



Roots for Resilience Runneling Webinar

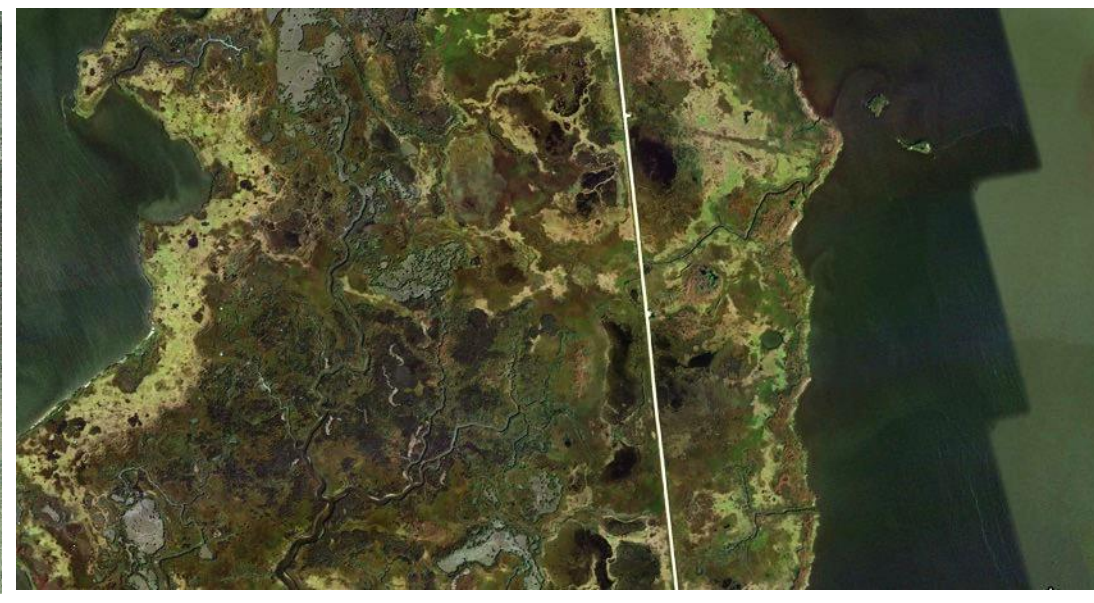
Dr. Alice Besterman
Biological Sciences
Towson University

April 29, 2026

Outline

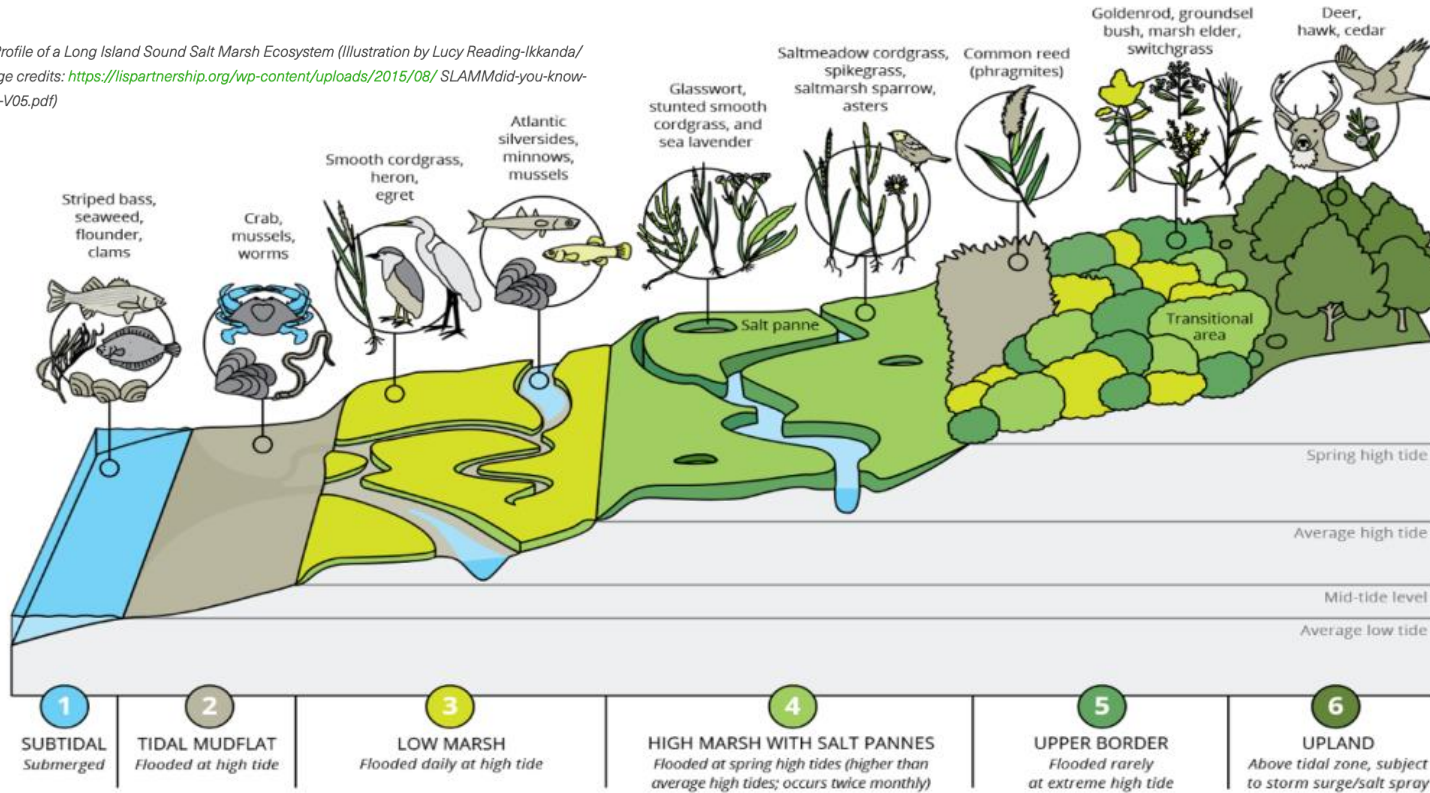
- Introduction to the problem: interior open-water conversion
- Runnels as a climate-adaptation technique
- What we know about runnels so far (evidence from two microtidal northeastern marshes — one case-study, one experiment)
- Best practices for site selection and lessons learned

Bare and shallow water areas on marsh interiors are increasing in number and size across the Northeast and Mid-Atlantic



A classic model of a marsh in equilibrium

Figure 1: "Profile of a Long Island Sound Salt Marsh Ecosystem (Illustration by Lucy Reading-Ikkanda/ LISS." (Image credits: <https://lispartnership.org/wp-content/uploads/2015/08/SLAMMdid-you-know-fact-sheet2-V05.pdf>)



- Dense stands of grasses, forbs
- Inundation related to tidal exposure along a gradual elevation gradient
- Tidal flushing dominated by “single channel hydrology”

Photo Credit: At Altitude Gallery

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Figure 1: "Profile of a Long LISS." (Image credits: <http://fact-sheet2-V05.pdf>)

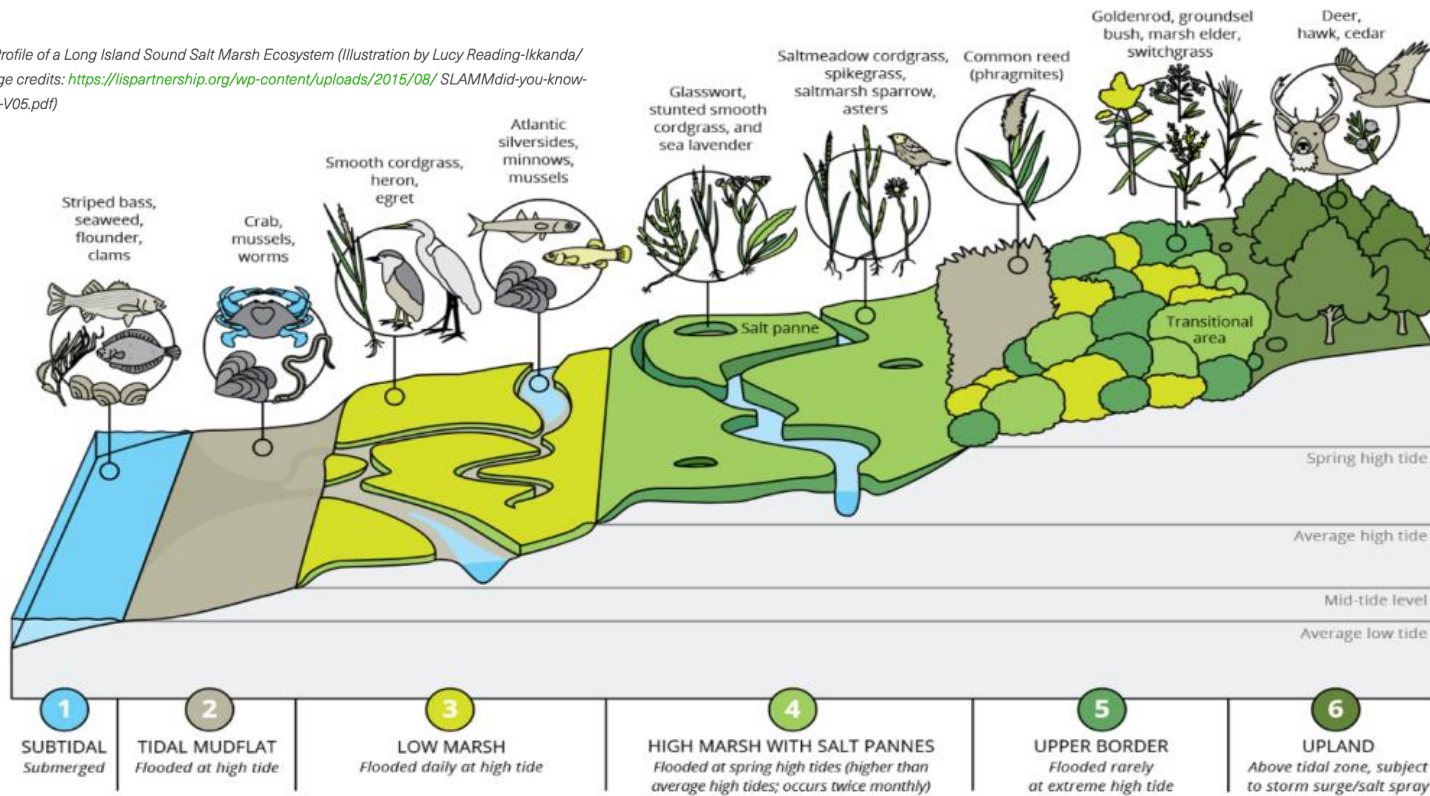


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A classic model of a marsh in equilibrium

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1 m



10 m

- Salt marsh pannes are dynamic, temporary habitats
- Salt marsh pools are stable wildlife habitat, over decades part of a dynamic equilibrium

Ditching, roads and culverts, berms and embankments, and impediments to marsh migration *in combination with* accelerated relative sea level rise are changing hydrology and vegetation.



