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16. Abstract

This report responds to the 1986 Beaches Bill which, in recognition of the deleterious impact on Florida's beaches of inlets modified for navigation, mandated a study of those inlets with identification of recommended action to reduce the impacts. This report addresses East Coast inlets; West Coast inlets are the subject of a companion report.

There are 19 inlets along that portion of Florida's East Coast commencing from St. Marys Entrance at the Georgia border to Government Cut at the south end of Miami Beach. Six inlets are constructed inlets and were cut for navigational and/or water quality purposes. Of the 19 total, all but two have been modified for navigational purposes.

A review of inlets in their natural condition demonstrates the presence of a shallow broad outer bar across which the longshore transport occurred. These shallow and shifting bar features were unsuitable for navigation which led to the deepening of the channels and training with jetties. Inlets in this modified state along with inappropriate maintenance practices have placed great erosional stress along most of Florida's East Coast beaches. The ultimate in poor sand management practice is the placement of good quality beach sand in water depths too great for

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the sand to reenter the longshore system under natural forces; placement depths of 12 ft or less are considered appropriate for Florida in order to maintain the sand in the system.

With the interruption of the longshore sediment transport by inlets modified for navigation, if the downdrift beaches are to be stabilized, there must be an effective sand transfer program. Several East Coast inlets have such transfer facilities; however, there is a need to increase substantially the quantities of sand transferred. Although an evolution and improvement in the technical capability to transfer sand around entrances is expected, a capability exists today and a concerted program should be made to commence a scheduled implementation of this capability at those entrances causing greatest erosional stress on the downdrift shorelines.

A brief summary review for each of the 19 inlets is presented including: a scaled aerial photograph, brief historical information, several items related to sediment losses at each inlet and special characteristics relevant to State responsibilities. For each inlet the above information is utilized to develop a recommended action, usually in the form of periodic sand transfer quantities.

UFL/COEL-87/017

FLORIDA'S EAST COAST INLETS: SHORELINE EFFECTS AND RECOMMENDED ACTION

by

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and

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Sponsor:

Division of Beaches and Shores
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Tallahassee, Florida 32399

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FLORIDA'S EAST COAST INLETS

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December, 1987

Submitted To:

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Department of Natural Resources

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ACKNOWLEDGEMENTS

Much of the data presented in this report were assembled by Professor A. J. Mehta and Captain J. N. Marino under contract with the Division of Beaches and Shores. This contract resulted in the University of Florida report "Sediment Volumes Around Florida's East Coast Tidal Inlets". Captain Marino participated in the early stages of the present study in organizing much of the data contained in the inlet summary forms. The contributions of Ms. Lethie Penquite in assembling and preparing the photographs for the inlet summary forms is greatly appreciated. Ms. Cynthia Vey provided her usual expert manuscript preparation including typing and checking.

FLORIDA'S EAST COAST INLETS
SHORELINE EFFECTS AND RECOMMENDED ACTION

INTRODUCTION

At present, the nineteen inlets and channel entrances between the Florida-Georgia border to Government Cut at the southern terminus of Miami Beach serve as navigational entrances and passageways for renewal of water to the bays and lagoons behind the barrier islands. All but two of these entrances have been modified for navigational purposes or were artificially created for navigation or water quality purposes. In their natural state, these entrances were generally unsuited for navigation of commercial size vessels. The deepening of these channels, the construction of jetties for reduced channel maintenance and the dredging to maintain channel depth and alignment have caused severe deleterious effects on the adjacent shorelines. The effects are due primarily to the deprivation of the downdrift shorelines of the supply of sand received in their natural conditions. Clearly, if these entrances are to serve navigation without causing severe downdrift effects, the transport of sand that has been interrupted by these entrances must be reinstated. The purpose of this report is to provide a very brief historical review and assessment of the effects of East Coast entrances on the adjacent shorelines and, based on the available information, to develop recommendations for remedial measures. This report is a companion document to the report "FLORIDA'S WEST COAST INLETS - SHORELINE EFFECTS AND RECOMMENDED ACTION".

EAST COAST INLETS IN THEIR NATURAL STATE

Under natural conditions, the East Coast inlets differed both in number and in character from those currently present. These entrances and their associated shoals achieved long-term equilibrium with the sand transport processes. Due to the predominant northeast direction of wave approach, the net longshore transport of sand is from north to south at the estimated rates presented in Figure 1.

Typically, as demonstrated by Fineren (1938), the characteristics of these inlets included a broad shallow ocean bar; perhaps with a channel incised through the bar. Table I, from Fineren, demonstrates that the bar depth was typically 3 to 6 ft, much too shallow for navigational purposes.

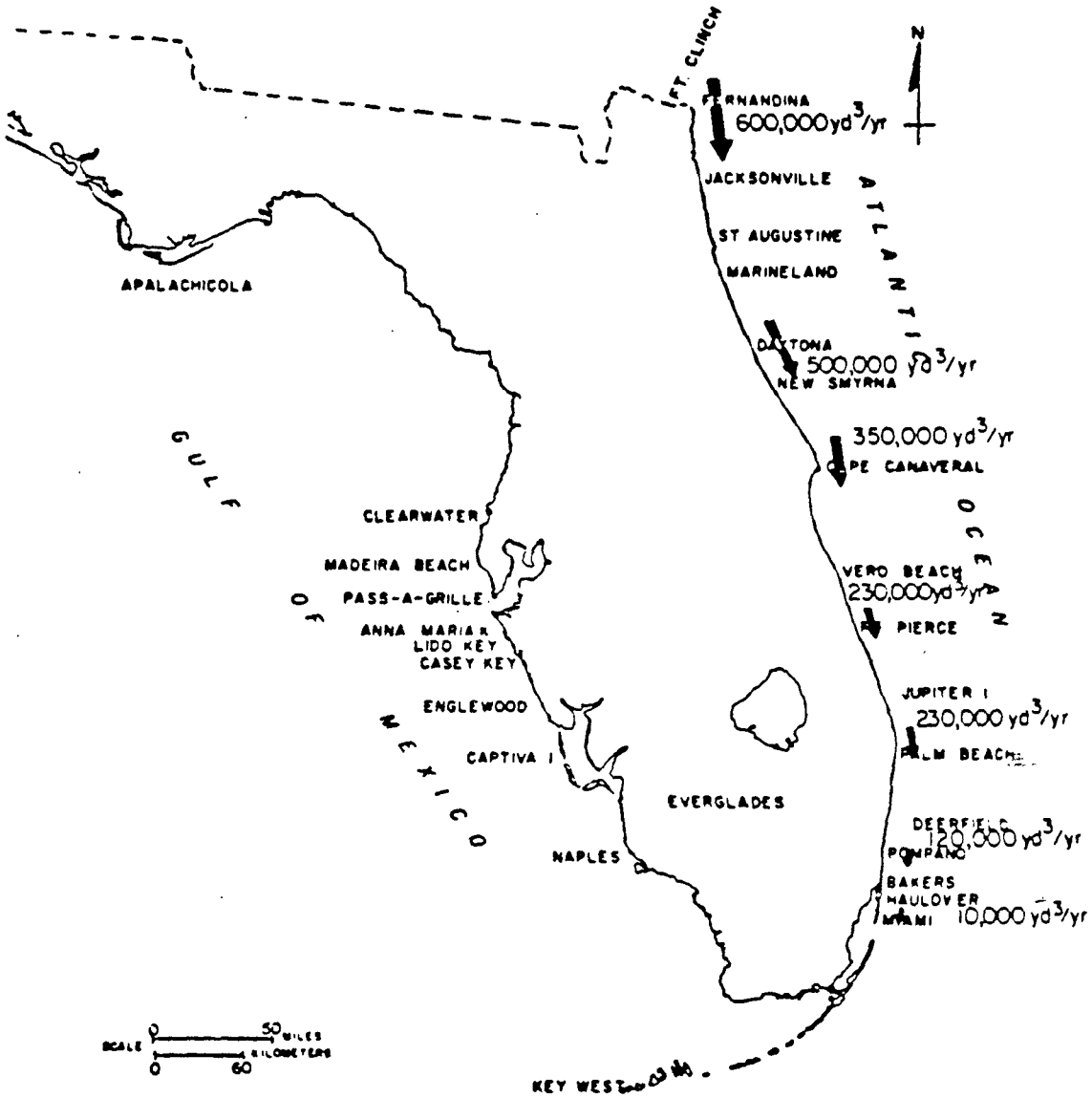


Figure 1. Estimates of Net Annual Longshore Sediment Transport Along Florida's East Coast.

TABLE I

NATURAL DEPTHS IN CHANNELS AND ON BARS

Florida's East Coast Entrances

(From Fineren, 1938)

Entrance	Depth on Bar (ft)	Channel Depth (ft)
Nassau Sound	4	21-27
Fort George Inlet	4	11-26
St. Augustine Inlet	6	10-30
Matanzas Inlet	Nearly Blocked	12-18
Mosquito Inlet	Nearly Blocked	9-26
Canaveral Bight	6 to 18	30-40
Indian River Inlet	Blocked	7-8
St. Lucie Inlet	4	8-12
Jupiter Inlet	Blocked	3-5
Lake Worth Inlet	3	3-9
New River Inlet	8	10-15
Hillsboro Inlet	2.5	3-4
Norris Cut	Not Affected by Sand	Shoal
Bear Cut	4	7-17
Cape Florida Channel	Not Affected by Sand	Coral Reefs

Although the channels incised through the bar were considerably deeper, they were still too shallow for modern commercial purposes. Additional serious navigational disadvantages of these natural channels were their tortuous alignments and migrational tendencies.

Although their number varied with time and storm history, in their natural condition, there were usually only 13 inlets present in the shoreline segment where there are now 19. Figure 2 presents a breakdown of the origin of the 19 inlets currently present.

In their natural state, inlets will achieve an equilibrium with the natural sand supply and processes. This "equilibrium" may include fairly severe fluctuations of the shoreline as the channel migrates through the bar to achieve transfer of the longshore transport. The ocean bar, its connection to the adjacent shorelines and the adjacent shorelines have been termed by coastal geologists as a "sand sharing system". It is important to recognize that the form and geometry of this sand sharing system play a vital role in maintaining the continuity of longshore sand transport processes along the East Coast. In particular, the broad shallow ocean bars functioned as "sand bridges" across which the sediment transport occurred from the updrift (north) to downdrift (south) beaches. The interference with or geometric modification of this sand sharing system, particularly the ocean bar, could cause substantial interruption of the sediment supply to the downdrift shoreline.

EAST COAST INLETS IN THEIR MODIFIED STATE

Entrances, constructed or modified for navigational purposes, differ from natural inlets in four respects: (1) the entrance channels are deeper, (2) jetties are generally present, (3) periodic dredging may be required to maintain the design channel depth, and (4) the channel alignment is fixed. The effects of each of these differences are discussed below. Dean (in press) presents a more detailed discussion of the effects of modified inlets on adjacent shorelines and recommends measures for improvement.

Deeper Entrance Channel

As noted previously, to accommodate the longshore sediment transport, inlets in their natural state include shallow broad ocean bars which function as sand "bridges" across which the net longshore sediment transport occurs

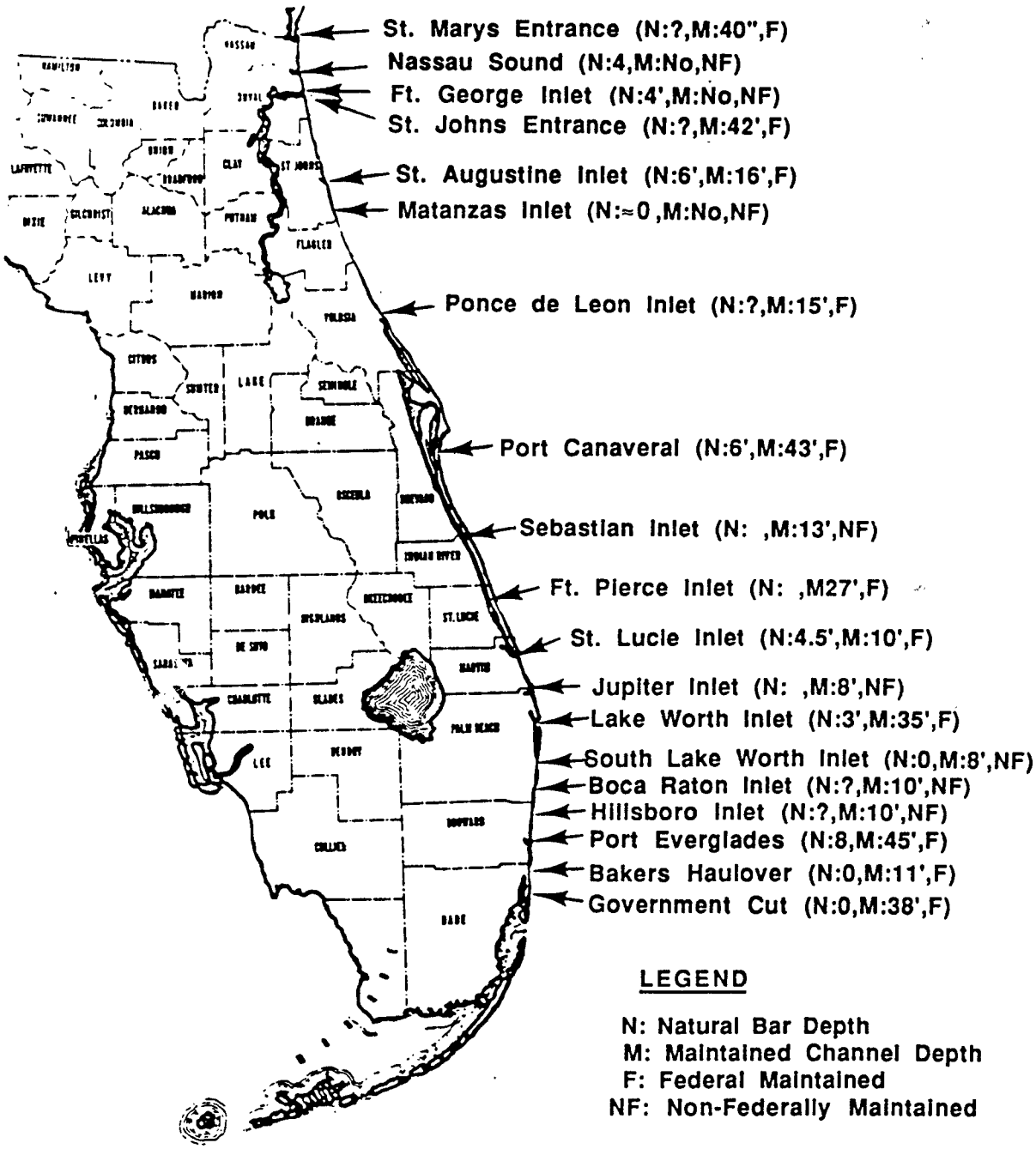


Figure 2. Natural and Modified Bar Depths Along Florida's East Coast Inlets and Jurisdiction of Channel Maintenance.

around the inlets. A channel deeper than the natural shallow depth over the bar interrupts this transport. The system responds by attempting to rebuild the bridge through deposition commencing on the updrift side of the channel, a well-known phenomenon. If no attempts are made to maintain the channel depth, the channel will fill, approaching the natural depth after which the full transport processes will resume. It is important to recognize that if a quantity of sediment is removed from the sand sharing system by dredging the navigational channel; and if the channel is allowed to fill, the fill volume will result in the downdrift system suffering that volumetric deficit required to fill the channel. In a more likely case, dredging is carried out to maintain the channel at the desired depth. If this dredged sediment is not reintroduced into the system at the proper location(s), erosion will occur at these location(s) and farther downdrift.

