FLORIDA SEA GRANT COLLEGE

ST. MARYS ENTRANCE GLOSSARY OF INLETS REPORT #11

T. M. Parchure

Report Number 44

January 1982

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FOREWORD

The numerous inlets and harbors connecting Florida's inner waters to the Atlantic Ocean and the Gulf of Mexico are important from the consideration of recreational and commercial vessel traffic and also because they provide small boats an access to safe refuge during unexpected severe weather and waves. Unfortunately, inlets and harbors also contribute significantly to the serious beach erosion problem prevalent along most of Florida's shoreline. The complexities of the hydraulic and sediment transport mechanics in the vicinity of inlets present a formidable challenge to engineers and scientists. These factors, along with the interesting historical role that inlets have played in the early development of Florida have resulted in considerable documentation pertaining to the major inlets of the State.

This report on St. Marys Entrance is one in a "Glossary of Inlets" series to be prepared under the Florida Sea Grant College project, "Glossaries of Tidal Inlets in Florida." The purpose of this series is to provide for each inlet a summary of the more significant available information and to list known documentation. It is hoped that this series will yield an improved understanding of the overall effect of each inlet on the economics, recreation, water quality and shoreline stability of the surrounding area. The proper future management, use, and control of Florida's inlets will require an appreciation of the evolution and past response of the inlets as well as considerable future study.

ACKNOWLEDGEMENT

The author wishes to thank Mr. Erik J. Olsen of Tetra Tech Inc., Jacksonville, for the drawings and other information he kindly supplied. Portions of this glossary have been adapted from studies at St. Marys Entrance by Mr. Olsen which are referenced in the text. Thanks also go to Dr. A. J. Mehta, the principal investigator of this project, for his guidance during the preparation of this report. The many hours spent by Lillean Pieter in the drafting of the figures are very greatly appreciated. Acknowledgement is due to Mr. Samuel Michael of National Marine Fisheries Service, NOAA, for information provided in Table 1.1. Matching funds for the project were derived from support provided by the Florida State Legislature to the Department of Coastal and Oceanographic Engineering.

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I. INTRODUCTION

St. Marys Entrance is located on the Florida-Georgia border in extreme northeast Florida (Figs. 1.1, 1.2, 1.3, and 1.4). The entrance lies 23 miles north of Jacksonville Harbor (St. John's River Entrance) and approximately 25 miles south of Brunswick Harbor, Georgia. The coordinates are as follows:

Latitude	Longitude
30° 43'N	81° 26' W

The entrance is bordered on the north by Cumberland Island and on the south by Amelia Island. Both are low, sandy barrier islands and considered to be part of the Sea Island chain which runs from North Carolina to Little Talbot Island, Florida. The entrance connects the Atlantic Ocean with Cumberland Sound. St. Marys River flows into Cumberland Sound and is the chief source of fresh water for the estuary. Several other rivers flow into the sound (see Fig. 1.2) among them being Crooked River to the north and Jolly and Amelia Rivers to the south. Amelia River provides ocean access to Fernandina Harbor via Cumberland Sound and St. Marys Entrance. St. Marys River is maintained by the U.S. Army Corps of Engineers as a navigable waterway and serves as an access to the Cumberland Sound for the harbor of the town of St. Marys, Georgia. These two harbors serve as base for a substantial commercial and recreational fishing fleet and also serve some commercial shipping interests as well. To the north, (approximately 8 miles from the inlet), the U.S. Navy Fleet Ballistic Missile (FBM) Submarine Support Base is located in Kings Bay (Fig. 1.2). This base serves as a major port for the Trident and other types of submarines. The entrance channel to the base from St. Marys entrance is currently undergoing enlargement in conjunction with the upgrading of facilities at the base.

The entrance has remained navigable throughout its recorded history, Because of this, and the sheltered harbor sound, the town of Fernandina was established in 1567, only two years after the city of St. Augustine. Fernandina had a larger relative importance in the latter part of the second Spanish dominion (1783-1821) than at the present time. It derived this importance from a combination of factors. It was a free port on the boundary beteen Florida (then under Spanish rule) and the United States, largely unpoliced by either country. The Jefferson embargo in 1807 made it the base of a vast smuggling trade, and the prohibition of the international slave trade by the United States in 1808 made Fernandina the logical center for that activity. It was not until 1817, when U.S. troops took the city and held it until the end of the Spanish period in 1821, that lawlessness was abated (Tebeau, 1971). The town has remained an active port since then, with the volume of shipping commerce varying considerably through the years.

The main entrance channel had been migratory in nature over the years, and in 1880 U.S. Congress approved funding for the construction of two rock jetties to stabilize the inlet. Work began in 1881 and after numerous delays and revisions to the original plan, the jetties reached their existing form in 1927. Presently, the north jetty has a total length of 19,150 ft., a crest width of 8 ft. at the shore end and 15 ft. at the seaward end, and a height of 7 ft. above mean low water (mlw). The south jetty has a total length of

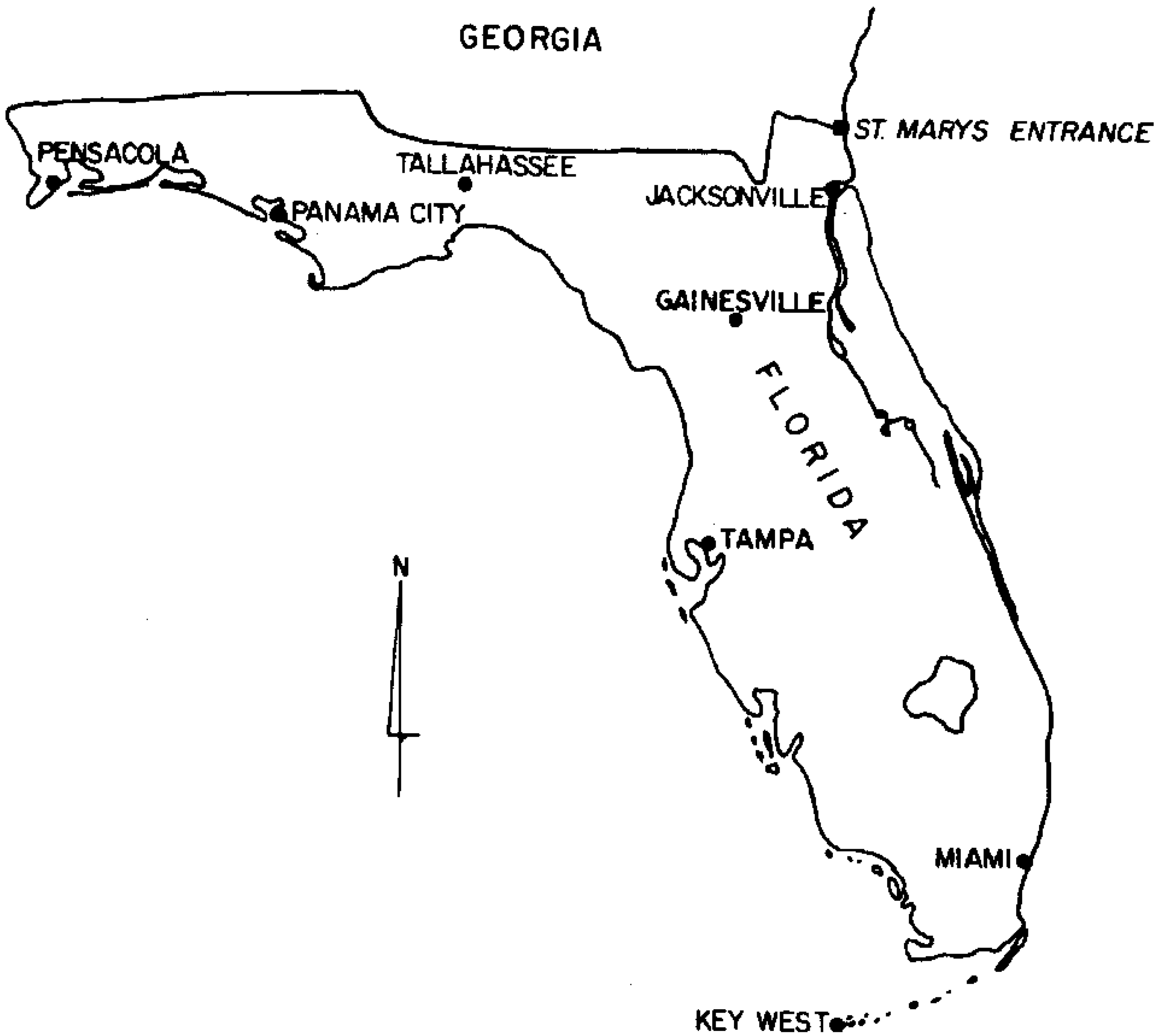

Fig 1.1 Location Map. (St. Marys Entrance is on the Atlantic Coast of Florida next to the Georgia border)

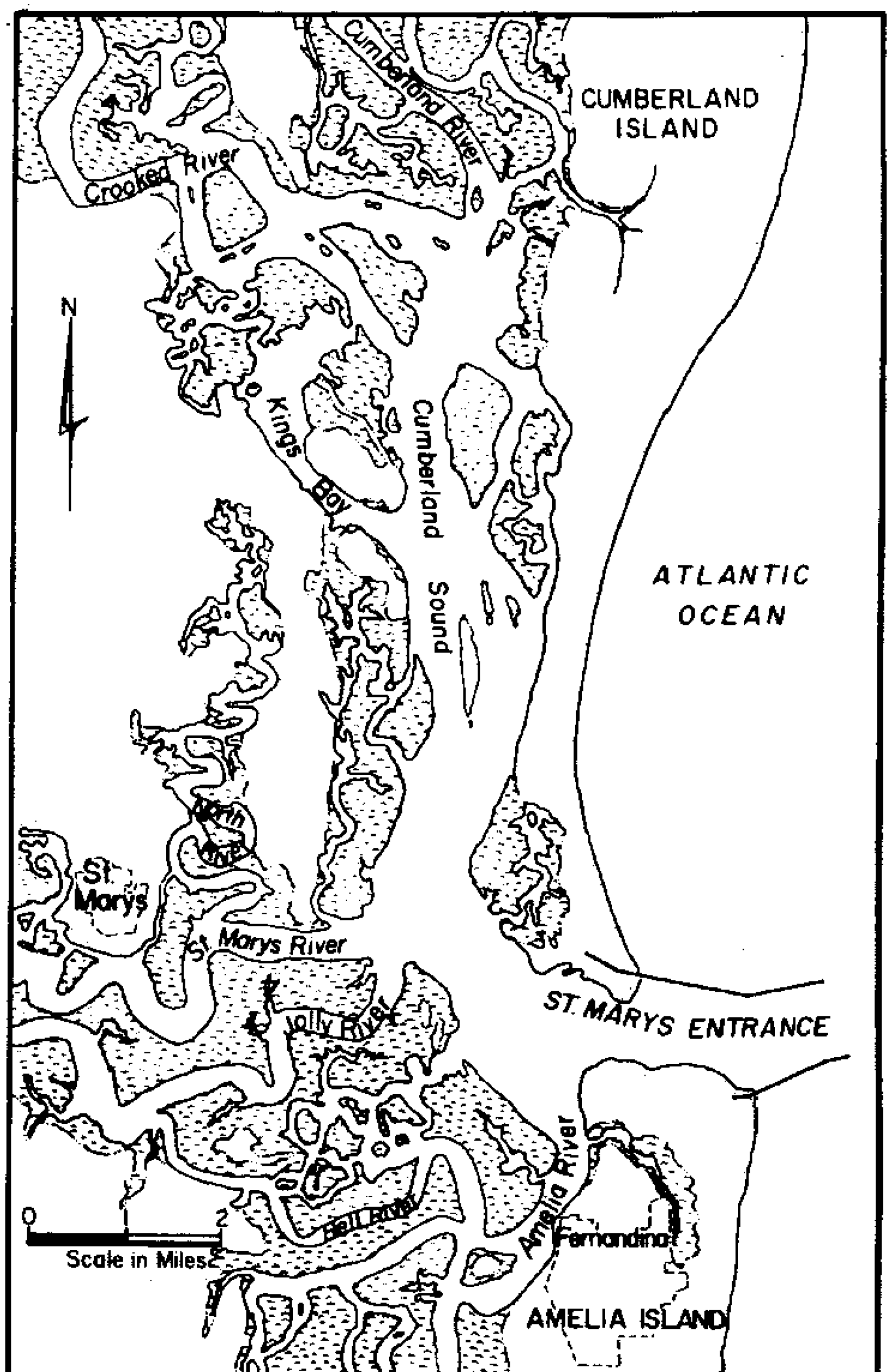

Fig 1.2 St. Marys Entrance, Cumberland Sound and Tributaries

Fig 1.3 An Aerial View of St. Marys Entrance (1942)

Fig 1.4 An Aerial View of St. Marys Entrance Showing (Arrow) Fort Clinch (1962)

11,200 ft., a crest width of 8 ft. throughout and a height of 6 ft. above mlw. The jetties have never been sand-tight due to the large size of the stone from which they were constructed and because of the relatively thin cross sections.

Commercial activity in the area has been on the upswing. The primary economic products of the area are wood pulp, seafood, and phosphate. Three wood pulp mills operate in the area, two in Fernandina (operated by I.T.T. - Rayonier, since 1939 and the Container Corporation of America, since 1941) and one in the town of St. Marys (operated by the St. Marys Kraft Company, since 1940) (U.S. Army Corps of Engineers, 1946; U.S. Congress, 1948). The seafood industry has remained a steady economic source for many years. The primary catch is menhaden which is processed for oil and fertilizer. Shrimp and other shellfish constitute the majority of the remaining cash value. Table 1.1 gives yearly totals for the poundage of various seafoods brought in and the overall cash value for all of Nassau County. This table does not reflect the value of seafoods brought via St. Marys Entrance alone, but is representative of the importance of seafood to the area.

Table 1.1
Total Seafood Catch for Nassau County 1955-1978

Years	Total Fish: Food and Non-food (lbs)	Total Shellfish Including Shrimp	Total (lbs)	Dollars
1955	36,331,012	2,573,472	38,904,484	1,147,389
1960	24,439,589	3,903,130	28,342,719	879,891
1965	31,241,940	3,260,774	34,502,714	1,221,141
1970	27,250,877	2,424,723	29,675,600	1,102,812
1975	11,624,414	1,449,190	13,093,404	535,238
1977	11,634,303	1,625,402	13,259,705*	591,312
1978	19,401,136	1,850,352	21,251,488*	995,089

*Preliminary totals subject to revision by NOAA

Tourism, unlike many of Florida's coastal regions, plays a comparatively smaller part in the local economy (although tourism is on the upswing). The region has some interesting tourist attractions such as the restored area of downtown Fernandina Beach, but the beaches themselves are not built up as resort areas and therefore provide unspoiled beauty. At the north end of Amelia Island is Fort Clinch State Park. The fort was constructed during 1850-1855 and saw limited action in the Civil and Spanish-American Wars. The park encloses approximately 1,100 acres of undeveloped land. Cumberland Island, Georgia, has been proclaimed a national seashore and is accessible by boat. With the construction and planned expansion of the Navy's facilities at Kings Bay, new economic growth is expected. Fig. 1.3 is an aerial view of the entrance in 1942. The comparatively significant length of the jetties is evident, as well as the intensity of the sediment-laden flows through the channel and through the permeable rock jetties. Fort Clinch (arrow) is visible on the south bank of the inlet shown in Fig. 1.4 which is an aerial view taken in 1962. Barwis (1975) has listed a series of aerial photographs spanning the period 1942-1971 that are available from various agencies. More recent photographs are available through the Jacksonville District office of the U.S. Army Corps of Engineers.

