Identifying nutrient sources driving algal blooms in Florida Bay: A causal modelling approach

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The Issue: Algal Blooms

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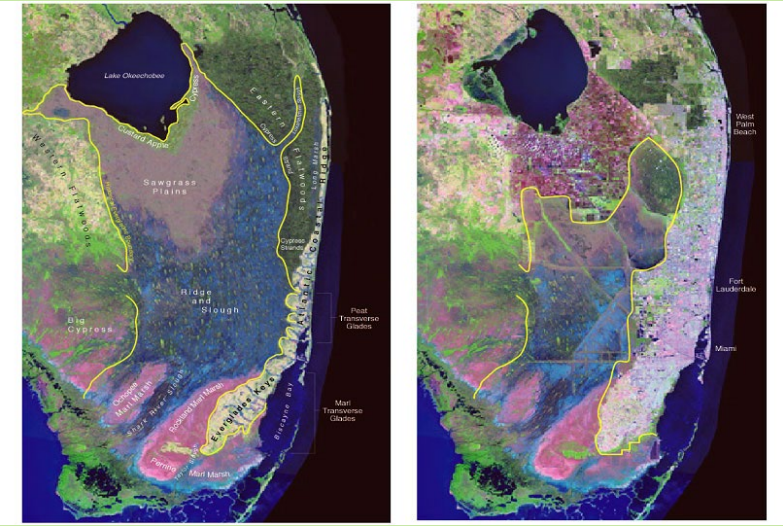
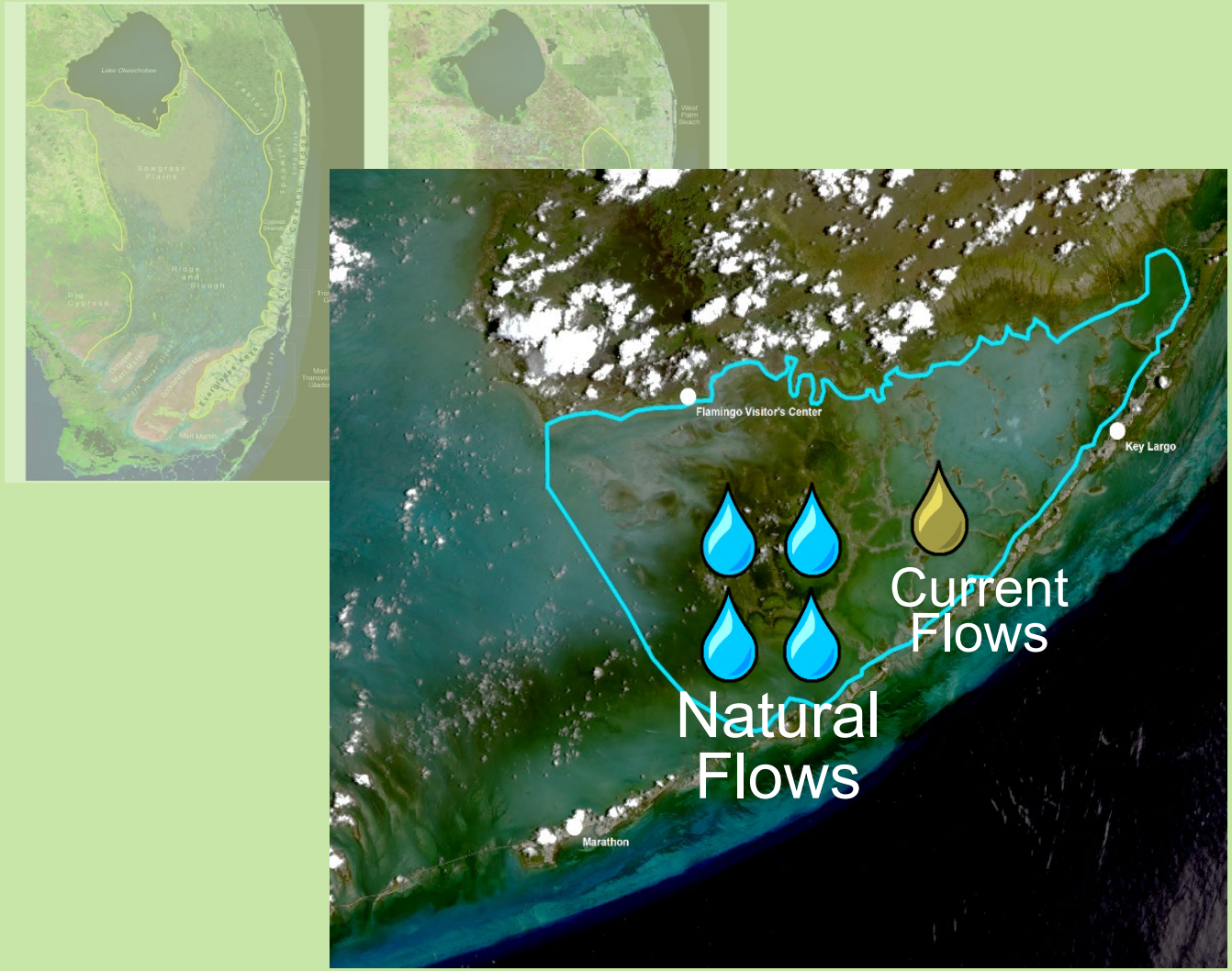


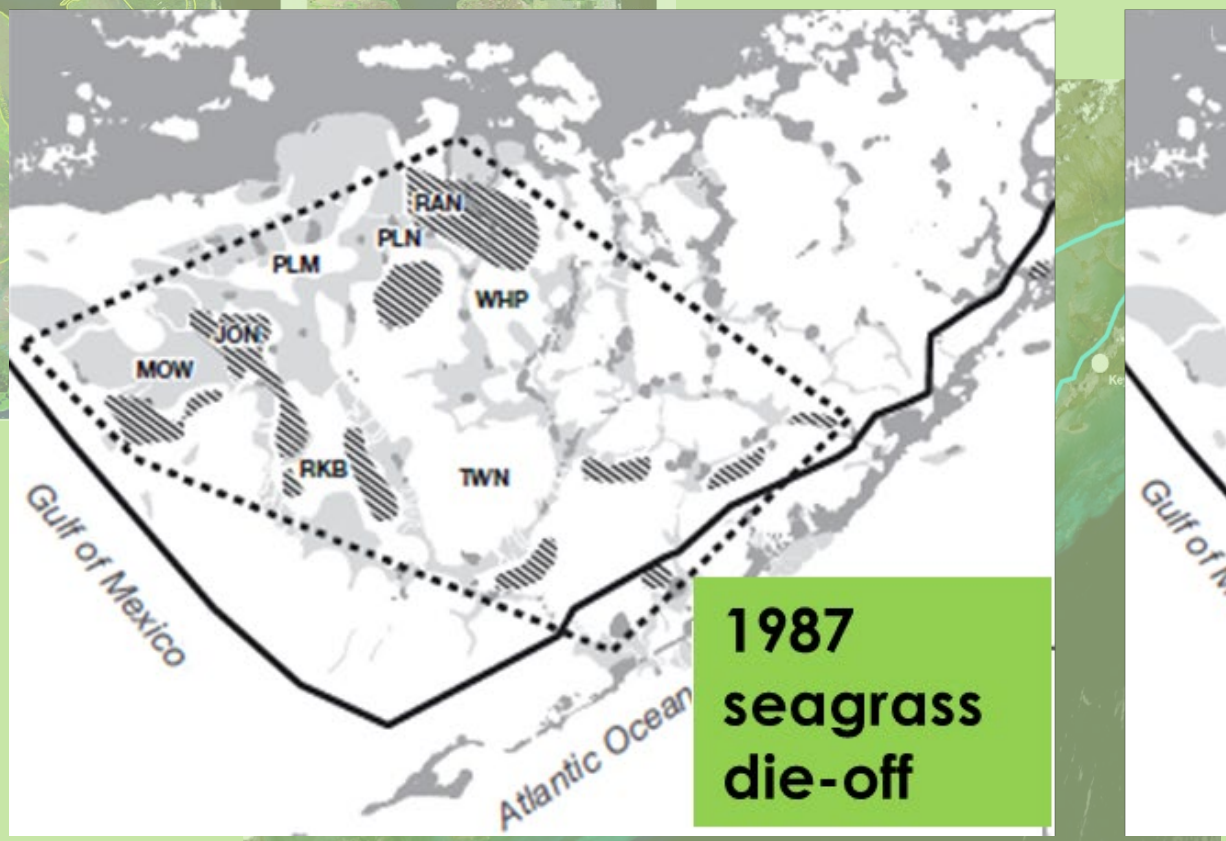
Marshall et al. 2014 Estuar. Coast., Marshall et al. 2020 Front. Envi. Sci.

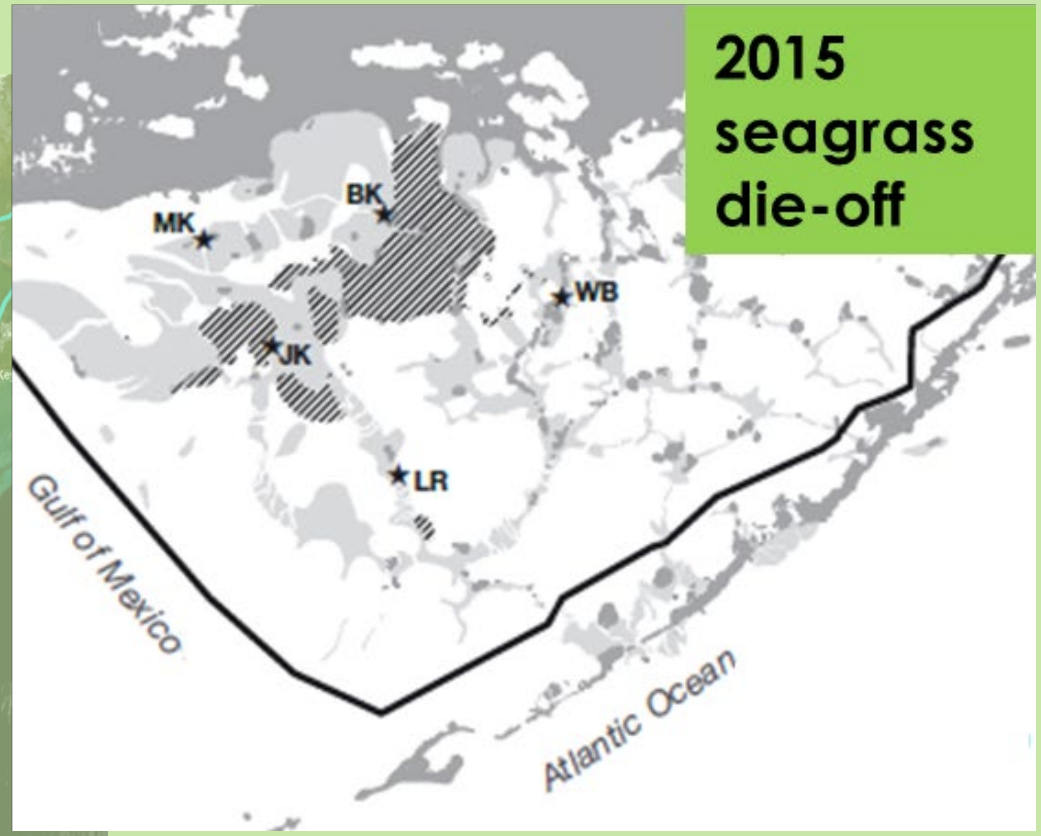
The Issue: Algal Blooms



Marshall et al. 2014 Estuar. Coast., Marshall et al. 2020 Front. Envi. Sci.

