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PONCE DE LEON INLET
GLOSSARY OF INLETS REPORT #6

by C. P. Jones and A. J. Mehta

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FOREWORD

The numerous inlets 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 access to safe refuge for small boats during unexpected severe weather and waves. In addition, inlets act as flushing agents, providing renewal of bay waters by exchange with outer continental shelf waters. Unfortunately, inlets 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 Ponce de Leon Inlet is one in a "Glossary of Inlets" series to be prepared under the State University System Sea Grant project, "Nearshore Circulation, Littoral Drift and the Sand Budget of 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

Our thanks go to the Jacksonville District of the Corps of Engineers for their assistance in obtaining dredging records, surveys and photographs. Robert Hood, of the Ponce de Leon Port Authority, and Ayres Davies provided historical and other information necessary for the completion of this report. Both Prof. Jim Purpura and Dr. T.Y. Chiu of the Department of Coastal and Oceanographic Engineering provided comments helpful to our understanding of the hydraulics of the inlet. The tireless efforts of Lillean Pieter and Cynthia Parsons during the preparation of this report are greatly appreciated.

I. INTRODUCTION

Ponce de Leon Inlet (Figs. 1.1, 1.2, and 1.3), located on the east coast of Volusia County, lies 65 miles south of St. Augustine Harbor and 57 miles north of Canaveral Harbor, Florida. Its coordinates are as follows:

29° 04' N   80° 55' W

The inlet connects the Atlantic Ocean with the Halifax River and the Indian River North (formerly known as the Hillsborough River). The Halifax River extends northward for 24 miles past Port Orange, Daytona Beach and Ormond Beach. The Tomoka River joins the Halifax River north of Ormond Beach and from there the Intracoastal Waterway extends northward, passing west of Matanzas Inlet. The Intracoastal Waterway extends southward through the Mosquito Lagoon, passes through the Haulover Canal to the Indian River and southward once again. Ocean access to the waterway is attained through the Canaveral Barge Canal and Canaveral Harbor.

The Intracoastal Waterway began initially as a project of the Florida East Coast Canal Company and after the company went into receivership in 1923, efforts began to declare the waterway a federal project. The Florida Inland Navigation District (FIND) was created by the Florida Legislature in 1927 and 11 coastal counties purchased the canal and rights of way which were subsequently surrendered to the federal government. The 1945 River and Harbor Act authorized a 12 ft. depth and 125 ft. width for this project. The Daytona Beach Side Channel is maintained at an 8 ft. depth and 80 ft. width (Corps of Engineers, 1975b).

Since the 1700's, the inlet has played an important role in the economy of the area. The port of New Smyrna was thriving long before Daytona Beach was consolidated as a city (in 1926), although today Daytona Beach generates considerably more commercial activity and demand for recreational facilities. Unquestionably, one of the major areas of commercial and recreational importance is that of boating. During 1972-73 there were 6,667 registered boats in Volusia County, 777 of which were commercial vessels (Ponce de Leon Port Authority, 1976). Coupled with the fact that over 120,000 people, approximately 72 percent of the population of Volusia County (in 1970), reside in the coastal areas of the county, the tremendous demands on inland waterways and locations of ocean access become readily apparent.

Tourism plays an important role in the economy of the area and in addition to the many attractions of Daytona Beach, there are several parks in the area. Tomoka State Park lies 3 miles north of Ormond Beach and the Port Orange Wildlife Sanctuary (a project of the Florida Audubon Society and FIND) lies south of the Port Orange Causeway. There are also several Indian middens throughout the area. In addition to those parks already mentioned, the Ponce de Leon Port Authority has proposed the development of two park areas and a marina (see Fig. 1.4). Details of these proposed sites are contained in the "Ponce de Leon Inlet Park and Marina Study" prepared by the Volusia County Planning Department for the Port Authority in 1976.

The Florida Marine Research Facility, a division of the Battelle Laboratories, conducted field investigations at selected sites in the vicinity

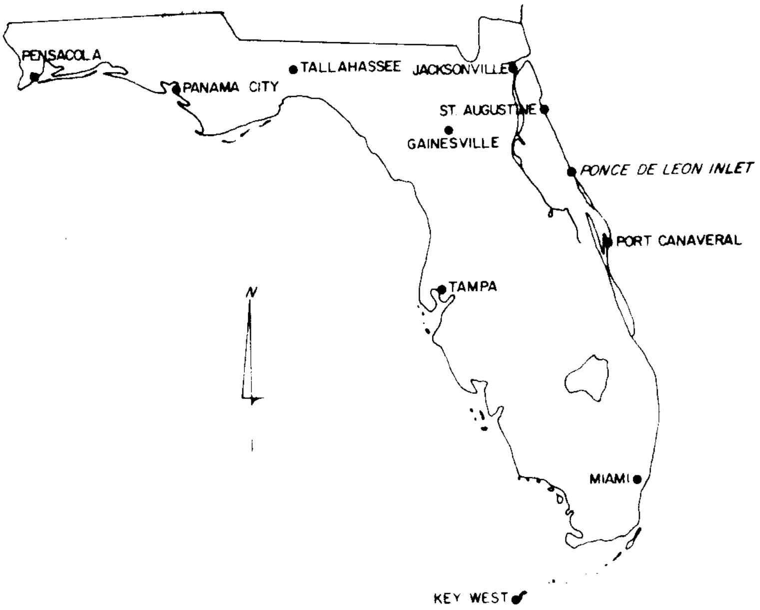


Fig. 1.1 Location Map.

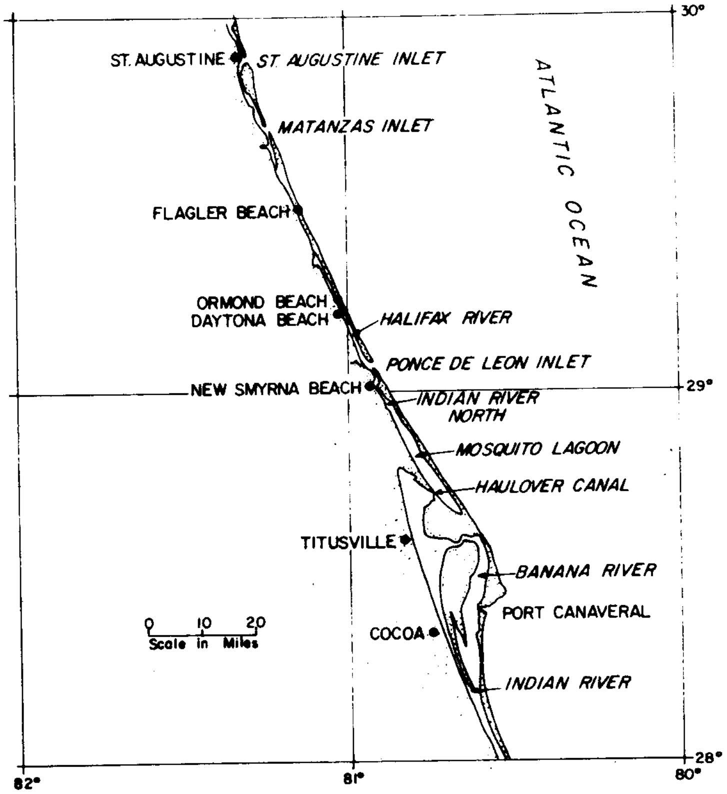


Fig. 1.2.

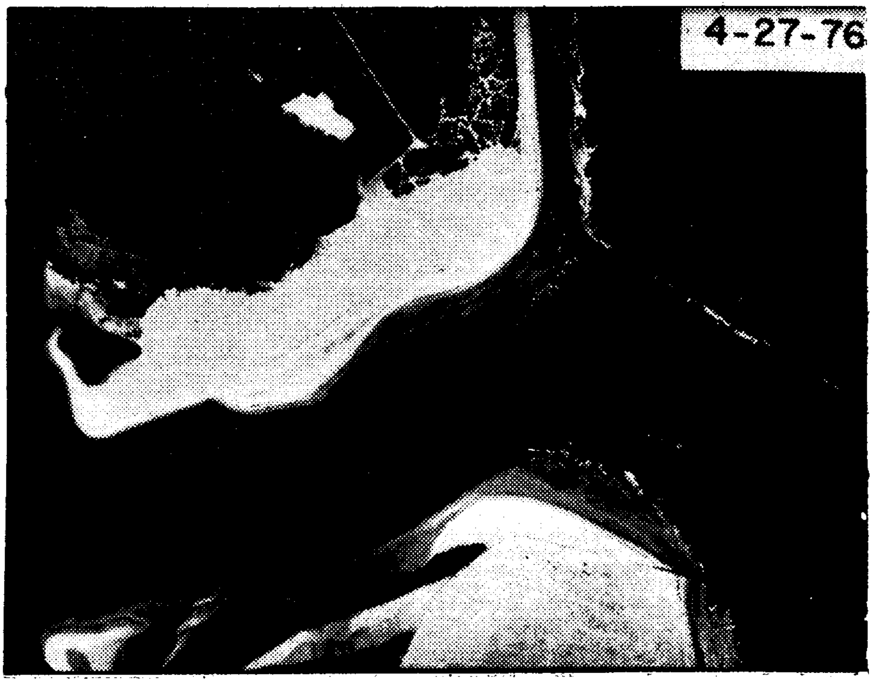


Fig. 1.3 Inlet on 4/27/76.

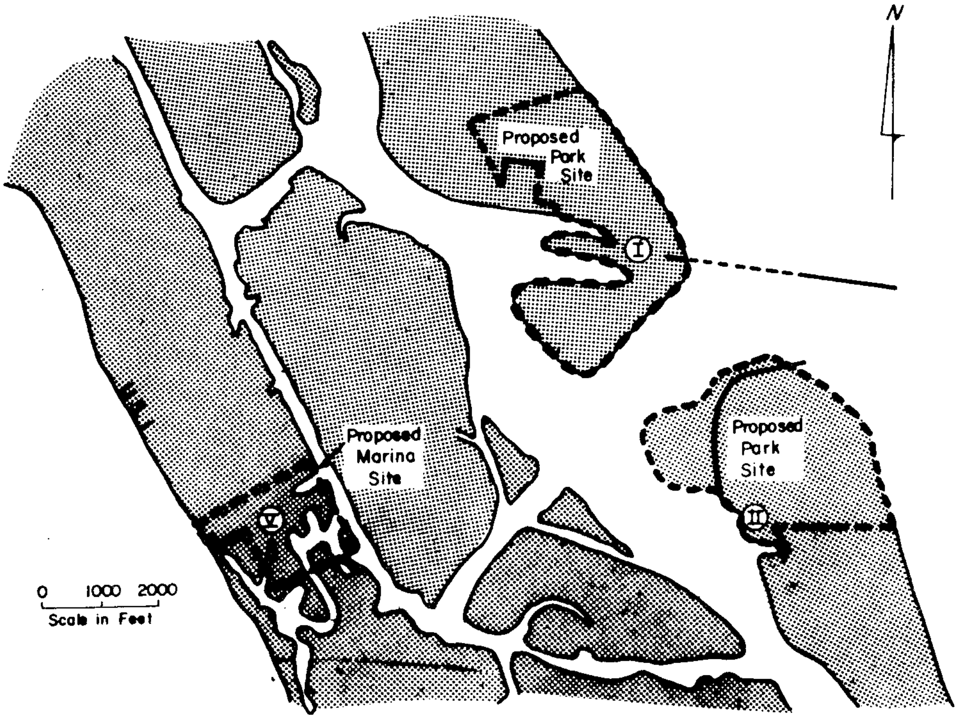


Fig. 1.4 Proposed Marina and Park Sites.

of the proposed park and marina areas shown in Fig. 1.4. These investigations were conducted between April and September 1975 in order to provide baseline information on the flora and fauna along the river regions (Tone, et al., 1975). The areas studied were those adjacent to the Halifax River in the southern section of the proposed park north of the inlet (Site I), south of the inlet near the U.S. Coast Guard reservation and adjacent to the Indian River North (Site II), and the marsh areas along the Intracoastal Waterway in the vicinity of the New Smyrna Power Station (Site V). Regarding these areas the Battelle report states:

> "From the data collected, it is apparent that the area bounded by Sites I, II and V is basically a mangrove-fringed estuary with sufficient flushing to fall within the classification of Class III waters. Dissolved oxygen and pH appeared to be primarily controlled by physical processes. With the exception of the high coliform bacteria counts in June, the nitrate and phosphate concentrations measured would appear to have little, if any, impact on the flora and fauna occupying the area under consideration."

At all three sites the dominant vascular plant was the black mangrove, Avicennia germinans. The red mangrove, Rhizophora mangle was present, but not in large numbers. At Site I, scattered patches of Sesuvium portulacastum, Batis maritima and Spartina were observed. The report also found that the blue crab, brown shrimp, white shrimp and oysters were present in the area. Over 40 species of fish were collected in the area, with juvenile populations most abundant. Mojarras, anchovies, and killifish were the most prevalent, with large numbers of mullet and menhaden also present. Benthic organisms, macroscopic algae and marsh grasses did not appear to be the primary food source for the juvenile fish populations, but instead plankton, epiphytic algae, epibenthic invertebrates and detritus are believed to be the principal source of primary and secondary production.

The retail value of the seafood harvest for Volusia County has generally increased in recent years. Fig. 1.5 shows this as well as the weight of the annual catch of various species. The value of the seafood harvest indicates the importance of Ponce de Leon Inlet to the area's economy. Historically this has also been the case. The Spanish, English and American settlers have used the inlet for commercial purposes for over two centuries.

Although navigation through the inlet has occurred for some time, it has almost always been difficult. Scores of ships wrecked on the shifting shoals and bars of the inlet, and as a result, the inlet became known as a "Killer Inlet" (Strickland, 1965). Prior to the inlet improvement in 1968 the main channel shifted too often for the Coast Guard to maintain channel markers in proper position (Corps of Engineers, 1963). Even since the completion of the inlet stabilization project in 1972, navigation has sometimes been difficult. However, those who use the inlet on a daily basis (primarily commercial fishermen) regard the current navigation problems as very minor when compared with those prior to the inlet stabilization. The reader is referred to section 4.3 for a discussion of project performance.

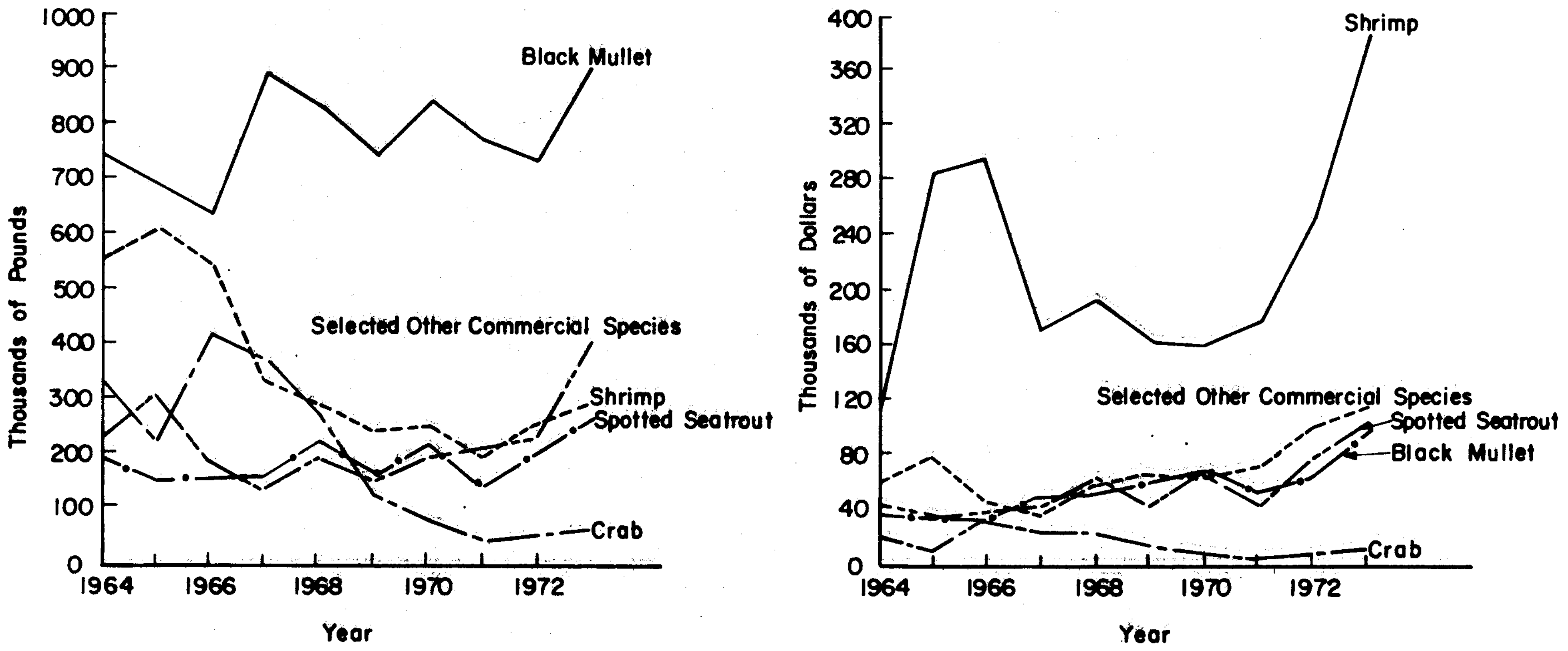

SELECTED SEAFOOD HARVEST

Fig. 1.5. (Ponce de Leon Inlet Port Authority, 1976).

II. GEOLOGIC SETTING

The coast of Volusia County, like most of northeast Florida, is a low relief, low elevation coastal plain surface overlain by relic Pleistocene terraces and beach ridges (Meisburger and Field, 1975). The geology of the county is described on the basis of rock cuttings collected during the drilling of water wells and from a study of the topography (Wyrick, 1960).

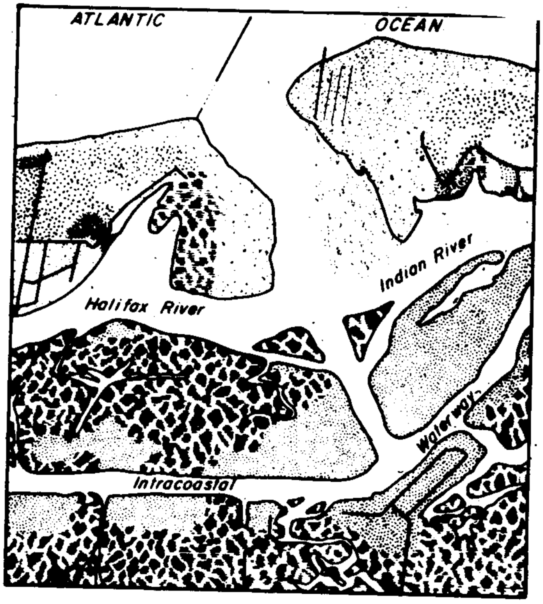
Limestone of early middle Eocene age, the Lake City Limestone, is the oldest formation penetrated by wells in the county. The Avon Park Limestone of late middle Eocene age lies above the Lake City Limestone and is approximately 200 ft. below the land surface along the coast. The Ocala Group overlies the Avon Park Limestone and is composed of three lithologically similar limestone formations: the Ingles, the Williston and the Crystal River, listed in ascending order. The Crystal River Formation has evidently been subject to post-Eocene erosion, and as such has probably been removed in Volusia and northern Brevard Counties (Wyrick, 1960). The top of the Ocala Group lies about 100 ft. below the land surface along the Volusia County coastline. Overlying the Eocene limestones are beds of shelly sand, clay and calcareous clay of Late Miocene and Pliocene age. The Anastasia Formation of Pleistocene age overlies these earlier formations and is the most important Pliestocene deposit in Florida. The Anastasia Formation is composed of a loosely cemented sandy coquina consisting primarily of mollusk shells. The cementing agent can be calcium carbonate or iron oxide.

The Anastasia Formation lies generally between 10 and 60 ft. below msl in the Daytona Beach area, but outcrops along the shore and nearshore at various places along the coastline between St. Augustine and the Palm Beach - Broward County line. These outcrops are easily weathered and eroded and as such, provide a tremendous amount of shell fragments to the beaches along the coast. Predominantly Holocene sands are draped over the Pleistocene features on the barrier island beaches (Mims, 1975). Figure 2.1, which shows the characteristics of the surficial sediments in the inlet vicinity, was prepared by the Volusia County Planning and Development Department for the Ponce de Leon Inlet Port Authority (1976). The reader is referred to section 7.3 for a further discussion of the sedimentary characteristics of the inlet vicinity.

