Inlet And Adjacent Shoreline Processes at Cascading Time Scales Using the Coastal Modeling System and GenCade

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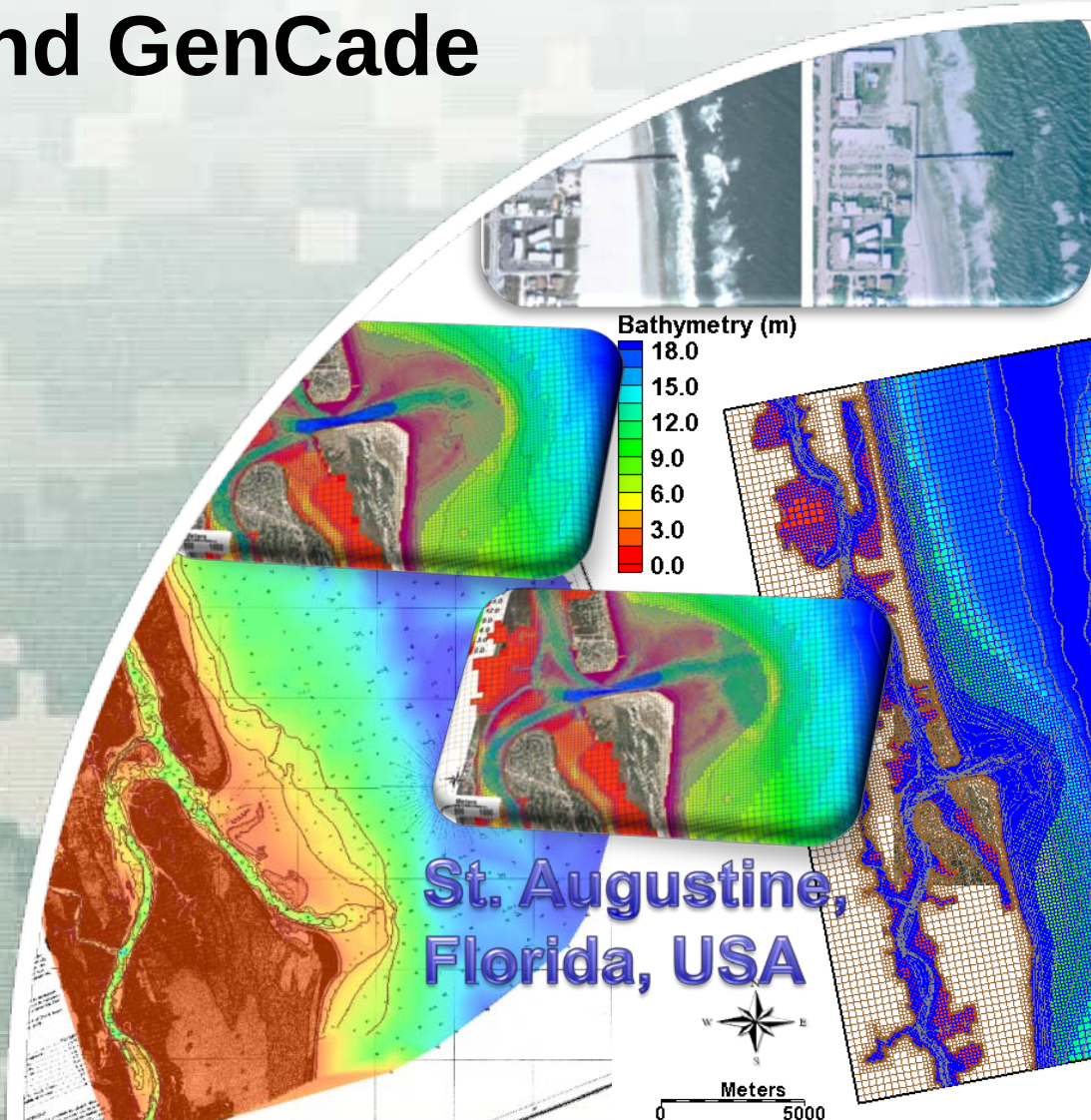
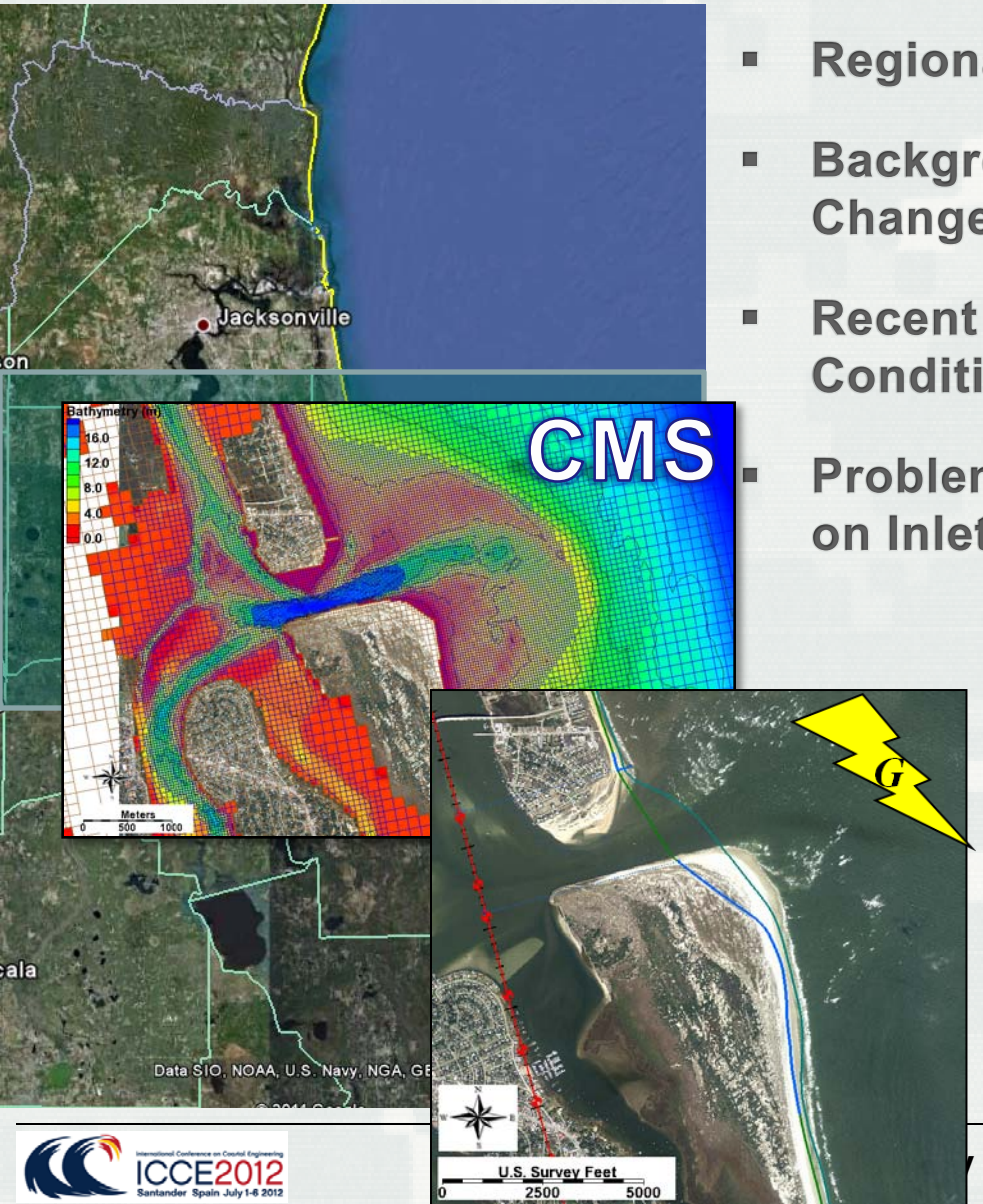
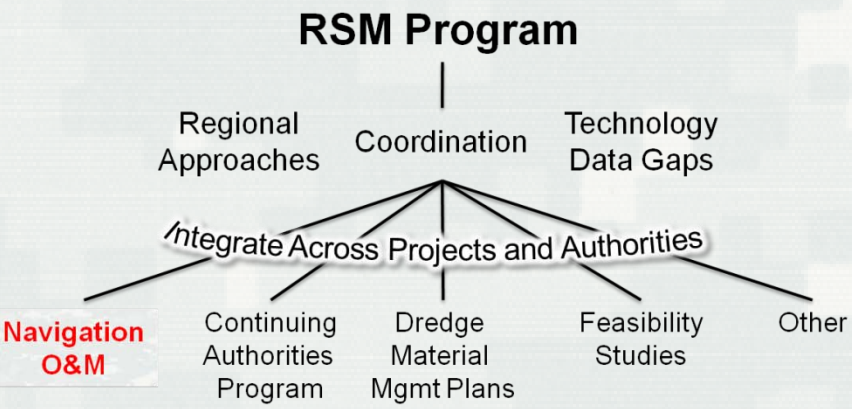


