

LITTLE ISLAND POND
LAKES LAY MONITORING PROGRAM
1985

Freshwater Biology Group (FBG)
University of New Hampshire
Durham

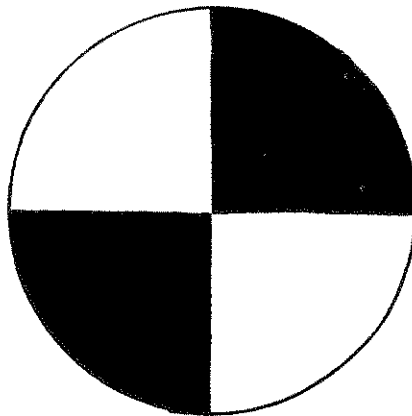
by

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LAKES LAY MONITORING PROGRAM

To obtain more information about the Lakes Lay Monitoring Program (LLMP) contact the LLMP Coordinator (T. Kenealy) at (603)-862-3848, Dr. Baker at 862-3845 or Dr. Haney at 862-2106.

TABLE OF CONTENTS

PREFACE.....iii

ACKNOWLEDGEMENTS.....v

NON-TECHNICAL SUMMARY OF 1985 DATA.....1

COMMENTS AND RECOMMENDATIONS.....2

METHODS

 Lay Monitors.....4

 Freshwater Biology Group, UNH.....7

RESULTS AND DISCUSSION

 Lay Monitor Data.....12

 Freshwater Biology Group, UNH.....14

REFERENCES.....19

APPENDIX A: 1985 LAY MONITOR DATA.....A-1

This is a LEVEL II report. (See last page for definition.)

All data in this report are available to any person or organization upon request and payment of costs involved.

PREFACE

Importance of long-term monitoring

Lake monitoring carried out weekly over the course of several consecutive summers benefits the lake in a number of ways. The resulting data not only indicate the lake's condition for a particular summer, but they also suggest what it was like in the past, and make it possible to predict its condition in the future.

For this reason, it is important to distinguish between short-term and long-term results. As an example, a 30 year time-span may provide evidence for a long-term trend towards eutrophy (Fig. 1). Yet, if one looks at data over a 1-5 year time-span, one sees only short-term fluctuations; there are no apparent trends nor is it possible to separate the "signal" from "noise". Chlorophyll, water transparency, and phosphorus may fluctuate from year to year in response to annual variations in climate and activity on the lake, and may be unrelated to long-term trends. The more such "noise" in the data, whether due to real or analytical variations, the longer a monitoring program must continue to demonstrate long-term trends.

Use of long-term trends

Long-term trends serve several important functions. From them, past deterioration of the lake can be recognized. They can also be used to forecast the future condition of

They can also be used to forecast the future condition of the lake, and if necessary, management techniques can be implemented to keep potential problems from becoming worse. Finally, long-term trends provide a basis for evaluation of existing management programs so that necessary changes may be brought about.

It takes a great deal of motivation, perseverance, and a love for one's lake to be a lay monitor. Sometimes it may seem to be an inconvenience, or to be discouraging when it's unclear just what a year's worth of hard work means with respect to the "big picture" of the lake. Yet, each observation by a lay monitor is a significant contribution.

Thus, continuation of data collection is important. The LLMP data base is becoming more comprehensive and valuable each year. We are pleased with the interest and commitment of lakeshore volunteers. Keep up the great work!