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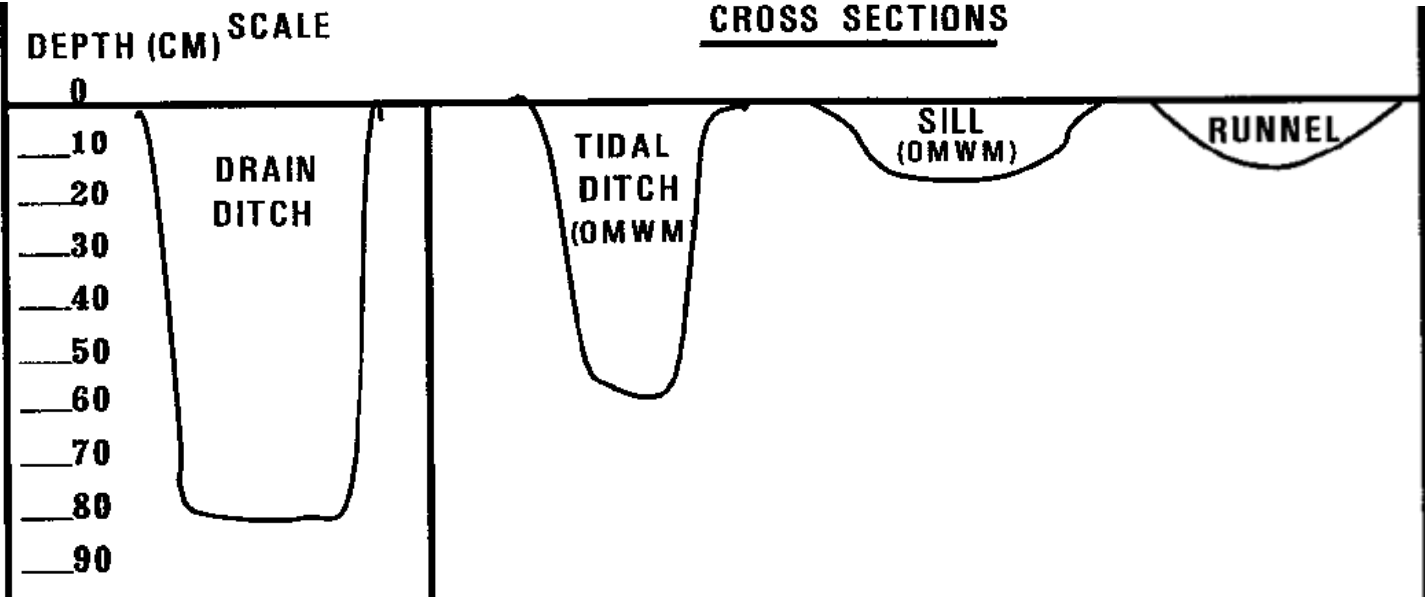
Runnels

- Small, shallow channels to drain standing water and restore tidal hydrology
- Technique for marsh areas that should drain, and typically not flooded daily (near or above MHW)
- Often constructed through a barrier to drainage (levee, ditch spoil, agricultural embankment), connected through low areas
- Revegetation through colonization of live plants around edges (not usually planted)

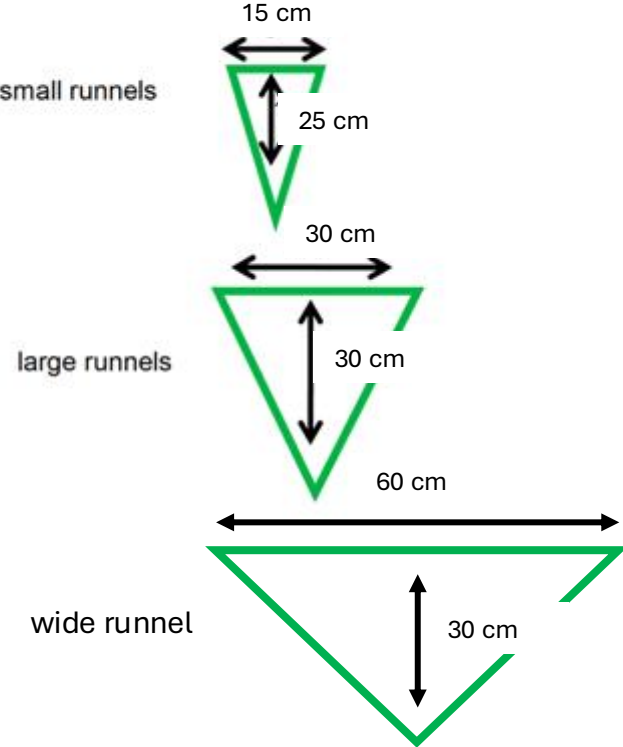


Shallow drainage – different from large creeks and ditches and placed strategically

Adapted from Wolfe 1996



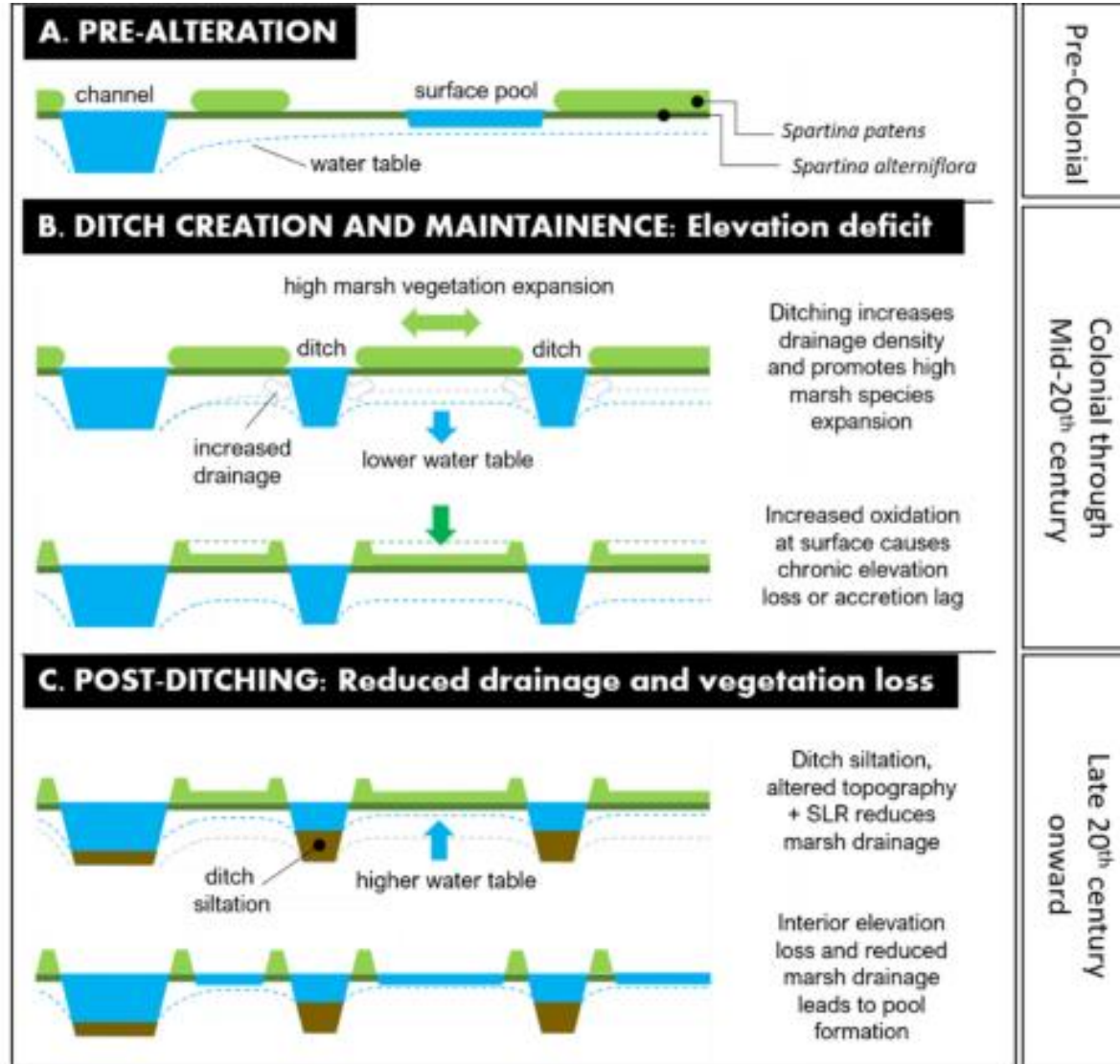
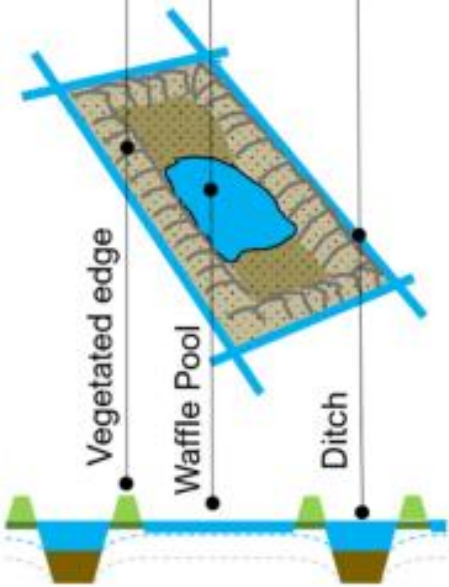
Adapted from W. Ferguson



Shallow drainage – different from large creeks and ditches and placed strategically

- Modeling single-channel hydrology





- Regularly-spaced, deep, and high-density ditches have resulted in “waffle-maple-syrup” pools due to over-oxidation of soil