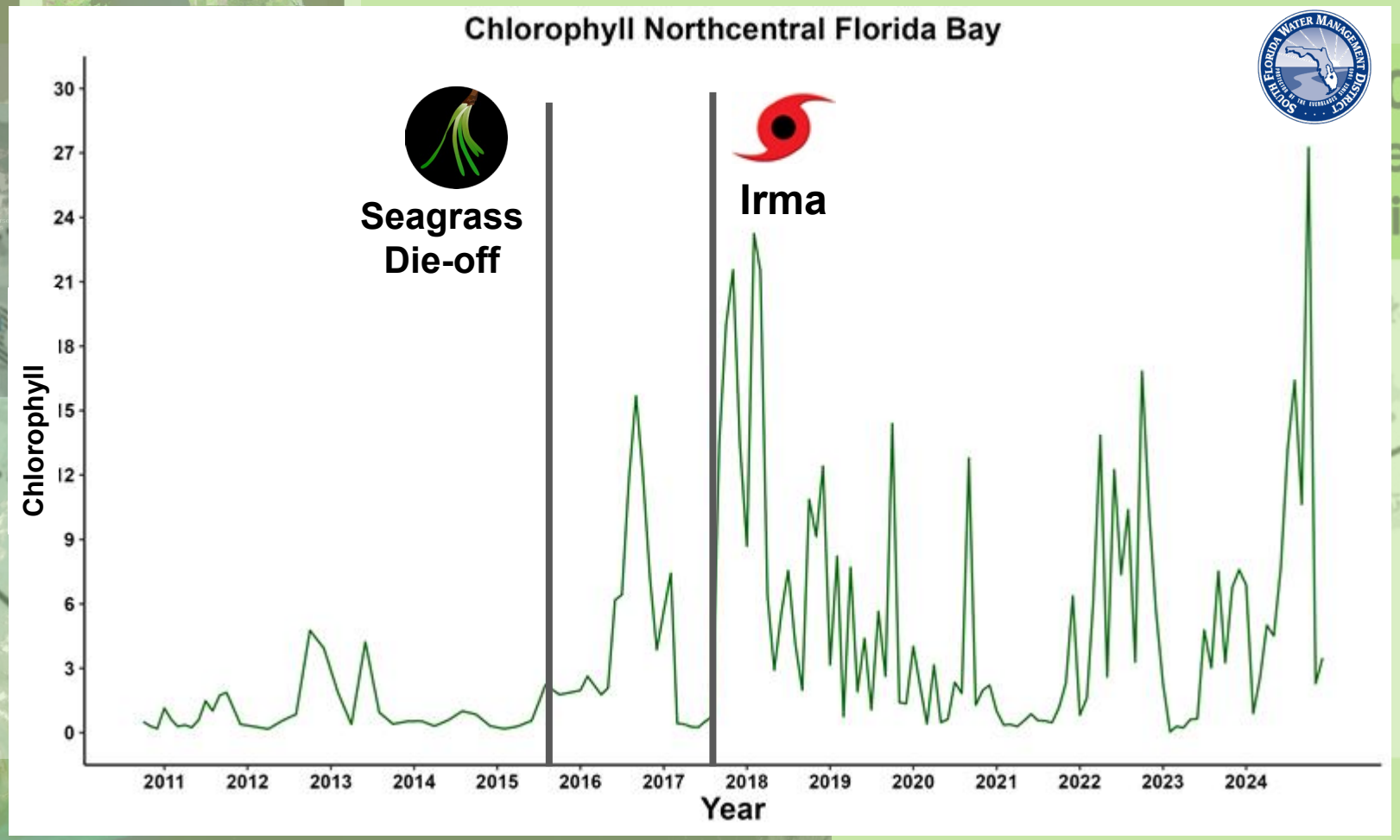
The Issue: Algal Blooms



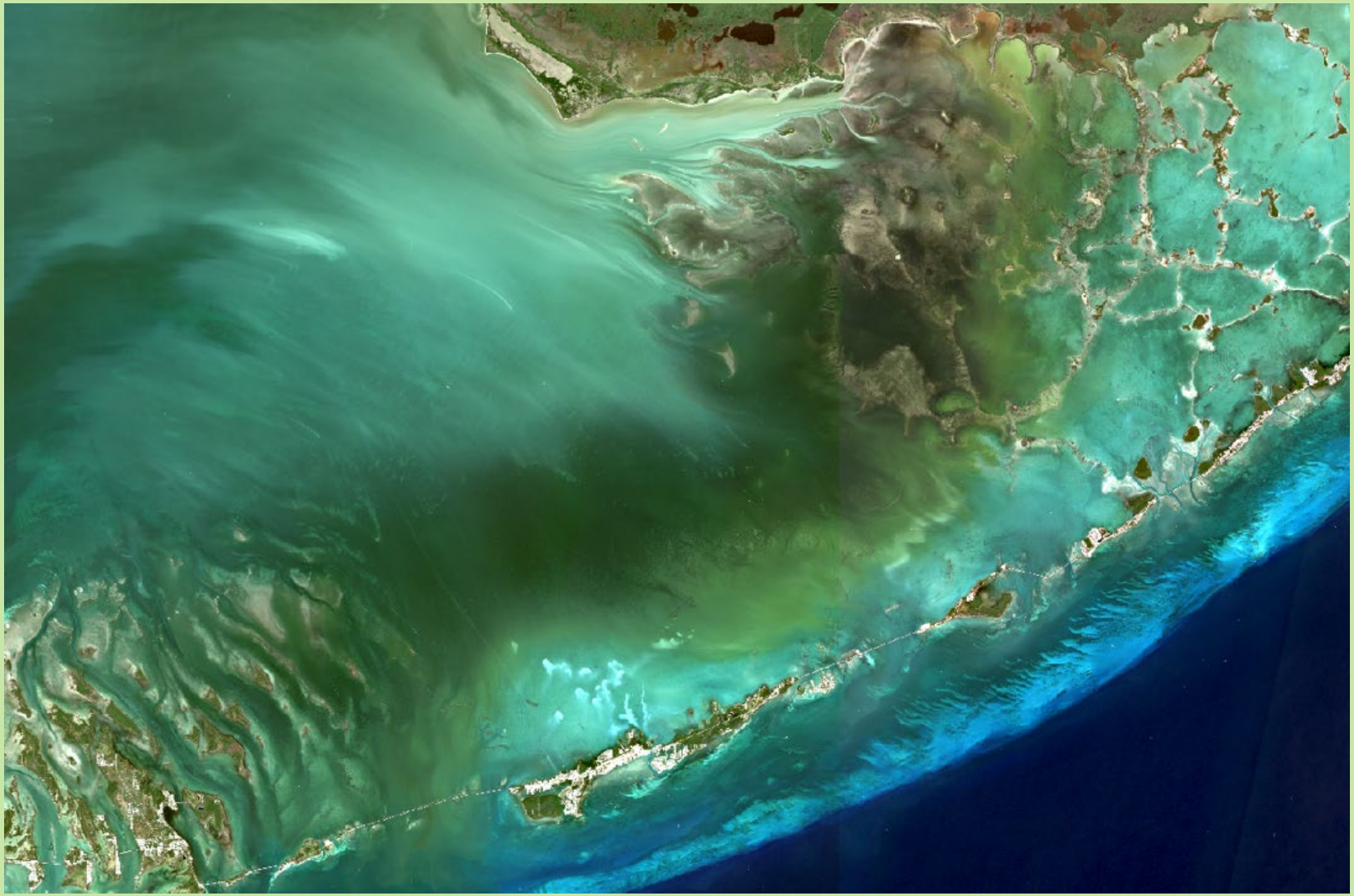


Hall et al., 2016 MEPS

The Issue: Algal Blooms



The Issue: Algal Blooms



The Culprit: *Synechococcus sp.*

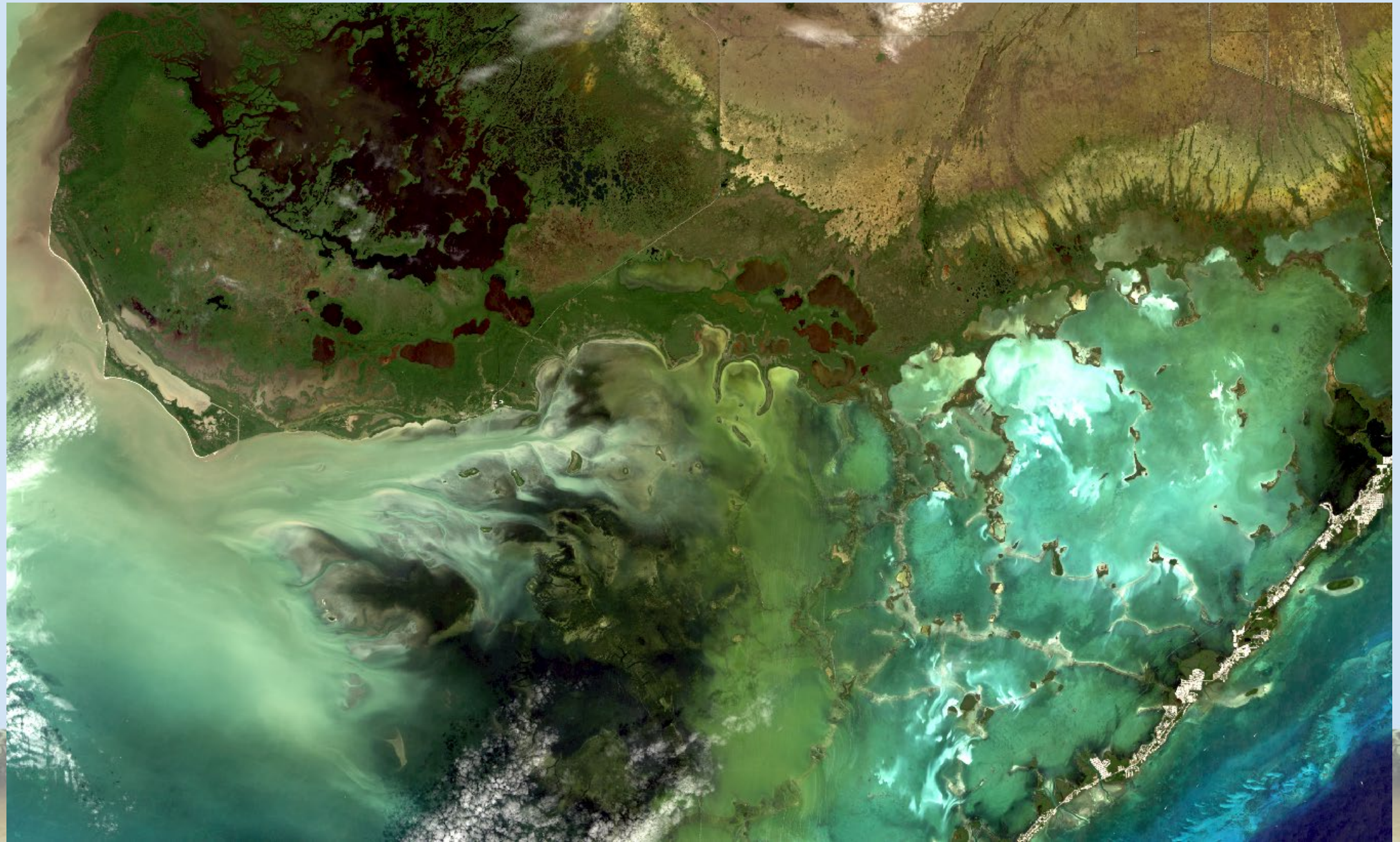
- Cyanobacteria
- Thick mucus layer
- Low P, high NH4

The Questions

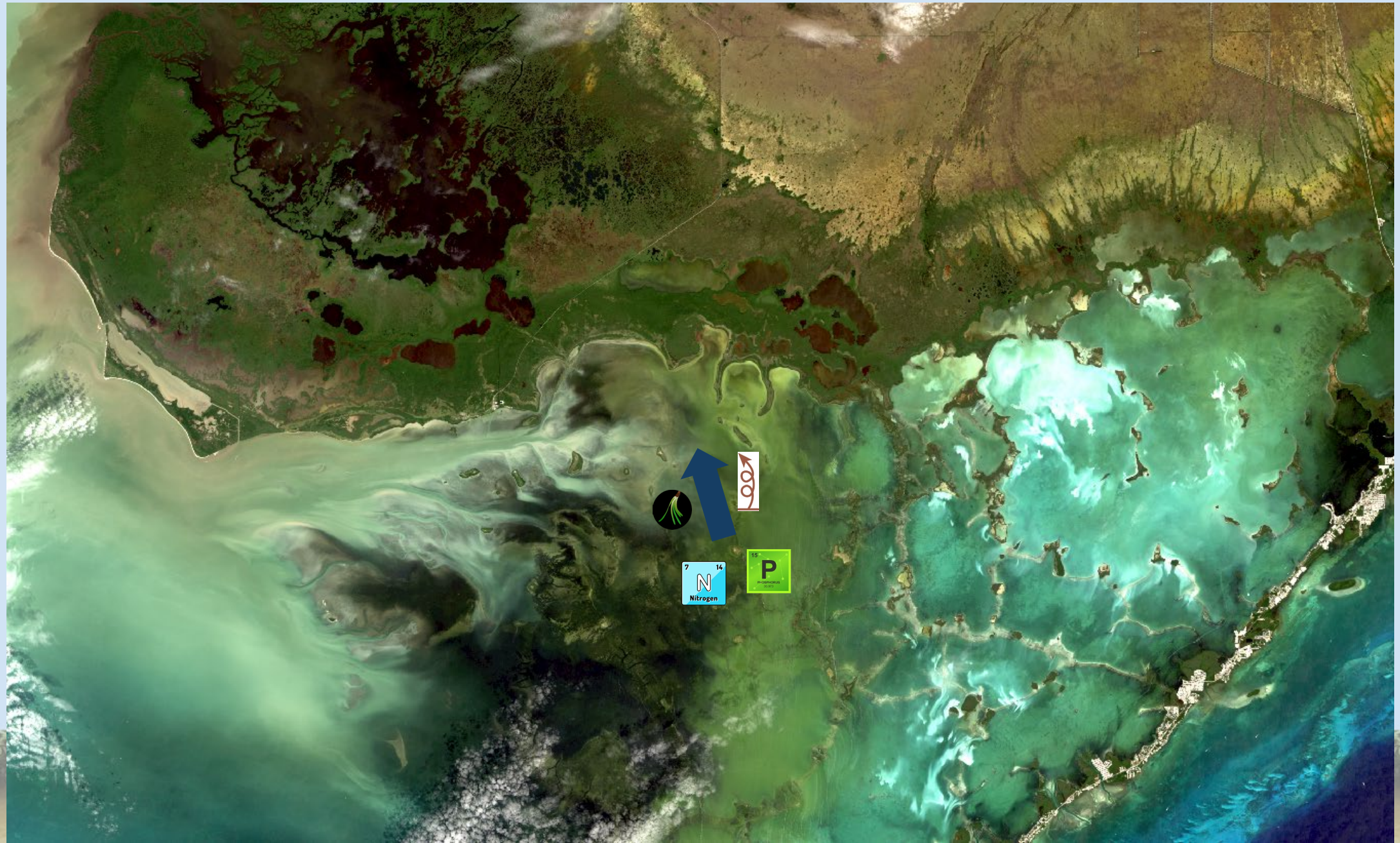
1. Are the nutrients causing the Florida Bay algal bloom derived from **sources inside or outside of Florida Bay?**

2. If the nutrients are derived from sources outside of Florida Bay, is the origin **upstream marshes, the coastal lakes system, areas of mangrove dieback, and/or the Gulf of Mexico**?

