

# Florida's Coral Reef unified water quality monitoring database: data aggregation and analysis

David Kochan

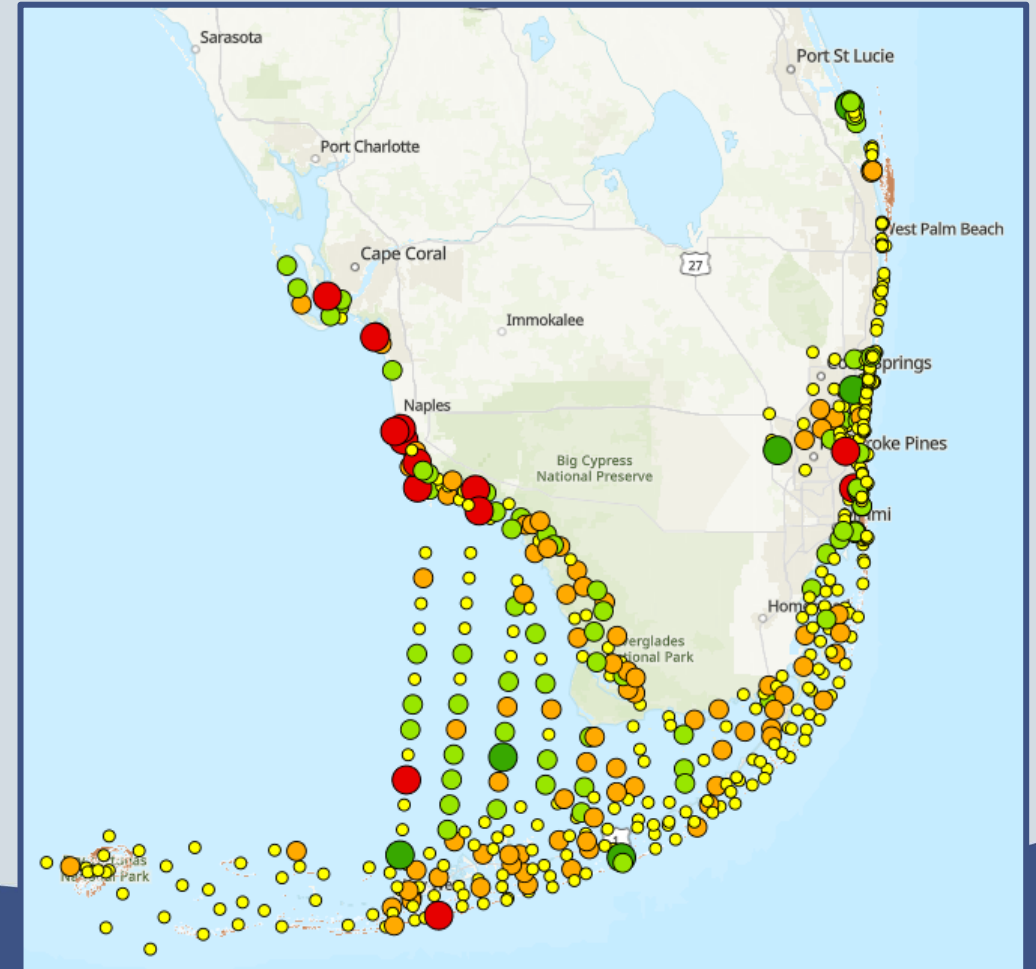
Center for Spatial Analysis

Florida Fish and Wildlife Research Institute

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Florida's Coral Reef Coordination Team Meeting

March 22, 2024



# Project team and funding

Funding provided by **Florida Department of Environmental Protection**

- **Karen Bohnsack**, Florida Keys National Marine Sanctuary
- **Andy Bruckner, Ph.D.**, Florida Keys National Marine Sanctuary
- **Alexandra Fine**, University of Miami Cooperative Institute for Marine and Atmospheric Studies, NOAA Atlantic Oceanographic and Meteorological Laboratory
- **Lauren Gentry**, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute
- **Christopher Kelble, Ph.D.**, NOAA Atlantic Oceanographic and Meteorological Laboratory
- **David Kochan, Ph.D.**, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute
- **Lucas McEachron, Ph.D.**, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute
- **Kelly Montenero**, University of Miami Cooperative Institute for Marine and Atmospheric Studies, NOAA Atlantic Oceanographic and Meteorological Laboratory
- **Frank Muller-Karger, Ph.D.**, University of South Florida
- **Tylar Murray, Ph.D.**, University of South Florida
- **Dan Otis, Ph.D.**, University of South Florida
- **Omar Ramzy**, University of Miami Cooperative Institute for Marine and Atmospheric Studies, NOAA Atlantic Oceanographic and Meteorological Laboratory
- **Tina Udouj**, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute



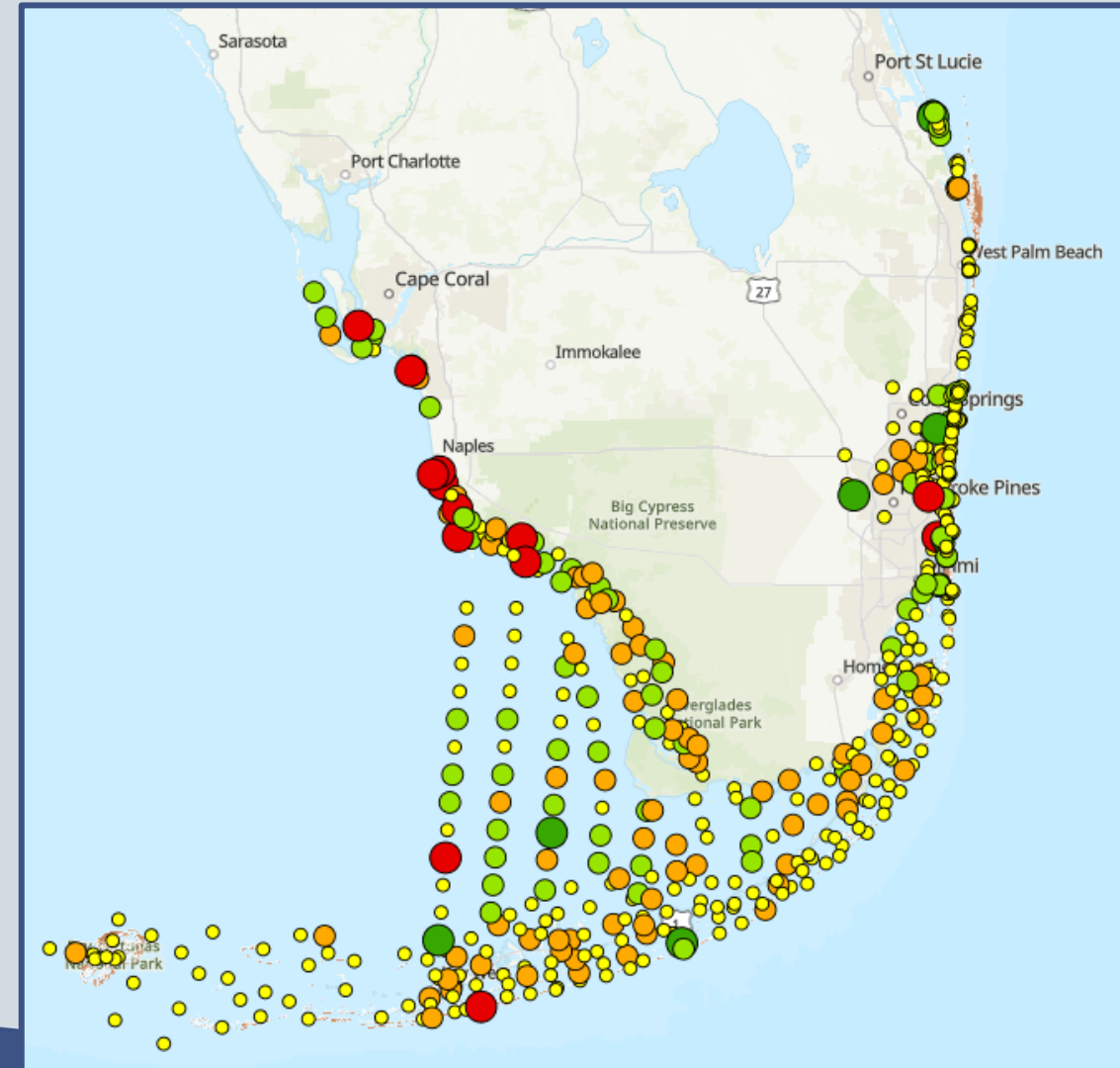
# Project goals

## Year 1-3 Goals:

- Create a **unified** water quality monitoring dataset across Florida's Coral Reef
- Identify long-term trends and monitoring gaps
- Provide 'one-stop shop' for data access

