Technical Paper 55

HISTORICAL MORPHODYNAMICS OF INLETS IN FLORIDA

Models for Coastal Zone Planning

by

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FLORIDA SEA GRANT COLLEGE PROGRAM

Research, education and extension for responsible marine resource use

Historical Morphodynamics of Inlets in Florida:

Models for Coastal Zone Planning

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MODELS FOR COASTAL ZONE PLANNING

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ABSTRACT

The west-central barrier coast of peninsular Florida represents one of the most diverse barrier island systems in the world although it is a very low energy coast; mean annual wave height is less than 30 cm and tidal range is less than 1 meter. The diverse morphology of islands and inlets provides an ideal setting for inlet dynamics. Historical records show the origin and demise of several inlets as well as major morphologic changes to numerous others.

Even though there is great range in size and shape of these tidal inlets, they can be conveniently grouped into a simple classification with only four types; tide-dominated, wave-dominated and mixed energy with both straight and offset varieties in the latter. Many of the inlets along the west-central Florida barrier system have changed from one category to another over only a few decades. These changes can be caused by natural or man-related phenomena.

Historical data show a nearly infinite variety of inlet behaviors along this coast. Some, both large and small, have been essentially stable whereas most have shown great change. Examples of tide-dominated becoming wave-dominated as well as major changes in size and shape have occurred over the past century. Thorough study of the processes in each inlet coupled with a knowledge of its history can enable predictions of future inlet behavior.

INTRODUCTION

Tidal inlets are geologically ephemeral environments which act as dynamic conduits between the sea and coastal bays and which divide the coast into barrier-island segments. Inlets may close and open, migrate or become stable on the order of tens of years in response to changing sediment supply, wave climate and tidal regime, rate of sea level rise, and back-bay filling or dredging. In turn, the associated sediment bodies, ebb- and flood-tidal deltas, may rapidly change character. Because most material making up the inlet sand bodies is taken from the littoral-drift system which feeds adjacent beaches, changes in inlet behavior are reflected by changes in adjacent shorelines and overall barrier-island morphologies.

There are two reasons to consider tidal inlets in a beach management program: 1) ebb-tidal deltas are prime borrow areas for beach nourishment projects and 2) inlet throat migration, wave refraction across ebb-tidal deltas, and sediment trapping by tidal inlet systems affects sedimentation and navigation along adjacent shore lines.

Tidal inlets are very dynamic and commonly show major changes in inlet size and shape, in some cases even without intervention by man's activities. Changes in wave climate, sediment availability, and nearshore bottom configuration can cause pertubations in coastal processes and ,therefore, in the morphology of the inlet or inlets. Probably the most common and most drastic situation is where a new inlet is opened by a storm. The inlet may grow and stabilize such has happened at Hurricane Pass in Pinellas County and at Redfish Pass in Lee County. Conversely, an inlet may close due to an abundance of sediment and strong littoral drift coupled with a small tidal prism. This closure may not only affect the inlet in question but may also cause changes in adjacent inlets.

A morphodynamic classification of inlets serves to place inlets in perspective regarding their behavior and effect on adjacent shorelines. Morphodynamics refers to changes in processes and shapes of subtidal and intertidal shoals and channels.

Inlets are chiefly shaped by tidal and wave forces, and a thorough understanding of inlet systems allows the prediction of inlet morphology given certain process conditions. This prediction is difficult even with accurate and complete data due to the feed-back effect that morphology has on processses. For example, an increase in tidal prism may cause an increase in the size of the ebb-tidal delta; the larger delta would affect wave refraction and thus sedimentation along the adjacent shoreline. Therefore, the successful prediction model must consider the inlet system as a whole.

A morphological classification which is related to tidal and wave forces and to sediment supply, but which involves overall inlet morphology, is necessary for the systematic study of inlets in space and time. It is also the first step in devising comprehensive inlet sedimentation models.

This report sets forth a preliminary inlet classification model for the west-central coast of Florida and discusses implications for shoreline management. It also includes a brief discussion of historical changes in inlets along the west-central coast of Florida and an extensive data base on inlet parameters.

COASTAL SETTING

The coast of west-central Florida (Fig. 1) is a microtidal, mixed-energy coast according to the classification of Hayes (1975, 1979). Mean tidal range along the west-central barrier chain is less than 1 m and tides are mixed and semi-diurnal. The overall wave energy is very low with mean annual breaker heights of 25-30 cm (Tanner, 1960; Davis & Andronaco, 1987). This part of the Gulf of Mexico is subject to tropical hurricanes and extratropical winter storms associated with cold fronts. These high-energy events are infrequent but may have a profound and lasting effect on the coast because of intervening low-energy conditions.

Sediment type in nearshore and inlet environments is consistent along the coast and is composed of 90 to 95 percent by weight of fine to very fine quartz sand. The remaining fraction consist of gravel-sized shell fragments and a minor amount of biologically produced mud-sized grains (Evans et al., 1985). Tidal deltas and channels may have a higher shell content and, therefore, a coarser mean-grain size than the adjacent shorelines (Lynch-Blosse, 1977). No rivers are inputing new sediment to the coastal system and the unconsolidated sediment cover thins rapidly seaward (Davis et al., 1985).

The west-central Florida coast (Fig. 2) has a wide range of tidal-inlet and barrier-island morphology (Davis, 1988). Because sediment type and availability and the shoreface setting are relatively constant along the coast, variations in inlet morphologies are mostly caused by differences in the relative magnitudes of tidal and wave energies. Tidal prisms range over nearly four orders of magnitude (Davis & Hayes, 1984) and are controlled by the size of the bay they serve.

Seismic profiling in the northern 50 km of the study area (Davis & Kuhn, 1985; Evans et al., 1985) and in the Charlotte Harbor area (Evans & Hine, 1986) has shown that the pre-Quaternary surface is an irregular, karstic surface, and that the location of barrier islands. Hence, tidal inlets are at least partly controlled by this irregular bedrock topography.

TIDAL INLET FEATURES

Figure 3 shows the elements that comprise an inlet system using the commonly accepted nomenclature of Hayes (1975). Outer shoal and inner shoal, which are terms often found in the engineering literature, are equilavent to ebb-and flood-tidal delta, respectively.

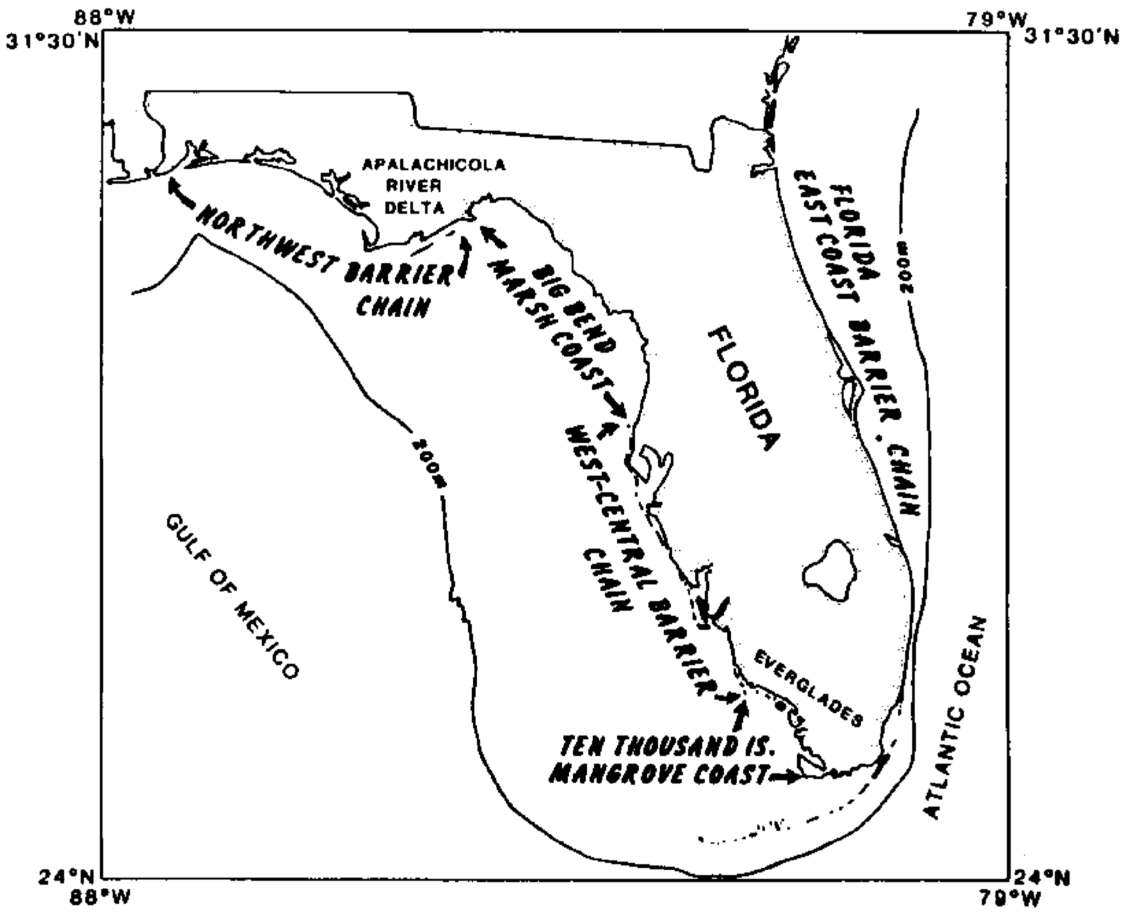


Figure 1.- Location map of Florida. Tidal inlets considered in this study are along the west-central barrier chain. From Hine et al. (1986).

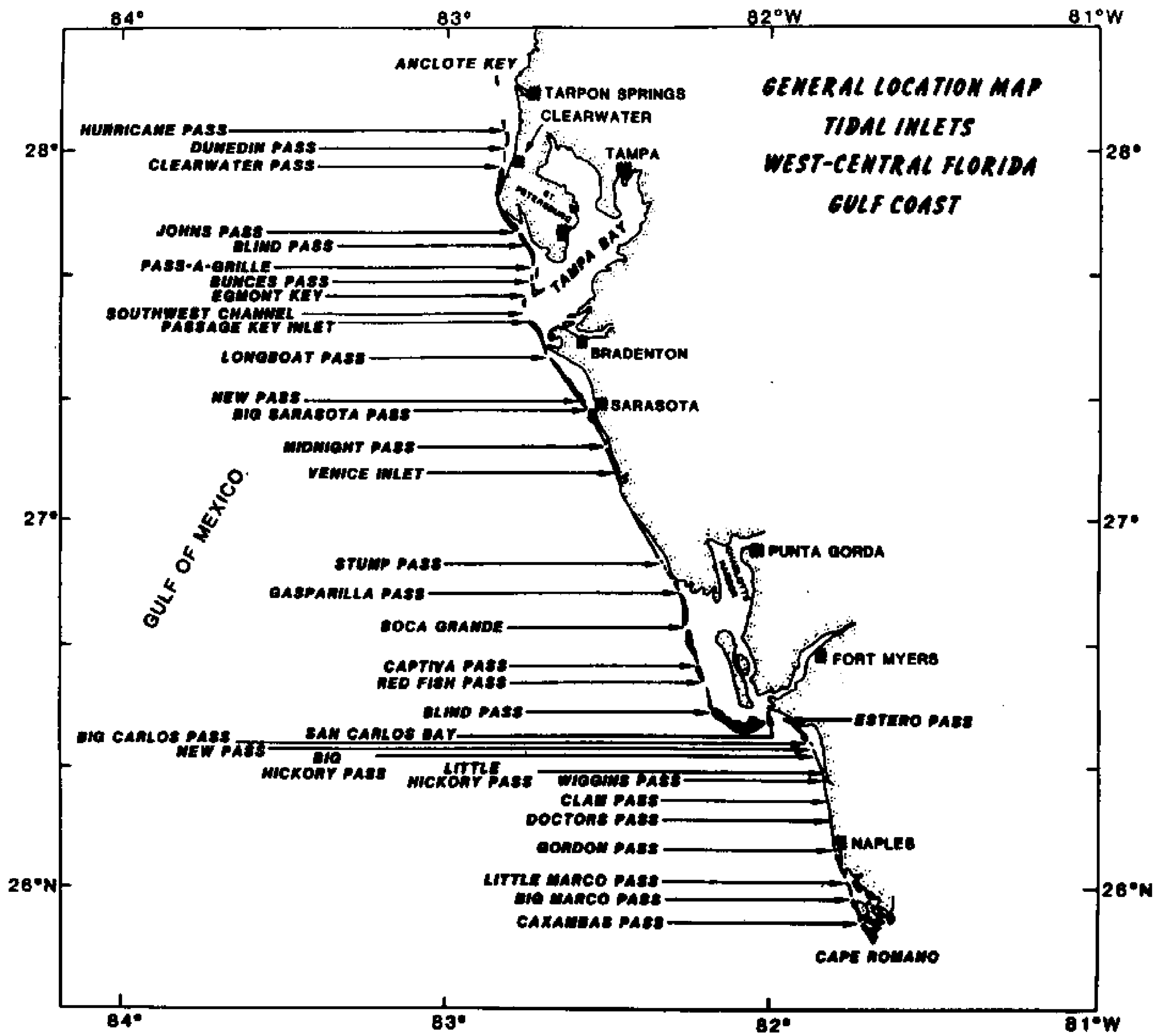


Figure 2.- Location map of inlets along the west-central Florida barrier chain. From Hine et al. (1986).

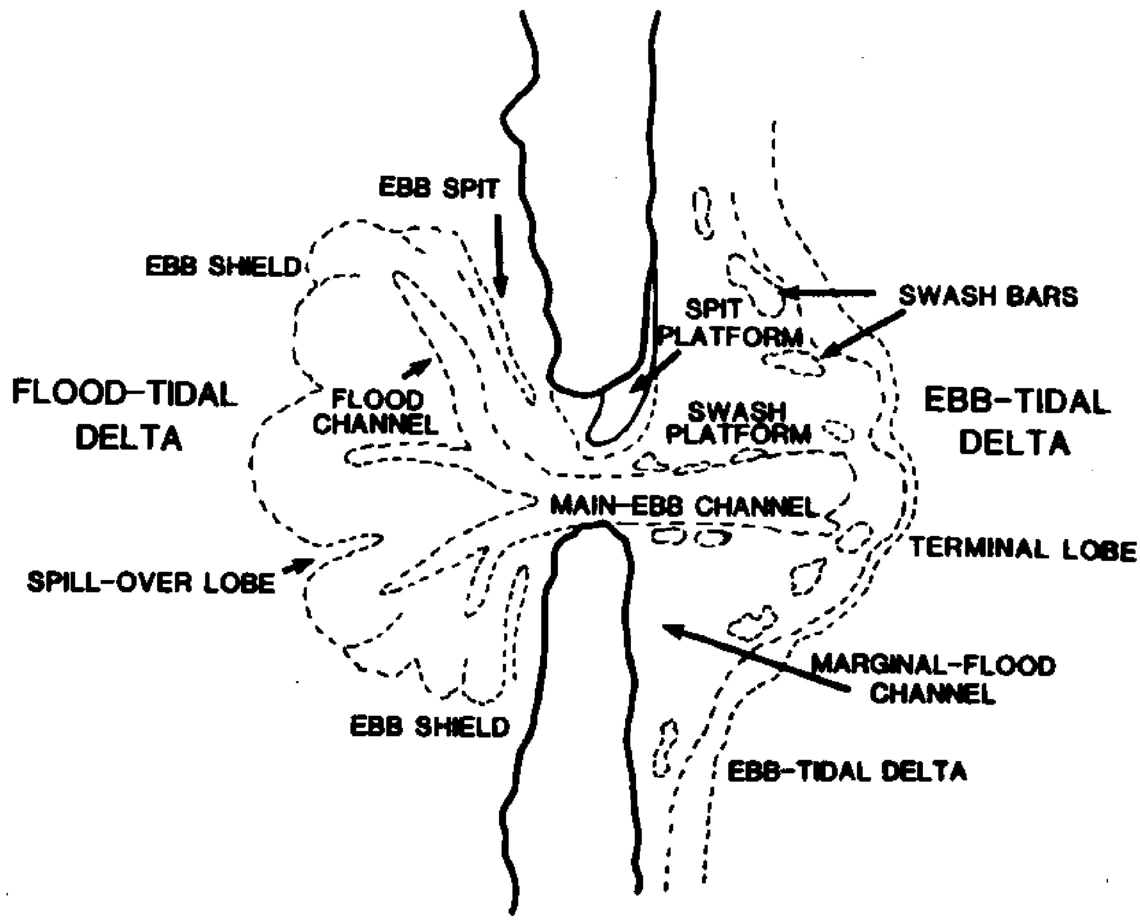


Figure 3.- Elements of a tidal inlet using the nomenclature of Hayes (1979). Not all of the morphological features will necessarily be present or as well-developed as shown.

The terminology of Hayes (1975) is preferred because of its comprehensive and simplistic nature. Not all the features shown in Figure 3 are necessarily present or well developed at all inlets. The ebb-tidal delta is where tidal and wave processes interact. The sources of sand for ebb-tidal deltas include material from the bay, material eroded from the inlet throat, and material moving in the littoral transport system.

The main-ebb channel is dominated by ebb currents which issue from the throat in an expanding-jet fashion. The ebb channel shallows seaward in response to the decreasing competence of the tidal flow to transport sediment and the increasing importance of onshore wave energy. Sediment carried by the ebb flow is dropped seaward and is reworked by waves on the swash platform.

Shoaling waves are the dominant process on swash platforms and often form landward and alongshore migrating swash bars. These swash bars may coalesce and weld to the adjacent beach (FitzGerald, 1982). Where swash bars approach the main-ebb channel, they are truncated by tidal currents and form channel-margin linear bars.

Marginal channels, where flood-directed tidal flow is reinforced by wave-generated currents (Davis & Fox, 1981), direct sediment to the ends of the barrier islands and to the inlet throat (Oertel, 1977). Spit platforms form at inlets where there is a high littoral drift rate coupled with a relatively small tidal prism. Growing spit platforms constrict the inlet throat and cause downdrift migration or closure of the inlet.

Flood-tidal deltas are relatively static features along the west-central Florida coast compared to the ebb-tidal deltas. Radially digitate flood channels and flood-tide deposits (ebb shield) are modified by ebb currents which form spillover lobes and ebb spits. Many of the flood-tidal deltas in the study area are stabilized by sea grasses and mangroves. A schematic diagram (Fig. 4) can be used to show the distribution of tide-generated and wave-generated current transport in inlet systems.

INLET CLASSIFICATION

Inlet types are recognized primarily by the morphologies of ebb-tidal deltas. Varying proportions of tidal and wave energy is the basic control on morphology. Four inlet categories have been delineated by inspection of coastal charts and vertical aerial photographs of west-central Florida inlets (Fig. 5).

Tide-dominated Inlets -

Tide-dominated inlets (Fig. 5) have a well-defined main-ebb channel with associated sand bodies which are oriented perpendicular to the shore. Marginal flood channels, which carry sediment to the throat and the ends of the barrier island, are often present. Redfish pass (Fig. 6) and Pass-A-Grille (Fig. 7) are examples of tide- dominated inlets.

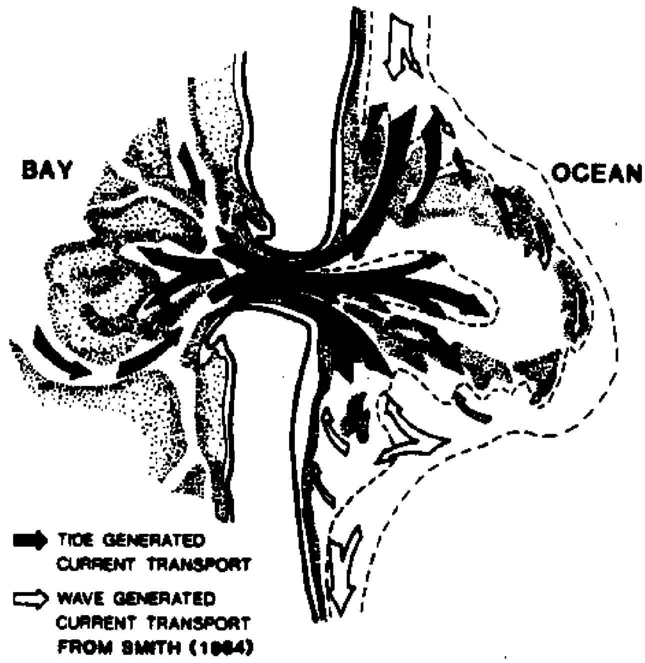


Figure 4.- Areas of tide- and wave-generated current transport in an inlet system. Littoral drift is depicted as moving from top to bottom. From Smith (1984).

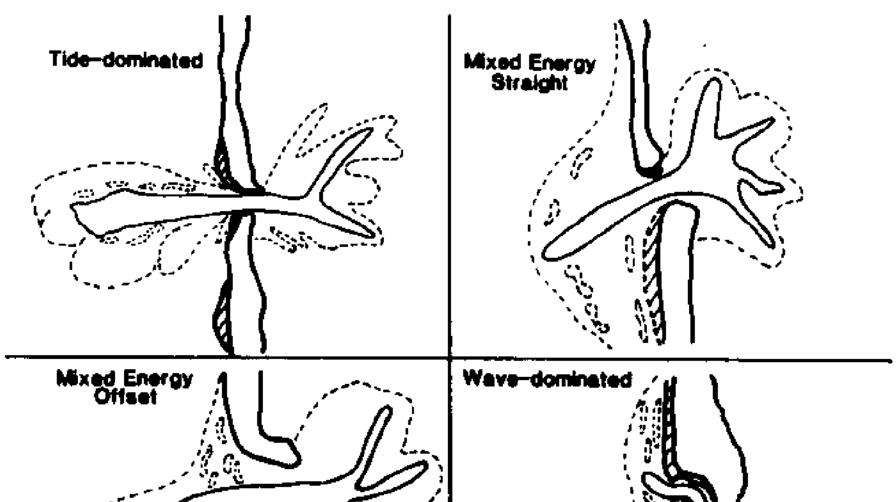


Figure 5.- Composite drawings of inlet types for the west-central Florida barrier chain. Hatching indicates areas along the shoreline that are most affected by tidal inlet dynamics. The ocean is to the left and the bays are to the right.

