into St. Andrew Bay at a location about midway of the island. The construction of this waterway was completed in 1934. Channel dimensions are 32 by 300 feet across the island and 34 by 450 feet in the gulf approach channel, which is protected by two jetties, each about 700 feet long. East of the present entrance channel into St. Andrew Bay, the island has been subjected to many changes during the period of record 1855-60 to 1945. The earliest survey showed an inlet about 1,500 feet wide which existed about two miles from the

eastern extremity of the island. The barrier island east of this inlet extended about two miles eastward to about the same location as the present island but the gulf shoreline was about 2,000 feet further gulfward. A survey in 1870 revealed that the inlet had closed. A survey in 1902 revealed that the eastern end of the island had receded to the west and another barrier island had formed. The new island extended about one mile eastward of the former island and was separated from the former island by an inlet about 6,000 feet wide. A survey in 1930 revealed that the main island had extended some 3,000 feet eastward while the barrier island eroded. By 1945 the eastern end of the island had formed its present configuration. Throughout this period of time the western portion of that part of Hurricane Island east of the present jettied channel, has remained relatively stable. From the jetties to Panama City Beach, the shoreline has remained about in the same position except for a small area of accretion near Panama City Beach and some scour adjacent to the west jetty.

107. **West of Panama City Beach**, the shoreline has remained fairly stable for 8 miles. Thence to a point 10 miles east of East Pass, entrance to Choctawhatchee Bay, erosion predominated, with shoreline recession of an average of 100 to 200 feet during the period 1868-72 to 1934-35. The beaches from Panama City Beach to East Pass are on the mainland and are generally high and wide. West of Lake Powell, a cliff 10 to 30 feet high rises behind the beach. From Panama City Beach to Lake Powell the coast is highly developed, and development of the remaining coast westward to Destin at East Pass is progressing at a rapid pace. Along the entire coastal reach between Panama City Beach and Pensacola, two sandbars parallel the beach at distances of about 200 feet and 700 feet, respectively, offshore.

108. East Pass was formerly about 10,000 feet east of its present location. The present pass came into existence in 1928 as a result of a severe storm and high tides, which breached a low, narrow portion of Santa Rosa Island. Between 1871 and 1929 the seaward end of the original pass migrated about 2,500 feet westward before it gradually shoaled and closed completely, some time between 1935 and 1938. A hydrographic survey covering the coast for a distance of 10 miles

on each side of the pass was made in 1962. A comparison of the location of the 1934-35 shoreline with that determined in 1962 reveals that accretion predominated over the entire 20-mile reach, except for a 1.5-mile reach west of the pass, where erosion predominated. The maximum movement of the shoreline as a result of both erosion and accretion was about 300 feet and the average movement was about 200 feet. Both shores of the pass have continually changed shape under the influence of tidal flow through the inlet.

109. **Santa Rosa Island** extends about 49 miles westward along the coast from East Pass to the gulf entrance into Pensacola Bay. It is separated from the mainland by Santa Rosa Sound. The width of the beaches along this island average about 100 to 125 feet. They are backed by dunes generally ranging in height from 8 to 12 feet, except along the western portion of the island, where heights range up to 35 feet. The toe of the dunes averages about 6 feet in elevation. Many of the dunes are not anchored sufficiently by vegetation to prevent migration. As previously stated, accretion predominated along the shore in the 10-mile reach west of East Pass between 1934-35 and 1962. From this point westward to the vicinity of the entrance to Pensacola Bay, the high-water shoreline as determined in 1934-35 had moved landward from its position as determined between 1855-60 and 1868-72 from 100 to 200 feet in the eastern half of the reach and from 300 to 500 feet in the western half. Accretion along the westernmost 2.6 miles of Santa Rosa Island has resulted in the gulfward movement of the shoreline and a westward extension of the island of about 2,500 feet. A physical inspection of the beaches and an examination of aerial photographs made in 1963 indicate that the beaches are at present relatively stable.

110. A barrier peninsula connected to the mainland at about its midpoint extends westward from Pensacola Bay to Perdido Pass. The Alabama-Florida boundary runs through Perdido Bay and crosses the peninsula about 1.5 miles east of Perdido Pass. The beaches along the peninsula vary from 50 to 100 feet in width. Back of the beaches, the toe of the dunes averages about 6 to 10 feet above mean sea level and is generally well anchored by vegetation. West-

ward from Pensacola Pass for about 5 miles erosion has resulted in landward movement of the high-water shoreline. At Pensacola Pass the eastern end of the peninsula has receded about 500 feet while the western end of Santa Rosa Island, which forms the opposite shore, has advanced to the west. The remaining beaches along the 5-mile reach underwent erosion, the shoreline moving landward an average of 300 to 400 feet during the period 1855-60 to 1934-35. During the same period, smaller changes occurred in the next 3 miles of shoreline. The easternmost 4,500 feet remained relatively stable while accretion advanced the shoreline of the next 1,200 feet gulfward for an average of about 100 feet, and erosion along the remaining 9,400 feet receded the shoreline an average of 100 to 200 feet. The next 3 miles of shoreline has remained relatively stable during the same period while accretion along the shore of the next 2.4 miles resulted in the shoreline advancing gulfward for an average of about 100 to 200 feet. At a point about 1.5 miles east of Perdido Pass the barrier peninsula was breached during a hurricane in 1906. The new inlet migrated about 2,500 feet westward before completely closing sometime before 1934. The shoreline developed by the survey in 1867, along the 1.5-mile reach westward to Perdido Pass, compared to that developed in 1962 reveals that over the period, accretion has extended the peninsula westward for about 2,700 feet while the gulf shoreline advanced seaward a maximum of about 300 feet.

111. **Problem areas.**—No major problems resulting from erosion of the beaches along the coast between Apalachee Bay and the Alabama state line are presently known. This is by no means intended to indicate that erosion of the beaches is not occurring. As previously stated, a large portion of the mainland shore is protected from the Gulf of Mexico by offshore sand islands. Many of these islands are unpopulated and undeveloped. Other islands, as well as long reaches of the mainland coast, are only sparsely developed. Erosion is known to be active along some of these shores and along some isolated reaches of the shoreline surrounding the inland bays. However, because of the lack of development, these areas have presented no major problems. It is expected that a more complete utilization

of the sparsely developed shores will give importance to erosion problems which are of little consequence at present.

112. The current problem areas, which have been made known by local interests seeking information on remedial erosion control measures, consist of a short reach of shoreline near Mexico Beach, several locations along Choctawhatchee Bay, a short reach along the northern shore of Santa Rosa Island opposite Fort Walton Beach, and the northern shore of Santa Rosa Peninsula near its western end, in the vicinity of Gulf Breeze.

a. **Mexico Beach.** A small boat channel has been dredged inland by local interests at Mexico Beach. The entrance to this channel is stabilized between creosoted timber and concrete bulkheads with a rock jetty extending seaward from the updrift (west) bulkhead. The jetty forms a littoral barrier which interrupts eastward drift, thereby creating an area of erosion downdrift from the channel. A creosoted timber bulkhead has been constructed along the downdrift shore in an effort to control erosion, but portions of this bulkhead have failed and the embankment behind it is continuing to erode.

b. **Choctawhatchee Bay.** Bank erosion resulting from a combination of wind-generated wave action and surface runoff has created a problem area along two miles of the northern shore of Choctawhatchee Bay in the vicinity of Villa Tasso, a residential subdivision east of the Okaloosa-Walton County line. Residents of the subdivision state that the vertical banks, which average 10 to 12 feet in height, have receded as much as 20 feet during the past 17 years. Bank erosion is also occurring along the southern shore of Choctawhatchee Bay near Destin and along a reach in the vicinity of the Okaloosa-Walton County line. Treated timber groins have been constructed in the latter area as a control measure.

c. **Northern shore of Santa Rosa Island opposite Fort Walton Beach.** Bank erosion is occurring along the northern shore of Santa Rosa Island for a distance of about 1,500 feet east and 10,300 feet west of U. S. Highway 98 bridge over Santa Rosa Sound. A comparison of surveys made by local interests in February 1958 and July 1963 indicates that both erosion and accre-

tion occurred. Although there were accretions varying up to about 40 feet, erosion predominated, with recessions varying up to about 100 feet. Local interests state that currents and wave action resulting from boat traffic, especially from tugs and barges, are causing erosion of the banks in the area. The property is owned by Okaloosa Island Authority, an agency of Okaloosa County, and is leased or will be leased for private use. There is no evidence that this erosion is the result of natural causes.

d. **Northern shore of Santa Rosa Peninsula.** Erosion of the embankment is occurring along the northern shore of Santa Rosa Peninsula adjacent to Pensacola Bay in the vicinity of Gulf Breeze. Local interests state that the rate of erosion has increased in recent years. All of the property along the affected area is privately owned, and many of the owners have constructed bulkheads and groins as a means of protection against further bank erosion. Some of the bulkheads have washed out, and erosion of the embankment in the rear thereof is continuing.

113. The costs of improving the aforementioned problem areas to halt erosion can be estimated roughly from cost experience with improvements at similar areas along the gulf coast. More specific data would be needed, however, to determine conclusively the most economical methods of improvement and to estimate costs more exactly.

114. The most economical solution to the erosion problem at Mexico Beach would most likely involve removal of the littoral barrier previously discussed. Since this structure is privately owned, no cost estimate is made for its removal. The remaining problem areas involve bank erosion within inland bay waters. Solutions to similar erosion problems included the use of rubblestone riprap and the construction of bulkheads. It is estimated that costs for similar improvements would range from \$60 per linear foot of shoreline for riprap revetments to \$100 per foot for bulkheads. All the eroding shores within the limits of the problem areas described heretofore are either privately owned or leased, or available for lease for private use; improvement would therefore result in no appreciable public benefits.

115. The State Road Department has built concrete sheet-pile structures along the embank-

ments of the causeways which cross Apalachicola Bay at Apalachicola and Choctawhatchee Bay near Freeport and similar structures at several other locations along the shoreline where highway embankments might be subject to erosion. Officials of the State Road Department report that, with normal maintenance, these structures successfully control erosion and the Department therefore has no serious embankment erosion problems at present.

116. Records of hurricanes which have affected the northwest Florida coast show that extensive damage to property and loss of life resulted from wind, storm surge, waves, and rainfall; however, specific data on the extent of erosion of the shores and the resulting shoreline changes are lacking. The limited information which is available is outlined in the following paragraph.

117. Available records show that St. George Island was breached by storm tides in August 1837 and October 1852. The 1837 opening was about 1.5 miles west of the present jettied channel, it was called "New Inlet" and was navigable until it shoaled and closed about 1900. The breach in 1852 occurred at a point about two miles east of West Pass, and this opening had also closed by 1902. Severe storms affected the shores of St. Andrew Bay in the vicinity of Panama City in 1856 and 1864. In 1856 the bluffs bordering the bay were extensively eroded, and runoff from 10-foot tides within the bay opened an inlet across Hurricane Island about two miles west of its eastern end. The storm of 1864 closed this inlet and breached Hurricane Island at Spanish Shanty Cove, about midway of the island and east of the present jettied channel. This opening closed in a short time. The barrier peninsula about 1.5 miles east of Perdido Pass was breached during the storm of 1906. This inlet closed sometime prior to 1934. Santa Rosa Island was also breached in 1906 and again in 1928. It was breached at a point east of the life guard station opposite Pensacola in the storm of 1906, during which tides reached a height of 10 feet in Pensacola Bay. In April 1928 a rainstorm accompanied by heavy winds and high tides in Choctawhatchee Bay caused a breach about 10,000 feet west of the then existing gulf entrance into Choctawhatchee Bay at Destin. Since the new channel was

shorter and offered less hydraulic resistance to tidal flow, it quickly widened and deepened and became the main channel, while the older channel gradually shoaled and closed. The storm of September 1956 (Flossy) affected the coast from Fort Walton Beach to Carrabelle. Panama City suffered extensive damage from high winds and wave action, which eroded beaches and undermined beach homes. Wave action also inflicted considerable damage to roadbeds and shoulders in the vicinity of Fort Walton Beach and Port St. Joe and lesser highway damage near East Point and Carrabelle.

118. **Present and future development.**—The gulf coast between Apalachee Bay and the Alabama state line is served by U. S. Highway 98, which traverses this entire reach, and by numerous connecting state and county roads. The principal towns are St. Marks, Carrabelle, Apalachicola, Port St. Joe, Panama City, Panama City Beach, Destin, Fort Walton Beach, Pensacola, and Pensacola Beach. Three large military installations contribute to the economy of the area, Tyndall Air Force Base near Panama City, Eglin Air Force Base near Fort Walton Beach, and Pensacola Naval Air Station at Pensacola. Industries include a number of chemical plants and paper mills at Port St. Joe, Panama City, and Pensacola. Each of these cities also has a deep-draft harbor which accommodates a substantial shipping industry. Pensacola, with an urbanized population of 128,000, is the largest city within the area as well as the most highly industrialized. Fishery resources and the tourist trade are important economic factors throughout the region. The eastern portion of the reach is sparsely developed, there being long coastal reaches which are relatively uninhabited and existing developments consisting primarily of small beach communities and fishing villages. It is expected however, that the beaches on St. George Island will be developed for housing and recreational purposes upon completion of the highway bridge, which is presently under construction, connecting that island with the mainland. The central portion of the gulf coast, between Panama City and Fort Walton Beach, supports a brisk tourist trade. The coastal reaches between Panama City and Lake Powell and in the vicinity of Destin and Fort Walton Beach, are well developed with

summer and permanent homes, motels, shopping centers, recreational beaches, and other facilities to attract tourists and vacationists. The beaches and gulf waters along the northwest Florida coast are among the most beautiful in Florida. A four-mile section of Santa Rosa Island opposite Navarre is presently being developed for recreational purposes by an agency of Santa Rosa County. Pensacola Beach, on Santa Rosa Island opposite Pensacola, is well developed with recreational facilities similar to those at Fort Walton Beach and Panama City Beach. A large portion of the shore between Mexico Beach and Panama City is presently being utilized by Tyndall Air Force Base for military purposes, and the Eglin Air Force Base reservation covers a large area in the vicinity of Fort Walton Beach, including about 21 miles of Santa Rosa Island.

119. The eight coastal counties have a combined population (1960 census) of over 369,000. The three eastern counties have a population of only 22,000 while the remaining five counties, where the population is augmented by personnel attached to the military installations near Panama City, Fort Walton Beach, and Pensacola, have a total of 347,000. Population statistics are given in table 3. As shown by these statistics, the total population increased from 80,000 in 1910 to 369,000 in 1960. Population projections indicate that this growth trend will continue at a rate which will cause the combined population of the eight counties to reach about 890,000 by the year 2000. It is expected that a considerable portion of the future population will be concentrated along the coast in presently undeveloped beach areas.

TABLE 3
Population statistics for eight coastal counties between
Apalachee Bay and Alabama state line

County	Year					
	1910	1920	1930	1940	1950	1960
Bay	(1)	11,407	12,091	20,686	42,689	67,131
Escambia	38,029	49,386	53,594	74,667	112,706	173,829
Franklin	5,201	5,318	6,283	5,991	5,814	6,576
Gulf	(1)	(1)	3,182	6,951	7,460	9,937
Okaloosa	(1)	9,360	9,897	12,900	27,533	61,175
Santa Rosa	14,897	13,670	14,083	16,085	18,554	29,547
Wakulla	5,129	4,802	5,468	5,463	5,258	5,257
Walton	16,460	12,119	14,576	14,246	14,725	15,576
Total	79,716	106,062	119,174	156,989	234,739	369,028

NOTE: (1) Not available (included in other county totals).

III. STATUS OF PROJECTS AND STUDIES

A. FLORIDA-GEORGIA LINE TO KEY WEST

120. Authorized projects. — a. Palm Beach County from Martin County Line to Lake Worth Inlet and from South Lake Worth Inlet to Broward County Line.—This project was authorized by the River and Harbor Act of 23 October 1962. It provides for Federal contribution toward

the cost of a local shore project for restoration of the beaches to a general width of 100 feet with a berm elevation of 10 feet, and periodic nourishment for a period of 10 years from the year of initial nourishment, as follows: 4.8 percent of the cost for the Martin County line-Jupiter Inlet segment (1.3 miles to be initially restored), 11.6 percent of the cost for the Jupiter Inlet-Lake Worth Inlet segment (2.5 miles to be initially

restored), and 5.1 percent of the cost for the South Lake Worth Inlet-Boca Raton Inlet segment (8.4 miles to be initially restored). Periodic nourishment would not be limited to the reaches initially restored but would be provided where needed in the three segments. There would be no Federal participation in protecting the county shore south of Boca Raton Inlet as no public benefits would result. Periodic nourishment will include operation and maintenance of the sand-transfer plant at South Lake Worth Inlet. No work has been performed under the project.

b. **Palm Beach County from Lake Worth Inlet to South Lake Worth Inlet.**—The project was authorized by the River and Harbor Act of 3 July 1958. It provides for Federal contribution toward the cost of a local shore protection project consisting of construction and future periodic nourishment of a protective beach 100 to 150 feet wide, with a berm elevation of 10 feet, along the ocean shore of Palm Beach Island, and construction and operation of a sand-transfer plant at Lake Worth Inlet. The Federal contribution authorized initially was 4.7 percent of the initial costs of the protective beach and costs of periodic nourishment for a period of 10 years from the year of initial placement, and 19.3 percent of the costs of construction and operation and maintenance of the sand-transfer plant for the same period. The sand-transfer plant was completed in 1958 and has been in operation since that date. No other work has been done on the project. As a result of the River and Harbor Act of 23 October 1962, the division of costs was recomputed under a new basis. Federal participation authorized for the construction and periodic nourishment of the protective beach is 7.5 percent, and for the remaining years of the authorized 10-year period for operation and maintenance of the sand-transfer plant it is 21.8 percent.

c. **Virginia Key and Key Biscayne.** — The project was authorized by the River and Harbor Act of 23 October 1962. It provides for Federal contribution of 70 percent of the cost of periodic nourishment of 1.8 miles of public beach on Virginia Key and 1.9 miles of public beach on Key Biscayne for an initial period of 10 years, and 70 percent of the initial cost of 3 groins on Virginia Key and 1 groin on Key Biscayne, con-

struction of which is subject to future determination of their need and justification. No work has been done on this project.

d. **Key West.**—The project was authorized by the River and Harbor Act of 14 July 1960. It provides for Federal contribution toward a local shore protection project consisting of restoration and future periodic nourishment of a protective beach with a berm 100 feet wide at elevation 4 feet along a section of South Roosevelt Boulevard 6,200 feet long. About 3,000 feet of protective beach has been provided under the project. The Federal share of the cost of that work was 33 1/3 percent. As a result of the River and Harbor Act of 23 October 1962, the Federal contribution toward the remaining work will be 50 percent of initial construction and 50 percent of the costs of periodic nourishment required to replace alongshore losses for a period of 10 years from the year of initial placement.

121. **Studies completed or under way.** — a. **Amelia Island Beach Erosion Control Study (Nassau County).**—This cooperative study was completed by the District Engineer, U. S. Army Engineer District, Savannah, in March 1960 and forwarded to the Secretary of the Army for transmittal to Congress in March 1961. The report was unfavorable to adoption of a Federal project as it was determined that measures required for protection in the problem area were not economically justified. The plan of protection developed by the study has not been implemented by local interests.

b. **Duval County.** — This study was completed by the District Engineer, U. S. Army Engineer District, Jacksonville, in November 1964. The report on the study is now being reviewed by higher authority in the Corps of Engineers. The District and Division Engineers recommend a project providing for restoration and periodic nourishment of the 10 miles of county shore south of St. Johns River by providing a protective and recreational beach having a level berm 60 feet wide at elevation 11 feet. The Federal share in the project would be 55.4 percent of the first costs exclusive of lands, easements, and rights-of-way, and 57.6 percent of the total nourishment cost.

c. **St. Johns County.** — The report on this study is nearing completion. The study provides for examination of the entire shore of St. Johns County to determine what is needed for protection in the interests of beach erosion control, hurricane flooding protection, and related purposes. The study will determine the economic justification of the necessary works and the degree of Federal participation warranted therein.

d. **Brevard County.**—This study was started in October 1964. The purpose of the study is to determine the need and justification for protective measures throughout the county shore, the economic justification thereof, and the degree of Federal participation warranted therein.

e. **Fort Pierce (St. Lucie County).**—This report was completed by the District Engineer in October 1963. It is now in the Bureau of the Budget for final consideration before transmittal to Congress. The report recommends adoption of a project by the United States providing for reimbursement to local interests of that part of the first costs of initial restoration and periodic nourishment for a period of 10 years of the two contiguous beaches, as follows: One-half of such costs for that part of the ocean shoreline starting at and extending 1.2 miles south of Fort Pierce Inlet which is in public ownership or use at the time of reimbursement; and 70 percent of such costs for the 0.1 mile ocean shoreline known as the Lions Club Beach Park and located 6,310 feet south of Fort Pierce Inlet. Final reimbursement would be based on actual conditions of ownership and use at the time of reimbursement.

f. **Jupiter Island (Martin County).** — The study was started in March 1963. Field surveys have been completed and office studies are under way. The study is completely funded. Its purpose is to determine the need for and develop a plan for protection, determine the economic feasibility of the plan, and determine the degree of Federal participation warranted toward the cost of the plan.

g. **Broward County.**—This report is now before the Bureau of the Budget for final consideration before it is transmitted to Congress. The report recommends improvements for beach erosion control from the north county line to

Hillsboro Inlet and from Port Everglades to the south county line, and a combined beach erosion control and navigation improvement of Hillsboro Inlet and the shore south thereof to Port Everglades. The beach erosion control features comprise restoration of a protective beach to a general width of 100 feet with a berm elevation of 10 feet and periodic nourishment thereof. The navigation features would provide for a channel 8 feet deep and 100 feet wide from the Intra-coastal Waterway to a point 1,500 feet oceanward in Hillsboro Inlet, thence 10 feet deep and 150 feet wide to deep water in the Atlantic Ocean; jetties on the north and south sides of the ocean entrance; and a permanently based floating dredge to maintain the navigation channel and transfer sand across the inlet with the provision that the dredge be replaced by a trestle-mounted sand-transfer plant if experience proves the dredge to be unsatisfactory. The Federal share of the projects would be 9.5 percent of the first cost of the beach restoration in the reach north of Hillsboro Inlet; 10 percent of the first cost allocated to beach erosion control and 50 percent of the first cost allocated to navigation in the combined beach erosion-navigation project between Hillsboro Inlet and Port Everglades; and 27.6 percent of the first cost of the beach restoration in the reach south of Port Everglades. Corresponding Federal participation in the costs of periodic nourishment would be 4.0, 10.0, and 22.3 percent, respectively.

h. **Dade County.**—This combined hurricane-beach erosion control study covers the shores of Dade County north of Government Cut. The purpose is to determine the need, character, and justification of works to control beach erosion and prevent hurricane induced flooding from the ocean. The study is also to determine the degree of Federal participation warranted in any required protective measures. A plan has been presented to local interests for consideration, and has received their approval. The report of the District Engineer is to be completed early in 1965.

122. **Studies authorized but not started.** There are no studies in this category along the east coast of peninsular Florida.

123. **Studies for which authority is being sought.** — Volusia County and Indian River County have contacted their congressional delegation for the purpose of obtaining a congressional resolution to authorize study of each county.

B. KEY WEST TO APALACHEE BAY

124. **Authorized projects.** — Pinellas County is the only authorized project in this reach. That project was authorized by the River and Harbor Act of 3 September 1954, and, due to inactivity, was placed in the inactive category in 1961. The project provides for Federal contribution toward the cost of a local shore restoration and protection project which would provide a 60-foot wide protective beach and the construction of groins at the south ends of Clearwater Beach Island, Sand Key, Treasure Island, and Long Key. The Federal participation authorized amounts to about 5 percent of the total first cost. As discussed below in a succeeding paragraph, a restudy of this area is under way.

