COLLABORATIVE SCIENCE FOR ESTUARIES

WEBINAR SERIES

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Gabrielle Sakolsky

Cape Cod Mosquito Control Project

Evaluating the Impact of Hydrologic Alterations on Salt Marsh Sustainability in a Changing Climate

National Estuarine
Research Reserve System
Science Collaborative

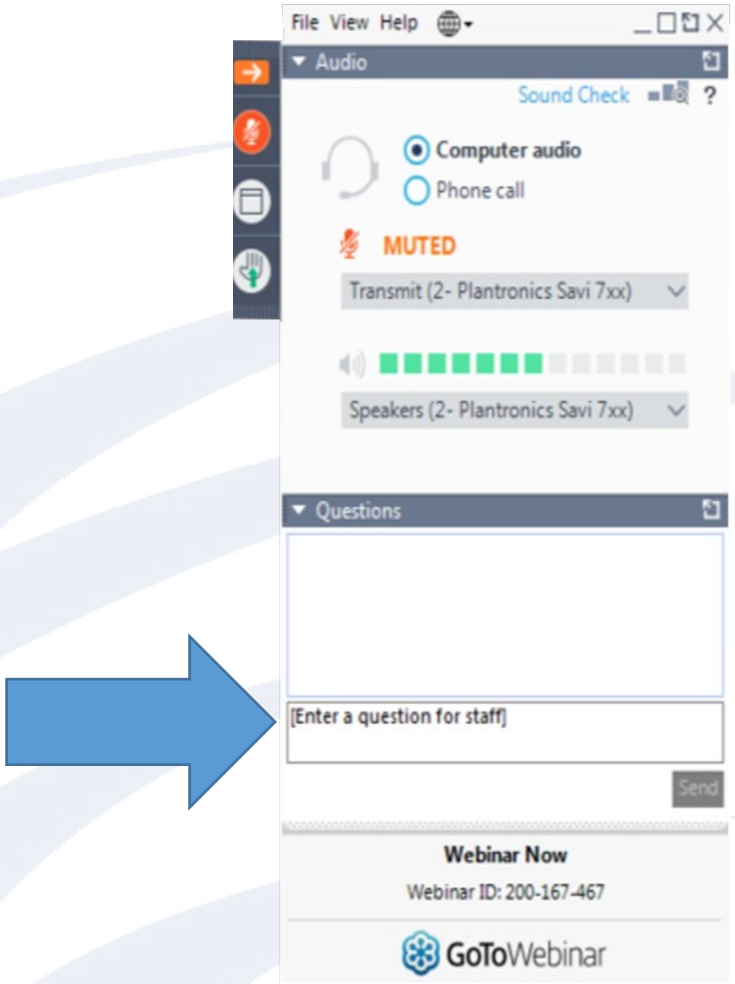
Date: Tuesday, December 7, 2021

Time: 2:00-3:00 PM ET

National Estuarine Research Reserve System

Have a question?

Use the “Questions” function to pose questions throughout the webinar.



National Estuarine
Research Reserve System
Science Collaborative

Presenters

Amanda Spivak
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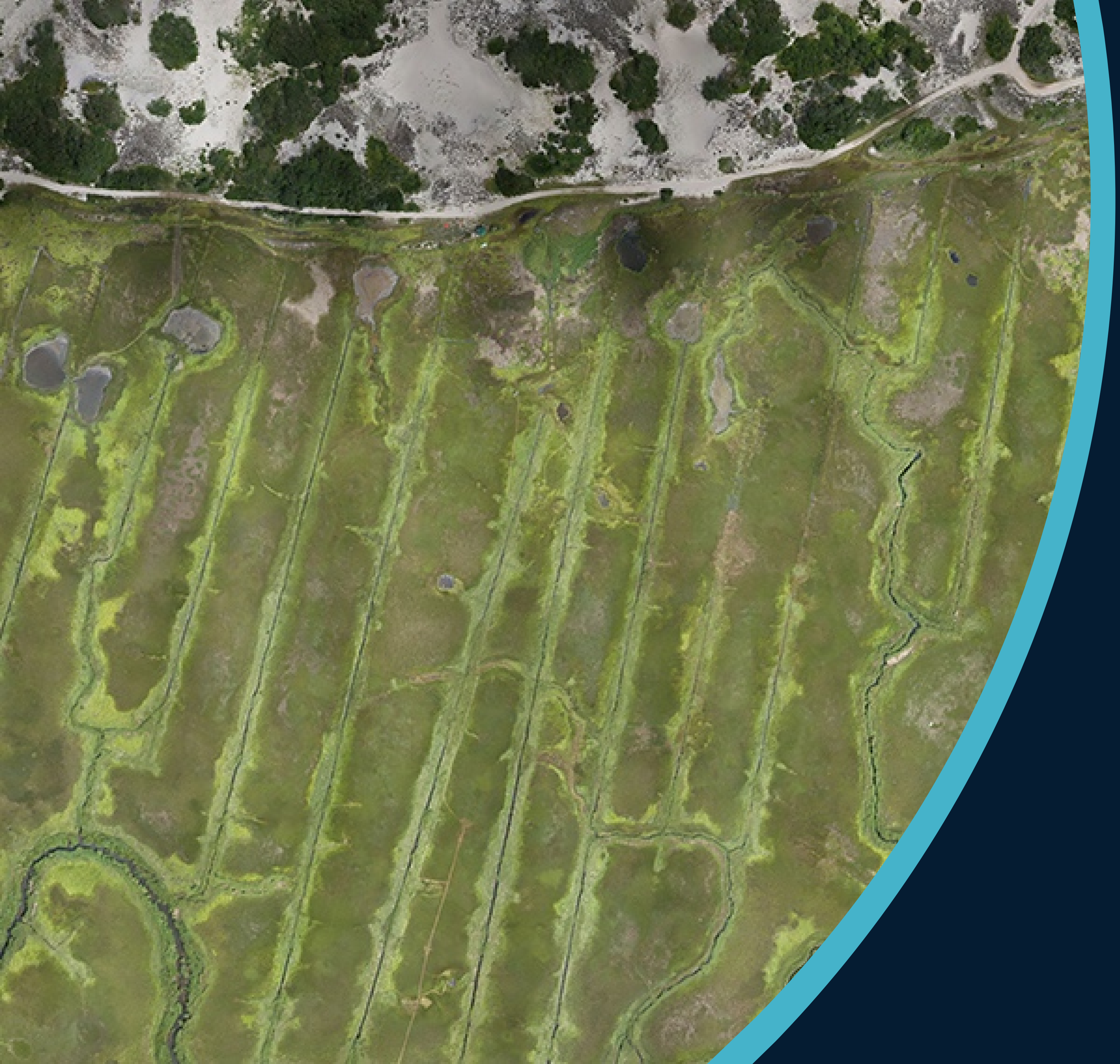


Marsh Sustainability and Hydrology (MSH) Project Webinar

DECEMBER 7, 2021

Agenda

- Introduction to the MSH Project and Team
- Setting the Stage: Motivation for This Work
- Using a Collaborative Research Approach: Linking Science to Management
- Research Questions and Results
- MSH Decision-Support Tool and Model
- Opportunities for Applying the MSH Tool
- Questions & Project Video

Meet the MSH Team

AMANDA SPIVAK
Principal Investigator
Co-Technical Lead
WHOI

SUSAN ADAMOWICZ
Science Team
End User
USFWS

MEAGAN EAGLE
Science Team
USGS

SHERON LUK
Science Team
WHOI

GIULIO MARIOTTI
Modeler
Co-Technical Lead
LSU

GABRIELLE SAKOLSKY
End User
CCMCP

TONNA-MARIE ROGERS
Collaborative Lead
WBNERR

MEGAN TYRELL
Science Team
End User
WBNERR

PROJECT MOTIVATION

- **Help wetland managers better evaluate, visualize, and plan for the impact of ditching and preserve ecosystem services under different climate scenarios**

End Users We Engaged

Wetland managers	Restoration practitioners	Local officials	Mosquito control & public health practitioners
Federal and state agency staff	Environmental protection staff and regulators	NERRs, NEPs, MPAs	Non-profit organizations

Priority Areas of Interest for Managers

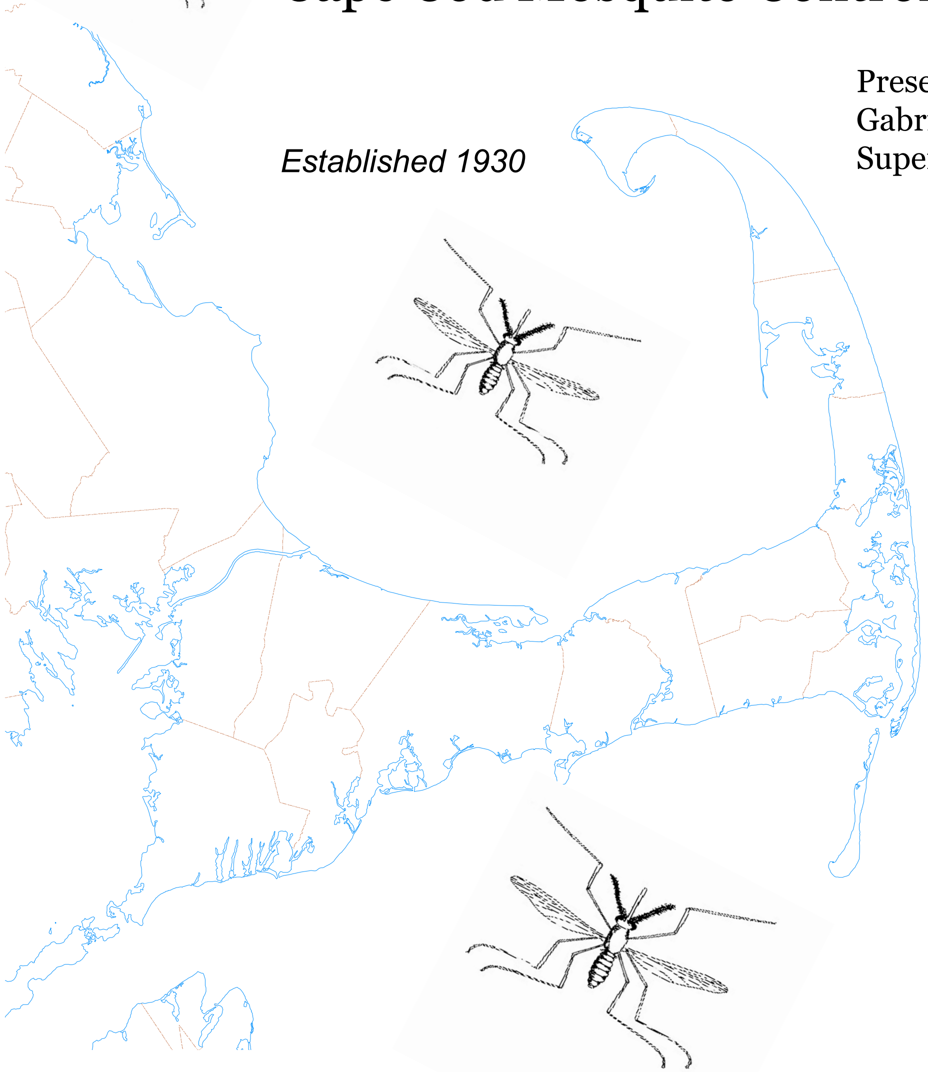
- Make better informed trade-off decisions regarding different wetland and ditch management strategies
- Be able to better predict what effect a management action will have
- Understand how ditch maintenance affects marsh elevation – different amounts, different ditch depths
- Understand processes that contribute to pool formation in marshes and how marshes will respond to changing ditch depth, shape, length and density
- Understand how different ditch management approaches affect water movement and fish passage in order to inform mosquito control efforts

