Sediment Sorting During Coastal Restoration Projects: Implications for Resource Management, Environmental Impacts, and Multiple Use Conflicts

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Interagency Agreement, Interagency Team

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The Project

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Objective:

Quantify changes in sediment characteristics (i.e., grain size, sorting) and the degree, timing, and variability of sediment sorting during dredging and placement operations to determine the extent of potential sediment coarsening to better inform sediment compatibility analyses and subsequent management of sediment resources.

Study Highlights:

- Specific focus on defining changes in sediment characteristics at loss points in process
- Laboratory experiments to develop hopper sampling methodology and define statistically significant sampling requirements
- Coordination with dredging industry
- 2 planned sampling events aboard dredge plants




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South Florida Sand Wars

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The New York Times

Where Sand Is Gold, the Reserves Are Running Dry

VeroNews.com
YOUR LOCAL NEWS SOURCE FOR INDIAN RIVER COUNTY

County to Miami-Dade: Keep your hands off our sand

Miami Beach has run out of sand. Now what?

For years the sea has been eating away at the shore, and the city has spent millions of dollars pumping up sand from the seafloor to replace it, only to have it wash away again.

THEVERGE.COM

(Naples Daily News)

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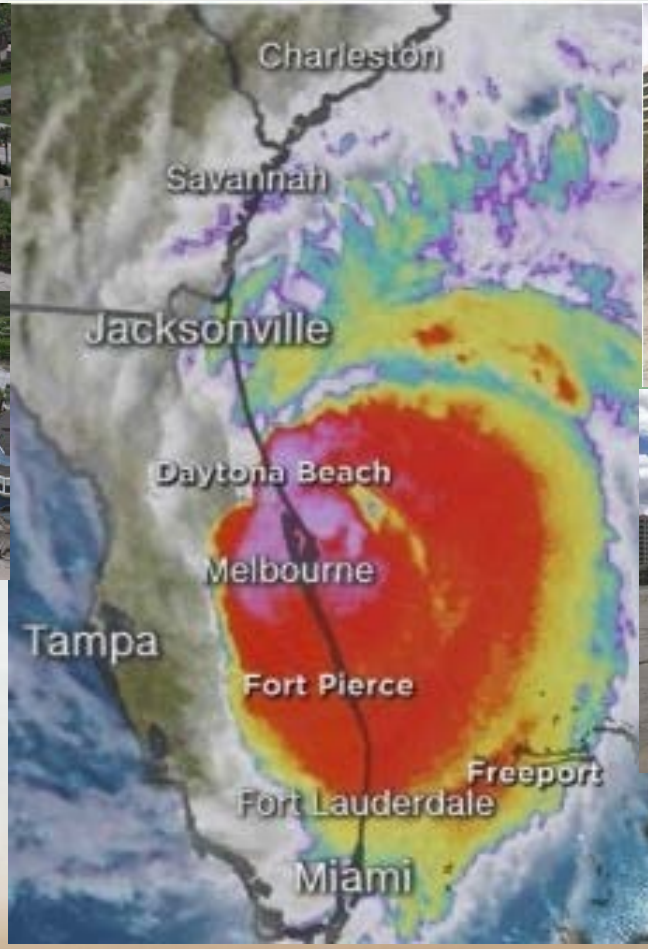
Hurricanes and Coastal Erosion



Hurricane Matthew:

- Overwashed 177 miles of beach dunes in 4 states
- 11% in Florida, 30% in GA, 58% in SC, and 9% in NC (USGS)

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Florida's "Sand Rule"

FAC 62B-41.007(2)(j)(k)

- Material for beach nourishment similar in grain size distribution to native or existing beach to protect environmental function and general character of the coastal system
- Fine sediment must be <5% (pass through #230 US Standard Sieve)
- Use of navigation channels dredged material (O&M):
  - <10% fines for beach placement
  - <20% fines for nearshore placement

*Rule assumes conservative assumption of 0% fines loss during dredging and placement process.

Other states with comparable regulations: ME, RI, MA, CT, NY, MD, VA, NC, SC.

BOEM Interests

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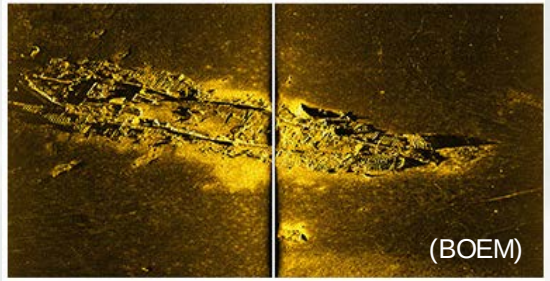
Encourages science-based resource management policies to support resource stewardship responsibilities

