The 14th International Symposium on
BIOGEOCHEMISTRY OF WETLANDS & AQUATIC SYSTEMS

Assessing Salt Marsh Greenhouse Gas Fluxes by Planting Treatment Across Elevational Gradients

Olivia Lemieux, Madeleine Meadows-McDonnell, Nicolette Nelson, Beth Lawrence, Ashley Helton, and Chris Elphick

Unique biogeochemistry makes salt marshes low emitters amongst wetlands

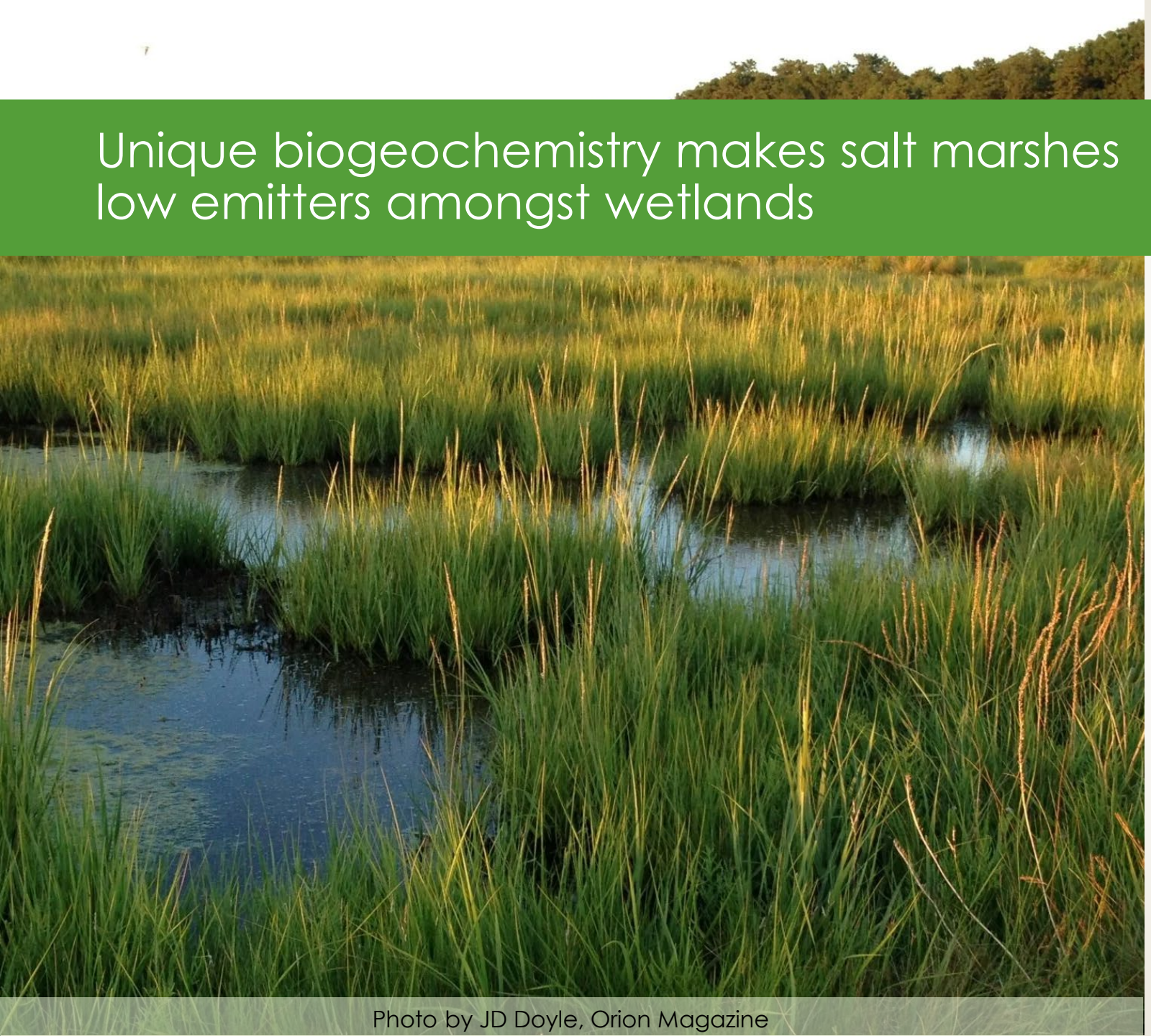
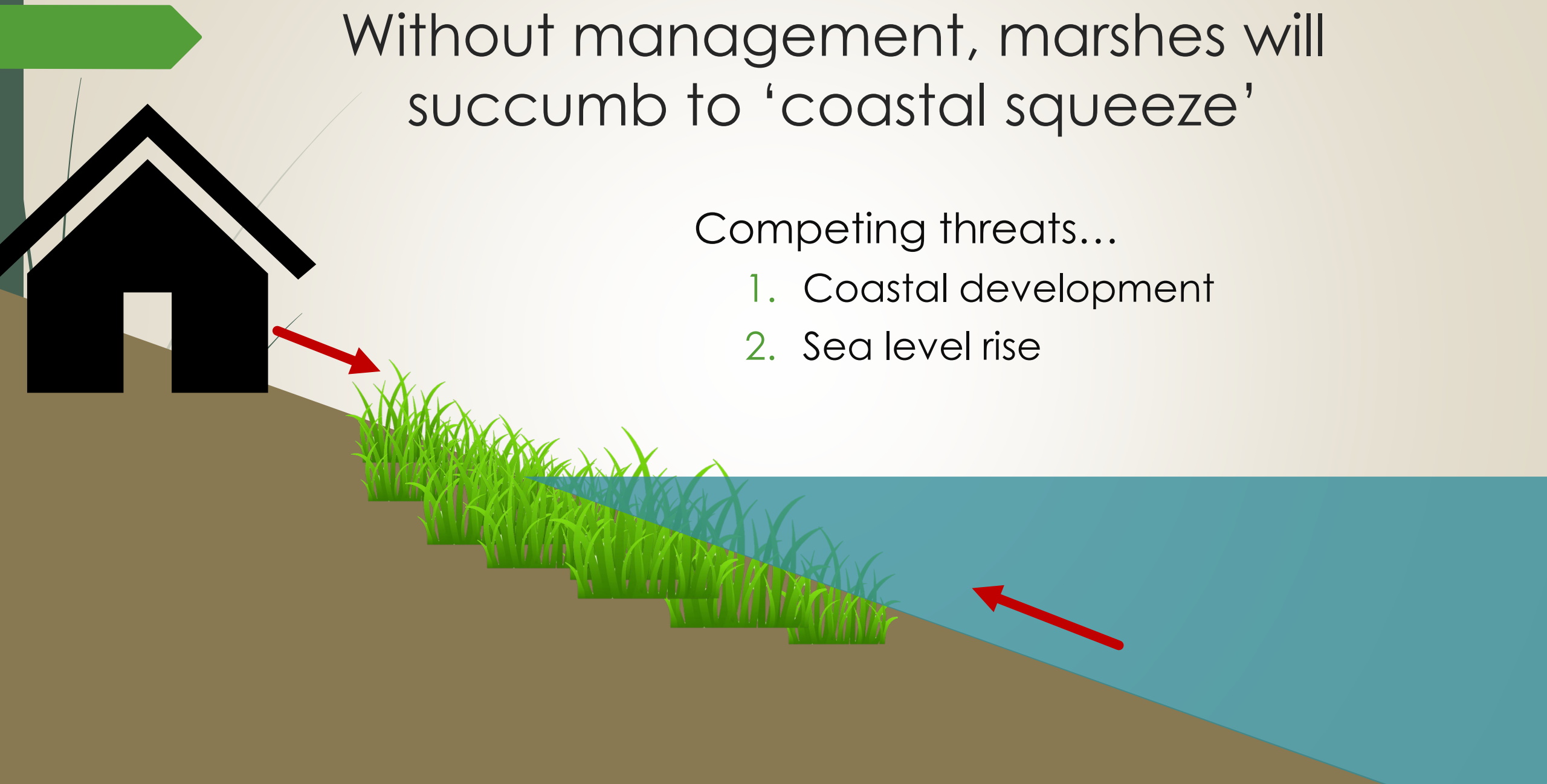


