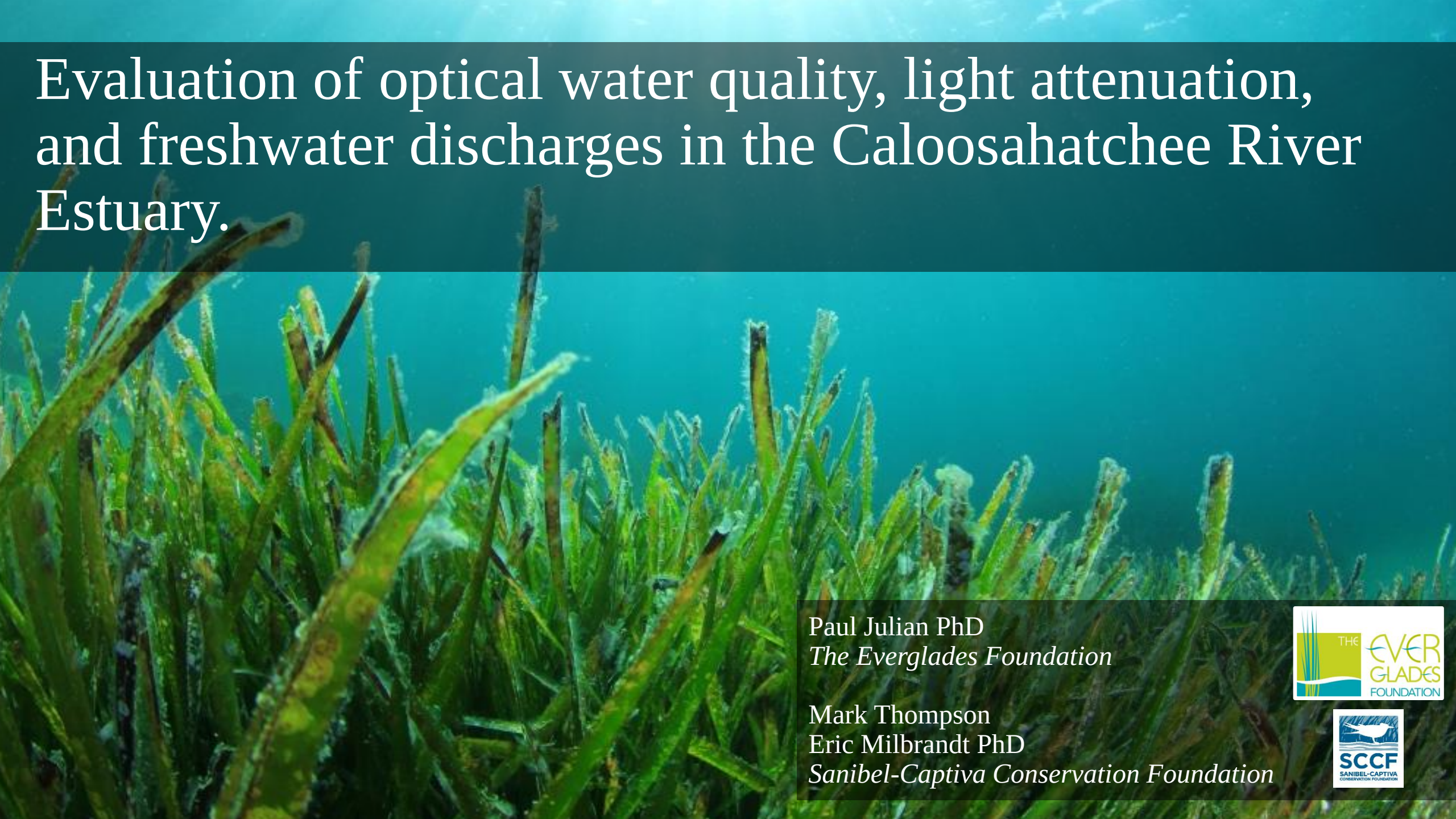
Evaluation of optical water quality, light attenuation, and freshwater discharges in the Caloosahatchee River Estuary.

