The Lake George Lay Monitoring Program

Completed by

D.R. Long, L.W. Eichler, R.F. Clifford

and D.H. Pope

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Dean R. Long, Lawrence W. Eichler,
Robert F. Clifford and Daniel H. Pope

RPI Fresh Water Institute
Troy, New York 12181

ABSTRACT

The Rensselaer Polytechnic Fresh Water Institute established a Lake Monitoring Program to assess the water quality of Lake George, NY in April of 1980. Eleven sampling stations, representing various physical characteristics of the lake, are located within the basin. Data for pH, conductivity, total phosphorus, total filterable phosphorus, orthophosphate, ammonia, nitrate, chloride, chlorophyll a, sodium, calcium, magnesium, potassium, dissolved oxygen and temperature are obtained for each site. Samples for bacteriological analyses are routinely collected at all sites.

Highlights from the 1981 research and monitoring program are: studies on the Warner Bay site showed that the concentration of total phosphorus in the Warner Bay Swamp is nearly two times greater than that found on adjoining Warner Bay. Warner Bay is the only site to consistently have detectable quanitities of orthophosphate (an important nutrient for growth of algae). Overall the total phosphorus concentration in the lake has changed very little since last year. Soluble silica concentration has been found to vary with depth, location, and season at most sites in Lake George. The levels of soluble silica do not appear to have changed appreciably in ten years. The concentrations of sodium and chloride were found to differ seasonally with the highest values being found in the spring and dropping off in the summer. Coliform bacteria were rarely detected at most sites except for Lake George Village, Tea Island and Warner Bay.

INTRODUCTION

Protection of lakes and streams from cultural eutrophication is a national concern as is evidenced by the International Biological Program, the Clean Lakes Program and the National Urban Runoff Program. Lake George water quality has received considerable attention (Fuhs, 1972; Wood and Fuhs, 1978; Ferris and Clesceri, 1974; Aulenbach et. al., 1977; Singer et. al., 1981) due to concerned citizens and scientific groups. In April 1980 an intensive water quality monitoring program, jointly sponsored by the Lake George Association and the RPI Fresh Water Institute, was initiated.

The goals of the program were to provide baseline and continuous water quality data. Data of this nature are essential in detecting short and long-term changes in water quality. The data from the first year of the program was reported by Long et. al. (1981). The present report covers the period from April 1981 to April 1982.

MATERIALS AND METHODS

In order to characterize the lake, eleven stations on a south to north axis were selected. Stations corresponded to those used by previous investigators (Wood and Fuhs, 1978; Ferris and Clesceri, 1974). Areas selected include Lake George Village, Tea Island, Warner Bay, Dome Island, Northwest Bay, French Point, Huletts Landing, Smith Bay, Hague, Rogers Rock, and Hearts Bay (Figure 1). An additional station at Harris Bay was added at the end of 1981.

Water samples were collected in two ways. Integrated samples, encompassing a portion of the water column, were collected with a PVC hose. The tubing was weighted at one end and lowered to the desired depth. The opposite end of the tube was sealed and the entire tube retrieved. The sample was drained into a collection bottle and replicates taken until sufficient volume was available for all analysis. Integrated samples were collected at all stations. At stations where the depth was 20 meters or greater, deep water point samples were taken with a Van Dorn collection bottle.

Sampling was conducted biweekly prior to spring stratification (April 3 - June 6) and immediately prior to, during and after fall overturn. During stratification, roughly the summer months (June 6 - October 1) samples were collected triweekly. Samples for bacterial analyses were collected weekly throughout the summer (July and August).

At each station, secchi depth and temperature and dissolved oxygen profiles were recorded. Samples were collected for chemical analyses, including: pH, conductivity, total phosphorus, total filterable phosphorus, orthophosphorus, nitrate, ammonia, chloride, calcium, sodium, potassium, soluble reactive silica and chlorophyll a.

Details of the analytical methods used in chemical determinations have been previously reported (Long et. al., 1981).

