



# CyanoMap: Mapping Cyanobacteria for Public Health

Beth Ziniti & Nathan Torbick – Applied Geosolutions  
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Eleventh Annual Lamprey River Symposium



Applied • Geosolutions

# Outline

- Who we are at Applied Geosolutions?
- Overview of our CyanoMap Program
- Case study project: ALS risk CHAB exposure modeling in Northern New England
- Relevance to Lamprey River Watershed
- Future directions



# Applied Geosolutions (AGS)

Science-based firm based in Newmarket (soon to be Durham) since 2000

- Williams Salas, PhD, Founder, and Chief Scientist
- Team of scientists, data analytics, and software developers
- Mission

Using remote sensing geospatial tools and Earth system models quantify interactions between the environment and humanity.

- Vision

provide the tools to track the impact of resilient land and water management



# CyanoMap Collaborators



## University of New Hampshire

James Haney  
Ernst Linder



## Dartmouth College

Elijah Stommel  
Xun Shi  
Angeline Andrew  
Tracie Caller  
Patricia Henegan



## University of Miami

Walter Bradley



## AGS

Ian Cook  
Rob Braswell  
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## Bowling Green State University

George S Bullerjahn  
Robert Michael McKay



## The Institute for Ethnomedicine

Paul Cox  
Sandra Banack



## University of Toledo

Tom Bridgeman



## Royal Belgian Institute of Natural Sciences

Quinten Vanhellefont

## Funding support



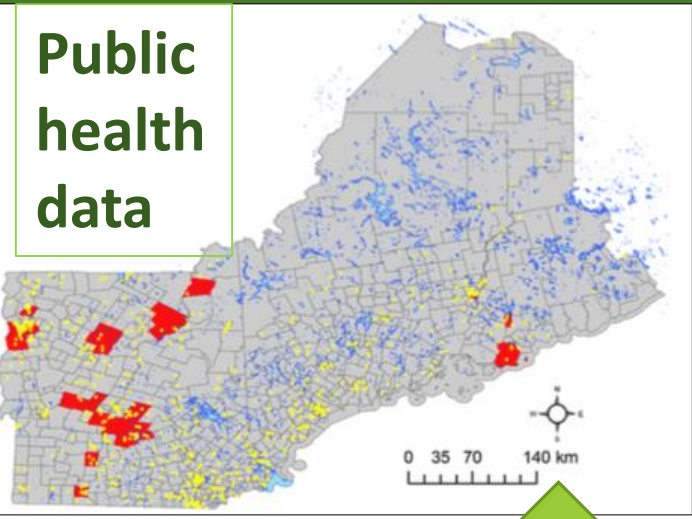
\*\*\*Data from many sources, citizen scientists, volunteers, EPA NLA, GLENDa, state agencies, & monitoring programs