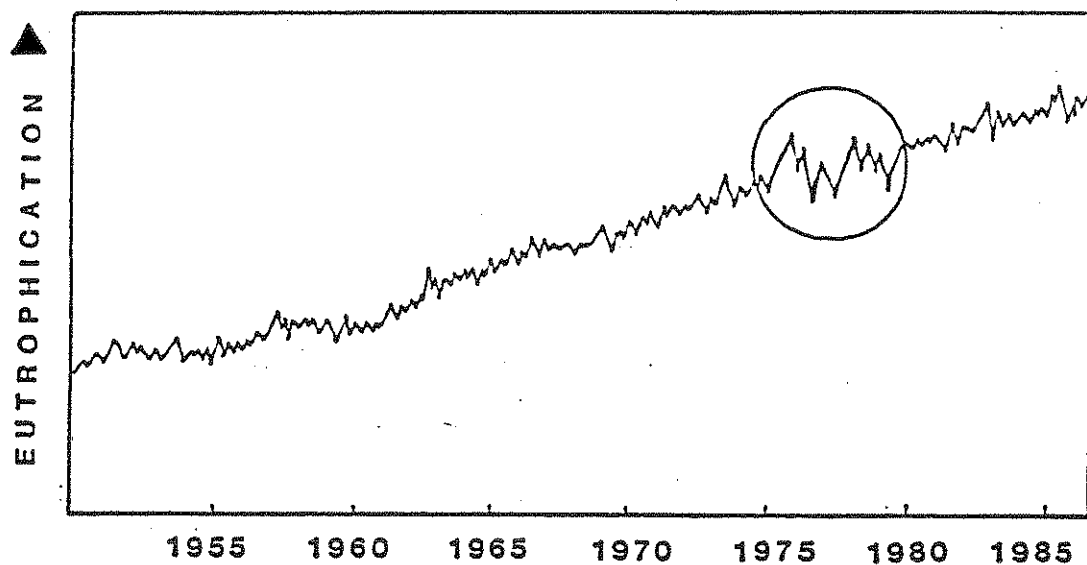


Figure 1. Long-term vs. short-term trends in a hypothetical lake approaching eutrophication.

ACKNOWLEDGEMENTS

The Lakes Lay Monitoring Program (LLMP) was established on Little Island Pond in 1985. Through the direction of Mr. Peter Bajor, this study was conducted jointly by the Freshwater Biology Group (FBG), the University of New Hampshire, and the Little Island Pond Rod and Gun Club. The program got off on an excellent start with the efforts of several dedicated monitors. Two sites, "1 Shallow" and "2 Deep" were monitored weekly from mid-July to September. Monitoring was carried out by Pete and Krista Bajor, Jennifer Hay, John McAndrew, Maurice Picard, Carl Trull, and Bill Wolfendale.

The Freshwater Biology Group congratulates the monitors on the quality of their work and the time and effort put forth. We encourage them and other interested lake residents or members of the Little Island Pond Rod and Gun Club to continue monitoring during the 1986 season. We would also like to thank Mr. Bajor for his help in organizing the LLMP for the lake.

Members of the Freshwater Biology Group included Kim Babbitt, Henry Burke, Tracy Kenealy, Sandra Lord, Elizabeth Trieff, Celia Acacia, and Deb Thunburg. Kim was the LLMP Coordinator, and was responsible for arranging the field trips and supervising the research team. Liz and Sandy were responsible for phosphorus, Henry for equipment production

and upkeep, Celia for phytoplankton, and Deb for zooplankton. Tracy was responsible for data entry and analysis, and for writing the reports in the fall.

We would also like to recognize the UNH Office of Computer Services for their provision of computer time and data storage space. The final text is available on an IBM-compatible diskette.

NON-TECHNICAL SUMMARY OF 1985 DATA

1) Both water transparencies and chlorophyll a concentrations indicate that Little Island Pond is oligotrophic. Seasonal readings for secchi disk and chlorophyll suggest that the lake is nutrient-poor and contains relatively few planktonic algae.

2) The pH of Little Island Pond ranged from 6.1 to 7.7 throughout the water column. Alkalinity, which measures the ability of water to buffer acids, was moderate. Alkalinity and pH results suggest that the lake has sufficient buffering capacity at this time to resist changes in pH due to acid rain.

3) Phosphorus levels in Little Island Pond were low. Low phosphorus concentrations indicate that nutrient loading into the lake is limited.

