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Natural History Notes

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WINTERKILL

During harsh winters like this past winter, we often read about massive fish die-offs in some of our lakes. The Department of Natural Resources will often remove the harvest regulations, allowing the dying fish to be taken from waters having severe winterkill problems. Winterkill or freeze-out can be complete, killing all the fish in the lake, or it can be partial, killing only a portion of the fish population. Some species are more vulnerable to winterkill than others. Fish like bullheads, golden shiners, or mudminnows often survive winterkill conditions. Winterkill occurs when the oxygen concentration in a lake or pond declines to levels where fish can no longer survive. During winter, healthy oxygen concentrations range from 5-10 parts per million (ppm). Fish kills usually occur when oxygen concentrations drop below 2 ppm. Let's take a closer look at the winterkill problem and its causes.

As winter approaches lakes cool to the point that ice forms on their surface. The lake becomes sealed over with ice which prevents the exchange of oxygen and other gases from the air. Additionally, any wind-caused water mixing stops. The lake is now a closed system. The waters contain a reservoir of oxygen from the open water period. Oxygen is also produced as a result of photosynthesis of green plants and algae. But, green plants need light to grow. On the other hand, oxygen is used up in the process of respiration, which is the burning up of energy by animals, non-green plants, and green plants that lack sufficient light to carry out photosynthesis or energy production. Respiration also occurs as dead plants and organic mucks decompose. With the lake sealed off from atmospheric oxygen by the ice layer, the oxygen supply is totally dependent upon the balance between photosynthesis and respiration.

If the first ice to form on a lake is clear and remains snow free, the lake water will become supersaturated with oxygen because more oxygen is produced by the plants than is used up in respiration and the ice seal prevents the excess from escaping. Five inches of clear ice allows about 85% of the light to pass through. But as the ice thickens and becomes cloudy, light penetration decreases. For example, only 11% of the light can penetrate 15" of ice with a cloudy top. Now add some snow on top of that and light penetration is decreased to near zero. Light penetration is most severely blocked by compacted snow, an ice covering made up of several layers of ice with slush in between, and crystalized translucent "snow ice" that usually occurs in late winter. As the winter season progresses, a lake's ability to produce oxygen via photosynthesis usually ceases.

Now let's look at the second part of the winterkill story: respiration and the rate at which oxygen is used up. The more weed, detritus, and mucky bottom in a lake, the more oxygen is used up. Small ponds and shallow bays become depleted of oxygen first. This occurs for two reasons: (1) most weed growth occurs in shallow water and the detritus amounts are highest; and (2) the volume of water to act as an oxygen reservoir is small. So a small pond will winterkill long before a deep lake.

Rivers flowing into lakes bring fresh oxygen rich water into a lake while the more stagnant oxygen depleted water flows out. By knowing the volume of a lake and the inflow and outflow the water exchange rate can be determined and the chances for winterkill predicted. A second source of new water into a lake in winter is from springs; however, spring water is most often low in oxygen because it has been underground for a long time. But large springs do cause mixing of water and thin ice or open spots.

Winterkill is a natural event in small or shallow lakes and fish populations usually bounce back in a few years because there is no competition from other fish. Large clean lakes do not winterkill because there is a large reservoir of oxygen available. But in many intermediate lakes winterkill is induced by input of nutrients from various activities such as lawn fertilizers, agricultural runoff or erosion of top soil. Inadequate septic systems are also a major culprit of lake enrichment. We can all do our part by keeping our lakes and streams clean and free of pollution.