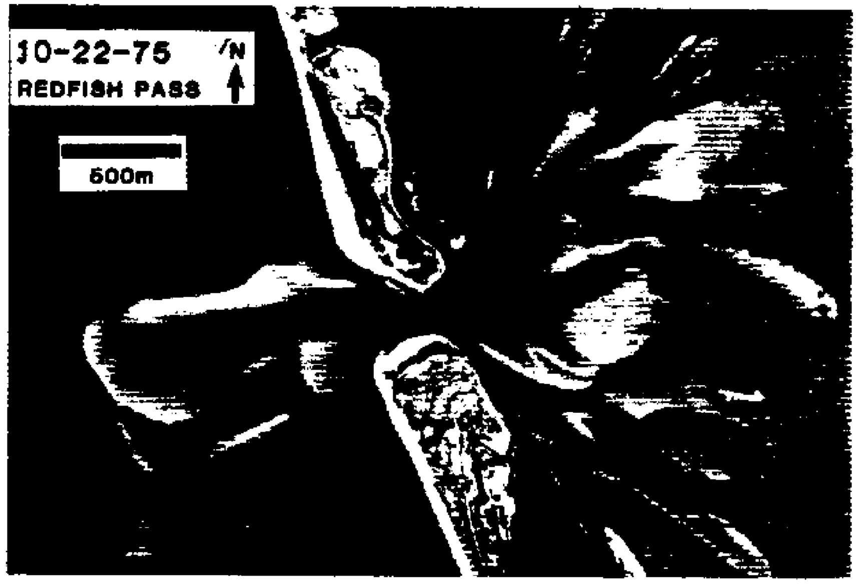


Figure 6.- Vertical aerial photograph of Redfish Pass (Lee County) in 1975. This inlet is tide-dominated with a distinct main-ebb channel and an ebb-tidal delta oriented perpendicular to shore. Marginal-flood channels are also present.

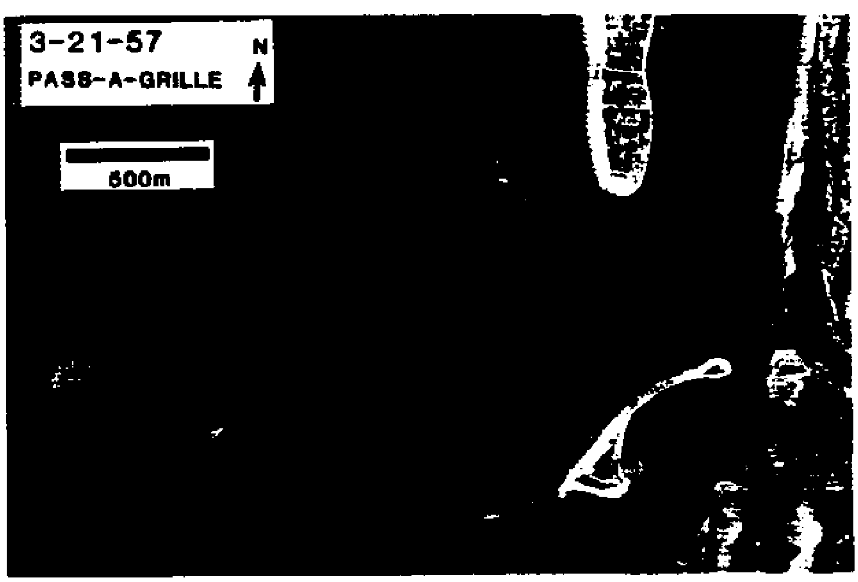


Figure 7.- Vertical aerial photograph of Pass-A-Grille Pass (Pinellas County) in 1957. This inlet is tide-dominated with a distinct main-ebb channel and an ebb-tidal delta oriented perpendicular to shore.

Tide-dominated inlets are relatively stable in their throat and main-ebb channel positions. Usually, the channels are deeply encised. Because ebb deltas may extend seaward several kilometers, they shield the adjacent shoreline on the downdrift side from wave attack and a depositional zone may develop. On the other hand, the prominent and stable ebb-tidal deltas of tide-dominated inlets are an effective barrier to littoral drift and may cause beach erosion on the downdrift barrier island.

Wave-dominated Inlets -

The ebb-tidal deltas of wave-dominated inlets (Fig. 5) are small and oriented subparallel to the shoreline often asymmetric in the direction of net-littoral drift. Shore-parallel swash bars may weld to the downdrift beach, and spit platforms are well-developed extending from the updrift beach. Blind Pass in 1953 (Fig. 8), Midnight Pass in 1983 (Fig. 9), and Dunedin Pass (Fig. 2) are examples of wave-dominated inlets.

These inlets are unstable and affect the adjacent shorelines by erosion on the downdrift island and tenuous extension of beach from the updrift island. As these inlets migrate, the main channel is lengthened and becomes hydraulically ineffecient for tidal exchange. During a storm, a new, more hydraulically efficient inlet may be breached across the updrift spit causing closure of the former inlet. Wave-dominated inlets do not cause a significant obstruction to littoral transport.

Mixed-energy Inlets (Straight, Offset) -

Mixed-energy inlets owe their morphologies to a combination of tidal and wave forces. Ebb-tidal delta morphology is intermediate between tide- and wave-dominated inlets (Fig. 5). Littoral drift may cause shifting orientations of the main-ebb channel and the channel may adjust to a more hydraulically stable position by ebb-delta breaching (FitzGerald, 1982). The throat position is relatively stable but sediment under the influence of wave and flood-generated currents may move into the inlet opening. Mixed-energy offset inlets (Fig. 5) have a prominant downdrift offset caused by a local reversal of littoral drift. Waves refracted around the ebb-tidal delta cause sediment transport toward the inlet on the downdrift side in the wave shadow of the ebb-tidal delta (Hayes et al, 1970).

Midnight Pass in 1972 (Fig. 10) and Big Sarasota Pass (Fig. 11) are examples of mixed-energy offset tidal inlets. Stump Pass in 1981 (Fig. 12) had a small offset and New Pass in 1948 (Fig. 13) had a mixed-energy straight morphology. Mixed-energy inlets affect the adjacent beaches most dramatically on the downdrift side where swash bars weld to the beach. The offset variety may trap a substantial amount of littoral drift causing progradation and widening of beaches on the updrift ends and beach narrowing on the downdrift ends of barrier islands.

INLET EVOLUTION

Inlets may change in character through time as they adjust to shifting processes. Except for the very large tide-dominated

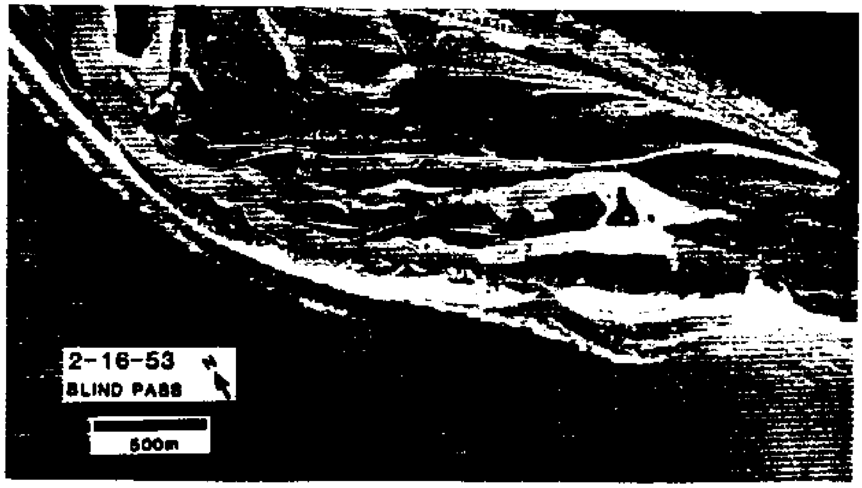


Figure 8.- Vertical aerial photograph of Blind Pass (Lee County) in 1953. Blind Pass has a wave-dominated morphology with an ebb-tidal delta subparallel to the shoreline and a long spit platform.

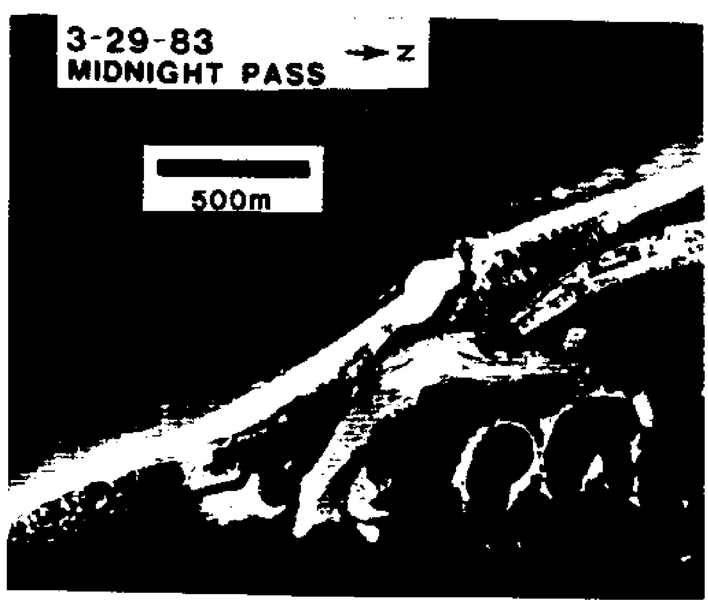


Figure 9. - Vertical aerial photograph of Midnight Pass (Sarasota County) in 1983. A wave-dominated morphology is displayed with an unstable channel and nearly nonexistent ebb-tidal delta.

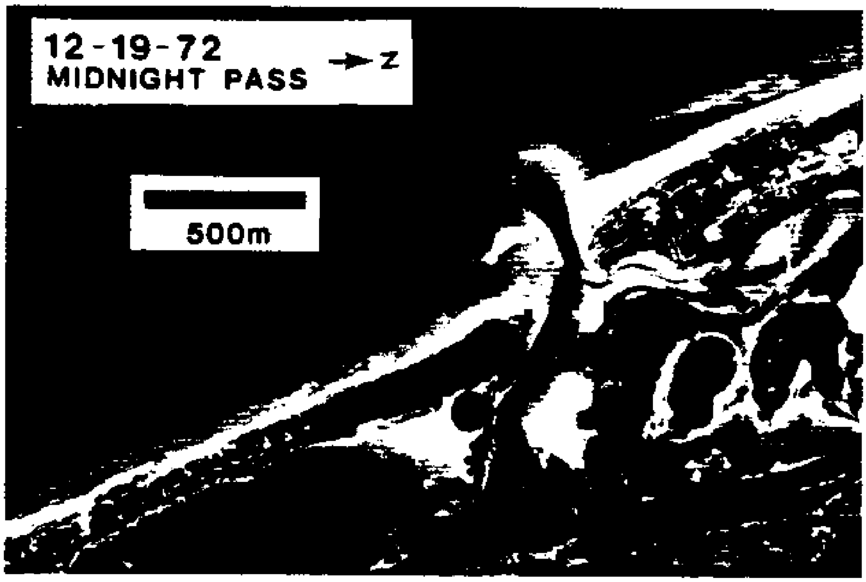


Figure 10. - Vertical aerial photograph of Midnight Pass (Sarasota County) in 1972. A mixed-energy offset morphology is displayed with a distinct main-ebb channel and ebb-tidal delta.

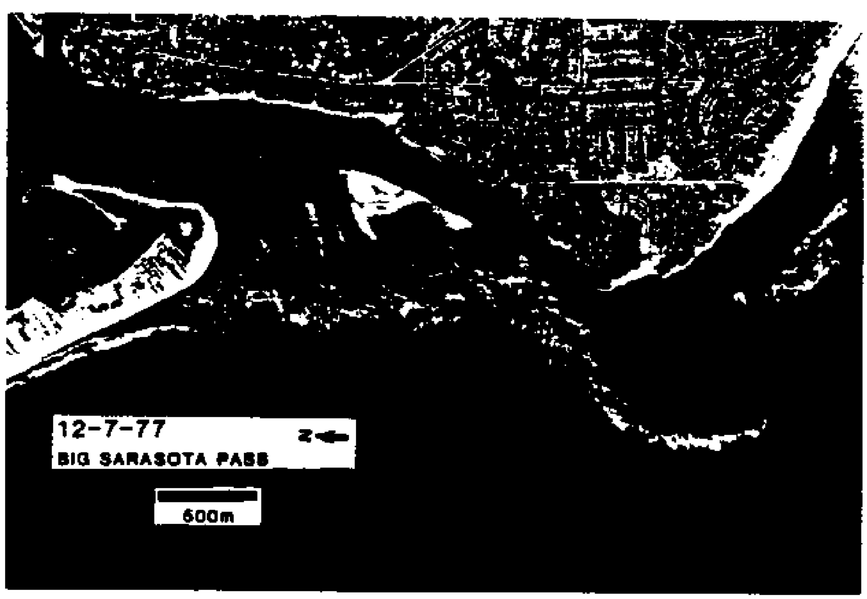


Figure 11.- Vertical aerial photograph of Big Sarasota Pass (Sarasota County) in 1977. This pass is an example of mixed-energy conditions with a prominent downdrift offset and intertidal shoals in the inlet opening.

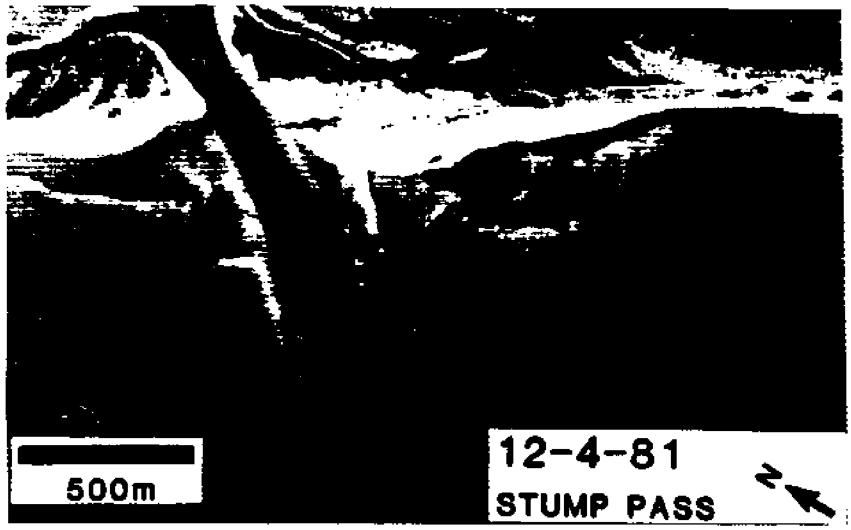


Figure 12.- Vertical aerial photograph of Stump Pass (Charlotte County) in 1981. Stump Pass has a mixed-energy morphology with a small offset.

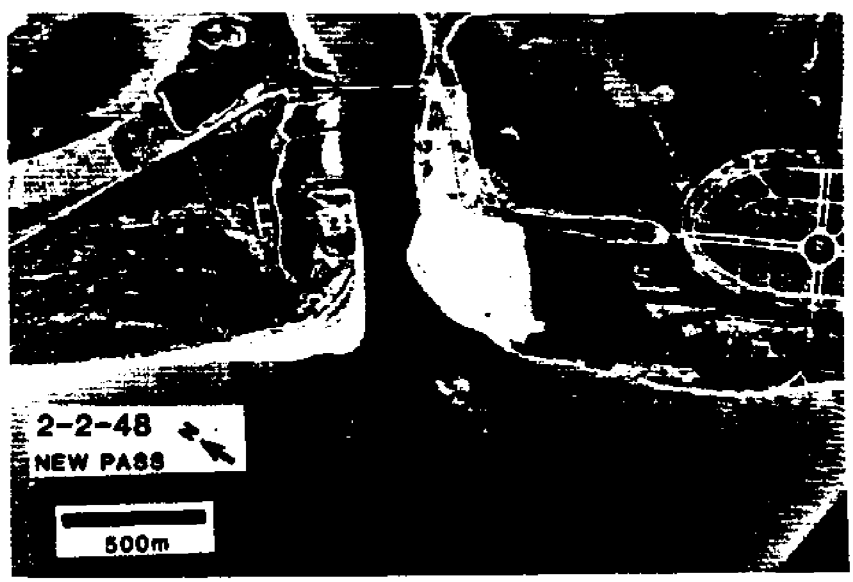


Figure 13.- Vertical aerial photograph of New Pass (Sarasota County) in 1948. New Pass has a mixed-energy straight morphology.

inlets such as Southwest Channel and Boca Grande (Fig. 2), the west-central Florida inlets are in a delicate balance between tide- and wave- dominated conditions Fig. 14). These dynamic conditions are caused by the overall low-energy environment. While slight decrease in tidal prism may be enough to cause an evolution from tide to wave-dominated morphology, a change in direction of littoral drift may cause the devopment of an offset morphology.

In 1972, Midnight Pass (Fig. 10) had a mixed-energy offset morphology. A distinct main-ebb channel and ebb-tidal delta were present. By 1983, Midnight Pass (Fig.9) had migrated northward and dispayed a wave-dominated morphology with an unstable channel and a greatly reduced ebb-tidal delta. Davis et al. (1987) attributed the change in Midnight Pass to a decrease in tidal prism caused by dredging of the intracoastal waterway in 1963 and 1964 through the bay served by Midnight Pass. The dredged channel directed tidal flow north and south through the bay and away from the pass.

In 1948, New Pass (Fig. 13) displayed a mixed-energy straight morphology. An increase in southerly littoral drift caused a mixed-energy offset morphology to develop by 1957 (Fig. 15). A reversal in littoral drift direction caused New Pass to returned to a mixed-energy straight morphology by 1983 (Fig. 16).

SUMMARY OF INLET DYNAMICS

The juxtaposition in space and time of different inlet types along the west-central Florida coast is at odds with previous regional inlet classification schemes developed for the German and Georgia Bights. Nummedal and Fischer (1978) noted the orderly geographical change in inlet type from wave-dominated to tide-dominated morphologies toward the apex of the bights.

They also observed that tide range increases and wave energy decreases gradually toward the apexes. Even though tide range and wave energy shows little variation along the west-central Florida coast, changes in tidal prism causes tide- and wave-dominated inlets to be geographically intertwined. Tidal prisms are controlled by the size of the bays and the number of inlets serving them.

Because barrier island locations and the nature and size of bays behind them are affected by pre-existing topography (Davis & Kuhn, 1985; Evans et al., 1985; Evans & Hine, 1986), the complicated inlet morphologies may be partly due to an irregular bedrock surface. The overall low-energy conditions result in a delicate dynamic balance of processes and morphology and relatively slight changes in tide or wave processes cause temporal shifts in inlet types.

Walton and Adams (1976) correlated ebb-tidal delta volumes with tidal prisms for inlets on the Atlantic, Gulf, and Pacific coasts. Although the data showed much scatter, a trend of increasing ebb-delta volume with increasing prism occurred over two orders of magnitude. Plots of tidal prisms and ebb-delta volumes against inlet types for some of the inlets in this study are shown in Figure 17. There is much overlap among the inlet types in tidal prisms and ebb-delta volumes.

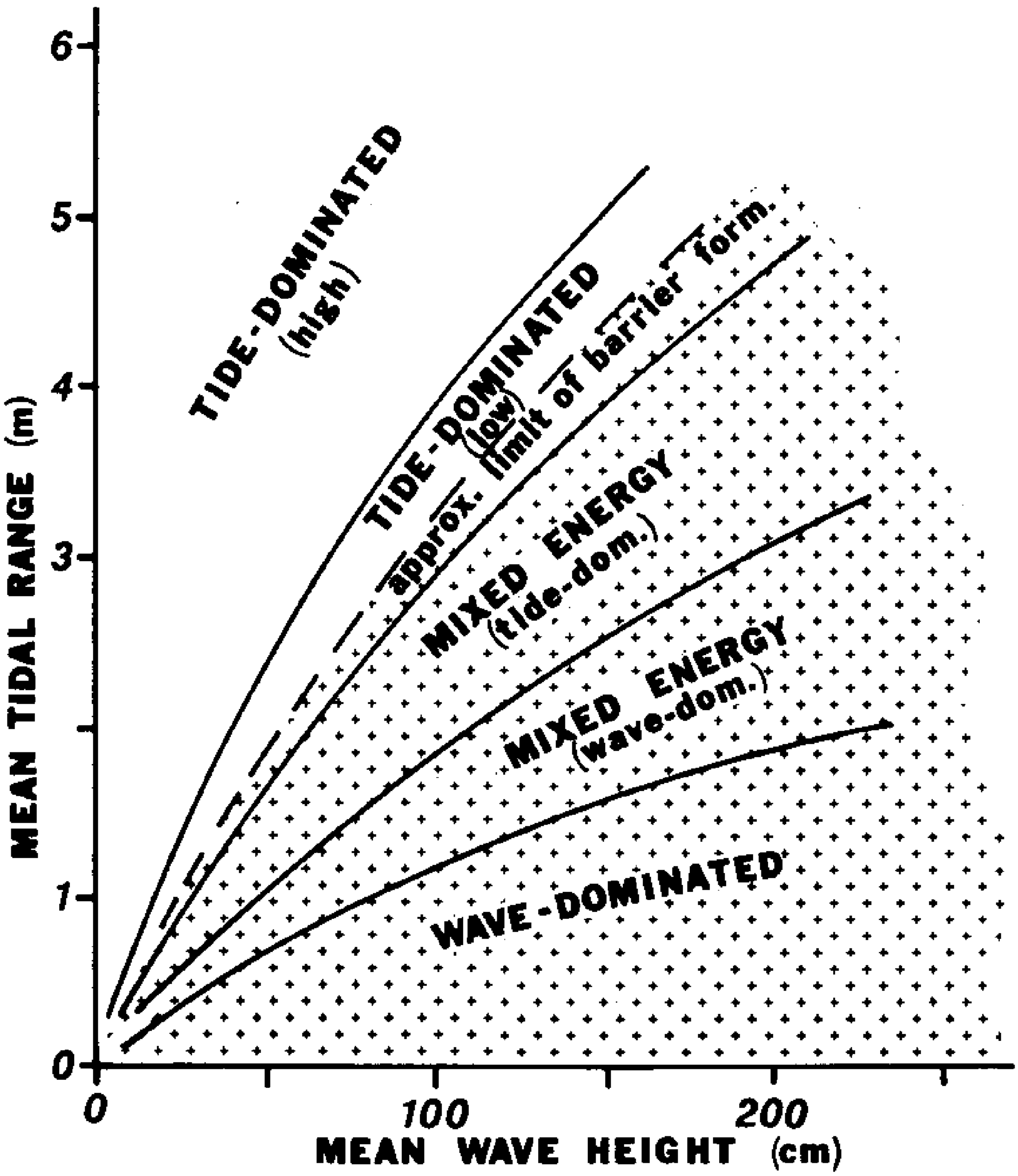


Figure 14.- Plot of tide range versus mean annual wave height showing dominant coastal process. The west-peninsular coast of Florida falls near the lower left corner where energy is quite low and where slight change in either parameter can cause a significant change in coastal morphology.

