Quantitative approaches to understand nutrient pollution in estuaries: An example for the upper San Francisco Estuary

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Evaluating estuarine condition

How do we collect and use data?

The foundation of environmental management is a strong monitoring network [National Research Council, 1990]

Monitoring provides information for decision-making based on apparent trends...

What are the changes in environmental condition over time?

Are these changes 'good' or 'bad' based on our management objectives?

What may have caused these changes?

Evaluating estuarine condition

How do we collect and use data?

The good news: We are getting better at monitoring - standardized, automated, increased coverage, real-time/continuous

The bad news: Our ability to use these data for decision-making has not kept pace with availability!

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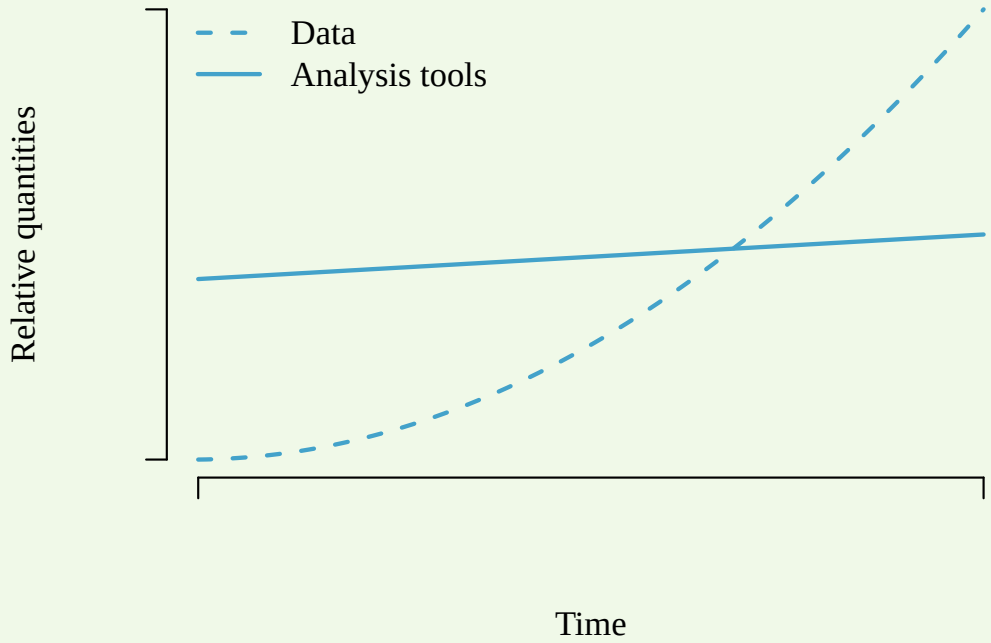

Evaluating estuarine condition

How do we collect and use data?

Most of my research career has focused on using monitoring data to understand effects of eutrophication in one form or another

> *Eutrophication (noun) - an* ***increase*** *in the rate of supply of* ***organic matter*** *to an ecosystem*
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Adapted from [Cloern, 2001]

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Nutrient Loading

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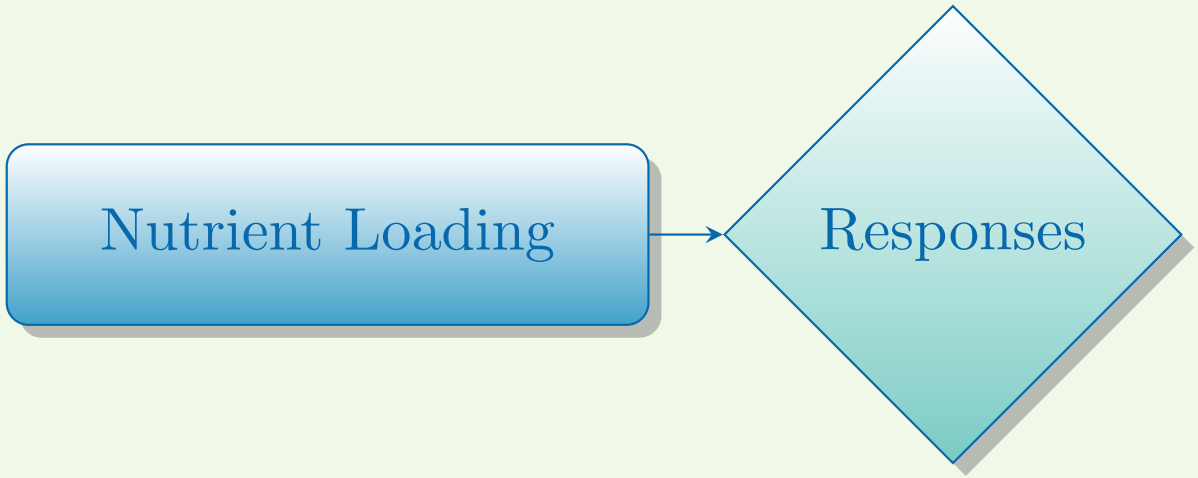

