Aquatic Carbon Fluxes from a Marsh Ecosystem in the Florida Everglades

Examining Carbon Release in Response to Pulsed Water Level and Salinity Manipulations

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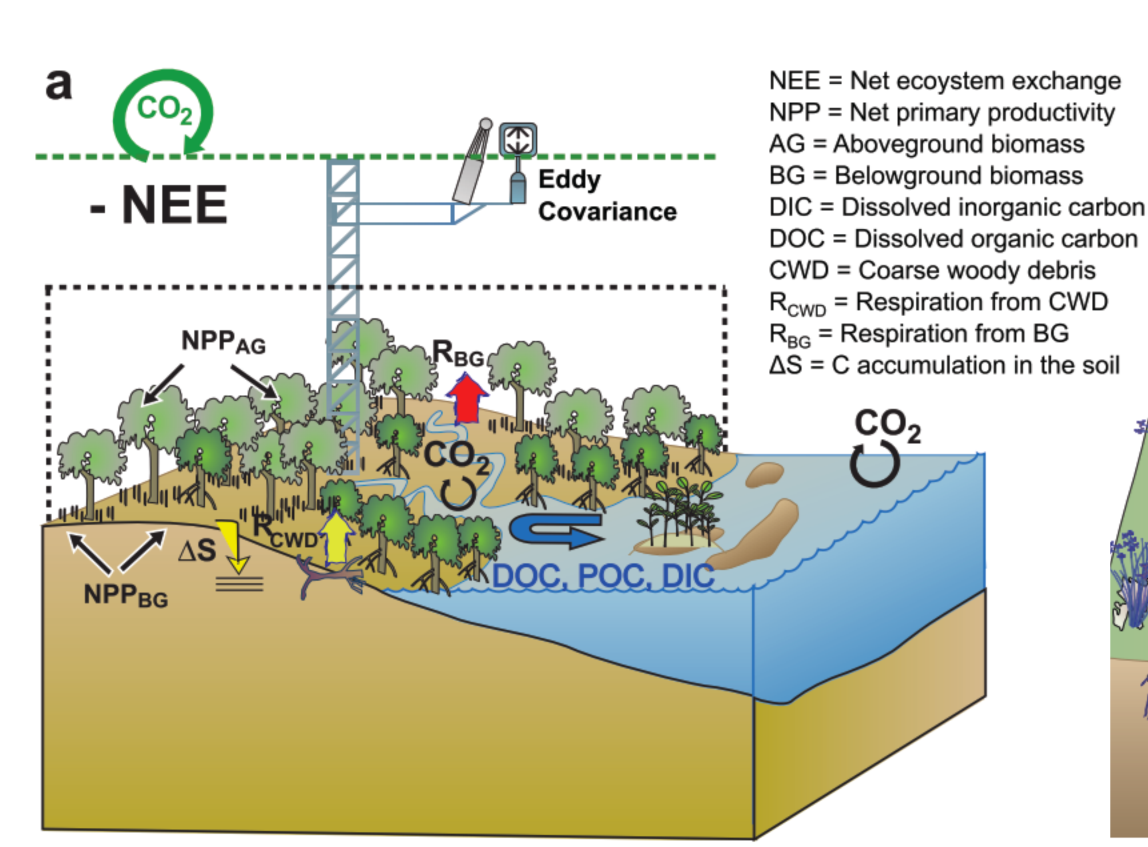
The Net Ecosystem Carbon Balance of Coastal Wetlands

- High rates of primary production, sediment and particle trapping help to develop large carbon sinks in coastal wetlands

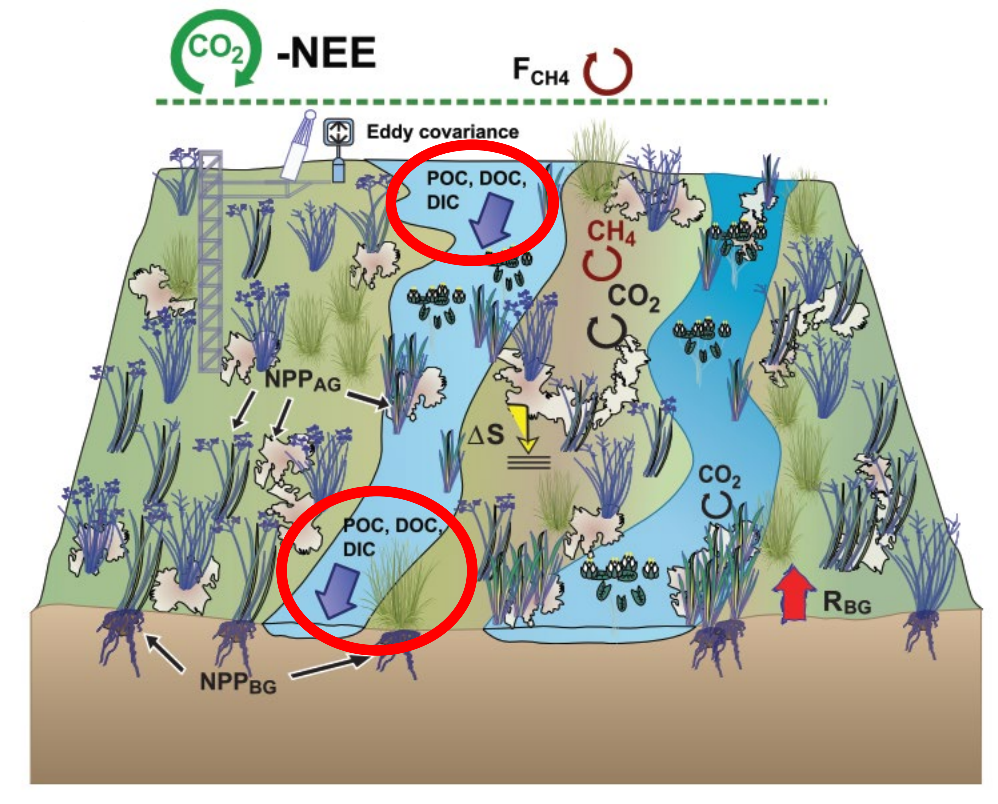
- Low levels of oxygen in saturated sediments lead to slowed decomposition and reduced respiration

