PENNSTATE

College of Agricultural Sciences • Cooperative Extension

School of Forest Resources

Pond Facts #6

Pond Ecology

Introduction

Pond ecology is best described as the interaction of the life in your pond with the environment that exists there. A shallow, nutrient-rich pond exposed to sunlight with little water flowing through it will be teeming with algae and aquatic plants. It may have very little animal life present because of low oxygen levels. In contrast, a newly created, deep, spring-fed pond may have little life of any kind in it because of low temperatures and lack of food supply.

All ponds age. A pond begins with mostly water, few nutrients, and little aquatic life. Over time, the pond accumulates nutrients through an enrichment process called eutrophication. The addition of nutrients stimulates the growth of aquatic life. These organisms live, grow, and die. Their remains decay in the pond and the nutrients it took to grow them are released back into the water of the pond to keep the cycle going. Eventually, though, there will be an accumulation of material that resists decay and the pond will fill up. It will become a bog and someday will resemble dry land. The process of return to dry land can happen in a decade or may take centuries. As a pond owner, your job is to slow the process down as much as possible. Some of the principles you can employ are described below.

Exclude Nutrients

Four basic elements are required to make aquatic organisms: carbon, oxygen, nitrogen, phosphorous. Of course, it takes more than these to make even the simplest organism, but these are the materials required in abundance. To prevent the rapid aging of a pond (eutrophication), aim to exclude the rapid introduction of these, especially nitrogen and phosphorous. Three practices are particularly helpful in slowing the aging process.

Animal access to ponds or streams that feed ponds should be restricted to limit inputs of nitrogen and phosphorous from their wastes.

Buffers

Maintaining vegetation in all areas through which water must flow to reach the pond is very beneficial to the pond. Such buffers both slow water down and filter it. Slow-moving water allows sediment to drop out of the water. A lot of phosphorous is attached to soil particles, so sedimentation is effective in keeping phosphorous out of the pond. Keeping sediment out of the pond also prevents the pond from being made shallow by filling it with sediment. This contributes directly to our primary objective—keeping the pond from returning to dry land.

A deeper pond will also be a cooler pond. A general principle of biology is that lower temperatures slow the growth of organisms. So again the buffer area contributes to conditions that help slow the aging process for the pond.

Sedimentation

Another method of keeping sediment out of ponds is to provide a shallow pool at the inlet of

the pond. Water passing through this pool on its way to the pond will have an opportunity to drop its sediment load in the pool. This pool should be of such dimensions that it can be easily cleaned with a backhoe from the shore of the pool. A sedimentation pool helps the pond in the same way that sediment removal by buffer strips does.

Limit Fertilization

When decreasing the use of fertilizer is possible on turf or crops grown in the watershed area of the pond, the pond benefits. One of the reasons for this is that plants are never 100 percent efficient in their use of fertilizer elements. So even applying fertilizers at appropriate rates results in some elements, particularly nitrogen, remaining unused and moving off site. Reductions in fertilizer rates will decrease the amounts getting off site.

Maintain Ecological Balance

Ponds are most satisfactory when a complete and balanced food web is in place. Starting at the top, this means that planktonic algae are present in sufficient quantity to feed some zooplankton. The zooplankton in turn provide food for the smallest fish and aquatic insects. These in turn become prey for larger fish, which finally may be taken by raccoons, bears, or anglers.

Another part of ecological balance involves the higher plant community. Too many plants are discouraging to the pond owner and are also detrimental to the food side of the ecology just described. From the pond owner's point of view, a pond full of vegetation presents a poor appearance and interferes with fishing, swimming, and boating. From the view point of aquatic life, there are problems too. Some aquatic plants are valuable in providing shade, hiding places for small fish, habitat for some aquatic insects and animals, as well as being a food source for some fish and animals. When the vegetation becomes excessive, not only does the angler's hook get entangled, the bait is hidden from that trophy bass. The vegetation that hides the bait also hides his prey, making the hunt unsuccessful. Such a pond decreases its capacity to produce fish.

Aquatic vegetation, like this elodea, provides habitat for fish but may grow abundantly when nutrients are out of balance.

Two other examples of excessive vegetation will serve to illustrate undesirable consequences than can occur. A pond completely covered with water lilies or lotus will so shade the pond that no other vegetation will grow under the water. Nor will there be enough light to grow planktonic algae. This will be a very unproductive pond for anything besides lilies. The other example is excessive growth of duck weed or watermeal. When the whole pond surface is covered with these plants, again the light is shut off and the pond will contain little life beneath the surface. These plants also virtually eliminate oxygenation of the water by maintaining a complete separation of the water surface from the atmosphere. As a result, such a pond becomes oxygen deficient to such an extent that any fish present are killed from lack of oxygen.

