NEWSLETTER OF THE LAKES OF MISSOURI VOLUNTEER PROGRAM

The Water Line

Volume 12 Number 2

Temporal Variation

The effect of time on water quality data

For 15 years, volunteers have dutifully collected and processed lake samples spring through fall, and then waited patiently for LMVP staff to report back with water quality data. Among the various graphs and tables, the annual data reports always list mean values for the monitored parameters. These values are used to summarize lake water quality.

Have you ever wondered just how well these numbers represent lake conditions? The answer to this question depends somewhat on you, the volunteer. The mean values that we report are nothing more than estimates, and the accuracy of the estimates hinges on a number of factors, starting with proper sample collection. The LMVP sampling protocol is designed to account for natural variation in nutrient, chlorophyll and suspended solids concentrations over time. In this article we consider the different scales of temporal variation and review what you, the volunteer, can do to ensure data quality. In the next issue of the Waterline we'll look at spatial variation in water quality.

DAY-TO-DAY VARIATION

Nutrient and algal chlorophyll concentrations are constantly changing within a lake. Conventional wisdom suggests that short-term shifts (day-to-day) would be fairly small, but actually these changes can be considerable (Figure 1). In 2004 the MU limnology lab collected samples from Little Dixie Lake on 108 consecutive days during summer (this lake was also monitored by LMVP). Most day-to-day fluctuations in phosphorus, nitrogen and algal chlorophyll were small, but occasionally changes were substantial. The largest 24-hour fluctuation in phosphorus was ±15 µg/L, a one day shift that equals 28% of the average phosphorus concentration (54 µg/L) during the project. The maximum daily nitrogen shift was ±200 µg/L, 22% of the overall average of 900 µg/L. Algal chlorophyll was even more variable, averaging 42 µg/L and having a few daily fluctuations larger than 30 µg/L (71% of the average). Again, these were the exceptions and not the rule. Most of these large changes occurred as a result of heavy rain fall which transported nutrients into the lake as nonpoint source pollution; quick sedimentation of the nutrients right after the rain fall (nutrients bound to soil particles settle out fairly quickly); and in the case of chlorophyll, an algal bloom that formed and dissipated quickly.

Continued on Page 2

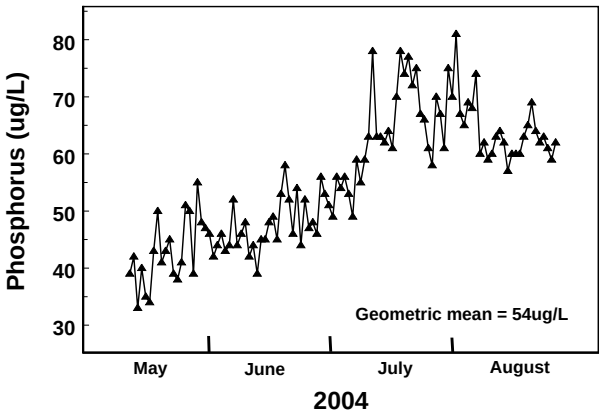


Figure 1. Day-to-day variations in phosphorus concentration in Little Dixie Lake during 108 days of monitoring in 2004.

IN THIS ISSUE

Continued from Page 1

Because daily sampling is not feasible for the volunteer program, we rely on random sample collection to account for variability in water quality. That is, we do not want to collect our samples only after heavy rains when the lake looks its worst or only on days when the lake is clear. By collecting samples on a pre-set schedule of every three weeks, we hope to avoid the potential problem of selectively targeting the worst or best of conditions. While having a pre-set sampling schedule to ensure randomness seems counter-intuitive, please remember the events that impact water quality (such as rainfall) are generally random. The pre-set schedule also assures that samples are not all collected during a short period of time (e.g. eight samples collected in one month). By scheduling sample collections evenly over the spring-fall period, we ensure data quality by monitoring the lake over a variety of conditions.

SEASONAL VARIATION

Lake water quality is dynamic, so we have to collect samples throughout the season to accurately estimate nutrient and algal chlorophyll concentrations. The exact number of samples depends on various factors, including: stability of water quality in a given lake (because of hydrology, some lakes are more variable than others); length of the sample period (e.g. spring-fall vs. summer only); and the desired precision of our estimates. In general, the more samples collected, the stronger our estimate of water quality.

