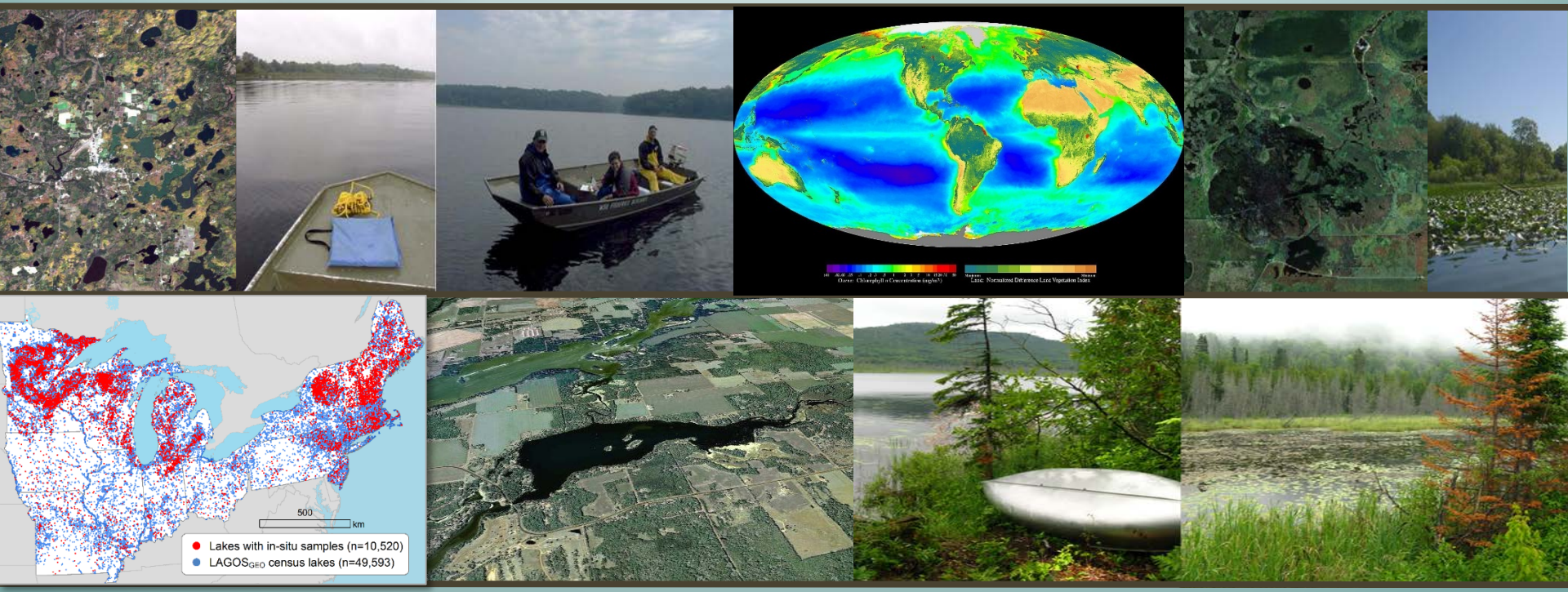
Using Citizen Science Data for Lake Water Quality Research to inform Policy:

Studying 50,000 lakes in the midwestern and northeastern US

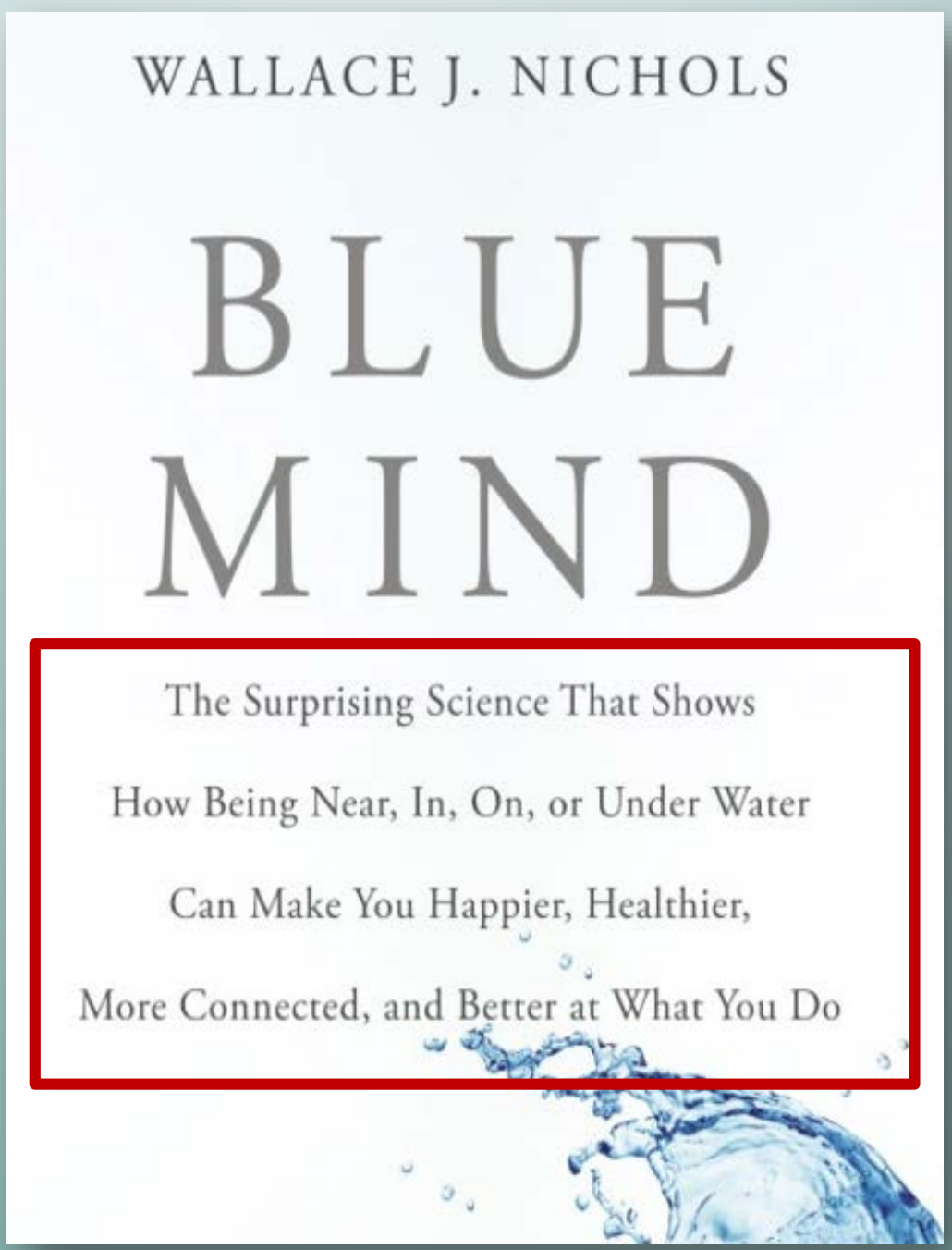


Patricia Soranno and Autumn Poisson

Dept. Fisheries & Wildlife

Michigan State University

November 2017


WALLACE J. NICHOLS
BLUE MIND
The Surprising Science That Shows
How Being Near, In, On, or Under Water
Can Make You Happier, Healthier,
More Connected, and Better at What You Do

Lake Trivia Quiz Bowl

INSTRUCTIONS:

1. Gather into teams of 2-3 near you
2. Pull out a piece of paper and pencil

Please answer the following questions for this region

A 17-state area of lake-rich states in the U.S.

Question 1

What is the most common lake name of lakes in this area?

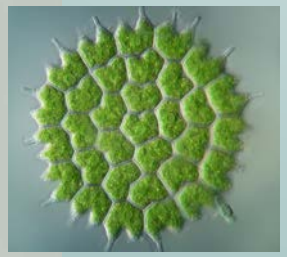
Question 2 - 3

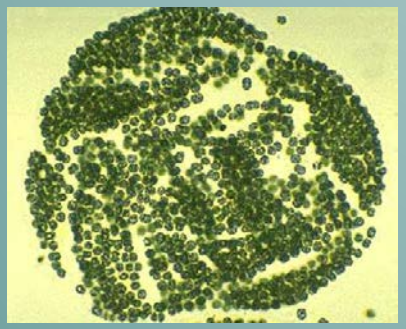
2) Not counting the Great Lakes, what is the deepest lake in this area?

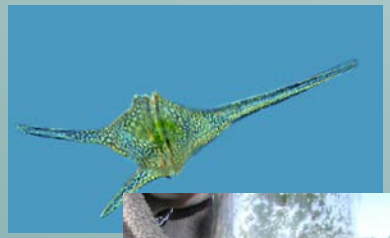
3) And… what is the largest?

Question 4

Which state has the lowest algal growth in their lakes? And, why?







Question 5

What group or organization is responsible for monitoring **water quality** in lakes in the US?

ANSWERS

2 pt per correct answer;

-----some partial credit

Question 1

ANSWERS

What is the most common lake name of lakes in this area?

1. **No name!** (~30% of lakes are not named)
2. **Mud Lake**
3. Long Lake
4. Bass Lake
5. Round Lake
6. Silver Lake
7. Horseshoe Lake
8. Spring Lake

Question 2

ANSWERS

Not counting the Great Lakes, what is the deepest lake in this area?

