Understanding sea level rise impacts in Florida Bay: spatial dynamics of water levels and salinity

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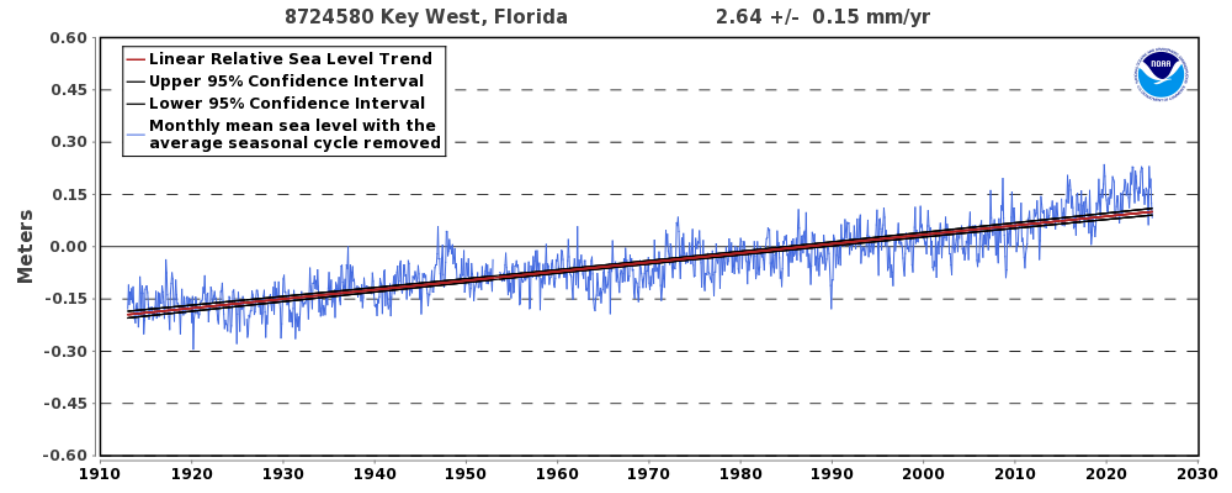
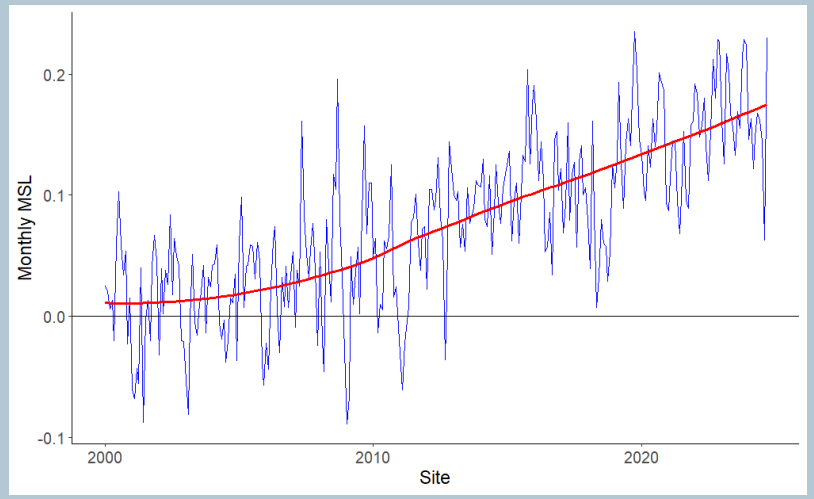
Sea level rise (SLR) and Florida Bay

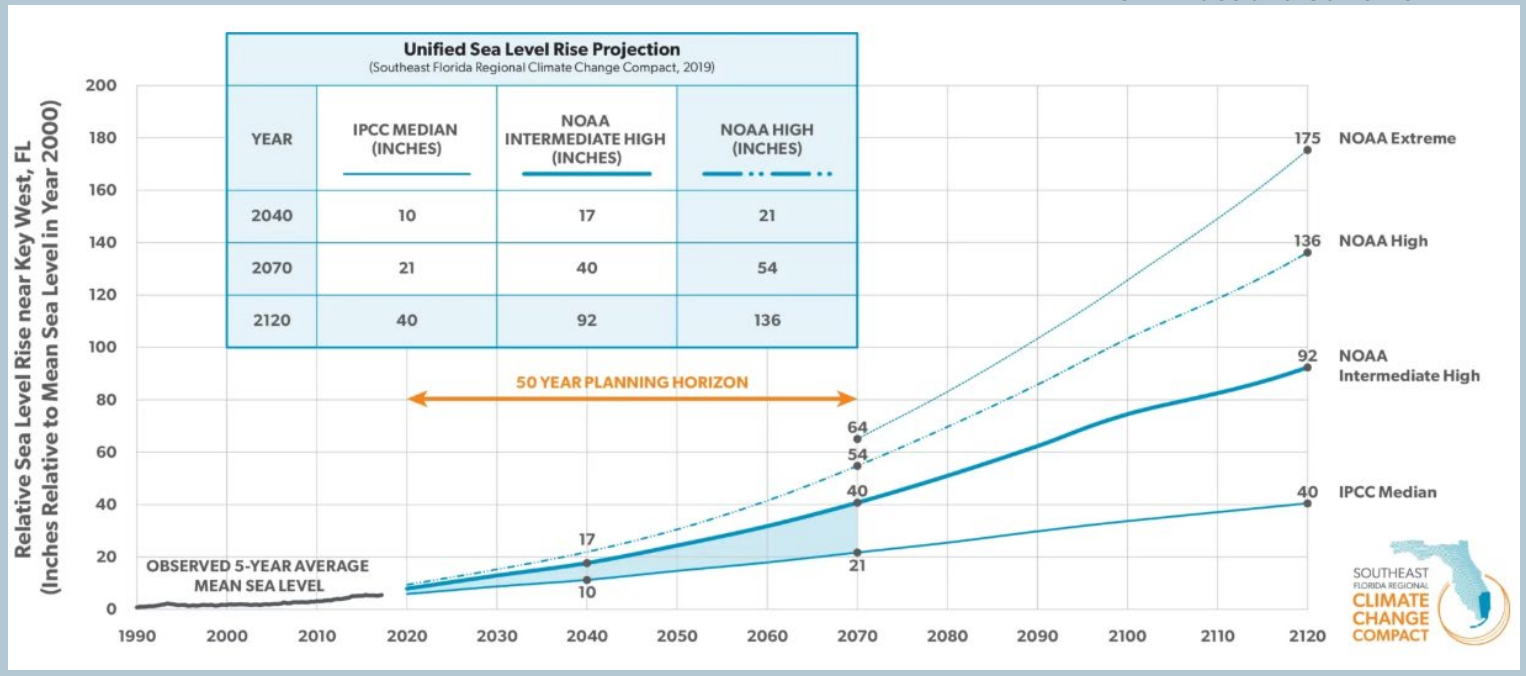
Key West SLR trend since 1913



NOAA Tides and Currents

Accelerated SLR trend over past ~20 years





SEFRCC Compact 2020

SLR projections (relative to 2000)

