



Response of Tidal Freshwater Marsh Plant and Microbial Communities in the Delaware River Estuary to Sea-Level Rise and Salt-Water Intrusion

Nathaniel B. Weston

Department of Geography and the Environment, Villanova University

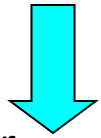
SWS/INTECOL

Salinization of freshwater wetlands: Implications for biogeochemistry, plant
communities, and ecosystem dynamics

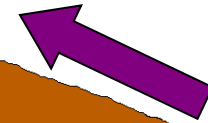
June 2012

Salinization of Tidal Freshwater Marshes

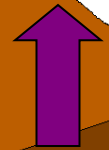
Changing
Precipitation &
Evapotranspiration



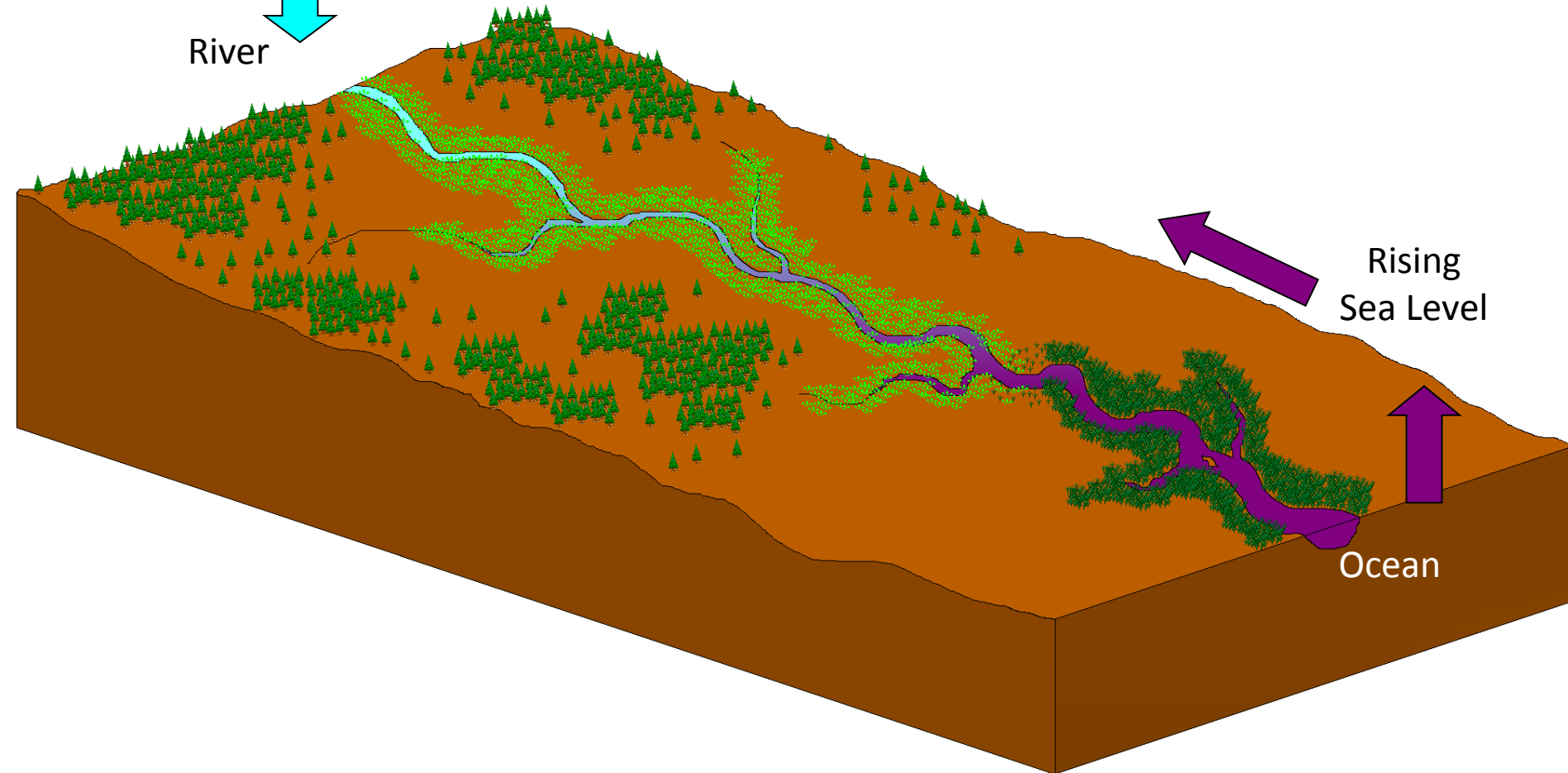
River



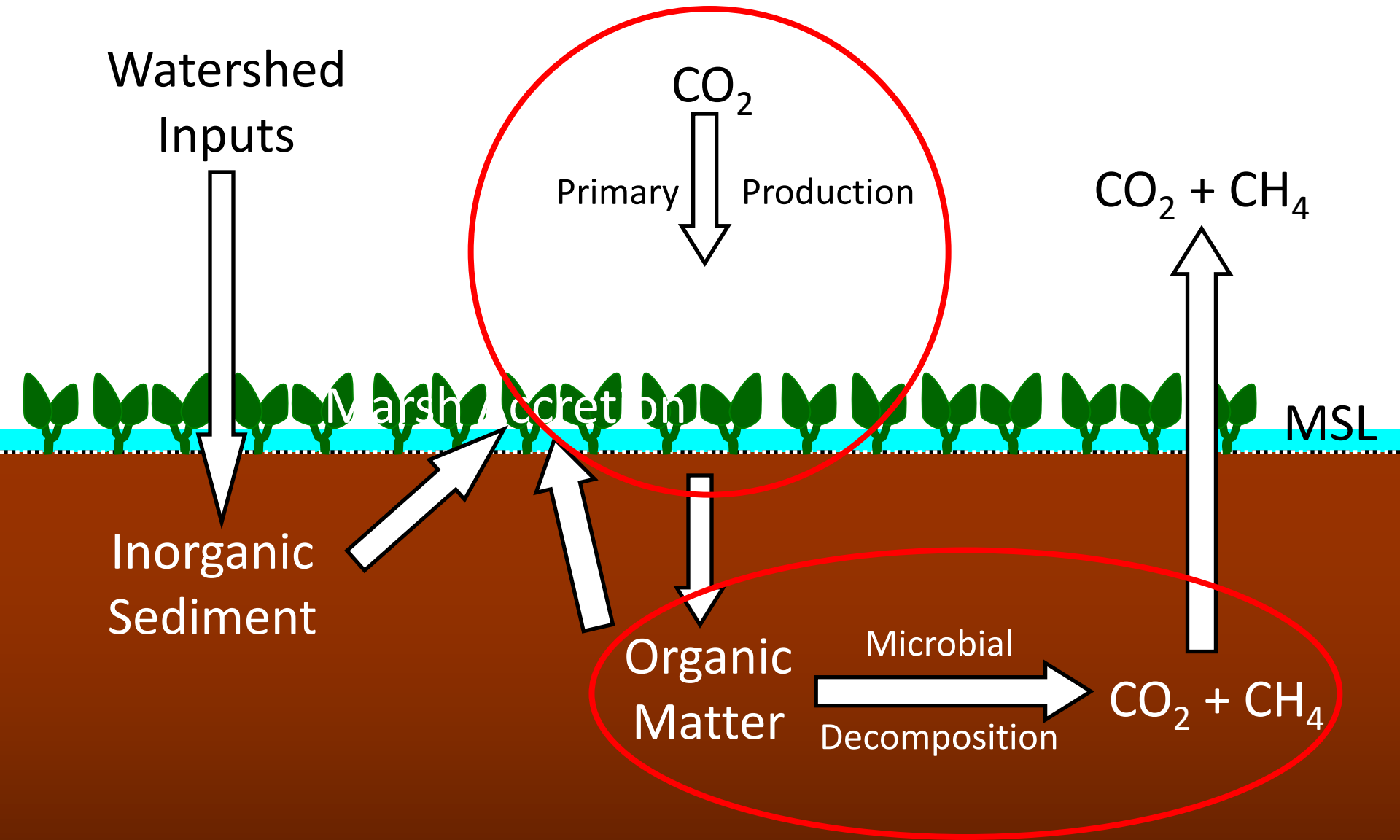
Rising
Sea Level



Ocean

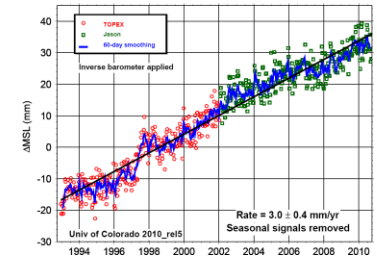


Salinization: Shift to Salt Marsh?



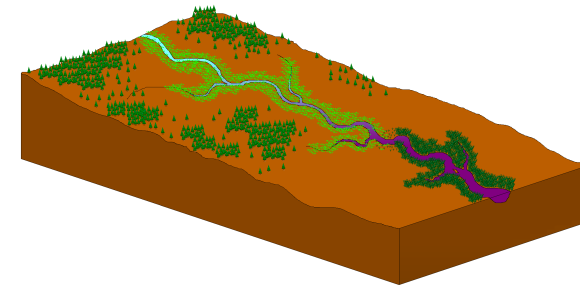
- How will tidal marshes respond to sea-level rise and altered flooding?

Sea Level Rise



- How will tidal freshwater marshes (TFMs) respond to salt-water intrusion?

Salt-water Intrusion



- How are microbial and plant responses coupled?

