PHOSPHORUS NORTH TO SOUTH…

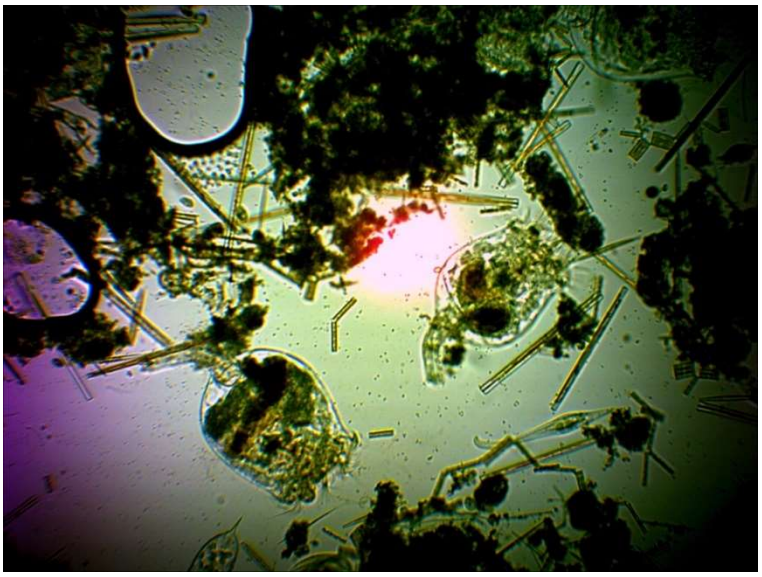
In this short piece Bruce provides an overview of how a waterway can be managed by tracking phosphorus and how it relates to both of nature's engines of life, sunlight and water chemistry. Here he answers the question… how to grow fish instead of algae. Follow the phosphorus, and whether you feed fish or rely on nature's food web, your waterway can be a gem!

Biology is a can of worms. Seriously!

With that as an opener, let me fill you in. It's like we are hunting, and there's a trail to follow. It leads us to our goal… fish. The trail goes up and around, and under, all kinds of obstacles. But by following it, you eventually can pattern your quarry. Once you have the pattern nailed, then it's a lot easier. A lot more understandable. You can grow fish, and healthy ones to boot!

Every step along the trail kind of glows in the dark… like it's phosphorescent. In fact, it's phosphorus that we are following. Phosphorus makes each step along this trail visible. It helps us see that every step is also a life form. Might be plant, might be microbe, might be animal. Interestingly, if your trail is a short one and gets to your goal without enough steps, without having moved through enough life forms, you can end up with big fish. They may even be obese. And, it's also likely that they aren't healthy to eat. In fact, it's particularly important for the trail to pass through some of the microbial and animal life forms. When this happens, an appropriate ratio of the Omega three form of fat, the healthy kind, happens in your fish.

Most microbes eat organic material, as do all animals. These guys are called heterotrophs. Most plants eat minerals, and they are called autotrophs. Phosphorus exists in, and is taken up by, both. If you follow phosphorus up the ladder of life, it frequently passes back and forth from heterotroph to autotroph, or it might cycle through several forms of heterotroph before coming back to an autotroph, as it moves up and eventually into your fish. For example, a heterotrophic microbe eats a dead plant. It grows some biofilm in the process. Biofilm is sticky and suspended solids in the water bond to it. This is called periphyton. All kinds of invertebrates eat periphyton. They actually live in it and are part of it. Some fish eat periphyton too… as part of their growth and life cycle, particularly forage fish and frequently the fry of game fish. Various forms of phytoplankton, both algae and diatoms, get stuck onto the periphyton, too. Some particulate minerals also get stuck onto this periphyton. So, between the invertebrates (organic) and the phytoplankton (also organic) this periphyton works like a full-course, meat and potatoes meal. It has those critical trace minerals needed in every diet. All this happens because of this sticky biofilm/periphyton. Fortunately, this process is kind of a self starter. You don't need to do much to make it happen.



Close-up of the "Jungle" that is Periphyton

This process doesn't need sunlight either. It doesn't even need dissolved oxygen, although when it has dissolved oxygen it's several times faster than without. Every bit of surface area in your pond is currently supporting this activity.

