



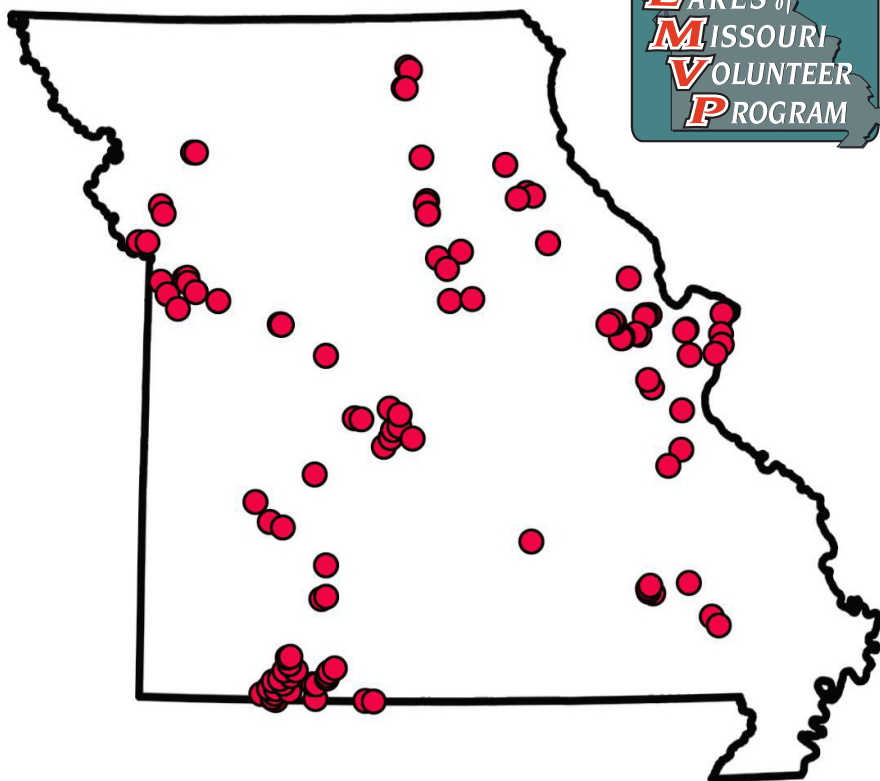
The Lakes of Missouri Volunteer Program  
**2021 LAKE REPORT**



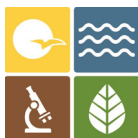
[WWW.LMVP.ORG](http://WWW.LMVP.ORG)

A summary of 2021  
water quality data

# Lake Sites Monitored in 2021



University of Missouri



Missouri Department  
of Natural Resources

Environmental Protection Agency Region 7 through the Missouri Department of Natural Resources has provided partial funding for this project under Section 319 of the Clean Water Act. MoDNR Cooperative Agreement G21-NPS-02

Cover: Ester Davis measuring water clarity at Knob Noster State Park



Data are available at [LMVP.org](http://LMVP.org)

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Above: Great egrets at O'Fallon Park Lake in St. Louis. Bob Virag photo.

# About the LMVP

The Lakes of Missouri Volunteer Program (LMVP) enlists volunteer scientists to track the effects of nonpoint source pollution in Missouri's lakes by measuring a variety of water quality elements. Using volunteer-generated data, we document water quality and patterns over time. When pollution problems occur, lake managers will use the information to apply remedies and measure the effectiveness of their efforts.

LMVP volunteers monitor at 3-week intervals from late spring to early fall. Samples are processed in the volunteers' homes using laboratory equipment provided by LMVP. The processed samples are stored in volunteers' freezers until picked up by LMVP staff. Samples are subsequently analyzed at the University of Missouri's Limnology Laboratory following accepted standard methods.

LMVP data are research quality and have been used in several scientific journal articles. One study\* shows LMVP data to be of comparable quality to data collected by employees of the University of Missouri. The LMVP data set provides up to 30 years of quality data for some of Missouri's most popular lakes.



Kris Mattern, Cydney Ross, and Arienne Barnes are ready to process their water sample at Houston Lake (Platte County).

\*D. Obrecht, M. Milanick, B. Perkins, D. Ready and J. Jones. 1998. Evaluation of data generated from lake samples collected by volunteers. *Lake Reserv Manag.* 14, pp 21-27.



# Nitrate and Ammonium

Over 3 million tons of atmospheric nitrogen are deposited each year in the United States alone\*. This can occur naturally (the air we breathe is around 78% nitrogen\*), from chemical reactions, or from fossil fuel combustion. Humans also add nitrogen to soil to better grow plants. Agricultural fertilizers account for 41% of the nitrogen runoff from the Mississippi River basin\*, which includes all of Missouri.

The LMVP has always measured nitrogen. We are now measuring two additional forms of nitrogen, nitrate and ammonium. These inorganic forms are favored by plants over other forms of nitrogen, making them a great choice for fertilizer. Unfortunately, nitrate and ammonium are also preferred by phytoplankton (algae and cyanobacteria, also called bluegreen algae). Too much phytoplankton in water can endanger the health of aquatic and terrestrial organisms, including humans.

Understanding and managing nutrient sources is the first step toward long-term lake health. By measuring these two nitrogen forms, we will learn more about the sources of nutrients in our lakes. This will help all users of LMVP data to make better decisions for their lakes.

