WATER QUALITY DYNAMICS IN LAKE LANIER

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Abstract. We present a summary of water quality changes in Lake Lanier using data from 1966, 1973, 1991, and 1997. The data are used to characterize water quality variability a) at various locations within the lake, b) with depth below the surface, c) by season of the year, and d) over the thirty years of record. We focus on the physical, chemical and biological parameters related to nutrient cycling in Southeastern reservoirs, including temperature, dissolved oxygen, pH, Secchi depth, TSS, and turbidity, specific conductance and alkalinity, chlorophyll *a* and biomass, and nutrients. Changes with depth dominate changes along the lake for most parameters, and short-term seasonal changes dominate long-term changes at most sites.

INTRODUCTION

Lake Lanier is the most important impoundment in the Atlanta metropolitan area. The reservoir is used for water supply, hydro-electric power generation, flood protection and recreation. Lake Lanier is unique in its position as a large, headwater reservoir within the Piedmont physiographic region of the Southeast. Central to the management of Lake Lanier is the need for a robust understanding of lake and watershed water and wastewater quality. The primary purpose of our study is to develop a management model that correctly incorporates the unique physical, chemical, and biological processes within Southeastern reservoirs.

We focus on developing and using geochemical models to better understand the constitutive relationships that govern water quality mechanisms. Previous efforts to examine these fundamental relationships in Southeastern lakes are minimal. Our intent is to couple basic scientific principles with known behavior to better specify the mechanics of Southeastern lake water quality in general and Lake Lanier water quality in particular. Figure 1 summarizes our water quality model.

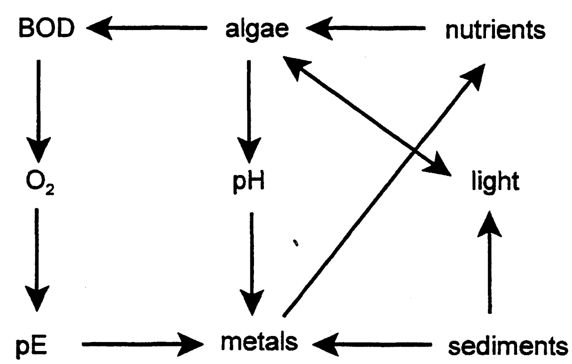


Figure 1. Simplified conceptual water quality model.

DATA SOURCES

We are utilizing four sources of historical data for Lake Lanier:

- Holder for monthly data in 1966-67;
- EPA's National Eutrophication Survey (1973);
- EPA's Clean Lake Study for monthly samples in 1991;
- Upper Chattahoochee River Basin Group's Study for weekly and biweekly data in 1996-97.

Table 1 summarizes the stations locations by study. Figure 2 presents lake sampling stations in 1966, 1973, and 1991. Seventeen stations in the 1997 study are not shown.

Table 1. Lake Station Locations in 1966, 1973, 1991.

	Station							
Year	1	2	3	4	5	6	7	8
1966	1-1	1-3	1-7	1-4	1-5	1-6		-
1973	2-1	2-2	2-3	2-4	2-5	2-6	2-7	2-8
1991	3-1	3-2	3-3	3-4	3-5	3-6	3-7	3-8

WATER QUALITY CHARACTERISTICS

Figures 3 and 4 summarize the horizontal, vertical, seasonal, and long-term water quality changes in Lake Lanier for the following parameters:

Temperature

Lake Lanier displays only minor temperature variations in the horizontal direction when compared to the larger temperature changes with depth. Thermal stratification results in a thermocline that varies from nonexistent during the winter months to a thickness of six meters in June and eight meters in September. In general, only small changes in temperature are observed below the thermocline. Surface water temperatures in shallower parts of the lake change faster than deeper parts of the lake. Lake temperatures do not appear to display long-term (i.e., 1966-1997) changes.

Dissolved Oxygen

Like temperature, we observe only small horizontal variations in dissolved oxygen as compared to the larger changes of dissolved oxygen with depth. The greatest dissolved oxygen changes occur from the chemocline (i.e., the bottom of the photic zone) to the bottom of the lake, with only small changes above the chemocline. The chemocline location generally coincides with the thermocline position, except in some embayments where the chemocline lies closer to the surface.