Global:
0.3 – 2.5 m by 2100 (Sweet et al. 2017)

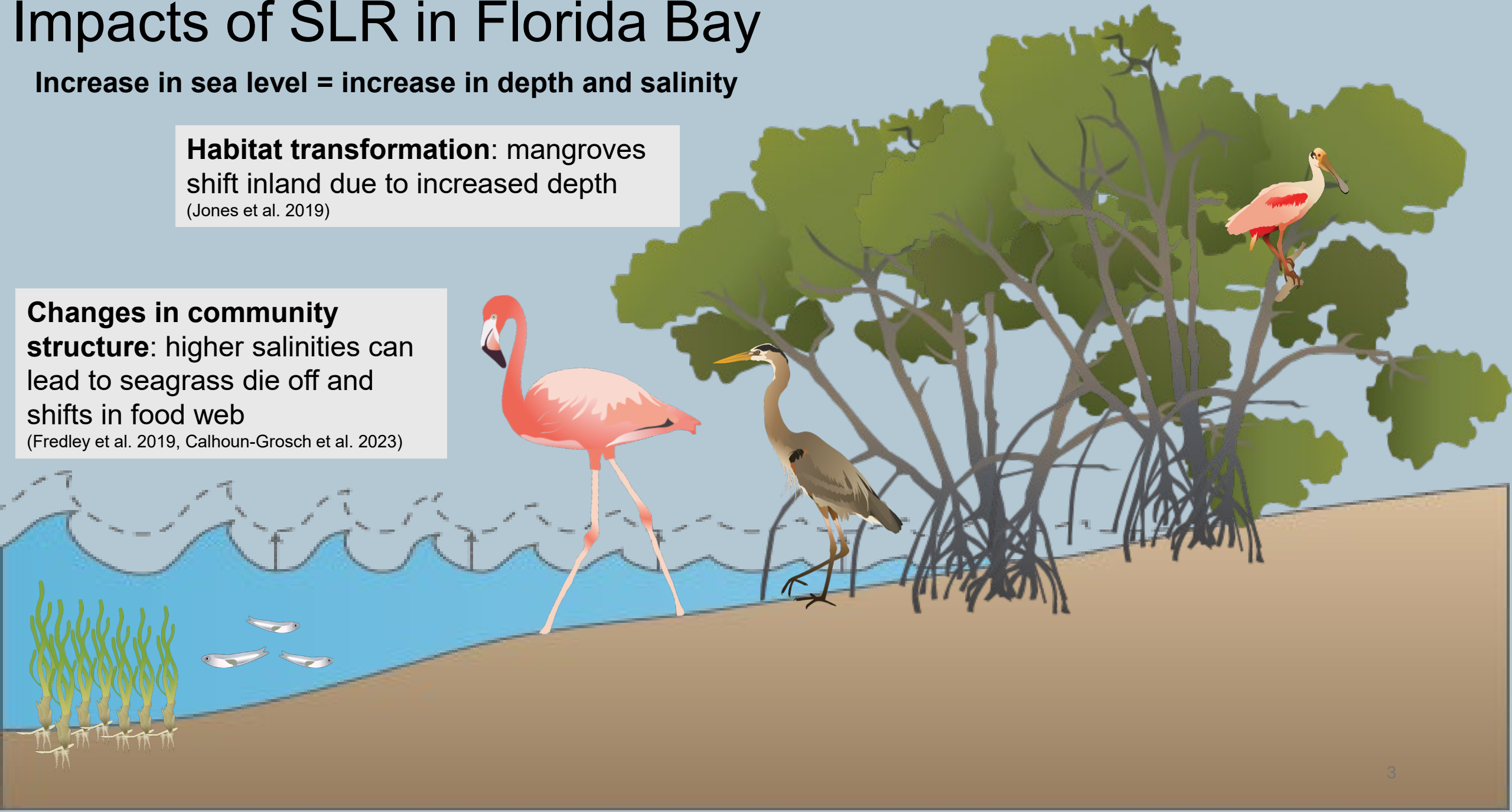
Regional:
0.3 – 0.4 m by 2040
0.5 – 1.4 m by 2070
(SEFRCC Compact 2020)

Impacts of SLR in Florida Bay

Increase in sea level = increase in depth and salinity

Habitat transformation: mangroves shift inland due to increased depth
(Jones et al. 2019)

Changes in community structure: higher salinities can lead to seagrass die off and shifts in food web
(Fredley et al. 2019, Calhoun-Grosch et al. 2023)