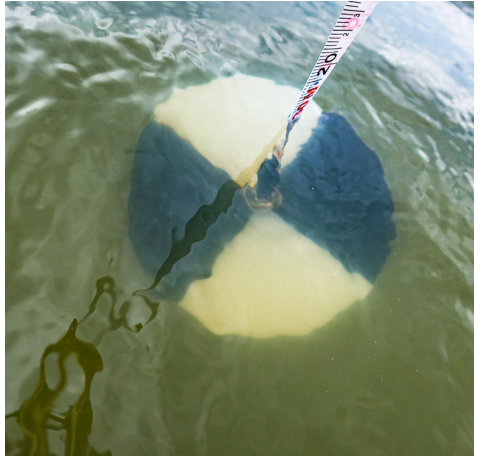
\* Source: <https://www.usgs.gov/special-topics/water-science-school/science/nitrogen-and-water>



Above: Casse Ward's view from her sampling site at Lake Lincoln (Troy County)

# Water Clarity

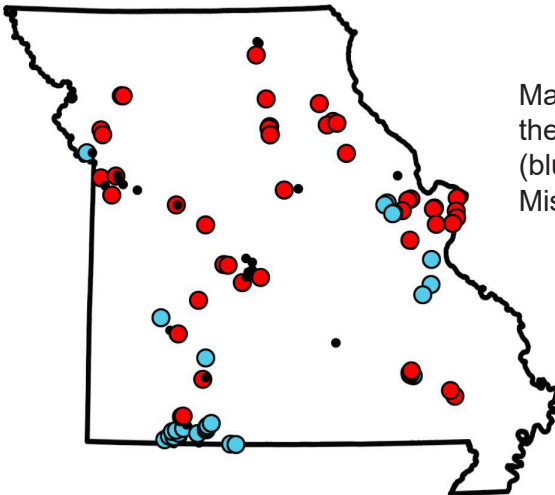
When we see murky water, we assume water quality is poor. Conversely, when we see clear water, we assume the water quality is good. Of course, water quality is not that simple, but monitoring water clarity is a good way to track the things that make water turbid. In Missouri, those things are usually algae and sediment.



Above: Secchi disk in Phillips Lake (Boone County). Julie Youmans photo.

Water clarity is measured in lakes using the Secchi disk. Our volunteers lower this disk into the water until it is no longer visible and record the depth. The Secchi disk is the standard tool for lake water clarity measurement. The simplicity, low cost, and portability of the Secchi disk have ensured its continued use for over 150 years.

Missouri lakes historically, on average, have about 3 feet of clarity near the dam, and clarity decreases with distance from the dam. In 2021, the average LMVP volunteer-measured lake water clarity was 4.3 feet and our water clarity measurements ranged from 4 inches to 20 feet.



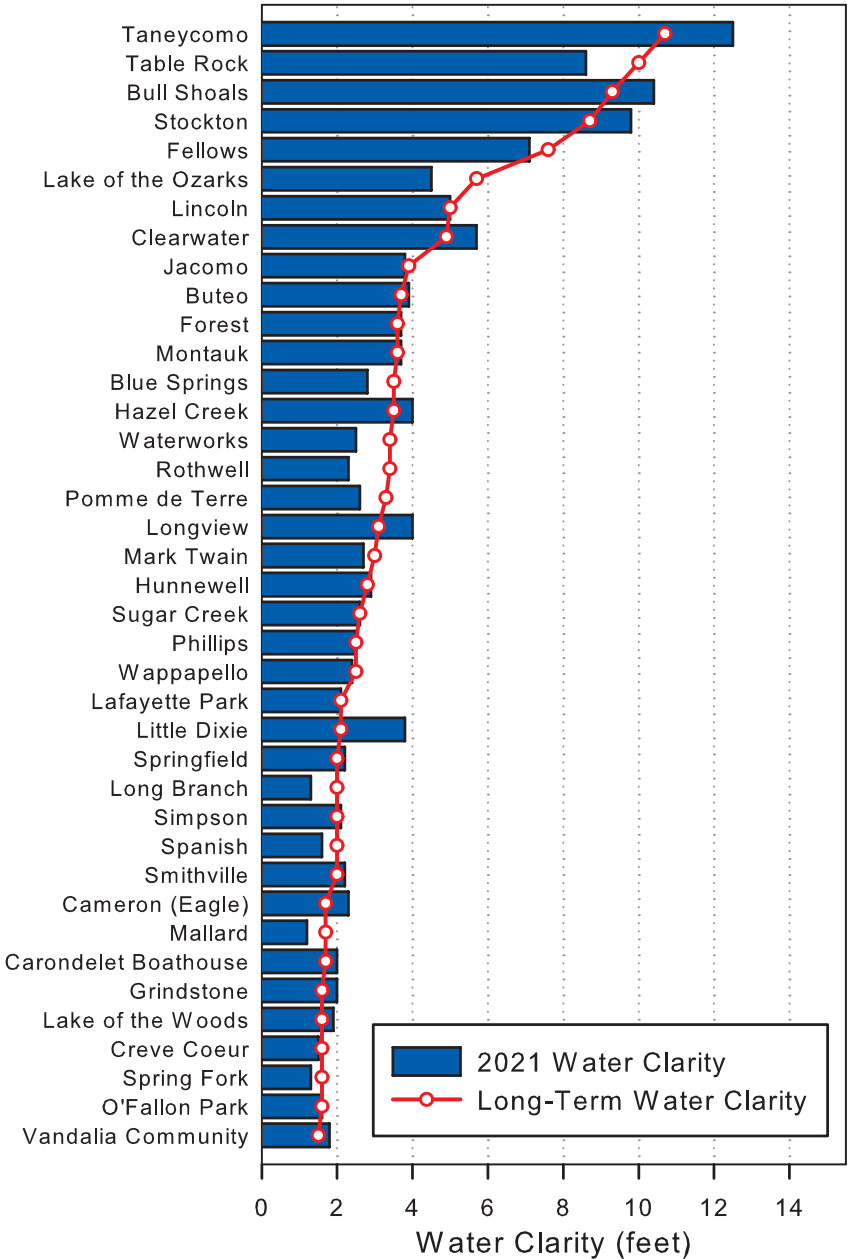
Map shows lake sites with the lowest (red) and highest (blue) average water clarity in Missouri during 2021.

