The West-Central Florida Coastline in 1500: How the explorers saw it.

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The purpose of this study was to determine the general characteristics of the west-central Florida coastline 500 years ago, during "the age of exploration", and to analyze bays and harbors that would have existed at the time, with the purpose of identifying bay entrances and landing sites that would have been navigable by ships of the era with drafts of 10-16 feet.

General Characteristics of the West-Central Florida Coastline c. 1500

When the last Ice Age ended due to global warming, starting approximately 18,000 years ago, the sea levels began to rise. For the next 14,000 years, sea levels rose very rapidly by an estimated 400 feet, or at 0.4 inch per year. The impact of this rise in sea levels was the reduction of the area of the Florida Peninsula, by approximately 60%, submerging vast areas of the present-day continental shelf which, prior to that, were dry land. At about 6,000-8,000 years ago the rate of sea-level rise slowed down substantially to about 0.1 inch per year. Starting at about that time, present-day Tampa Bay and Charlotte Harbor were flooded by seawater and became the estuaries that we see today.

Sea level at the west-central Florida coastline reached close to its present position approximately 2,000-4,000 years ago. The rate of sea-level rise slowed further down at that time to about 0.04 inch per year. At that time, the chain of barrier islands started to develop along the coast. Radiocarbon dating and archaeological discoveries have indicated that many existing barrier islands have been in their present location for more than 1,000 years. The absence of radiocarbon dating or

archaeological discoveries on other barrier islands simply indicates the lack of data and does not prove that they were not there. It is also known that some barrier islands have been formed, or have shrunken or disappeared, during the past five centuries. An example, Egmont Key, illustrates the point. While archaeological evidence proves that Egmont Key has existed for an estimated 2,000 years, it is known that in the mid-1800's it was nearly twice as wide as it is today. Whether it was smaller or larger in 1500 is unknown, but it demonstrates that barrier islands, while always being present on the coastline, have been subject to considerable change as to size, location, and even existence, during the past five centuries.

Large scale coastal morphology changes are caused by sea-level rise or fall, in addition to sediment deposited from rivers, or from seaward from the continental shelf. In the case of the west-central Florida coast, sea-level did not change significantly over the past 500 years. Furthermore, rivers in Florida do not carry large amount of sediment to the coast and are not capable of causing large scale morphology change in a short geological time. Sediment supply from the continental shelf is controlled by rate of sea-level change. The relatively slow sea-level rise over the past 500 years would not have induced large onshore sediment movement and subsequent regional scale morphology change. Therefore, no major morphology changes have occurred during the past 500 years. The coast in 1500 CE was generally similar to that of today's, with the exception of the impact of substantial alterations by humans in some areas, primarily dredging of channels, landfill, and construction of causeways and bridges during the past 100 years.

In a broad sense, the west-central coastline of Florida during the past 1000 years has not undergone significant change. It consists of two headlands, Indian Rocks Beach in Pinellas County and Sanibel Island, south of Charlotte Harbor; and two large estuaries, Tampa Bay and Charlotte Harbor, as well as a significant number of smaller bays along the coastline, all bordered seaward by a chain of barrier-islands punctuated by numerous tidal inlets.

The west-central Florida coast has a wide, gentle and shallow inner continental shelf. Based on an 1880s bathymetry map, the 6-m (20-ft) contour (relative to Mean Sea Level) is located at about 4 to 6 miles from the shoreline, or almost at the limit that one could see the land from a ship offshore. The 4-m (13-ft) contour is located at 0.5 to 1.5 miles from the shoreline. It is worth noting that the 13-ft contour, i.e., about 11 ft at spring low tide, may have been too shallow for the

vessels, requiring ships to stay at least ½ to 1 ½ miles offshore in order to stay safely in deeper waters while attempting to identify bay or harbor entrances.

The two largest harbors on the west Florida coastline, Charlotte Harbor and Tampa Bay, have been mostly unchanged during the past several millennia. Other smaller estuaries, including Boca Ciega Bay, Sarasota Bay, Lemon Bay, and Estero Bay, were in approximately their present locations in 1500 CE.

The coastal geology of west Florida contains no hills, mountains, or promontories that would be available as landmarks from which early pilots/navigators could have determined their location. The coastline is generally flat, and is made up of barrier islands and coastline with no remarkable features from which to deduce location. However, the Pinellas Headland at Indian Rocks Beach protrudes nearly seven miles into the Gulf of Mexico, relative to the main entrance to Tampa Bay. It is possible, even likely, that the early sailors who were sailing northward along the coast, e.g., along the 20 ft contour, four to six miles offshore, might have recognized this protruding headland as a landmark.