Overview



- Regional Sediment Management Principles
- Background Information & Historical Change of St. Augustine Inlet
- Recent Activity at Inlet & Present Conditions
- Problem Statement: Influence of Dredging on Inlet & Adjacent Beach Dynamics
  - Application of the Coastal Modeling System (CMS) to Both Verify and Predict How Dredging Activities Affect the Inlet
  - Application of GenCade to Determine Optimal Sediment Management Scenarios based upon Shoreline Response

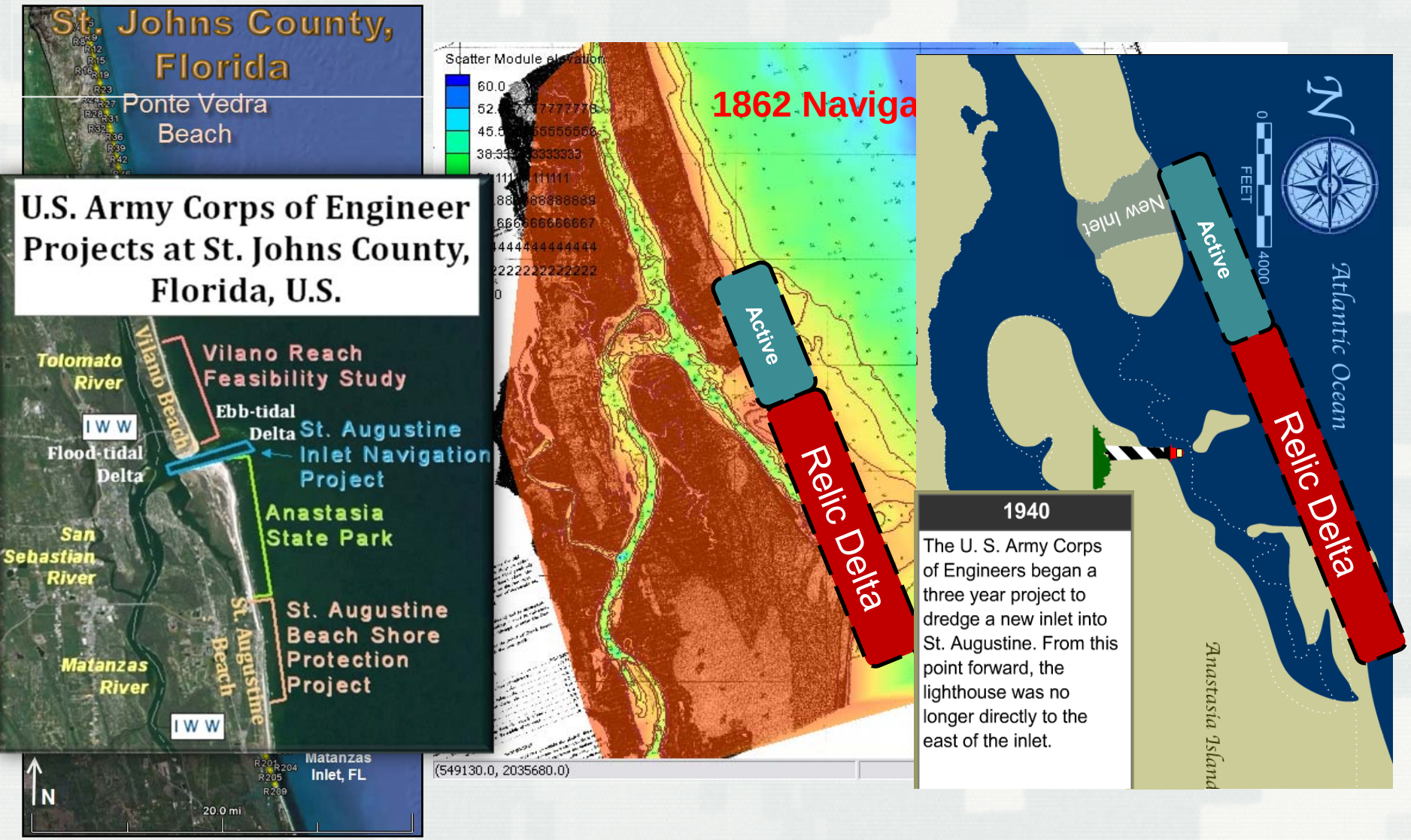
Regional Sediment Management Approach



RSM Operating Principles

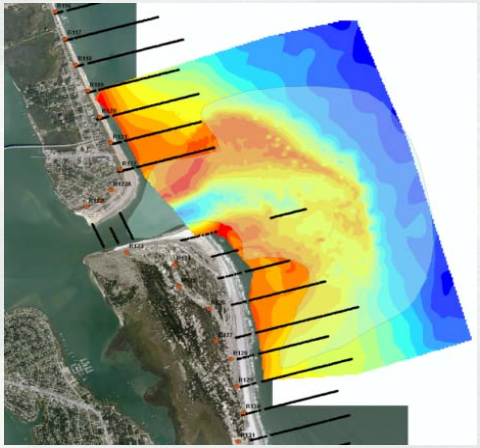
- Recognize sediment as a regional resource – connect beaches & inlets
- Evaluate use of all sediment sources & sinks
- Optimize operational efficiencies & natural exchange of sediments
- Balanced, economically viable, environmentally sustainable solutions
- Improve economic performance by linking multiple interacting projects
- Consider regional impacts
- Adaptively manage

