NCCOS | NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

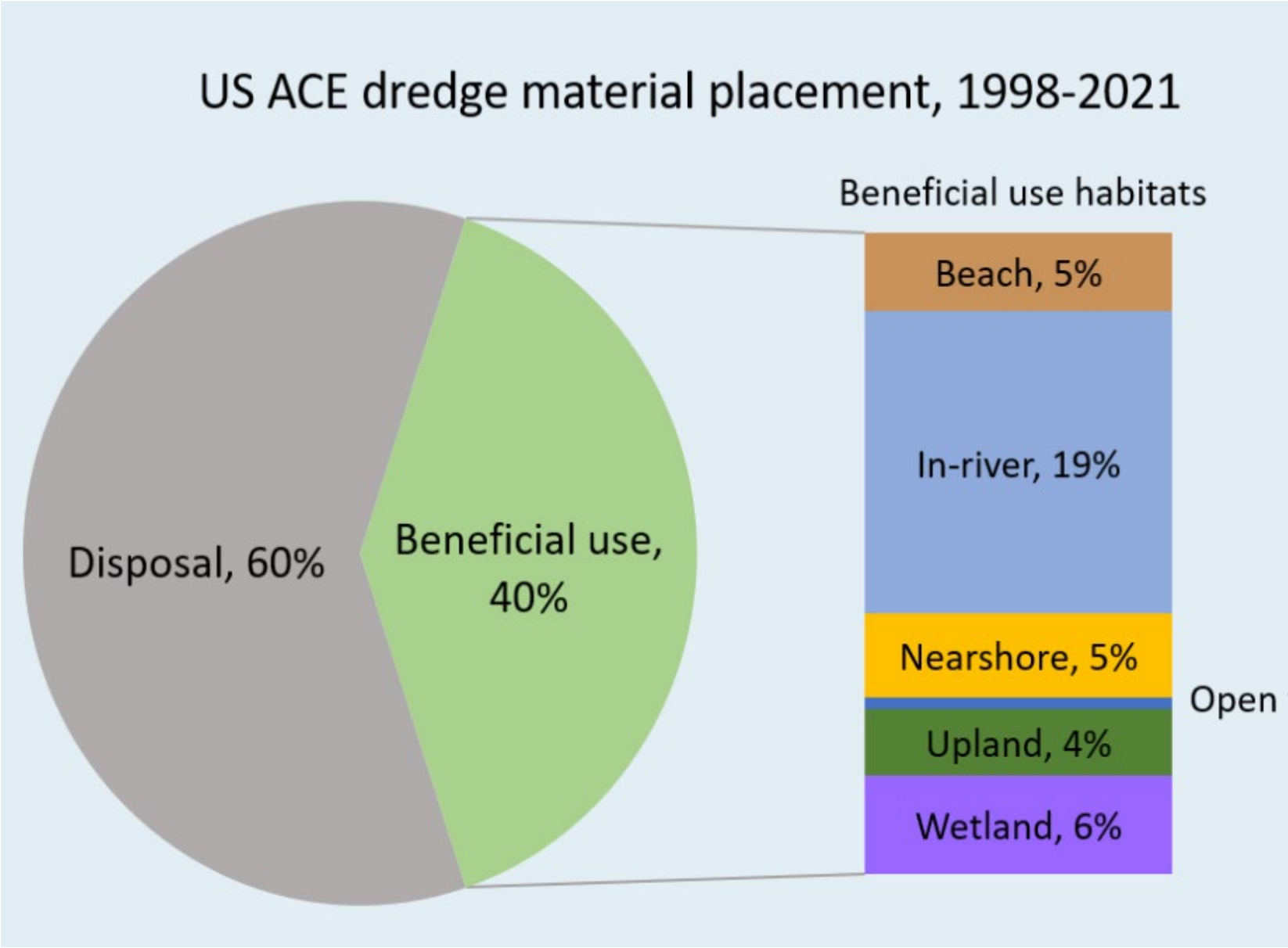
Beneficial Use of Sediments for Habitat Restoration & Creation

Jenny Davis
jenny.davis@noaa.gov

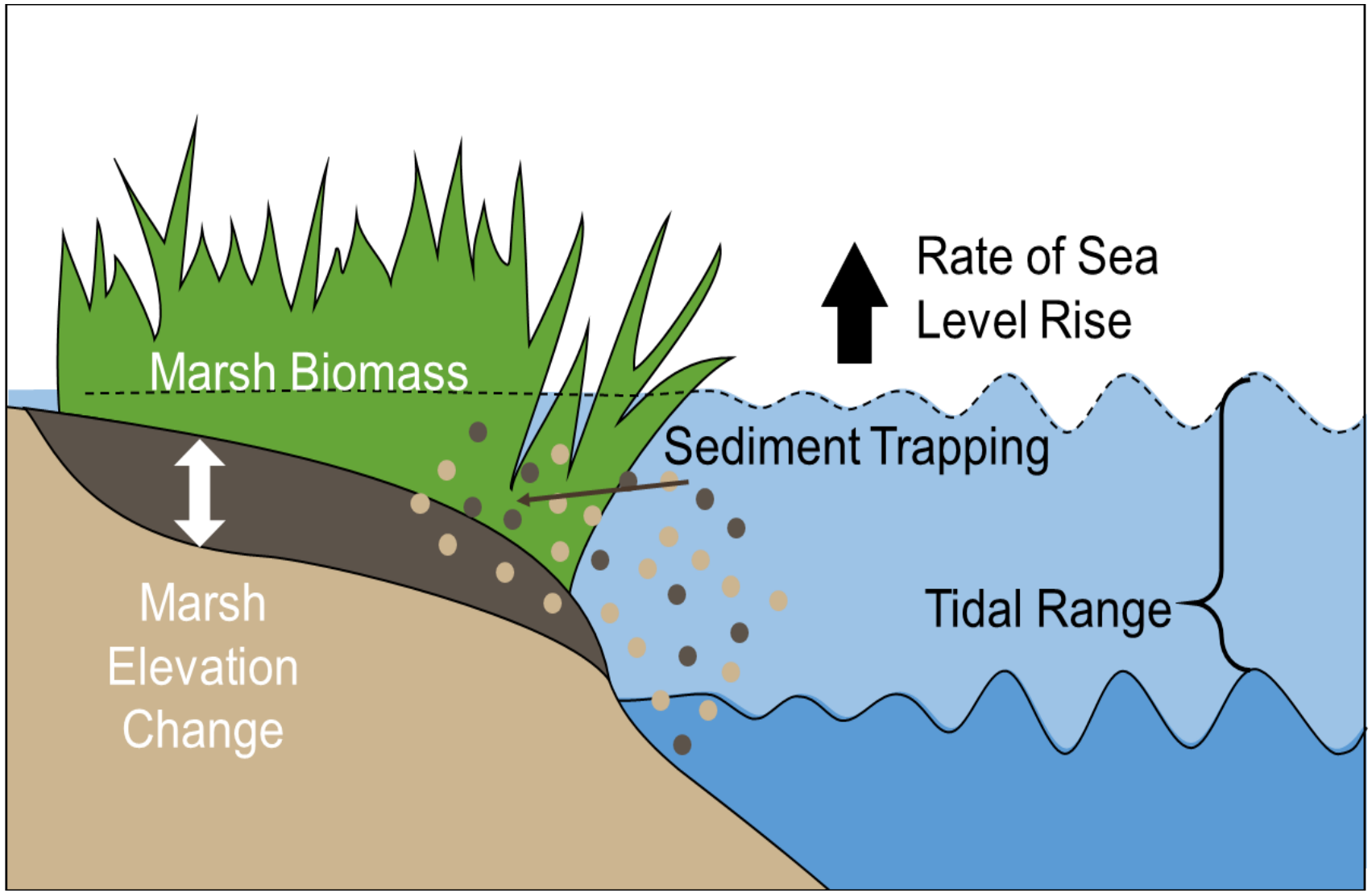
~ 200 million yd^3 of sediment removed from navigation channels annually

Beneficial Use

"productive and positive uses of dredged material, which cover broad use categories ranging from fish and wildlife habitat development, to human recreation, to industrial/commercial uses" (USACE Beneficial Uses of Dredged Material, Engineer Manual 1110-2-5026).



