Fall Turnover

"Lake turnover" is a term that is often used incorrectly to describe one period of the annual cycle of lake stratification (layering), which affects the water quality of Southeastern reservoirs. Throughout the year at Georgia's latitudes and elevations, reservoirs go through a fairly predictable annual cycle. I will address the annual cycle of Lake Lanier and its impact on water quality downstream in the Chattahoochee River. In general this pattern is similar through the Carolinas, Tennessee and most other reservoirs that do not freeze, or are not in tropical climates. Sunlight, air and water temperatures and the density of water at different temperatures drive this annual cycle.

During the cold winter months Lake Lanier's water is generally the same temperature from the top to the bottom. The lake's water is cold (around 45-50 degrees F) and clear. Water on the top and bottom of the reservoir has similar densities. Wind action on the surface water rolls the lake and surface water mixes with the bottom water. The exposure that all of the lake water has to the surface allows the lake to have plenty of oxygen from top to bottom. In winter, water temperature and oxygen concentration do not limit fish movement in the lake. Lake water, which is released from the bottom of the lake into the Chattahoochee River below the dam, is cold, oxygenated and clear.

During spring and early summer the lake begins to gain heat and stratify into three somewhat distinct layers: the surface layer called the epilimnion, a bottom layer called the hypolimnion, and a layer between the two called the metalimnion or, as anglers know it, the thermocline, which is how I will refer to it as well.

During the warm months, high air temperatures and more sunlight heat the lake surface faster than the lake can mix. The warm water, which is less dense, floats to the surface and becomes the epilimnion. This warm layer is fairly uniform in temperature and varies from 15 to 30 feet thick throughout the summer. It is full of oxygen from wind action and from oxygen production by microscopic algae, called phytoplankton, via photosynthesis.

The hypolimnion, the cold (45-55 degrees F) bottom layer, becomes isolated and no longer mixes with the warm, oxygenated epilimnion.

Oxygen is not produced in the hypolimnion, because this cold, deep layer does not receive sunlight and is devoid of phytoplankton production. Early in the lake stratification process the hypolimnion still contains some oxygen and fish movement is not restricted, but dissolved oxygen levels decline through summer as biological and chemical processes consume oxygen. That is, oxygen is used up in the decomposition of organic matter (nutrients). The amount of nutrients entering the lake from its watershed is called nutrient loading. Water released into the Chattahoochee River from the dam comes from this deep- water zone. Native river species could not adjust to the changed conditions created by Buford Dam, but the cold river water, once re-oxygenated by running over shoals, was a great new habitat for trout.

Between the epilimnion and hypolimnion layers is a layer of rapid temperature change (at least 2 degrees F per yard), called the thermocline. The thermocline, usually 20 to 30 feet thick, does not mix with the surface layer and has little sunlight reaching it. Therefore, oxygen production in the thermocline begins to decline after the lake stratifies.

By summer's end, the lake is strongly stratified. The epilimnion is warm; it receives sunlight and has plenty of oxygen. Water temperature and oxygen concentrations within the thermocline are both lower, but still often provide acceptable habitat for cool water fish species like stripers and walleye.

In the hypolimnion (deeper than 60 feet), the water is stagnant, cold, and low in oxygen (less than 3 parts per million or ppm). Fish cannot survive in this deepest layer when dissolved oxygen drops much below 3 ppm. As the oxygen concentrations get low, some metals and sulfides in the lake sediments become soluble. These dissolve in the water and are passed downstream as water leaves Lake Lanier and enters the river. This is first noticeable in late September or early October, when these metals and sulfides give the river water its distinctive fall colors and a rotten egg smell. Although these are stressors for the river fish, low oxygen concentrations and high metal and sulfide concentrations are very rarely associated with fish mortality in the river. The river water becomes re-aerated quickly as it flows downstream, and fish in the river avoid water with low dissolved oxygen by finding seeps, springs or feeder streams that have higher dissolved oxygen and lower metal and sulfide concentrations.

However, trout fishing in the river near the dam suffers in the fall, because of these water quality conditions.

Prior to the 1980s, oxygen concentrations (greater than 5 ppm) and temperatures in the thermocline of Lake Lanier, a young reservoir at that time, were adequate to allow trout to survive. Since then, organic matter entering the lake has increased, and the oxygen needs of trout can no longer be met. There just isn't enough oxygen to keep trout alive through this critical summer period. Today striped bass still find enough oxygen and adequate cool water habitat in the lake's thermocline to survive the summer; however, they can be stressed by low oxygen conditions (2-4 ppm).

In the fall, as air temperatures drop, the lake begins to lose heat, and the process of de-stratification begins. The warm water of the epilimnion cools and becomes deeper and denser. It still has lots of oxygen. As the epilimnion's density approaches the density of the hypolimnion, mixing of the layers can take place. When this happens the stratification is broken and the bottom water mixes with the surface water, and the lake is no longer stratified. This event is called "Lake Turnover, and generally occurs around Christmas each year. After the mixing there are no layers, and the entire lake will have high oxygen concentrations. Within a few days after lake turnover, the dissolved metals become insoluble and settle to the bottom. This leaves the lake water clear from the top to bottom, and the river water clears as well. Metals that have settled on the river bottom are eventually washed downstream by the daily generations.

With the warming of spring, the stratification process will repeat itself, and the plankton, fish, and other aquatic wildlife will react to these changes in their habitat.