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

The workflow

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 Alzheimerâ€™s"](#)

How are we open?

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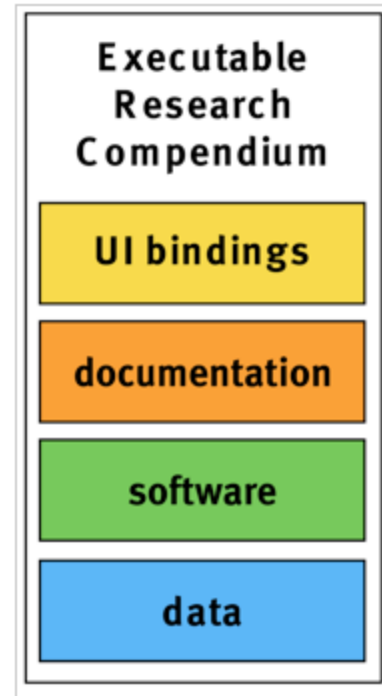
R Packages

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 NÃ¼st, 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](#)
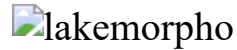 - [Ben Marwick](#)
- Our examples
  - https://github.com/usepa/LakeTrophicModelling
  - https://github.com/usepa/Microcystinchla)
- GitHub and Zenodo (Archive)

ghz

Packages to solve common problems

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

`lakemorpho`

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`

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

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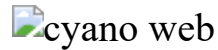
- Started in 2013
  - New England Region Cyanobacteria Monitoring Workgroup
- Three Projects
  - bloomWatch
  - cyanoScope
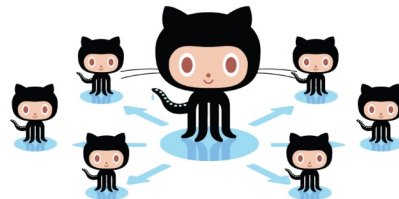 - Monitoring
- Data Viz with Shiny

Project URL: http://cyanos.org

[Shiny: Demo](#)

Sharing and Collaborating

GitHub

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

[GitHub: Demo](#)

Open Access

Publishing

- Preprints
    - [Hollister *el 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)](#)

ecosphere

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

models

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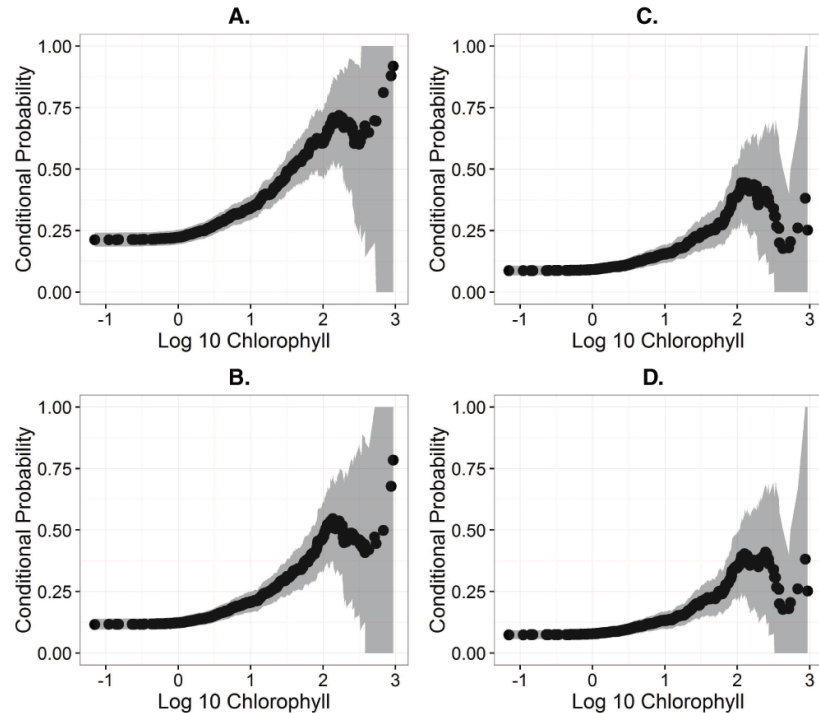- Total Accuracy
    - 0.6
- Balanced Accuracy
    - 0.68 to 0.78

Re-thinking the Lake Trophic State Index

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

ecol_model

Chlorophyll *a* and microcystin

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

Chlorophyll *a* and microcystin

- The numbers!

mcyst_table

Chlorophyll *a* and microcystin

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

f1000

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?

cyano_space_time

New work

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

Thanks!

Jeff Hollister

US EPA
Atlantic Ecology Division
Narragansett, RI
email: hollister.jeff@epa.gov
twitter: @jhollist
github: jhollist

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