Summary of Historical Shoreline Change for the Sea Island, Georgia's South Groin Region

1869 to 2013

By

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The following narrative provides a summary of a recent assessment of historical shoreline movements since the 1800s adjacent to the southern-most groin {erosion control structure) for long- and short time periods, and, pre- and post-groin installation. This assessment was performed using the best available technology for calculating shoreline change and employs methodologies widely used amongst coastal researchers globally. The intent of this analysis was to assist with determining if the behavior/shape of the shoreline has changed since the installation of the groin and to quantify the rates of erosion or accretion {deposition).

The summary initially begins with a brief section that provides a background on some of my expertise in the field of coastal geology and also includes a brief section of the methodology employed to analyze shoreline change. Finally, the data are summarized in a map and table in order for coastal scientists, managers, and other stakeholders/decision-makers to interpret the results in the best interest for preservation of coastal environments, wildlife, and humans.

Although I am not providing a section with detailed interpretations in this summary, it is clear from the shoreline's shape and movements that the groin has had a noticeable impact following its installation. Erosion rates south of the groin following its installation are nearly 3 times the rate of what Ihave been able to define as an erosion hotspot, based on statistical analyses of over 70,000 transect locations from historical shoreline change analyses spread throughout the southeast U.S. alone. Currently, we define an erosion hotspot as a shoreline that has a rate of shoreline change of -1m/yr. (Note: in this report negative rates indicate erosion and positive rates indicate accretion/deposition .)

GENERAL QUALIFICATIONS/EXPERTISE

My research interests center on utilizing both field and GIS techniques to investigate shoreline, inlet,and sediment dynamics along Southeastern U.S. and Caribbean coasts in response to natural and anthropogenic influences. Focal points of my research include quantifying and predicting shoreline/inlet changes, determining how the inherited geological framework plays a role in the evolution of the coast, and developing software tools for analyzing shoreline and vulnerability to coastal hazards. Currently, Iam conducting research in North Carolina, South Carolina, Georgia, Florida, Puerto Rico, and U.S. Virgin Islands. I am collaborating with a number of scientists,coastal managers, and policy makers within each region including academic institutions, state and federal agencies, and NGOs. I have developed a software tools called AMBUR that assists with performing various assessments of change in the position of a boundary (e.g. shorelines, glacier edges, lava flows) over time, and, AMBUR-HVA which assesses coastal vulnerability to shoreline change and storm surge and flooding. Both packages are publicly available for free and are used by researchers in the U.S. and abroad. My research has been funded through NOAA and various state and local agencies over the past decade and has included assessing historical changes along tens of thousands of kilometers of shorelines. In Georgia, historical shoreline change data derived from funded projects by GA Sea Grant, GA DNR CRD, and NOAA for all of the "Tier 1" coastar counties are available via the Georgia Coastal Hazard Portal (http:(/gchp.skio.usg.edu/).This summary report provides additional shoreline data recently obtained from current and past projects.

METHODOLOGY

The general process of performing a shoreline change assessment involves three main phases: 1) identification of multiple dates of aerial/satellite imagery and maps; 2) extraction of shoreline positions (digitization); and 3) analysis of shoreline changes (distances and rates) between each date. A more detailed description of the processes involved with the methodology employed in this study can be found in Jackson (2010), Jackson et al. (2012), Jackson (2013), and Jackson.(2015). This methodology is consistent and comparable with techniques currently being applied by coastal researchers in the U.S. and abroad.

Of particular importance is how the shoreline is defined and identified. There are a number of shoreline proxies (features) that can be used to assess shoreline change and each has their advantages and disadvantages (Boak and Turner, 2005). Some shorelines may be defined as a physical feature within the shore system and an analyst might choose either a high water line (HWL), water/land interface, or first line of stable vegetation . Alternatively, and more difficult, the analyst may choose a numerical proxy such as a tidally based datum (e.g. mean low water, mean high water, low tide line etc.). These datums are defined by NOAA (2000) and require rigorous calculations that involve the use of a first order surveyed tide gage(s) with data that contain 19 or more years of historical tide levels (spanning an 18.6 tidal epoch). This can prove problematic when there is not a locally available tide gage and when

