Balancing Estuarine Light and Salinity with Restoration and Operations on the Resiliency Superhighway.

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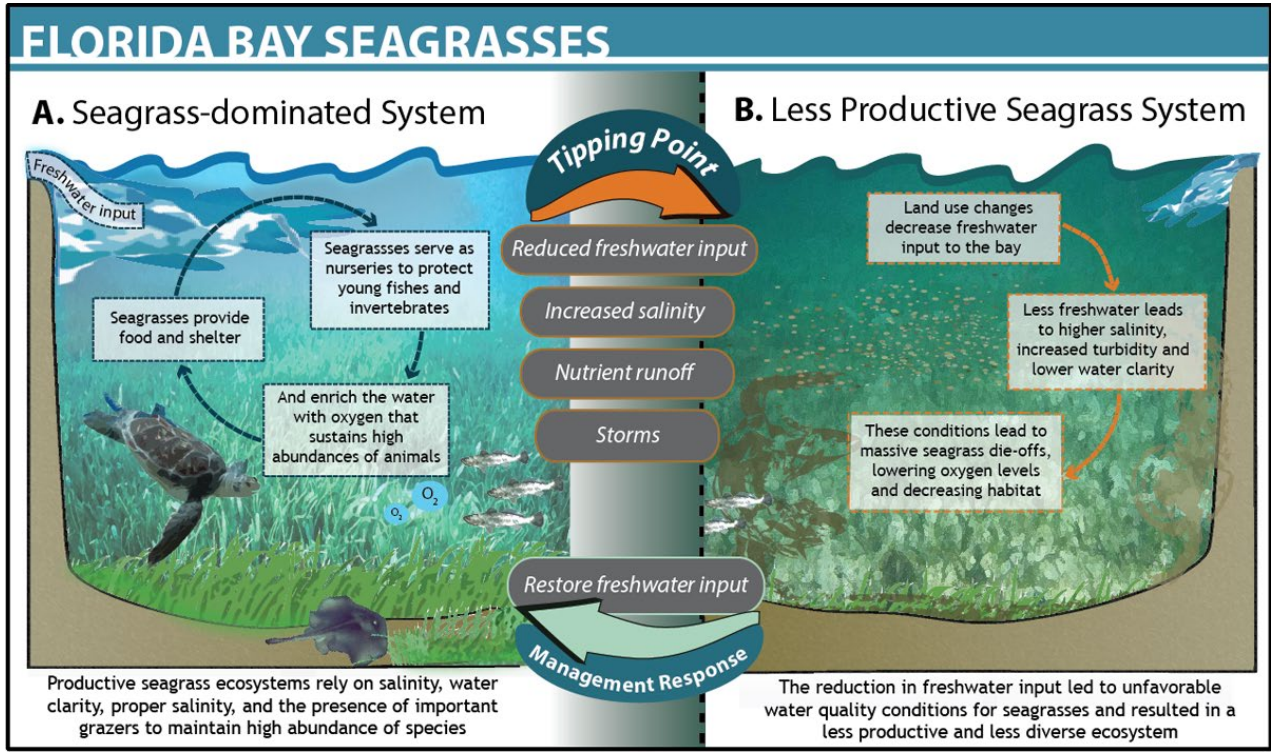
Image generated with ChatGPT using the title of the presentation as the prompt

Seagrass Ecosystems

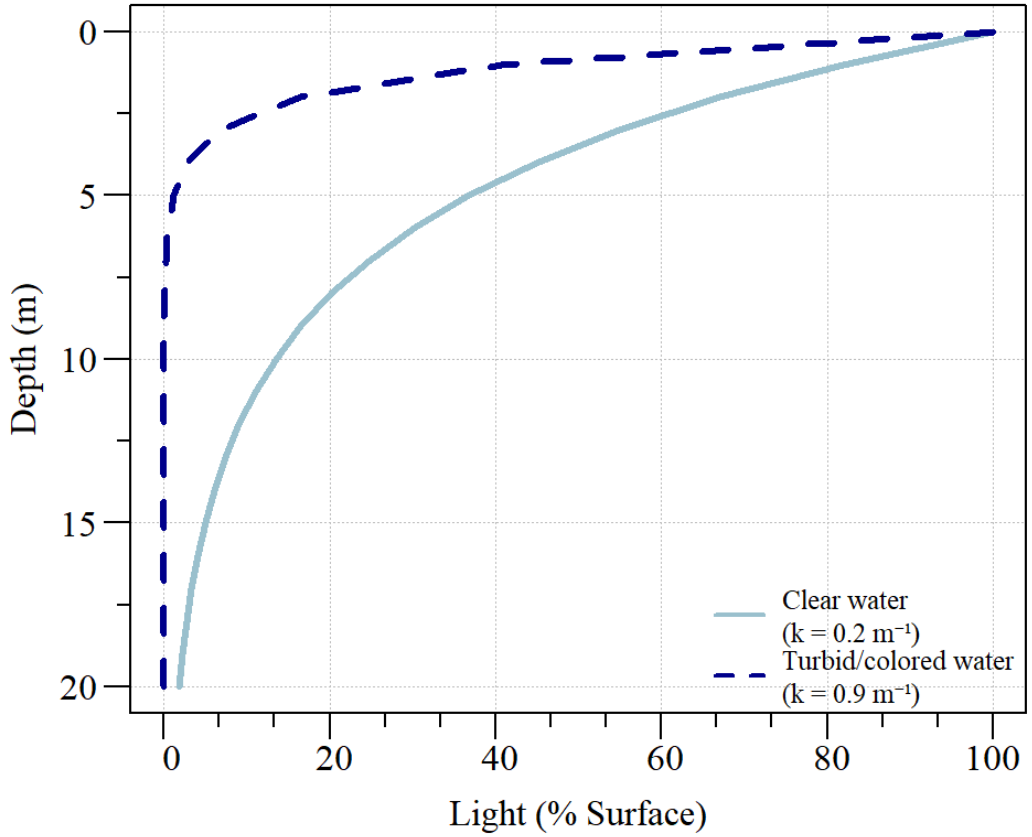
- Vitally important ecosystem
- Sensitive to anthropogenic pressures
  - water quality (nutrients, biological and optical parameters)
  - freshwater management
- Generally, light limited



http://oceantippingpoints.org/seagrasses-florida-bay

Light Attenuation

- How light moves through the water column is an additive function of light scattering and absorbing characteristics.
- Important for photosynthetic benthic organisms.
- Management actions can be developed to restore/improve the underwater light environment.

