# FLORIDA SEA GRANT PROGRAM

## SEBASTIAN INLET
## GLOSSARY OF INLETS REPORT # 3

by A. J. Mehta, Wm. D. Adams, and C. P. Jones



Report Number 14

August 1976

# SEBASTIAN INLET
## GLOSSARY OF INLETS REPORT NO. 3

A. J. Mehta

Wm. D. Adams

C. P. Jones

Coastal and Oceanographic Engineering Laboratory
University of Florida
Gainesville, Florida 32611

Sea Grant Report No. 14
State University System of Florida
Sea Grant Program
August, 1976

TABLE OF CONTENTS

## FOREWORD

The numerous inlets connecting Florida's inner waters to the Atlantic Ocean and the Gulf of Mexico are important from considerations of recreational and commercial vessel traffic and also because they provide small boats access to safe refuge 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 of Sebastian Inlet is one of 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 management, use and control of Florida's inlets will require an appreciation of the evolution and past response of the inlets.

## ACKNOWLEDGEMENT

We sincerely thank Kenneth Damerow of Beindorf and Associates, Vero Beach for furnishing engineering material on Sebastian Inlet. Many thanks also to Harry Goode of the Sebastian Inlet Commission, Melbourne and to Andy Hobbs, Chief Coastal Engineer, Corps of Engineers Jacksonville District, for the valuable information they have provided.

Computations made originally by Robert Baker of the Coastal and Oceanographic Engineering Laboratory have been incorporated in this study. Todd Walton has given a number of useful explanations regarding the sedimentation in Sebastian Inlet. We are grateful to George Kerr of the Harbor Branch Foundation Laboratory for providing us a boat for a preliminary survey of Sebastian Inlet. The figures have been drafted by Lillean Pieter.

# I. INTRODUCTION

Sebastian Inlet is a man-made cut connecting the Atlantic Ocean to the Indian River on the east coast of Florida, about 45 miles south of Cape Canaveral, as shown in Fig. 1.1. Its coordinates are as follows:

| Latitude | Longitude |
|---|---|
| 27°51'35"N | 80°26'45"W |

Indian River is a 120 mile long coastal lagoon, as indicated in Fig. 1.2. The northern extremety of this river is connected to Mosquito Lagoon through Haulover canal, and at the southern end is St. Lucie Inlet. Another inlet at Fort Pierce is located between Sebastian Inlet and St. Lucie Inlet. Glossaries on the latter two inlets have been published by Walton (1974 a, b), and an extensive study of the ecology of Indian River has been carried out by the Harbor Branch Consortium, Fort Pierce (see Young, et al., 1974).

Sebastian Inlet (Fig. 1.3) is at the boundary between Brevard and Indian River Counties, and is under the jurisdiction of the Sebastian Inlet Commission in Melbourne.[1] District boundaries are shown in Fig. 1.2. Major engineering projects related to the improvement of the inlet have been supervised in recent years by the firm of Beindorf and Associates of Vero Beach. Fig. 1.4 shows the inlet with the two jetties and the bridge of Route AlA spanning the inlet. The alignment and the lengths of the most recent (1970) extensions of the jetties and the design of the bridge fender system were established in accordance with a number of studies carried out by the Coastal and Oceanographic Engineering Laboratory (COEL), University of Florida (See COEL reports, 1962, 64, 65). Sebastian Inlet State Recreational Area (Fig. 1.5) south of the inlet maintains camping grounds and picnicking facilities. The McLarty State Museum, located at the south end of the recreation area, was constructed in 1970 on the site of an old Spanish salvage camp. In 1715 a hurricane wrecked a Spanish treasure fleet off the coast in the vicinity of the inlet which did not exist at that time. The fleet was returning home from Peru and Mexico, laden with gold and silver. Exhibits and artifacts in the museum describe the occurrence of this event, attempts to salvage the treasure and display some of the gold and silver that was brought out of the wreck.

The first National Wildlife Refuge in the nation was established in 1903 on a three acre site on Pelican Island, south of Sebastian Inlet. In succeeding years the boundaries of the refuge were expanded to those shown on Fig. 1.5. At the turn of the century Pelican Island was the principal nesting area of the Brown Pelican, but as time progressed the birds all but abandoned this site and moved northward to islands in Mosquito Lagoon north of Cape Canaveral (Du Mont, 1963).

Sebastian Inlet, unlike Fort Pierce Inlet, is not a federally maintained waterway; however, small craft can reach the Intracoastal Waterway

---

[1]Located at 1231 New Haven Avenue, Melbourne, Florida 32901.

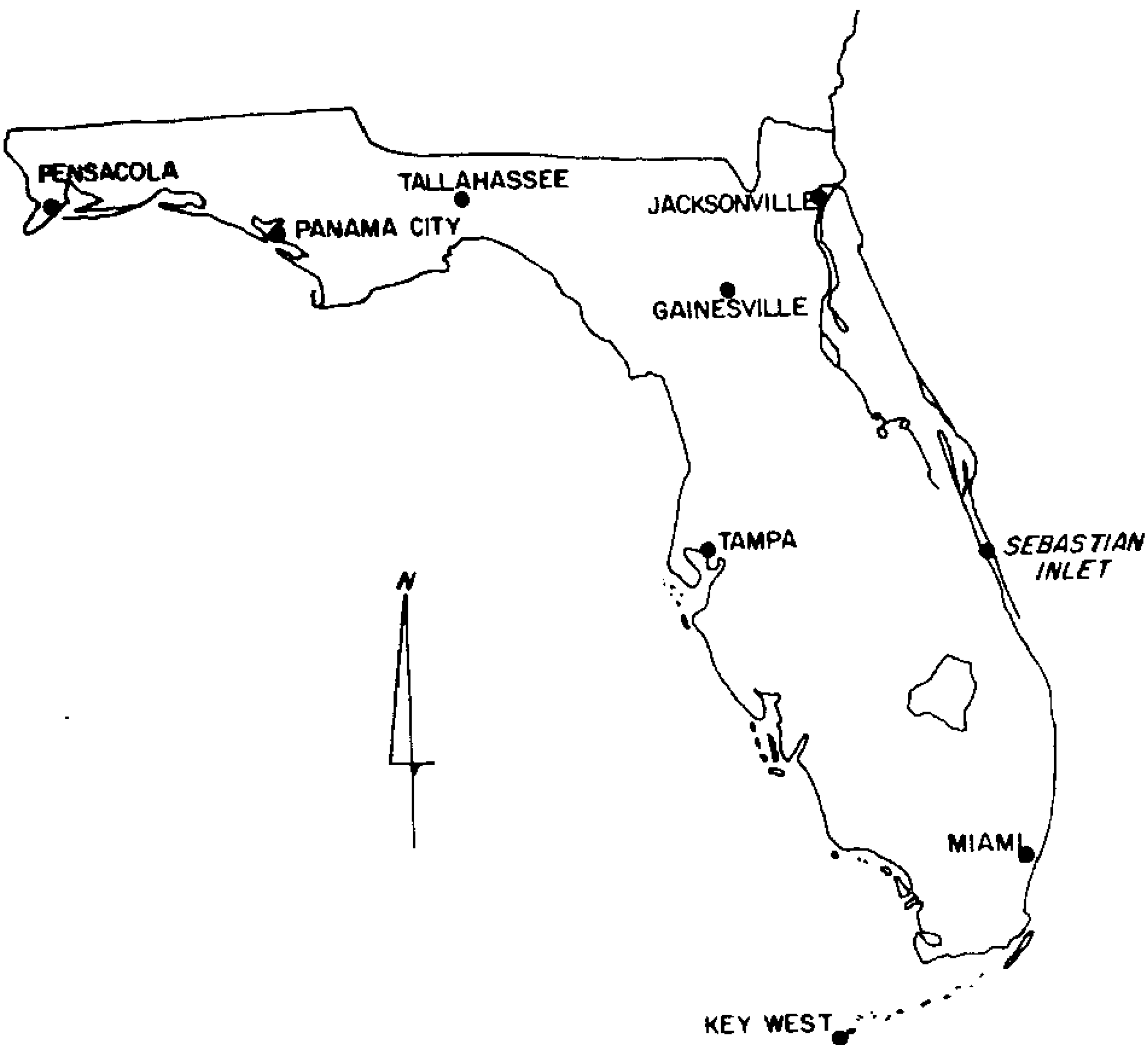



Fig. 1.1 Map of Florida Indicating Location of Sebastian Inlet.

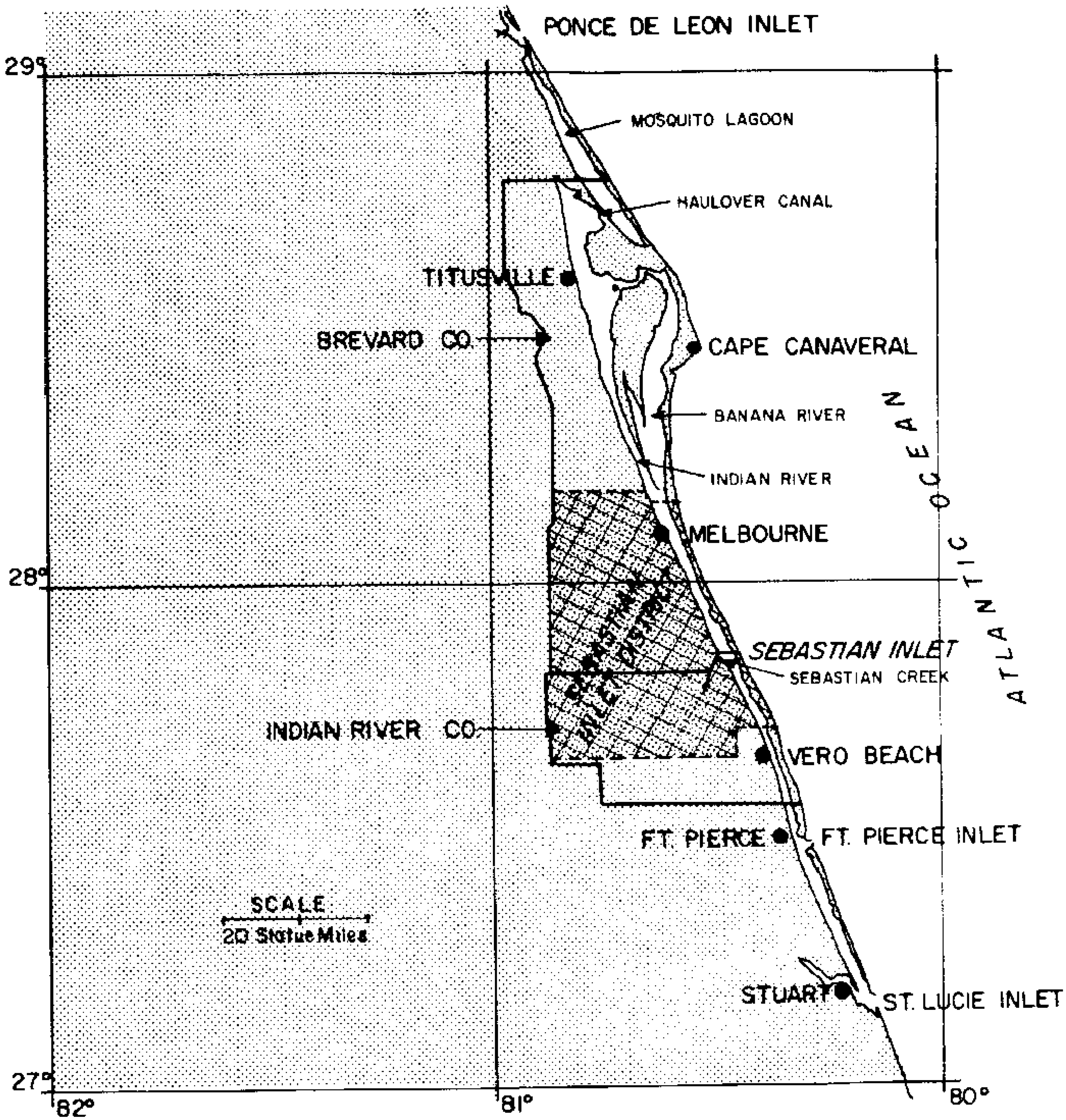



Fig. 1.2 Map Showing Brevard and Indian River Counties, Indian River and the Boundaries of Sebastian Inlet District.

Fig. 1.3 Sebastian Inlet in 1970 (Courtesy U.S.D.A.) after Jetty Extensions.

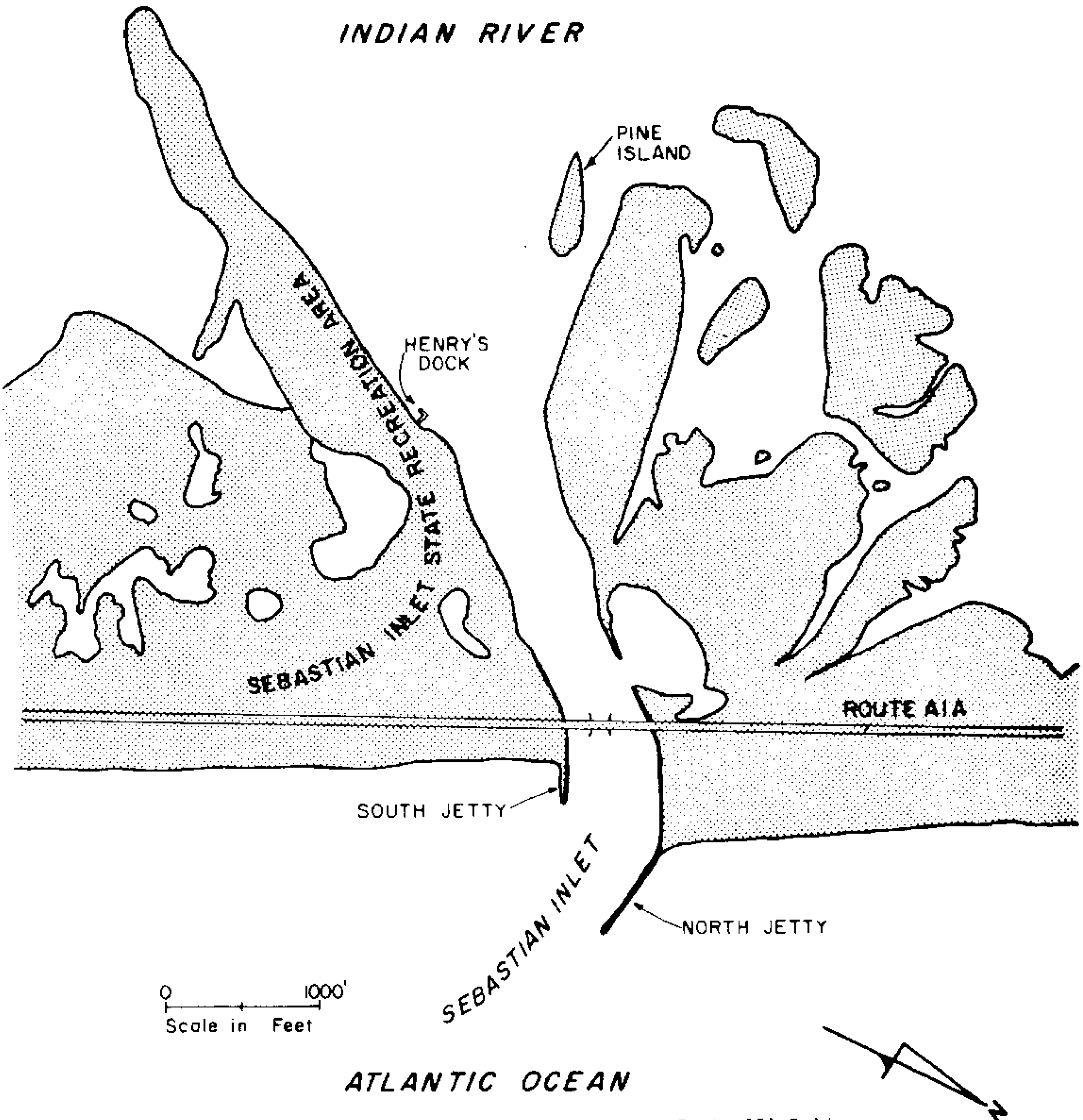



Fig. 1.4 Sebastian Inlet has two Jetties. Route AIA Bridge Spans the Inlet.

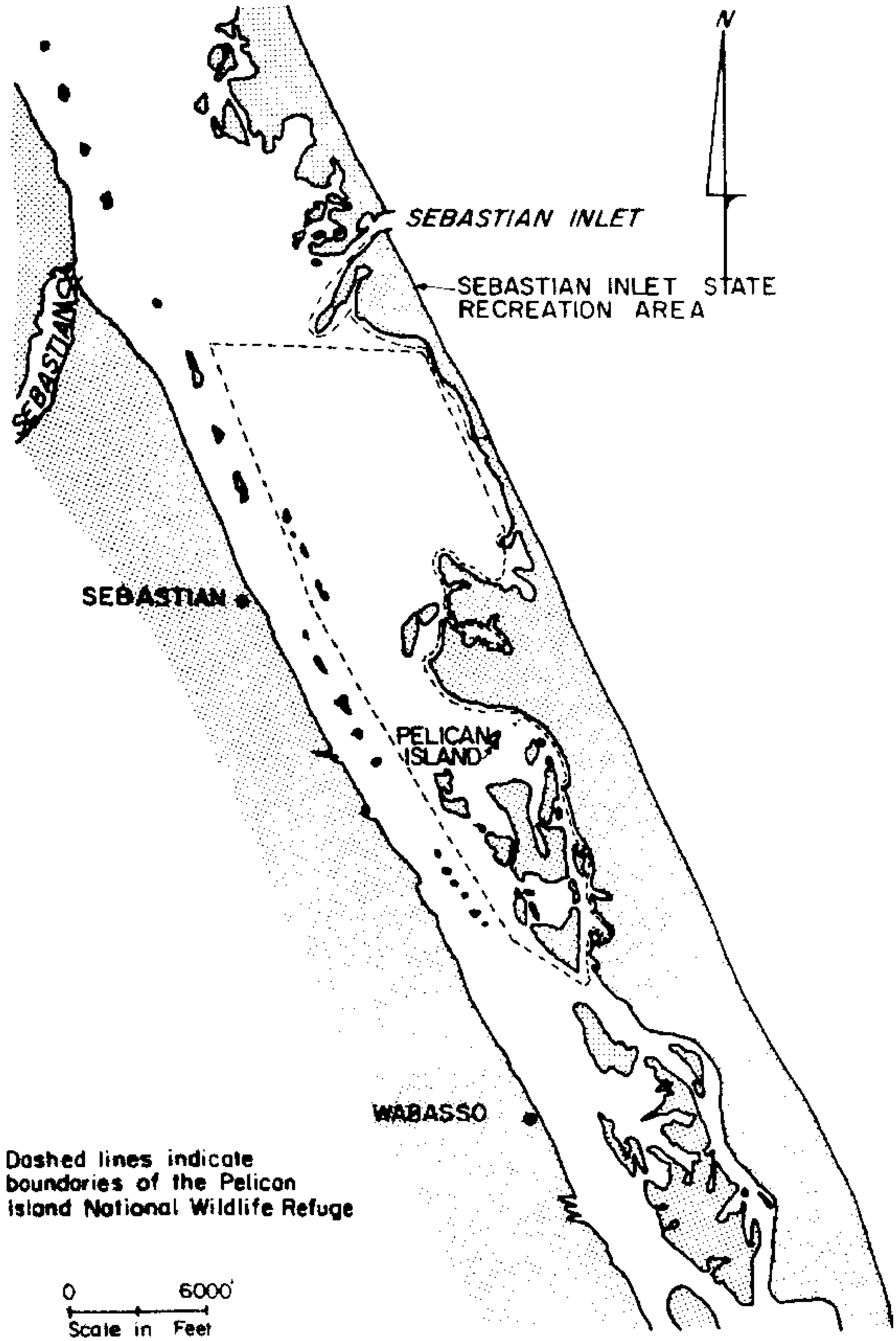



Fig. 1.5 Boundaries of Sebastian Inlet State Recreation Area and Pelican Island Wildlife Refuge.

in Indian River from the inlet. The north jetty, the catwalk under the bridge and Henry's Dock (Fig. 1.4) are heavily used by fisherman (see Sebastian Inlet User Study, 1973). With the 1970 extension of the north jetty, the refraction of the waves breaking on the beach next to the north jetty created a favorable condition for surfers who then inundated the area. This resulted in considerable friction between the fishermen and the surfers; consequently laws had to be passed in order to define the domains of the two groups. In general, more tourists visit the inlet and recreation area in fall, winter and spring than in summer. Winter months are also the best commercial fishing months.