II. GEOLOGIC SETTING, CLIMATE AND STORM HISTORY

2.1 Geology

Both Amelia and Cumberland Islands are considered to be a part of the string of coastal barrier islands known as Sea Islands. This chain of islands is in general separated from the mainland by a maze of tidal creeks and swampy islands which seem to have resulted from a mixture of fluvial and tidal sedimentation occuring in derelict lagoons and coastal marshes between beach ridges. Landward of this zone, the coast is recognized as a broad plain which, in a geologic context, has been termed the St. Marys Meander Plain (Florida Coastal Engineers, 1976).

The long, thin barrier islands which separate the plain from the ocean are composed of reworked Pleistocene marine terrace deposits known as the Pamlico (10-25 ft. elevation) and Silver Bluff (0-10 ft. elevation) terraces, and of more recent Holocene deposits (Leve, 1966). The Pleistocene deposits generally have well developed podzols, humate zones, and are commonly coarser than the Holocene deposits. They are usually of subdued relief and are typically well vegetated with oak/pine forests. The Holocene sands are light tan, unweathered, and composed mainly of fine grains. Shell material is present in the upper zones with no obvious soil zones in the well-defined beach/dune ridge complexes (Nash, 1977). Underlying these deposits are several different layers of sedimentary limestone. Leve (1966) has compiled information on the formations in Duval, Nassau and Baker counties. Table 2.1 which is adapted form Leve's work is based on data obtained by collecting rock cuttings from a number of water wells drilled in the area and examining these cuttings to determine the texture, mineral composition and fauna of different formations. Additional geologic information was obtained from driller's logs, and from lithologic and electric logs on file with the Florida Geological Survey.

2.2 St. Marys River Drainage Basin

The St. Marys River rises in the Okefenokee Swamp in southeastern Georgia, at an elevation of 110 to 120 ft. From there it flows circuitously eastward about 125 miles, emptying into Cumberland Sound. It is responsible for almost all the freshwater inflow to the St. Marys Entrance Region. It has no major tributaries but many minor ones. The St. Marys River Drainage Basin, as seen in Figure 2.1 is bounded on the north by Satilla River Basin, on the west and south by the Swannee River Basin, and on the south and east by the Nassau and St. Johns River Basins. The watershed area, excluding the Okefenokee Swamp portion, covers approximately 1,500 square miles.

Use of the rational method of discharge estimation was employed to determine the influence of the river on the flow characteristics of the inlet. The results for various storm return intervals are given in Table 2.2. With a tidal prism of 9.8×10^9 ft.^{3}, the average discharge over one-half tidal cycle would be 430,000 cfs. Thus the net river discharge rates with return intervals of one year or less amount to less than 5% of the total discharge attributable to the tides and therefore probably have little effect on the geometric characteristics which relate to the hydraulics of the system (Florida Coastal Engineers, 1976), although the vertical flow structure in the entrance channel itself is influenced to some degree.

Table 2.1
Stratigraphic Units (after Leve, 1966)

Geologic age	Stratigraphic unit		Approximate thickness (feet)	Lithologic character
Recent and Pleistocene	Recent and Pleistocene deposits		0-150	Soil, muck, coarse to fine sand, shell, and some clayey sand
Pliocene?	Pliocene or Upper Miocene deposits		20-110	Gray-green calcareous, silty clay and clayey sand; contains shell beds and white soft, friable limestone beds
Miocene	Hawthorn Formation		260-480	Gray to blue-green calcareous phosphatic, sandy clays and clayey sands; contains fine to medium phosphatic sand lenses and limestone and dolomite beds, particularly near the base of the formation
Eocene	Ocala Group	Crystal River Formation	50-100	White to cream chalk, massive fossiliferous marine limestone.
	Ocala Group	Williston Formation	20-100	Tan to buff granular, marine limestone
	Ocala Group	Inglis Formation	40-120	Tan to buff granular, calcitic, marine limestone; contains thin dolomite lenses and zones of Miliolidae foraminiferal coquina
	Avon Park Limestone		50-280	Alternating beds of brown to tan hard, massive dolomite, brown finely crystalline dolomite, and granular calcitic limestone
	Lake City Limestone		425-600+	White to brown, purple-tinted lignitic, granular limestone and gray hard, massive dolomite; contains lignite beds and zones of Valvulinidae foraminiferal coquina
	Oldsmar Limestone		540	Cream to brown massive to chalky, granular limestone and tan to brown massive to finely crystalline dolomite

Table 2.2
Net Freshwater Discharge Prediction for St. Marys River (Florida Coastal Engineers, 1976)

Return Interval (years)	Discharge (cfs)
1	19,000
2	23,000
5	29,000
10	35,000
25	43,000
50	50,000

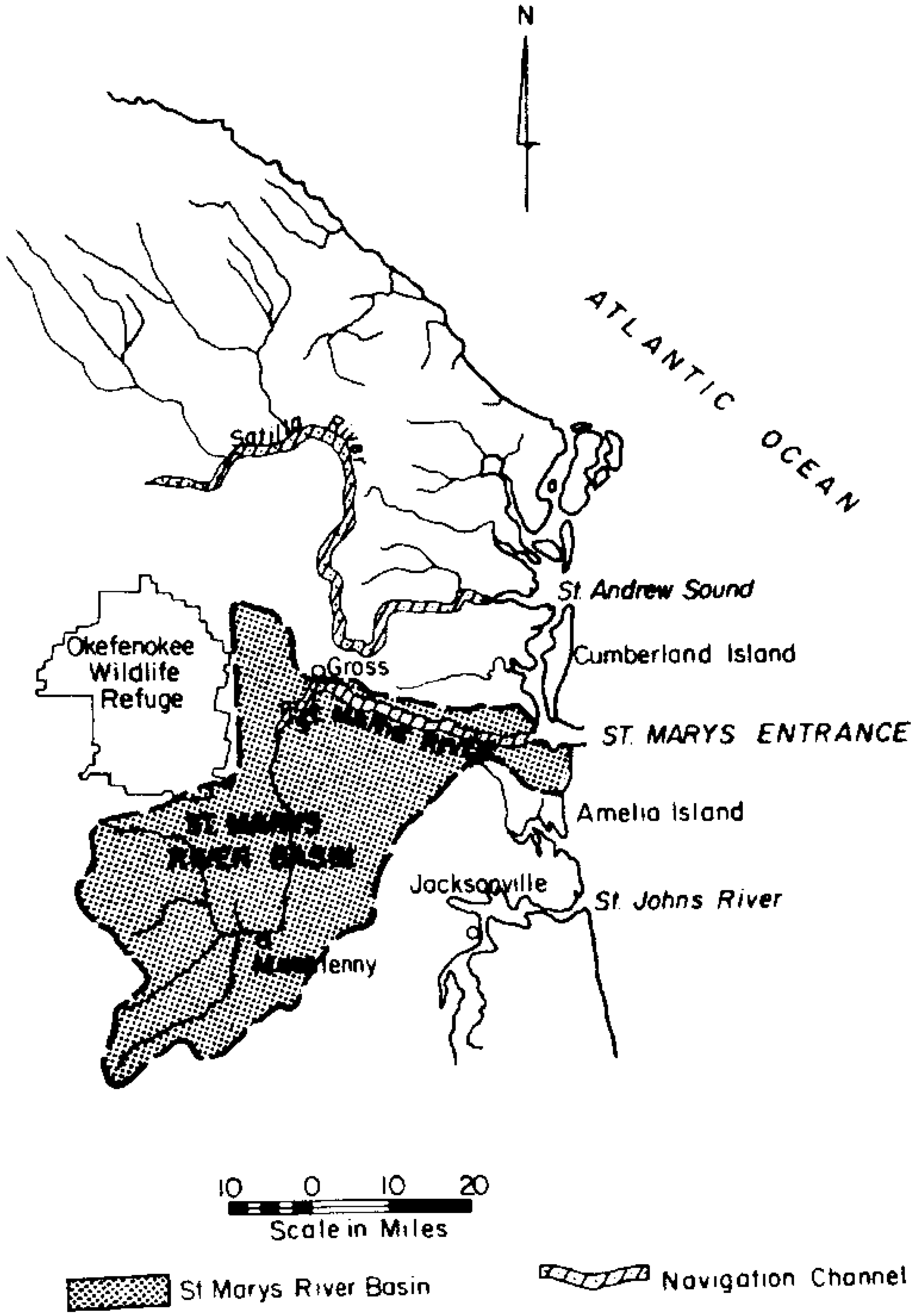

Fig 2.1 St. Marys River Drainage Basin

An interesting discussion on the geological setting of the tidal inlets between Cape Hatteras, North Carolina and Cape Canaveral, Florida, has been given by Nummedal et al. (1977). With reference to St. Marys Entrance, they have provided the following data:

Tidal Lagoon Area	= 189×10^6 m^3	(6670×10^6 ft^3)
Open Water Area (OWA)	= 40×10^6 m^3	(1412×10^6 ft^3)
Percent OWA to total	= 21	
Maximum throat depth	= 23 m	(75.4 ft)
Ebb-tidal delta area	= 76×10^6 m^3	(2682×10^6 ft^3)
Inner shoal area	= 0	

The above data indicate that 79 percent of the lagoonal area which drains through St. Marys Entrance is covered by marshland.

2.3 Climate

Fernandina and vicinity has a humid, semi-tropical climate characterized by long summers with heavy rainfall and relatively mild and dry winters. The annual mean temperature is 70° F with seasonal mean temperatures of 58° F in winter, 69° F in spring, 82° F in summer, and 75° F in autumn. No official U.S. Weather Bureau station exists in the area. The closest is in Jacksonville (no. 4358), 20 miles south of Fernandina Beach. The reported temperatures and rainfall were gathered by Weather Bureau observations over the period 1885-1972.

Of the normal annual precipitation of 50.4 inches, over half falls in the thunderstorm months of June through September. These storms, which form over land by convective processes, can be quite severe at times with high winds, heavy rainfall, and a large number of lightning strikes. The maximum rainfall occurs in September with an average 8.74 inches, and November is lowest with an average of only 1.75 inches. Snow is a rarity and even a trace does not occur on an average of once a year. The maximum monthly precipitation for the period of record occurred in September 1897 with a total of 20.88 inches for the month. The maximum annual precipitation occurred in 1905 with 83.31 inches for the year (U.S. Army Corps of Engineers, 1974).

A wind diagram appropriate for the study area is shown in Fig. 2.2 (U.S. Congress, 1961a). The data were gathered for the period 1949-1954 at Jacksonville. This diagram indicates that the direction of the predominant onshore wind is from the northeast. The largest duration of winds over 19 mph is also from the northeast and is the result of storms usually referred to as "northeasters" which are generated from the early fall through the winter by intense low pressure systems over the western Atlantic Ocean (Florida Coastal Engineers, 1976).

2.4 Storms

Hurricanes (or tropical storms which did not reach hurricane intensity), and northeast storms are the two major kinds of storms which cause beach erosion and related damage to the inlet vicinity. Large, intense Atlantic storms are generally caused by a stationary high pressure area north of a low pressure area at the southeastern part of the United States during the winter months. These storms have caused great damage to the beaches and the beachfront properties due to their longer durations.

The study of storms by the Shore Protection Board includes 54 storms of hurricane intensity between 1837 and 1945, each of which in some way affected the beach. (U.S. Army Corps of Engineers, 1946, Appendix A). During the 100 year period 1871-1972, a total of 19 hurricanes passed through Nassau County within a 50 mile radius of St. Marys Entrance. This means that on an average a storm of hurricane intensity affected the inlet region every 5.3 years (Florida Coastal Engineers 1976). Most of the storms originating in the Atlantic Ocean travel in an anticlockwise direction and may cross the eastern shoreline of Florida twice. Over the area of St. Marys Entrance, most of the storms moved out to the Atlantic Ocean from the land. Figure 2.3 shows tracks of hurricanes which passed in the vicinity of Fernandina between 1837 and 1979.

