Thin Layer Sediment Placement: Evaluating an Adaptation Strategy to Enhance Marsh Resilience Across the NERRS

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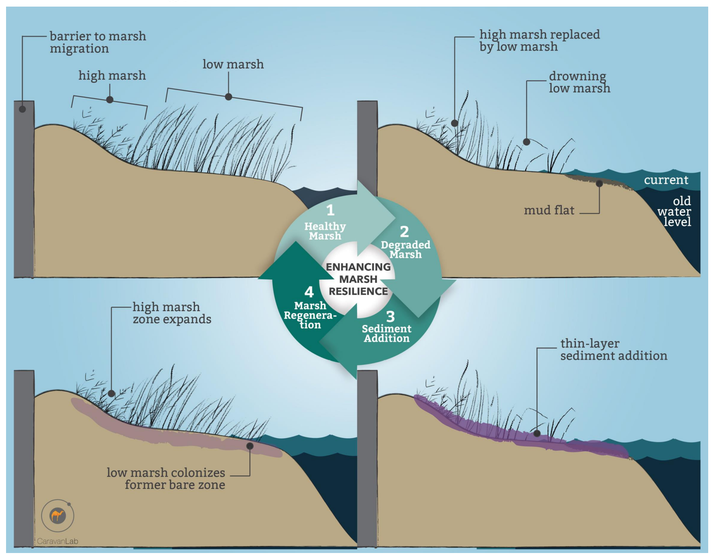
Greenhouse Experiment Lead: Elizabeth Watson, Drexel University, PA.

Introduction

Tidal marshes provide key ecosystem services, but are threatened by sea level rise. Eight NERRs are conducting replicated restoration experiments examining the effectiveness of thin-layer sediment placement (TLP) as a climate adaptation strategy to increase the resilience of these important ecosystems. While raising elevation is predicted to protect marshes from drowning, and is the basis for an increasing number of large-scale restoration projects that use sediment to protect and restore marshes, results from recent sediment addition projects have been variable and hard to find. Coastal managers and decision makers, including NERR staff, have expressed a need for better, clearly communicated science to determine conditions where sediment addition is an effective strategy to enhance marsh resilience.



Project Approach and End User Engagement

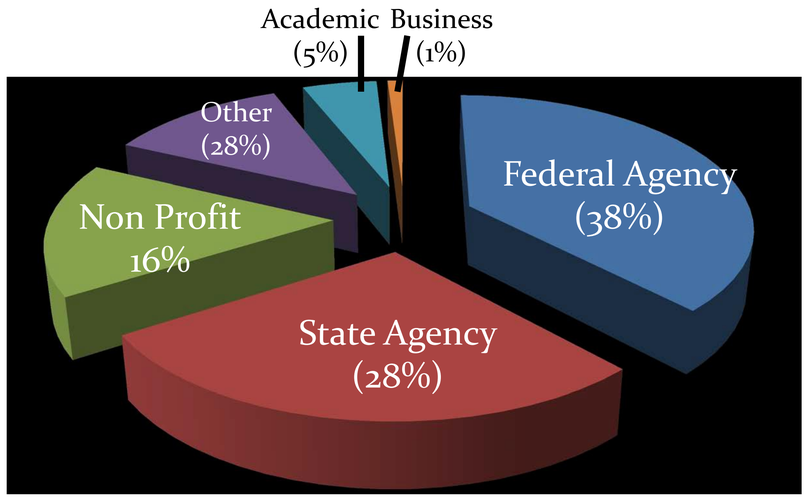
A collaborative learning approach will be used to structure and manage a process that encourages and accommodates effective ongoing collaboration and iteration between the project team, an external advisory committee, and end users, to ensure participation at all stages of project.

Advisory Committee

- Nicole Carlozo, MD DNR
- Caitlin Chaffee, RI Coastal Resources Management Council
- Jo Ann Muramoto, Association to Preserve Cape Cod
- Elizabeth Murray, US Army Corps of Engineers
- Richard Nye, US Fish and Wildlife
- Christina Tome, SFB Regional Water Quality Control Board
- Robert Tunstead, NJ Natural Resources Conservation Service
- Jim Turek, NOAA Restoration Center
- Cathy Wigand, US EPA Atlantic Ecology Division

Surveyed End Users

- An initial project survey was completed by 86 individuals representing a variety of organizations, as shown below. Follow-up interviews were conducted with 32 of those individuals to obtain additional input..



