The Lake CONNECTION

The land "behind" the lake: watersheds and lake water quality

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Where does your lake's water come from?

The next time you are enjoying the view of the water at one of Wisconsin's 15,000 lakes, take a moment to look at the land "behind" the lake. This is the land that "drains" water to the lake. It might seem hard to believe on a dry August day, but this land is likely the major source of water to your lake.

What about the rain that falls directly on the lake? While that provides some water, over the course of year, almost as much water will evaporate from a lake as falls in rain. In contrast, of the water that falls on the nearby land, approximately one-third or about 8- 14 inches of that water will likely make it to the lake, and only two-thirds will evaporate or be taken up by plants.

Eight to fourteen inches of water is a lot of water. Imagine just ten inches of water sitting on an acre of land—that is more than 270,000 gallons of water. If it is on a square mile of land—that would be more than 170 million gallons of water. The land area that "drains" water to your lake, often referred to as the "watershed" may be hundreds or thousands of acres and produce billions of gallons of water in just a single year. All of this water goes somewhere, and water runs downhill.

A watershed is the area of land where all surface water draining off the land (when snow melts or rain falls) drains into common waterways. All lands and waterways are within a watershed. Some rain and snowmelt soaks into the soil can become groundwater, which is also a source of water for many lakes. Photo: UW-Extension lakes

Water working its way through the watershed

In your lake's watershed, the lake is "downhill" from the land that drains water to it. For all water in Wisconsin, downhill ultimately means either the Great Lakes (Lake Michigan and Lake Superior) or the Mississippi River (and ultimately, the Gulf of Mexico).

All of Wisconsin is at a much higher elevation than these destinations. This water will travel hundreds of feet vertically and many miles horizontally as it works its way out of the state. For a portion

of this trip, it is the water in our lakes and streams. Depending on the path it takes, this trip can take a few days to many, many years. The type of trip that this water makes to your lake can tell us a lot about your lake's water quality.

Starting as rain falling on the ground or melting snow, water in your watershed can work its way through the soil. Moving downward, if it isn't taken up by plants, it will ultimately enter groundwater. Groundwater is the continuous water that fills all the spaces between grains of sand or cracks in rock below ground. Dig deep enough anywhere in Wisconsin and you'll run into this groundwater. This is a layer of water that is still well above the Great Lakes or the Mississippi River. The water within it continues to move downhill, now traveling more horizontally as it takes a long, slow pathway to the stream or lake. Because water has been moving through Wisconsin groundwater for thousands of years, water that enters groundwater is replacing groundwater that is continuously draining to streams and lakes. It's the same water we drink from our wells. This pathway is generally considered very good for lakes. It provides a continuous source of water that is filtered and contains dissolved minerals useful for plant and animal life.

Water can also take other paths downhill to the lake. Like most of us, water is likely to take the path of least resistance. We can create easy paths to the lake by designing drainage systems with culverts and storm drains. Similarly, when we remove vegetation and expose soil to the impact of raindrops, or compact soil with heavy equipment, we increase the likelihood that water will move across the ground surface. These changes to the land result in water taking a different downhill path to our lakes.

Fifty years from now, when someone else is enjoying the view of the lake, they will have you to thank for it

Water paths and water quality

The path that water takes is very important to water quality. Water that moves through the soil and into groundwater is filtered during its passage. This filtering removes nutrients such as phosphorus and allows them to be reused by plants on the land. In contrast, surface runoff pathways do not allow for this removal and can move water with higher concentrations of phosphorus to the lake. Because phosphorus is a critical nutrient for biological growth in lakes, if we increase the phosphorus concentration, we will increase the amount of algae in the lake. This leads to a greener color to the water and makes it more difficult for light to penetrate the water.

