

*ICCE '18 – Baltimore MD USA*

*Session: Beach Nourishment Projects*

*Tuesday – 31 July - 4:30-4:50 pm*

# *Five Key Elements For A Sustainable Beach Nourishment Program*

*Tim Kana PhD PG*

*Haiqing Liu Kaczkowski PhD PE*

*Steven B Traynum MS*

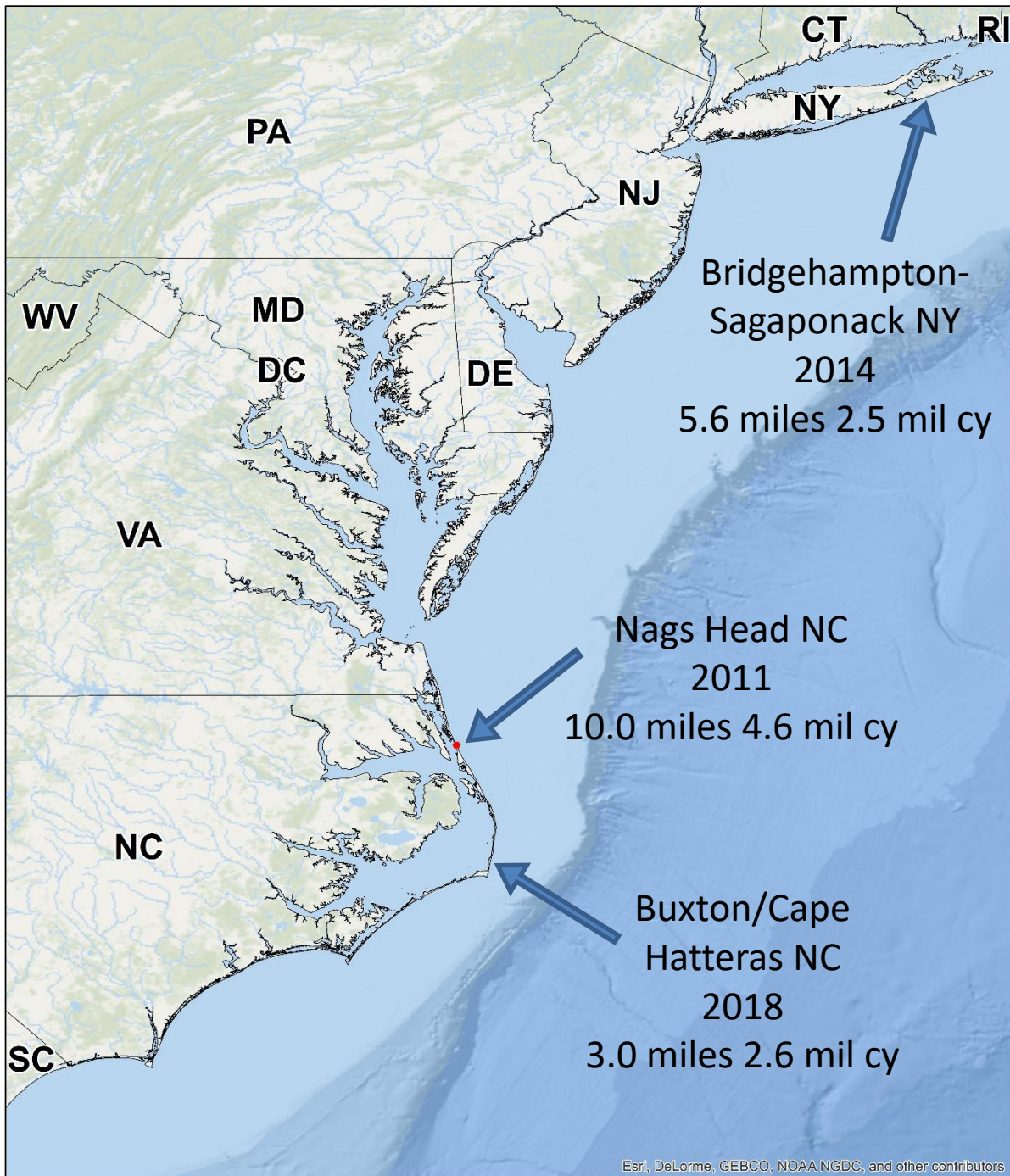
*Based on Chap 38 in:*

Young Y Kim (ed) **Handbook of Coastal Engineering – 2<sup>nd</sup> Edition**

World Scientific Singapore



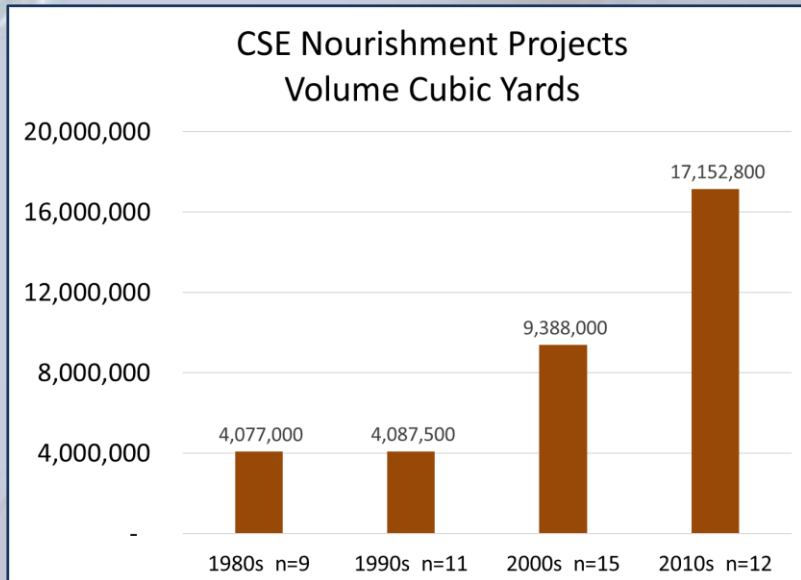
COASTAL SCIENCE & ENGINEERING



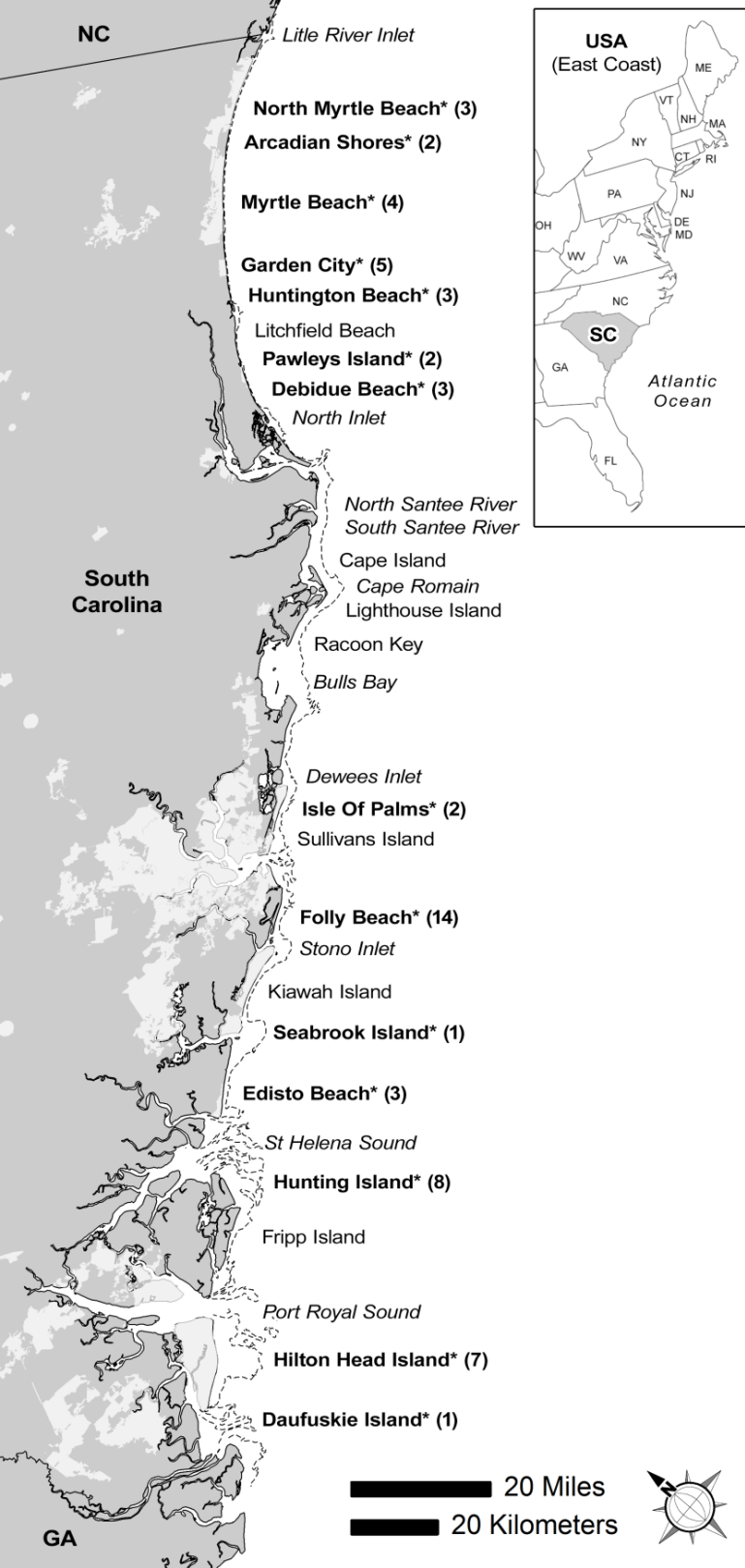
0 25 50 100 Miles  
0 25 50 100 Kilometers

# Outline

- Motivation
- Five Key Design Elements
  - Shoreline Inventory
  - Erosion Database
  - Conceptual Geomorphic Models
  - Target Beach Condition
  - Identify Borrow Area
- Sustainability







# South Carolina USA

307 km Sandy Coast

35 Tidal Inlets

52% Developed and Managed

33% Nourished 1954 to Present

**1980-2010**

30.1 million m<sup>3</sup>

Nourishment Volume

Source: Kana 2012 Shore & Beach

# Importance of Preliminary Design

Build on Prior Knowledge

Rapidly Quantify the Problem

Establish a Project Scope and Scale

Provide a Realistic Budget to the Client

Formulations “Locked In” at Time of Permitting

An aerial photograph of a coastal region. A large river or estuary flows from the top left towards the bottom right, branching into several smaller channels. The surrounding land is a mix of green and brown, indicating vegetation and possibly agricultural or natural land. The water is a light blue-grey color. The text "Key Design Element #1" is overlaid in the upper half of the image.