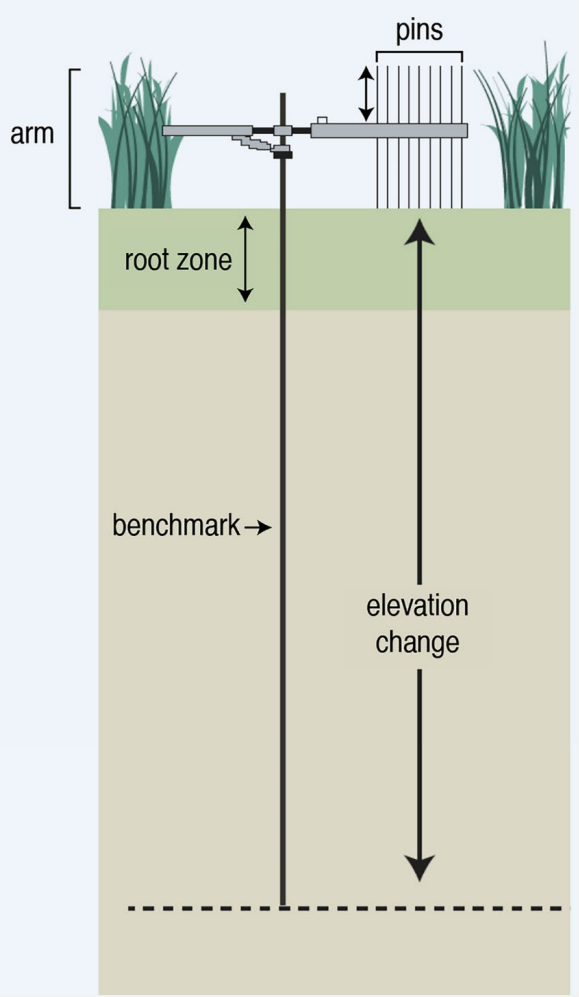
Meanwhile….Sediment is a Critical Resource for Vegetated Coastal Habitats



Coastal wetlands remain in place despite rising sea levels by trapping sediment from the water column; faster sea level rise means more sediment needed to keep up

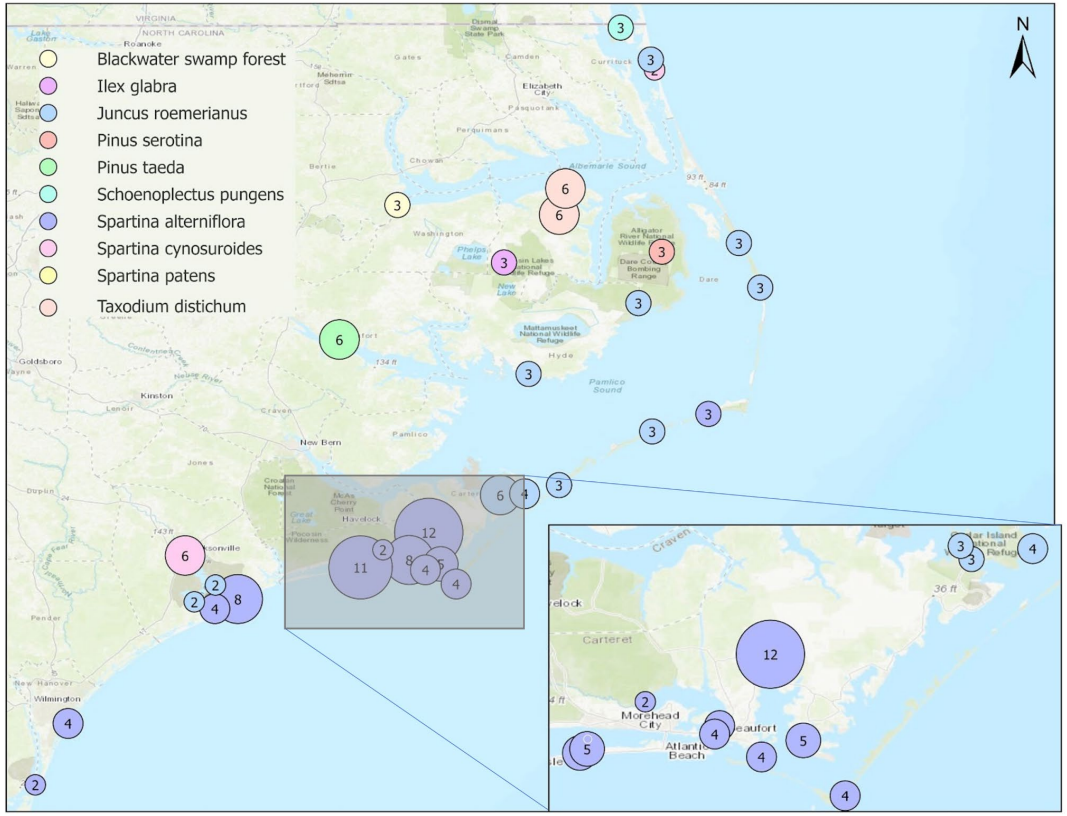
Surface Elevation Tables Provide High Resolution Measures of Marsh Elevation Change

Surface Elevation Table



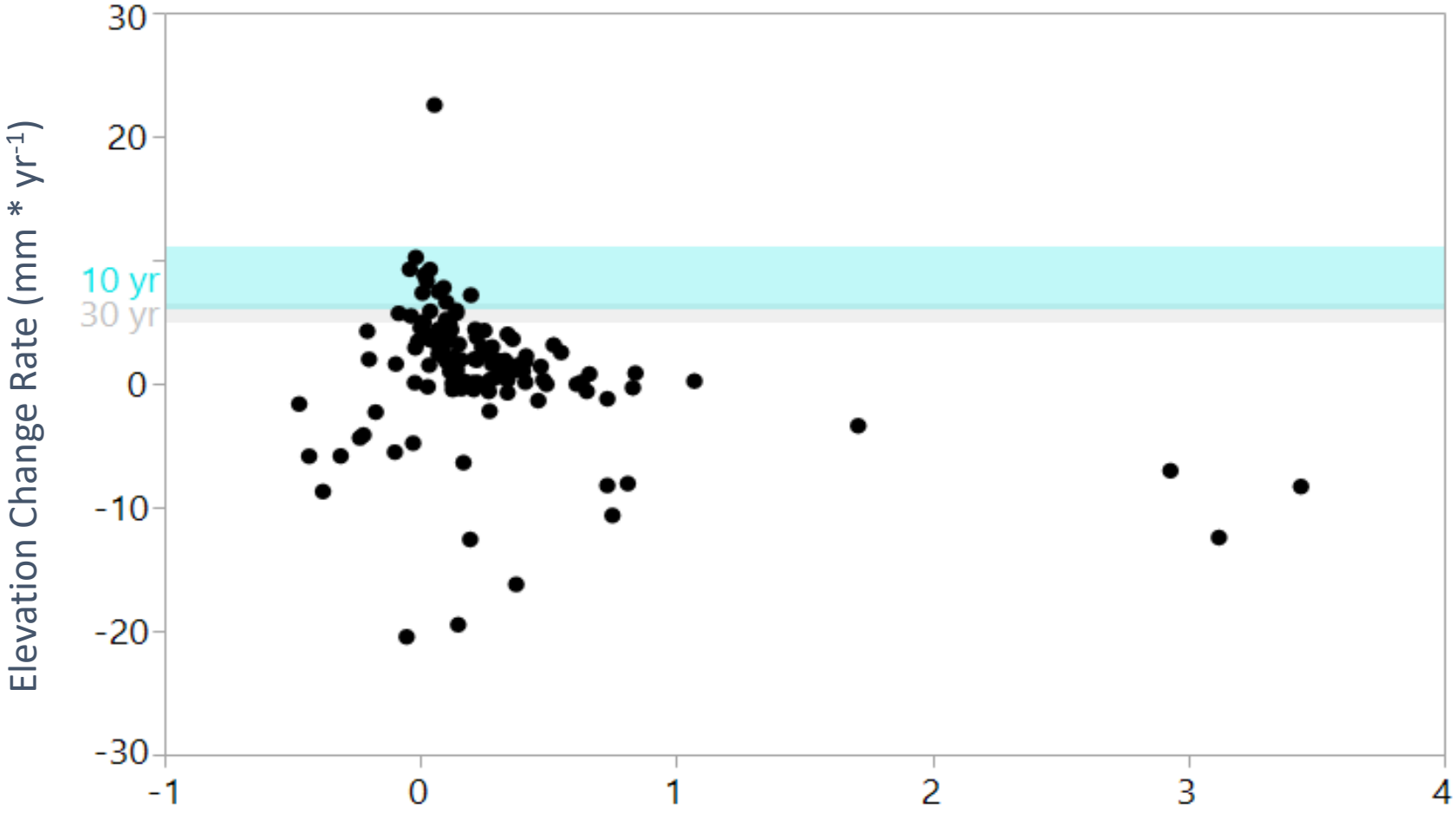
Changes in sediment surface elevation translate directly into differences in pin length above the SET arm