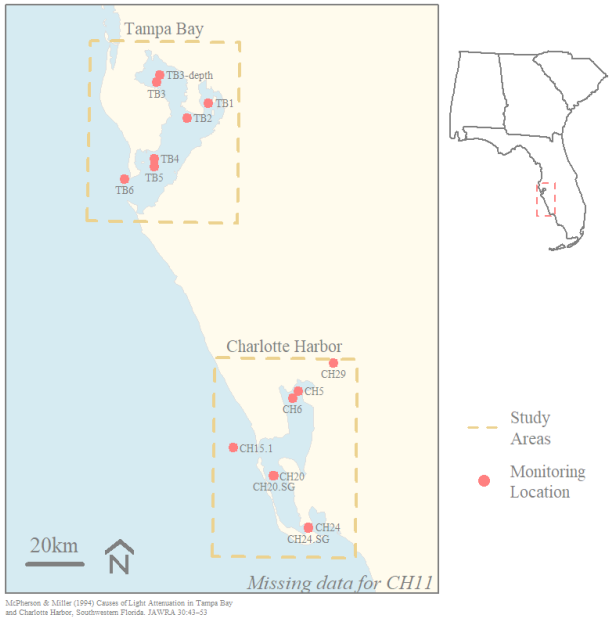


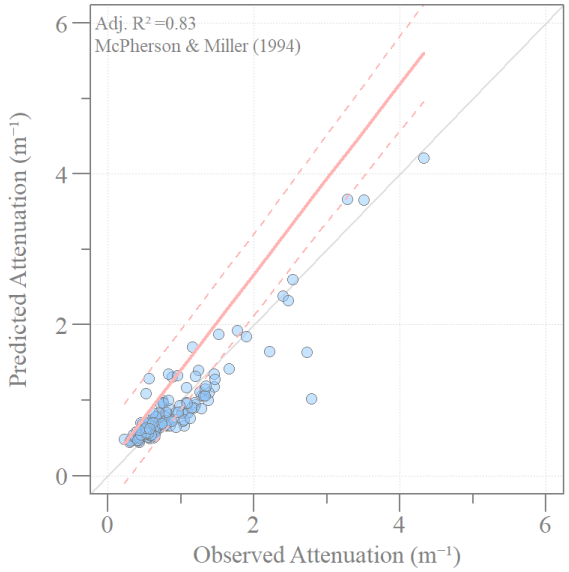
Light Attenuation

- Light attenuation coefficient (K_d) gives a metric of water clarity.
- Statistical models can be developed to estimate K_d.
- These models have been used to develop restoration goals/targets (Corbett and Hale 2006).

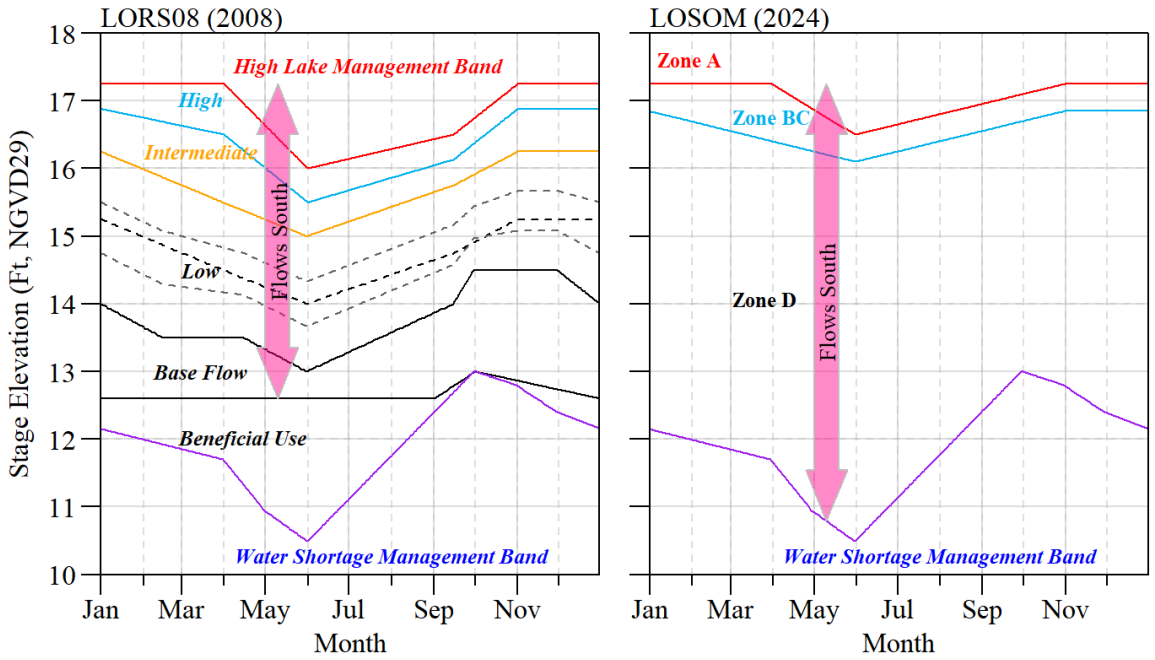
$$K_d = 0.014 \times Color + 0.062 \times Turb + 0.049 \times Chla + 0.30$$

McPherson and Miller (1994)





Caloosahatchee River Water Management

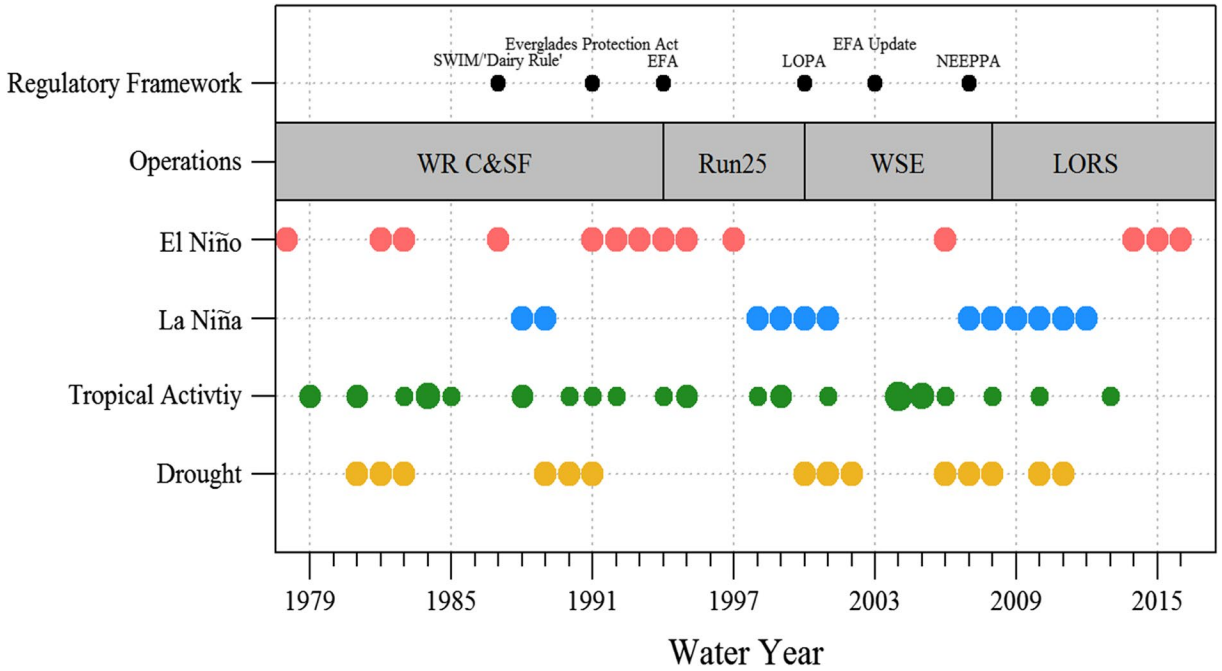


Prior (left) and current (right) Lake Okeechobee Regulation Schedule.

