Seagrass Monitoring Program

27 years of status & trends in the FKNMS

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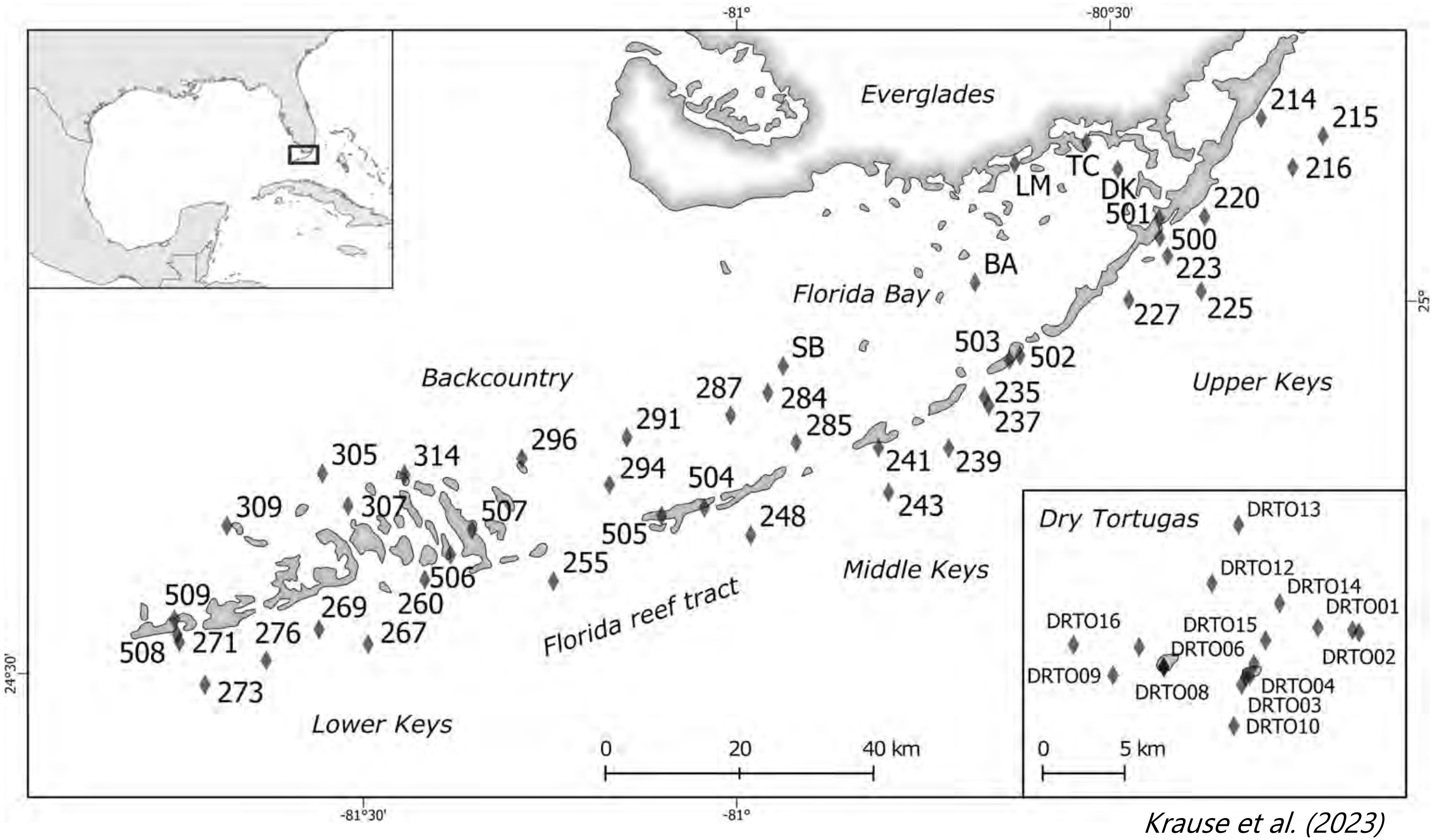
Marathon, FL


Benthic community
status & trends

Long-term monitoring in the FKNMS and beyond

- 40 sites in FKNMS for benthic community monitoring
- Coinciding with water quality monitoring stations
- Integrates into wider network of seagrass monitoring with consistent methodology (Florida Bay, Dry Tortugas)

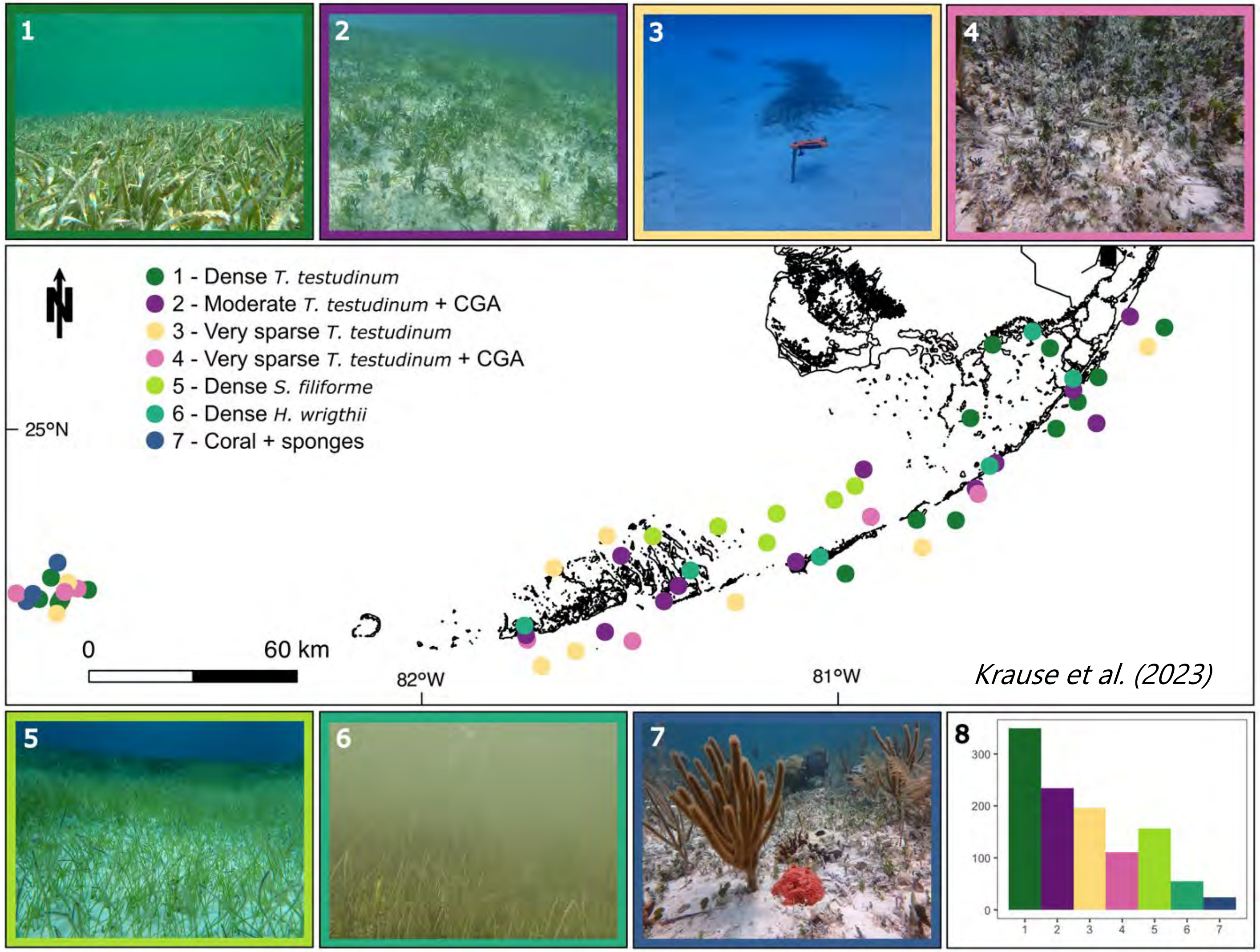


Krause et al. (2023)

