Water Quality in Charlotte County

The History, Regulation, and Natural Systems Governing Our Watershed

January 22nd, 2025

Charlotte County Florida

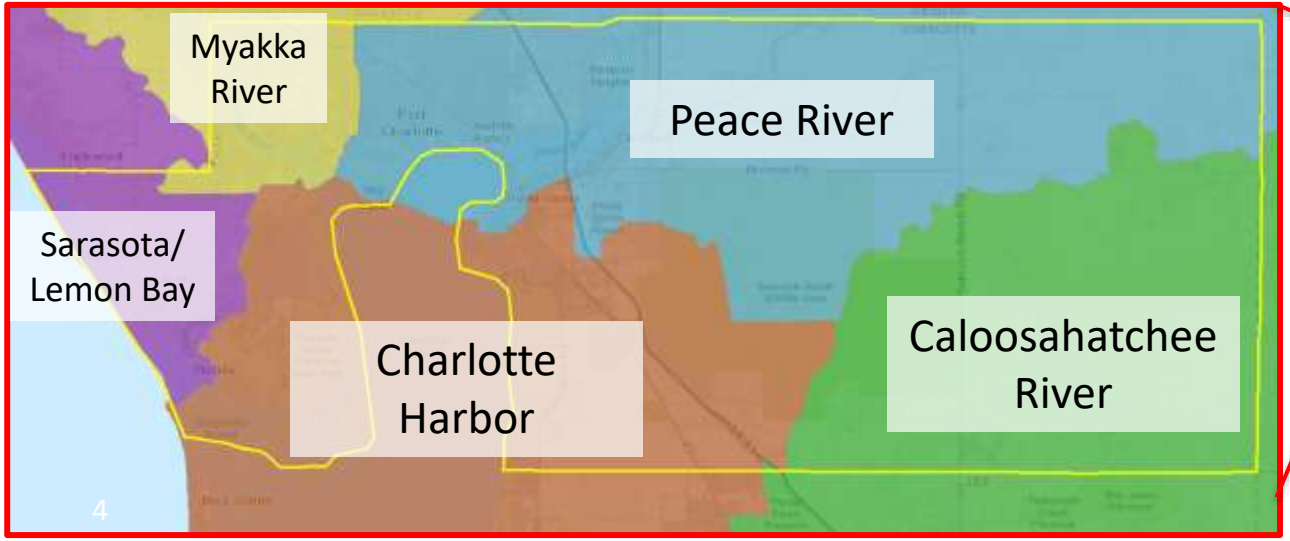
Who am I?

- Water Quality Manager- New position as of March 2021
- Goals:
  - Creation of water quality monitoring strategy
  - Coordination of water quality management/improvement plan
  - Coordination of inter-departmental response to WQ issues in the county

Overview

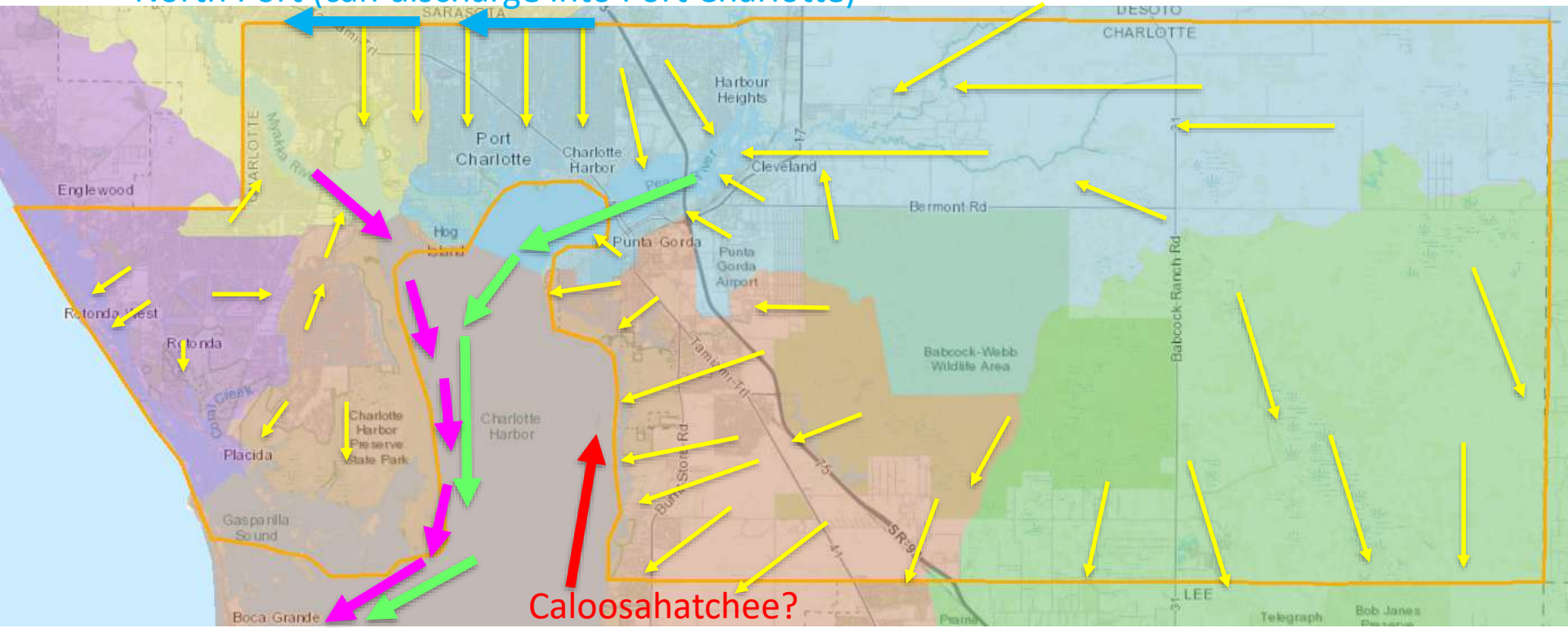
- Where does the Harbor's water come from, and where does it go?
- General chemistry characteristics
- How have we changed the water landscape?
- What is "healthy" water (the regulatory version)?

Drainage Basin Overview



Drainage Basin Overview

North Port (can discharge into Port Charlotte)



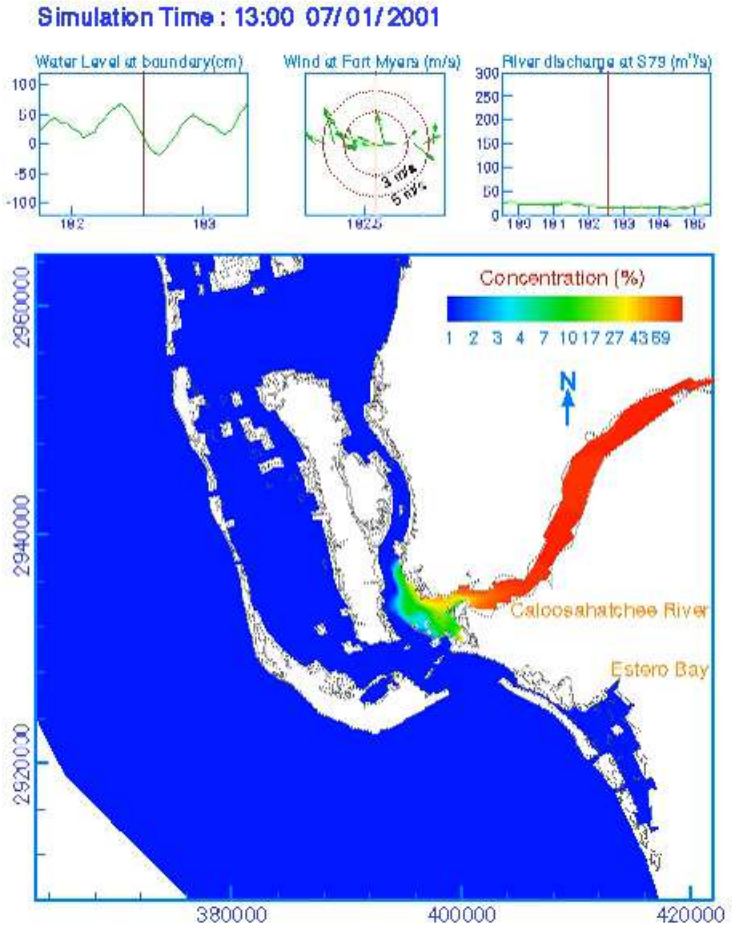
Caloosahatchee Flow Models

Predicted Flow Directions from Caloosahatchee Discharges

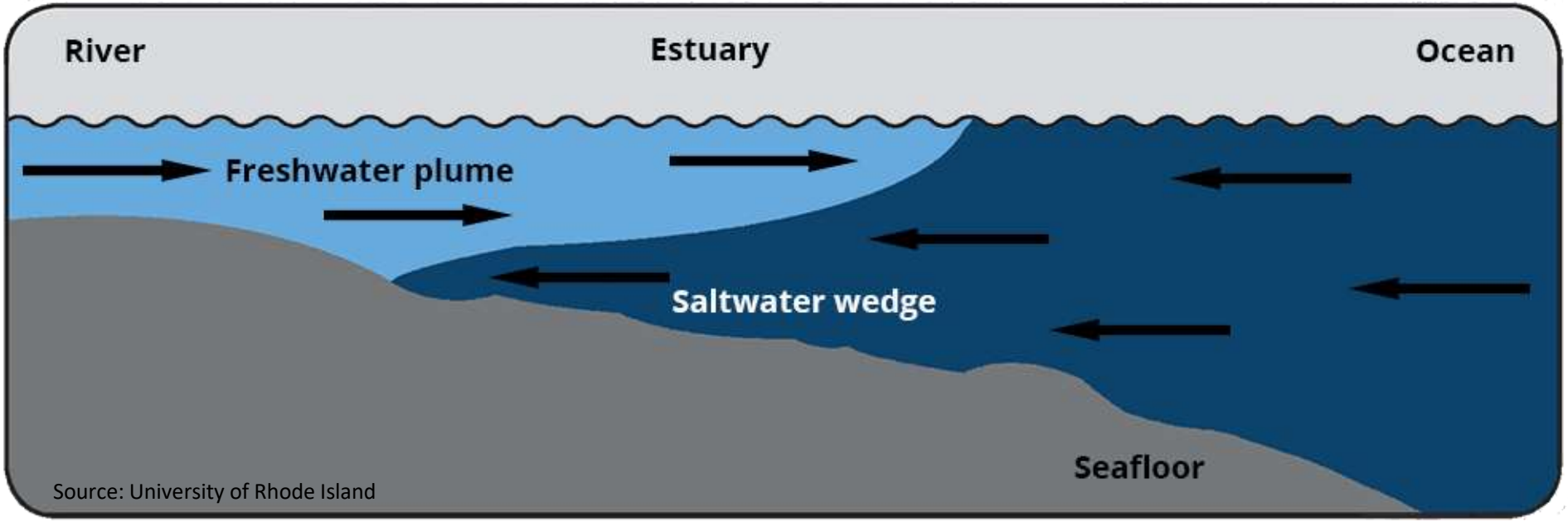
Early Wet Season Movement

Peak Wet Season Movement

High Discharge Movement



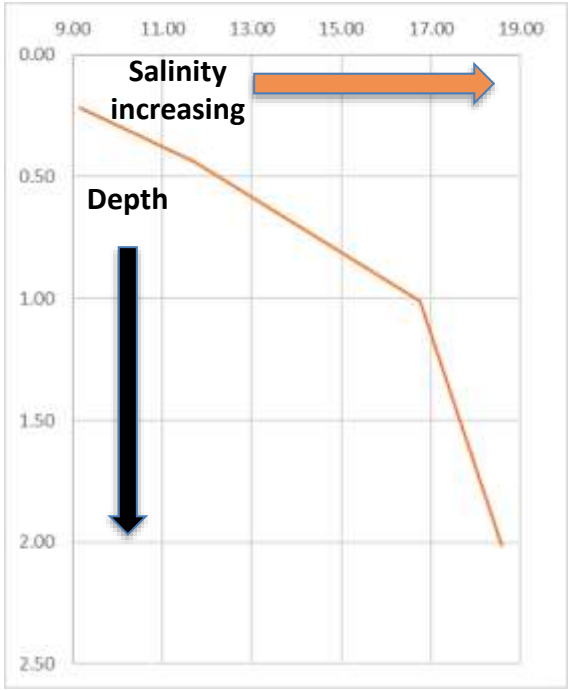
Water Varies Vertically

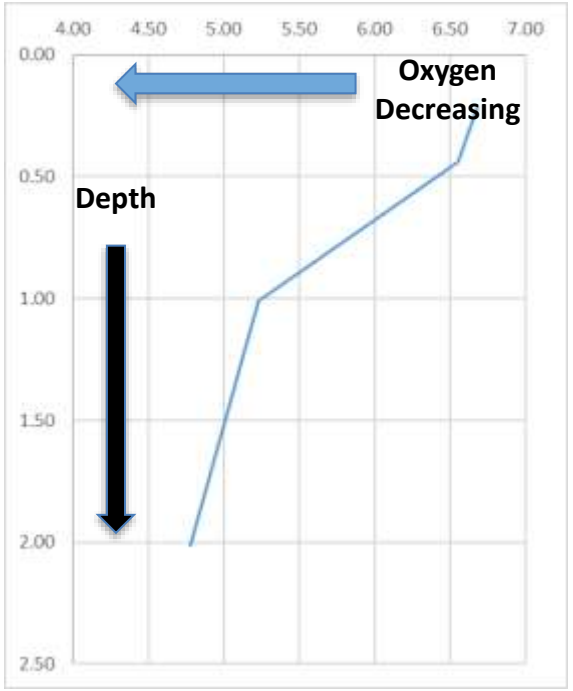


Source: University of Rhode Island

Water Varies Vertically

- Conditions in the water can be different throughout the water column
- Light, oxygen, salinity and other factors can all vary





Salinity and Dissolved Oxygen in Tidal Peace, 10/2023

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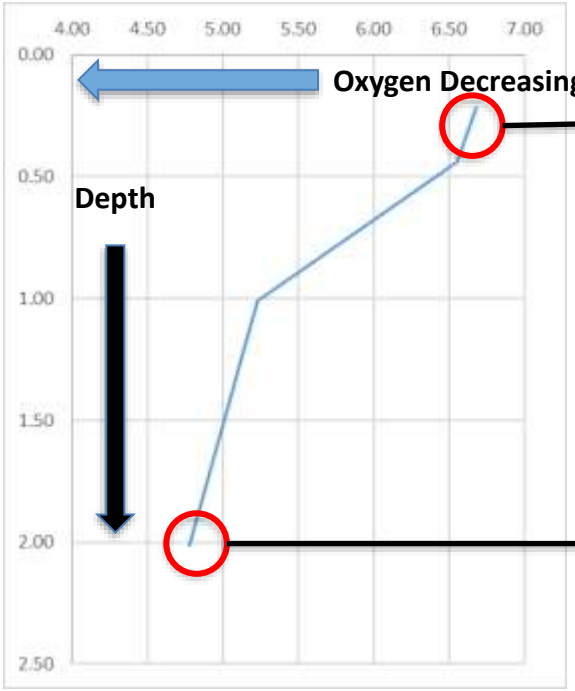
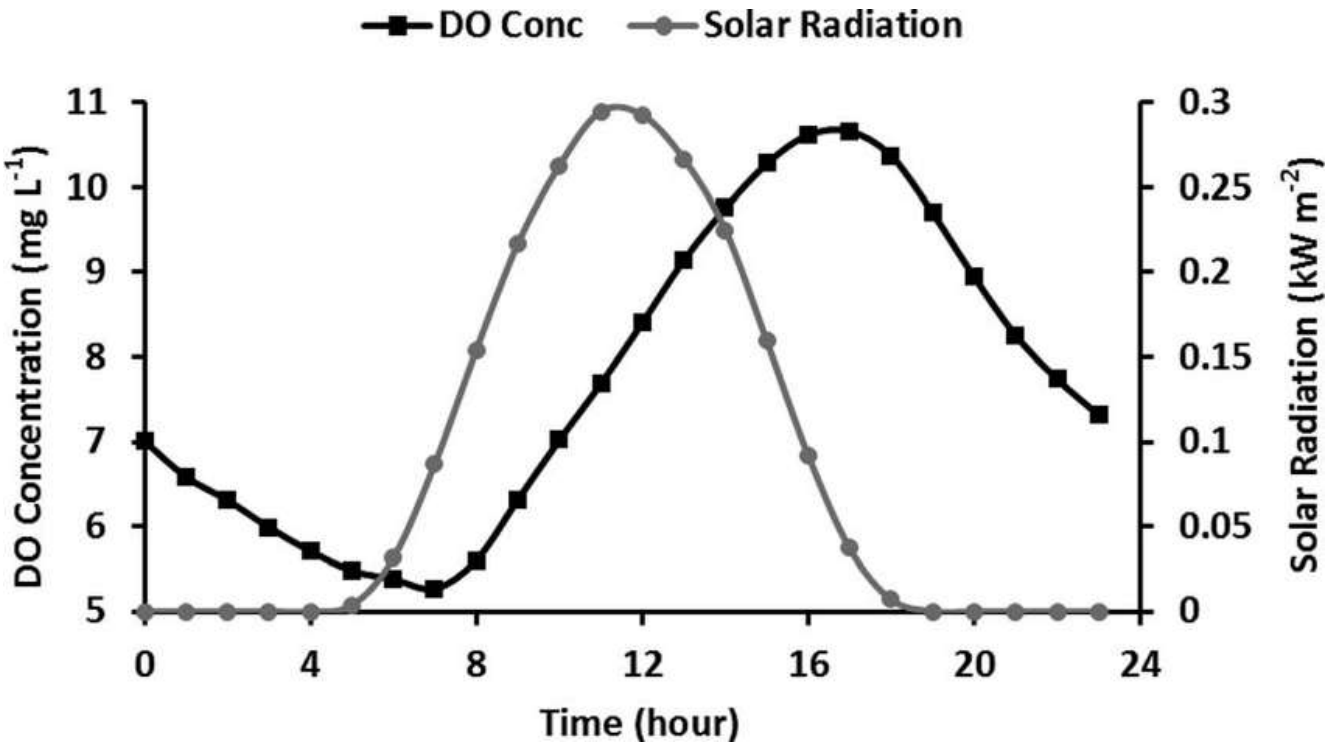
Water Varies Vertically



