Causes of "Water Turnover" and Low Dissolved Oxygen Concentrations in Kentucky Ponds

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Introduction

Kentucky pond owners often have difficulty understanding the causes of "water turnover" in ponds and the reasons for the fish kills which may occur following these events. Fish kills are frequently caused by low dissolved oxygen concentrations in the water. The following article will attempt to explain the causes of these events and the relationship between them.

Water Turnover in Ponds

Most ponds in Kentucky mix or circulate their waters during the winter months. Generally, the pond surfaces only freeze for short durations, or do not freeze at all. However, little or no mixing of the pond's water volume may occur during the hottest months of summer. Large populations called "blooms"

During winter when water temperatures reach 32 degrees F, ice forms at the water's surface and not the pond bottom. Water reaches its maximum density at 39.4 degrees F. Colder or warmer waters will always be found closer to the pond's surface. Pond turnovers often occur during summer after cold, hard rains, windy weather or following the first cold weather of fall. When air and surface composed of microscopic algae decreases sunlight penetration into the pond to a depth of about 6 feet. [Suspended clay particles in the water may also decrease sunlight penetration.] This deeper water cools due to the absence of sunlight to warm it. Cooler water has a greater density than warmer water. A "layering effect" of water occurs throughout the pond when the cooler, more dense water remains near the pond bottom, and warmer water resides near the surface. During daylight hours, plants and algae release oxygen into the water while producing glucose, their sugar-like food. Little or no oxygen is produced in these cool layers of water, due to the absence of sunlight which prohibits plant and algae growth. Eventually, the dissolved oxygen is consumed from the cool waters by decomposing organic matter. This is caused by plants and animals that have died and sunk to the pond bottom.

water temperatures cool during the fall, surface waters will "sink" when they become more dense than the waters near the pond bottom. Warmer, less dense bottom waters are forced to the surface creating a mix or a "turnover." If large volumes of oxygen deficient bottom waters are present in the pond, the entire pond may be depleted of dissolved oxygen as the waters mix. Low concentrations of dissolved oxygen are

responsible for most fish kills.

Abrupt changes in weather conditions and air and water temperatures can rapidly affect the pond environment. Typically, ponds that are older, have greater depth, or are sheltered from prevailing winds, may be affected more severely from water turnovers. Shallow ponds, which have a maximum depth of 6 to 8 feet and are located in sites subject to prevailing winds, are less likely to have fish kills associated with water turnovers. Similarly, those ponds that contain less organic matter such as leaves, manure, and aquatic plants are less likely to experience fish kills as a result of water turnover. The type of vegetation in the watershed (wooded or pasture) will influence the amount of oxygen consuming organic matter which enters the pond. Human activities such as livestock pasturing, over-fertilizing lawns, and drainage from septic systems will encourage aquatic plant growth which will eventually die and consume dissolved oxygen.

Dissolved Oxygen and Fish Kills

Unless the pond has dense aquatic plant growth, microscopic algae "blooms" generally produce most of the dissolved oxygen in ponds and lakes. Algae and plants produce oxygen during daylight hours, but consume oxygen during the night.

Due to the dying algae bloom, the water color may change from green to black or gray with black streaks. Partial fish kills may occur selecting the pond's largest fish or a particular species which has a high oxygen requirement (ie trout). Other fish may be seen at the water's surface "piping" or gasping for air. Warmwater fish (bass, bluegill, catfish) require 5 mg/L of dissolved oxygen to maintain good health while coldwater fish (trout, salmon) typically require 7 mg/L. All fish can tolerate low concentrations of dissolved oxygen for short periods,

To a lesser extent, oxygen is also absorbed from the atmosphere at the water's surface. Wave action or other disturbances will increase the water's dissolved oxygen concentration by expanding its surface area for oxygen to enter. Healthy algae blooms and aquatic plant populations will produce enough dissolved oxygen to support life in a pond throughout a 24 hour period. However, dying populations may consume more dissolved oxygen at night then they produce during the day. When algae blooms or aquatic plants release less dissolved oxygen during cloudy days than they consume at night, low dissolved oxygen conditions may occur. The oxygen consumed by the constant decay of algae, vegetation and other organic matter will further deplete dissolved oxygen concentrations in the pond. Low dissolved oxygen conditions often occur during the night or just before dawn, particularly when water temperatures are warm. Warm water holds less oxygen than cold water. Increases in altitude and salinity will also lessen the ability of water to hold dissolved oxygen.

Sudden fish kills caused by dissolved oxygen depletions are among the most common. Extreme dissolved oxygen depletions may kill all fish, invertebrates and often microscopic algae populations. However severe, these conditions typically last only a few days.

however these conditions may result in disease causing stress. Prolonged exposure to dissolved oxygen of less than 3 mg/L will cause death to warmwater fish, while concentrations of less than 5 mg/L will kill coldwater fish.

Low oxygen conditions may occur in ponds with prolonged ice and snow cover. Snow covered ice will prevent sunlight penetration to the algae blooms and aquatic plants, and if prolonged, will eventually cause their death. Under these conditions, dissolved oxygen cannot be produced, but is consumed by the algae blooms and plants. The water beneath the ice has no access to air at the surface. Decaying algae blooms and plant material will further lower dissolved oxygen concentrations, and eventually a fish kill may occur. To prevent a fish kill, ponds may be partially cleared of snow by shoveling long strips across the pond to allow some sunlight to penetrate the ice. Clearing snow from frozen ponds should only be done when the ice is 4 inches thick or greater. Aeration devices may be used to prevent ice formation.

Proper aeration, water circulation and water quality management will reduce the severity of “water turnover” and prevent dissolved oxygen-related fish kills. Avoiding excessive depths (greater than 8 feet deep when possible) and shallow areas when constructing ponds can help reduce the severity of dissolved oxygen depletions. Constructing minimum pond depths of 3 feet will help prevent the growth of aquatic plants and filamentous algae.

For more information regarding pond management, contact your county extension agent, regional fisheries biologist or an aquaculture extension specialist.

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