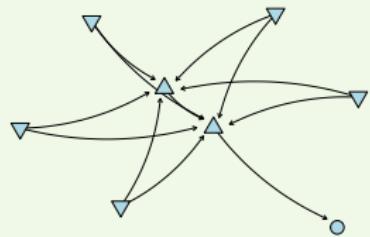
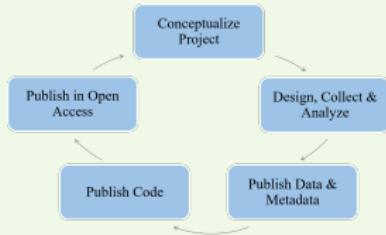


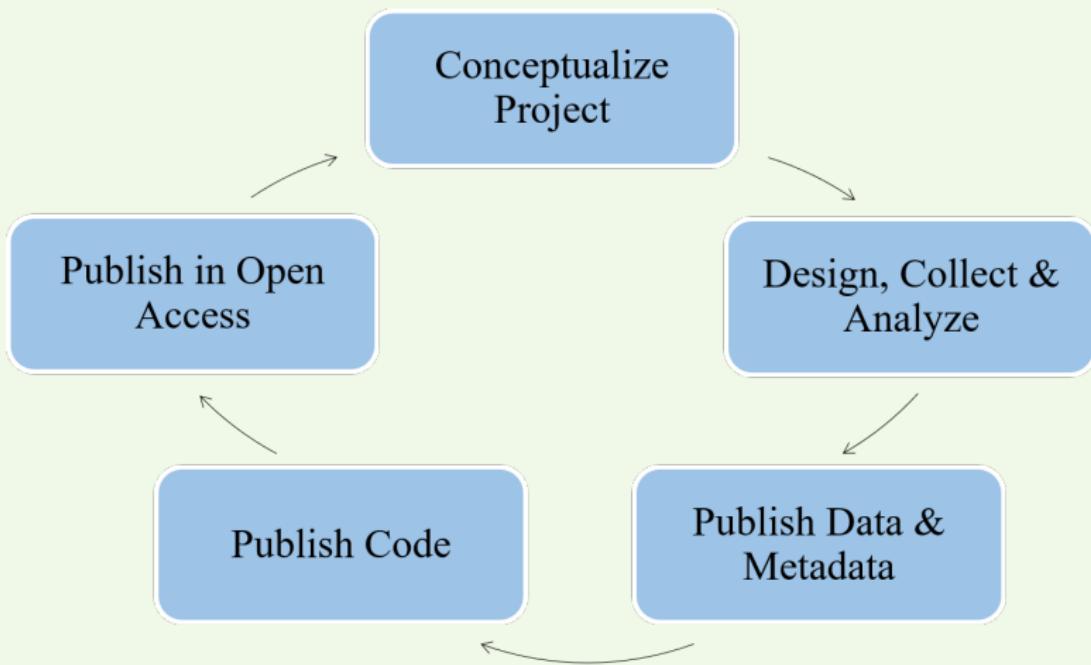
Use of open science to inform restoration projects in estuaries: A Tampa Bay example

Marcus W. Beck¹, Ed Sherwood, Kirsten Dorans, Jessica Renee Henkel, Kathryn Ireland, Patricia Varela

¹Southern California Coastal Water Research Project, Costa Mesa, CA
marcusb@sccwrp.org, Phone: 714-755-3217

April 23, 2018





Modified from Hampton et al. 2015. The Tao of open science for ecology. *Ecosphere* 6(7):1-13.

Open science workflow

Open Science for Synthesis: Gulf Research Program

July 10 - July 28, 2017

NCEAS, Santa Barbara, CA





Today's talk

Our experience using the open science workflow to inform restoration projects in estuaries



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Can we use disparate data to prioritize future restoration projects aimed at improving water quality?

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Our experience using the open science workflow to inform restoration projects in estuaries

Can we use disparate data to prioritize future restoration projects aimed at improving water quality?

- *Synthesize* data in space and time to evaluate cumulative effects of restoration projects
- *Develop* a decision support tool with empirical observations to evaluate likelihood of potential outcomes

Tampa Bay - from gross to less gross



Past:

- Mid-1970s N load 8.2×10^6 yr^{-1} [Greening and Janicki, 2006]
- Elevated chl-a concentrations
- Increased occurrence of HABs



Tampa Bay - from gross to less gross



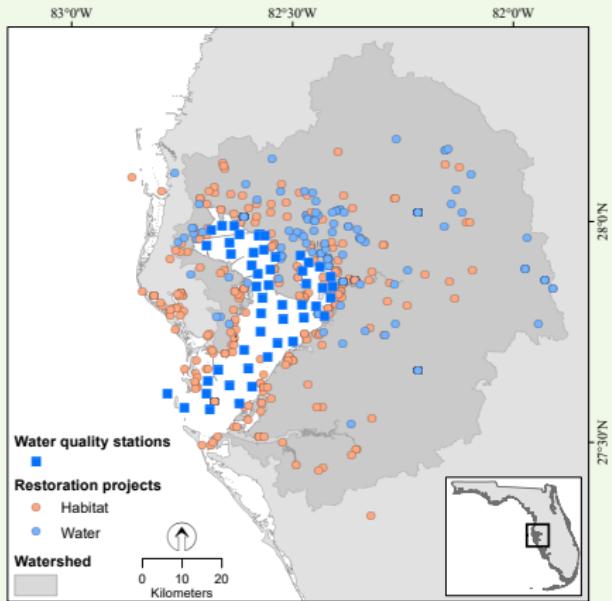
Past:

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Present:

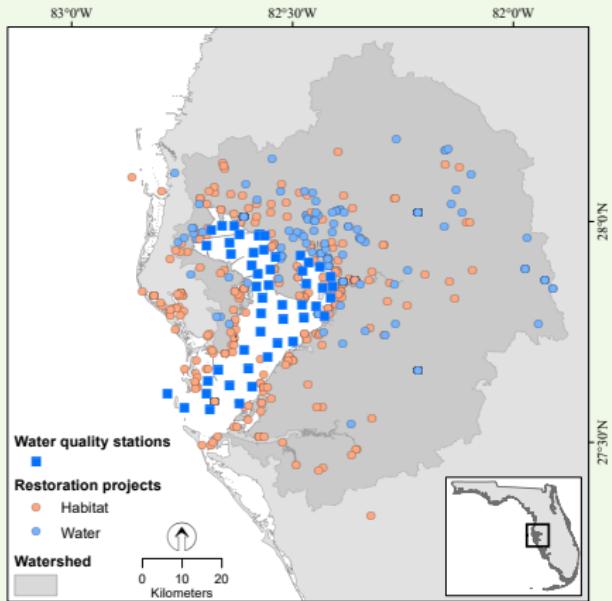
- 2016 seagrass at ~17k ha [Sherwood et al., 2017]
- Reductions in nutrient load, chlorophyll
- Increase in water clarity [Morrison et al., 2006, Beck et al., 2017]

