

STATISTICALLY VALID SURVEYS OF LAKES AND RESERVOIRS IN THE UNITED STATES

ILMA Conference 2022

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Illinois Environmental
Protection Agency





Environmental Protection A

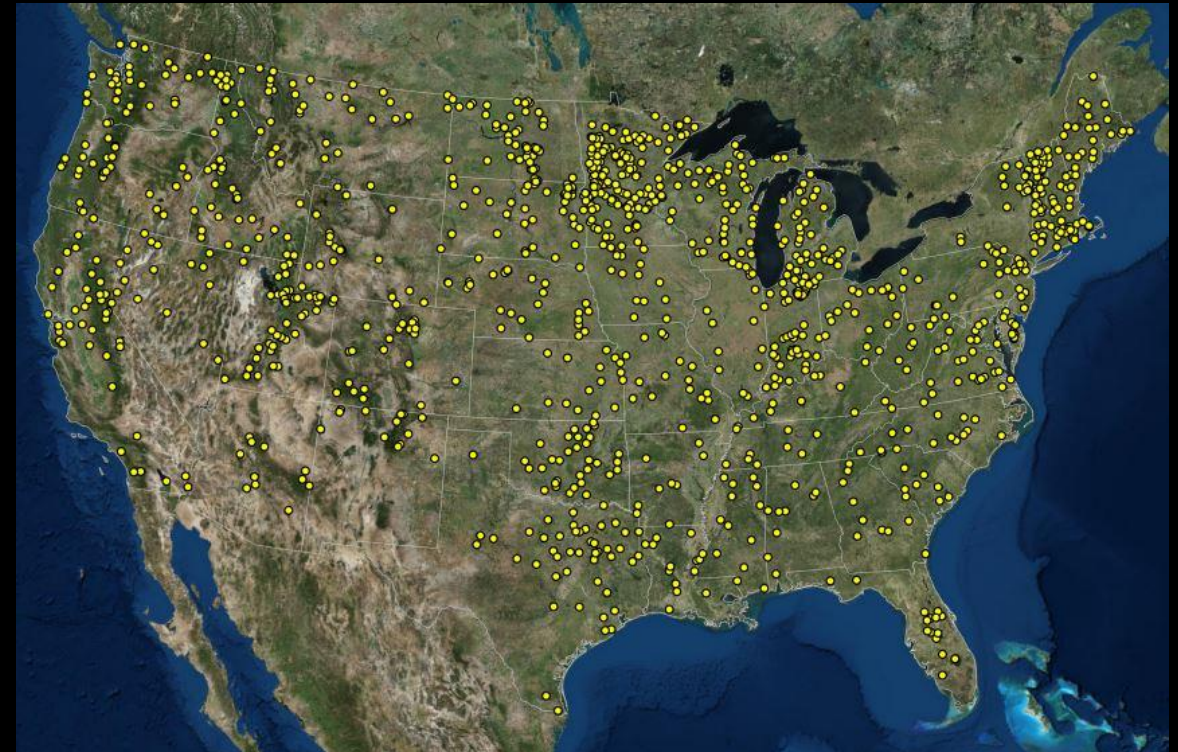
BROAD SCALE SURVEY DESIGN



Condition
Assessment

USEPA NATIONAL AQUATIC RESOURCE SURVEYS

- NARS forms nationwide collaboration and standardization
- Controlled and repeatable statistically valid survey design for
 - **Lakes**
 - Rivers and Streams
 - Coastal Waters
 - Wetlands

