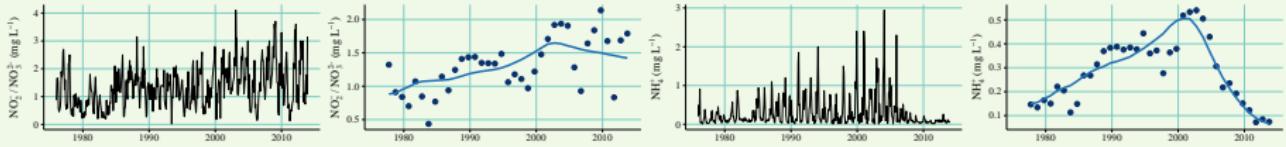


Nutrients, estuaries, and coffee: Memoirs of a GED post-doc

Marcus W. Beck, Ph.D.

USEPA National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, beck.marcus@epa.gov, Phone: 8509342480

August 28, 2017



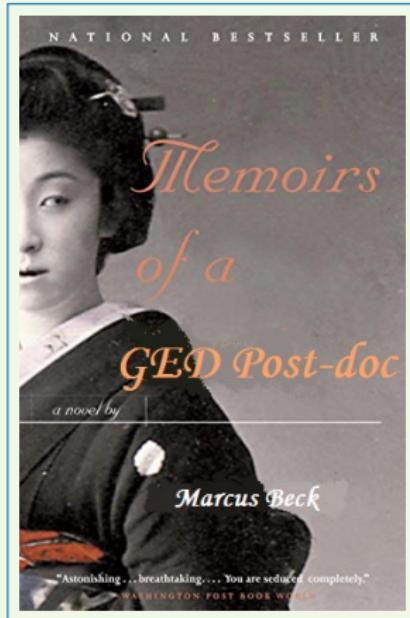
Why are we here today?



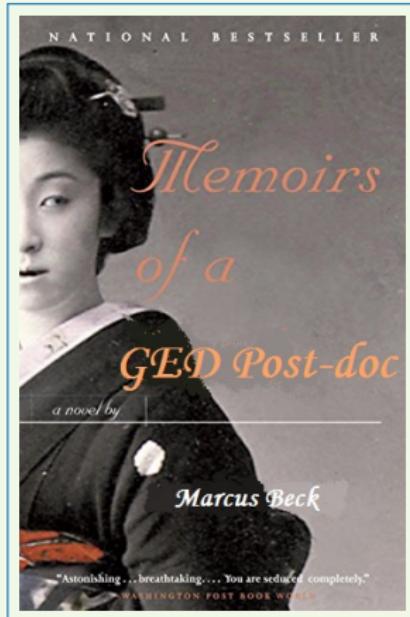
Freedom is what you do with what's been done to you.

– J. P. Sartre

Why are we here today?

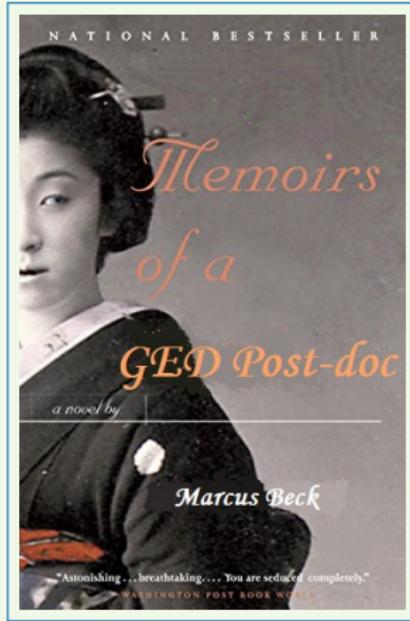


Why are we here today?



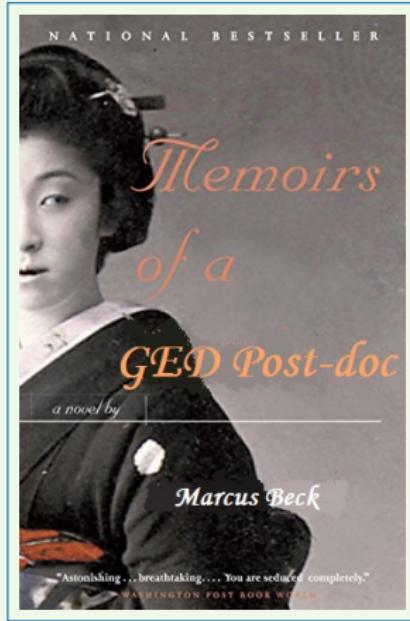
- Where did I come from?

Why are we here today?



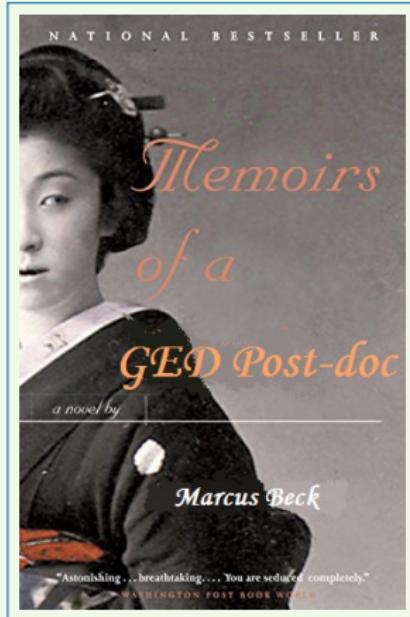
- Where did I come from?
- The ORISE experience

Why are we here today?



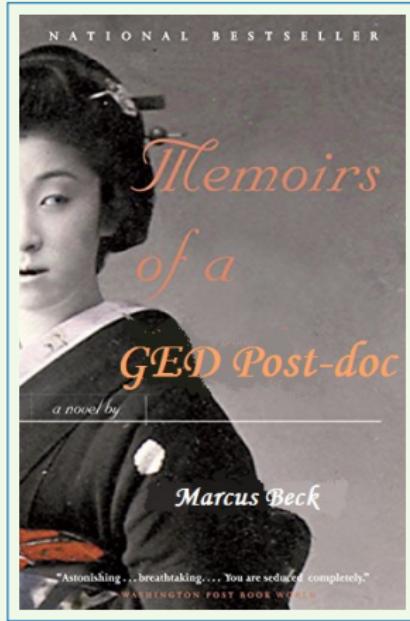
- Where did I come from?
- The ORISE experience
- The EPA experience

Why are we here today?



