SEDIMENT SOURCING AND CONTRIBUTIONS TO VERTICAL MARSH ACCRETION IN THE NORTHEASTERN U.S.

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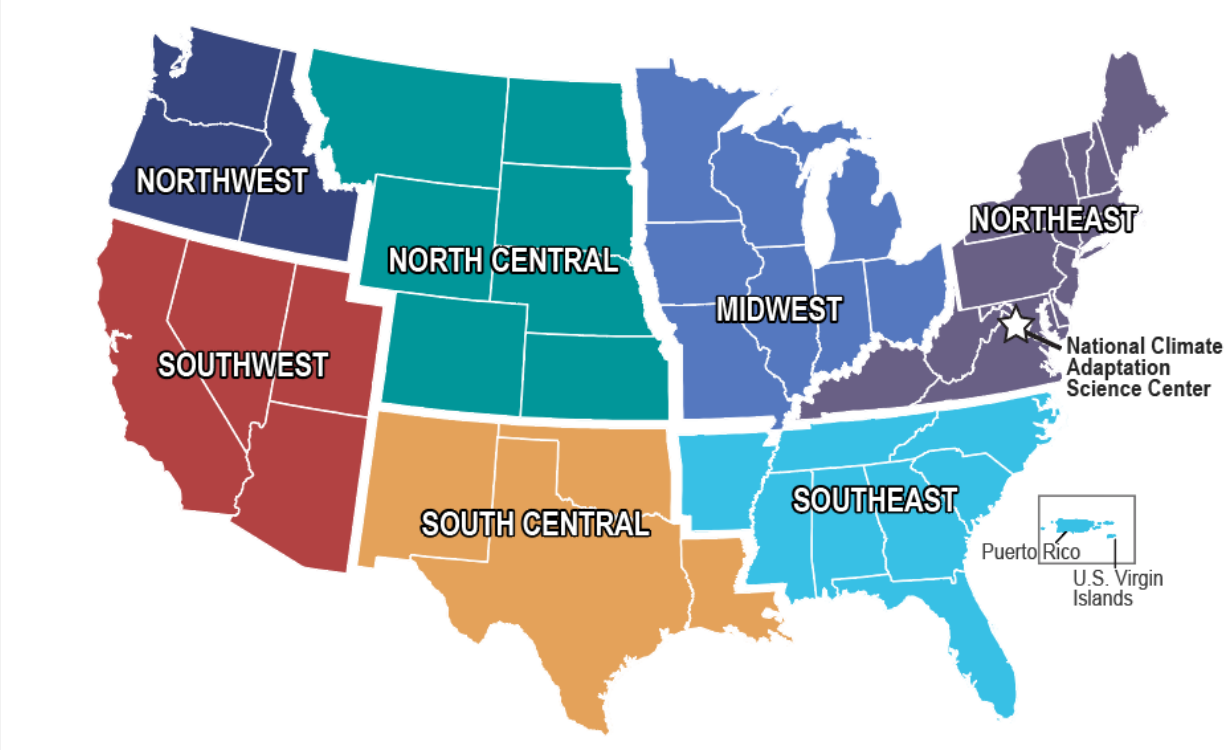
University of Massachusetts

Cousins River Marsh
Photo Credit: MCHT

NECASC

Northeast Climate Adaptation Science Center



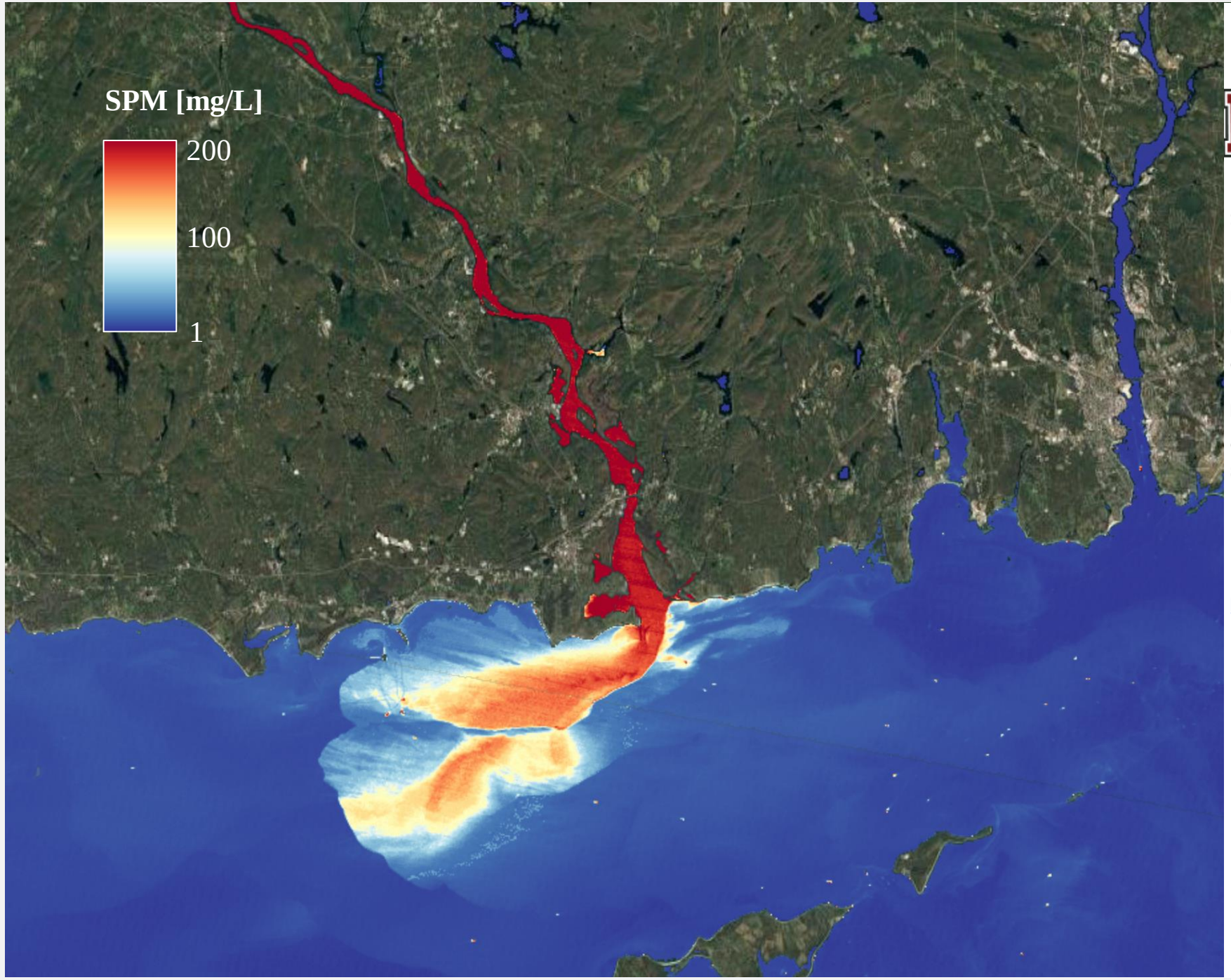
Delivering science to help fish, wildlife, water, land, and people adapt to a changing climate.

SEDIMENTARY COASTAL ECOSYSTEMS

Beaches/Estuaries

Tidal Flats

Tidal Marshes



High Spatial-Resolution Mapping of Suspended Particulate Matter in Global Coastal Waters

University of Massachusetts Amherst

EGCS Earth, Geographic, and Climate Sciences

1. Draw a polygon and click SPM Map button to show the SPM map.

2. Draw a polygon and click Statistics button to show the statistics figures.

Note: If you wish to display the map, consider using a larger polygon. However, for statistical analysis, it is more efficient to use a smaller polygon to reduce calculation time.

Click on the map to display the SPM value at the selected point.

This web app was created by: Wenxiu Teng

Related paper: Teng et al., 2024 (under review). Preprint available

This project was funded by the Northeast Climate Adaptation Science Center (NE CASC)

NECASC Northeast Climate Adaptation Science Center

Project Website

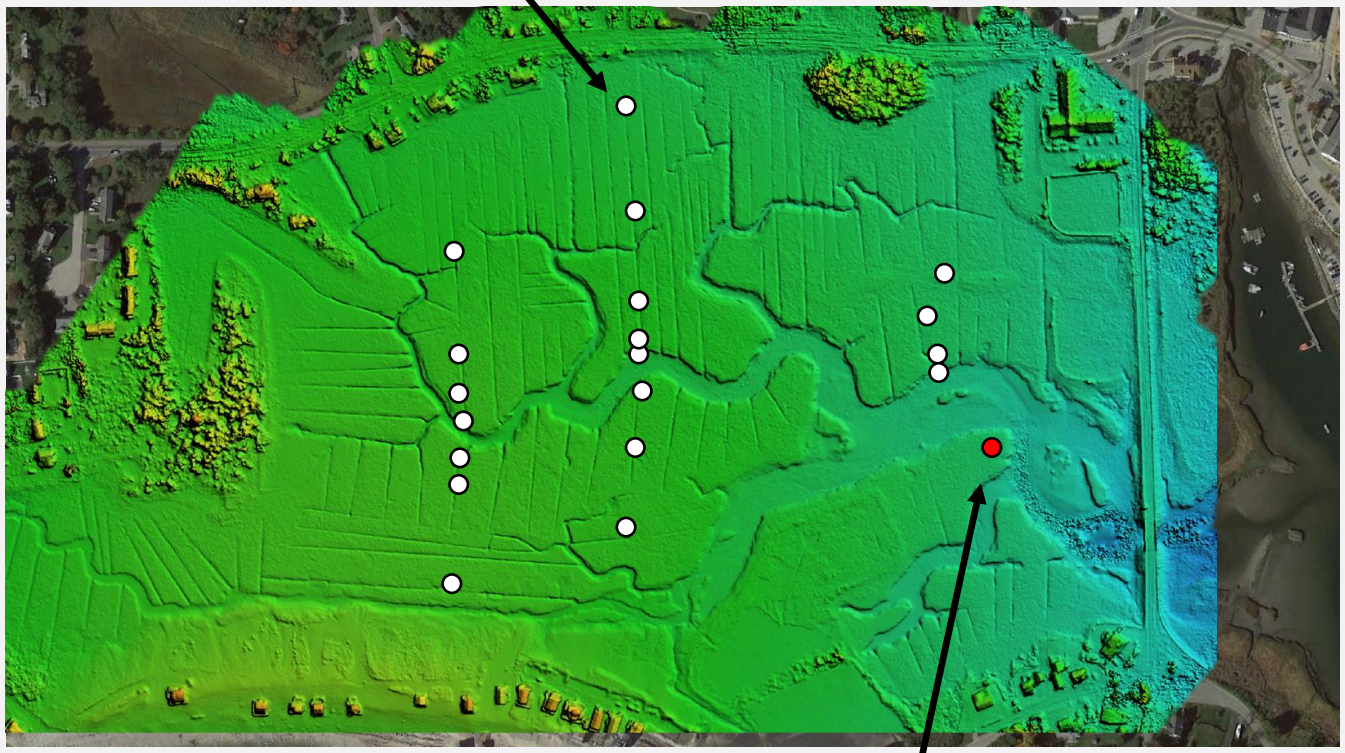

Wenxiu Teng


Brian Yellen


Qian Yu

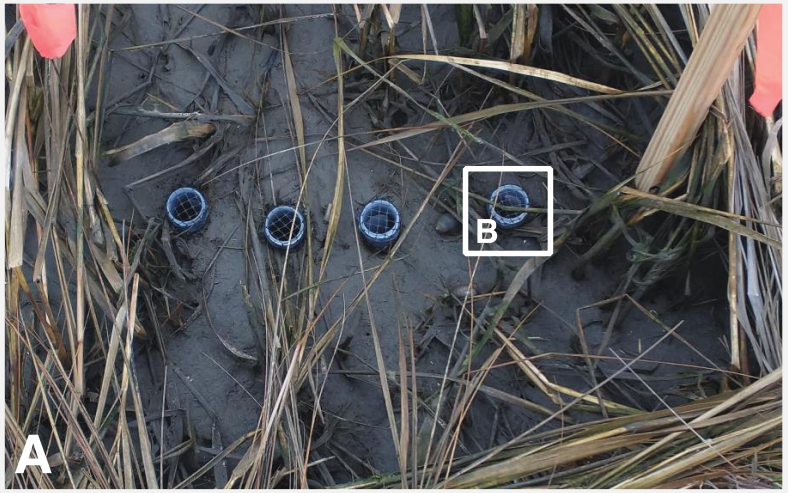
METHODS

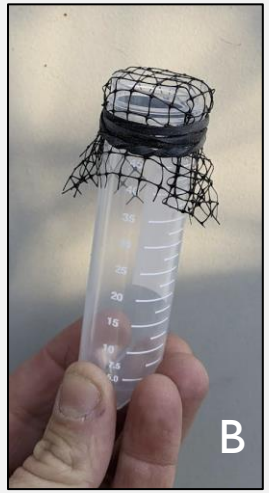
Seasonal Sediment Traps + Bulk Surface Samples