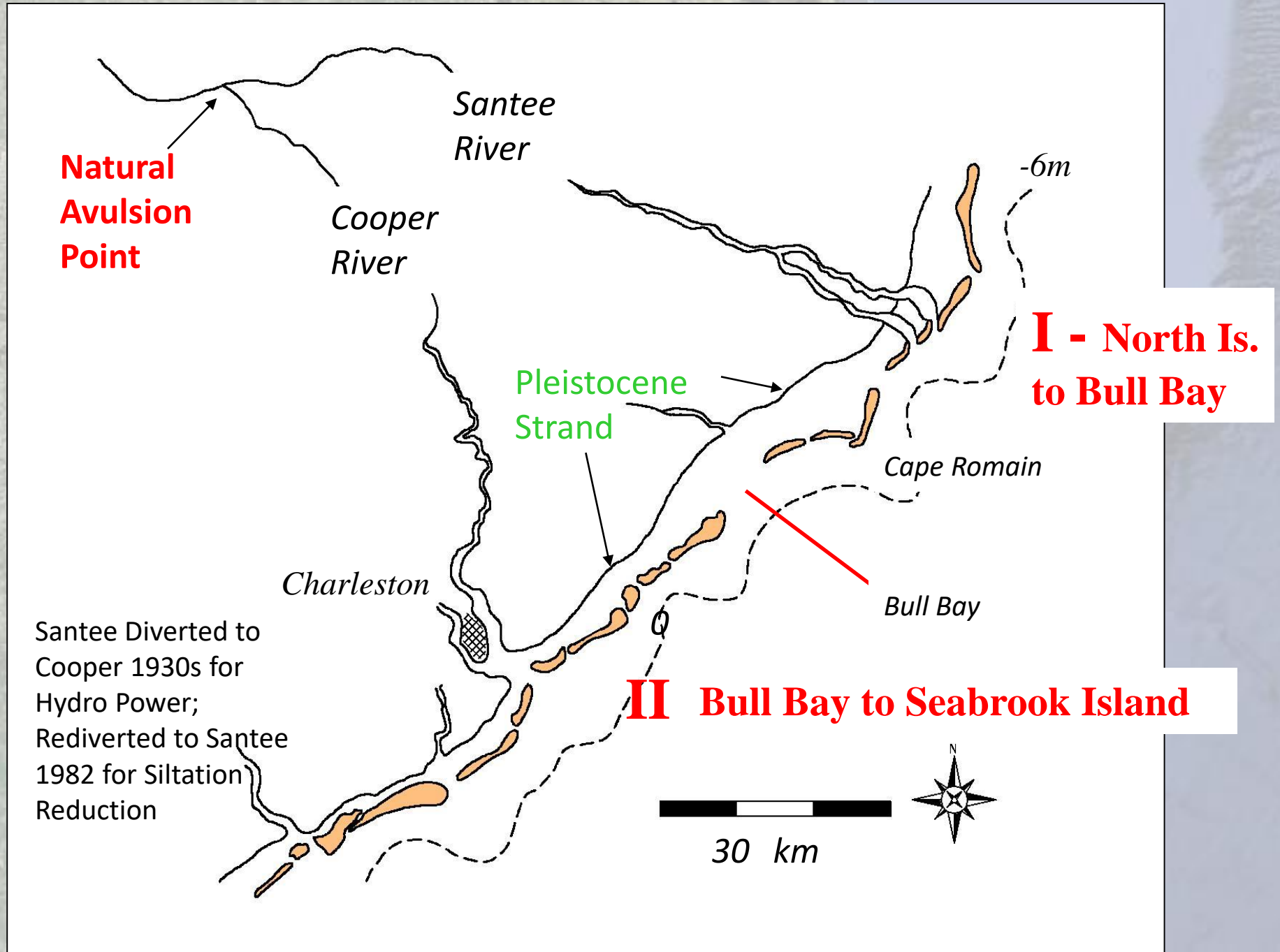
Key Design Element #1

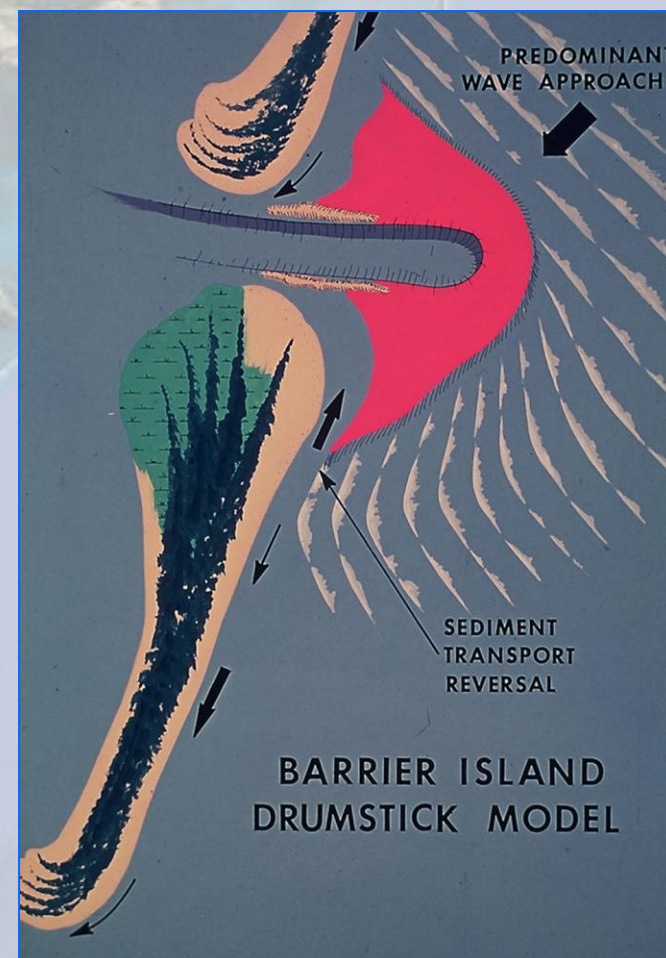
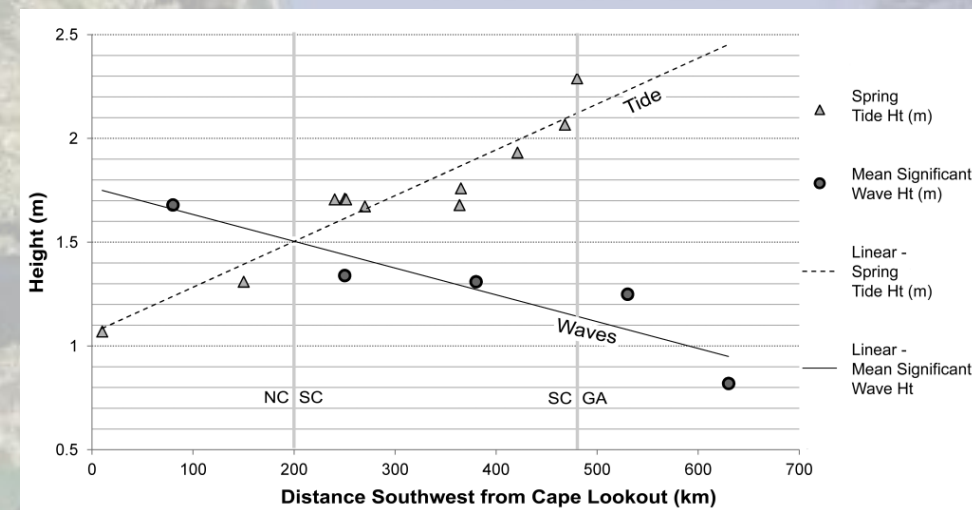
# **Shoreline Inventory**



# South Carolina Holocene Barrier Island Systems – Santee & Cooper River Basins

Mega Scale Geologic Controls & Sediment Sources

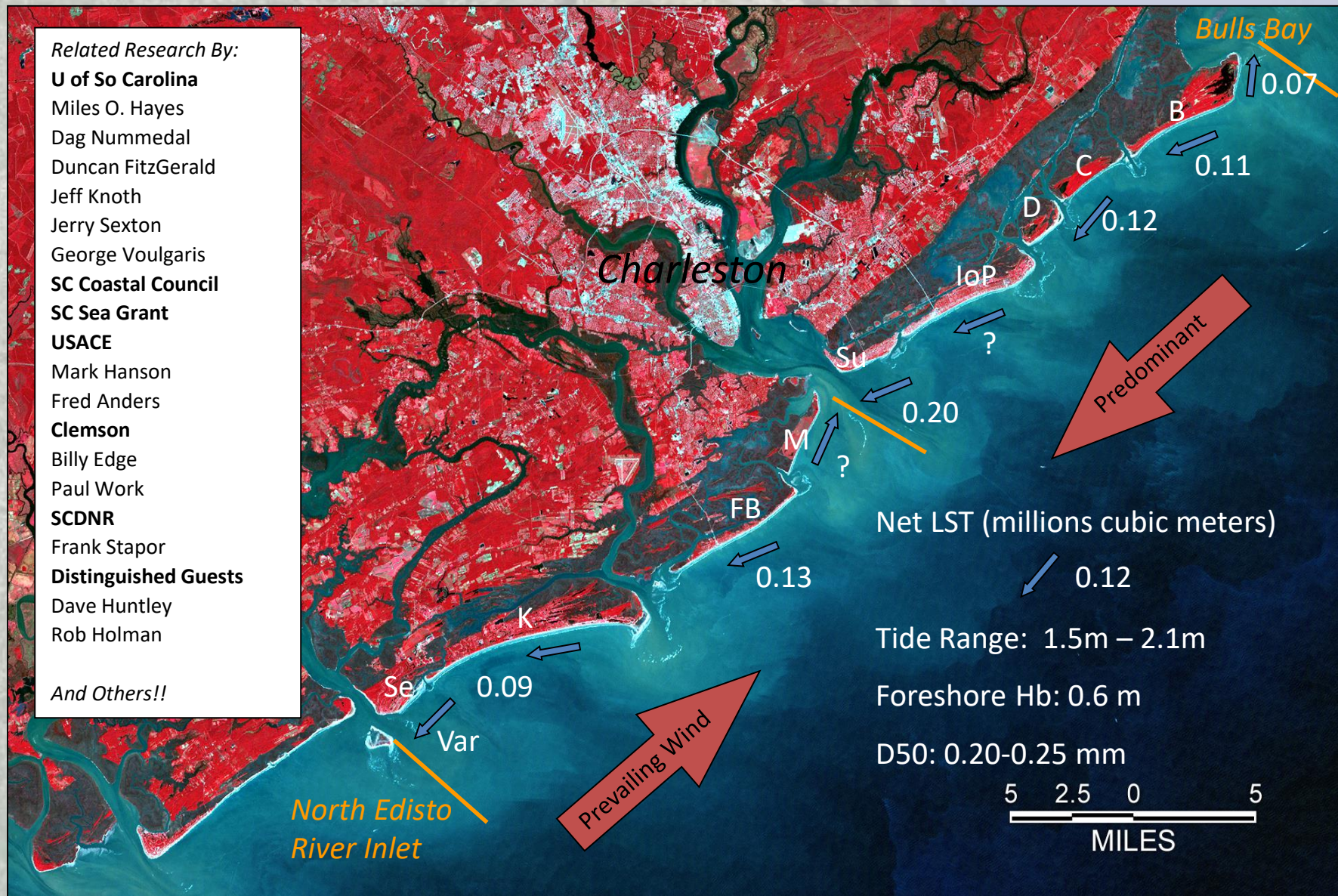




After Hayes 1976



# Net Longshore Transport Directions & Rates (in Millions $\text{m}^3/\text{yr}$ )



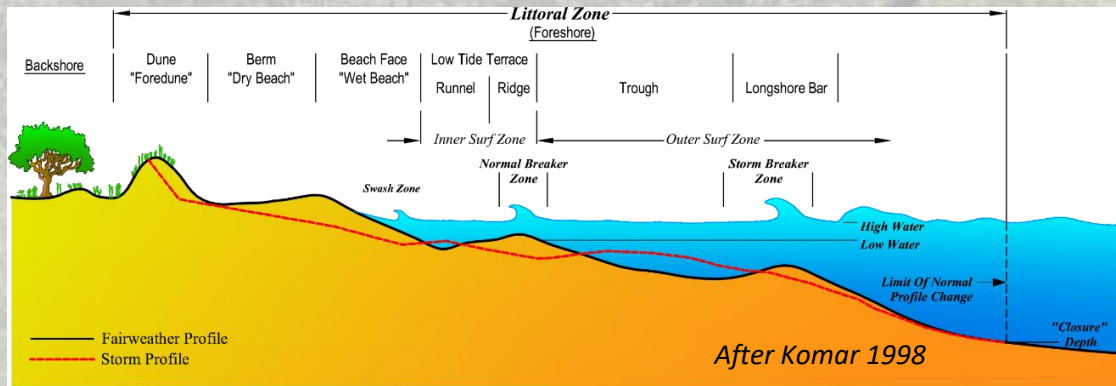


An aerial photograph of a coastal region, likely a river delta, showing a complex network of waterways and land. The land is a mix of green and brown, indicating vegetation and bare earth or agriculture. The water is a light blue-grey color. The text is overlaid on the upper half of the image.