## Year 4 & 5 Goals:

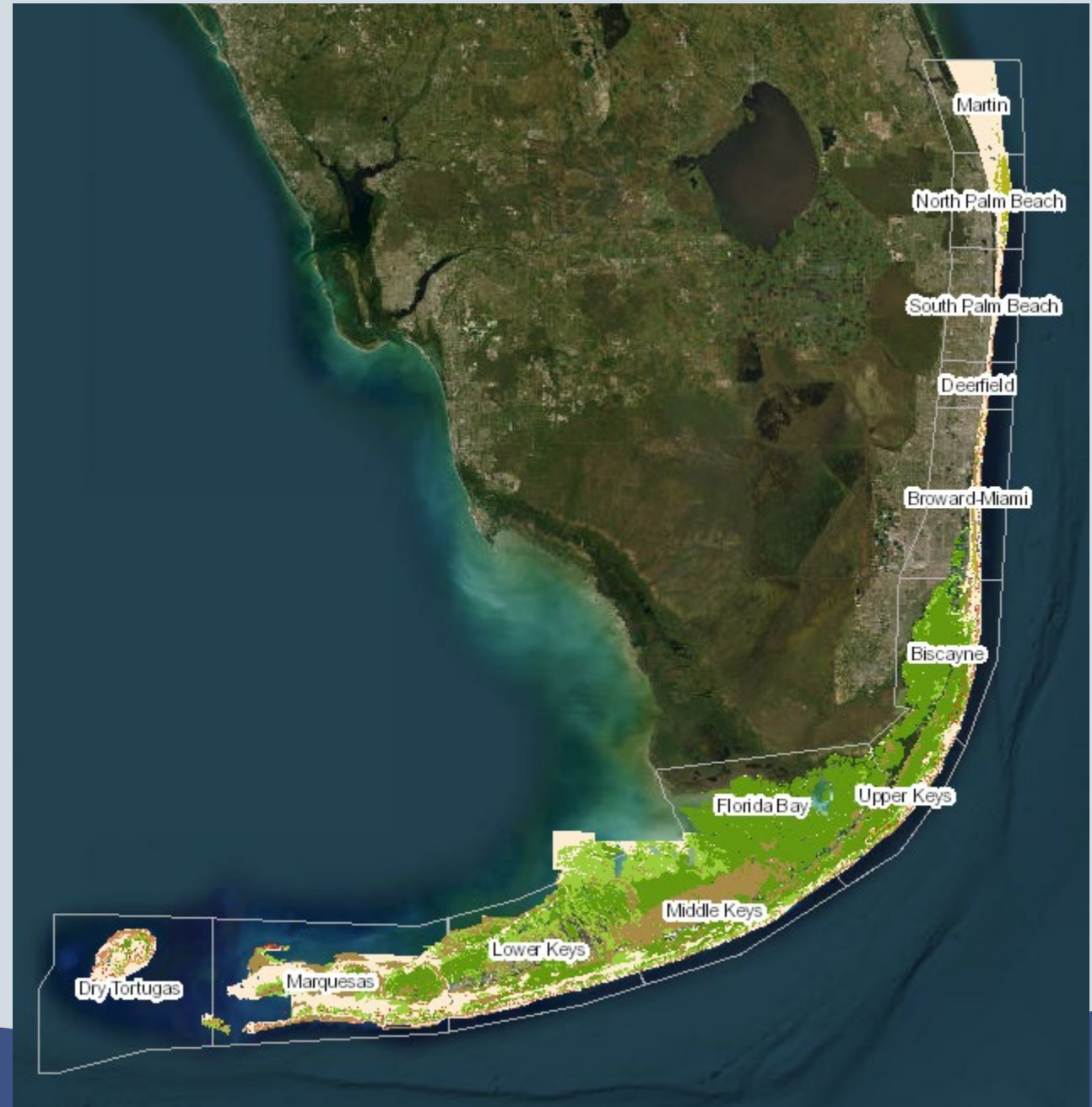
- Update database and create new visualizations
- Contribute to integrated framework to answer question: **Can we detect change from management and restoration efforts?**



# History

## Florida Unified Reef Map

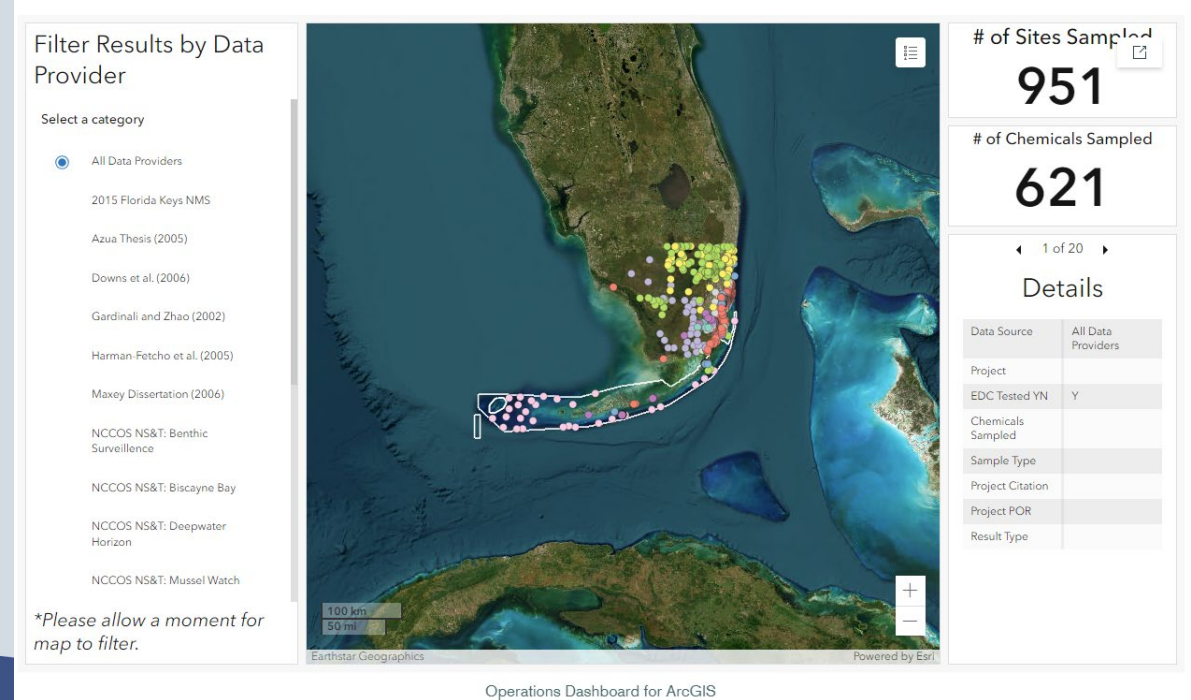
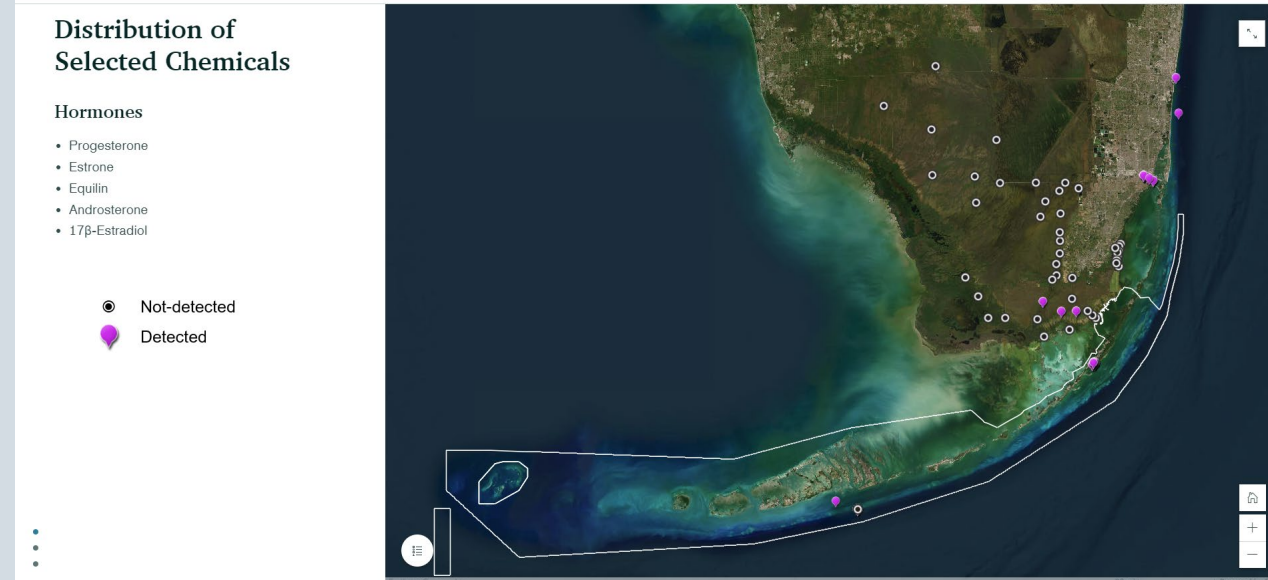
- Initiative to integrate maps and monitoring from a network of sources
- 5-year project “finished” in 2017
- Will be updated with new data
- <https://myfwc.com/research/gis/fisheries/unified-reef-map/>



# History

## Endocrine Disrupting Compounds

- FDEP-funded project to summarize type, concentrations, sampling gaps, and distribution of EDCs
- Outreach, Geodatabase, Mapping
- Finished in 2021
- <https://storymaps.arcgis.com/stories/5b4d8b965cc74c4b8fafceac556a6635>