Photo by JD Doyle, Orion Magazine

- Highly productive vegetation → high carbon sequestration rates
- Soil sulfate abundance → reduced methane emissions

Without management, marshes will succumb to ‘coastal squeeze’



Competing threats…

1. Coastal development
2. Sea level rise

Photos sourced from U.S. Army Engineer Research and Development Center

Restoration is ongoing and widespread

Methods

- Sediment placement
- Vegetation planting

Goals

- Preserve/restore
  - Vegetation diversity
  - Habitat for wildlife
  - Biogeochemical conditions?

Restoration Site: Great Meadows Marsh, Stratford, CT

- 173 hectares
- Part of Stewart B. McKinney National Wildlife Refuge
- Globally Important Bird Area
- Endangered species habitat

Credit: Long Island Sound Study

Credit: USFWS

Credit: Nicolette Nelson

Credit: USFWS

Restoration Need

Past of development and degradation

Surrounded by industry

Poor drainage, invasion, mosquito outbreaks

Image produced by Long Island Sound Study

Restoration Details

Goal: create high marsh habitat for marsh-nesting birds

Methods:

- Channel creation
- Soil placement in mounds (hummocks; 62 - 775 m^2)
- Planting with native marsh species

Proposal: Plant hummocks experimentally and monitor short- and long-term wildlife, vegetation, and biogeochemical responses

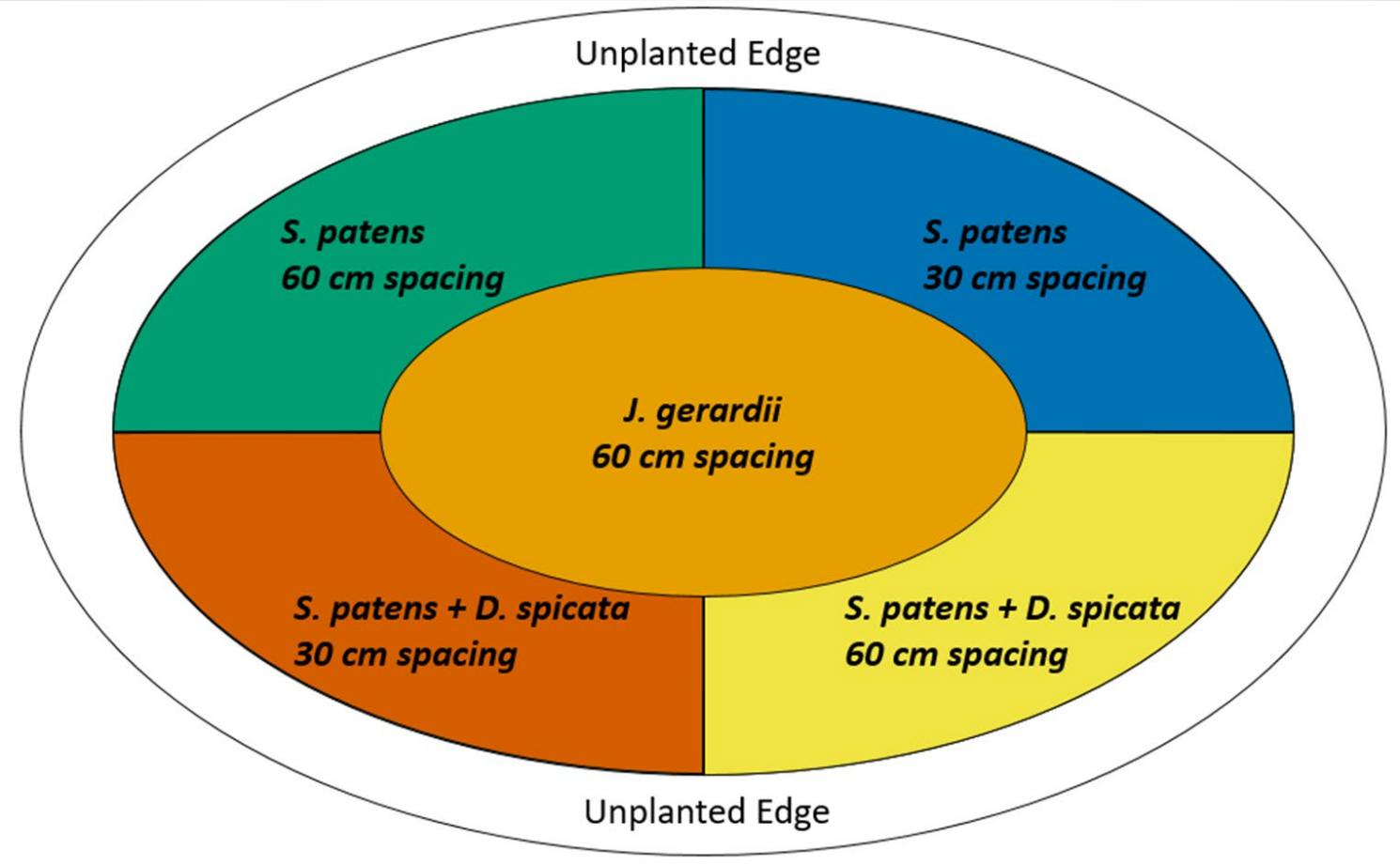


Figure credits: F. Gigliotti

Goal: Identify potential unintended consequences of wildlife-focused restoration for marsh biogeochemical cycles

