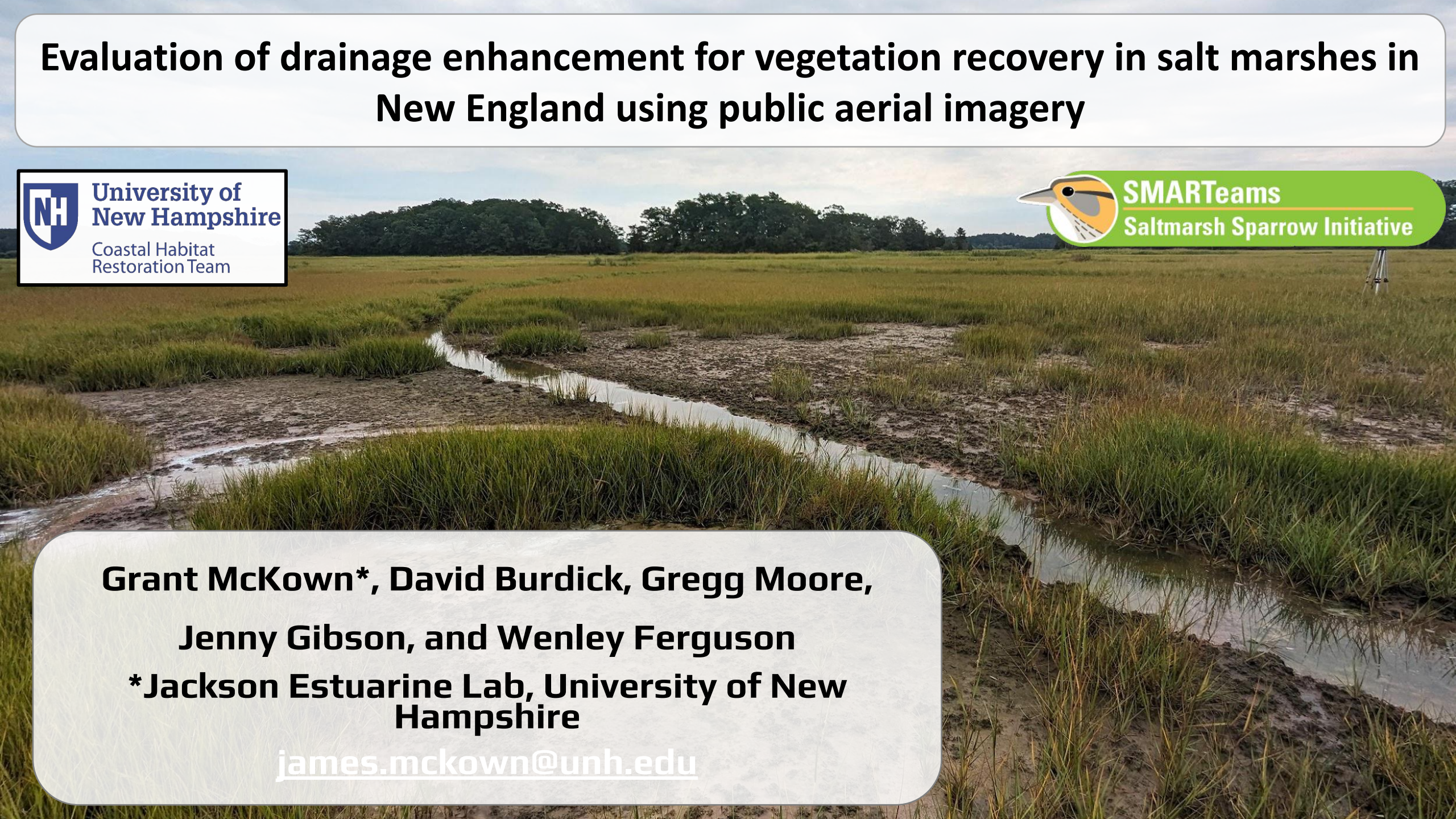
Evaluation of drainage enhancement for vegetation recovery in salt marshes in New England using public aerial imagery



University of New Hampshire
Coastal Habitat Restoration Team

SMARTeams
Saltmarsh Sparrow Initiative

Grant McKown*, David Burdick, Gregg Moore,

Jenny Gibson, and Wenley Ferguson

***Jackson Estuarine Lab, University of New Hampshire**

james.mckown@unh.edu

Acknowledgements and Funding

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Susan Adamowicz
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Nathan Hermann
Katie Low
Liz Gorrill
Nick Ernst
Ben Gaspar
Andrew Payne
Chris Peter

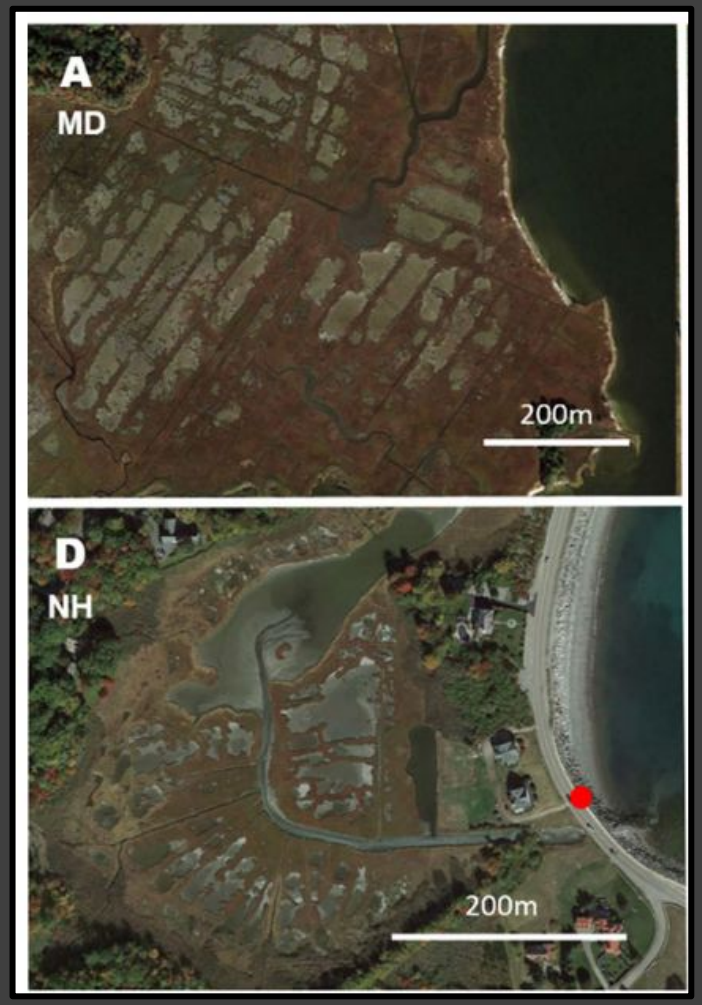
Talk Roadmap

1. Marsh Degradation and Runnels Background
2. Remote Sensing Workflow
3. Impact of Runnels on Revegetation
4. Impact of Initial Marsh Condition on Revegetation
5. Site-specific examples of runnel restoration

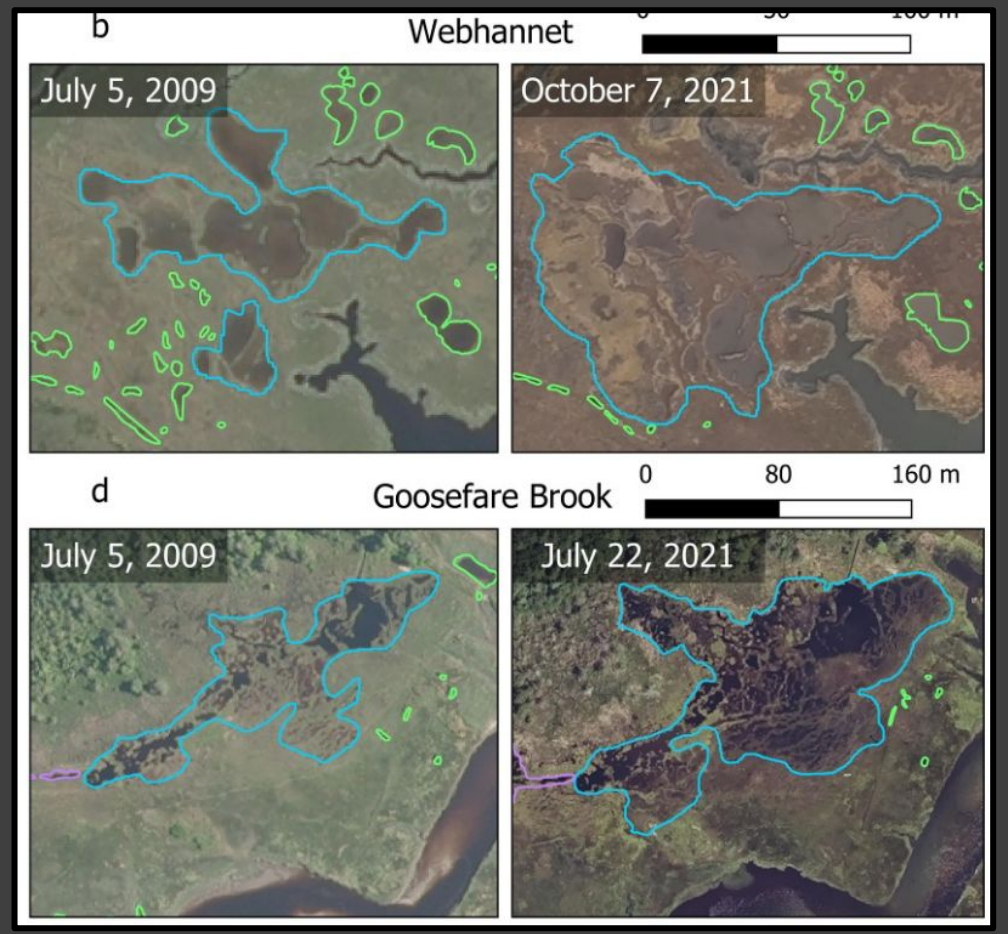
Expansion of Mega-pools and Loss of High Marsh Habitat!

Embankments

Sea Level Rise



Smith et al. 2021



Waters et al. 2025

Drainage Enhancement & Restoration of Tidal Flow

Buying Time with Runnels: a Climate Adaptation Tool for Salt Marshes

Alice F. Besterman[1,2] · Rachel W. Jakuba[2] · Wenley Ferguson[3] · Diana Brennan[4] · Joseph E. Costa[5] · Linda A. Deegan[2]

Runnels mitigate marsh drowning in microtidal salt marshes

Elizabeth B. Watson[1]*, Wenley Ferguson[2], Lena K. Champlin[1], Jennifer D. White[3†], Nick Ernst[3], Habibata A. Sylla[1], Brittany P. Wilburn[1] and Cathleen Wigand[4]

Salt marsh climate change adaptation: Using runnels to adapt to accelerating sea level rise within a drowning New England salt marsh

Danielle C. Perry[1,2,3], Wenley Ferguson[4], Carol S. Thornber[1]

Runnels Reverse Mega-pool Expansion and Improve Marsh Resiliency in the Great Marsh, Massachusetts (USA)

J. Grant McKown[1] · David M. Burdick[2] · Gregg E. Moore[3] · Christopher R. Peter[4] · Andrew R. Payne[5] · Jennifer L. Gibson[3]