Effects of Jetties

There are several purposes of jetties at navigational entrances. In addition to providing wave sheltering to vessels entering the channel, jetties are designed to prevent or reduce the amount of sand which would enter a channel, primarily in the more active nearshore region. Also, as the term suggests, jetties are intended to "jet" sand that would otherwise tend to be deposited within the region of natural sediment motion including the outer bar to water depths in excess of that desired for navigation. This explains the rule of thumb that jetties should be constructed out to the desired navigational depth. Olsen (1977) has determined that the St. Marys Entrance jetties, constructed in the late 1800's and early 1900's, have caused the seaward displacement of 120 million cubic yards an additional 2 miles offshore. Jetties can cause adverse effects to the downdrift beaches simply by impounding sand which must be manifested as downdrift erosion. The aforementioned jetting of material an additional distance offshore such that it no longer is part of the sand sharing system results in a loss to the nearshore system in general and adjacent shorelines in particular.

Channel Maintenance Dredging

Sand dredged from navigational channels to maintain their depths, if not placed at the appropriate locations on the adjacent beaches, will cause a

deficit of sediment to be manifested as erosion. In the simplest case of a unidirectional sediment transport and in which only the net transport enters the channel, obviously placement of the dredged material on the downdrift beaches is appropriate. In more realistic cases, the proper placement location may be best determined by monitoring the adjacent shorelines to determine need. A modified inlet may result in the transport and deposition in an inlet channel of substantially greater quantities than the net longshore sediment transport. The legacy of offshore placement in deep water of large quantities of beach quality sand dredged from inlets has caused a serious erosional stress on Florida's East Coast beaches. As shown in Table II, as recently as during the 1980-1985 period, almost half (47%) of beach quality material dredged from the Federally-maintained East Coast inlets was placed in water depths too great to return to and benefit the beach system.

Fixed Channel Alignment

Although the character of channel alignment differs for modified and natural channels, the fixed alignment per se is not necessarily responsible for adverse effects to adjacent shorelines. It is the previously discussed measures that are taken to maintain the alignment that cause these adverse shoreline effects.

Summary of Modified Channel Effects

In summary, there are two types of potential adverse effects that a modified channel entrance can have on adjacent beaches: (1) a distribution effect, i.e. accretion in one location and corresponding erosion in another, and (2) a net erosion. Jetty impoundment is an example of the former in which the volumetric increase of sand on the updrift side of the inlet is balanced (in volume) by a corresponding erosion on the downdrift side. In this case, there is no net loss of sand to the system. The offshore deposition of dredged sand or the jetting of sand to water depths greater than those of the sand sharing system will result in a net and permanent loss to the nearshore system. Although both of these types of effects are serious, the net loss of sand to the nearshore system is more detrimental and will appear as a net erosion of the shoreline.

TABLE II

SUMMARY OF ANNUALIZED (1980 - 1985) QUANTITIES AND PERCENTAGES FOR PLACEMENT OF BEACH QUALITY SAND

(Federally Maintained East Coast Inlets)

Entrance	Amount Dredged Beach (yd^3/yr)	Amount Placed on Beach (yd^3/yr)	Amount Placed Offshore (yd^3/yr)	Offshore Depth of Placement (ft.)
St. Marys Entrance (Fernandina Harbor)	60,000	60,000	0	-
St. Johns Inlet (Jacksonville Harbor/ Mayport)	644,530	214,070 (33%)	430,460 (67%)	41-50
St. Augustine Inlet	20,210	0 (0%)	20,210 (100%)	17
Ponce de Leon Inlet	163,700	163,700 (100%)	0	-
Port Canaveral Harbor	0	0	0	44-48
Ft. Pierce Harbor	4,260	0 (0%)	4,260 (100%)	50
St. Lucie Inlet	76,800	76,800 (100%)	0 (0%)	-
Lake Worth Inlet (Palm Beach Harbor)	82,640	40,270 (49%)	42,370 (51%)	40-50
Totals	1,052,140	554,840 (53%)	497,300 (47%)	

METHOD OF BYPASSING SAND AND EXISTING EFFORTS

From the preceding discussion, it is clear that generally improved sand management practices will be required at entrances if the adverse effects on adjacent shorelines are to be reduced. Undoubtedly, considerable innovation will be required to minimize future costs and maximize efficiency.

Perhaps somewhat surprisingly, responsible entities at some East Coast entrances have been bypassing sand for several decades. Jones and Mehta (1980) have summarized the bypassing efforts in Florida. In most cases, the bypassing and funding are accomplished by an "inlet district", a taxing district authorized by the Florida Legislature. To provide perspective, the six entrances at which bypassing is being carried out are discussed below.

Sebastian Inlet

Sand transfer at this inlet is managed by the Sebastian Inlet Commission, a taxing authority which encompasses portions of Brevard and Indian River counties. Transfer is accomplished from a depositional basin located 2,500 ft inside (west) of the inlet throat. Recent transfer efforts have been hampered by environmental concerns over the amounts of fines present and the presence of Sabellariid (worm) rock reefs immediately south of the south jetty.

Jupiter Inlet

This entrance is managed by the Jupiter Inlet Authority and bypasses sand on a biennial basis with the material obtained predominatly from a deposition basin located 1,000 ft west of the inlet throat.

Port of Palm Beach Entrance

This entrance, also known as Lake Worth Entrance, was cut in 1917 as a replacement for a natural shallow inlet located to the north. The fixed bypassing plant was installed on the north jetty in 1958. Currently, the county is responsible for bypassing. Records indicate an average annual bypassing of approximately 70,000 cubic yards per year compared with the estimated net longshore sediment transport of 250,000 yd^3 per year. One shortcoming of the bypassing plant is that interests on the updrift (north) Singer Island were effective in requiring the installation of a low submerged

"coffer dam" around the sand intake point to limit the amount of sand which can flow to the bypassing plant. The limited effectiveness of the bypassing plant is reinforced by the annual dredging to maintain the channel depth of 35 ft. Records available over the six year period, 1980-1985, indicate that an average annual amount of 42,370 cubic yards was dredged from the channel and placed offshore.

Over the history of this entrance, 2.8 million cubic yards of dredged material have been lost due to deep water disposal. In addition to placing large quantities of sand offshore, earlier disposal practices included placement in an interior shoal called "Peanut Island" which has been built to approximately 25 ft in elevation and contains an estimated 1.2 million cubic yards. Much of the 20 mile segment forming Palm Beach Island is in an advanced degree of erosion.

South Lake Worth Inlet

This entrance, also known as Boynton Inlet, is located approximately 20 miles south of Lake Worth Inlet and was cut in 1927 to provide additional flushing to improve the water quality of Lake Worth. Upon completion of cutting the inlet and installation of short jetties, downdrift erosion was swift and dramatic. Recognizing the need to replace the interrupted longshore transport, in 1937 local interests installed the first (in the world) fixed sand bypassing plant. This plant has undergone modifications and relocations, but in principle is the same as initially installed in 1937. The bypassing history at this entrance indicates recent average annual transfer rates of 60,000 cubic yards per year compared with the estimated net longshore sediment transport of 220,000 cubic yards per year. The fact that the bypassing is inadequate is evident by the large offset at the entrance and the eroded conditions of the downdrift shoreline as compared to that updrift.

Boca Raton Inlet

This inlet is maintained by the City of Boca Raton utilizing a small dedicated floating dredge to bypass sand flowing through a fairly small (60 ft wide) low weir section in the updrift jetty. The weir feature was added fairly recently (1980) and appears to be functioning reasonably well. In addition to bypassing material settling in the deposition basin, approximately

750,000 cubic yards were removed from the ebb tidal shoal in 1985 and placed on the downdrift beaches. This placement widened these beaches substantially; however a visit in November 1987 showed that these beaches were returning to an eroded condition.

Hillsboro Inlet

Inlet modifications in 1966 incorporated a weir section into the updrift (north) jetty. The base of this weir section is a natural rock reef. A deposition or settling basin is located immediately inside the weir section. This entrance is managed by the Hillsboro Inlet District and has been bypassing sand for the past 25 years.

Bypassed quantities, averaged over 1952 to 1976, are 70,000 cubic yards per year and are to be compared with the estimated annual net longshore sediment transport of approximately 200,000 cubic yards per year.

A CASE STUDY - PORT CANAVERAL ENTRANCE

Although, because of the complexity and diversity of East Coast entrances, no particular entrance can be representative, Port Canaveral Entrance is selected here as an example for more detailed discussion as it is fairly young and documentation in terms of shoreline effects is relatively good.

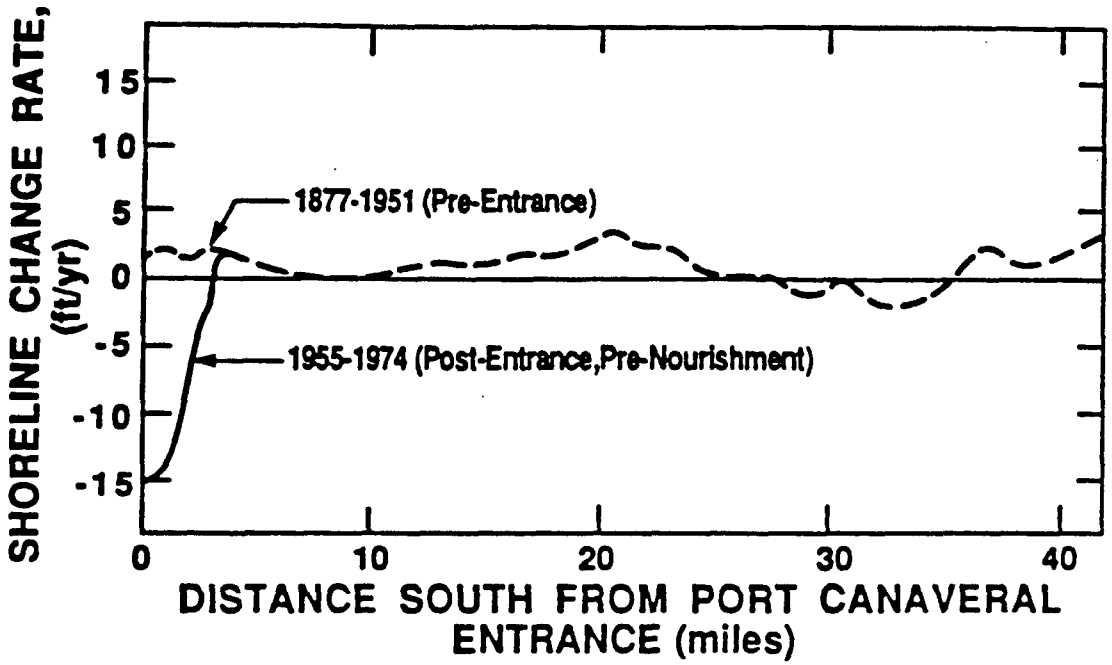
Port Canaveral is an artificial entrance which was cut in 1951 in the Canaveral Bight, a location sheltered from the northeast waves by Cape Canaveral and the associated offshore shoals. Jetties were not constructed prior to excavation of the channel and erosion of the adjacent shorelines with deposition in the channel occurred so rapidly during construction that it was not possible for the dredge to excavate the channel to the desired depth. Jetty construction was carried out in 1953-1954.

Prior to the channel construction, it was estimated by the U.S. Army Corps of Engineers that the net longshore sediment transport was 350,000 cubic yards per year to the south, and that erosion would occur at this rate in the downdrift located cities of Port Canaveral, Cocoa Beach, Satellite Beach, etc. In recognition of this potential for downdrift erosion, in 1967 the Corps of Engineers studied the possibility of installing a sand transfer

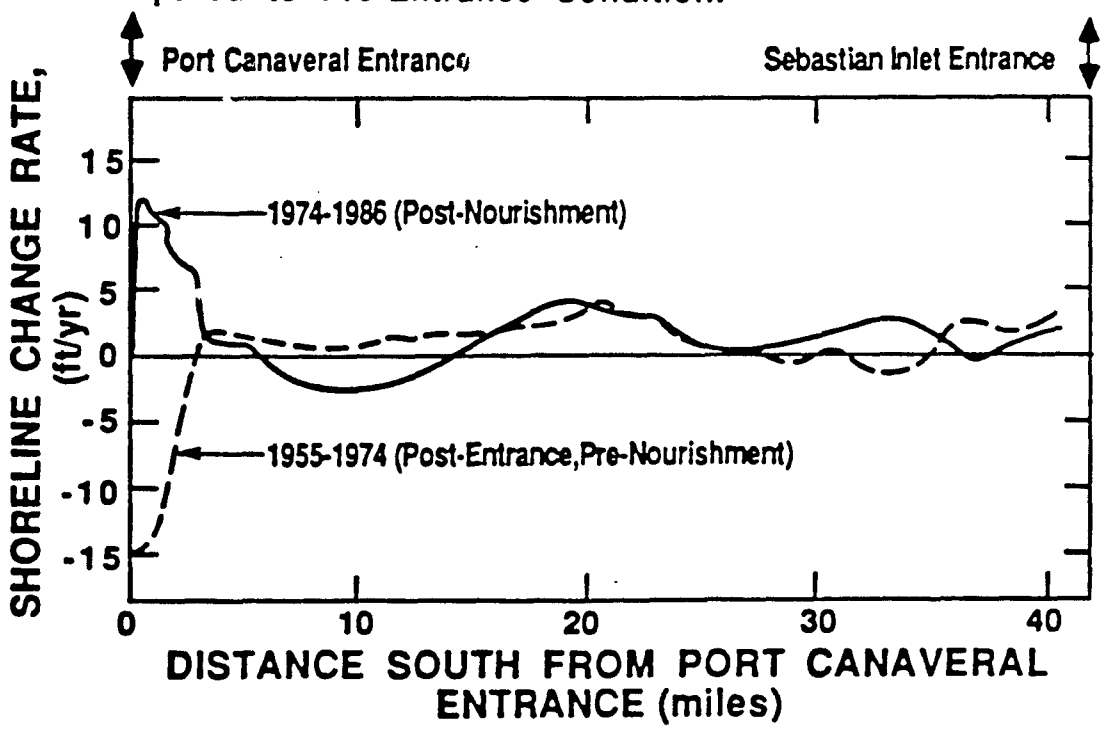
system and concluded that it was practical. This possibility is again currently (1987) under study. None of the study efforts to date has resulted in a sand bypassing installation, even though the need for such a facility was recognized in the initial (1950) report and a sand transfer facility was authorized in 1967.

It is enlightening to examine pre- and post-entrance downdrift shoreline changes. Figure 3a presents the shoreline changes from 1877 to 1951, prior to entrance construction for the 41 mile segment downdrift of Port Canaveral Entrance. It is clear that in its natural condition, although there were areas of erosion and accretion, on the average this 41 mile shoreline segment was accreting at a rate of approximately 1 ft per year. Figure 3a also documents the erosion over the 23 year period 1951 to 1974. Immediately downdrift (south) of the entrance, erosion rates were up to 16 ft per year with a maximum localized erosion extent of nearly 400 ft in the 23 year period. Interpretation of these data indicated that the volumetric rate of erosion is approximately 200,000 cubic yards per year rather than the 350,000 cubic yards per year originally estimated.