NOAA's tidal epochs become outdated or interpolated for areas far away from the nearest tide gage (10s to OOs of kilometers). Given these challenges, the high water line or wet/dry line was used in this study given that it has been shown to be a viable and often robust shoreline proxy for assessing change (Dolan et al.,1978; Dolan et al., 1980; Dolan et al.,1991; Pajak and Leatherman, 2002). It is often easy to identify on aerial photographs and was also mapped in earlier historical maps (U.S. Coast and Geodetic Survey T-sheets) used in this study from the 1800s to 1950s as discussed by Shalowitz (1964). Digitization of the HWL using maps aerial photography is also discussed in Moore (2000) and taken into account in this study's methodology.

Following the extraction and digitization of shoreline data from imagery and maps, historical shorelines were analyzed using AMBUR (Jackson, 2010). A total of 22 transects that approximate the general trajectory of shoreline movements for a given location over time were created in AMBUR and are spaced approximately SO-meters starting south of the groin and ending north of the groin (Figure 1). The result is that there are 11 transects south of the groin and 11 transects north of the groin (Figure 1). Historical shoreline change rates were calculated between the dates present along each transect.

RESULTS

Figure 1 provides the locations of the AMBUR transects (with ID numbers) used for the analysis and representative historical shorelines. The transect ID numbers or labels in Figure 1 coincide with transect numbers and shoreline change rate data provided in Table 1. Table 1 provides a summary of pre- and post-groin installation of shoreline change rates in meters per year (m/yr).

The table also provides long- and short term time periods or eras along with averages (means) and worst-case assessments of +/- possible error in shoreline change rates. As stated before, erosion rates south of the groin following its installation are nearly 3 times the rate of what is defined as an erosion hotspot (-1m/yr). Rates south of the groin exceed -3 m/yr for the 25 year period between 1988 and 2013. The 1988 aerial photo in this study was used given that it was provided in the recent request for a permit for a new groin on Sea Island to represent the shoreline prior to installation of the existing groin.

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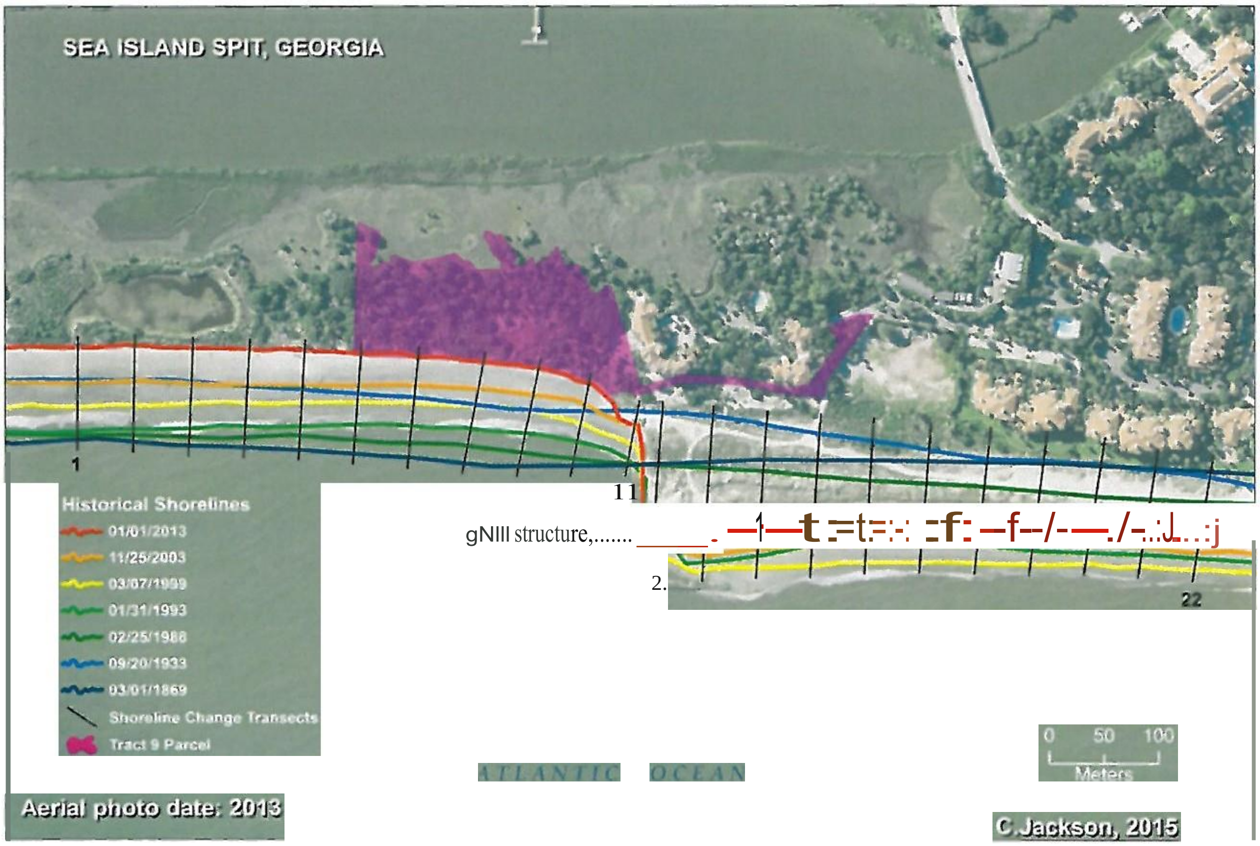