Offshore sediment characteristics between Georgia and Cape Canaveral were investigated between August 1966 and February 1967 to determine the availability of offshore sands suitable for beach nourishment purposes. Detailed findings are available in the report by Meisburger and Field (1975). Preliminary results indicate the possibility of finding suitable sand deposits offshore near Flagler Beach, Daytona Beach and Turtle Mound.

According to Knochenmus (1968), 58 percent of Volusia County drains into the St. Johns River or its tributaries, 11 percent has no surface drainage, and 31 percent drains into the Atlantic Ocean. The characteristically flat marine terraces - Talbot, Pamlico and Silver Bluff - are the major topographic features that influence surface drainage. The Talbot Terrace lies for the most part at an elevation of 40 feet, the Pamlico Terrace at 25 feet and the Silver Bluff Terrace at 10 feet. These terraces are separated by narrow sand ridges (Rima Ridge and the Atlantic Coastal Ridge) and these ridges mark positions of ancient stands of sea level. Typically, the areas just east of these ridges are relatively low and the piezometric surface is at or above the land surface. For this reason these areas tend to be poorly drained. Oftentimes these areas are swampy and the excess water either evaporates or runs off to adjacent areas (Knochenmus, 1968). Details of the Atlantic Coastal drainage region are shown in Fig. 2.2. This drainage region is composed of eight drainage basins (note that the Tomoka River includes the Little Tomoka River and Groover Branch), which are shown with their approximate areas in the table included on Fig. 2.2 (Knochenmus, 1968).

Although Ponce de Leon Inlet is the only inlet to break the present-day Volusia County coastline, geological evidence suggests that as few as 1,500 years ago other inlets allowed drainage directly to the ocean. These inlets cut through the barrier island south of Ponce de Leon Inlet and east of Mosquito Lagoon. The most recent of these inlets closed at approximately 500 A.D. and existed near what is known today as Turtle Mound (Mehta and Brooks, 1973).



CLASSIFICATION		Recreational Development	Residential Development	Agricultural Development	Wildlife Habitat
		USE SUITABILITY			
Palm Beach - Paola	▓	*	*		
Beach Sand		*			
Mangrove	▦				*
Canaveral Sand		*	*		
Dune Land	░	*			*
Canaveral Sand with Clayee Substrata -	░				*
Myakka				*	
Palm Beach	░	*	*		

Fig. 2.1 Surface Sediments.

Drainage Basin	Area (sq. miles)
1. Groover Branch	13
2. Little Tomoka R.	15
3. Tomoka River*	121
4. Halifax River	48
5. Spruce Creek	96
6. Mosquito Lagoon	34
7. Turnbull Creek	17
8. Turnbull Creek	47
	363

*Includes 1 and 2

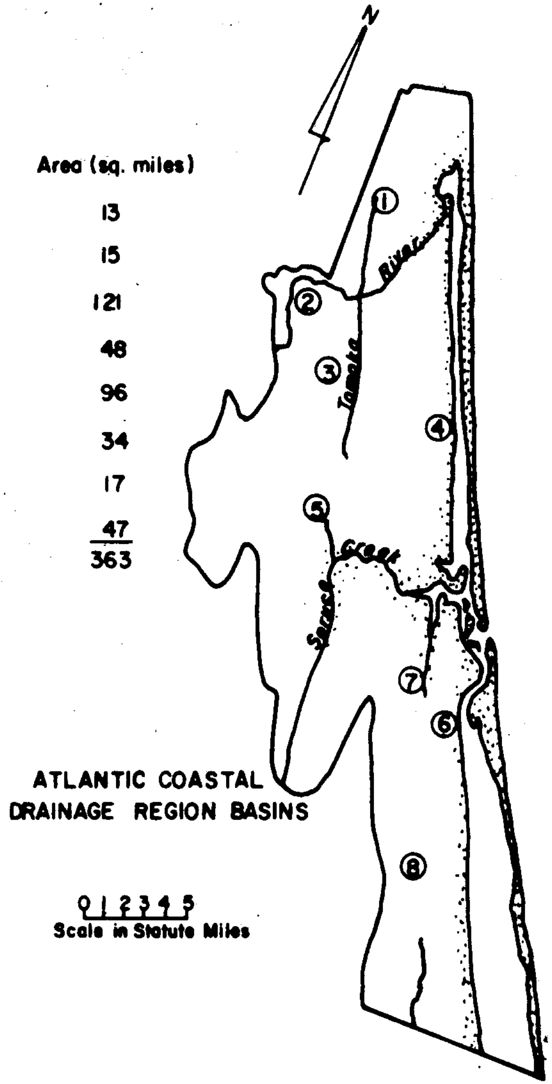


Fig. 2.2 (Knochenmus, 1968).

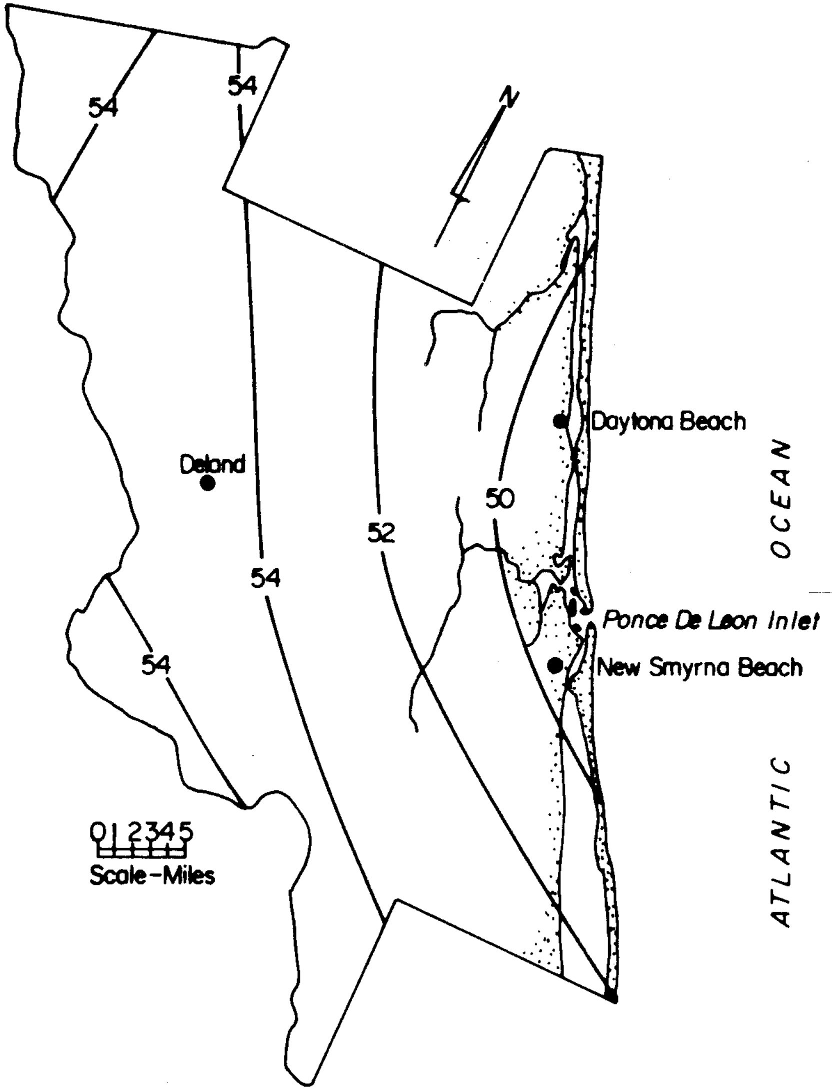


Fig. 3.1 Average Annual Rainfall in Inches.

III. CLIMATE AND STORM HISTORY

3.1 Climate

The Ponce de Leon Inlet vicinity experiences a humid, subtropical climate characterized by long summers and relatively mild winters. The mean yearly temperature is about 71° F and the yearly average rainfall is about 50 in. The U.S. Weather Bureau has a weather station at Daytona Beach (Sta. No. 2150), although one existed 4 miles north of New Smyrna Beach until 1959 (U.S. Weather Bureau, 1964). The waters of the Atlantic Ocean, the Halifax River and the Indian River North tend to moderate temperatures somewhat along coastal Volusia County and the presence of ocean breezes tend to retard the movement of rainstorms moving west to east across the coastline. Thus the yearly average rainfall at Daytona Beach is less than that at Deland, which is about 23 miles WNW of Ponce de Leon Inlet (see Fig. 3.1, adapted from Knochenmus, 1968). Note that this map is based on data at a few locations only, and therefore local variations in rainfall of up to a few inches may be expected. Winds in the Ponce de Leon Inlet vicinity are predominantly out of the S and E during the summer months and out of the N during the winter months. The winds are typically 8 to 11 mph on the average, but are considerably higher during severe storms.

3.2 Storms

Storms that cause flooding, beach erosion and related damage to the inlet vicinity and surrounding areas are typically hurricanes (or tropical storms) and northeast storms. The majority of the damage is caused by flooding due to abnormally high water levels, wave runup and overtopping, and the undermining of structures as a result of erosion. While hurricane winds are stronger than those from most northeast storms, they usually occur over a smaller area and for a shorter duration. Beach erosion damage is, as a result, sometimes more serious during a northeast storm.

Records show that a tropical storm of hurricane intensity will pass within 50 miles of the inlet vicinity, on the average, once every 8 years (see Fig. 3.2). Northeast storms, which are typically caused by a low pressure cell located off of the SE coast of the U.S., may occur several times during each winter. Some of the more damaging northeast storms occurred in 1932, 1947, 1956, 1962 and 1973; descriptions of some follow:

Sept. 1-13, 1878	This hurricane passed over Florida, emerging north of Volusia County on Sept. 11 and caused 13 shipwrecks along the NE coast of Florida, including 3 in the vicinity (Dunn and Miller, 1964).
July 22 - August 2, 1926	This hurricane passed the inlet vicinity on July 27 and 28 and caused extensive damage along the east coast of Florida. The storm wrecked the "Inlet Terrace" - a million dollar hotel under construction in Ponce Park. The foundations can still be seen from the beach (Hebel, 1963).

October 13-21, 1944	This hurricane passed west of Volusia County on October 19. It caused tides 8.4 ft. above msl on the coast at Daytona Beach. Total property damage estimates for Florida were put above $60,000,000 and 18 persons were killed (NOAA, 1971).
Sept. 24-Oct. 7, 1947	This northeast storm was most destructive between Sept. 26 and 30, causing serious beach erosion, flooding and damage to roads and structures. Dozens of houses between Ormond Beach and New Smyrna Beach were washed away; roads and seawalls were destroyed. The beach profile receded 100 ft. horizontally in some areas with dune scarps of 10 ft. (Daytona Beach Evening News, Sept. 27-30, 1947).
Oct. 15-19, 1950	Hurricane "King" passed through western Volusia County and caused high tides 8 ft. above msl along the coastline between St. Augustine and Daytona Beach. Tides 8 ft. above msl also occurred in the Halifax River. Homes were flooded in Ormond Beach, Port Orange and Daytona Beach (Corps of Engineers, 1971a).
Nov. 26-Dec. 2, 1962	This northeast storm caused severe beach erosion along the entire NE coast of Florida, and as a result Duval, St. Johns and Flagler Counties were declared disaster areas. Seawalls were destroyed at Daytona Beach and highway A1A was reveted along New Smyrna Beach as a result of wave overtopping. Dune scarps of 10 ft. were cut in areas along the coastline (Daytona Beach Evening News, Dec. 1-3, 1962).
Sept. 9-12, 1964	Hurricane "Dora" caused considerable beach erosion from Daytona Beach to Jacksonville. Wind damage north of Daytona Beach was extensive and flooding occurred along the Halifax River. The Coast Guard station south of Ponce de Leon Inlet reported losing 100 ft. of beach on the NE and NW sides of the station and between 18 and 60 ft. along the Intracoastal Waterway (Daytona Beach Evening News, Sept. 9-12, 1964; Corps of Engineers, 1971a).
Feb. 10-11, 1973	This northeast storm caused extensive beach erosion in St. Johns County, but beach erosion in Volusia County was less severe. It was reported that stones from the

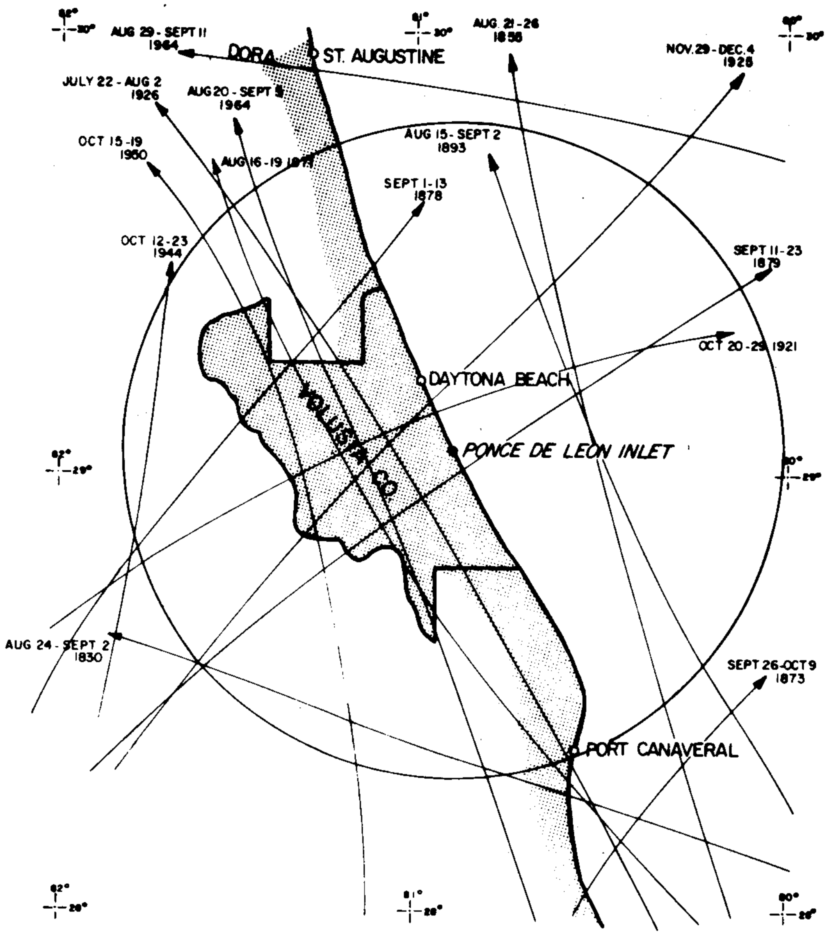


Fig. 3.2 Storm Tracks (NOAA, 1971).

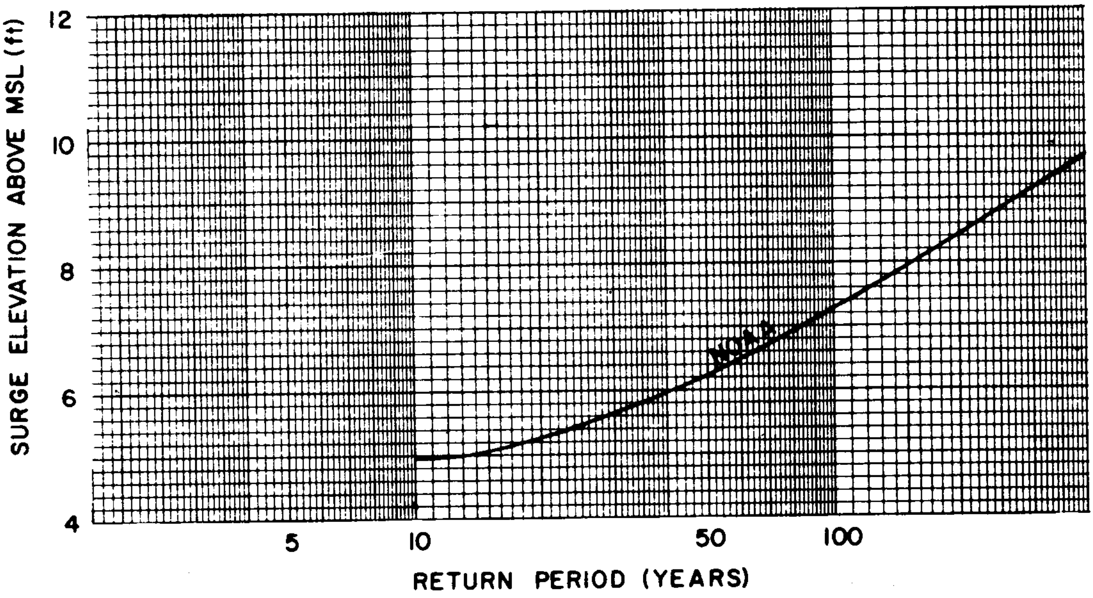


Fig. 3.3 Storm Surge Frequencies - Volusia County (COEL, 1972b).

	rubble-mound portion of the north jetty at Ponce de Leon Inlet were dislodged. A seawall at the Ponce Inlet Club South condominium, located north of the inlet, was washed out (Daytona Beach Evening News, Feb. 13, 1973). This same storm breached an old channel on the north side of the inlet which was subsequently closed in 1974.
Oct. 16-29, 1973	Tropical storm "Gilda" caused heavy damages between Brevard and Broward County. Except for some substantial dune erosion north of Ponce de Leon Inlet, erosion was minor. Some seawalls in the area were damaged (Daytona Beach Evening News, Oct. 29, 1973).

3.3 Flooding

Flooding caused by abnormally high tides frequently accompanies hurricanes that pass through or near the area. This super-elevation of the water surface is due primarily to storm surge and wave setup. Figure 3.3 shows storm surge frequencies for Volusia County as calculated by NOAA. The curve is approximate and based upon preliminary data (COEL, 1972b). If the 100-year return frequency of approximately 7 ft. is combined with a 2 ft. estimate of wave setup (a typical value for the area under storm conditions) the resulting water surface elevation of 9 ft. above msl on the coastline is obtained. This agrees with Corps of Engineers predictions of hurricane tides caused by an Intermediate Regional Hurricane (IRH) (one with a 100-year return frequency). The Corps of Engineers also estimates hurricane tides caused by a Standard Project Hurricane (SPH) (the most severe storm to be expected in an area). Estimates of IRH and SPH tides are shown in Table 3-1.

TABLE 3-1

PREDICTED HURRICANE TIDE ELEVATIONS IN FEET ABOVE MSL*

Location	IRH (100 year)	SPH
Oceanfront Shoreline	9	11.5
Ponce de Leon Inlet and vicinity	8	10 - 11
New Smyrna Beach and vicinity	7	9
Halifax River	7 - 8.5	8 - 10
Mosquito Lagoon south of Oak Hill	6	7

*Predicted tide elevations by the Corps of Engineers (1971a, 1972b). These tide elevations are estimates only - actual elevations may vary. The reader is advised to contact the Jacksonville District Office of the Corps of Engineers for help in interpreting these data, or further information.

IV. HISTORY

4.1 Chronology

The early history of Volusia County, like the history of most northeastern Florida coastal areas, was dominated by several groups: the native Indians, the Spanish, the French and the English. While records of the European settlers are often well documented, the only clues to the Indian activities and lifestyles are found in archeological sites throughout the area. Turtle Mound, about 10 miles south of New Smyrna Beach, is the most prominent of all Indian mounds in Florida. The mound, originally about 400 ft. long, 250 ft. wide and 40 ft. high, has been dated at approximately 500 A.D. Before Turtle Mound was declared an historic site, approximately three-fourths of the original volume of this kitchen midden (consisting primarily of oyster shells) was utilized for road construction material.

The history of the inlet from the 1500's through the present is summarized in the following chronology of events:

1513 - According to the historian of the "Indies," appointed by King Phillip II of Spain, Ponce de Leon made the first landing on April 2, somewhere between the mouth of the St. Johns River and St. Augustine. He then sailed southward along the coast and landed again near Turtle Mound. Upon meeting resistance from the Indians, he proceeded to a nearby river which he called the "Rio de la Cruz" (River of the Cross). Some think this was the junction of Ponce de Leon Inlet with the Halifax and Indian Rivers (Davies, 1975).

1573 - Pedro Menendez Marques, who succeeded Pedro Menendez de Avilles as Governor of Florida, made a voyage along the east coast of Florida. Among his observations were depths over the bar at Mosquito Inlet (the name of Ponce de Leon Inlet prior to 1926). He reported a depth at ebb tide of 4.2 ft. and a depth at high tide of 7.0 ft. (Gould, 1927).

1765 - Colonel James Moncrief surveyed the inlet for the British, who had obtained possession of Florida from the Spanish in 1763. Moncrief entitled his map, "Plan of the Harbour of Musquitos - Distant From St. Augustine 72 Miles." Soundings over the bar at low water showed between 6 and 8 ft. of water (Hulbert, 1915). At this time the English recognized a great resource in the area - the live oak tree. This resource was vital to the construction of many naval vessels, both for them and for the Americans in the 1800's.

