The fate of added nitrogen in mangrove ecosystems differs due to wetland position

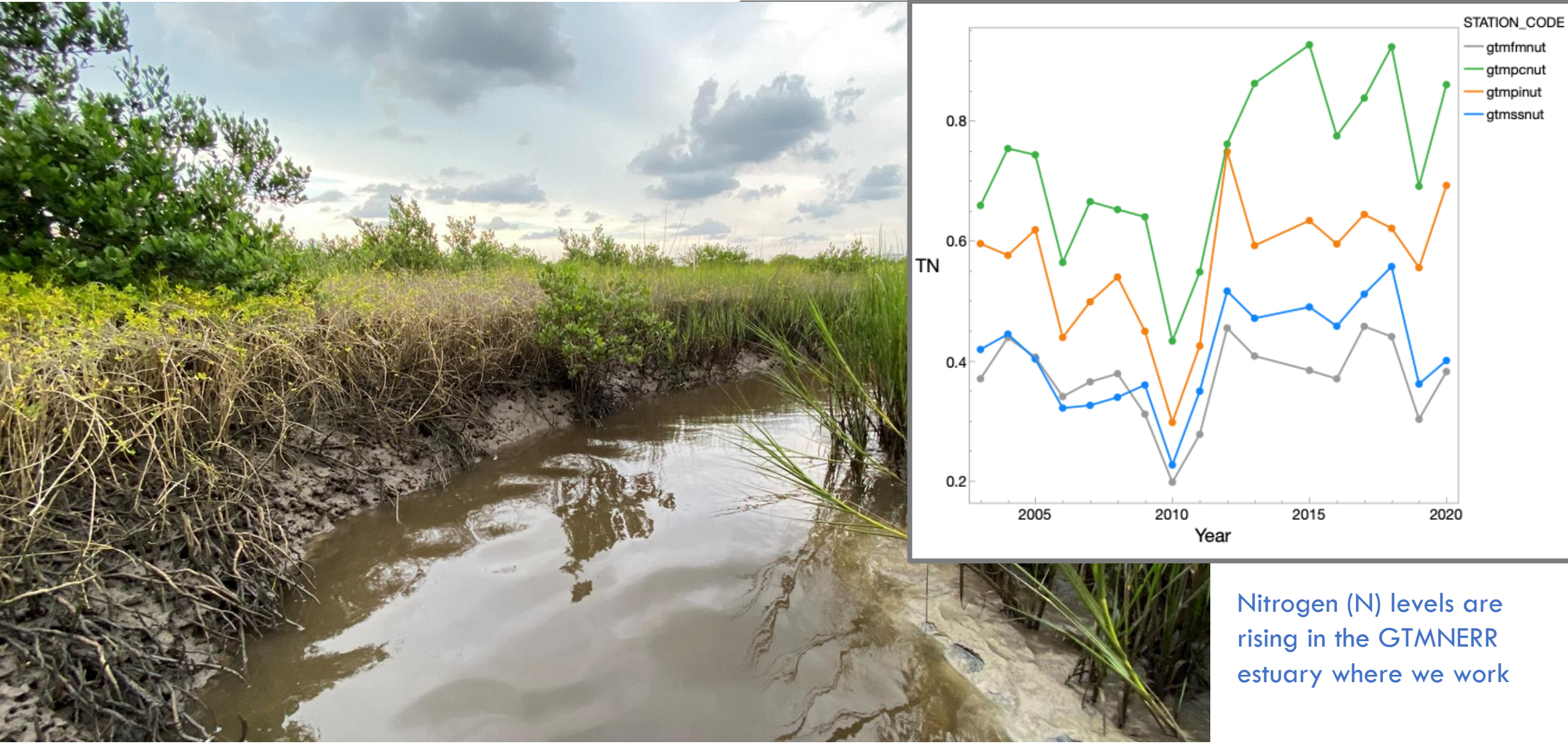
Samantha Chapman

With: Morgan Mack, Jocelyn Bravo, Jim Morris, Lisa Chambers, Adam Langley, Tess Adgie, Ches Vervaeke, Damir Creecy, & Candy Feller

Research conducted in the traditional territory of the Lenni Lenape people at Villanova University and of the Timucua people in Florida, U.S.A

Conflicting findings in the literature on the influence of nitrogen on coastal wetlands

(Deegan et al. 2012, Turner et al. 2011, Morris et al. 2013, Weaver and Armitage 2018, 2020, Dangremond and Feller 2020)

