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

US EPA, Region 7

Jeff Hollister, Farnaz Nojavan, Betty Kreakie, Stephen Shivers, and Bryan Milstead

2017-10-11

Lenexa, KS

Twitter?

hashtag: #cyanobacteria

me: @jhollist

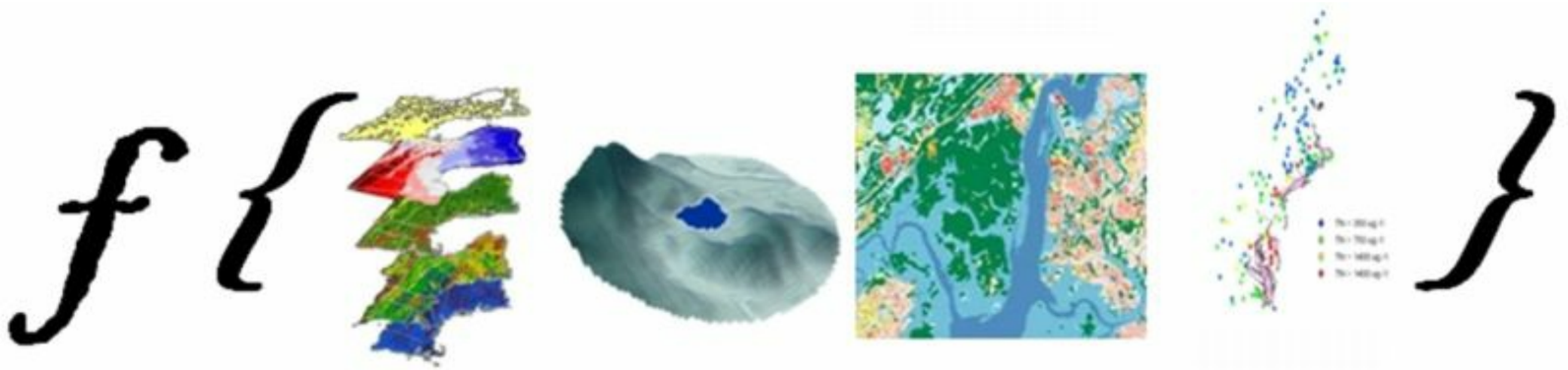
Who, what, why, and how?

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
- 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
  - Research compendia
  - Tooling for common problems
- Visualization
- Sharing and collaborating
- Publishing
- Apply to our research efforts

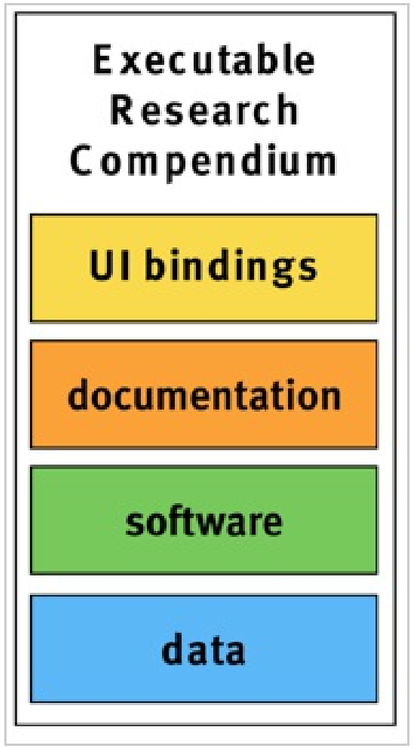
R Packages

Why R Packages

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

Research Compendia

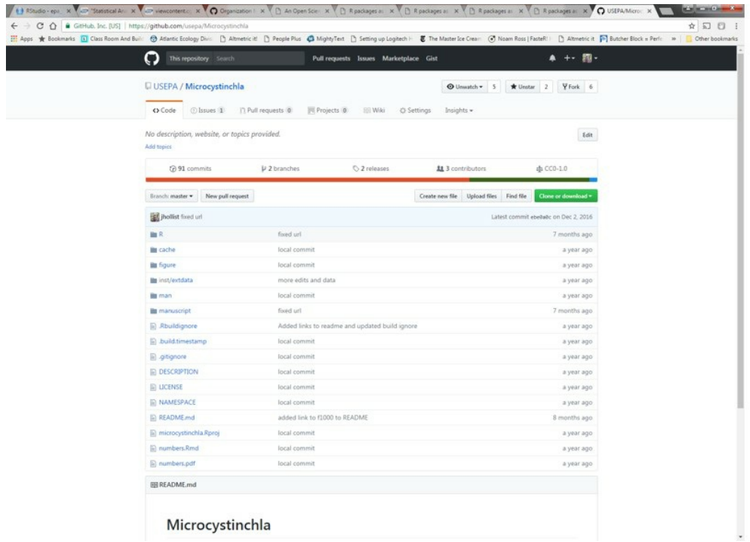
- Define
- Origins
  - Gentleman and Lang (2004)
- Part of
  - Reproducible Research
  - Literate Programming (ala Donald Knuth)
- ROpenSci efforts
  - rrrpkg
  - ROpenSci unconf 2017 discussion