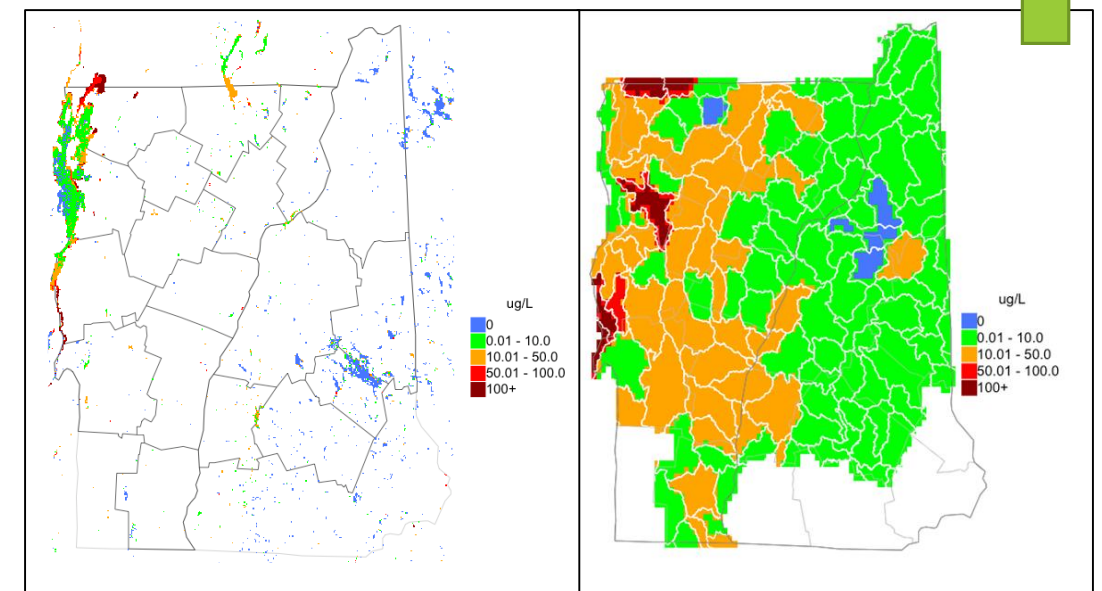
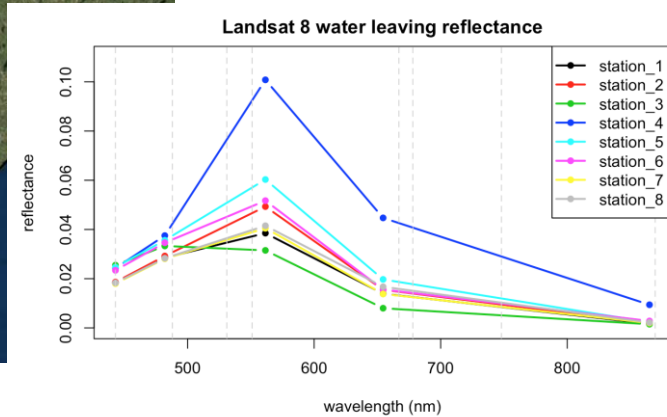
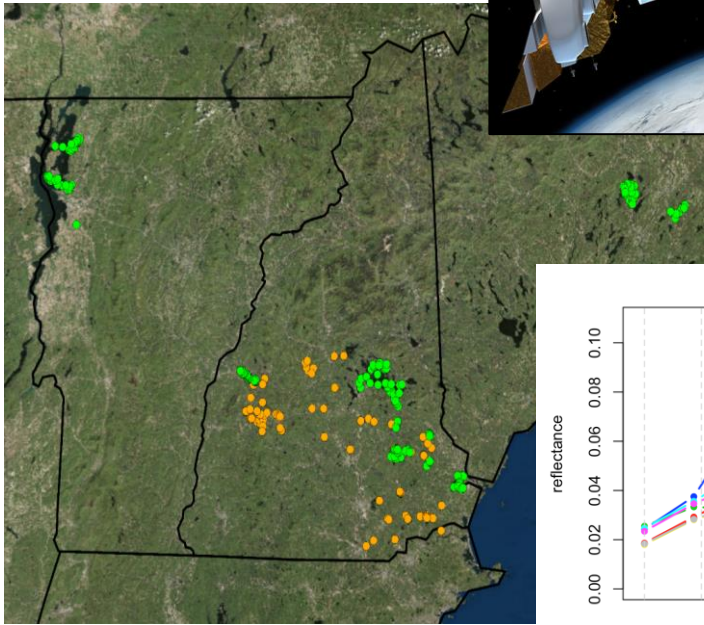