Figure 1. Map depicting historical shorelines and AMBUR analysis transect locations for Sea Island, Georgia's southernmost groin erosion control structure.

Table 1. Summary of shoreline changes rates (m/yr) for the Sea Island, GA southern groin area.

Transect	1869 to 1988 (119 yrs)	1933 to 1988 (SS yrs)	1988 to 2013 (25 yrs)	2003 to 2013 {10 yrs)
	pre-groin installation		post-groin installation	
	south (downdrift) side of groin			
1	-0.04	0.92	-3.23	-3.56
2	-0.05	0.92	-3.31	-3.57
3	-0.06	0.93	-3.28	-3.55
4	-0.08	0.86	-3.24	-3.58
5	-0.11	0.77	-3.15	-3.56
6	-0.10	0.78	-3.20	-3.20
7	-0.11	0.77	-3.18	-2.85
8	-0.14	0.70	-3.14	-2.71
9	-0.11	0.73	-3.15	-2.65
10	-0.06	0.82	-2.83	-2.19
11	-0.01	0.89	-1.47	-0.16
mean:	-0.08	0.83	-3.02	-2.87
± *error estimate:*	0.07	0.13	0.31	0.86

Transect				
	north (updrift) side of groin			
12	0.01	0.89	3.02	-0.05
13	0.05	0.87	2.99	-0.71
14	0.09	0.77	2.19	-1.90
15	0.12	0.71	1.82	-1.95
16	0.16	0.67	1.49	-1.90
17	0.17	0.57	1.38	-1.67
18	0.19	0.46	1.38	-1.64
19	0.22	0.52	1.31	-1.40
20	0.24	0.54	1.30	-1.26
21	0.24	0.49	1.29	-1.34
22	0.24	0.42	1.36	-1.43
mean:	0.16	0.63	1.78	-1.39
± *error estimate:*	0.07	0.13	0.31	0.86

Note: Positive numbers indicate accretion and negative numbers are erosion.