Many storms and hurricanes have impacted the west-central Florida coast during the past five centuries. Although the hurricanes do not have the ability to fundamentally alter the general coastal landscape, they can substantially alter the localized configurations of the barrier island chain particularly in terms of tidal inlet locations. This is discussed in more detail in the following concerning the specific bays and harbors. It is worth specifying here that hurricanes would not have been able to cause dramatic changes at the main Egmont Channel entrances to Tampa Bay, or to the Boca Grande Inlet at Charlotte Harbor.

In summary: The west-central Florida coastline of 1500 CE was remarkably similar in the depth of water, presence of barrier islands, and locations of bays and harbors, to the coastline of today.

Characteristics of Specific Bays and Harbors

Although the smaller bays (Boca Ciega Bay, Sarasota Bay, Lemon Bay, and Estero Bay) are in the same general locations, the locations of tidal inlets into these bays could have been in different locations than those of today. Storms and hurricanes could open up a new inlet and cause an old inlet to close. Such a process typically

takes a few decades. An example is the opening of John's Pass in 1848 by a hurricane, which caused a subsequent rapid southward migration, of up to 500 ft per year, of Blind Pass. If Blind Pass had not been stabilized by human engineering, it would have likely closed.

Before John's Pass was opened in 1848, Blind Pass would have been the main inlet into Boca Ciega Bay. The size of Boca Ciega Bay requires that it has an outlet connecting to the Gulf of Mexico. The size of the pass, prior to the opening of John's Pass in 1848, would roughly be the sum of today's John's Pass and Blind Pass. Based on the characteristics of many similar inlets along the west-central Florida coast, the main channel between the two barrier islands would be wide and deep enough for vessels with drafts of 10-15 feet to sail through. However, like almost all other inlets, with the exception of the two main entrances to Tampa Bay and Charlotte Harbor, the challenge for the early sailors would be to pass through the shallower water at the seaward edge of the pass, (technically referred to as the terminal lobe), and to find anchorage with deep water landward of the inlet. Based on the present morphologies of the ebb and flood shoals at the un-structured inlets along the west-central Florida coast, getting past the shallow terminal lobe would be very difficult at some inlets and virtually impossible at others.

A key element in determining the size of an inlet is the volume of water that flows landward (flood tide) into the bay and seaward (ebb tide) into the Gulf through the inlet. This volume of tidal water, referred to as the tidal prism, and the additional water from rivers (if any), and the number of inlets for water to flow through during incoming and outgoing tides, controls the width and depth of the channel/s that would be required to maintain the regular exchange of seawater between the bay and the Gulf. Several empirical equations have been developed linking the tidal prism to the size of the cross-section of the inlet. A commonly used relationship between tidal prism (*P*) during a spring tide and minimum equilibrium inlet cross-sectional area (A_c) for the Gulf coast inlets is:

$$A_c = 9.311 \times 10^{-4} P^{0.84} \quad \text{(Using metric units)}$$

This formula can be used to estimate the cross-sectional area of inlet/s serving a particular bay. Using Boca Ciega Bay as an example, with data based on historical charts, the area of the bay was approximately 26,000,000 square meters before the human alterations. The average spring tidal range in this area is 1.05 m. This yields

a tidal prism of roughly 27,000,000 cubic meters. Based on the above formula, the equilibrium minimum cross-sectional area of the inlet serving the Boca Ciega Bay is about 1,600 square meters, or roughly 17,000 square feet. West-central Florida tidal inlets, such as today's John's Pass and Bunces Pass, have a depth of 16 to 18 ft. This would give a width of Boca Ciega Bay inlet of about 1000 ft. It is worth noting that the above calculation yields the cross-sectional area typically between the two barrier islands. It does not predict the cross-sectional areas (depth of water) of the seaward end or the landward end of the inlet.

For purposes of this analysis we have used Mean Sea Level (MSL) to estimate water depths. MSL is the midpoint between high and low tides. In general, there are two high tides and two low tides each day on the west Florida coast. The maximum spring tide ranges from nearly 2 feet above Mean Sea Level (MSL) to 2 feet below MSL. The maximum spring tidal range is therefore roughly four feet from the highest to the lowest tide. Using MSL as a baseline, we can add 2 feet to estimate channel and bay depths at maximum spring high tide. However, ships entering or leaving a harbor would most likely use the incoming or outgoing tide to assist them, which would require entering a harbor on an incoming (still rising) tide, or leaving a harbor on an outgoing (water depth decreasing) tide. It is thus reasonable to assume that determining the navigability of bay or harbor openings should be based on MSL.