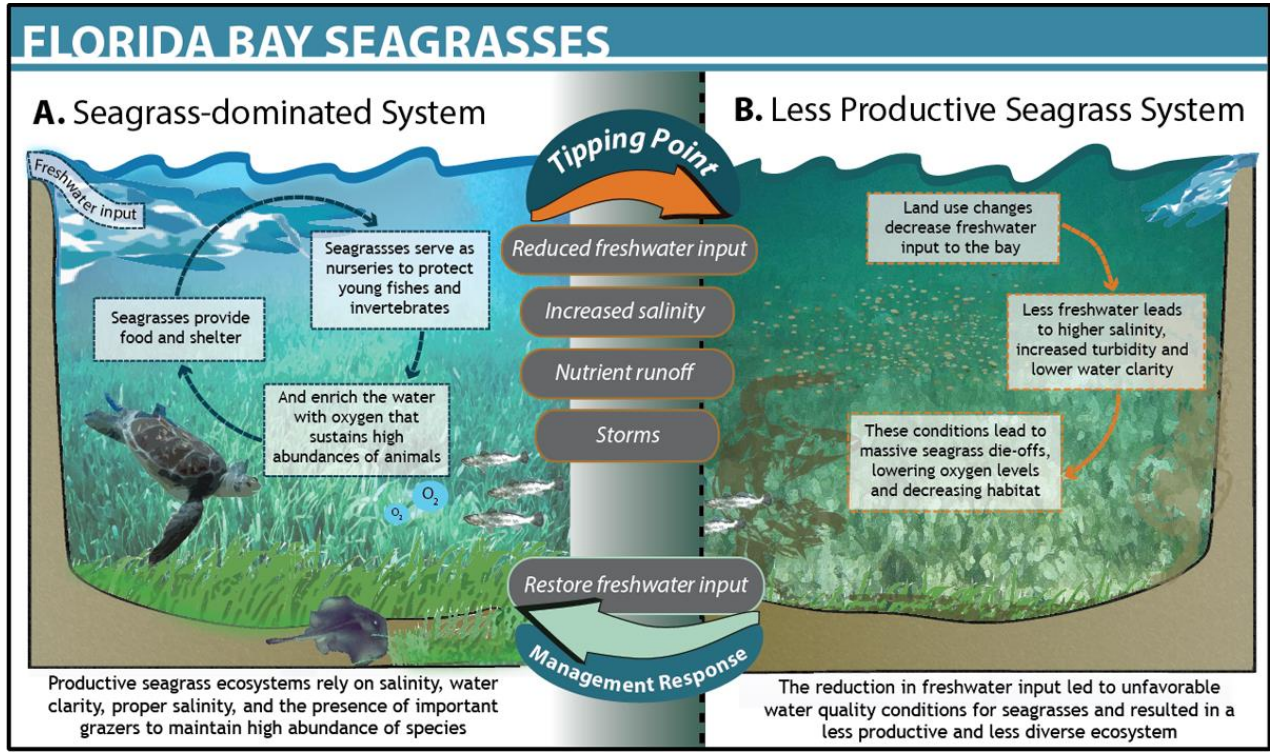


Paul Julian PhD
The Everglades Foundation

Mark Thompson
Eric Milbrandt PhD
Sanibel-Captiva Conservation Foundation

Marine Seagrass Ecosystems

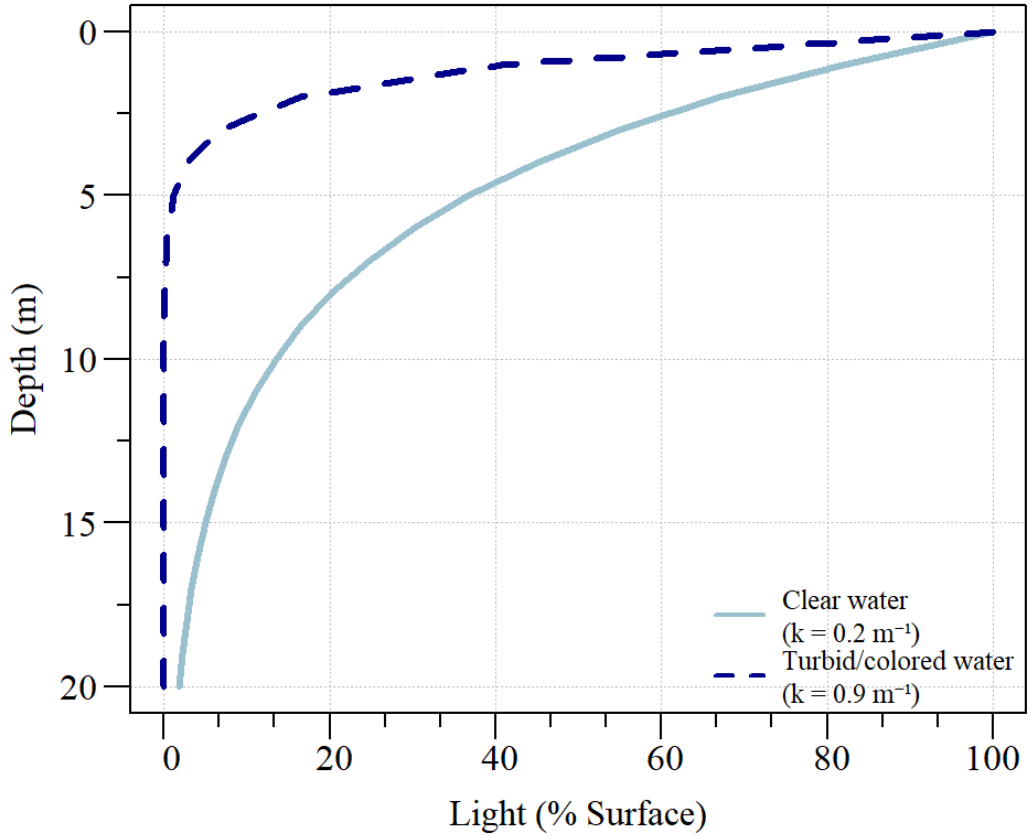
- Vitally important ecosystem
- Sensitive to anthropogenic pressures
  - water quality (nutrients, biological and optical parameters)
  - freshwater management
- Generally, light limited



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.