The history of Sebastian Inlet can be broadly divided into three seqments. The first covers the period 1886-1924 during which several unsuccessful attempts were made to open the inlet. As the subsequent sections indicate, these attempts failed essentially because the efforts were of too small a scale to result in a minimum flow cross-section required for a stable inlet. The Sebastian Inlet Commission office in Melbourne has a collection of newspaper items and reports on the engineering projects and the state of the inlet since 1919.

The second historical segment covers the period 1924-1941/42. During this 17 to 18 year period the inlet remained open but was not sufficiently stable. Two causes for this appear to be insufficient flow cross-section and insufficient protection from the jetties, both against littoral drift and wave attack. In 1931 a 1,500 ft long steel bulkhead was constructed (Fig. 4.5) to guide the flow along the southern bank of the inlet, in the northwest-southeast direction. This alignment of the channel was apparently assigned with the notion that since the predominant direction of the littoral drift along the outer coast is from north to south, the northwest-southeast direction of the channel would prevent any significant flow of sand into the inlet. This would allow the tidal flow through the inlet to pass, and scour if necessary, the outer bar of sand around the jetties. The inlet, however, shoaled up slowly and finally closed during 1941 or 1942.

The third phase of the inlet's history begins with its reopening in 1948. Possibly as a result of the unsuccessful history of the old inlet and substantial shoaling of the inner flats, a completely new channel was dredged beginning through the old entrance between the jetties, but cutting across the barrier island in a northeast-southwest direction thereby swinging the flow channel by nearly 45° to the south. Since that time, the old bulkhead has been covered by sand and vegetation, and is partly buried in the barrier north of the inlet. The southeastern end of the bulkhead ends close to the northern bank of the present channel.

Since the reopening of the inlet, a series of dredging operations and jetty improvements have widened the flow area so that, apparently, the inlet is now stable. The throat section, which is in the vicinity of the bridge, is laden mostly with small and big rocks including those made by Sabellariid worms. Because of the rocky bottom, the flow cross-section is about one-half that which would result in a stable inlet with a sandy bottom. In other words, the tidal prism is about twice the value corresponding to the existing minimum flow cross-section. This has resulted in rather strong currents through the inlet, which have often been hazardous to inexperienced navigators. Just west of Henry's Dock, however, the channel rapidly flares out and the flow velocities drop correspondingly. Thus, beginning with the tips of the jetties, the inlet has a 2,800 ft long and approximately 600 ft wide channel which then flares out to a width of about 2,800 ft between the western tip of the south bank and Pine Island (Fig. 1.4). This expansion of the channel occurs westward of Henry's Dock over a distance of about 2,800 ft.

The depth of the main channel, which runs between the bridge fenders, is about 10 ft. Before reaching Henry's Dock it splits into two sections, one running along the north bank by Pine Island, and the other along the south bank. There have been some complaints by boatmen that the sections of the channels between the inlet and the Intracoastal Waterway have been meandering too much causing damage to boats.

The tidal variation near the Waterway is on the average less than one-quarter foot, even though the oceanic tidal range is of the order of 4 ft. This is apparently because more than 85% of the tidal energy is dissipated as the tide propagates bayward from the ocean. Much of this dissipation occurs by the time the tide passes Henry's Dock. This is likely to be due to the severe energy losses as the flow bends adjacent to the north jetty, and is also due to the rocky bottom, which offers a substantial frictional resistance to the flow. The north jetty also helps bypass part of the littoral drift moving south, and protects the inlet from northeasterly wave action during the severe winter season. The high resistance to flow through the inlet results in a three hour lag between high water or low water in the ocean and current reversal (slack water) in the inlet.

Although not much sand desposits in the narrower section of the inlet, deposition does take place in the flared section. A sand trap was dredged there in 1962 to collect sand. Plans called for a periodic dredging of the sand trap (the rocky bottom there is at about 11 ft below MLW) to nourish the beach near the inlet, particularly the section of the sand-starved beach south of the inlet. Such an operation was carried out in 1972, and another is anticipated,

Since the 1948 reopening of the inlet was along a new alignment, the new inlet is quite different from the old. Details are given in subsequent sections.

## II. GEOLOGIC SETTING

The rock formation nearest to the surface at Sebastian Inlet is the Anastasia formation which is found along the East Coast of Florida from the type locality on Anastasia Island to the Palm Beach/Broward County line where it merges with the Miami oolite. The lithology of this unit varies from coarse rock composed of whole coquina shells and minor amounts of quartz sand to a sandstone composed of carbonate and quartz sand particles. Cementing agents can be calcium carbonate or iron oxide (Cooke, 1945). The environment of deposition of the more conspicuous parts of this formation was an offshore bar. The Anastasia formation was formerly believed to be of late Pleistocene age, but it is now known to have been formed during several events in the Pleistocene (Brooks, 1972). Outcrops are found on the inner continental shelf and in Sebastian Inlet where the Anastasia formation has been exposed by dredging.

The barrier island breached by Sebastian Inlet is a Pleistocene feature with mixed Holocene sands (Mims, 1975). This is referred to as a perched barrier island since its sands are in effect draped over the Anastasia formation. Information concerning the soils of the barrier island north of the inlet as well as the soils of the mainland portion of Brevard County may be obtained from the U.S. Department of Agriculture "Soil Survey of Brevard County, Florida," (1974). A similar survey presumably exists for Indian River County.

Core borings to depths of 45 ft taken in 1967, preparatory to the construction of jetty extensions, revealed the following general stratagraphic sequence near the jetties. Sand or a mixture of sand and shell are usually found at the top of the column. Variations at the surface may be due to scour or deposition. These unconsolidated sands give way to the more consolidated sediments of the Anastasia formation. Beneath this there are layers of unconsolidated sand and shell. The characteristics of the offshore sediments were investigated by the U.S. Army Corps of Engineers between January and May of 1965 to determine the availability of sand suitable for beach nourishment. Seismic reflection profiles and sediment cores were taken along the inner continental shelf at that time and findings are available in the report by Meisburger and Duane (1971).

A Coastal and Oceanographic Engineering Laboratory report (See COEL, 1965) notes that many of the rocks obstructing the inlet channel were made by the Sabellariid worms. Reefs and rock-like formations constructed by these worms have also been found in other inlets along the Atlantic Coast of Florida (Kirtley, 1968).

# III. CLIMATE AND STORM HISTORY

## 3.1 Climate

The climate of the Sebastian Inlet vicinity is characterized by long, relatively humid summers and mild winters. Temperatures in the area are moderated by both the Atlantic Ocean and the Indian River. The closest U.S. Weather Bureau weather stations to Sebastian Inlet are at Melbourne (Sta. No. 5612) and Vero Beach (Sta. No. 9214).

Rainfall in the vicinity is heaviest during the months of June through October (approximately two-thirds of the annual total falls during these months); the rainfall during these months is due primarily to convective processes. The remaining one-third of the annual rainfall is fairly evenly distributed during the months November through May and is usually caused by the frontal lifting of warm, moist air over a wedge of cool, dry air. Table 3-1 summarizes average monthly rainfall rates for Vero Beach during the ten year period 1943 - 1952. Rainfall rates at Melbourne are quite similar to those at Vero Beach.

During those same years, 1943 - 1952, the mean temperature at Vero Beach was 73.5°F. (Table 3-1 also summarizes average monthly temperatures for this location and time period.) The mean maximum temperature and mean minimum temperature were 81.5°F and 65.4°F, respectively. During the years 1951 - 1960 the mean, maximum and minimum temperatures were 73.0°F, 81.1°F and 64.8°F. Again, conditions at Melbourne were quite similar and therefore are not listed here (U.S. Weather Bureau, 1964).

TABLE 3-1

AVERAGE MONTHLY TEMPERATURES
AND RAINFALL RATES FOR
VERO BEACH 1943 - 1952*

| Month | Mean Temp. (°F) | Ave. Rainfall (in.) |
|---|---|---|
| Jan. | 65.0 | 1.16 |
| Feb. | 65.1 | 1.91 |
| Mar. | 68.9 | 2.82 |
| Apr. | 72.1 | 3.11 |
| May | 76.5 | 3.41 |
| June | 80.3 | 4.54 |
| July | 81.2 | 6.02 |
| Aug. | 81.7 | 6.85 |
| Sept. | 80.7 | 8.71 |
| Oct. | 76.1 | 7.94 |
| Nov. | 69.1 | 2.51 |
| Dec. | 65.3 | 1.40 |
| | 73.5 (Ave.) | 50.38 (Total) |

*From U.S. Weather Bureau (1957)

Winds in the Sebastian Inlet area are predominantly out of the SE during the spring and summer and out of the NE during the winter months. Those winds during the winter months average 11 m.p.h. The SE winds are typically lesser in strength. One danger that may accompany sustained N or NE winds in the inlet vicinity is the flooding in the southern areas of the Indian River adjacent to and south of the inlet. On Sept. 22, 1948 the river stage was 4.77 ft above normal because of sustained N winds of 50-55 m.p.h. The resulting floods damaged several hundred acres of citrus groves in the low-lying areas adjacent to the Indian River.

### 3.2 Storms

Storms that affect the inlet and surrounding areas can be either hurricanes (and tropical storms) or North East storms. Because the N.E. storms may occur for a longer period of time and affect a larger area, they are frequently more damaging than hurricanes. Between the years 1871 and 1970 there were 20 storms of hurricane or tropical storm intensity that passed within 50 miles of Sebastian Inlet. Between 1918 and 1973 there were at least 8 N.E. storms that affected the area. Descriptions of some of the more damaging storms are given below; many of the storm tracks within a 50 mile radius of Sebastian Inlet are shown in Fig. 3.1.

| | |
|---|---|
| July 31, 1715 - | This hurricane wrecked a Spanish treasure fleet off the east coast of Florida in the vicinity of present day Sebastian Inlet. The nearby McLarty State Museum was constructed on the site of a Spanish salvage camp. |
| Oct., 1895 - | Just after a small channel was opened by hand labor a hurricane closed the inlet. Details of this storm are not well documented, but it is known that the storm was minor. |
| 1918 - | Within 4 hours after the completion of a channel dredged 5 ft deep, 60 ft wide and 200 ft long across the barrier island a severe N.E. storm closed the inlet (Survey - Review Report, 1952). |
| Aug. 29, 1924 - | A storm opened the inlet. Work begun earlier to accomplish this was substantially completed before the storm struck. |
| Sept. 18-25, 1948 - | This hurricane caused extensive flooding along the Indian River on Sept. 22 (Survey - Review Report, 1952). |
| Oct. 15-19, 1950 - | Storm tides 3-4 ft above normal coupled with storm waves breached the sand dike across the old inlet channel. This subsequently closed naturally by December of that same year (Survey - Review Report, 1952). |
| March 8-9, 1962 - | This storm, known as the "Fair Weather Storm" because of the beautiful weather that was present while the storm waves from a distant N.E. storm |

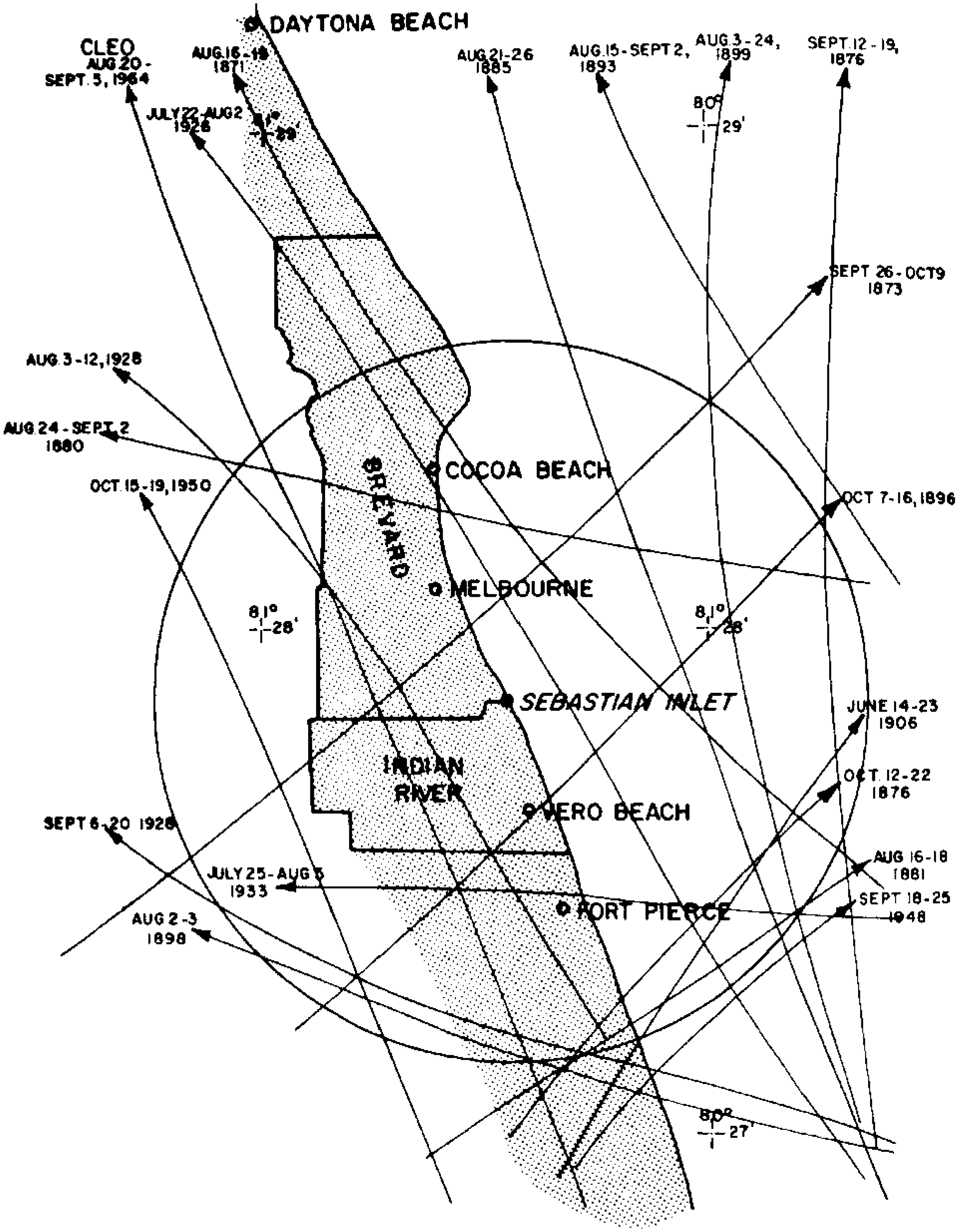



Fig. 3.1 Storm Tracks within 50 Statute Mile Radius of Sebastian Inlet (NOAA, 1971).

battered the southern east coast of Florida, caused an estimated $5 million in damages. The northern extent of severe beach erosion was Southern Brevard County (Miami Herald, Mar. 11, 1962).

Nov. 26 - Dec. 3, 1962 - This N.E. storm caused extensive beach erosion in N.E. Florida. While Duval, St. Johns and Flagler Counties were declared disaster areas, damage to the beaches in Brevard and Indian River Counties was minor (Miami Herald, Dec. 3, 1962).

Aug. 20 - Sept. 5, 1964 - Hurricane Cleo passed through Indian River and Brevard Counties on August 27. Damage to all of Florida was put at $125 million (NOAA, 1971, 1973). Local damage to beaches was minimal.

Feb. 10-11, 1973 - This storm was second in intensity only to the Great Middle Atlantic Coast Storm of Nov. 20 - Dec. 3, 1962 in recent times (Dolan, et al., 1973). Damage to the Atlantic coastal states was severe but damage in Florida was minor; only the St. Johns County coastline was damaged to any significant extent. Beach erosion in Vero Beach and the Sebastian Inlet area was limited to 5-10 ft horizontally in some areas. This same storm system brought freezing temperatures to all of Florida and snow to the northern sections (Miami Herald, Feb. 11, 1973).

Oct. 16-29, 1973 - Tropical Storm Gilda passed several hundred miles east of the Sebastian area but caused significant damage to Volusia and Brevard Counties. Tides were 4 to 6 ft above normal and the beaches at Melbourne Beach, 16 miles north of Sebastian Inlet, were closed to the public to prevent injuries from falling seawalls and other hazards (Miami Herald, Oct. 27, 1973). During November thirty-three coastal construction setback profile lines in Brevard County, along with seventeen in Indian River County, were resurveyed. Results showed beach erosion and dune erosion from 5 to 25 ft horizontally (COEL, 1974a, b).

Fig. 3.2 shows a relationship between the storm surge elevation above mean sea level (MSL) and the storm return period. The curve is based on data obtained by the National Oceanic and Atmospheric Administration (NOAA) and is applicable to the open coast in the proximity of Sebastian Inlet. This curve has been used in the computation of the coastal construction setback line (COEL, 1974a).

