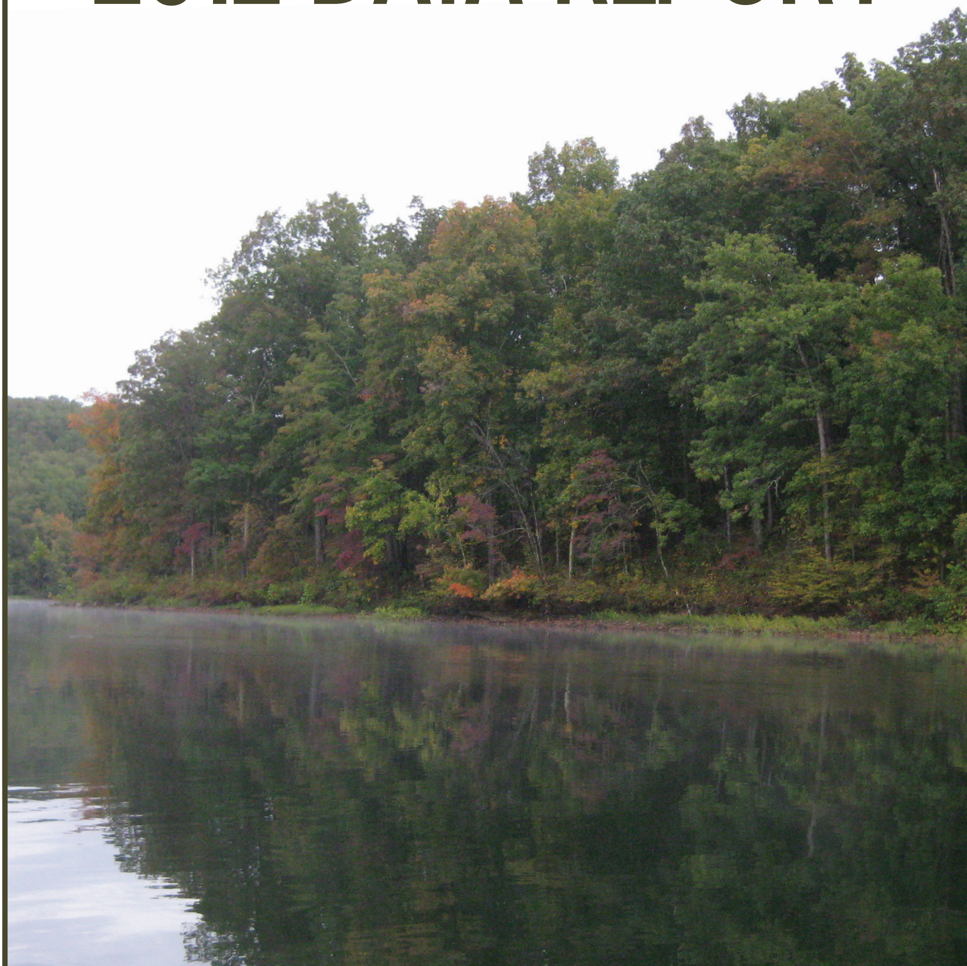
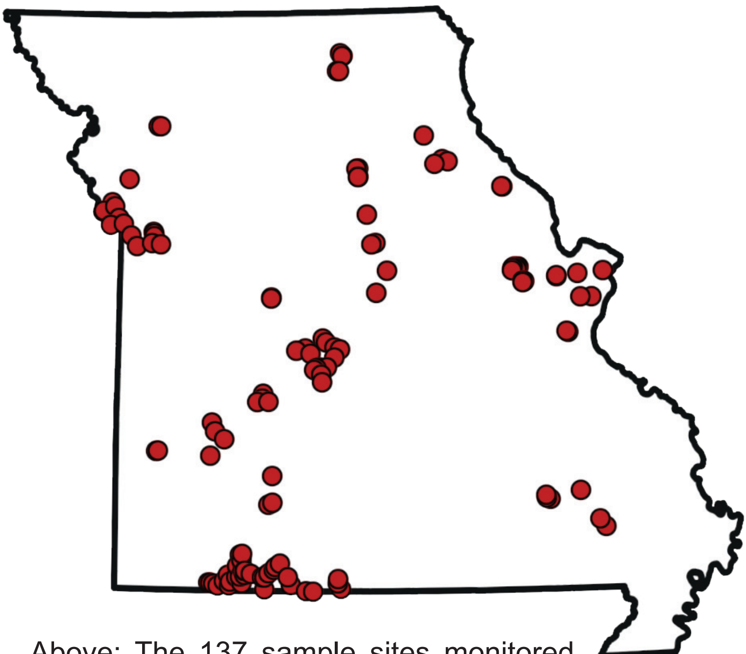
THE LAKES OF MISSOURI VOLUNTEER PROGRAM

2012 DATA REPORT



A summary of 2012 water quality data generated by the Lakes of Missouri Volunteer Program

