

# Water Quality Trends in the Peace River Basin & Estuary

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June 21, 2023



**ECONOMIC IMPACT  
ANALYSIS PROGRAM**



**CENTER FOR  
PUBLIC INTEREST  
COMMUNICATIONS**  
UNIVERSITY OF FLORIDA



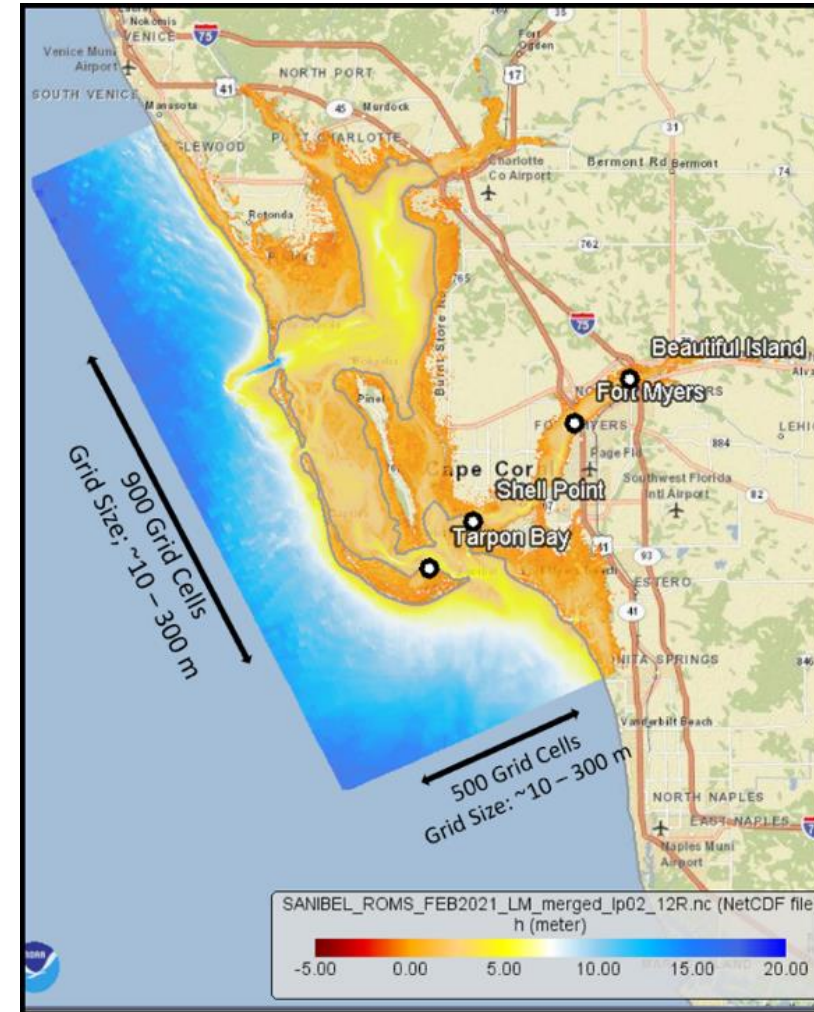
**UF** Herbert Wertheim  
College of Engineering  
UNIVERSITY of FLORIDA

# CCS' PEACE RIVER BASIN PROJECT (2022-23)

## GOALS & OVERVIEW

Study hydrodynamics and water quality in the Peace River basin and estuary, relationships to the regional economy, and stakeholder/public information needs and biases

- Water quality trends and drivers
- Estuarine hydrodynamics
- Watershed modeling & discharge forecasting
- 3D modeling of the estuary, coastal ocean, and pollutant transport
- AI-enhanced satellite monitoring of red tides
- Economic analyses
- Stakeholder engagement

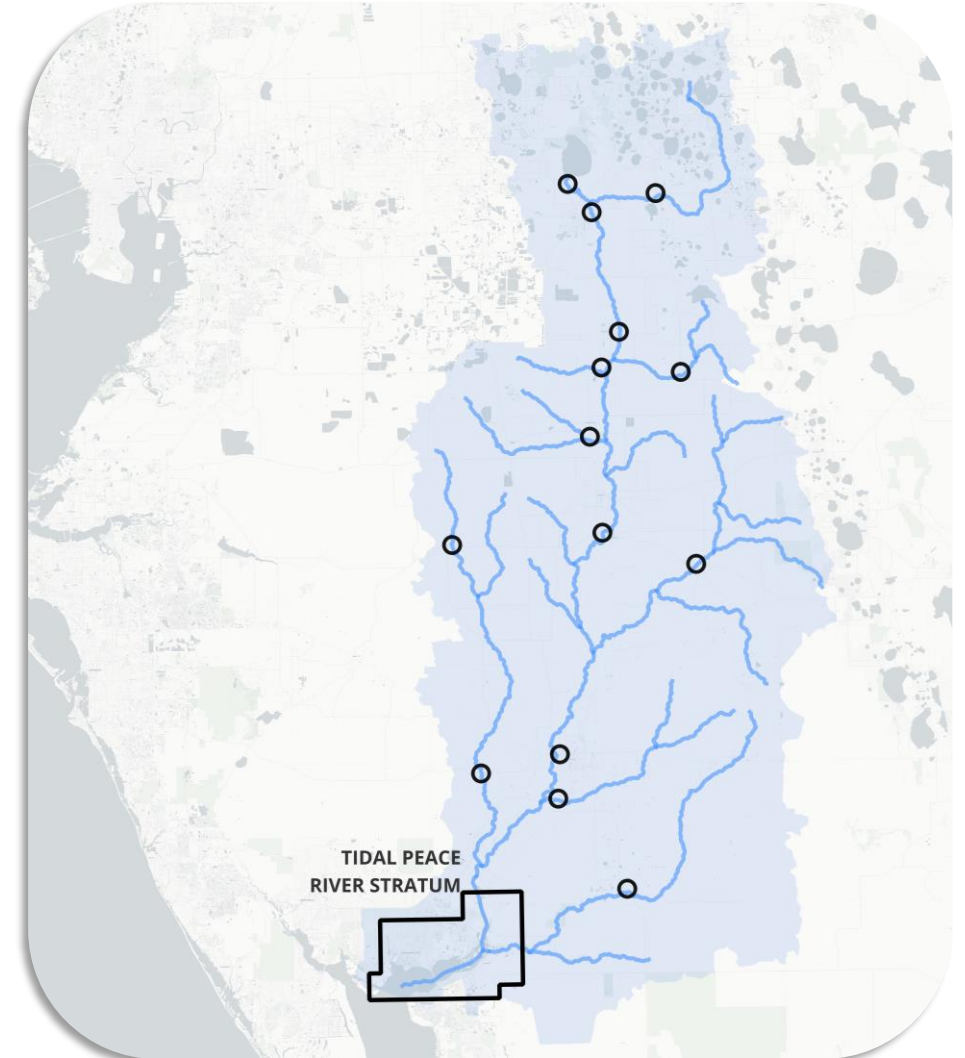


# WATER QUALITY DYNAMICS

## GOALS

Leverage ~20 years of consistent water quality monitoring data to understand changes over time