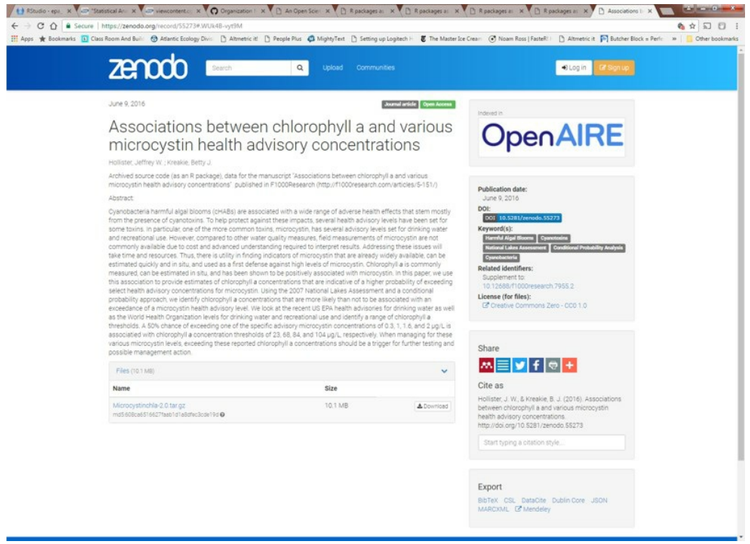


from Nüst, Konkol, et al (2017), https://doi.org/10.1045/january2017-nuest

Packages as Research Compendia

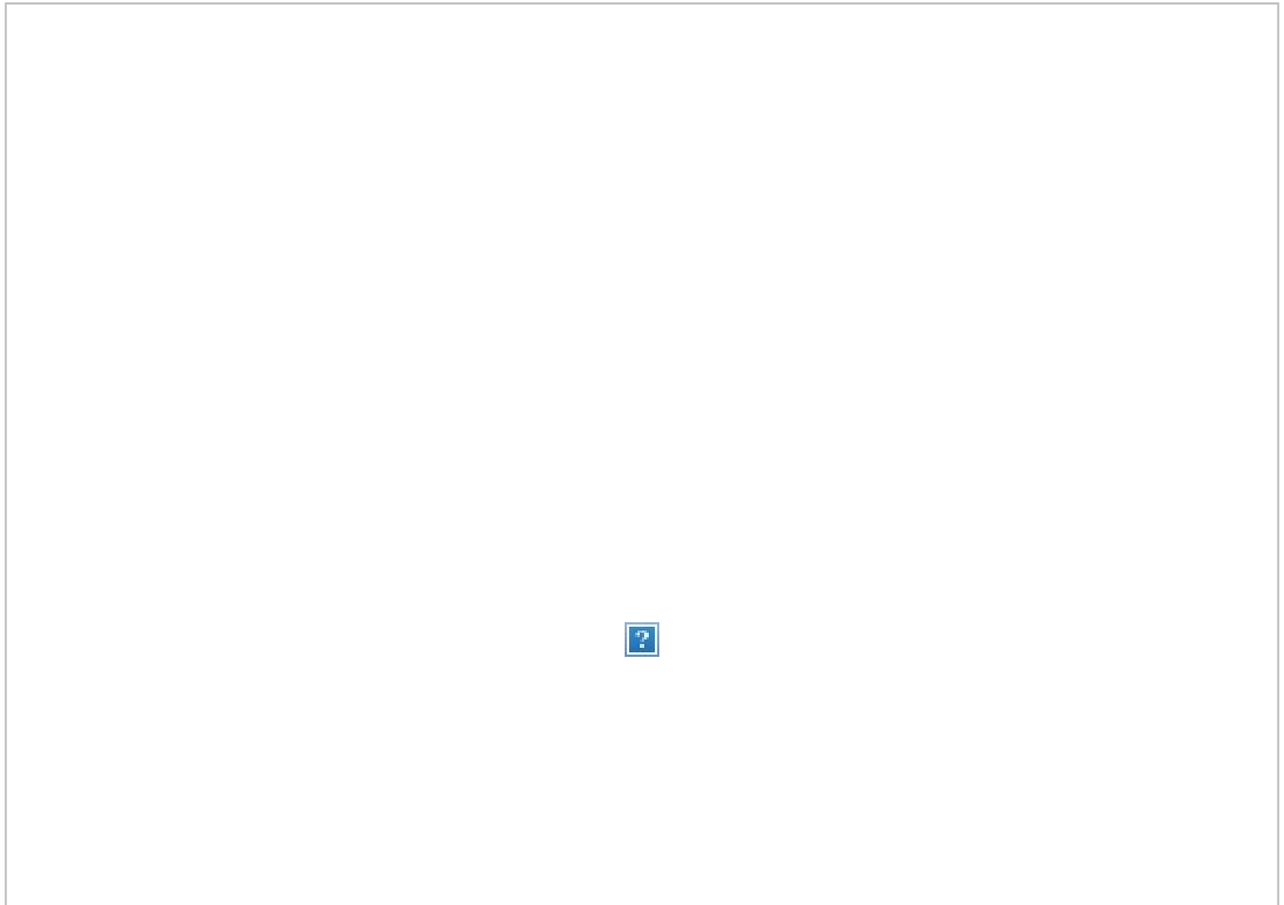
- R, Data, and Vignettes folders
- Other examples
  - Carl Boettiger's template
  - Ben Marwick
- Our examples
  - https://github.com/usepa/LakeTrophicModelling
  - https://github.com/usepa/Microcystinchla)
- GitHub and Zenodo (Archive)





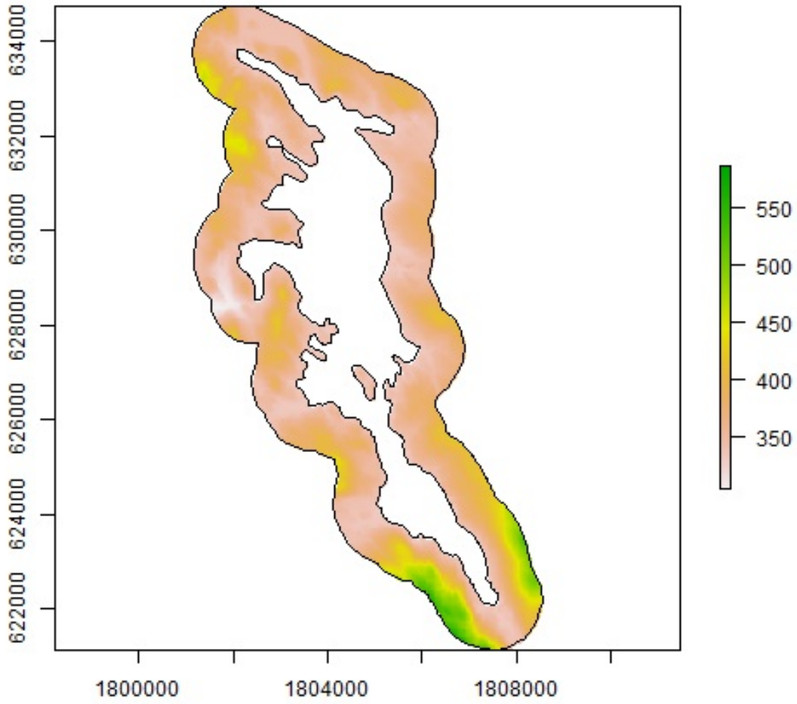
Packages to solve common problems

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



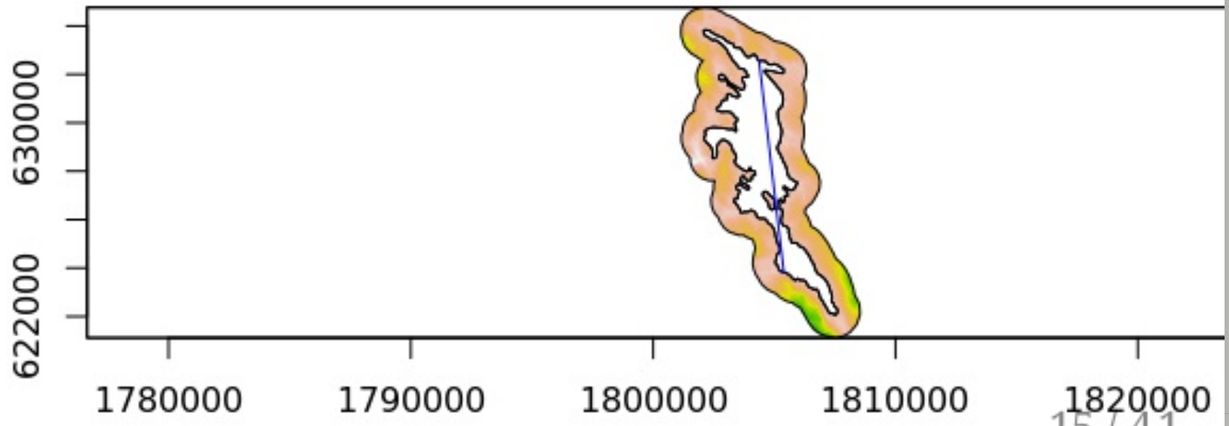
lakemorpho

- 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)