We see these differences in Wisconsin lakes. Those lakes in watersheds with conditions that lead to more surface runoff, such as urban areas or areas with more agricultural activity, generally have more algae. Other factors, such as the area of the land that drains water to the lake and the depth of the lake also influence the concentration in the lake. In all cases, if the phosphorus moving into the lake increases, the amount of algae produced will also increase. Researchers have developed some methods to estimate the impact of changes in lakes from changes in the movement of phosphorus

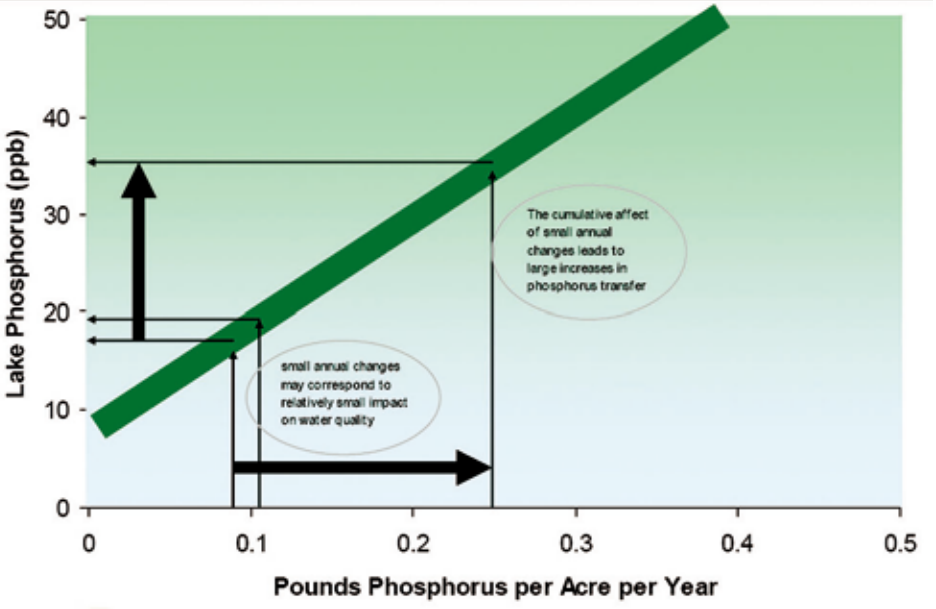

Figure 1. The relationship between average phosphorus transfer rate from the watershed to the lake and the lake phosphorus concentration. Continuing small changes in the average phosphorus transfer rate eventually lead to large changes in lake water quality.

from land to water.

One of our challenges is that the current phosphorus transfer rate for the land behind many of our lakes is relatively small. As shown in the figure, transfer rates of less than one tenth of a pound of phosphorus per acre per year, and even lower, may be necessary to maintain the water quality we desire. Those rates simply cannot have water moving in the rapid surface pathways, but instead require the water move into the ground (infiltrate) and take the slow path to our lakes and streams.

Watershed changes can mean lake changes

Figures like these allow us to better understand the implications of watershed change on phosphorus concentrations, and ultimately algae levels, in our lakes. It shows why for most watersheds, the change in water quality may be subtle from year to year, but dramatic over longer time frames. For example, consider the development of a largely forested watershed that leads to increases in phosphorus rates of two or three percent per year. As the figure shows, year to year changes will be relatively small, and likely difficult to see when combined with year to year variations in rainfall, but over fifty years, this could double or triple phosphorus transfer rates and lead to large increases in phosphorus concentration and the associated algae production.

Many of our lakes benefit from having large areas of land behind them that are producing high quality, low phosphorus water. Currently, these areas effectively dilute the impact of a few high phosphorus transferring areas. As these areas develop, if those areas do not retain many of the natural mechanisms that keep phosphorus transfer rates low, then the lakes will change. Evaluating land use change in terms of an average annual phosphorus transfer may allow us to better understand how land use changes may ultimately have profound impacts on our akes.

The figure shows how the average annual rate of phosphorus transfer to the lake from the watershed, shown as pounds of phosphorus per acre of land in the watershed, influences the concentration of phosphorus in the lake.

As you think about land use changes “behind” the lake, consider how they will change the movement of water. Anything we can do to increase the movement of water into the ground should help reduce the impact of these changes. Consider how you can move those thousands

Activity within the watershed can cause changes in lake water quality.

and thousands of gallons of water into the ground. For example, instead of shaping land continuously to the lake, make it more difficult for that water to run uninterrupted across the ground surface. Take a lesson from nature, and leave some variations in slope and vegetation between any land changes and the lake. Don’t direct water in channels but allow it to spread out and infiltrate in areas well above the lake. Direct the runoff from roofs and patios to vegetated areas where it can infiltrate, and foster land management practices that don’t compact soil and instead make it easy for water to move back into the ground.

Wisconsin Lakes Partnership

Citizens Science Education

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