Watershed Insights Report No. 6

Nutrient-Algae-Oxygen Interactions in Lake Greenwood

Lake Greenwood, located approximately 65 miles downstream from the Saluda River headwaters in the SC Blue Ridge Mountains, is the cornerstone of the Greenwood community. In addition to its vital role as the primary water source for the area, Lake Greenwood provides numerous recreational opportunities for visitors and residents alike. Although this lake has a productive fishery and supports a robust recreation-based economy in the area, nutrient inputs from its upper tributaries (Saluda and Reedy Rivers) may alter water quality and biotic habitat in the lake. Excessive loading of nutrients like nitrogen and phosphorus often stimulates growth of algae, which can lead to widespread oxygen depletion in the lake, especially during the summer and fall.

This report summarizes the results from a year of intensive water quality sampling that focused on key interactions among nutrients, algae, and oxygen depletion in the lake. Throughout 2004, water was collected at 12 sampling sites along the length of the lake and analyzed for temperature, dissolved oxygen, phosphorus and algal growth. Phosphorus concentrations in Lake Greenwood's upper tributaries (Saluda and Reedy Rivers) were typically above the South Carolina Department of Health & Environmental Control (SCDHEC) standard (0.06 mg/L) for surface water. These enriched conditions are consistent with the recent inclusion of the Reedy Arm of Lake Greenwood on SCDHEC's listing of nutrient-impaired waters. These high phosphorus concentrations were primarily seen in the shallow depth zone of the upper half of the lake; however, high concentrations also accumulated in the deeper waters further down the lake. This pattern was likely due to the settling of particulate matter, such as algae, to the bottom waters as well as release of phosphorus from bottom sediments.

Patterns of algal growth varied considerably with seasonal changes in light levels and water temperature, as well as with nutrient concentrations and turbidity (the degree of cloudiness of the water). The accumulation of algal biomass peaked during late fall, perhaps due to storm-related peaks in nutrient loading during late summer.

Excessive algal growth can lead to high rates of oxygen depletion in some lakes. Levels of dissolved oxygen (DO) in the bottom waters of Lake Greenwood declined rapidly over the course of the season, from well-oxygenated conditions in March (8-10 mg/L) to low-oxygen conditions (less than 2 mg/L) by mid-May. This rate of oxygen decline (greater than 4 mg/L/month) resulted in oxygen-depletion in the deeper zones of the lake (less than 0.2 mg/L) from May through October. Figure 1 illustrates the impact that a decline in DO and a seasonal increase in water temperatures can have on aquatic habitats. The left-hand red lines indicate 4 mg/L of dissolved oxygen, which is a desirable oxygen concentration for many fish species. The right-hand red lines indicate 25° C (about 77° F), which is the upper temperature preferred by some important predatory species, such as striped bass. Maintenance of high-quality fish habitat requires DO above 4 mg/l and temperature below 25° C.

As spring progressed, the zone of oxygen-depleted water increased steadily within the water column as did the zone of

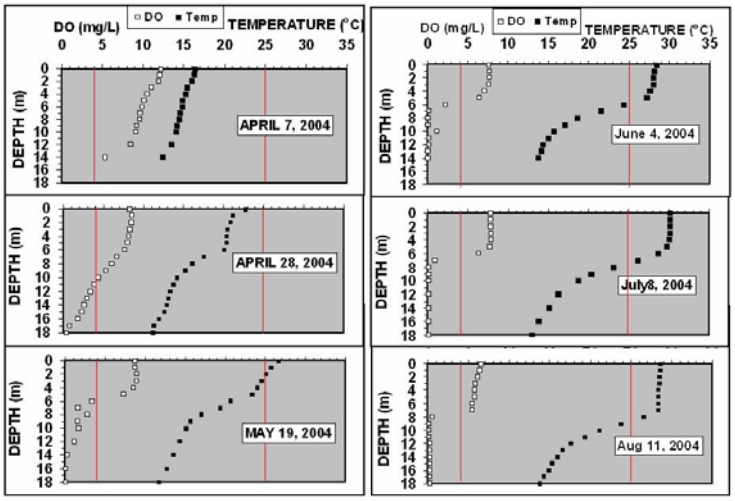

Fig 1. DO & Temperature Profiles, Lower Lake Greenwood

over-heated water. By early summer, the two zones overlapped, leaving very little water volume that was sufficiently cool *and* sufficiently oxygen-rich for high-quality fish habitat. The spatial extent, intensity and duration of this 'habitat squeeze" is a function, in part, of the interactions between water flow and nutrient loading from the watershed.

In collaboration with other researchers in the Saluda-Reedy Watershed Consortium and SCDHEC's environmental managers, these findings will be used to develop a computer model of water quality and habitat dynamics in Lake Greenwood. The model will help predict implications of

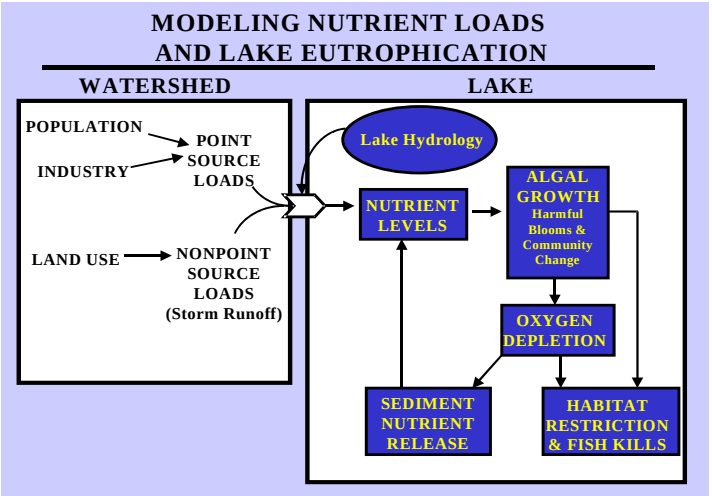

Fig 2. Nutrient Loads and Lake Eutrophication

alternate management scenarios and will help formulate long-term plans for water quality enhancement and aquatic habitat protection in the lake.

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The SRWC is a broad-based group of universities, public agencies, private consultants, and non-profit organizations focused on assuring "Clean, Healthy and Abundant Water for a Sustainable Economy and Environment Throughout the Saluda-Reedy Watershed." Visit www.saludareedy.org.