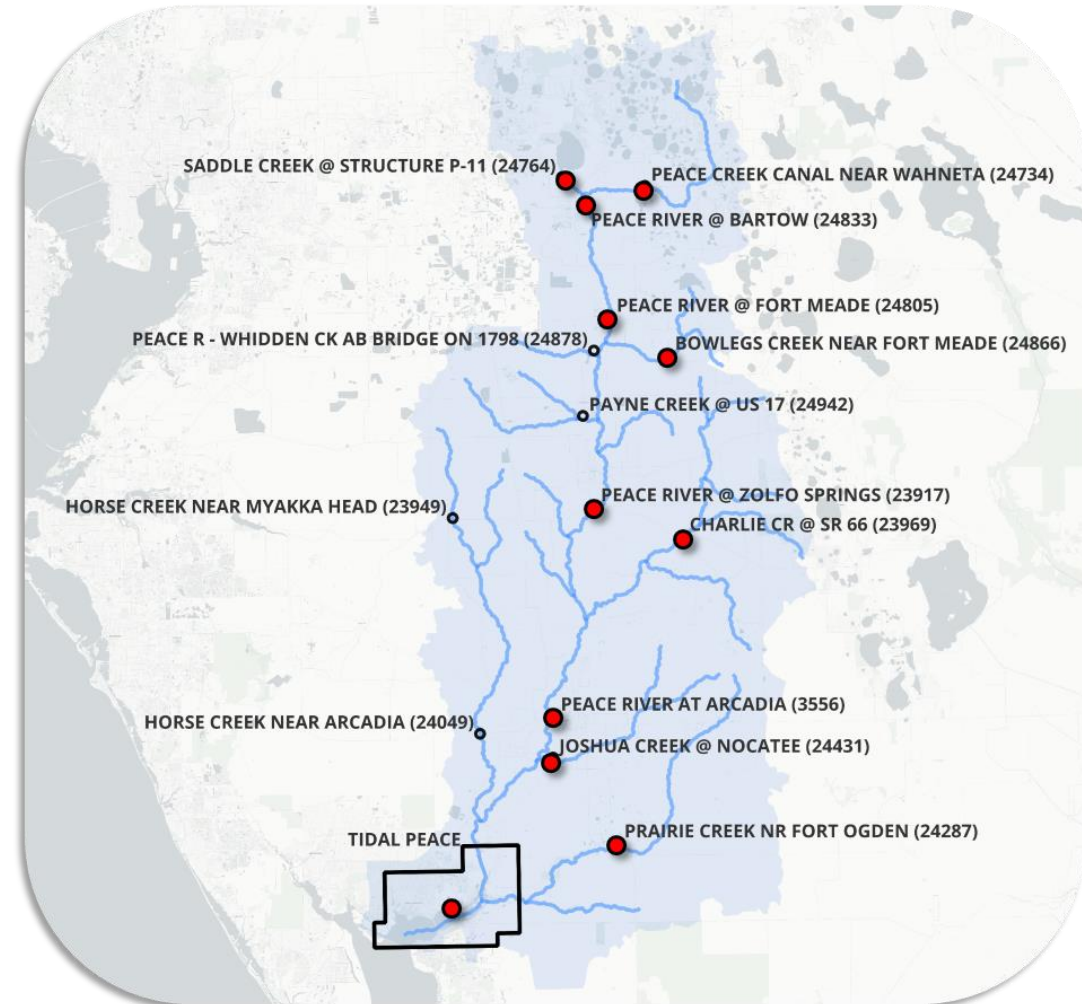
- Detect water quality trends in the estuary and throughout the basin
- Prioritize water quality hot spots in the basin
- Infer causal drivers of water quality hazards



# WATER QUALITY DYNAMICS

## KEY TAKEAWAYS

1. **Nitrogen concentrations in the estuary are above the criterion and trending upward**
2. **Nutrient hot spots are distributed throughout the upper and lower basin**
3. **Red tide blooms are linked to nutrient loading from inland parts of the Peace River basin (preliminary results)**



# WATER QUALITY DATA

## ACQUISITION, CLEANING & EXPLORATION

Acquire water quality data from FDEP's WIN/STORET: Jan 2000 – Mar 2023

Clean the data to resolve and document lingering QA/QC issues

Explore data availability in time & space to support research objectives

### Data Cleaning: FDEP STORET Water Quality

#### Data (CC)

Miles Medina PhD, Nov 29, 2022

#### Contents

- Overview
- Load R libraries
- Subset data by date
- Subset and abbreviate analytes
- Subset data by observation
- Re-label analytes
- Remove blanks and other QC samples
- Remove non-surface water samples
- Standardize measurement units
- Standardize sample depth units
- Remove duplicate records
- Remove records flagged with fatal qualifier codes
- Remove missing values
- Detection limits and non-detects
- Standardize labels for Charlotte Harbor estuary strata (CCHMN)
- Standardize labels for fixed monitoring locations
- Standardize labels for Peace River isohaline transects
- Discard result values outside of specified ranges
- Export clean data
- Notes
- References