1768-1777 - Dr. Andrew Turnbull, a London physician, brought over 1400 Italians, Minorcans, Corsicans and Greeks together in a colony at New Smyrna (named in honor of his wife). This ill-fated colony was abandoned by the colonists in 1777 when Dr. Turnbull was in England. Most of the colonists moved to St. Augustine (Strickland, 1965).

1783 - Possession of Florida was returned to Spain by treaty.

1803 - Antonio Pons received a land grant of 175 acres on the north side of Mosquito Inlet from the Spanish government. Apparently Pons had occupied and farmed the land for 20 years prior to this date. Pons Park (later misrepresented as Ponce Park) was named after him. After Pons' death in 1812 his widow was granted additional lands. This grant, totaling 320 acres, was recognized by the United States when Florida was acquired by treaty in 1821 (Davies, 1976).

1834 - With the advent of shipping through the inlet, a need for a lighthouse was recognized. Accordingly, a lighthouse was constructed on the south side of the inlet during this year. The light, however, was never used. It was damaged by a storm and the Indians destroyed it in 1835 (Davies, 1976).

1851 - The inlet was surveyed by the U.S. Coast Survey. (See Fig. 5.1).

1874 - Mosquito Inlet was surveyed by the U.S. Coast Survey (see Fig. 5.1).

1883 - The Florida East Coast Canal Company received 1 million acres of state owned lands in exchange for the construction of an intracoastal canal along the east coast of Florida.

1883 - The frequency of shipwrecks in the vicinity of the inlet brought demands for the construction of another lighthouse. (There were 12 ships lost in the inlet vicinity between 1858 and 1880). The United States government purchased 10 acres of the former Pons grant for this purpose and placed General Orville Babcock in charge of the construction. After he drowned in 1884, construction continued under the supervision of General Jarrell Smith (Strickland, 1965). Babcock, who had purchased the north quarter of the Pons grant, built a home (later destroyed by fire) and intended to make a park on his property. He called his land Ponce Park.

1887 - The lighthouse went into commission on November 1. The Halifax Herald reported earlier in January 1886 that 5 of the 8 or 10 schooners employed in the lighthouse work had been wrecked and one was crippled at the lighthouse dock.

1901 - The Hillsborough River was renamed Indian River North.

1912 - The Florida East Coast Canal was completed, although the controlling depth (3 to 3.5 ft. in places) was less than the authorized depth of 5 ft. The project width was 40 to 50 ft. In subsequent years the canal deteriorated and the project dimensions were not maintained.

1923 - The Florida East Coast Canal Company went into receivership.

1925 - The U.S. Coast and Geodetic Survey charted the inlet (see Fig. 5.1).

1926 - The name Mosquito Inlet was changed to Ponce de Leon Inlet during the boom days in Florida in hopes of making the name less forbidding. During this time of prohibition the inlet was the site of numerous clashes between bootleggers from the Bahamas and federal agents.

1926 - A $1,425,000 bond issue was endorsed by voters on June 21. The purpose was for deepening the inlet and developing a port at Daytona Beach. When objection was raised as to the validation of the bonds, no further progress was made.

1927 - The Florida Inland Navigation District was formed by the legislature. The Jan. 21, 1927 River and Harbor Act authorized increasing the project dimensions of the Intracoastal Waterway to an 8 ft. depth by a 75 ft. width.

1928 - Eleven east coast counties between Duval and Dade completed purchase of the Florida East Coast Canal and rights of way for surrender to the federal government.

1930 - The July 3, 1930 River and Harbor Act authorized increasing the project width of the Intracoastal Waterway to 100 ft.

1932/33 - A project dimension by-pass channel was cut through the marsh west of the inlet, rerouting the Intracoastal Waterway from the Halifax River and Indian River North in the inlet vicinity. The cut, 3.87 miles in length, was constructed between August 1, 1932 and January 18, 1933. About 934,000 yd^3 of material were removed at a cost of $63,397.93.

1934 - The Corps of Engineers surveyed the inlet in September.

1935 - The Intracoastal Waterway enlargement to project dimensions (8 ft. x 100 ft.) was completed. The Corps of Engineers awarded a contingent contract for deepening the ocean bar channel at the inlet by experimental dragging and propeller wash. After repeated unsuccessful attempts, the contractor abandoned the work (Corps of Engineers, 1963).

1938 - The Ponce de Leon Coast Guard Station, located just south of the inlet, was opened in this year.

1939 - The Corps of Engineers surveyed the inlet in preparation for dredging of the ocean entrance channel. The controlling depth was approximately 4.5 ft. mean low water (mlw).

1940 - The controlling depth in the Intracoastal Waterway in the vicinity of the inlet was 6 ft. (Corps of Engineers, 1940).

1941 - The Ponce de Leon Inlet and Port District was formed. The special tax district, shown in Fig. 4.1, encompassed congressional districts 4 and 5 at that time, about 500 square miles.

1942 - The Corps of Engineers surveyed the inlet.

1943 - The Corps of Engineers dredged the inlet and interior connecting channels. This was done as a war measure with U.S. Navy funds to aid passage of Navy and Coast Guard craft. About 860,000 yd^3 of material were removed by a 22-inch pipeline dredge at a cost of $209,000. The dredging resulted in a channel 14 ft. deep across the seaward bar.

1944 - Shoaling has severely restricted use of the inlet. The Navy provided $175,000 to redredge the inlet. About 317,000 yd^3 of material were removed by a 26-inch pipeline dredge to provide a 16 ft. channel depth. Surveys indicated rapid and continued shoaling of the dredged channel (Corps of Engineers, 1963).

1945 - Condition surveys showed continued shoaling of the channel dredged in 1944.

1945 - The March 2, 1945 River and Harbor Act authorized enlarging the Intracoastal Waterway to a 12 ft. depth and 125 ft. width (Corps of Engineers, 1945).

1952 - The enlargement of the Intracoastal Waterway to project dimensions (12 ft. by 125 ft.) between Holly Hill and Oak Hill (approximately 13 miles on either side of the inlet) began on March 10 and was completed on Nov. 3. About 2,377,227 yd^3 of material were removed at a cost of $444,407.44 (Corps of Engineers, 1952, 1953). Intracoastal Waterway dredging data from this point on are summarized in Table 4-1 (see also Fig. 4.2).

1952 - The Corps of Engineers surveyed the inlet entrance channel during April of this year. Depths across the outer bar were between 4 and 6 ft.

1958 - The Daytona Beach Side Channel was authorized. The project dimensions were 8 ft. by 80 ft. by 1,267 ft. This channel was dredged in August 1960.

1963 - The small community north of the inlet known as Ponce Park was incorporated by the Florida legislature in May and was renamed Ponce Inlet.

1963 - The Corps of Engineers surveyed the inlet. The "Survey Review Report on Ponce de Leon Inlet" recommended that the inlet be improved (Corps of Engineers, 1963).

1964 - A referendum held on May 27 approved the expansion of the Ponce de Leon Inlet and Port District commission from three to five members. A $2,724,000 bond issue was approved, with the provision that the District Commissioners be able to sell up to $4,000,000 in bonds for the costs of stabilizing the inlet.

1965 - The October 27, 1965 River and Harbor Act authorized improvement of the inlet. The project (Fig. 4.3) consisted of: a 15 ft. deep by 200 ft. wide dredged channel across the ocean bar, a 12 ft. deep by 200 ft. wide channel through the inlet, a 12 ft. deep by 100 ft. wide channel south through the Indian River North to the Intracoastal Waterway, a 7 ft. deep by 100 ft. wide channel north through the Halifax River to the Intracoastal Waterway and construction of jetties on both sides of the inlet. The south jetty, approximately 4,078 ft. in length, is of rubble-mound construction. The north jetty, approximately 4,050 ft. long, is composed of 500 ft. of prestressed concrete sheet piling, 1,800 ft. of king pile panels (weir section), and a 1,750 ft. rubble-mound section (Corps of Engineers, 1963; COEL, 1973).

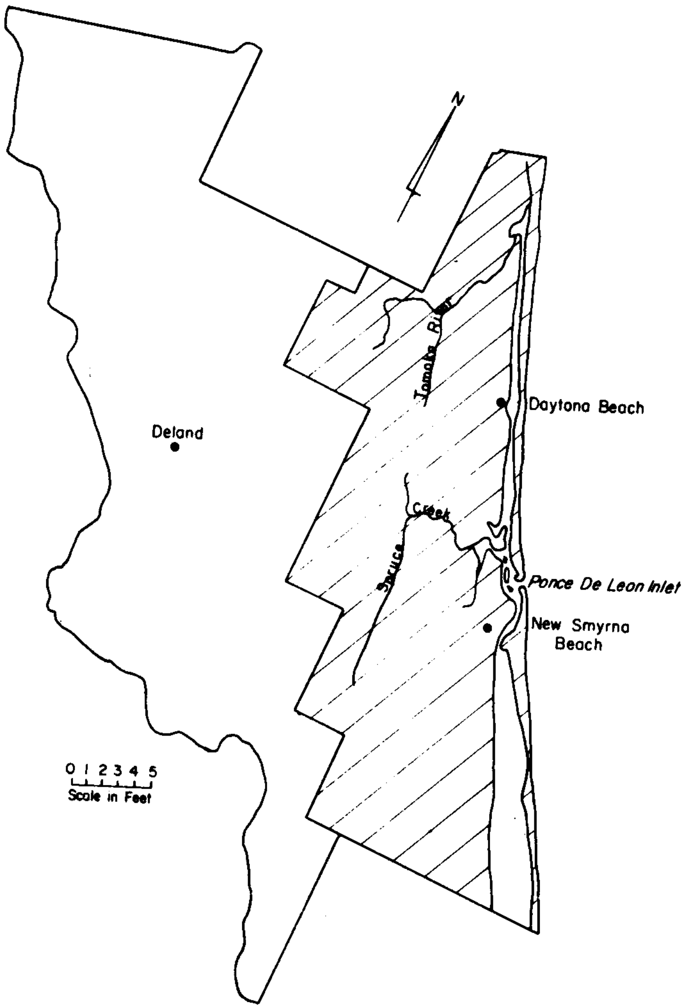


Fig. 4.1 Ponce de Leon Inlet and Port District Boundaries.

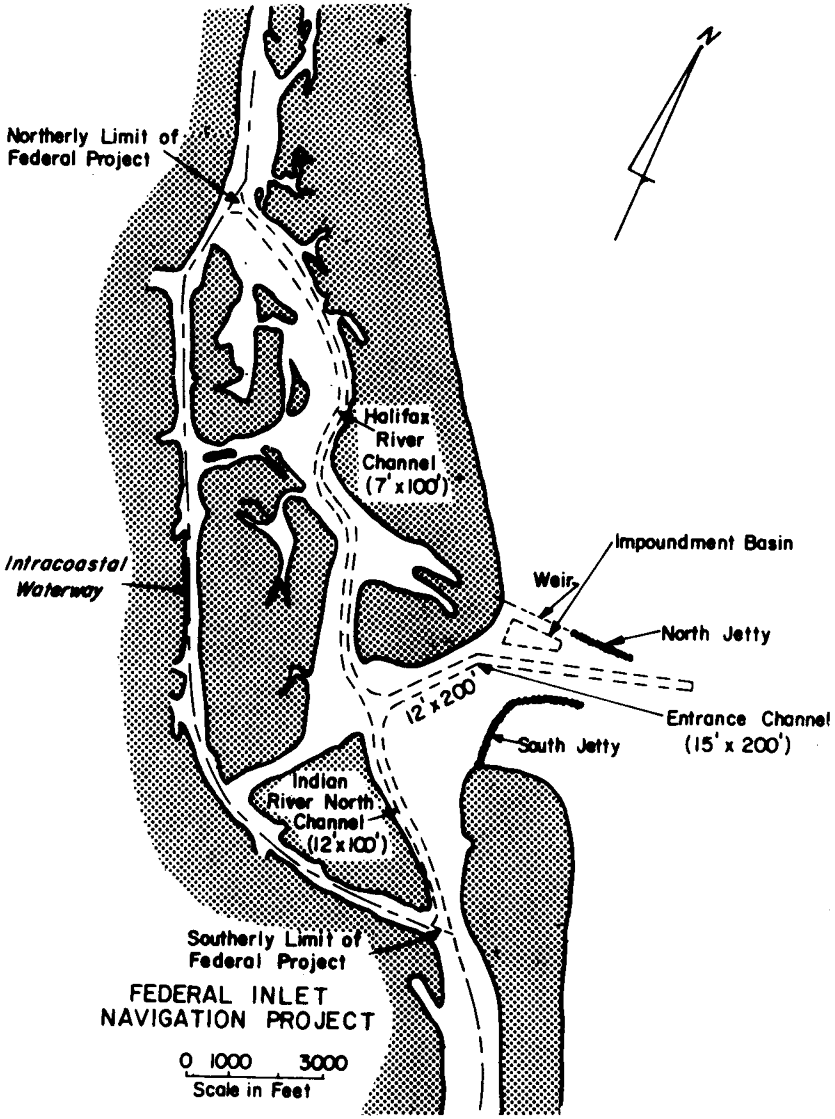


Fig. 4.3 Federal Navigation Project Details.

TABLE 4-1·

INTRACOASTAL WATERWAY DREDGING RECORD SINCE 1958

Year	Location (Measured in Statute Miles From Fernandina Beach. See Fig. 4.2 For Locations).	Amount Dredged (cu. yds.)
1958	122.7	15,451
	123.9	32,048
	125.4	93,666
	126.2	7,596
1960	122.7	26,646
	125.0	76,504
	126.2	16,367
1962	122.7	10,048
	125.0	52,133
	125.7	13,948
	126.2	12,250
1963	122.7	6,252
	125.4	27,404
	125.9	4,123
1964	125.0	80,739
1966	125.0	58,489
	126.5	7,388
1967	125.0	33,033
	126.2	44,559
	126.6	32,575
1968	122.7	43,080
	123.2	28,470
	123.9,124.0	27,654
	125.0	111,043
	126.0	14,710
	128.3	25,798
	129.4	2,692
1970	122.4	9,302
	125.2	108,198
	126.5	20,893
1973	127.8	98,423

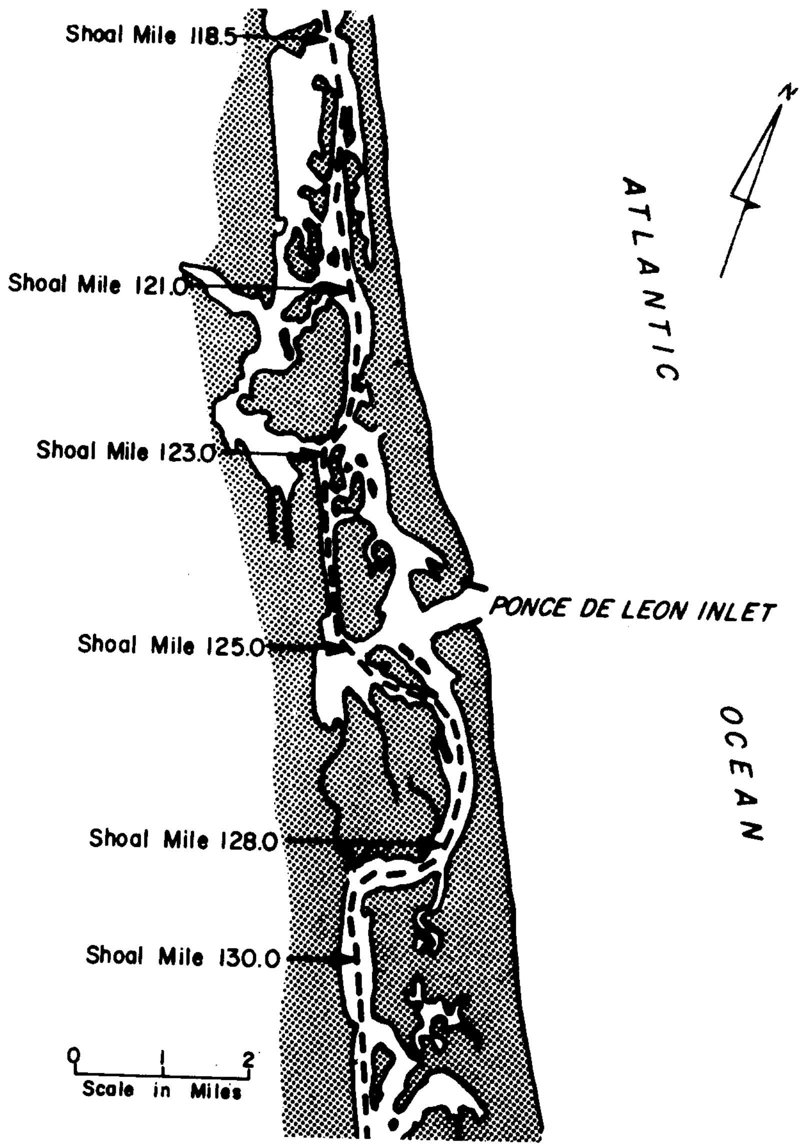


Fig. 4.2 Intracoastal Waterway Dredging Locations.

1966 - Assurances of local cooperation on the federal project were accepted on Aug. 26. The local interests agreed to the following: to pay 54.9% of the contract price plus supervision and administration thereof for all items of work to be provided by the Corps, pay an estimated $1,379,000 toward the cost of future maintenance and operation to be provided by the Corps; provide all lands, rights of way and alterations to existing improvements required for construction and subsequent maintenance of the project; hold the U.S. free from damages and provide and maintain necessary mooring facilities and utilities open to all (Corps of Engineers, 1967). The local sponsor for the project was the Ponce de Leon Inlet and Port Commission.

1967 - The Corps of Engineers made a detailed preconstruction survey of the inlet and inner channels in September.

1968 - The Ponce de Leon Inlet and Port District evolved into the Ponce de Leon Port Authority. A $3,378,775 bond issue was approved for stabilization project financing. Subsequent financing came from ad valorum tax assessments levied by the Port Authority. These are shown in Table 4-2.

1968 - South jetty construction began in July. The driving of king piles for the weir section of the north jetty began in October (COEL, 1973).

1969 - The driving of king piles for the weir section was completed in March. South jetty construction was completed in October (COEL, 1973).

1970 - The U.S. government erected a smaller light at the Coast Guard Station south of the inlet and discontinued use of the Ponce de Leon Lighthouse on the north side of the inlet.

1970 - A "Beach Erosion Control Study" by the Jacksonville District of the Corps of Engineers was authorized for the Volusia County shoreline.

1970 - Construction began on the 1,750 ft. rubble-mound section of the north jetty in January.

1971 - The University of Florida's Coastal and Oceanographic Engineering Laboratory (COEL) was retained by the Corps of Engineers to monitor the improvement project at the inlet. Frequent beach and hydrographic surveys as well as dye studies and other analyses have been made from June 1971 through the present (COEL, 1977).

1971 - The horizontal beams in the weir section were placed between March and July. Construction of the rubble-mound section of the north jetty was completed in July. Dredging in the entrance channel began in July and the dredging of the impoundment basin began in August. The dredging of the interior channel in the Indian River North began in September.

1971/72 - The COEL studied tides and currents in the Halifax River from the inlet north to Ormond-by-the-Sea to determine what effect the Port Orange causeway had on the water quality of the area. The study determined that there was no significant flow restriction imposed by the causeway (COEL, 1972a).

1972 - The dredging of the impoundment basin and entrance channel was stopped in February because of bad weather conditions. Impoundment basin dredging resumed in May and was completed in August. Approximately 400,000 yd^3 were removed in the basin area (COEL, 1973). Small riprap was placed adjacent to the concrete weir sections to prevent scour.

1972 - On June 20 the town of Ponce Inlet was deeded the Lighthouse and reservation property for the establishment of an historic park and museum.

1972 - The coastal construction setback line for Volusia County was completed (COEL, 1972b).

1973 - Redredging in the entrance channel began on March 3 and was completed on April 10. The sidecast dredge "Merritt" removed 27,373 yd^3 (as a pilot channel for the hopper dredge "Hyde") at a cost of $29,929.42. The "Hyde" removed 95,314 yd^3 at a cost of $117,318.57 (records on file, Operations Section, Corps of Engineers, Jacksonville District).

1973 - In February, under the influence of a strong northeast storm, an old channel on the north side of the north shoal at the inlet was breached. This breach tended to close naturally, but it was recommended that this process be expedited by the use of dredge spoil (COEL, 1973).

1974 - The Volusia County Beach Erosion Control Study was funded. This Corps of Engineers study is expected to be completed by 1979.