Status & trends

Synthesis study of 25 years of monitoring data

- Identified 7 prevalent benthic community types via cluster analysis
- Described spatial pattern of benthic community distribution
- Identified environmental correlates of benthic community status and trends



Estuaries and Coasts (2023) 46:477–493
https://doi.org/10.1007/s12237-022-01158-7

Status and Trajectories of Soft-Bottom Benthic Communities of the South Florida Seascape Revealed by 25 Years of Seagrass and Water Quality Monitoring

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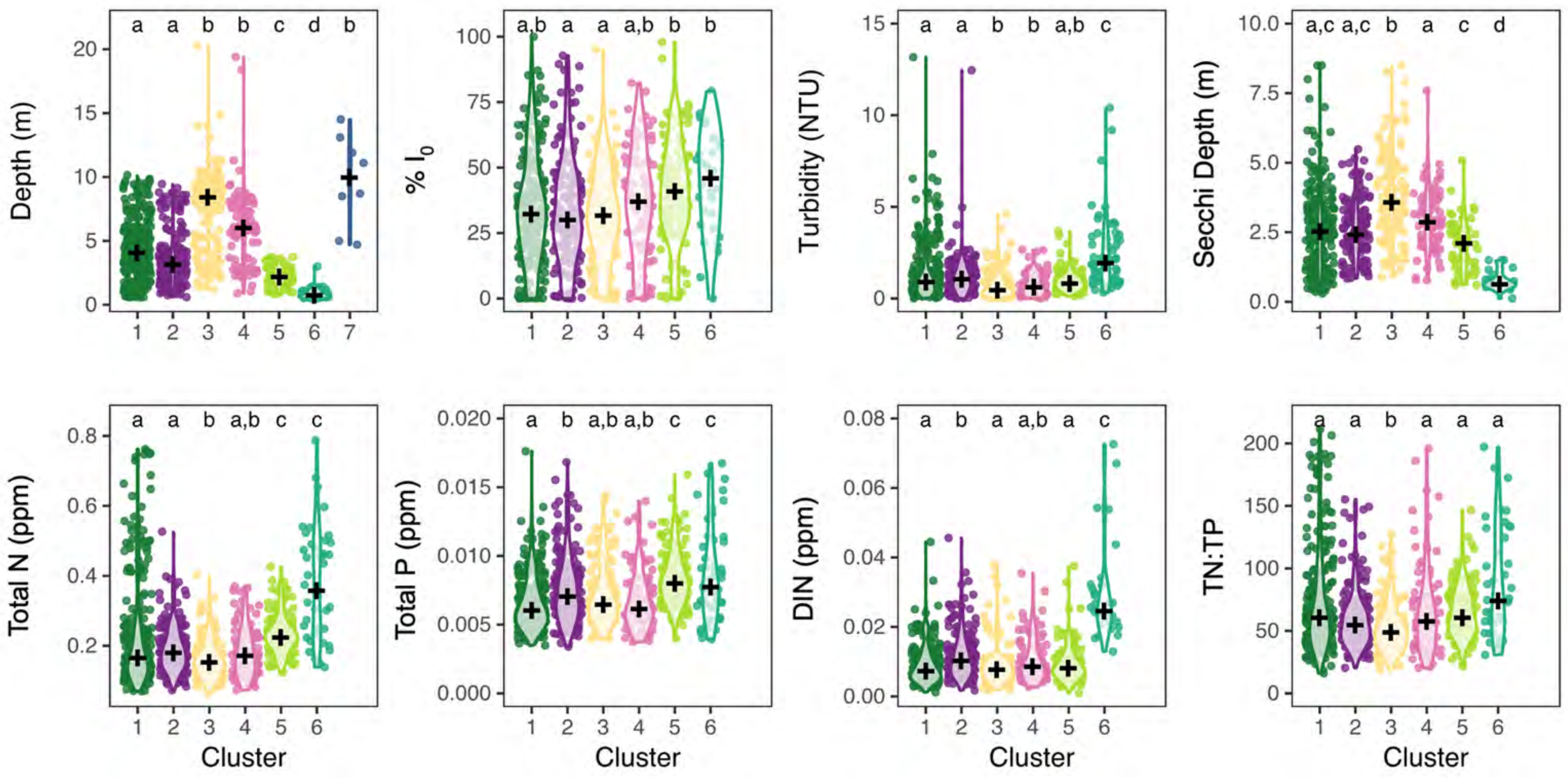
Status & trends

Synthesis study of 25 years of monitoring data

- Dense Thalassia at 1-10m depth and very low TP
- Dense Syringodium in shallower, higher-nutrient (TN & TP) water
- Dense Halodule at <4 ft depth, highest TN, DIN, TP
- Patchy, low-density sites in offshore, deepest, lowest TN:TP

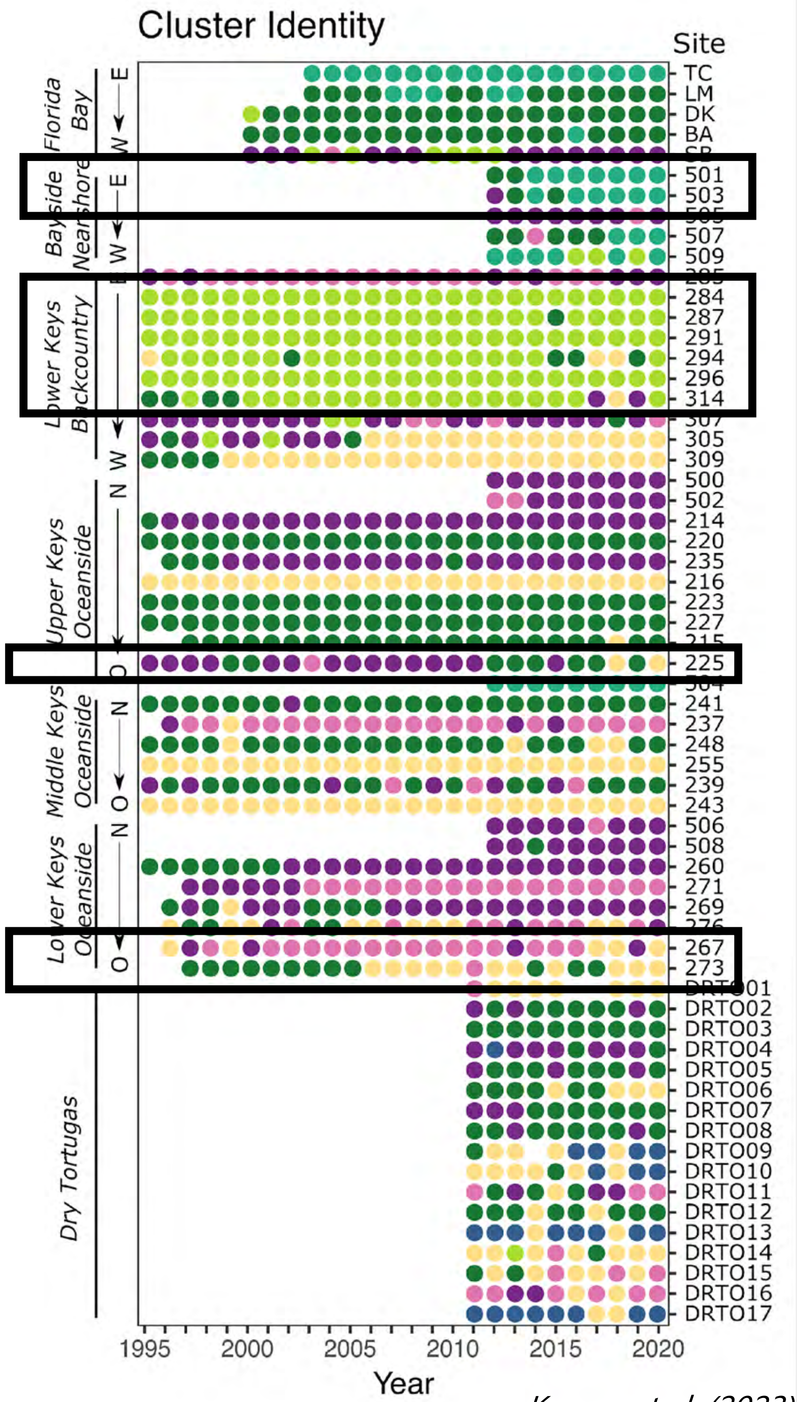


Krause et al. (2023)