Core Research Questions

- Is sediment addition an effective adaptation strategy for marshes facing SLR?
- How does marsh resilience respond to different levels of sediment addition? and
- How do low versus high marsh habitats differ in response to sediment addition?

Experimental Design

Experimental Treatments

- Elevation (high and low; all sites)
- Sediment thickness (7 cm and 14 cm; all sites)
- Biochar (3 sites)
- Sediment type (quarry vs dredge; 2 sites)

Experimental Sampling Design

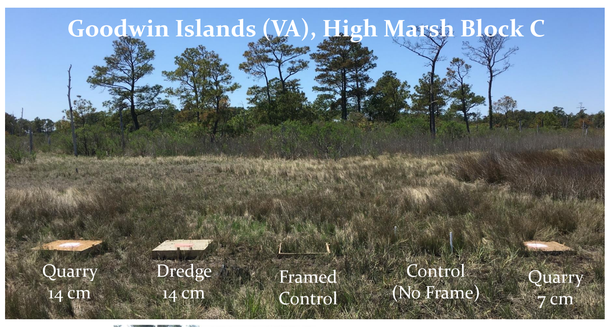
- Blocked design
- 2 types of controls (frame and no frame)
- n=10 blocks (5 each in high and low marsh zone)
- 5 replicates for each treatment and control type
- 10 target reference plots
- Total n=50-60 plots per site

Monitoring Components

- Vegetation (cover, composition, canopy height)
- Crabs (burrow density and presence)
- Elevation (referenced to project benchmarks)
- End of Study (pore water chemistry, soils, accretion)

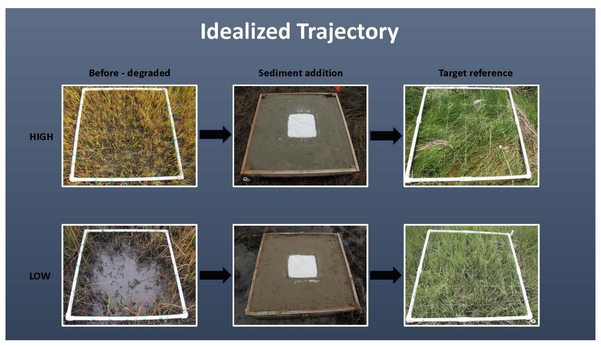
Project Timelines

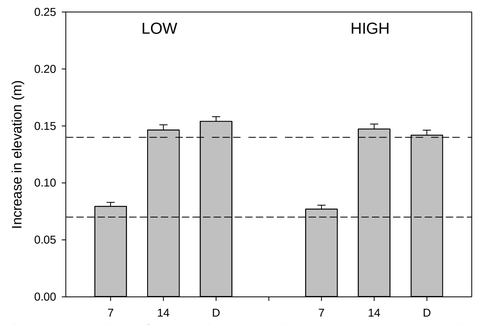
- Pre-restoration monitoring in Fall of 2017 or Spring of 2018
- Sediment addition in Spring of 2018 at all sites.
- Elevation surveys immediate after sediment addition
- Vegetation and elevation data collected every six months.



Vegetation Monitoring

Sediment Addition

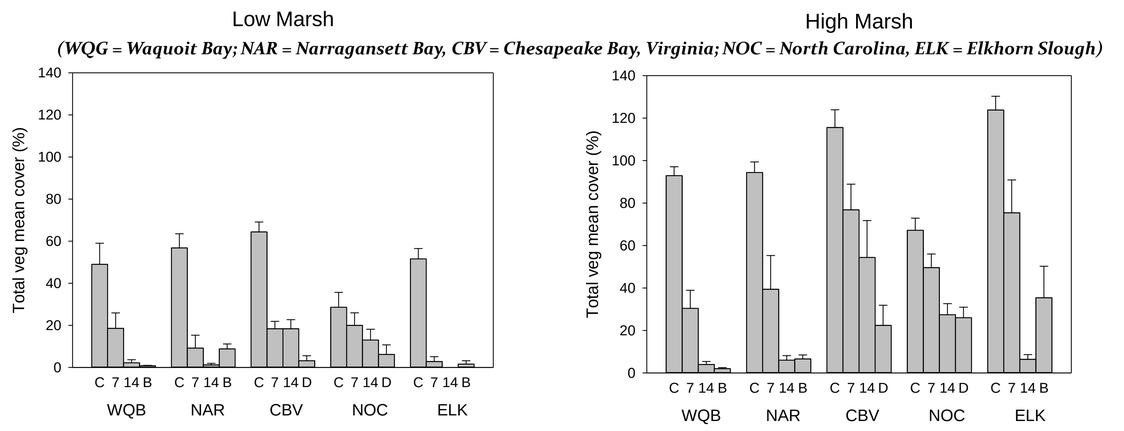




Example survey data from Chesapeake Virginia post sediment addition. Data indicates target plot elevations were slightly exceeded in each category (7 cm, 14 cm, and dredge sediment addition) across both marsh zones. At other sites, plot elevations slight below targets (compaction issues).