- Where did I come from?
- The ORISE experience
- The EPA experience
- The next chapter

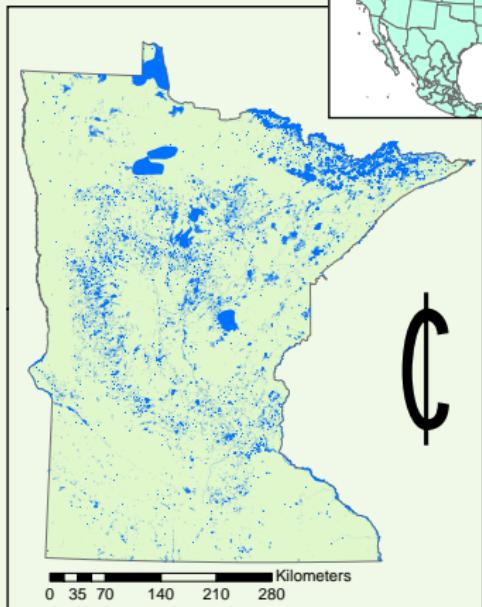
Why are we here today?



- Where did I come from?
- The ORISE experience
- The EPA experience
- The next chapter
- Final thoughts/ramblings

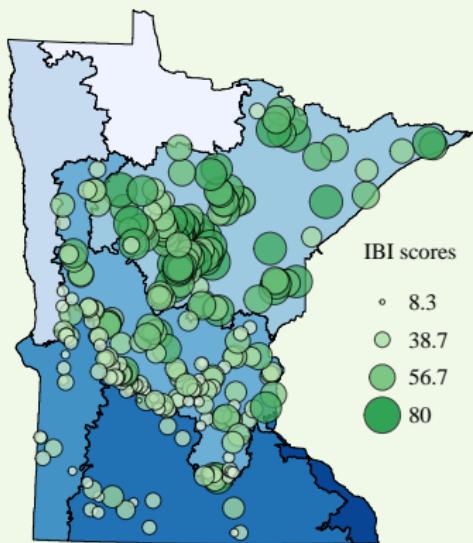
Where did I come from?

Minnesota, the land of 11,842 lakes



Where did I come from?

- Dataset of 332 vegetation surveys, courtesy of MNDNR [Beck et al., 2014]
- Environmental data describing lake characteristics and anthropogenic stressors



- lake surface area
- maximum lake depth
- trophic state index
- growing degree days
- percent agriculture in wshed
- percent impervious surfaces in wshed
- density of groundwater wells in wshed
- wshed area to lake area
- crop productivity index of wshed
- dock density
- ...

The ORISE experience

July 2013, moved to Pensacola



The ORISE experience



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SCIENCE AND EDUCATION**
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OAK RIDGE ASSOCIATED UNIVERSITIES

- ORISE is a mysterious entity

The ORISE experience



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- ORISE is a mysterious entity
- You are not an EPA employee

The ORISE experience



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- ORISE is a mysterious entity
- You are not an EPA employee
- EPA employees cannot tell you what to do

The ORISE experience



**OAK RIDGE INSTITUTE FOR
SCIENCE AND EDUCATION**
Managed by ORAU for DOE



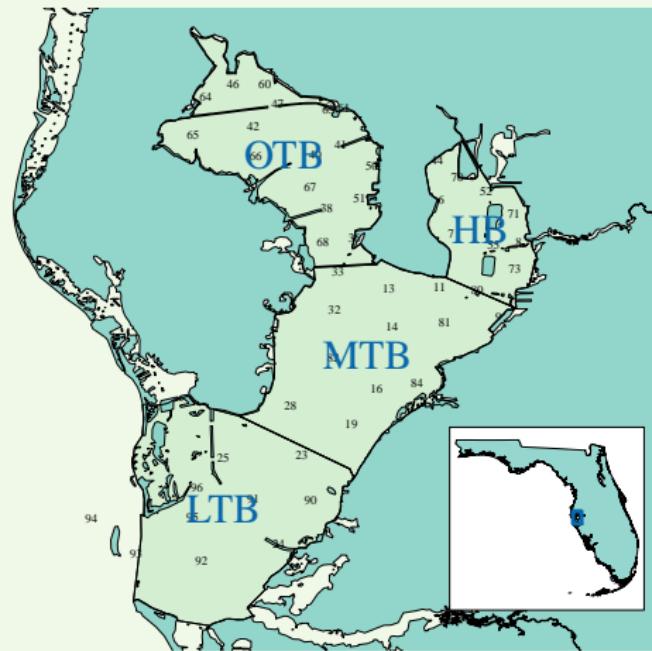
- ORISE is a mysterious entity
- You are not an EPA employee
- EPA employees cannot tell you what to do
- You are not responsible for anything

