NEWSLETTER OF THE LAKES OF MISSOURI VOLUNTEER PROGRAM

The Water Line

Volume 12 Number 3

SPATIAL VARIATION

INTRODUCTION

In the last issue of The Water Line we discussed temporal variation in lake water quality and how volunteers can reduce the influence of these variations on LMVP's data. In this issue we will review spatial variation, and explain how the LMVP deals with differences in water quality across a lake surface.

LARGE SCALE VARIATION

When flipping through the 2008 LMVP data report you will notice that not all lakes have the same water quality characteristics. 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 sediments, and very murky (turbid) water.

LONGITUDINAL VARIATION

Not only do water quality conditions differ depending on the region of the state, conditions can vary within a single lake. Sites located in tributary arms or up-lake (A in the illustrations) tend to have higher nutrient and suspended sediment levels than sites located in the main lake channel or near the dam (B in the illustrations). The reason for this variation is that the tributary/up-lake sites tend to be located closer to pollution sources, with water quality reflecting these inputs. As water moves down-lake, processes such as dilution and sedimentation lead to a decrease in nutrient and suspended sediment concentrations.

To deal with these variations, the LMVP simply sets-up multiple sites on the larger lakes in the program. 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.

SMALL SCALE VARIATION

When we start looking at variation within a smaller area we find that differences do occur, but they tend to be smaller than differences observed among tributary arms or from opposite ends of the lake. During the first LMVP sample season volunteers collected three samples from along the dam instead of the one sample that is currently taken. Results from that first year indicated that the differences among the three sites tended to be quite small (around 15%), so the program moved to just one site at the dam. For our purposes, it is better to collect data from more lakes than collect redundant data on a

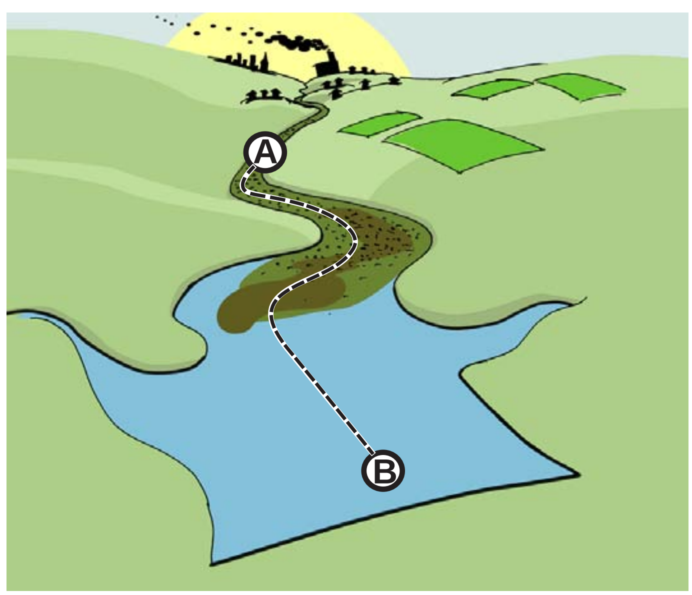

Figure 1. Top-down view of longitudinal variation in reservoir water quality (cross section on next page)