#### Overview

The script underlying the STORET database and

### Data Cleaning: WIN Water Quality Data

#### (South Florida)

Miles Medina PhD, Nov 21, 2022

#### Contents

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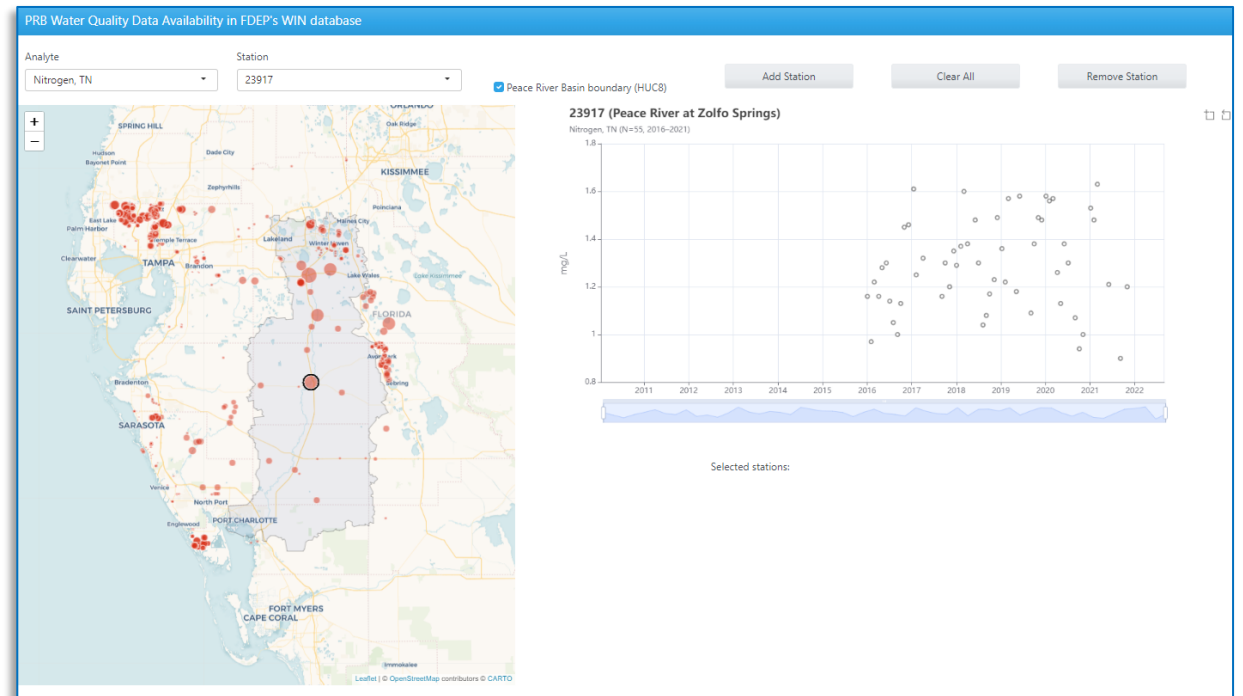
### Data Cleaning: WIN Water Quality Data

#### (South Florida)

Miles Medina PhD, University of Florida Center for Coastal Solutions April 4, 2023

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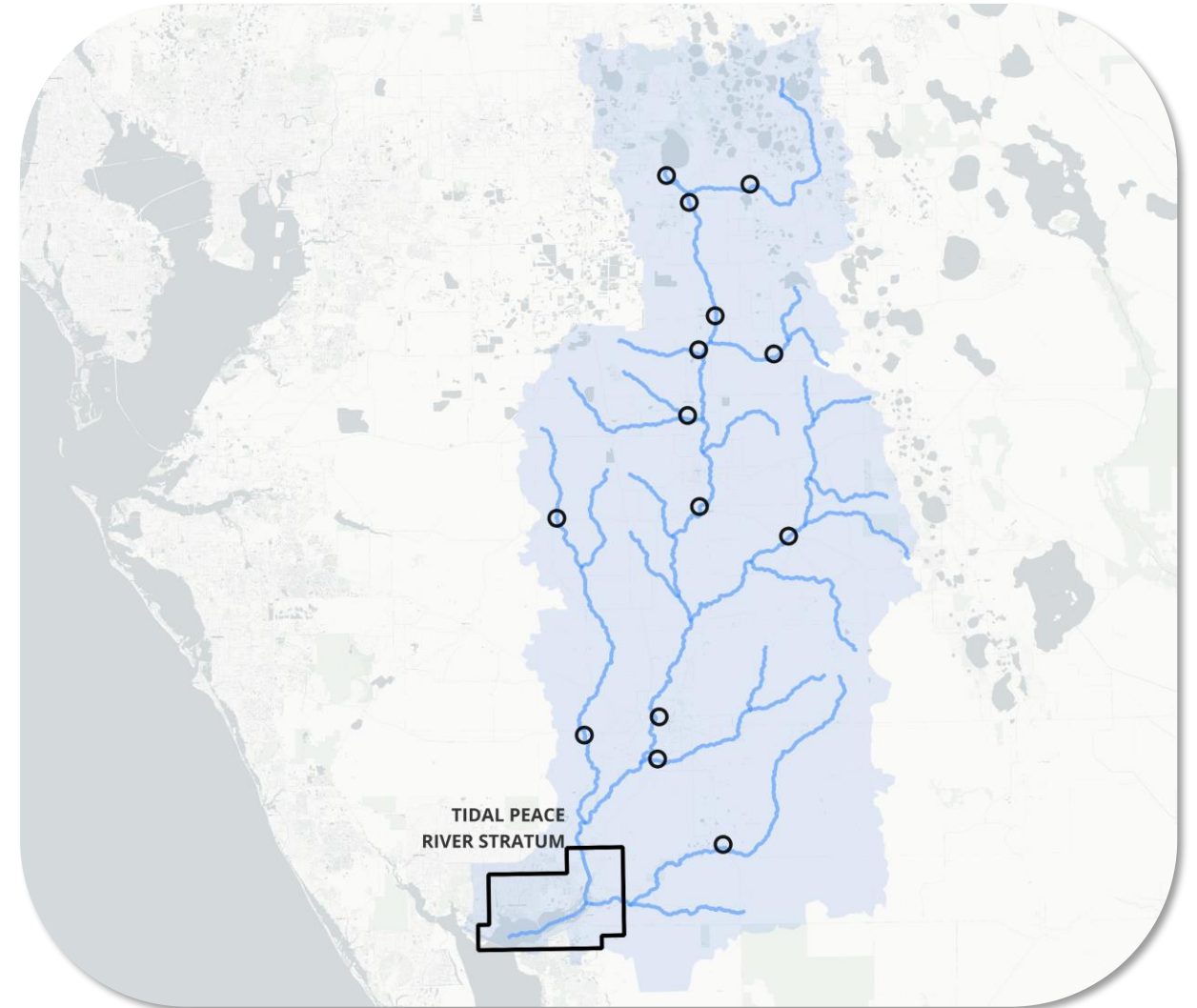
# WATER QUALITY TREND ANALYSIS