The Navigation Project and Erosional Hotspot

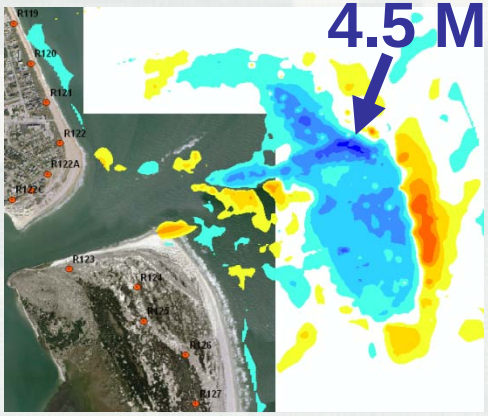


Planned and Historic District Activity in Last Decade

St. Augustine Ebb-shoal Mining



1998 - Bathymetry



1998 – 2003 Difference

St. Augustine Beach Shore Protection Project

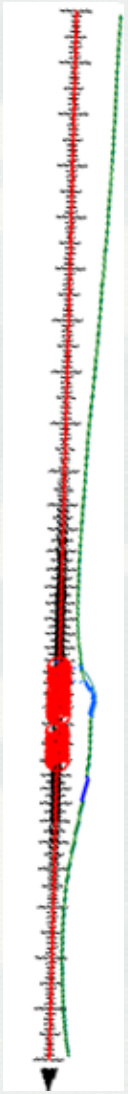
Project	*Volume Placed (CY)*	*Placement Area*	*Placement Length*
2003 Phase 1	*4.2 mcy*	R-145 to R-151	1.1 miles
Phase 2		T-132 to R-151	3.6 miles
2005	*2.8 mcy*	R-137A to R-151	2.6 miles

Legault et al., 2012

Vilano Beach Feasibility Study

Project	*Volume Placed (CY)*	*Placement Area*	*Placement Length*
Proposed Project	*880 kcy*	R-109 to R-120	2.0 miles

Problem Statement



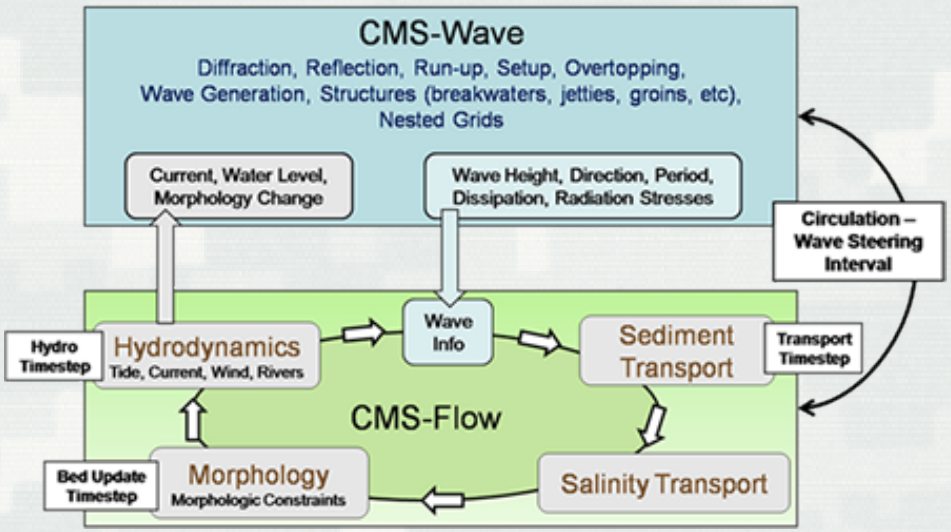
Investigate optimal dredging volumes and intervals, and determine the beach placement volume and interval that will adequately supply sand to maintain two Shore Protection Projects in St. Johns County.

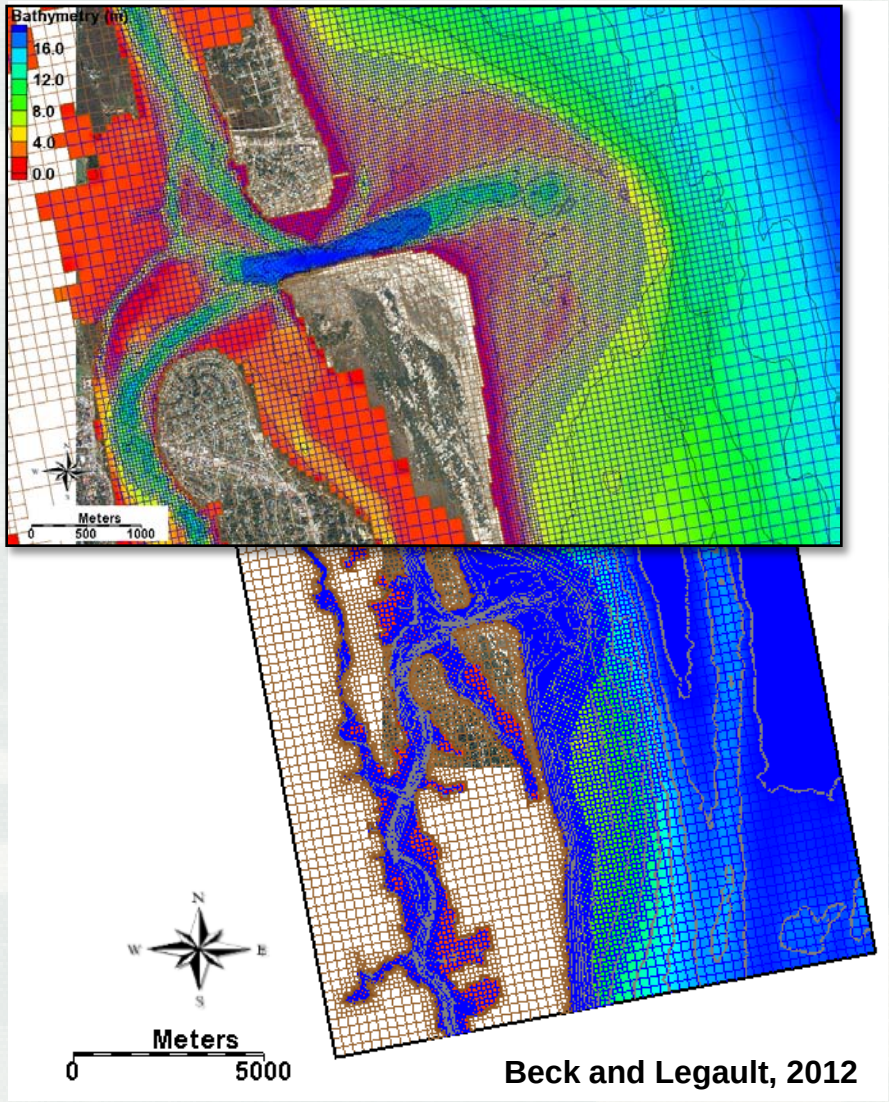
Questions:

What is the volumetric limit (cubic yards of sediment) that can be mined regularly from the ebb shoal in its present condition which does not cause a significant long-term effect on the morphology and volumetric recovery of the shoal?

How much sediment and what nourishment interval is required to maintain present volume of the active and planned Shore Protection Projects?