1974 - Maintenance dredging of the entrance channel and the south shoal of the inlet was performed between May 15 and August 20. In addition, the breach opened by the Feb. 10, 1973 northeast storm was closed and the beach north of the inlet was nourished. About 433,751 yd^3 of material were used in the breach closure and 89,167 yd^3 of material were used as beach fill. The work was done by the Parkhill-Goodloe Co., Inc. of Jacksonville at a cost of $769,751.20. See Fig. 4.4 for the location of the breach closure and beach fill.

1975 - The U.S. hopper dredge "Hyde" removed 149,362 yd^3 of material from the entrance channel at a cost of $330,413.30 between May 13 and June 30. This material was deposited in a disposal area located about 1½ miles north of the north jetty and about ½ mile offshore.

1975 - Water quality investigations and a biological assessment of several areas in the inlet vicinity were made by Stetson University (in Deland) and the Battelle Laboratories, at Ponce Inlet between May and October (see Chapter I). These studies were made for the Ponce de Leon Port Authority in conjunction with a planned park and marina development. The proposed sites are indicated in Fig. 1.4.

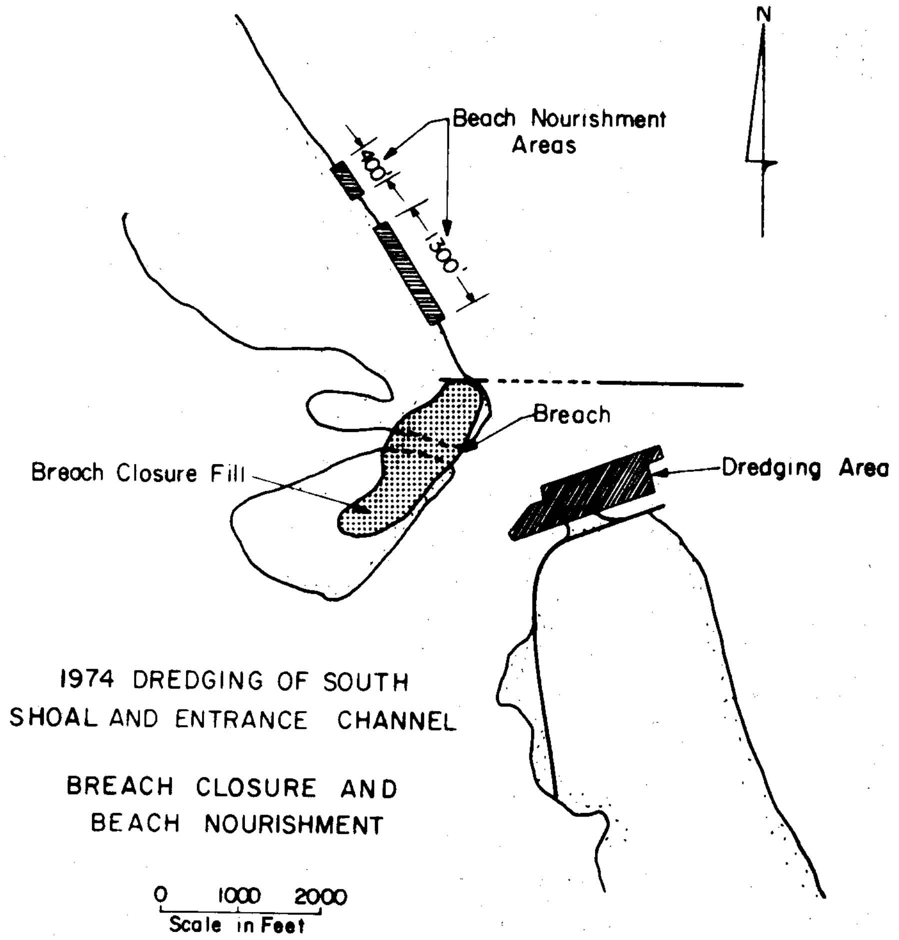


Fig. 4.4.

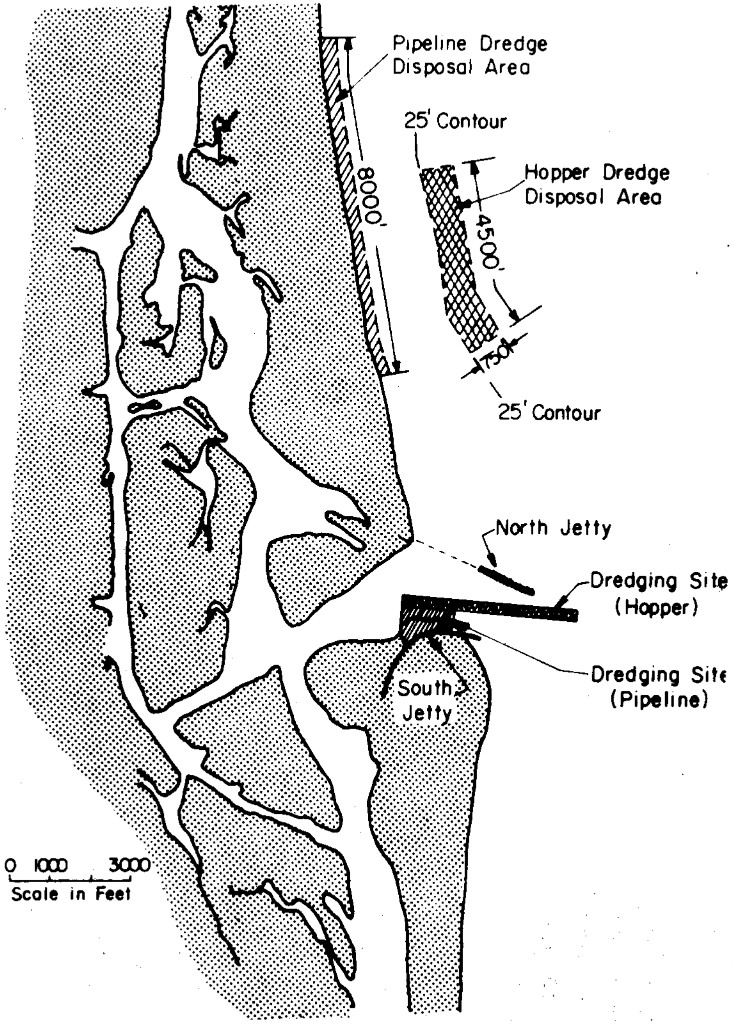


Fig. 4.5 Proposed Dredging - 1977.

1976 - The U.S. hopper dredge "Davison" operated in the entrance channel between March 9 and 23, removing 13,504 yd^3 of material at a cost of $116,668.95. This material was deposited in a disposal area located about 1½ miles north of the north jetty and about ½ mile offshore.

1977 - A notice concerning the maintenance dredging of the south shoal and entrance channel of the inlet was issued by the Corps of Engineers in February. The dredging, scheduled to be done as two separate operations, is scheduled for fall 1977. A hopper dredge is to remove approximately 80,000 cu. yds. from the entrance channel and place the material in a 4,500 ft. long area contiguous with the 25 ft. depth contour and beginning about one mile north of the inlet (see Fig. 4.5). The contract cost is $156,948. A hydraulic pipeline dredge is to remove approximately 300,000 yd^3 (at a contract cost of $944,200) from the south shoal area and place it along an 8,000 ft. long stretch of beach beginning approximately one mile north of the inlet.

4.2 Inlet Stabilization Project

Prior to the Ponce de Leon Inlet stabilization project, the inlet was regarded as oftentimes hazardous to navigation. Scores of ships were lost and dozens of people died as a result of hazardous conditions at the inlet. The construction of the lighthouse in 1883 aided mariners somewhat, but the shifting bars and channels of the inlet continued to take their toll. The Ponce de Leon Inlet and Port District was formed in 1941 and the members sought to stabilize the inlet and develop a port in the area. It was largely through the efforts of this district (known after 1968 as the Ponce de Leon Port Authority) that the inlet was stabilized.

The general project plan was described in section 4.1 (see 1965) and is shown in Fig. 4.3. Financing of the project was initially accomplished by a 1968 bond issue amounting to $3,378,775; continued costs for project maintenance and port development are financed by ad valorum taxes levied over the tax district area (Fig. 4.1). Table 4-2 shows the tax assessments levied by the Port Authority. Note that the assessment is divided into two portions. The sinking fund is used to repay bond indebtedness, and the operating fund is used for Port Authority operating expenses and for planning and permitting costs for the proposed park and marina development (personal communication with Robert Hood, Ponce de Leon Port Authority, March 1, 1977).

The project was constructed by the Hardaway Contracting Company of Jacksonville at a cost of $3,980,739.53 and accepted by the government on July 27, 1972. The original contract cost was to be $2,304,600 and the project was initially scheduled to be completed on March 21, 1970 (cost overruns were responsible for the shortening of the north jetty from 4,250 ft. to 4,050 ft. and the south jetty from 4,440 ft. to 4,078 ft.).

The weir section of the north jetty was designed so that the impoundment of sand on the updrift side of the north jetty could be regulated by the removal or addition of horizontal concrete beams. Since construction, however, some of the weir section king piles and concrete panels have been shifted, rendering

TABLE 4-2

PONCE DE LEON PORT AUTHORITY TAX ASSESSMENTS (IN DOLLARS)

Year	Operating Fund	Sinking Fund	Property Valuation
1969	*	267,000	-
1970	50,000	392,611	-
1971	35,888	391,055	-
1972	591,000 (0.82 mills)	388,833 (0.54 mills)	720,465,441
1973/74	79,198	364,312	791,982,608
1974/75	*	(0.22 mills)	-
1975/76	*	(0.215 mills)	-
1976/77	510,513 (0.30 mills)	323,235 (0.19 mills)	1,701,719,954

* No assessment

\- No information

TABLE 4-3

INLET STABILIZATION PROJECT DREDGING RECORD

Date	Location	Amount (yd^3)	Spoil Location
7/71-2/72	Entrance Channel	178,000	S. of South Jetty
8/71-8/72	Impoundment Basin	400,000	S. of South Jetty
10/71-2/72	Indian River Channel	*	S. of South Jetty
3/73-4/73	Entrance Channel	95,314	Offshore
4/74-8/74	Entrance Channel and South Shoal	522,918	Breach Closure and North Beach Nourishment
5/75-6/75	Entrance Channel	149,362	N. Beach Area-Offshore
3/76	Entrance Channel	13,504	N. Beach Area-Offshore

* No information.

the weir section in effect fixed in elevation (0.0 ft. mlw), not adjustable. Figure 4.6 shows some cross-sections of the south jetty and the rubble mound portions of the north jetty. Note that the jetties are 10 ft. wide at the top (elevation +7.0 ft., mlw). The actual jetty cross-sections may vary somewhat depending upon location (Corps of Engineers, 1972b). See Figure 4.7 for the station locations noted in Fig. 4.6.

4.3 Project Evaluation

A brief discussion in part I indicated that navigation through the inlet has been improved considerably since the inlet stabilization project was completed. The "Second Report on the Performance of the Ponce de Leon Inlet, Florida Improvement System," (COEL, 1977) indicates this as well as many other findings.

Apparently the construction sequence led to intensified erosion on the north side of the inlet. The rubble-mound portions of both jetties were constructed before the weir section was completed and as a result considerable flow passed through the weir area. This flow increased erosion of the beach areas both north and west of the north jetty. Evidently, the completion of the weir section helped build the profile north of the north jetty seaward once again as the flow through the weir section was reduced. However, between July 1973 and July 1976, this same area experienced considerable erosion (COEL, 1977).

The tremendous accretion on the south side of the south jetty is evidently due to a combination of factors. Wave refraction analysis (see section 6.5) indicates that there is no appreciable wave energy entering the inlet and striking the north side of the south jetty. Coupled with a variable direction of littoral drift south of the south jetty, this had caused an accretion of approximately 3 million cubic yards of material between October 1969 and July 1973. Much of this material passed around the tip of the south jetty and aided the growth of the south shoal north of the south jetty. However, between July 1973 and July 1976, erosion predominated over that area south of the south jetty.

The presence of the south shoal and the northward migration of the main channel are probably related in one of two ways: either the continued growth of the south shoal has forced the channel northward, or both are being caused by the same forces. In either case, the inlet appears to be adjusting to the presence of the jetties and their influence on the nearby shorelines. The impoundment basin is, as a result of the channel migration, not functioning as intended. As the channel moved northward, cutting through the impoundment basin, scouring took place and the volume of sand contained in the basin decreased. Observation has also shown that at higher tidal stages a portion of the flow (both ebb and flood) passes over the weir section. This also tends to scour material from the impoundment basin and adjacent to the north jetty, especially during ebb flow.

Based upon these observations and developments the COEL (1977) recommended that the stability of the north jetty be determined, that the weir section be closed either entirely or partially and that monitoring be continued.

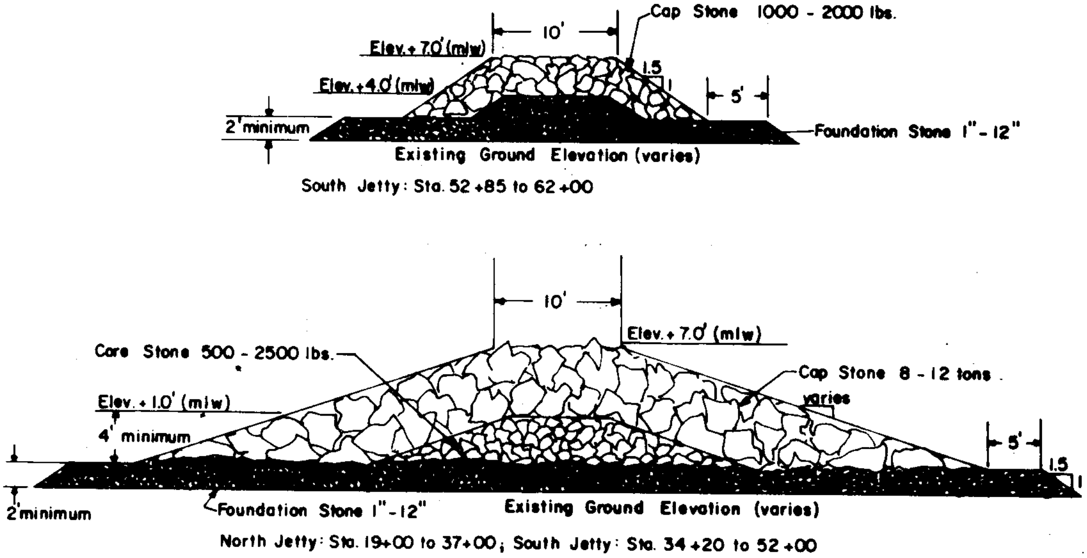


Fig. 4.6 Jetty Cross-Section Details (Corps of Engineers, 1967).

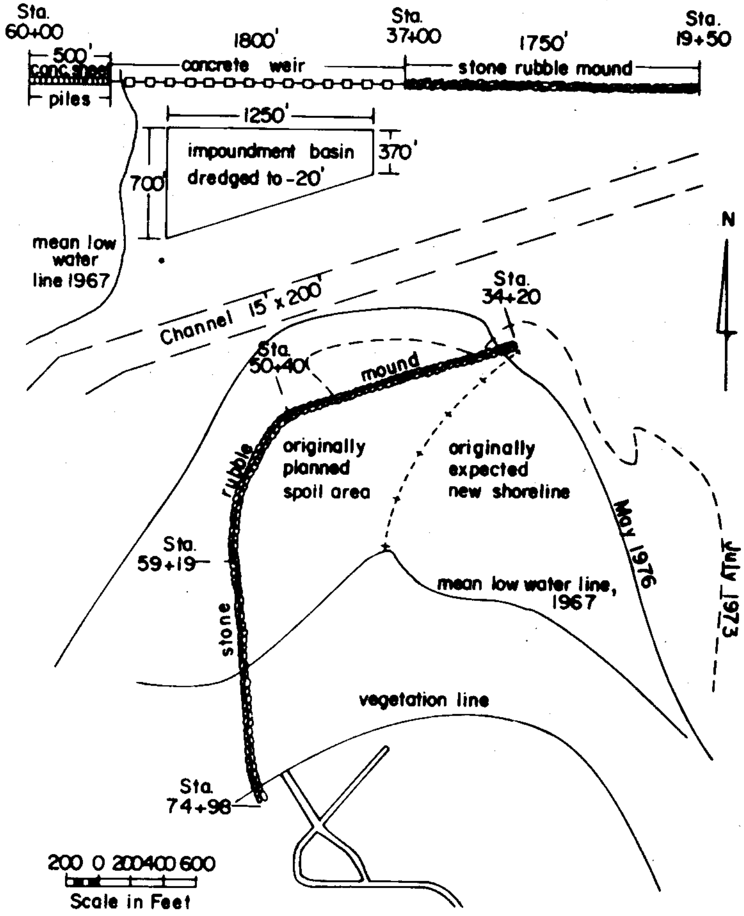


Fig. 4.7 Jetty Station Locations
and MLW Shoreline Changes.

V. MORPHOLOGICAL CHANGES

5.1 Maps, Surveys and Photographs

Ponce de Leon Inlet appears on the following charts and maps: NOS Coast Chart 11484 (replacing No. 1245), NOS Small Craft Chart No. 11485 (replacing No. 843-SC), and USGS New Smyrna Beach Topographic Quadrangle, photorevised in 1970.

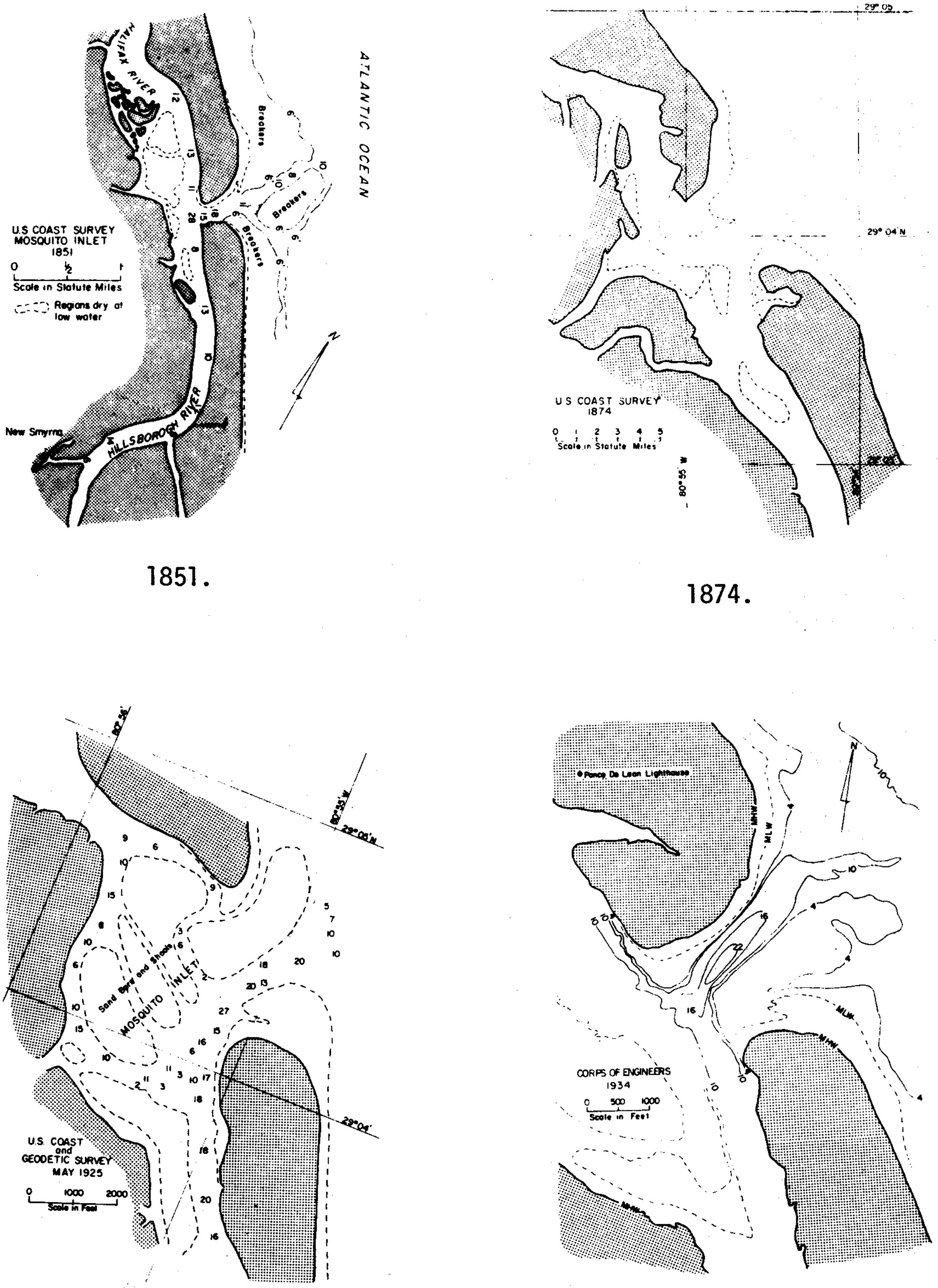
Surveys of the inlet and surrounding areas have been made frequently since June 1971 by the University of Florida's Coastal and Oceanographic Engineering Laboratory and the U.S. Army Corps of Engineers, Jacksonville District. These surveys - numbering more than 30 - have been made in conjunction with the monitoring of the Ponce de Leon Inlet Improvement System and as pre- and post-dredging surveys. Prior to this date surveys of the inlet and adjacent areas have been made by: Moncrief (1765), U.S. Coast Survey (1851), U.S. Coast Survey (1874), U.S. Coast and Geodetic Survey (1925), and the Corps of Engineers (1934, 1939, 1942, 1943, 1944, 1945, 1952, 1963, 1967). Figure 5.1 shows some of these surveys.