1.	**Seneca lake, NY**	**200 m**
2.	Rabbit Lake, MN	103 m
3.	Lake Champlain, VT	97 m
4.	Sebago Lake, ME	96 m
5.	Lake Willoughby, VT	94 m
6.	Torch Lake, MI	87 m

Question 3

ANSWERS

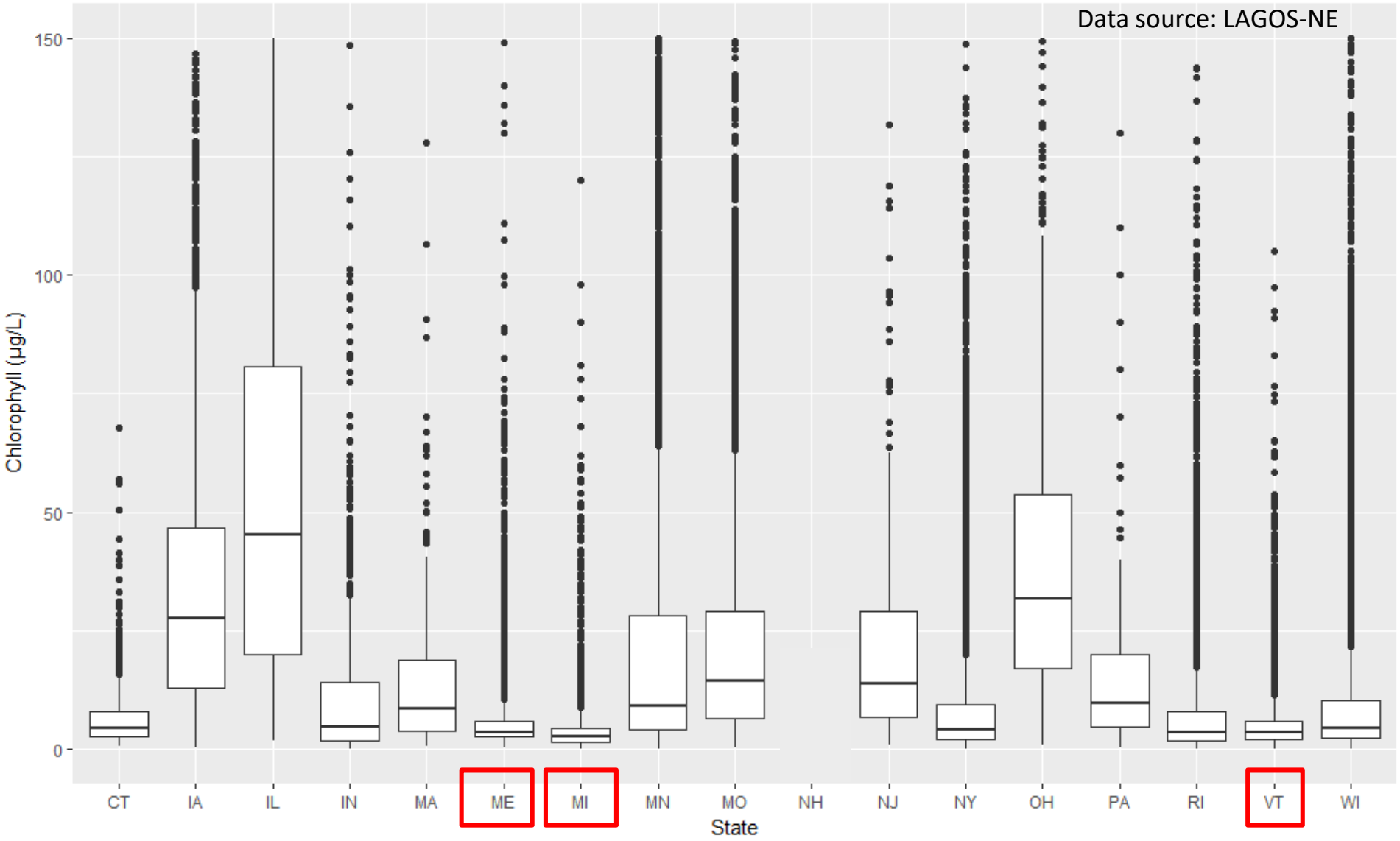
Not counting the Great Lakes, what is the largest lake in this area?

1. **Lake Champlain, VT**
2. Red Lake, MN
3. Lake Winnebago, WI
4. Mille Lacs Lake, MN
5. Leech Lake, MN
6. Moosehead Lake, ME

Question 4

ANSWERS

Which state has the lowest algal growth in their lakes?



Question 5

ANSWERS

What group or organization is responsible for monitoring **water quality** in lakes in the US?

State (and tribal) natural resource agencies

*** BUT, many others sample water quality too!*

Why do these kind of statistics matter?

People care

Why do these kind of statistics matter?

Scientists need this type of information

Image ©Patricia Soranno

Why do these kind of statistics matter?

Policymakers need this type of information

Image: https://s-media-cache-ak0.pinimg.com/736x/c8/66/a1/c866a159e88cf71d38ffc835f667ccae--detroit-michigan--states.jpg

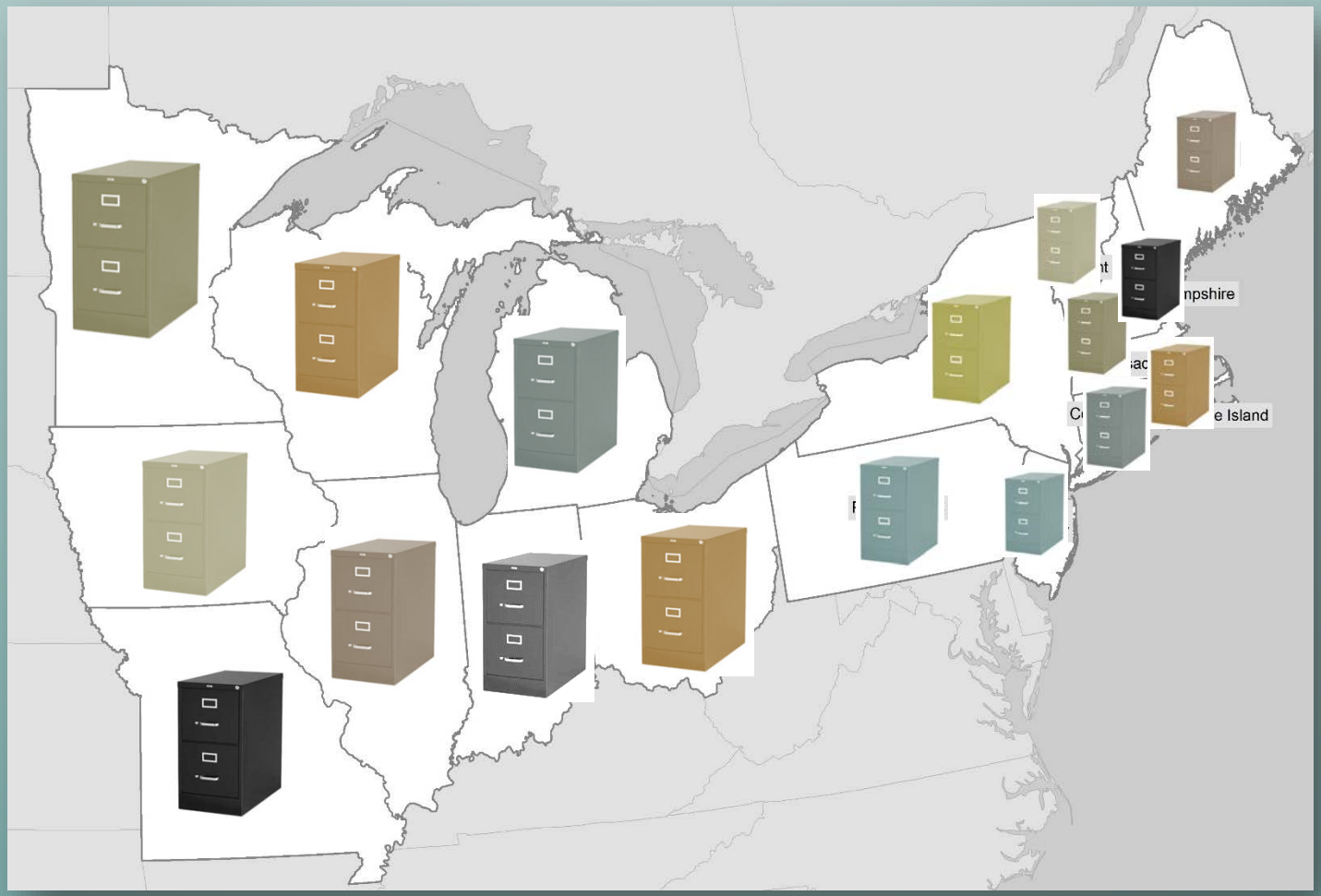
So, where did the information come from?

6 years ago, we could not answer many of these questions…

And, many scientists study individual lakes at a time

So, where did the information come from?

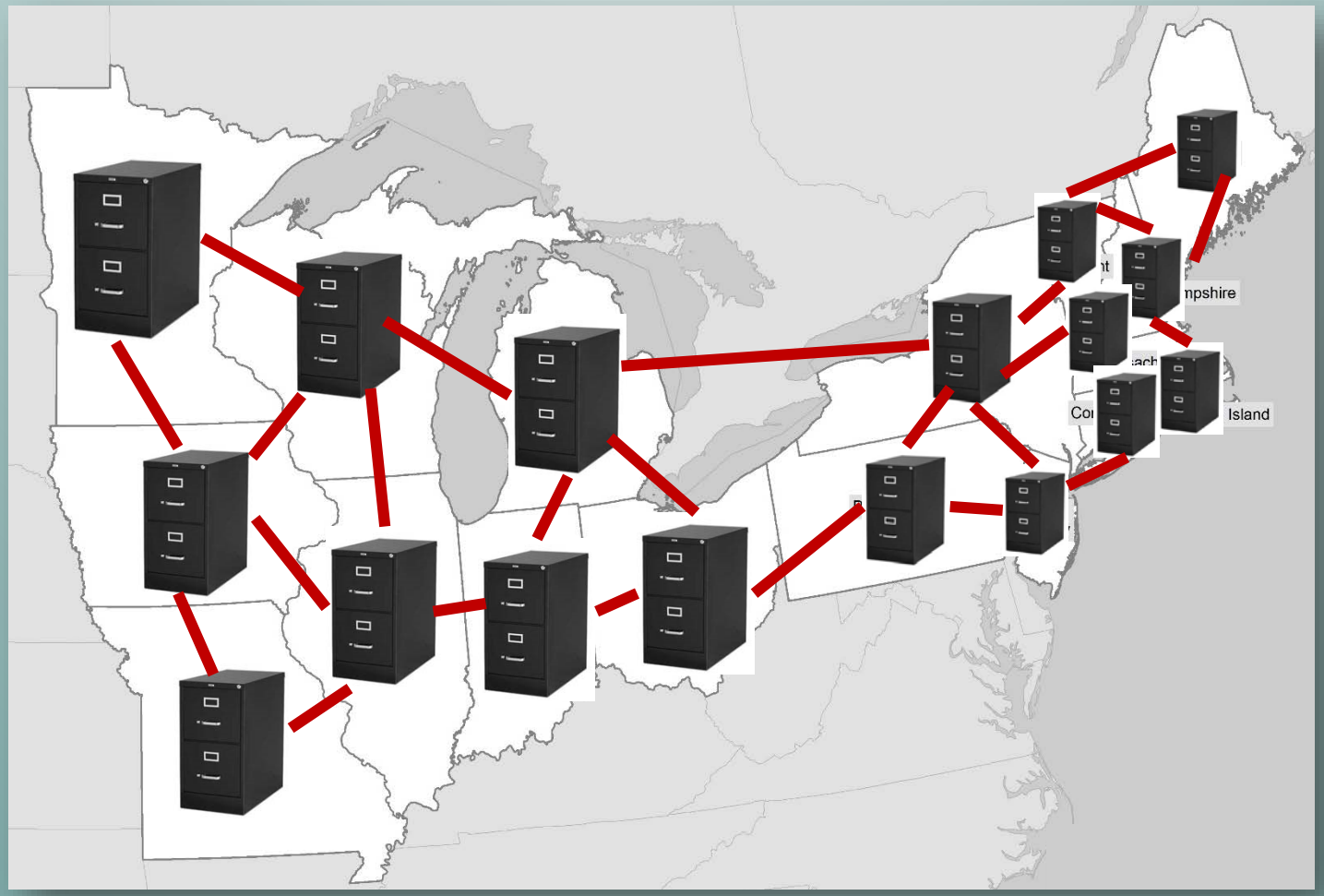
6 years ago, we could not answer most of these questions…



Our idea:

Build a database with the needed information to better understand **water quality in ALL lakes** in this part of the US.