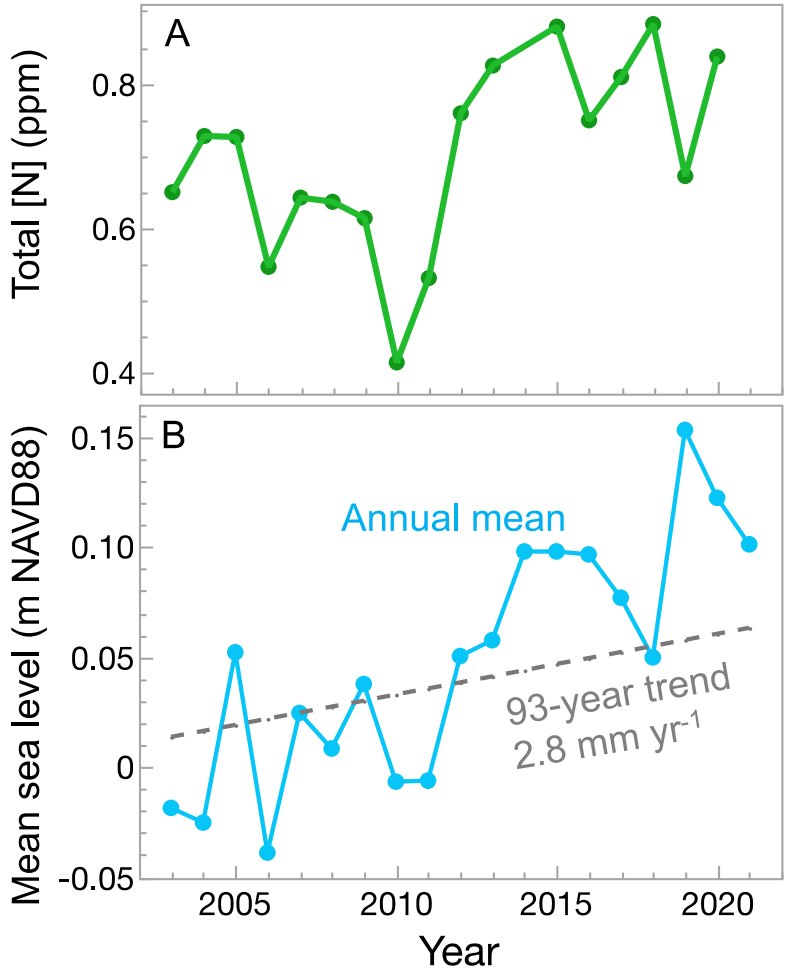


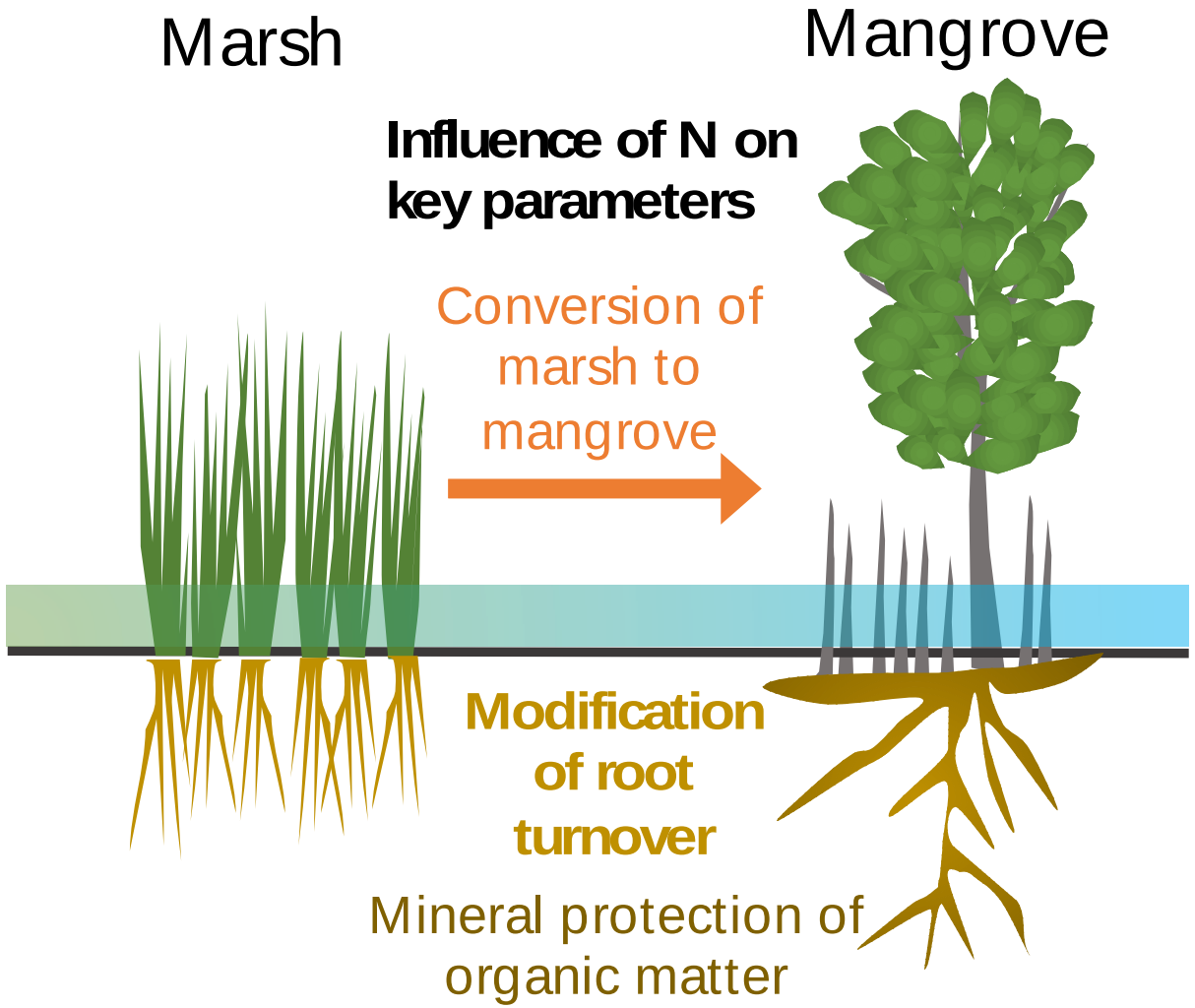
Nitrogen (N) levels are rising in the GTMNERR estuary where we work

Conflicting findings in the literature on the influence of nitrogen on coastal wetlands

(Deegan et al. 2012, Turner et al. 2011, Morris et al. 2013, Weaver and Armitage 2018, 2020, Dangremond and Feller 2020)

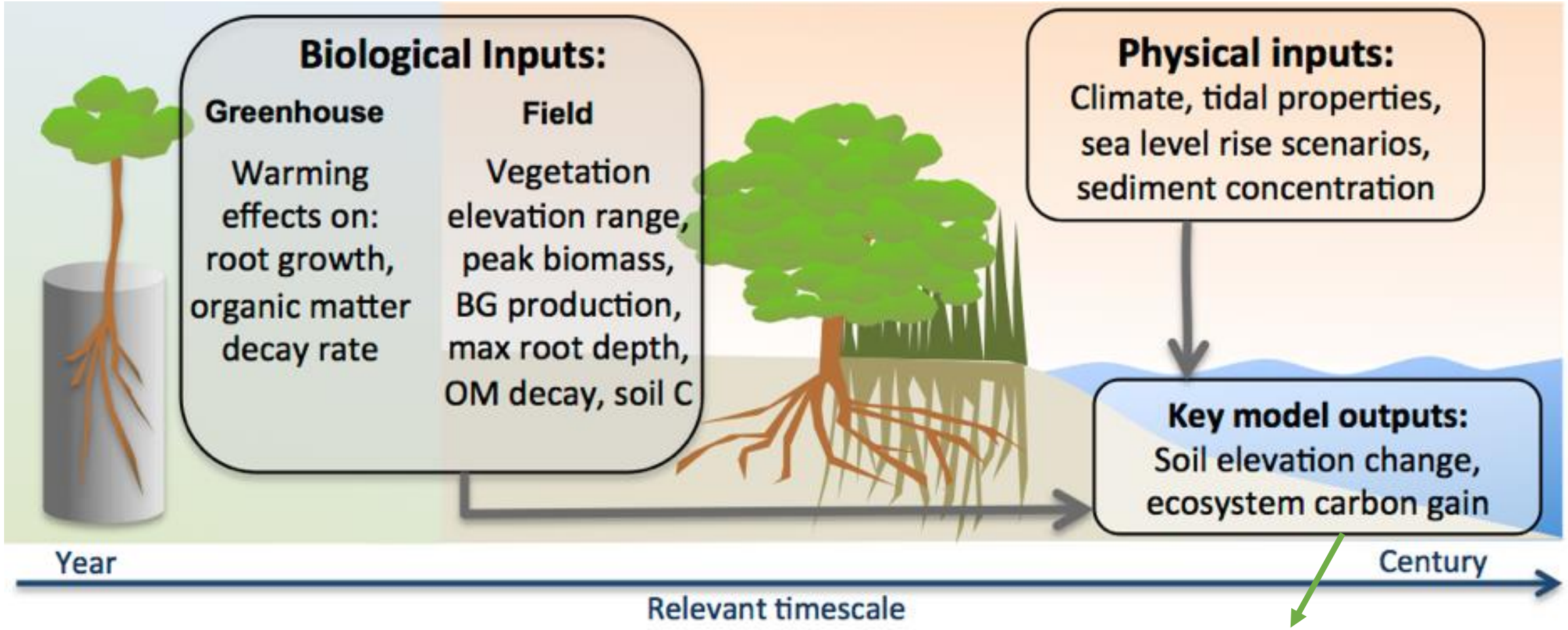
How do increasing nitrogen loads influence retention of nitrogen in coastal wetlands ?