125. **Studies completed or under way.** — a. **Mullet Key.**—This study was started in March 1964. Its purpose is to determine what remedial measures are warranted in the interest of beach erosion control, hurricane flooding protection, and related purposes. Because the key is an entity to itself, and is entirely publicly owned, this study was not combined with that of Pinellas County, which is discussed in the paragraph below. Field work on the study has been completed and office studies are well under way.

b. **Pinellas County.** — This is a restudy of Clearwater Beach, Sand Key, Treasure Island, and Long Key to determine whether the existing project should be modified in the light of new laws governing Federal participation in beach erosion control matters and of changes in physical development of the islands since authorization of the existing project in 1954. The study was started in March 1964. Field surveys and office studies are under way.

126. **Studies authorized but not started** — a. **Collier County.**—This study was authorized by resolution of the Senate Committee on Public Works, dated 21 September 1964. The purpose of the study is to determine what corrective

measures are required in the interest of beach erosion control, hurricane flooding protection, and related purposes. The study will determine the economic justification of measures determined to be necessary, and the degree of Federal participation therein which is warranted under existing law. The study, which is estimated to cost \$115,000, is not yet funded.

b. **Lee County.**—A study of Lee County with particular reference to Captiva, Sanibel, La Costa, Estero, and Bonita Beach Islands was authorized by resolution of the House Committee on Public Works, dated 23 June 1964. The purpose of the study is to determine what corrective measures are warranted in the interests of beach erosion control, hurricane flooding protection, and related purposes. The study will determine the economic justification of protective measures determined to be necessary, and the degree of Federal participation therein which is warranted under existing law. The study, which is estimated to cost \$164,000, is not yet funded.

c. **Sarasota County.**—This study was authorized by resolution of the Senate Committee on Public Works dated 3 September 1964. The purpose of the study is to determine what corrective measures are necessary in the interests of beach erosion control, hurricane flooding protection, and related purposes. The study will determine the economic justification of measures determined to be necessary, and the degree of Federal participation therein which is warranted under existing law. The study, which is estimated to cost \$136,000, is not yet funded.

127. **Studies for which authority is being sought.**—There are no studies in this category between Key West and Apalachee Bay.

C. APALACHEE BAY TO PERDIDO BAY

128. There are no authorized beach erosion projects in the area, and no studies are at present authorized or expected.

IV. IMPROVEMENT COSTS

A. FLORIDA-GEORGIA LINE TO KEY WEST

129. The costs of improvements which have been either authorized are in the process of being

recommended, or are under consideration are shown in table 4 below.

B. KEY WEST TO APALACHEE BAY

130. The only improvements to fall in this category are those for the now inactive project authorized for Pinellas County in 1954. Since the area is under restudy and the bases of cost division between local interests and the Federal

Government have changed two times since 1954, it is not considered appropriate to present improvement costs.

C. APALACHEE BAY TO PERDIDO BAY

131. As there are no authorized projects or recommended projects not yet authorized, this section is not applicable.

TABLE 4
Improvement costs

Location	Item	Estimated Cost					
		Initial			Annual		
		Total	Federal	Local	Total	Federal	Local
Authorized improvements							
Palm Beach County	Beach restoration Nourishment (1)	\$ 3,111,800	\$ 193,400	\$ 2,918,400	\$198,300	\$ 12,500	\$185,800
Palm Beach Island (2)	Beach restoration Nourishment	3,281,000	314,200	2,966,800	208,600	20,500	188,100
Virginia Key and Key Biscayne	Groin construction Nourishment (3)	660,000	462,000	198,000	144,000	100,800	43,200
Key West	Beach restoration Nourishment (4)	785,000	344,300	440,700	54,800	18,600	36,200
Recommended improvements							
Fort Pierce (5)	Beach restoration Nourishment	425,000	220,000	205,000	72,000	37,200	34,800
Broward County (6)	Beach restoration and navigation improvement Nourishment	5,588,000	1,102,900	4,485,100	381,300	86,100	295,200
Considered improvements							
Duval County	Beach restoration Nourishment	4,060,000	2,220,000	1,840,000	400,000	230,000	170,000
Dade County (7)	Beach restoration	29,533,000	11,766,000	17,767,000	488,300	79,400	408,900

- NOTES:** (1) Includes operation and maintenance of sand-transfer plant at South Lake Worth Inlet.
(2) Includes construction and operation and maintenance of sand-transfer plant at Lake Worth Inlet.
(3) Deferred construction.
(4) Federal share of nourishment limited to that required to replace alongshore losses.
(5) Federal participation shown is based on local intent to acquire for public use all shores to be improved.
(6) Includes items for navigation improvement of Hillsboro Inlet.
(7) Combined beach erosion control-hurricane protection plan.

V. LITTORAL DRIFT

A. FLORIDA-GEORGIA LINE TO KEY WEST

132. **General.**—The predominant direction of littoral drift along the east coast is from north to south. Reversals of drift direction occur seasonally. The normal period for northerly drift is spring and summer. However, it is not unusual for short periods (a few days) of drift reversal to occur in the early fall or late winter. Conversely, there may be short periods of southerly drift during the spring and summer. Available estimates of net littoral drift rates are given in table 5 below.

TABLE 5
Estimated net littoral drift rate
(Florida-Georgia line to Key West)

Location	Net average annual drift rate (cubic yards)
St. Johns River, Duval County..	500,000
St. Augustine Harbor	400,000-500,000
Ponce de Leon Inlet	500,000
Canaveral Harbor	350,000
Fort Pierce Inlet	200,000-250,000
St. Lucie Inlet	230,000
Lake Worth Inlet	230,000
Hillsboro Inlet	120,000
Port Everglades	50,000
Ocean entrance, Miami Harbor	10,000
Key West	Negligible

B. KEY WEST TO APALACHEE BAY

133. There is less knowledge of drift rates along the gulf shore of peninsular Florida than there is along the ocean shore. To date the basic approach to estimating the amount of sand in littoral movement has been to measure the accumulation against a major littoral barrier during

a known period of time. The numerous jetties and inlets along the ocean shore of Florida have thus provided "measuring points" at fairly regular intervals. Such is not the case along the gulf shore of the peninsula. The two known jettied inlets are Venice Inlet and Johns Pass. Those jetties have accumulated sand on the north side, indicating a predominantly southerly drift direction at those localities, but the jetties at neither place are long enough to be a complete or nearly complete littoral barrier, and the amount of material which passes around the jetties is not known. In addition, the curved jetty at Johns Pass has been in only a few years, and even if a complete littoral barrier, would not yet in itself provide reliable indication of the drift rate. The predominant direction of drift appears to change from one place to another, and in some localities cannot be identified. Available estimates of net drift, and the estimated predominant direction are given in table 6 following.

TABLE 6
Estimated net littoral drift rate
and direction
(Key West to Apalachee Bay)

Location	Net average annual drift rate (cubic yards)	Direction
Gordon Pass	66,000	Southerly
Fort Myers Beach	22,000	Northerly
Venice Inlet	40,000	Southerly
Little Sarasota Pass	40,000	Do.
Anna Maria Island	Not estimated	Northerly
Treasure Island	50,000	Southerly
Clearwater Pass	10,000	Southerly

C. APALACHEE BAY TO PERDIDO BAY

134. **General.**—The gulf shoreline of northwest Florida and southwest Alabama bears generally east and west. This predominant winds and

swells in the offshore zone approach the coast from the east and southeast, generating a predominantly westward littoral current and drift. All other available evidence bears out this conclusion. The western end of Santa Rosa Island at the inlet to Pensacola Bay is accumulating sand whereas the opposite shore at the location tends to erode. Other indications include observed westward migration of the inlet into Perdido Bay, Alabama, accretion on the east side of the east jetty at Panama City, westward migration of Cape St. George (St. George Island, Florida), and westward migration of Old East Pass between 1871 and 1929. There are, however, indications of seasonal reversals.

135. Predominant directions.—There is little evidence of littoral drift along the shore of Apalachee Bay east of Ochlockonee Bay. Throughout this reach, the energy of littoral forces is very low and few sandy beaches are present. To the west along the shore between Lighthouse Point and Alligator Point littoral drift is westward as evidenced by the westward growth of the spit. The extension of the east end of St. George Island indicates an eastward littoral drift, but the greater extension of its west end and the westward migration of Cape St. George indicate that a westward drift predominates. The drift continues westward along St. Vincent Island. Along the shores of St. Joseph spit the drift is from south to north. At Mexico Beach, near the base of Crooked Island, the accumulation of sand on the west side of a jetty with accompanying erosion of the beaches eastward indicates eastward littoral drift in that area. In the vicinity of Panama City the drift appears to be from both the east and west. There are indications on the mainland between Crooked Island and Hurricane Island of a nodal zone where the littoral drift approaches from both directions. Accretion on the east side of the east jetty at the St. Andrew Bay entrance channel across Hurricane Island indicates westward drift at that location. At East Pass, entrance to Choctawhatchee Bay, the physical evidence and history of inlet changes do not furnish conclusive evidence as to direction of drift. The pass channel has a tendency to move to the east. However, the western shore of the pass initially eroded at a much faster rate than

the opposite shore. Also, historical shoreline change maps show that the original pass, which closed between 1935 and 1938, was migrating to the west. It is concluded, therefore, that the easterly migration of the present channel is a case of counterdrift migration and that the predominant direction of drift at the location conforms to the westward direction of the littoral forces. At the gulf entrance to Pensacola Bay, the predominant littoral drift is to the west and continues westward to Perdido Pass, Alabama, with seasonal reversals at each location.

136. Annual volume.—In general, the net annual volume of littoral drift is probably quite small along the entire northwest Florida coast. No doubt sizeable quantities of material pass a given point, but frequent seasonal reversals in the direction of drift result in relatively small net annual movements in a given direction. Studies made in 1930 by the former Shore Protection Board on "Sand Movement and Beach Erosion" determined that the rate of sand deposit at the western end of Santa Rosa Island and on the middle ground bar amounted to an average of 160,000 cubic yards annually. Estimates made in 1954 of the volumetric growth of the western end of the peninsula terminating at Perdido Pass and the adjacent marine bar by comparing hydrographic surveys made in 1934, 1948, and 1953 showed that accumulation during the 19-year period averaged 165,000 cubic yards annually. These estimates are believed to be somewhat higher than the actual westward drift because they include an undetermined amount of material deposited by easterly littoral currents and by ebb currents from the bays. The volume of material removed by hopper dredge from the 32- by 500-foot entrance channel into Pensacola Bay during maintenance operations amounts to an average of 240,000 cubic yards annually. It is believed that the Pensacola Inlet is a virtually complete littoral barrier and that this quantity represents shoaling from all sources including scour and fill within the channel itself. It is estimated that 80 percent of the annual shoaling is supplied by littoral drift. In previous studies, it was estimated that the average annual westward drift at the Pensacola Inlet is 130,000 cubic yards and eastward drift, about 65,000 cubic yards. The

net westward drift at that location is therefore estimated to be 65,000 cubic yards annually. No quantitative studies have been made of littoral drift movements at any other locations between Apalachee Bay and the Alabama state line.

VI. ESTIMATED STUDY COSTS

A. FLORIDA-GEORGIA LINE TO KEY WEST

137. **General.**—Studies made since 1956 are considered adequate from technical and economic viewpoints. The division of costs in those studies completed before passage of the River and Harbor Act of 23 October 1962 were recomputed under the criteria established by that Act, and the authorized Federal participation increased accordingly. Areas not studied since 1956 would profit from a restudy, or, as is the case at most localities, an original study.

138. **Estimates of cost** for those areas not considered adequately investigated are presented in table 7 following. The areas are listed in geographical order, from north to south.

TABLE 7

Estimated study costs
(Florida-Georgia line to Key West)

Area	Estimated cost
Flagler County	\$ 75,000
Volusia County	200,000
Indian River County	90,000
Monroe County (the keys)	140,000

B. KEY WEST TO APALACHEE BAY

139. **General.**—Only one area, Pinellas County, is represented by an up-to-date study or by a study now under way. As brought out earlier, a restudy of Pinellas County is now under way. In addition, studies of Collier, Lee, and Sarasota Counties have been authorized, though not yet funded.

140. **Estimated study costs** for all the counties of this area except Pinellas County are presented in table 8 following.

TABLE 8
Estimated study costs
(Key West to Apalachee Bay)

Area	Estimated costs
Collier County	\$115,000
Lee County	164,000
Charlotte County	55,000
Sarasota County	136,000
Manatee County	50,000
Pasco County (1)	80,000
Hernando County (1)	77,000
Citrus County (1)	100,000
Levy County (1)	154,000
Dixie County (1)	123,000
Taylor County (1)	181,000
Jefferson County (1)	19,000

NOTE: (1) Estimates prorated from estimates for counties to the south, based on miles of shore subject to future need for study.

C. APALACHEE BAY TO PERDIDO BAY

141. The shores between Apalachee Bay and the Alabama state line have been divided into study areas for the purpose of preparing future beach erosion control reports and for estimating the cost of a study program. The study areas and tentative cost estimates for each study are listed in table 9.

TABLE 9

Estimated study costs
(Apalachee Bay to Perdido Bay)

Study area	Estimated cost of study
St. Marks River to Ochlockonee Bay ..	\$ 50,000
Ochlockonee Bay to Cape San Blas	165,000
St. Joseph spit and shores of St. Joseph Bay	70,000
St. Joseph Bay to entrance of St. Andrew Bay	70,000
Entrance of St. Andrew Bay to East Pass at Destin	100,000
East Pass at Destin to Entrance to Pensacola Bay	85,000
Pensacola Bay to Perdido Bay	50,000
Total cost of studies	590,000

VII. SUGGESTED PRIORITY OF FUTURE STUDIES

FLORIDA-GEORGIA LINE TO FLORIDA-ALABAMA LINE

142. Bases for priority.—Physical characteristics, including the severity of the erosion problem, combined with present and projected future shorefront development form the bases for assigning study priorities.

143. Priorities.—Assigned priorities for the entire State shoreline are given in table 10 below. It would be reasonable to expect some future changes in the priorities assigned, particularly as concerns those following priority 8 (Charlotte County). It would be some few years in the future before all areas having higher priorities could be studied.

TABLE 10
Suggested priority and schedule of future studies and rough estimate of project costs

Prior-ity	Area	Remarks	Feasible schedule	Estimated project cost (1)
1	Lee County	Study already authorized	1967-1968	\$2,400,000
2	Sarasota County	do.	1967-1968	2,800,000
3	Volusia County	Study authority being sought	1968-1969	3,100,000
4	Indian River County	do	1968-1969	1,200,000
5	Manatee County	-	1969-1970	1,400,000
6	Collier County	Study already authorized	1969-1970	700,000
7	Flagler County		1970-1971	600,000
8	Charlotte County		1970-1971	570,000
9	Pasco County		See paragraphs 144 and 146	
10	Monroe County (Keys)		Do.	
11	Hernando County		Do.	
12	Taylor County		Do.	
13	Levy County		Do.	
14	Dixie County		Do.	
15	Citrus County		Do.	
16	Jefferson County		Do.	
17	St. Andrew Bay Entrance to East Pass at Destin		Do.	
18	East Pass at Destin to Pensacola Bay		Do.	
19	St. Joseph Spit and shore of St. Joseph Bay		Do.	
20	Pensacola Bay entrance to Perdido Bay		Do.	
21	Ochlockonee Bay to Cape San Blas		Do.	
22	St. Joseph Bay to St. Andrew Bay entrance		Do.	
23	St. Marks River to Ochlockonee Bay		Do.	

NOTE: (1) Based on average unit cost per mile of protected beach in other areas.

VIII. A FEASIBLE SCHEDULE OF FUTURE STUDIES

FLORIDA-GEORGIA LINE TO FLORIDA-ALABAMA LINE

144. **Schedule.**—It is considered that the beach erosion control studies now under way should be continued to completion at the earliest date consistent with sound engineering procedures and availability of study funds. Beyond that point, the schedule should reflect the urgencies of the situation and the desires of State and local interests. Table 10 above presents a schedule which could be considered. It may be noted that the schedule dates end with Charlotte County. Under existing conditions of the problem and of development, it is not considered feasible to extend the schedule beyond that point at this time.

IX. ROUGH ESTIMATE OF PROJECT COSTS

145. **Bases for estimates.**—Reliable project cost estimates of survey scope have been prepared for a number of areas along the east coast of Florida. By using those estimates an **average** project cost per mile of shore protected can be obtained. Such an average figure would probably not be appropriate for any given specific area, but it would yield a fair approximation of the magnitude of the cost of a potential project in any area.

146. **Estimates of project costs,** or approximations of such costs, are given in table 10 above. As no detailed estimates have been prepared for the shoreline north and west of Pinellas County, and as there are, relatively speaking, only a negligible quantity of sandy beaches between Pinellas County and Apalachee Bay, no approximations are provided for that area.

X. ROUGH ESTIMATE OF FEDERAL PARTICIPATION IN FUTURE PROJECTS

147. **Basis for Federal participation.**—Public Law 87-874, enacted in the River and Harbor Act of 23 October 1962, provides the basis for Federal participation in the study and control of beach erosion. The law provides that the Federal Gov-

ernment will bear all the costs of protecting federally owned shores. Federal participation in the costs of a project for restoration and protection of State, county, and other publicly owned shore parks and conservation areas may be, in the discretion of the Chief of Engineers, not more than 70 percent of the total cost exclusive of land costs, when such areas:

- a. Include a zone which excludes permanent human habitation;
- b. Include but are not limited to recreational beaches;
- c. Satisfy adequate criteria for conservation and development of the natural resources of the environment;
- d. Extend landward a sufficient distance to include, where appropriate, protective dunes, bluffs, or other natural features which serve to protect the uplands from damage; and
- e. Provide essentially full park facilities for appropriate public use.

Federal participation in the restoration of other publicly owned non-Federal shores may not be more than 50 percent. Shores other than public are eligible for Federal assistance if there is benefit such as that arising from public use or from the protection of nearby public property or if the benefits to those shores are incidental to the project, and the Federal contribution to the project is adjusted in accordance with the degree of such benefits.

148. Available information on the status of public use and public ownership in those areas for which rough estimates of project cost are presented in the preceding section has been used to develop an approximation of the potential future Federal participation in those projects. It is emphasized that the degree of Federal participation indicated in table 11 below is preliminary and is based on incomplete information. Detailed study of survey scope, in which the project would be precisely defined and economically analyzed, would be required to accurately determine the degree of Federal participation warranted for a given, specific project.

TABLE 11

Rough estimate of Federal participation
in future projects (1)

Project	Federal participation (percent)
Lee County	9
Sarasota County	9
Volusia County	9
Indian River County	3
Manatee County	54
Collier County	33
Flagler County	9
Charlotte County	3

NOTE: (1) Estimate is preliminary, and is based on incomplete information. Precise determination of Federal participation requires detailed investigation of survey scope. The percentage of Federal participation shown is based in part on the degree of public ownership of shores shown in table I of "A Review of Florida Beach Resources," published by the Florida Development Commission several years ago. The percentages shown are further based on the assumption that the improved section of beach would be concentrated along public shores and would have tripled the ratio of public-to-private shores as that of the entire county in which the improved beach is located, and that the Federal participation in the cost of improving the public shores would be 50 percent. At some locations the actual percentage as developed by detailed study would be much higher than that shown in the table; at other locations it might be lower.

XI. BASE FOR FINANCIAL SUPPORT OF PROJECTS

149. **Existing conditions.**—There has been relatively little actual construction carried out on authorized Federal beach erosion control projects in Florida. In those areas where work has been accomplished under the project (Palm Beach Island and Key West), project costs have been borne by local interests, municipal and county, and by the Federal Government. No State participation in construction costs has existed to date. Because of the limited Federal participation in many areas, this has placed a burden at county and municipal levels that has been beyond their capability, and the result has been that

authorized projects are not implemented. In other words, erosion continues as though no effort has been expended in developing a plan of protection and no recognition has been granted the problems of the area by Congress.

150. **Other States.**—A number of coastal states have evolved a policy of providing financial support for both Federal and local beach erosion control projects. The degree of State participation varies among such States. New Hampshire has borne all the non-Federal costs for protection of State-owned shores. Connecticut assumes one-half the non-Federal cost of Federal erosion control projects. A summary of available information on State participation in beach erosion control projects was presented by Colonel F. O. Diercks, Director of the Coastal Engineering Research Center of the Corps of Engineers, at a meeting in Jacksonville, Fla., 29 September 1964. It is believed that the information presented by Colonel Diercks is of value to the State of Florida, and his paper is presented herein as appendix I.

XII. ZONING CONSIDERATIONS

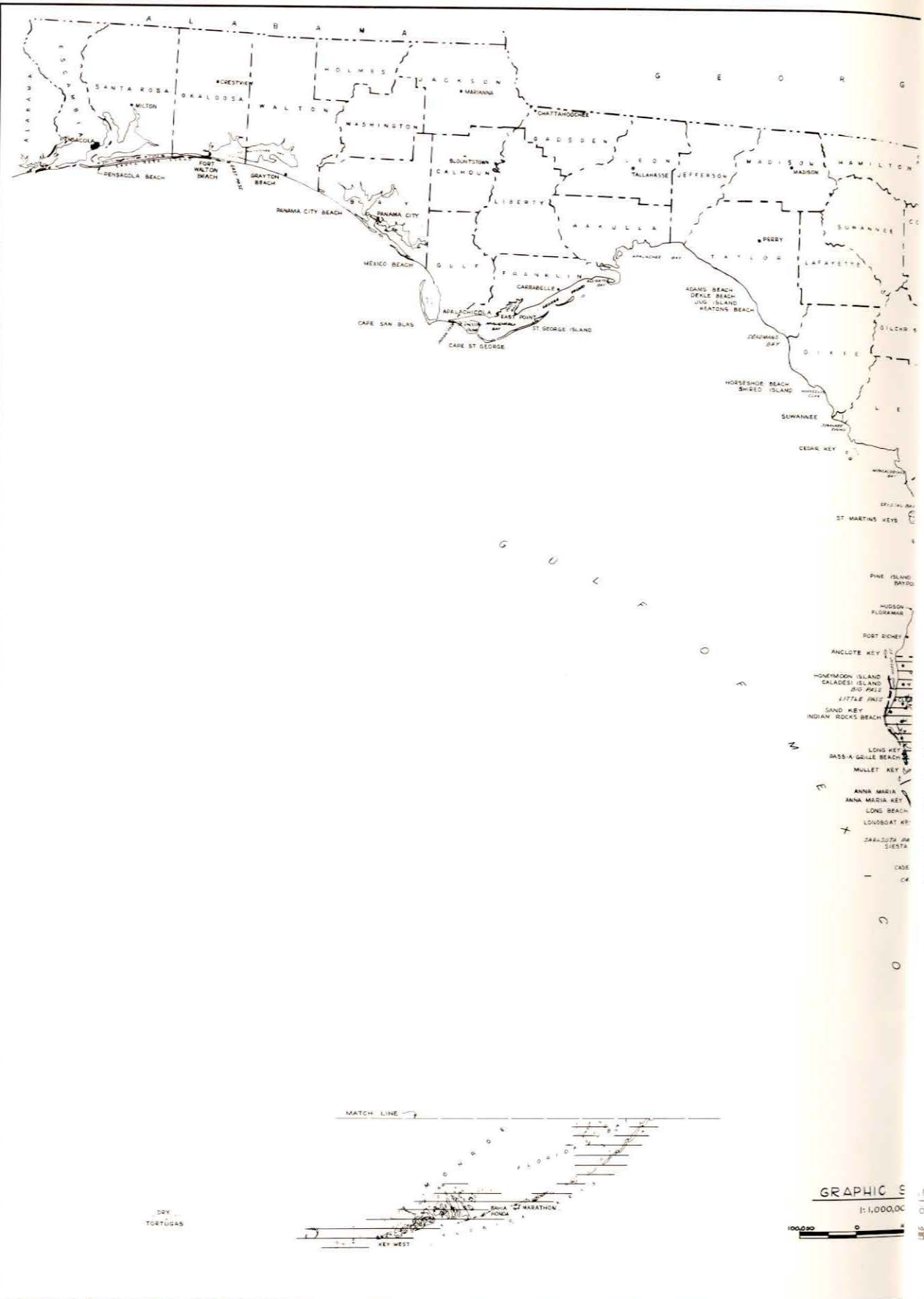
151. **Existing conditions.**—For some years certain areas of the State have enforced local zoning laws to prohibit residential construction in low-lying lands subject to flooding. It is understood that the basic approach to such zoning is to establish a minimum ground surface elevation on which building permits will be issued. It is not known that there is any parallel in Florida where the hazards of beach erosion are concerned. It would appear appropriate to consider whether it would be advantageous for Florida to establish zoning legislation with a view to (1) preventing damage to development and (2) protecting those dunes which still exist. Appendix II presents the amendment to its building code enacted by the town of Wrightsville Beach in the interest of (1) above. Also shown in appendix II, as pertains to (2) above, is the preliminary draft of a bill providing for protection of the dunes along the Outer Banks of North Carolina. That appendix also includes a copy of a law to protect the dunes in Maryland. The inclosed paper on that subject was given by Mr. L. Hollingsworth Pittman, Attorney for Worcester County, Maryland, at

the 1961 annual convention of the American Shore and Beach Preservation Association.

