Engineer Research and Development Center

Strategic Placement of Dredged Sediment

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ERDC-CHL

US Army Corps of Engineers®

Outline

- Background and Definition
- Challenges
- Evaluation Process
- Stakeholder Engagement
- Examples
  - Coastal
  - Estuarine
  - Riverine

Sediment Management for Resilience

Coastal resilience and ecosystem function disrupted by alterations to the regional sediment system.

- Land use change
- Impoundments
- Channelization
- Shoreline/river bank hardening
- Jetties

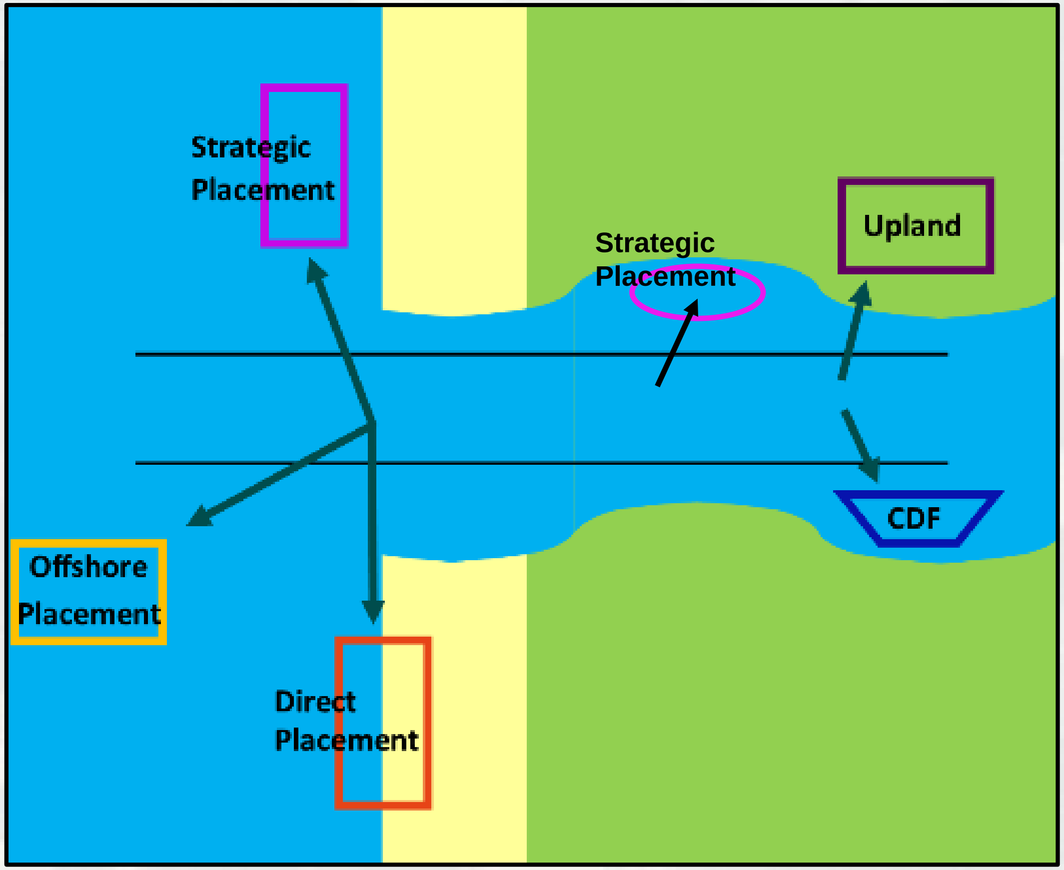
Dredged sediment used to mitigate for loss of function

Sustainable BU practices can improve sediment distribution

Dredged Sediment Management for Resilience

Sustainable BU supports navigation mission while also supporting FRM and ecosystem function.

- BU methods
  - Construction
  - Thin-Layer Placement
  - Strategic Placement
  - Other??



Dredged Sediment Strategic Placement

Definition

. **Placing dredged sediment in open water at one location with the expectation that hydrodynamic forces will transport some fraction of sediment to targeted receptor sites**

- Improved practice that better reflects natural processes
- Increase volume used beneficially – compliments construction and TLP
- Target resources most in need of sediment
- Cost-effective compared to direct placement/construction
- Less disruption to targeted receptor sites
- Sustainable – provides renewable placement site capacity
- Sustainable - ongoing nourishment process
- Support USACE BU, RSM, and EWN strategies

Strategic Placement is a long-term change in practice – It is not a series of construction project

ERDC/CHL SR-XX-X

Coastal & Hydraulics Laboratory

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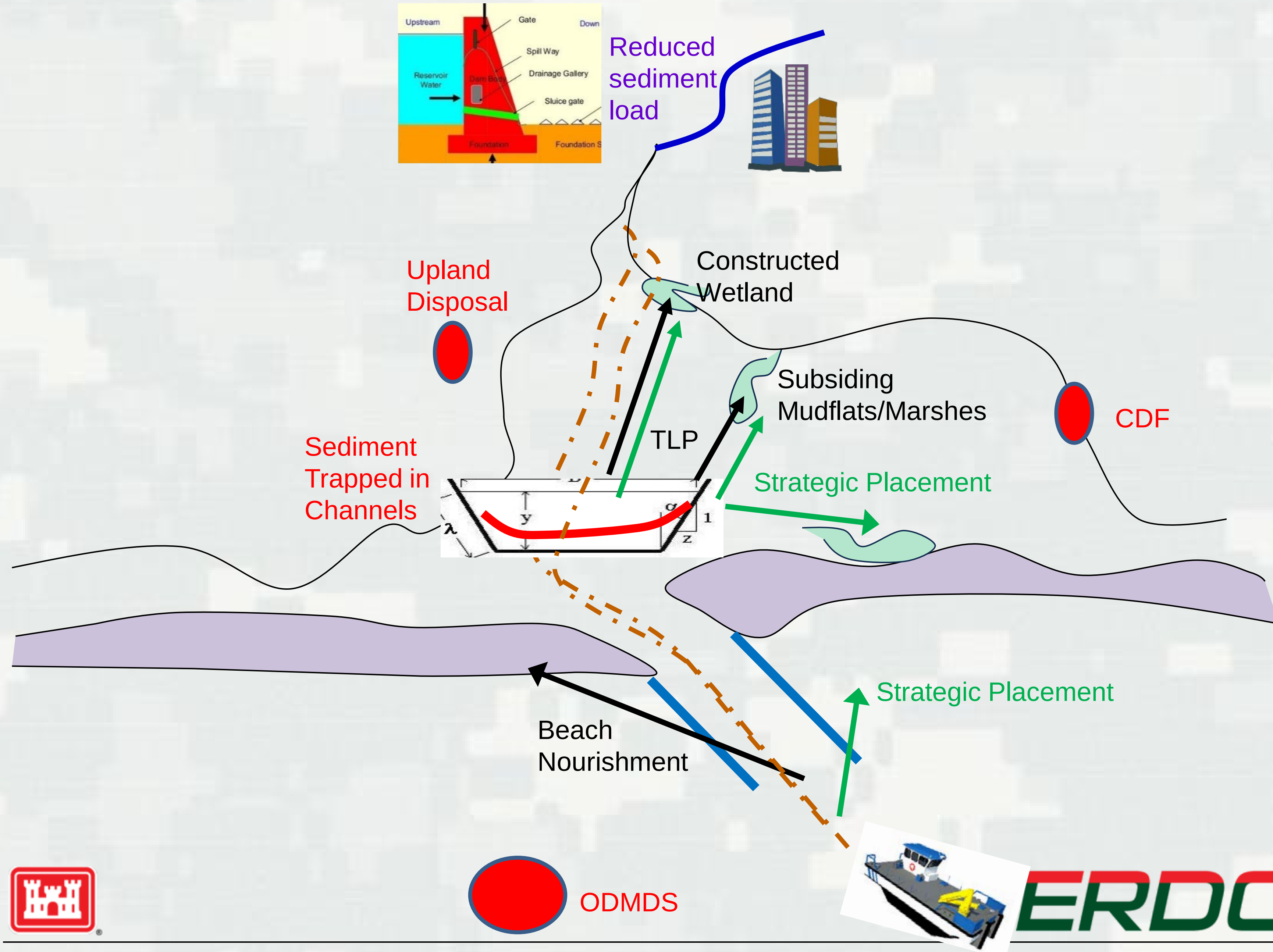
Strategic Placement for Beneficial Use of Dredged Material

Joseph Gailani, Katherine E. Brutsche, Elizabeth Godsey, Ping Wang, Michael A. Hartman


Upstream
Gate
Down
Spill Way
Reservoir Water
Drainage Gallery
Sluice gate
Foundation
Reduced sediment load
Constructed Wetland
Upland Disposal
Subsiding Mudflats/Marshes
CDF
TLP
Sediment Trapped in Channels
Strategic Placement
Strategic Placement
Beach Nourishment
ODMDS
ERDC