Aerial view of hummocks and treatments

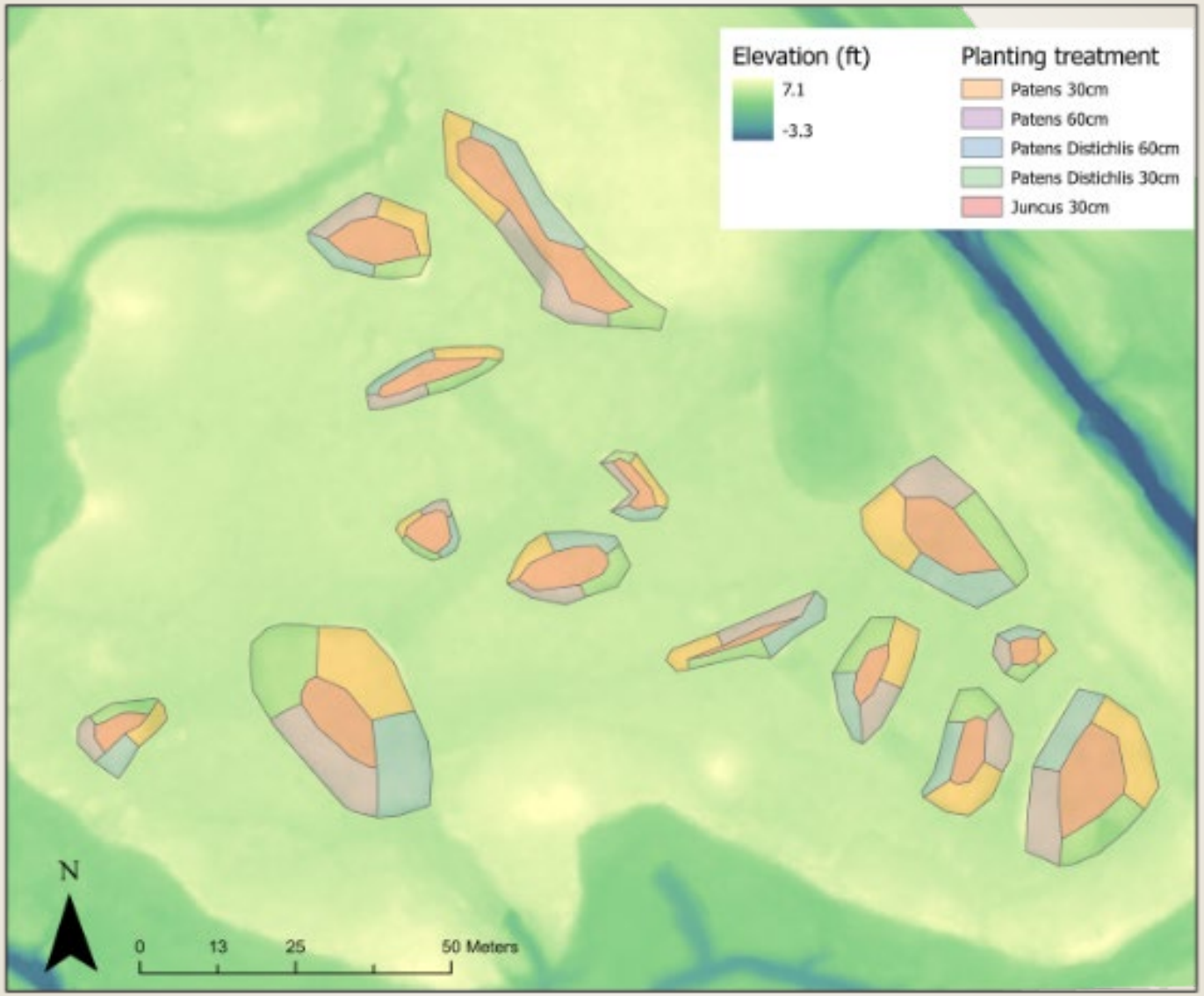


Figure credits: N. Nelson

Is restoration application a predictor of GHG flux?

Does treatment type predict fluxes?

Greenhouse Gas Flux Measurements

- Chamber cap, syringe method of gas collection employed
- Time-series gas samples → plot-level fluxes