Paired Sediment Trap + Turbidity & Water Level Logger

Sediment Traps





Water Level & Turbidity Sensors

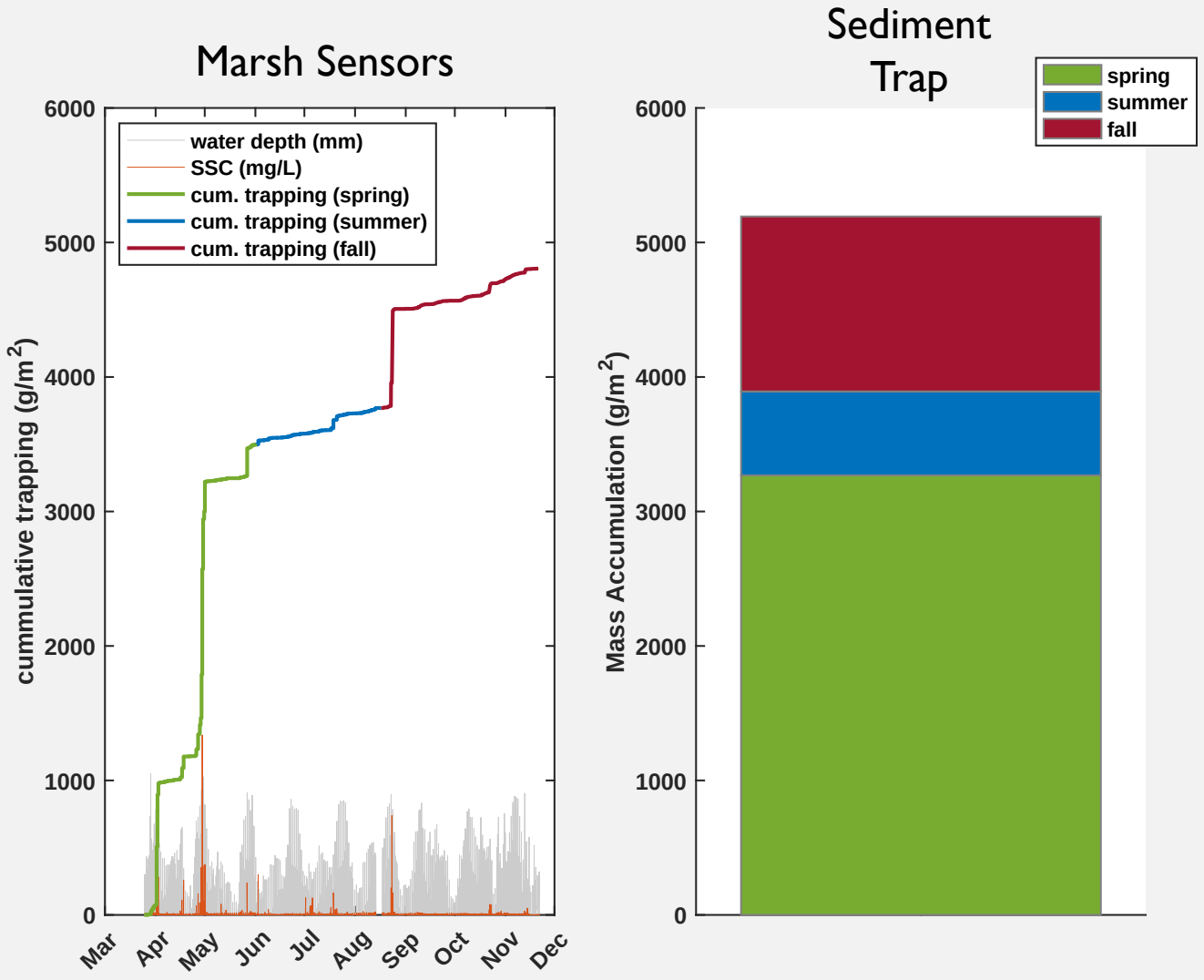
Bulk Density LOI

Elevation Distance

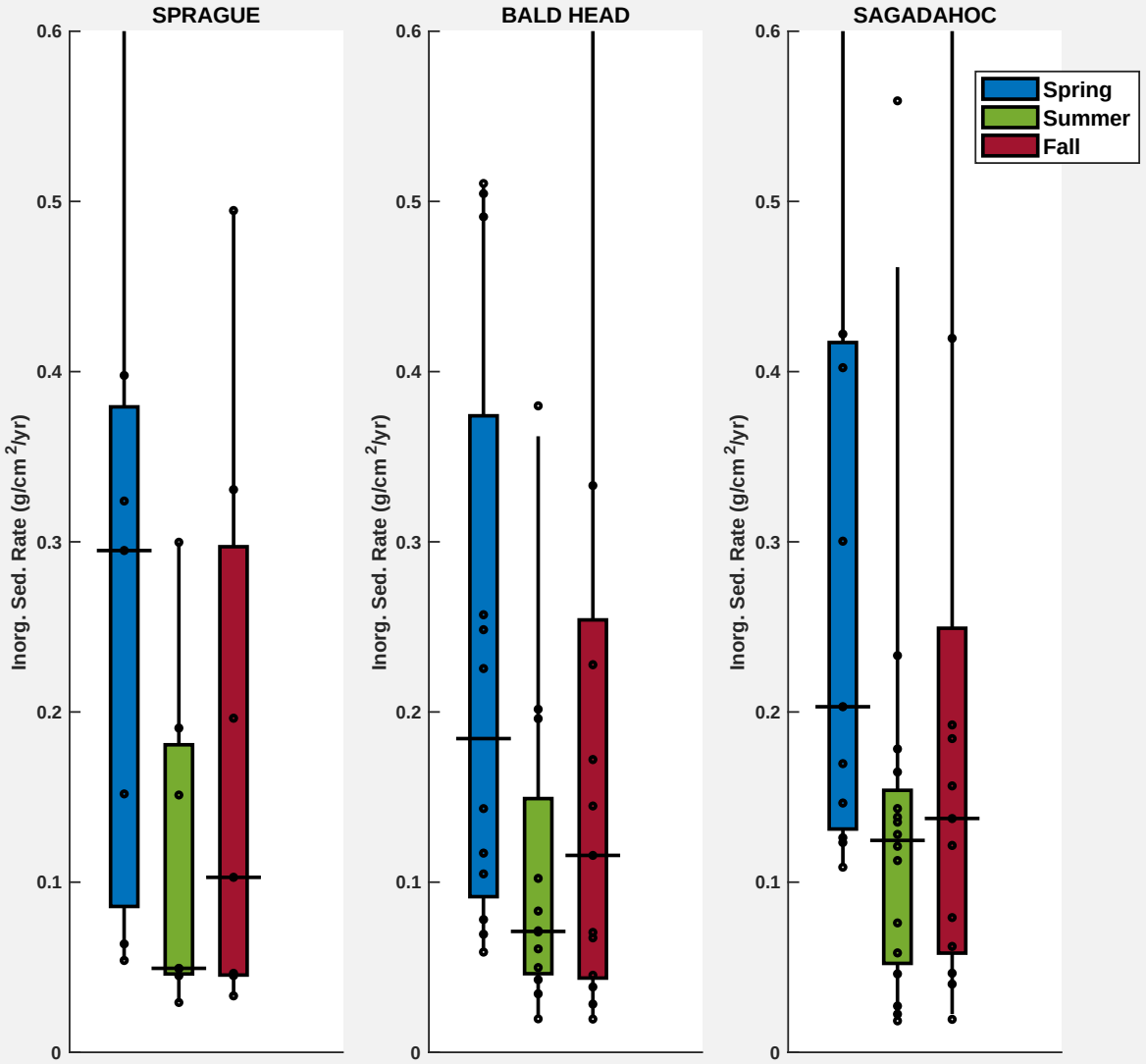
OUTLINE

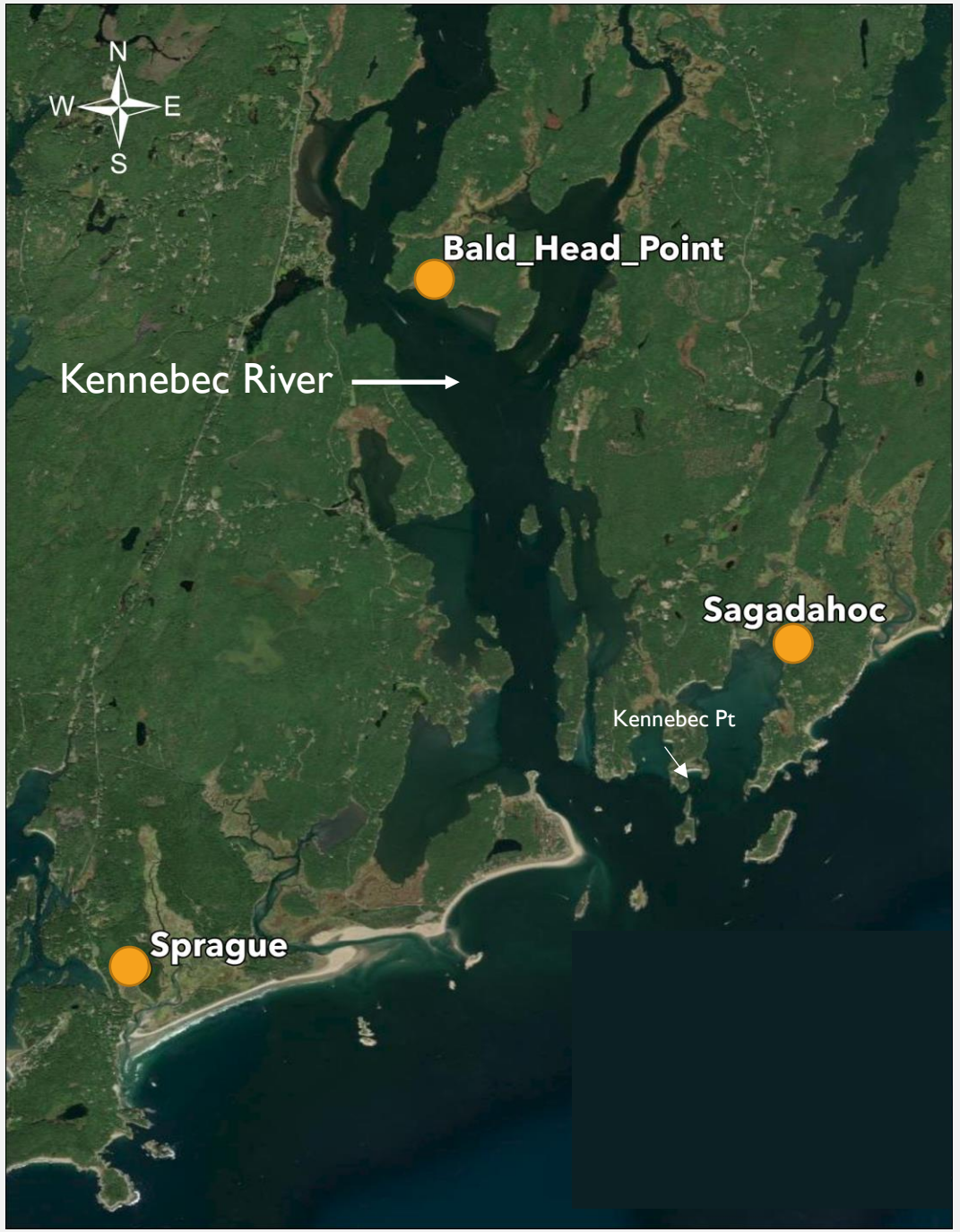
1. Salt Marsh Sediment Sourcing
2. Sediment Contributions to Accretion
3. Relevance to Restoration

SPRAGUE/BATES SITE SENSORS VS. SEDIMENT TRAPS

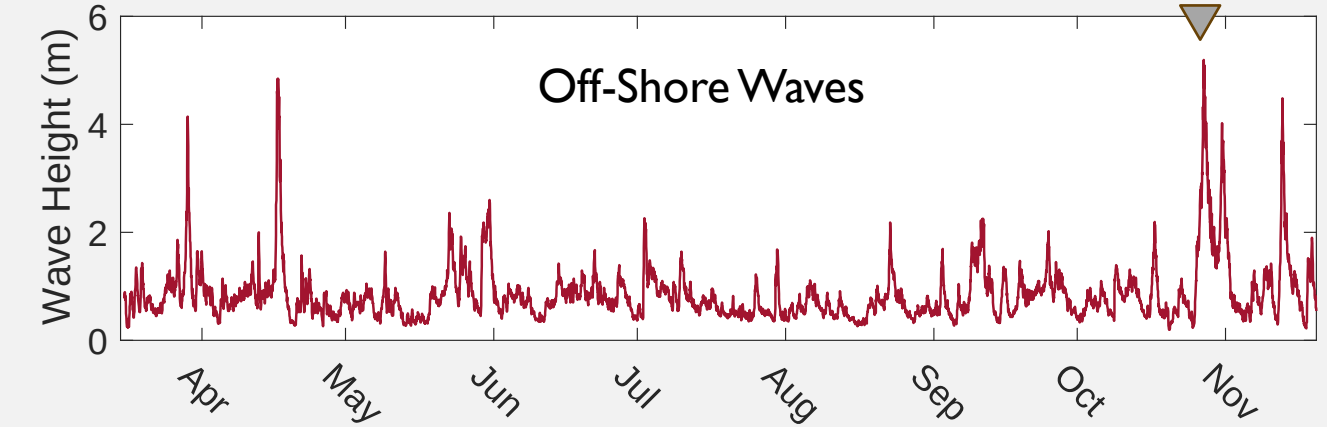


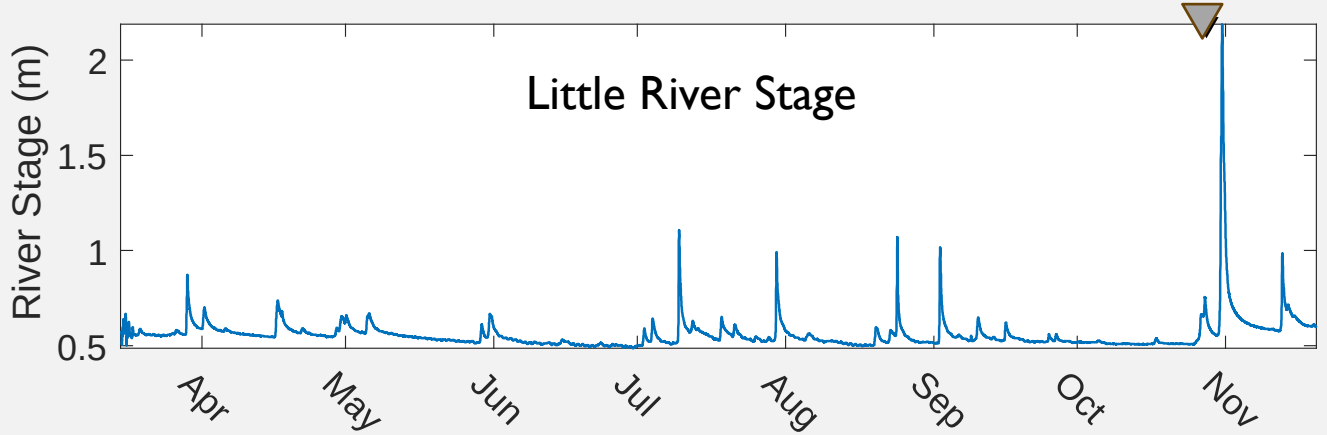
SEDIMENTATION PROXIMAL TO THE KENNEBEC RIVER