Linking Science to Management

Cape Cod Mosquito Control Project

Established 1930

Presenter
Gabrielle Sakolsky, Entomologist
Superintendent



Mosquito Life Cycle

Egg

Larva

Pupa

CDC

Mosquito Habitats

Swamps and standing water

Floodwater

CDC


Altosid

Hand cleaning ditches to keep waterways open.

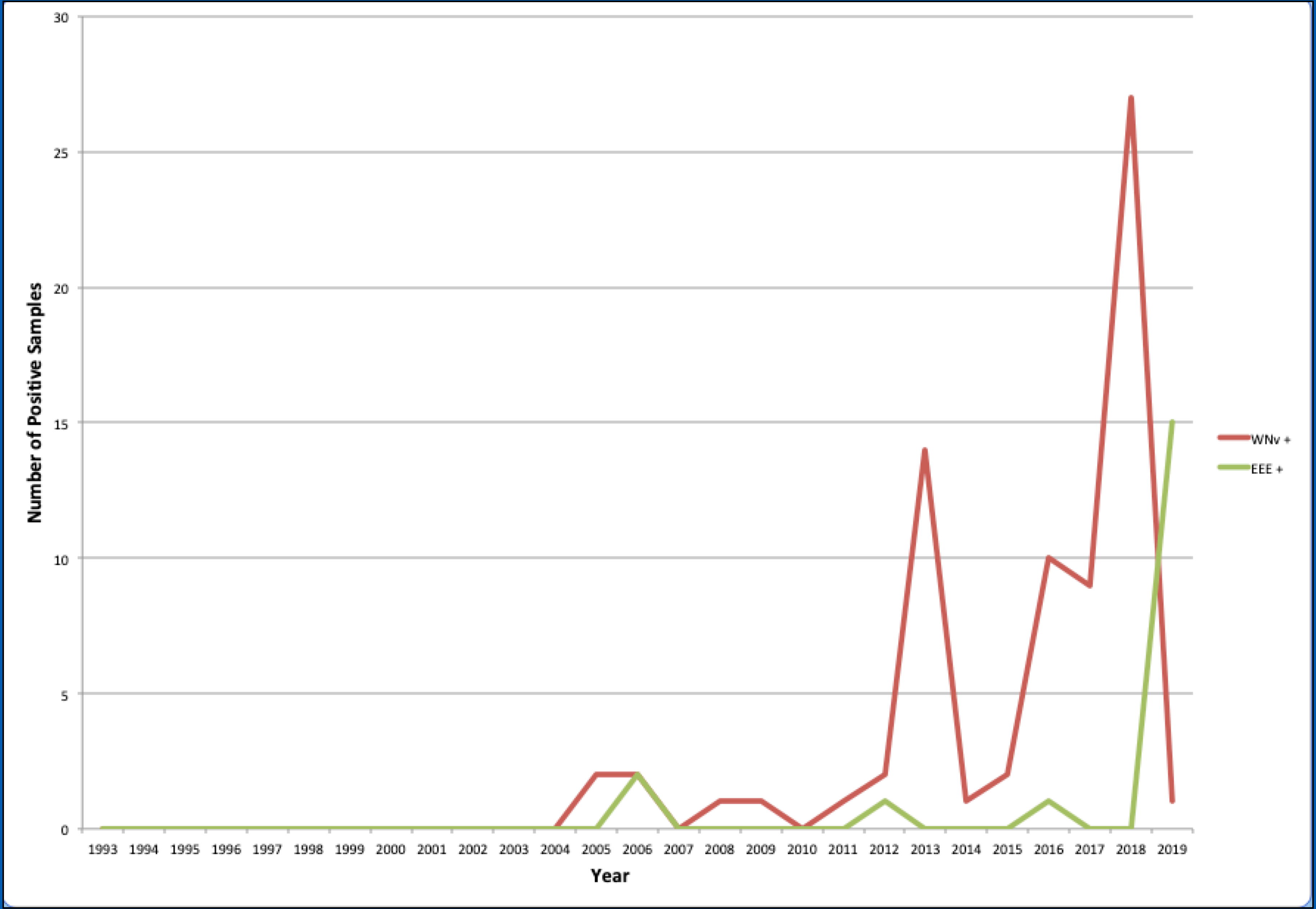
148,166 feet of inland ditches and 40,399 feet of saltmarsh ditches maintained in 2020.


MALETTI

Mechanized ditch maintenance.


42-DT

Arbovirus positive mosquito samples collected in Barnstable County, 1993-2019



Evaluating the Impact of Hydrologic Alterations on Salt Marsh Sustainability in a Changing Climate

Amanda Spivak
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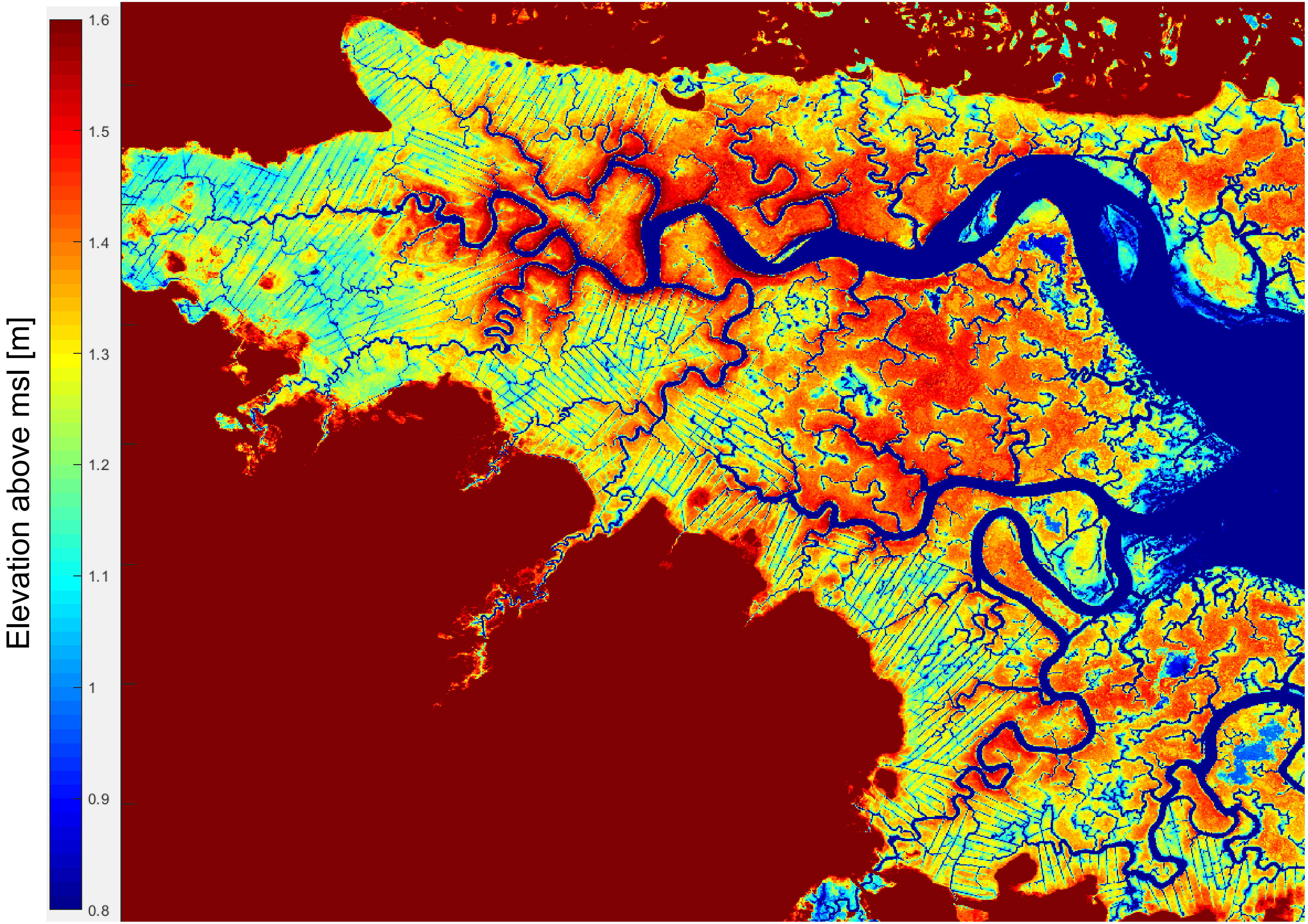
1785



What are the long-term effects of ditching and how are these best managed?