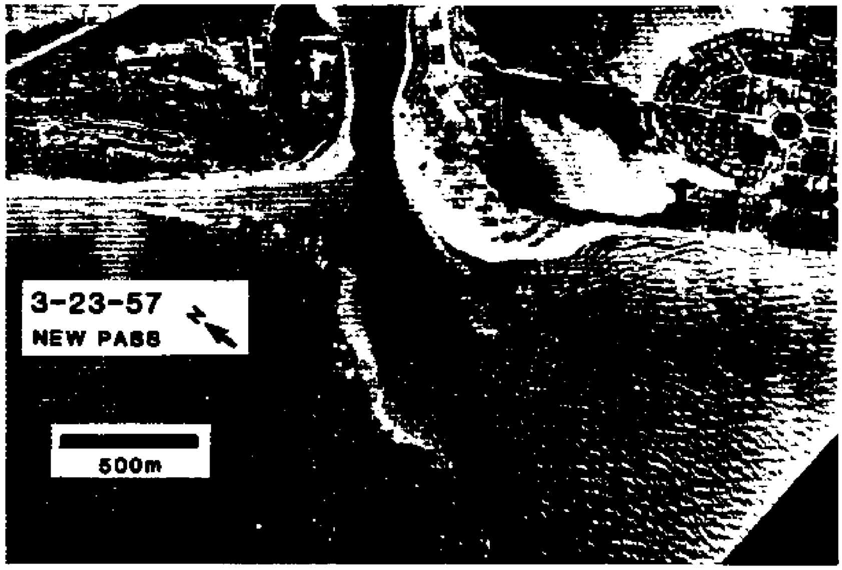


Figure 15.- Vertical aerial photograph of New Pass (Sarasota County) in 1957. New Pass has a mixed-energy offset morphology. The shift from a straight morphology in 1948 (Fig. 13) to an offset morphology in 1957 was accomplished by an increase in southerly littoral drift.

Figure 16.- Vertical aerial photograph of New Pass (Sarasota County) in 1983. A restoration of northerly littoral drift eliminated the offset morphology present in 1957 (Fig. 14).

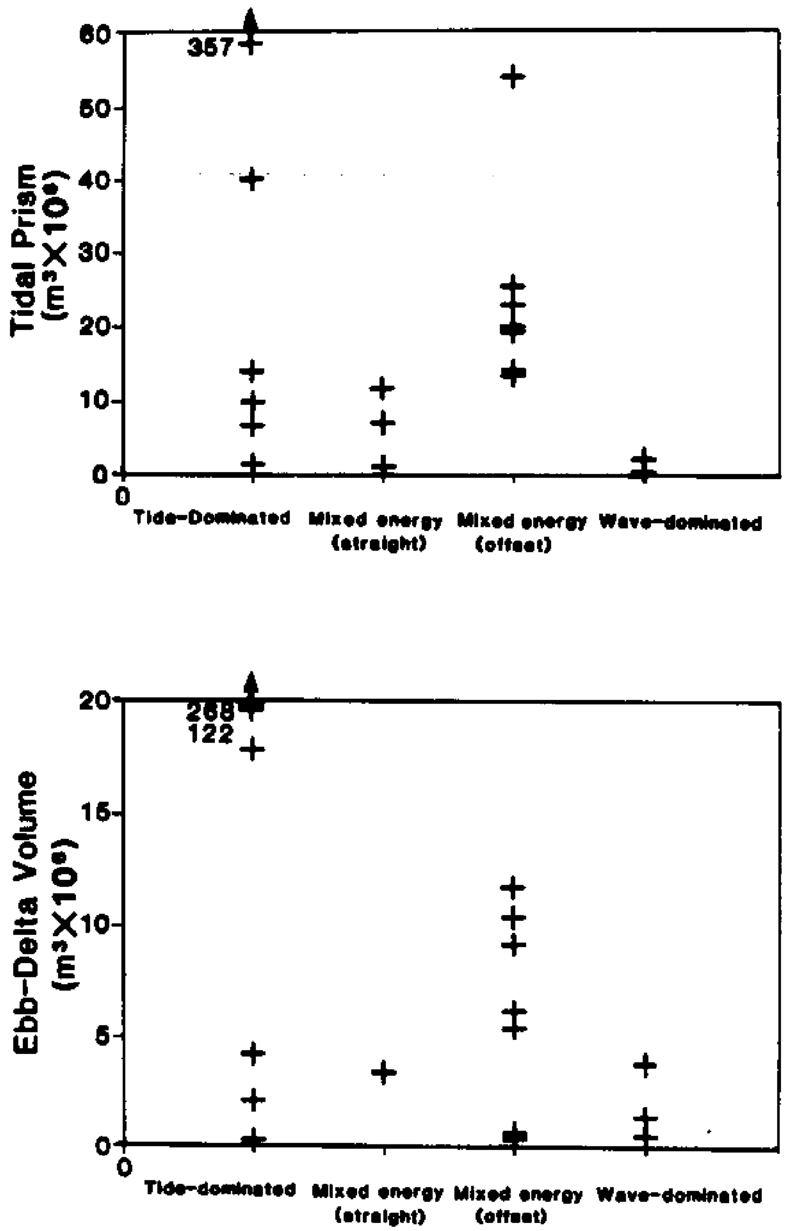


Figure 17 - Plots of tidal prism and ebb-tidal delta volumes against inlet types for some inlets along the west-peninsular Florida barrier chain. Ebb-tidal delta volumes are from Hine et al. (1986); prisms are from various sources.

This demonstrates that although empirical relationships such as those of Walton and Adams (1976) may predict gross features of inlet sedimentation. These empirical relationships are not satisfactory for describing modes of sedimentation and inlet effects on adjacent shorelines.

The size of ebb-tidal deltas controls the length of shoreline influence and in part the location of inlet beach sedimentation and erosion (FitzGerald & Hayes, 1980). The size as well as the type of inlet must, therefore, be considered in shoreline management. Figure 17 shows there is no simple relationship between scale and inlet morphology.

ROLE OF INLETS IN COASTAL MANAGEMENT

Most of the attention of managing the open coast tends to be directed toward problems associated with beaches and adjacent dunes. This is rapidly changing as we gain greater awareness of inlet dynamics and their impact on the coast. Inlets represent tremendous sediment sinks, that is, places where sediment tends to accumulate. Several inlets along the west-central barriers system in Florida contain several million cubic meters of sediment in their flood- and ebb-tidal deltas. Both the fact that the sediment is there and the sediments potential as borrow material of coastal nourishment are important considerations in coastal management of inlets.

The fact that inlets present natural interruptions to the littoral transport system along the coast presents problems for coastal management. Of course, some inlet types allow for much sediment to bypass the inlet and continue in this littoral system. However, there are some inlets, specifically tide-dominated inlets, that act much like jetties in their prohibition of littoral transport across the tidal channel(s). Such inlets, like Johns Pass in Pinellas County, can yield considerable borrow material for nourishment but present major barriers for alongshore transport of material. By way of contrast, wave-dominated inlets like Midnight Pass and Blind Pass (Lee County) have almost no ebb-tidal delta and allow virtually all of the littoral drift sediment to pass by. They, of course, have essentially no value as borrow sources.

Another important type of management problem associated with inlets is instability. As inlets become wave-dominated they are susceptible to considerable migration alongshore; some, such as Midnight Pass, both Blind Passes and Big Hickory Pass, have migrated kilometers in less than a century. This causes serious problems along a developed coast and artificial stabilization is frequently invoked. Such practice can also cause problems such as inlet shoaling or closure and local erosion adjacent to the structures installed for stability of the inlet.

The overall management of inlets must be accomplished in much the same fashion as for beaches. It is necessary to have a comprehensive understanding of inlets in general and of specific types; both from the historical perspective and the current processes operating on the inlets. This knowledge, coupled with the analogous information on adjacent beaches, can then permit the best management decisions. It should be noted that in many cases there are no solutions, just better approaches that have been applied in the past.

HISTORICAL CHANGES IN INLETS

The coast of Florida has been visited and settled for several hundred years but it is only during the past century that widespread and accurate maps have been available for this region. The surveys that were undertaken and the maps produced by the United States Coast and Geodetic Survey (now part of NOAA) in the last quarter of the ninteenth century represent the first reliable charts for this coast. This time period will be used as the datum for a general discussion of the trends in inlet changes. The reader must be aware that even as this discussion is being written changes in inlet morphology are taking place.

Numerous inlets have been closed during the past century, some have been formed for the first time and others have experienced both closure and reopening (Fig. 18). Much of this activity has been due to natural processes, some has been with the indirect influence of man and some has been directly by the activities of man. Dredging of one inlet can "rob" some of the tidal prism, that is, the water budget during a tidal cycle, from an adjacent inlet. Dredging of the intracoastal waterway can do the same. The recently abandoned practice of dredge-and-fill of mangrove and marsh environments on bay margins also altered the tidal prism by changing the area of the bay. Each of these activities results in a modification, generally a decrease, in the tidal prism of affected inlets. The obvious impacts of man that involve structuring inlets, dredging of the inlet and in some cases, closing of inlets are also very important factors in the overall coastal environment.

Figure 18 shows the west-central barrier/inlet system of the Florida peninsula. The closed triangles represent inlets that have closed at least once since 1880 and the open triangles represent those that have been opened during the same time; in both case without direct influence of man.

Historical information about the role of human activities on each of the following inlets can be obtained from a report entitled "Impact of Florida's Gulf Coast Inlets on the Coastal Sand Budget" (Hine et al., 1986) which was prepared for the Division of Beaches and Shores, Florida Department of Natural Resources.

The following section includes a brief historical synopsis each inlet, a recent generalized map showing flood- and ebb-tidal deltas, and a tabulation of inlet data for the past century. An explanation of the symbols used in this tabulation is provided on page 78.

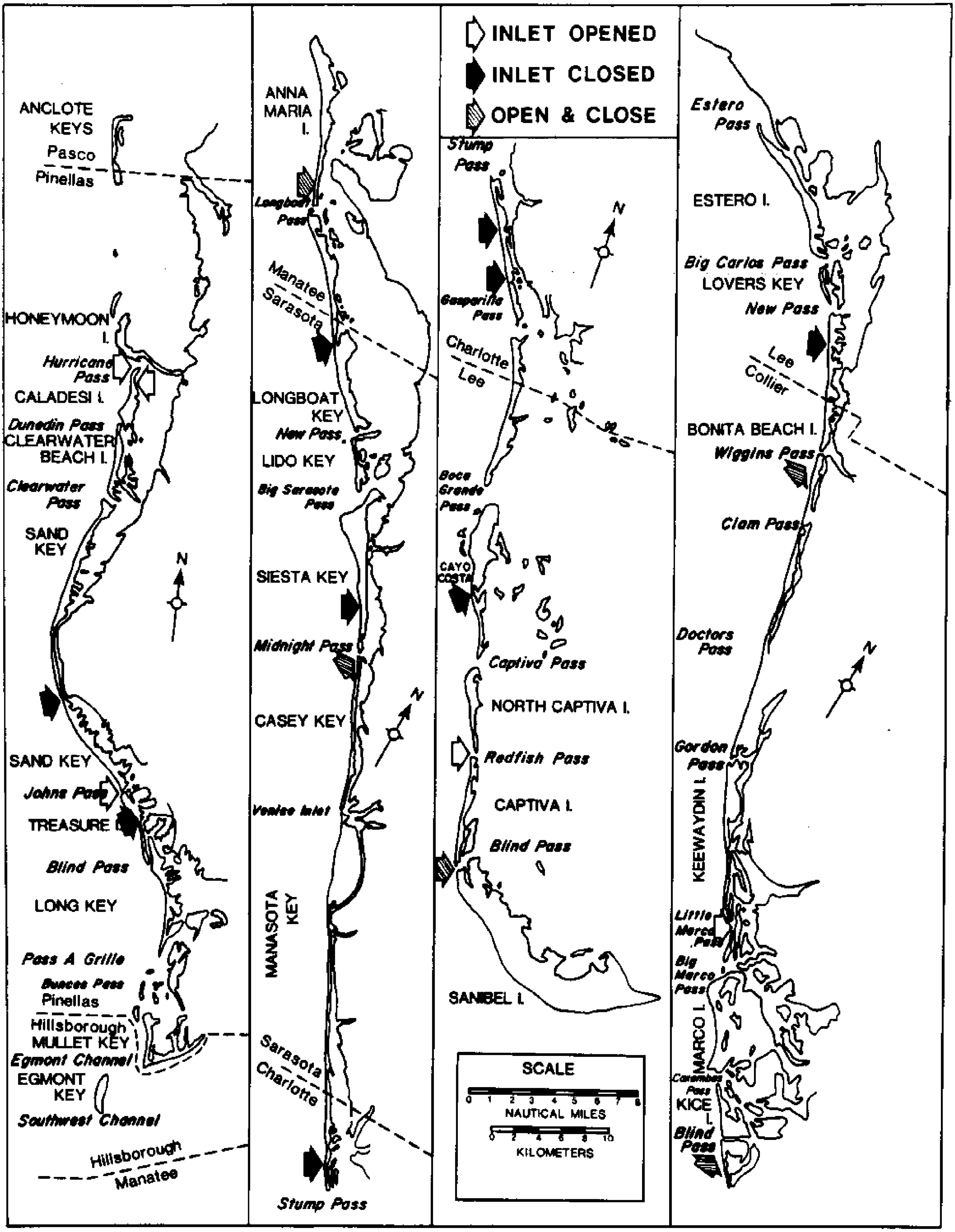


Figure 18 - Strip map of the west-peninsular Florida barrier coast showing barrier islands and inlets. Inlet openings and closures during historical time are shown by the appropriate arrows.

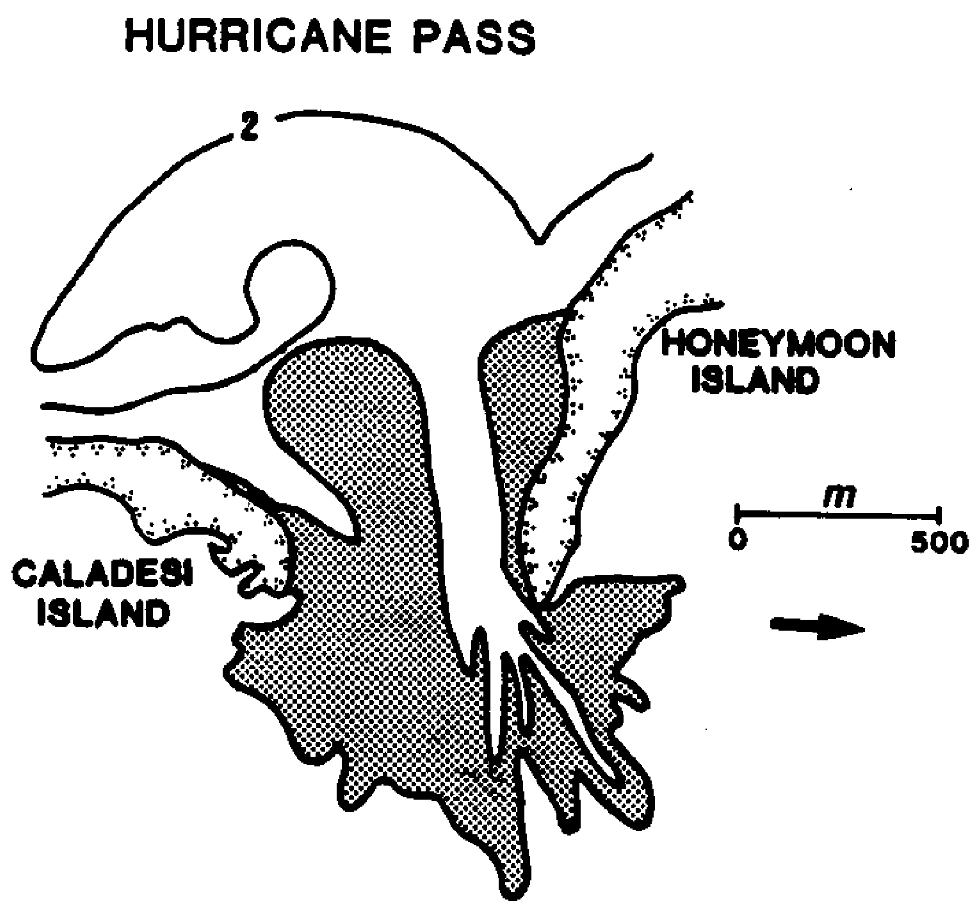
Hurricane Pass -

This inlet in Pinellas County was formed by the hurricane of October, 1921 which breached Hog Island. The flood delta is lobate in shape, has remained essentially unchanged since formation, and currently supports a diverse benthic community including sea grasses.

The inlet widened initially after formation until the mid 1960s when the causeway was constructed between Honeymoon Island and the mainland. This reduced the tidal prism and caused the inlet to decrease in width by about 200 m (Lynch-Blosse & Davis, 1977). Hurricane Pass has remained rather stable since that time with a maximum depth of nearly 7 m. There is some indication of recent narrowing of the inlet due to the development of Willy's Cut immediately to the south after Hurricane Elena in 1985.

Hurricane Pass does not have a prominent ebb delta (Fig. 19) due in part to its flood-dominated nature (Lynch-Blosse & Davis, 1977) and to the overall embayed configuration of this local section of barrier coast. There has been little historical change to the overall morphology of this inlet during its short existence.

Figure 19



HURRICANE PASS
Diurnal Tide Range: ocean= 88cm bay= 85cm
Net Littoral Drift= 57,300 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CENO	CENA	CXSA	CW	CDA	CDN	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1926							697	213		3.2					
1941							1301	327							
1949										4.5					
1951										1.4					
1957	2		1.383		640	95		670							0
1958										4.6					
1962	2		1.454		740	91		520		3.3					100E
1963								648							
1972								312		2.8					
1975							800	206	4.0	8.1	9.600		70.0	57.0	
1976	2		1.310		740	96		240							40SE
1977							1042	259	4.0	7.4					
1977-79											7.362	7.362	52.4	55.8	
1980	2		1.537		800	102		230							20NW
1984	2	0.758		1.988				220	2.1		9.848		39.6	50.3	70E
1986							1040								
1987							552	192	2.9	5.4			93.0	88.0	

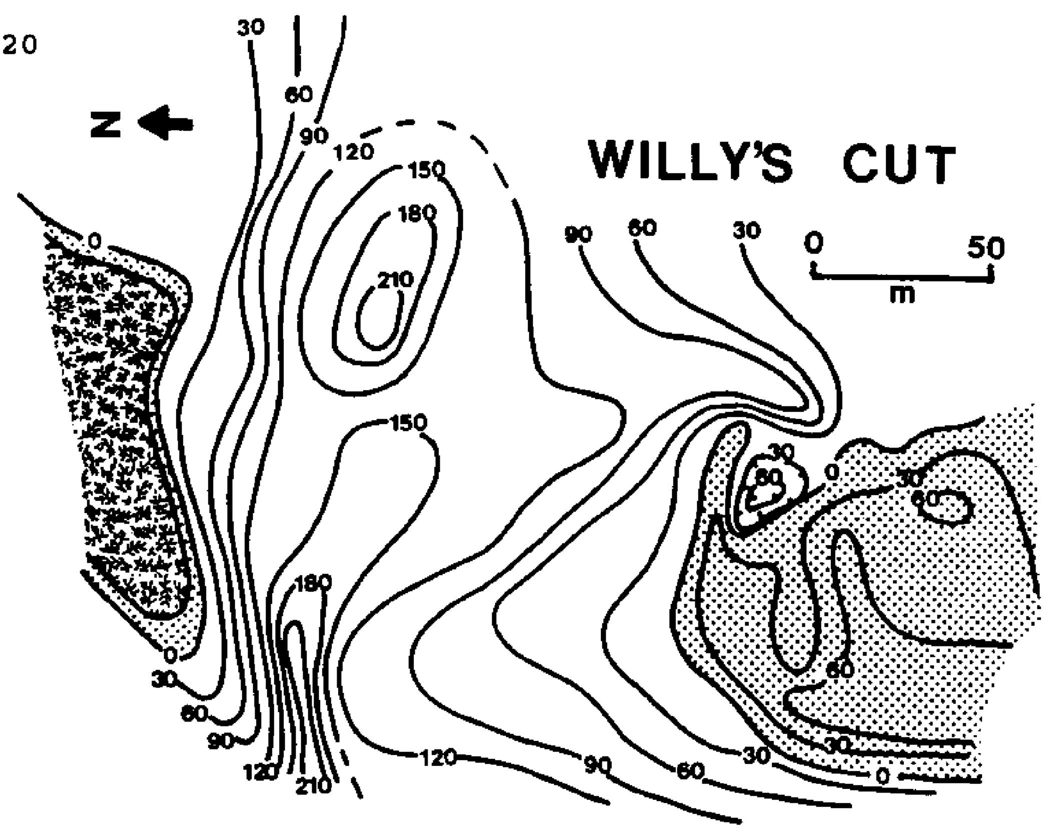
Willy's Cut-

Hurricane Elena did not have landfall on the west - central Florida coast but did have a great effect during August 31 - September 2, 1985. It caused a breach on the narrow northern part of Caladesi Island which initially resulted is a large washover fan with a sediment volume of 20,000 m3 (Davis et al., in press). Over the following two years a tidal inlet developed at this breach in the island and appears to be on its way to stability. The tidal prism appears to be taken from Hurricane Pass rather than from Dunedin Pass (B. Ross, personal communication).