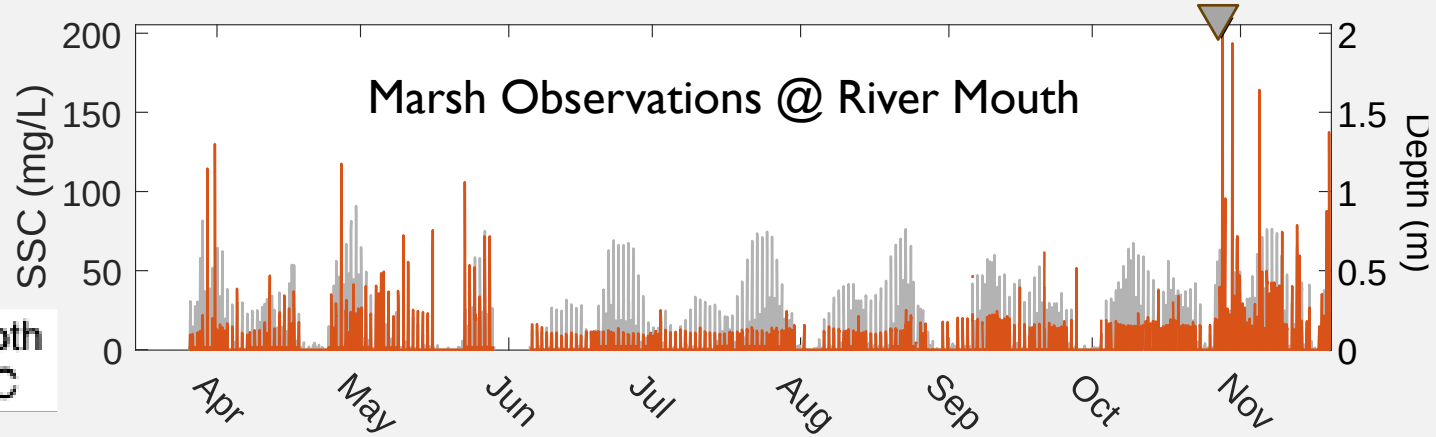




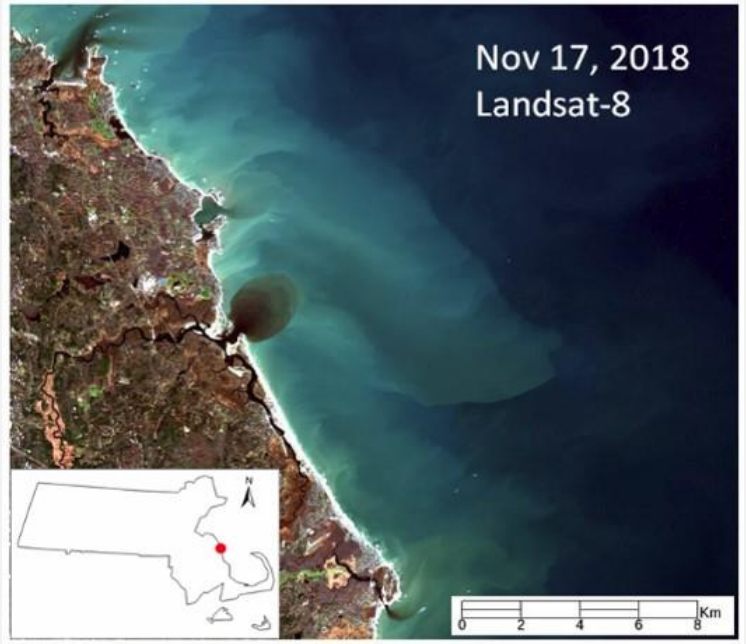
SEASONAL TRENDS IN SEDIMENT CONCENTRATION



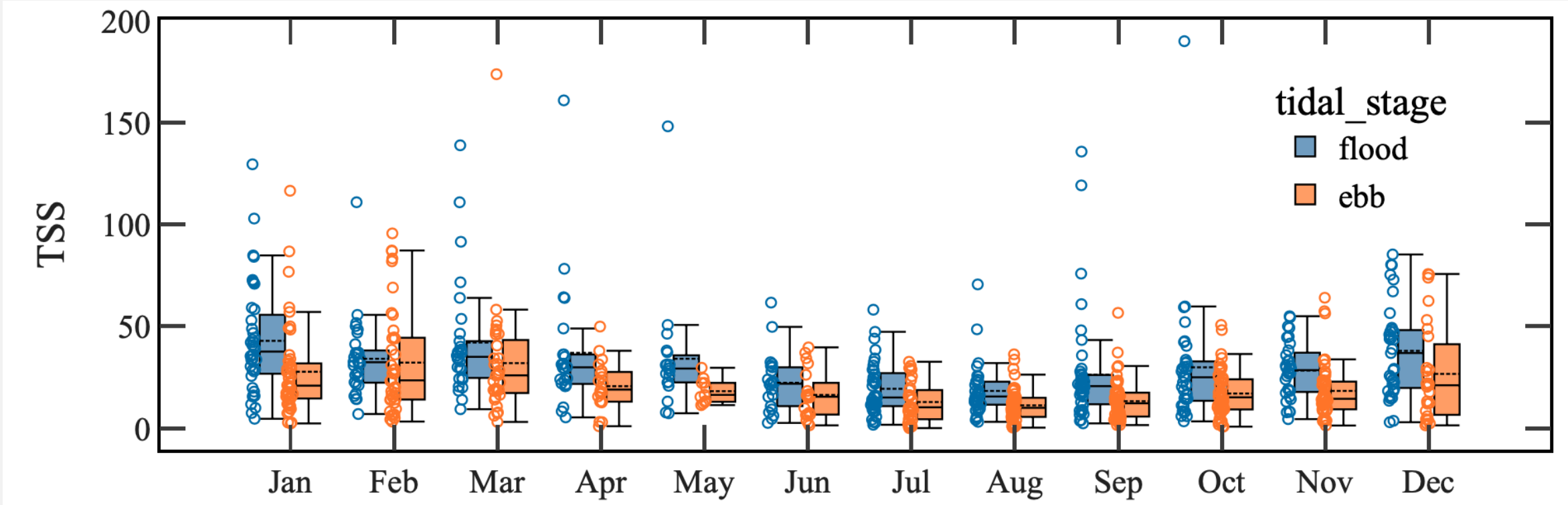




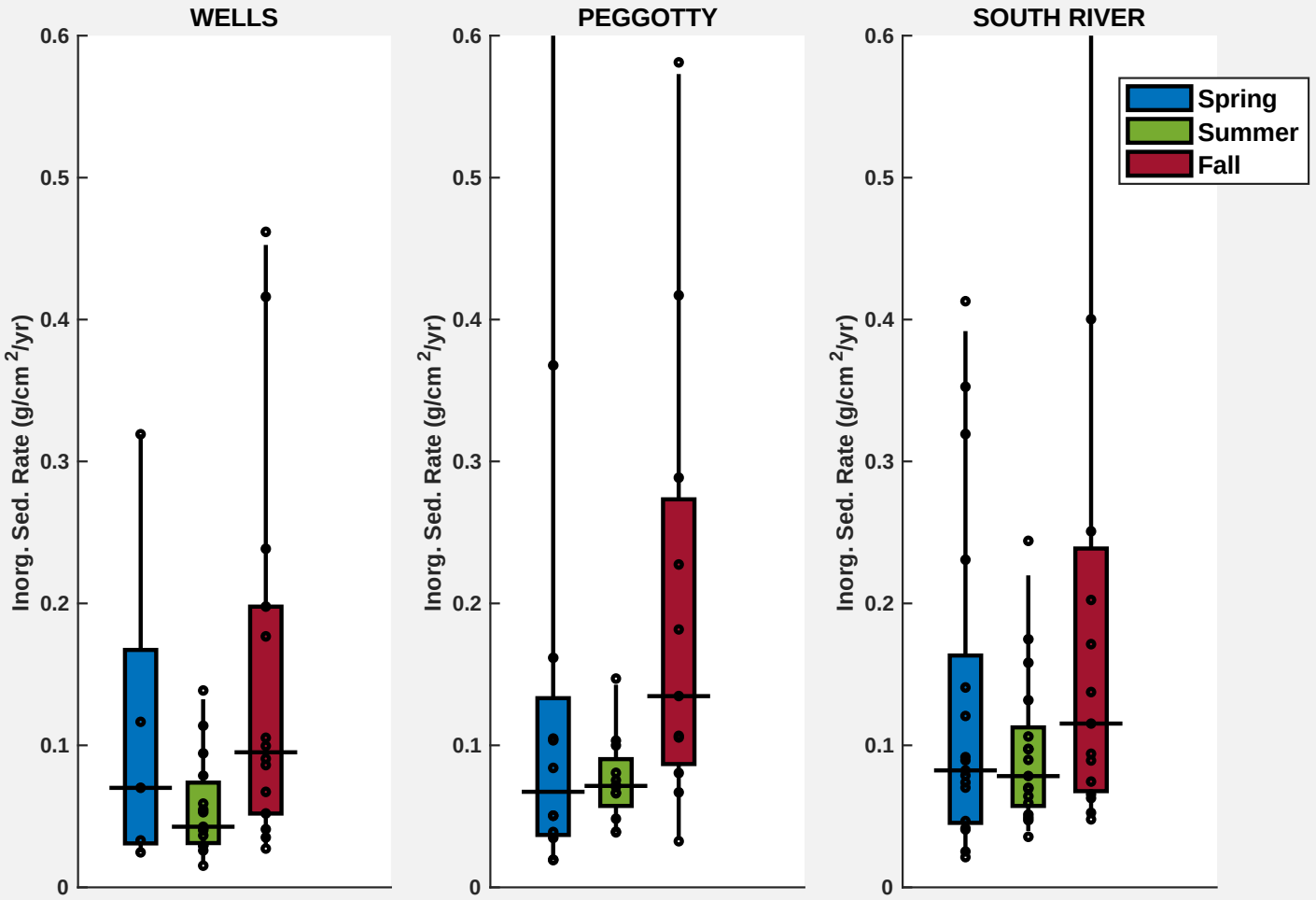
FLOOD TIDE SSC > EBB



Teng et al., (in review)



EXAMPLES FROM OTHER PREDOMINANTLY MARINE SOURCED SYSTEMS



Implications for Coastal Armoring

NORTHEAST MARSHES SUSTAINED BY MARINE SEDIMENT

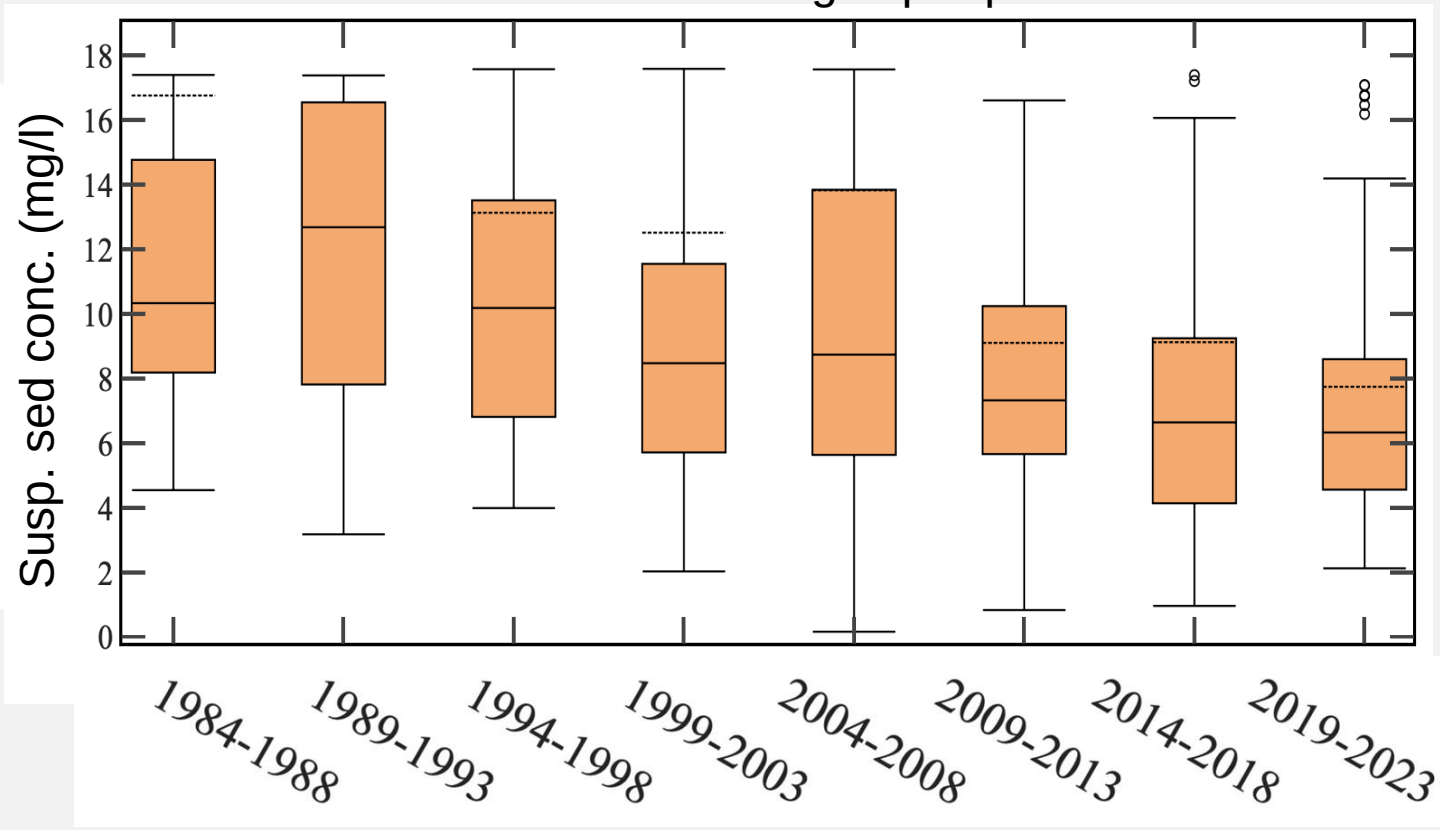
Sediment comes from bluff erosion


Wenxiu Teng


Brian Yellen


Qian Yu

~800 observation images per pixel



OUTLINE

1. Salt Marsh Sediment Sourcing
2. Sediment Contributions to Accretion
3. Relevance to Restoration

QUESTION: HOW MUCH DOES SEDIMENT CONTRIBUTE TO SALT MARSH ACCRETION?