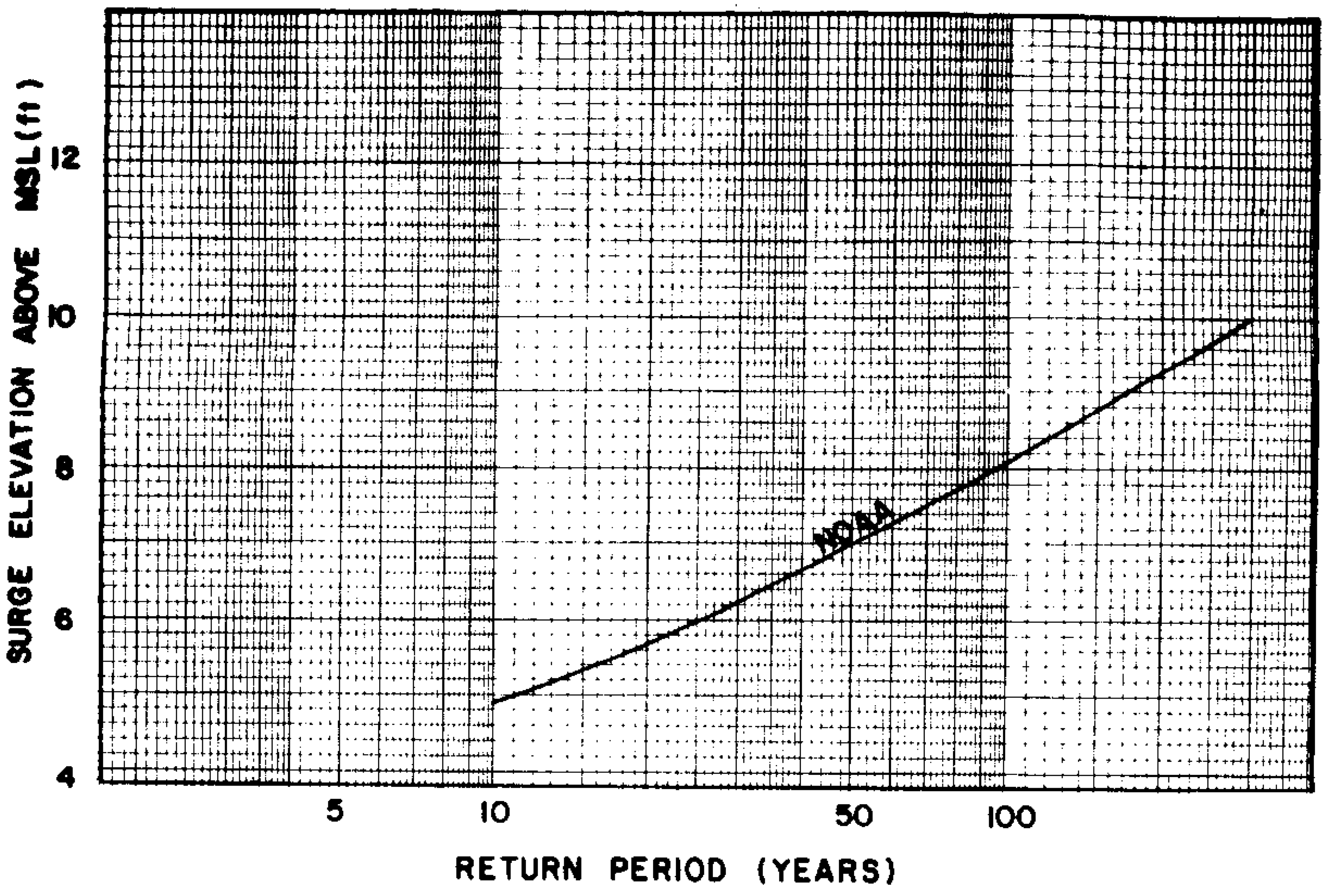



Fig. 3.2 Storm Surge Elevation Versus Return Period Applicable to the South Limit of Brevard County. Based on a Preliminary Data of NOAA (COEL, 1974a).

## IV. HISTORY OF THE INLET

### 4.1 Chronology of Events

The first recorded attempt to establish a man-made inlet ("Gibson's Cut") in the vicinity of the present Sebastian Inlet was made in 1886 by Captain David O. Gibson, a local pioneer who wanted an inlet to serve his land holdings on the west bank of the Indian River.[2] He and a band of volunteers made the attempt using shovels, but their enthusiasm for the project waned before the breach was completed. In 1895 a channel was completed but it was soon closed by a storm. Other attempts using shovels were made between 1896 and 1918. In 1918 the first excavation using a dredge was made. The operation was protected by jetties of local rock on the ocean side and by a bulkhead of palmetto trunks on the river side. The result was a channel that was 40 to 60 ft wide and 4 to 5 ft deep, but it was closed within hours by a northeaster.

A special tax district, with responsibility for the maintenance of Sebastian Inlet, was established by the Florida Legislature in 1919 (Special Acts Chapter, 7,976). Initial financing was accomplished by a $100,000 bond issue. The law establishing the Sebastian Inlet District was ammended in 1921 (Chapter 8,901), in 1927 (Chapter 12,259) and in 1945 (Chapter 22,891 Section 4). The boundaries of the district are shown in Fig. 1.2. The total area enclosed by the boundaries is 334 square miles in Indian River County and 381 square miles in Brevard County. Beginning in 1957, the district has levied the tax millage on 100% property evaluation. The millage rate has decreased steadily since that time as Table 4-1 indicates.

TABLE 4-1
SEBASTIAN INLET DISTRICT MILLAGE RATE

| Year | Millage Rate (mills) | Year | Millage Rate (mills) |
|---|---|---|---|
| 1957/58 | 1.00 | 1967/68 | * |
| 1958/59 | 0.80 | 1968/69 | 0.48 |
| 1959/60 | 0.80 | 1969/70 | 0.48 |
| 1960/61 | 0.80 | 1970/71 | * |
| 1961/62 | 0.80 | 1971/72 | * |
| 1962/63 | * | 1972/73 | * |
| 1963/64 | * | 1973/74 | 0.00 |
| 1964/65 | 0.50 | 1974/75 | 0.17 |
| 1965/66 | 0.60 | 1975/76 | 0.00 |
| 1966/67 | 0.60 | 1976/77 | * |

* No information

Events which have taken place since the formation of the Sebastian Inlet District are:

<u>1923</u> - A permit for dredging was obtained from the War Department and dredging operations were begun.

<u>1924</u> - Dredging of a channel 100 ft wide and 6 ft deep was completed. Two

[2] The site of Gibson's Cut is also indicated in the 1881 U.S.C. & G.S. Boat Sheet, but historical reports quote 1886 as the year when the first attempt was made to open the cut to the ocean.

local rock jetties were included. They were 600 ft apart on the ocean side and 400 ft apart on the landside. The north jetty extended 400 ft seaward and was 6 ft high while the south jetty extended 150 ft into the ocean and was 2 ft high. In an article in the Florida Engineer and Contractor, Fineren (1924) of the Univ. of Fla. questioned the wisdom of this operation in the light of the 1918 experience of rapid closure (due, in his opinion, to the rather wide spacing between the jetties) after a dredging of the channel.

<u>1927</u> - An attempt was made to deepen the channel by blasting rocks which had hindered dredging operations, but the rock fragments settled in place. The height of the south jetty was raised to 6 ft. An extensive inner shoal was reported at this time.

<u>1929</u> - Rocks obstructing the channel were partially removed and were used to reinforce the jetties and extend them landward. (Survey - Review Report, 1952).

<u>1930</u> - The inlet was surveyed by the U.S. Coast and Geodetic Survey.

<u>1931</u> - A steel bulkhead (sheet pile) extending 1,500 ft westward from the west end of the south jetty was constructed. Its purpose was to direct tidal currents in a manner that would cause them to erode the inner shoals.

<u>1934</u> - The inlet was surveyed by the U.S. Army Corps of Engineers. No shoaling was evident in the channel along the bulkhead.

<u>1935</u> - The inlet was surveyed by the Corps of Engineers. This survey showed some shoaling along the bulkhead.

<u>1938</u> - The Corps of Engineer survey showed significant shoaling near the bulkhead,and the eastern end of the bulkhead was noted to be in a bad condition. Fineren (1938) cited Sebastian Inlet as an example of engineering failure because the inlet had been shoaling up.

<u>1939</u> - In April, a channel approximately 7 ft deep, was dredged from the Indian River to within 300 ft of the ocean. Approximately 72,000 cu. yds. of material were removed at a cost of $6,000, $1,000 of which was Federal money. A Corps of Engineers survey of the new channel in April showed that the bulkhead no longer flanked this channel and was essentially abandoned as a means of controlling the currents through the inlet. Storms in August and in November caused the north jetty to be buried and added material to the inner shoals.

<u>1940</u> - The inlet was surveyed by the U.S. Army Corps of Engineers. At this time the inlet throat cross-section had reduced to 980 ft$^2$ below MLW, with a width of about 75 ft.

<u>1941/42</u> - Reports vary, but in 1941 or in 1942 Sebastian Inlet was closed by a northeaster. See Fig. 4.1.

<u>1945</u> - U.S. Navy demolition teams used the site of the inlet for training purposes. A small channel was opened, but it closed within hours.

<u>1947</u> - In September, a channel 8 ft deep and 100 ft wide at the ocean was opened at a cost of $35,000 ($23,000 District Funds, $1,500 Federal funds and $10,500 in local contributions). 70,000 cu. yds. were dredged.

Fig. 4.1 Sebastian Inlet (photo on February 14, 1943, courtesy U.S.D.A.) Closed by Sand Accumulation at the Entrance. Note the Large Accretion of Sand between the Jetties in the Inner Shoals.

1948 - The inlet closed in February due to the fact that the spoil from the dredging had been placed on the banks of the channel. By October, Sebastian Inlet was reopened on a new northeast/southwest alignment (See Figs. 4.2, 4.3 and 4.4) at a cost of $50,000. At this time 166,000 cu. yds. of sand and 6,567.5 cu. yds. of rock were removed. Additional dredging in November and December removed 36,000 cu. yds. from the channel at a cost of $7,625. The U.S. Army Corps of Engineers surveyed the inlet.

1949 - Shoaling reduced the controlling depth to 0.7 ft by April, but a hurricane in August scoured the channel to give a controlling depth of 1.8 ft. A jetty back fill cost $200. The U.S. Army Corps of Engineers surveyed the inlet.

1950 - Maintenance dredging removed 140,840 cu. yds. of sand and 4,843 cu. yds. of rock at a cost of approximately $38,000. The channel was 1,650 ft long, 160 ft wide, and 8 ft deep following this dredging.

1951 - The river approach to the inlet was dredged in March. At this time 55,000 cu. yds. of material were removed. The resulting channel was 9 ft deep by 150 ft wide by 1,900 ft long. The cost of this project was $10,000.

1952 - A new rubble mound north jetty was completed in September. This jetty extended 100 ft southeast, then 200 ft east. The cost of the jetty was about $24,300. Channel dredging, which cost $13,000, followed the jetty construction. The channel was dredged to a depth of 8 ft and 18,000 cu. yds. of material were removed.

1955 - In March, maintenance dredging of the channel removed 60,000 cu. yds. of material and cost $16,680. The controlling depth after dredging was 8 ft. By August, two new jetties were completed. Specifications called for the following: A 2 ft thick base of small rock and rubble, granite cap rocks of 6 tons or more, base widths of 45 ft, top widths of 6 to 10 ft and completed heights of 6 ft above MLW sloping to 4 ft above MLW. The north jetty was extended 75 ft east and then 175 ft southeast. The south jetty was extended 175 ft east. A total of 5,640 tons of granite was used at a cost of $10.65 per ton. Also in this year, the District Engineer recommended that the inlet be narrowed to 500 ft (from 600 ft) in order to force higher current velocities and thereby reduce the need for maintenance dredging.

1958 - Maintenance dredging of the channel removed approximately 65,000 cu. yds. of material from the river approaches. The resulting channel was 5 ft deep by 80 ft wide. Late this year a contract for the landward extension of the north jetty to the old steel bulkhead was let.

1959 - The landward extension of the north jetty was completed in September, as was a similar extension of the south jetty. The landward extension of the south jetty was necessitated by increased erosion of the south bank of the inlet during the construction of the north jetty extension. A total of 7,314 tons of rock were used on the north jetty extension while 2,832 tons of rock were used on the south jetty extension. This year a referendum established the center line of Sebastian Inlet as the boundary between Brevard and

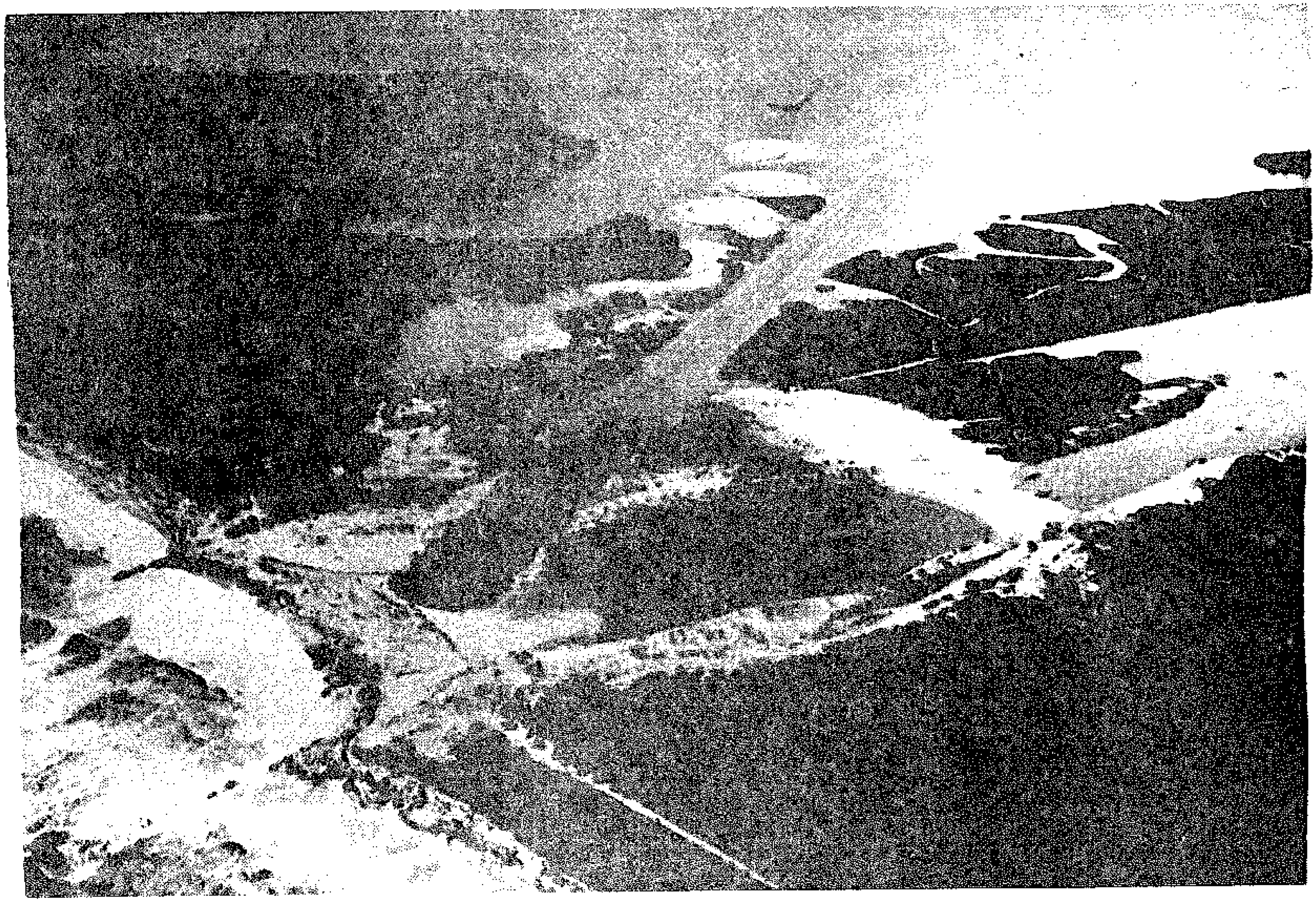


Fig. 4.2 Sebastian Inlet being Reopened on October 25, 1948, along a New Channel Alignment. (Courtesy: Corps of Engineers, Jacksonville District).

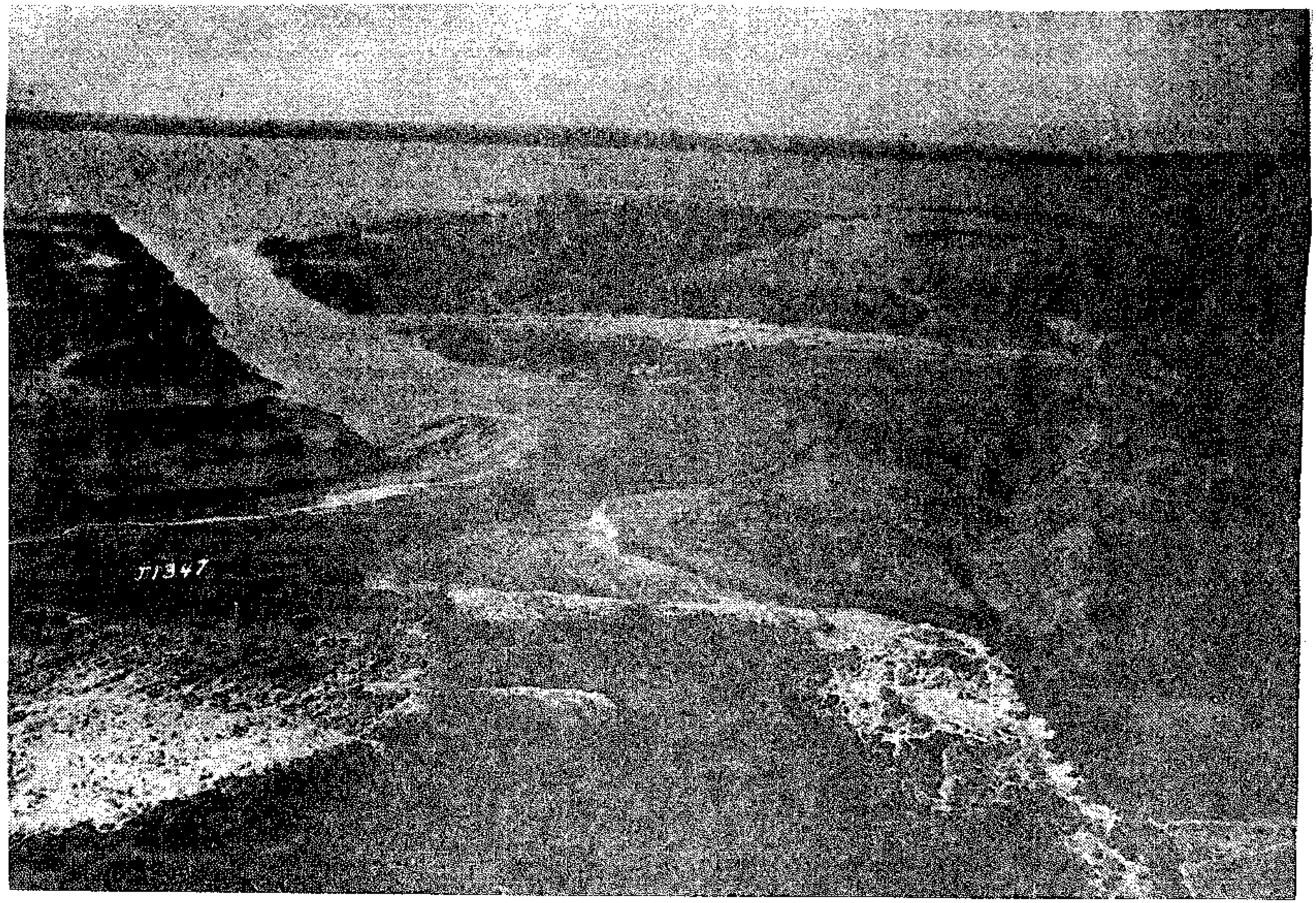



Fig. 4.3 Sebastian Inlet on November 5, 1948. Note the Sand Spit Growing Southward (Courtesy: Corps of Engineers, Jacksonville District).