WWW.LMVP.ORG



Above: The 137 sample sites monitored by LMVP volunteers in 2012

Lakes of Missouri Volunteer Program

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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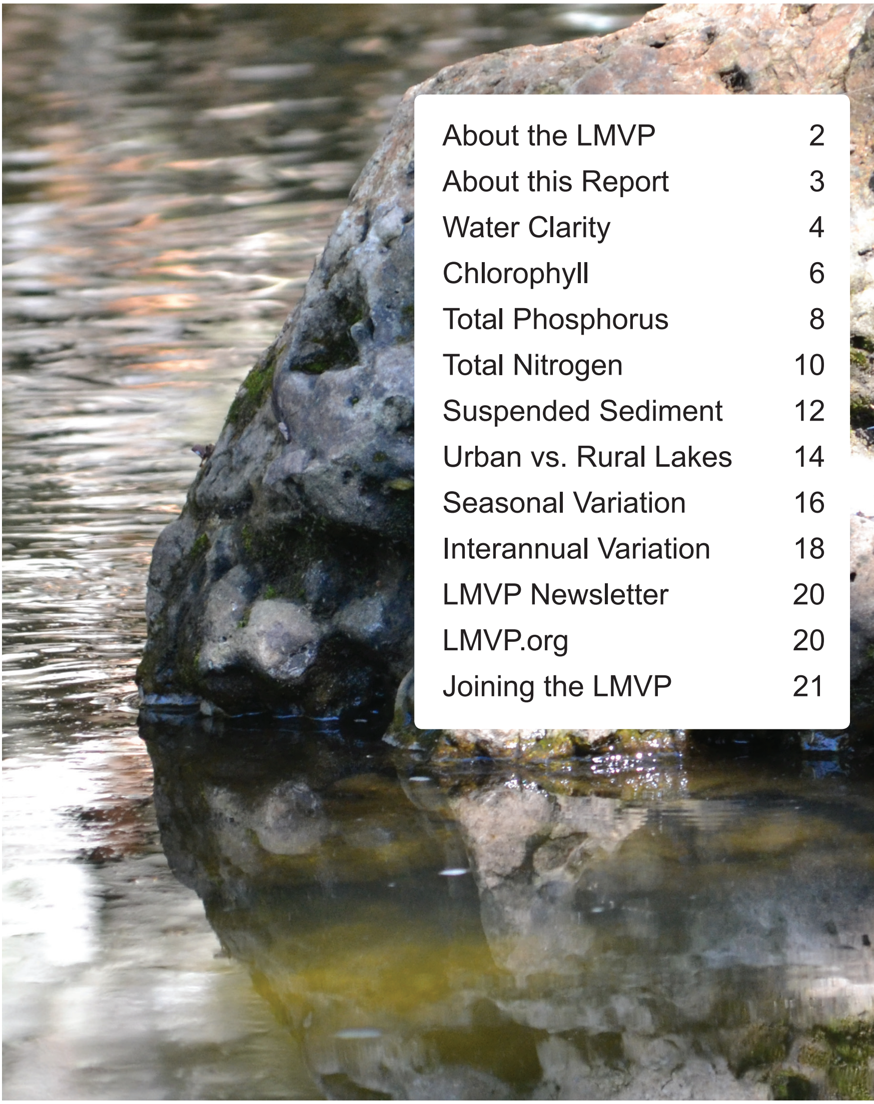


GOALS OF THE LMVP

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 nonpoint source pollution, through runoff. The way to limit the impact that excessive nutrients and sediments have 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, phosphorus and nitrogen (nutrients), 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 water sampling equipment

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. The samples are then 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 extends to 1992, providing 21 years of quality data for some of Missouri's most popular lakes.

ABOUT THIS REPORT

Reading this report should provide you with the background necessary to interpret the full LMVP 2012 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 2012.

Pages 14 and 15 discuss how the parameters differ between lakes with urban watersheds and those with rural watersheds.

Pages 16-19 cover the common types of variation observed in a given season and point out some long-term trends.

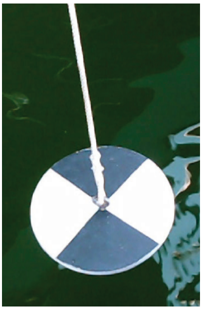
Finally, the last few pages (20-22) address the LMVP newsletter, available online or by request, the LMVP website and how you can join the LMVP to begin monitoring a lake site of your own.

2012 DATA AVAILABLE AT LMVP.ORG

WATER CLARITY

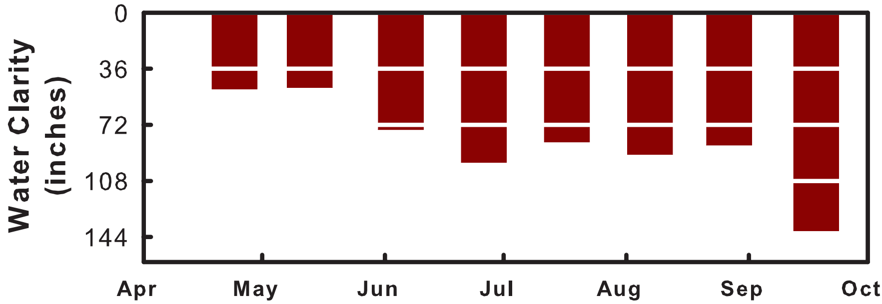
Water clarity is the way most of us relate to water quality. If we see murky water, we assume the water quality is poor. Conversely, if we see clear water, we assume the water quality is good. Of course, water quality is not that simple, but monitoring water clarity is a good way to track the things 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 is a flat, weighted, disk with alternating black and white quadrants that 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.