Management Decisions Are Complex

Management priorities vary:

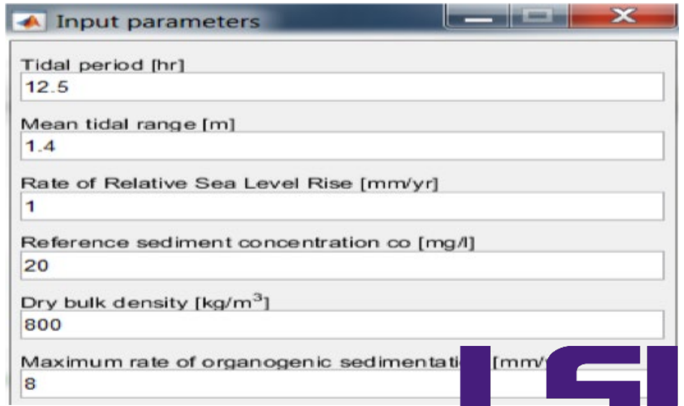
- Human health (e.g., mosquito populations)
- Sustainability (e.g., vertical accretion rates)
- Ecosystem services (e.g., C sequestration)
- Recreation (e.g., birding)

What we heard from managers:

- Faced with highly localized and complex scenarios that force trade-off decisions.
- Decisions are often made in response to an on-the-ground problem, and the implications are learned later.
- Trial-and-error approaches can consume time and budgets.

Project Goals

- Identify knowledge gaps regarding the management of marsh hydrology and drainage;
- Quantify ditching impacts on ecoservices and sustainability in macro- & micro- tidal marshes;
- Develop a two-dimensional model that predicts changes in elevation, geomorphology, and ecoservices in response to hydrologic alterations and RSLR;
- Translate model results and field data into decision support tools;
- Create model outputs that will be easily transferrable to other systems



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1785
USGS
science for a changing world
WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930
LSU
LOUISIANA STATE UNIVERSITY

Research Question:

What are the long-term (~90 y) impacts of ditch installation and maintenance on marsh ecosystem properties and soil carbon storage?

Research Question and Methods:

What are the long-term (~90 y) impacts of ditch installation and maintenance on marsh ecosystem properties and soil carbon storage?

Triplicate Transects

Surveys:

- Elevation
- Plant communities

Soils:

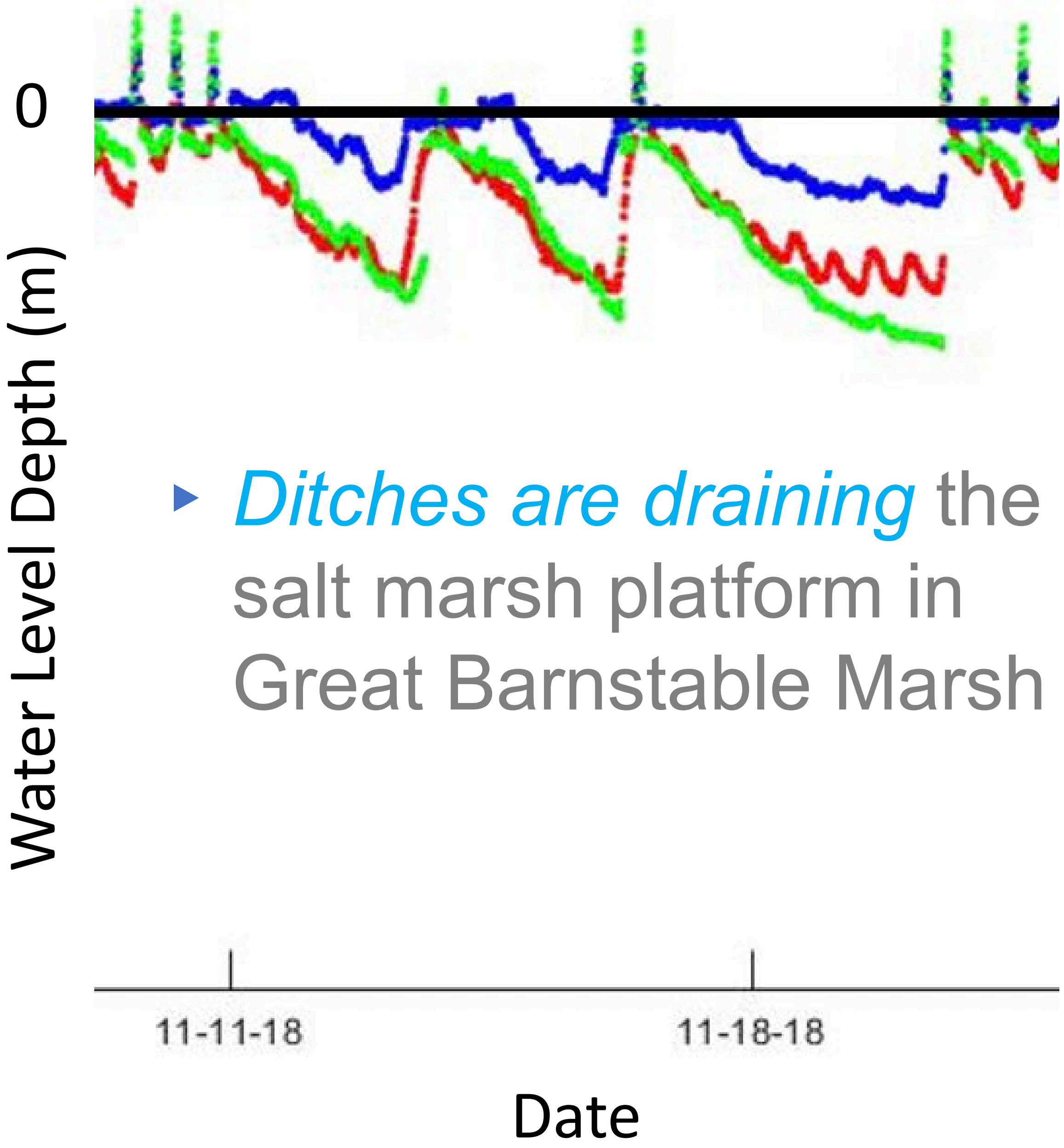
- Physical properties
- Elemental content
- Organic matter composition
- Vertical accretion rates

