# An Open Science Framework for Research on Cyanobacteria in Lakes and Ponds


## US EPA, Region 7

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2017-10-11

Lenexa, KS

# Twitter?


hashtag: #AAG2017

me: @jhollist

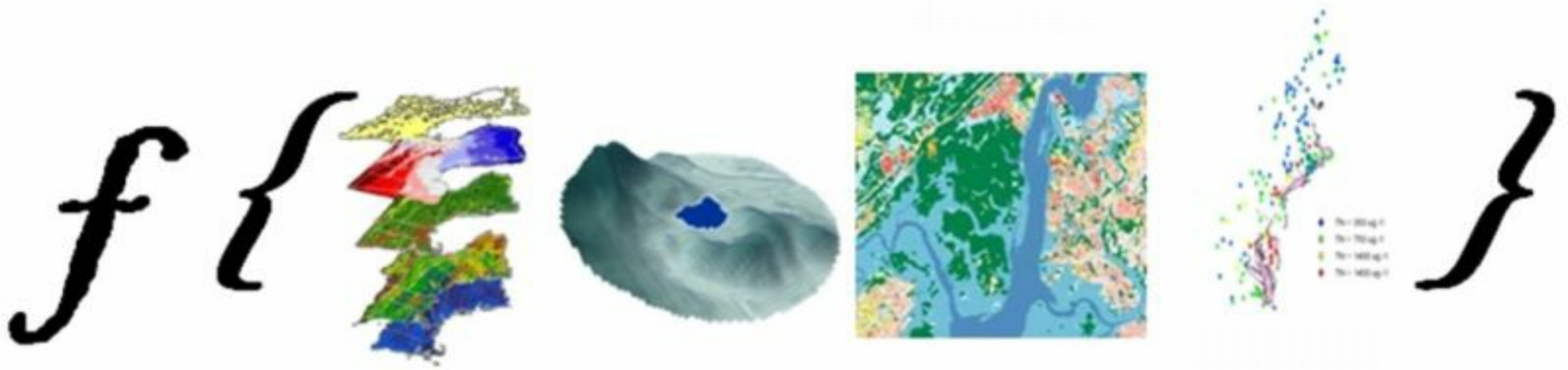
# Who, what, why, and how?

# Who are we?

- Ecologists
- Computational focus
  - Enough to be dangerous
- 3 FTE
  - Myself
  - Betty Kreakie
  - Bryan Milstead
- 2 Post-docs
  - Farnaz Nojavan
  - Stephen Shivers

# What do we do?

- Apply computational approaches to understand water quality impacts in lakes
  - Modelling (Not this talk!, but see Farnaz's talk)
- Open Science



# What is open science?

- Access to materials
- Reproducible/ Repeatable
- The Web!
- A process, not a state

# Why open science?

- Often required
  - Government/Funders/Journals
- Benefits researchers
  - Mciernan et al. (2016) How open science helps researchers succeed
- Improves quality
  - The classic example: Reinhart and Rogoff
- Benefits to society
  - "Sharing of Data Leads to Progress on Alzheimer's"

# How are we open?

- R package development
- Visualization
- Sharing and collaborating
- Publishing
- Open data (not in this talk)

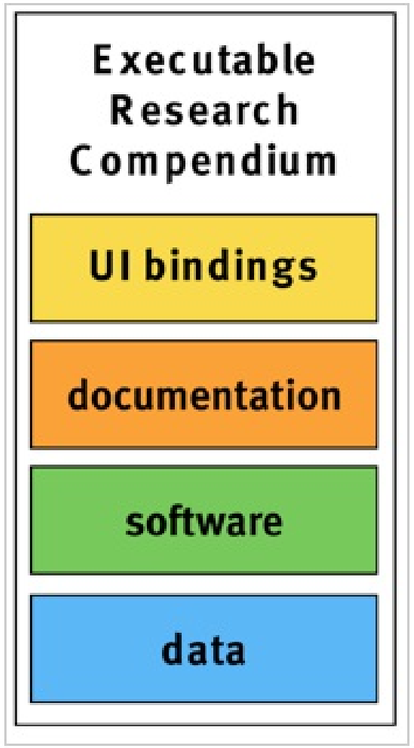
# Packages

# Why Packages

- Useful structure
- Infrastrcutre for sharing
  - GitHub
  - CRAN
- We are an R shop!

# Research Compendia

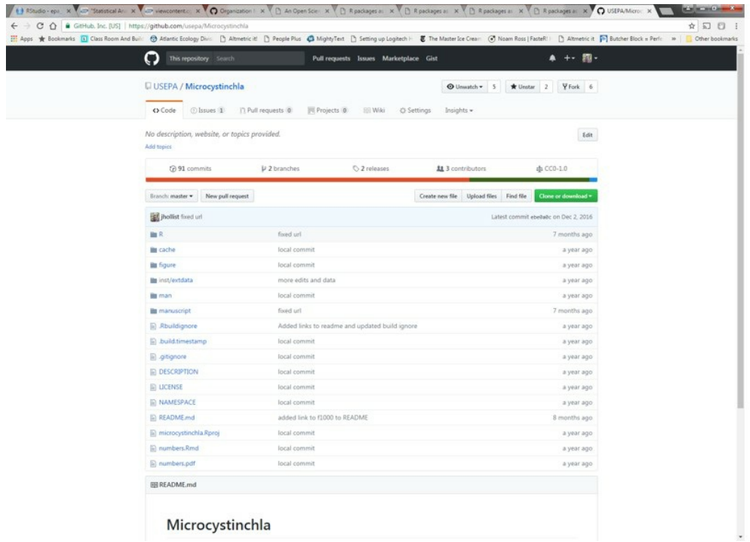
- Define
- Origins
  - Gentleman and Lang (2004)
- Part of
  - Reproducible Research
  - Literate Programming (ala Donald Knuth)
- ROpenSci efforts
  - rrrpkg
  - ROpenSci unconf 2017 discussion