By the early 1970's, the downdrift erosion had become so acute that local interests initiated legal action to remedy the erosion conditions caused by the entrance. The legal settlement included the placement, in 1974, of approximately 2.5 million cubic yards of sand on the 2.1 mile segment immediately south of the south jetty. The shoreline over this segment was advanced seaward an approximate distance of 400 ft which more-or-less reestablished the pre-entrance shoreline. Figure 3b presents the shoreline changes between 1974 and 1986. Several features are noteworthy. First by 1986, the erosion that was formerly located within 4 miles south of the south jetty had by 1986 spread out to a distance of 14 miles south of the entrance. Secondly by 1986, the nourishment placed within 2.1 miles of the south jetty had benefitted the beach system up to 4 miles south. Finally, even though the 12 year period (1974-1986) is not long compared to shoreline changes, it is of interest to note that by-and-large the shoreline changes outside the limit of influence of the entrance exhibit strong similarities to those based on the longer term changes (1877-1951).



a) Effects of Channel Entrance on Downdrift Beach Stability, Compared to Pre-Entrance Condition.



b) Shoreline Changes Following 1974 Nourishment Project.

Figure 3. Effects of Establishment of Cape Canaveral Entrance and Subsequent Nourishment Project on Downdrift Beaches (Shoreline Change Results Provided by J. H. Basillie).

INFORMATION AND RECOMMENDATION SUMMARY

This section presents, for each inlet, information and recommendations in a two-page summary form. The order of presentation of the inlets is from north to south, commencing with St. Marys Entrance at the Florida-Georgia border and concluding with Government Cut at the south end of Miami Beach. The items presented and some background as to their relevance are discussed briefly below.

Photograph - A scaled aerial photograph is presented to illustrate the character of the inlet including modifications if present. In many cases, qualitative effects of the entrance on the downdrift and updrift shorelines are evident.

Brief Historical Information - Provides background, including whether inlet is natural or constructed and the timing of modifications.

Sediment Balance - Addresses several items relevant to adjacent shoreline stability. Increases in volumes of sand in the ebb tidal shoal generally represent good quality sand removed from the beach system and in most cases sand suitable for shoreline nourishment.

Net littoral transport rates provide a measure of the net amount of sand moving under natural forces along the shoreline. Where inlet modifications have altered the system through channel deepening, jetty construction, etc. to a degree that natural transport is interrupted, it is this quantity that must be transferred by engineering measures to ensure stability of the downdrift shoreline. Two estimates of the net longshore sediment transport are presented. The first denoted USAE is as presented by the U.S. Army Corps of Engineers and is generally based in part on the rate of updrift sediment accumulation against newly constructed jetties. The second estimates were developed by Walton (1976) based on observations of wave characteristics made by ships at sea.

Shoreline volume changes provide a measure of the impact of the entrance on the adjacent shoreline. The usual pattern is

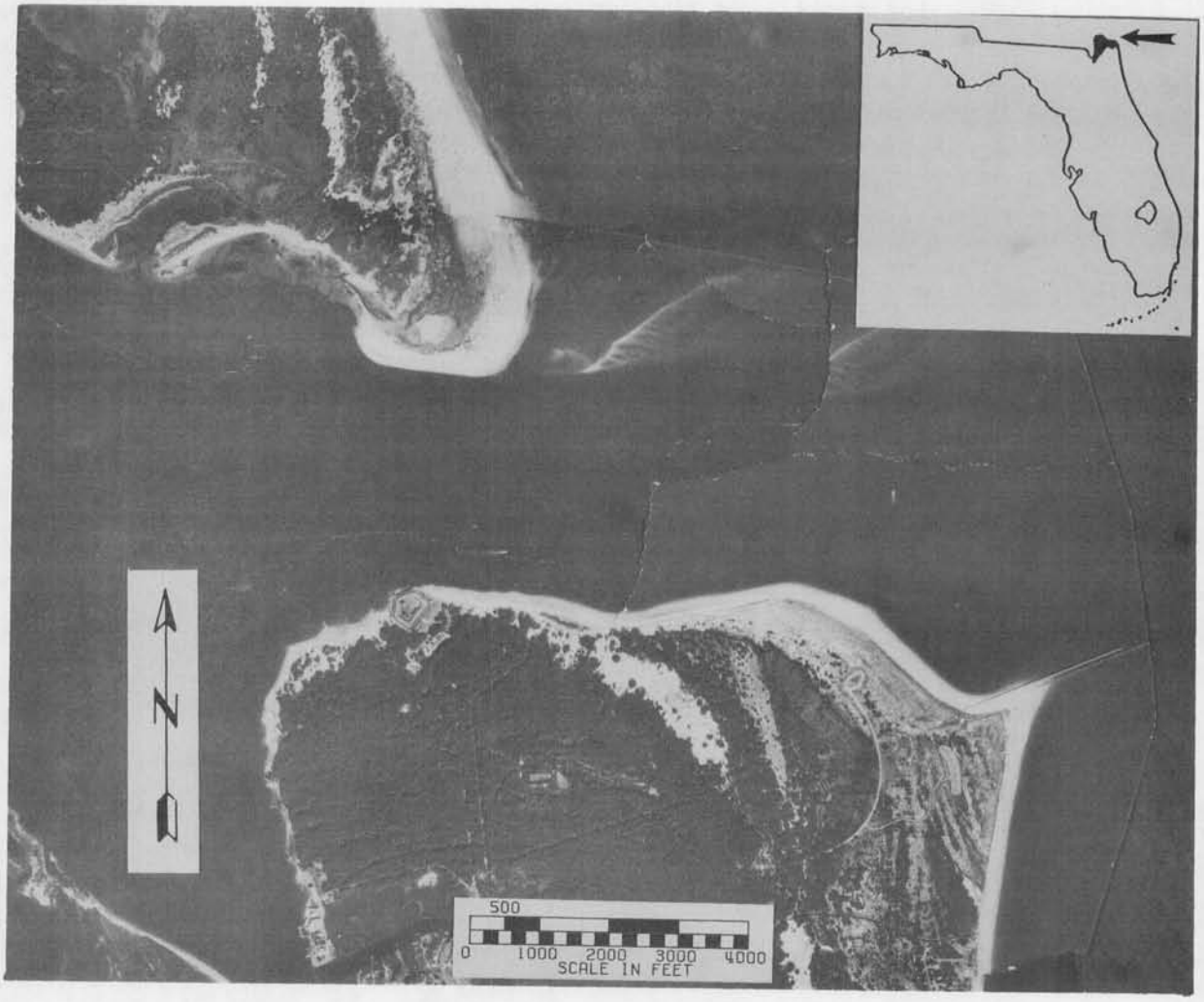
accretion updrift of the entrance and erosion of the downdrift shoreline. However, if the updrift jetties allow sand to drift through them, it is possible that the updrift shorelines will accrete at lower rates than the net longshore transport, or in the limiting case, erosion of the updrift shoreline can occur.

Brief Dredging History - Provides information relevant to adjacent shoreline impact. In particular good quality sand disposed in deep water usually represents sand from the longshore transport system and therefore will result, on a per unit volume basis, in erosion of the adjacent shoreline(s).

Special Characteristics Relevant to the State Responsibilities - Identifies those operational or jurisdictional features that are relevant to the State's responsibility to providing maximum stability of the beach resource.

Recommended Action - All available information is synthesized into concise recommendations which are in accordance with the requirements of the 1986 Beaches Bill. Because of the importance of these recommendations, they are highlighted inside a rectangular enclosure.

ST. MARYS ENTRANCE



(Date of Photography: December 17, 1985)

Brief Historical Information

- First survey of the natural inlet in 1875.
- Construction started on north jetty in 1881.
- South and north jetties completed in 1904.
- In connection with the King's Bay Terminal project, depth became 36-40 ft. and channel width 375 ft. in 1978.
- Present plans include a project depth of 46 ft.

ST. MARY'S ENTRANCE

Sediment Balance

Ebb shoal:

1870 -	118.2 million cubic yards
1974 -	126.0 million cubic yards

Net littoral transport rate:

550,000 cubic yards per year (Southward-USAE)
200,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1857-1975:

+11.6 million cubic yards over 14,600 ft. south of south jetty
+10.5 million cubic yards over 5,000 ft. north of north jetty
-12.2 million cubic yards (erosion) over 25,000 ft. of shore north of the 5,000 foot fillet north of north jetty

Brief Dredging History

- From 1903-1985, 12.9 million cubic yards was dredged from the entrance channel; 400,000 cubic yards was placed on the south beach; the remainder has been disposed of at sea.

Special Characteristics Relevant to State Responsibilities

- St. Mary's Entrance is part of the King's Bay Trident project.
- There is erosion in the City of Fernandina and along the southerly portions of Amelia Island.

Recommended Action

- The net littoral transport (between 200,000 and 550,000 cubic yards per year) should be by-passed to Fernandina Beach. The Navy and the State of Florida have signed a Memorandum of Understanding calling for all maintenance dredging to be placed on Amelia Island, as required to maintain stability of this shoreline.

NASSAU SOUND

(Date of Photography: December 27, 1985)

Brief Historical Information

- Natural inlet without dredging or jetties.
- Over the past century, the major changes have been the recession of the southern portion of Amelia Island to the north, the accretion of Little Talbot Island to the south, and the emergence of Bird Island.
- Entrance 5,600 ft. wide with quite variable depth, up to 20 ft.

NASSAU SOUND

Sediment Balance

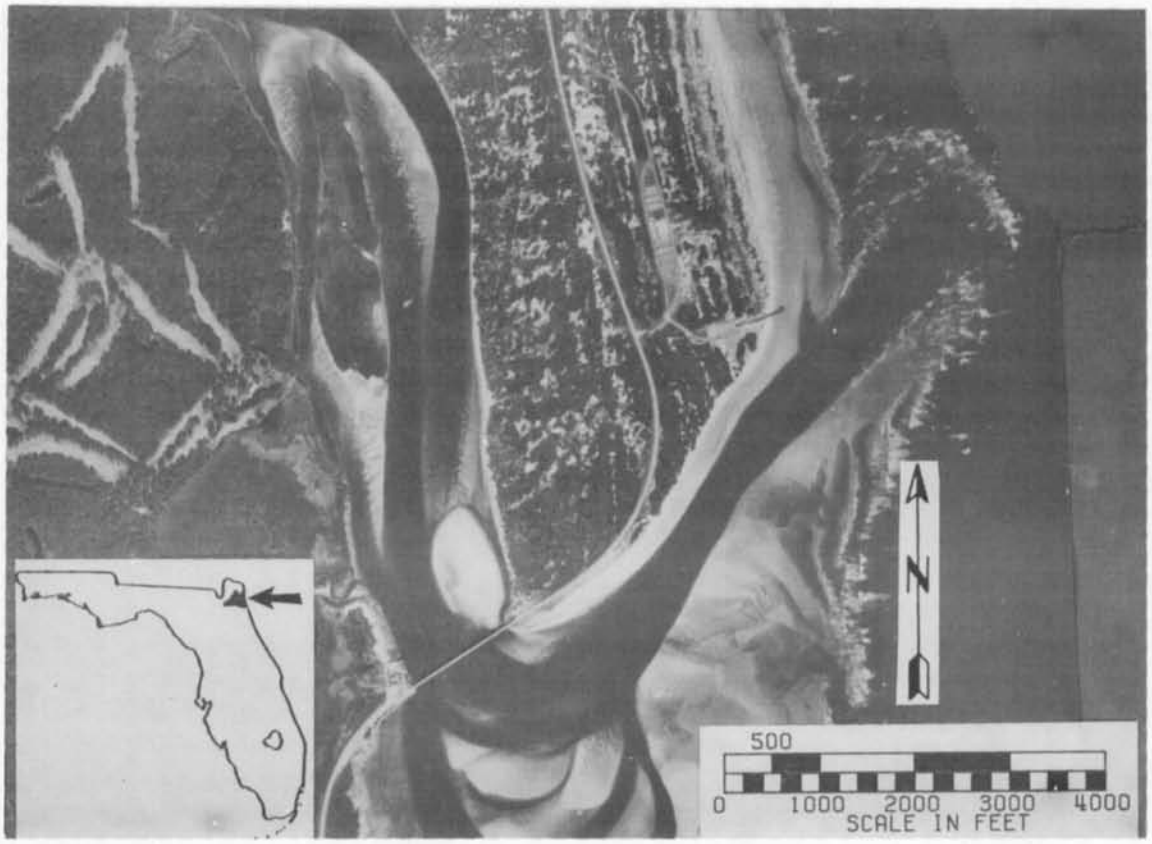
Ebb shoal:

1871 -	49.4 million cubic yards
1954 -	53.7 million cubic yards
1973 -	40.5 million cubic yards

Recommended Action

- As this is a natural entrance, no action is recommended.

FT. GEORGE INLET



(Date of Photography: January 5, 1982)

Brief Historical Information

- In 1881, construction of the north jetty at St. John's River partially stabilized the position of Ft. George Inlet.
- In 1934, the north jetty at St. John's Entrance was sand-tightened with a concrete cap.
- In 1937, jetties at St. John's River were extended: north jetty, 14,300 ft. long; south jetty, 11,200 ft. long.
- In 1949, bridge of 30 bents constructed across Ft. George channel near mouth.

FT. GEORGE INLET

Special Characteristics Relevant to State Responsibilities

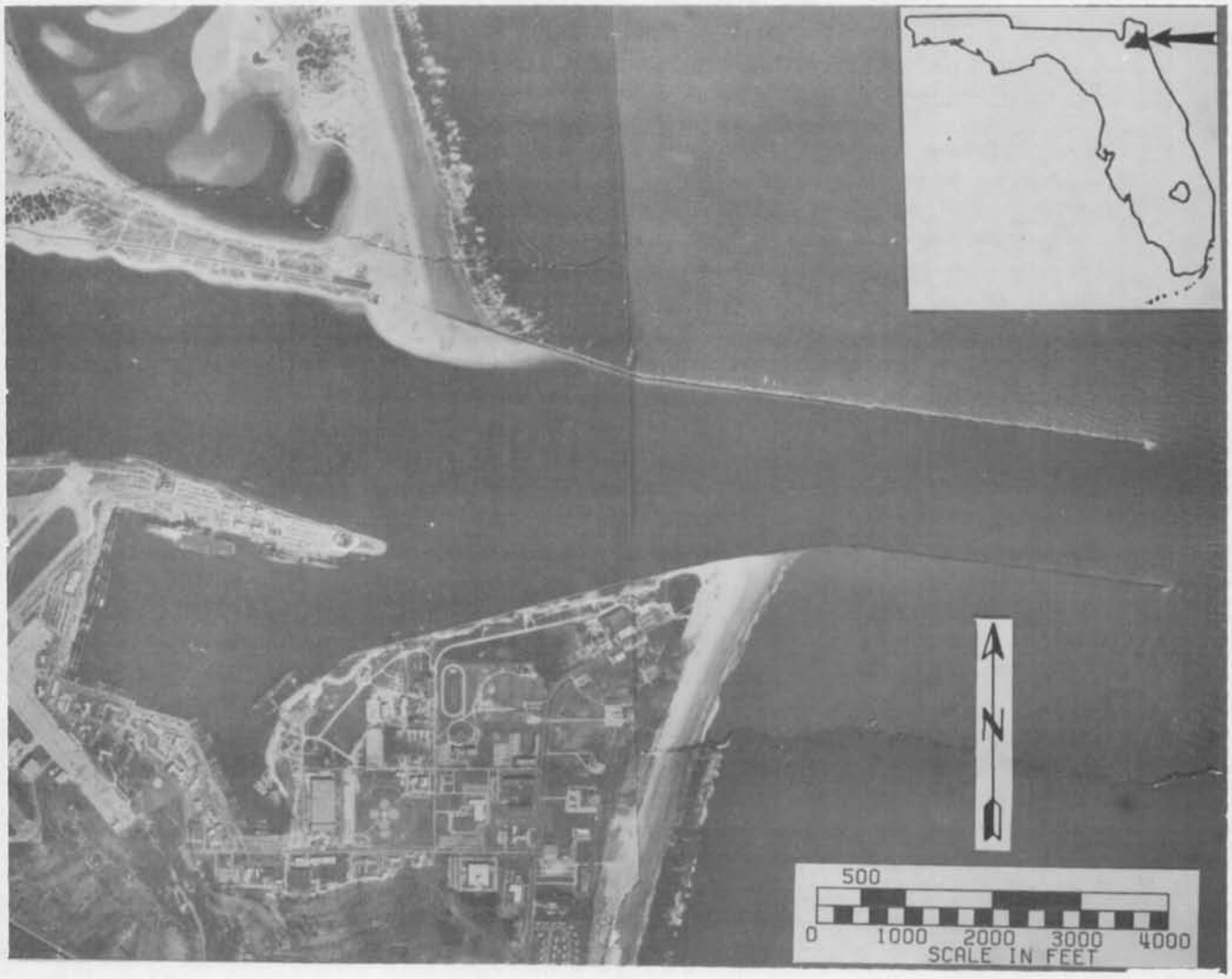
- The Ft. George ebb shoal coalesces with St. John's shoal and is reported with St. John's data.