Context for nitrogen questions: Modeling mangrove ability to keep pace with sea level rise in northeast Florida, USA

with the new Coastal Wetland Equilibrium Model (CWEM)



Morris et al. 2023, *Earth's Future*

But what about nitrogen gain?

Earth's Future

RESEARCH ARTICLE
10.1029/2022EF003202

Special Section:
Prediction in coastal geomorphology

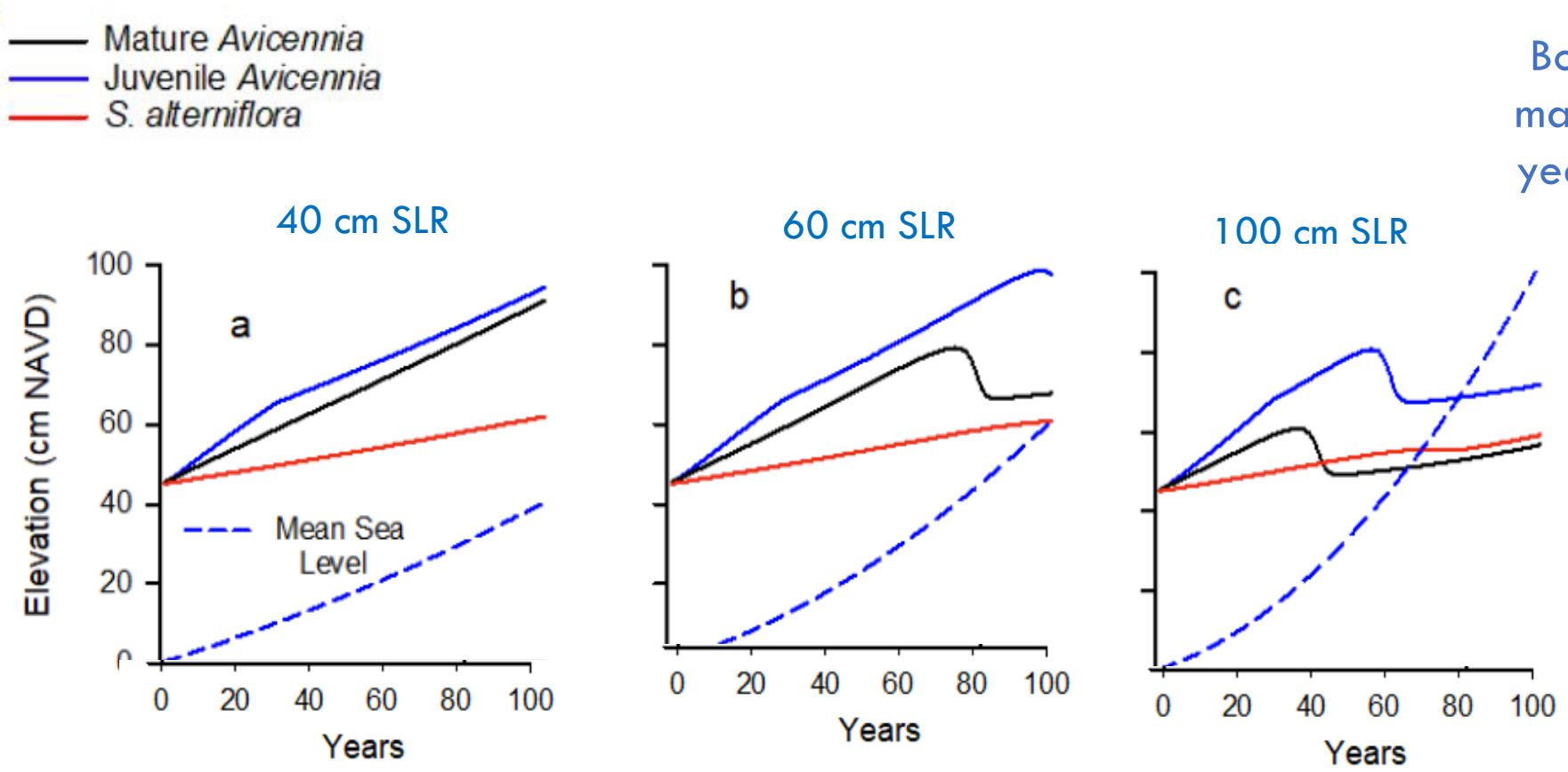
Mangrove Trees Outperform Saltmarsh Grasses in Building Elevation but Collapse Rapidly Under High Rates of Sea-Level Rise

James T. Morris[1], J. Adam Langley[2], William C. Vervaeke[3], Nicole Dix[4], Ilka C. Feller[5], Pam Marcum[4], and Samantha K. Chapman[2]

KEY FINDINGS:

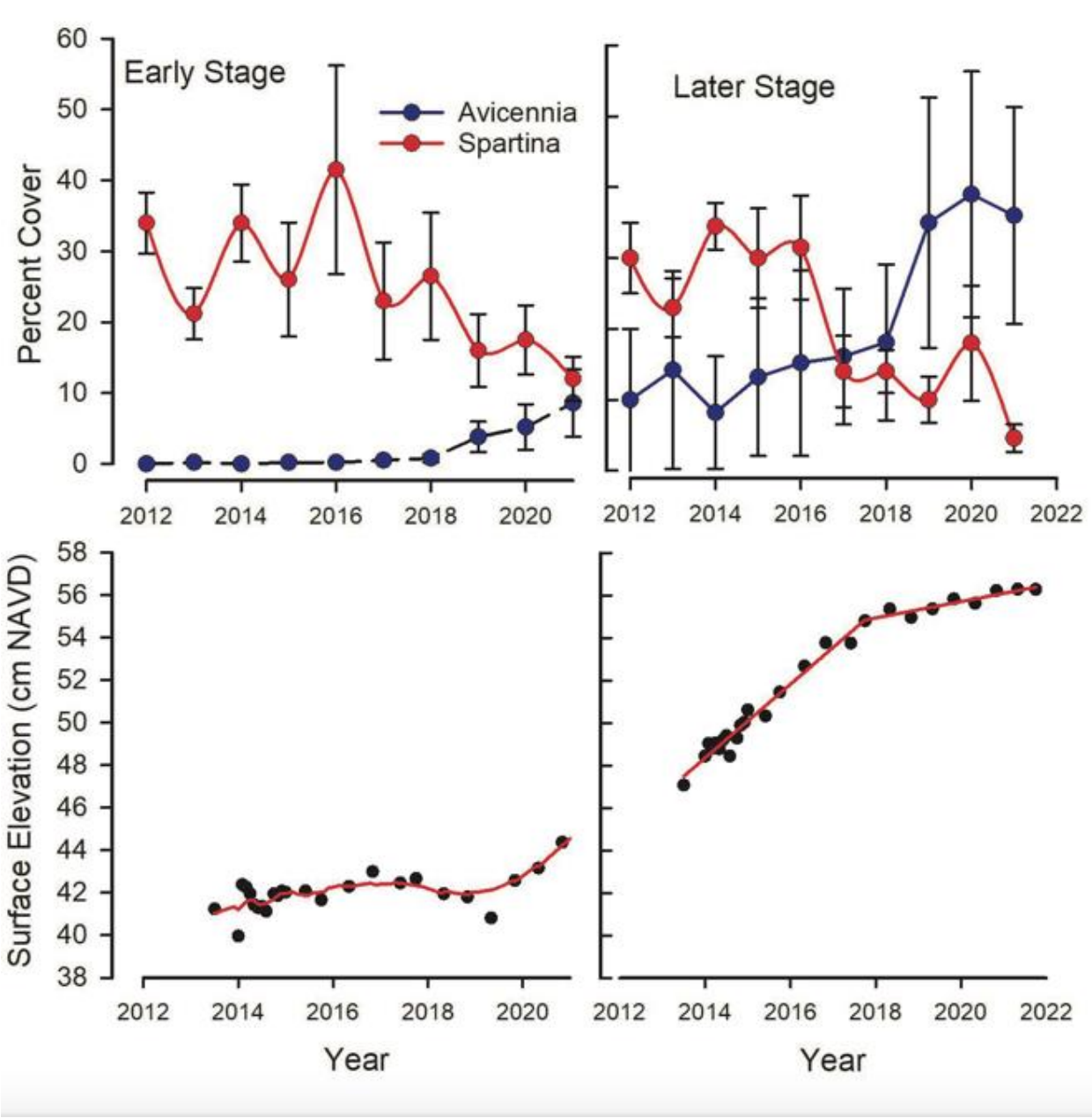
Mangroves build elevation more effectively than marshes (can tolerate 8 mm/yr) but also go down more quickly.

Both salt marshes and mature mangroves can collapse 60-80 years from now at a moderate sea level rise scenario.

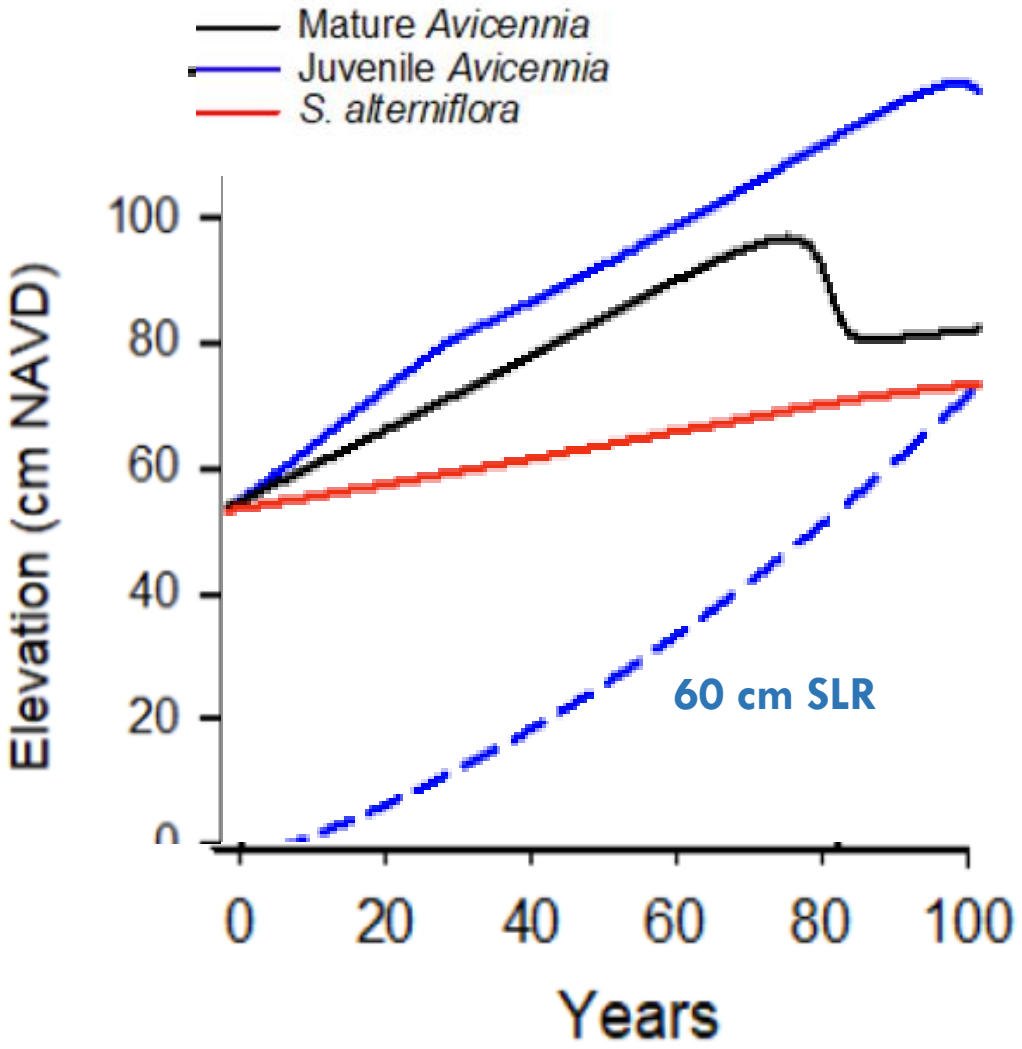


Coastal Wetland Equilibrium Model (CWEM) Results for GTMNERR, FL, USA with Jim Morris, Univ. of South Carolina

Field-based SET data and planting experiments echo these findings



How do the high accretion rates of mangroves translate into nitrogen gains with rising seas?