- NECB: the rate of carbon accumulating in a system (Chapin et al. 2006)



Source: Troxler et al. 2013

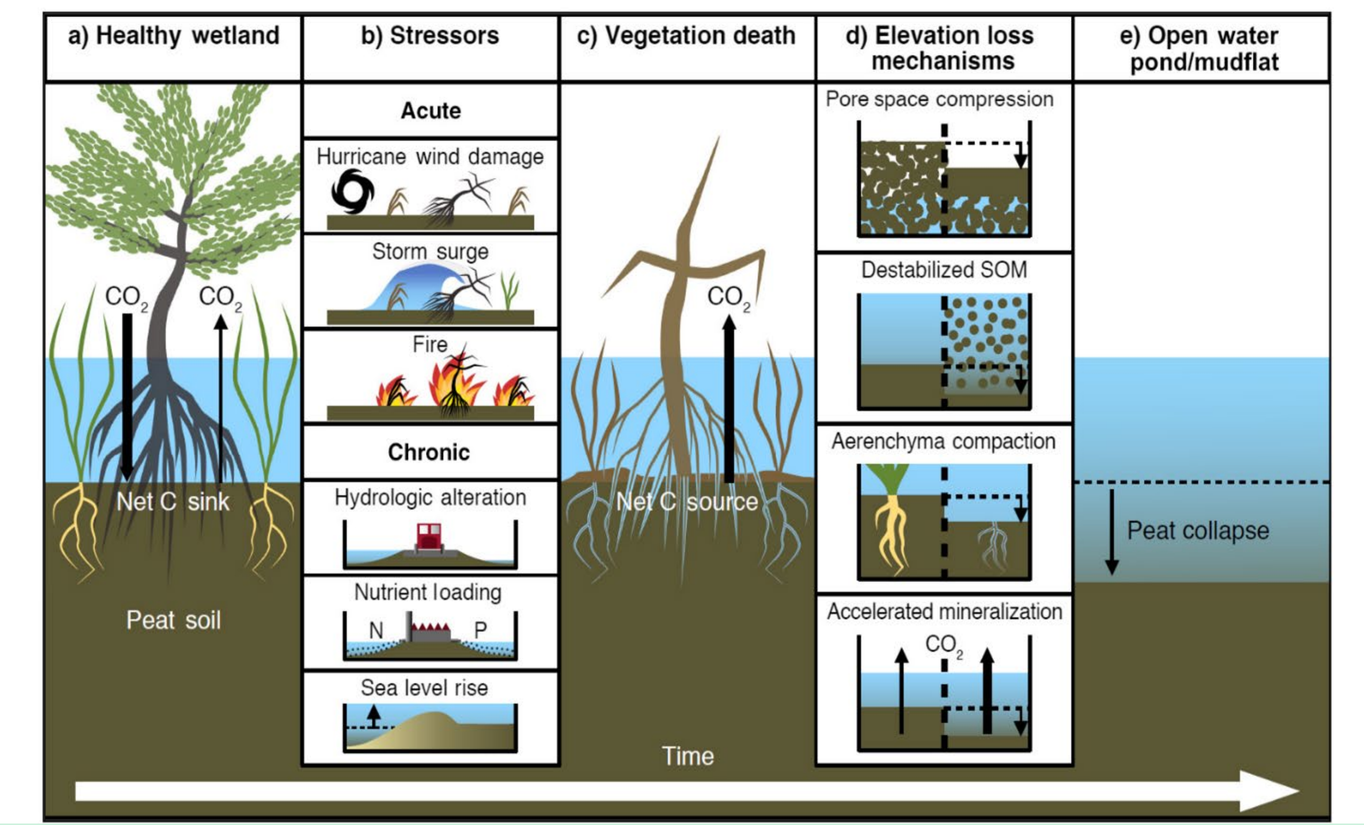
The Missing Fluxes



Source: Troxler et al. 2013

- Aquatic carbon fluxes are often overlooked in the NECB (Webb et al. 2019, Dinsmore et al. 2013).
- Models indicate that aquatic carbon flux might be enhanced by saltwater intrusion, but this has not been validated by field studies (Ishtiaq et al. 2022).