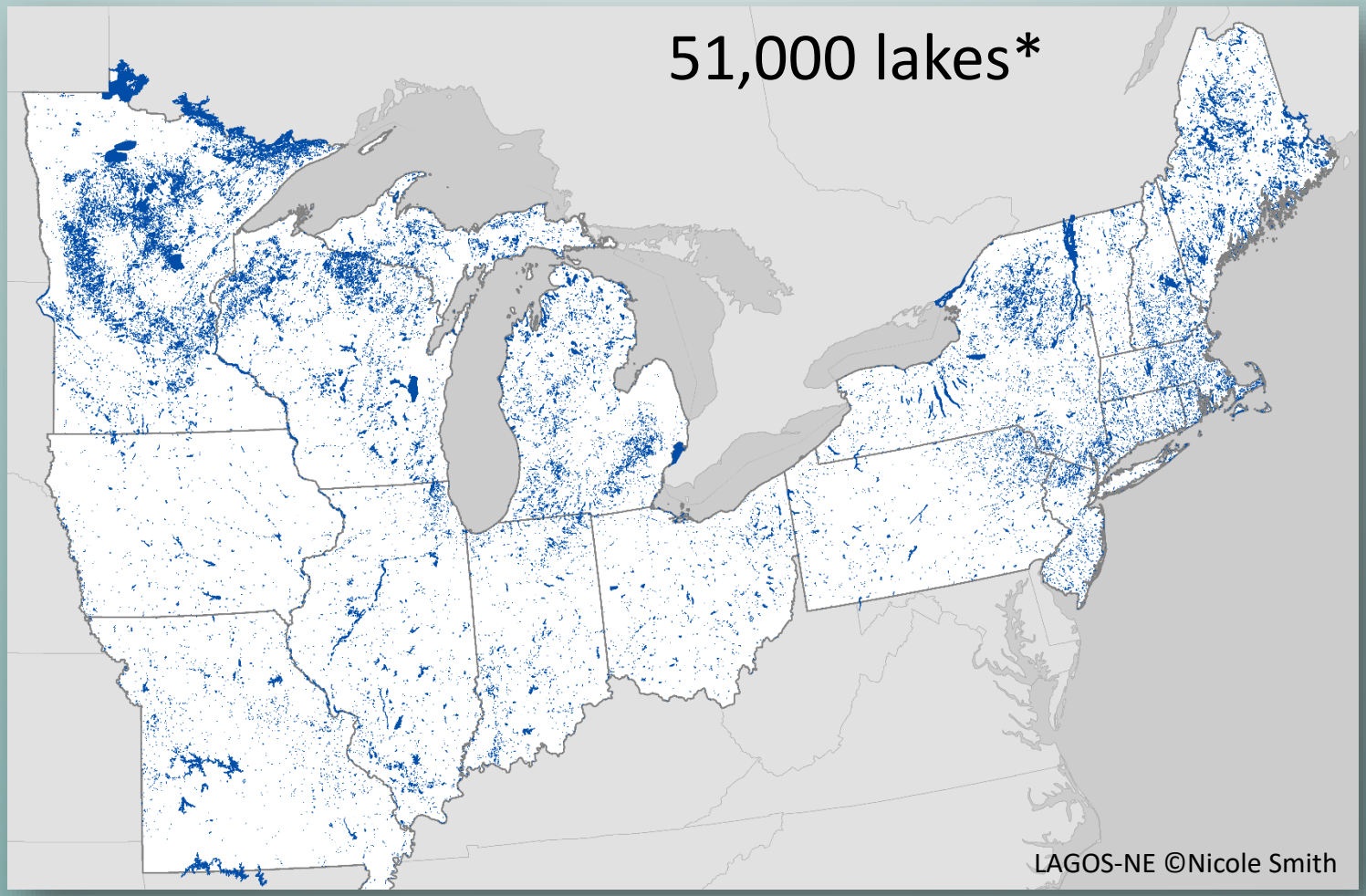
Our idea…



Data sources for water quality:

- State natural resource agencies
- Tribal natural resource agencies
- Federal agencies
- Citizen science programs
- University researchers