Plant Response

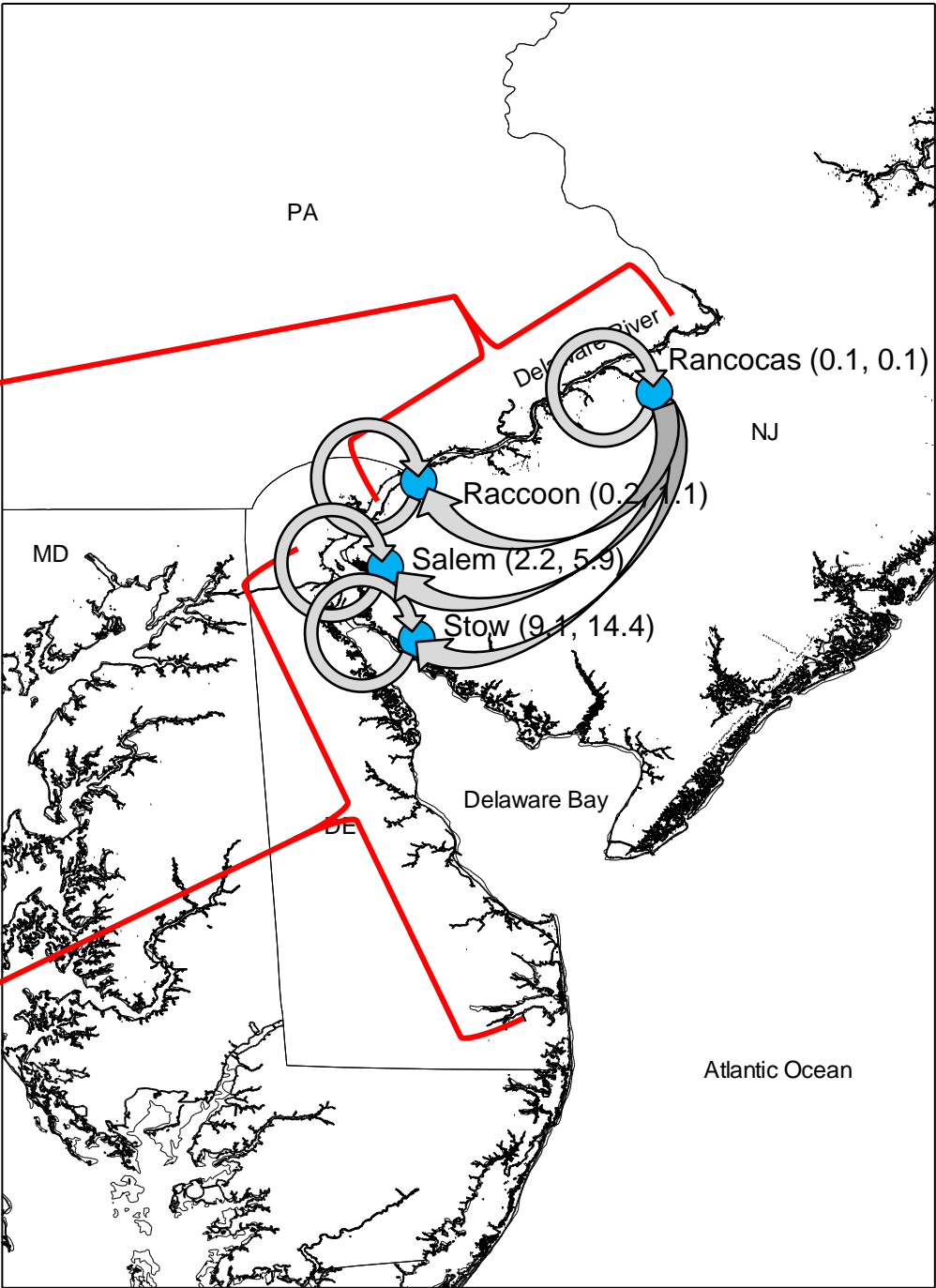


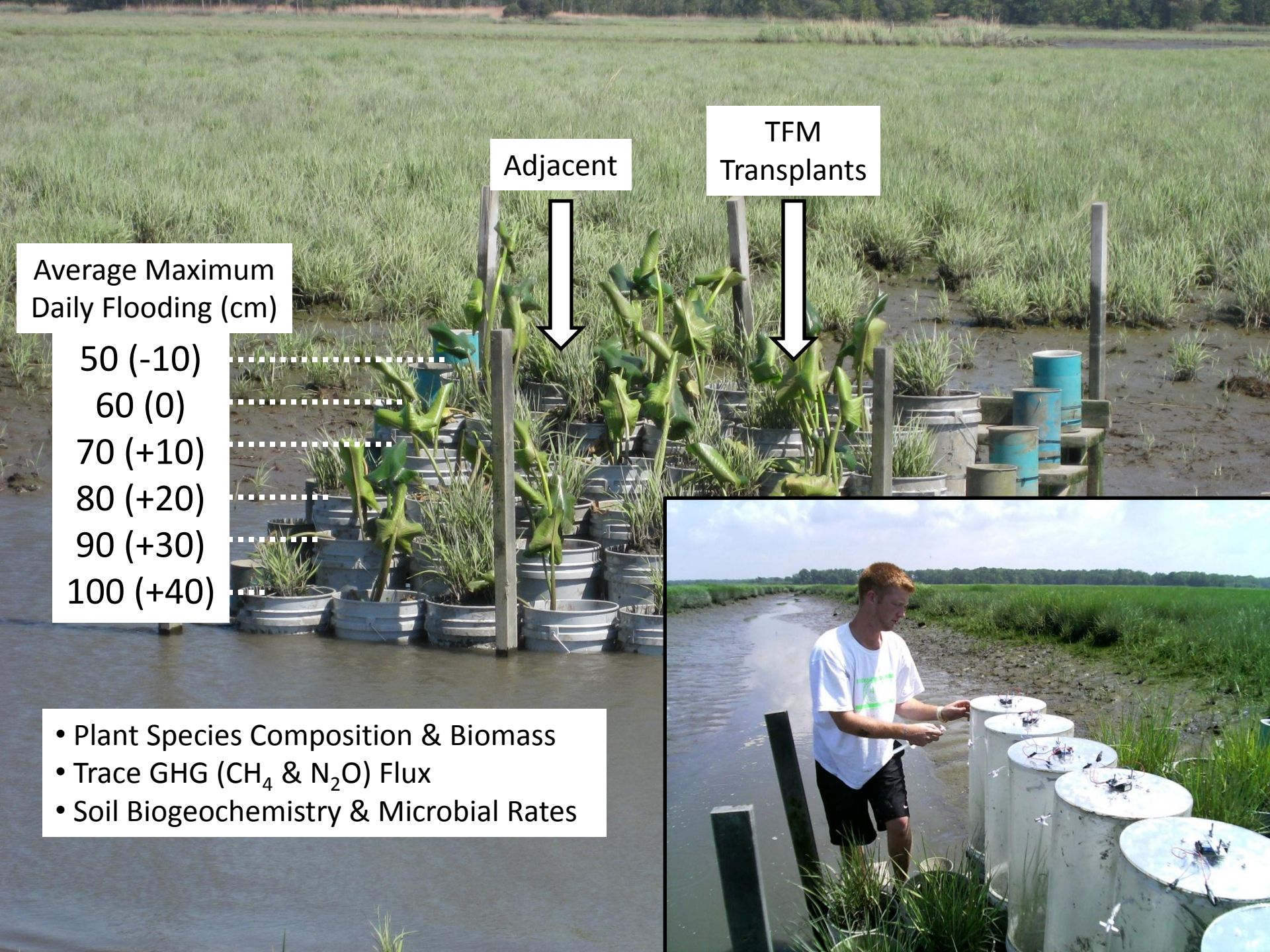
- What are implications for C cycling and marsh stability?

Tidal Freshwater Marshes



Salt Marshes





Adjacent

TFM
Transplants

Average Maximum
Daily Flooding (cm)

50 (-10)

60 (0)

70 (+10)

80 (+20)

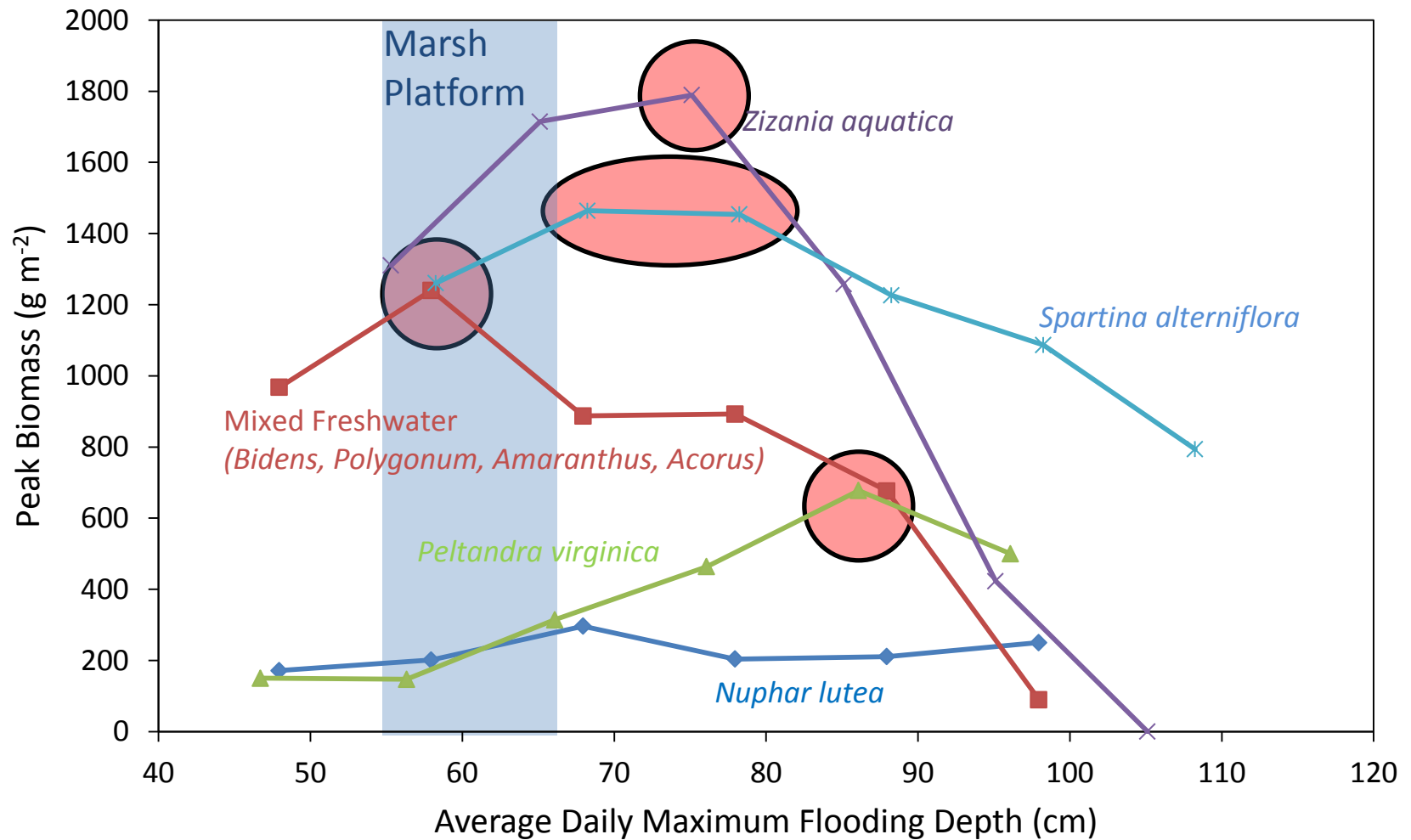
90 (+30)