## GEOSPATIAL CONTEXT

Trend analysis includes  
~12 water quality parameters

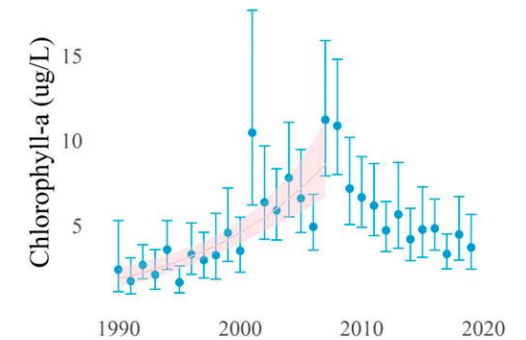
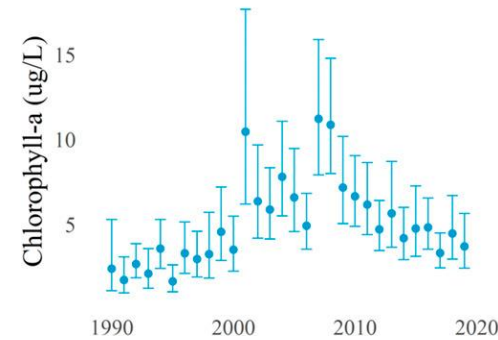
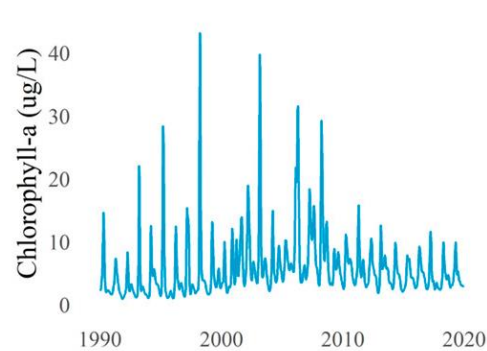
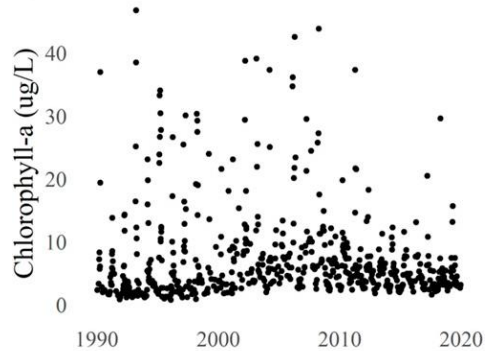
For today, we'll focus on  
nutrient trends (N & P):

- Peace River estuary
- 14 fixed locations within the Peace basin



# TREND ANALYSIS WITH GAMs

## AND UNCERTAINTY PROPAGATION



### 0. Water quality data

### 1. Fit the generalized additive model (GAM)

- Flexible regression captures complex dynamics and estimates uncertainty
- The GAM includes terms for the long-term tendency + seasonal cycles + interaction

### 2. Estimate the annual mean with uncertainty

- Standard errors reflect variance in the data and uncertainty due to sampling effort (N)

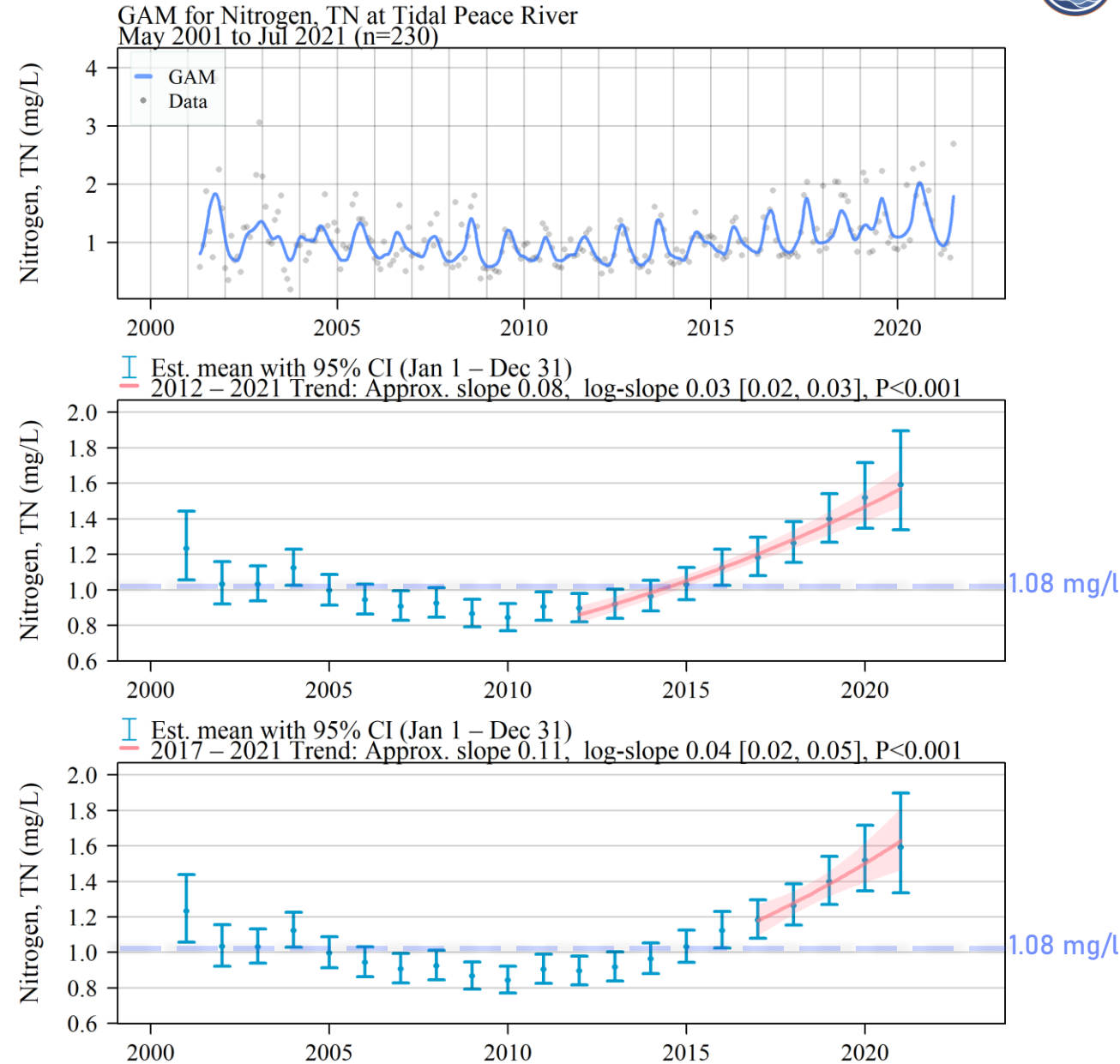
### 3. Quantify the trend in annual means