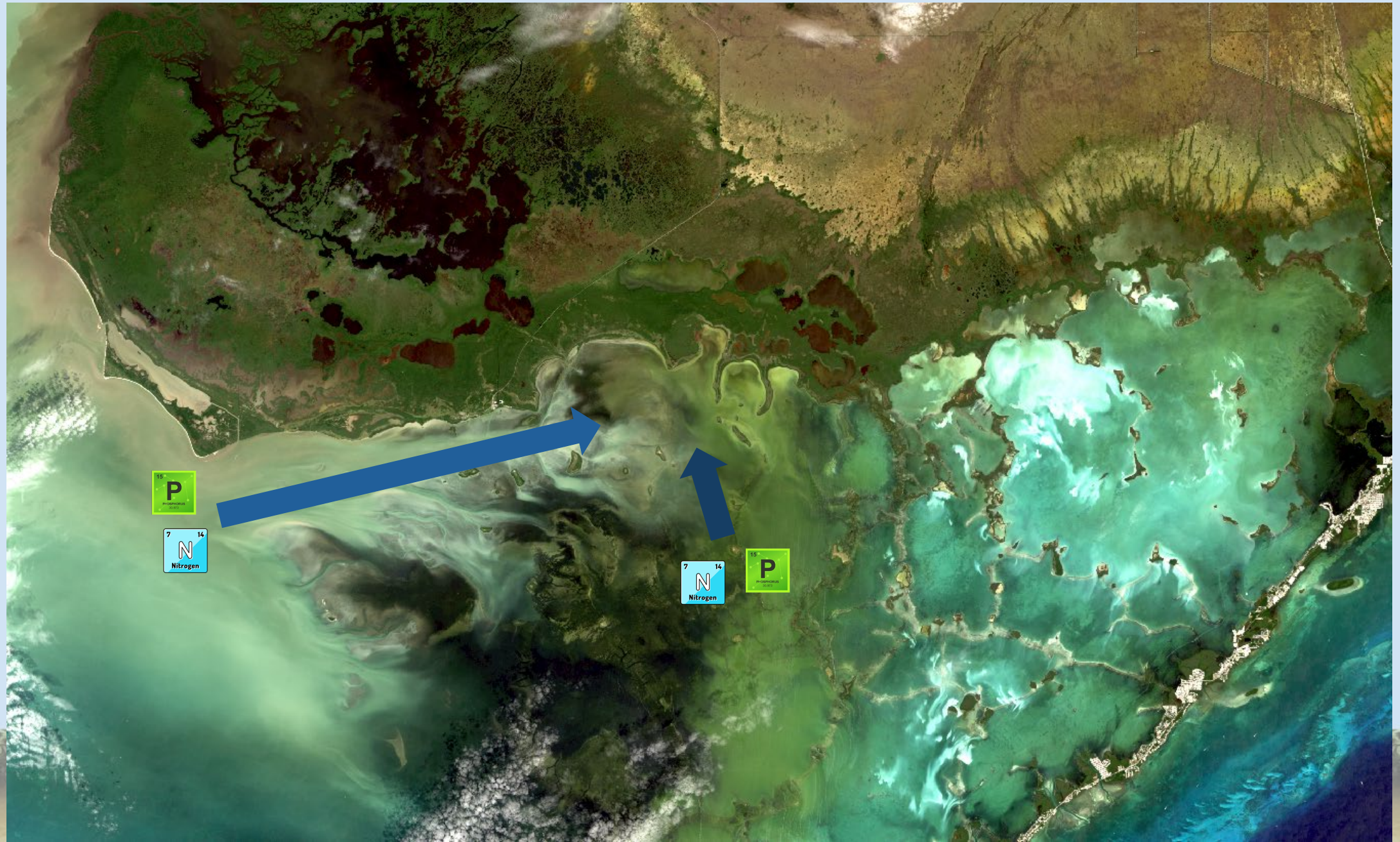
The Hypotheses



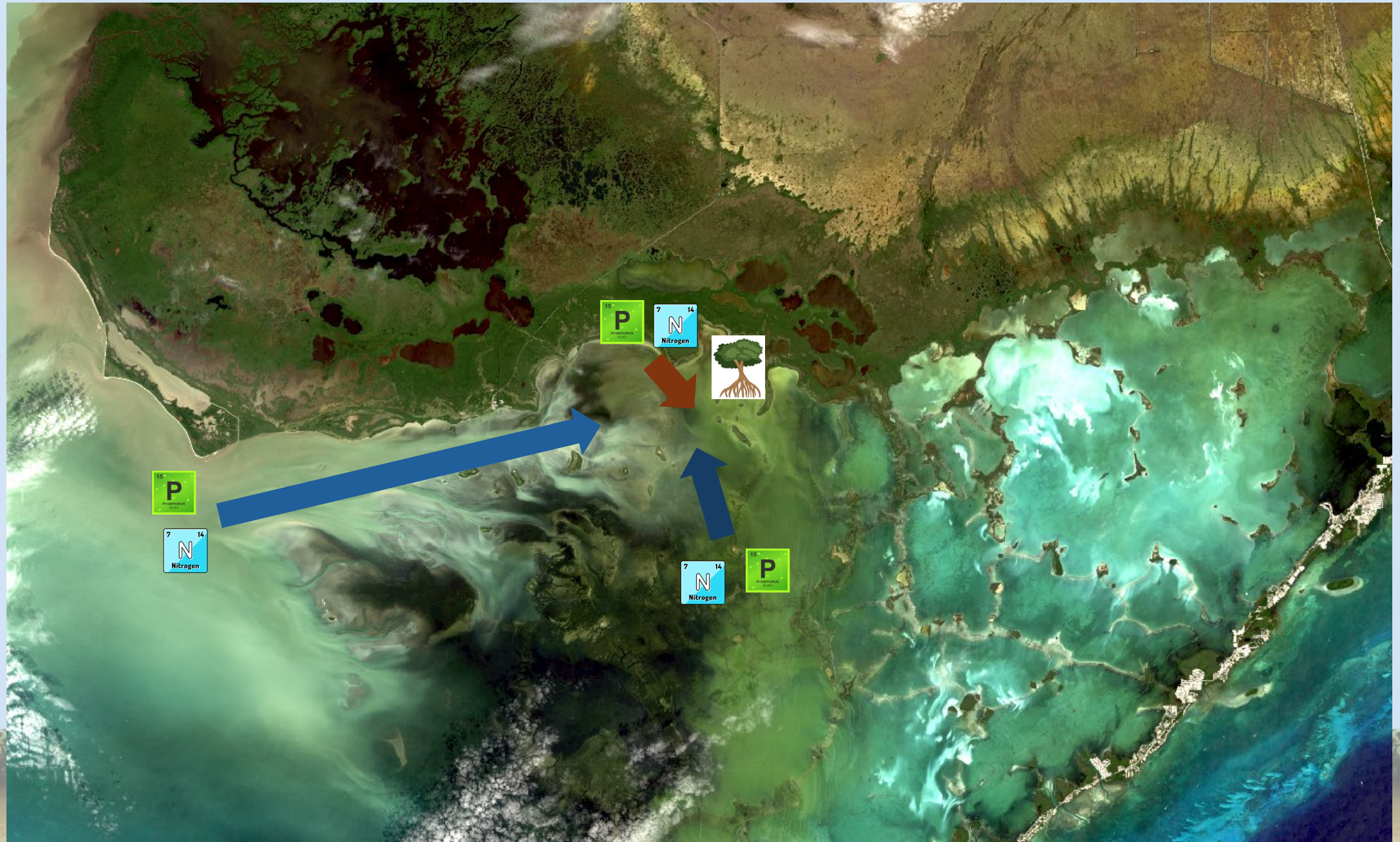
The Hypotheses



The Hypotheses



The Hypotheses



The Hypotheses

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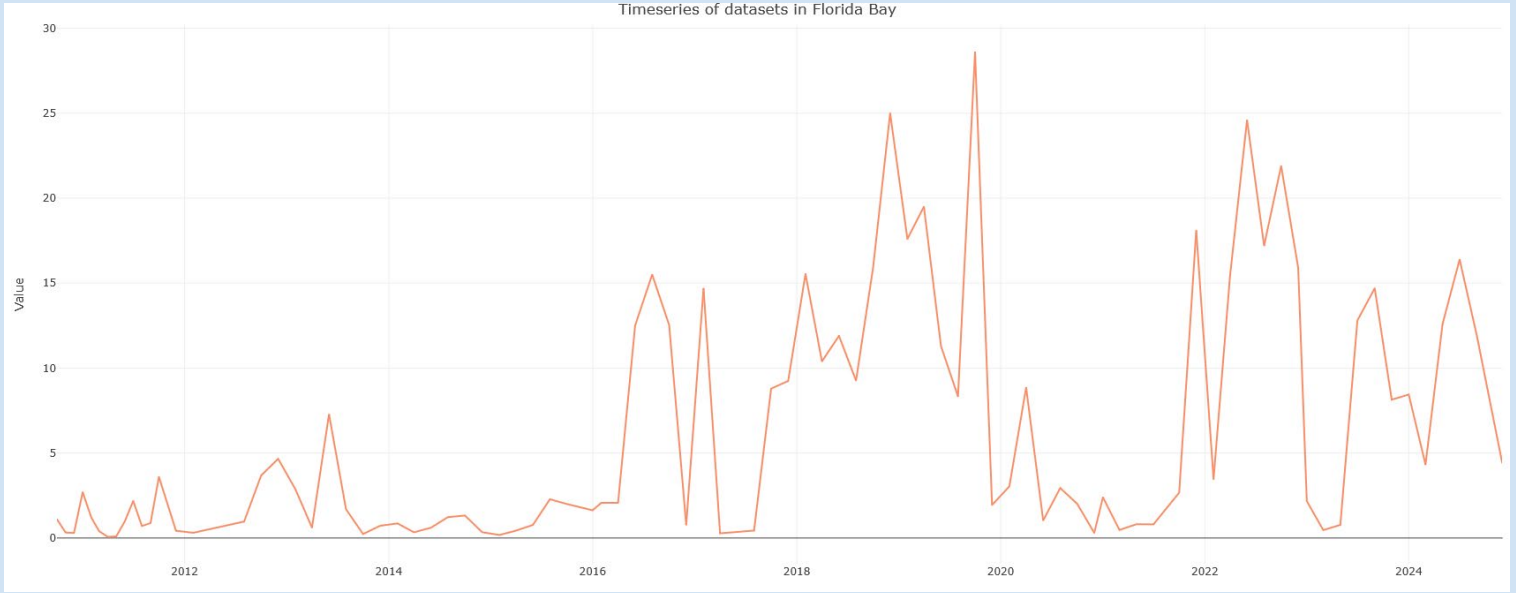
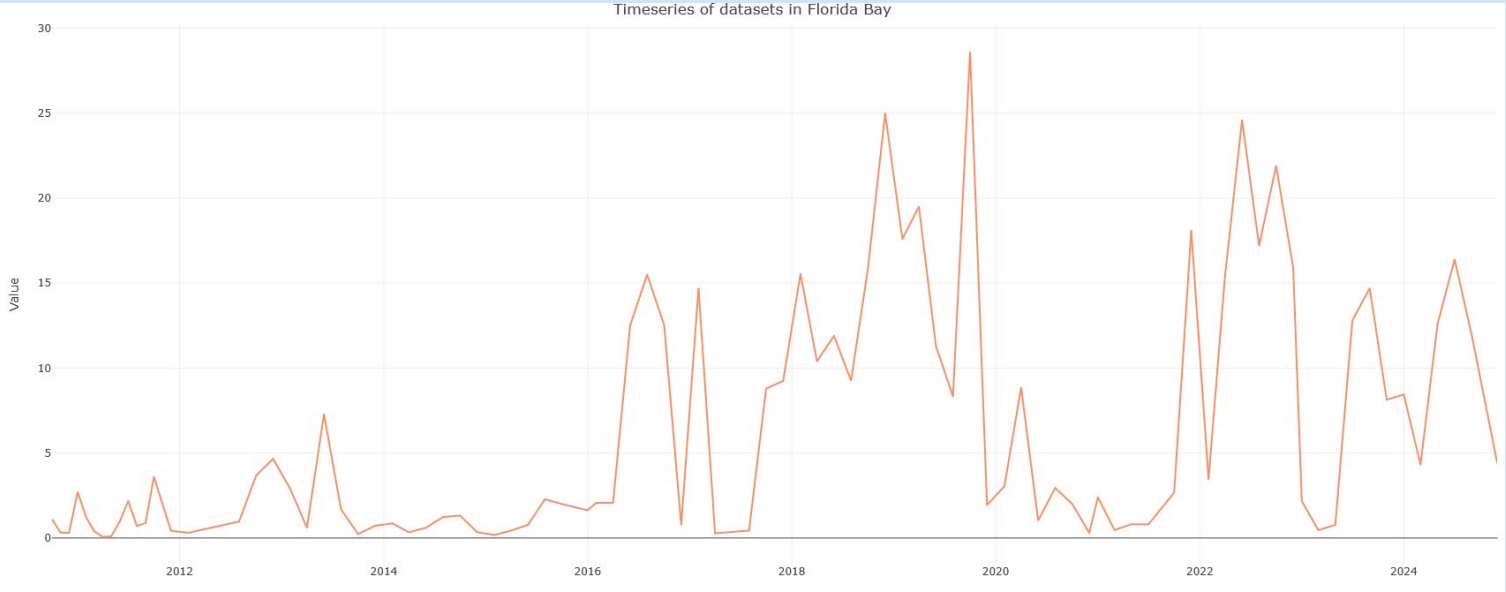
The Approach: Empirical Dynamic Modelling (EDM)