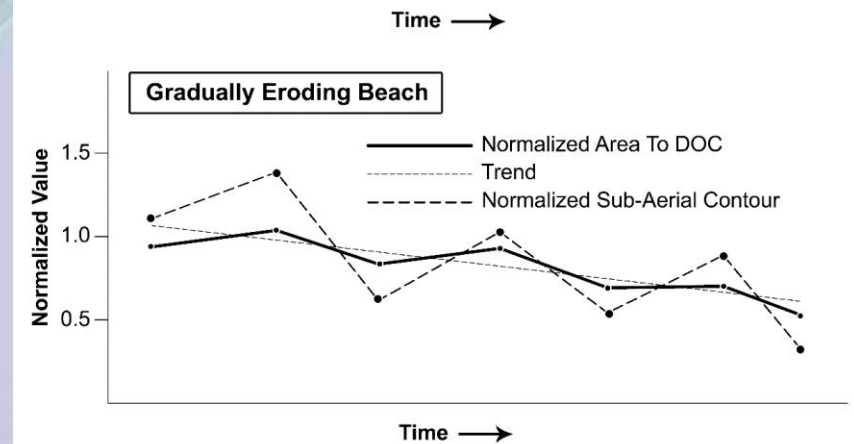
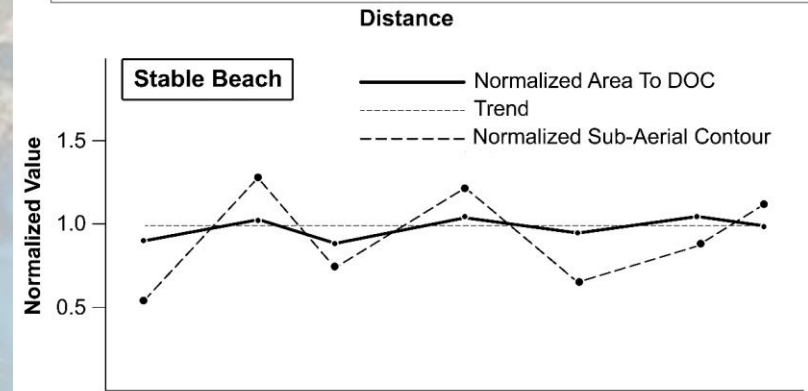
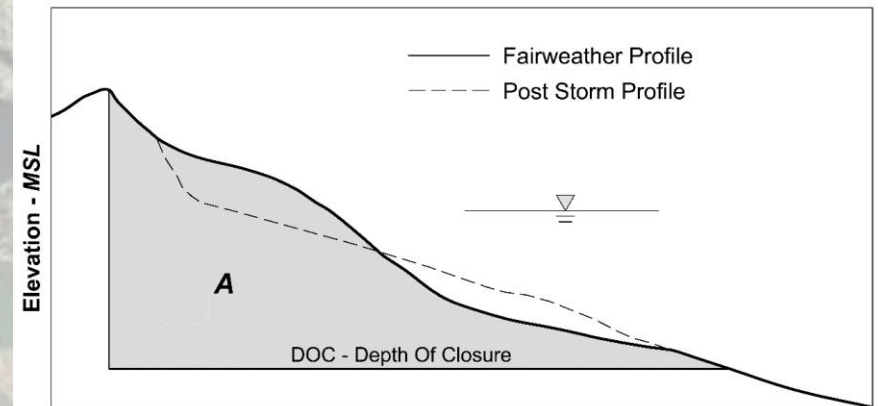
**Key Design Element #2**

**Erosion Database**

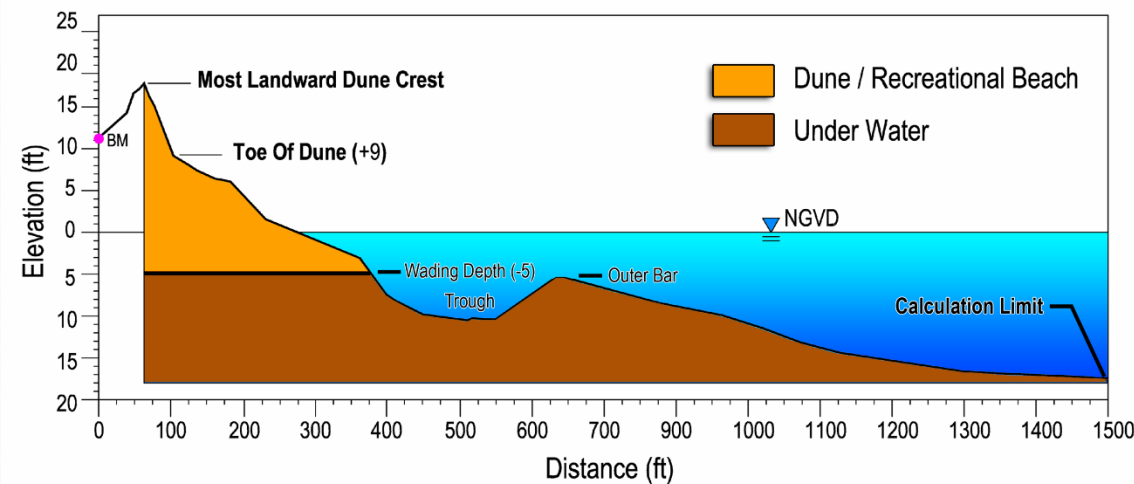
# 1980s – Before reliable beach surveys to closure...



- Beach Cycle – Winter-Summer/Storm-Post-Storm
- Linear vs Volumetric Measures
- Subaerial Surveys vs Profiling to DOC

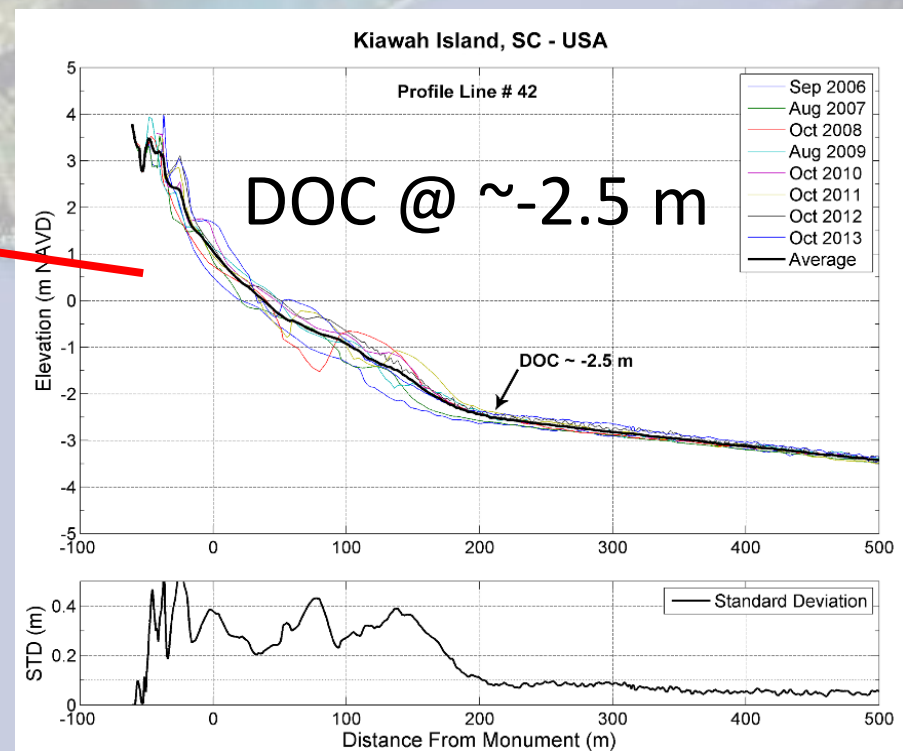
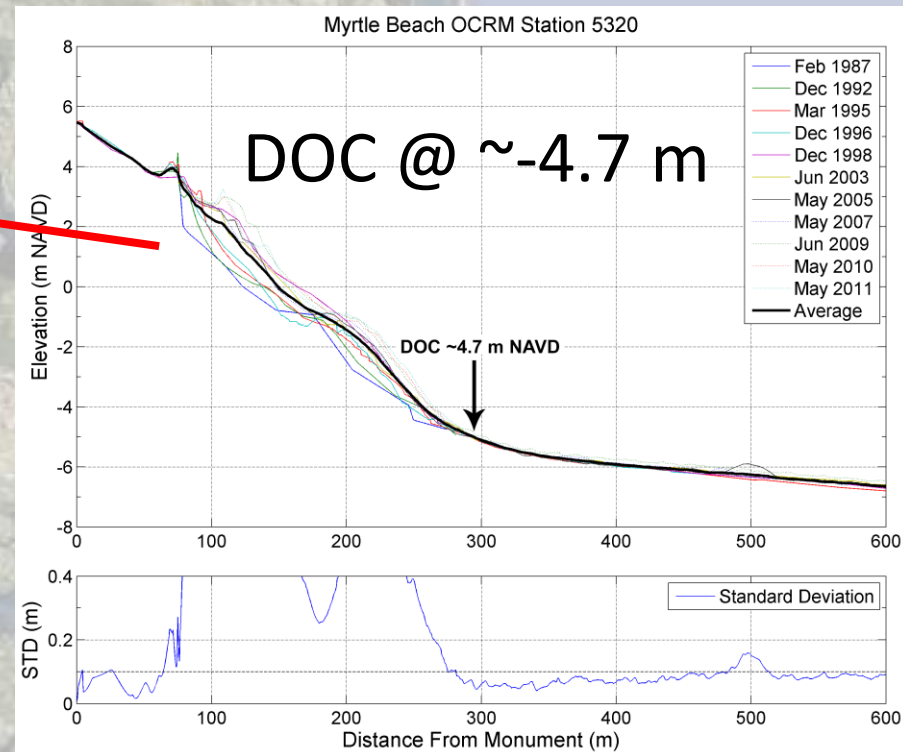
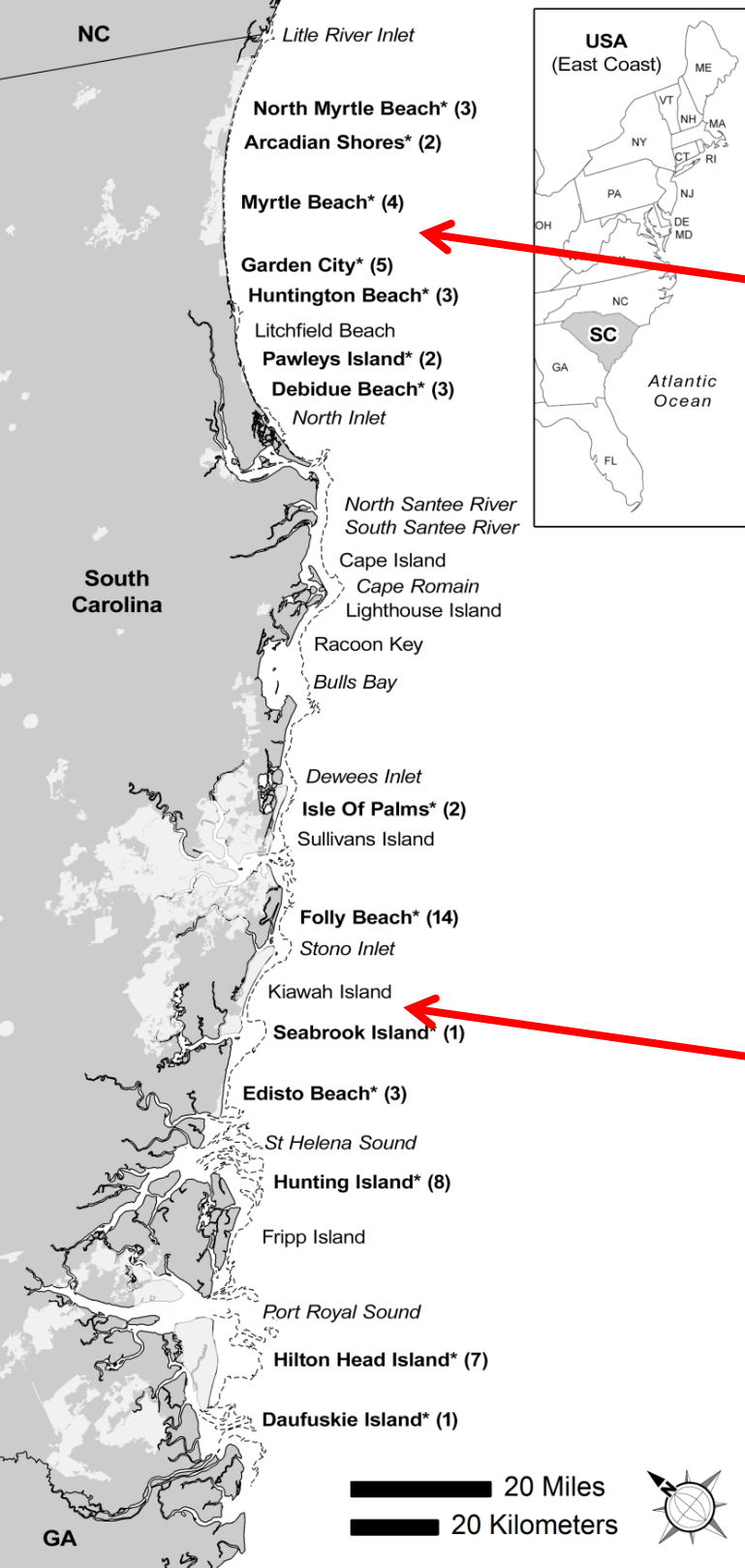


