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Phosphorus in aquatic systems

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Abstract
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INTEGRATED CROP MANAGEMENT

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Phosphorus in water systems

It is normal for P to exist in Iowa's aquatic systems. But the levels that now exist are some of the highest in the world. It is not normal or healthy, and contributes to a condition called eutrophication, the overfertilization of aquatic systems that generates unnaturally vigorous algal growth, also known as algal blooms.

Bloom and biological system reactions

Algal blooms are frequently the result of nutrient pollution resulting from human activities. In undisturbed conditions (before natural vegetation was cleared, ground was plowed, and large numbers of domestic animals were introduced) P losses from Iowa's soil were very slight. Field studies of undisturbed areas suggest that water in Iowa was probably oligotrophic (low in phosphorus) to mesotrophic (moderate in phosphorus). After bloom, aging blue green algal cells can exude dermatoxins, neurotoxins, cytotoxins, and hepatotoxins--all detrimental to wildlife and humans.

Now, the majority of Iowa's water bodies are eutrophic (high in phosphorus) to hypereutrophic (extremely high in phosphorus). When aquatic systems become eutrophic, their natural systems cease functioning efficiently and begin to break down.

Healthy aquatic systems are not only indicators of healthy landscapes but also are economically important. One of the negative impacts of eutrophication is the unpleasant smell of decomposing algae, impairing recreational use of water. Scientists have estimated, for example, that recreational use of Iowa lakes generates more than $20,000 per acre, per year. Few agricultural lands generate as much.

Impact of agriculture

Compounding contributions from agricultural use of P fertilizers are reductions in wetlands (both in size and number), decreasing the nutrient and water-holding capacity of Iowa's watersheds. Shaw and Fredine's (1956) (Wetlands of the United States. U.S. Department of the Interior, Fish and Wildlife Circular 39) data show the decrease in acreage of Iowa wetlands over time: year 1850, 1,196,000 acres; 1906, 930,000 acres; 1922, 368,000 acres; and 1956, 117,000 acres.

Furthermore, changes in drainage from the landscape have made the flow of aquatic systems erratic, with rich concentrations in nutrients present in spring flows (favoring blooms), and abnormally low summer flows, decreasing the rate at which nutrients are flushed from aquatic systems.

Municipalities also can contribute to the problem if they are not conscientious about storm drain management, street cleaning, and similar issues. Although inadequate sewage treatment was a problem, it has been largely corrected. But the number and size of agricultural operations in Iowa, use of fertilizer, and disturbance of soil surfaces means that P losses will be very high compared with normal urban impact.

Producers can keep P out of surface water by managing soil erosion and nutrient losses from runoff. Improving tillage strategies, such as conservation tillage or no-till, using best management practices such as soil testing, and limiting P applications to soils where testing indicates P deficiencies can help. Buffers, grassed waterways, terraces, repair of erosion control devices, contour tillage, and other means of erosion reduction limit P losses as well.

Pfisteria: Not a direct health risk in Iowa

There are also health concerns regarding eutrophic waters. Pfisteria--an alga that creates toxic exudates as it grows and dies--has not been found in Iowa waters, but many other toxic algae can grow when water bodies receive too much P. They include Cyanobacteria (formerly called blue green algae) that occur in Iowa waters and exude a variety of toxins. So far, there have not been any reports of human illness or death from cyanotoxins from waters in Iowa.

Phosphorus use dynamics in aquatic systems

There is a role for P in aquatic systems. It is an essential element for life. Every living thing uses phosphorus in the form of adenosine triphosphateor ATP.

Sediment transports P in loosely to tightly bound forms, and it is easy to cleave from particles through chemical or microbial action. Particulate P in sediment acts as a reservoir of P that can be brought into the water when water is warm and wind mixing is high.

In aquatic systems, balance is the key, and it is achieved when the rate of input of P is lower than the rate of permanent binding of P in inorganic sediments. In general, by decreasing P losses from fields and pastures, producers can help achieve balance by limiting P input rates so waters do not become hypereutrophic.

Other things to consider when trying to manage P levels include the management of dust--a serious issue, because a great deal of P moves by dust particles. Burning crops and other debris also liberates a large amount of P that returns to earth with precipitation. Restricting the access to streams of cattle and other livestock can limit P movement into aquatic systems.

Summary

Eutrophication is a sign of an unhealthy aquatic system. But it is easily prevented by controlling the amount of P that enters the water. Producers can reduce levels of P in water by using best management practices such as soil testing and limiting P applications when indicated, and by using conservation tillage to reduce erosion.

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