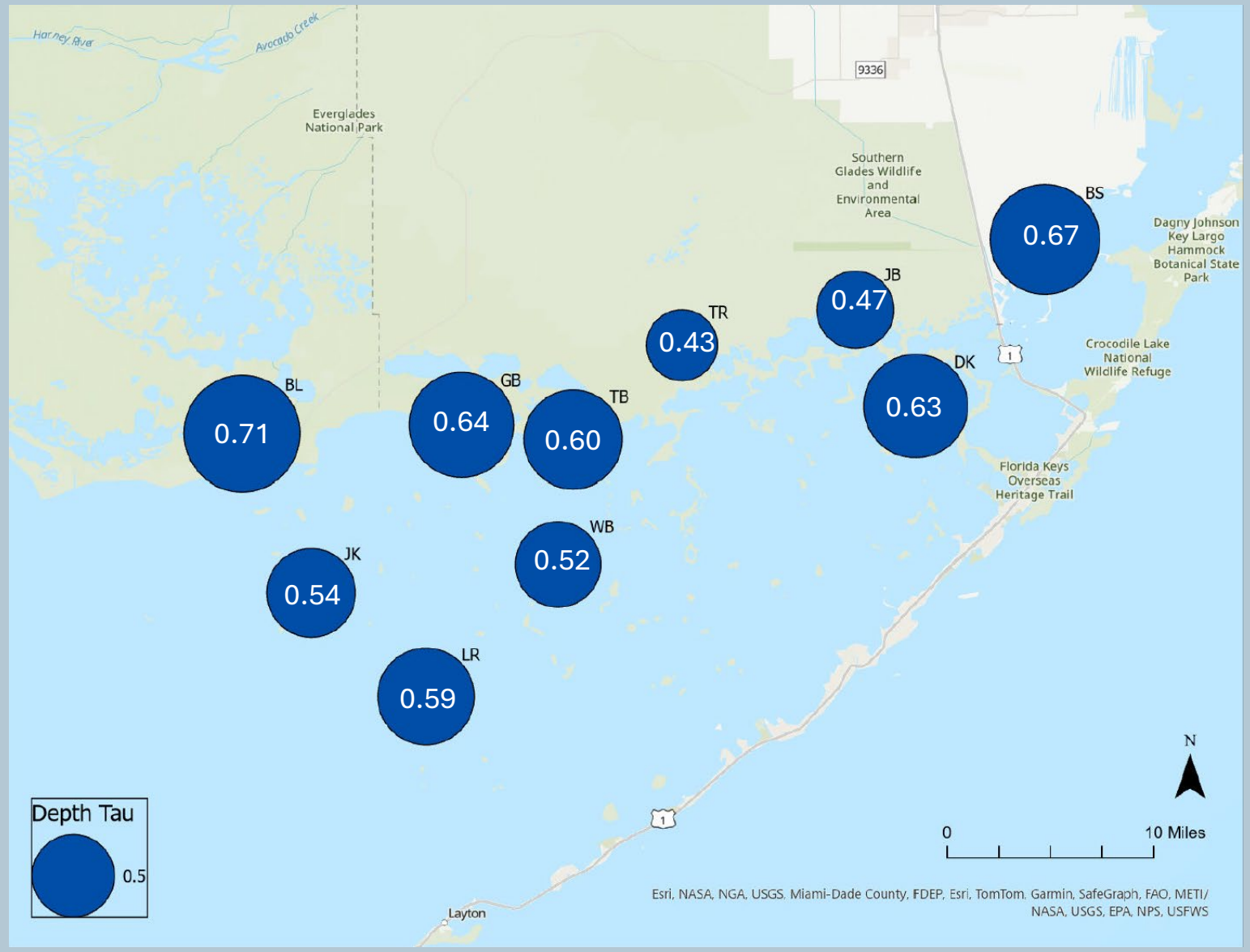
Objectives

How are **depths and salinity changing** across Florida Bay?

What is the **relationship between SLR and depth and salinity**?
How does this relationship compare to other variables?

How do these relationships **vary over time and space**?

Seasonal Kendall test of depth

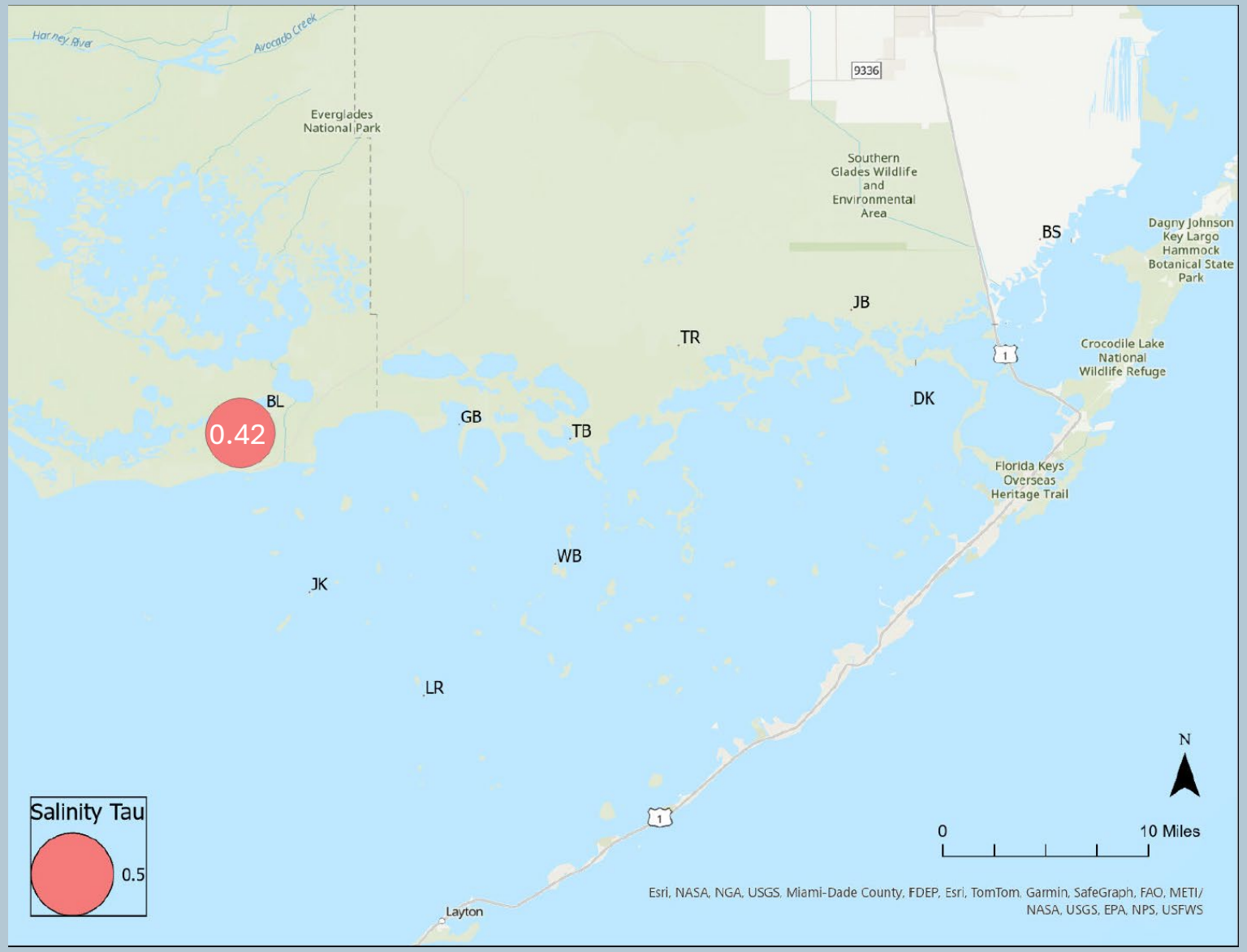


Trends in depth from 2000-2023

Tau measures direction and strength of trend (-1 to 1)