Courtesy of L Reidenbach

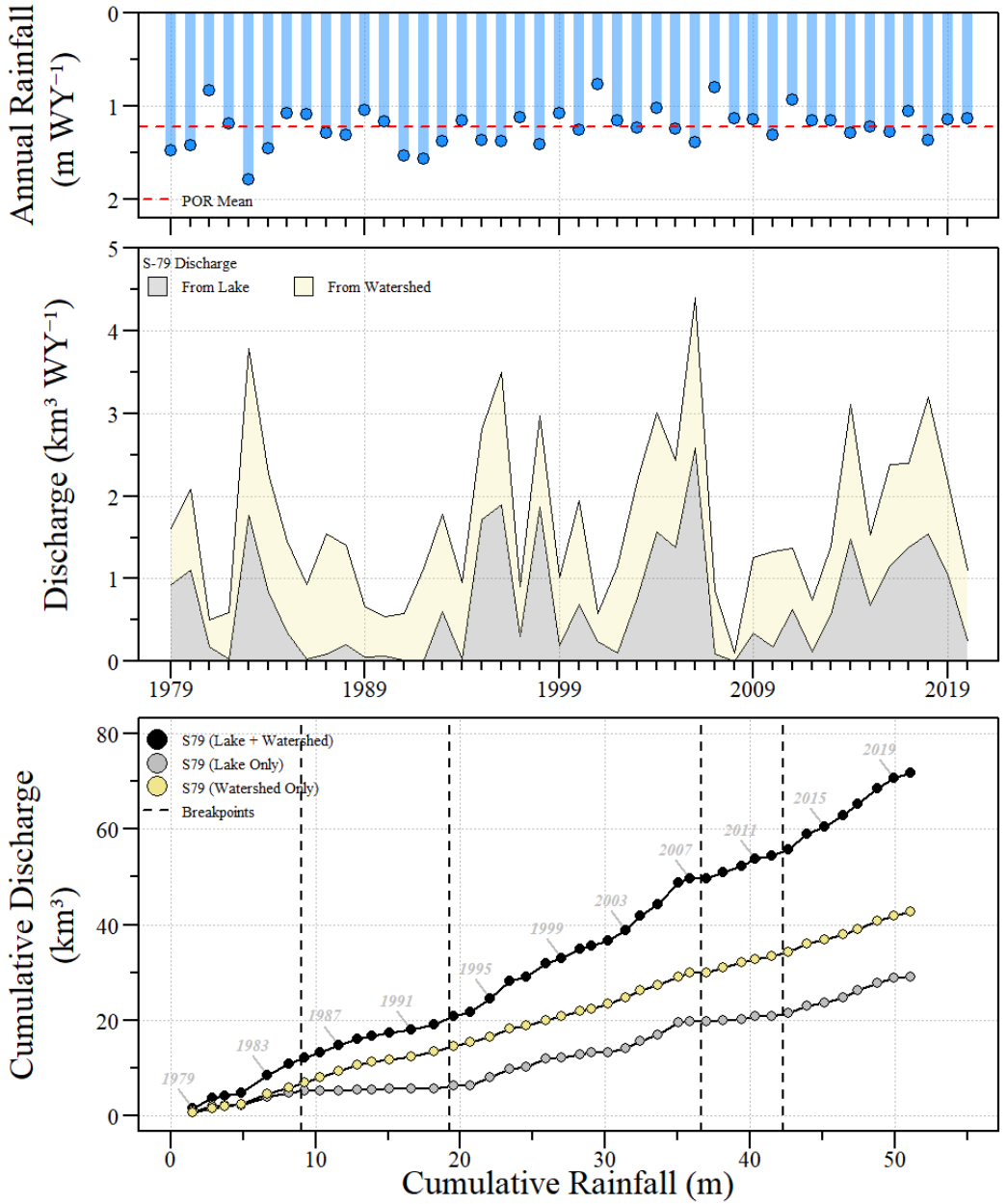
- Major freshwater inputs to Caloosahatchee managed based on LOSOM via S79 (aka Franklin Lock)
- Other smaller tributaries

Hydrology



Julian and Osborne (2018)

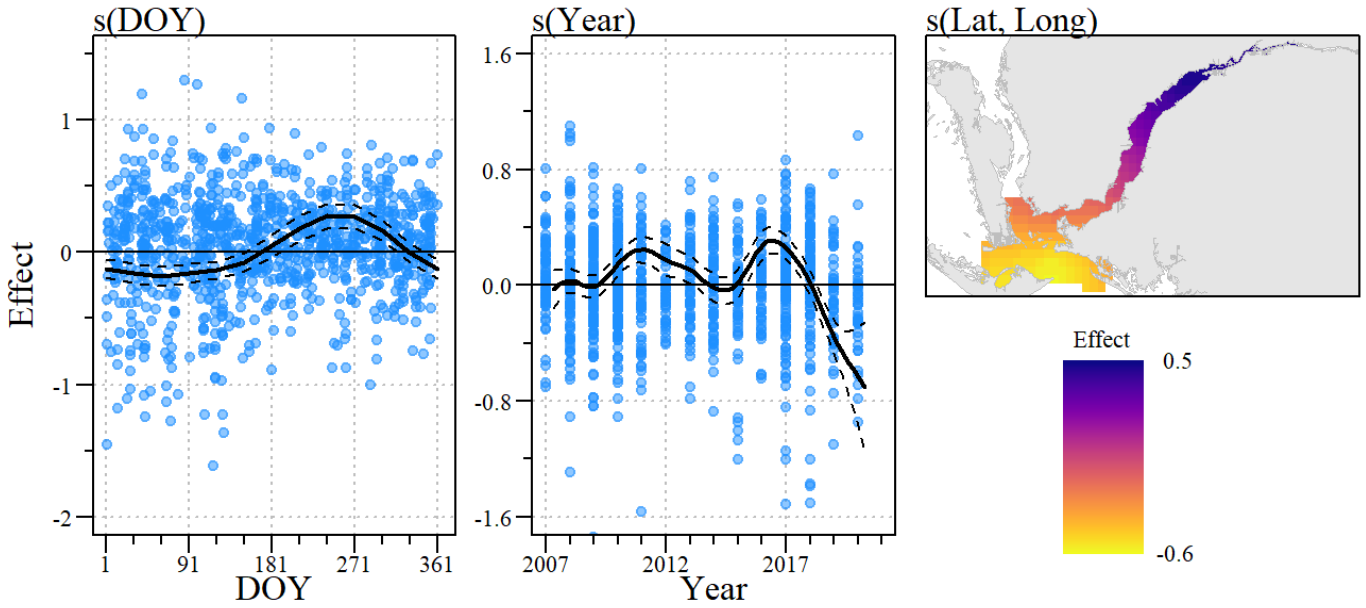
- Watershed significantly contributes freshwater to the estuary.
- Changes to rainfall-runoff relationship over time linked to upstream water management (and climate).



