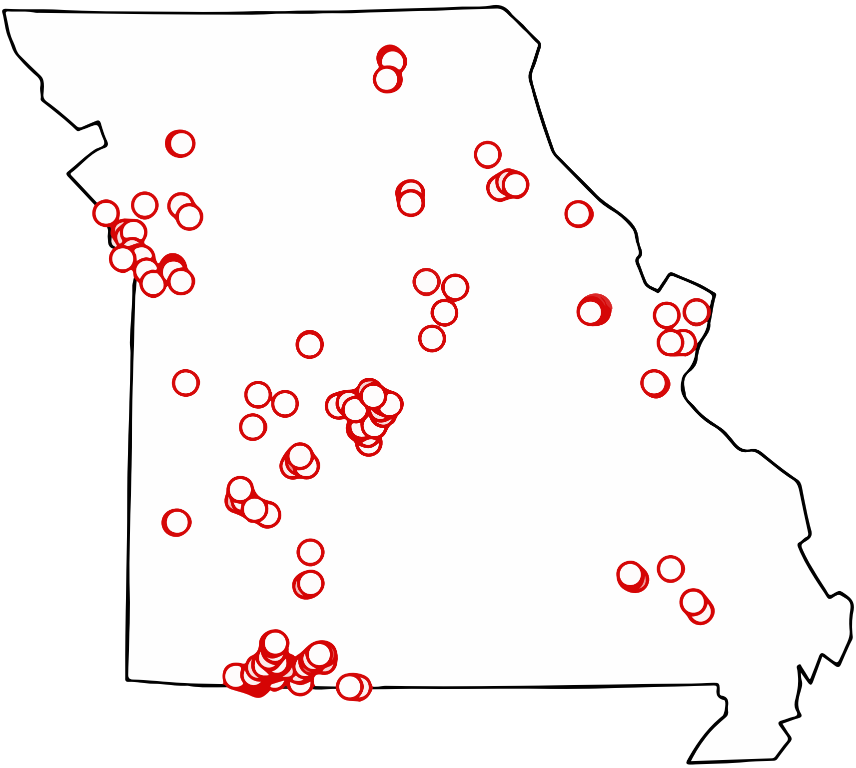
LAKES of MISSOURI VOLUNTEER PROGRAM

THE LAKES OF MISSOURI VOLUNTEER PROGRAM

2013 DATA REPORT

A summary of 2013 water quality data from the Lakes of Missouri Volunteer Program

WWW.LMVP.ORG



Above: The 133 sample sites monitored by LMVP volunteers in 2013

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

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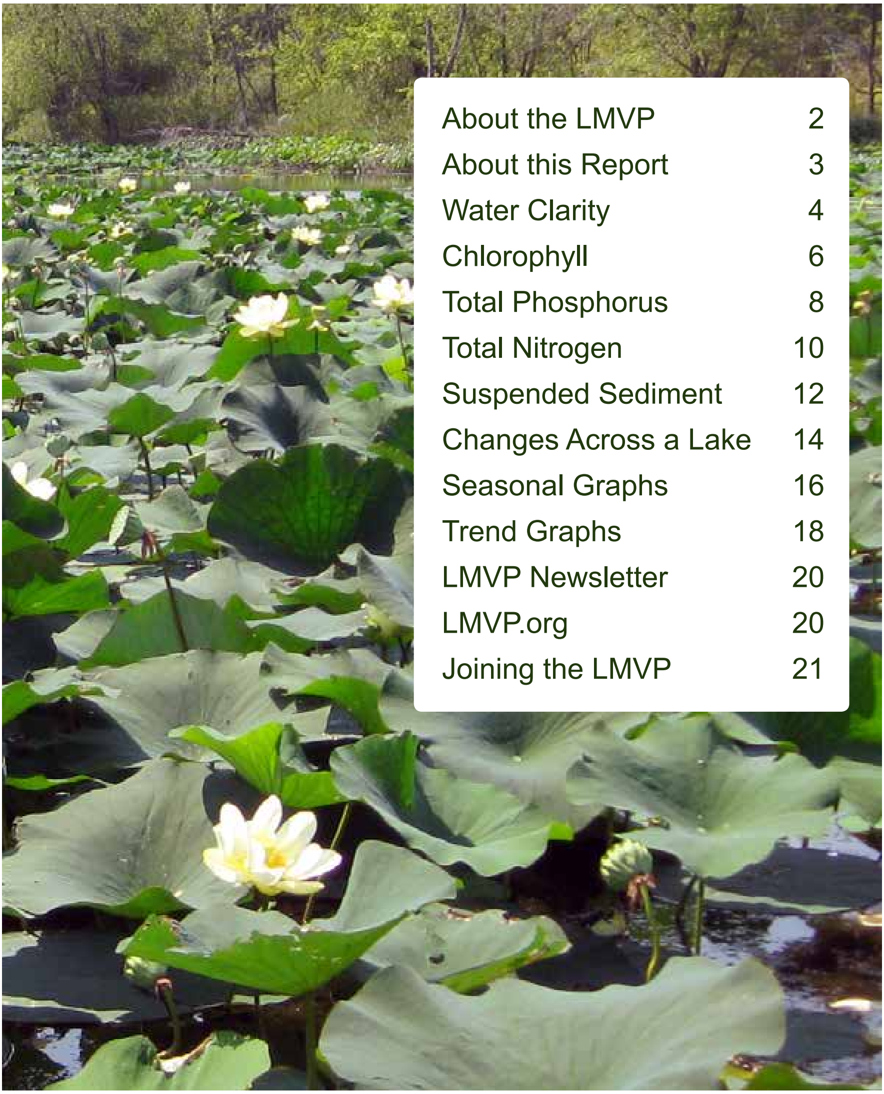

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GOALS OF THE LMVP

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

ABOUT THE LMVP

Nutrients and sediments are two of the top three pollutants in lakes, according to the EPA. These pollutants often enter our lakes as non-point source pollution, through runoff. The way to limit the impact of excessive nutrients and sediments on our lakes is to reduce nonpoint source pollution coming from the watershed.