Historians have postulated that early explorers may have entered and anchored in, Old Tampa Bay, Tampa Bay proper, Sarasota Bay, Boca Ciega Bay, Charlotte Harbor, Lemon Bay, and Estero Bay. These bays were studied in an effort to determine whether navigable entry and anchorages could have existed in these places, and to identify any other bays or harbors that have the characteristics that would allow a vessel drawing 10-15 feet to enter and anchor.

A review of the general morphology, as well as tidal prisms and tidal flow patterns of Tampa Bay, Charlotte Harbor, Sarasota Bay, Boca Ciega Bay, Lemon Bay, and Estero Bay, reveals the following:

1. Tampa Bay- Tampa Bay has two wide and deep entrances on either side of Egmont key. They are easily sufficient to support a ship drawing 10-15 feet. Water depths would allow such ships to sail into, and the full length of Tampa Bay. Many sites for suitable anchorages exist.

2. Old Tampa Bay- Entry into Old Tampa Bay was possible, as the entrance channel would have been sufficiently deep. There are several areas that could support anchorage.

3. Charlotte Harbor- The main entrance, Boca Grande Inlet, could have supported large ships entering the bay, although the depth of approaches to this channel would make it more challenging than Tampa Bay, due to the large and mostly shallow ebb shoal. There are many areas directly landward of Boca Grande inlet that could support anchorage.

4. Boca Ciega Bay and Estero Bay – These two small bays provide similar conditions as discussed above concerning Boca Ciega Bay. The inlets serving these bays likely had one main channel for each bay that were deep and wide enough for vessels drawing 10-15 feet. The major challenges for the early sailors would be to navigate over the shallower terminal lobe in order to reach the deeper channel, and to find deep water inside the bay for anchorage. The bathymetry map from the 1880s shows narrow entrances into the channels and small areas within the bays that are deep enough for anchoring. However, it is not clear if the early sailors had the precision to navigate these waters.

5. Lemon Bay and Sarasota Bay - Neither of these bays appear to have been navigable by deep-draft ships in 1500 CE. In the case of Lemon Bay, the tidal prism would not have produced channels of the required depth. In the case of Sarasota Bay, there were three inlets serving the bay, which would result in shallower inlets. In addition, the shallow bedrock level in the bay would result in practically no area deep enough for anchoring.

6. A maximum speed of tidal driven flow is about 3-4 ft/s, or about 2 knots. This current velocity should be expected for most of the inlets. It is often referred to as an equilibrium velocity, in that if the flow is stronger it would scour the channel and make it larger and subsequently result in a slower flow, and vice versa. This 2-knot water speed would have been a significant factor in aiding or hindering ships as they attempted to enter or leave through a pass.

In Summary, in terms of bays that would be considered the most-likely prospects for early navigators to enter, anchor and exit, Tampa Bay presents the least difficult choice to the mariner, and perhaps the easiest to find. Tampa Bay is just below the Pinellas Headlands, extending seven miles to the west from the coast. As the most-westward headland visible to seafarers as they sailed north along the coast of Florida, it may have represented a significant landmark, and a point from which to deduce the location of Tampa Bay. (Boca Ciega Bay is just south of this headland, just north of the Tampa Bay entrance).