Julian et al. (2024)

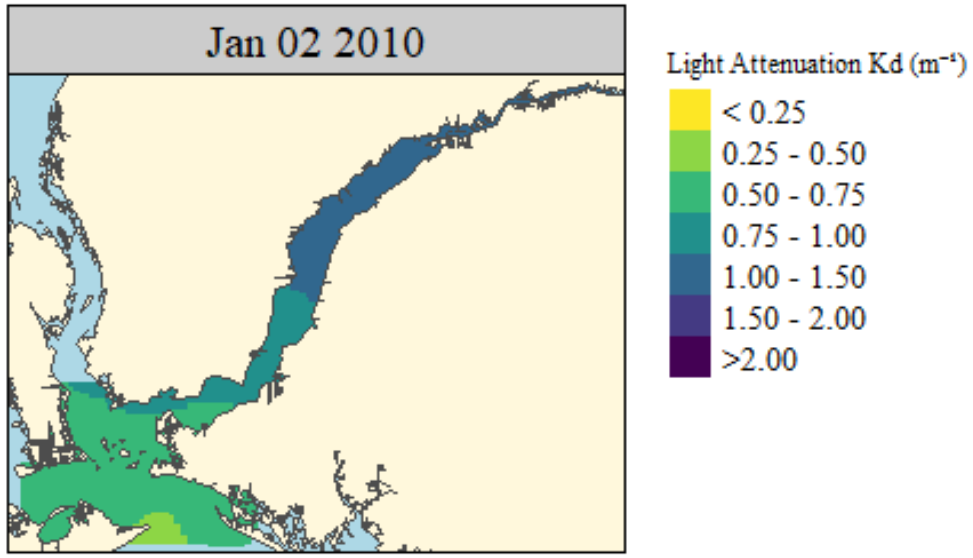
Light Attenuation Model

- Space and time model (2008-2020).
  - High spatial and temporal variability in parameters
  - Lead to space-time GAM



Adjusted R-squared: 0.70, Deviance explained 0.74

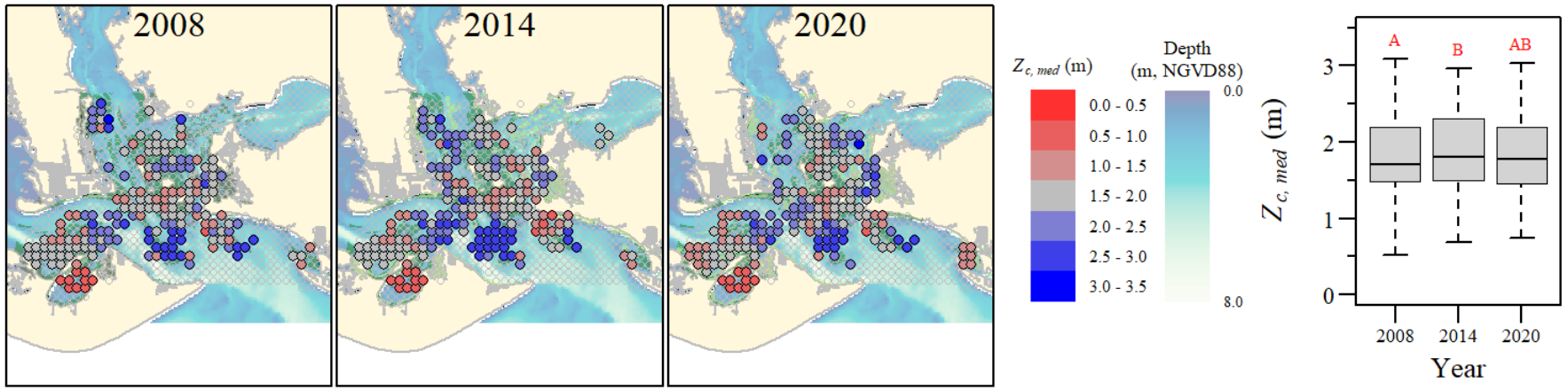
Example of K_d prediction (2010)