# CyanoMap

*Develop regional cyanobacteria exposure maps for public health*



Linking Cyanobacteria & color reflectance



Exposure Maps: Phycocyanin Concentration

Lake sampling 2014-2016 coordinated with UNH Dr. Haney's lab

# Amyotrophic Lateral Sclerosis (ALS)

Rare and fatal neurodegenerative disease



Lou Gehrig's Disease

incidence: ~ 2 per 100,000 per year

life expectancy: ~ 2 - 5 years

highest incidence: males ages 55-75

90% no known genetic cause

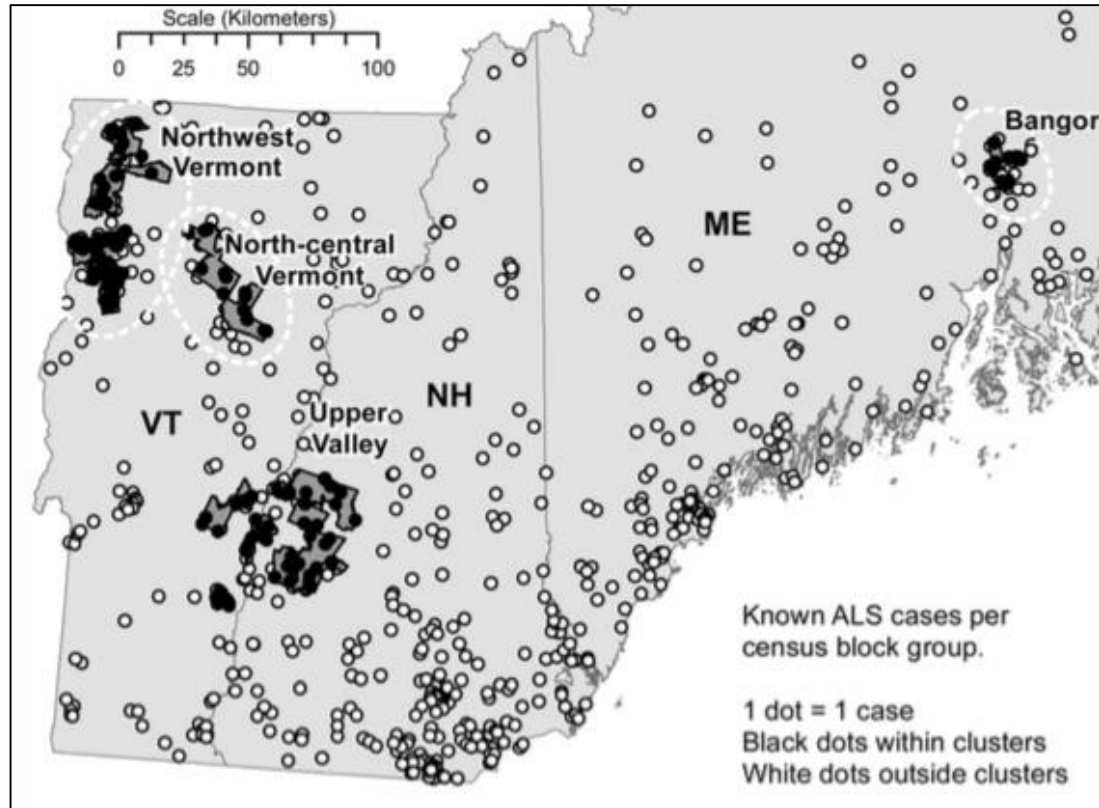


#ALSicebucketchallenge





# ALS clusters in NNE lead to question of CHABs risk



Caller et al. (2013)



## Diet of Chamorro in Guam

Very High ALS incidence

Mulder and Kurland (1987)

Cox and Sacks (2002)

Cox et al. (2003)



Neurotoxin (**BMAA**)