COMMENTS AND RECOMMENDATIONS

1) The consistency of data collection by the lay monitors was excellent throughout the 1985 season. The data collected represent the beginning of a useful data base for Little Island Pond. A data base resulting from several years of monitoring will be a valuable in the future as trends in the chemistry and biology of the lake become evident. Sampling should be continued in 1986, and should begin as early as possible. Variations in trophic indicators (secchi disk depth, chlorophyll a and total phosphorus) occur throughout the summer sampling period. In order to monitor these variations properly, data should be collected throughout the entire summer, and if possible, in the spring after ice-out.

2) A program of lay monitor alkalinity testing should be initiated to assess the effects of acid precipitation on the lake. Alkalinity indicates the ability of water to buffer acids, and is a reliable early indicator of acidification. It is important to establish a data base for alkalinity in order to detect changes as early as possible, especially in a lake such as Little Island Pond where the buffering capacity is already low. This could be accomplished by training at least one lay monitor the procedures for the chemical test for alkalinity.

3) Phosphorus sampling should be continued in 1986. While concentrations in 1985 were low, phosphorus levels can fluctuate from year to year in response to annual variations in the climate and activity in and around the lake. Phosphorus is usually the least abundant (most limiting) nutrient in a lake, and high phosphorus levels will cause increased production, which in turn may accelerate the eutrophication process.

4) As a general addition to our Lakes Lay Monitoring Program, we are suggesting that each lake in the Program begin monitoring the condition of the fish taken from the lake. The "Fish Monitoring" will require that at least one lay monitor record the species, length and weight and collect a sample of fish scales for each fish examined. In most lakes this will involve periodic creel census of sport fishermen on the lake. Equipment required will cost approximately \$100. Special instruction will be given to the lay monitors who chose to measure this parameter.

Length-to-weight ratios give a measure of the nutritional condition of the fish. Analysis of the fish scales (to be done at UNH) will tell how old each fish is. Together, these data will be extremely useful indicators of the health of the fish populations in the lake, and, of course, the "health" of the lake.

METHODS OF LAY MONITORS

This year data were collected on five parameters: thermal stratification, water clarity (secchi disk depth), chlorophyll a concentration, total phosphorus and dissolved water color. Whenever possible, testing was done weekly between the hours of 9 am and 3 pm, the period of maximum sunlight penetration into the water. All samples and data were mailed to the FBG at UNH for analysis.

Thermal (temperature) profiles were obtained by collecting lakewater samples at several successive depths using a modified Meyer bottle (Lind, 1979). A weighted, empty bottle with a stopper was lowered to a specific depth. At that depth, the stopper was pulled, allowing the bottle to be filled with water. The bottle was quickly pulled back up to the surface where the temperature of the sample was taken with a Taylor pocket thermometer, and recorded in degrees Celsius. This procedure was repeated at one meter intervals through the epilimnion and hypolimnion, and at one-half meter intervals throughout the metalimnion.

Water clarity was measured by lowering a secchi disk (approximately 20 cm. or 8 inches) through the water off the shady side of the boat, and noting the average depth at which it disappeared upon lowering and reappeared when being raised (the cord attached to the secchi disk was marked in

one-half meters). This process was done while holding a view-scope just below the surface to eliminate effects of surface reflection and wave action. This was repeated two or three times, and an average to the nearest one-tenth of a meter was recorded.

Chlorophyll a concentration was used as an index of algal biomass that is useful in determining the trophic state of the lake. A weighted plastic tube (10 meters in length) was lowered through the epilimnion, or "upper lake" to the top of the metalimnion, or "middle lake" (the depths of the epilimnion and metalimnion are determined from the temperature profile). The end of the tube above water is folded to shut off the water flow into or out of the tube. The weighted end of the tube is pulled up out of the water with an attached cord, trapping an integrated sample of water representing the "upper lake" in the tube. This sample is poured into a plastic 2.5 liter bottle and stored for chlorophyll filtration and alkalinity determination.