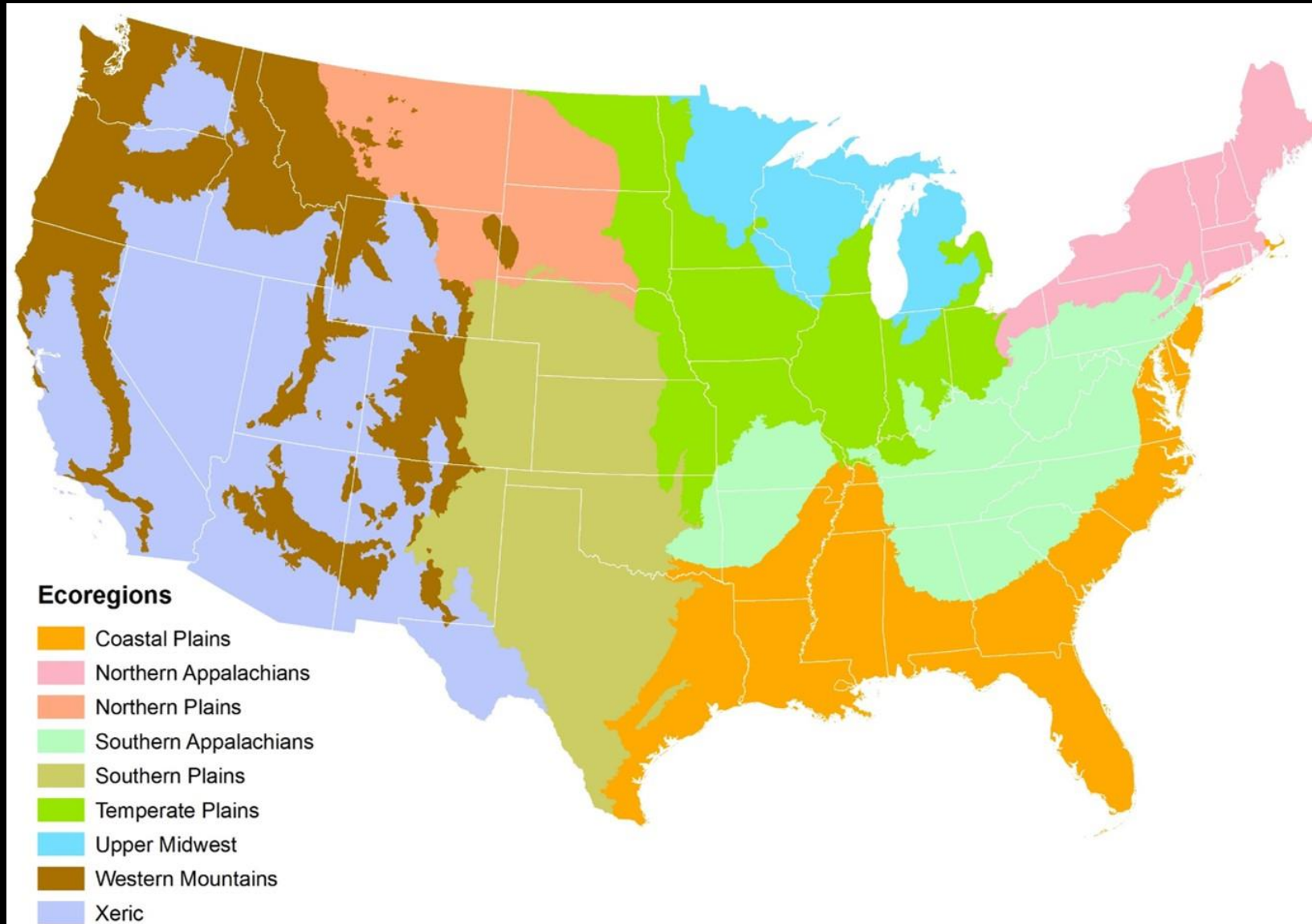


2012 Field season NLA stations 1,038 lakes
sampled by 89 crews

SURVEY OBJECTIVES

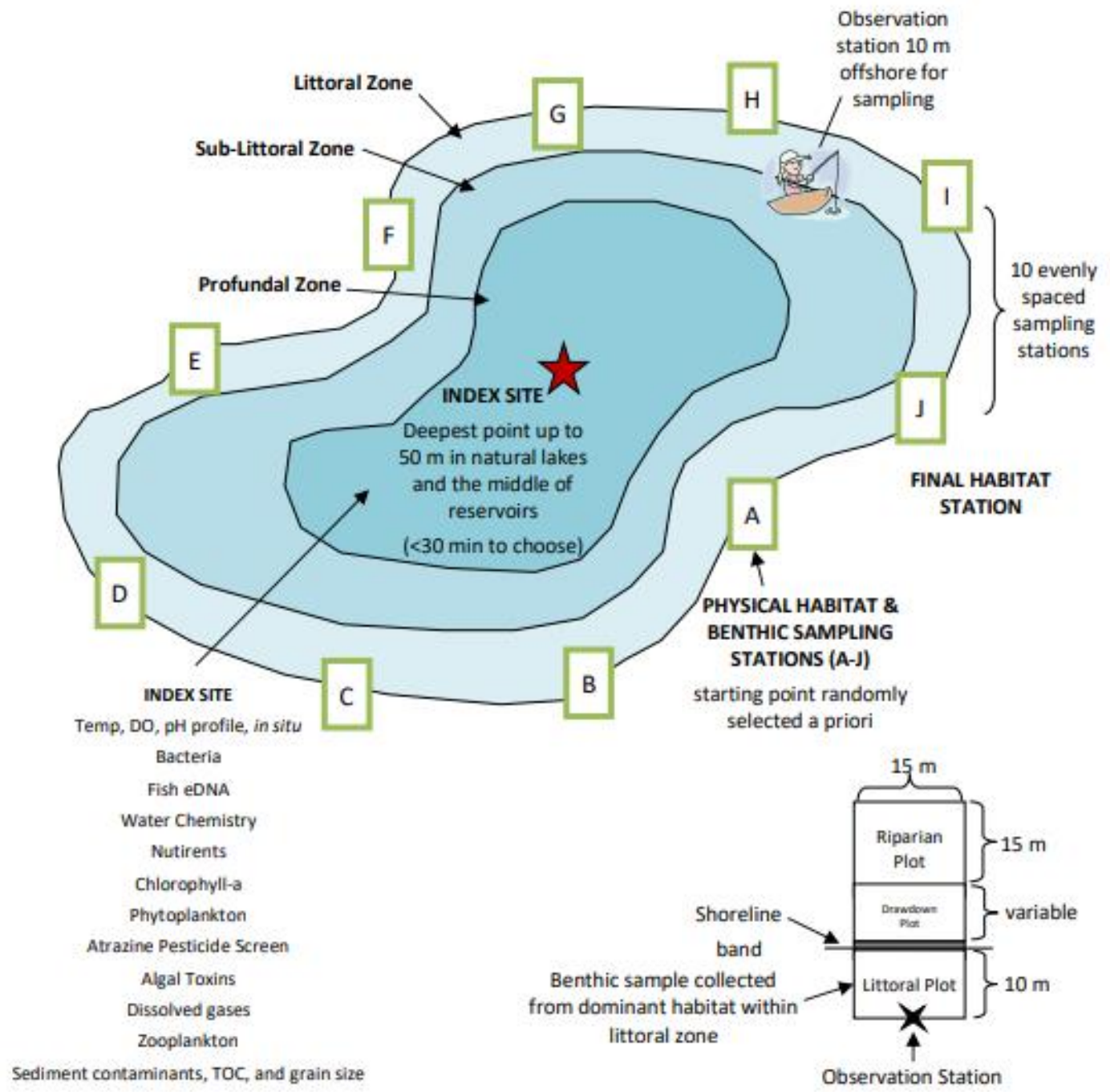
- Assess the condition of the nation's lakes.
- Establish a baseline to compare future surveys for trends assessment and evaluate change in condition since previous surveys.
- Help build State and Tribal capacity for monitoring and promote collaboration across jurisdictional boundaries.
- The surveys try to address key questions about the quality of the nation's lakes.
 - What percent of the nation's lakes are least, moderately, and most disturbed for key indicators of trophic state, ecological health, and human use (recreation)?
 - What is the relative importance of key stressors such as nutrients and pathogens?

ECOREGIONS FOR THE LAKE DRAW

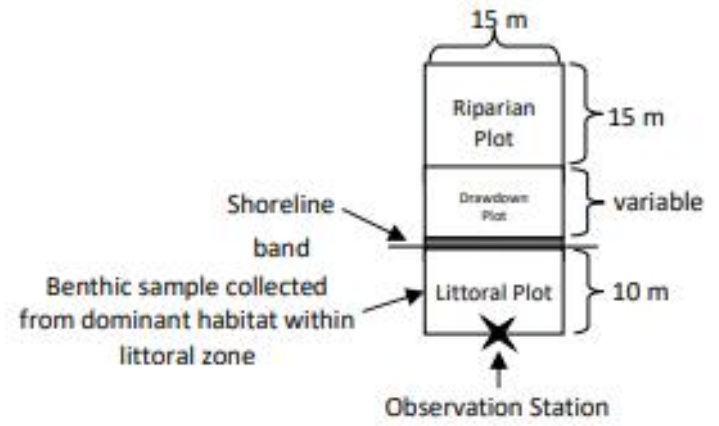


FIELD WORK



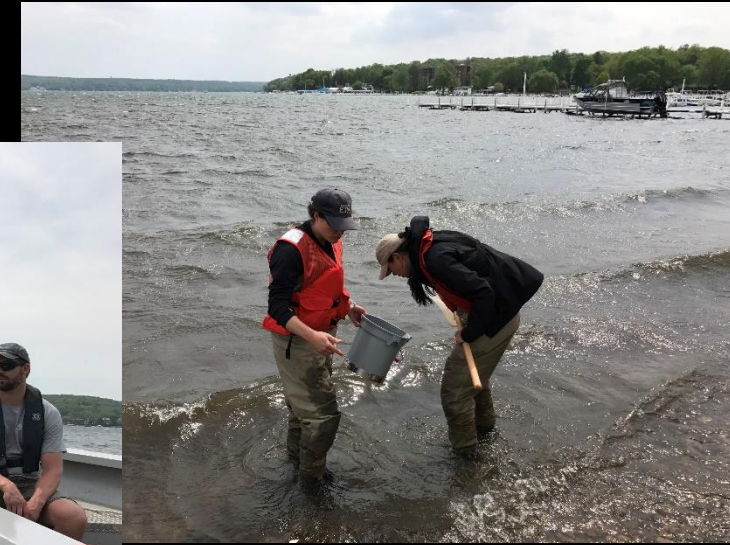


- INDEX SITE**
- Temp, DO, pH profile, *in situ*
 - Bacteria
 - Fish eDNA
 - Water Chemistry
 - Nutrients
 - Chlorophyll-a
 - Phytoplankton
 - Atrazine Pesticide Screen
 - Algal Toxins
 - Dissolved gases
 - Zooplankton
 - Sediment contaminants, TOC, and grain size