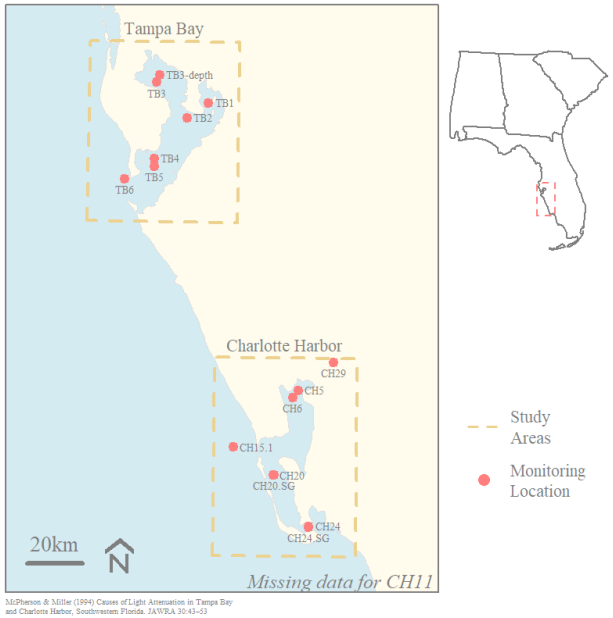


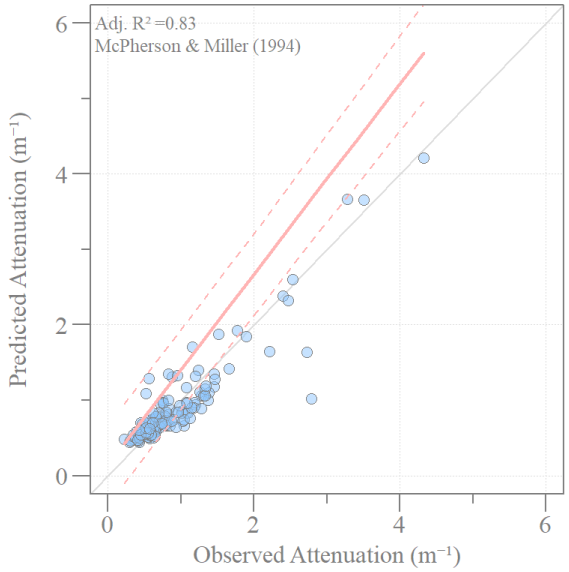
Light Attenuation

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

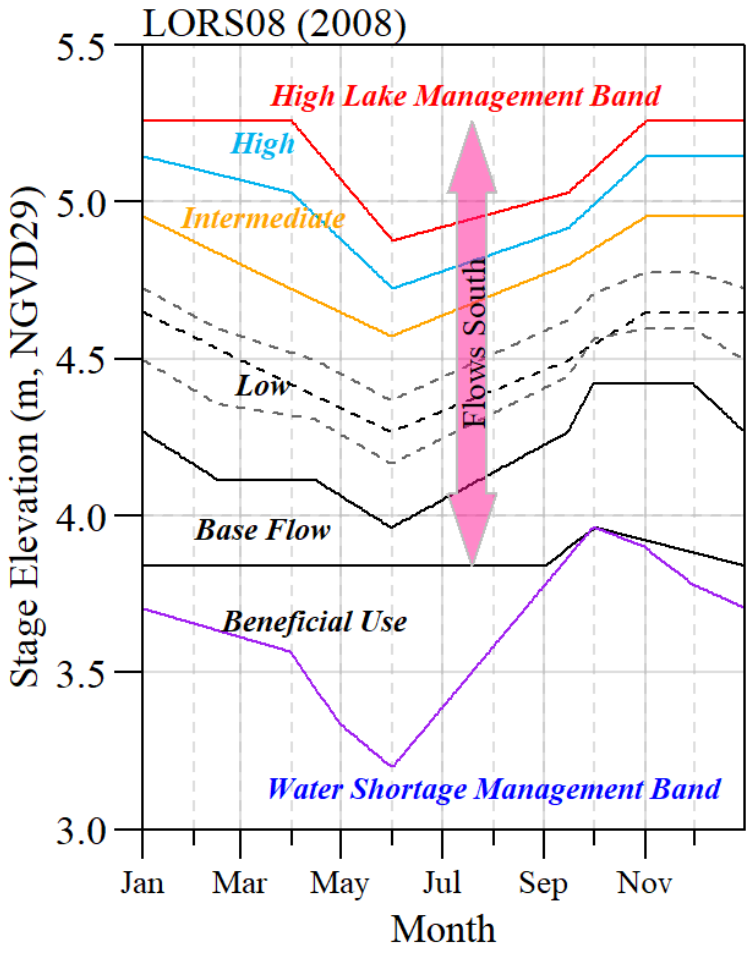
$$K_d = 0.014 \times Color + 0.062 \times Turb + 0.049 \times Chla + 0.30$$

McPherson and Miller (1994)





Caloosahatchee River Water Management



Julian and Reidenbach (Submitted)

Lake Okeechobee Regulation Schedule of 2008

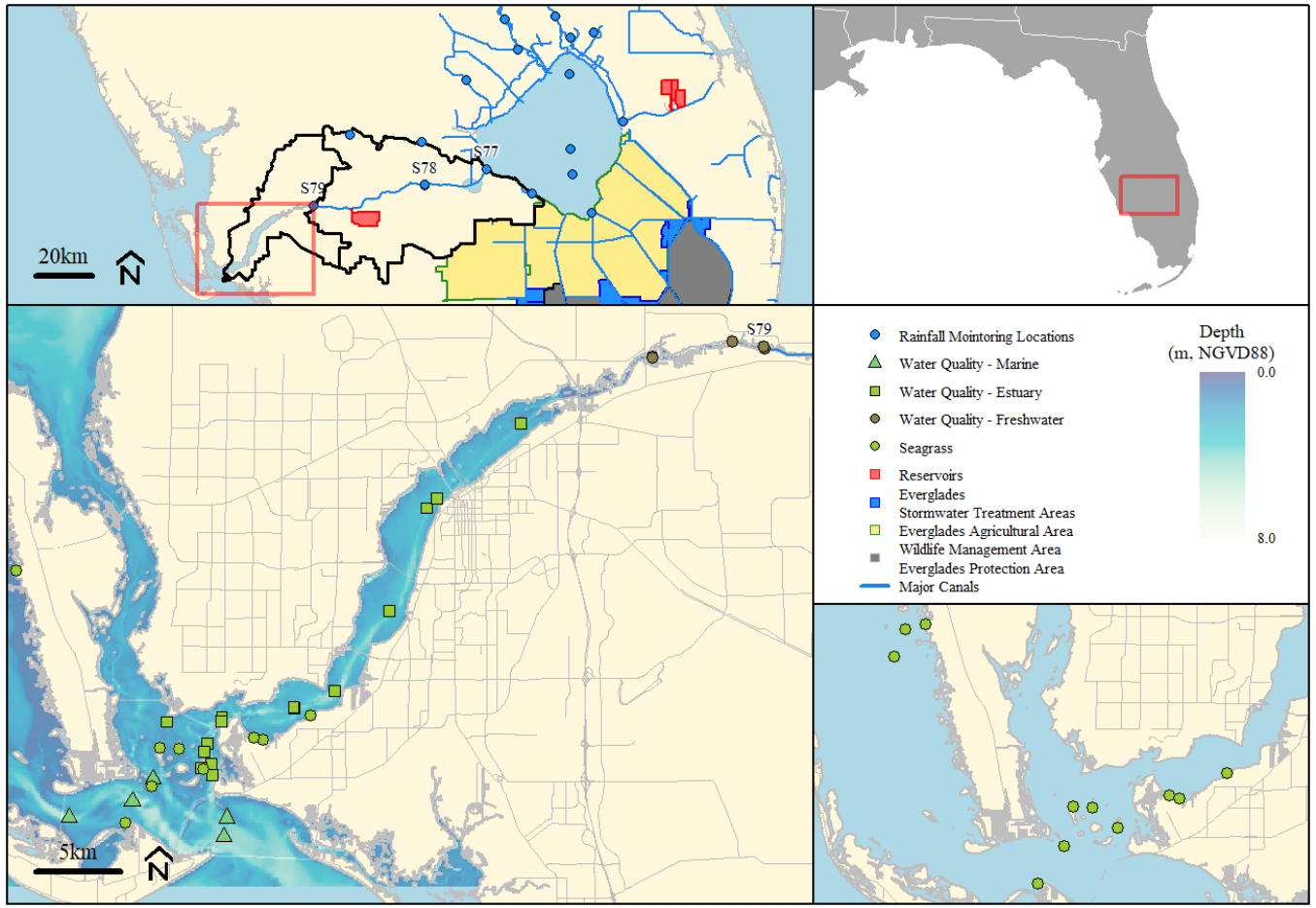
Courtesy of L Reidenbach

- Major freshwater inputs to Caloosahatchee Managed according to LORS08 via S79 (aka Franklin Lock)

Data and methods

- Objectives
  - Evaluate changes to freshwater inputs.
  - Develop a light attenuation model.
  - Evaluate changes in seagrass colonization depth.