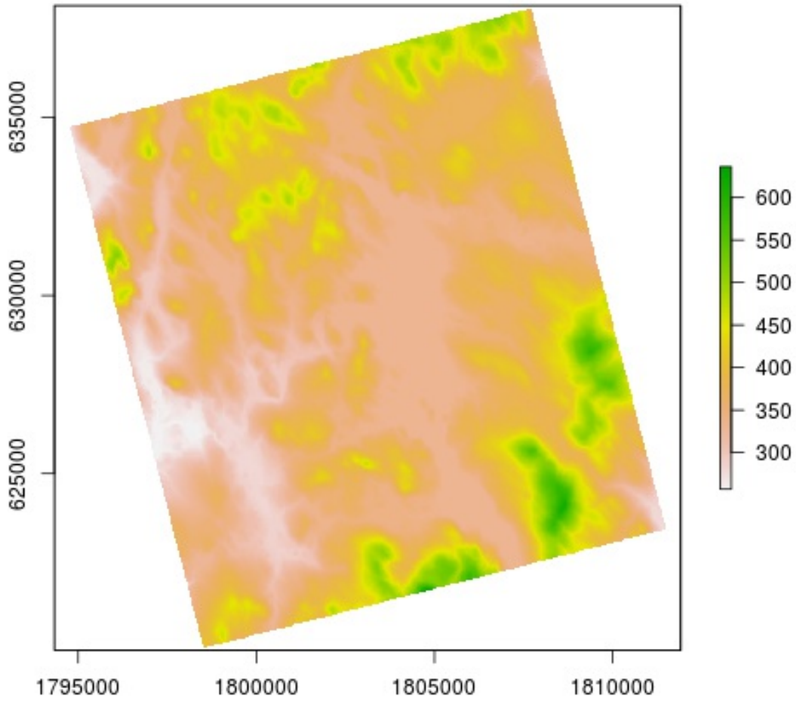
Package URL: https://cran.r-project.org/package=lakemorpho