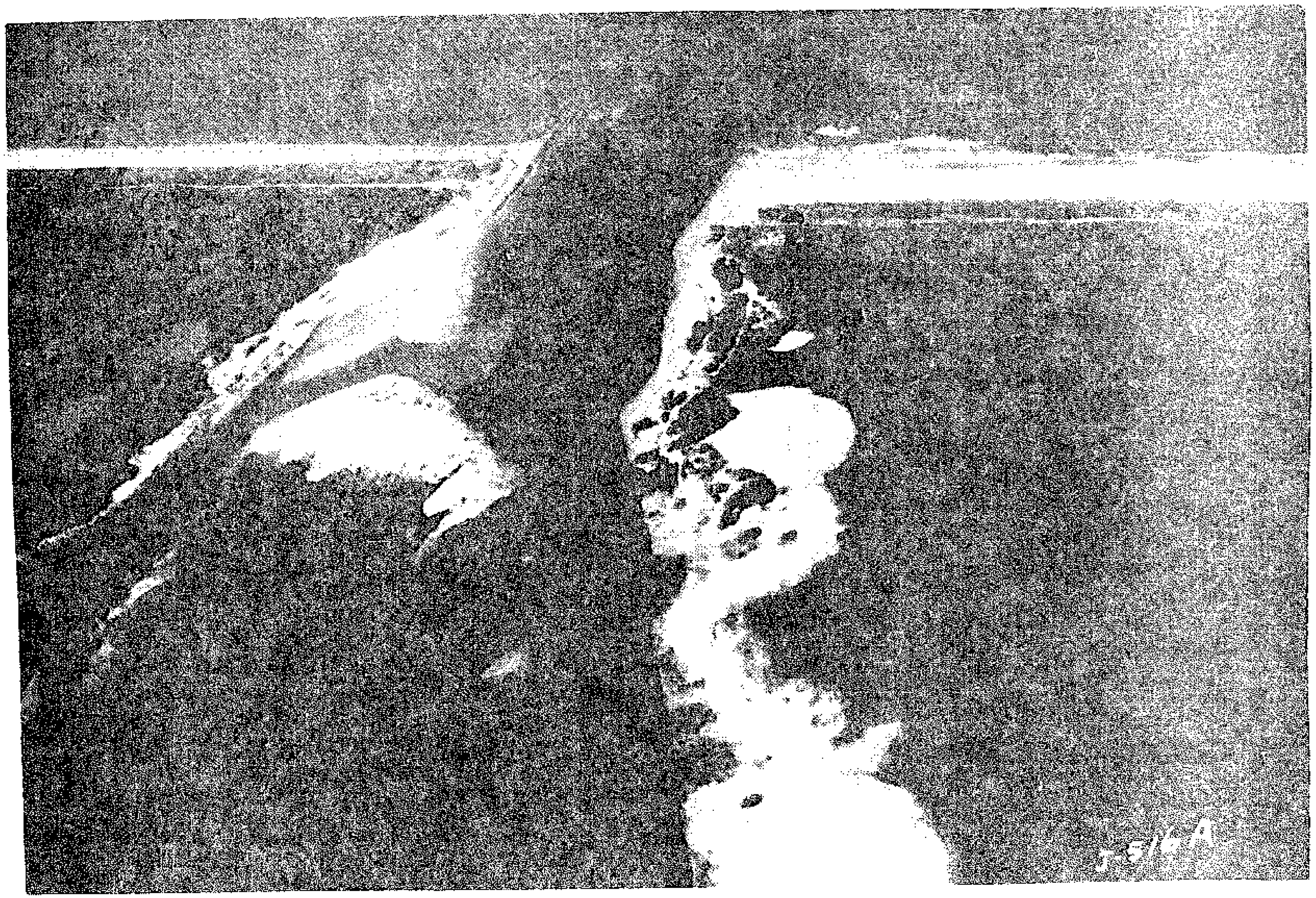



Fig. 4.4 Sebastian Inlet on August 30, 1949 (Courtesy: Corps of Engineers, Jacksonville District).

Indian River Counties.

1961 - Beindorf and Damerow surveyed the inlet channel.

1962 - A 200 ft wide and 11 ft deep channel was excavated east of the proposed bridge on route A1A, and a 150 ft wide, 12 ft deep and 1,500 ft long channel was excavated west of the bridge. 45,700 cu. yds. of sediment were removed. A small channel 125 ft wide, 700 ft long and 7 to 9 ft deep was excavated near the western extremity of the southern bank of the inlet. 22,100 cu. yds. were removed there. A sand trap (See Fig. 4.5) was dredged to -11 ft at a site 2,500 ft west of the inlet entrance. The 214,600 cu. yds. removed from the trap were used to shore up the inlet banks and the beach south of the inlet. This work, by Hardaway Marine of Jacksonville, was carried out between April 19 and December 17 at a cost of $247,138.50.

1965 - Route A1A highway bridge which spans the inlet was opened in February. The cost of the 1,548 ft span was $745,000.

1968 - Construction of a north jetty extension began in February.

1970 - The north jetty extension was completed at a cost of $547,800. The south jetty extension began in June and was completed in August at a cost of $12,260.

1972 - A new 37 acre sand trap (Fig. 4.6) was dredged by Trans-State Dredging Co. of Fort Pierce between April 1 and July 10. A total of 425,000 cu. yds. of material were dredged and placed on the south beach at a cost of $228,000. Riprap was placed along the southern bank of the inlet west of Henry's Rock. During September through November of this year, beach profiles were taken in Brevard County to help determine the location of the coastal construction setback line. Similar profiles were taken in Indian River County during November and December.

1973 - It was estimated that 110,000 cu. yds. of sand were deposited in the sand trap between July, 1972 and January, 1973. Thirty-three beach profiles in Brevard County and seventeen profiles in Indian River County were resurveyed during November to determine the effects of tropical storm Gilda on the coastline of the area.

1974 - The coastal construction setback line was completed for Brevard and Indian River Counties.

1975 - Ten moveable navigation buoys were placed westward of the sand trap at 500 ft intervals. These buoys cost $4,000 each. The Coastal and Oceanographic Engineering Laboratory surveyed the throat section of the inlet in September.

1976 - As of this writing a sand nourishment program is proposed for the south beach. The sand will be made available from maintenance dredging of the sand trap. The expected cost of this dredging is approximately $500,000.

## 4.2 Jetty Improvements

Some details of the various jetty constructions and improvements have been noted in the above section. Table 4-2 briefly summarizes these events.

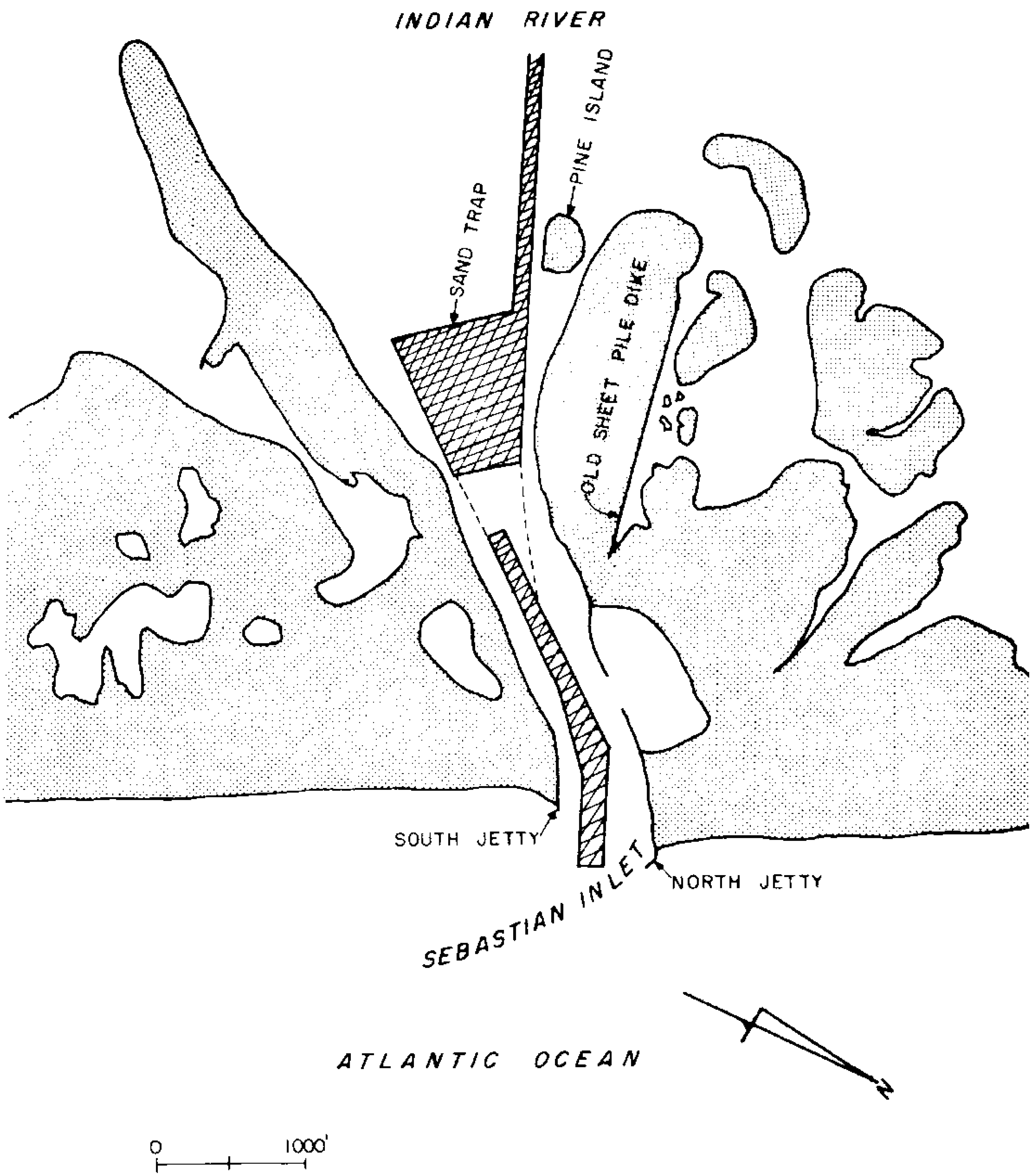



Fig. 4.5 1962 Location of the Sand Trap and Dredged Channel. A Small Channel near the Western End of the South Bank is not Shown.

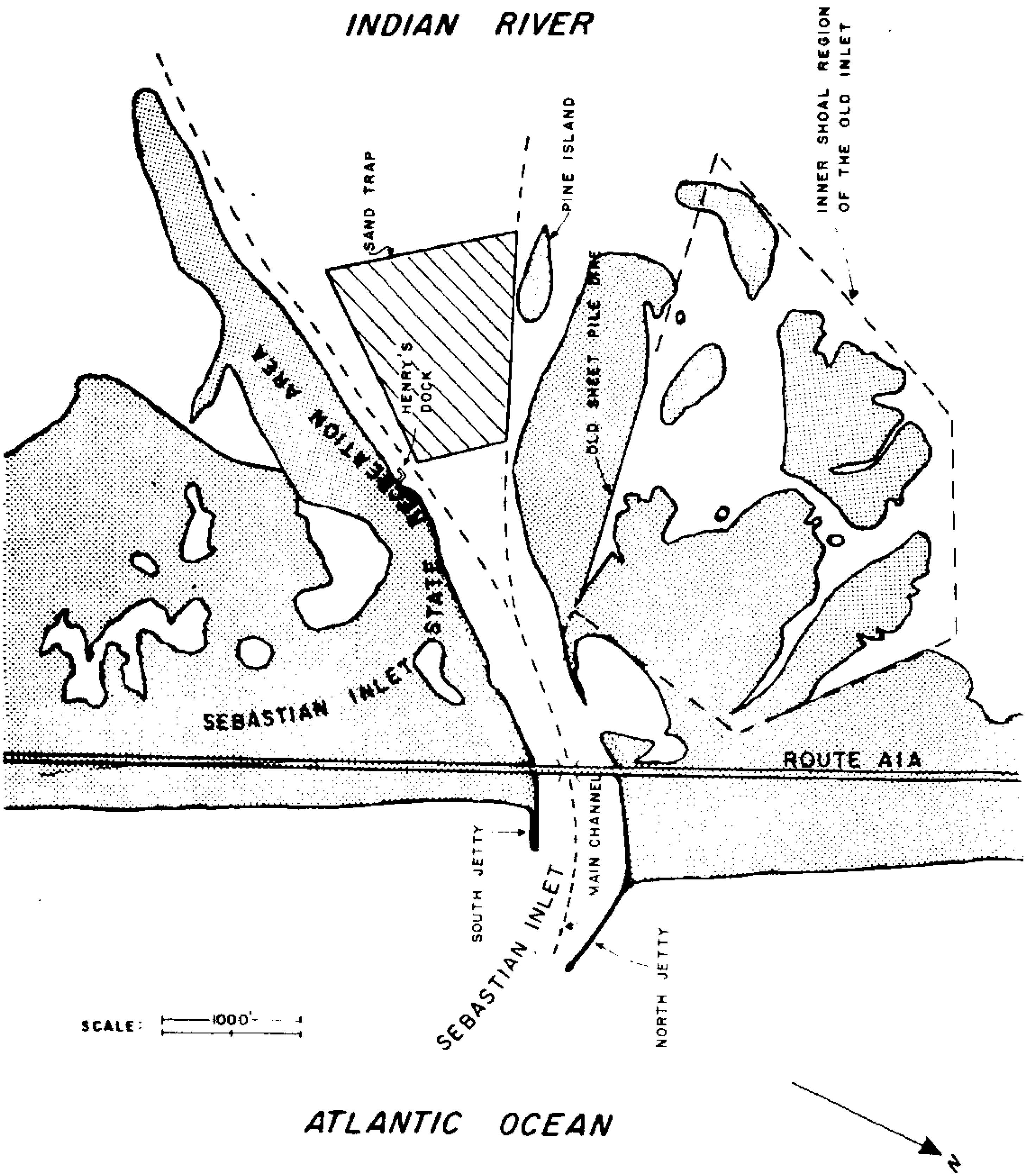



Fig. 4.6 1972 Location of the Sand Trap, Sebastian Inlet.

Fig. 4.7 depicts the constructions, but as some have overlapped others, not all are visible. Note that the riprap placed along the banks of the inlet essentially amounts to landward extensions of the jetties.

TABLE 4-2
SUMMARY OF JETTY IMPROVEMENTS

| Date | Improvement |
|---|---|
| 1918 | Local rock jetties to protect dredging operations. |
| 1924 | North and south jetties constructed. |
| 1927 | South jetty raised. |
| 1929 | Jetties extended landward. |
| 1931 | A 1,500 ft long steel bulkhead (sheet pile dike) constructed to regulate the flow along the south bank. |
| 1949 | Jetty back fill. |
| 1952 | New rubble mound north jetty completed. |
| 1955 | North and south jetties raised and extended. |
| 1959 | Landward extension of both jetties. |
| 1970 | Completion of north and south jetty extensions. |

Fig. 4.8 shows sketches of the most recent (1970) extension of the two jetties, as they appear in the 1967 plans of Beindorf and Associates. These plans give detailed information on the jetty cross-sections as well as core logs, three near the north jetty and one near the south jetty.

As discussed previously, the AIA bridge across the inlet was completed in 1965. Bridge plans are available from the Department of Transportation, State of Florida (State Project Number 88070-3501). These plans also include core logs.