- Multi-agency water quality, hydrology, and seagrass dataset (SFWMD, Lee County, SCCF).
- Bathymetry and seagrass areal coverage data retrieved from SFWMD.

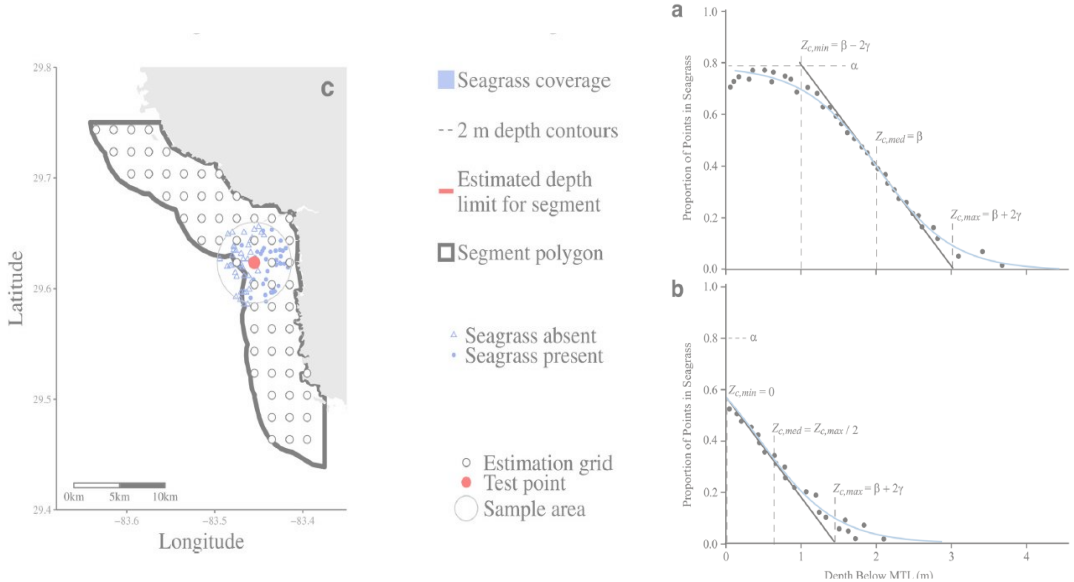


Data and methods

- Light Attenuation Model
  - Measured K_d was adjusted for light angle
  - Spatial and temporal generalized additive model (GAM) was fit to data

$$
\begin{aligned}
&K_d \\
&= \alpha + s(DOY) + s(CY) \\
&+ s(Long, Lat) + ti(DOY, CY) \\
&+ ti(Long, Lat, DOY) \\
&+ ti(Long, Lat, CY)
\end{aligned}
$$

- Colonization depth
  - Iterative process using observed seagrass coverage and bathymetry combined with a logistic model to estimate the median colonization depth of a given location within the estuary consistent with Beck et al (2018)

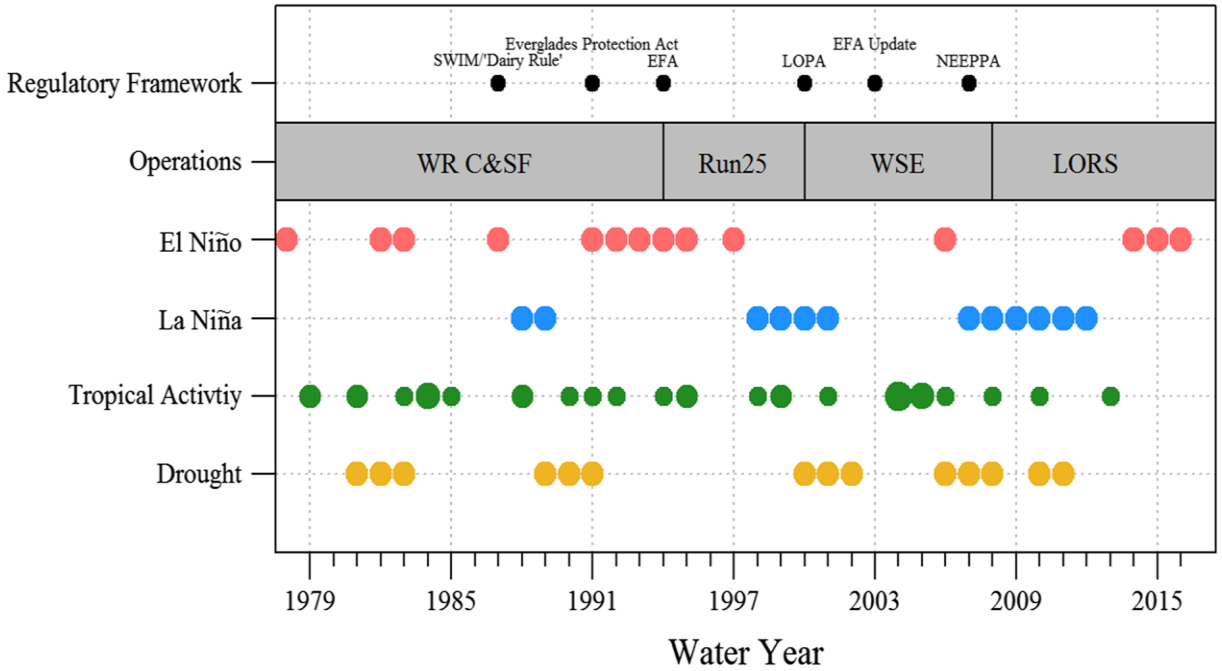


Beck et al (2018)