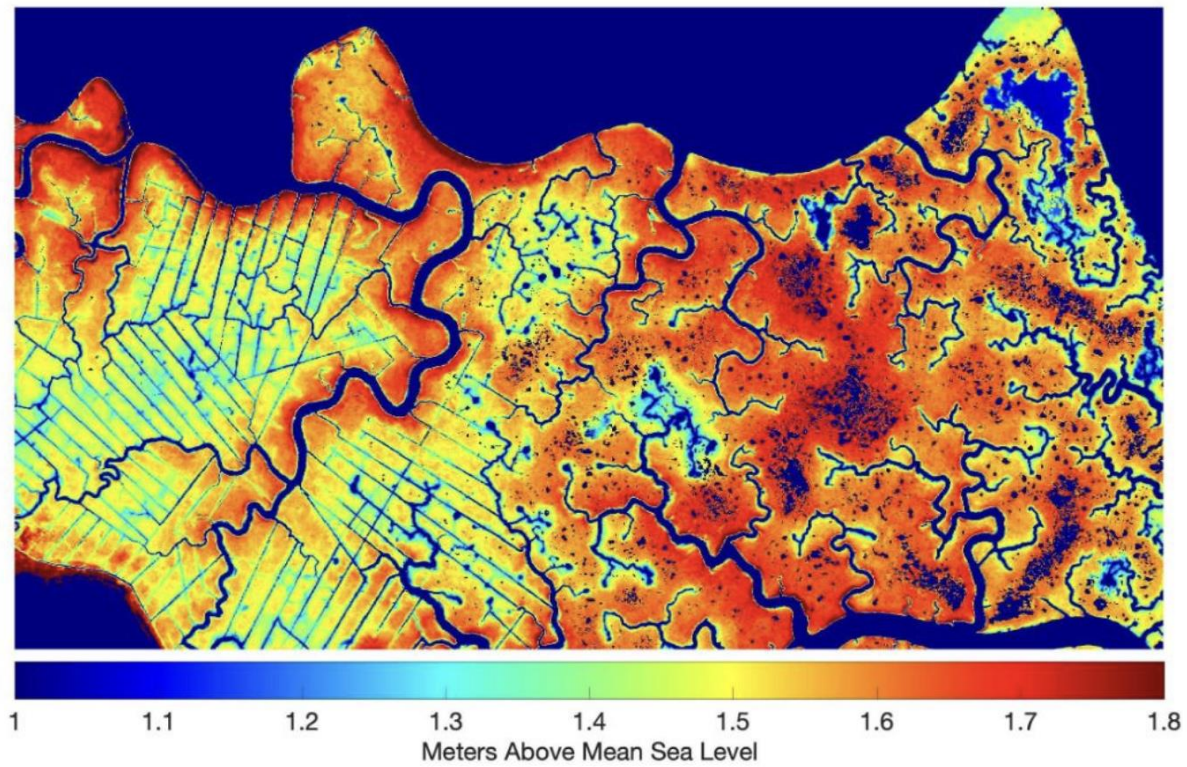
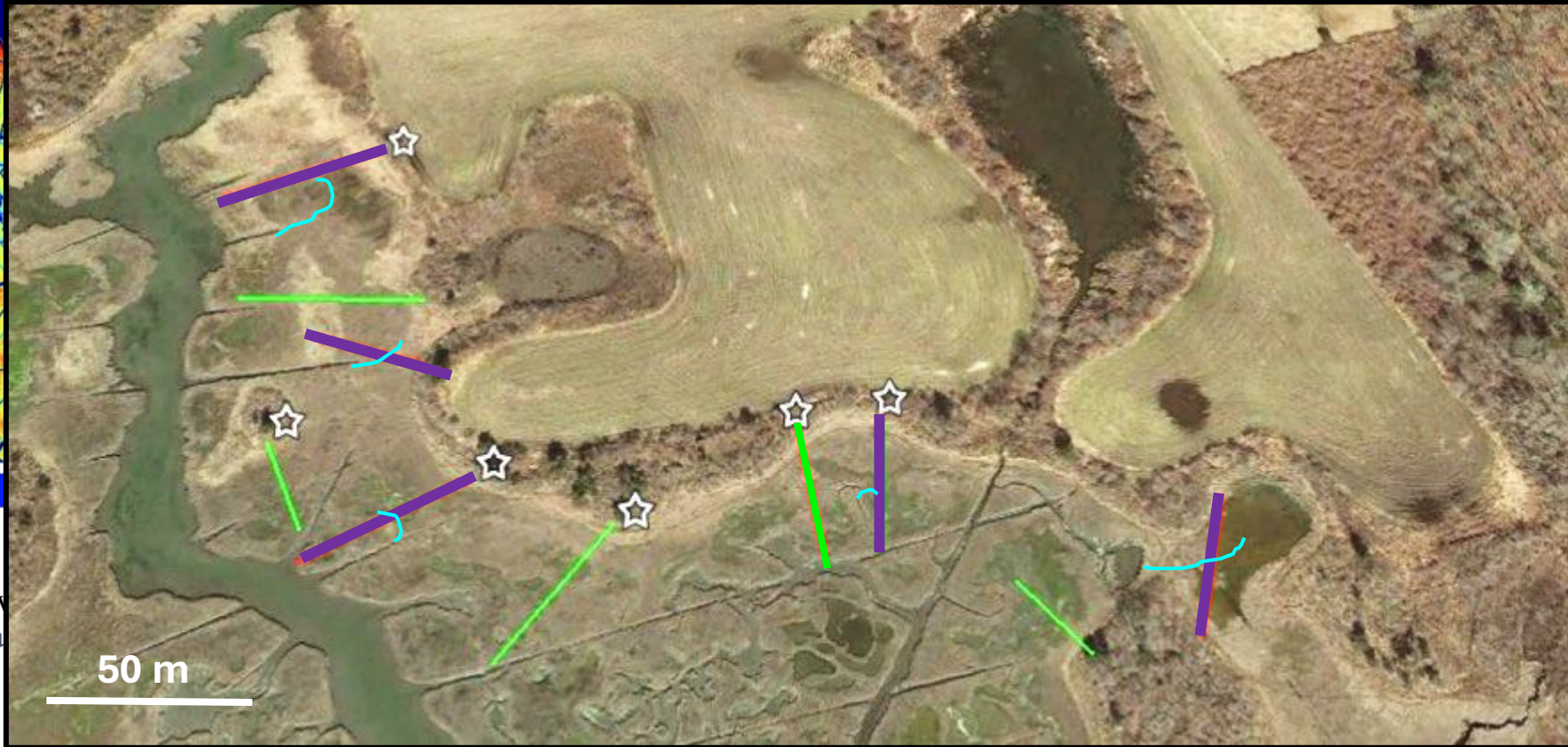


Figure 5: Digital elevation model based on LIDAR data from ditched and unditched areas of the Great Barnstable Marsh courtesy of Giulio Mariotti.



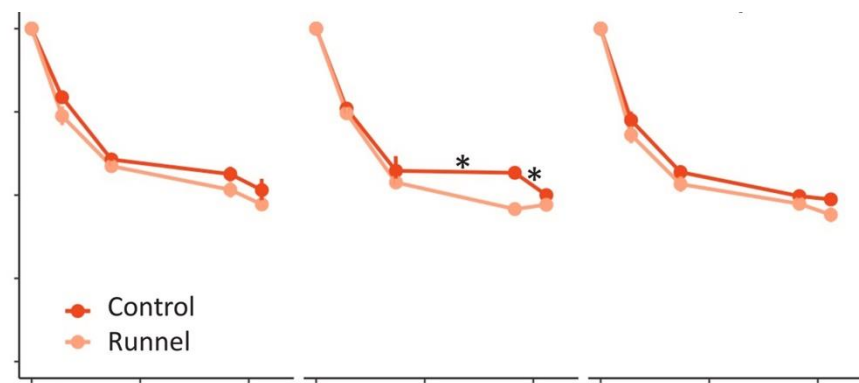
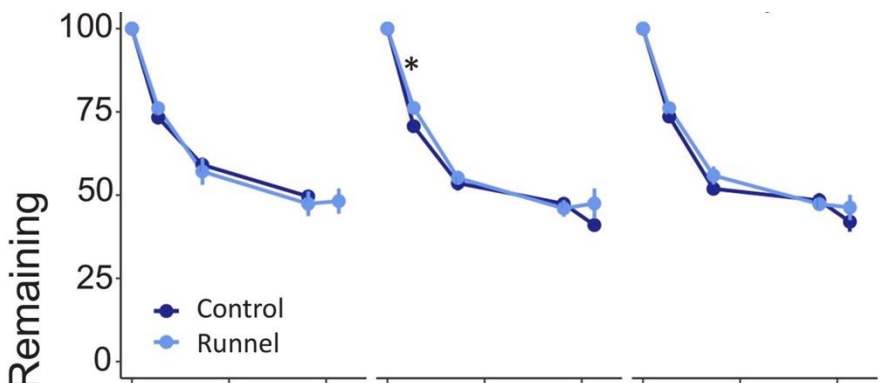


Figure 5: Digital elevation map of Great Barnstable Marsh

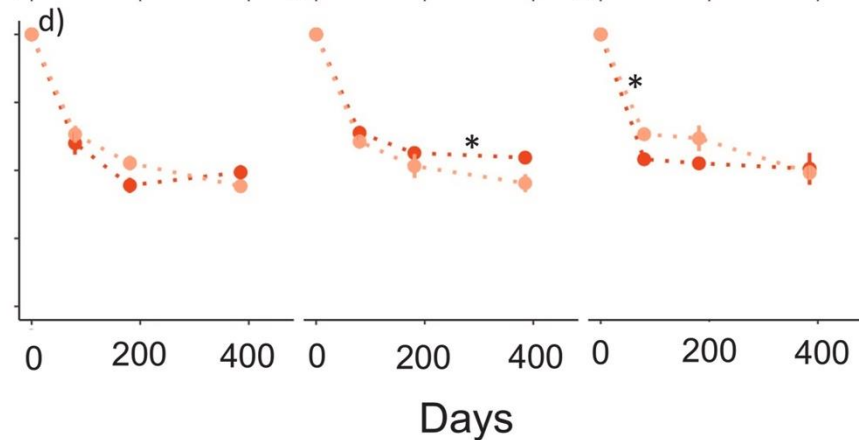
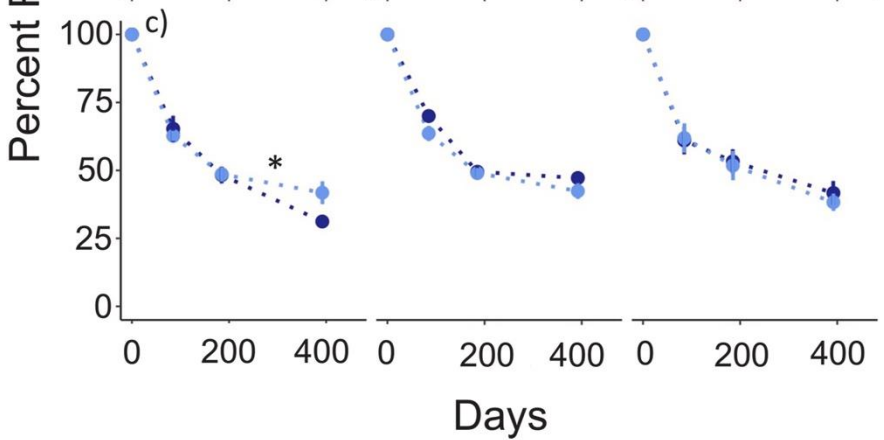


