Monitoring the Health of Your Watershed

A lake exists in a state of balance with its watershed because lake watersheds have a strong bearing on the physical, chemical and biological characteristics lake water, and on the plants and animals that live in and around the lake.

An example of a physical influence is the way in which the size of the watershed affects the amount of time that it takes for all of the water in a lake to be replaced or flushed by water that flows from the watershed to the lake basin (sometimes referred to as "flushing rate"). With the exception of what falls directly on the surface, all rain, sleet, and snow passes through the lake watershed before it flows into the lake. The larger the area of the watershed, relative to the volume of the lake basin, the faster the lake flushes.

The chemistry of lake water is strongly affected by weather and climate, and the influence of these forces over time on the slow wearing down and leaching of the watershed soils. This, in turn, influences a number of chemical characteristics of lake water, including the pH, the relative abundance of several major ions, and the ability of substances to dissolve in the water.

The availability of nutrients – primarily phosphorus – from watershed soils, and from the plants and animals that live in the watershed, has a strong bearing on lake biology, beginning with the simplest plants (algae), and working up the food web to insects, fish, frogs, turtles and virtually all creatures that rely on the lake for food and shelter.

These, and many more watershed influences, help define the characteristics of individual lakes. They determine natural "baseline" conditions for the lake ecosystem. The simple Secchi disk reading that we take to determine lake water clarity (transparency) actually indirectly measures physical, chemical and biological attributes of a lake, which in turn reflect conditions in the watershed. We collect total phosphorus samples because this nutrient is strongly linked to the growth of algae, an important indicator of overall lake water quality. But lake phosphorus levels also yields clues about conditions in the watershed. Monitoring the health of a lake provides information about the health of the watershed, and it can be reasonably assumed that a lake is more or less in balance, or equilibrium, with its watershed. This dynamic process between a lake and its watershed occurs continuously, although for the most part, measureable conditions in the lake don't change immediately when an alteration of conditions occurs in the watershed.

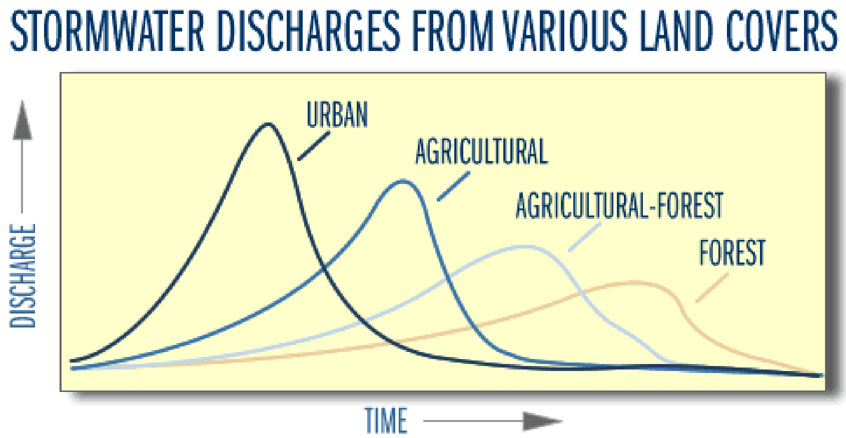
A number of common characteristics of watershed development may have a strong negative influence on lake ecosystems. These changes are common, in varying degrees, to nearly all forms of development, whether residential, commercial, agriculture or timber harvesting:

1. Natural vegetation is removed in order to create space for roads, buildings, parking, cropland, and other uses. As vegetation is cleared, nutrients, including phosphorus, that were held in place by plants and the soils, may be washed away toward the lake.