Higher O2 near the surface because of photosynthesis, wind-based mixing, etc

Lower O2 at the bottom because of bacterial respiration, lack of vertical mixing in the water column, etc

Water Varies Temporally



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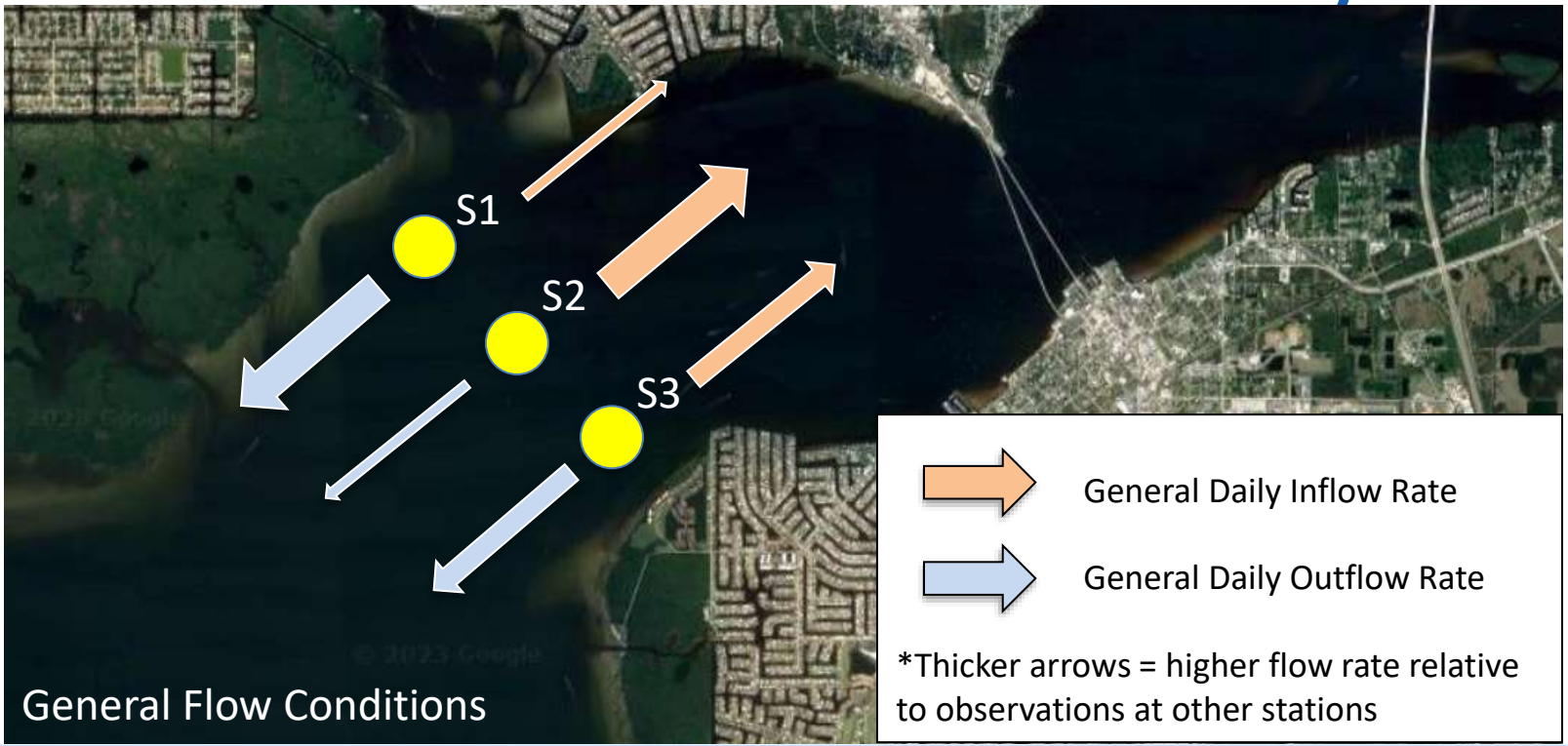
Water Varies Horizontally



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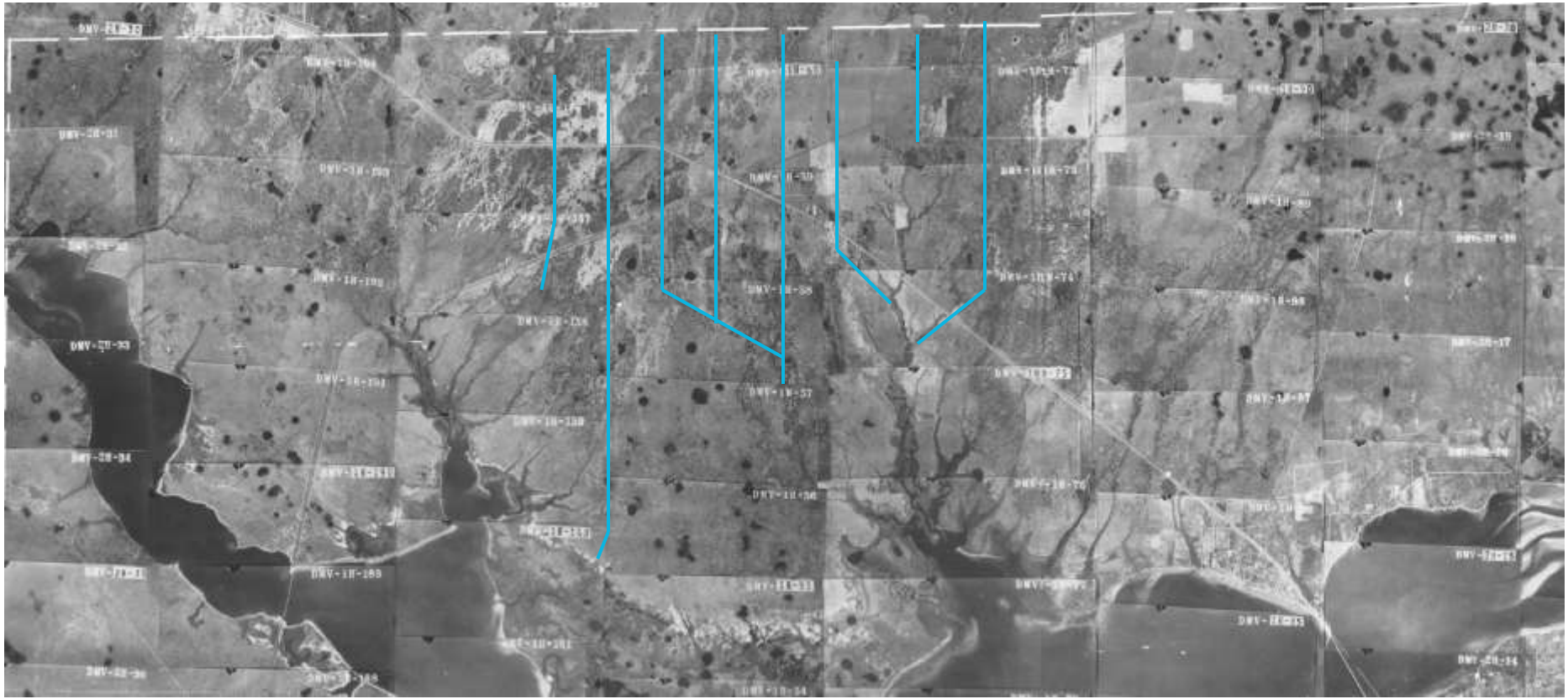
The Big Picture- Charlotte in the 1950's

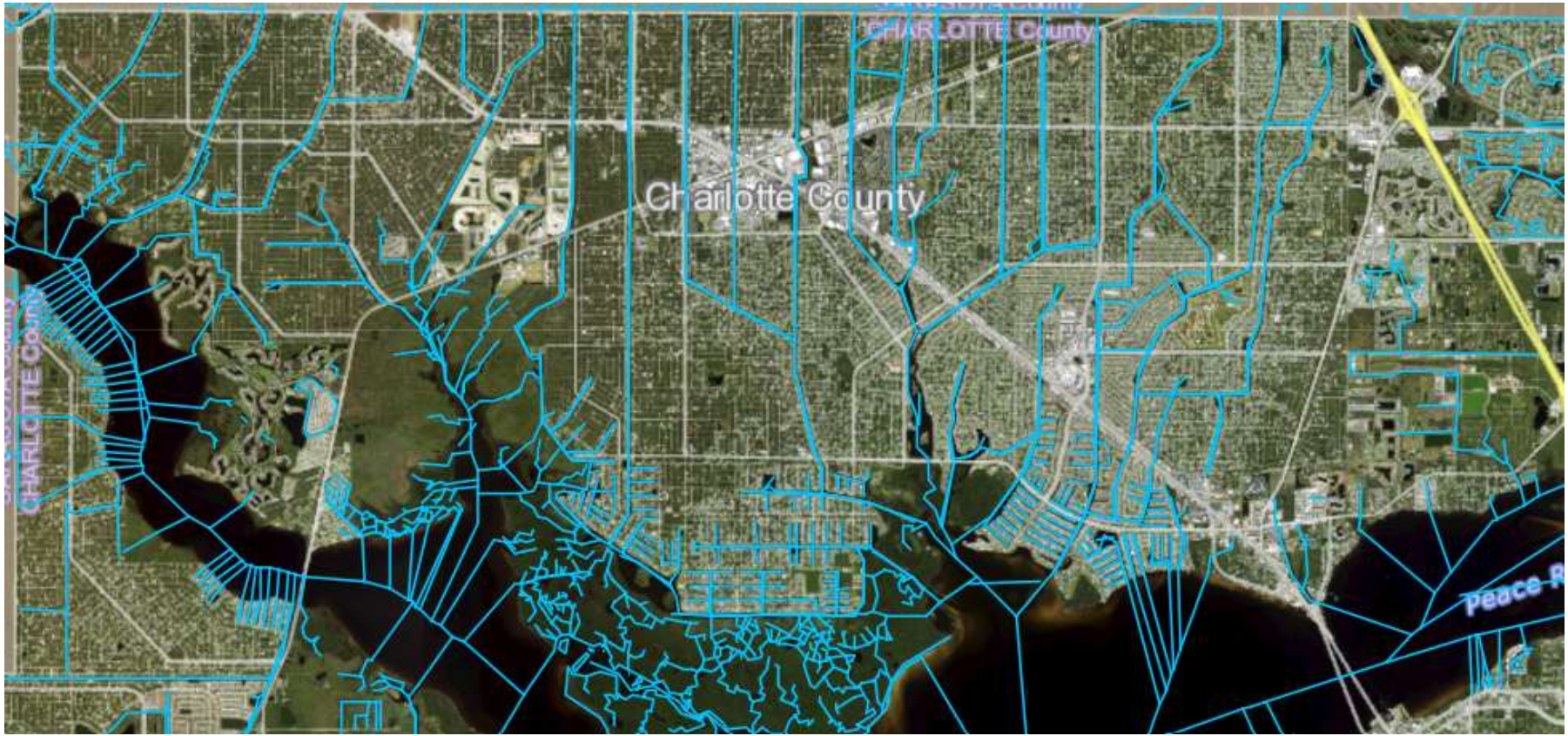


Source: UF Digital Imagery Collections

The Big Picture- Charlotte in the 1950's

Source: UF Digital Imagery Collections

The Big Picture- Charlotte Today



Source: USACE EIS 2013

Punta Gorda, Circa 1950's

Source: UF Digital Imagery Collections

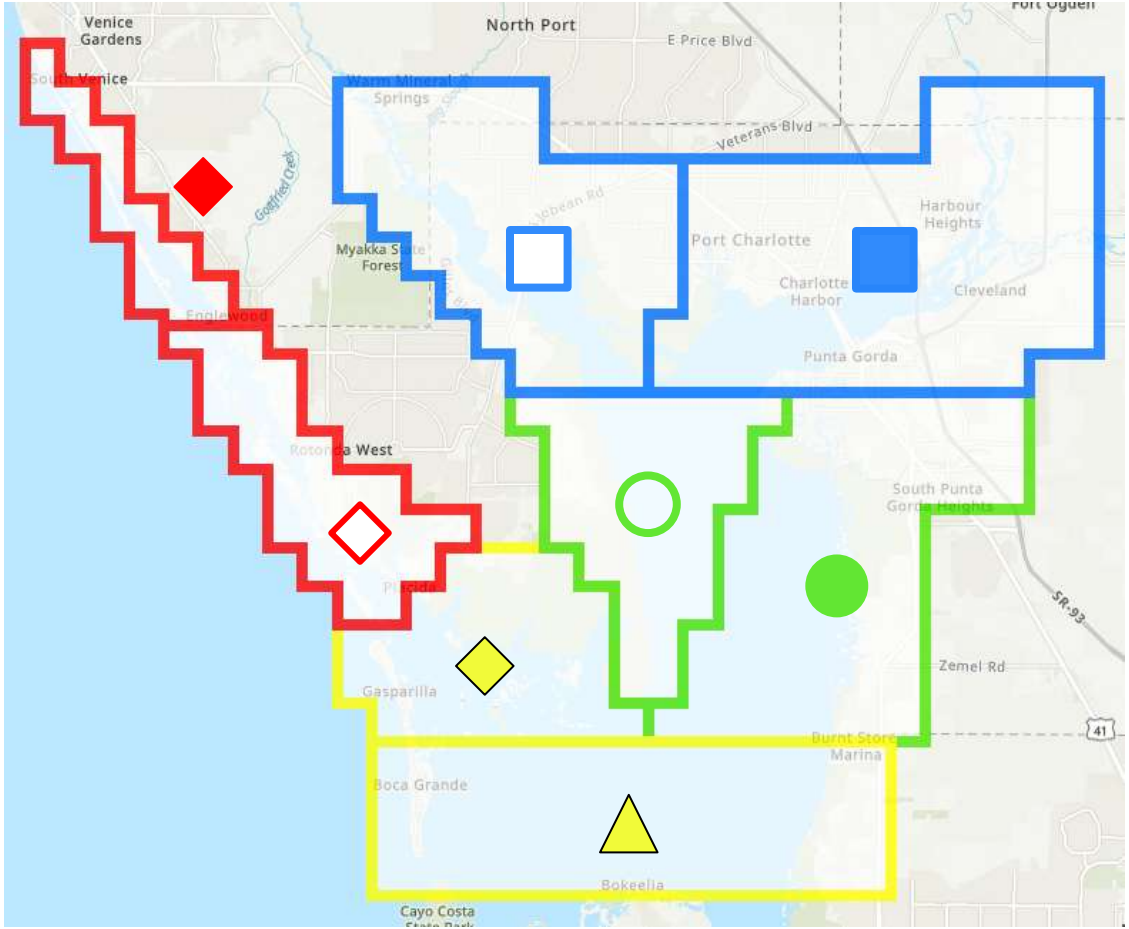
Punta Gorda Today

General WQ Characteristics

Region key for the next slides:

- Tidal Peace River
- Tidal Myakka River
- Charlotte Harbor West Wall
- Charlotte Harbor East Wall
- Lower Charlotte Harbor
- Cape Haze
- Upper Lemon Bay
- Lower Lemon Bay

Note: The following information is based on data collected in the upper 1 meter of the water column



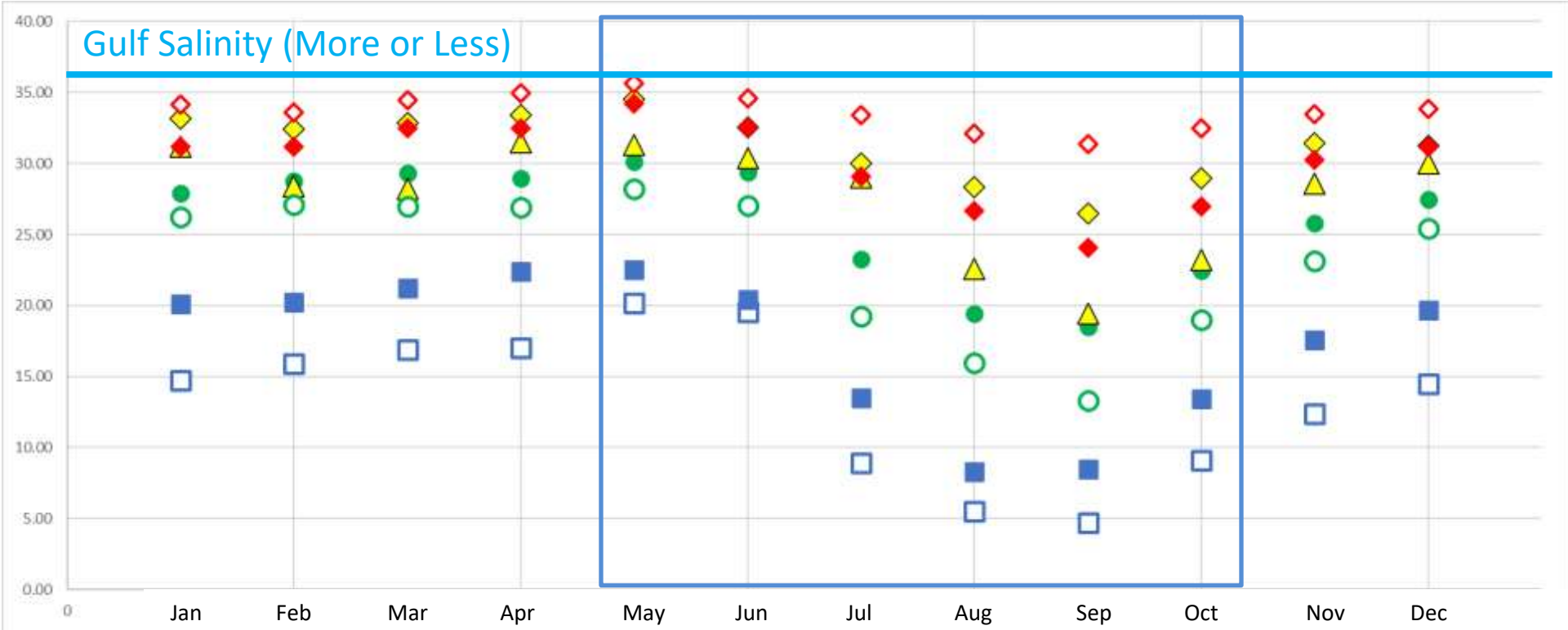
Before We Look at Data…

- Intensive sampling/survey programs in the harbor are only ~25-30 years old. We don't have water chemistry data that tells us what the water looked like pre-development. (*sediments can give us some insight, though; more on that in a bit).