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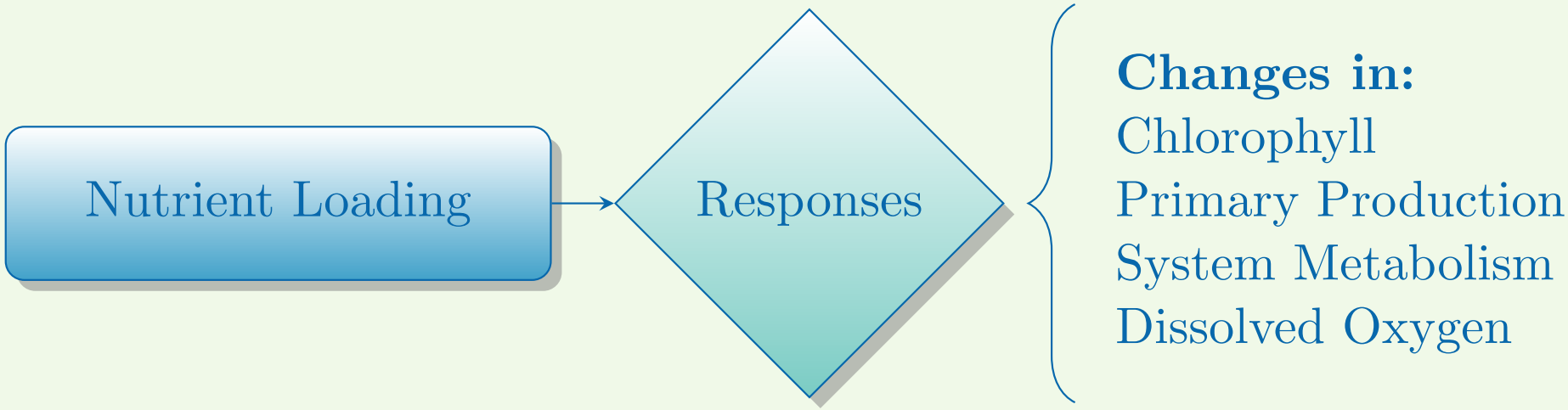

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Evaluating estuarine condition

How do we collect and use data?

Today's talk: My experience evaluating monitoring data to inform our understanding of the eutrophication paradigm

Water quality trends in the Delta:

- ***Example 1***: Model theory and application
- ***Example 2***: Trends over time
- ***Example 3***: Selected case studies

Model theory and background

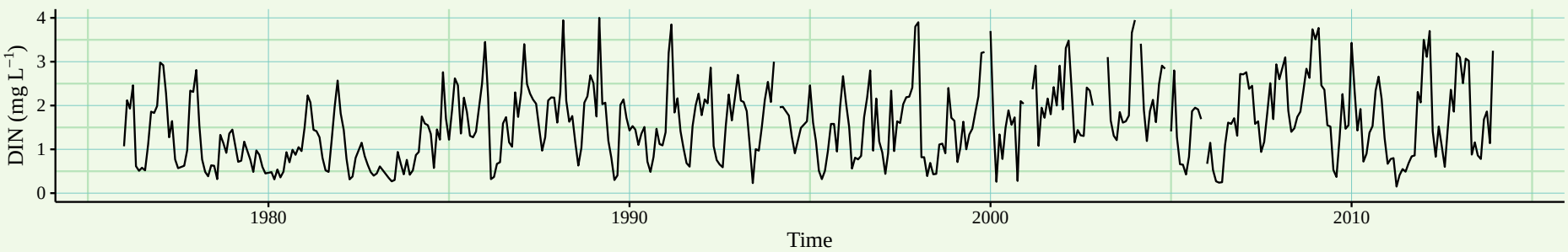
WRTDS adaptation for tidal waters

Increasing availability of records describing ***long-term changes***

Observed data can provide a means to an end, potentially ***high power*** with large sample size

Can we ***develop*** and ***apply*** tools that leverage the descriptive capabilities of these large datasets?

