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Dissolved Oxygen (DO) / Temperature Monitoring at Big & Little Sand Lakes by Doug Kingsley, Minnesota DNR

In 2007, Big and Little Sand Lake Associations agreed to jointly purchase a high quality meter and a probe with 100 feet of cable to measure dissolved oxygen (DO) and temperature from the surface to bottom of the lakes. In 2007, sampling didn't get started until the equipment arrived in mid-June. Since then, sampling has usually started in mid-May and DO and temperature have been measured about every two weeks through mid to late-October or November.

One of the reasons for measuring DO and temperature is to determine how much of the lake is suitable habitat for Cisco (tullibee), throughout the open water season and whether that may be changing over the years. Cisco is a cold water fish species that generally requires temperatures cooler than about 68^{o} Fahrenheit (F), and DO levels greater than 3 parts per million (ppm). Cisco are important because they are a primary source of food for the lake's predators, particularly walleye and northern pike. Since Cisco are not very tolerant of warm water or poor water quality, they can also serve as an early detection of degrading environmental conditions, the proverbial "canary in a coal mine".

There are two ways that Cisco habitat can get worse over the years. One is if air temperatures increase with climate change, and that causes increased water temperatures of the surface and upper layer of our lakes. That could negatively affect not only cold water fish species like Cisco, but also cool water species like walleye and northern pike. DNR Fisheries is already seeing some expansion of warm water species like Largemouth Bass that may be attributable to warming water temperatures. And, we have seen increasing water temperatures in annual monitoring of the Straight River south of Park Rapids that appears to be due to increasing air temperatures. Increasing air temperatures may seem like a larger problem that we can't do much about as individuals. However, we can make lifestyle changes that reduce our carbon footprint, and we can demand that elected officials make wise environmental decisions.

The other way that habitat of Cisco and other fish can be degraded is with increased oxygen consumption. That can result in lower DO levels both in winter and summer. Nutrients like phosphorus or nitrogen are always being added to our lakes and streams, stimulating growth of microscopic phytoplankton, algae and rooted plants. When those plants die they fall to the bottom of a lake and decompose. During the decomposition process bacteria break down the organic material and use oxygen. When a lake is stratified, in summer and winter, the decomposition and oxygen consumption reduces DO in the bottom layer of water. As the summer or winter progresses, the anoxic layer of water, with little or no DO, gradually increases, creeping upward.

If nutrient loading is increased, it increases plant growth, resulting in more organic material, more decomposition, more oxygen consumption, and lower DO in the lower layers of water. Increased nutrient loading generally comes from disturbed or poor land uses such as excessive use of fertilizers, little or no vegetative cover, increased impervious surfaces, storm sewers, failing septic systems, or shallow rooted vegetation like turf lawn. Increased nutrient loading can come from anywhere in the watershed of a lake or stream, but the closer you get to the water body, the greater the chance of those nutrients making it into the lake or stream.

In winter our lakes are usually covered with ice and snow, preventing the addition of oxygen directly from the air to water, and reducing or preventing sunlight from reaching aquatic

plants, reducing or stopping them from adding oxygen to the water during respiration, and even causing them to die. As oxygen is consumed, DO levels are depleted starting at the bottom and gradually extending upward toward the surface. If a lake is small, shallow, fertile (lots of nutrients), heavily vegetated, or has no tributaries to add oxygenated water, and if the lake is ice and snow covered for a longer duration, there is a greater chance that DO levels may decline so low that fish are unable to survive, resulting in a winter fish kill.

Something similar occurs in deeper lakes that stratify in summer. The upper layer of water gets oxygen added from wind, waves and growing plants, but that doesn't mix with the deeper layer of water. Again, as oxygen is consumed in the deeper layer of water DO levels are depleted starting at the bottom and gradually extending upward toward the surface. At the same time, water temperatures are increasing in the upper layer of water and warmer water is extending deeper over the course of the summer. As a result, the middle layer of water with both suitable temperatures less than 68^{o} F and DO levels greater than 3 ppm is shrinking through the summer. If air temperatures stay too warm for too long, the lake stays stratified, DO continues to decline in the lower layer of water, and the layer of suitable temperature and DO for cold water species like Cisco or Whitefish shrinks to the point that a summer fish kill of those species can occur. Warmer water and lower DO can also affect cool water species like Walleye or Northern Pike by decreasing growth or stressing them to the point that they may be more susceptible to diseases that are always present in the water.

Monitoring DO and temperatures can help anticipate an imminent summer kill of cold water fish. More importantly, monitoring over time can show changes in habitat suitability for cold and cool water fish that might be attributable to changing temperatures and/or water quality. Monitoring might not have to be done as often during the summer season, but it would be important to monitor "worst case" conditions, generally in August or early September. Monitoring could be done less frequently, perhaps every other year, but it would be important to continue sampling regularly to look for long term trends, either improving or declining.

If there are questions about this information, you can contact:
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