Lakes and their water quality

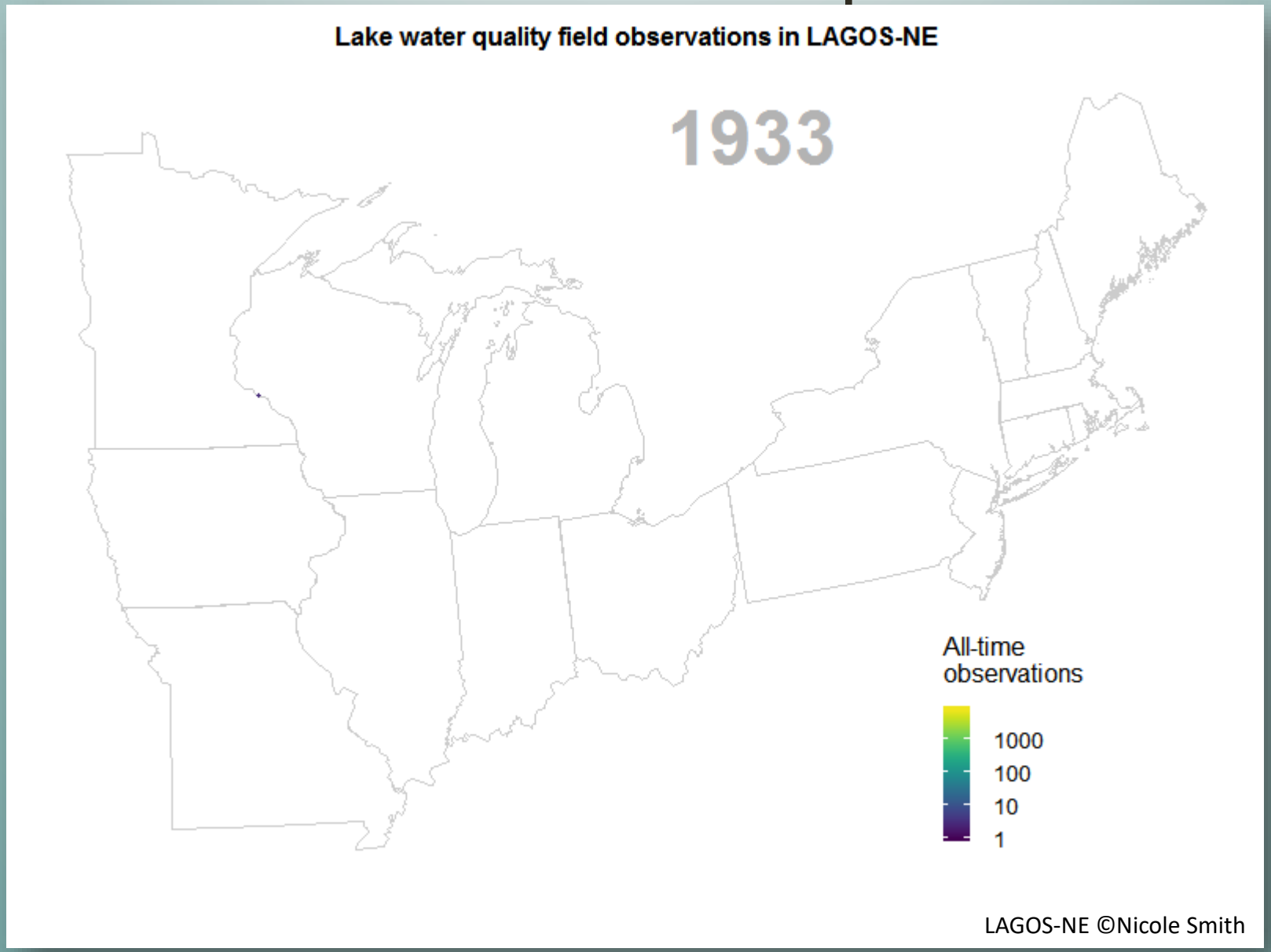


LAGOS-NE

www.lagoslakes.org

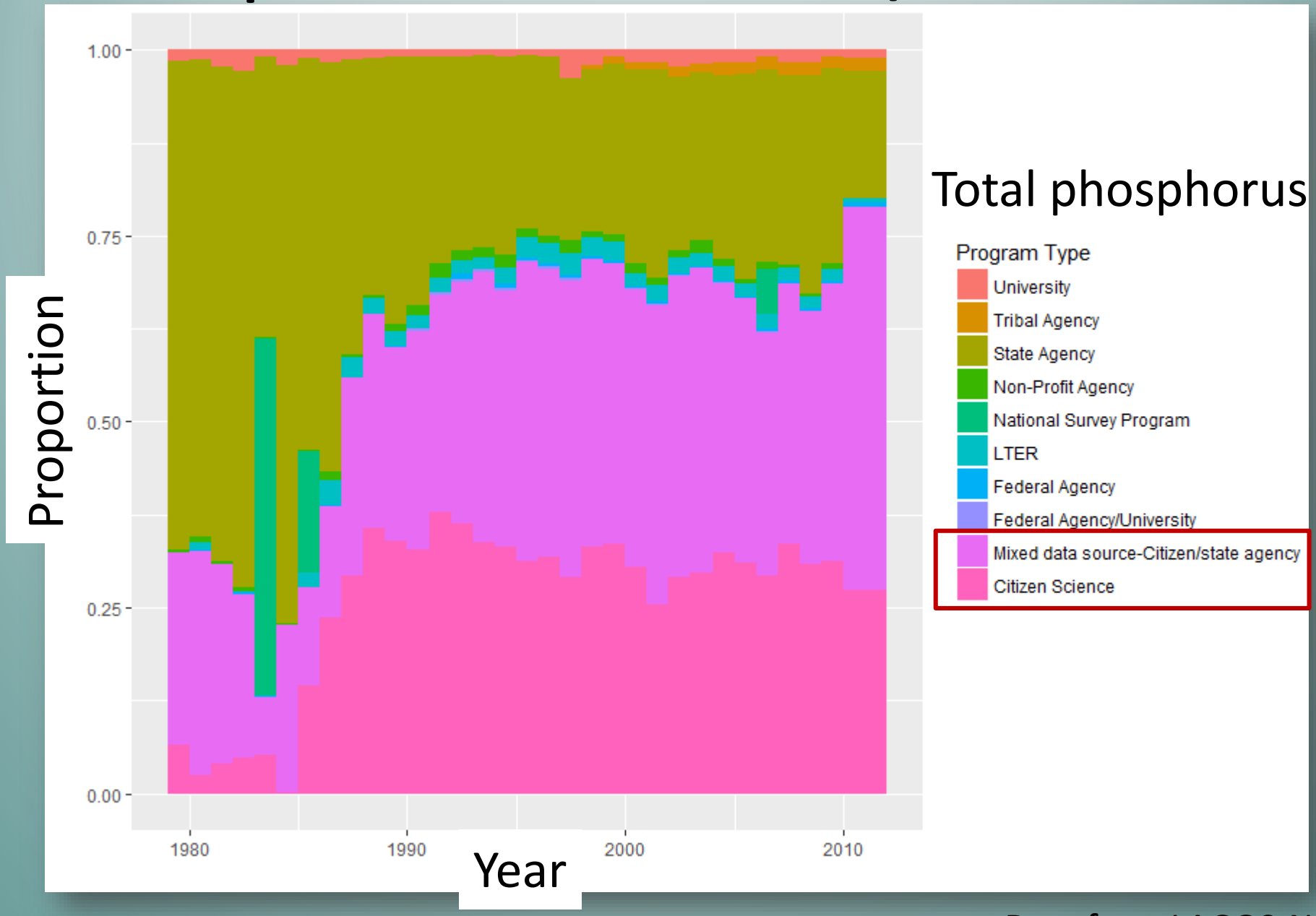
* *Greater than ~10 acres*

When have lakes been sampled?



To see this animation, go to:
https://lagoslakes.org/2017/10/27/water-quality-observations-through-time-in-lagos-ne-by-nicole-smith/

Who samples lakes in the Midwest/NE US?



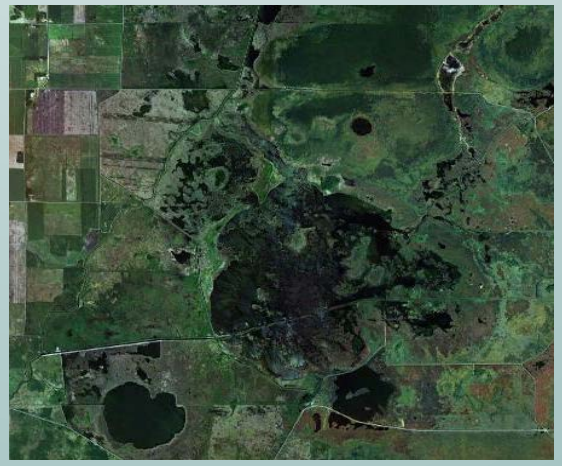
Data from LAGOS-NE

Take home messages:

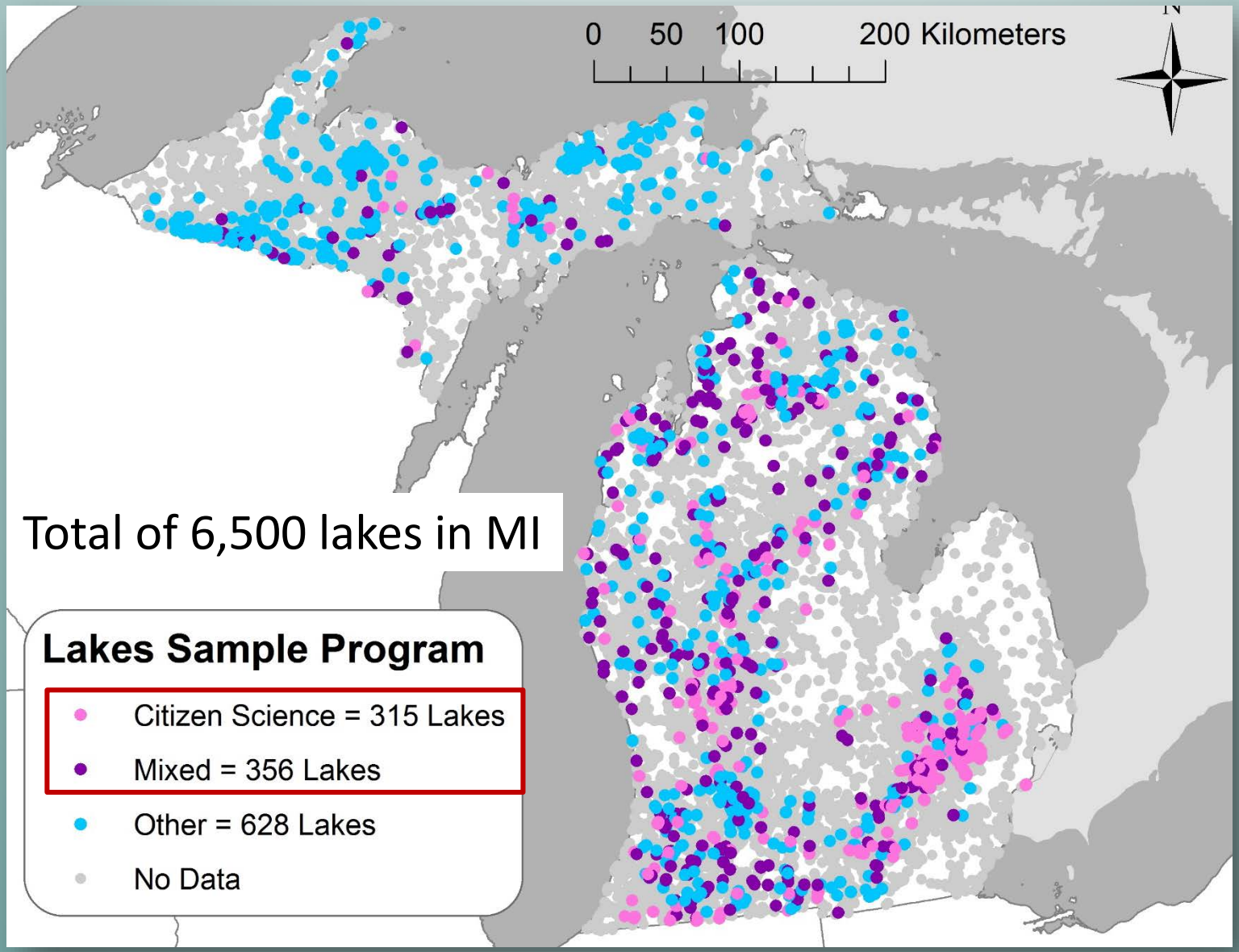
(1) Citizen-collected data make up a large proportion of available water quality data

What about Michigan lakes?

Cooperative Lakes Monitoring Program
Michigan Lakes – Ours to Protect



Who samples lakes in Michigan?



Data from LAGOS-NE

But, what about long-term data?

Program	Number of Years of Samples				
	0-5 years	6-10 years	11-15 years	16-20 years	21+ years
Citizen volunteers	*312*	*134*	*100*	*57*	*62*
State/fed agency	*579*	*3*	*8*	*8*	*0*

Data from LAGOS-NE

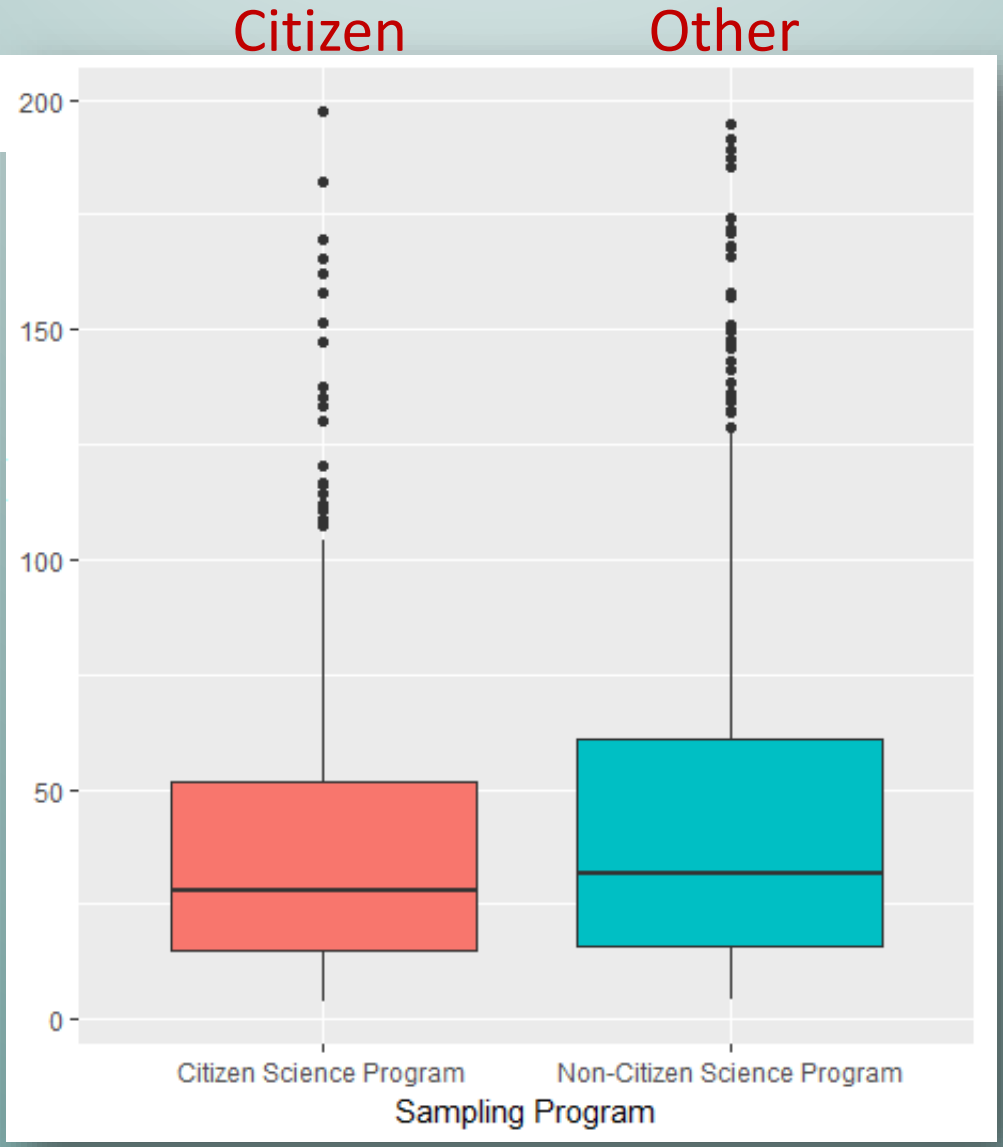
Take home messages:

(1) Citizen-collected data make up a large proportion of available water quality data

(2) Citizen-collected data contribute a VERY HIGH proportion of the long-term data available for research and policy

What kind of lakes are sampled by citizens and other groups?

