PENNSTATE

College of Agricultural Sciences • Cooperative Extension

School of Forest Resources

Pond Facts #5

Water Quality Concerns for Ponds

A 1998 survey of 557 pond owners in Pennsylvania found that about 10 percent had experienced water quality problems in their ponds, ranging from muddy water to fish kills. Unfortunately, most pond owners have never tested their ponds, and water quality problems are usually only detected after they cause a problem. This fact sheet discusses some common water quality parameters that may cause problems in ponds and how to detect and treat them.

Water quality conditions in a pond are controlled by both natural processes and human influences. Natural factors such as the source of the pond water and the types of rock and soil in the pond watershed will influence some water quality characteristics. These factors are difficult to control but usually cause few problems. Instead, most serious water quality problems originate from land uses or other activities near or in the pond. The effects of these activities can often be minimized through proper management and early detection of problems through testing.

Pond Uses and Water Quality Concerns

Concerns about pond water quality are directly related to the use(s) of the pond. As with all pond management decisions, consider the primary uses of your pond to determine which water quality parameters are of greatest concern. For example, a pond used to supply drinking water for animals should be tested for different parameters than a pond used exclusively for fishing. Table 1 summarizes the important water quality parameters and pond uses that are described in this fact sheet.

Common Water Quality Parameters

Temperature

Temperature is most important for fish and other aquatic life in the pond. Ponds that are generously fed from underground springs will have colder water that can support cold-water fish such as trout. Temperature can vary greatly throughout the pond, with surface water affected more by air temperature than deeper water. Thus, the top of the pond will be slightly warmer in the summer and colder in the winter than deeper portions of the pond.

Little can be done to alter the temperature of pond water. Groundwater may be pumped into the pond to create cold-water ponds during the summer. In most cases, however, it is best to match the types of fish stocked in a pond with the existing temperature regime. Cold-water fish prefer maximum water temperatures below 70°F, while warm-water fish like bass and bluegill prefer summer temperatures in the 80s. Water temperature is also important when using aquatic herbicides to treat plant or algae growth. Aquatic herbicides are most effective when water temperatures are between 60 and 75°F. Consult the herbicide label for details.

Dissolved Oxygen

The amount of oxygen that is dissolved in the water is critical for fish and other pond life. The maximum amount of oxygen that can be dissolved is controlled by the water temperature. Warmer water can hold less dissolved oxygen than colder water. In general, most pond water can hold about 10 to 12 mg/L of oxygen. Dissolved oxygen is reduced by the biological decay of organic material such as decaying plants and animals or animal and human wastes. Dissolved oxygen levels below about 6 mg/L can

Table 1. Important water quality parameters and criteria for common pond uses in Pennsylvania. Missing values represent parameters that are not important for that use.

Parameter	Primary Pond Use				
	Animal Drinking	**Swimming**	**Fishing**	**Irrigation**	**Beauty**
Fecal coliform bacteria	Less than 10 colonies per 100 mL	Less than 200 colonies per 100 mL			
E. coli bacteria	0 colonies per 100 mL	Less than 150 colonies per 100 mL			
pH	5.5 to 8.5		6.0 to 9.0	6.5 to 8.4	
Copper	< 1 mg/L		< 1 mg/L		
Iron	< 0.3 mg/L			< 0.3 mg/L	
Manganese	< 0.05 mg/L			< 0.05 mg/L	
Nitrate-Nitrogen	< 23 mg/L				< 3 mg/L
Phosphorous					< 0.01 mg/L
Ammonia-Nitrogen			< 0.1 mg/L		
Blue-green algae	None				None
Pesticides	See pesticide label for information on harmful effects in water.				
Turbidity		Secchi disk > 3’	Secchi disk > 1’		Secchi disk > 5’
Parasites	None	None			None
Summer Maximum Water Temperature			Less than <70° F for trout and smallmouth bass		
Dissolved oxygen			Trout > 6 mg/L Bass > 5 mg/L		> 5 mg/L
Aquatic herbicides	See herbicide label for water use restrictions and concentrations for different pond uses.				

begin to have detrimental effects on pond life.