Shallow drainage – runnels do not over-oxidize soils

Year 1

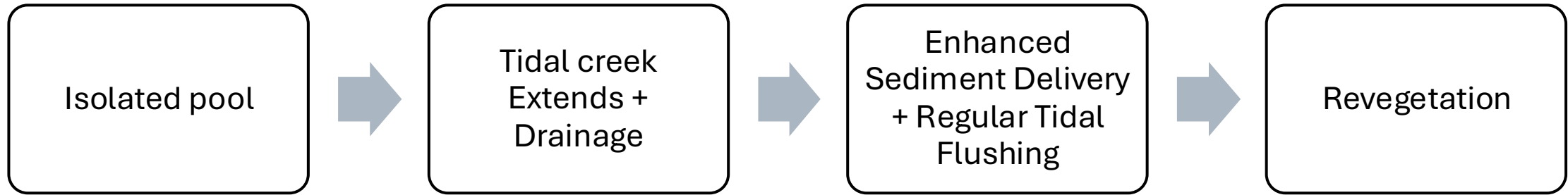


Year 2

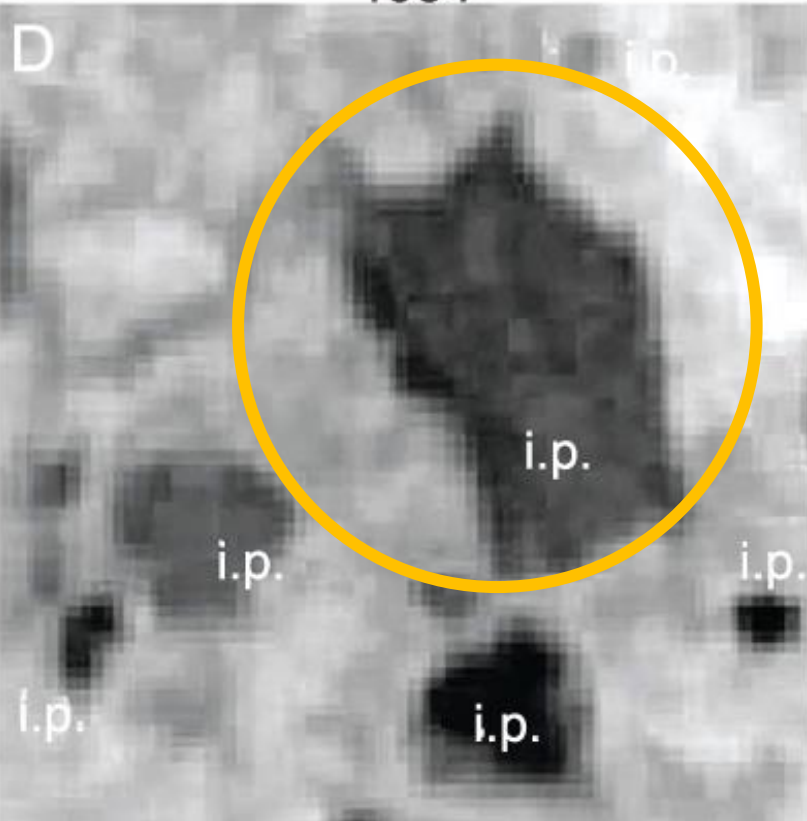


Hillary L. Sullivan, Alice F. Besterman, Rachel W. Jakuba, Joseph E. Costa, Delaney Mezan, Linda A. Deegan, Jennifer L. Bowen, Salt marsh decomposition after hydrologic restoration with runnels, *Estuarine, Coastal and Shelf Science*, 2025.

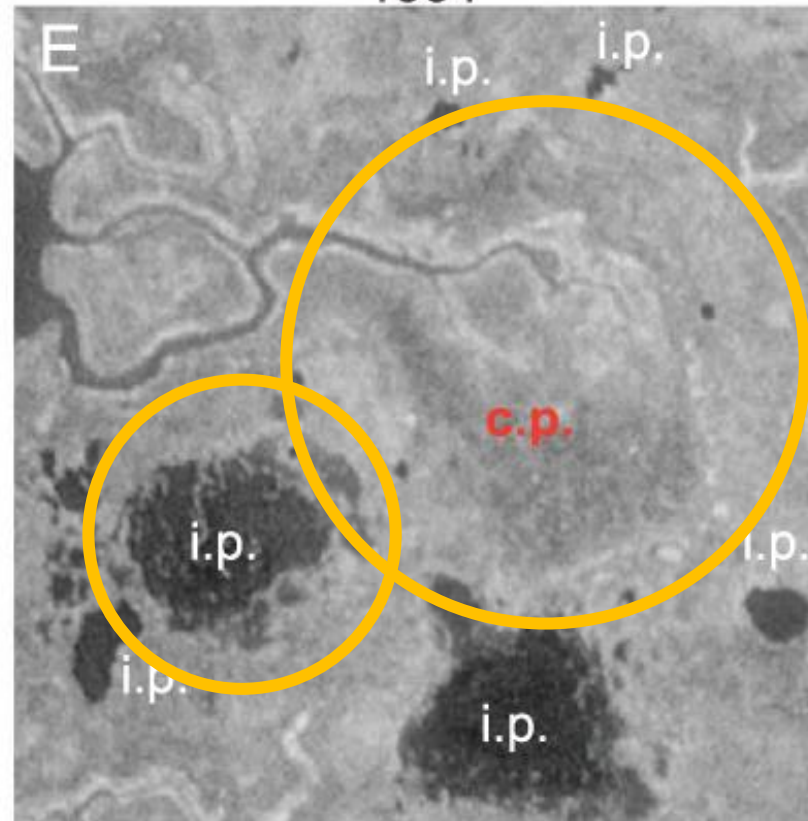
Example from Cape May NJ, Figure adapted from Mariotti 2016



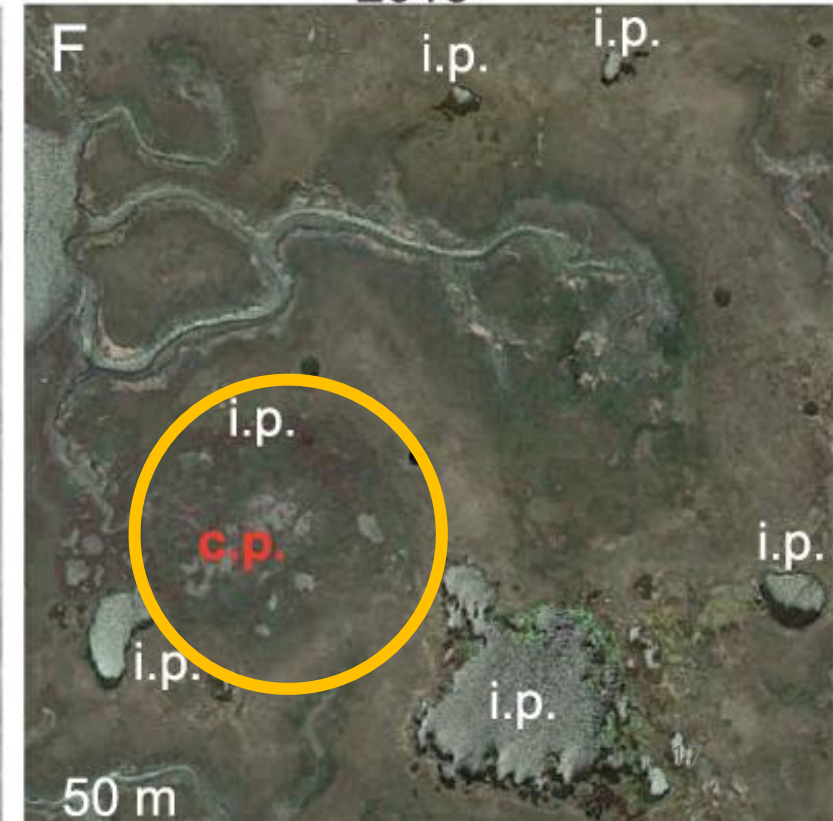
1954



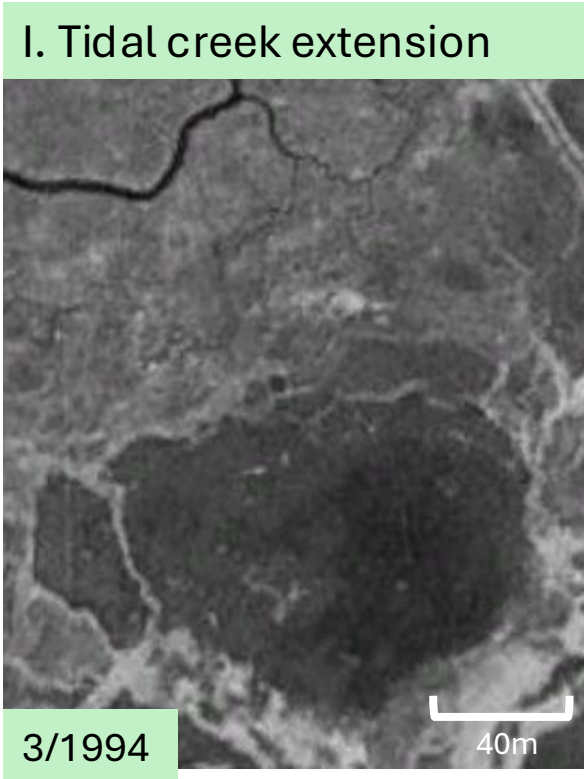
1991



2015



Evidence from Chesapeake Bay marshes



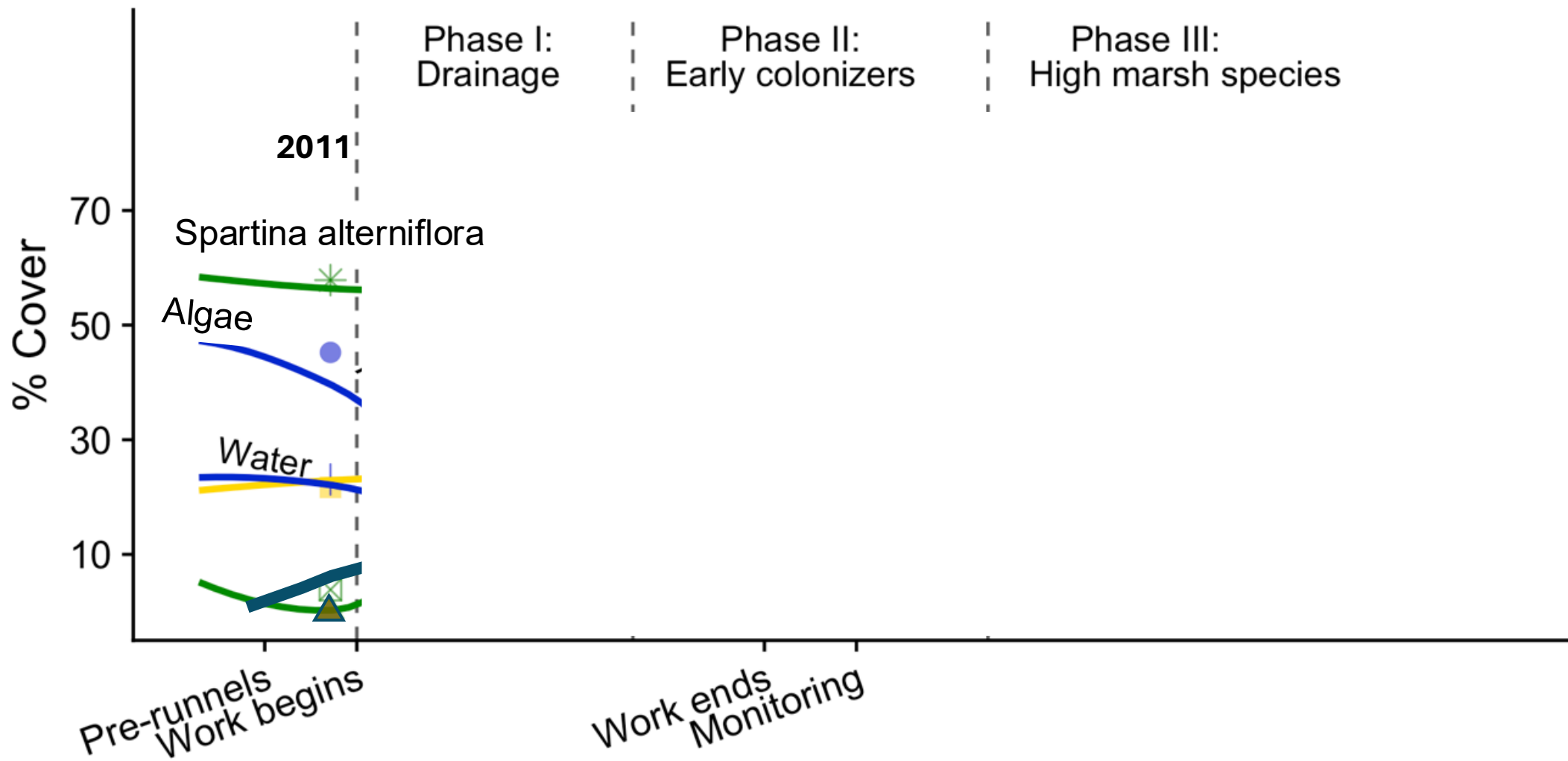
Runnels model single-channel hydrology and tidal creek capture