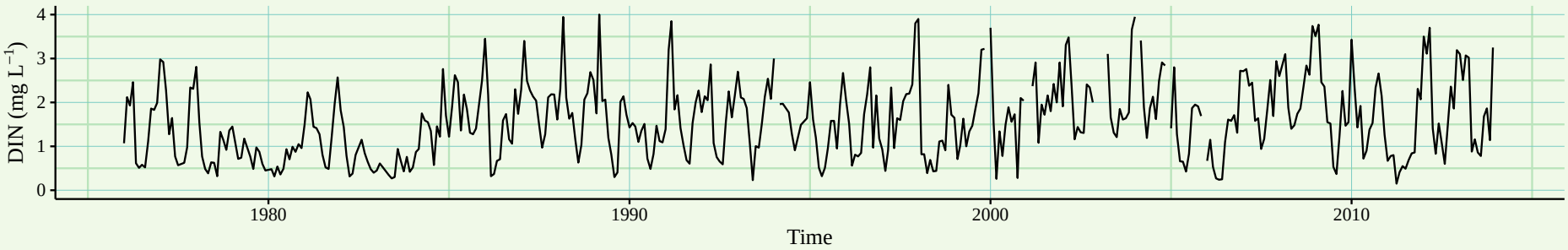
Can we ***link descriptions*** to ***causal events*** to inform management or understanding?



Model theory and background

WRTDS adaptation for tidal waters

Observed data represents effects of many processes



Climate	***Local***	***Regional/historical***
precipitation	light/turbidity	watershed inputs
temperature	residence time	point sources
wind events	invasive species	management actions
ENSO effects	trophic effects	flow changes

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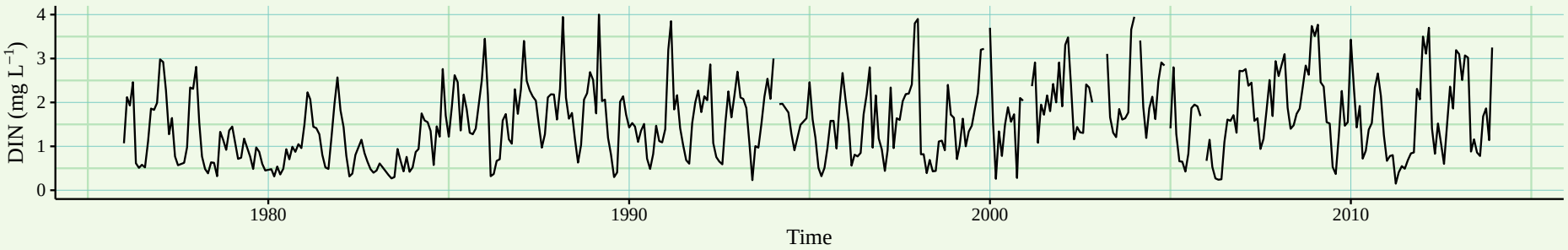

Models should describe components to evaluate effects

Model theory and background

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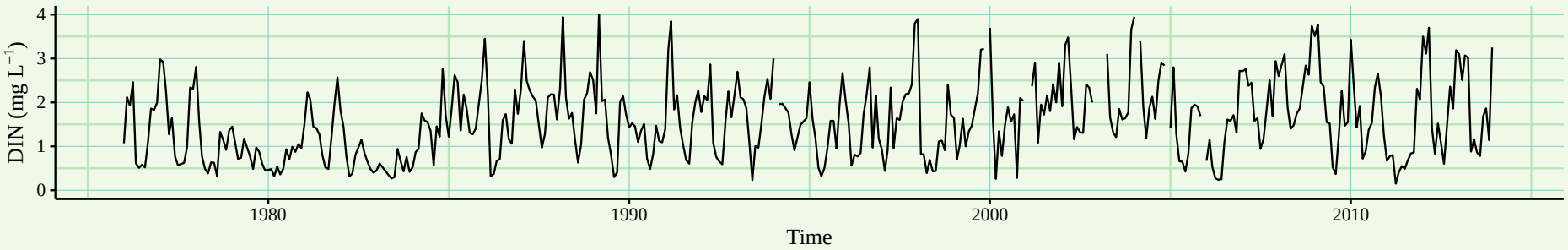