## Water Clarity

- Secchi < 3 feet
- Secchi 3.1 - 6 feet
- Secchi > 6 feet



Average water clarity values for 39 public lakes monitored (at or near the dam) by LMVP volunteers in 2021 (bars). Long-term lake values shown in red.



# Chlorophyll

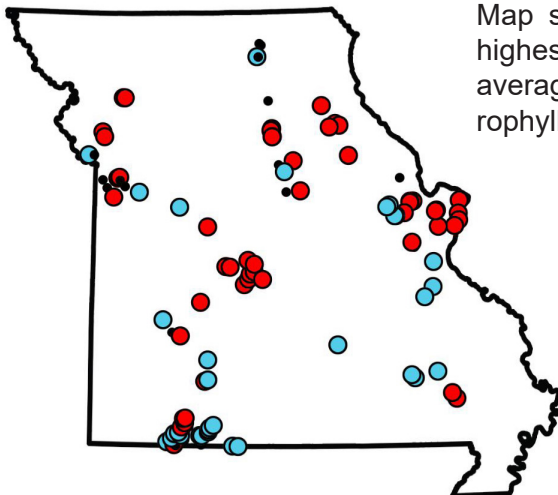
Phytoplankton (algae and cyanobacteria, or bluegreen algae) are tiny plant-like organisms found in lakes that use the sun's energy to convert  $\text{CO}_2$  and nutrients into carbohydrates via photosynthesis. We estimate the amount of phytoplankton present by measuring the presence of the photosynthetic pigment, chlorophyll. High chlorophyll values indicate the presence of too much phytoplankton



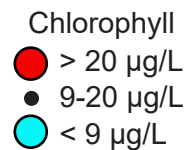
Algae at Carondelet Park in St. Louis. Brenda Switzer photo.

Many organisms consume phytoplankton. These are in turn eaten by predators, moving the sun's energy through the food web. While phytoplankton are essential for other aquatic life, too much can be a problem. Phytoplankton populations can increase quite rapidly (bloom) in the presence of excess nutrients and throw the lake out of balance.

On average, Missouri lakes have 21  $\mu\text{g}/\text{L}$  of chlorophyll at the dam. The average 2021 LMVP chlorophyll value was 19.5  $\mu\text{g}/\text{L}$ , with individual values ranging from 0.2 to 142.5  $\mu\text{g}/\text{L}$ .