100 (+40)

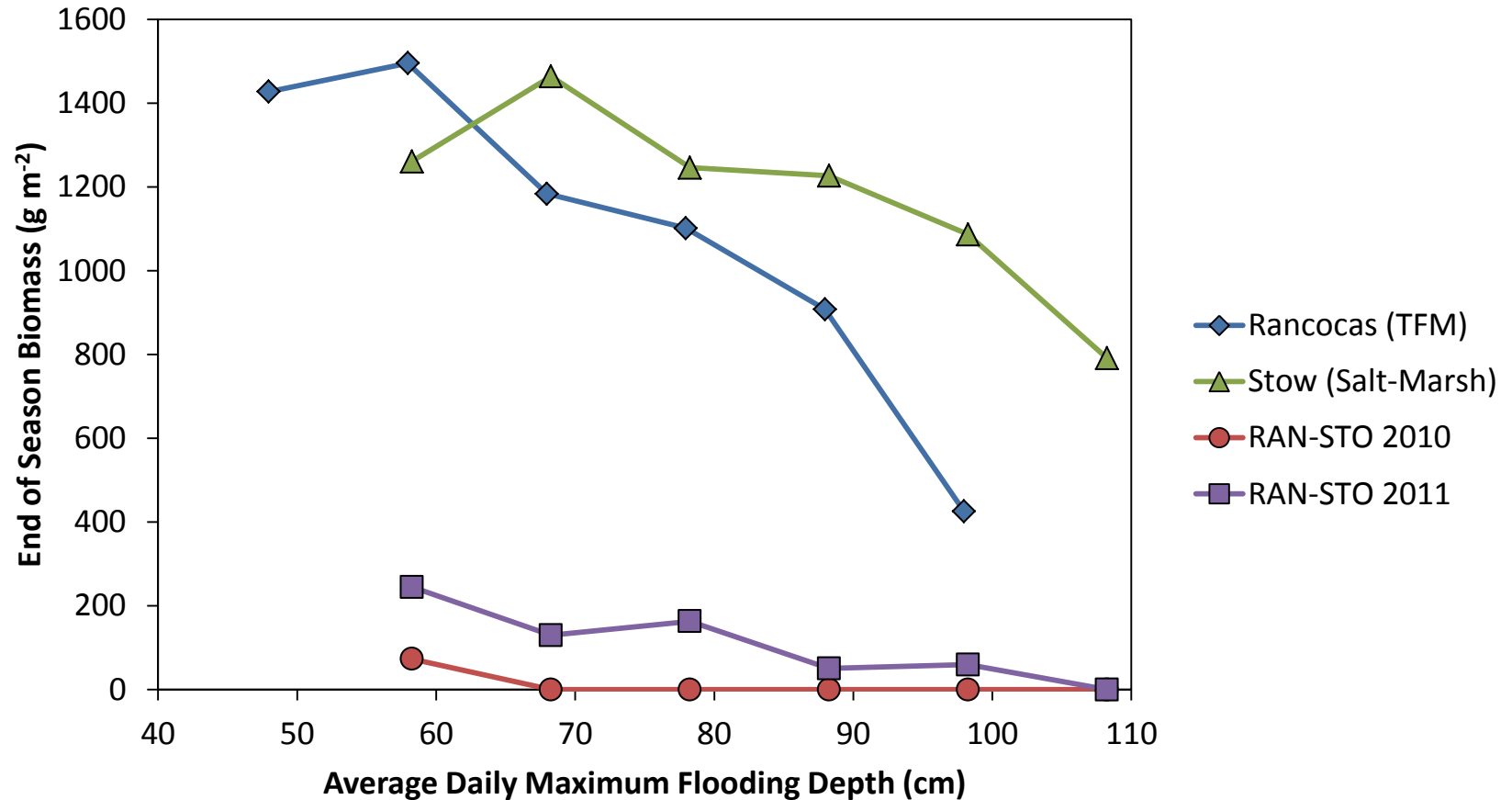
- Plant Species Composition & Biomass
- Trace GHG (CH_4 & N_2O) Flux
- Soil Biogeochemistry & Microbial Rates



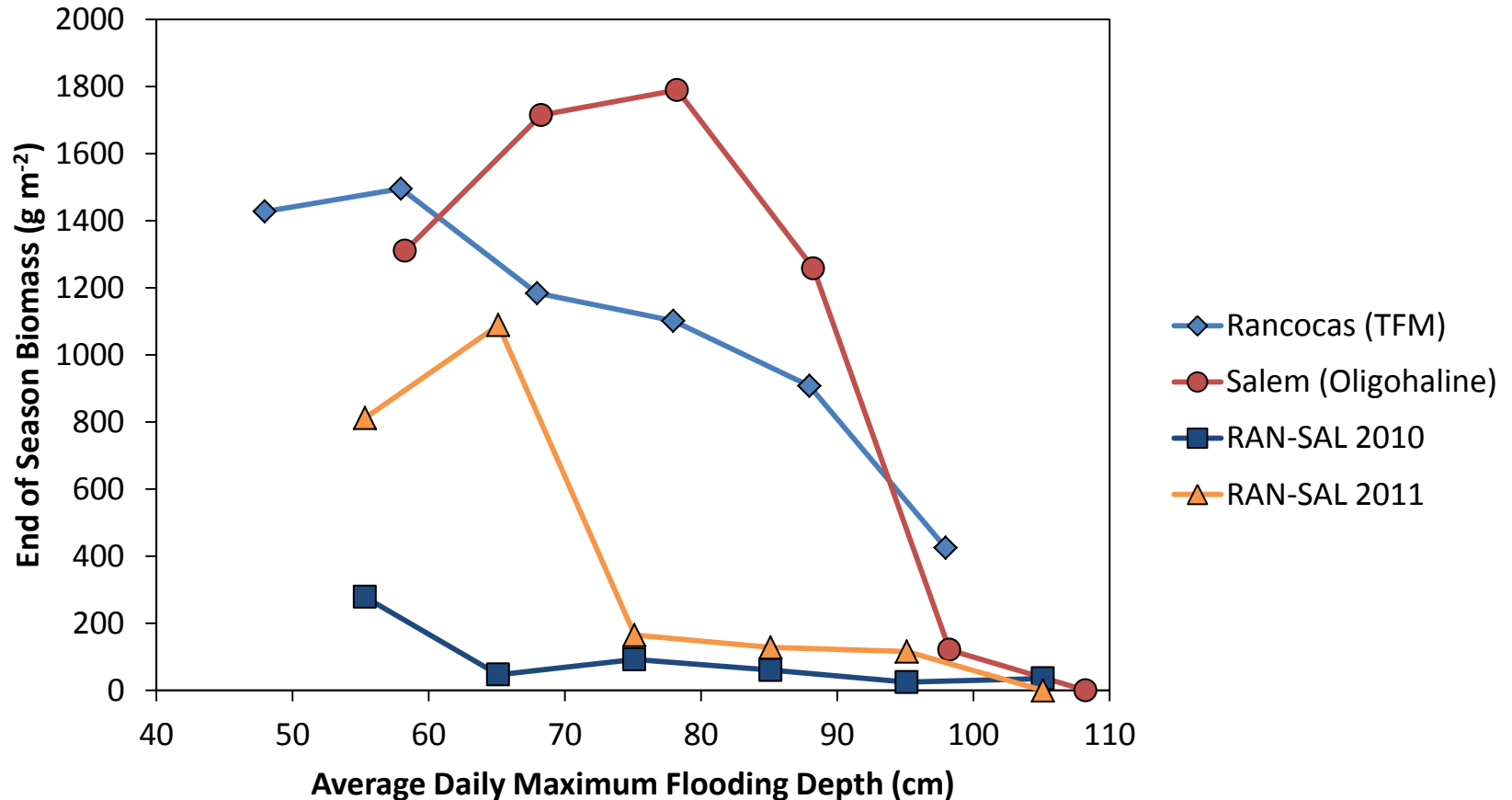
End of Season Peak Biomass



Plant Response to Salinization (Stow; Salinity 9.9)



Plant Response to Salinization (Salem; Salinity 2.2)