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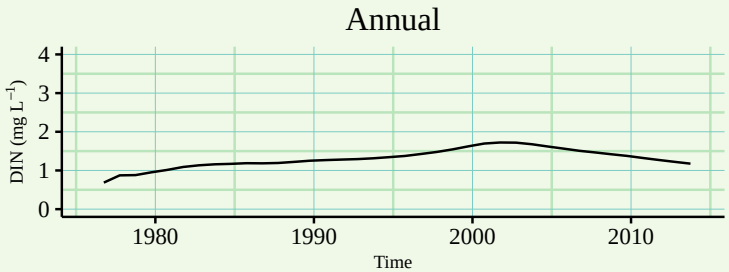

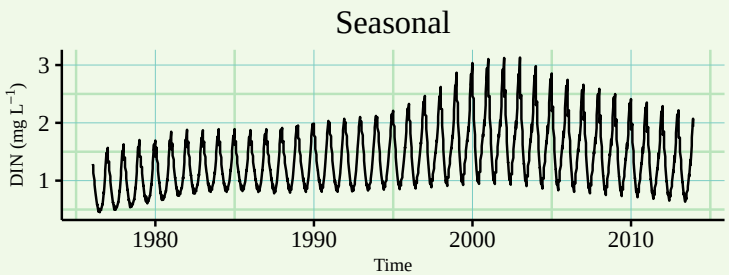

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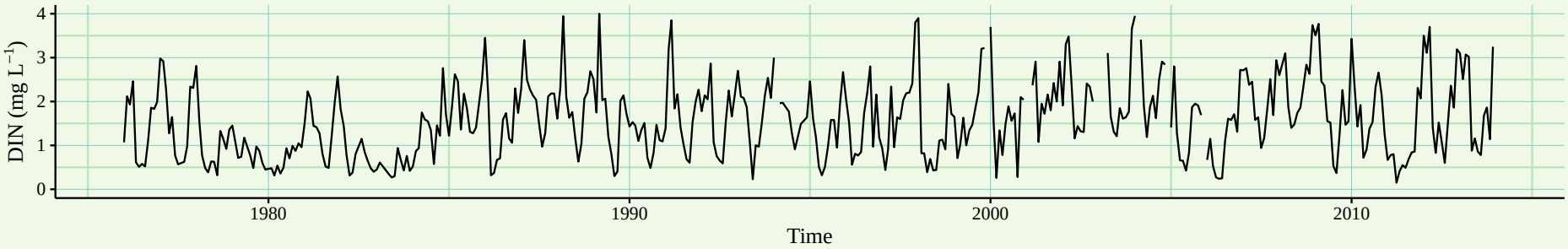