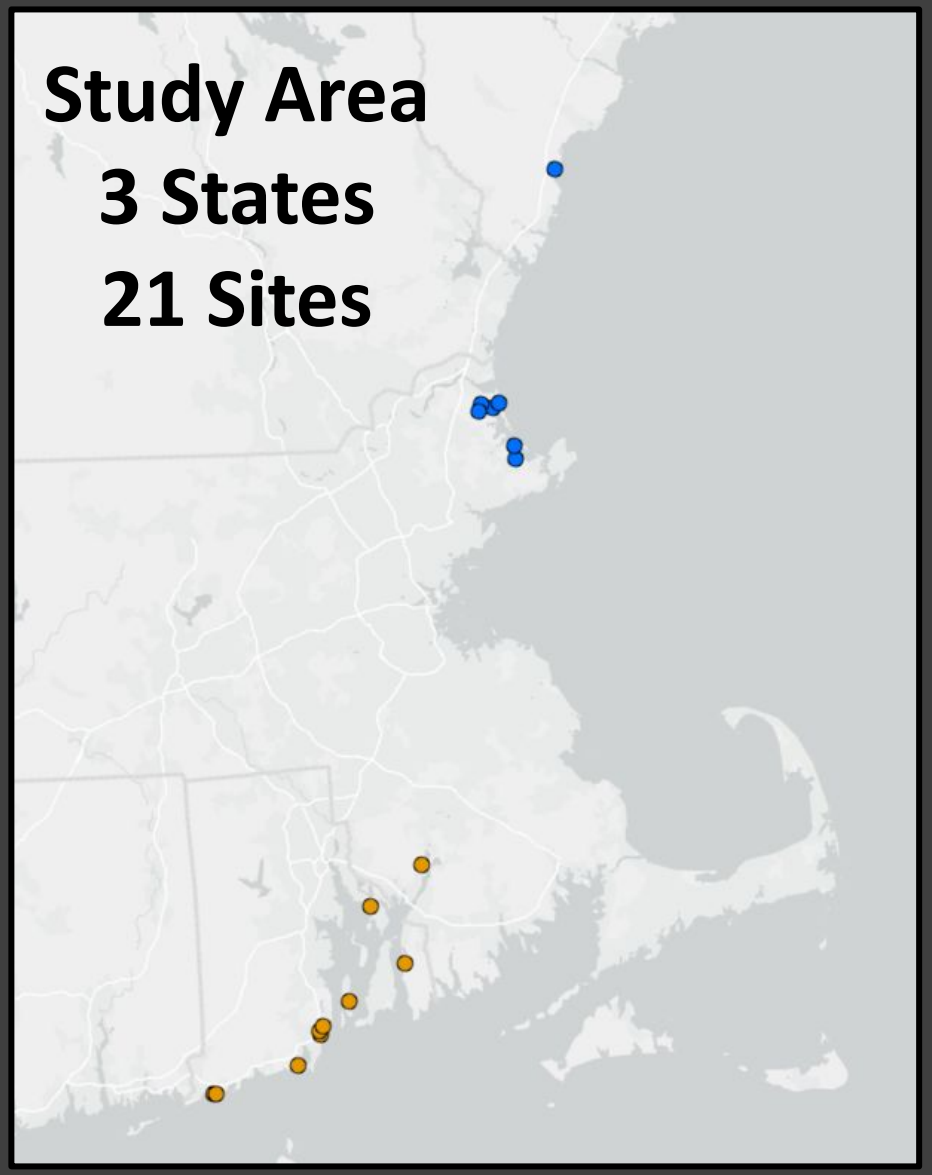
The Effect of Runnels on Salt Marsh Sediment Dynamics, Vegetation, and Nitrogen Cycling

Hillary L. Sullivan[1,2] · Julia Holtzer[3] · Linda A. Deegan[1] · Jennifer L. Bowen[2]

Research Question

Does drainage enhancement restore high marsh habitat?