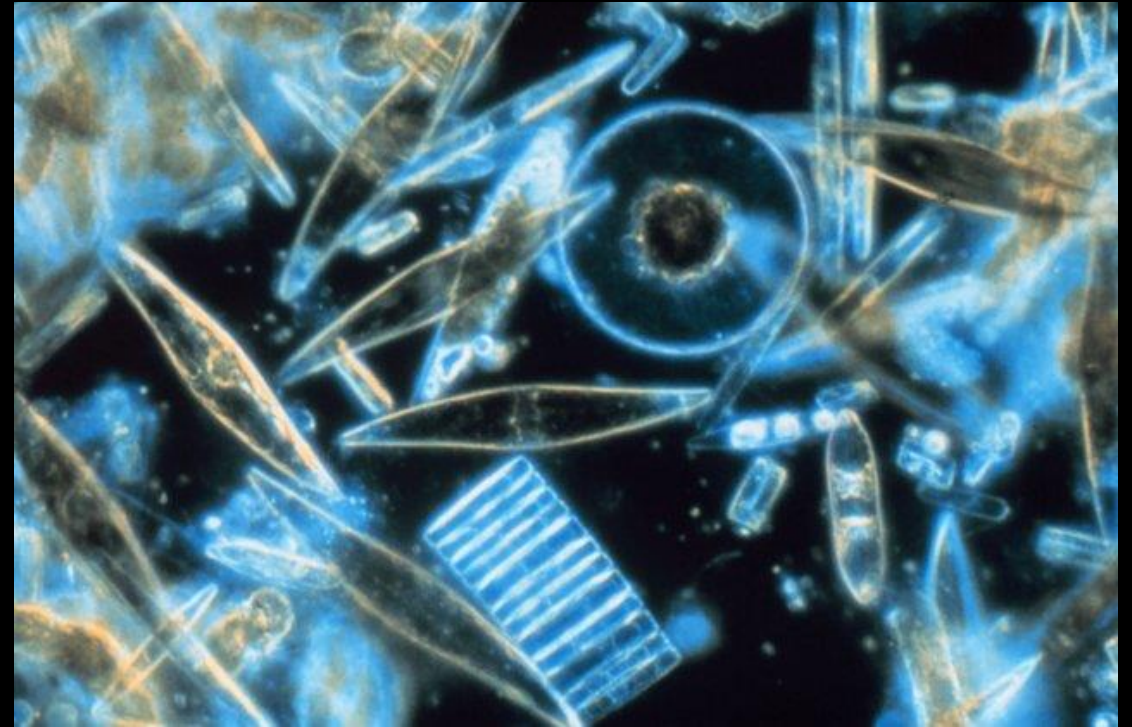
MONITORING TOOLS

- Integrated water sampler
- Sediment core sampler
- Syringes collecting gasses
- Sieve buckets and nets
- Zooplankton nets 2 nets, 50um and 150 um mesh
- A limited number of labs and taxonomists are chosen for standard analysis methods all outlined in the QAPPs



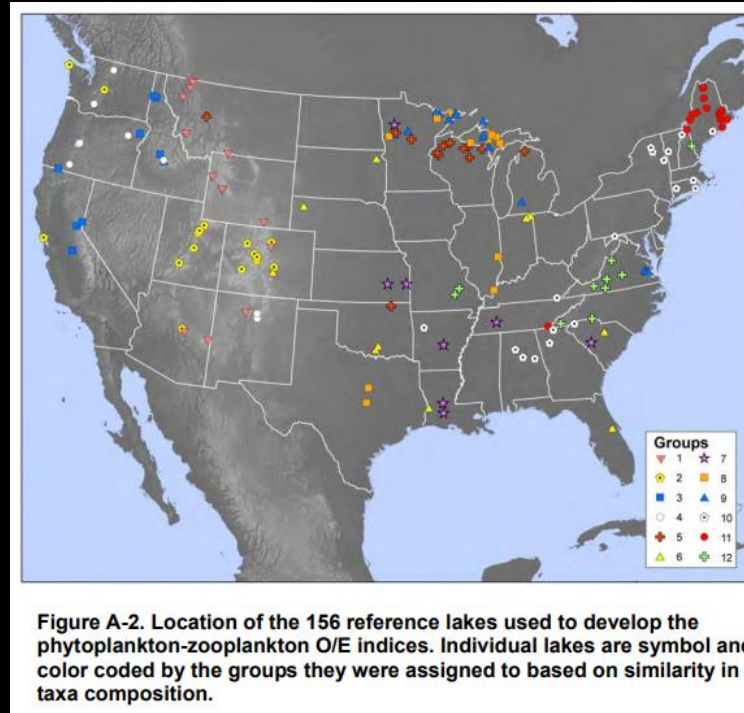
DIATOMS

- Sediment Diatoms
- Indicator used for 2007
- Produced a Lake Diatom Condition Index
 - Based on expected Lake Diatom Condition
- Abundant in freshwater
- Silica cell wall
- Food source
- Biological condition gradient