- Spit growing northward from St. John's River north jetty towards Ft. George Entrance. Substantial erosion of Little Talbot Island has resulted.

Recommended Action

- Consideration should be given to relocating the channel to the south, thereby reducing the erosion on the south end of Little Talbot Island.

ST. JOHNS RIVER ENTRANCE (JACKSONVILLE HARBOR)



(Date of Photography: January 5, 1987)

Brief Historical Information

- Federal navigation project.
- St. Johns River mouth stabilized by jetties in period 1881-1890.
- North jetty sand-tightened with concrete cap in 1934.
- In 1937, north jetty lengthened to 14,300 ft. and south jetty lengthened to 10,600 ft.
- Channel deepened to 42 ft. in 1965.

ST. JOHNS RIVER ENTRANCE (JACKSONVILLE HARBOR)

Sediment Balance

Ebb shoal:

1874 -	52.7 million cubic yards
1967 -	90.2 million cubic yards
1978 -	174.0 million cubic yards

Flood shoal:

1970 -	1.0 million cubic yards

Net littoral transport rate:

480,000 cubic yards per year (Southward-USAE)
250,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1924-1970:

- 31.0 million cubic yards over 59,000 ft. south of entrance
+ 13.0 million cubic yards over 21,000 ft. north of entrance

Brief Dredging History

- From 1925-1985, 26.4 million cubic yards were dredged. Of that total 20.8 million cubic yards were disposed at sea, 4.1 million cubic yards were placed inland, and 1.5 million cubic yards were placed on the south beach.

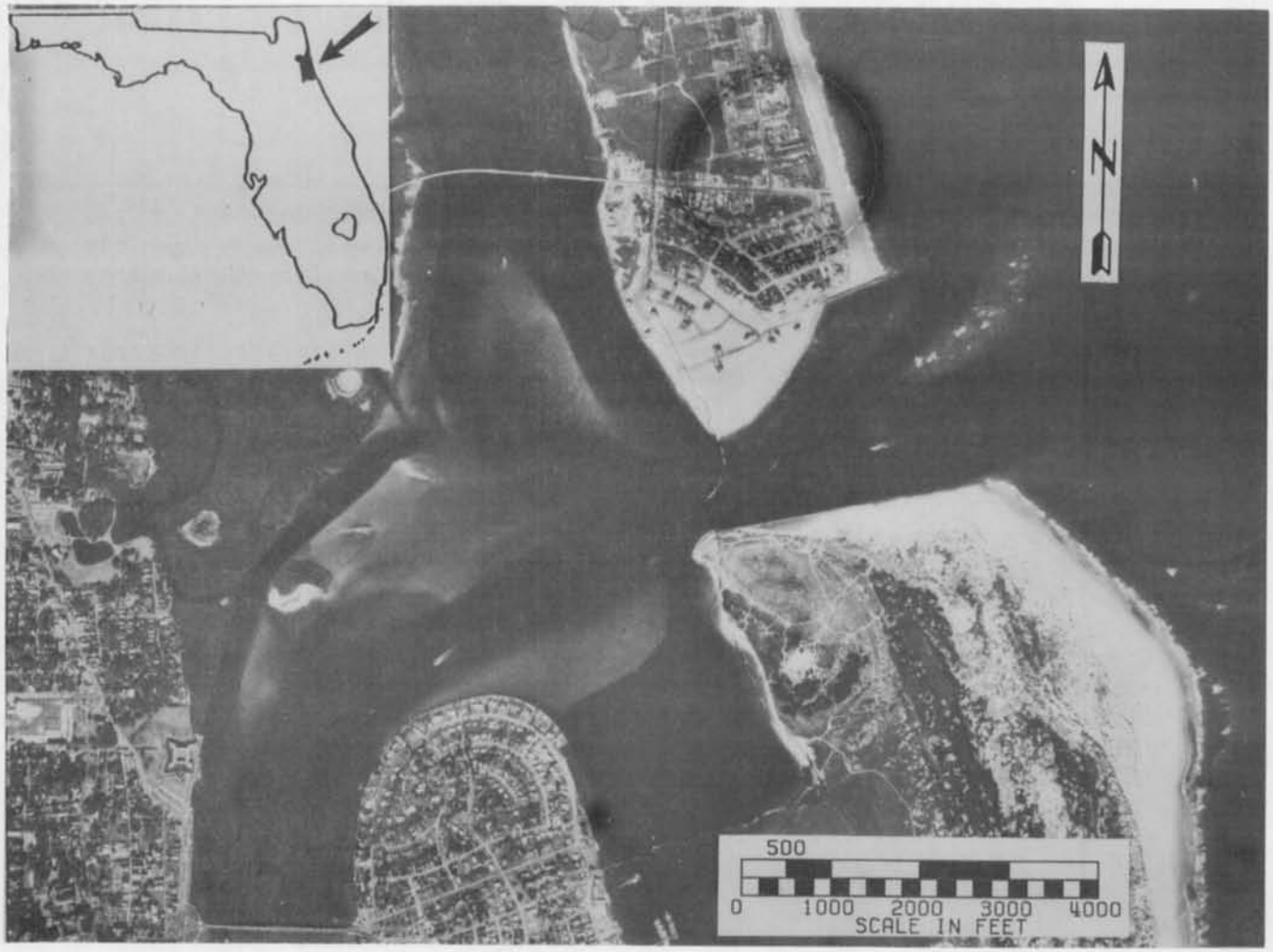
Special Characteristics Relevant to State Responsibilities

- Channel maintenance by Corps of Engineers.
- Beach south of entrance must be replenished at frequent intervals.
- Over the period 1980-1985, an average of 214,070 cubic yards per year or 33% of the beach quality sand dredged for maintenance was placed on the downdrift shoreline.

Recommended Action

- Place all beach quality dredged material from the channel on the beach south of the entrance in a "feeder beach". Similar previous placements have proven effective.

ST. AUGUSTINE INLET



(Date of Photography: December 31, 1985)

Brief Historical Information

- Two natural inlets existed before construction of the north jetty and excavation of the channel at a third location in 1941. South jetty constructed in 1957.
- Authorized channel width 200 ft.; depth 16 ft.
- Maintenance by Corps of Engineers.
- Connected to Intracoastal Waterway.

ST. AUGUSTINE INLET

Sediment Balance

Ebb shoal:

1924 -	76.7 million cubic yards
1955 -	106.0 million cubic yards
1979 -	110.4 million cubic yards

Flood shoal:

1970 -	0.7 million cubic yards

Net littoral transport rate:

440,000 cubic yards per year (Southward-USAE)
380,000 cubic yards per year (Southward-Walton)

Reversal of direction frequent in summer months. Shoreline has changed markedly since opening the new channel.

Shoreline volume change, 1924-1976:

+1.5 million cubic yards over 13,000 ft. north of inlet
+7.3 million cubic yards over 30,000 ft. south of inlet

No erosion occurring over 4 mile segment south of inlet, but severe erosion occurs south of this point.

Brief Dredging History

- From 1940-1985, a total of 1.6 million cubic yards of material has been dredged. All but 120,000 cubic yards of this material has been placed on the beach or within the littoral zone (greater than 12 ft. depth).

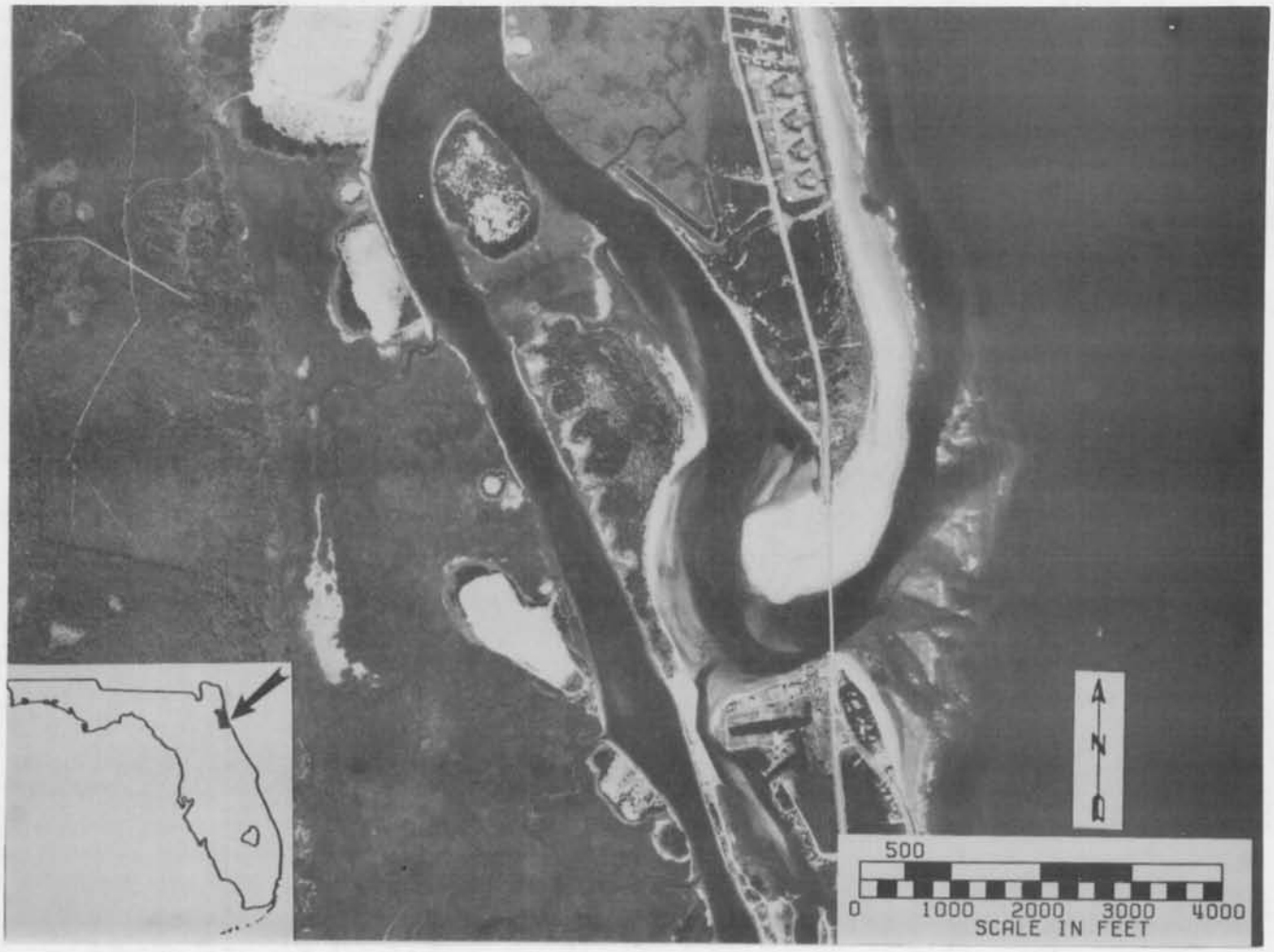
Special Characteristics Relevant to State Responsibilities

- The littoral transport does not appear to be passing around this entrance.
- Anastasia State Park is located south of entrance.
- Severe erosion of shore evident beyond 4 miles south of entrance, near the City of St. Augustine Beach.

Recommended Action

- Continue to place all sand dredged on downdrift shoreline. Placement should occur at sufficient distances south (approximately 30,000 ft) to reduce the severe erosion there.

MATANZAS INLET



(Date of Photography: December 31, 1985)

Brief Historical Information

- A natural inlet without dredging or jetties, Matanzas Inlet has been affected by bridge and abutment construction.
- In 1925, highway bridge constructed parallel to the shore and near the throat of this inlet. Replaced in 1956.
- In 1972, breakthrough in Rattlesnake Island from Intracoastal Waterway to Matanzas tidal area.
- Breakthrough was closed by dike construction in 1976.