The Lakes of Missouri Volunteer Program (LMVP) enlists volunteer monitors to track 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). By tracking nonpoint source pollution we can not only determine when and where it is a problem, we can also determine how effective our efforts to manage the problem are.

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.

ABOUT THIS REPORT

Reading this report provides the background necessary to interpret the full LMVP 2013 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 2013.

Pages 14 and 15 show the water quality differences observed from the inflow to the dam.

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) address 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.

2013 DATA AVAILABLE AT LMVP.ORG

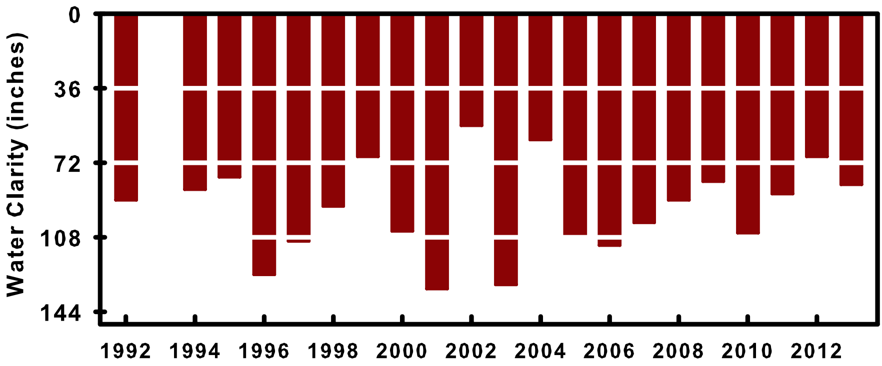
WATER CLARITY

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.

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 nearly 150 years.

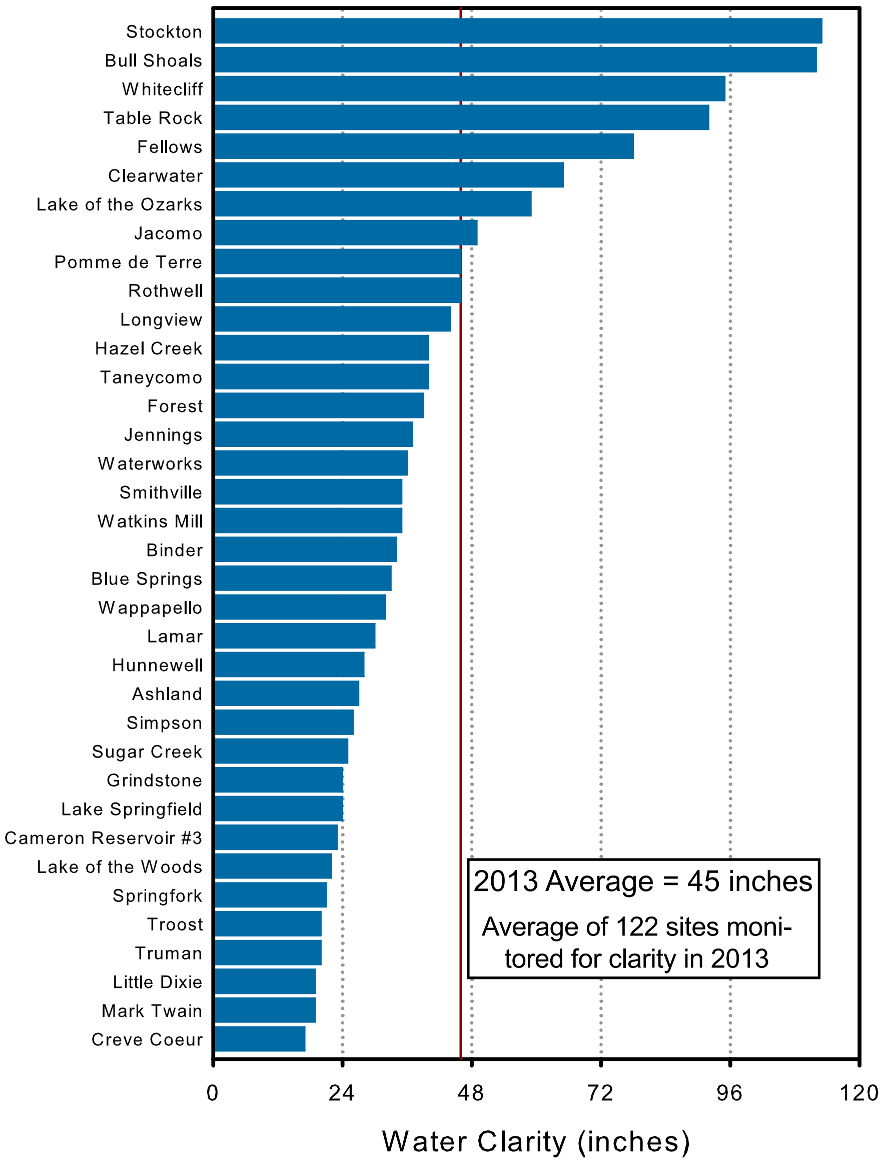
A Secchi disk

Long-term, statewide data from the University of Missouri (167 lakes) show that Missouri lakes, on average, have about 35 inches of clarity. In 2013, the average LMVP volunteer-measured lake water clarity was 45 inches, with individual readings ranging from 6 inches (Mark Twain) to 324 inches (Table Rock).