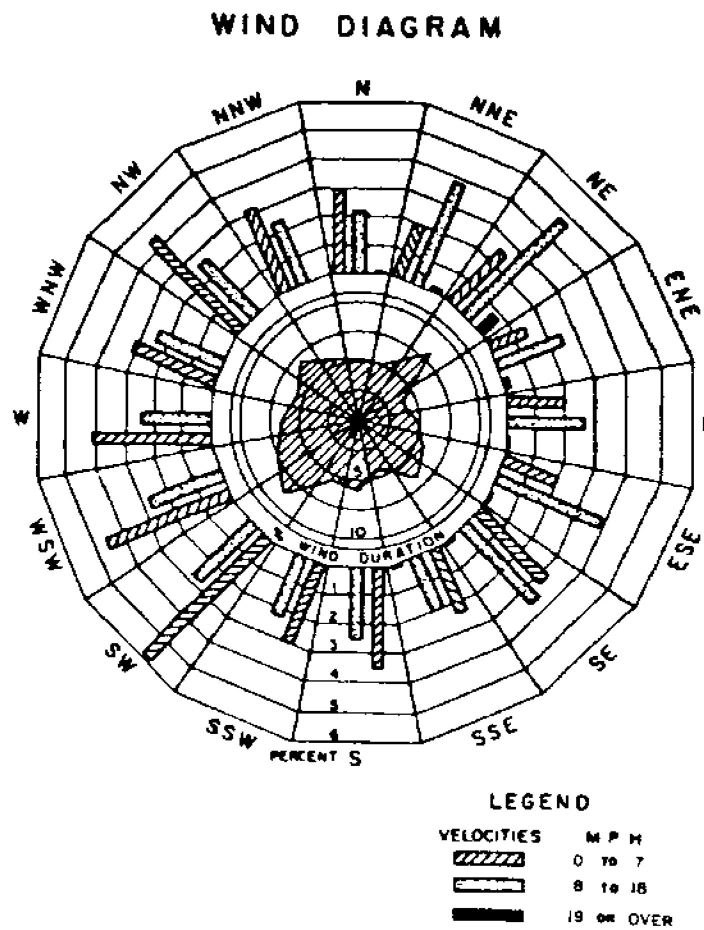

Fig 2.2 Wind Diagram based on U.S. Weather Bureau Data gathered for the period 1949-1954 at Jacksonville (FL) (U.S. Congress, 1961a)

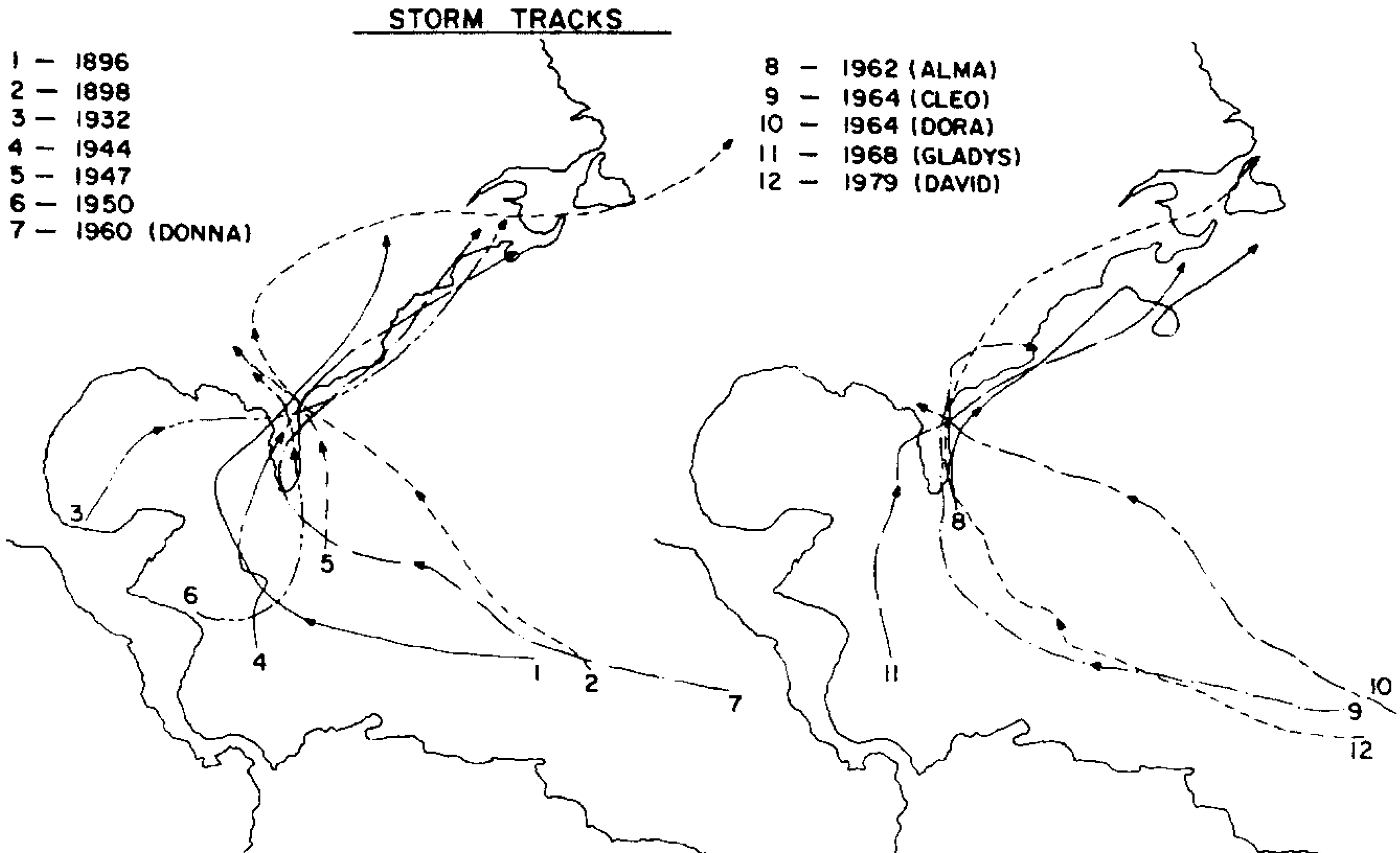

Fig 2.3 Paths of Tropical Storms of Hurricane Intensity that have passed in the vicinity of Fernandina Harbor from 1896 to 1979 Inclusive (U.S. Dept. of Commerce 1978)

Little factual data are available concerning hurricanes prior to the storm of 1896. The storms of August 1830, September 1854, June 1873, October 1877, August 1885 and September 1885 passed either through or very near Fernandina Beach. Although several of these probably caused considerable damage, a historical account indicating the magnitude of damdage is not readily available (U.S. Congress, 1961b). For the subsequent storms, the information given below has been compiled from different sources as indicated by the reference against each storm. It may be pointed out that some discrepancies are noticed regarding the dates of some of the older storms. Also the cost estimates of damage do not always specify whether the estimate is related to the limited area under consideration or the damage caused by the storm over the entire shoreline.

September, 1896

This hurricane crossed northern Florida from the Gulf of Mexico and traveled up the coast of Georgia. It was reported as an intense storm of short duration. Maximum reported winds (1-minute average) were 100 mph at Jacksonville and 75 mph at Savannah, Georgia. The barometer reading of 29 inches was registered of Savannah. 25 people lost their lives in the storm. The damage along the coast, mostly from winds, was estimated at $3,000,000 (U. S. Congress 1961b).

October, 1898

This very destructive storm caused as much as 3 feet of water flooding the downtown district of Fernandina. Serious damage was done along the beaches. All beach buildings and shore structures were damaged. Beaches were eroded as much as 200 feet landward and 4 feet vertically. 200 people lost their lives in the Brunswick, Georgia area. Should a storm of this magnitude occur again, the estimated damage based on the development stage in the year 1961 would be about $6,000,000 (U.S. Congress, 1961b).

November, 1932

This northeast storm was one of the most severe to occur along the Florida coast. Exceptionally heavy damage was reported from north Florida to Palm Beach. The storm waves were accompanied by unusually high tides (2 feet above normal) and large waves reached the shore in advance of high winds. Wind velocities reached a maximum of about 50 mph. Waves were reported to have a greater height than at any time during the preceding 60 years. Many houses were undermined and beach access ramps and timber seawalls were destroyed. The beach dropped about 3 feet in elevation (U.S. Army Corps of Engineers, 1964, Appendix C).

October 12-23, 1944

This hurricane formed in the western Caribbean, entered the Gulf coast of Florida near Sarasota and passed directly over Fernandina Beach on

October 19. The hurricane was large in size, high winds extending 200 miles east and 100 miles to the west of the eye. The minimum barometer reading recorded at Jacksonville was 28.94. The strongest winds at Fernandina occurred between 1000 and 1300 hours from the northeast and the maximum estimated speed was 65 mph with gusts reaching 81 mph. A total of 7.78 inches of rain was recorded at Fernandina Beach. The severe winds from the northeast occurred at the same time as high tide (12 ft above mlw) causing waves to cut away large sand dunes above the normal high water line. Damage was estimated at $260,000 along Fernandina Beach (U.S. Congress, 1961b and NOAA, 1973).

September 24 - October 7, 1947 This northeaster was accompanied by exceedingly high winds, tides and large waves. The storm was exceptional not only for its severity but also for its unusually long duration. Damage was estimated at $1,400,000 along the northeast Florida coast on 1947 price level. Waves, winds and high tides combined to cause severe erosion (as much as 5 feet in elevation) and destroyed seawalls, dwellings and beach access ramps (U.S. Army Corps of Engineers, 1964, Appendix C).

October 15-19, 1950 This small but violent hurricane moved from the Caribbean Sea, across Cuba and up the entire Atlantic Coast of Florida. Total losses in the State were estimated at $28 million. High tides and waves overtopped dunes and seawalls along the beachfront. (U.S. Army Corps of Engineers, 1964; Bunting et al., 1951).

September 10-11, 1960 This hurricane, called Donna crossed the Keys and Florida Bay and continued up the west coast almost to Tampa Bay before turning inland. Storm tides generated by winds from the South caused water levels to rise about 12 feet above mean sea level at Flamingo and Everglades. On September 11, the minimum pressure recorded at Jacksonville was 29.20 inches and the maximum wind speed was 46 mph, with gusts reaching 67 mph (Florida Hurricane Report, 1961).

March 8-9, 1962 The winds from this northeast storm, known as the Great Middle Atlantic Coastal Storm, caused extensive damage along virtually the entire east coast of the United States. This storm was exceptionally destructive due to the long fetch (1,200 miles) and its occurrence during a perigee spring tide which is the maximum astronomical tide. The estimated wave height was 40 feet with

	wave period up to 23 sec. (Lundlum, 1963, and Stewart, 1962).
August 26-28, 1964	Hurricane Cleo entered Florida at Miami and traveled generally northward over land about 300 miles until passing back into the ocean south of Jacksonville. Peak wind gusts at Jacksonville were measured at 45 mph. Total storm damages in Florida were estimated at $125 million. Beach damages were relatively insignificant with maximum reported shoreline recession being 10 feet in Nassau County (U.S. Army Corps of Engineers, 1964).
September 9-11, 1964	Hurricane Dora was the first hurricane of record to move inland from the Atlantic over extreme northeastern Florida. The eye passed over St. Augustine. Sustained winds of 64 knots were recorded at Jacksonville. Damage at Fernandina Beach was very heavy. 30-60 ft. of dune was washed away for extensive lengths. 30 homes were destroyed or heavily damaged. The fishing pier was heavily damaged. Beaches were lowered up to 5 ft. in certain sections. Damage estimates for Florida were $200-230 million (NOAA, 1973 and COEL, 1964).
October 13-21, 1968	Hurricane Gladys was spawned from a depression in the western Caribbean Sea. Gladys battered Florida's west coast with 75 mph winds leaving 3 to 7 ft. tides in her wake, then moved ashore between Bayport and Crystal River on the 19th. By late on the 19th, the violent storm was generating 90 mph winds around 965 mb center. Damage in Florida, estimated at $5 million, was concentrated primarily in Pinellas, Pasco, Hernando, Citrus, Marion and Hillsborough counties (U.S. Dept. of Commerce, 1968).
February 9-13, 1973	This extremely intense northeaster, known as Lincoln's Birthday Storm, was responsible for extensive beach erosion and beachfront flooding along the southern half of the Atlantic coast of the United States. During the height of the storm, the fetch was approximately 1,100 miles, the longest recorded in the last 30 years. High waves and tides caused erosion and some dune overtopping along the beaches. The deep water waves in the Cape Hatteras area reached a maximum height of 23 feet and waves in excess of 5 feet occurred for an 89 hour period (Dolan, et al., 1973).

August 25 - September 15, 1979

Hurricane David was spawned far out in the Atlantic and attained hurricane strength prior to reaching the Lesser Antilles. It peaked in the north-central Caribbean when 150 mph winds were estimated around 924 mb center. Florida coastline from Miami Beach to Daytona Beach was affected by wind gusts of 60 to 85 mph and tides up to 5 feet above normal. Several areas received up to 10 inches of rainfall. Preliminary damage for David was estimated at nearly $2 billion, with most of that in the Dominican Republic, where the death toll was estimated at about 1,000. In the United States, David was responsible for 16 deaths (DeAngelis, 1979).

Hurricanes and northeasters are usually accompanied by a rise in the still water level near the coast caused by wind stresses on the water surface. This is known as storm surge. Figure 2.4 shows a relationship between the storm surge elevation and the storm return period which is used in computation of Floria's Coastal Construction Control Line (COEL, 1975). The curves are based on available tide and surge data along the coast. The curves given in Fig 2.4 designated as northern boundary and southern boundary from NOAA represent the northern and southern extent of Nassau county. Since St. Marys Entrance is at the northern end of the county, the upper curve is applicable to the open coast adjacent to the entrance.

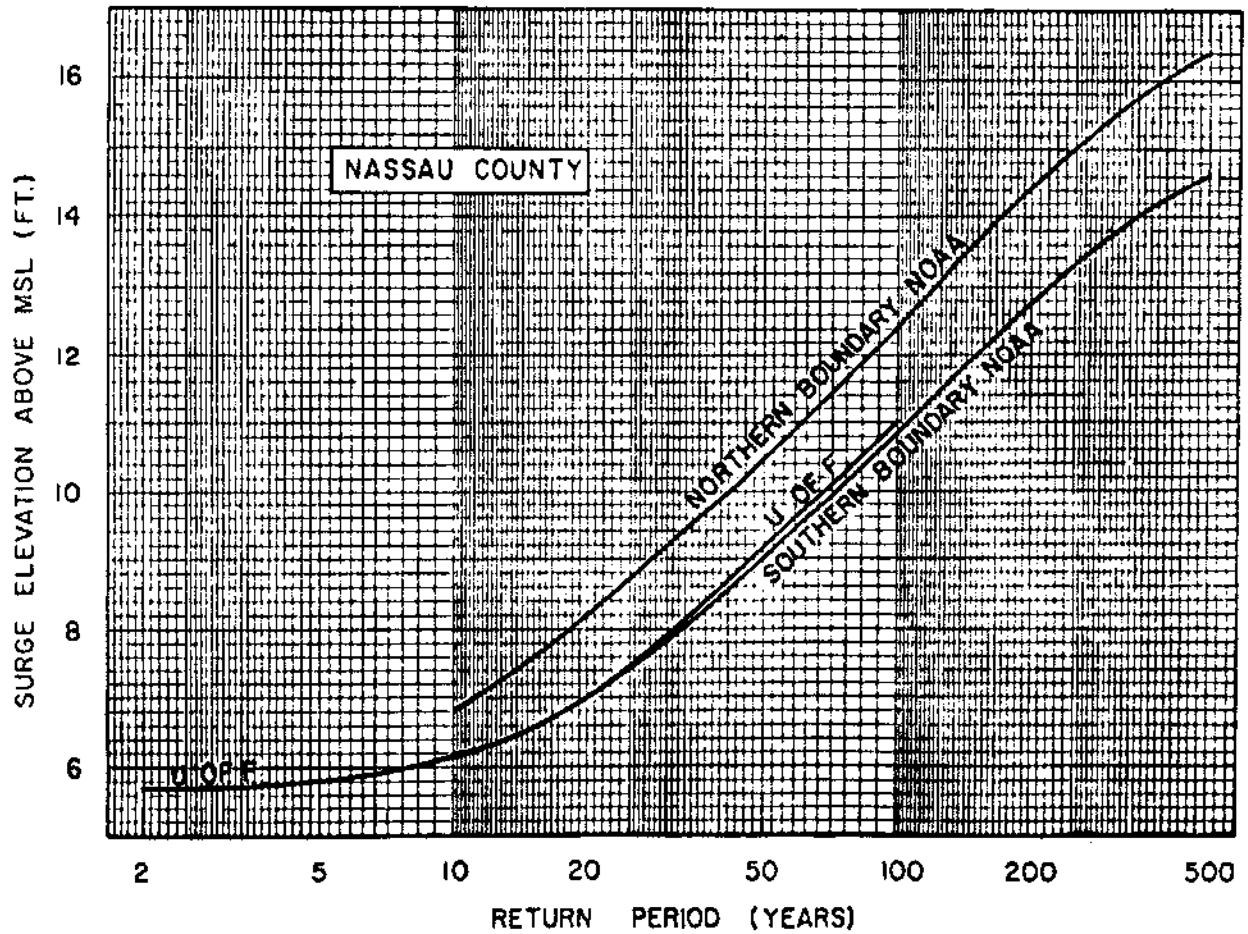

Fig. 2.4 Storm Surge Frequencies in Nassau County, Florida (COEL, 1975)

III. HISTORY

3.1 Engineering Works

Description provided in Section 3.1 is adapted from a report by Florida Coastal Engineers (1976), later summarized briefly by Olsen (1977) elsewhere.