lakemorpho::demo



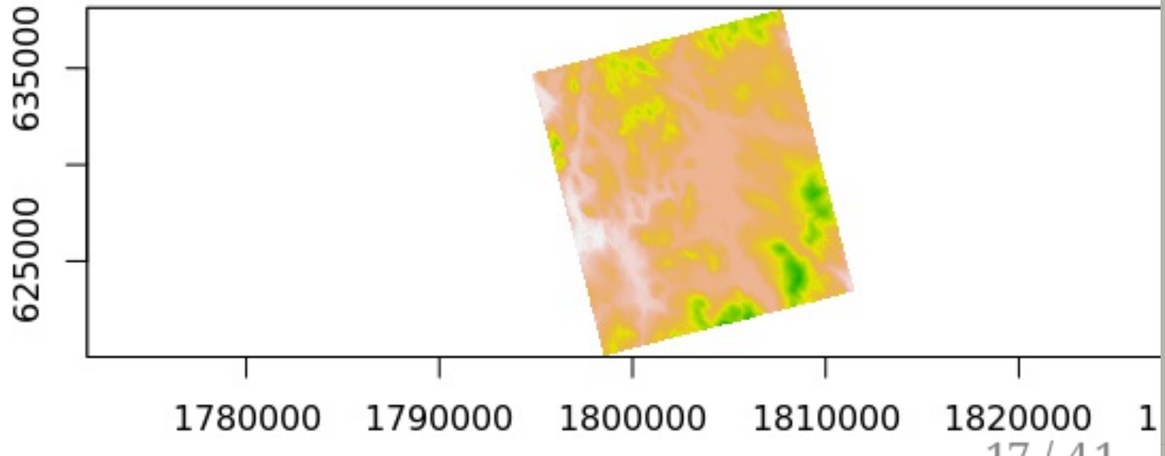
elevatr

- 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



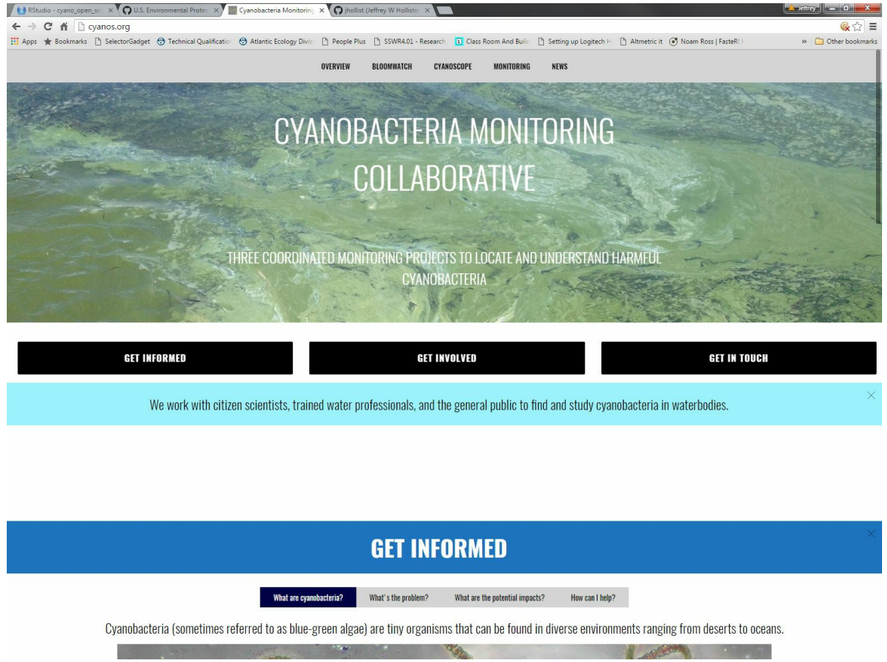
goatscape

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

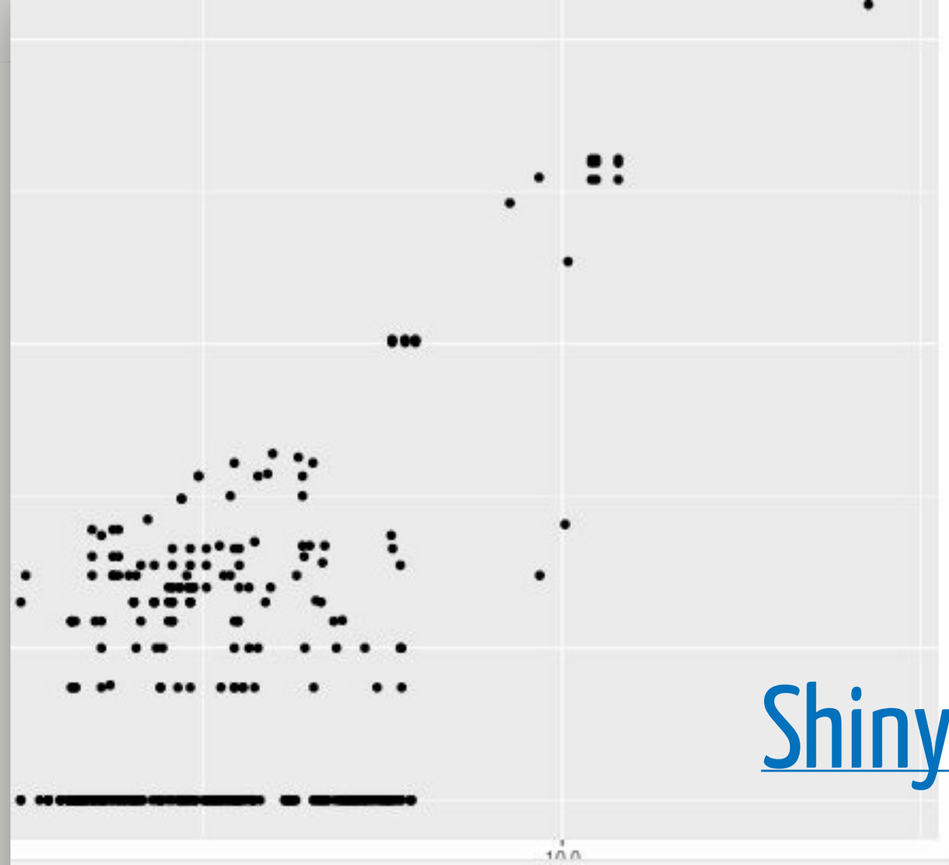
Data Visualization

Shiny: Cyanobacteria Monitoring Collaborative

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

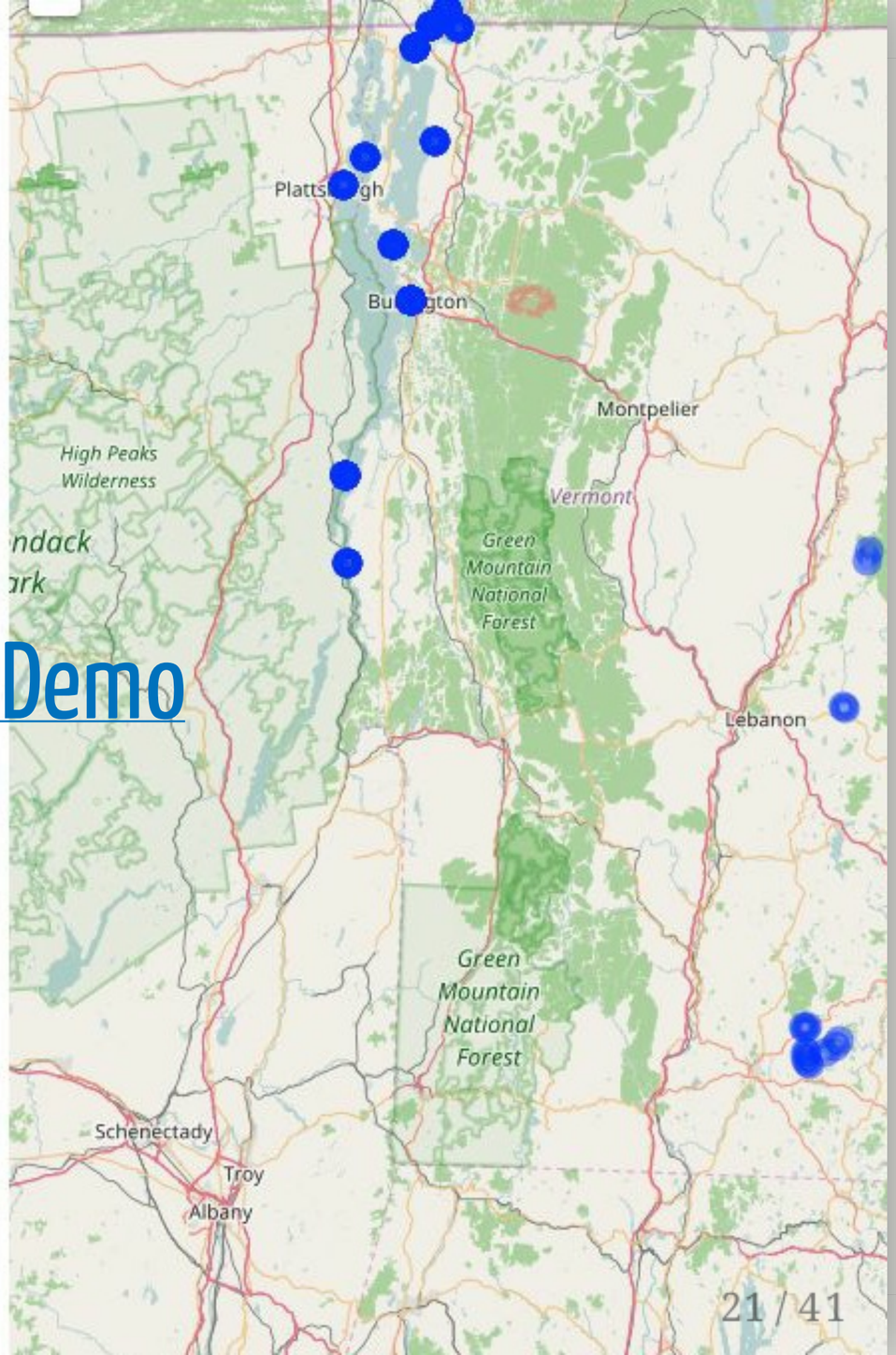