Strategic Placement – Challenges

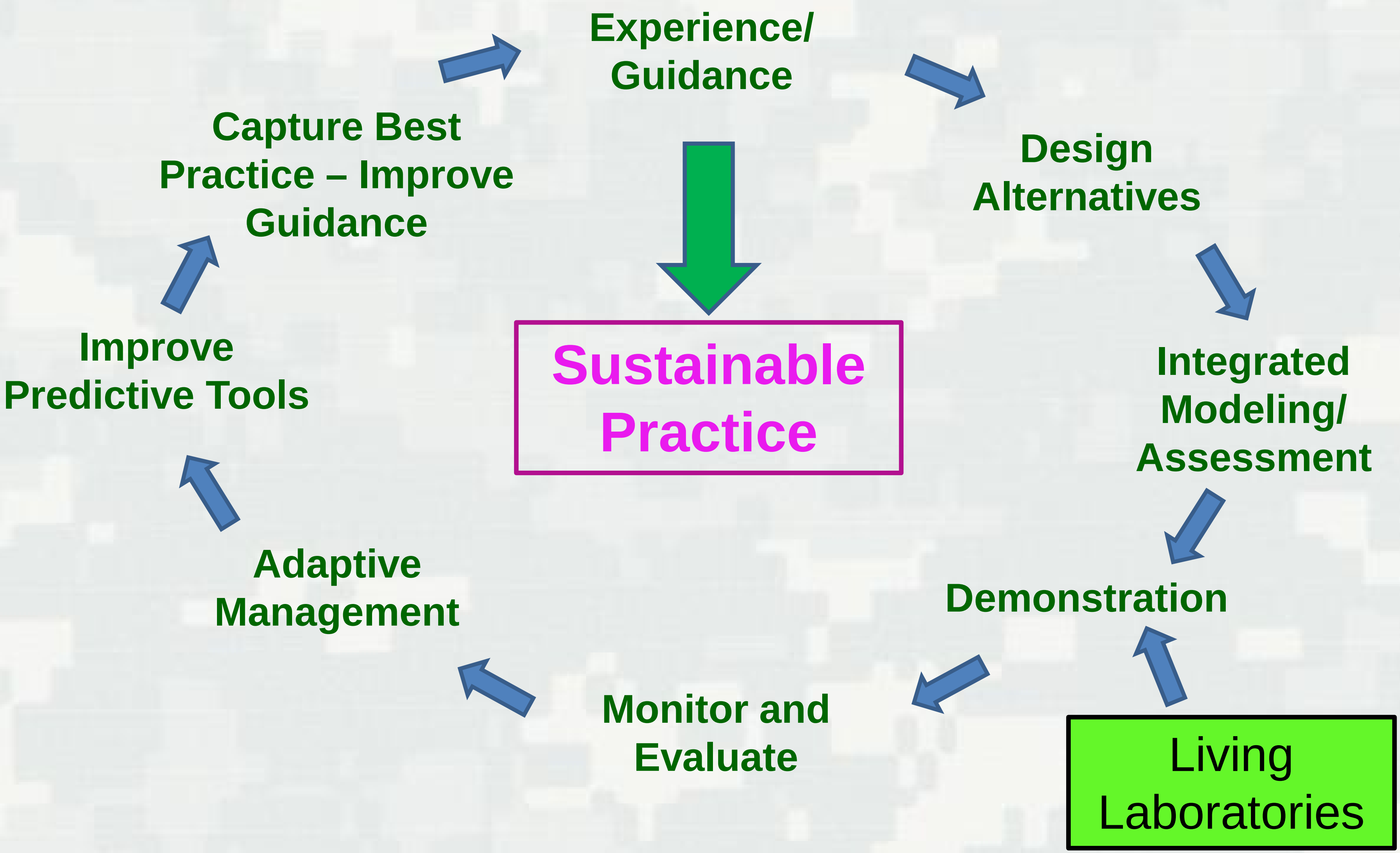
- Limited understanding of transport processes, especially in nearshore
- Transport rates and directions are highly variable
- Small volume of sediment placed in vast system

Difficult to monitor/demonstrate sediment fate & ”success”

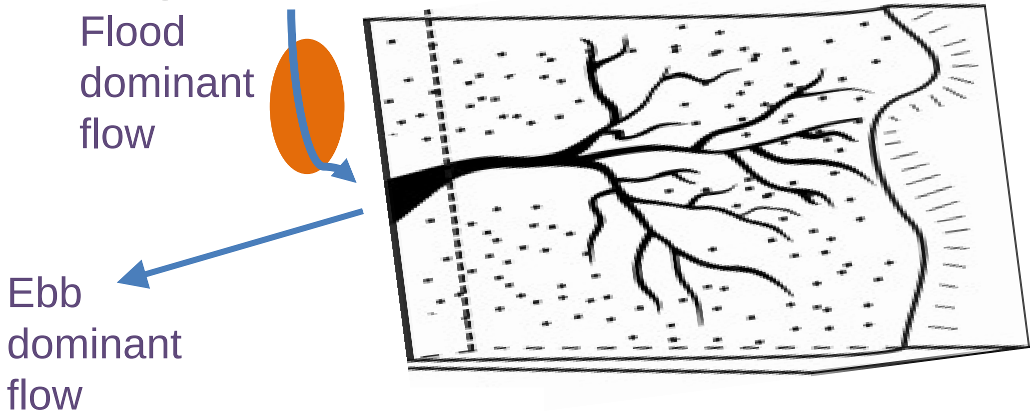
Required experience, process descriptions, predictive tools, engineering guidance and monitoring data – continuous improvement as we learn

Strategic Placement – Challenges

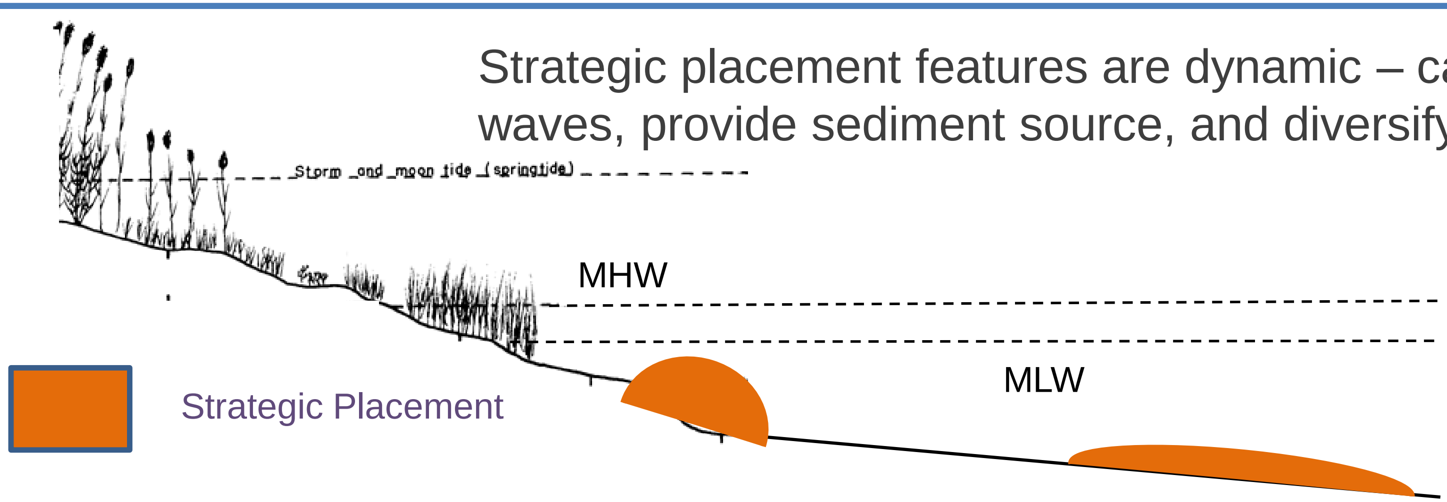
- Where to place?
- How to place?
- How much to place?
- Characterizing risk within area of influence
  - Experience characterizing risk
- Quantifying long-term benefits
- Communicating with stakeholders/regulators
- Transition from demonstration to change in practice


Experience/ Guidance
Design Alternatives
Integrated Modeling/ Assessment
Demonstration
Living Laboratories
Monitor and Evaluate
Adaptive Management
Improve Predictive Tools
Capture Best Practice – Improve Guidance
Sustainable Practice

Strategic Placement
Supporting resilient mudflat/marsh systems



Strategic placement features are dynamic – can attenuate waves, provide sediment source, and diversify habitat



Innovative solutions for a safer, better world

Strategic Placement and Federal Standard

There are US applications within the federal standard

- Cost is similar to offshore disposal
  - Reduced dredging time vs. offshore placement
  - Lower fuel use
- Do “sound engineering” and “environmentally acceptable” support strategic placement

Strategic Placement – Stakeholder Engagement

- Present dredging practices permit continued resource loss
- Direct placement/construction can mitigate for some loss
- Not all dredged sediment will be placed directly
- Sustainable strategic placement can increase the volume of sediment nourishing resources
- Acknowledge risks → discuss USACE experience managing risk
- Manage expectations → benefits may not be immediately measureable
- Compliments direct placement – does not replace them

Develop Plans with Stakeholders

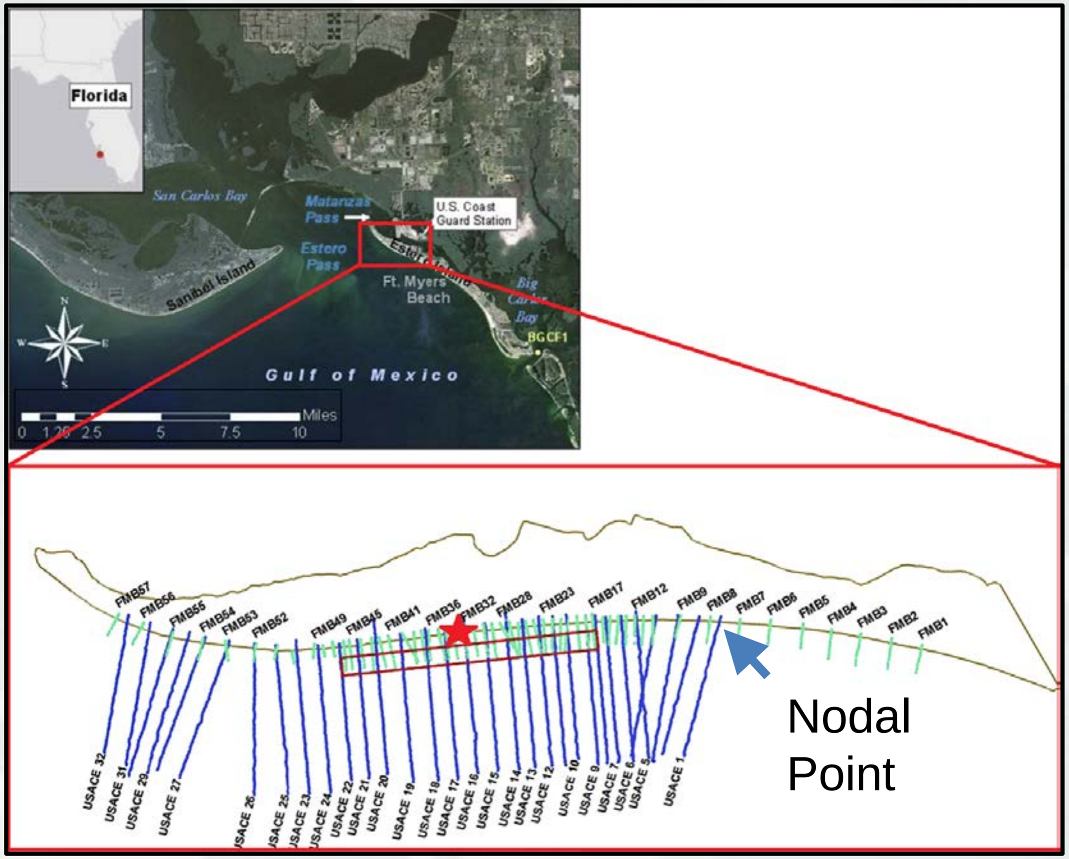
- Engage stakeholders early – involvement in decision making process
- Describe the system
  - Evolution since anthropogenic interference
  - Identify past/present sediment sources and fate
  - Circulation → capacity and directions of transport
  - Ecosystem response – past/present/future
  - Identify where sediment is needed
- Discuss present practice
- Identify strategic placement alternatives
  - Risk characterization (including no-action scenario)
  - Long-term benefits
  - Cost/sustainability
- Identify stakeholders who will support demonstration

