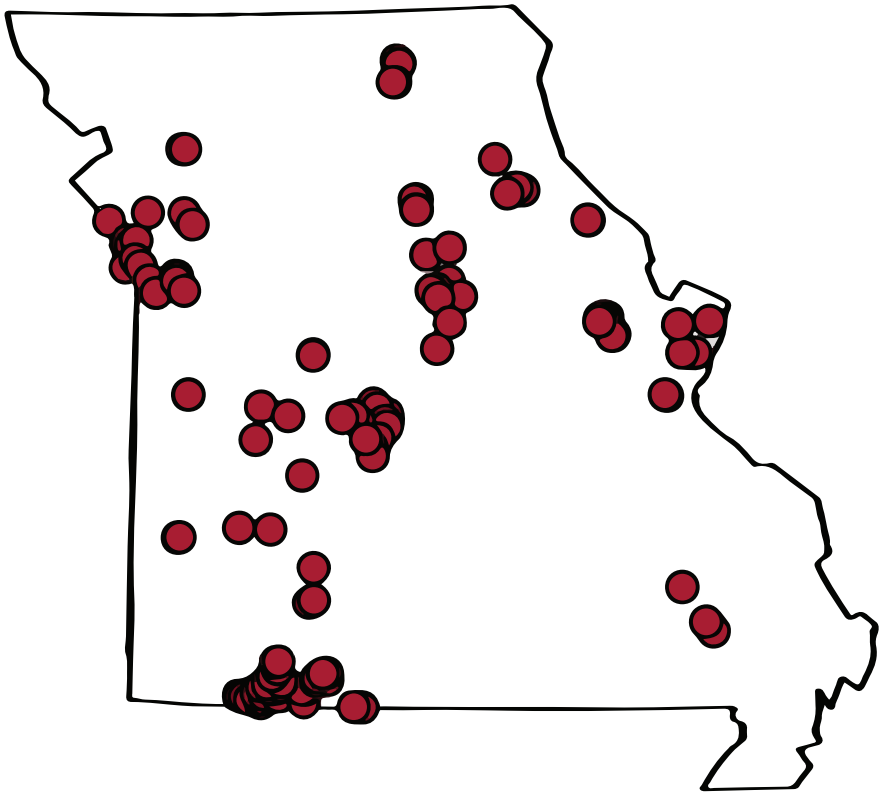
THE LAKES OF MISSOURI VOLUNTEER PROGRAM

2014 DATA REPORT

A summary of 2014 water quality data from the Lakes of Missouri Volunteer Program

WWW.LMVP.ORG



Above: The 125 sample sites monitored by LMVP volunteers in 2014

Missouri Department of Natural Resources

University of Missouri

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 Subgrant G10-NPS-04

Cover photo: LMVP volunteers process samples at Mark Twain Lake. From left to right, Kaylee Faddis, Suzanne Stillwell, Zerihun Wohleber, Mark Stillwell. University of Missouri Cooperative Media Group photo.

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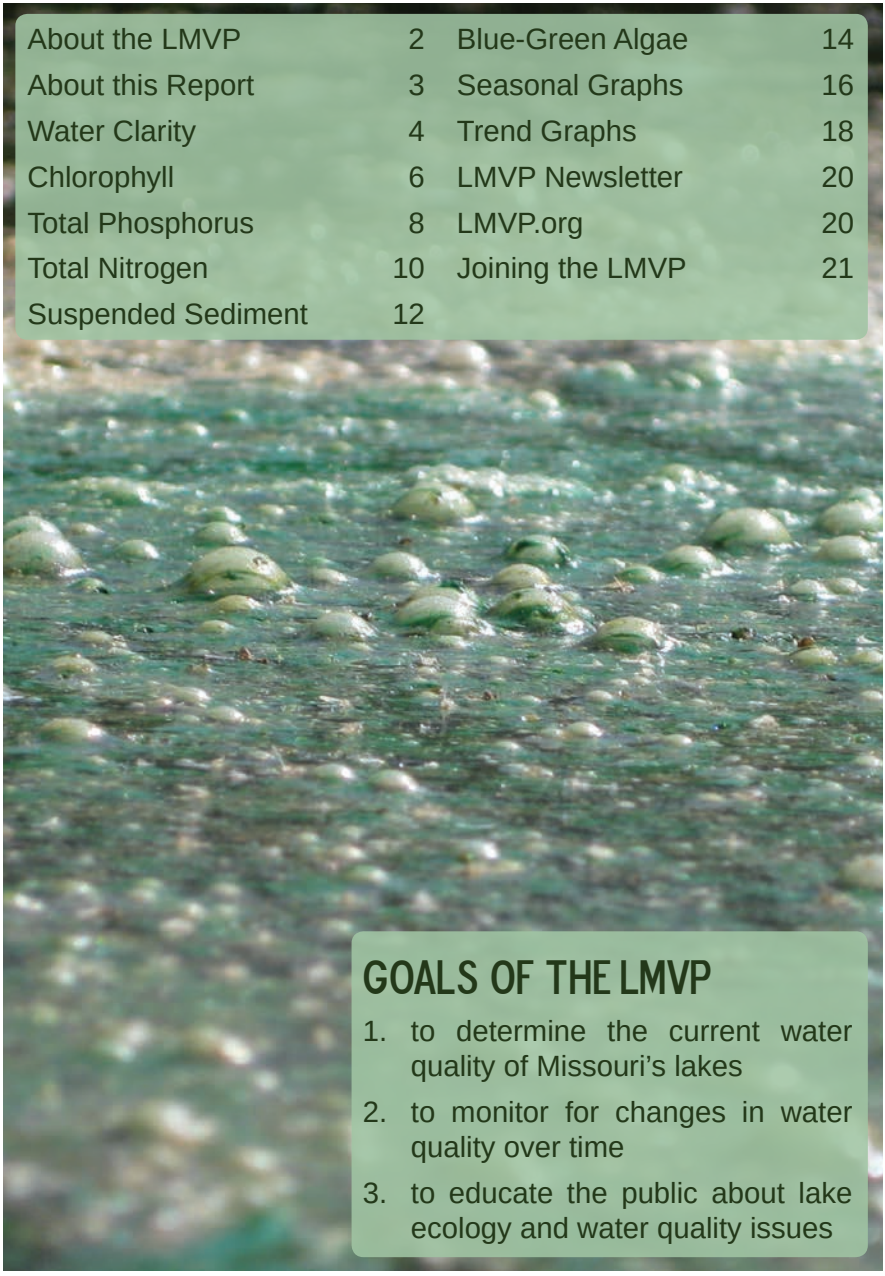


GOALS OF THE LMVP

1. to determine the current water quality of Missouri's lakes
2. to monitor for changes in water quality over time
3. to educate the public about lake ecology and water quality issues

Photo: Algae bloom on a Boone County lake. Tony Thorpe photo.