Prior to stabilization of the channel by the construction of jetties, St. Marys Entrance was fronted on its seaward side by a very large bar formation which was cut by two relatively stable channels. The northernmost channel was primarily a short secondry channel and extended in a NNE direction very close to the shoreline of Cumberland Island. The main channel hugged the shore of Amelia Island in the Forth Clinch vicinity then continued in a generally ESE direction to ocean for a very great distance. A pictorial description of St. Marys Entrance by the French in 1779 (Fig. 3.1) coincides very well with more detailed bathymetric surveys performed in the mid 1800's by the U.S. Government (for example Fig. 3.2). This suggests that both channel configurations were relatively permanent features of the inlet prior to stabilization.

The deepest section of the inlet throat (minimum flow area) occurred opposite the Fort Clinch shoreline (Fig. 1.4) where the confluence of the Amelia River to the south and the St. Marys River to the north produced scour of the bed to depths in excess of 65 feet. The controlling depth across the inlet bar in 1870 was approximately 8 feet below mlw. It occurred seaward of the Amelia Island shoreline at a distance of approximately two nautical miles. The history of the jetty project is summarized below.

Most improvements until the development of the Navy's facilities at Kings Bay were carried out for the expressed purpose of providing a safe and economic waterborne navigation route between the Atlantic Ocean and the City of Fernandina, Florida. Implementation of this goal has been through the stabilization of the entrance to the Sound by the construction of rubble-mound jetties and the periodic maintenance dredging as required.

1875 The U.S. Congress called for a report on the importance and practicability of improving the condition of Cumberland Sound.

1879 A presentation of a feasible project based on the commercial potential of the Port of Fernandina was made to Congress. The plan called for deepening the entrance by constructing large twin stone jetties.

1880 Approval was given by Congress to carry out a survey of Cumberland Sound.

1881 Construction was begun on the north jetty. Because of rapid shoreline recession at Fort Clinch, 5 spur groins were constructed along the westernmost portion of the shoreline near the counterscarp wall of the Fort.

1882 The northern jetty foundation had been extended 7,200 feet and work begun on the south jetty.

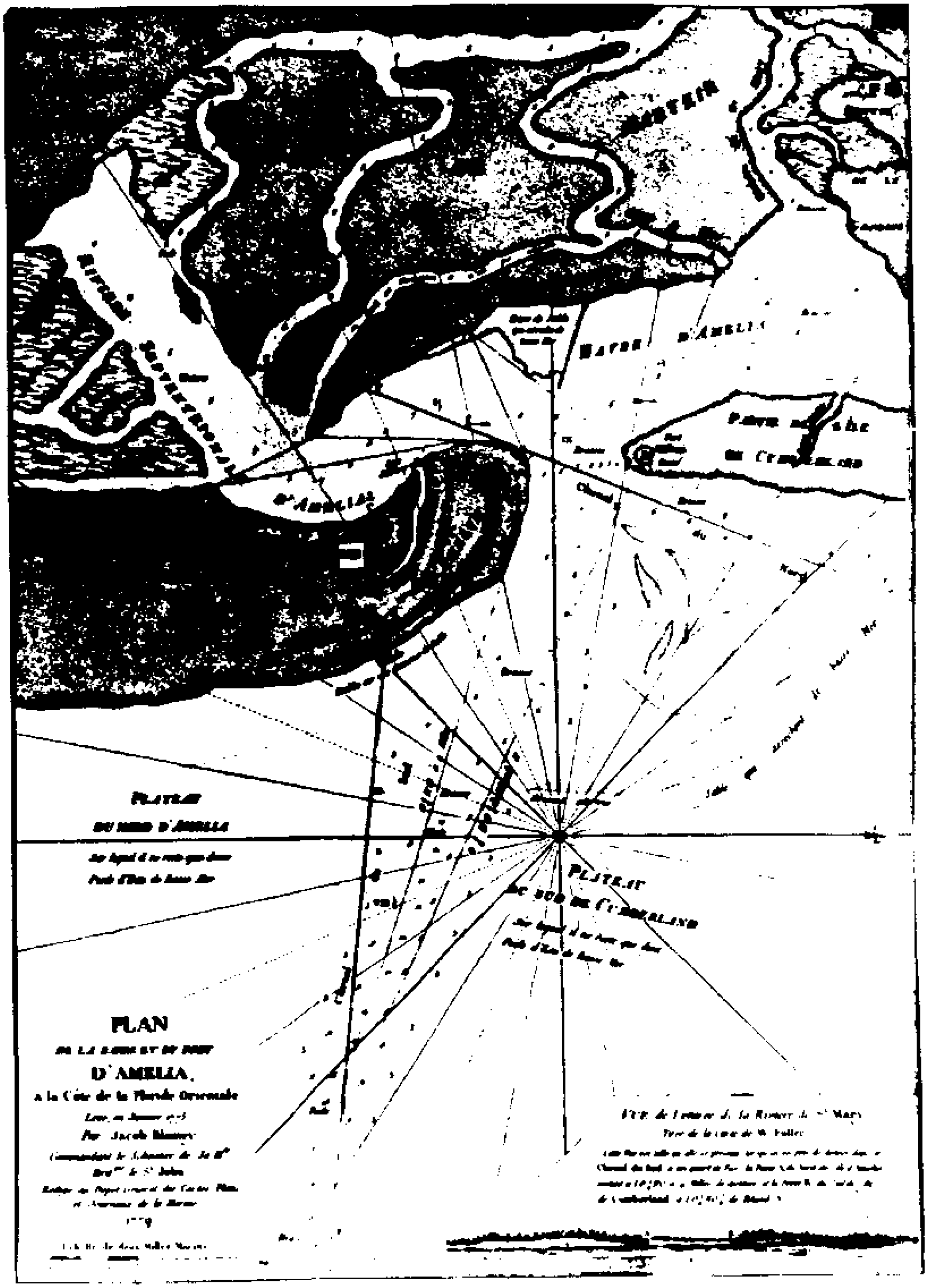

Fig 3.1 French Map of St. Marys Entrance in 1779

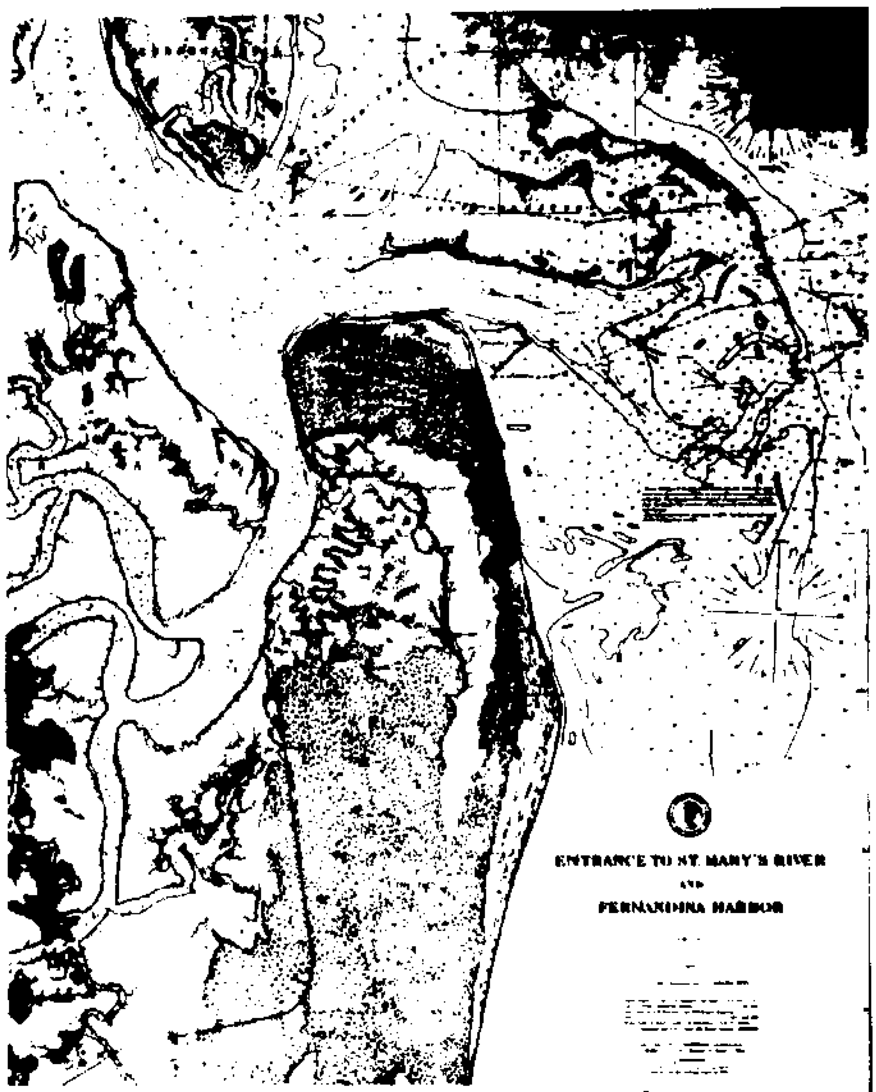

Fig 3.2   U.S. Coast Survey Map of St. Marys Entrance in 1875

1883	Work continued on both jetties, but two additional spur groins had to be added to the shoreline adjacent to Fort Clinch.
1884	Work was suspended for lack of appropriations.
1885	The authorized plan of improvement was continued. It was noted that since 1883 several hundred feet of accretion had occurred at the shore end of the south jetty.
1886	Work continued on both jetties with a corresponding noticeable increase in depth of water where the new ship channel was to be located, due primarily to the extension of the south jetty.
1887	Work continued with the jetties remaining in good condition.
1888	Work slowed because of a lack of sufficient appropriations.
1889-1895	Work was completed at a satisfactory rate. However, as the main navigation channel became poorly defined because of shoaling, a gap was opened in 1894 in the south jetty to accomodate shipping via the prior natural channel alignment.
1896	Work was suspended because of a lack of funds for the year.
1898	A hurricane forced a breach across the outer beach of Cumberland Island a short distance north of the north jetty (see also Section 2.4).
1902	A viable navigation channel through the seaward inlet shoal opened adjacent to the north jetty.
1903-1904	A total of 546,000 cu. yds. were removed from the vicinity of the north jetty in order to improve the rapidly forming natural channel. Construction on the jetties was completed in 1904. However, the breach in Cumberland Island deepened and widened so quickly that emergency improvements had to be made by means of a 6,900 foot long dike. Construction of the rubble-mound jetties dramatically changed the configuration of the natural inlet system. Instead of a very broad expansive inlet throat served by two channels, a single inlet with its flow completely confined within the man-made jetties was created. The secondary northern channel was cut off by the construction of the north jetty. The main channel which had originally tended to orient in a southeasterly direction was correspondingly intercepted by the construction of the south jetty. All tidal flows were then forced to enter and exit between the jetties until the modified hydraulic regime had scoured the bottom between the structures to depths capable of conveying the newly confined flow.
1905-1937	During 1905-1913, repair work was required to maintain the jetties. In 1927, the crest elevation of the north jetty was increased to 7 ft. mlw and the south jetty to 6 ft. mlw. During 1905-1937 maintenance of the entrance channel required removal of 717,438 cu. yds. of sediment giving an annual average rate of 22,420 cu. yds.

1940 An increase in the authorized project dimensions required dredging of 248,048 cu. yds. of sediment.

1945 Maintenance requirements were 196,350 cu. yds. for the previous five year span resulting in an annual average of 39,270 cu yds.

1955-1956 The realignment of the entrance channel to a position within the natural channel near the south jetty required the excavation of 1,712,733 cu. yds.

1957 The entrance channel was realigned and deepened to 34 ft. in fiscal year 1957 in connection with the Kings Bay Army Terminal.

1963-1973 Total entrance channel maintenance was 1,933,976 cu. yds. giving an annual average rate of 193,398 cu. yds.

1978-1979 During these years the project depth for the navigational channel to Kings Bay through Cumberland Sound was increased to 36-40 ft.

3.2 Recent Dredging in Outer Channel

Fig. 3.3 shows the 400 ft. wide entrance channel and the segment which is normally dredged for maintenance (between stations 325+00 and 130+00). During 1978-79 channel deepening (to 36-40 ft.) was carried out in the reach between stations 325+00 and -68+00, for the Navy, in connection with the Kings Bay facility. Maintenance dredging volumes between 1965 and 1976 are given in Table 3.1. The 2,574,533 cu. yds. listed for 1978-79 is the sum of capital and maintenance dredging. The average maintenance dredging rate is noted to be 178,000 cu. yds. per year.