Project URL: http://cyanos.org



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

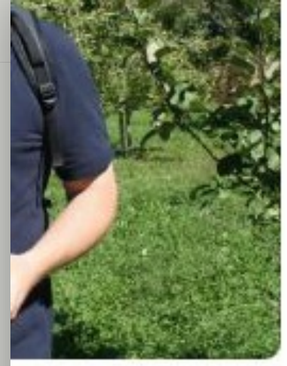
Shiny: Demo



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

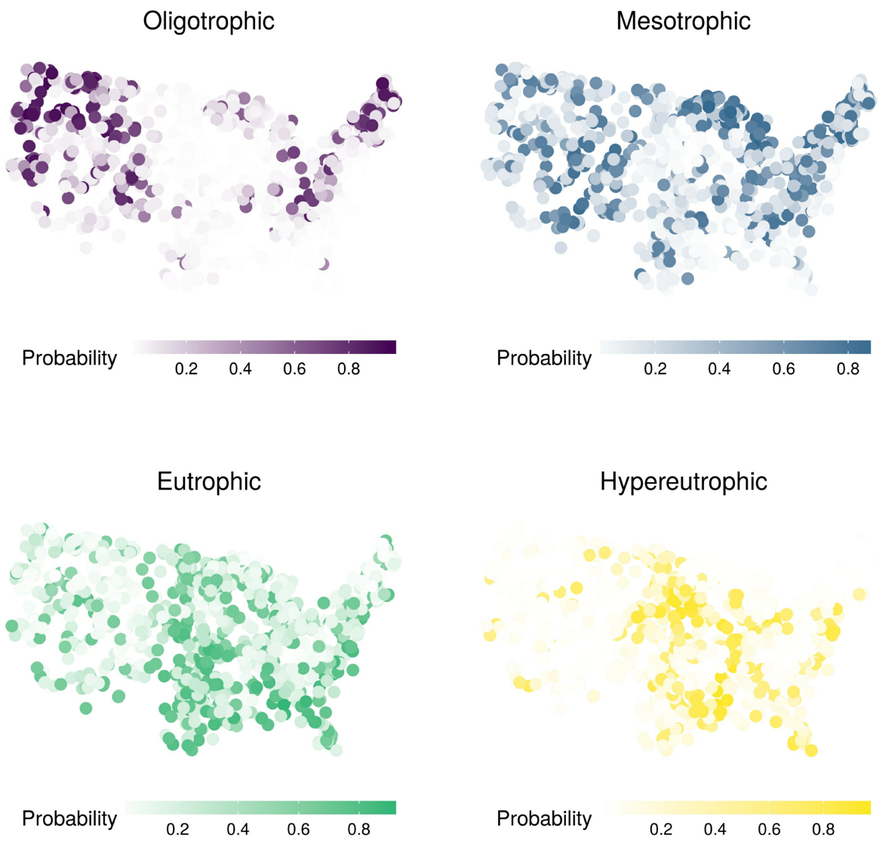
Open Science Research

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

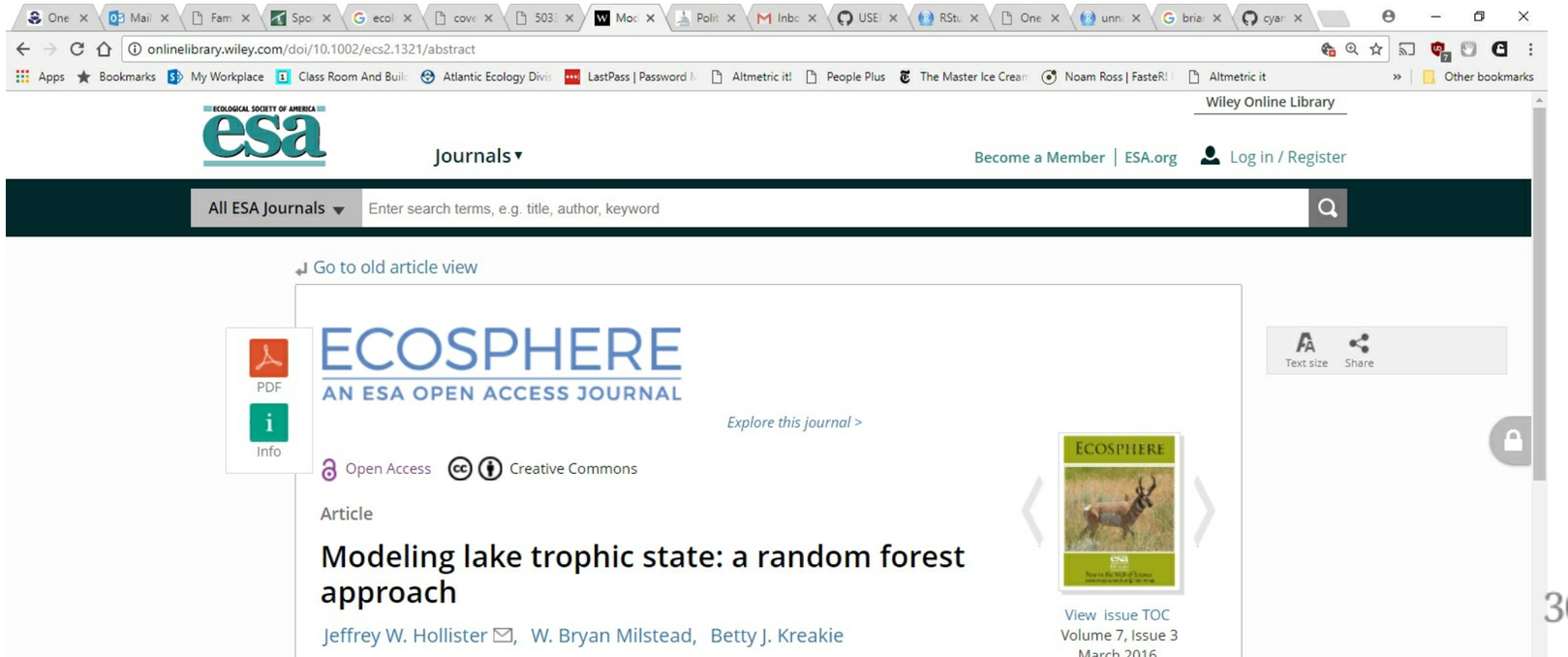
Random forest models of trophic state and chlorophyll a