Potential increase in borrow area inventory

Potentially reduce environmental impacts and multiple use conflicts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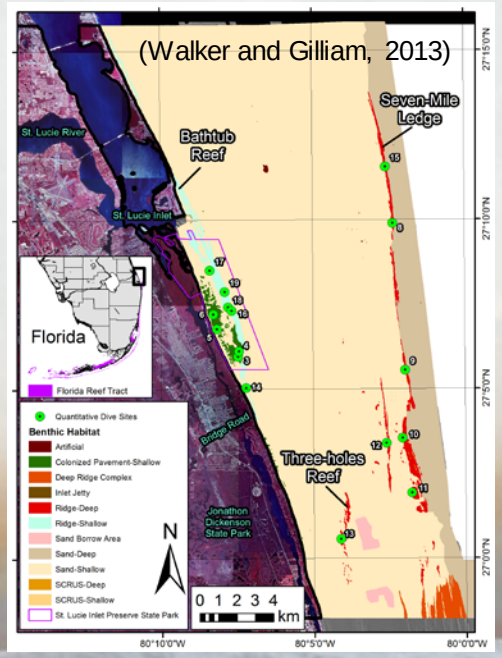

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USACE Interests

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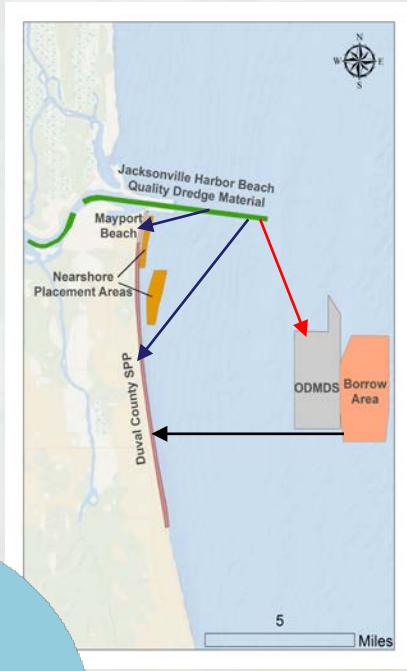
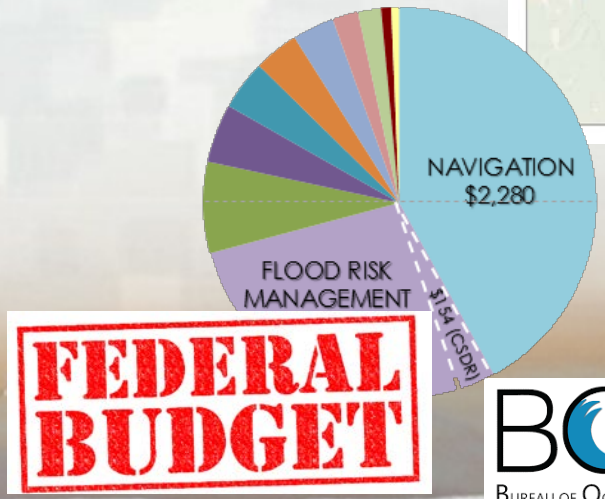
Save taxpayer money by reducing project costs

- Distance from borrow source to project location is huge project cost
- Scarcity : Cost

Promotes **R**egional **S**ediment **M**anagement principles

- Supports concept of sediment as a resource and beneficial reuse of sediments
- Support cross-business line approaches to achieve long-term environmental, economic solutions
- Enhances relationships with stakeholders and partners
- Advancing applied science and technology





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Industry Engagement

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Industry Day: January 2017

- Meeting to solicit industry input to develop safe sampling methods aboard industry dredges
- Industry supported study objectives
- Did not support weir sampling but did support hopper sampling

Industry Partner: Great Lakes Dredge and Dock

- Coordination, dredge plant site visits
- Engineers and safety personnel active in method development
- Sampling aboard GLDD dredge plant at Ship Island Restoration Project

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Tasks

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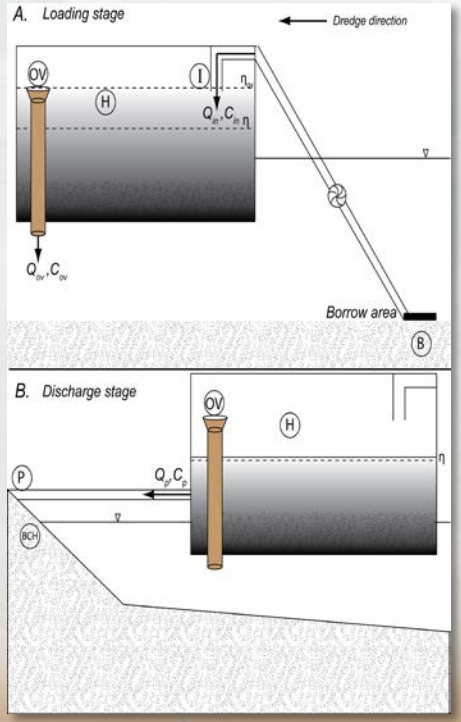
Task 1: Literature Review, Conceptual Model; Completed March 2017