Table 3.1
Dredging Volumes In Outer Channel, 1965-79*

F.Y.	BIN	CREDIT	Amount** Cu. yds	Capital (c) or Maintenance (m)
1965	305,780	160,967	254,817	m
1966	343,217	178,557	286,014	m
1967	114,800	52,972	95,668	m
1968	221,728	201,000	184,773	m
1969	292,127	180,000	243,439	m
1970	262,625	160,000	218,854	m
1973	72,250	65,000	60,208	m
1973	452,988	411,800	377,490	m
1974	42,693	35,694	35,577	m
1975	81,476	75,915	67,896	m
1976	155,397	108,557	129,498	m
1978-79	4,749,050	2,343,867	2,574,533***	c and m

*Data provided by the U.S. Army Corps of Engineers Jacksonville District office

**Volumes computed by a constant ratio of BIN to place of 1.2 to 1

***Computed prior to project completion

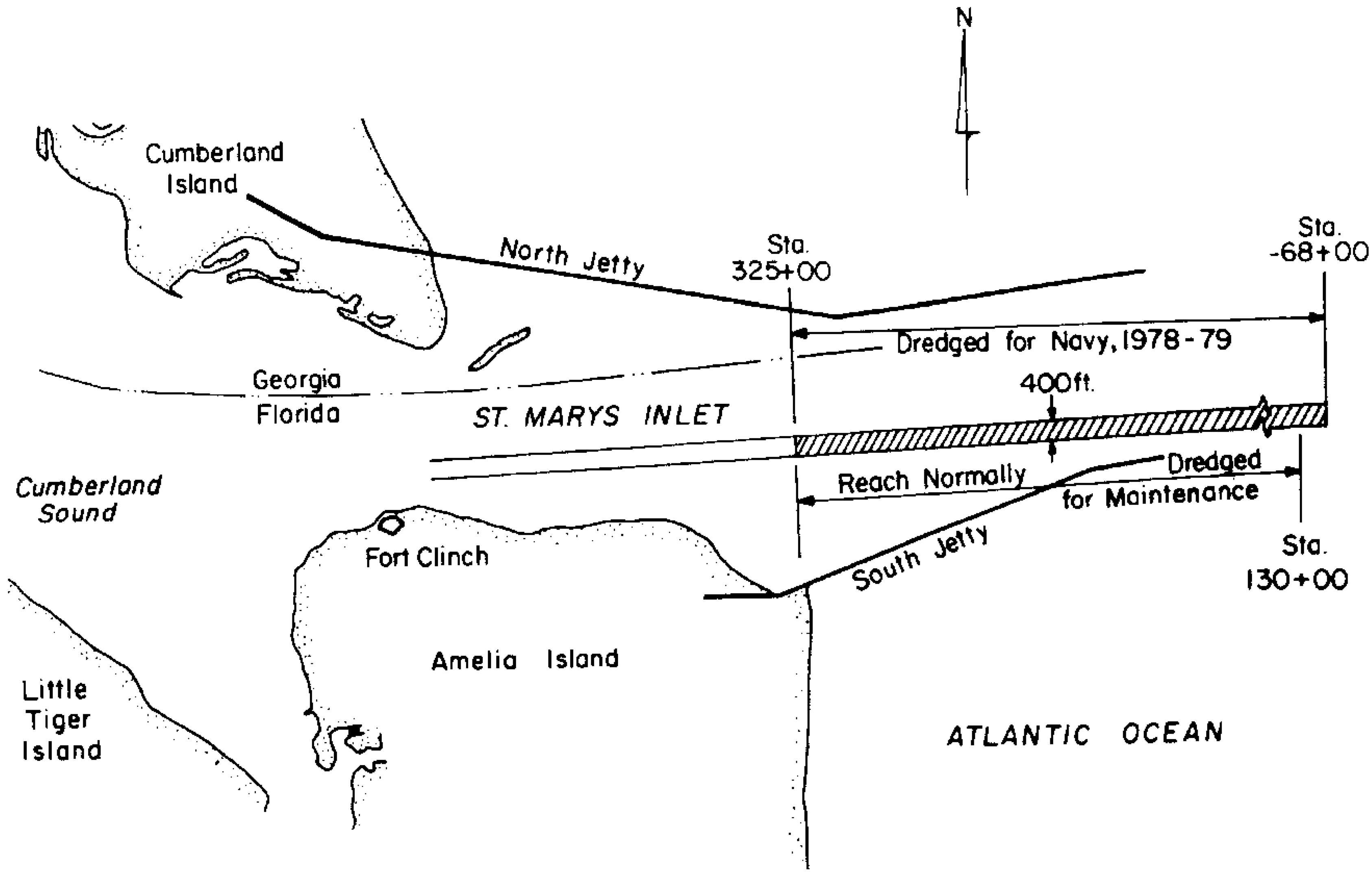

Fig. 3.3 Outer Channel Where Maintenance Dredging is Carried Out by U.S. Army Corps of Engineers, Jacksonville District

3.3 Fort Clinch

Fort Clinch is a pentagonal brick structure located on the northern tip of Amelia Island on the southern bank of St. Marys Entrance. Its construction was begun in 1850, was used during the War between the States, and the Spanish American War, and was later abandoned. In 1935, the State of Florida purchased the area for development as a state park. The fort was originally designed to guard the passage into the deep water harbor by way of Cumberland Sound. Its disposition was based on defense principles first perfected by the French in the 17th Century. The construction site selected was not only the narrowest section of inlet throat between Amelia and Cumberland Islands but unfortunately, also the most dynamic and unstable. Between surveys of 1843 and 1880 this reach had widened by approximately 1,500 feet, forcing the construction of seven spur groins in order to prevent further shoreline recession (Fig. 3.4). With the start of construction of the navigation project in the 1880's, the shoreline directly eastward of the fort began to recede, thus leaving the fort heavily exposed to current and wave action. Acting as a headland, the fortification began to interrupt the littoral transport to the west along the northern tip of Amelia Island, thus necessitating the construction of additional six groins (COEL, 1958).

To date, the entire groin field has been successful in retaining the basic integrity of the shoreline adjacent to the fort. Without it, serious undermining of the permanent fortification walls would have occurred. Some recession of the shoreline is still occurring due to various reasons. The first of these is a general degradation of the groins by the action of storms and through gradual subsidence. Another is the improved efficiency of the inlet hydraulics.

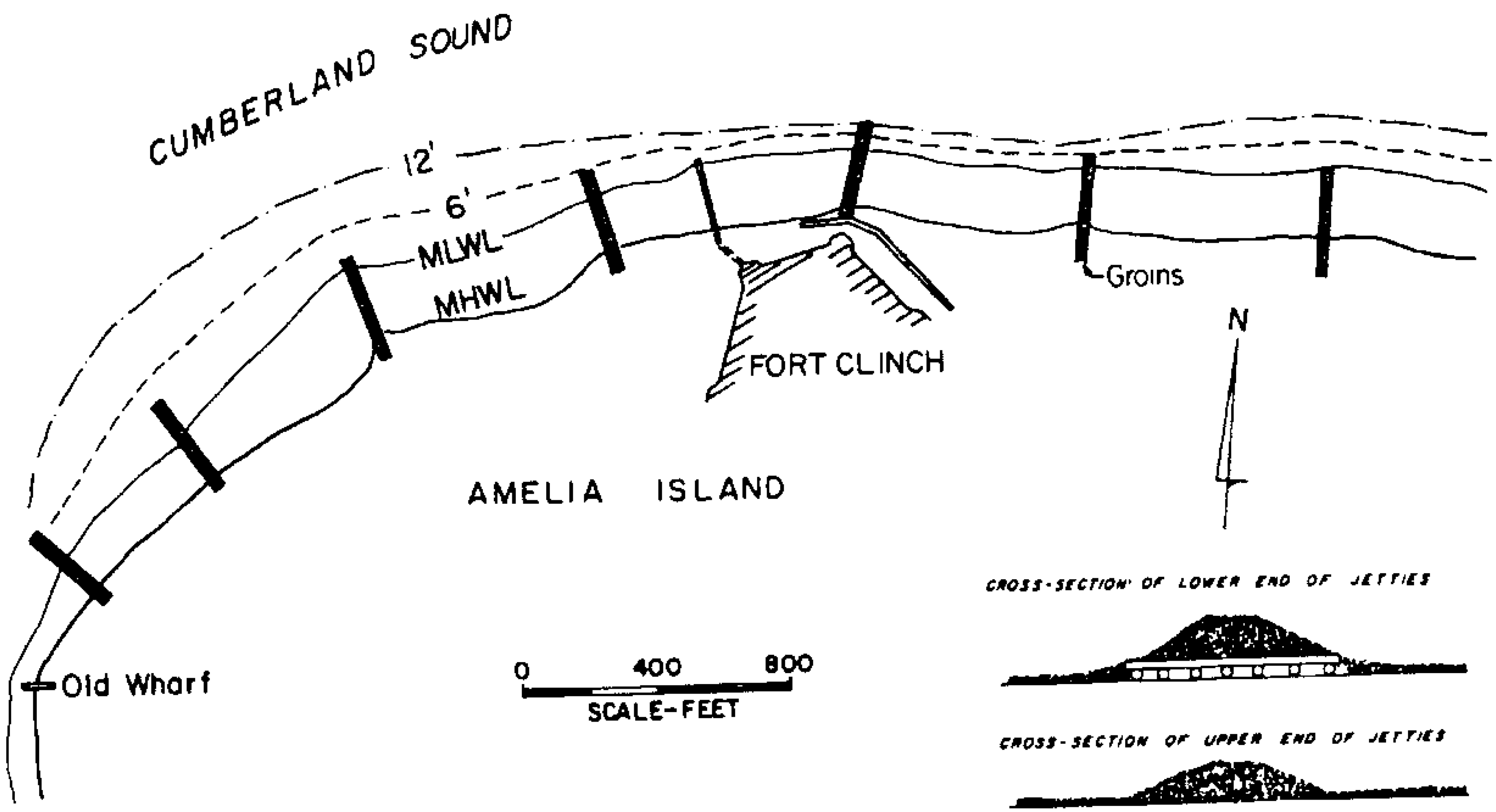

Fig. 3.4 Protective Shoreline Structures at Fort Clinch (Florida Coastal Engineers, 1976)

IV. HYDRAULICS AND MORPHOLOGIC CHANGES

4.1 Tide

The tide is predominantly semi-diurnal with an ocean (outer coast) range of 5.7 ft (mean) and 6.7 ft (spring). Table 4.1 gives mean and spring ranges at several locations in the inlet vicinity, as reported by the National Ocean Survey Tide Tables.

Table 4.1
Tidal Ranges in Inlet Vicinity

Location	Range (ft) Mean	Range (ft) Spring
North Jetty	5.8	6.8
Crooked River Entrance	6.8	8.0
St. Marys (St. Marys R.)	6.0	7.0
Crendall (St. Marys R.)	5.1	6.0
Fernandina Beach (outer coast)	5.7	6.7
Fernandina Beach (Amelia R.)	6.0	7.0
Chester (Bells R.)	6.4	7.5
Kingsley Creek (S.A.L. RR. Bridge)	6.0	7.0

Tidal fluctuations within Cumberland Sound and the rivers entering the sound are somewhat unique in Florida in that they are subject to amplification due to geometry. This is exemplified by a comparison of the mean and the spring ranges at north jetty with those at Crooked River Entrance, St. Marys, Fernandina Beach (Amelia River), Chester and Kingsley Creek. All the latter ranges are higher than at the north jetty. This phenomenon can be explained by the conservation of energy of a progressive wave in a channel. When an upstream location in an estuary has a smaller cross-sectional area than that at its mouth, the tidal range upstream is often higher than the tidal range at the mouth.* To the west, this historical limit of tidal influence within the St. Marys River is at Woodstock, Florida, some 75 miles upstream of the river mouth (Florida Coastal Engineers, 1976). It is likely that both the Green's Law effect and Helmholtz resonance play a role in the observed amplification phenomenon.

4.2 Currents and Tidal Prism

Tidal currents within both the inlet throat (minimum flow area) and the rivers are a direct function of the water surface slope which results from the head difference between the ocean and the "effective bay" during propagation of the tidal wave. Within the ocean, outside the project jetties, indications are that two current systems exist. The first is a seasonal current to the north which tends to predominate in the winter and into the early or mid-summer. The net transport is clearly to the north during this period at least in the zone of the first several miles offsore and parallel to the coast. The

*Hou (1974) has essentially ascribed the cause of amplification to Helmholtz resonance of the inlet-bay system. (See also, Bruun, 1978.)

second current system is oscillatory in nature from north to south and is generated by the hydraulic demands of the inlet. Because of the permeability of the project jetties, hydraulic flows occur through the structures during both the ebb and the flood cycles. From oceanographic outfall measurements carried out by the I.T.T. Corporation in 1969 (I.T.T., 1969) these hydraulic effects are definitely discernable for a distance of several miles south of the southern rubble-mound jetty.

The superposition of these two currents produces an almost constant northerly mass transport during the winter and early summer months. During the remainder of the year, water motions follow a radial pattern dictated by the hydraulic gradients directed to or away from the inlet and are in phase with the tides (Florida Coastal Engineers, 1976).

Current measurements in the inlet have been obtained from time to time (for example Hou, 1974; Florida Coastal Engineers, 1976; Environmental Science and Engineering, 1980a). Because of the complexity of the flow field in the channel and the limited instrumentation involved in measurement, the available measurements are of variable degrees of accuracy, and discrepancies are notable. Also, the data were obtained over comparatively short time periods (e.g. one tidal cycle) and therefore cannot be considered to be synoptic. The following description is derived from field measurements by Florida Coastal Engineers (1976):

Two separate sets of velocity measurements were taken during a field study in May, 1975. A series of spot measurements over depth were first made during both ebb and flood cycles on the seaward side of each jetty in order to estimate the potential net flow through the rubble-mound structures. Velocities on an ebb tide averaged about 0.6 fps over depth at the outside of both jetties, whereas flood velocities were somewhat stronger at approximately 1.0 fps. Since both jetties combined have over 21,000 linear feet of structure susceptible to this phenomenon, it became obvious that a sizeable portion of both the total ebb and flood discharge is transmitted through the rubble. For the mean tide range observed during the study period, it was estimated that up to 28% of the total flood flow enters through the permeable jetties rather than at the ocean terminus of the structures. It is this transmissibility of the jetties which is promoting the tremendous losses of sediment to offshore by permitting littoral material to pass into the inlet and be carried to the seaward shoals by the extremely efficient tidal hydraulics of the system.

The second set of velocity measurements was performed across the inlet throat in order to determine an accurate total inlet discharge and, correspondingly, the tidal prism. The observations made were limited primarily to surface measurements because extreme difficulty in maintaining a vertical orientation of the current meter at depths was encountered during periods of peak discharge. An adjustment was made to the integrated unit discharge derived from the data in order to arrive at an average cross-sectional value. The product of this number and the measured area of the inlet throat at the time of the study resulted in an estimated tidal prism of 9.8×10^9 ft^3 on the spring range of tide (see Table 4.1). Measurement of the time lag of slack water relative to the time of HW or LW in the ocean yielded values ranging from 0.83 to 0.93 hr, which compares reasonably with 1.04 hr reported by O'Brien and Clark (1974) based on data provided by NOS Tide Tables and Tidal Current Tables (see also Table 4.2). O'Brien and Clark however reported a prism of 5.58 x 10^9 ft^3 based on NOS data under a mean range of tide. This is 43% lower than the value of 9.8 x 10^9 ft^3 obtained by Florida Coastal Engineers. Although the spring prism would in general be higher than the mean prism, the observed difference cannot be attributed to this cause entirely. In fact, the mean prism would be lower than the spring prism by 8-10% only. Measurements by Environmental Science and Engineering (1980) yielded a value of 6.02 x 10^9 ft^3 which is closer to the value obtained by O'Brien and Clark.

Table 4.2
Measured and Predicted Currents

Quantity	Measured*	NOS Current Tables
Strength of flood (fps)	4.0	4.3
Strength of ebb (fps)	4.0	4.3
Slack before High Water (hr)	1055	1033
Slack before Low Water (hr)	1715	1636

*Measurements were made at the inlet throat on October 14, 1973.