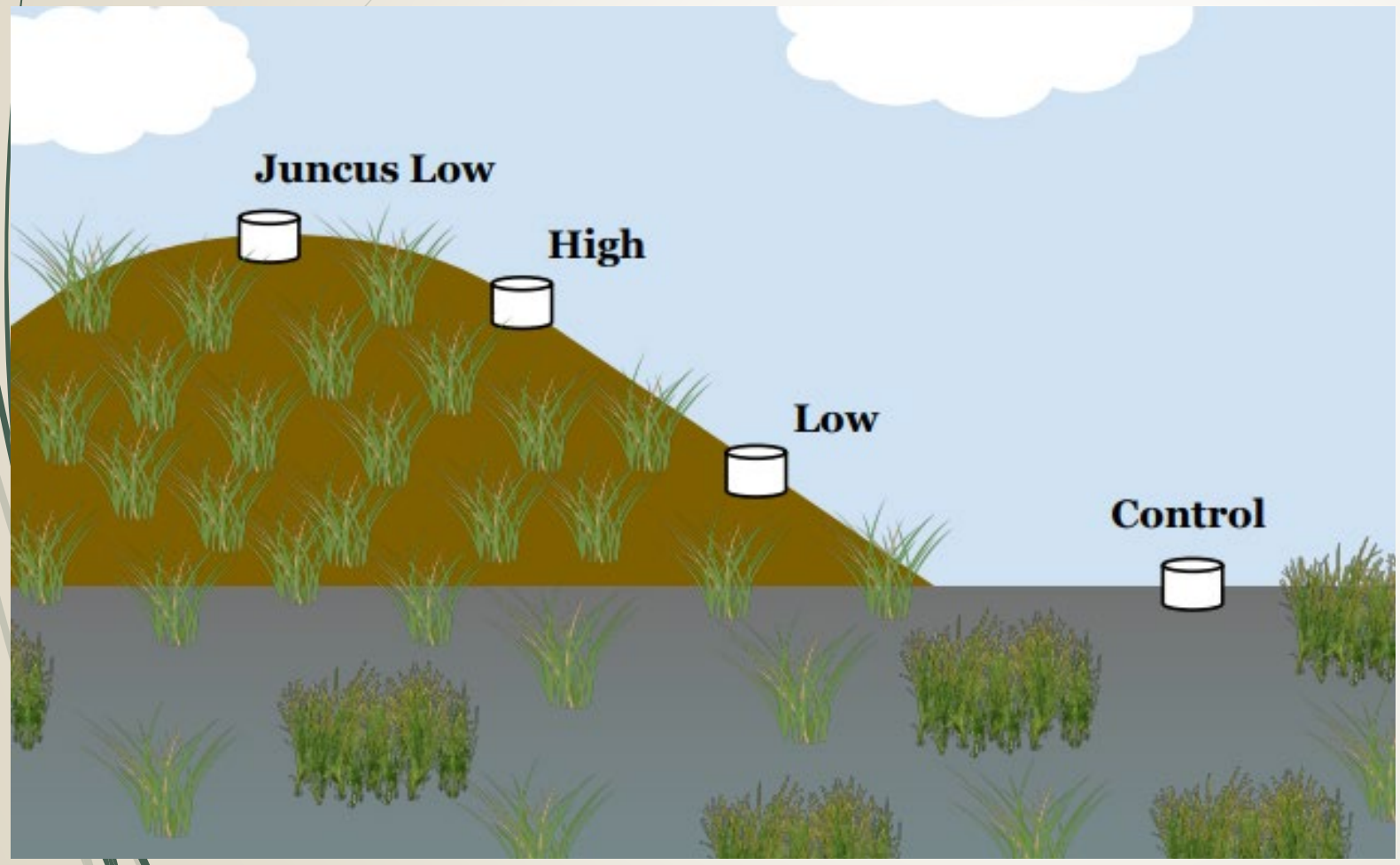
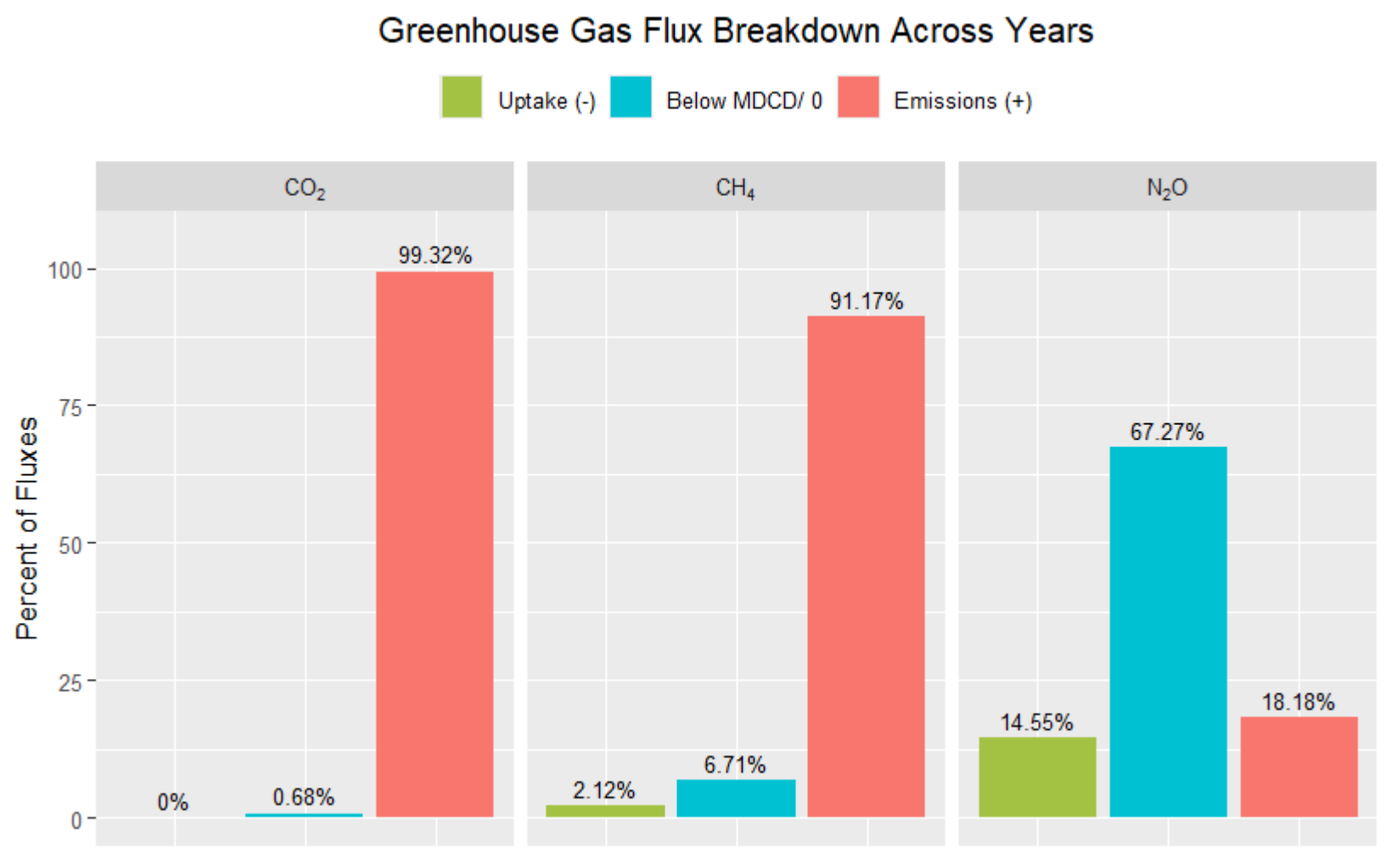