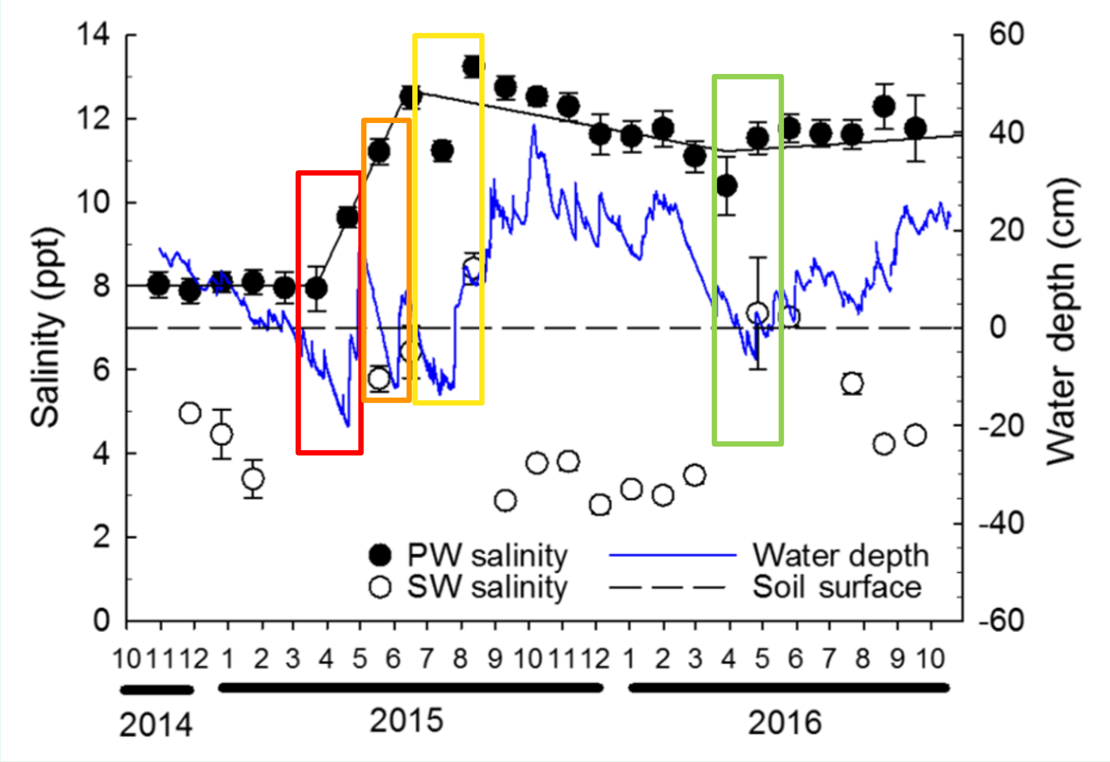
Marsh Degradation from Saltwater Intrusion and Peat Collapse



Source: Chambers et al. 2019

Peat pedestal left behind by peat collapse.

Chapter 2: Examining Carbon Release in Response to Pulsed Water Level and Salinity Manipulations



Wilson et al. 2018.

Research questions

1. How do recurring dry-down events followed by increases in porewater salinity during rewetting influence carbon (DOC and DIC) release in marsh ecosystems?
2. How does DOC and DIC release differ between soils from marshes degraded by saltwater intrusion and intact freshwater marsh?

Site Locations and Site Types

Site locations.

Examining Carbon Release in Response to Pulsed Water Level and Salinity Manipulations

Methods: *Experimental Design*

- 12 3-in cores taken to a depth of ~40 cm from both sites (Brackish water and Freshwater) were randomized and sorted into one of three treatments: Control, Dry Down (ambient), Dry Down + Salinity

- Additional 3 cores were taken at each site for analysis of soil bulk density and carbon fraction.

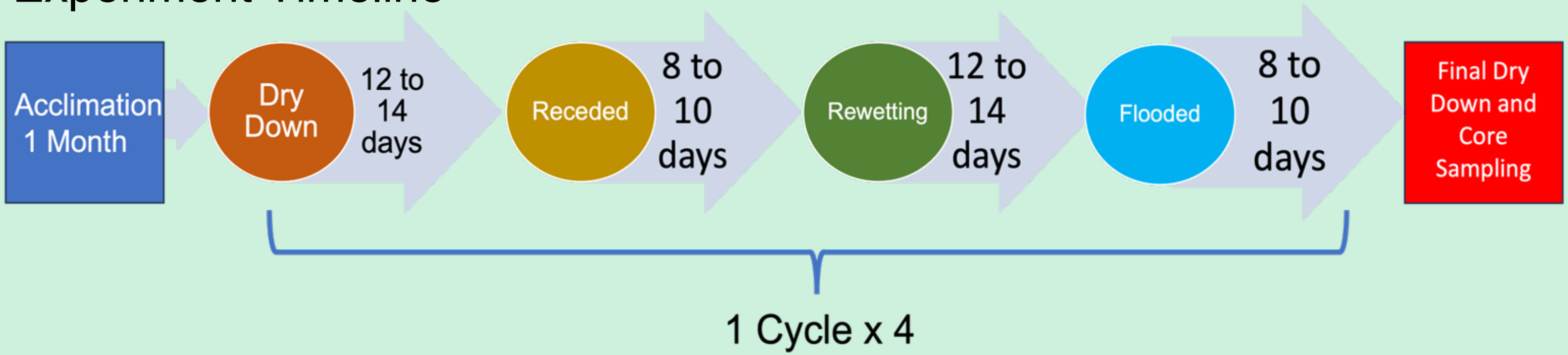
- Surface water, porewater and leachate samples for DIC and DOC analysis.