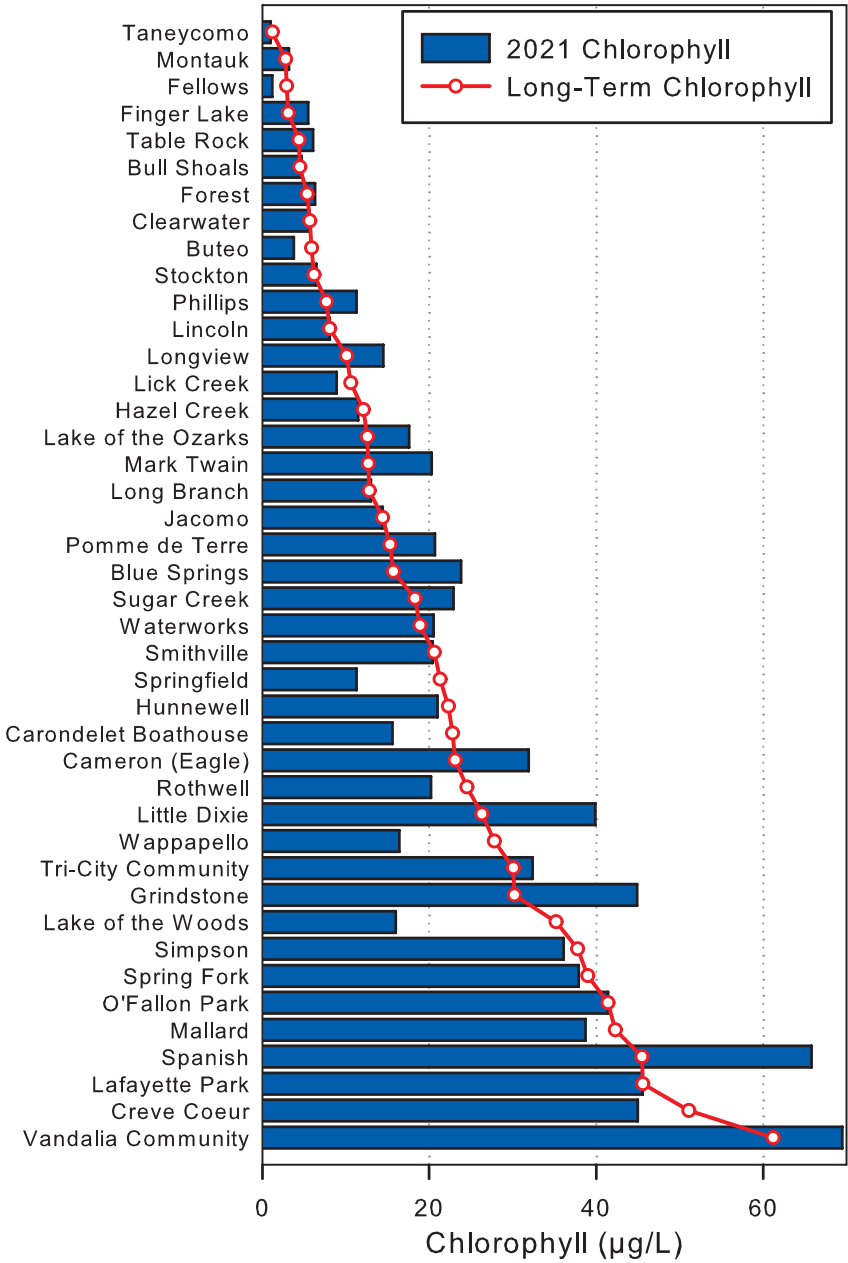


Map shows lake sites with the highest (red) and lowest (blue) average concentrations of chlorophyll in Missouri during 2021.





Average Chlorophyll values for 42 public lakes monitored (at or near the dam) by LMVP volunteers in 2021 (bars). Long-term lake values shown in red.



# Total Phosphorus

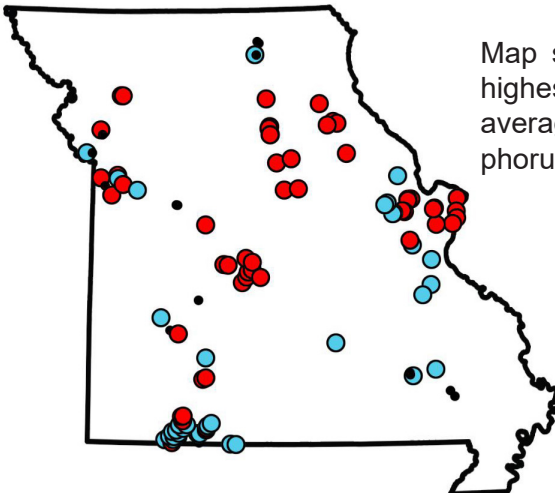
Phosphorus is a naturally occurring element and a required nutrient for life. In Missouri lakes, the amount of algae a lake can support is often controlled by the phosphorus concentrations in the water. Missouri lakes vary in terms of phosphorus levels, with some lake sites having single digit values while others have hundreds of micrograms per liter ( $\mu\text{g/L}$ ). Lakes with high phosphorus concentrations often have problematic algal levels that reduce recreational opportunities and are detrimental to other aquatic life.

The best approach to managing phosphorus and the excess algal growth associated with it is to keep the phosphorus on the landscape and out of the lake. Wise applications of fertilizers to terrestrial systems, reductions of phosphorus in sewage effluent, proper maintenance of septic systems and management of animal waste are the key to reducing phosphorus in lakes.

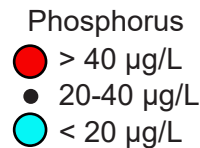
Long-term data from 167 lakes indicate the average Missouri lake phosphorus concentration is  $58 \mu\text{g/L}$  near the dam. The 2021 LMVP average was  $49 \mu\text{g/L}$ . Individual values ranged from 3 to  $558 \mu\text{g/L}$ .



Zain and Sania Rehman measure Secchi at Table Rock Lake (Stone County)