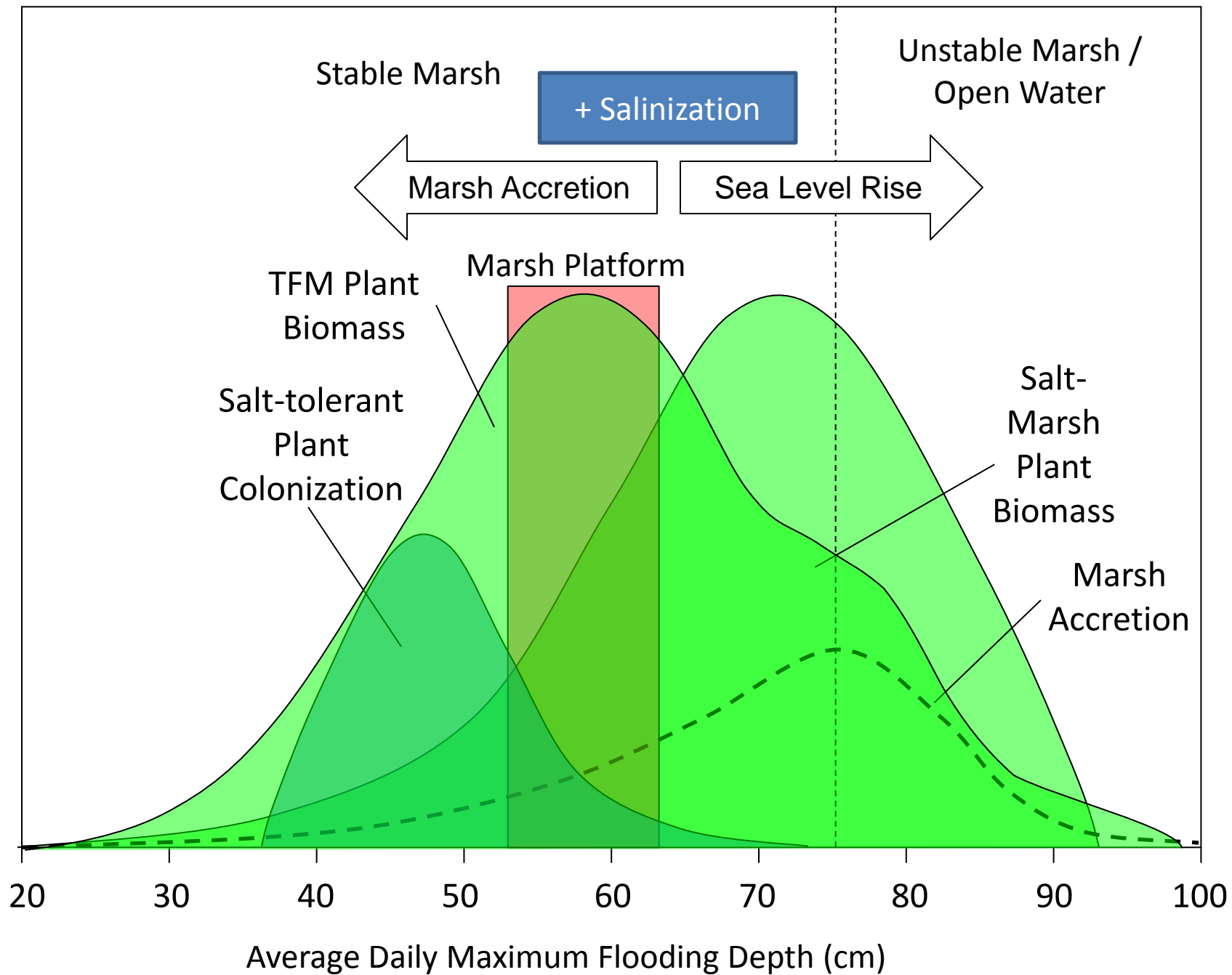
TFM Marsh Biomass Response to Sea-Level Rise and Salt-Water Intrusion

Variable	Coefficient	p value
Flooding Depth (cm)	-11.3	0.002
Conductivity (mS cm ⁻¹)	-50.8	< 0.001
Year	332.8	0.006
Intercept	1203.8	< 0.001

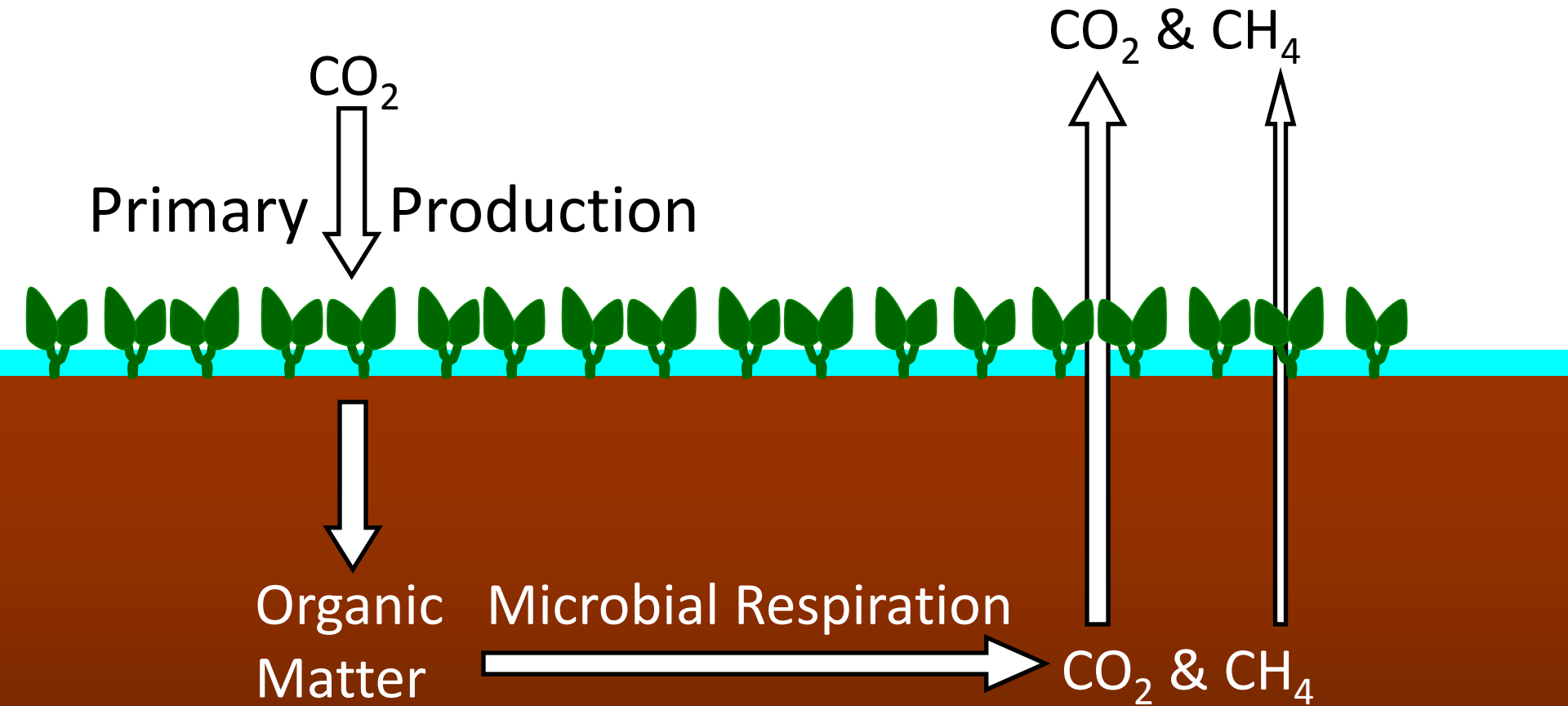
R ²	F	p value
0.49	18.1	< 0.001



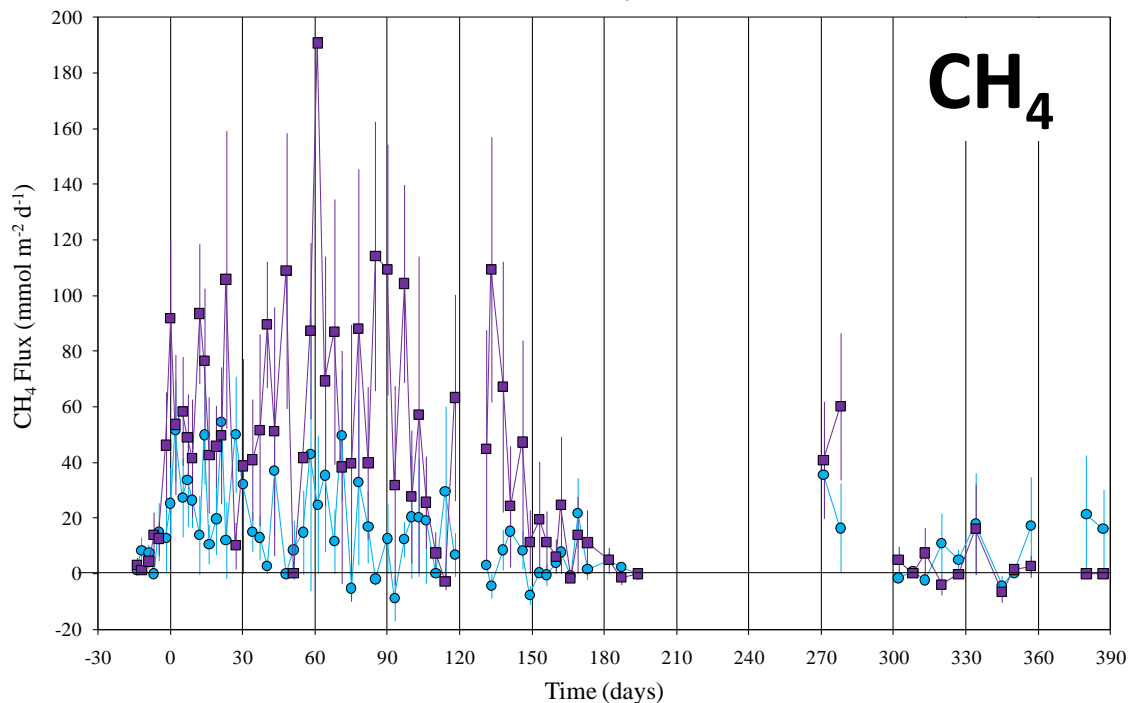
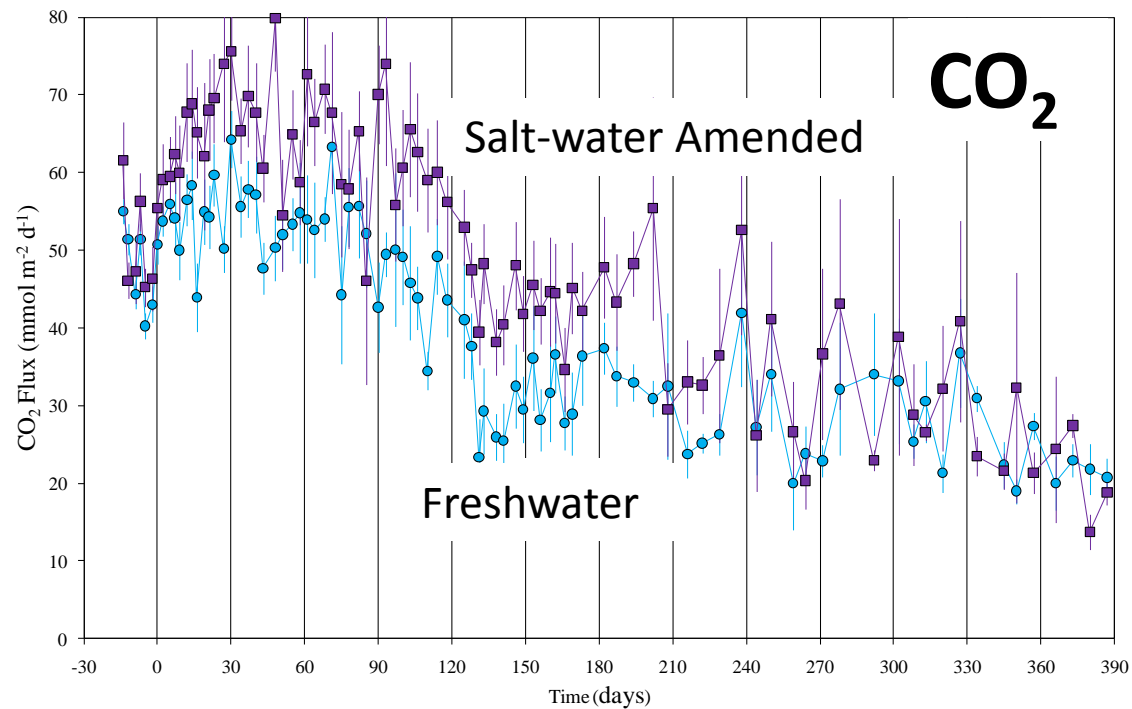
Relative Plant Biomass
and Marsh Accretion