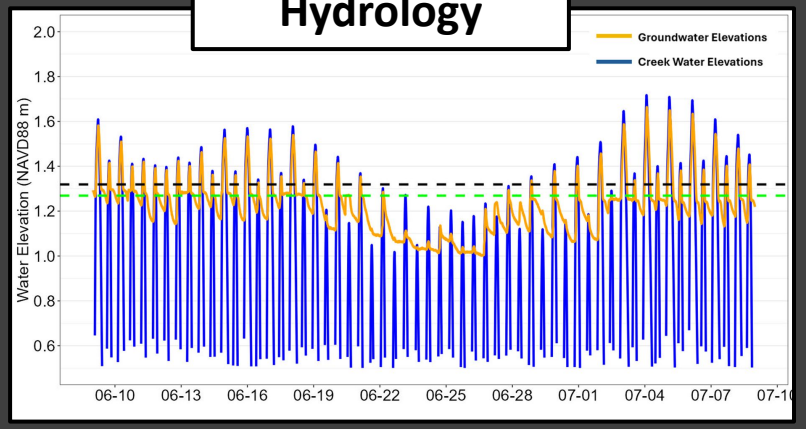
Study Area
3 States
21 Sites



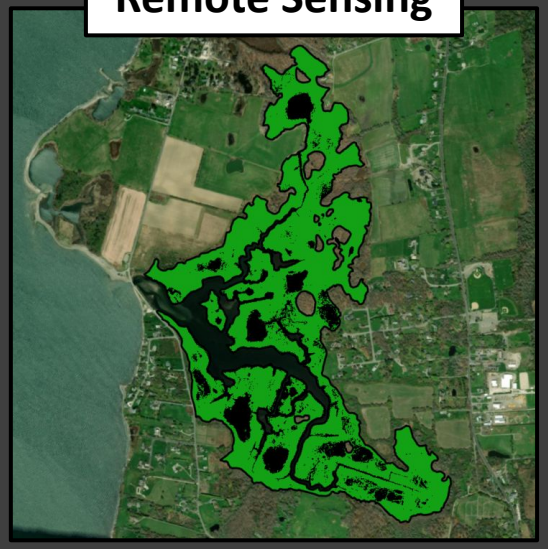
Vegetation

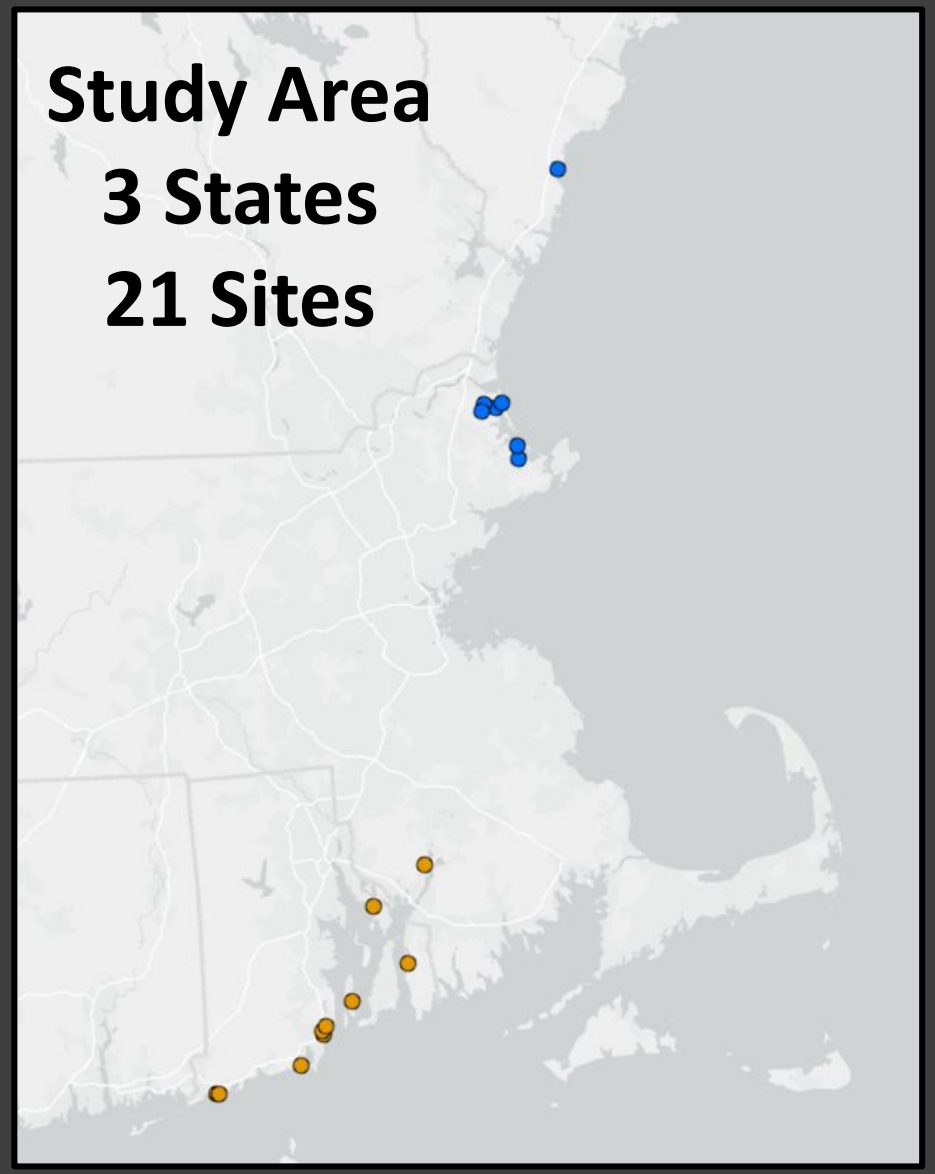
Sparrow Point Counts

Hydrology

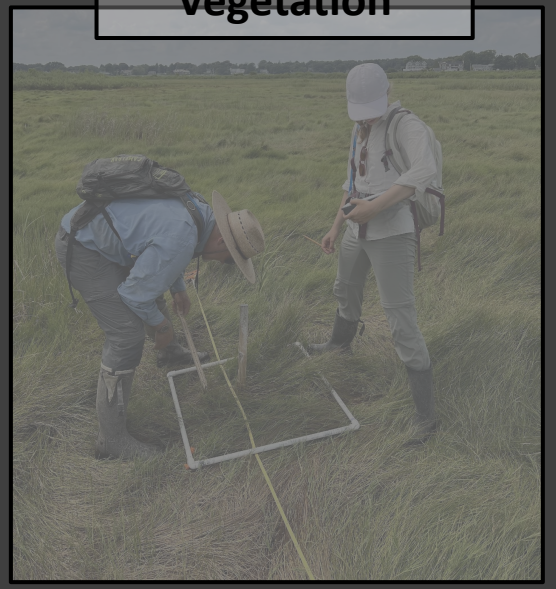


Remote Sensing

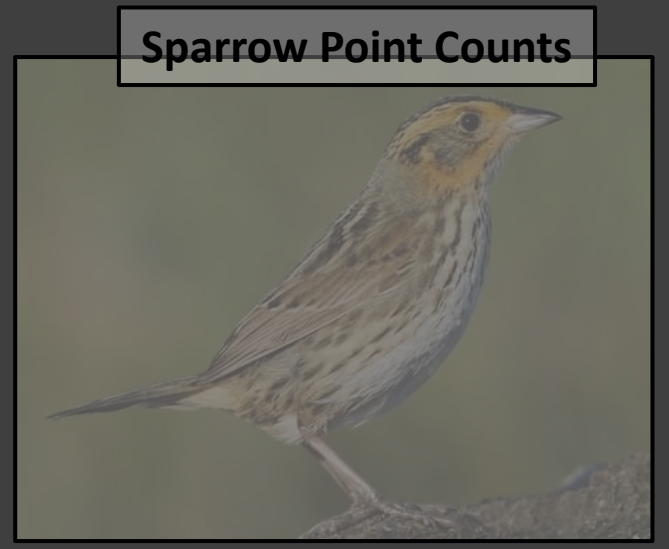




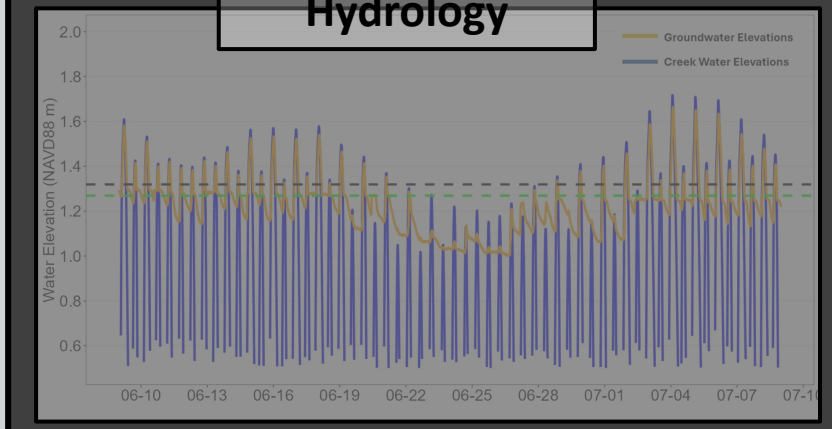
Vegetation



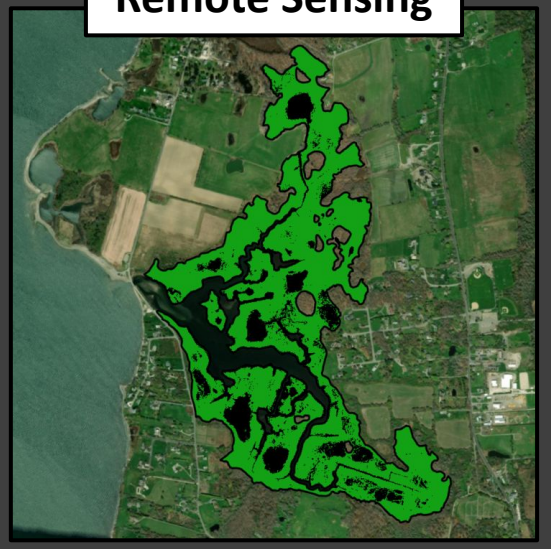
Sparrow Point Counts



Hydrology



Remote Sensing

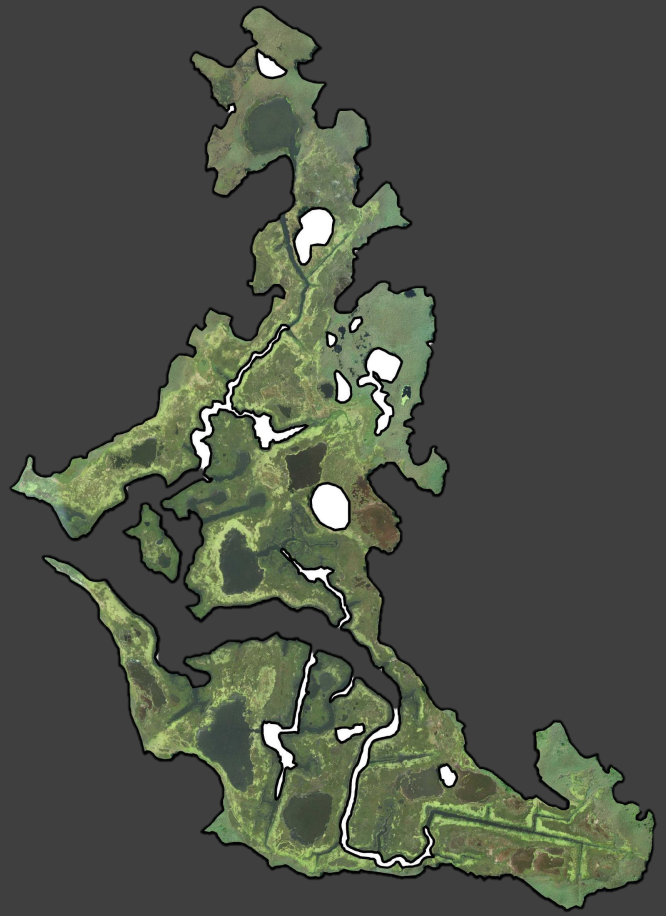


Research Question

Does drainage enhancement promote re-vegetation?

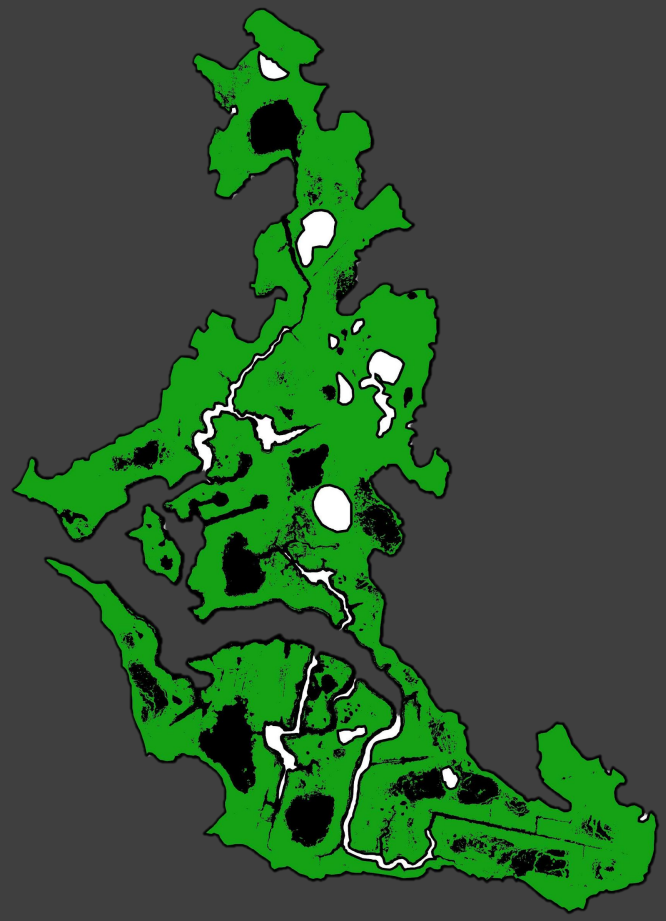
Does the pre-restoration marsh condition impact the rate of recovery?