XIII. CONCLUSIONS

152. **Conclusions.**—It is concluded that there should be vigorous prosecution of measures to control erosion in those areas for which firm plans have been developed, with a broadened financial base to include the State of Florida as well as municipal, county, and Federal governments. It is also concluded that, in the interest

of defining the problem and developing sound solutions thereto, an orderly sequence of studies should be maintained for these areas for which erosion control projects have not been formulated. In these regards, the Corps of Engineers is ready to cooperate with State and local elements at all times and on all levels. Finally, it is concluded that appropriate State and local elements should consider the desirability of establishing zoning procedures in the interest of preventing damage to development and of preserving those dunes which still exist.



GRAPHIC SCALE

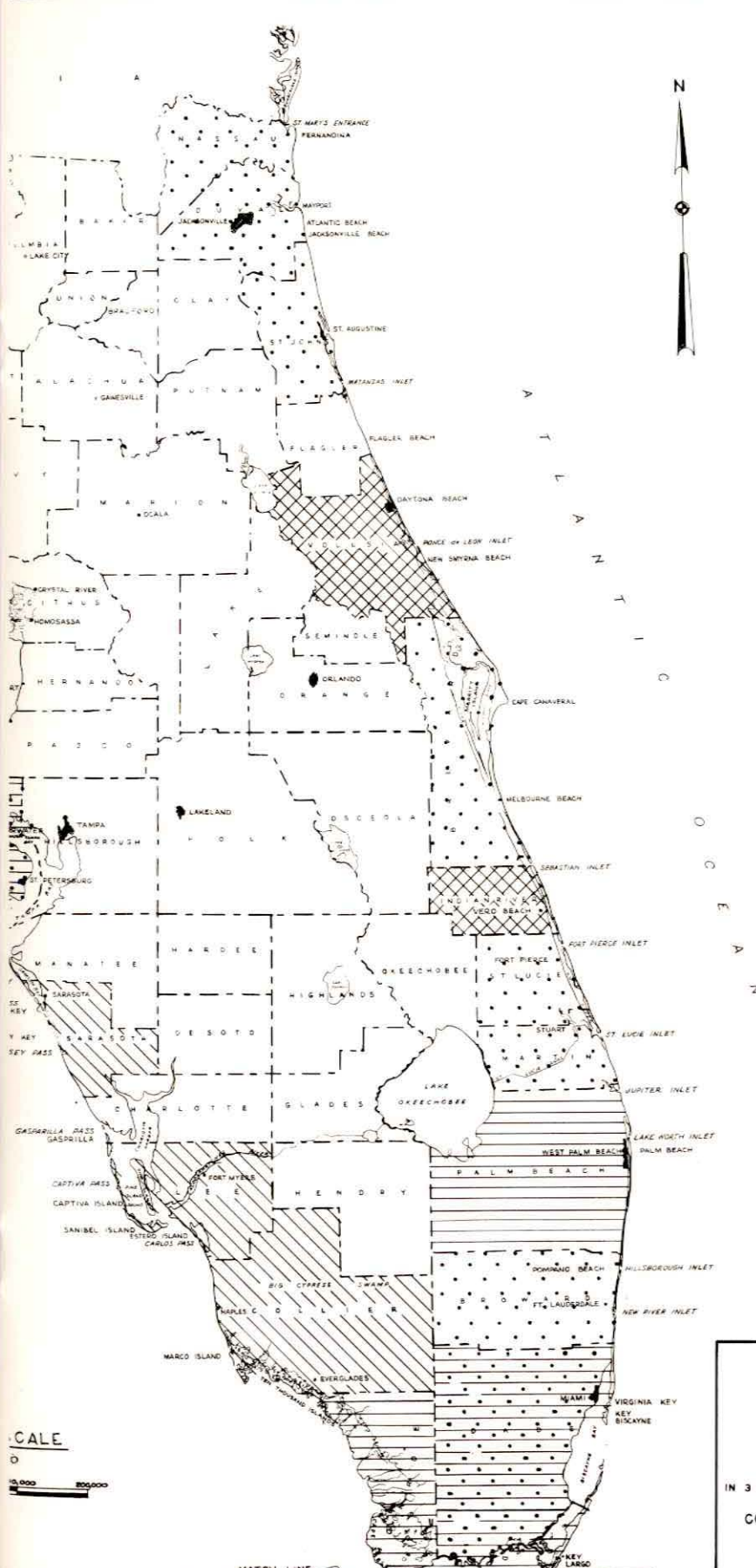
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





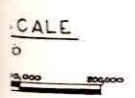
DRY TORTUGAS

MATCH LINE

KEY WEST



- LEGEND**
-  COUNTIES IN WHICH FEDERAL PROJECTS HAVE BEEN AUTHORIZED.
 -  COUNTIES IN WHICH STUDIES ARE UNDER WAY OR COMPLETED.
 -  COUNTIES IN WHICH STUDIES ARE AUTHORIZED.
 -  COUNTIES IN WHICH STUDIES ARE BEING SOUGHT.

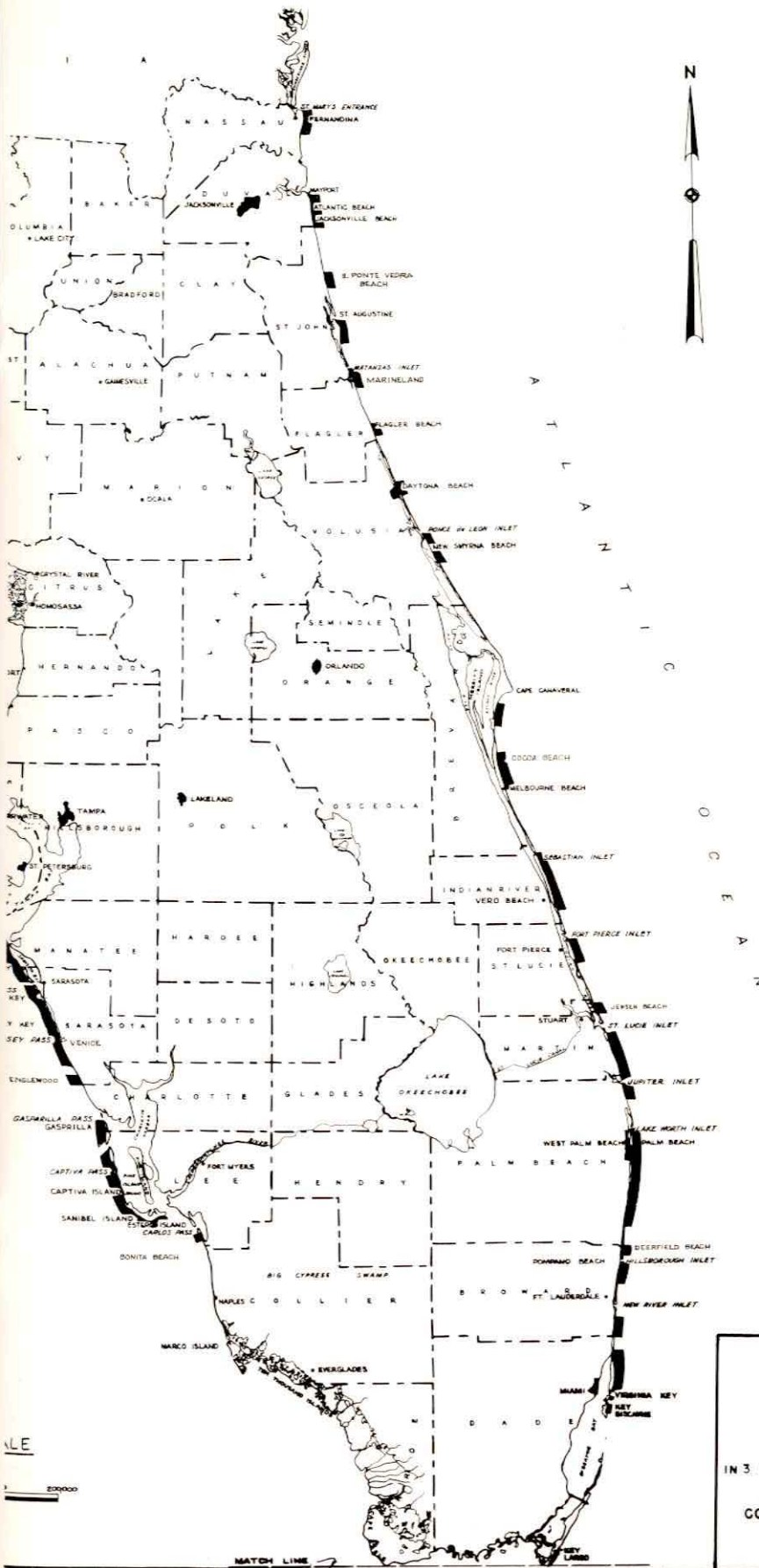


**APPRAISAL REPORT ON BEACH
CONDITIONS IN FLORIDA**

STATUS MAP

IN 3 SHEETS SHEET NO. 1 SCALES AS SHOWN
 U.S. ARMY ENGINEER DISTRICT, JACKSONVILLE
 CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

D.O. FILE NO.
 27-28,894



LEGEND

SEVERE EROSION

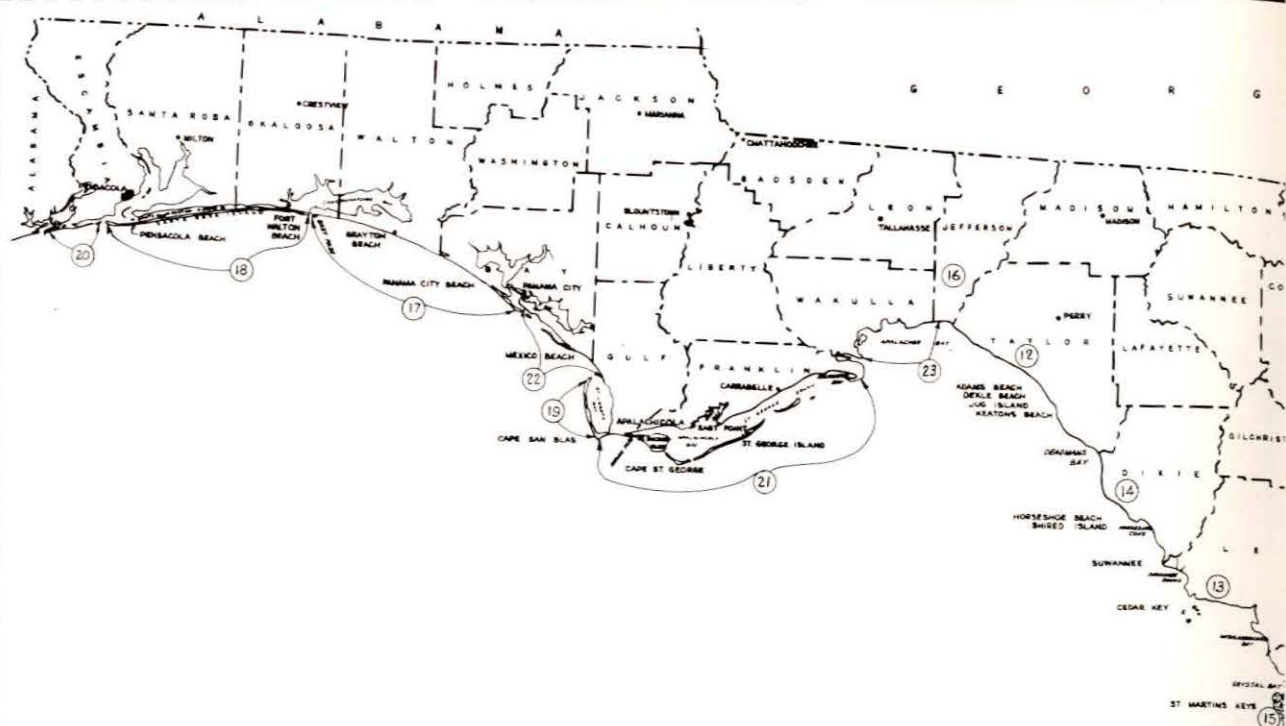
APPRAISAL REPORT ON BEACH CONDITIONS IN FLORIDA

PROBLEM AREAS

IN 3 SHEETS SHEET NO. 2 SCALES AS SHOWN

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CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

D.O. FILE NO.
27-28,894

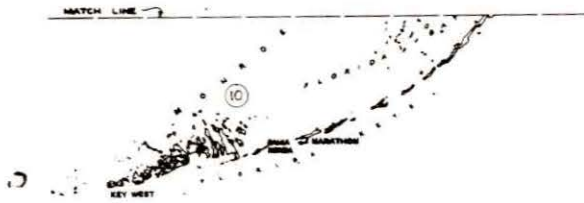


RECOMMENDED PRIORITY OF FUTURE STUDIES
(ENTIRE STATE)

PRIORITY	AREA	REMARKS
1	LEE COUNTY	STUDY ALREADY AUTHORIZED
2	SARASOTA COUNTY	DO.
3	VOLUSIA COUNTY	STUDY AUTHORITY BEING SOUGHT
4	INDIAN RIVER COUNTY	DO.
5	MANATEE COUNTY	
6	COLLIER COUNTY	STUDY ALREADY AUTHORIZED
7	FLAGLER COUNTY	
8	CHARLOTTE COUNTY	
9	PASCO COUNTY	
10	MONROE COUNTY (KEYS)	
11	HERNANDO COUNTY	
12	TAYLOR COUNTY	
13	LEVY COUNTY	
14	DIXIE COUNTY	
15	CITRUS COUNTY	
16	JEFFERSON COUNTY	
17	ST. ANDREW BAY ENTRANCE TO EAST PASS AT DESTIN	
18	EAST PASS AT DESTIN TO PENSACOLA BAY ENTRANCE	
19	ST. JOSEPH SPIT AND SHORE OF ST. JOSEPH BAY	
20	PENSACOLA BAY ENTRANCE TO PERDIDO BAY	
21	OCHLOCKNEE BAY TO CAPE SAN BLAS	
22	ST. JOSEPH BAY TO ST. ANDREW BAY ENTRANCE	
23	ST. MARKS RIVER TO OCHLOCKNEE BAY	



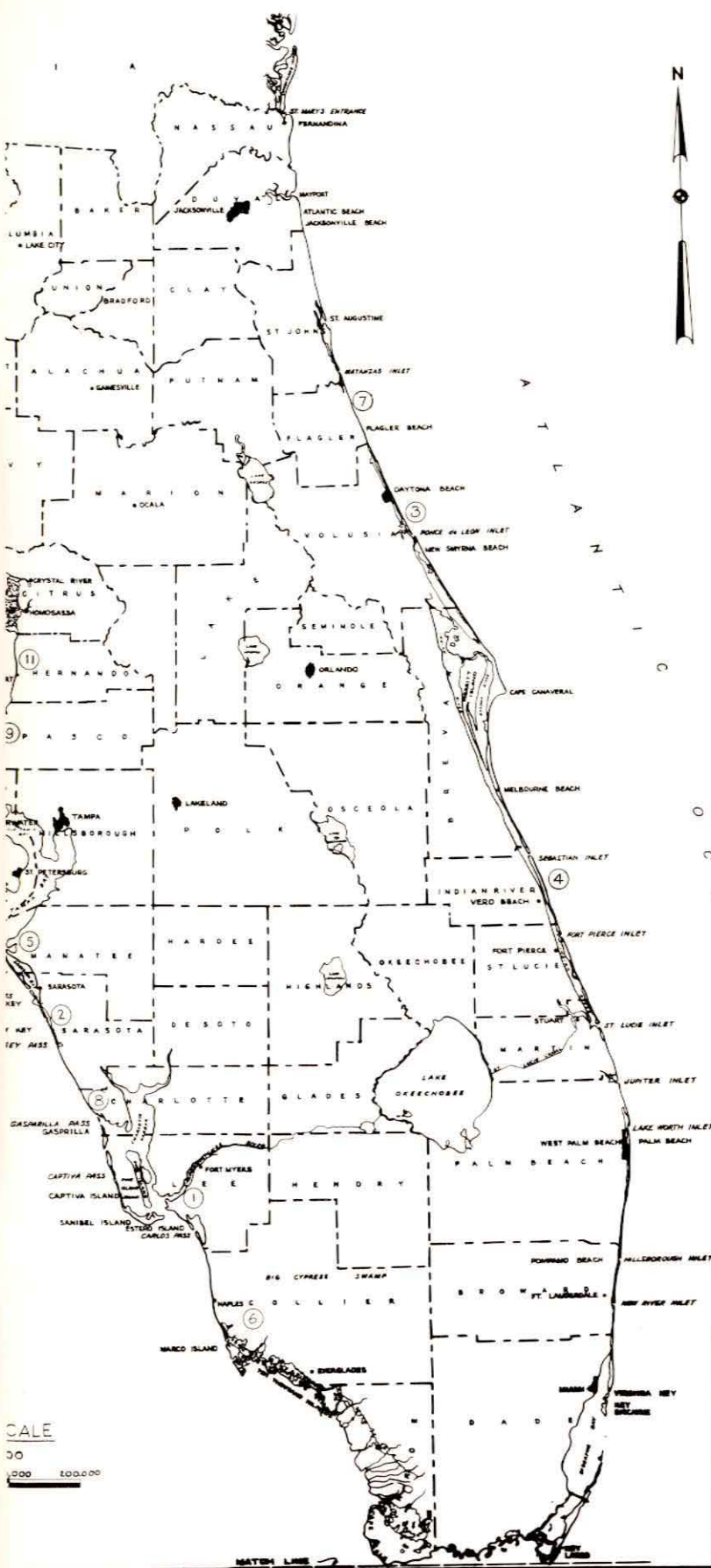
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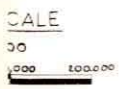
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LEGEND

③ PRIORITY



**APPRAISAL REPORT ON BEACH
CONDITIONS IN FLORIDA
PROPOSED FUTURE STUDIES
OF
SHORELINE**

IN 3 SHEETS SHEET NO. 3 SCALES AS SHOWN

**U.S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA**

D.O. FILE NO.
27-28,894

APPENDIX I

STATE PARTICIPATION IN
LOCAL SHORE PROTECTION
PROJECTS

STATE PARTICIPATION IN LOCAL SHORE PROTECTION PROJECTS

As may be expected there is a great variety in the manner shore protection projects are handled in the various coastal States. Some States have firm continuing policies which apply to various projects as they are developed, while others enact legislation for specific projects. Although such specific legislation may be considered as establishing general policy, each project requires a new legislation. Of course in the case of State parks, all non-Federal costs are borne by a state agency.

Time has permitted only a general review of the various State policies based on information presently available in my office. Therefore the information should be considered only for general guidance in the matter.

The State of **New Hampshire** has only a short coast but has three authorized Federal projects. Two of these are for State-owned beaches, therefore the State has made funds available for the non-Federal share for development of these beaches by direct appropriations. The third project has not been funded, presumably being considered of more local than State interest. Thus it could be stated that the policy of State aid in this case applies only to what are considered facilities of interest under the State's park and recreational system.

The Commonwealth of **Massachusetts** has long had a policy of financial assistance in constructing shore protection works. In practice, the State has an annual appropriation from which it will match local funds on non-Federal projects. Presumably these funds could also be used to pay one-half of the non-Federal share in the case of Federal projects. The projects are normally constructed by the State Department of Public Works. In some cases it is believed that State appropriations have been made for specific projects on which local cooperation has not been required.

Federal projects constructed to date in **Rhode Island** have been for State-owned recreational beaches. Therefore all local funds have been State funds directly appropriated for the work.

In **Connecticut**, the State cooperated with the Corps of Engineers in a study of its entire shore-

line. As a result, twenty Federal projects for shore protection were authorized. Of these, all but two have been completed and one of these has been partially constructed. As this record is one of the best in the country, the methods of financing in this case are of particular interest. It is understood that a general State appropriation has been available from which these projects have been financed. On Federal projects the State requires local participation of one-half the non-Federal share, but on request of the local public agency the State would advance the local share and construct the project. Repayment of the advanced share in 20 years is required, but no interest is charged on the advanced funds. In addition, many plans of protection considered in the Federal study, but not recommended as Federal projects, have been constructed. On such improvements for publicly owned shores (other than State-owned), the State pays two-thirds of the cost and the local agency one-third. Improvements for privately owned shores are paid one-third State and two-thirds local.

In **New York**, the State has a general law permitting State financing of one-half the non-Federal share on Federal projects. The remaining costs must be financed by a lower subdivision of government.

New Jersey is somewhat similar to Massachusetts in policy in financing shore protection projects. The State has an annual appropriation from which it will match local funds for projects sponsored by lower subdivisions of government. On Federal projects the State has financed one-half the non-Federal share.

Delaware had a Federal study of many of its shore problems which resulted in one Federal project, but also in plans of improvement for several other localities. The State financed the non-Federal share of the Federal project, but also built other shore protection measures considered in the report entirely with State funds. This policy was apparently applied regardless of shore ownership.

Maryland has no Federal shore protection project to date. A State law permits establish-

ment of erosion districts for specific projects under which protection can be provided for private property on an assessment basis. Counties are also permitted to participate up to 25% of the costs. It is understood that general State policy is to contribute 25% of the costs of erosion control projects, but no projects have as yet been approved under this policy.

Virginia has assisted on the Federal project for Virginia Beach, by making specific appropriations to the local Erosion Commission. It has no general policy for assistance applicable to other localities.

North Carolina is probably the most recent State to establish a general policy for assistance in constructing beach erosion control and hurricane protection and is one of the most liberal. The State will provide 80% of the non-Federal share on Federal projects and 80% of the total costs of other projects. Local governments must provide the remaining 20%.

South Carolina has appropriated small amounts of State funds for beach erosion control, but as yet has no Federal projects nor general policy for State participation as far as is presently known.

Georgia, Alabama, Mississippi and Texas have no general policy of State assistance in shore protection.

In **Louisiana**, the State has made specific appropriations for protective works at Grand Isle, the only locality in the State which has needed such works until very recently.

