Beneficial Use of Muddy Dredged Sediment in the U.S.

Joseph Gailani, PhD
US Army Corps of Engineers
Engineer Research and Development Center, Vicksburg, MS
Joe.Z.Gailani@usace.army.mil

11th International SedNet Conference
Dubrovnik, Croatia
April 5, 2019

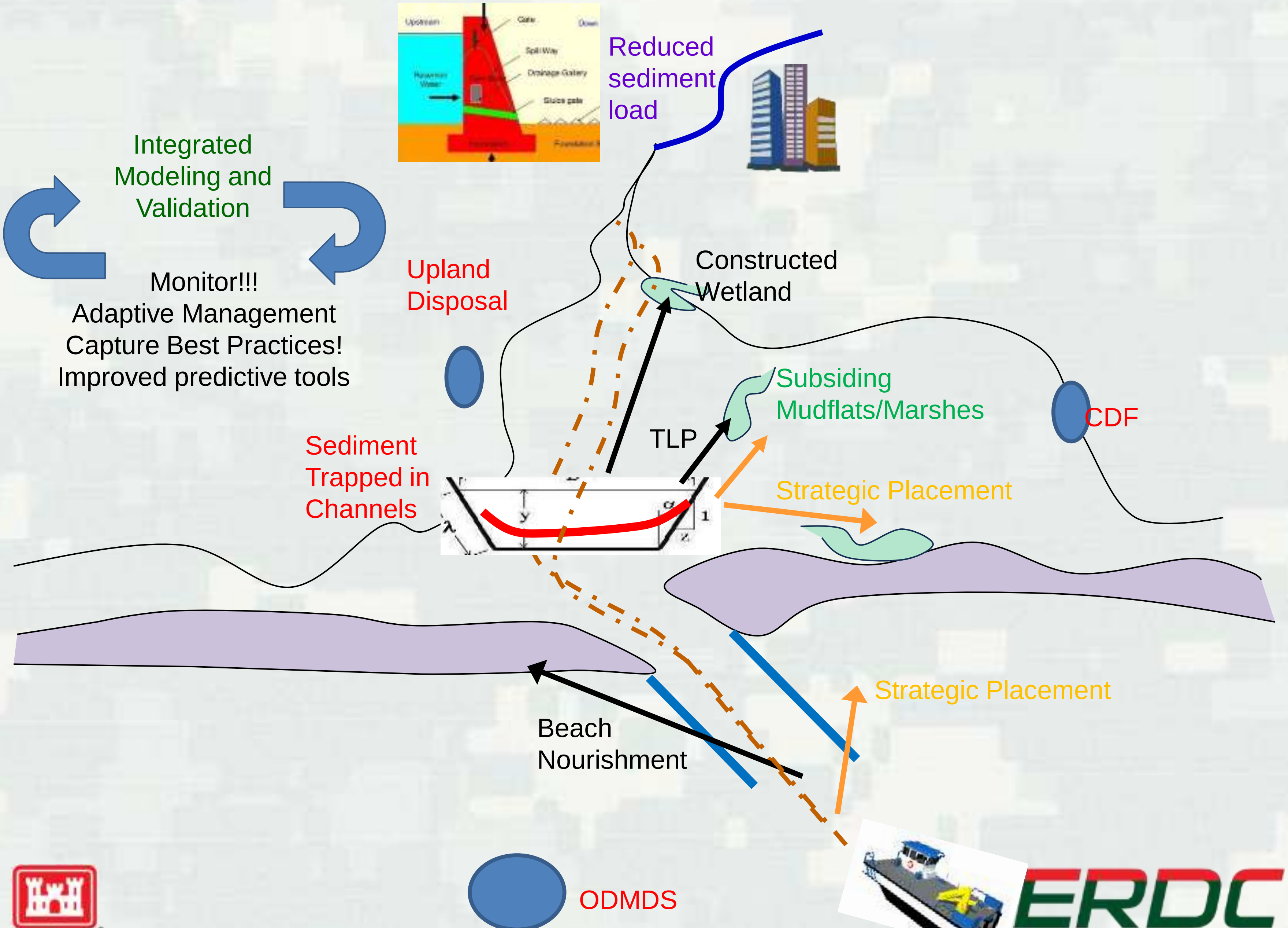
ERDC
Engineer Research and Development Center