Power of Long-Term Data



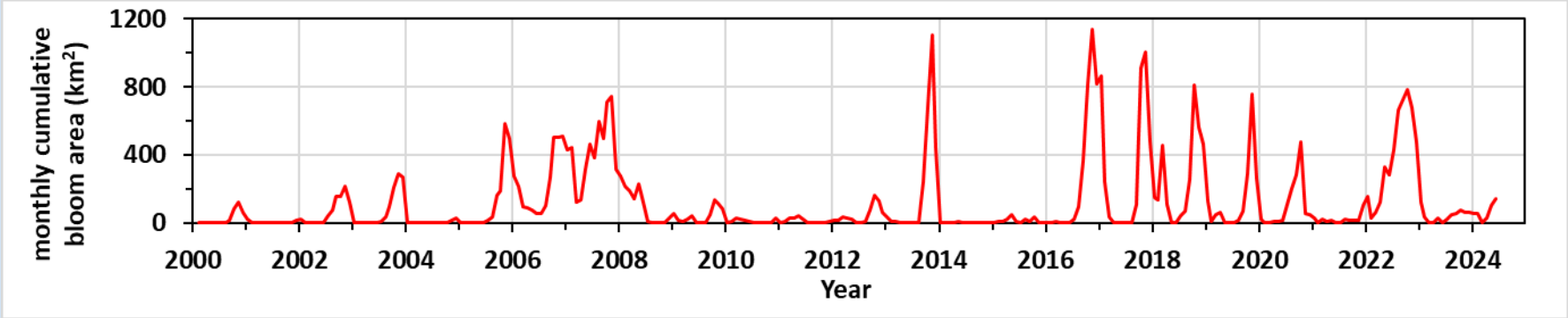
Chlorophyll levels via grab sampling

Power of Long-Term Data

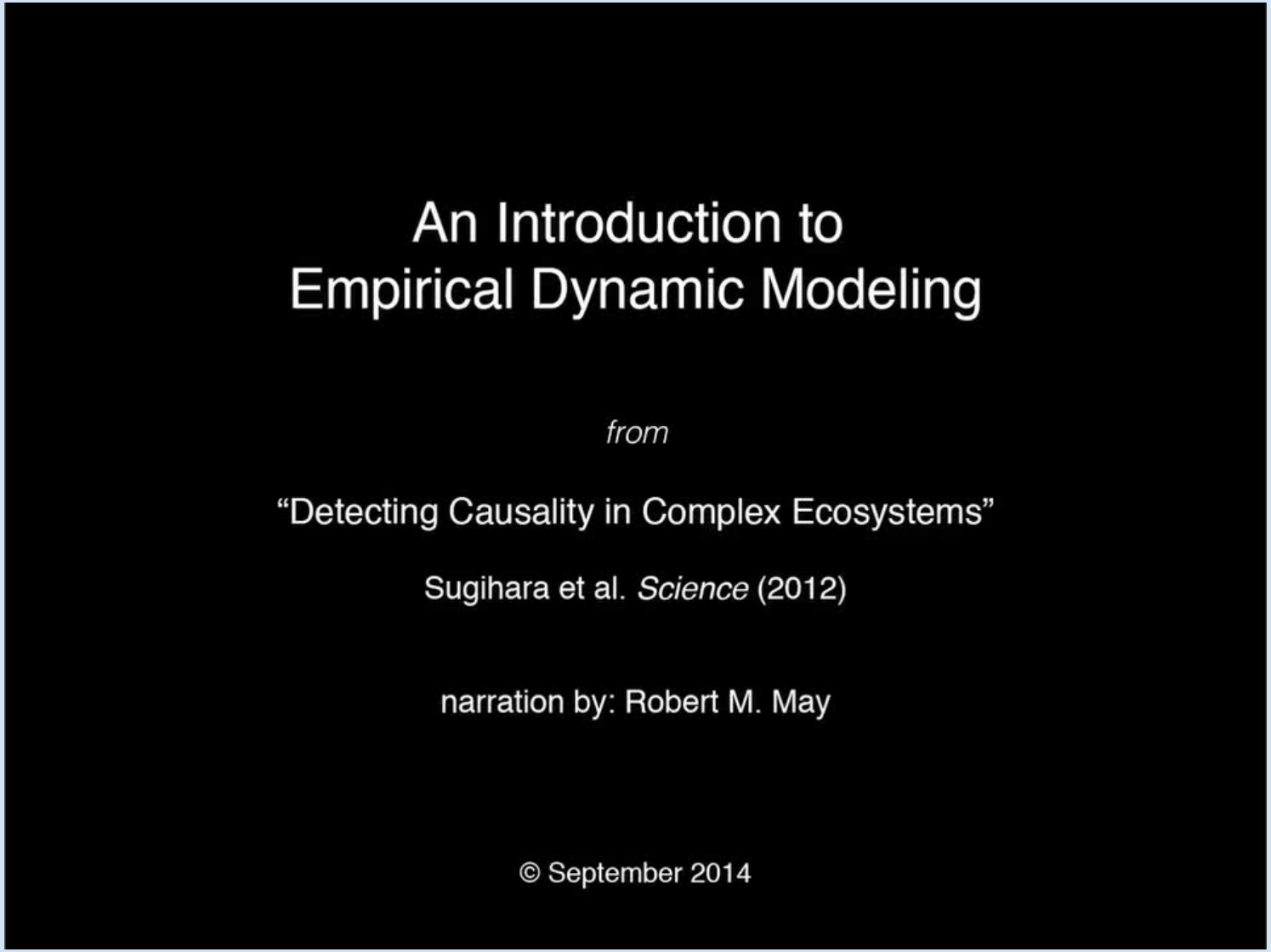


Chlorophyll levels via grab sampling

Bloom area via remote sensing



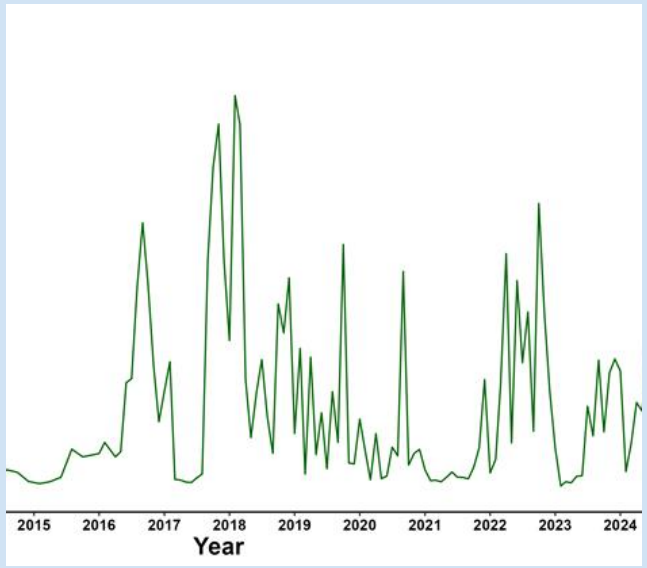
The Approach: EDM



Sugihara et al., 2012 Science, Medina et al., 2020 Sci Tot En

Methodology

The Approach: EDM

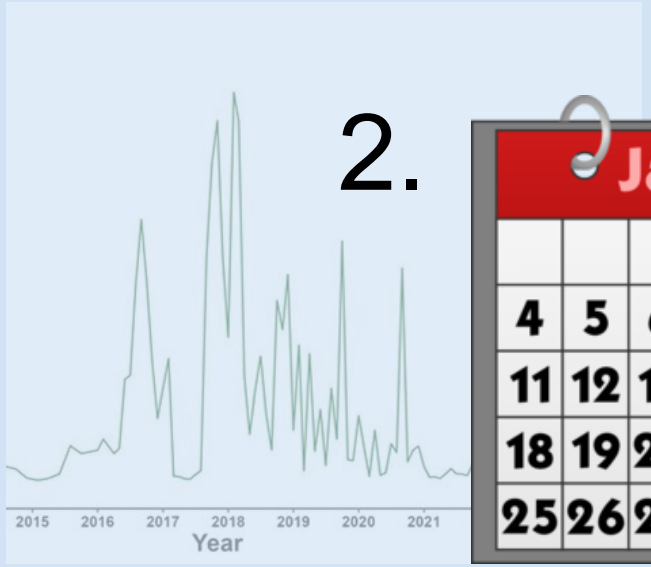
1. 

Crop time series to 2015 - 2023

Methodology

The Approach: EDM

1.



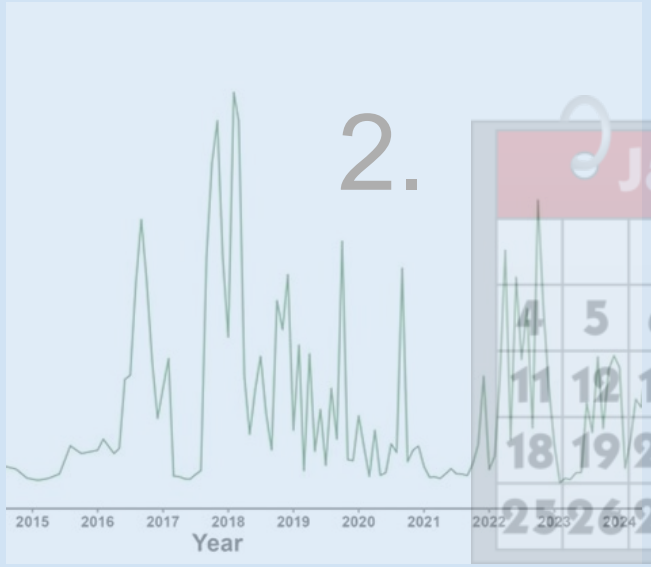
2.

Average data to monthly

Methodology

The Approach: EDM

1.



2.

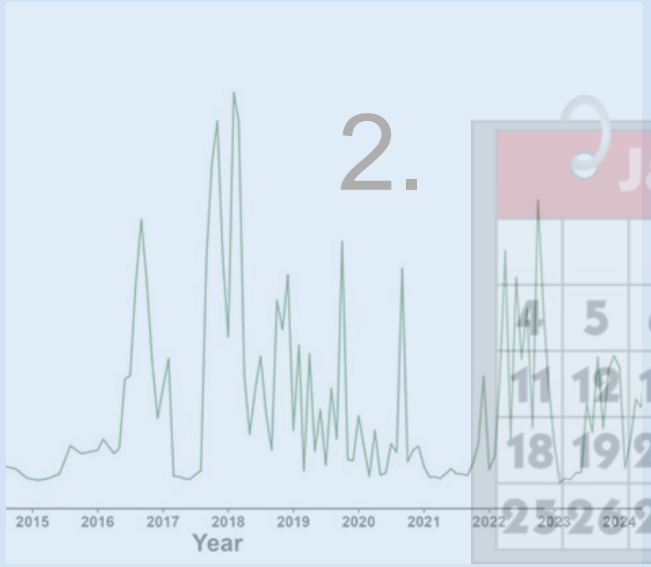
3.

Interpolate missing values

Methodology

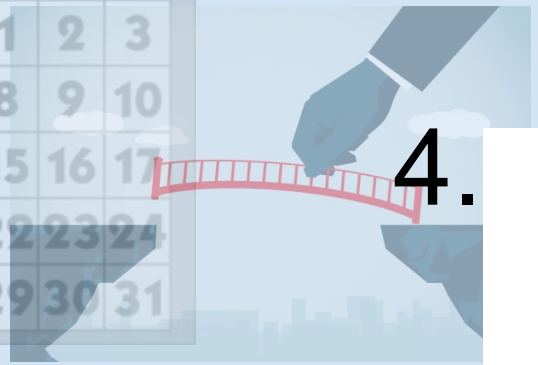
The Approach: EDM

1.



2.

3.



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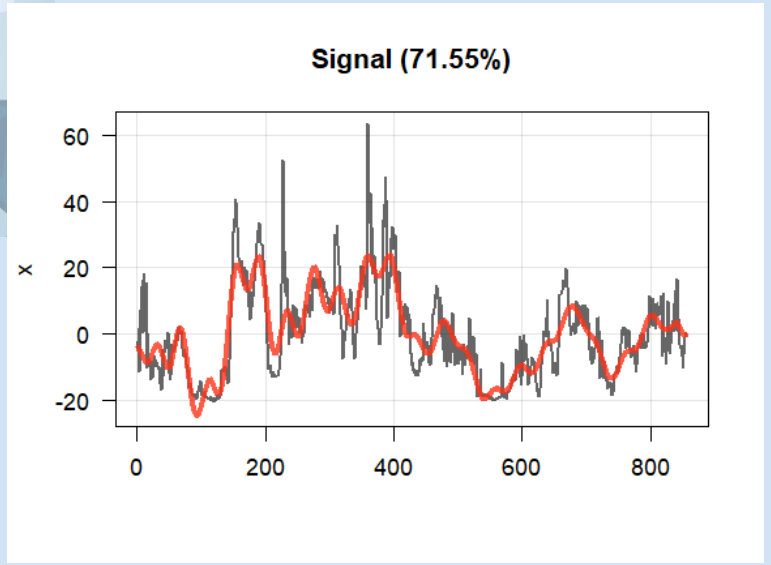


Isolate temporal signal

Methodology

The Approach: EDM

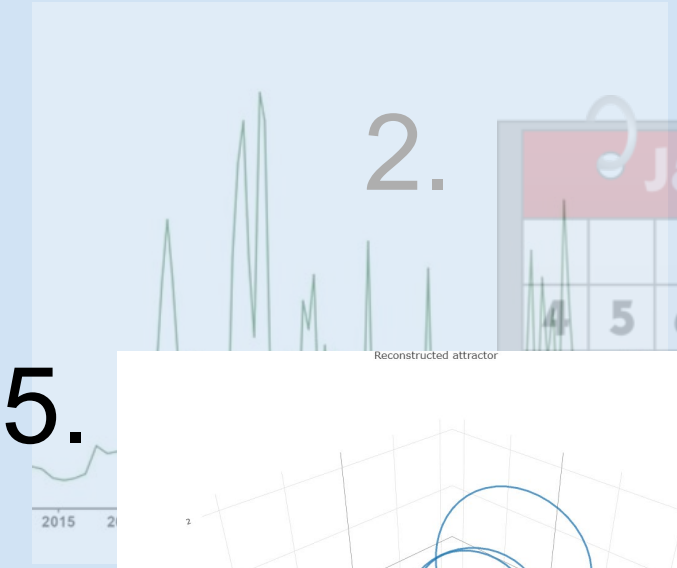
1.

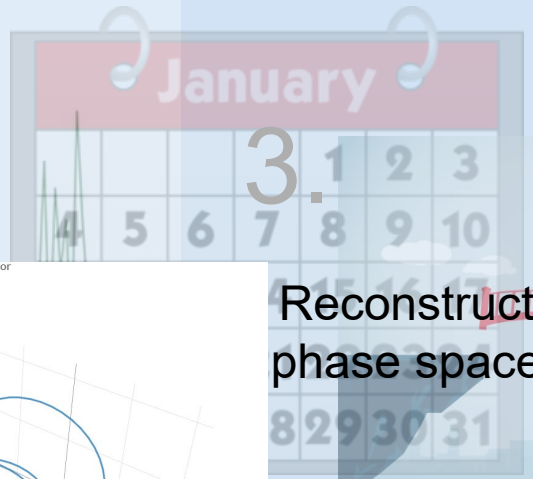
2.

3.

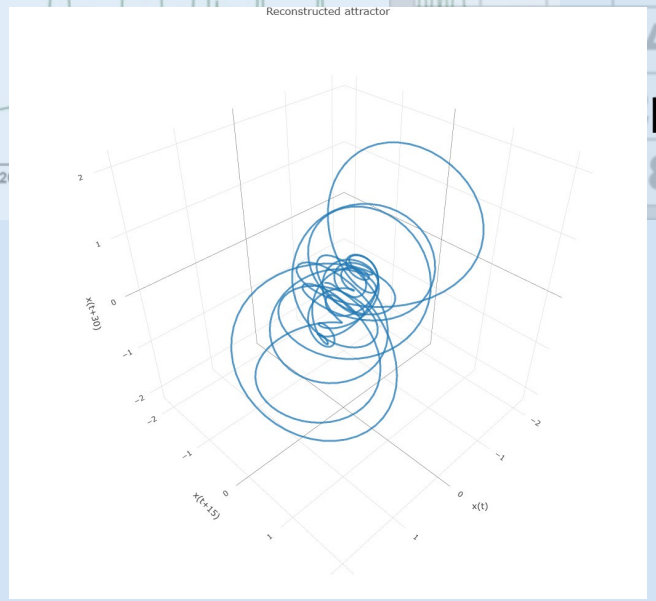
4.

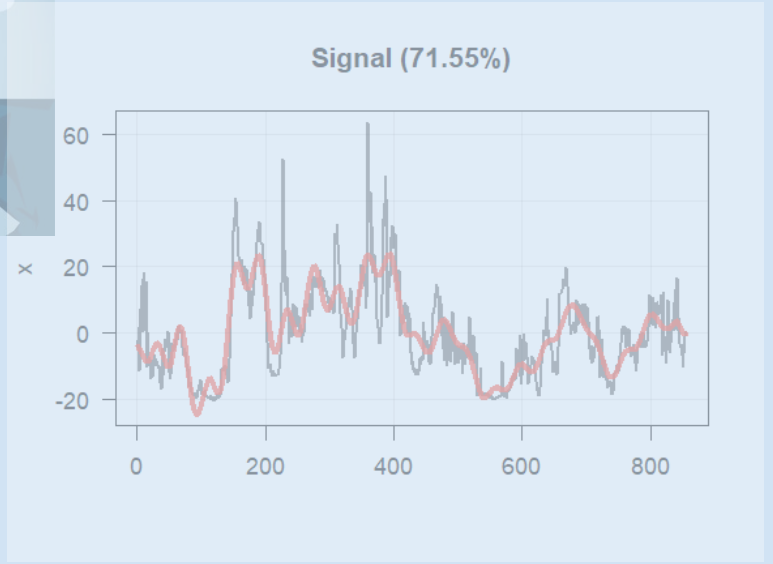
5.





Reconstruct phase space

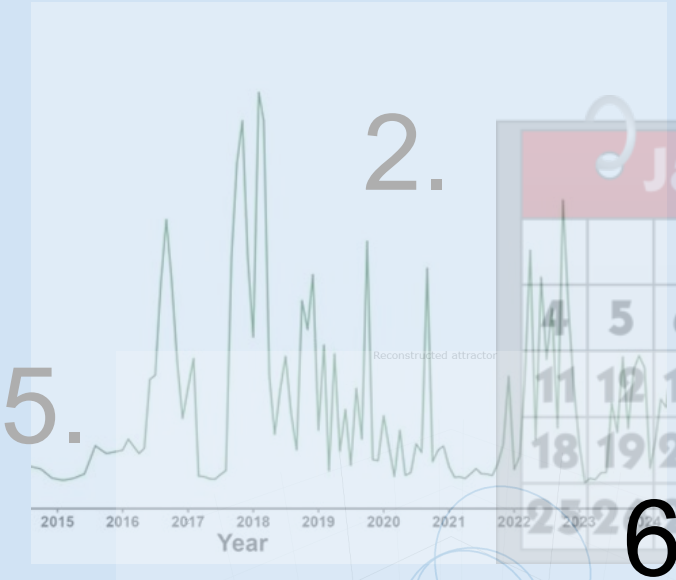




Methodology

The Approach: EDM

1.