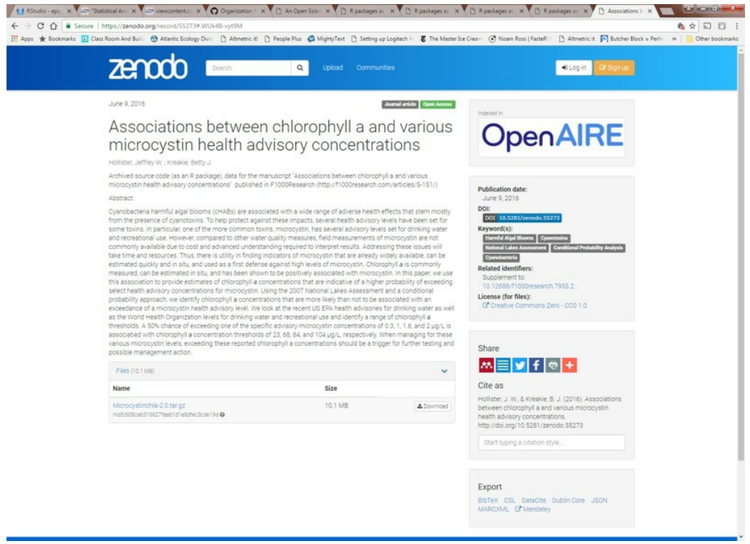



from Nüst, Konkol, et al (2017), https://doi.org/10.1045/january2017-nuest

# Packages as Research Compendia

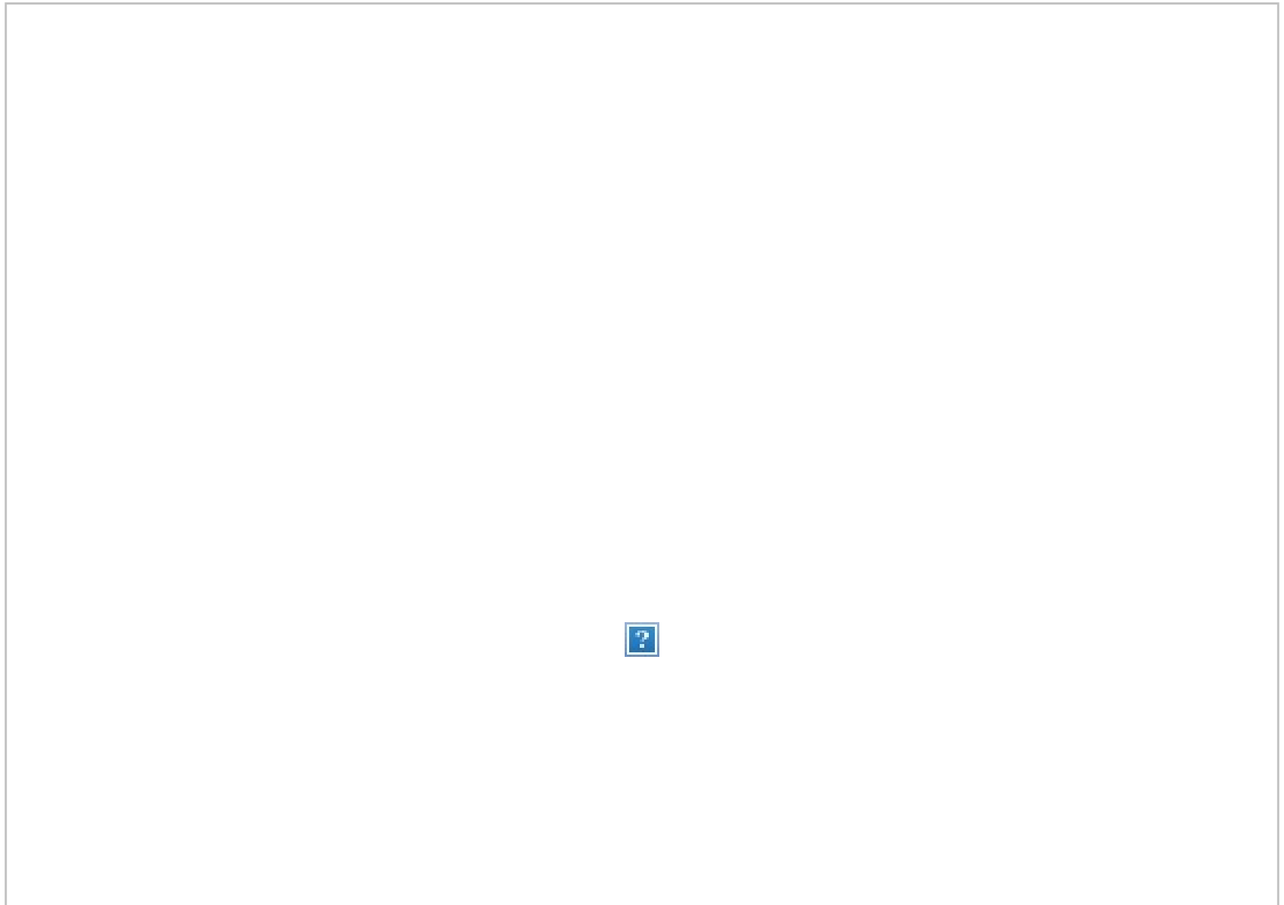
- R, Data, and Vignettes folders
- Other examples
  - Carl Boettiger's template
  - Ben Marwick
- Our examples
  - https://github.com/usepa/LakeTrophicModelling
  - https://github.com/usepa/Microcystinchla)
- GitHub and Zenodo (Archive)