## 4.3 Dredging Record

The history of dredging in the inlet given in Section 4.1 has been summarized in Table 4-3. It is observed that the volume of material being dredged has in general increased since the reopening of the inlet in 1948. This is also visualized in Fig. 4.9. It should, however, be noted that prior to 1962, there was not much concern about beach nourishment. Professor Per Bruun, then director of the Coastal Engineering Laboratory, University of Florida, studied the nourishment problem at that time. As noted, a sand trap was dredged in 1962 and again in 1972, and the beach was nourished for the first time by pumping the sand. Future

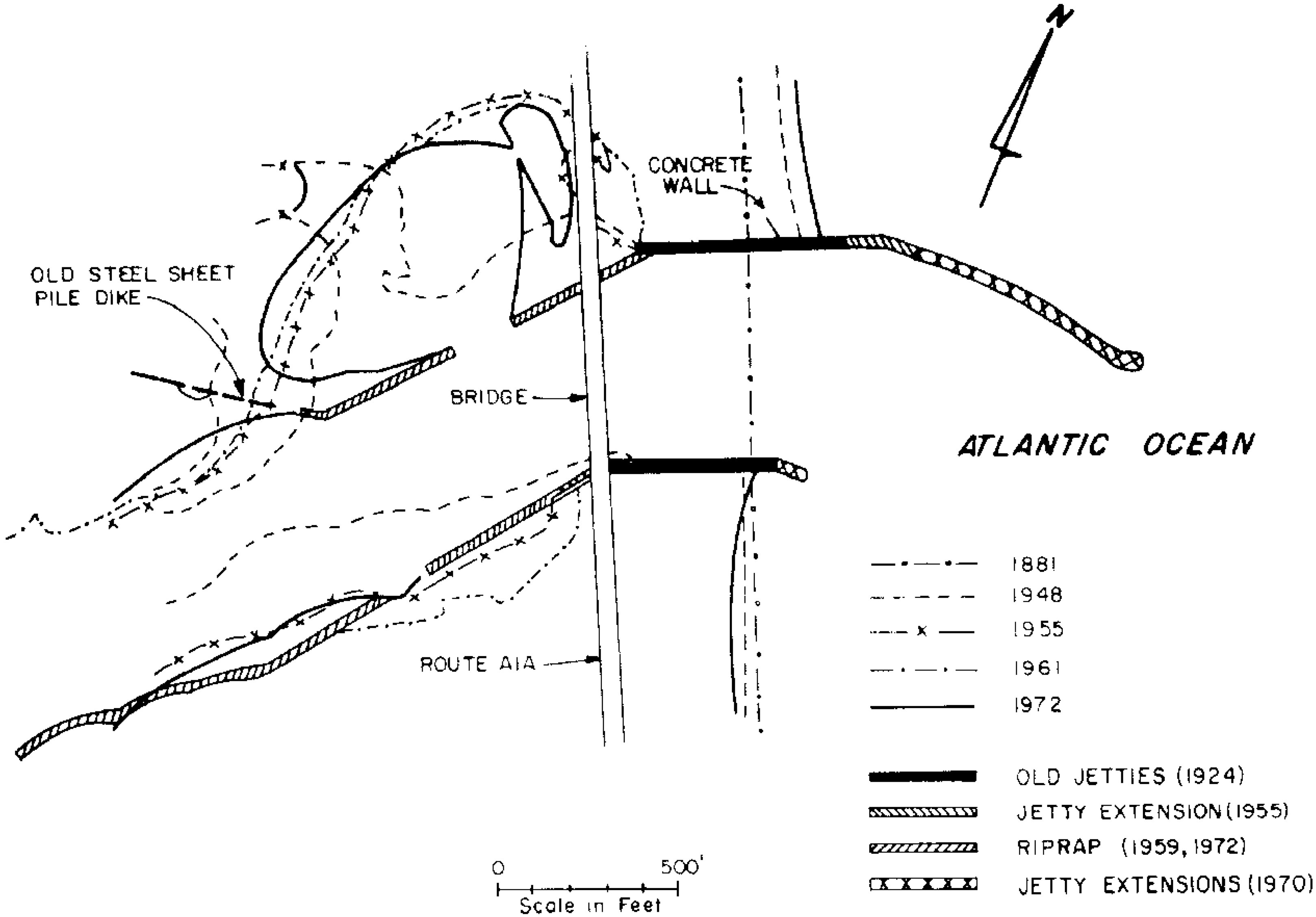



Fig. 4.7 Jetty Extensions and HW Shoreline Changes Since 1948 at Sebastian Inlet.
1881 Shoreline is also Shown for Comparison.

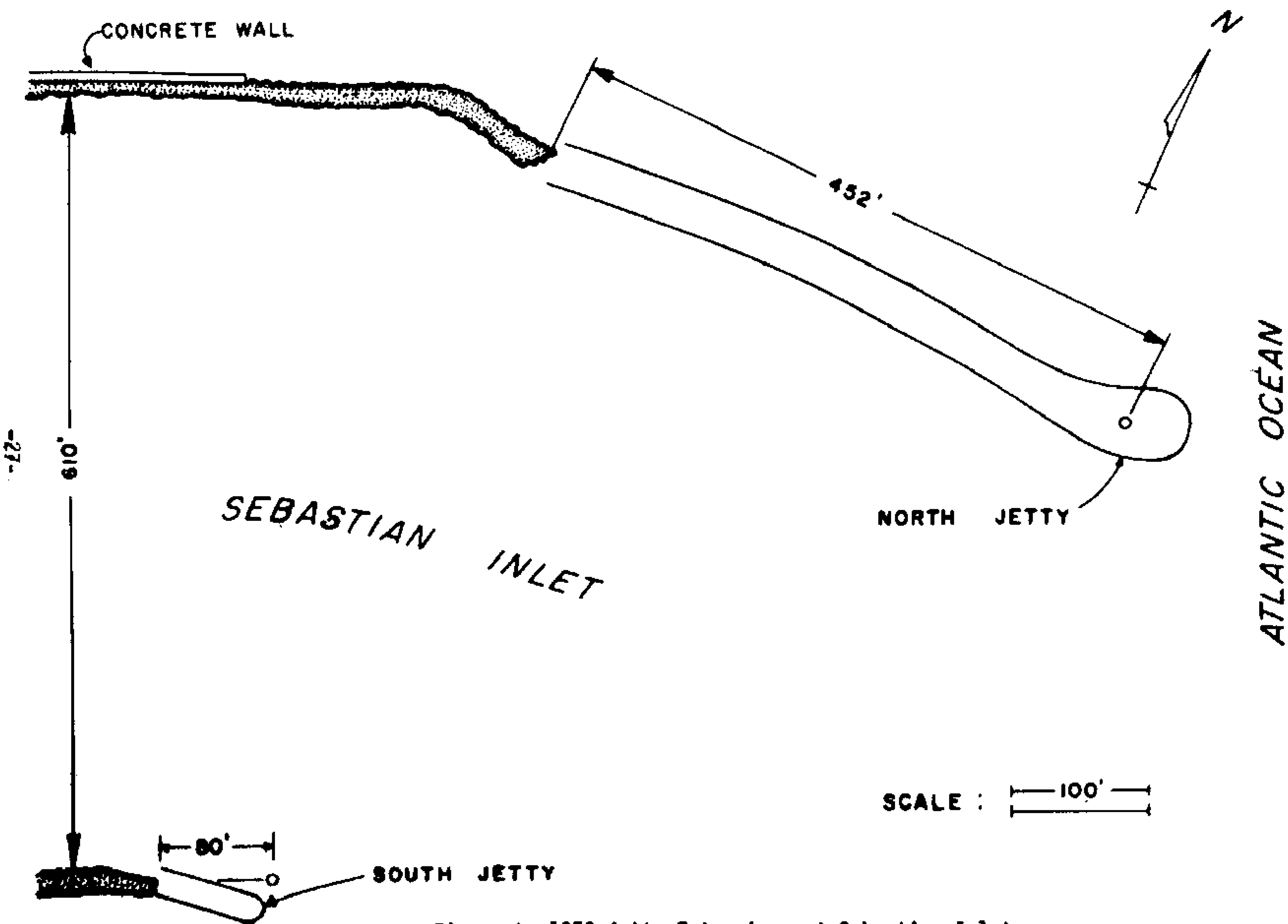



Fig. 4.8 1970 Jetty Extensions at Sebastian Inlet.

dredging of the trap will be maintenance dredging every three years, and the amount to be dredged each time will only be about one-third of the quantity dredged in 1972 (Kenneth Damerow, personal communication). Some erosion has occurred west of the steel bulkhead (approximately 110 feet since 1962). This may have some effect on sand deposition in the trap.

TABLE 4-3
DREDGING RECORD

| Date | Location | Amount Dredged (Cubic Yards) |
|---|---|---|
| 1886 | Dredging of "Gibson's Cut." | * |
| 1895-1917 | Several unsuccessful attempts to dredge open the cut. | * |
| 1918 | Unsuccessful opening of 10 ft wide and 4 to 5 ft deep channel. | * |
| 1924 | 100 ft wide and 6 ft deep channel. | 66,000 - sand<br>500 - rock |
| 1927 | Rock blasting from the channel. | * |
| 1929 | Rock removal from the channel. | * |
| 1939 | A channel dredged to within 800 ft of the ocean. | 72,000 |
| 1947 | 100 ft wide and 8 ft deep channel dredged to open the inlet unsuccessfully. | 70,000 |
| 1948 | A new channel dredged to open the inlet. | 202,000 - sand<br>6,568 - rock |
| 1950 | Maintenance dredging. Channel 1,650 ft long, 160 ft wide and 8 ft deep after dredging. | 140,840 - sand<br>4,843 - rock |
| 1951 | River approach to the inlet dredged. | 55,000 |
| 1952 | Channel dredged to 8 ft depth. | 18,000 |
| 1955 | Maintenance dredging. | 60,000 |
| 1958 | Maintenance dredging. | 65,000 |
| 1962 | A 200 ft wide and 11 ft deep channel excavated east of the proposed bridge and a 150 ft wide, 12 ft deep and 1,500 ft long channel west of the bridge. A 125 ft wide, 700 ft long and 7 to 9 deep channel dredged near the western end of the southern bank. | 67,800 |

TABLE 4-3 Continued

| Date | Location | Amount Dredged (Cubic Yards) |
| --- | --- | --- |
| 1962 | Sand trap excavated 2,500 west of the inlet entrance. Sediment from the trap used to shore up the inlet banks and to nourish the beach south of the inlet. | 274,600 |
| 1972 | Dredging of a new 37 acre trap. Dredged material placed south of the inlet. | 425,000 |
| 1973 | Volume of sand in the trap between June, 1972 and December, 1973 estimated to be 110,000 cu.yds. | |
| 1976 | Proposed dredging and deepening of the sand trap. Nourishment of the beach south of the inlet proposed. Volume of sand in the trap between December, 1973 and June, 1975 estimated to be 34,600 cu.yds. | * |

*No Information

Note: Since 1962, several relatively small dredging operations have been carried out. The quantities of dredged material removed have been of the order of 10,000 to 20,000 cubic yards.

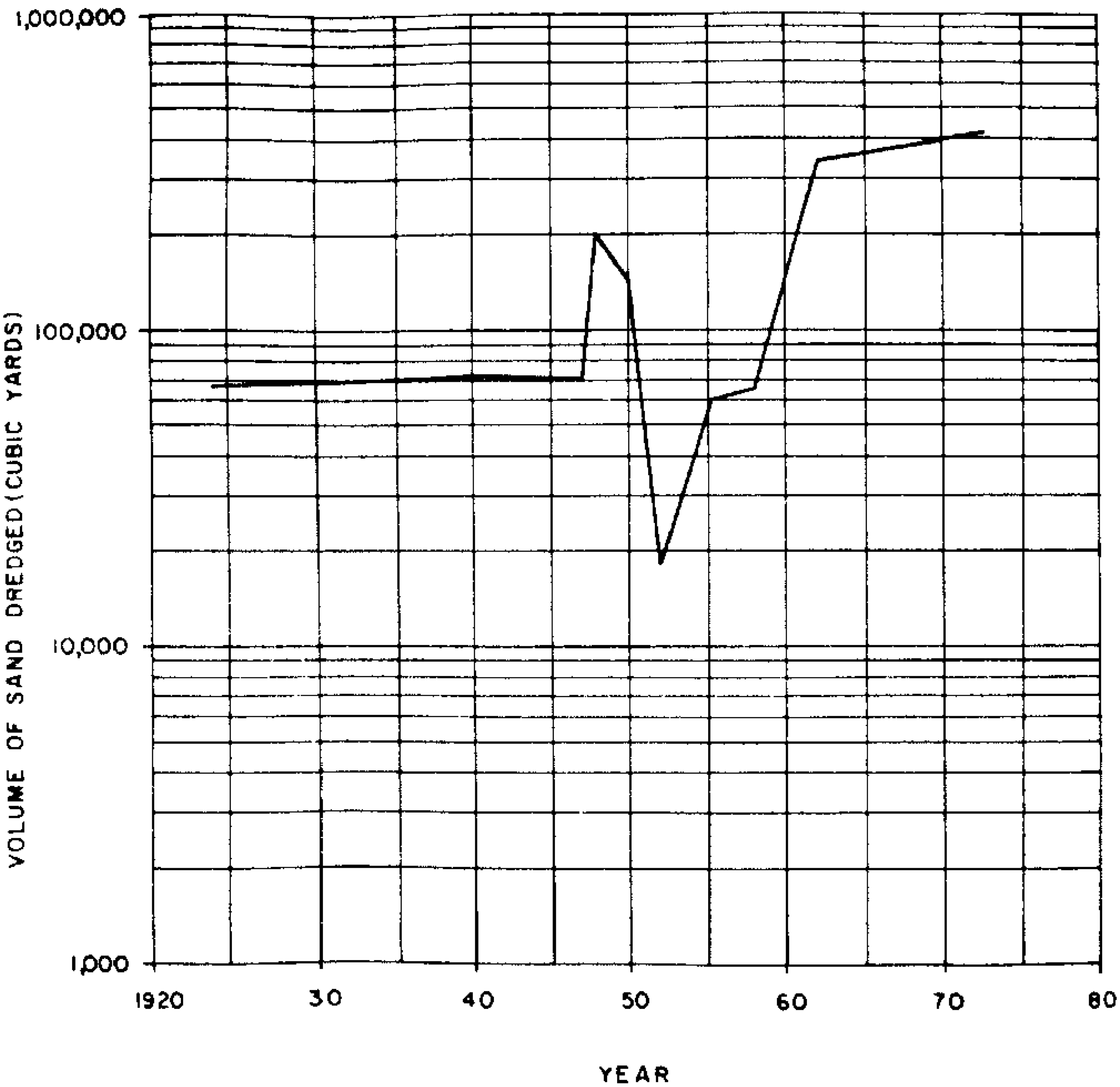



Fig. 4.9 Volume of Sand Dredged from Sebastian Inlet as a Function of Years.

# V. MORPHOLOGICAL CHANGES

## 5.1 Maps, Surveys and Photographs

Sebastian Inlet appears in National Ocean Survey Coast Chart No. 11476 (replacing No. 1246), and in somewhat greater detail in the NOS Small Craft Chart No. 11472 (replacing No. 845-SC). However, no channel depths appears there.

Surveys of the inlet carried out between 1930 and 1961 have been listed in Section 4.1, but extensive detailed surveying apparently ended with the Corps of Engineers survey in 1940. Since 1961, sections of the inlet, particularly the area covered by the sand trap have been periodically surveyed, but it appears that no comprehensive post 1940 survey of the entire inlet region exists.

Twenty-four photographs showing the inlet are available in the Coastal and Oceanographic Engineering Laboratory Archives, University of Florida. These cover the period 1936 to 1974. Several dated 1945 and later that are not available in the Archives may be obtained from other sources (Barwis, 1975). A copy of the earliest known photograph of the inlet, made by Fairchild Aerial Survey in 1926, is with the Sebastian Inlet Commission.

## 5.2 Changes in the Throat Section

The variation in the throat section (minimum flow area) of Sebastian Inlet shows an interesting correlation with the dredging history of the inlet. Available data are given in Table 5-1. The items included are the year, throat cross-section below MLW, mean depth across the inlet at the throat below MLW, surface width, maximum depth at the throat below MLW and the controlling depth, i.e. minimum depth at the inlet entrance, below MLW. Note that some of the data correspond to the dimensions of the dredged channel only (superscript a in the second column from the left). The actual throat section may have been significantly wider in some of these situations. In the old inlet, the location of the throat varied somewhat from survey to survey; it was approximately 1,400 ft westward from the tips of the old jetties. Since the stabilization of the new inlet, it has been localized approximately 300 to 400 ft west of the bridge.

TABLE 5-1
INLET/CHANNEL THROAT SECTION
CHARACTERISTICS AND CONTROLLING DEPTH
IN THE INLET

| Year | Throat Section Below MLW ($ft^2$) | Mean Depth (ft) | Surface Width (ft) | Max Depth (ft) | Controlling Depth (ft) |
|---|---|---|---|---|---|
| 1918 | 160-300[a] | 4-5 | 40-60 | - | - |
| 1924 | 600[a] | 6 | 100 | - | - |
| 1930 | 2730 | 4.9 | 560 | 7.8 | 3 |
| 1934 | 1690 | 3.8 | 450 | 6.3 | 4 |

TABLE 5-1 (Continued)

| Year | Throat Section Below MLW (ft) | Mean Depth (ft) | Surface Width (ft) | Max Depth (ft) | Controlling Depth (ft) |
|---|---|---|---|---|---|
| 1935 | 1900 | 4.0 | 470 | 8 | 3.5 |
| 1938 | 1215 | 4.3 | 280 | 7 | 2 |
| 1940 | 980 | 3.1 | 316 | 5.7 | 3.8 |
| 1941/42 | 0 | 0 | 0 | 0 | 0 |
| 1947 | 800[a] | 8 | 100 | - | - |
| 1948 | 315 | 0.9 | 350 | 5.3 | 4.3 |
| 1949 | 2180 | 5 | 440 | 7.6 | 1.6 |
| 1950 | 1280[a] | 8 | 160 | - | - |
| 1952 | - | 8[a] | - | - | - |
| 1955 | - | 8[a] | - | - | - |
| 1958 | 400 | 5[a] | 80 | - | - |
| 1961 | 3460 | 8.1 | 467 | 10.6 | 4 |
| 1962 | 2200[a] | 11 | 200 | 11 | 11 |
| 1963 | 3875 | 8.3 | 467 | 13 | - |
| 1973 | - | 12[a] | - | 12 | 12 |
| 1975 | 3900 | 8.4 | 467 | 13 | - |

[a] Dimensions of the newly dredged main channel only.

The throat cross-section is plotted as a function of time (year) in Fig. 5.1. There appears to be an interesting correlation with the history of the inlet, as manifested in the dredging of the channel and improvements in the jetties. Beginning with the opening of the inlet in 1924, with jetty improvement and some dredging, the inlet is observed to have survived, albeit with some difficulty, until its closure during 1941/42. Then, after a brief, unsuccessful opening in 1947, the inlet was finally reopened in 1948 along its new alignment. Thereafter the throat section increased steadily, mainly because of periodic channel dredging coupled with jetty improvements. After the dredging of the channel and the excavation of a sand trap, the cross-section at the throat seems to have stabilized at approximately 3,900 $ft^2$ below MLW, or 4,400 $ft^2$ below MSL.