Stakeholder Engagement – Other Ideas

- Sediment dispersion is temporally and spatially variable – feature will eventually disperse
- Only a fraction reaches receptor site
- Risk can be bracketed and managed adaptively but we know how to avoid “irreparable harm”
- Redefine “success” – better practice vs. measureable dry beach or wetland acreage
- Turbidity is natural, necessary, and variable
  - Describe science-based risk to various receptors
  - Degrading resources are not receiving sufficient sediment
  - Which is worse – continued degradation or additional turbidity?

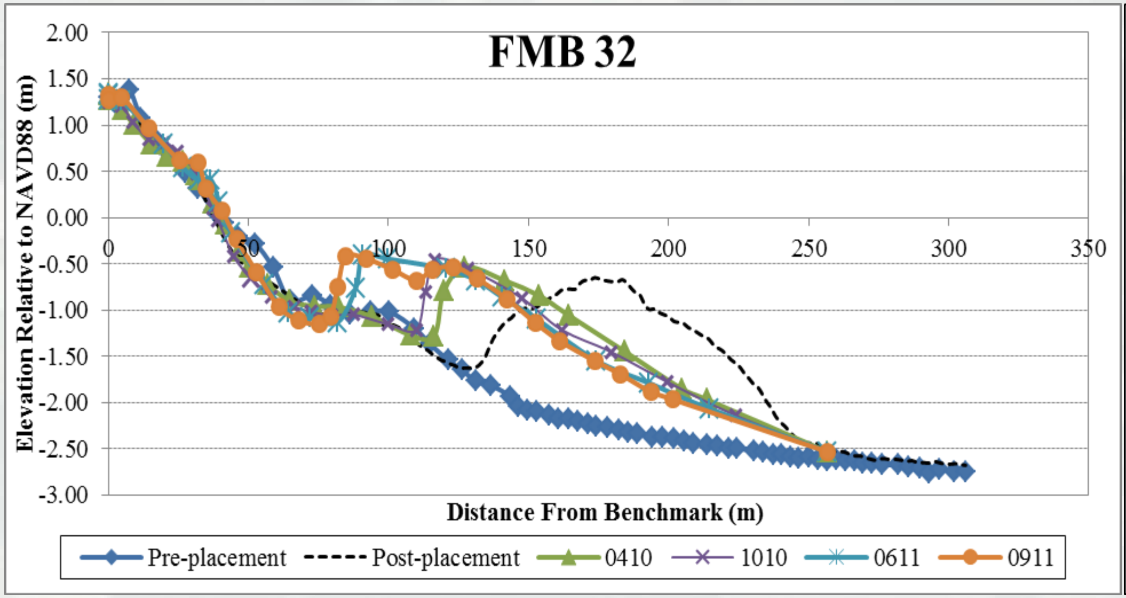
Fort Myer Beach, Florida

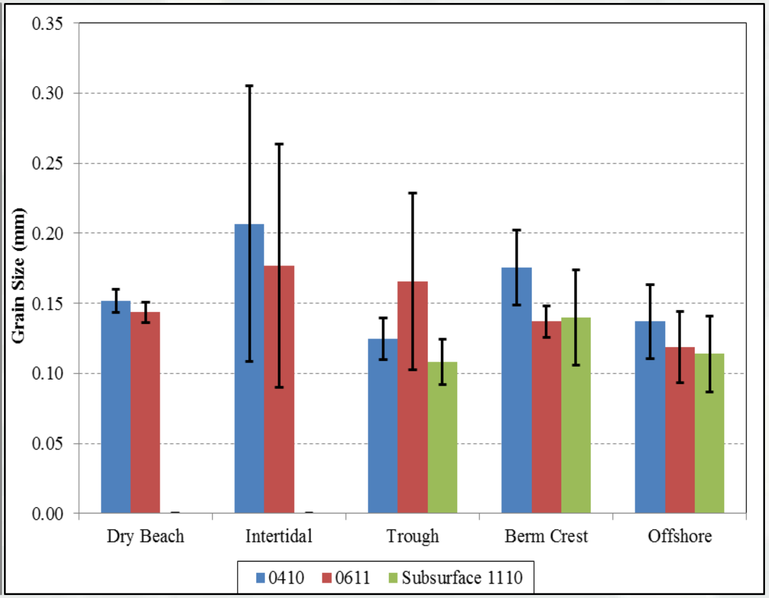
- Maintenance material >80% sand
- Not acceptable for beach nourishment
- Low energy environment
- 3 x 400 x 6000 ft
- 230,000 cy
- Highly engineered nearshore berm placed in ~ 6 ft water
- Increased hauling and engineering increases cost
- Wave energy analysis used in design



from Brutsché and Pollock 2017

Fort Myers Beach, Florida





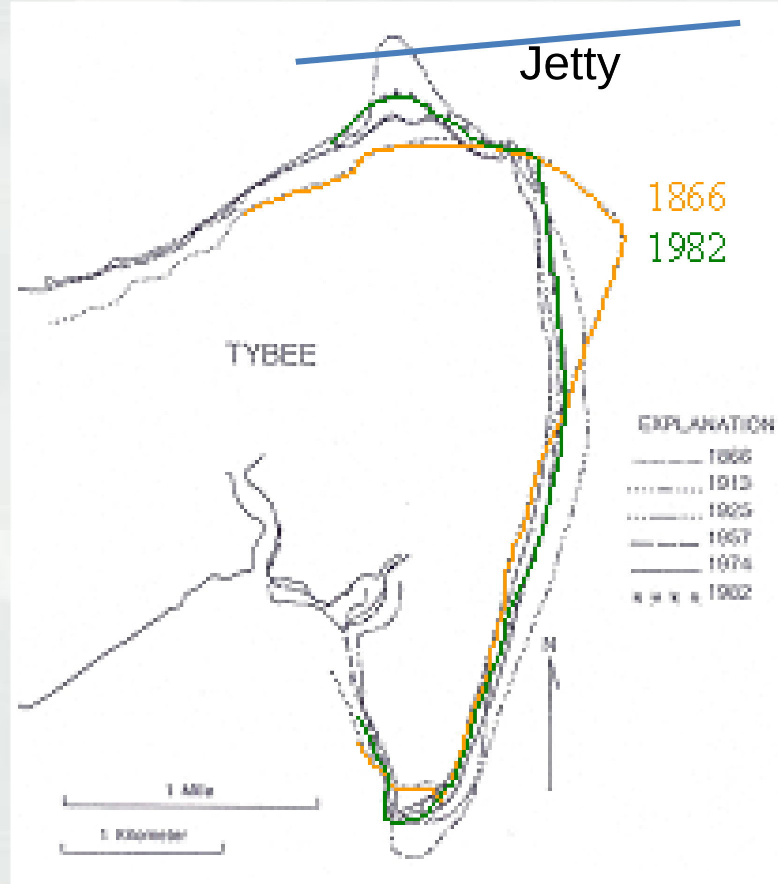
Profile during first two years after placement (Brutsche et al, 2014)

Spatially averaged cross-shore GSD

- Dynamic natural bar ~ 150 ft offshore - constructed berm 600 ft offshore
- Berm migrated onshore over 4-years – mostly during two storms
- Onshore movement more rapid during high-energy winter months
- GSD of dry beach remained constant during study period
- Project area experienced less erosion than control area during storms
- Nourishment from berm vs. decreased long-shore transport?