Figure credits: Juliette Doyle

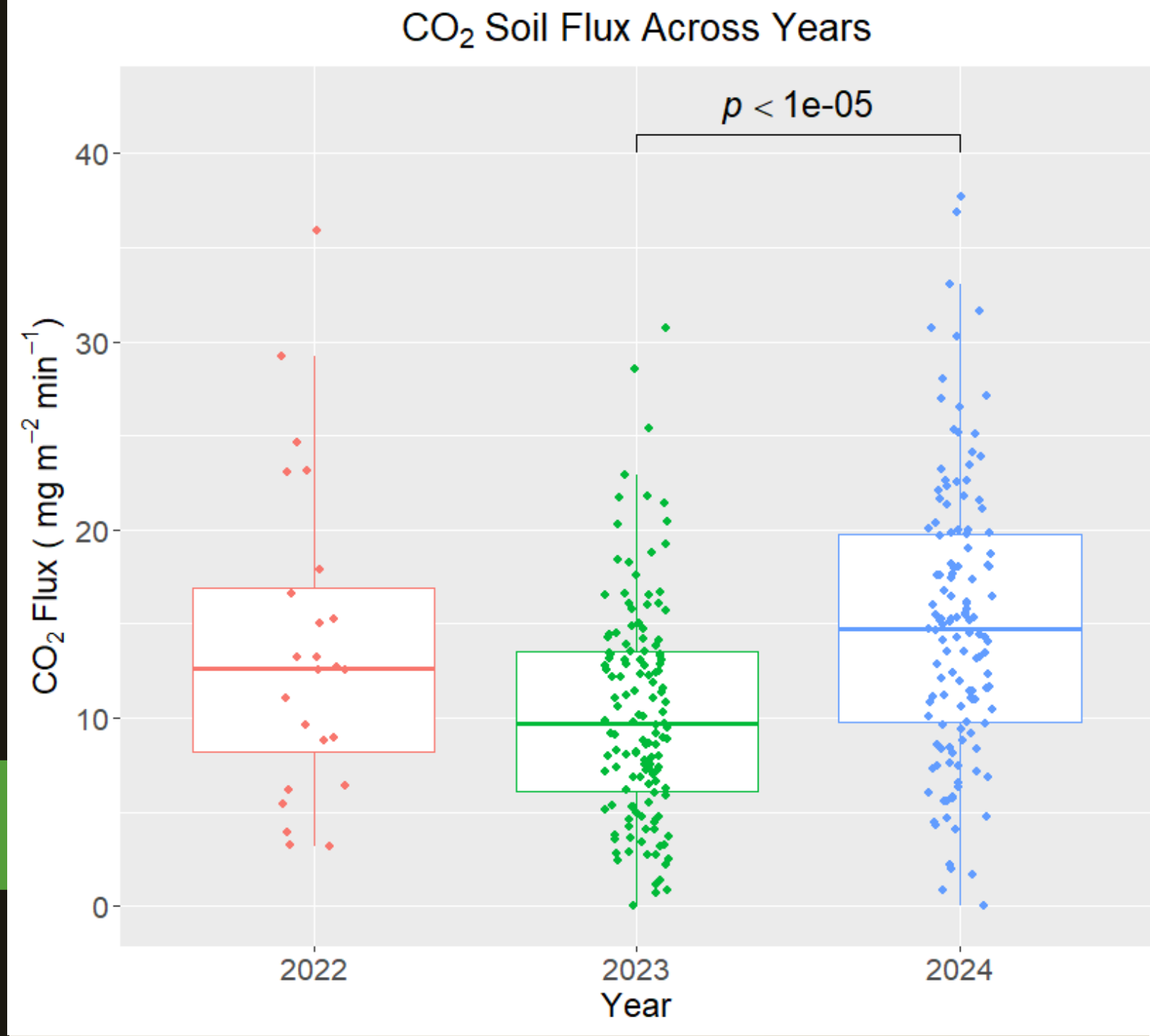
Photo by M. Meadows McDonnell

Soil Flux Site Trends Across All Years



- CO_2 and CH_4 dominated by emissions
- N_2O dominated by cases of no measurable flux

CO_2 soil flux significantly higher in 2024 than 2023



2023 and 2024: CO_2 flux best predicted by vegetation cover, but less predictable in 2024

2023

Predictor(s)	ΔAICc	R^2
Vegetation Cover	0	0.37
Treatment + Elevation	3.4	0.45
Treatment * Elevation	6.4	0.48
Null	42.9	0.08
Soil Temperature	43.3	0.06
Microbial Diversity	43.7	0.08
Treatment	51.5	0.08

2024

Predictor(s)	ΔAICc	R^2
Vegetation Cover	0	0.19
Treatment + Elevation	13.3	0.15
Null	13.5	0.07
Soil Temperature	15.3	0.08
Treatment	20.4	0.09
Treatment * Elevation	20.7	0.15

* Model comparisons for linear mixed effects models run with hummock as a random effect

2023 and 2024: CO_2 flux best predicted by vegetation cover, but less predictable in 2024