Even sampling just once every three weeks, LMVP is able to detect much of the variation in water quality that occurs during the sample season (Figure 2). Revisiting Little Dixie Lake, which has been part of the LMVP for nine years, we find that the maximum measured nutrient values are generally twice the minimum values. On average, phosphorus ranges from 40 to 80 µg/L and nitrogen ranges 620 to 1200 µg/L. During some years the ranges are larger than this 2-fold range. Chlorophyll is more variable, with the maximum value averaging about five times the minimum (average range 12.4 to 46.8 µg/L). To account for the variable nature of water quality, we need to collect a sufficient number of samples to allow for a strong estimate of average conditions.

By collecting the eight scheduled samples each season, volunteers ensure sufficient data points to allow an accurate estimate of water quality. We could go into the statistical explanation of why more is good, but that would make for a boring article. Trust me, more data result in a more accurate estimate of conditions. While there is no such thing as too much data, we find the gains in accuracy associated with collecting more than eight samples per year are relatively small.

Continued on Page 3

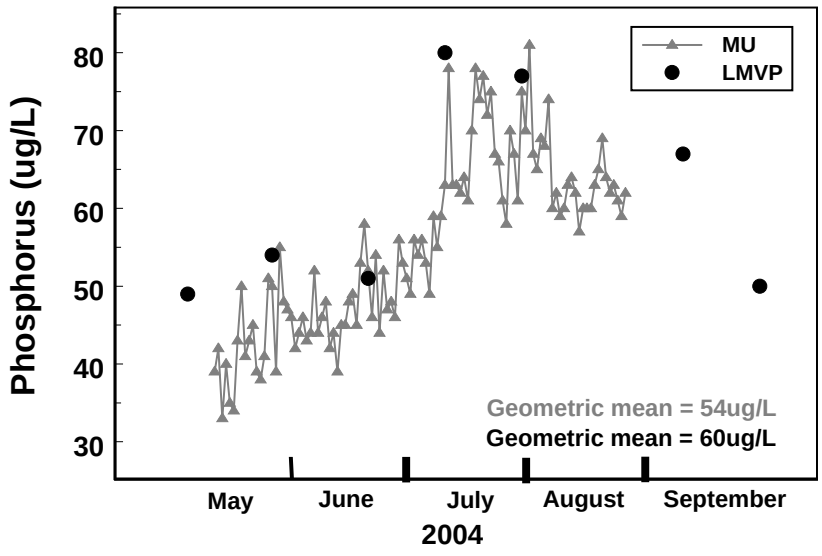


Figure 2. Comparison of volunteer and MU phosphorus data from Little Dixie Lake during 2004.

Continued from Page 2

YEAR-TO-YEAR VARIATION

Monitoring a lake for one sample season informs us only about water quality for that period. Even if a large number of samples were collected and we were confident about the generated mean values, one season of data tells us little about the overall water quality of a lake. Much like the need to collect multiple samples during an individual season to estimate annual conditions, we need multiple years of data to allow a long-term estimate of water quality. In Little Dixie Lake we find that annual geometric means for phosphorus range between 44 and 69 µg/L, nitrogen ranges from 603 to 1159 µg/L, and chlorophyll ranges between 10.4 and 57.4 µg/L (Table 1). Variation among annual geometric means from the nine years of sampling is comparable to the variation observed within most individual seasons. Differences among the seasonal geometric means relate mostly to climate (e.g. wet versus dry conditions).

How influential is climate on lake water quality? During summer 1989, after a long period of drought, the average phosphorus concentration in Mark Twain Lake was 18 µg/L. Following an exceptionally wet spring, phosphorus concentrations in this lake during summer 1990 averaged 163 µg/L. This example, while going from one extreme to another, shows the obvious influence that climate has on lake water quality.

Research on Missouri's lakes indicates that at least four years of data are needed to begin generalizing lake water quality, with more data being better (especially if the lake in question tends to be more variable than the average Missouri lake). Not only are multiple years of data necessary to describe general conditions, but even more data are needed to identify long-term shifts in water quality taking place within a given lake.

To achieve the LMVP's goals of describing current water quality of Missouri lakes and monitor for changes over time, volunteers need to be diligent in collecting enough samples over the spring-fall period to allow an accurate estimate of lake conditions, and lakes must be monitored for multiple years to allow long term evaluation.