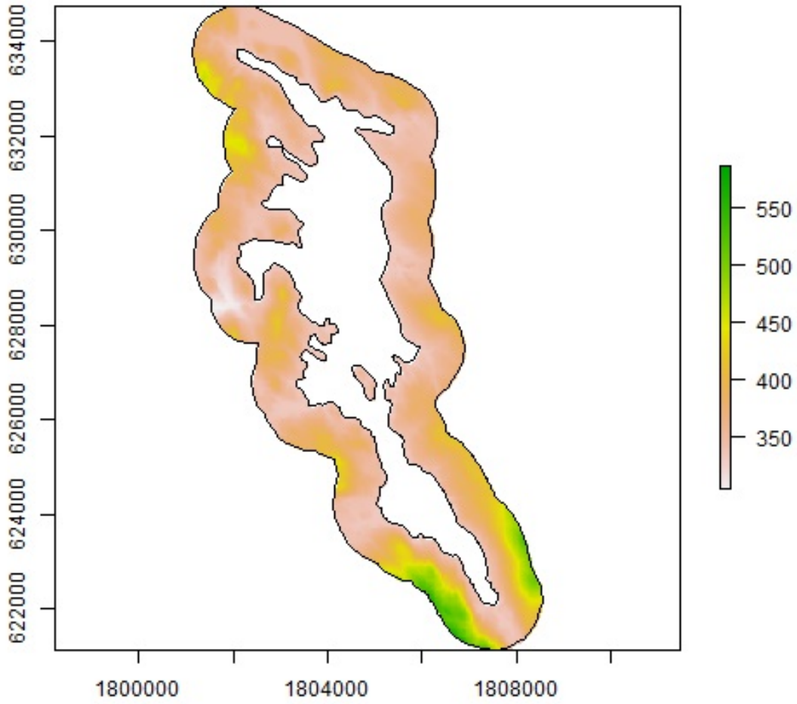
# Packages to solve common problems

- `lakemorpho`
- `elevatr`
- `goatscape` (in development)



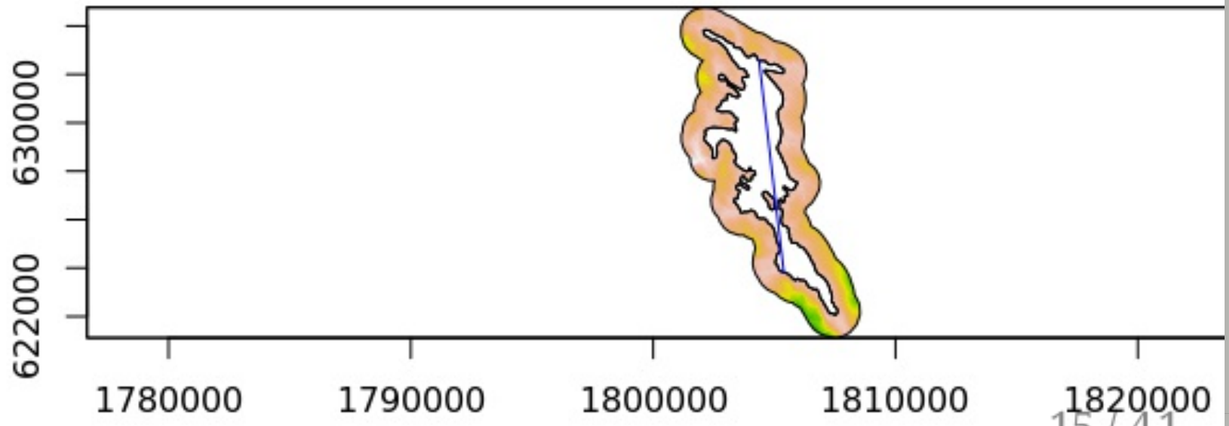
# lakemorpho

- Lake morphometry metrics in R
- Version 1.0
  - August 2014
- Version 1.1.0
  - December 2016
- `sf` support to be added
- National Lake Morphometry
- Hollister and Milstead (2010)
- Hollister *et. al.* (2011)
- Hollister and Stachelek (2017)