Water samples for chlorophyll a filtration were filtered through a 0.45 micron membrane filter. Damp filters, containing chlorophyll-bearing algae, were air-dried for at least 15 minutes, out of the sun, to prevent decomposition or bleaching of the chlorophyll on the filter. These filters were sent to UNH where members of the FBG analyzed them for chlorophyll a (see Methods of the Freshwater Biology Group).

Dissolved water color was determined by saving the filtrate from the the chlorophyll filtration and storing it frozen in a 50 ml plastic bottle. The bottles were sent to UNH and the color was analyzed by reading the absorbance of the samples at two different wavelengths (440 and 493).

Samples for total phosphorus analysis were collected in two ways. For determination of epilimnetic phosphorus, water was taken from the integrated sample collected with the tube-sampler. On parts of the lake where it was suspected that phosphorus might be high, (eg. sites along the shoreline, inlets or outlets), surface samples were taken by dipping a bottle into the water and letting it fill. All samples were collected in acid-washed 250 ml bottles, fixed with 1.0 ml of concentrated sulfuric acid, and stored frozen until analysis by the FBG team. (See Methods by the Freshwater Biology Group.)

METHODS OF THE FRESHWATER BIOLOGY GROUP

The Freshwater Biology Group (FBG) research team took one trip to the lake and conducted several tests which included measurements of sunlight penetration into the water, dissolved oxygen, alkalinity, free (unbound) carbon dioxide, pH, specific conductivity, chlorophyll a, total phosphorus, and a survey of the microscopic plants (phytoplankton) present. The FBG was also responsible for chlorophyll a and phosphorus analysis of lay monitor samples, as well as filing and analyzing 1985 data, performing statistical tests, and determining possible trends based on past data.

Field and Laboratory Methods

On the lake, a dissolved oxygen and temperature profile was taken using a Yellow Springs Instruments Model 54A Oxygen/Temperature meter with a submersible probe. Readings were taken at one-meter intervals throughout the epilimnion and hypolimnion, and at one-half meter intervals through the metalimnion.

Sunlight and skylight penetration into the water was measured with a Whitney submersible photometer model LMA-8A, off the sunny side of the boat. From the relative light

intensities which were recorded, the coefficient of light extinction was later determined.

Samples for water chemistry (dissolved oxygen, alkalinity, free (unbound) carbon dioxide, pH, and specific conductivity) were collected with a 3-liter Van Dorn bottle at depths which represented the surface, mid-epilimnion, metalimnion, and hypolimnion. Alkalinity, free carbon dioxide, and pH samples were stored on ice in 250 milliliter polyethylene bottles and were analyzed in the field within 1 to 2 hours of sampling. Specific conductivity samples were analyzed in the FBG lab at room temperature.

In addition to the oxygen profile taken, the dissolved oxygen (DO) concentration of specific lakewater samples (epilimnetic and hypolimnetic) was determined chemically using the Winkler method for dissolved oxygen. The precision of the method allows us to check the accuracy of the electronic probe, so that adjustments could be made in the probe readings if necessary. In the Winkler method, water is collected in Biological Oxygen Demand (BOD) bottles and fixed with manganese sulfate and alkali-iodine-azide. A loose precipitate (floc) of manganous hydroxide is formed that will absorb any dissolved oxygen present. The sample is then acidified with concentrated sulfuric acid in the presence of iodide, and iodine is released in a quantity equal to the amount of dissolved oxygen present.

To determine the alkalinity, a two-endpoint titration was done with 0.002 N sulfuric acid to a pH of 4.5 and 5.1. The endpoint indicator used was methyl red/bromocresol green. The amount of titrant used (dilute sulfuric acid) was recorded to the nearest 0.1 ml, representing the equivalent milligrams of calcium carbonate per liter.

Free carbon dioxide concentration was determined by titrating the fresh lakewater samples with 0.0027 N Sodium Hydroxide to a final pH of 8.3, using the dye phenolphthalein as the end-point indicator.