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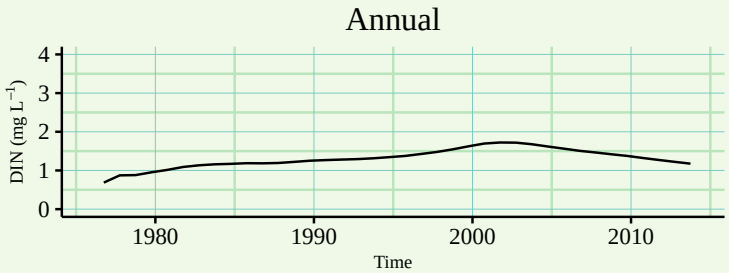
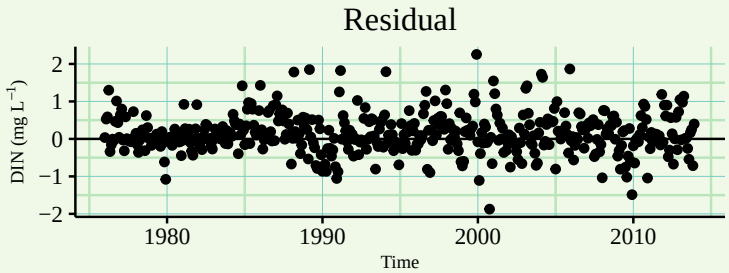
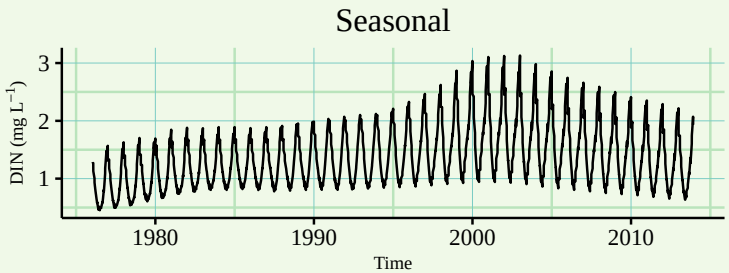
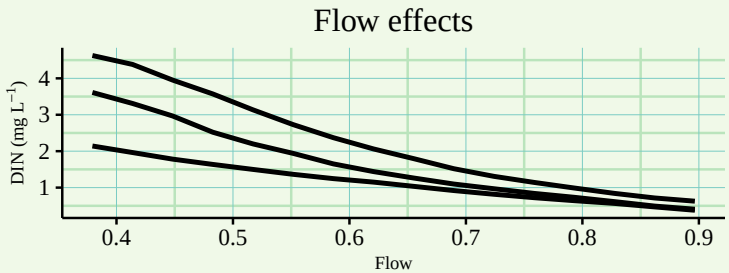








Model theory and background

WRTDS adaptation for tidal waters

Problem: Response endpoints of eutrophication vary naturally over time and with discharge or tidal patterns

Solution: Develop a model that accounts for changes in relationships between drivers of pollution over time

The ***weighted regression (WRTDS)*** model is being developed by USGS for pollutant modelling in rivers [Hirsch et al., 2010]

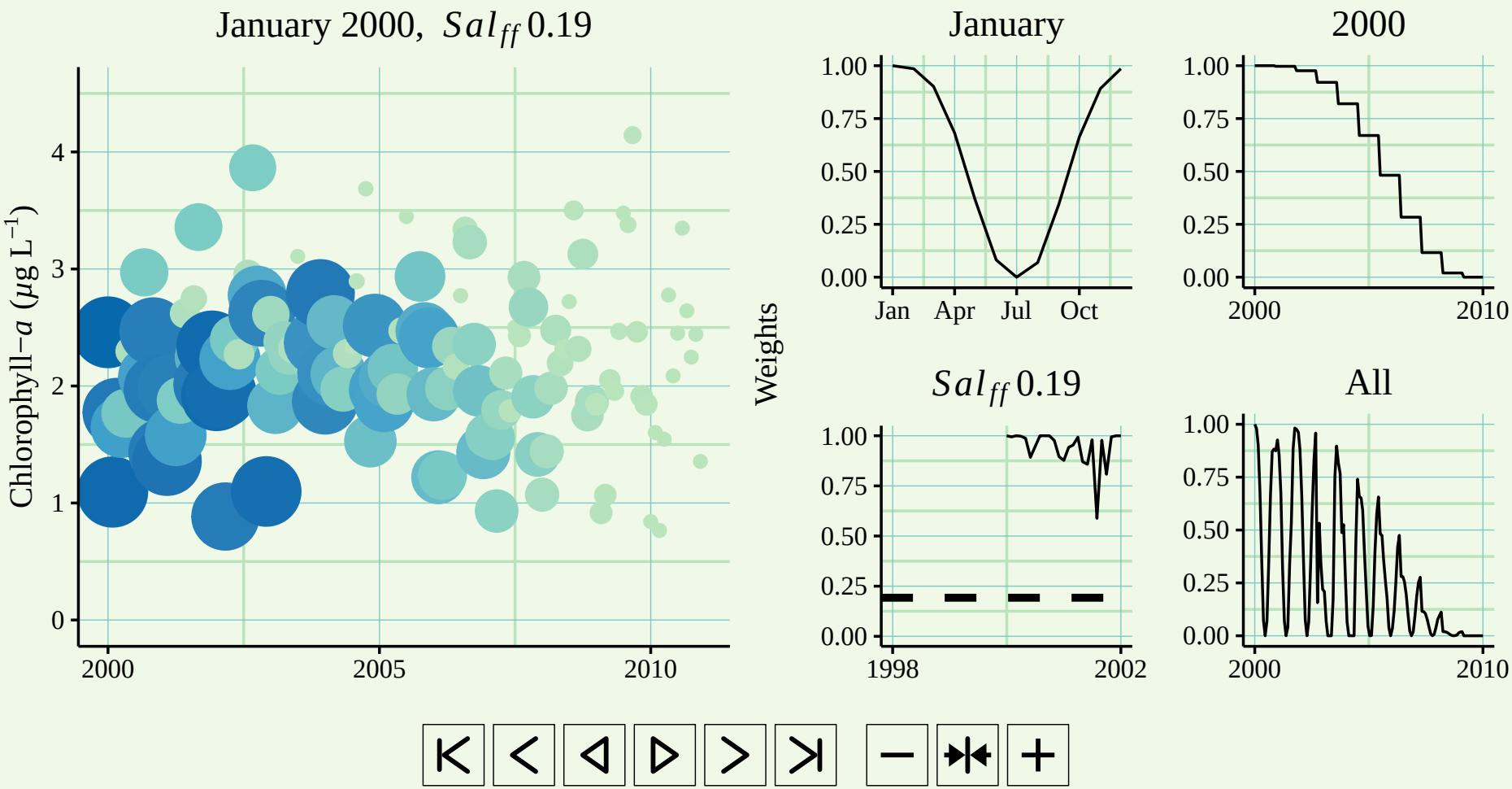
Models pollution concentration as a function of ***time***, ***discharge***, and ***season***