ABOUT THE LMVP

The Lakes of Missouri Volunteer Program (LMVP) enlists volunteer monitors to track the effects of nonpoint source pollution in Missouri's lakes by measuring water clarity, nutrients (phosphorus and nitrogen), chlorophyll (a measure of algal biomass), and suspended sediments (soil particles). 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 (Obrecht et al. 1998) shows LMVP data to be of comparable quality to data collected by employees of the University of Missouri. The LMVP data set dates from 1992, providing 23 years of quality data for some of Missouri's most popular lakes.

Left:

Caroline Toole measures the rope of her Secchi disk. The Secchi disk is used to determine water clarity. Don Toole photo.

Right:

Ed Young precisely measures water for chlorophyll analysis. Tony Thorpe photo.

ABOUT THIS REPORT

Reading this report provides the background necessary to interpret the full LMVP 2014 data set (available at LMVP.ORG).

The next 10 pages of this report (4-13) cover the parameters monitored by LMVP volunteers, what they mean, and what we found in Missouri lakes during 2014.

Pages 14 and 15 discuss blue-green algae and the toxins associated with blue-green algae.

Pages 16-19 cover the differences in water quality one might observe during a single season and across several years.

Finally, the last few pages (20-22) highlight the LMVP newsletter, available online or by request, the LMVP website, and how you can join the LMVP to begin monitoring a lake site of your own.

2014 DATA AVAILABLE AT LMVP.ORG

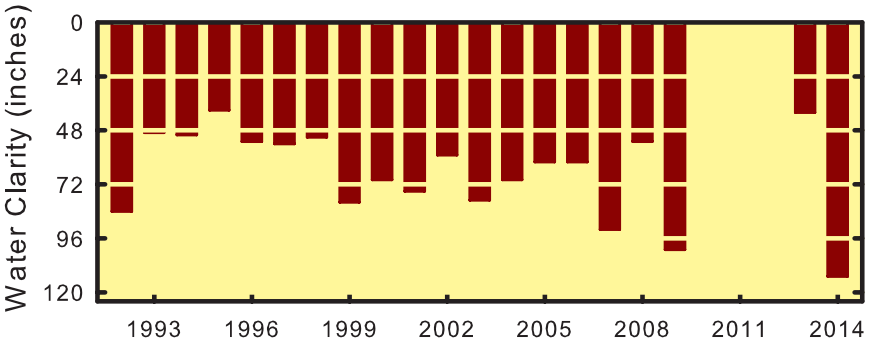
WATER CLARITY

Water clarity is the way most of us relate to water quality. If we see murky water, we assume the water quality is poor. Conversely, if 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.


The Secchi disk

Water clarity is measured in lakes using the Secchi disk. The Secchi disk has alternating black and white quadrants on its surface and a weight underneath. It is attached to a rope and lowered into the water until it is no longer visible. The depth where the disk is no longer visible is recorded. 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 150 years.

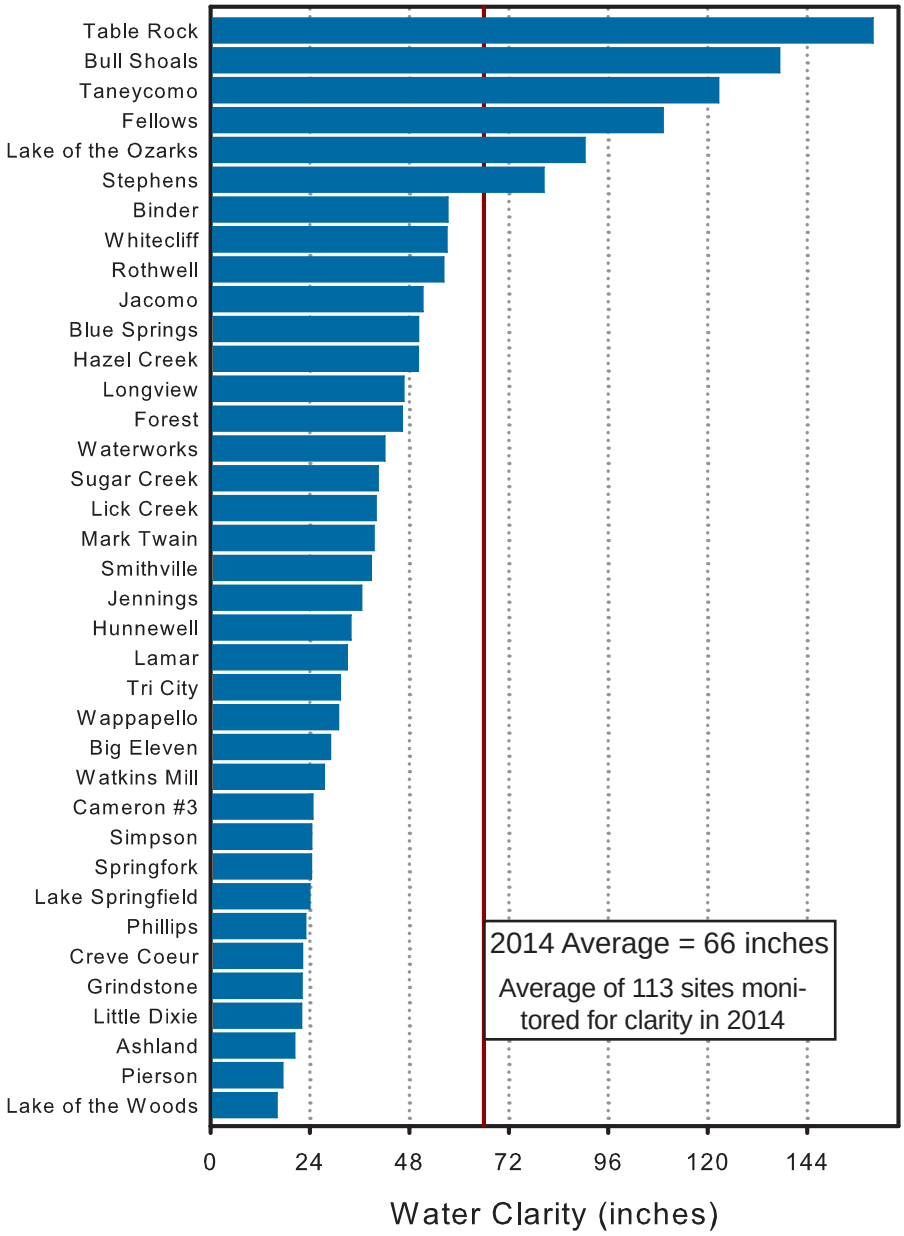
Long-term, statewide data from the University of Missouri (167 lakes) show that Missouri lakes, on average, have about 35 inches of clarity. In 2014, the average LMVP volunteer-measured lake water clarity was 66 inches, with individual readings ranging from 8 inches (Lake of the Woods, KC) to 293 inches (Taneycomo).



