Dissolved Oxygen and Temperature in Lake RoamingRock: Warm Weather Woes

By

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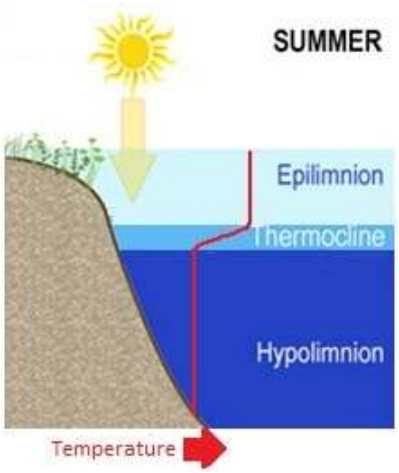
As part of an ongoing series on the biology and water quality of Lake Roaming Rock, this month's article focuses on an element critical to all life- oxygen. Unlike our atmosphere where oxygen levels remain constant, oxygen levels in the water of a lake (called dissolved oxygen or DO) varies greatly from season to season, with temperature and even depth. Because healthy DO levels are so important to the lake's aquatic life, it's worth examining some of the factors that influence DO in Lake RoamingRock.



As we all know, lake surface temperatures change year round and peak during the dog days of late summer. What's going on below the surface, though? Seasonal temperature fluctuations create predictable changes in lake temperature, with warmer weather causing stratified layers of water in the lake. The amount of sunlight entering a lake coupled with wind for mixing surface layers influences the creation of these pronounced layers, with the warmest, upper-most layer called the **epilimnion** and the bottom, coldest layer called the **hypolimnion**. Separating these two is the metalimnion, or **thermocline**. The thermocline is a relatively narrow band where the temperature changes rapidly the deeper you go in the water column. Past sampling that we've done in Lake RoamingRock indicates that during August, this thermocline occurs at a depth somewhere around 15 feet. All three layers play a role in physical and chemical cycling in the lake, with the thermocline acting as a barrier between the warmer oxygenated water above and the cold, low oxygen water near the bottom.

Vegetation and algae in the shallow depths of the lake is at its highest in the summer, giving off oxygen during photosynthesis. The warmer water near the surface is less dense than the cooler water near the bottom, so very little mixing takes place and dissolved oxygen (DO) created in the top layer stays put. In most cases, the distinct thermal layers form by mid-summer and will stay that way until late fall when the surface water begins to cool with the onset of winter. At that time, the thermocline breaks down and a rapid mixing of the layers, or turnover, occurs. In some lakes, turnover can also occur in the spring when surface ice melts and water temperatures at the surface rise rapidly.

While stratified, water near the bottom of the lake has only a finite supply of DO. Bacteria in the bottom layer (the hypolimnion) rapidly use up most available oxygen to break down plant material and other detritus sinking down from above. Nutrient-rich lakes (referred to as **eutrophic**) like RoamingRock can

lose their dissolved oxygen near the bottom in a matter of a few weeks once the lake begins to stratify in summer. The table below shows some of the DO and temperature information EnviroScience collected in Roaming Rock during 2005.

Depth	05/17/05 Temp. (F)	05/17/05 D.O. (mg/L)	08/27/05 Temp. (F)	08/27/05 D.O. (mg/L)
3.2 ft.	60.3	10.0	79.5	7.3
15.1 ft.	60.1	10.0	75.0	2.1
30.9 ft.	49.2	6.4	51.3	0.6

So how does this affect fish in Lake RoamingRock? If DO levels become too low, fish populations can be adversely affected. Some species (like trout) thrive in colder water with high oxygen levels. In general, levels above 5 mg/L are considered healthy for a freshwater lake environment, while 3 to 5 mg/L can induce high amounts of unhealthy stress on underwater organisms. Readings at or below 2 mg/L result in hypoxia, in which the DO concentration in a system is below the threshold needed to sustain animal life. The most extreme case - referred to as anoxia- is where a body of water is completely devoid of oxygen. In hypoxic and anoxic scenarios, fish kills can result when the demand for oxygen exceeds the supply.

As the table indicates, past water quality sampling in Lake RoamingRock shows that during the peak of summer, DO levels in the upper layers of the water column remain consistently high (well above 5 mg/L) and in a range that is healthy for fish. During mid-summer and a depth of about 15 feet, things begin to change quickly. The water temperature drops suddenly and DO readings here are much lower than at the surface. In the deepest parts of the lake, mid-summer water temperature will drop into the low 50-degree range and DO will approach zero. Because these deep waters have to little DO to sustain life, fish will migrate to warmer, oxygen rich waters near the surface until the lake turns over again in the fall.

Summer stratification and anoxic conditions at the bottom of Lake RoamingRock also contributes to another set of problems: excessive algae and plant growth. Under anoxic conditions, phosphorus stored in the sediment is drawn out into the water column. When this phosphorus eventually gets into the warmer surface water, it does the same thing that fertilizer does on your lawn- it 'greens' it up. Excessive plant growth and periodic algae blooms have been a problem in Roaming Rock for years, and the phosphorus that is drawn out of the sediments due to low DO conditions is a major contributor to this problem.

I'll wait until a future article to discuss possible solutions, but the problem of high phosphorous and anoxic water caused by summer stratification is one that the Lake Management Committee has been actively working on. Unfortunately, there's no simple solution to this complex problem.