US Army Corps of Engineers

Dredged Sediment Management and Resilience

Cross-mission = Cost Savings

- USACE dredges over 200MCY/yr
- ~ 30% used beneficially
- USACE has multiple missions
- BU support FRM and ecosystem missions while simultaneously supporting navigation
- Challenges to BU projects in US
  - Increased costs
  - Planning/coordination between navigation and restoration projects
  - Regulatory framework**s**
  - Perception of DM – especially muddy sediment
  - Cost-share partners


Reduced sediment load
Integrated Modeling and Validation
Monitor!!!
Adaptive Management
Capture Best Practices!
Improved predictive tools
Upland Disposal
Constructed Wetland
Subsiding Mudflats/Marshes
CDF
TLP
Sediment Trapped in Channels
Strategic Placement
Strategic Placement
Beach Nourishment
ODMDS
ERDC

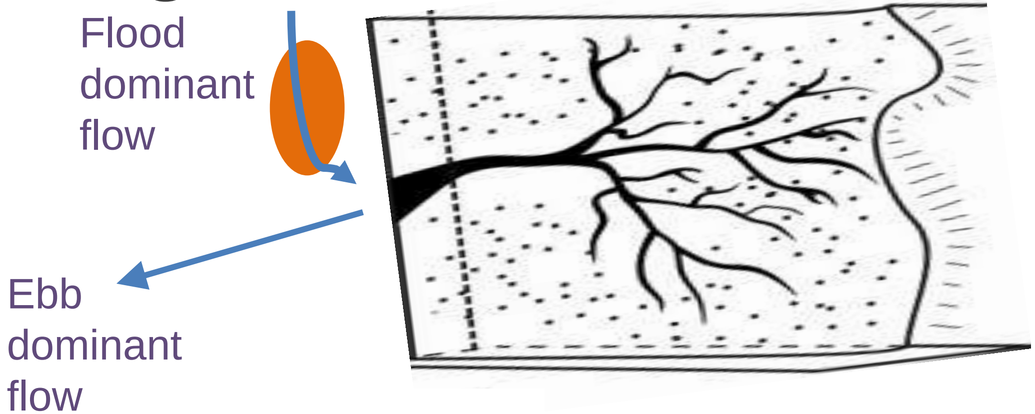
Dredged Sediment Strategic Placement

Definition

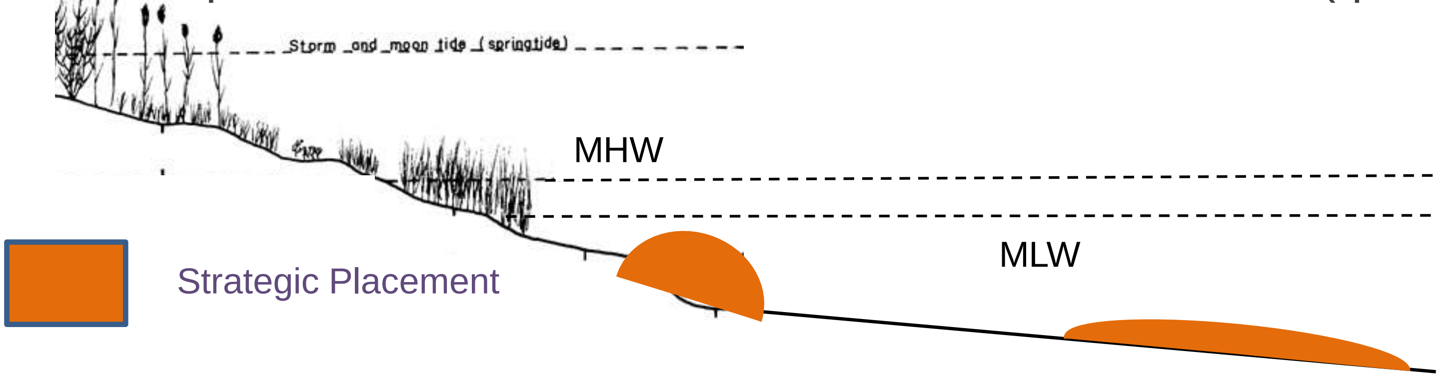
The process of placing dredged sediment in open water at one location with the expectation that hydrodynamic forces will transport sediment to targeted receptor sites.