	Year	Total accretion (mm)	Annual accretion (mm/yr)	Nitrogen gained (Mg/ha)
Juvenile mangrove	25	173	7.3	6.66
	50	302	4.9	11.63
	75	432	5.4	16.63
	100	523	-6.7	20.14
Mature mangrove	25	112	4.7	4.31
	50	234	5.0	9.01
	75	337	0.5	12.97
	100	223	1.1	8.59

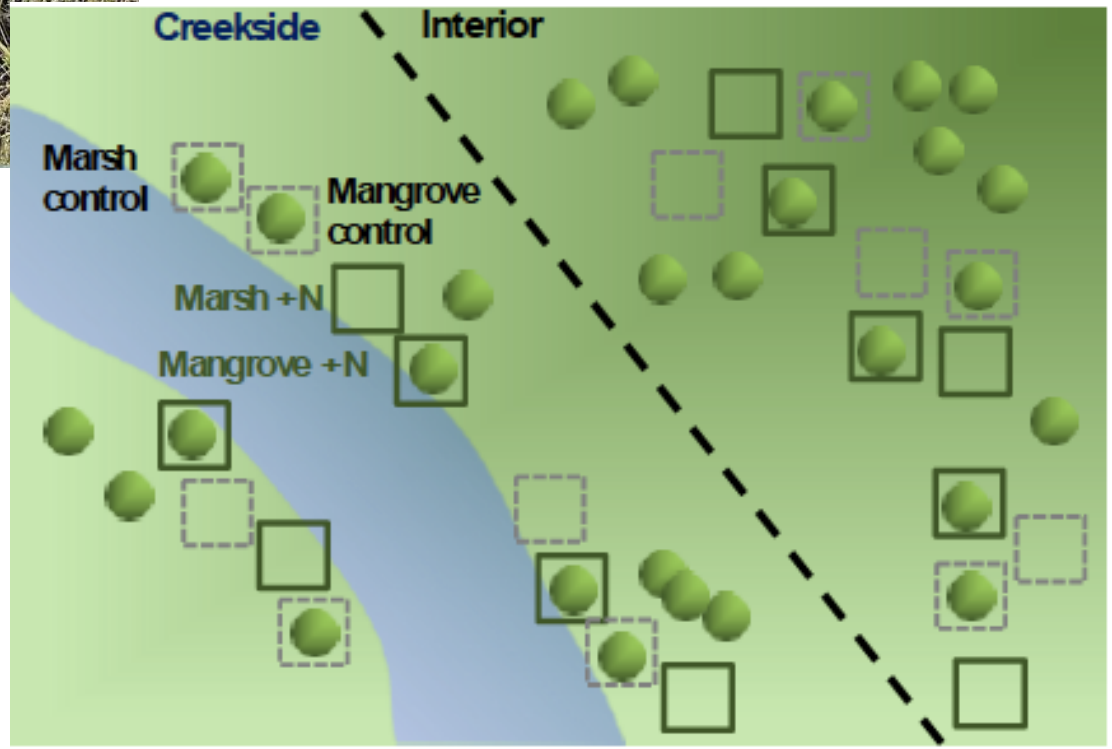
To put this in perspective, a 5000 ha mangrove restoration could yield 0.024 Tg of nitrogen storage after 25 years, assuming an average 5mm/yr accretion rate.

Benefits to estuaries in the short term could be enormous!

Lisa Chambers

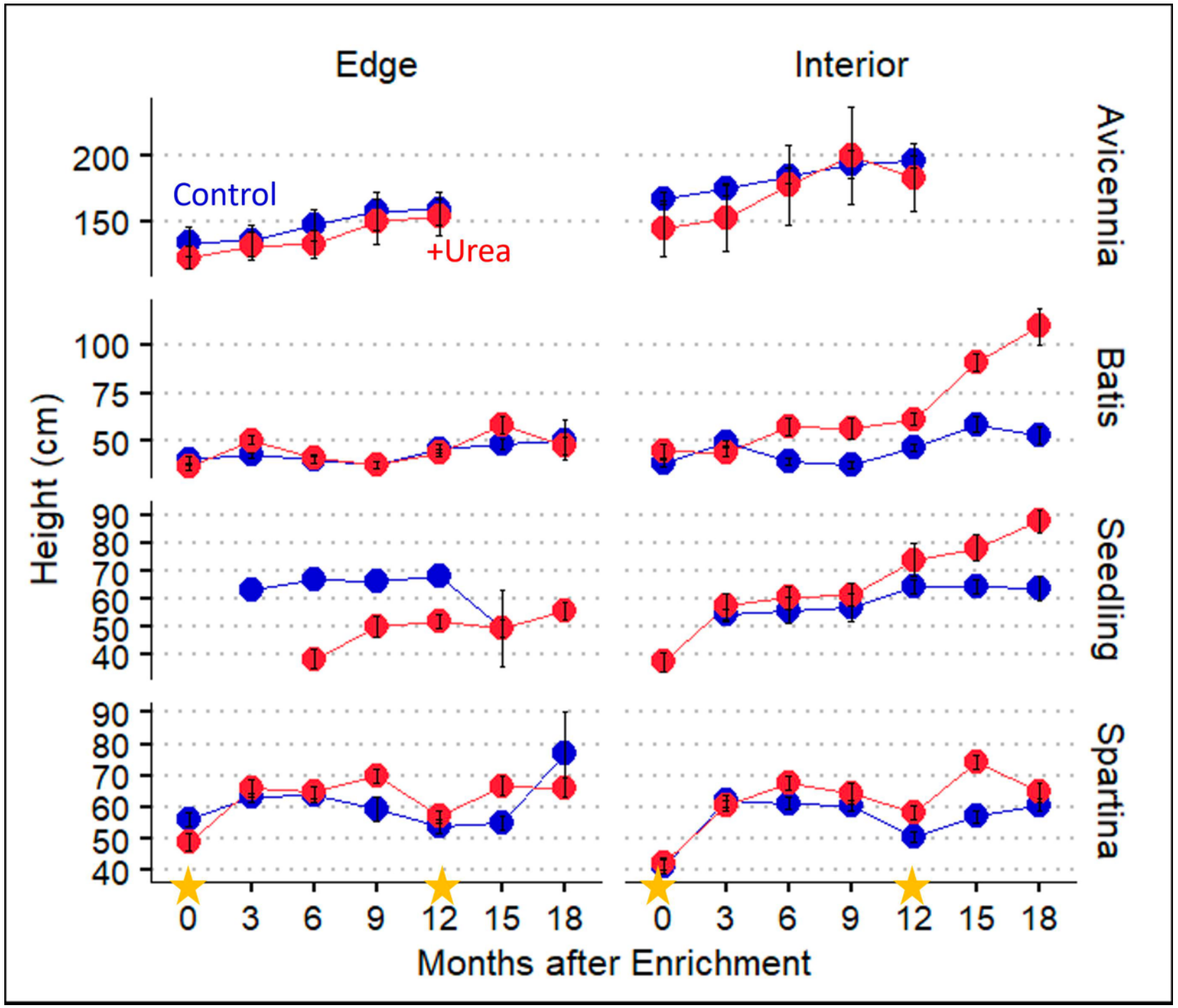
Adam Langley

Exploring mangrove ^{15}N retention in different hydrological positions in new fertilization experiments