From an engineering standpoint, it is instructive to determine the relationship between the width and the depth of the throat cross-section for Sebastian Inlet. In Table 5-2 we have computed the ratio of width to depth (below MLW) at the throat based on the data in Table 5-1. In Fig. 5.2, where this ratio is plotted against time in years, it is observed that prior to the closure of the inlet during the early forties the ratio was nearly twice as large as at the present time. Since a larger ratio indicates a shallower inlet

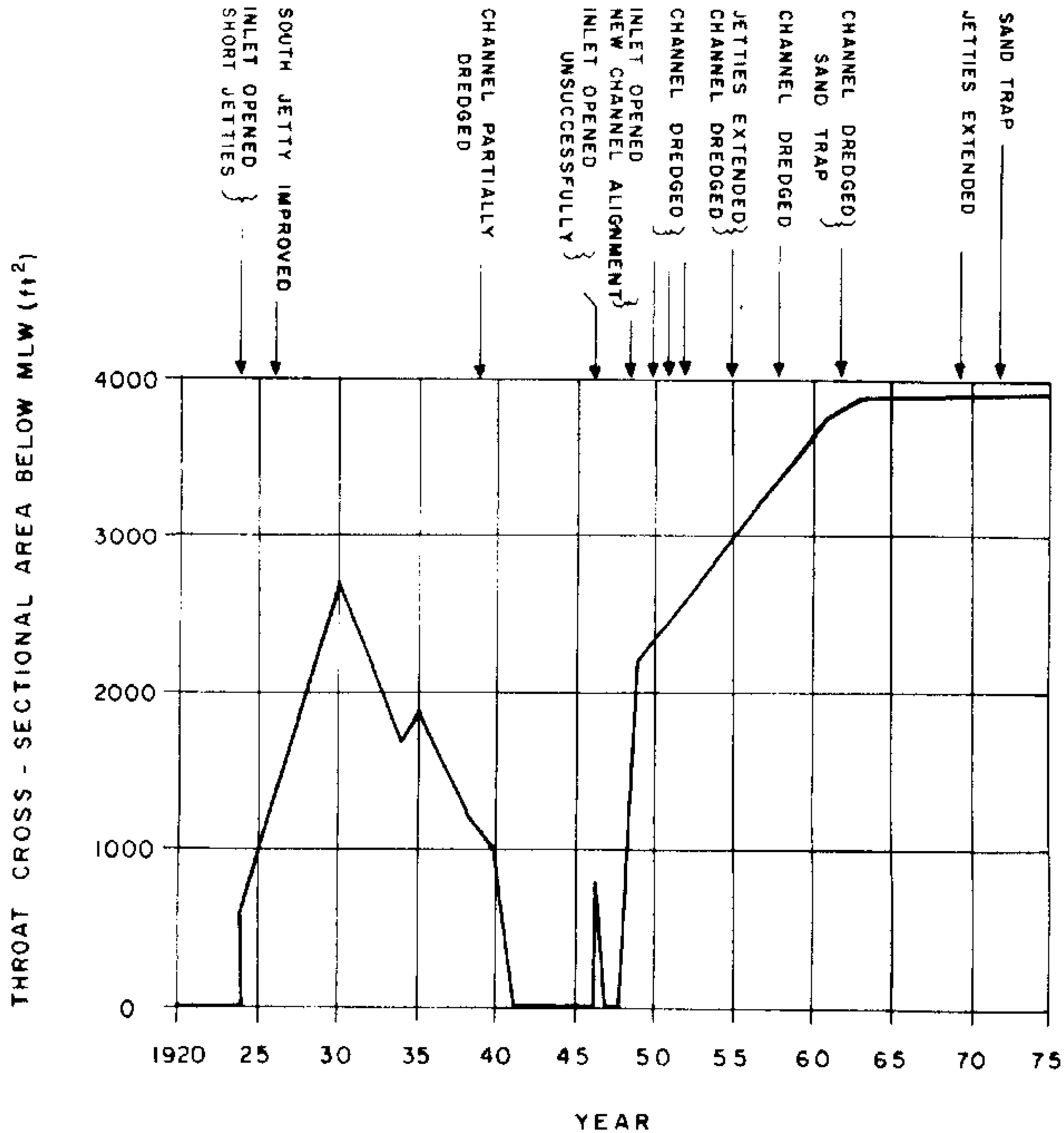



Fig. 5.1 Variation in the Throat Cross-sectional Area Below MLW at Sebastian Inlet.

on a relative basis, Fig. 5.2 appears to be a method for indicating the history of the stability of Sebastian Inlet. It is interesting to note that the width to depth has stabilized at 56. Although this is a stable ratio for Sebastian Inlet, it should be remembered that its throat section does not have a sandy bottom, therefore Fig. 5.2 does not necessarily indicate what may happen in a similar inlet with a sandy bottom.

TABLE 5-2
RATIOS OF WIDTH TO MEAN DEPTH

| Year | Width/Depth |
|---|---|
| 1930 | 114 |
| 1934 | 108 |
| 1935 | 118 |
| 1940 | 102 |
| 1948 | 389[a] |
| 1949 | 88 |
| 1961 | 56 |
| 1963 | 56 |
| 1975 | 56 |

[a]Inlet near closure.

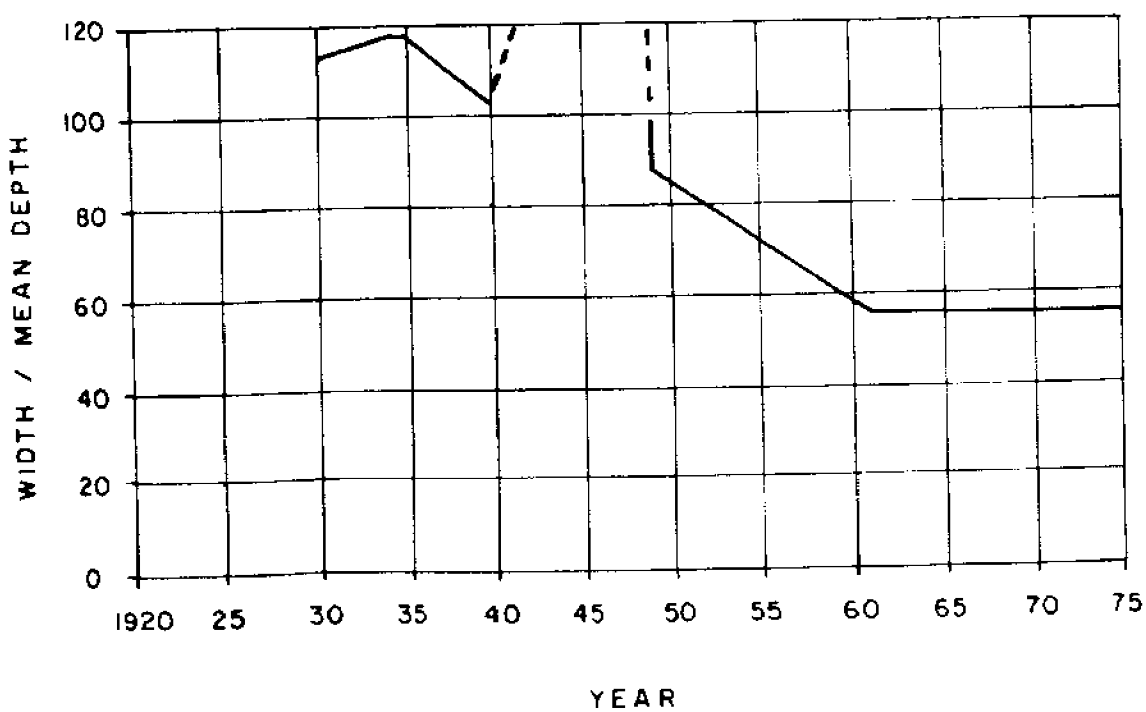



Fig. 5.2 Ratio of Width to Depth (below MLW) at the Throat Section of Sebastian Inlet Plotted against Time in Years.

## 5.3 Changes in Channel Alignment

The construction of a steel bulkhead (old sheet pile dike in Figs. 4.1 and 4.5) in 1931 was an attempt to establish a stable channel alignment for the inlet. This bulkhead, which extended 1,500 ft westward from its eastern end near the present inlet, had a bearing of 263°T. The new channel alignment in 1948 was close to the present alignment, as defined by the riprap extending bayward from the jetties (Fig. 4.7). The new channel, which runs from northeast to southwest, has a bearing of 220°T. The channel alignment was thus rotated by 43° to the south.

Changes in the bank shoreline between 1948 and 1972 are shown in Fig. 4.7. The shallow pool-like area of water trapped north of the riprap on the north bank with a small opening is a vestige of the old inlet. prior to 1948. The banks of the inlet appear to have been considerably stabilized since the placement of the riprap.

## 5.4 Outercoast Shoreline Changes

In recent years, beach and offshore profiles have been made both by the Coastal and Oceanographic Engineering Laboratory for the coastal construction setback line program (see COEL 1974a,b) and by Beindorf and Associates of Vero Beach. Fig. 5.3 shows the locations of the setback line profiles designated R-180 etc). Fig. 5.4 shows the locations and lengths of profiles in the vicinity of the inlet for the setback line and those by Beindorf and Associates (designated 1 + 00, 10 + 00 etc). The profiles with long lines, e.g. R-216, R-219, are offshore profiles extending to a depth of 30 to 35 ft. The other setback line profiles extend up to wading depths.

TABLE 5-3
MWH SHORELINE CHANGES IN THE VICINITY OF SEBASTIAN INLET 1881-1974

| Station \ Period | 1881 1934 (ft) | 1934 1938 (ft) | 1938 1948 (ft) | 1948 1967 (ft) | 1967 1972 (ft) | 1967 1974 (ft) | Avg. Ann. change (ft) |
|---|---|---|---|---|---|---|---|
| 2,000 ft N | + 60 | + 10 | + 40 | + 40 | | 0 | +1.6 |
| 1,500 ft N | +100 | 0 | + 35 | + 45 | | +10 | +2.0 |
| 1,000 ft N | +120 | - 30 | + 80 | + 60 | | -35 | +2.1 |
| 500 ft N | +120 | - 50 | + 95 | + 95 | | -90 | +1.9 |
| 500 ft S | -100 | - 20 | +135 | -120 | +30 | | -0.8 |
| 1,000 ft S | -160 | 0 | +130 | -120 | -10 | | -1.8 |
| 1,500 ft S | -160 | - 20 | +135 | -115 | +50 | | -1.2 |
| 2,000 ft S | -160 | - 10 | +140 | -115 | +45 | | -1.1 |
| Avg. Ann. change (ft) | -1.0 | -3.8 | +9.9 | -1.5 | (+5.8) | (-4.7) | |

- denotes erosion; + denotes accretion

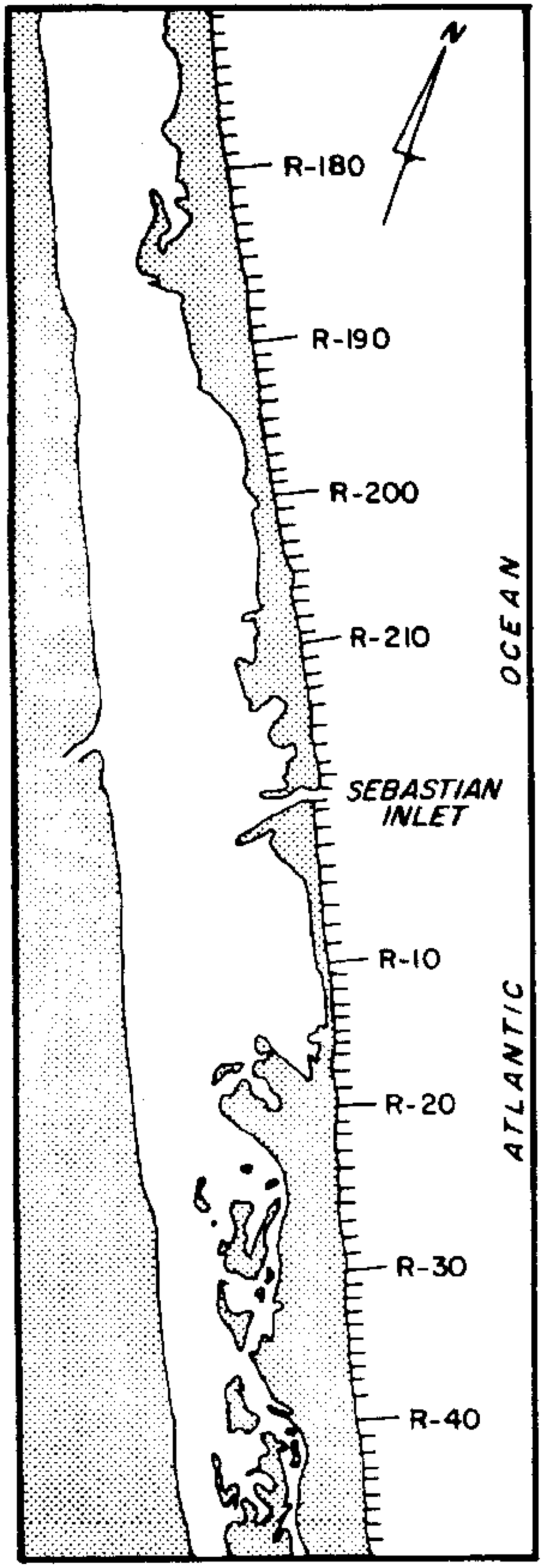



Fig. 5.3 Locations of Setback Line Profiles in the Proximity of Sebastian Inlet (COEL, 1974a,b).

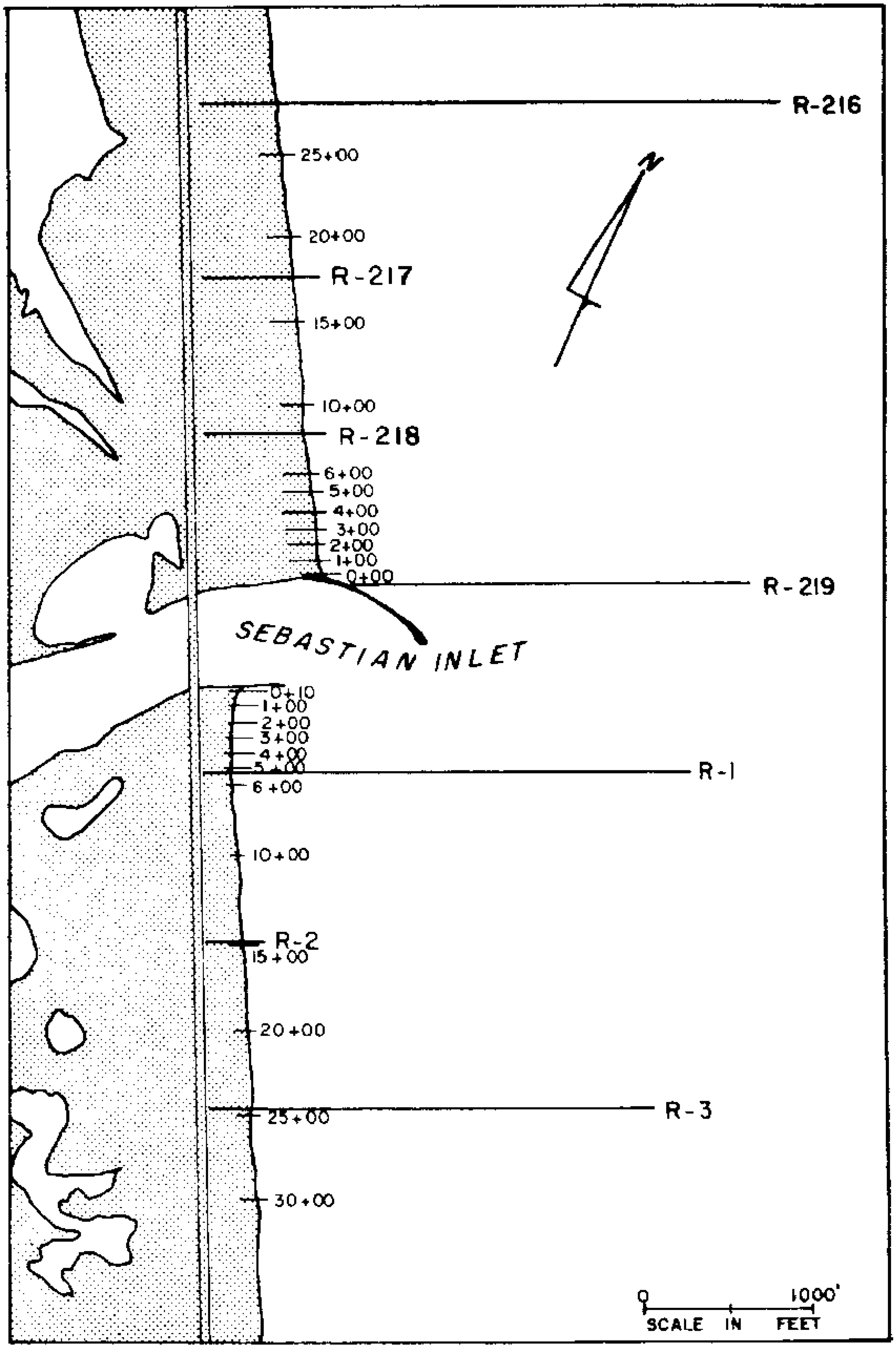



Fig. 5.4 Locations and Lengths of Setback Line Profiles near Sebastian Inlet. Also Shown are Locations of Profiles by Beindorf and Associates of Vero Beach. The Latter Profiles have been obtained once a Year Since 1967.

Changes in the outercoast MHW shoreline up to 2,000 ft north and 2,000 ft south of the inlet centerline were determined at 500 ft intervals (Table 5-3) for the years 1881 to 1934, 1934 to 1938, 1938 to 1948, 1948 to 1967, and 1967 to 1972/74. The state of the shoreline in 1972/74 was determined from aerial photographs obtained for setback line determination. The photography of the beach north of the inlet was taken in 1974, but the photography of the beach south of the inlet was taken in 1972. The average annual change computed in the right-hand column of Table 5-3 indicates an overall trend of accretion north of the inlet and a trend of erosion south of the inlet during the 91 year period covered. These trends presumably began with the construction of the first jetties in 1918. On the other hand, the average annual change for the various periods computed in the bottom row of the table shows on overall erosion between 1881 and 1938, substantial accretion between 1938 and 1948, erosion between 1948 and 1967 and accretion between 1967 and 1972/74. The accretion during 1938-48 is most likely to be due to the fact that, during much of this period, the inlet was either closed or was near closure. This enabled the entire shoreline to gain sand, both from the longshore drift which deposited in the relatively sheltered region between the outer bar and the beach, and possibly from the bar itself. The accretion of the shoreline south of the inlet between 1967 and 1972 is because the 1972 photograph on which the data are based was taken in December, after the nourishment of the beach which took place earlier the same year.

The overall trend of accretion north of the inlet and erosion south of the inlet is an indication of the predominance of the southerly direction of the littoral drift. In order to control the erosion south of the inlet, material from the sand trap was deposited on the south beach in 1962 and in 1972. Funding for another nourishment has been authorized, but the dredging operation has been delayed by concern over the effect it would have on the habitat of nearby marine organisms.

The U.S. Army Corps of Engineers (1971), citing the Survey-Review Report (1952), notes that the presence of Sebastian Inlet has caused accretion of the shoreline for at least four miles to the north and erosion for at least four miles to the south of the inlet.

# VI. HYDRAULICS

Not many hydraulic measurements have been made at Sebastian Inlet. Those that were made were prior to the jetty extensions in 1970 (COEL reports, 1962, 1964, 1965), and therefore do not truly reflect the conditions at the present time. However, assuming the conditions are not substantially different, it is instructive to use the available data to examine the hydraulic characteristics of the inlet.