PROFILE VOLUME ANALYSIS - CALCULATION LENSES



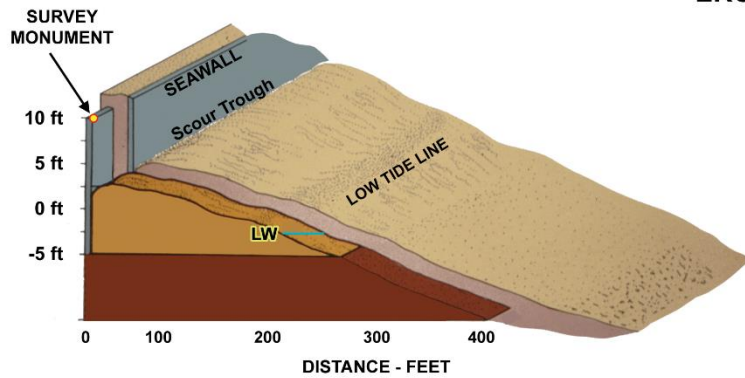


# Determine Littoral Boundaries

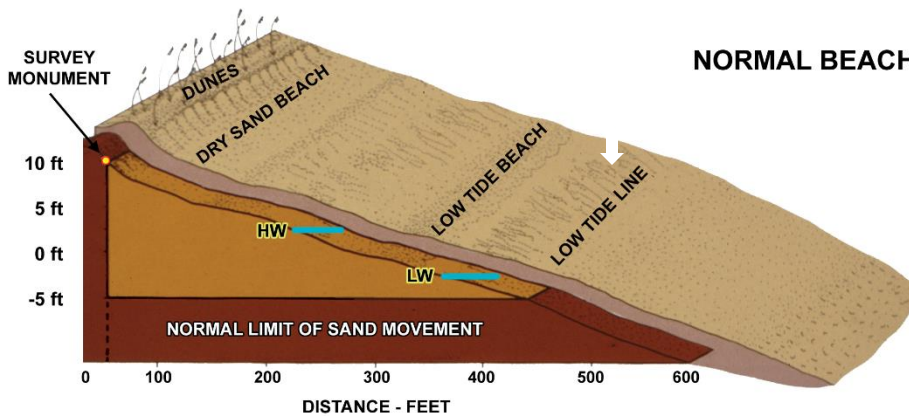


# Beach Condition as Measured by Unit Profile Volumes

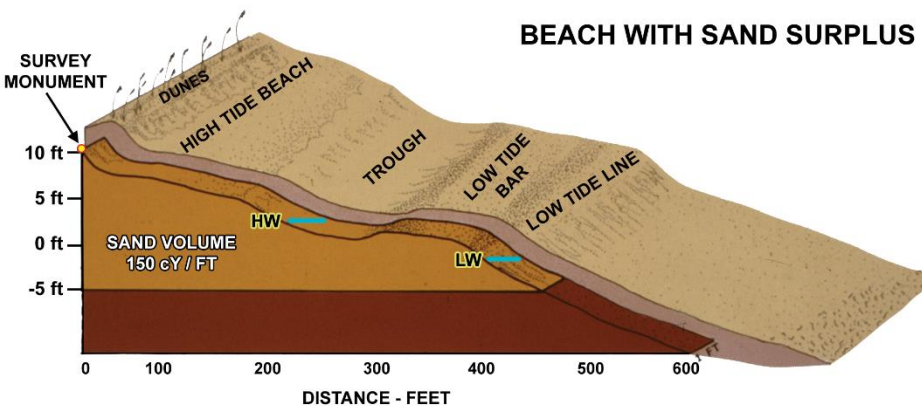
ERODED BEACH



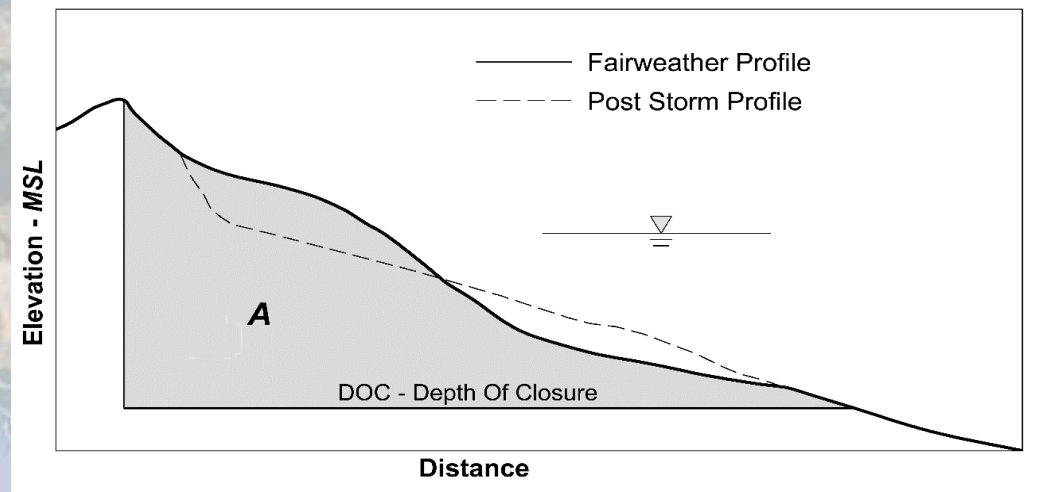
NORMAL BEACH



BEACH WITH SAND SURPLUS



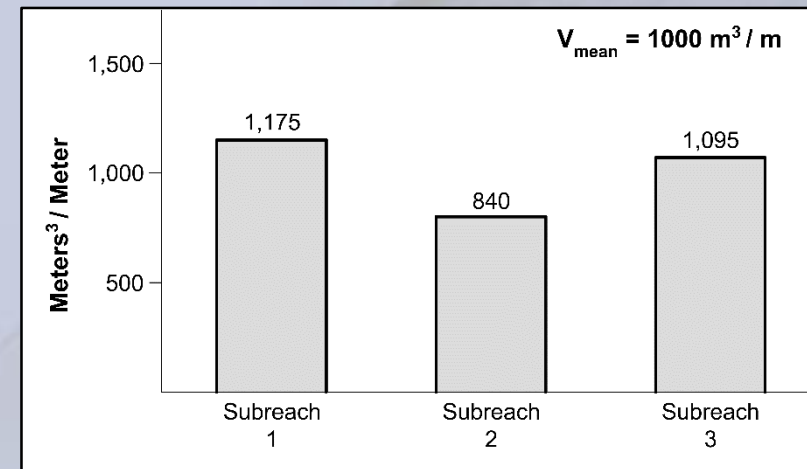
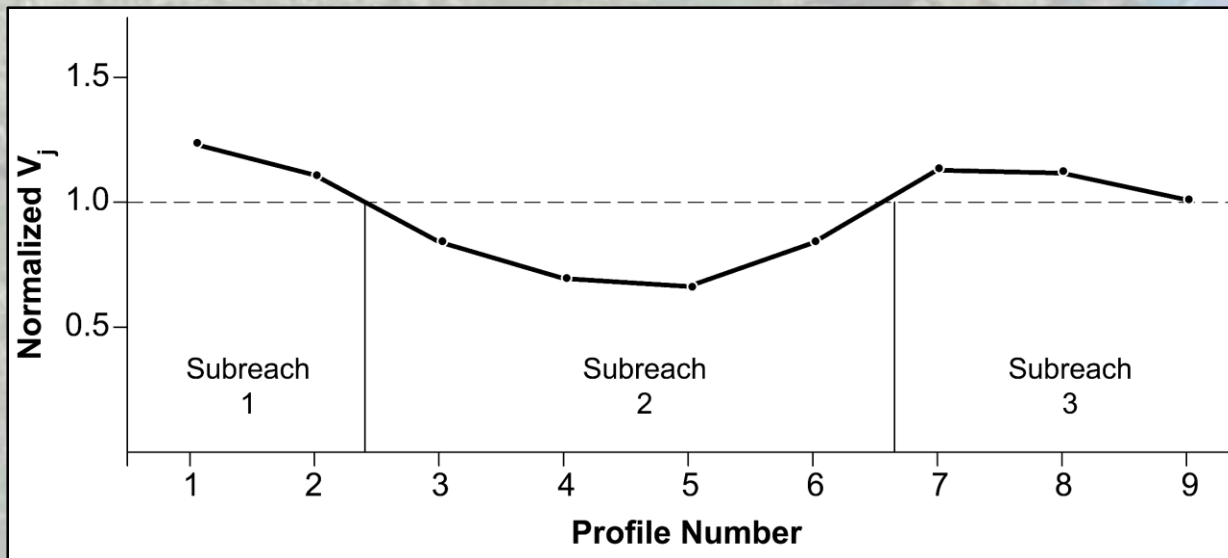
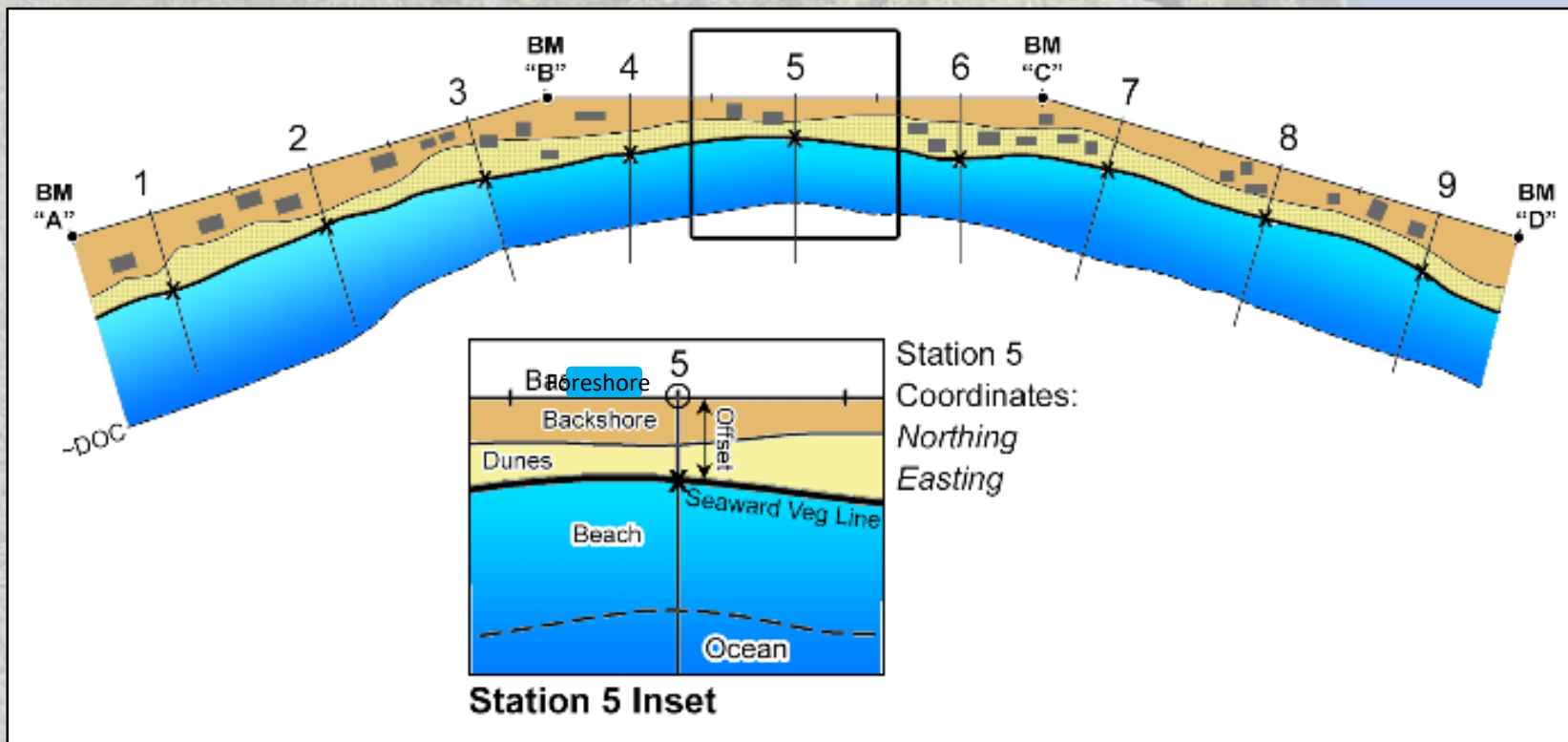
Convert Unit Area,  $A$ , to Unit Volume to DOC,  $V_e$ , for a simple measure of profile condition – irrespective of beach stage