A lack of dissolved oxygen is the most common cause of fish kills in ponds. This occurs frequently when aquatic plants and algae die in the summer or when they are treated with aquatic herbicides. Fish kills due to low oxygen are most common during hot, dry spells when algae grow and then die quickly. The organisms that decompose the dead algae may use so much oxygen that what remains is insufficient for fish. In very deep ponds, the deepest portions of the pond may have very low dissolved oxygen concentrations due to poor aeration.

Problems with dissolved oxygen can usually be controlled by carefully using aquatic herbicides to prevent excessive plant and algae growth in the pond. Ponds that frequently have reduced dissolved oxygen concentrations could benefit

Figure 1. Low dissolved oxygen is the most common cause of fish kills in ponds.

from commercially available continuous aeration devices.

Muddy Water (Turbidity)

Muddy or turbid pond water is usually only an aesthetic problem. It is frequently caused by runoff from disturbed areas around the pond or from bottom-dwelling fish and muskrats. Muddy water is best solved by eliminating the source of the problem. This might include planting grass or other vegetation on exposed areas, putting a layer of rocks over exposed banks, or removing muskrats or bottom-dwelling fish. Persistent muddy water problems can be treated with additions of ground limestone, hydrated lime, gypsum, or alum. Ponds that are only turbid or colored during the summer are probably experiencing zooplankton blooms. Zooplankton are small animals that serve as a food source for fish and other aquatic life. Zooplankton can be distinguished from sediment in water by holding a clear glass of pond water up to a bright light. If most of the particles in the water move erratically, the pond is experiencing a zooplankton bloom. If the particles do not move, sediment is the cause of the water discoloration. Zooplankton blooms can be eliminated with copper sulfate, but in most cases the health of the pond is best served if they are left untreated.

Muddy water is very common in new ponds and usually disappears as vegetation grows around the pond. In established ponds, muddy water can almost always be traced to a preventable source.

Sediment or turbidity in pond water can be measured using a simple device called a Secchi disk. This black and white weight is lowered into the water until it is barely visible and the depth of water is recorded. Recommended Secchi disk values for various pond uses are given in Table 1 with larger values representing clearer water.

Coliform Bacteria

Coliform bacteria are a large group of many different bacteria, some of which can cause waterborne illnesses. Some coliform bacteria will occur in all ponds, but dangerously high levels may occur in ponds that receive animal wastes from barnyards or wildlife or human wastes from septic systems. Large numbers of waterfowl will increase bacterial contamination in small ponds. Coliform bacteria from human or animal wastes can be identified through separate water tests for fecal coliform bacteria or *E. coli* bacteria. A certified water-testing laboratory should do this test. These bacteria are generally only a concern if the water will be used for animal drinking water or for swimming. It is recommended that ponds used for swimming contain less than 200 fecal coliform bacteria per 100 mL of water and less than 150 *E. coli* bacteria per 100 mL of water. Pond waters used for livestock watering should contain less than 10 fecal coliform bacteria per 100 mL and no *E. coli* bacteria, especially for calves and other young livestock.

Nutrients

Many ponds suffer from excessive amounts of nitrogen and phosphorous from barnyards, crop fields, septic systems, lawns, golf courses, and waterfowl. Nitrogen is usually present in ponds as ammonia or nitrate, while phosphorous occurs as phosphate. Ammonia usually originates from animal or human wastes directly entering the pond. It is extremely toxic to fish and other aquatic life and any measurable amount of ammonia-nitrogen above 0.1 mg/L can be detrimental to the pond's health. Both nitrogen and phosphorous can be readily

used by aquatic plants and algae, which may lead to excessive growth. Long-term control of overabundant plants is best accomplished by reducing or redirecting nutrient sources to the pond. This may be done by reducing fertilizer use near the pond, maintaining, improving or relocating septic systems, directing nutrient-laden runoff away from the pond, or maintaining buffer strips around the pond. If you fail to address the underlying cause of plant growth, you must rely on continuous control of the plants using mechanical, biological, or chemical techniques. The death of large amounts of aquatic plants or algae, whether naturally or as a result of herbicide use, will consume dissolved oxygen from the water and may lead to fish kills.