Microbial Response to Sea-Level Rise and Salinization

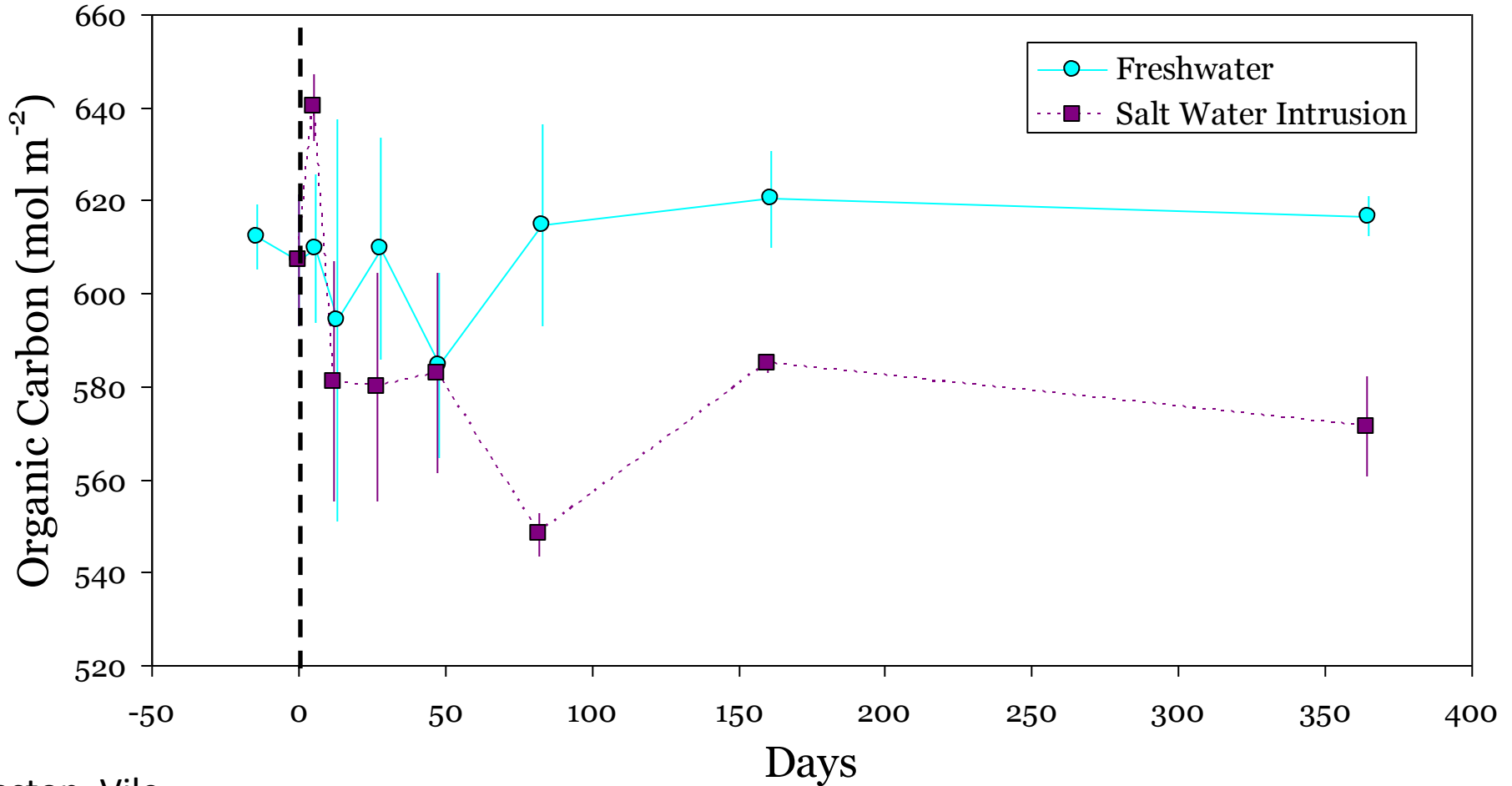


Lab Experiment CO₂ and CH₄ Flux



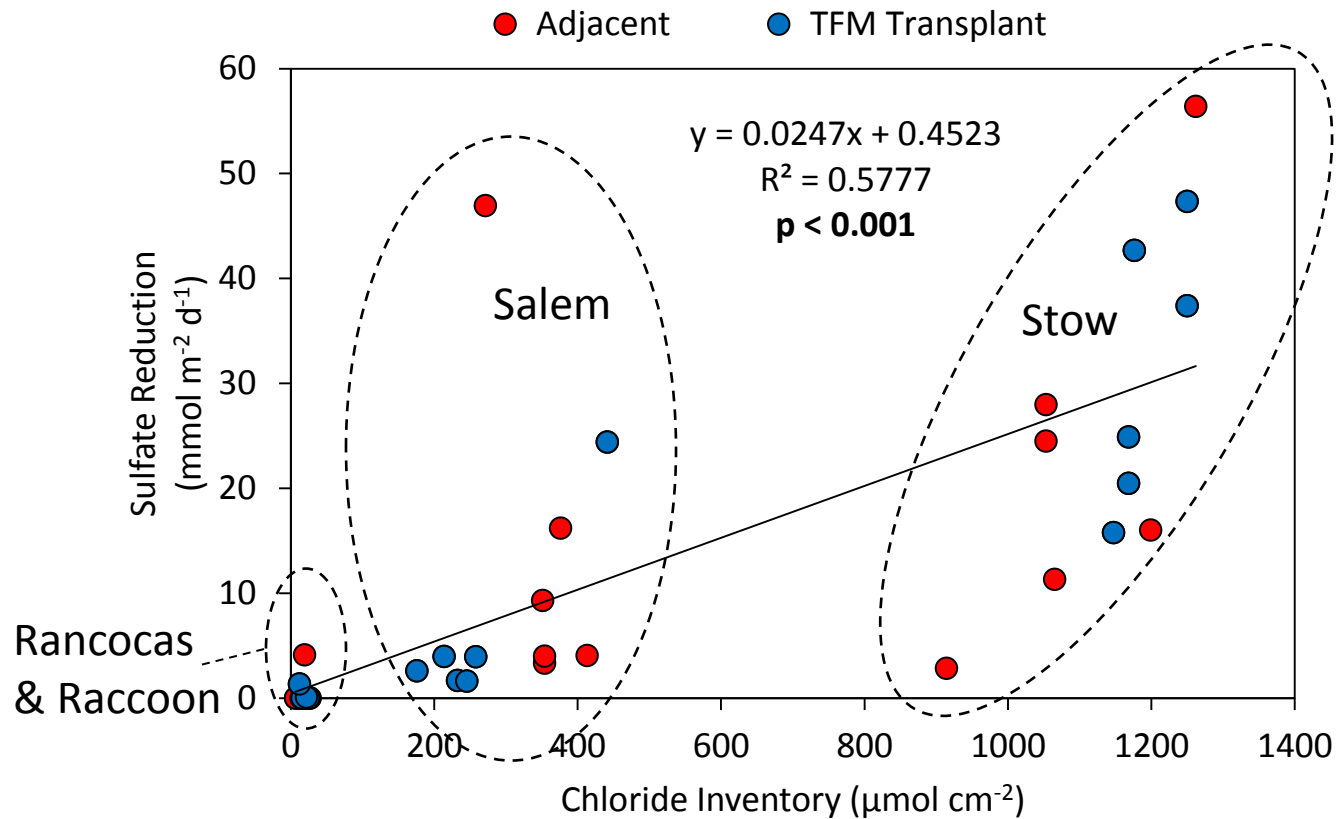
Weston, Vile,
Neubauer & Velinsky
(2011)
Biogeochemistry