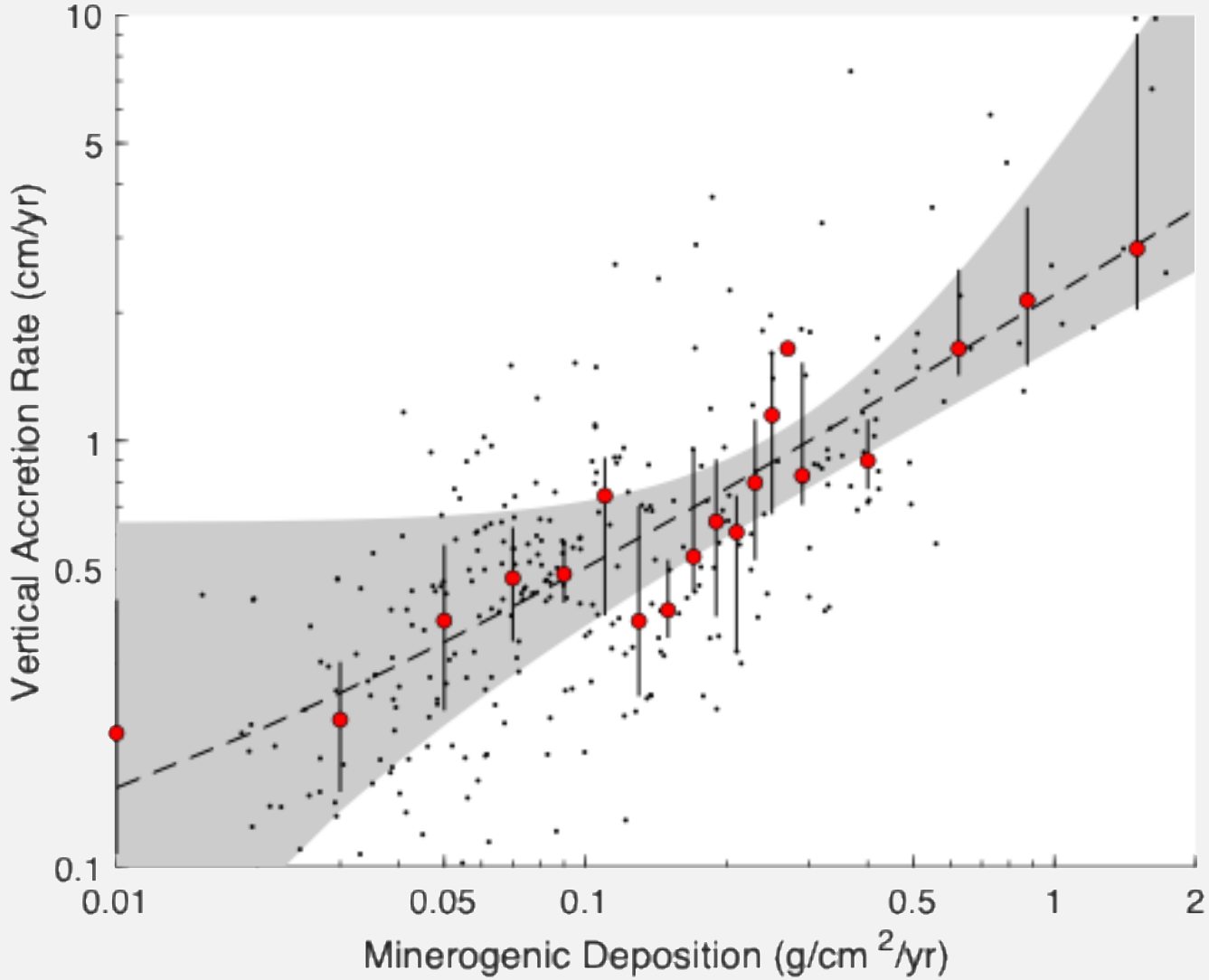
Marsh/Carry-On Analogy

Sediment Just Fills Void Space

V.S.

Sediment Takes Up Additional Space

INORGANIC DEPOSITION VS. VERTICAL ACCRETION RATE



$$\text{Accretion Rate} = \frac{Minerogenic\ Deposition}{\rho_{drybulk} * (1 - LOI_{marsh})}$$

QUESTION: HOW MUCH DOES SEDIMENT CONTRIBUTE TO SALT MARSH ACCRETION?

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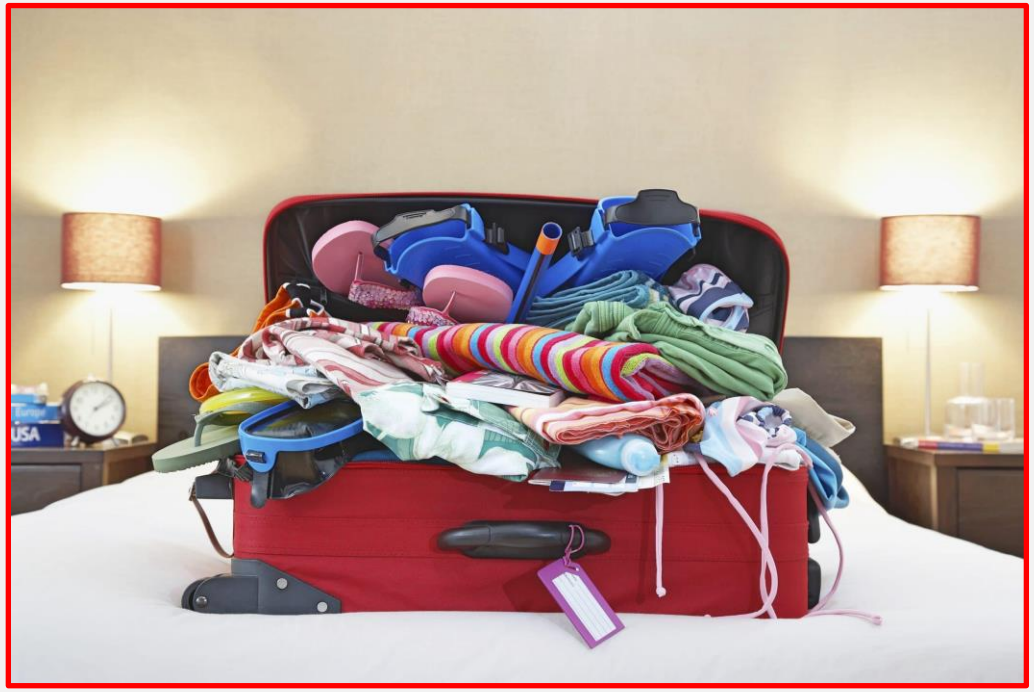
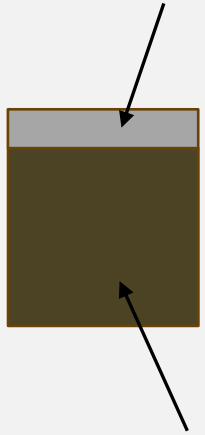


TWO CAMPS ON HOW TO CONVERT SEDIMENTATION (MASS) TO ACCRETION (VOLUME)

CAMP 1

Morris et al. (2016)

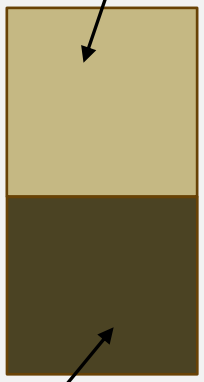


Minerogenic Sediment = 1.99 g/cm^3

In Situ Organics = 0.085 g/cm^3

CAMP 2

Mariotti et al. (2020)



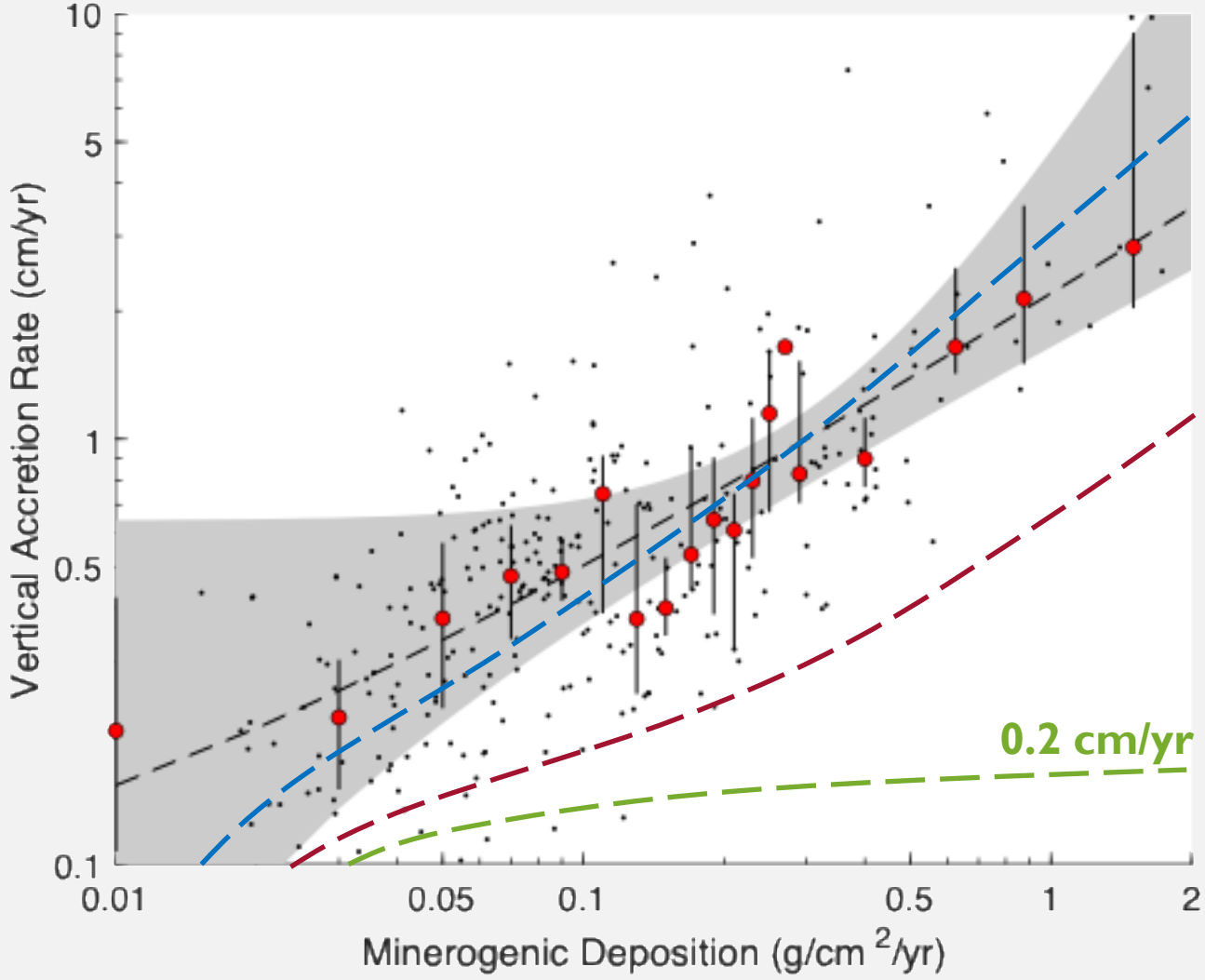
Minerogenic + Organic = 0.42 g/cm^3

In-Situ Organics = 0.085 g/cm^3

In Situ Biomass Production/Preservation Estimation

Alizad et al. (2022)

INORGANIC DEPOSITION VS. VERTICAL ACCRETION RATE



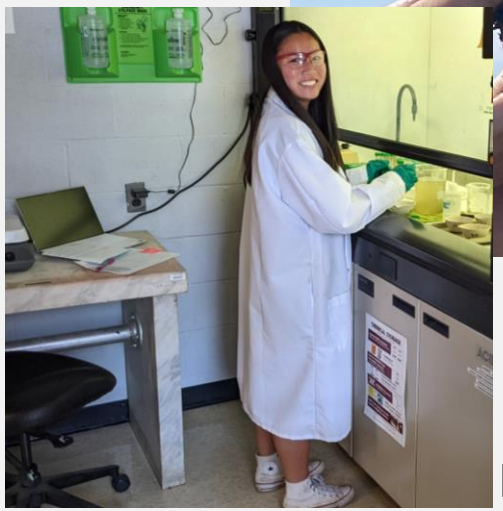
Decreasing Elevation →

Bulk Mud Packing Density = 0.42 g/cm³
Marriotti et al. (2020)

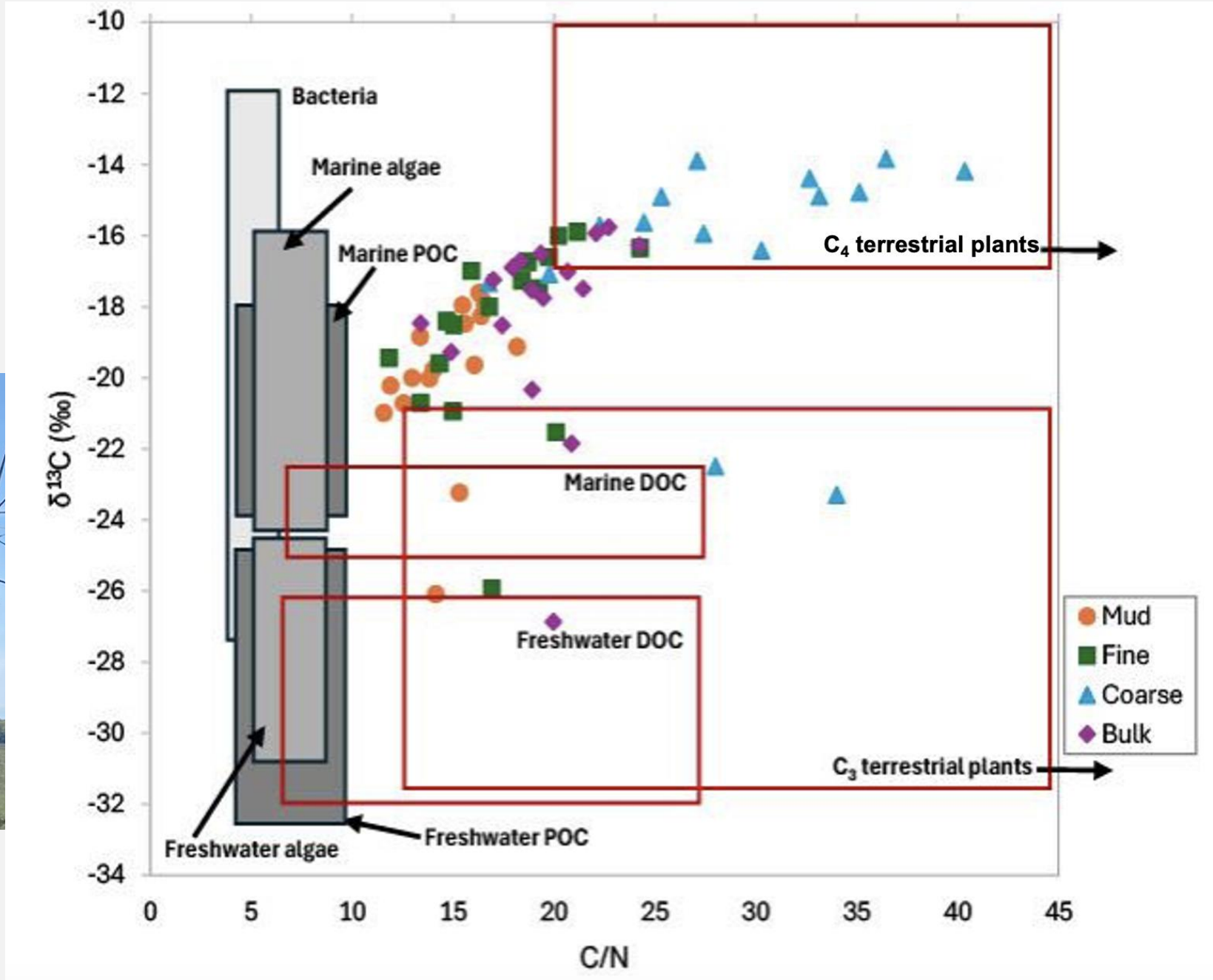
Inorganic Packing Density = 1.99 g/cm³
Morris et al. (2006)

In Situ Biomass Production/Preservation
Alizad et al. (2022)

ADDITIONAL EVIDENCE FOR FINE ORGANICS COMING FROM SEDIMENT



Hannah Chan



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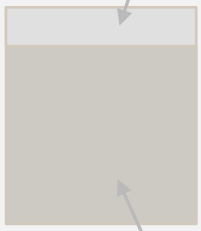