Lakewater pH was measured with a digital pH meter (Orion model 231) equipped with a combination probe (Orion Co.)

Specific conductivity was measured with a Barnstead Conductivity Bridge Model PM-70CB, with a model B-10 probe (cell constant = 1.0). Corrections were made for sample temperatures with a standard curve.

Samples to be analyzed for chlorophyll a, total phosphorus and phytoplankton were collected with a vertical tube sampler into a 2.5 liter plastic bottle. Chlorophyll samples were filtered through a 0.45 micron membrane filter and air-dried until analysis. The chlorophyll a content was analyzed by extracting the chlorophyll with a 95% acetone solution saturated with magnesium carbonate. The samples were then centrifuged and their light absorbance read at two standard wavelengths (663 and 750 nanometers).

Phosphorus samples were fixed with 1.0 milliliter of concentrated sulfuric acid and stored refrigerated until analysis. Also, phosphorus samples from lay monitors were received by the FBG in a refrigerated or frozen state, and stored cold until analysis. To determine the total phosphorus content, ammonium persulfate and 11 N sulfuric acid was added to digest the total phosphorus, and the samples were autoclaved for one hour. A single-reagent method was employed using potassium antimony tartrate, ammonium molybdate, and a fresh solution of ascorbic acid (E.P.A. 1979). Absorbance of the blue phosphorus complex was measured with a spectrophotometer at 650 nm. Each sample was analyzed twice and an average of the two values taken as the phosphorus content in parts per billion.

Phytoplankton samples were fixed with iodine (Lugol's solution) immediately after collection. The preserved samples were later counted with an inverted microscope after settling for 24 hours in counting chambers. At least 200 individual algal "units" were counted with a modified scan technique (Baker, 1973).

How the data are analyzed

Incoming data are received through the mail during the sampling season and are first filed in an "incoming data" book. This provides temporary storage until the corresponding chlorophyll and/or phosphorus sample for each data sheet is analyzed. All data, including date, lake,

site, secchi disk depth, chlorophyll a and phosphorus content, alkalinity, and color measurements, are filed and stored on a computerized data-management system of the University of New Hampshire. Data can be easily retrieved by lake, sampling station or date, and used for individual reports and for each year.

Statistical treatment of the data for each lake includes a comparison of seasonal tendencies found throughout the year, monthly means for the different parameters tested, and confidence levels for each site. The same comparisons mentioned above are made on a yearly basis if the lake has been in the program for two years or more. If sufficient data are available from several years, regression analyses and other statistical tests are performed. Such analyses may identify trends and help explain variations in the data (eg. secchi disk depth, chlorophyll a, color). In addition, data is compared with other lakes in the program and to published water quality classifications. Trophic boundaries of Forsberg and Ryding (1980) are used to classify each lake.

RESULTS AND DISCUSSION OF LAY MONITOR DATA

Results from the lay monitors are presented separately from those obtained by the Freshwater Biology Group, as the two groups conducted separate research.

Data on water transparency, chlorophyll a concentration, total phosphorus, and dissolved water color were collected by the lay monitors. Weekly monitoring was done from sites "1 Shallow" and "2 Deep" from July 20 through September 14, 1985.

Water Transparency and Chlorophyll a

Water transparency (secchi disk depth) at site 2 was in the range from 4.8 to 5.9 meters, with an average of 5.3 m. At site 1, most secchi disk readings were recorded as "bottoming out", as the secchi disk was visible at the bottom of the lake (approximately 4.5 m). At both sites, water transparency was highest in July, and decreased slightly as the summer progressed.

During this same time period, the average chlorophyll a concentration was lowest in July at site 1 (no July chlorophyll samples from site 2 were taken) and increased on the average during August and September at both sites. The average chlorophyll a concentration was 0.8 milligrams per cubic meter (mg/cubic m) at site 1 and 1.2 mg/cubic m at

site 2. Values ranged between 0.1 to 1.9 mg/cubic m for both sites.