PLANKTON

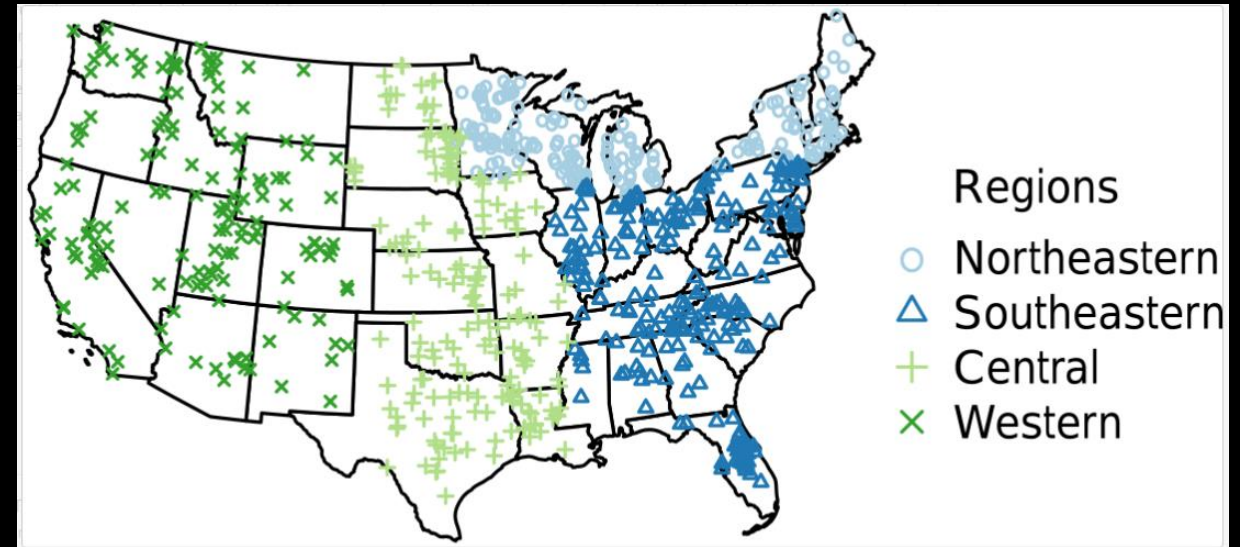
- Plankton 2007
- Combined phytoplankton and zooplankton index
- Observed/Expected predictive Model
- 259 reference taxa
- Regional and site characteristics to form lake classes
- Expected taxa developed for each class
- Determine percentile ranges of reference condition to identify good, fair, poor



CHLOROPHYLL

- Chlorophyll a-increase in algae biomass can indicate degraded water quality condition
- Trophic state
- Compared with NES dataset 1972-1975
- Celebrate the 50th anniversary of the CWA resurvey the NES lakes with the 2022 NLA
 - Chlorophyll a
 - Secchi transparency
 - Nutrients
 - conductivity

Map of NES sites 1972-1975



Change in Trophic State (Chlorophyll)

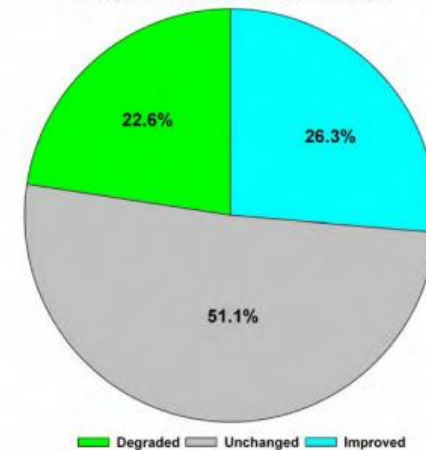


Figure A-4. Change in trophic state of lakes between the 1972 NES and 2007 NLA studies.

MACROINVERTEBRATES

- Benthic macroinvertebrates
- Region specific characteristics
some discrepancies to reconcile
- 5 biological ecoregions of the
9 national ecoregions
- MMIs developed
independently
- Index scores represent stressor
gradient



WATER SAMPLES

- Acidification
- Atrazine
- Dissolved Oxygen
- Nitrogen
- Phosphorus
- Sediment mercury



Instructions ?

Input data for one lake below to see how it compares to a nationwide representative sample. Afterward, [click here](#) to export an image of the results.

Select an Indicator

Choose an indicator ▼

Input Your Data

Year Data Collected

NLA Year

2012 ▼

Lake Name (optional)

Select State

This tool provides data for your state's EPA region, in addition to data at the national and state levels.



Welcome to EPA's Lake Comparison Tool



This tool was produced by the National Aquatic Resource Surveys (NARS) program of the U.S. Environmental Protection Agency (EPA). The NARS program conducts large-scale studies of the quality of the nation's waters. One such study is the National Lakes Assessment (NLA).

What Can the Tool Do? This tool allows you to input water quality data for a lake you care about, then see it compared to statistically representative data collected by the NLA. You'll view comparisons to the national, regional and state level. This is currently possible using 2012 and 2017 NLA data for any of four important and common indicators of water quality:

- *Secchi Depth* (a measure of water clarity)
- *Total Phosphorus* (a nutrient that can trigger problematic algal blooms)
- *Total Nitrogen* (another such nutrient)
- *Chlorophyll a* (a measure of algal population)

How Do I Get Started? Complete the form on the left, then your output will appear in place of these instructions. (Entering the name of your lake in the form is optional.)

How Do I Interpret Results? For help interpreting the results, click the "?" icon on the left.

What Devices Are Best? For best results, use this tool in Chrome or Edge using a laptop or desktop computer. It may not display properly on mobile or other devices with smaller screens.

How Do I Learn More? Visit the EPA's [NLA website](#).

- <https://owshiny.epa.gov/nla-lake-context-tool/>

Instructions ?

Input data for one lake below to see how it compares to a nationwide representative sample. Afterward, [click here](#) to export an image of the results.

Select an Indicator

Secchi Depth ▾

Input Your Data (in meters)

2.2

Year Data Collected

2010

NLA Year

2012 ▾

Lake Name (optional)

Clear Lake

Select State

IL ▾

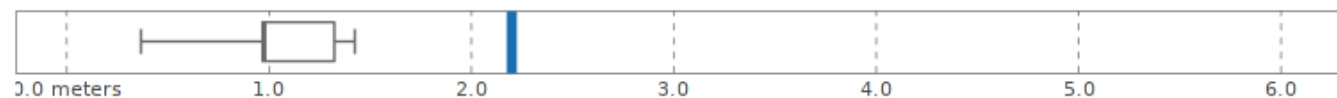
Illinois is in EPA Region 5.



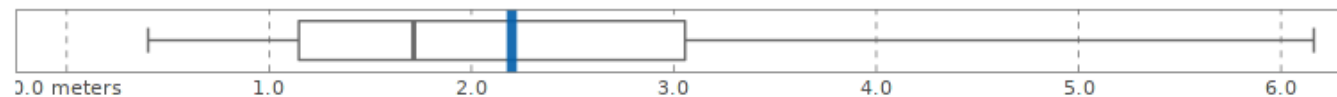
How Does Clear Lake Compare to Other U.S. Lakes?

You reported that Clear Lake in Illinois (IL) had an observed value of **2.2 meters** for Secchi Depth in 2010. The graphs below show how your lake ranks at the state, regional and national levels compared to representative data collected by the U.S. National Lakes Assessment in **2012**. For Secchi Depth, an upper percentile ranking is generally preferable.

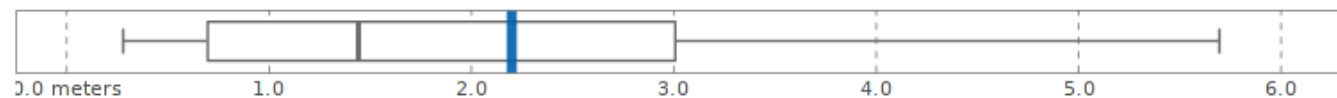
In IL, Clear Lake is in the 97th percentile.*



In Region 5, Clear Lake is in the 59th percentile.*



Nationally, Clear Lake is in the 67th percentile.*



***Important:** These population estimates are based on a weighted analysis of lake data from the U.S. EPA's 2012 U.S. National Lakes Assessment (NLA). Secchi Depth was measured once at an open water location from June to September 2012. Sampled lakes were selected using a statistically representative approach that balances lake size with their distribution across the continental U.S. Results shown are weighted based on those factors. Percentiles are rounded to the nearest whole number. Estimated max. margin of error for IL percentile ranking, based upon limited observations: ±5.5. To learn about the NLA, please visit the [EPA's website](#).