beta-methylamino-L-alanine

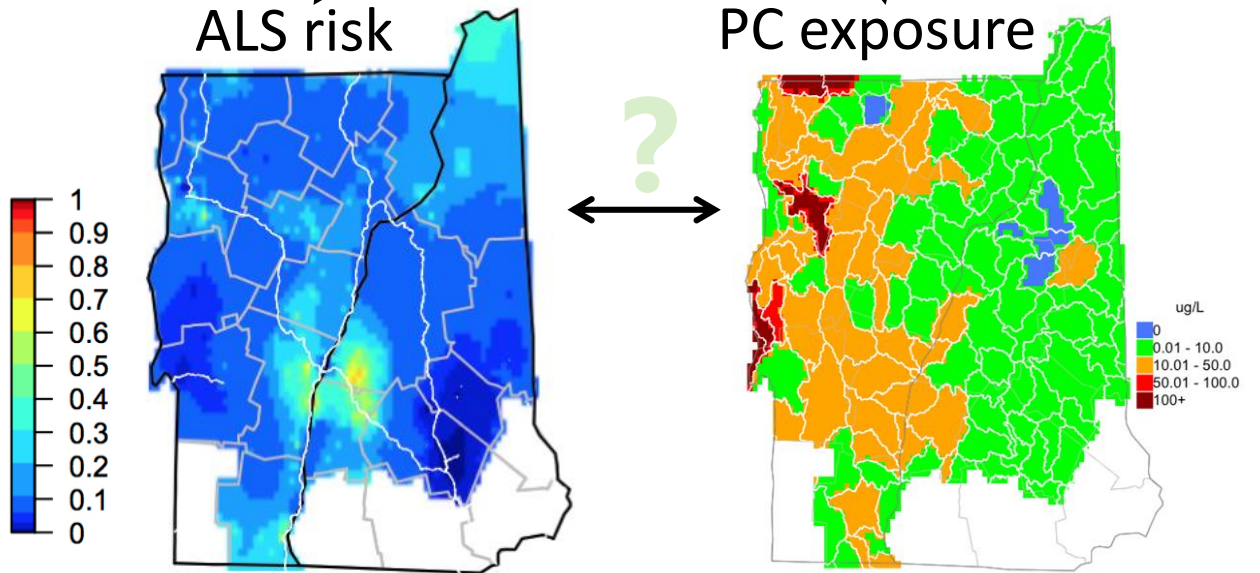
produced by cyanobacteria



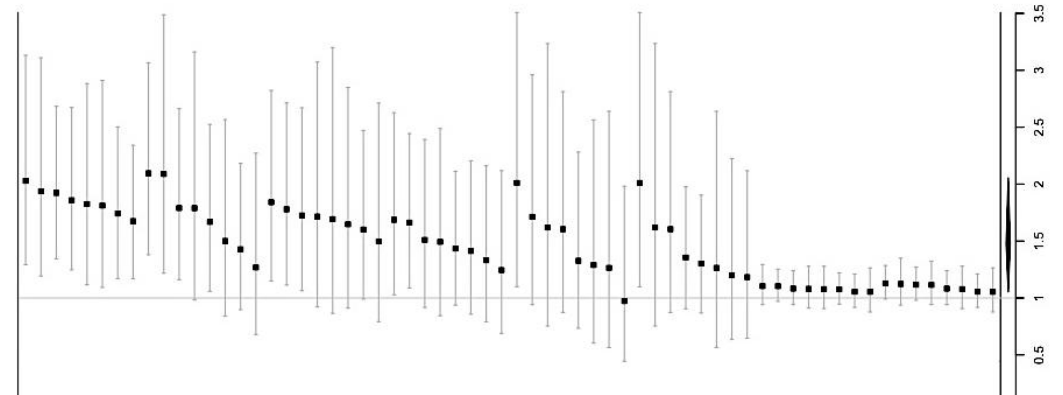
# Torbick et al. (2017) investigates using Bayesian hierarchical models