NAIP Imagery



Normalized Difference Vegetation Index

Marsh Surface Classification



NAIP Imagery Dates

106 Classifications

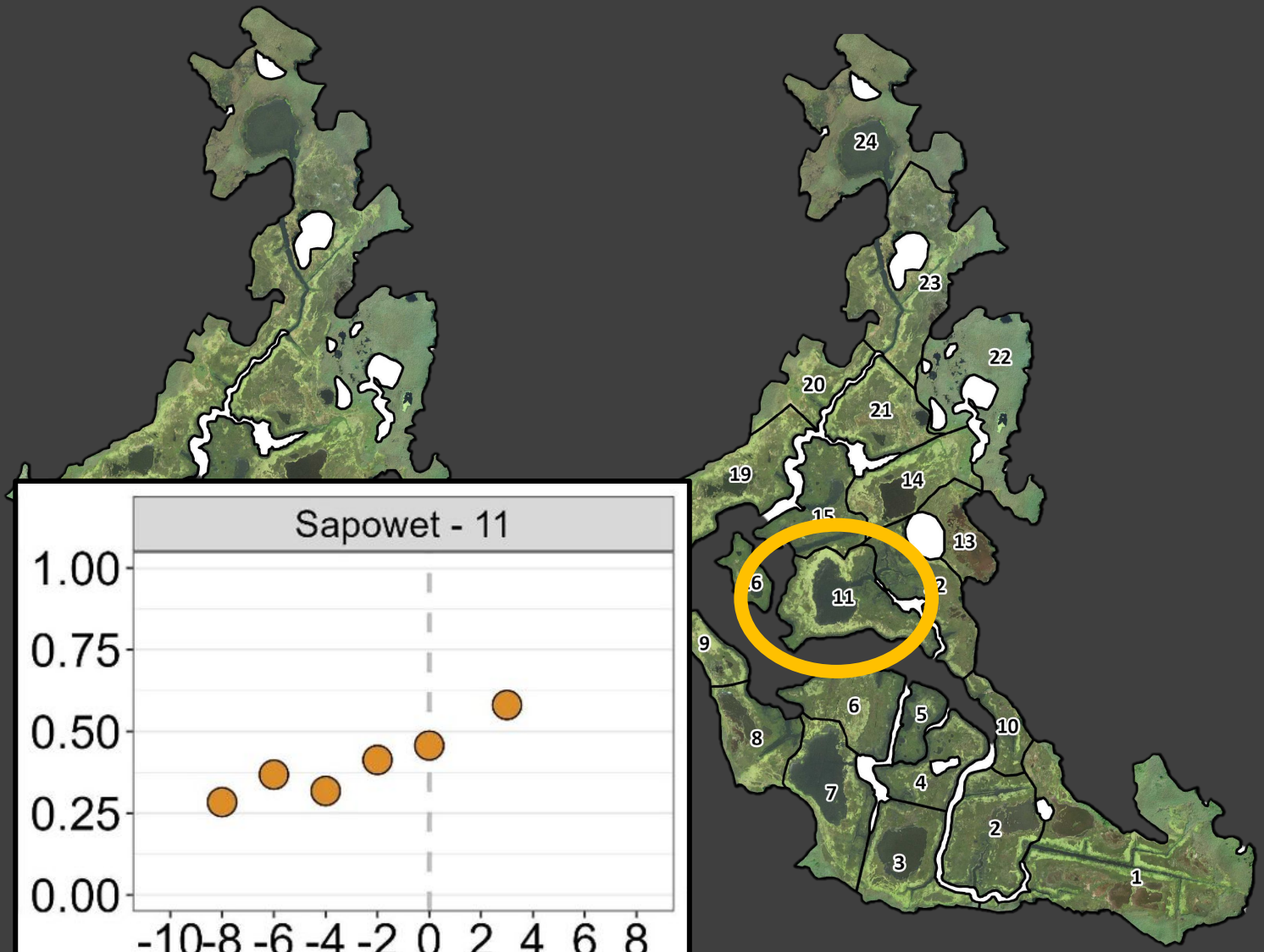
89 ± 6% Accuracy

NAIP Imagery

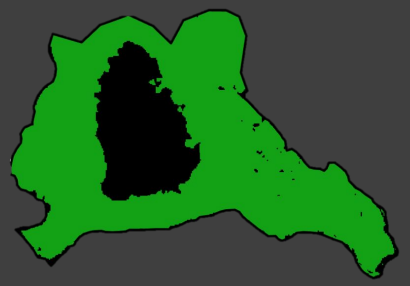
Sub-tideshed

UVVR Calculation

$$UVVR = \frac{\sum Unvegetated\ Pixels}{\sum Vegetated\ Pixels}$$

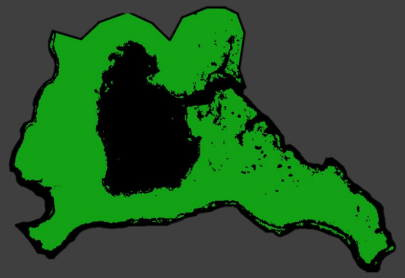


2010



$$\frac{9552}{33475} = 0.28$$

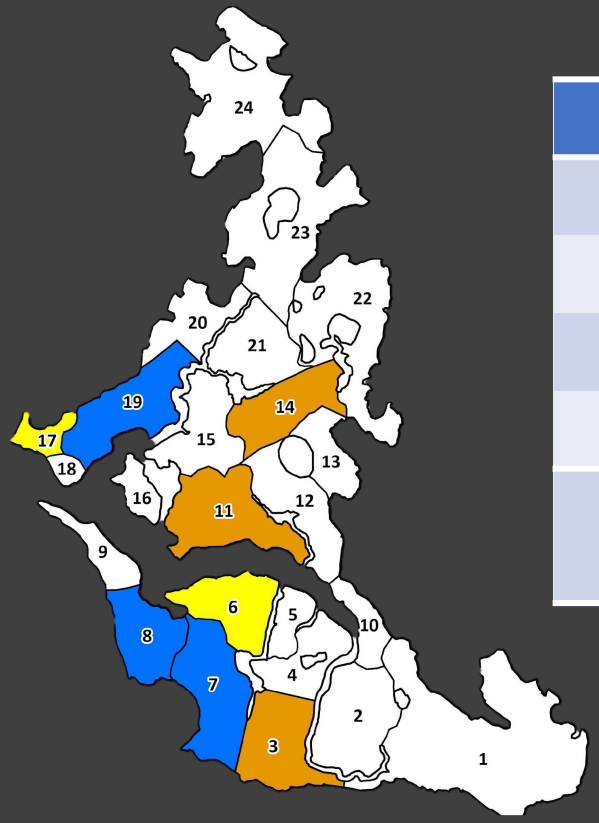
2021



$$\frac{14298}{28717} = 0.50$$

Sub-tidesheds

Classified Sub-tidesheds



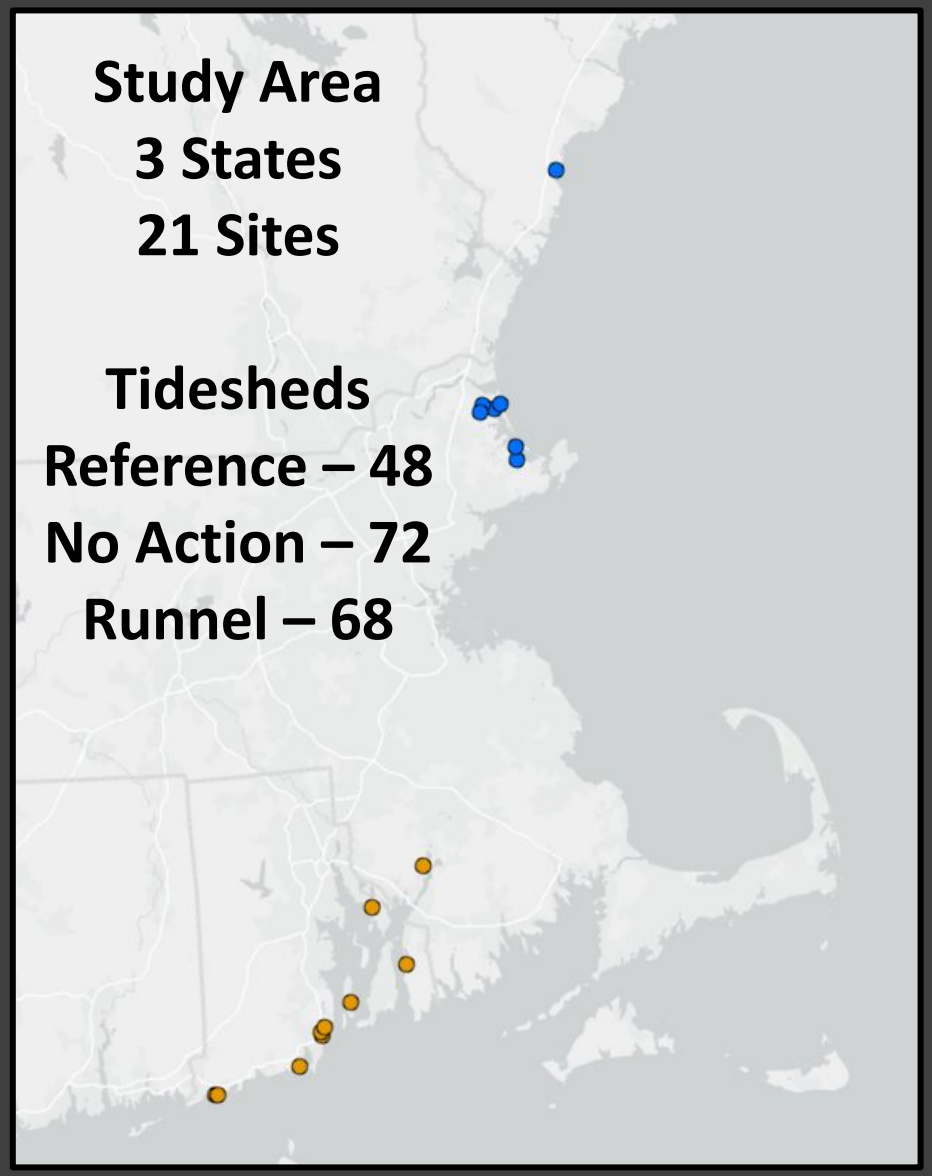
Treatment	Tidesheds	Acreage
Reference	48	277
Runnel	68	324
No Action	72	378
Miscellaneous	89	747
Retained in Analysis	188	981