After Kana 1993



# Determining Site Specific Sand Deficits

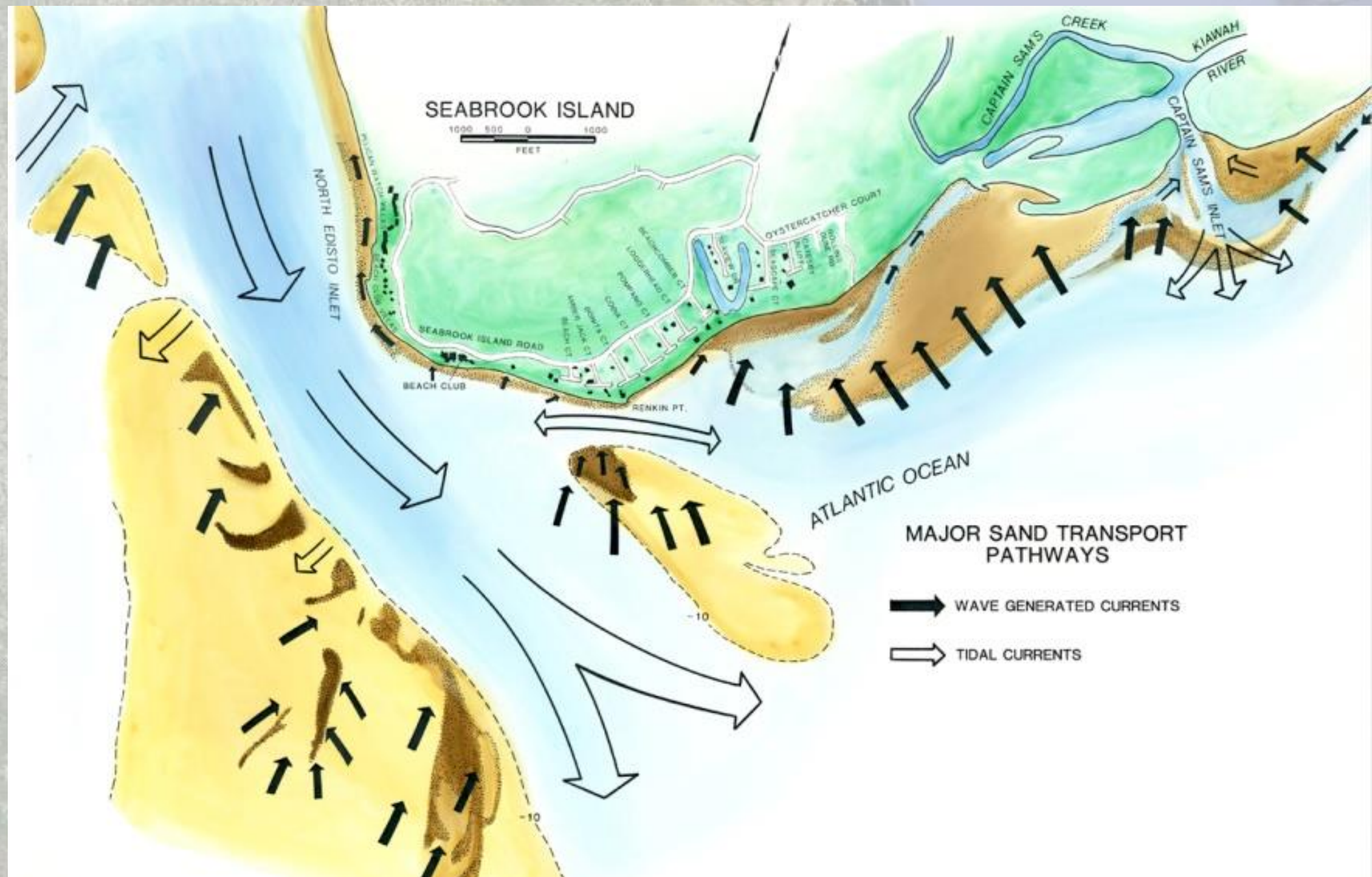


An aerial photograph of a coastal region, likely a river delta, showing a complex network of waterways and land. The land is a mix of green and brown, indicating vegetation and bare earth or agriculture. The water is a light blue-grey color. The overall shape of the land area is somewhat triangular, with the river entering from the top and spreading out towards the bottom right.

Key Design Element #3

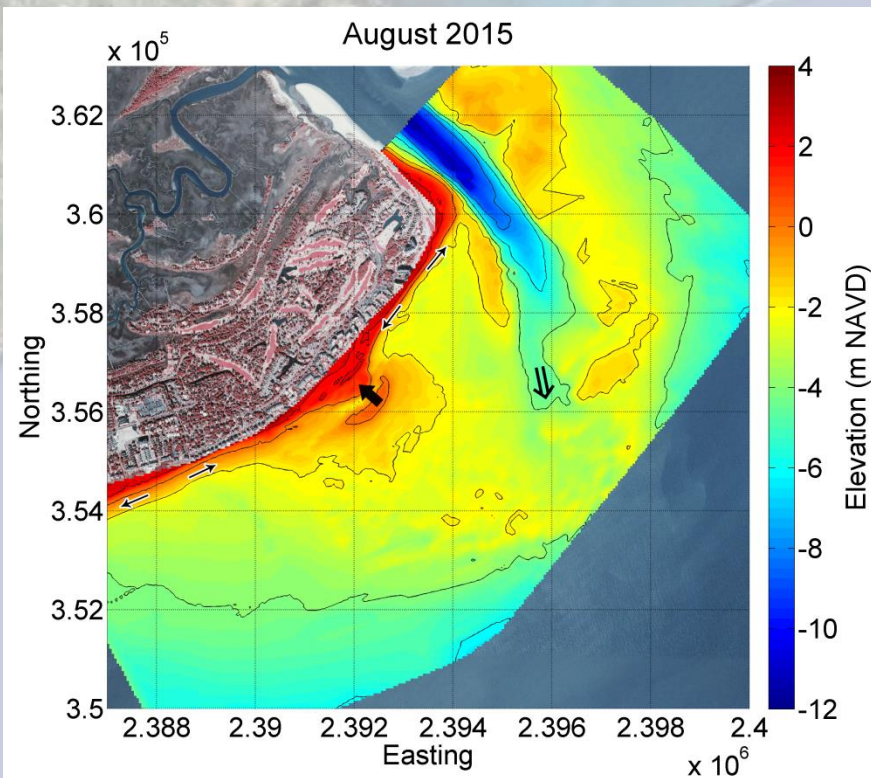
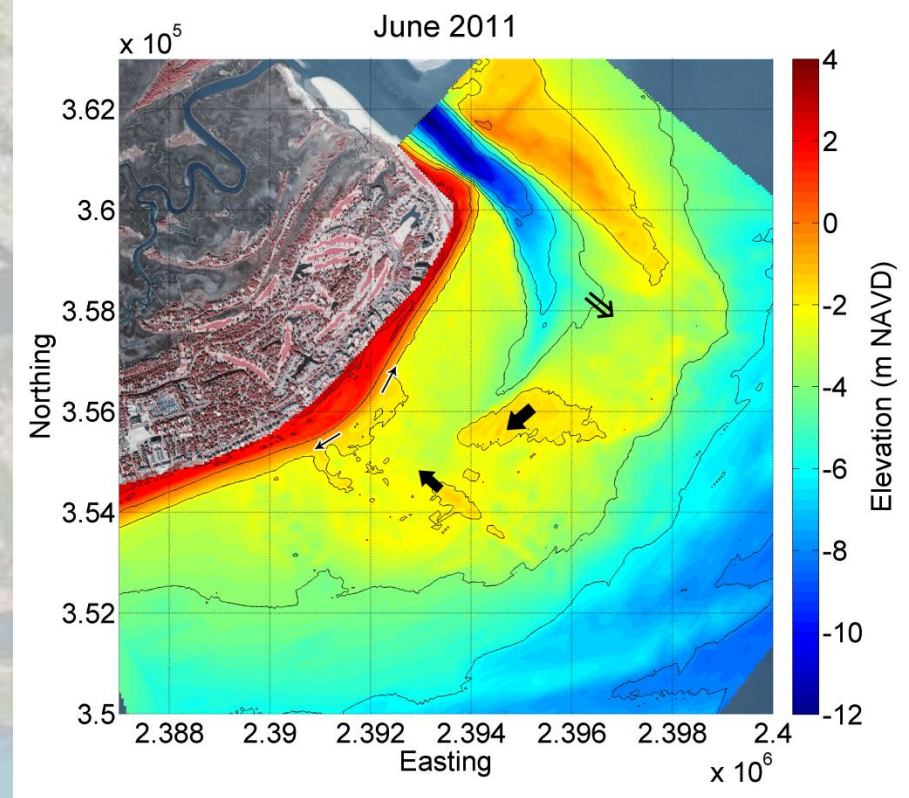
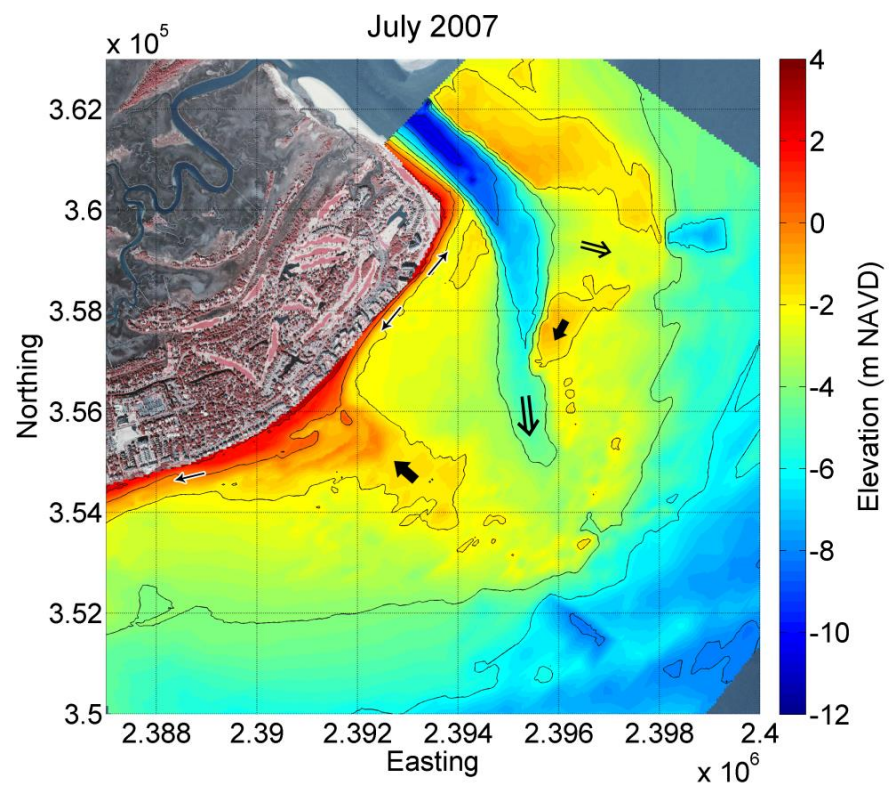
# **Geomorphic Models of Controlling Processes**