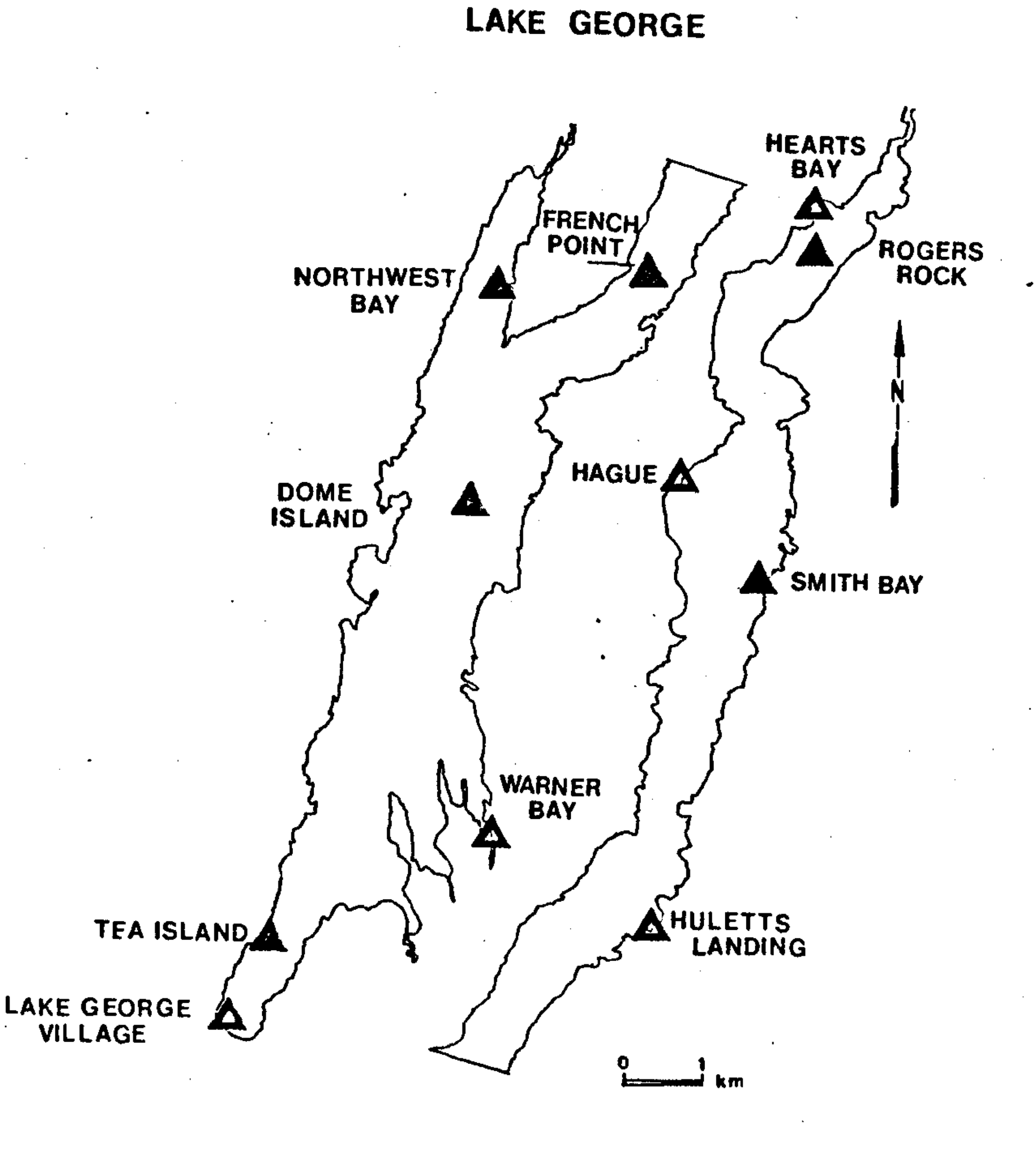
RESULTS

Dissolved oxygen profiles failed to show serious oxygen depletion at any time. The lowest dissolved oxygen value (4.0 mg/l) was reported at Tea Island on October 13, 1981 at a depth of 30 m. All metered dissolved oxygen values were verified on a daily basis by Winkler titration.