Only minor changes in dissolved oxygen profiles are observed over the thirty year period, except at Stations 6 and 7, where the concentration of dissolved oxygen in 1991 is higher than before. Both Stations 6 and 7 are located near the inflow of the Chattahoochee River, indicating that either a) the dissolved oxygen concentration, b) the total nutrient load, or c) the total biochemical oxygen demand maybe have improved in the Chattahoochee upstream of Lake Lanier over time.

pH

Like dissolved oxygen and temperature, vertical changes in pH dominate horizontal variations. The greatest change occurs across the chemocline, with additional large short-term changes within the photic zone. We hypothesize that elevated pH readings within the photic zone are attributable to photosynthesis, while lowered pH readings below the chemocline are due to respiration and decay.

Secchi Depth, TSS and Turbidity

TSS and turbidity are elevated and Secchi depths are reduced within upper portions of the lake, decreasing toward the dam. There appears to be an improvement in Secchi depth over time (1991 vs. 1973), except in June when only the lower part of the lake shows improvement.

Chlorophyll a and Biomass

Like turbidity, the spatial distribution of Chlorophyll *a* and biomass is highest near influent tributaries, and decreases toward the dam. While no substantial changes are apparent over thirty years, we find a seasonal change within the upper part of the lake. When comparing 1991 to 1973, we find that Chlorophyll *a* is lower in June, but slightly higher in September.

Alkalinity and Specific Conductance

Alkalinity appears to be higher in 1973 than during both the 1966 and 1991 observations. Differences between 1991 and 1966 are minor. The conductivity in June 1991 is much lower thàn in June 1973, but with little difference between September 1991 and September 1973.

Nutrients

In June, the concentration of NH_3-N is much lower in 1991 than 1973, but the concentration of NO_2^-+$NO_3^-$is much higher in 1991 than 1973. In September, the concentration of NH_3-N and NO_2^-+NO_3^- are higher in 1991 than 1973 respectively. The concentration of total phosphorus appears to be much higher in 1991 than 1973, which may be due to increased nonpoint phosphorous source loadings.