## 6.1 Tides

National Ocean Survey Tide Tables give predictions for the water level variation at Sebastian Inlet. These predictions are based on measurements between October 26 and November 9, 1966, at the bridge (NOS Predictions Branch, personal communication). The stated mean range of tide is 2.2 ft. The spring range is 2.6 ft, and the mid-tide level is 1.1 ft above MLW. Note that the measurements were obtained prior to the 1970 jetty extensions. In September, 1975, the Coastal and Oceanographic Engineering Laboratory obtained a one day tidal record from a gage installed at Henry's Dock. Since this location is approximately 2,200 ft bayward of the bridge, some reduction in the range and time lag of the order perhaps of a fraction of an hour between these two locations may be expected. However, a comparison of the measurement with Tide Table predictions showed a lack of correspondence, particularly with respect to the time lag. High water was predicted approximately when low water actually occurred. The measured range was 0.6 ft as opposed to the prediction of 2.5 ft. It does not seem reasonable that such a substantial difference could be due to jetty extensions. There appears to be a need to determine the validity of the predictions.

During September 1963 and March 1964, the Coastal Oceanographic Engineering Laboratory (COEL, 1965; Bruun et al., 1966) obtained tidal records at seven locations in and around the inlet. Selecting two of these records, one representing the ocean tide (gage was located at the outer side of the north jetty) and the other representing the bay tide (gage was located at the western extremity of the southern bank of the inlet), the following information has been obtained:

The average ocean range over the period of measurement was 3.8 ft and the average bay range was 0.23 ft, which amounts to a reduction of 94% in the tidal range or an 88% reduction in the tidal energy. This reduction is substantial and the records show that most of it occurs in the section of the channel between the ocean and Henry's Dock, where the rock-laden bottom as well as the curvature of the channel cause a significant dissipation of the tidal energy.

## 6.2 Currents

Sebastian Inlet can be hazardous to an inexperienced navigator because of the high flood and ebb currents. Current measurements have been relatively few; all those recorded here were obtained by the Coastal and Oceanographic Engineering Laboratory.

On November 1, 1962, surface current measurements indicated a maximum flood of 6.0 fps and ebb of 6.1 fps, both in the main channel. The corresponding currents 125 ft north of the channel center were 6.1 and 8.2 fps, respectively. In March 1965, the surface currents in the center of the channel under the bridge were estimated to be 7.2 fps for flood flow and 9.1 fps for ebb flow. Since the construction of the jetty extensions in 1970 the spatial distribution of the currents was altered, but if the Coastal and Oceanographic Engineering Laboratory model tests (see COEL, 1965) are indicative of the actual trends, the distribution of the flow through the channel under the bridge has probably not been affected significantly.

From the tidal records noted in Sections 6.1, the average time lag between the time of slack water in the inlet and the time of high water or low water in the ocean is estimated to be 3.2 hours, on the average. A direct observation in 1962 (COEL report, 1962) confirms this estimate. Jetty extensions probably have increased this time lag to some extent. This rather large lag is due to the high degree of frictional and other energy losses in the inlet.

## 6.3 Tidal Prism

Bruun (1966) has estimated the tidal prism to be equal to $3.5 \times 10^8$ $ft^3$ on the spring range of tide, in which case the corresponding value on the mean range can be estimated to be $3.0 \times 10^8$ $ft^3$. It is interesting to note that for this value of the tidal prism, the stable cross-section for an inlet with a sandy bottom under sedimentary equilibrium would be (O'Brien, 1969; Mehta, 1975) 8,460 $ft^2$ below MLW[3]. The actual area, 3,900 $ft^2$, is thus less than one-half the stable cross-section for sedimentary equilibrium. This clearly is the case because the throat section is lined with rocks rather than sand, and therefore has no scope for expansion. Alternatively, for the given cross-section, the tidal prism is more than twice the volume that would flow through an inlet with a sandy bottom. This explains the rather strong currents through the inlet. In fact, it can be shown that the strengths of flood and ebb (6 to 9 fps surface currents in the center of the channel) are higher than those in a "normal" inlet by approximately a factor of two.

## 6.4 Waves

No information on the wave climate specific to the outer coast vicinity of Sebastian Inlet is available. Using the synoptic deep water wave height and period information based on ship observations, Walton (1973) has prepared wave period and height roses (Figs. 6.1 and 6.2) which pertain to Florida's Atlantic Coast between Ponce de Leon Inlet and the southern tip of the peninsula. They are included here because of their relevance to Sebastian Inlet. They are frequency distributions including directional dependance on an annual average basis. With reference to the approximate

---

[3] The equilibrium relationship is between the tidal prism and the throat cross-section at MSL; we have derived the corresponding cross-section at MLW in order to be consistent with the rest of this report.

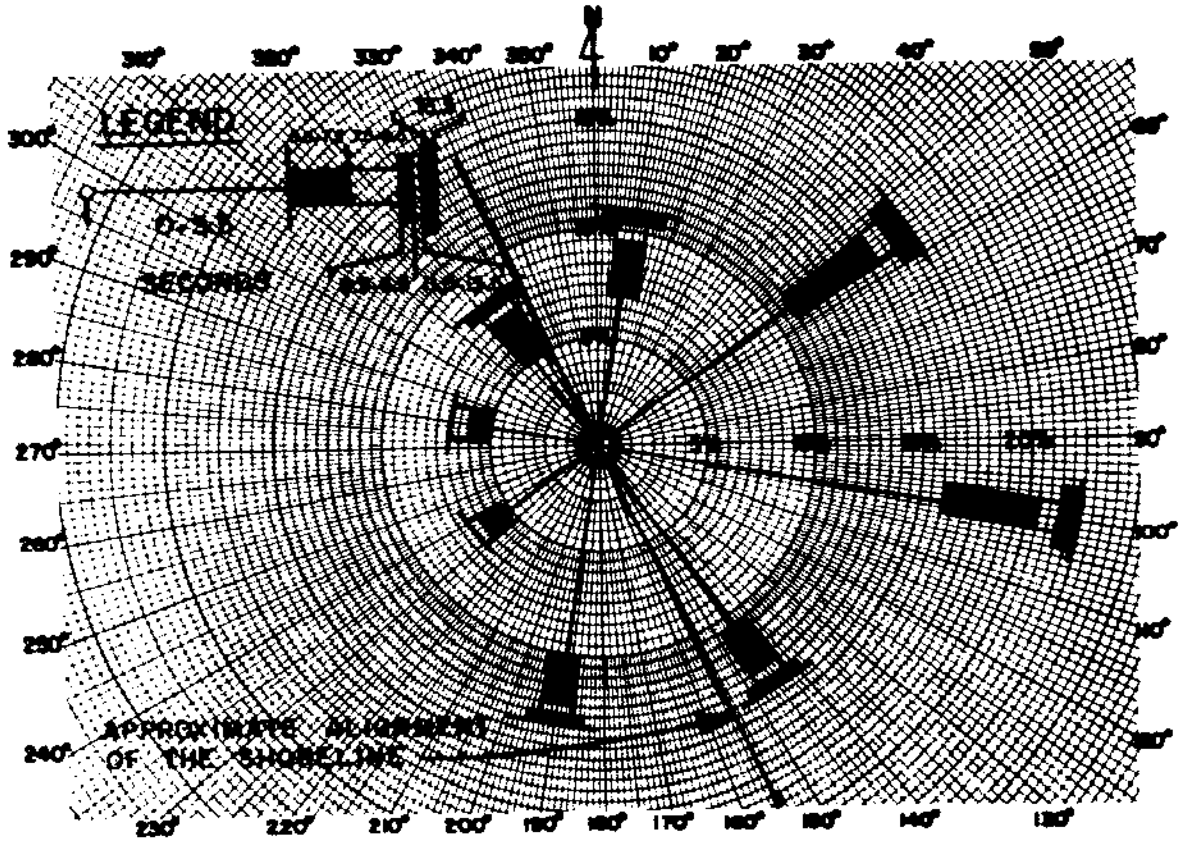



Fig. 6.1 Annual Average Deep Water Wave Period Rose (after Walton, 1973). The Direction of Wave Propagation is from Center out.

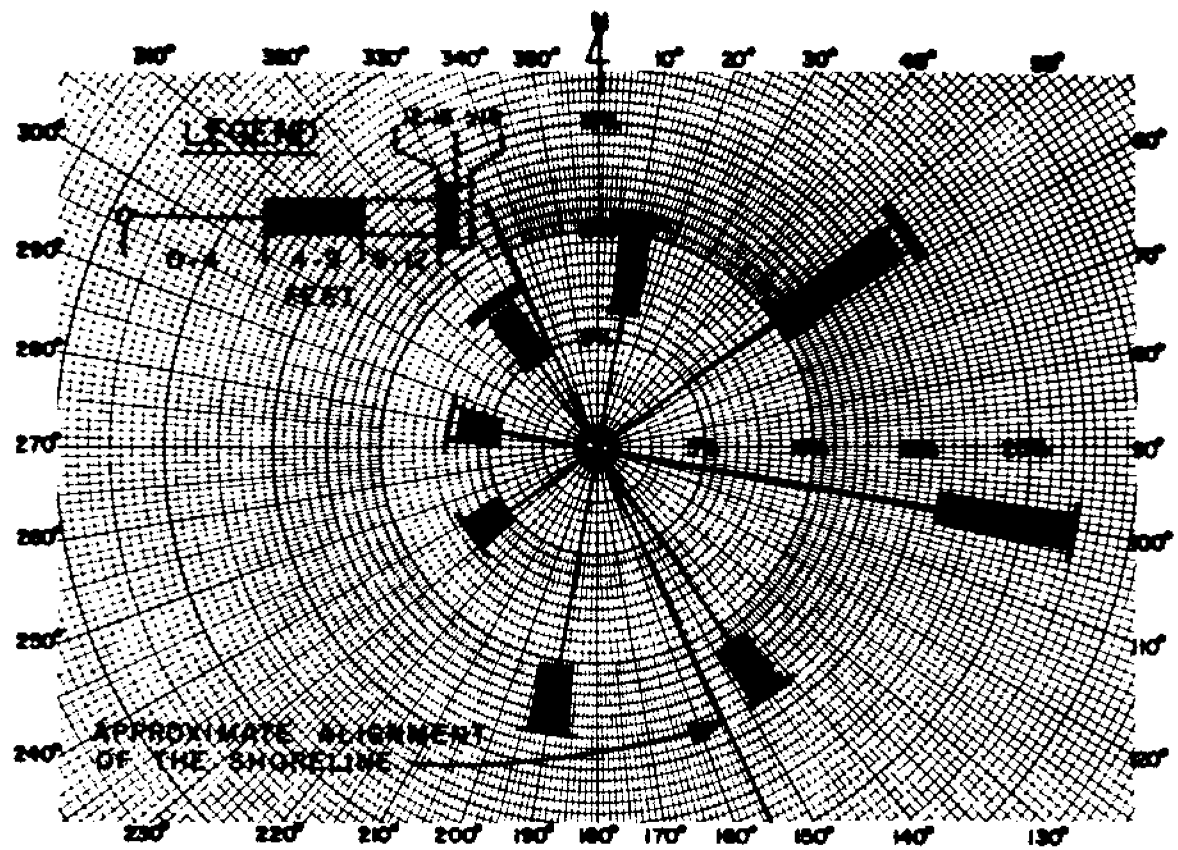



Fig. 6.2 Annual Average Deep Water Wave Height Rose (after Walton, 1973). The Direction of Wave Propagation is from Center out.

alignment of the shoreline, it is observed in Figs. 6.1 and 6.2 that the frequency of approach of the waves is greater from the northeasterly direction (190°T), which explains the predominance of the southerly littoral drift along the coastline. Note that these roses are for deep water conditions, which, for example, in the case of an 8 second wave exist in depths greater than 200 to 300 ft. Quite often local winds generate waves of periods less than 4 seconds, which, however, tend to move significant quantities of sand near the shoreline (O'Brien, personal communication). These short period waves and the detailed bathymetry near an inlet are generally quite unique to the environment and therefore, the wave roses should be used with caution. They give a resonable description of the deep water wave climate for relatively long segments of the shoreline, but where details are involved, the roses tend to assume a more qualitative role.

# VII. SEDIMENTARY PROCESSES

## 7.1 Sand Volume Changes

The rather large number of dredging operations and the unavailability of a sufficient number of detailed surveys of the inlet and vicinity after 1940 make it difficult to estimate the magnitudes of sand volume changes in the inlet region. In computing the sand volumes we selected the following surveys: 1881 and 1930 by the U.S. Coast and Geodetic Survey; 1934, 1935, 1938 and 1940 by the U.S. Army Corps of Engineers.

The outer bar volume computations were carried out in accordance with the method proposed by Dean and Walton (1975). The changes in the channel and the inner shoals between surveys were estimated with the help of a computer program which calculated the volume change per 100 x 100 ft square area, in a 41 x 42 grid of such squares covering the inlet and the inner shoals.

The outer bar volume based on 1930 as well as 1935 surveys has been estimated to be 50,000 cu.yds., although this is a rough estimate because of the rather large observed fluctuations in the accumulation outside the inlet from survey to survey. The following table shows volume changes in the inlet and in the inner shoals (+ = accretion, - = erosion):

TABLE 7-1
SAND VOLUME CHANGES IN THE INLET AND THE INNER SHOALS

| Year | Inlet (cu. yds.) | Inner Shoals (cu. yds.) |
|---|---|---|
| 1924 - 34 | * | + 1,902,000 |
| 1934 - 35 | - 2,900 | - 3,800 |
| 1935 - 38 | + 114,000 | + 382,000 |
| 1938 - 40 | + 101,000 | - |
| Total | + 212,000 | + 2,280,400 |
| Ann. Avg. | + 35,350 | + 142,525 |

*No Information

The numbers in Table 7-1 indicate a rate of accumulation of 35,350 cu. yds. per year in the inlet and 142,525 cu.yds. per year in the inner shoals. Inasmuch as the inlet is along a new alignment with its jetties extended, it is not certain as to how much material is now accumulated in the inner shoals. It seems, however, that a substantial quantity of sand is still tied up in the inner shoals of the old inlet. These shoals are in the region just north of the present channel (See Fig. 4.6).

Walton and Adams (1976) have shown that, in general, an empirical relationship exists between the outer bar volume $V$ and the tidal prism $P_s$ on the spring range for inlets in long-term sedimentary equilibrium. For such inlets exposed to a moderate wave climate, e.g. the east coast of Florida, the proposed relationship is

$$V = 10.5 \times 10^{-5} P_s^{1.23}$$

where $V$ is in cubic yards and $P_s$ in cubic feet. With $P_s = 3.5 \times 10^8 ft^3$ for Sebastian Inlet this relationship yields $V = 3.4 \times 10^6$ cu.yds, which is 68 times the measured accumulation of $5 \times 10^4$ cu. yds. This significantly lower out bar volume in comparison with the number of other inlets examined by Walton and Adams is possibly attributable to the presence of offshore reefs in the vicinity of Sebastian Inlet. These reefs may be altering the distribution of the flood and ebb flows in the littoral zone surrounding the inlet entrance.

## 7.2 Inlet Stability

Inasmuch as the stability of an inlet is reflected in the stability of the throat cross-section (Escoffier, 1940; O'Brien, 1969; O'Brien and Dean, 1972) Fig. 5.1 is a good record of the history of stability of Sebastian Inlet. As observed, since the dredging of a channel in 1962 and the excavation of a sand trap, the cross-section seems to have stabilized at 3900 ft below MLW. The following comments on the various aspects of stability relevant:

1. During the period 1930-35, the throat cross-section had approached approximately 2800 $ft^2$ and yet the inlet was unstable as it closed subsequently in the early forties. It therefore appears that the critical cross-section for the stability of this inlet lies somewhere between 2,800 $ft^2$ and 3,900 $ft^2$ below MLW.

2. Even though a stable opening of the inlet was achieved after a new alignment of the inlet (see section 5.3), it does not necessarily follow that the stability of the inlet is related to this event. Indeed it is possible that the new alignment would probably have proved to have had the same degree of success against steady sand accumulation and consequent constriction of the throat, had it not been for the periodic channel dredging and jetty improvement that followed the opening in 1948. What seems to be of importance is that apparently between 1949 and 1961, the throat cross-section was expanded through dredging beyond the critical value.

3. Although the cross-section is stable, sand is being transported from the littoral zone, through the channel, into the sand trap. The estimated accumulation in the trap during the period December, 1973 to June, 1975 has been 34,600 cu.yds. (Table 4-3). This is equivalent to about 23,000 cu.yds. per year transported through the channel. Interestingly enough, the amount of sand accumulated in the trap between June, 1972 and December, 1973 was 110,000 cu.yds. This is a rate of 73,000 cu.yds. per year noted above. This rather large variability in the rate of transport of sand through an inlet may not be unusual, because the amount of sand that enters an inlet is possibly more strongly related to the frequency and intensity of storms, than to the tidal flow characteristics. This point needs to be futher investigated. There also exists the possibility that some of the sand accumulates bayward of the trap, and therefore is not accounted for in the above budget.

4. It was noted in section 6.2 that the throat section at Sebastian Inlet is less than one-half the size required for stable sedimentary equilibrium in a sandy inlet. This, as noted, is due to the rocky bottom of the inlet near its entrance which prevents throat expansion. The strong

currents through the rather narrow channel enable the sand to be transported to the trap without any significant deposition in the narrow channel itself.

## 7.3 Littoral Drift

U.S. Army Corps of Engineers (1971) have not estimated the rate of drift near Sebastian Inlet, but they note a net annual southerly drift of 350,000 cu. yds. per year at Canaveral Harbor and 200,000 to 250,000 cu. yds. annually at Fort Pierce Inlet. This indicates a reduction of 100,000 to 150,000 cu. yds. per year between Canaveral Harbor and Fort Pierce. Since the only "trap" between these two locations is Sebastian Inlet, it would mean that most of this sand accumulates there. If we assume that much of the sand that enters the inlet ends up in the inner shoals, we have a computed rate of accumulation of 142,525 cu. yds. from Table 7-1, which shows a reasonable agreement with the estimated 100,000 to 150,000 cu. yds. It should be noted that this budget is valid for the inlet as it existed prior to the jetty improvement beginning 1952. This is because the littoral drift values are primarily based on surveys older than this date (Ken Humiston, Corps of Engineers, personal communication). Also, the inner shoal accumulations are based on surveys between 1934 and 1940.

## 7.4 Sediment Characteristics

In September 1975, the Coastal and Oceanographic Engineering Laboratory collected bottom sediment samples at the outer beaches adjacent to the jetties, in the main inlet channel and in Indian River between the inlet and Sebastian Creek. In the inlet channel, not much sand was found in the deep channel between the tip of the jetties and the bridge; therefore the data given in Table 7-2 are for the section of the inlet between the bridge and the western boundary of the sand trap.