On the Pacific coast only **California** has specific laws establishing policy on assistance in beach erosion control. In California, the State will contribute one-half of the non-Federal share of Federal projects; the other half is furnished by lower political subdivisions. The State will also advance the Federal share, thus enabling construction prior to appropriation of Federal funds.

In **Hawaii** the State has made specific appropriations for Federal erosion control projects and it appears that the general policy will be for the State to provide all of the non-Federal share.

The only State on the Great Lakes having a general policy of assistance is **Ohio**. That State may pay two-thirds of the cost of projects for protection of publicly owned shores and one-

third for privately owned shores. The remaining costs are paid by other political subdivisions of the State. The policy has not been applied to any Federal project to date.

No doubt you would also be interested in a brief discussion of items relating to **Florida's** beaches on which the Coastal Engineering Research Center is cooperating or is supporting. One of the items is the Appraisal Report which Mr. Brannen has already reviewed for you. Another is a sand inventory program which is expected to be completed this fiscal year. Under this inventory, borings and geophysical exploration will be made to locate suitable sand in offshore sources for beach restoration and nourishment. Studies will be continued relative to the role of shell material in the beach sands between Lake Worth Inlet and Government Cut, Miami. Installation of a wave gage at Daytona Beach is planned this fiscal year, and another one may be installed in the Florida Gulf Coast next year. In connection with the program of beach restoration by dragline from offshore bars at Jupiter Island, surveys are being made so that the effectiveness of this method of nourishment may be evaluated.

Thank you.

SUMMARY OF GENERAL POLICY OF STATE PARTICIPATION IN SHORE PROTECTION PROJECTS FEDERAL PROJECTS

State Participation— Portion of Non-Federal Share	
100%	Delaware, Hawaii
80%	North Carolina
50%	Massachusetts, Connecticut, New York, New Jersey, California

OTHER PROJECTS

State Participation— Portion of Total Costs	
100%	Delaware, Hawaii, Louisiana
80%	North Carolina
2/3	Connecticut, Ohio (for Public Shores)
50%	Massachusetts, New York, New Jersey, California
1/3	Connecticut, Ohio (for Private Shores)
25%	Maryland

APPENDIX II

ZONING LEGISLATION
IN
OTHER AREAS

AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION

Annual Convention — June 14, 15, and 16, 1961

Ocean City, Maryland

TOPIC: Preservation of Maryland Sand Dunes
SPEAKER: L. Hollingsworth Pittman, Esquire, Pocomoke City, Maryland
Attorney for Worcester County, Maryland

WHEREAS, The area of the State of Maryland lying along the Atlantic Ocean front is a principal asset to the economy of the entire State of Maryland, and as such should be protected and preserved. It also is one of the principal assets of Worcester County, and as such likewise should be protected and preserved. The area is itself wholly or in part protected from the actions of the Atlantic Ocean by a system of natural or constructed dunes providing a natural protective barrier for adjacent lands from the actions of sand, wind and water, but certain persons, firms or corporations have undertaken to modify or destroy the effectiveness of such natural protective barriers. These practices constitute serious threats to the safety of the adjacent lands and the ocean highway, and also to the value and therefore to the assessable basis of those adjacent lands; and they constitute a real danger to the health, safety, and welfare of the persons living, visiting or sojourning in such area. It therefore is deemed necessary to protect that area and especially the system of natural protective barrier dunes; now therefore

SECTION 1. Be it enacted by the General Assembly of Maryland, That New Sections 6A to 6J, inclusive, be and they are hereby added to Article 24 of the Code of Public Local Laws of Maryland (1930 Edition), title "Worcester County," to follow immediately after Section 6 thereof and to be under the new subtitle "Beach Protection," and all to read as follows:

BEACH PROTECTION

6A. No person, firm or corporation shall dig, mine, strip, excavate, move or remove, relocate or carry away any sand, dirt, soil, stones, or gravel of any nature or description upon or away from that area in Worcester County, Maryland,

lying between the Atlantic Ocean on the East and Assowoman Bay, Isle of Wight Bay, Sinepuxent Bay and Chincoteague Bay on the West, and between the Delaware State Line on the North and the Virginia State Line on the South, except in connection with the construction or alteration of a building or grading of the premises incidental thereto, or unless excess material exists on the premises above that required to bring the premises to the officially established grade in that area, which shall be established by the County Commissioners of Worcester County or an administrative department thereof, in which case the excess material may not be removed without first having secured a permit therefor from the County Commissioners of Worcester County. In areas where the grade has not been officially established, the grade shall be established for the purposes of this Section as a line running Westerly from the crest line of the protective barrier dune system established in Section 6B of this sub-title, at a crest elevation of plus 16.0 above mean low water on the East, then Westerly at such crest elevation for a distance of 25 feet, and then continuing Westerly in a slope to an elevation of plus 10.0 above mean low water at the Easterly edge of the ocean highway (generally referred to as the Coastal Highway), then with the contour of said ocean highway to the Westerly edge thereof, then continuing Westerly with a one percent grade to the waters of whichever bay may lie to the West of said area. Before digging, mining, stripping, excavating, moving or removing, relocating or carrying away any of said material where the elevation shall be less than the established grade, a permit therefor must be obtained from the County Commissioners of Worcester County.

6B. No person, firm or corporation shall in any manner, dig, mine, strip, excavate, move or

remove, relocate or carry away, or otherwise disturb, injure, destroy or reduce the effectiveness as a natural protection barrier of any sand dune, rise, hill, bluff or elevated section of land or beach in that area described in Section 6A of the subtitle, whether natural or created, which does or could form a part of the protective barrier dune system as shown on a profile plat of the State Roads Commission of Maryland, entitled, "Beach Dunes, and M. L. W. lines from 26th Street, Ocean City, Md. to Delaware State Line, under date of June, 1960," or revisions thereof, without first having secured a permit therefor from the County Commissioners of Worcester County. In no event shall the elevation thereof be lowered below the crest elevation of plus 16 above M. L. W. as established by the aforementioned plat of the State Roads Commission of Maryland from data secured in July of 1954, nor shall the crest be reduced in width to less than 25 feet wide, nor shall the seaward runoff slope be less than 1 on 12, nor shall any of the remaining formation be left in an unstabilized condition. Also, in no event shall any construction or reconstruction of said dune formation or any part thereof injure or destroy or in any way interfere with or reduce the operation of any then-existing groins, jetties, or any other erosion control works.

6C. No person, firm or corporation shall in any manner dig-up, strip, cut, smother, remove or otherwise injure or destroy any trees, grass, weeds, plants or any type or kind of vegetation growing on any dune referred to in Section 6B of this subtitle, without first having secured a permit therefor from the County Commissioners of Worcester County, and then only in connection with the permission granted in Section 6B of this sub-title, and further only upon condition that the same or like trees, grass, weeds, plants or other vegetation, to be approved by said County Commissioners, or some other type or kind or stabilizing material, also to be approved by said County Commissioners, will be planted or replanted, placed, or replaced thereupon for the purpose of stabilizing the remaining formation.

6D. The County Commissioners of Worcester County shall not consider any application for a permit pursuant to Sections 6A and 6B of this sub-title unless and until the owner of the premises shall first file with it an application

requesting such permission and setting forth in detail a description of the property for which such permit is sought, the types and quantities of material to be affected, the purposes thereof, the manner in which such is to be accomplished and the time at which work is proposed to begin and will be completed, together with a map of the premises showing the contour lines and proposed contour grades resulting from the operation for which the application is filed and in relation to the topography of the premises: and the said proposed contour lines and proposed grades shall be subject to the inspection and approval of said County Commissioners, no such permit to be issued until such map has been filed and until the proposed contour lines and grades have been approved by said County Commissioners.

6E. Upon written request for a hearing made by the applicant to the County Commissioners of Worcester County, an opportunity to be heard within thirty (30) days thereafter shall be granted, and said County Commissioners in considering and reviewing the application and in arriving at its decision shall be guided by and take into consideration the public health, safety and general welfare, and particular consideration shall be given to the following factors:

- (1) Sand or soil erosion by water and wind.
- (2) Drainage.
- (3) Lateral support slopes and grades of abutting streets and lands.
- (4) Land values and uses.
- (5) Any and all standards, conditions or restrictions established by planning and zoning programs and ordinances, building codes, fire codes, health regulations and ordinances, health department requirements.
- (6) Such other factors as may bear upon or relate to the coordinated adjusted and harmonious physical development of the area.

If after examining the application and the map provided for in Section 6D of this sub-title, and after the hearing, in the event a hearing is requested by the applicant, said County Commissioners shall be of the opinion that the proposed relief for which a permit is sought will not create conditions inimical to the public health, welfare

and safety and will not result in the creation of any sharp declivities, pits or depressions, sand or soil erosion, depressed land values, nor create any drainage, sewerage problems or other conditions of danger, nor violate any applicable ordinances, regulations or programs of any state, county or local governmental agency, nor be deleterious, obnoxious or objectionable to the surrounding areas, then the permit shall be granted.

6F. Before any permit shall be granted or issued pursuant to this sub-title, the owner or applicant shall file with the County Commissioners of Worcester County a bond, in form and with surety acceptable to said County Commissioners, in such amount as in the opinion of said County Commissioners, shall be sufficient to insure the faithful performance of the work to be undertaken pursuant to the permit granted by the County Commissioners of Worcester County, pursuant to the provisions of this sub-title.

6G. The County Commissioners of Worcester County may from time to time by ordinance enact, adopt, amend, repeal or alter such reasonable rules and regulations as may be necessary and proper to carry out the intent and provisions of this sub-title; and may set or establish reasonable charges for the issuance of the permits required by the provisions of this sub-title.

6H. The powers and duties conferred upon the County Commissioners of Worcester County by this sub-title shall be performed by it, unless otherwise provided, until such time as said powers and duties shall be delegated by resolution of said County Commissioners to an administrative department thereof which has been or shall be created by state or local law or ordinance: provided, however, that any action taken pursuant to Section 6J of this sub-title or any powers exercised pursuant to Section 6G of this sub-title, shall be taken and exercised only by the County Commissioners of Worcester County.

6I. Any person, firm or corporation, violating any of the provisions of this sub-title or of any regulation validly in force thereunder, shall be guilty of a misdemeanor, and upon conviction thereof shall be subject to a fine not exceeding One Thousand Dollars (\$1,000.00), or imprisonment in the County jail for ninety (90) days, in

the discretion of the Magistrate or Court. Each and every violation and nonconformance of this sub-title, or each day that any provision of this sub-title shall have been violated, shall be construed to be a separate and distinct violation thereof.

6J. In addition to the penalties set forth in Section 6-I, the County Commissioners of Worcester County may prevent, deter or stop any violations or attempted violations of the provisions of this sub-title by way of injunction or resort to other remedies or proceedings of a legal or equitable nature in the courts of Worcester County.

SEC. 2. And be it further enacted, That if any section, sub-section, sentence, clause or other provision of this Act, or the application thereof to any person or circumstance is held invalid or unconstitutional, such invalidity or unconstitutionality shall not affect the remaining provisions of this Act, and the application of such provisions to other persons or circumstances.

SEC. 3. And be it further enacted, That this Act is hereby declared to be an emergency measure and necessary for the immediate preservation of the public health and safety, and having been passed by a yea and nay vote supported by three-fifths of the members elected to each of the two houses of the General Assembly, the same shall take effect from the date of its passage.

AMENDMENT TO BUILDING CODE — WRIGHTSVILLE BEACH, N. C.

WHEREAS, as a result of the extensive property damage caused by the recent Hurricane Hazel, it is the opinion of this governing body that an amendment to the Building Code is necessary for the protection of life and property from future hurricanes and storms and,

WHEREAS, the construction requirements provided by this amendment will materially reduce the possibility of extensive property damage in the event of future hurricanes, severe storms, and unusual high water, and, therefore, promote the safety and general welfare of this community, NOW THEREFORE, be it ordained by the Board of Commissioners of the Town of Wrightsville Beach, N. C.

Section 1. General construction. The Building Code of the Town of Wrightsville Beach is hereby amended to include as additional requirements to the present code the following:

(1) At least every third rafter shall be anchored to the ceiling joists or partitions directly beneath by no less than the equivalent of 1- x 6-inch boards securely nailed. Such braces shall be attached to the rafters at their mid-points, or at the third points if two are used per rafter. In peaked roofs, opposite rafters shall be laterally braced to each other at the ridge in a manner satisfactory to the Building Inspector.

(2) Roof trusses shall be securely anchored to masonry walls at points of bearing.

(3) Where wood partitions and masonry walls join, the stud abutting the masonry shall be doubled and bolted to the masonry with three ½-inch galvanized bolts; one to be embedded in the tie beam, one in midsection, and one near the base. The end of the partition plate shall also be anchored to the stud abutting the wall and to the wall plate in an approved manner.

(4) Rafters shall be anchored to the wall plate by approved metal anchors attached to at least every other rafter or shall be otherwise anchored to the satisfaction of the Building Inspector.

(5) Girders resting on masonry foundation walls or piers shall be anchored thereto with not less than ½-inch bolts embedded at least 6 inches in the masonry.

(6) Wooden columns and posts shall be securely anchored to their foundations and to the members which they support.

Section 2. Roof coverings. The Building Code of the Town of Wrightsville Beach is hereby further amended to include as additional requirements to the present code the following:

(1) Roof coverings shall be securely attached in accordance with methods approved by the Building Inspector.

(2) Nails, clips, and similar attaching devices shall be galvanized or otherwise suitably corrosion-resistant.

(3) Wood roof decks to which composition roofing is attached shall be solidly sheathed.

(4) Where two or more layers of roofing are applied to wood decks, the first layer shall be spot-mopped and tin-capped and nailed to the sheathing with nails not over 12 inches on centers in each direction.

(5) Roll roofing applied in a single layer shall be spot-mopped, and top edge blind-nailed to sheathing not less than 6 inches on centers, with lap not less than 2½ inches.

Section 3. Piles required. The Building Code is hereby further amended to read as follows:

All new structures and all structures rebuilt or repaired where the structure required a new foundation or where rebuilding or relocating a building on existing foundations is necessary, shall be built upon piles in accordance with the following requirements:

(1) **Height.** Piles shall not be less than eight (8) feet in height, measured from the "Building Line" of the Town of Wrightsville Beach as established by the North Carolina General Assembly and as shown on the map of the Town of Wrightsville Beach dated September 4, 1941. The height of the piles, measured from the mean-high-water mark if established by competent authority, may be used in lieu of the "Building Line" in measuring the required pile height. The average elevation of the building lot may be obtained by averaging the known elevations measured at the corners of such lot.

(2) **Type of pile.** Wood piles, reinforced concrete, or steel piles may be used. Wood piles shall be in one piece and shall be of Southern Pine, Douglas Fir, or other approved wood. Piles shall be free from short kinks and shall have a uniform taper from end to end. The tops of all wood piles shall be sawed off clean along a horizontal plane. Reinforced concrete or steel piles may be used if made and installed in accordance with accepted good building practice.

(3) **Required depth of piles.** Piles shall be sunk or buried to a depth of not less than 100% of the required height of the pile.

(4) **Size of wood piles.** Round timber piles shall not be less than 8 inches in diameter at the

butt. Squared timber piles shall not be less than 8 inches square, nominal.

(5) **Spacing of wood piles.** The maximum center-to-center spacing of wood piles shall not be more than eight (8) feet on centers under weight bearing sills. However, for two-story or larger buildings, or where the load-bearing requirements demand it, piles may be required to be spaced closer together by the Building Inspector.

(6) **Tieing and bracing of wood piles.** Wood piles shall be tied to the structure with bolts or galvanized strips at least 4 inches wide with galvanized nails, or tied in some other approved manner. Each pile shall be properly braced in an approved manner, and, when timber braces are used, the recommended size shall be 4" x 4".

(7) **Wood piles treated.** All wood piles shall be treated except when the type of wood pile, in the opinion of the Building Inspector, requires no treatment. Treatment of piles shall be substantially as follows:

Piles shall be pressure-treated by an empty-cell process with grade one coal-tar creosote to a net final retention of not less than 12 pounds of creosote per cubic foot of wood.

Section 4. Application of ordinance. Sections 1 and 2 of this Ordinance amending the building code of the Town of Wrightsville Beach shall apply to all new structures and to those portions of existing structures repaired, rebuilt, or remodeled after the effective date of this Ordinance. Section 3 of this Ordinance shall apply as set forth in Section 3 above.

Section 5. Exceptions. The requirements of this Ordinance may be varied by the Board of Commissioners and the Mayor of the Town of Wrightsville Beach by unanimous vote when, in their opinion, such variation will not substantially reduce the requirements set forth herein. Provided, however, the Board shall not act on any variation without first obtaining the recommendation of the Building Inspector.

Section 6. Repealing clause. All Ordinances or parts of Ordinances in conflict with this Ordinance are hereby repealed.

Section 7. Effective date. This ordinance shall be in full force and effect from and after the _____ day of _____, 1955.

Attest:

Town Clerk
January 17, 1955

Approved as corrected:

Robert N. Drain
E. F. Peschau
M. E. Bullard
Lawrence C. Rose
G. W. Gillette

Approved by the Building Inspector:
L. P. Grimes

(PRELIMINARY DRAFT)

August 12, 1964

A BILL TO BE ENTITLED AN ACT AMENDING ARTICLE 3 OF CHAPTER 104B OF THE GENERAL STATUTES SO AS TO MAKE MORE SPECIFIC THE POWER OF LOCAL GOVERNMENTS TO PROTECT SAND DUNES ALONG THE OUTER BANKS.

The General Assembly of North Carolina do enact:

Section 1. Article 3 of Chapter 104B of the General Statutes of North Carolina as the same appears in Replacement Volume 2C, 1958, is hereby repealed and the following new Article 3 is substituted therefor:

"Article 3.

"Protection of Sand Dunes along Outer Banks.

§104B-3. Legislative findings. It is hereby determined and declared as a matter of legislative finding that the area of the State of North Carolina lying along the Atlantic Ocean front, and in particular the Outer Banks of this State as hereinafter defined, is a major asset to the economy of the entire state and as such should be protected and preserved. This area is wholly or in part protected from actions of the Atlantic Ocean and storms thereon by a system of natural or constructed dunes providing a protective barrier for adjacent lands and inland waters and land against the actions of sand, wind, and water. Certain persons, firms, and corporations have

from time to time modified or destroyed the effectiveness of protective barriers in the process of developing the waterfront for various purposes. These practices constitute serious threats to the safety of adjacent properties and to public highways, as well as to the value and taxable basis of such adjacent properties, and they constitute a real danger to the health, safety, and welfare of persons living, visiting, or sojourning in such area. It is therefore deemed necessary to protect that area and especially the system of protective barrier dunes as hereinafter provided. The intent of the passage of this legislation is to declare enforcement under the police power since the incumbents are solely for the protection of the public as it relates to their health, morals, welfare and their well being.

§104B-4. Damaging, constructing or removing without permit.—It shall be unlawful for any persons, firm, or corporation in any manner to damage, destroy, or remove any sand dunes, or part thereof, kill, destroy, or remove any trees, shrubbery, grass, or other vegetation growing on said dunes, construct any building or part thereof, open any new road or street or remove sand, sea shells and similar materials, within 250 feet of mean sea level along the outer banks of this State as hereinafter defined, without first having obtained a permit as specified herein authorizing such proposed damage, destruction, or removal.

§104B-5. Findings prerequisite to issuance of permit.—No such permit shall be granted by any officer, agency, or board charged with the issuance of permits hereunder unless such officer, agency, or board shall first have found as a fact that the particular action, damage, destruction, or removal proposed will not materially weaken the dune as a means of protection from the effects of high wind and water, taking into consideration the height, width, and slope of the dune or dunes and the amount and type of vegetation thereon. In no event shall a permit be granted which would authorize (a) lowering of the crest of the dune below an elevation of 15 feet above the mean low water level, (b) reducing the width of the crest of the dune to less than 50 feet, (c) increasing the seaward runoff slope of the dune to a steepness of more than 1 in 10, (d)

leaving any of the remaining formation in an unstabilized condition, (e) or in any manner injuring, destroying, interfering with, or reducing the operation of any then-existing groins, jetties, or any other erosion-control works.

§104B-6. Designation of Shoreline Protection Officer or Officers.—Any board of county commissioners whose county includes a portion of the area subject to this act may appoint one or more Shoreline Protection Officers, to serve at the will of the board. At its discretion, the board of county commissioners may designate as a Shoreline Protection Officer:

a. A Shoreline Protection Officer of any other county or counties, with the approval of the board of county commissioners of such other county or counties;

b. A municipal employee or official of any municipality or municipalities within the county, with the approval of the municipal governing body;

c. Any employee or official of the county; or

d. Any other person or persons whom the commissioners deem to be qualified.

In the absence of such appointment or appointments, the board of county commissioners shall itself have the duties of the Shoreline Protection Officer as specified herein.

The board of county commissioners may pay a Shoreline Protection Officer a fixed salary or may in lieu thereof reimburse him for his services by paying over any fees which he collects. The board of county commissioners may also accept and disburse any funds which may be made available by the state or federal governments as contributions towards the salary or expenses of a Shoreline Protection Officer. The board of county commissioners may make necessary appropriations for the special purpose of paying the salary or salaries of Shoreline Protection Officers and any expenses pertaining to shoreline protection and may levy annually taxes for the payment of such appropriation as a special purpose, in addition to any allowed by the Constitution.

The board of county commissioners may enter into and carry out contracts with any other county or counties under which the parties agree

to support a joint Shoreline Protection Department. The board of county commissioners may make any necessary appropriations for such a purpose.

§104B-7. Duties of Shoreline Protection Officer.—It shall be the duty of the Shoreline Protection Officer to receive applications for permits under this Article, to check each application for compliance with this Article and any regulations adopted by the board of county commissioners, to inspect the property or properties involved, to make the findings called for under this Article, to issue the permit where no fact appears which would make such issuance a violation of this Article or of regulations adopted hereunder, to collect such fees as may be specified by the board of county commissioners and to deliver same to the county treasurer, to furnish a surety bond for the faithful performance of his duties and the safeguarding of any public funds coming into his hands (which bond shall be approved as to amount, form, and solvency of sureties by the board of county commissioners), and to carry out such related duties as may be specified by the board of county commissioners.

§104B-8. Regulations by board of county commissioners.—The board of county commissioners is hereby empowered to adopt and enforce such regulations as it may deem necessary concerning the form, time, and manner of submission of any application for a permit under this Article. It may also fix any reasonable fees to cover part or all of the cost of necessary inspections or other administrative procedures under this Article.

§104B-9. Appeal from decision of Shoreline Protection Officer.—In the event that a Shoreline Protection Officer denies a permit under this Article, the applicant may within 30 days file an appeal with the board of county commissioners. In the event that a Shoreline Protection Officer grants a permit under this Article, any property owner whose property may be damaged by action taken under the permit may within 30 days file an appeal with the board of county commissioners. On receipt of any appeal, the board of county commissioners shall be entitled to consider the matter ab initio and may take any action which

the Shoreline Protection Officer could have taken under this Article.

Every decision of the board of county commissioners on such appeal shall be subject to review by the superior court of the county by proceedings in the nature of certiorari.

Pending the final disposition of any such appeal, no action shall be taken which would be unlawful in the absence of a permit issued under this Article.

§104B-10. Enforcement.—Any violation of this Article shall constitute a misdemeanor, and upon conviction thereof, any person, firm, or corporation committing such violation shall be fined not less than \$50 nor more than \$500. Failure to restore any sand dune or part thereof which has unlawfully been damaged, destroyed, or removed, or to restore or replace any trees, shrubbery, grass, or other vegetation which has unlawfully been killed, destroyed, or removed from said dunes shall constitute a separate violation of this Article for each ten days that such failure continues after written notice from the Shoreline Protection Officer or the board of county commissioners.