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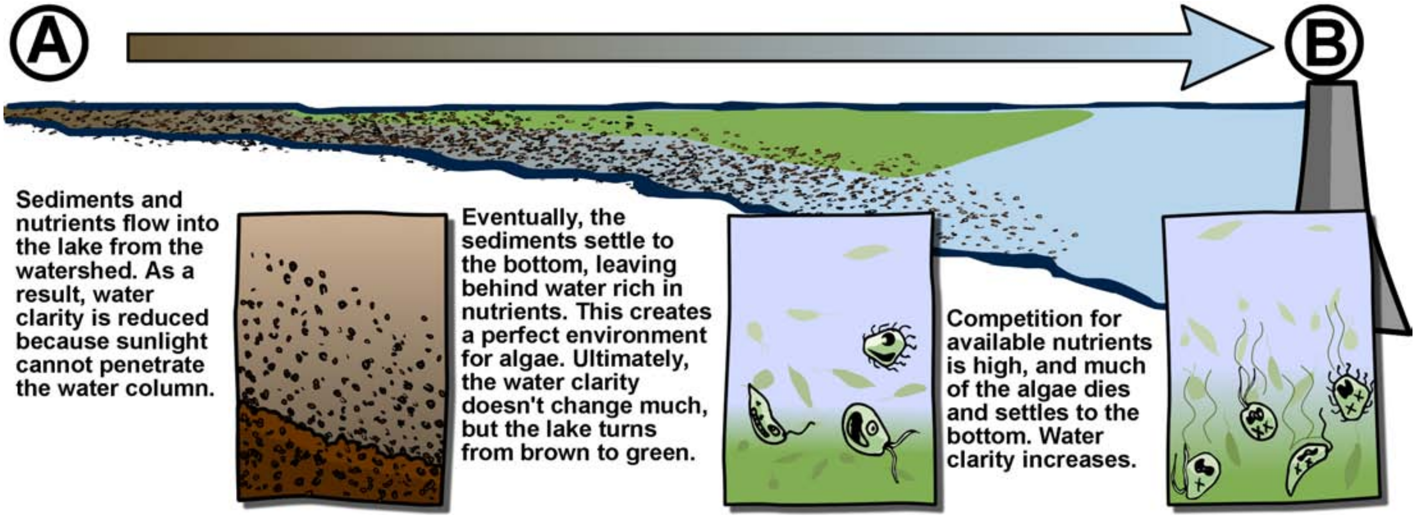

Figure 2. Cross-section of longitudinal variation in reservoir water quality

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single lake.

While the difference is likely negligible, chlorophyll concentrations (our measure of the 'standing crop' of algae) might even vary from one side of the boat to the other. Causes for variation at this scale may include patchy algal populations, activity by the grazer community (e.g. zooplankton, zebra mussels, etc) or wind-driven water circulation (see Langmiur Circulation: Windrows and Scumlines, next page).

To address this scale of spatial variation, LMVP volunteers are asked to 'composite' sample. For our purposes, that means they grab three separate water samples from their lake site (from around the boat) and combine those samples in a bucket before filling their sample bottle. This effectively 'averages' the water in the immediate area.

VERY SMALL SCALE VARIATION

Variation associated with space is present even within the sample bottle. In the laboratory we take multiple subsamples (10 mL in size) for nutrient analyses and pipette them into test tubes. Inevitably there are differences among these tubes. Usually the difference among the individual tubes is less than 5%, meaning we feel quite comfortable with the average value that we generate. When the difference among the tubes is greater than 5%, we will repeat the analysis until we have an average value that we can feel confident in. While some differences observed among the test tubes can probably be attributed to human error in the laboratory, variation caused by particles within the sample bottle is a much larger issue. A single daphnia (a.k.a. water flea, a genus of zooplankton) may contain up to 0.2 µg of phosphorus and 1.5 µg of nitrogen. Even though these estimates are at the high end, this is still a very small quantity of nutrients. However, when a single daphnia is put into a 10 mL tube (1/100 of a liter), it could alter the final estimation of lake nutrient concentrations by as much as 20 µg/L for phosphorus or 150 µg/L for nitrogen!

Like algae, zooplankton are part of the total lake nutrients and we don't want to exclude them from our samples. However, the particulate nature of zooplankton, algae and sediments highlight the necessity of thoroughly shaking the sample bottle multiple times during processing.

ENSURING QUALITY DATA

The LMVP office at the University of Missouri addresses variability mathematically. In our data report we display seasonal values as geometric means, a way of describing the central tendency of the data while minimizing the influence of extreme values. This mathematical technique is commonly used to remove much of the 'noise' associated with water quality data's inherent variability.

A few simple steps by volunteers can reduce the confounding effects of temporal (see last newsletter) variation and spatial variation. Sampling regularly is the best approach for addressing temporal variation. Sampling in the same spot and compositing the sample helps address spatial variation.

Langmuir Circulation:
WINDROWS AND SCUMLINES

What is that crud on my lake?! You may have said this to yourself after seeing rows of scum on the surface of your lake. You may have noticed that these rows appear to be parallel and pointing in the same direction as the wind. These scum rows, also called windrows, scum lines or windlanes, are caused by a rather complex water movement known as Langmuir circulation. A specific blend of wind speed and wave movement is required for Langmuir circulation to be established, but it happens rather often on many Missouri lakes.