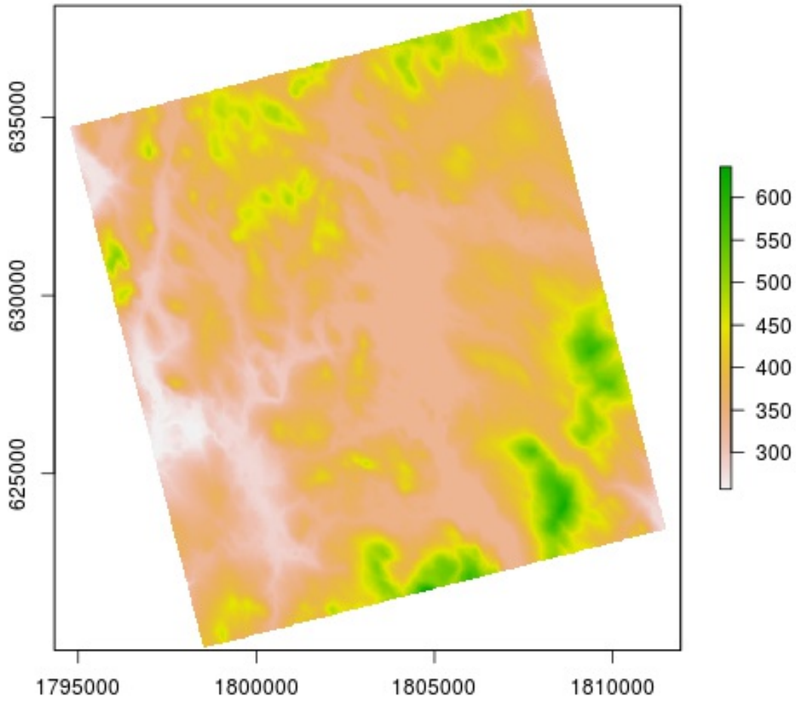

Package URL: https://cran.r-project.org/package=lakemorpho

# lakemorpho::demo



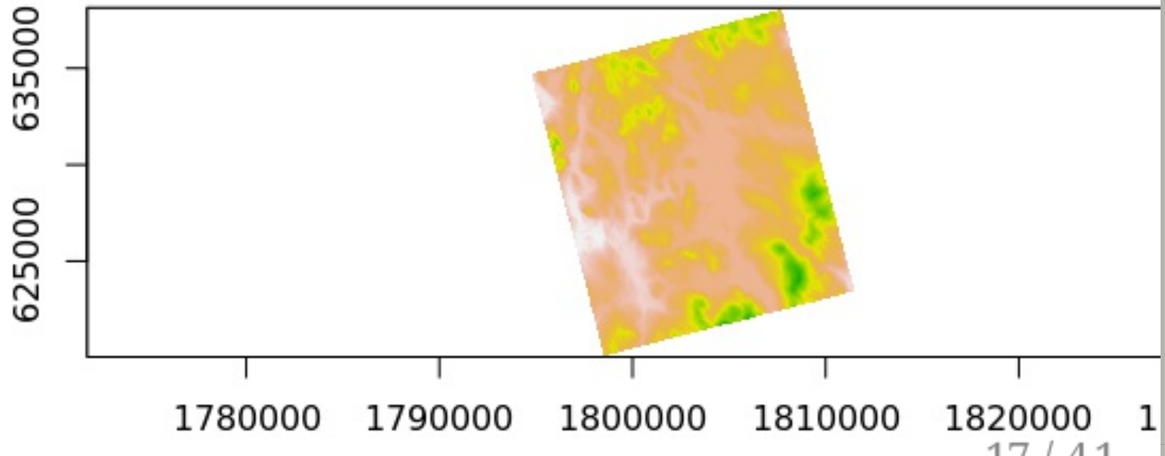
# elevatr

- Access elevation data in R
  - Mapzen
  - AWS
  - USGS
- Version 0.1.1
  - January 2017
- Version 0.1.3
  - March 2017
- Will be paired with `lakemorpho`
- `sf` support to be added



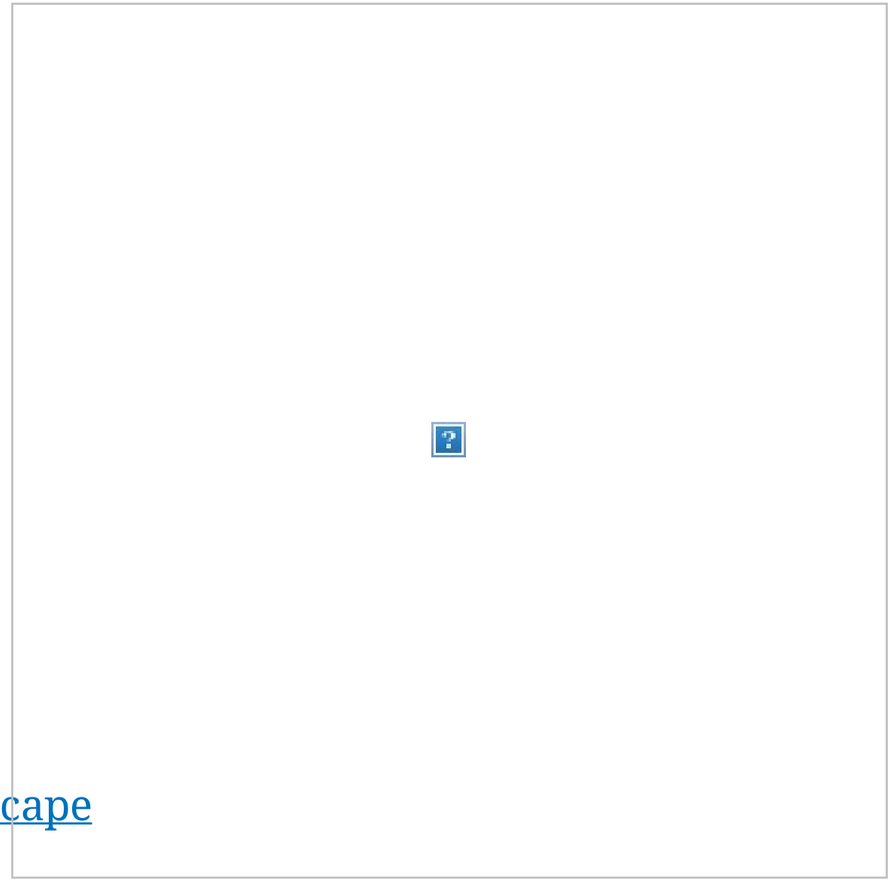

Package URL: https://cran.r-project.org/package=elevatr

# elevatr::demo



# goatscape

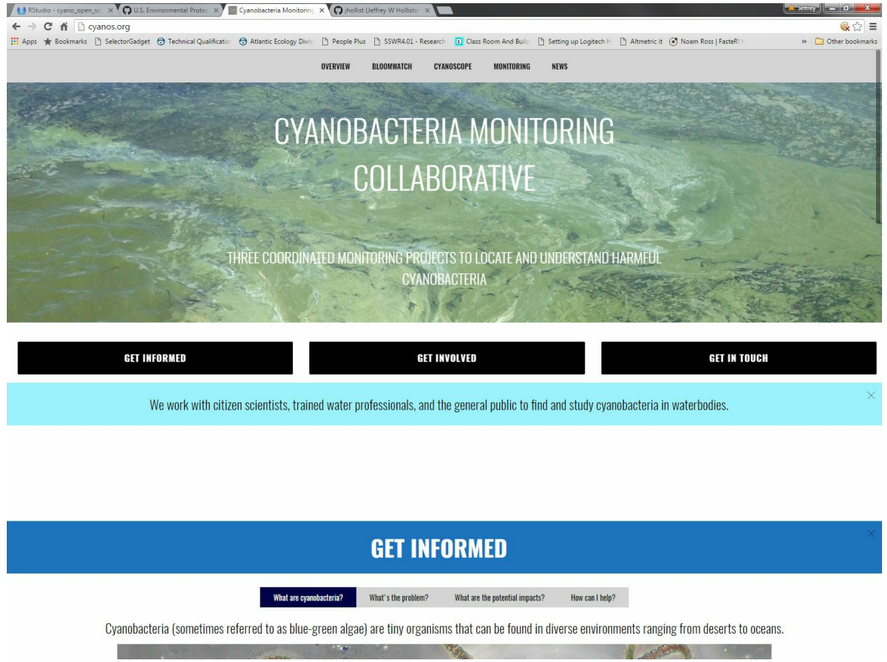
- New effort with Bryan Milstead
- What's in a name?
- Summarizes ancillary data for a user-define landscape polygon
  - Census (via `censusapi`)
  - Landscover
  - Impervious
- Accepts arbitrary spatial data for the landscape
- Based on `sf` and tidy by design
- https://github.com/usepa/goatscape