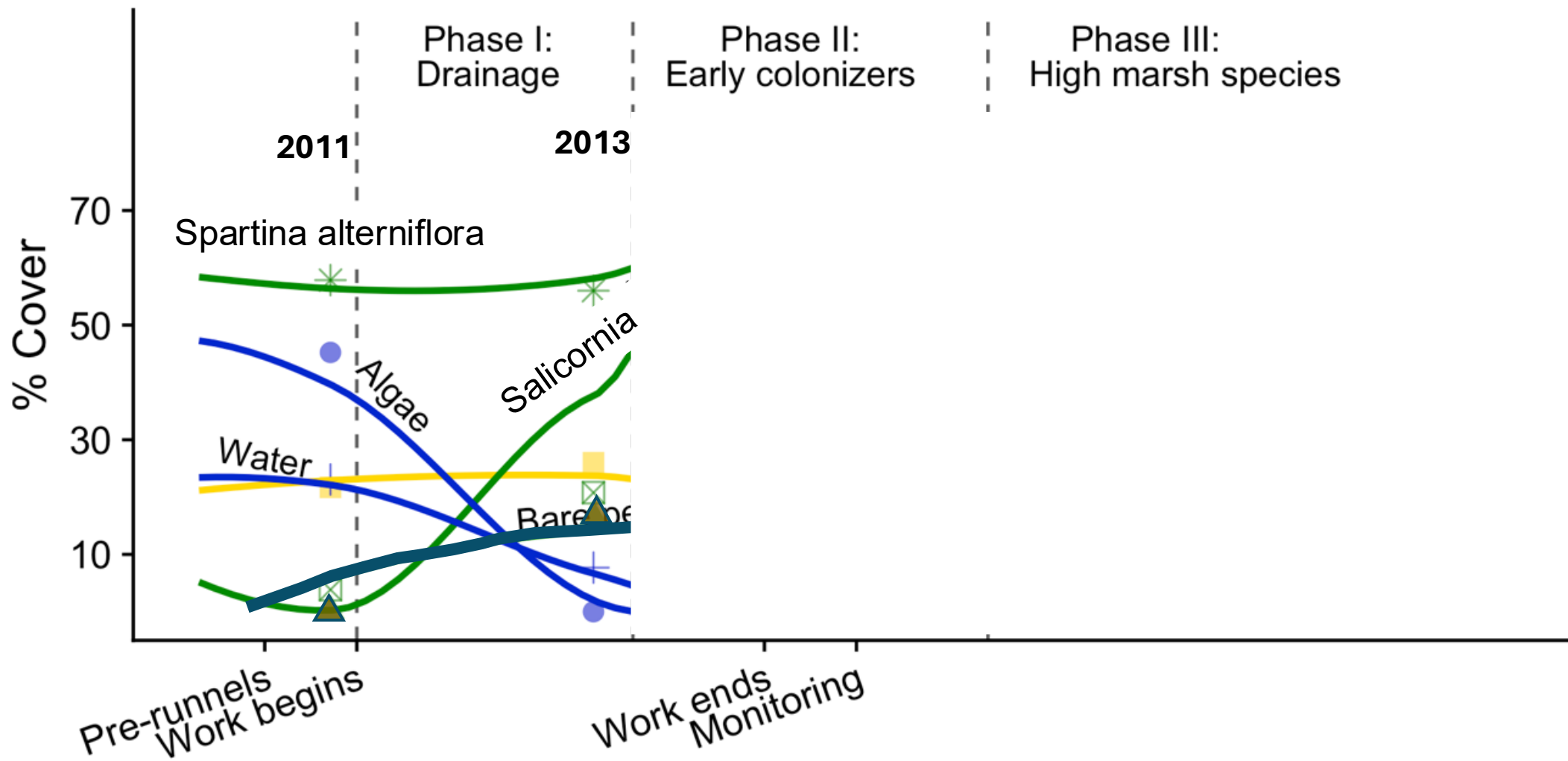
But how does that process work? What changes are expected after runnel creation?