2. Impervious surfaces replace the vegetation that is removed. These include any material or structure that prevents rain and other forms of precipitation from filtering into the ground. Road surfaces, buildings, parking areas and other structures have this effect. Even lawns are relatively impervious, compared to similar woodland areas

Click on this animated slide to view the cumulative change in watershed land use from forested to residential, and the accompanying increase in impervious area

3. Stormwater runoff is a common effect of heavy rain events. However, for average storms, much of the precipitation filters into the soil and is taken up by plants, or it evaporates in small depressions on the surface. When development occurs the loss of watershed vegetation, combined with the creation of impervious surfaces, results in greater volumes of stormwater runoff flowing down through the watershed. The conventional approach to dealing with excess stormwater runoff from developed areas has been to catch and concentrate the water quickly, and move it away (downstream) via ditches and other conveyances. As a result, this large volume of water moves more rapidly, travelling faster than runoff from similar undeveloped areas in the watershed It is therefore more likely to run directly to the lake, carrying pollutants with it.



This graph shows how stormwater runoff discharge changes as land is converted from an undisturbed forest (lowest impervious area) to urban development (highest impervious area). Note that as more vegetation is removed and replace with buildings, roads and other hard surfaces, stormwater flow peaks more quickly with a higher volume, compared to a natural forested cover, where runoff peaks very slowly over a longer period of time.
(Graphic courtesy of "Water on the Web")

4. Runoff sweeps over the land surface like a broom, picking up and carrying a wide range of potential pollutants to the lake. These include numerous lake pollutants associated with lawns, including phosphorus and other nutrients in fertilizers, biological contaminants from human and animal waste, a wide range of toxic substances, such as pesticides and oil and gas residue, and even pharmaceutical substances that leach from septic systems. However, the most common component of stormwater runoff is fine (tiny) soil particles that are scoured from the ground surface by the fast-moving water. The particles are easily suspended in the water, and can travel long distances through the watershed to the lake via the runoff – and they are a major source of phosphorus. The fast-moving volume of stormwater runoff from developed areas is more likely to reach the lake – unless stormwater control practices to protect water quality are put in place.

4. Soil erosion is a universal development-related problem because large areas of the ground are exposed when vegetation is removed, and adequate measures for stabilizing soils are often not used or properly installed. Gravel roads, including public roads, camp roads and driveways are at the top of the list of potential sources of soil erosion. The scouring force of stormwater runoff creates even more soil erosion, which is the source for the fine sediment particles in the runoff,

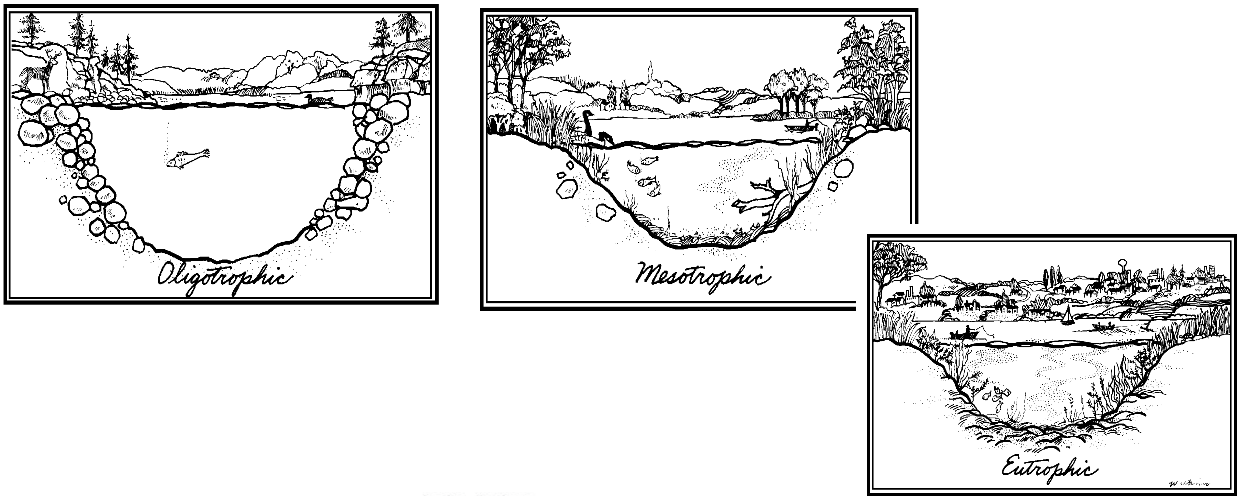
mentioned above. These particles nearly always carry high concentrations of phosphorus, some of which is biologically available to algae. If runoff from developed areas reaches a lake, the high concentrations of phosphorus associated with the particles can stimulate the growth of algae, and the accumulation of the particles on the lake bottom can cover and damage habitat for invertebrates, fish and other aquatic life.