Moderate to strong **increases in depth** ($p < 0.05$) at all sites

Seasonal Kendall test of salinity



Trends in salinity from 2000-2023

Tau measures direction and strength of trend (-1 to 1)

No significant trends ($p > 0.05$) except at BL

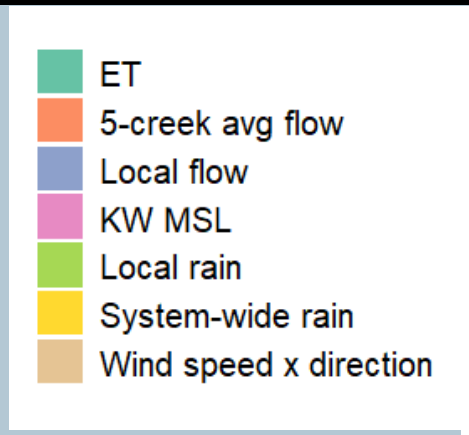
Generalized Additive Models (GAMs) of depth and salinity

Predictor variables:

- **Evapotranspiration (ET)**
  - Averaged across 3 inshore USGS stations
- **5-creek average flow**
  - From Mud, McCormick, Taylor, Trout, West Highway USGS stations
- **Local creek flow**
  - From creek within same basin as site when possible
- **Key West Mean Sea Level (KW MSL)**
  - Sea level with seasonal cycle removed (indicative of SLR)
- **System-wide rain**
  - From ENP rain gauges
- **Local rain**
  - ENP rain data localized to site when possible
- **Wind speed x wind direction**
  - From Long Key NOAA buoy

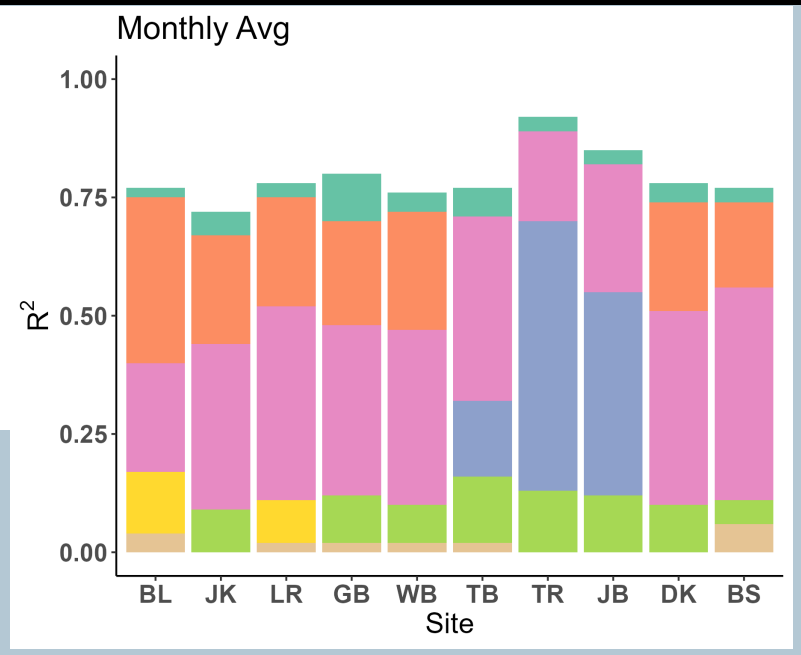
Variables averaged at monthly, yearly and seasonal (wet and dry) time scales