Results: Hydrology

Interior

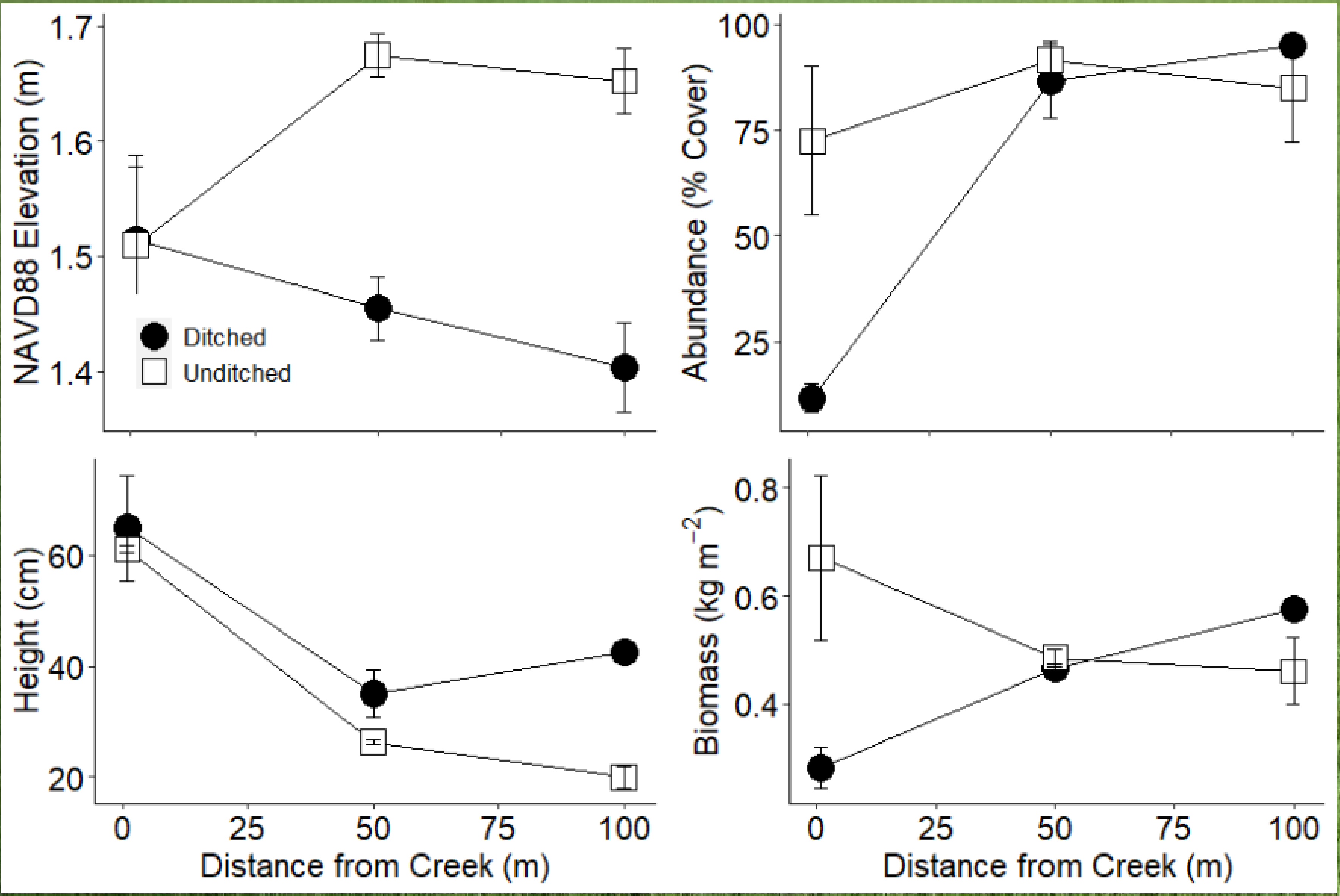
Ditch edge

Creek edge



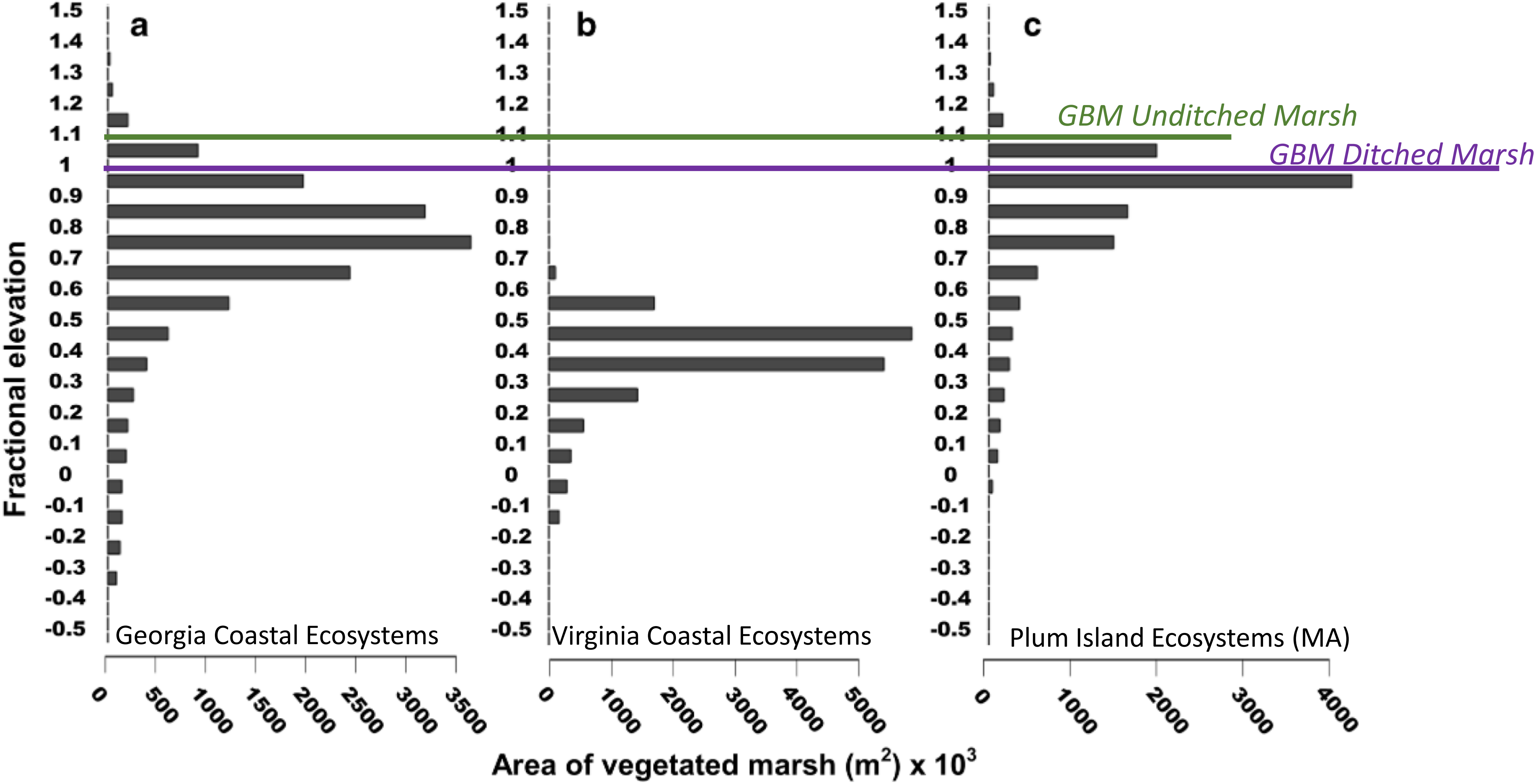
- *Ditches are draining* the salt marsh platform in Great Barnstable Marsh

Results: Elevation and Marsh Grasses



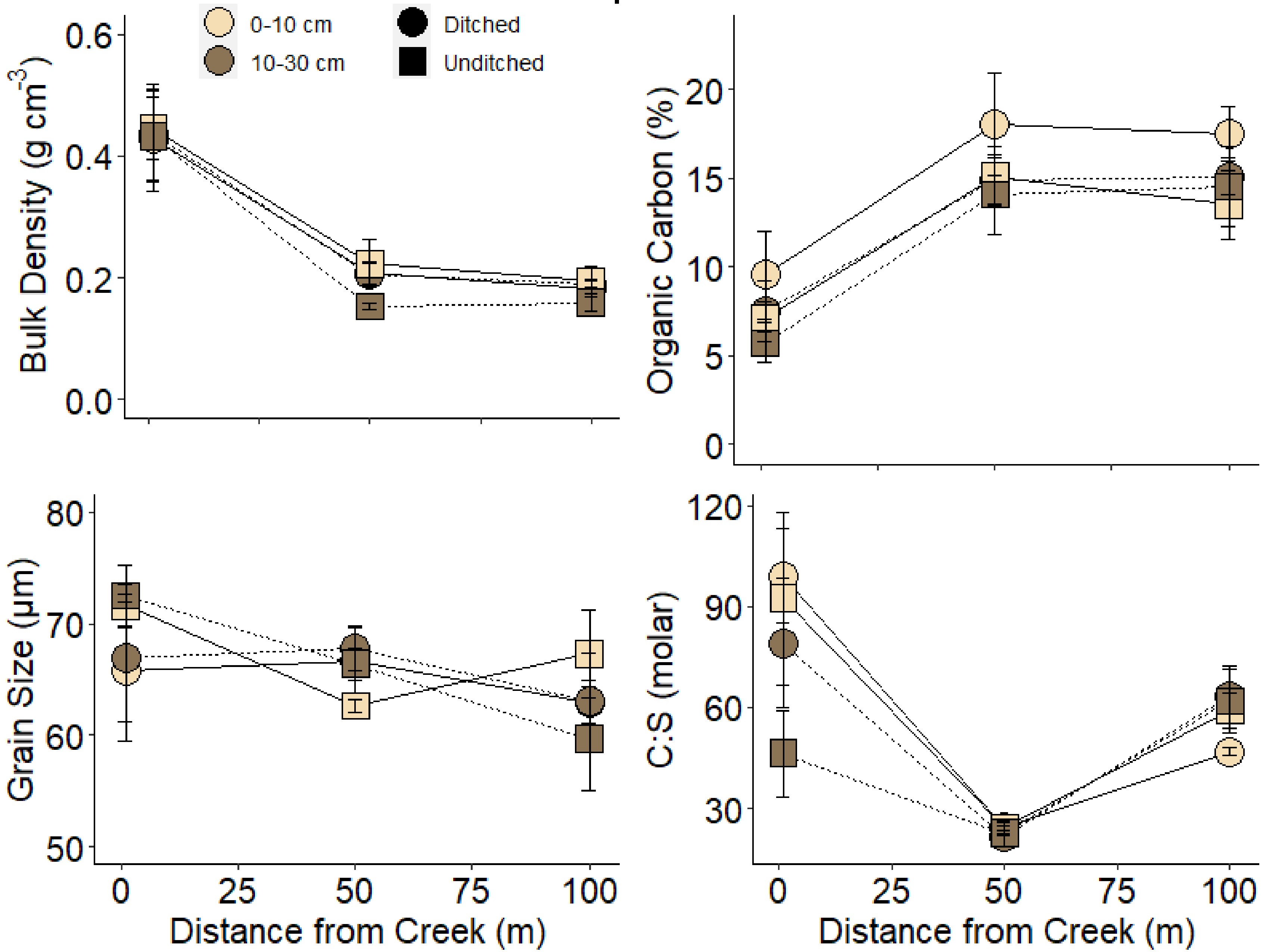
- Long-term ditching effects on elevation
- Grass properties are similar between ditched and unditched marshes, despite elevation difference