Space-Time GAM + Colonization Depth = spatially explicit percent subsurface irradiance (%SI)

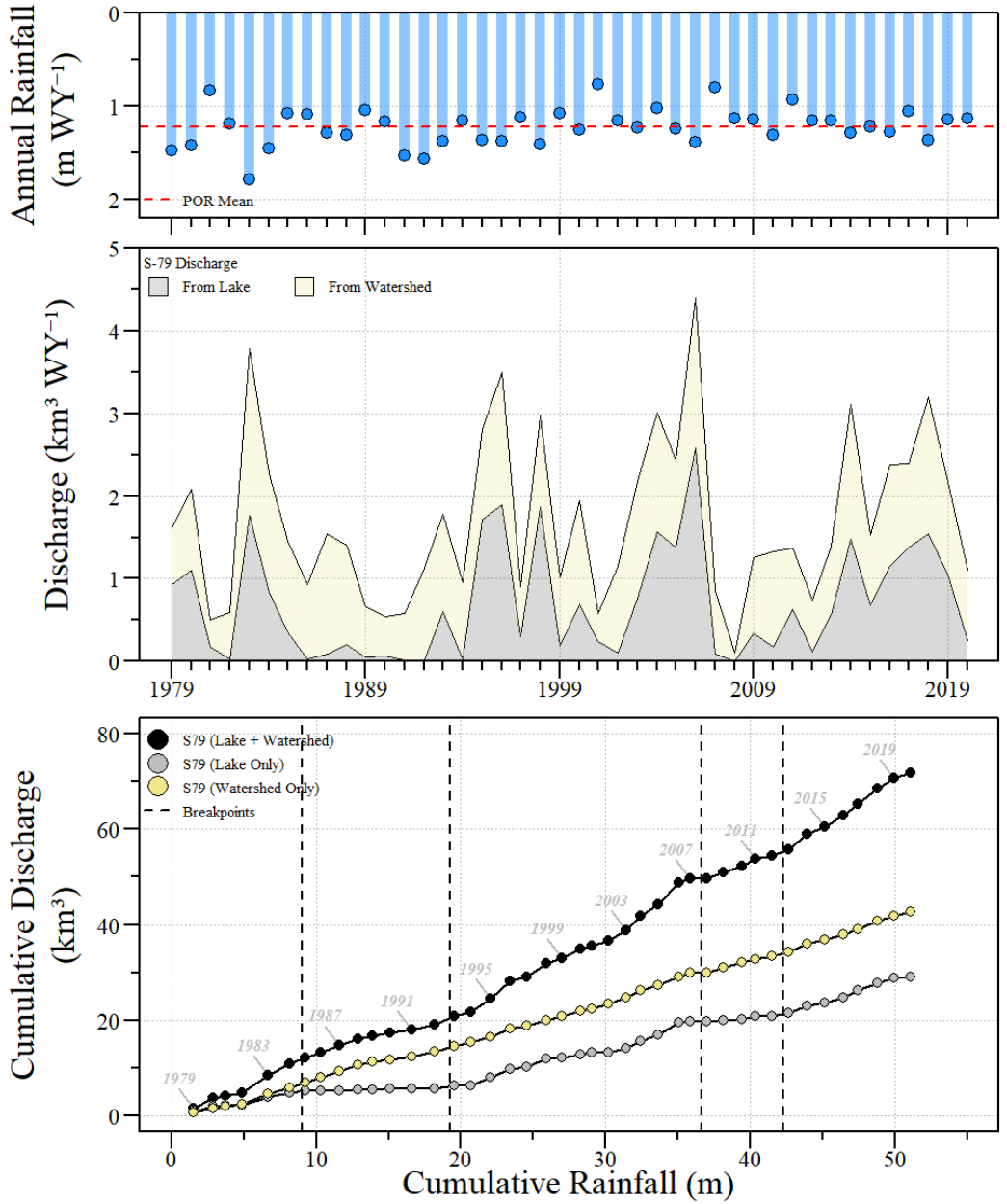
$$\%SI = \exp\left(-K_{d,pred} \times Z_{c,med}\right)$$

Hydrology



Julian and Osborne (2018)

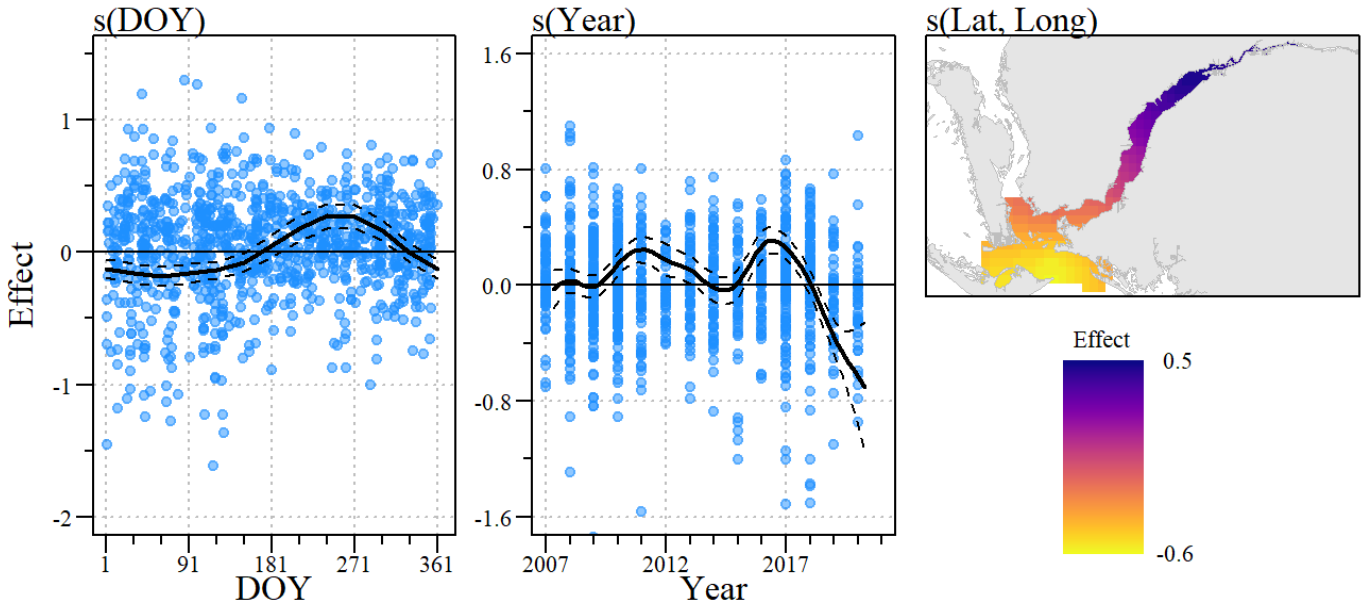
- Watershed significantly contributes freshwater to the estuary.
- Changes to rainfall-runoff relationship over time linked to upstream water management (and climate).