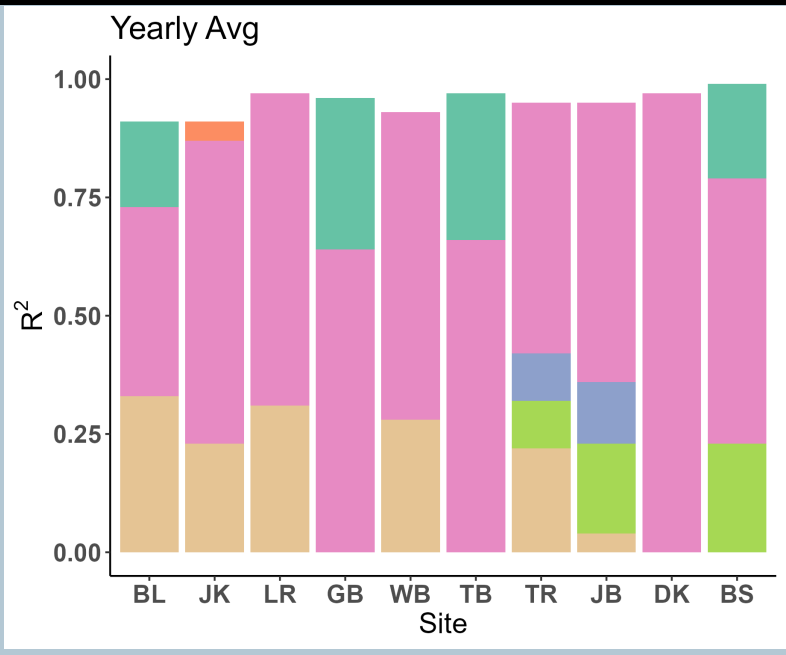
GAMs of depth

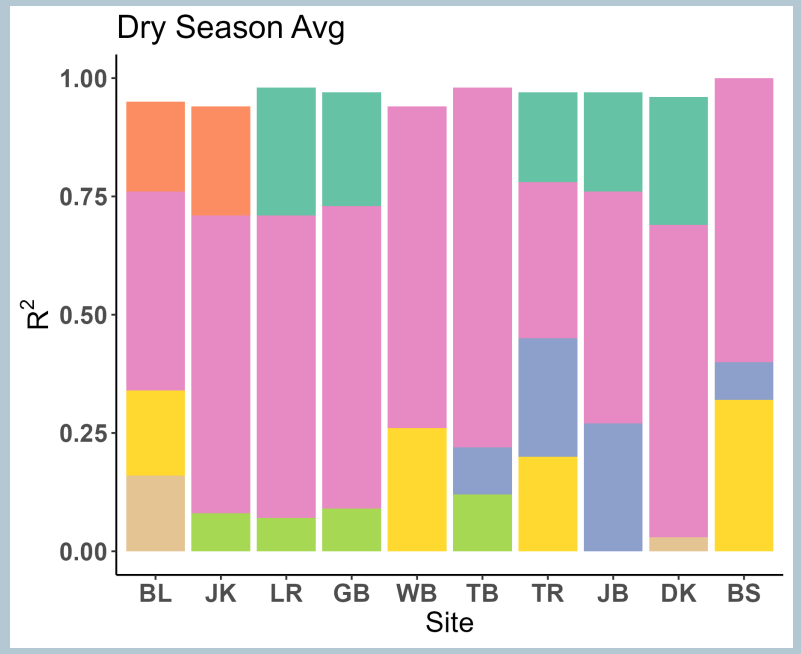


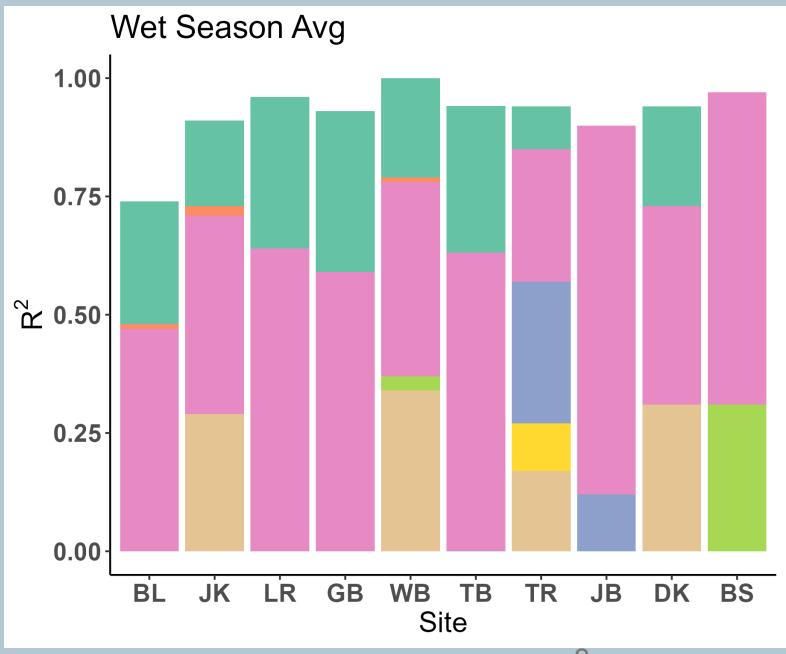
Strong relationship with KW MSL at all stations and time scales

Greater relationship with **flow** (local and 5-creek avg) and **rain** (local and system-wide) at **monthly time scale**



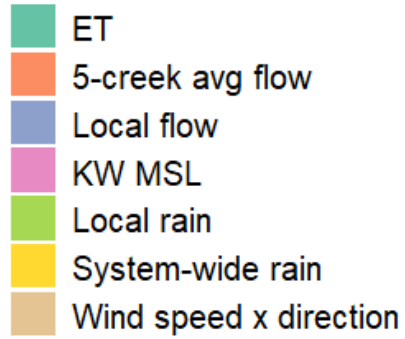






West → East

GAMs of salinity

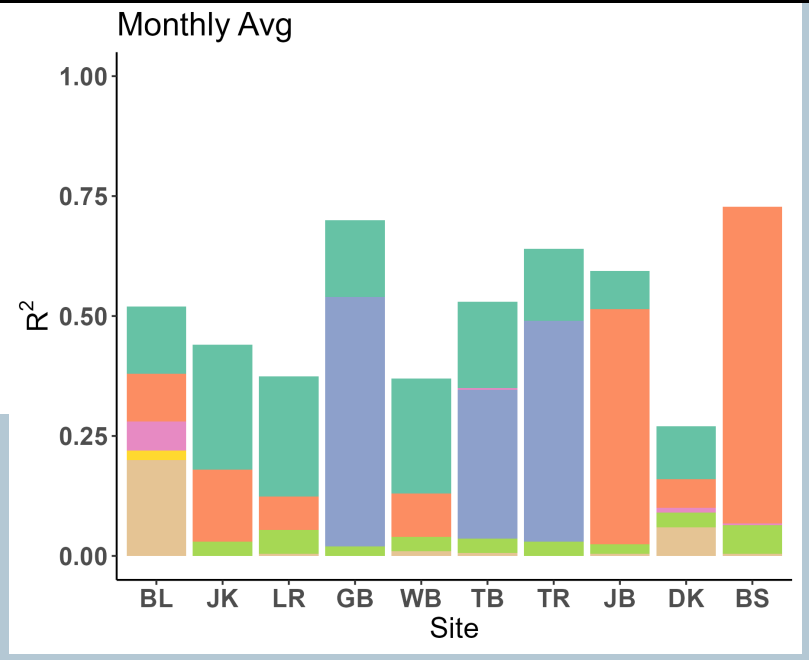


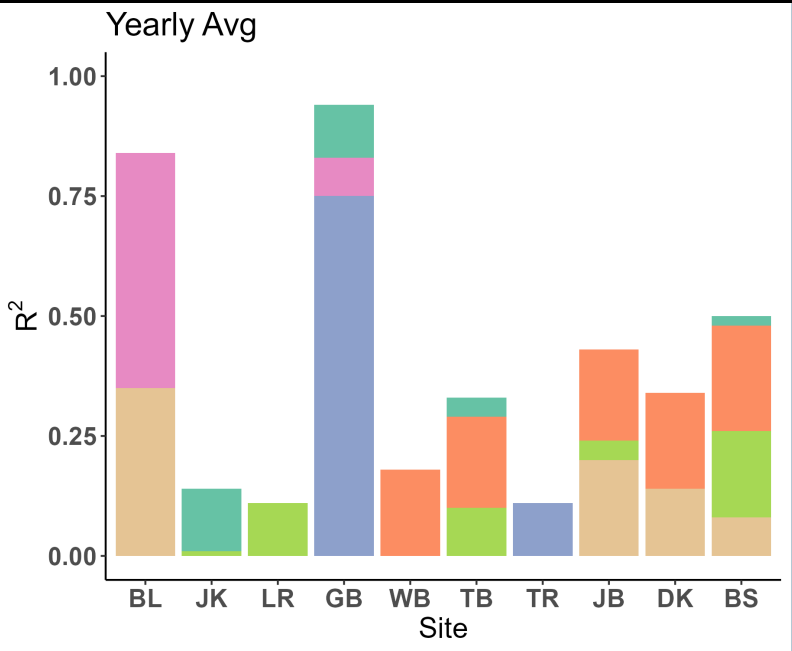
Greater spatial variability in relationships

