

A CLEAN LAKES PHASE I - DIAGNOSTIC/FEASIBILITY STUDY OF LAKE ALLATOONA: A PRELIMINARY REPORT

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INTRODUCTION

Lake Allatoona is an 11,862 acre impoundment of the Etowah River in northwest Georgia, lying along the southern tail of the Blue Ridge Mountains, only 30 miles northwest of Atlanta. The impoundment has been designated for flood control, hydropower, navigation, drinking water supply, fish and wildlife, and recreation. The lake first reached full pool level in 1950. Since that time, the southern part of Allatoona's watershed has developed rapidly as suburban Atlanta has expanded northward and initial surveys by the Georgia Environmental Protection Division suggested that the lake may be approaching a eutrophic state. Intensive sampling of Lake Allatoona was initiated in May of 1992 as part of a Clean Lakes Phase I - Diagnostic/Feasibility Study. Water quality data collected during the first several months of this study are examined here to assess the trophic status of Lake Allatoona.

METHODS

Thirteen lake sites, 12 tributaries and the outflow below the dam (Figure 1) were sampled twice a month from May to October of 1992 and once a month thereafter. At each site, temperature, pH, dissolved oxygen and conductivity was measured (at a series of depths in the lake and single depth in tributaries) and water was collected (as a composite sample of the photic zone in the lake and a single sample in tributaries) for analysis of chlorophyll *a*, total suspended solids, nutrients, and a series of other standard limnological parameters. Fecal coliform bacteria were sampled bimonthly from May to October of 1992 and once a month thereafter. Primary productivity was estimated by comparing changes in dissolved oxygen in 300 ml light and dark bottles (2 replicates of each per depth) at the surface and 1/3, 2/3 and 3/3 the depth of the photic zone incubated over 4 h at midday (at 8

sites, each measured in late spring, summer, and early fall).

Figure 1. Map of Lake Allatoona showing tributaries sampled in the present study.



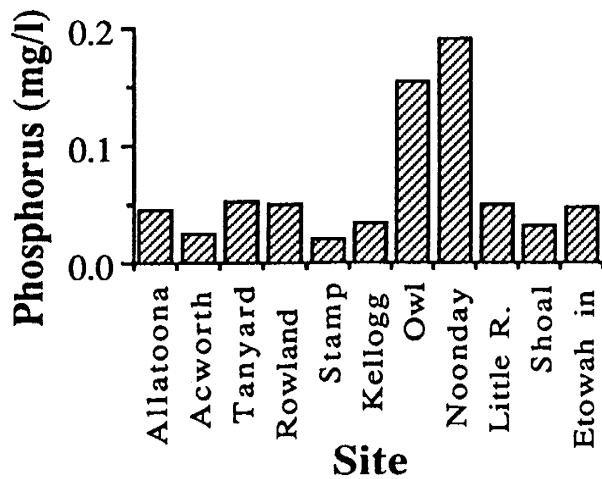
RESULTS

Average primary productivity was 1142 mgC/m²/d (range = 580 - 2367 mgC/m²/d). This classifies the lake as eutrophic, though not far from the mesotrophic-eutrophic boundary (1000

mgC/m²/d; Kimmel, et al., 1990). The average water transparency was 1.84 m (range = 0.8 - 2.9 m), chlorophyll *a* averaged 9.4 ppm (range = 2.5 - 33 µg/l), and total phosphorus averaged 0.032 mg/l (range = 0.016- 0.056 mg/l). Mean values for these parameters also characterize Lake Allatoona as slightly eutrophic according to the Trophic State Index developed by Carlson (1977).

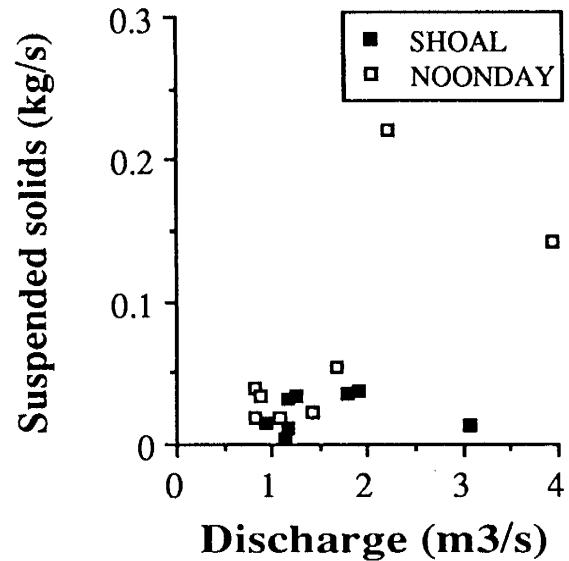
In the tributaries, concentrations of phosphorus tended to be higher within the tributaries that drain the southern, more populated watershed, particularly within Owl and Noonday Creeks (Figure 2).