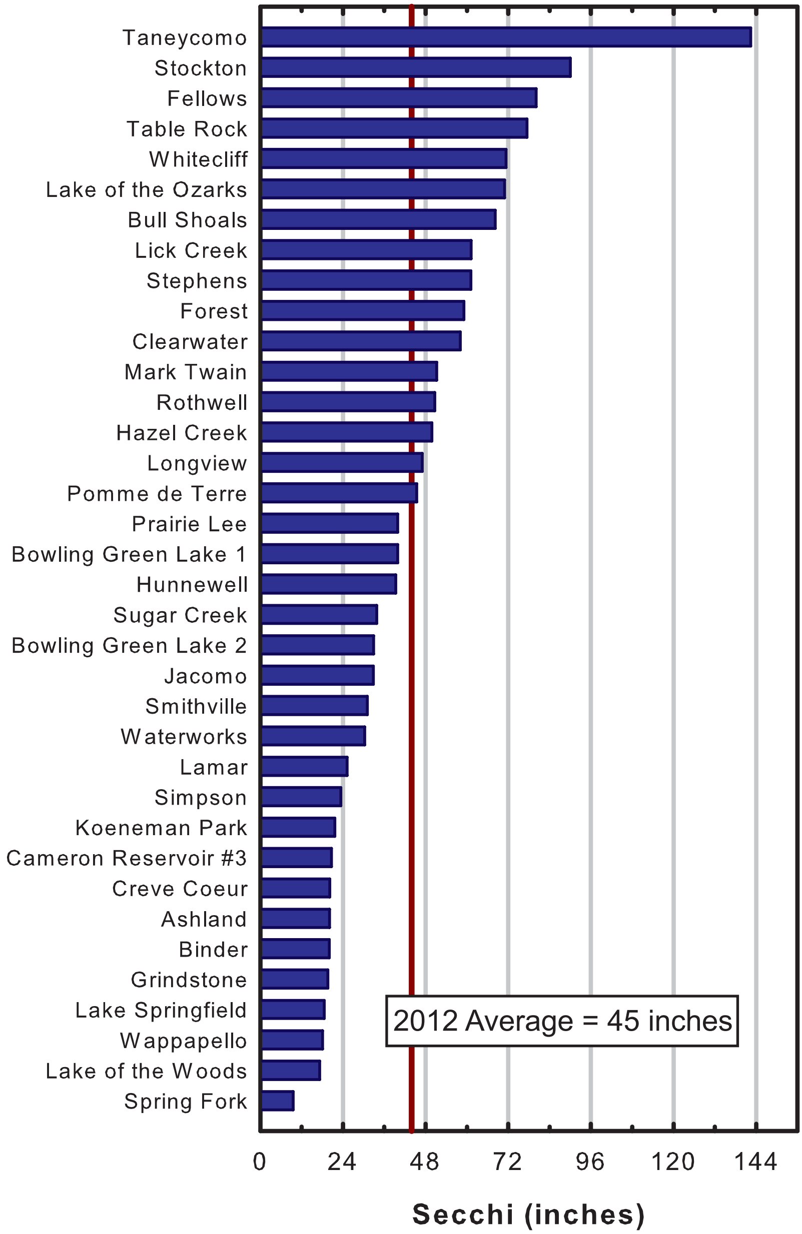
A Secchi disk

Long-term, statewide data from the University of Missouri (167 lakes) show that Missouri lakes, on average, have about 35 inches of clarity. In 2012, the average LMVP volunteer-measured lake water clarity was 44 inches, with individual readings ranging from 7 to 252 inches.



Water clarity measurements in Bull Shoals Lake. Note that zero is at the top of the 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.

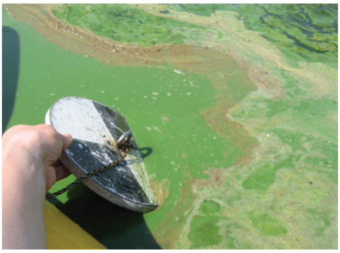
Mean Secchi values for 36 public lakes monitored by LMVP volunteers in 2012.



CHLOROPHYLL

Algae are tiny plant-like organisms found in lakes (and just about everywhere else). Algae, like plants, 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.

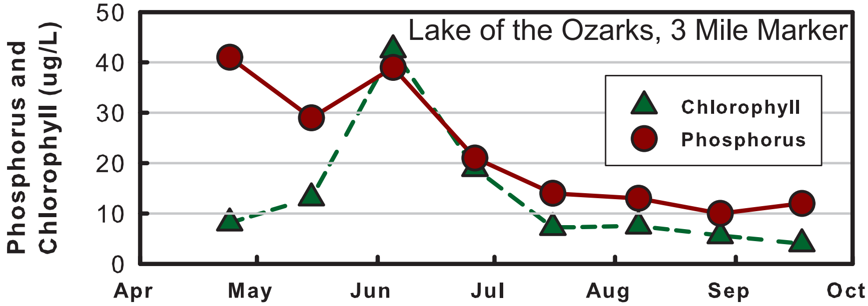
Other organisms, like zooplankton, mussels, and certain fishes, consume algae. These first-order consumers are in turn eaten by predators and thus the carbohydrates move through the food web. While it is essential to aquatic life that algae be present, too much can be a problem. Algal populations can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



An extreme algal bloom in a Missouri farm pond.

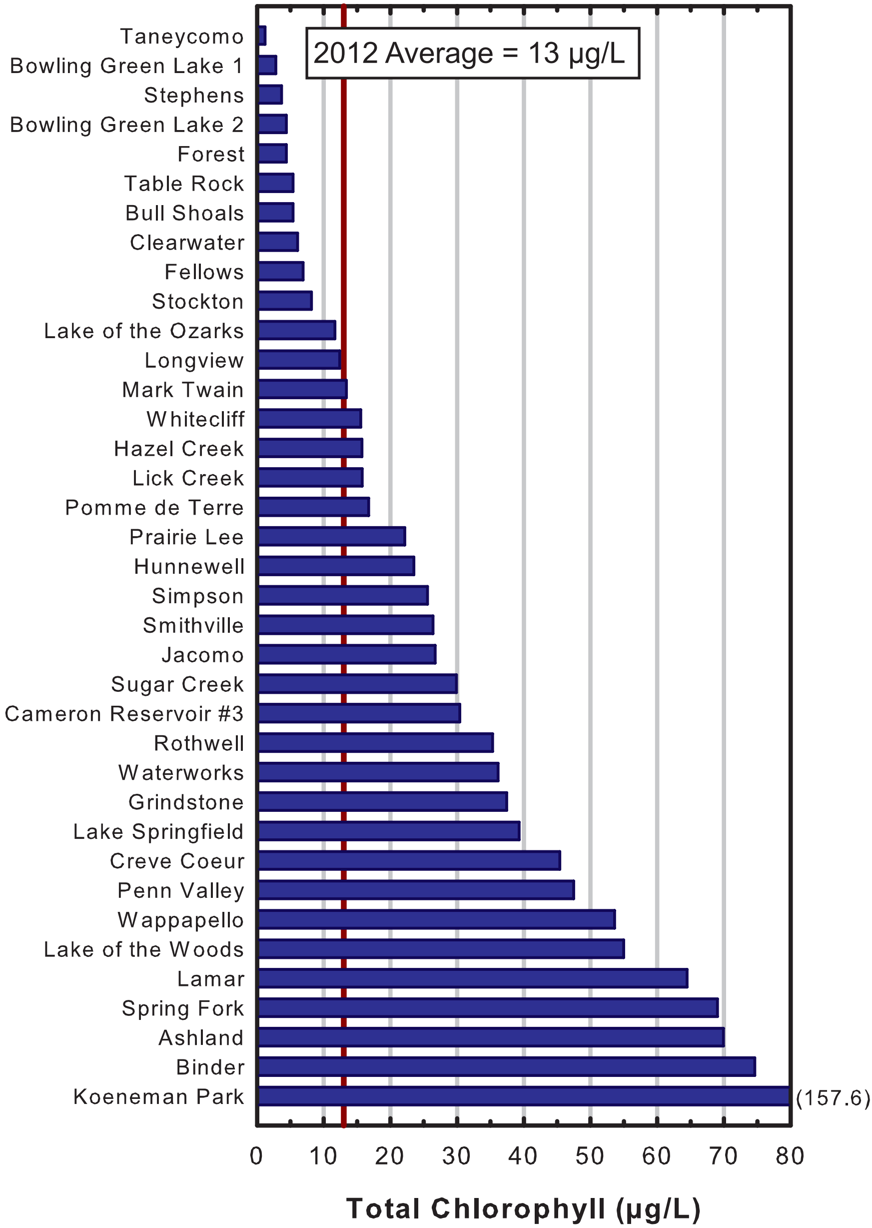
Some blue green algae (cyanobacteria) are capable of producing toxins that are a danger to fish, wildlife, and humans. Several of our neighboring states have closed water bodies to public use because of concerns with blue green algal toxins.