Reference

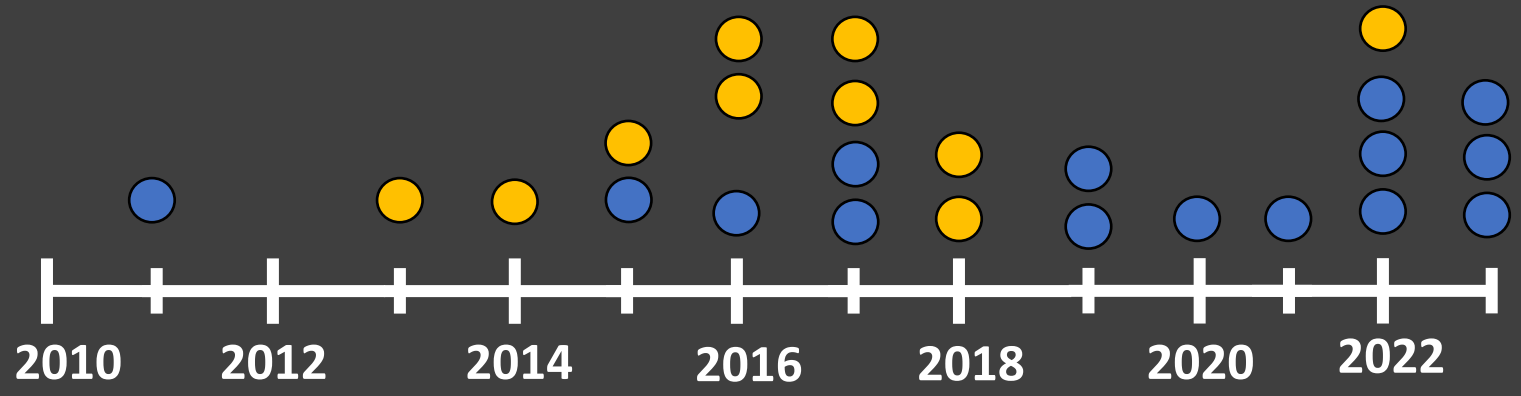
No Action

Runnel

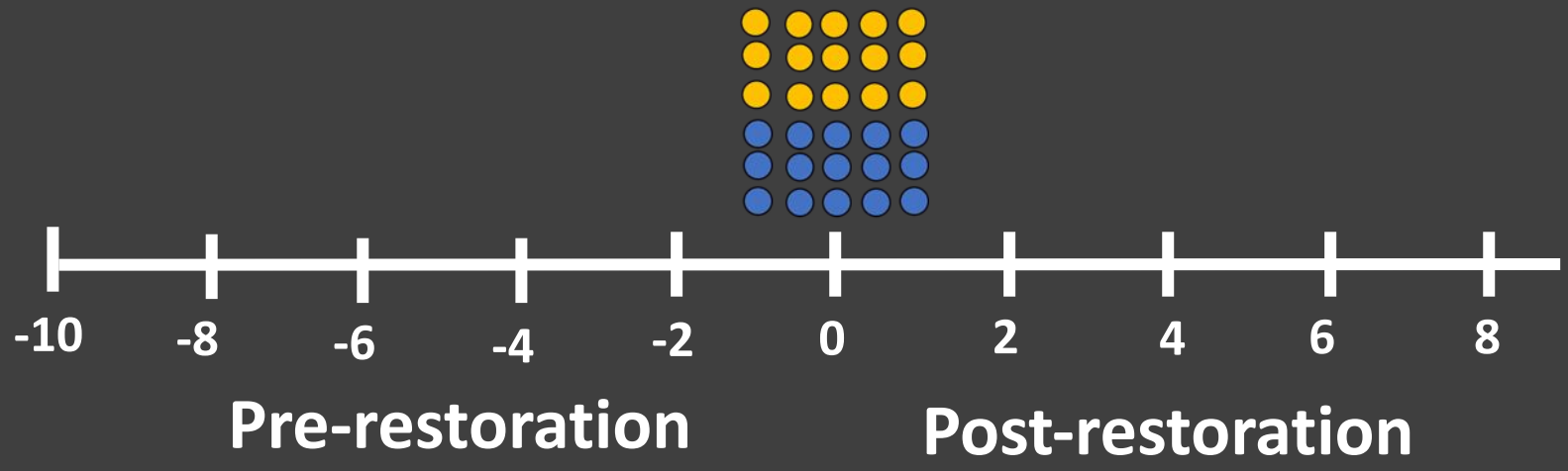
Miscellaneous

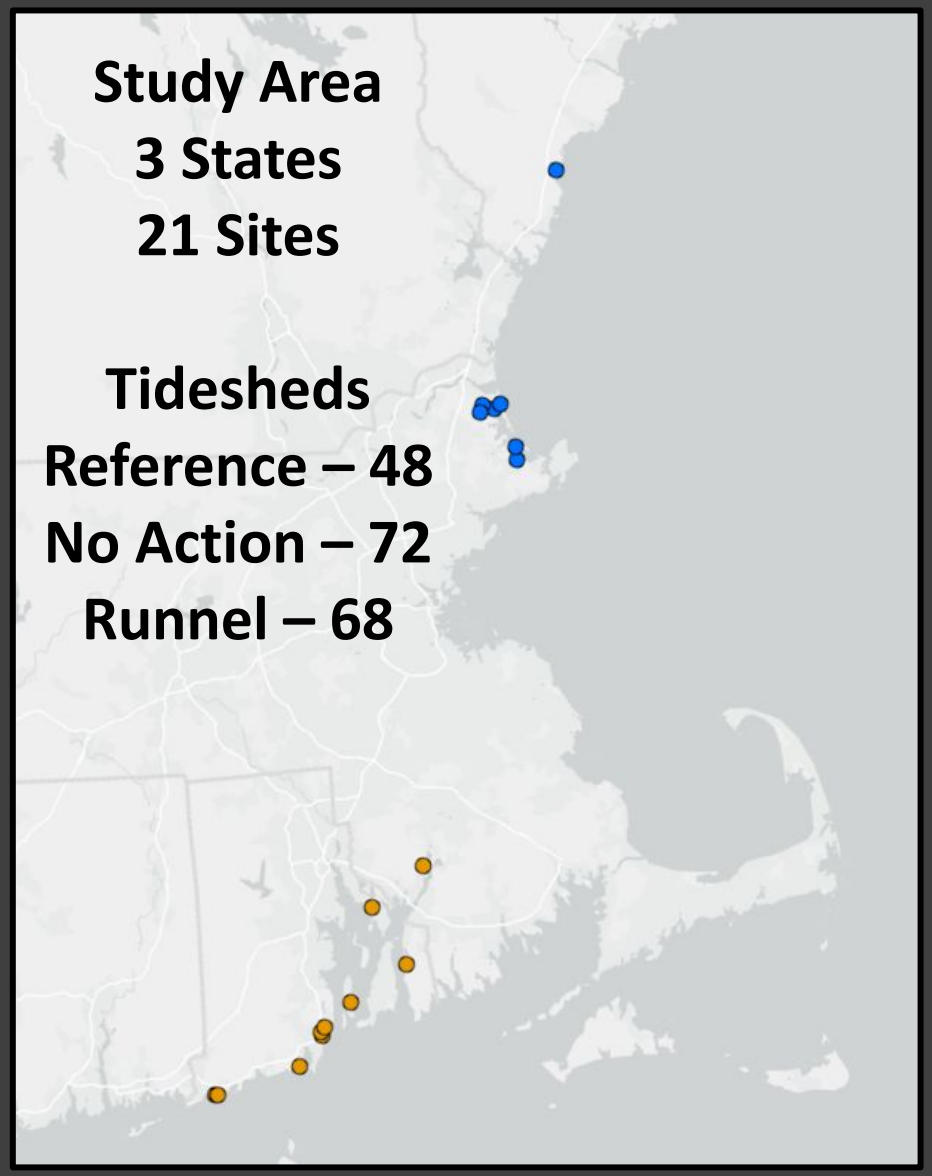


Date of Restoration per Site

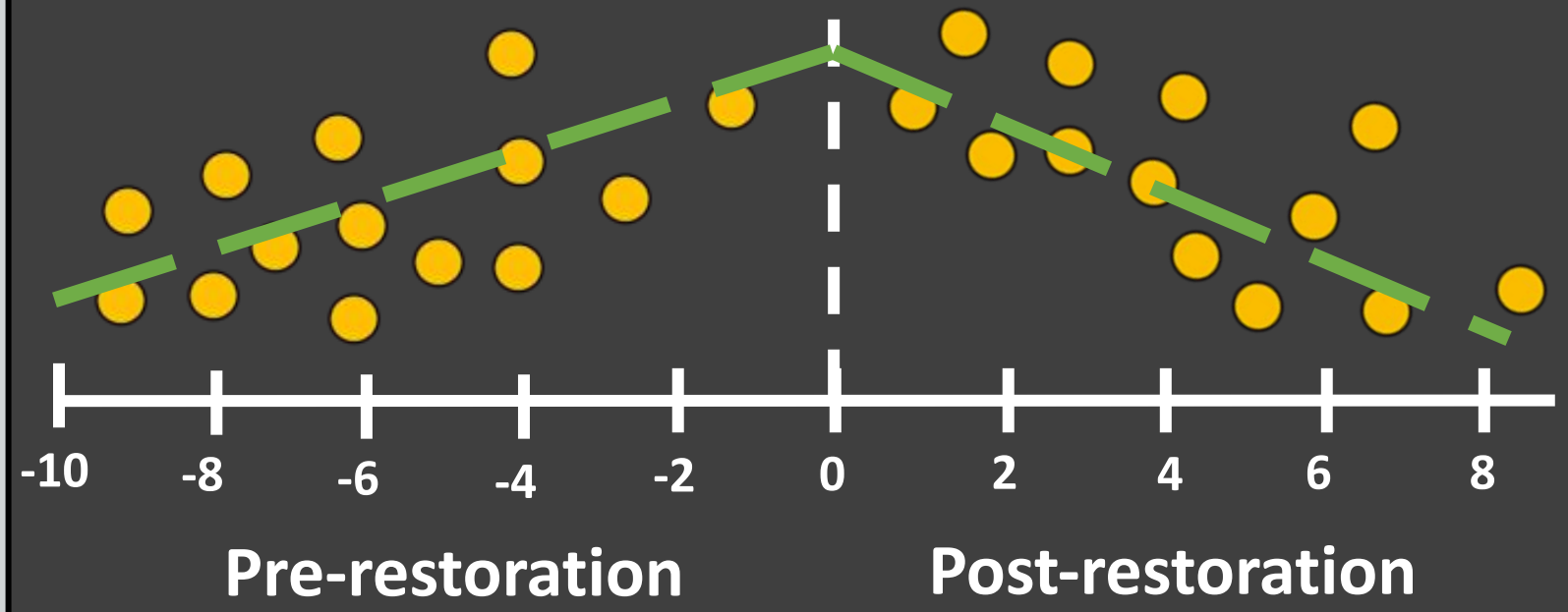


Restoration dates adjusted to Year 0 for common recovery timeline





Linear Mixed Spline Modeling

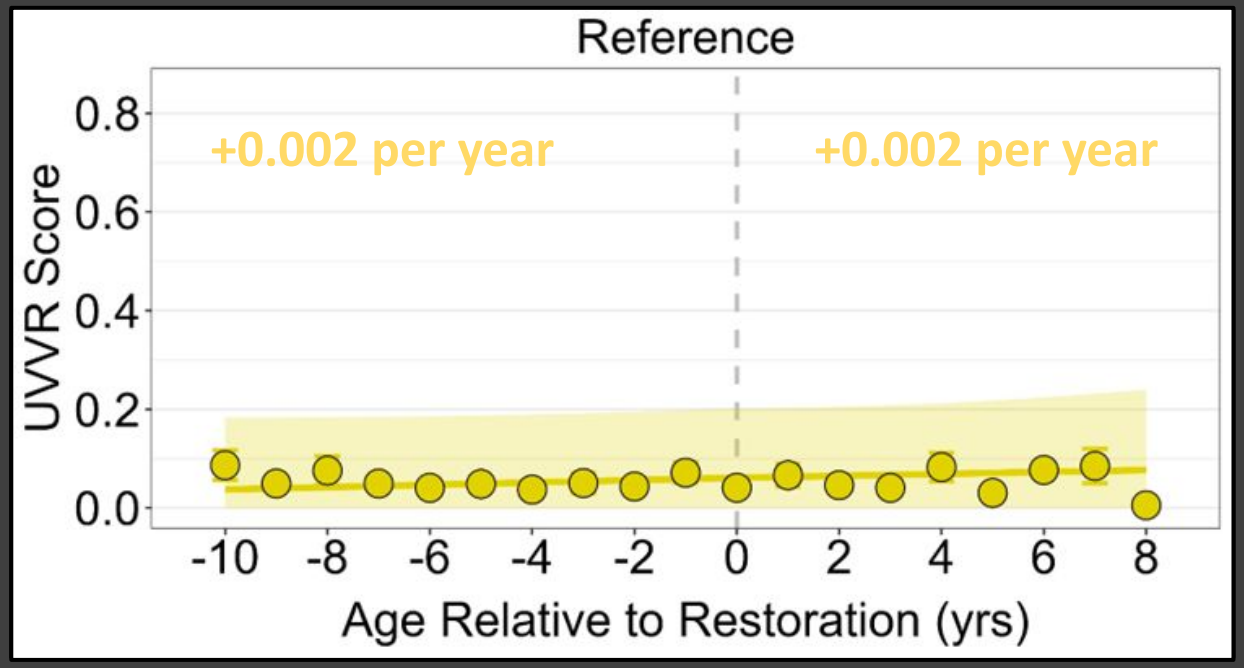


Research Question

Does drainage enhancement promote re-vegetation?

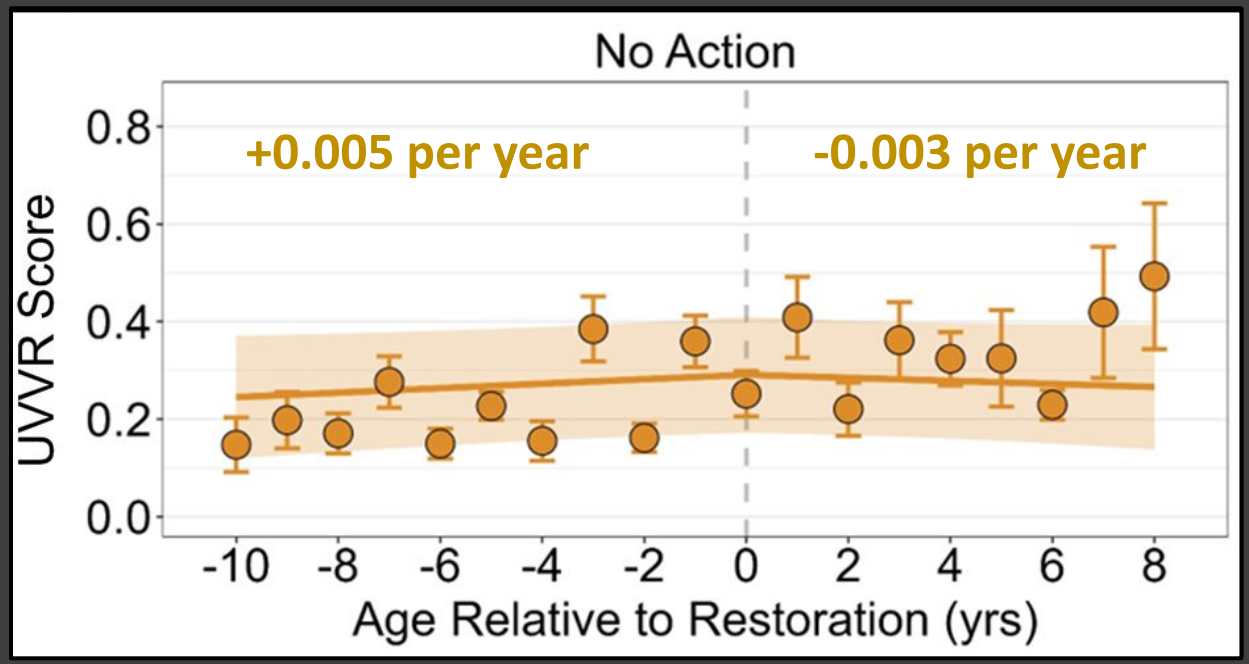
Does the pre-restoration marsh condition impact the rate of recovery?

Does drainage enhancement promote re-vegetation?



Continued trend of increasing loss of vegetation

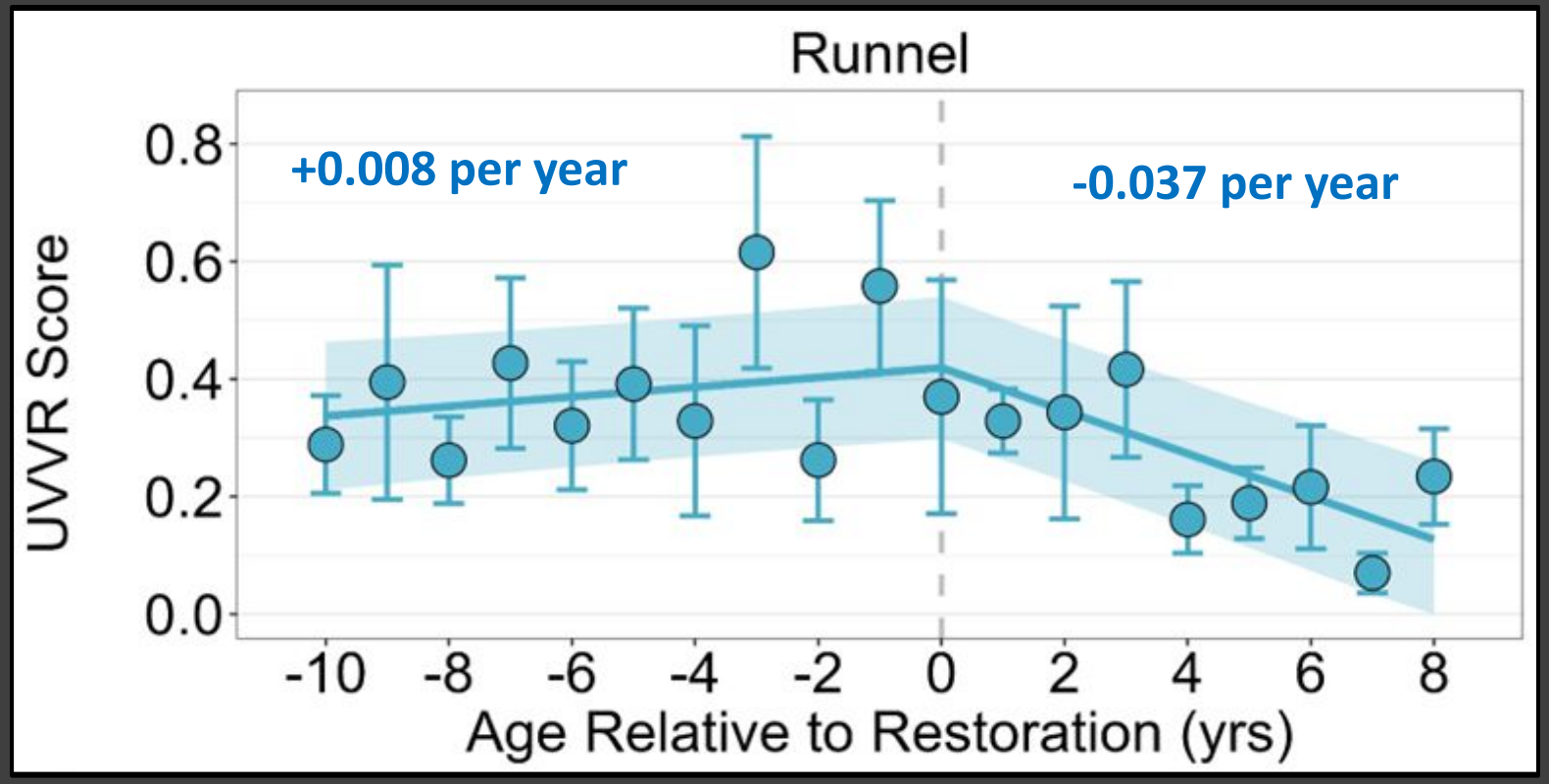
Minor reverse trend from loss to gain in vegetation