The ORISE experience

Tampa Bay trend analysis

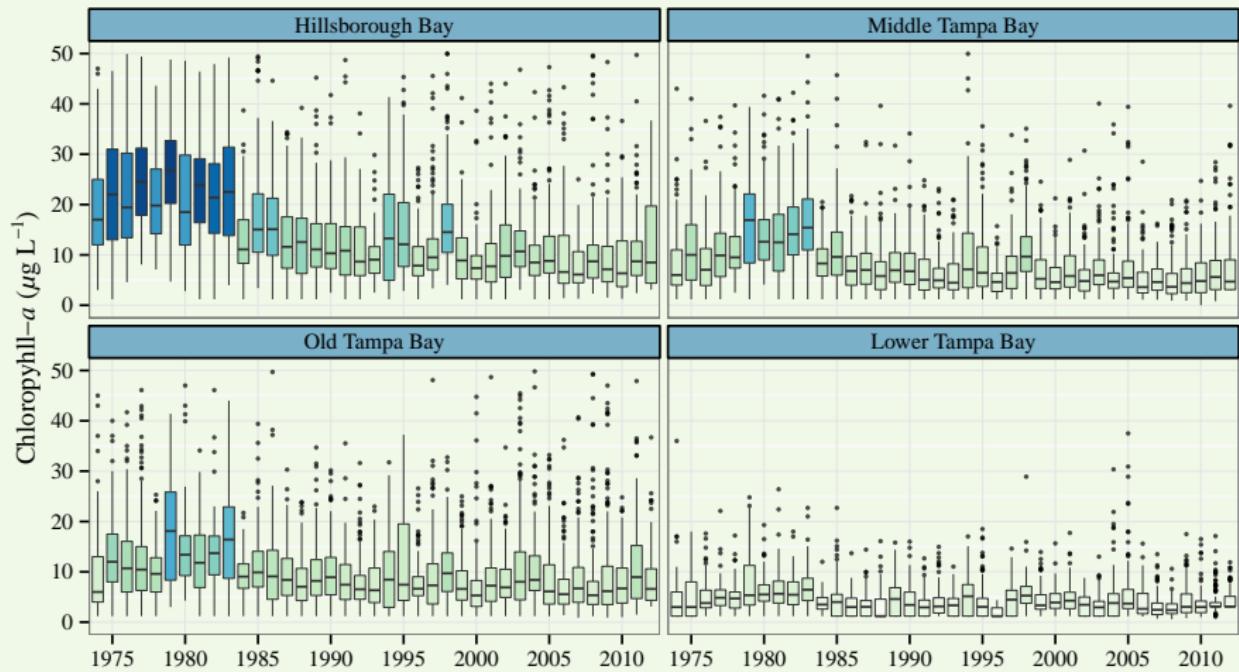
- Four bay segments
- Monthly wq data at 50 stations from 1974 to present
- Longitudinal profile of nutrient load and salinity

Data from [TBEP (Tampa Bay Estuary Program), 2011]



The ORISE experience

Tampa Bay trend analysis



The ORISE experience

Tampa Bay trend analysis

Study objective

Adapt and apply a nutrient response model for estuaries that leverages the descriptive capabilities of large datasets [Beck and Hagy III, 2015]

The ORISE experience

Tampa Bay trend analysis

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Questions of concern – Can we...

- ...provide a natural history of water quality that is temporally consistent with drivers of change?

The ORISE experience

Tampa Bay trend analysis

Study objective

Adapt and apply a nutrient response model for estuaries that leverages the descriptive capabilities of large datasets [Beck and Hagy III, 2015]

Questions of concern – Can we...

- ...provide a natural history of water quality that is temporally consistent with drivers of change?
- ...improve our understanding of the nutrient-response paradigm in estuaries?

The ORISE experience

Tampa Bay trend analysis

How does it work?

$$\ln(N) = \beta_0 + \beta_1 t + \beta_2 Sal + \beta_3 \sin(2\pi t) + \beta_4 \cos(2\pi t)$$

N : nitrogen (or other response endpoint)

t : time

Sal : Salinity (or other flow-related variable)

The ORISE experience

Tampa Bay trend analysis

How does it work?

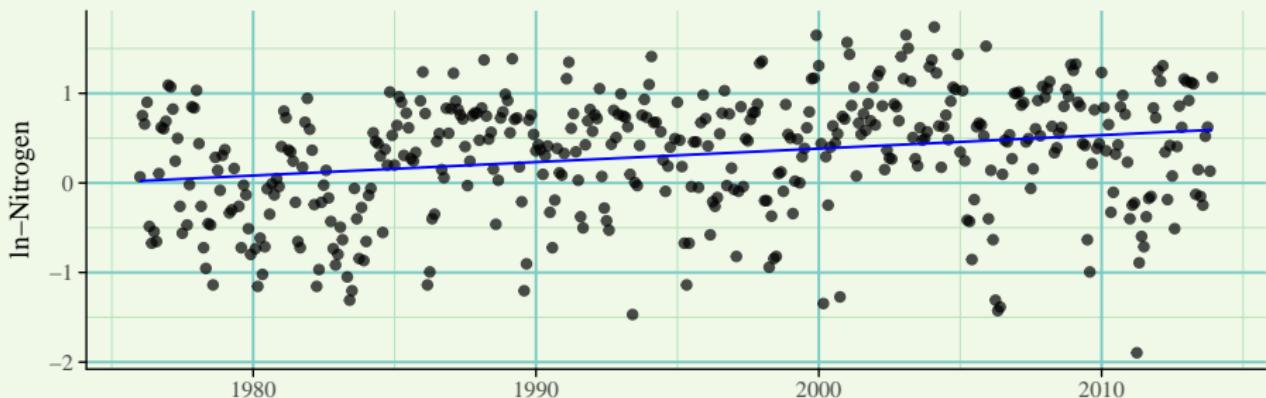
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$\ln(N) \sim t$



The ORISE experience

Tampa Bay trend analysis

How does it work?

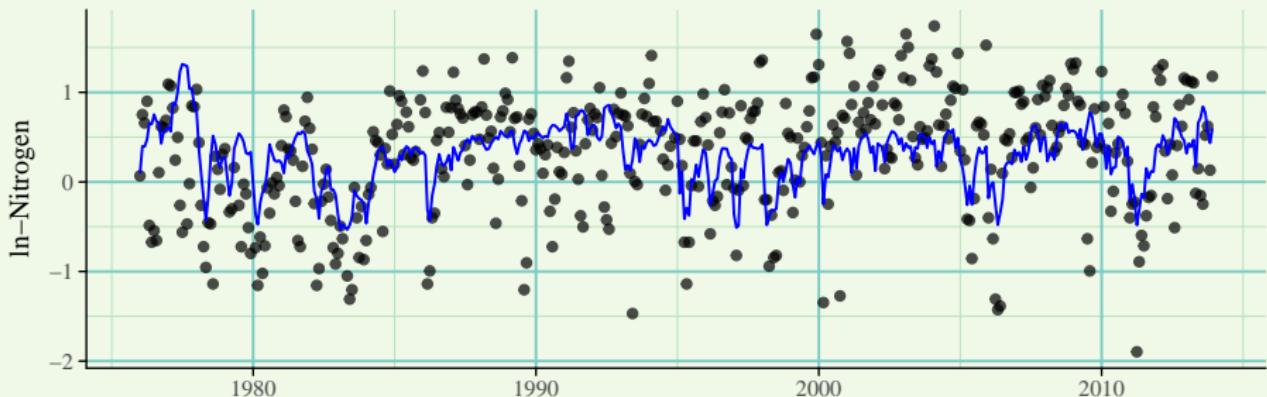
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The ORISE experience