- We are only measuring concentrations in the water column; some of the nutrients are also bound up in flora/fauna, sequestered in sediment, etc etc.

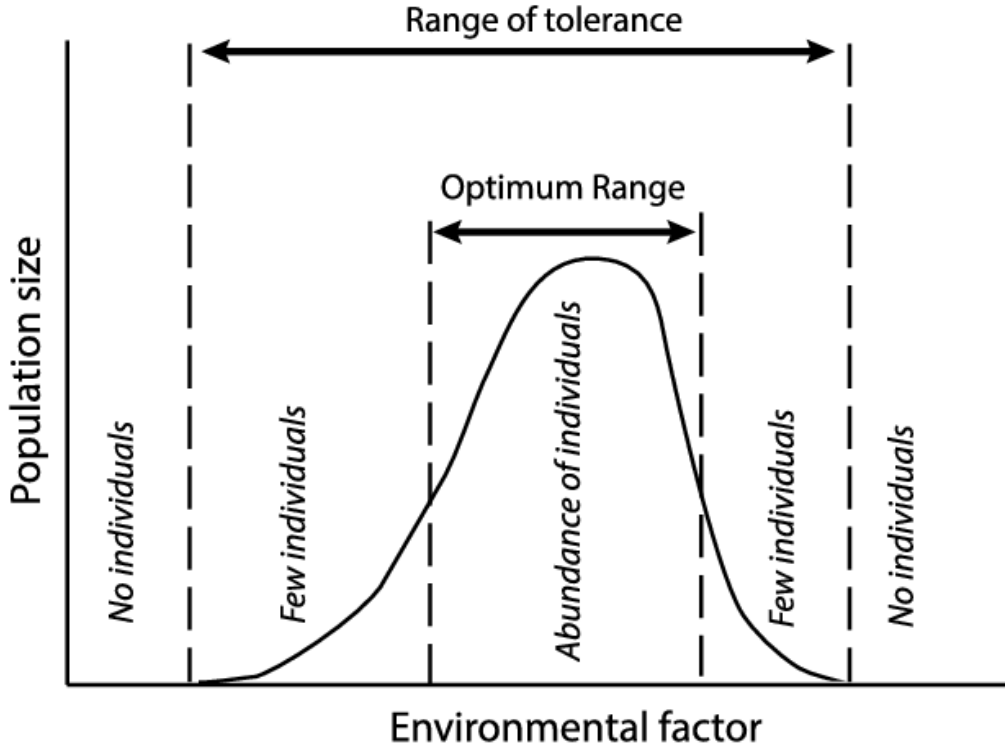
Average Salinity By Month (PSU)

Wet Season (May-October)

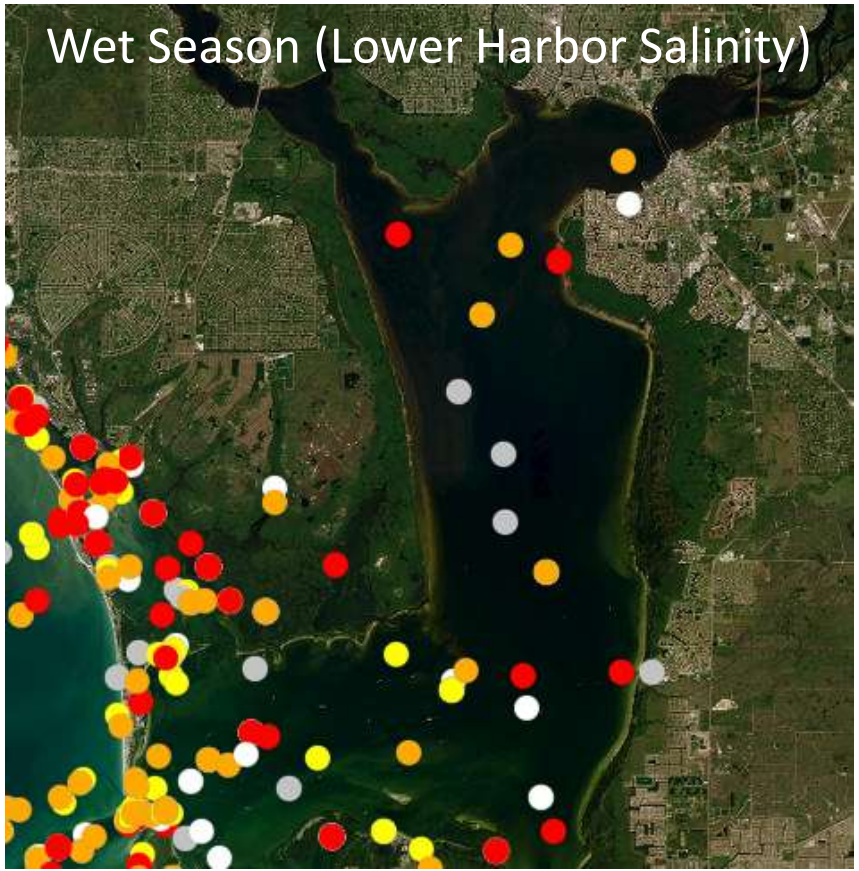


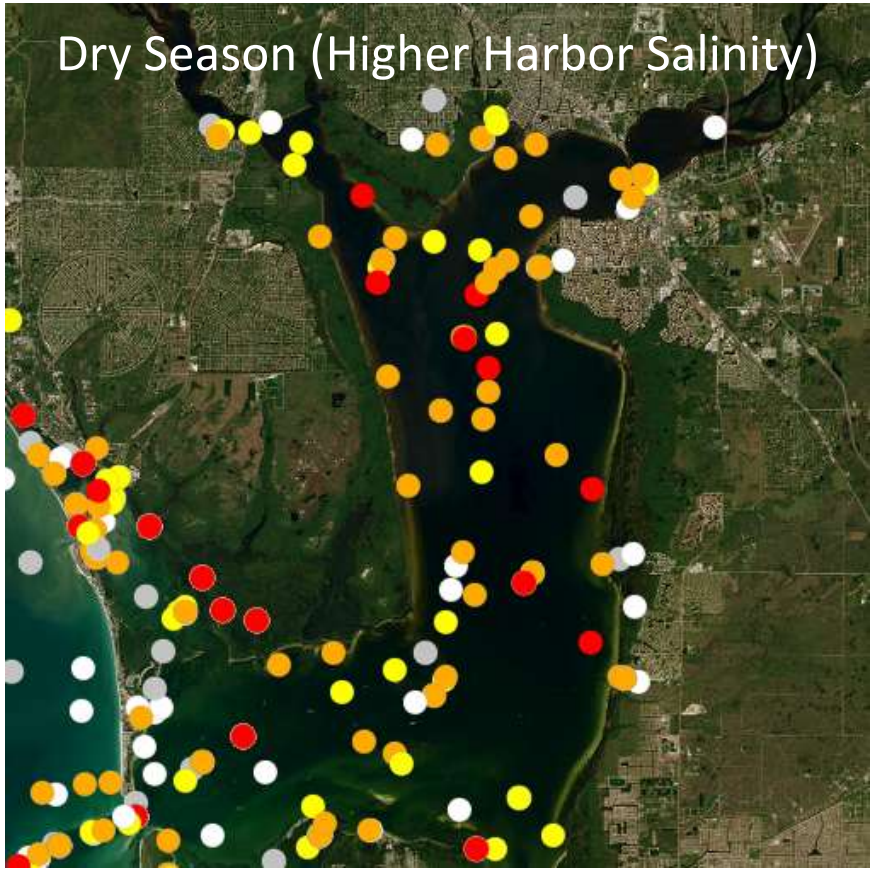
Salinity is Important

- Salinity impacts the flora and fauna that can thrive in a given area
- Changing the salinity can keep things out that you do want, and let things in that you DON'T want



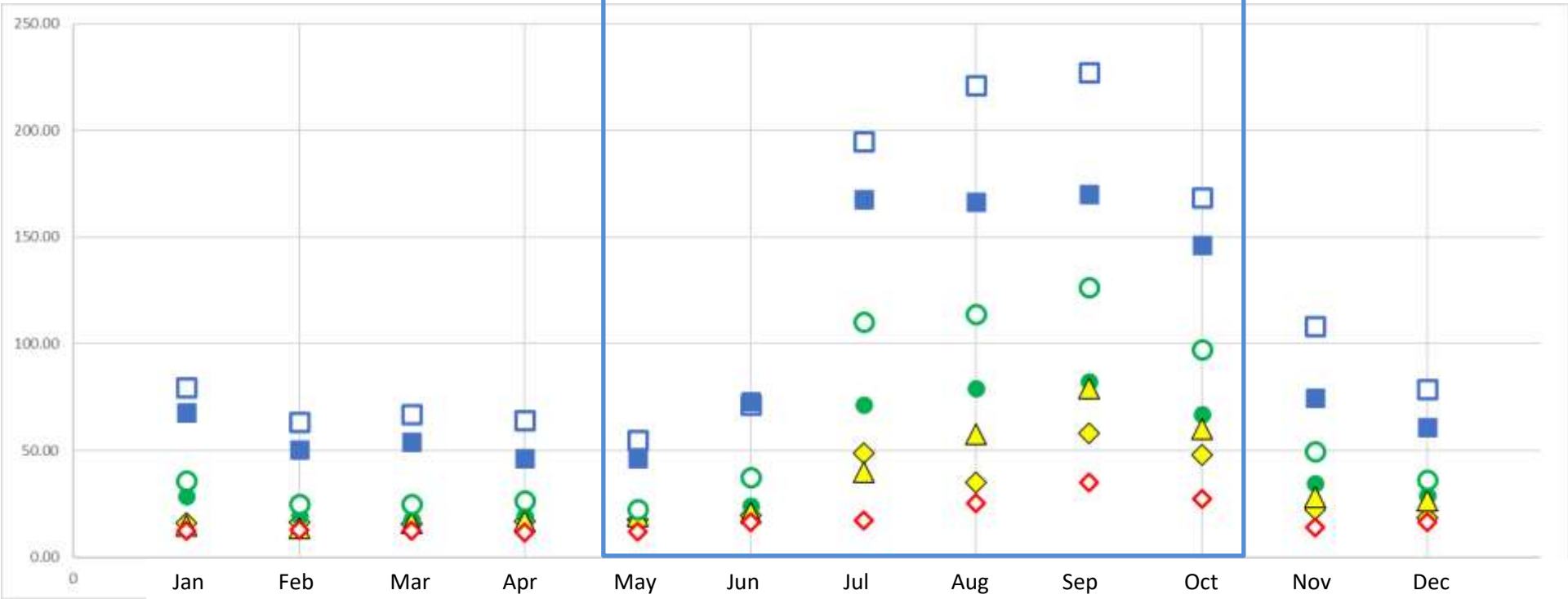
Red Tide Detects in Charlotte Harbor, 2015-2022





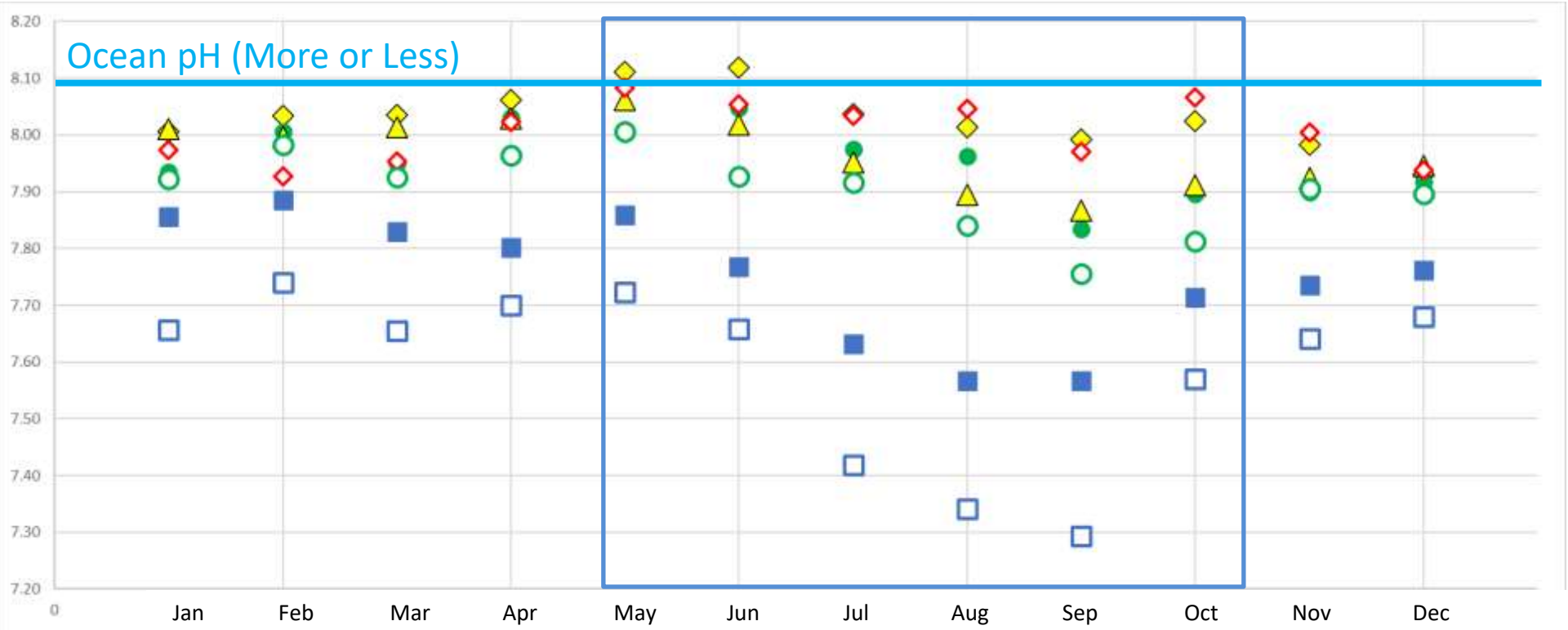
Average Color by Month (platinum-cobalt unit)

Wet Season (May-October)