The flood tidal delta is a modification of the original washover fan and is arcuate in shape. There has been little change since formation except for the excavation of the tidal channel. The inlet throat was >2 m deep by October, 1988 (Fig. 20). It is somewhat stabilized in its position by the resistant peat which forms part of the channel wall on both sides of the inlet. There is a small recurved spit that persists on the southern or updrift side indicating the presence of a south to north littoral drift. A small but distinct ebb-tidal delta has developed that extends about 75 m into the Gulf (Davis et al., in press). This feature consists of two levee-type shoals on each side of the inlet channel.

Willy's Cut is the youngest inlet on this reach of coast and its future is unknown, but it appears to be slowly increasing in size. There is a possibility that the growth of this inlet will cause a reduction of size of Hurricane Pass.

Figure 20



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Dunedin Pass -

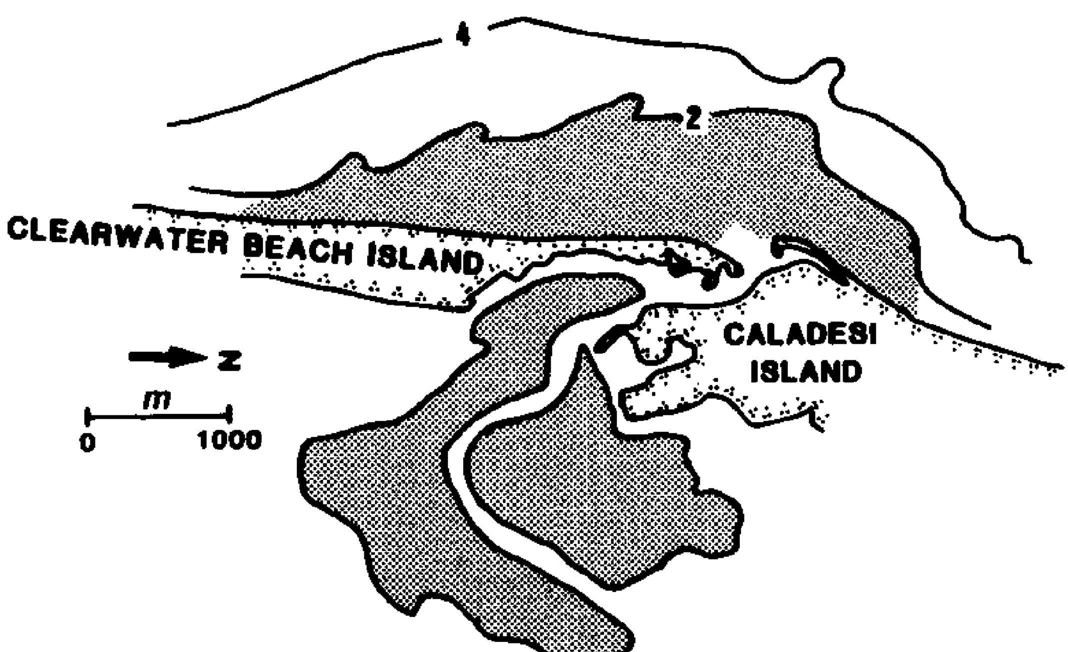
Until the 1960s this inlet was known as Big Pass because it described it well. In the latter part of the 19th century this inlet was several hundred meters wide and carried a large tidal prism. There was significant reduction in size as the result of the hurricane of 1921 and the construction of the causeway connecting Clearwater Beach Island with the mainland in the mid- 1920s (Lynch-Blosse & Davis, 1977). This was followed by further reduction in width after construction of the Dunedin causeway in the 1960s.

The flood tidal delta of Dunedin Pass is quite large (Fig. 21), it is stable and it hosts an extensive benthic community including widespread sea grass beds.

The inlet channel was not only quite wide but was about 5 m deep in the late 1800s. Even at that time the channel was oriented toward the northwest indicating a dominance of northerly littoral drift throughout historical time. The inlet throat became narrower, shallower and shifted toward the north throughout the past century. As a result, the southerly end of Caladesi Island experienced considerable erosion due to the combination of the migrating channel and tidal currents.

The ebb-tidal delta of Dunedin Pass extended about 700 m into the Gulf in the latter part of the 19th century. This has gradually been reduced in size as tidal prism has been reduced in combination with a decrease in littoral sediment budget. The inlet has become less tide-dominated and more wave-dominated throughout this period. Hurricane Elena destroyed the remaining portion of this ebb-tidal delta and thereby enabled the inlet to close due to littoral drift. This occurred in 1986 and although there are plans to open it, Dunedin Pass is no longer an active tidal inlet.

Figure 21 **DUNEDIN PASS**



DUNEDIN PASS
Diurnal Tide Range: ocean= 87cm bay= 85cm
Net Littoral Drift= 76,400 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1873								500		5.8					
1880-85	2	6.713		1.835			1300	520		4.7					
1926							1904	396		4.7					
1941								396							
1949								427		4.6					
1950		6.499						305							
1951										3.0					
1956								373							
1957	2		1.248		740	135		200							0
1958								137.		4.4					
1959							1337*	563*	2.4*		10.641		51.5	51.5	
1962	2		0.821		630	134		80		4.3					260N
1970	3		0.606		400	98		84		2.8					130N
1972								137		2.9					
1973	2		0.821		460	125		170							180S
1974								75							
1975	2		0.654		350	96	160	110	1.5	3.2	2.100		68.0	79.3	240N
1976	4		0.969		460	78		70							70S
1977							169	107	1.6	4.1					
1977-79											1.869		55.8	53.9	
1980	4		0.362		330	61		70							300N
1984	4	0.917	0.262	1.835	200	67		70	1.8		2.349		36.0	40.0	80S
1986							70								

* NOT AT THROAT, AT MOUTH

Clearwater Pass -

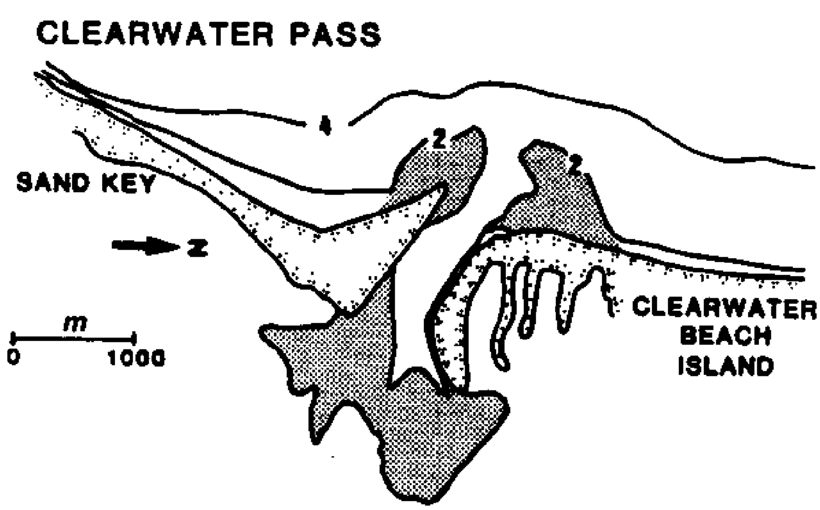
The origin of Clearwater Pass is not known. However, it has changed greatly over the past several decades. A century ago it was called Little Pass and although it was only about 100 m wide, it was over 8 m deep. The pass carried a large tidal prism and was pressured by converging littoral drift from Sand Key on the south and Clearwater Beach Island on the north. A thorough discussion on Clearwater Pass is available in the report by Newman (1983).

This inlet did not have a clearly defined natural flood-tidal delta about 100 years ago. At the present time there is a shallow shoal landward of the inlet that appears to represent a flood-tidal delta in its location and form. Its origin is primarily the result of northerly transport of sediment by longshore currents on Sand Key which were then entrained by tidal currents and deposited in the form of a tidal delta. The supply of sediment to this flood delta has largely been cut off by the construction of the long jetty on the south side of the inlet in 1975.

The inlet channel of Clearwater Pass has been problematical throughout much of recent history. Continual influx of sediment by littoral drift caused persistence of a narrow but deep channel until the turn of the century when the width increased nearly an order of magnitude (University of Florida, 1973; Lynch-Blosse, 1977). After construction of the causeway between Clearwater and the island, this trend of widening was reversed due to reduction in tidal prism. Eventually the combination of littoral drift from the south and reduced tidal prism resulted in the need for a jetty to stabilize the inlet.

The ebb-tidal delta at Clearwater Pass was prominent in the late 1800s. It extended about 500 m into the Gulf and had a shape of a mixed-energy ebb delta. As the tidal prism was reduced, the relative impact of waves increased and the ebb-tidal delta was greatly reduced in size. At the present time, small shoals at each side of the inlet on the Gulf side (Fig. 22) are forming a vestigal ebb delta.

Figure 22



CLEARWATER PASS

Diurnal Tide Range: ocean= 86cm bay= 79cm

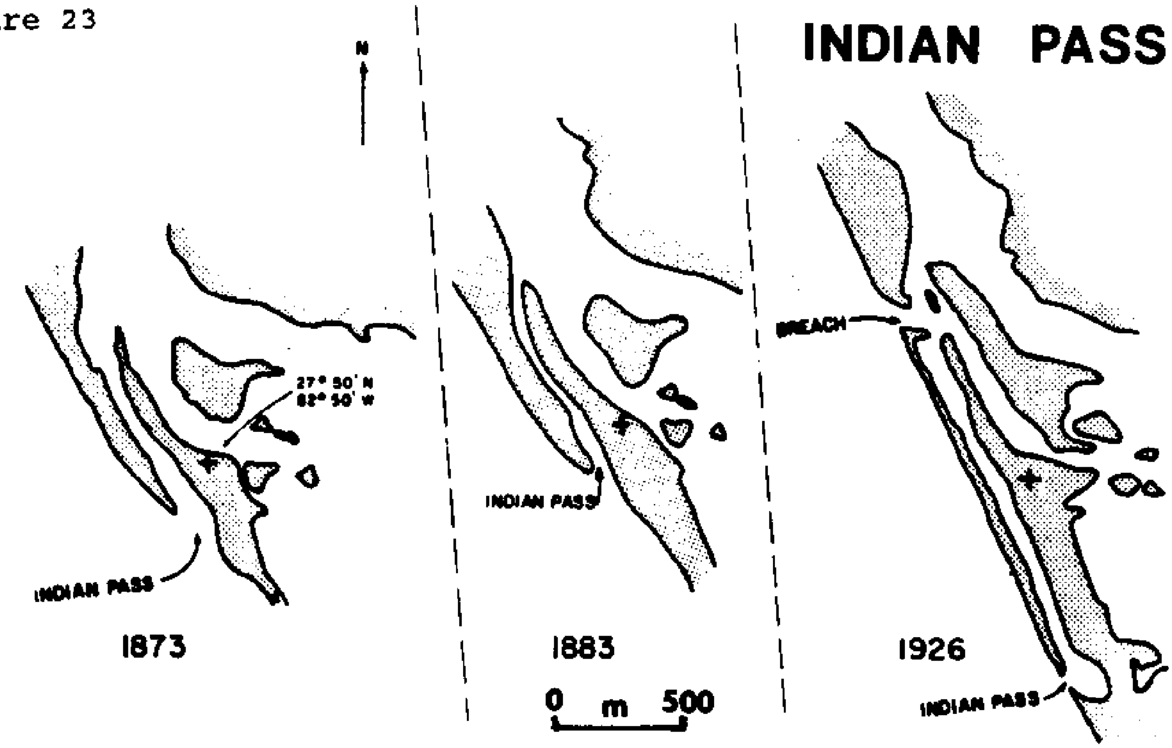
Net Littoral Drift= 76,400 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1873								140							
1880-85	2	1.552		0.688				106							
1926								1410							
1941								914							
1949							1853	926	2.0	3.2					
1950		2.294		3.892				747							
1951							2071	1075	1.9		19.244		67.0	56.7	
1956								745							
1957	2		2.053		880	96		670		2.8					0
1959															
1962	2		1.678		930	102		520							50N
1965								373							
1968								343							
1972								274							
1973	2							335							200NW
1977								411							
1984		5.367		0.688				411	2.6		25.753		45.7	50.3	
1986							1133								

Indian Pass -

Indian Pass was a small, wave-dominated inlet located south of Indian Rocks on Sand Key (Fig. 23). It was closed in 1929 by the U. S. Army, Corps of Engineers. This inlet was a wild pass because it migrated rapidly over long distances and had the associated spit breached on numerous occasions. Indian Pass was <2 m deep and <100 m wide throughout its historical existence. No tidal deltas are apparent on old charts and no residual sediment bodies remain.

Figure 23



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John's Pass -

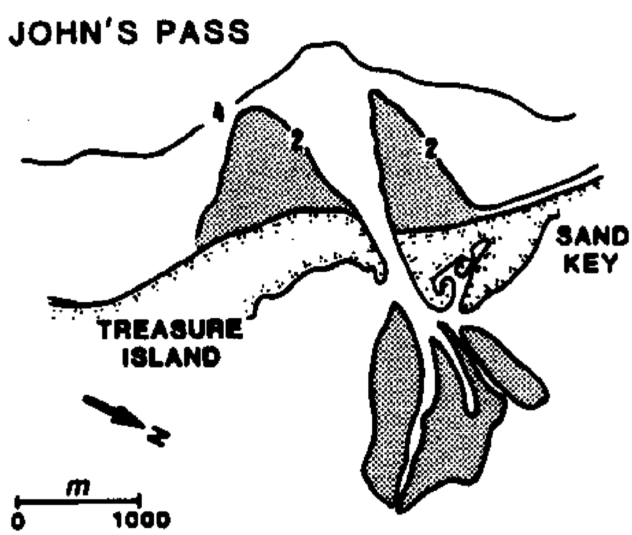
An intense hurricane in 1848 created Johns Pass by breaching the barrier that is now called Sand Key to the north and Treasure Island to the south. This primary inlet serving Boca Ciega Bay has remained fairly stable over the past century.

The flood tidal delta is large and consists of multiple sediment lobes which have apparently not changed significantly since their formation. These sediment bodies, which are in part intertidal and supratidal, have been vegetated for decades. As a result, the flood delta is completely stable.

The inlet channel has also been stable with a migration of only 100 m or so to the south during the past century (Mehta et al., 1976). The primary reason for the relative stability of this pass is its tide-dominated nature although some structuring has also facilitated its position. The tidal prism is large because most of Boca Ciega Bay is serviced by this single tidal inlet.

The present ebb-tidal delta at Johns Pass is large and typical of a tide-dominated inlet. This situation has not prevailed throughout the past century. In the late 1800s the ebb delta extended several hundred meters into the Gulf but its shape was that of a mixed inlet with a downdrift offset. There was an arcuate terminal lobe (Fig. 24) indicating significant wave effect on the morphology. Over the next several decades the inlet had an increase in the tidal prism as Blind Pass, the next inlet to the south, decreased in size (Mehta et al., 1976). This resulted in a more tide-dominated ebb delta although it became assymetrical and there was some influence by man. The north or updrift side of the ebb-tidal delta became quite elongate parallel to the channel and extended over a kilometer into the Gulf. This was in response to the increased tidal prism and tidal current strength redistributing the sediment being provided by the southerly littoral drift along Sand Key. The south or downdrift side of the ebb delta showed less change from its earlier shape (Fig. 24).

Figure 24



JOHN'S PASS

Diurnal Tide Range: ocean= 81cm bay= 70cm

Net Littoral Drift= 38,200 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CENO	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1873							474	130							
1883							431	113							
1885	3														
1926							531	136							
1941							636	155							
1949							782	190	4.0		14.037		103.0	77.0	
1952		4.817					849	183							
1957	3		1.588		880	57		150							0
1962	3		1.328		750	42		170							220SW
1964															
1973	1							190							30SE
1974							882	180	4.9	7.6			48.5	65.5	
1976	1		1.029		710	64		200							10SE
1980	1							190							40E
1984	1	3.838		0.382				180		6.1					70N

Blind Pass (Pinellas County) -

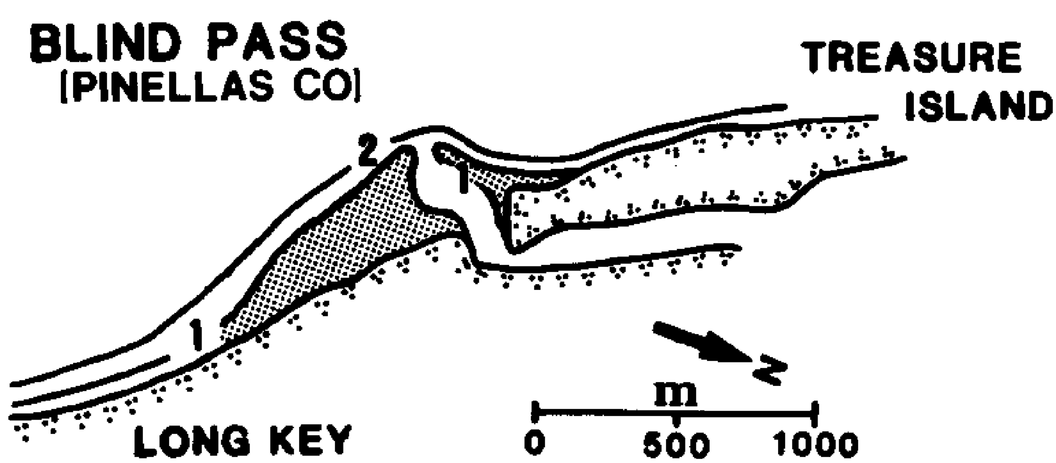
Blind Pass has undergone considerable change during the past 150 years. These changes were initially due to the formation of John's Pass by the hurricane in 1848 and more recently as the result of man-related activities. In the late 19th century Blind Pass was a large, mixed-energy inlet with a pronounced downdrift offset. In 1873 Blind Pass was larger than John's Pass, by 1925 it had become smaller and by the 1970s Blind Pass had only 5% of the cross sectional area as John's Pass (Mehta et al., 1976).

There is a large flood-tidal delta associated with Blind Pass, however, it is far north of the inlet mouth (Fig. 25). During the latter part of the 19th century, the inlet channel trended to the southwest and the flood delta was in a position similar to that of Dunedin Pass (see Fig. 21). Since that time the inlet has migrated over a kilometer to the south and the flood delta has been greatly modified by man's activities.

The inlet channel of Blind Pass was greatly reduced in size and migrated rapidly to the south as John's Pass increased in size and tidal prism. The decrease in tidal prism changed Blind Pass from a typical mixed-energy offset inlet to a distinctly wave-dominated inlet. By the 1920s it had been reduced to about 100 m in width and a depth of <2 m (Mehta et al., 1976). Eventually its position was stabilized by hardening the south (downdrift) side in 1938.

A similar trend has taken place in the ebb-tidal delta of Blind Pass over the past century. Initially, it was well-developed and typical of a mixed energy inlet. It extended > 500 m into the Gulf in the 1880s. The advent of wave-dominated conditions resulted in the nearly total destruction of the ebb delta. Jetties have permitted some accumulation of sediment however the present inlet has no significant ebb shoal at its mouth.

Figure 25



BLIND PASS (Pinellas County)
Diurnal Tide Range: ocean= 80cm bay= 69cm
Net Littoral Drift= 38,200 cubic meters per year, south.

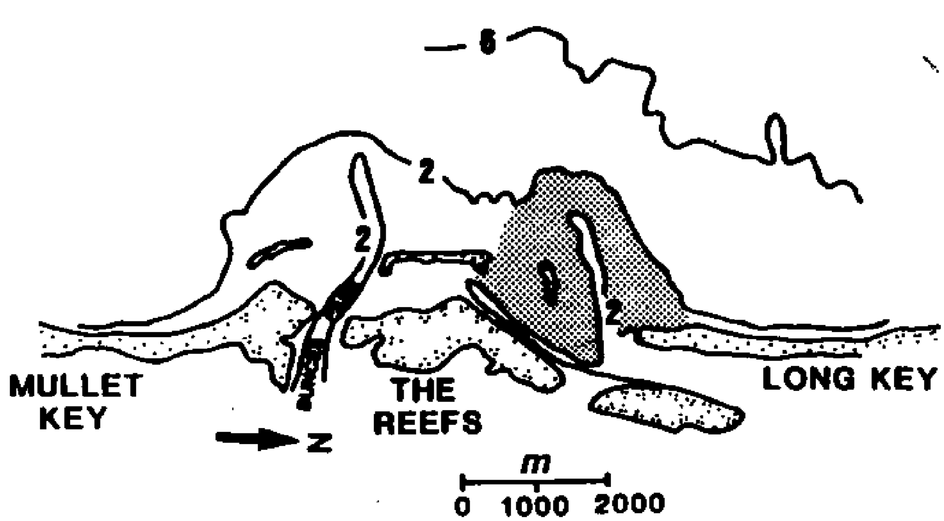
YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1873							538	155	3.5						0
1883							496	165	3.0						
1885		0.872		0.000											
1926							209	108	1.9						1190S
1936							225	155	1.4						
1939															670S
1952		0.328					157	59	2.7						
1974	4						40	25	1.6		0.990		80.2	114.6	
1984		1.262		0.000				182	1.2						

Pass-a-Grille -
The inlet at the south end of Long Key is rather unconfined and has historically included two main channels that bifurcate in the Gulfward direction. It was quite large a century ago with an ebb delta that extended 1.5 km into the Gulf. There was little definition to the inlet throat due to the lack of a confining barrier island to the south, however, that has been changed with accretion on the mangroves to the south where islands know as The Reefs have developed. A distinct ebb-tidal delta was not present and has not developed since. The primary changes in this inlet during the past century have been in the size and position of the two channels, North Channel and South Channel, and Shell Key, which is the mobile island that separates these channels.