- Compliments construction and TLP – does not replace it
- Target resources most in need of sediment
- Cost-effective compared to direct placement/construction
- Permit nature to do the “heave lifting”, sorting, etc
- Less intrusive at the receptor site
- Ongoing sediment source to receptor site – mimic natural processes
- Renewable placement site capacity
- Increase volume of dredged sediment used beneficially

Strategic Placement
Supporting resilient mudflat/marsh systems



Strategic placement features are dynamic – can attenuate waves, provide sediment source, and create diverse habitat (quiescent areas)



ERDC

Innovative solutions for a safer, better world

Strategic Placement and Federal Standard

Dredged material management in the US is required to meet the "Federal Standard"

- This law requires that dredged material be managed in the 'least cost, sound engineering, environmentally acceptable' manner
- "environmentally acceptable" provides some flexibility, but was generally not used to address coastal resilience or ecosystem restoration
- Strategic placement cost can be similar to non-beneficial disposal
    - Reduced hauling distance/time vs. offshore placement
    - Lower carbon foot print
- Placement sites highly dispersive – renewed capacity each dredging cycle
- Laws related to cross-mission benefits need to be refined

Strategic Placement – Stakeholder Engagement

When discussing with stakeholders:

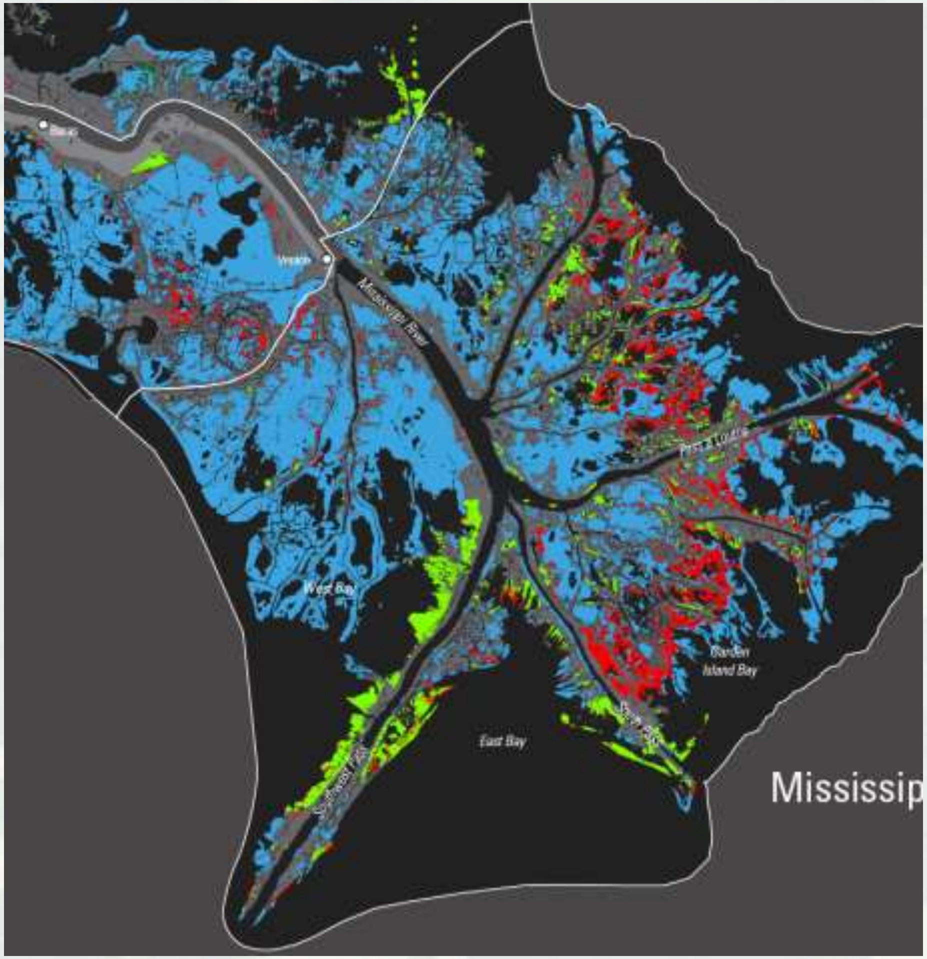
- Build the case
  - Present practice: system will continue to degrade
  - Decades of DMM experience permit us to manage risk
  - Compliments other strategies – does not replace construction
- Manage expectations
  - Unlike construction, benefits may be harder to quantify
  - Practices that mimic natural processes difficult to measure
  - One component of identified solution
- Monitor for:
  - Ecosystem response and diversity
  - Suspended solids and accretion
  - Morphologic evolution
- Better way of doing business → keep sediments in the regional system, mimics "natural" sediment distribution