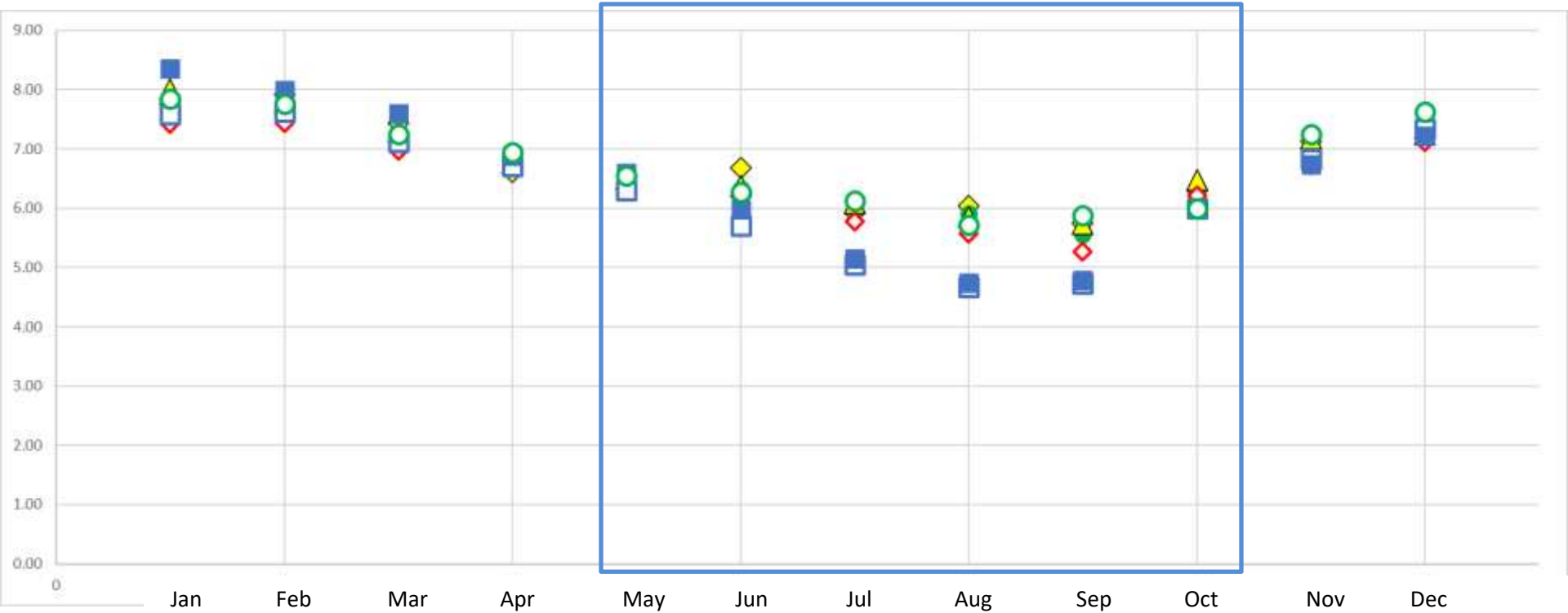
Average pH by Month

Wet Season (May-October)



Average Dissolved Oxygen by Month (mg/L)

Wet Season (May-October)



Average Dissolved Oxygen by Month (mg/L)

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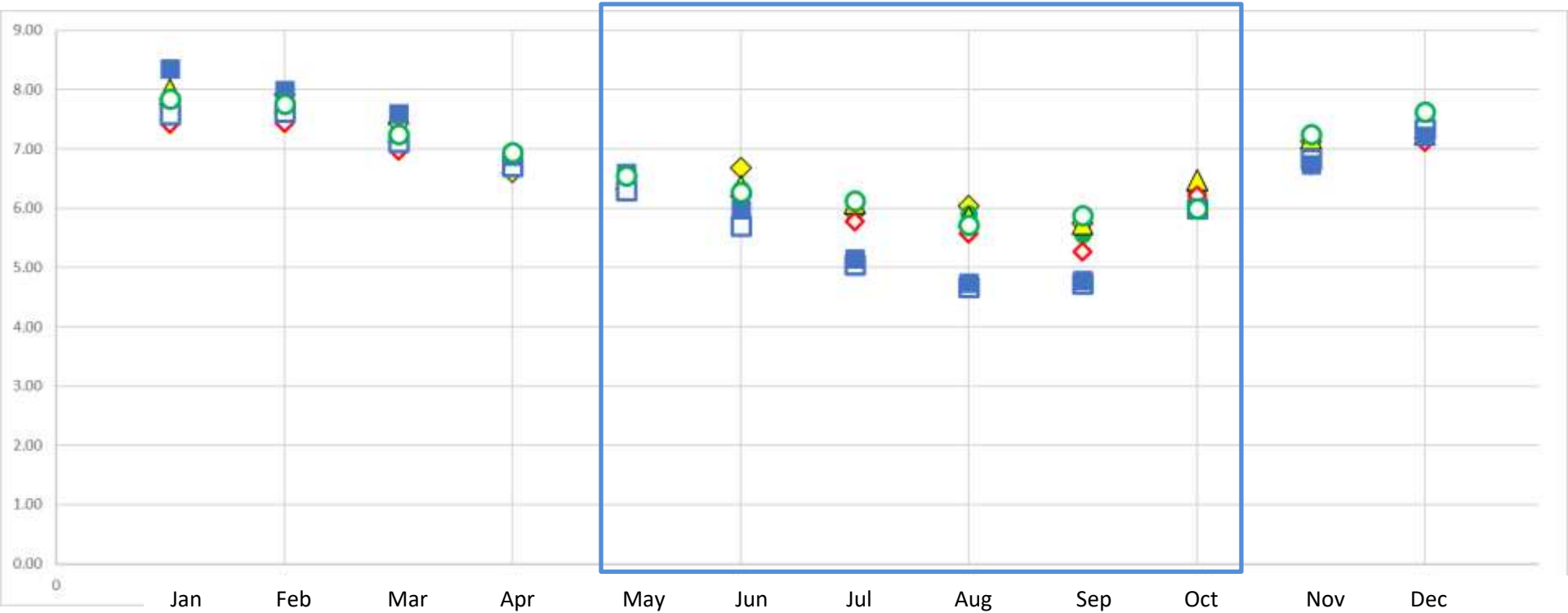
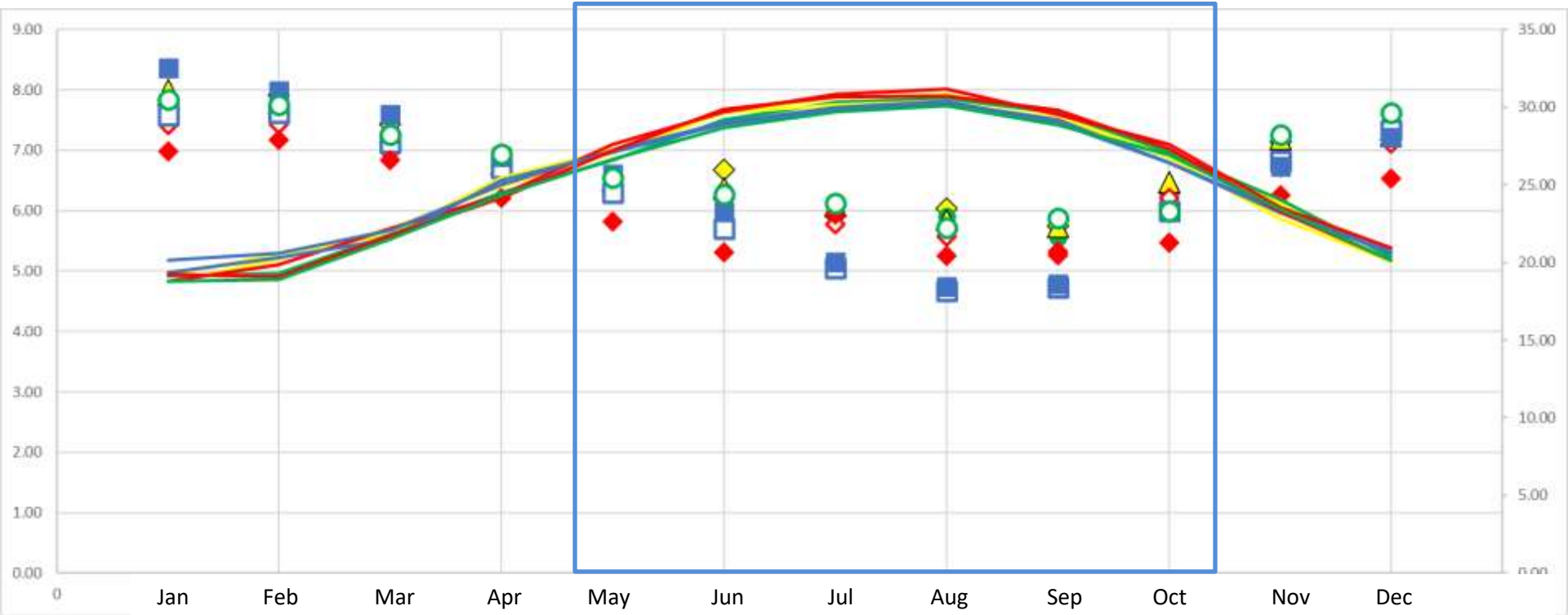


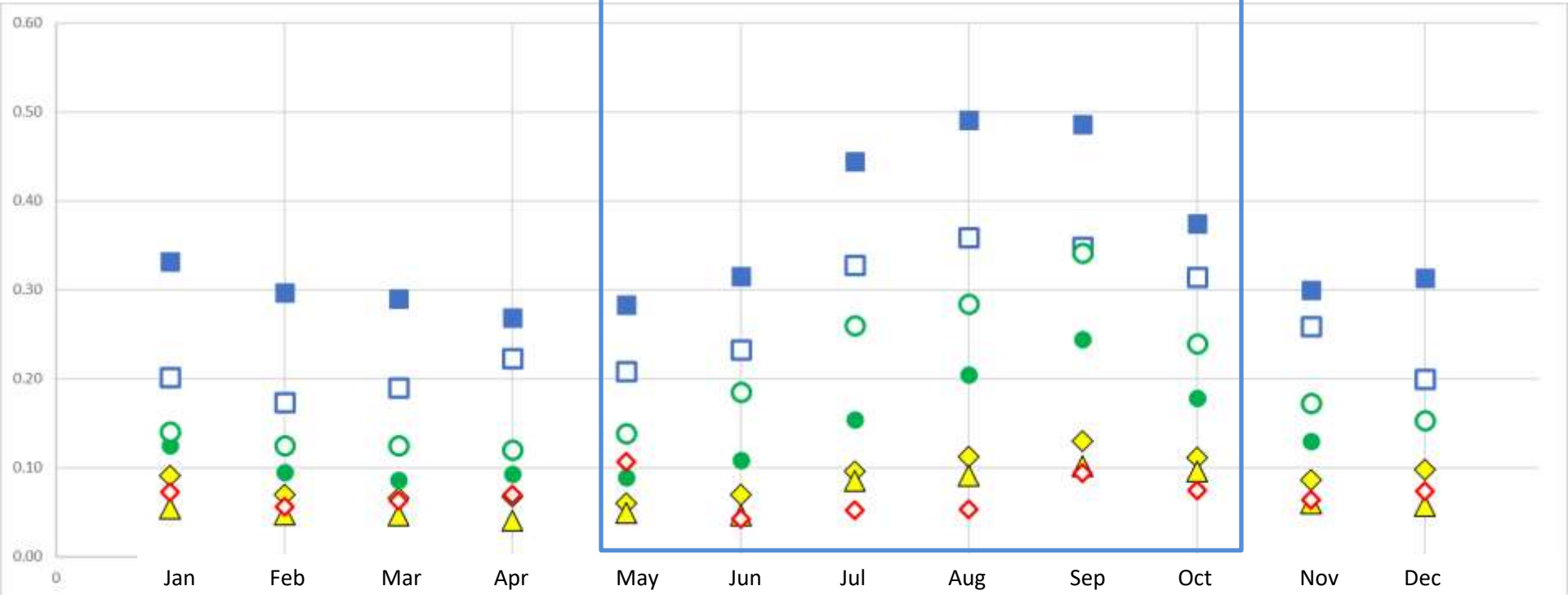
Dissolved Oxygen (mg/L) vs Temperature (˚C) by Month

Wet Season (May-October)



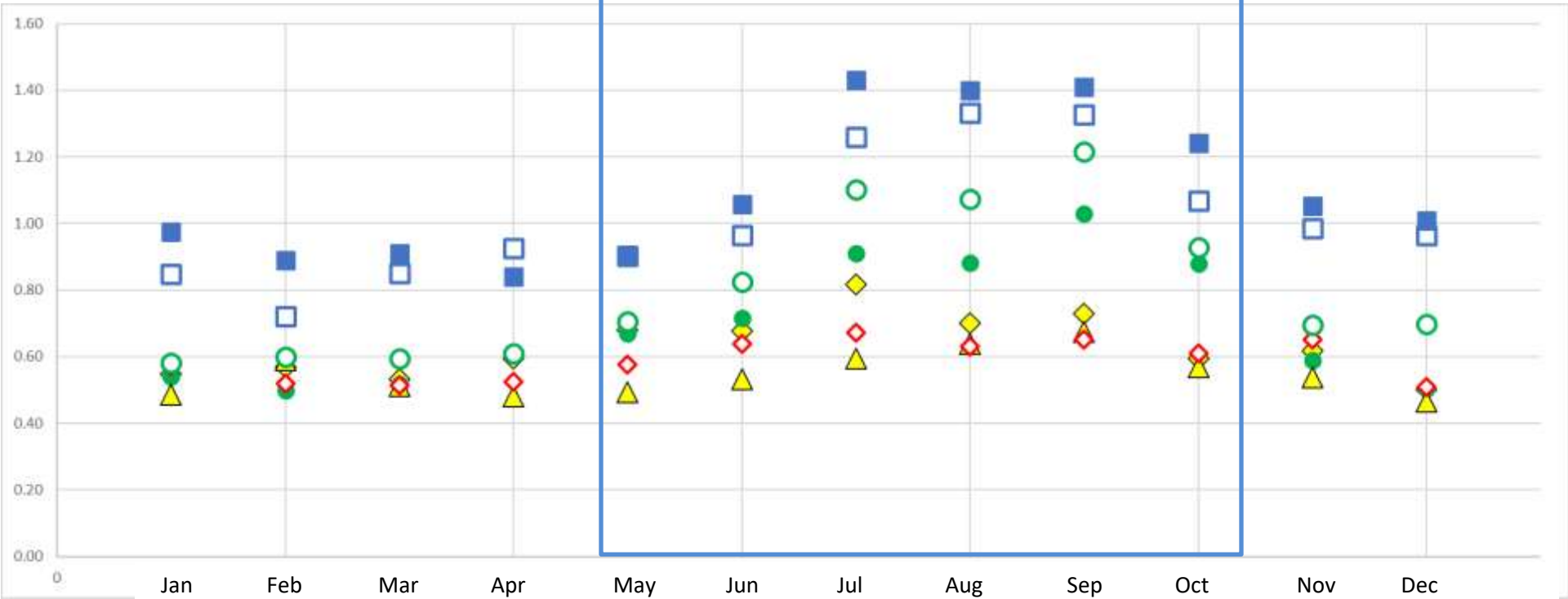
Average Total Phosphorus by Month (mg/L)

Wet Season (May-October)



Average Total Nitrogen by Month (mg/L)

Wet Season (May-October)



Takeaways and Caveats

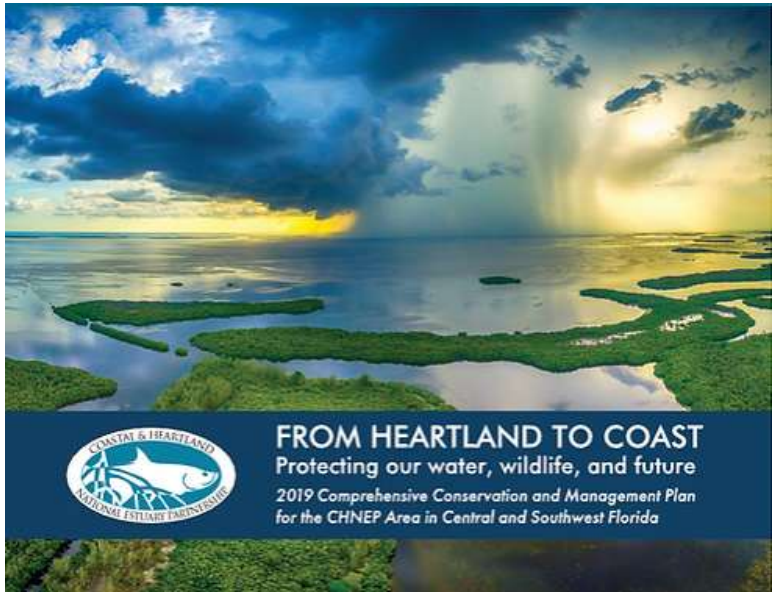
- Wet season inflows (and runoff) influence color, salinity, and nutrient levels in the Harbor; nutrient concentrations are generally higher in freshwater systems

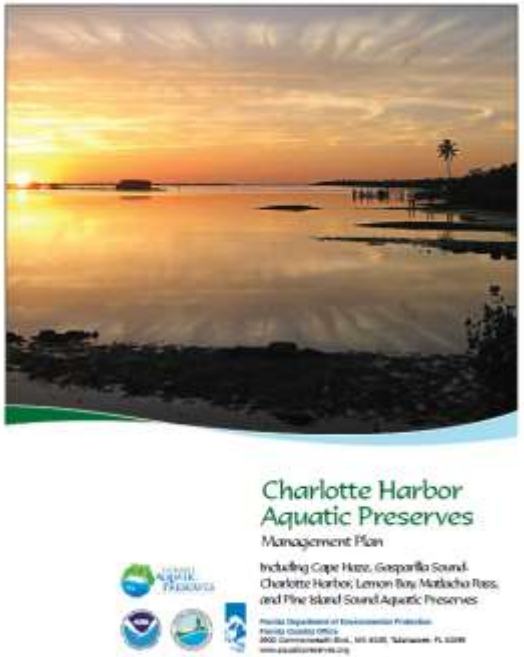
- CAUTION: Not all nutrient input comes from anthropogenic activities