There are 132 SETs installed across the NC coast, these devices have associated data records of between 5 and 30 years



NC Marshes are not building elevation fast enough to keep up with Sea Level

(this problem is not unique to NC)



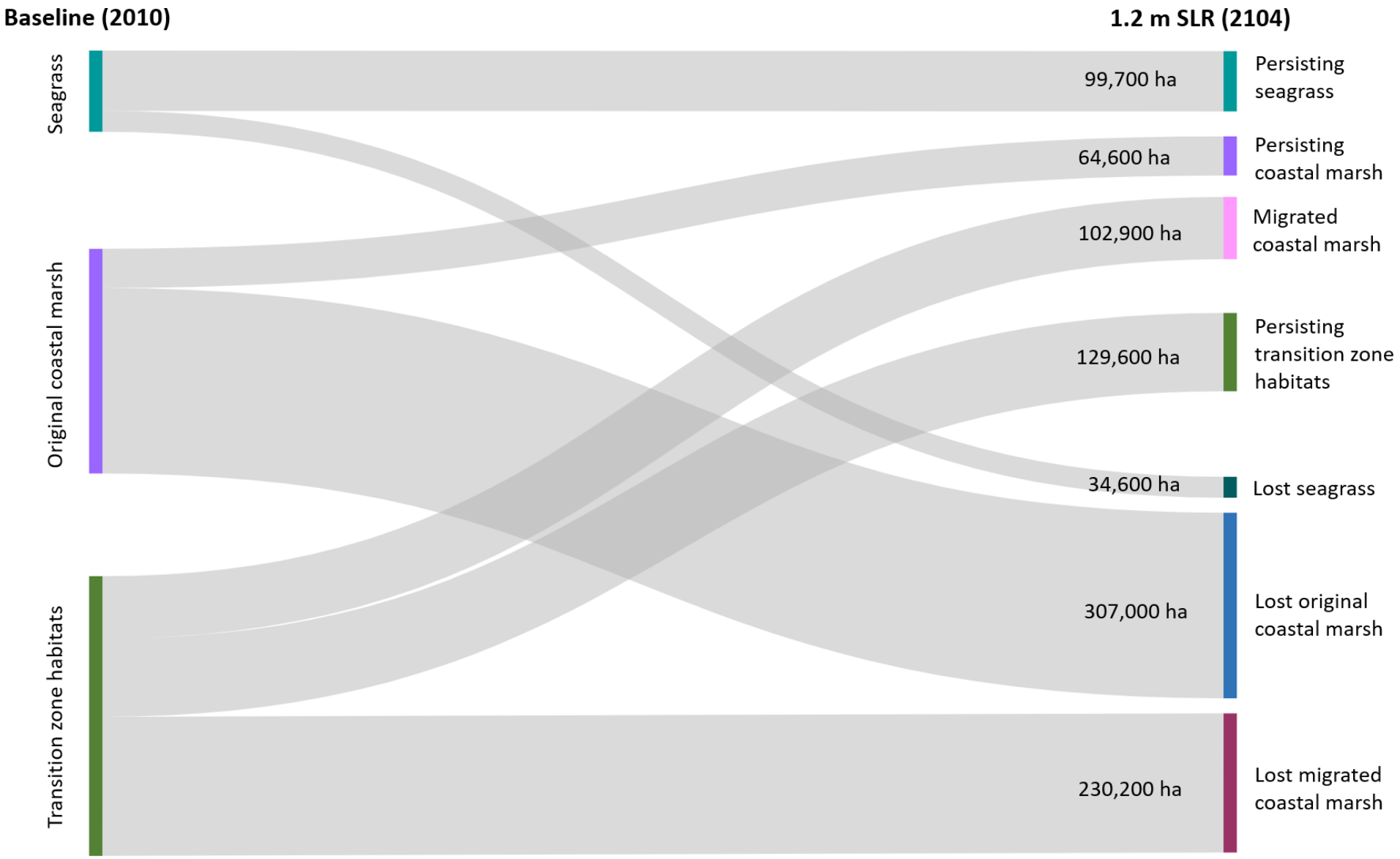
OF 132 SETs analyzed:

- 33 documented net losses in elevation

- 79 measured increases in elevation – but at rates < the lower end 30 yr rSLR rate

Surface Elevation Trends in North Carolina's Coastal Wetlands. https://pubs.usgs.gov/publication/70264589

Predicted Future Coastal Habitat Change



Warnell et al, 2022. doi:10.1371/journal.pclm.0000044

There are many options for beneficially using dredged sediments to reverse/offset habitat loss

1 . Thin Layer Placement – add elevation to deteriorating marsh to create more suitable conditions for growth