Year	Phosphorus (µg/L)	Nitrogen (µg/L)	Chlorophyll (µg/L)
1999	44	603	10.4
2000	49	700	16.8
2001	50	798	16.9
2002	49	846	17.8
2003	51	690	16.2
2004	60	1159	28.2
2005	53	844	25.4
2006	69	945	57.4
2007	66	1120	37.7
Range:	44 - 69	603 - 1159	10.4 – 57.4

Table 1. Annual geometric mean values for trophic parameters monitored in Little Dixie Lake.

Next Newsletter - Spatial Variation

TIPS TO AVOID THE FILTERING FAUX PAS

Filtering is an essential part of processing LMVP water samples. To ensure the data are of the highest quality possible we issue an annual "report card" to our volunteers summarizing the precision of their filtering technique. The grades, which are based on the difference between both chlorophyll filters' values, provide valuable feedback to volunteers by reinforcing good techniques and revealing bad techniques.

Usually the difference between the filters is small and the volunteer gets a good grade. In 2007, for example, nearly 90% of the paired filters rated either "excellent" or "good." Occasionally, however, the paired values are very different from one another and a poor grade is given. If you received a poor grade on your card last year, it is probably due to a common error that is easily correctable.

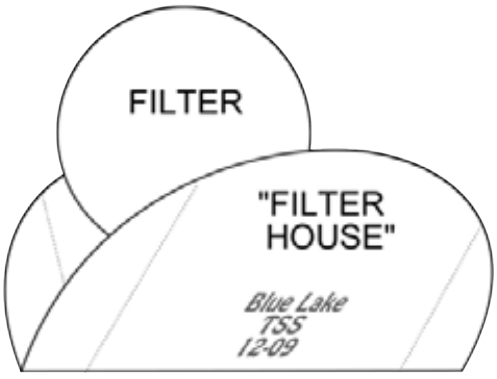
Here's a review of some of the common errors that we see with volunteer processed filters. The same issues apply to both chlorophyll and suspended solids filters. While these errors don't occur frequently, they are common enough to warrant addressing.

Labeling:
Don't write on the filter "house" when the filter is still inside. The pressure from the pencil can damage the filter. If the damage occurs before filtering, then water and the material we're measuring can pass through the tiny holes created by the pencil. If the damage occurs after filtering, the wet filter can be mangled and pieces of it lost.

Measuring the volume:
Be certain that the correct volume of water passes through the filter and that the volume is recorded on both the filter house and the data sheet.

When we see poor replication, we often notice that one filter will have twice the concentration of chlorophyll found on its duplicate. This is probably the result of accidentally doubling the volume of wa-

Continued on Page 5



The TSS and Chlorophyll filters are protected by the "filter house" both before and after processing.

Make sure the filter isn't inside the "house" when you write on it or you can damage the filter.

If you tear the filter after filtering, save all of the pieces by folding them inside the filter.

Continued from Page 4

ter going through a single filter. This can happen if a volunteer (or even a lab employee) forgets that they've already filtered the correct volume of water through the filter and repeats the process unnecessarily.

Folding the filter:

When you remove the filter from the filtering apparatus, be careful that you don't tear the filter. Occasionally a piece of the filter might break off. If this happens, place the piece inside the filter before folding.

When folding the filter, be sure that the stained area is on the inside of the folded filter. Also, double check that all of the colored circle on the filter is enclosed within the fold. This prevents the material we're measuring from rubbing off and sticking to the inside of the paper "house" we use to transport the filter.

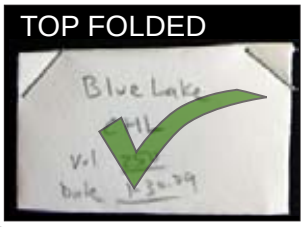
To protect the integrity of the LMVP dataset, we will discard values that don't replicate well. Poor replication, while rare, creates holes in the dataset which represent both a lost opportunity and wasted effort. By going slow and being careful, you can prevent that from happening.

Fold the stained side inward to make sure it is protected.

Also make sure the fold is in the center, or material will be lost inside the "house."

Five Common Filtering Issues

- Not folding or folding incorrectly
- Failing to record the volume, date, site, filter number (TSS)
- Writing on the "filter house" with a filter inside
- Filtering the wrong volume
- Stapling through the filter



When stapling the "filter house" closed, the top should be folded down to prevent the desiccant from contaminating the filter.

While the large desiccant particles are easily removed, the smaller desiccant particles can be confused with sediment when the filter is weighed.

If the filter is folded poorly, material can stick to the inside of the "filter house."

Staple the "filter house" closed, but do not staple through the filter.

The filters are very brittle when dried and will break when the staple is removed.