Figure 2. Average concentration of total phosphorus within the major tributaries during the summer of 1992



While point sources such as a waste water treatment plant on Noonday may contribute to this loading, non-point sources within this developed watershed are also suggested. Far more total suspended solids in Noonday Creek were transported downstream during times of high stream discharge associated with rain events (Figure 3). Nutrients also tended to show increases with increasing discharge. Suspended solids and nutrient loading in the less developed tributaries to the north (e.g. Shoal Creek) did not show strong increases with higher discharge. Increased loading during rain events might be expected from non-point sources and indicate a need to further investigate such sources.

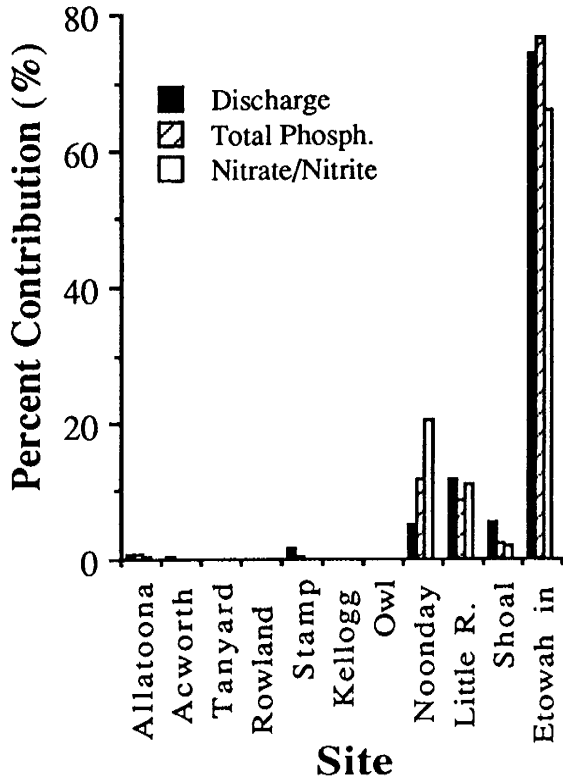
Figure 3. Total suspended solids under different stream discharge conditions in two creeks on several dates during the summer of 1992



Current velocity measurements made in this study indicate that four tributaries, the Etowah River, Little River, Shoal Creek, and Noonday Creek, all of which drain into the upper main arm of the lake, contribute 96% of the water measured flowing into the lake (Figure 4). Because some creeks with high nutrient concentrations have relatively little flow (e.g. Owl Creek), their nutrient load contribution to Allatoona is very low. Noonday Creek, with both high nutrient concentrations and significant flow, contributes a considerable nutrient load to the lake (disproportionately more than the amount of water that it contributes). The Etowah River dominates flow (74%) and as a result contributes the highest nutrient loads despite lower nutrient concentrations.

Only about half of the phosphorus measured flowing into the lake was measured flowing out of the lake at the dam during the summer months. The fate of this phosphorus (e.g. resuspension and export during other times of year) will be better understood as a phosphorus budget is constructed for an entire year of data.

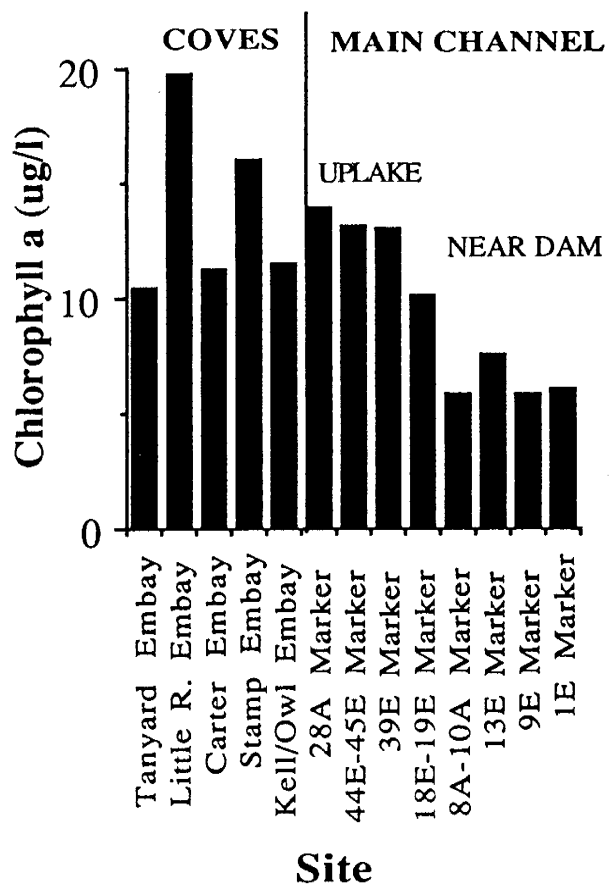
Figure 4. Average percent contribution of stream discharge, total phosphorus load, and nitrate/nitrite load for each of Allatoona's major tributaries during the summer of 1992. Average stream discharge in Tanyard, Kellogg, and Owl Creeks are <0.2%.