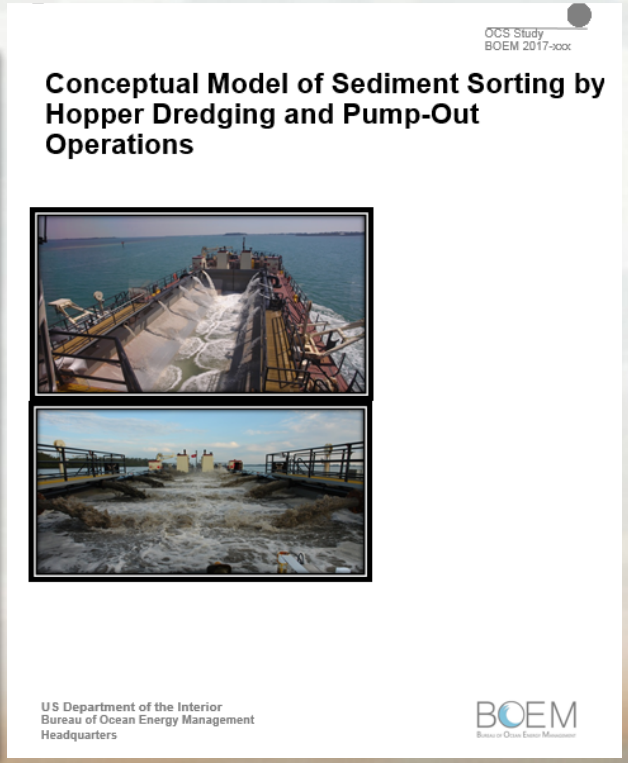
Task 2: Proof of Concept, Develop Field Sampling Plan

Task 3: Field Sampling

Task 4: Laboratory Analyses

Task 5: Draft Report, Final Report





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Loss Points and Sampling Strategy

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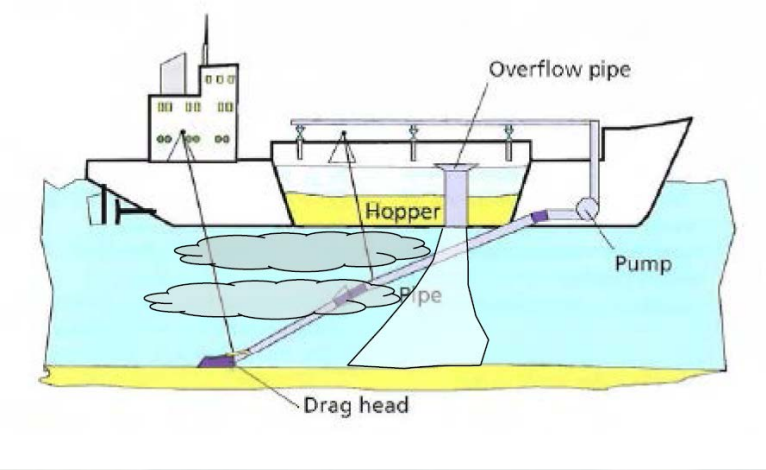
Loss Points:

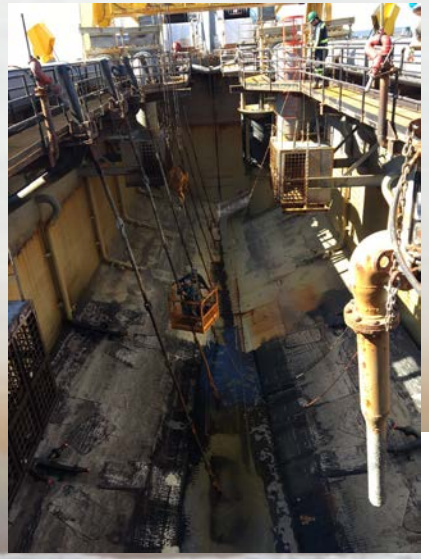
- Drag head
- Overflow
- Pump-Out
- Placement



Sampling Locations:

- Borrow Area*
- Inflow
- ~~Weir~~ Hopper
- Beach (coring)

*Geotechnical data for borrow area from USACE Mobile District (MsCIP - Ship Island Restoration)



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How to quantify fines loss at the hopper:

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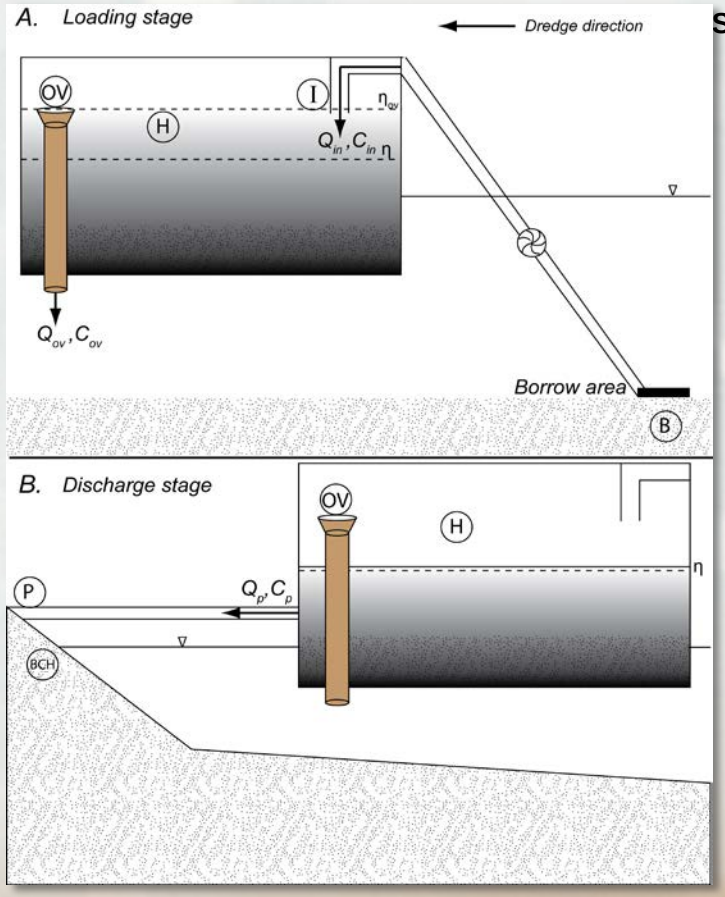
- Method 1:
  - Quantify fines at inflow
  - Quantify fines over the weir
- Method 2:
  - Quantify fines at inflow
  - Quantify fines in hopper
- Method 3:
  - Quantify fines at inflow
  - Quantify fines at outflow



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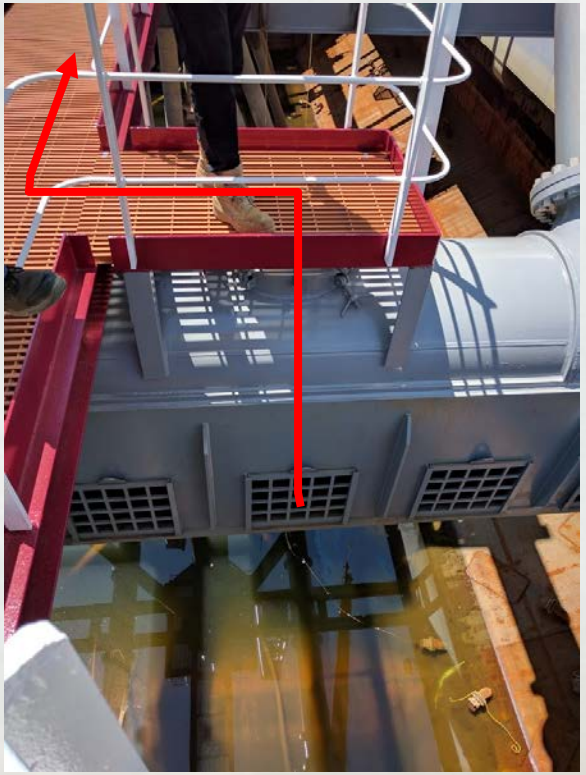
Inflow Sampling



- Two inflow sampling locations (fore and aft)
- Pump sampler method
- Appropriate sampling interval to yield least error?

Inflow Sampling: Sampling Frequency and Error Analysis

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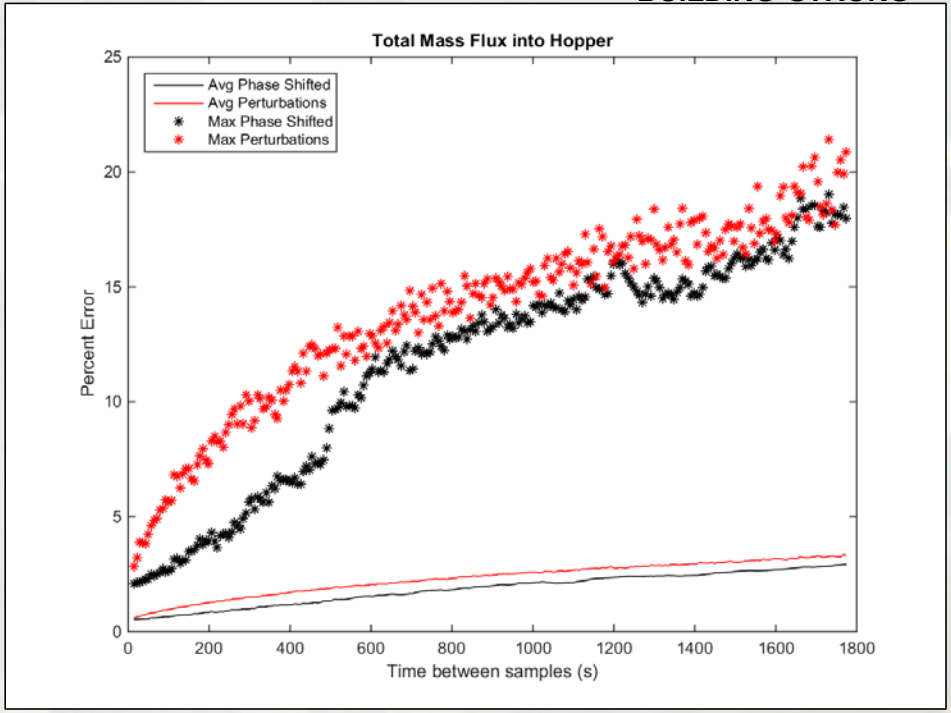