The Coastal Modeling System (CMS) at St. Augustine Inlet

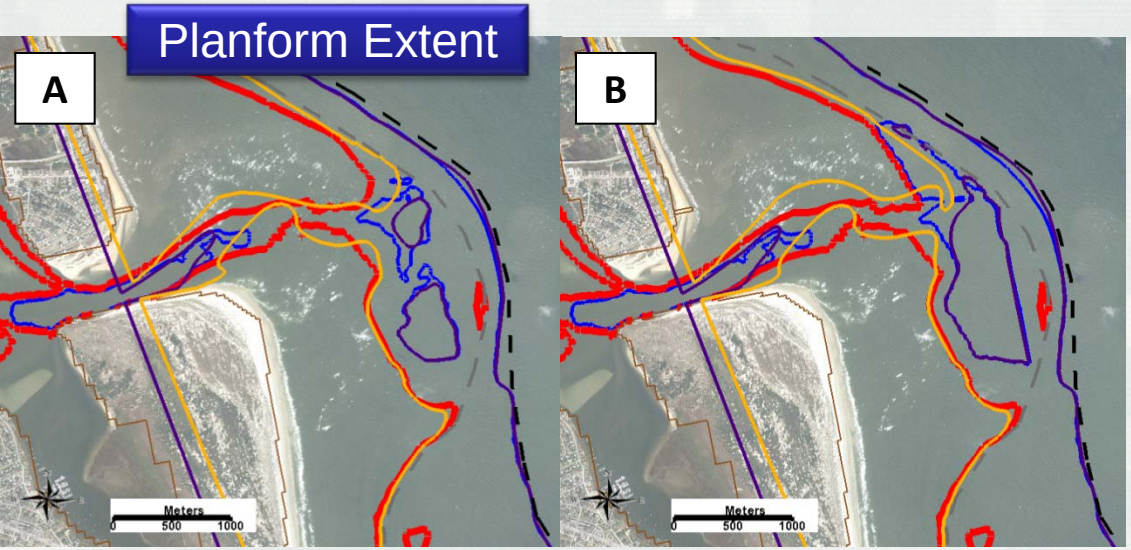


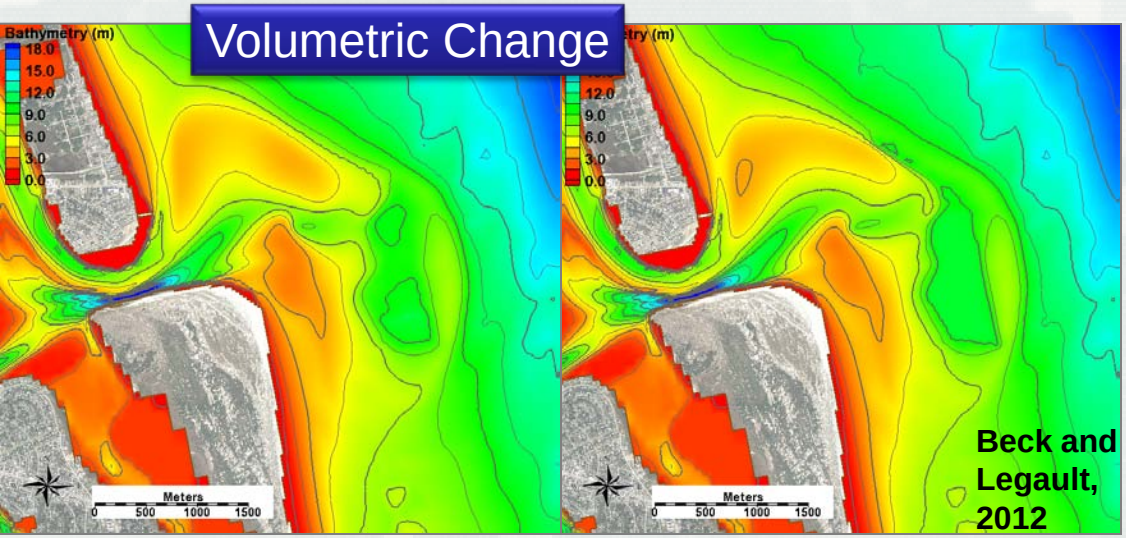


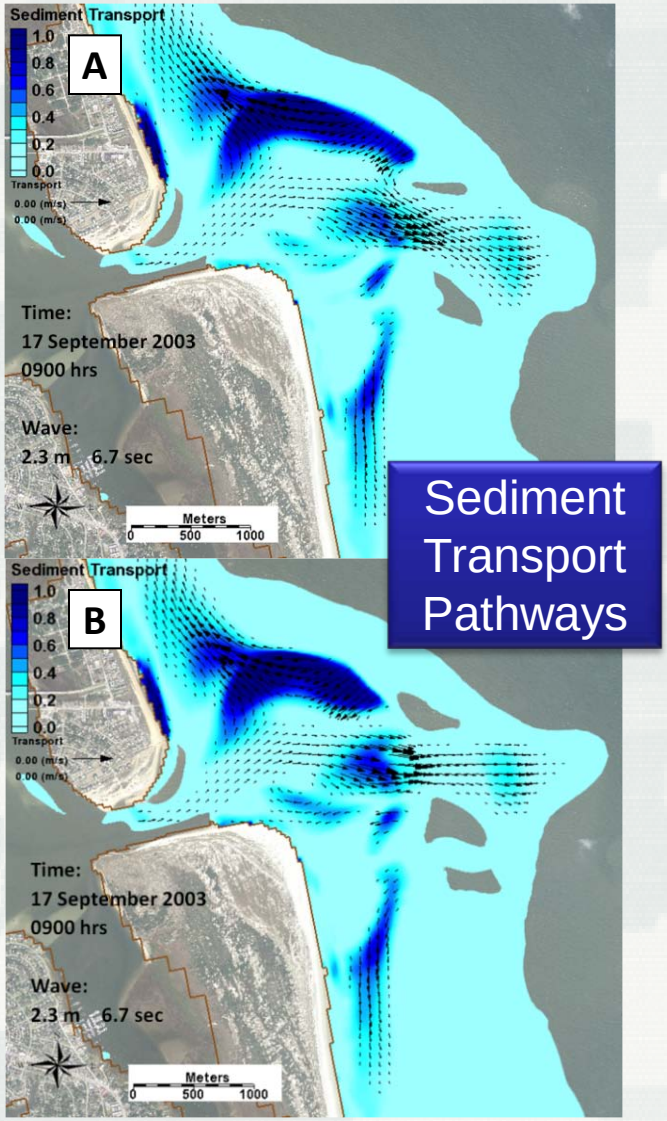
Beck and Legault, 2012

- **Analysis to Conduct:**
  - Volumetric change of ebb shoal
  - Planform change of ebb shoal
  - Shoreline position