Above: Average water clarity measurements near the dam of Lake Taneycomo. Note that zero is at the top of the graph and each bar segement represents 2 feet.

In Missouri, reductions in water clarity can usually be associated with an increase in algae (chlorophyll) or suspended sediment.

Mean Secchi values for 37 public lakes monitored by LMVP volunteers in 2014.



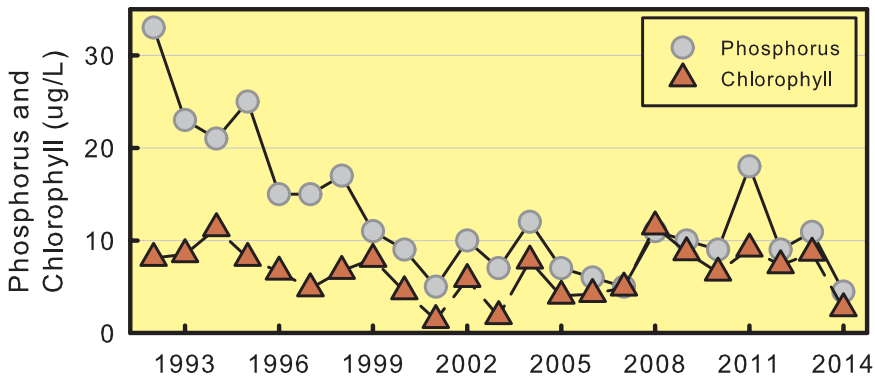
CHLOROPHYLL

Algae are tiny plant-like organisms found in lakes (and just about everywhere else). Algae use the sun's energy to convert CO_2 and nutrients into carbohydrate via photosynthesis. We estimate the amount of algae present by measuring the presence of the photosynthetic pigment, chlorophyll.

Other organisms, like zooplankton, mussels, and certain fishes, consume algae. These first-order consumers are in turn eaten by predators, moving the sun's energy through the food web. While it is essential to aquatic life that algae be present, too much can be a problem. Algal populations can increase quite rapidly (bloom) in the presence of excess nutrients and throw the lake out of balance. Algae blooms can create a number of problems. For example, oxygen levels will vary widely between day and night during a bloom, and other aquatic life will suffer as a result.

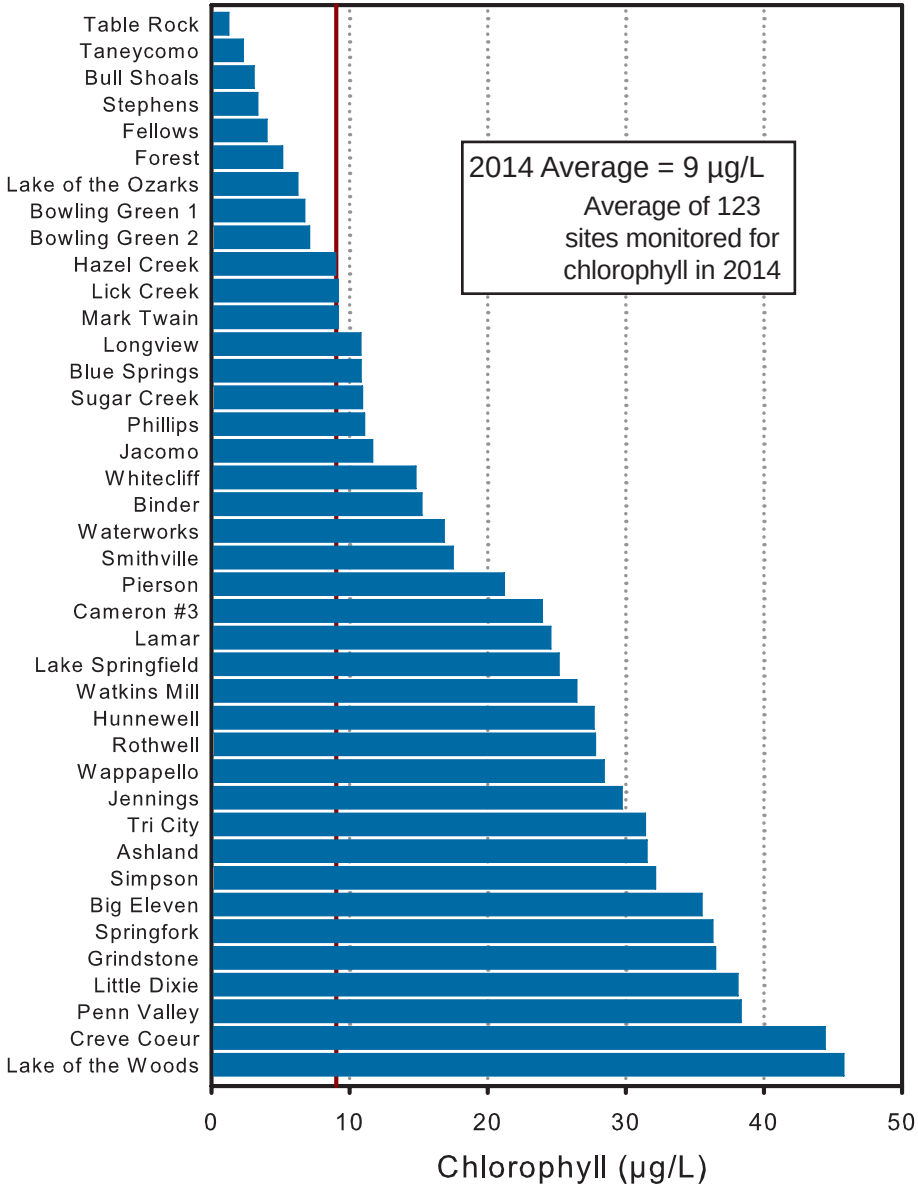
Some blue green algae (cyanobacteria) can produce toxins that are a danger to fish, wildlife, and humans. Several of our neighboring states have closed water bodies to public use because of concerns with blue green toxins. See pages 14 and 15 for more information about blue-green algae.