The pH of the lake appears to be stable with means of 7.38 and 7.44 in 1980 and 1981, respectively. Lower (more acidic) pH values were noted in the hypolimnion, especially at the Tea Island station (range 6.78 - 7.06). This slight depression in pH coincides with increased levels of nitrate and ammonia.

Nitrate and ammonia concentrations reported for 1981 are similar to 1980 results. In integrated (epilimnion) samples, detectable concentrations (range of <0.01 - 0.07 and <0.01 - 0.04 for nitrate and ammonia, respectively) were commonly found during the period from ice off to thermal stratification (April 3 - June 6). After stratification, nitrate and

Figure 1.



Study site on Lake George April 15 to present. Open triangles are sites where maximum depth does not exceed 6 m.

ammonia values above the detection limit (0.01 mg/l), were rarely observed.

Deepwater samples frequently displayed detectable concentrations of nitrate and occasionally ammonia. South lake deepwater samples (Dome and Tea Island) were consistently above the detection limit for nitrate (range .01 - .10 mg/l). Ammonia was detected at Tea Island and occasionally at Dome Island.

Phosphorus, considered to be the major limiting nutrient to algal growth in Lake George (Wood and Fuhs, 1978; Stross et. al. 1973) was measured in three ways; total phosphorus, total filterable or soluble phosphorus, and orthophosphorus. Measurable concentrations ($\geq$ 1.0 µg/l) of orthophosphorus were rarely found at most stations. Warner Bay was the only location where concentrations were consistently above the detection limit (range 1.0 - 2.0 µg/l). Total phosphorus and total filterable phosphorus concentrations were significantly different between sites (Figure 2). Warner Bay consistently had the highest concentration with maximum values of 16.0 and 5.0 µg/l, respectively. The results for total phosphorus and total filterable phosphorus concentrations did not show any significant seasonal trends.

We did a short term comparison of total phosphorus concentrations in Warner Bay and its associated wetland (Table 1). Total phosphorus levels in the wetland were nearly double those reported for the bay. Mean concentrations for the wetland and the bay were 18.0 and 9.6 µg/l, respectively. The summer mean total phosphorus concentration for Warner Bay was 9.6 µg/l.

The mean total phosphorus concentration for the lake during 1981, 4.6 $\pm$ 2.1 µg/l, was significantly different from the 1980 mean of 4.2 $\pm$ 2.3 µg/l (Figure 3). Means were determined using only integrated samples. Total phosphorus was found to be significantly different between the integrated and deep point samples (Figure 4). The deep samples displaying slightly higher concentrations.

In April of 1981, measurements for soluble silica were begun. Soluble reactive silica concentrations varied with season, depth and location on the lake (Figure 5). Concentrations of this nutrient were significantly greater in the hypolimnion at all sites during months of thermal stratification (Figure 6). A review of the 1981 soluble silica data has been presented by Long et. al. (1982).

Sodium and chloride concentrations displayed seasonal variation. Highest sodium (4.80 mg/l) and chloride (9.0 mg/l) values were recorded shortly after ice off at Lake George Village and Tea Island (Figure 7). A slight south to north gradient in sodium concentration was observed but may not be statistically significant.

Chlorophyll _a_ concentrations were higher in the south lake than the north with highest concentrations reported in Warner Bay. The greatest chlorophyll _a_ concentration was reported for Warner Bay on June 2 (5.4 µg/l). Chlorophyll _a_ varied seasonally, with greatest concentrations ($\bar{x}$ = 1.59 µg/l) reported in April shortly after ice out. The mean