If your pond has lots of three-dimensional structure in it, congratulations! If it has circulation to go with that three-dimensional surface area, why, that's even better!

Plants are limited by sunlight and access to minerals. They are influenced by many other variables too, including temperature. Perennial plants, though, are a real home run, in that they contribute surface area without the same annual oxygen demand required by plants that die off every year.

Let's get back on the phosphorus trail. On one hand, if your phosphorus trail is really short, just a step or two, then more of your input, like fish food, can cycle into fish. The fish tend to miss out on the health attributes associated with a wild diet though. A long trail spells biodiversity and is associated with the vibrancy of a natural system. The bright colors, the health, including the fighting qualities of your fish, are intertwined with this wildness. The jury's still out about which system is best at producing world records. We all know that farm fish can be grown to an outrageous weight. Kobe fish, so to speak. But they don't qualify in most record books because everyone recognizes essentially, that these are farmed fish. Not quite the same as wild ones and much of their weight is taken up by an unhealthy ratio of Omega six fat, instead of the muscle and sinew that we want in our world-record fish.

Phosphorus is the road map to a healthy and super productive system. If you key on following the phosphorus, your system's bottlenecks will show up.

Here are a few examples:

Let's say you are in the Deep South and your water chemistry analysis has phosphorus at non-detect. When your pond manager adds gallons of phosphorus, it disappears in just a few days. He tells you it's being "adsorbed" by the clay on the bottom of the pond. He adds more and you finally get a nice green algae bloom. But then your manager warns you… "let's keep this water green, turbid, because if/when sunlight hits the bottom, there could be an explosion of aquatic vegetation." You want some aquatic plants, like 30% or so, but you don't want an impenetrable jungle of milfoil or hyacinth. When the jungle does happen, you about have to resort to chemical treatment. If not, the weeds mess with fish and fishing and eventually rob the water of dissolved oxygen. Note that this water is now hamstrung because as you keep the water turbid, sunlight (one of the two drivers of life) is being limited. Beyond that, turbid water isn't normally what we associate with real health. When the added phosphorus cycles into a green phytoplankton it can drive zooplankton productivity. In the south, there's plenty of filter feeders, like gizzard shad, that consume the zooplankton and in turn cycle into big fish. While this design is somewhat compromised because it limits sunlight, it can work since the fish are essentially being fed.

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In our second example, let's say we are up north. Like right here in Montana. There's no shortage of mineral-based phosphorus here. In fact, unless we cycle it into something better, we end up with massive algae blooms and/or a jungle of aquatic vegetation.

In this scenario we want the phosphorus to cycle into diatoms, another form of phytoplankton, but one that when bound to periphyton can grow fish. These diatoms emit a bit more oxygen than they consume on a steady-state basis. This is much better than the explosive oxygen demand connected with a filamentous algae die-off! So, we circulate the water through floating islands, where biofilm on the island's filter matrix ties up diatoms and everything else floating around in particulate form. The result is improved water clarity, so now sunlight isn't being shut out. Note that there are two primary starting blocks for life — sunlight (which triggers plant growth) and proper water chemistry (which triggers biofilm growth). This system has both. On the other hand, it's really easy for the pervasive phosphorus to cycle into a filamentous algae bloom, unless the waterway has enough of the critical surface area/circulation needed to cycle phosphorus into that diatom form of phytoplankton.

Here's a third scenario. We are in somebody's back yard, checking out their old fish pond. It's now nearly gone. It used to be 12 feet deep, now you could walk across it without getting your knees wet, except you can't walk across it because it's total muck. In fact, you can smell the ammonia and sulfur in the pitch-black ooze! No fish left now either. This pond has been receiving chemicals to kill algae for years. No one has harvested a fish out of this pond for decade and way back when they last did, they weren't sure it was safe to eat.

A Dead Pond Being Brought Back to Life

Hey folks, today scenario three is playing out in many of our lakes. It's the same scenario taking place in Chesapeake Bay, and the dead zone in the Gulf of Mexico. The reality is many of us are caught up in the chemical spiral. It's a downward spiral, but time, cash constraints and education too, are what lead to this being the norm.

Follow the phosphorus. If you track it, your system's bottlenecks will show up. Don't ignore either of the engines of life. Both sunlight and biofilm. Combine the two and hold on to your fishin' rod!

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