2. Creation or restoration of degraded islands/(re)building habitat on tidal flats

3. Rebuilding eroded shorelines to a historical extent

4. Strategic placement, aka sand motor/mud motor

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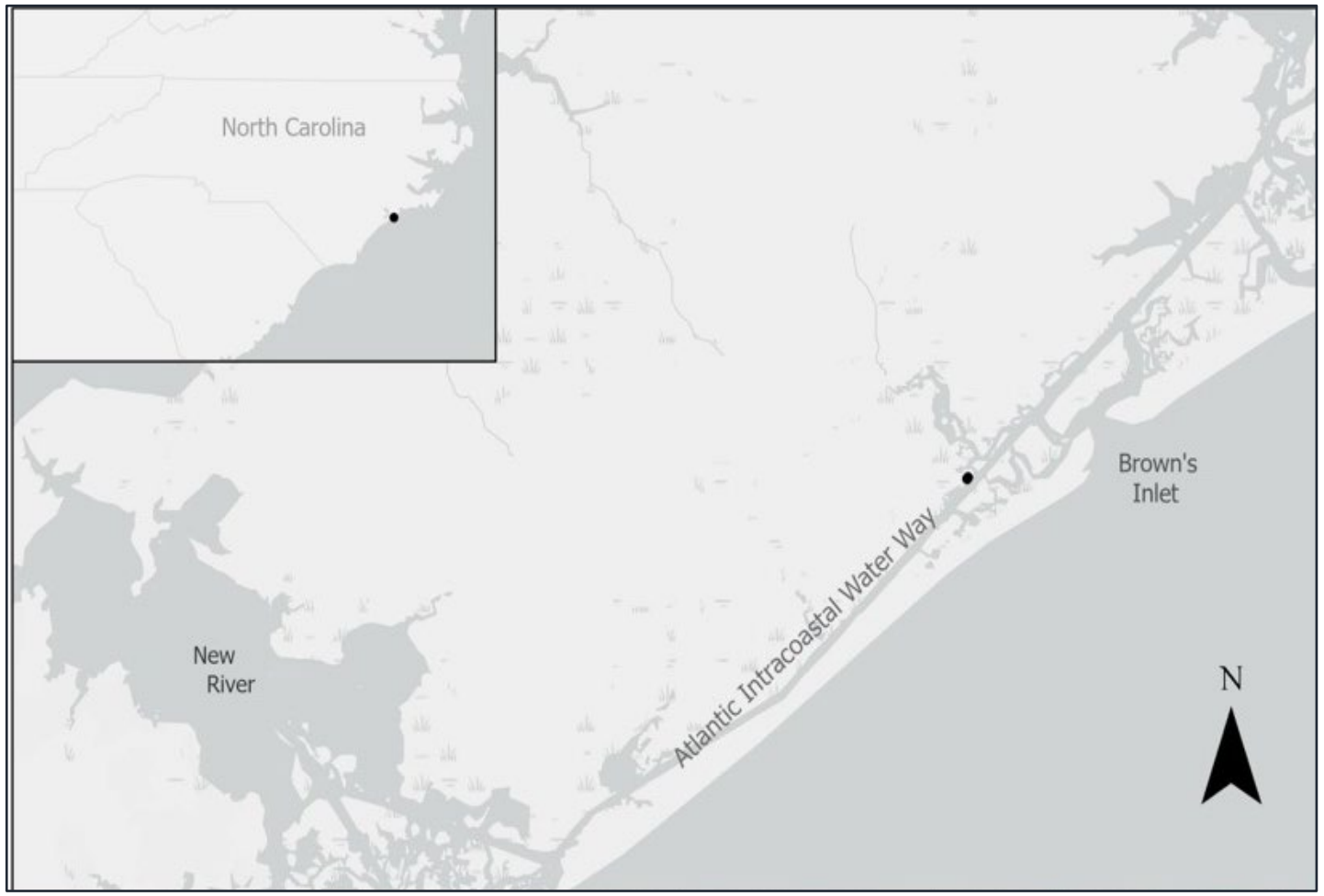
1 Freeman Creek Thin Layer



from 2008 to 2017:

- Water level increased at a rate of ~14 mm yr^{-1} (NWLON # 8656483)
- Marsh surface elevation increased at a rate of 6 mm yr^{-1}

Davis et al., 2022. Ecological Engineering 106566

https://coastalscience.noaa.gov/news/thin-layer-sediment-placement-boosts-marsh-growth-in-new-experimental-study/

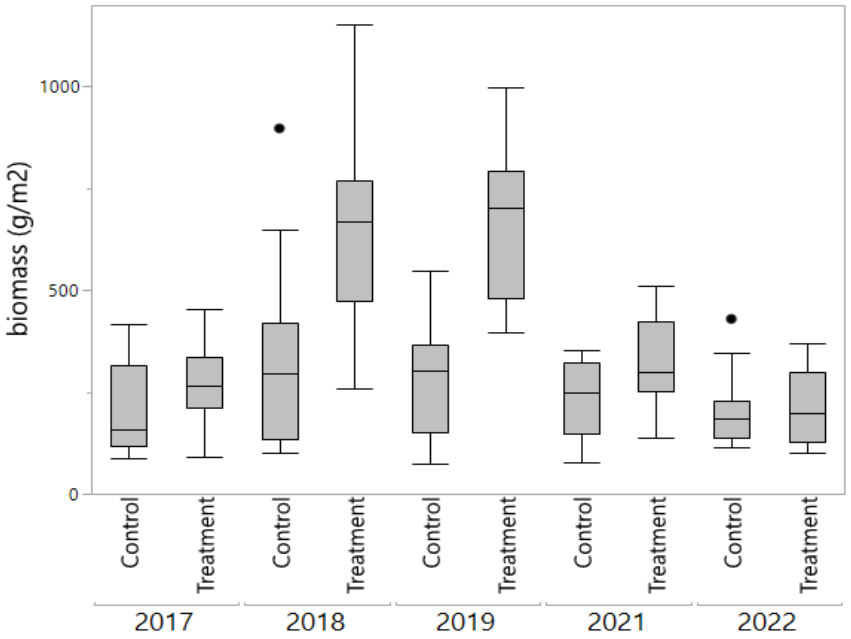
1 Freeman Creek Thin Layer

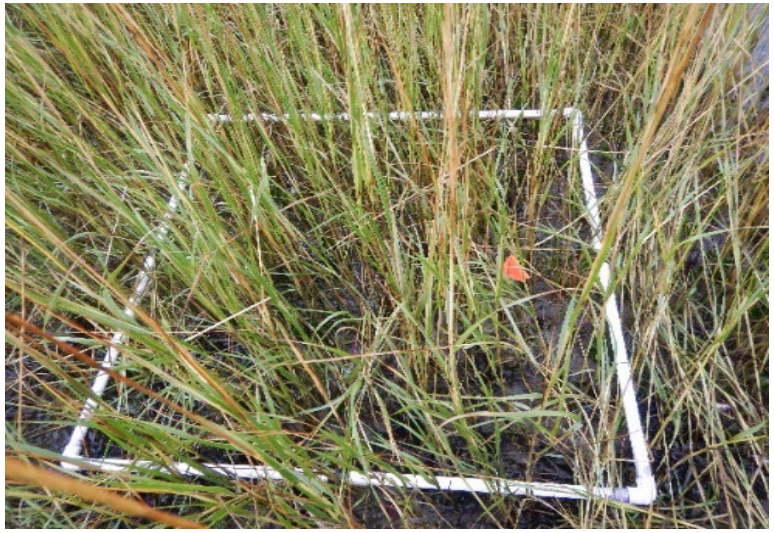
We added sediment to a *Spartina alterniflora* marsh that was very low in the tidal frame to document the impacts on vegetation & elevation