	Control	+N	
Creekside	5	5	Marsh
	5	5	Mangrove
Interior	5	5	Marsh
	5	5	Mangrove

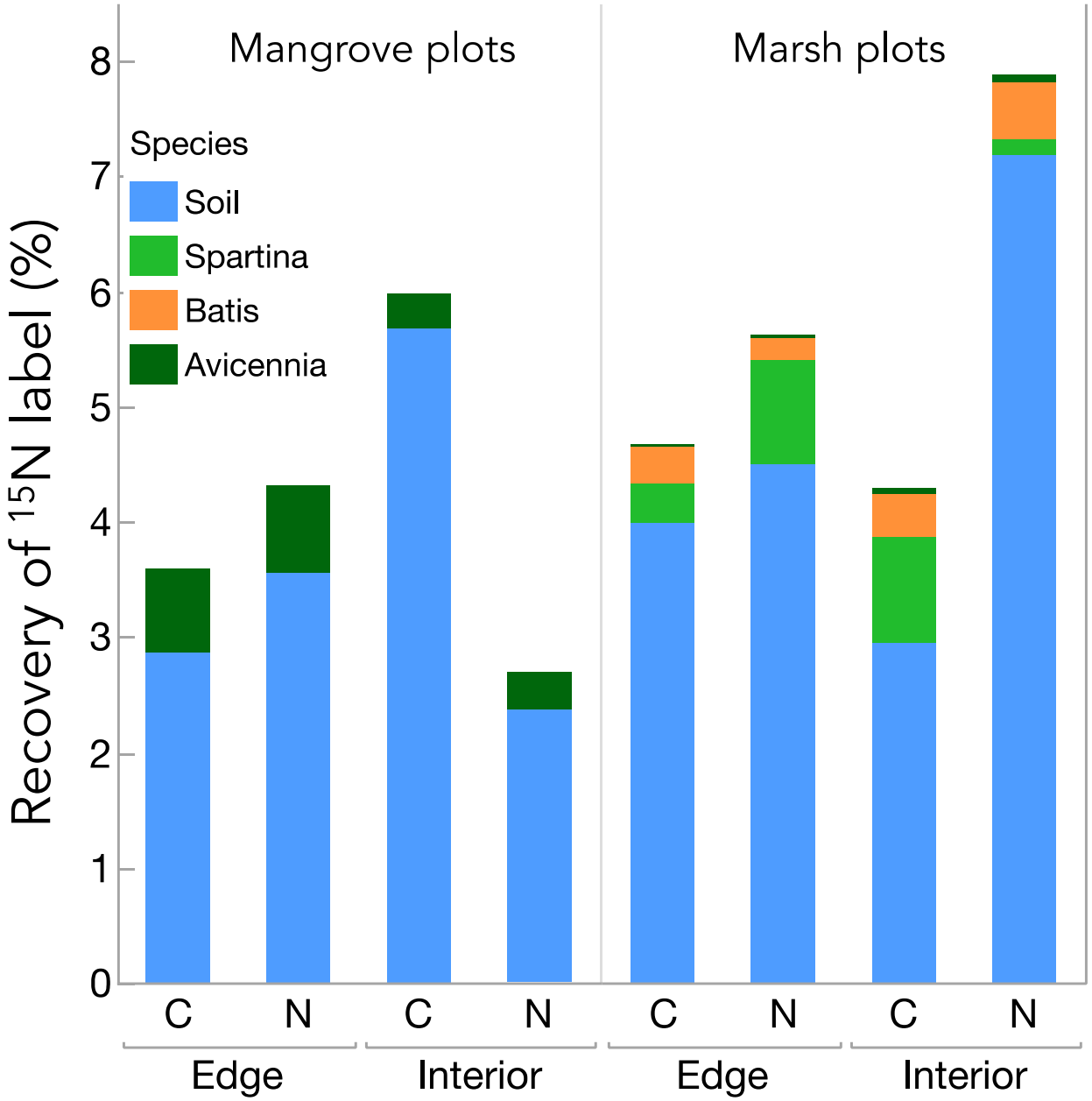
X2 sites



KEY FINDINGS

Mangrove seedlings responded more than adult mangroves to added nitrogen.

Nitrogen fertilization seems to be speeding up mangrove encroachment at our sites in NE Florida.