Tampa Bay - open data sources



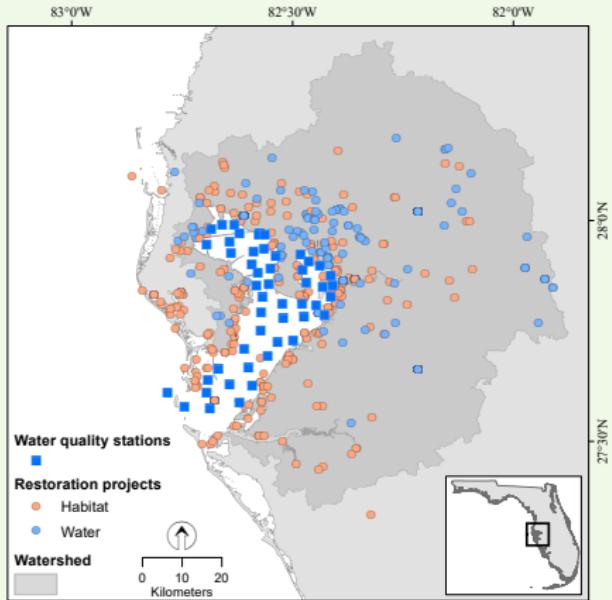
- **Water quality** monitoring dataset: 1974 to present, ~500 obs. per site

Tampa Bay - open data sources



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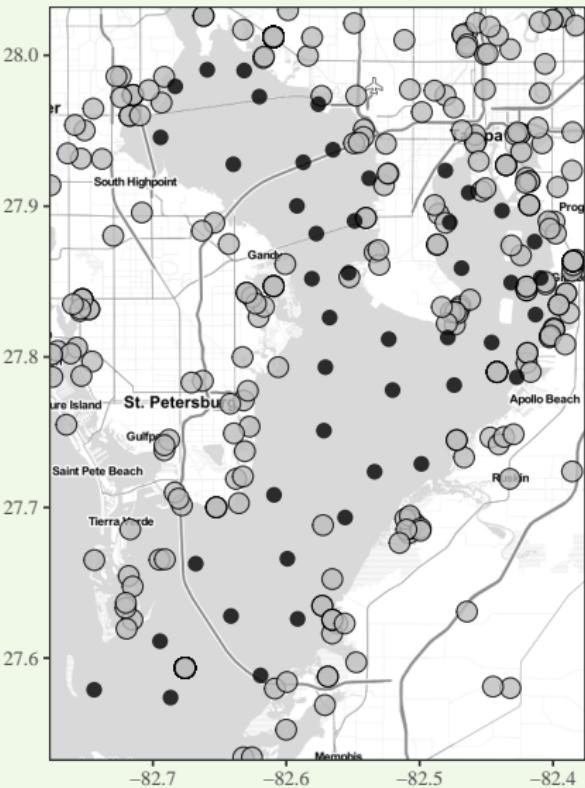
Despite considerable *investments* in restoration, *effectiveness evaluation* continues to elude practitioners at geographic scales

[Diefenderfer et al., 2016]

Task 1: Can we empirically link 500 restoration projects to chlorophyll changes at water quality stations over a forty year period?

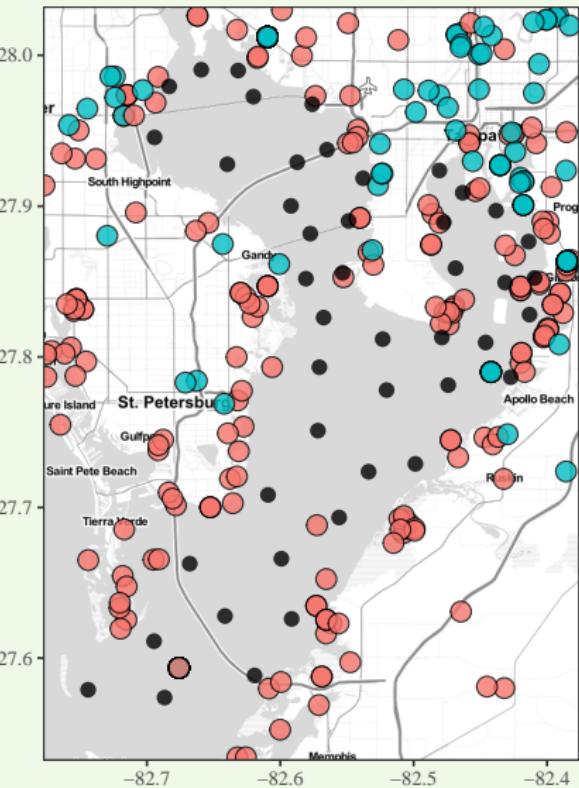


Data munging with open source tools



Can we link 500 restoration projects to chlorophyll changes over a forty year period?

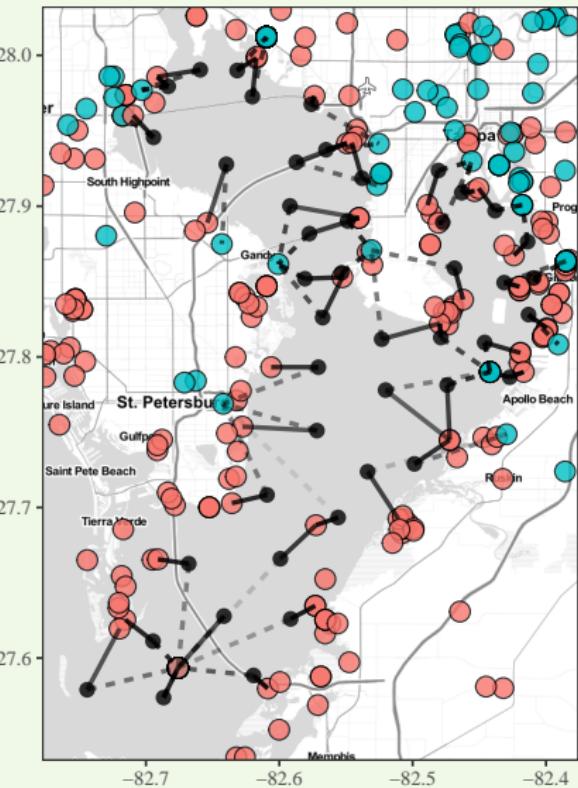
Data munging with open source tools



Can we link 500 restoration projects to chlorophyll changes over a forty year period?