Soil core collection (top), experimental set-up in the lab (bottom).

Examining Carbon Release in Response to Pulsed Water Level and Salinity Manipulations

Methods: *Experimental Design*

- Experiment Timeline



Cycle Number	Brackish Water Dry	Brackish Water Dry + Salinity	Freshwater Dry	Freshwater Dry + Salinity
1	5.4 ppt	18 ppt	0.3 ppt	5 ppt
2	6 ppt	23 ppt	0.3 ppt	10 ppt
3	5.8 ppt	28 ppt	0.2 ppt	15 ppt
4	5.5 ppt	33 ppt	0.2 ppt	20 ppt

Preliminary Results

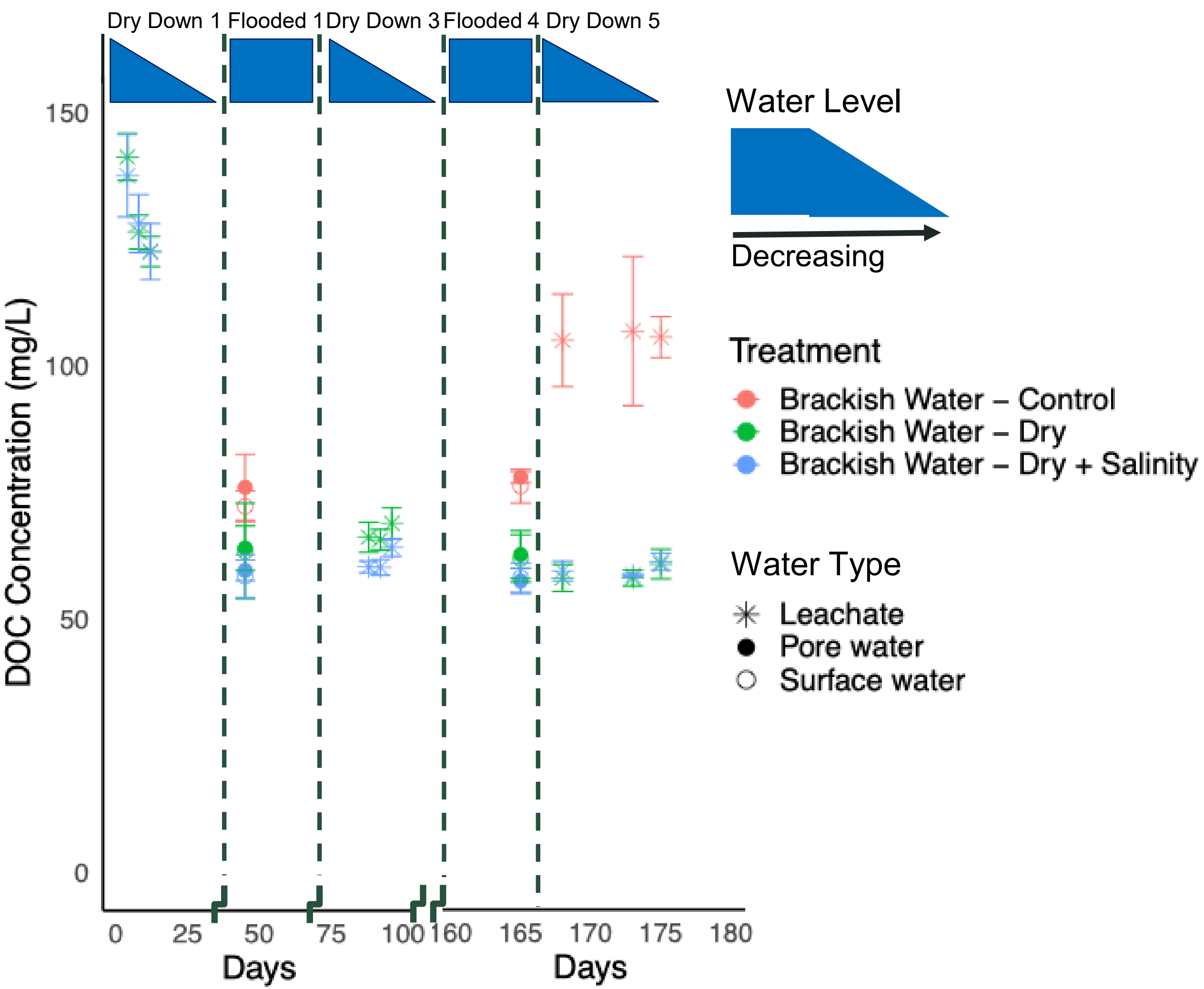
Mean DOC over Time

Brackish Water

- DOC concentrations in leachate ***declined*** over time for experimental treatments (50 – 59% decrease).

- At the end of Dry Down 5 (Days = 176), treatments Dry and Dry + Salinity had a 42% and 42.5% ***decrease*** in DOC compared to the control (lnRR = -0.55, 95% CI [-0.61– -0.49] and lnRR = 0.54, 95% CI [-0.59 – -0.50], respectively).

- While effect size CI's indicates significant treatment effects on DOC, similar effect sizes suggest the addition of salinity did not impact the treatment effect on DOC.