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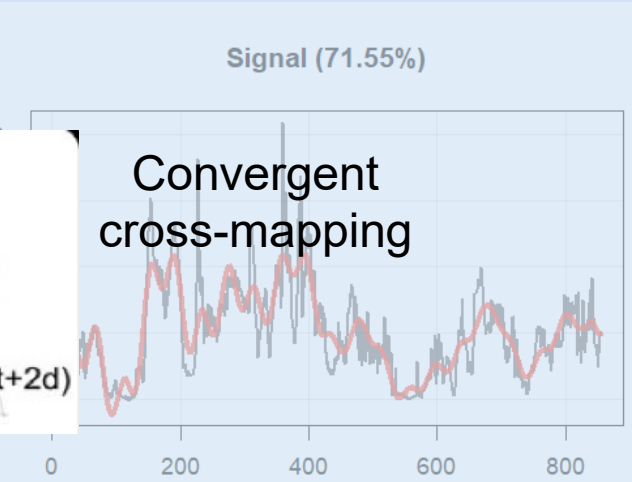

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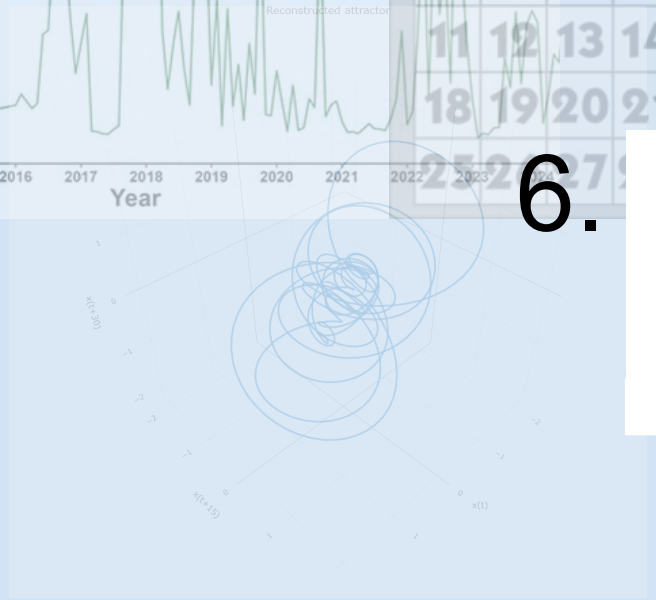

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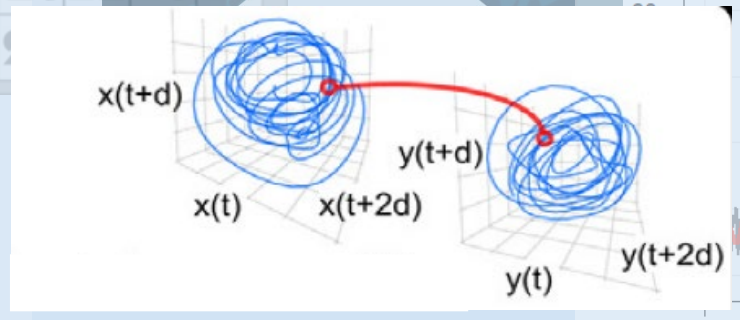


Convergent cross-mapping

The **Preliminary** Results

Progress so far

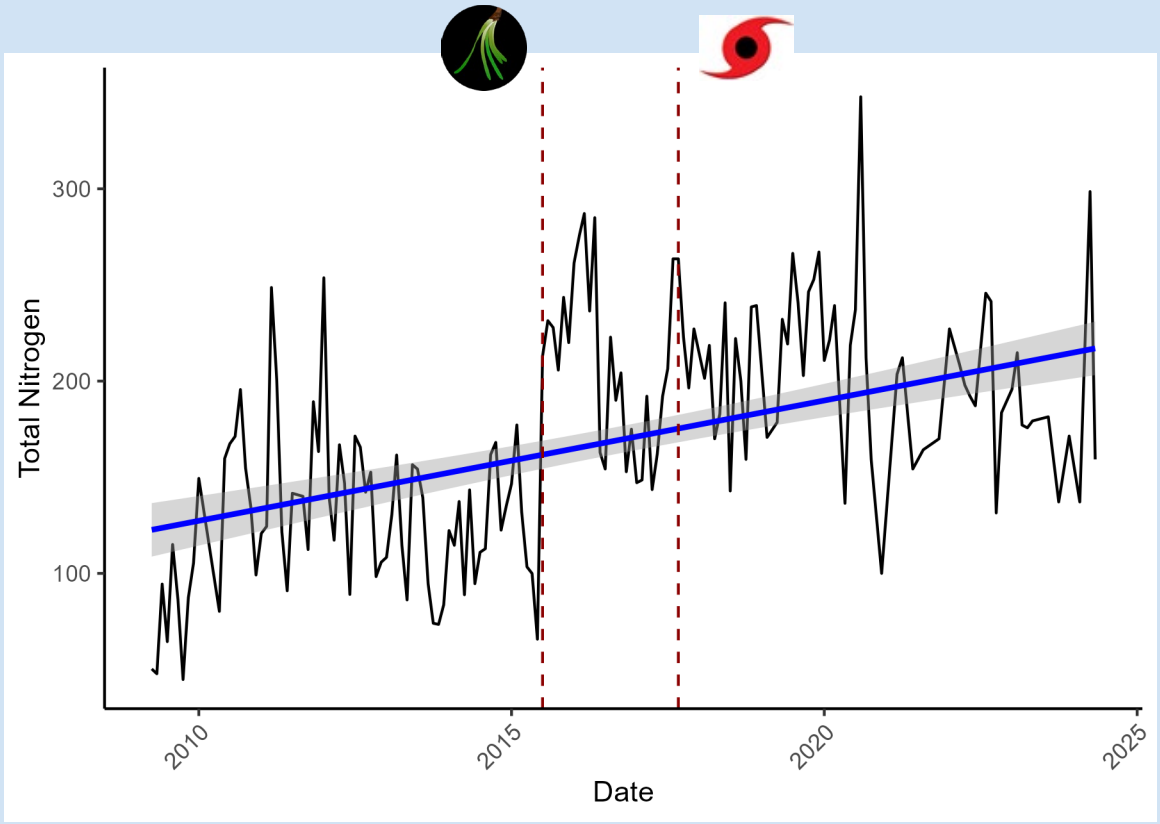
The **Preliminary** Results

- Total samples collected: **1,784**
- Total samples submitted: **1,444**
- Total datasets downloaded and standardized: **108**