Status & trends

Benthic community trajectories

- Used clusters to track community change over time
- Overall, stable communities at most sites
- *S. filiforme* meadows most stable
- Least stable communities transition between dominant *T. testudinum* and calcareous green algae
- Some inshore sites change species composition (*T. testudinum* to *H. wrightii*)
- Some offshore sites suddenly lose seagrass cover and do not recover for many years



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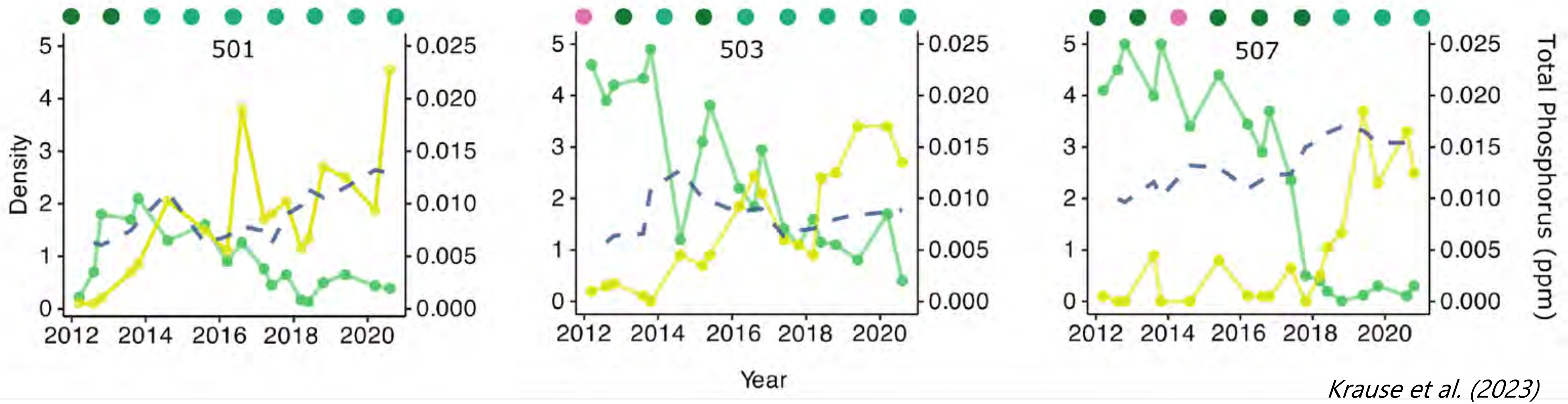
Status & trends

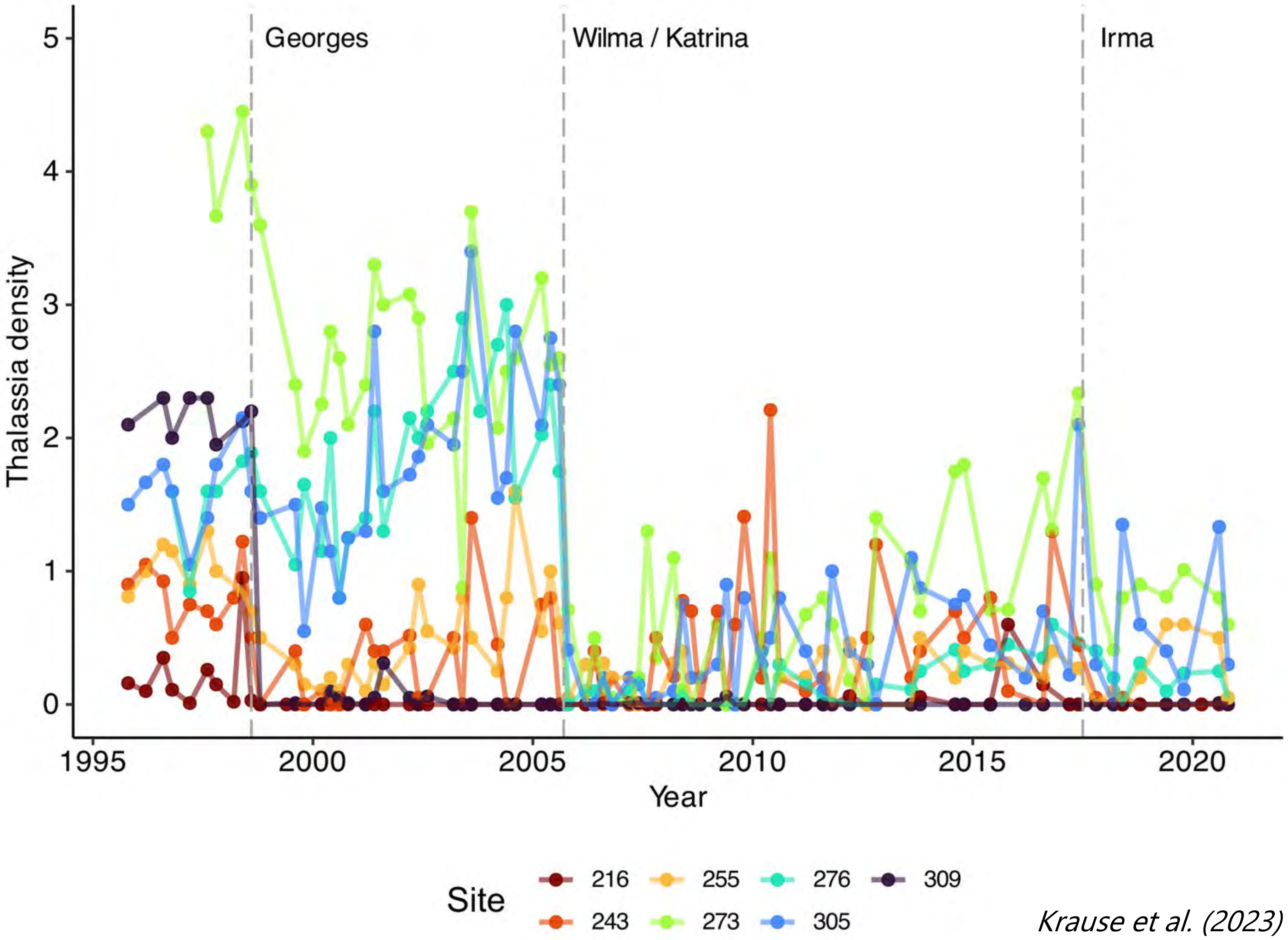
Nutrient enrichment causes inshore community change



Krause et al. (2023)

- Nutrient enrichment at inshore sites (within 100m of shore)
- Increasing water total phosphorus concentrations (blue dashed)
- Change from climax seagrass *T. testudinum* (green) to fast-growing *H. wrightii* (yellow)

Hurricane impacts



Krause et al. (2023)

- *T. testudinum* lost at offshore sites after passage of hurricanes
- Spatially heterogenous impacts, likely due to erosion from currents and wave action
- Hurricanes caused "blow-outs" in offshore seagrass meadows (ca. 8-10 yr periodicity), but recovery time of climax seagrass density takes 10+ years.
- Spatial extent of loss and recovery unclear – need for remote sensing analysis