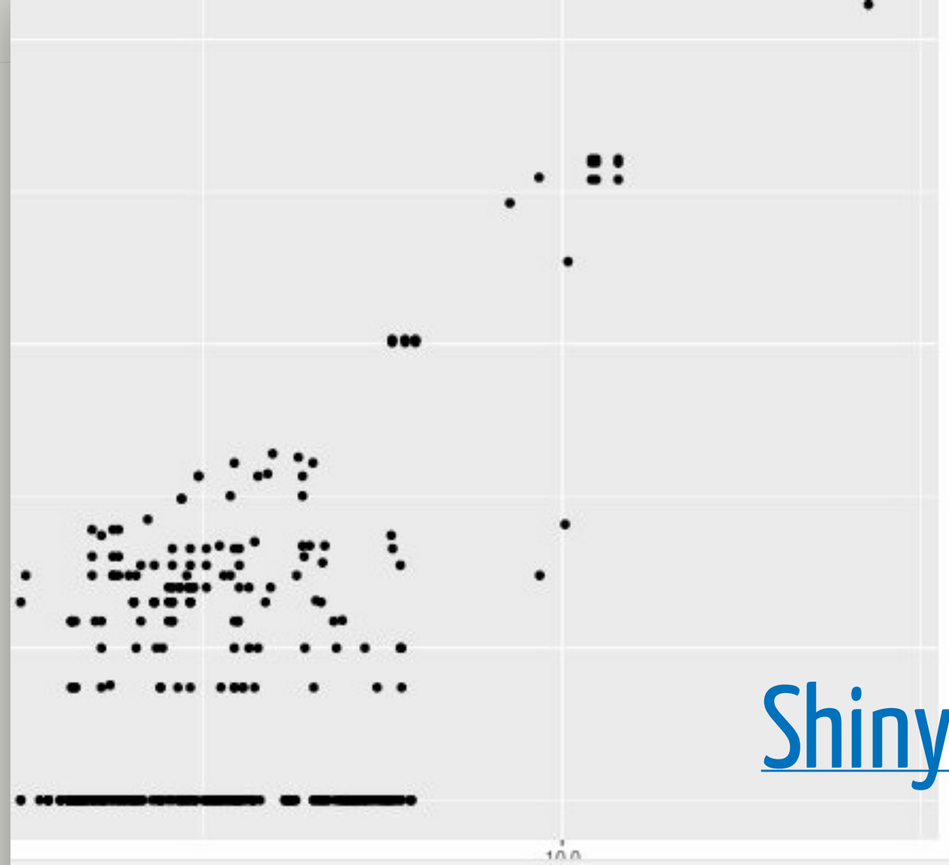
# Data Visualization

# Shiny: Cyanobacteria Monitoring Collaborative

- Started in 2013
  - New England Region Cyanobacteria Monitoring Workgroup
- Three Projects
  - bloomWatch
  - cyanoScope
  - Monitoring
- DataViz with Shiny