Results: Elevation and Marsh Grasses



Burns et al. 2021 Estuaries and Coasts

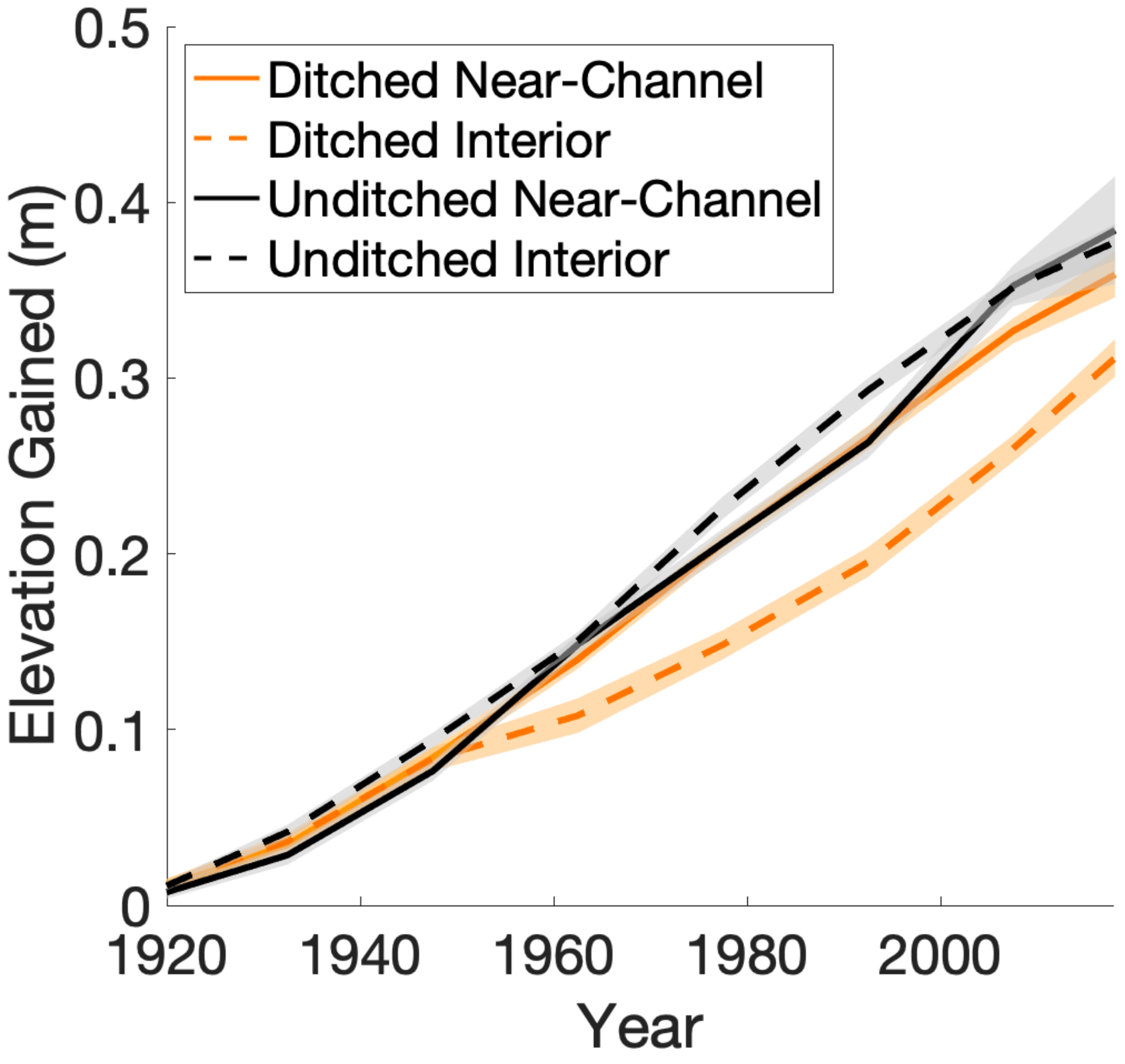
Results: Bulk Soil Properties

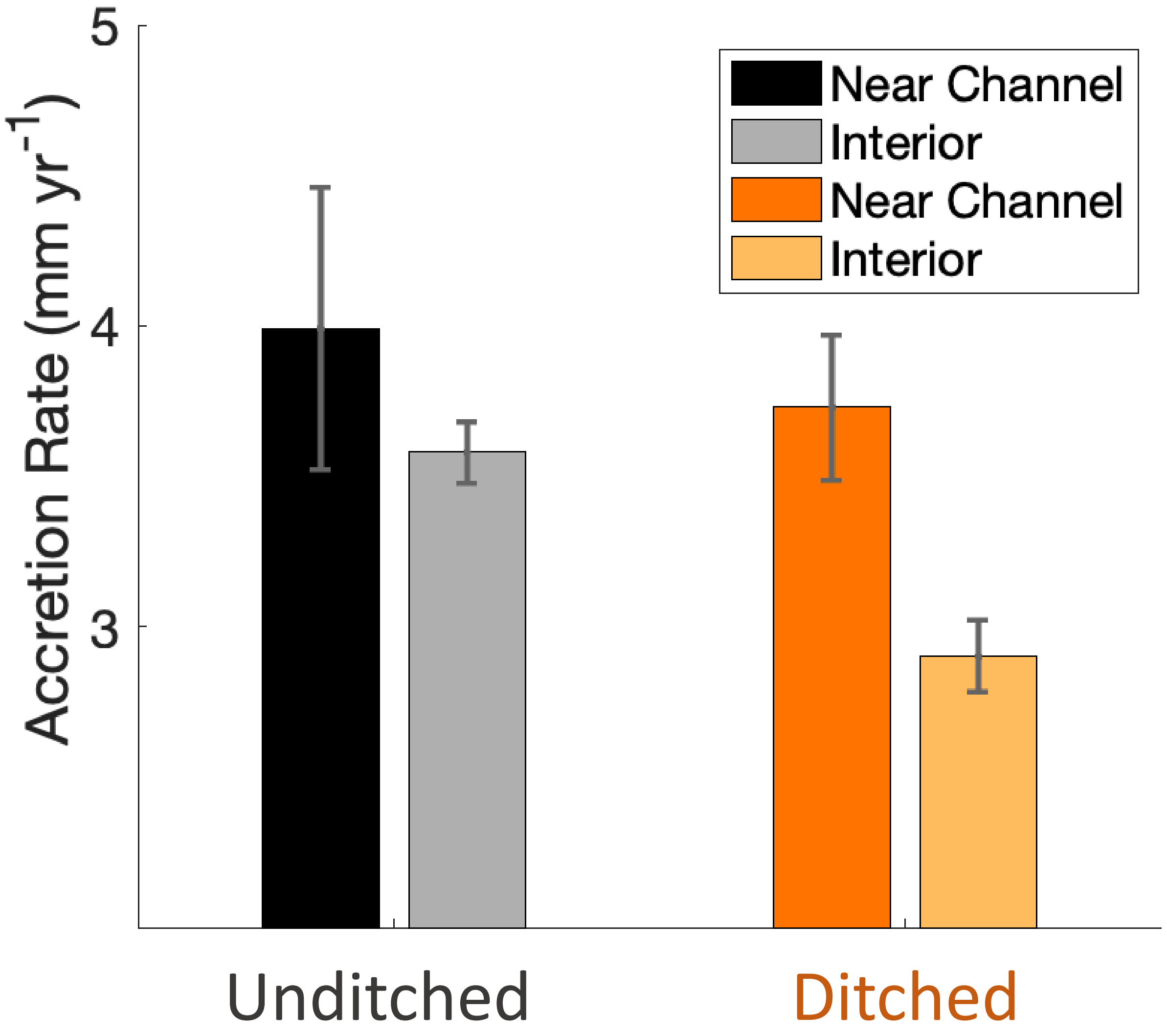


- Stronger creekbank-to-interior gradients than between ditched and unditched
- Higher surface %TOC in ditched marsh mirrors taller grasses
- C:S is higher at creekbanks where drainage efficiency is greater

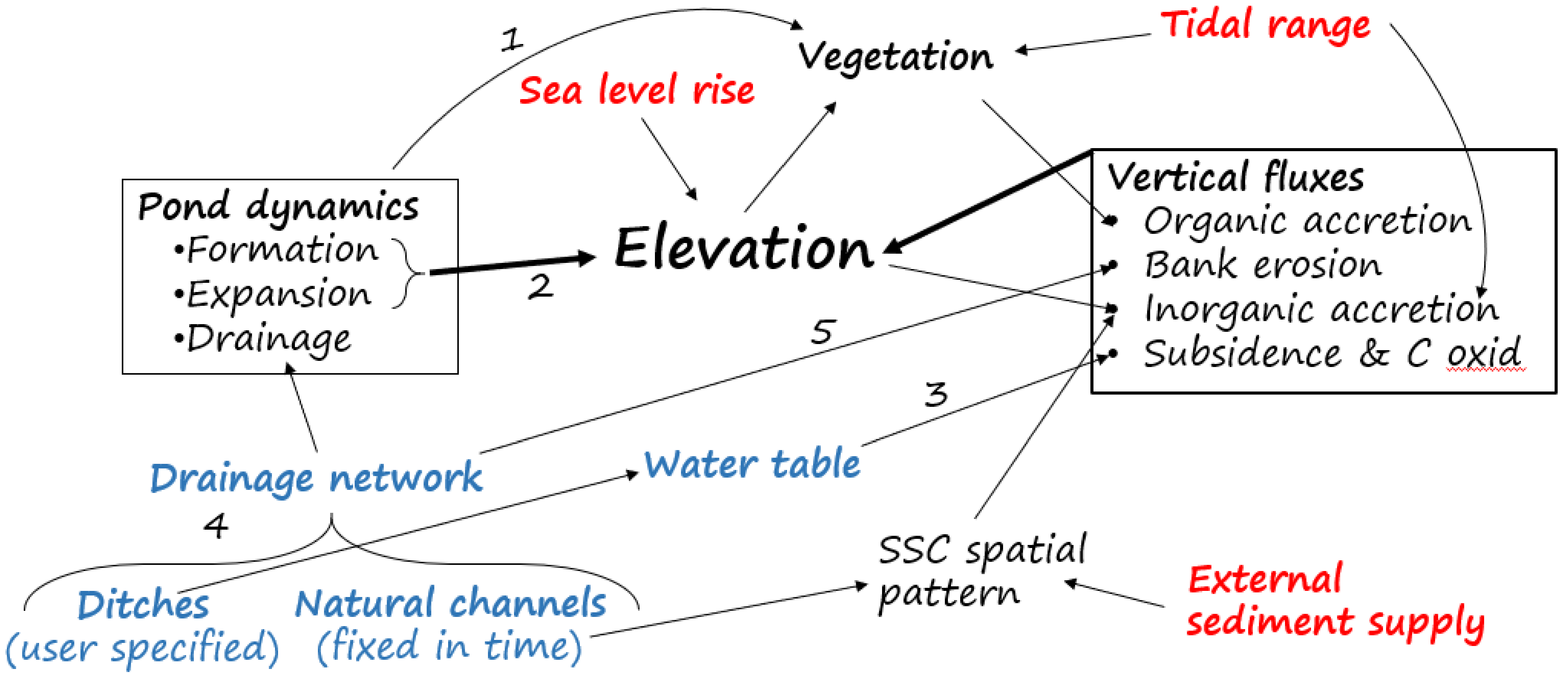
How has ditching affected vertical accretion rates?

Results: Vertical accretion rates





Modeling



1. Isolated ponds prevent marsh plant growth. This affects organic accretion.
2. Pond formation and expansion reduce elevation.
3. Ditches lower the water table and cause subsidence and C oxidation.
4. Ditches affect the drainage network and pond drainage.
5. Bank erosion / creep on both natural and ditches lowers the elevation.

https://www2.whoi.edu/site/marshsustainabilityandhydrology/model-description/

Decision Support Tool

Marsh Sustainability AND Hydrology

ABOUT US | DECISION SUPPORT TOOL | THE TEAM | NEWS | END USER FEEDBACK

End-User Decision Support Tool

Please select parameters that best describe your marsh.