Average water clarity measurements in the Indian Creek Arm of Table Rock Lake. Note that zero is at the top of the graph. In this graph, each bar segement represents 3 feet. In Missouri, a reduction of water clarity can usually be associated with an increase in algae (chlorophyll) or suspended sediment.

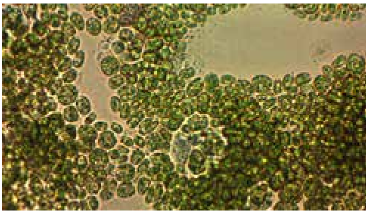
Mean Secchi values for 36 public lakes monitored by LMVP volunteers in 2013.



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.

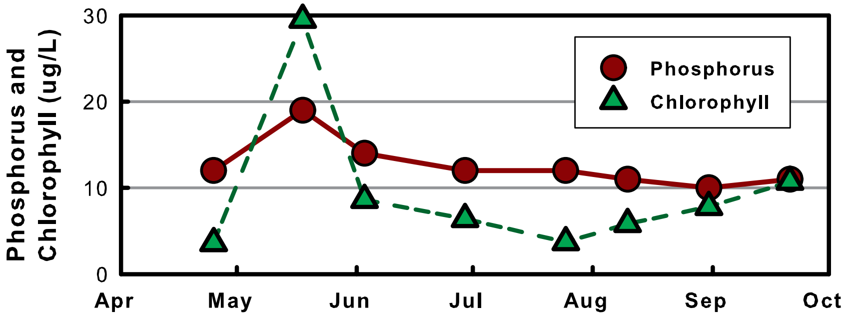
Other organisms, like zooplankton, mussels, and certain fishes, consume algae. These first-order consumers are in turn eaten by predators, moving the sun's energy through the food web. While it is essential to aquatic life that algae be present, too much can be a problem. Algal populations can increase 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.



Microscopic algae can make a lake appear green.

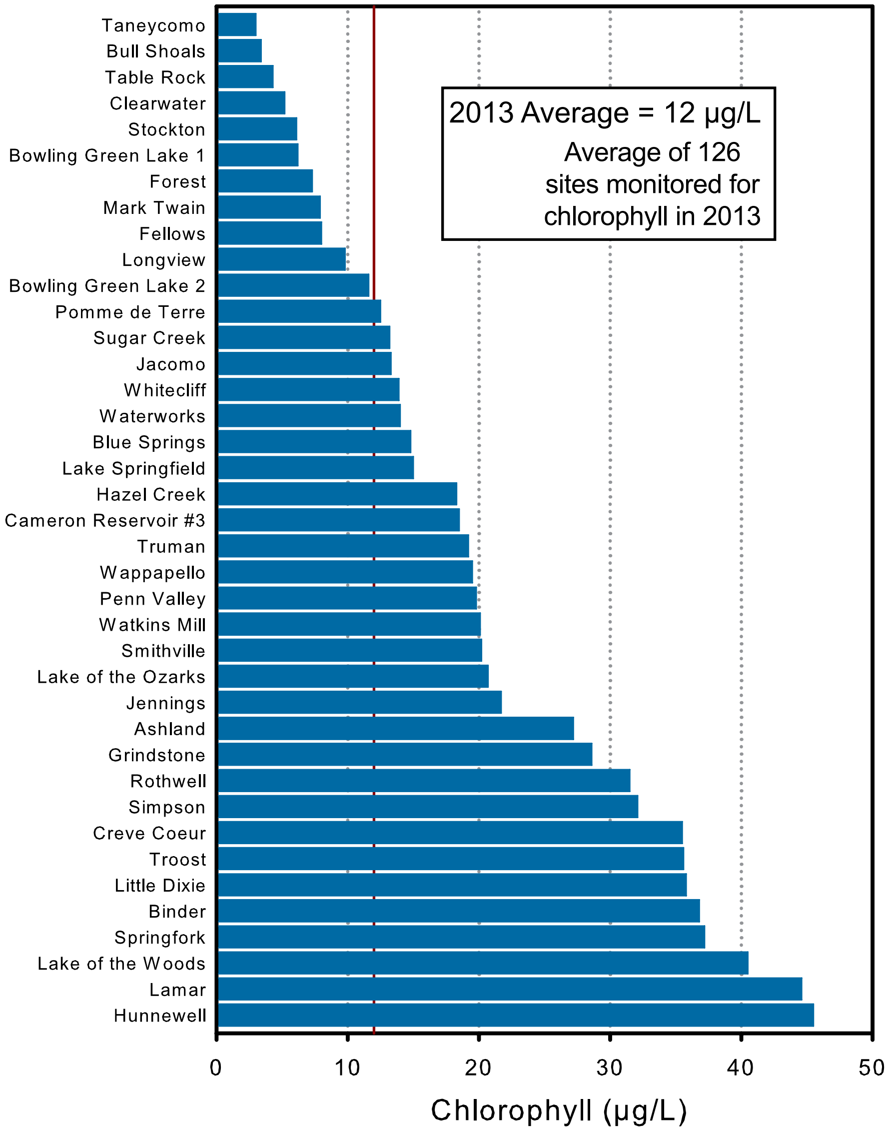
Some blue green algae (cyanobacteria) can produce toxins that are a danger to fish, wildlife, and humans. Several of our neighboring states have closed water bodies to public use because of concerns with blue green toxins.