- Use USACE DQM data to determine sampling frequency that yields the least amount of error
- Results: Samples taken every 3 min = less than 1% error

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Method 1: Quantify fines over the weir Laboratory Experiment

- **Receiving tank holds all contents of weir overflow and keeps sediment in suspension**
- **Compare samples captured at weir and receiving tanks**

Laboratory Methods

- Target supply mixture concentration: 400 g/L
  - Fines content: 10%, 20%, 30%
    - Vicksburg Loess
- Total test time: 7 minutes
  - Sampling frequency: 20 seconds
  - ~14 samples per test
    - ½ → Sediment concentration
    - ½ → Grain size analysis and % fines



- Perform experiments with three sampling methods to determine possible bias between methods

Weir sampling

Composite sampling for average Sediment Concentration

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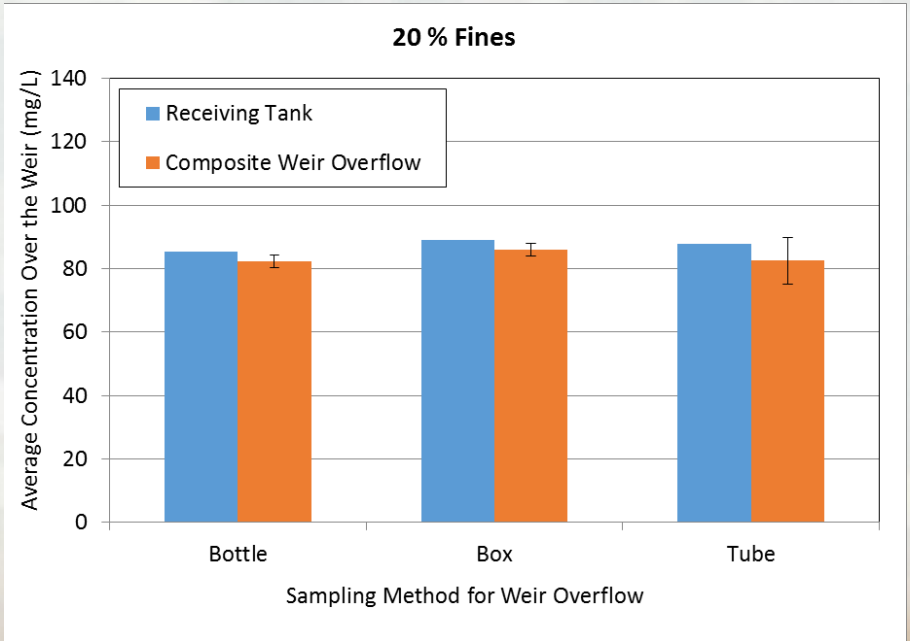
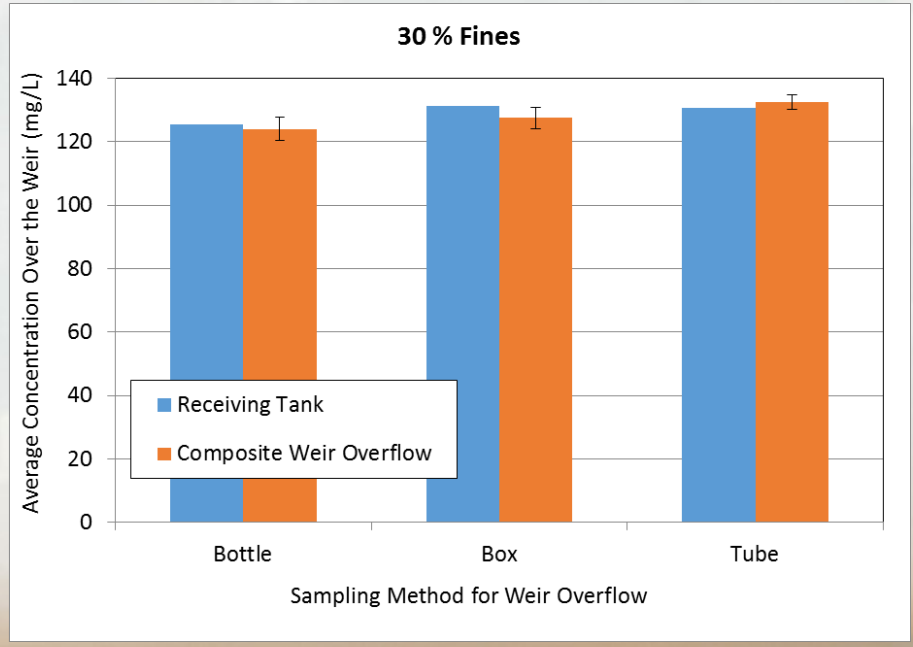
- No significant bias in concentration between sampling methods
- Error bars correspond to the standard error of the samples