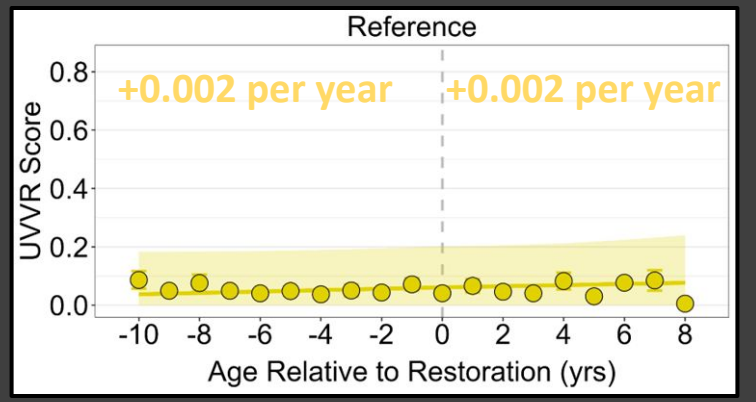
n = 1043

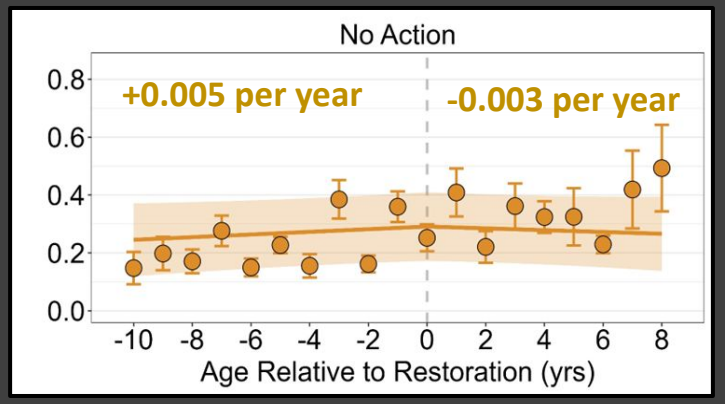
Treatment * Time: $F_{4, 838.1} = 839.2$, $p < 0.001$

Does drainage enhancement promote re-vegetation?



Substantial revegetation over time after restoration!





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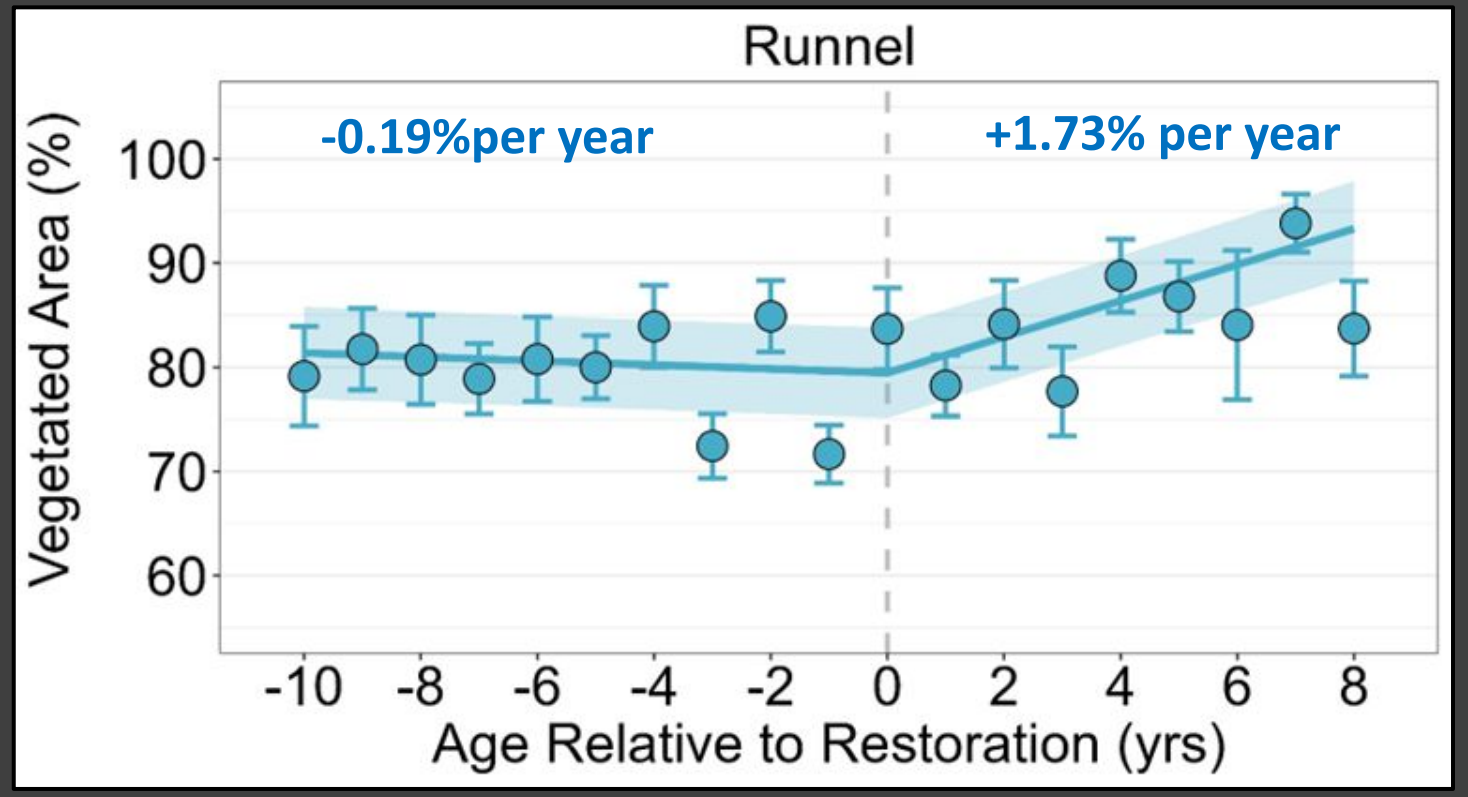

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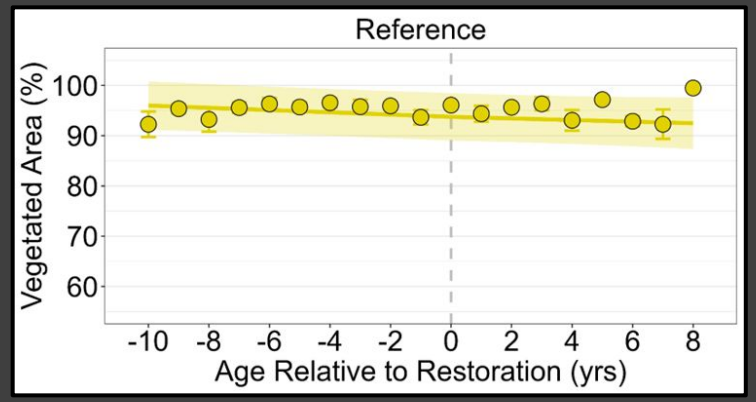