The water transparency and chlorophyll a concentrations indicate that Little Island Pond is oligotrophic, based on trophic state boundaries of Forsberg and Ryding (1980).

Dissolved Water Color

Dissolved water color, which is the brown coloring of lakewater due primarily to dissolved humic substances (dark-colored organic matter), was very low on Little Island Pond. Measured as the absorbance of light per 5 centimeters at 440 nanometers, it averaged 0.004 at both sites. Both the low dissolved water color and chlorophyll a concentrations help account for the relatively high water transparency on the lake.

Total Phosphorus

Two samples for total phosphorus collected by the lay monitors indicate low levels of phosphorus in Little Island Pond. The concentration was 5.4 micrograms per liter at site 1, and 2.5 at site 2. These low levels indicate oligotrophic conditions, and that there is little nutrient loading into the lake.

RESULTS AND DISCUSSION OF FBG DATA

Temperature and Dissolved Oxygen

Little Island Pond was thermally stratified at site 2 on July 12 when the FBG visited the lake. The epilimnion extended to 4.5 m, the metalimnion (thermocline) occurred from 4.5 to nearly 10 m, and the hypolimnion began at 10 m. The maximum depth was 14.8 m. Site 1 was not thermally stratified. The shallow depth at this site permits mixing of the water column to the bottom, and it is possible that a thermocline (which acts as a barrier to mixing) rarely forms. This is confirmed by temperature profiles from lay monitor data, as a thermocline was found only once during the seven-week sampling period.

Oxygen was abundant at the surface (8 parts per million, or ppm) at both sites. At site 2, there was still sufficient oxygen at 12 meters (4 ppm), but it was near depletion at the bottom. At site 1, oxygen was more abundant at the bottom than at the surface (8.5 ppm). This results from the entire water column mixing to the bottom in combination with the slightly colder temperatures at the lower depths, as the solubility of oxygen increases as temperature decreases.

Water Transparency

The secchi disk depth measured by the FBG was 6.8 m at site 2, and it bottomed out at site 1. These values are comparable to those found by the lay monitors in July. Although the secchi disk depth measured by the FBG at site 2 was higher than any measurements made by the lay monitors, the FBG visited the lake before weekly monitoring began. Chlorophyll and secchi disk data from the lay monitors indicate that water transparency was highest early in July and became lower during August and September. This, along with the fact that water transparency can vary from day to day, may account for the difference in FBG and lay monitor measurements.

Chlorophyll a and Dissolved Water Color

Water transparency is affected by three major factors: the planktonic algae in the water column (assessed by the chlorophyll a concentration), the dissolved water color, and amounts of suspended particulate matter in the water. By measuring two of these parameters, the chlorophyll a concentration and the dissolved water color, the relative influence each has on the secchi disk depth can be estimated.

The chlorophyll a concentrations were 1.0 milligram per cubic meter at site 1 and 1.2 mg/cubic m at site 2. The dissolved water color was 0.02 at site 1 and 0.01 at site 2.

Values in this range are low, and represent the average color for lakes in the LLMP. Results from both chlorophyll a and water color are very low and account for the high water transparency on Little Island Pond.

Total Phosphorus

The FBG found total phosphorus levels which were higher than those found by the lay monitors. At site 1 the concentration was 8.4 micrograms/liter, and at site 2 it was 7.6 micrograms/liter. Although these values are higher than other measurements made, they are still considered low, classifying the lake as oligotrophic. It is possible that the lakewater level was high when the FBG sampled. When this occurs, more nutrients enter the water from along the lakeshore, as well as from inlet streams to the lake.

Alkalinity, pH, and Free Carbon Dioxide

The pH of near-surface water on Little Island Pond was 6.8 at site 1 and 7.1 at site 2, and values remained above 6 throughout the entire water column.