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Composite Sampling for average Percent Fines

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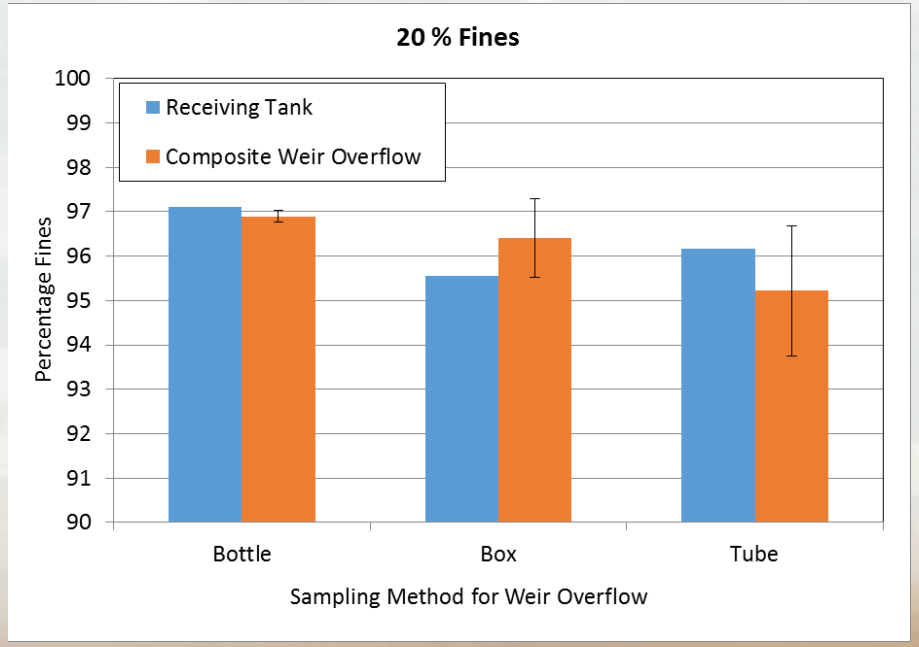
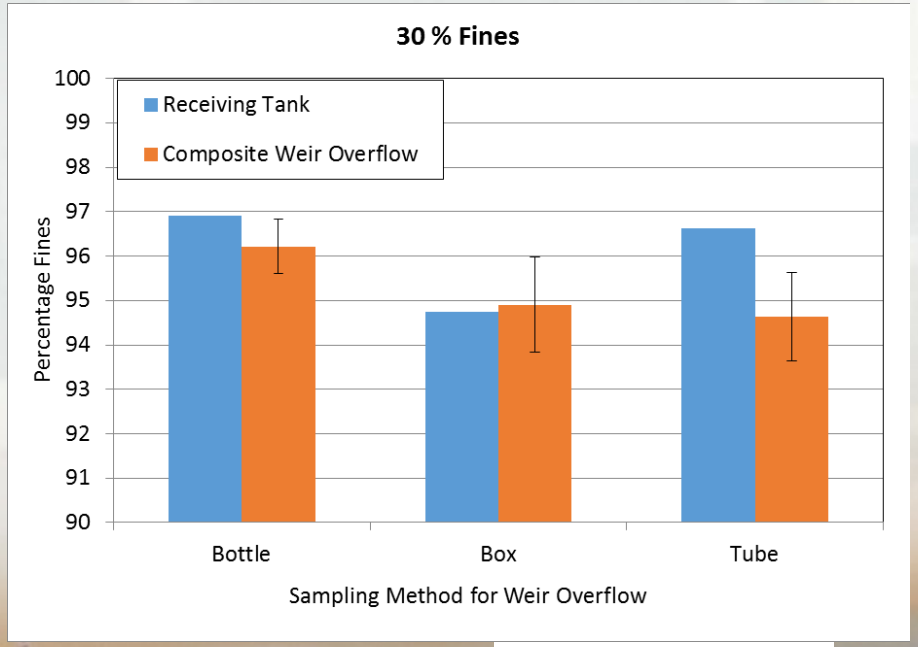
- For 20% and 30% fines experiments: averaged weir overflow samples had percent fines within 2% of that measured from receiving tank

- Error bars correspond to the standard error of the samples





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Preliminary Conclusions From Measuring Weir Overflow

- Despite challenges in sampling weir overflow, the composite samples had a mean concentration effectively equal to that measured from the receiving tank.