Julian et al. (In Prep)

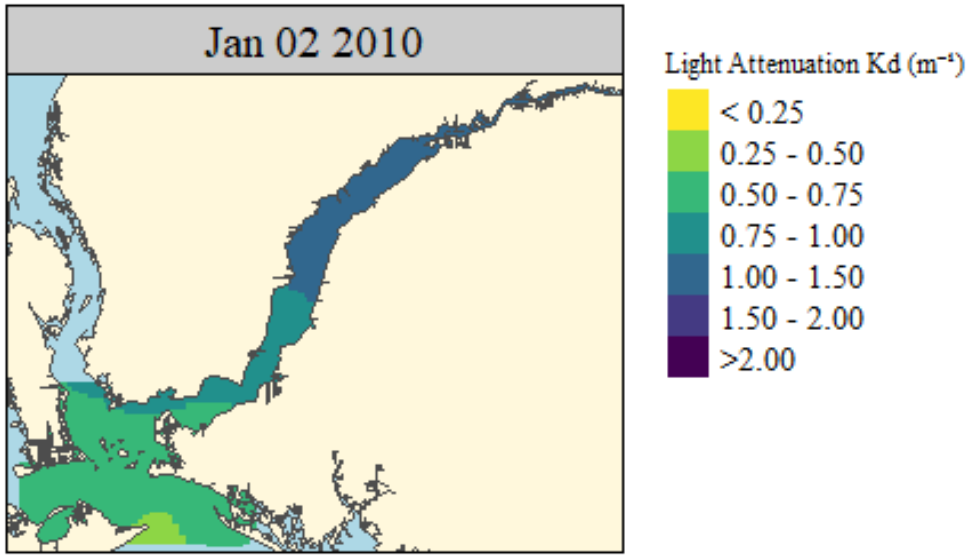
Light Attenuation Model

- Originally attempted to develop a multiple-parameter model K_d specific to Caloosahatchee.
  - High spatial and temporal variability in parameters
  - Lead to space-time GAM



Adjusted R-squared: 0.70, Deviance explained 0.74

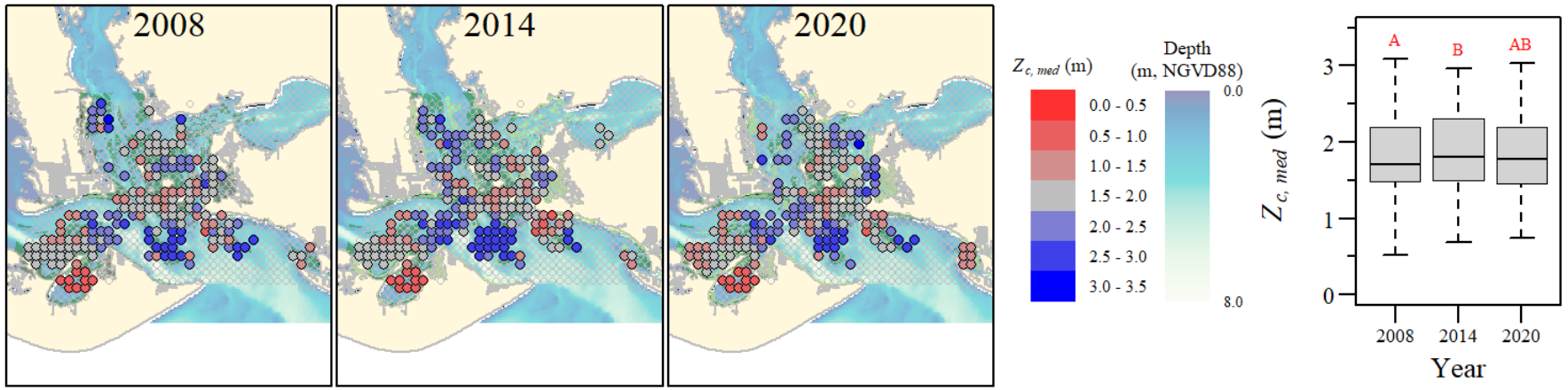
Example of K_d prediction (2010)