Lab Experiment - Soil Organic Carbon



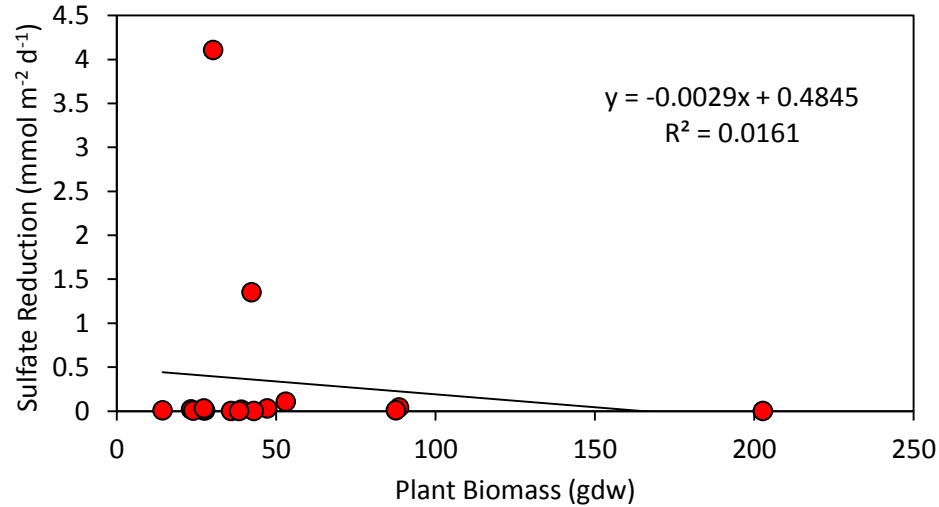
Weston, Vile,
Neubauer & Velinsky
(2011)
Biogeochemistry

Sulfate Reduction - Salinity



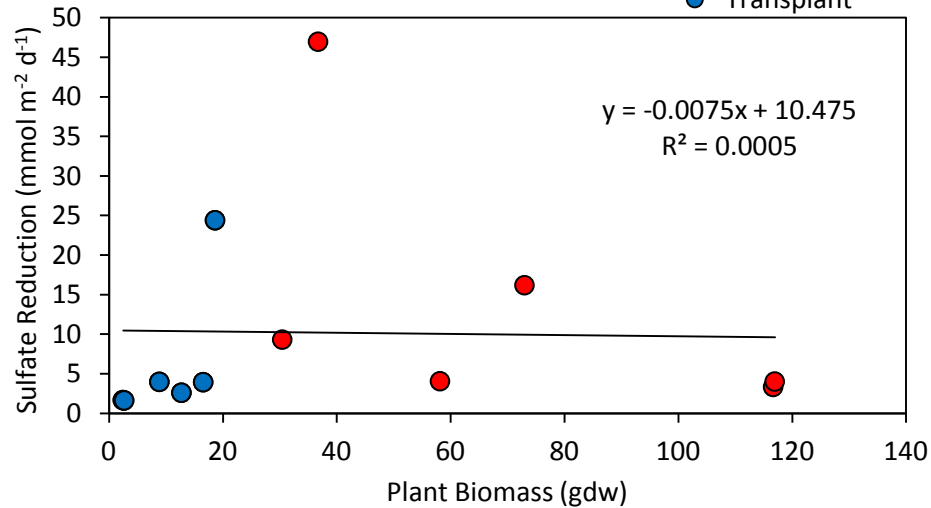
Sulfate Reduction – Plant Biomass

Raccoon & Rancocas (freshwater marsh)



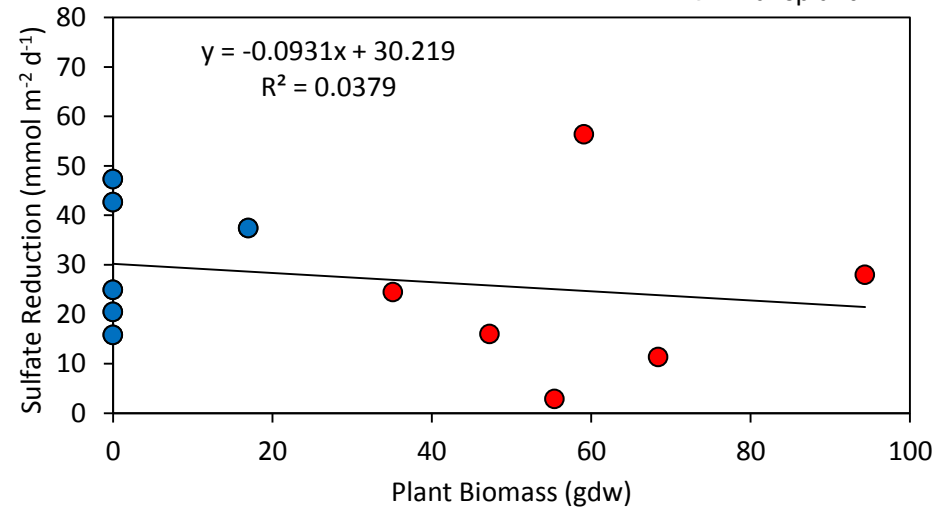
Salem (brackish marsh)

- Adjacent
- Transplant



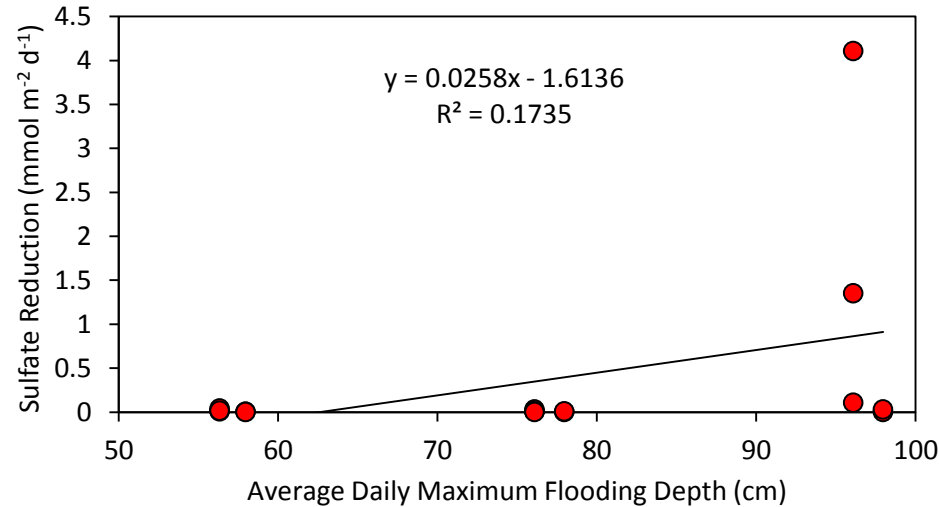
Stow (saltmarsh)

- Adjacent
- Transplant



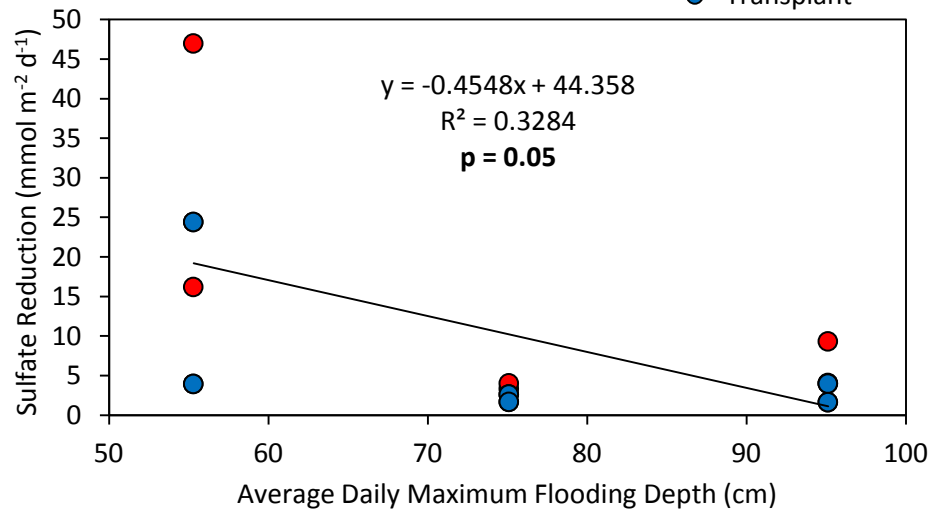
Sulfate Reduction – Flooding Depth

Raccoon & Rancocas (freshwater marsh)



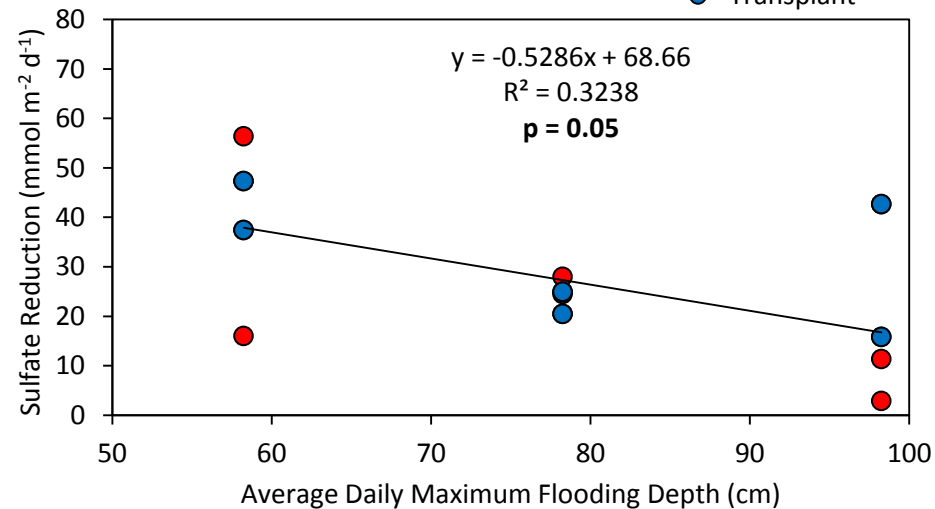
Salem (brackish marsh)