Mean Elevation Change in Treatment Cells = 5 cm

Plants were not buried by the applied sediments

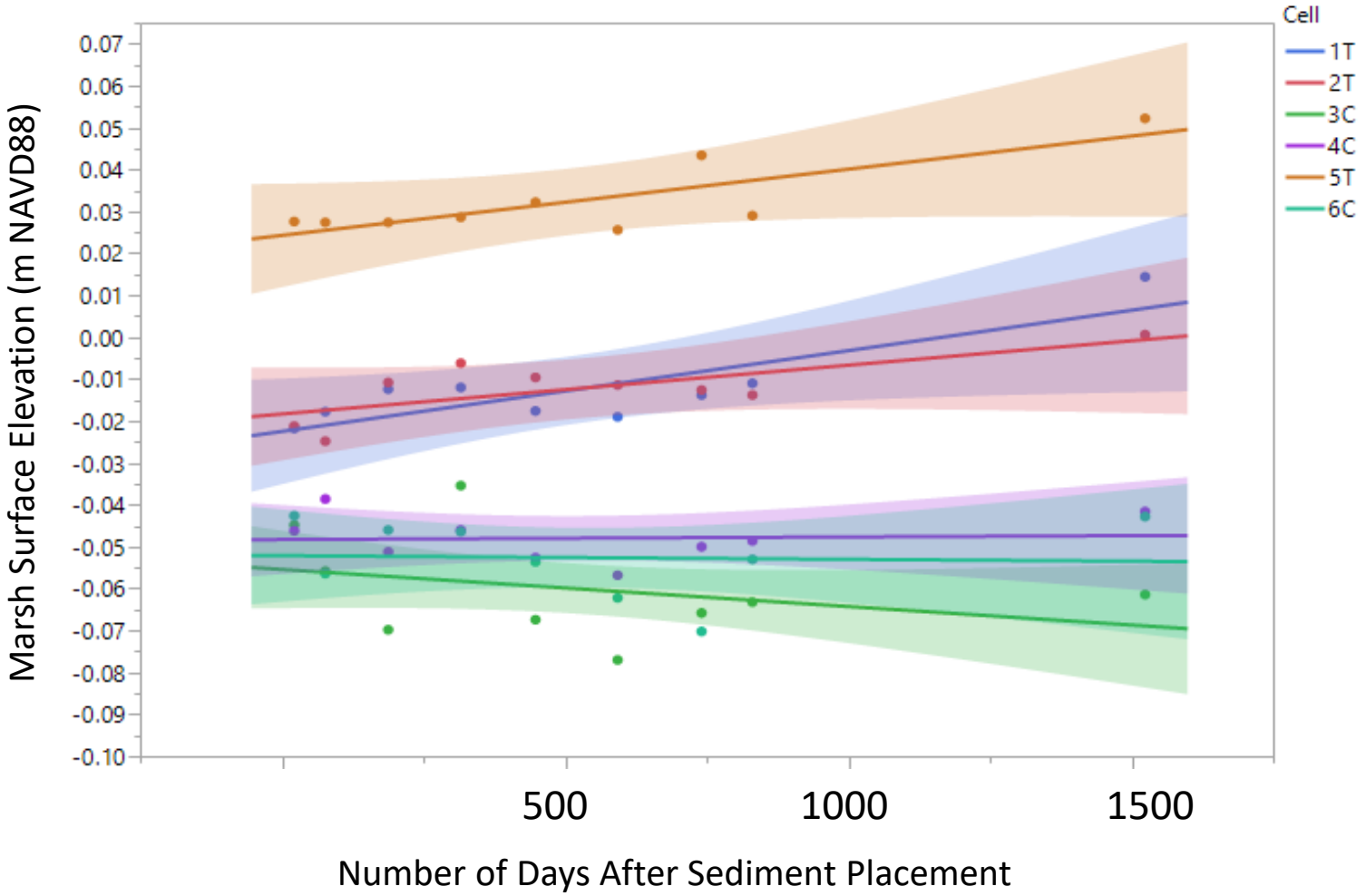
1 Freeman Creek Thin Layer





Plant biomass in the sediment-treated plots doubled within one year

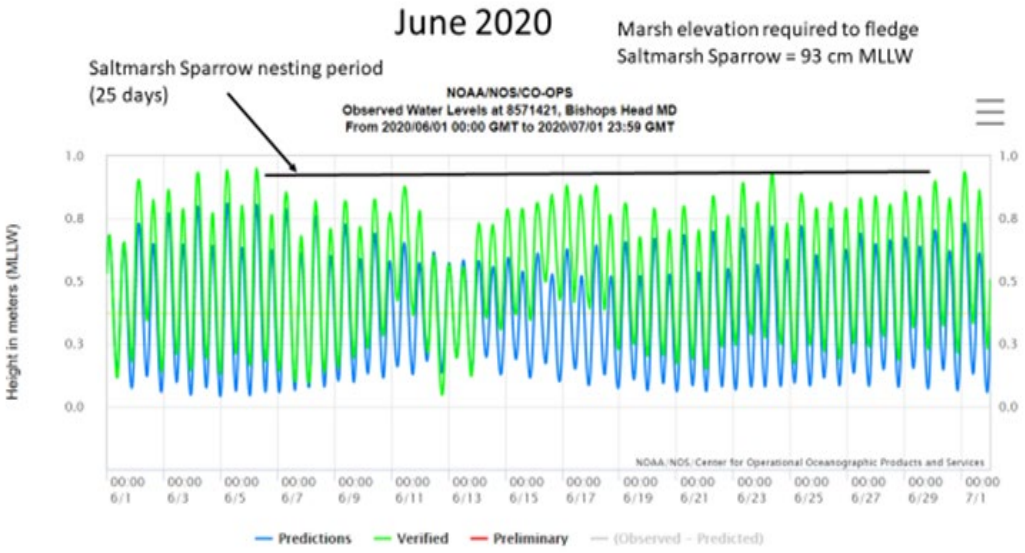
& sediment-treated plots built additional elevation over time

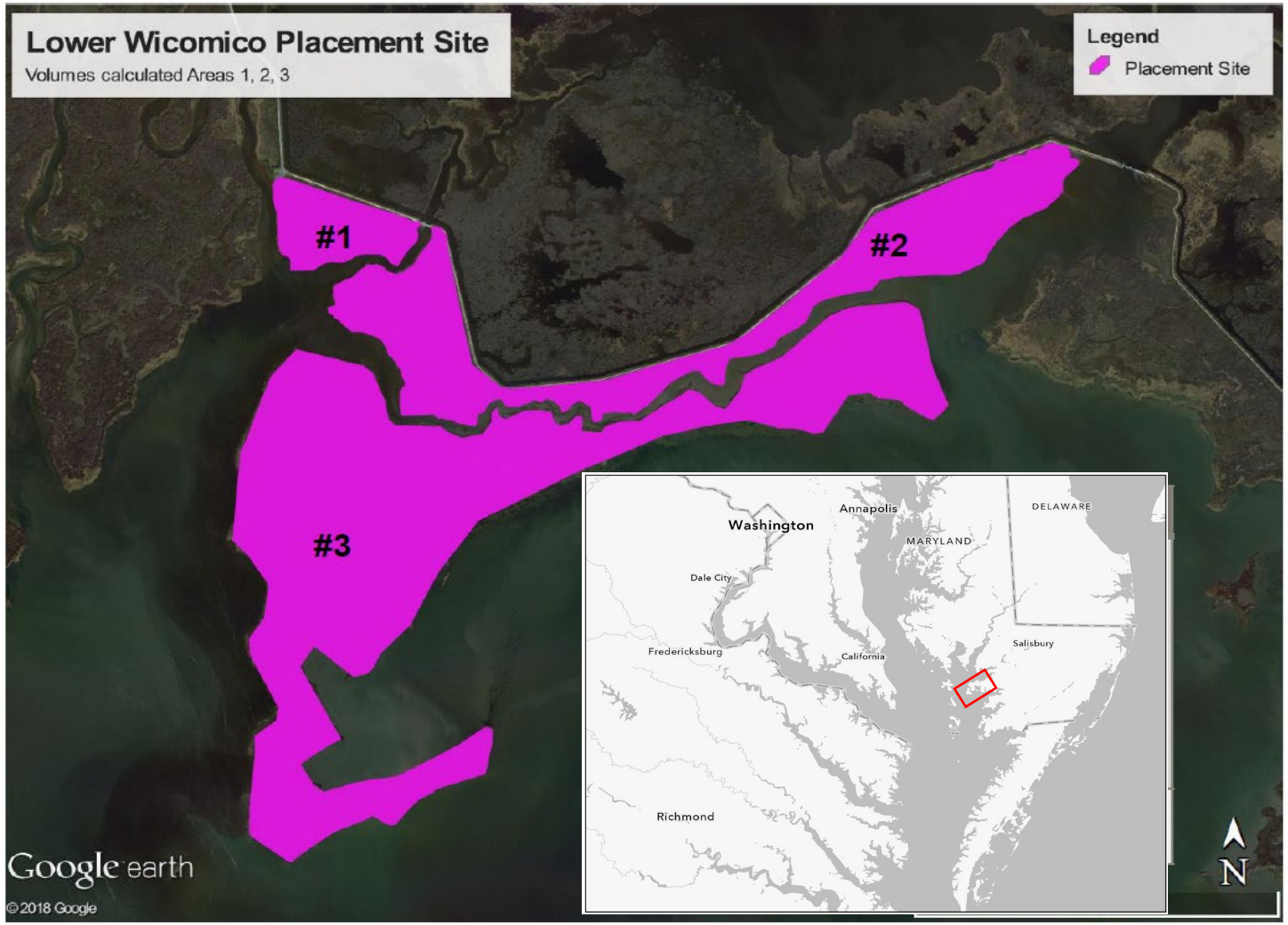


2 Deal Island Thin Layer

Fine sediment, pumped into a *Juncus*-dominated marsh.