TABLE 7-2
SEDIMENT GRAIN CHARACTERISTICS

| Location | $D_{25}$ (mm) | $D_{50}$ (mm) | $D_{75}$ (mm) | $S_o$ | % Shell | % Silt and Clay |
|---|---|---|---|---|---|---|
| Outer Beaches | 0.26 | 0.34 | 0.44 | 1.30 | 25 | Negligible |
| Inlet Channel | 0.31 | 0.43 | 0.71 | 1.51 | 29 | Negligible |
| Indian River | 0.21 | 0.29 | 0.42 | 1.41 | 9 | 5 |

The grain diameters at 25, 50 and 75 cumulative percent show an interesting correlation with the locality. It is seen that the sand is finer in the Indian River than in the inlet. Also, it is finer in the outer beaches than in the inlet, but not as fine as that in Indian River. This is because both course and fine particles are likely to be trapped on the beach by the jetties. The sorting coefficient $S_o = \sqrt{D_{75}/D_{25}}$ varies from 1.30 to 1.51, but the range is rather narrow, and therefore not much significance can be attached to this variation. The percent of shell drops from 29 in the inlet to 9 in Indian River. This is apparently because the shell in the inlet is derived mostly from the ocean. The amount of silt and clay is negligible and in the inlet, but increases as one proceeds toward Sebastian Creek. The average percent of silt and clay be weight in the Indian River is 5.

## VIII SUMMARY

Sebastian Inlet is a man-made cut connecting the Atlantic Ocean to the Indian River on the east coast of Florida, about 45 miles south of Cape Canaveral. The centerline of the inlet is also the dividing line between Brevard County to the north and Indian River County to the south. Collected information and computed data in this report are summarized in the sequel.

1. The inlet has two jetties, and Route A1A bridge spans the inlet. The jetties have been extended a number of times since the first successful opening of the inlet in 1924. The most recent extensions were completed in 1970. The jetties are popularly used by fisherman. The State Recreation Area south of the inlet has camping and picnicking facilities.

2. The inlet is cut through a barrier island of the Anastasia formation. In addition to rocks of this formation, sand and shell, the inlet bed has rocks made by Sabellariid worms.

3. The climate of the Sebastian Inlet vicinity is moderate, and is characterized by relatively humid summers and mild winters. Much of the rainfall occurs during the summer months. The annual total rainfall is about 50 inches. The mean temperature is 73.5°F.

4. The storms that have had major effects on the inlet have been hurricanes (and tropical storms) or North East storms. The latter have often been more damaging because they occur over a longer period of time and affect a larger area; e.g. storm of March, 1962.

5. The inlet is within the jurisdiction of Sebastian Inlet District Commission at Melbourne, Florida. The tax millage levied on the property by the commission for the purpose of inlet maintenance and improvement has been decreasing steadily since 1957.

6. The history of the inlet begins with the first recorded attempt to dig a cut by Captain David O. Gibson in 1886. This and subsequent attempts were all unsuccessful until the opening in 1924. However, the inlet shoaled up slowly and closed in 1941 or 42. The history of the present inlet begins with its reopening in 1948 along a new channel alignment. Subsequent channel dredging and jetty improvements have kept the inlet stably open for navigation. The present stable throat cross-sectional area (minimum flow area) is 3,900 $ft^2$ below MLW.

7. A sand trap in the bayward section of the inlet channel was dredged in 1962. Sand from the trap was used to shore up the inlet banks and nourish the beach south of the inlet. A similar operation was carried out in 1972.

8. The tidal prism on the spring range has been estimated to be $3.5 \times 10^8$ $ft^3$. This prism appears to be nearly twice the value that would be expected to result in a similar inlet with a sandy bottom.

9. Sebastian Inlet has strong currents in the channel between the bridge and the ocean ends of the jetties. Surface ebb currents of the order of 9 fps have been reported in the main channel. For this reason, the inlet

can be hazardous to inexperienced navigators.

10. Tidal measurements in 1963/64 indicated a 94% reduction in the range of tide between the ocean and Indian River west of the inlet. This amounts to an 88% reduction in the tidal energy as the tide propagates between the ocean and Indian River. Most of this reduction occurs between the ocean and Henry's Dock, apparently due to frictional and other energy losses in that segment of the inlet channel.

11. The outer bar sand volume has been estimated to be 50,000 cubic yards. This volume is significantly smaller that the amount stored in the outer bars of other inlets on sandy shores of a similar size.

12. Computations of inner shoal sand accumulation between 1924 and 1940 indicate an annual accumulation of 142,525 cubic yards. This figure is in agreement with the loss of littoral drift in this region reported by the Corps of Engineers.

13. The outer coastline has shown an overall accretion north of the inlet and erosion south of the inlet since 1924. This is clearly indicative of the predominance of the southerly direction of the littoral drift. The inner banks of the inlet have been substantially stabilized after theplacement of riprap along the banks.

14. The median sediment (sand and shell) grain diameter is 0.34 on the outer beaches, 0.43 in the channel and 0.29 in Indian River. Percent shell decreases bayward from 25 to 9 whereas percent silt and clay increase up to 5 by weight in Indian River. The sorting coefficient is on the order of 1.4.

## IX. REFERENCES


1. Barwis, J. H.,"Catalog of Tidal Inlet Aerial Photography," GITI Rept. No. 75-2, U.S. Army Waterways Experiment Station, Vicksburg, Miss., June, 1975.

2. Brooks, H.K., "Geology of Cape Canaveral," in "Space Age Geology," S.E. Geol. Soc. 16th Field Conference, 1972, pp. 35-44.

3. Bruun, P.M., "Tidal Inlets and Littoral Drift - Stability of Coastal Inlets Vol. 2," Printed in Trondheim, Norway, 1966.

4. Bruun, P.M., Battjes, J.A., Chiu, T.Y., and Purpura, J.A., "Coastal Engineering Study of Three Florida Coastal Inlets," in Engineering Progress at University of Florida, Vol. XX, No. 6, Bulletin No. 122, June, 1966.

5. "Coastal Engineering Study of Current Activity at Sebastian Inlet, Florida," UFL/COEL-62/011, Coastal and Oceanographic Engineering Laboratory, University of Florida, November, 1962.

6. Escoffier, F.F., "The Stability of Tidal Inlets," Shore and Beach, Vol, 8, No. 4, 1940, pp. 114-115.

7. "Fender Alignment for Sebastian Bridge Piers," UFL/COEL-64/019, Coastal and Oceanographic Engineering Laboratory, University of Florida, 1964.

8. "Coastal Engineering Hydraulic Model Study of Sebastian Inlet, Florida," UFL/COEL-65/006, Coastal and Oceanographic Engineering Laboratory, University of Florida, September, 1965.

9. Cooke, C.W., "Geology of Florida," Florida Geological Survey Bulletin No. 29, 1945.

10. Dean, R.G., and Walton, T.L. Jr., "Sediment Transport Processes in the Vicinity of Inlets with Special Reference to Sand Trapping," in "Estuarine Research," Edited by L.E. Cronin, Vol. II, Academic Press, 1975.

11. Dolan, R., Hayden, B., Vincent, L., and Riddel, P., "The Ninth February Mid-Atlantic Storm," Unpublished Report, National Park Service, 1973.

12. DuMont, P.A., "Coastal National Wildlife Refuges," Shore and Beach, Vol. 31, No. 1, April, 1963, pp. 31-36.

13. Fineren, W.W., "The Proposed South Lake Worth Inlet near Boynton, Florida," The Florida Engineer and Contractor, published by the Florida Engineering Society, Vol. I, No. 5, June, 1924.

14. Fineren, W.W., "Early Attempts at Inlet Construction on the Florida East Coast," Shore and Beach, Vol. 6, No. 3, July, 1938, pp. 89-91.

15. Kirley, D.W., "The Reef Builders," Natural History, January, 1968 pp. 41-45.

16. Ludlum, D.W., Ed., Weatherwise, Vol. 27, No. 1, February, 1974, pp. 14-15.

17. Mehta, A.J., "Notes - A Short Course in Coastal Engineering Topics, University of Florida, Part I: Hydraulics of Tidal Inlets - Simple Analytic Models for the Engineer," November, 1975.

18. Mehta, A.J., "Notes - A Short Course in Coastal Engineering Topics, University of Florida, Part II: Inlet Stability and Case Histories," November, 1975.

19. Meisburger, E.P., and Duane, D.B., "Geomorphology and Sediments of the Inner Continental Shelf - Palm Beach to Cape Kennedy, Florida," U.S. Army Corps of Engineers, Coastal Engineering Research Center, Technical Memorandum No. 34, February, 1971.

20. Mims, J.T., "Location and Evolution of Borrow Material for Beach Nourishment, Melbourne, Florida," M.S. Thesis, University of Florida, 1975.

21. National Oceanic Atmospheric Administration (NOAA), "Flood Insurance Study - Brevard County, Florida," U.S. Department of Commerce, Silver Spring, Md., 1971.

22. National Oceanic and Atmospheric Administration, "Flood Insurance Study - Indian River County, Florida," U.S. Department of Commerce, Silver Spring, Md., 1973.

23. O'Brien, M.P., "Equilibrium Flow Areas of Inlets on Sandy Coasts," J. Waterways and Harbors Division, WW1, February, 1969, pp. 43-52.

24. O'Brien, M.P., and Dean, R.G., "Hydraulics and Sedimentary Stability of Coastal Inlets," Proc. 13th Coastal Engineering Conference, Vancouver, Canada, July, 1972, pp. 761-780.

25. "Recommended Coastal Setback Line for Brevard County, Florida," UFL/COEL - 74/004, Coastal and Oceanographic Engineering Laboratory, University of Florida, 1974a.

26. "Recommended Coastal Setback Line for Indian River County, Florida," UFL/COEL - 74/005, Coastal and Oceanographic Engineering Laboratory, University of Florida, 1974b.

27. "Sebastian Inlet User Study," The Bureau of Beaches and Shores, Department of Natural Resources, Tallahassee, Florida, September, 1973.

28. "Survey-Review Report on Sebastian Inlet, Florida," Corps of Engineers, Jacksonville District Report (Not for Public Release), June, 1952.

29. U.S. Army Corps of Engineers, "National Shoreline Study, Regional Inventory Report: South Atlantic-Gulf Region," August, 1971.

30. U.S. Soil Conservation Service, "Soil Survey of Brevard County, Florida," U.S. Department of Agriculture, November, 1974.

31. U.S. Weather Bureau, "Climatography of the U.S. No. 11-6, Supplement for 1931-1952: Florida," U.S. Department of Commerce, Washington, D.C., 1957.

32. U.S. Weather Bureau, "Climatography of the U.S. No. 86-6, Supplement for 1951-1960: Florida," U.S. Department of Commerce, Washington, D.C., 1964.

33. Walton, T.L., Jr., "Littoral Drift Computations along the Coast of Florida by Means of Ship Wave Observations," Technical Report No. 15, Coastal and Oceanographic Engineering Laboratory, University of Florida, February, 1973.

34. Walton, T.L., Jr., "Glossary of Inlets Report No. 1 - St. Lucie Inlet," University of Florida Sea Grant Report, July, 1974a.

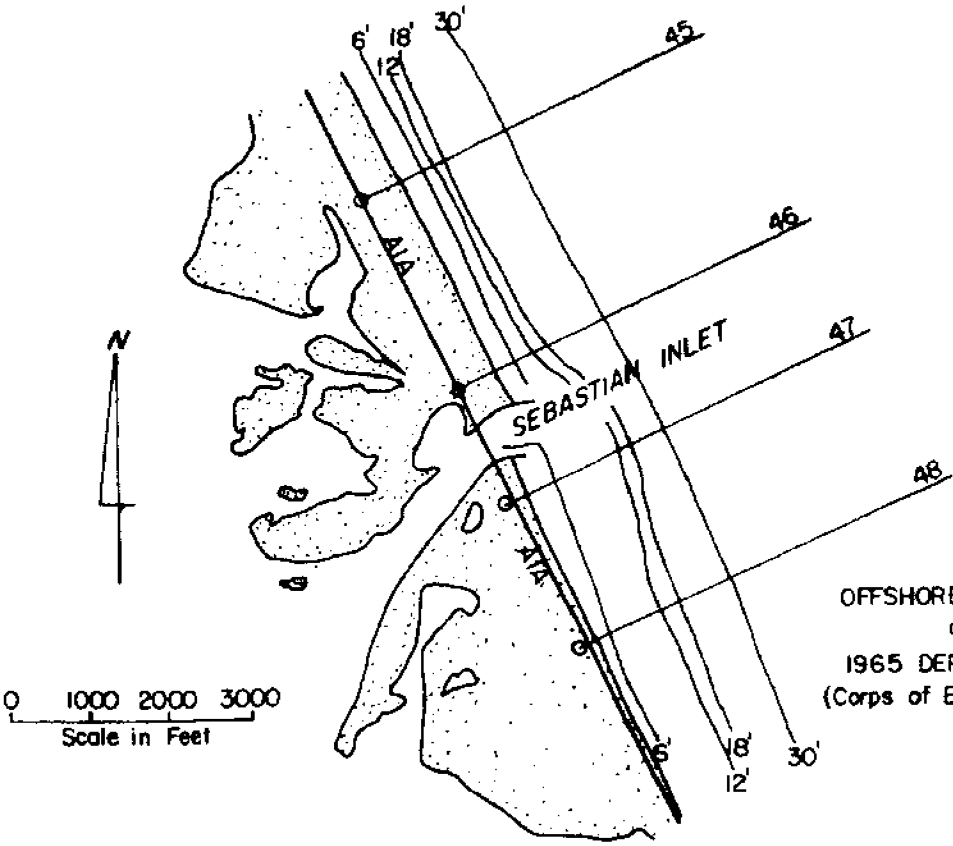
35. Walton, T.L., Jr., "Glossary of Inlets Report No. 2 - Ft. Pierce Inlet," University of Florida Sea Grant Report, July, 1974b.

36. Walton, T.L., Jr., and Adams, Wm.D., "Capacity of Inlet Outer Bars to Store Sand," Proceedings of the 15th Coastal Engineering Conference, Hawaii, July, 1976.

37. Young, D.K., et al., "Indian River Study Annual Report," The Harbor Branch Consortium, Vols. 1 and 2, Fort Pierce, Florida, 1974.

SEBASTIAN INLET
FLORIDA SEA GRANT REPORT NO. 14
ADDENDUM - SECTION 7.1, SAND VOLUME CHANGES

Surveys made by the USC&GS in 1928 and the Corps of Engineers in 1965 provide the data necessary for determining offshore depth contour movements and rates of volumetric accretion and erosion. There are four profile lines taken from these surveys in the vicinity of Sebastian Inlet as shown in the figure below.




OFFSHORE PROFILES
and
1965 DEPTH CONTOURS
(Corps of Engineers, 1967)

Data from tables D-2 and D-3 of the "Beach Erosion Control Study on Brevard County, Florida," (Corps of Engineers, November 1967) show the following trends (Note: these trends took place between 1928 and 1965, during which time the inlet closed and was reopened along a considerably different orientation; also, these trends have most certainly changed as a result of the 1970 jetty extensions):

1) The 6, 12, 18 and 30 ft. depth contours at profile line 45 advanced seaward 120, 10, 20 and 20 ft., respectively.

2) The 6 and 30 ft. depth contours at profile line 46 advanced seaward 180, and 50 ft., respectively, while the 12 and 18 ft. depth contours each receded 100 ft.

3) The 12, 18 and 30 ft. depth contours at profile line 47 advanced seaward 400, 310 and 20 ft. respectively, while the 6 ft. depth contour receded 200 ft.

4) The 6 and 30 ft. depth contours at profile line 48 receded 300 and 150 ft., respectively, while the 12 ft. depth contour advanced seaward 90 ft.; the 18 ft. depth contour did not change.

5) There has been a net volumetric accretion in the vicinity extending from 1300 ft. north of profile line 46 to 1000 ft. south of profile line 47 of 463,000 cu. yds. Approximately two-thirds of this amount accreted in the region between Sebastian Inlet and 1000 ft. south of profile line 47, for an average accretion of 4.8 cu. yds. per year per ft. of beach. The average accretion between 1300 ft. north of profile line 46 and Sebastian Inlet amounted to 2.8 cu. yds. per year per ft. of beach.

6) There has been a net volumetric erosion in the vicinity of both profile line 45 and 48, amounting to 1.1 and 4.0 cu. yds. per year per ft. of beach, respectively. The former occurred over 4,800 ft. of beach while the latter occurred over approximately 2,000 ft. of the beach.

ADDITIONAL REFERENCE

U.S. Army Corps of Engineers, Jacksonville District, "Beach Erosion Control Study on Brevard County, Florida," November, 1967.

## OTHER SEA GRANT REPORTS

No. 1 -- Research and Information Needs of the Florida Spiny Lobster Fishery

No. 2 -- St. Lucie Inlet - Sea Grant Glossary of Inlets Report #1

No. 3 -- Fort Pierce Inlet - Sea Grant Glossary of Inlets Report #2

No. 4 -- A System for the Determination of Chronic Effects of Pollutants on the Physiology and Behavior of Marine Organisms

No. 5 -- On the mariculture of the Florida Seaweed, *Eucheuma isiforme*

No. 6 -- Seawall and Revetment Effectiveness, Cost and Construction

No. 7 -- Stabilization of Beaches and Dunes by Vegetation in Florida

No. 8 -- An Indexed Bibliography of the Spiny Lobsters, Family Palinuridae

No. 9 -- Economic Structure of the Florida Shrimp Processing Industry

No.10 -- Conference Proceedings: Sharks and Man: A Perspective

No.11 -- Florida Commercial Marine Fisheries: Growth, Relative Importance and Input Trends

No.12 -- The Florida Spiny Lobster Fishery: Landings, Prices, and Resource Productivity

No.13 -- Littoral Drift Estimates Along the Coast of Florida

Copies available from:
Marine Advisory Program
G022 McCarty Hall
University of Florida
Gainesville, FL 32611

The Florida Sea Grant Program is supported by award of the Office of Sea Grant, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, contract number 04-3-158-43, under provisions of the National Sea Grant College and Programs Act of 1966. The Florida Sea Grant Program was initiated in 1972 with three major components: applied marine research, education, and advisory services.

This public document was promulgated at a cost of $ 553.63 or 37 cents per copy, to provide current information to persons interested in the management, use, and control of Florida's coastal inlets.

State University System of Florida Sea Grant Reports are published by the Marine Advisory Program which functions as a component of the Florida Cooperative Extension Service, Joe N. Busby, dean, in conducting Cooperative Extension work in Agriculture, Home Economics, and Marine Sciences, State of Florida, U.S. Department of Agriculture, U.S. Department of Commerce, and Boards of County Commissioners, cooperating. Printed and distributed in furtherance of the Acts of Congress of May 8 and June 14, 1914.

8 /1.5M/76