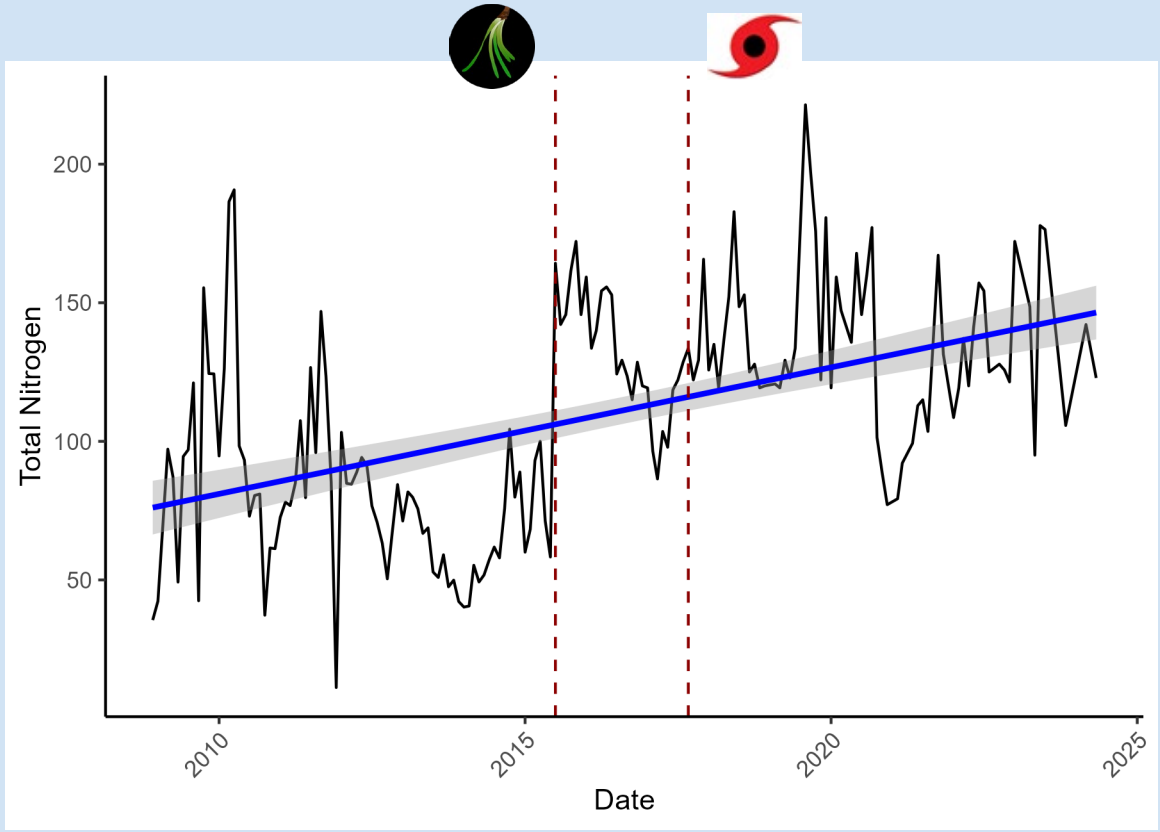
Total Nitrogen ↑

The **Preliminary** Results

Alligator Creek



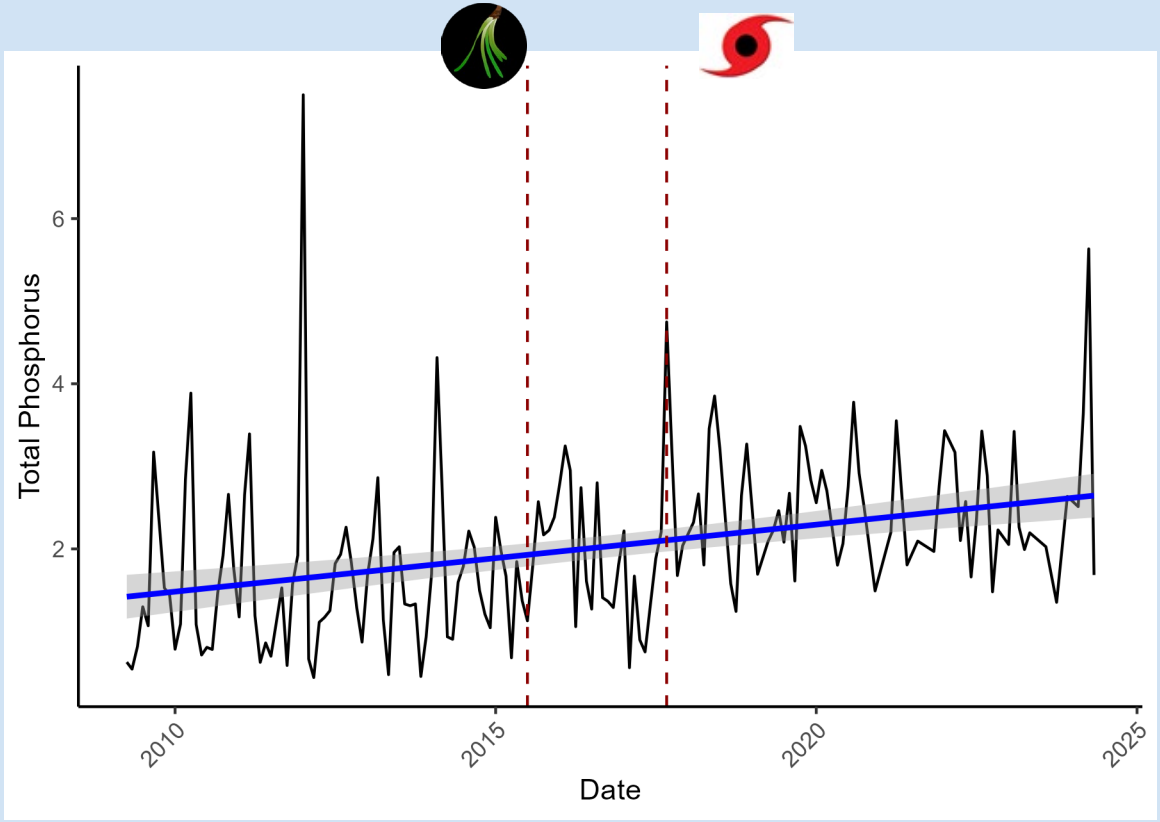
McCormick Creek



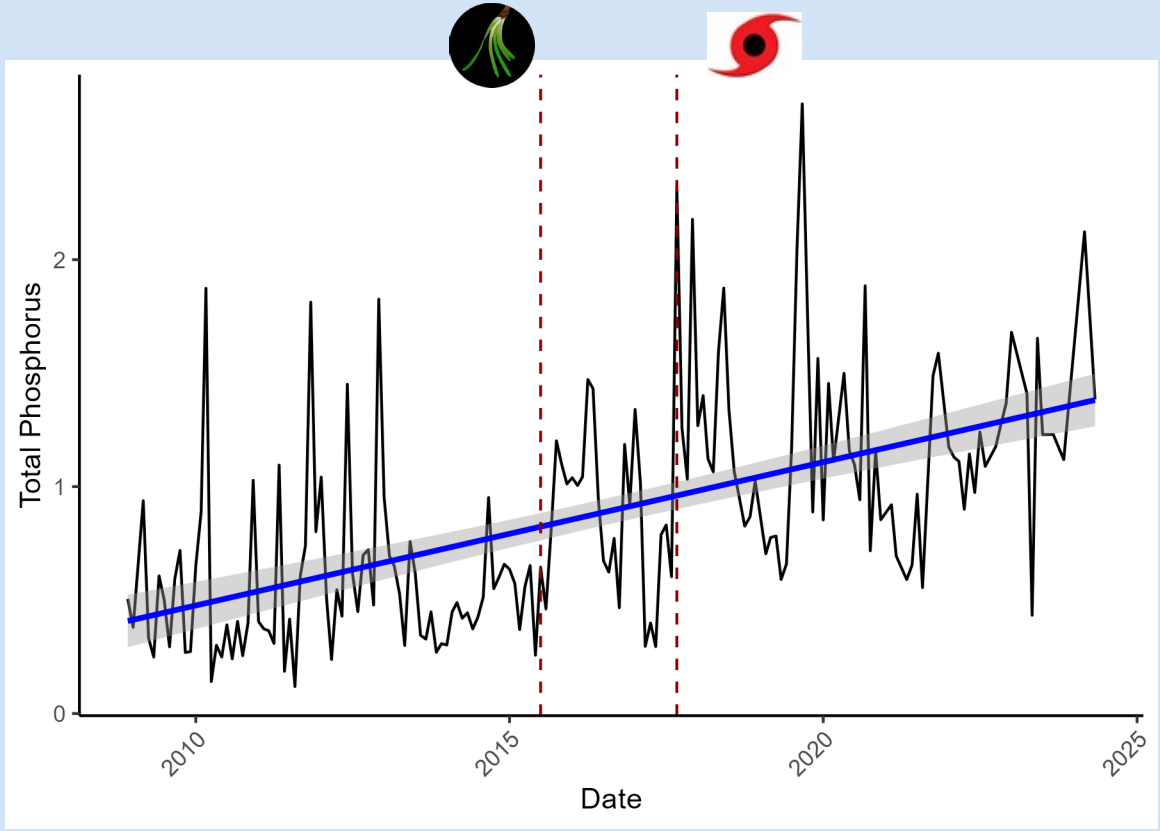
Total Phosphorus ↑

The **Preliminary** Results

Alligator Creek



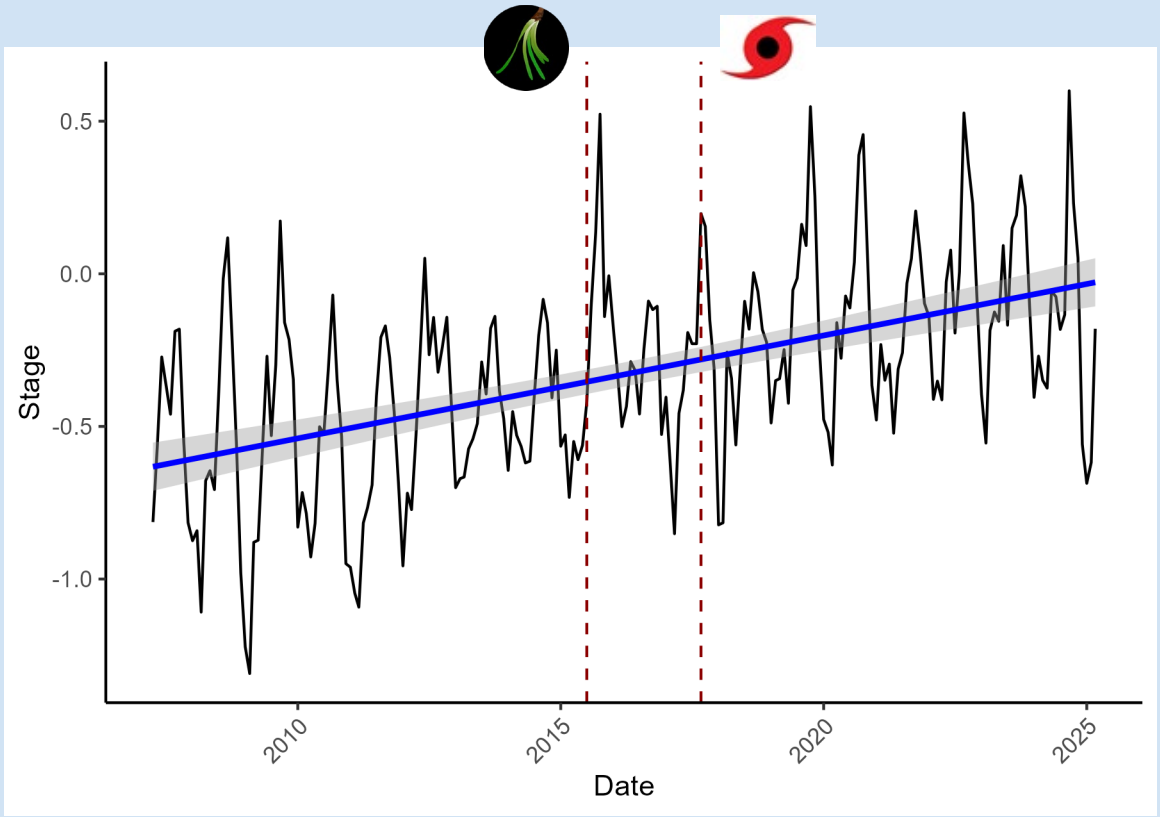
McCormick Creek



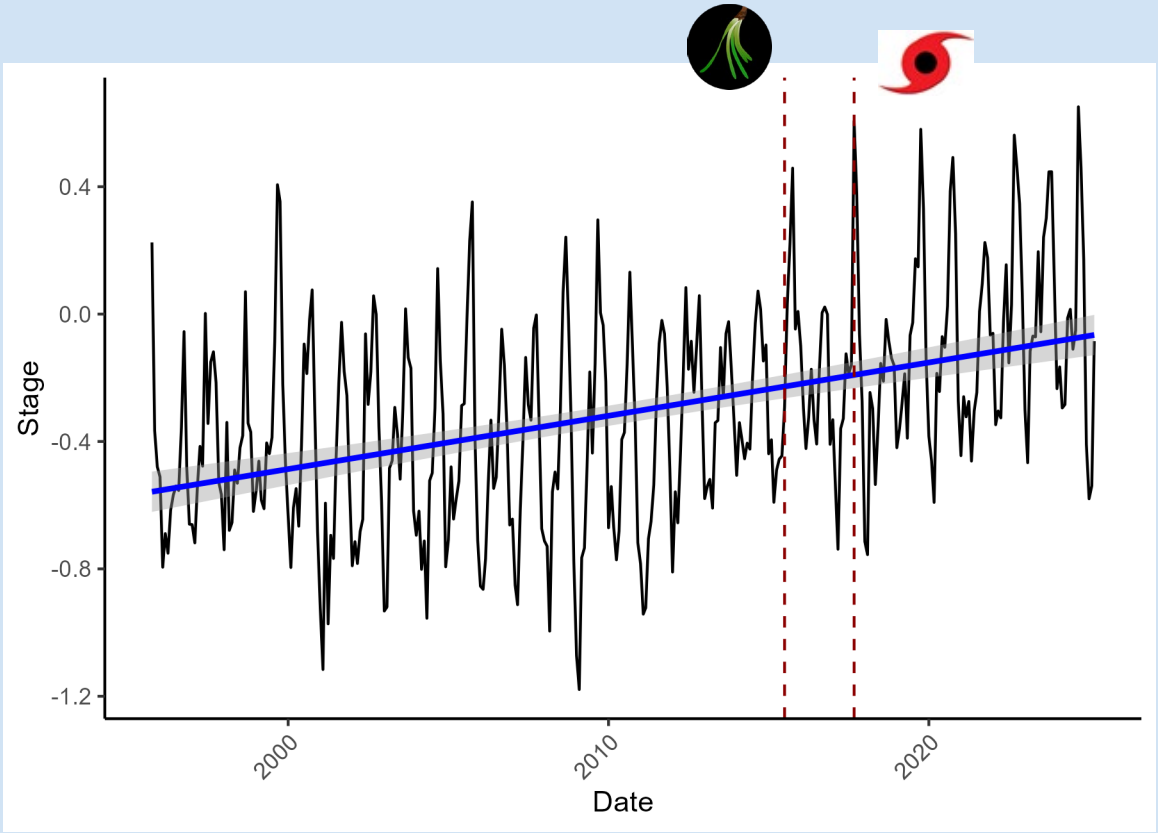
Stage ↑

The **Preliminary** Results

Alligator Creek



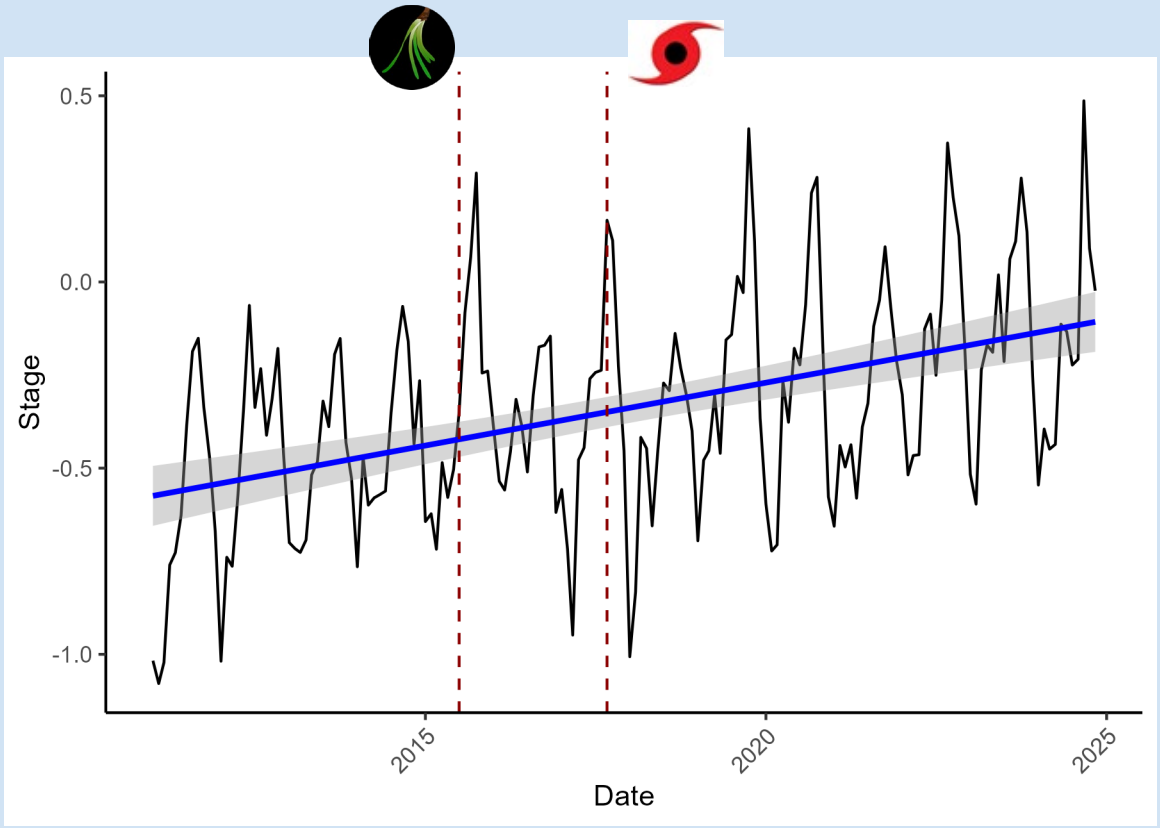
McCormick Creek



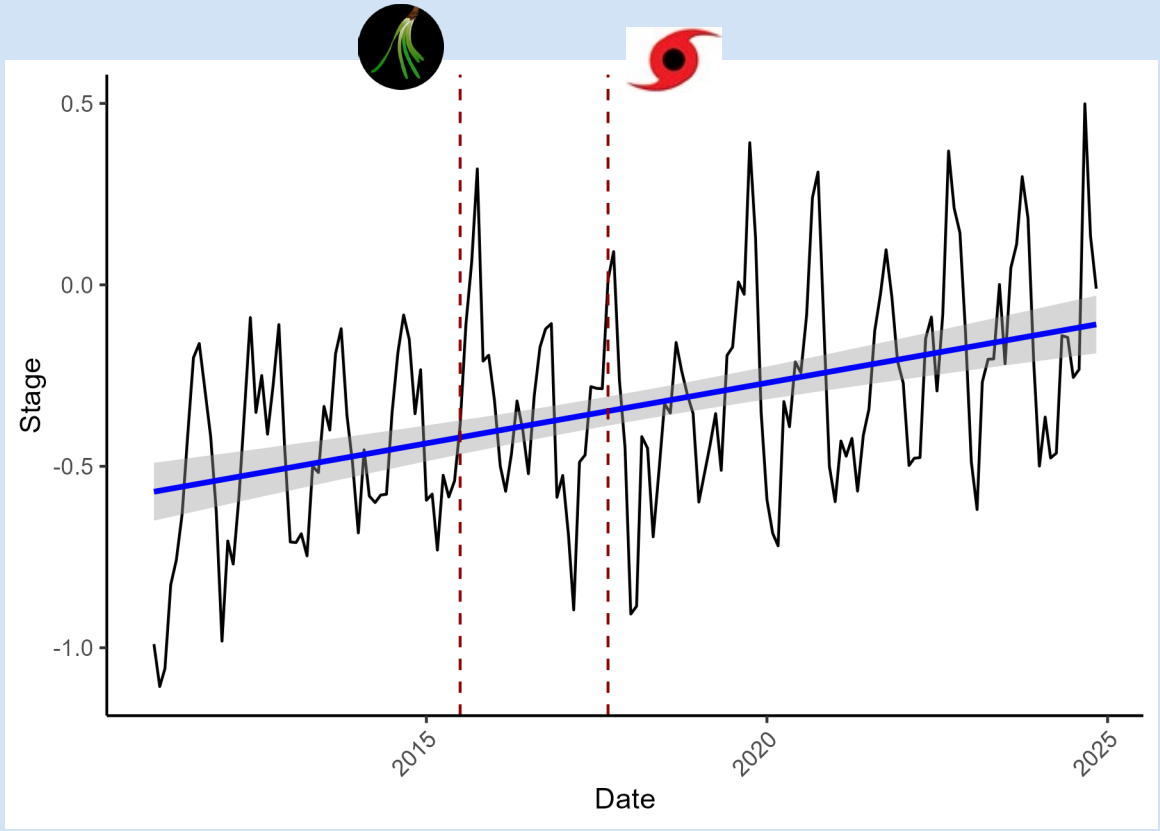
Stage ↑

The **Preliminary** Results

Garfield Bight



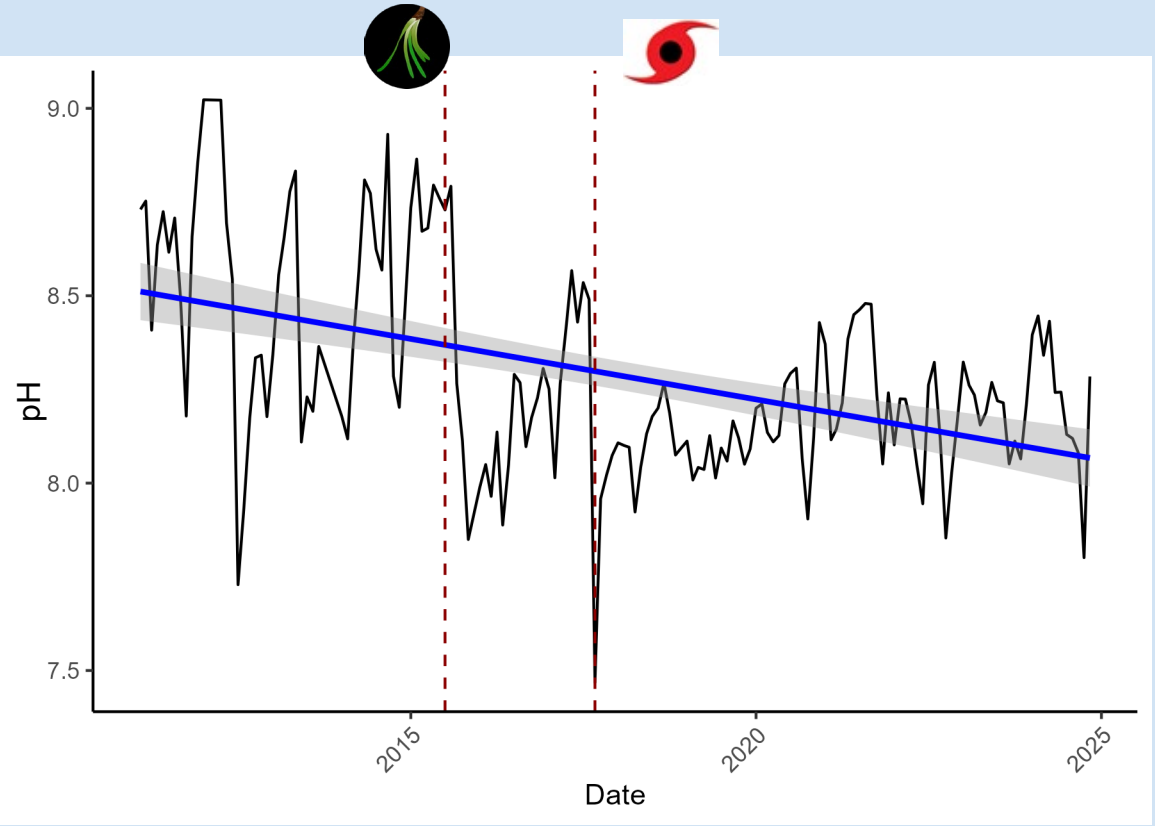
Terrapin Bay



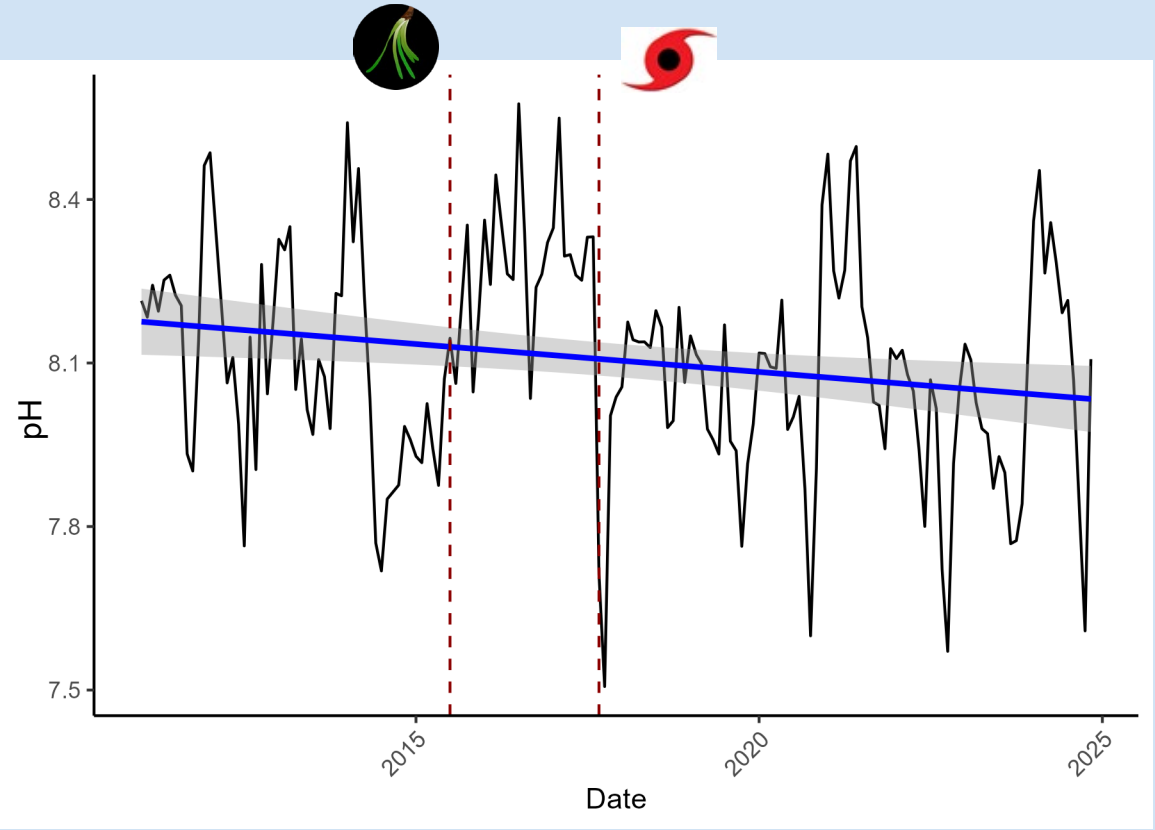