- A mixed effects model estimates the trend in the annual means
- Lower-confidence mean estimates have less influence on trend slope
- Results provide a familiar up/down determination

# WATER QUALITY TRENDS IN THE ESTUARY

In the Peace River estuary:

Nitrogen levels, primarily organic N, are elevated and increasing. TN criterion is 1.08 mg/l.



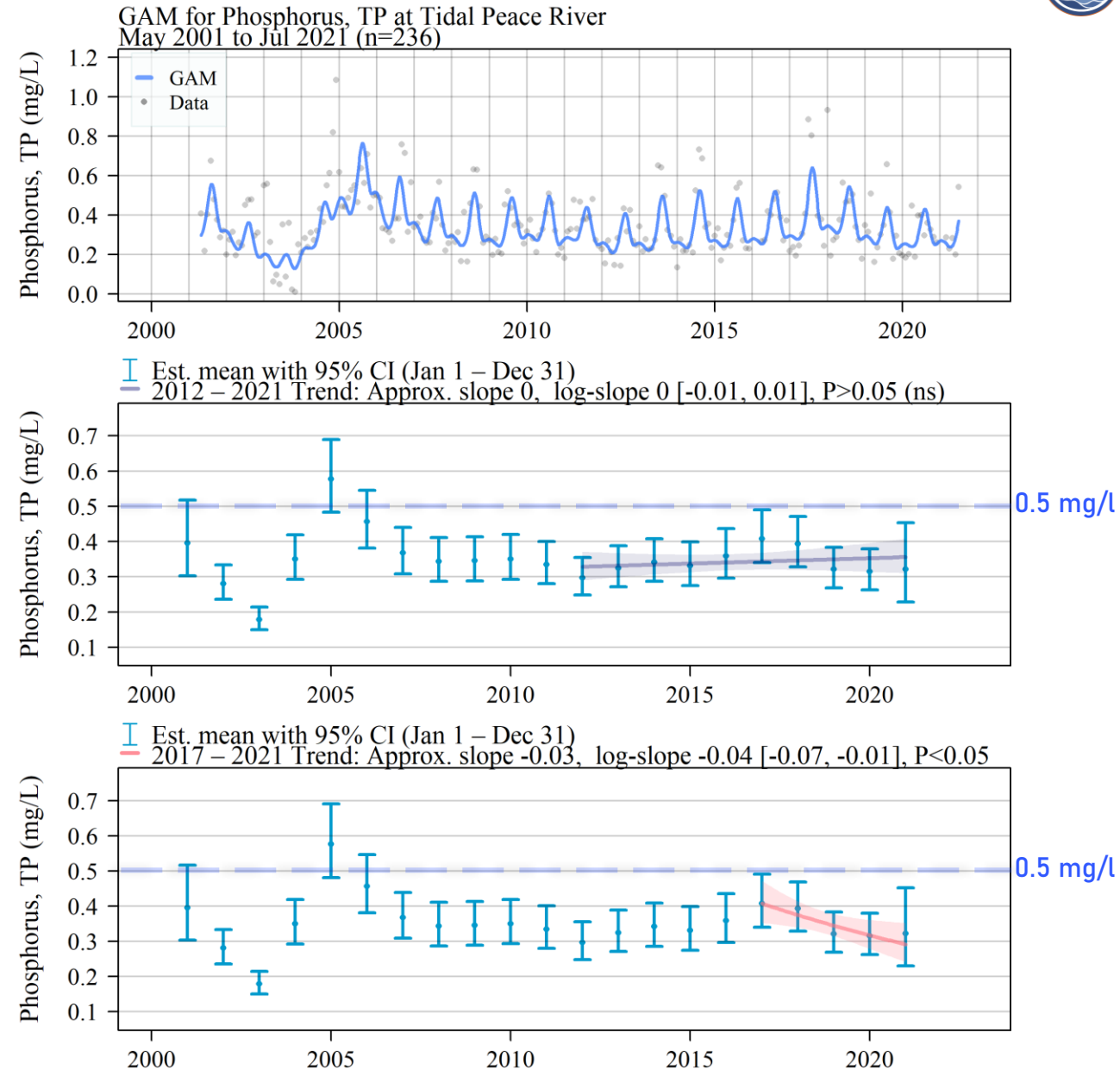


# WATER QUALITY TRENDS IN THE ESTUARY

## In the Peace River estuary:

Nitrogen levels, primarily organic N, are elevated and increasing. TN criterion is 1.08 mg/l.

**Phosphorus** levels are below the TP criterion (0.5 mg/l) and recently decreasing.



# 5-YEAR NUTRIENT TRENDS (2017–2021)

We classified the trends relative to thresholds informed by the estuary's numeric criteria.