GOAL: raise the elevation enough to provide flood-free nesting for salt marsh sparrow





2 Deal Island Thin Layer

Natural containment via a levee road on the northern perimeter

Berm of straw bales (30,000!) on southern edge

> 250,000 plugs of vegetation planted so far (900,000 plugs budgeted)...

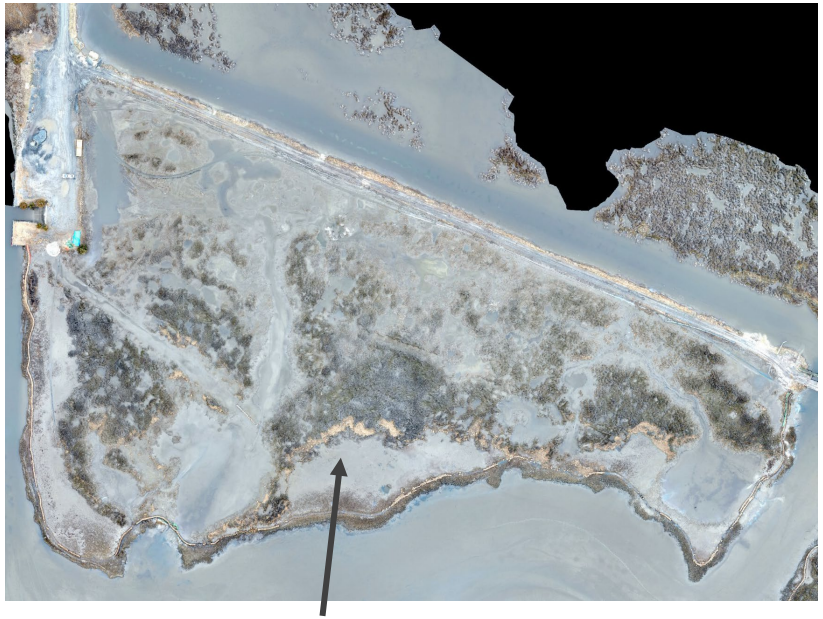
2 Deal Island Thin Layer

July 2022

Preplacement

February 2024

Near end of placement



Sections of the perimeter were destroyed by a winter storm and are scattered across the marsh

July 2024

4 months post-placement

A significant portion of the bright green vegetation is volunteer growth (not planted)

*Much of the pre-existing Juncus survived the placement and seems to be thriving

2 Deal Island Thin Layer

Inside the straw bale perimeter:

- elevations increased 15-40cm
- Avg porewater nutrients >> (NH_4 = 276 uM, PO_4 = 5uM)

Outside the perimeter:

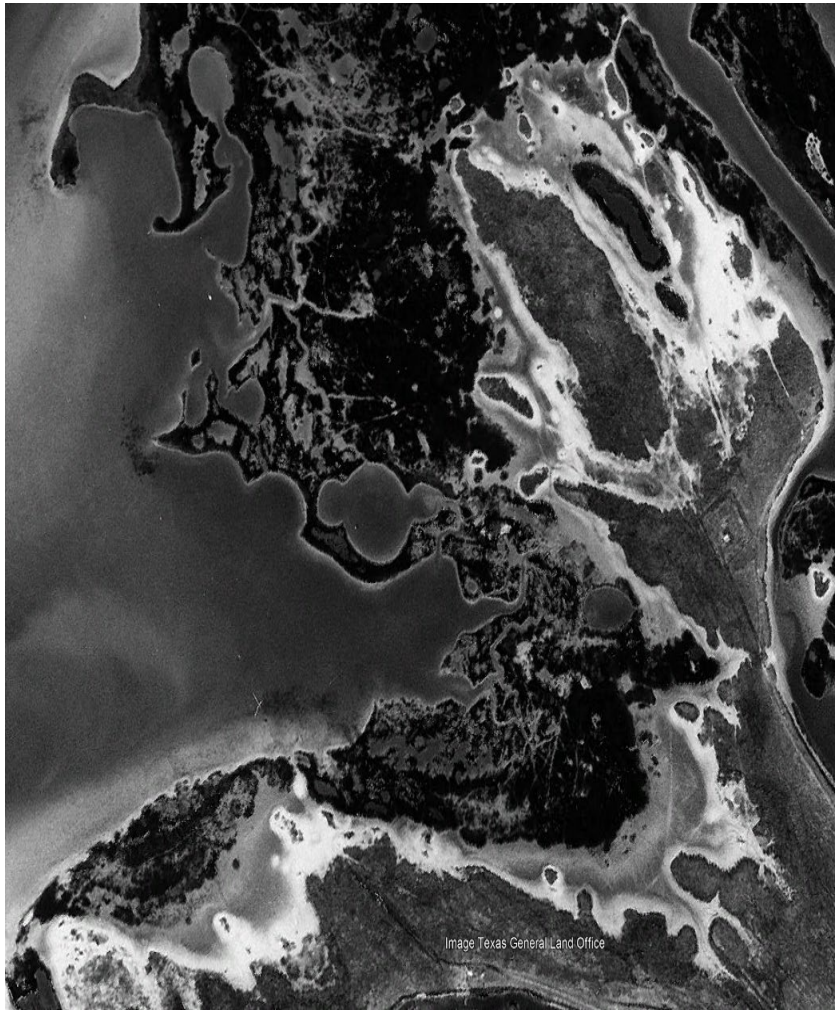
- No elevation change
- Much lower nutrient levels (NH_4 =10 uM, PO_4 = 1.1 uM)