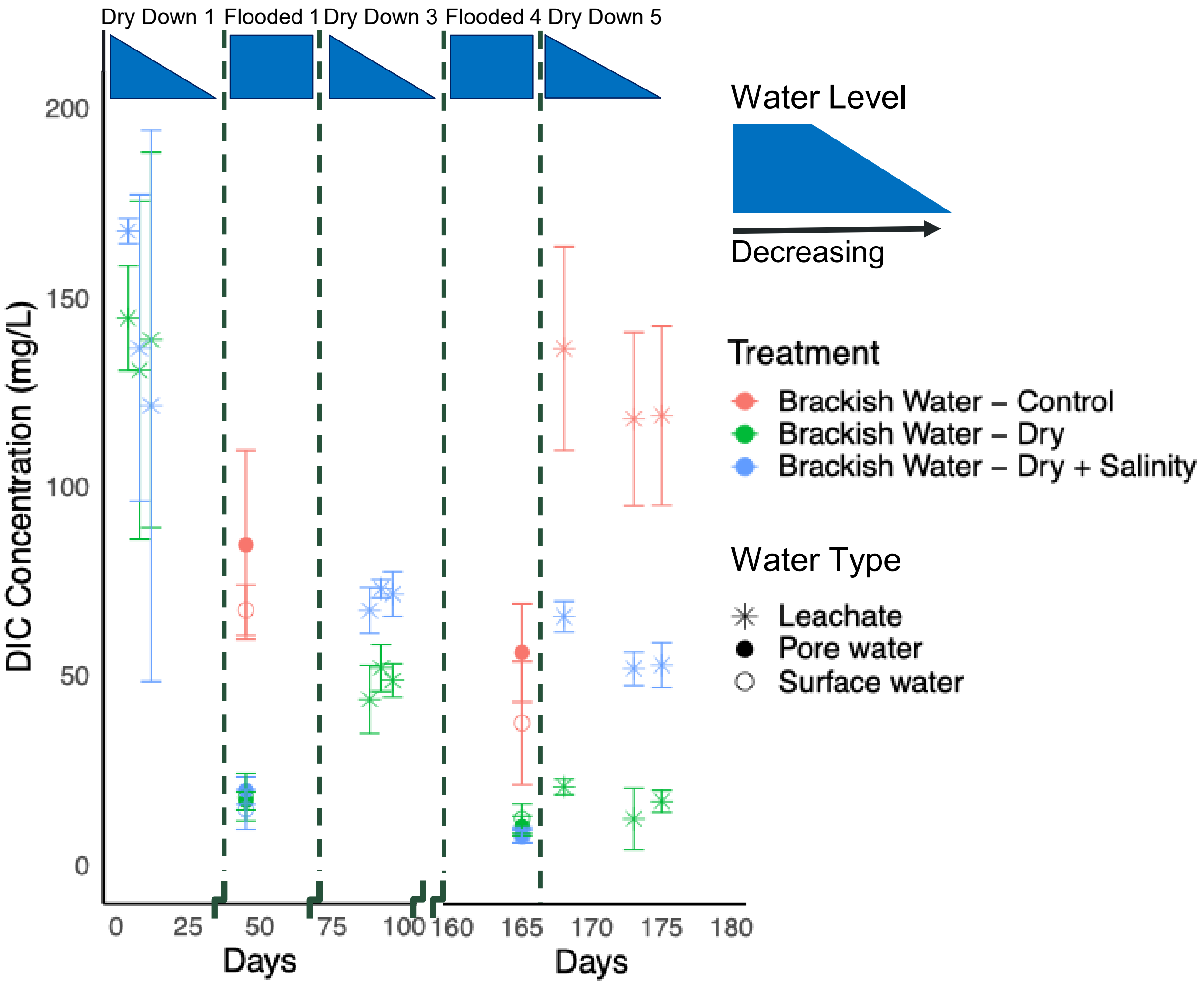


Preliminary Results

Mean DIC over Time

Brackish Water

- DIC concentrations in leachate, pore water and surface water ***declined*** over time for experimental treatments (30 – 90% decrease).
- At the end of Dry Down 5 (Days = 176), treatments Dry and Dry + Salinity had an 86.5% and 55.5% ***decrease*** in DIC compared to the control (lnRR = -1.94, 95% CI [-2.19 – -1.68] and lnRR = -0.81, 95% CI [-1.03 – -0.58], respectively).
- Effect size CI's indicates significant treatment effects on DIC.



