Understanding Your Watershed

WATER QUALITY
UTAH STATE UNIVERSITY EXTENSION
Water is Life: Quality Matters

Phosphorus

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What is phosphorus?

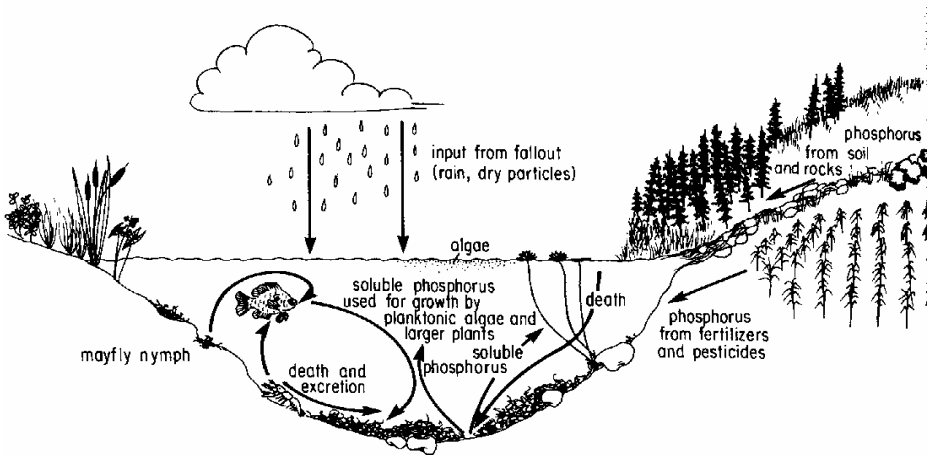
Phosphorus is an important plant nutrient that occurs in different forms throughout the environment. Excess phosphorus in aquatic systems can lead to over-fertilization in a lake or stream. This over fertilization can result in an overabundance of aquatic plants which in turn can deplete oxygen from the water through the decay process.

Phosphorus in aquatic systems is usually divided into solid and dissolved forms. These forms function differently in streams and lakes and also have different sources.

Total phosphorus includes all the phosphorus found in a water sample. Most of this phosphorus is bound in a solid form. Phosphorus in rock and other mineral forms is called "inorganic." "Organic" forms of phosphorus are incorporated into biological materials such as plants or animals, their dead remains and waste products. Native soils in Utah can be quite high in phosphorus and therefore sediment is often a major source of phosphorus.

The fraction of total phosphorus that can pass through a fine filter is called dissolved or soluble. Dissolved forms include organic and inorganic molecules. The form that is most readily taken up by aquatic plants is an inorganic molecule called orthophosphate (PO_4^{-3}).

The phosphorus cycle illustrates how natural and human activities move phosphorus throughout the environment. Note that unlike nitrogen (another important plant nutrient), phosphorus does not exist as a gas. Also, because it adsorbs so readily to sediments and combines readily with minerals, phosphorus from surface applications does not move through most soils into ground water as readily as does nitrogen.



Phosphorus changes forms under a number of different conditions. For example, orthophosphate readily combines with different minerals and metals in the soil and in water, such as calcium or aluminum. This creates a solid form that is no longer available for plant use. Therefore, phosphorus that plants can utilize may be very scarce in natural waters. Because of this, phosphorus is often the nutrient that limits plant growth in streams and lakes, even though there may be relatively high concentrations of total phosphorus in the water.

Why is phosphorus in water important?

Although phosphorus at concentrations found in natural waters is not toxic to humans or other animals, it may still have a significant impact on the living organisms in a lake or stream. This is because phosphorus is often the nutrient that limits how much plant growth occurs in a water body. Therefore, even a small amount of additional phosphorus, especially in its inorganic dissolved form, may lead to excess plant growth. Too many aquatic plants in a stream or lake can cause various problems:

- When aquatic plants die, the natural decaying process consumes oxygen that is dissolved in the water. An overabundance of dead plants may use up oxygen faster than it can be replenished (for example in a frozen lake with no contact to the atmosphere). When this occurs, oxygen concentrations may drop to dangerous levels for fish and other aquatic animals. As a result, fish kills are common in waters that are over-enriched with phosphorus and other nutrients.

- Large attached plants in shallow areas of lakes can entangle boaters and swimmers. In addition, huge mats of decaying plants create odor and aesthetic problems.

- Blooms of microscopic algae can make the water cloudy and unsightly.

- Certain types of microscopic algae can be toxic if they reach high concentrations. Animals, such as dogs or livestock, that drink from these toxic water bodies can become sick or even die.

How do natural conditions affect phosphorus concentrations?

Phosphorus concentrations in a stream or lake change during the year. During periods of rapid aquatic plant growth, concentrations of dissolved phosphorus may be too low to measure accurately by chemical tests. Total phosphorus concentrations may still be relatively high, however, because of the phosphorus found in plants and soil particles.

When flows are high, such as during spring runoff or after a big summer storm, total phosphorus concentrations can be quite high in the stream, due to higher concentrations of sediment that wash into the stream.

How can human activities change phosphorus concentrations in a stream?

Activities that cause erosion in the watershed may result in particulate phosphorus entering the stream. These include:

- logging or construction activities;
- overgrazing and trampling by livestock or wildlife in riparian areas;
- any changes in land uses near a stream, such as roads, urban construction, or agricultural activity that remove the plants along the edge of a stream or other water body. When this occurs, these plants can no longer filter out sediments in surface runoff, and the stream banks themselves may become unstable and erode into the stream.

Runoff from the land can also introduce dissolved forms of phosphorus into a stream. Sources include:

- fertilizers that run off lawns, golf courses and agricultural fields during snow melt, rainstorms or heavy irrigating;
- runoff from poorly operated animal feeding operations or improper application of manure on fields;
- poorly functioning septic tanks that release phosphorus into ground water.

Point sources such as waste water treatment plants may also introduce phosphorus into Utah's water bodies. Most of these treatment plants are not required by state agencies to remove phosphorus from their effluent and therefore may be significant sources.

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Reducing phosphorus concentrations in our waters requires actions by almost everyone in the watershed. Actions include reducing runoff and erosion from roads, construction sites and stream banks, lower rates of fertilizer use, proper maintenance of septic tanks and eliminating runoff of animal wastes into waterbodies. Treatment for phosphorus removal in municipal wastewater facilities may also be required in some areas of Utah in the future.

How is phosphorus in a stream measured?

Phosphorus cannot be measured by a field probe, but must be analyzed in a laboratory. Typically samples collected by the Division of Water Quality for watershed studies are analyzed from an unfiltered sample and from a sample filtered immediately after it is collected. These samples are then preserved with acid and analyzed in a laboratory. The results are reported as total phosphorus and dissolved total phosphorus.

Simple field tests for phosphorus are available for volunteer monitoring projects. These tests are interesting for demonstration purposes, but will not produce the level of quality control necessary for accurate watershed studies.

What do the results mean?

Phosphorus is not toxic and its negative impacts come from the series of events that begin with over-fertilizing a water body and end with low oxygen and fish kills. The State of Utah considers a total phosphorus concentration of 0.05 mg/liter (parts per million) in a stream or river to be an indicator of pollution problems. A concentration of 0.025 mg/liter in lakes is considered a potential problem. When monitoring indicates that phosphorus concentrations exceed the indicator concentration, additional studies are conducted to determine if the phosphorus has actually resulted in a loss of beneficial uses of the water body, such as recreational value or fish habitat.

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