

CONWAY LAKE

LAKES LAY MONITORING PROGRAM

1986

Freshwater Biology Group (FBG)

University of New Hampshire

Durham

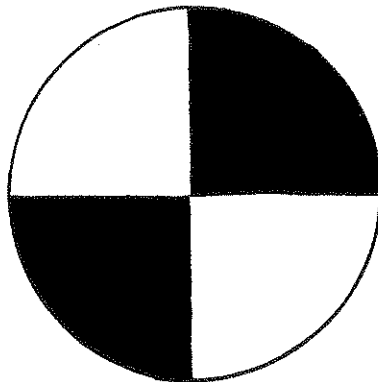
by

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LAKES LAY MONITORING PROGRAM

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



the fall, Alice Hibberd assisted in data organization and data entry and Jeff continued as **LLMP** Coordinator responsible for data interpretation and report writing.

The **FBG** would like to thank the University of New Hampshire Undesignated Gifts Committee for the partial funding of the coordinator position. Eileen Wong of the Department Zoology provided accounting and secretarial service. The Department of Botany and Plant Pathology provided lab and storage space. We would also like to recognize the UNH Office of Computer Services for the provision of computer time and data storage space.

Participating groups in the **LLMP** for 1986 included: The New Hampshire Audubon Society, Derry Conservation Commission, Nashua Regional Planning Commission, Center Harbor Bay Conservation Commission, Governor's Island Club Inc., Little Island Pond Rod and Gun Club, Walker's Pond Conservation Society, United Associations of Alton, the associations of Baboosic Lake, Beaver Lake, Berry Bay, Bow Lake Camp Owners, Lake Chocorua, Flint Pond, Lake Kanasatka Watershed, Langdon Cove, Long Island Landowners, Moultonbouro Bay, Lake Winnipесаaukee, Naticook Lake, Newfound Lake, Nippo Lake, Scruton Pond, Silver Lake (Hollis), Silver Lake (Madison), Squam Lake, Sunset Lake, Lake Winona, and Lake Wentworth and the towns of Hollis and Stratham.

## PROGRAM DESCRIPTION

### The Lakes Lay Monitoring Program

The New Hampshire Lakes Lay Monitoring Program (LLMP) is a research and educational function of the Freshwater Biology Group (FBG) at the University of New Hampshire co-directed by Professors Alan Baker, Department of Botany and Plant Pathology, and James Haney, Department of Zoology and coordinated by Jeffrey Schloss. The program involves the cooperative participation of lake residents, lake associations, conservation and planning commissions and local governments with University faculty and students. Developed in 1978 around Squam Lake, the program has grown to include more than 30 lakes throughout New Hampshire.

As a research project, the LLMP has investigated the extent of lake degradation caused by perturbations such as acid rain, septic and agricultural runoff, and lakeshore development. Essentially the monitors in the program collect data once each week. The data are stored on a computer, the results are analyzed periodically, and interpretive reports are written that include graphics and statistical analyses. A major goal is to detect any short or long-term changes in the water quality of the lakes. To that end a long-term data base has been established.

As an educational tool, several students are trained each year to collect and analyze lakewater samples for physical, chemical and biological parameters, and to interpret water quality data. In addition, more than 200 "lay" monitors have been trained to monitor their own lakes and educated about lake water quality.

As a service to the state and to local communities, the reports of the LLMP are available at cost, and should prove useful to lake residents, conservationists, developers and land-use planners. Also, LLMP staff members conduct workshops, lectures and informal talks on various lake related topics and hold advisory positions on many municipal and private conservation and planning boards. The LLMP is a not-for-profit organization with funding derived primarily from the participating groups.

## COMMENTS AND RECOMMENDATIONS

1) We recommend that each association, including the Walker's Pond Conservation Society continue to develop their data base on lake water quality through continuation of the long term monitoring program. The data base will provide information on the short and long-term cyclic variability that occurs in the lake and eventually will enable more reliable predictions of water quality trends.

2) We suggest that lay monitors initiate dissolved color testing on a weekly basis to better document the variability. There is no additional expense for this test.

3) We recommend the initiation of total phosphorus testing as early as possible after spring melt. This should be combined with sampling of the lake during a time of heavy use (ie: 4 July, Labor Day). Early spring phosphorus data combined with summer sampling can provide information on the amount and sources of phosphorus loading into the lake. The lake seems to be at a critical point of development and a better idea of nutrient loading is important

4) The **FBG** trip provided a more in-depth analysis of the lake during late stratification conditions. We recommend one or more **FBG** trips in 1987. This will also allow sampling of the metalimnion of the lake to follow the stratification of

algae. The trip also showed that the data the lay monitors are collecting compares well to data collected by the **FBG**.

5) As a general addition to our Lakes Lay Monitoring Program, we recommend that each lake in the Program begin monitoring the condition of the fish taken from the lake. The "Fish Monitoring" will require at least one lay monitor to 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. The required equipment, supplies and analytical costs will be approximately \$100. Explanation of procedures and fish identification will be given to monitors who decide to measure this parameter.

Length-to-weight ratios give a measure of the nutritional condition of the fish. Age analysis of the fish scales (to be done at UNH) will tell how old each fish is. Together, these variables can help to track changes in the condition of the fish populations in the lake, and, of course, the "health" of the lake.