Status & trends

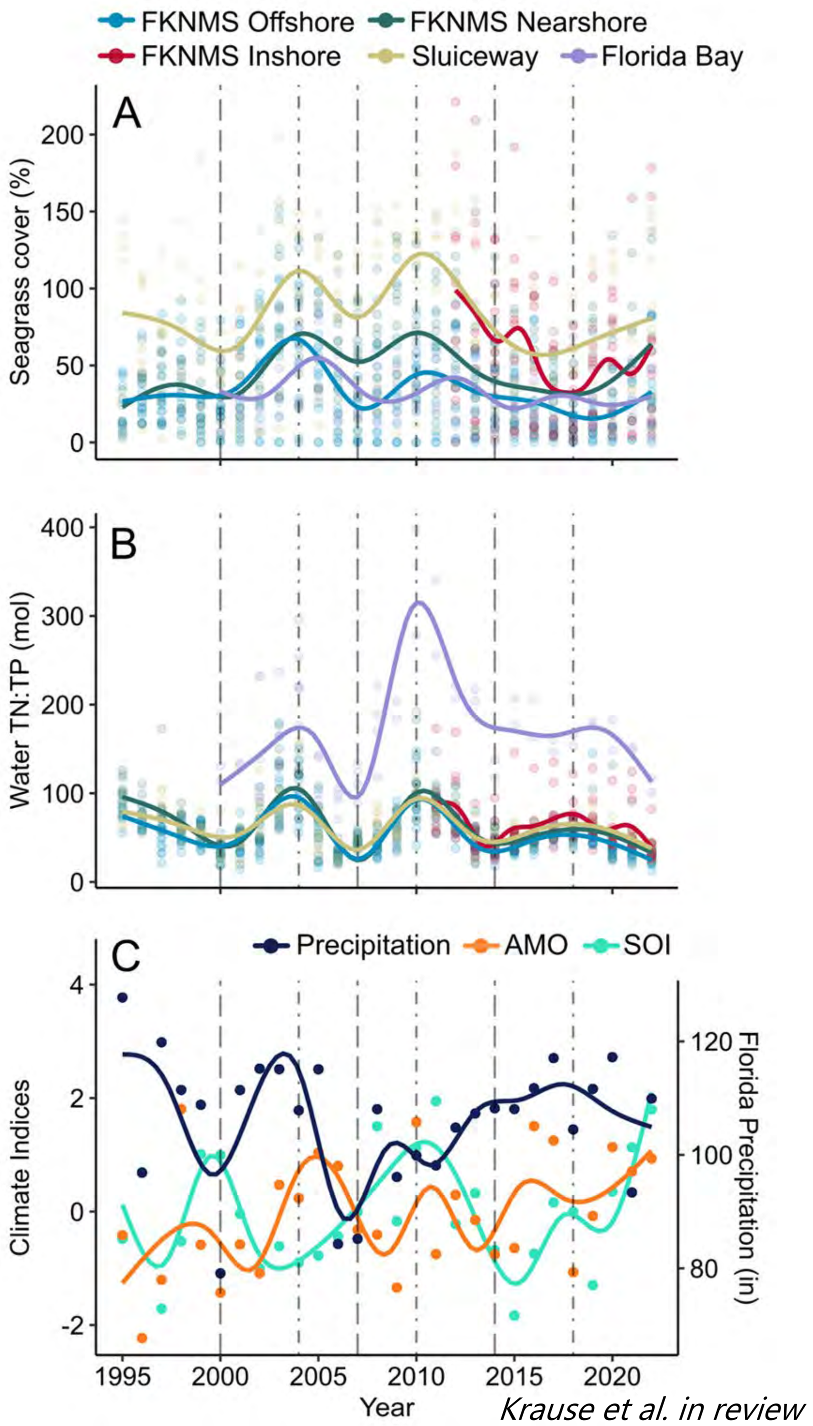
Benthic community status and trends

- Overall, benthic communities at FKNMS stable over past 25 years
- Spatial pattern in nutrient environment drive benthic community distribution
- Nutrient-enrichment in nearshore waters associated with benthic community shifts to *Halodule* meadows
- Catastrophic, lasting loss of seagrass in FKNMS only after major hurricane passages
- Long-term monitoring needed to track recovery dynamics and learn about resilience of South Florida seagrass meadows

Climate Variability

Interannual fluctuations

- Oscillating pattern in seagrass abundance
- Mirroring pulses in water TN:TP
- Synchronous pulses throughout FKNMS
- Rainfall pattern in South Florida and climate indices (SOI, AMO) with similar oscillations



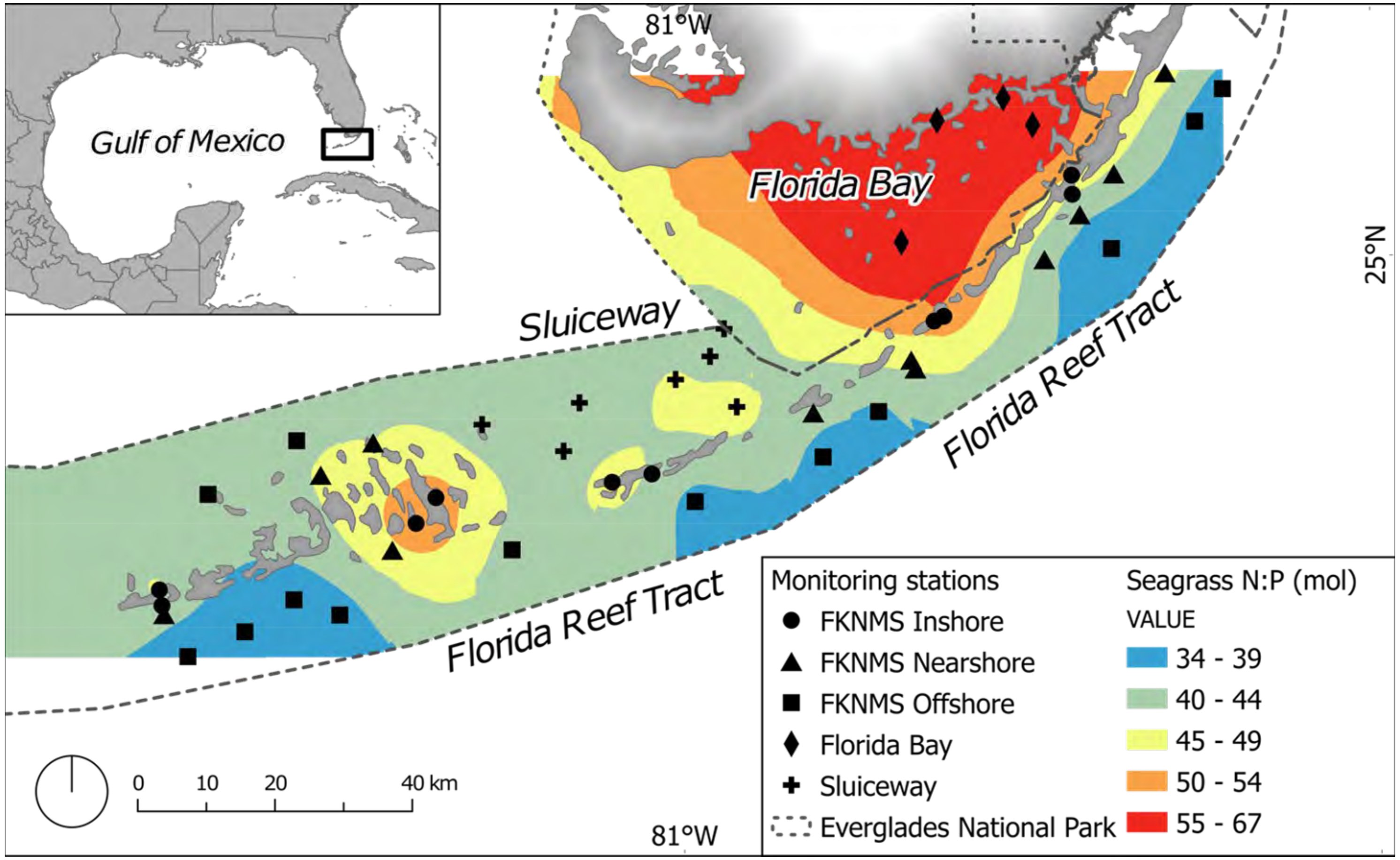
Krause et al. in review

Climate variability

Spatial pattern in relative nutrient availability

- Seagrasses are nutrient limited in Florida Bay (P-limited) and FKNMS backreef meadows (N-limited)

- Do fluctuations in relative nutrient availability (TN:TP) affect seagrass growth in FKNMS?