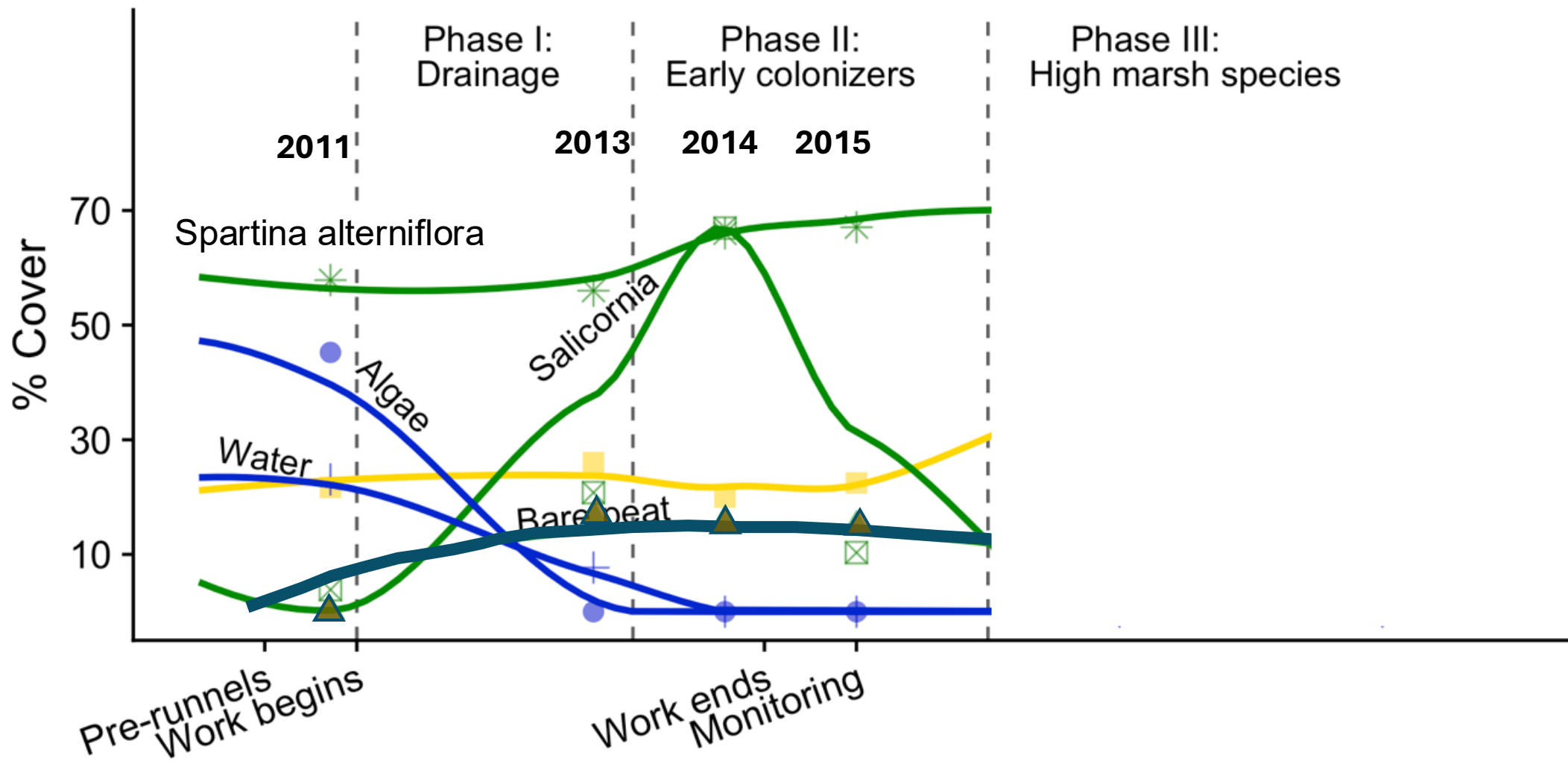
Winnapaug Marsh

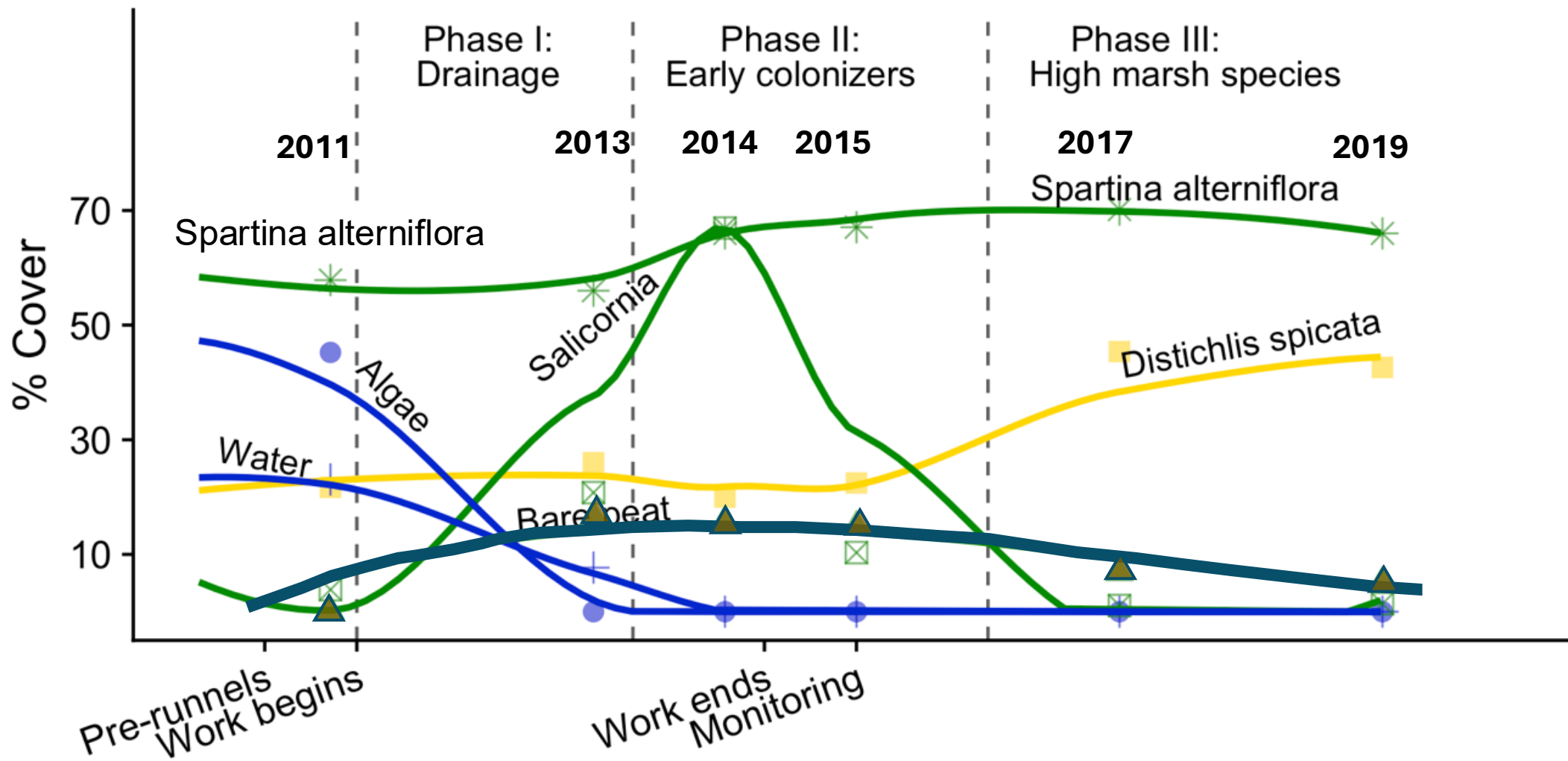
- Winnapaug Marsh, Rhode Island
- Grid-ditched, microtidal, back-barrier pond with tidal restriction (max 0.5 m TR)
- 25-50% cover of high marsh species in 2011
- Save the Bay, W. Ferguson
- Small number of hand-dug runnels in 2012
- 2013 and 2014 excavation











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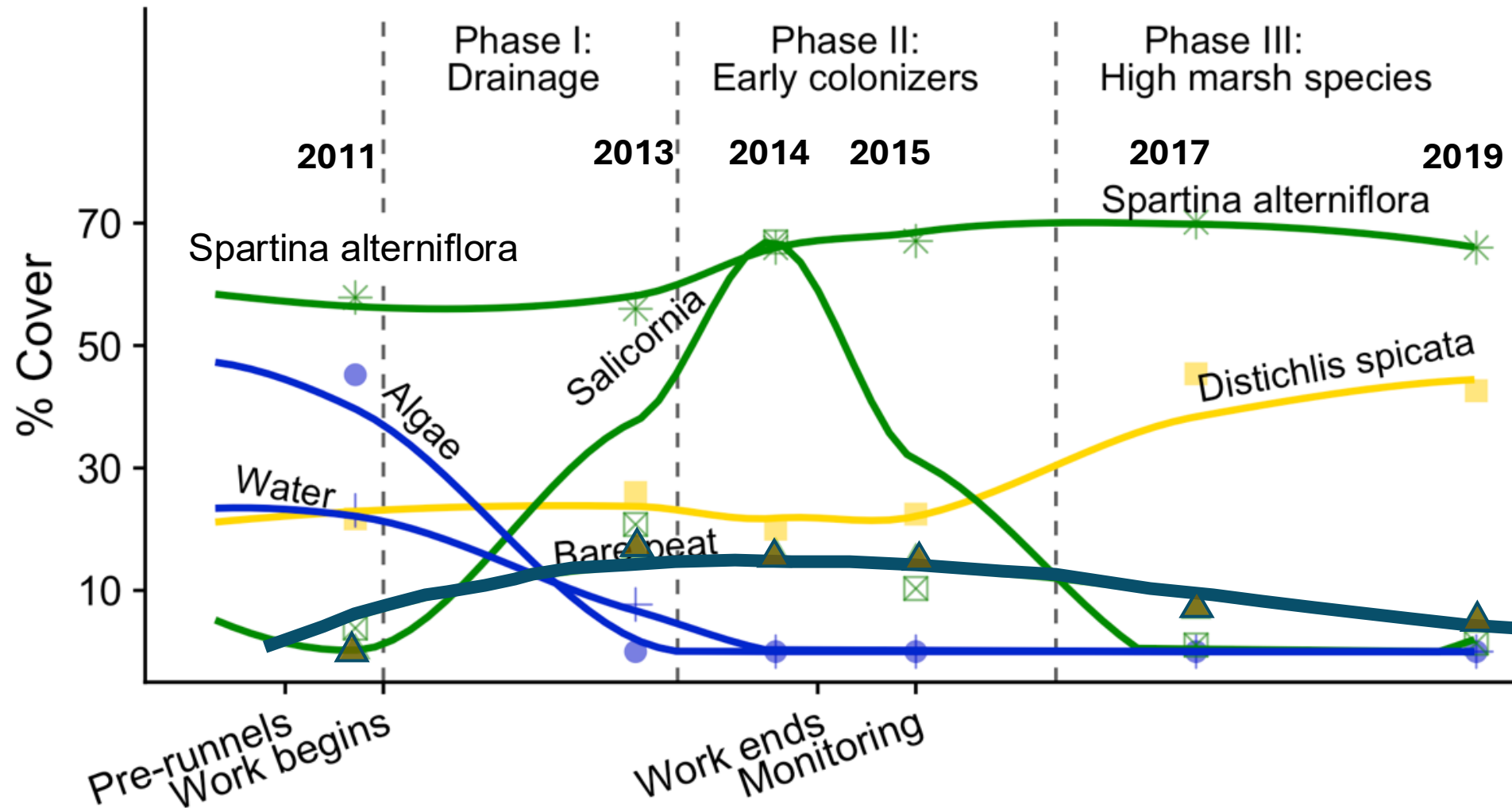
What do we know about runnels so far?

1. Open water cover can decrease
2. Vegetation can recover, despite significant variability

Fundamentals from two projects

- Winnapaug, Rhode Island
- Buzzards Bay, Massachusetts

1. Open water cover can decrease





Fringing Marsh

Cape Cod

- 1.1-m tidal range
- Mean relative tidal elevation 1.17-m
- Shallower interior water features

Salt Pond Marsh

Buzzards Bay

- 0.5-m tidal range
- Mean relative tidal elevation 1.28-m
- Deeper interior water features

Vineyard

- BACI, 20 s...
- pannes
- Pre-monito...
- Runnels cr...
- 2020 - Feb...
- Monitoring