The average Missouri long-term chlorophyll value is 21 µg/L with the middle half of the data ranging from 7 to 25 µg/L.



A graph showing a typical algae bloom. A 33% increase in phosphorus (June 5, 2012) is accompanied by a three-fold increase in chlorophyll. Note how the chlorophyll value exceeds the phosphorus value.

Mean Chlorophyll values for 37 public lakes monitored by LMVP volunteers in 2012.

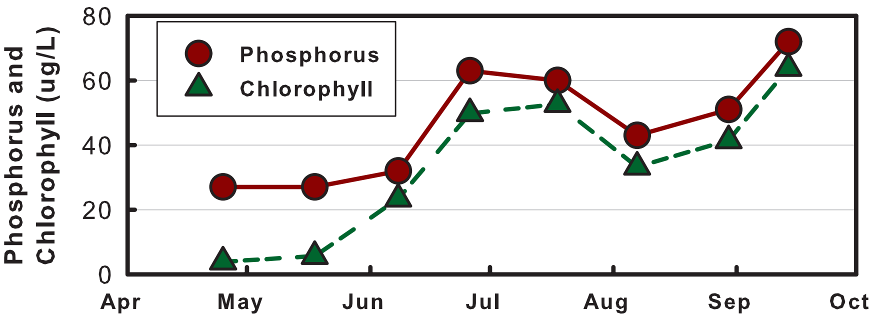


TOTAL PHOSPHORUS

Nutrient analyses are conducted spectrophotometrically at the Limnology Laboratory of the University of Missouri

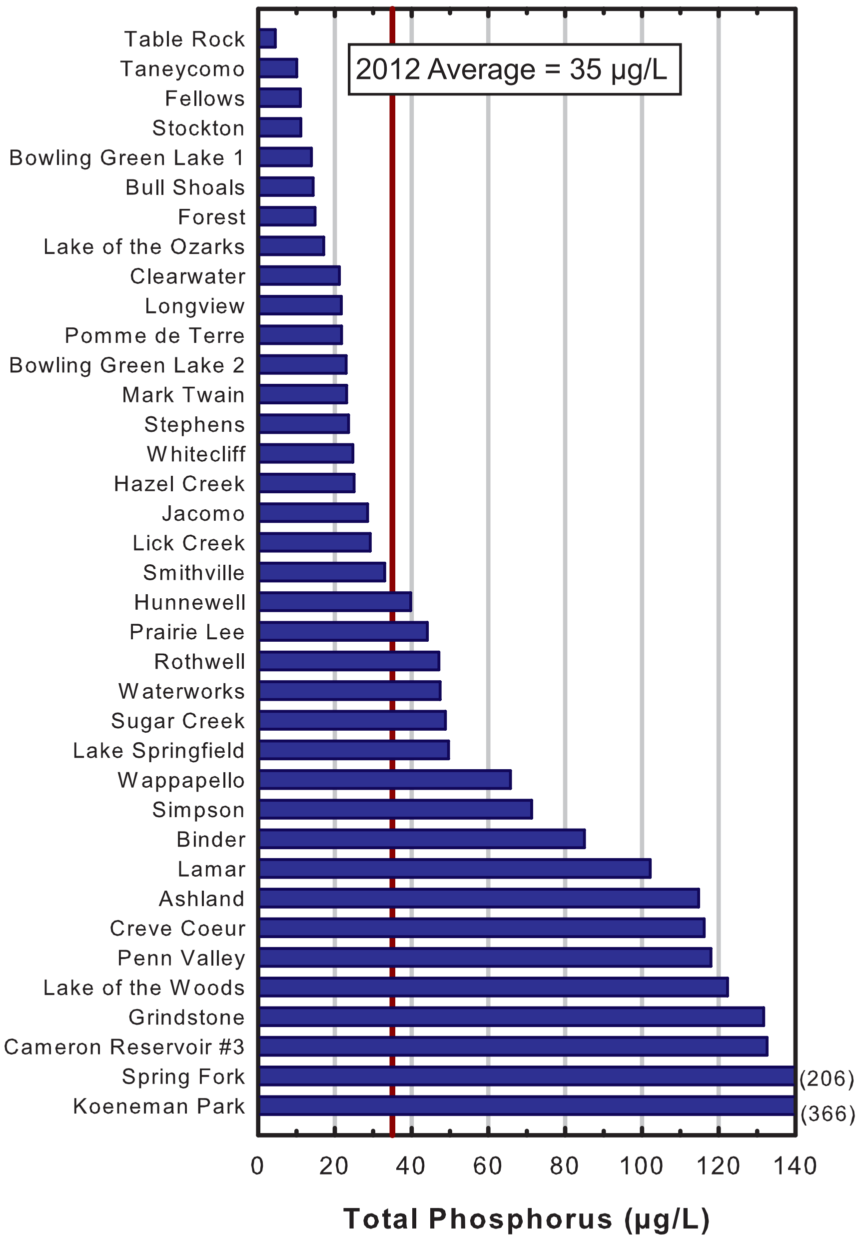
Phosphorus is a naturally-ocurring element and a required nutrient for life. In Missouri lakes, phosphorus tends to be the nutrient that is in the shortest supply relative to need for algal growth. Thus the amount of algae a lake can support is often controlled ("limited") by the phosphorus concentrations 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 2012 LMVP average was 35 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.



A graph showing the close correlation between phosphorus and chlorophyll in Rothwell Lake (Randolph County). Similar correlations can be observed in many Missouri lakes.

Mean Total Phosphorus values for 37 public lakes monitored by LMVP volunteers in 2012.