The average Missouri long-term chlorophyll value is 21 µg/L. The average 2013 LMVP chlorophyll value was 12 µg/L, with individual values ranging from 0.1 to 161 µg/L



A graph showing an algae bloom (Fellows Lake, 2013). An increase in phosphorus (May 18) is accompanied by an increase in chlorophyll. Note how the chlorophyll value exceeds the phosphorus value.

Mean Chlorophyll values for 39 public lakes monitored by LMVP volunteers in 2013.

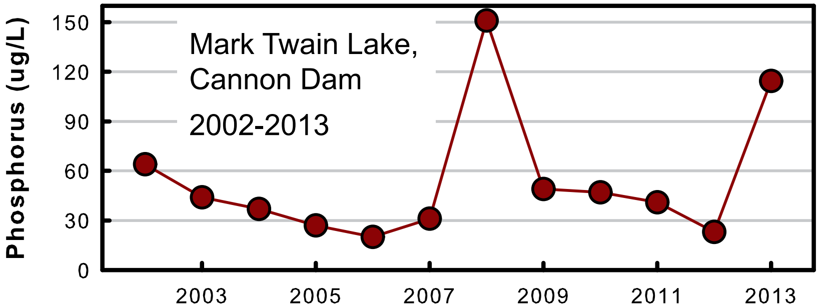


TOTAL PHOSPHORUS

The management of healthy lakes usually includes reducing phosphorus inputs to keep algae populations in check.

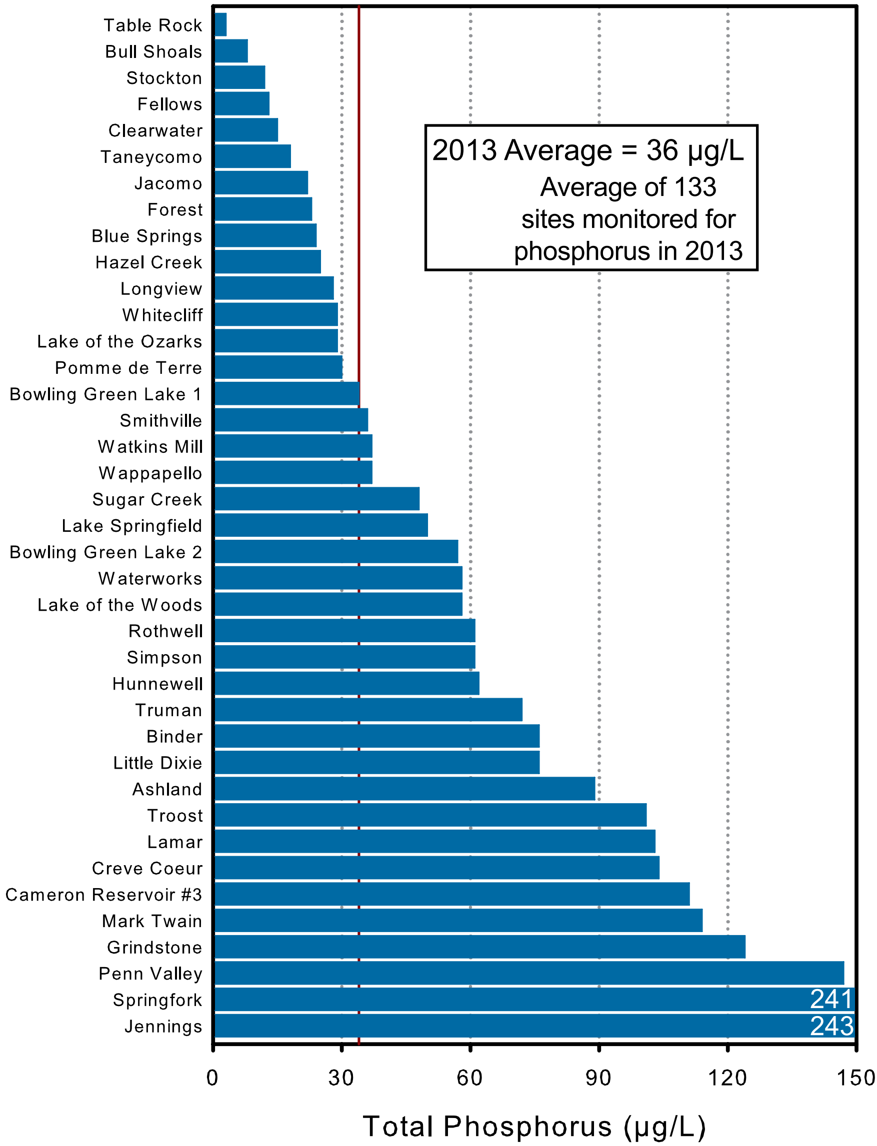
Phosphorus is a naturally-ocurring element and a required nutrient for life. In Missouri lakes, the amount of algae a lake can support is often controlled ("limited") by the phosphorus concentrations in the water. Missouri lakes vary in terms of phosphorus levels, with some lake sites having single digit 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, with the middle half of the lakes ranging from 23 to 64 µg/L. The 2013 LMVP average was 36 µg/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.



Phosphorus concentrations in Mark Twain Lake, 2002-2013. Flooding in 2008 and 2013 and the associated runoff resulted in higher than usual phosphorus loads to the lake.

Mean Total Phosphorus values for 39 public lakes monitored by LMVP volunteers in 2013.