- Consider an effect of restoration *site type*?

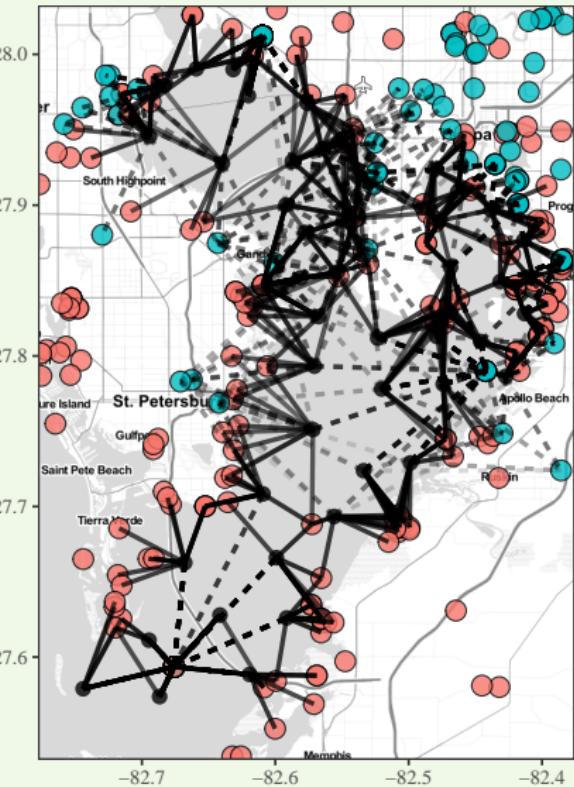
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Can we link 500 restoration projects to chlorophyll changes over a forty year period?

- Consider an effect of restoration *site type*?
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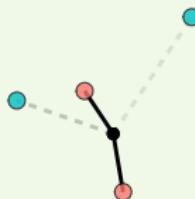
Data munging with open source tools



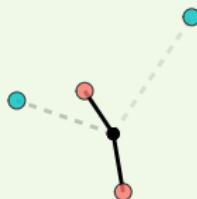
Can we link 500 restoration projects to chlorophyll changes over a forty year period?

- Consider an effect of restoration *site type*?
- Consider *distance* of sites from water quality stations?
- Consider *cumulative effects*?

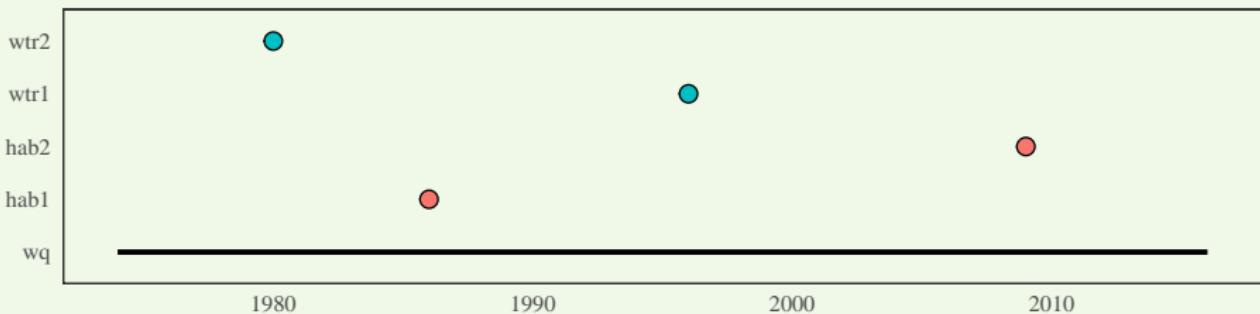
WQ and restoration sites: *spatial join*



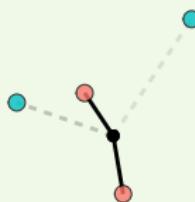
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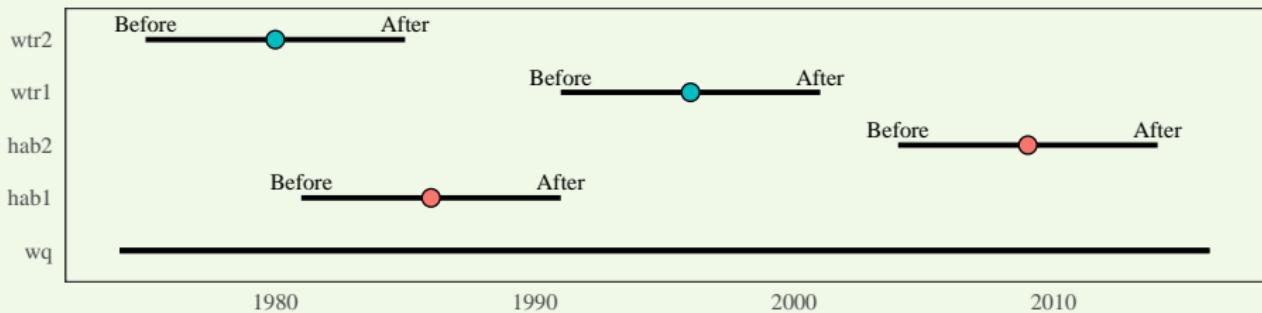
WQ and restoration sites: *temporal join*



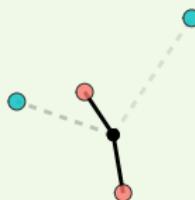
WQ and restoration sites: *spatial join*