Symbols indicate the 5-year trend directions:

- ↑ up trend
- no trend
- ↓ down trend
- NA insufficient data

Colors indicate the 2021 mean concentration relative to the threshold:

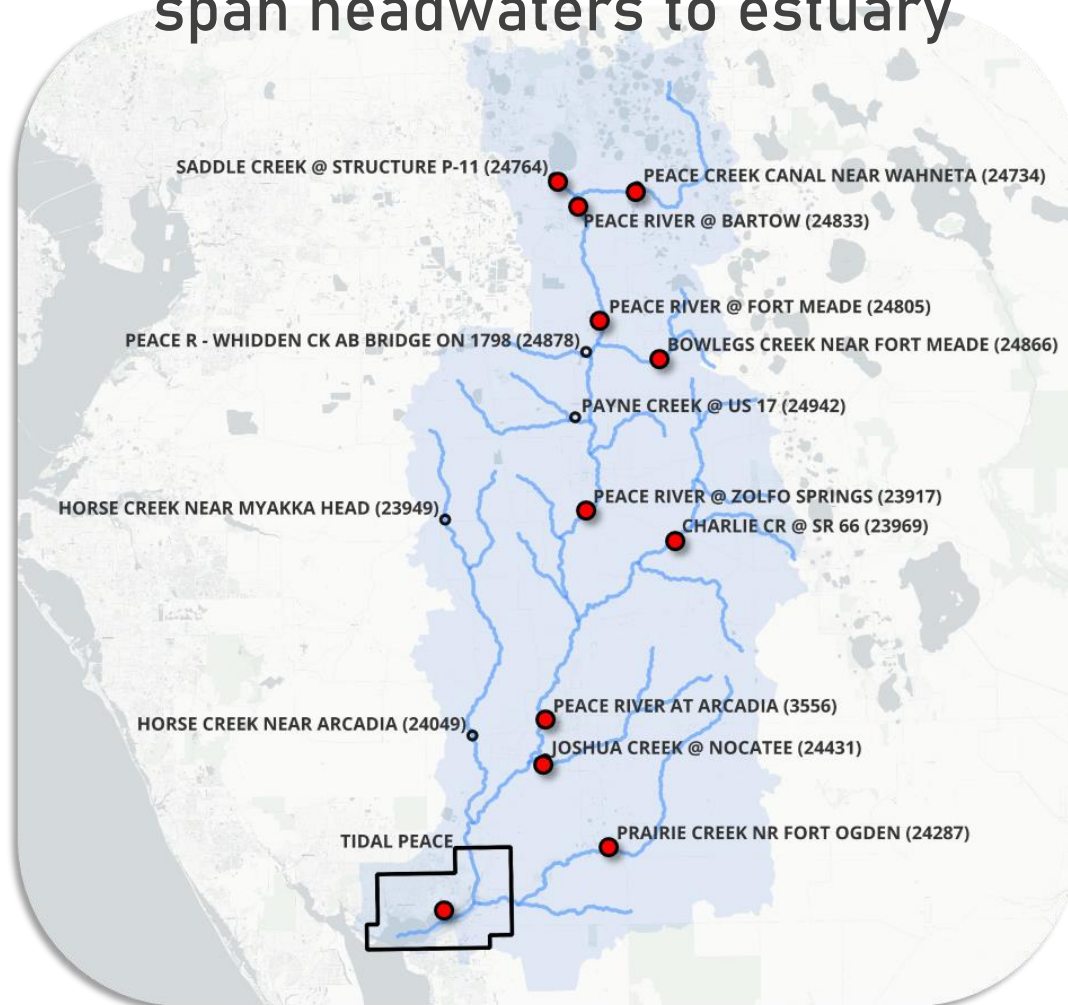
- 10% **above** or **below** threshold, or
- Within 10% of threshold

Location	TN	NOx	TKN	TP	P04
Tidal Peace River	↑	•	↑	↓	•
23917	•	•	NA	•	•
23949	•	•	NA	•	•
23969	•	↓	NA	•	•
24049	•	•	NA	•	•
24287	•	•	NA	↑	↑
24431	•	•	NA	↑	↑
24734	↓	•	NA	↓	•
24764	•	•	NA	•	↓
24805	•	•	NA	•	•
24833	•	•	NA	•	•
24866	•	•	NA	•	•
24878	•	•	NA	•	•
24942	•	•	NA	•	•
3556	•	•	•	•	NA