TOTAL NITROGEN

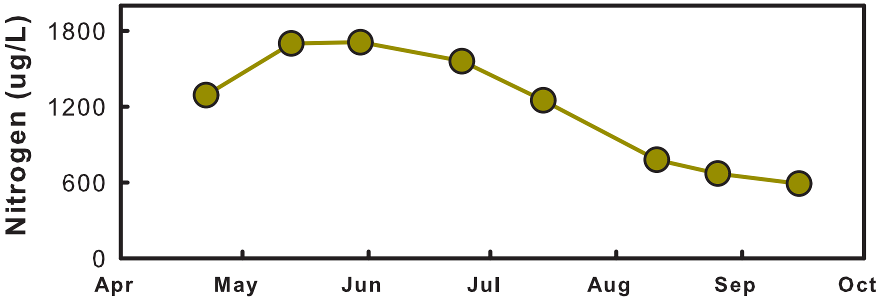
Nitrogen, like phosphorus, is a naturally-occurring element and a required nutrient. In most Missouri lakes nitrogen can limit algal growth during summer, though there are some lakes with high phosphorus levels where nitrogen limits algal growth year-round. Because algae require roughly twenty times more nitrogen than phosphorus, nitrogen can limit algal growth even though it shows up 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.

Blue-green algae blooms are common in late summer

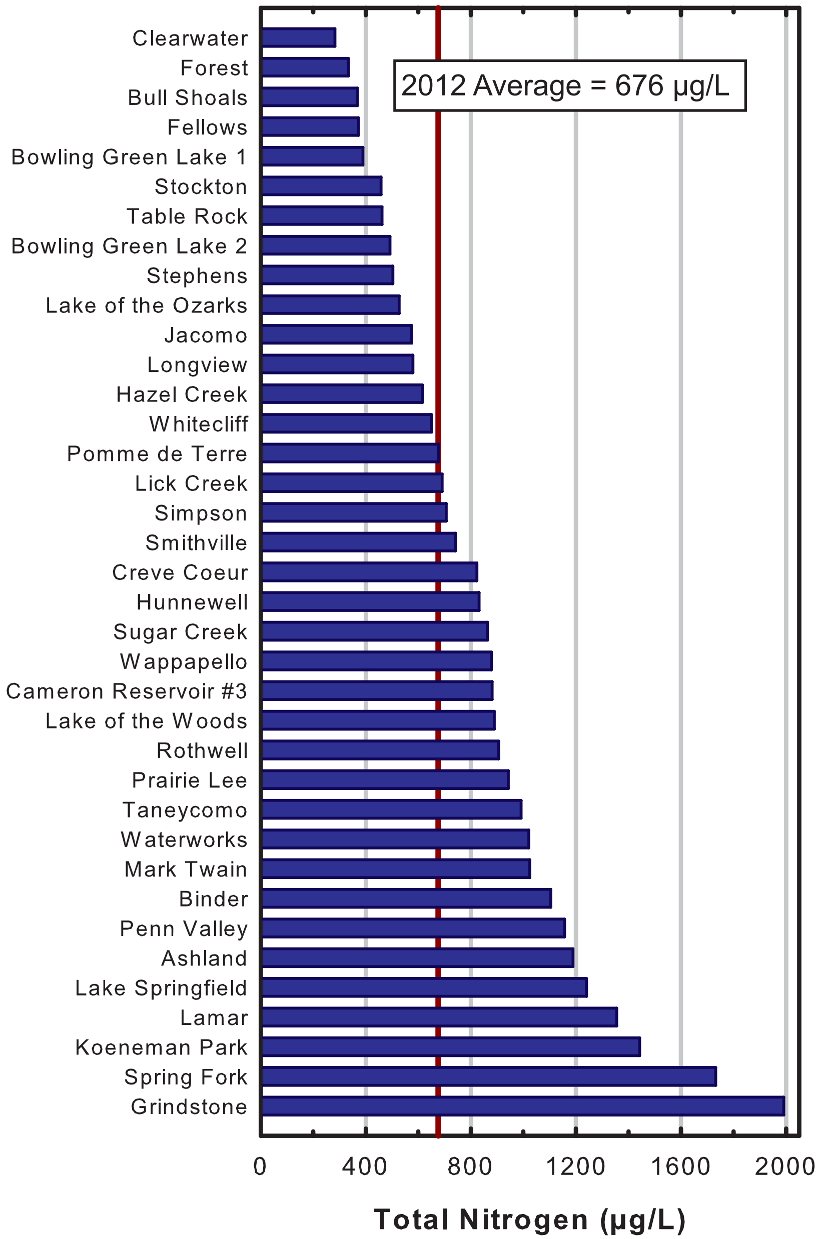
Sources of excess phosphorus also apply to nitrogen. However, nitrogen doesn't bind to soil particles as strongly as phosphorus, so eroded soil entering a lake will have less of an effect on nitrogen values than on phosphorus. Secondly, nitrogen has a gas phase while phosphorus does not. This means nitrogen 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 2012 average nitrogen value was 676 µg/L.

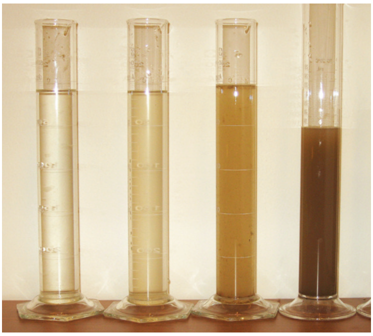


A typical seasonal nitrogen graph (Mark Twain Lake). Nitrogen values are often higher in the spring and decrease through the summer.

Mean Total Nitrogen values for 37 public lakes monitored by LMVP volunteers in 2012.



SUSPENDED SEDIMENT

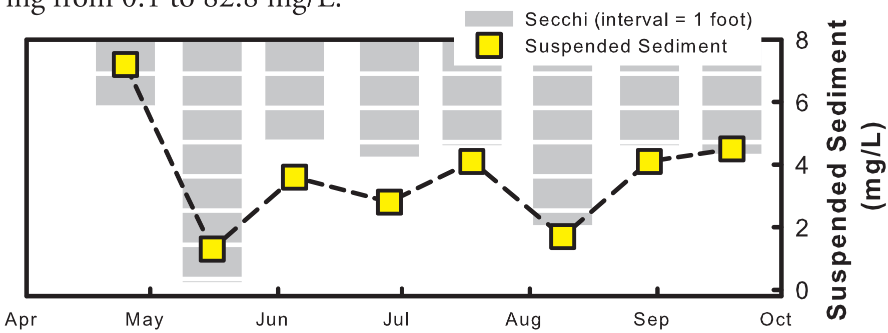


Water from 4 Missouri lakes with very different suspended sediment levels

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 tendency to be built near human activity, reservoirs are much more susceptible to filling in than natural lakes.