- No significant bias between sampling methods was identified for concentration or percent fines (except for the 10% case – being reanalyzed).

- The tests reinforce the concept that composite sampling could serve as a cost effective way to determine mean sediment concentration and % fines. (vs. bed samples/load ~ 80; inflow samples/load ~ 120)

Method 2: Quantify fines in hopper
Proposed Hopper Bed Sampling Method

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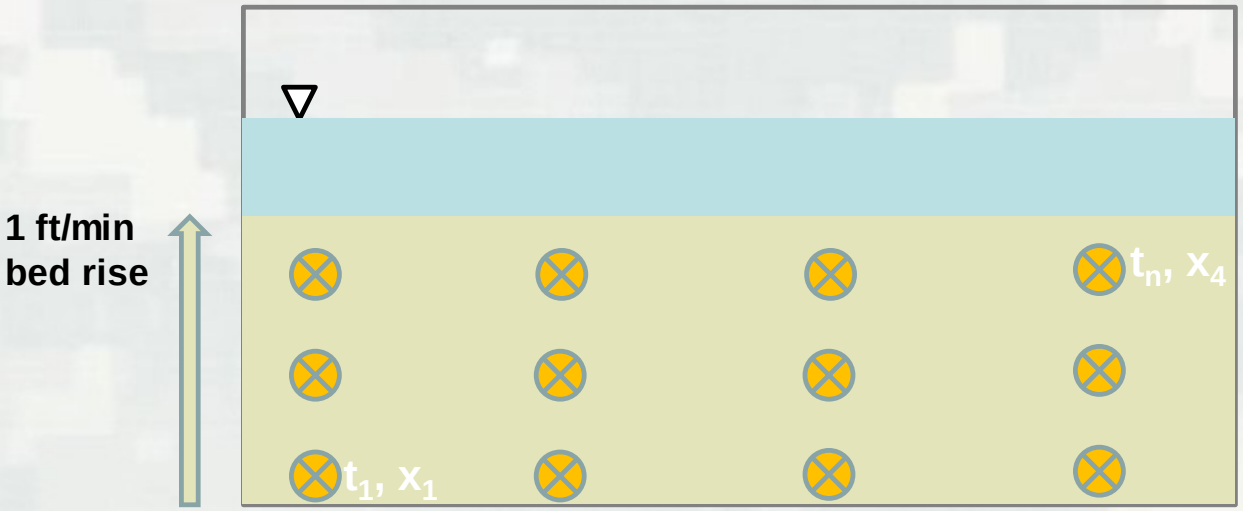
Prototype hopper (x-section)



- Proposing to sample hopper bed via wide, shallow sediment trap constructed with pond liner
- Capped at bottom with a steel plate to ensure vertical position during placement and removal
- Top section of the sample would be disregarded due to hydrodynamics experienced during removal (1 L sample)
- Four sample locations, 3-4 min sampling rate, 15-20 samples/location

How to quantify fines at the beach

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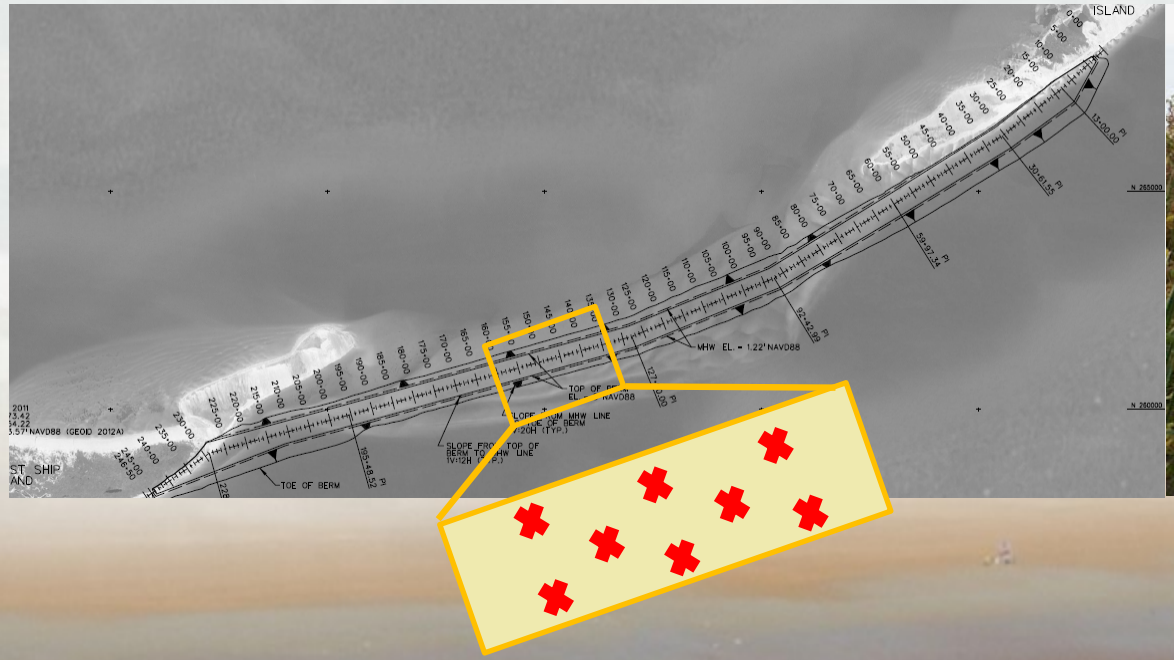
- 5-8 sampling locations that cover cross and longshore directions
- Stay away from coring in active portion of the beach; only sample dry berm
- Estimate necessary core depth based on grade stakes
- Will core up to 1 ft shy of template (approx. 10-12 ft cores)