The average Missouri long-term chlorophyll value is 21 µg/L. The average 2014 LMVP chlorophyll value was 9 µg/L, with individual values ranging from 0.8 to 149 µg/L



Above: Long-term summer chlorophyll concentrations (red triangles) at Table Rock Lake, Site 3. Phosphorus concentrations are also shown (grey circles). Note the very tight correlation between chlorophyll and phosphorus from 1999 to 2014.

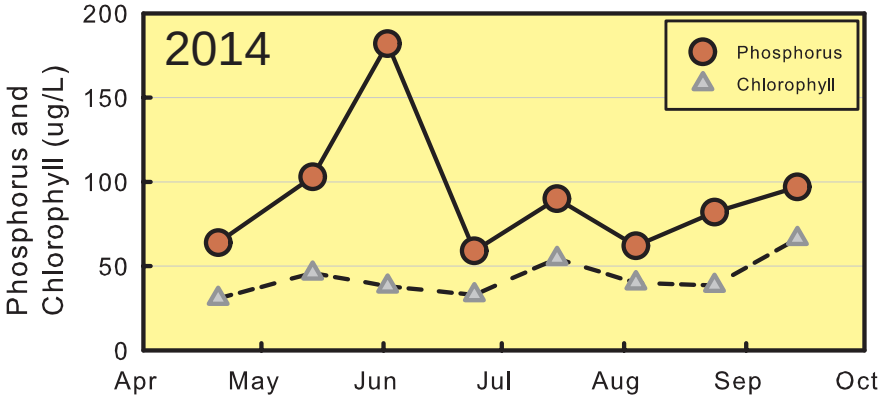
Mean Chlorophyll values for 40 public lakes monitored by LMVP volunteers in 2014.



TOTAL PHOSPHORUS

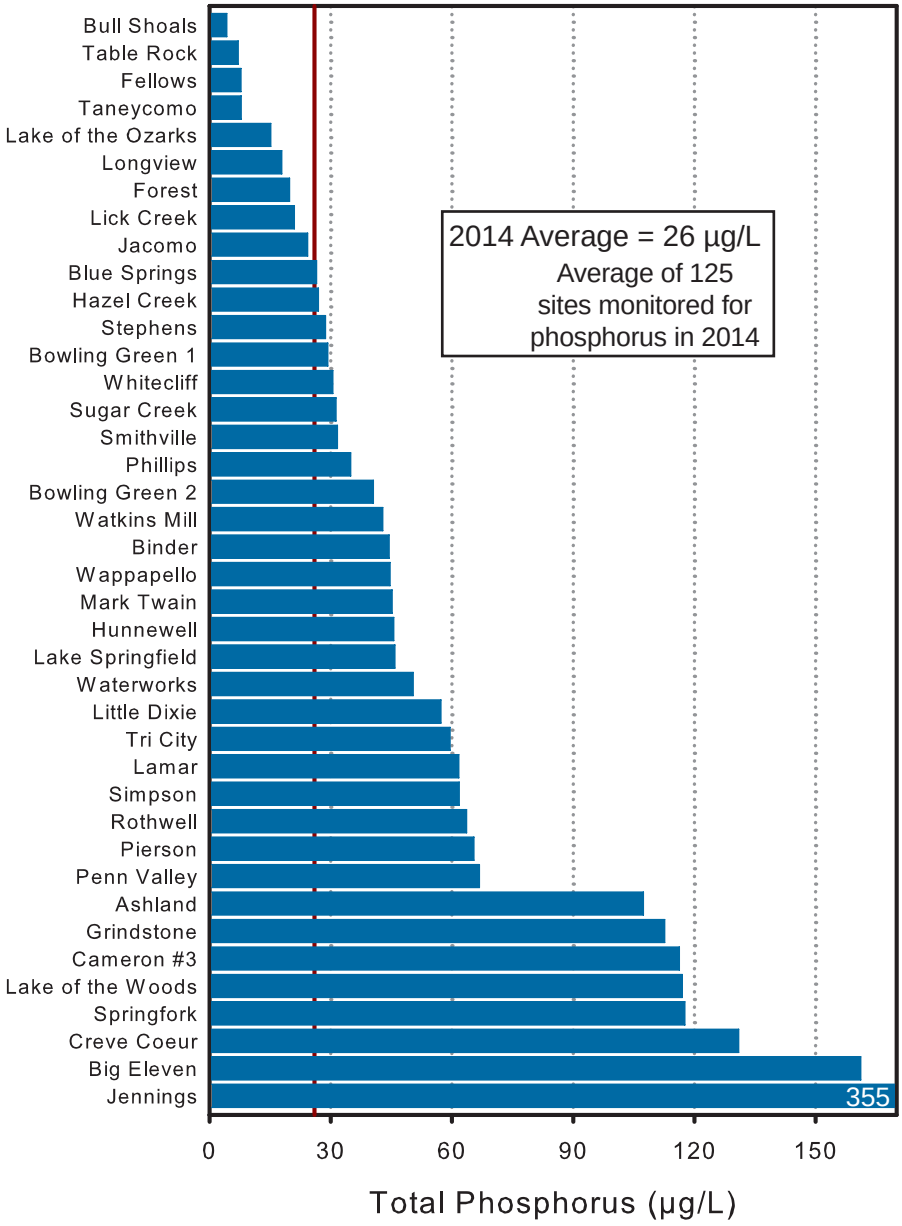
Phosphorus is a naturally-ocurring element and a required nutrient for life. In Missouri lakes, the amount of algae a lake can support is often controlled ("limited") by the phosphorus concentrations in the water. Missouri lakes vary in terms of phosphorus levels, with some lake sites having single digit values while others have hundreds of micrograms per liter (µg/L). Lakes with high phosphorus concentrations often have problem algal levels that reduce recreational opportunities and are detrimental to other aquatic life. Long-term data from 167 lakes indicate the average Missouri lake phosphorus concentration is 58 µg/L. The 2014 LMVP average was 26 µg/L, with individual values ranging from 2 to 767 ug/L

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.