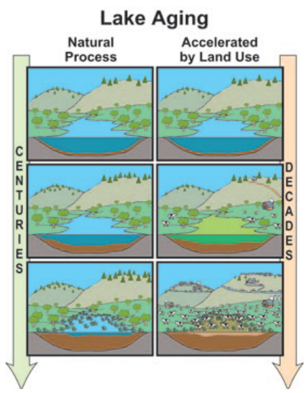
Top: Large areas of nutrient and sediment-rich soil are often exposed during the construction of residential and commercial lots. Unless protective measures are in place, eroded soil particles in stormwater runoff can carry the particles through the watershed to tributary streams and lakes

Left: Exposed soils in road ditches create a high potential for the erosion of sediment particles and nutrients to lakes

Right: This stream channel, which flows directly into a nearby lake, is filled with sediment and stone that has eroded from a nearby road ditch. Small chunks of asphalt can be seen mixed in with the stone

The effects of watershed development on lakes are cumulative and pervasive, and may not be observable or measureable in individual lakes for years. It is difficult to measure the impact of any single watershed development project in lake water, because the large volume of water in even relatively small ponds immediately dilutes the concentration of phosphorus and other pollutants in stormwater runoff. However, over time, the cumulative effect of development-related change in a watershed can become apparent in lake data through changes in water clarity, increases in phosphorus levels, lower dissolved oxygen concentrations during the summer, and in other ways. This process is known as cultural eutrophication.





Two options for cultural eutrophication graphic. The color graphic is better, but I'm uncertain of whether or not it is copyrighted. It came from an EPA website, but some material on the website was produced by contractors

Without the long-term lake data collected by volunteer lake monitors, it would not be possible to identify the often subtle changes in lake water quality associated with watershed development. Lake data can be a powerful tool to be used for lake and watershed protection. Data collected by volunteer monitors have been used very effectively at the local and state level to provide protection for individual lakes, and for lakes throughout Maine, as discussed in an accompanying article by the Maine DEP's Linda Bacon and Roy Bouchard (link??). But you don't have to wait until your Secchi disk readings show a negative long-term trend before taking action to monitor and assess the health of your lake watershed! In fact, waiting until there is evidence of a decline in lake water quality will make the road to recovery much longer, and more costly.

What can you do to monitor and protect the health of your lake watershed? Volunteer lake monitors in many watershed communities throughout Maine have played key roles in watershed stewardship projects, ranging from using their lake data to inform and educate their local lake associations, town planners, conservation commissions and students, to helping organize and conduct a watershed survey that identifies (and resolves) specific land use problems affecting lake water quality, to providing valuable information in the watershed planning process. And as is always the case, one of the most valuable ways in which volunteer lake monitors have helped their lake has been by providing an example of lake-friendly conservation practices on their own watershed property.

Volunteers participate in a watershed restoration/lake protection project by planting trees and shrubs and mulching areas of eroding soil

Future articles in this series will cover specific information about watershed monitoring and protection initiatives, volunteer success stories, and programs and resources to help you move forward with stewardship projects in your lake community.

Except for a meandering walking path to the water, this forested lake shoreline property has been left relatively undisturbed, proving a critical protective buffer to filter runoff between upland developed areas and the lake. The photo was taken from the deck of a shorefront property of a VLMP volunteer water quality monitor!