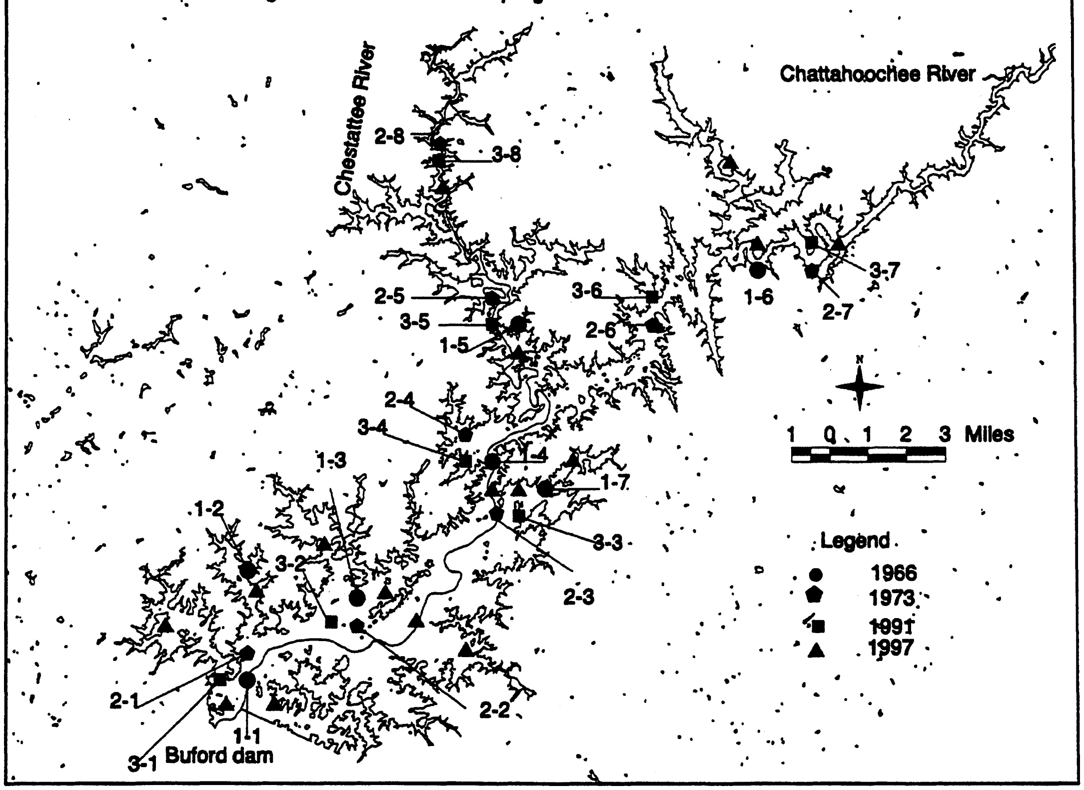
CONCLUSIONS

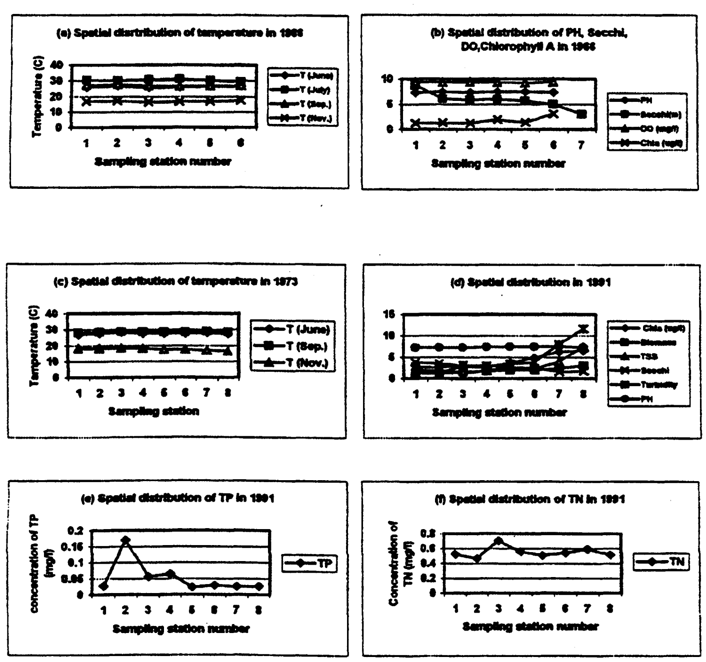
Lake Lanier water temperature, pH, and dissolved oxygen concentration distributions are basically uniform horizontally, but highly variable in the vertical direction. No clear long-term changes are apparent.

TSS, turbidity, and secchi depth have obvious spatial distributions, with higher TSS and turbidity near tributaries and lower values downstream. Secchi disk transparency has the reverse distribution. No clear long-term changes are apparent, other than small changes in the seasonal distribution.

The concentration of Chlorophyll *a* and biomass have variable spatial distributions-higher in the upper portions of the lake and lower in the lower lake. This distribution has not changed markedly during the thirty years of study.

Figure 2 Locations of sampling stations in Lake Lanier





Note: Photic zone water quality in 1991.