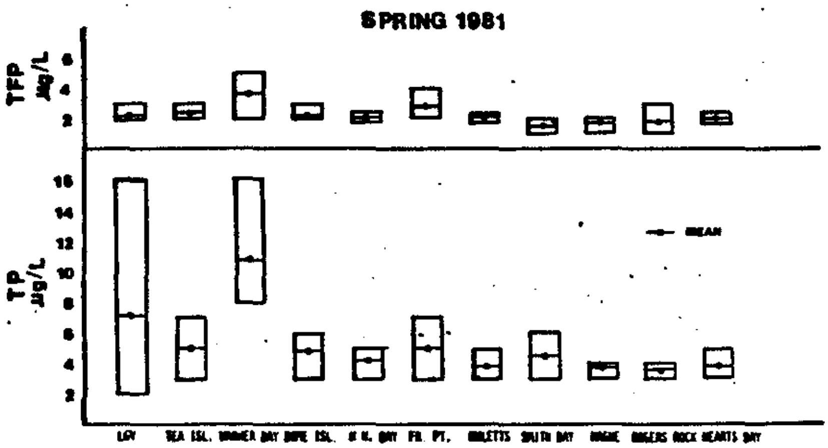


Figure 2. Total phosphorus (TP) and total filterable phosphorus (TFP) concentration at integrated samples sites during Spring 1981.

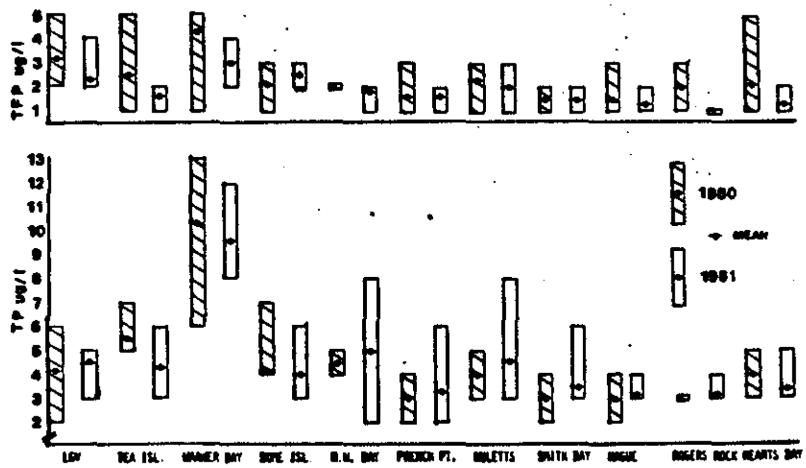


Figure 3. Total phosphorus (TP) and total filterable phosphorus (TFP) concentration at integrated samples sites during the summers of 1980 and 1981.

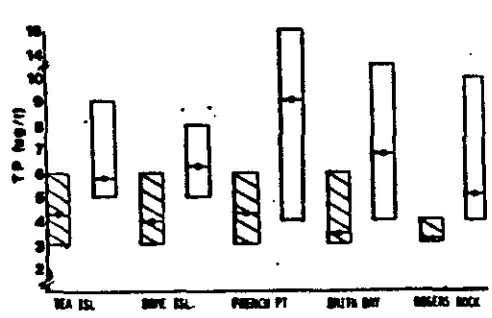


Figure 4. Comparison of total phosphorus concentration in 0-10m integrated samples to deepwater samples.

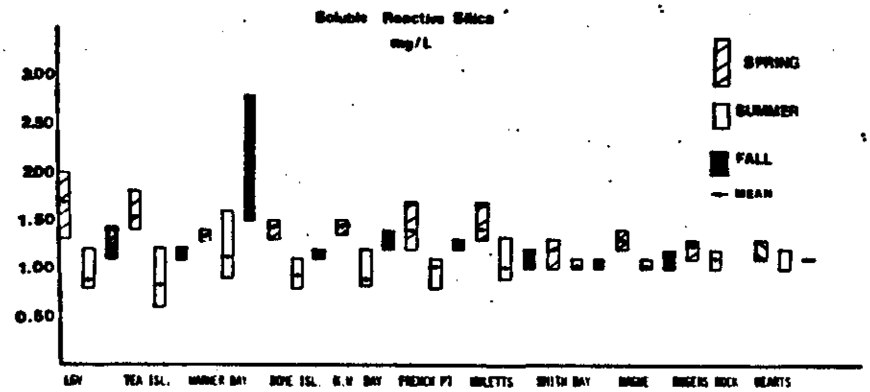


Figure 5. Soluble reactive silica concentration found in integrated samples during the Spring, Summer and Fall. Insufficient Fall data was collected at Rogers Rock.