2023

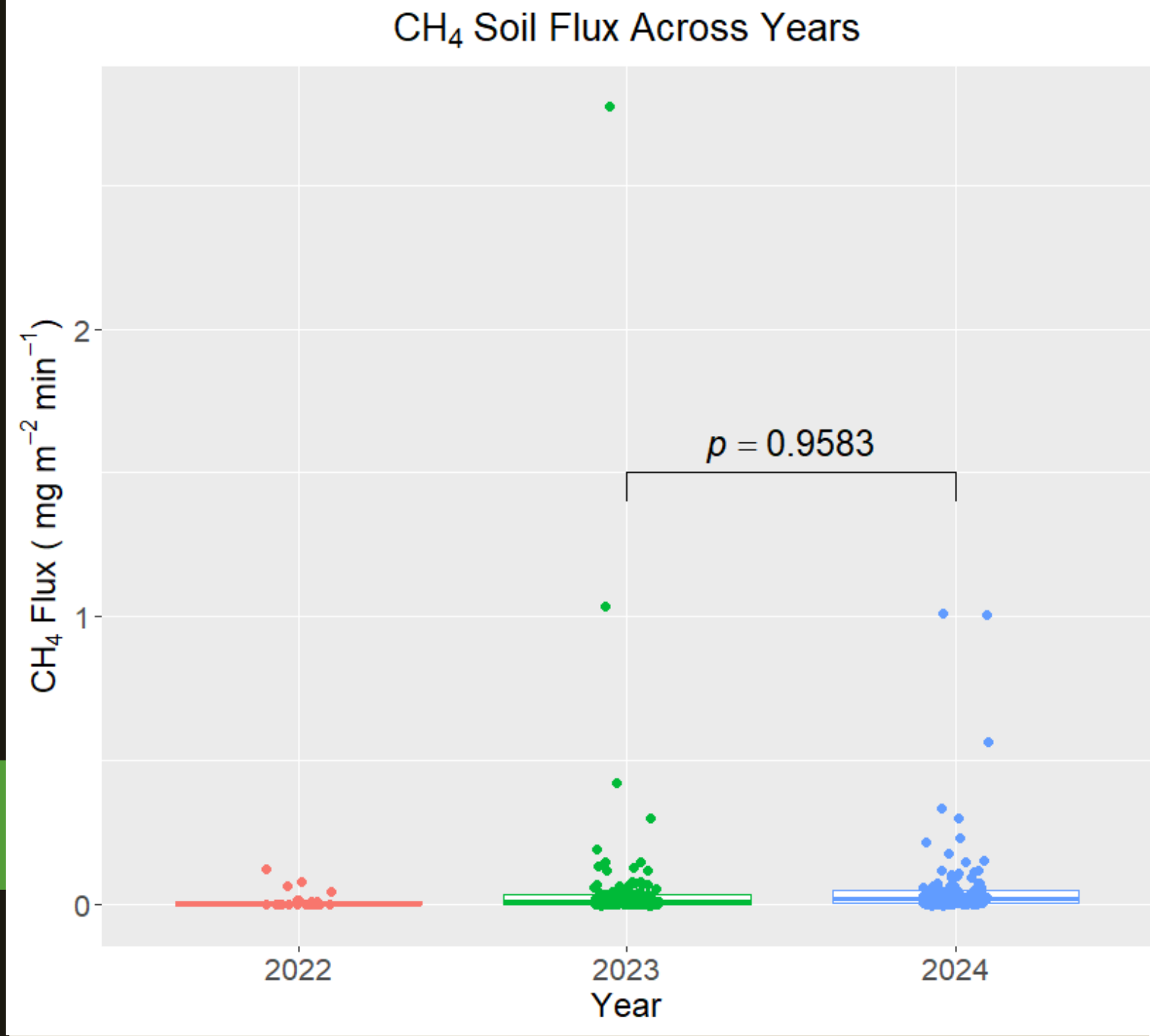
Predictor(s)	ΔAICc	R^2
Vegetation Cover	0	0.37
Treatment + Elevation	3.4	0.45
Treatment * Elevation	6.4	0.48
Null	42.9	0.08
Soil Temperature	43.3	0.06
Microbial Diversity	43.7	0.08
Treatment	51.5	0.08

2024

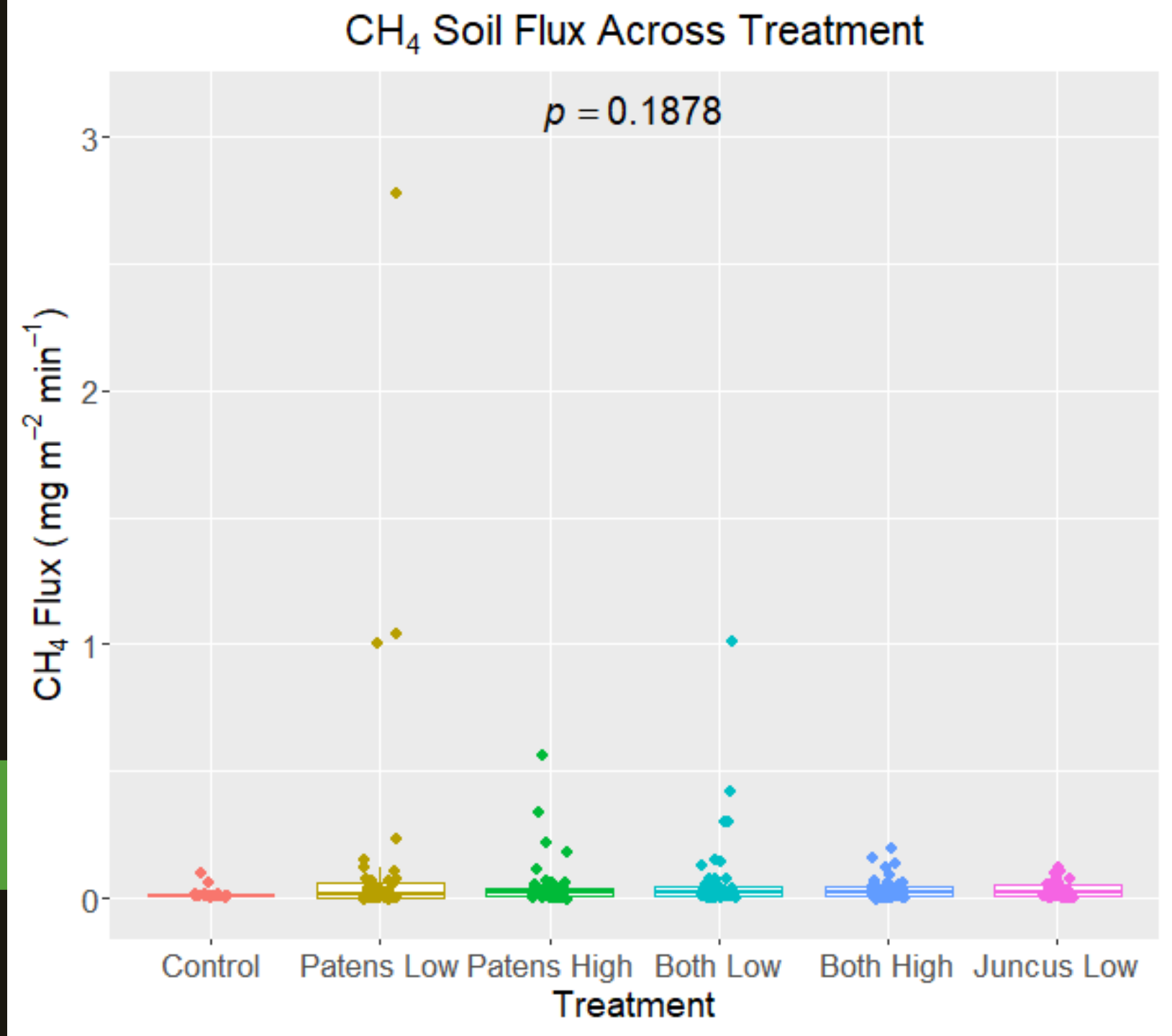
Predictor(s)	ΔAICc	R^2
Vegetation Cover	0	0.19
Treatment + Elevation	13.3	0.15
Null	13.5	0.07
Soil Temperature	15.3	0.08
Treatment	20.4	0.09
Treatment * Elevation	20.7	0.15