1. Tidal Classification:
Mesotidal (Spring Tidal Range ~ 3.8m)

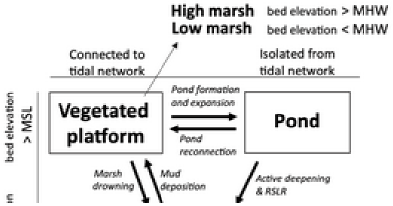
2. Suspended sediment concentration:
5 (mg/l)

3. Sea-level rise rate since 2010:
3 (mm/yr)

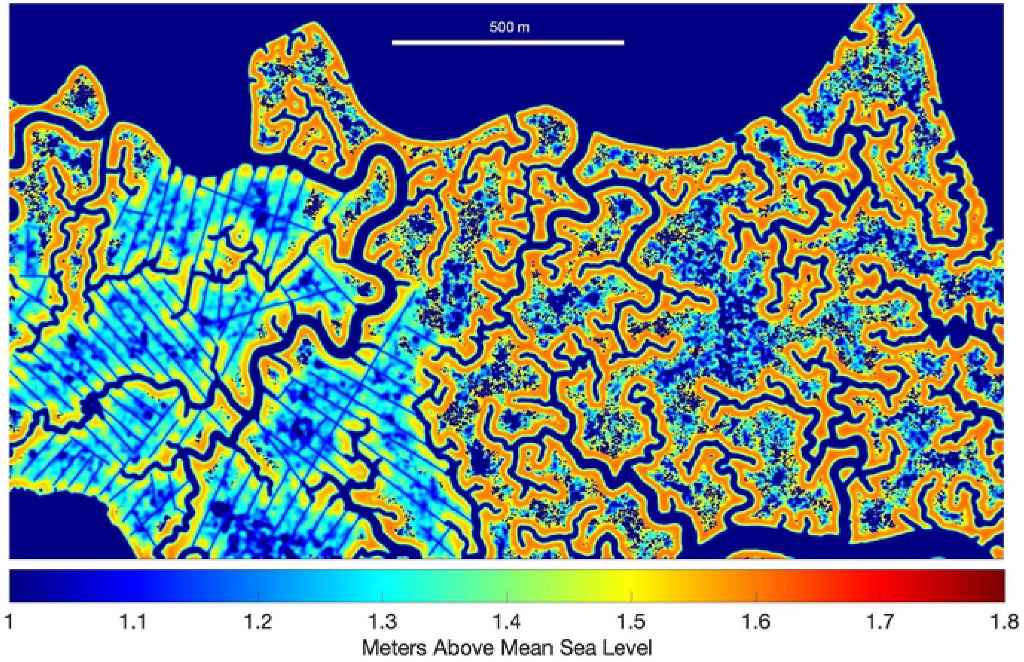
4. Ditches maintained:
0 (%)

5. Time horizon:
Present Day (modeled)

Enter



Elevation Results | Accretion Results | Summary



https://www2.whoi.edu/site/marshsustainabilityandhydrology/

Evaluating the Impact of Hydrologic Alterations on Salt Marsh Sustainability in a Changing Climate

Model Tool

Giulio Mariotti

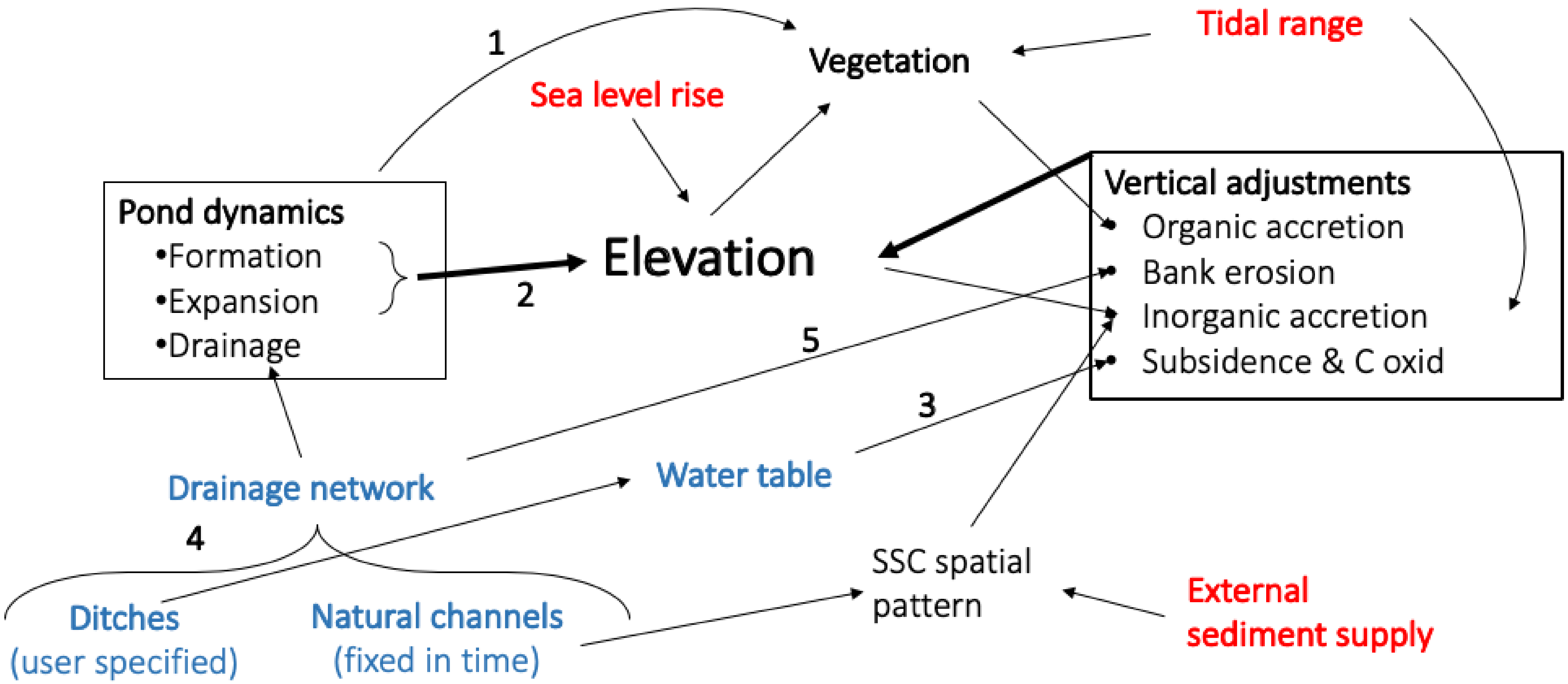
gmariotti@lsu.edu

Predict future marsh landscape

- Different environmental settings (SLR, sediment supply, tidal range)

- Different maintenance (ditch extent, ditch depth)

- Easy to access (pre-loaded simulations)



1. *Isolated ponds prevent marsh plant growth. This affects organic accretion.*
2. *Pond formation and expansion reduce elevation.*
3. *Ditches lower the water table and cause subsidence and C oxidation.*
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Baseline model

- Organic accretion: MEM model
  - One vegetation cohort
  - Parabolic with elevation
  - Maximum accretion rate

  Morris et al. 2002

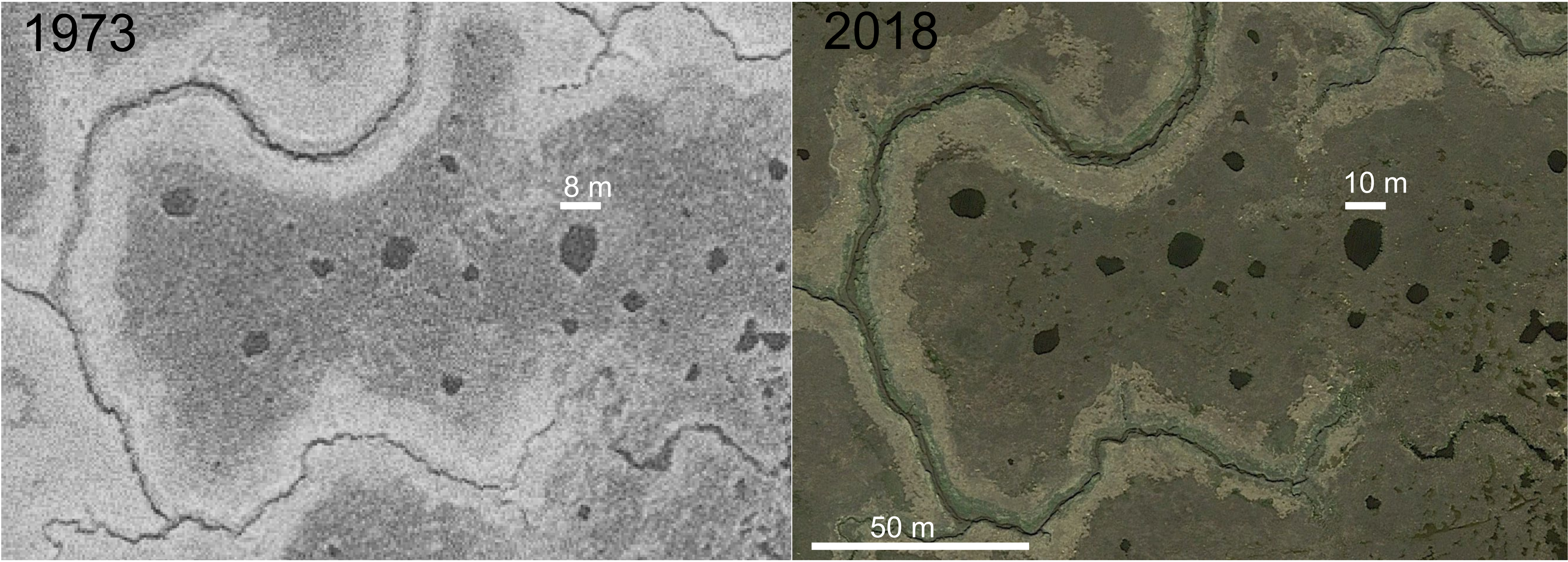
- Inorganic accretion: Elevation+ Spatially variable SSC

- Bank slumping

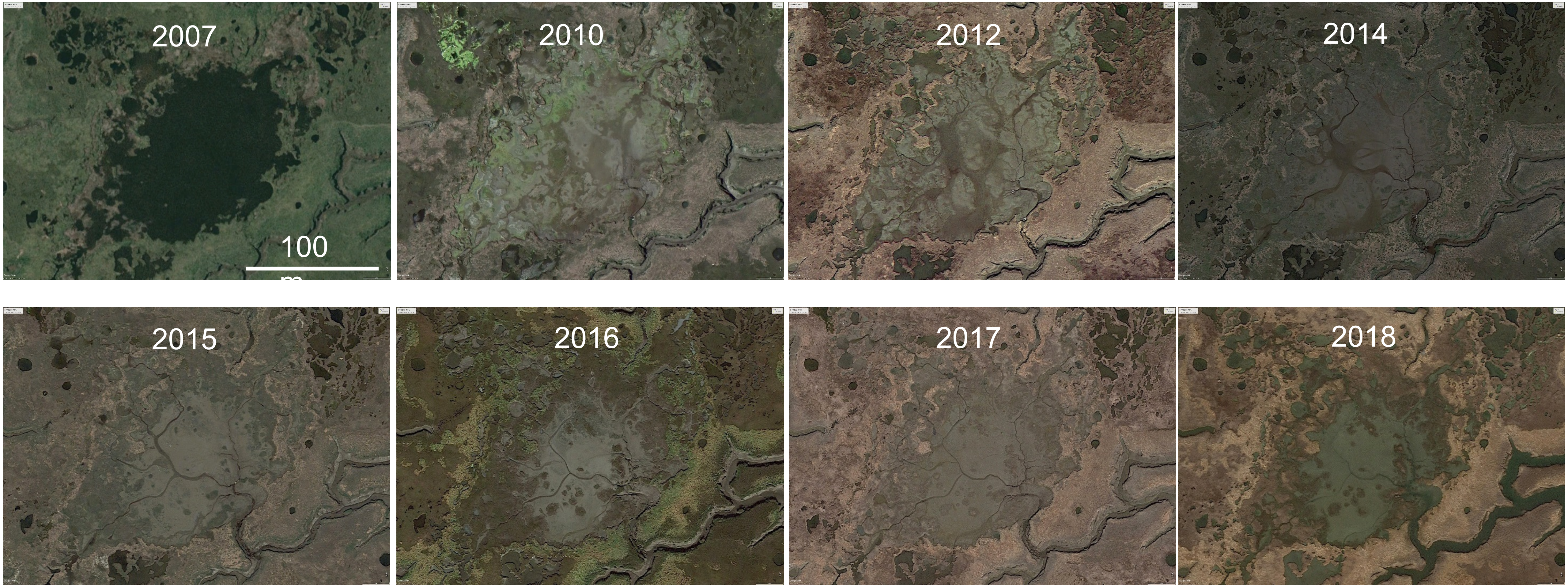
Pond dynamics (without ditches)