Chlorophyll levels are variable over the 13 lake sites measured (Figure 5). Not surprisingly, the Little River embayment of the lake (receiving nutrient-rich water from both Little River and Noonday Creek) has the highest chlorophyll levels of all lake sites on most dates from May to October. However, elevated chlorophyll levels were also recorded at several sites far from the area of high nutrient loading in the upper reaches of the main arm of the reservoir. For example, the second highest chlorophyll level was at the Stamp Creek Embayment, located only 4 km from the dam and fed by a tributary with a relatively low nutrient load. In general, sites with elevated chlorophyll (sufficiently high to be considered as moderately eutrophic) tend to be either uplake sites or embayments. Differences in water quality in different areas of the lake must result from a

combination of factors including nutrient load and concentration, transport of nutrients through the lake, availability of nutrients from the sediment, and basin morphometry. Low water transparency (due to algae and suspended sediments) contributed to a depletion of oxygen (<3.0 mg/l) in deeper waters at 10 of 13 stations during the late summer.

Figure 5. Average chlorophyll concentrations for lake sites during the fall of 1992. Main channel sites are arranged by depth (the deepest to the right) and higher numbered channel markers are further from the dam along the Etowah arm (E) and the Allatoona arm (A).



The lake is also being evaluated from a direct human health standpoint. Densities of fecal Coliform bacteria (an indicator of possible raw sewage contamination) in the lake were within acceptable limits for recreational waters (monthly geometric means <200 organisms/100 ml) at all stations (with the exception of one station during

one month). However, within some tributaries (particularly those that drain densely populated areas) the fecal coliform levels were substantially higher (e.g. all tributary stations exceeded 200 organisms/100ml in late summer with 7 stations exceeding 2000 organisms/100ml) and may pose a potential threat to swimmers when bacteria-rich water is displaced into the lake after storms. More persistent pollutants potentially affecting human health are heavy metals and organic toxins and are presently (December 1992) being examined in the water, sediment, and fish of Lake Allatoona.

CONCLUSIONS

Lake Allatoona is on the edge. It is on the edge of Atlanta's suburban growth. We believe the data so far indicate that Allatoona is also on the edge in terms of water quality. Further degradation of Allatoona's water quality will, in all likelihood, seriously impair several, if not all, of the multi-value aspects of this resource. All of the major parameters used to assess the age of the lake (primary productivity, water clarity, chlorophyll concentration, and phosphorus concentration) characterize Lake Allatoona as a lake entering a eutrophic state. The influence of poor water quality from the tributaries within the watershed is apparent not only in areas where these tributaries enter the lake but also in other areas over the lake.

These results clearly characterize the state of the lake, but do not as yet indicate the rate at which the lake is aging. Continued monitoring of the lake through this year and for the next several years will document the rate at which water quality is being degraded. So far, phosphorus is emerging as the key nutrient causing high abundance of algae within Allatoona. Again, further monitoring through this year and into the future will determine if phosphorus is the limiting nutrient at all times under all conditions. We must be extremely careful in this determination because these data will be used to help set standards for water quality within the watershed. Future monitoring must also focus on the movement back into the lake water of phosphorus already in the lake sediment. This will be important in determining the relative importance of management efforts directed at regulating phosphorus from the tributaries versus management efforts directed at minimizing resuspension of phosphorus within the lake. Three tributaries (Etowah and Little Rivers, and Noonday Creek) appear to be the major contributors of nutrients and sediment into Lake Allatoona at this point. Further

research should focus on identifying problem sources upstream of present sampling sites and on detailed monitoring of nutrient and sediment loads during rain events in one or two of the more impacted tributaries.

Overall, the data at this point in the study clearly demonstrate the need for a comprehensive watershed management plan if the current value of Lake Allatoona is to be maintained. It is far more costly to bring a lake back from a degraded state than to prevent the lake from reaching that state within the foreseeable future. Continued research is necessary to determine the type of plan that will be most effective and economically feasible.

ACKNOWLEDGEMENTS

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LITERATURE CITED

- Carlson, R. 1977. A trophic state index for lakes. *Limnology and Oceanography*. 22:361-369.
- Kimmel, B.L., O.T. Lind, and J. Paulson. 1990. Reservoir primary production. *In: Reservoir Limnology: Ecological Perspectives*, K.W. Thornton, B.L. Kimmel, and F. E. Payne, editors. John Wiley & Sons, Inc., New York.