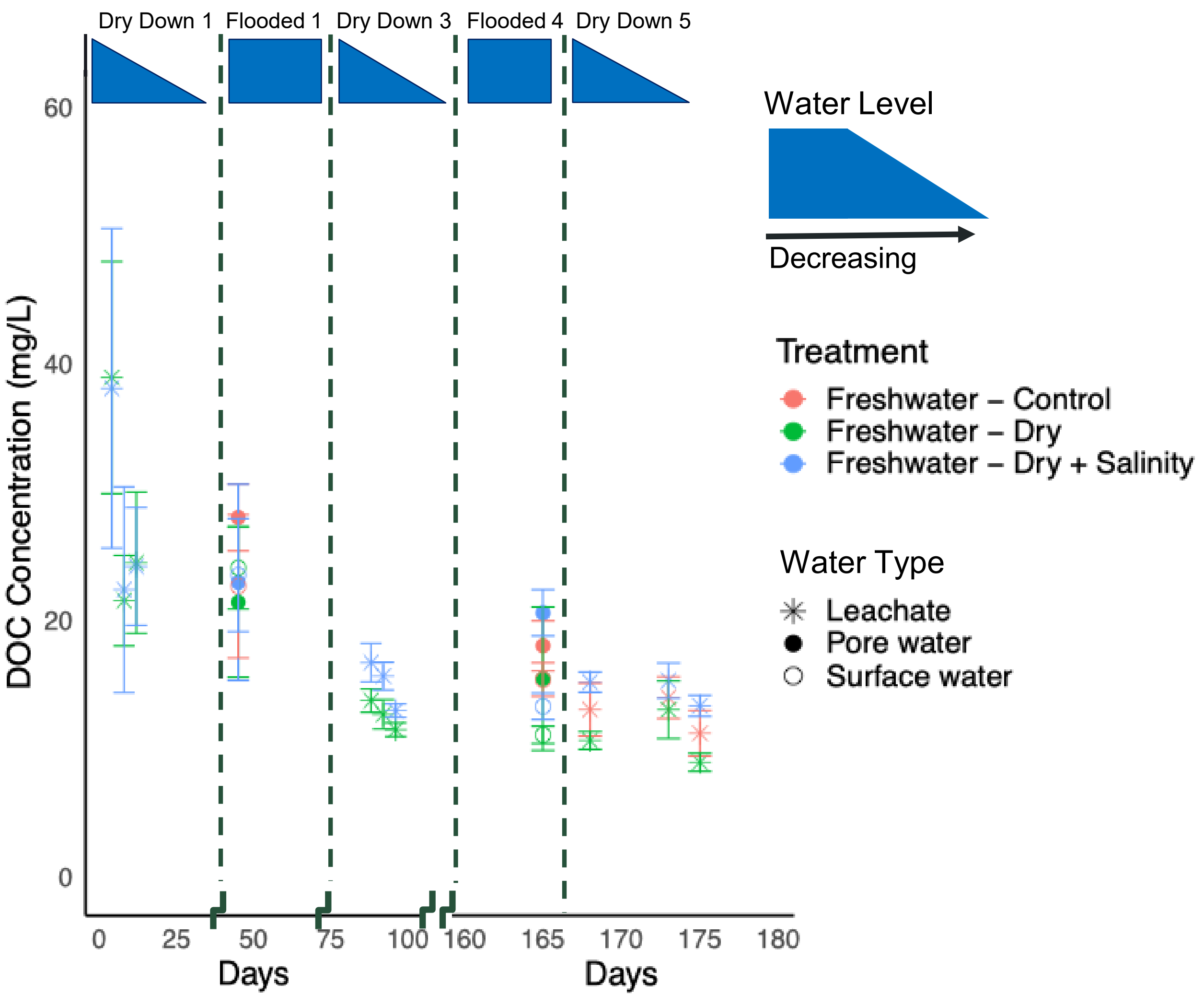
Preliminary Results

Mean DOC over Time

Freshwater

- DOC concentrations in leachate and pore water and surface water ***declined*** over time for experimental treatments (10 – 72% decrease).

- By the end of Dry Down 5 (Days = 176), treatments Dry and Dry + Salinity had a 20% ***decrease*** and an 19% ***increase*** in DOC compared to the control (lnRR = -0.22, 95% CI [-4.00 – -0.05] and lnRR = 0.17, 95% CI [0.08 – 0.34], respectively).