pH ↓

The **Preliminary** Results

Garfield Bight



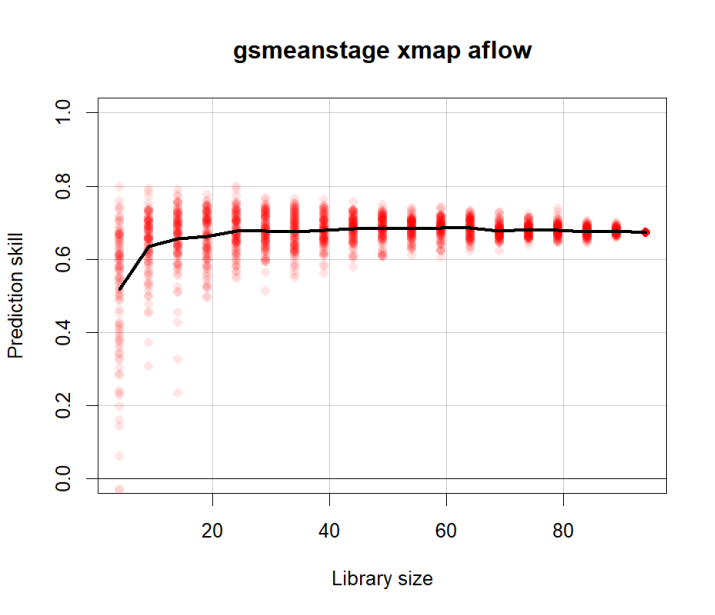
Terrapin Bay



Causality

The **Preliminary** Results

Flow out of Alligator drives Mean Stage in Garfield



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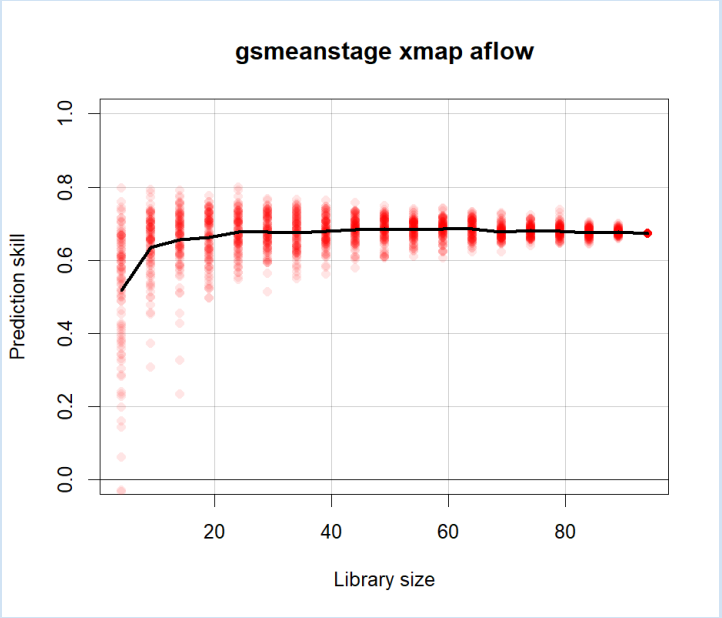
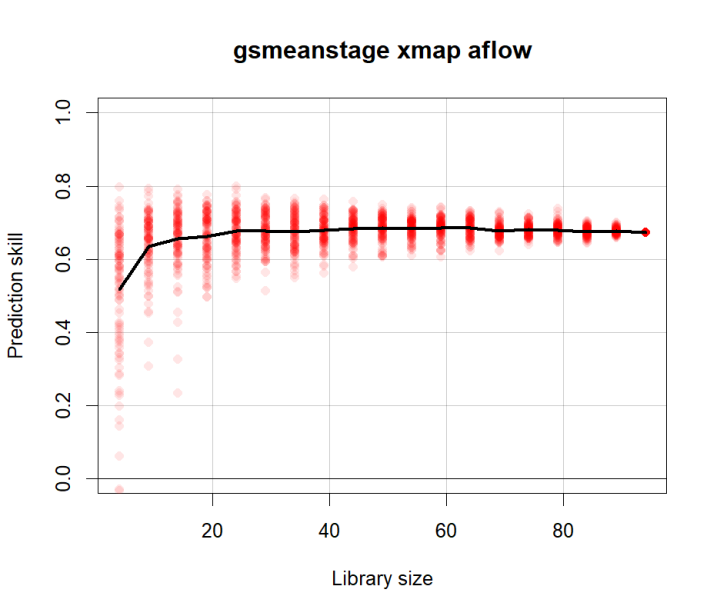


Mean Stage in Garfield drives Total Nitrogen in Garfield

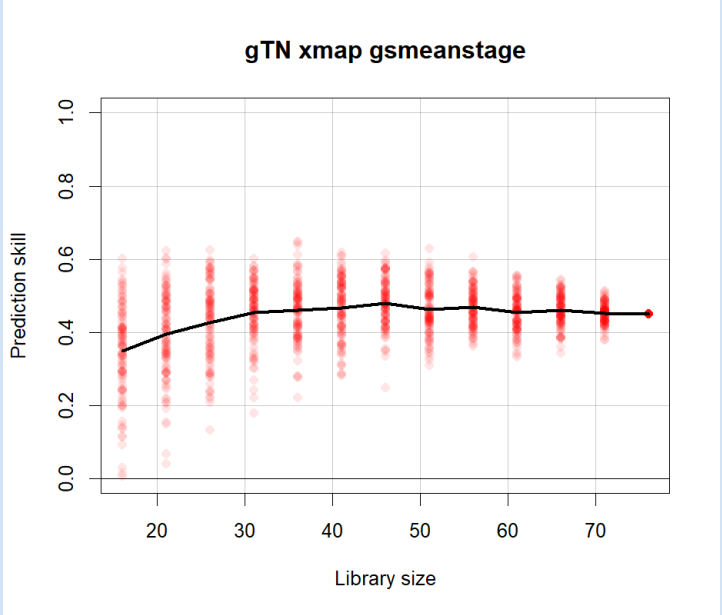
Causality

The **Preliminary** Results

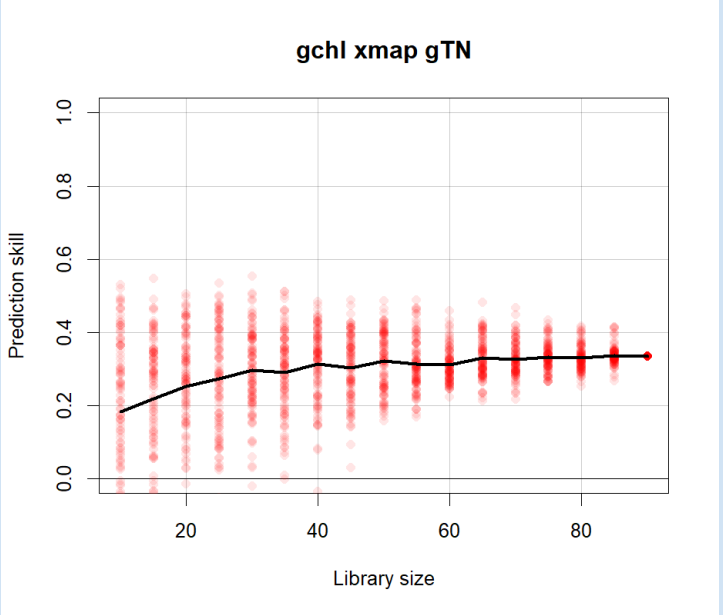
Flow out of Alligator drives Mean Stage in Garfield



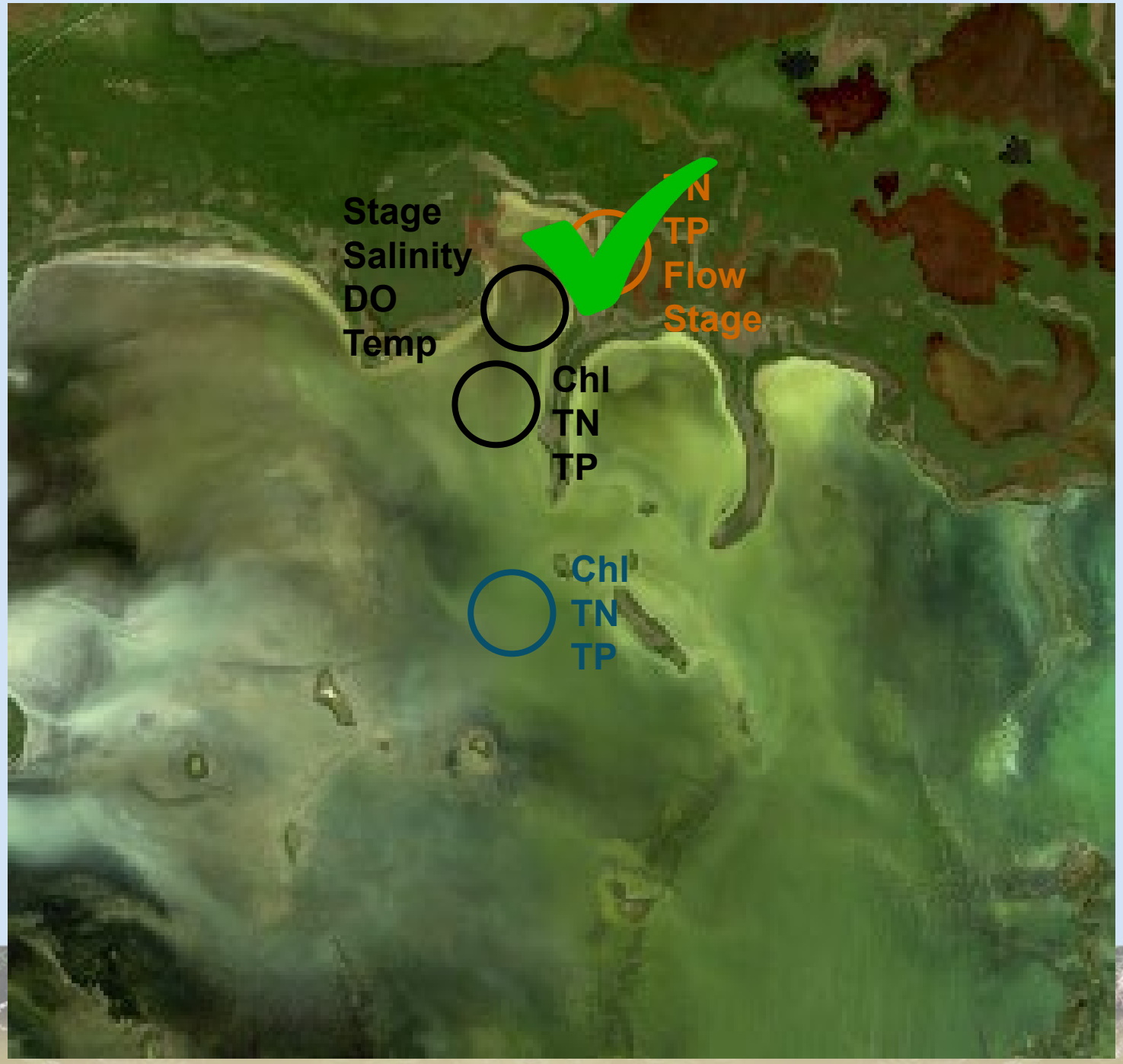
Mean Stage in Garfield drives Total Nitrogen in Garfield