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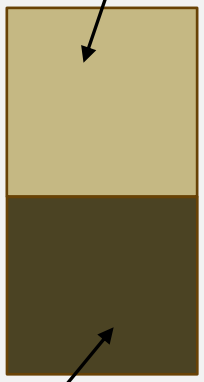

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In-Situ Organics = 0.085 g/cm^3

In Situ Biomass Production/Preservation Estimation

Alizad et al. (2022)

Massachusetts Sea Level Affecting Marshes Model (SLAMM) Viewer

Intro | Interactive Map | Methods | Interpretation | Additional Info

Legend

Adapted SLAMM Wetland Classes

Salt or Brackish Marsh

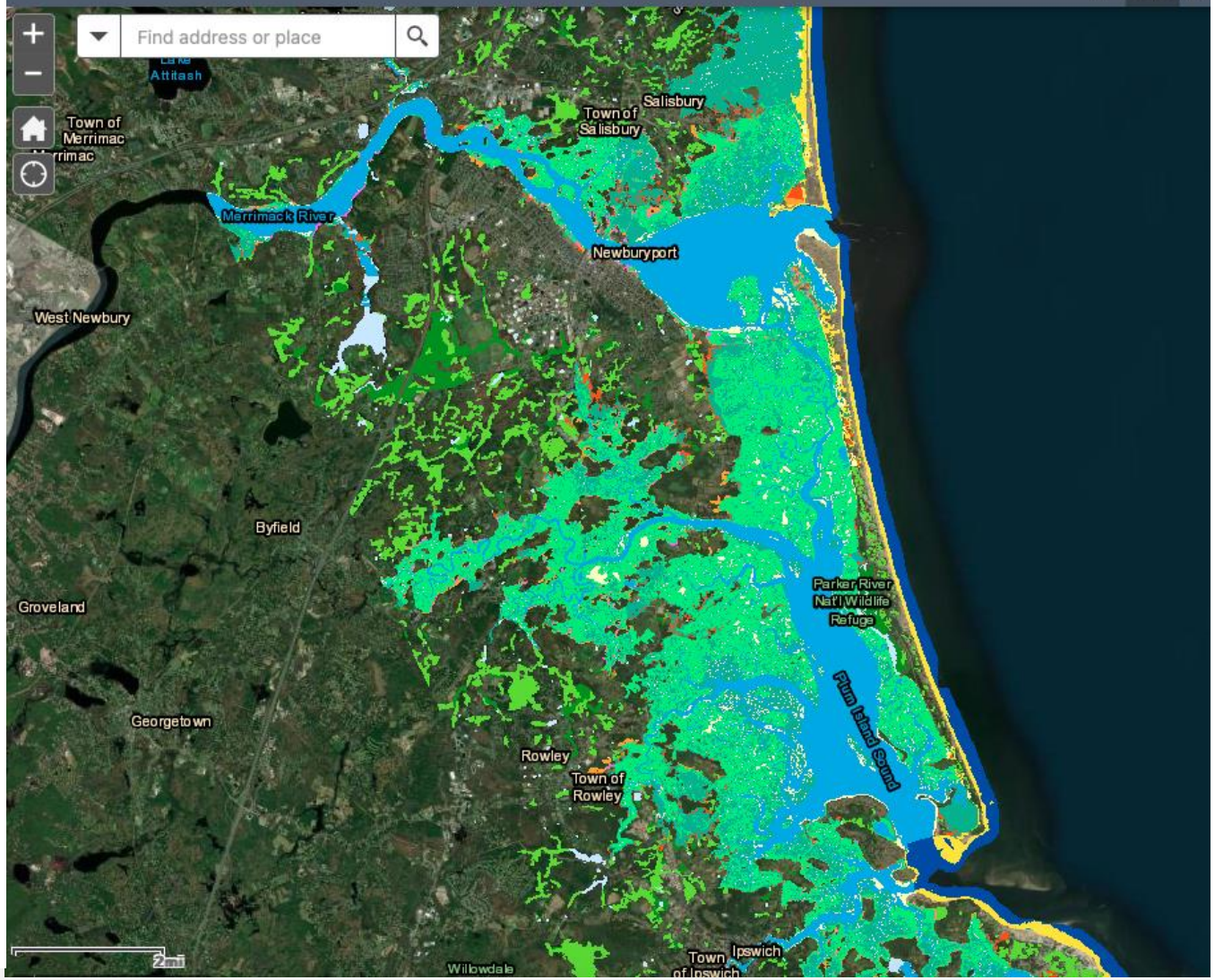
- Regularly Flooded Marsh *(Low Marsh)*
- Irregularly Flooded Marsh *(High Marsh)*
- Transitional Marsh or Scrub-Shrub *(Marsh Border)*

Freshwater Marsh or Swamp

- Tidal Fresh Marsh
- Tidal Swamp
- Inland Fresh Marsh
- Nontidal Swamp

Other Wetlands and Open Water Habitats

- Rocky Intertidal Shore
- Tidal Flat or Estuarine Beach
- Ocean Beach
- Ocean Flat
- Inland Open Water
- Estuarine or Riverine Tidal Open Water
- Open Ocean



About MEM

Marsh Equilibrium Model (MEM)

Salt marsh accretion is the natural process of accumulating inorganic matter (e.g., sand) and organic matter (e.g., marsh grass). This accretion allows marshes to grow vertically, which means that the surface elevation of the marsh rises if accretion rates are greater than subsidence (sinking). If sea level rises faster than marsh surface elevation, a marsh will eventually drown and become mud flat or open water. Accretion is critical to marsh survival.

The data layers with statewide coverage were produced using the historical sea level change rate for a given area as a proxy for accretion rate in SLAMM. Accretion rates specific to the Great Marsh, which extends from Salisbury to Gloucester on the upper North Shore of Massachusetts, were generated by running the Marsh Equilibrium Model (MEM). MEM was developed and calibrated for the Plum Island Estuary (encompassing much of the Great Marsh) by Dr. James Morris at the University of South Carolina, one of many principal investigators at the Plum Island Ecosystems Long Term Ecological Research site (PIE LTER). These accretion rates vary over time, based on the interactions between sea level rise, sediments, and vegetation. The data layers developed using MEM-derived accretion inputs are labeled with "Great Marsh" and "MEM Accretion" in the layer list (e.g., Great Marsh 2100 Wetlands - High SLR [7.1 ft] - MEM Accretion).

OUTLINE

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WHAT DO THESE TWO WETLANDS HAVE IN COMMON?