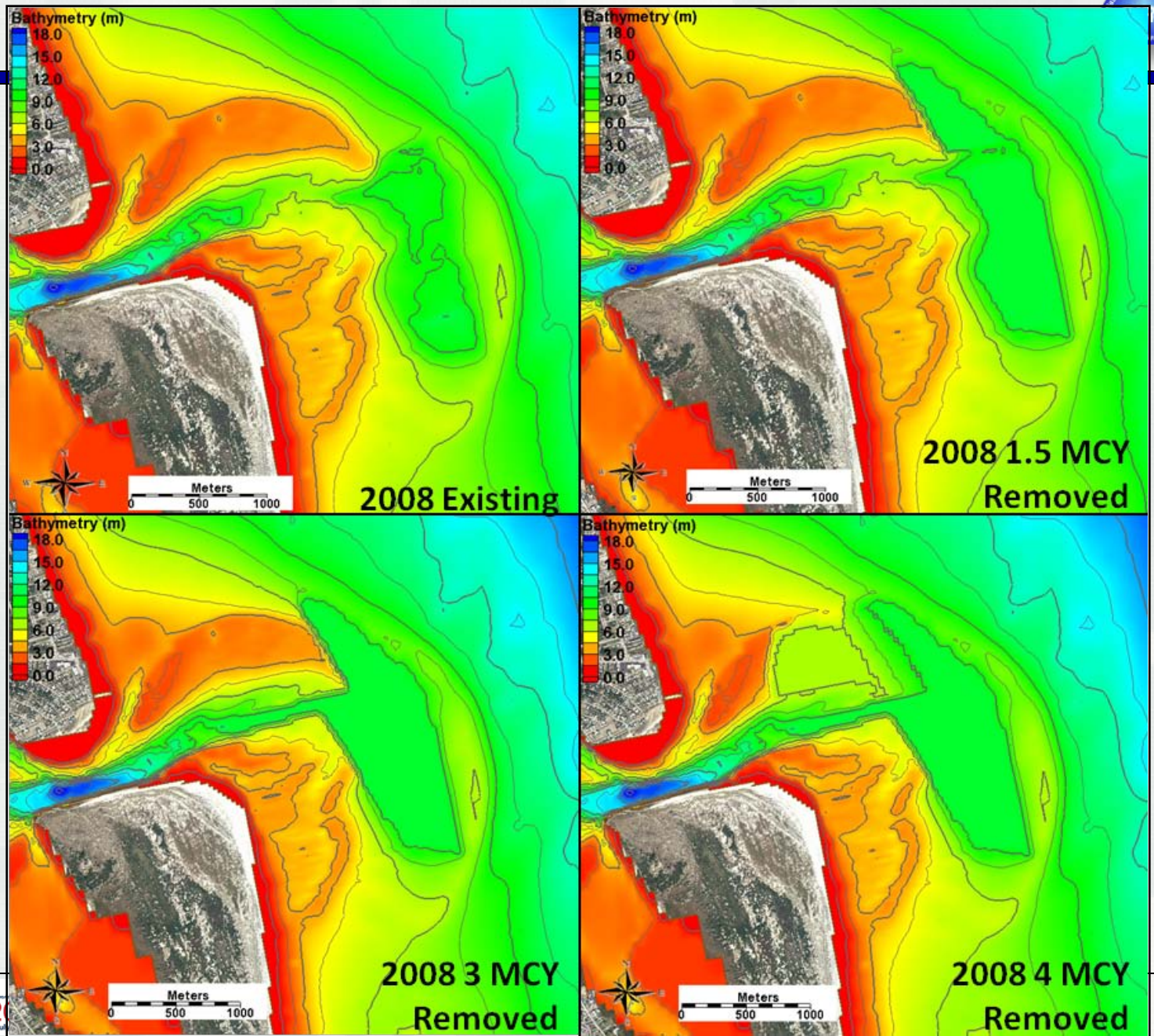
Comparison to the 1.5 MCY Removed



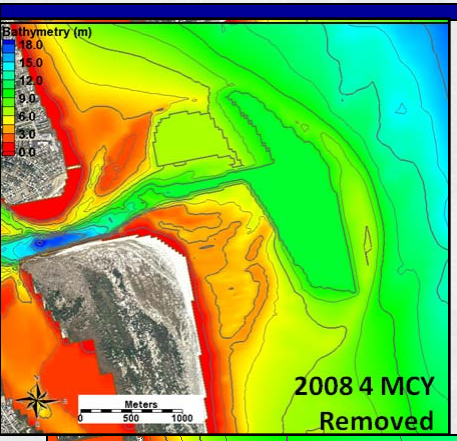


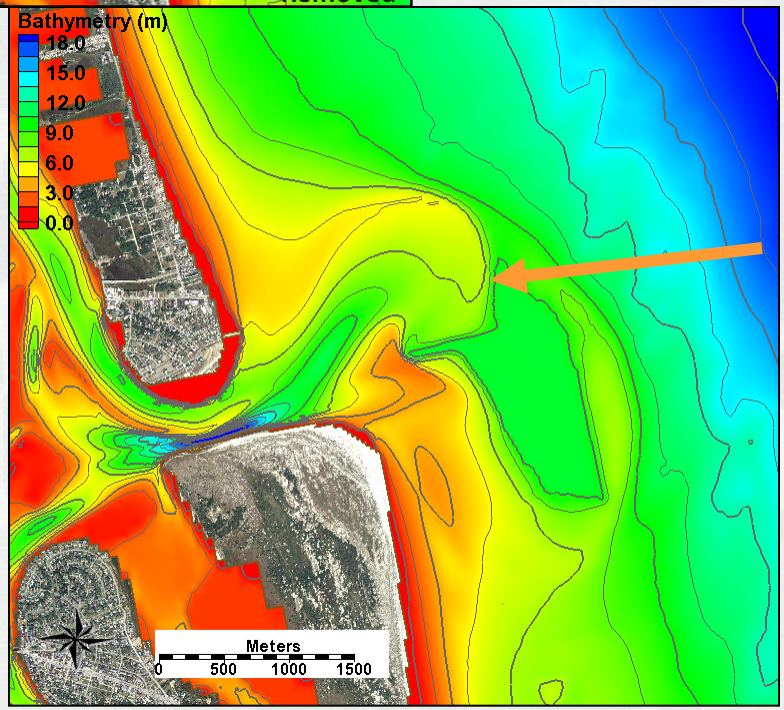


Ebb Delta Mining Alternatives



Ebb Shoal Collapse in the 4.0 MCY Removed Scenario





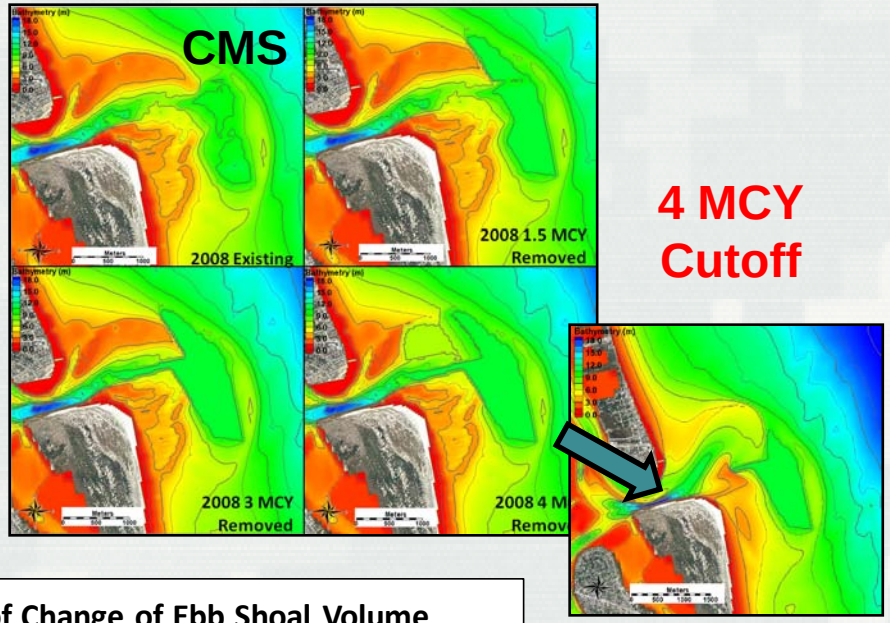
- Certain conditions collapse the active shoal through disruption of natural sand pathways
  - by reducing its depth either through deflation or collapse
  - and/or reducing its planform area