The tidal range at Fernandina Beach (Amelia River) was 6.7 ft (Hou, 1974). Although the current magnitudes compared reasonably well, the times of slack water are less accurately predicted.

4.3 Salinity and Temperature

The following surficial (up to a depth of about 8 ft) observations were made at the throat station on October 14, 1973 (Hou, 1974):

Table 4.3
Salinity and Temperature Readings

Time on October 14, 1973 (EST)	Salinity (ppt)	Temperature (°c)
Slack before High Water:	29.7 (28)	25.3 (24.3)
Slack before Low Water:	26.0 (24)	25.5 (25.0)

It is observed that whereas the temperature remained almost constant from slack to slack, the salinity decreased by 3.7 ppt, indicatng the influence of freshwater outflow during ebb. Data in parentheses are based on similar measurements made by Florida Coastal Engineers (1976) in May, 1975. The trends are observed to be similar as well.

More recently, Environmental Science and Engineering (1980a and b) obtained salinity profiles over depth at a number of stations in the entrance and elsewhere. In the simplest model for salinity intrusion in an estuary, the estuary is assumed to be a channel of constant cross-section in which the degree of intrusion is defined by the opposing forces represented by the tide in the ocean and the upland freshwater outflow. Ippen (1966) has described the model which relates the salinity at high water (HW) and at low water (LW) as a function of distance from the estuarine mouth. In Fig. 4.1 measured salinities at HW and LW are compared with predictions based on the simple model. The distance is measured from the ocean tip of the jetties through the

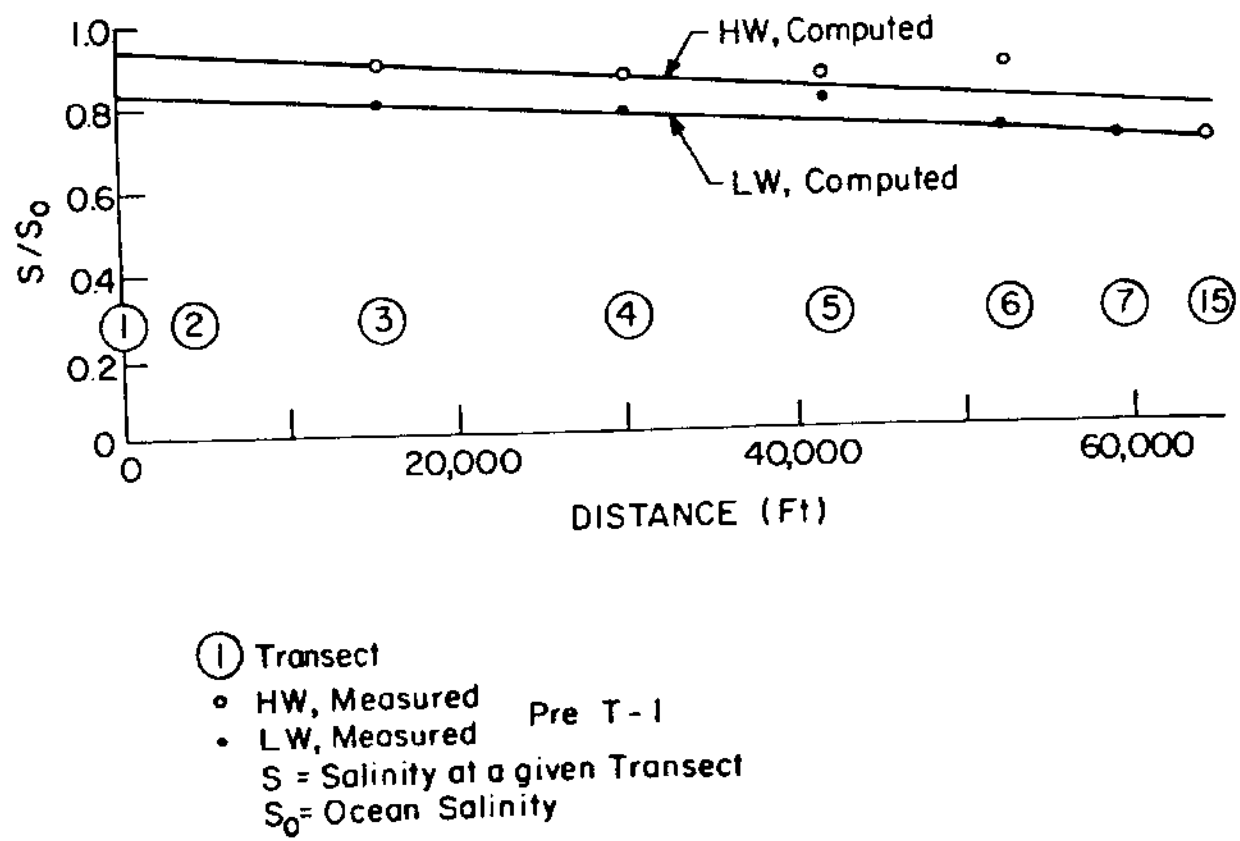

Fig. 4.1 Comparison between Measured and Computed Salinity in St. Marys Entrance and Cumberland Sound (Environmental Science and Engineering, 1980b)

entrance and into Cumberland Sound. Considering the complexity of the estuarine system, the agreement between measurement and prediction should be considered to be reasonable.

4.4 Waves

Wave and swell roses applicable to northeastern Florida are given in Fig. 4.2. The swell chart was published by the Hydrographic Office of the U.S. Navy and is based on a total of 46,515 observations during the period 1932-1942 (U.S. Congress, 1961a). The annual wave height and period roses for data square number 11 were derived from ship observations compiled by the U.S. Naval Weather Service Command (see Walton, 1973). Note that these data are for the deep water conditions offshore. An understanding of the distribution of wave energy along the shoreline near St. Marys Entrance would require investigating the patterns of shoaling and refraction of the deep water waves. In conjunction with determining the direction and the rate of littoral drift along the shoreline in the vicinity of the inlet, Florida Coastal Engineers (1976) studied the wave refraction pattern extensively. Wave periods ranging from 4 to 8 seconds were selected for study. For further details, reference may be made to the publication. Conclusions reached in that study on the sand budget in the vicinity of the inlet have included considerations on the littoral transport direction and the littoral transport rates derived from the wave refraction analysis. The sand budget is briefly discussed in Section V.

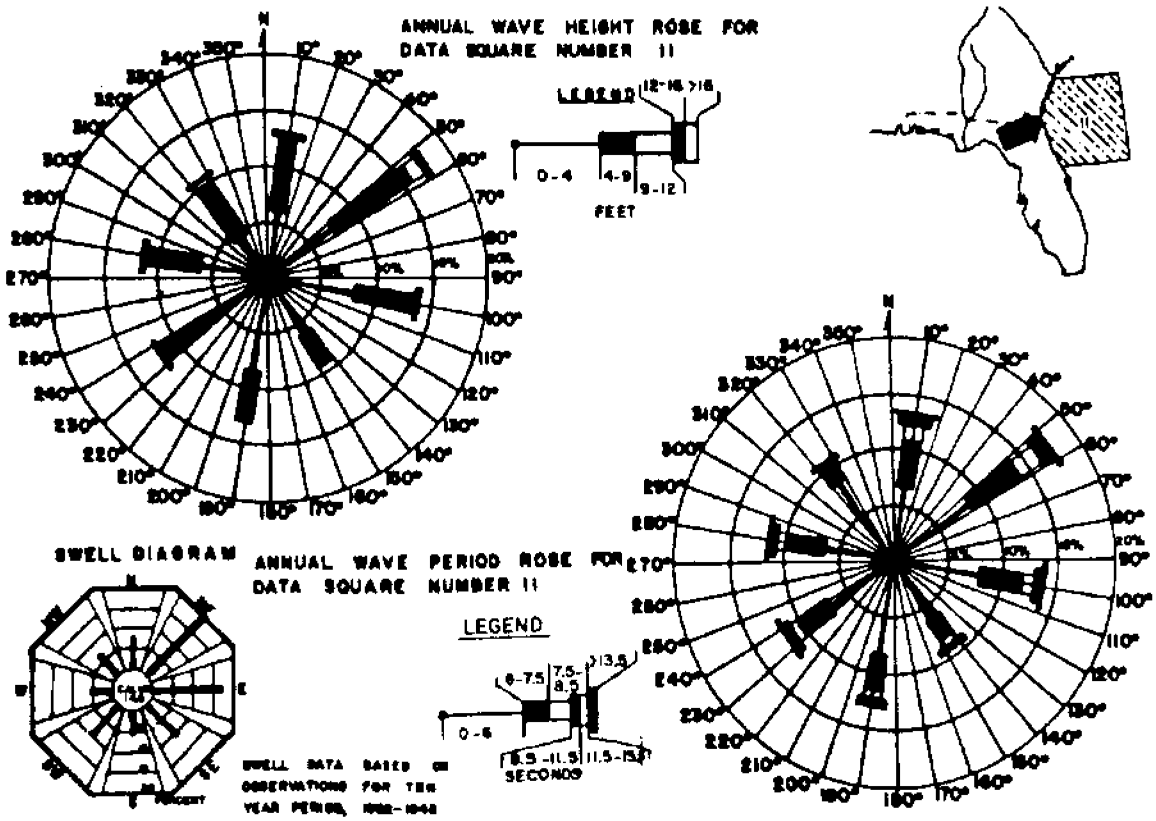

Fig 4.2 Wave and Swell Roses Applicable to Northeastern Florida (Florida Coastal Engineers, 1976)

4.5 Inlet Geometry

Hou (1974) has reported the following values of inlet flow area at six sections along St. Mary's Entrance. (The locations are shown in Fig. 4.3.)

Table 4.4
Inlet Geometric Parameters

Section No.	Distance from Section 1 (ft)	Area below mwl (ft^2)	Mean Depth below mwl (ft)
1	0	154,160	40
2	2,960	138,900	34
3	7,820	153,750	27
4	11,960	135,360	29
5	15,840	147,960	42
6	20,180	197,550	32

Since the inlet itself may be thought of as being the channel segment between sections 1 and 6, the length of the inlet channel is 20,180 ft. The Throat (minimum flow area) is noted to be at section 4 (135,360 ft^2) which is in the vicinity of Fort Clinch. Over the years, the Throat cross-section has increased with time, both as a result of long-term changes in the regional morphology and particularly due to the construction of the jetties to train the inlet. Fig. 4.4 shows the trend between 1855 and 1974. Judging from the observed decreases in the rate of increase of the area in recent years it appears that the inlet is approaching an equilibrium condition dictated by the hydraulic and the sedimentary factors. Olsen (1977) has shown that the inlet throat area will probably stabilize (barring no significant man-made changes in the flow regime) at about 148,000 ft^2.

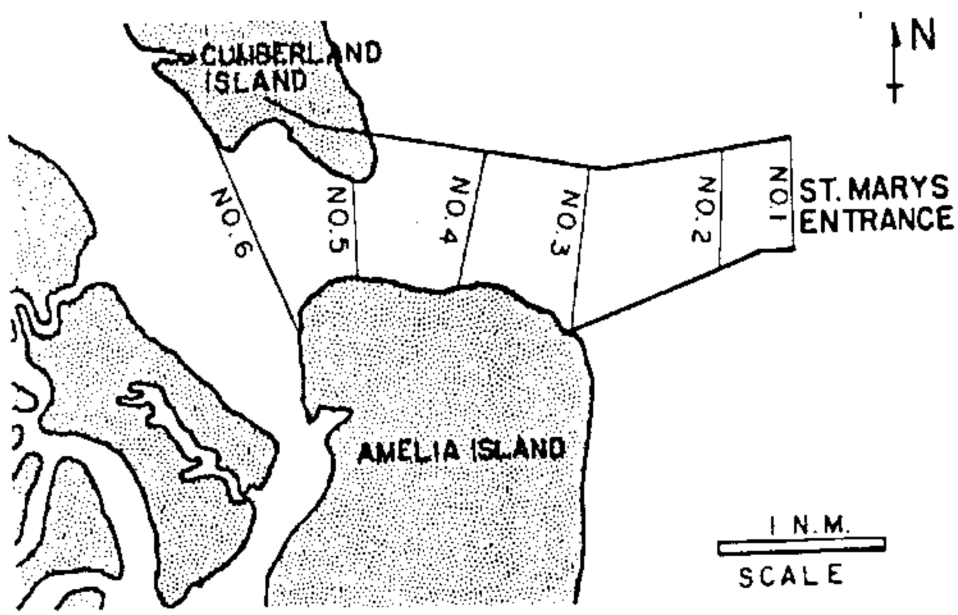

Fig 4.3 Locations where Cross-Sectional Areas were Measured (Hou, 1974)

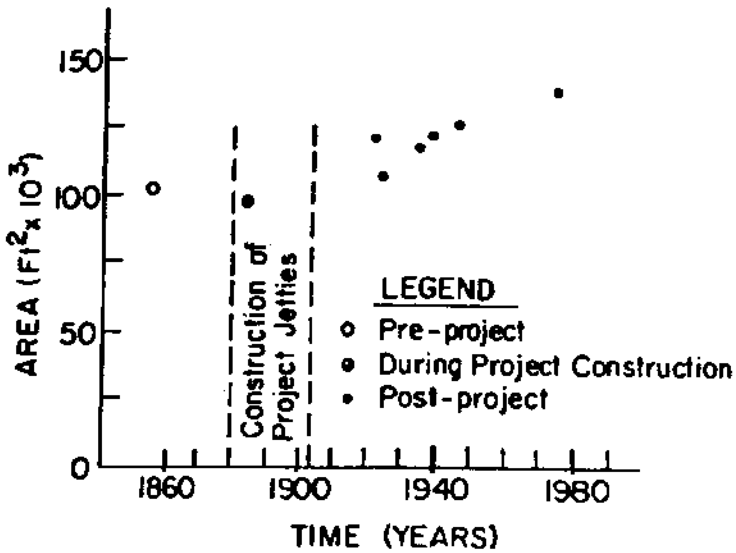

Fig 4.4 Change in Inlet Throat Cross-Sectional Area, 1855-1974 (Olsen, 1977)

4.6 Shoreline Changes

The most demonstrable shoreline changes attributable to the stabilization of the inlet have occurred at or adjacent to Fernandina Beach which is located approximately 2 miles south of the entrance (Olsen, 1977; Nash, 1977). Fig. 4.5 shows the shoreline changes between 1843 and 1943. Shoreline recession in this area has resulted from both a steepening of the offshore slopes and a general straightening of the coastline caused by a northward migration of sediments comprising a pre-jetty nearshore shoal system and associated seaward "bulge" in the shoreline. Fig. 3.2 shows these physiographic features as well as the pre-project inlet channels with which these features were once related. Fig. 4.6 shows the inlet in a portion of the NOS nautical chart (No. 11503) dated December, 1979. It is observed that the shoreline south of the inlet has now become nearly straight, with a north-south orientation. Accretion on the south side of the entrance and distribution of sediment during ebb flow may be seen from the photograph given in Fig. 4.7. It should be noted that although the southern end of Cumberland Island has experienced similar erosion of the shoreline, structural damage due to shoreline recession has neither occurred, nor is anticipated to occur due to the lack of appreciable inhabitation on the southerly portion of the island affected by inlet stabilization (Olsen, 1977). Fig. 4.8 (after Nash, 1977) shows a striking constrast between shoreline and the offshore bar before jetty construction and at the present time.