Above: 2014 phosphorus concentrations at Site 8 in Stockton Lake (red circles). Phosphorus concentrations are high at this up-lake site on the Little Sac Arm, with a peak of 182 ug/L observed on June 2. Chlorophyll concentrations are also shown (grey triangles).

Mean Total Phosphorus values for 40 public lakes monitored by LMVP volunteers in 2014.

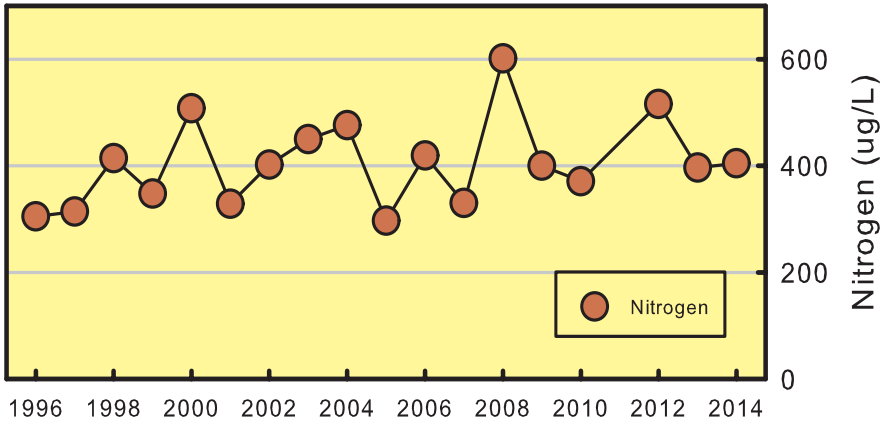


TOTAL NITROGEN

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. Some blue-green algae can use atmospheric nitrogen directly. This gives them a competetive advantage, especially in the late summer when in-lake nitrogen is in short supply. This ability is also why blue-green algae blooms are often a problem in the late summer.

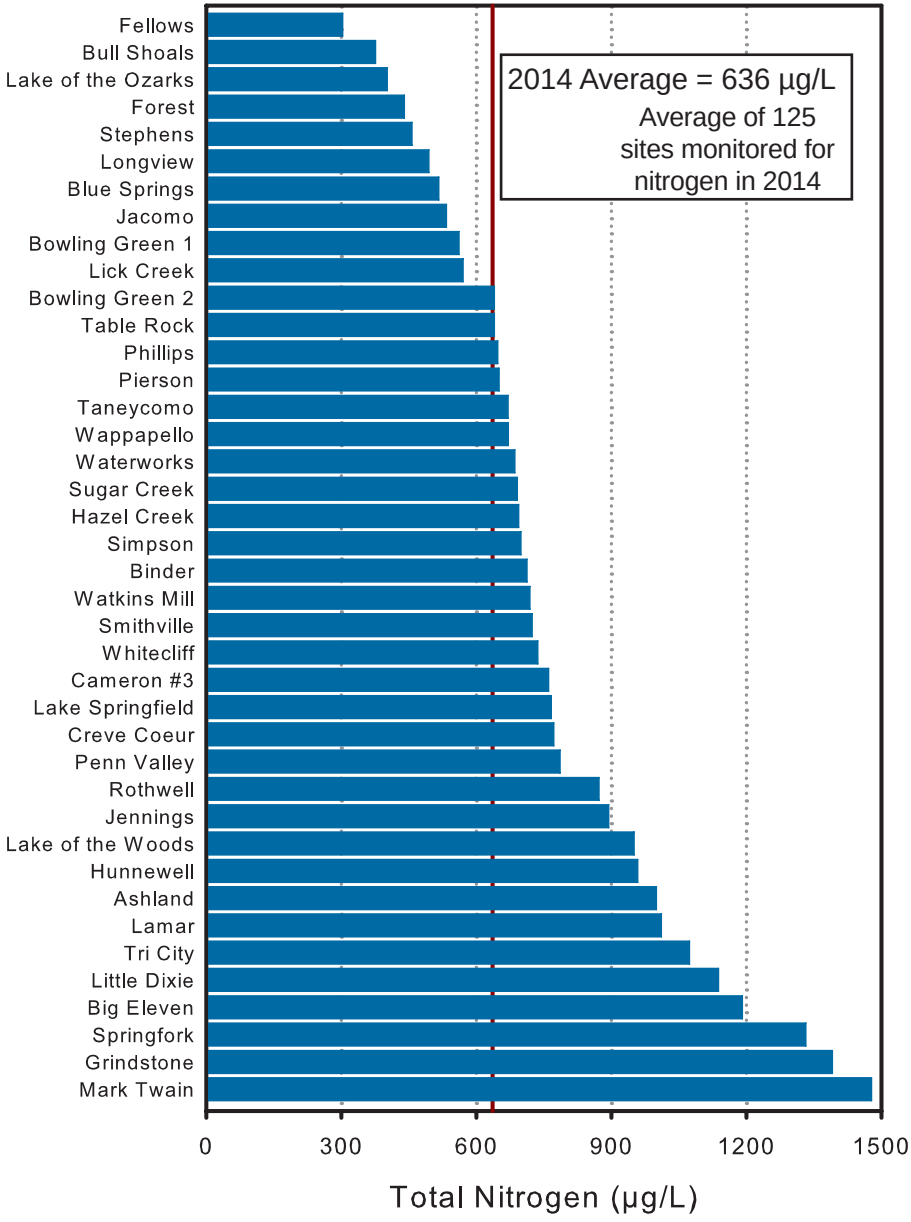
Sources of excess phosphorus also apply to nitrogen. However, nitrogen doesn't bind to soil particles as strongly as phosphorus, so eroded soil entering a lake will have less of an effect on nitrogen values than on phosphorus. Secondly, nitrogen has a gas phase while phosphorus does not. This means nitrogen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

The long-term average nitrogen concentration for 167 Missouri lakes was 800 µg/L. The LMVP 2014 average nitrogen value was 636 µg/L, with individual values ranging from 105 to 2970 µg/L.



Above: Long-term nitrogen values measured in the Kings River Arm at Table Rock Lake. Each dot in the in this graph represents a mean of all samples collected between May 15 and September 15.

Mean Total Nitrogen values for 40 public lakes monitored by LMVP volunteers in 2014.