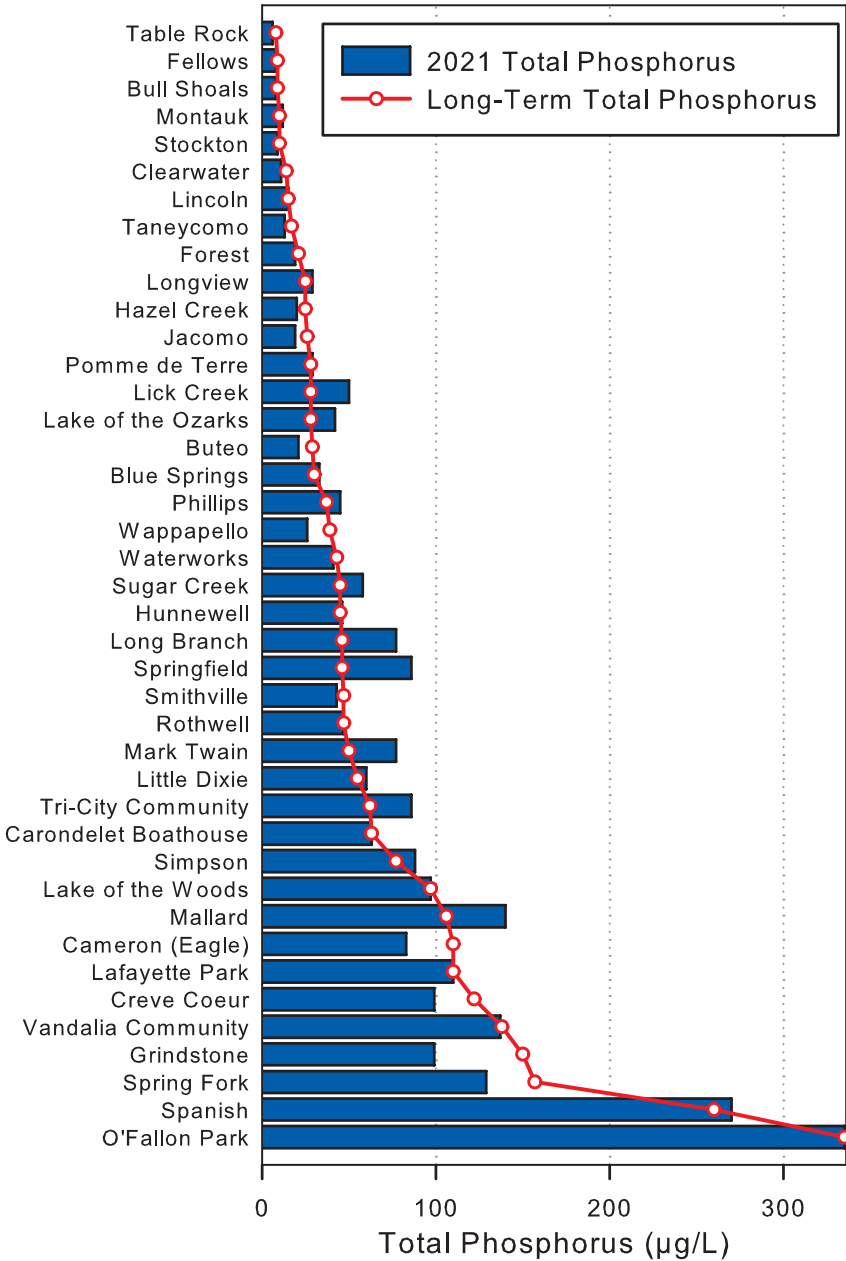


Map shows lake sites with the highest (red) and lowest (blue) average concentrations of phosphorus in Missouri during 2021.





Average Total Phosphorus values for 41 public lakes monitored (at or near the dam) by LMVP volunteers in 2021 (bars). Long-term lake values shown in red.



# Total Nitrogen

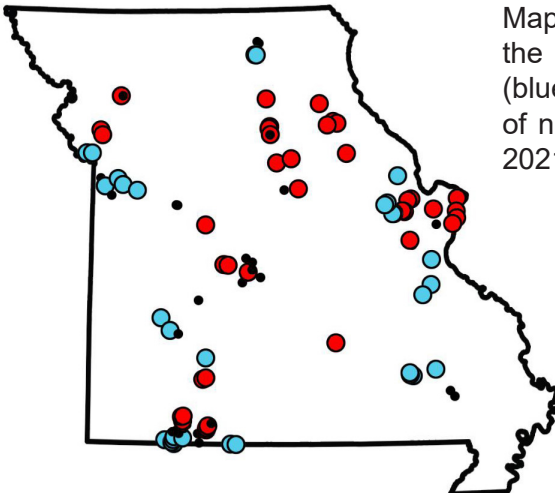
Nitrogen, like phosphorus, is a naturally-occurring element and a required nutrient for algae. Because algae require roughly twenty times more nitrogen than phosphorus, nitrogen can limit algal growth even though it is present in higher concentrations.

Sources of excess phosphorus also apply to nitrogen. However, nitrogen doesn't bind to soil particles as strongly as phosphorus, so eroded soil entering a lake will have less of an effect on nitrogen values than on phosphorus. Secondly, nitrogen has a gas phase while phosphorus does not. This means nitrogen can leave the lake as a gas and it can also enter the lake from the atmosphere.

The long-term average near-dam nitrogen concentration for 167 Missouri lakes is 800  $\mu\text{g/L}$ . The LMVP 2021 average nitrogen value was 720  $\mu\text{g/L}$ , with individual values ranging from 105 to 3565  $\mu\text{g/L}$ .



Above: Mike Hogan meets a friend after collecting his sample at Spanish Lake (St. Louis County)