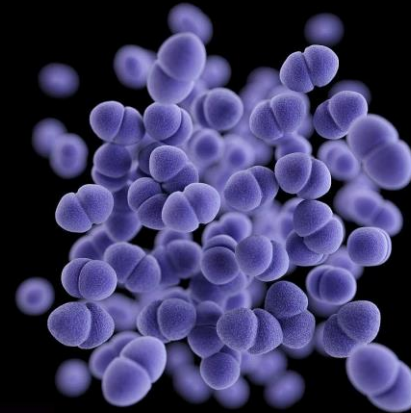
- Physical

- Drawdown
- Human Disturbance
- Lakeshore Habitat
- Physical Habitat Complexity
- Shallow Water habitat



RECREATIONAL/HUMAN HEALTH

- Cyanobacteria-high cell counts can indicate stress to waters and affect benthic macroinvertebrates and plants-
reduce water clarity
- Fish tissue-contaminants PFAs and Mercury
- Microcystin-algal toxin
- Enterococci-abundance of fecal bacteria



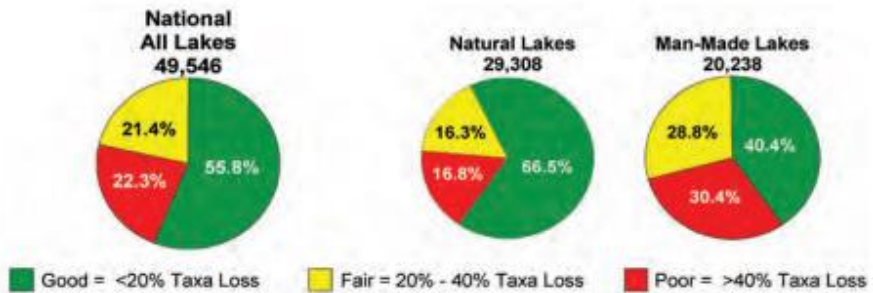
Rainbow trout. Photo: Lisac Mark, U.S. Fish and Wildlife Service

Centers for Disease Control and Prevention

[20170511-cdc-enterococcus.jpg \(873×1063\)](#)
[\(nih.gov\)](#)

KEY FINDINGS FROM 2007

Biological Condition



National Summary
56% Good
21% Fair
22% Poor



- 56% of lakes in US were in good biological condition
- 22% were found to be in poor biological condition
- 36% of lakes exhibited poor shoreline habitat
- 20% of lakes had high levels of nitrogen and phosphorus
- 49% of lakes have mercury concentrations that exceed health-based limits.

FACT SHEETS-2012

- Condition of the Lakes in the US?
 - > 35% of lakes suffer from nutrient pollution
 - < 1% of lakes have Microcystin at a level of concern established by WHO
 - 31% of lakes have a degraded benthic macroinvertebrate community



Lakes and reservoirs provide many environmental, economic, and public health benefits. We use lakes for drinking water, energy production, food and recreation. Fish, birds and other wildlife rely on them for habitat and survival. In the [National Lakes Assessment](#) (NLA), the U.S. Environmental Protection Agency (EPA) and its partners surveyed a wide array of lakes representative of those found in the U.S., from small ponds and prairie potholes to large lakes and reservoirs. The NLA is part of the National Aquatic Resource Surveys, a series of statistically-based assessments designed to provide the public and decision-makers with nationally consistent and representative information on the condition of the nation's waters.

What is the condition of lakes across the country?

>35% **Nutrient pollution:** Nutrient pollution is a widespread problem across the country. About 1 in 3 lakes (35%) have excess nitrogen and 2 out of 5 lakes (40%) have excess phosphorus. Too much of the nutrients nitrogen or phosphorus can contribute to algal blooms, low levels of oxygen, and harm to aquatic life.

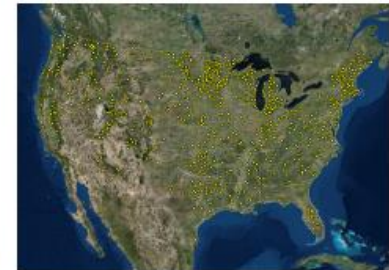
<1% **Microcystin:** An algal toxin, microcystin, is detected in 39% of lakes, but concentrations rarely reach moderate or high levels of concern established by the World Health Organization (<1% of lakes).

<1% **Atrazine:** The herbicide atrazine is detected in 30% of lakes, but concentrations rarely reach the EPA level of concern for plants in freshwaters (<1% of lakes).

31% **Biological condition:** We find that 31% of lakes have degraded benthic macroinvertebrate communities, which include small aquatic creatures like snails and mayflies. Analyses show an association between nutrients and biological condition. Lakes with high levels of phosphorus are 2.2 times as likely to have a degraded benthic macroinvertebrate community and lakes with high levels of nitrogen are 1.6 times as likely to have a degraded benthic macroinvertebrate community.

The margin of error for national results is approximately +/- 5%.

NLA 2012 Sampled Sites



The NLA indicates that nutrient pollution is common in U.S. lakes. Compared to other measures, nutrient pollution is the most widespread stressor measured in the NLA and can contribute to blooms and affect recreational opportunities in lakes.



The National Lakes Assessment (NLA) 2012

Are conditions getting better or worse?

A comparison of the 2007 and 2012 National Lakes Assessments indicates little change between surveys. In most cases, the percentage of lakes in degraded biological, chemical and physical condition did not change over this five year period, with a few notable exceptions.

13% ↓ **Lake drawdown:** Drawdown of lake water levels, whether by natural process or through direct manipulation, can adversely affect physical habitat conditions. Between 2007 and 2012, the NLA shows improving conditions with 13% fewer lakes in the most disturbed condition.

8.3% ↑ **Cyanobacteria:** The NLA measured the density of cyanobacteria cells, which can produce cyanotoxins, as an indicator of toxic exposure risk. The analysis reveals worsening conditions, with 8.3% more lakes in the most disturbed condition in 2012 than in 2007.

9.5% ↑ **Microcystin:** The NLA shows a 9.5% increase in the detection of an algal toxin, microcystin. However, concentrations of this algal toxin remain low and rarely exceeds World Health Organization recreational levels of concern (<1% of the population) in both assessments.

Phosphorus: In addition, a supplementary analysis of the NLA data finds that phosphorus has increased in lakes that were previously low in phosphorus. In 2012, there were 18.2% fewer low-phosphorus lakes than in 2007.

What are we doing to address problems?