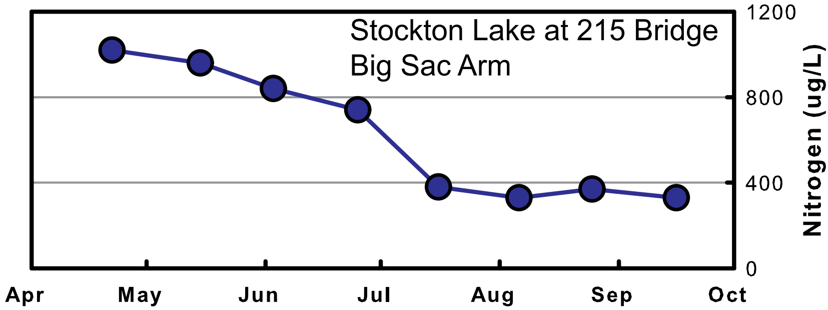
TOTAL NITROGEN

Blue-green algae blooms are common in late summer

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 (see graph below). This ability is also why blue-green algae blooms are often a problem in the late summer.

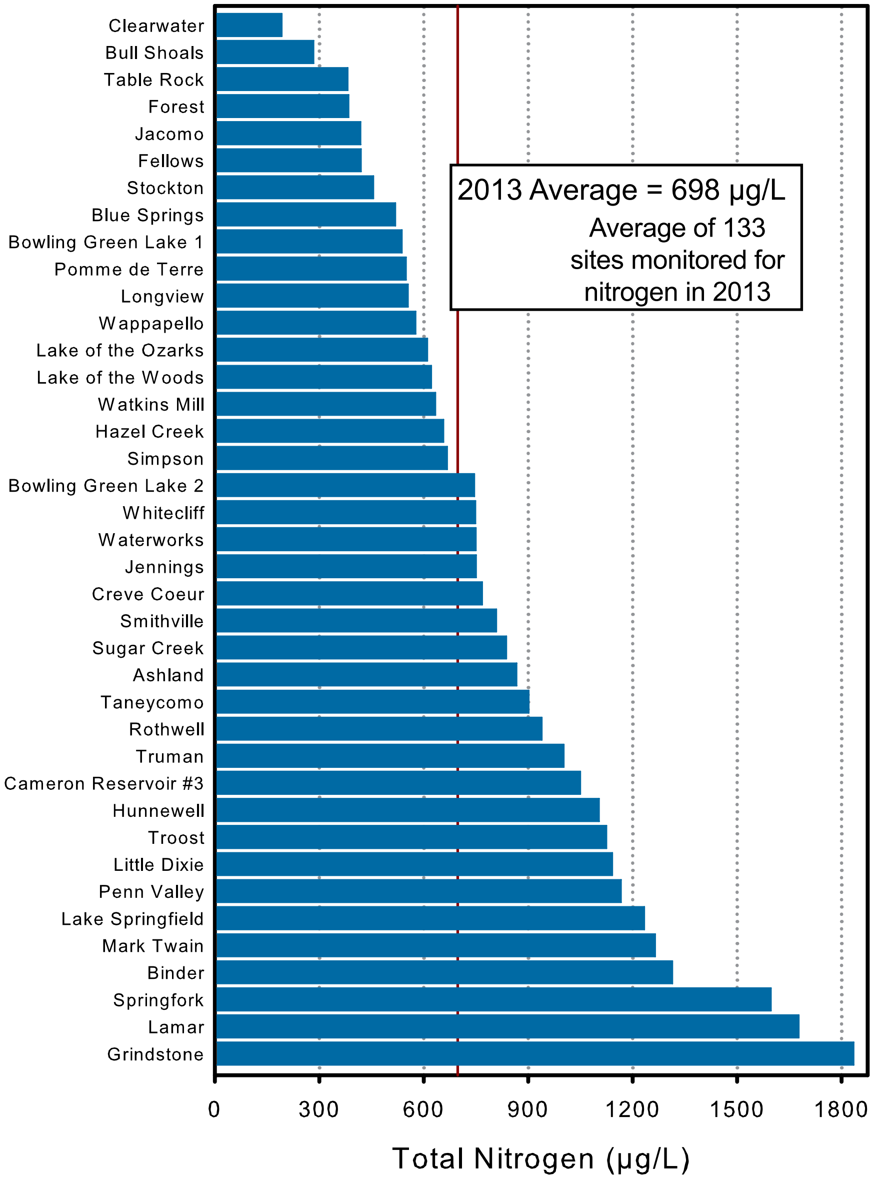
Sources of excess phosphorus also apply to nitrogen. However, nitrogen doesn't bind to soil particles as strongly as phosphorus, so eroded soil entering a lake will have less of an effect on nitrogen values than on phosphorus. Secondly, nitrogen has a gas phase while phosphorus does not. This means nitrogen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

The average nitrogen concentration for 167 Missouri lakes monitored long-term was 800 µg/L, with the middle half of lakes ranging from 535 to 960 µg/L. The LMVP 2013 average nitrogen value was 698 µg/L.



A typical seasonal nitrogen graph (2013, Stockton Lake). Nitrogen values are often highest in spring and decrease through the summer.

Mean Total Nitrogen values for 39 public lakes monitored by LMVP volunteers in 2013.



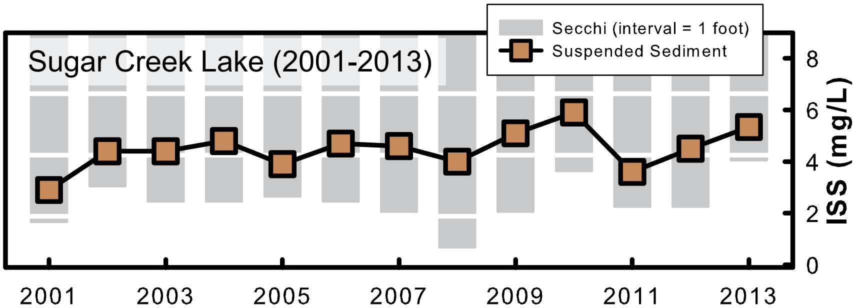
SUSPENDED SEDIMENT

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. Suspended sediment will eventually settle to the bottom, where it 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.