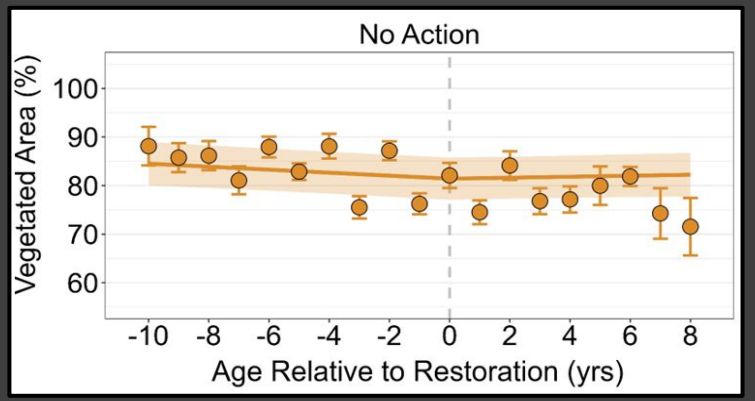

n = 1043

Treatment * Time: $F_{4, 838.1} = 839.2$, $p < 0.001$

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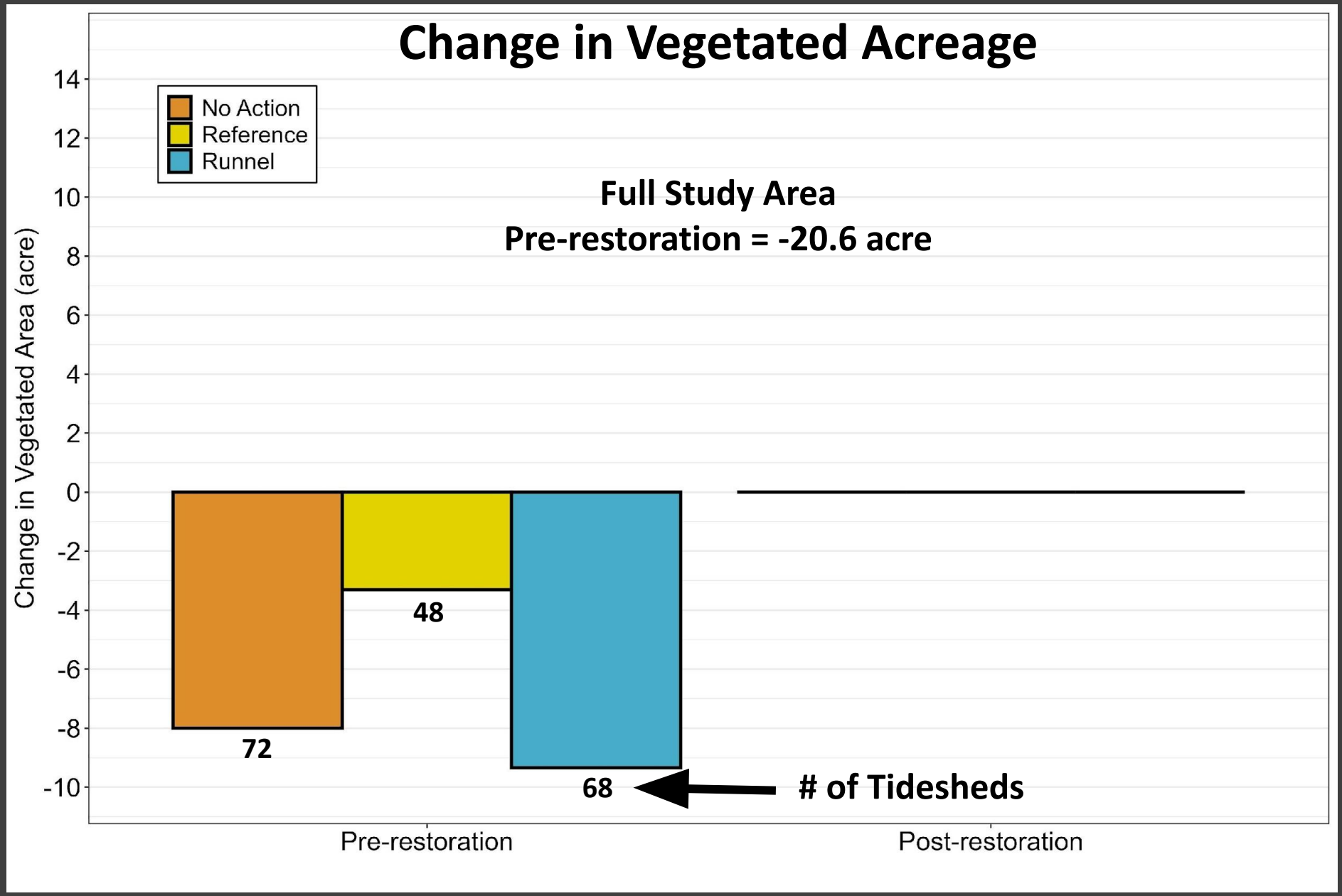
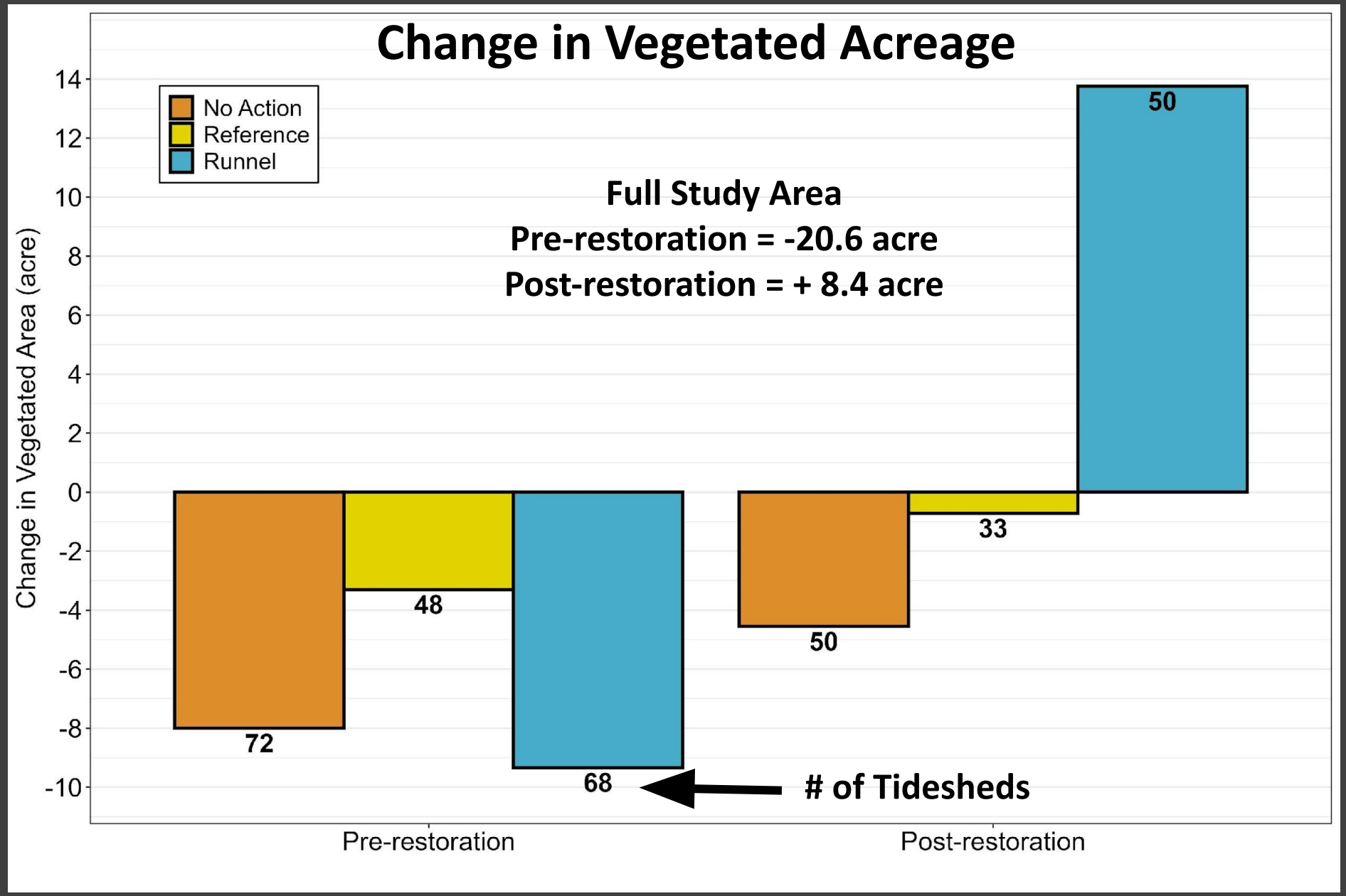


Does drainage enhancement promote re-vegetation?



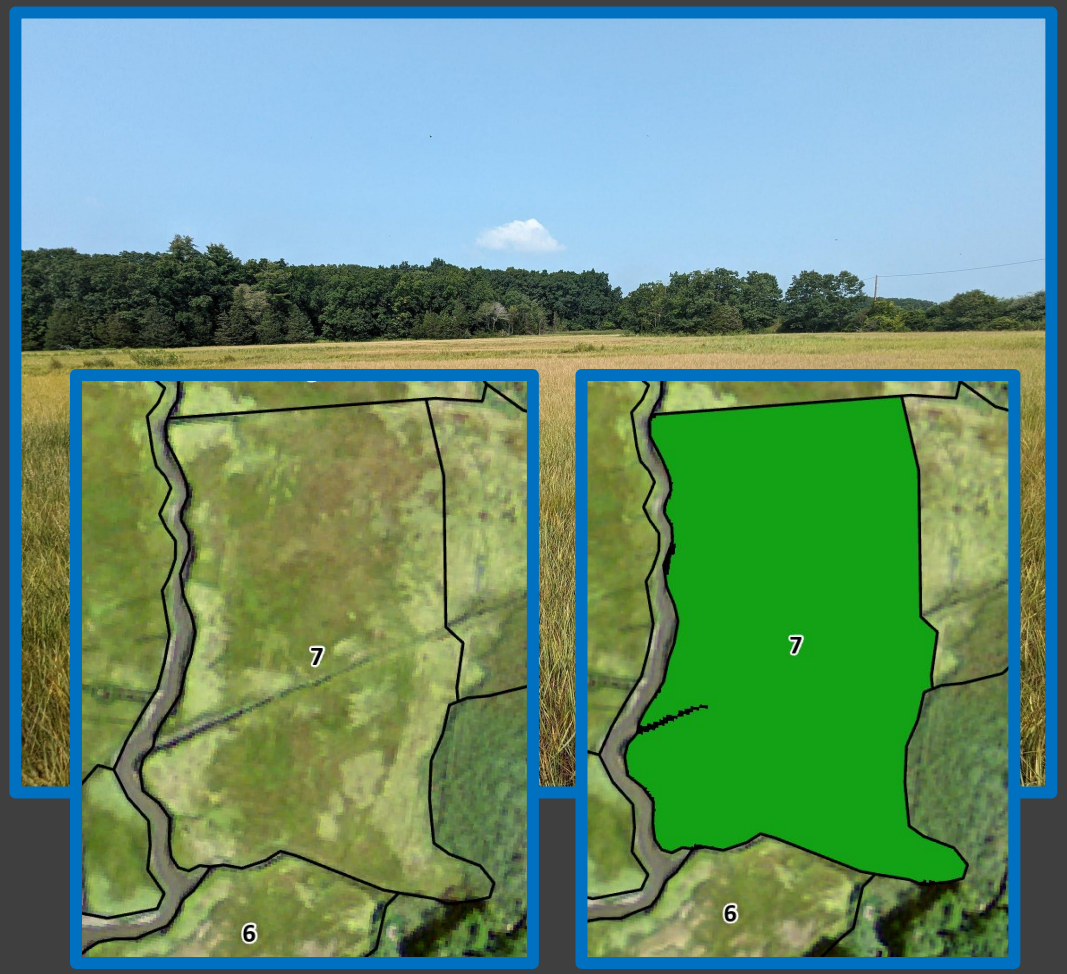
Research Question

Does drainage enhancement promote re-vegetation?

Does the pre-restoration marsh condition impact the rate of recovery?

Does the pre-restoration marsh condition impact the rate of recovery?

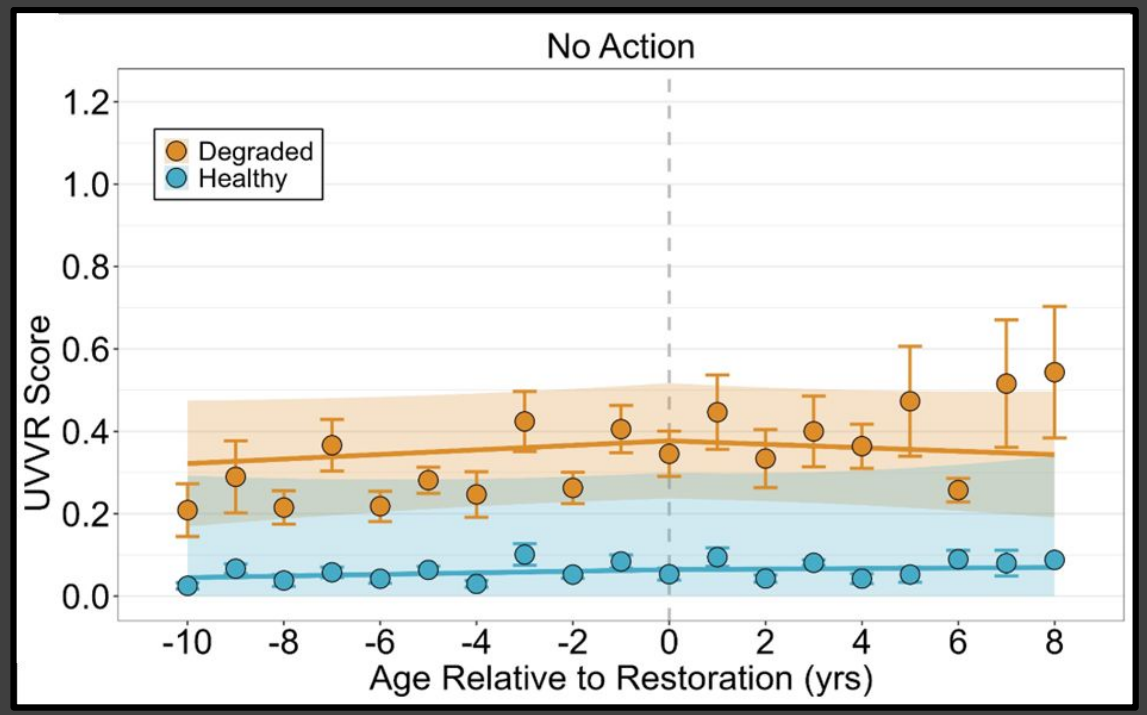
Degraded Panne Condition
UVVR < 0.15

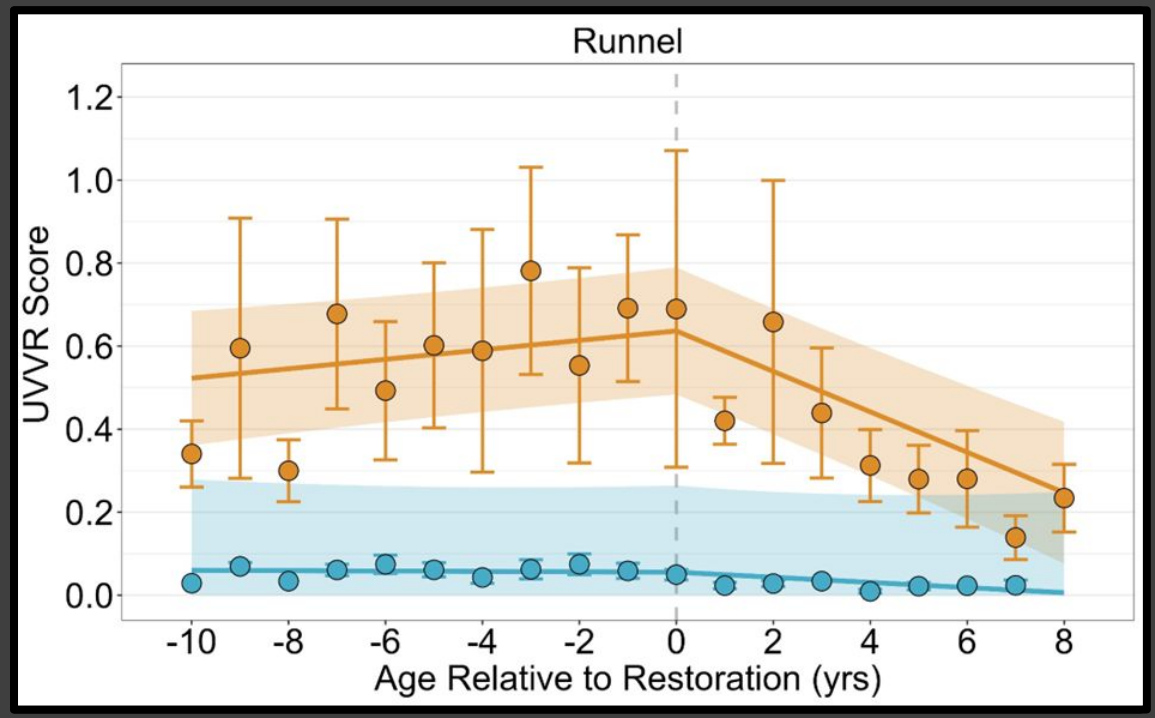


Degraded Pool Condition
UVVR > 0.15

Does the pre-restoration marsh condition impact the rate of recovery?