Tampa Bay trend analysis

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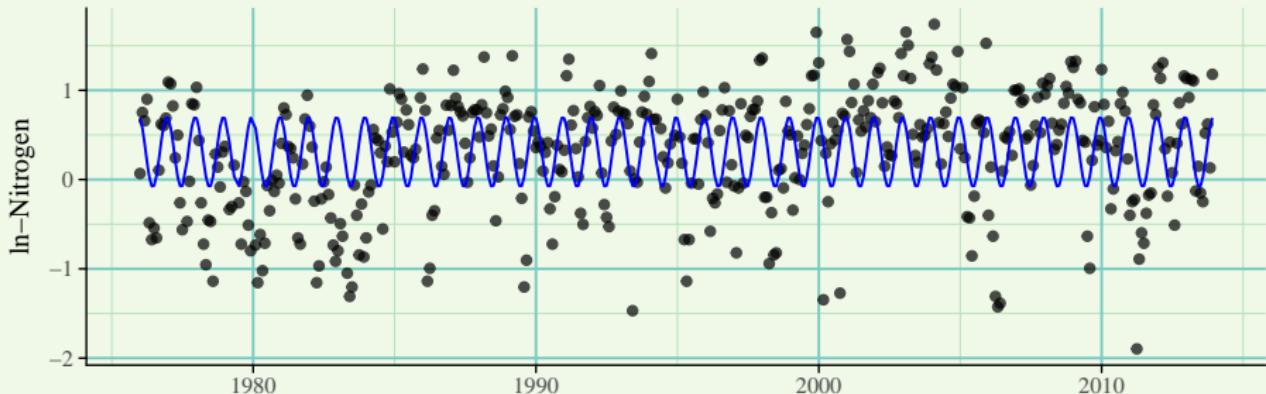
$$\ln(N) = \beta_0 + \beta_1 t + \beta_2 Sal + \beta_3 \sin(2\pi t) + \beta_4 \cos(2\pi t)$$

N : nitrogen (or other response endpoint)

t : time

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$$\ln(N) \sim \cos(2\pi * t) + \sin(2\pi * t)$$



The ORISE experience

Tampa Bay trend analysis

How does it work?

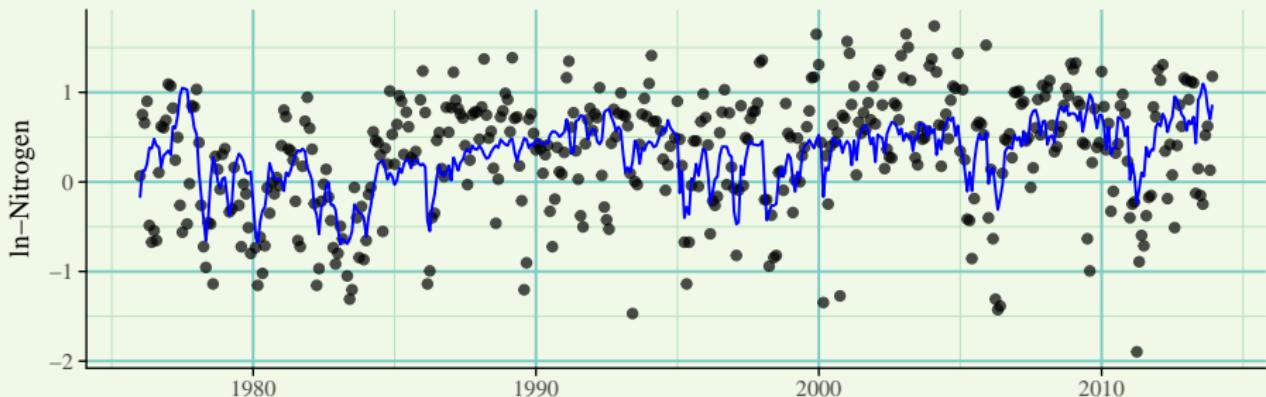
$$\ln(N) = \beta_0 + \beta_1 t + \beta_2 Sal + \beta_3 \sin(2\pi t) + \beta_4 \cos(2\pi t)$$

N : nitrogen (or other response endpoint)

t : time

Sal : Salinity (or other flow-related variable)

$$\ln(N) \sim t + Sal$$



The ORISE experience

Tampa Bay trend analysis

How does it work?