- Functionality of the updrift channel margin shoal is crucial – needed to sustain channelized flow to maintain typical bypassing

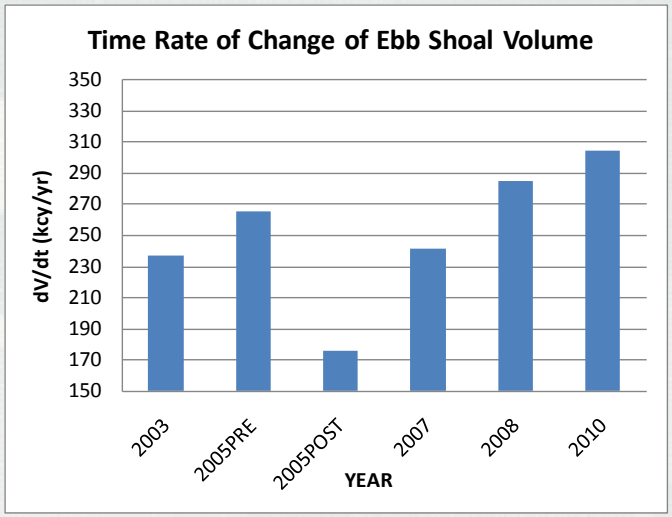
Dredging Boundaries: CMS Results & Historical Data

Ebb Shoal Recovery:

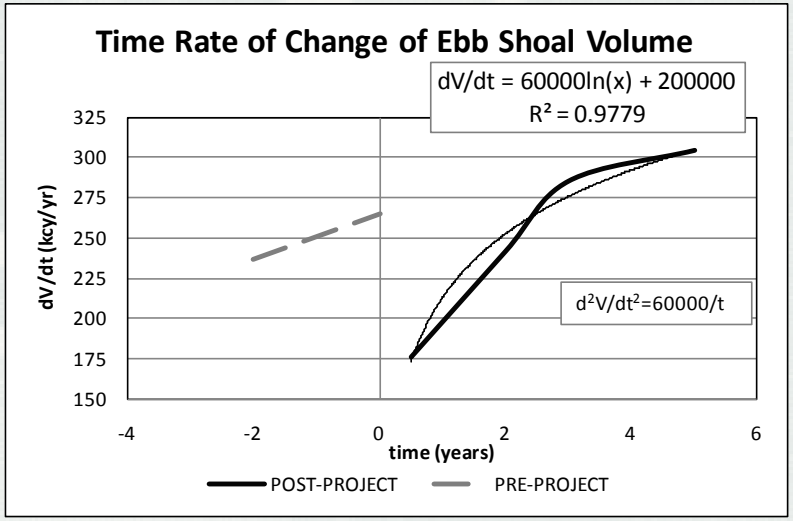
- Cannot remove so much as to force the inlet out of “equilibrium”: <4MCY
- Account for inlet recovery by historical evidence for infilling: Rate of volume change (growth) determined from 2001-03 and 2005 mining events



4 MCY Cutoff

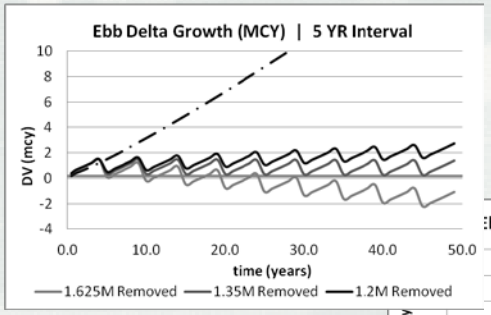


Legault et al., 2012

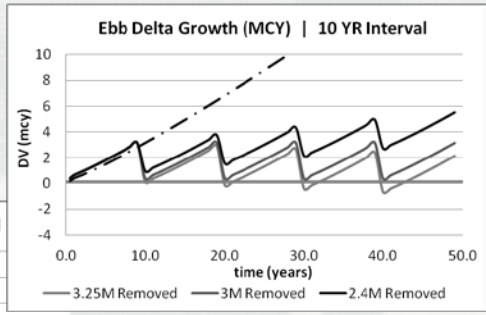


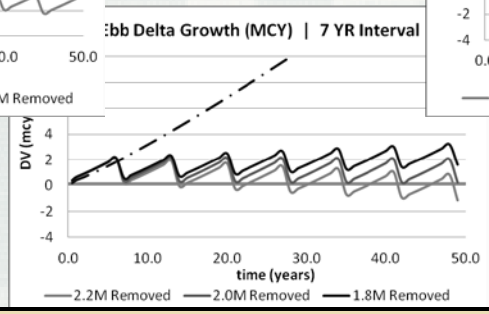
Beck and Legault, 2012

Defining Dredging Interval Alternatives for 50-YR Planning Horizon



Legault et al., 2012

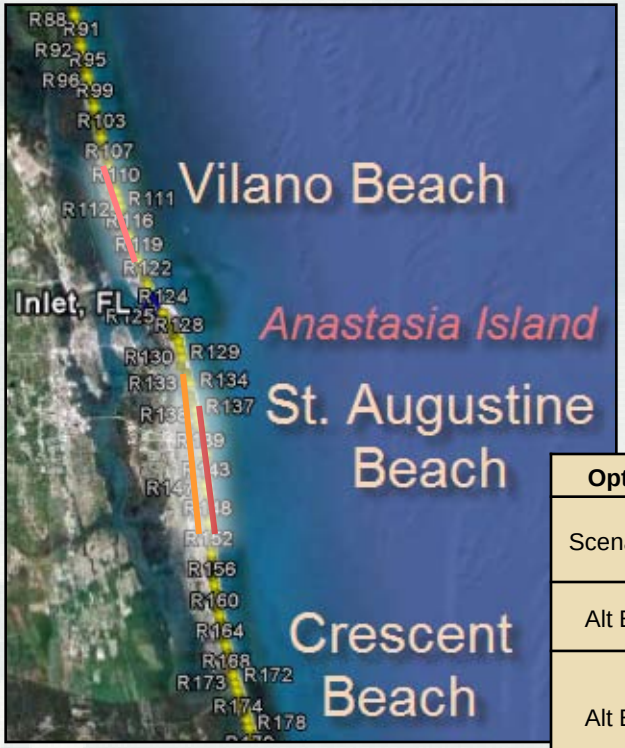




Dredging intensity scenarios considering equal or accretional status of the ebb-tidal delta.