Beach profiles have been taken during several of the project monitoring surveys mentioned above; in addition, beach profiles have been taken at approximately 1,000 ft. intervals along the entire Volusia County coastline in conjunction with the Coastal Construction Setback Line study. Permanent reference monuments were set at each profile line location. The profiles at every third monument were taken to a depth of 20 to 40 ft., a distance of approximately 3,000 ft. offshore. All other profiles were taken to wading depth. Since Florida Statutes require that the setback line be reviewed by the Florida Department of Natural Resources every 5 years, this project should provide valuable information concerning erosion and accretion along the coastline (Purpura and Sensabaugh, 1974; COEL, 1972b).

Aerial photographs of the inlet have been taken by several government agencies in the years 1942, 1943, 1945, 1947, 1949, 1954, 1956, 1962, 1964 and 1967. The listing of pertinent details may be obtained from Barwis (1975). In addition, numerous aerial photographs have been taken since 1971 in conjunction with the Inlet Improvement System monitoring project. Fig. 5.2 shows photographs of Ponce de Leon Inlet in 1943, 1958, 1967 and 1973.

5.2 Outercoast Shoreline Changes

There is little information on the shoreline changes in the inlet vicinity prior to the 1930's. However, the Beach Erosion Board made a study of the movement of the line of mean high water between 1872/74 and 1936 using 2 USC&GS surveys (1872/74 and 1928) as well as a U.S. Army Engineer survey (1936). The report indicates that the high water shoreline from the inlet northward, for a distance of approximately 1 mile, advanced seaward (House Document 571/75/3, 1938). The report indicates that the high water shoreline south of the inlet receded as much as 800 ft. in places. This recession was apparently linked with the northward migration of the south side of the inlet. Likewise, the advance of the shoreline for 1 mile north of the inlet was apparently linked with the northward migration of the northern side of the inlet. While quantitative conclusions as to the inlet's migration cannot be



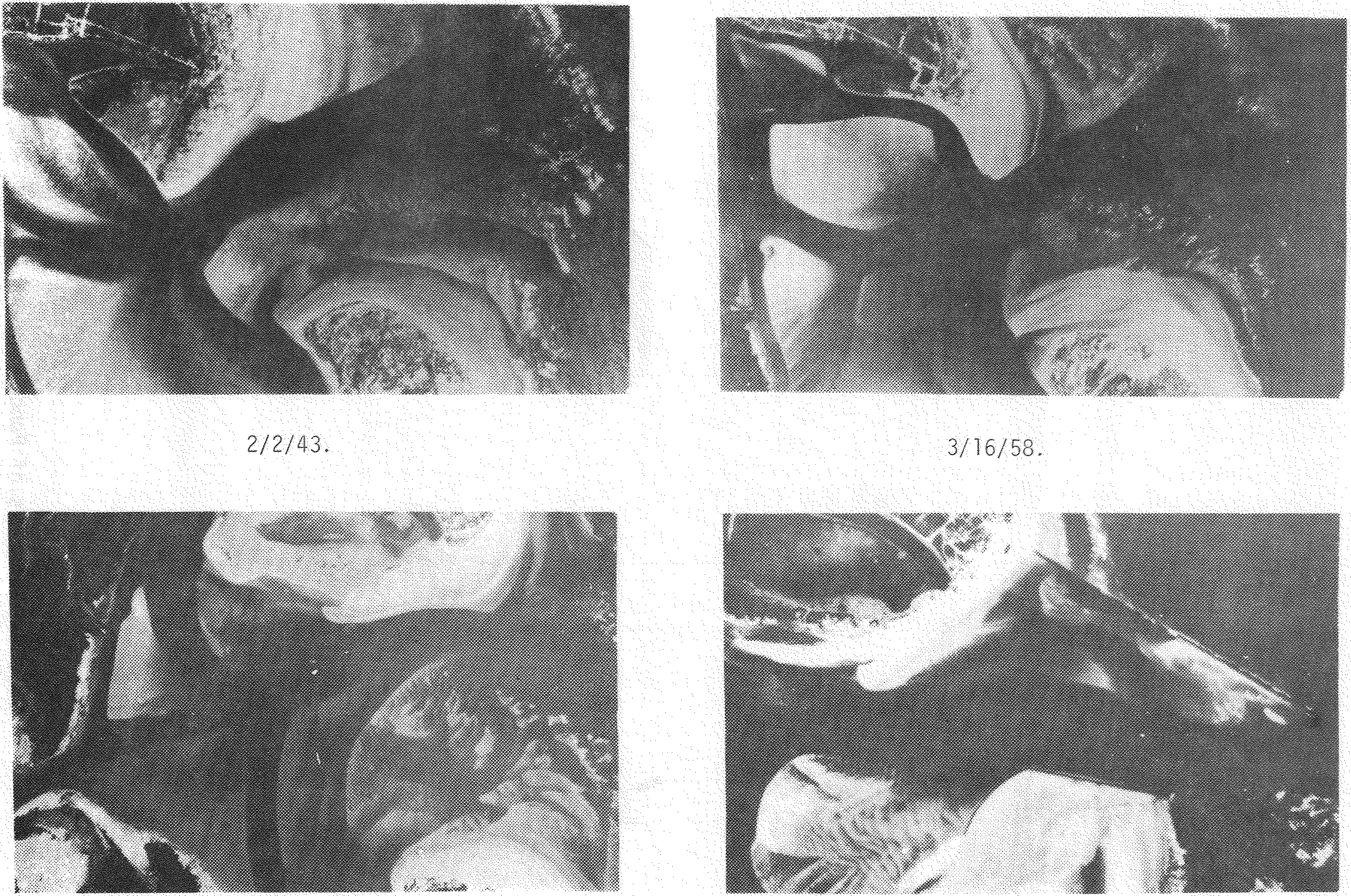
1851.

1874.

1925.

1934.

Fig. 5.1 Surveys of Ponce de Leon Inlet.



2/2/43.

3/16/58.

4/4/67.

5/11/73.

Fig. 5.2 Aerial Photographs of Ponce de Leon Inlet.

deduced from the movement of the shoreline at a given elevation, (the movement of the low water shoreline and channel cross sections should also be studied) the inlet apparently migrated northward between 1872/74 and 1936. It is interesting to note here that the 1851 U.S. Coast Survey chart of Mosquito Inlet also shows a former position of the inlet (although no date is given, the authors presume it was around 1834, concurrent with the construction of the lighthouse on the south side of the inlet) approximately one-third mile north of the 1851 position. Whether or not the apparent migration of the inlet southward between 1834 and 1851 and northward between 1872/74 and 1936 is due to survey error, actual movement, or both, is unanswered.

The Corps of Engineers (1963) tabulated the movement of the line of mean high water (mhw) between 1936 and 1962 and the results are presented in Table 5-1. It is apparent that erosion predominated over a 2-mile stretch north of the inlet, and that both accretion and erosion have taken place over a distance of 4 miles south of the inlet. Over that portion south of the inlet, shoreline recession is accompanied by accretion of the offshore part of the profile. This could be caused by displacement of material from the landward portion of the profile into the seaward portion. More recently, the shoreline changes in the vicinity of the inlet have resulted from (at least partially) the inlet improvement system. Figure 5.3 shows the changes of the mean low water (mlw) shoreline in the inlet vicinity between 1932 and February 1973 (COEL, 1973). Figure 4.7 has already shown the shoreline movements south of the inlet between September 1967 and May 1976.

5.3 Changes in the Inlet Cross Section

As can be seen from Table 5-2, the throat section (minimum flow area) of Ponce de Leon Inlet below mwl has remained approximately constant over the last 40 years, while the surface width has decreased and the ratio of the width to mean depth has decreased. The decrease in the inlet width and in the width to mean depth ratio is a result of the inlet stabilization. The south shoreline advanced northward a considerable distance and as the inlet cross-sectional area remained essentially unchanged, the mean depth increased, resulting in a deeper inlet. It is instructive to note that the position of the throat section has changed with time. The location of the 1976 throat section is shown in Fig. 6.2; the location of the 1973 throat section was about 2,000 ft. west of the 1976 throat section (COEL, 1977).

It is also interesting to examine the changes in the position of the channel centerline over time. Figure 5.4 shows the position of the channel centerline at several times between 1962 and July 1976 (COEL, 1977). Note the position of the design channel for the inlet stabilization project. It can be seen from Fig. 5.4 that the channel centerline has tended to migrate toward the north jetty despite the dredging of the entrance channel and south shoal.

TABLE 5-1

MHW SHORELINE CHANGES*

1936-1962

Station (ft)	Accretion	Erosion
12,000 N	60	
11,000 N	30	
10,000 N		30
9,000 N		30
8,000 N	20	
7,000 N		20
6,000 N		50
5,000 N		120
4,000 N		190
3,000 N		320
2,000 N		460
1,000 N		580
0 N		270
0 S		720
500 S		340
1,500 S	420	
2,500 S	550	
3,500 S	350	
4,500 S	220	
5,500 S	150	
6,500 S	100	
7,500 S	70	
8,500 S	20	
9,500 S		20
10,500 S		30
11,500 S		20
12,500 S		20
13,500 S		20
14,500 S		60
15,500 S	0	0
16,500 S		40
17,500 S	10	
18,500 S	0	0
19,500 S	0	0

* Figures are in feet.

From Corps of Engineers (1963).

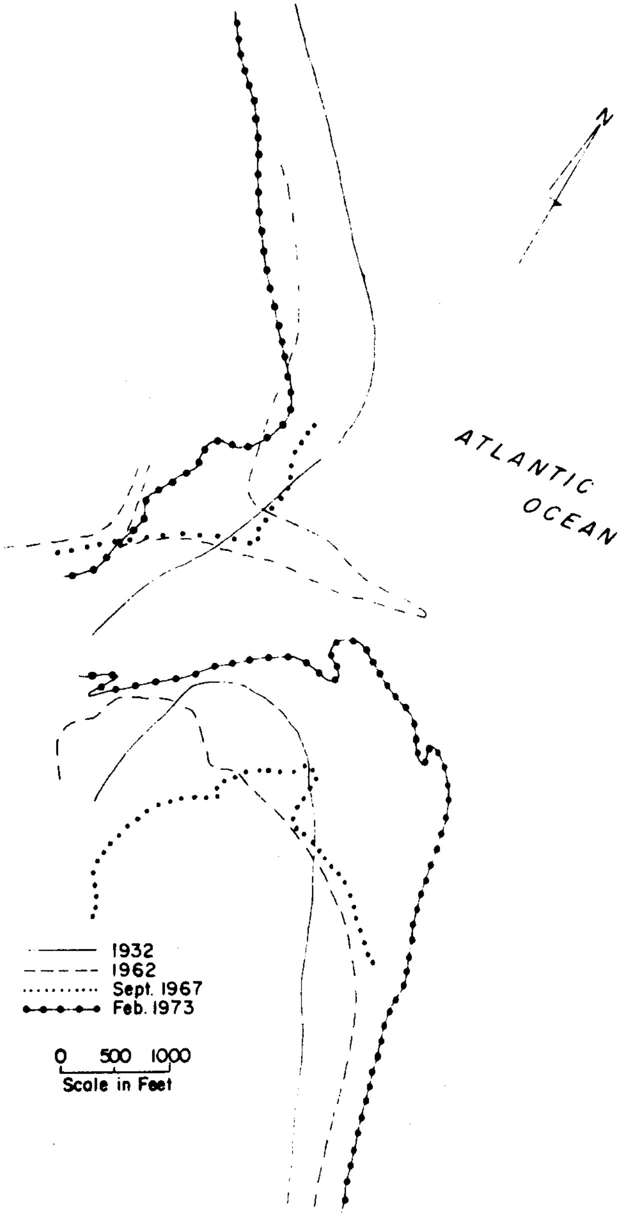


Fig. 5.3 Inlet Shoreline Changes - MLW (COEL, 1973).

TABLE 5-2

INLET THROAT CROSS-SECTIONAL AREA AND WIDTH TO MEAN DEPTH RATIO

Date	Throat Section Below MWL (ft^2)	Surface Width (ft)	Mean Depth (ft)	Width/Depth
Sept. 1934	15,800	1,900	8.3	228
Oct. 1939	10,800	1,640	6.6	249
Apr. 1943	13,500	1,250	11.4	103
Apr. 1952	13,000	1,200	10.8	111
Apr. 1976	14,648	1,025	14.3	72
May 1976	13,688	1,010	13.6	74

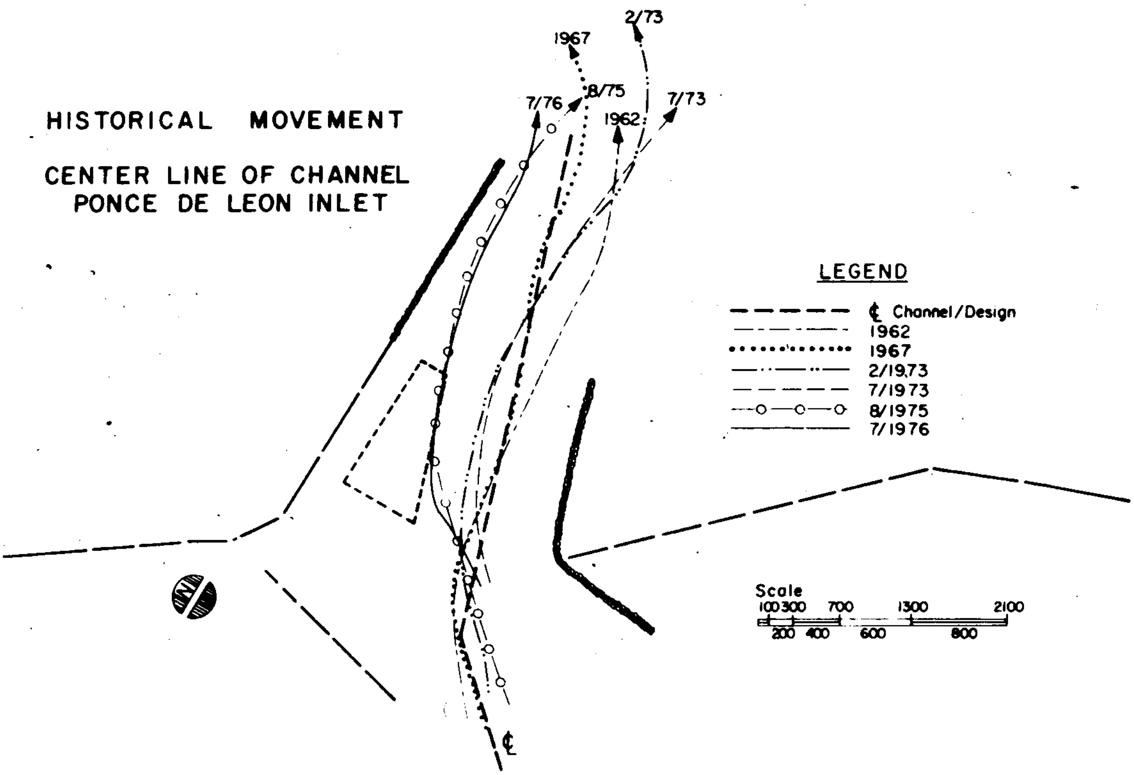


Fig. 5.4.

VI HYDRAULICS

6.1 Freshwater Discharge and Salinity Measurements

Data from Fig. 2.2 has indicated that the two major streams carrying freshwater into the coastal region in the vicinity of Ponce de Leon Inlet are the Tomoka River and Spruce Creek. Table 6-1 includes information extracted from Water Resources Data for Florida, Part 1, Volume 1 (U.S. Department of the Interior, 1974).

TABLE 6-1

FRESHWATER DISCHARGE
TOMOKA RIVER AND SPRUCE CREEK*

	Tomoka River	Spruce Creek
Gage Location	29°02'13" N 81°06'32" W	29°03'01" N 81°02'49" W
Average Discharge	63.2 cfs**	33.2 cfs***
Maximum Discharge	2,100 cfs (Oct. 19, 1968)	1,610 cfs (Sept. 10, 1964)
Minimum Discharge	0 cfs (Feb. 26, 1968)	0 cfs (April 23, 1962)

* Note that this gage was placed upstream such that only 32 sq. miles drains into this portion of the creek. The total drainage area for Spruce Creek is 96 sq. miles (see Fig. 2.2).

** 10-year period (Oct. 1964-Dec. 1974).

*** 23-year period (May 1951-Dec. 1974).

The Spruce Creek gage was placed such that only 32 sq. miles drains into the creek upstream of the gage. The table in Fig. 2.2 indicates that the total area draining into Spruce Creek is 96 sq. miles. It is not known what the total discharge of all of Spruce Creek is, as the drainage area above the gage is about one-third the total drainage area of the Creek.

Salinity measurements in the inlet vicinity have been made during two separate field investigations in the area: Sept. - Oct. 1971 and May 1972, during the coastal engineering study at Port Orange (COEL, 1972a); May-Oct. 1975, during the field investigation for the proposed marina and park sites in the inlet vicinity (Ponce de Leon Port Authority, 1976). Figure 6.1 indicates the salinity distributions along the Halifax River north of Ponce de Leon Inlet on Oct. 6, 1971 and May 23, 1972. The figure shows the salinity distribution at both, high water slack and low water slack (COEL, 1972a). All the salinity distributions except the May 23, 1972 high water slack

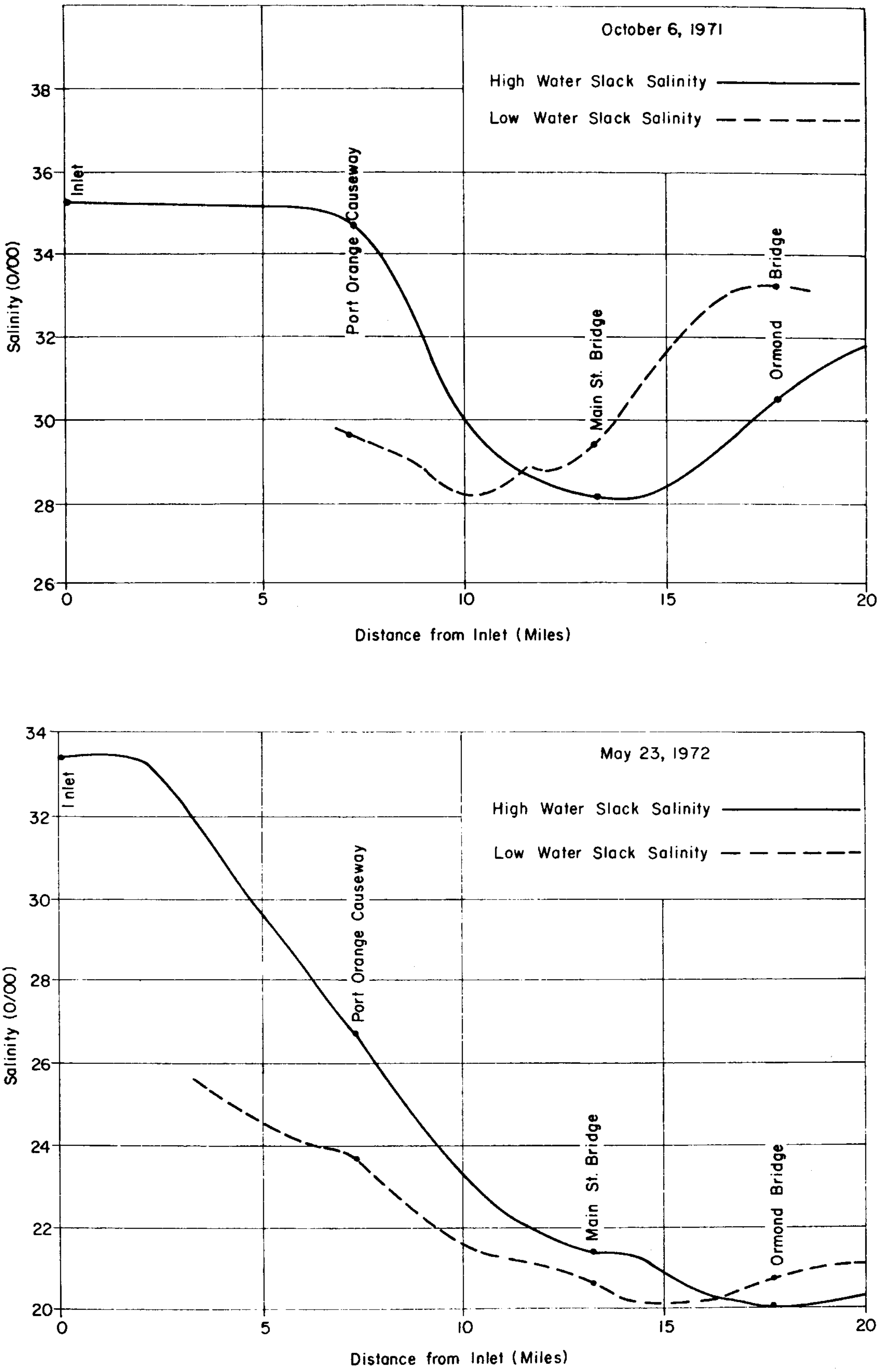


Fig. 6.1 Halifax River Salinity Profiles (COEL, 1972a).

distribution indicate the lowest salinity occurred at about 10 to 15 miles north of the inlet. This trend was apparently the result of the Daytona sewerage outfall which discharged about 11 million gallons per day during this time period. Comparing the position of the low salinity point on each day indicates the lowest salinity did not fluctuate much but the location at which it occurred varied about 3 miles. This distance is the tidal excursion distance. The distance that the sea water passing through the inlet traveled during flood is approximately given by the horizontal portion of the high water slack curves. The sea water only penetrated about 1.5 miles into the river on May 23, 1972, which corresponded to nearly mean tidal conditions. The sea water penetrated about 6 miles into the river on Oct. 6, 1971, which corresponded to spring tide conditions.