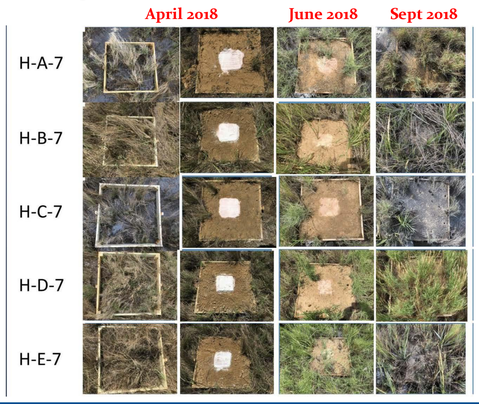
Preliminary Vegetation Results

(WQG = Waquoit Bay; NAR = Narragansett Bay, CBV = Chesapeake Bay, Virginia; NOC = North Carolina, ELK = Elkhorn Slough)



Data from 5 Reserve Sites from 2018 Fall Sampling (approximately 5 months post sediment addition). Treatments include 7-cm quarry sediment addition plots (labelled "7"), 14-cm quarry sediment addition plots (labelled "14"), 14-cm biochar addition plots (labelled "B"), and 14-cm dredged sediment plots (labelled "D"). Control Plots (labelled "C") represent both framed and unframed plots. Point intercept methods were used to calculate percent cover. Data represents average sums across all plots in the different treatments. Data for species were summed within each plot explaining > 100% cover in certain treatments. Initial data indicate slower recovery in the low marsh plots (compared to high marsh plots) and faster recovery in the thinner addition plots (7-cm) than 14-cm plots across both marsh elevations. Note: Potential "edge effect" issues are being addressed.

Goodwin Islands (Time Series Photos)
High Marsh Blocks (7 Cm Addition)



Some Challenges Encountered in Field Plots....

Companion Greenhouse Study

Q1: Does salt marsh plant growth vary among benthic sediments of varying textures and in quarry fines?

- **Preliminary Result: Yes. *Spartina* spp. photosynthetic rate highest in quarry fines.**

Q2: Does biochar ameliorate acid sulfate conditions?

- **Preliminary Result: No.**

Q3: Do additions of biochar and compost facilitate plant regeneration?

- **Preliminary Result: No. Spartina spp. grow best in raw sands.**

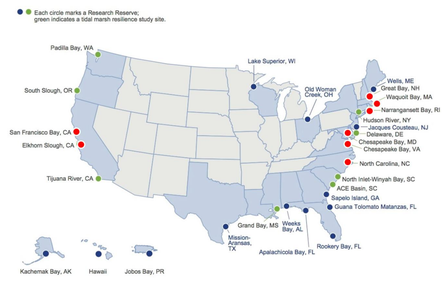
Sediment Textures (% Clay/Slit/Sand)

- **Benthic Sandy Mud (30 / 53 / 17)**
- **Benthic Muddy Sand (9 / 26 / 65)**
- **Benthic Sand (2 / 3 / 95)**
- **Quarry Fines (1 / 5 / 94)**

End Users and Anticipated Products

- **Technical report and publications detailing the restoration methods, experimental design, monitoring results, and lessons learned to inform future projects;**
- **Easily transferrable monitoring protocol for projects designed to enhance marsh resilience through sediment addition;**
- **Consensus statement on thin-layer sediment addition identifying conditions and sites where this strategy will be most successful in bolstering marsh resilience;**
- **Synopsis of permitting considerations;**
- **User-friendly summary, presentations,**
- **and outreach materials.**

Participating Sites and Funding Sources



- **Chesapeake Bay NERR, Maryland**
- **Chesapeake Bay NERR, Virginia**
- **Elkhorn Slough NERR, California**
- **Great Bay NERR, New Hampshire**
- **Narragansett Bay NERR, Rhode Island**
- **North Carolina NERR, North Carolina**
- **San Francisco NERR, California**
- **Waquoit Bay NERR, Massachusetts**

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