Scenario	Dredged Volume	Dredging Interval	Beach Placement Volume	Beach Placement Location & Length
Alt A1	1.0 MCY	5 Years	1.0 MCY	T137a – R151 (15,000 lft)
Alt A2	1.35 MCY	5 Years	1.35 MCY	T137a – R151 (15,000 lft)
Alt A3	2.0 MCY	7 Years	2.0 MCY	T137a – R151 (15,000 lft)
Alt A4	3.0 MCY	10 Years	3.0 MCY	T137a – R151 (15,000 lft)

Refined Nourishment Intervals for 50-YR Planning Horizon



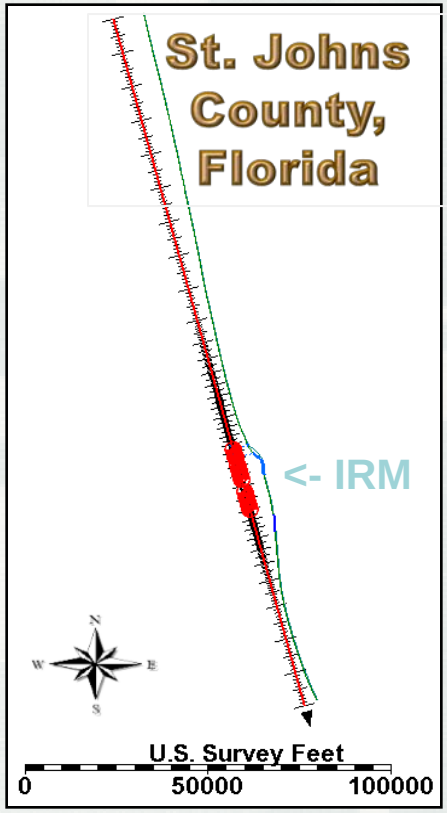
Optimized beach fill placement scenarios following the results of the Alternative A dredging scenarios.

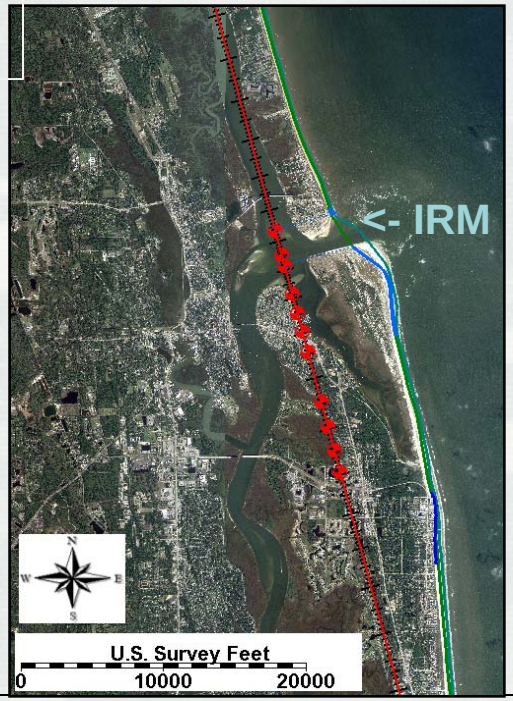
Scenario	Dredged Volume	Dredging Interval	Beach Placement Volume		Beach Placement Location & Length
Alt B1	1.35 MCY	5 Years	1.35 MCY	70 cy/lft	T132 – R151 (20,000 lft)
Alt B2	1.65 MCY (Includes Vilano Shoal ~300KCY)	5 Years	1.65 MCY	40 cy/lft	R109 – R120 (11,000 lft)
				80 cy/lft	T137a – R151 (15,000 lft)
Alt C1	3.0 MCY	10 Years	3.0 MCY	50 cy/lft	R109 – R120 (11,000 lft)
				125 cy/lft	T132 – R151 (20,000 lft)
Alt C2	3.0 MCY	10 Years	3.0 MCY	100 cy/lft	R109 – R120 (11,000 lft)
				125 cy/lft	T137a – R151 (15,000 lft)

The GenCade Model

GenCade is a one-dimensional (1-D) numerical model that calculates regional coastal change including inlet voumetric evolution.

The model is a combination of Genesis, a shoreline change model designed for project-scale engineering studies, and Cascade, a regional alongshore sediment transport model that includes barrier islands and the inlets that separate them.



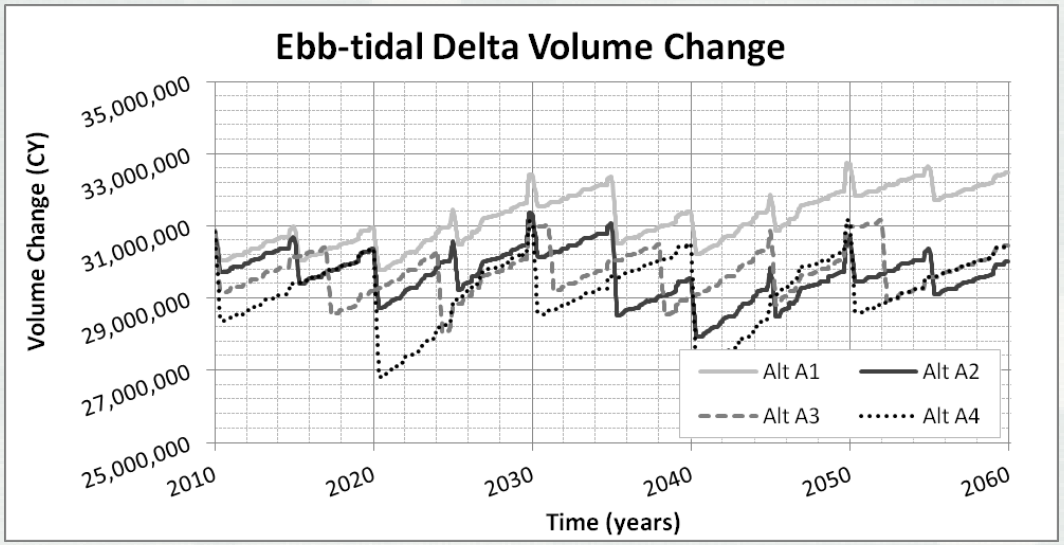


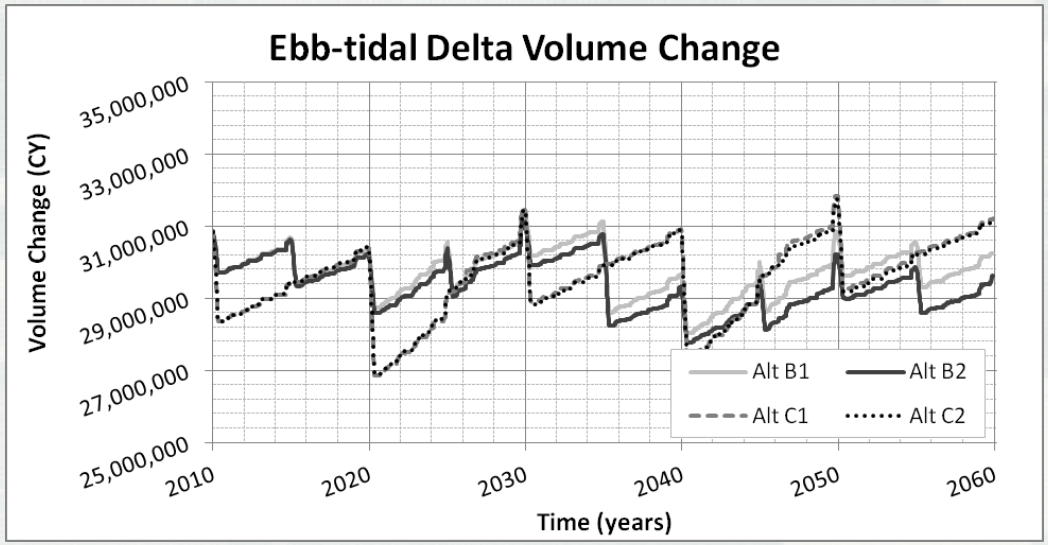
The combination of the two models, with the addition of the Inlet Reservoir Model, which investigates the sediment sinks in inlets, result in a regional model capable of modeling shoreline change at the structure or project level, up to regional distances on the order of hundreds of kilometers.