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Upcoming Field Sampling

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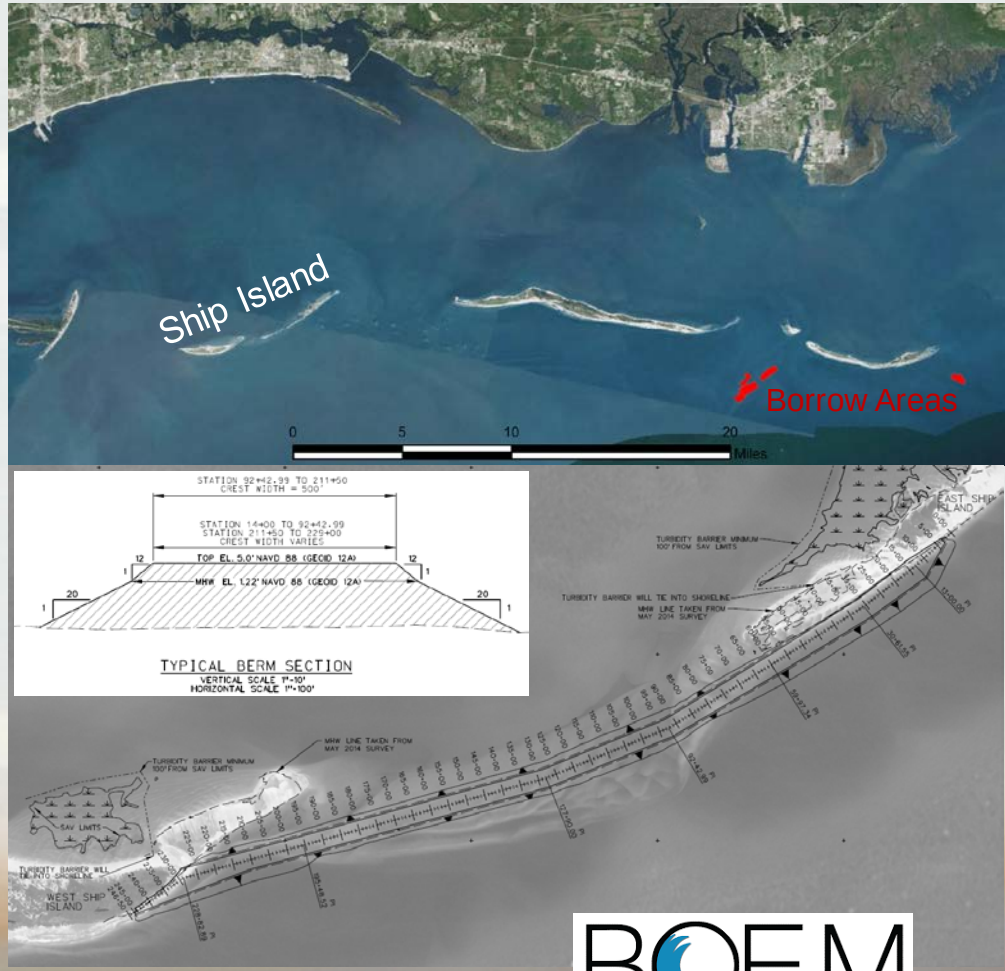
Ship Island Restoration Project:

- Inflow, hopper, beach sampling
- 5 – 10 hopper loads
  - 20+ miles from borrow area to pump-out
- Challenge to collect full placement depth at restored beach

Field Effort 2: TBD

- Spring 2018



Summary

- Purpose: Determine amount of fines loss and at what point during the dredging process
- In situ fines content determined by borrow site sampling
- Fines quantification at hopper difficult to address
  - Determined 3 different methods to do this
- Performed several lab experiments to determine best sampling methods and error associated with methods
- Fines at beach will be quantified with beach cores
- Field experiment at Ship Island using methodology results of lab experiments