Controlling sediment in the lake usually means managing the land around the lake.

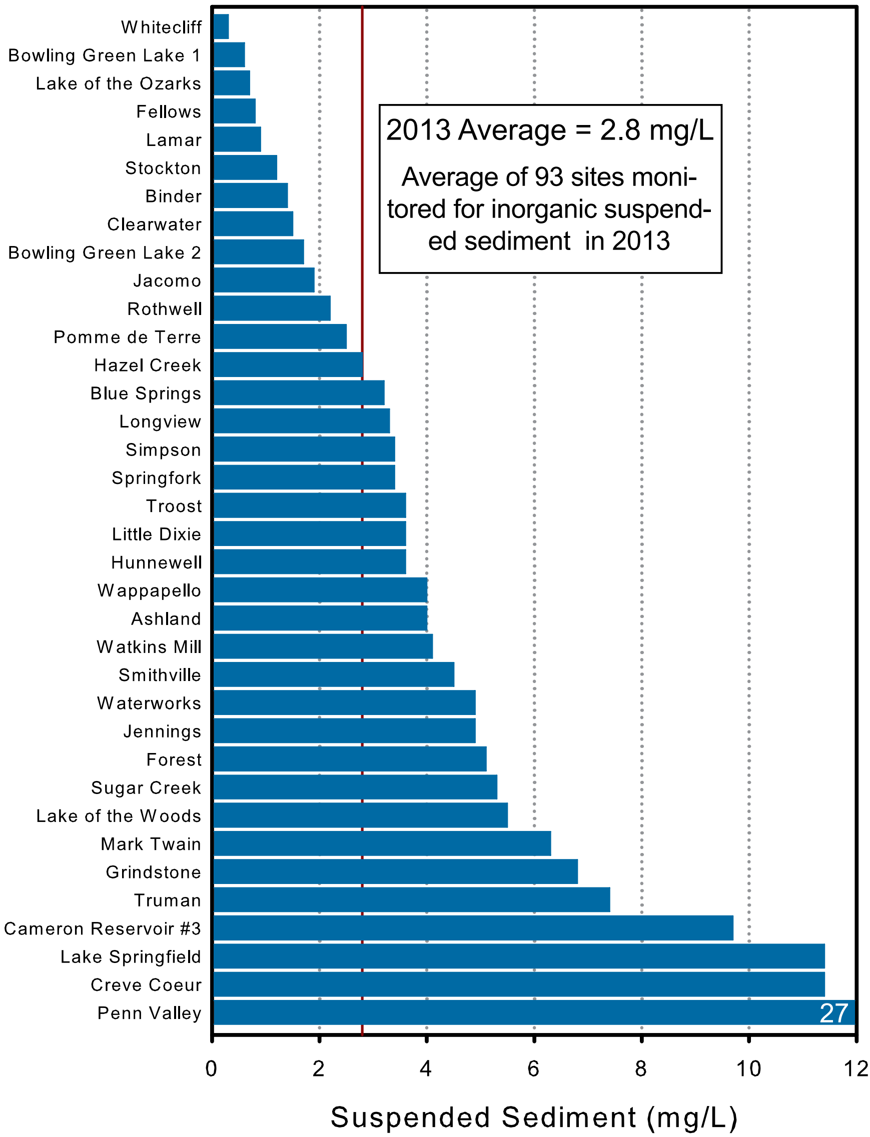
Suspended sediment will block light and can inhibit algae growth. Because phosphorus binds so readily to sediment, sediment washing into the lake will bring phosphorus with it. The best way to deal with suspended sediment is to keep the soil on the ground in the watershed with erosion control measures. Removing grass carp from the lake will also help. They 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 2013 LMVP average was 2.8 mg/L with observed values ranging from 0.1 to 82.8 mg/L.



This graph shows the close correlation between suspended sediment (brown squares) and water clarity (gray bars, 1 foot Secchi depth intervals) in Sugar Creek Lake, 2001-2013.

Mean Suspended sediment values for 36 public lakes monitored by LMVP volunteers in 2013.



CHANGES ACROSS A LAKE

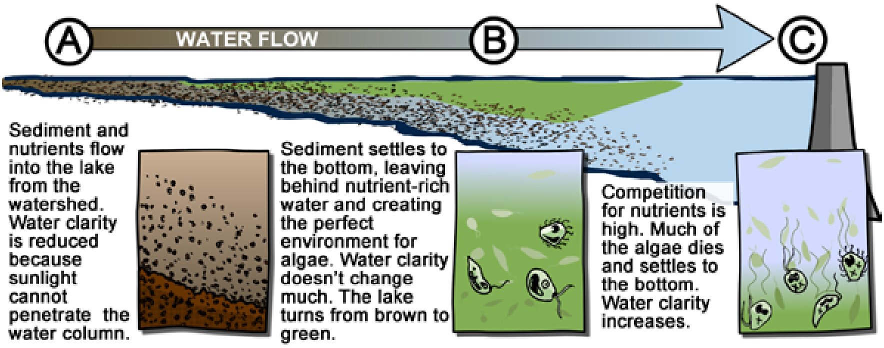
Lake water quality is not consistent across the state of Missouri. Differences among lakes can be attributed to variations of lake shape and depth (morphology), watershed size and slope (hydrology), and land use within the watershed. Large, deep lakes in unaltered watersheds have the lowest concentrations of nutrients, algae and sediments, as well as the clearest water. Shallow lakes in rich soils with large watersheds dominated by agriculture have high concentrations of nutrients, algae and suspended sediment, and very murky (turbid) water.