* Model comparisons for linear mixed effects models run with hummock as a random effect

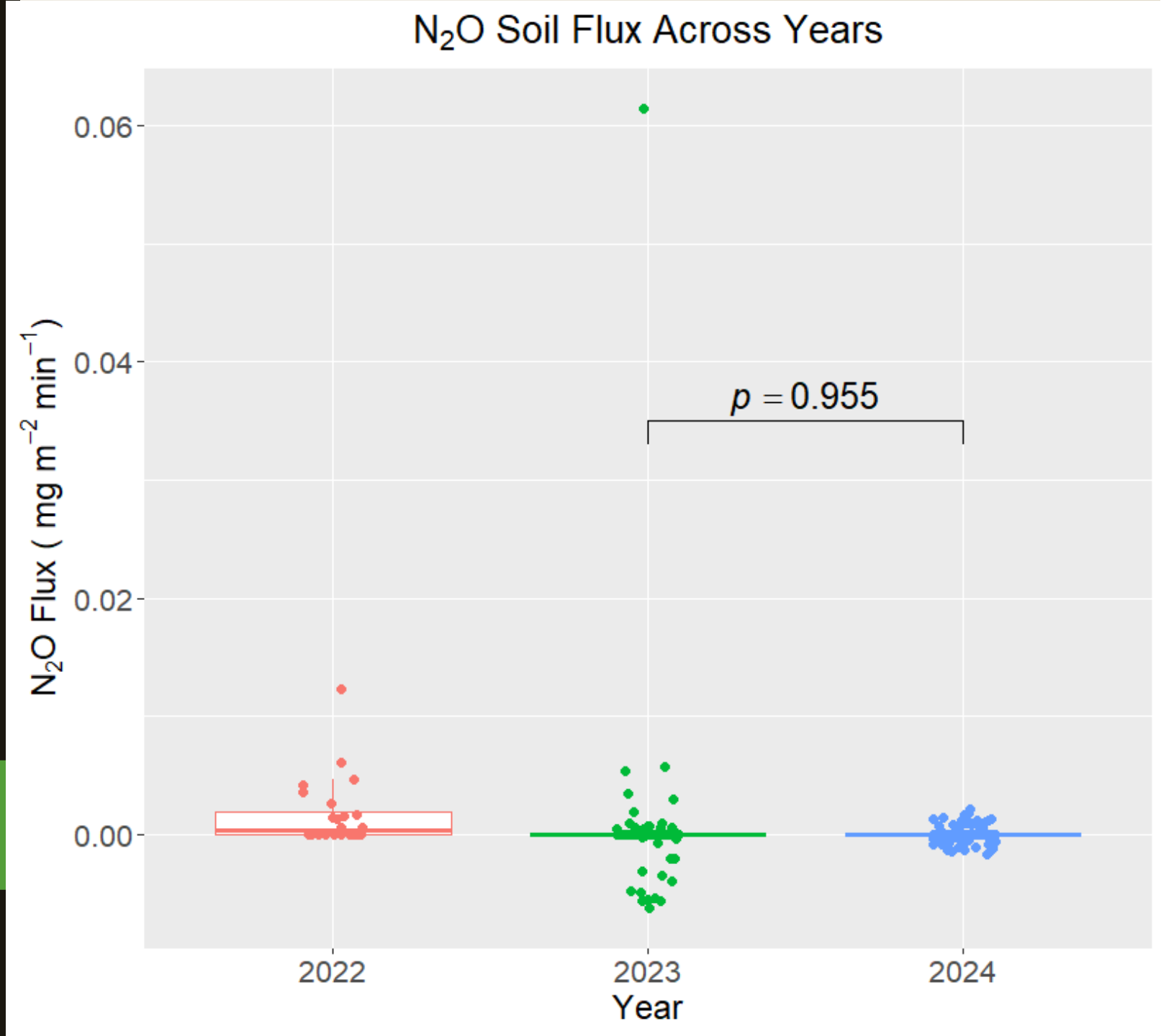
CH_4 soil flux does not differ over time



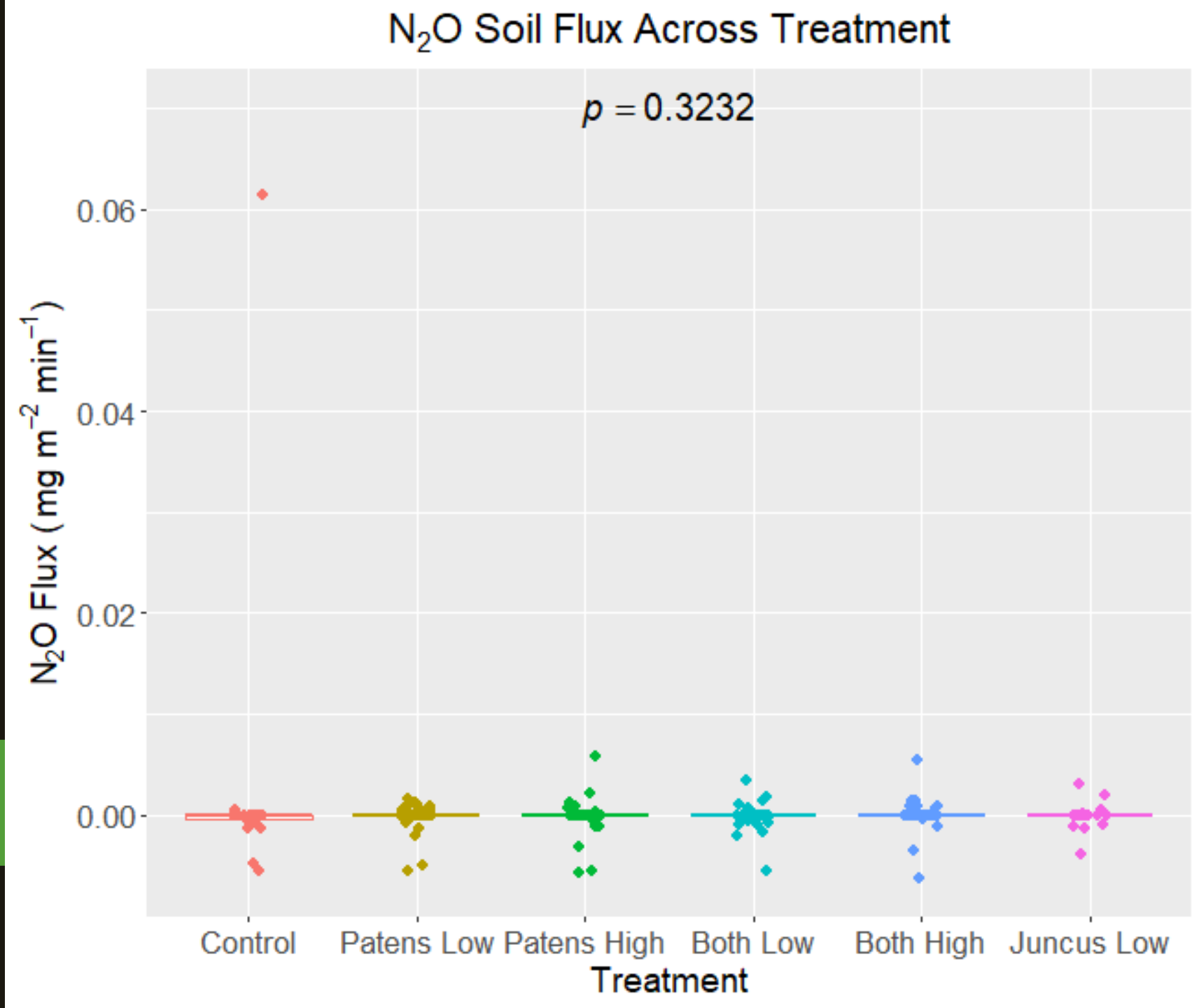
CH_4 soil flux not correlated with treatment or other variables tested