Developing a Site Plan

- Engage stakeholders early – involvement in decision making process
- Understand the system
  - Evolution since anthropogenic interference
  - Identify where sediment is going
  - Circulation – capacity and directions of transport
  - Evolution of ecosystem – past/present/future
  - Identify where sediment is needed
- Predictive tools to evaluate strategic placement alternatives
  - Risk characterization (include “no-action” scenario)
  - Long-term benefits
  - Cost/sustainability
- Identify most promising alternatives
- Living Laboratory – follow the Dutch example!
  - Location(s) to evaluate strategic placement options
  - Obtain stakeholder/regulator concensus for demonstrations
  - Being adopted at Avalon, NJ and Galveston, TX

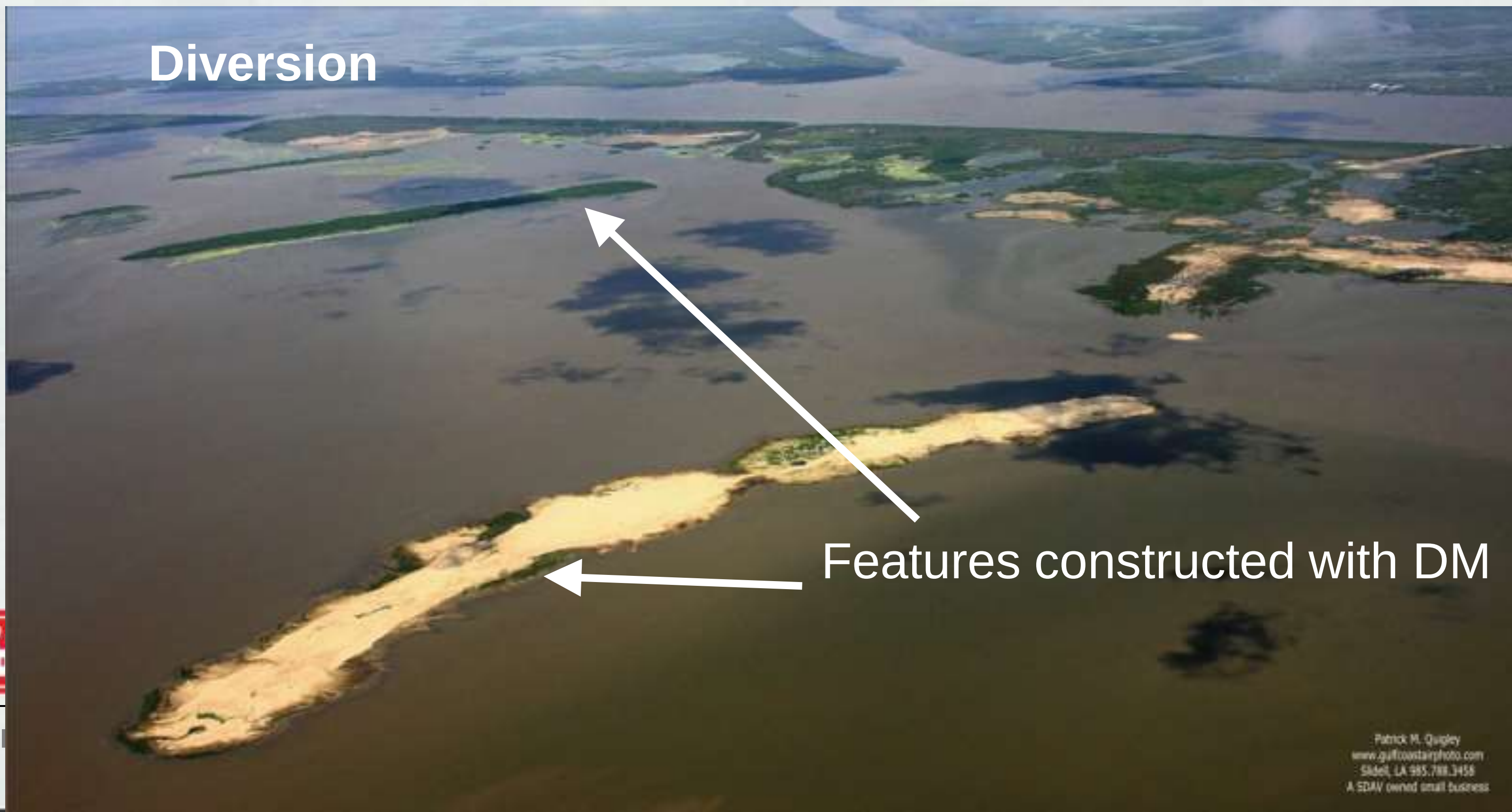
Example: West Bay Diversion

- Louisiana wetlands isolated from wetland sediment source
  - Significant wetland loss
  - Multiple diversions are designed for flood control
  - Navigation channel withholds sediment from diversions
- Place dredged sediment into diversion channels
- Monitor benefits



Example: 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



Example: West Bay Diversion

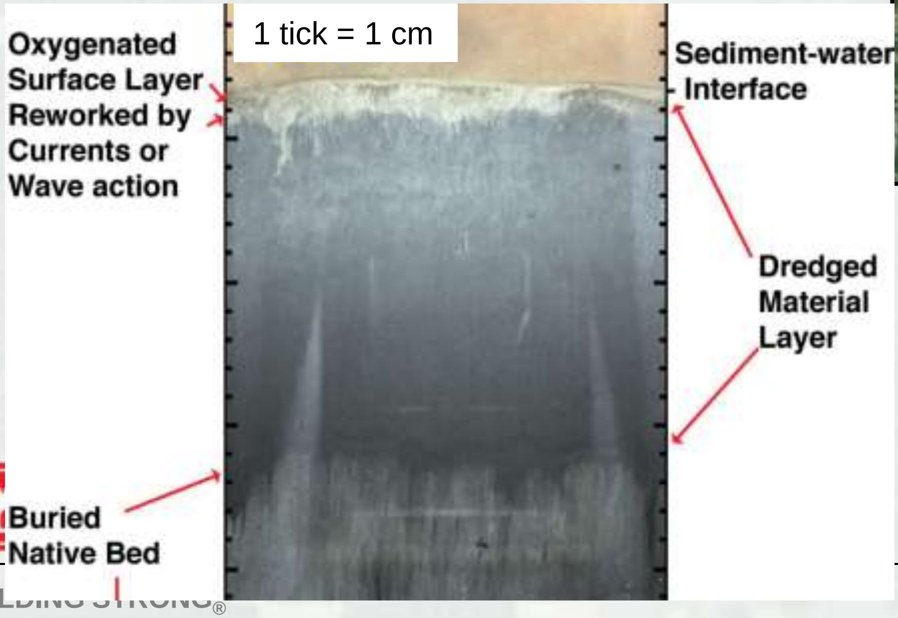
Mobile Bay, Alabama

- 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
- Sediment Budget: Bay is losing sediment ~ 1.6 Mcy/year (Byrnes et al, 2013)
- 2012 permission for emergency in-bay thin-layer placement → monitor ecosystem response