Both channels were about the same width (100 m) and depth (6-9 m) during the 1880s but South Channel extended about 0.5 km further into the Gulf. During the next few decades the north channel widened greatly. In the 1960s North Bunces Key developed across the mouth of South Channel (Fig. 26) and stopped tidal flow (Davis et al., 1985). The channel has not been filled in but has become relict in nature. North Channel currently carries a large tidal prism and has been somewhat stabilized by the construction of a jetty at the south end of Long Key.

The ebb-tidal delta at Pass-a-Grille has maintained a rather large and tide-dominated accumulation throughout recent history. The cessation of flow through South Channel had little apparent effect on the overall inlet morphology. The ebb delta protrudes nearly two kilometers into the Gulf and has been the source of borrow material for recent beach nourishment projects in southern Pinellas County.

Figure 26 PASS-A-GRILLE AND BUNCES PASS



PASS-A-GRILLE PASS
Diurnal Tide Range: ocean= 79cm bay= 64cm
Net Littoral Drift= 76,400 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	COA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1926							3762	1447	2.6	7.2					
1950							3251	604	5.4		40.186		61.9	71.9	
1952		17.967													
1957	1		2.112		830	77		750							0
1962	1		2.205		850	72		800							40SW
1964															
1973	1		2.164		780	79		930							120E
1976	1		2.759		930	81		820							70NW

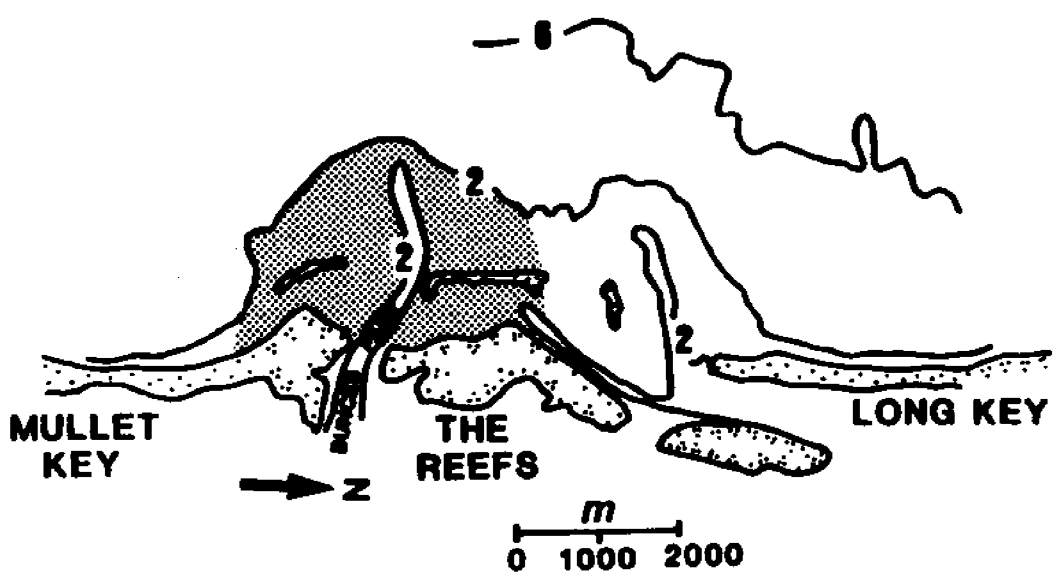
Bunces Pass -

The inlet at Bunces Pass remains one of the few totally pristine tidal inlets along the west-penisular coast of Florida. This inlet, along with Pass-a-Grille, are actually part of the huge tidal delta complex associated with the mouth of Tampa Bay even though each is a distinct system. The type and configuration of Bunces Pass have not changed significantly over the past century, however, it has enlarged somewhat in the past few decades. There has been a southerly migration of the seaward part of the channel over the past 100 years.

This inlet has no flood tidal delta. The channel retains its definition several kilometers eastward across the shallow grass flats of the margin of Tampa Bay. The throat of the channel is 6-7 m deep and has been stable for the past few decades. This stability is made possible by the large tidal prism and the large sediment accumulations which have recently emerged into small barrier islands on each side of the seaward inlet channel.

The ebb-tidal delta is distinctly tide-dominated with elongate shoals extending nearly 2 km into the Gulf (Fig. 27). This tidal delta has increased in size during the past few decades, probably in response to the closure of South Channel of Pass-a-Grille. It rests on the north side of the Egmont tidal delta system at the mouth of Tampa Bay and is, thereby, sheltered from some wave energy by the shallow waters in the Gulfward direction. All indications are that this inlet is stable and no significant changes are forecast.

Figure 27 **PASS-A-GRILLE AND BUNCES PASS**



BUNCES PASS

Diurnal Tide Range: ocean= 79cm bay= 66cm

Net Littoral Drift= 76,400 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	COM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1889	1														
1957	1		3.926		1150	86		590							0
1973	1		2.994		930	72		550							120NW
1976	1		3.816		990	74		510							40SW
1980	1		1.361		800	97		580							450W
1984	1		1.753		910	94		500							100E
1987	1						1490	428	3.5	5.9	11.478		60.0	80.0	

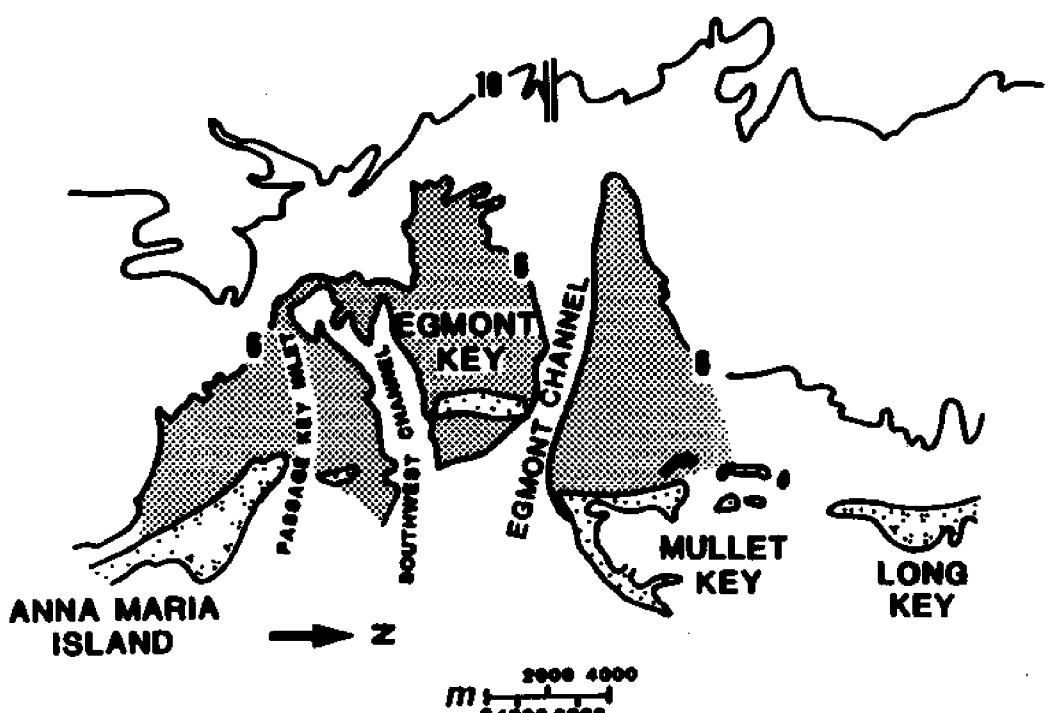
Egmont/Southwest Channels -

The largest tidal delta complex in the Gulf of Mexico is located at the mouth of Tampa Bay. This huge channel complex and sediment body system serves a tremendous body of water and carries an enormous tidal prism (Fig. 28). There has been little natural change in the overall system over the past century due to its size and tide- dominated nature. Locally some channels have shoaled and required maintainance. Considerable dredging has been completed to remedy this problem and to deepen channels for larger ship traffic.

There is no flood tidal delta associated with this tidal system. The three channels decrease in size and depth from north to south. Egmont (North) Channel was up to 28 m deep a century ago and is the same now with the deepest natural area just to the north of Egmont Key. Southwest Channel is considerablly smaller with a maximum depth of about 10 m and Passage Key Inlet is only a few meters deep except just off the north end of Anna Maria Island. These deep locations are the result of extreme tidal scour at the ends of islands, which is a common phenomenon in most barrier/inlet systems.

The ebb-tidal delta system associated with this tidal environment is distinctly tide-dominated but is broad on the Gulf side. It extends 9 km into the Gulf at present and has done so without major change for at least the past century. The linear shoals that border the channels, especially along the north side of Egmont Channel are quite shallow at the crest; only a meter or so. Southwest Channel is less defined and Passage Key Inlet is diminishing in size due to the pressures of littoral drift.

Figure 28 **EGMONT CHANNEL, SOUTHWEST CHANNEL, AND PASSAGE KEY INLET**



EGMONT CHANNEL, SOUTHWEST CHANNEL, AND PASSAGE KEY INLET
Diurnal Tide Range: ocean= 76cm bay= 73cm
Net Littoral Drift= 84,040 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1885	1	267.594		0.000											
1983													61.0	137.2	
1984	1	267.594		0.000				1280	6.4						

Longboat Pass -

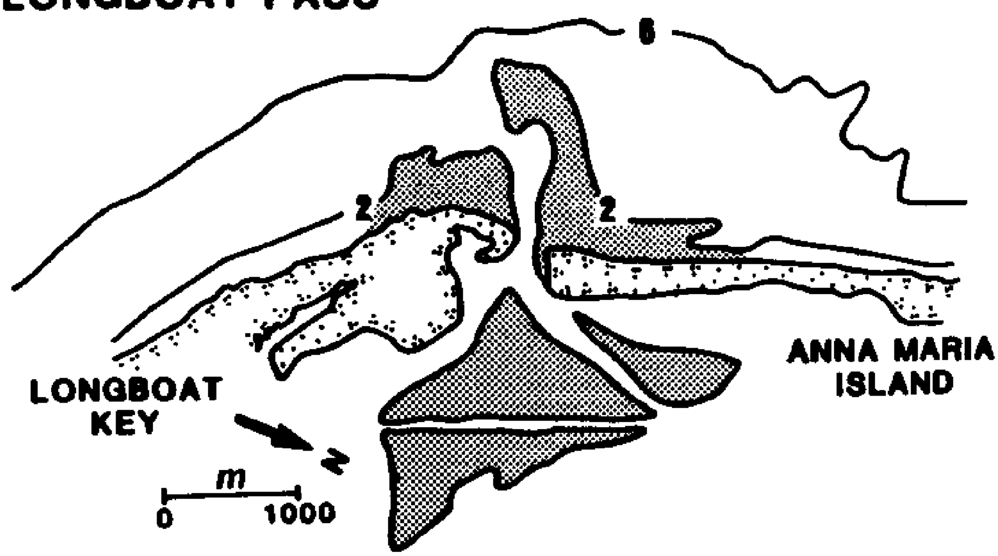
The vicinity of the present Longboat Pass has experienced major changes over the past 100 plus years. There have been some breaches in the narrow portion of Anna Maria Key on the north and there were some major changes to the north end of Longboat Key about 100 years ago. The inlet had a wave-dominated to mixed- energy (straight) configuration during the latter part of the 19th century but changed to a mixed-energy (offset) type. At present, the inlet is tide-dominated (Fig. 29).

There appears to be multiple flood-tidal deltas associated with this inlet. These evidently were formed by storm activity associated with the known and the apparent breaks in southern Anna Maria Island and northern Longboat Key. There are no indications that these multilobate sediment accumulations have been active during the past 100 years. Some vegetation has developed on the higher elevations.

The inlet channel at Longboat Pass has maintained a fairly similar size and shape over the past several decades. It is about six to seven m deep at the throat and has been 100-200 m wide. The channel was deflected to the south up until the 1970s. It is now nearly perpendicular to the shore and retains its definition over a kilometer from the coast.

Currently, the ebb-tidal delta at Longboat Pass shows a tide-dominated morphology with the north side distinctly linear and shore-normal, whereas, the south side is more arcuate. A comparison with John's Pass (see Fig. 24) shows a very similar morphology. The gradual trend from a mixed-energy to a tide-dominated ebb-tidal delta is a response to an increase in tidal prism or a decrease in wave energy and sediment supply. There is no apparent reason for an increased prism at Longboat Pass based on activities of man or natural changes.

Figure 29 **LONGBOAT PASS**



LONGBOAT PASS
Diurnal Tide Range: ocean= 77cm bay= 67cm
Net Littoral Drift= 45,840 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1888	2	12.386		1.147											
1951	1		1.217		710	85		130							0
1953							1059	241	4.3	8.8	13.867		92.6	82.3	
1954		5.948													
1957	1		1.297		650	86		160							90W
1965	3		1.454		680	69		250							70E
1966													91.4	82.3	
1970	3		1.605		490	83		240							100W
1973	3		1.555		680	64		240							40NE
1976															
1977	3		1.885		790	55		230							20SW
1980	1		1.908		810	62		170							80E
1982		6.216		1.147				228	3.4						
1984	1		1.806		790	64		210							30NW
1987							833	194	4.3	8.7	8.426		65.0	118.0	

New Pass (Sarasota County) -

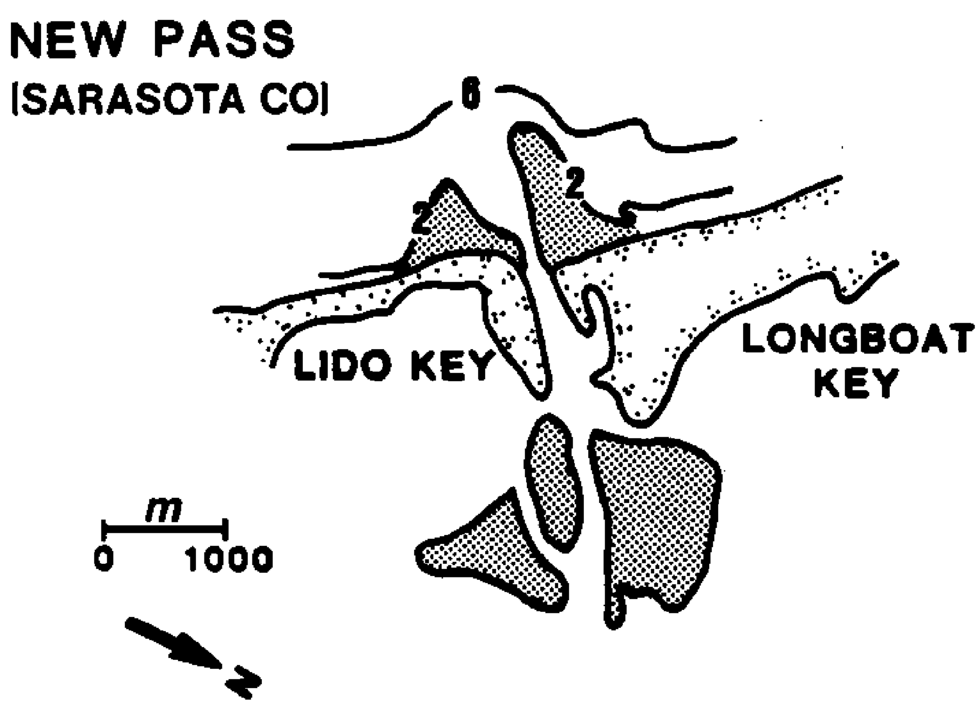
This inlet was quite deep and well developed in the late 19th century. There has been little change in the overall morphology during the past 100 years, except that the ebb-tidal delta has become larger. Dredging of the inlet has taken place since 1926 (Hine et al., 1986), thus imprinting man's activities on the morphology.

In the late 19th century a prominent flood-tidal delta was marked on coastal charts with "soft sand" and "quick sand" which is suggestive of mobile sediment at that time. During the past half- century there has been some benthic vegetation and its abundance is increasing.

The inlet channel is narrow and deep and has been since the surveys of the 1880s. At that time the channel was <100 m wide and the maximum depth was 7 m. The channel was deflected slightly to the south as it entered the Gulf. Shoaling became a problem in the early 1900s and the inlet has been regularly dredged for the past 60 years. Present channel depth is four to five m and the width is about 125-150 m.

The ebb-tidal delta at New Pass was essentially absent during the latter 19th century. At that time the inlet was in the wave-dominated category however it has become a mixed-energy (straight) inlet during the past half-century. A small but prominent ebb delta with distinct channel margin shoals now persists (Fig. 30). Wave energy is not sufficient to close off the Gulfward end of the main channel. Undoubtedly, the repeated dredging during the last several decades has contributed to this morphology by keeping the channel area rather large and thereby encouraging tidal flow.

Figure 30



NEW PASS (Sarasota County)
Diurnal Tide Range: ocean= 77cm bay= 64cm
Net Littoral Drift= 45,840 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1888	4	0.994		4.740				90		7.0					
1948	2		1.006		680	68		160							0
1953							592	170	3.5		11.320		82.3	51.5	
1954		5.046													
1957	3		1.016		620	66		160							170SW
1969	3							170							130S
1972	3		0.908		540	104		170							90N
1974	2		1.204		550	73		130							50SW
1977	2		0.992		650	80		170							30NE
1982		3.364		4.740				137	4.6						
1983	2		0.965		530	78		170							60S
1987							447	156	2.9	6.1	4.292		60.0	65.0	

Big Sarasota Pass -

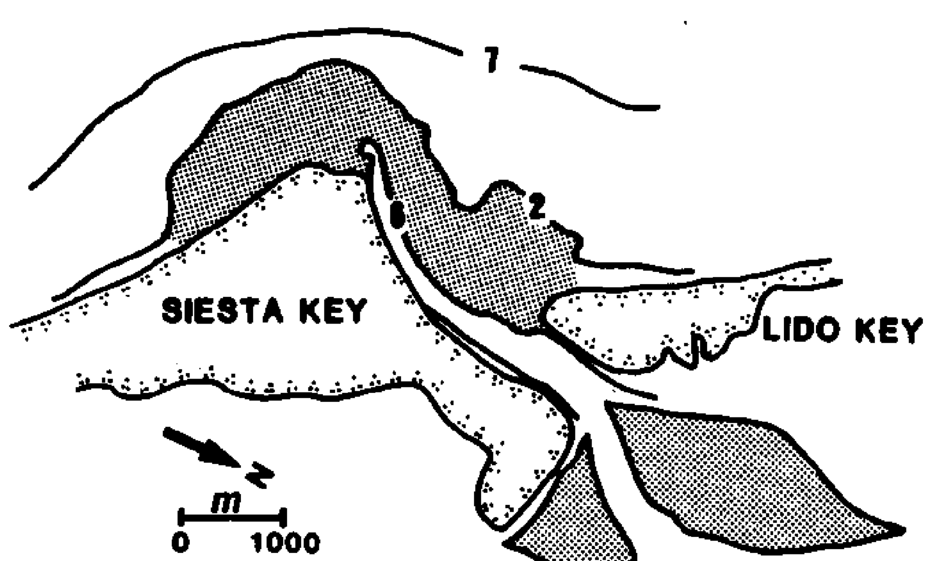
Most of the tidal prism of Sarasota Bay flows through Big Sarasota Pass and it probably carried more tidal flow in the past. This large inlet is a classic example of a mixed-energy (offset) type and it has shown little change in morphology over the historical past. This has been aided by the hardening of the south side (downdrift) of the channel which has stabilized the position of the inlet.

Big Sarasota Pass has a very large flood-tidal delta which is located more than a kilometer north of the inlet channel due to early migration. The general situation is similar to that at Dunedin Pass (compare Figs. 31 and 21) but is more extreme at Big Sarasota Pass. This flood-tidal delta was inactive and stabilized by vegetation in the early 1900s and then became the site of residential development in the 1960s. Dredge and fill activities have completely converted the flood delta into a finger canal housing development.

The main inlet channel trends in a southerly and arcuate course into the Gulf (Fig. 31). It is asymmetric with the deep side against the north end of Siesta Key to the south. The channel is wider at the landward end than where it enters the Gulf. This is due to the pressures of southerly littoral drift of the shoals in the ebb- tidal delta. The inlet has narrowed a bit over the past 100 years in response to dredge and fill activity in Sarasota Bay and the contiuned maintenance of New Pass.

The ebb-tidal delta at Big Sarasota Pass is large and asymmetrical; the latter being partly related to the large offset (Fig. 31). Tides are the primary controlling process with wave modification being secondary. There are small and shallow channels that cut through the ebb shoal on the updrift side similar to flood channels. Only a small sand body is present on the downdrift or south side. There has been a decrease in the Gulfward extent of this ebb delta during the past several decades, which also reflects the loss of prism mentioned above.