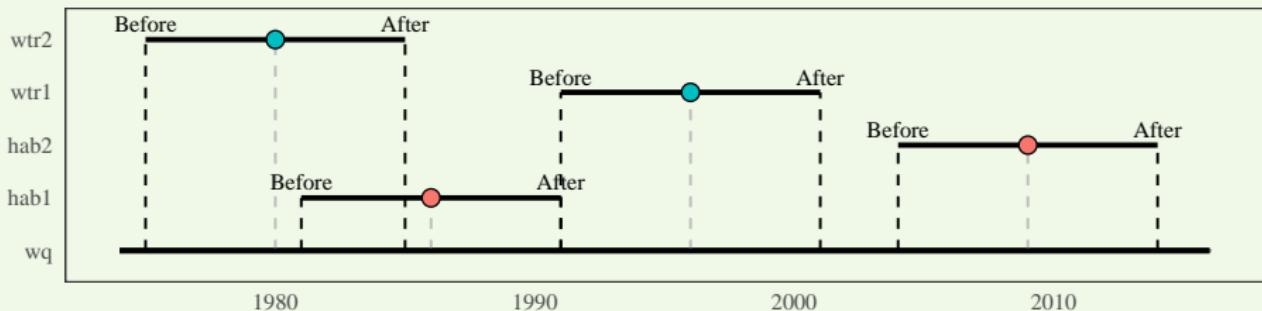
WQ and restoration sites: *temporal join, before/after*



WQ and restoration sites: *spatial join*

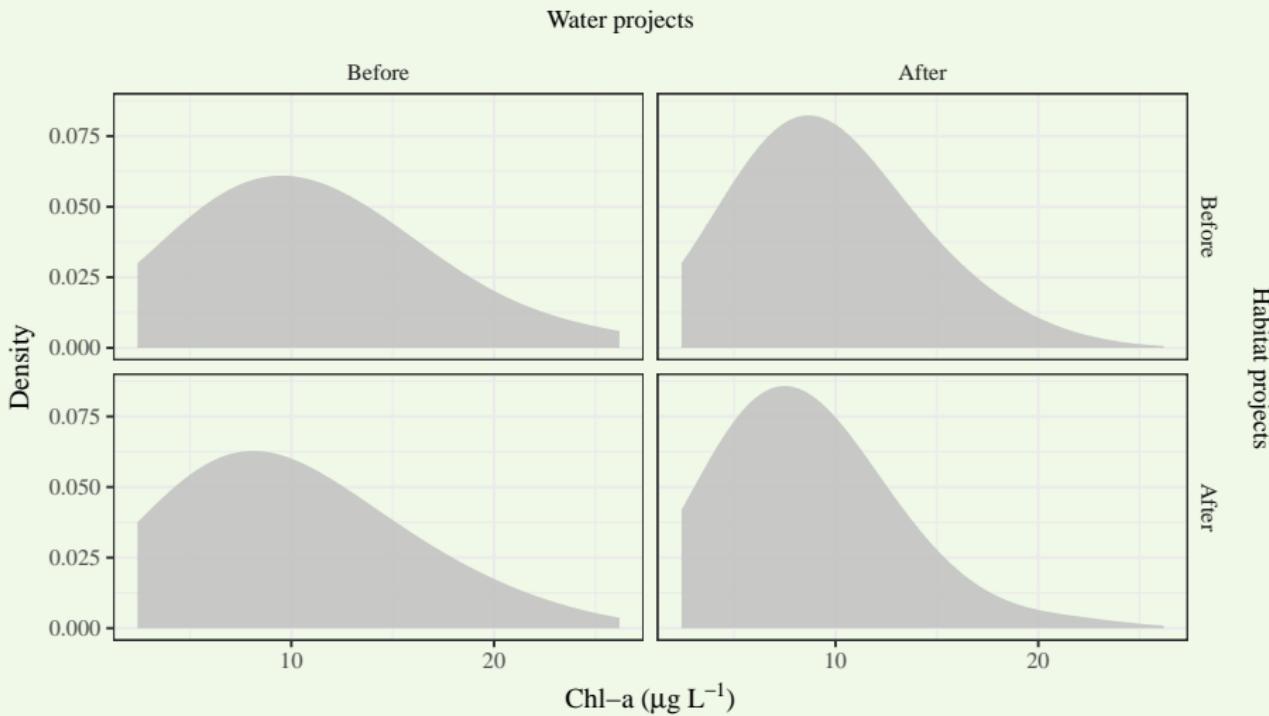


WQ and restoration sites: *temporal join, before/after, slice*



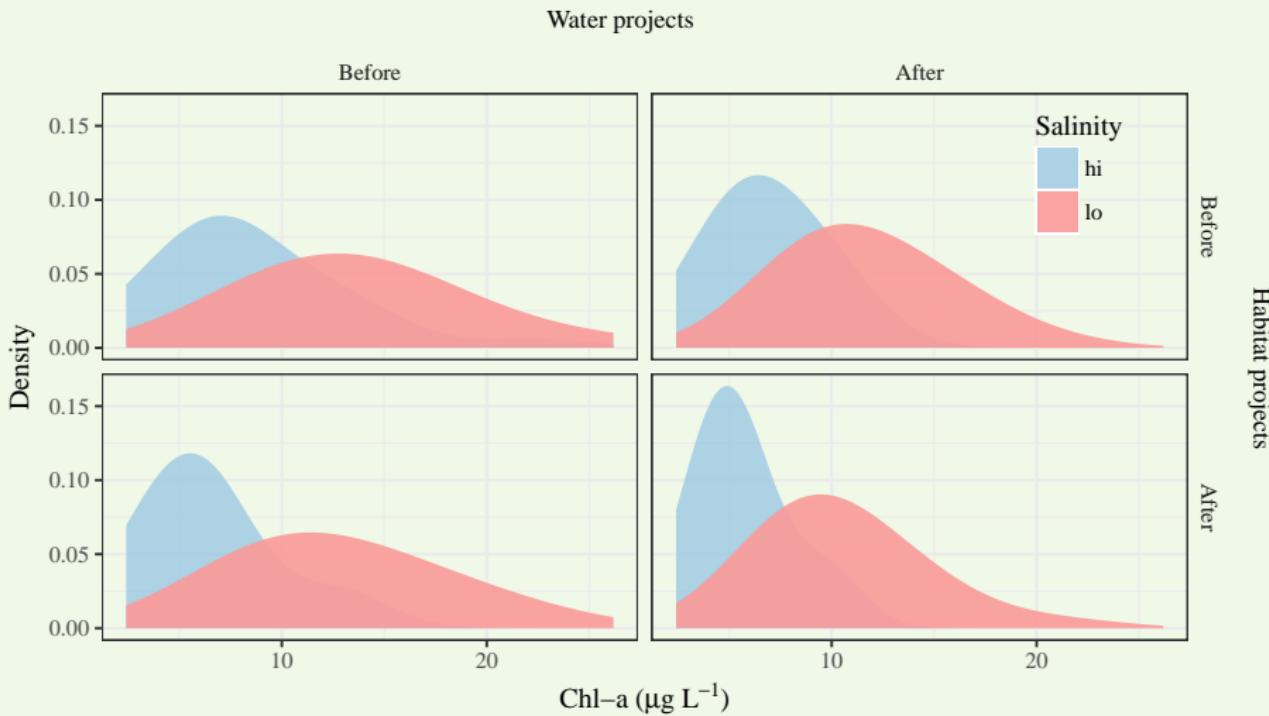
Data munging with open source tools

For *many* water quality stations matched to *many* restoration sites...