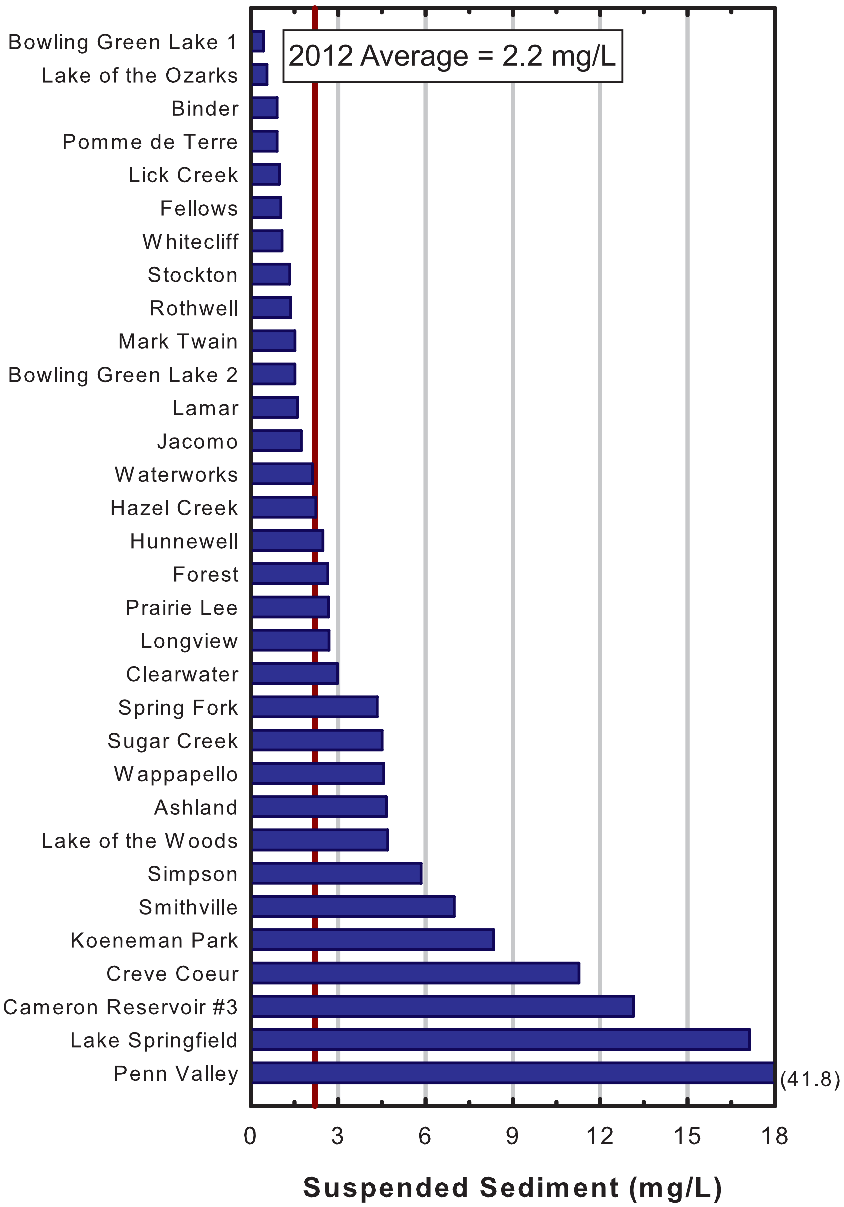
Suspended sediment will block light and can inhibit algae growth. Because phosphorus binds so readily to sediment, sediment washing into the lake will bring phosphorus with it. The best way to deal with suspended sediment is to keep the soil on the ground in the watershed with erosion control measures. Removing grass carp from the lake will also help. 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 2012 LMVP lake average was 2.2 mg/L with observed values ranging from 0.1 to 82.8 mg/L.



This graph shows the close correlation between suspended sediment (yellow squares) and water clarity (gray bars, 1 foot Secchi depth intervals) in Longview Lake, Jackson County (2012).

Mean Suspended Sediment values for 33 public lakes monitored by LMVP volunteers in 2012.



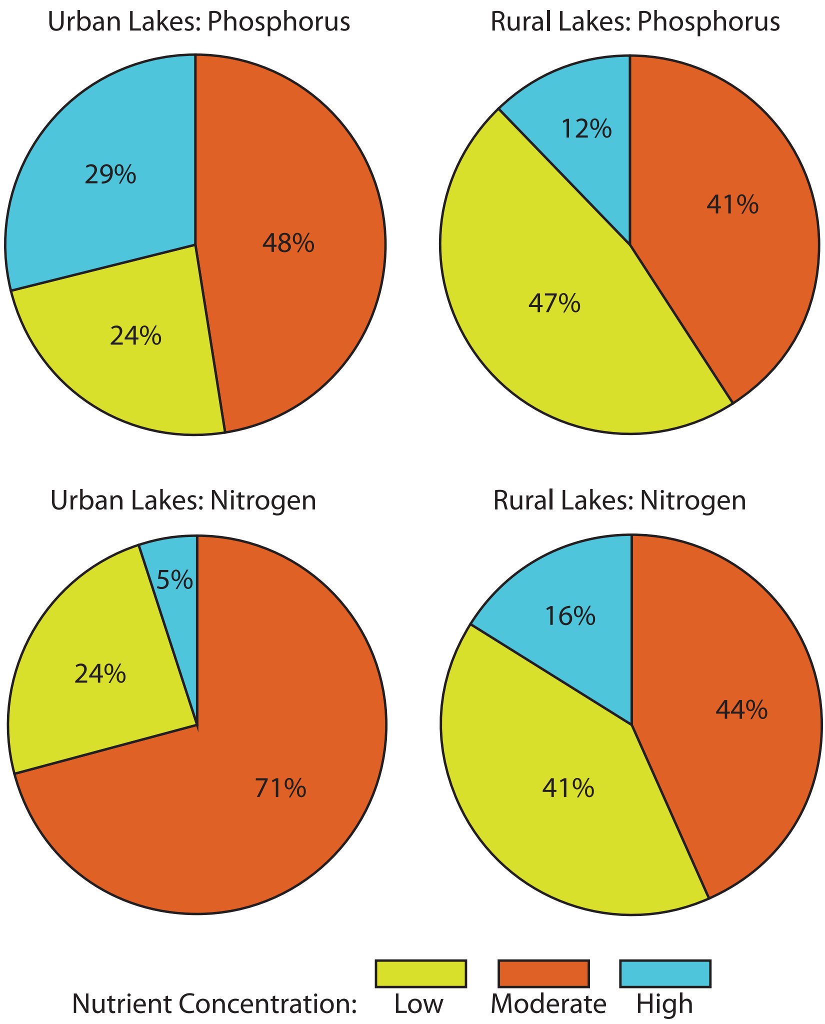
URBAN VS. RURAL LAKES

Because the LMVP has volunteers monitoring across the state, we can make comparisons among different lake groups. In an effort to tease out the influence of urban landscapes on water quality, we divided the 2012 LMVP data into two groups; urban (defined as having a watershed that is at least 20% developed) and rural (defined as having a watershed that is less than 20% developed). Because their size sets them apart from the rest of the LMVP-monitored lakes, we have excluded the 9 largest lakes.