# Year 1

- Data compilation
- Inclusion criteria
- Trend analysis

# Year 2

- Additional data sets
- Gap analysis
- Data compatibility

# Year 3

- Streamline data processing
- Improve data accessibility and visualization

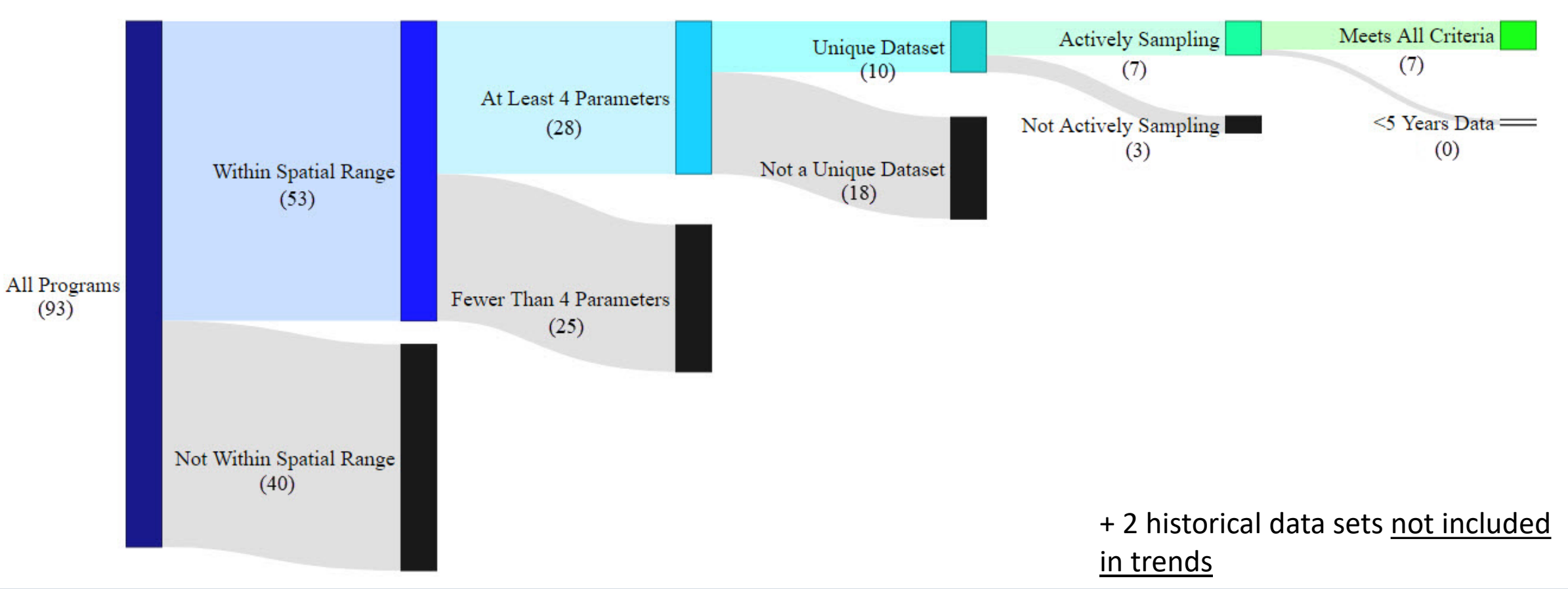
# Year 4

- Provide technical support for the Florida's Coral Reef Coordination Team
- Develop data visualization tool

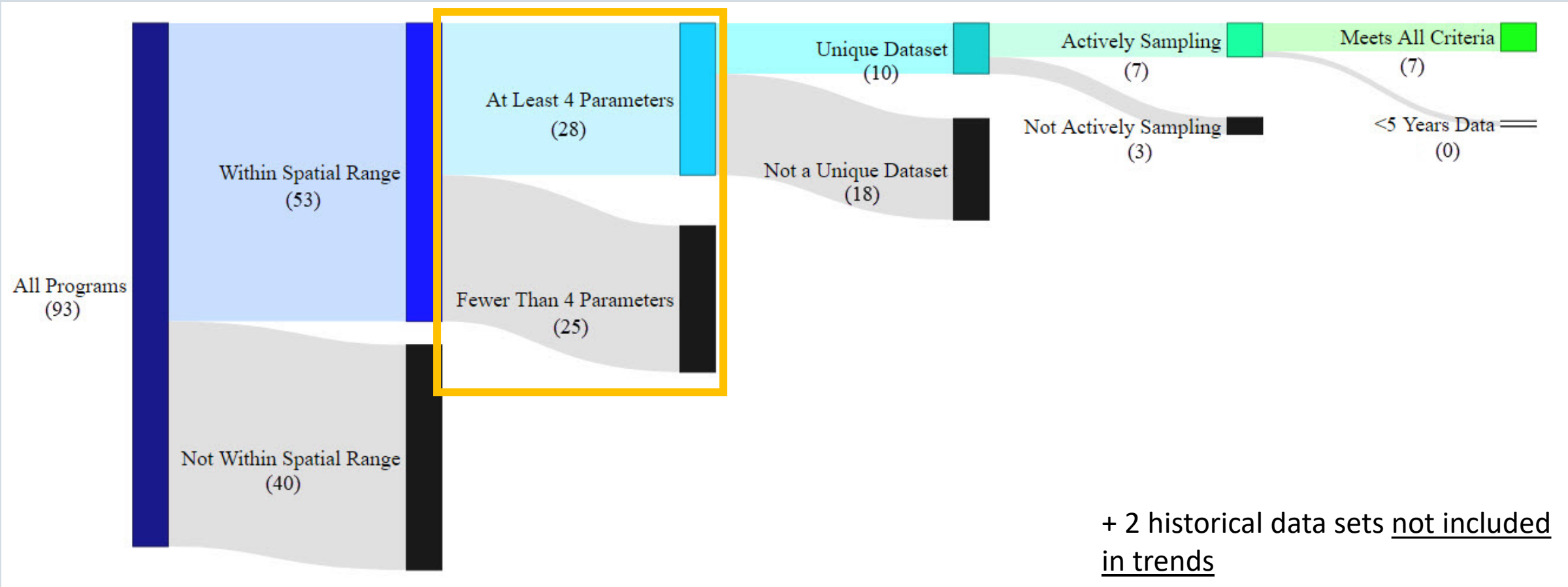
- Update WQ database and maps with each year's data
  - Add new programs as they meet criteria



# Data inclusion



# Data inclusion



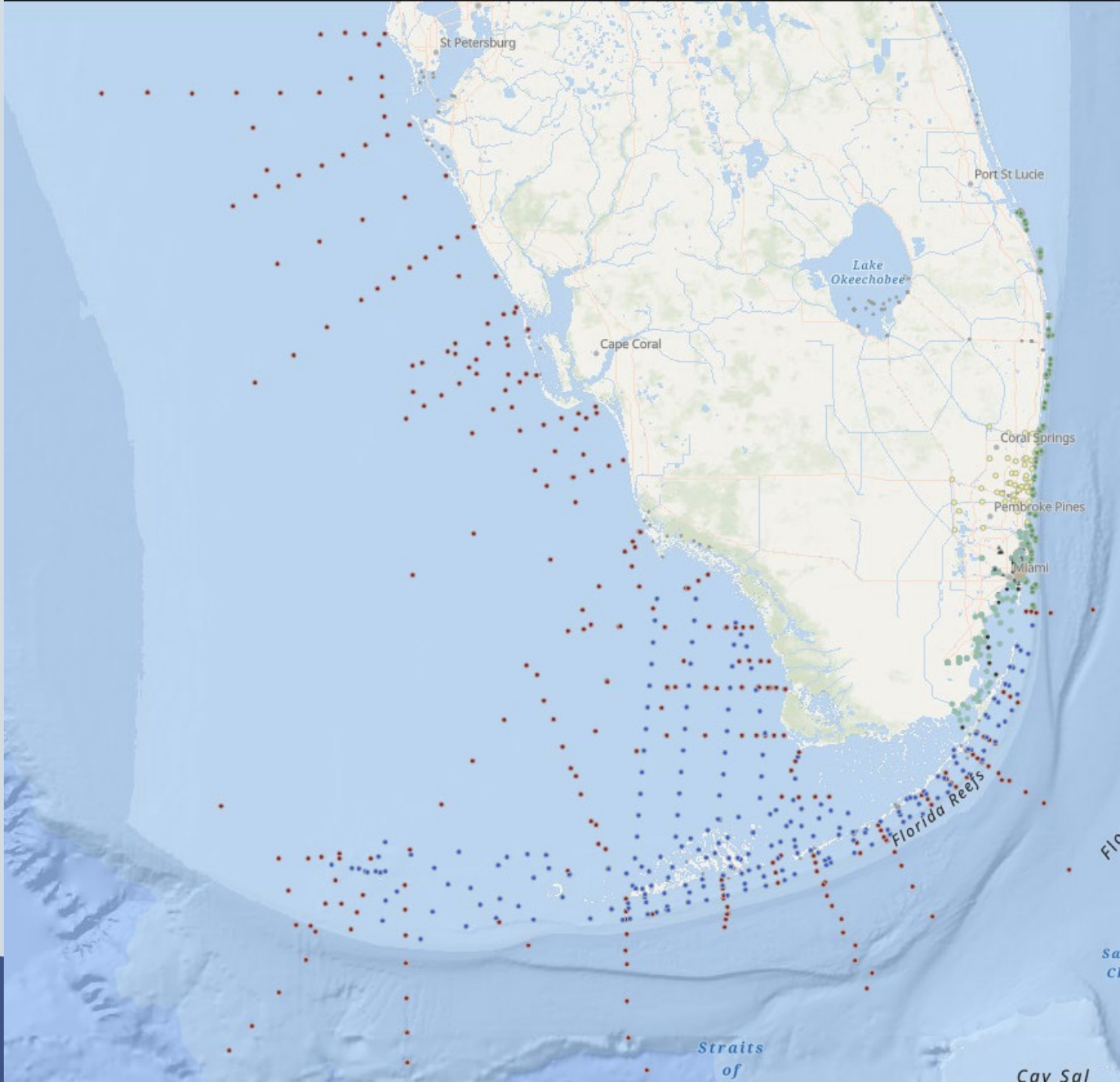


# Water quality analytes and nutrients

- Nitrogen
  - Total Nitrogen
  - NO<sub>2</sub>
  - NO<sub>3</sub>
  - Ammonium
  - TKN
- Phosphorous
  - Total Phosphorous
  - Orthophosphates (OPO<sub>4</sub>)
- Water Clarity
  - Chlorophyll a
  - Turbidity
  - Silicates