Non-Tidal Freshwater Marsh

Tannery Brook, NH

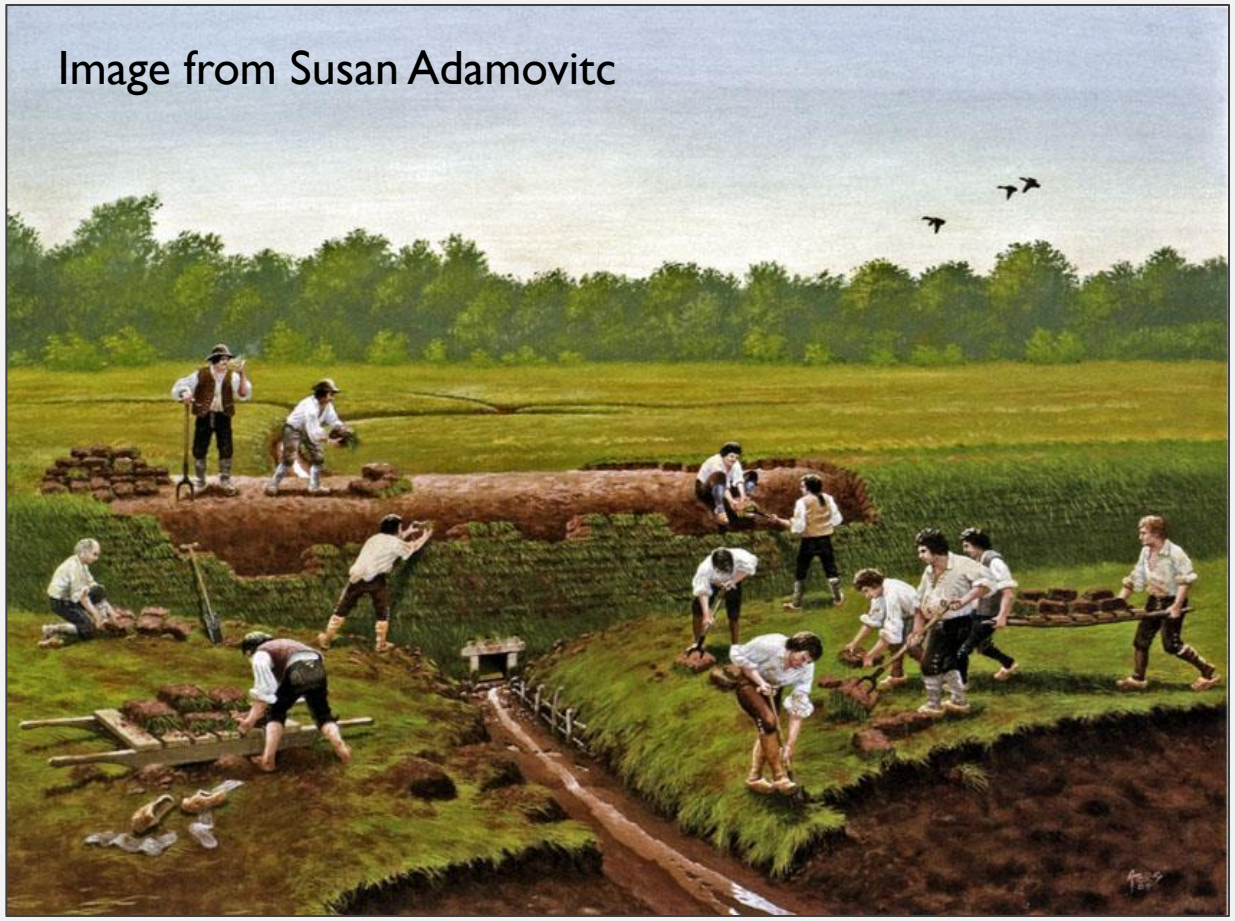
Tidal Salt Marsh

Old Pond, ME

REASON ELEVATIONS ARE SO HIGH ON COUSINS MARSH

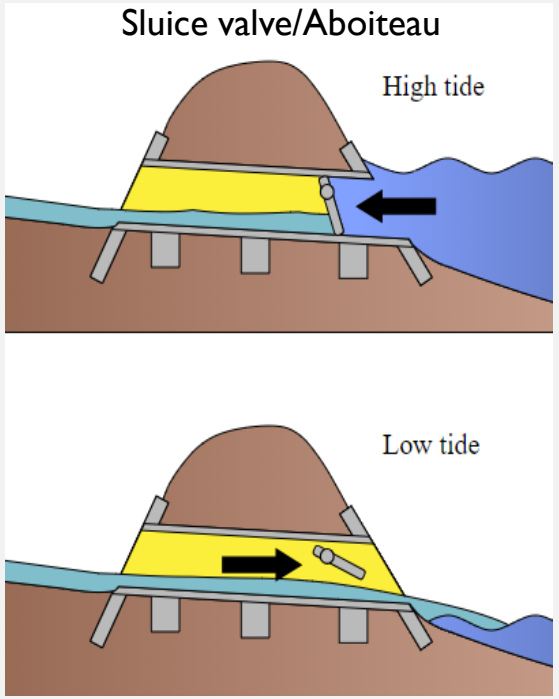
Cousins River, Maine

Photo Credit: Maine Coast Heritage

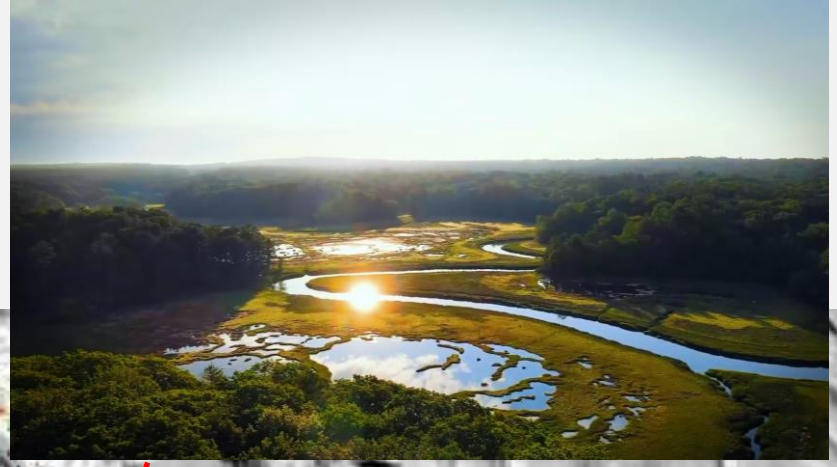


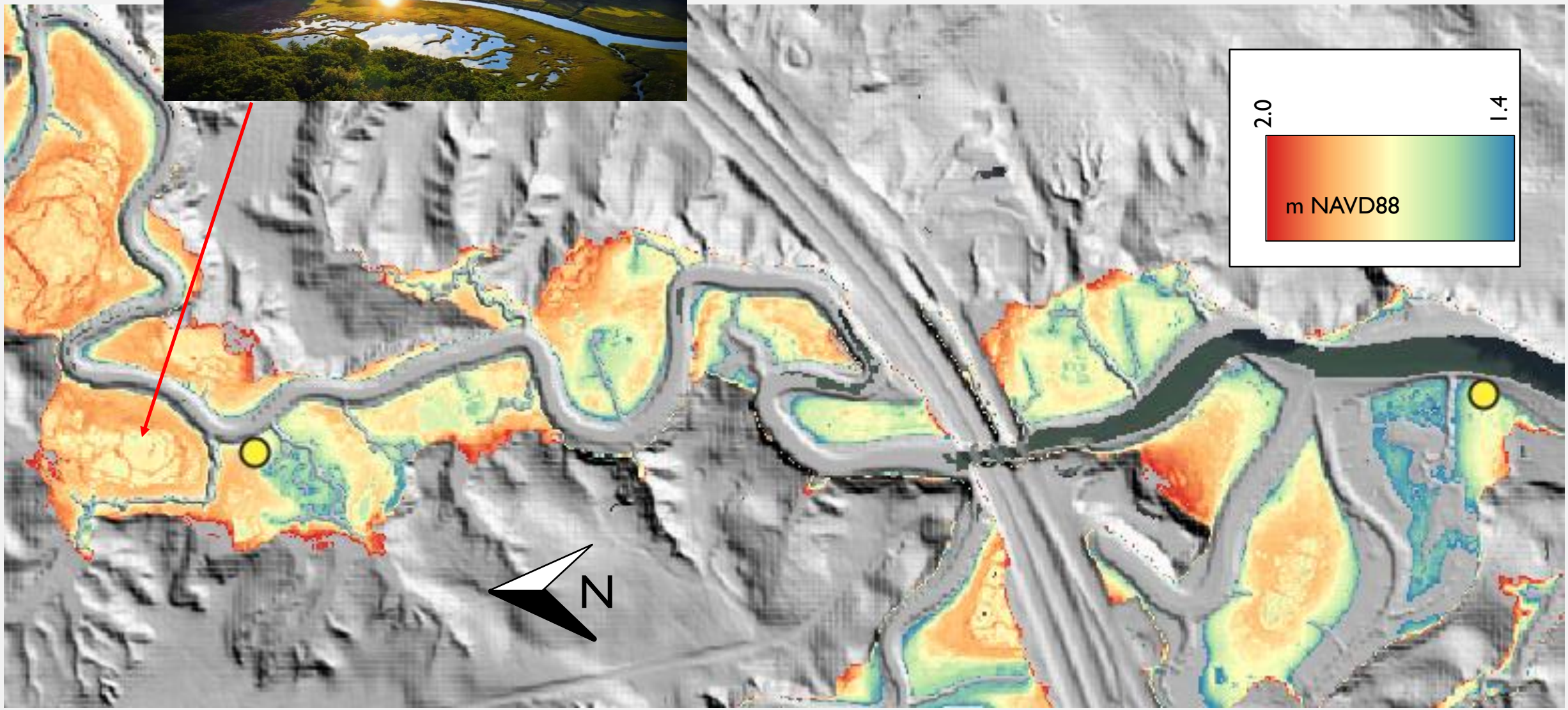
"Repairing a dyke" by Azor Vienneau

EMBANKMENTS AND CLAPPER VALVES



ELEVATIONS ON COUSINS MARSH





Geoff Wilson

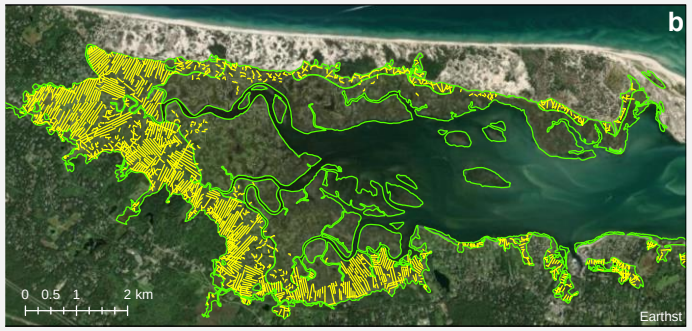
LEETES ISLAND, GUILIFORT, CT

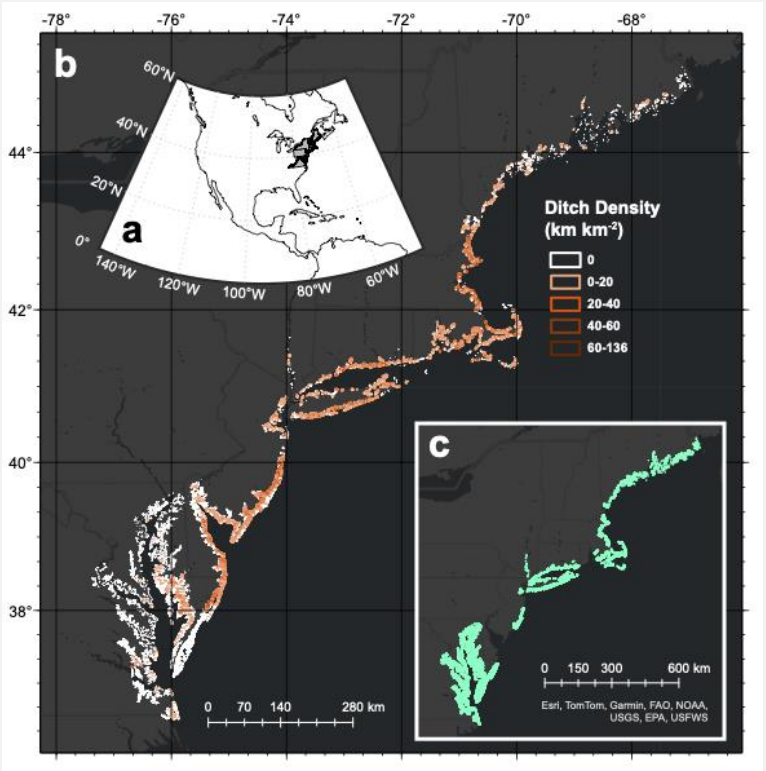
Photo Credit: Ron Rozsa (c/o Geoff Wilson)

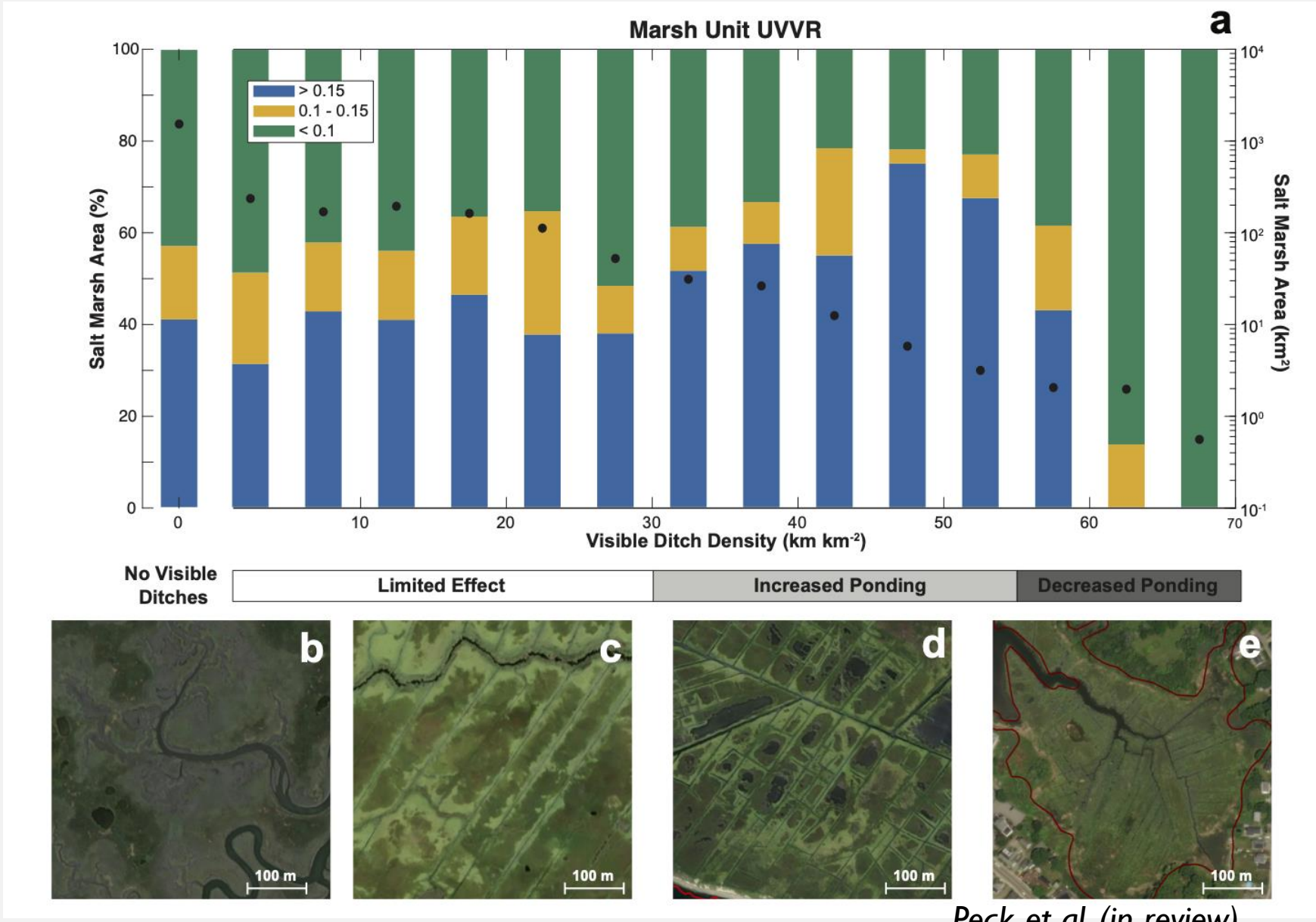
Erin Peck

Julie Walker

DITCHES VS. PONDED AREA



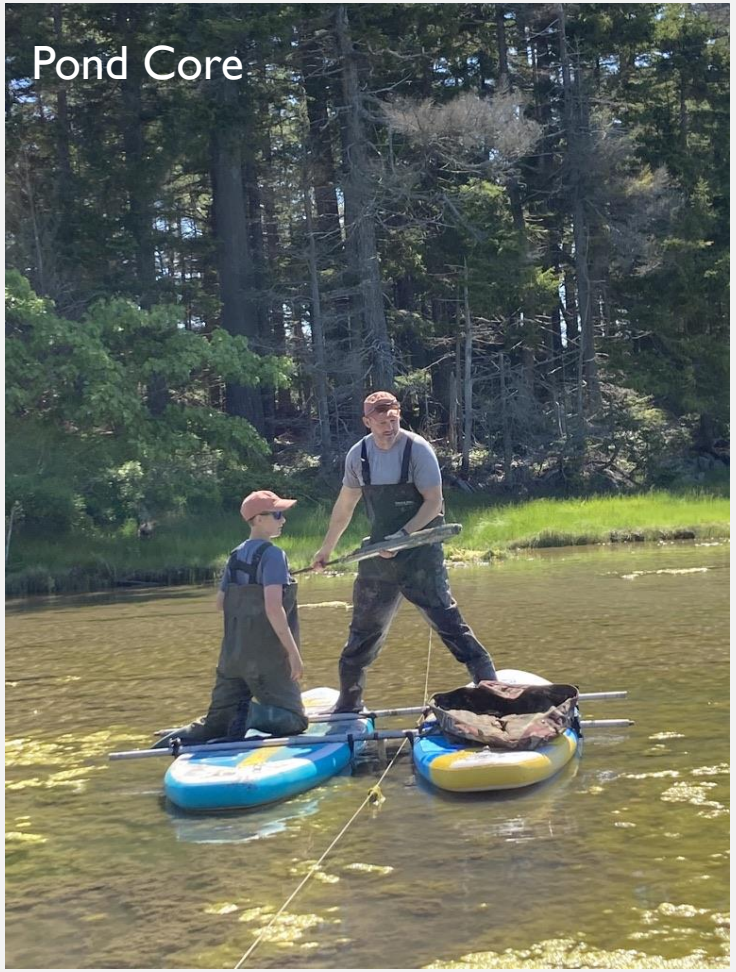


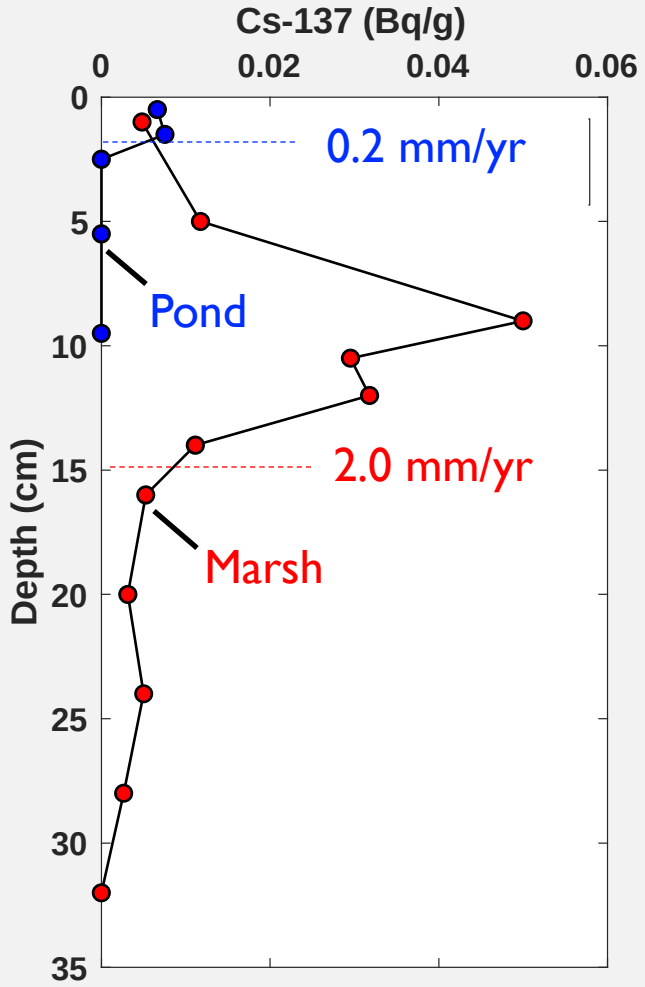


Peck et al. (in review)