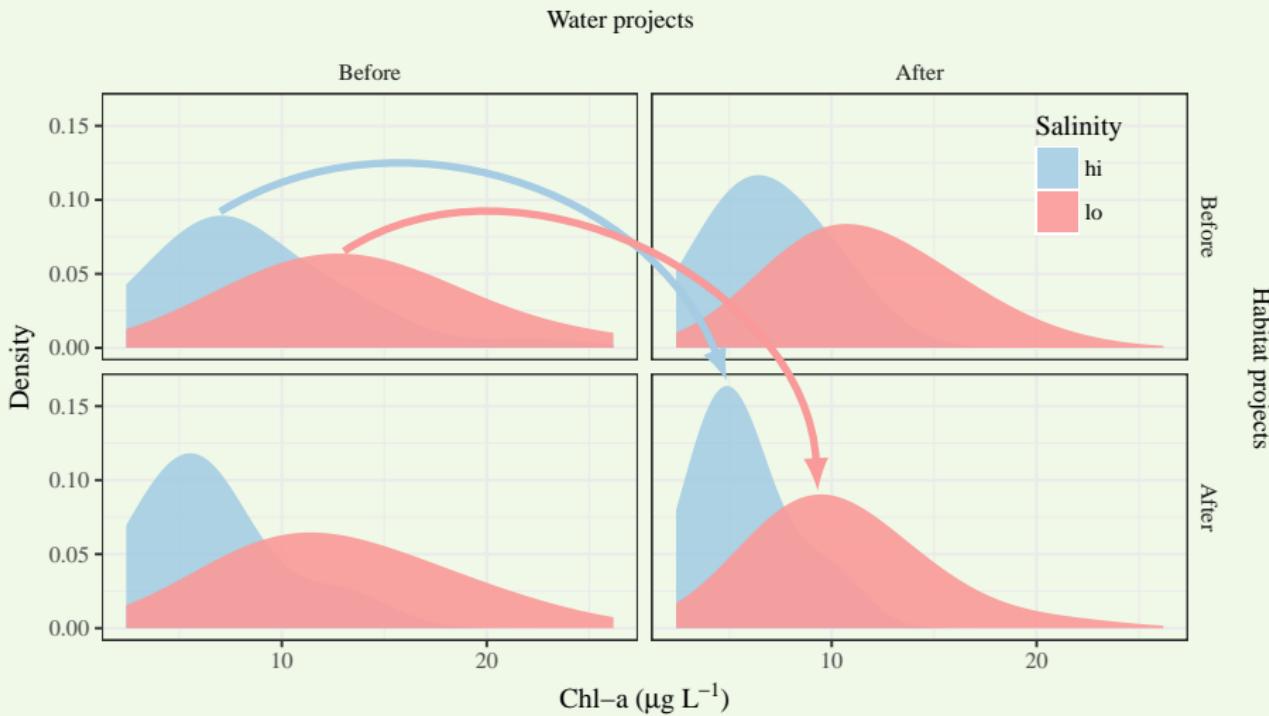
Data munging with open source tools

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Data munging with open source tools

For *many* water quality stations matched to *many* restoration sites...



Building a decision support tool

What is the probability of low/high chlorophyll given other events?

$$P(Chl \mid Event) = \frac{P(Event|Chl) \cdot P(Chl)}{P(Event)}$$

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- Does it differ by low/high *salinity* as a natural covariate?

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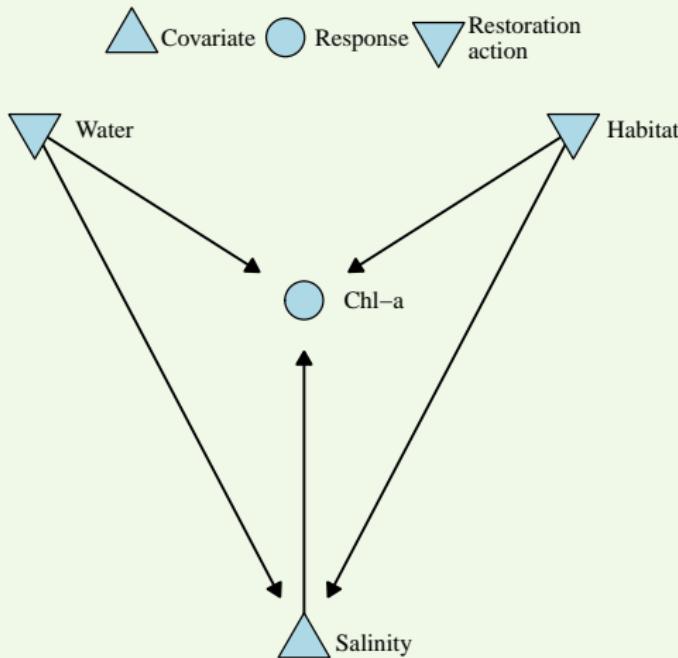
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Bayesian models let us evaluate likelihood of potential outcomes given conditional distributions