N_2O soil flux does not differ over time



N_2O shows no correlation with treatment or other hypothesized predictors

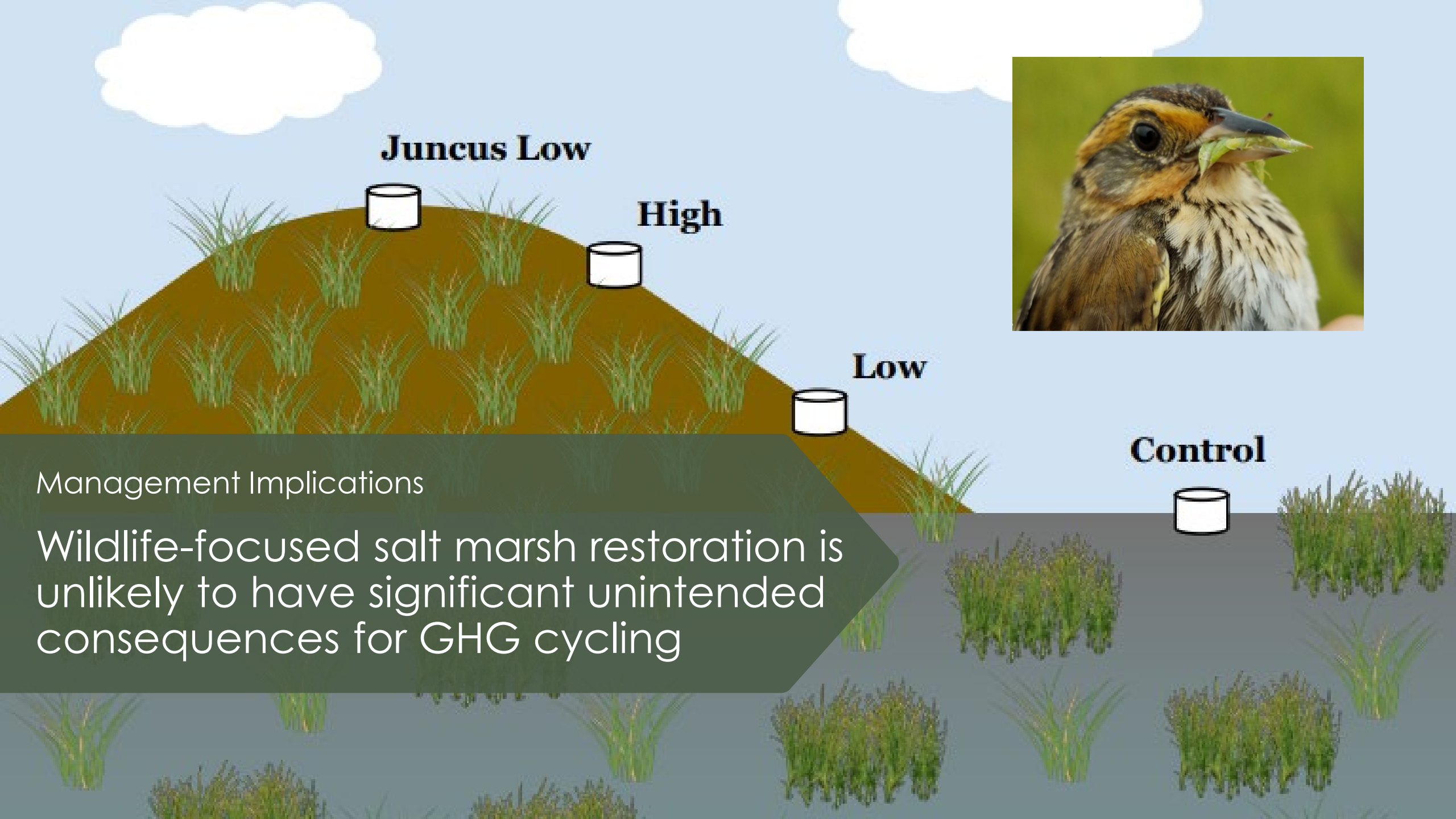


Is restoration application a predictor of GHG flux?

No – there was no significant difference in emissions of any gas between restored and non-restored plots.

Does treatment type predict fluxes?

No – fluxes were not significantly affected by any treatment type.



Management Implications

Wildlife-focused salt marsh restoration is unlikely to have significant unintended consequences for GHG cycling

Want to learn more about the Great Meadows Marsh Restoration? Scan to visit Audubon Connecticut's webpage dedicated to project information and updates!

Thank you!