Seagrass Colonization Depth

In the lower Caloosahatchee River

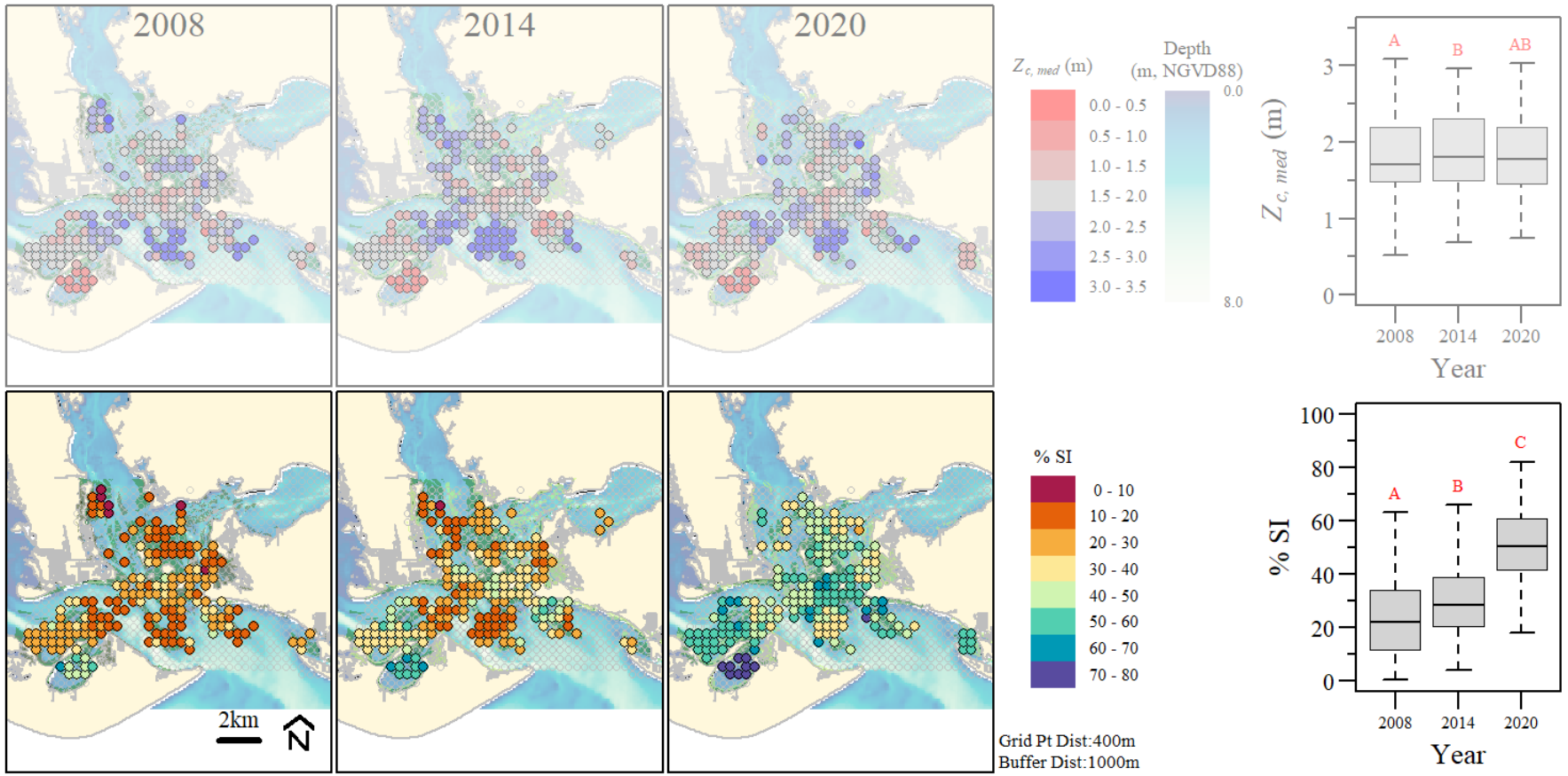
- Depth of colonization has significantly varied between years over the decade +