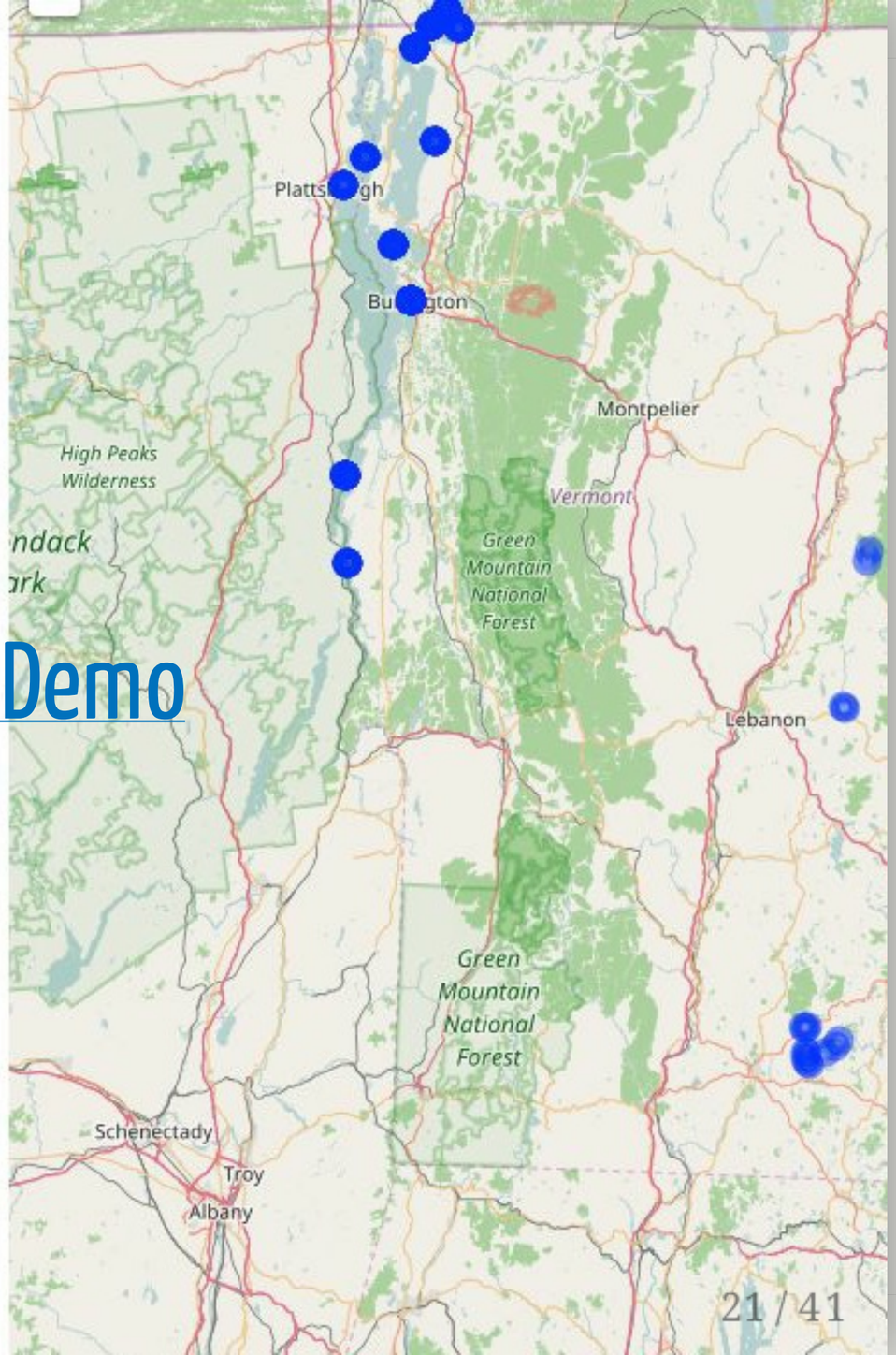



Project URL: http://cyanos.org



| Date | Chlorophyll | Phycocyanin |
|---|---|---|
| 2014-09-03 | 71.37 | 16998.17 |
| 2014-07-10 | 2.18 | 0.10 |
| 2014-07-17 | 2.44 | 1.52 |
| 2014-08-08 | 3.17 | 0.10 |
| 2014-08-08 | 3.57 | 0.10 |
| 2014-08-08 | 3.22 | 0.10 |

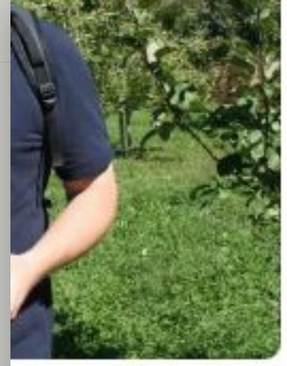
# Shiny: Demo



# Sharing and Collaborating

# GitHub

- What is it?
- How do we use it?



Hollister

pen Science at

al Protection A...

.gov

com

Pinned repositories

Customize yo

**quickmapr**

An R package for quickly mapping and navigating spatial data

R 44 6

**elevatr**

An R package for accessing elevation dat

R 33 4

**rmd_word_manuscript**

rmd to docx: draft manuscript

TeX 17

**ropensci/lawn**

turf.js R client

R 42 8

# GitHub: Demo

**USEPA/lakemorpho**

ORD lakemorpho

R 8 7

**manuscriptPackage**

Template for writing manuscripts as an R

R 30 6

1,876 contributions in the last year

Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb

Mon

# Open Access

# Publishing

- Preprints
  - Hollister *et al.* (2016) PeerJ Preprints
- Open first
  - Milstead *et al.* (2013) PLoS One
  - Hollister and Kreakie (2016) F1000Research
- Money where our mouth(s) is(are)
  - Kreakie *et al.* (2015) LakeLines



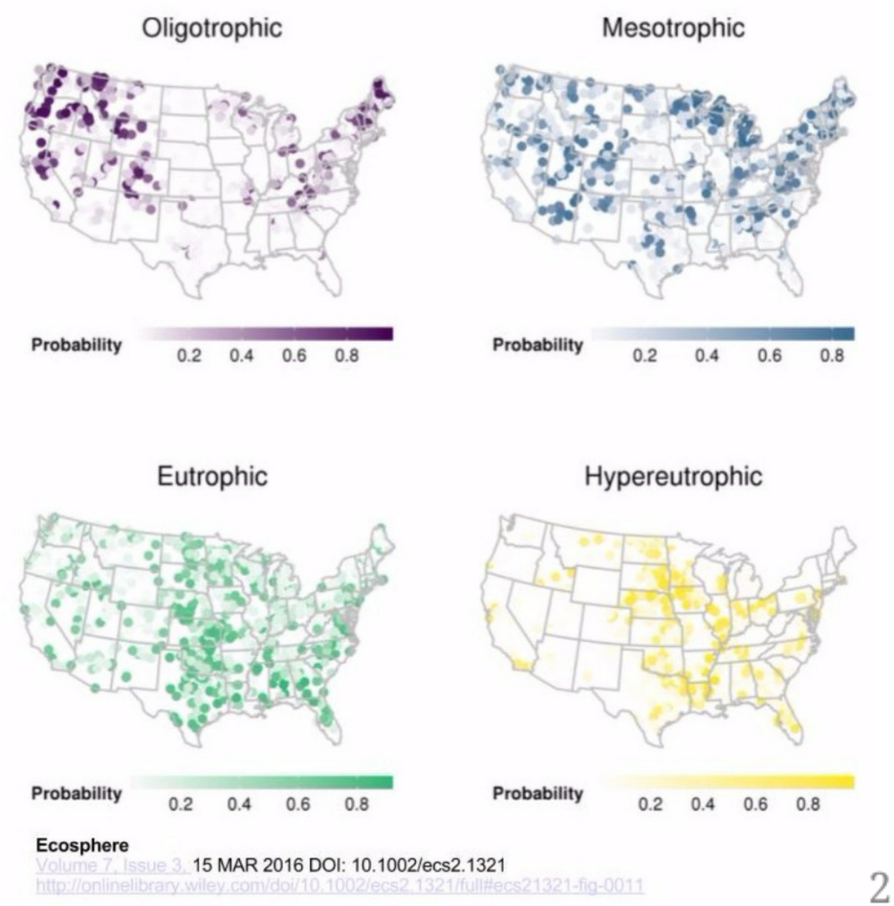

# Research efforts

# Models and field research

- Random forest models of trophic state and chlorophyll **a**
- Re-thinking the Lake Trophic State Index
- Chlorophyll *a* and microcystin
- Temporal and spatial dynamics of cyanobacteria blooms
- New work
  - Lake photic zone temperature
  - Phytoplankton community analysis

# Random forest models of trophic State and chlorophyll a

- National
- Data
  - National Lakes Assessment
  - Landcover
- `randomForest` package
- Variable selection
- All variables (water quality and GIS)
  - 68.7% Total Accuracy
- GIS only variables
  - 49% Total Accuracy
- But …