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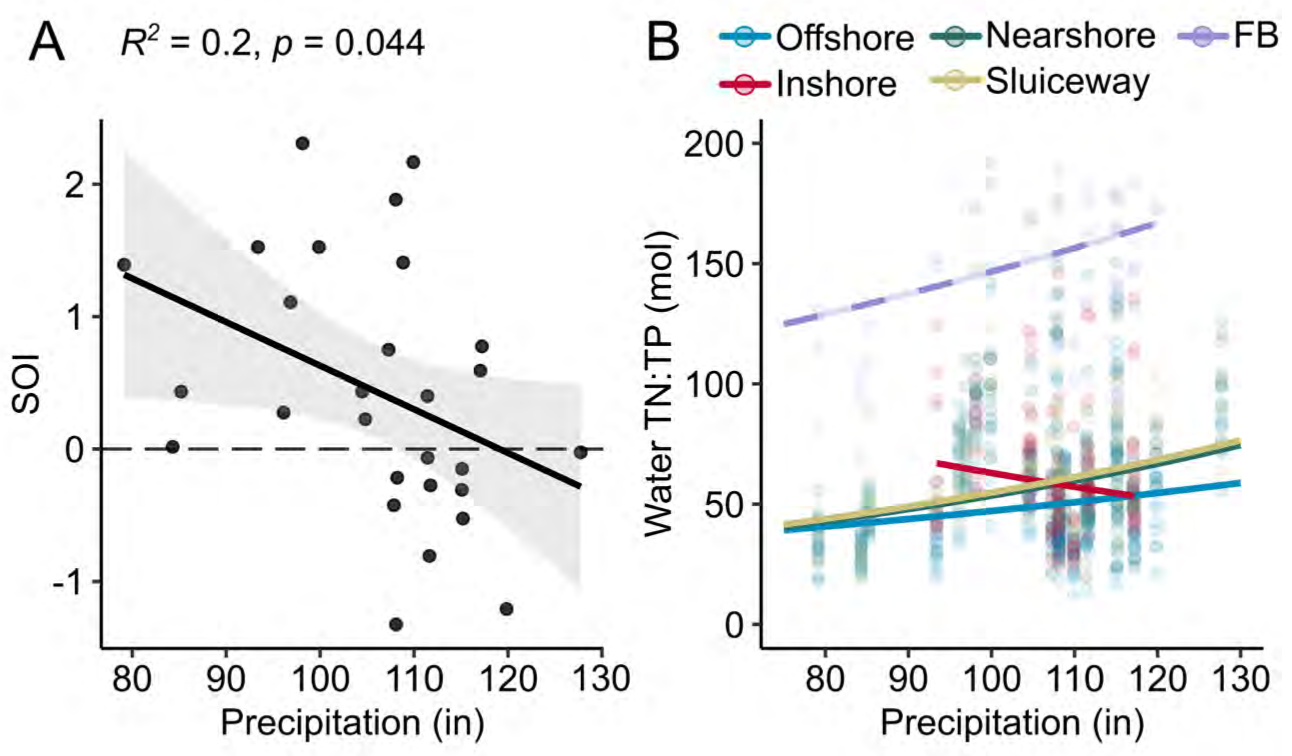
Climate variability

Climate drivers of nutrient availability

- Negative SOI (El Niño) with high-rainfall years
- High rainfall years coincide with high TN:TP
    - Potential effects of freshwater on upwelling of nutrient-rich waters (Cherubin & Burgman 2022)
    - Potential increased terrestrial nitrogen inputs from runoff



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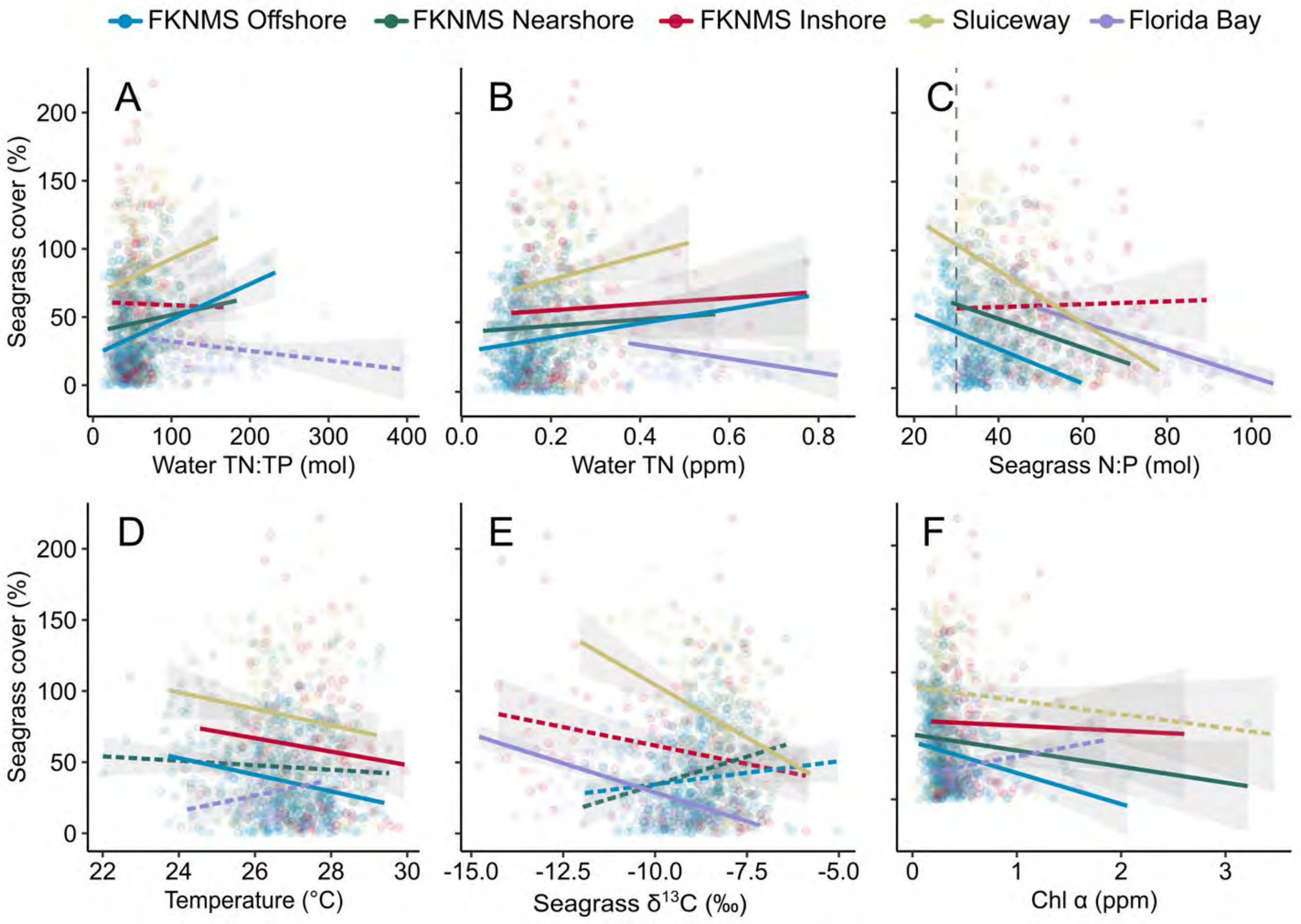
Climate variability

Water quality affects seagrass abundance

- Seagrasses abundance affected by relative nutrient availability
- Relationships differ depending on region
- Relatively more TN supports higher seagrass cover in FKNMS backreef and Sluiceway meadows
- Relatively more TP may support higher cover in Florida Bay and Inshore