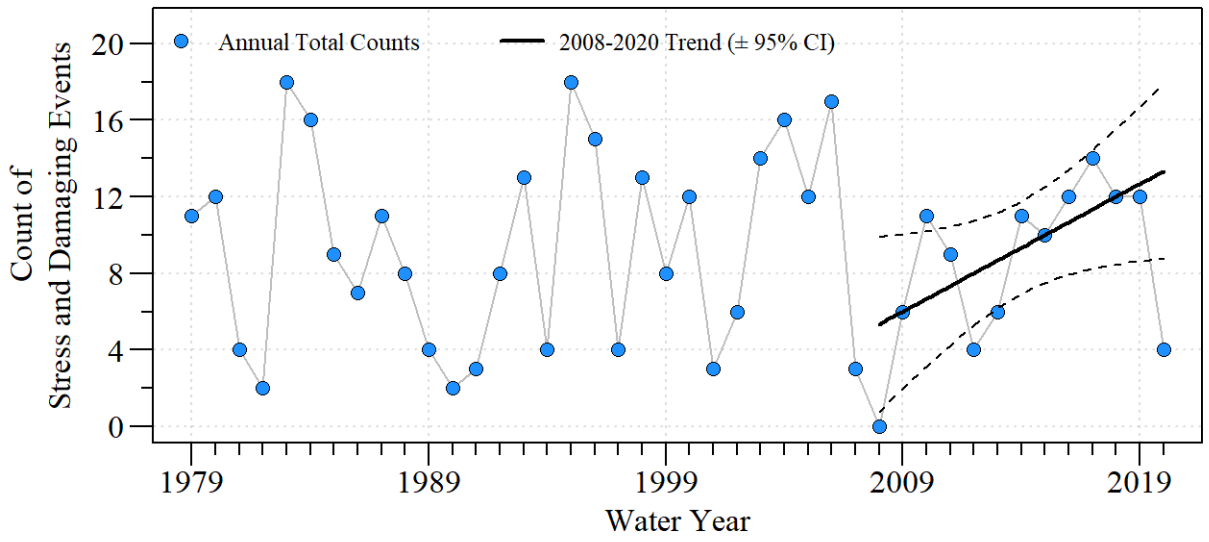
Seagrass Colonization Depth

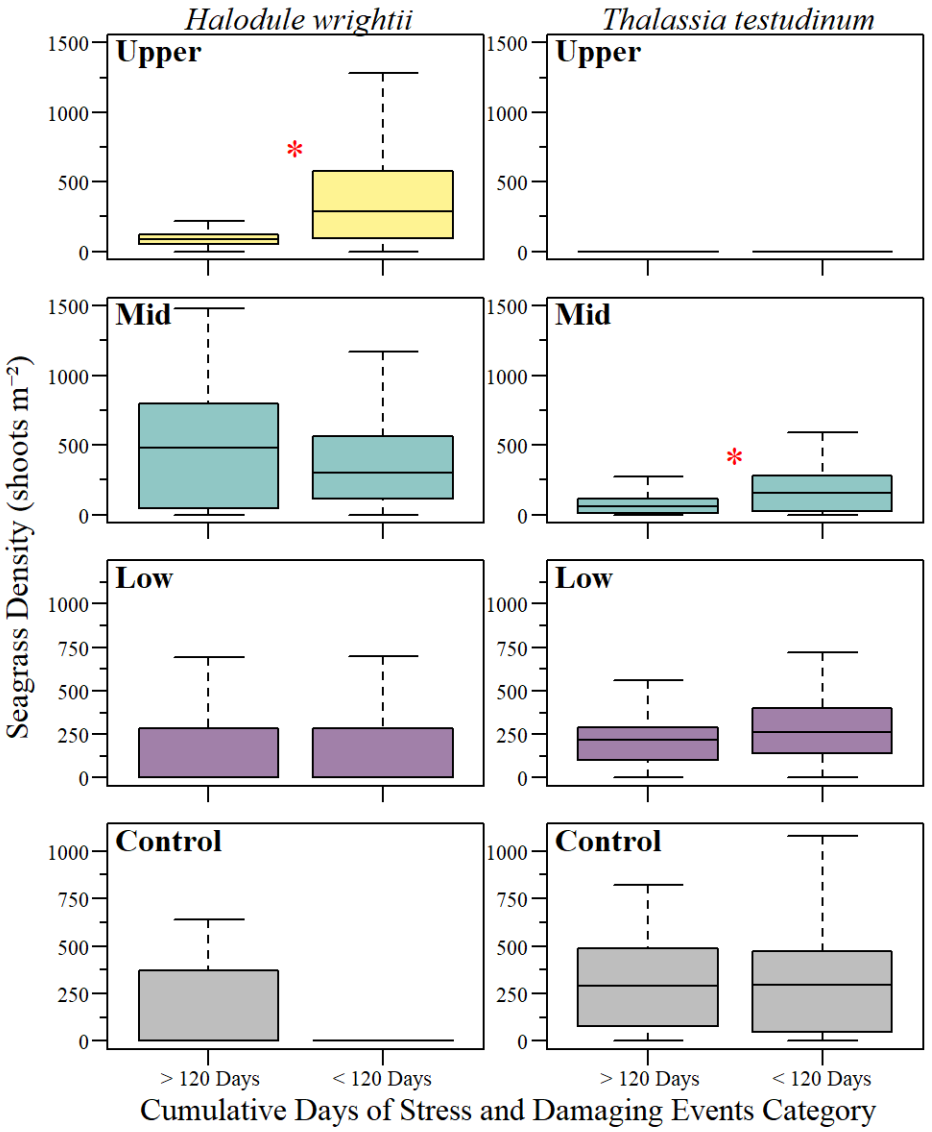
In the lower Caloosahatchee River

- Depth of colonization has significantly varied between years over the decade +
- %SI was significantly different between years and increasing



Freshwater Discharge and Seagrass





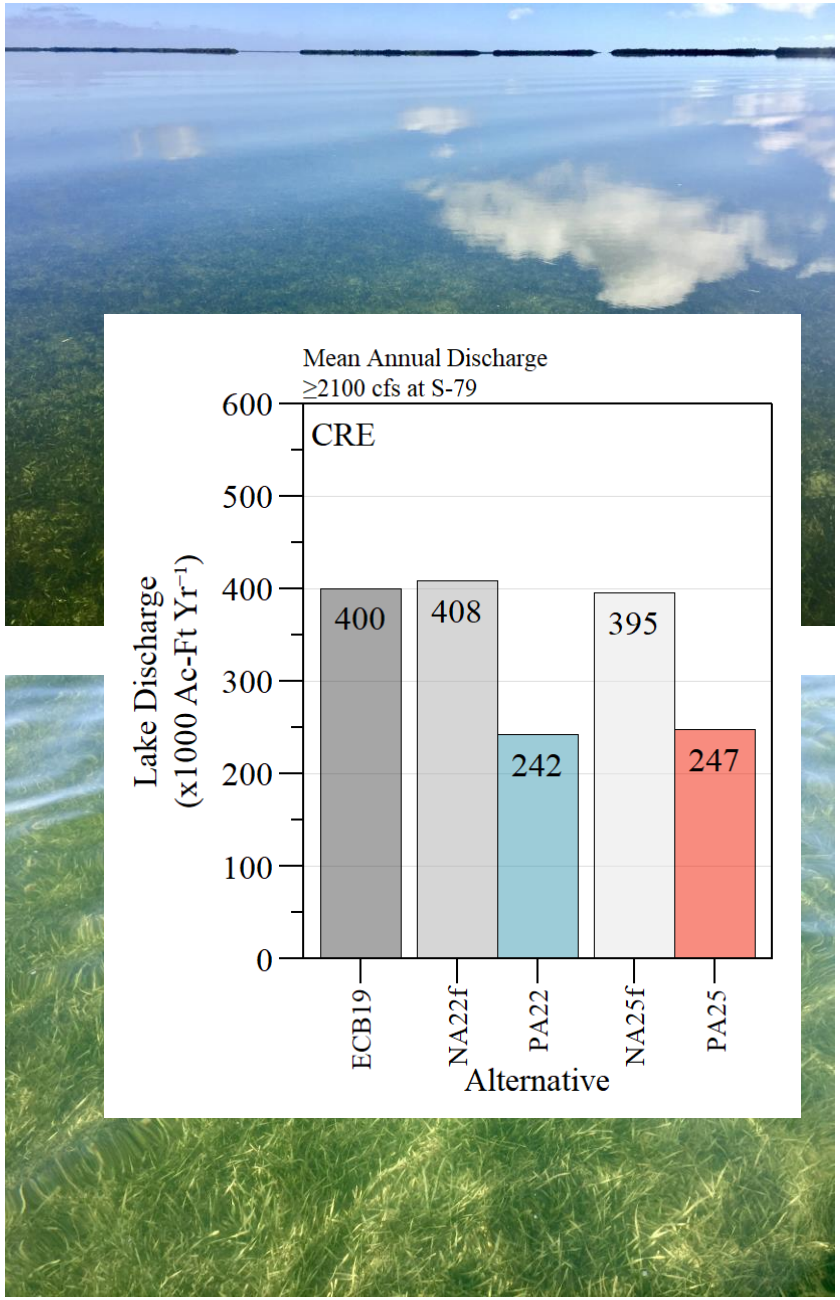
- Since 2008, the count of annual stress and damaging events (> 2100 cfs @ S79) has significantly increased peaking with H. Irma.
- During this period K_d values have also varied (significant decline post Irma).
- The duration of these events has a significant impact on seagrass density.

- 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

- 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).
- New Lake Okeechobee regulation schedule aims to reduce stress and damaging flow events to the Caloosahatchee.



Courtesy of S Davis