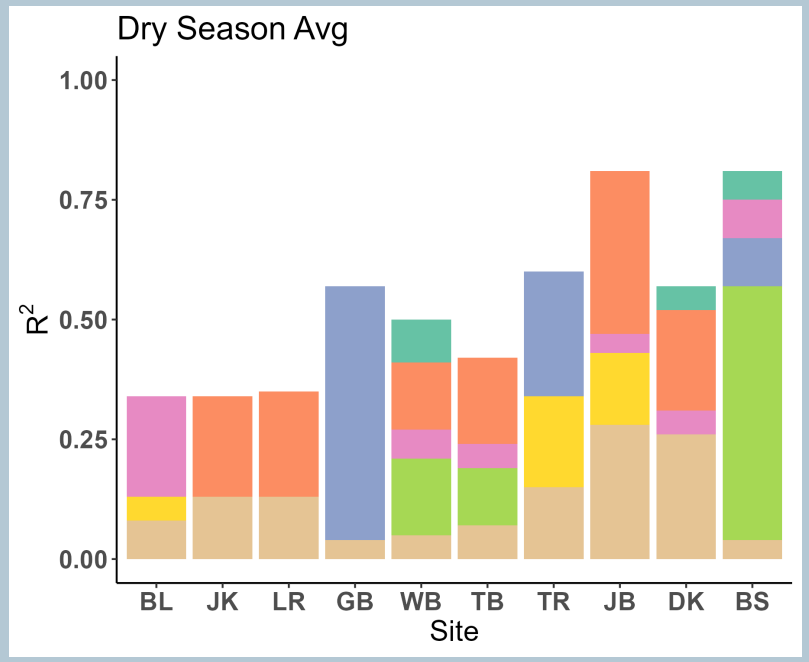
Relatively strong relationship with flow (local and 5-creek avg) at most sites (particularly inshore)

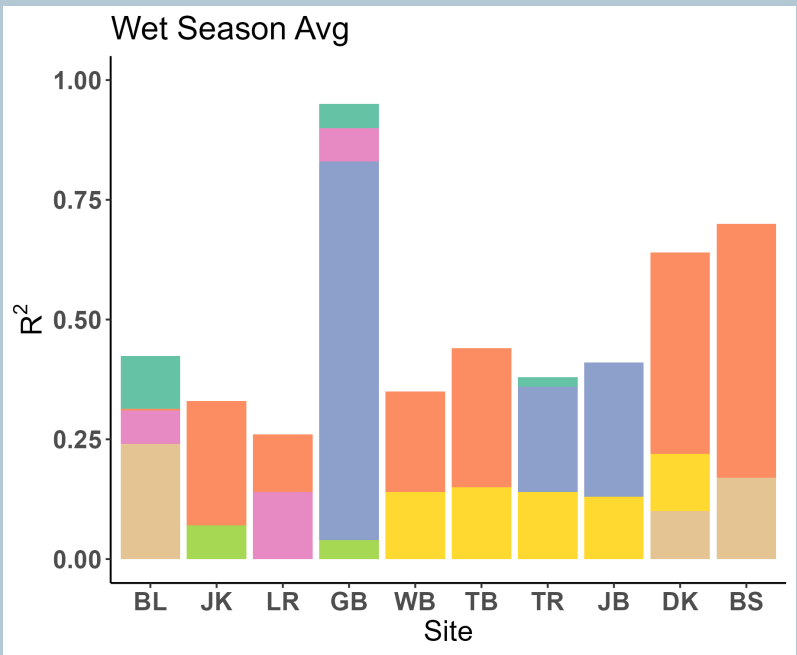
Little relationship with KW MSL overall except at BL

Greater relationship with KW MSL during dry season than wet at most sites









West ⟶ East

Main takeaways

Strong relationship between KW MSL and depth,

little relationship with salinity

Relatively strong relationship between flow and salinity in all cases, flow and depth at monthly time scale

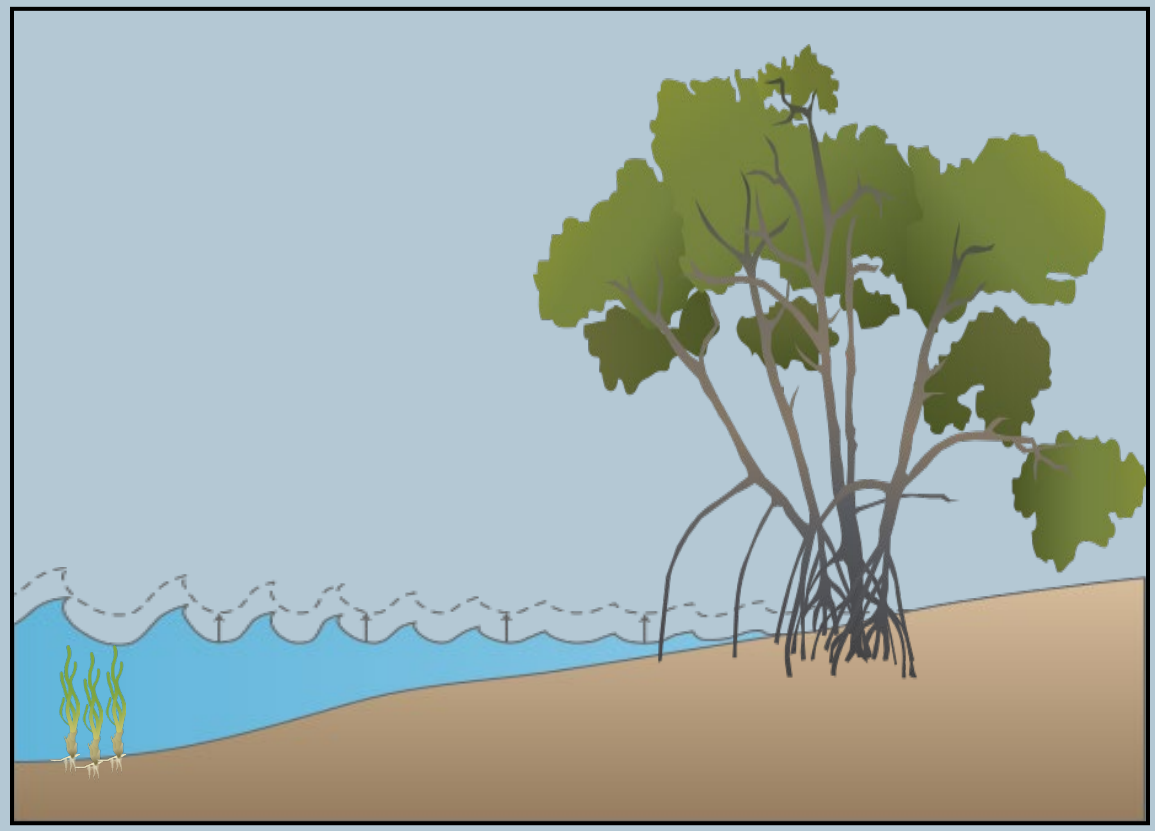
What does this mean?