In addition to other remedies, the board of county commissioners may institute any appropriate action or proceedings (1) to restrain or prevent any violation of this Article or (2) to require any person, firm, or corporation which has committed a violation to restore any sand dune or part thereof which has unlawfully been damaged, destroyed, or removed, or to restore or replace any trees, shrubbery, grass, or other vegetation which has unlawfully been killed, destroyed, or removed from said dunes in violation of this Article.

§104B-11. "Outer Banks of this State" defined.—As used in this Article, the term "Outer Banks of this State" shall be construed to mean all of that part of North Carolina which is separated from the mainland by a body of water, such as an inlet or sound, and which is in part bounded by the Atlantic Ocean, and in New Hanover, Onslow, and Brunswick Counties this shall include the land areas lying between the Inter-Coastal Waterway and the Atlantic Ocean.

§104B-12. Powers of Department of Water Resources. — The Department of Water Resources shall be empowered to render advice and assistance to any Shore Protection Officer or Officers, board of county commissioners, or other officer, agency, or board having responsibilities under this article. In exercising this function it shall specifically be authorized to furnish manuals, suggested standards, plans, and other technical data; to conduct training programs; and to give advice and assistance with respect to the handling of particular applications; but it shall not be limited to such activities.”

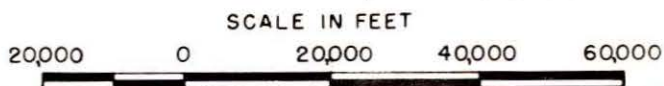
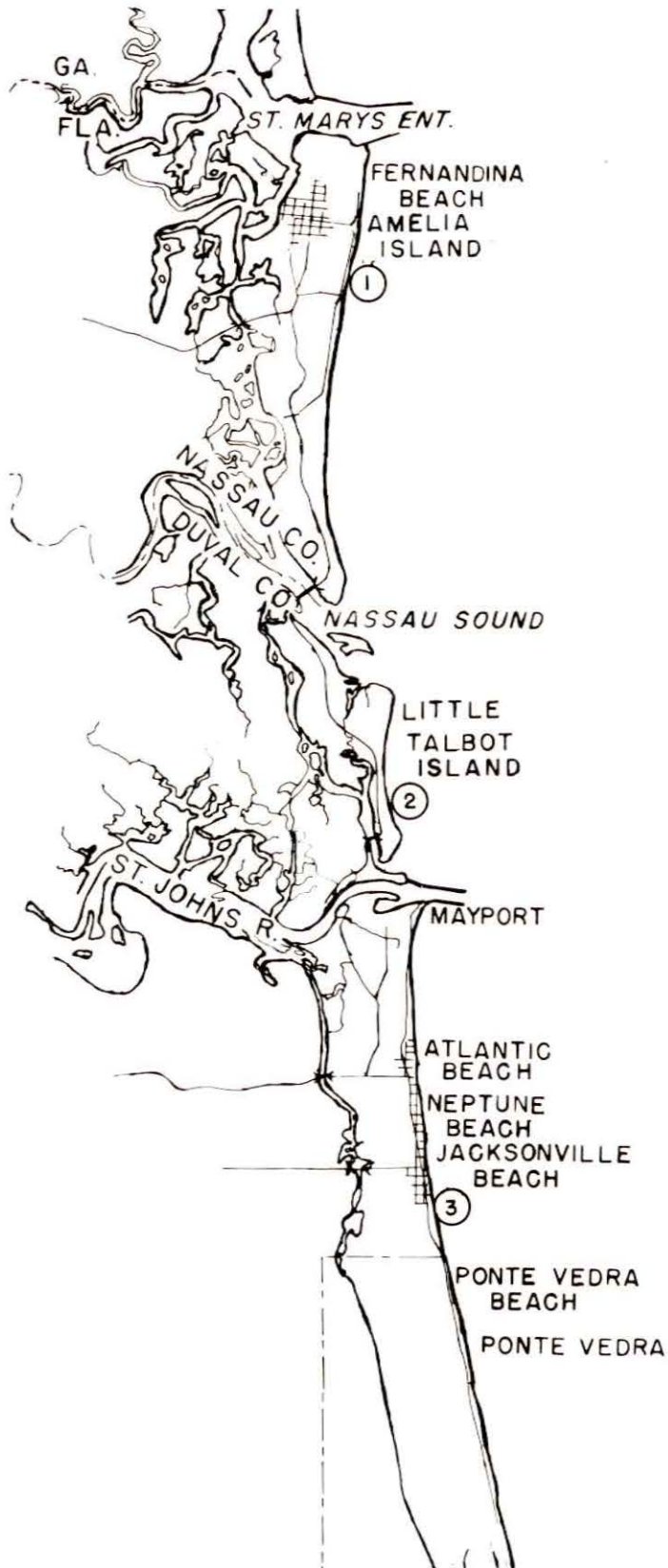
Sec. 2. Should any section, clause, or provision of this Act be declared by the courts to be unconstitutional or invalid for any reason, such decision shall not affect the validity of the Act as a whole or any part thereof other than the part so decided to be unconstitutional or invalid.

Sec. 3. All laws and clauses of laws in conflict herewith are hereby repealed to the extent of such conflict.

Sec. 4. This Act shall become effective upon its ratification.

APPENDIX III

**PHOTOGRAPHIC SURVEY
OF
SHORELINE**





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③

PHOTOGRAPHIC SURVEY
OF
SHORELINE



DUVAL CO.
ST. JOHNS CO.

SOUTH PONTE
VEDRA

USINAS BEACH

VILANO BEACH
VILANO

ST. AUGUSTINE
INLET

ST. AUGUSTINE
BEACH (4)

BUTLER BEACH (5)

CRESCENT
BEACH

MATANZAS
INLET
SUMMER HAVEN (6)

MARINELAND
(7)

ST. JOHNS CO.
FLAGLER CO.

A T L A N T I C
O C E A N

SCALE IN FEET

20000 0 20000 40000 60000





4



5

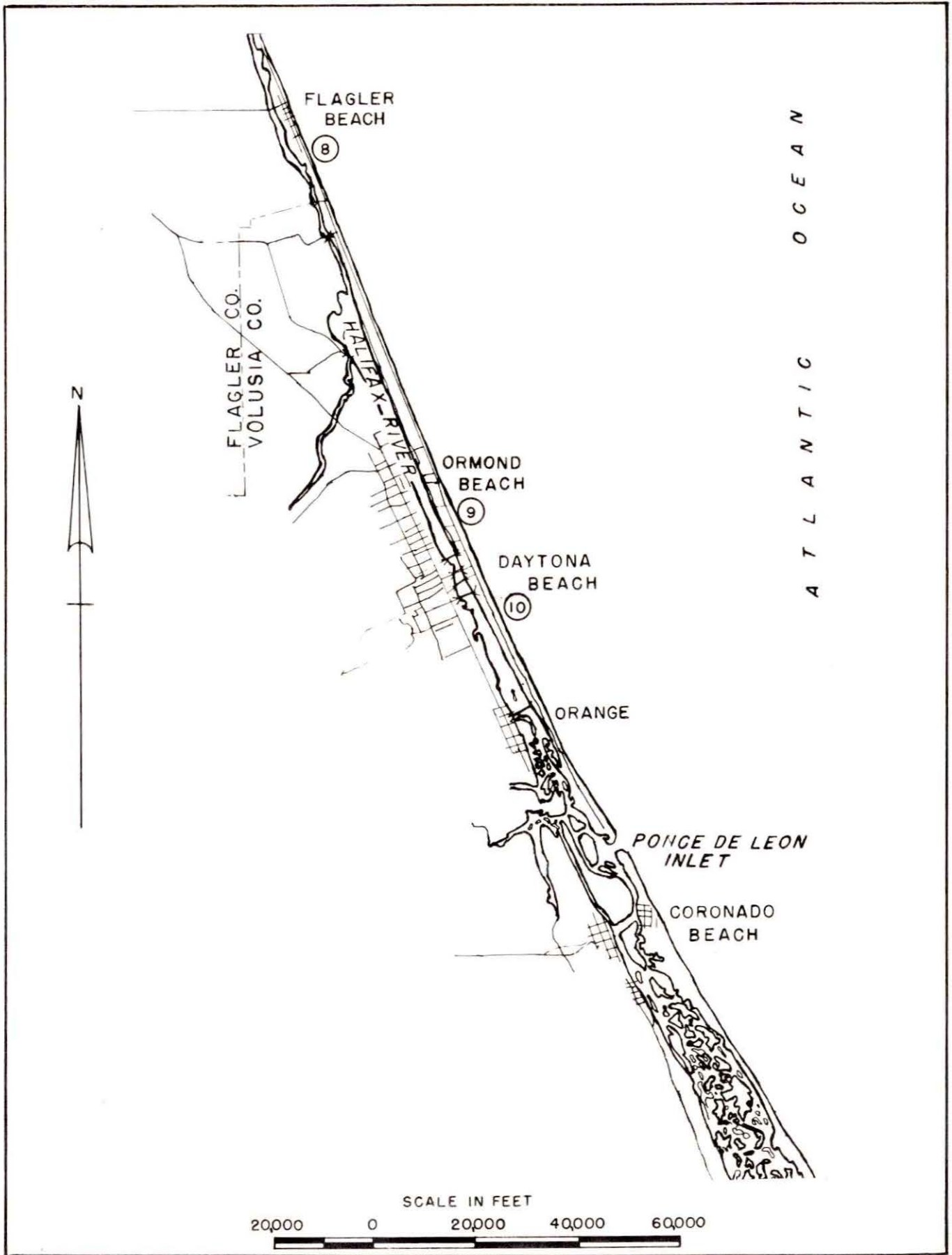


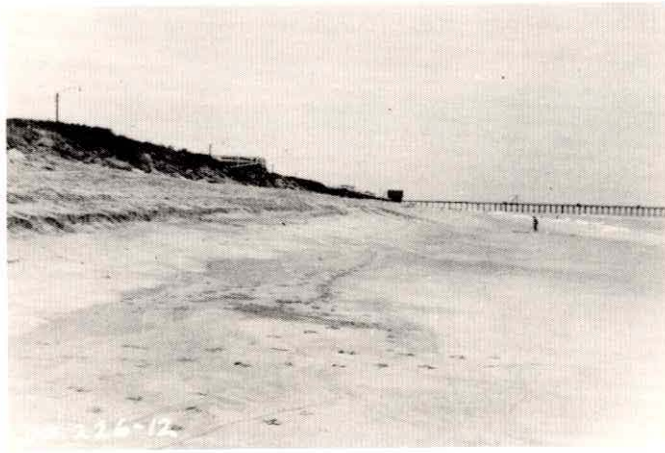
6



7

PHOTOGRAPHIC SURVEY
OF
SHORELINE





8

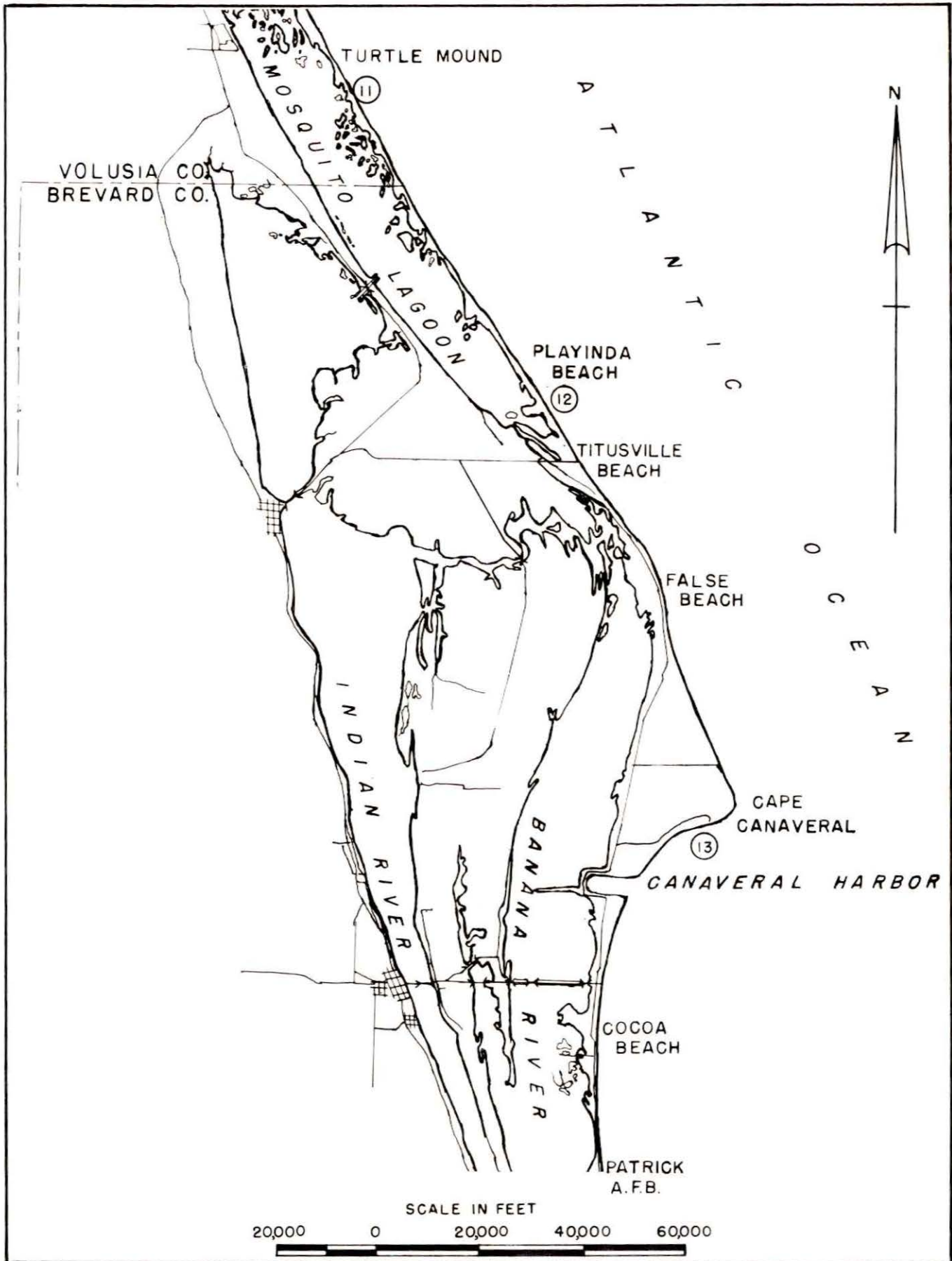


9



10

PHOTOGRAPHIC SURVEY
OF
SHORELINE



TURTLE MOUND

VOLUSIA CO.
BREVARD CO.

MOSQUITO LAGOON

A T L A N T I C
O C E A N

PLAYINDA BEACH

12

TITUSVILLE BEACH

FALSE BEACH

INDIAN RIVER

BANANA RIVER

CAPE CANAVERAL

13

CANAVERAL HARBOR

COCOA BEACH

PATRICK A.F.B.

SCALE IN FEET

20,000 0 20,000 40,000 60,000



11

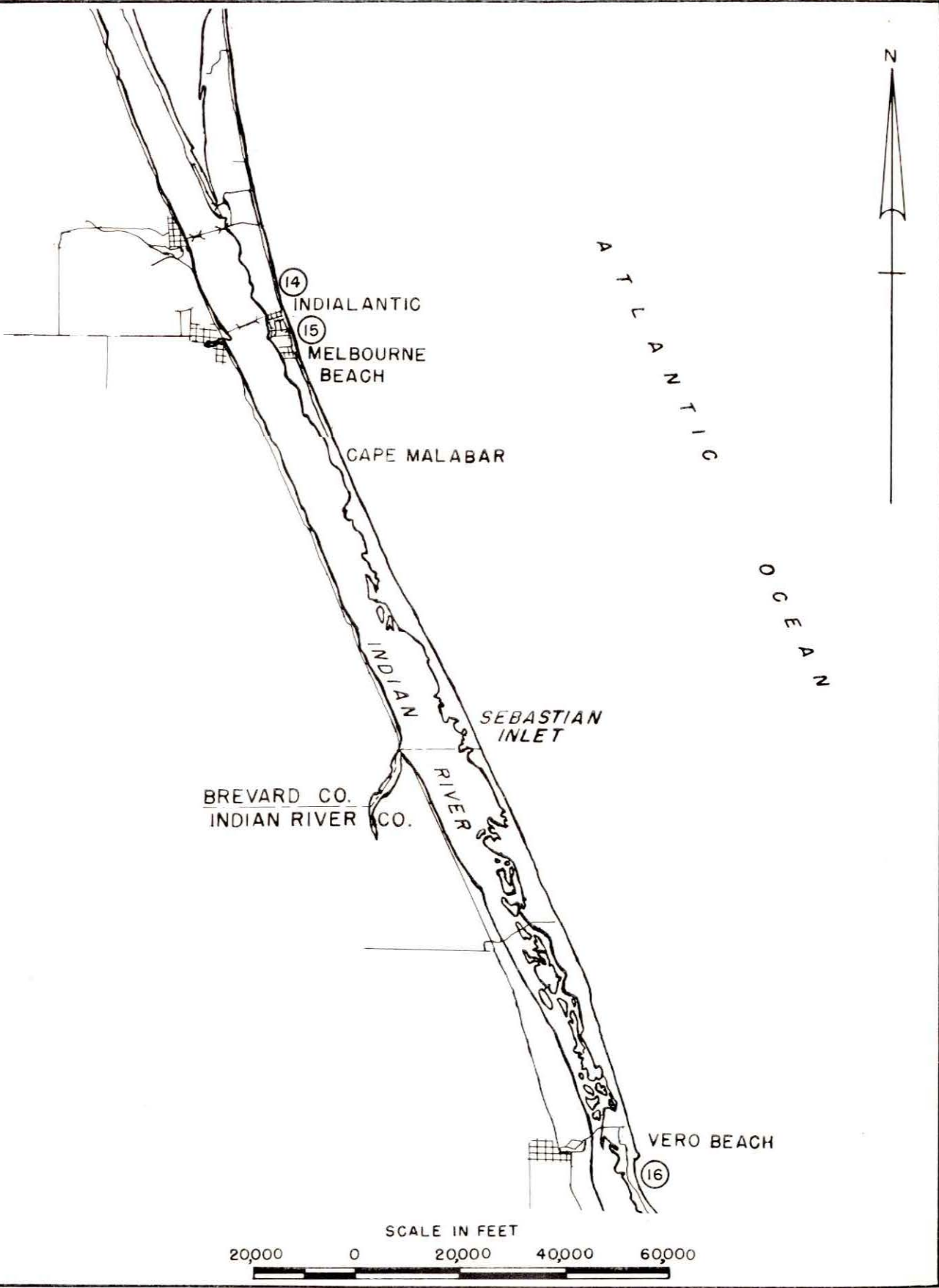


12



13

PHOTOGRAPHIC SURVEY
OF
SHORELINE





14



15



16

PHOTOGRAPHIC SURVEY
OF
SHORELINE

INDIAN RIVER CO.
ST. LUCIE CO.

PEPPER PARK (COUNTY BEACH)

17

FT. PIERCE INLET

FORT PIERCE BEACH

18

INDIAN
RIVER

ST. LUCIE CO.
MARTIN CO.

ST. LUCIE INLET

JUPITER ISLAND

19

A
T
L
A
N
T
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C

O
C
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A
N



SCALE IN FEET

20,000 0 20,000 40,000 60,000





17



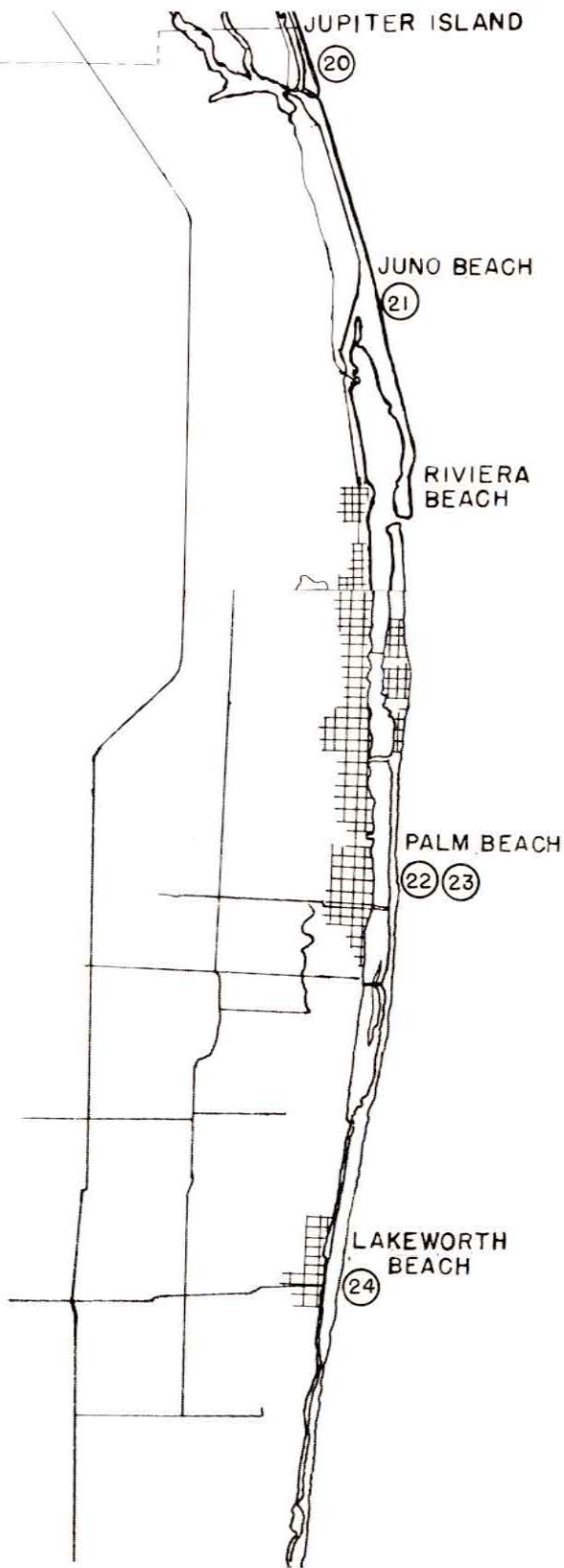
18



19

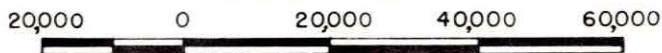
PHOTOGRAPHIC SURVEY
OF
SHORELINE

MARTIN CO.
PALM BEACH CO.



A T L A N T I C
O C E A N

SCALE IN FEET

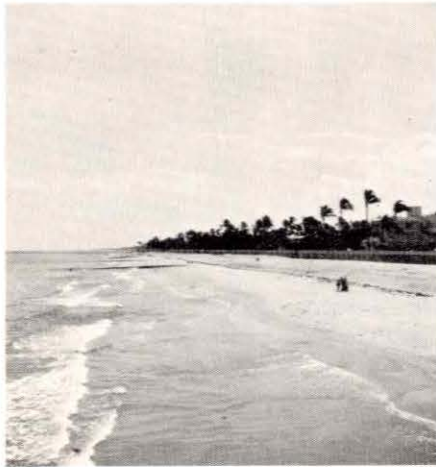




20



21



22



23



24

PHOTOGRAPHIC SURVEY
OF
SHORELINE



PALM BEACH CO.

BROWARD CO.

FORT LAUDERDALE

(25)

HOLLYWOOD

(26)

BROWARD CO.

DADE CO.