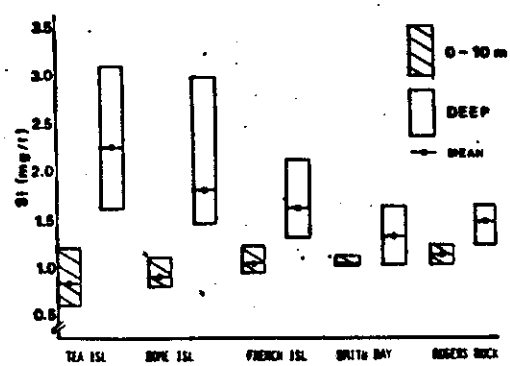


Figure 6. Comparison of soluble silica concentration in 0-10m integrated samples to deep water samples.

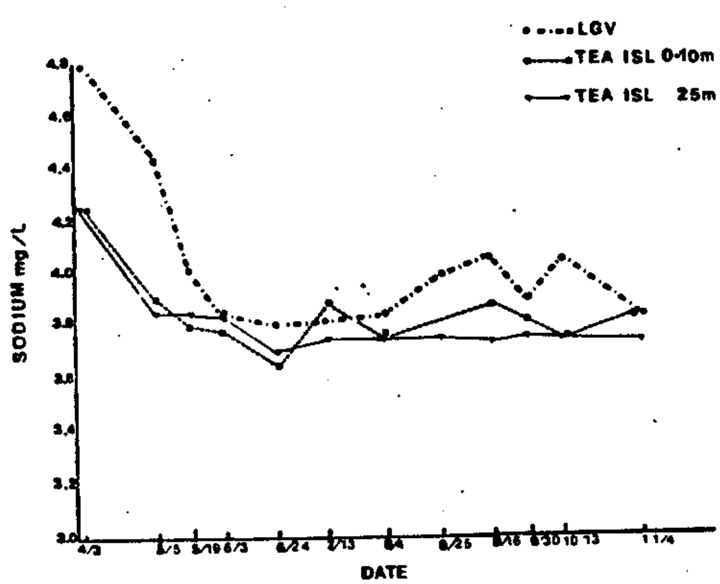


Figure 7. Sodium concentrations at Lake George Village and Tea Island.

concentration for the lake was 1.07 μg/l.

Table 1. Comparison of total phosphorus (TP) in Warner Bay and Warner Bay Wetland

Site	Date	TP μg/l	Comparison Site	TP μg/l
Warner Bay Wetland 0-m	8/18	21	Warner Bay 0-2m	9.6*
Warner Bay Wetland 0-m	8/26	21	Warner Bay 0-2m	8
Warner Bay Wetland 0-m	9/16	22	Warner Bay 0-2m	8
Warner Bay Wetland 0-m	10/1	14	Warner Bay 0-2m	11
Warner Bay Wetland 0-m	10/13	12	Warner Bay 0-2m	6

* Mean Warner Bay summer T.P. concentration

Coliform analyses were initiated in January, 1981. Concentrations frequently exceeding the N.Y.S. standard for potable water of 2 total coliform colonies or greater per 100 ml of water frequently occurred at Lake George Village and Warner Bay. All other stations rarely or never exceeded this standard. The highest concentration of total coliform organisms occurred at Lake George Village on July 21 and was too numerous to count. The highest countable concentration (190 colonies/100 ml) was found at Warner Bay on November 3.

Due to a lack of space, tables of raw data are not included with this report. These are available from the Lake George Association or the Fresh Water Institute upon request.