Adaptation: Applied to Tampa Bay [Beck and Hagy III, 2015], further validated/compared in Patuxent Estuary [Beck and Murphy, In review]

Model theory and background

WRTDS adaptation for tidal waters

How does weighted regression work?

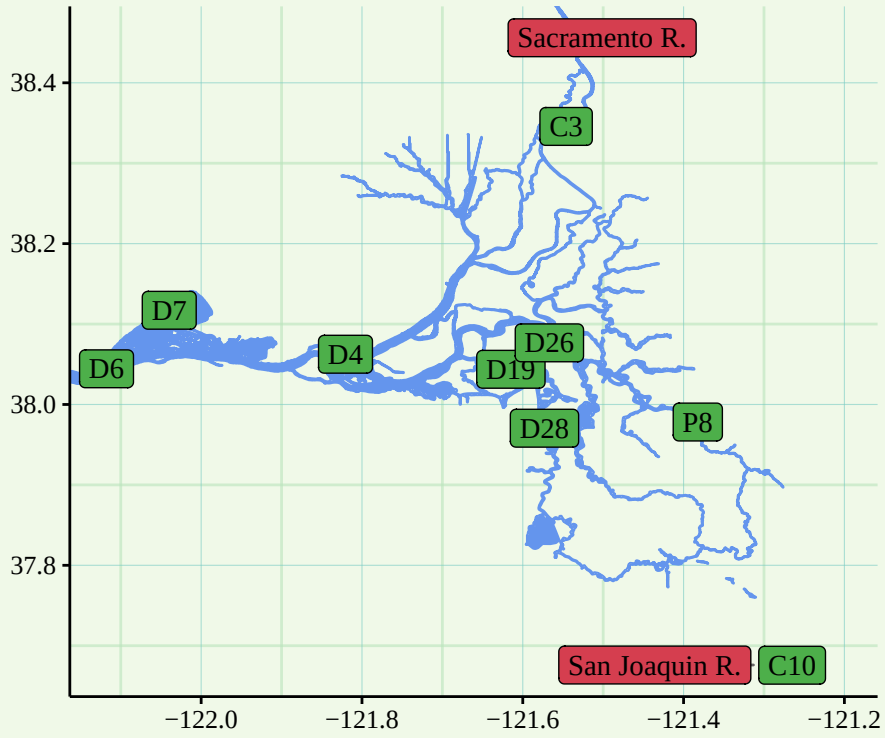


Model theory and background

WRTDS adaptation for tidal waters

Application to Delta:

- Nine stations (three Suisun, three middle, three delta)
- Three analytes (DIN, ammonium, nitrite/nitrate), two flow records
- Four decades of data



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