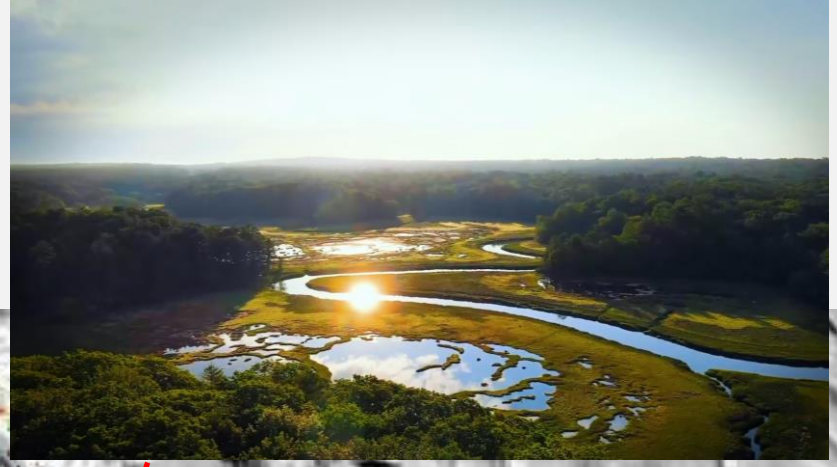
DEPOSITION VS PONDING

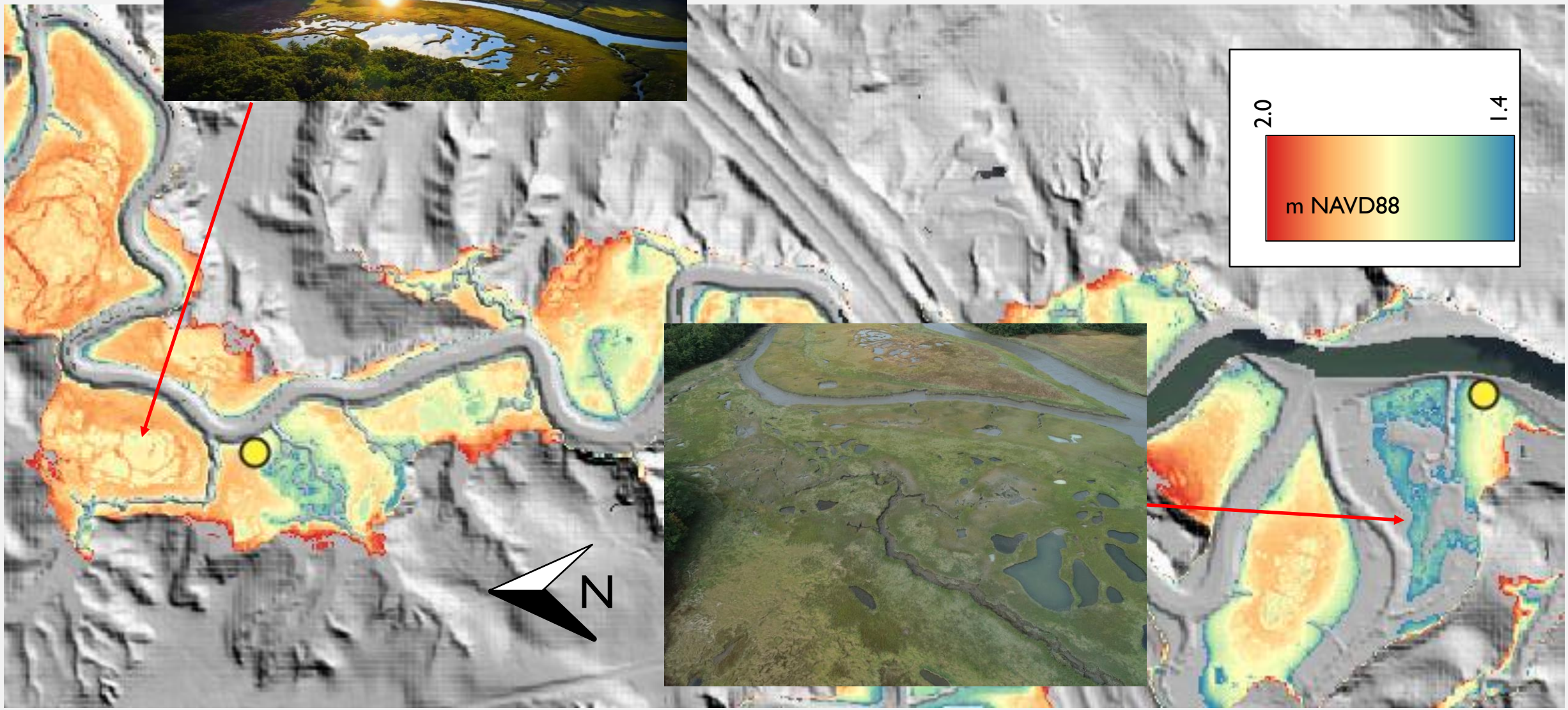
Tatia Bauer, MCHT





ELEVATIONS ON COUSINS MARSH





EXPERIMENT WITH NATURALLY DRAINING POND

Year=1956

Year=1964

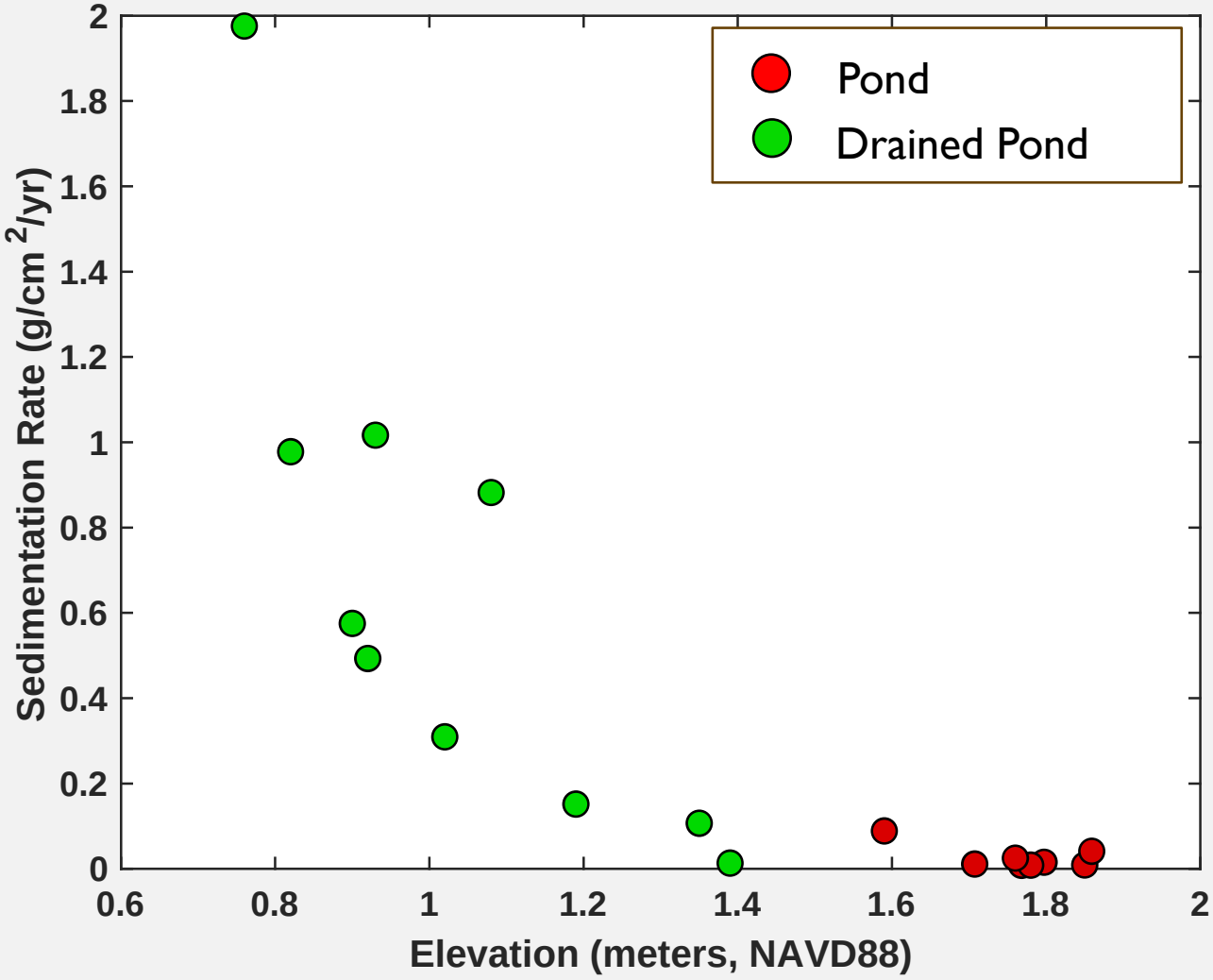
Year=1998

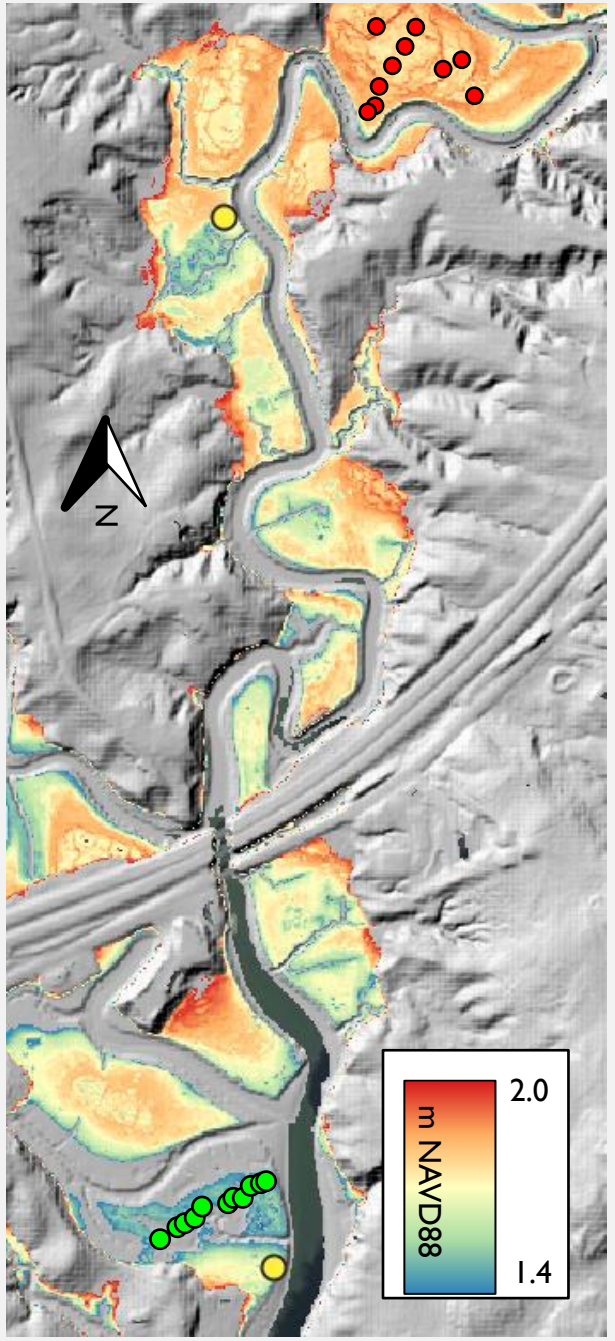
Year=2006

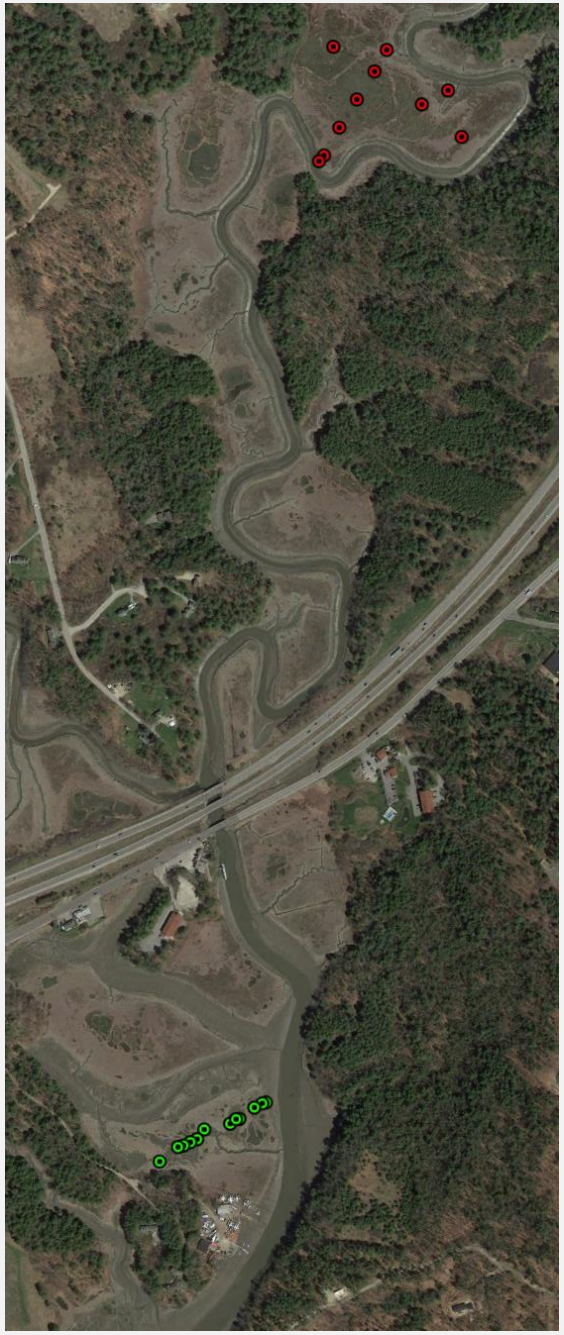
Year=2010

Year=2023

SEDIMENTATION IN POND VS. DRAINED POND





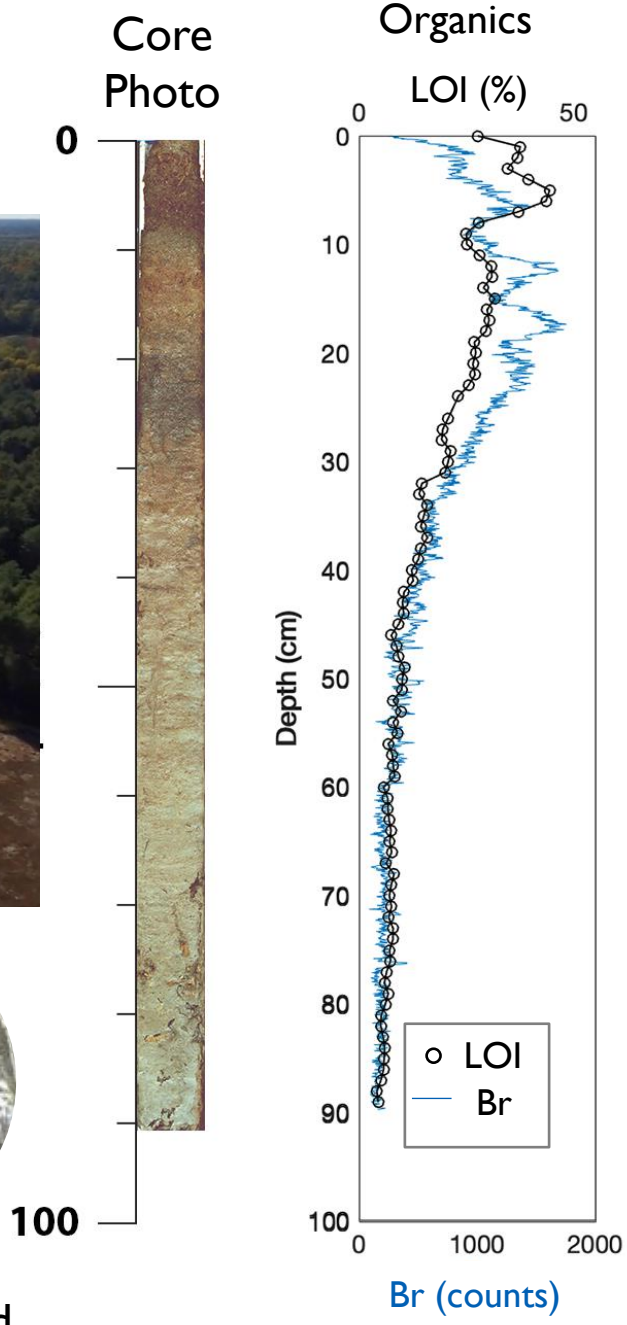


POLLEN/ FORMANIFERA INSIGHT

Phoenix Susak

Molly Autery

Dana MacDonald



OUTLINE

1. Salt Marsh Sediment Sourcing
2. Sediment Contributions to Accretion
3. Relevance to Restoration

THANK YOU

Molly Autery

Hannah Baranes

Tim Cook

Frances Griswold

Niamh Gallen

Meagan McKiernan

Erin Peck

Wenxiu Teng

Julie Walker

Brian Yellen

Qian Yu

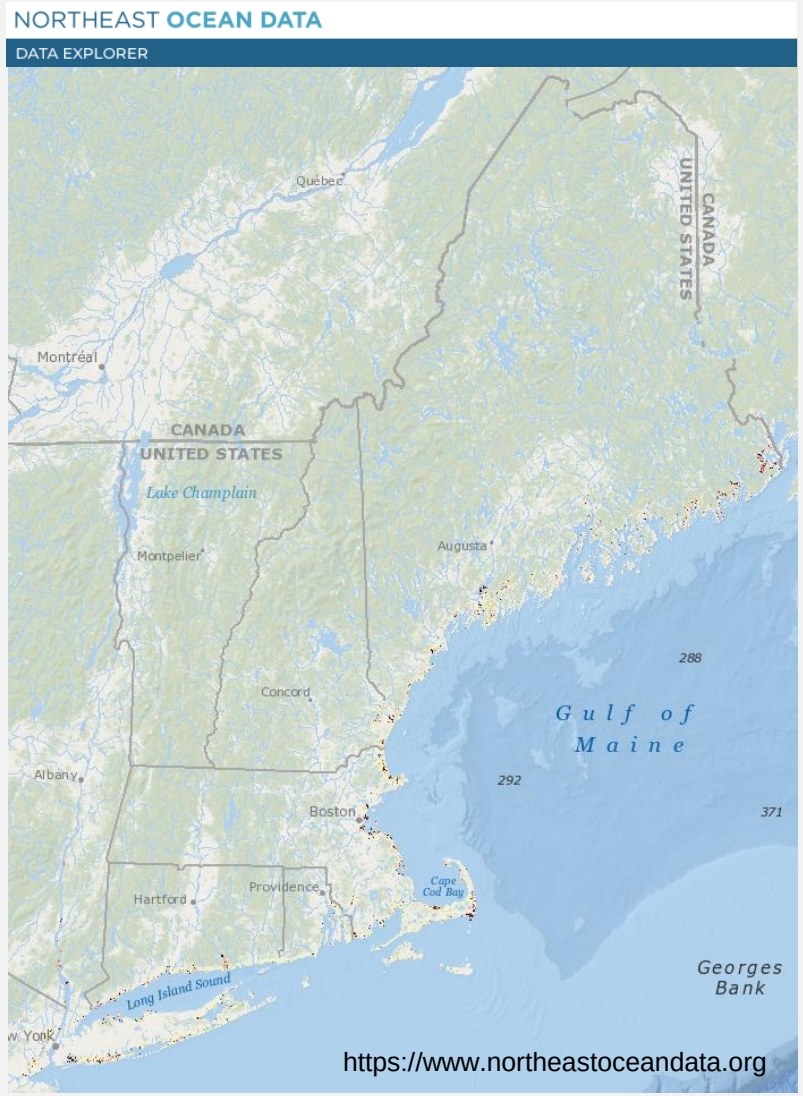

Wenxiu Teng

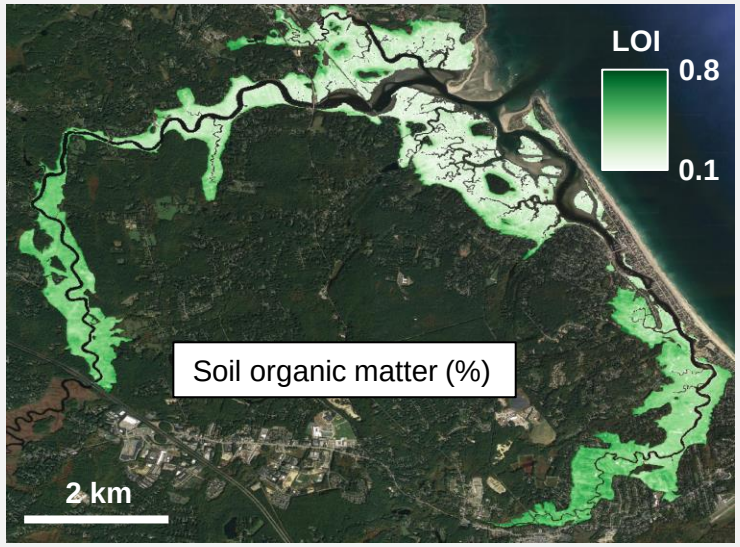

Bonnie Turek

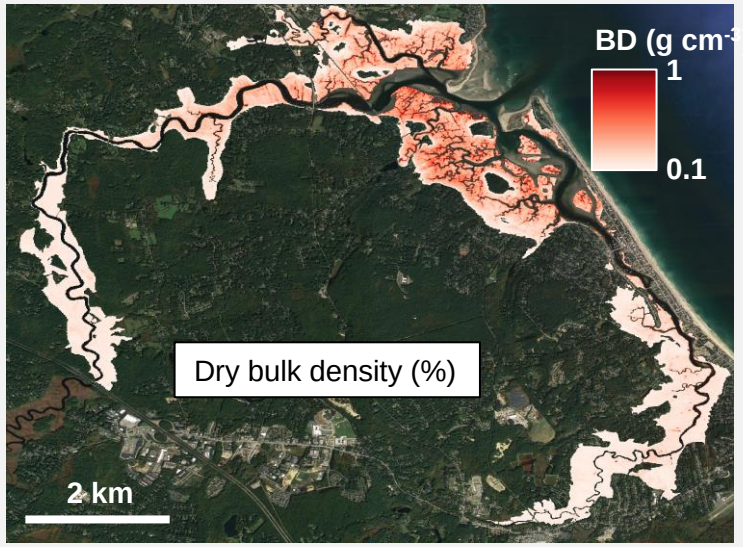

Brian Yellen

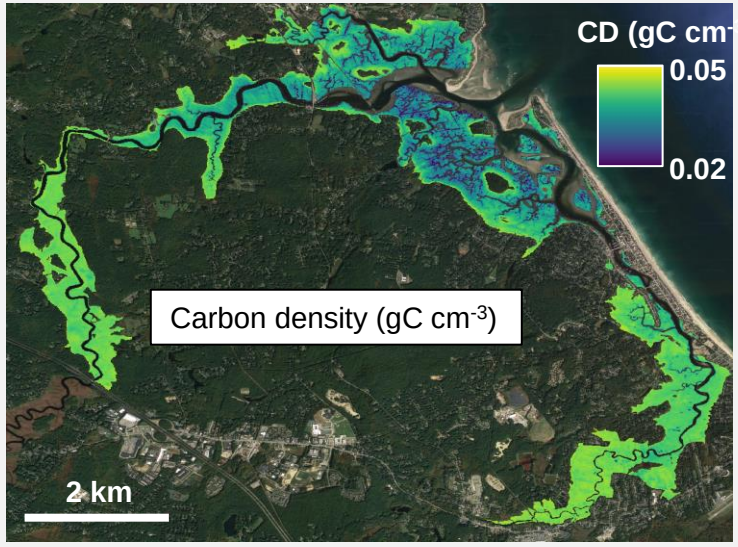

Qian Yu

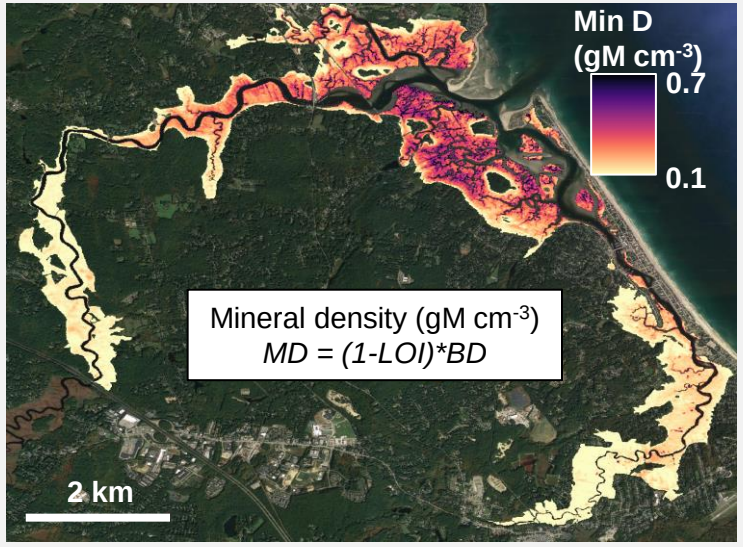