The salinity measurements made between May and October 1975 in conjunction with the environmental studies of the proposed marina and park sites (see Fig. 1.4) indicate no discernible trends except that the average salinity tended to decrease from 39 parts per thousand (ppt) in May to 28 ppt in August, increased to 35 ppt in Sept. and fell to 33 ppt in October. The rather wide variation is due primarily to freshwater runoff.

6.2 Tides

The National Ocean Survey (NOS) maintains tide gages on the pier at Daytona Beach and on the Coast Guard Reservation dock south of the inlet. The tidal ranges for these locations are indicated in Table 6-2.

TABLE 6-2

RANGES FROM NOS TIDE TABLES

Station	Mean Range (ft)	Spring Range (ft)
Daytona Beach	4.1	4.9
Ponce de Leon Inlet	2.3	2.7

The line of mean water level (mwl) along the open coast in the vicinity of Ponce de Leon Inlet is estimated to be 0.30 ft. above the zero on the 1929 mean sea level datum, which is the reference datum for many USC&GS and SRD benchmarks (Corps of Engineers, 1968). The line of mlw is estimated to lie 2.0 ft. below mwl.

Figure 6.2 indicates the locations of six tide gages used to monitor tidal conditions throughout the project monitoring area (COEL, 1977) between April 21, 1976 and May 14, 1976. Tide gages were placed at locations 8, 9 and 10 during previous studies in the area (COEL, 1974). Also included in Fig. 6.2 are the locations of the inlet throat and current measurement stations. Table 6-3 shows the ratio of the bay tide range $2a_b$ to the ocean tide range $2a_0$ at each tide station. The ratio, for the April 28 and May 12, 1976 measurements, was computed using the ocean tide gage shown in Fig. 6.2. This NOAA gage was located near Halifax Estates - about 5 miles north of the inlet. The ocean gage used in the July 18-19, 1974 measurements was located south

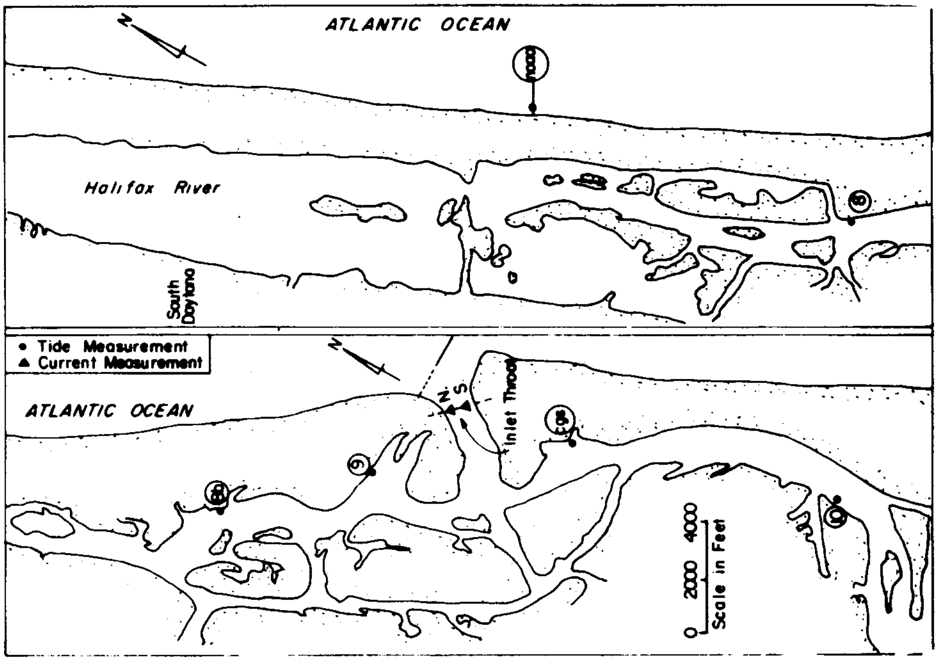


Fig. 6.2 Tide and Current Measurement Locations (COEL, 1977).

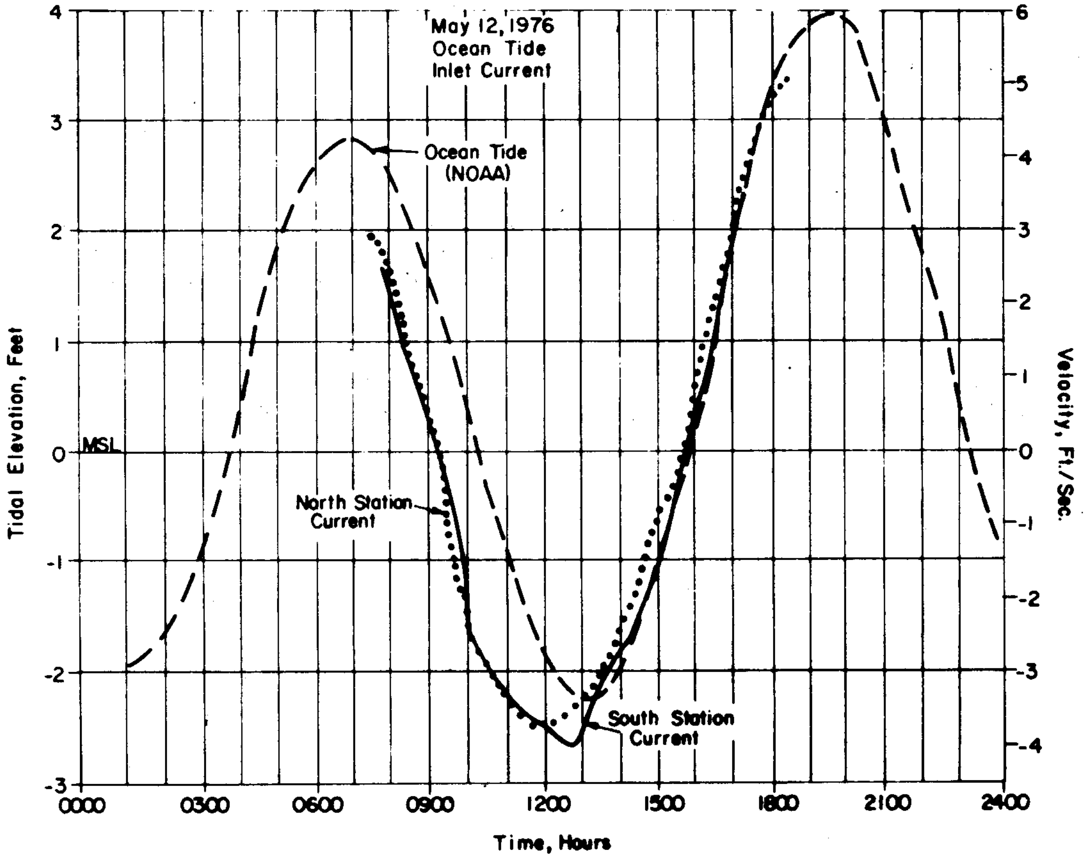


Fig. 6.3.

of Flagler Beach - about 26 miles north of the inlet. According to the Corps of Engineers (1968), the ocean tide range near Flagler Beach is approximately 1.04 times the range near Halifax Estates. The entries for July 18-19, 1974 in Table 6-3 have been corrected for this difference, i.e., the actual ocean range of 5.94 ft. was divided by 1.04 to yield the tide range near Halifax Estates of 5.71 ft. The April 28, 1976 ocean tide was a rather weak spring tide (4.20 ft.), while the ocean tide on May 12, 1976 was a strong spring tide (6.17 ft.). The latter tide is indicated in Fig. 6.3.

TABLE 6-3

RATIO OF BAY AND OCEAN TIDE RANGES* FOR SPRING TIDAL CONDITIONS

Station	$2a_B/2a_0$	
	July 18-19, 1974	April 28 and May 12, 1976
8	0.45	0.50
8B	---	0.65
9	0.72	0.75
CGS	---	0.74
10	0.60	0.65

* See Fig. 6.2 for station locations.

6.3 Currents

Figure 6.3 shows inlet current measurements for May 12, 1976 as measured at two stations (indicated N. station and S. station on Fig. 6.2). A similar drawing for April 28, 1976 is included in the project monitoring study report (COEL, 1977). Note the close similarity of the two current curves, which are both depth averaged velocity measurements. The highest measured point velocity on May 12 was 4.5 ft/sec during flood at a location 1.65 ft. below the water surface. Note also that the flood current is stronger than the ebb.

6.4 Hydraulic Parameters

a. Tidal Prism

The tidal prism is defined as the volume of water that enters an inlet during flood flow and exits during ebb flow; however, the flood and ebb prisms are not always equal. Such is the case at Ponce de Leon Inlet where the flood tidal prism was significantly higher than the ebb tidal prism during April and May 1976 (COEL, 1977). One possible reason for this difference is that the bay and river areas in the inlet vicinity have a large and variable capacity for the storage of water. That is to say, not all of the flood prism must exit through the inlet during ebb, but may remain in the bay area for an undetermined time before exiting through the inlet. Also, a portion of the flood prism may find its way into the Intracoastal Waterway or Mosquito Lagoon and may leave through another inlet (e.g. Matanzas or Canaveral). Observations have also indicated (personal communication, Chiu, COEL) that the inlet-bay system is rather peculiar in the sense that the flood prism tends to vary with the tidal elevation whereas the ebb prism tends to vary with the tidal range.

Several estimates of the tidal prism during spring tide conditions have been made, three of which are included in the report by Jarrett (1976). Another estimate of the ebb tidal prism was determined from velocity measurements (COEL, 1977), and finally, one estimate was computed by a numerical model that was calibrated with field tidal measurements taken during April and May 1976 (COEL, 1977). These estimates are included in Table 6-4.

TABLE 6-4

SPRING TIDAL PRISMS AT PONCE DE LEON INLET

Tidal Prism (ft^3)	Source
5.74×10^8	Jarrett (1976, by cubature)
6.19×10^8	Corps of Engineers (1967)
5.65×10^8	Bruun and Gerritsen (1960)
6.02×10^8 (ebb)	COEL (1977)*
5.09×10^8	COEL (1977)**

* Computed from discharge measurements on May 12, 1976 (ocean tide range: 4.89 ft).

** Computed by numerical model

Although the first three entries in Table 6-4 were computed prior to the inlet stabilization, these figures should still apply (the tidal prism will vary considerably more as a result of changes in the bay area than from the improvement of the inlet). The tidal prism quoted by Jarrett (1976) will be used in computations.

b. Maximum Current

Figure 6.3 indicated that the maximum depth averaged ebb velocity on May 12, 1976 was 3.9 ft/sec. While the velocity measurements did not extend to the strength of flood flow, a maximum depth averaged flood velocity is estimated to be 5.8 ft/sec. The maximum cross sectional average velocities may be estimated by dividing the maximum ebb and flood discharges by the cross sectional area (13,688 sq. ft.) yielding 4.1 ft/sec on flood and 2.6 ft/sec on ebb (the spring tide range was 6.17 ft).

c. Lag of Slack Water

It is observed from Fig. 6.3 that the time lag of slack water (zero current) after high water in the ocean is 135 minutes and the lag after low water is 155 minutes. These figures are comparable to those computed by Clark (1973) where the average lag of slack water was found to be 148 minutes.

d. Bay Tidal Range

The average bay tidal range may be estimated by averaging tidal records throughout the bay area provided the bay area is known and a sufficient number of tide recorders have been placed throughout the bay. Table 6-3 has indicated the ratio $2a_B/2a_0$ for several locations throughout the area; however, the exact bay area is not known. Thus the average $2a_B/2a_0$ ratio, which equals 0.63, may not represent the actual value, which may be less. If it is assumed that this value is correct, the bay tidal range during spring conditions is 3.88 ft.

e. Bay Area

The bay area may be obtained by dividing the spring tidal prism by the bay spring tide range, i.e.,

$$5.74 \times 10^8 / 3.88 = 1.48 \times 10^8 \text{ ft.}^2$$

The following hydraulic parameters have thus been obtained (based on May 12, 1976 data):

Spring ocean tide range = 6.17 ft.

Spring bay tide range = 3.88 ft.

Spring max. cross-sectional average velocity (flood) = 4.1 ft./sec.

Spring max. cross-sectional average velocity (ebb) = 2.6 ft./sec.

Spring max. cross-sectional average velocity = 3.35 ft./sec.

Spring tidal prism = 5.74×10^8 ft.^{3}

Bay area = 1.48×10^8 ft.^{2}

Tidal period = 12.5 hours

Inlet throat cross-sectional area (below mlw) = 13,688 ft.^{2}

Inlet throat surface width = 1,010 ft.

Inlet throat hydraulic radius (mean depth) = 13.5 ft.

Lag of slack water after high water = 135 minutes

Lag of slack water after low water = 155 minutes

Average lag of slack water = 145 minutes

6.5 Wave Climate

The U.S. Army Coastal Engineering Research Center (CERC) operated a step resistance wave gage at the Sunglow Pier in Daytona Beach intermittently between 1954 and 1964. A pressure type wave gage was operated at the same pier between November 1964 and July 1974 (Thompson, 1977). The CERC data included on Fig. 6.4 are the results from the wave observations between 1954 and 1964.

Walton (1973) developed a method by which littoral drift computations along the coastline could be made from offshore wave statistics, taken in this case from the "Summary of Synoptic Meterological Observations," (U.S. Naval Weather Service Command, 1970). Fig. 6.5 and 6.6 show wave height and period distributions as calculated from the SSMO data. The SSMO wave height data are also included on Fig. 6.4. The middle curve on the same graph represents the SSMO data as it would be near the shoreline accounting for shoaling, refraction and friction. The CERC data and adjusted SSMO data show reasonable agreement with respect to wave heights, as seen in Fig. 6.4 , but the correlation between wave periods is not as good. Walton (1973) suggests that this is largely due to errors in observation in the SSMO data.

Table 6-4 summarizes the wave characteristics derived from the pressure type wave gage operated by CERC between 1964 and 1974. The significant wave height is the average of the largest one-third of the wave heights for each wave record Likewise, the significant wave period is the average of the periods of the same waves used to calculate the significant wave height.

TABLE 6-4

WAVE CHARACTERISTICS FROM THE CERC PRESSURE GAGE

	Nov. 1964-May 1968 (3819 wave records)	July 1969-July 1974 (1980 wave records)
Av. Significant Wave Height (ft.)	1.92	2.37
Variance (ft.^{2})	1.03	1.35
Standard Deviation (ft.)	1.02	1.16
Average Significant Wave Period (sec.)	8.85	8.38
Variance (sec.^{2})	4.44	8.17
Standard Deviation (sec.)	2.11	2.86

Wave refraction computations (COEL, 1977) were made to qualitatively examine the influence of local waves on erosion patterns and littoral drift in the inlet vicinity. The refraction study used deepwater waves of 5, 7 and

12 sec. periods approaching the shoreline from both perpendicular and 45° angles. The 12 sec. wave was used to simulate typical storm waves, while the 5 and 7 sec. waves represented typical wave conditions. The results indicate that for an equal distribution of waves approaching from different directions, a net southerly littoral drift predominates on the north side of the inlet while the littoral drift on the south side of the inlet would vary in both the north and south directions. The study also indicates that there is wave energy penetration through the weir section directed to the inner beach south of the north jetty. However, very little wave energy penetrates the inlet channel, resulting in a "shadowed" area north of the south jetty. This may account for the continued accretion in that area.

6.6 Inlet Stability

Data from section 5.3 has shown that the throat section area has remained approximately constant over the past 40 years, although the location of the throat section has shifted. Several studies (Escoffier, 1940; O'Brien, 1969; O'Brien and Dean, 1972) have shown that the stability of a tidal inlet is reflected by the stability of the throat cross-section. It thus appears that the inlet is stable; this is also indicated by the width to mean depth ratio which has decreased and, since the inlet stabilization, has varied between 111 and 72. Note that a lower width to mean depth ratio implies a deeper, more stable inlet. Historical evidence also indicates that the inlet has remained open for 400 years and navigable (although sometimes dangerous) for most of that time.

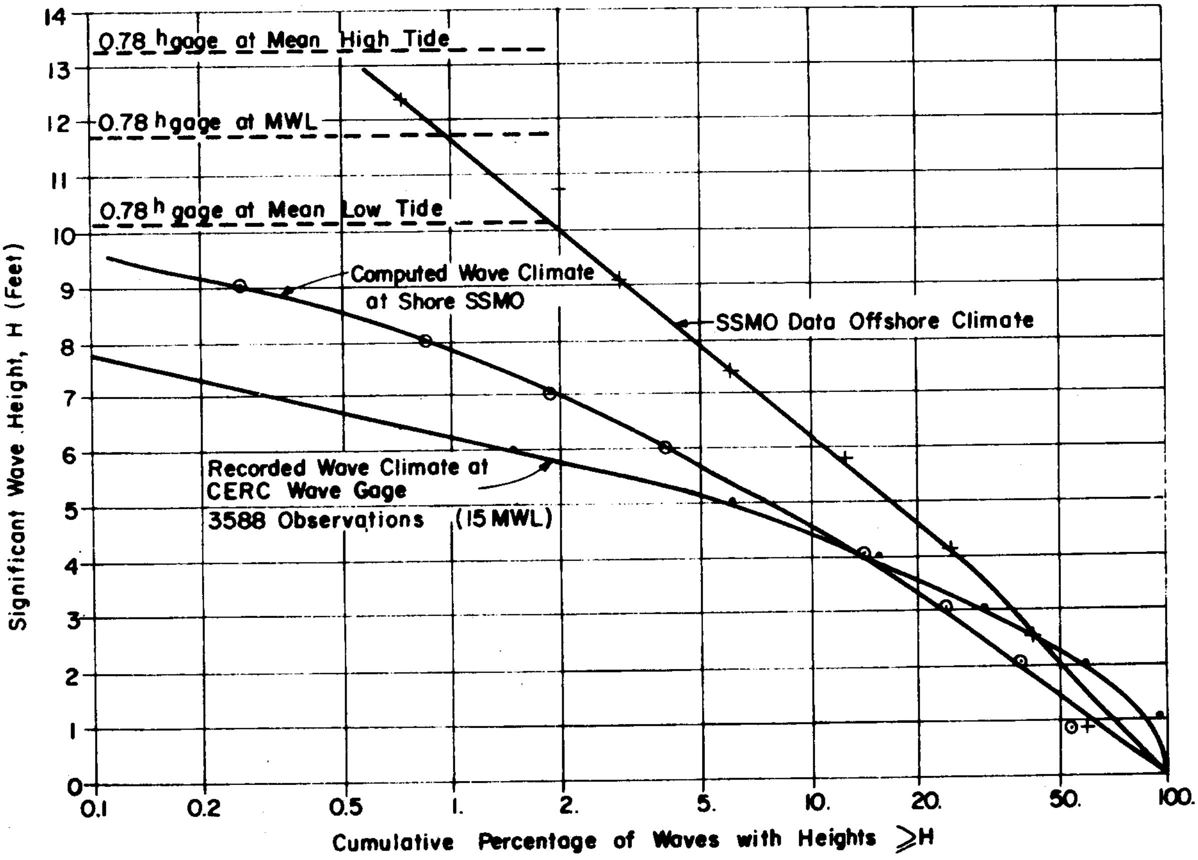


Fig. 6.4 Wave Height Comparison - Daytona Beach (Walton, 1973).

