OHIO STATE UNIVERSITY EXTENSION

Your Pond Update

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Winter 2018- Winter Fish Kills on Ponds Revisited

Brrr... As of January 2018, you may have noticed that Ohio has very recently been rather cold, and perhaps you've even noticed that ice has pretty rapidly covered many of our surface waters, even many rivers. This inspired me to rework and share this article, most of the following content originally posted in February 2014, but some borrowed from an article I just wrote for The Ohio Woodland Journal (in press).

Water As Habitat

Of course, a water molecule is a pair of hydrogen atoms attached to an oxygen atom. Water as a liquid substance is dense (about 775 x the density of air) and viscous (about 100 x as much as air), and aquatic organisms, including fishes, have adapted accordingly. Water also has high specific heat, meaning it takes a great deal of energy to change water's temperature. The temperature of water thus changes much more slowly than the air around, and aquatic organisms are buffered by their environment against sudden temperature changes.

Water's density has an additional quirk. Most things increase in density as they grow colder. Water does the same, but only to a point. That point is approx. 39°F (4°C); water molecules begin to arrange into a lattice below that temperature, and the angle between its hydrogen atoms begins to slightly spread to occupy more space. Liquid water thus decreases in density with further falling temperature to its freezing point. Ice forms in pure water at 32°F (0°C). Ice is very damaging to living tissue, lysing cells and usually killing entombed organisms. Because ice is less dense than cool water, ice floats, forming a protective layer on the surface of liquid water in winter and allowing life (including fish) to persist beneath (at least where there is sufficient depth or energy imparted by flow).

Dissolved Oxygen Under Ice

Many game fishes become stressed when dissolved oxygen (DO) concentration falls below 5 parts per million (ppm). Very few fish species can tolerate DO concentrations of 2 ppm or less for long. The vast majority of fish kills in Ohio ponds during any season will be the result of the loss of DO from the water. Oxygen crashes on ponds can have several causes, but they are most likely following a sudden summer storm or under prolonged ice cover during winter.

Dissolved oxygen enters aquatic systems by simple diffusion from the atmosphere and as a byproduct of photosynthesis (i.e., the process by which plants and algae use solar energy to synthesize sugars for their own energy). Most DO in the pond environment (perhaps as much as 70–90%) is likely to have originated in the activity of plants and algae under sunlight. Of course, respiration—by both animals and plants—consumes oxygen. Thus, photosynthesis decreases or ceases if sunlight is obscured and as the sun sets each evening; plants and algae then become net consumers of oxygen through respiration.

Given their valuable function in producing oxygen, there is a value in managing an appropriate coverage of aquatic plants. Depending upon your management goals for the pond and its fishery, up to 20% of the surface area is probably appropriate. The presence of planktonic algae is a little too unpredictable, and planktonic algae populations can crash seasonally, suddenly depriving a pond of oxygen production. ...And filamentous algae simply tend to be a nuisance within ponds. A reasonable coverage of submerged plants both provides ponds with a more consistent source of DO and helps to suppress nuisance blooms of blue-green algae (i.e., cyanobacteria), filamentous algae, and duckweeds through beneficial competition for nutrients.

Cold water is actually better capable of holding DO than warm water. Of course, metabolism and biological oxygen demand decrease in cold water, but do not completely end. Fish still need to breathe within a healthy concentration of DO