EXHIBIT 2

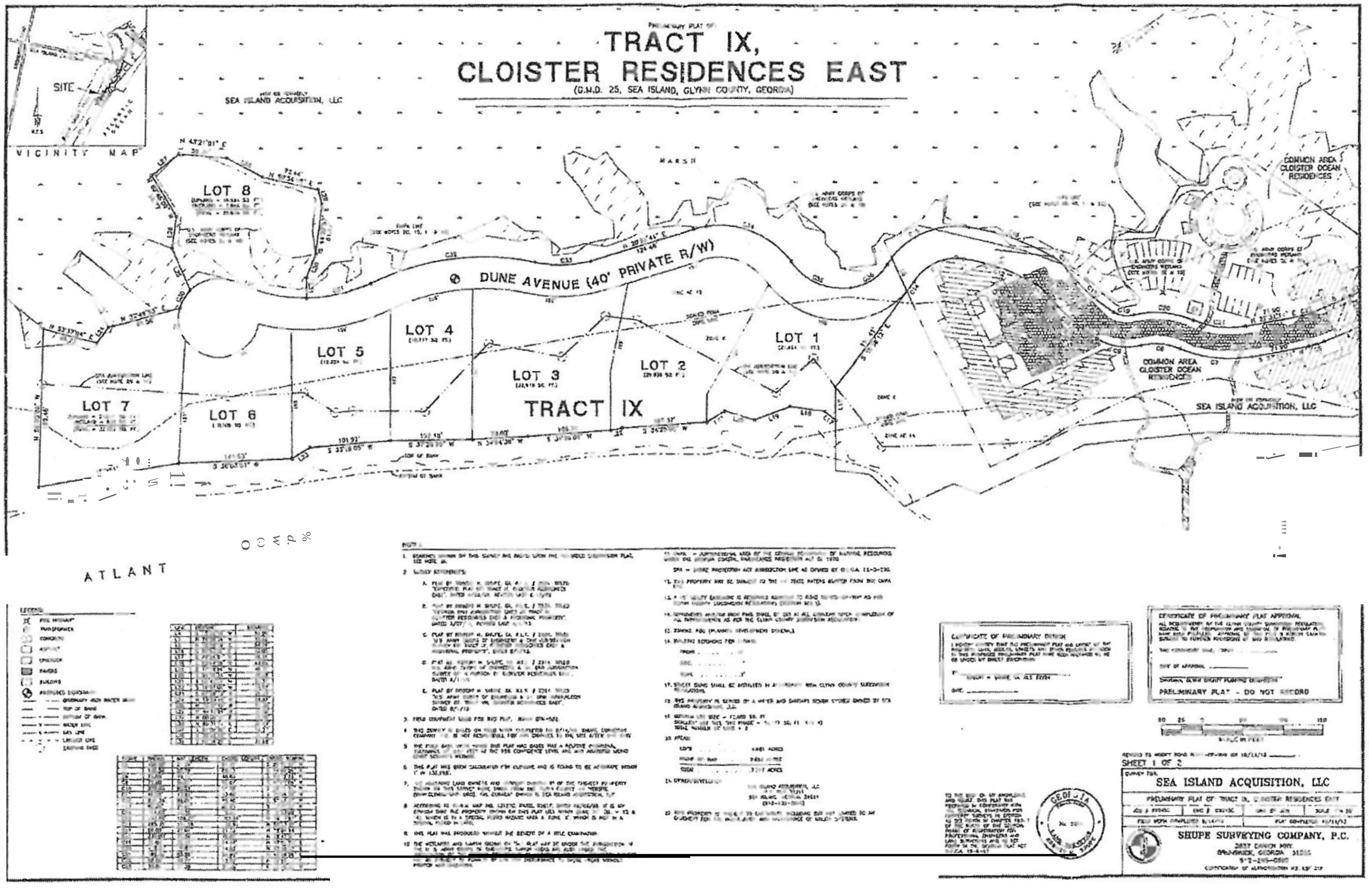
TRACT IX,
CLOISTER RESIDENCES EAST
(G.M.D. 25, SEA ISLAND, GLYNN COUNTY, GEORGIA)
SEA ISLAND ACQUISITION, LLC
SITE
VICINITY MAP
MARSH
LOT 8
DUNE AVENUE (40' PRIVATE R/W)
LOT 1
LOT 2
LOT 3
LOT 4
LOT 5
LOT 6
LOT 7
TRACT IX
COMMON AREA CLOISTER OCEAN RESIDENCES
COMMON AREA CLOISTER OCEAN RESIDENCES
SEA ISLAND ACQUISITION, LLC
ATLANT
LEGEND
NOTES
CERTIFICATE OF PRELIMINARY DESIGN
CERTIFICATE OF PRELIMINARY PLAT APPROVAL
PRELIMINARY PLAT - DO NOT RECORD
SHEET 1 OF 2
SEA ISLAND ACQUISITION, LLC
SHUPE SURVEYING COMPANY, P.C.