Nitrate-nitrogen concentrations above 3 mg/L are indicative of pollution. Phosphate concentrations as low as 0.01 mg/L may be sufficient to increase plant and algae growth. Excessive amounts of nitrate can also be dangerous for drinking water. Dairy cows should not drink water with nitrate concentrations in excess of about 23 mg/L measured as nitrate-nitrogen.

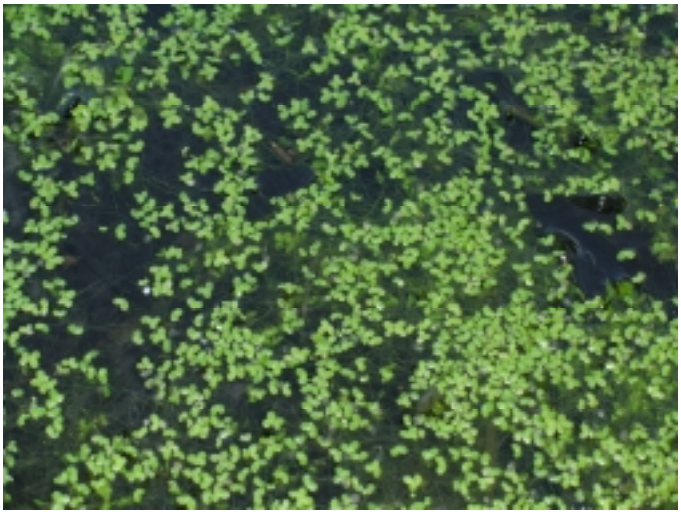

Figure 2. Excessive nutrients cause abundant plant growth (like duckweed in this picture) than can result in reduced dissolved oxygen in the pond.

Nitrate and phosphate can both be measured with simple water test kits or through certified commercial water testing laboratories.

Pesticides

Pesticides in ponds may result from their use on nearby land areas or from aquatic herbicides used to reduce plant and algae growth. When using aquatic herbicides, make sure you obtain the required state permit, and read and follow the herbicide label instructions carefully. In some cases, the pond water should not be used for swimming, irrigation, livestock watering, or fish consumption for a specified period of time. Many aquatic herbicides are also toxic to fish and should be used carefully in ponds with fish.

Pesticides applied to the land surrounding a pond may occasionally reach the pond, especially on windy days or when heavy rain occurs shortly after application. Excessive concentrations are usually short lived, but they may result in fish kills, waterfowl death, animal sickness, and plant injury if the pond water is used for irrigation. Insecticides are especially problematic and have occasionally caused fish kills in ponds. These problems are rare and short-lived but underscore the importance of careful use of pesticides in and around ponds.

pH

The pH of a pond is a measure of the acidity of the water. Farm ponds in valleys underlain by limestone will usually have a pH of 7.0 to 8.5. Higher elevation ponds or those located in the Poconos or northern Pennsylvania tend to have a lower pH, often less then 7.0. The pH of pond water is important for a number of pond uses. Different types of fish tolerate different pH levels but, in general, most fish will do better in ponds with a pH near 7.0. Ponds with a pH less than 6.0 may result in stunted or reduced fish populations. Ponds with a pH less than 5.5 or above 8.5 should not be used for dairy cows. Very low pH may be found in ponds in mining areas that are affected by acid mine drainage. In this case, the pH may be too low to support fish life, and the water also may be unusable for livestock watering. Low-pH ponds are often treated by applying limestone. This is most easily done by broadcasting one to two tons of pulverized limestone over the pond ice during

the winter. Repeated applications are often necessary to maintain a high pH in acidic ponds.

Hardness

Hardness is a measure of calcium and magnesium concentration in water and is controlled by the source of the pond water. Ponds in limestone areas will generally have harder water than those in areas underlain by sandstone or shale. The hardness of pond water is usually unimportant except when using some aquatic herbicides. Hardness concentrations above 50 mg/L can reduce the effectiveness of some copper-based herbicides. Consult the label of aquatic herbicides to see if water hardness needs to be considered.