- 2014 permission for long-term in-bay placement approved

Mobile Bay, Alabama

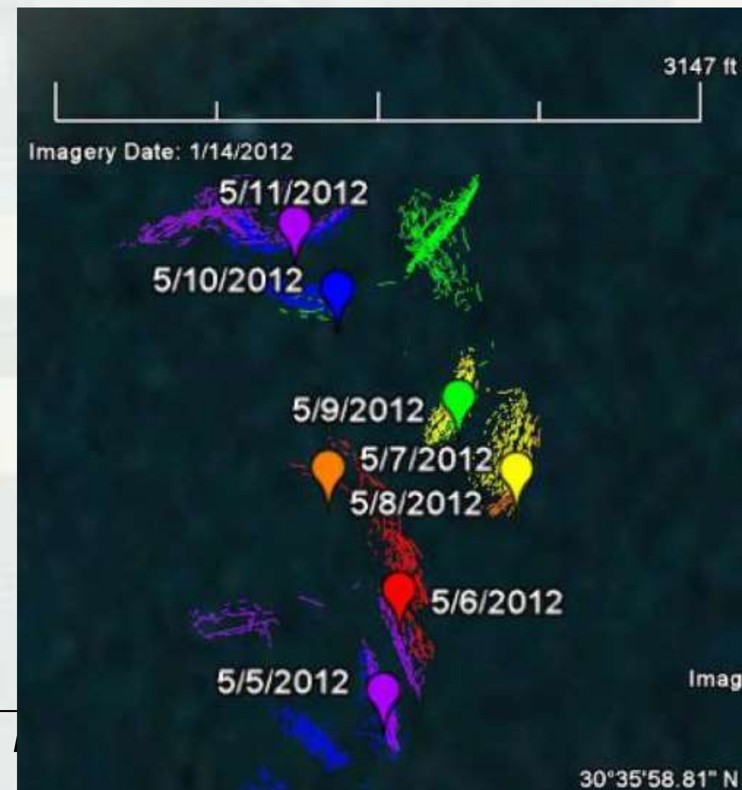
- Channel-Adjacent thin layer placement in 2012
- <30 cm placement to permit benthic organism migration
- Sediment placement, process and transport studies applied to evaluate placement options



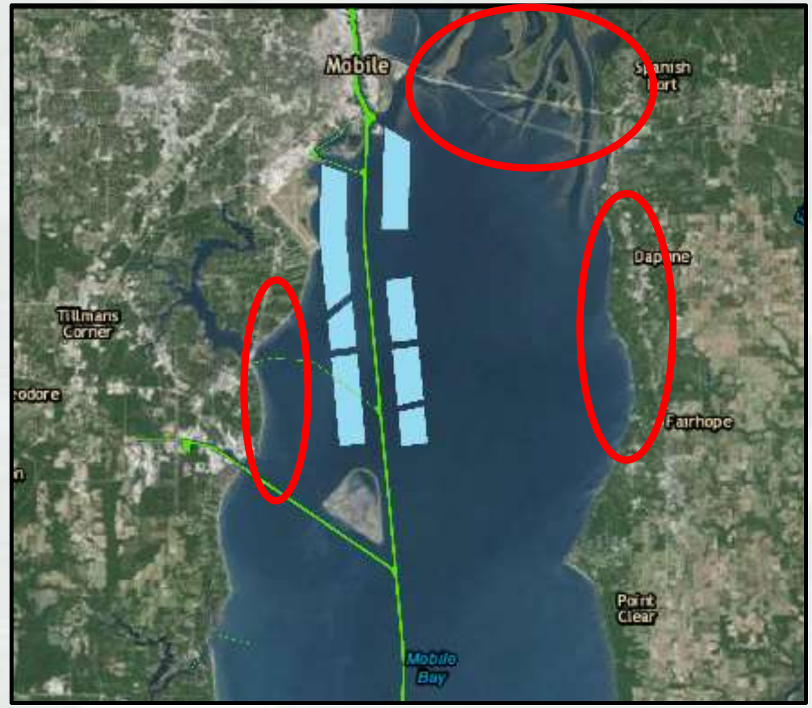
PLACEMENT TIMELINE

- 200 SPI stations
- 185 push core stations
- Monitoring started at 24-hours post-placement and continued for six months
- cross-referencing SPI, core, and pipeline station coordinates to improve placement practice
- Normalize practice 2012-present

DOWNTURNED PIPELINE TERMINUS



Mobile Bay, Alabama
Next Steps



- Use circulation/sediment transport model to identify placement sites that will increase dredged sediment fraction supporting wetland resources
- Identify partners to address increased costs
- Monitor evolution/fate of placed sediment
- Develop sustainable practice

SF Bay - Background

- History
  - Significant wetland complex
  - Much of this was diked in the late 19^{th} and early 20^{th} centuries
  - Hydraulic mining in 19^{th} century increased sediment load into Bay – resulting in thick, contaminated deposits in some areas
  - Increased TSS also sustained remaining wetlands
- Present/Future
  - ~ 50% reduction in TSS since 1980s (Schoelhamer 2011)
  - Wetlands are threatened by combined SLR and reduced TSS
  - Diked lands being restored to wetland
  - Beneficial use proposed to support both existing and restored wetlands