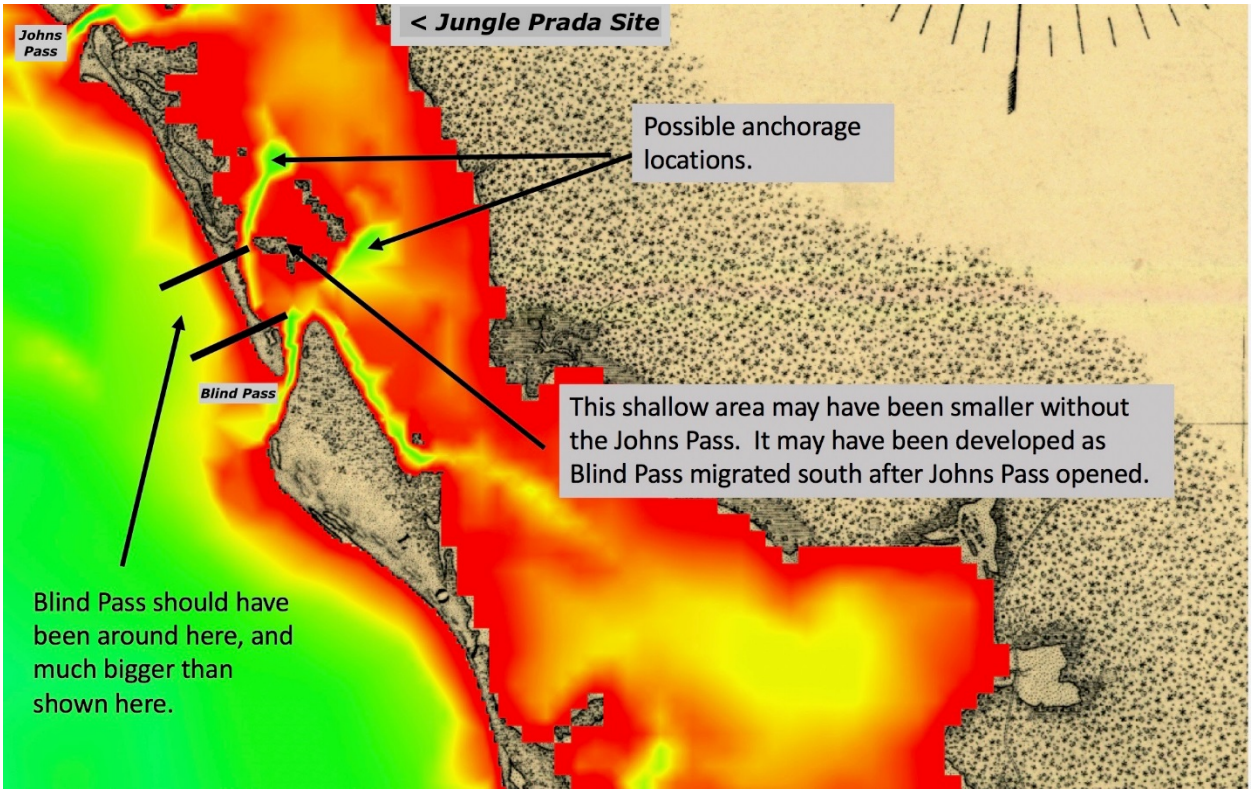
Charlotte Harbor also represents a likely point of entry and anchorage, but would be more challenging due to the fact that it has more entry/exit channels and a smaller tidal prism, resulting in shallower channels and shallower approaches to the main and deepest channel, Boca Grande Pass. It has a deep main channel, and sufficient depth inside the main channel for suitable anchorage places.

Both Estero Bay and Boca Ciega Bay would have had channels sufficient for large ships of the 1500s, but the shallows approaching the main channels, and the depths of the bays themselves, would have presented significant obstacles.

Neither Lemon Bay nor Sarasota Bay appear to have the characteristics that would have provided channels with sufficient water depth, or depth within the bay, to support large ships of the era.

Below is an example, using Boca Ciega Bay 1870 bathymetric data, indicating possible entry and anchorage sites for ships of 10-15 foot draft. With the exception of the actual location of the passes, data from the era prior to extensive human engineering can be used to approximate water depths in passes and in bays and harbors during the preceding five centuries.

Similar charts of other passes, bays, and harbors were presented at the History Council Symposium in St. Petersburg in October, 2018.



Bathymetry of Boca Ciega Bay. Data from charts c. 1870.

-Red color is depth of < 2 meters (< 6 feet)
-Yellow color is depth of 2-4 meters (est. 6-12 feet)
-Green color is depth of 4-7 meters (est. 12-21 feet).

-<u>Yellow/Green colors identify possible entrances and anchorages for ships drawing 10-14 feet.</u> These are depths at MWL. High tide would add about 2 feet, low tide minus 2 feet.

-Size of "tidal prism", i.e. surface area of water in bay that is blocked by barrier islands, would always have required an outlet for tidal flows.

-Shows 1870's John's Pass at top left, which was opened in 1848.

-Also shows 1870's Blind Pass, which had "migrated" south rapidly since John's Pass had opened only 25 years earlier.

-Approximate location of original Blind Pass is indicated on map, which would have been much larger pre-1848 because it was the main inlet for Boca Ciega Bay. In other words, it would be the size of John's Pass and Blind Pass combined. Depth inside John's Pass would have been deeper pre-1848.