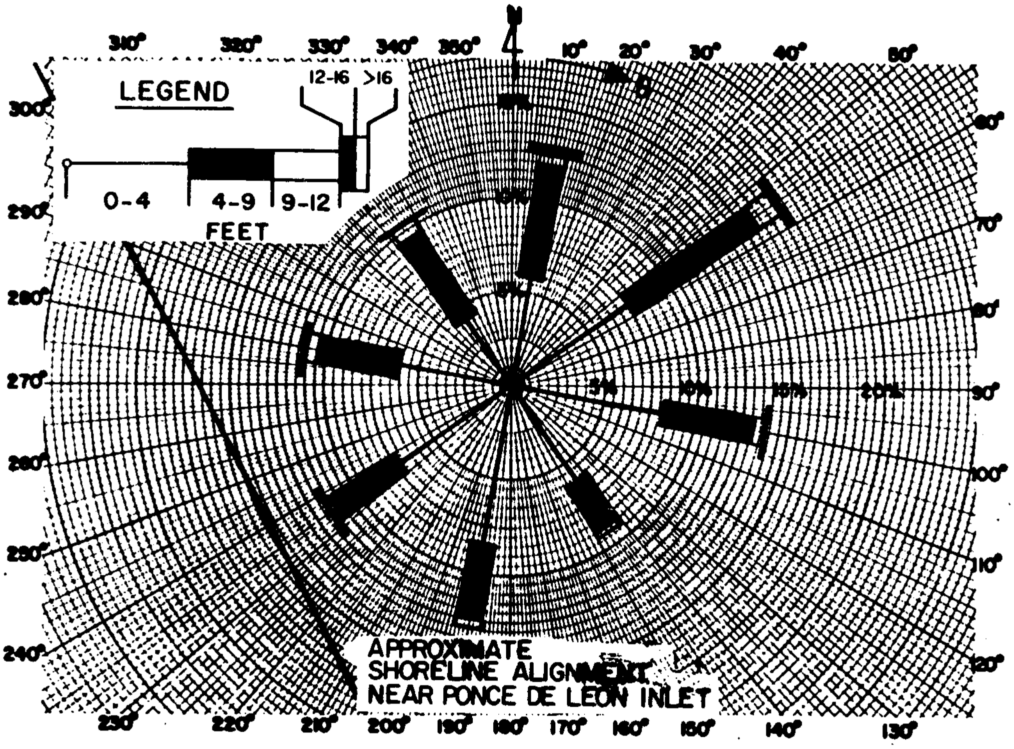


Fig. 6.5 Wave Height Rose for Offshore Wave Climate - SSMO data Square 11 - Annual (Walton, 1973).

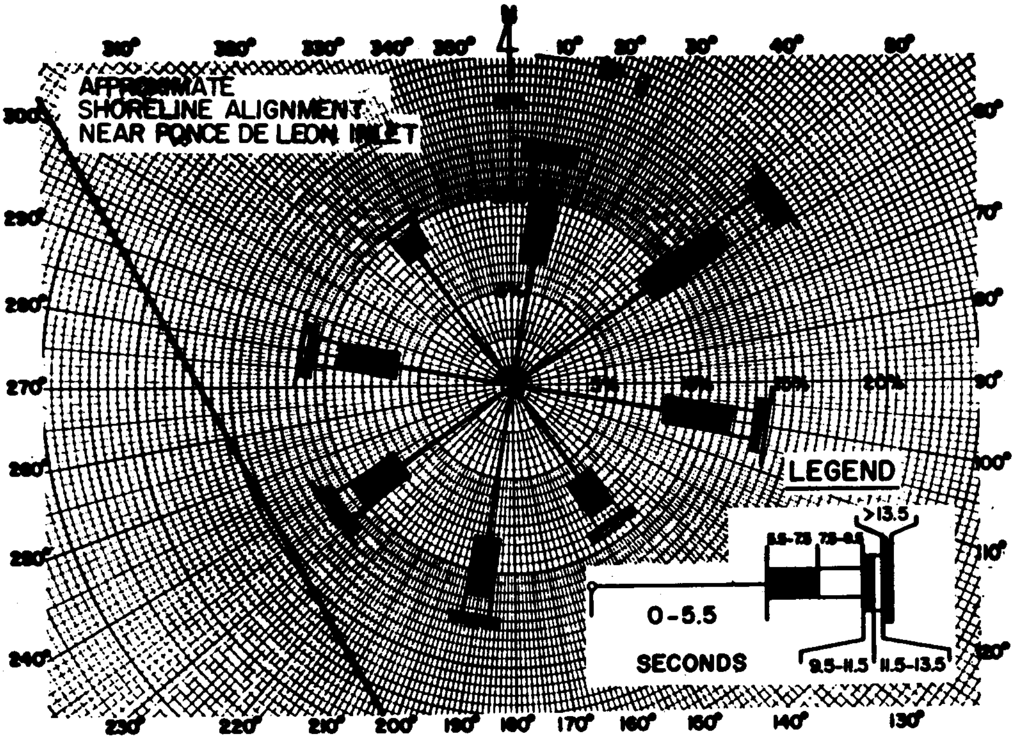


Fig. 6.6 Wave Period Rose for Offshore Wave Climate - SSMO Data Square 11 - Annual (Walton, 1973).

VII. SEDIMENTARY PROCESSES

7.1 Volumetric Changes

a. Outer Coast

Bruun (1962) has postulated that the eustatic rise in the sea level during the recent past has caused a general trend of erosion to take place along Florida's coastline. This trend has been observed at numerous places around the state. The average yearly rise in sea level over the past century has been about 0.01 ft., causing shoreline recession (see section 5.2) and volumetric erosion offshore of varying magnitude.

Table 5-1 has shown the predominance of shoreline erosion about both sides of Ponce de Leon Inlet (Corps of Engineers, 1963). Tables 7-1 and 7-2, adapted from the same reference, show the corresponding volumetric changes offshore over the same region between 1936-1962. Figure 7.1 shows graphically the average annual volumetric erosion (from Table 7-2) over the study area during these years. Those areas that experienced accretion are indicated by the white areas and those that experienced erosion by the lined areas. Note that the first station south of the inlet (Sta. 0 S) is located at approximately the northern end of the south side of the inlet in 1962. This location is approximately one-third of one mile south of the south jetty, which was completed in 1969. The first station north of the inlet (Sta. 0 N) is located a few hundred feet south of the north jetty. Figure 7.1 also indicates the approximate 1976 shoreline location with dashed lines.

More recent volumetric computations have been made (COEL, 1977) and the study area has been divided into three regions: the North Baseline area, which covers the outer coast area north of the north jetty for a distance of 3,600 ft.; the South Baseline area, which covers the outer coast area south of the south jetty for a distance of 4,500 ft.; the Channel Baseline area, which includes the inlet area between the jetties. Note that the Channel Baseline area includes the impoundment basin which is also listed separately in Table 7-3. These three regions are shown in Fig. 7.2.

Comparing the average annual volumetric erosion north of the inlet over a distance of 5,000 ft. between 1971 and 1976 to that between 1936 and 1962, one finds that it has increased from 17 to 26 cu. yds. per year per ft. of beach. This may be due to a combination of factors, including the occurrence of at least one severe northeast storm during the later time interval and also the fact that the inlet was (and still may be) adjusting to the new hydraulic and sedimentary conditions imposed by the inlet improvement. Continued monitoring should determine whether the inlet improvement system has been a contributing factor to the erosion immediately north of the north jetty.

As noted previously, the area south of the south jetty experienced tremendous accretion northward and eastward. Figures from Table 7-3 indicate that the 4,500 ft. stretch of shoreline south of the south jetty increased by over 3 million cu. yds. between 1969 and 1973. Between 1973 and 1976 the same area experienced erosion on the order of 800,000 cu. yds. (COEL, 1977).

TABLE 7-1
VOLUMETRIC ACCRETION AND EROSION*
1936-1962

North of Inlet

Station (ft.)	Accretion	Erosion
12,000 N	35	
11,000 N		
10,000 N		
9,000 N		1,710
8,000 N		
7,000 N		
6,000 N		
5,000 N		
4,000 N		2,000
3,000 N		
2,000 N		
1,000 N		
0 N		
Net Change		3,675

*Figures are in 1,000 cu. yds./year.

South of Inlet

Station (ft.)	Accretion	Erosion
0 S		1,745
500 S		
1,500 S	760	
2,500 S		
3,500 S		
4,500 S		
5,500 S		
6,500 S		
7,500 S	170	
8,500 S		
9,500 S		
10,500 S		
11,500 S		
12,500 S		430
13,500 S		
14,500 S		
15,500 S		
16,500 S		
17,500 S		13
18,500 S		
19,500 S		
Net Change		1,232

From Corps of Engineers (1963).

TABLE 7-2
AVERAGE ANNUAL VOLUMETRIC ACCRETION AND EROSION*
1936-1962

Station (ft.)	Ave. Annual Accretion	Ave. Annual Erosion
12,000 N	0.5	
11,000 N		
10,000 N		
9,000 N		13
8,000 N		
7,000 N		
6,000 N		
5,000 N		
4,000 N		17
3,000 N		
2,000 N		
1,000 N		
0 N		
Average Change		11

*Figures are in cu. yds. per year per ft. of beach.

Station (ft.)	Ave. Annual Accretion	Ave. Annual Erosion
0 S		67
500 S		
1,500 S	5	
2,500 S		
3,500 S		
4,500 S		
5,500 S		
6,500 S		
7,500 S	1	
8,500 S		
9,500 S		
10,500 S		
11,500 S		
12,500 S		4
13,500 S		
14,500 S		
15,500 S		
16,500 S		
17,500 S		0
18,500 S		
19,500 S		
Average Change		2

From Corps of Engineers (1963).

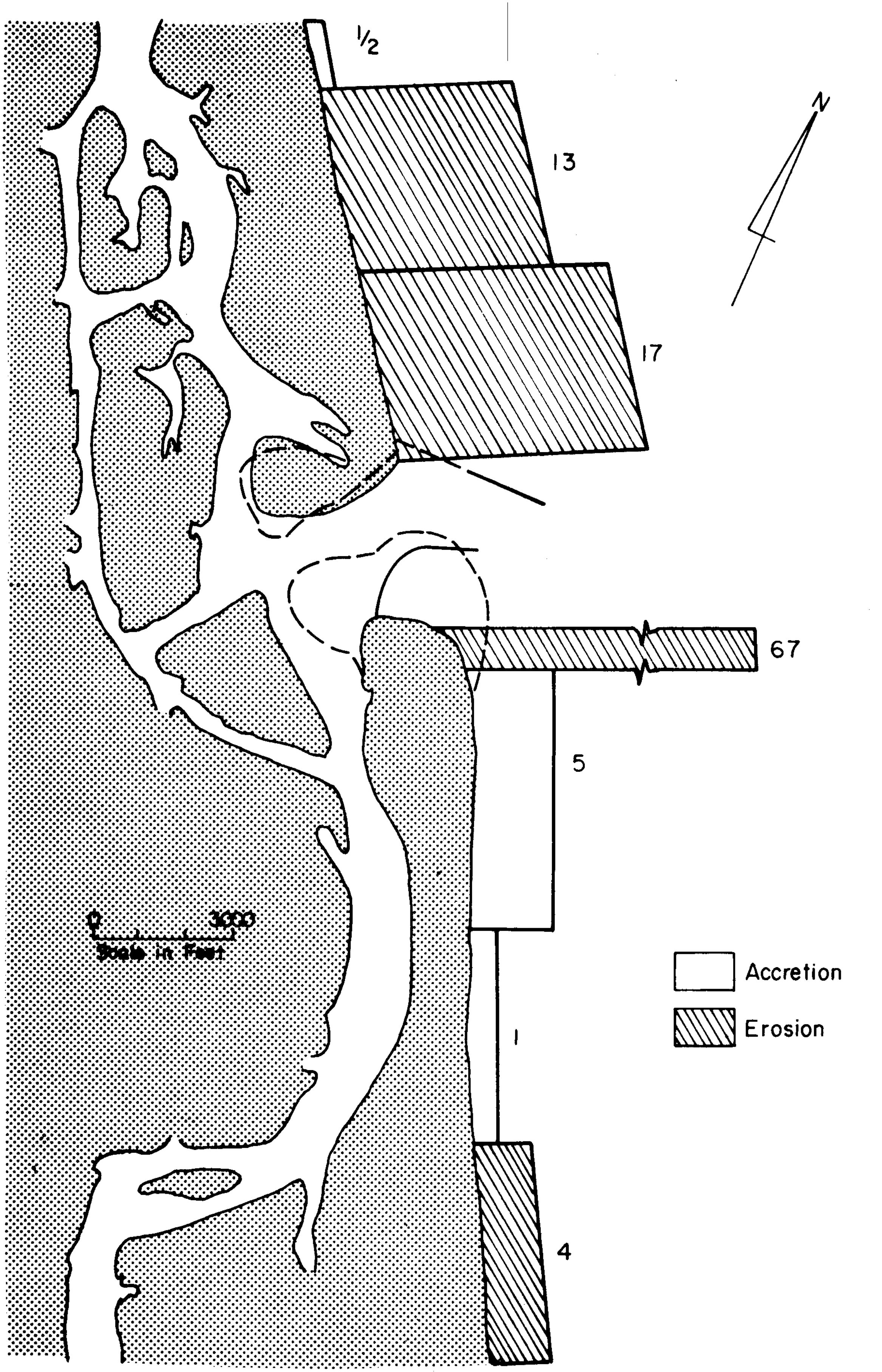


Fig. 7.1 Average Annual Volumetric Accretion and Erosion 1936-1962. Figures are in ft^3 per year per ft. of beach (Corps of Engineers, 1963).

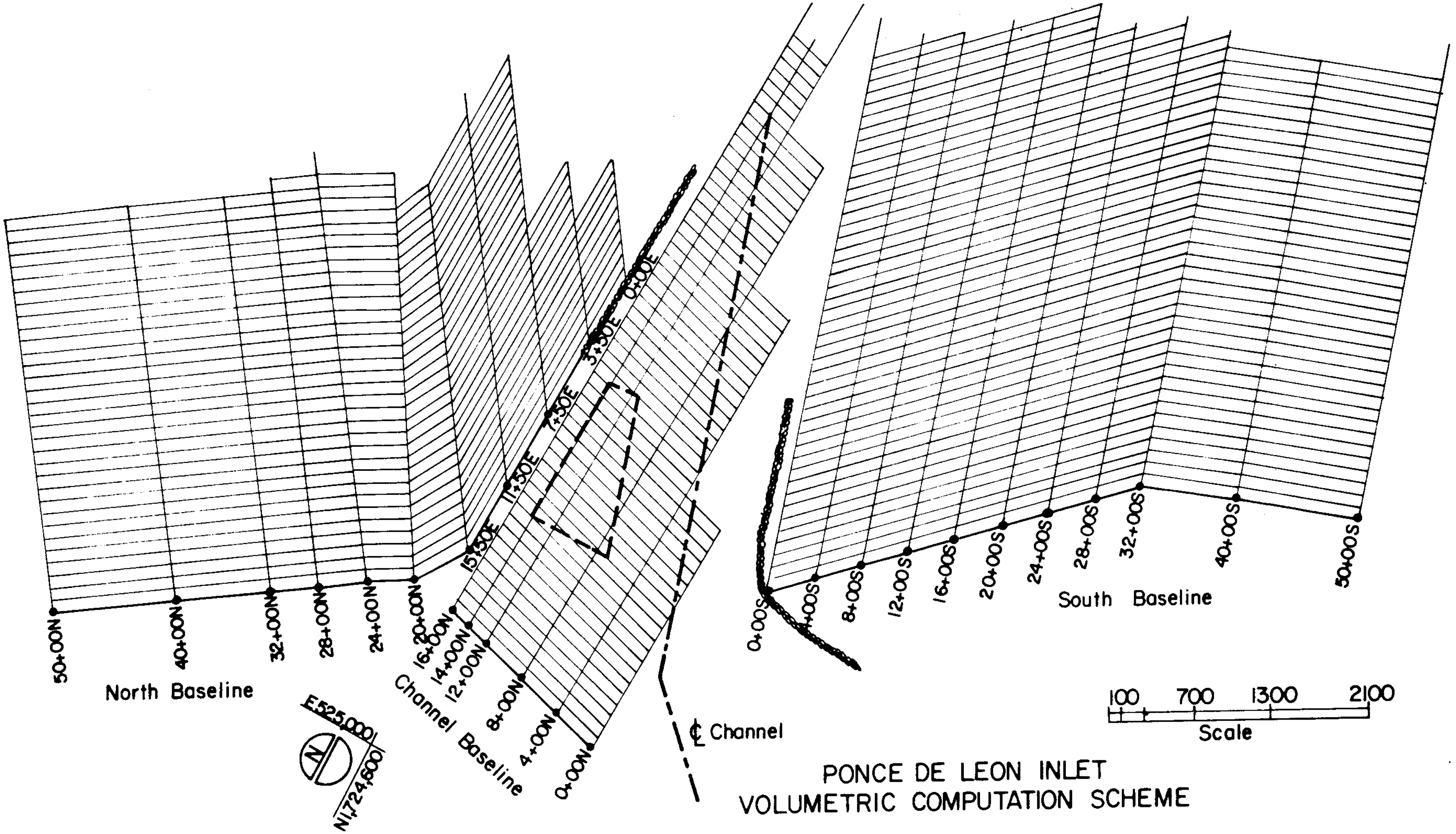

PONCE DE LEON INLET
VOLUMETRIC COMPUTATION SCHEME
North Baseline
50+00N
40+00N
32+00N
28+00N
24+00N
20+00N
16+00N
14+00N
12+00N
8+00N
4+00N
0+00N
Channel Baseline
15+50E
11+50E
7+50E
3+50E
0+00E
℄ Channel
South Baseline
0+00S
4+00S
8+00S
12+00S
16+00S
20+00S
24+00S
28+00S
32+00S
40+00S
50+00S
E525,000
N1,724,600
N
100
700
1300
2100
Scale

Fig. 7.2.

TABLE 7-3

VOLUMETRIC ACCRETION AND EROSION IN THE PROJECT MONITORING AREA

NORTH BASELINE

	8/71 to 7/73	7/73 to 7/76
Beach area	-638,000 yd^3	+ 17,000[a] yd^3
Offshore area	+693,000 yd^3	-381,000 yd^3
Totals	+ 55,000 yd^3	-364,000 yd^3
Net for Entire Period		-309,000 yd^3

SOUTH BASELINE

	10/69 to 7/73	7/73 to 7/76
Beach area	+2,960,000 yd^3	- 273,000 yd^3
Offshore area	+ 160,000 yd^3	- 549,000 yd^3
Totals	+3,120,000 yd^3	- 822,000 yd^3
Net for Entire Period		+2,298,000 yd^3

CHANNEL BASELINE
(Including Impoundment Basin)

	9/67 to 7/73	7/73 to 7/76
Area Between Jetties (Includes Impoundment Basin)	-421,435[b] yd^3	+189,109[c] yd^3
Net for Entire Period		-232,326[d] yd^3

IMPOUNDMENT BASIN

	8/72 to 7/73	7/73 to 7/76
	+ 300,000 yd^3	- 58,000 yd^3
Net for Entire Period		+ 232,000 yd^3

[a] includes beach nourishment of 89,167 yd^3

[b] includes dredging:

400,000 yd^3 - impoundment basin
95,314 yd^3 - entrance channel

[c] includes dredging of 685,753 yd^3 from south shoal and entrance channel with 433,751 yd^3 being used to fill the breach; hence, the net loss due to dredging was only 252,032 yd^3

[d] includes a loss due to dredging of 747,346 yd^3

b. Channel Baseline

Numbers from Table 7-3 show that the channel baseline area lost over 421,000 cu. yds. between 1967 and 1973. This is due to the fact that over 495,000 cu. yds. of material were dredged from the impoundment basin and entrance channel (a sidecast dredge removed over 27,000 cu. yds. while cutting a channel for a hopper dredge, but usually this material is not spoiled far from the dredge site - assume this material remained in the channel baseline area). Thus, neglecting dredging, the channel baseline area would have gained approximately 74,000 cu. yds. between 1967 and 1973.