Algae

Some types of blue-green algae are a water quality concern in ponds used for livestock watering. Although they are very rare in Pennsylvania, some of these algae can produce toxins that may sicken or quickly kill animals that drink the water. These toxins are produced during or following excessive growth or "blooms," which usually occur after extended periods of hot weather. Testing for toxic blue-green algae is difficult and not commonly available. Thus, farmers using a pond for livestock watering should prevent excessive algae growth or limit animal access to these ponds during and immediately after algae blooms. The common types of filamentous algae that produce long strands or mats are not harmful to animals.

Metals

Metals such as iron, manganese, and copper in ponds can produce offensive tastes that may affect animal intake. Iron and manganese are most common in ponds in coal mining areas in western Pennsylvania. While these metals are not harmful, they may cause offensive tastes that will cause animals to limit or refuse intake of the water. High iron concentrations may also adversely affect pond aesthetics by precipitating as an orange coating on the pond bottom, docks, and vegetation. Iron concentrations above 0.3 mg/L and manganese concentrations above 0.05 mg/L will impart a metallic taste to water and may cause problems with irrigation injury to plants. Similarly, copper concentrations above 1.0 mg/L can cause an offensive metallic taste. High copper concentrations may result from repeated use of copper-based algaecides in a pond.

Protozoan Parasites

Various protozoa or parasites can occasionally affect ponds. *Giardia* and *Cryptosporidium* are protozoa that can occur in any surface water and may cause severe gastrointestinal problems if ingested. Even if they are present, they are unlikely to cause a problem for animal consumption or for humans swimming in the water. Another rare parasite in ponds may cause "swimmer's itch." This parasite burrows into the skin of swimmers where it dies, causing an itchy feeling after leaving the water. While rare, this problem can occur occasionally in ponds especially those with low fish populations. The parasite requires snails in the pond to complete its life cycle. It can be controlled by reducing the snail population by treating the water with copper sulfate. Snail populations may also be reduced by stocking red-ear sunfish in the pond; however, they may compete with other fish in the pond.

Water Testing Options

Testing your pond's water quality is relatively simple and inexpensive. Identify the uses of your pond, then test the water for the parameters that are important for that use. Inexpensive water testing kits are available at many pet stores and also online. Two large manufacturers of water testing kits are:

LaMotte Company: http://www.lamotte.com/
Hach Company: http://www.hach.com/

Water testing can also be accomplished by dozens of certified commercial water testing laboratories in Pennsylvania. A list of these laboratories is available at your local Penn State Cooperative Extension Office or online at http://www.dep.state.pa.us/labs/.

Figure 3. Simple water test kits, available from many pet stores or online retailers, are adequate for most water quality pa-

Preventing Water Quality Problems

Water quality problems in ponds can usually be prevented with some proper management techniques. Here are some tips:

- Test the pond water periodically to determine bacteria levels and to monitor the presence of any other nonvisible problems.
- Match fish to the natural temperature regime of the pond.
- Prevent overabundant growth of aquatic plants and algae.
- Never treat more than half of the pond with aquatic herbicides.
- Carefully read and follow label directions when using aquatic herbicides.
- Strictly limit polluting activities near the pond or in areas that drain into the pond.
- Maintain a vegetated buffer strip around the pond. For gentle slopes around a pond, a buffer four to ten feet wide of unmowed grass will suffice. A wider buffer would be needed if the land slopes more steeply around the pond.
- Use ditches and grading to divert polluted surface water away from the pond.

More Information

More detailed information on pond water quality and other aspects of pond management can be found in *Management of Fish Ponds in Pennsylvania* available from your county Penn State Cooperative Extension office or online at: http://pubs.cas.psu.edu/FreePubs/uh137.html

For further information and publications on pond management visit our Web page at: http://www.sfr.cas.psu.edu/water/ or contact your local cooperative extension office.

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