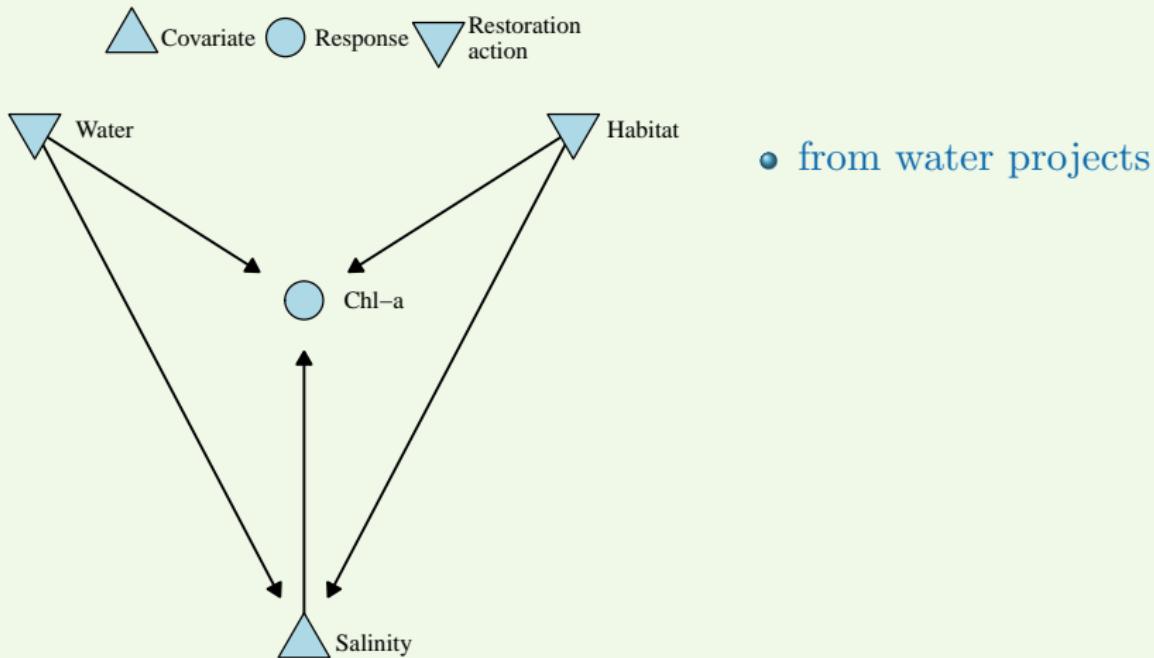
Building a decision support tool

Using the *conditional probabilities* from the *empirical response*, what's the probability of low chlorophyll...



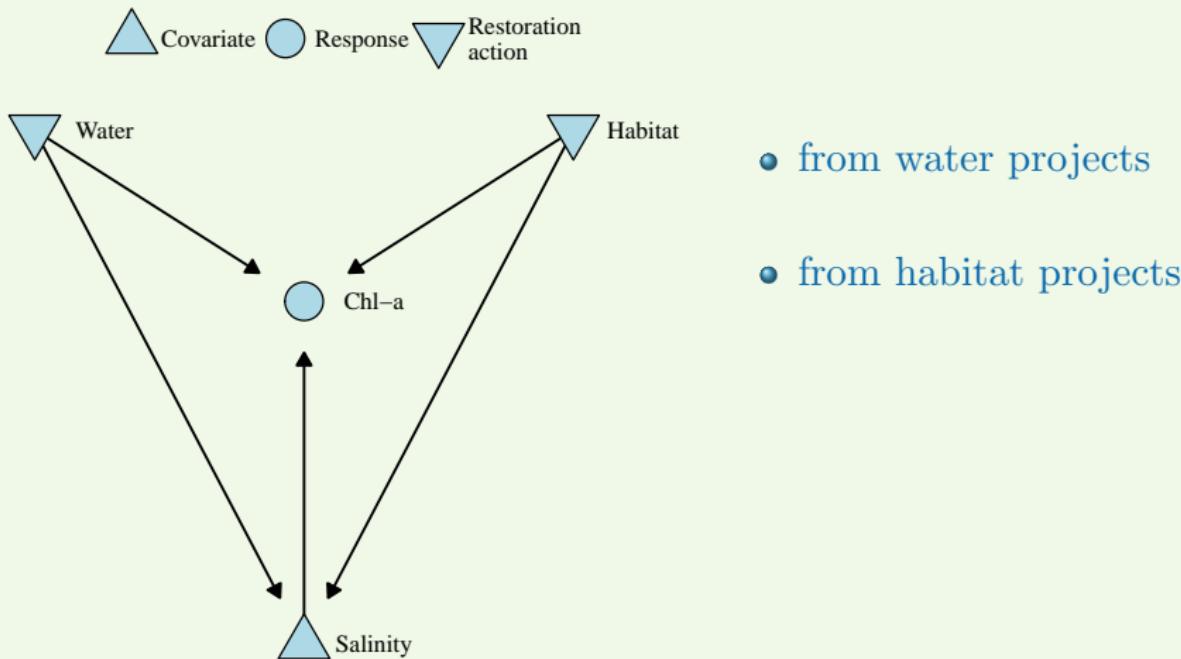
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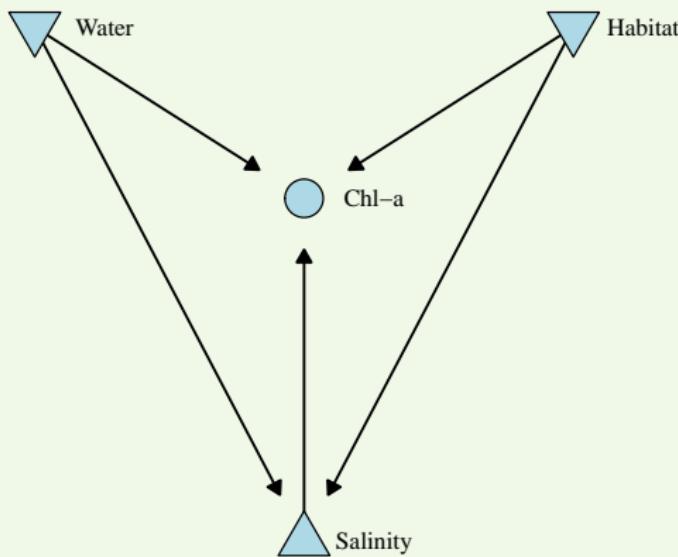
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Using the *conditional probabilities* from the *empirical response*, what's the probability of low chlorophyll...