SALT MARSH CARBON DENSITY





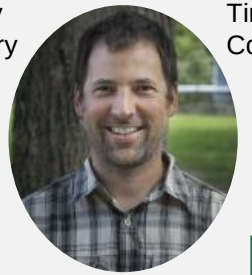






ACCRETION RATES AND ELEVATION CHANGE

Molly Autery



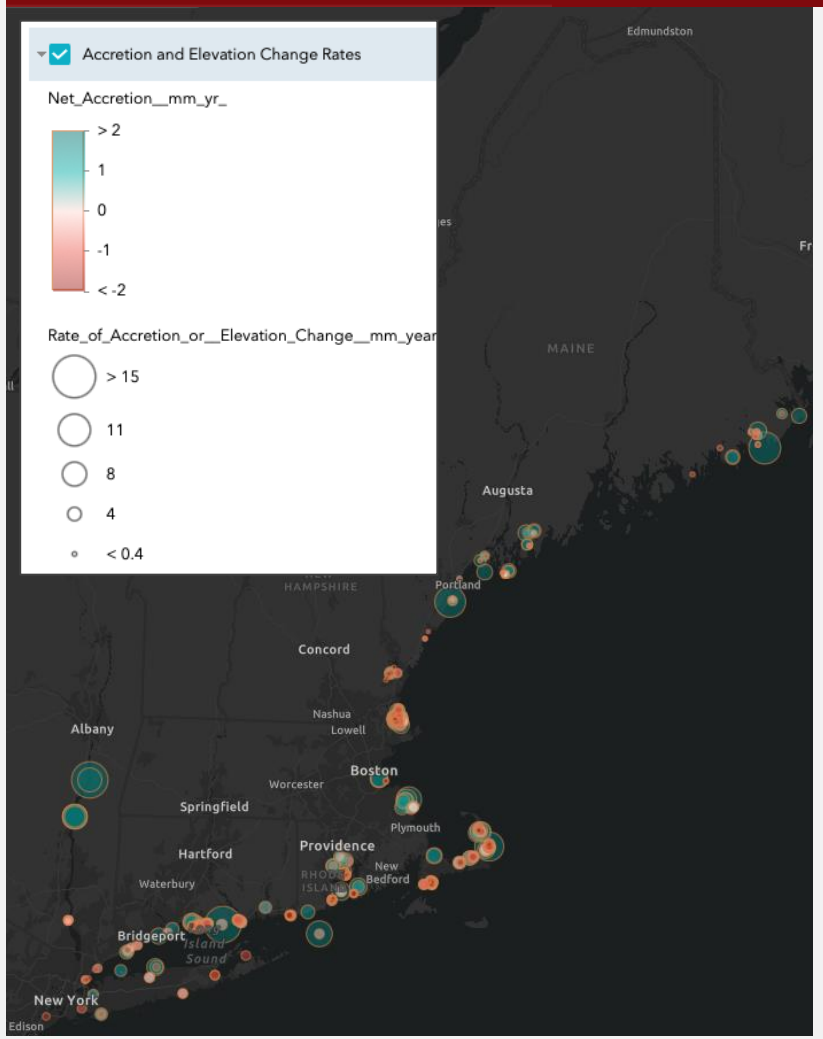
Tim Cook

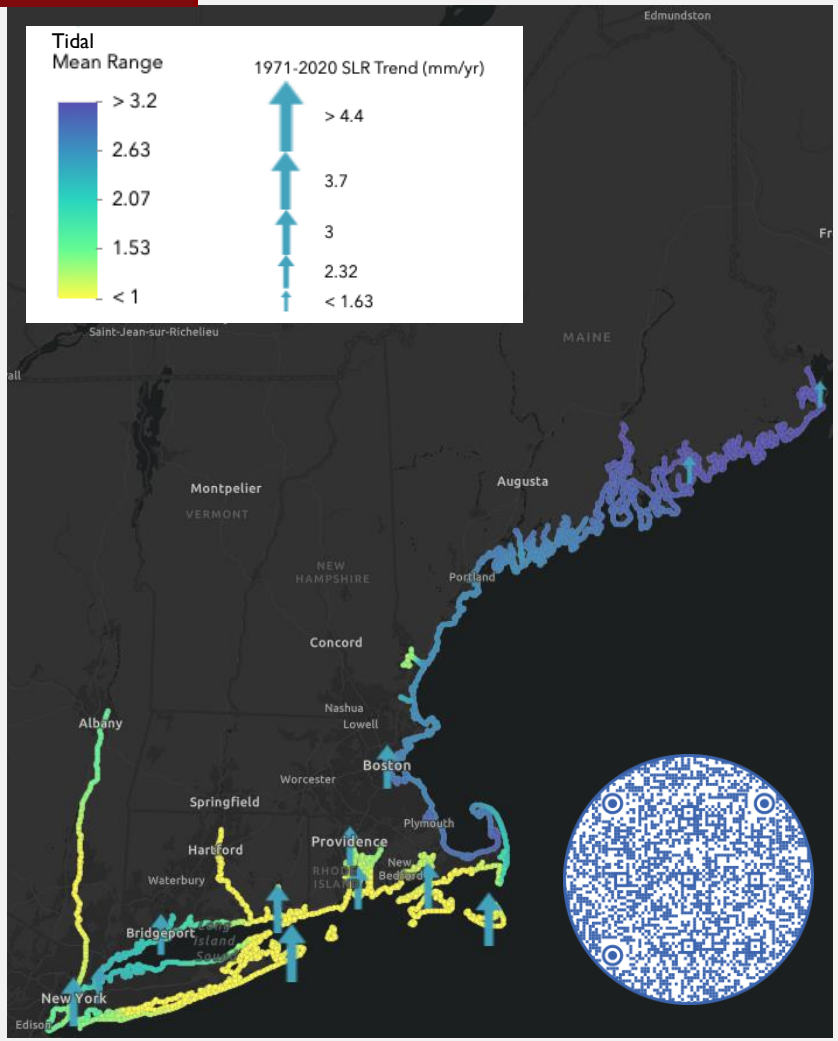
NECASC

UMassAmherst

Northeast USA Tidal Wetland Accretion and Elevation Change

UMass Sediment & Coastal Dynamics





RECENT NECASC SPONSORED SEDIMENT/MARSH WORK

1. Sediment Delivery, Deposition and Sourcing

Papers: Teng et al. (in review, B); Woodruff et al. (in review … well almost); Cook et al., (in prep)

Data Product: Northeast USA Tidal Wetland and Elevation Change Viewer

Data Product: High-Res Mapping of Suspended Particulate Matter in Global Coastal Waters

2. Carbon Storage Assessments

Papers: Turek et al. (in press); Peck et al. (in review, A); Teng et al. (in review, A); Yellen et al. (in prep).

Data Product: Northeastern Ocean Data Salt Marsh Blue Carbon Viewer

3. Controls on Resilience & Relevance to Restoration

Papers: Peck et al. (in review, B)

Data Product: Linear Ditches of Northeastern U.S. Coastal Marshes from Maine to Virginia