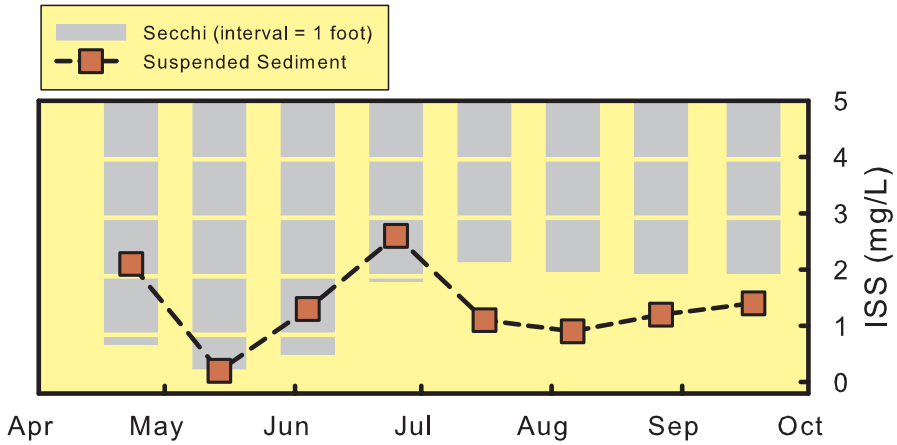


SUSPENDED SEDIMENT

Missouri lakes can appear blue, green, or brown. The green color is from algae, the brown color is from suspended sediment. Suspended sediment can wash in from the landscape during a rain event, be scoured from the stream bank by an inflowing stream, 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 existing valleys, reservoirs are much more susceptible to filling in than natural lakes.

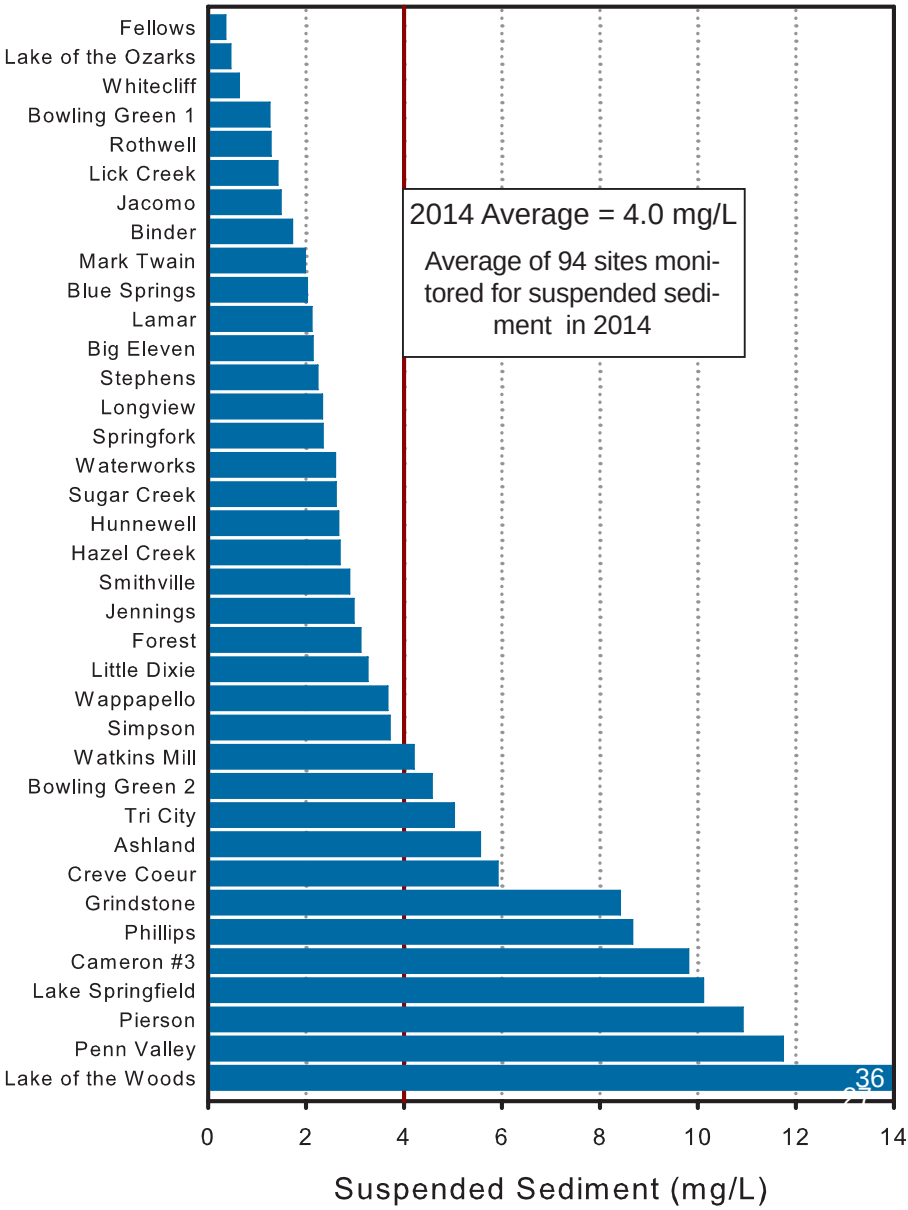
Suspended sediment will block light and can inhibit algae growth. Because phosphorus binds so readily to sediment, sediment washing into the lake will bring phosphorus with it. The best way to deal with suspended sediment is to keep the soil on the ground in the watershed with erosion control measures. 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 suspended sediment value is 3.1 mg/L. The 2014 LMVP average was 2.2 mg/L with observed values ranging from 0.1 to 94.4 mg/L.



Above: This graph shows the correlation between suspended sediment (red squares) and water clarity (gray bars, 1 foot Secchi depth intervals) in the Little Niangua Arm of Lake of the Ozarks during 2014.

Mean Suspended sediment values for 37 public lakes monitored by LMVP volunteers in 2014.