If you want to know how this works, keep reading. Otherwise, turn the page quickly while your sanity is still in tact. It takes some 3-dimensional visualization, but I've put together an illustration that might help. Here goes: As the wind blows across a lake, a unit of water is moved from point A to point B. As this unit of water leaves point A, more water rushes up from beneath to occupy the space left behind. This net movement of water creates an upwelling. At point B there is now more water than before. A downwelling occurs as the excess water pushes downward.

As this continues to happen, spiraling 'cells' are established in the water. In the illustration the cells are the things that look like fruit roll-ups. The arrows indicate the direction of the water movement within each cell. Wherever the cells touch the surface, scum resting on top of the surface tension is pushed from the upwelling point to the downwelling point.

When you see a scumline, look around for another. The distance from one scumline to the next is equal to the width of 2 cells. If you put your boat on one of these scumlines, the water beneath you is more or less moving down and downwind. If you park your boat in between two scumlines, the water beneath you is coming up and moving downwind. When you collect your sample, be sure to position your boat over an upwelling point as opposed to over a scum line. This will help keep the nutrient-rich surface scum out of the sample.

There are other forces working in a lake that influence water movement. Otherwise, all of the water would be in a big heap on the downwind shore of the lake! We'll discuss these in future issues of The Water Line.

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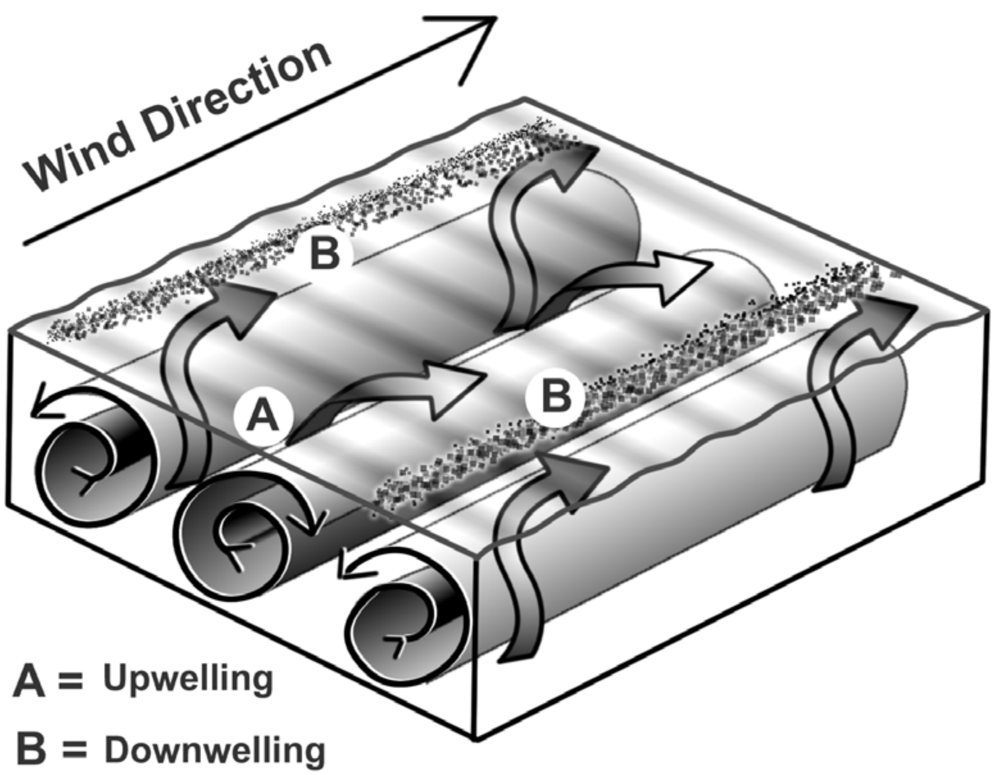
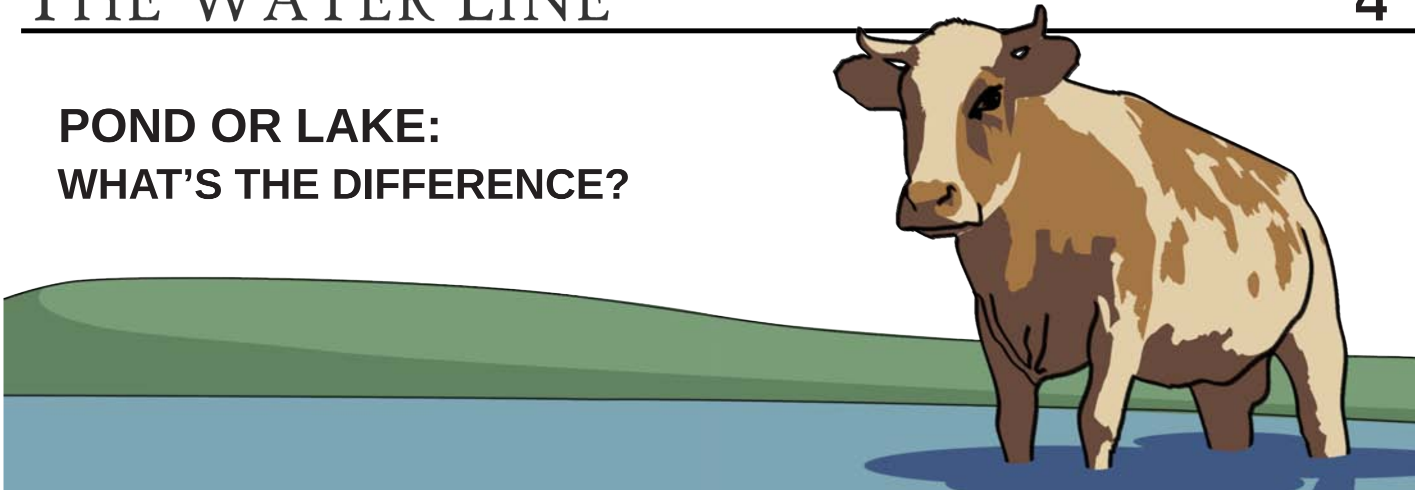