HALLANDALE BEACH

(27)

HAULOVER
BEACH

(28)

MIAMI BEACH

(29)

(30)

A T L A N T I C
O C E A N

SCALE IN FEET

20,000 0 20,000 40,000 60,000





25



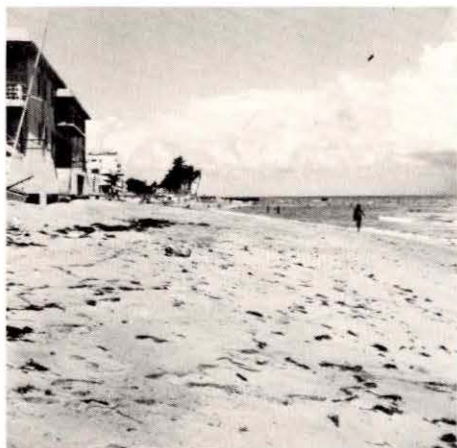
26



27



28

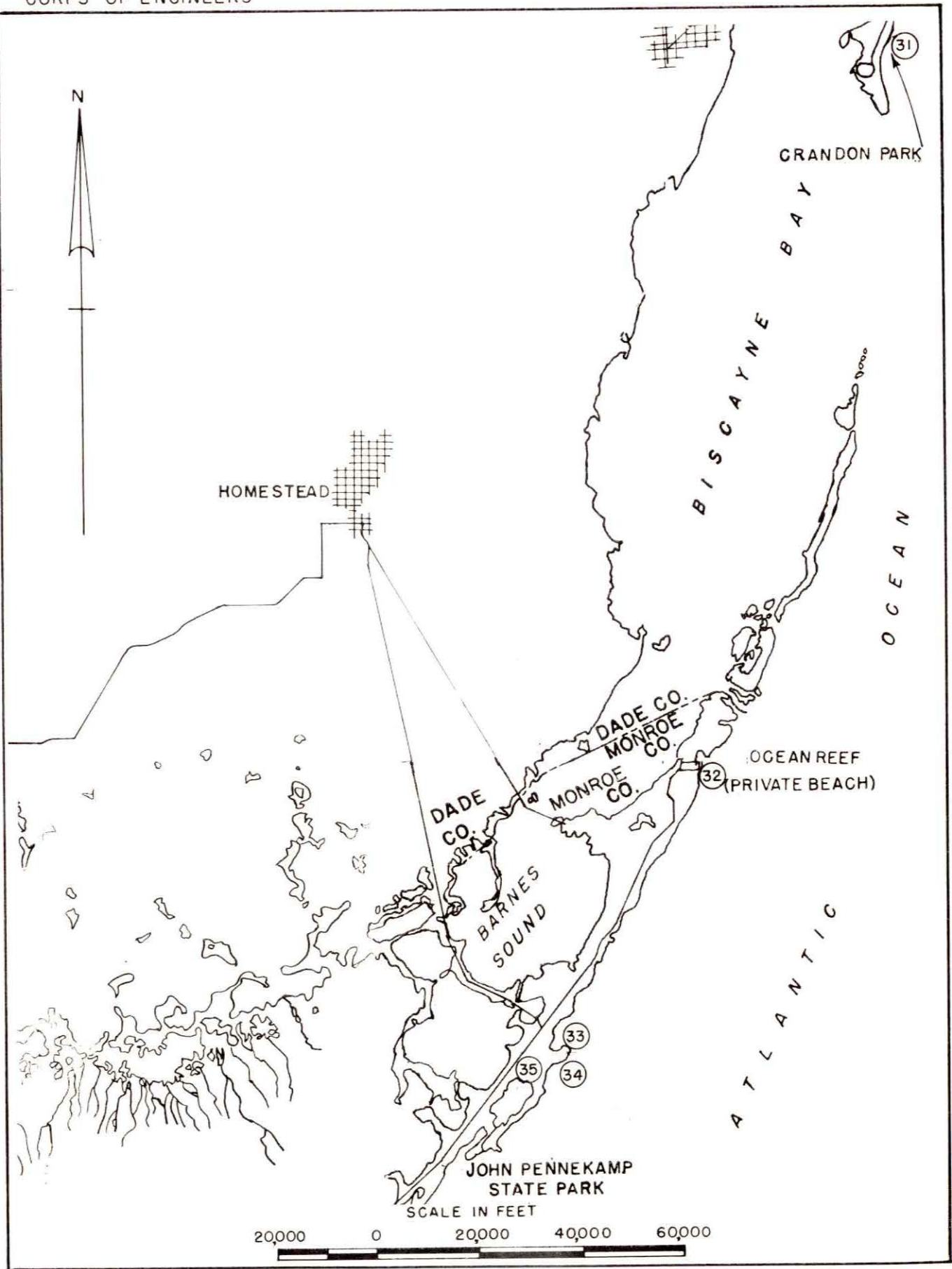


29



30

PHOTOGRAPHIC SURVEY
OF
SHORELINE





31



32



33

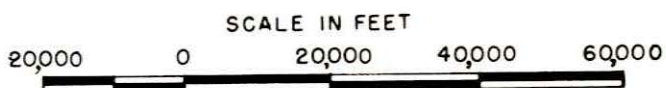
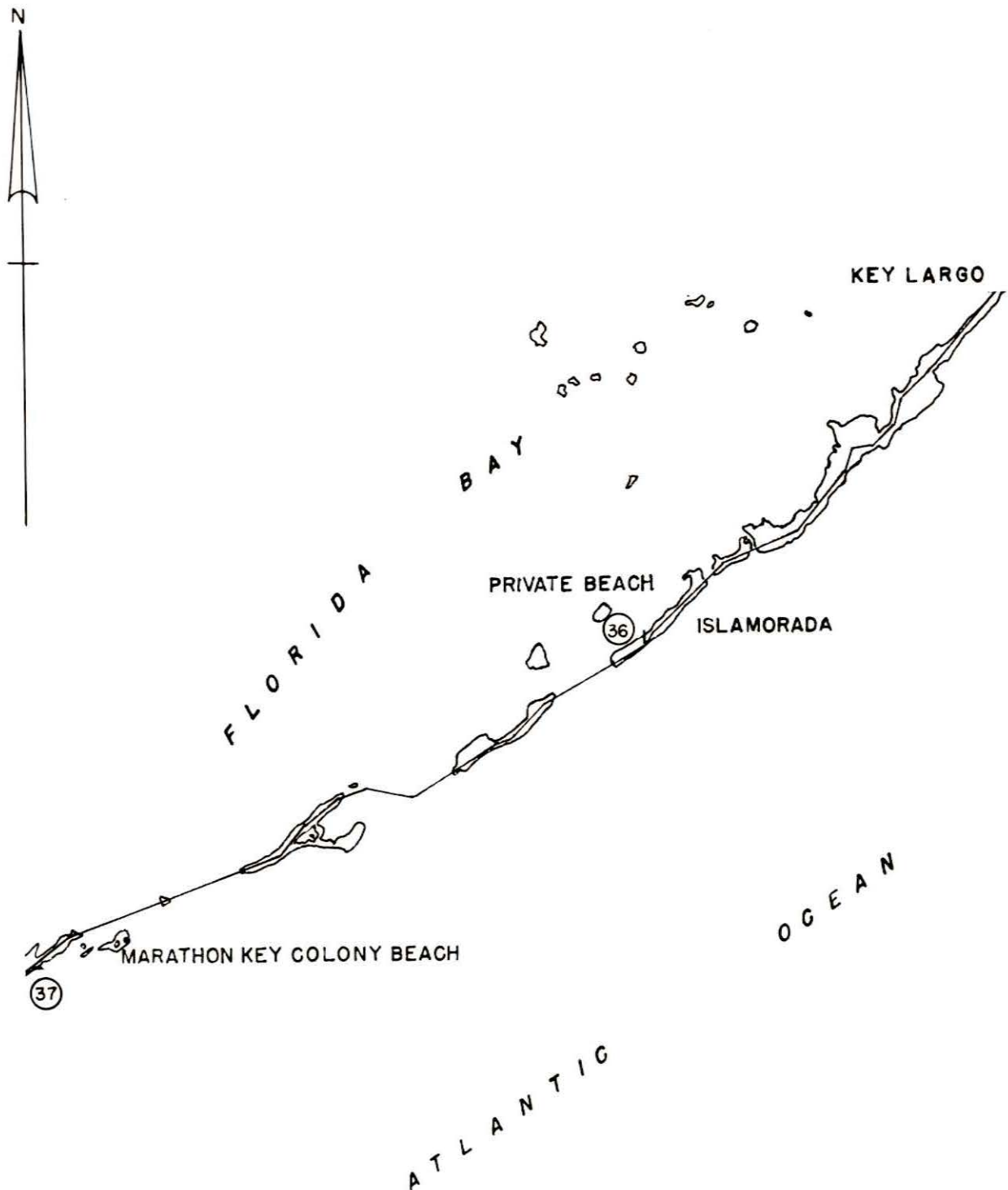


34



35

PHOTOGRAPHIC SURVEY
OF
SHORELINE





36



37

PHOTOGRAPHIC SURVEY
OF
SHORELINE

G U L F O F M E X I C O

BAHIA HONDA ST. PK.

39

38

BAHIA HONDA ST. PK.

A-A
MATCHLINE

G U L F O F M E X I C O

A-A
MATCHLINE

STRAITS OF FLORIDA

KEY WEST (SMATHERS BEACH)