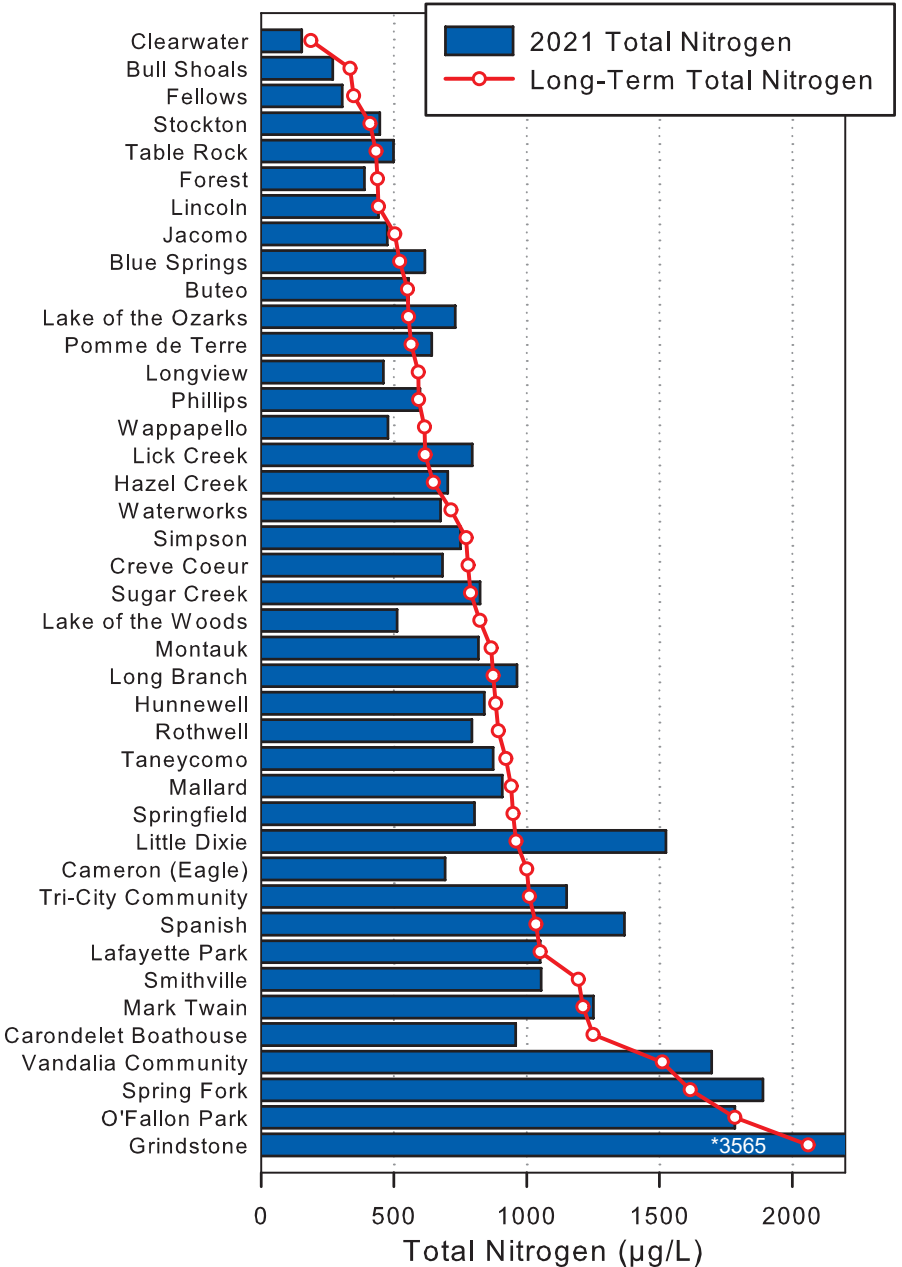
Map shows lake sites with the highest (red) and lowest (blue) average concentrations of nitrogen in Missouri during 2021.

Nitrogen

- > 800  $\mu\text{g/L}$
- 500-800  $\mu\text{g/L}$
- < 500  $\mu\text{g/L}$

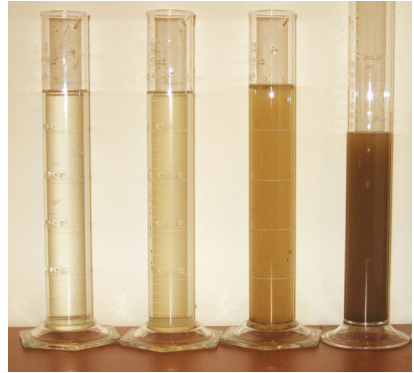


Average Total Nitrogen values for 41 public lakes monitored (at or near the dam) by LMVP volunteers in 2021 (bars). Long-term lake values shown in red.



# Suspended Sediment

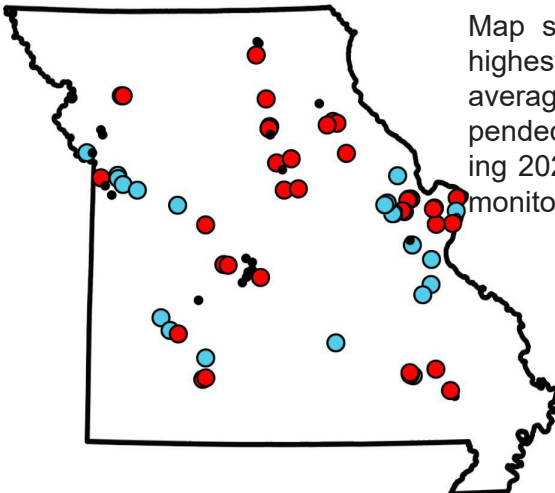
Suspended sediment can wash in from the landscape during a rain event, be scoured from the stream bank, erode from the shoreline by wave action, or it can be re-suspended from the lake bottom. These soil particles will eventually settle downward, where they will begin to fill the lake in. Because of their hydrology and location in eroding valleys, reservoirs are much more susceptible to filling in than natural lakes.



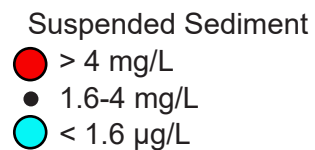
Above: Four water samples with increasing concentrations of suspended sediment.

Suspended sediment will block light entering the water and because phosphorus binds so readily to sediment, any sediment washing into the lake will bring additional nutrients. The best way to deal with suspended sediment is to keep the soil on the ground in the watershed with erosion control measures. Removing grass carp from the lake will also help, as these fish destroy the vegetation that breaks up wave activity and holds sediment to the lake's bottom.