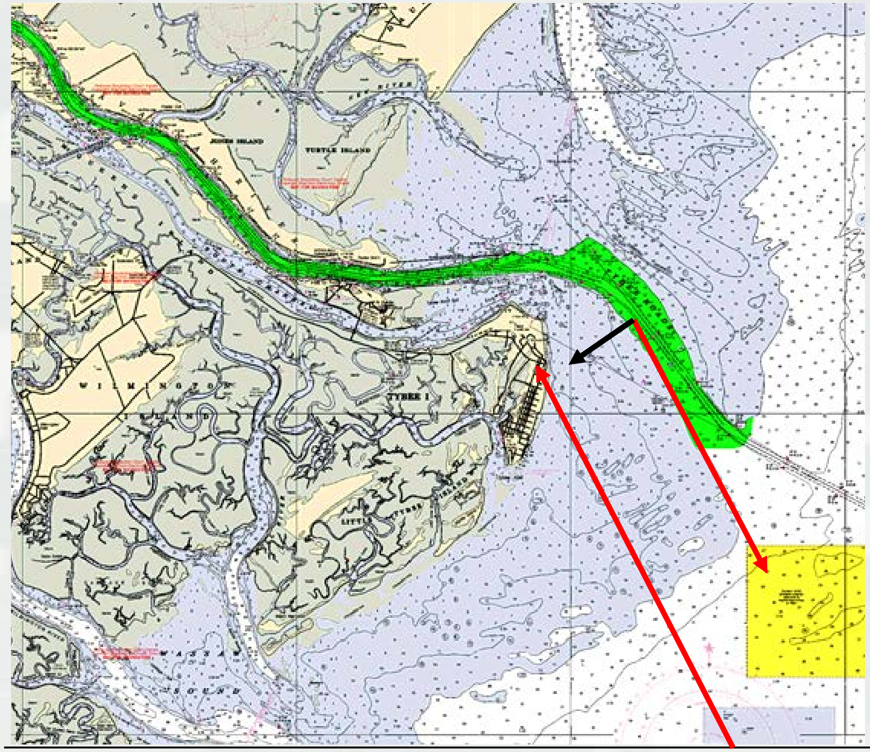
Savannah River/Tybee Island, GA

- Entrance channel to major East Coast Port
- Jetties protect navigation
  - Littoral transport disrupted
  - River sediment load moves further offshore
  - Dredging: offshore disposal
- Response of ebb shoal attachment bar
  - Migrating south
  - Accretion on south end of Tybee
  - Recession due to sediment deficit of north end of Tybee



Savannah River/Tybee Island, GA

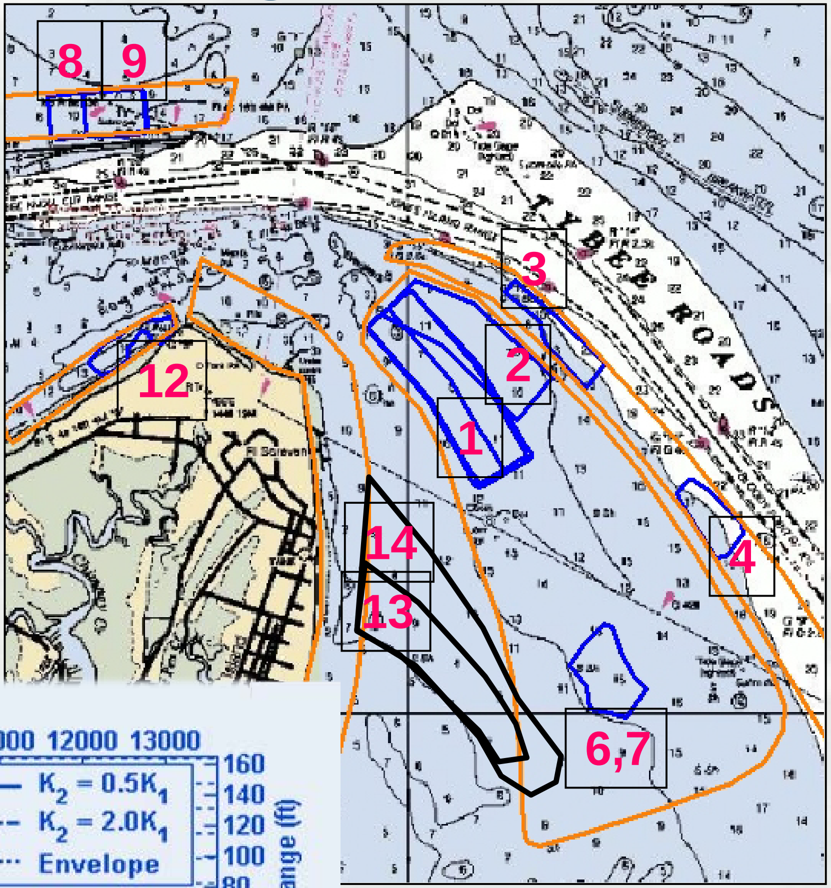
- Maintenance material 75% sand
- Not acceptable for beach nourishment
- Separate navigation and FRM (beach fill) projects

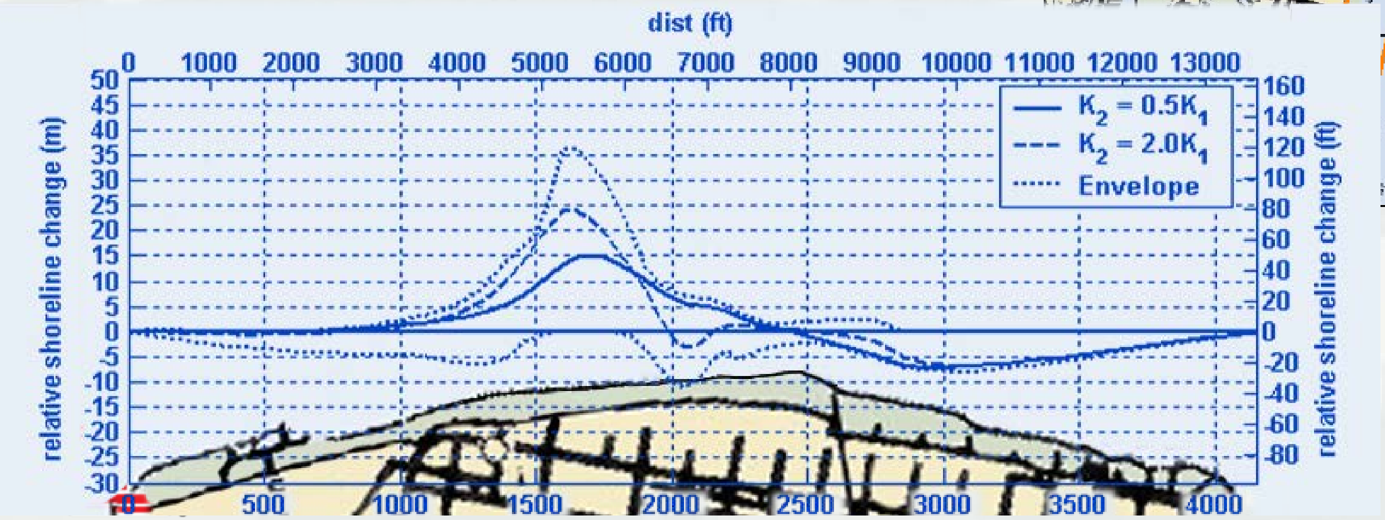


- Place dredged sediment in nearshore
- Nourish littoral system
- Reduce frequency of beach nourishments

Tybee Island, Georgia

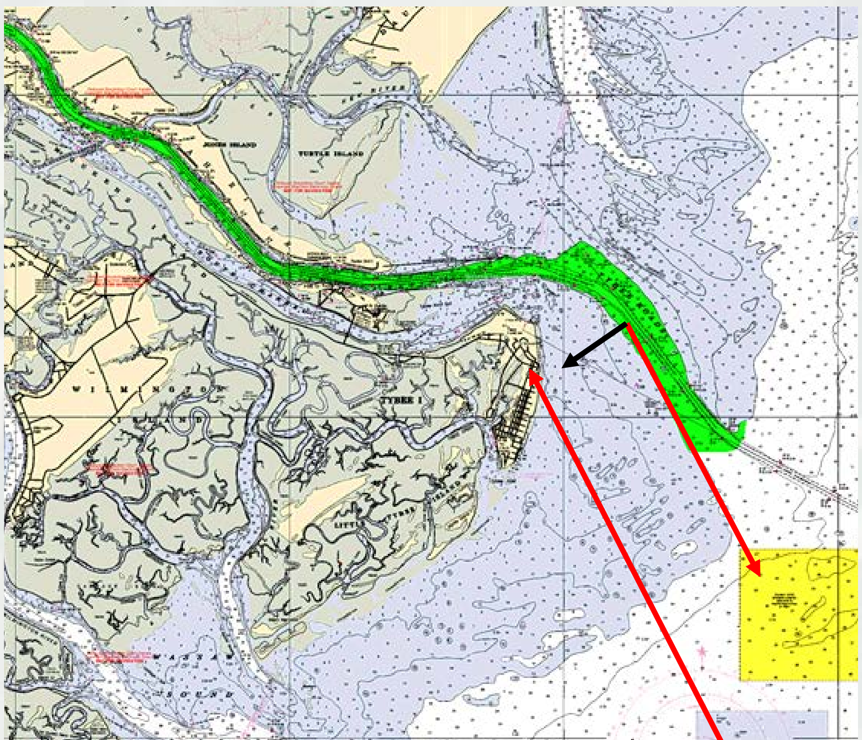
- Numerical models applied to address:
  - Circulation
  - Wave transformation/focusing
  - Transport and fate of fines and sand fractions
- Monitoring at similar inlet (Brunswick) demonstrated dispersion of fines/sand