MATANZAS INLET

Sediment Balance

Ebb shoal:

1964 -	4.4 million cubic yards
1978 -	6.3 million cubic yards

Flood shoal: 400,000 cubic yards

Net littoral transport rate:

440,000 cubic yards per year (Southward-USAE)
290,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1923-1978:

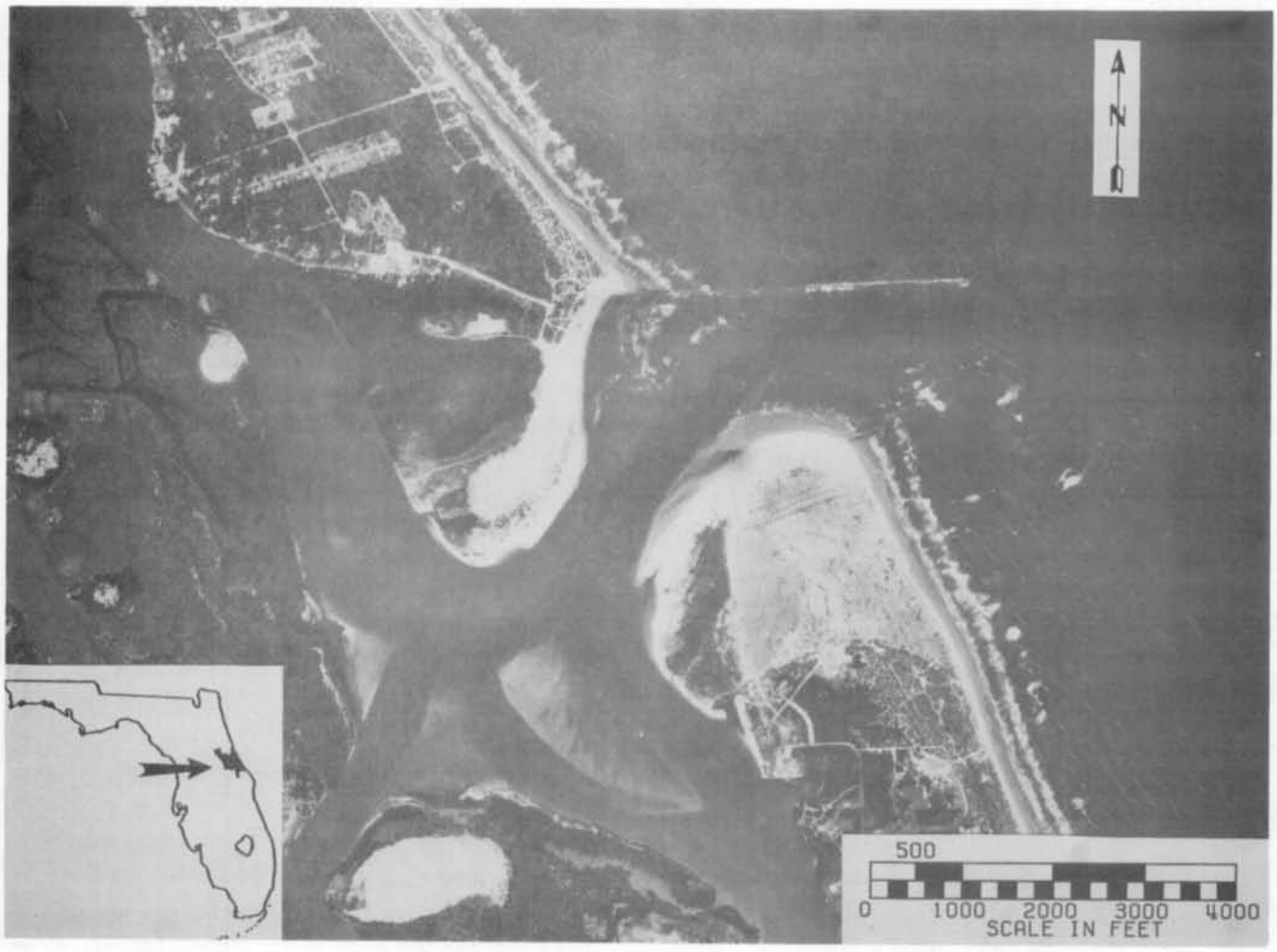
+400,000 cubic yards over 4000 ft. north of inlet
-300,000 cubic yards over 2900 ft. south of inlet

The tendency for the inlet to migrate southward is prevented by the presence of the concrete bridge abutments.
There is severe erosion immediately south of Matanzas Inlet, undoubtedly due to the storage of large quantities of beach quality sand as an emergent flood tidal shoal.

Recommended Action

- Bypass sand so that there is no additional storage inside the flood tidal shoal.

PONCE DE LEON INLET



(Date of Photography: March 8, 1984)

Brief Historical Information

- A natural inlet, surveyed by U.S. Coast and Geodetic Survey in 1851.
- Lighthouse constructed in 1883.
- First dredging of inlet channel in 1943.
- Construction of north and south jetties completed in 1971. Weir section 1,800 ft long in inshore portion of north jetty.
- Weir section of north jetty closed by addition of rock in 1984.

PONCE DE LEON INLET

Sediment Balance

Ebb shoal:

1925 -	21.8 million cubic yards
1974 -	22.5 million cubic yards

Net littoral transport rate:

500,000 cubic yards per year (Southward-USAE)
180,000 cubic yards per year (Southward-Walton)

- Strong transport reversals may occur in summer months.
- Severe erosion occurs at Bethune Beach, some 8 miles south of inlet.

Shoreline volume changes, 1936-1977:

1936-1962:	-3.7 million cubic yards (erosion) over a distance of 12,000 ft. north of inlet
1971-1976:	-300,000 cubic yards (erosion) over 3,600 ft. north of inlet
1936-1962:	-1.2 million cubic yards (erosion) over 19,500 ft. south of inlet
1971-1977:	+2.3 million cubic yards (accretion) over 4,500 ft. south of inlet

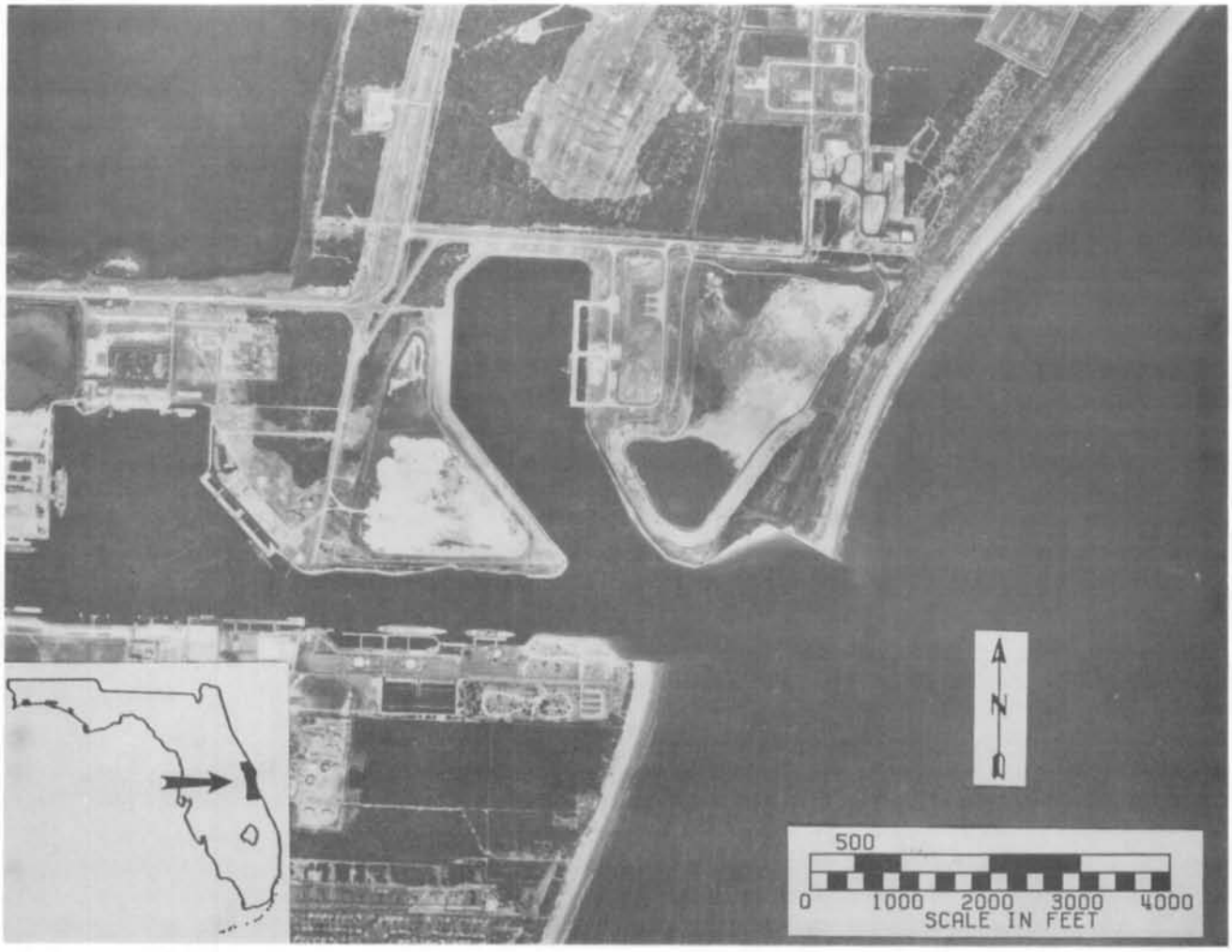
Brief Dredging History

- Total of 3.6 million cubic yards dredged from channel and all placed on north beach.

Recommended Action

- By-pass to the south the normal rate of littoral transport (180,000 to 500,000 cubic yards per year) at sufficient distances southward to reduce erosion in vicinity of Bethune Beach.

PORT CANAVERAL ENTRANCE



(Date of Photography: April 18, 1986)

Brief Historical Information

- Entrance cut in 1951. Twin jetties 1,150 ft. long built in 1953-1954. Port depth 43 ft.

- Surveys of this shore available back to 1855.

Sediment Balance

Ebb shoal:
1979 - 5.6 million cubic yards

Net littoral transport rate:
360,000 cubic yards per year (Southward-USAE)
250,000 cubic yards per year (Southward-Walton)

Transport direction usually reversed (northward) in summer months.

PORT CANAVERAL ENTRANCE

Sediment Balance (Continued)

Shoreline volume changes, 1928-1971:

1928-1958:	+10.8 million cubic yards over 22,000 ft.	north of entrance
	+2.0 million cubic yards over 24,000 ft.	south of entrance
1956-1965:	-0.5 million cubic yards over 22,000 ft.	north of entrance
	-0.9 million cubic yards over 24,000 ft.	south of entrance
1965-1971:	-1.1 million cubic yards over 12,700 ft.	south of entrance

Brief Dredging History

- From 1877-1951, average change in width of 40 mile-long south beach: + 1 ft. per year.
- In 1955, average erosion rate immediately south of south jetty: 16 ft. per year.
- In 1974, erosion not evident beyond 3.4 miles south. Two and one-half million cubic yards of sand were placed on 11,000 feet of beach south of south jetty.
- In 1986, 1974 replenishment wave had advanced 4 miles south, and preceding erosion wave 14 miles, south of entrance.
- From 1953-1985, entrance channel and harbor excavated by dredging; volume, 31.1 million cubic yards. Ten million cubic yards of this total was for maintenance of the channel. 2.5 million cubic yards has been placed on the adjacent beaches.

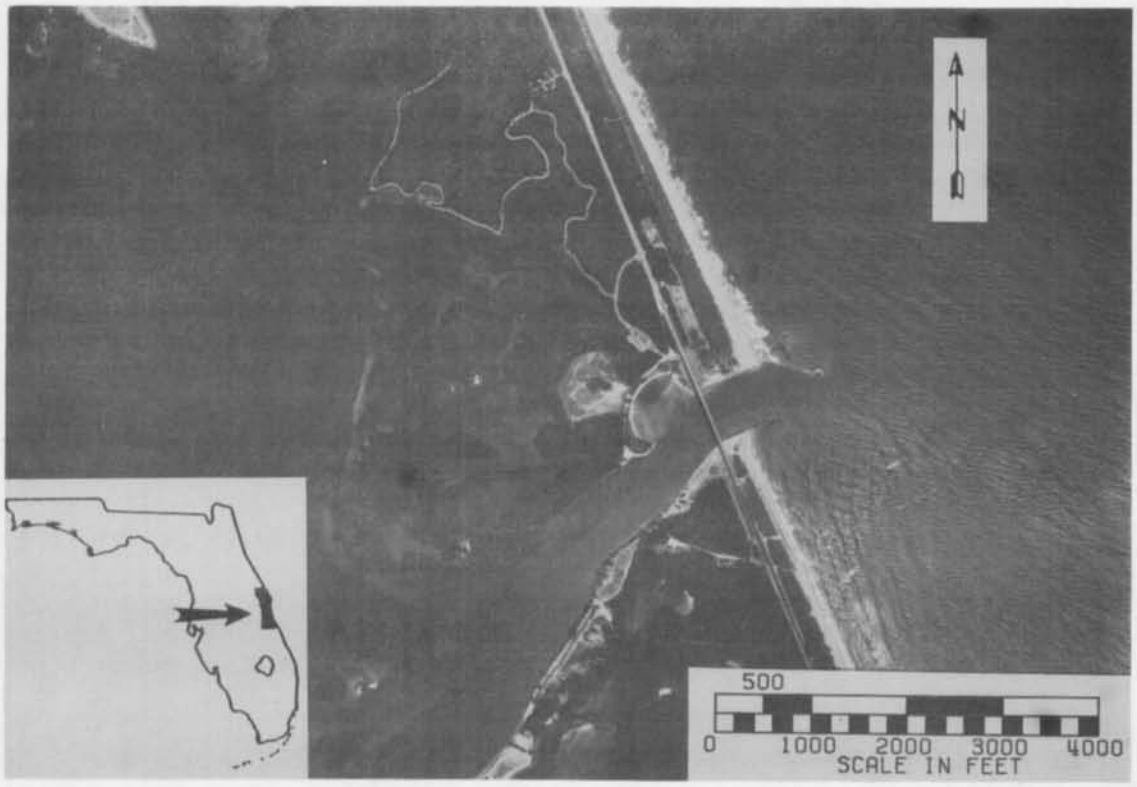
Special Characteristics Relevant to State Responsibilities

- Harbor is a Federal navigation project. Maintenance by U.S. Army Corps of Engineers.
- South beach responds quickly to change in sediment supply. Frequent replenishment required.
- Ebb shoal contains only 5.6 million cubic yards, however, Cape Canaveral shoal contains in excess of 100 million cubic yards of good quality sand.
- Interception of transport on north side and bypassing planned by Corps of Engineers but not yet constructed.

Recommended Action

- Federal government construct and operate system to by-pass the volume of the net longshore transport (250,000 to 360,000 cubic yards per year).

SEBASTIAN INLET



(Date of Photography: April 18, 1986)

Brief Historical Information

- Many early attempts to maintain a navigable inlet, starting in 1886.
- Inlet opened on present alignment in 1948.
- Jetties constructed and modified from 1950's to 1970.
- Interior sand trap located 2,500 ft. west of inlet throat.
- Inlet under the jurisdiction of the Sebastian Inlet Commission.

Sediment Balance

Ebb shoal:

Contains less than 100,000 cubic yards as estimated in 1974

Net littoral transport:

300,000 cubic yards per year (Southward-USAE)
160,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1948-1974:

+100,000 cubic yards over 2,000 ft. north of the inlet
-200,000 cubic yards over 2,000 ft. south of the inlet

SEBASTIAN INLET

Brief Dredging History

- A total of 1.8 million cubic yards of sediment generated by construction dredging has been placed offshore.
- At present, an attempt is made by the Sebastian Inlet Commission to place all beach compatible sand on the downdrift shorelines.