Total Nitrogen in Garfield drives Chlorophyll in Garfield



Causality

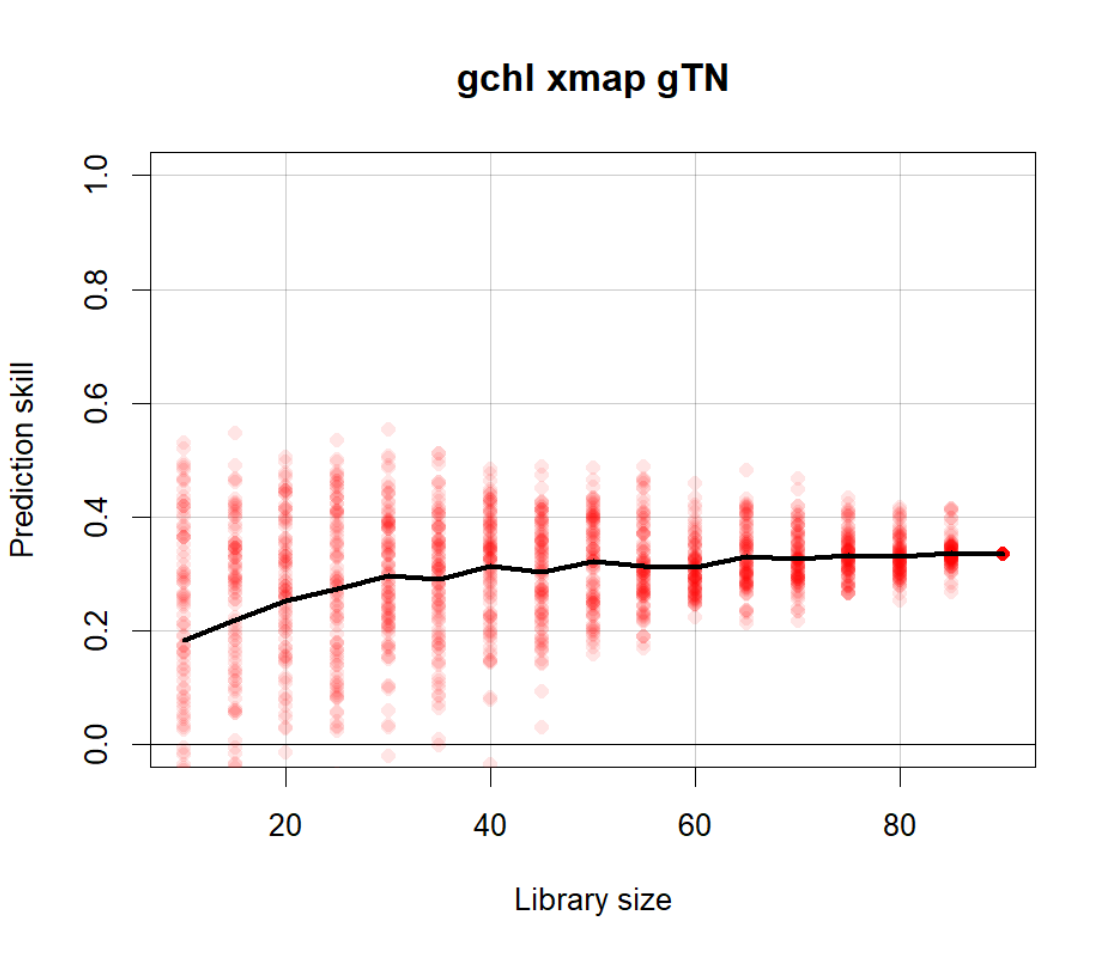


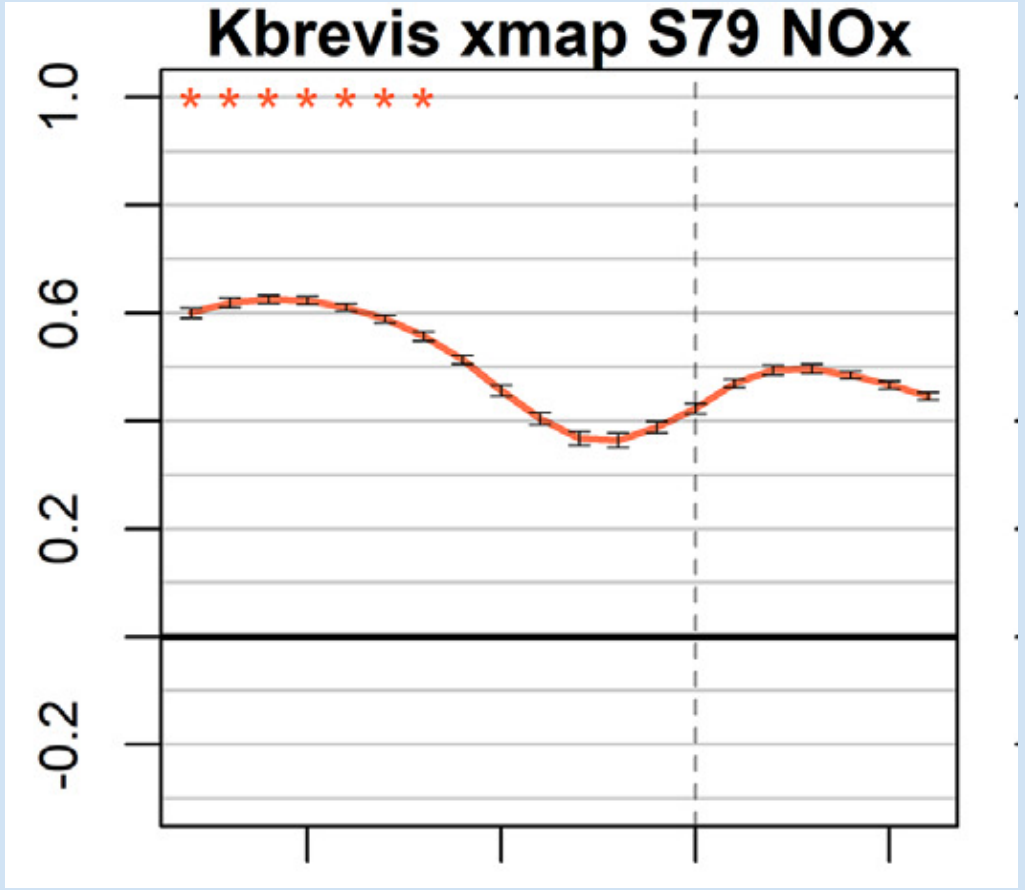
The **Preliminary** Results

- Flow out of lakes is a factor
- Still need to investigate more!

The Next Steps

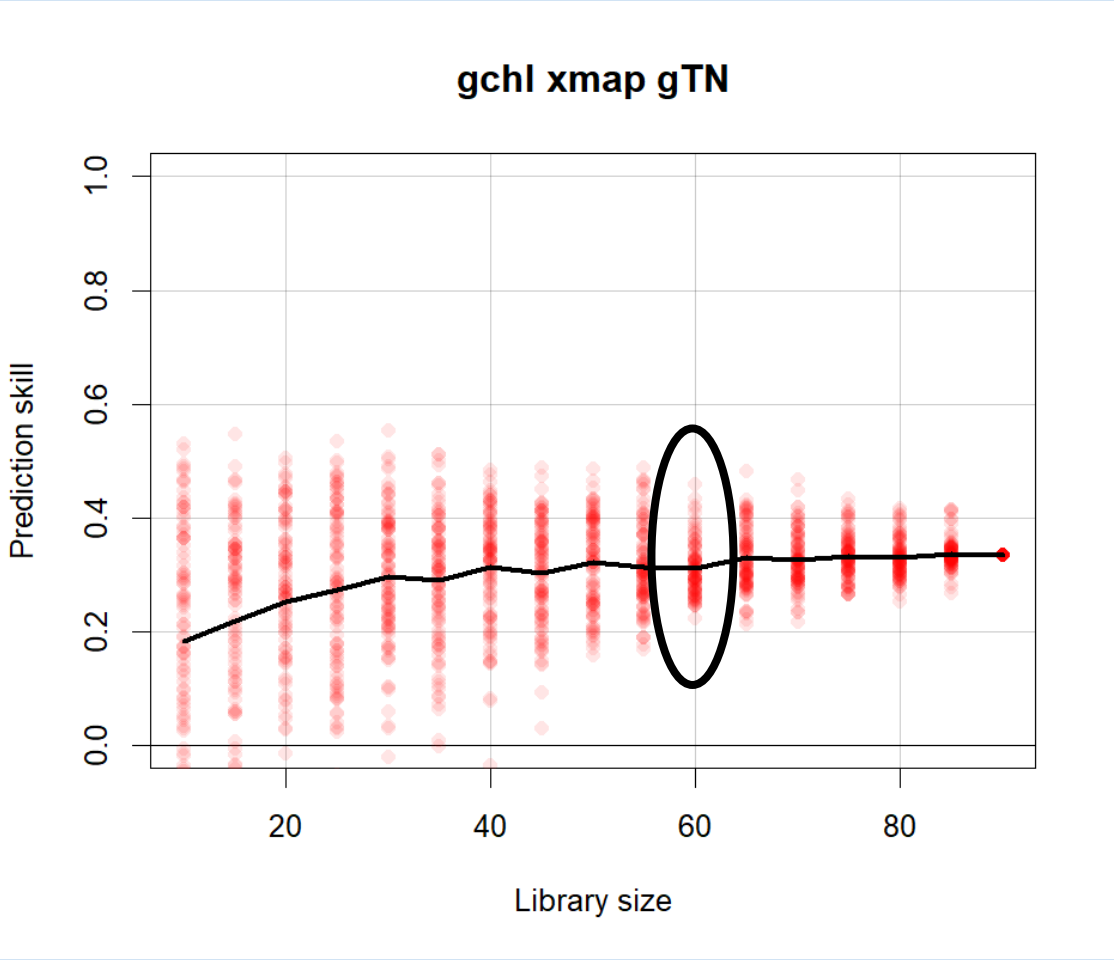
Lag-effect CCM

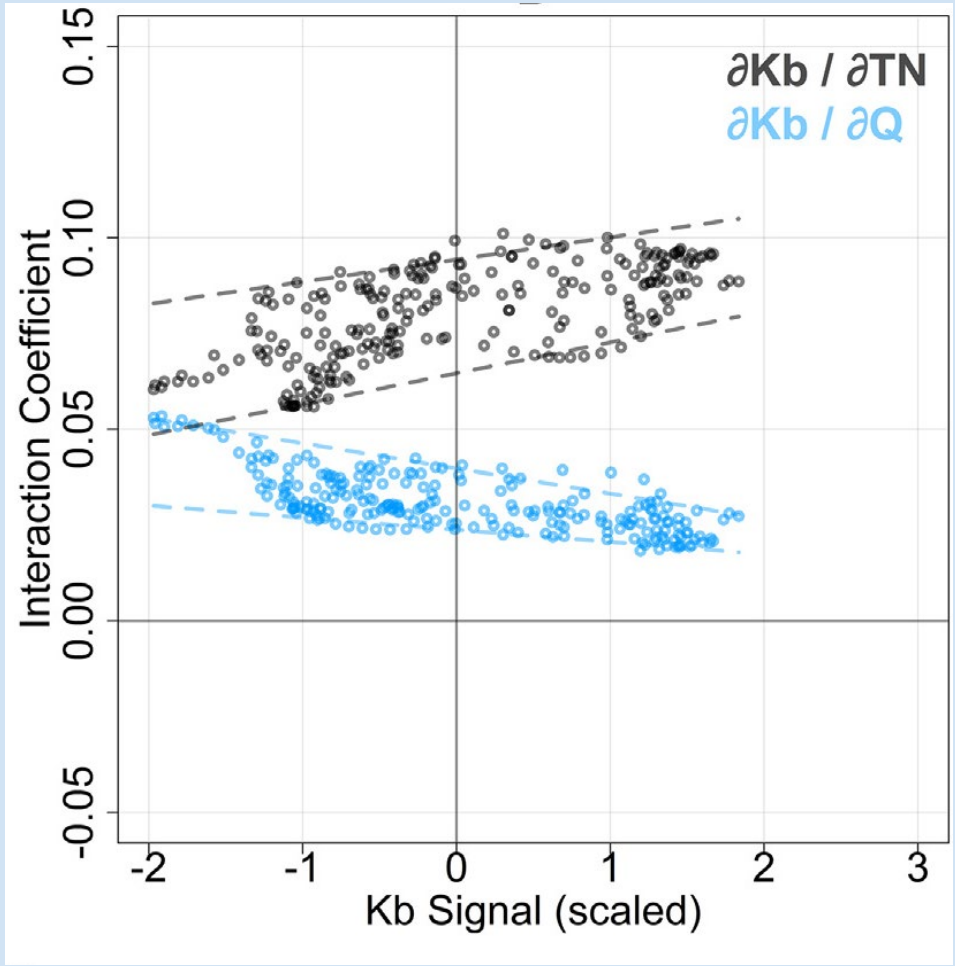




Ye et al., 2015 Sci Rep, Medina et al., 2020 Sci Tot En

S-mapping





Deyle et al., 2016 Proc R Soc B Biol Sci, Medina et al., 2020 Sci Tot En

Add in other data

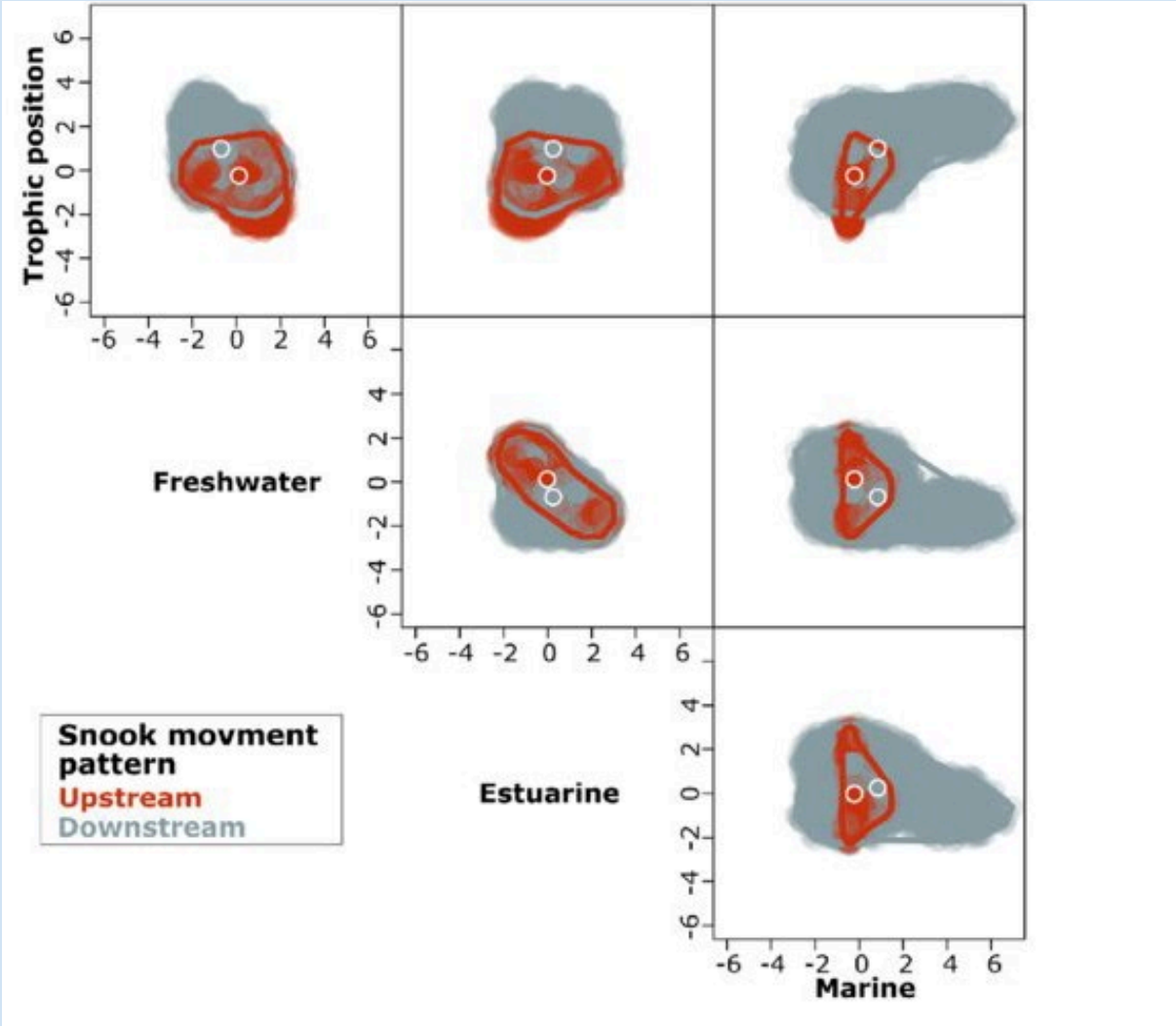
Stable Isotope Analysis

$\delta^{13}C$

$\delta^{15}N$

$\delta^{34}S$

The Next Steps



Questions?

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