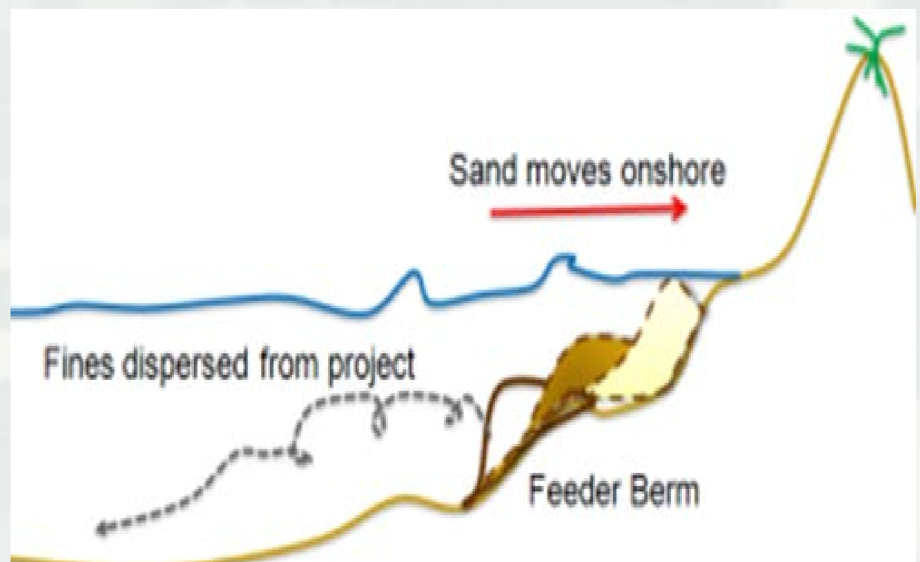




Savannah River/Tybee Island, GA

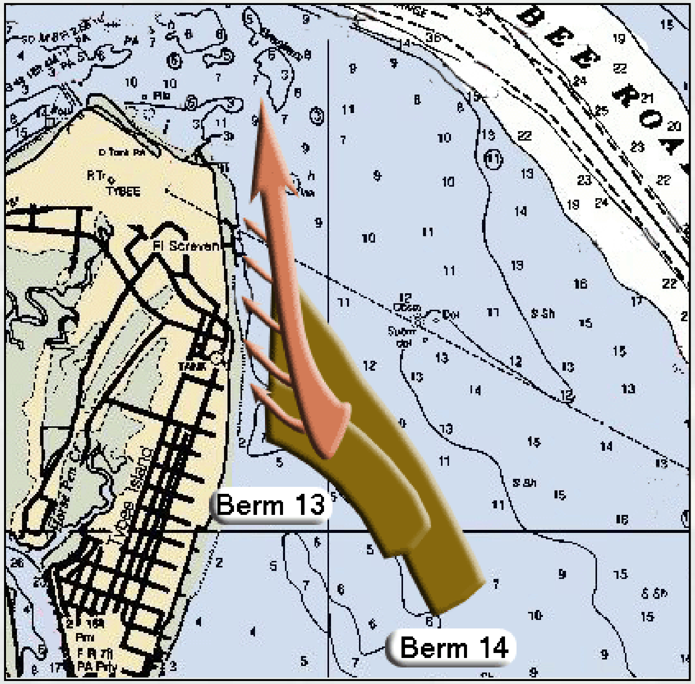
- Maintenance material 75% sand
- Not acceptable for beach nourishment
- Separate navigation and FRM (beach fill) projects
  - Reduce cost by combining projects

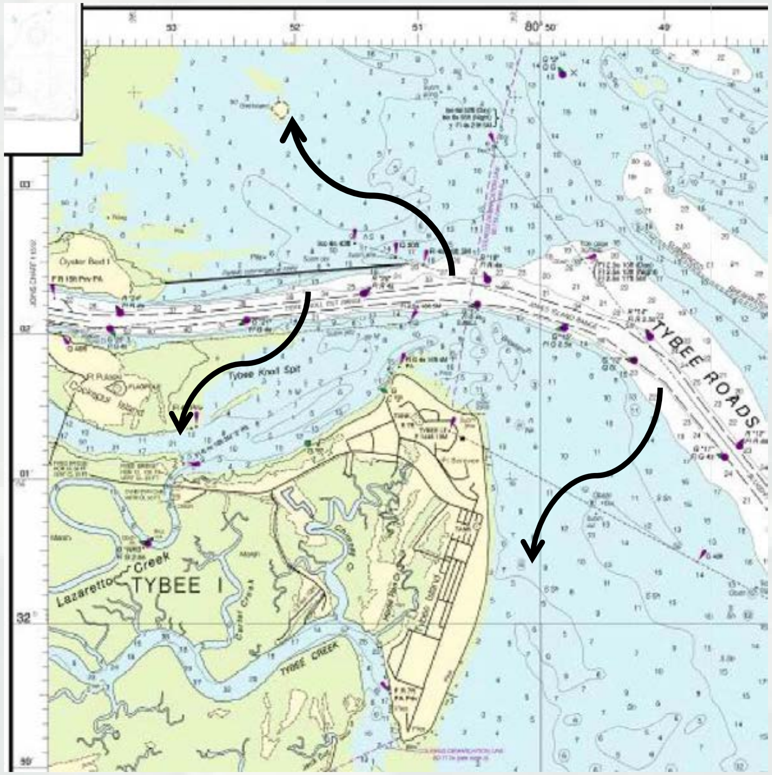




Savannah River/Tybee Island, GA

- Placement design to optimize littoral nourishment
- Next Phase: Placement of fine sediment near wetland dendritic creek network





Mouth of the Columbia River

- Shoreline recession north of jetty
- Historic use of DWS and SWS
- SWS volume limited due to mounding → nearby shoreline recession
- NJS is cost-effective solution which may support littoral nourishment
- Limited NJS volume
- NHS site proposed to increase volume which can support littoral nourishment

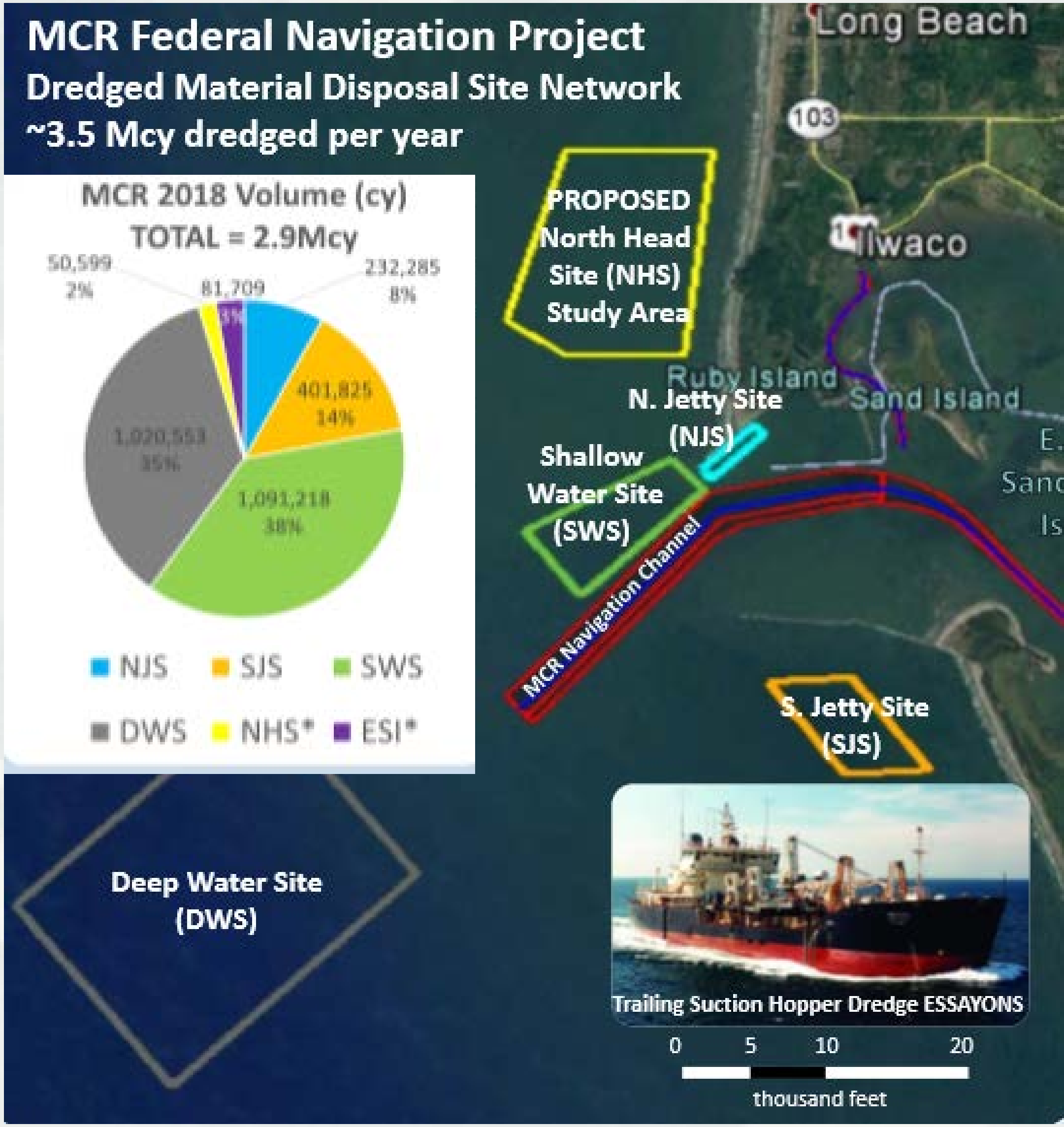
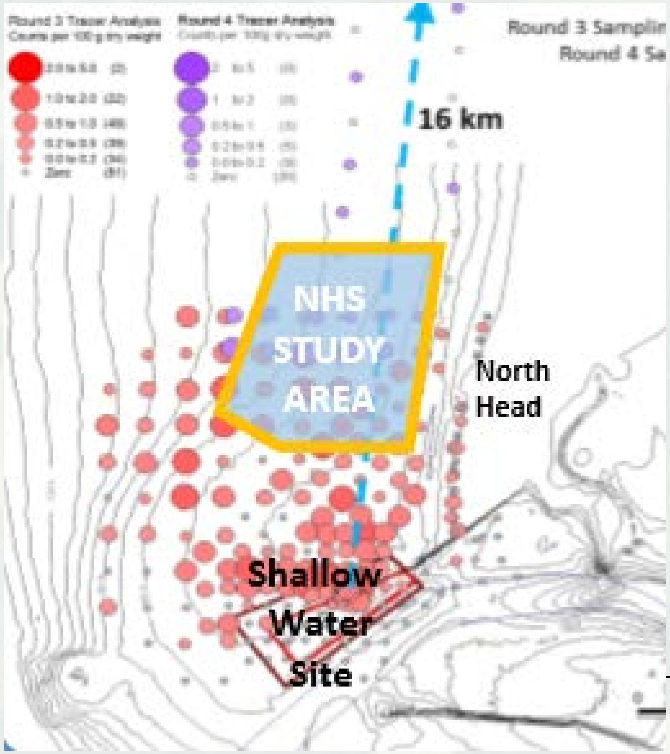
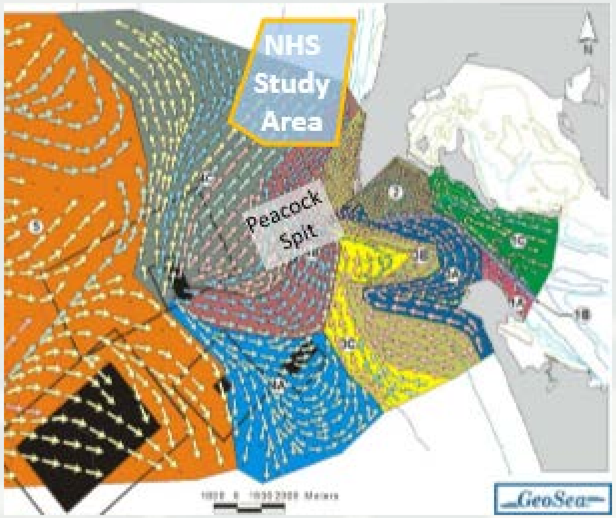