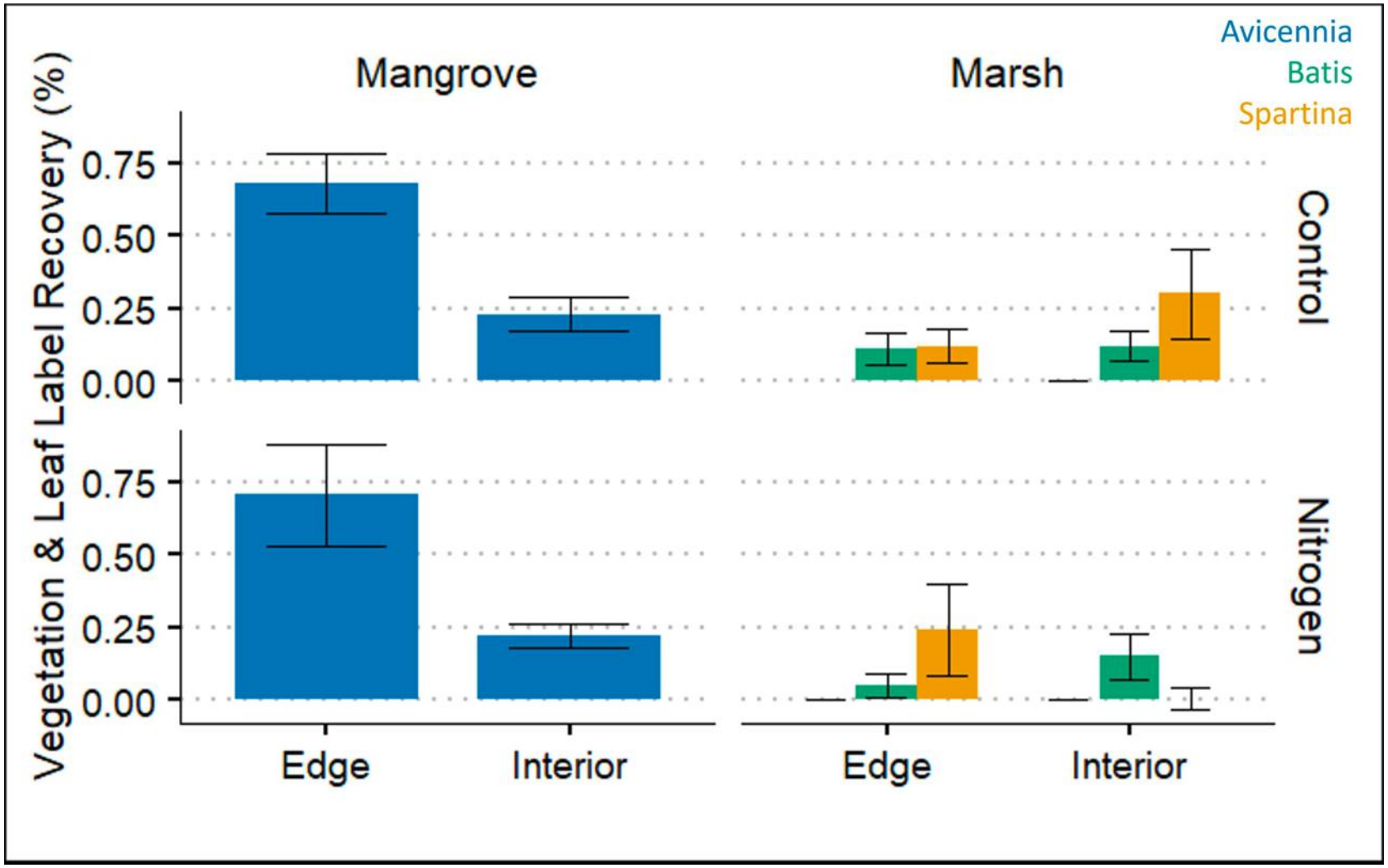
PRELIMINARY FINDINGS

Ecosystem Components Nitrogen Retention:

After 3 months, most ^{15}N label is recovered in soil, as urea must first be processed by microbes.

Interior plots have more soil organic matter and edge (creekside) plots are more mineral, potentially impacting ^{15}N binding.

Effects of fertilization on N retention are preliminary but seem to suggest some priming in most cases.

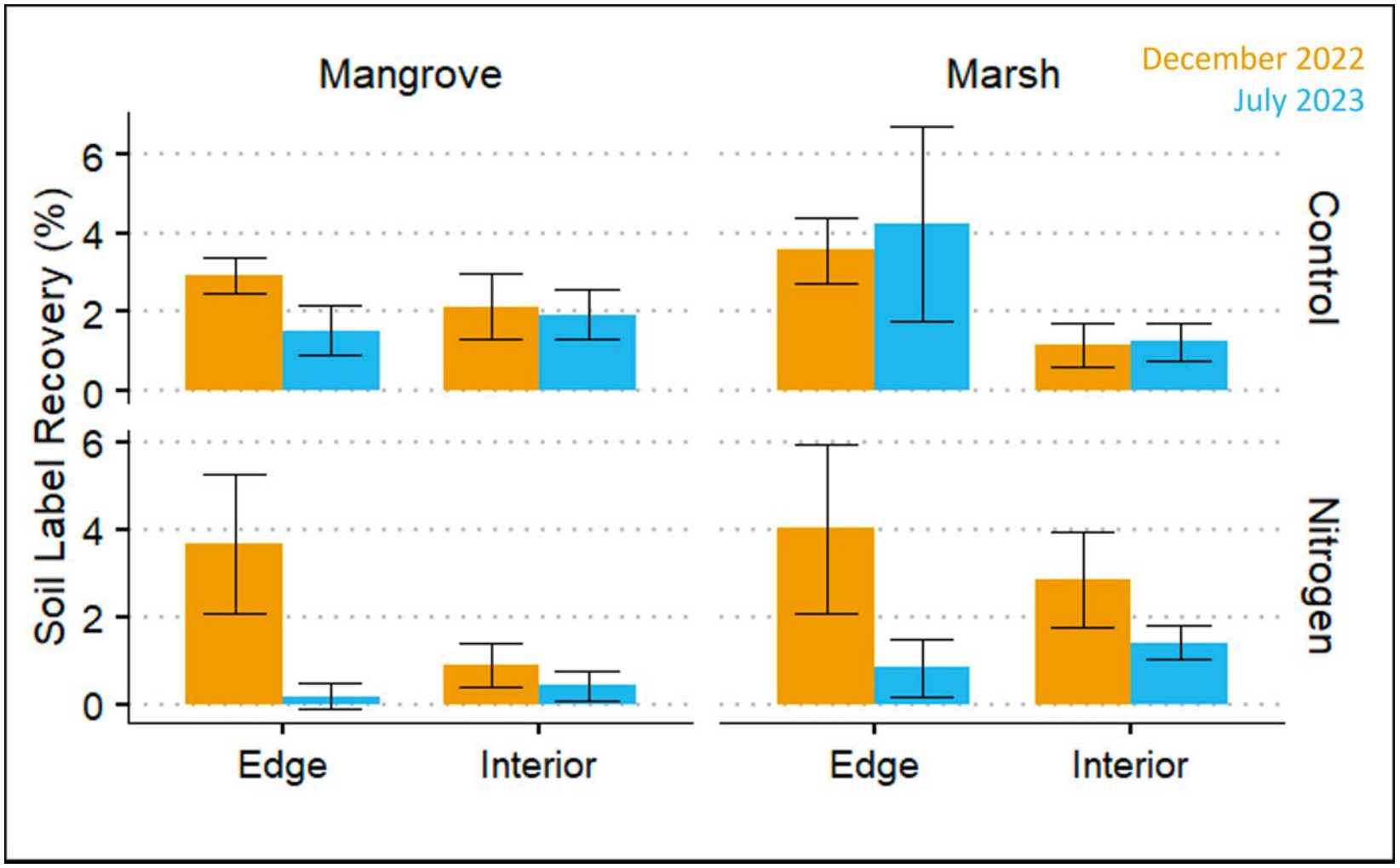


PRELIMINARY FINDINGS

Vegetation Nitrogen Retention:

After 3 months, more ^{15}N label is recovered in mangroves than in marsh vegetation.

Counter to our predictions, edge plot mangroves are retaining more nitrogen than interior plot mangroves



PRELIMINARY FINDINGS

Soil nitrogen retention over time:

Edge plot soils in mangroves are retaining more nitrogen than interior plots.

Marsh soils seem to be holding more nitrogen than mangrove soils, particularly in edge plots.