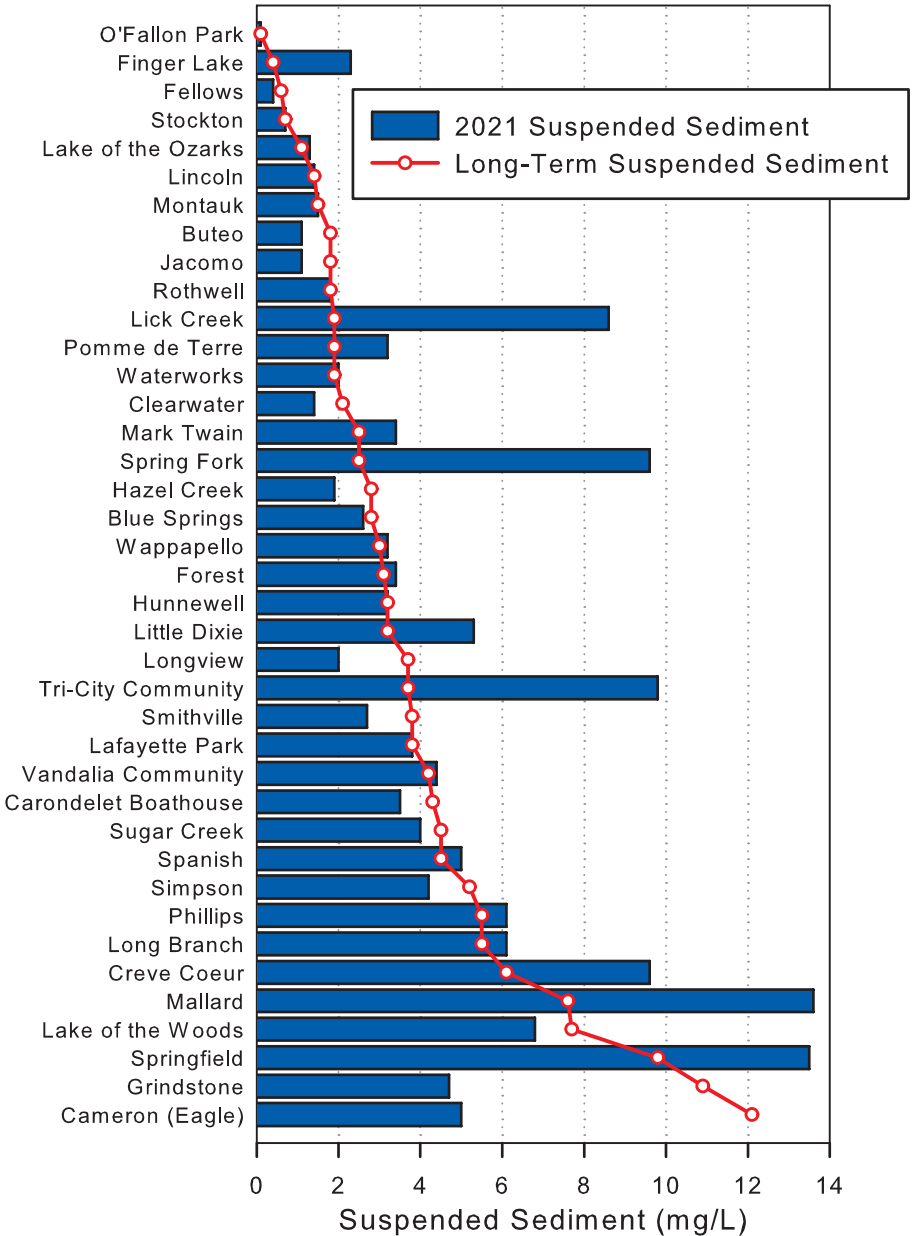
The long-term average Missouri near-dam suspended sediment value is 3.1 mg/L. The 2021 LMVP average was 5.0 mg/L with observed values ranging from 0.1 to 102.5 mg/L.



Map shows lake sites with the highest (red) and lowest (blue) average concentrations of suspended sediment in Missouri during 2021. Note: not all lake sites monitor suspended sediment.



Average Suspended sediment values for 35 public lakes monitored (at or near the dam) by LMVP volunteers in 2020 (bars). Long-term lake values shown in red.



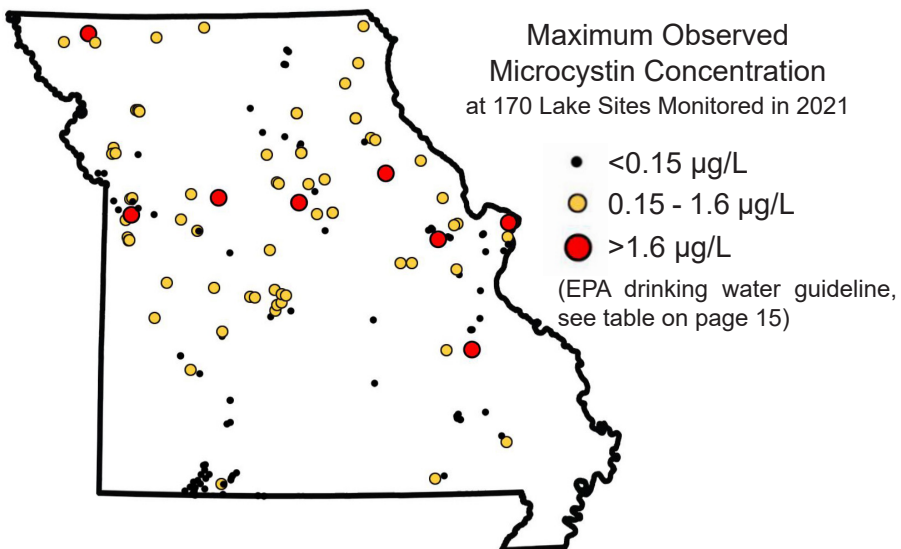
# Cyanotoxins in Missouri

In 2021, LMVP volunteers and employees of the University of Missouri Limnology Laboratory monitored 170 Missouri Lake sites for the presence of 2 cyanotoxins. These toxins are produced by cyanobacteria, or bluegreen algae. Microcystin (the most commonly observed toxin) and cylindrospermopsin are both hepatotoxins, meaning they affect the liver.