What size lakes are sampled?



Cooperative Lakes Monitoring Program
Michigan Lakes – Ours to Protect

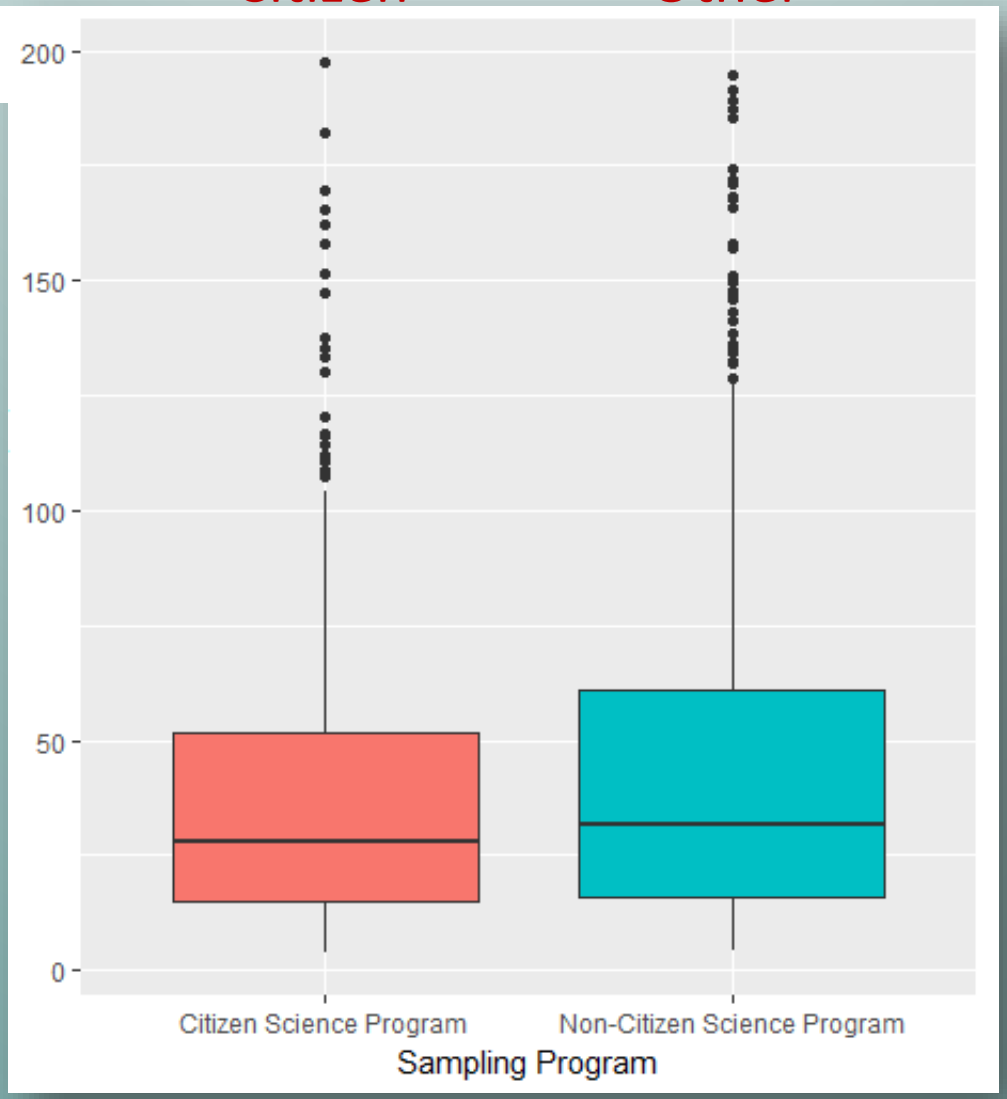
Data from LAGOS-NE

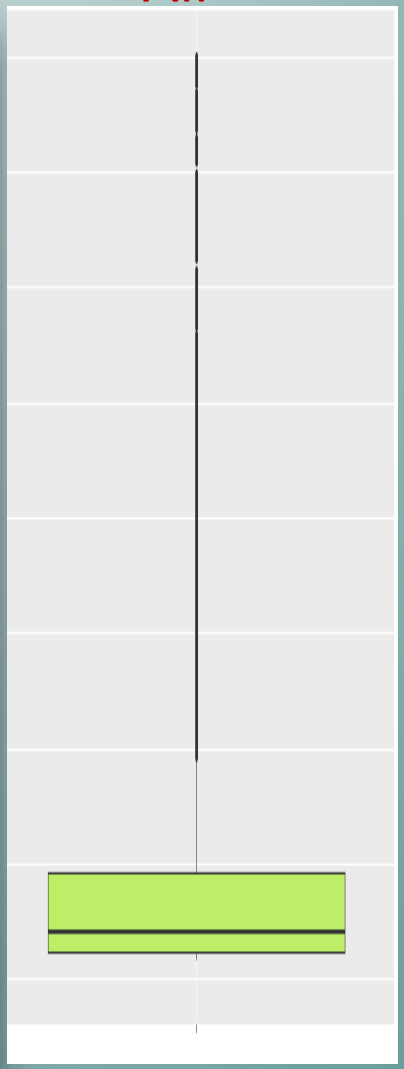
What kind of lakes are sampled by citizens and other groups?

Data from LAGOS-NE

What size lakes are sampled?

Lake area (ha)





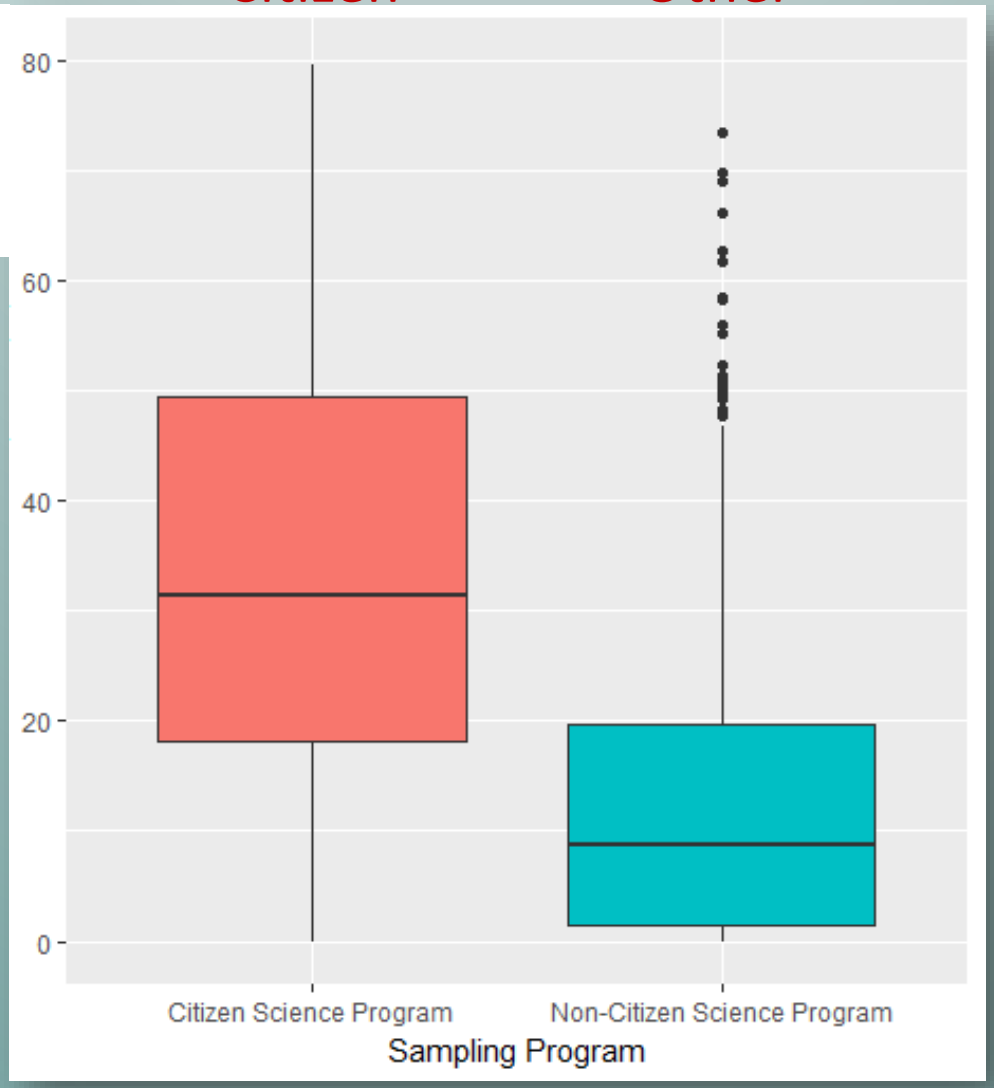
Cooperative Lakes Monitoring Program
Michigan Lakes – Ours to Protect

What kind of lakes are sampled by citizens and other groups?

Data from LAGOS-NE

What is the land use around lakes that are sampled?