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



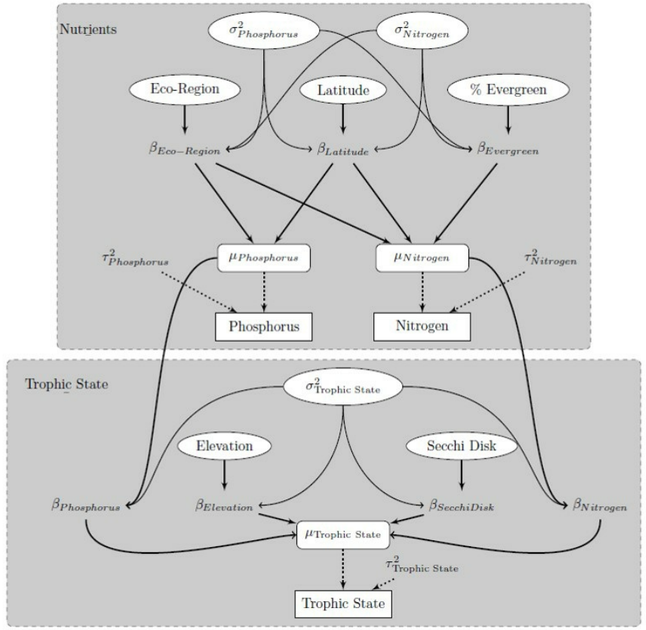
Random forest models of trophic state and chlorophyll a

- 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



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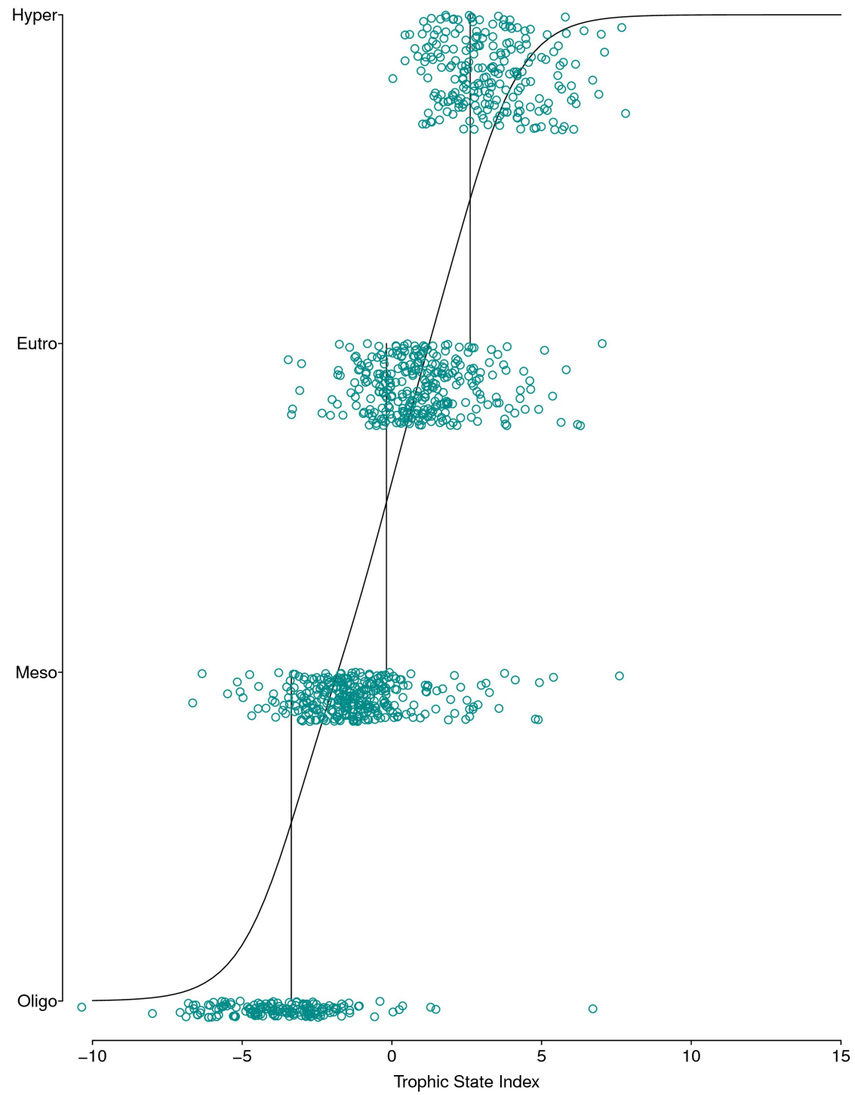
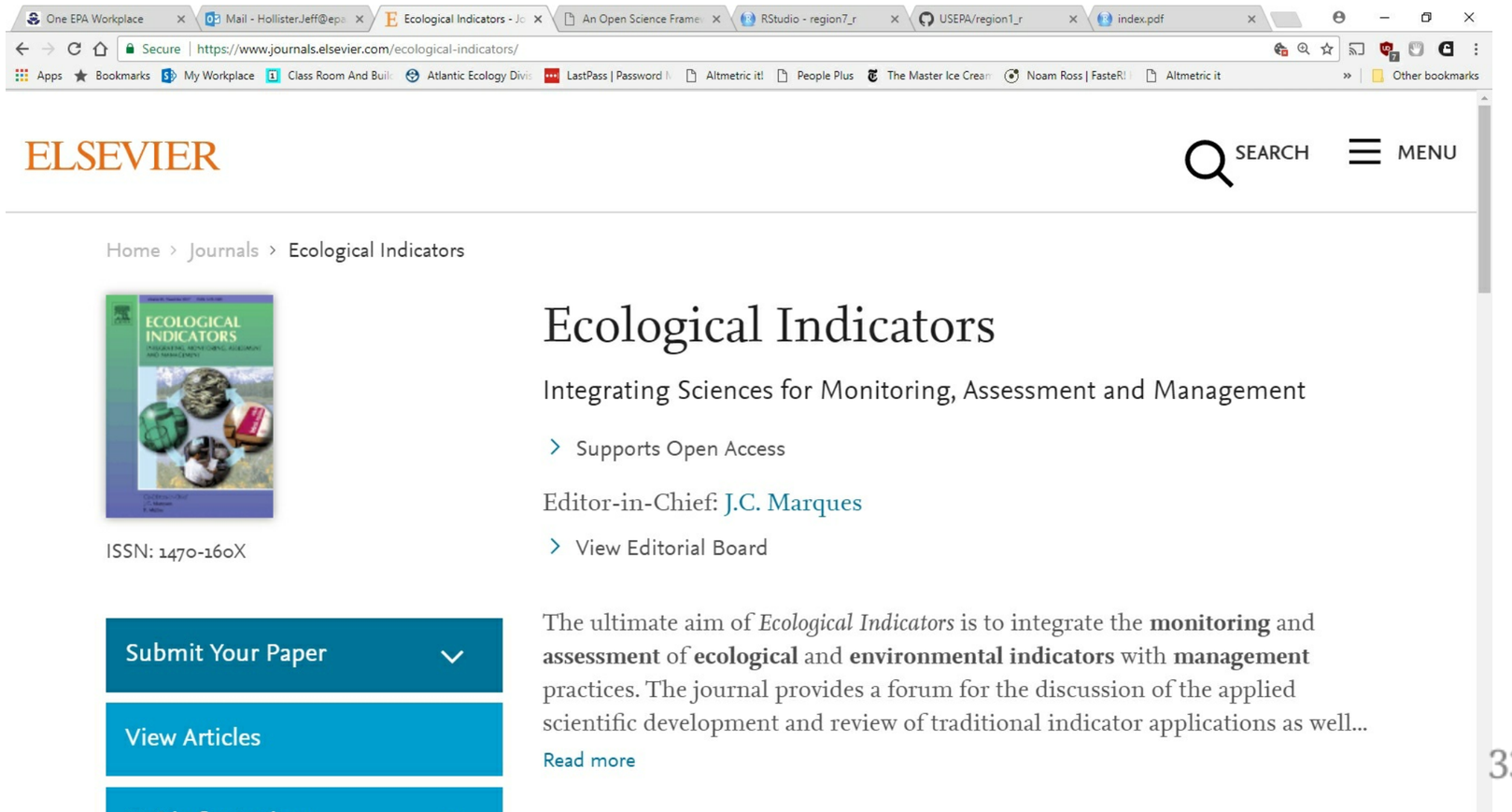