Data  $\left\{ O \sim \text{Poisson}(L) \right.$

Process  $\left\{ \log(L) = b_0 + b_1 x + W + \log(E) \right.$



## Results:



- Mean PC has a statistically significant effect on ALS risk

Based on Meta-analysis

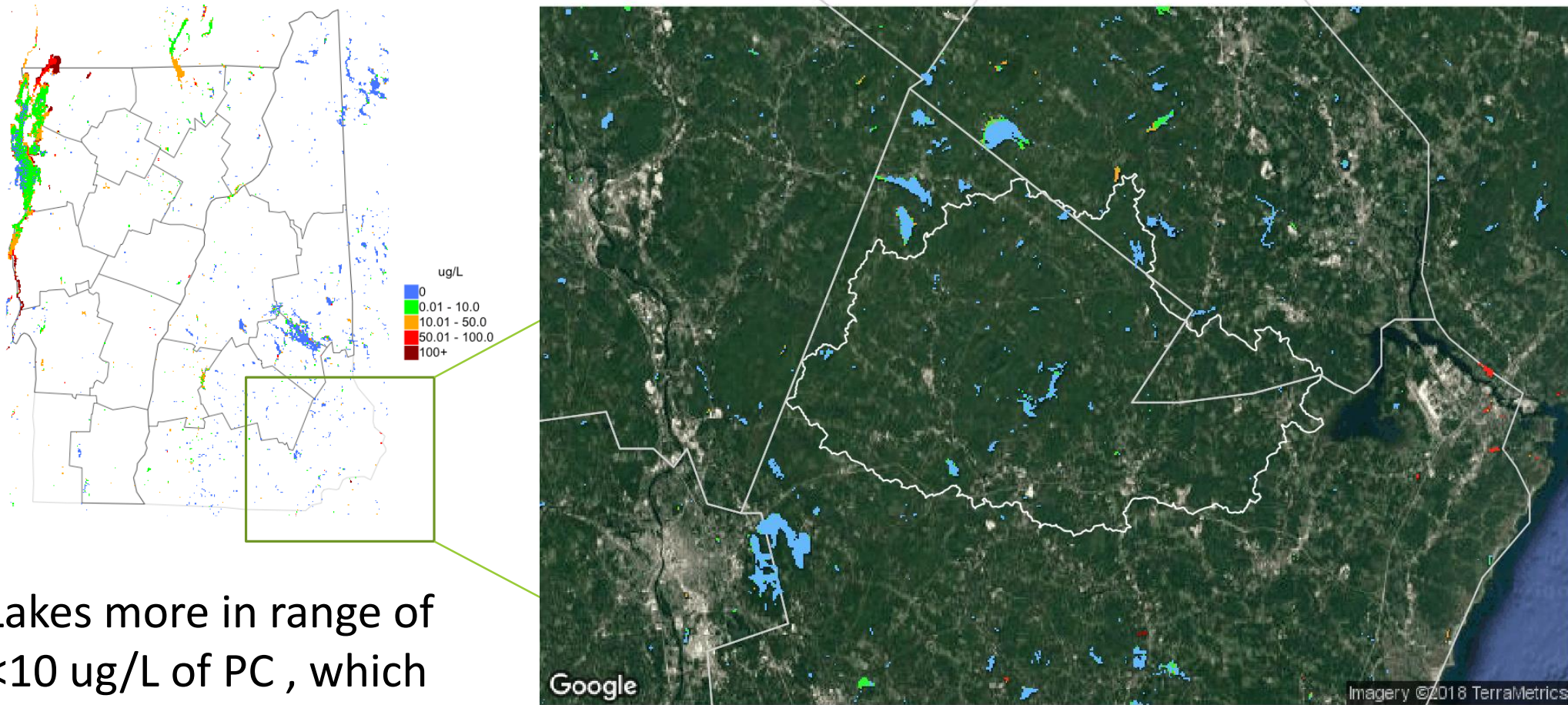
- 10 ug/L of PC the odds ratio  $\sim 1.04$ ;
- 100 ug/L of PC the odds ratio  $\sim 1.48$