Residential development (%)



Cooperative Lakes Monitoring Program
Michigan Lakes – Ours to Protect

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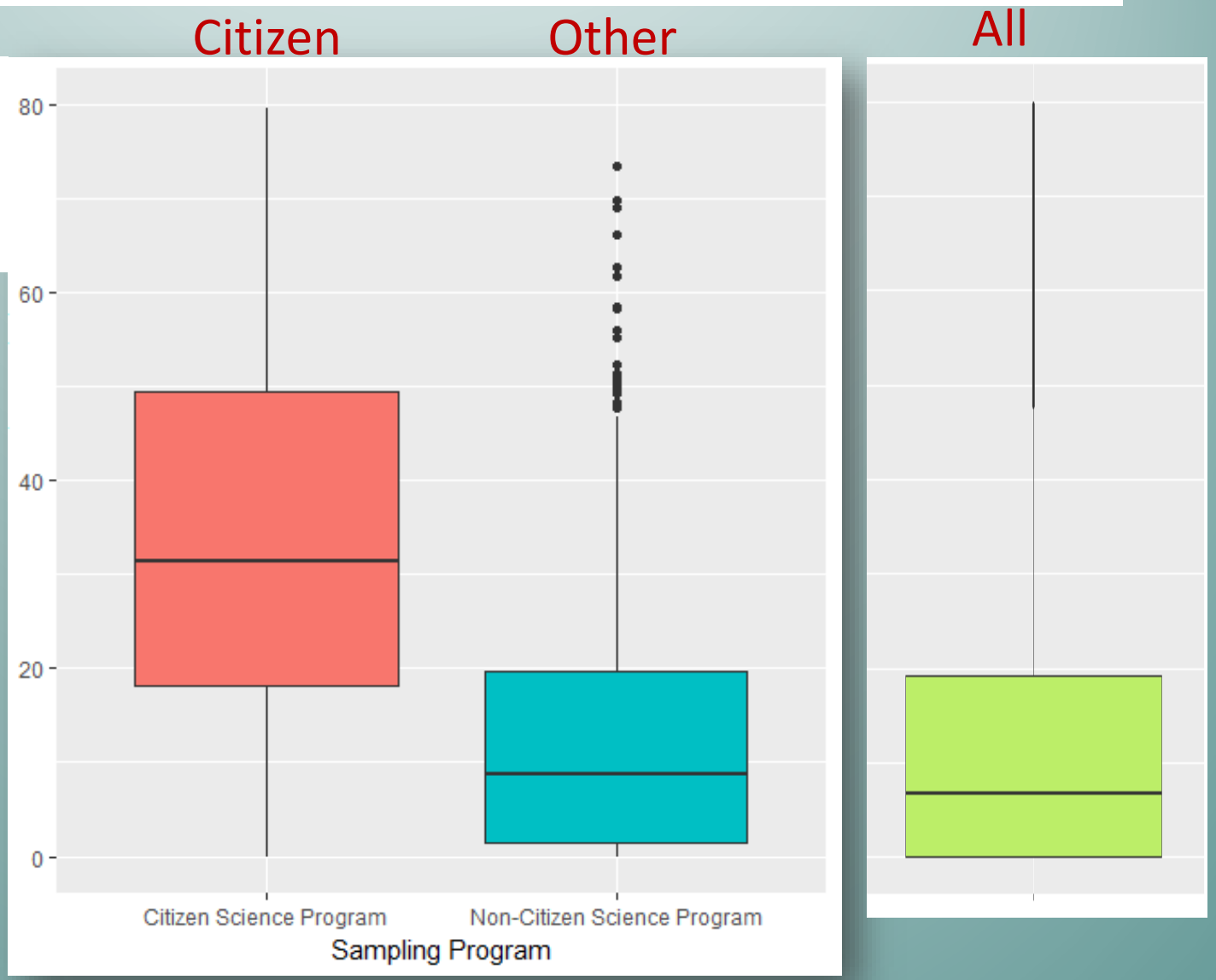


Cooperative Lakes Monitoring Program
Michigan Lakes – Ours to Protect

Take home messages:

(1) Citizen-collected data make up a large proportion of available water quality data

(2) Citizen-collected data contribute a VERY HIGH proportion of the long-term data available for study

(3) Lakes sampled by citizen-volunteers are more likely to be more 'developed' than lakes sampled by state agencies. And, there are gaps in the current water quality sampling in MI.

So, how is the water quality in these lakes?

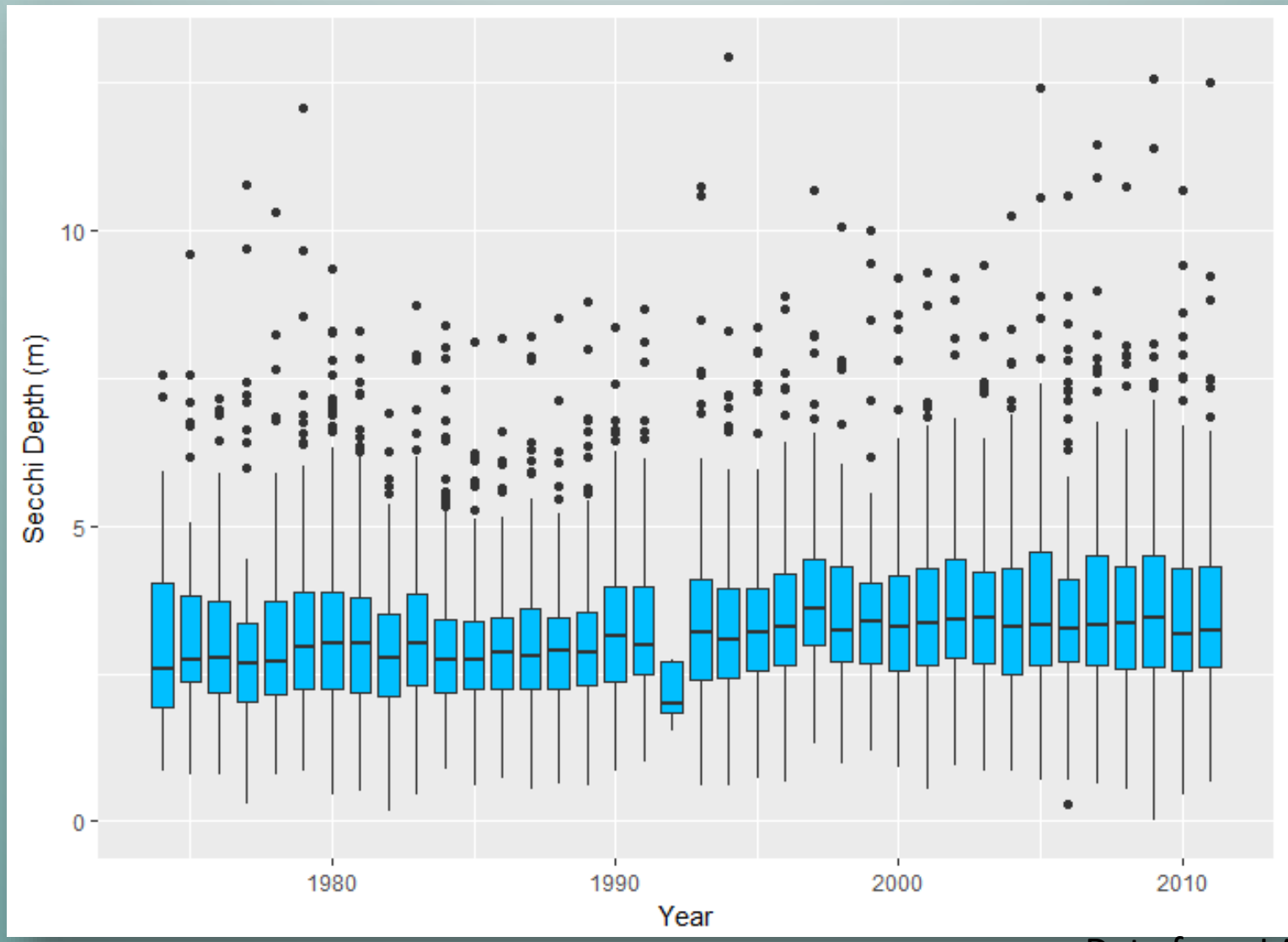
TROPHIC STATUS	# lakes in 2011
Oligotrophic	51
Mesotrophic	15
Eutrophic	3

Cooperative Lakes Monitoring Program
Michigan Lakes – Ours to Protect

Data from LAGOS-NE

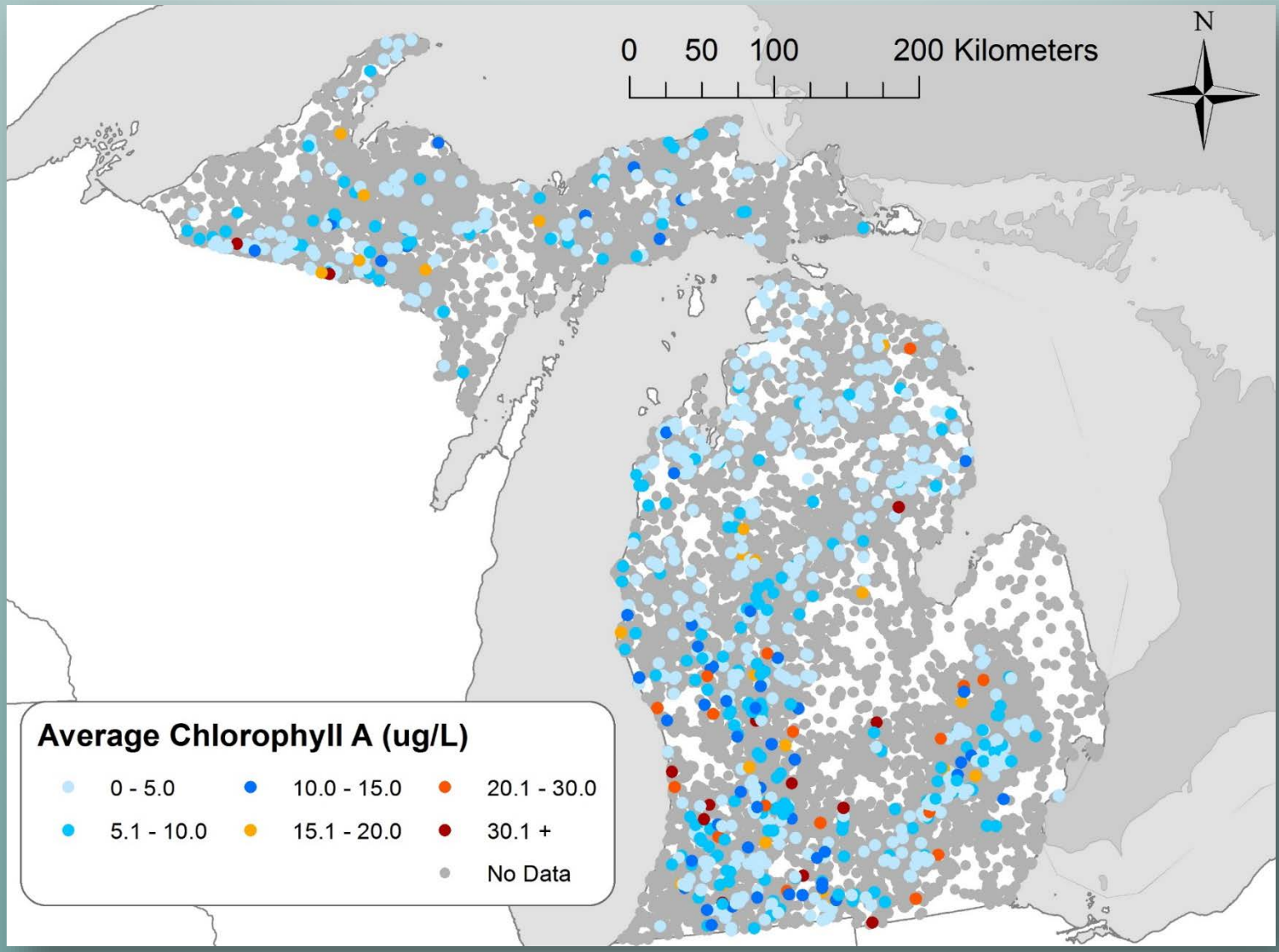
So, how is the water quality in these lakes?