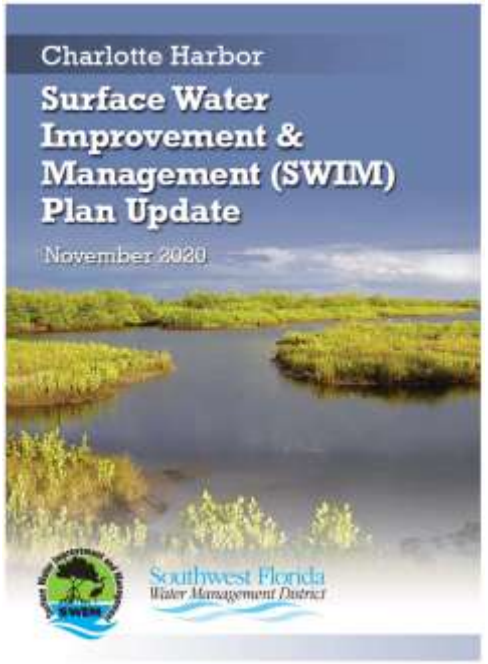
- Oxygen levels decrease as water temp and biological activity increases

Break Time

Managing the Harbor







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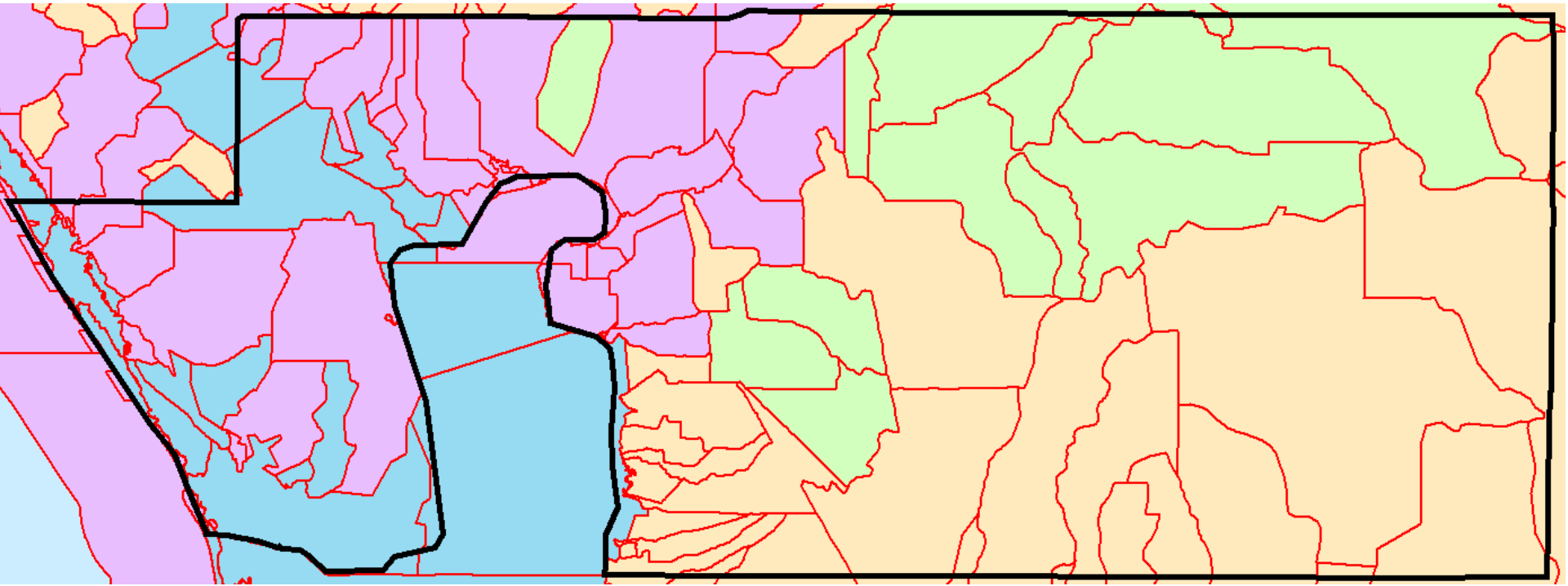
Water Quality Assessment: The Basics

- The impairment assessment process is defined in Clean Water Act and state statutes
- For each pollutant of concern, Florida has established a water quality standard
- Water quality standards have 3 parts:
  - Designated Use
  - Criteria
  - Anti-degradation statement

Water Bodies and Designated Uses



Class 1 (Potable)
Class 2 (Shellfish)
Class 3F (Fish Consumption)
Class 3M (Fish Consumption)

Water Quality Criteria

- EPA develops criteria for many pollutants of concern; a state may either adopt those or propose alternative criteria
- Alternative criteria must be approved by EPA
- Florida's criteria can be found in 62-302, FAC

Case Study: Charlotte Harbor Nutrient Criteria

- Numeric nutrient limits are based on an **interpretation** of the following:

  In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.

- This is based on the **Nutrient-Chlorophyll-light paradigm**:

  More nutrients = more algae = less light reaching the bottom = shading out submerged plants

- Harbor criteria used data collected from 2003-2007, when seagrass populations were at their peak over the past 30+ years (at the time of criteria development in the early 2010s).

- Criteria was developed as an annual average value, not to be exceeded more than once every three years.

Case Study: Charlotte Harbor Nutrient Criteria

- Charlotte Harbor criteria is based on concentrations, i.e. the amount of nutrients found in 1 liter of water.

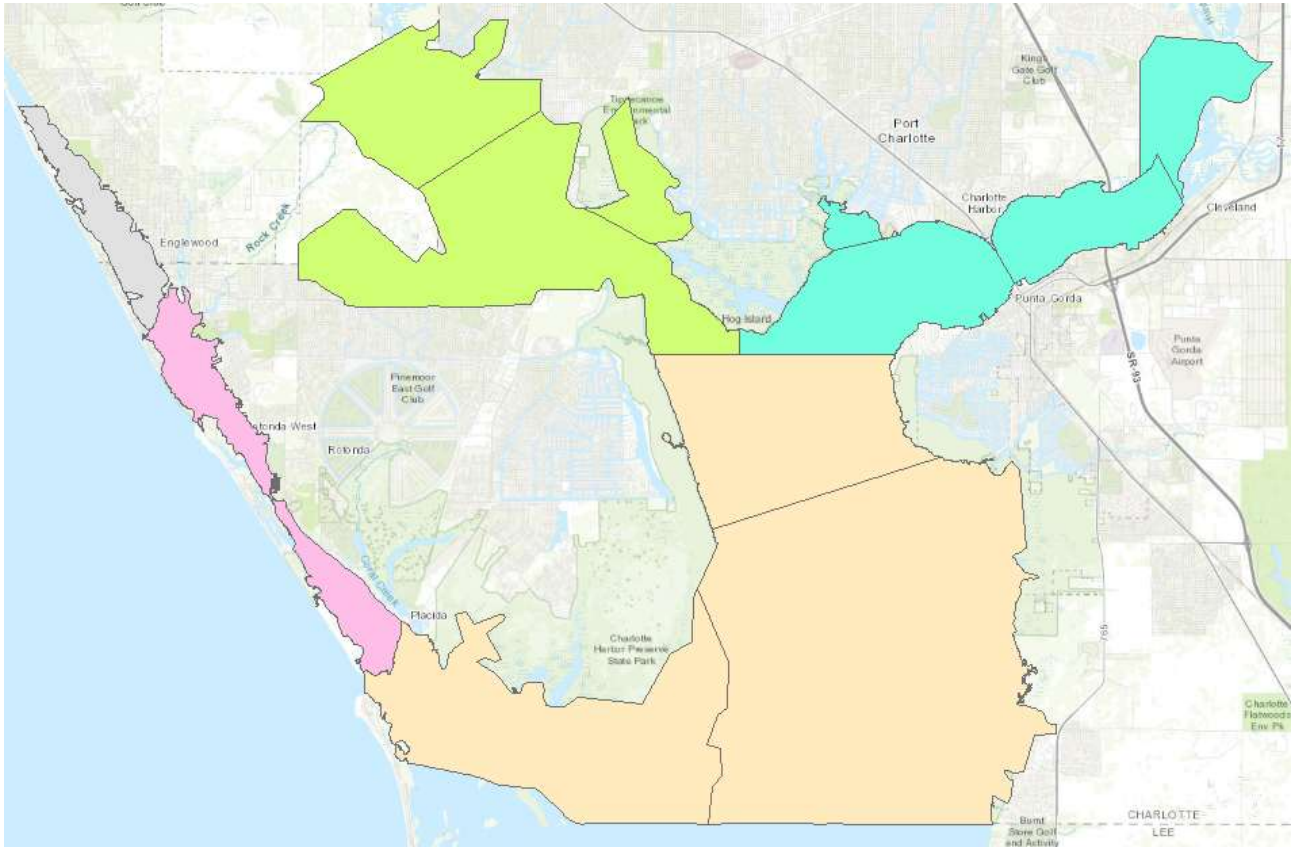
- Nutrient Criteria is expressed as milligrams of Nitrogen or Phosphorus per 1 liter of water

Harbor-Specific Nutrient Criteria

Annual Avg Criteria

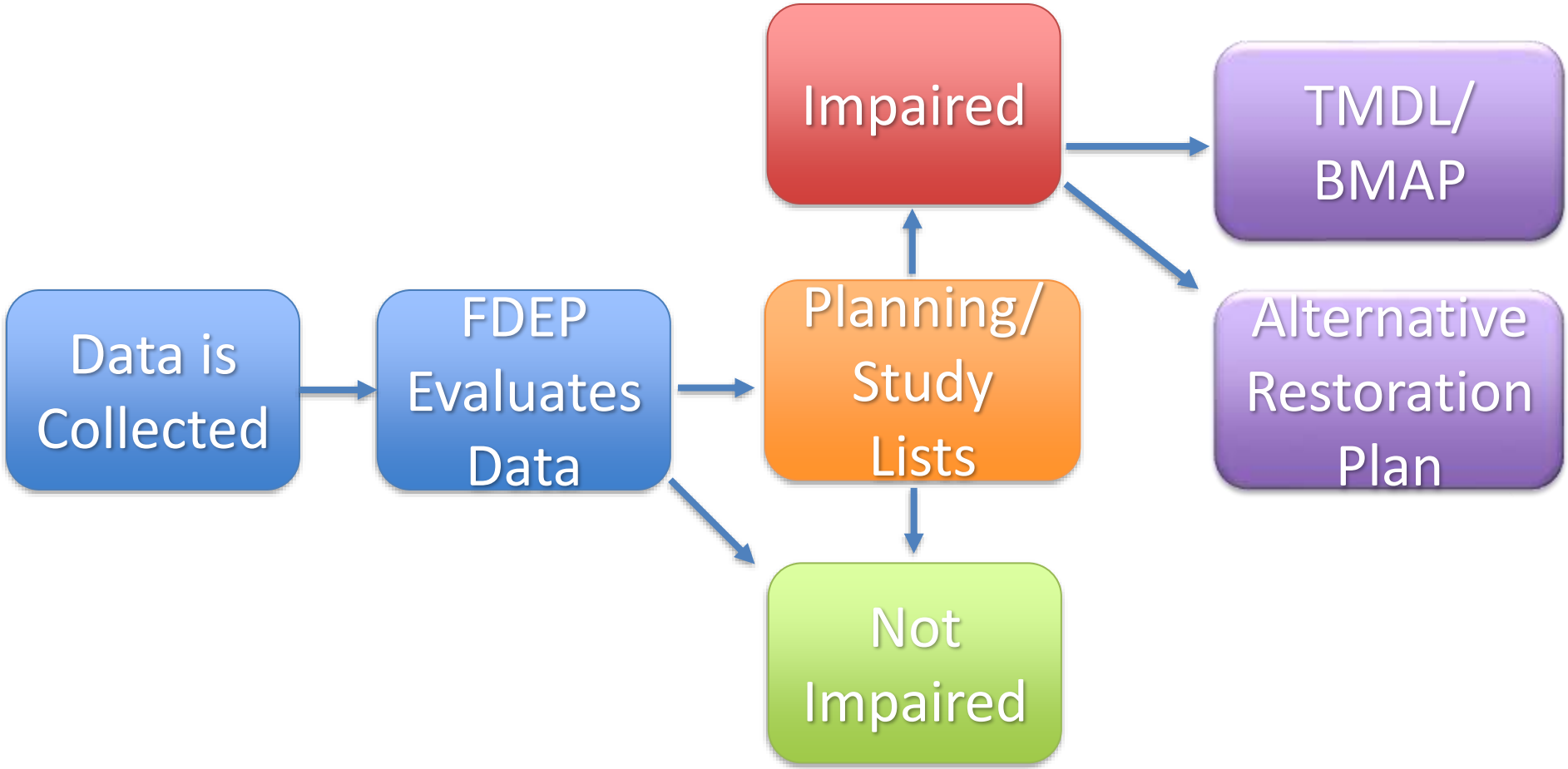
(not to be exceeded more than once every 3 years):

	TP	TN	Chl-a
	0.26	0.56	8.9
	0.17	0.62	6.1
	0.19	0.67	6.1
	0.5	1.08	12.6
	0.31	1.02	11.7



Source: IWR 60 Database

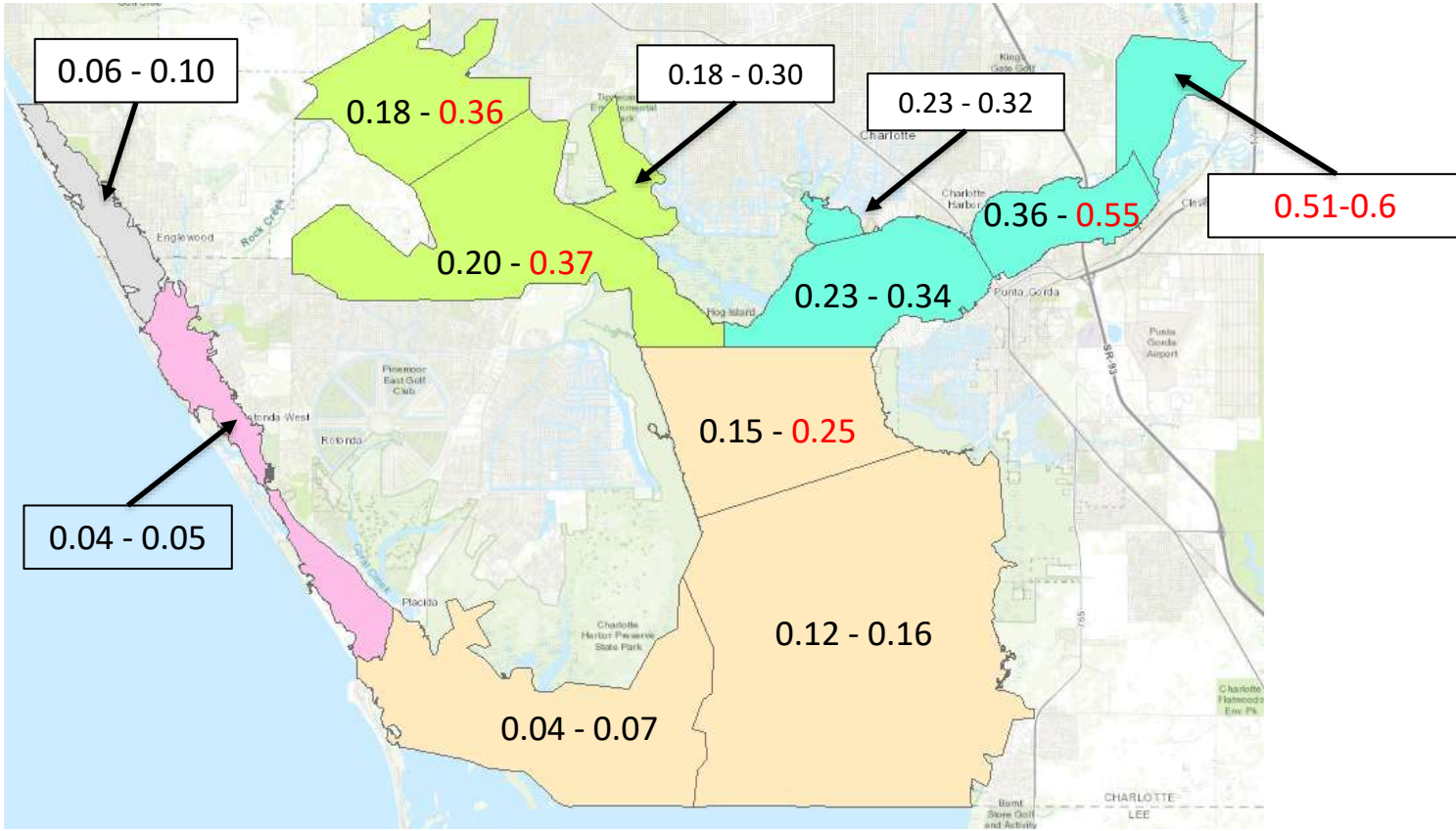
Water Quality Assessment: The Basics



Total Phosphorus Annual Average Ranges: 2014-2023 (mg/L)

Annual Avg Criteria
(not to be exceeded more than once every 3 years):