Image courtesy of H.R. Moritz

Mouth of the Columbia River

- Increase volume retained in littoral system
- Wave/current modeling to support design
- Monitor NJS strategic placement –tracer study
- Evaluate habitat and response to placement

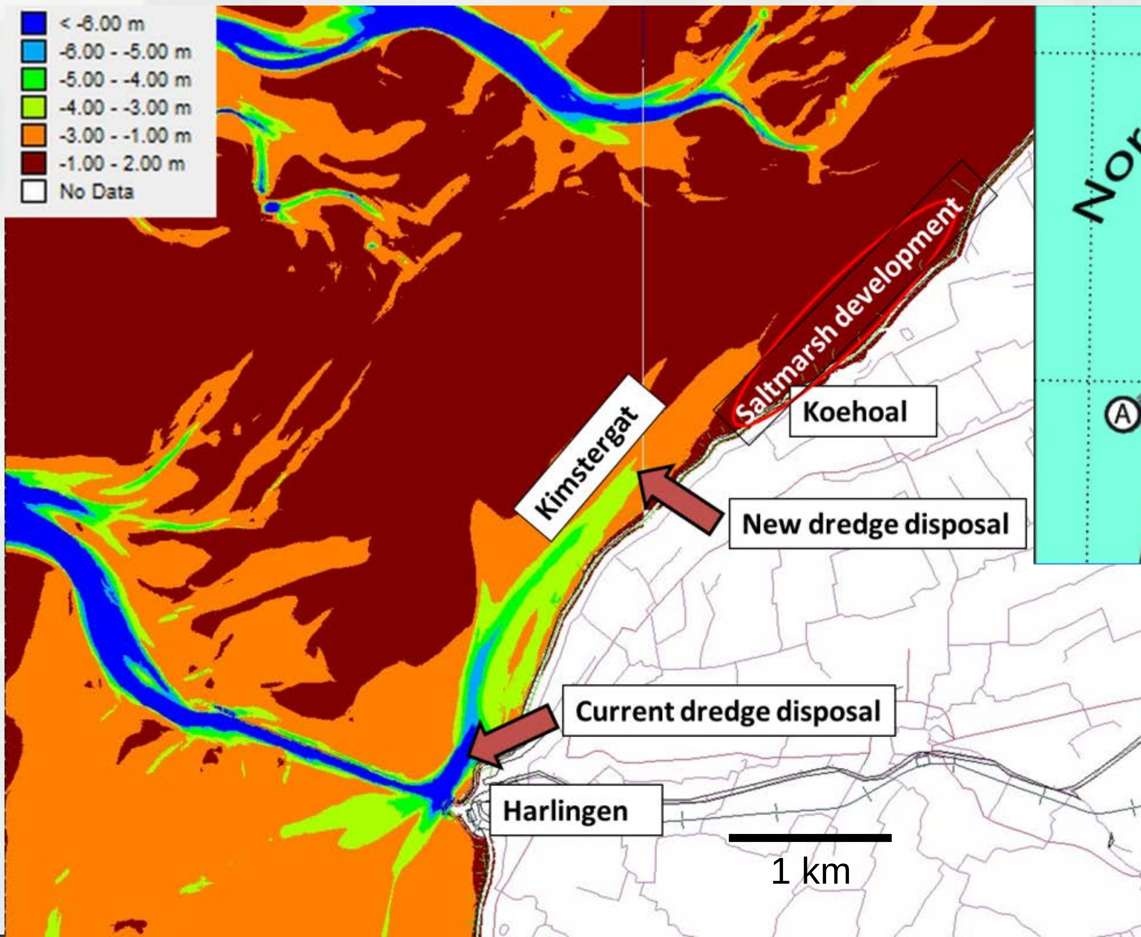


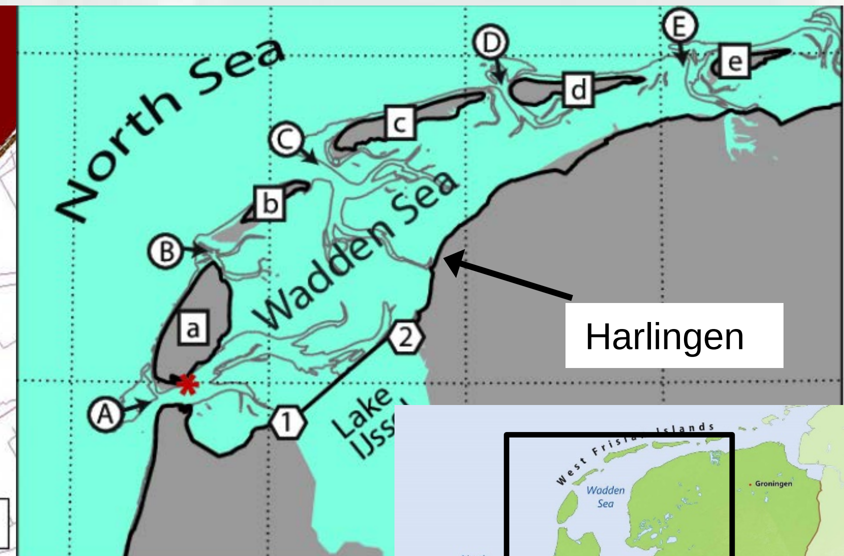


Images courtesy of H.R. Moritz

Wadden Sea, The Netherlands

- Port of Harlingen – channel adjacent placement
- 2-year demonstration project: place dredged sediment midway between port and targeted wetlands
- 100,000 m^3/year for two years

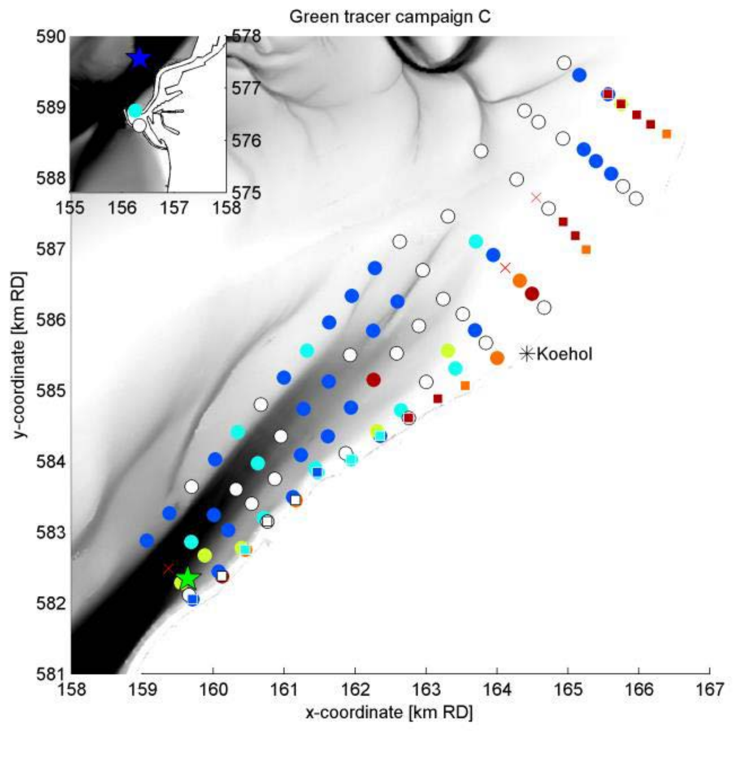




ovative solutions

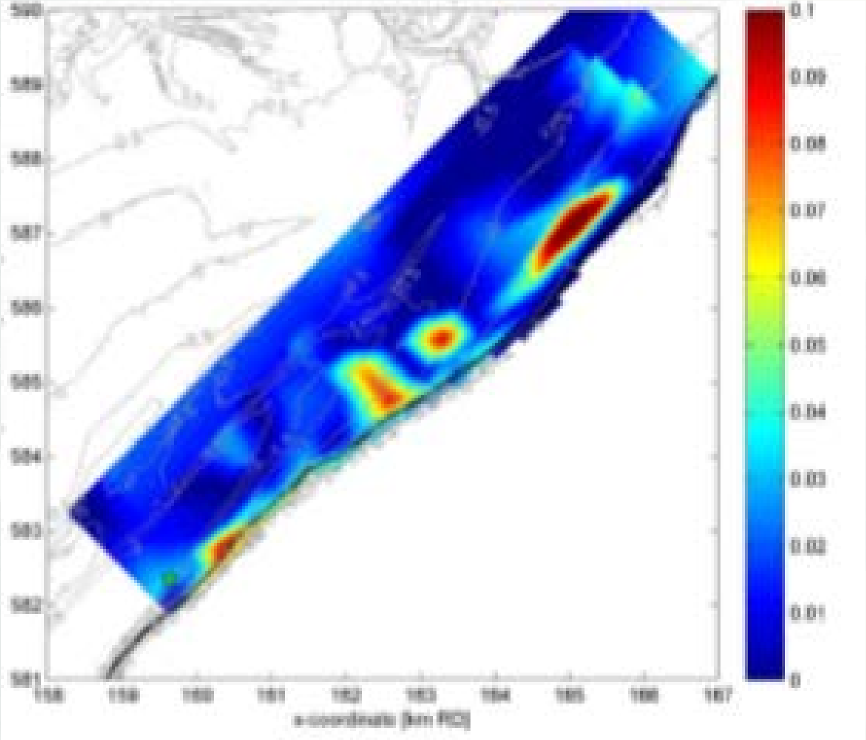
Wadden Sea, The Netherlands

- Modeling applied to evaluate alternatives
- 4-year monitoring to evaluate risks and benefits
  - Benthic community rapidly recovered
  - Fish and intertidal habitats unaffected
  - Mud dispersed over large area
  - Large demonstration required for monitoring