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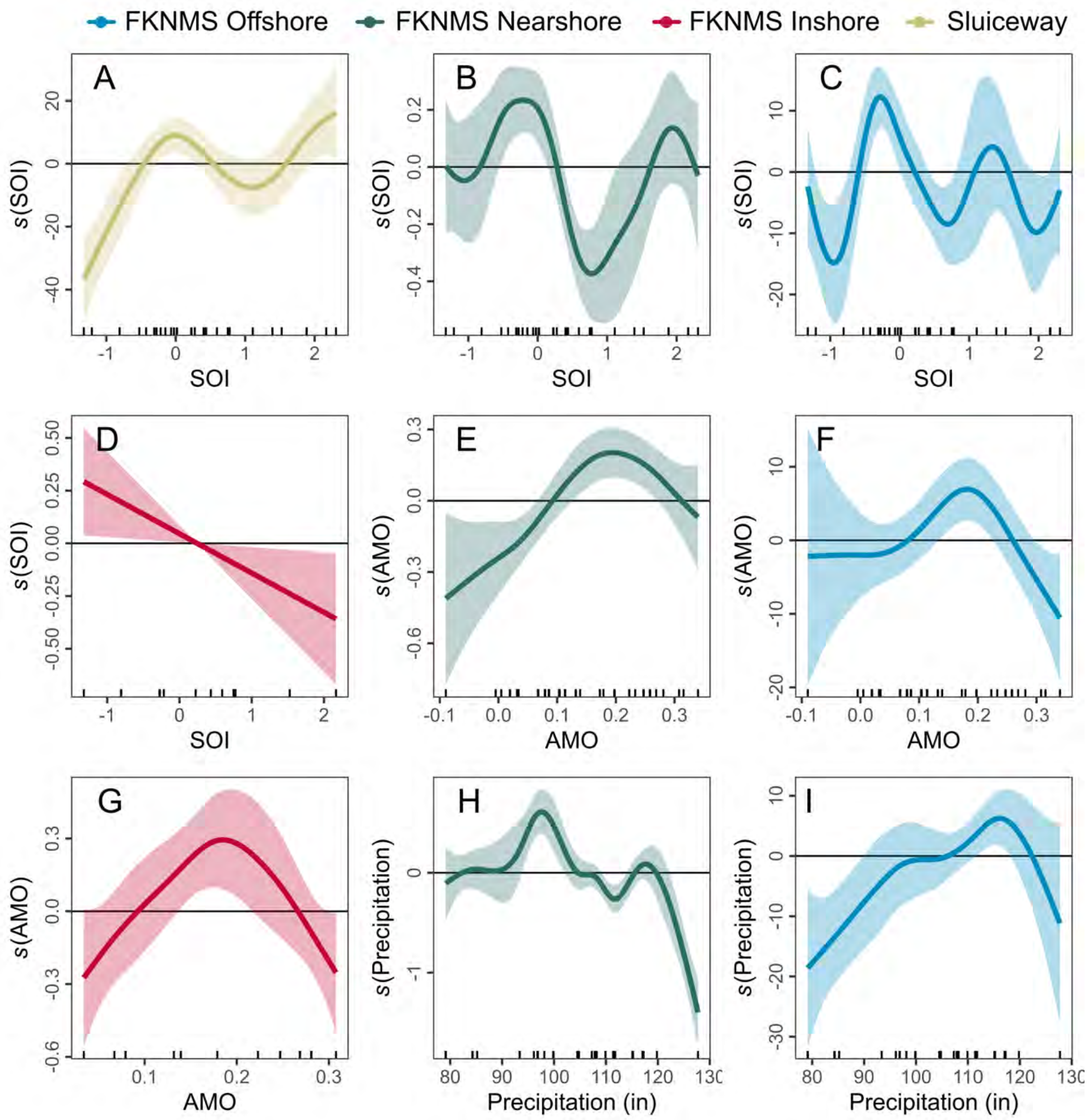
Climate variability

Climate drivers of seagrass cover

- Negative SOI (El Niño conditions) associated with higher seagrass cover in FKNMS nearshore, offshore, inshore
- Positive SOI (La Niña conditions) relates to lower seagrass cover
- Moderate AMO associated with higher seagrass cover
- Higher precipitation related to higher cover in offshore meadows, but not closer to shore (nutrient-limitation gradient)



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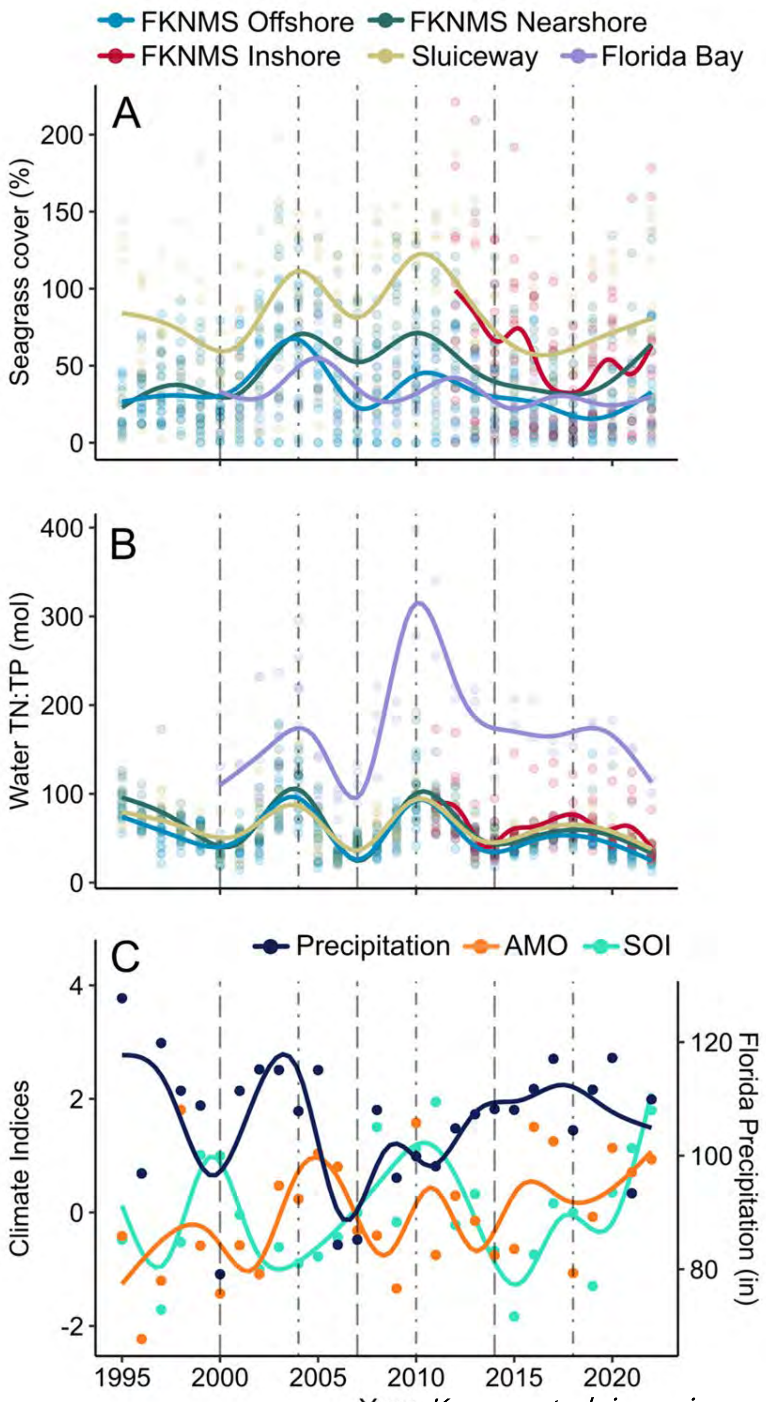
Climate variability

Climate variability affects seagrass cover

- Coupled long-term seagrass and water quality monitoring allows for analysis of interannual trends in relation to climate drivers
- Relative nutrient availability oscillates in FKNMS, possibly in relation to annual rainfall pattern driven by climate oscillations (ENSO, AMO)
- Higher N availability does not affect Inshore and Florida Bay (P-limited), but backreef meadows are periodically fertilized
- Nutrient-enrichment effects on seagrass cover are not permanent
- Seagrasses show resilience to pulsed nutrient enrichment (different from press-type that led to species shifts)