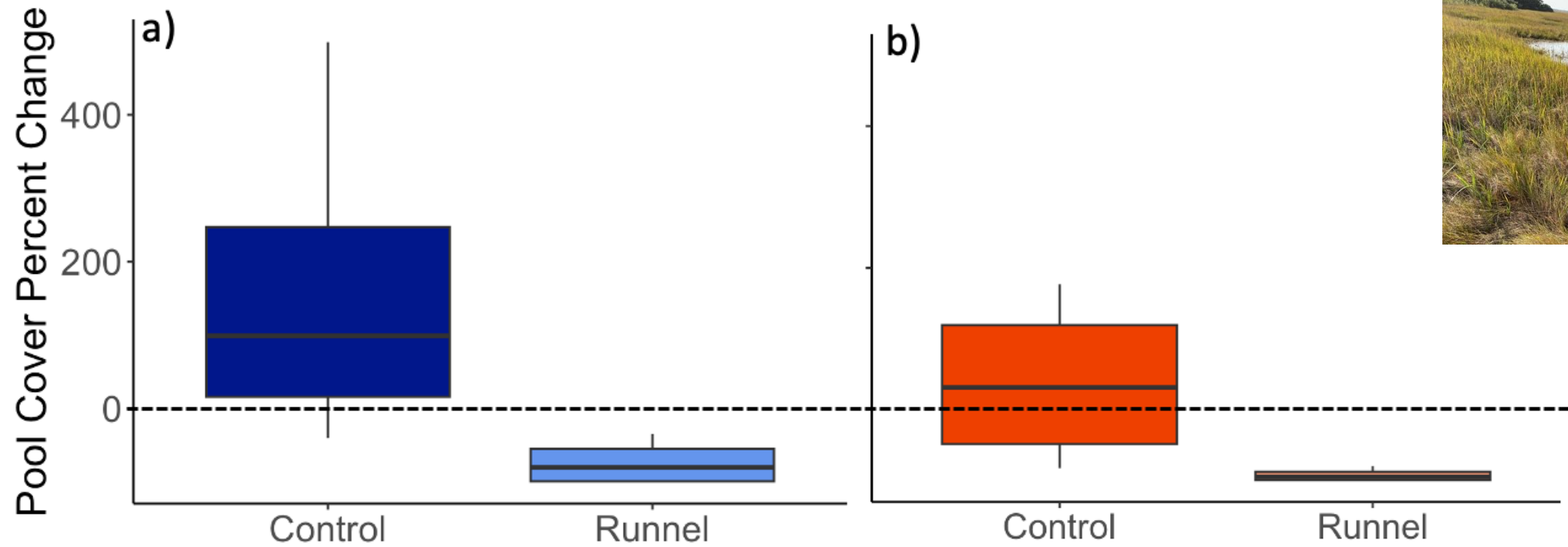


Experimental-runnel site

Reference site

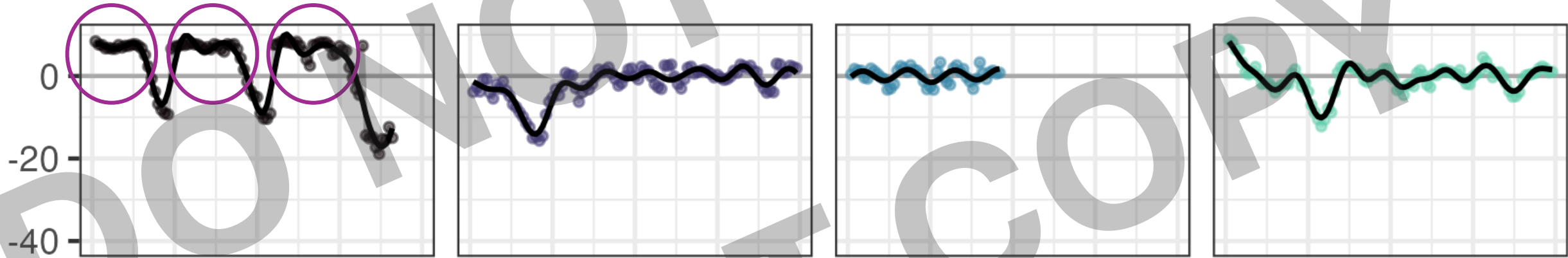
Comparative site

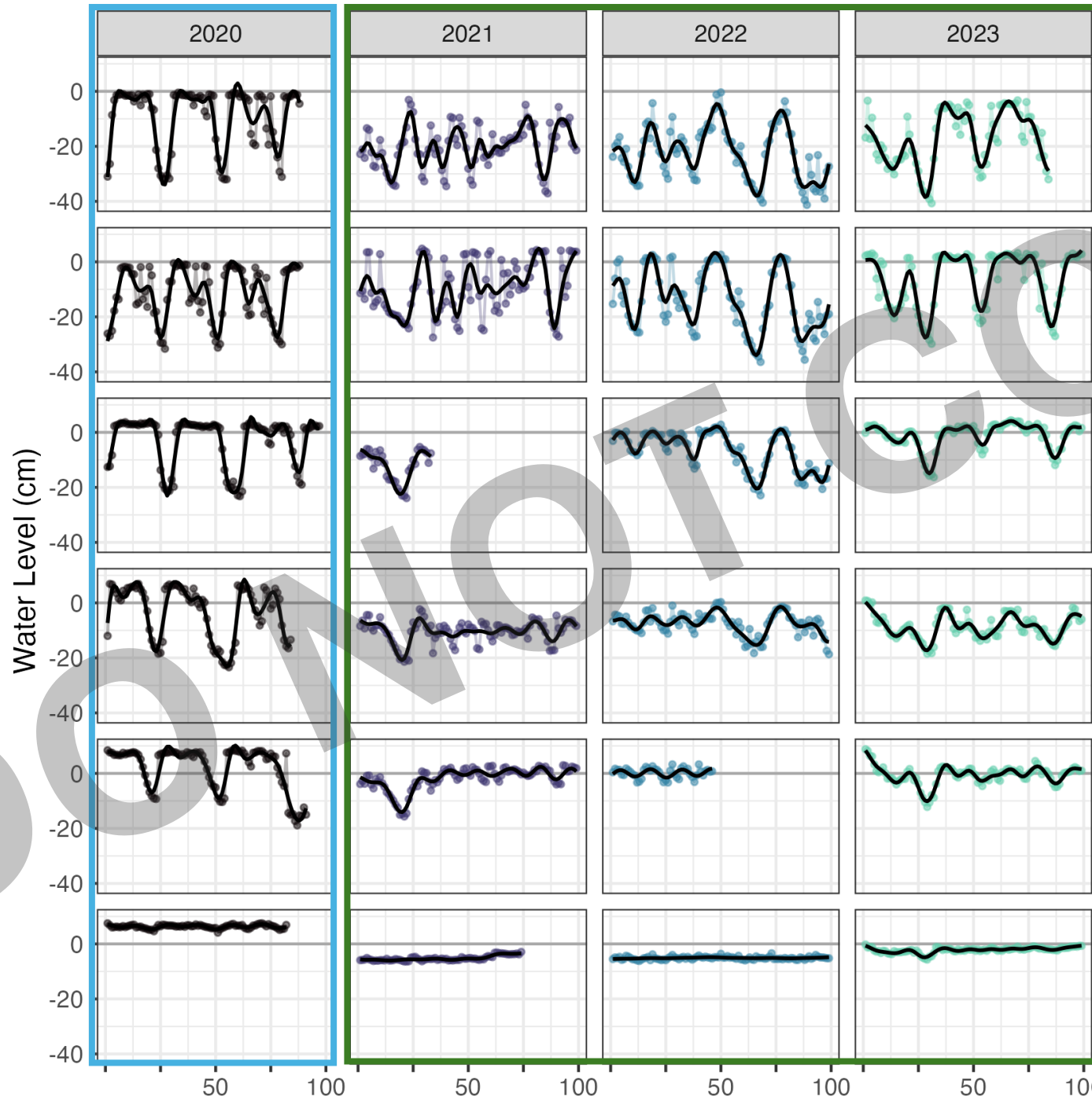
1. Open water cover can decrease – 3 years



Hillary L. Sullivan, Alice F. Besterman, Rachel W. Jakuba, Joseph E. Costa, Delaney Mezan, Linda A. Deegan, Jennifer L. Bowen, Salt marsh decomposition after hydrologic restoration with runnels, *Estuarine, Coastal and Shelf Science*, 2025.

1. Open water cover can decrease





Fringing (1-m TR)

Salt Pond (0.5-m TR)

What do we know about runnels so far?

1. Open water cover can decrease
2. Vegetation can recover, despite significant variability

2. Vegetation cover can increase

Experimental Runnel



Before: 2020



After: 2023

Experimental Runnel



Before: 2020



After: 2023



**Live vegetation recovered to average of 88%
across 10 Runnel Sites**

Experimental Runnel



Before: 2020



After: 2023

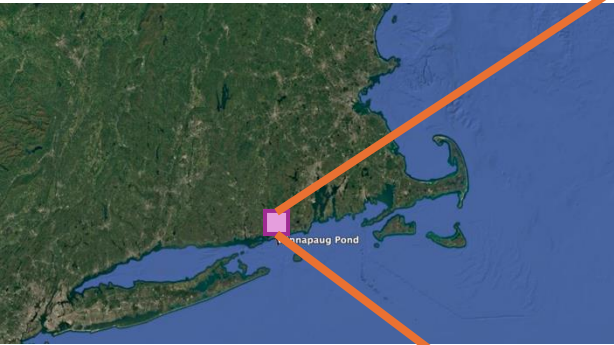


**Live vegetation decreased slightly (1-2% points)
across 10 Control Sites**

What do we know about runnels so far?

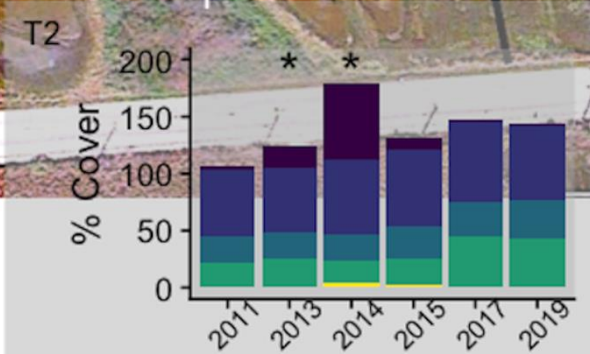
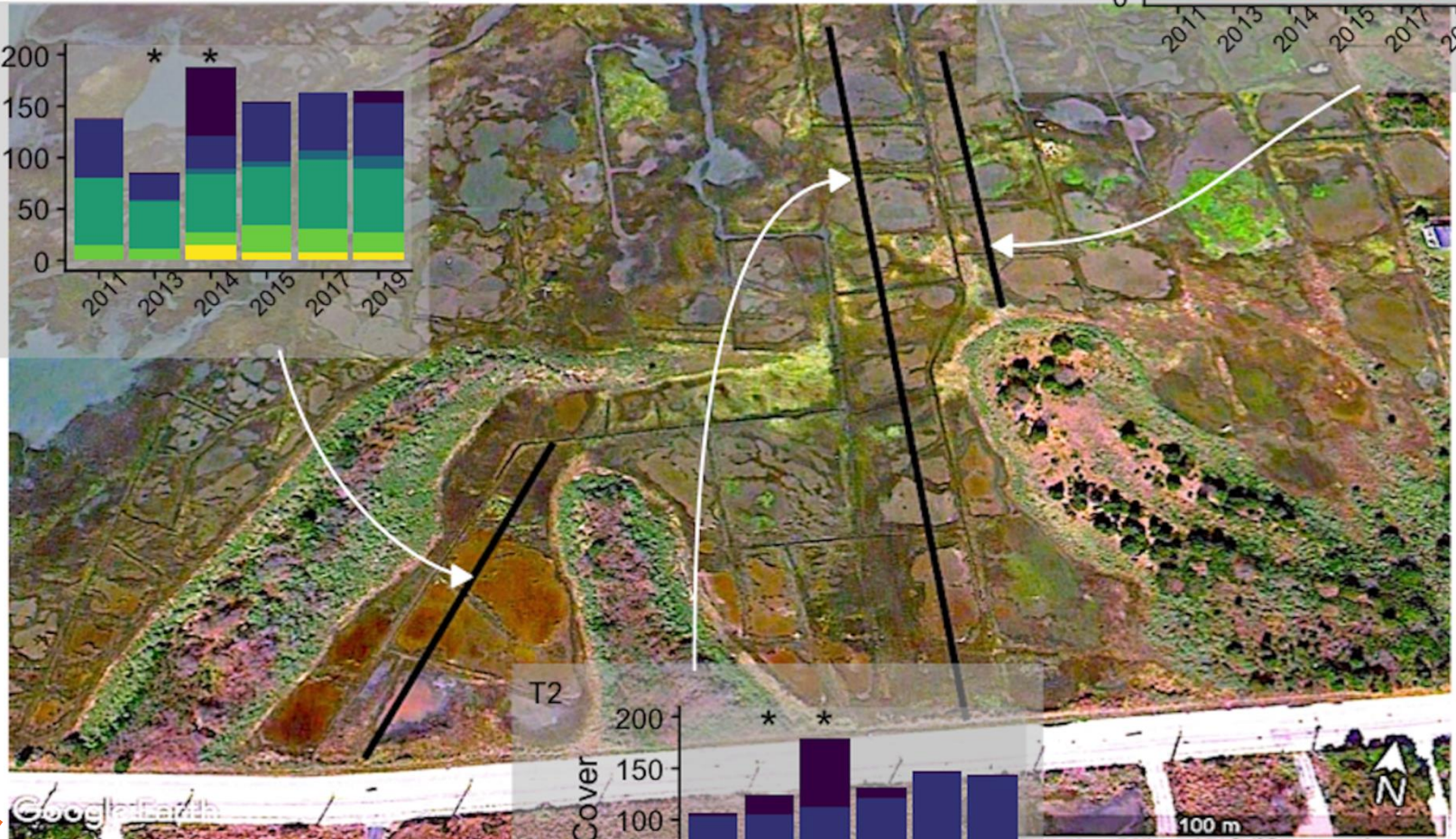
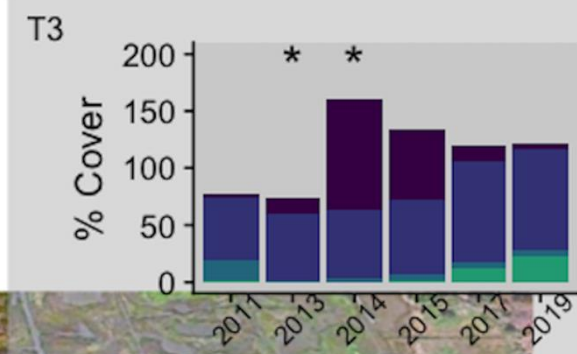
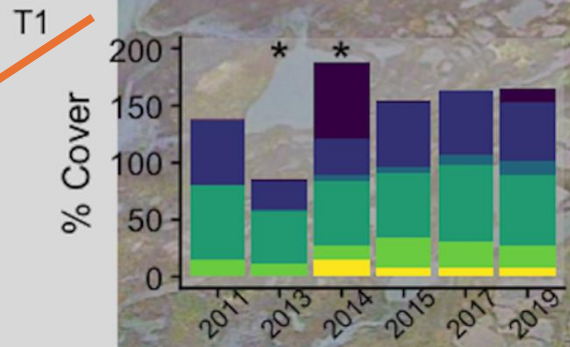
1. Open water cover can decrease
2. Vegetation can recover, despite significant variability
 - a. High marsh species can increase in marsh around pools