Seagrass Colonization Depth

In the lower Caloosahatchee River

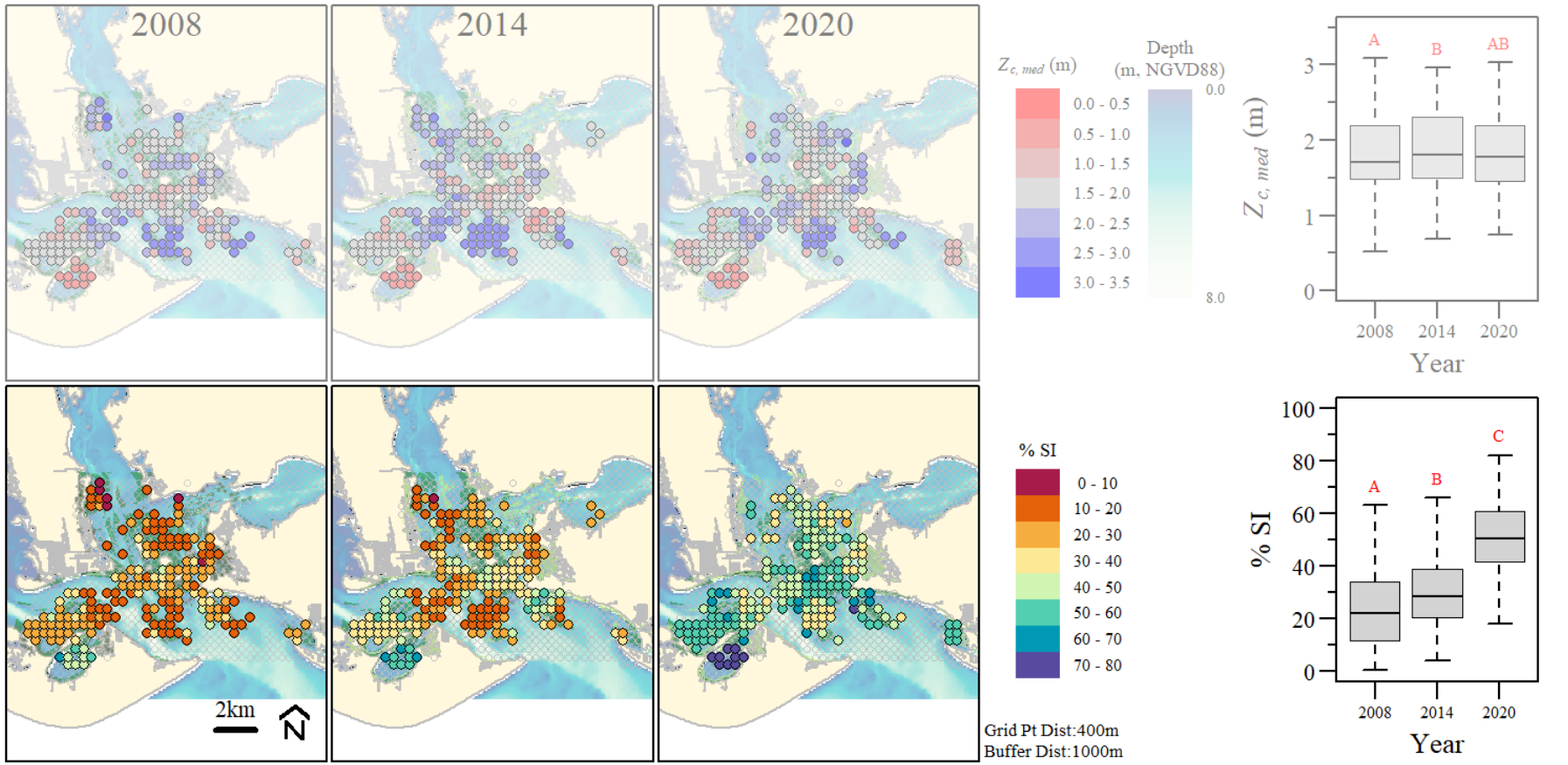
- Pairwise differences in depth of colonization have occurred between years over the decade



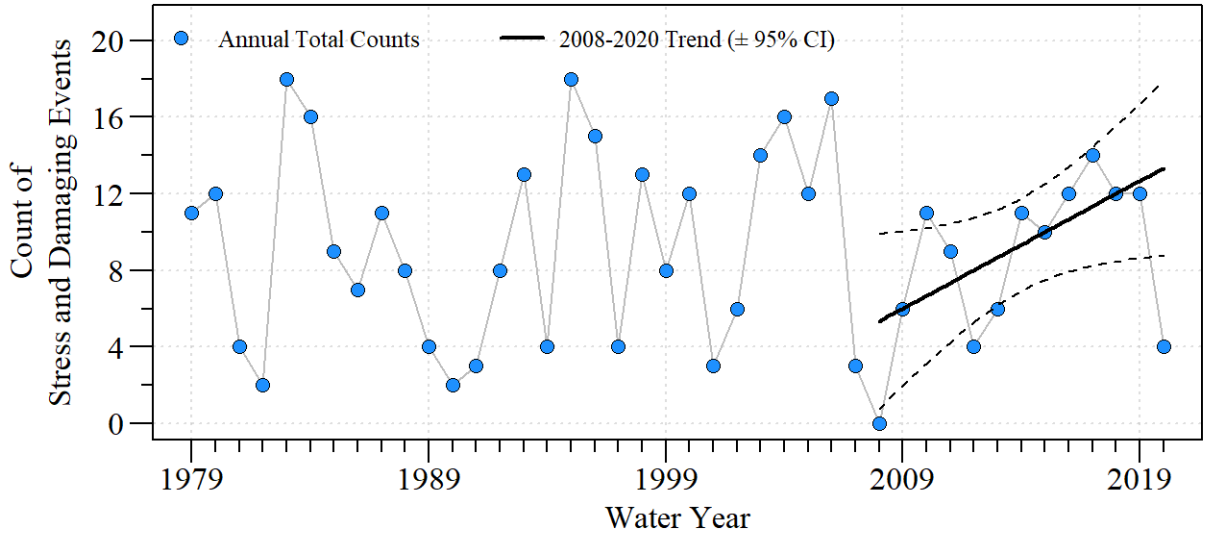
Seagrass Colonization Depth

In the lower Caloosahatchee River

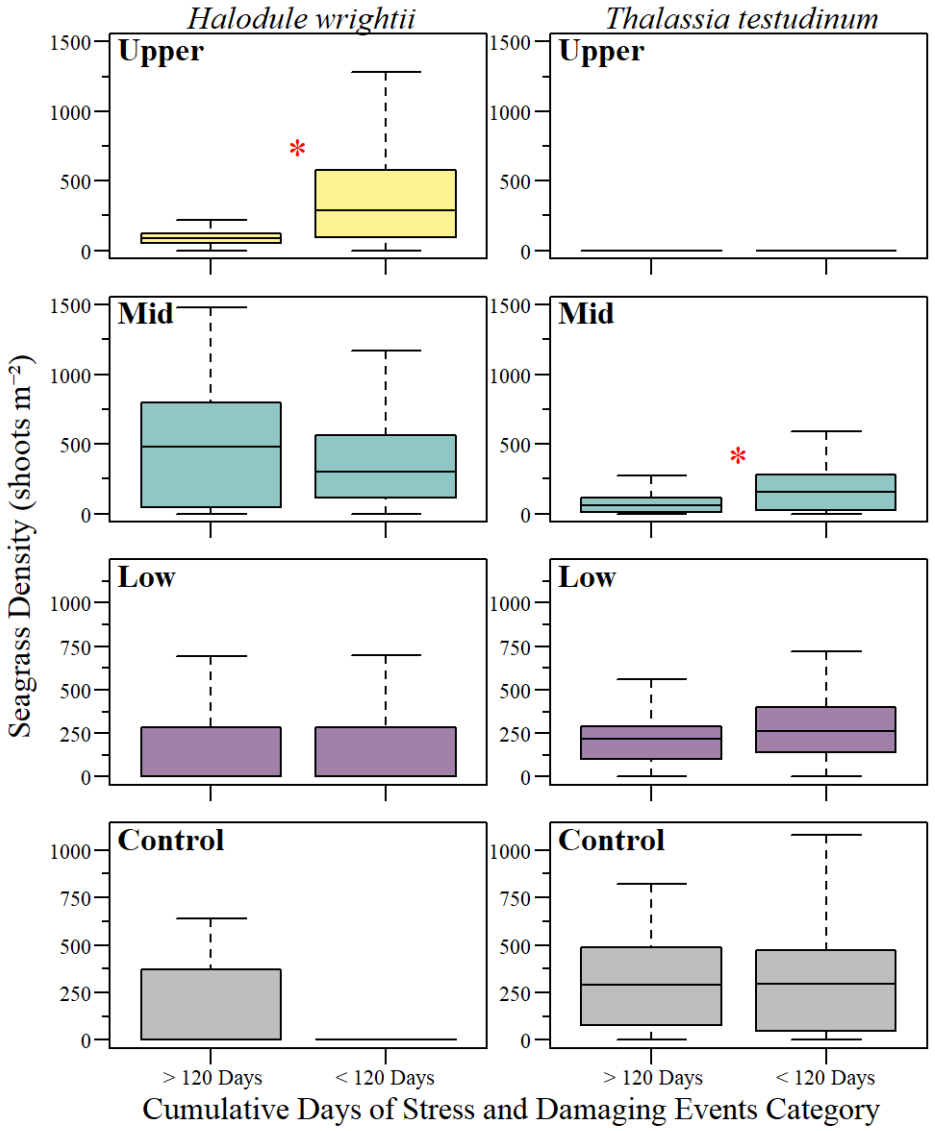
- Pairwise differences in depth of colonization have occurred between years over the decade
- %SI was significantly different between years and increasing