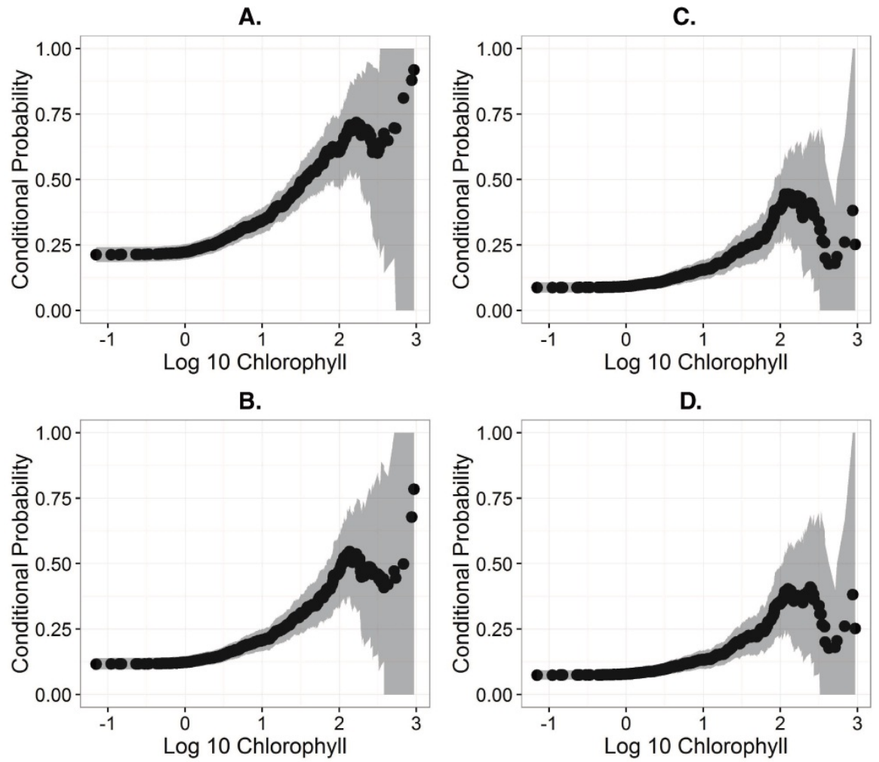
Re-thinking the Lake Trophic State Index