The average 2012 season phosphorus and nitrogen values for each lake were rated as Low, Moderate, or High (see table for cut-points). As a group, urban lakes tended to have more phosphorus than rural lakes, with 29% of urban lakes in the high category vs. 12% of rural lakes. When looking at nitrogen values, the results aren't so clear-cut. While the distribution among categories differed between urban and rural lakes, the average nitrogen concentration was nearly identical among the two groups (Urban = 766 µg/L, Rural = 771 µg/L).

	Low	Moderate	High
Phosphorus	<25 µg/L	26 – 100 µg/L	>100 µg/L
Nitrogen	<550 µg/L	550 – 1200 µg/L	>1200 µg/L

Above: Concentrations of nutrients used for the Low, Moderate, and High categories.



Above: Pie charts comparing nutrients in urban and rural lakes. Top graphs compare phosphorus, bottom graphs compare nitrogen.

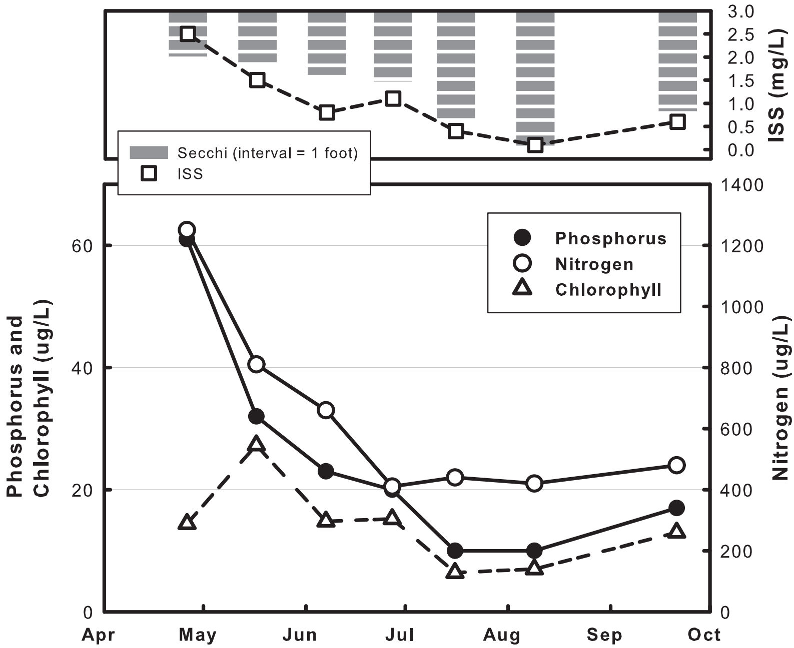
SEASONAL VARIATION

The graphs to the right show how water quality at Bagnell Dam in the Lake of the Ozarks varied over the 2012 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 seven sample dates is shown in chronological order starting with the April 26th sample and ending with the September 21st sample.

The inorganic suspended sediment (ISS) levels were at their highest on the first sample date, measuring 2.5 mg/L. Concentrations declined as the summer progressed, reaching a low of 0.1 mg/L in August. Water clarity as measured by Secchi depth followed this seasonal pattern in a predictable fashion. The shallowest Secchi was on the first sample date, at 3.3 feet. As summer progressed the water got clearer, with the maximum Secchi being taken in August at 10 feet.

Both total phosphorus and total nitrogen follow the same seasonal pattern observed for the ISS, maximum values in April, with declining levels during May and relatively stable concentrations during the summer. Chlorophyll differed in that the value in April was lower than expected given the nutrient concentrations, probably due to a deeper mixing of surface water prior to thermal stratification.

The graphs to the right highlight how much water quality can change within a single season, and why it is important to collect a full set of samples across the season.



Above: April through October 2012 data from Lake of the Ozarks at Bagnell Dam. Top graph shows water clarity (Secchi, grey bars) and suspended sediment (ISS, squares). Bottom graphs shows phosphorus (black circles), nitrogen (white circles), and chlorophyll (triangles).

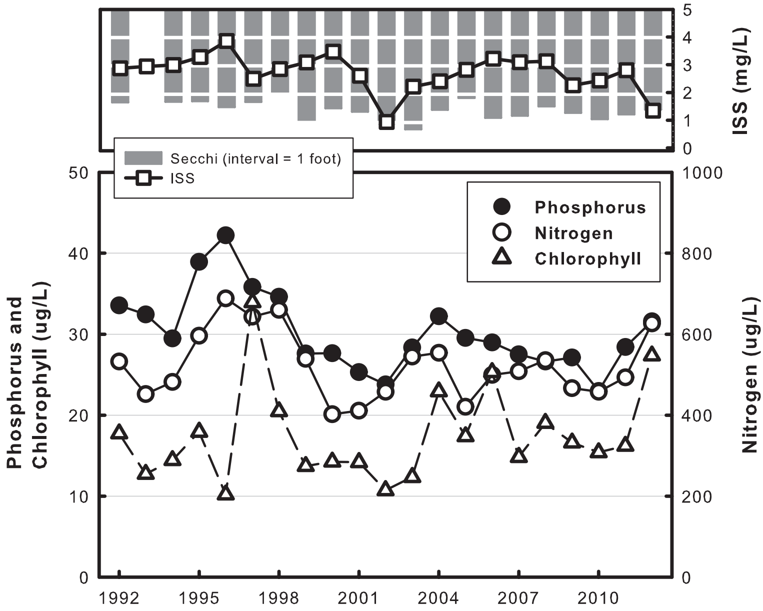
INTERANNUAL VARIATION

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.