Strong relationship between KW MSL and depth,

little relationship with salinity

Increasing depths lead to changes in habitat, flooding and hydrology

Degree of relationship with salinity is spatially and temporally dependent



What does this mean?

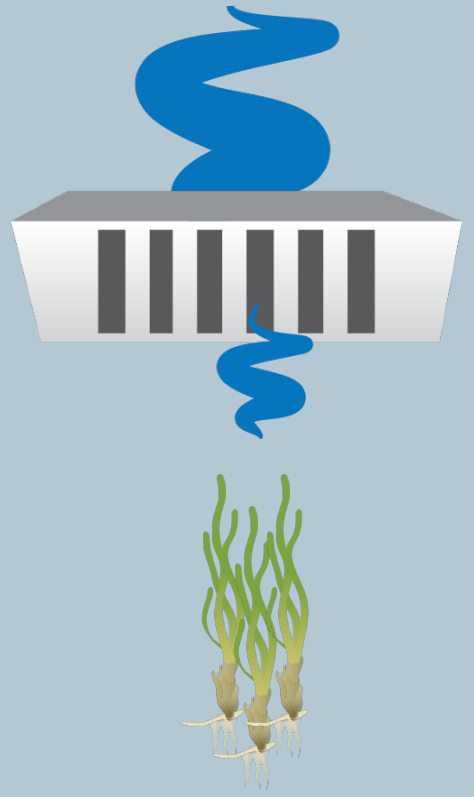
Relatively strong relationship between flow and salinity in all cases, flow and depth at monthly time scale

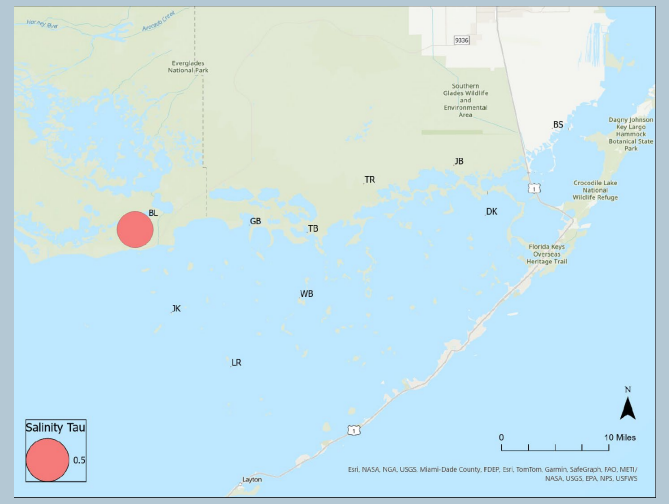
Salinity is influenced by water management actions

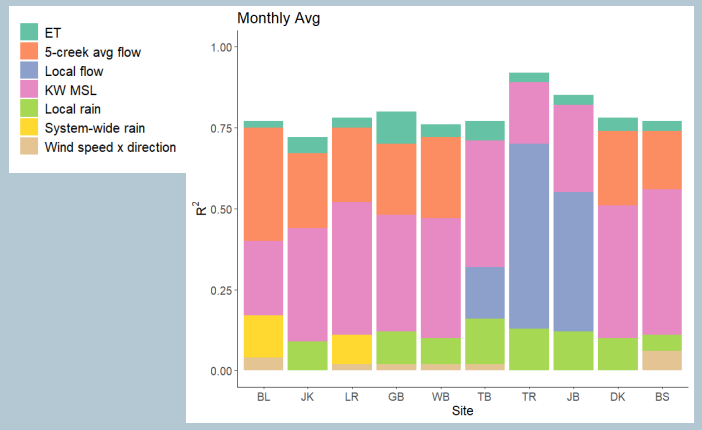
Delivery of freshwater inflow is important for maintaining ecologically desirable salinities

Influence of freshwater inflow may contribute to lack of long-term trend in salinity