Average Secchi depth in all citizen-volunteer lakes



Data from LAGOS-NE

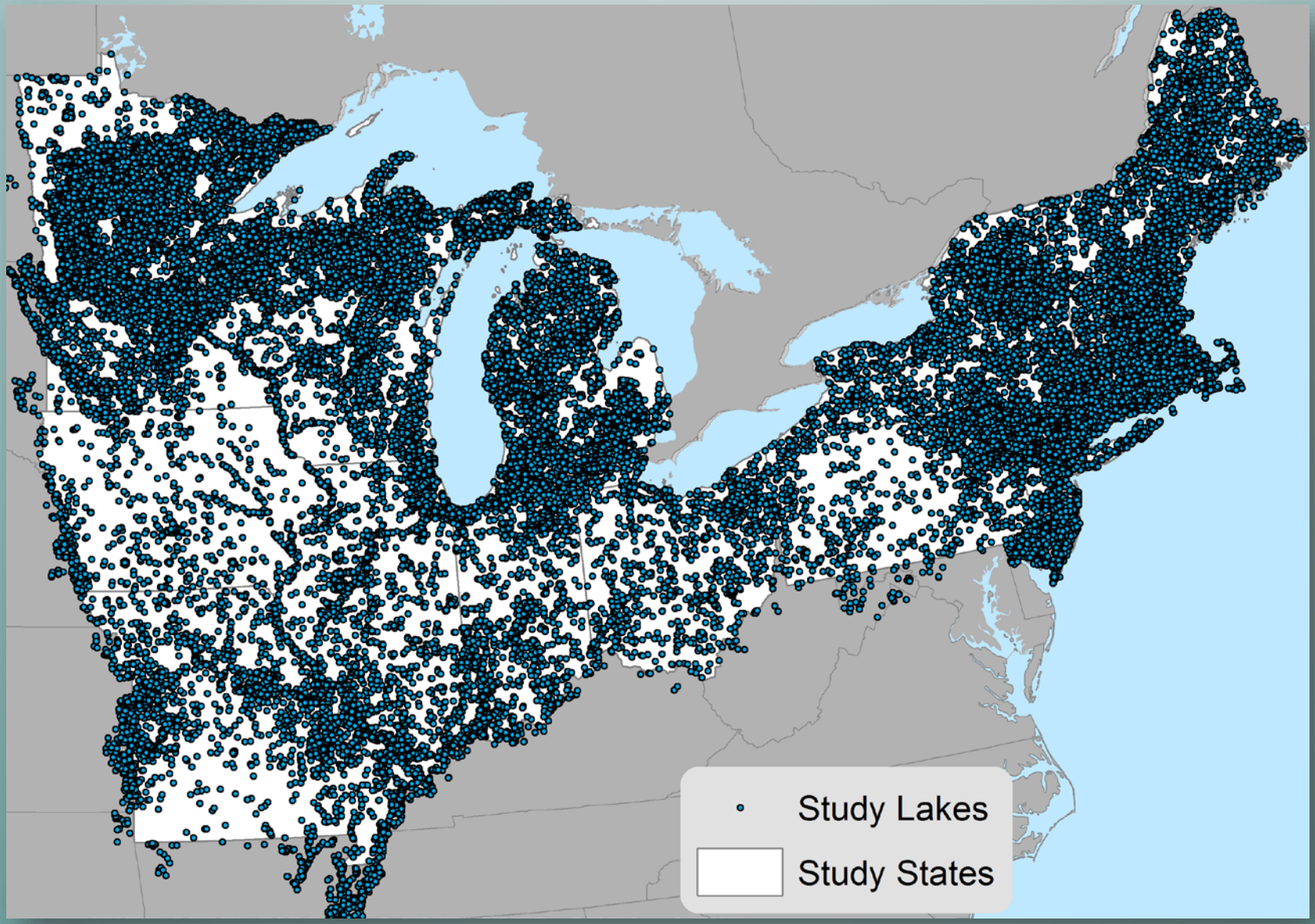
Average chlorophyll concentrations in all lakes in MI



Data from LAGOS-NE

So, lets look at ALL lakes in LAGOS-NE….

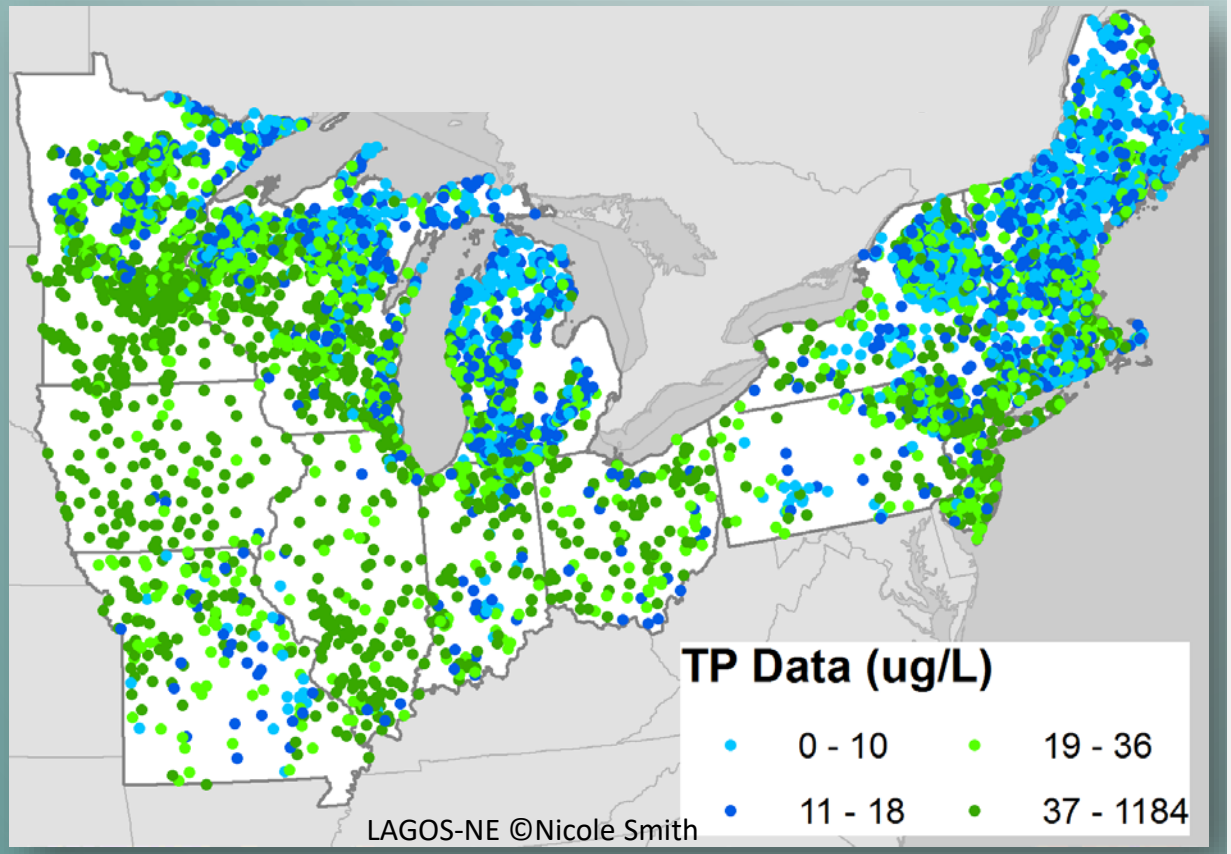
What have we learned???



LAGOS: What have we learned???