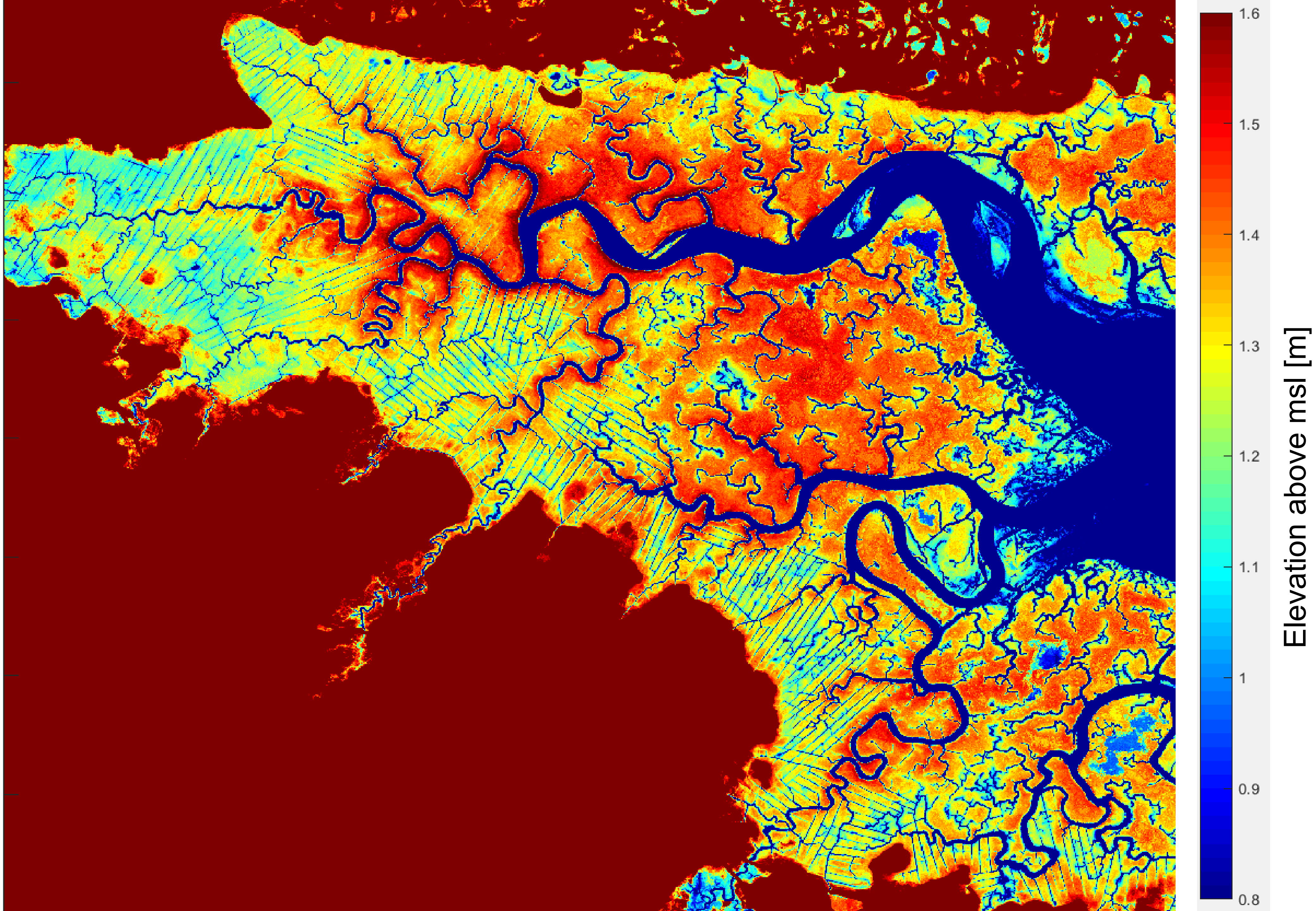
- Pond formation
- Pond expansion
- Pond drainage

Pond expansion
(~ 5 cm/yr)



Pond drainage





1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
Elevation above msl [m]

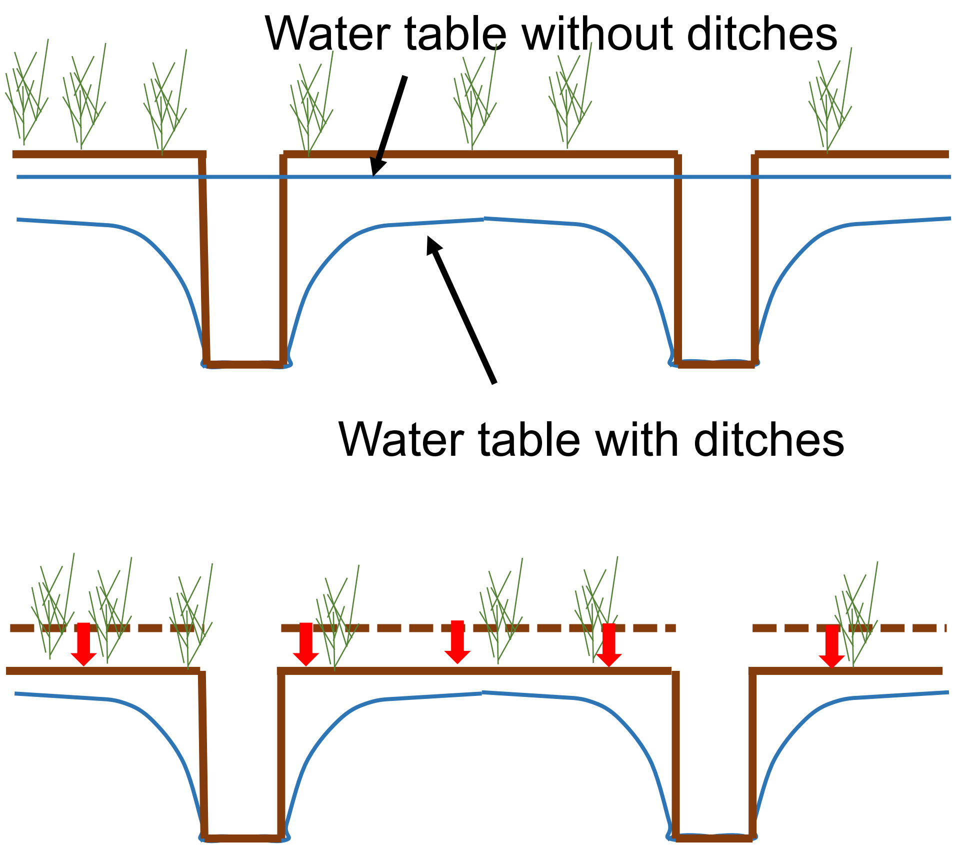
Ditch drainage

↓

Water table lowering

↓

- Consolidation
- Carbon oxidation



Effect of drainage in Holme Fen Posts (UK)

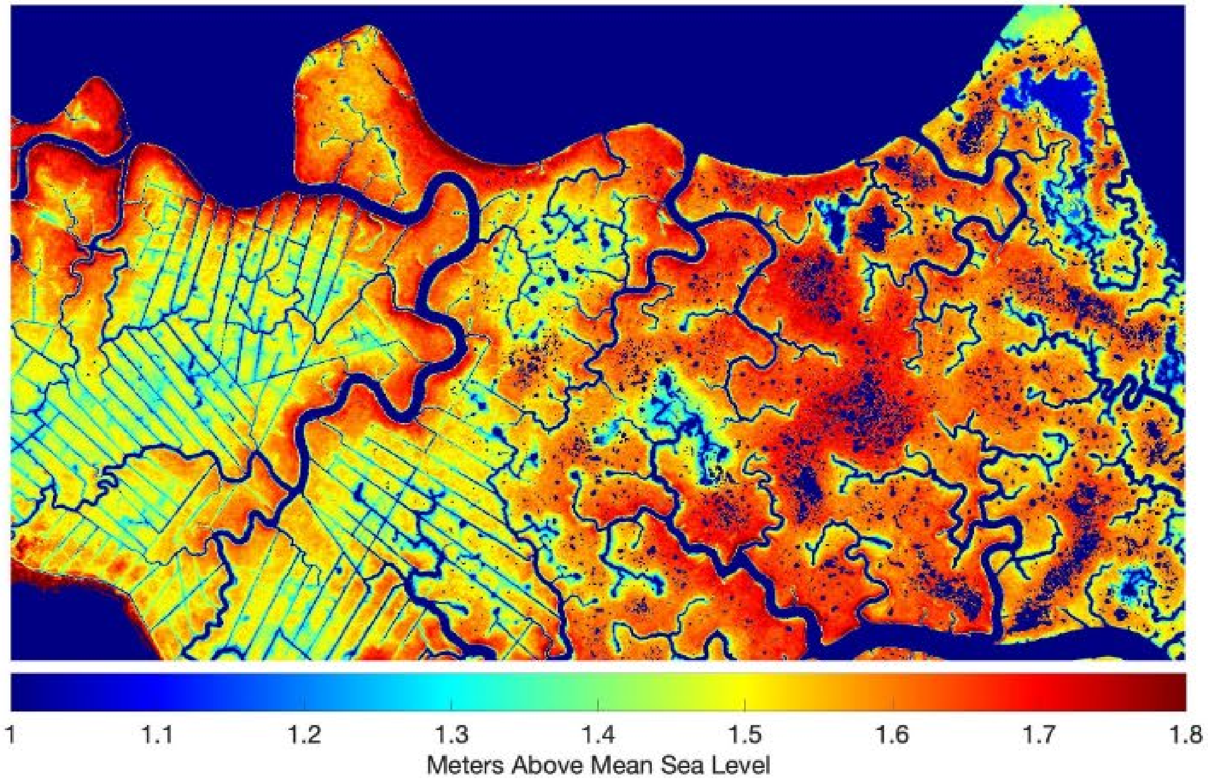
http://www.greatfen.org.uk/holme-fen-posts