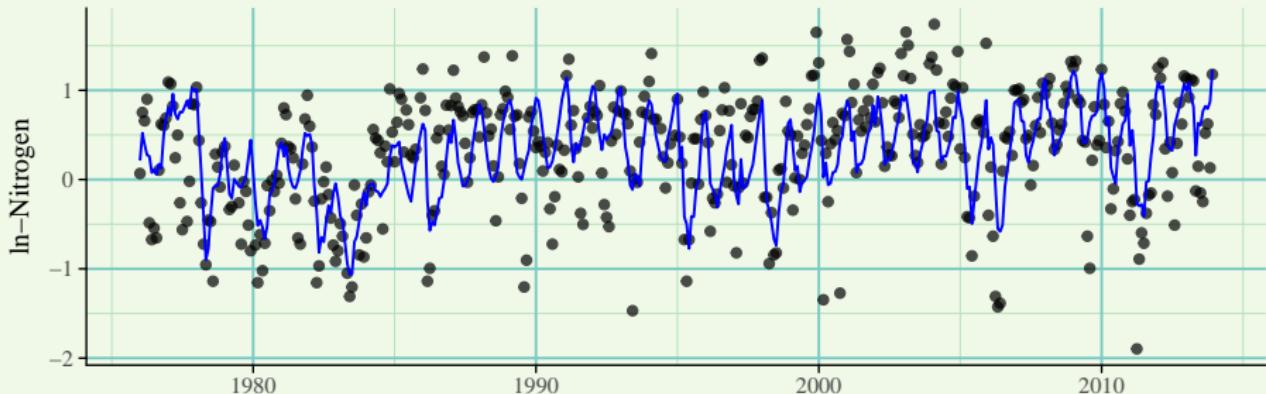
$$\ln(N) = \beta_0 + \beta_1 t + \beta_2 Sal + \beta_3 \sin(2\pi t) + \beta_4 \cos(2\pi t)$$

N : nitrogen (or other response endpoint)

t : time

Sal : Salinity (or other flow-related variable)

$$\ln(N) \sim t + Sal + \cos(2\pi * t) + \sin(2\pi * t)$$



The ORISE experience

Tampa Bay trend analysis

Points: observed time series (black are weighted, grey is zero weight)

Green point: observation at the center of the regression

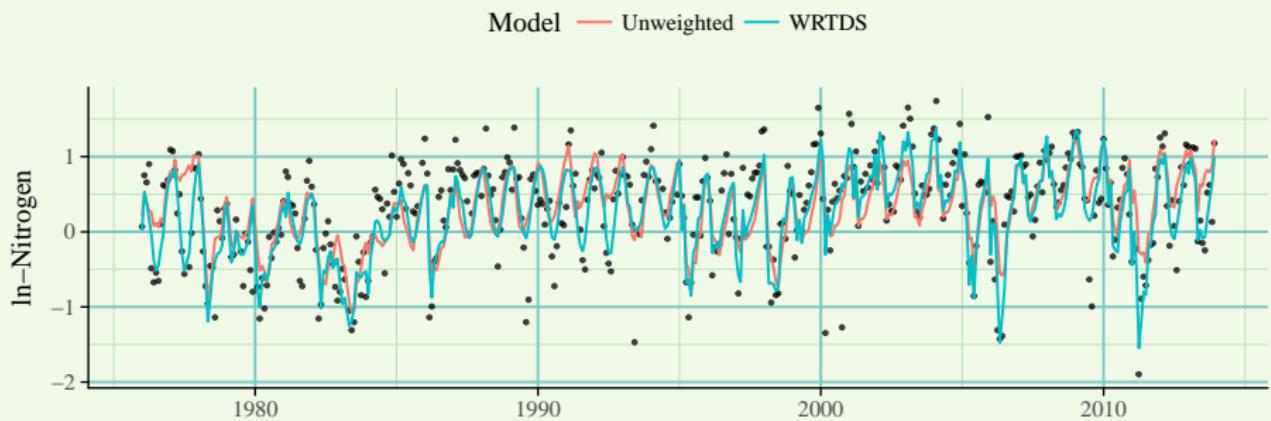
Blue line: Global model with weights specific to the window

Red line: Accumulated WRTDS model

The ORISE experience

Tampa Bay trend analysis

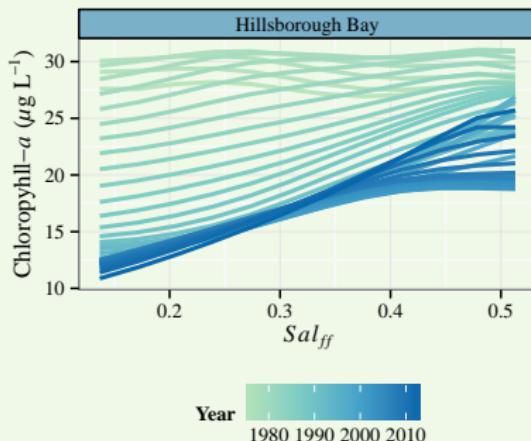
RMSE fit for unweighted = 0.58, WRTDS = 0.36



The ORISE experience

Tampa Bay trend analysis

Because the model is dynamic, we have parameters describing the relationship of chlorophyll with other factors specific to different time periods



- Early period (light blue) - point-sources
- Late period (dark blue) - non-point sources
- Chlorophyll shows increasing response to freshwater input in recent years

The ORISE experience

Tampa Bay trend analysis

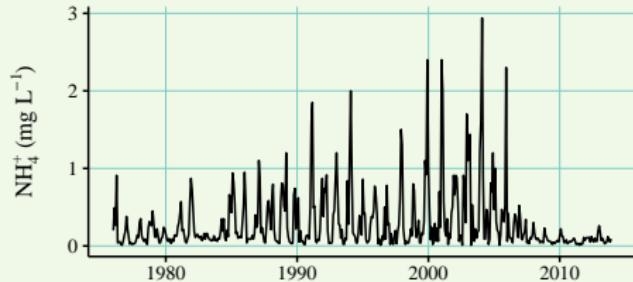
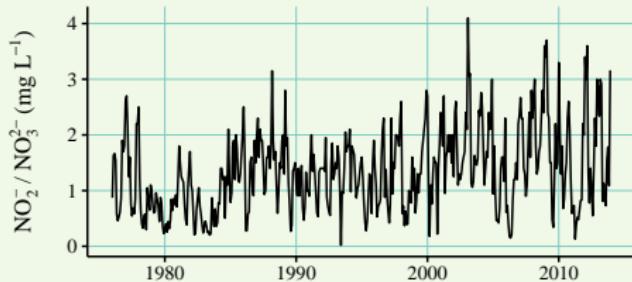


Figure : Observed nitrogen time series at P8 (SF Bay Delta RMP)