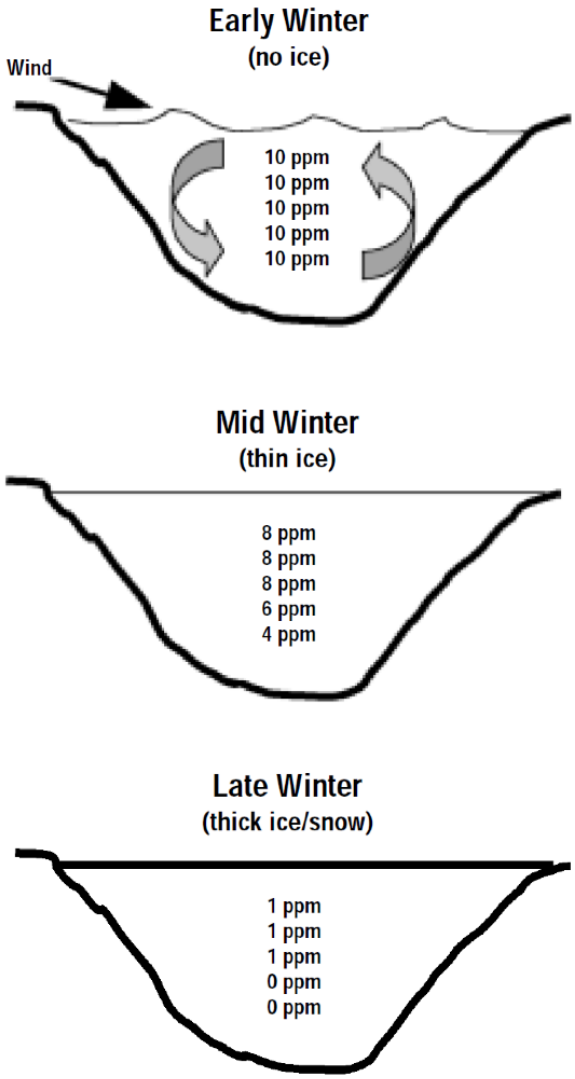

Figure 1. Oxygen depletion scenario during winter ice cover. Oxygen levels are expressed as parts per million (ppm) and show generalized levels and trends (Lynch and Norland 2001).

to survive. Of course, the greater the biomass of fish in your pond, the more DO they will need to sustain them all.

I usually describe winter fish kills as somewhat uncommon to Ohio. However, problems arise when a pond's surface is completely sealed by ice, ending the diffusion of DO from the atmosphere. If that ice is opaque or if snow is allowed to accumulate on its surface, it limits or cuts off the penetration of sunlight to the few plants and algae still present. The addition of DO to pond water through diffusion and photosynthesis ends; the consumption of oxygen, while slowed by cold, continues. If the situation is prolonged for long enough a time, the pond can deplete its DO supply and cause a substantial fish kill (Fig. 1).

Ponds with a greater volume of water potentially hold a greater reservoir of DO and tend to be less susceptible to winter kill. Austin et al. (1996) recommend that ponds be constructed with at least 25% of the area greater than 8 feet deep for most of Ohio and 10–12 feet in the north of the state. Treating large areas of vegetation or algae with herbicides or an excessive natural die off of aquatic plants in the seasons before increases the amount of decomposing organic matter, increasing biological demand for oxygen and making a pond more susceptible to winter kill. Maintaining an appropriate coverage of vegetation within a pond that has an appropriate expanse of deep water will have a natural resistance to winter kill; a shallow pond that is choked with excessive vegetation will be much more susceptible to winter kill. Old ponds with excessive accumulations of organic muck or substantial input of organic material via leaf litter are also at greater risk (Fig. 2). As your pond thaws with the approaching spring, watch for signs of winter kill. If you are unfortunate to experience one, know that you have some susceptibility and take actions to mitigate when bad winters are predicted in the future.