The average alkalinity at both sites was 6.2 milligrams calcium carbonate/liter. Values in this range are low on a national scale, and slightly below average for the state of New Hampshire. The average alkalinity for lakes in the LLMP is approximately 9 milligrams/liter. Alkalinity is a measurement of the ability of a lake to buffer acids. When the buffering capacity is too low (alkalinity of 2 mg/l),

the lake is unable to resist changes in pH, and the pH will decrease rapidly if further acid is added. A pH of 5.9 or lower may create an environment harmful to fish and other organisms. Because of this, and because acid precipitation is a potential problem for many New Hampshire lakes, alkalinity monitoring is very important and should be continued in the future.

At both sites, levels of free carbon dioxide were very low at the surface (less than 0.6 mg/liter). At site 1, levels remained low to the bottom, and at site 2, levels of carbon dioxide accumulated at the bottom. High levels of carbon dioxide in the hypolimnion indicates the presence of bacterial respiration in the sediments.

Specific Conductivity

Little Island Pond had a low specific conductivity, with an average of 83.0 micromhos at both sites. Low specific conductivity suggests that low levels of road salt and/or raw sewage enter the lake.

Phytoplankton

The density of phytoplankton was high at both sites on Little Island Pond. At site 1 Shallow, there were 7200 cells per milliliter (cells/ml). The Prymnesiophyceae were dominant, with high numbers of Chrysochromulina. In addition, the Cyanophyceae (bluegreens) and Chlorophyceae (greens algae) were also relatively abundant. At site 2

Deep, there were 4236 cells/ml, also dominated by the Chrysophyceae. At this site, the oxygen profile showed elevated oxygen concentrations from 4 - 6 meters, which suggests the presence of a phytoplankton bloom. A phytoplankton sample taken at 4.5 m had 2028 cells/ml, dominated by the Cyanophyceae, with Aphanothece being the most abundant.

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APPENDIX A

11:40.56 LLMP -- Lay Monitor Data: Little Island Pond Feb-21-86

Date	Lake	Site	SDD	Chl
Jul-20-85	Little Island	P 1 Shallow	---	.14
Jul-27-85	Little Island	P 1 Shallow	---	.14
Aug-04-85	Little Island	P 1 Shallow	4.50	1.07
Aug-11-85	Little Island	P 1 Shallow	---	1.21
Aug-18-85	Little Island	P 1 Shallow	4.30	.78
Aug-27-85	Little Island	P 1 Shallow	---	.93
Sep-02-85	Little Island	P 1 Shallow	---	1.36
Sep-14-85	Little Island	P 1 Shallow	---	---
Jul-20-85	Little Island	P 2 Deep	5.90	---
Jul-27-85	Little Island	P 2 Deep	5.70	---
Aug-04-85	Little Island	P 2 Deep	4.75	1.43
Aug-11-85	Little Island	P 2 Deep	5.50	1.21
Aug-18-85	Little Island	P 2 Deep	5.10	.71
Aug-28-85	Little Island	P 2 Deep	4.80	.93
Sep-02-85	Little Island	P 2 Deep	5.10	1.78
Sep-14-85	Little Island	P 2 Deep	---	---

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NOTE

There are three levels of reports available to participating lake associations in the LLMP. They are differentiated as follows:

LEVEL I - This is a basic report that includes sections on the methods employed, comments and recommendations, and a brief summary of results. It also contains an appendix listing data from the present and past years.

LEVEL II - This is a mid-level report that includes methods employed, a non-technical summary of lay monitor and FBG data, comments and recommendations and an in-depth results and discussion section. It contains an appendix listing data from the present and past years.

LEVEL III - This is a full report which includes the following sections: methods employed, a non-technical summary, comments and recommendations, a technical summary, and a complete results and discussion section supplemented by computerized graphics. It also contains 3-4 appendixes: a listing of present-year and past data, limnological concepts and technical terms, and a glossary.