EXHIBIT 3

An Analysis of the Potential Impacts of the Proposed Sea Island Groin and Beachfill Project

Submitted by: Robert S. Young, PhD, PG

Background: It is important to remember why groins are regulated in all states. The United States Army Corps of Engineers' Coastal Engineering Manual describes groins as: "...probably the most misused and improperly designed of all coastal structures...Over the course of some time interval, accretion causes a positive increase in beach width updrift of the groin. Conservation of sand mass therefore produces erosion and a decrease in beach width on the downdrift side of the groin"(USACE, 2002). In his textbook (used by most coastal engineering programs to introduce beach processes) Paul Komar, professor emeritus in the College of Oceanographic and Atmospheric Sciences at Oregon State University, states, "Groins and jetties have the same effect in damming the longshore sediment transport, the shoreline builds out on the updrift side and erodes in the downdrift direction" (Komar, 1998). A de facto assumption must be made that a functioning groin field is increasing beach width on the updrift side (the north in this case) and decreasing beach width and sand volume on the downdrift side.

For example, South Carolina State Law regulating the construction of new groins explicitly recognizes the likelihood of downdrift harm by the following:

- The applicant shall provide a financially binding commitment, such as a performance bond or letter of credit that is reasonably estimated to cover the cost of reconstructing or removing the groin and/or restoring the affected beach through renourishment *S.C. Code Ann. § 48-39-290(A){B)(b)*

The existing south groin on Sea Island is a perfect example of the downdrift impact of a typical groin constructed on a barrier island shoreline. Since the groin's construction in 1990, the south end of the barrier island has lost a significant volume of sand and the spit has retreated over 2000 ft. This dramatic loss has included the disappearance of beach, sand shoals, dunes and marsh.