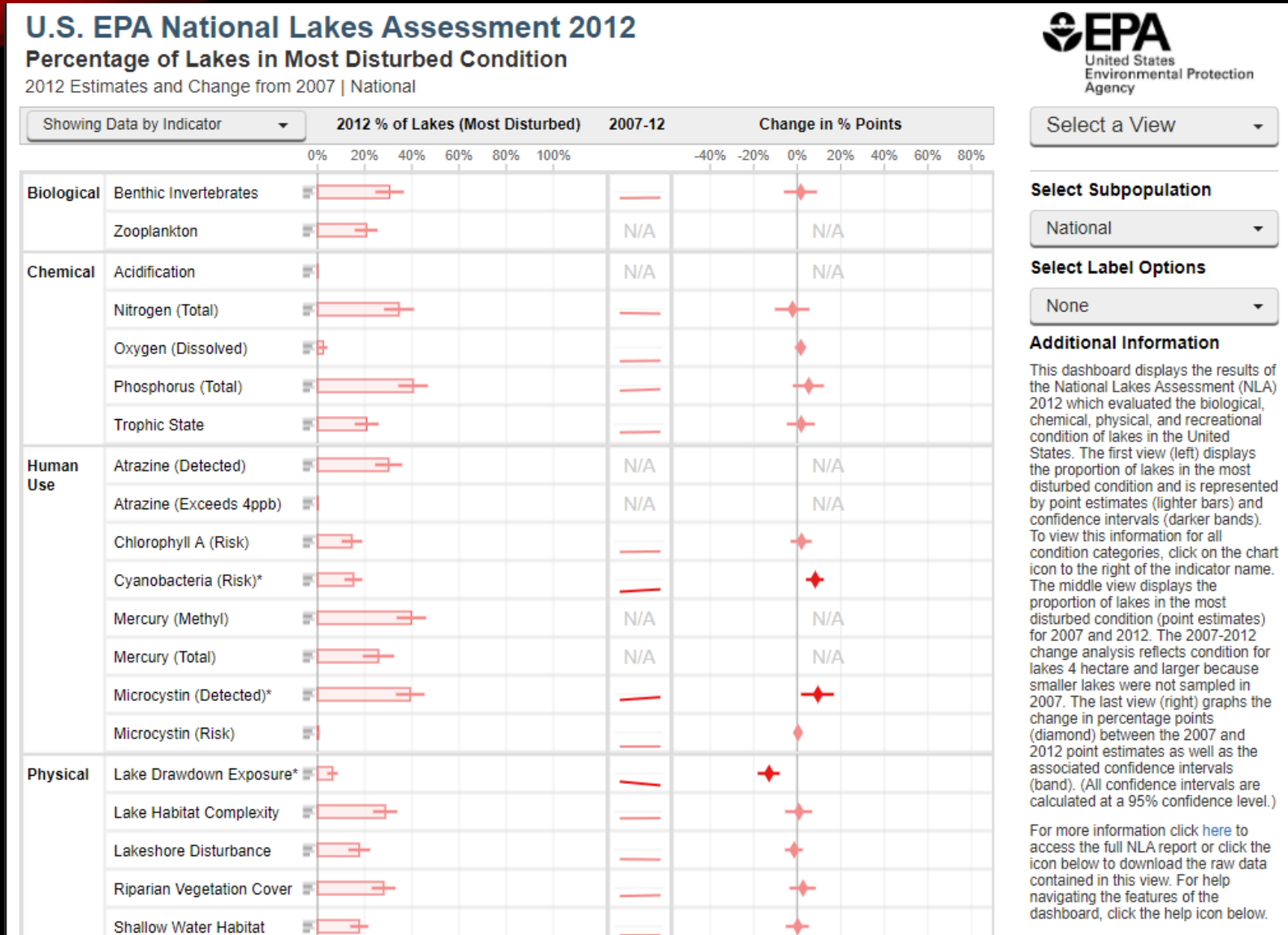
The NLA indicates that our lakes are under stress. In particular, the NLA suggests a need to reduce nutrient pollution to improve lake conditions. EPA is working on many fronts to reduce the severity, extent, and impacts of nutrient pollution in our nation's lakes and other waters. These efforts involve overseeing regulatory programs, conducting outreach and engaging partners, providing technical and programmatic support to states, financing nutrient reduction activities, and conducting research and development. For more information on what EPA is doing to reduce nutrient pollution, visit epa.gov/nutrientpollution.



The NLA offers a unique opportunity to frame discussions and plan strategies for the protection and restoration of lakes across the United States. Additional information from the NLA is available online at epa.gov/national-aquatic-resource-surveys/nla. Website visitors can explore NLA results with interactive dashboards, find assessments of regional conditions, examine differences between natural lakes and reservoirs, and more.

- Conditions better or worse?
 - Fewer lakes impacted by drawdown overall (Temperate plains)
 - Worsening conditions for cyanobacteria from 2007 to 2012
 - Increase in detection of Microcystin overall, although few sites had levels of concern
 - Reduction in low phosphorus lakes between 2007 and 2012, 18% fewer low-phosphorus lakes

DATA REPORTING-DATA DASHBOARD



U.S. EPA National Lakes Assessment 2012

Percentage of Lakes in Most Disturbed Condition

2012 Estimates and Change from 2007 | Temperate Plains



Select a View

Select Subpopulation

Temperate Plains

Select Label Options

None

Additional Information

This dashboard displays the results of the National Lakes Assessment (NLA) 2012 which evaluated the biological, chemical, physical, and recreational condition of lakes in the United States. The first view (left) displays the proportion of lakes in the most disturbed condition and is represented by point estimates (lighter bars) and confidence intervals (darker bands). To view this information for all condition categories, click on the chart icon to the right of the indicator name. The middle view displays the proportion of lakes in the most disturbed condition (point estimates) for 2007 and 2012. The 2007-2012 change analysis reflects condition for lakes 4 hectare and larger because smaller lakes were not sampled in 2007. The last view (right) graphs the change in percentage points (diamond) between the 2007 and 2012 point estimates as well as the associated confidence intervals (band). (All confidence intervals are calculated at a 95% confidence level.)

For more information click [here](#) to access the full NLA report or click the icon below to download the raw data contained in this view. For help navigating the features of the dashboard, click the help icon below.

U.S. Environmental Protection Agency (USEPA). 2016. National Lakes Assessment 2012: A Collaborative Survey of Lakes in the United States. Interactive NLA Dashboard. <https://nationallakesassessment.epa.gov/>

* Reflects a statistically significant change at 95% between 2007 and 2012. Such changes are also indicated using darker colors.