Blue Springs was one of the first lakes sampled by LMVP volunteers back in 1992, so this graphic represent data from the last 21 years. Average water quality shows a fair amount of fluctuation from one year to the next, with phosphorus and nitrogen having maximum annual values that are about 70% higher than the minimum annual values. In contrast, chlorophyll differed by over three-fold. Interestingly this range occurred in consecutive years (1996 & 1997), when chlorophyll increased from 10 to 34 µg/L.

None of the parameters show a continuous or predictable change in water quality, but there are some potential trends within the long-term data. Total phosphorus annual means in the first seven years of monitoring were all 30 µg/L or higher. In contrast, only twice during the subsequent 14 years has the annual mean phosphorus value reached that level.

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.

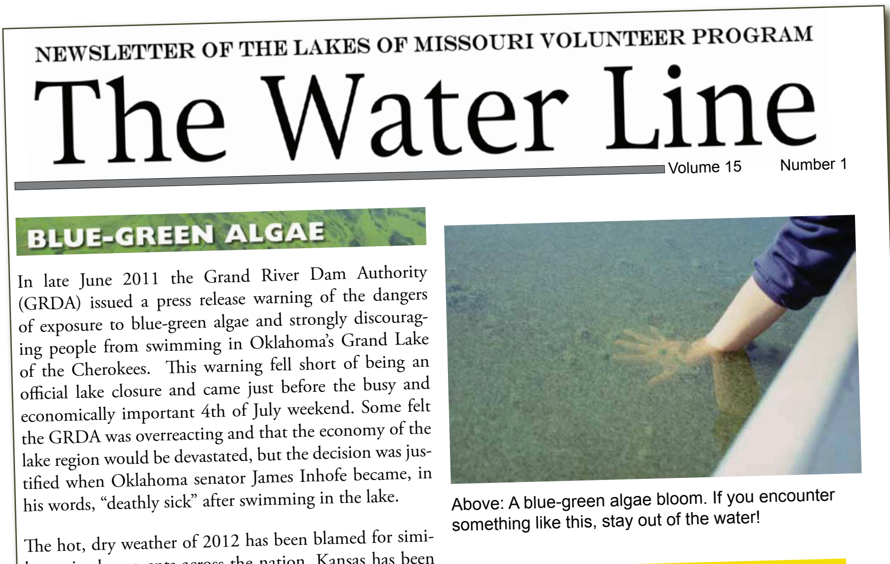


Above: Annual summer mean data (1992-2012) from Blue Springs Lake in Jackson County. Top graph shows water clarity (Secchi, grey bars) and suspended sediment (ISS, squares). Bottom graphs shows phosphorus (black circles), nitrogen (white circles), and chlorophyll (triangles).

LMVP NEWSLETTER

Twice a year, the LMVP distributes its newsletter, the Water Line. The two issues distributed in 2012 covered blue-green algae, algae blooms, cyanotoxins, the history of the LMVP, quantifying the contributions of volunteers, volunteer-initiated monitoring of lake turnover, and more.

To sign up for the newsletter, contact Tony and let him know you'd like to be put on the mailing list.



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 similar toxic algae events across the nation. Kansas has been

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.

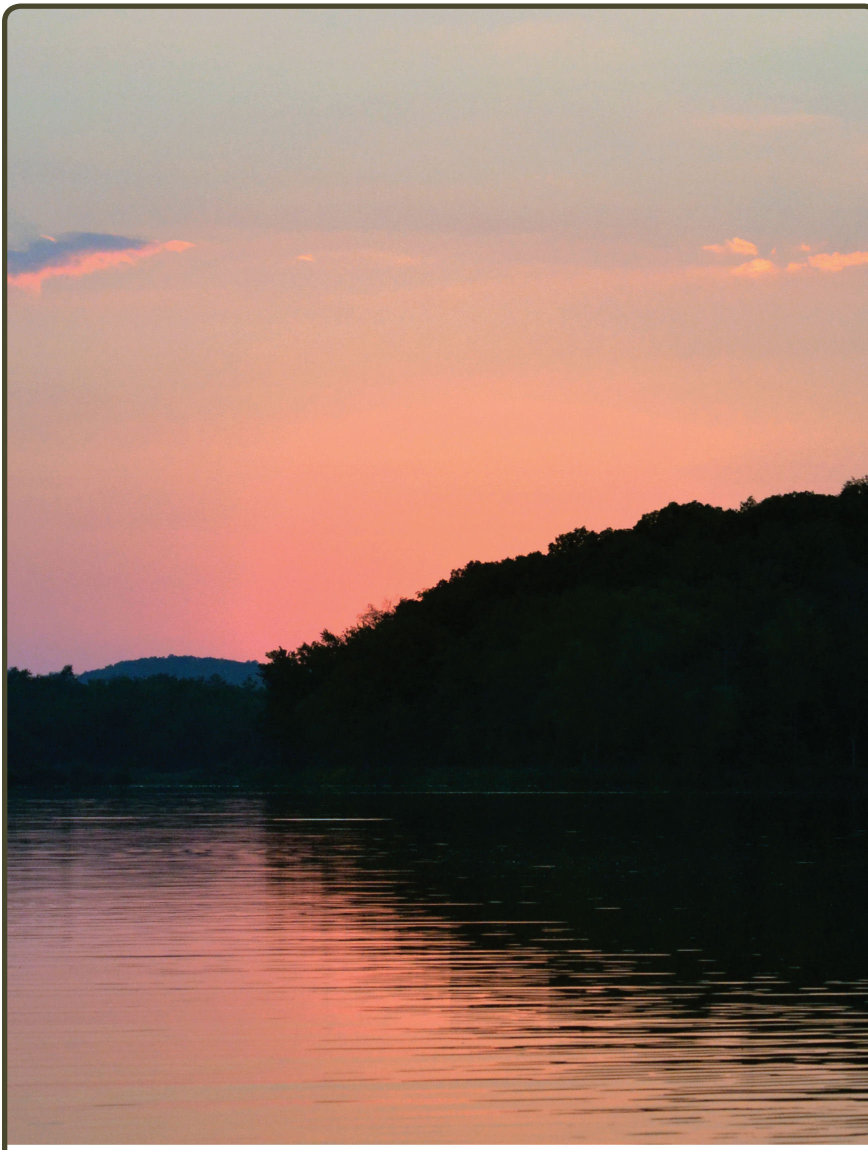
JOINING THE LMVP

BECOMING A VOLUNTEER:

- The first step is to pick a lake you are willing to monitor every three weeks between April and September and be willing to commit one or two hours 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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