# PC concentrations in Lamprey River Watershed

Estimates of summertime conditions circa 2014-2016



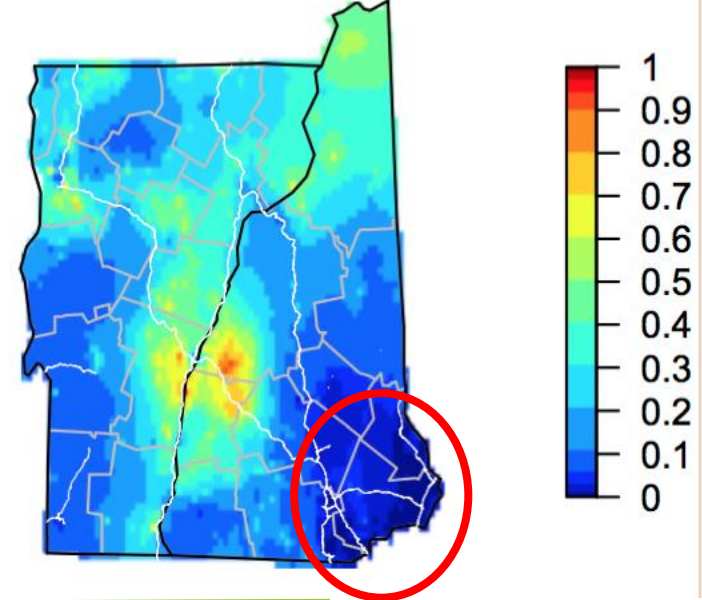
- Lakes more in range of <math><10\text{ ug/L}</math> of PC, which corresponds to ALS risk odds ratio  $\sim 1.04$   $\longrightarrow$  Valid?



# Biases in public health data

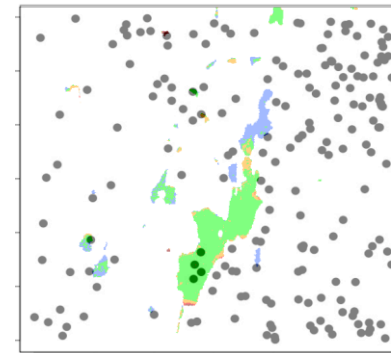
- Ecological Studies require near complete case ascertainment

(not always possible due to privacy concerns and independent hospitals)



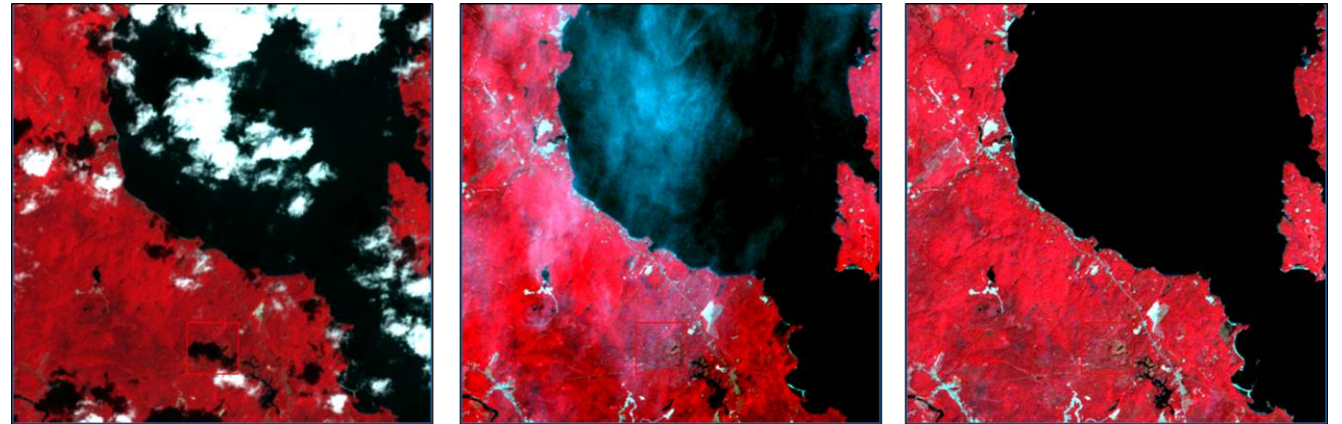
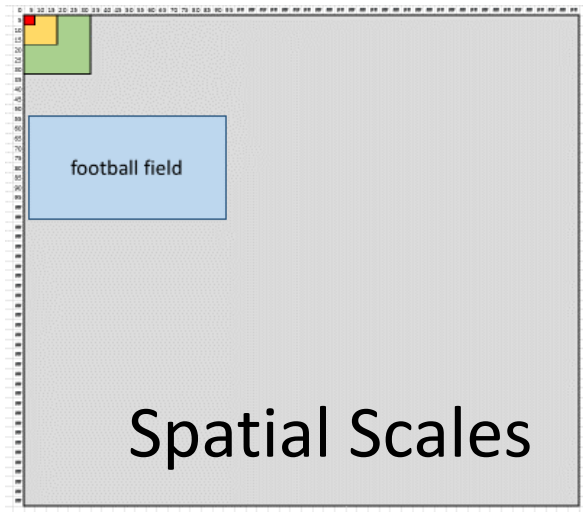
\* Boston

- People are not fixed points  
need total exposome =  
residential history, work locations, etc.