Special Characteristics Relevant to State Responsibilities

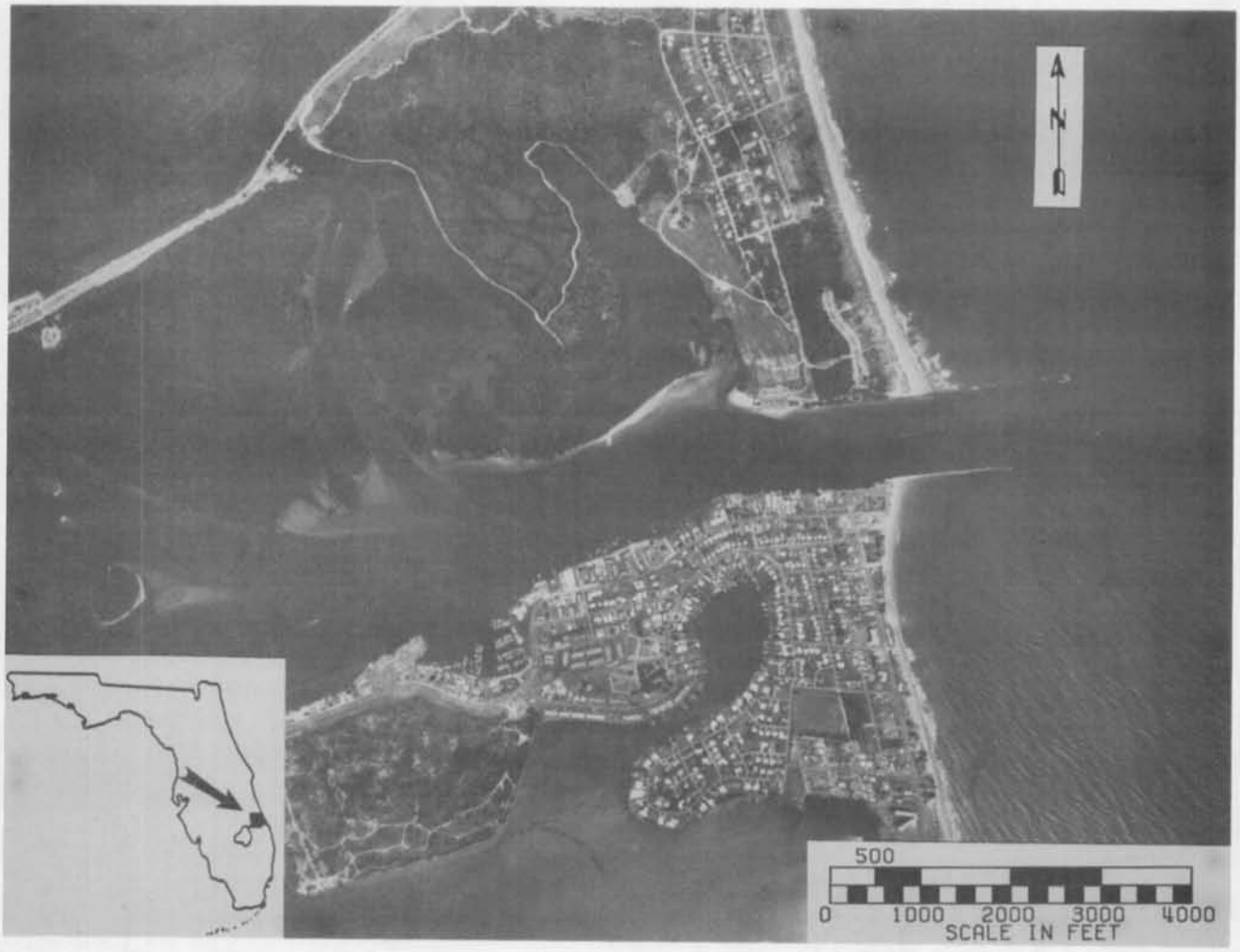
- This inlet places significant erosional stress on the downdrift shoreline.
- There is no substantial ebb tidal shoal from which to borrow material to establish a feeder beach.
- Present bypassing procedure has been hampered by considerable environmental concerns over turtle nesting, tern habitat and worm rocks.

Recommended Action

- Cooperate with the Sebastian Inlet Commission to:

  1. Continue to bypass the sand collecting in the interior sand-trap.
  2. Evaluate alternate bypassing systems that would result in less environmental constraints.
  3. Augment the by-passed volumes with material from an alternate (as yet unidentified) source to ensure the flow to the downdrift beaches of the net transport amount (approximately 200,000 cubic yards annually).

FT. PIERCE INLET



(Date of Photography: April 11, 1986)

Brief Historical Information

- Artificial entrance constructed in 1920 to replace smaller inlet to north.
- Harbor construction started in 1925.
- In 1926, harbor structures rebuilt with jetties 1,800 ft. and 1,200 ft. long north and south respectively, spaced 900 ft. apart. Project depth 27 ft.
- Federal navigation project since 1935.
- Sabellariid (worm) reefs in channel.

FT. PIERCE INLET

Sediment Balance

Ebb shoal:
1975 - 29.4 million cubic yards

Flood shoal:
1930 - 7.9 million cubic yards

Net littoral transport rate:
225,000 cubic yards per year (Southward-USAE)
140,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1882-1975:
+ 55.2 million cubic yards over 40,000 ft. north of inlet
- 47.6 million cubic yards over 32,000 ft. south of inlet

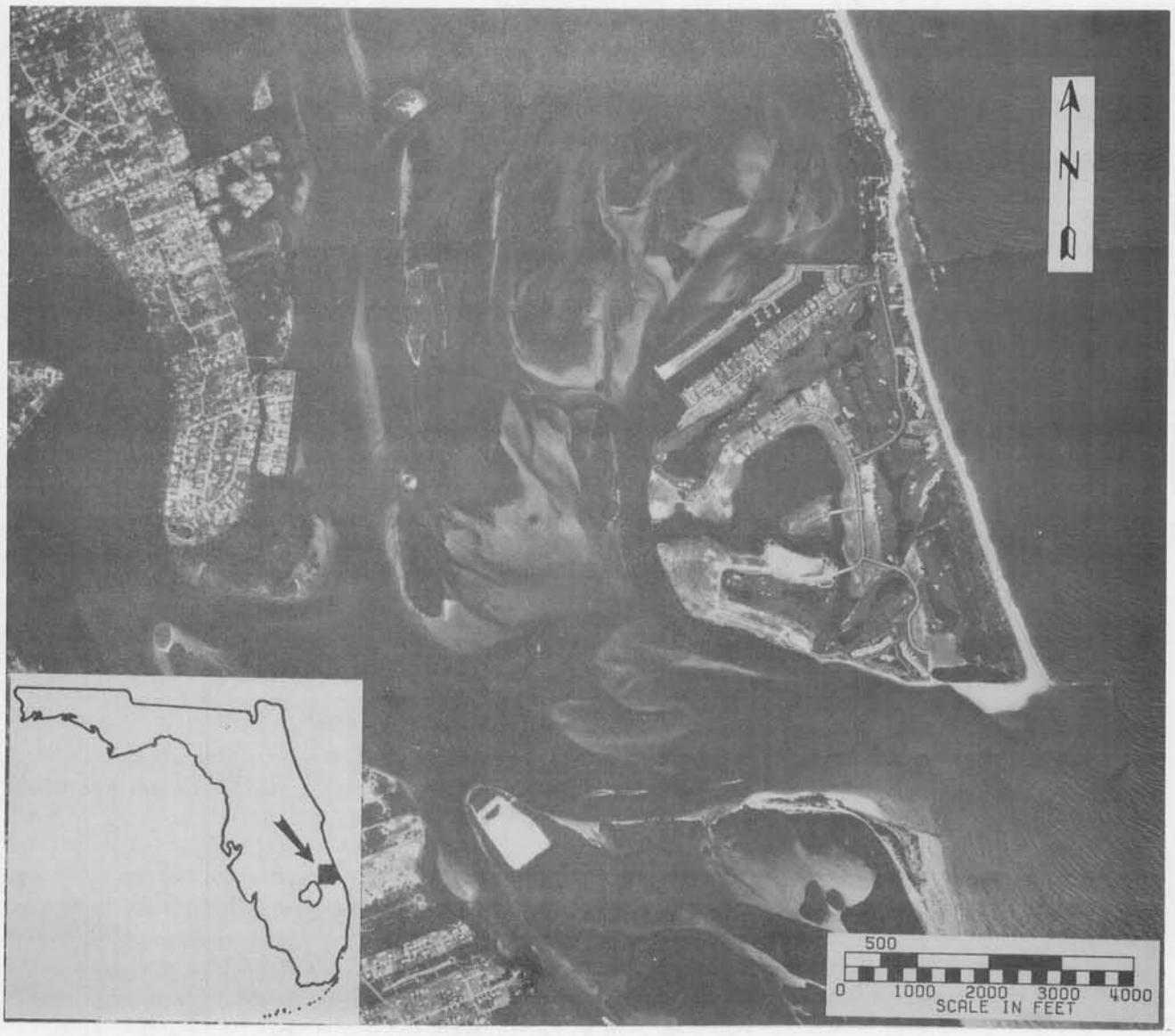
Brief Dredging History

- From 1930-1985, total volume dredged: 3.2 million cubic yards, dumped at sea: 2.7 million cubic yards, placed inland: 0.5 million cubic yards and placed on beach: 0 cubic yards.

Recommended Action

- Place all compatible dredged material on the beach south of entrance.
- Restore the normal littoral transport rate south of entrance by by-passing the net longshore sediment transport (140,000 to 225,000 cubic yards per year) with a target value of 200,000 cubic yards per year.

ST. LUCIE INLET



(Date of Photography: April 17, 1986)

Brief Historical Information

- Inlet cut in 1892, 30 ft. wide by 5 ft. deep.
- North jetty constructed 3,325 ft. long.
- From 1980-1982, "Dog-leg" extension added to north jetty (900 ft. long), detached breakwater added south of channel (500 ft. long) and south jetty constructed (1,500 ft. long).
- Inlet is a Federally maintained navigation project.
- Authorized channel dimensions 6 ft. deep by 100 ft. wide.

ST. LUCIE INLET

Sediment Balance

Ebb shoal:
1964 - 21.7 million cubic yards

Flood shoal:
1977 - 3.0 million cubic yards

Net littoral transport rate:
230,000 cubic yards per year (Southward-USAE)
200,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1888-1964:
1888-1929: -0.2 million cubic yards over 9,250 ft. north of inlet
-23.0 million cubic yards over 35,000 ft. south of inlet
1929-1964: +2.4 million cubic yards over 9,250 ft. north of inlet
-23.0 million cubic yards over 35,000 ft. south of inlet

Brief Dredging History

- There has been no deep water disposal.
- A total of 3 million cubic yards is reported to have been placed on the south beach.

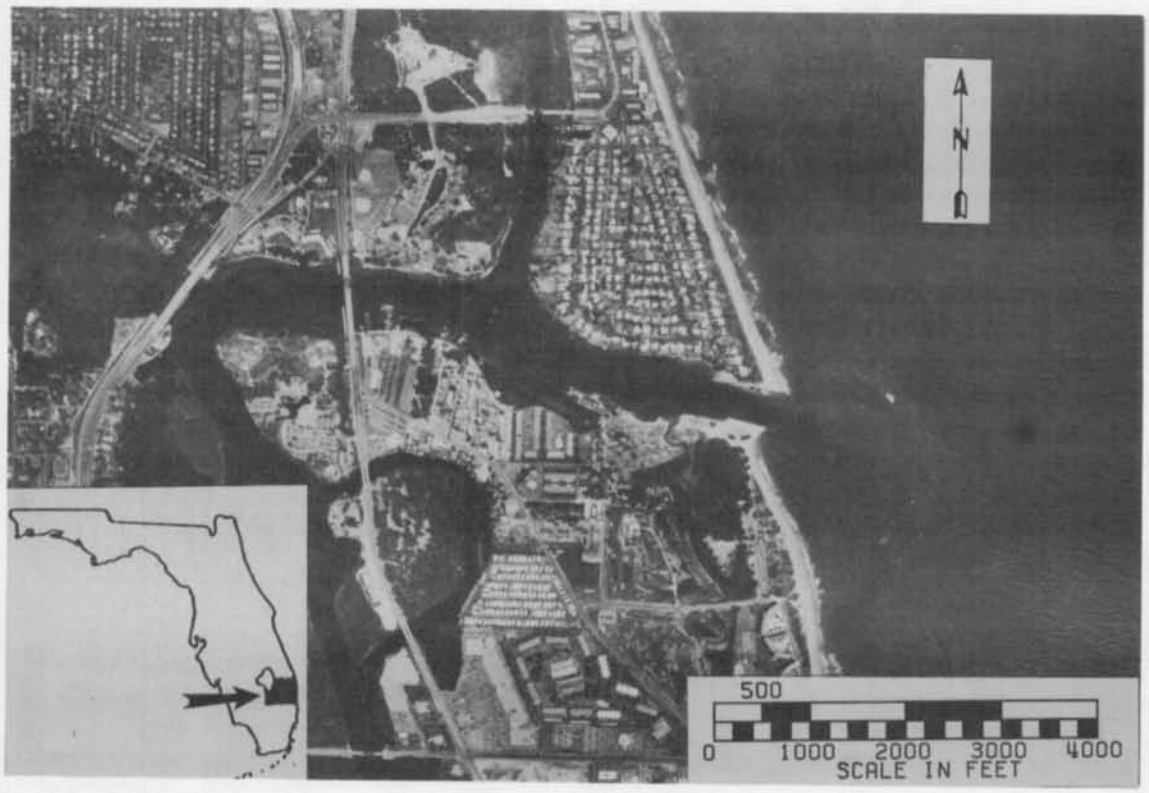
Special Characteristics Relevant to State Responsibilities

- Inlet has accumulated a total of approximately 25 million cubic yards in the adjacent shoals and updrift of the north jetty.
- Inlet has resulted in severe erosion to the north beaches of Jupiter Island. For many years, this erosion was the most rapid in the state.
- Until approximately 1980 the sand drifting through and depositing inside the porous south jetty appeared to be equal to the net longshore sediment transport. Since 1980, erosion has been acute north of the north jetty. If sand deposited inside the north jetty is not bypassed, the currents and waves redistribute the sand so that it is less available for bypassing.

Recommended Action

- Short-Term: Conduct a one-time by-passing of approximately 3 million cubic yards to the downdrift beaches. Source of material is sand inside inlet.
- Long-Term: Implement a periodic (annual or biennial) bypassing from the shoal inside the north jetty. The target bypassing quantities on an annual basis should be on the order of 200,000 cubic yards.

JUPITER INLET



(Date of Photography: April 23, 1986)

Brief Historical Information

- Natural inlet, relocated approximately 1,200 ft. north to present position, in 1913-1922.
- Jetties, 400 ft. long and 300 ft. apart, constructed in 1922.
- In 1929 north and south jetties extended 200 ft. and 75 ft., respectively.
- Inlet requires regular bypassing from a trap located 1,000 ft. west of inlet throat.
- Inlet is under the jurisdiction of the Jupiter Inlet District.

JUPITER INLET

Sediment Balance

Ebb Shoal:

1883 -	0.9 million cubic yards
1967 -	1.0 million cubic yards
1978 -	0.4 million cubic yards

Net littoral transport rate:

230,000 cubic yards per year (Southward-USAE)
240,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1913-1975:

-3.5 million cubic yards over 32,500 ft. north of inlet
-3.2 million cubic yards over 10,000 ft. south of inlet

Brief Dredging History

- From 1952-1977, a total of 1.1 million cubic yards has been dredged.
- All of the material dredged has been placed on the south beach.
- On an average annual basis, the amount of bypassed sand is 44,000 cubic yards.