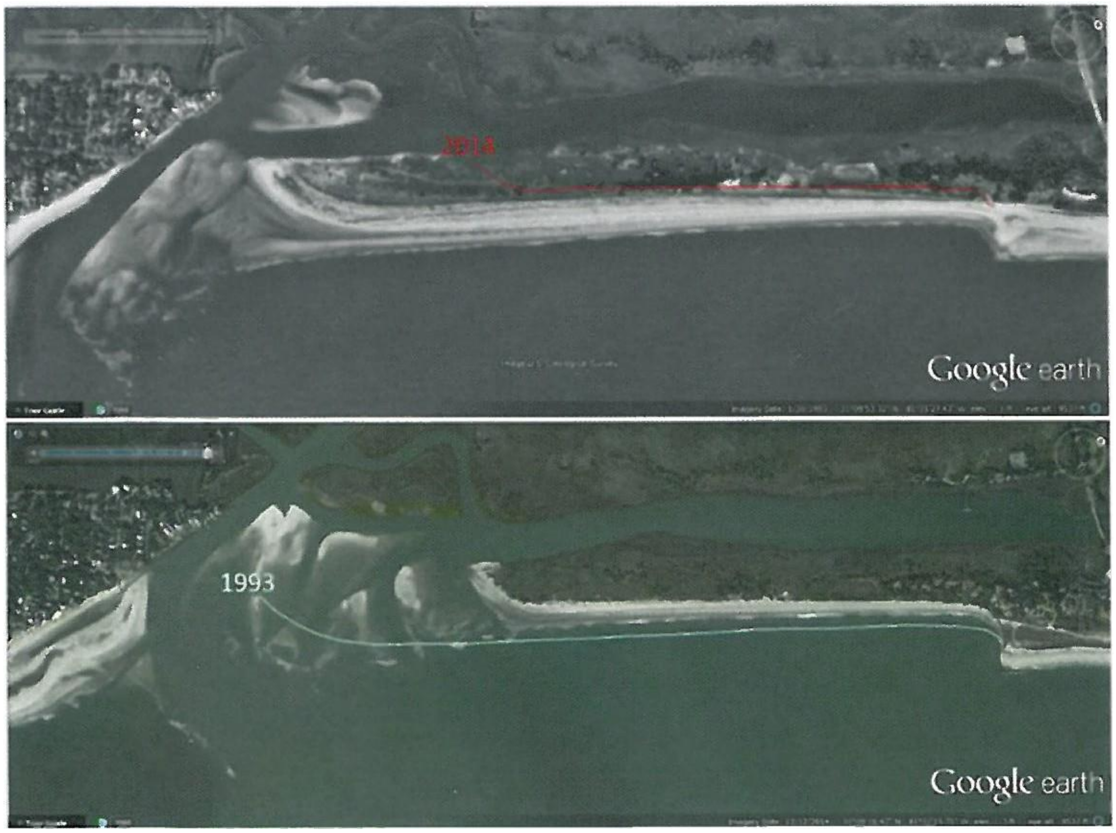

Figure 1: The upper image is a digitized shoreline from the 2014 aerial photograph of Sea Island, GA superimposed on the 1993 aerial image as acquired from Google Earth. The lower image is the 2014 aerial photograph with the 1993 shoreline superimposed showing how much shoreline and habitat has been lost on the south end since the construction of the south groin.