In order to establish a Coastal Construction Control Line for limiting the seaward extent of construction, the Department of Natural Resources of the State of Florida established bench marks and survey range lines along Amelia Island. Monumented stations approximately 1,000 ft. apart were placed on the baseline where beach profiles were measured (Fig. 4.9). The actual profiles based on a 1975 survey are available elsewhere (COEL, 1975). NOS publishes bathymetric maps extended to the continental slope under a category of maps entitled, "Outer Continental Shelf Resource Management Map." Offshore (Contintental Shelf) bathymetry relevant to the shoreline of northeast Florida is given in NOS map 17-5 (OCS), 1976.

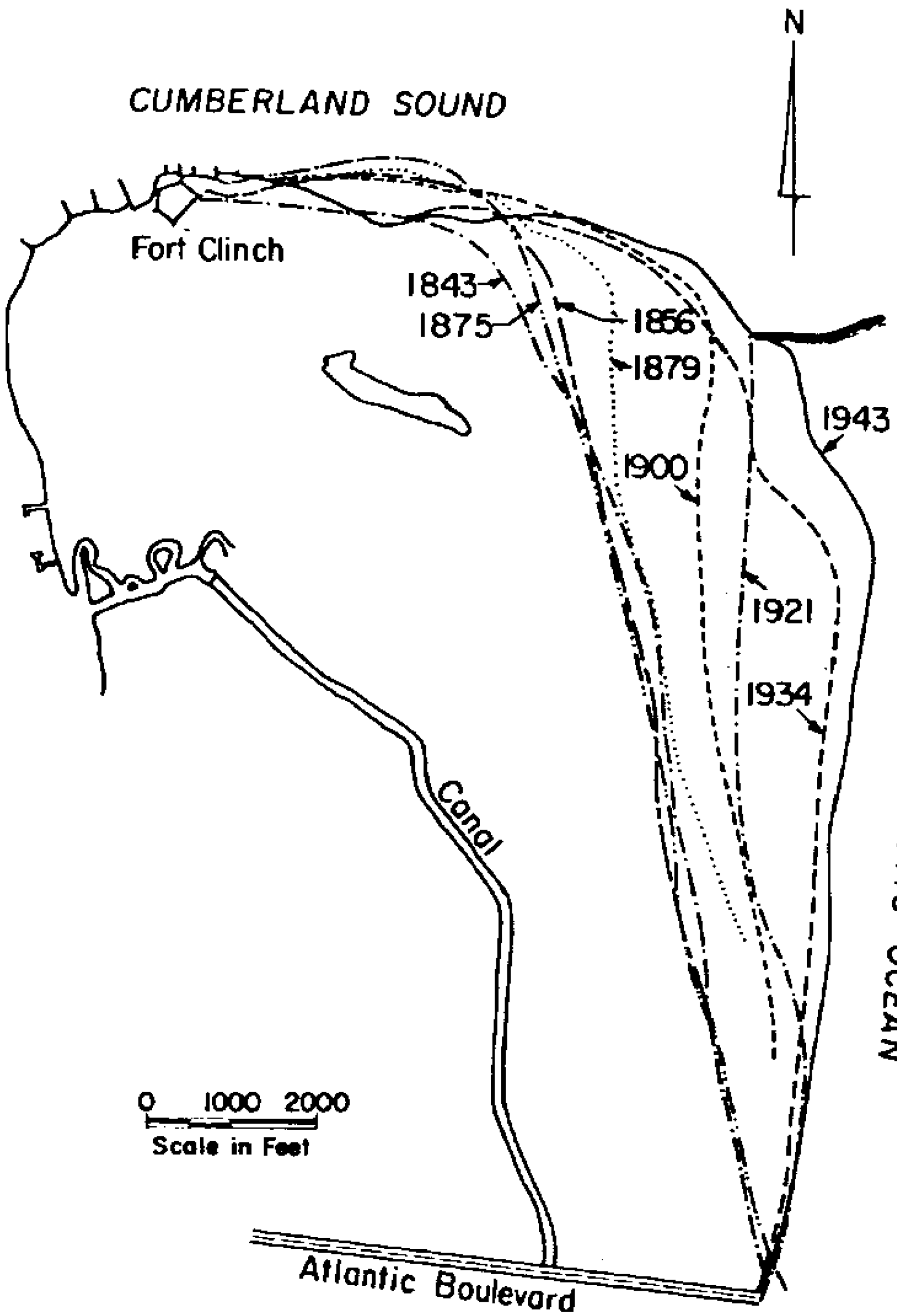

Fig 4.5 Shoreline Changes South of the Inlet, 1843-1943
(Florida Coastal Engineers, 1976)

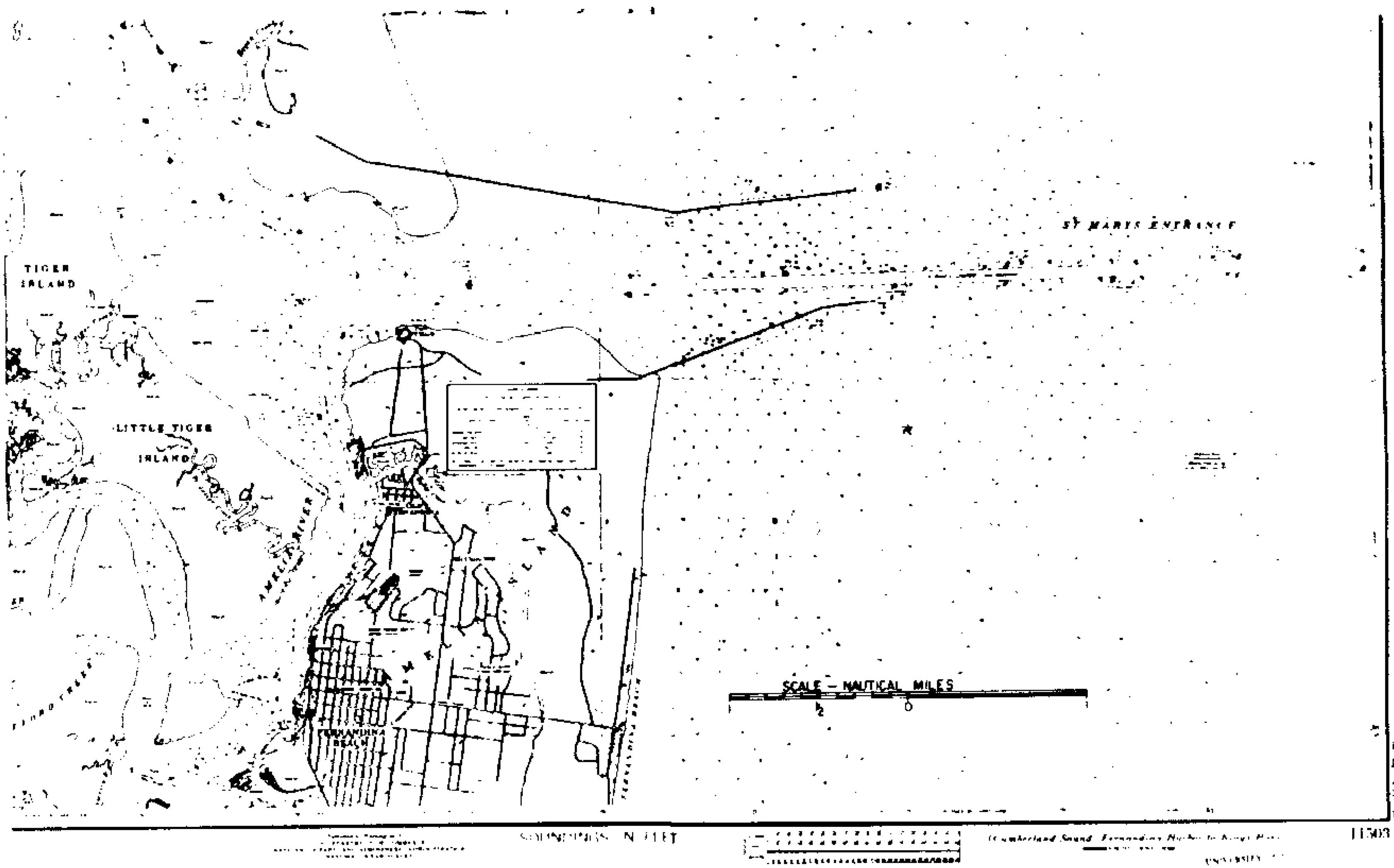

Fig. 4.6 St. Marys Entrance and Outer Navigation (NOS Chart, December, 1979)

Fig. 4.7 Photograph showing accretion on the south side of the entrance and distribution of sediment during ebb.

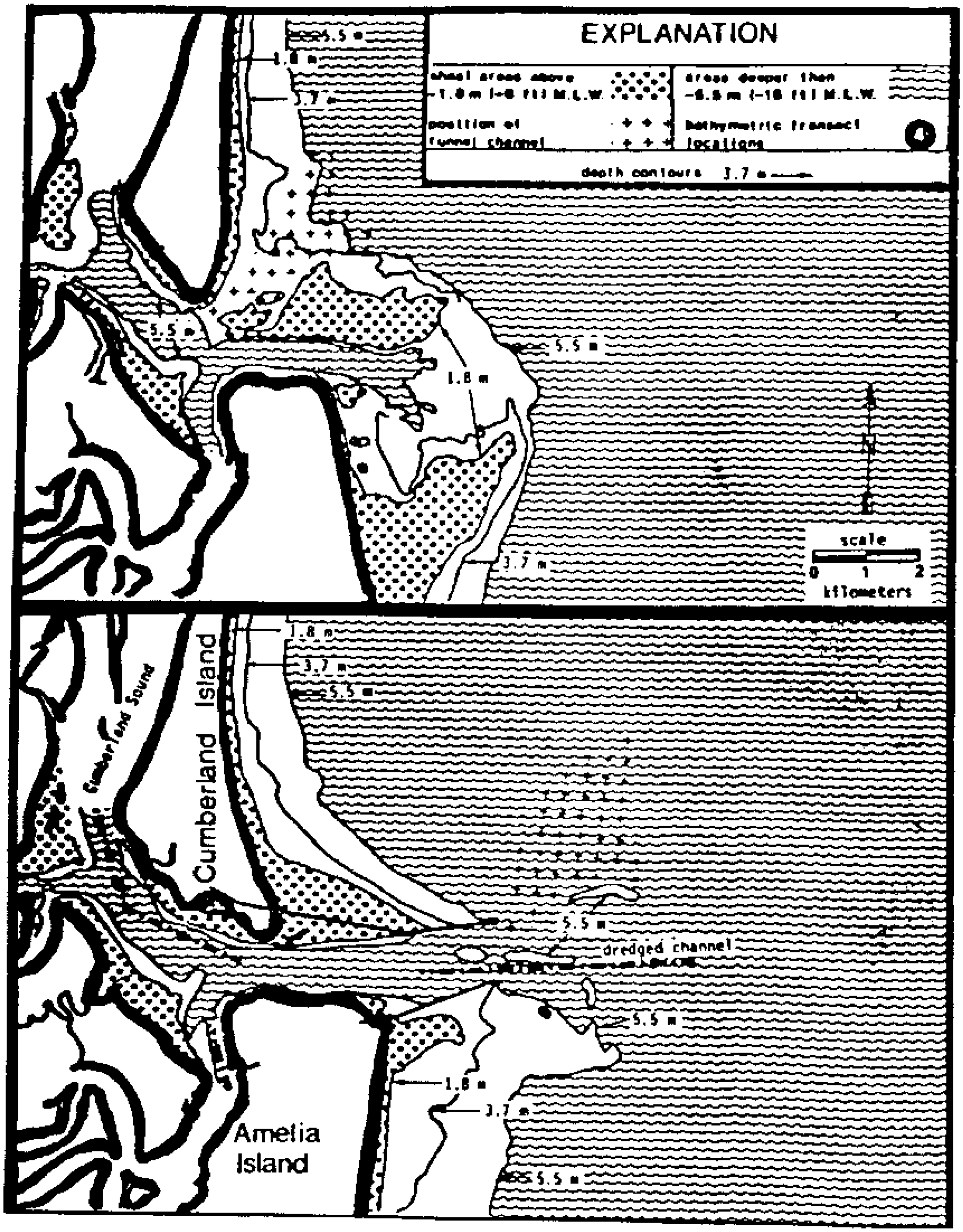

Fig 4.8 Configuration of St. Marys Entrance and Cumberland Sound, Georgia prior to the construction of the jetties, 1876 (upper figure) and present configuration, 1976 (lower figure). Nash 1977