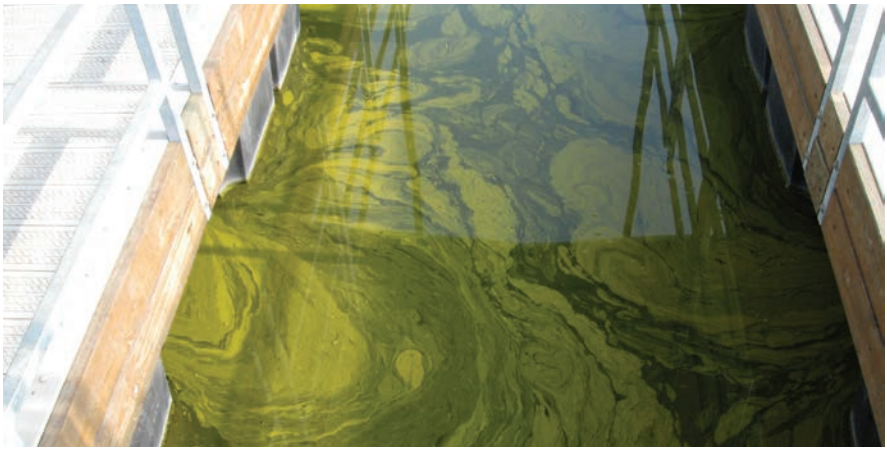
BLUE-GREEN ALGAE

Blue-green algae (also called cyanobacteria) are common in Missouri lakes. These tiny, primitive, photosynthesizing organisms grow in the water alongside the green algae, invertebrates and fish. As with green algae, excessive growth of blue-green algae is fueled by abundant nutrients.

Some species of blue-green algae can produce toxins that are harmful to humans and wildlife. Lake managers across the U.S. have posted advisories, warnings, and even closed lakes due to excessive growth, or blooms, of blue-green algae.

Blue-green algae blooms are often accompanied by a film or scum on the surface of the water. Water with surface scums or films should be avoided by humans and pets. Blue-green algae blooms are typically green and often make the water look like pea soup or as if someone has spilled green paint on the water. Some blue-green blooms look like green curds floating in the water, others look like burgundy wine. Often, blue-green blooms will be accompanied by an "earthy" odor similar to freshly cut grass.

The toxins produced by some species of blue-green algae can be difficult to detect. A microscope is often required to determine if a particular



Above: A blue-green algae bloom in Adair County. Missouri Department of Conservation photo.

bloom is composed of blue-green algae, and chemical tests to determine if toxins are present are traditionally expensive and time-consuming. Improvements are being made as the demand for inexpensive, simple analyses increases.

Even experts need tools to determine if lake water is safe to swim in during an algae bloom. The best plan is to play it safe and avoid water with obvious algae problems.

When in doubt, stay out.

Citizen scientists with the Lakes of Missouri Volunteer Program will begin monitoring blue-green algae toxins in 2015. If you would like to participate, contact us at info@LMVP.org or call 1-800-895-2260

Above: Blue-green algae bloom

Below: Blue-green algae blooming on a Kansas lake. USGS photo.

SEASONAL GRAPHS

Graphs for all public lakes monitored by the LMVP in 2014 can be found online at www.LMVP.org.

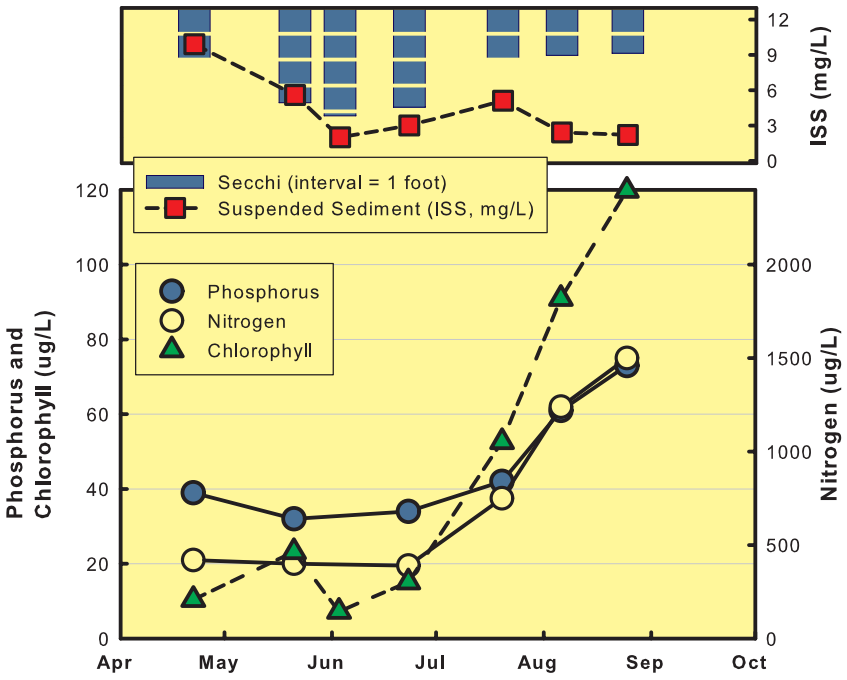
The graphs to the right show how water quality at Lake Wappapello varied over the 2014 sample season. The upper portion presents the Secchi and suspended sediment data, while the bottom portion presents phosphorus, nitrogen and chlorophyll concentrations. Data from each of the eight sample dates is shown in chronological order starting with the April 22nd sample and ending with the August 25th sample.

The suspended sediment (ISS) levels were at their highest on the first sample date, measuring 9.9 mg/L. Concentrations remained between 2.0 and 5.6 mg/L for the remainder of the sampling season. Water clarity (as measured by Secchi depth) tracked sediment values through July, when the sediment settled and the algae started blooming. The shallowest Secchi was on the final sample date, at 21 inches. The clearest water of the season (50 inches) was measured on the same day as the lowest suspended sediment.

Total phosphorus and total nitrogen follow an atypical Missouri trend with the highest concentrations of nutrients occurring at the end of the season. Chlorophyll concentrations were lowest when suspended sediment concentrations were highest, due to the reduced penetration of sunlight into the water.

The graphs to the right highlight how much water quality can change within a single season and why it is important to sample consistently and continuously across the season.

Left: LMVP volunteer Tom Wells measures lake water for filtering at Mark Twain Lake. University of Missouri Cooperative Media Group photo



Above: April through August data from Lake Wappapello (Wayne County). Top graph shows water clarity (Secchi, blue bars) and suspended sediment (ISS, red squares). Bottom graph shows phosphorus (blue circles), nitrogen (yellow circles), and chlorophyll (green triangles).