41

40



SCALE IN FEET

20,000 0 20,000 40,000 60,000





38



39

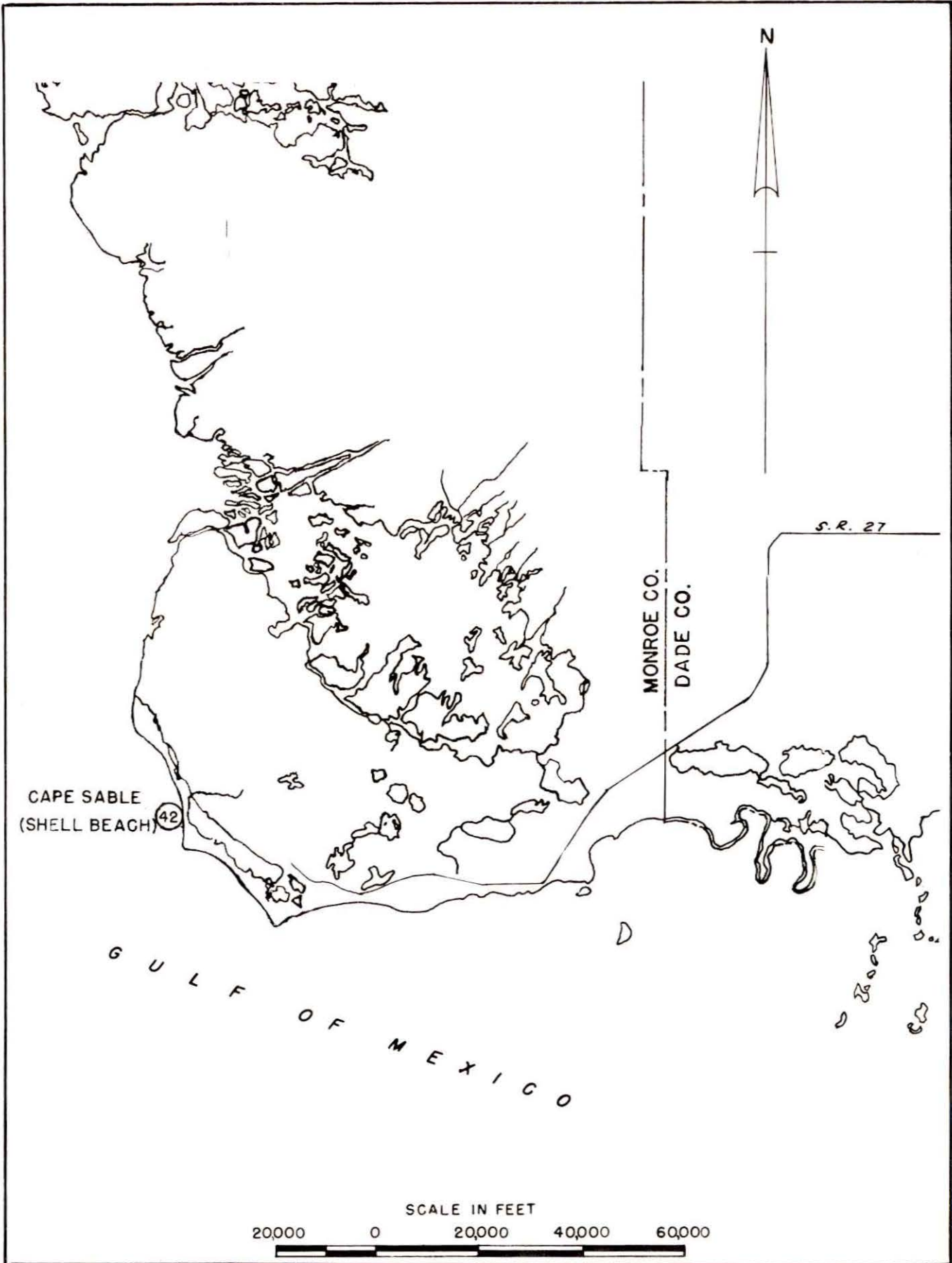


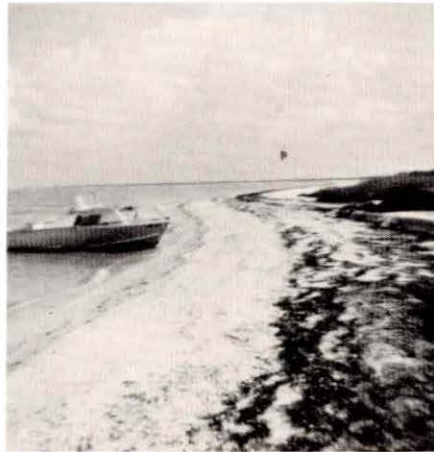
40



41

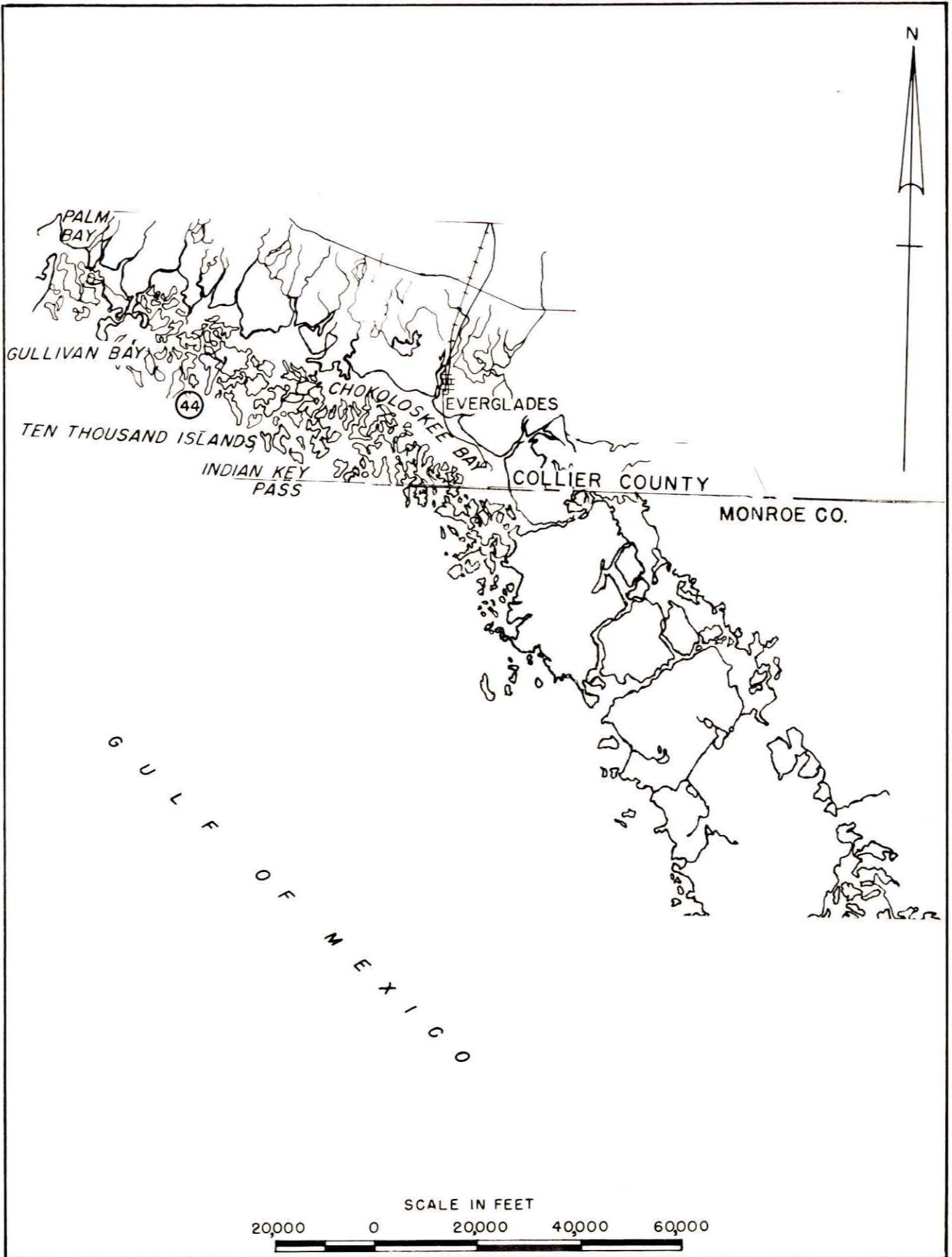
PHOTOGRAPHIC SURVEY
OF
SHORELINE





42

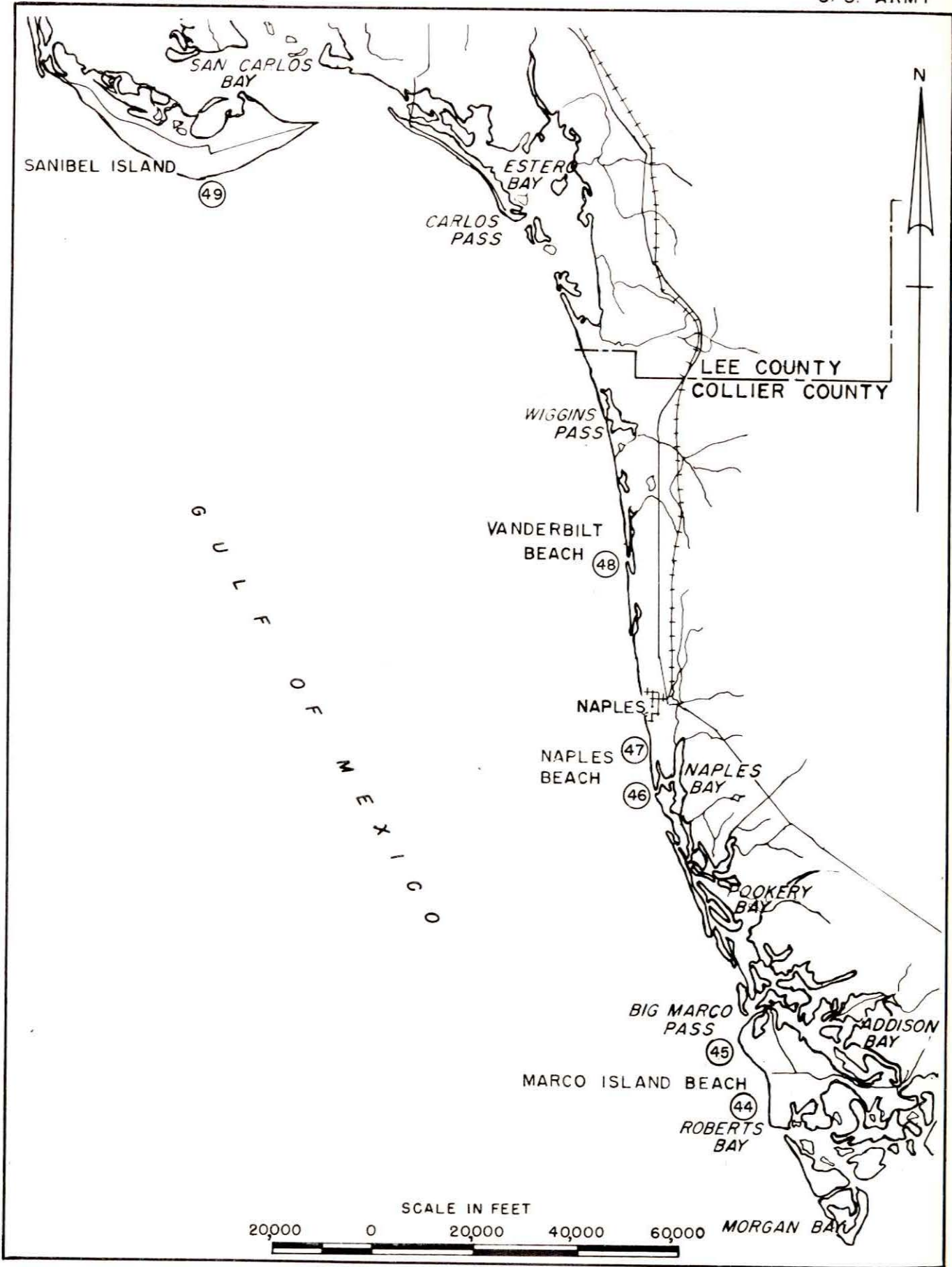
PHOTOGRAPHIC SURVEY
OF
SHORELINE





44

PHOTOGRAPHIC SURVEY
OF
SHORELINE



G
U
L
F
O
F
M
E
X
I
C
O



LEE COUNTY
COLLIER COUNTY

SCALE IN FEET

20,000 0 20,000 40,000 60,000

MORGAN BAY



44



45



46



47



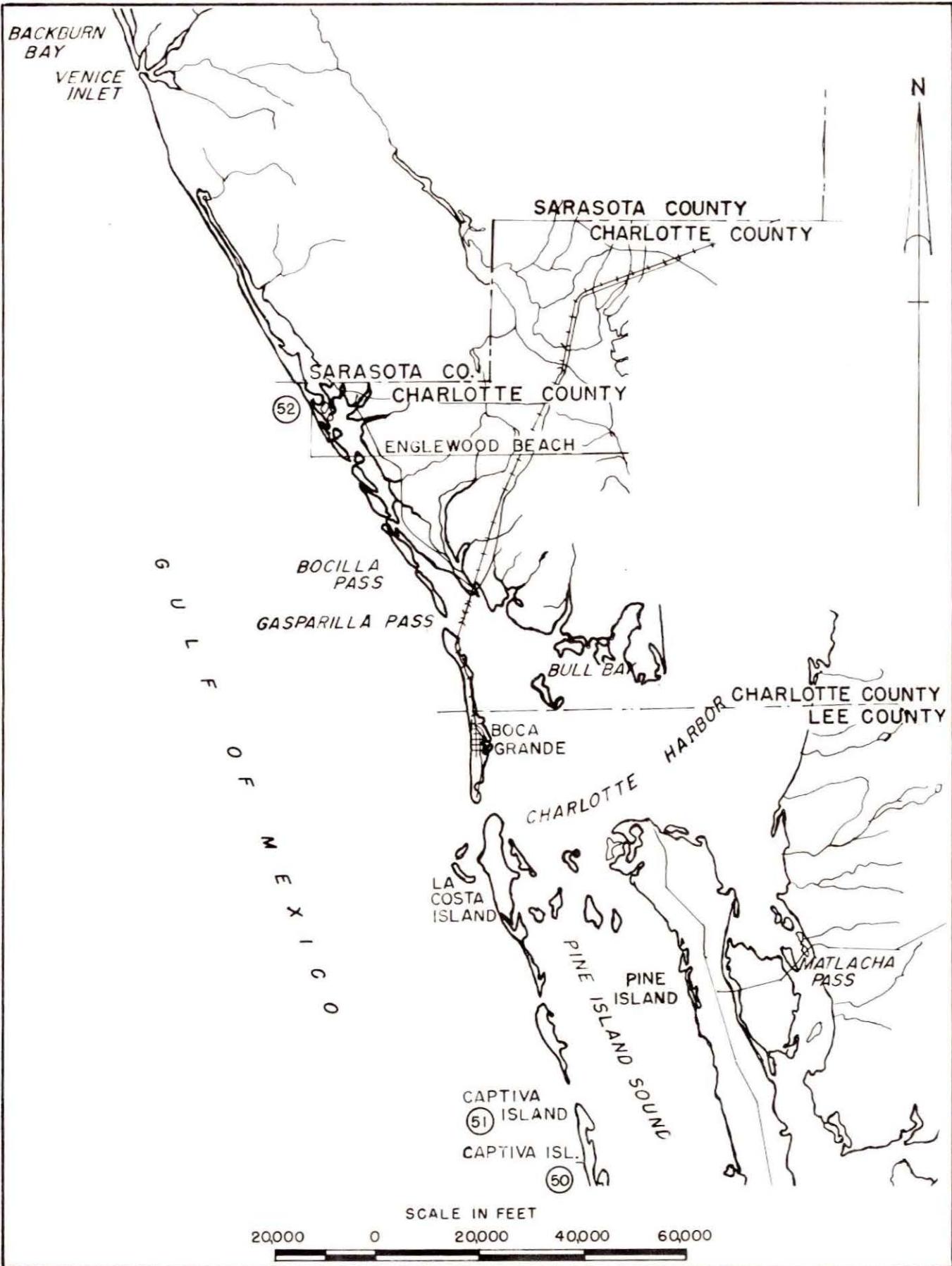
48



49

PHOTOGRAPHIC SURVEY
OF
SHORELINE

FIG. III - 14





50

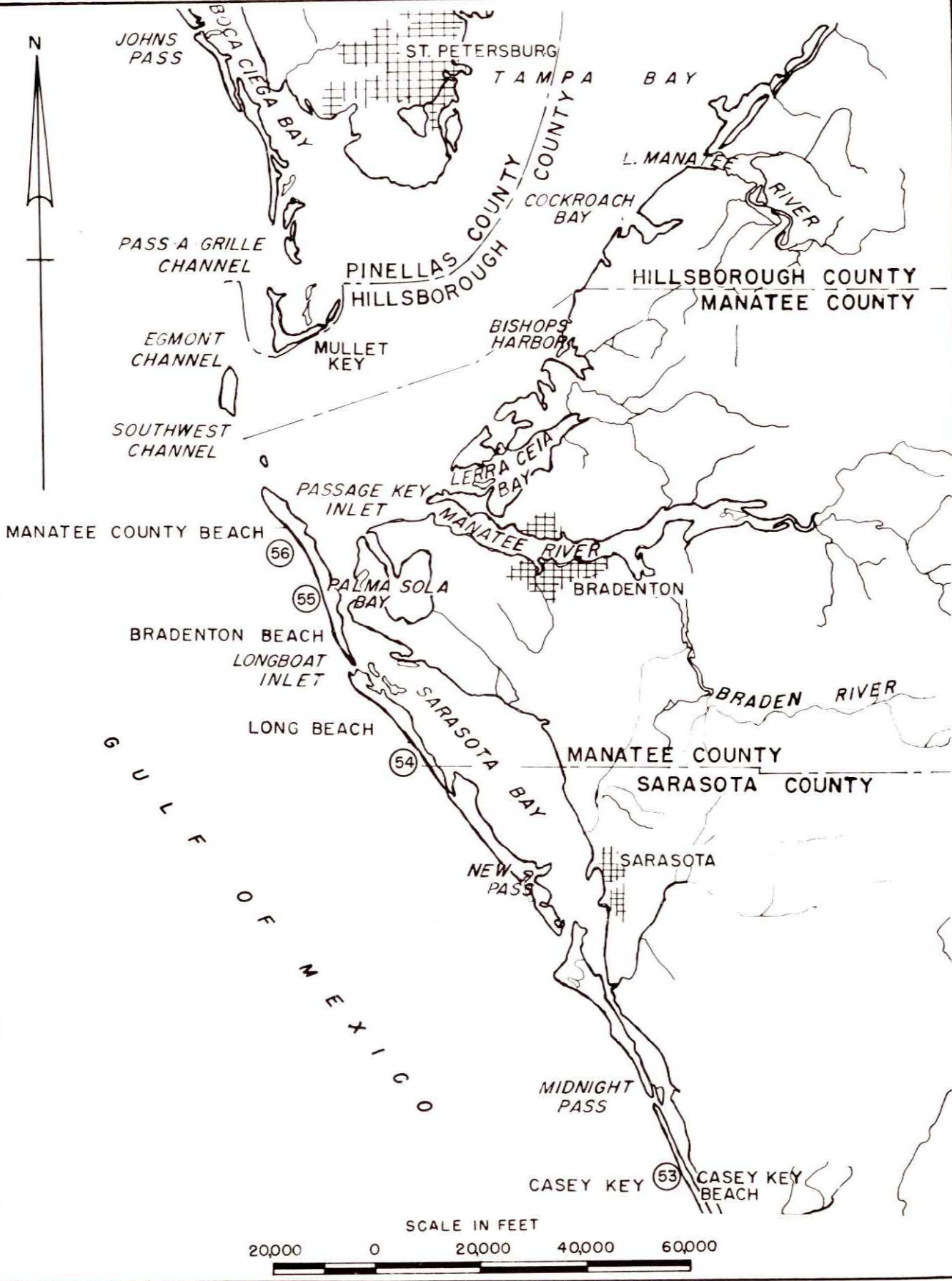


51



52

PHOTOGRAPHIC SURVEY
OF
SHORELINE





53



54

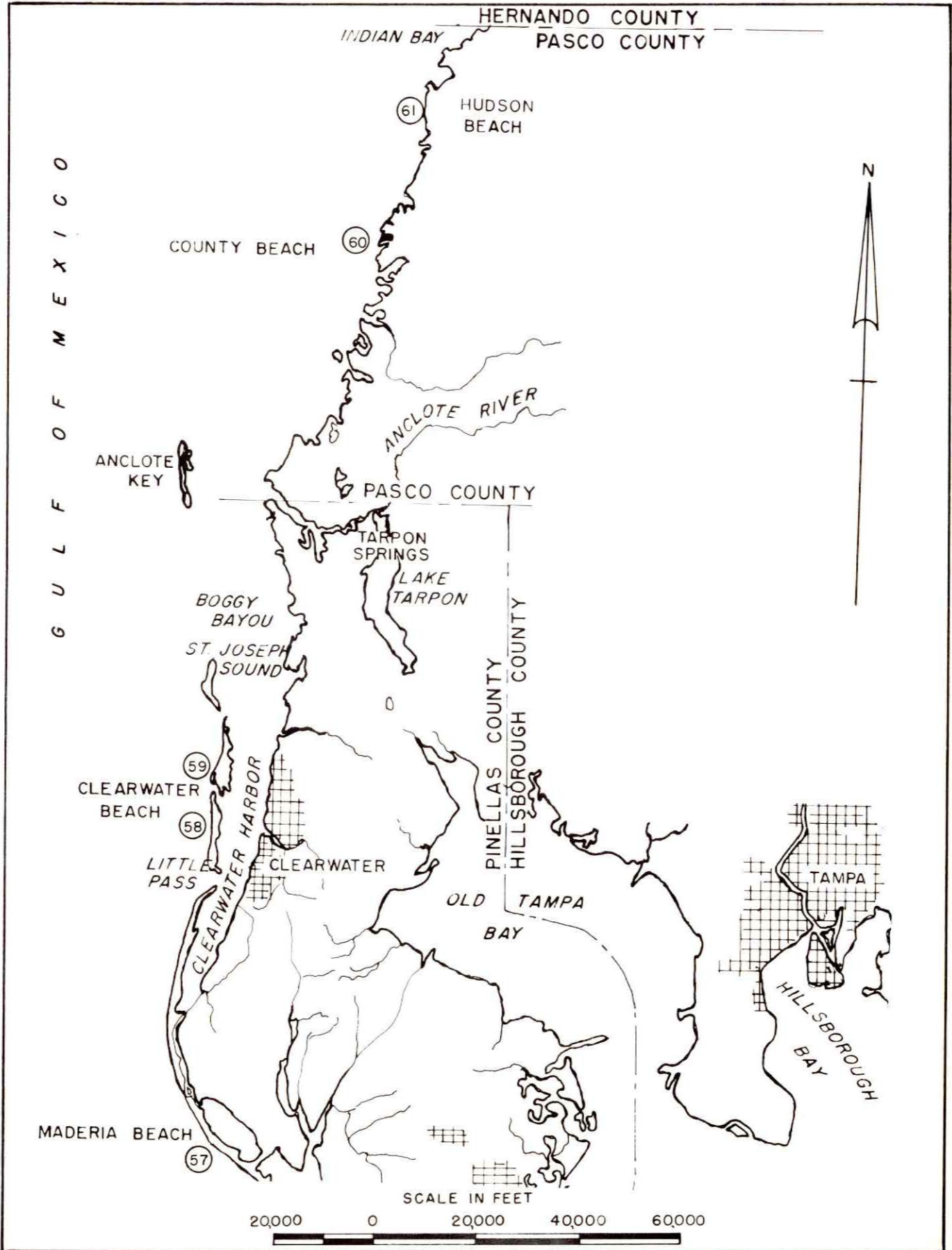


55



56

PHOTOGRAPHIC SURVEY
OF
SHORELINE





57



58



59



60



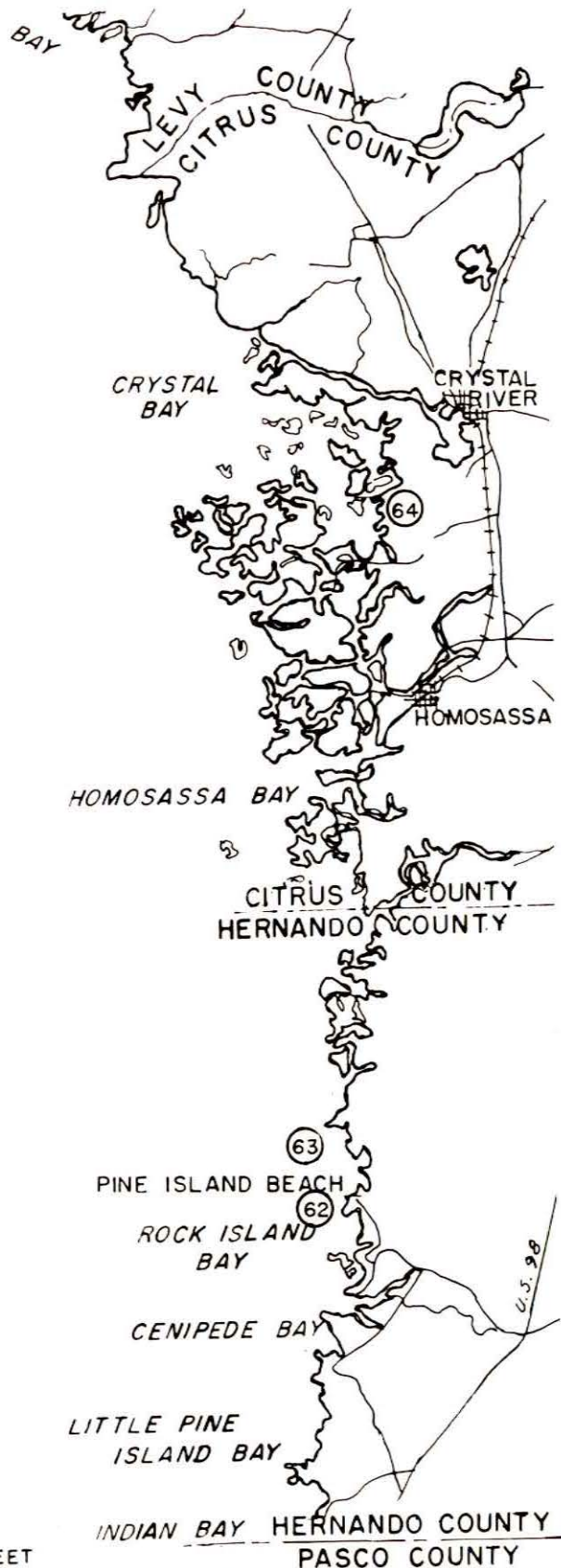
61

PHOTOGRAPHIC SURVEY
OF
SHORELINE

WITH LACOCHEE



G U L F O F M E X I C O



20,000 0 20,000 40,000 60,000



62

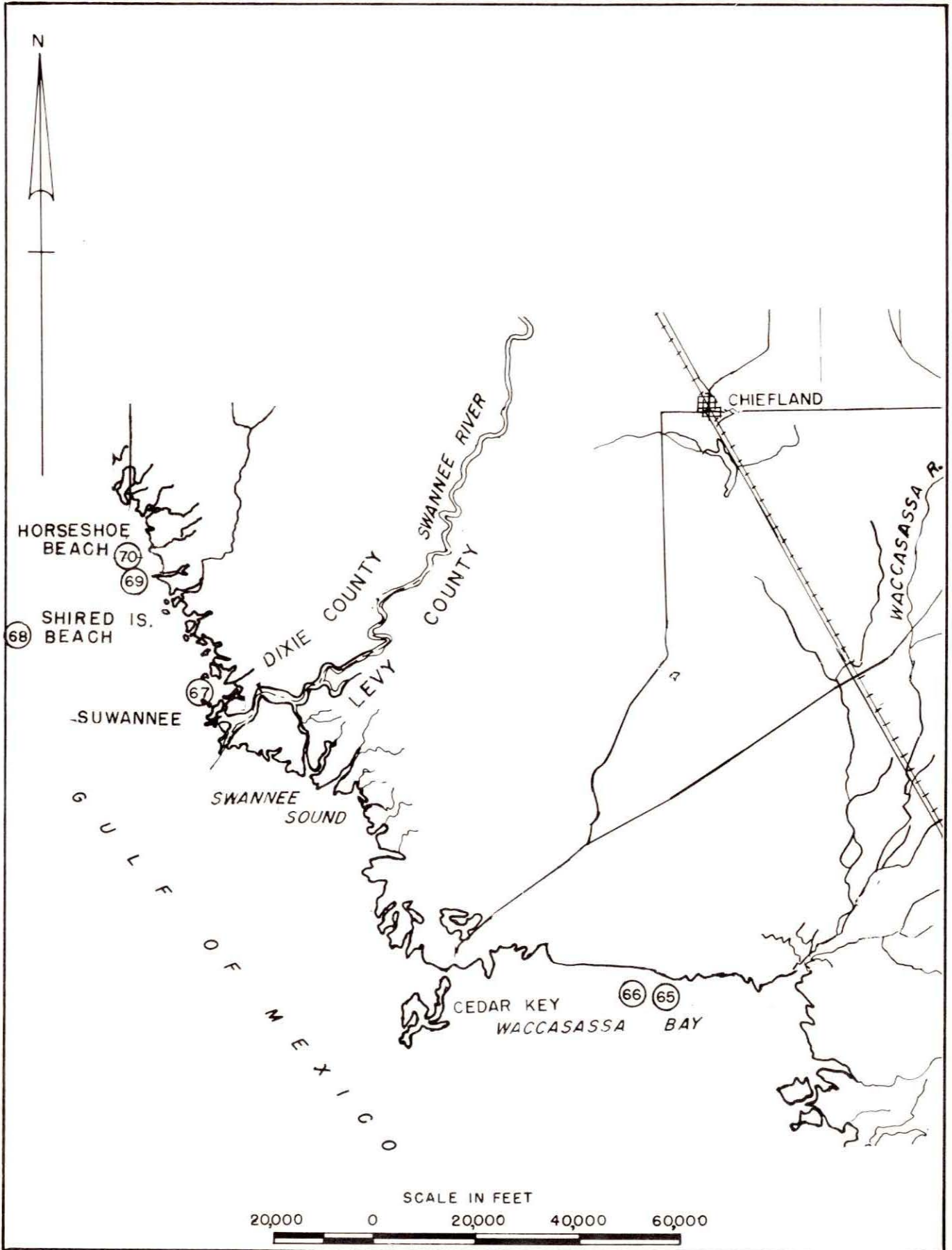


63



64

PHOTOGRAPHIC SURVEY
OF
SHORELINE





65



66



67



68

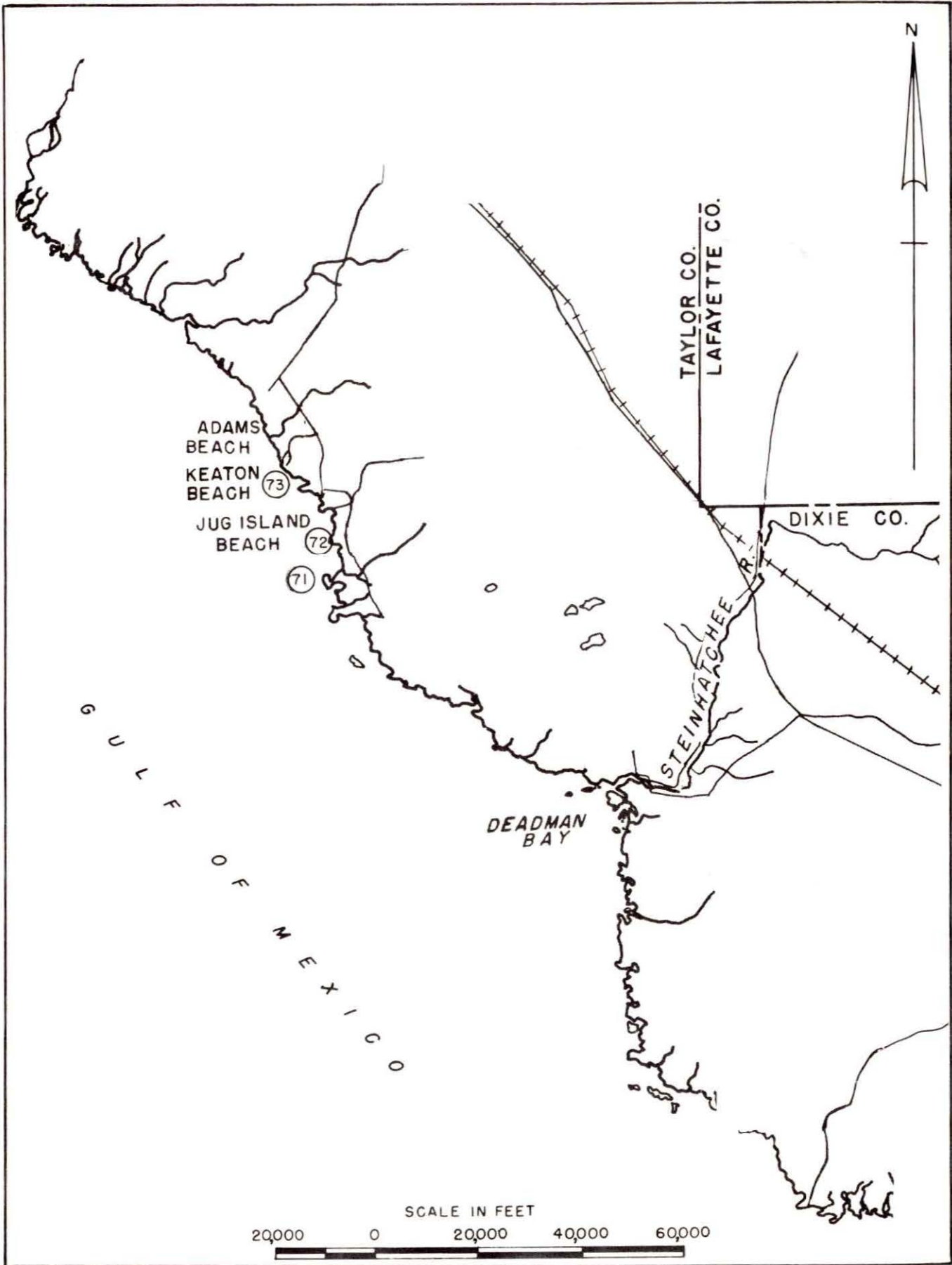


69



70

PHOTOGRAPHIC SURVEY
OF
SHORELINE





71

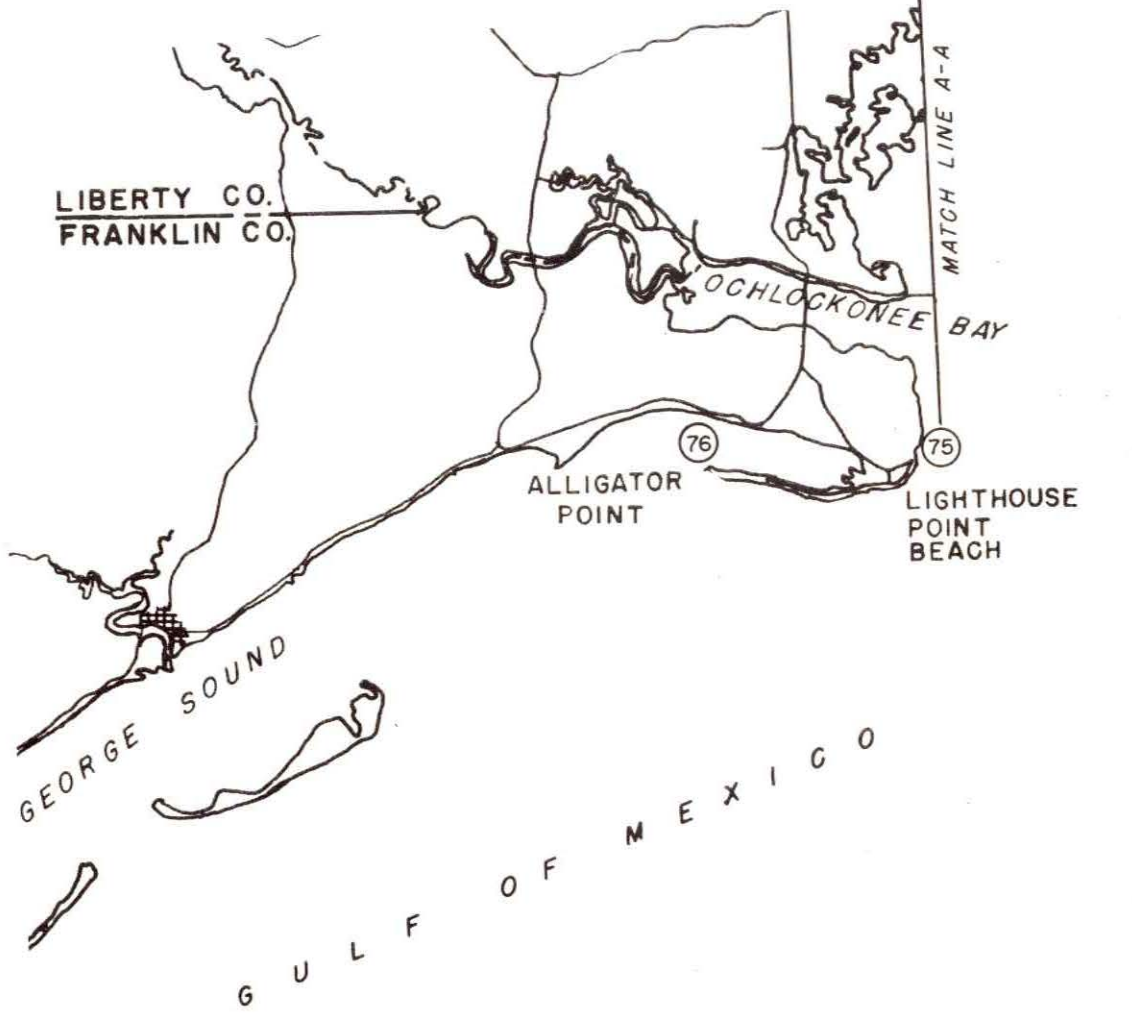
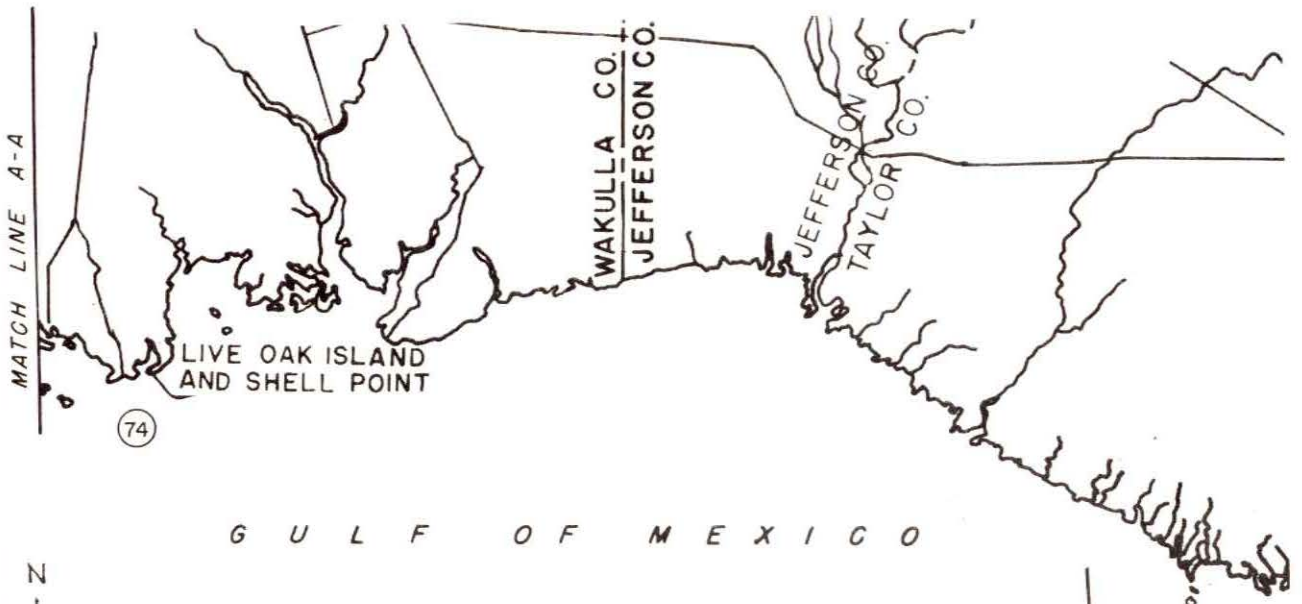