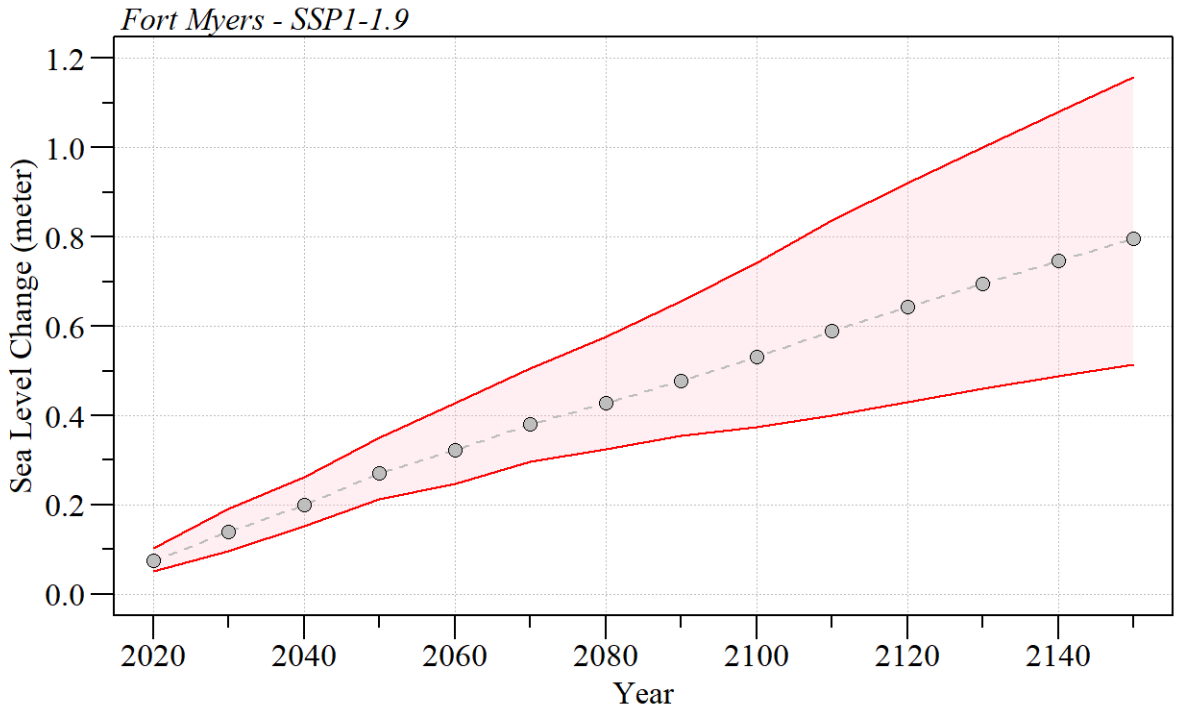
Freshwater Discharge and Seagrass



- Since 2008, the count of annual stress and damaging events (> 2100 cfs @ S79) has significantly increased peaking with H. Irma.
- During this period K_d values have also varied (significant decline post Irma).
- The duration of these events has a significant impact on seagrass density.