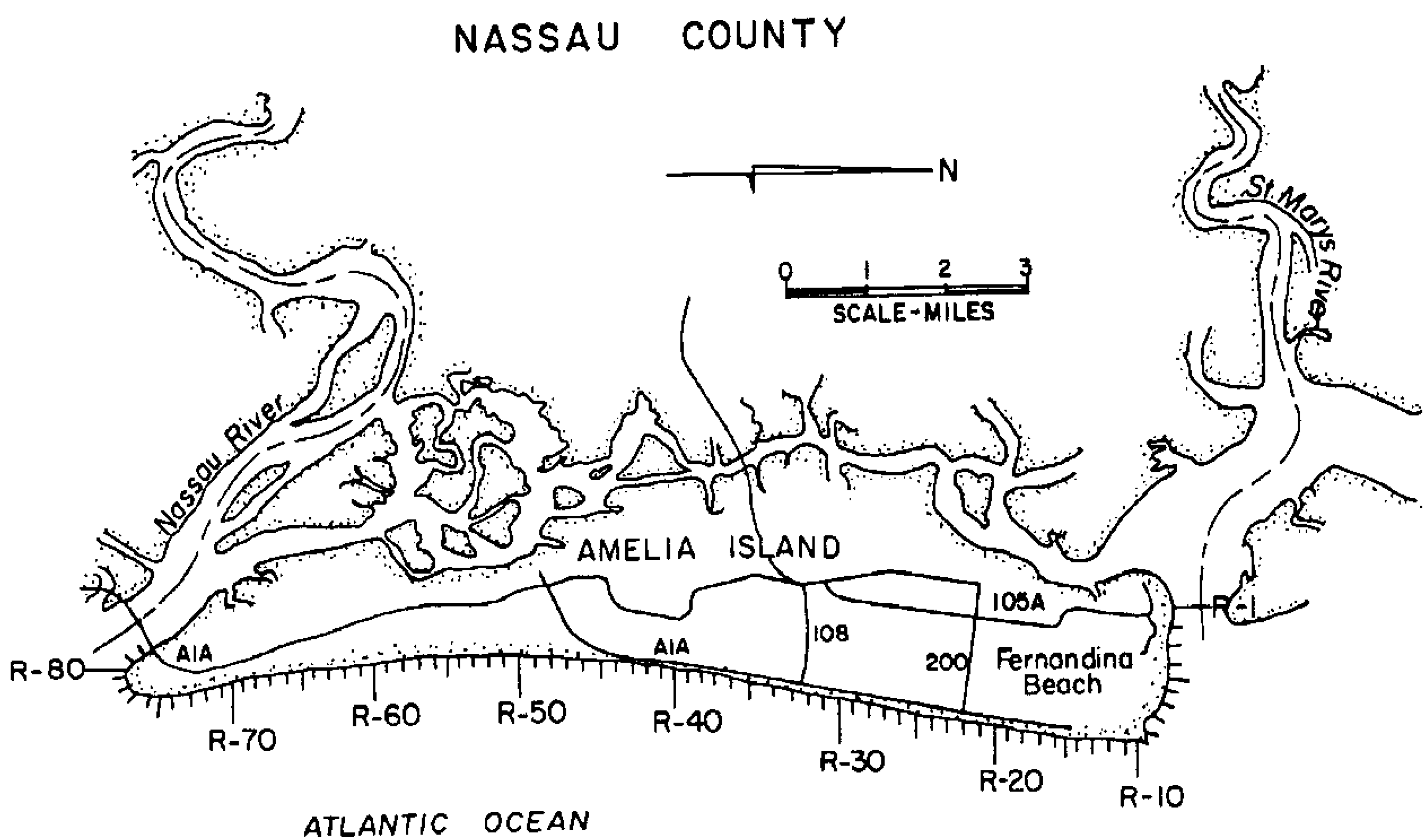

Fig. 4.9 Department of Natural Resources: Coastal Construction Control Lines on Amelia Island (COEL, 1975)

5.1 Sediments

Sediment samples collected from the bottom (Hou, 1974) indicate a range of sizes of sand, from 0.12 mm (very fine) to 0.52 mm (medium). Samples collected by Bruun (1958) near Fort Clinch were found to contain 0.15 mm sand. The sorting coefficient ranged from 1.21 to 1.40. "Bayward" of the entrance, significant amounts of silt and clay are found in association with sand plus some shells and shell fragments. Analysis of sediments collected from a marina (Fernandina Beach Marina) in Amelia River in the city of Fernandina Beach (2.4 nautical miles south of Fort Clinch) indicated 19% sand, 25% silt and 44% clay, by weight, plus some large shells (not considered in the above). Adjacent outer coast beaches consist of very fine to medium sands. A description of offshore (up to 14 nautical miles) sediments has been given by Meisburger and Field (1975).

5.2 Sand Budget

In order to determine both historical shoreline and offshore bottom changes resulting from the initial construction of the project jetties in the 1880's and from subsequent authorized improvements or modifications, Olsen (1977) developed a method to calculate the spatial volumetric changes over time. The analysis consisted of comparing digitized bathymetric features from pre- and post-jetty project hydrographic surveys which spanned a period of approximately 100 years. Each data matrix was 37 x 69 thereby generating a depth grid consisting of 2,448 points. A specific grid element was assigned a representative depth by averaging the four corner values. A net rise in sea water level of 0.6 ft. during the approximately 100 year period was taken into consideration. This sea level rise magnitude was derived from records of mean water level at Fernandina Beach and at other nearby East Coast tidal stations. A computer program compared the average depths, calibrated the volumetric changes and presented the output in a form suitable for depiction.

Fig. 5.1 shows the isolines of accretion and erosion obtained by the program as well as a summary of integrated volumetric sediment losses or gains. It was determined that the total geologic transformation as a result of inlet stabilization extended northward for a distance of 8.5 miles and southward for a distance of approximately 7.5 miles from the entrance. Computed volumes of erosion indicate that over a hundred year period, 123 million cu. yds. have been displaced from the nearshore regions of Cumberland and Amelia Islands combined. An additional 31 million cu. yds. have been scoured from within the confines of the jetties. Correspondingly during the same period approximately 120 million cu. yds. have accumulated in the form of shoals directly seaward of the inlet jetties and are essentially lost from the active littoral system. Volumes of accretion in the form of fillets at the bases of the rubble-mound structures have been minor by comparison. Each of the jetties has accumulated a total of only about 10 million cu. yds since their construction around the turn of the century. The physiography of these accretions has been in the form of seaward extensions of the shorelines at the tip of both islands. These two areas of deposition have reached an equilibrium with respect to growth, with the shoreline adjacent to the south jetty currently being in a known state of mild recession.

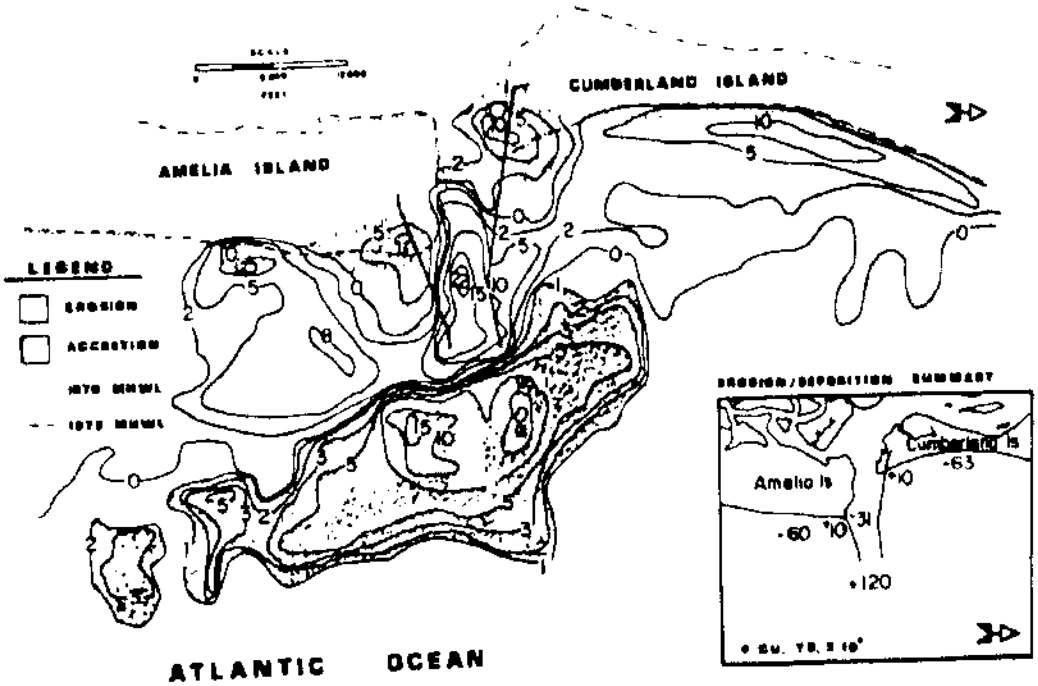

Fig 5.1 Isolines of Accretion and Erosion over a 100 Year Period at St. Marys Entrance, Florida (Feet) (Olsen, 1977)

5.3 Littoral Transport

According to Olsen (1977) for the approximately 100 year interval of documentation, littoral transport rates within the study area have far exceeded the predicted rates of both the U.S. Army Corps of Engineers and the Univerity of Florida, given in Table 5.1. Furthermore, classical directions of net movement do not correspond to measured erosion volumes north and south of St. Marys Entrance. The sand budget noted in the previous section indicates that net sediment movement northward from both the nearshore and offshore vicinity south of the navigation project has been much greater than classically predicted. Significant variations indicted by the summary of the sand budget analysis presented in Fig. 5.1 (inset) can be catagorized as follows:

a. The long-term northward movement of the offshore bar.

b. The sedimentation in the pre-project channel and adjacent shoreline accretion southward of the south jetty.

c. The scouring of former shoal trapped between the jetties during construction.

d. The deposition of sediment eastward of the project structures resulting in the creation of a new seaward shoal formation.

e. The sedimentation in the pre-project secondary channel and adjacent shoreline accretion northward of the north jetty.

f. A general steepening of the nearshore profile along Cumberland Sound.

Table 5.1
Classical Littoral Drift Rates for Nassau County, Florida
(Florida Coastal Engineers, 1976)

Source	Annual Southerly (Cu. Yds.)	Annual Northerly (Cu. Yds.)	Annual Net (Cu. Yds.)	Annual Gross (Cu. Yds.)
Corps of Engineers	600,000	100,000	500,000	700,000
University of Florida	380,000	142,000	238,000	522,000

According to Olsen (1977), it is not realistic to assign annual transport rates to the long-term sediment budget since it is recognized that the aforementioned events have occurred or are continuing to occur at varying degrees of intensity. As an example, a post-project sediment study made (Olsen, 1977) from 1902 to 1907 indicated that over that period, 62% of the sediment scoured to date had been removed from between the jetties and deposited on the seaward shoal (Fig. 5.2). Accordingly, only about 12% of the total sediment accumulation in the ocean shoal was recorded as occurring during the same time span.

It is interesting to note that for the 18 mile by 9 mile area included in the sand budget analysis, the total calculated volume of erosion was within 3% of the total volume of accretion. Since stabilization through jetty construction, the inlet has become a littoral trap. Sediment continues to be transported toward the inlet by the same physical forces, but the net process essentially results in a net offshore deposition and a net loss from the nearshore littoral system and consequential shoreline erosion. Thus, both the concepts of bar-bypassing and net littoral drift appear to be unsatisfactory in explaining large scale sediment transport processes at St. Marys Entrance (Olsen, 1977).

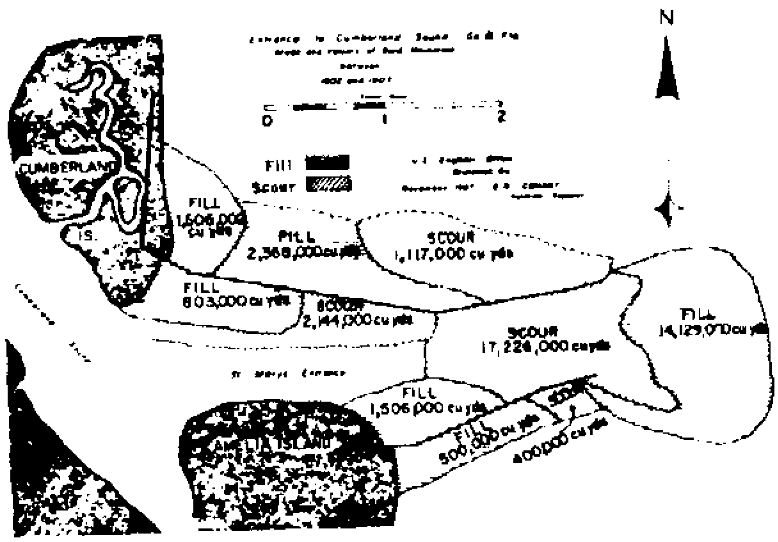

Fig. 5.2 Erosion/Accretion Patterns between 1902 and 1907 at St. Marys Entrance (Olsen, 1977).

VI. SUMMARY

Information documented in this report is summarized below:

1. St. Marys Entrance (latitude: 30° 43' N, longitude: 81° 26' W) is located on the Florida-Georgia border in northeast Florida. It is a historic navigable entrance which is federally maintained by the U.S. Army Corps of Engineers (Jacksonville District). The entrance is an important passage for commercial vessels and the Navy's facilities at King's Bay, Georgia.

2. The inlet is bordered on the north by Cumberland Island (Georgia) and on the south by Amelia Island (Florida). These islands are a part of the string of coastal barrier islands known as Sea Islands. These islands are separated from the landward zone known as St. Marys Meander Plain by a maze of tidal creeks and swampy islands. The St. Marys River Drainage Basin watershed area excluding the Okefenokee Swamp portion covers approximately 1,500 square miles. The tidal lagoonal area is 73 square miles. 79% of this lagoonal area is covered by marshland.

3. The climate is humid, semi-tropical, characterized by long summers (82° F) with heavy rainfall (50.4 inches average precipitation per year), and relatively mild and dry winters (58° F). Tropical storms and hurricanes have affected the area historically, with a return period of 5.3 years for hurricanes.

4. The most important engineering project took place beginning 1881 when work was initiated on the construction of two jetties for training the inlet. The jetties reached their existing form in 1927. The north jetty is 19,150 ft. long with a crest width of 8 ft. at the shore end, 15 ft. at the seaward end,and a height of 7 ft. above mean low water. The south jetty is 11,200 ft. long, with a crest width of 8 ft. throughout and a height of 6 ft. above mean low water. Because of the large rock used for jetty construction, the structures are permeable to flow and sediment. It is estimated that up to 28% of the total flood flow through the inlet enters through the jetties rather than at the ocean end of the structures.

5. Estimates of the spring tidal prism have varied from 5.6×10^9 ft^3 to 9.8×10^9 ft^3. The reason for this discrepancy appears to be the lack of accurate measurements. It is estimated that the freshwater outflow is approximately 5% of the tidal prism, over a tidal cycle. The effect of freshwater outflow is apparent in the temporal (HW and LW) and spatial (longitudinal) variation of salinity in the entrance and in Cumberland Sound.

6. The entrance throat area (minimum flow area) has slowly increased, particularly since jetty construction, and is likely to be approaching an equilibrium value of 148,000 ft^2.

7. The open coast shoreline in the entrance vicinity appears to have been influenced by jetty construction. This influence, generally shoreline recession, has been reported to be apparent for distances of 8.5 miles

to the north and 7.5 miles to the south. The shoreline south of the inlet is in a state of mild recession (as of 1977).

8. The sediments in the inlet and adjacent beaches consist of very fine to medium sand with some shells and shell fragments. "Bayward" of the inlet, the amount of silt and clay becomes appreciable.

9. Sand budget indicates that over a hundred year period, 123 million cu. yds. have been displaced from the nearshore regions of Cumberland and Amelia Islands combined. An additional 31 million cu. yds. have been scoured from within the confines of the jetty. Correspondingly, during the same period approximately 120 million cu. yds. accumulated in the form of shoals directly seaward of the jetties and are essentially lost from the active littoral system. Each of the jetties has accumulated a total of only about 10 million cu. yds.

10. Littoral transport rates in the vicinity of the inlet have far exceeded the predicted rates. The inlet itself has acted as a barrier for littoral transport, and there appears to be no net direction of transport as assumed in the classical sense (i.e. "river of sand" concept).

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