The map below shows the maximum microcystin value observed at each of the lake sites in Missouri during 2021. A small black dot means that all samples from that particular lake had undetectable concentrations of microcystin. Large red circles mean that at least one observation had a concentration greater than 1.6  $\mu\text{g/L}$ , EPA's finished drinking water recommendation for school aged children and adults. One lake twice exceeded the EPA recommended recreational exposure level of 8.0  $\mu\text{g/L}$ .

The map on the opposite page similarly shows maximum observed cylindrospermopsin concentrations during 2021. In 2020, only 1 lake exceeded the EPA finished drinking water recommendation for school-age children and adults (3.0  $\mu\text{g/L}$ ). No samples exceeded EPA recommended recreational exposure value (15  $\mu\text{g/L}$ ).

Toxin levels can vary greatly from one lake visit to the next, so if you see suspicious water don't swim in it and keep your pets out of it. Visit the link at the top of the opposite page to report a suspicious algae bloom.





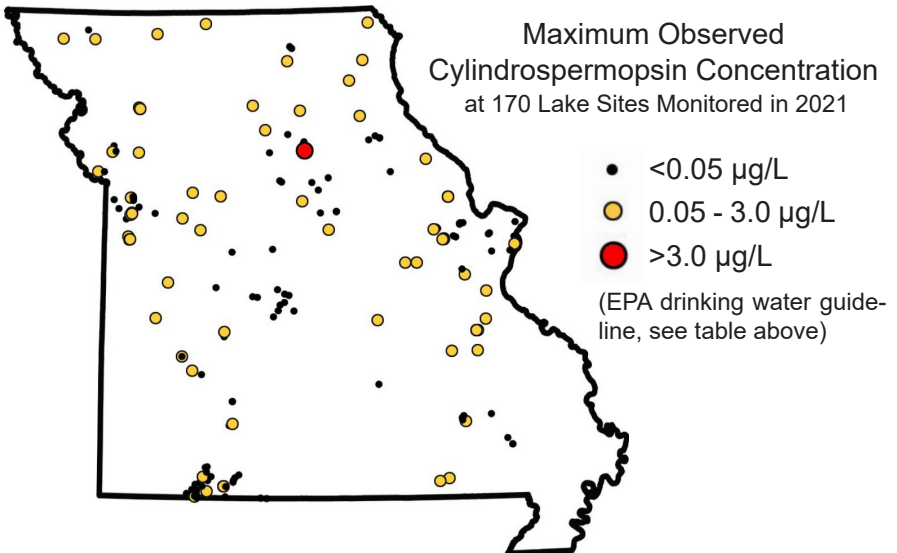
EPA Recommended Microcystin and Cylindrospermopsin Guidelines

	Recreational Exposure	Drinking Water	
Microcystin:	8.0 µg/L	Bottle-fed infants and pre-school children	0.3 µg/L
		School-age children and adults	1.6 µg/L
Cylindrospermopsin:	15.0 µg/L	Bottle-fed infants and pre-school children	0.7 µg/L
		School-age children and adults	3.0 µg/L

Opposite: Maximum microcystin concentration measured at 139 lake sites.  
 Above: EPA draft recommended criteria for Microcystin and Cylindrospermopsin in surface waters of the USA.

Below: Maximum cylindrospermopsin concentration measured at 170 lake sites.

- Algal toxin monitoring was made possible thanks to a joint effort between*
- Missouri Department of Health and Senior Services.
  - Missouri Department of Natural Resources
  - The Lakes of Missouri Volunteer Program
  - University of Missouri



# LMVP Newsletter

The Water Line is the email newsletter of the LMVP. To sign up, send an email to [info@LMVP.org](mailto:info@LMVP.org), or visit [LMVP.org](http://LMVP.org).

Issues of The Water Line discuss topics such as cyanobacteria (bluegreen algae), goose poop, freshwater jellyfish, and much more.



Above: Casandra Barker (left) and Ashley Staab (right) sampling at Knob Noster State Park

## LMVP.org

The LMVP hosts an abundance of information about local lakes, lake ecology, water quality and water in general at its website.

Visit [www.LMVP.org](http://www.LMVP.org) and see for yourself!

While you're on the computer or your phone, give us a "Like" on Facebook!



# Joining the LMVP

## Becoming a volunteer:

- Pick a lake you are willing to monitor every three weeks between April and September (one or two hour commitment each visit).
- Make sure you have access to a boat and all the appropriate safety equipment.
- We will provide you with all necessary supplies and come to your lake to train you one-on-one.

## Volunteer duties:

- Measure water temperature, water clarity, and collect water samples.
- Record observations about wave conditions.
- Process water for laboratory analysis.
- Preserve and store all processed samples.



Above: Brooke Pace, Ashley Staab, and Cassandra Barker (left to right) sampling at Knob Noster State Park.

Back Cover: Finger Lakes State Park (Boone County)





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