Climate variability



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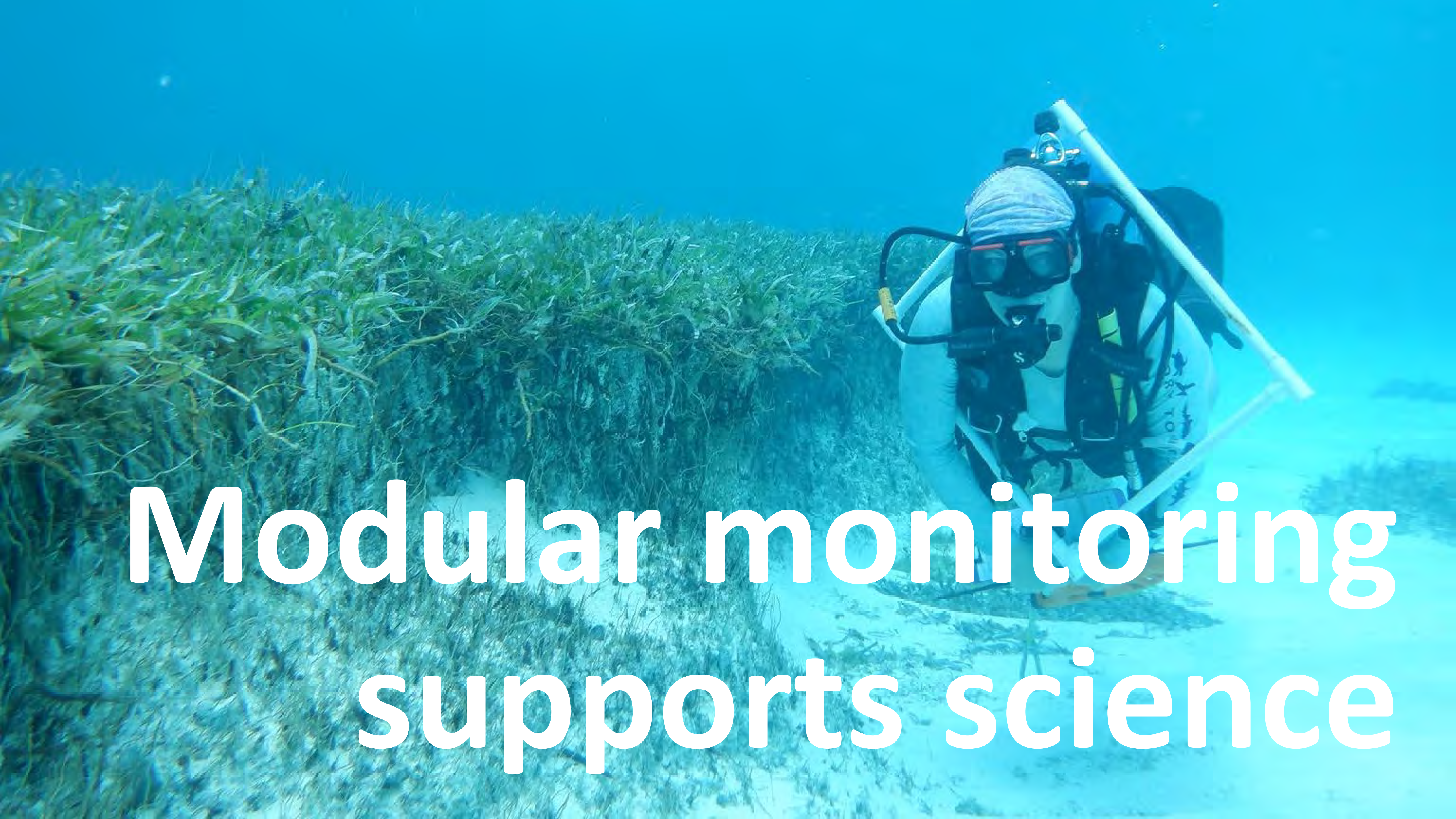
Modular monitoring
supports science

Monitoring program as platform for science modules

- Network of sites with long—term ecological and water quality data
- Monitoring program infrastructure well established
- Platform to add research activities at long-term monitoring sites
- Recent examples:
  - Fish community surveys
  - *Syringodium* reproduction and seed bank surveys
  - Sediment carbon and nutrient stocks

Modular monitoring

Fish community survey module

- Performed transect surveys at long-term monitoring sites
- Recorded over 100 fish species utilizing seagrass habitat across FKNMS
- Will use seagrass monitoring data to study fish communities in relation to
  - Seagrass traits
  - Seascape configuration
  - Environmental controls

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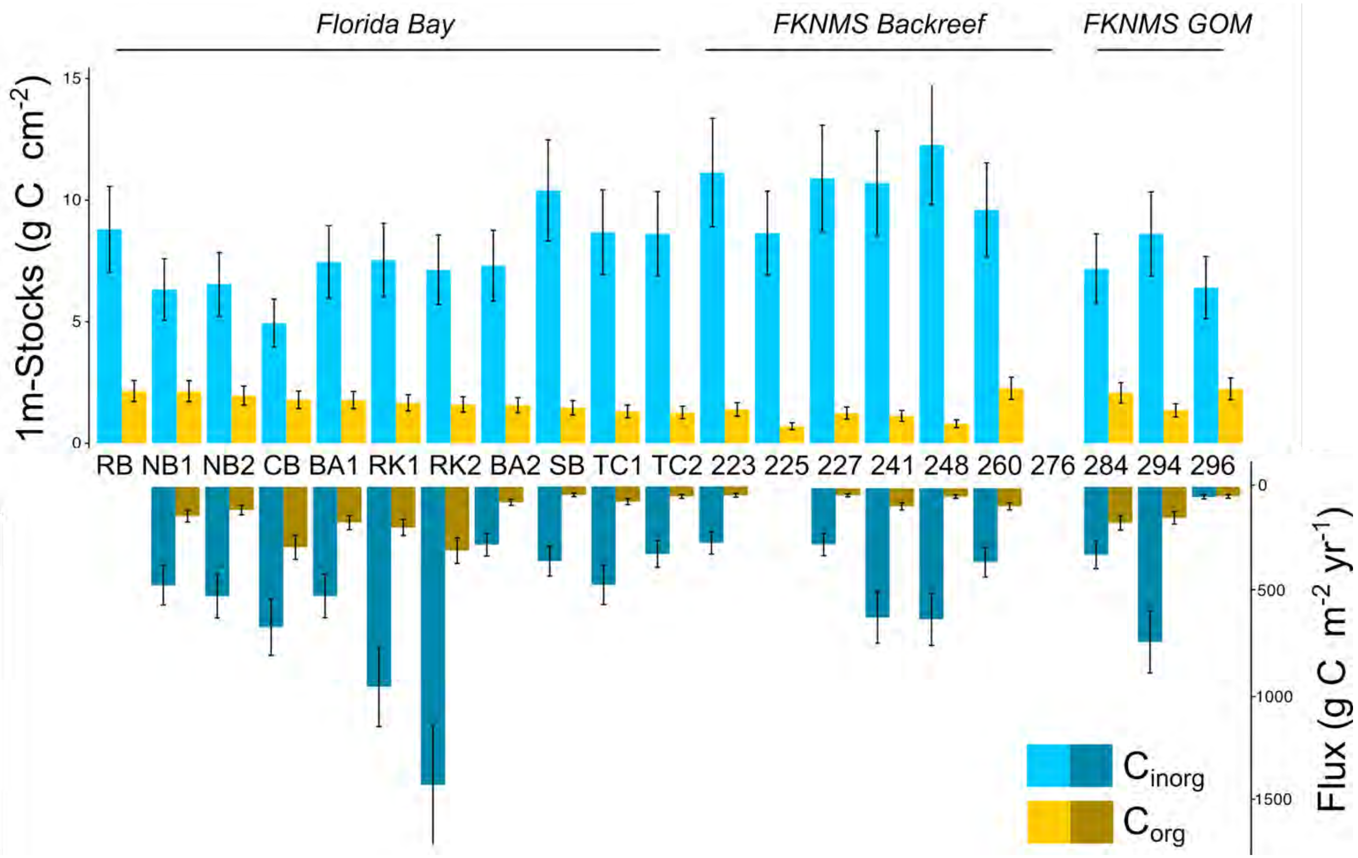
Modular monitoring

Sedimentary carbon and nutrient stock module



- Collected sediment cores at long-term monitoring sites
- Analyzed for sediment carbonate, organic carbon, and nutrient stocks and burial rates
- Found decoupling of stocks and rates
- Long-term monitoring data used to relate stocks and burial rates to
  - Seagrass traits
  - Seascape configuration
  - Environmental controls

Modular monitoring

Syringodium reproductive phenology module

- Performed seed bank surveys at long-term monitoring sites

- Record occurrence of reproductive organs

- Use seagrass monitoring data to study
  - Seed production
  - Resilience to disturbance
  - Dispersal potential
  - Suitability of *Syringodium* for seed—based restoration

Modular monitoring

Monitoring program as platform for science modules

- Long-term datasets on benthic ecology and water quality invaluable assets for seagrass research

- Spatial and temporal distribution of seagrass monitoring in FKNMS great framework for ecological research

- Investigations into ecosystem service provision (e.g., fisheries, carbon)

- Very few seagrass systems globally with such wealth of monitoring data

Modular monitoring

Thank you for your attention!