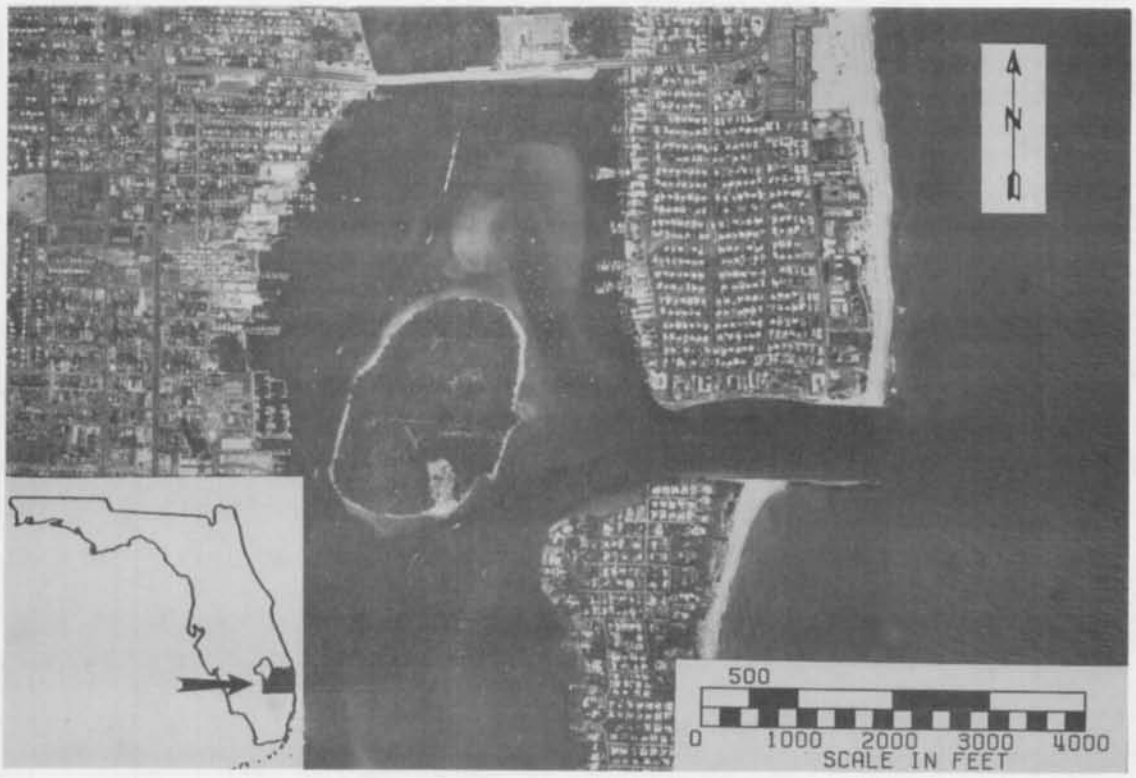
Special Characteristics Relevant to State Responsibilities

- The bypassing program at this inlet appears to be functioning well and is a "near model" program.
- Some material may be bypassed naturally along the outer bar.

Recommended Action

- Encourage the Jupiter Inlet District in its program of inlet maintenance.
- An attempt should be made to increase the bypassing to the net longshore transport rate of approximately 200,000 cubic yards per year.

LAKE WORTH INLET (PORT OF PALM BEACH ENTRANCE)



(Date of Photography: April 23, 1986)

Brief Historical Information

- Inlet cut in 1917 to width of 750 ft. and depth of 15-18 ft.
- Jetty construction completed in 1925.
- Channel dredged to 35 ft. in 1967.
- Since 1936, maintained by Corps of Engineers.
- Sand transfer plant installed in 1958.

LAKE WORTH INLET (PALM BEACH HARBOR)

Sediment Balance

Ebb shoal:

1929 -	8.5 million cubic yards
1967 -	3.9 million cubic yards

Net littoral transport rate:

230,000 cubic yards per year (Southward-USAE)
380,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1883-1957:

+6.3 million over 7,500 ft. north of inlet
-0.9 million over 3,000 ft. south of inlet

Brief Dredging History

- Total dredged volume, 1929-1986: 5.2 million cubic yards, placed at sea: 2.8 million cubic yards, placed inland: 1.2 million cubic yards, placed on beach: 0.7 million cubic yards, bypassed to south beach: 1.5 million cubic yards. Current average amounts bypassed by sand transfer plant: 70,000 cubic yards per year.

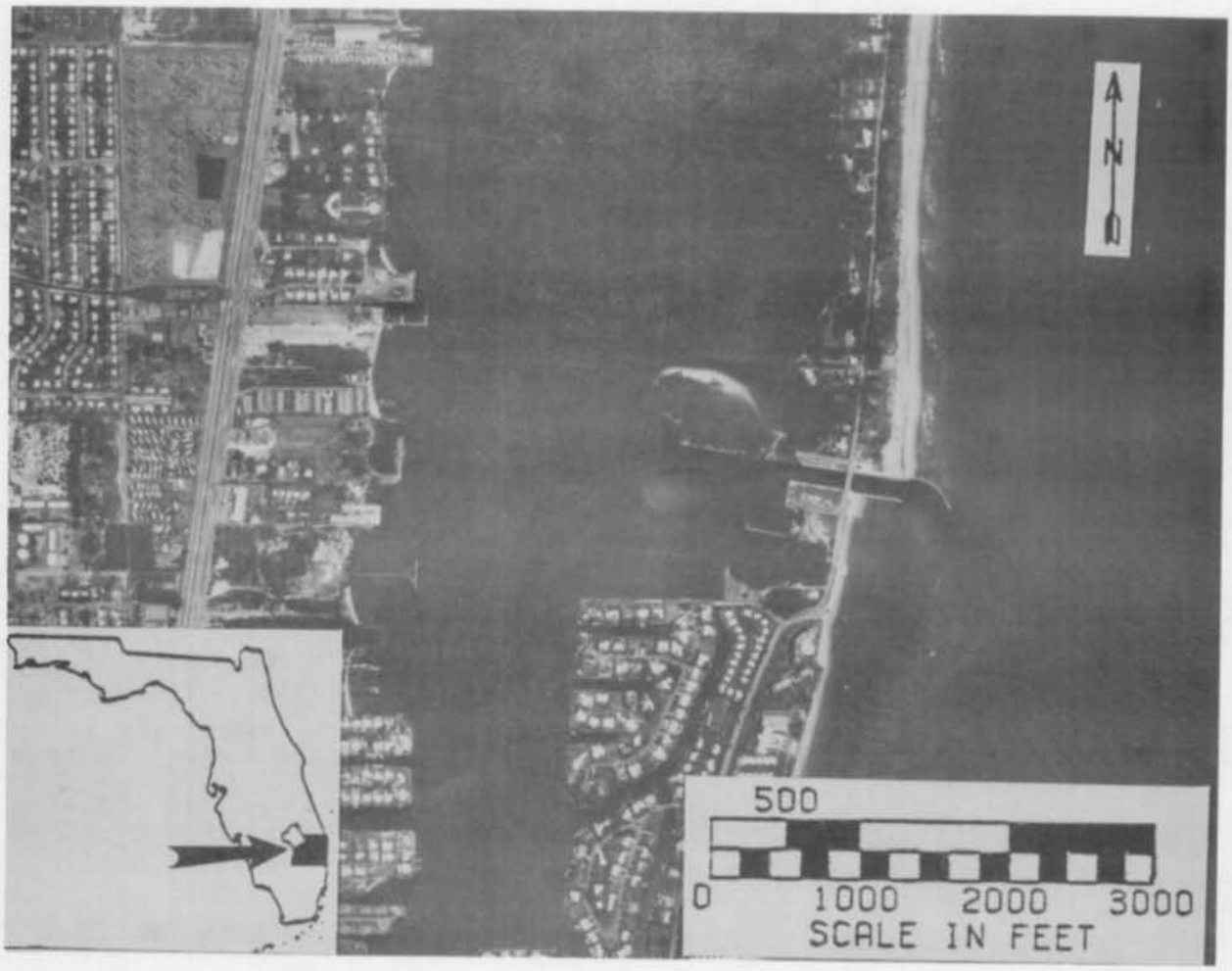
Special Characteristics Relevant to State Responsibilities

- South beach is badly eroded.
- Restrictions on operation of sand by-passing plant have reduced volume of sand by-passed below natural rate here.

Recommended Action

- Eliminate restrictions on by-passing plant operation imposed by coffer dam around pumping plant intake.
- Attempt to increase bypassing to estimated net longshore transport rate (approximately 200,000 cubic yards per year).

SOUTH LAKE WORTH INLET



(Date of Photography: April 23, 1986)

Brief Historical Information

- An artificial inlet dredged through the beach in 1927 to improve water quality in Lake Worth.
- Jetties constructed in 1936.
- First sand transfer plant installed in 1937, and discontinued in 1942 due to war-time fuel shortage.
- Operation of sand transfer plant resumed in 1945.
- Sand transfer plant replaced in 1948; new plant capacity of 73 cubic yards per hour.
- Jetties extended seaward in 1967.
- Larger sand transfer plant installed 118 ft. seaward of earlier plant in 1967.
- Sand production monitor installed in sand transfer plant in 1984.

SOUTH LAKE WORTH INLET

Sediment Balance

Ebb shoal:

1967 -	700,000 cubic yards
1968 -	1,000,000 cubic yards
1969 -	1,400,000 cubic yards

Net littoral transport rate:

230,000 cubic yards per year (Southward-USAE)
280,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1927-1979:

+450,000 cubic yards over 2,400 ft. north of inlet
-400,000 cubic yards over 3,500 ft. south of inlet

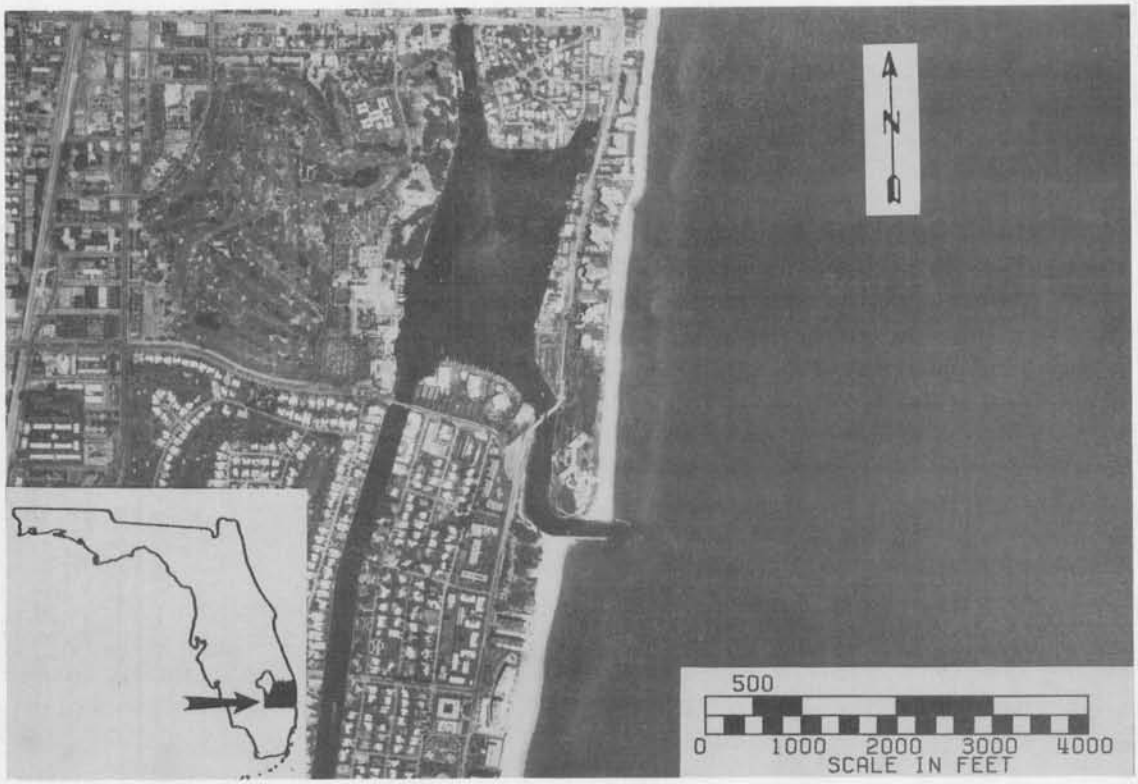
Brief Dredging History

- The average annual bypassing by the sand transfer facility is approximately 60,000 cubic yards per year.

Recommended Action

- It may be necessary to augment the bypassing system.
- By-pass an annual volume equal to the natural rate of transport (approximately 200,000 cubic yards per year).

BOCA RATON INLET



(Date of Photography: April 23, 1986)

Brief Historical Information

- Although this inlet was not opened artificially, it was open only after heavy rainfalls, was very shallow and only marginally navigable by small craft.
- Dredged but continued to shoal, in 1925.
- Two jetties contructed, in 1930.
- North jetty extended 180 ft. and south jetty reinforced, in 1975.
- Weir section installed in north jetty, in 1980.
- City of Boca Raton currently operates a dedicated dredge in channel to move sand to south beach.

BOCA RATON INLET

Sediment Balance

Ebb shoal:
1981 - 1.1 million cubic yards

Net littoral transport rate:
150,000 cubic yards per year (Southward-USAE)
280,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1927-1971:
+600,000 cubic yards over 3,500 ft. north of inlet
-100,000 cubic yards over 5,200 ft. south of inlet

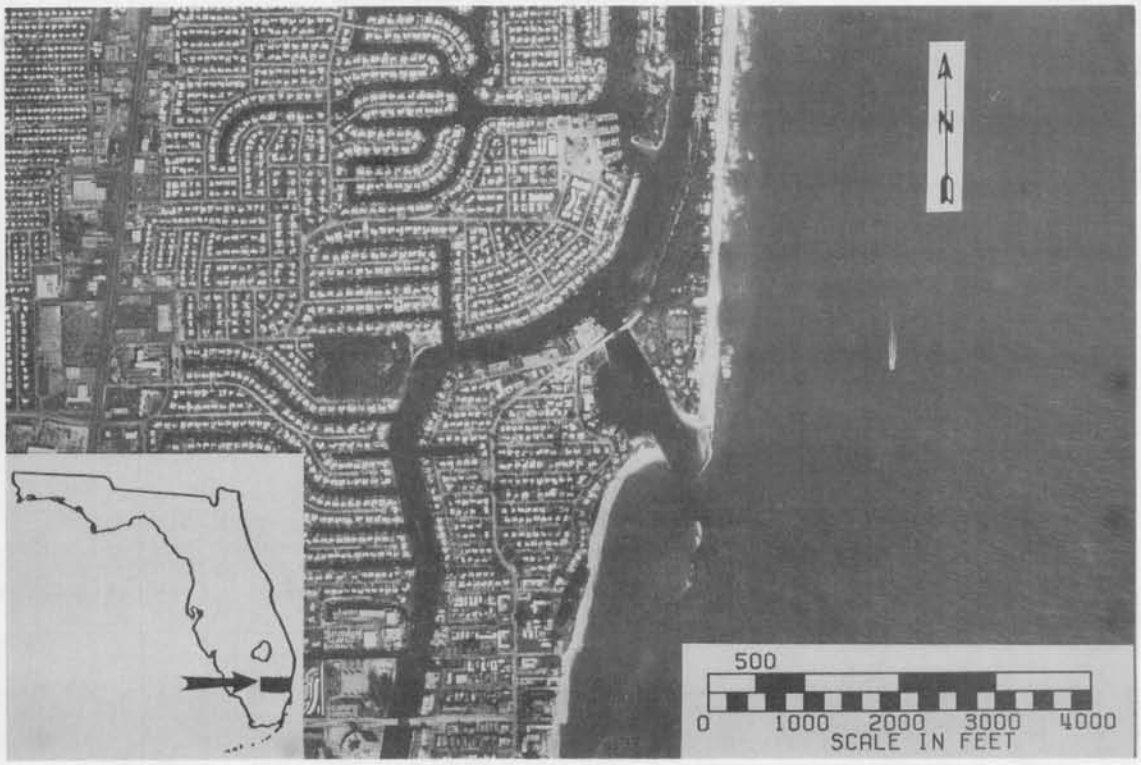
Brief Dredging History

- From 1940-1985, a total of 1.1 million cubic yards of material has been dredged. It has all been placed on the south beach.

Recommended Action

- Encourage City of Boca Raton to continue by-passing sand to beach south.
- Attempt to increase bypassing rates to approximately 200,000 cubic yards per year.