Wadden Sea, The Netherlands

- Monitor hydrodynamic conditions, sediment fate (tracer), ecosystem response
- Sediment placed nearer wetland will increase TSS and sedimentation in the wetland but must accept that only fraction deposits there
- Added Benefit: reduced channel infilling

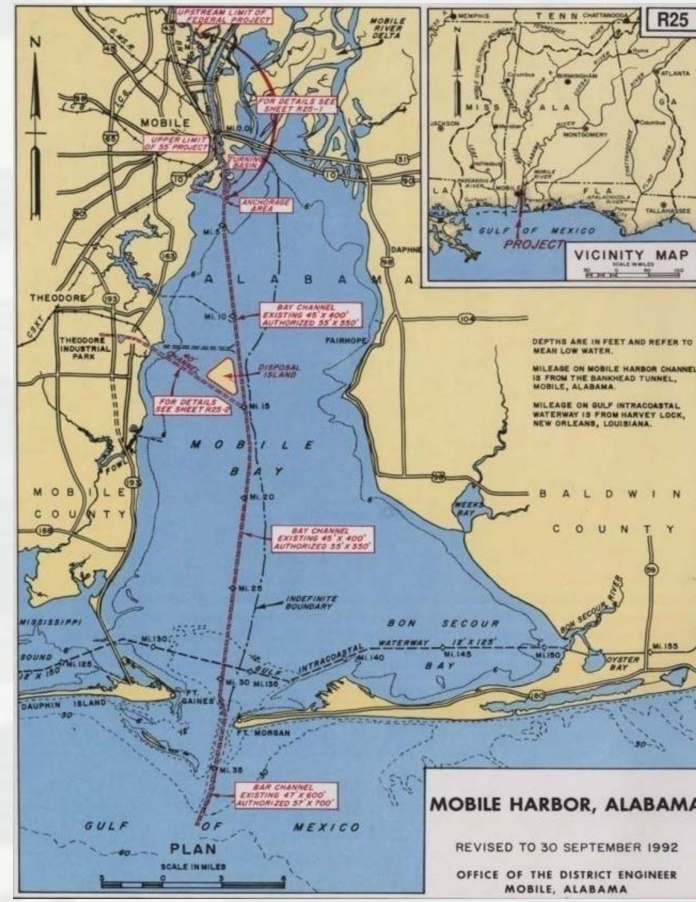


Wadden Sea, The Netherlands Lessons Learned

- Short term risks small and acceptable
- Dredged sediment dispersed over a wide area, including targeted intertidal zone
- Large uncertainty quantifying increased accretion based on tracer
- Present to stakeholders as a better business model
- Benefits derived from long-term change in practice, not short-term demonstration
- Possibly reduced channel dredge volumes due to placement far from channel

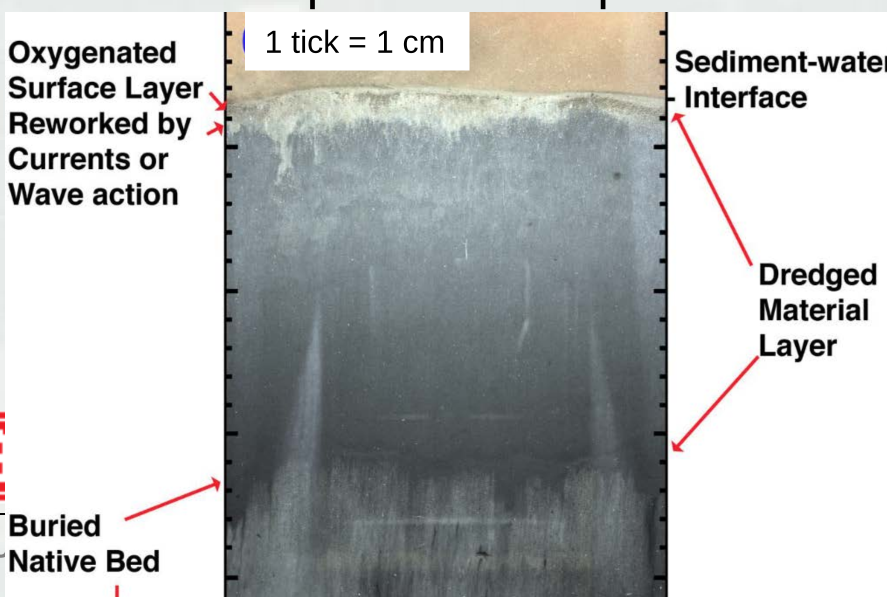
Mobile Bay, Alabama

- Mobile-Tensaw system is 6th largest river system in US
- Majority of dredged sediment placed in Bay until WRDA 1986
- Post-WRDA, all sediment placed in Gulf to improve Bay “environmental quality”
- ~ 4 Mcy annually transported up to 40 miles to ODMDS
- Bay is losing sediment ~ 1.6 Mcy/year (Byrnes et al, 2013)
- → Wetland loss and shoreline recession
- 2012 permission for emergency in-bay thin-layer placement → monitor construction and recovery
- 2014 permission for long-term in-bay placement approved



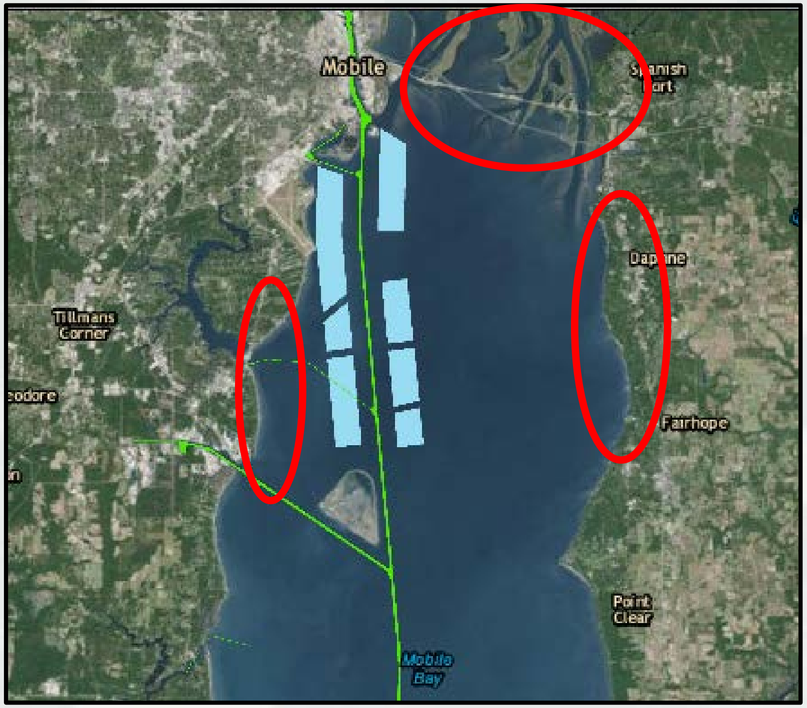
Mobile Bay, Alabama

- Channel-Adjacent thin layer placement only in 2012
- <1 ft placement to permit re-establishment of benthic organisms → better represent “natural” sedimentation
- Sediment placement, process and transport studies applied to evaluate placement options



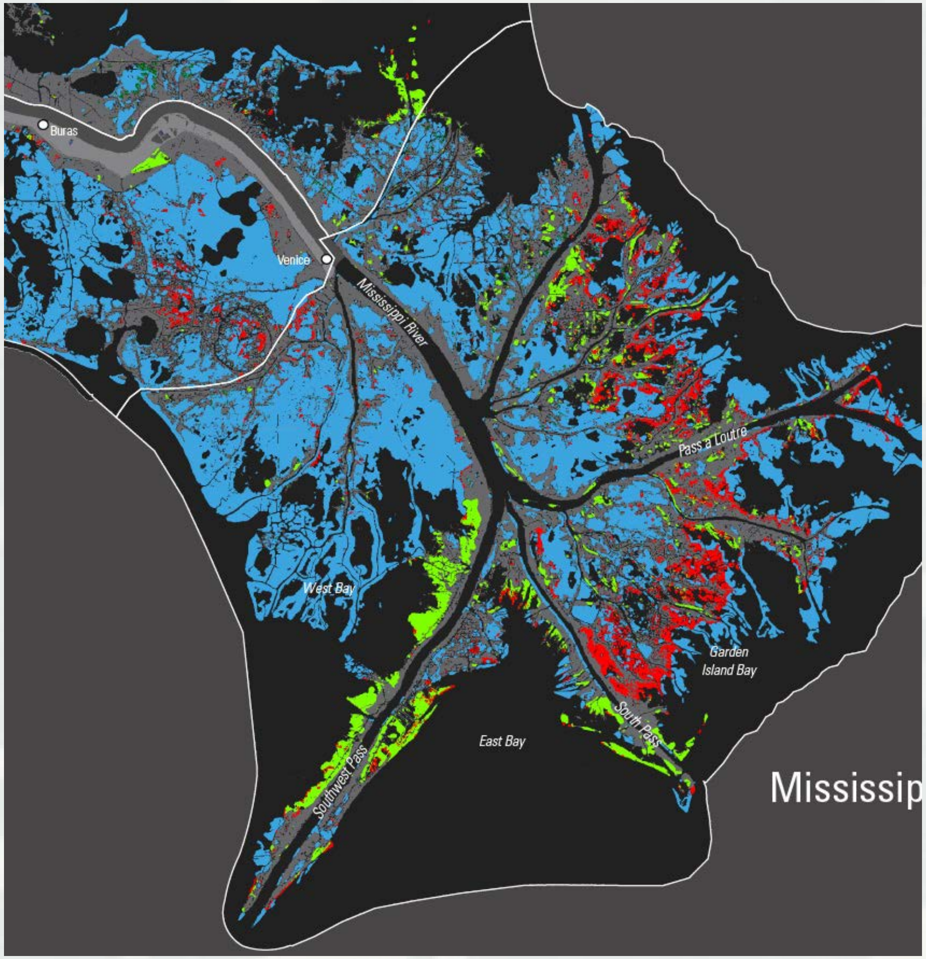
Mobile Bay, Alabama
Next Steps

- Use circulation/sediment transport model to identify placement sites that will increase dredged sediment supporting targeted resources
- Identify partners to address increased costs
- Monitor dredged sediment entering wetlands