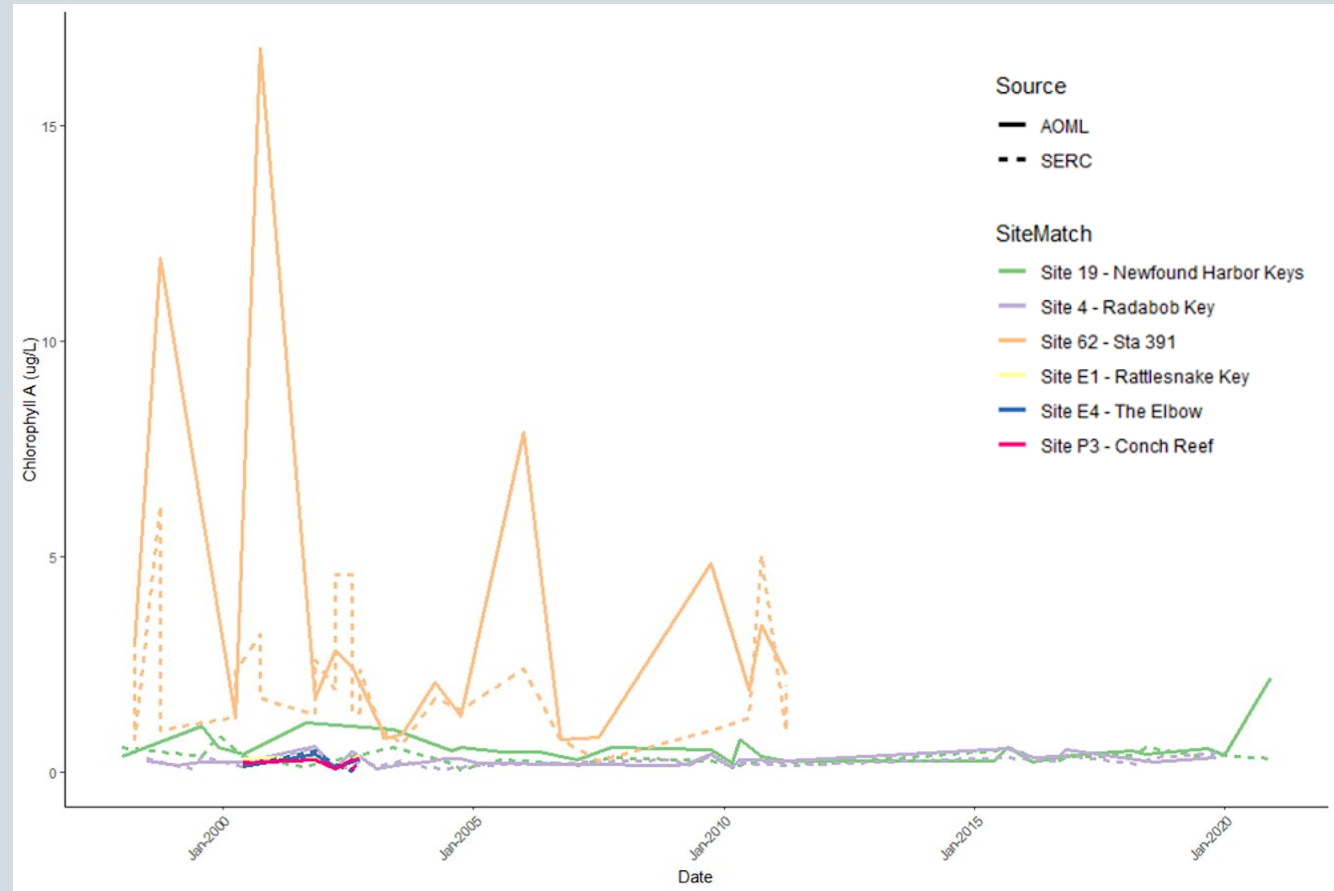


Source	Sites
FL Keys Nearshore	406
AOML	303
Biscayne Bay Aquatic Preserve	19
Biscayne Bay Water Watch	54
Broward County	115
DEP ECA	147
SERC/FIU	236
City of Miami/Miami Beach	92
<b>Total</b>	<b>916</b>



# Data comparability

1. Send identical samples to multiple labs
  - ✗ Expensive and time consuming
2. Overlapping samples
  - ✗ Very few sites overlapping spatially and temporally →
3. Lab and method certification
  - ✓ Programs required to use certain methods by funders



# Data comparability

## Additional considerations

- Basic data compatibility like units, analyte names, etc.
- Should report minimum detection levels for MDL estimation techniques like Flynn method
- Unable to find consistent relationship between remotely sensed and *in situ* Chlorophyll or turbidity measures – still useful but not compatible



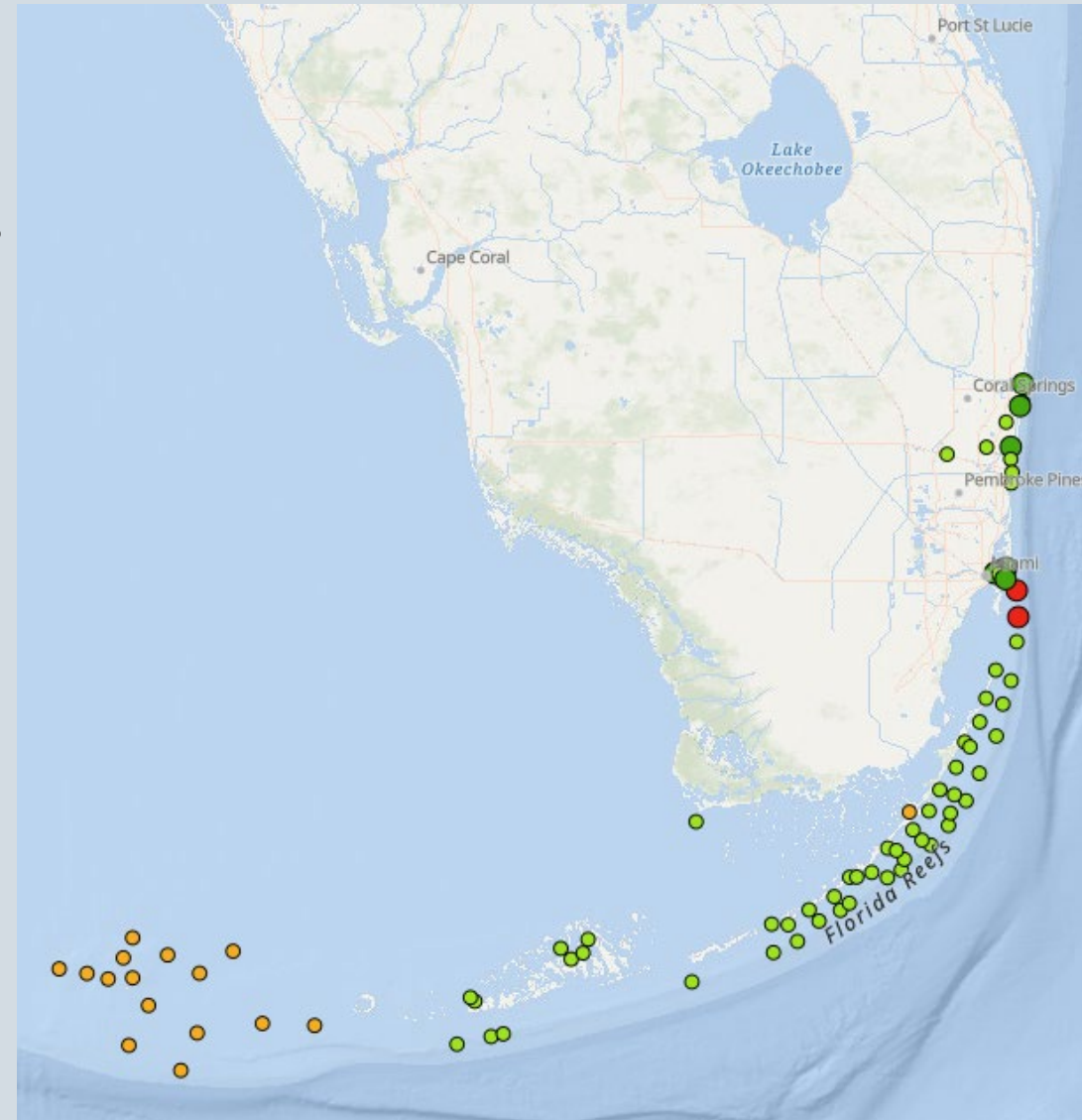
# Trend analysis

- Basis for comparing data across Florida's Coral Reef
  - Even if raw values not directly comparable, the same trends should be captured