The ORISE experience

Tampa Bay trend analysis

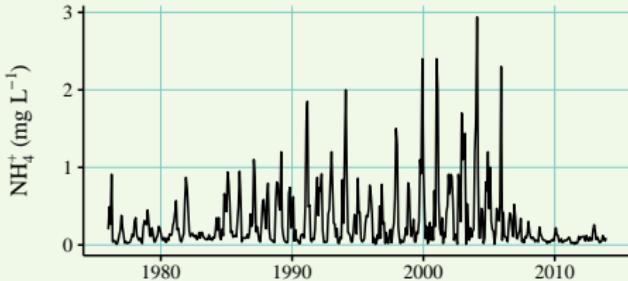
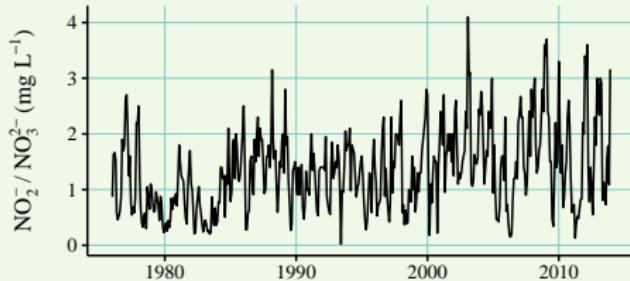


Figure : Observed nitrogen time series at P8 (SF Bay Delta RMP)

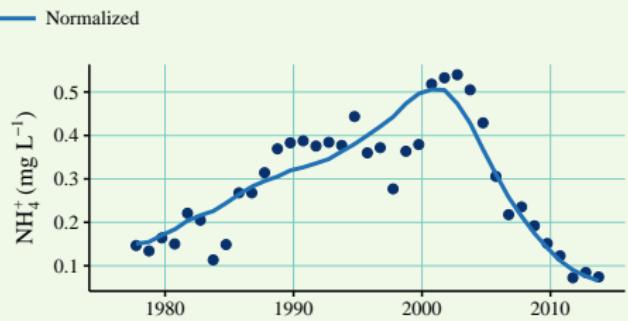
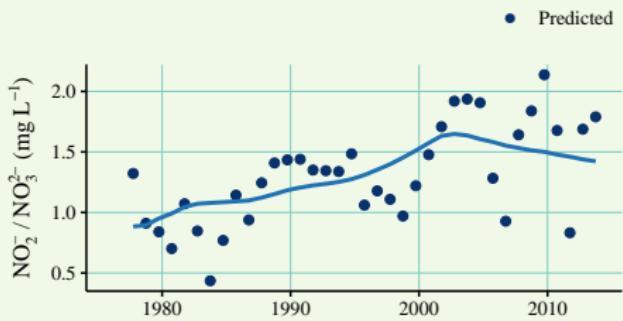


Figure : Annual predicted and flow-normalized nitrogen from WRTDS.

The ORISE experience

Time series detiding

The ‘Odum’ open-water method has been used for decades to estimate rates of ecosystem metabolism [Odum, 1956]

$$\frac{\delta DO}{\delta t} = P - R + D$$

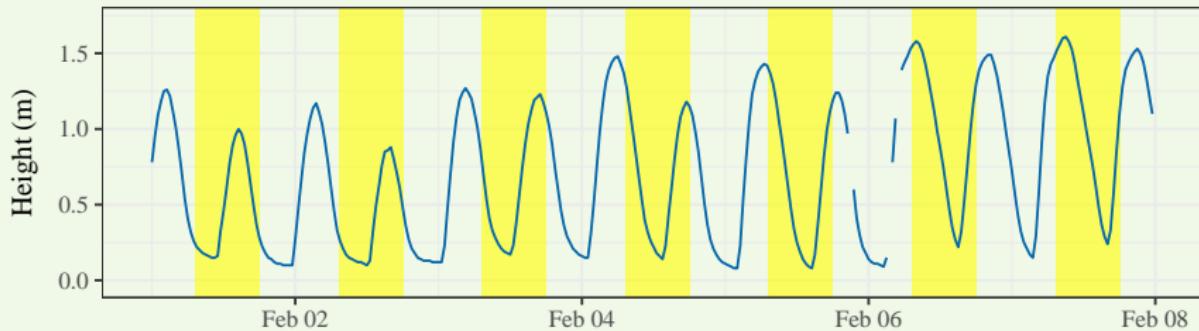
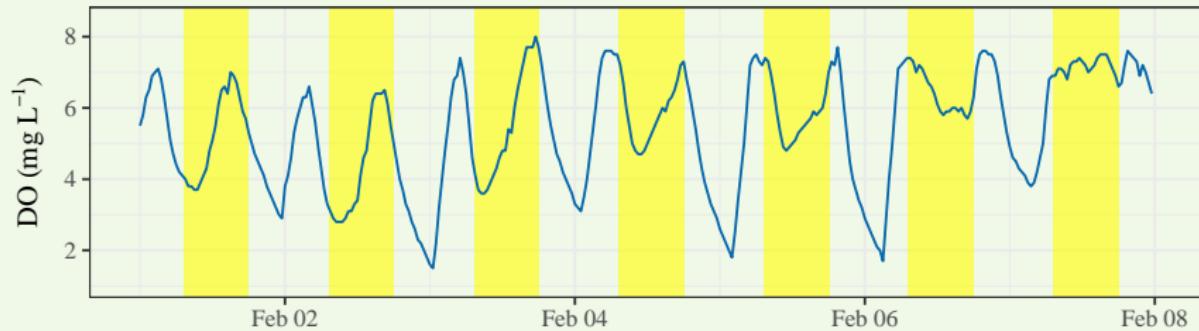
Metabolic rates provide a measure of productivity in a system - are estuaries sources or sinks of organic matter? [Caffrey et al., 2013]

Applications to estuarine monitoring data have been somewhat successful - why??

The ORISE experience

Time series detiding

The ‘Odum’ method assumes DO represents biological processes...