NLA SUCCESS

- Data from the 2007 NLA helped Vermont legislators see how big of a problem shoreline habitat degradation was in their state.
- Prompted a comparison study between protections in Maine and water quality comparisons with Vermont's degraded shorelines
- In 2014 the Shoreland Protection Act became law
- The law provides education, and technical assistance to manage properties in lake-friendly ways
- Including demonstration sites
- Good stewards receive awards to post on properties



Vermont Lake Wise Program

Contact Information

Vermont Dept. of Environmental Conservation
Watershed Management Division
Lakes and Ponds Section
1 National Life Drive, Davis 3
Montpelier, VT 05620-3522

Tel.# [802-828-1115](tel:802-828-1115)

Lakeshore Manager and Lake Wise Coordinator
Amy Picotte

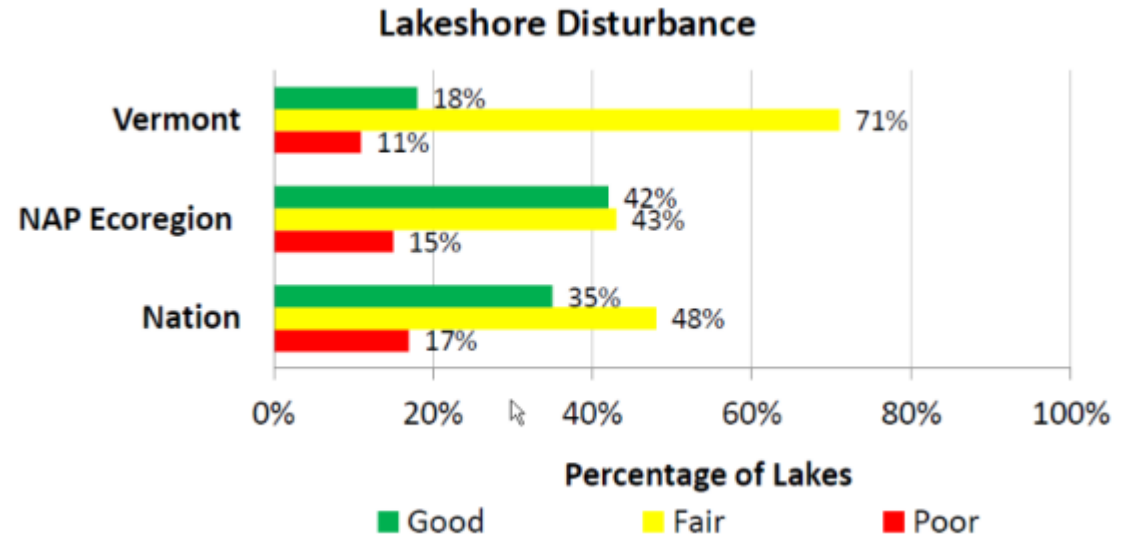
Amy.Picotte@vermont.gov
[802-490-6128](tel:802-490-6128)