Some of the WETFEET team

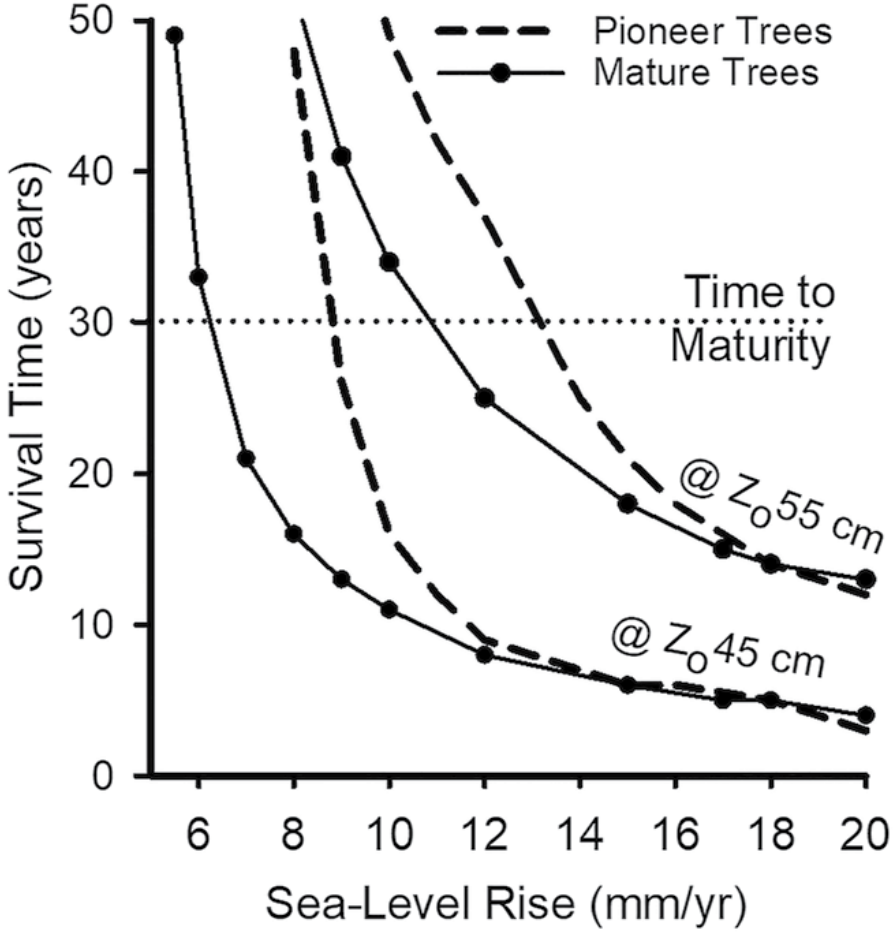


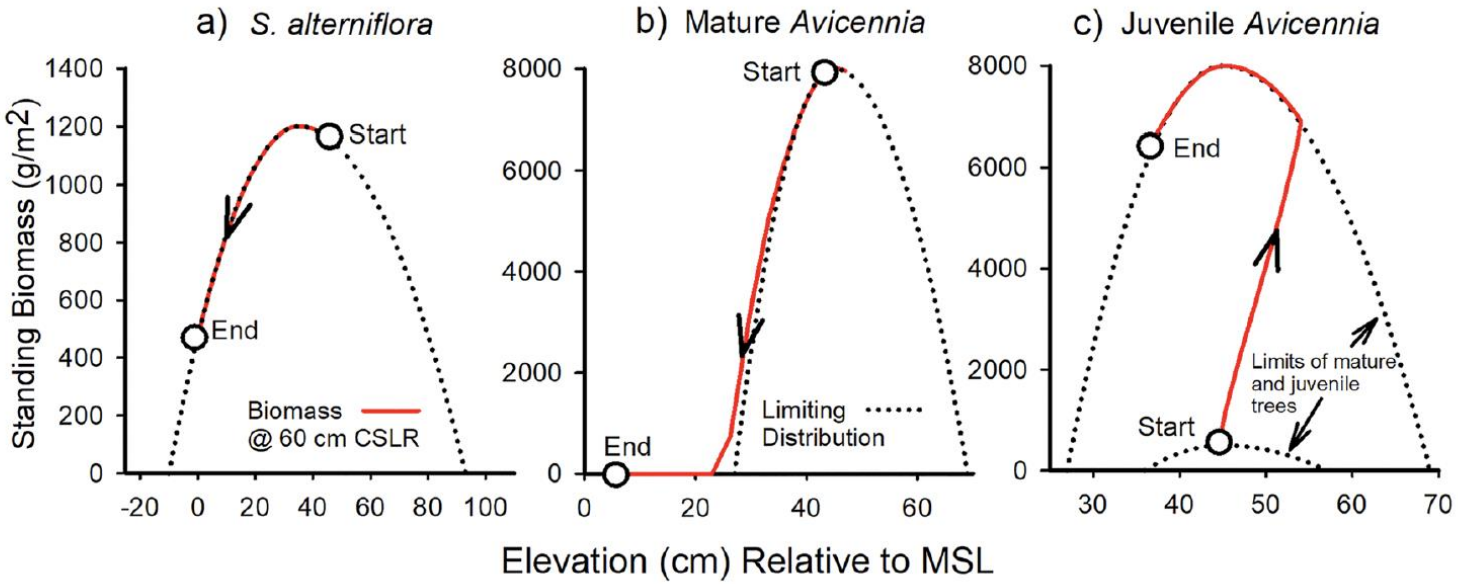


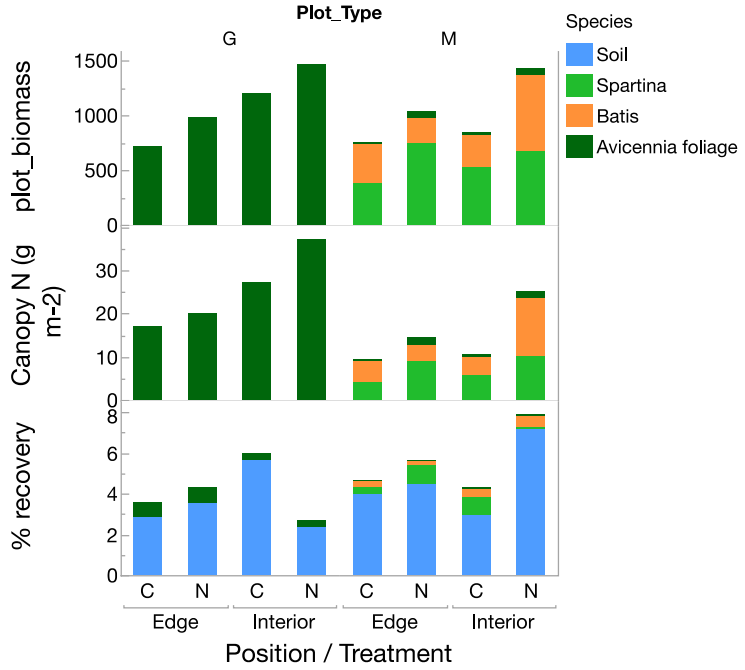







Pioneer Trees
Mature Trees
Time to Maturity
@ Z_o 55 cm
@ Z_o 45 cm
Survival Time (years)
Sea-Level Rise (mm/yr)


a) S. alterniflora
b) Mature Avicennia
c) Juvenile Avicennia
Standing Biomass (g/m2)
Start
End
Biomass
@ 60 cm CSLR
Limiting
Distribution
Limits of mature and juvenile trees
Elevation (cm) Relative to MSL


Plot_Type
G
M
Species
Soil
Spartina
Batis
Avicennia foliage
plot_biomass
Canopy N (g m-2)
% recovery
C
N
Edge
Interior
Position / Treatment

Extra info