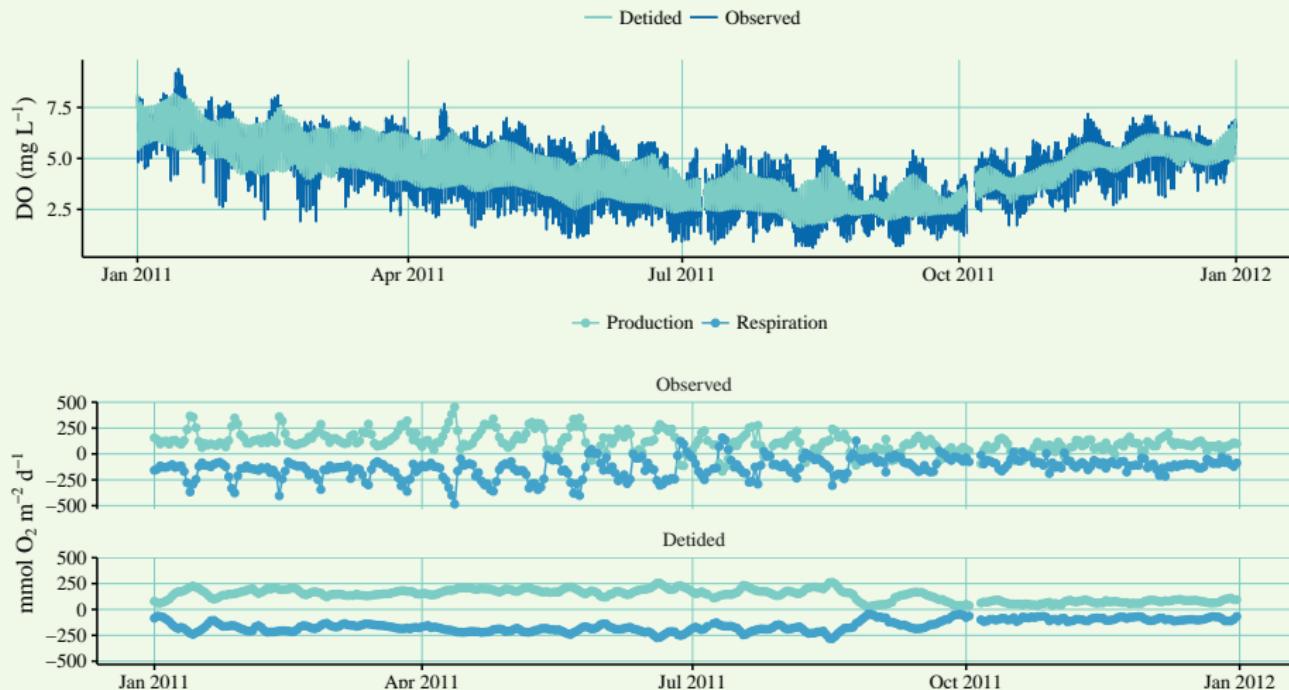
The ORISE experience

Time series detiding

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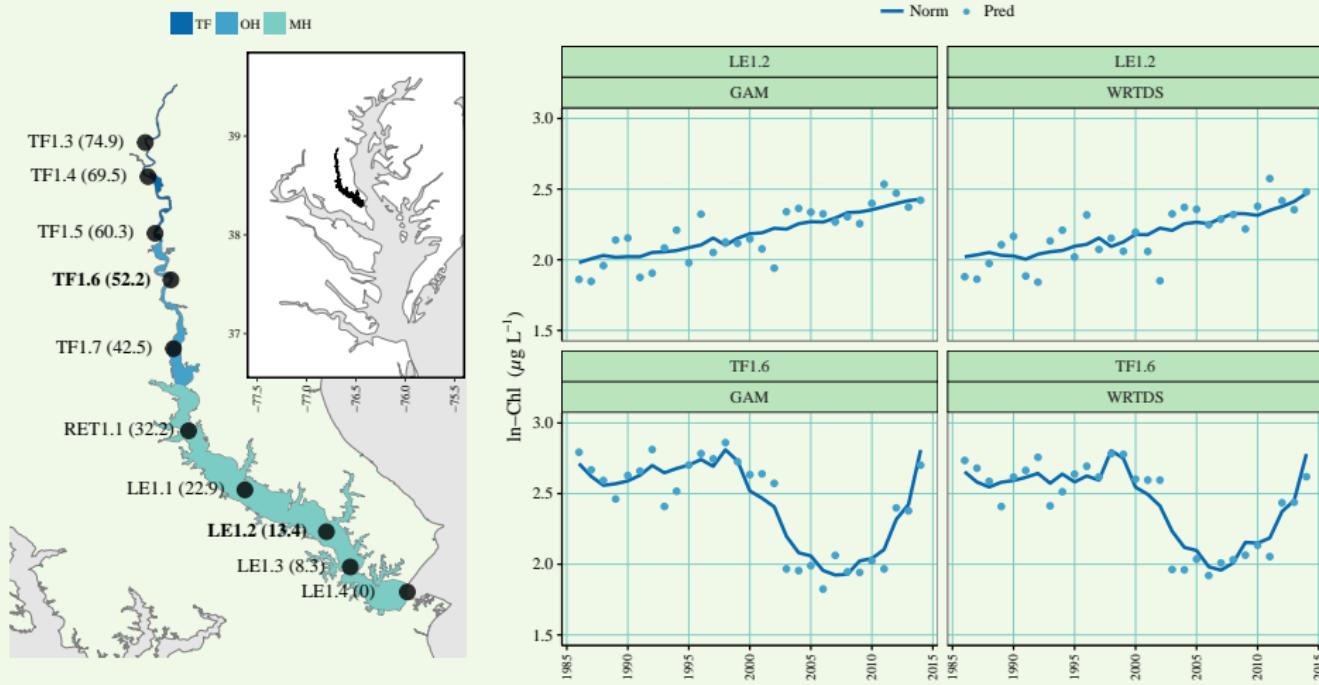
DO time series and ecosystem metabolism [Beck et al., 2015]