Figure 31 **BIG SARASOTA PASS**



BIG SARASOTA PASS
Diurnal Tide Range: ocean= 77cm bay= 64cm
Net Littoral Drift= 45,840 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1888	3	6.850		5.428											
1948	3		3.226		1610	60		570							0
1954	3	14.297					2845	889	3.2	6.3					
1955	3						2146	573	3.7		21.508		77.1	51.5	
1957	3		3.640		1620	56		540							90N
1969	3		3.700		1840	51		560							100S
1972	3		4.098		1810	52		540							40E
1974	3		4.417		1850	52		570							50S
1977	3		3.782		1810	54		550							70N
1982	3	10.367		5.428				457	6.7						
1983	3		3.105		1620	55	2223	574	3.9		22.806		93.0	93.0	30S

Midnight Pass -

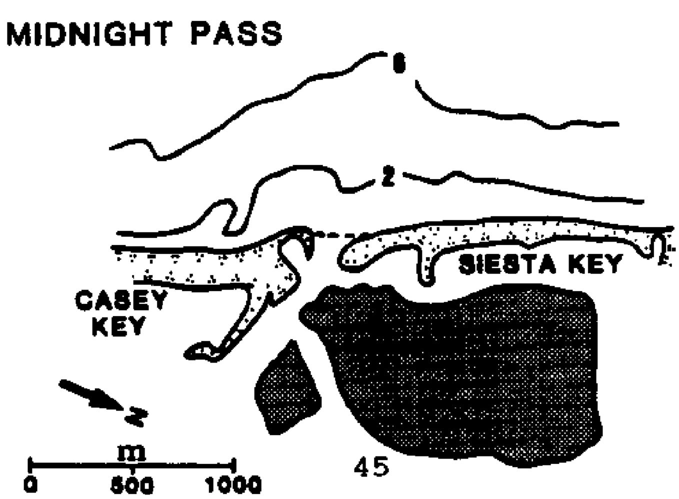
The tidal inlet recently called Midnight Pass was preceded by an inlet in the same location called Little Sarasota Pass. This inlet was wave dominated in the late 19th century. It had the configuration of a wild inlet, with channel migration in excess of four kilometers toward the north. Further northward migration was prohibited by the lithified sediment at Point of Rocks. The narrow spit produced by this migration was breached on multiple occasions. Typically, this occurred in the area of the original inlet and the associated flood-tidal delta. In the 1950s, Midnight Pass was a healthy mixed-energy inlet, but it became unstable and wave-dominated in the late 1960s and is closed at present. There are proposals to open it and structure it for stability.

The flood-tidal delta at Midnight Pass is quite large and has been stable for at least the past century. Vegetation has persisted for several decades. The addition of spoil from the dredging of the Intracoastal Waterway has enabled upland vegetation to become established.

The inlet channel has experienced extreme variation over the past century, both in terms of location and size. The distinct wave-domination and channel migration persisted until the breaching of the spit by the 1921 hurricane. From that time until the 1970s, Midnight Pass displayed a fair amount of stability and increased in size (Davis et al., 1987). Several reversals in dominant littoral drift direction took place during this time. By 1955 the channel had reached its maximum size and stability; it was 140 m wide and 4.5 m deep at the throat (Vincent & Corson, 1980). Instability of the channel began in the late 1960s and by 1982 the channel had narrowed to 15 m with a depth of about 1 m (Fig. 32). It was closed in 1984 with the assistance of man.

There was no ebb-tidal delta throughout the time that Midnight Pass was distinctly wave-dominated. During the period of relative stability, this situation changed and a prominent but small ebb-tidal delta was developed in the 1950s. It was a mixed-energy (straight) type inlet at that time but this morphology was short-lived. Diminution of the tidal prism by the dredging of the Intracoastal Waterway, 1963-1964, resulted in the return to wave-domination and the eventual closure of the inlet.

Figure 32



MIDNIGHT PASS
Diurnal Tide Range: ocean= 78cm bay= ?
Net Littoral Drift= 53,480 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1885	4														
1948	4		0.345		230	117		100							0
1954		0.482													
1955							299	140	2.1	4.5	7.900	7.650	96.0	72.0	
1957	2		0.254		270	53		70							350SE
1969	3		0.156		210	96		100							80NW
1972	4		0.356		270	107		190							30NE
1974	4		0.369		210	53		80							100W
1977	4		0.172		160	63		70							120NW
1982		0.122		0.994			15	15.4		1.2	0.150		28.0	21.0	
1983	4		0.056		130	35		35							280NW

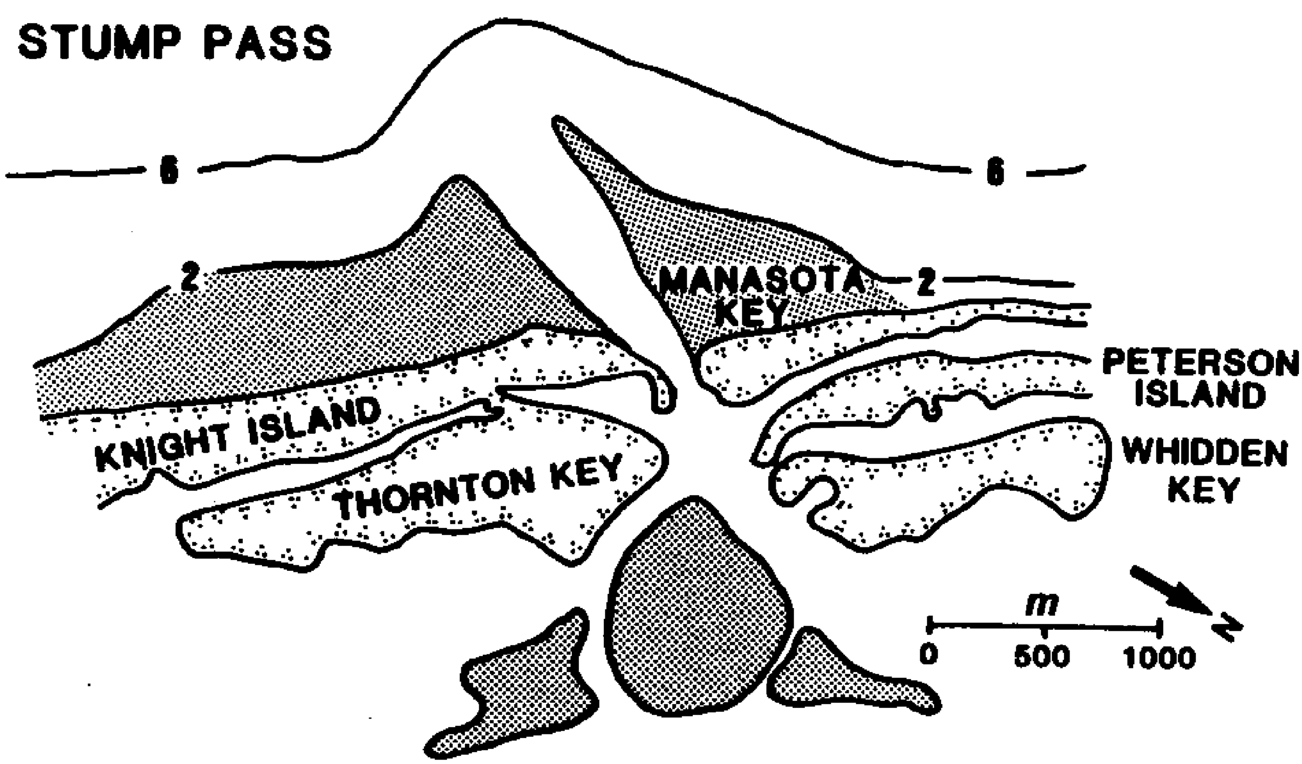
Stump Pass -

There have been numerous changes in the location of what is now called Stump Pass. In the late 19th century there was a tidal inlet located 1.5 km north of the present Stump Pass. This unnamed inlet was 7 m deep and had a reasonably well-developed flood-tidal delta. There was also what appears to be a flood-tidal delta at the present site of Stump Pass behind a narrow barrier. The opening of the present inlet took place during the hurricane in 1910 which had landfall near the present inlet (Reynolds, 1976). The flood-tidal delta associated with Stump Pass is typical of this coast. It is primarily intertidal and vegetated with mangroves. The two channels that pass on either side have remained stable since the last opening of the inlet.

The channel of Stump Pass has remained stable in its location during the period that it has been opened. There has been a modest shift in orientation from southwest to northwest and back. The channel has shallowed from five m in 1955 (Vincent & Corson, 1980) to less than three m in 1980 when initial dredging took place.

The ebb-tidal delta at Stump Pass has exhibited modest change over the past 60 years with a general shape of a mixed-energy inlet. Whereas the initial configuration was straight, there has been development of a modest downdrift offset since the mid 1970s. This shape of the ebb delta and the southwesterly orientation of the channel (Fig, 33) are the result of a significant southerly net littoral drift.

Figure 33



STUMP PASS

Diurnal Tide Range: ocean= 78cm bay= 49cm

Net Littoral Drift= 30,560 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1952	2							250							
1955							548	226	2.4	5.4					
1955-56											10,216				
1970	2		0.487		430	45		160							0
1972							459								
1973	2		1.068		460	47		130							20NE
1974	2		1.043		430	41		130							50SW
1977	2		1.293		600	42		110							110NE
1979	2		0.771		540	34		130							100S
1981	3		0.983		530	42		150							50E
1983							494	195	2.5		6.943		115.8	149.4	
1987							413	180	2.3	3.6					

Bocilla and Boca Nueva Passes -

Two tidal inlets were present during the latter part of the 19th century in Charlotte County on what are now Don Pedro Island and Little Gasparilla Island. Bocilla Pass on the north was distinctly wave-dominated with a marked southerly overlap of the ebb shoal. Depth in the channel throat was 2.2 m which shallowed to 0.5 m over the ebb shoal. There is indication that a flood- tidal delta was present. The actual date of closure is not known.

Boca Neuva inlet was only about 1.5 km south of Bocilla Pass in the 1880s. This inlet later became known as Little Gasparilla Pass. The inlet appears to be about three to four m deep with an ebb shoal depth of 0.5 m on the 1895 coastal chart (U.S.C. & G.S. #175). There is no indication of a flood tidal delta. The spit at the mouth of the inlet indicates a northward net littoral drift; opposite of that at Bocilla Pass. By 1950 this inlet had developed a distinct flood-tidal delta and a slight downdrift (south) offset. The inlet, which was quite narrow and shallow, was closed naturally by 1957.

Although the former locations of these two inlets are quite apparent on maps and aerial photographs, neither is active today.

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INTENTIONALLY

Gasparilla Pass -

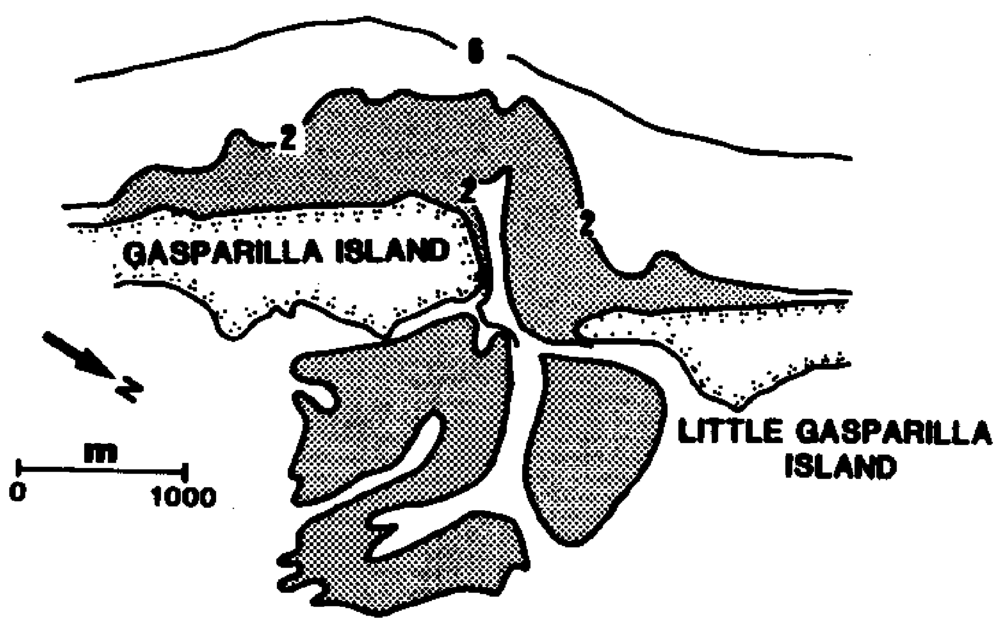
This is the largest inlet between Sarasota Pass and Boca Grande. It has been rather stable over the past century with the primary change being an increase in the downdrift offset. The inlet is natural with the exception of two causeways that traverse the flood-tidal delta.

The flood-tidal delta is large and is dissected by several channels. There is considerable vegetation throughout most of its extent. Undoubtedly, the construction of the causeways from Gasparilla Island to the mainland caused modification to the flood delta. The apparent activity of the most distal lobes in the 1940s was probably associated with the causeways.

The channel of Gasparilla Pass has been stable over the past century although the depth has varied. In the 1880s the channel was about 5 m deep but that increased to a maximum of 8 m in 1955 (Vincent & Corson, 1980). The present depth is 4 m. The orientation of the channel has persisted as essentially perpendicular with a southwesterly turn in the ebb-tidal delta.

The ebb-tidal delta of Gasparilla Pass exhibits a typical downdrift offset (mixed) configuration (Fig. 34). The offset has increased from about 100 m or so in the latter 19th century to nearly a kilometer at present. The channel width is presently 600 m. The ebb-tidal delta at Gasparilla Pass is well-developed and strongly resembles Sarasota Pass (compare Figures 31 and 34). The typical asymmetry of a mixed energy-offset inlet is displayed with the updrift ebb-delta shoal extending at least a kilometer beyond the coastline of the downdrift island (Fig. 34). The only pronounced change over historical time is the increase in the downdrift offset.

Figure 34 GASPARILLA PASS



GASPARILLA PASS
Diurnal Tide Range: ocean= 78cm bay= 49cm
Net Littoral Drift= 76,400 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1883		3.456		1.835											
1951	3		1.602		760	62		330							0
1956		5.275					1177	406	2.9	8.4					
1958							1235	479	2.6		13.300		51.5	56.7	
1970	3		1.369		820	63		570							120NW
1974	3		1.796		660	73		560							30S
1979	3		1.166		740	67		560							50E
1981	3		1.492		820	64		550							20W
1982		2.659		1.835				548	4.0						
1987							1240	626	2.0	8.6	9.571		71.0	93.0	

Boca Grande Pass -

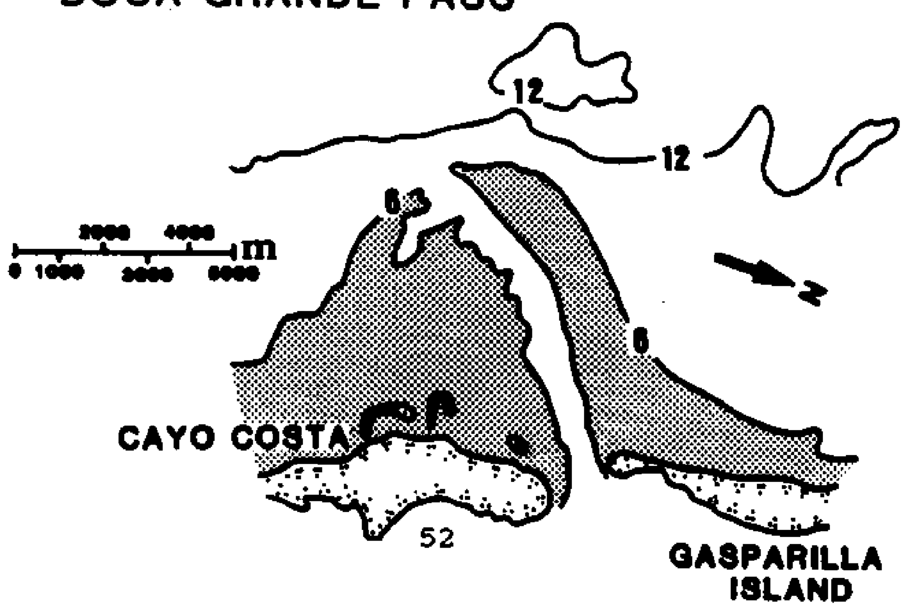
Boca Grande Pass is the second largest inlet along the west-peninsular coast of Florida, trailing only the Egmont Channel complex at the mouth of Tampa Bay. Boca Grande has been quite stable over time due to its size and its extreme tidal prism. It is the primary inlet serving Charlotte Harbor. There has been significant maintenance since the early 1900s which has resulted in some morphologic changes to the inlet and to the adjacent islands.

Like the Egmont area, Boca Grande has no flood-tidal delta due to its broad width. A distinct channel extends several kilometers into Charlotte Harbor and has done so for at least a century.

The main inlet channel at Boca Grande had a maximum depth of 13 m in the 1880s. This increased slightly to 17 m in 1956 (Vincent & Corson, 1980). Because of the abrupt shallowing both seaward and landward of the throat, dredging has taken place in order to maintain a channel of 10 m for shipping. The channel has not changed position and has increased in width from 1.2 km to about 1.5 km from 1930 to 1970, largely at the expense of the south end of Gasparilla Island (Dean & O,Brien, 1987).

The ebb-tidal delta at Boca Grande is extremely large and has been tide-dominated at least throughout the past century. There is a distinct asymmetry to the ebb delta, similar to, but more extreme than at Johns Pass (compare Fig. 24 and 35). The north or updrift lobe is long and narrow extending about 4 km into the Gulf whereas the southern lobe is broad and extends into the Gulf a bit less than its north counterpart. There has been a tendency for the inlet to try to become a downdrift offset by accreting beach ridges on the north end of Cayo Costa Island. Numerous supratidal bars have developed on a nearly continuous basis with some migrating shoreward and welding to the island and others being destroyed. Cayo Costa has also displayed alternations of cuspate foreland development with erosion of beach ridge systems (Herwitz, 1977). The main ebb channel, which bends toward the southwest, has changed position depending upon the presence and position of these ephemeral sand bars.

Figure 35 BOCA GRANDE PASS



BOCA GRANDE PASS
Diurnal Tide Range: ocean= 79cm bay= 56cm
Net Littoral Drift= 84,040 cubic meters per year, south.

YEAR	TYPE	ETDV	ETOA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1883	1	86.089		0.000					5.8						
1956	1	133.797													
1959	1						15421	1589	9.7		356.580		113.4	92.6	
1970	1						10854	1447	7.5	17.9					
1985	1	122.099		0.000				914	9.8						
1988	1									15.3					

Captiva Pass -

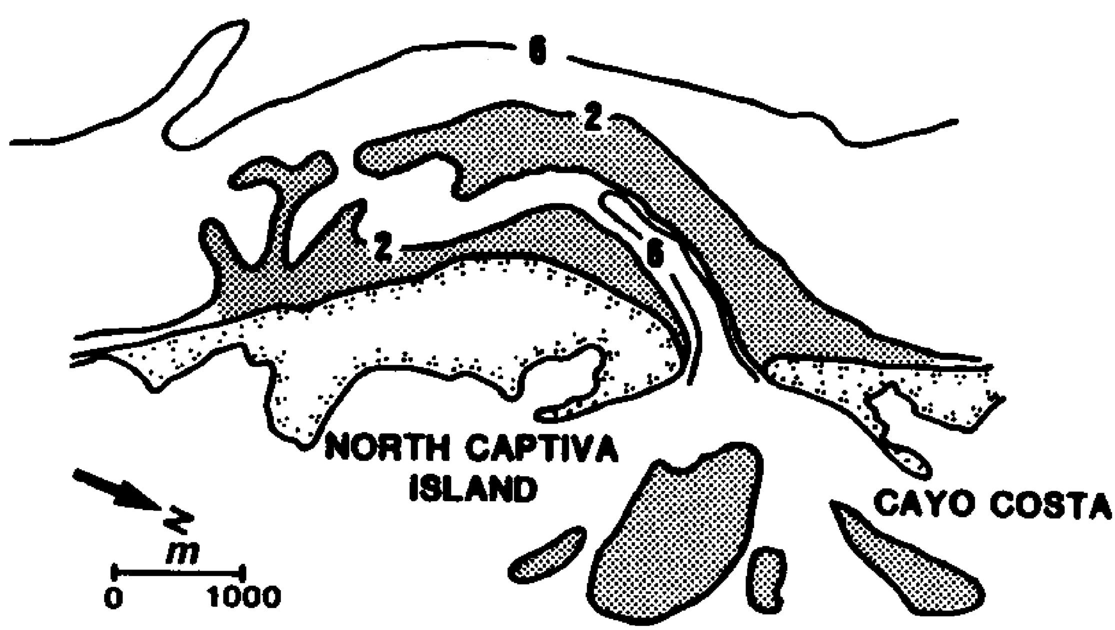
Captiva Pass is a good example of a mixed energy inlet with a pronounced downdrift offset (Fig. 36) and has remained so throughout at least the last 100 years. It has a flood-tidal delta and a distinctly asymmetric ebb-tidal delta, which is somewhat like that at Sarasota Pass (see Fig. 36). Captiva Pass has been quite stable throughout recent history and is a pristine inlet system.

The flood-tidal delta has a multilobate morphology similar to most of those along this barrier coast. However, unlike most others, it is totally subtidal. Shallowest depths are about one m and do show stabilization by sea grasses. The relatively deep surface of this flood delta is probably related to the large size of the inlet.

The main inlet channel has been stable in position and size over the past century. It was about 600-700 m wide at the throat with a maximum depth of 12 m in 1960 (Vincent & Corson, 1980). There is an abrupt shallowing landward onto the flood ramp of the flood delta. The ebb channel retains its definition for about three km and curves distinctly toward the south producing an acurate ebb delta shoal on the updrift or north side.

The ebb delta is pronounced and large with a volume of about 10 million cubic meters. It is quite asymmetric with a large and accurate north or updrift lobe, and a much smaller southern lobe which is limited by the southerly and nearshore location of the main ebb channel (Fig. 36). There has been some progradation of beach ridges on the North Captiva Island side over the past several years thus increasing the downdrift offset which is presently about 0.5 km.