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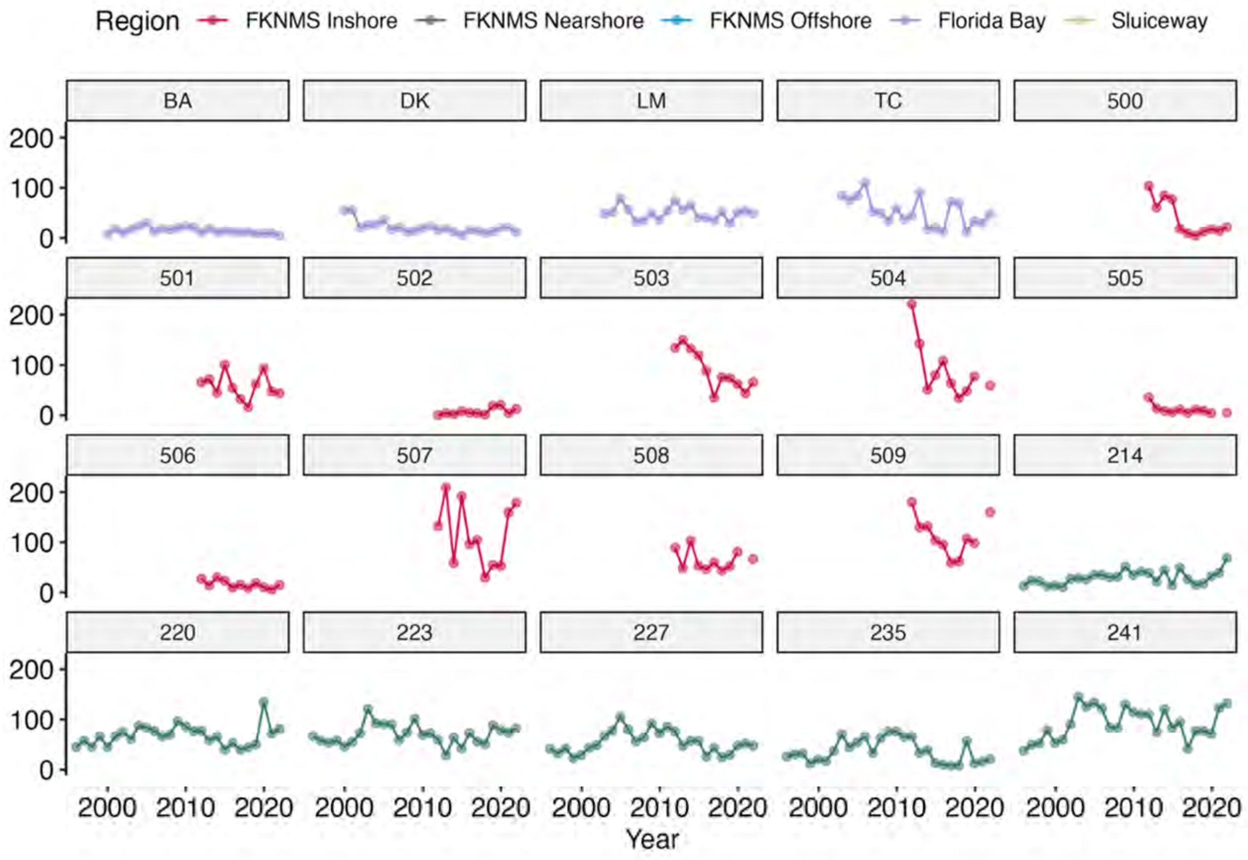
Region
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FKNMS Nearshore
FKNMS Offshore
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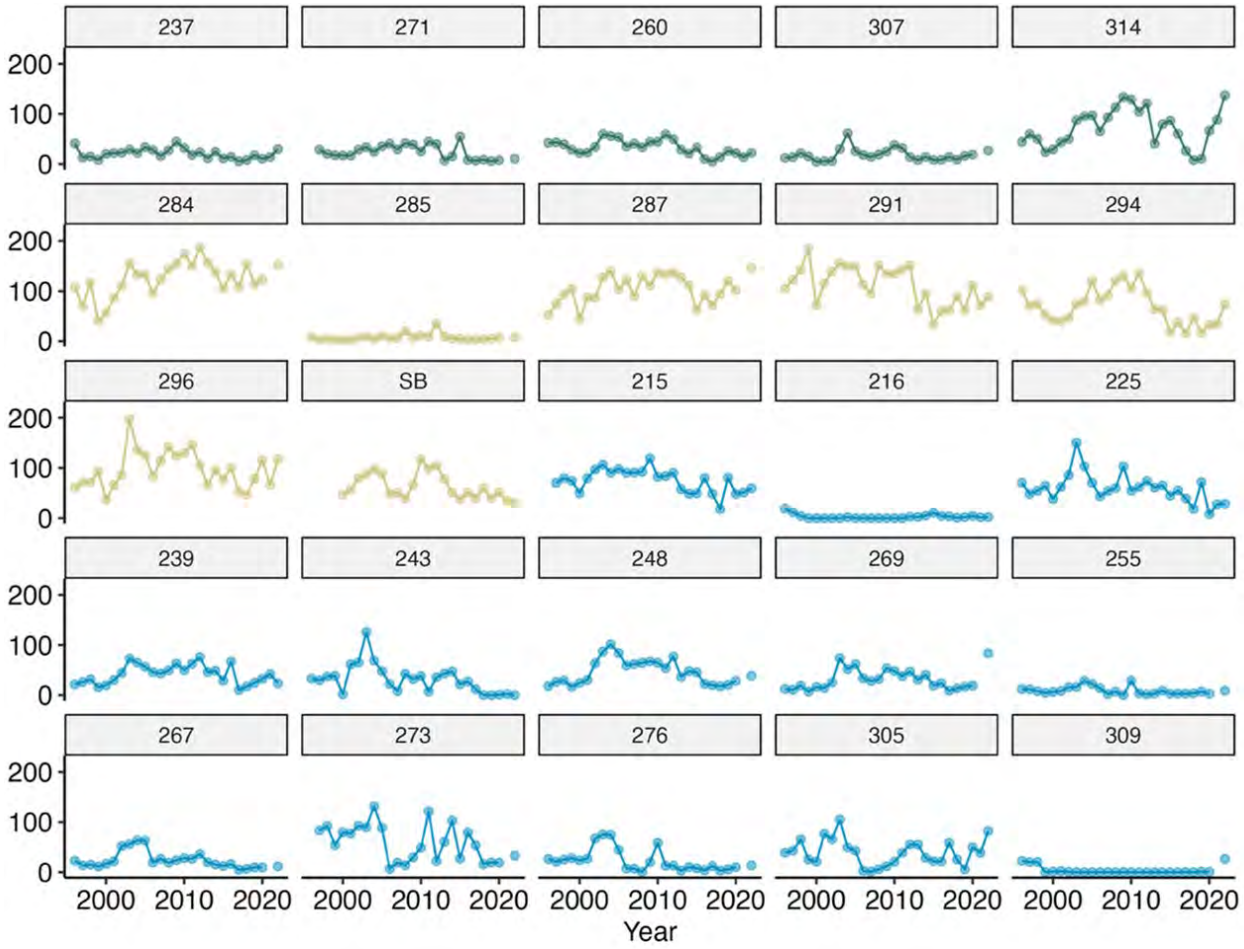
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