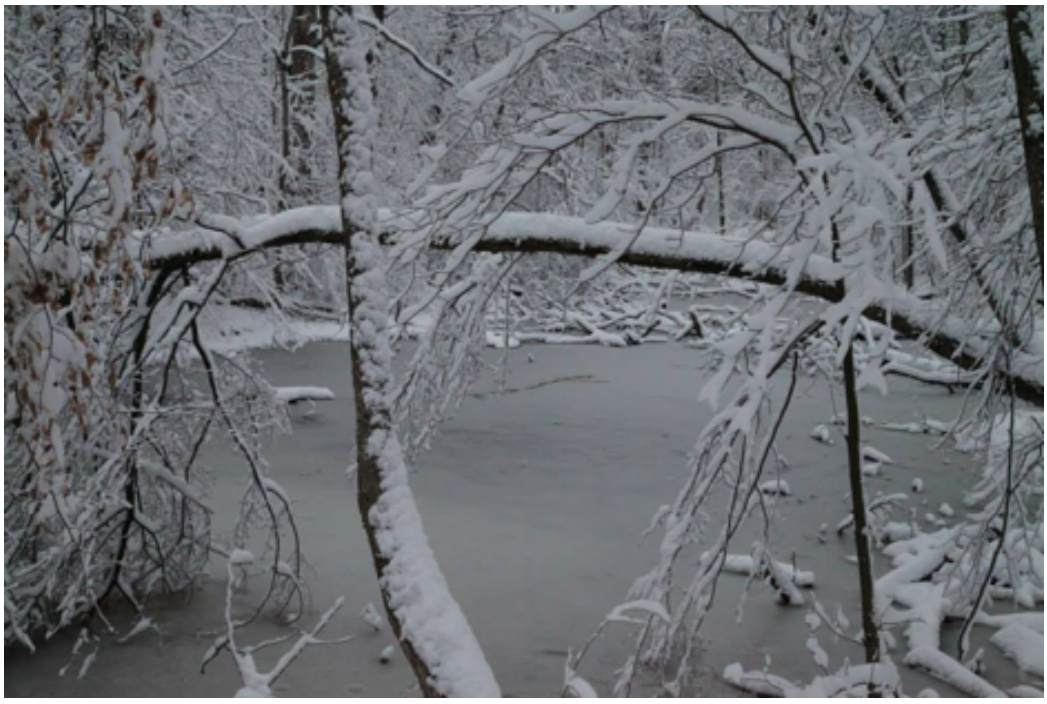

Figure 2. Ponds with a substantial input of leaf litter or old ponds with substantial accumulation of organic muck are at greater risk of winter fish kills (Donna Braig 2013).

Mitigation

...Via repurposed aeration: Aerating from spring, throughout the summer, and into autumn—in particular with a bottom-bubbler/diffuser or air lift—can help to sustain healthy DO levels throughout the warm season and improve resistance to winter kill. As winter approaches, suspending your air lift's air stone from a float approx. 2 feet below the water's surface or shifting your diffuser to a shallower area can help keep surface water moving to maintain or erode a hole in ice, allowing some surface agitation and diffusion of atmospheric oxygen.

If you ordinarily aerate with a diffuser from deep water, do not operate it from deep water for long periods of time under ice. As discussed, water is densest at 39°F. Thus, deep water (removed from the cold 32°F of surface ice) normally provides some warmer-water refuge for fish. Circulating the water column from deep water with a diffuser will force ordinarily warmer water from the deep, circulate that water mass under the cold of ice, and bring it back down to depth, potentially cooling the entire water column to near freezing and stressing fish. There is even the possibility to super-cool liquid water below freezing if that moving water interacts with colder air through a hole in the ice.

Some owners of larger ponds will install the majority of their diffusers spaced along deep water, but will deliberately place one at about half maximum depth or a little less. This allows them to shut the deeper installations off with a valve as winter approaches and allow the shallower to erode a hole in ice without disturbing deep-water fish refuge. Some pond owners will operate a single deep-water diffuser just long enough to clear a hole in ice and then shut it down, repeating occasionally as necessary. This latter method is less ideal, but occasionally necessary.

Be warned! Any bit of open water in the midst of an ice-rich winter has potential to attract waterfowl, especially Canada Geese. If an excessive number of geese intrude upon a relatively small pond, their waste excreted into open water can increase the biological demand for oxygen.

...Via shovel: If maintaining an area of open water with aeration is not an option, you can reduce the risk of fish kill by simply removing snow from the ice's surface, allowing the penetration of sunlight to stimulate some photosynthesis and oxygen production. Plan to keep 25–50% of the pond's ice free of snow (the Ohio Department of Natural resources recommends snow removal from at least 30% as a rule of thumb: Austin et al. 1996). Of course, the snow-shovel option is much easier for smaller ponds: e.g., it takes a tremendous amount of cold-weather resolve to clear snow from a full one of four acres of solid ice.

...But not both: Pick one management strategy or the other, not both. If you're deliberately eating holes in ice using diffusers to create erosive currents, you certainly don't want to go walking around out there with a shovel: i.e., eroded ice might not safely support the weight of a person. Don't test it!

...And stay warm out there, my aquafriends.

References

Austin, M., H. Devine, L. Goedde, M. Greenlee, T. Hall, L. Johnson, and P. Moser. 1996. Ohio pond management handbook: a guide to managing ponds for fishing and attracting wildlife. Ohio Department of Natural Resources, Division of Wildlife, Columbus, OH.

Lynch, W. E. Jr. and E. R. Norland. 2001. Winter and summer fish kills in ponds: extension fact sheet A-8-01. Ohio State University Extension, Columbus, OH.