After CSE 1984





Deweese Inlet SC  
Steven Traynum

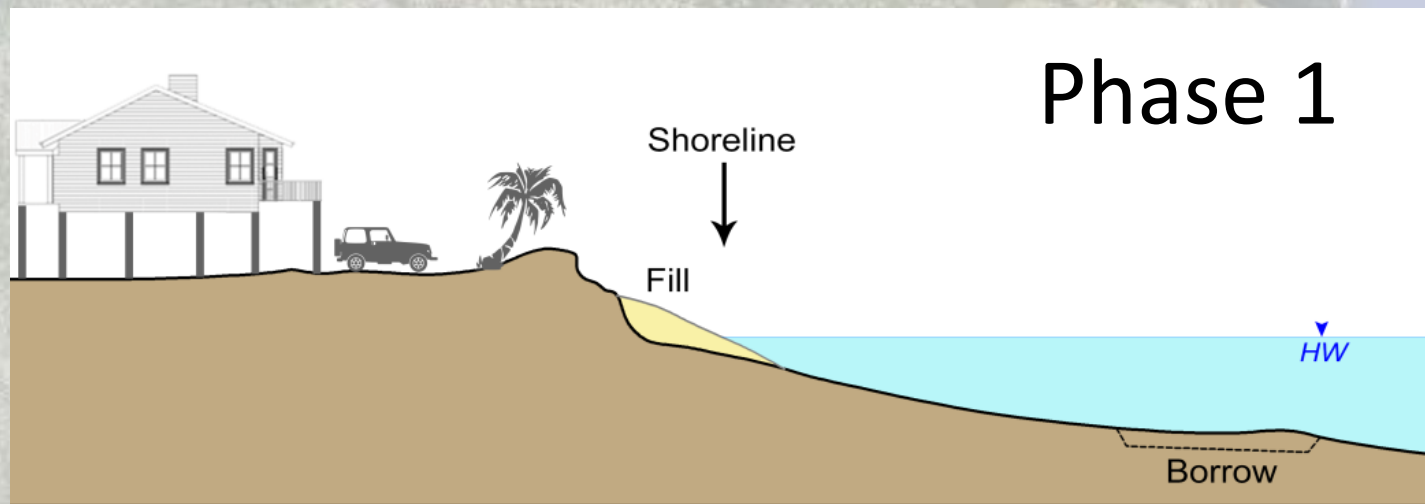
Decadal-scale  
Surveys  
Particularly  
Around Inlet  
Deltas



An aerial photograph of a coastal region, likely a delta or estuary, showing a network of waterways and wetlands. The land is a mix of green and brown, indicating vegetation and bare earth or marsh. The water is a light blue-grey color. The coastline is irregular, with several inlets and peninsulas.

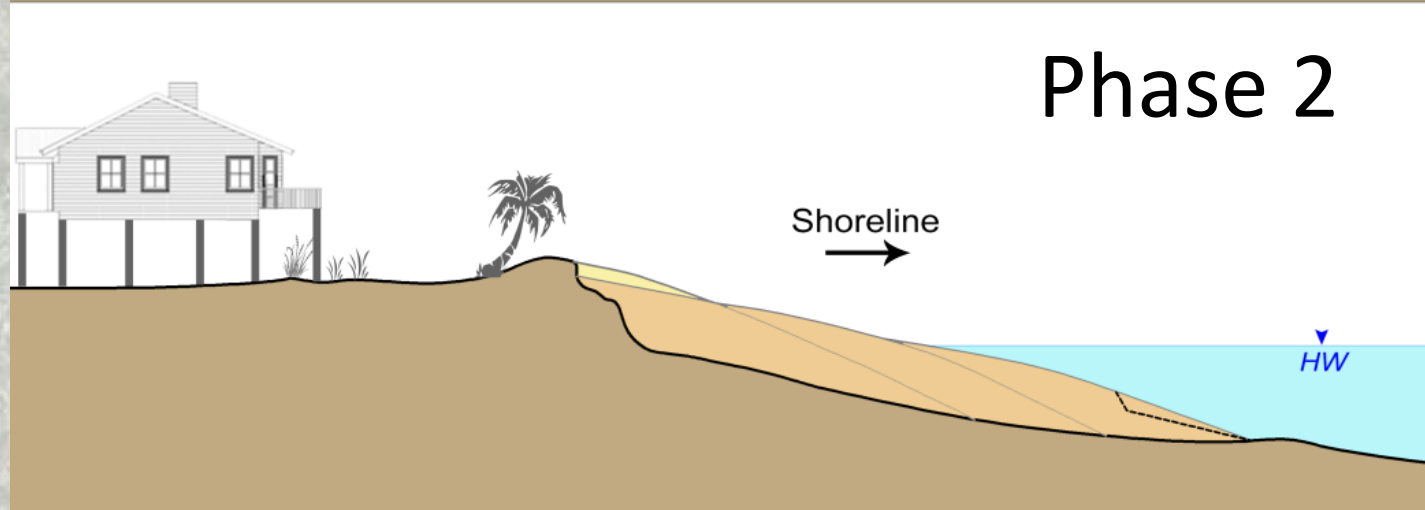
Key Design Element #4

**Define A Target Beach  
Condition**

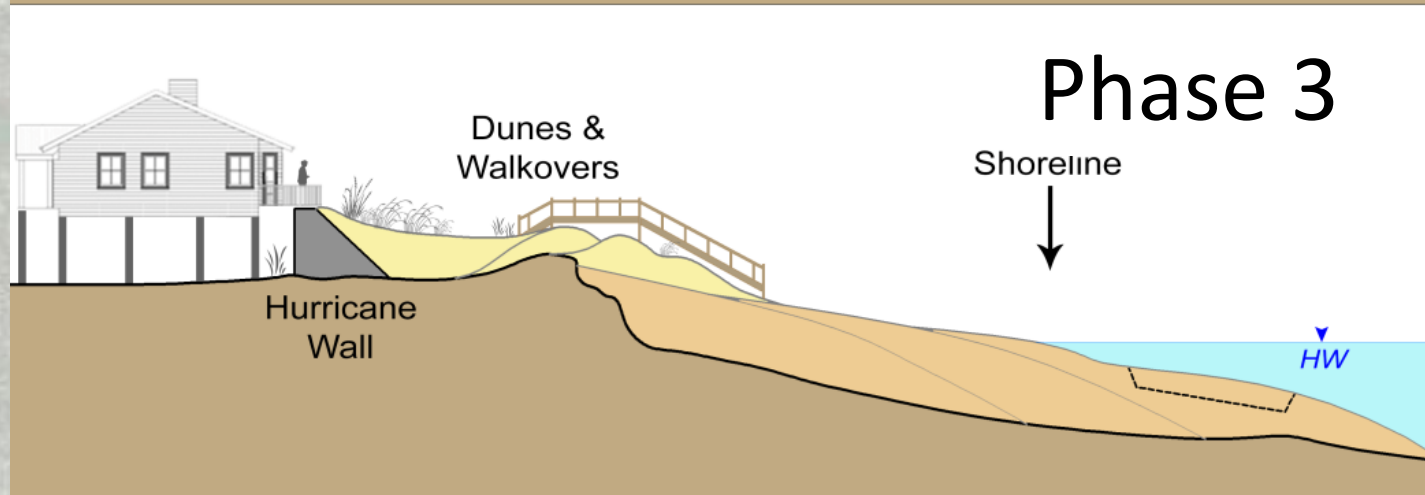


Performance  
( $f$  Volume)