HILLSBORO INLET



(Date of Photography: February 4, 1981)

Brief Historical Information

- Surveys of shore in this area date back to 1855. Natural depth on bar 2.5 ft.
- Natural inlet, with rock structure built in 1930 to protect lighthouse.
- North jetty constructed of rock on natural reef in 1966, gap in north jetty functions as a sand weir with deposition basin inside.
- Inlet maintained by dedicated pipeline dredge pumping from deposition basin since 1959.
- Outer channel dimensions are 10 ft. deep by 150 ft. wide.
- Inlet has been under the jurisdiction of the Hillsboro Inlet District since 1957.
- Inlet connected to Intracoastal Waterway.

HILLSBORO INLET

Sediment Balance

Ebb shoal:

1883 -	2.7 million cubic yards
1961 -	-0.3 million cubic yards

Net littoral transport rate:

100,000 cubic yards per year (Southward-USAE)
280,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1927-1967:

+0.2 million cubic yards over 1,700 ft. north of inlet
-0.7 million cubic yards over 2,500 ft. south of inlet

Brief Dredging History

- In addition to the bypassed maintenance material, a total of 2.2 million cubic yards has been dredged.
- Of the above, all but 0.6 million cubic yards has been placed on the south beach.
- Currently, on an average annual basis, approximately 70,000 cubic yards per year is bypassed with the small dredge.

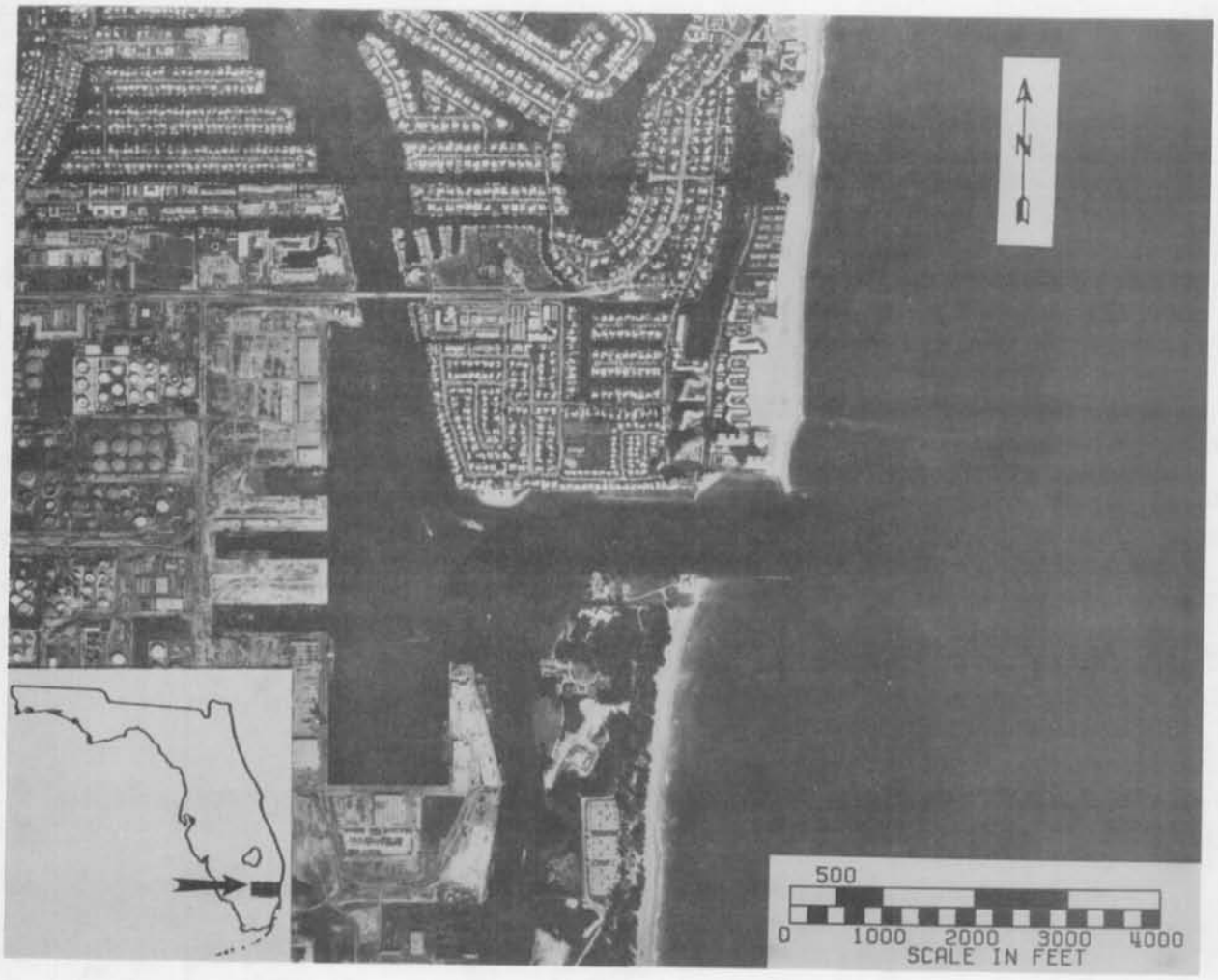
Special Characteristics Relevant to State Responsibilities

- The bypassing program at this inlet appears to be functioning well and is a "near model" program.

Recommended Action

- Encourage and support the Hillsboro Inlet District in its program of inlet maintenance.
- Attempt to increase amount of sand bypassed to the magnitude of the net longshore sediment transport (approximately 150,000 cubic yards per year).

PORT EVERGLADES ENTRANCE



(Date of Photography: February 4, 1981)

Brief Historical Information

- Inlet opened through barrier island, in 1928. Earlier, a smaller entrance, New River Inlet, had been located some 1,000 ft. to the north.
- Initial plan completed in 1931, including: north jetty 1,450 ft. long; south jetty 1,250 ft. long; entrance channel 35 ft. deep by 210 ft. wide.
- Current project depth is 45 ft.
- Entrance is a Federal navigation project. Connected to Intracoastal Waterway.

PORT EVERGLADES ENTRANCE

Sediment Balance

Ebb shoal: 1978 - negligible

Net littoral transport rate:

50,000 cubic yards per year (Southward-USAE)
270,000 cubic yards per year (Southward-Walton)

Apparently some transport reversal during summer months.

Shoreline volume changes, 1928-1981:

+2.1 million cubic yards over 4,800 ft. north of inlet
-0.6 million cubic yards over 15,000 south of inlet

Brief Dredging History

- From 1934-1984, of the 8 million cubic yards dredged, only 3.2 million cubic yards has been placed on the south beach.

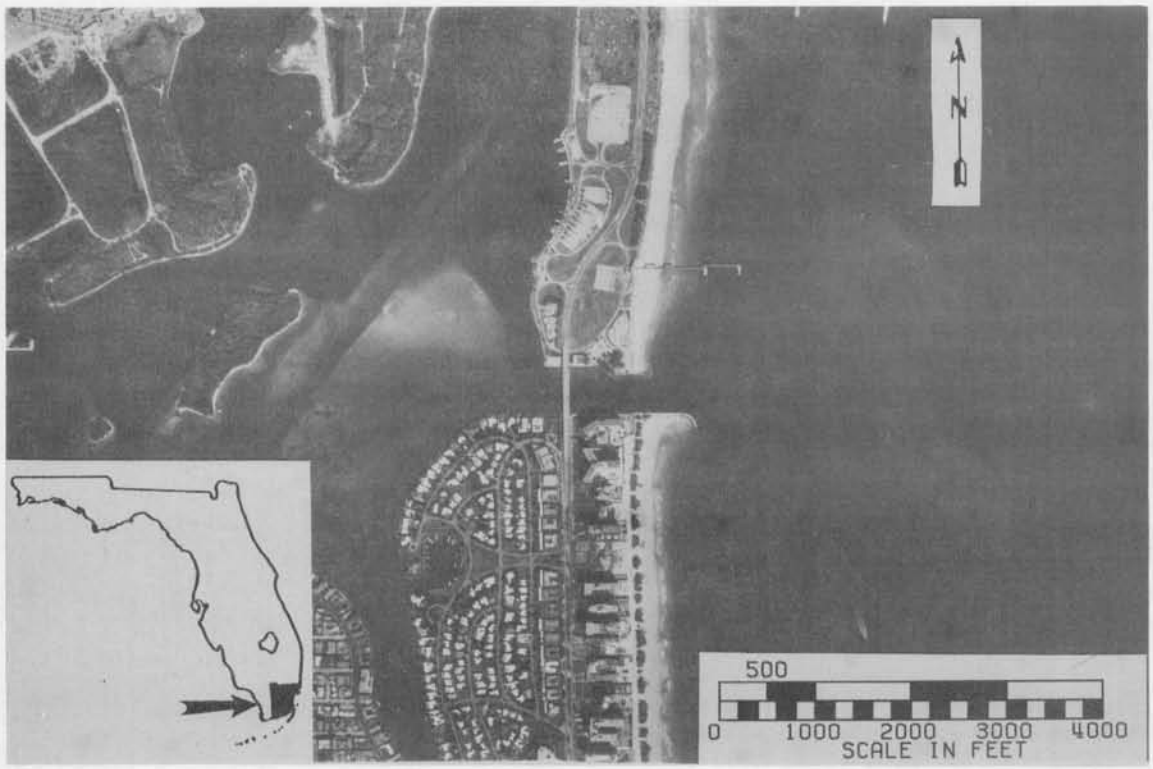
Special Characteristics Relevant to State Responsibilities

- This entrance has caused substantial downdrift (south) erosion.
- There does not appear to be as much maintenance dredging required as the downdrift erosion experienced.
- Shore northward is highly developed.
- No ebb shoal.

Recommended Action

- Implement a program of placing on the south beach on an average annual basis, the net longshore sediment transport (50,000 to 270,000 yd^3/yr). A minimum of 100,000 yd^3/yr is recommended.
- The source of this material could be bypassing from the north beach or elsewhere.

BAKER'S HAULOVER INLET



(Date of Photography: February 14, 1985)

Brief Historical Information

- Baker's Haulover was cut through the barrier beach in 1925; stabilized by two jetties.
- South jetty extended in 1975.
- North jetty extended in 1986.

Sediment Balance

Ebb shoal:

1928 -	0.3 million cubic yards
1969 -	0.6 million cubic yards

Net littoral transport rate:

20,000 cubic yards per year (Southward-USAE)
270,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1919-1961:

-0.4 million cubic yards over 250 ft. north of inlet
-0.6 million cubic yards over 2,000 ft. south of inlet

BAKER'S HAULOVER INLET

Brief Dredging History

- From 1937-1978, a total of 2.7 million cubic yards of material has been dredged. Most of this, 2.5 million cubic yards, has been dredged since 1960 and it has all been placed on the adjacent beaches.

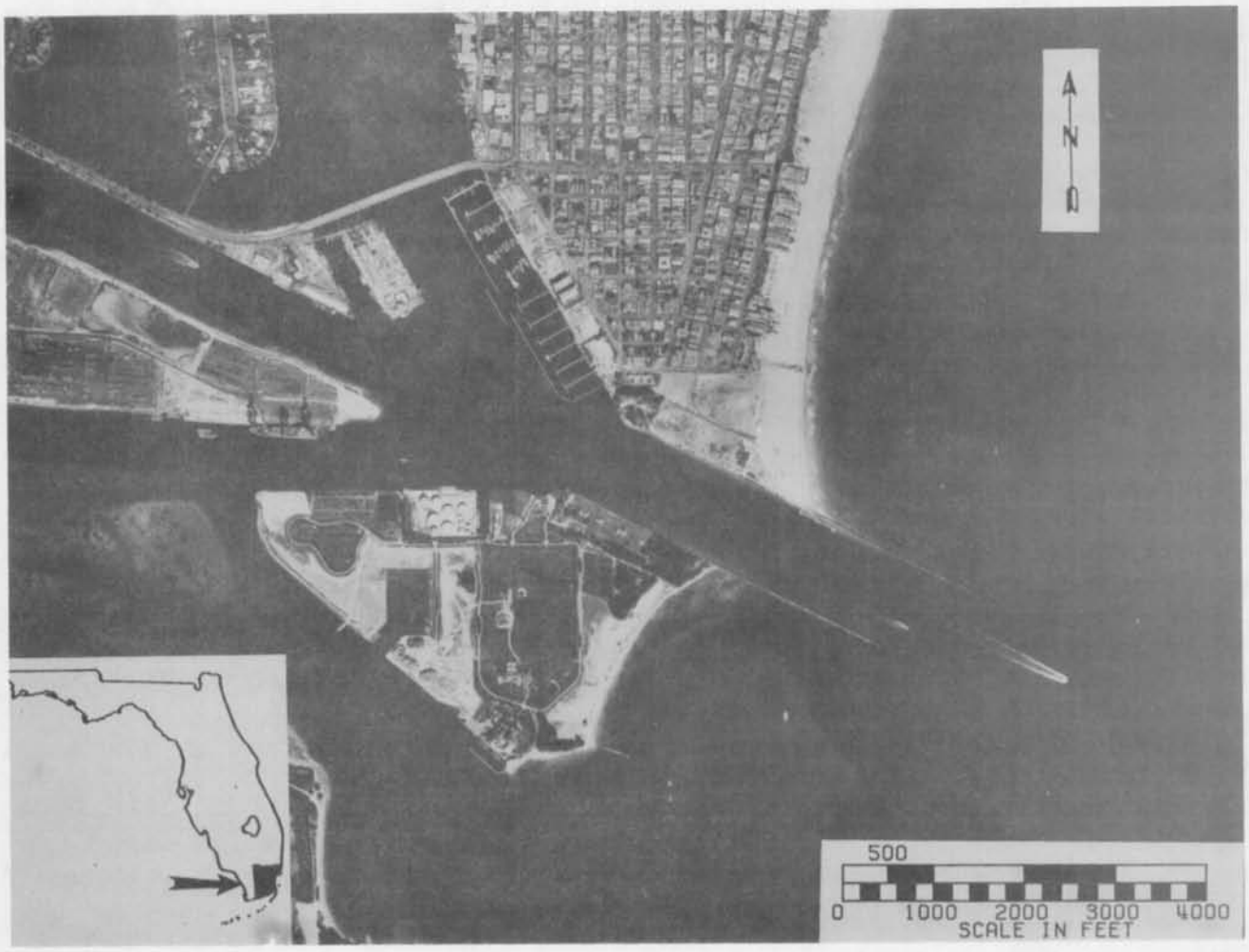
Special Characteristics Relevant to State Responsibilies

- Baker's Haulover is the north limit of the Miami Beach Restoration Project. Since extension of the south jetty (1975), the area immediately to the south has stabilized substantially.

Recommended Action

- Place any material dredged from the channel on the south beach.

GOVERNMENT CUT (MIAMI HARBOR)



(Date of Photography: February 14, 1985)

Brief Historical Information

- Entrance cut across southern end of Miami Beach in 1902.
- North and south jetties stablized a channel 500 ft. wide and 38 ft. deep.
- North jetty 3,000 ft., south jetty 2,000 ft. in length.
- Maintenance by Corps of Engineers.

GOVERNMENT CUT (MIAMI HARBOR)

Sediment Balance

Ebb shoal: Small and difficult to identify because of presence of reefs

Net littoral transport rate:
20,000 cubic yards per year (Southward-USAE)
270,000 cubic yards per year (Southward-Walton)

Shoreline volume changes, 1867-1961:
+1.3 million cubic yards over 2,500 ft. north of inlet

Brief Dredging History

- From 1957-1982, total volume dredged: 7.4 million cubic yards, placed inland: 3.3 million cubic yards, placed on north beach: 4.1 million cubic yards.

Recommended Action

- Continue to place compatible dredged material on north beach.

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