- 0.26
- 0.17
- 0.19
- 0.5
- 0.31

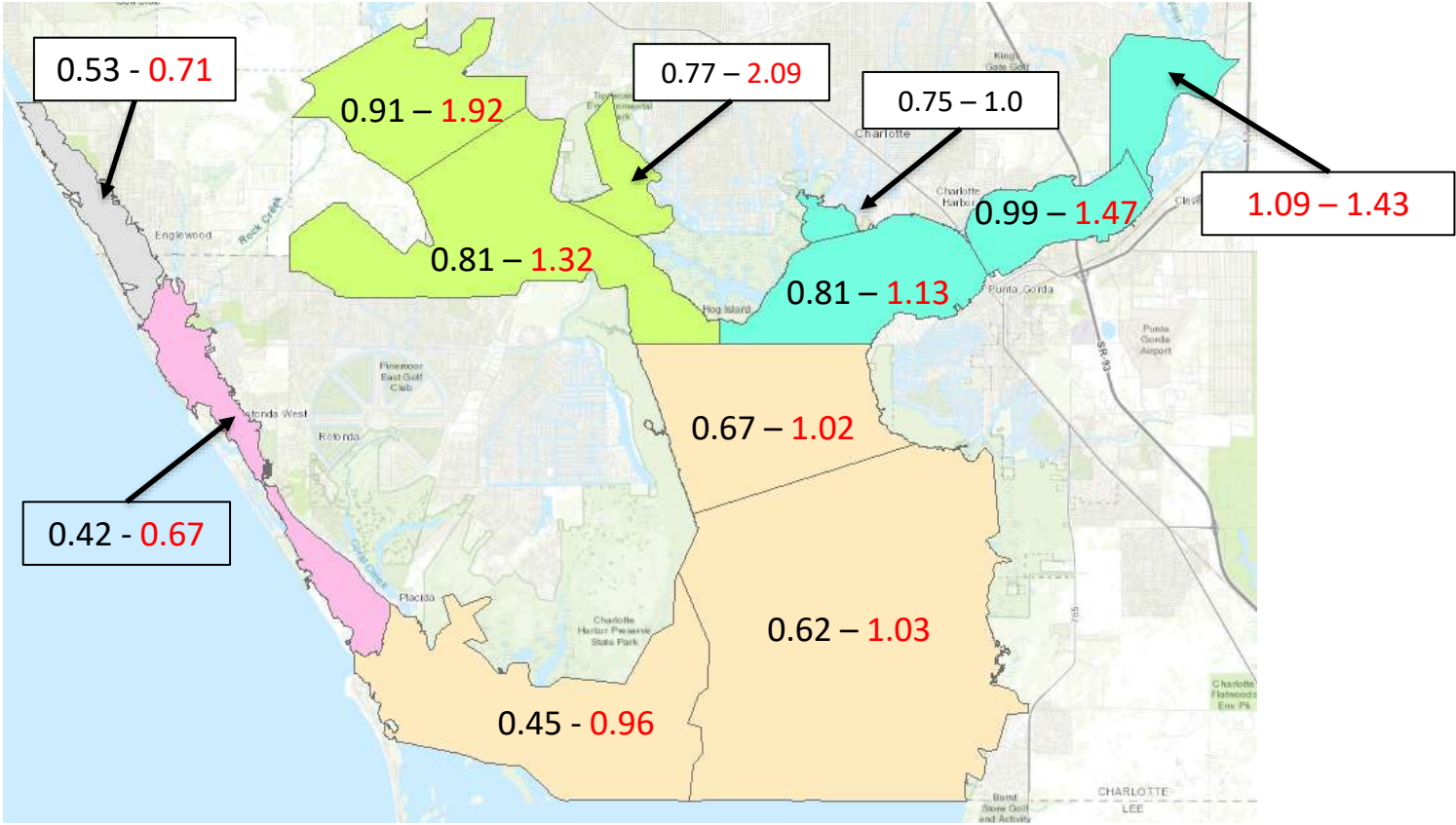


Source: IWR 60 and 66 Database

Total Nitrogen Annual Average Ranges: 2014-2019 (mg/L)

Annual Avg Criteria
(not to be exceeded more than once every 3 years):

- 0.56
- 0.62
- 0.67
- 1.08
- 1.02

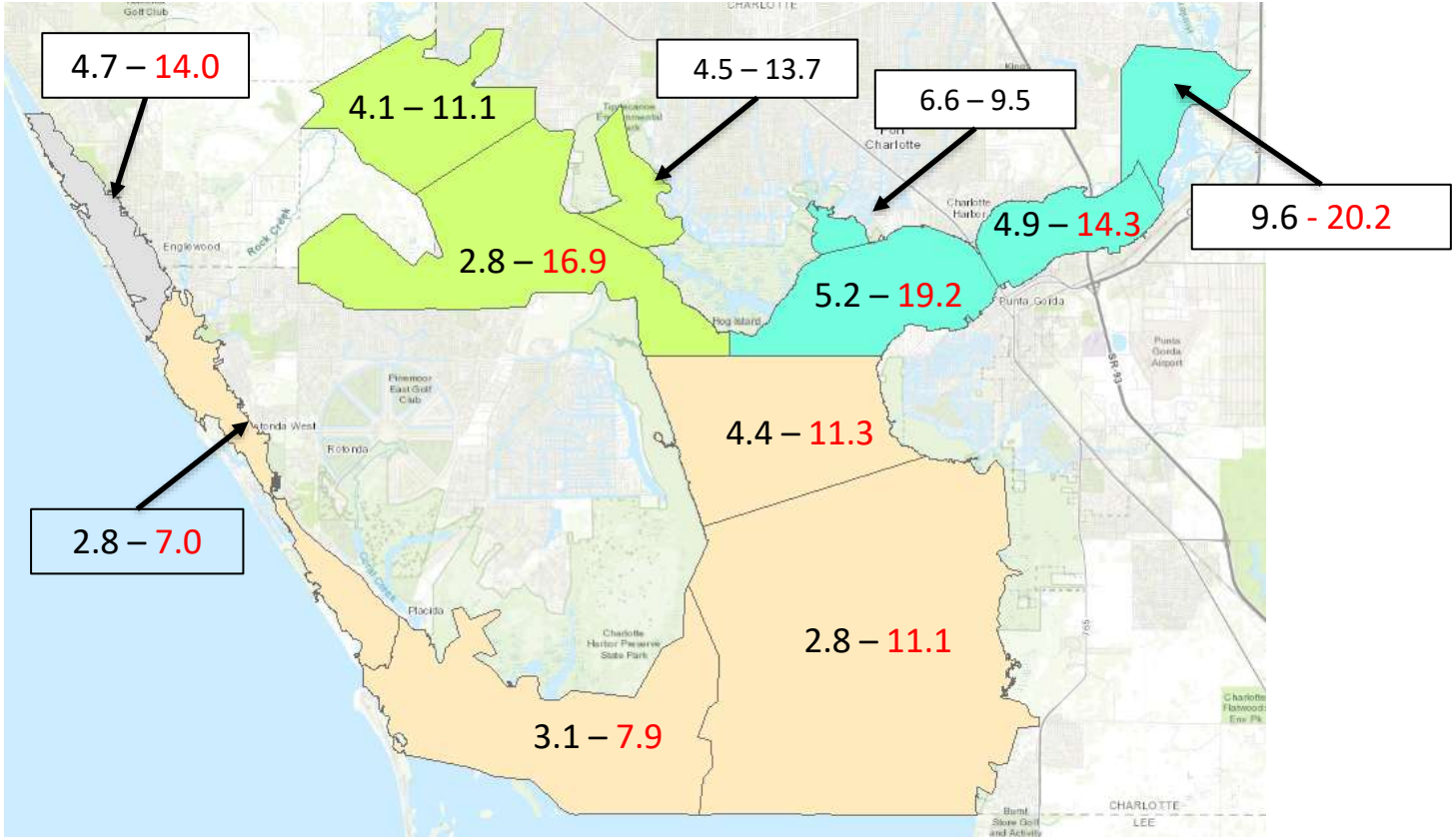


Source: IWR 60 and 66 Database

Chlorophyll-a Annual Average Ranges: 2014-2019 (µg/L)

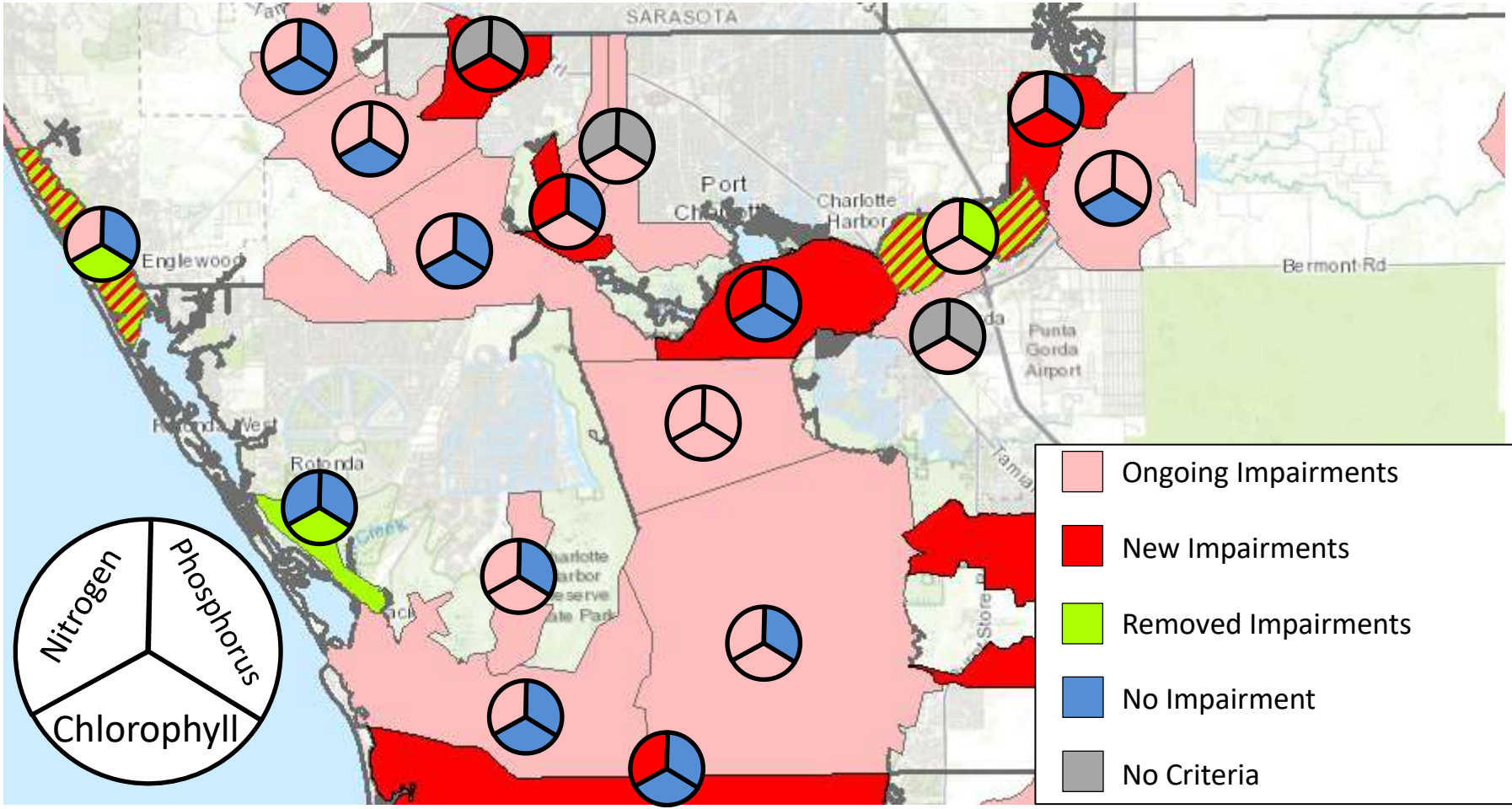
Annual Avg Criteria
(not to be exceeded more than once every 3 years):

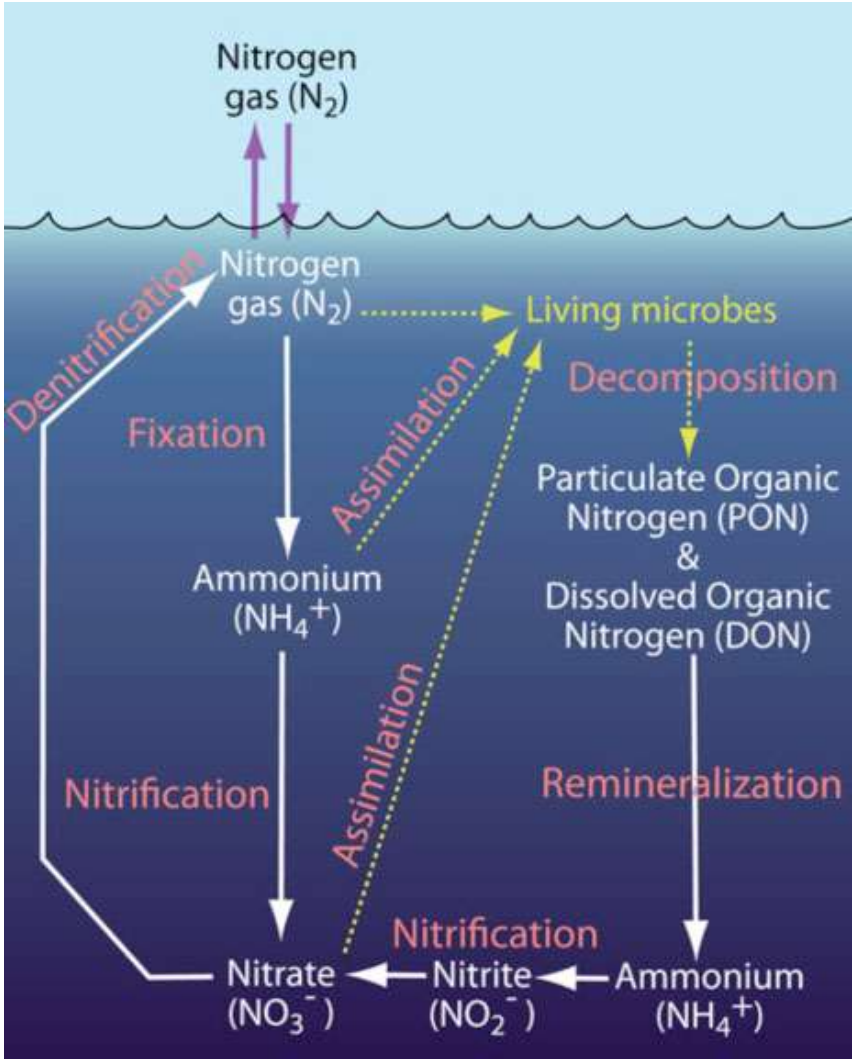
- 8.9
- 6.1
- 12.6
- 11.7



Source: IWR 60 and 66 Database

State Water Quality Assessments 2023: Nutrients





Nitrogen in our Environment (It's Complicated)

1. Nitrogen enters the water through precipitation, nitrogen gas interacting with the surface, anthropogenic input, runoff of organic matter, decomposition of organisms

2. Remineralization- the creation of ammonium (NH4) that occurs when microorganisms are breaking down organic nitrogen

3. Nitrification- when microbes extract energy from NH4, creating NO2 (and from NO2 to NO3)

4. Denitrification- the microbial conversion of NO3 to Nitrogen gas

5. Fixation- Certain microbes can convert Nitrogen gas to Ammonium

6. Assimilation- the consumption of Nitrogen compounds by organisms

Nitrogen- A Closer Look

When testing for Total Nitrogen, we measure multiple compounds and then combine them:

- Ammonia/Ammonium (NH3-NH4): usually analyzed together
  - NH3 to NH4 ratio generally depends on pH and temp; high pH/temp = more NH3 and less NH4
  - NH4 is a highly bioavailable food source
  - NH3 can be toxic to wildlife if high enough in concentration

- Nitrate/Nitrite (NO2-NO3): usually analyzed together.
  - NO3 is a bioavailable food source

- Organic Nitrogen: takes many different forms, but involves N attached to some sort of carbon-based compounds
  - Organic Nitrogen needs to be “broken down” and converted to inorganic forms of N before it can be utilized by flora