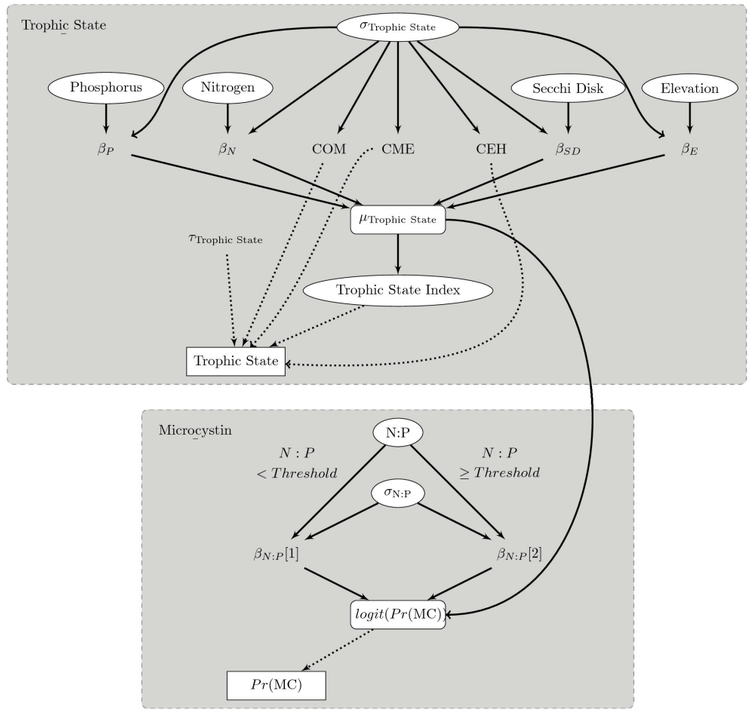

Ecosphere
Volume 7, Issue 3, 15 MAR 2016 DOI: 10.1002/ecs2.1321
http://onlinelibrary.wiley.com/doi/10.1002/ecs2.1321/full#ecs21321-fig-0011

# Random forest models of trophic State and chlorophyll a

- How is it open and reproducible?
  - GitHub
  - 10.5281/zenodo.40271
  - PeerJ Pre-print
  - Ecosphere (OA)

# Re-thinking the Lake Trophic State Index

- Led by Farnaz Nojavan
- Hierarchical model
  - Nitrogen and Phosphorus
  - POLR: Revised Trophic State Index
- Total Accuracy
  - 0.6
- Balanced Accuracy
  - 0.68 to 0.78



# Re-thinking the Lake Trophic State Index

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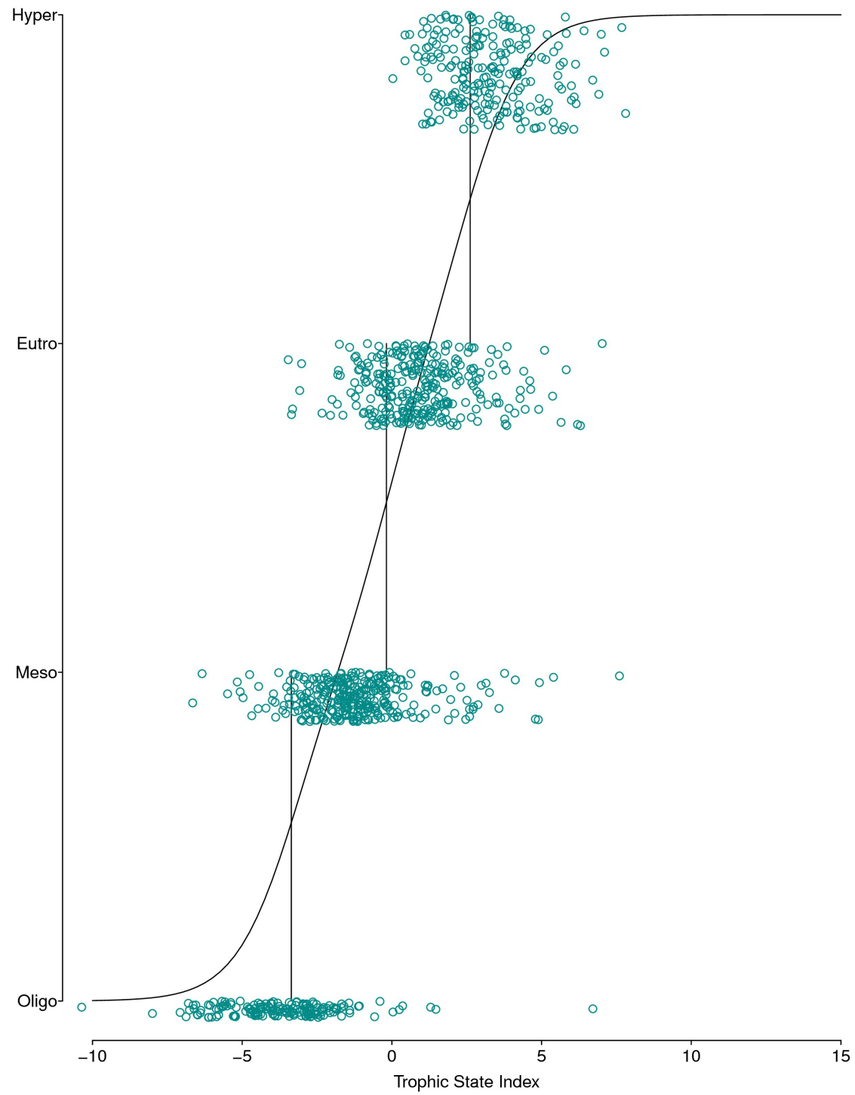
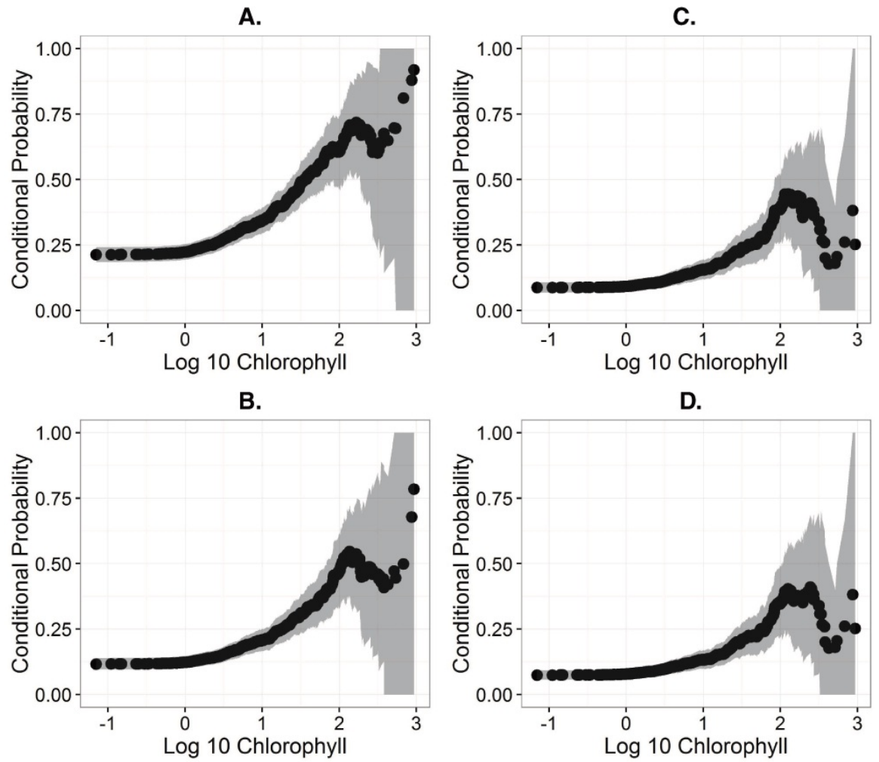