4 m of
compaction in
150 years

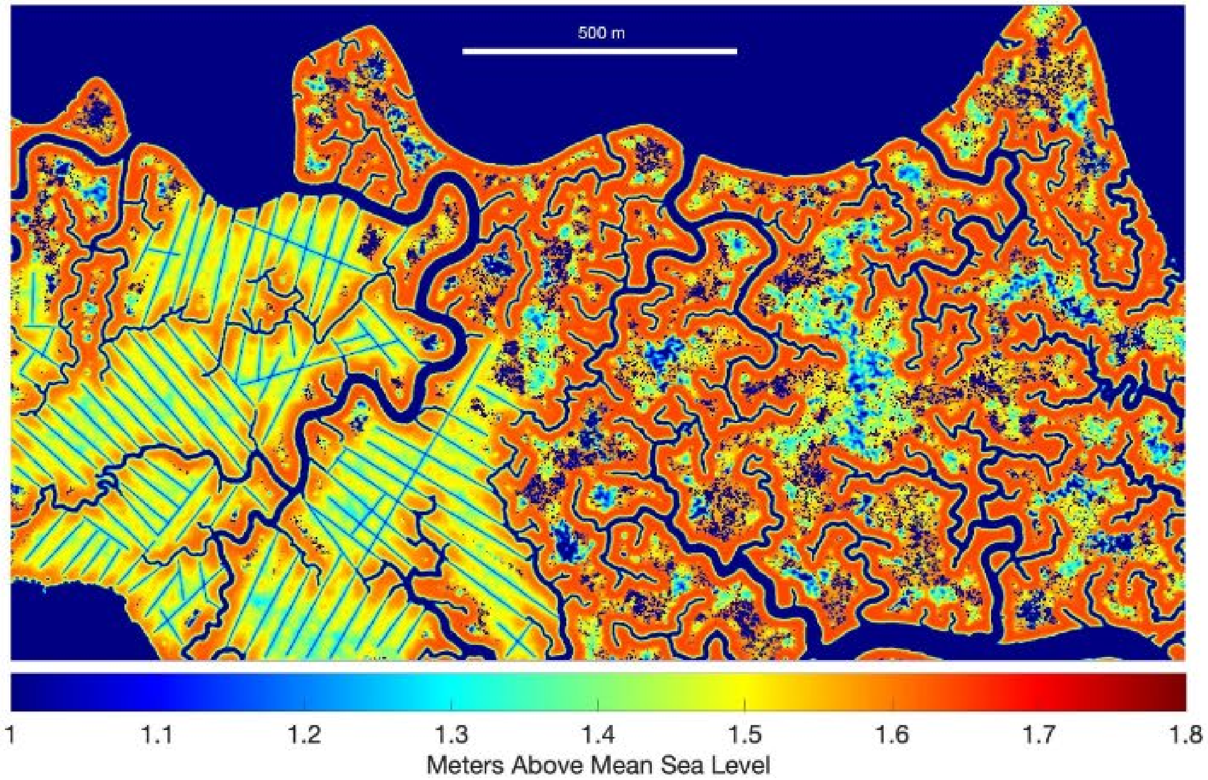
http://www.ramsey-
town.co.uk/album/detail.asp?GetAPicID=990

Model validation

Observed Elevation

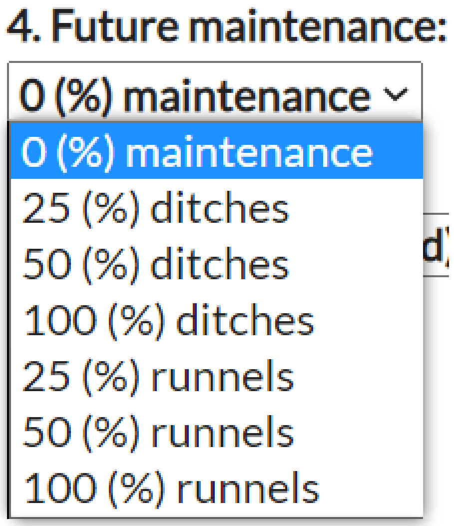


Modeled Present Day Elevation



End-users feedbacks

- Simulate different amount of ditch maintenance (%)
- Simulate different ditch depth (ditches vs runnels)



	Tidal range = 3.8 m	Tidal range = 0.7 m
Low marsh	0-1.6 m aMSL	0-0.3 m aMSL
High marsh	>1.6 m aMSL	>0.3 m aMSL
Ditch elevation	1.1 m aMSL	0 m aMSL
Runnel elevation	1.3 m aMSL	0.1 m aMSL
Unvegetated marsh	<0 m aMSL	

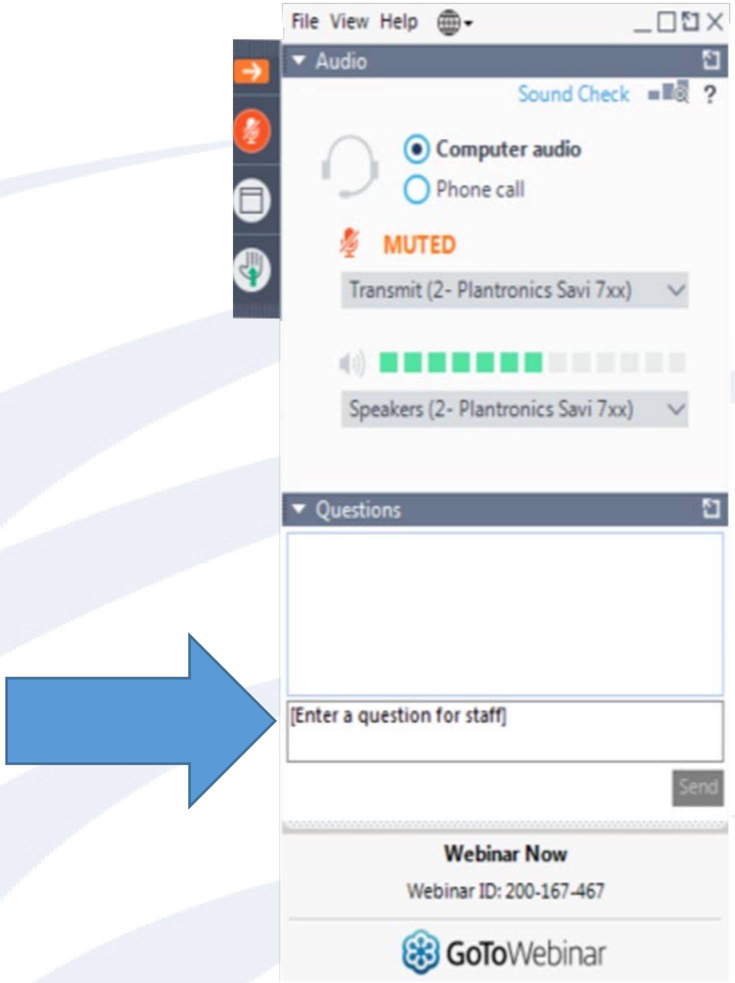
Processes not included

- Channel dynamics (e.g., channel migration and widening)
- Wave edge erosion
- Upland marsh migration
- No salinity effects

Q&A time

Have a question?

Use the "Questions" function to pose questions throughout the webinar.



National Estuarine
Research Reserve System
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Q&A

Q: What are some of the main adaptive strategies that have emerged from this research?

- **A**: Cape Cod Mosquito Control Project is looking at ditch depth more closely, and looking at where we can user shallower ditches.

Q: This tool is only available for this specific site. How easily, if we have the data, could it be applied elsewhere?

- **A**: The code is available online, though you might need help from a grad student to run it. You need some knowledge of programming to impose channel geometry and parameters for your own conditions.

Q: It looked like there was a change in the rate of accumulation for the ditched marsh interior around 1930. How was that determined, and does that correspond with when the ditches were constructed?

- **A:** We determined rates of accretion based on how lead-210 activities changed with depth in the soil cores we collected. We collected cores down to 1m, sectioned in 1cm increments, and measured lead-210 and cesium-137 activities. Based on those decay rates for those radioisotopes, we can calculate about when different horizons were deposited.

Q: How stable is the ditch and creek channel geometry? What time scales are required to see changes?

- **A**: The ditches are pretty stable, though we're only looking at 80 years of time. Channels, it depends. If you look over 100 years, they might have migrated a little, but not so much. It's still not clear why some tidal channels migrate faster than others, it might depend on soil properties. In general marsh soil is very cohesive because of all the mud and marsh plant roots, so channels don't migrate as fast. If we were to look at a longer timescale, say 1000 years, there would probably be noticeable migration.

Q: It remains unclear whether mosquito ditches are favored or unfavored. The first presenter showed the ditches being deepened and widened. Yet later the data showed the unditched areas rising in elevation compared to those marshes that are ditched. Can you elaborate?

- **A**: Ditches aren't necessarily good or bad all the time. When making decisions, managers need to assess the level of sea level rise, sediment supply, whether the marsh is deteriorating, and other specific characteristics of the marsh.

Q: Do you also look into wildlife (birds, fish, invertebrates etc.) data in the model?

- **A**: Not directly. In theory, the model gives a distribution of landscape. If you have some information that gives additional context based on the behavior of the wildlife in question – for example, more pond coverage is good for waterfowl – the model could help you make decisions based on that.