Porewater

Vegetation & Elevation

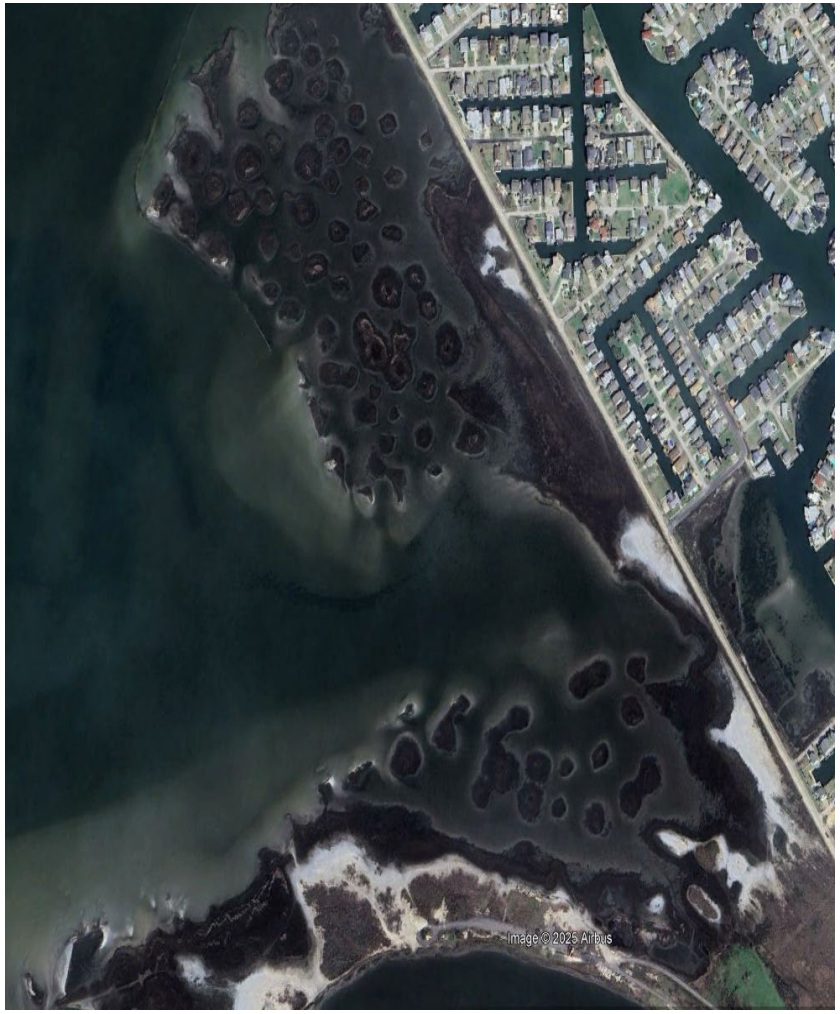
3 Galveston Bay Marsh Mounds

1954



1995

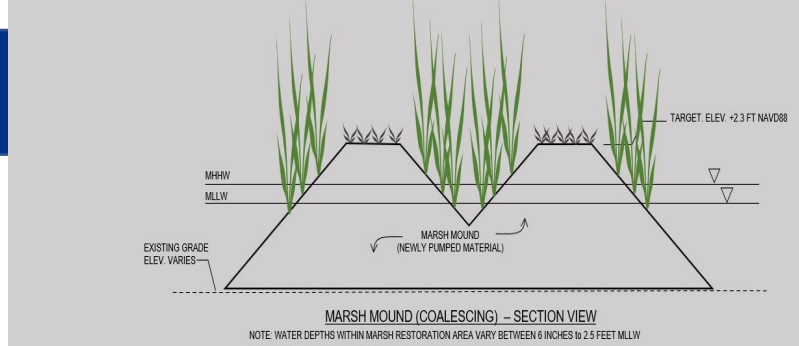
2023



3 Galveston Bay Marsh Mounds

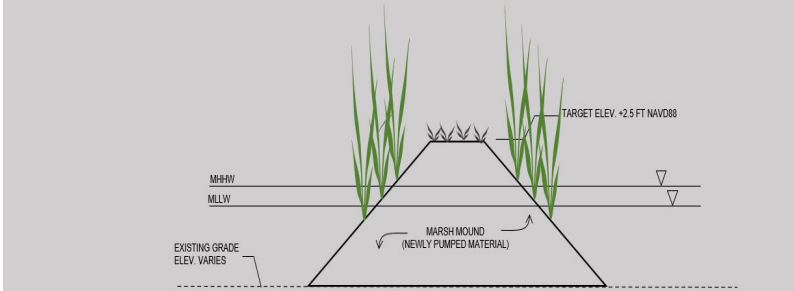
multiple mound complexes created by hydraulically pumping dredged sediments to a predetermined elevation then planting with native vegetation

Goal: restore lost estuarine complex with high fishery habitat value (lots of edge)



MARSH MOUND (COALESCING) – SECTION VIEW

NOTE: WATER DEPTHS WITHIN MARSH RESTORATION AREA VARY BETWEEN 6 INCHES to 2.5 FEET MLLW



MARSH MOUND – SECTION VIEW

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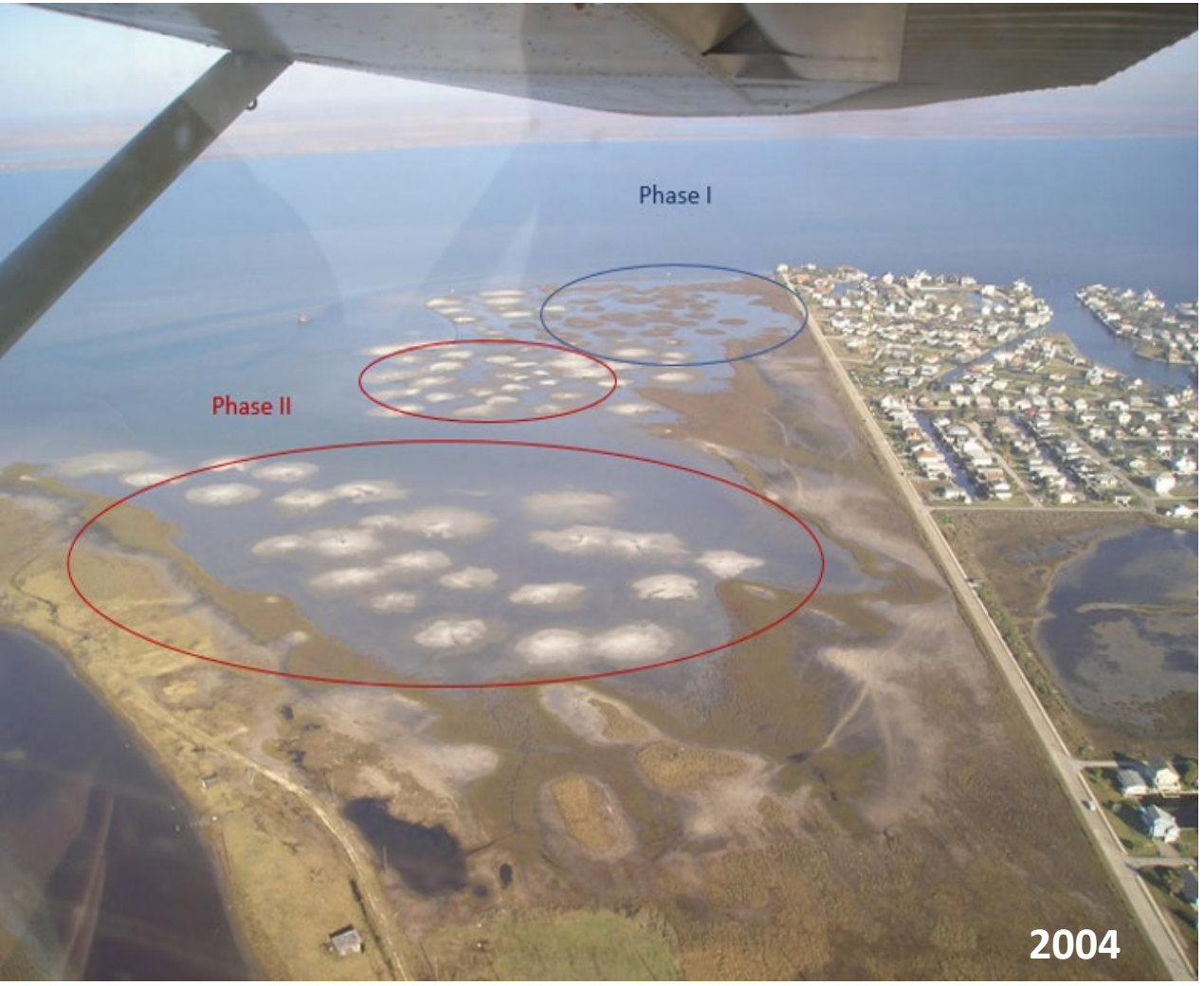
https://storymaps.arcgis.com/stories/e4119e8608d64ce58f47667b84724c99

3 Galveston Bay Marsh Mounds

many of the exterior mounds have eroded or been significantly reshaped; interior mounds have been more consistent over time