Winnapaug – Rhode Island



Species

- Salicornia depressa
- Spartina patens
- Juncus gerardii
- Spartina alterniflora
- Distichlis spicata
- Iva frutescens



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Building consensus through Decision-Maker Workshop

- 2020 workshop designed to introduce concepts to stakeholders, + solicit expert opinion on site selection, permitting, methods, monitoring
- Attended by scientists, regulators, resource managers, restoration practitioners, landowners across several northeastern states
- About 60 in-person, and 20 online participants



DONOR

Decision-Maker Exercise: Approach

- Goal: Solicit expert opinion on site selection for runnels
 - Focus on eco-geomorphic factors, less emphasis on factors such as landowner interest, conservation value, etc.
- Assignment: Rank marshes according to likelihood runnels alone could restore vegetation to denuded areas, with greatest long-term impact
- Packets with data, maps, and photos for 10 marshes around Buzzards Bay- each group ranked 3 marshes, and each marsh was ranked by 2 groups

Decision-Maker Exercise

- Rankings varied
- Marsh characteristics weighed differently among participants



Legend

- Long-Term Monitoring Trans
- Option 1 - 27 ft
- Option 2 - 20 ft
- Option 2 - 30 ft

Decision-Maker Exercise: Recommendations

1. Runnelling not enough in isolation. Runnel maintenance, complementary techniques needed in most cases (e.g., ditch maintenance, ditch remediation, sediment placement).
2. Infrastructure (roads, upland barriers, culverts) may create complexity, require additional management (e.g., culvert replacement) for runnel to be successful.
3. Should prioritize sites with elevation capital, some healthy high marsh vegetation, pools underlain with firm in-tact peat
4. **Percent cover of bare, denuded area most important factor to consider: avoid sites “too far gone”.**

Lessons learned through practice

- Runnels in phases beginning 2018
- Unconsolidated sediments
 - Sills
 - Phases



- Sill – trap sediment
 - “speed-bump”
 - vegetated edge

- Phases – manage discharge
 - Initial drainage



Lessons learned through practice

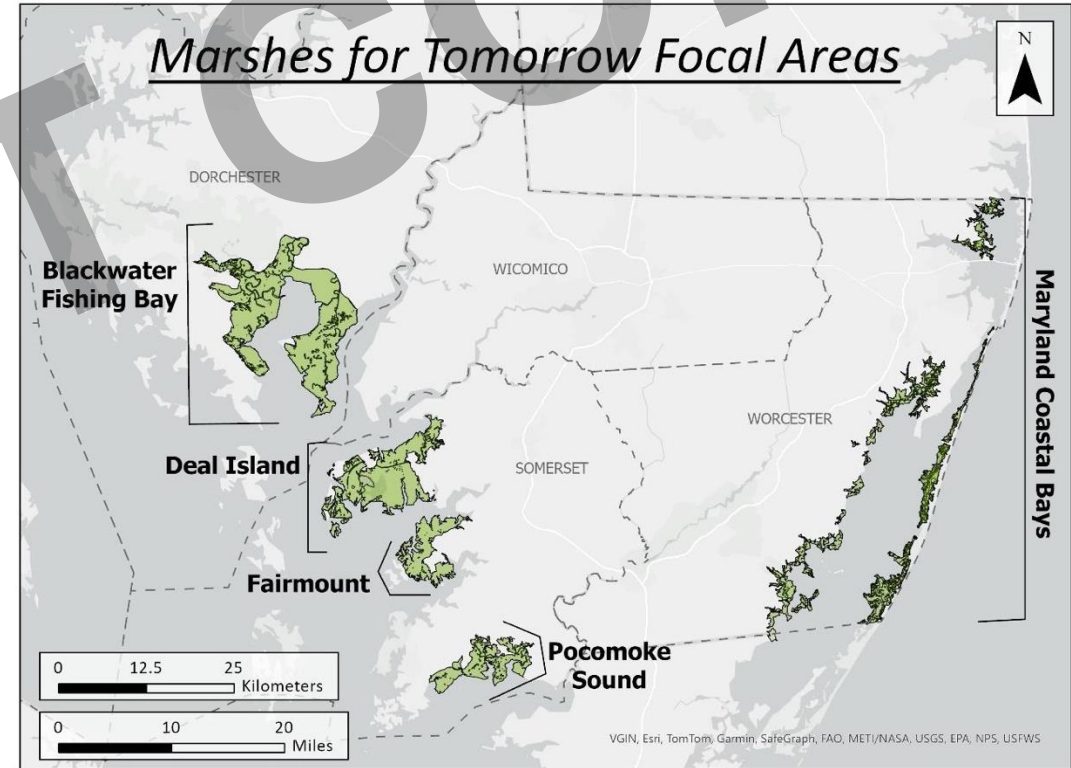
- Runnels began in 2018
- High unvegetated area relative to vegetated area (UVVR)
- Practitioners have hypothesized elevation is too low (not been measured to-date)



What questions still exist?

Lots!

Maryland Marshes 2026-2030: What factors determine the timing and pattern of vegetation recovery at landscape, marsh, and microhabitat scales?



Collaborators: Andy Baldwin (UMD), Sophia Seufert (USFWS), Dave Curson (Audubon), Henrietta Bellman (Audubon), Neil Ganju (USGS)

O1: Landscape-scale factors

- Tidal range
- Elevation
- Geomorphic setting (e.g., fringing, back-barrier)
- Local relative sea level rise rate
- Unvegetated-Vegetated Ratio
- Will include Maryland, along ~25 other project sites in Mid-Atlantic and Northeast

State	Project Sites with NAIP Imagery	Geographic Region	Range of Implementation Years	Approximate Range of Tidal Amplitudes
Maine	1	Coastal Maine	2019	2.01-3.00 m
Massachusetts	5	Ipswich Bay	2015-2023	2.01-3.00 m
Massachusetts	5	Taunton River and Buzzards Bay	2017-2022	0.5-1.05 m
Massachusetts	1	Cape Cod	2023	0.76-1.25 m
Rhode Island	3	Block Island Sound	2013-2020	0.5-1.05 m
Rhode Island	5	Narragansett Bay	2010-2018	1.05-1.31 m
Connecticut	3	Long Island Sound	2004-2014	0.73-2.05 m
New York	3	Fire Island (Great South Bay)	2018-2020	<0.40 m
New Jersey	1	Delaware Bay	2017	1.75-2.00 m
Maryland	4	Coastal Bays	2023-2025	0.07-0.20 m
Maryland	1	Chesapeake Bay	2026	0.50-0.90 m
TOTAL	32	11 regions	2004-2026	0.067-3.00 m

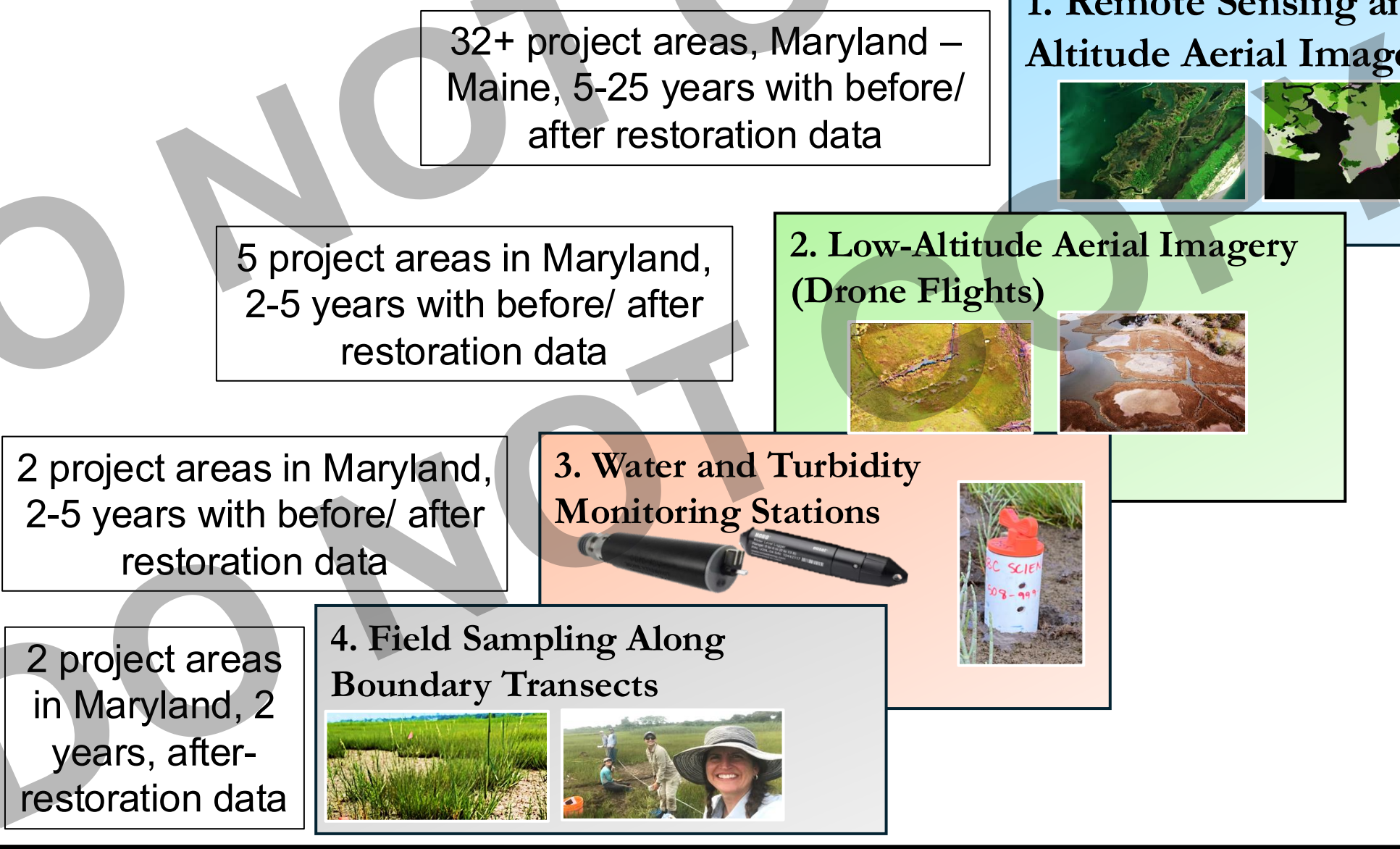
Spatio-temporal scale of study design

Kilometers

Decadal

Centimeters

Seasonal



Centimeters

Spatial scale of controlling factors

Kilometers



**Thank you!
Questions?**