Nitrogen- A Closer Look

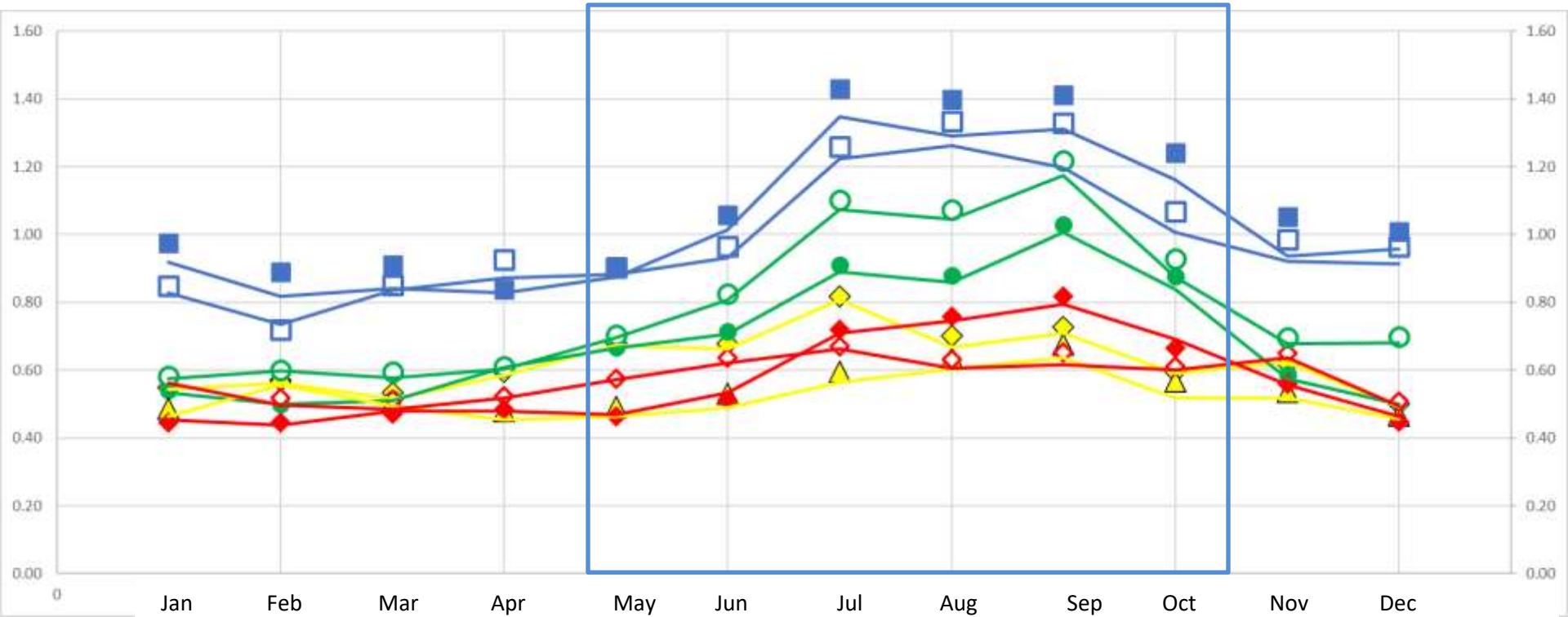
We measure Total Nitrogen as **Total Kjeldahl Nitrogen** (TKN) + **NO2-NO3**

Total Kjeldahl Nitrogen = **NH3-NH4** + **Organic Nitrogen**

Average Total Nitrogen VS TKN (mg/L)

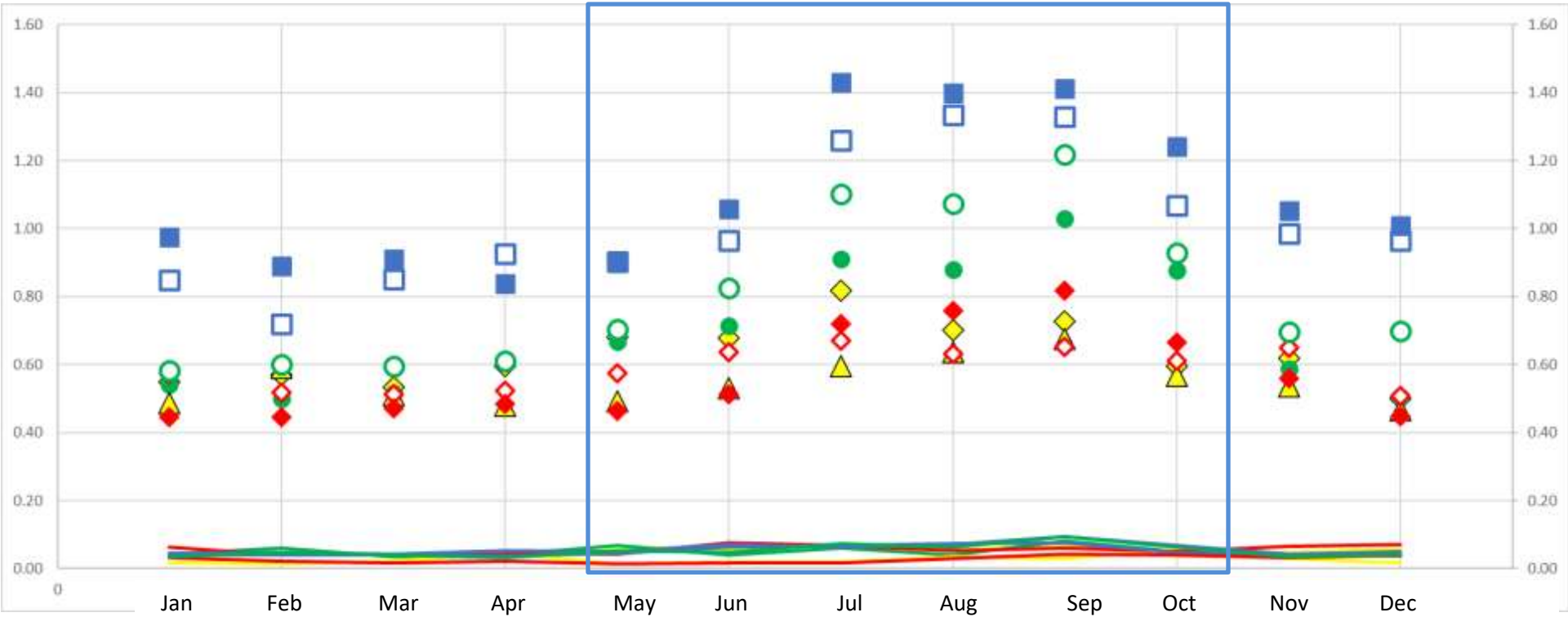
*TKN = Organic N + NH3/NH4

Wet Season (May-October)



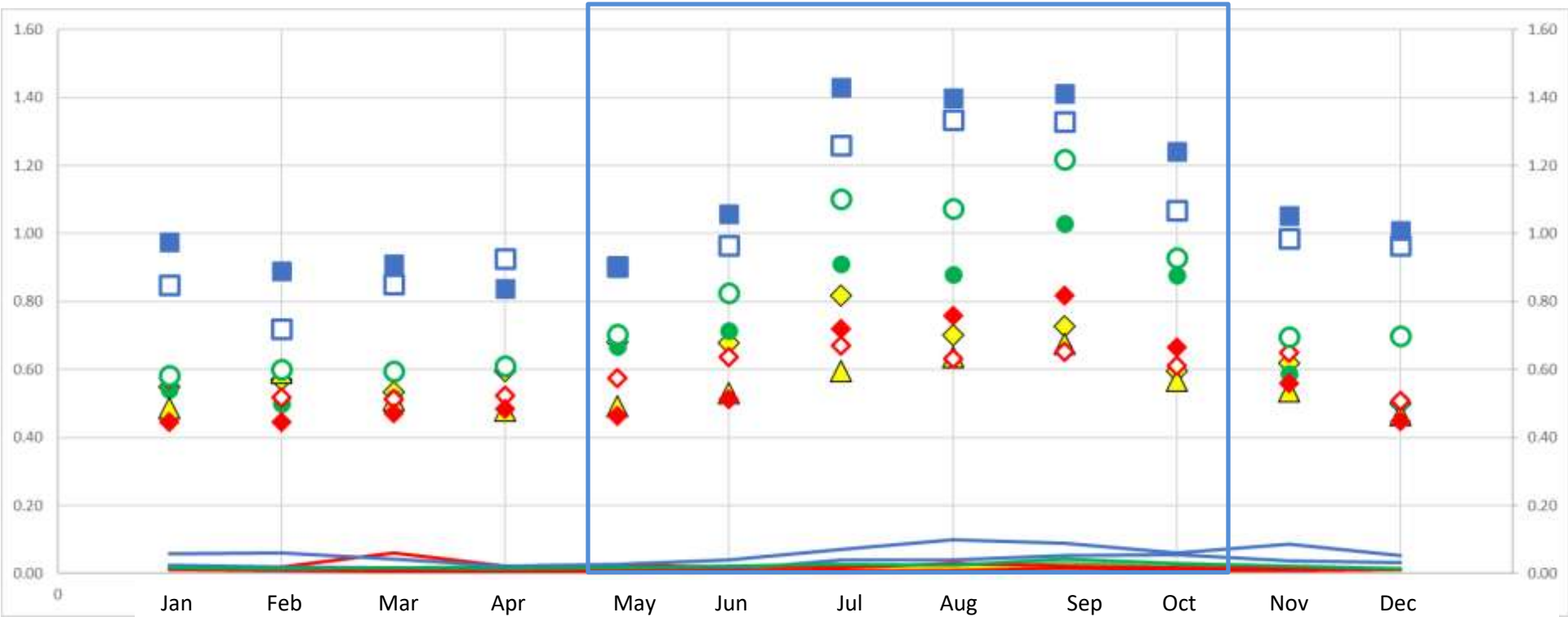
Average Total Nitrogen VS NH3/NH4 (mg/L)

Wet Season (May-October)



Average Total Nitrogen VS NOx (mg/L)

Wet Season (May-October)



Takeaways and Caveats

The majority of nitrogen found **in the water column** is organic (e.g. from tannins, breakdown of organic matter in the water, runoff of terrestrial organic matter like grass clippings, etc)…

Takeaways and Caveats

…But is this the whole story? REMEMBER: NH_4 and NO_3 tend to be low because they are consumed fairly quickly by organisms. Organic N hangs around longer because it has to undergo decomposition/ remineralization. Hence the overarching water quality standard for nutrients:

In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.

Evidence of “Imbalance” in the System

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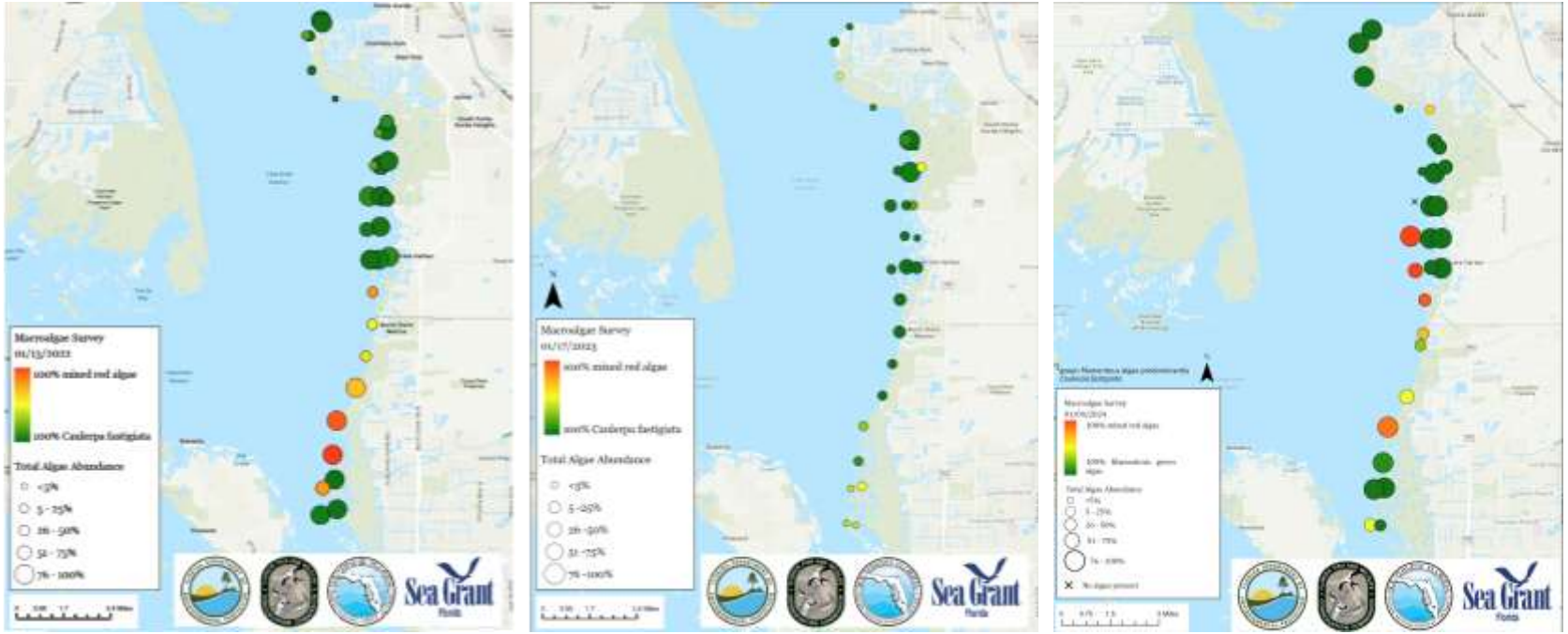
Evidence of “Imbalance” in the System



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Charlotte Harbor

Segments	2020	2022	Δ Acres	% Change
East Wall North	1,770	1,593	-178	-10%
East Wall South	1,258	1,183	-76	-6%
Myakka River	189	148	-40	-21%
Peace River	349	244	-105	-30%
Placida	4,029	3,881	-148	-4%
Southern Charlotte	2,079	2,112	+34	+2%
Turtle / Bull Bay	4,178	3,944	-233	-6%
West Wall	1,421	1,807	+386	+27%
Total	**15,273**	**14,913**	**-360**	**-2%**

Evidence of “Imbalance” in the System

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Where Are the Nutrients Coming From???

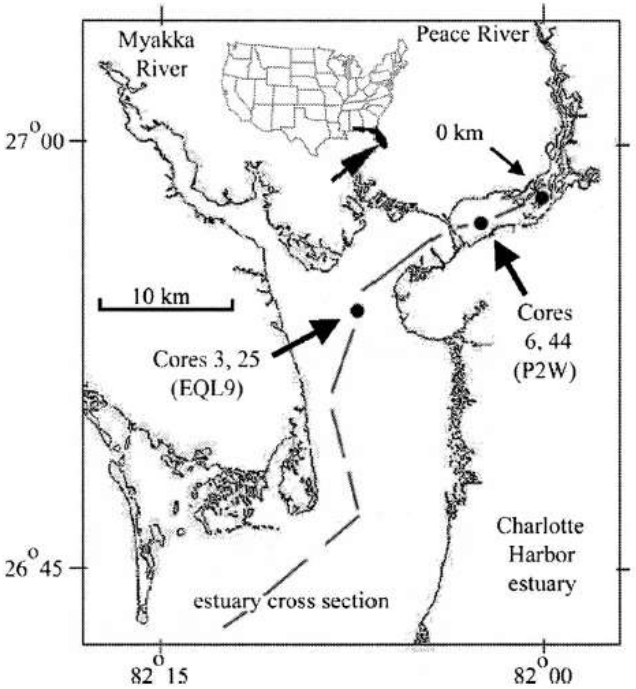
There are many theories…

1. Ongoing enrichment from communities here and upstream
2. Leaching/malfunctioning septic tanks
3. Reclaimed water
4. Residential fertilizer application
5. Agricultural operations
6. Phosphate mining industry
7. The “hangover effect”
8. Natural sources (precipitation, N-fixing bacteria, naturally high P)
9. Lack of landward attenuation (e.g. loss of wetlands, high velocity, flashy flow instead of sheetflow, etc)

Where Are the Nutrients Coming From???

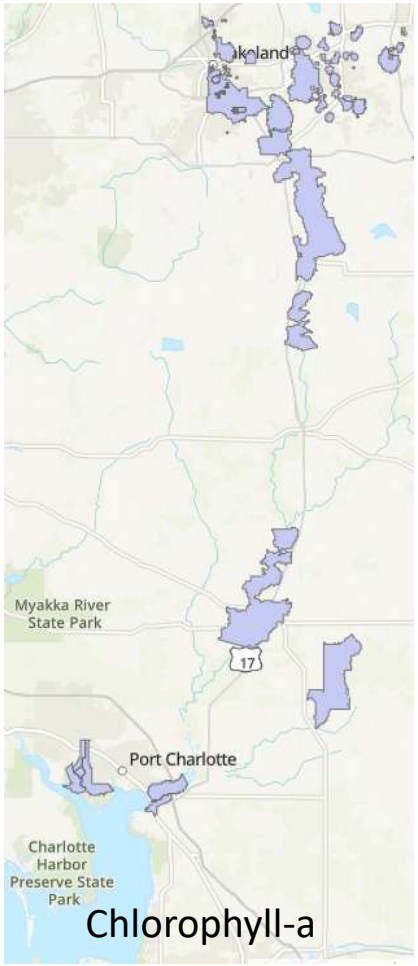
Clues in the sediment:

In the late 90's/early 2000's, SWFWMD and LSU studied sediment cores in the Peace River/Charlotte Harbor. They found evidence of nitrogen loading rates ~3x higher during 1930's-1980's vs the 1800s.