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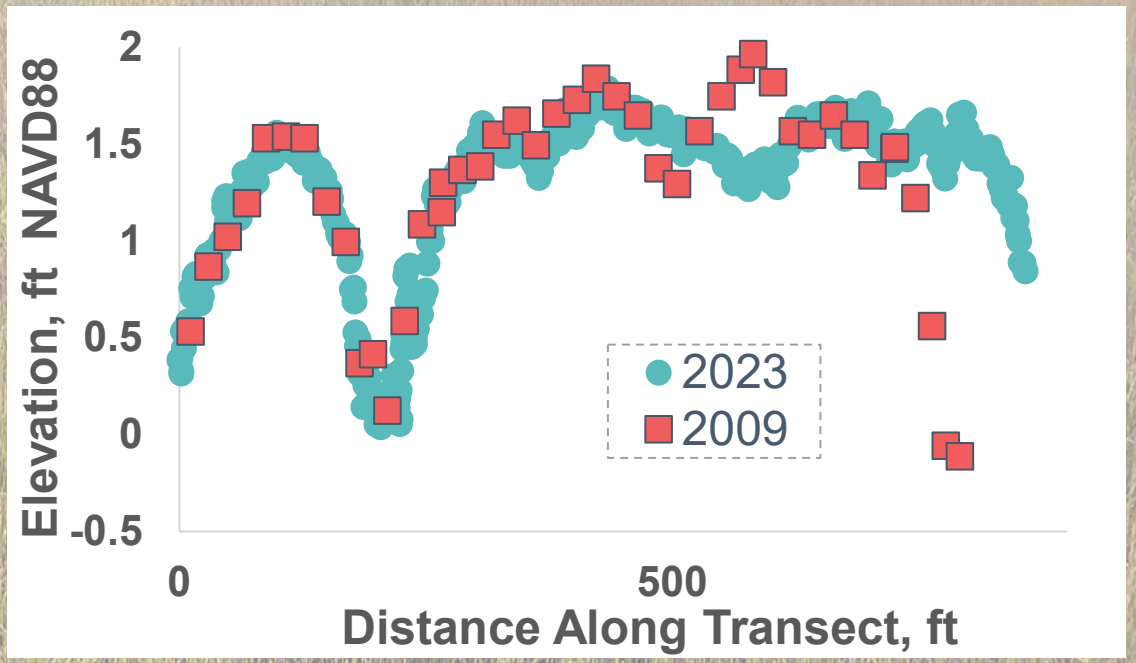
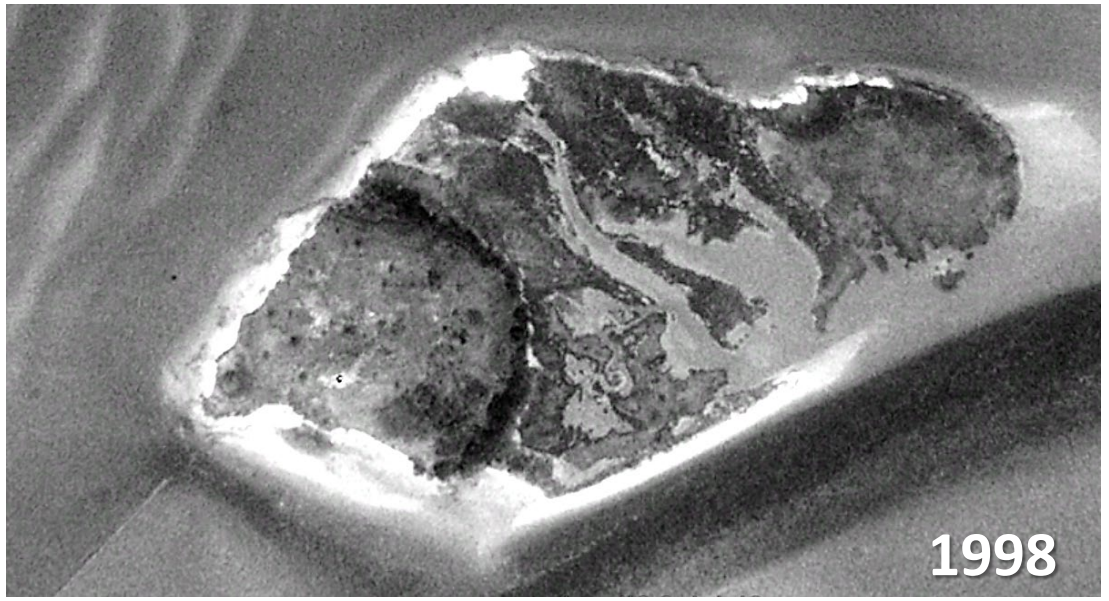


4 Swan Island Maryland



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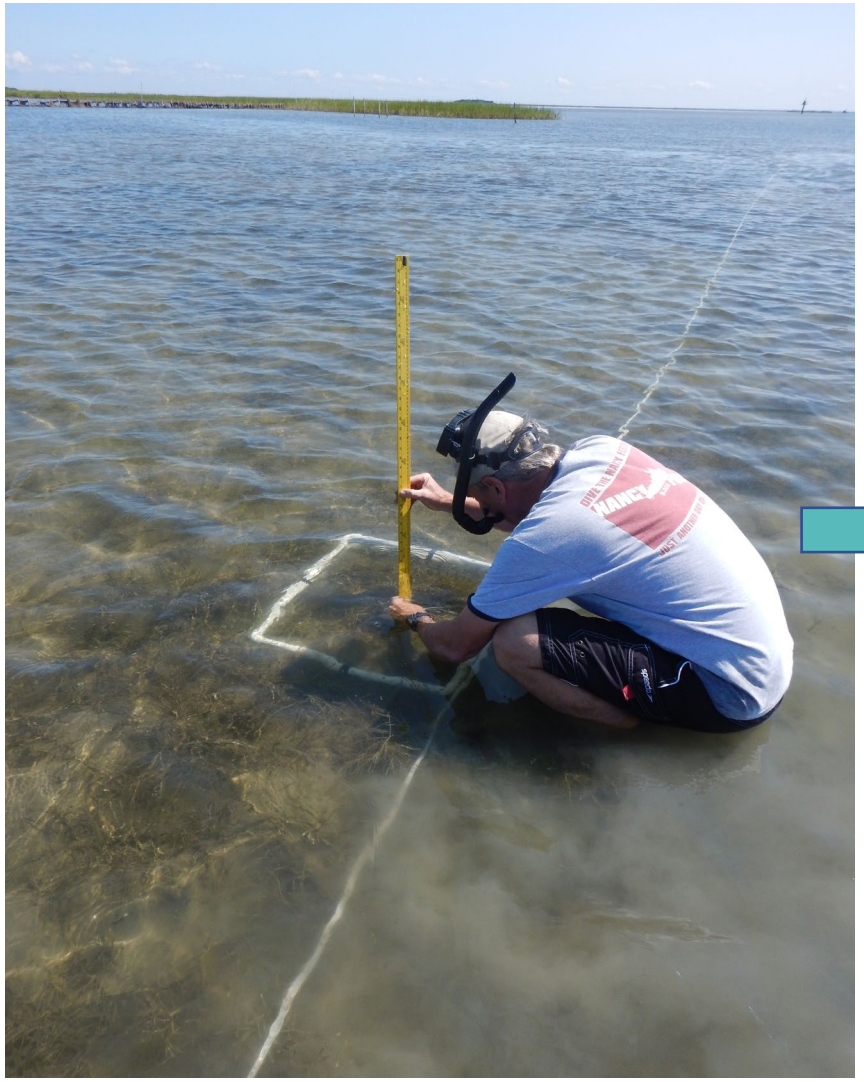
High marsh grew rapidly and continues to expand

Large parts of the low marsh continue to struggle

4 Swan Island Maryland



The coir log structure was not effective at containing the placed sediments; the 2 acre SAV bed was buried by ~30 cm of sediment – but keeping the island in place serves to protect the much larger (~150 acre) SAV bed to the south

4 Swan Island Maryland

The vegetative response is often very dynamic early in a project's life cycle

Davis et al, 2022. doi: 10.3389/frsus.2024.1359721
https://storymaps.arcgis.com/stories/7156cfc6353048ad92ef80f737b77c29

Considerations for Beneficial Use:

Good Candidate Sites
- drowning marsh, eroding islands/shorelines
- proximity to dredge action (cost increases with distance)

Determining Target Elevation
- Need a thorough understanding of local tide range and natural plant community distribution
- Plan for future Sea Level Rise?

Sediment Characteristics
- Sand is more challenging to distribute across a large area but easier to build elevation with, and to contain
- Character of dredged sediments determines nutrient loads, likelihood of compaction after placement
- Sediment matching (with underlying substrate) doesn't seem to be necessary in marshes

Monitoring & Adaptive Management
- Having a plan is crucial
- Most important in the early years

Closing Thoughts

Offshore & Upland disposal of dredge material deprives marshes of sediment that is critical for their survival = missed opportunity

Habitat tradeoffs are inevitable

No two BU projects are the same, and success is never guaranteed BUT… there is a wealth of previous experience to guide project development

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