△ Covariate ○ Response ▼ Restoration action

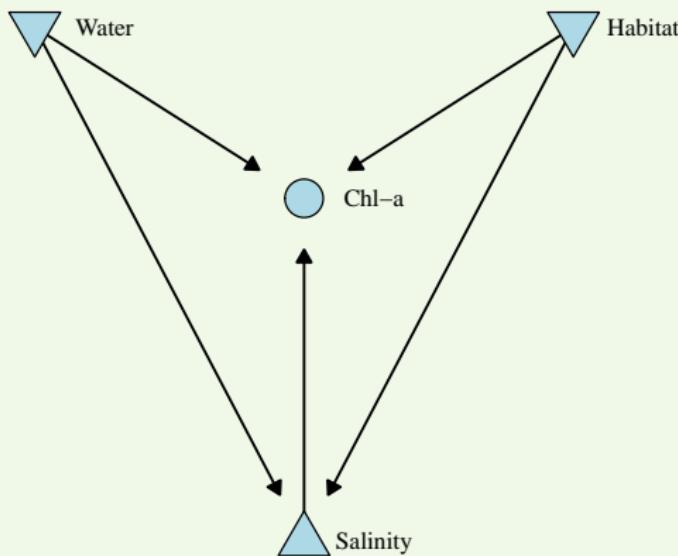


- from water projects
- from habitat projects
- from all projects

Building a decision support tool

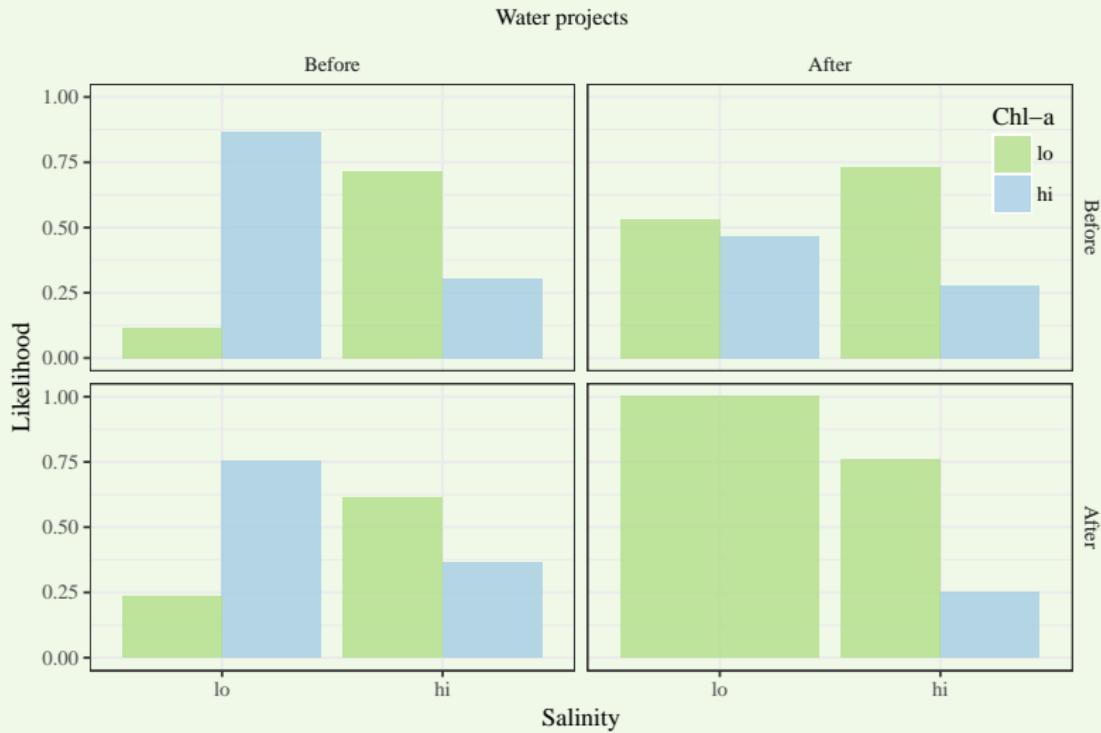
Using the *conditional probabilities* from the *empirical response*, what's the probability of low chlorophyll...

△ Covariate ○ Response ▼ Restoration action



- from water projects
- from habitat projects
- from all projects
- by salinity regime

All possible scenarios:



Individual scenarios: Probability of high chlorophyll

Water projects:

- Before: 53%
- After: 26%

Habitat projects:

- Before: 50%
- After: 50%

Individual scenarios: Probability of **high** chlorophyll

Water projects:

- Before: 53%
- After: 26%

Habitat projects:

- Before: 50%
- After: 50%

Individual scenarios: Probability of **low** chlorophyll

Water projects:

- Before: 46%
- After: 77%

Habitat projects:

- Before: 49%
- After: 51%

Where is the sweet spot?

Probability of low chlorophyll before/after **both project types** by
low/high salinity

Where is the sweet spot?

Probability of low chlorophyll before/after **both project types** by
low/high salinity

Low salinity:

- Before both projects: 13%
- After both projects: 100%

High salinity:

- Before both projects: 69%
- After both projects: 75%

Take home:

- Water infrastructure projects had the largest effect

Take home:

- Water infrastructure projects had the largest effect
- Habitat projects had an effect but less so

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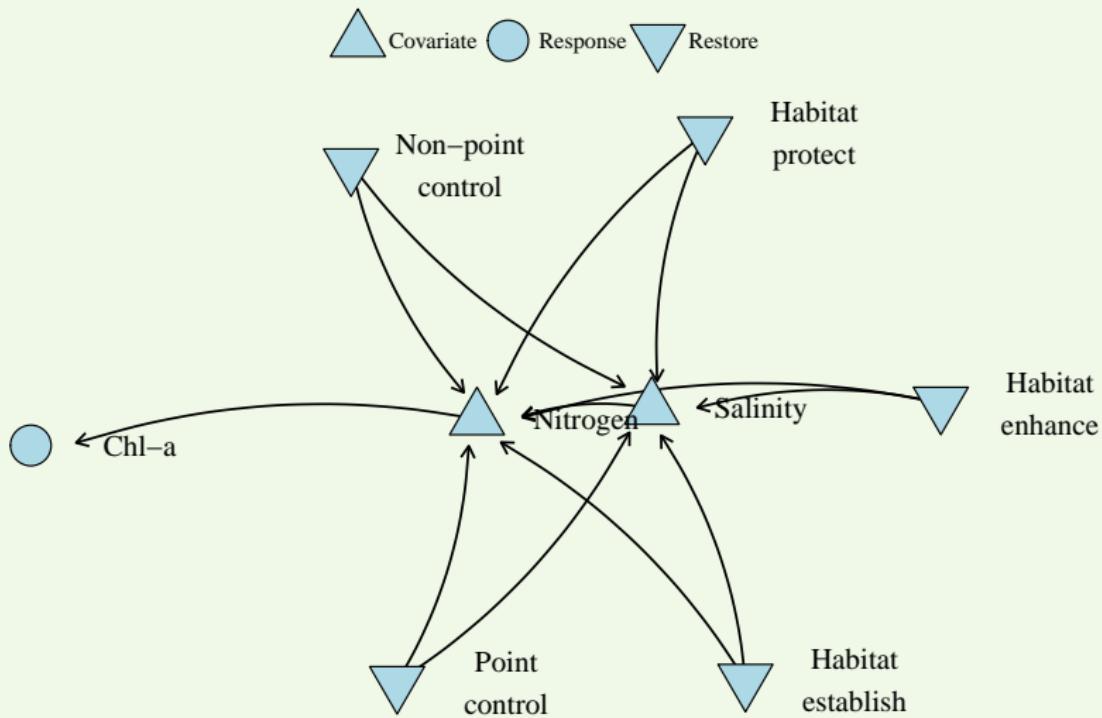
- Depends on year, distance combinations