Sea-level rise effect

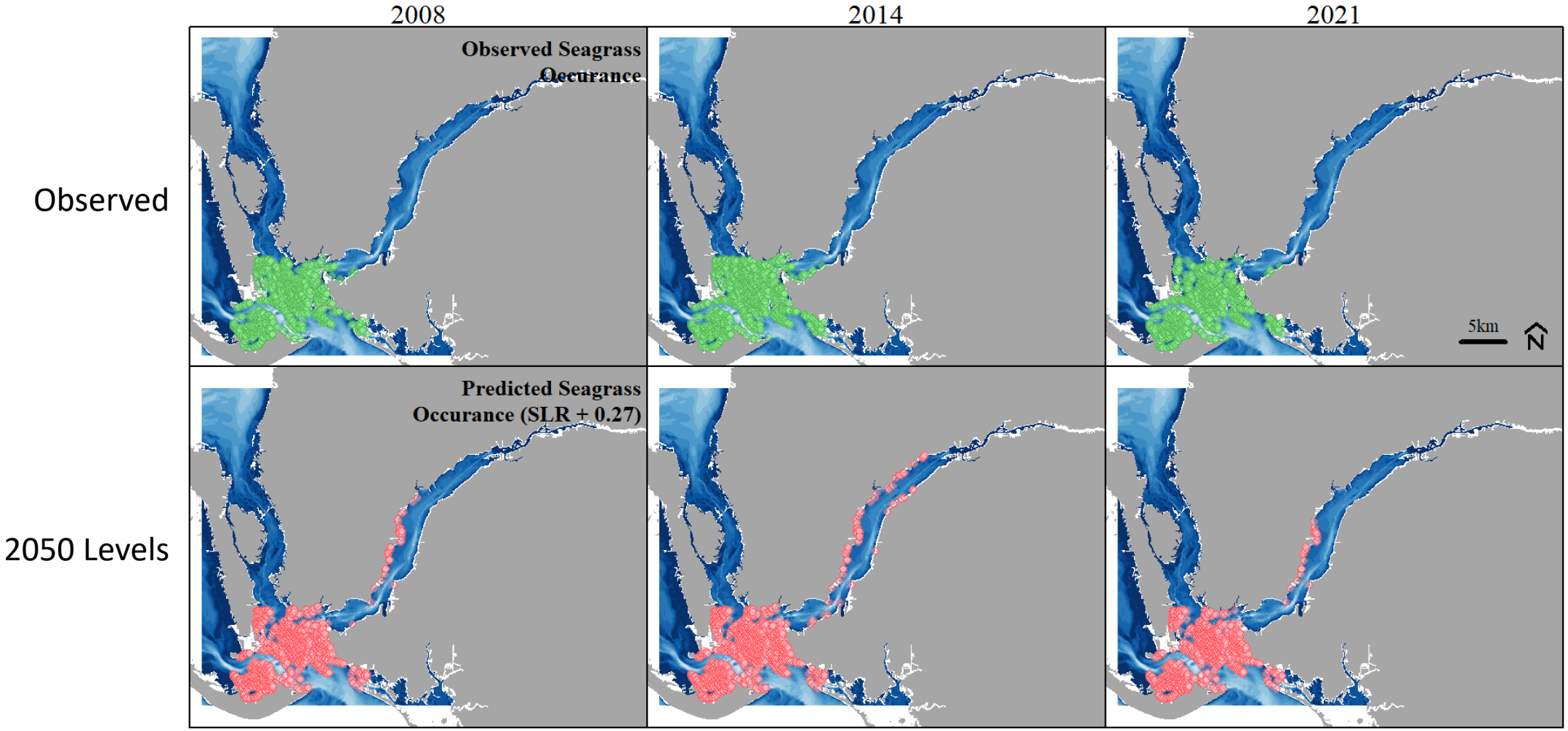


https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool?psmsl_id=1106&data_layer=scenario

SSP1-1.9: Holds warming to approximately 1.5°C above 1850-1900 in 2100 after slight overshoot (median) and implies net zero CO2 emissions around the middle of the century

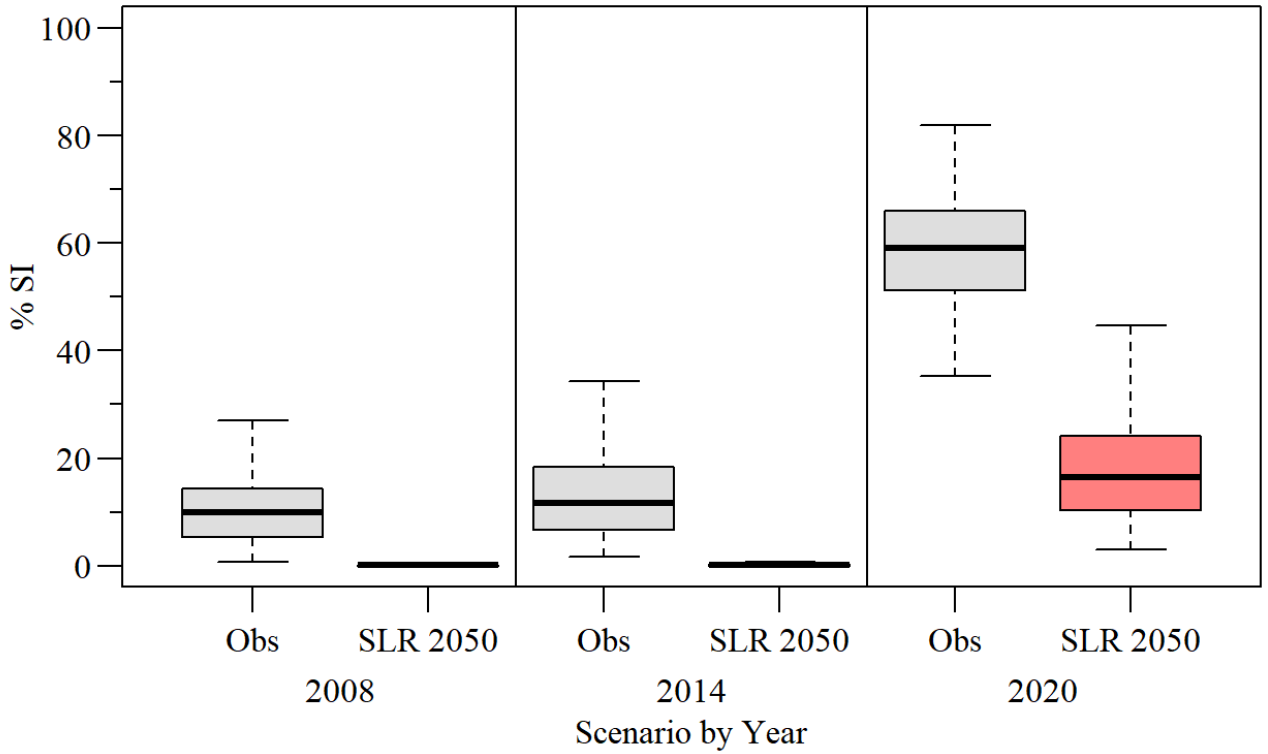
Sea-level rise effect

- Simple spatial presence/absence model using seagrass coverage data and bathymetry meeting
- How does sea level rise potentially change seagrass distribution?