The channel baseline area showed a gain of 189,000 cu. yds. between 1973 and 1976. However, there was a net loss due to dredging of 252,000 cu. yds. Thus the area would have gained over 441,000 cu. yds. over this 3-year period. Note that this area undoubtedly experienced considerably more accretion than that noted here since the limits of the channel baseline study area do not include part of the region immediately north of the south jetty - the area that has experienced the greatest growth.

c. Impoundment Basin

The impoundment basin was initially dredged between August 1971 and August 1972 and since that time it has not been dredged. The initial dredging removed approximately 400,000 cu. yds.; the capacity of the initial basin was estimated to be approximately 620,000 cu. yds., allowing for overflow into adjacent areas (COEL, 1973). The Corps of Engineers (1967) originally anticipated that this capacity would be filled in two years - a rate of 310,000 cu. yds./year. This figure was based on gross annual littoral drift rates estimated to be about 600,000 cu. yds. southerly and 100,000 cu. yds. northerly, resulting in a net southerly drift of 500,000 cu. yds. More recent estimates suggest these figures may be incorrect (see section 7.2).

The amount of sand deposited in the impoundment basin during the first year (August 1972 to July 1973) was 300,000 cu. yds. - a figure close to the design estimate. However, between July 1973 and July 1976, the volume of material in the impoundment basin decreased by 58,000 cu. yds. (COEL, 1977). It is believed (COEL, 1977) that all of the material that was trapped by the impoundment basin did not pass over the weir. Evidently some material was transported from the shoal area in the south side of the inlet into the impoundment basin. The decrease in material in the impoundment basin has been attributed to the migration of the entrance channel northward through the impoundment basin area (see Fig. 5. 4).

d. Bar Volume

The offshore bar volume at Ponce de Leon Inlet was calculated from the Feb. 1973 and July 1976 inlet monitoring project surveys. Although individual depth measurements were not indicated, the contour lines enabled an approximate calculation to be made following the method developed by Dean and Walton (1975). The bar volume was calculated over that region indicated in Fig. 7.3. The Feb. 1973 bar volume was estimated to be 6.26 x 10^6 cu. yds. and the 1976 bar volume was estimated to be 6.06 x 10^6 cu. yds. While the method is not accurate enough to predict small changes in the bar volume, the fact that there has been a decrease between Feb. 1973 and July 1976 is

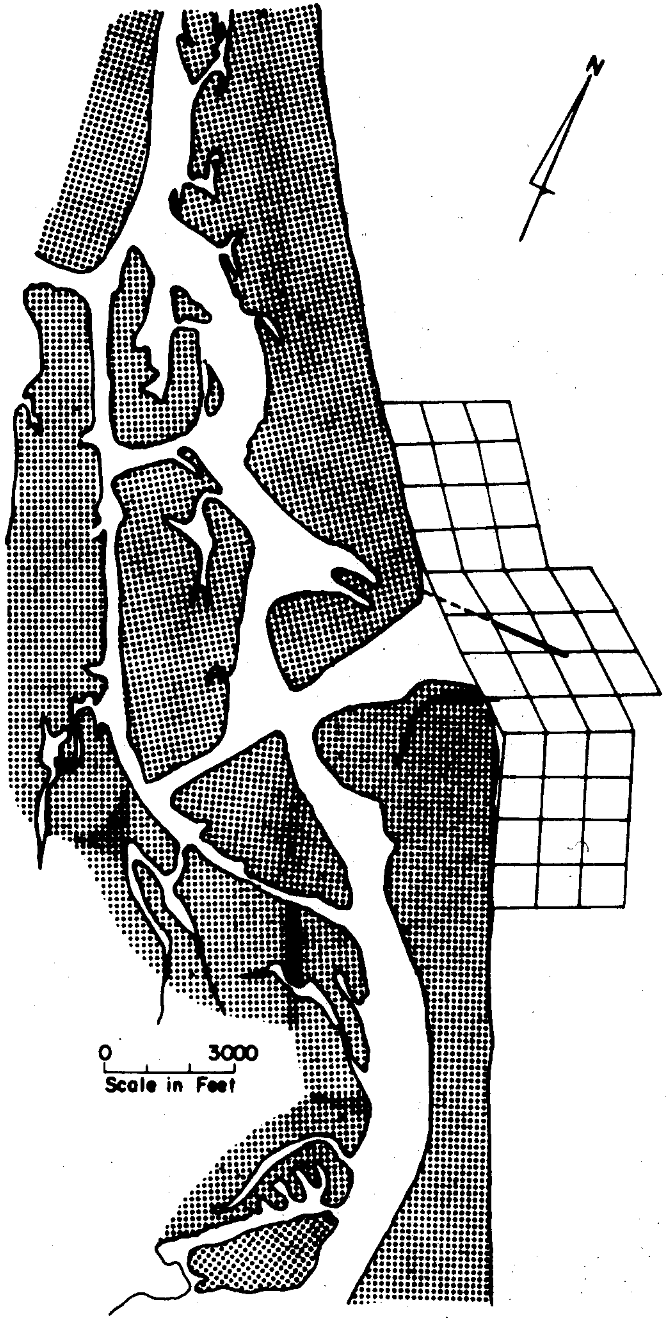


Fig. 7.3 Region of Outer Bar Calculations.

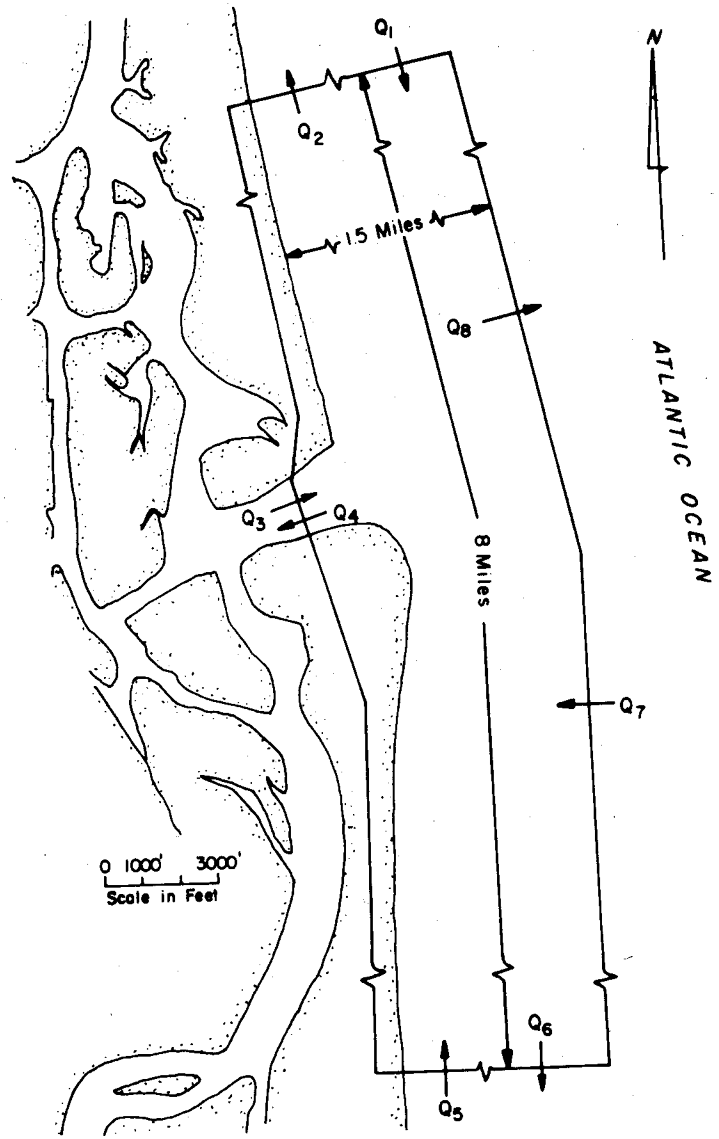


Fig. 7.4 Littoral Control Volume.

corroborated by comparing actual hydrographic surveys. The COEL (1977) indicates that during this time period there had been a net volumetric decrease of 10^6 cu. yds. in the project monitoring area, most of which had taken place in the South Baseline area. This determination was made by comparing the actual survey data.

Walton and Adams (1976) have shown that a relationship exists between the outer bar volume and the spring tidal prism for sandy inlets along coastlines of varying wave energies. Inlets on Florida's east coast lie on what is referred to as a "moderately exposed" coastline and the relationship determined was

$$\forall = 10.5 \times 10^{-5} P_s^{1.23} \tag{7-1}$$

where $\forall$ = outer bar volume in cubic yards
P_s = spring tidal prism in cubic feet.

The spring tidal prism for Ponce de Leon Inlet was determined to be 5.74×10^8 cu. ft. (see section 6.4). For this value of P_s, the above relationship yields $\forall = 6.25 \times 10^6$ cu. yds., which is close to the estimated value.

7.2 Littoral Material Balance

Fig. 7.4 shows a control volume encompassing the offshore region surrounding the inlet; the boundaries of the control volume have been selected as follows. The western boundary passes through the throat section of the inlet. The eastern boundary is in the offshore region and parallel to the shoreline. The northern and southern boundaries are normal to the shoreline and are assumed to be sufficiently far from the inlet such that the influence of the latter on the shoreline may be considered negligible. These last two boundaries are placed 4 miles north and south of the inlet.

With reference to the subscripted rate of littoral drift, Q, in Fig. 7.4, the material balance for the control volume may be expressed as

$$\frac{\Delta\forall}{\Delta t} = Q_1 + Q_3 + Q_5 + Q_7 - (Q_2 + Q_4 + Q_6 + Q_8) \tag{7-2}$$

where $\Delta\forall$ is the change of sediment volume within the control volume over a time period Δt. It is assumed that Q_7 and Q_8 are equal to zero if the eastern boundary is chosen to lie contiguous to the 60 ft. contour, a distance of approximately 1.5 miles offshore. Further, it is also presumed that $\Delta\forall$ should be approximately zero since it is assumed that the sediment within the control volume is redistributed as local changes in bathymetry occur. This assumption is perhaps better suited for a control volume surrounding a stable inlet that has not undergone any significant alterations, but will be invoked for computational purposes. The transport rates Q_1, Q_2, Q_5, and Q_6 are taken from calculations by Walton (1973). The difference between transport rates Q_3 and Q_4 are taken from Corps of Engineers estimates (Corps of Engineers, 1971b). Estimates of the volumetric transport rates are presented in Table 7-4.

TABLE 7-4

VOLUMETRIC TRANSPORT RATE ESTIMATES

Quantity	Amount (cu. yds./year)	Source of Data
Q_1	407,000	Walton (1973)
Q_2	306,600	Walton (1973)
$Q_4 - Q_3$	50,000	Corps of Engineers (1971b)
Q_5	312,100	Walton (1973)
Q_6	365,000	Walton (1973)
Q_7	0	Assumption
Q_8	0	Assumption

Substituting these values for Q into Eq. (7-2) and solving for $\Delta\forall/\Delta t$, where Δt is in this case taken to be one year

$$\frac{\Delta\forall}{\Delta t} = -2{,}500 \text{ cu. yds./year}$$

This value of -2,500 cu. yds./year is in reasonable agreement with the original assumption that $\Delta\forall/\Delta t = 0$. Also, this result does not contradict the previous findings (COEL, 1977) that the project monitoring area had lost about one million cubic yards of sediment between Feb. 1973 and July 1976. The decrease of sediment is explained by the fact that the study area did not cover the entire control volume considered here. In fact, the study area did not cover that region just north of the south jetty - the site of dramatic and continuing accretion. Also, some of the material dredged from the inlet and used as beach nourishment material offshore of the area north of the inlet could have moved out of the study area.

7.3 Sedimentary Characteristics

The beach sand in the inlet vicinity is similar to that along the entire Volusia County coastline - clean, fine, hard-packed, relatively uniform and with a mean grain size around 0.2 mm. The shell content is small, but it begins to increase about 8 miles south of the inlet resulting in a steeper, softer beach (COEL, 1973). However, on occasion the shell content may increase significantly. This localized phenomena was responsible for the abandonment of the beaches as a site of auto racing and land speed record attempts in the 1930's. The speed records were approaching 270 mph by this time and small patches of shell rendered the beach unsafe for these attempts (U.S. Congress, 1938).

The Corps of Engineers has taken sediment samples and core borings in the inlet vicinity between 1962 and 1976. Sediment samples were taken during dredging operations in the project entrance channel area in March 1973, May-June 1975 and March 1976. Core borings were taken prior to project construction in September 1962, March - April 1967 and December 1967 (see Fig. 7.5 for their respective locations). Table 7-5 includes core boring data and Table 7-6 includes grain size data for samples taken during dredging operations.

The sidecast dredge Merritt (used to dredge a pilot channel for the hopper dredge Hyde) most likely dredged material with a very high shell content. Note that D_{20} represents the grain size below which 20% of the sample lies, D_{50} represents the grain size below which 50% of the sample lies (the median grain diameter), etc. The material dredged by the Hyde and Davison was most likely almost entirely fine sand which was well sorted. The sample from the Merritt was poorly sorted.

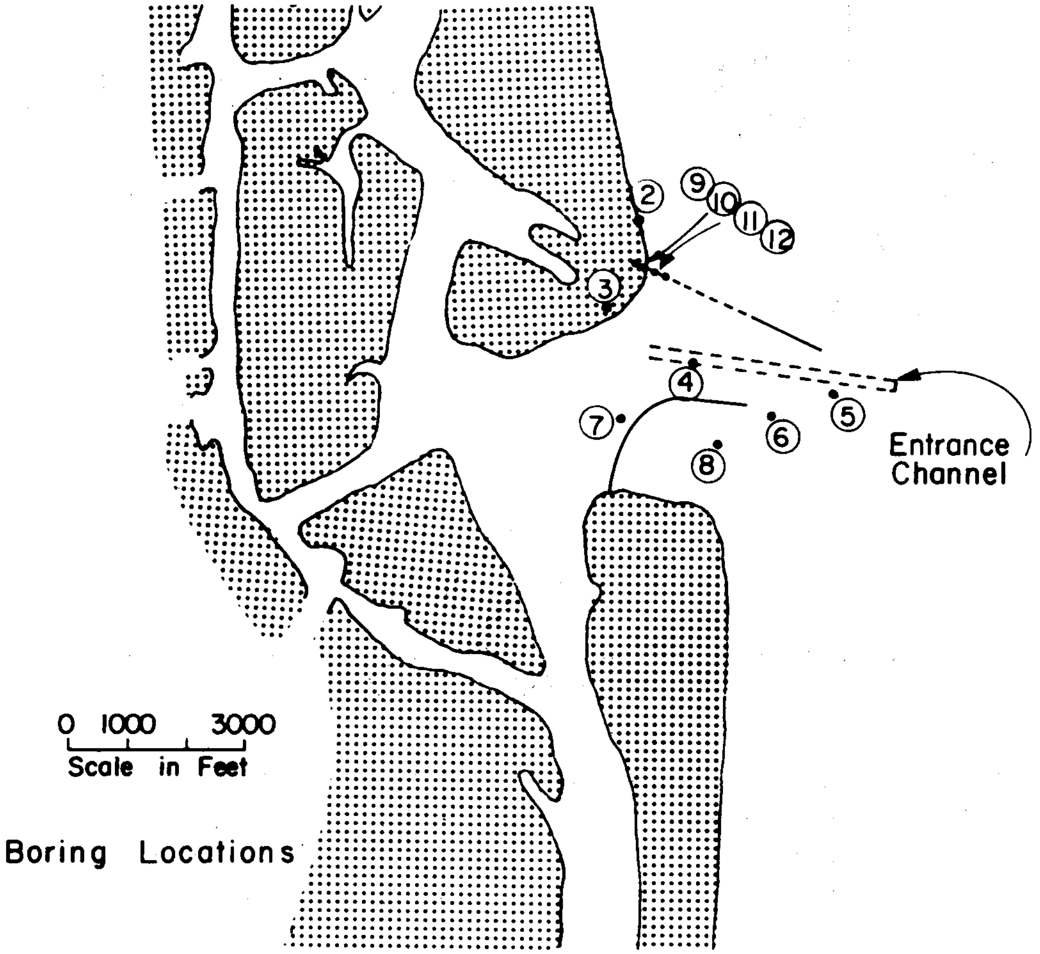


Fig. 7.5

TABLE 7-5

CORE BORING DATA*

Boring	Date	Boring Depth (ft. below mlw)	Remarks
2	9/25/62	-40.0	Medium to very fine sand, slightly shelly
3	3/21/67	-37.3	Fine sand, slightly shelly
4	4/13/67	-43.1	
5	4/17/67	-39.5	
6	4/16/67	-31.8	
7	3/22/67	-43.5	
8	4/18/67	-42.7	
9	12/14/67	-33.8	Fine sand with some shell, silty below -22 to -25 ft.
10	12/13/67	-31.8	
11	12/14/67	-32.0	
12	12/15/67	-32.5	

* See Fig. 7.5 for boring locations.

From Corps of Engineers, 1967.

TABLE 7-6

SEDIMENT SIZES OF SAMPLES FROM DREDGING OPERATIONS IN THE ENTRANCE CHANNEL

Dredge	Date	D_{20}, D_{50}, D_{80} (mm)
Merritt	March 1973	0.18, 0.42, 2.0
Hyde	May-June 1975	0.16, 0.17, 0.19
Davison	March 1976	0.16, 0.17, 0.19

XIII SUMMARY

Highlights of the information documented in this report are summarized below.

1) Ponce de Leon Inlet is a natural inlet located approximately 12 miles south of Daytona Beach, Florida. It has remained open to navigation since the 1500's when the Spanish explored the area, although navigation was frequently hazardous. The Spanish named the inlet Mosquito Inlet, and this name remained until 1926 when it was renamed Ponce de Leon Inlet.

2) Boating, both recreational and commercial, is an important activity in the area. The retail value of the seafood harvest has generally increased in recent years (over $700,000 in 1973), pointing to the importance of the inlet.

3) The coast of Volusia County is a low relief, low elevation coastal plain surface overlain by relic Pleistocene terraces and beach ridges. Predominantly Holocene sands are draped over the Pleistocene features on the barrier island beaches.

4) The mean yearly temperature in the inlet vicinity is 71° F and the yearly average rainfall is approximately 50 in.

5) Storm records indicate that a hurricane will pass within 50 miles of the inlet, on the average, once every 8 years. Hurricane King (Oct. 1950) was one of the more damaging storms to strike the county and caused severe flooding in the area.

6) The Spanish were the first Europeans to visit the area, possibly as early as 1513. The first English colony in the area was at New Smyrna. This colony was established in 1768 and was all but abandoned in 1777.

7) A by-pass channel was dug through the marsh west of the inlet in 1932/33. This enabled the Intracoastal Waterway to be rerouted away from the Halifax River and the Indian River North in the vicinity of the inlet.

8) The Ponce de Leon Inlet and Port District was formed in 1941. It was largely due to the efforts of this District (known after 1968 as the Ponce de Leon Inlet Port Authority) that the inlet was stabilized.

9) The inlet stabilization project, consisting of a south jetty, a weir jetty north of the inlet, a dredged impoundment basin and dredged navigation channels, was begun in 1968 and completed in 1972. The cost was originally estimated at $2.3 million, but cost over $4 million.

10) Unexpected results of the inlet stabilization include the tremendous accretion south of the inlet, the northward migration of the navigation channel, and erosion north of the inlet.

11) A stable inlet cross sectional area appears to be approximately 14,000 ft.^{2} below mwl. Although the thalweg tends to shift northward, the inlet can be considered stable.

12) Pertinent hydraulic data include the following:

- Spring ocean tide range = 6.17 ft.
- Spring bay tide range = 3.88 ft.
- Average spring max. cross sectional velocity = 3.35 fps.
- Spring tidal prism = 5.74×10^8 ft.^{3}
- Bay area = 1.48×10^8 ft.^{2}
- Average lag of slack water = 145 min.

13) The inlet outer bar contains approximately 6 million yd.^{3} of sedimentary material.

14) Calculations indicate that the inlet "captures" approximately 50,000 yd.^{3} of material annually.

15) The gross littoral drift past the inlet has been estimated to be approximately 700,000 yd.^{3} yearly. Estimates of the net littoral drift vary considerably, but show a net southward movement.

16) The beach sands in the area are for the most part fine, hard-packed and relatively uniform in size (0.2mm). Shell content may vary widely depending upon location.

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