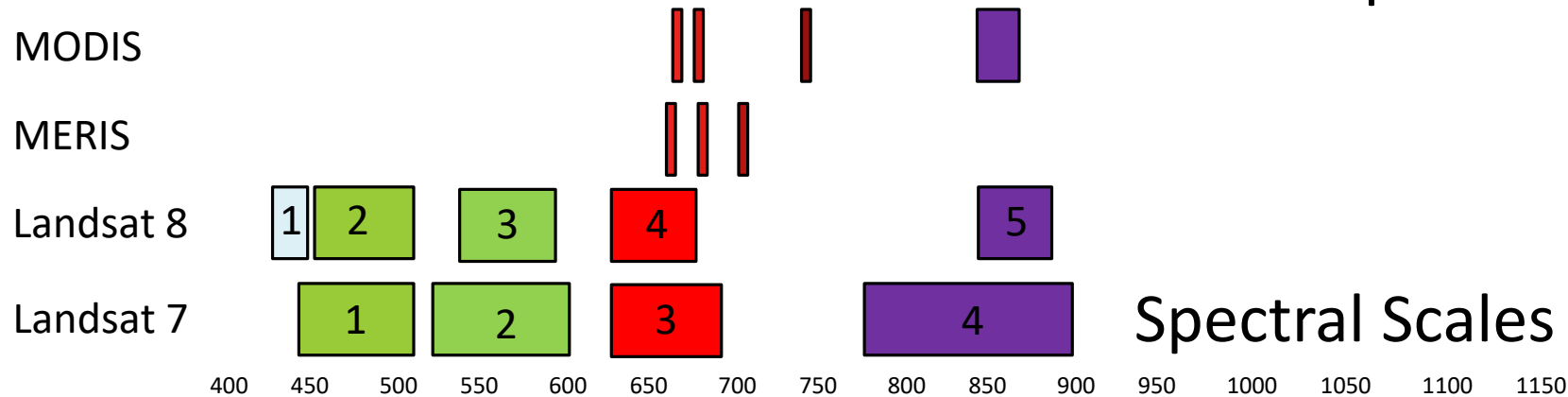


# Challenges of water quality remote sensing

No one best sensor, all vary in spatial resolution, overpass frequency, and spectral sensitivity



Repeat frequency



# Take home messages

- Current work points to association between exposure to cyanobacteria and higher ALS risk in Northern New England
- Unexplored temporal domain is the future
- Operational robust fusion of multiple large complex satellite data sets is needed





*ALS work Published in:*

Torbick, N., Ziniti, B., Stommel, E., Linder, E., Andrew, A., Caller, T., Haney, J., Bradley, W., Henegan, P., Shi, X. (2017).

***Assessing Cyanobacterial Harmful Algal Blooms as Risk Factors for Amyotrophic Lateral Sclerosis. Neurotoxicity Research.***

*Thank you*

*Questions?*

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# Photo Credits

[Photograph of Lou Gehrig]. Retrieved from [www.lougehrig.com/imgs/photo-gallery/full/2-2\\_full.jpg](http://www.lougehrig.com/imgs/photo-gallery/full/2-2_full.jpg) (page 6)  
Amendola, Elise [Associated Press] (2014). *Ice bucket challenge* [Photograph]. Retrieved  
from <http://finance.yahoo.com/news/als-bucket-challenge-raised-220-210653731.html> (page 6)  
Ziniti, Beth [Photographer] (2016). *Algae bloom near UNH visitor center on Aug 5* [Photograph]. (page 7)