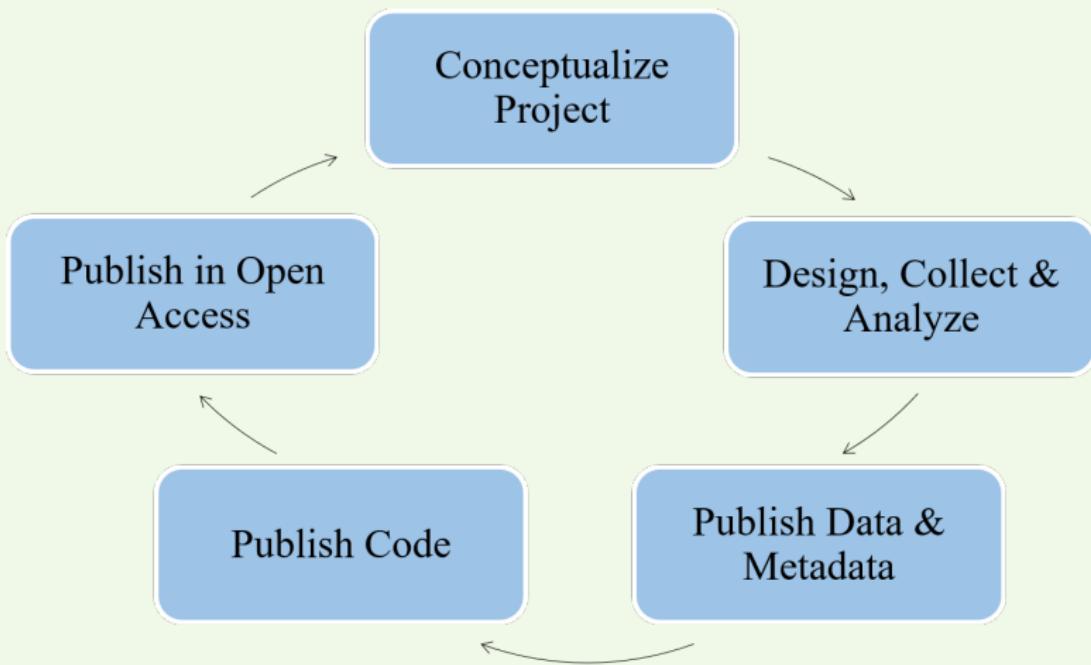
Take home:

- Water infrastructure projects had the largest effect
- Habitat projects had an effect but less so
- Effects most noticeable in low salinity zone

But...

- Depends on year, distance combinations
- This is a simple model

The holy grail:

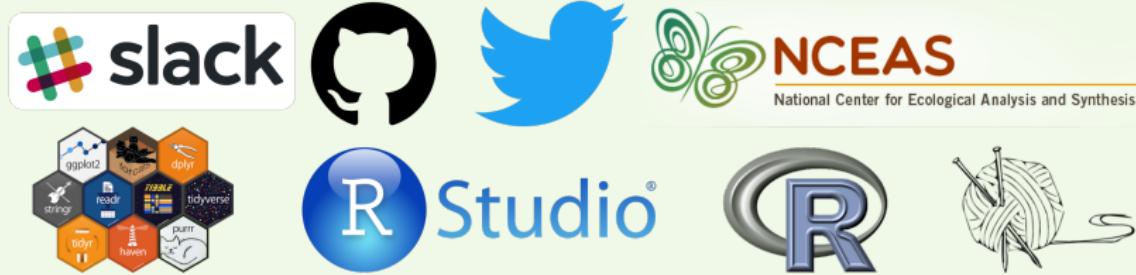


Modified from [Hampton et al., 2015]

Open science workflow

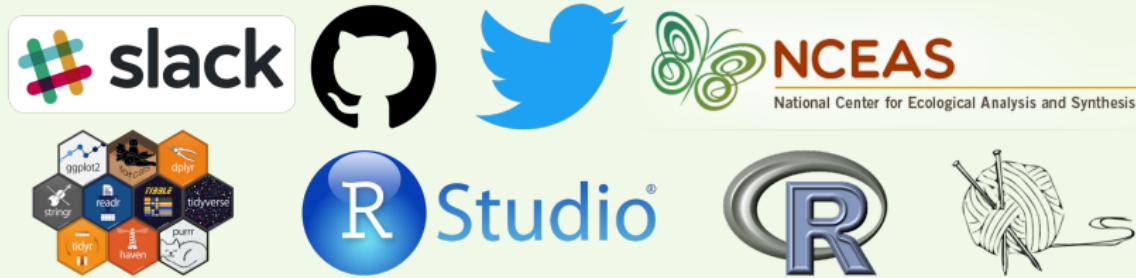
What aspects of our project used and benefitted from open science?

- Early idea conception
- Long distance collaboration
- Transparent and reproducible analysis



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... but the circle is not complete

Acknowledgments:

Research staff and employees at NCEAS: M. B. Jones, A. Budden, T. Neal, B. Mecum, C. Lortie, L. Wasser, J. Brun

The Gulf Research Program

Field staff and data managers at Hillsborough County Environmental Protection Commission

Abel Santana (SCCWRP) for cartography

Funding sources and contact:



marcusb@sccwrp.org, 7147553217

GitHub (project):
<https://github.com/fawda123/restorebayes>

GitHub (presentation):
https://github.com/fawda123/AWRA_2018

Twitter: @fawda123

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