- Long-term analysis
- Identify hotspots and gaps

Map shows Total Nitrogen

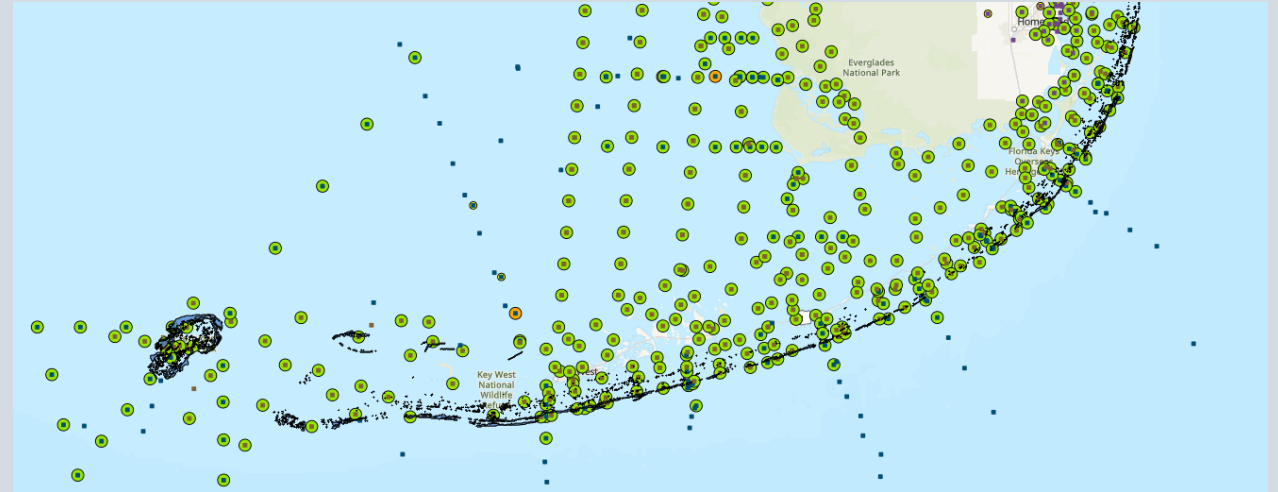
- Only significant trends
- Lots of decreasing TN, 2 hotspots of increasing TN



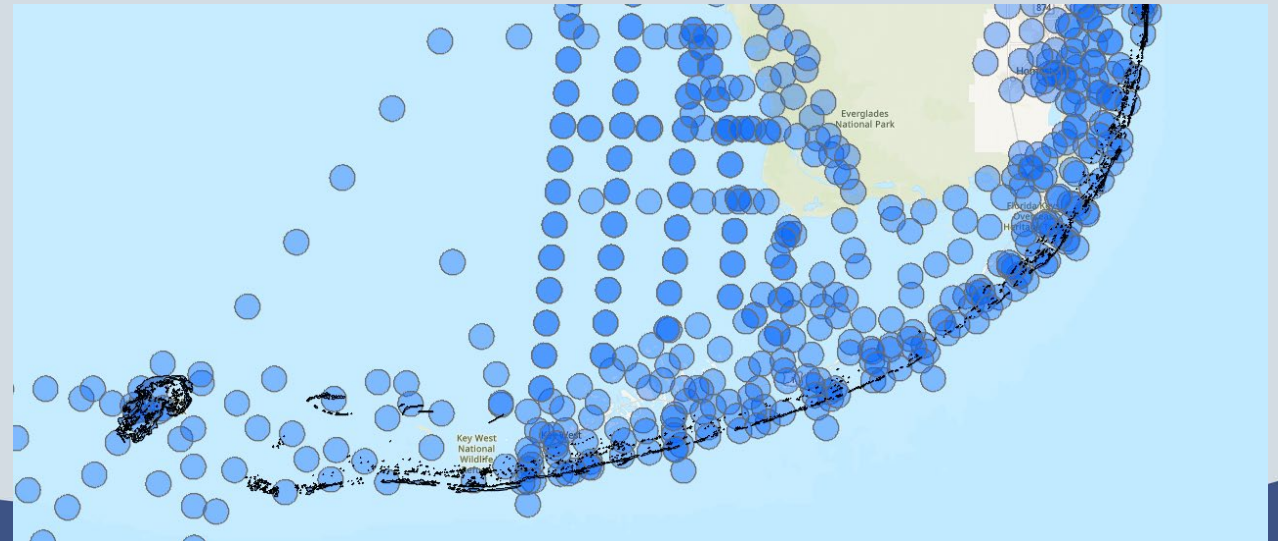
# Gap Analysis

- Semivariograms show spatial correlation – how far apart does sampling still show the same trend
- Buffer zones vary by analytes from 1.7 – 7+ km
- Some analytes have no buffer due to inshore-offshore gradient

Total Phosphorous – 1.7 km buffer



Orthophosphates – 3.5 km buffer



# Satellite-based estimates of Sen's slope

Data from MODIS satellite (1-km pixel, 2003-present)

Products:

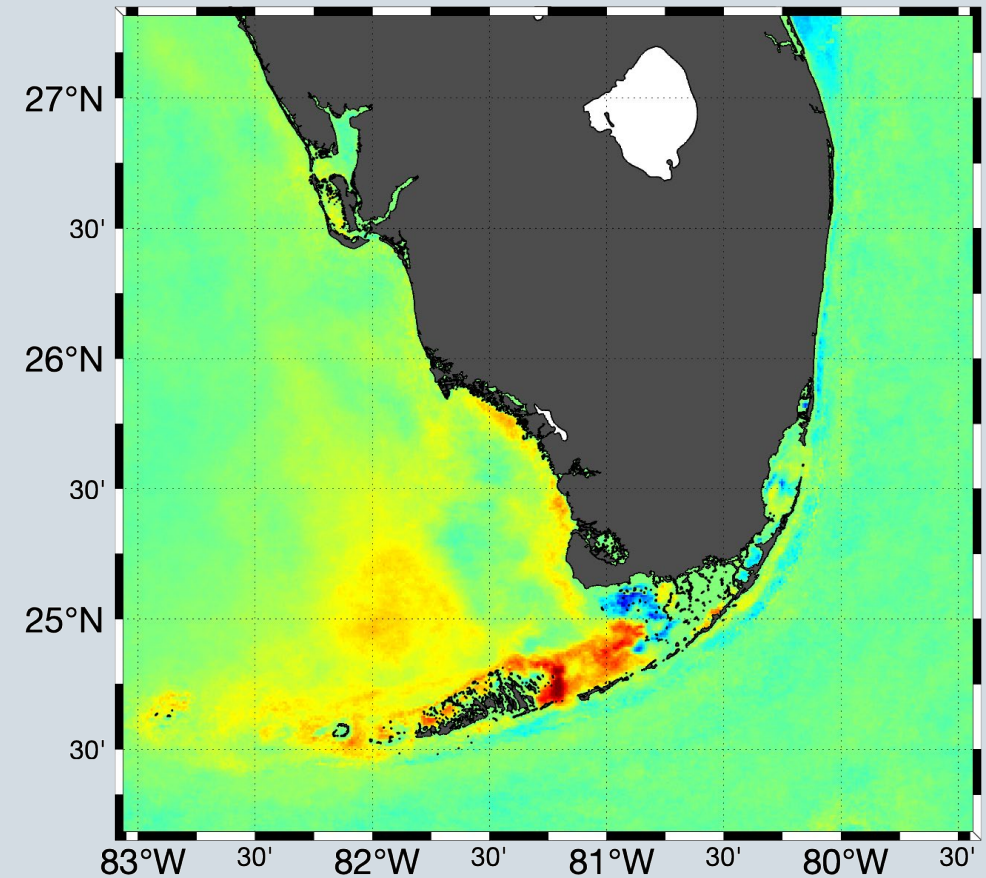
Chlorophyll-a (proxy for phytoplankton biomass)

Rrs\_667 (red reflectance; proxy for suspended sediments)

Kd\_490 (proxy for water clarity in the blue-green region of the spectrum)

adg\_443 (absorption at 443 nm by CDOM)

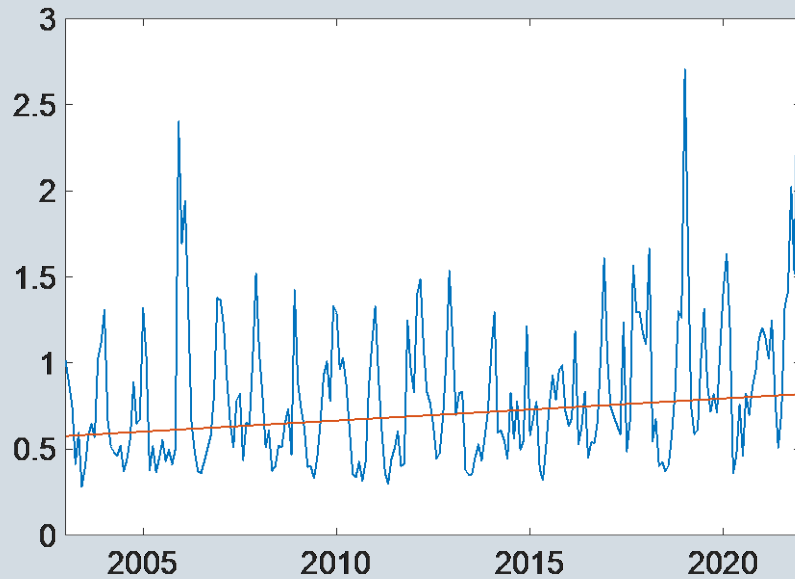
SST (sea surface temperature)