Below: Gar in Camden County. Tony Thorpe photo

TREND GRAPHS

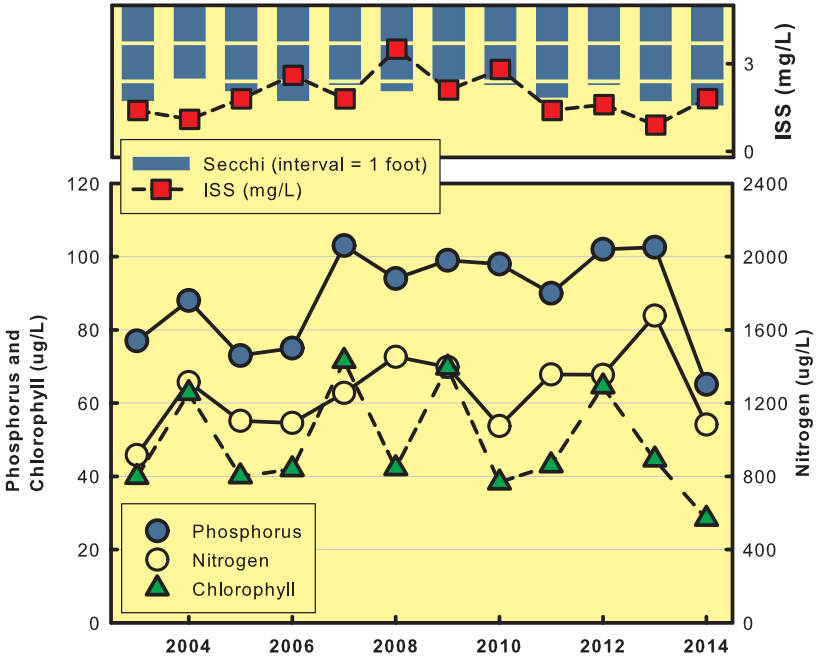
Graphs for all public lakes monitored by the LMVP in 2014 can be found online at www.LMVP.org.

The graphs to the right are set up in the same fashion as the seasonal graphs on the previous page. The main difference is the horizontal axis shows multiple years instead of a single sample season. Also, each data point represents a mean value from a sampling season instead of a single sample value.

Lamar City Lake is located in Southwest Missouri. Data from the last 12 years show lower mean phosphorus and chlorophyll values in 2014 than in any previous year of monitoring. On average, the water clarity (Secchi) was greater in 2014 than measured in previous years, though only by one inch. Average chlorophyll values (green triangles) often vary by more than 50% from one year to the next and track phosphorus values rather well.

Because water quality can fluctuate substantially from one year to the next, identifying water quality trends in Missouri lakes requires consistent sampling over a long period of time. To reduce the variability associated with spring mixing and fall turnover, trend data are limited to the period of May 15 through September 15.

Above: Fish at Fiery Fork Conservation Area. Tony Thorpe photo

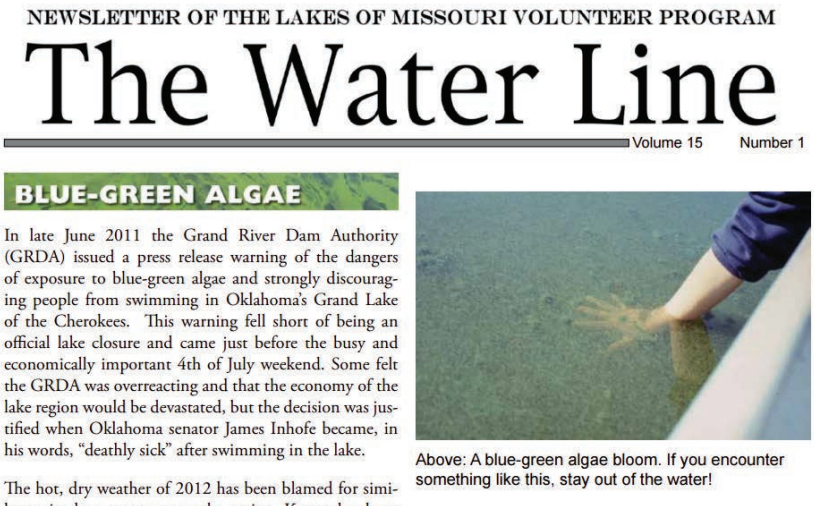


Above: Annual summer mean data (2003-2014) from Lamar City Lake in Barton County. Top graph shows water clarity (Secchi, blue bars) and suspended sediment (ISS, red squares). Bottom graphs shows phosphorus (blue circles), nitrogen (yellow circles), and chlorophyll (green triangles).

Below: Don Toole flies the water sampling flag at Lake of the Ozarks. Caroline Toole photo.

LMVP NEWSLETTER

The LMVP produces two newsletters each year, covering topics such as blue-green algae, fish kills, lake turnover, and more. To receive the newsletter send an email to info@LMVP.org or call 1-800-895-2260 and tell us to put you on the mailing list. Newsletters will be delivered via email unless a paper copy is requested.



NEWSLETTER OF THE LAKES OF MISSOURI VOLUNTEER PROGRAM

The Water Line

Volume 15 Number 1

BLUE-GREEN ALGAE

In late June 2011 the Grand River Dam Authority (GRDA) issued a press release warning of the dangers of exposure to blue-green algae and strongly discouraging people from swimming in Oklahoma's Grand Lake of the Cherokees. This warning fell short of being an official lake closure and came just before the busy and economically important 4th of July weekend. Some felt the GRDA was overreacting and that the economy of the lake region would be devastated, but the decision was justified when Oklahoma senator James Inhofe became, in his words, "deathly sick" after swimming in the lake.

The hot, dry weather of 2012 has been blamed for simi-

Above: A blue-green algae bloom. If you encounter something like this, stay out of the water!

LMVP.ORG

The LMVP newsletter, past data reports, maps of sampling sites, and more can be found at the LMVP website, www.LMVP.org.

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.

Left: Gary Davis and Tom Wind measure their Secchi rope to determine water clarity while Gary Lomax records the data.

Below: Scott Ellis and Ed Young filter lake water to measure the amount of sediment suspended in it.

VOLUNTEER DUTIES:

- Measure water temperature, water clarity, and collect a water sample
- Record observations about wave conditions
- Process water for nutrient analysis
- Filter measured water volumes for chlorophyll and suspended sediment analysis
- Preserve and store all processed samples

Back cover: Front to back, Sandy Wells, Suzanne Stillwell and Karl Shellabarger process water samples at Mark Twain Lake.

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LAKES of MISSOURI VOLUNTEER PROGRAM