- Adjacent
- Transplant

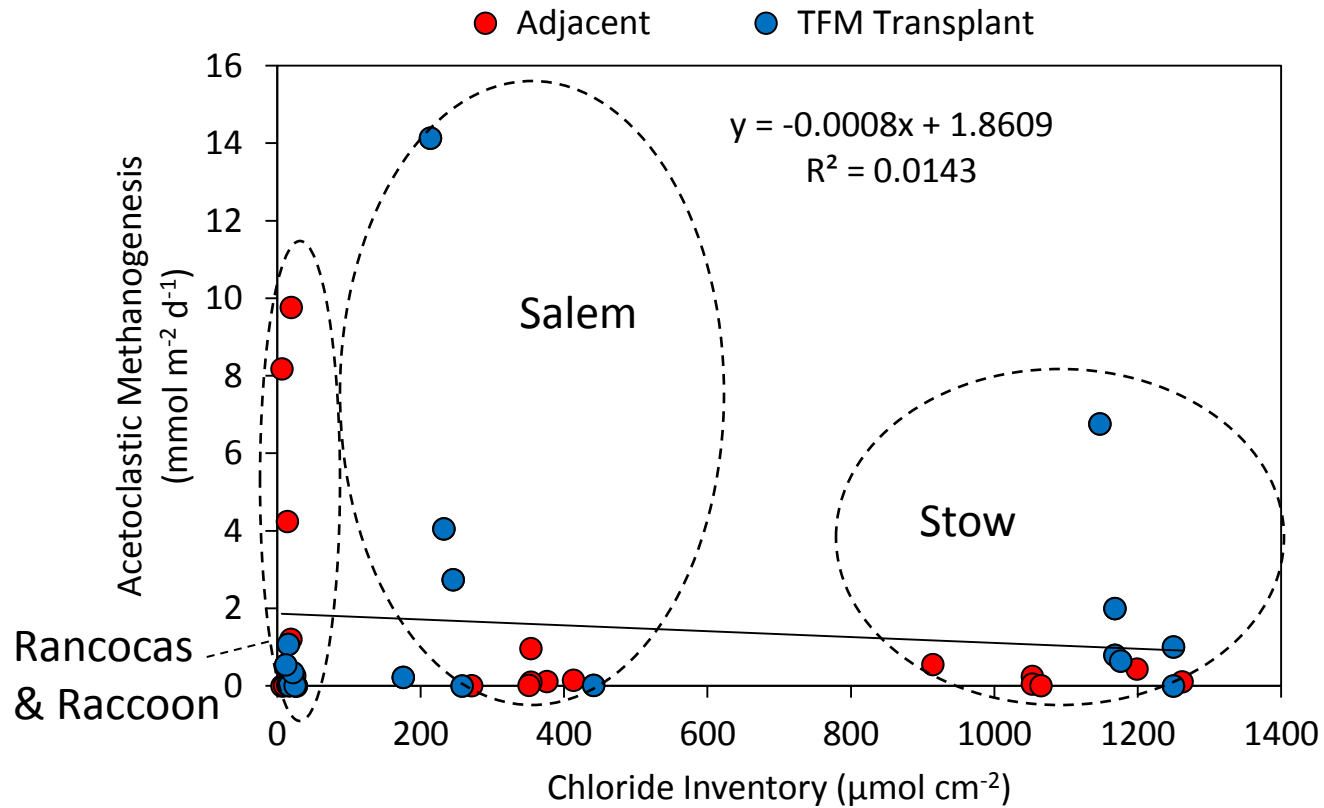


Stow (saltmarsh)

- Adjacent
- Transplant

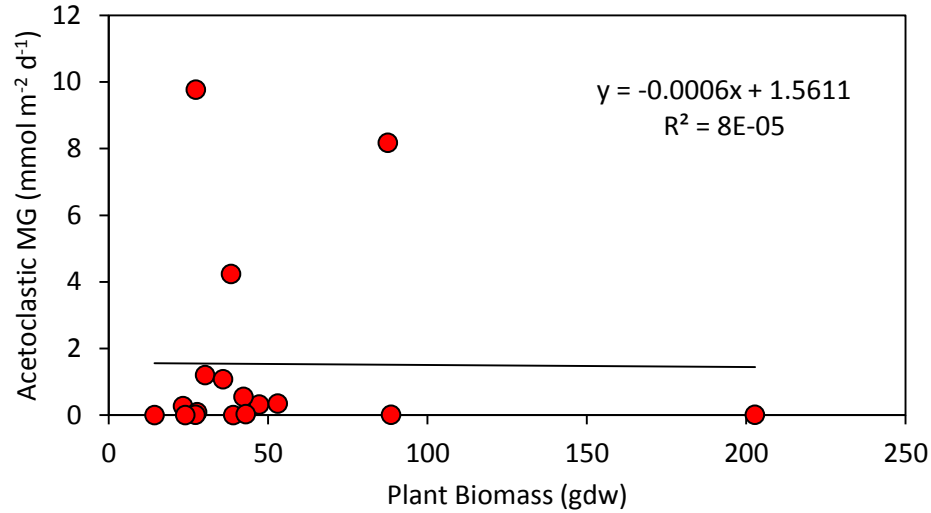


Methanogenesis - Salinity

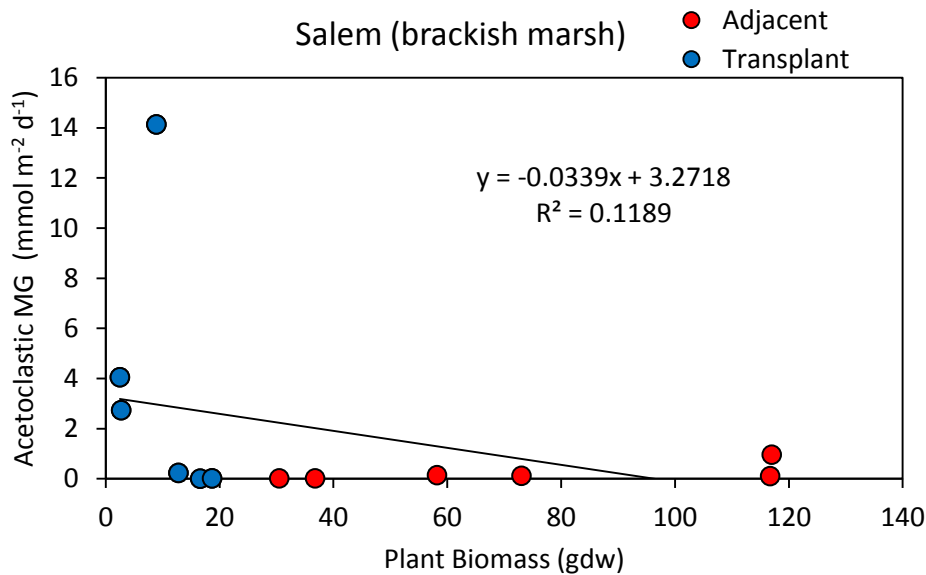


Methanogenesis – Plant Biomass

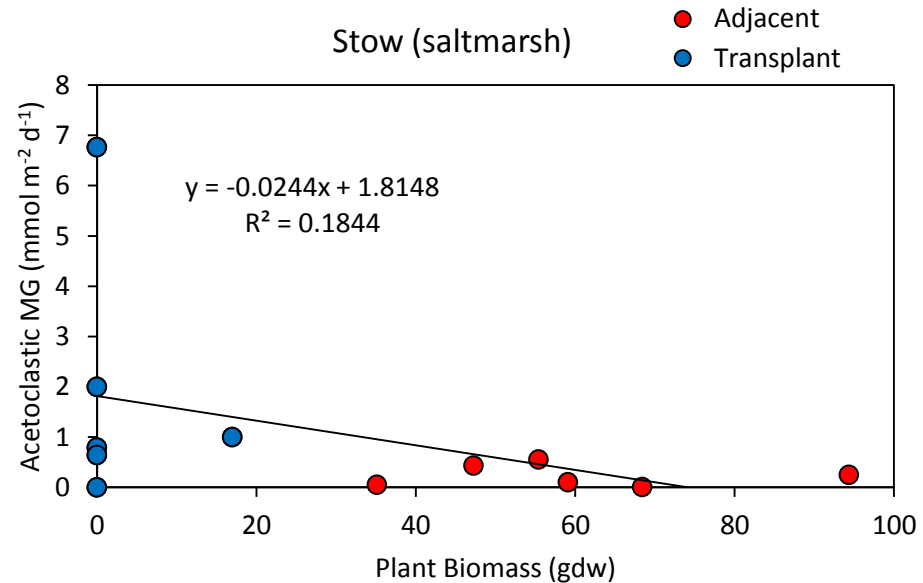
Raccoon & Rancocas (freshwater marsh)



Salem (brackish marsh)

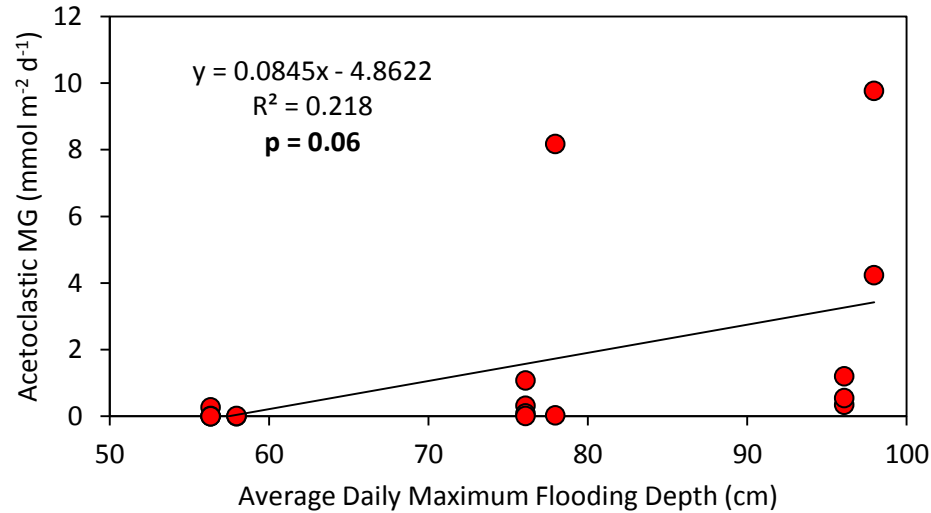


Stow (saltmarsh)