Figure 36 **CAPTIVA PASS**



CAPTIVA PASS

Diurnal Tide Range: ocean= 79cm bay= 58cm

Net Littoral Drift= 76,400 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1883	3	6.269		2.064											
1956		9.435													
1958	3		3.849		1540	37		520							0
1960							2666	579	4.6	12.7	53.770		92.6	97.8	
1970	3		3.796		1460	42		550							90NE
1975	3		3.718		1360	45		580							60SE
1982		9.152		2.064				548	4.6						
1988							2811	540	5.2	10.6					

Redfish Pass -

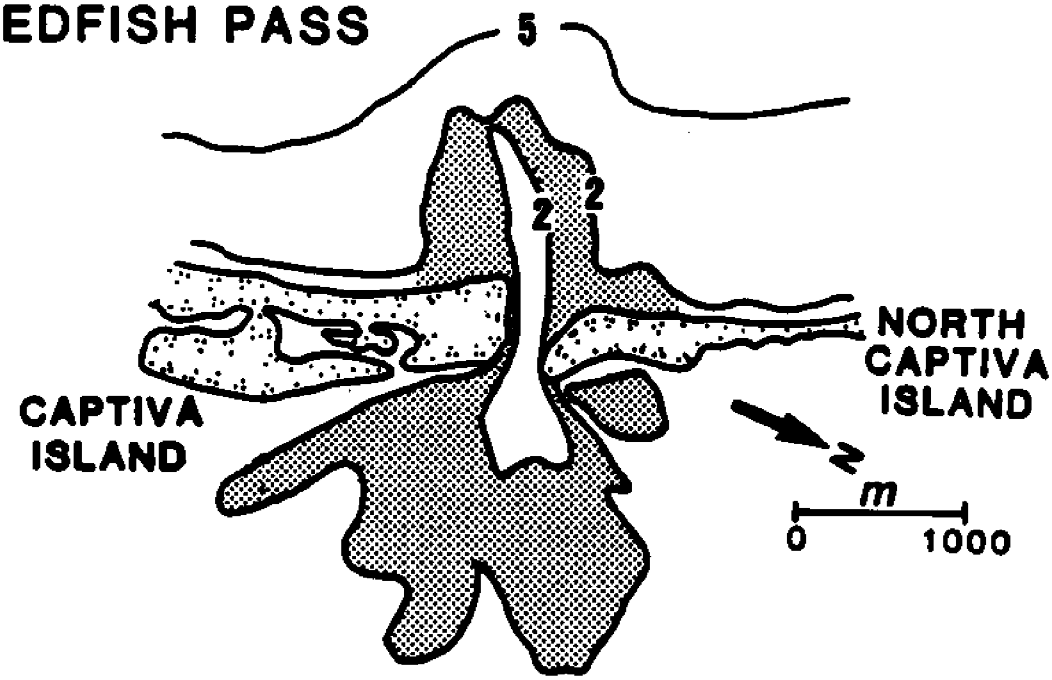
The hurricane of 1921 separated Captiva Island from North Captiva Island by forming Redfish Pass. However, maps from the 19th century, indicate that a channel was present at this site, but was closed by a narrow barrier. It is probable that Redfish Pass occupies the position of a former tidal inlet. This inlet has been relatively stable throughout its short history and has developed a tide-dominated morphology, although there has been some recent tendency toward a downdrift offset.

The flood-tidal delta at Redfish Pass is very distinct and multi-lobate (Fig. 37). All data indicate that there have been no significant changes in its configuration or size since its formation. The flood delta is completely subtidal and has been stabilized by sea grasses since shortly after its formation.

The main channel at Redfish Pass has been stable since its development by the 1921 hurricane. The channel has maintained a minimum width of 200-300 m and it achieved a maximum depth of 12 m in 1955 (Vincent & Corson, 1980) since shortly after its formation without benefit of any dredging.

The rather large tidal prism of Redfish Pass has not only maintained a stable channel but has produced a tide-dominated ebb delta morphology. The channel-margin linear bars are nearly perpendicular to the shore and rather symmetrical although the southern lobe is typically broader. No substantial change has taken place on the ebb delta except the removal of borrow material for beach nourishment in the late 1970s. The tendency for downdrift offset has varied through time with the present situation tending toward a straight coast on either side of Redfish Pass. Maximum offset occurred about 1960.

Figure 37 **REDFISH PASS**



REDFISH PASS
Diurnal Tide Range: ocean= 79cm bay= 64cm
Net Littoral Drift= 76,400 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1926								1257							
1944								201							
1953	1		0.629		600	87		230							0
1956				2.867											
1958	1		0.871		660	79		180							80W
1960		3.249					1249	208	6.0	11.8					
1970	1		0.784		690	90		180							120E
1972	1		0.965		730	84		170							20N
1975	1		1.208		760	86		200							40NE
1979	1		1.221		750	82		190							40SW
1982		2.141		1.988				182	4.6						
1988	1						1002	180	5.6	7.6					

Blind Pass (Lee County) -

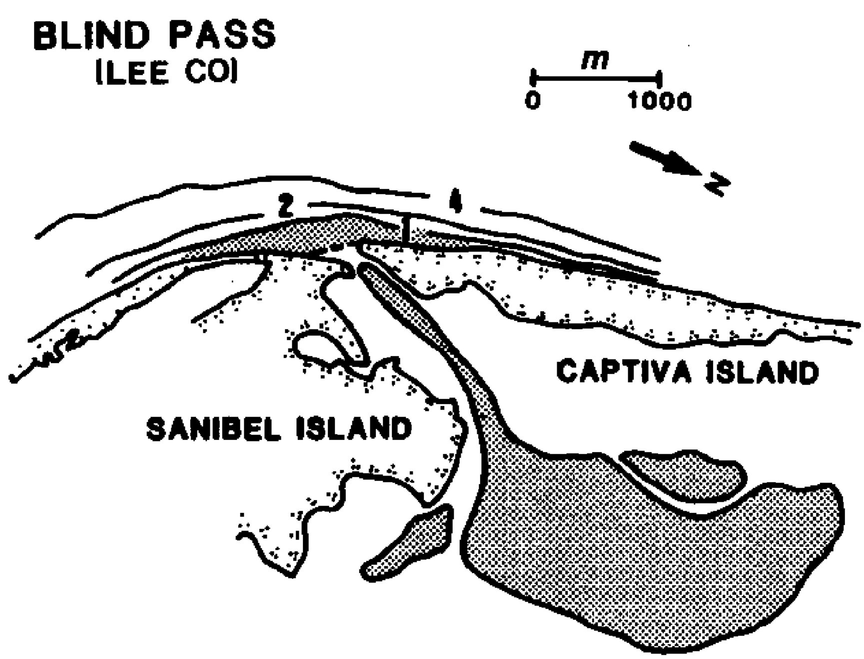
Blind Pass, which separates Captiva Island from Sanibel Island, has experienced a varied history. Surveys from the late 19th century show this inlet with a mixed-energy offset morphology. There are suggestions from the 1895 chart (U.S.C. & G.S. #175) that there was at least one relict channel which indicated a wave-dominated inlet morphology. Since the formation and development of Redfish Pass, Blind Pass has been distinctly wave-dominated and has been closed for extended periods.

The flood-tidal delta at Blind Pass is large and well-defined. It is intertidal to subtidal and has an extensive sea grass community on it. There is no indication that the size or shape of the flood delta has changed in the past century.

The inlet channel at Blind Pass has experienced much change in both size and configuration during recent history. About 100 years ago the inlet was 200 m wide and five m deep at the throat. There was a distinct offset of 250 m. By the mid-20th century the inlet channel had migrated over two km to the south but remained open. Closure took place in the 1960s. Blind Pass opened again in the mid-1970s as the result of erosion of the long spit across its mouth. This was short-lived however, as closure again took place by 1979. It was opened again in 1986 (Dean & O'Brien, 1987) and remains so at the present time, 1988.

A century ago Blind Pass had a mixed-energy downdrift offset morphology. The formation of Redfish Pass and the capture of most of the tidal prism from Blind Pass led to its becoming a wave-dominated, "wild pass" type of inlet. There has not been an appreciable ebb-tidal delta for about 50 years. Closure is the typical situation due to the combination of significant littoral drift and small tidal prism. The present open channel has a small ebb shoal but it is unlikely to maintain this configuration (Fig 38).

Figure 38



BLIND PASS (Lee County)
Diurnal Tide Range: ocean= 79cm bay= 64cm
Net Littoral Drift= 84,040 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1889	3														
1953	4		0.244		350	11		60							0
1958	4		0.135		210	40		20							660S

Big Carlos Pass -

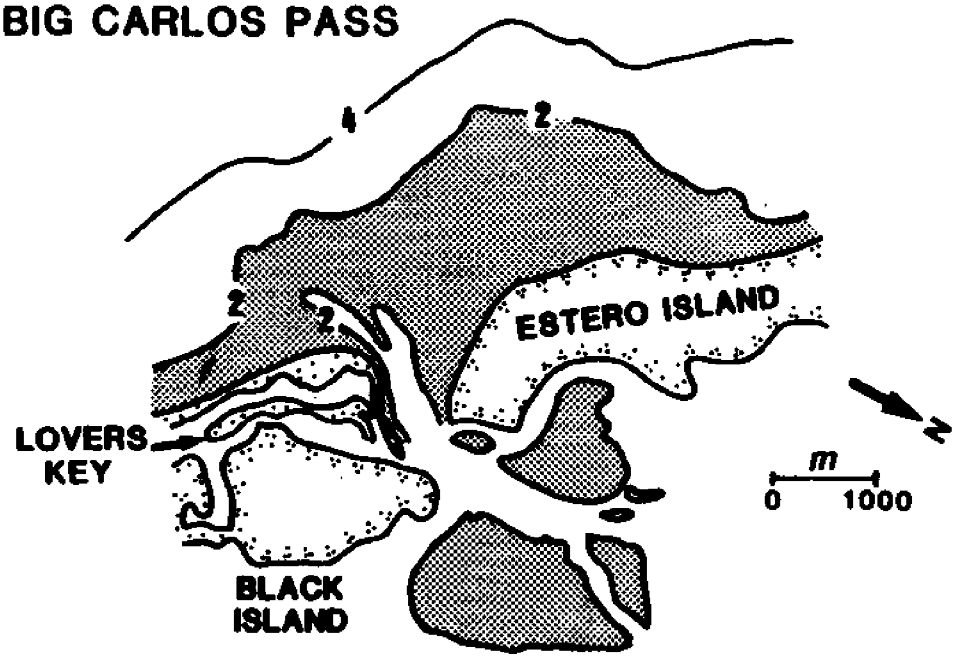
Although good survey data are more limited for this inlet in comparison to those to the north, there appears to have been overall stability of Big Carlos Pass over the past 100 years. Its size and position have remained essentially the same over that period.

There is a large, distinct, multi-lobate flood-tidal delta at Big Carlos Pass. It is almost entirely intratidal to supratidal and is covered with a dense mangrove community. All indications are that the flood delta has been stable over at least the past century.

The channel has maintained a width of 300-400 m and a depth of about four m over the past century. It extends well landward into the flood delta area and is nearly perpendicular in the Gulfward direction. Some stabilization has been provided by the causeway which was completed in the mid-1960s and the increased tidal prism due to the closure of small inlets to the south (Hine et al., 1986).

The ebb-tidal delta at Big Carlos Pass has a mixed-energy (straight) coast shape. Although the surveys of the 1880s showed a northward deflection of the main ebb channel (U.S.C. & G.S. #174), there is a general symmetry to the ebb delta. This plus the absence of a distinct outer wave-modified lobe gives some cause to consider a tide-dominated classification. The tide-domination is due to the fairly large prism and the very low wave energy along this reach of coast which is sheltered from northerly storm waves by the offset in the coast at Sanibel Island (see Fig. 39). There has been significant accretion of spits and beach ridges on both sides of the inlet. This appears to have ceased on the south but continues on the north (Dean & O'Brien, 1987). The general pattern indicates lack of significant net littoral drift.

Figure 39 BIG CARLOS PASS



BIG CARLOS PASS
Diurnal Tide Range: ocean= 82cm bay= 82cm
Net Littoral Drift= 42,020 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1889	2	3.578		3.211											
1960	2	3.970					1908.	435		6.7					
1970	2		3.875		1030	104		500							0
1975	2		3.454		1100	102		410							140N
1978											19.737		75.0	81.1	
1976-80	2						1933	487	3.9	6.1					
1982	2	6.147		3.211				410	3.4						

New Pass (Lee County) -

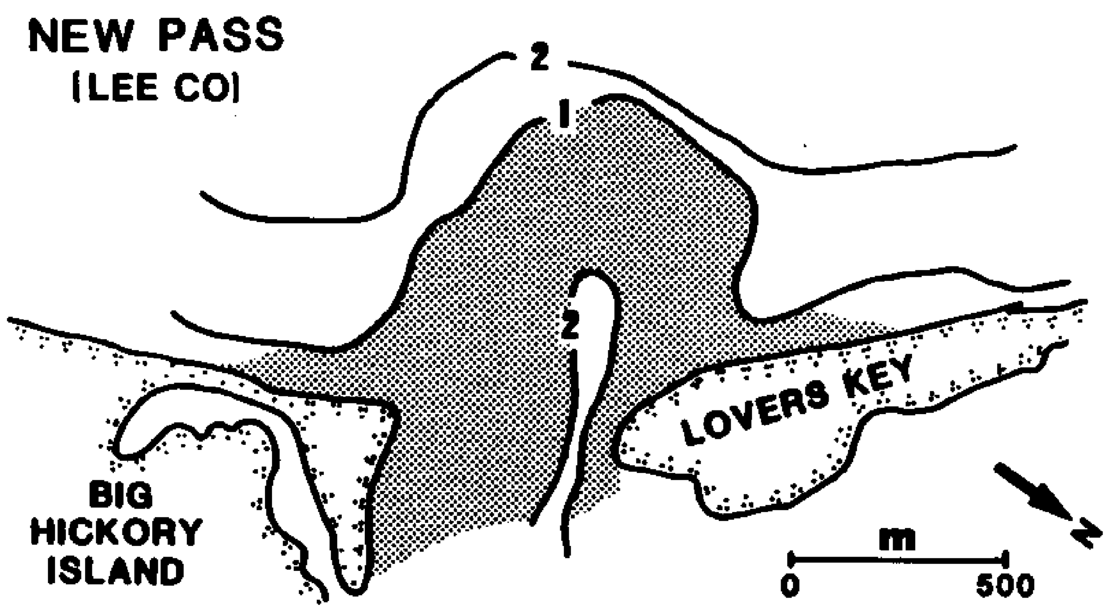
There is no real documentation on the origin of New Pass. The surveys of the 1880s show an inlet, Little Carlos Pass, between Big Carlos and Big Hickory Passes. However, the location is not coincident with New Pass and there are no indications of migration of this pass. The barrier through which Little Carlos Pass flowed was removed through persistent erosion. The definition and development of New Pass seems to have arisen from increasing tidal flow through a tidal channel coupled with accretion on adjacent mangrove islands forming a precursor barrier island to the north. The aerial photos of the early 1950s show several tidal channels just north of the present New Pass that have subsequently been closed with New Pass gaining their tidal prisms.

The flood-tidal delta at New Pass appears to be unlike most in that it represents scour and channelization of a bifurcating system through the previously existing and vegetated shallow bay environment. Aerial photos indicate some sediment movement in the area but primarily of an erosive nature.

The main channel at New Pass has become more defined and deeper over the past few decades. The channel width has increased from 300 m to over 400 m since 1953 and the cross-section area increased from 470 to 680 square meters between 1960 and 1978 (Jones, 1980). Maximum depth increased from about 3.5 m to five m over the same time period. The position of the inlet channel has been fairly stable although the thalweg has moved toward the north since the late 1970s.

Initially there was no ebb-tidal delta at New Pass. This has changed greatly to the point that now there is a rather substantial ebb delta which extends nearly 600 m into the Gulf (Fig. 40). The lobes of this ebb delta display little wave influence and, like Big Carlos Pass to the north, could be considered tide-dominated due to the absence of waves. During the past few years, there has been some ridge accretion on the north side of the inlet and there are indications of an offset developing to the north, the direction of net littoral drift.

Figure 40



NEW PASS (Lee County)
Diurnal Tide Range: ocean= 82cm bay= 82cm
Net Littoral Drift= 42,020 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1953	2		0.215		270	143		320							0
1958	2							180							
1960							466	238		3.1					
1965		0.410													
1970	2		0.515		430	84		90							250N
1972	2		0.500		430	92		170							90E
1975	2		0.512		350	113		440							160S
1978											6.697	0.000	78.3	64.6	
1979			0.454		340	113	678	243	2.7	5.5					80E
1982		0.321	0.592	0.229	480	106		250	2.1						160N

Big Hickory Pass -

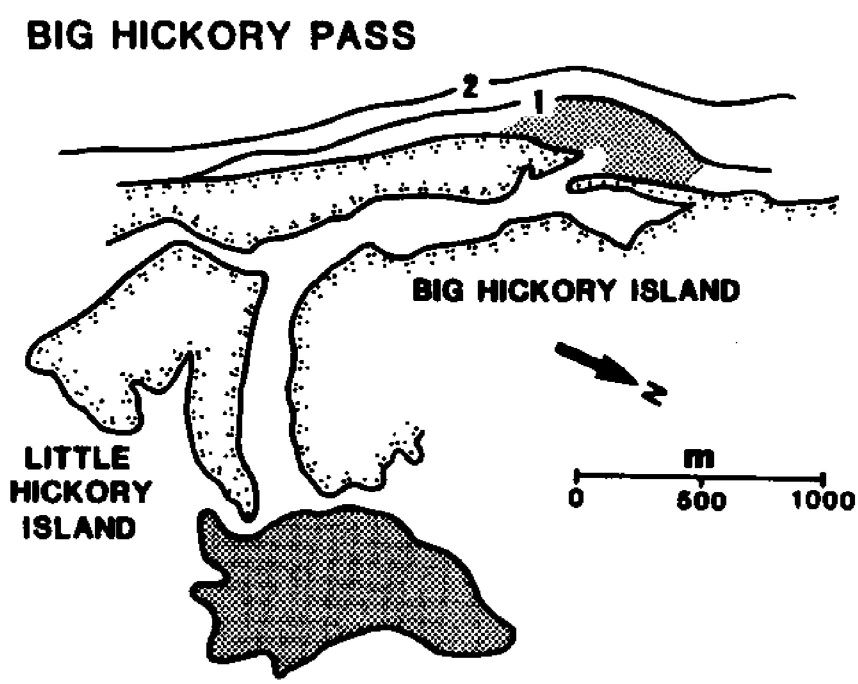
This inlet has been small or closed for the periods of record. One hundred years ago Big Hickory Pass was about 300 m wide with a maximum depth of less than 3 m. None of the historical records show a larger inlet at this location and it is likely that the name came from the adjacent Big Hickory Island rather than from the size of the inlet.

Old surveys show a mangrove island just landward of the inlet in 1869 (Jones, 1980). It is likely that this represents the original flood-tidal delta. There are no indications of mobility or modification since that survey.

During most of historical time, the inlet channel at Big Hickory Pass has been a "wild inlet". It migrated in a northerly direction continuously throughout the past century. It migrated 400 m from 1885 to 1927, 150 m between 1944 and 1953 and continued in this path until it was closed in 1976, 1.8 km north of its location in 1885 (Jones, 1980). The increase in size of New Pass to the north captured much of the tidal prism of Big Hickory Pass and eventually led to closure. Although it was opened by dredging in 1976 (Fig. 41), it closed again in 1979, 300 m north of the position of 1976 (Hine et al., 1986).

Little or no ebb-tidal delta has been present at this inlet since the original surveys of the Corps of Engineers in 1869. At that time there was a small, shore-attached and northwest oriented shoal on the south side of the inlet channel (U.S.C. & G. S. #174). Subsequent charts and photos show significant spit platform development and lack of ebb shoals as the inlet migrated northward. There have, however, been short periods of southwesterly channel orientation such as shown on the aerial photos of 1953.

Figure 41



BIG HICKORY PASS
Diurnal Tide Range: ocean= 82cm bay= 76cm
Net Littoral Drift= 42,020 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CENO	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1885	4														0
1927															400N
1944							214	106	2.0						
1953		0.000		0.535											150N
1958	4		0.126		270	37	167	88	1.9						45N
1965	4						204	103	2.0						
1970	4		0.133		190	155	111	64	1.7						210N
1975	4		0.036		160	162		23							500N
1976							56	38	1.4						
1978											0.034			152.4	
1978-80							3	6	0.3	0.9					

Wiggins Pass -

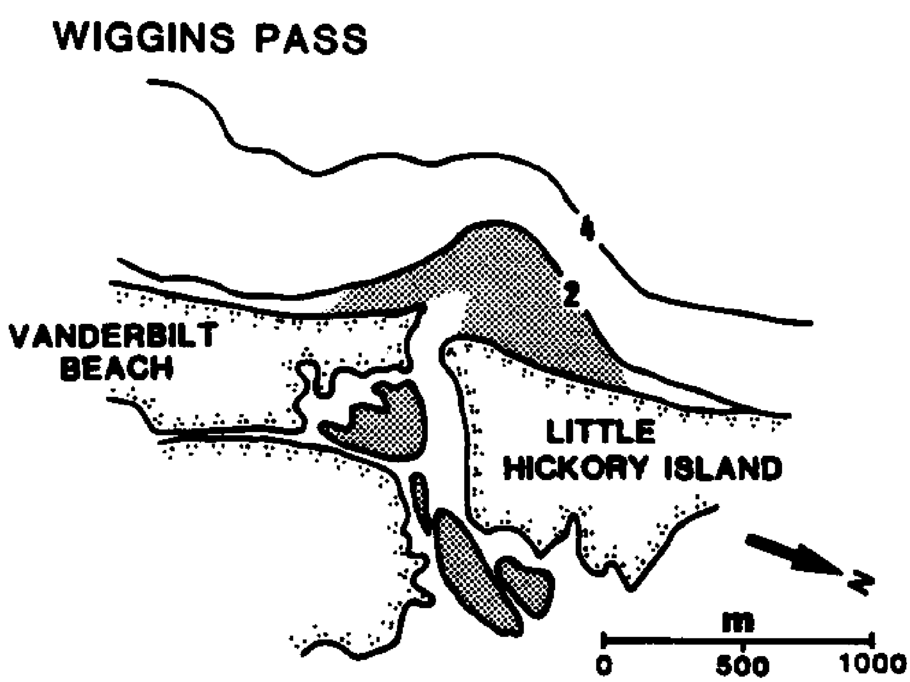
This inlet has been small throughout the historical record and closed multiple times prior to 1952 (Hine et al., 1986). No measurements on size are available prior to 1952 and the chart of the late 19th century shows no depths. Channels through the wetlands landward of the barrier islands were dredged in 1952 and caused an increase in the tidal prism of 50 percent (Hine et al, 1986).