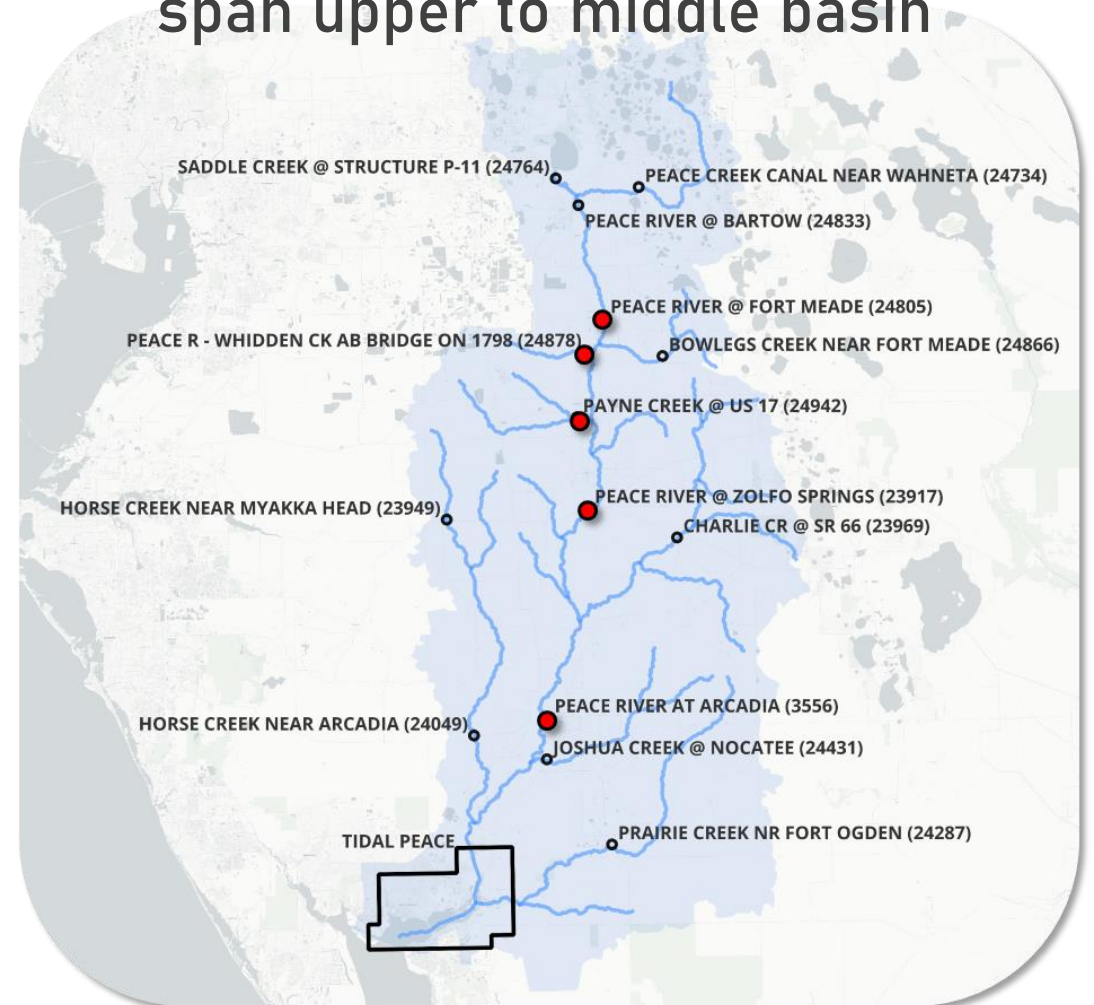
# NUTRIENT HOT SPOTS

BASED ON 5-YEAR TREND RESULTS

**Nitrogen hot spots**  
span headwaters to estuary



**Phosphorus hot spots**  
span upper to middle basin



# NUTRIENT HOT SPOTS & LAND USE

## BASED ON 5-YEAR TREND RESULTS

Nutrient hot spots are distributed throughout the upper and lower basin.

**N** and **P** hot spots are associated with **agricultural areas** and **mining areas**.

Data from coastal urban areas were insufficient to identify hot spots.

**LEGEND**

**Peace River Basin**

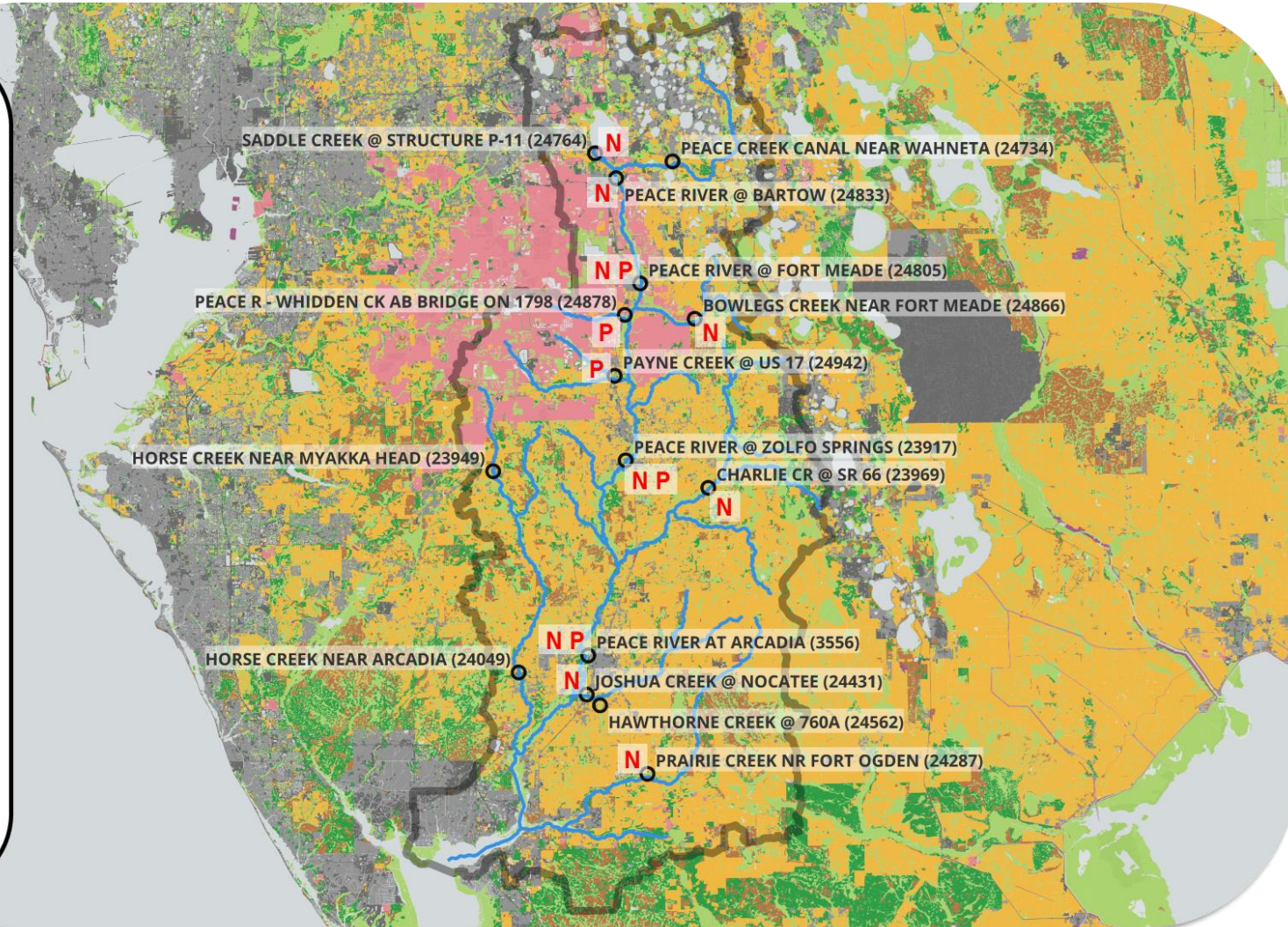
- HUC-8 boundary
- River and tributaries

**Land Use / Land Cover**

- Urban, residential
- Urban, non-residential
- Agricultural
- Rangeland
- Mining
- Barren
- Wetland
- Upland forest
- Water

**Nutrient Hot Spots:**  
Hot spots show a 2021 mean concentration above the threshold with a 5-year upward trend or no trend.