Lake Wise Award



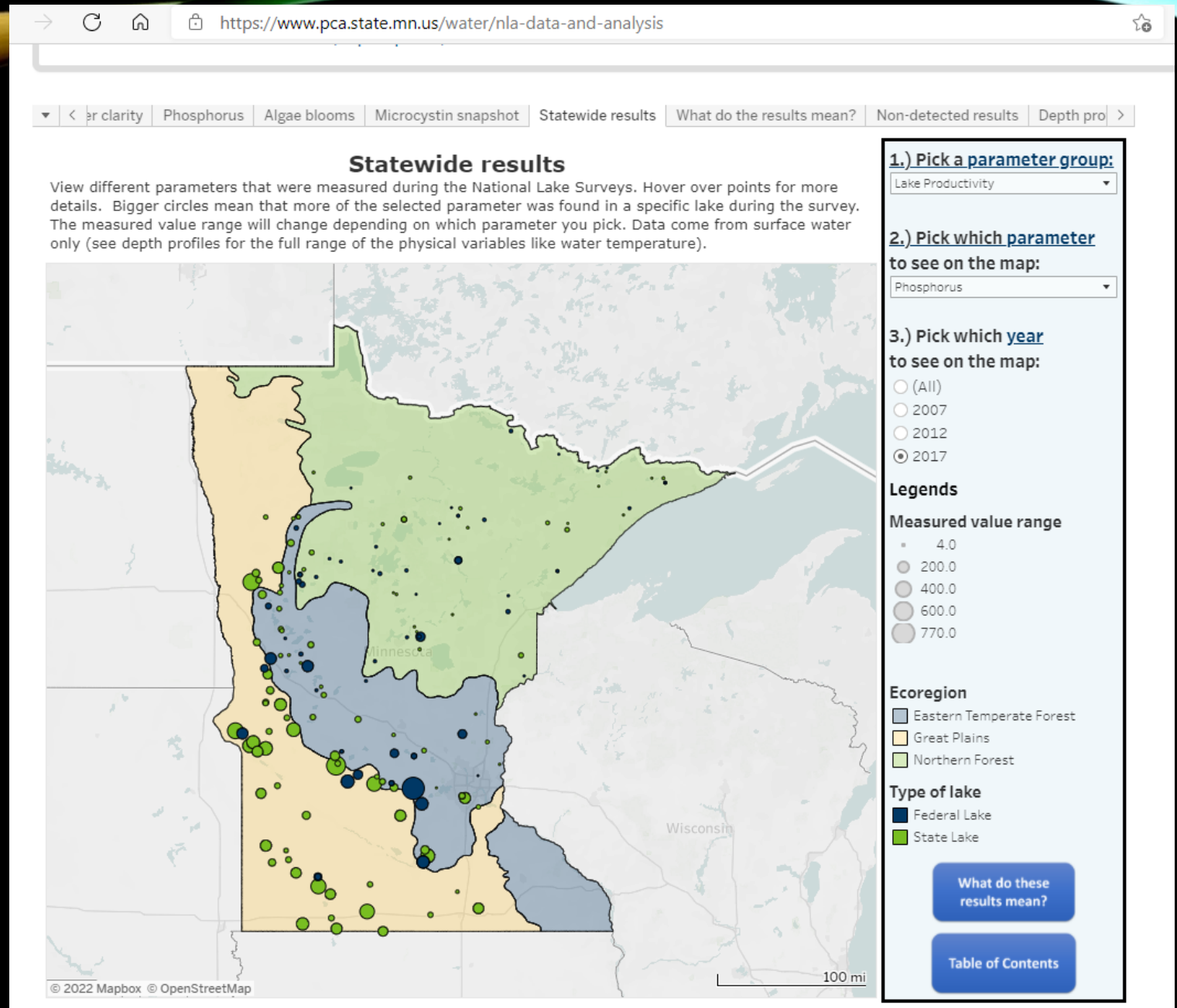
Lake Friendly Living

Vermont Agency of Natural Resources
www.anr.state.vt.us



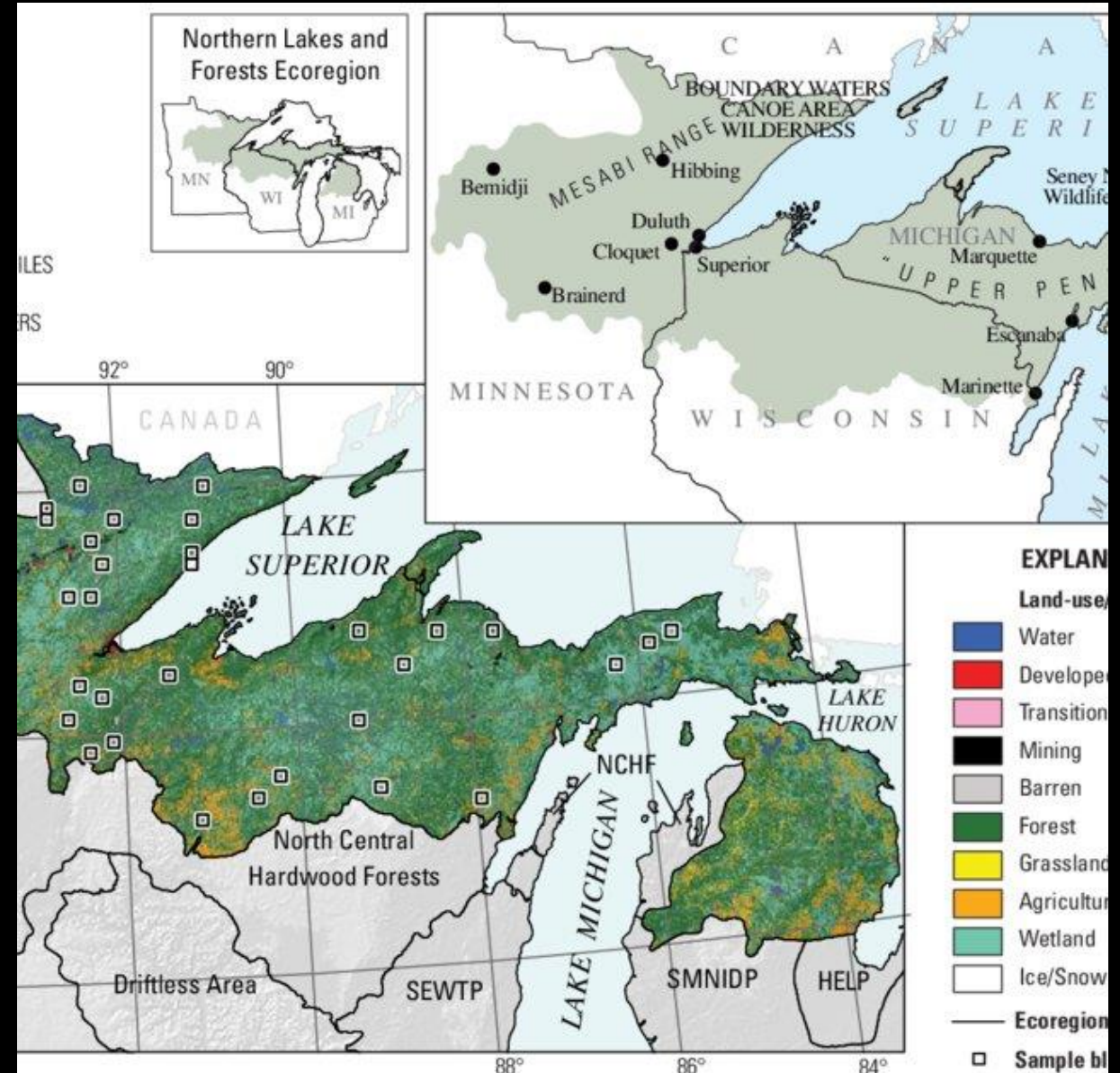
MINNESOTA POLLUTION CONTROL AGENCY

- Statewide condition assessments available every 5 years
- Searchable database on website to communicate lake health to the public



2022 PLANNING/INTENSIFICATIONS

- USEPA regions 1 and 2 are continuing the sediment diatom sampling. Continue to develop the IBIs and recalibrate with new data
- The Northern Lakes and Forest ecoregion is very remote and largely unmonitored. Intensifications are planned there to get 250 lakes sampled to provide baseline information and ecological classification for that area
- Wisconsin is planning investigating PFAs in fish tissue



What can you do with the data?

New: NARS Data Challenge

[click here](#)

What is the challenge?

Apply the NARS data to examine climate change, environmental justice, nutrient management, and other critical water quality challenges

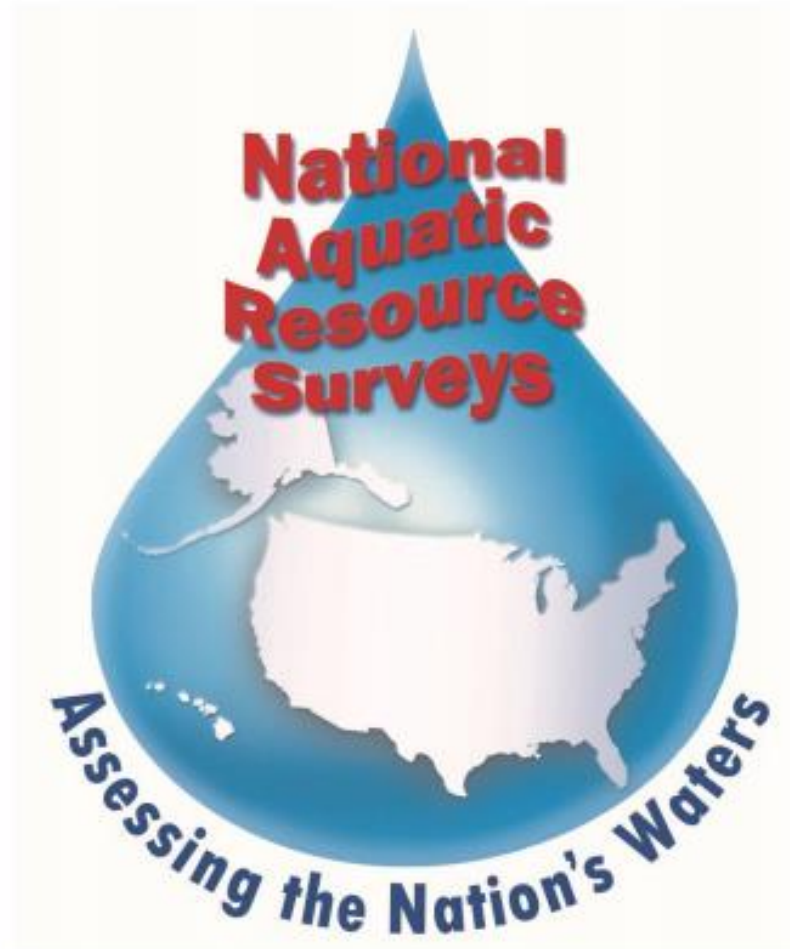
Who can apply?

Current graduate students (Masters or PhD program) affiliated with an accredited college or university

Research scientists including postdoctoral researchers, non-profit research organizations, academics, and scientists from other organizations

Applicants may apply singly or as a team.

Applicants must be U.S. citizens. Federal employees are not eligible to apply.





REFERENCES/LINKS

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https://engagedscholarship.csuohio.edu/scibges_facpub/112

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