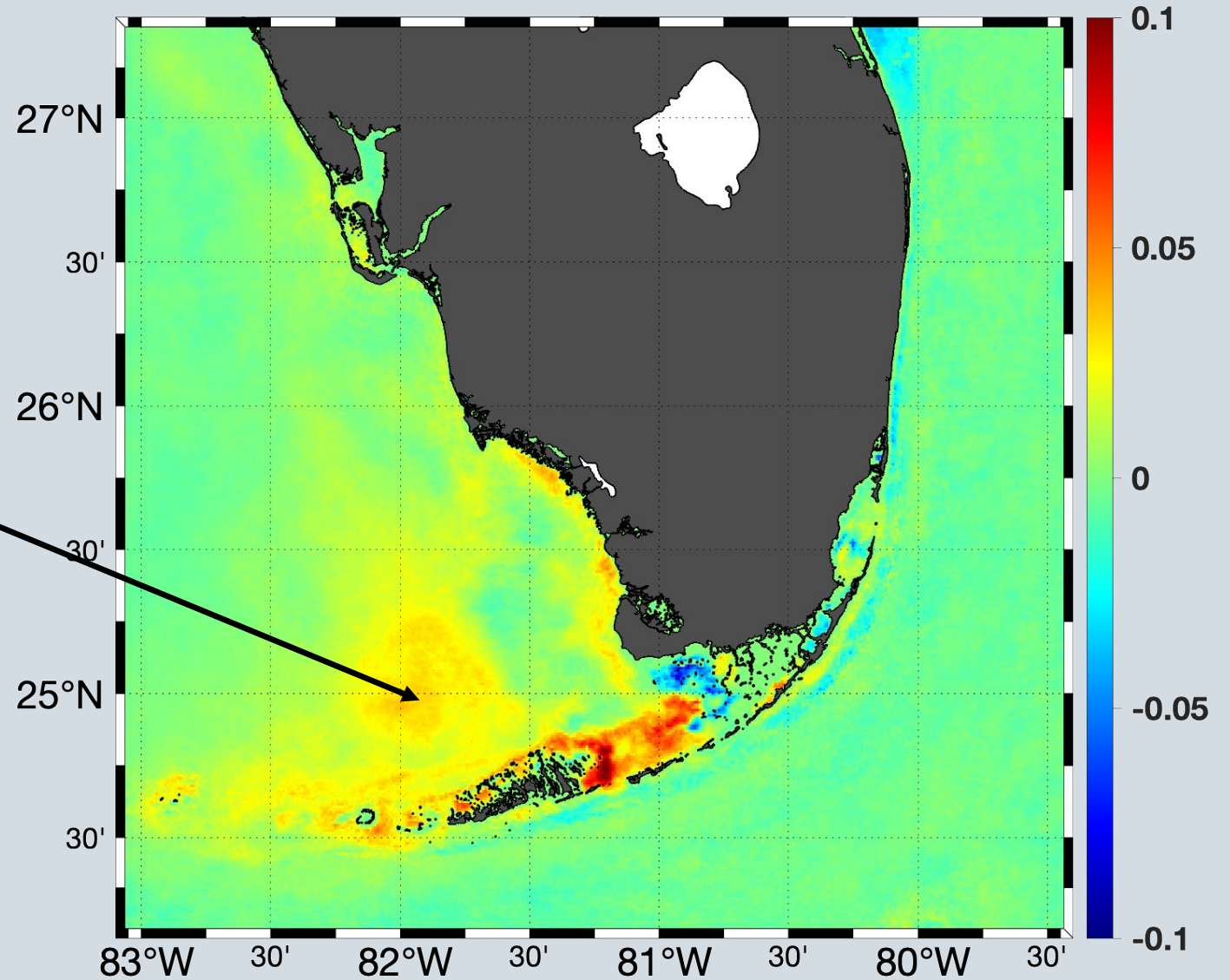
UNIVERSITY OF  
SOUTH FLORIDA  
College of MARINE SCIENCE

# Chlorophyll-a (2003-2021)

Red colors indicate positive slopes



**Slope = 0.013 mg/m<sup>3</sup>/yr**





# Data Visualization

- Web Mapping Applications
- StoryMaps
- Data Dashboards
- Data Visualization Tools



# ESRI Instant App – guided data viewer & exploration (Years 1-3)

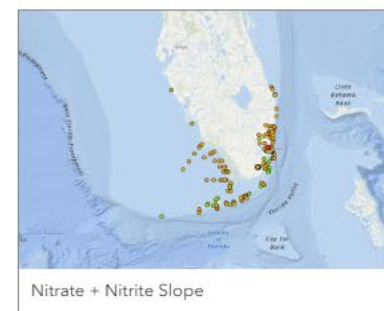
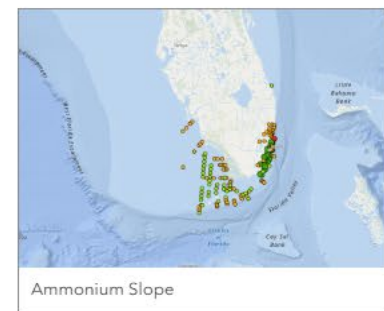
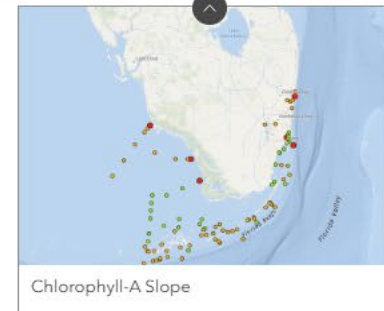
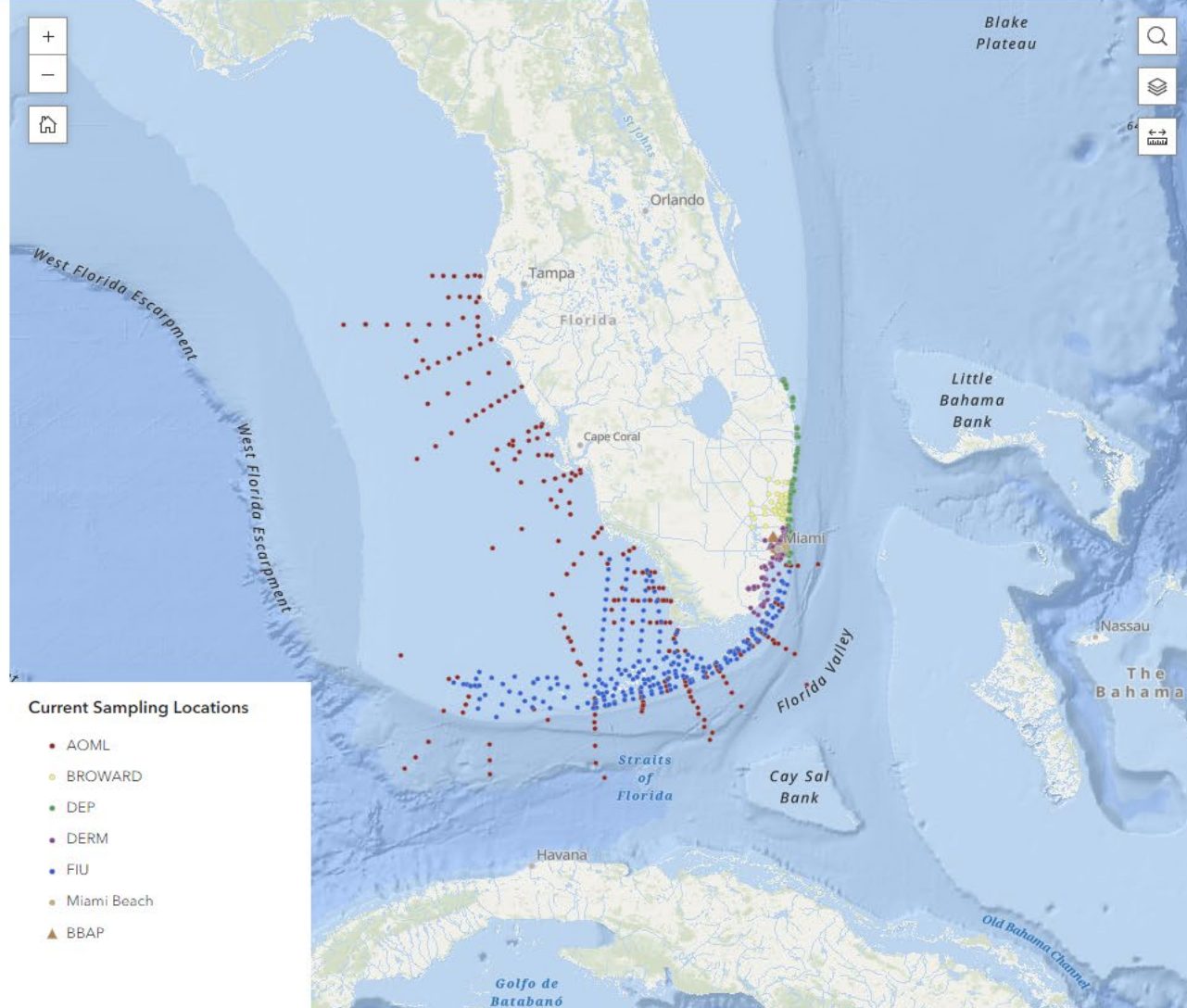
Florida's Coral Reef Water Quality Data

- > Data Compilation, Analysis and Decision Support Year 1
- > Data Compilation, Analysis and Decision Support Year 2
- > Data Compilation, Analysis and Decision Support Year 3

DEP WQ

Sampling Programs

Significant Rate of Change



[Instant App Link](#)