Water quality also varies within a lake. If you've been on a Missouri lake, you may have noticed that the water quality appears to differ from one end to the other. This pattern is very common and is most pronounced on the larger lakes.

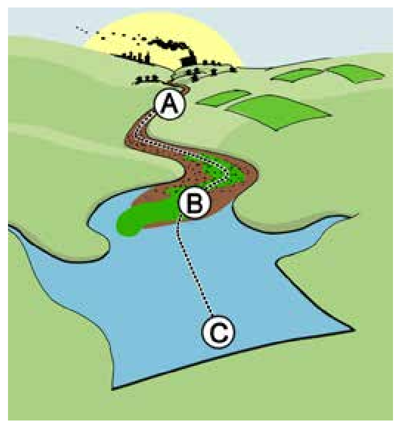
Nearly all of Missouri's lakes are actually reservoirs, with dams that impede the flow of a stream. Water in streams will often keep sediment and other particulates in suspension, the flow preventing settling. Monitoring sites in the upper ends of lakes (reservoirs) typically have higher concentrations of nutrients and suspended sediment than sites near the dam.

Nutrients and sediment flow into the lake from the watershed. Suspended sediment in the water column will block out sunlight and inhibit algae growth (A in the illustrations). As the water loses velocity and the sediment particles begin to settle toward the bottom, more light is allowed to penetrate the water column and stimulate algal growth. Be-

Fog on Lake Taneycomo



Water quality varies not only across lakes, but also within lakes. We measure different values at points A, B and C.



cause of this phenomenon, water color in Missouri reservoirs will sometimes transition from brown to green as it moves from the inflowing stream toward the dam (B in the illustrations).

In our larger lakes, the algae may consume a significant proportion of the nutrients before the water reaches the dam. Algae have short lifespans. Dead and dying cells will settle out of the water column, moving nutrients from the water to the sediment. Reduced nutrient levels near the dam limit algal growth and lead to clearer water (C in the illustrations).

To deal with spatial variation, especially in the larger lakes, LMVP volunteers monitor multiple sites. We try to space the sites out wisely, monitoring enough sites to describe water quality throughout the lake while avoiding monitoring redundant sites. The differences in water quality observed at either end of a small lake are negligible compared to the differences observed on a large lake. Using the additional equipment to monitor another lake is better than collecting samples from sites on the same lake that replicate information.

SEASONAL GRAPHS

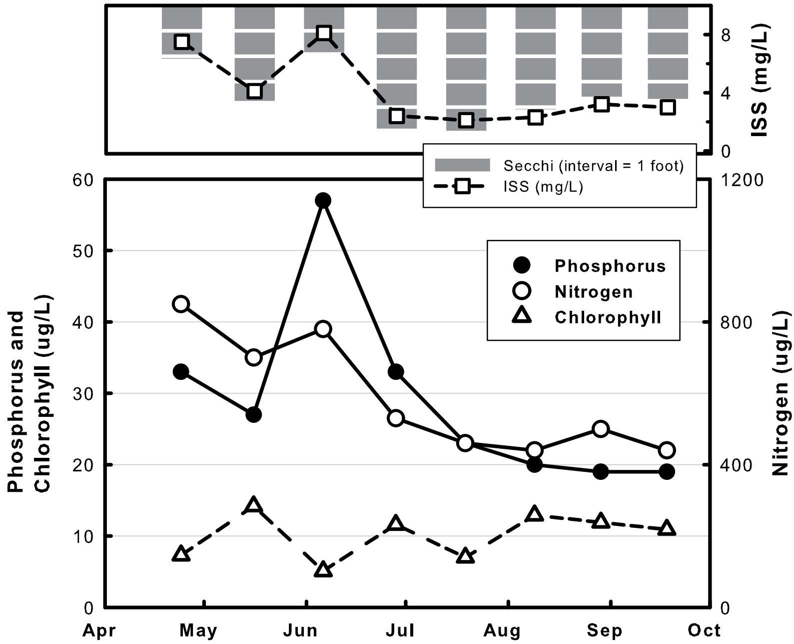
Graphs for all public lakes monitored by the LMVP in 2013 can be found online at www.LMVP.org.

The graphs to the right show how water quality at Longview Lake varied over the 2013 sample season. The upper graph presents the Secchi and inorganic suspended sediment data, while the bottom graph presents phosphorus, nitrogen and chlorophyll concentrations. Data from each of the eight sample dates is shown in chronological order starting with the April 24th sample and ending with the September 18th sample.

The inorganic suspended sediment (ISS) levels were at their highest on the third sample date, measuring 8.1 mg/L. Concentrations remained between 2.1 and 3.2 mg/L for the remainder of the sampling season. Water clarity as measured by Secchi depth followed this seasonal pattern in a predictable fashion. The shallowest Secchi was on the third sample date, at 22 inches. The clearest water of the season (60 inches) was measured on the same day as the lowest suspended sediment.

Total phosphorus and total nitrogen follow a typical Missouri trend with higher concentrations in the spring/early summer followed by lower concentrations for the remainder 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.



Above: April through September 2013 data from Longview Lake (Jackson County). Top graph shows water clarity (Secchi, grey bars) and suspended sediment (ISS, squares). Bottom graph shows phosphorus (black circles), nitrogen (white circles), and chlorophyll (triangles).