GenCade Reaches of St. Johns Co., FL (R-Monument Profile Locations)

Location	Reach (R-Mon)
Ponte Vedra Beach	R1 – R109
S. Ponte Vedra & Vilano Beach	R109 – R122
St. Augustine Inlet	Ebb & Flood Tidal Deltas
Anastasia Island Headland	R123 – R128
St. Augustine Beach	R128 – R151
Crescent Beach to Matanzas Inlet	R151 – R195

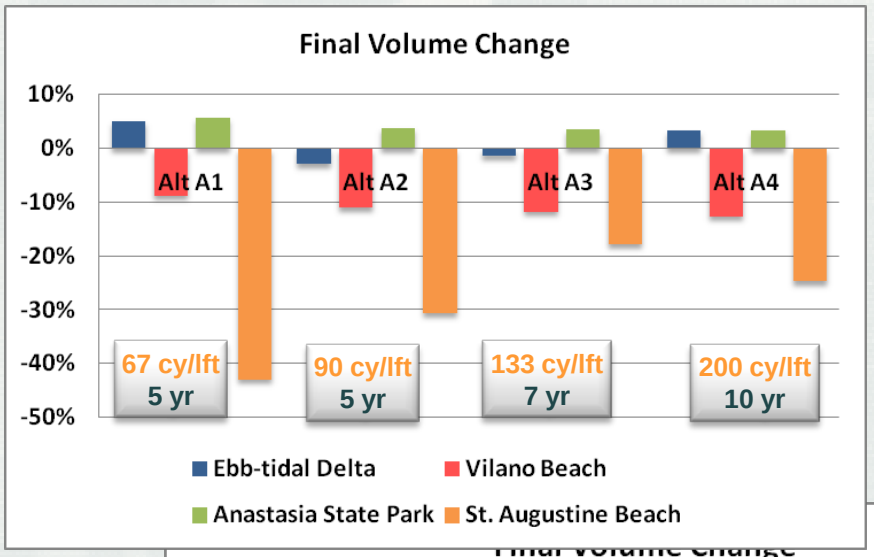
RESULTS: Ebb-Tidal Delta Volume Change for Alternatives

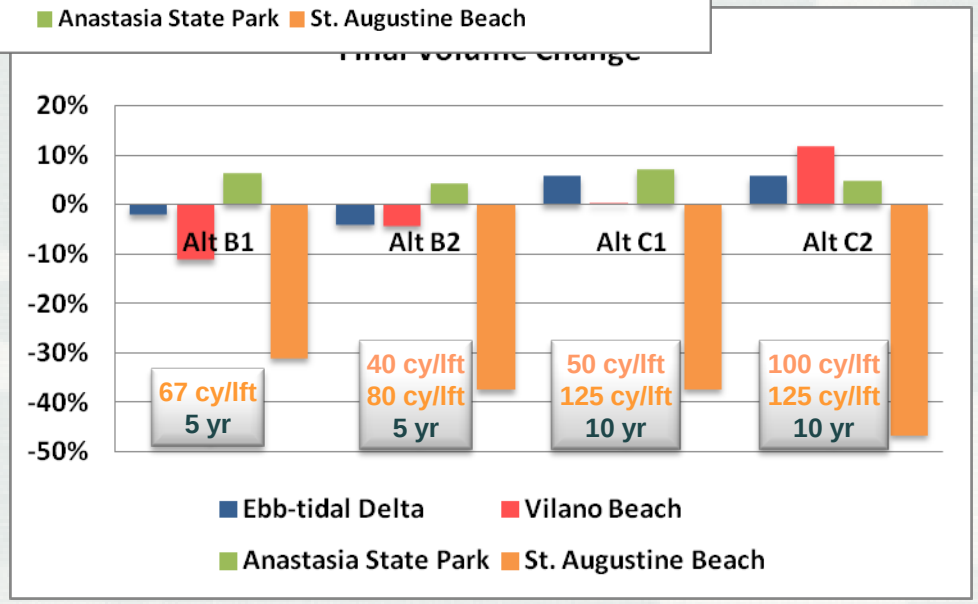




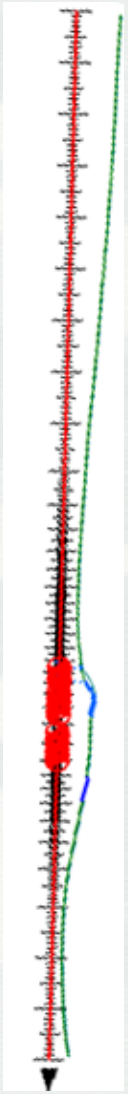
RESULTS: Plotted Shoreline Position on GenCade Grid

Volumetric Results of Alternatives





Summary



- An analysis of the CMS model results determined that dredging scenarios under 4 MCY removed did not significantly modify the ebb-tidal delta through the 1) elevation and planform extent, 2) sediment transport patterns, or 3) volume flux provided to the adjacent beaches.
- The CMS modeling results provided crucial constructive bounds on the optimized scenarios modeled in GenCade.
- The benefits of coordinating and modifying dredging volumes and intervals can be explored in GenCade simultaneously with varying beach fill volumes and intervals to calculate how sediment sources and sinks evolve over time for future sediment budgets.
- An analysis of the GenCade results found that there is not a sustainable dredging amount and interval for St. Augustine Inlet that will meet the beach fill needs of St. Johns County. At least another 1 MCY/YR is necessary to sustain the present SPP.
- The greatest benefit of this methodology is in determining optimal dredging periods and coordinating regional efforts to save in mobilization and demobilization costs for dredging and beach fill placement.

Thank You!

Questions?

Three Part Technical Report Series Published by ERDC/CHL:

Legault K.R. Rosati J.D., Beck T.M., and Engle J. 2012. *St. Johns County, St. Augustine Inlet, FL Report 1: Historical Analysis and Sediment Budget.* **Technical Report ERDC-TR-12-XX, U.S. Army Research and Development Center, Vicksburg, MS.**

Beck, T.M. and Legault K.R. 2012. *St. Augustine Inlet, Florida: Application of the Coastal Modeling System, Report 2.* **Technical Report ERDC-TR-12-XX, U.S. Army Research and Development Center, Vicksburg, MS.**

Beck, T.M. and Legault K.R. 2012. *Optimization of Ebb Shoal Mining and Beach Nourishment at St. Johns County, St. Augustine Inlet, FL, Report 3*. **Technical Report ERDC-TR-12-XX, U.S. Army Research and Development Center, Vicksburg, MS.**