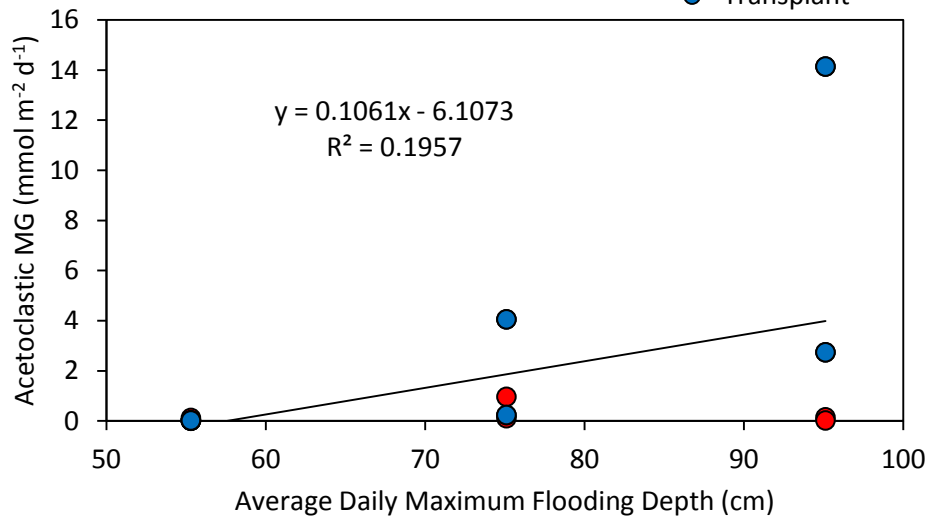


Methanogenesis – Flooding Depth

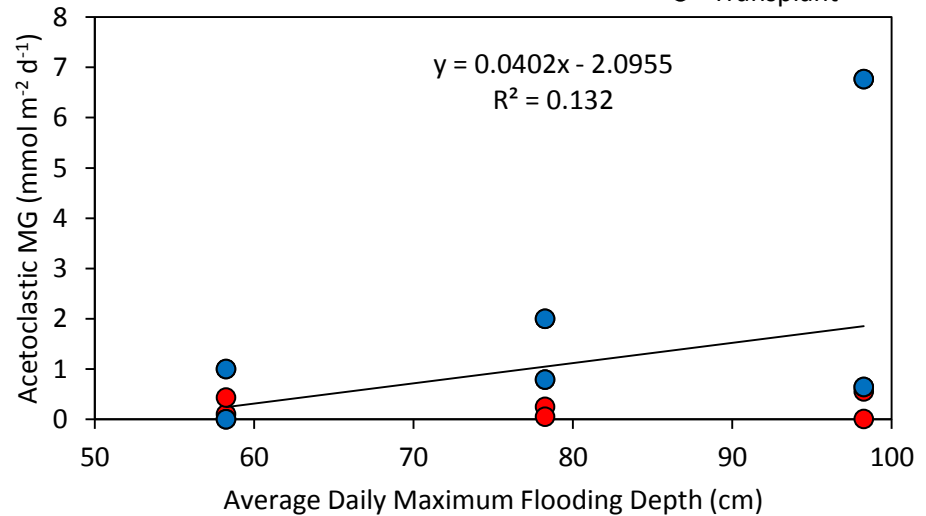
Raccoon & Rancocas (freshwater marsh)



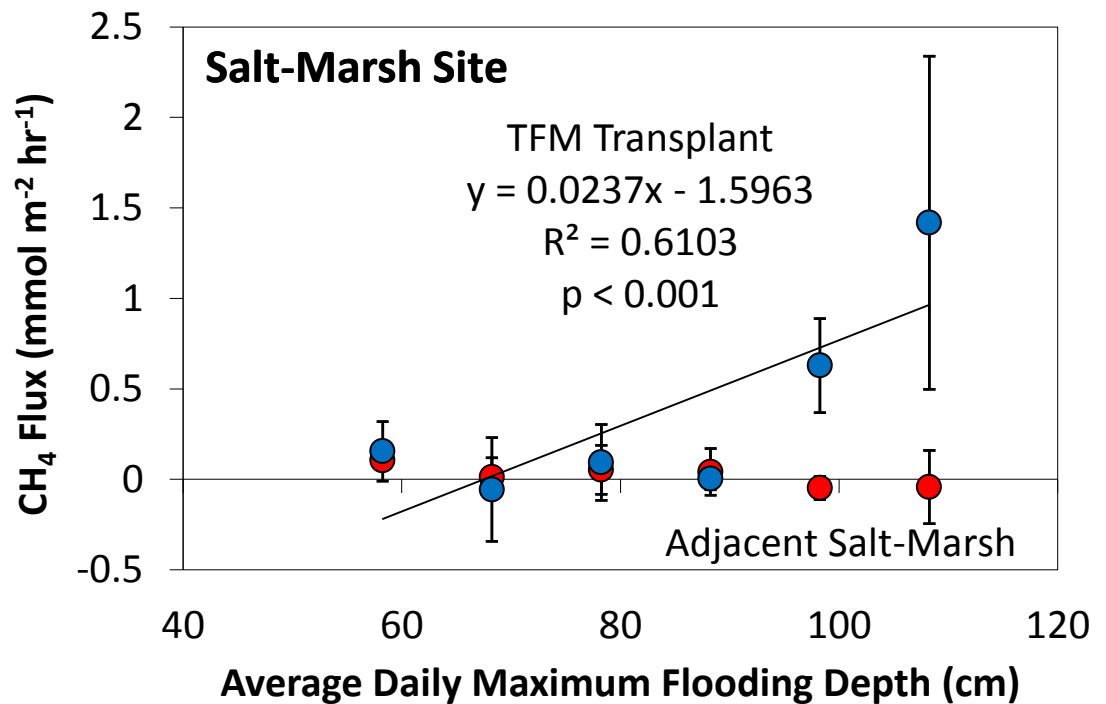
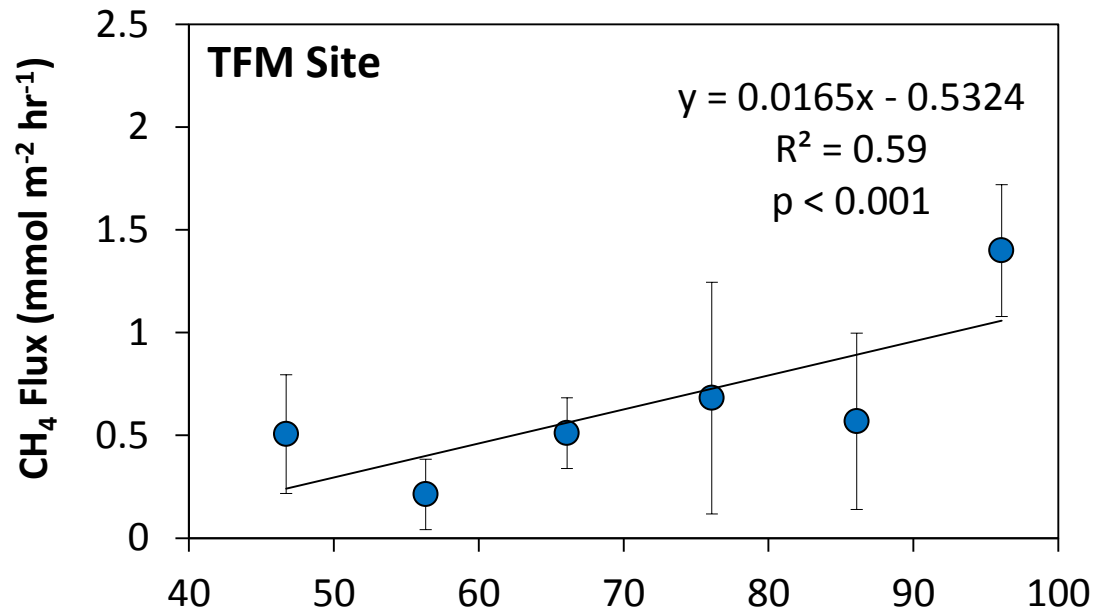
Salem (brackish marsh)



Stow (saltmarsh)



Short-Term Methane Flux (Months)



Methane Flux – 2 years

Variable	Coefficient	p value
Conductivity (mS cm ⁻¹)	-0.04	0.016
Date (days)	-0.62	0.001
Flooding Depth (cm)	0.01	0.082
Intercept	68.4	0.001

R ²	F	p value
0.03	5.3	0.001



Sea-Level Rise, Salinization & Ecosystem Function

	Sea-Level Rise	Salt-Water Intrusion	Sea-Level Rise + Salt-Water Intrusion
Sulfate Reduction	↓	↑	↑
Methanogenesis	↑	↑ then ↓	↑ then ↓
Organic Matter Decomposition	↓	↑	↑
Plant Biomass and Organic Matter Production	↓ or ↑*	↓**	↓
Organic Matter Sequestration	↓ or ↑*	↓**	↓
Marsh Stability	↓ or –*	↓**	↓

*Depends on rate of SLR

**Unless/until salt-marsh develops

*Eric Au
*Sarah Celone
*Patrick Costello
*Amanda Foskett
*Margaret Garcia
Olivia Gibb
Anthony Geneva
Paul Kiry
Chris McLaughlin
Avni Malhotra
*Neil Mehta
*Justin Meschter
Stephen Mowbray
Scott Neubauer

*Michael Patson
*Melanie Pingoy
*Tatjana Prša
James Quinn
*Daniel Russo
*Mariozza Santini
Kimberli Scott
Roger Thomas
*Cindy Troy
*John Ufferfilge
David Velinsky
Melanie Vile
*Justin Walsh
*Paul Weibel

(* - Undergraduate Student)

National Science Foundation
Environmental Protection Agency, STAR
Program
Villanova University