Figure 3 Spatial (at surface) and vertical ditribution of water quality

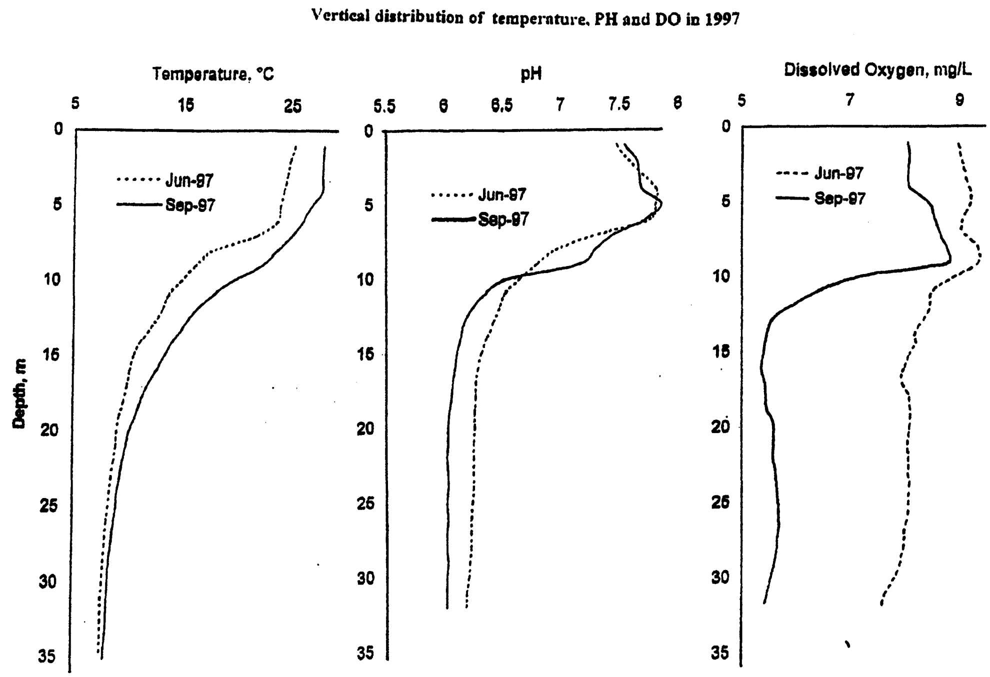
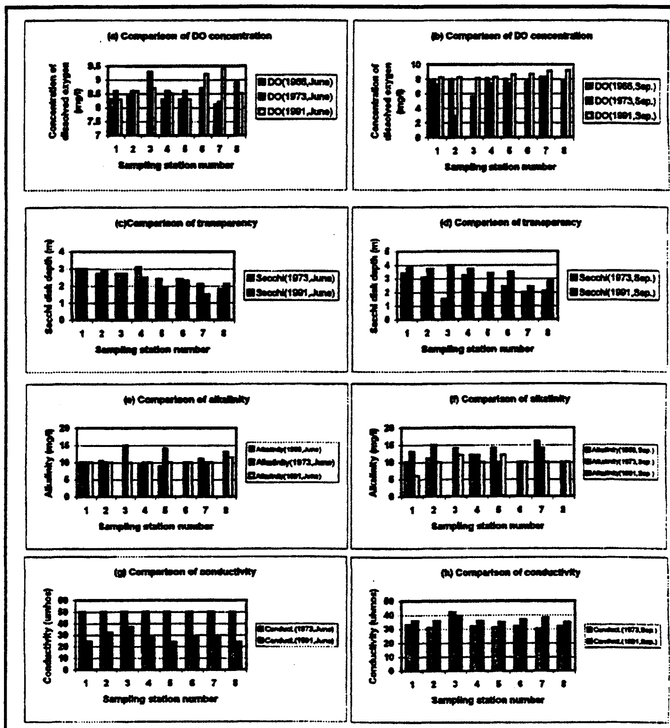


Figure 3 (Continued)



Note: Photic zone water quality in 1991.

Figure 4 Comparison of water quality at surface

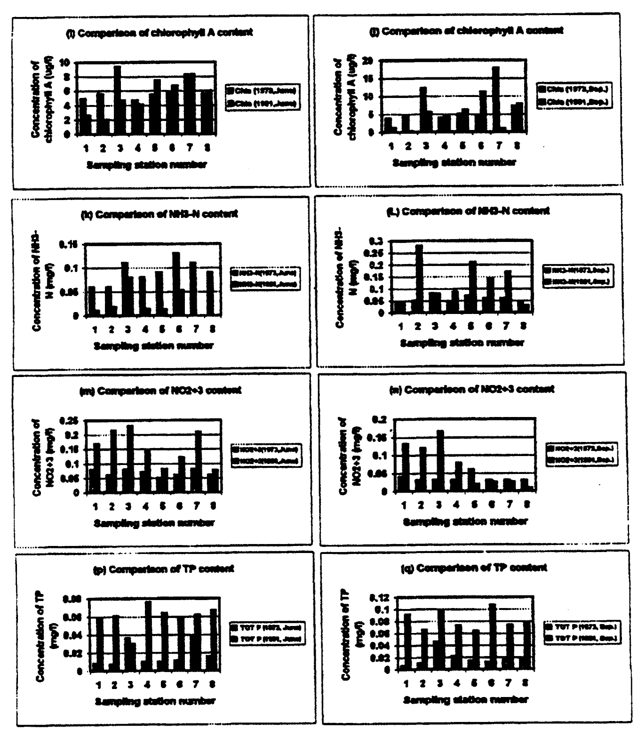


Figure 4 (Continued)