The ORISE experience

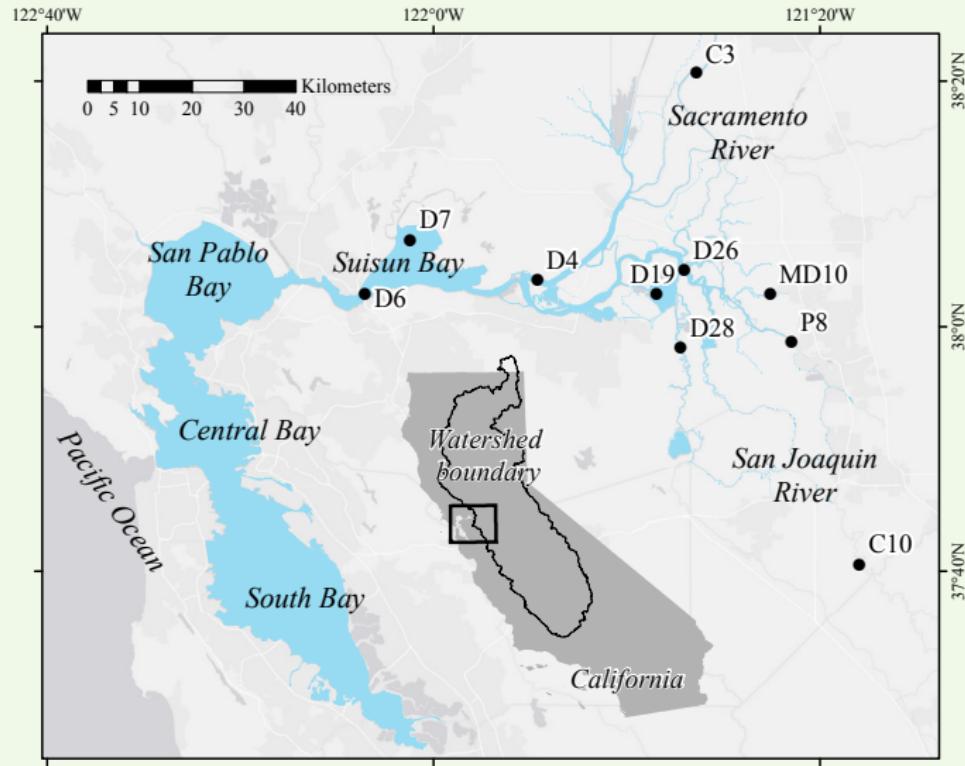
Additional WRTDS applications

Comparing WRTDS and GAMs for trend evaluation [Beck and Murphy, 2017]



The ORISE experience

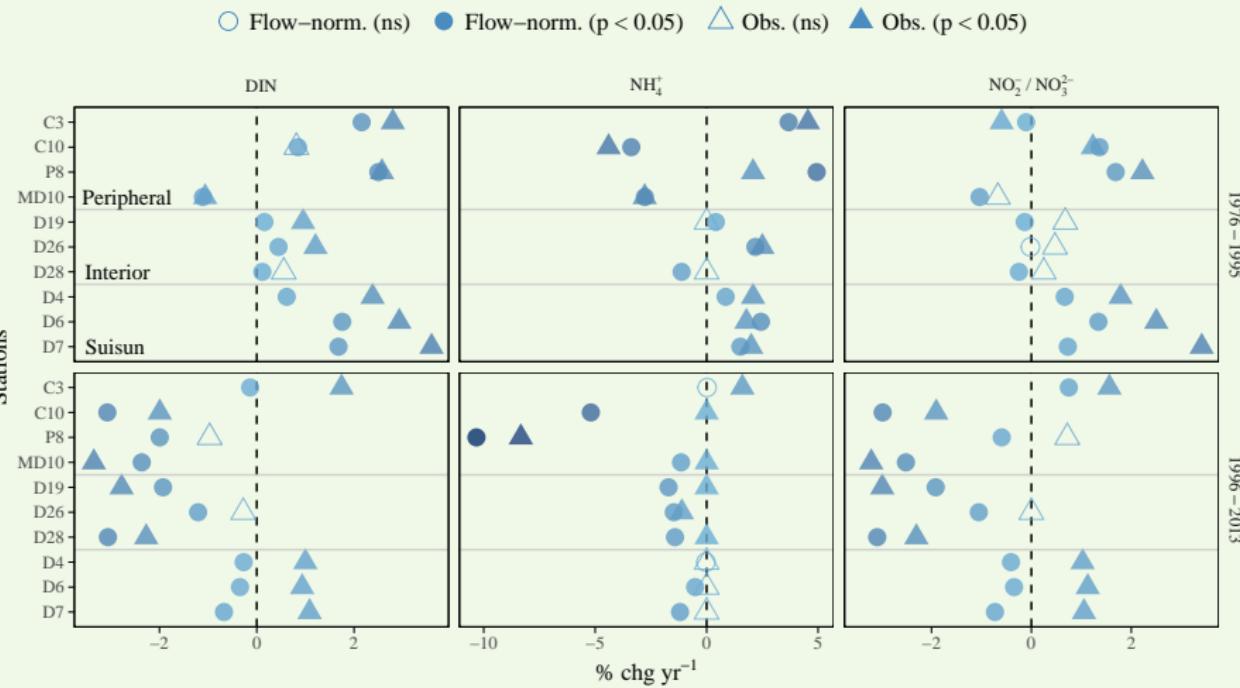
Additional WRTDS applications



The ORISE experience

Additional WRTDS applications

Better description of nutrient endpoints can change conclusions



The EPA experience



R-term post-doc, Dec. 2015

- You are a federal employee

The EPA experience



R-term post-doc, Dec. 2015

- You are a federal employee
- You are not a permanent federal employee

The EPA experience



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- You can't tell contractors what to do

The EPA experience



R-term post-doc, Dec. 2015

- You are a federal employee
- You are not a permanent federal employee
- You can't tell contractors what to do
- You can hoard library books

The EPA experience

4.02B Nutrient Response and Recovery

- Simulation modelling of NGOM hypoxia

4.02A Microbial Indicators

- Data munging

3.01D Watershed Sustainability

- Coral Biocriteria development

The next chapter

Final thoughts

Sincere thank-yous

References I

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