1. Lake water quality varies a lot across states, but ALSO within states

Total phosphorus in ~8,000 lakes



(Collins et al. 2017)

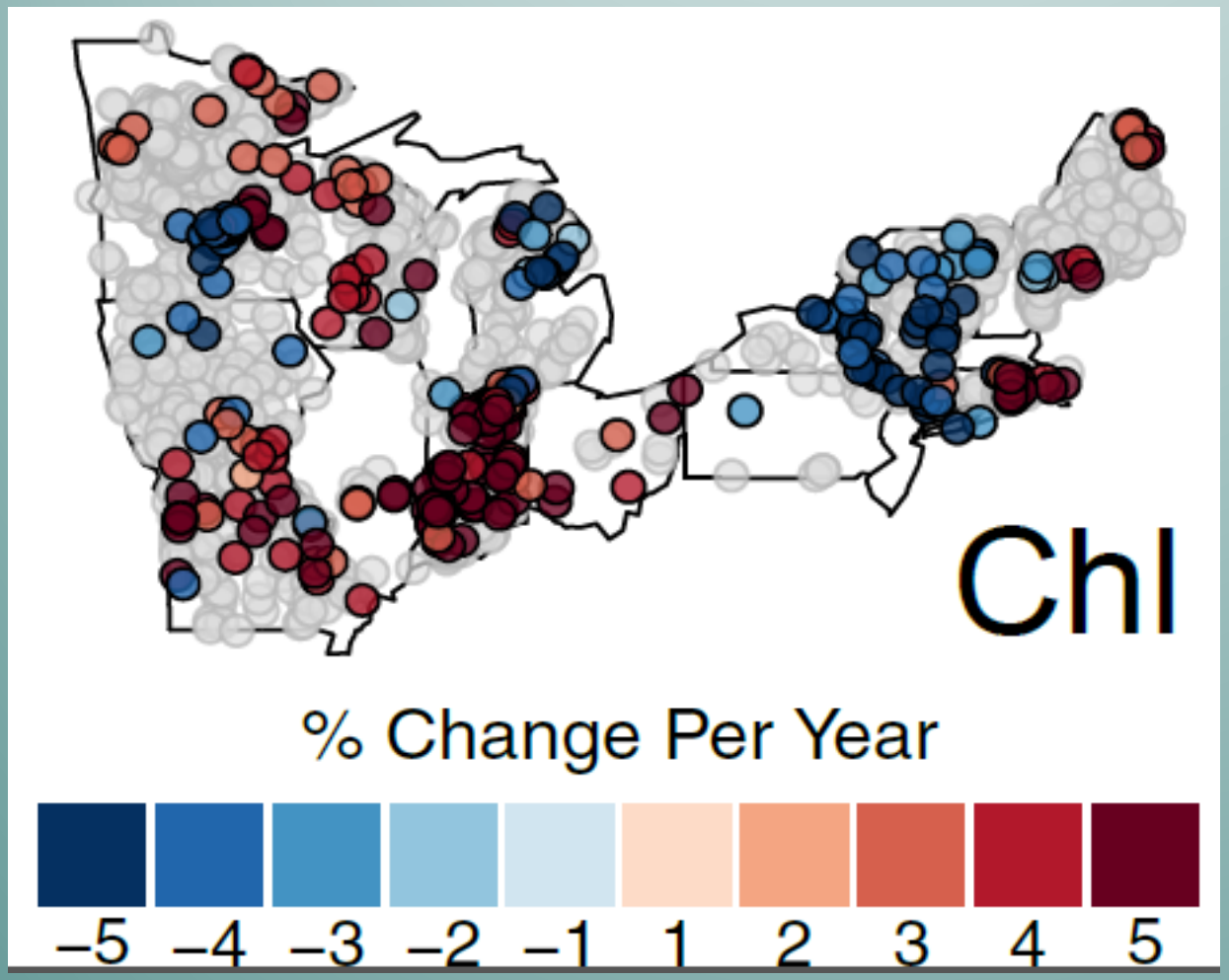
Lakes with poorer water quality are:

- *Shallower*
- *Have agriculture in their watersheds*
- *Have large watersheds compared to their lake area*
- *In the warmer regions of the study area*

LAGOS: What have we learned???

2. Water quality has NOT changed drastically since 1990

Chlorophyll trends in ~ 3,000 lakes



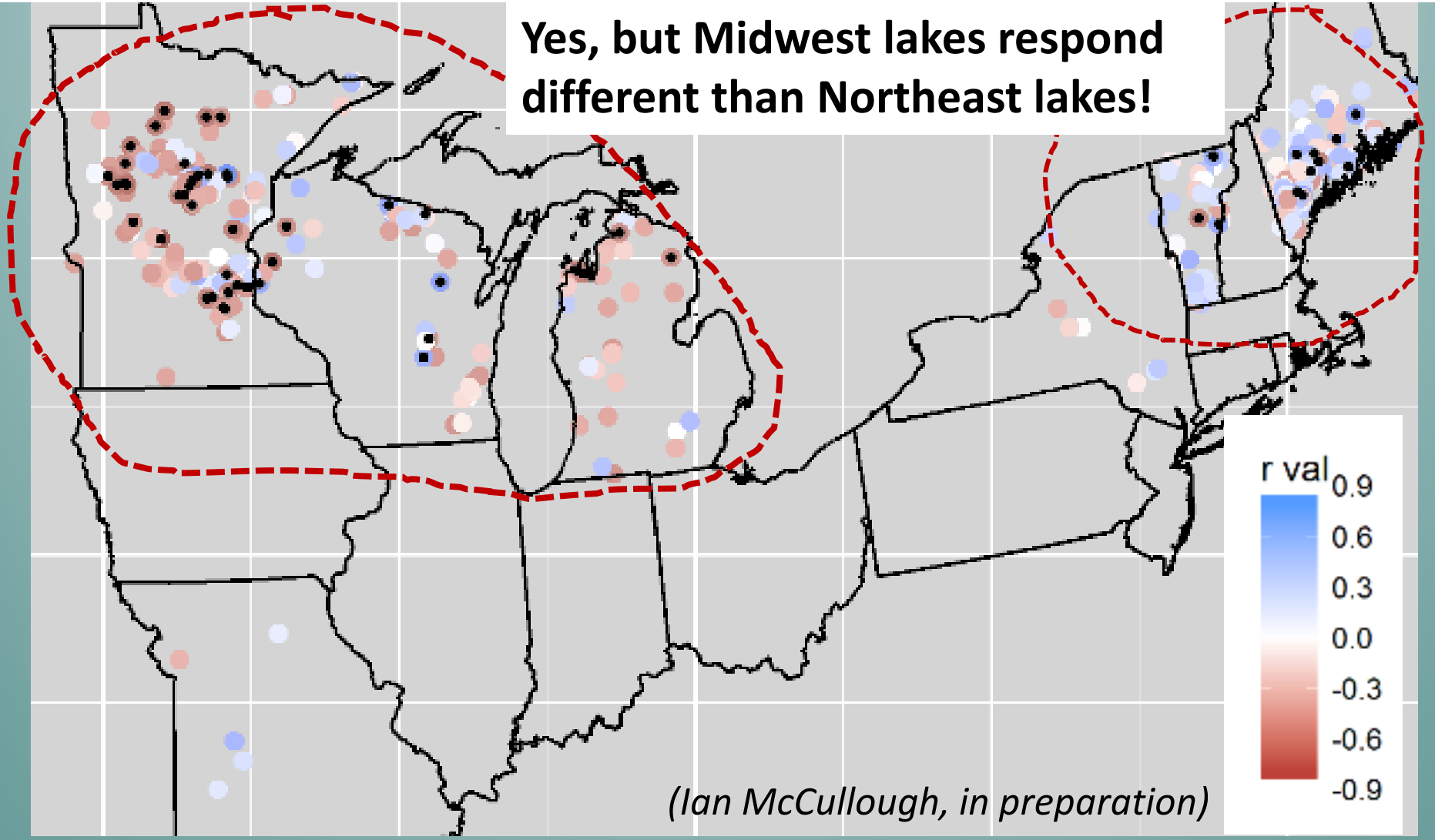
- 10% of lakes **increased** chlorophyll a small amount
- 5% of lakes **decreased** chlorophyll a small amount

(Oliver et al. 2017)

LAGOS: What have we learned???

3. Water quality does respond to climate, but ….

Response of Secchi depth to maximum summer temperature



Take home messages:

(1) Citizen-collected data make up a large proportion of available water quality data

(2) Citizen-collected data contribute a VERY HIGH proportion of the long-term data available for study

(3) Lakes sampled by citizen-volunteers are more likely to be more 'developed' than non-sampled lakes. And, there are gaps in the current water quality sampling in MI.

(4) We have learned many new things about water quality of lakes in regions and states and how and why they are or aren't changing.

Many people to thank for LAGOS

(1) The LAGOS-NE team

- Aquatic ecologists
- GIS professionals
- Data managers
- Statisticians
- Computer scientists

MSU, Univ Wisconsin, Iowa State University, Penn State, NOAA-GLERL

NSF Macrosystems Biology Program

(2) YOU of course!

And….

- Many additional data providers:

The database is made available through publication of this article:

LAGOS-NE: A multi-scaled geospatial and temporal database of lake ecological context and water quality for thousands of U.S. lakes

Patricia A. Soranno, Linda C. Bacon, Michael Beauchene, Karen E. Bednar, Edward G. Bissell, Claire K. Boudreau, Marvin G. Boyer, Mary T. Bremigan, Stephen R. Carpenter, Jamie W. Carr Kendra S. Cheruvelil, Samuel T. Christel, Matt Claucherty, Sarah M. Collins, Joseph D. Conroy, John A. Downing, Jed Dukett, C. Emi Fergus, Christopher T. Filstrup, Clara Funk, Maria J. Gonzalez, Linda T. Green, Corinna Gries, John D. Halfman, Stephen K. Hamilton, Paul C. Hanson, Emily N. Henry, Elizabeth M. Herron, Celeste Hockings, James R. Jackson, Kari Jacobson-Hedin, Lorraine L. Janus, William W. Jones, John R. Jones, Caroline M. Keson, Katelyn B.S. King, Scott A. Kishbaugh, Jean-Francois Lapierre, Barbara Lathrop, Jo A. Latimore, Yuehlin Lee, Noah R. Lottig, Jason A. Lynch, Leslie J. Matthews, William H. McDowell, Karen E.B. Moore, Brian P. Neff, Sarah J. Nelson, Samantha K. Oliver, Michael L. Pace, Donald C. Pierson, Autumn C. Poisson, Amina I. Pollard, David M. Post, Paul O. Reyes, Donald O. Rosenberry, Karen M. Roy, Lars G. Rudstam, Orlando Sarnelle, Nancy J. Schuldt, Caren E. Scott, Nicholas K. Skaff, Nicole J. Smith, Nick R. Spinelli, Joseph J. Stachelek, Emily H. Stanley, John L. Stoddard, Scott B. Stopyak, Craig A. Stow, Jason M. Tallant, Pang-Ning Tan, Anthony P. Thorpe, Michael J. Vanni, Tyler Wagner, Gretchen Watkins, Kathleen C. Weathers, Katherine E. Webster, Jeffrey D. White, Marcy K. Wilmes, Shuai Yuan

GigaScience, gix101, https://doi.org/10.1093/gigascience/gix101
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LAGOS: What have we gained?

- New **knowledge** about lakes in different regions and states

- Data **preservation** -- We have archived this data so that it will not be lost
  - ***Cost of archiving*** *was a fraction of original cost for collection estimated at ~$ 0.5 billion US*

- **Data resource** or future researchers, policymakers, public

What we are trying to do and why

To build a new **geography of lakes** to understand and protect our waters to preserve water quality for future generations.