POND OR LAKE:
WHAT'S THE DIFFERENCE?



As coordinator of the Lakes of Missouri Volunteer Program I am frequently asked the question "what's the difference between a pond and a lake?" I usually have a glib answer, like "if a cow can stand in the middle, it's a pond," or "if you tip your boat and your head gets stuck in the mud, it's a pond." In truth there is no universally accepted distinction. The difference between a pond and a lake is only semantic, and the characteristics that distinguish the two will vary by region.

Ultimately a small body of still water is a 'pond' and a comparatively larger one is a 'lake.' However, the precise surface area at which a pond becomes a lake is unclear. The pond/lake size division leans toward larger acreage in regions with abundant natural lakes. A water body of 200 acres might be considered a pond in the northeastern United States where natural lakes are abundant, while in Missouri a 200 acre water body would absolutely be called a lake. For folks who spend their weekends boating on lakes where they can't see the far shore, 200 acres must seem like a pond!

Surface area is not the only variable used to distinguish ponds from lakes. Depth is often considered, with ponds often defined as being so shallow that the water mixes from top to bottom all year round. Conversely, lakes are deeper and will thermally stratify during the summer. Some define a pond as shallow enough that light reaches the bottom, allowing rooted plant growth throughout. Lakes on the other hand have areas deep enough that light won't reach the bottom, thus excluding rooted plant growth. Finally, Some may use origin to distinguish between a pond and a lake, labeling a pond as a man-made body of water and a lake as a naturally occurring feature.

The criteria for categorizing still waters are numerous and often contradictory. Let's take Rothwell Lake in Moberly as an example. It has a surface area of about 25 acres, and could easily be called a pond in other regions of the country, simply because of its (relatively) small surface area. However, according to our data, this lake stratifies in the summer, thereby making it a lake by one definition. Light will not reach the bottom at the center of Rothwell Lake and rooted plants will not grow there; thus, it is a lake by another definition. Rothwell Lake is a man-made impoundment, and thus a pond by yet another definition.

Ecologically speaking, it doesn't really matter if a water body is called a pond or a lake. A water body deep enough to stratify is very different from a water body so shallow that it mixes throughout the year, regardless of its name. While surface area is probably the most common variable for distinguishing between ponds and lakes, it is not as ecologically important as depth. What likely makes area the most commonly used characteristic is the ease with which it can be estimated. A lake's surface area can be estimated by looking at a map, while estimating depth requires multiple measurements from a boat.