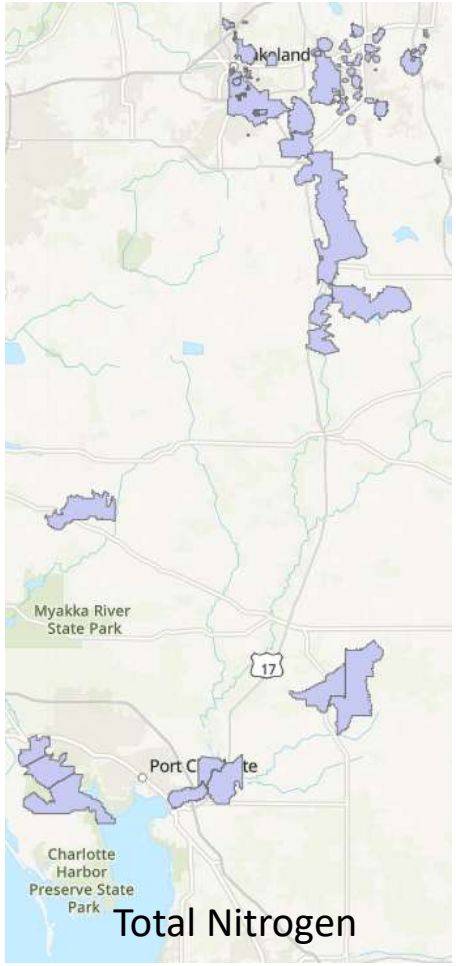


Source: Turner et al. 2006. Paleo-indicators and water quality change in the Charlotte Harbor estuary (Florida). Limnology and Oceanography, 51(1, part 2), 518-533

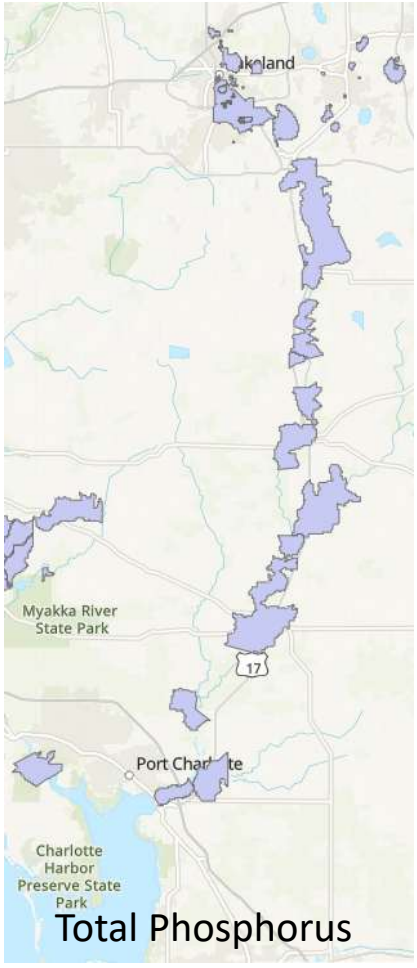
Waterbodies Not Attaining Standards, Peace River



Chlorophyll-a



Total Nitrogen



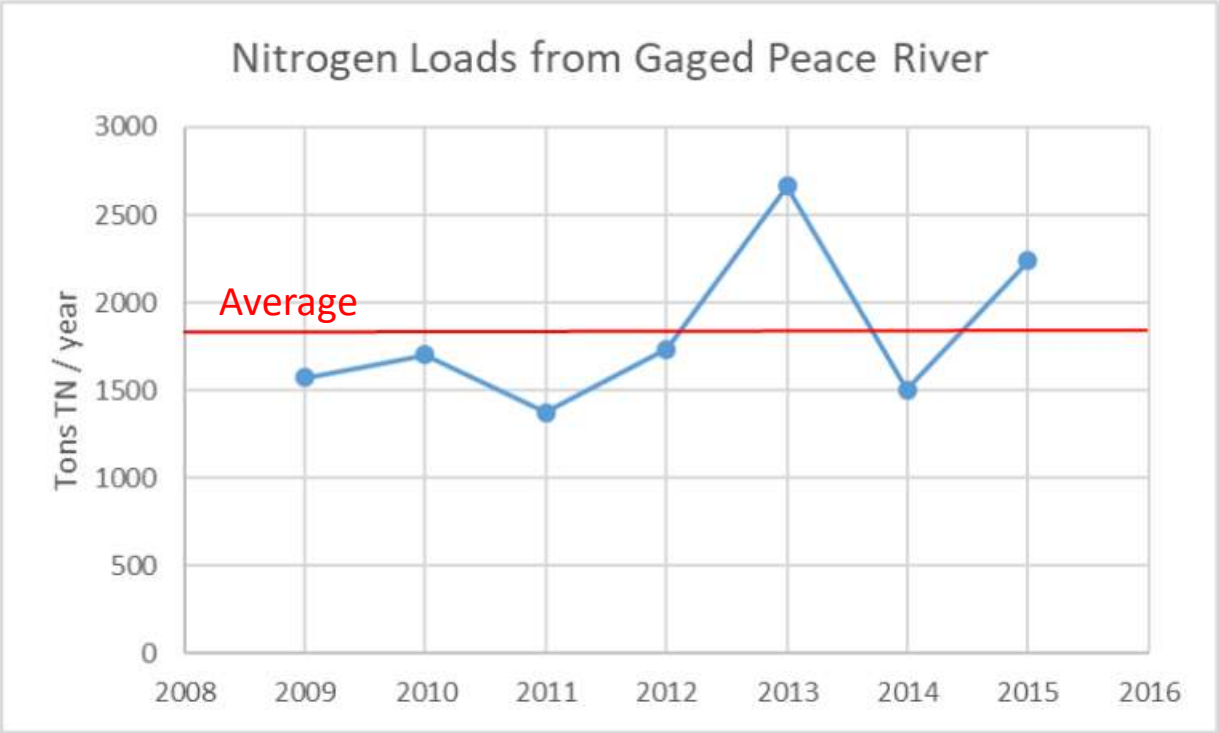
Total Phosphorus

Where Are the Nutrients Coming From???

The 2020 SWIM Plan update by SWFWMD looked at nitrogen loads in the Peace River. They found:

- From 2009-2015, average nitrogen load from the gaged Peace River was 1,827 tons/year
- The average nitrogen load from 1985 to 1992 was 1,820 tons TN per year, a difference of less than 5% vs 2009-2015.

Remember: seagrass populations had been steady/increasing in the harbor until around 2018 (though signs of imbalance were starting to appear prior to then)



Source: 2020 Charlotte Harbor Surface Water Improvement and Management Plan Update, Southwest Florida Water Management District

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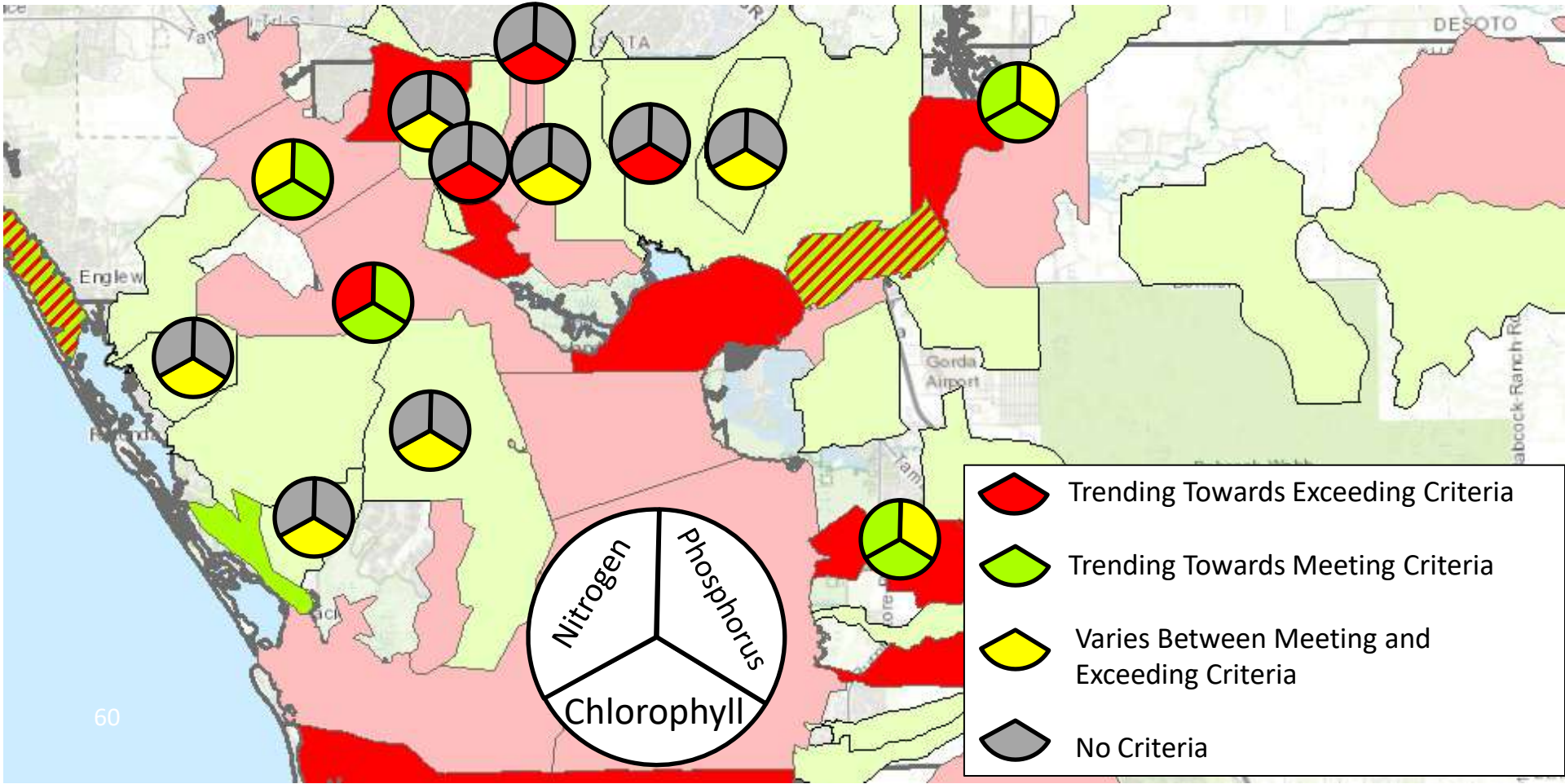
Nutrient Data in Charlotte County Waterways, 2022-2023



Reclaimed Water Has A Lot More Nitrogen Than the Natural Environment

Wet Season (May-October)

Concentrations in irrigation ponds

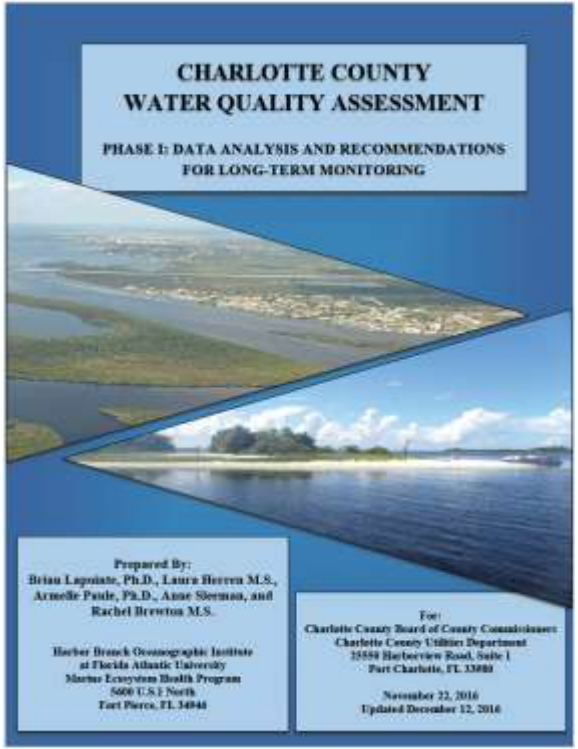
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Where Are the Nutrients Coming From???

Harbor Branch Oceanographic Institute (Brian Lapointe) conducted septic tank study in Port Charlotte, finding linkages between septic discharges and nutrients in surface water/filter feeders.

This, in part, led to creation of the Sewer Master Plan and initiation of the Septic to Sewer Program.



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The “Hangover Effect” Theory

- Seagrass populations declined dramatically throughout SW Florida (not just Charlotte Harbor) during the period 2018-2020.
- 2017 saw massive runoff/discharges into our estuaries from Hurricane Irma.
- A large-scale, protracted red tide event occurred shortly thereafter, resulting in tons of decomposing organisms releasing nutrients back into the system.
- Perhaps these two factors combined for a mass loading event during that timeframe, fueling algae/cyanobacteria blooms, reducing clarity, and killing off seagrass.

Evidence supporting this:

- Charlotte Harbor’s seagrass populations overall remained somewhat steady in 2020-2022, implying we may have seen the worst of the die-off.
- Portions of Sarasota bay has experienced increased growth/recovery of seagrass beds over the last year or so. The upper west wall of Charlotte Harbor is also seeing some increased abundance.

Caveat:

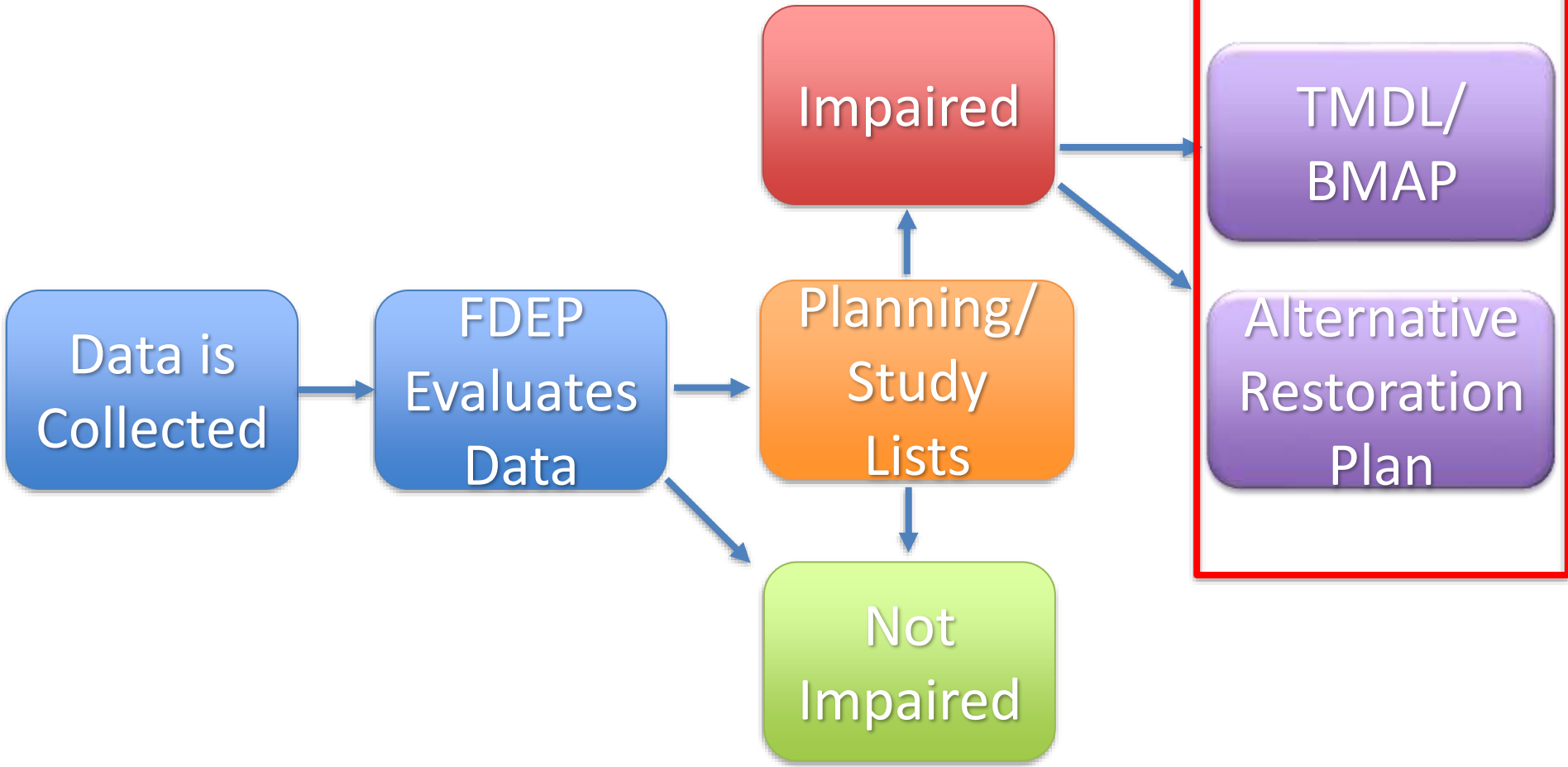
Anecdotal evidence from agencies and the public indicate that Charlotte Harbor began seeing algae/cyanobacteria issues as far back as 2012/2013, long before Irma. That said, massive blooms weren’t widespread until recent years.

How Do We Figure This Out?

- FGCU's Peace River basin nutrient study/modeling- commissioned by the state

- Continued WQ and Flow data collection that will allow us to better model Charlotte County waters and the entire system, and detect changes from "baseline" conditions

What's Next?


Data is Collected
FDEP Evaluates Data
Planning/ Study Lists
Impaired
Not Impaired
TMDL/ BMAP
Alternative Restoration Plan

What's Next?

Draft One Charlotte, One Water Plan
Public Meeting #1

Feb. 20, 2025 5:00-7:00 PM

Charlotte Harbor Event and
Conference Center

To Summarize…

- Water chemistry dynamics are complex and affected by a variety of climatological, meterological, physical, and biological factors

- EPA and States have created criteria to help us assess if waters meet their “designated use”

- Many factors can influence the health and impairment of waters; rarely is there a single “smoking gun”

Other Topics of Interest

- Hypoxia in Estuaries: Upper Charlotte Harbor experiences very low Oxygen near the bottom during certain times of the year. This has been the case for decades, and is fueled by a combination of natural processes and eutrophication

- pH and acidification of our oceans: pH affects many chemical and biological processes; the “recent” increase in CO2 in our atmosphere has resulted in a decrease in pH of our waters, impacting organisms’ ability to build and maintain their shells, skeletons, and other calcium carbonate structures.

- Alteration and restoration of hydrology in the Charlotte Harbor watershed: MANY projects are underway in the Peace/Myakka/Caloosahatchee basins to restore historic inflow patterns into our system. This will possibly affect some of the biochemical characteristics of the system


Mary Lundeberg