A damselfly waits for its wings to unfold after it emerges from a Crawford County lake.

TREND GRAPHS

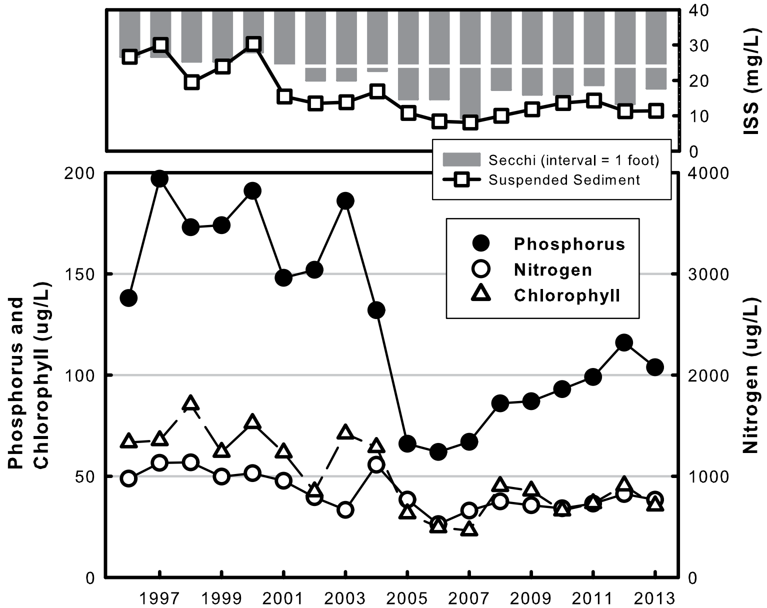
Graphs for all public lakes monitored by the LMVP in 2013 can be found online at www.LMVP.org.

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, the data points represent summertime mean values from an individual year instead of a single sample value.

Creve Coeur Lake in St. Louis County is a shallow oxbow lake, formed by the natural meandering of the Missouri River. Data from the last 18 years show that sediment, phosphorus and chlorophyll values declined after the lake depth was increased and a smaller lake was constructed upstream to trap sediment in 2005. Phosphorus and chlorophyll values have been slowly increasing since 2005, but are still significantly lower than their pre-2005 values.

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.

A cricket frog from a private lake in Adair County.

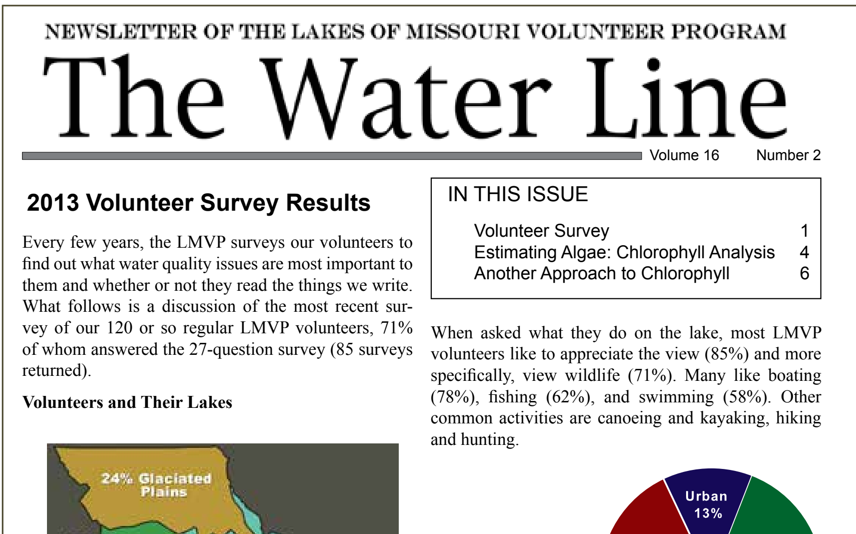


Above: Annual summer mean data (1996-2013) from Creve Coeur Lake in St. Louis County. Top graph shows water clarity (Secchi, grey bars) and inorganic suspended sediment (ISS, squares). Bottom graphs shows phosphorus (black circles), nitrogen (white circles), and chlorophyll (triangles).

LMVP NEWSLETTER

Twice a year, the LMVP distributes its newsletter, the Water Line. The two issues distributed in 2013 covered the effect of bears on water quality, data quality control, a survey of volunteer, and much 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.



NEWSLETTER OF THE LAKES OF MISSOURI VOLUNTEER PROGRAM

The Water Line

Volume 16 Number 2

2013 Volunteer Survey Results

Every few years, the LMVP surveys our volunteers to find out what water quality issues are most important to them and whether or not they read the things we write. What follows is a discussion of the most recent survey of our 120 or so regular LMVP volunteers, 71% of whom answered the 27-question survey (85 surveys returned).

Volunteers and Their Lakes

24% Glaciated Plains

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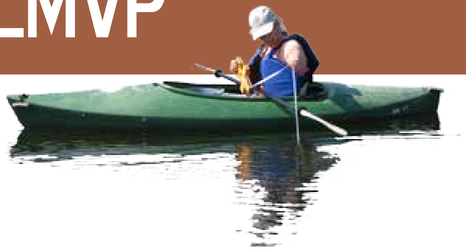
When asked what they do on the lake, most LMVP volunteers like to appreciate the view (85%) and more specifically, view wildlife (71%). Many like boating (78%), fishing (62%), and swimming (58%). Other common activities are canoeing and kayaking, hiking and hunting.

Urban 13%

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:

- The first step is to 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 even come to your lake to train you one-on-one. The training takes about two hours.

VOLUNTEERS LEARN TO:

- 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

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