Preliminary Results

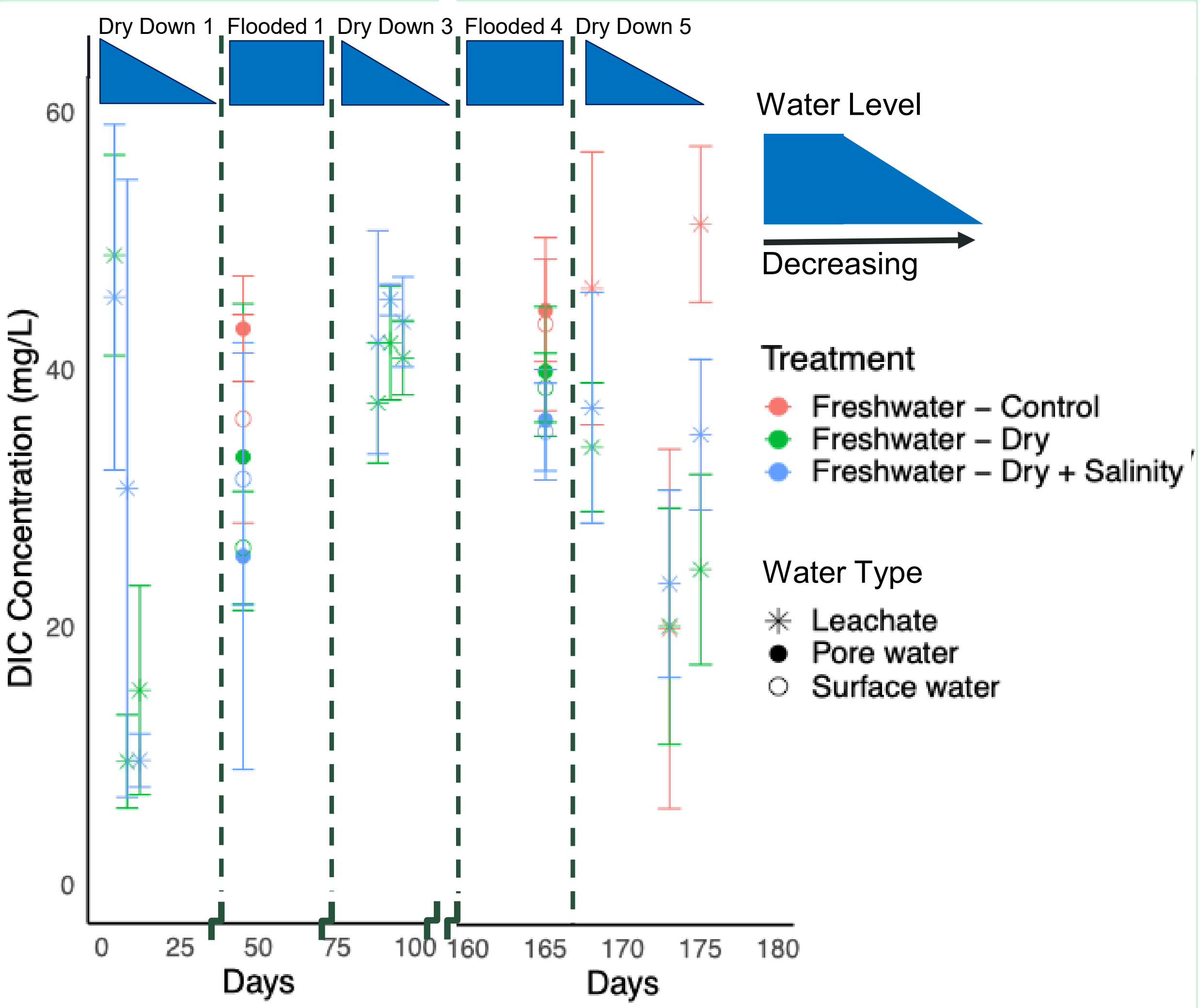
Mean DIC over Time

Freshwater

- DIC concentrations in leachate ***declined*** from the middle of the experiment and onward for experimental treatments (8 – 20% decrease).

- DIC in porewater and surface water ***increased*** with time (20 – 47% increase).

- By the end of Dry Down 5 (Days = 176), treatments Dry and Dry + Salinity had a 52.13% and 31.76% ***decrease*** in DIC compared to the control (lnRR = -0.74, 95% CI [-1.05 – -0.42] and lnRR = -0.38, 95% CI [-0.58 – -0.18], respectively).



Preliminary Findings

- DIC and DOC concentrations were generally highest in the control treatments for both brackish and freshwater cores, emphasizing the impact of dry down on aquatic carbon losses.

- DIC and DOC release in treatment cores was generally greatest in the leachate of the first dry down and declined over time.

- While dry down caused significant declines in DOC and DIC in brackish water cores, pulse events of increasing salinity do not appear to appear to additionally impact DOC but may boost DIC release in brackish water cores.

- Dry down generally coincides with declines in DOC and DIC over time in the leachate of freshwater cores; however, added salinity may boost DOC and DIC release, and some pore water and surface water concentrations increased in DIC over time.

Conclusions and next steps!

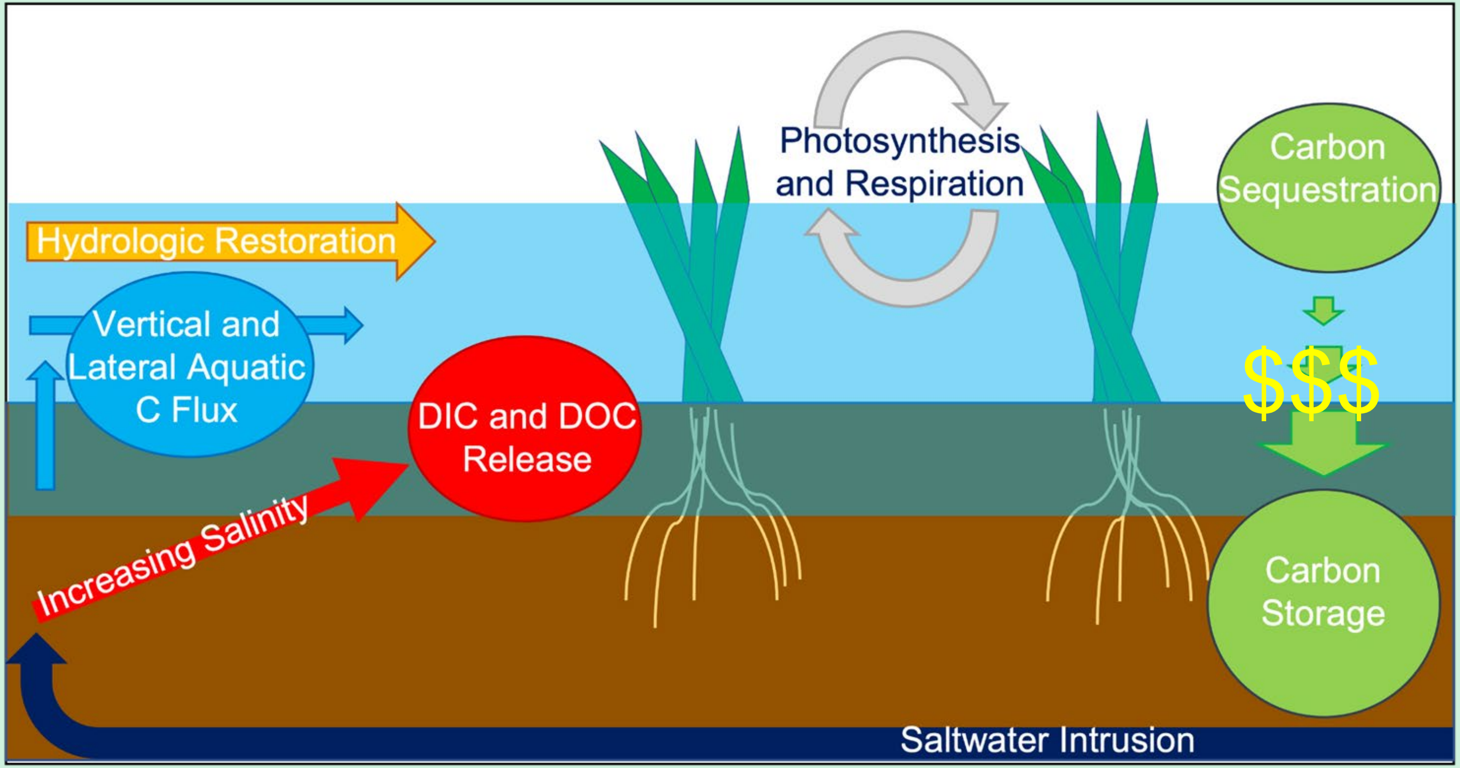
- *In our lab-based experiment, dry down is a key driver of aquatic carbon release in wetland ecosystems.*