- Monitoring location
- N** Nitrogen hot spot
- P** Phosphorus hot spot



# PRELIMINARY CAUSALITY ANALYSIS FOR RED TIDE

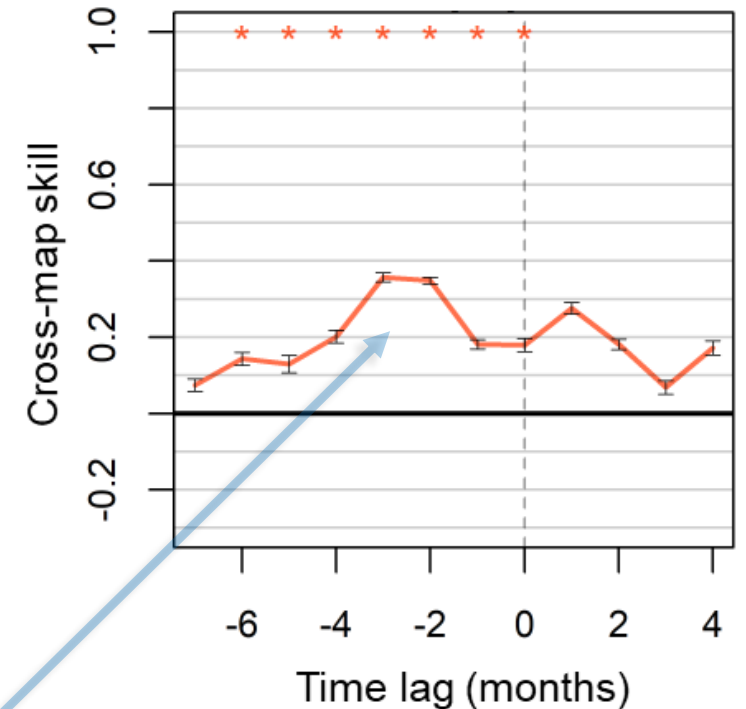
NEW DISCOVERY: POSSIBLE LINK between RED TIDES and PEACE RIVER NITROGEN LOADS



**PRELIMINARY RESULTS from CAUSALITY ANALYSIS:**  
**Peace River TN (Arcadia) drives *K. brevis* blooms throughout Charlotte Harbor (2005–2021)**

This link suggests TN loading from the upper Peace basin has a detectable causal influence on red tide blooms.

Peak influence occurs with a delay of 2–3 months.



## TAKEAWAYS AND NEXT STEPS

**Basin-wide interventions are needed to improve water quality in the Peace River estuary.** Nitrogen loading is of particular concern.

**Upcoming:** A paper presenting a **~20-year history of water quality** for Charlotte Harbor, based on GAM-based trend analysis of CCHMN data.

**Further empirical investigations and estuary/watershed modeling can shed light on nutrient hot spots and pollutant transport, to support development of an RA Plan for the Charlotte Harbor watershed.**

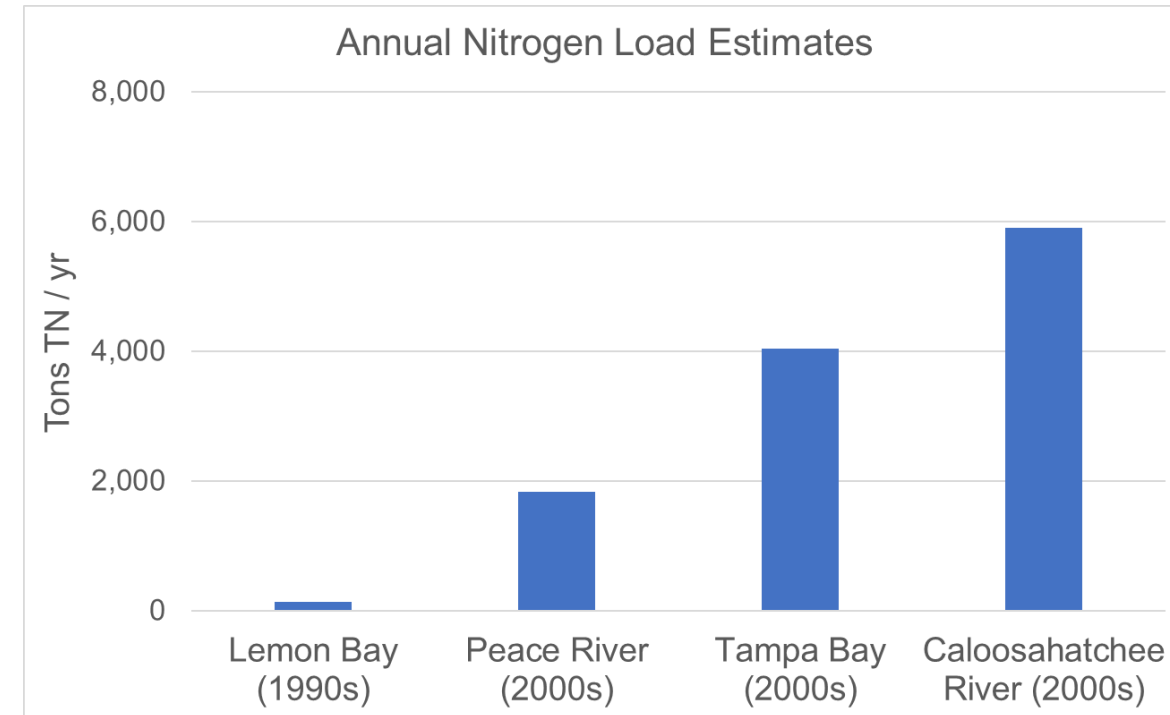
**The data dashboards, trend detection workflow, and causal analyses presented here can easily be replicated elsewhere in Florida.**

# BROADER CONTEXT

**Nitrogen loads from the Peace River are dwarfed by loads from the Caloosahatchee & Lake Okeechobee.**

**Charlotte Harbor red tides are exacerbated by nitrogen loads in Caloosahatchee/Lake discharges (Medina et al., 2022).**

**The Army Corps is interested in operational guidance to inform Lake discharge decisions to reduce the severity and duration of red tides (and improve Charlotte Harbor water quality).**



Tomasko et al. (2001), SWFWMD CH SWIM Plan (2020), Tomasko et al (2018), FDEP TMDL (2009).



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