# Re-thinking the Lake Trophic State Index

- How is it open and reproducible?
  - GitHub
  - 10.5281/zenodo.556175
  - OA (when published)

# Chlorophyll a and microcystin

- National
- Diagnostic tool
- Probability
  - Exceeding microcsytin advisory
  - Given chlorophyll *a* concentration



# Chlorophyll a and microcystin

- The numbers!

| Cond. Probability | USEPA Child (0.3 µg/L) | WHO Drink (1 µg/L) | USEPA Adult (1.6 µg/L) | WHO Recreational (2 µg/L) |
|---|---|---|---|---|
| 0.1 | 0.07 | 0.07 | 0.07 | 1 |
| 0.2 | 0.07 | 4 | 12 | 17 |
| 0.3 | 3 | 17 | 32 | 45 |
| 0.4 | 11 | 37 | 68 | 77 |
| 0.5 | 23 | 68 | 84 | 104 |
| 0.6 | 39 | 97 | 115 | 185 |
| 0.7 | 66 | 126 | 871 | 871 |
| 0.8 | 116 | 271 | 871 | 871 |
| 0.9 | 170 | 516 | 871 | 871 |

# Chlorophyll a and microcystin

- How is it open?
  - GitHub
  - Zenodo
  - F1000Research
    - Pre-print and peer-reviewed in one!

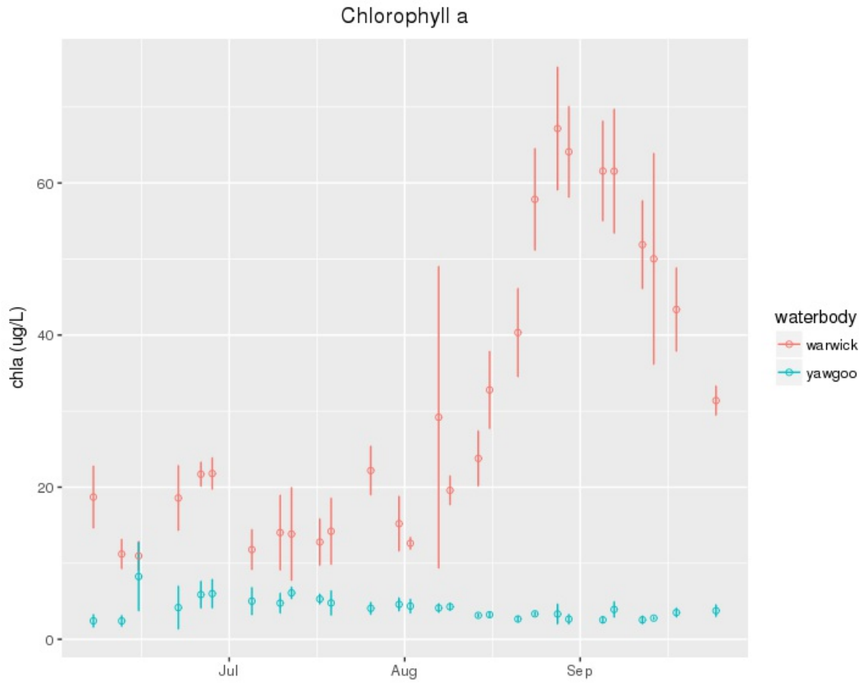
# Temporal and spatial dynamics of cyanobacteria blooms

- Led by Stephen Shivers
- Rhode Island
- Field effort
- 2 ponds
  - Yawgoo Pond (the nice wooded site)
  - Warwick Pond (gritty and (somewhat) urban site)
- Twice weekly
- Seven sampling locations in each

need maps

# Temporal and spatial dynamics of cyanobacteria blooms

- Measurements
  - Chlorophyll *a*
  - Phycocyanin
  - Microcystin
  - Turbidity
  - Physical profiles
  - Secchi
  - Plankton
  - Nutrients



# Temporal and spatial dynamics of cyanobacteria blooms

- How will it be open?
  - Private (for now) GitHub
  - Zenodo
  - Open Access publications
  - Data publication?

image of repo

# New work

- Lake photic zone temperature
- Phytoplankton community analysis

# Thanks!


## Jeff Hollister

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Slides created via the R package **xaringan**.