- *In brackish water marsh systems, salinity has a limited impact on DOC release but may enhance DIC release.*

- *In freshwater marsh systems, salinity may enhance DOC and DIC release. Periods of higher water level coincide with greater DIC.*

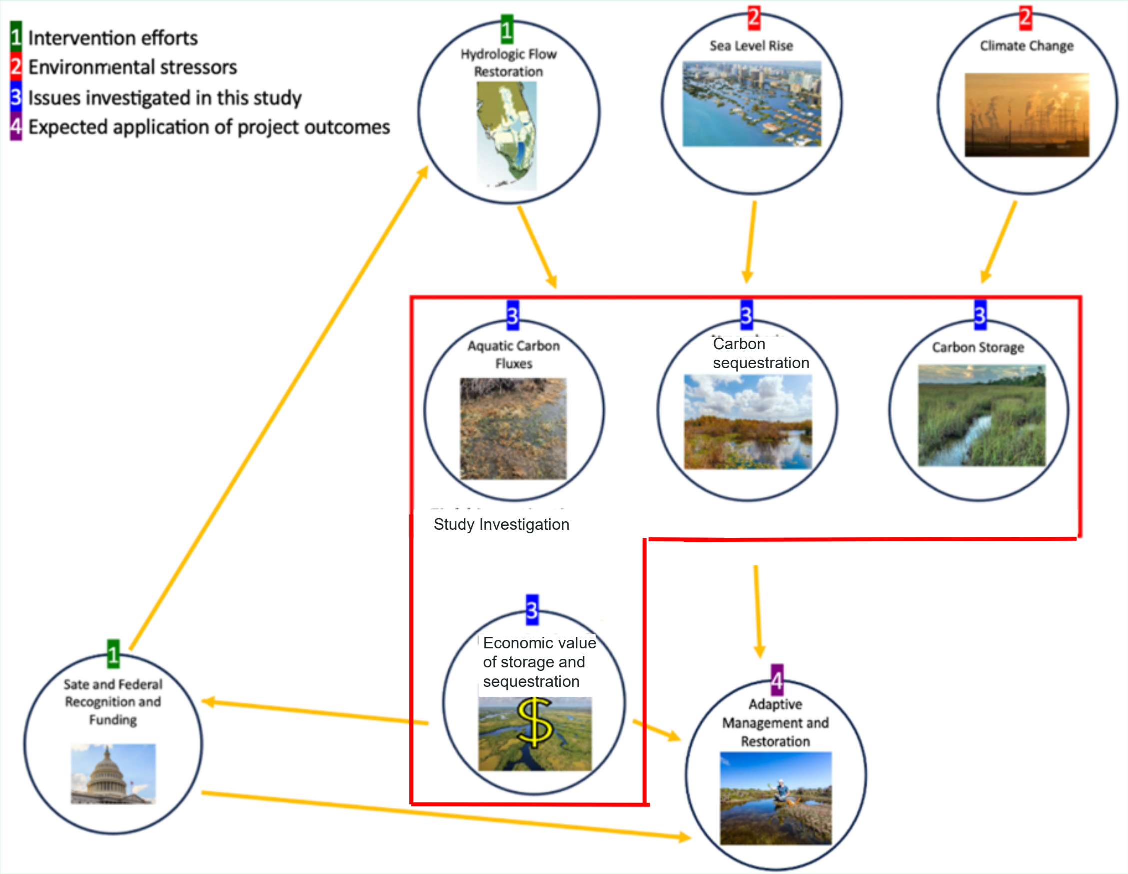
- *Analysis is still on-going! To be continued…*

Dissertation Research Focus



Carbon pools, fluxes and carbon dynamics explored in this study.

Conceptual Model



Conceptual model of drivers and impacts, research addressed in this study and potential project outcomes.

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