The LMVP has been working with the Missouri Department of Natural Resources to develop nutrient criteria for Missouri's "lakes." As we moved forward, we needed to make a distinction between lakes and wetlands. We decided on the

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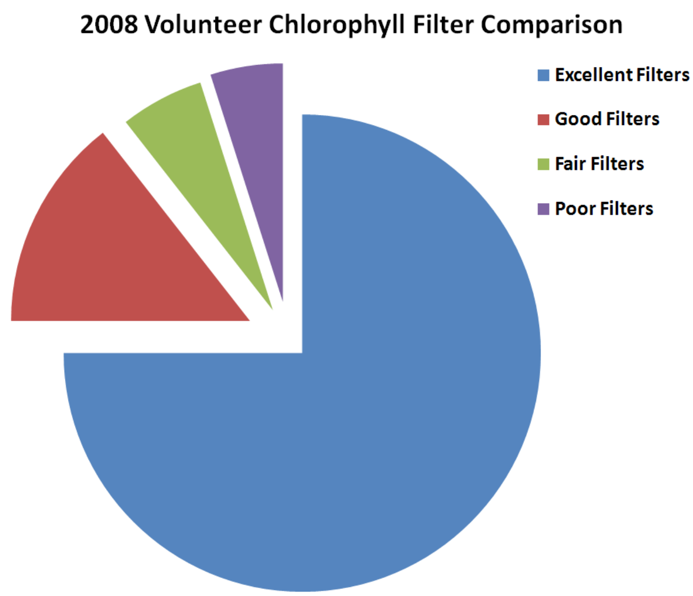
EPA's recommendation of 4 hectares (10 acres) as the minimum surface area for a water body to still be considered a lake. The water must also be at least 3 meters deep (9.5 feet) to ensure stratification. Smaller and shallower water bodies would fall into the "wetland" category due to the overwhelming influence of bottom and shoreline sediments on overall water quality. So Missouri's regional, semantic definition of a lake is a body of still water with a surface area greater than 10 acres and deeper than 9.5 feet. We did not define ponds.

The definitive answer is that there is no definitive answer. The lake or pond designation is a naming convention that varies by region. However, the absolutely clearest distinction I've read states that "if it's 3 acres and it's yours, it's a pond. If it's 3 acres and it's mine, it's a lake."

VOLUNTEERS GET GOOD GRADES

Volunteers for the LMVP measure chlorophyll by drawing water through 2 glass fiber filters that are later analyzed at the University of Missouri. Not only does having 2 values allow us greater insurance against laboratory error, it also allows us to examine how readily the samples replicate.

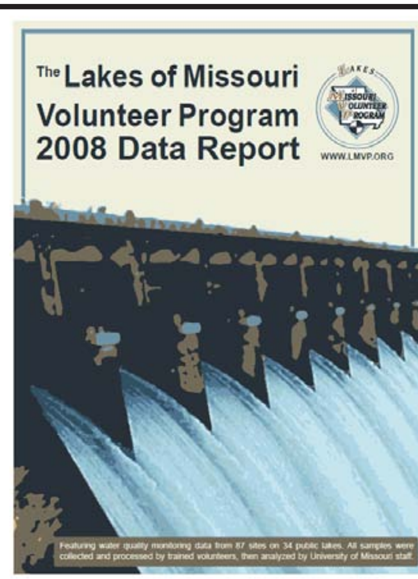
By comparing the values obtained from each filter, we issue 'grade cards' to our volunteers. This year, 91% of the filter pairs examined were either 'Excellent' or 'Good', meaning the differed by less than 10%. Only 6% were 'Fair', differing by 10 to 15%, and only 4% were 'Poor', differing by more than 15%.



2008 DATA REPORT

The 2008 LMVP Data Report is available for download. Visit www.lmvp.org to download the report. Additionally, you may request a print copy by contacting us (see back page for contact information).

The 2008 report features water quality monitoring data from 87 sites on 34 public lakes. A highlight of the 2008 data is the near-record amount of rainfall across much of the state. Lake levels at many of the state's larger reservoirs approached record flood stages. Mark Twain Lake was even closed for several days as the lake rose to its highest level since the dam was built.



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MISSOURI DEPARTMENT OF NATURAL RESOURCES

The Lakes of Missouri Volunteer Program

302 A.B.Natural Resources Building
University of Missouri
Columbia, MO 65211

Phone: 573-882-5430
800-895-2260
Fax: 573-884-5070

WWW.LMVP.ORG

Coordinators
Tony Thorpe - Tony@LMVP.ORG
Dan Obrecht - Dan@LMVP.ORG

The Lakes of Missouri Volunteer Program
302 ABNR - University of Missouri
Columbia, MO 65211-7240

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