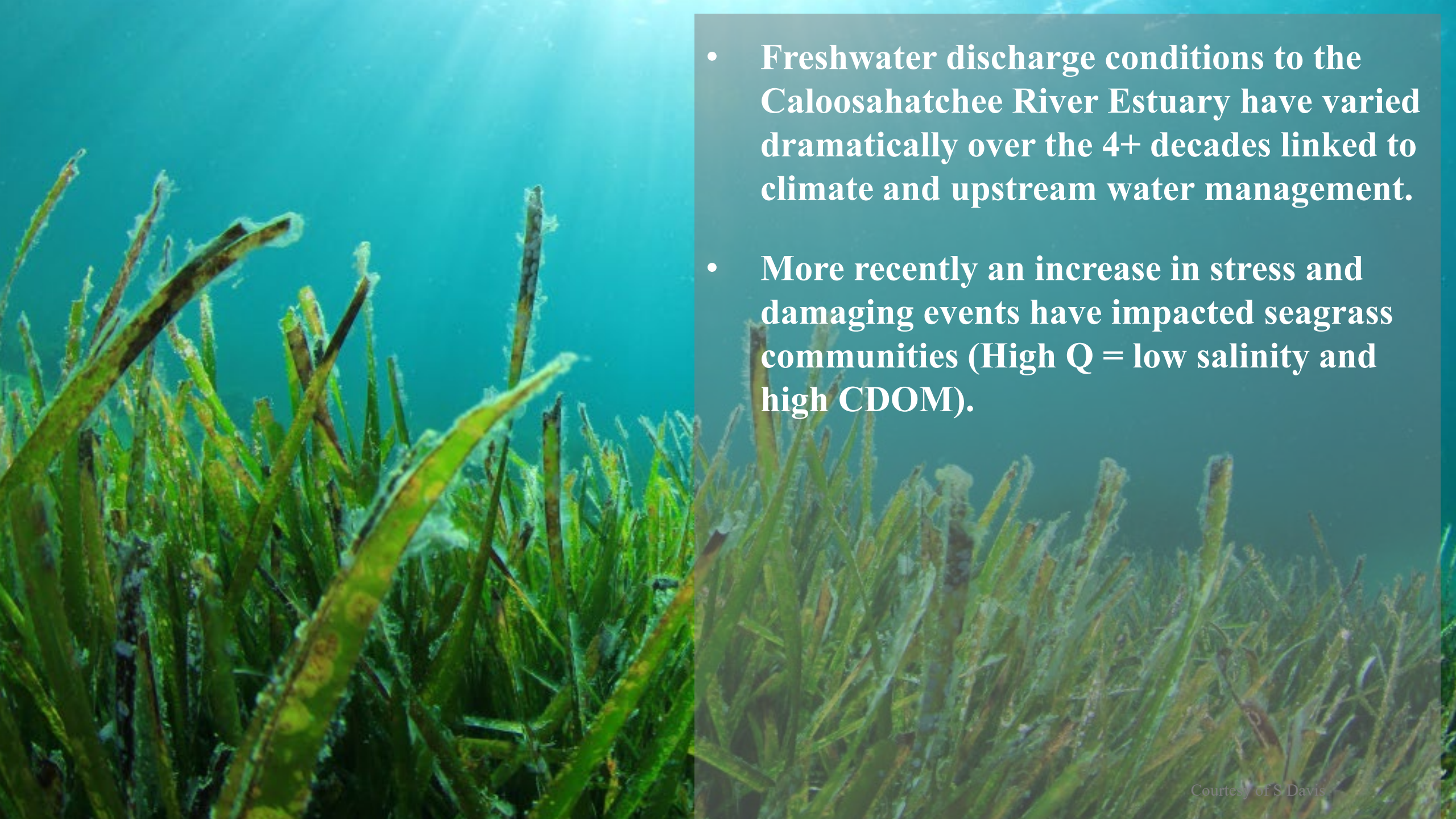


Sea-level rise effect

- Sea level change of 0.27 meters
- How does potential sea-level rise affect surface irradiance?

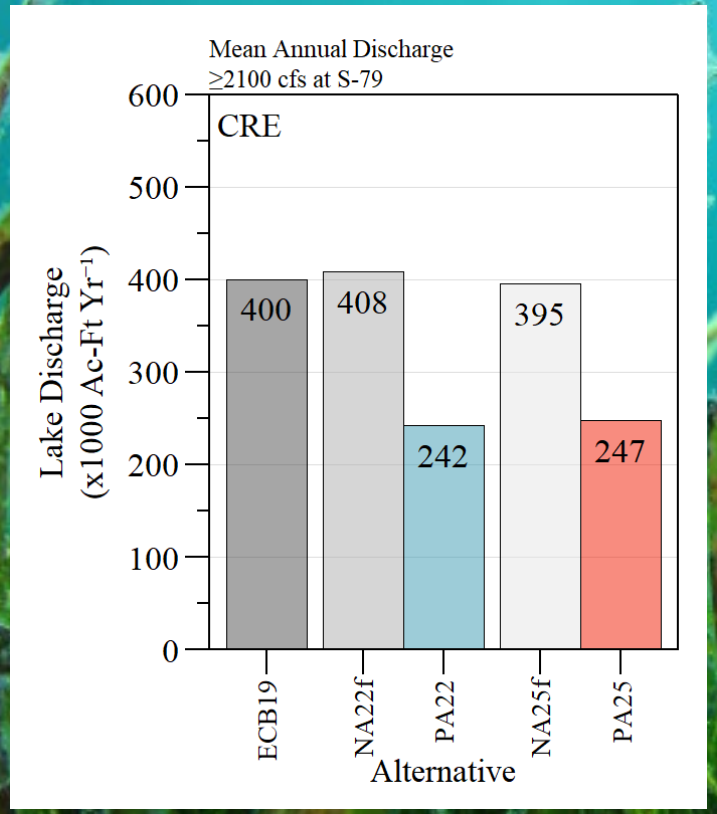


Comparing observed and SSP1-1.9 (0.27 m) percent surface irradiance (%SI)



- **Freshwater discharge conditions to the Caloosahatchee River Estuary have varied dramatically over the 4+ decades linked to climate and upstream water management.**
- **More recently an increase in stress and damaging events have impacted seagrass communities (High Q = low salinity and high CDOM).**

Courtesy of S. Davis



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- **New Lake Okeechobee regulation schedule aims to reduce stress and damaging flow events to the Caloosahatchee making the system more resilient.**

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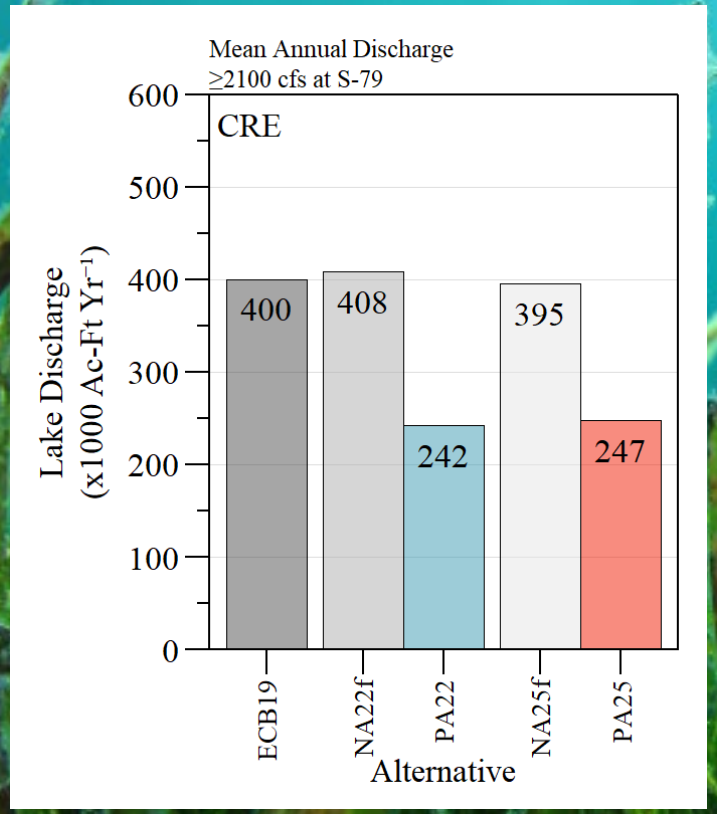

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- New Lake Okeechobee regulation schedule aims to reduce stress and damaging flow events to the Caloosahatchee making the system more resilient.
- **Need to understand uncertainty in SLR relative to changes in water quality and freshwater inputs.**

Courtesy of S. Davis