\$/m



\$\$/m



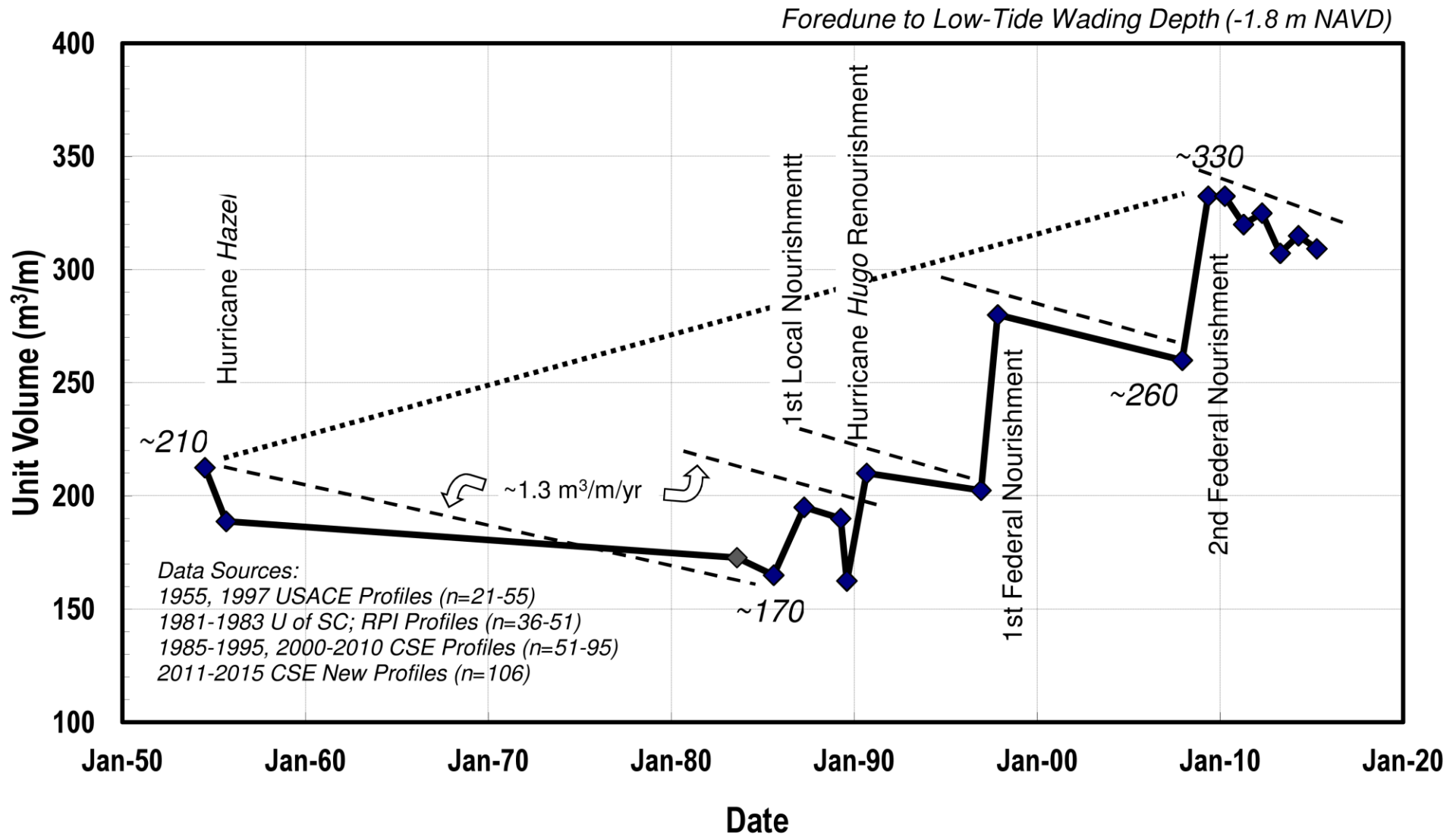
\$\$\$ /m

After CSE 1984



# Sustained Increase in Beach Volume Four Nourishment Events over 30 years

**Average Unit Beach Volume 1954–Present  
Myrtle Beach SC - 14.9 km**



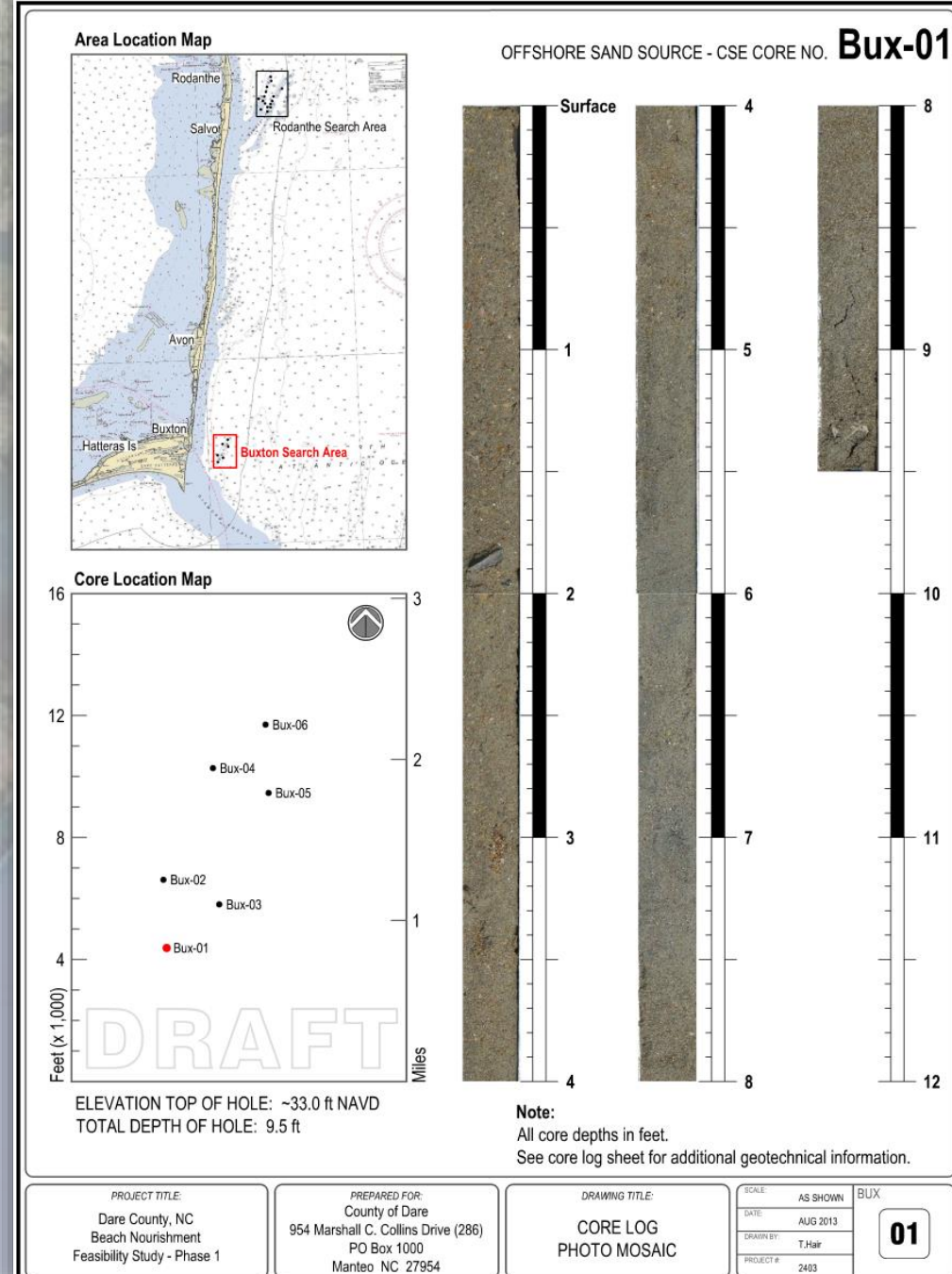
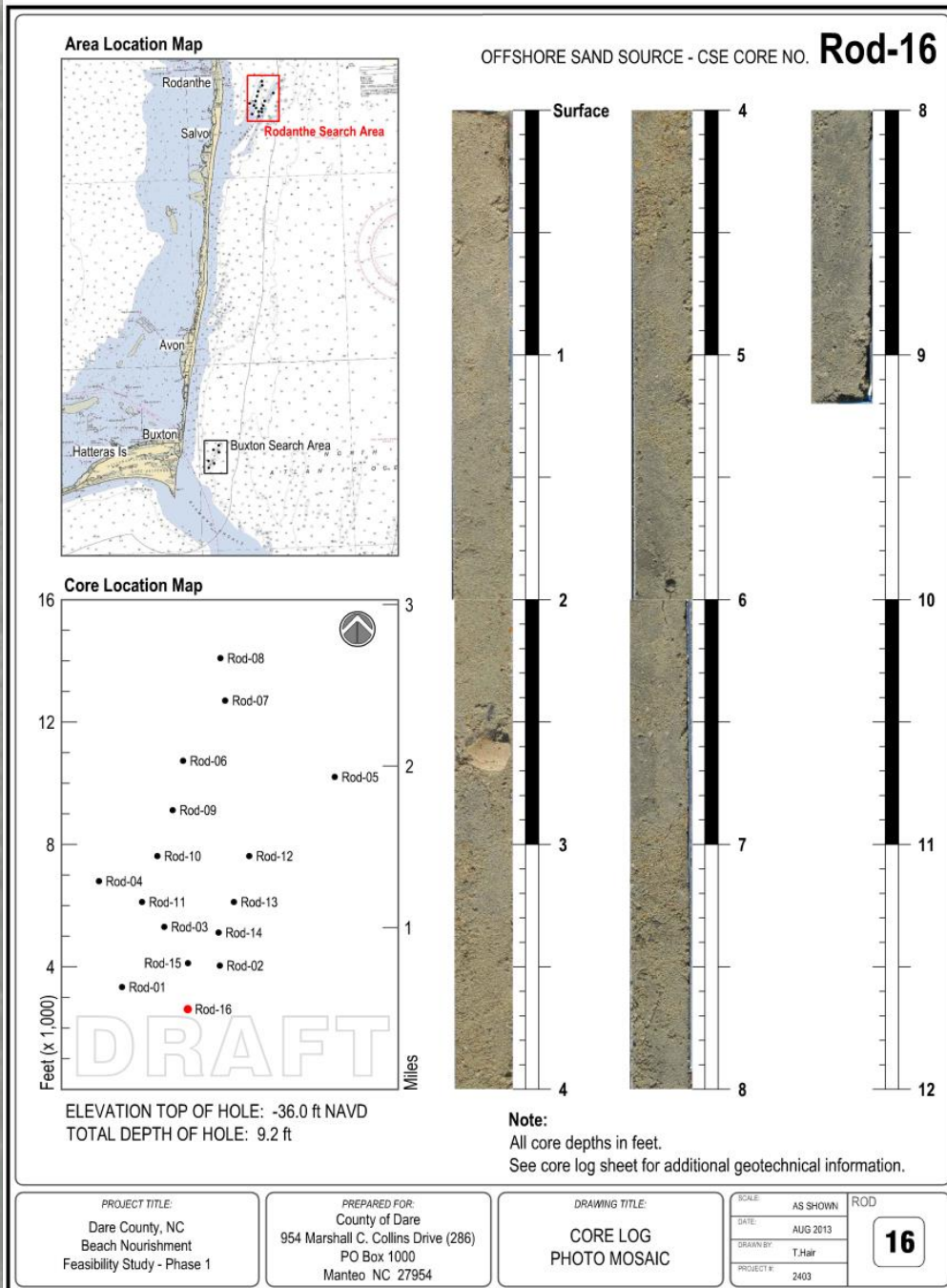
An aerial photograph of a coastal region, likely a delta or estuary. A river or large waterway flows from the top center towards the bottom right, branching into smaller channels. The surrounding land is a mix of green (vegetation) and brown/tan (possibly bare earth or marshland). The water is a light blue-grey color. The text is overlaid on the upper half of the image.