Agenda Item #6, David Kochan

# ESRI Web Mapping Application – data viewer & exploration (Year 3)

DEP WQ Year 3 Web Map

Open in Map Viewer Classic

David Kochan david.kochan

Legend

Current Sampling Locations

- AOML
- BROWARD
- DEP
- DERM
- FIU
- Miami Beach
- ▲ BBAP

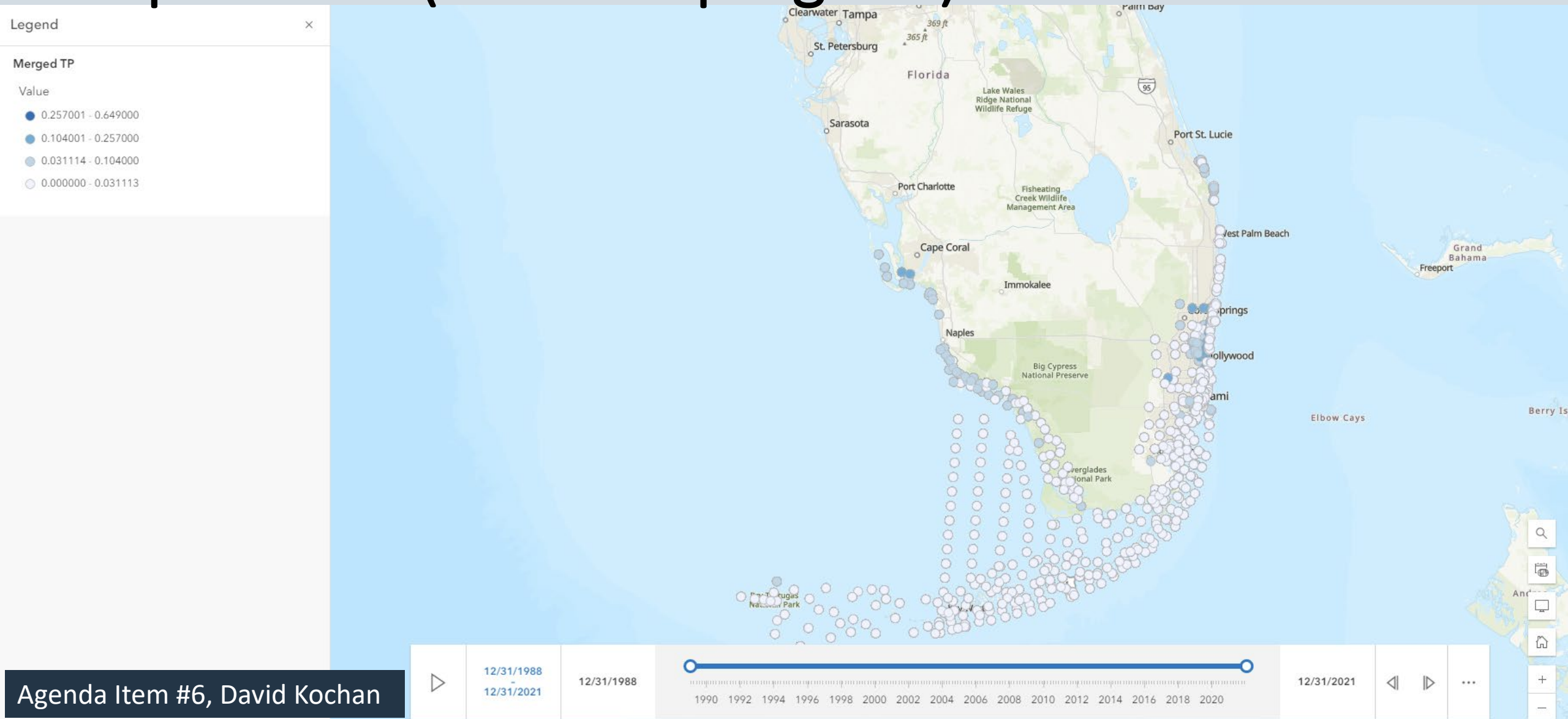
[Web Map Link](#)

Agenda Item #6, David Kochan

Esri, GEBCO, Garmin, NaturalVue | University of South Florida, FDEP, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NPS, USFWS

Powered by Esri

# ESRI Web Mapping Application – data viewer & exploration (Year 4 in progress)



# ESRI StoryMaps – narrative data discussion



Florida's Coral Reef Water Quality Data

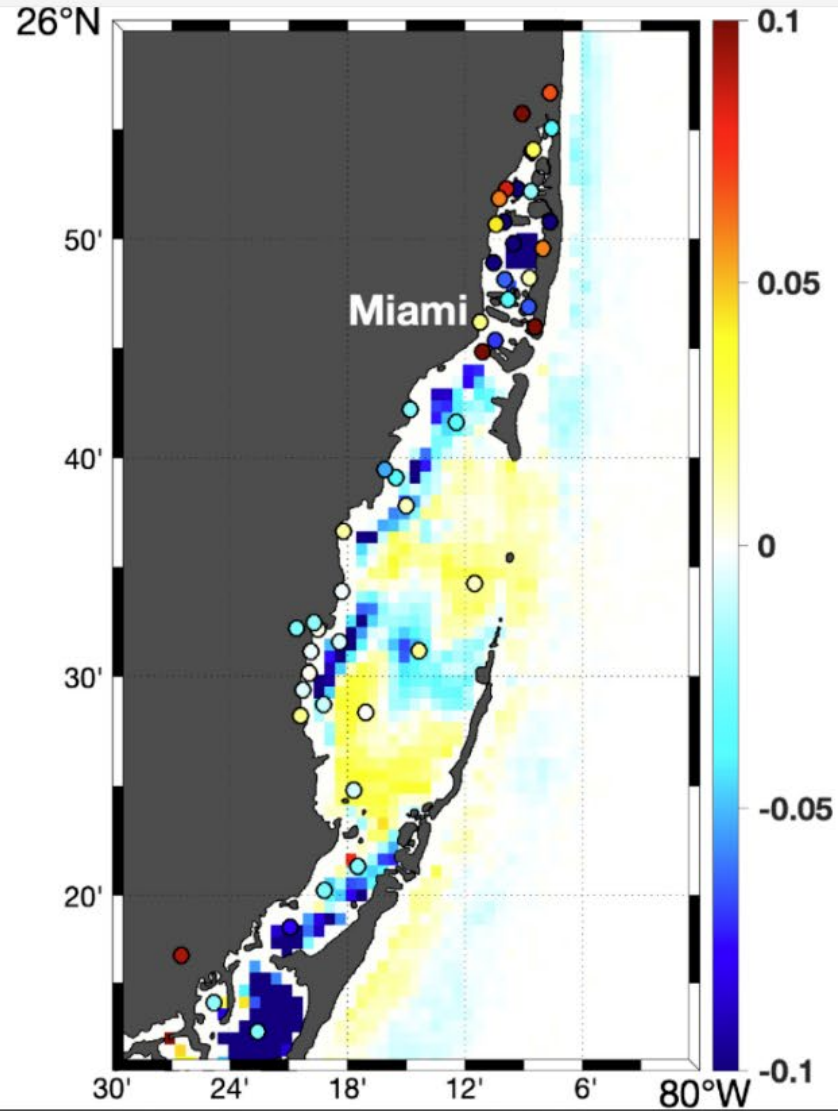


[Background](#) [Project Results](#) [Patterns](#) [Lessons Learned](#) [Investigators](#)

## Chlorophyll-a Theil-Sen slope images

Image based on monthly MODIS satellite data (2003-2021). Filled circles indicate locations of in situ chlorophyll-a measurements by DERM.

There is reasonable agreement between satellite and in situ Theil-Sen slopes for Chlorophyll-A in Biscayne Bay where negative slopes are seen in each.



[Year 1 StoryMap link](#)

[Year 2 StoryMap link](#)