Wetland Construction – SF Bay

- 2600 acre wetland restoration on former wetland diked in late 19th Century
- Farmland converted to AAFS in early 20th Century
- Subsidence resulted in land below MLLW
- 6MCY of navigation dredged sediment placed to increase elevation
  - Promote sediment recruitment to obtain required elevation for wetland plants
  - Berms constructed to reduce fetch and encourage accretion
  - Monitor and model


Vallejo
San Rafael
Berkeley
Angel Island
San Francisco
San Francisco Bay
Pacifica
San Mateo
Breach
3000 ft
N

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/island creation
- Began mid-river placement in 2002
- Monitor island development (acreage, habitat, soils, etc…)
- USACE EWN Project, certified by PIANC as a WwN project

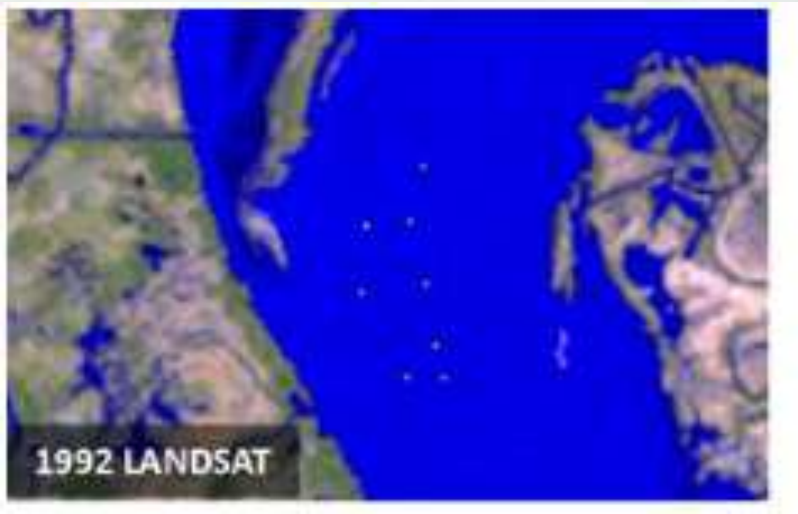
From Berkowitz et al, 2015

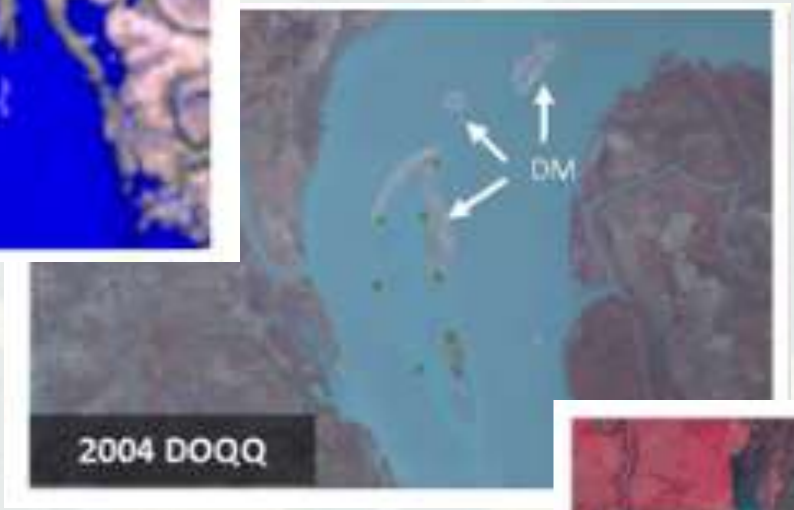
Horseshoe Bend, Louisiana

- 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

Evolution of Horseshoe Bend Island





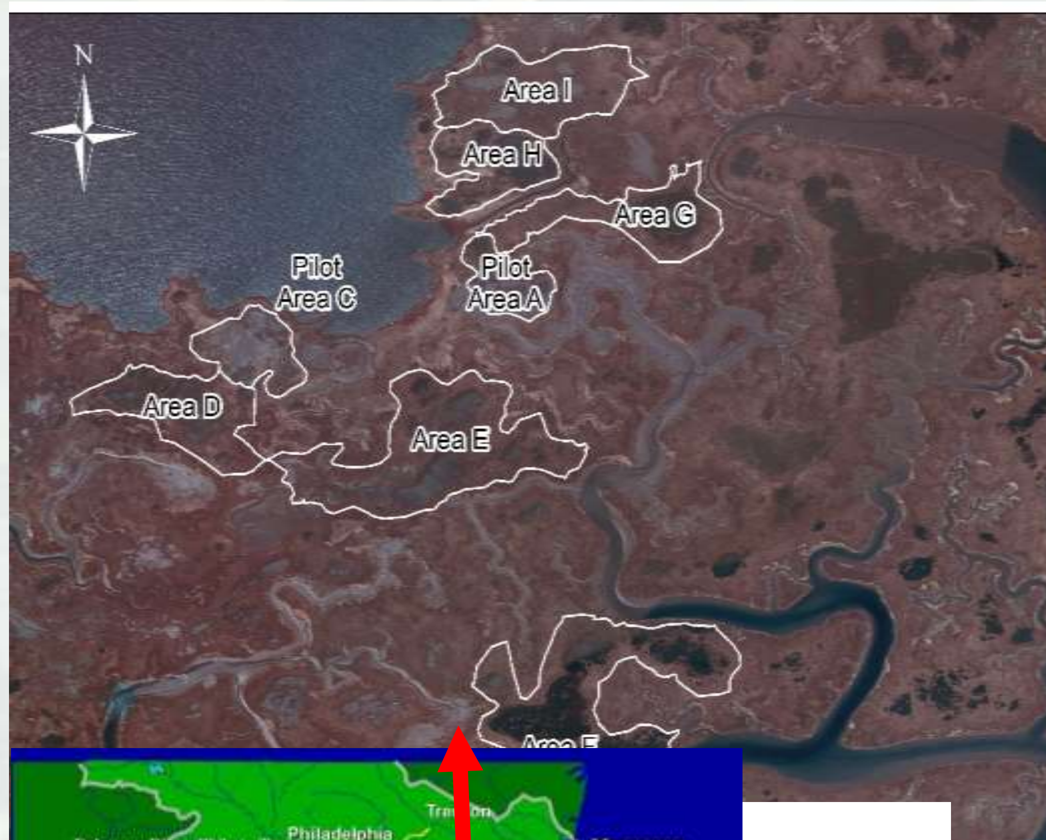
2013

2014

From Suedel et al, 2015

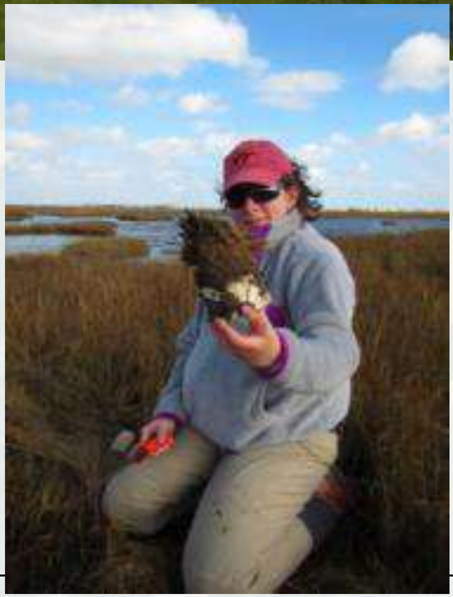
Avalon, New Jersey

- Reduced mineral sediment input
- Subsidence and marsh fracturing
- Loss of FRM and ecosystem benefits
- Apply navigation dredged sediment to fill pools/pannes forming in marsh interior
- Monitor over multiple years
- Two phases
- Pipeline placement – block flow into vegetated areas



Avalon, New Jersey

Avalon, New Jersey



- Some plant die-off near fill site
- Recovery after ~ 2 years
- Temporary change in pH
- Confinement structure inhibited creation of elevations that represent natural marsh
- Positive feedback resulted in stakeholder support for “living laboratory” at Avalon

Summary

- Combine strategic and direct placement to increase BU
- Do not over-engineer strategic placements
- Design to support multiple missions simultaneously
- Communicate and manage expectations
- Placement design is critical to maximizing benefits while minimizing costs and risk
- Monitoring and modeling can support design and develop guidance (physical and ecology)

Dredged Sediment Management for Resilience

Increased BU can support USACE FRM and ecosystem missions while simultaneously supporting navigation.

- Most dredged sediment is acceptable for BU
- Beneficial use of dredged sediment
    - Construction
    - Direct Thin-Layer Placement (TLP)
    - Strategic Placement
    - Other methods