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



Chlorophyll a and microcystin

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



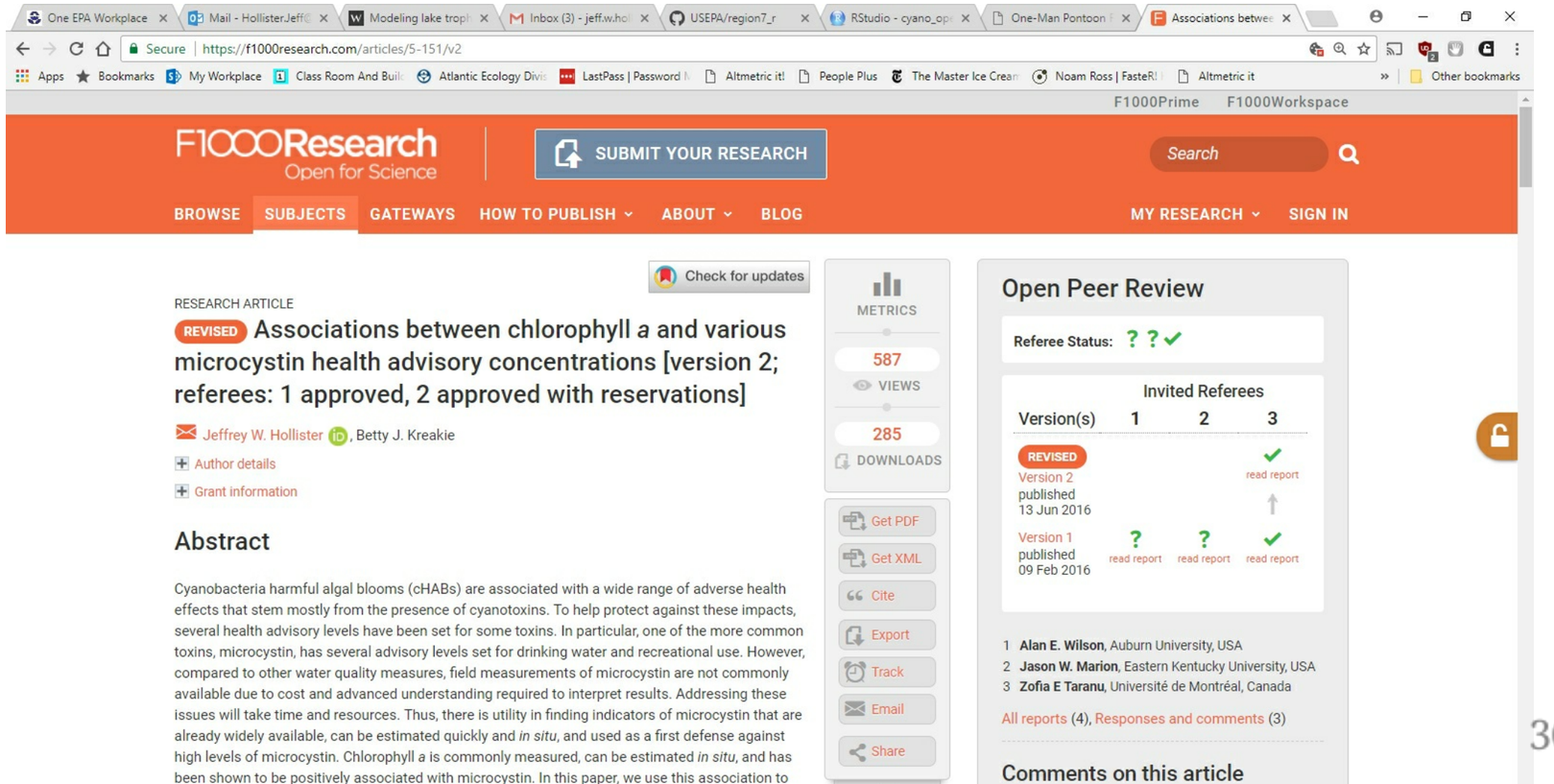
Chlorophyll a and microcystin

- 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!

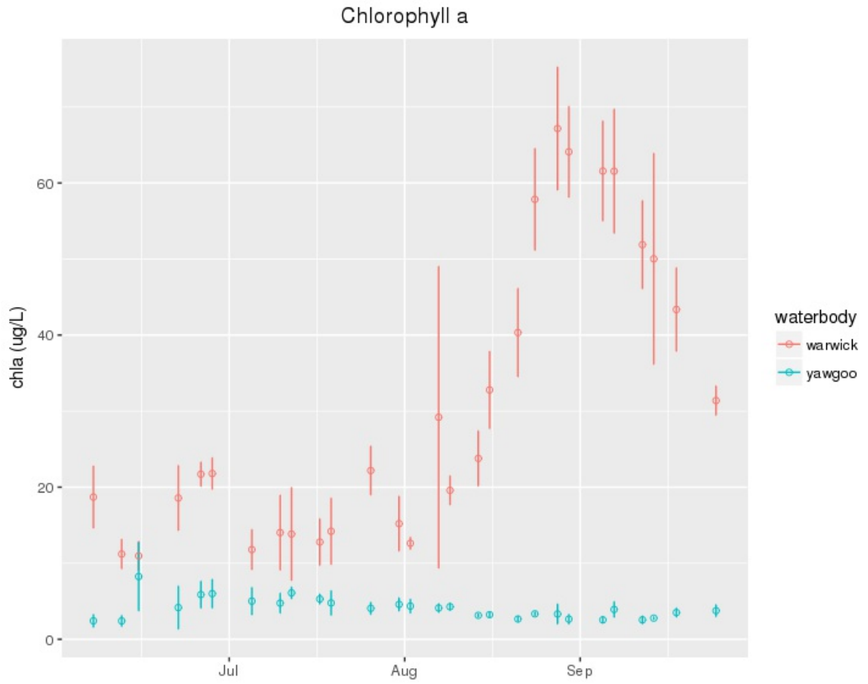


Temporal and spatial dynamics of cyanobacteria blooms

- 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

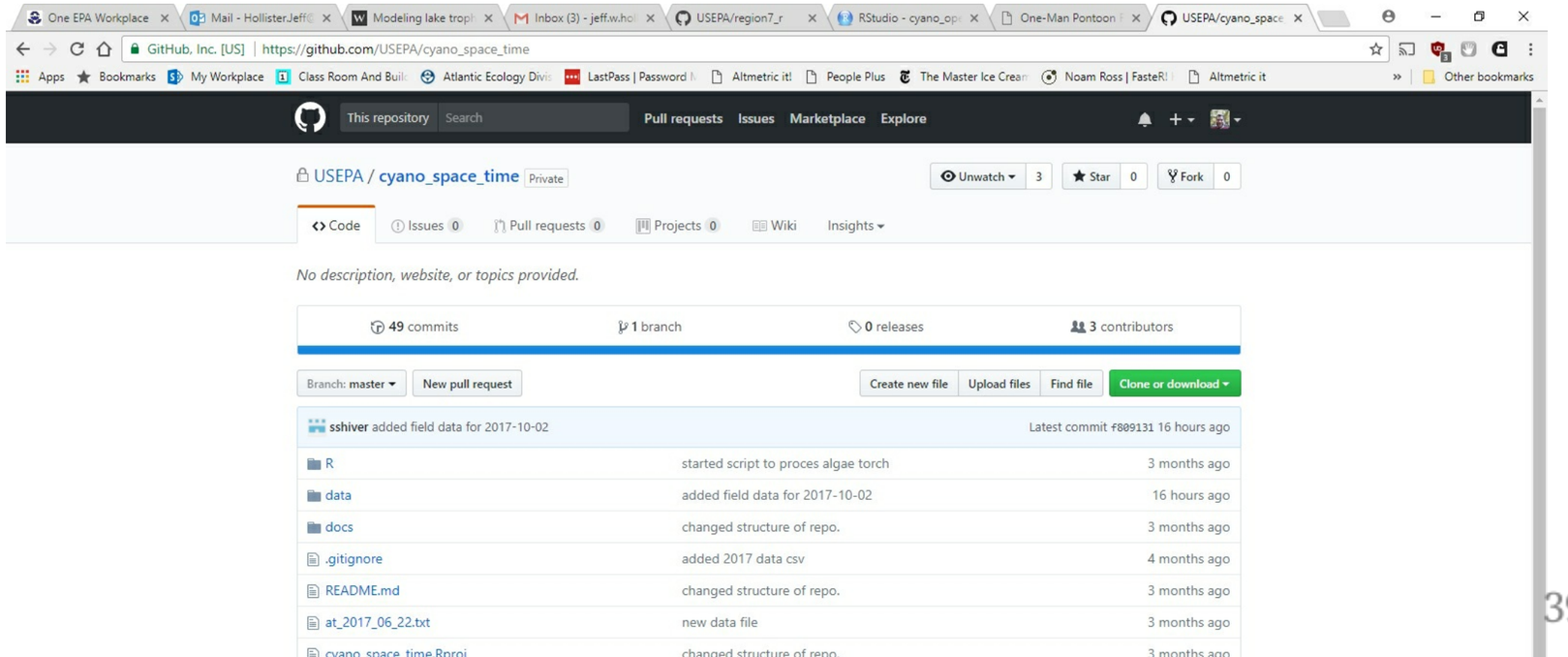
Temporal and spatial dynamics of cyanobacteria blooms

- 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?



New work

- Hierarchical Bayes models of microcystin
- Lake photic zone temperature
- Phytoplankton community analysis

Thanks!

Jeff Hollister

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