Louisiana: West Bay Diversion

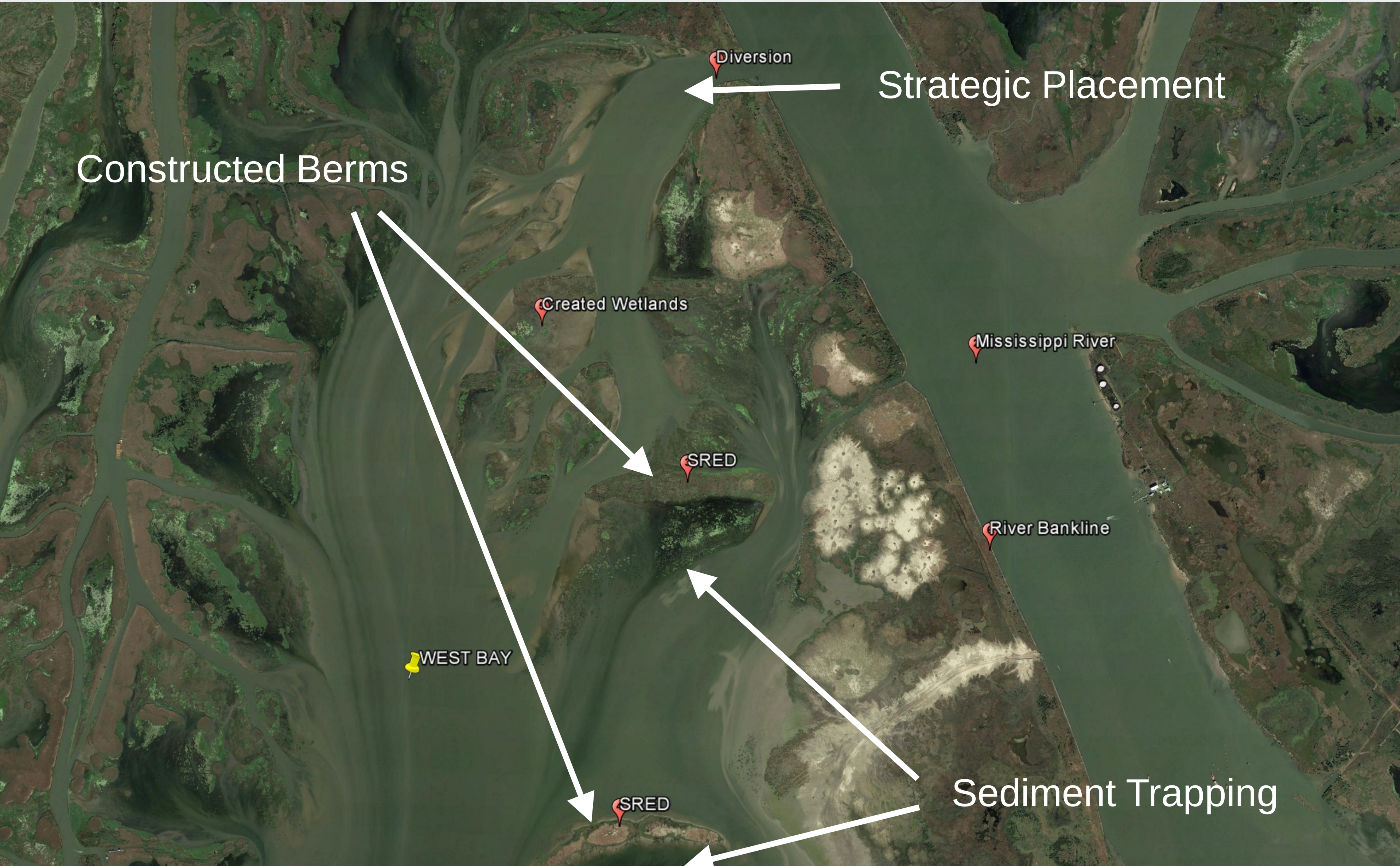
- Wetland loss at West Bay is threatening levee
  - Significant wetland loss
  - Multiple diversions on river designed for flood control
  - Navigation channel withholds sediment from diversions
- Place dredged material into diversion channels for dispersion when open



Louisiana: West Bay Diversion

- Dredged sediment placed in diversion to increase sediment load to targeted wetlands
- High velocity moved sediment past targeted resources
- Solution: Use dredged sediment to create features which slow current
- Monitor effectiveness at trapping sediment

Louisiana: West Bay Diversion



Mississippi River, Missouri

- Upland sites filled
- Alternative:
  - ▸ Place near-bank
  - ▸ Dynamic features

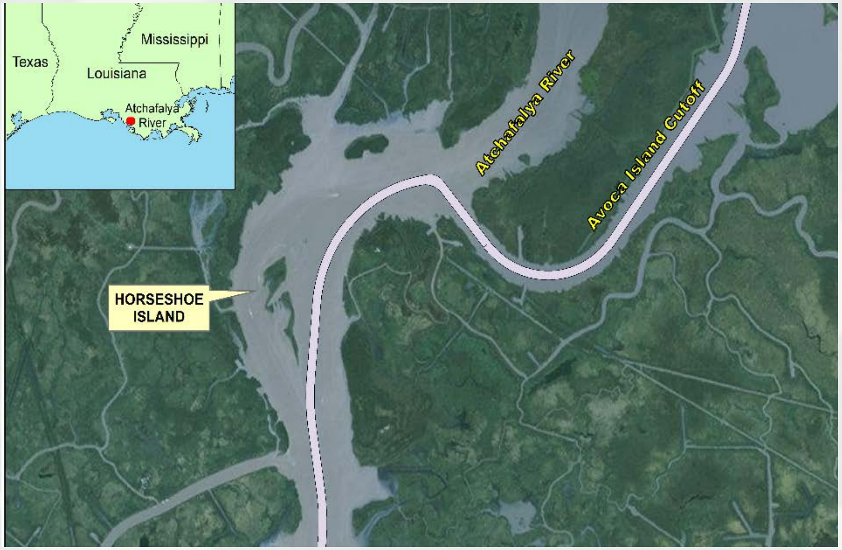
- Create bars and islands to protect eroding banks

- Sustainable solution to DMM: “dynamic” features permit reuse of the placement site
- Added benefit: diversify habitat

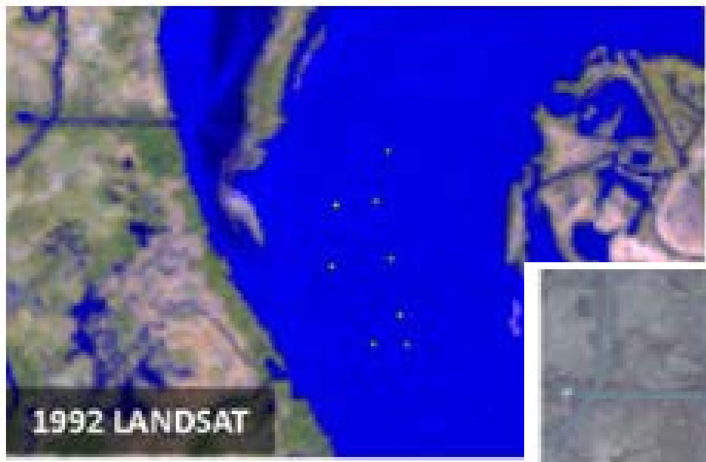
Mississippi River, Missouri

Horseshoe Bend, Louisiana

- 1990s: Placement at wetland development sites
- Site capacity filled by 1999
- Alternative placements
  - ► Convert wetland to upland
  - ► Long-distance pipeline to Atchafalaya Bay
  - ► Mounding of material mid-river
- Mid-river placement selected to investigate downriver shoaling
- Began mid-river placement in 2002
- Monitor island development (acreage, habitat, soils, etc…)
- USACE EWN Project, certified by PIANC as a WwN project



Horseshoe Bend, Louisiana



From Suedel et al, 2015

Horseshoe Bend Modeling

Suspended solids transport 01-03 2012 ($m^3/m/s$)

Bedload transport 01-03 2012

From Suedel et al, 2015

- Understand hydrodynamics in channel, at placement site, and at island
- Quantify potential for transport from placement site to island
- Quantify stresses that move sand in the channels
- Evaluate changes to channel infilling

Strategic Placement Summary

- Sustainable and better sediment management practice
- Supports broader USACE RSM/EWN/BU goals
- Supports FRM and Ecosystem Restoration missions
- Requires stakeholder engagement
- Managing expectations is critical
- Used in combination with other measures to partially address sediment deficits
- Placement design is critical to maximizing benefits while minimizing costs and risk
- Monitoring and modeling support design