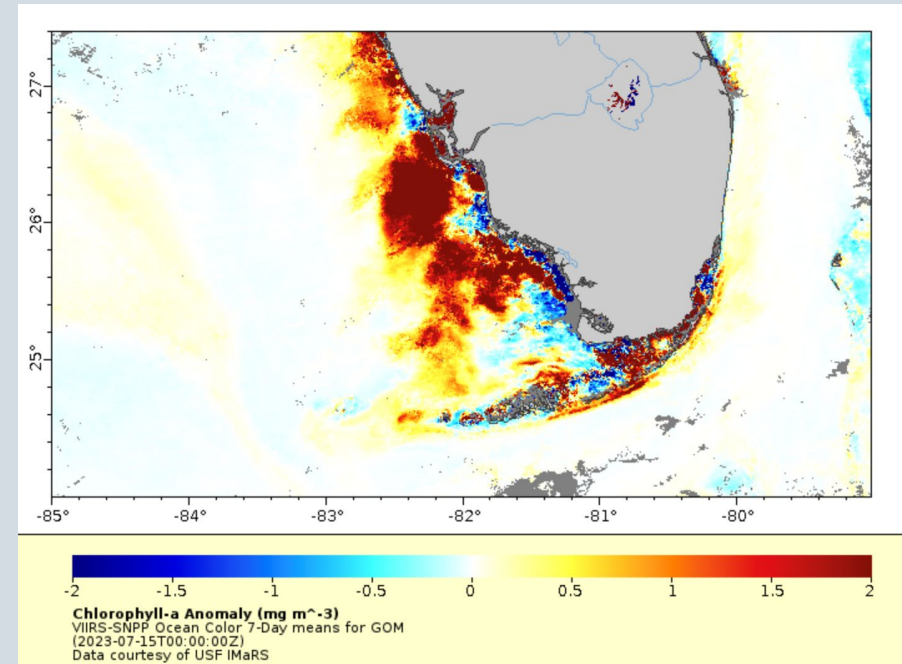
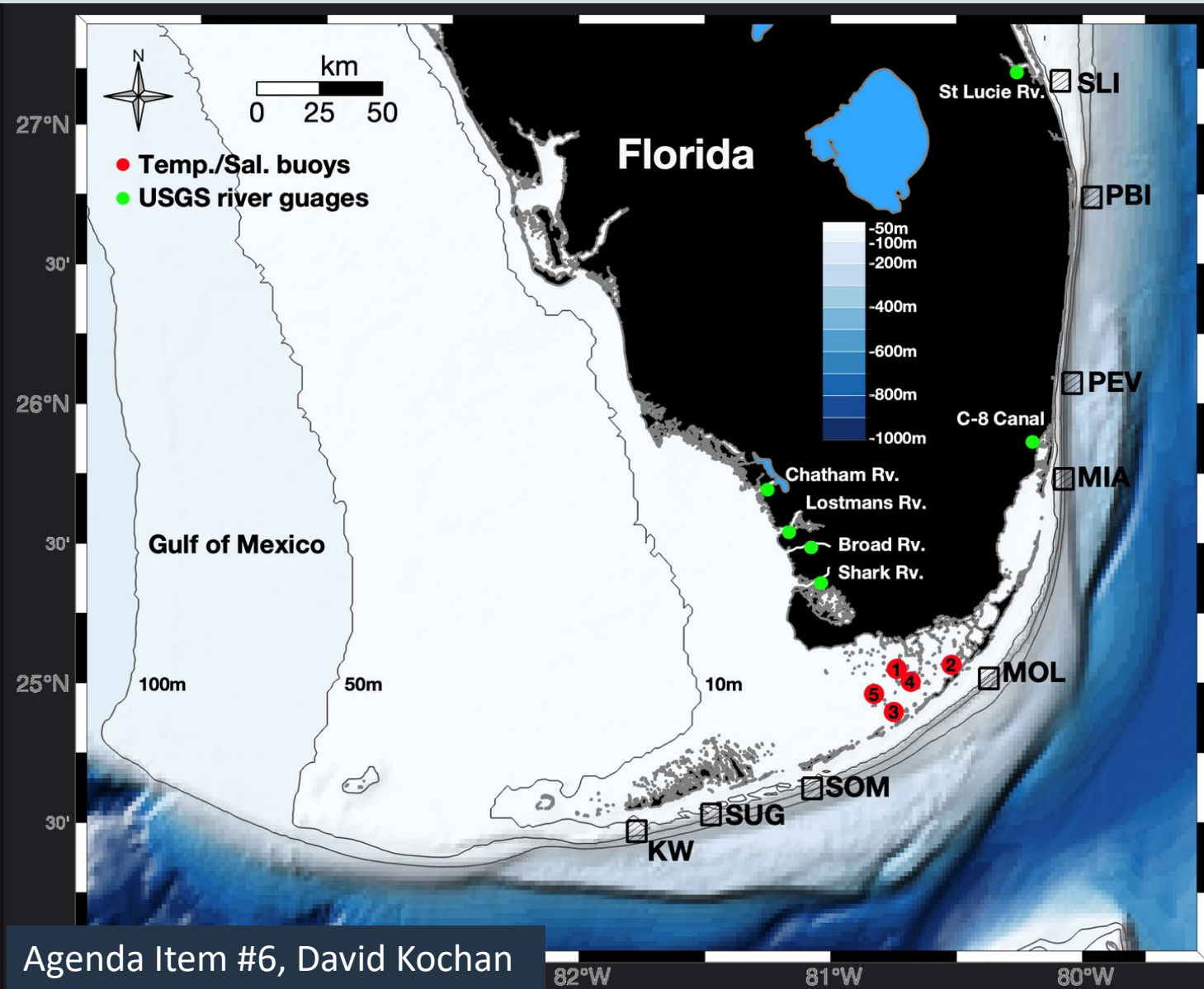
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# FWC - FDEP Data dashboard

Satellite images and time series  
(Chl-a, SST, turbidity, bloom index)

River discharge and gauge height

Natl. Park Service buoys  
(temp. and salinity)



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[Dashboard Link](#)

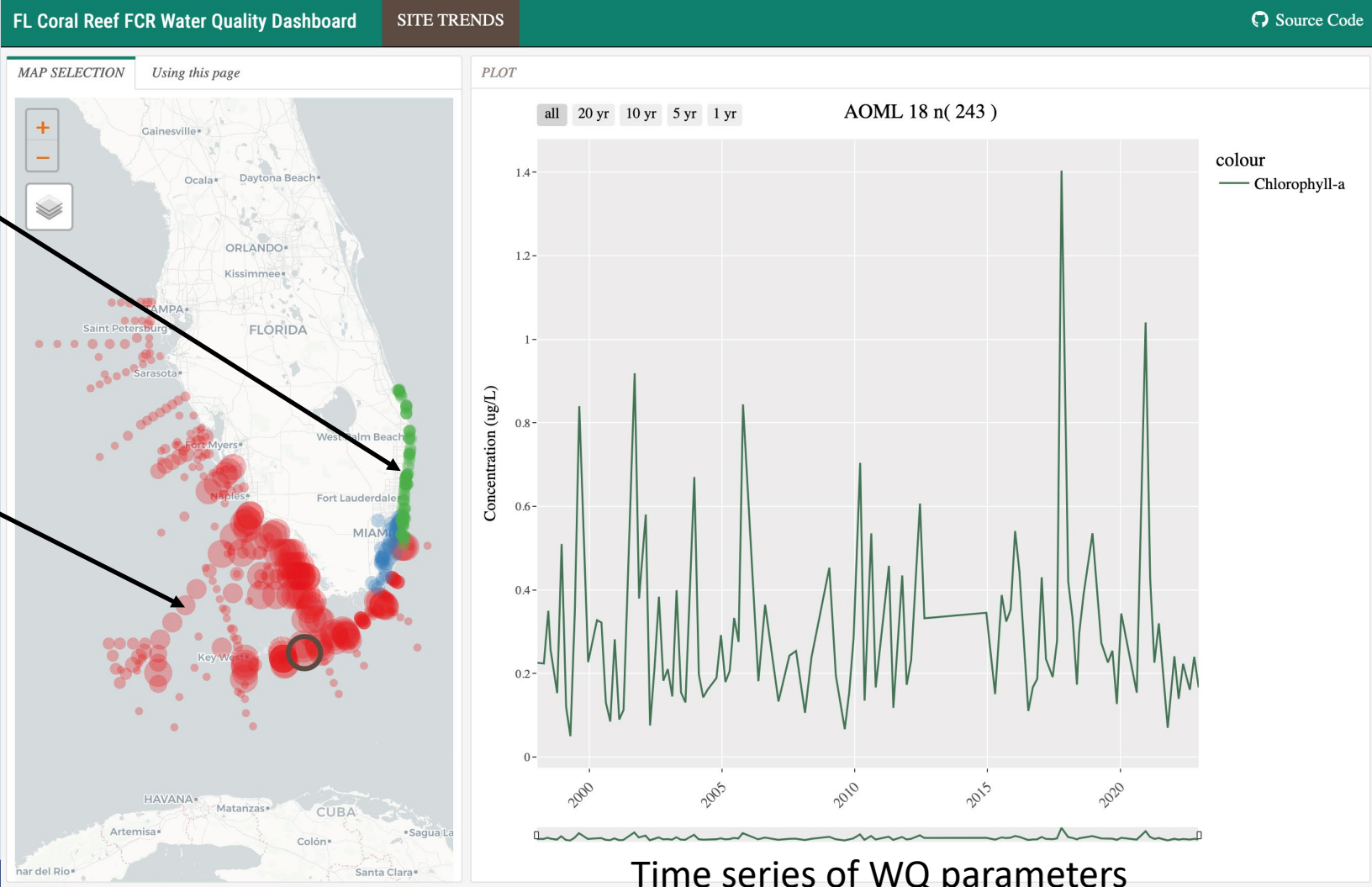


# Data Visualization tool (beta)

Sampling program  
(icon color)

Number of  
observations  
(icon size)

- Filters:**
- Actively sampled?
  - Time period
  - Program
  - Number of obs.



# Year 5 Goals

- Continue contributing to FCRCT and FCRRP Water Quality Team
- Inventory and methods analysis of abiotic factors
  - Temperature
  - Salinity
  - Dissolved Oxygen
  - pH
- Integration with SEACAR
- Fine-scale analyses of hotspots and localized trends





# Resources

- Year 1 StoryMap: <https://storymaps.arcgis.com/stories/52a114b2d89d4e60ac3fd75d713d90f7>
- Year 2 StoryMap: <https://storymaps.arcgis.com/stories/af888136b3264d15bad463be3d8a9b22>
- Year 3 Web App: <https://myfwc.maps.arcgis.com/apps/mapviewer/index.html?webmap=fc1ae00969284d2da070150decf5ec7d>
- Year 3 WQ Instant App: <https://myfwc.maps.arcgis.com/apps/instant/portfolio/index.html?appid=32aae567458c4ed787191576c4292291>
- Satellite and Gauge data dashboard: <http://fwc-dashboard.marine.usf.edu:3000/>