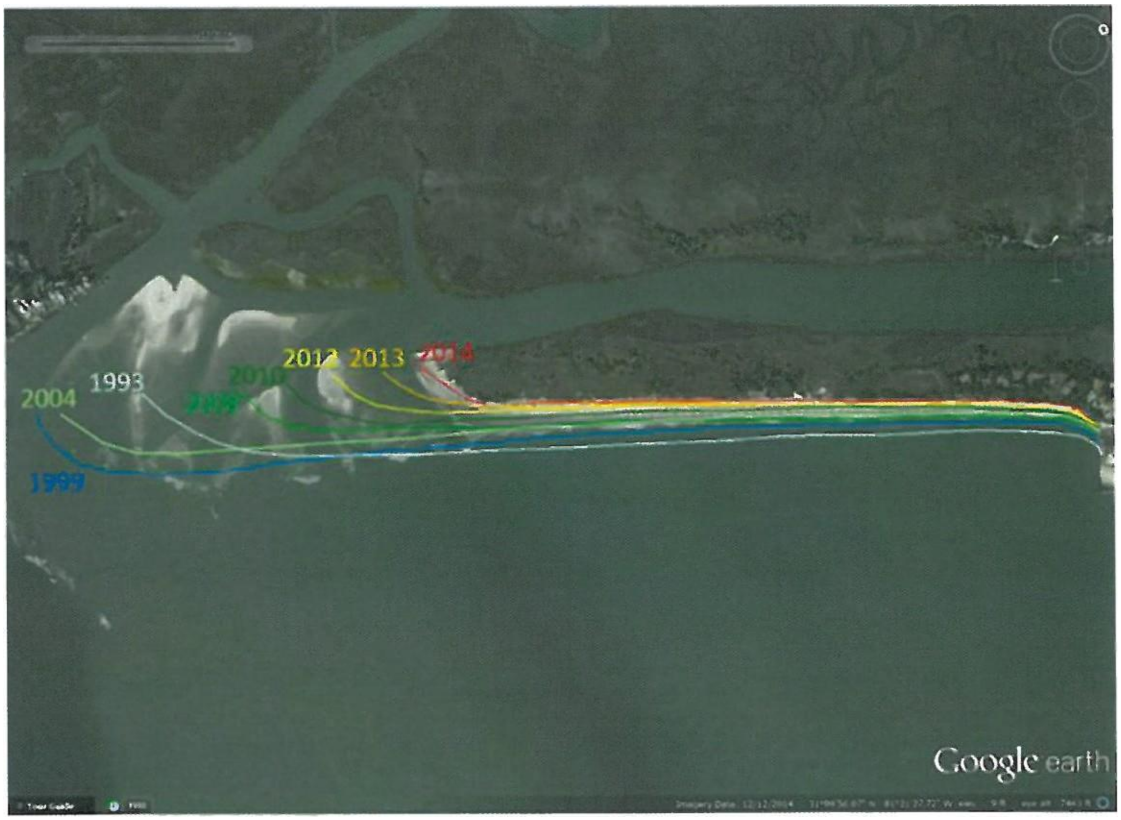

Figure 2: Digitized shorelines from a series of aerial images from Google Earth. After the construction of the south groin in 1990 the spit continues to extend south until approximately 1999. Chester Jackson at GSU has documented the southward extension of the spit since 1869. Since 1999, the south end of the island has been rapidly retreating, reversing a 130-year trend. The entire oceanfront shoreline has also retreated significantly. Inlet dynamics may play some role in the changes at the spit, but there is no question that the large deficit in longshore sediment transport caused by the trapping of sand behind the existing groins has also played a significant role. And the groin must be assumed to be entirely responsible for the rapid erosion of the beach along the oceanfront. Another groin, as proposed in this project, will simply exacerbate the existing, rapid decline on the south end of the island.

Comments on the Permit Application:

1) The application contains no documentation of any real engineering or scientific analysis conducted to evaluate the alternatives proposed, the project efficacy, reasonableness of design, storm damage reduction, impact to the borrow area, or downdrift impacts. There is absolutely no way that any regulator or permitting agency could make an informed decision on the impacts/efficacy of the project based on this application.

2) The permit application does not include the most likely alternative: Beach nourishment only, no groin.This would allow bypassing ·sand around the existing south groin without the construction of another groin. It would serve to mitigate for damage already caused by the 1990 groin. This alternative must be considered and adequately evaluated as a reasonable and less damaging option to the construction of another groin along this shoreline.

3) The proposed groin is smaller than the existing groins, but the cumulative impacts of adding another groin along a shoreline that is already being significantly impacted by an interruption in longshore sediment transport could be catastrophic. The end of the island is already retreating rapidly, and it is more likely than not that the cumulative impacts of adding another groin will increase this rate of retreat and associated habitat loss. In fact, it might only be a few years before the foundation of the groin itself will be threatened .

4) There is no substantive analysis in the permit application to support the chosen length and design of the proposed groin as it relates to benefits/impacts or benefits/ costs.

5) There is no substantive analysis in this proposal to document the degree to which this relatively small beach nourishment project will reduce long-term coastal

retreat or storm surge flooding. How long will the project last? Are there plans for another beach nourishment interval in a few years as is typically required?

6) One cannot assume that the beach nourishment proposed in this project will last as long as the project to the north. The inlet setting is very different and the large groin at the south end of the existing project is blocking sand that would feed the new beach.

7) There is no analysis of the degree to which removing sand from the proposed borrow area will increase the hazard exposure to properties behind the borrow area.

8) There is not adequate analysis to conclude that the project will improve, or not negatively impact, nesting sea turtle habitat. Beach nourishment projects typically have a negative impact initially, but that can change with time as the project equilibrates and provided that there is still adequate dry beach available after several years. The permit application does not provide adequate analysis to evaluate any potential benefits. In addition, the project will have downdrift impacts that will remove sandy beach habitat. This balance of gain vs. loss has not been evaluated.

9) Significant foraging, resting, and nesting shorebird habitat has been lost on southern Sea Island over the last 10 years (Figure 1). The beach nourishment portion of this project may temporarily increase dry beach along the project shoreline. It takes several years for the beach to recover enough to provide forage. The constructed dunes will prevent overwash as long as they last. Unvegetated sand flats, like overwash fans, are prime habitat for many shorebirds including nesting piping plovers. The USACE has had to create sand flats by knocking down dunes as mitigation for protective dune building in other areas as a part of their consultation with USFW in recent federal beach nourishment projects. There is no analysis of the degree to which the proposed groin will reduce shorebird habitat

through reduced longshore sediment transport. As previously stated, I believe that it will.

10) Finally, the proposal does not examine the potential impacts the project may have on East Beach, St. Simons island as cumulative sand losses reduce the amount of sand making it into inlet shoals, and thus reduce the amount of sand bypassing the inlet onto St. Simons.

Conclusions: In general, the permit application includes an alternatives analysis, a project design, and an impact analysis that is unsupported by substantiating analysis. This is as thin of an engineering design document as I have ever seen. An important alternative was not considered (beach nourishment without a groin). In my opinion, the project is likely to increase the rate of erosion of the ocean front shoreline and northward migration of the southern end of Sea Island. This will result in beach, dune, and marsh habitat losses that have not been considered.