Degraded Panne Degraded Pool





Pre-restoration	Post-Restoration
+0.006 per year	-0.004 per year
+0.002 per year	+0.001 per year

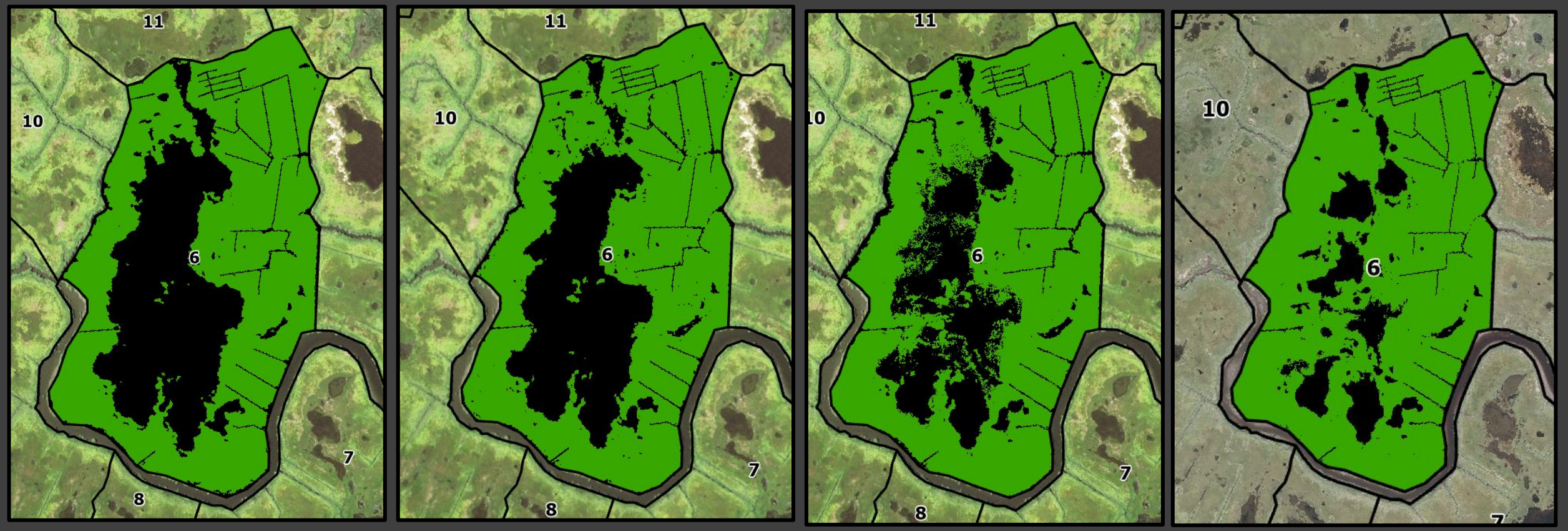
Pre-restoration	Post-Restoration
+0.011 per year	-0.049 per year
-0.001 per year	-0.006 per year

n = 773

Treatment * Time*Condition: $F_{2, 622.8} = 7.06$, $p = 0.001$

Pine Island – Tideshed 6 (South Pool)

Year 0	Year 3	Year 6	(Preliminary) Year 8
6.66 ha	7.15 ha	7.81 ha	8.51 ha

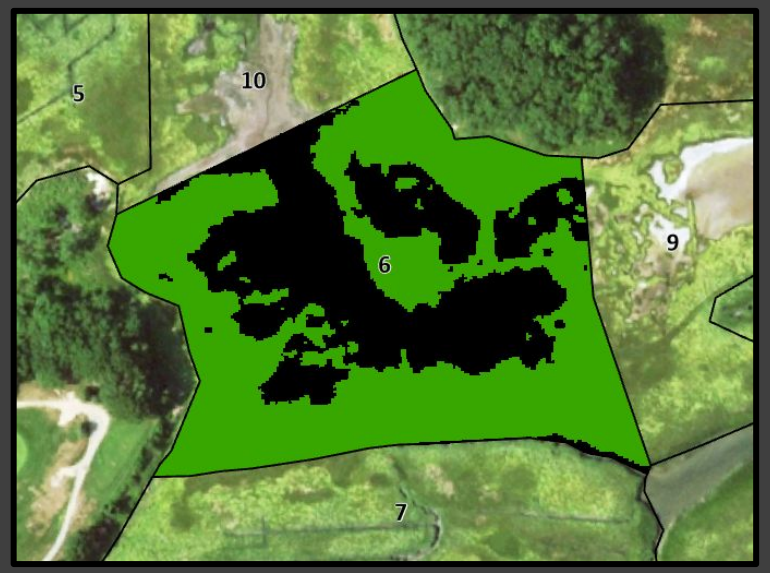


Vegetated Marsh Surface

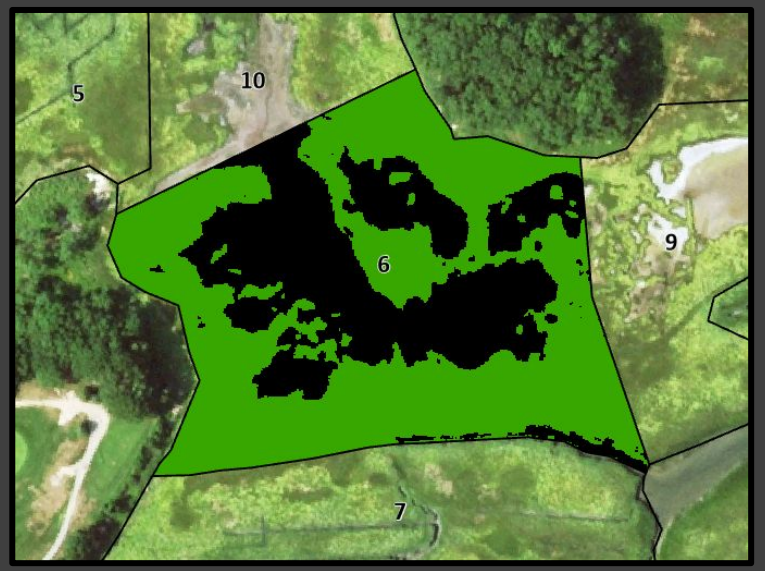
Open Water, Bare Surface

See McKown et al. 2023 for project details

Year -3 – 1.22 ha



Year -1 – 1.24 ha

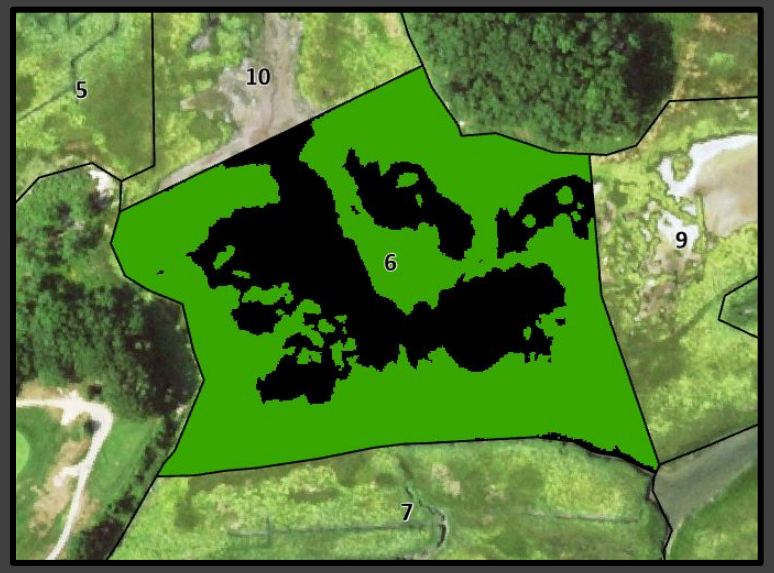


Essex – Tideshed 6

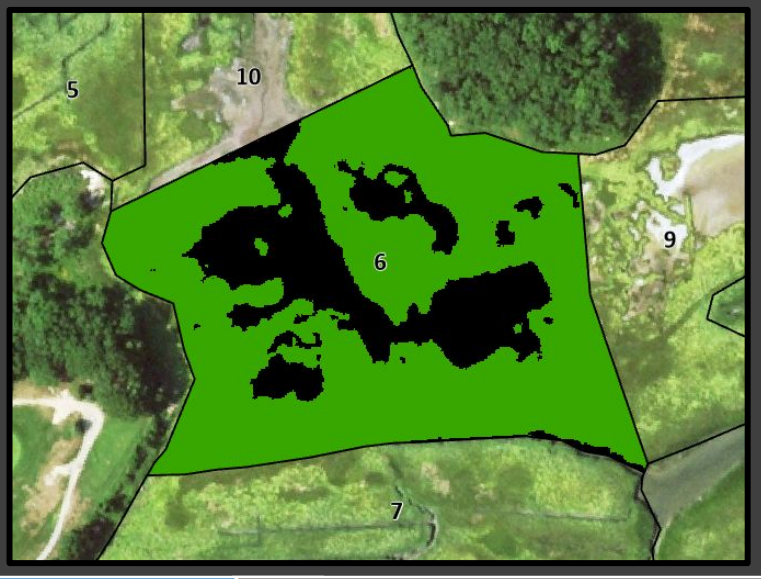
Vegetated Marsh Surface

Open Water, Bare Surface

Year 1 – 1.31 ha



Year 4 – 1.51 ha



Next Steps

- Similar analysis with field work assessments of hydrology and vegetation
- Possible trends of hydrology and vegetation to the avian community?

Journal of Coastal Research	40	6	1144–1159	Charlotte, North Carolina	November 2024

Evaluation of Drainage Enhancement for Vegetation Recovery in New England Salt Marshes Using Public Domain, High-Resolution Aerial Imagery

J. Grant McKown[†*], David M. Burdick[†‡], Gregg E. Moore[†§], Jennifer L. Gibson[†§], and Wenley Ferguson[††]

[†]Jackson Estuarine Laboratory
School of Marine Sciences and Ocean Engineering
University of New Hampshire
Durham, NH 03823, U.S.A.

[‡]Department of Natural Resources
University of New Hampshire
Durham, NH 03823, U.S.A.

[§]Department of Biological Sciences
University of New Hampshire
Durham, NH 03823, U.S.A.

[††]Save the Bay
Providence, RI 02905, U.S.A.

www.cerf-jcr.org

Publication

Dataset & R Code

Thank you!
Questions?