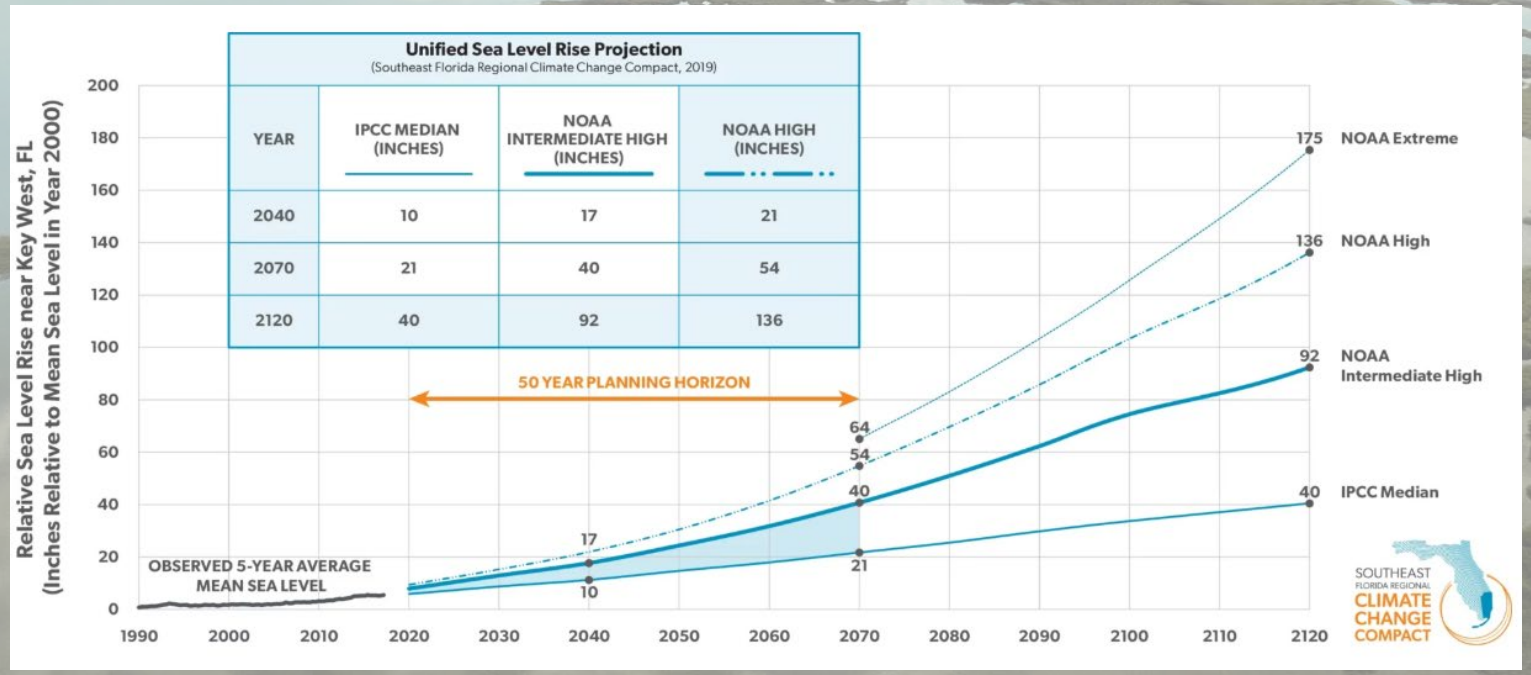
Creek flow may have greater impact on depth in short term vs long term

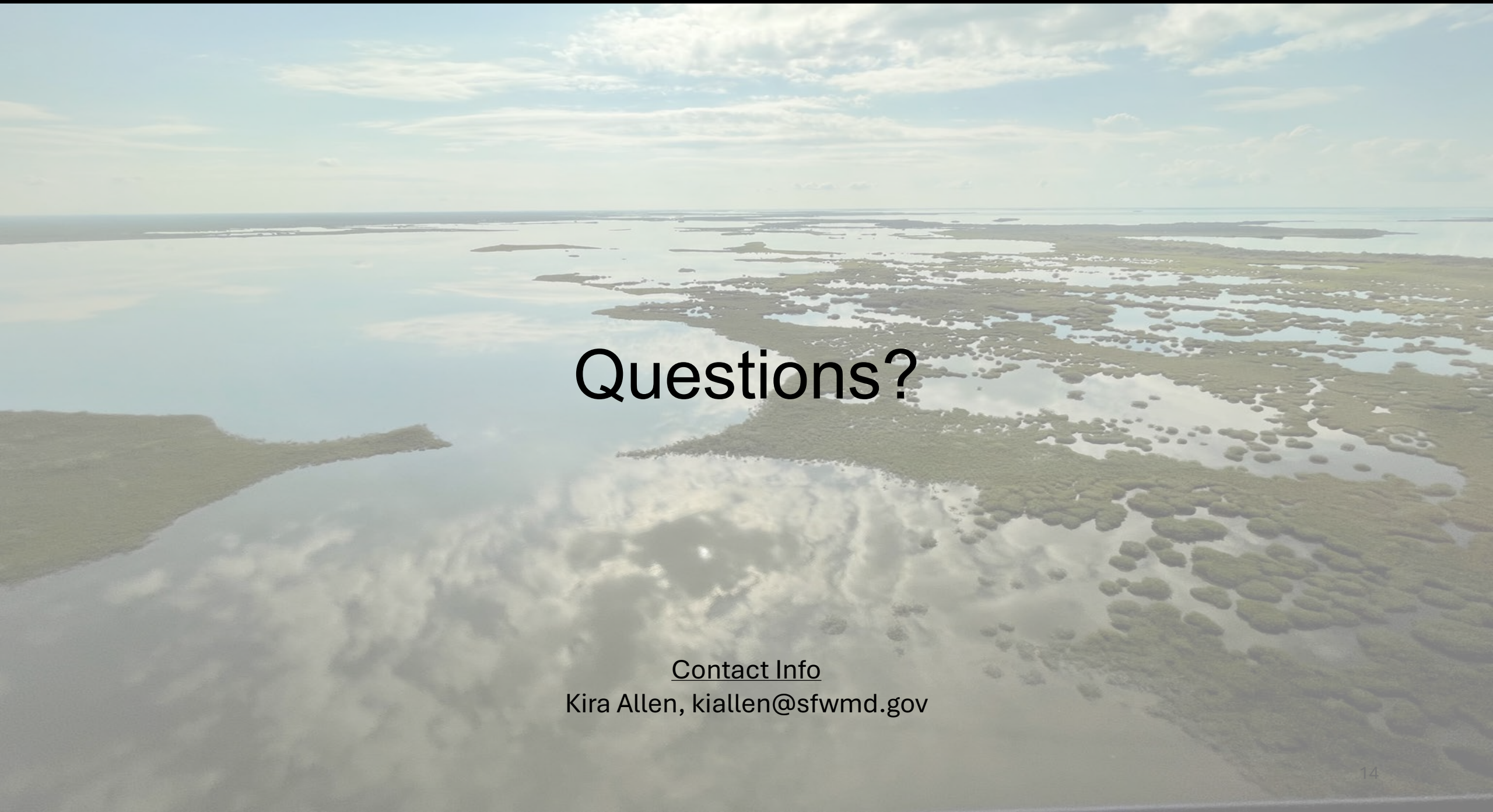






Sea level rise is and will continue to affect Florida Bay.





Questions?

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