DISCUSSION

In general the water quality parameters measured remained relatively unchanged from 1980 to 1981. Several trends do, however, merit further discussion.

A lack of seasonal variation in pH indicates that at present, the watershed retains sufficient buffering capacity to neutralize the effects of acid precipitation. Spring snow melt episodes have been shown to cause the most drastic depression of lake pH (Overrein, Seip and Tolland, 1980; Schofield, 1977). The effects of a snow melt episode on Smith Bay Lake George, NY were studied by Singer et. al. (1981). They noted that with a rain input of pH 5.56 water Smith Bay Brook maintained a pH of between 7.5 and 7.7.

Nitrogen and phosphorus are the major limiting nutrients to algal productivity in lakes (Ruttner, 1974). Phosphorus, considered to be the major limiting nutrient in Lake George has received considerable attention (Aulenbach et. al. 1970; 1973; Wood and Fuhs, 1978; and data from the Clean Lakes, and FWI Monitoring Programs). The lack of detectable concentrations of nitrate or ammonia after stratification indicate that these nutrients may also play a part in limiting algal biomass. Williams et. al. (1973) found some correlation between nitrate concentration and algal biomass in Lake George. In some lakes addition of either phosphorus or nitrate increase algal productivity while in others, addition of both phosphorus and nitrate are necessary to cause increased algal growth (Sakamoto, 1971). Additional nutrient enrichment studies are desirable to determine the influence of nitrate addition to natural algal productivity in Lake George.

Warner Bay, the smallest and most densely populated area in our study consistently displayed the greatest total phosphorus, total filterable phosphorus, orthophosphate and chlorophyll a concentrations. Elevated phosphorus values may be attributable to resuspension of this nutrient from the sediments (Wetzel, 1975; Yousef et. al. 1980) or contributions from Warner Bay Wetland.

Warner Bay Wetland was found to have total phosphorus concentrations twice those of Warner Bay, indicating that the wetland may be a major source for the high total phosphorus values reported for Warner Bay. Future analyses of total filterable phosphorus and total phosphorus concentrations in the wetland and along a transect from the wetland to the bay are necessary to assess the impact of the wetland on the water quality in Warner Bay.

Sodium and chloride reached highest concentrations in the spring at the Lake George Village and Tea Island sites. This trend was not as apparent at any other station. As these two sites are the most urbanized, urban runoff of road deicing salts may be the cause of this phenomenon. Huling and Hollocher (1972) demonstrated that once a soil has reached near-saturation levels of sodium it will act to steadily release this element, more rapidly at first but extending into the summer months. The observed trend of decreasing sodium concentration from south to north may also be explained by the slow steady release of sodium from saturated soils. Data from the National Urban Runoff Program currently sampling the south basin should help to clarify the dynamics of sodium in the lake.

Significant differences between deep point and integrated samples were apparent. Concentrations of total phosphorus, nitrate and ammonia were higher in deepwater samples, possibly due to resuspension from the sediment and/or insufficiently large biological populations in these locations to fully utilize these nutrients.

Total coliform bacteria data show that with the exception of Lake George Village and Tea Island the lake meets the N.Y.S. criteria for potable waters. Coliform counts reported were considerably less than the DEC/DOH records due to the intent of the two programs. The present study attempts to assess background or mean concentration present while DEC/DOH researchers actively sought pollution sources.

CONCLUSIONS

A comparison at 1980 and 1981 data indicates little or no change in water quality which is as expected on a year to year basis. Mean total phosphorus values, though slightly higher in 1981 should not be overly emphasized, as variation from year to year does not necessarily indicate a serious degradation of water quality. A continuing upward trend would

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be cause for serious investigation.

The south lake displays greater nutrient enrichment, especially in the shallow areas. This may be the results of greater population density, urban runoff, and the physical characteristics of the two basins (shallower mean depth, larger watershed and lake surface area).

ACKNOWLEDGEMENTS

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DISCUSSION

Siegfried - The range for chlorphyll a seems very low.

Eichler - Yes, our results do not agree with yours, we should check our methods.