Aerial photos and topographic maps indicate that there are presently some partly vegetated, shallow subtidal to intertidal sediment bodies landward of the inlet channel which may represent a flood-tidal delta (Fig. 42). Historical information on the size and tidal prism suggest, however, that they may simply be recently modified but previously existing shallow banks in the lagoon landward of the inlet/barrier complex. The increase in tidal prism that took place in 1952 could be responsible for the relatively recent modification of these sediment accumulations.

The inlet channel has shown significant stability since 1952 with depth increased from about 1 m to nearly 2 m in 1982. Recent dredging in 1983 increased the cross-section to a width of 60 m and 2.5 m in depth. It has been partially reduced since that time (Dean & O'Brien, 1987).

No prominent ebb-tidal delta has existed at Wiggins Pass throughout the period of record. The aerial photo of 1981 does show a small yet distinct ebb shoal that extends a few hundred meters into the Gulf. During most of the time, there is an indication of modest accretion on both sides of the inlet channel in the Gulfward direction in the form of prograding beach ridges.

Figure 42



WIGGINS PASS

Diurnal Tide Range: ocean= 83cm bay= 65cm

Net Littoral Drift= 64,940 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CENO	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1952	2		0.090	0.107	200	140		50							0
1953	4		0.069		120	104		40							10S
1962	3		0.104		190	104		70							60NE
1970	4		0.196		190	129		70							40W
1972	2		0.076		180	110		70							50NW
1973	2		0.064		190	125		70							70SE
1975	2		0.152		270	150		50							40W
1978							61	44	0.9	1.8	0.787	0.787	79.0	89.0	
1979	2							80							20NE
1981	2		0.136		150	108		90							0
1982							46	91	1.8			0.708			
1987							87	64	1.3	2.6					

Clam Pass -

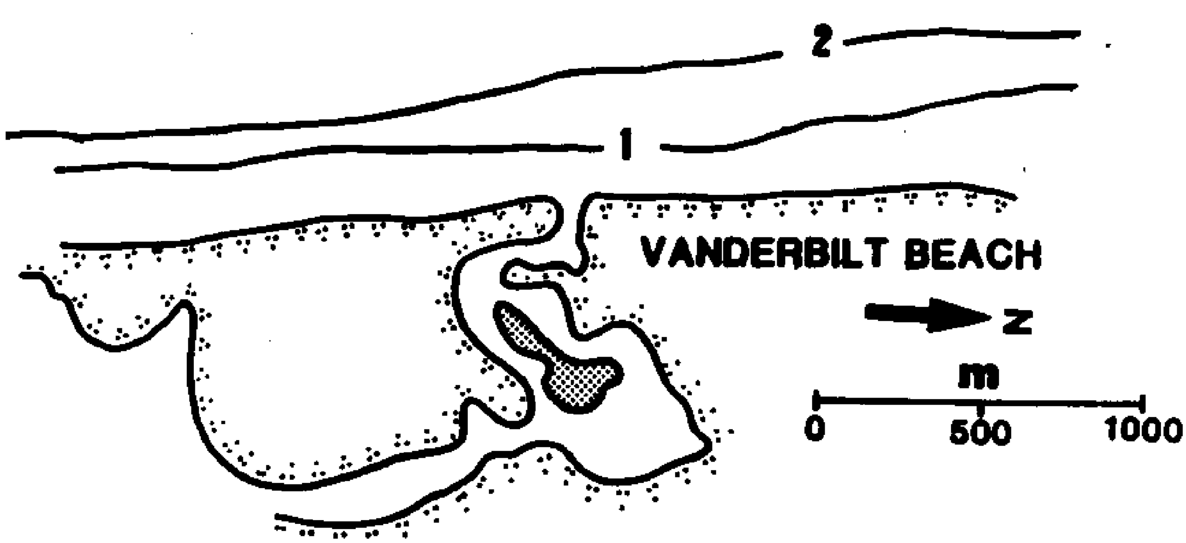
This inlet has been quite small throughout the period of record. There is no early map of the entire inlet. Only a map of the outer coast which shows no bulge in contours or soundings that indicate the presence of an ebb-tidal delta. No early data on the inlet channel or flood-tidal delta are available.

The morphology of the inlet as it appeared on 1952 photos indicates a small and active flood-tidal delta. Active sand accumulation landward of the inlet channel was primarily subtidal and intertidal with very little stabilizing vegetation at that time. Recent photos indicate that most of this apparent flood delta has been vegetated, primarily with mangroves and is, therefore, stable.

The inlet channel at Clam Pass is small but has been reasonably stable in its position considering the small tidal prism that it serves. Channel width has been 30-40 m with a depth of 1.0-1.5 m. Seasonal shifting of the inlet mouth has been common (Hine et al., 1986) and there was a northward migration of 30 m from 1952 to 1973. The inlet closed due to natural processes in 1976 and again in 1981. It was open by dredging each time and remains open at the present time.

There has been no sediment accumulation on the Gulf side of Clam Pass that is worthy of the ebb-tidal delta designation. Very small sand shoals appear on some aerial photos but they are ephemeral. The present situation consists of a small spit and spit platform on the south side of the inlet (Fig. 43).

Figure 43 **CLAM PASS**



CLAM PASS

Diurnal Tide Range: ocean= 84cm bay= ?

Net Littoral Drift= 64,940 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	COM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1952	4		0.027		80	127		8							0
1972							11	15	0.8	1.8					
1973	4		0.012		50	129		16							30NE
1979	4		0.005	0.031	50	24		13	1.2						10NW

Gordon Pass -

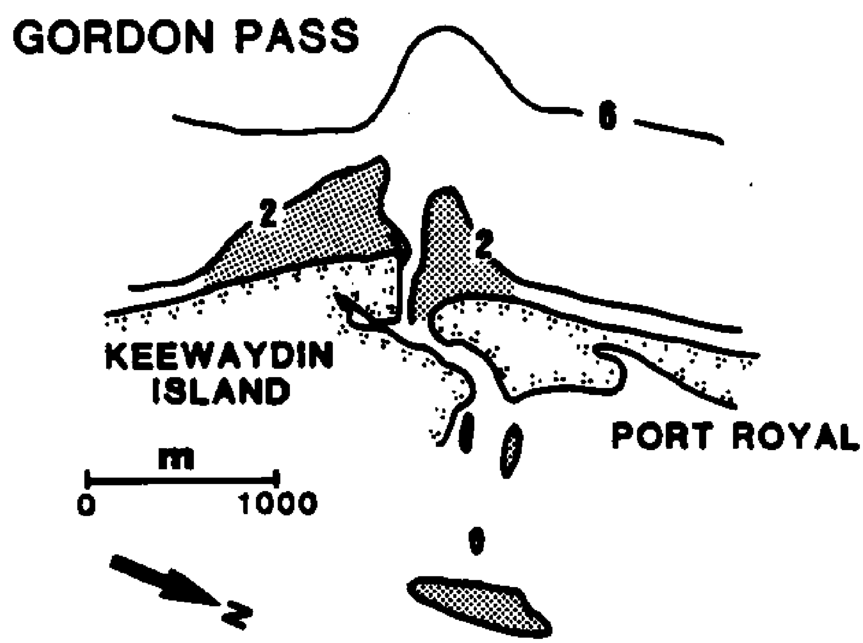
This inlet is the largest between New Pass and Big Marco Pass on the southwest Florida coast. Like most of the inlets in Collier County, there is not an accurate chart or map from the 19th century. Available data indicate that there have not been major changes in the size and location of Gordon Pass since the 1880s. However, development on the north side of the inlet since the 1960s has resulted in considerable structuring in order to attempt to maintain stability.

There is no good information to support the presence of a flood-tidal delta at this inlet. There are vegetated uplands and mangrove communities landward of the inlet throat that may include relict flood deltas, but the morphology is not at all distinct. Spoil disposal areas have also acted to mask the origin of these intertidal and supratidal environments landward of the north tip of Keewaydin Island.

The inlet channel has been narrow throughout its natural history with a minimum of 30 m in the early 1950s. Depth was only a meter or so at that time. Dredging of the channel began in 1962 and has continued to the present with a width of 160 m and depth of 2.5 m (Hine et al., 1986). Structuring of the inlet with groins on the north and a jetty on the south took place at the same time as initial dredging.

Gordon Pass has always maintained a distinct ebb-tidal delta. In the late 19th century, it was small but distinct as shown by the Gulfward protuberance of the six and 12 foot contours on the coastal chart (#174). The aerial photos and maps beginning in the early 1950s show a more pronounced ebb delta (Fig. 44) extending 400-500 m into the Gulf and having a rather broad shape indicative of mixed energy conditions. Although the dredging has resulted in a straight and perpendicular channel, the ebb delta has not shown significant change since dredging was initiated.

Figure 44



GORDON PASS

Diurnal Tide Range: ocean= 87cm bay: ?

Net Littoral Drift= 53,480 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	COA	CDN	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1952	3		0.533		390	79		45							
1970							366	182	2.0	3.9					
1982		0.443		0.092				164	2.4						
1987							936	298	3.1	7.3	11.976		103.5	123.9	

Little Marco Pass -

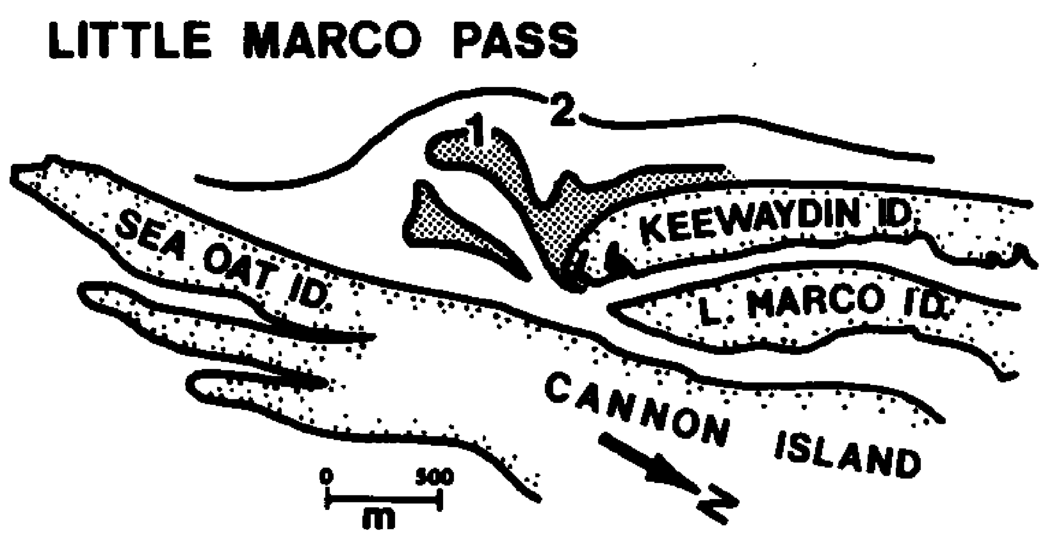
This inlet has shown tremendous change in both morphology and location since the late 19th century. In the 1880s Little Marco Pass had a distinct downdrift offset and was in the mixed energy category. During most of this century it has been distinctly wave-dominated and has migrated nearly 5 km to the south.

The present position of the inlet mouth and channel are far removed from their original location. Based upon the location on chart #174 and the morphology landward of the barrier at that latitude, there appears to be a relict flood-tidal delta associated with the ancestral Little Marco Pass. A somewhat lobate and currently vegetated intertidal and supratidal environment is located landward of the former position of the inlet.

The inlet channel was 4.5 m deep at the throat and about 200-250 m wide in the 1880s. An apparent decrease in tidal prism permitted the strong southerly littoral drift to dominate and cause a rapid and extreme shift in the channel position to the south. By 1952 the "wild inlet" had migrated 3.5 km and this increased to over 5 km at the present time. The channel is presently about 100 m wide and 1.5 m deep.

About a century ago there was a small but distinct ebb-tidal delta at Little Marco Pass. As the inlet became wave-dominated and migrated to the south (Fig. 45) this was removed by waves and currents. The present inlet mouth has a small and undoubtedly ephemeral sand shoal at its mouth.

Figure 45



LITTLE MARCO PASS
Diurnal Tide Range: ocean= 95cm bay= ?
Net Littoral Drift= 53,480 cubic meters per year, south.

YEAR	TYPE	ETDV	ETOA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1885	3							225		4.5					
1952	2		0.597		430	77		70							0
1962	4		0.549		480	28		80							410S
1973	4		0.482		400	59		80							580SE
1981	4		0.639		510	56		240							500SE
1987							465	183	2.5	3.3	6.066		101.6	123.4	

Big Marco Pass -

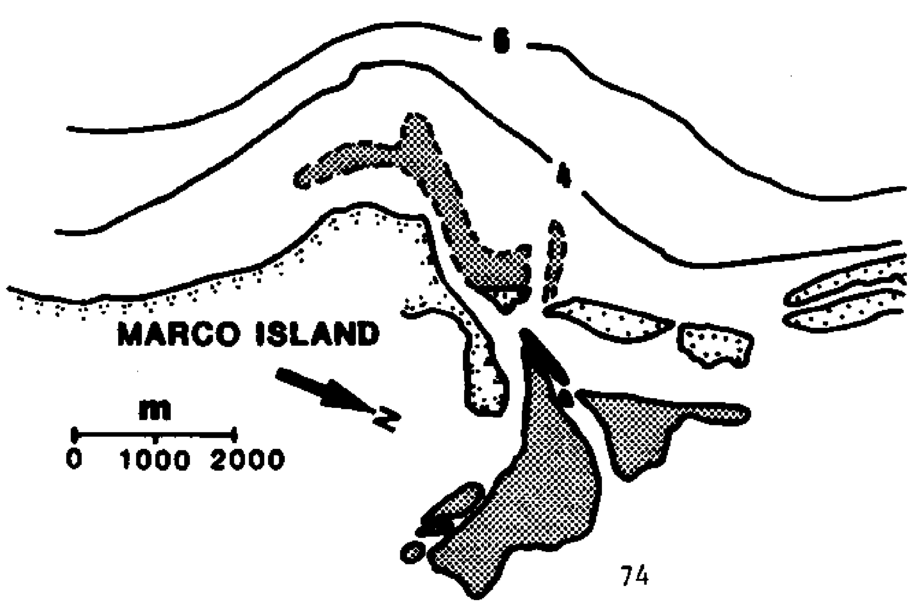
This has been one of the largest and most stable inlets along the southern part of the west-peninsular barrier system of Florida. Its overall size and morphology are quite comparable to that of Big Sarasota Pass (compare Figs. 31 and 46). Even though development on Marco Island on the south side of the inlet is extensive, the inlet itself is pristine.

The survey of the late 19th century shows what is probably a relict flood-tidal delta with lobes between two rather large channels on the landward side of the inlet. These have been vegetated throughout the period of record and in the 1960s were extensively developed including dredge and fill with the usual finger canals. This development does not seem to have affected the stability of the inlet itself.

The inlet channel has had a similar size and shape for at least the past 100 years. In the late 1880s, the inlet channel was about 300 m wide with a maximum depth of nearly 10 m. Nearly 100 years later, 1970, the inlet was 280 m wide and 7.5 m deep (Vincent & Corson, 1980). A complicating factor in the tidal prism of Big Marco Pass developed when the narrow barrier to the north was breached sometime between 1962 and 1973, and Capri Pass was formed. This inlet has not only captured a significant portion of the prism formerly carrier by Big Marco Pass, but it left a small vegetated island which has separated the two inlets (Fig. 46). Both of these inlets are about 300 m wide at the present time (Dean & O'Brien, 1987).

The ebb-tidal delta at Big Marco Pass is a classic example of a mixed energy offset morphology. This general morphology has persisted for at least the past century. The large shallow to intertidal shoal on the north (updrift) side extends about 500 m Gulfward of the downdrift offset which itself is quite pronounced. There has been a relatively continuous appearance of shoreward-migrating sand bars on the south (downdrift) side. The accretion of these bars has produced the beach ridge and catseye-pond complex at the north end of Marco Island.

Figure 46 **BIG MARCO PASS**



BIG MARCO PASS

Diurnal Tide Range: ocean= 95cm bay= 79cm

Net Littoral Drift= 53,480 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1869	3	15.673		2.599											
1952	3		2.832		1370	66		230							0
1962	3		2.900		1320	65		270							190S
1970							1600	266	6.0	7.8					
1981	3		2.937		1670	47		270							300N
1982		11.698		2.599				347	3.0						
1987							2685	610	4.4	5.6	19.133		33.5	103.9	

Caxambas Pass -

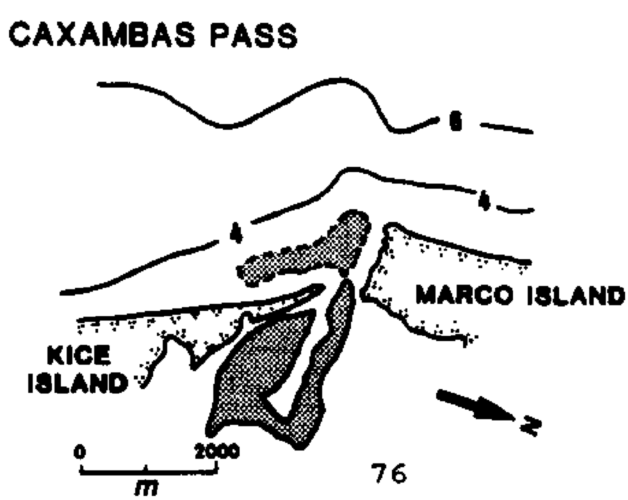
This inlet presents problems for the inlet classification presented earlier in this report. The morphology is, and has been, one of mixed energy offset with the distinct offset on the north side of the inlet making it an updrift offset. The island to the south shows what appears to be a spit-like configuration however there is little evidence of northerly growth that would indicate a local reversal in littoral drift. The construction of a major seawall at the south end of Marco Island in 1958 has caused major changes in the inlet (Stephen, 1981).

There is a large flood-tidal delta with multiple lobes associated with Caxambas Pass (Fig. 47). Most of it has been stabilized throughout the period of record by mangroves, although there is indication of subtidal sediment movement on several sets of aerial photos.

The inlet channel has shown significant change during the last 60 years especially after the construction of the seawall in 1958. The coastal chart of 1924 (U.S.C. & G.S. #12564) shows a channel oriented somewhat to the northwest. By 1952 the orientation was essentially east to west and than persisted until severe erosion on the south end of Marco Island produced a southerly growing spit which deflected the channel to the south. The spit was eventually breached and the inlet developed two distinct channels, the situation that prevails now. The inlet was 500 m wide with a maximum depth of 8 m in 1924. The change in inlet morphology has not significantly altered the cross section area; it was 1850 square meters in 1978 (Stephen, 1981).

The ebb-tidal delta was very large and well developed prior to and shortly after construction of the seawall. It had a relatively tide-influenced morphology in 1924 when the north side extended nearly a kilometer Gulfward of Marco Island and the south side extended over 1.5 km out from Dickman's Point on Kice Island. By the 1950s the ebb delta was a bit more wave-influenced, but was still quite large and well-developed. By the late 1960s, the ebb delta was quite reduced in size and the ephemeral shoal was in the outer part of the inlet channel. Although a distinct ebb-tidal delta persists, it shifts markedly over just a few years. At the present time, there is little of the ebb delta that protrudes Gulfward of the south end of Marco Island.

Figure 47



CAXAMBAS PASS

Diurnal Tide Range: ocean= 102cm bay= 71cm

Net Littoral Drift= 42,020 cubic meters per year, south.

YEAR	TYPE	ETDV	ETDA	FTDV	CEND	CENA	CXSA	CW	CDA	CDM	PRIS_SP	PRIS_MN	MAXFL	MAXEB	MIG
1952	3		1.562	2.141	860	110		460							
1978							1854	600	3.0	5.6	25.410		170.0	155.0	

EXPLANATION OF SYMBOLS IN DATA TABLES

Tide Range - These data are from NOAA tide and tidal current tables.

Net Littoral Drift - These data are derived using the technique of Walton (1973) as compiled by Dean and O'Brien (1987).

TYPE - Morphological classification of the inlet.
1= tide dominated
2= mixed energy straight
3= mixed energy offset
4= wave dominated

EDTV - Ebb-tidal delta volume in cubic meters $x10^6$.

ETDA - Ebb-tidal delta area in square meters $x10^6$.

FTDV - Flood-tidal delta volume in cubic meters $x10^6$.

CEND - Distance in meters from the center of the inlet throat to the centroid of the ebb delta. The centroid is the geometric center or "center of gravity" of the outline of the ebb delta.

CENA - Angle in degrees formed between the vector extending from the center of the inlet throat to the ebb delta centroid and the general shoreline trend. This angle is measured clockwise from the shoreline. Thus, a CENA value of 90 would indicate the ebb delta is oriented perpendicular to shore, a value of 45 would indicate the ebb delta is slanted to the southeast, and a value of 135 would indicate a slant to the north or west.

CXSA - Cross sectional area in square meters of the channel at the inlet throat (measured below msl).

CW - Channel width in meters at the inlet throat.

CDA - Channel depth (average) in meters at the inlet throat (measured below msl).

CDM - Channel depth (maximum) in meters at the inlet throat (measured below msl).

PRIS_SP - Tidal prism (spring) in cubic meters $x10^6$.

PRIS_MN - Tidal prism (mean) in cubic meters $x\ 10^6$.

MAXFL - Maximum flood current velocity in cm/s.

MAXEB - Maximum ebb current velocity in cm/s.

MIG - Migration in meters and direction (N= north, S= south etc.) of the center of the inlet throat. The value shows the amount and direction of migration since the date of the previous value. The data begin with the year marked with a MIG value of 0.

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