A seldom-discussed problem in the management of aquatic vegetation is the potential to eliminate too much vegetation or to eliminate beneficial plants along with the targeted weeds. This is something to remember when considering weed control in ponds. Some helpful tips are to treat the pond in parts over time, to use mechanical methods, or perhaps to use an appropriate number of grass carp to keep things "pruned up" instead of wiped out.

Maintain Water Flow

A discussion that occurs when a new pond is planned concerns the water supply for the pond.

A pond with a continuous supply of water is almost always going to be a more satisfactory pond than one with an intermittent water supply. Ponds lose significant water by evaporation during the summer. Ponds with sufficient inflow stay full while the water level in others declines, exposing an unattractive muddy beach around the perimeter of the pond. The nutrient conditions in a pond with a continuous overflow are likely to be better because excess nutrients will leave with the overflow water. In contrast, the pond having intermittent flows only has a chance to purge excess nutrients during storm events. Such ponds are prone to accumulate nutrients much more rapidly than their overflowing cousins. The accumulation of nutrients leads to excessive vegetative growth of all kinds as was noted above.

Ponds with little water flow, like this surface drainage pond, are more likely to accumulate nutrients and excessive aquatic plants.

Encourage Aeration

Oxygen in pond water is very beneficial to the overall health of the pond. The value to fish is obvious. Less obvious, but of great importance, is the ability of the pond to get rid of waste. The waste that occurs in the pond includes “deposits” from its animal life (fish and geese), waste material that enter with stormwater runoff, as well as from plant and animals that die in the pond. Aerobic bacteria work about 20 times faster than anaerobic bacteria in breaking this waste down and putting it into solution. Once in solution it can be flushed out or is available to grow new life.

Oxygenation of ponds is quite interesting and happens in two major ways. Plants and algae do photosynthesis during the day and wind adds oxygen at night. The oxygen plants produce is released into the pond water and remains high at high levels in the pond. That’s why conditions that prevent light from entering the pond have to be monitored or disaster can occur such as the complete cover by watermeal mentioned earlier. All the oxygen manufactured by the watermeal is released to the atmosphere rather than into the pond water. Any part of the pond that is too dark for photosynthesis to occur is also likely to be oxygen deficient unless the pond is being mixed from top to bottom. A Secchi disk can be lowered into the water to check for visibility. The depth of disappearance is noted. The surface water above this disappearance depth will be oxygenated by photosynthesis while water below that depth must be mixed to receive oxygen.

The other method of getting oxygen into pond water occurs by oxygen exchange with the atmosphere at the surface of the pond. The rougher the surface, the more rapid the exchange. Also, the more deficient the oxygen content of the water, the faster the exchange occurs. This process is important at night and is critical for the pond with a heavy load of plants and animals. At night the plants perform respiration instead of photosynthesis—the same as the animals. By dawn, the pond may be oxygen deficient if atmospheric aeration is impeded by lack of wind or especially by a covered surface.

Winter Pond Ecology

In the winter, water gets much colder and ice may cover the top of the pond for an extended period of time. How do these factors affect the animals living in the pond?

Fish, frogs, and turtles are amphibians with adaptive features to accommodate this less friendly environment. Their body temperature falls with the water temperature, decreasing their respiration rate and energy needs. Frogs and turtles burrow into the mud at the bottom of the pond and hibernate there. They are able to do this by breathing through their skin.

Since ice cuts off the entry of oxygen into the pond water through the surface, you may wonder how even the low level of oxygen

needed is supplied during this time. Enough light gets through the ice to cause some photosynthesis among aquatic plants. A completely snow-covered pond can cause "winter kill," the death of fish, frogs, and turtles. However, hand plowing lanes across a pond to clear the snow from about half the ice prevents that from happening.

A winter management consideration is to keep about 30 percent of the ice free of extended snow cover. Be sure that the ice is safe for the method of snow removal proposed. An alternative is to use a diffuser-type aerator to add oxygen and keep a small area free of ice.

Summary

Ponds have a life cycle. A long life is best achieved by limiting the inputs of nutrients to the pond. Capture sediment before it enters the pond, limit the use of fertilizers within the pond's watershed to the extent possible, limit animal access when possible, and prevent the addition of organic matter. Flushing nutrients from the pond is encouraged by a clean, year-round water supply. Mechanical removal of plant vegetation is also a method of eliminating significant nutrients from a pond. Finally, the values of aeration in both supporting aquatic life and promoting the decay of waste material were noted. Keeping the surface clear of plant cover and open to wind action are aids to better aeration.

More Information

More detailed information on all aspects of pond management can be found at your local Penn State Cooperative Extension office or on our Web site at http://water.cas.psu.edu/ponds.

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