72



73

PHOTOGRAPHIC SURVEY
OF
SHORELINE





74

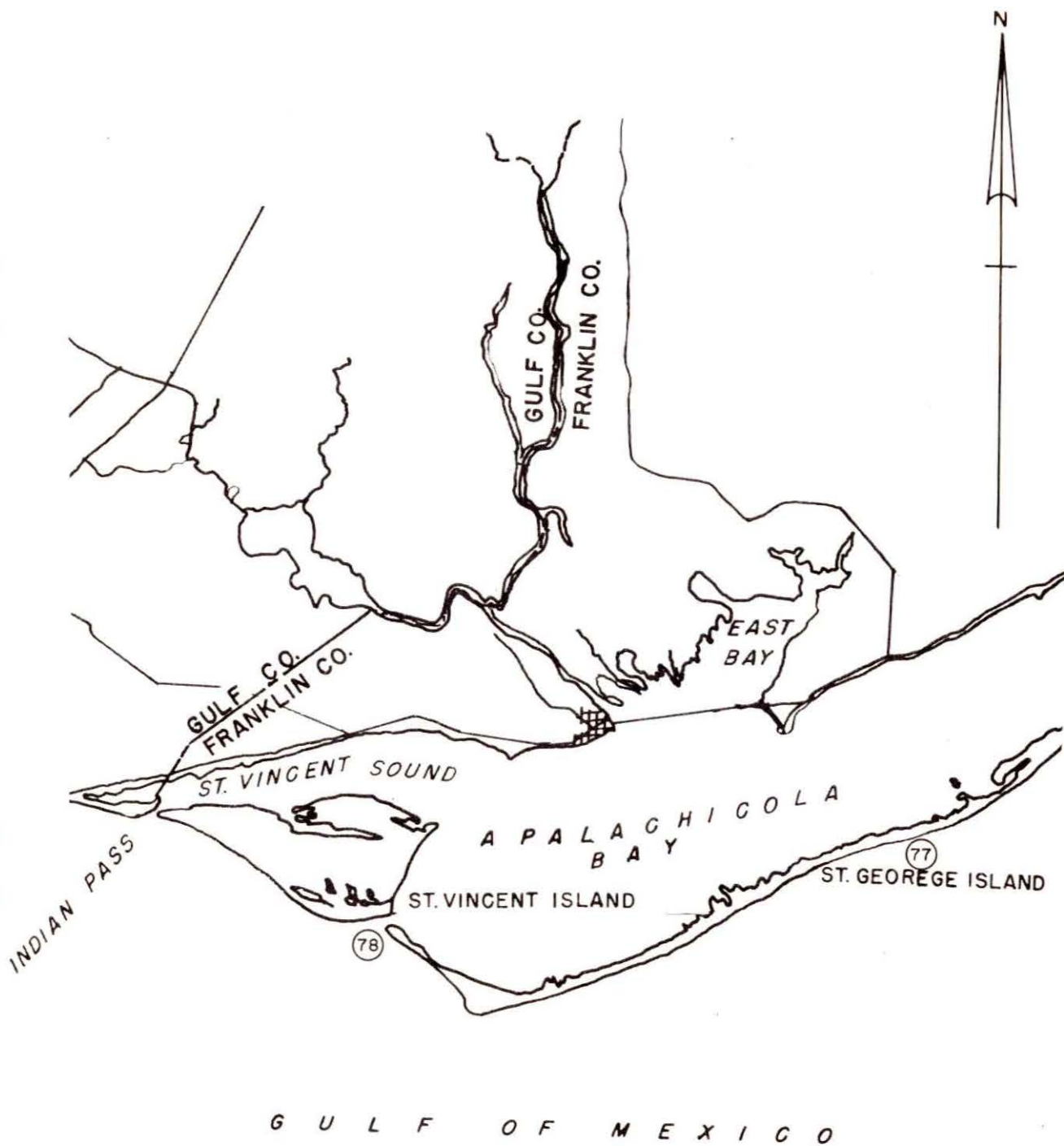


75

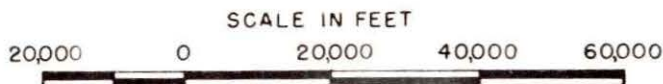


76

PHOTOGRAPHIC SURVEY
OF
SHORELINE



G U L F O F M E X I C O



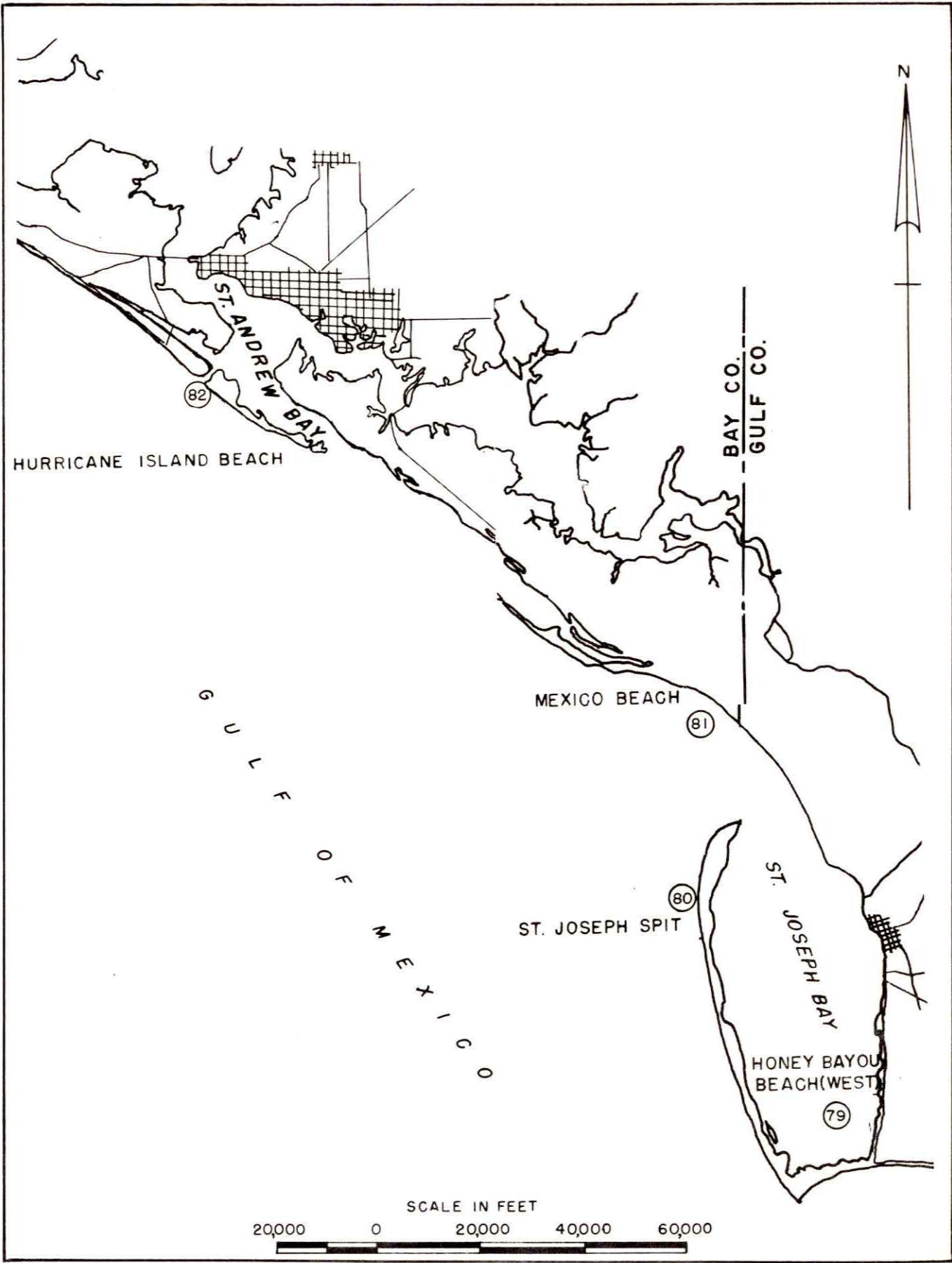


77



78

PHOTOGRAPHIC SURVEY
OF
SHORELINE



HURRICANE ISLAND BEACH

(82)

ST. ANDREW BAY

MEXICO BEACH

(81)

BAY CO. -
GULF CO.

G U L F
O F
M E X I C O

ST. JOSEPH SPIT

(80)

ST. JOSEPH BAY

HONEY BAYOU
BEACH (WEST)

(79)

SCALE IN FEET

20,000 0 20,000 40,000 60,000



79



80

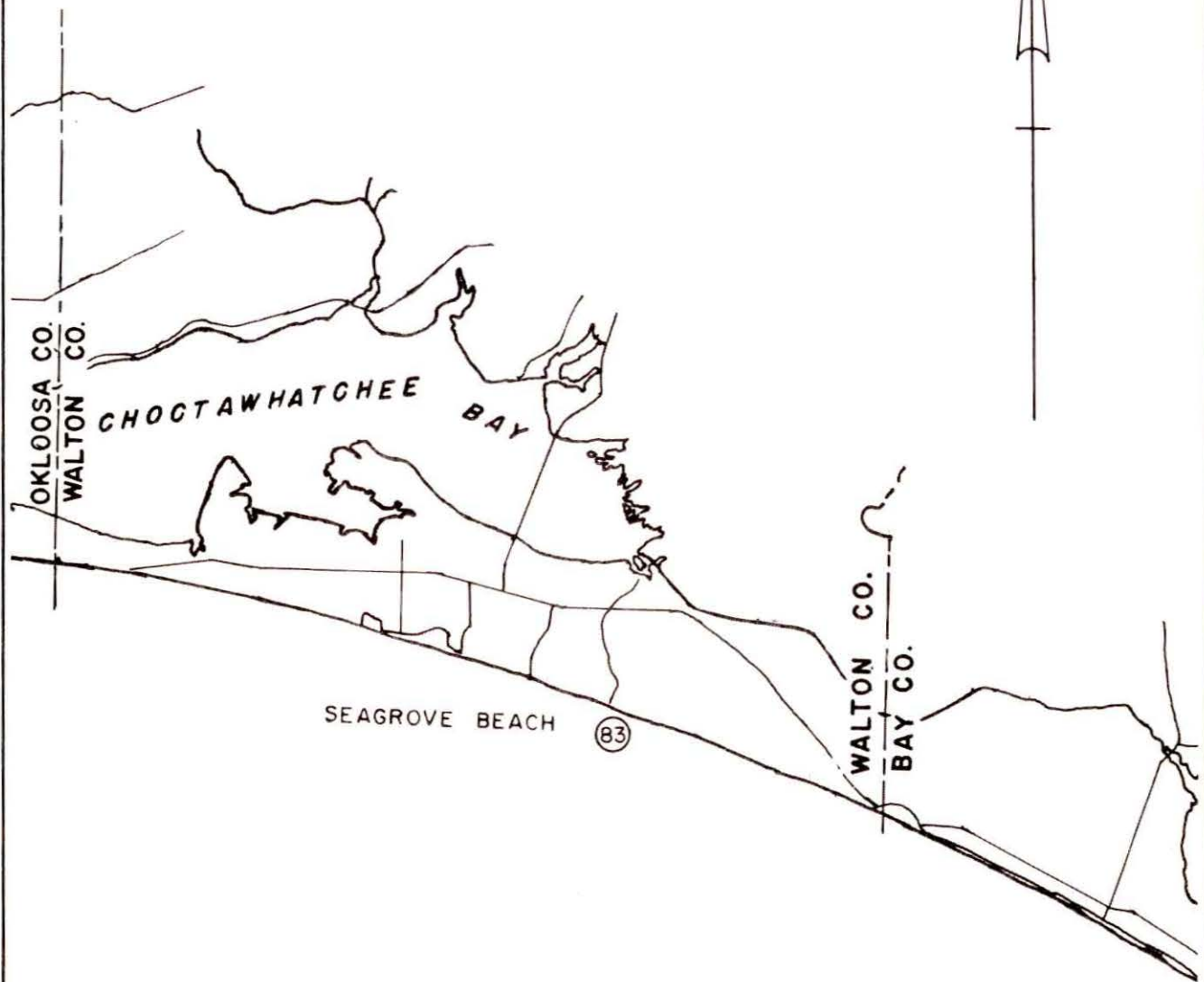


81

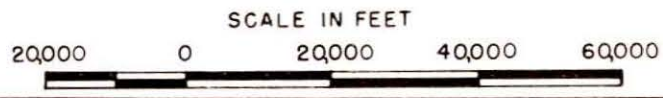


82

PHOTOGRAPHIC SURVEY
OF
SHORELINE



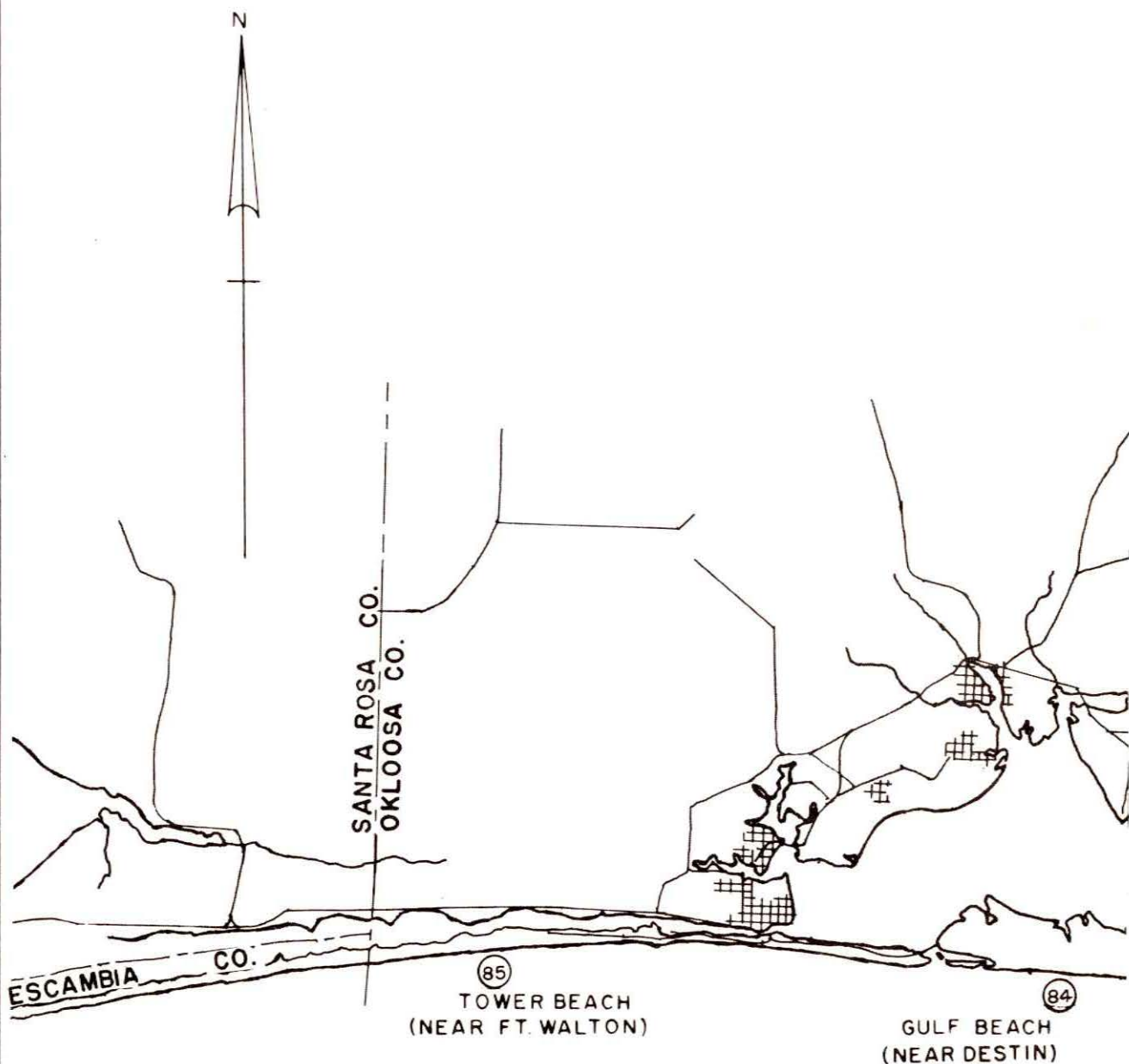
G U L F O F M E X I C O



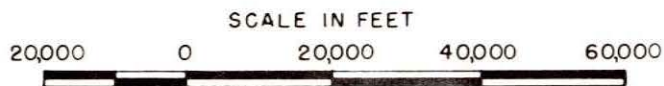


83

PHOTOGRAPHIC SURVEY
OF
SHORELINE



G U L F O F M E X I C O



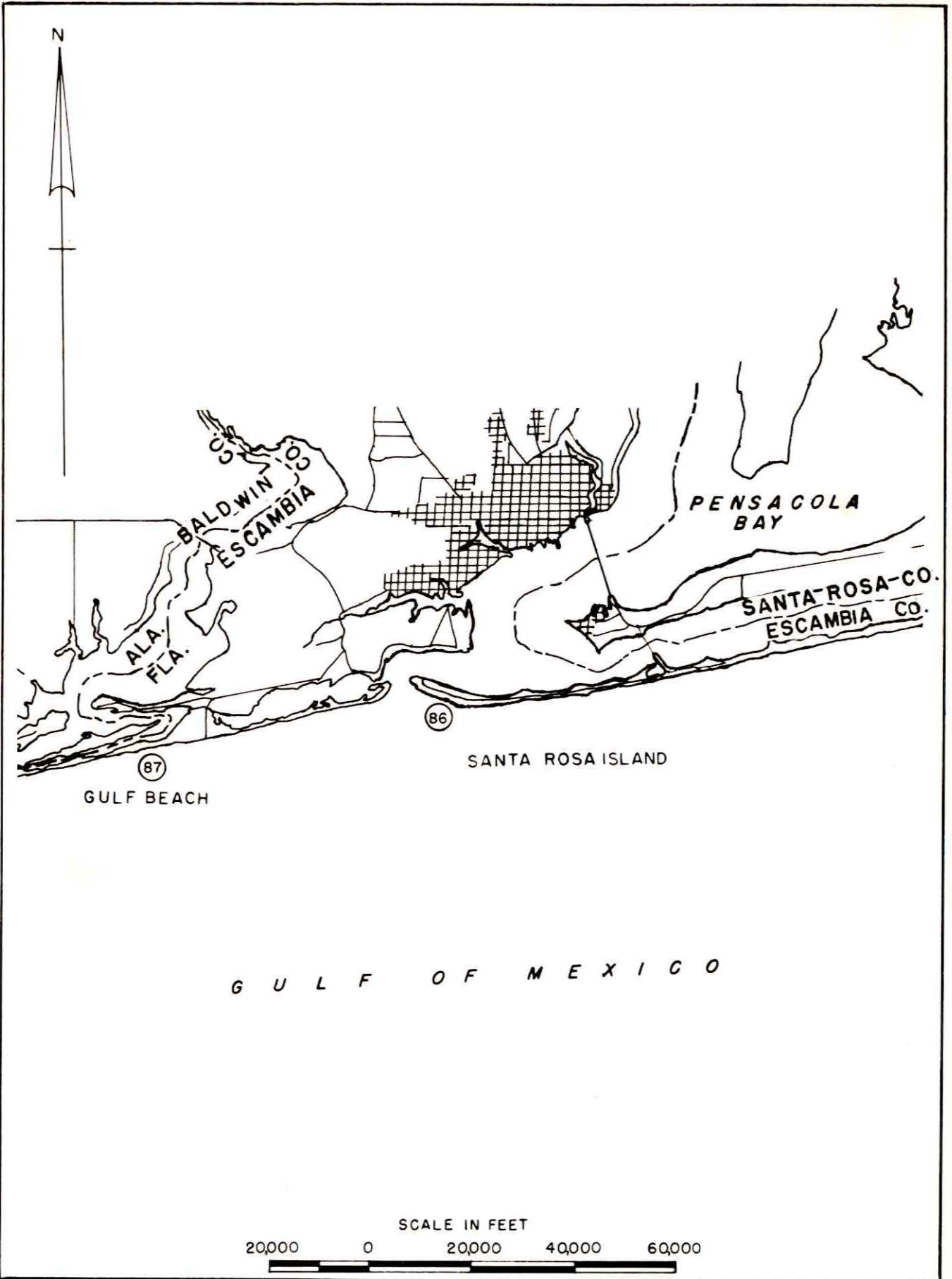


84



85

PHOTOGRAPHIC SURVEY
OF
SHORELINE





86



87

PHOTOGRAPHIC SURVEY
OF
SHORELINE