# Key Design Element #5

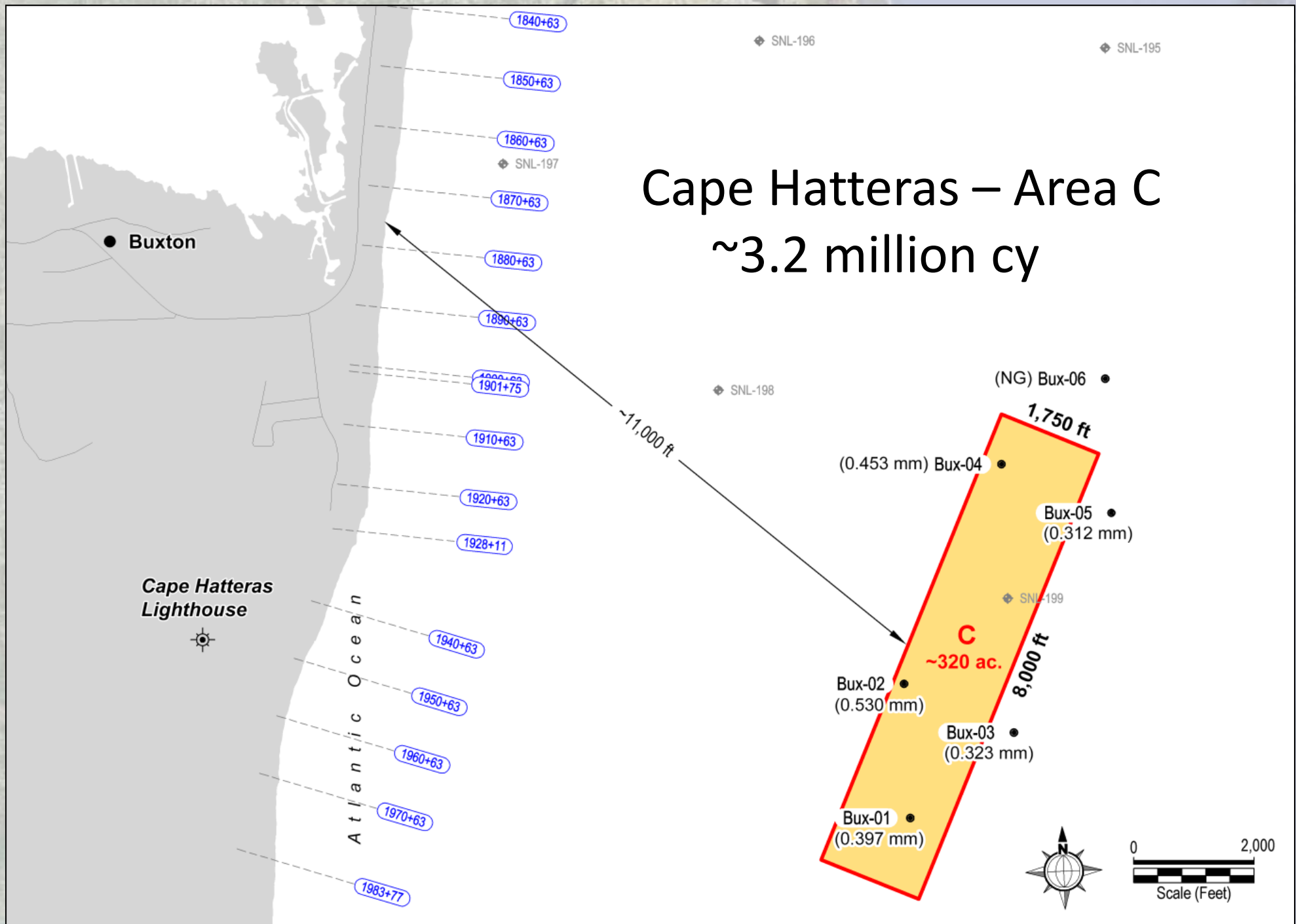
## **Identify Borrow Site**



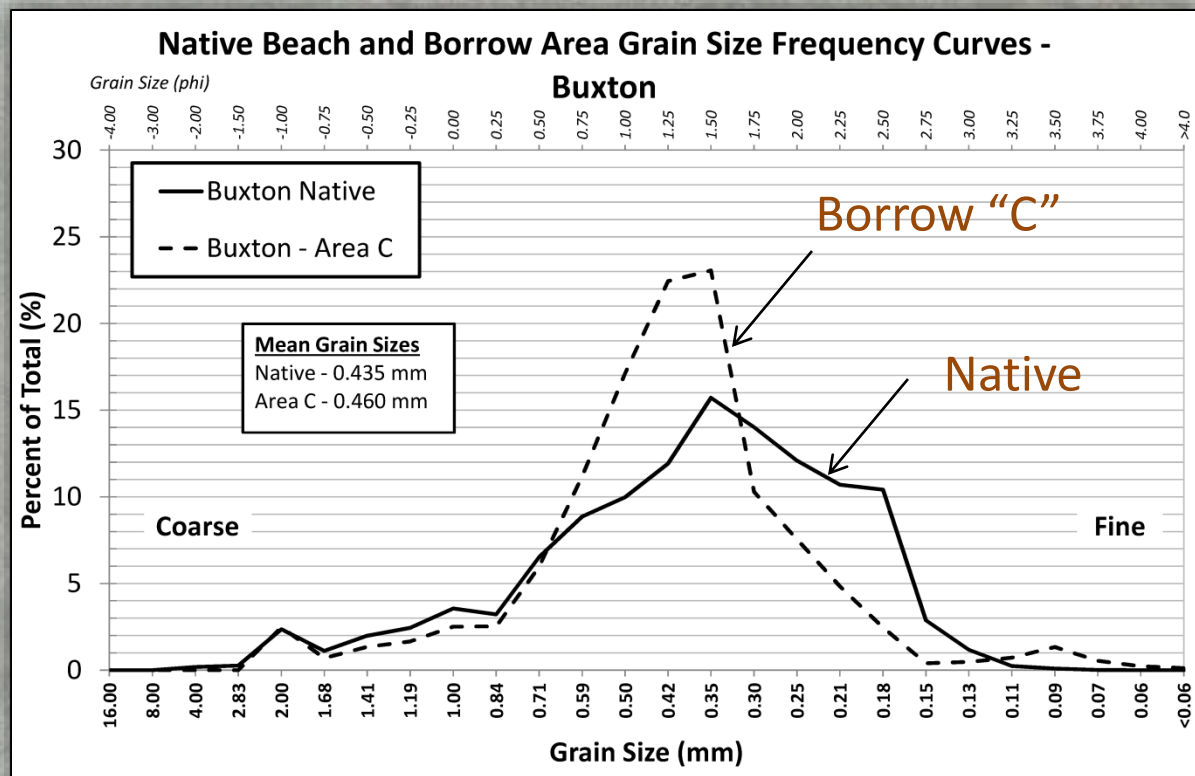
# Sand Search & Confirmation Outer Banks - Cores ~ 8 ft long



# Phase 1 - Potential Borrow Area







## Native vs Borrow Sediments

### Grain Size Distributions =

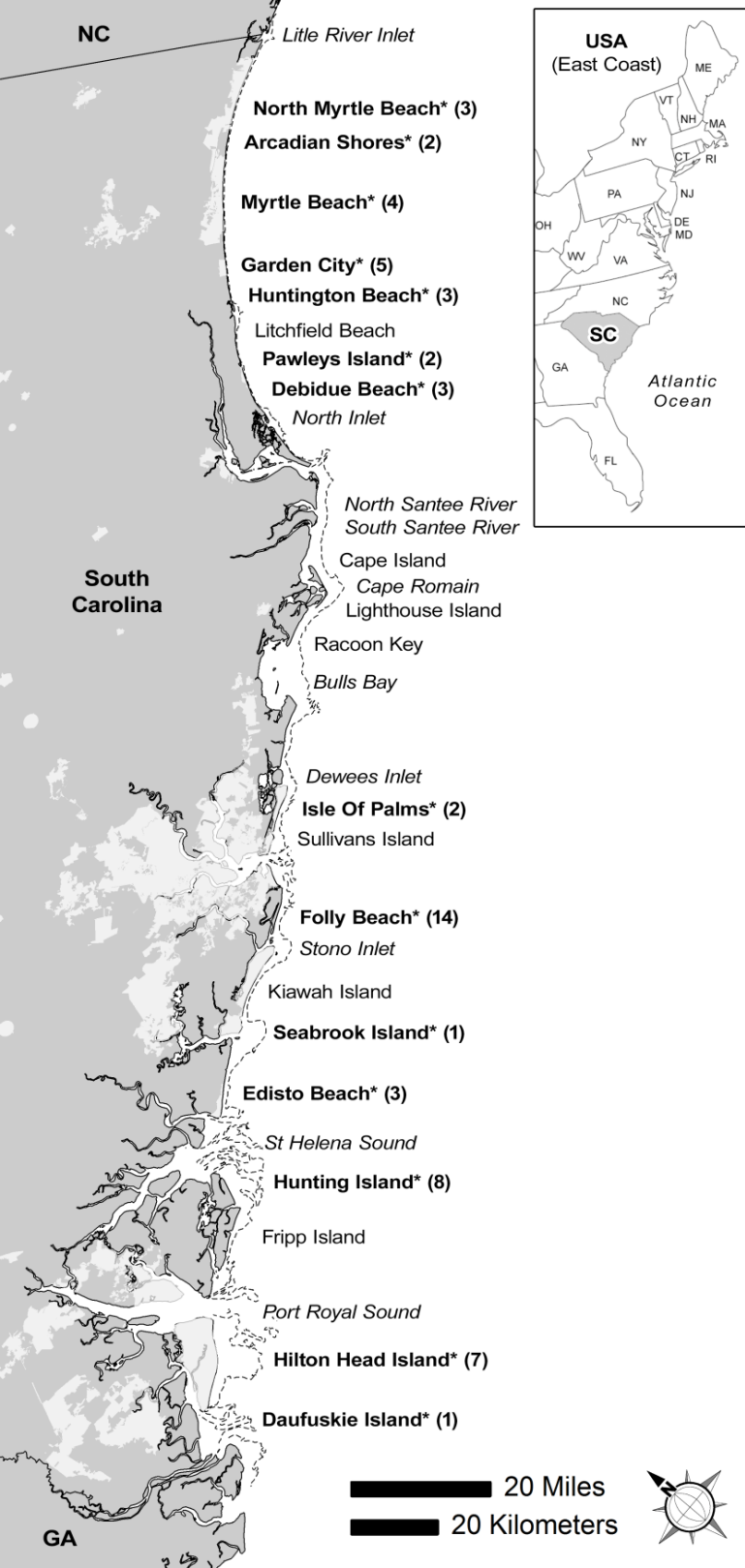
- The Proportions of Various Sand Sizes On the "Native" Beach and In the Borrow Areas
- A Perfect Borrow Source Matches The Native Sand

### Phase 2 – Detailed Surveys to Confirm

- More Offshore Cores For Design
- More Beach Samples –

*Goal – Match Sediments  
Reduce Uncertainty*





# Sustainability

## South Carolina USA

**1980-2010**

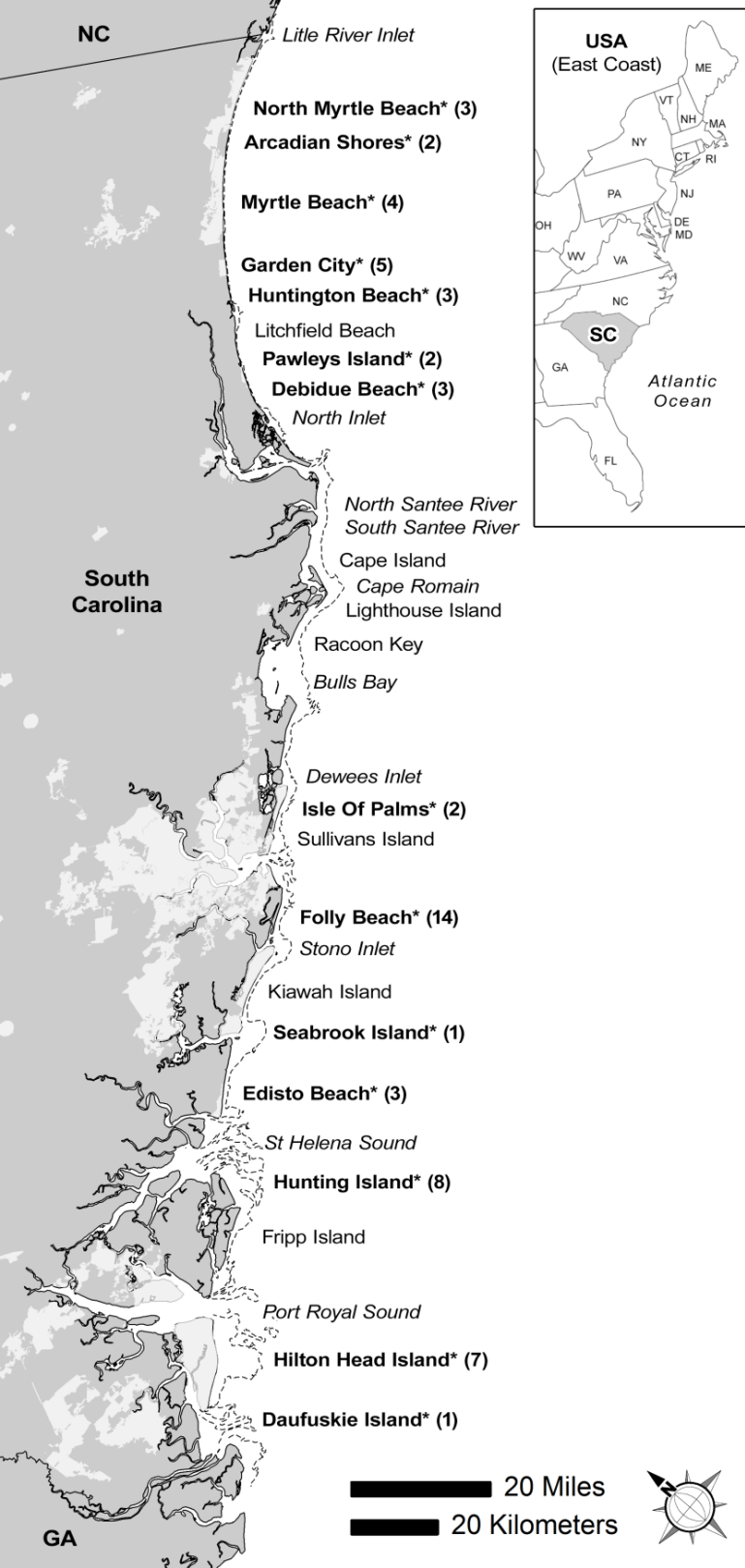
~80% of developed beaches wider

Average Annual Expenditures for  
Beach Improvement:  
~\$128 per meter per year

Present Value of Developed  
Oceanfront –  
\$16,000 – 165,000 per meter of  
beachfront

Source: Kana 2012 Shore & Beach





# Key to Sustainability

# Measure Measure Measure

## Continually Update Costs, Impacts And Benefits

Source: Kana 2012 Shore & Beach