## INTRODUCTION

### Importance of long term monitoring

A major goal of this program is to identify any short or long-term changes in the water quality of the lakes. Of major concern, is the detection of cultural eutrophication; increases in the productivity of the lake due to the addition of nutrients from human activities. Changes in the natural buffering capacity of the lakes in the program is also a topic of great concern since New Hampshire receives large amounts of acid precipitation. Weekly sampling of a lake during a single summer provides information only on the variation that occurs. Short-term differences may be due to variations in weather or lake activity, or other chance events. The resulting short-term fluctuations may be unrelated to the actual long-term trend.

As an example, a 30 year study of a lake may indicate a long-term trend toward eutrophy (Fig. 1). Yet if only the data from a five year period (ie: Fig 1, years 1975-80) are examined, no apparent trends can be seen. If only two years are examined, the data suggest a decrease in eutrophy! Monitoring carried out weekly over the course of many summers can provide the information required to distinguish between short-term fluctuation ("noise") and long-term



trends ("signal"). To that end, each lake must establish a long-term data base.

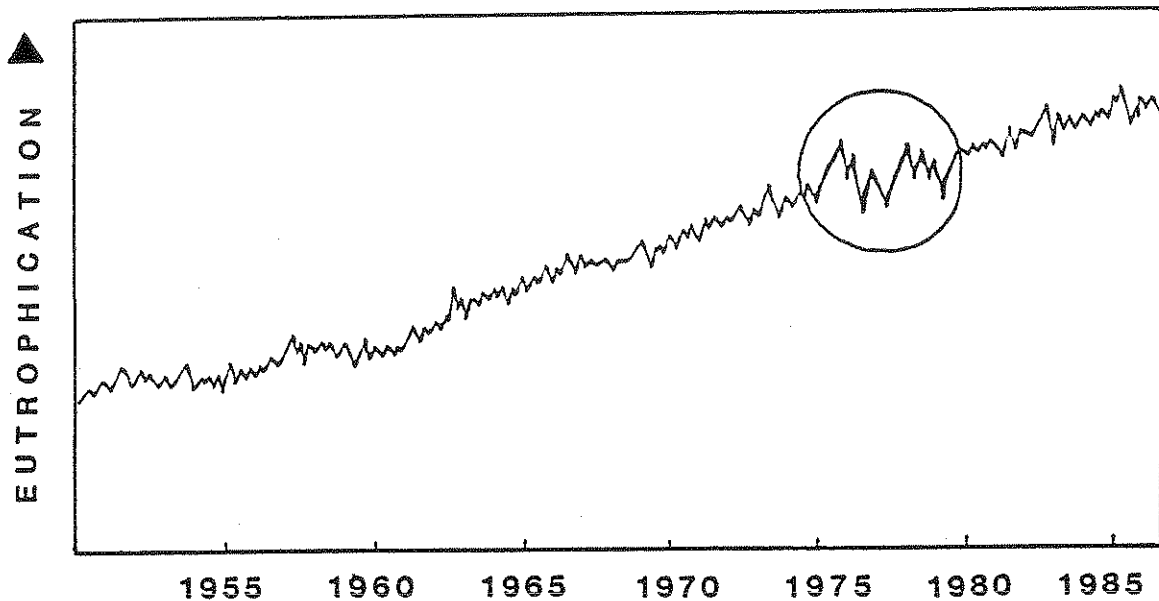


Figure 1. Eutrophication of a hypothetical lake over time. Circled area is enlarged for comparison between short and long-term trends.

The number of seasons it takes to discern between the noise and the signal is not the same for each lake. Evaluation and interpretation of a long term data base will indicate that the water quality of the lake has worsened, improved, or remained the same. As more data is collected prediction of current and future trends can be made. No matter what the outcome, this information is essential for the intelligent management of the lake.

There are also short-term uses for lay monitoring data. The examination of different stations in a lake can disclose specific problems and corrective action can be initiated to handle the situation before it becomes more serious. On a lighter note, some associations post their weekly data for use in determining the best depths for finding fish!

It takes a considerable amount of effort as well as a deep concern for one's lake to be a lay monitor. Many times a monitor has to brave inclement weather or heavy boat traffic to collect samples. Sometimes it even may seem that one week's data is just the same as the next. Yet every sampling provides important information on the variability of the lake.

Every data sheet the LLMP receives is significant to further the understanding of the lakes in the program. We are pleased with the interest and commitment of our lay monitors and are proud that their work is what makes the LLMP the most extensive, and we believe, the best volunteer program of its kind.



## METHODS OF LAY MONITORS

Lay monitors receive their initial training either on-site or on campus from a member of the FBG. Workshops covering new techniques are usually offered on a yearly basis and updates may be held on-site during an FBG sampling trip.

This year data were collected on six parameters: thermal stratification, water clarity (secchi disk depth), chlorophyll a concentration, total phosphorus, total alkalinity 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 or hand delivered 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, stoppered, empty bottle 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 (upper water column), at one-half meter intervals throughout the metalimnion (depths at which

the temperature change is greater than 1 degree Celsius per meter) and at one meter intervals through the hypolimnion (depths below the metalimnion).

Water clarity was measured by lowering a secchi disk (approximately 20 cm. or 8 inches) through the water off the shaded side of the boat, and noting the average of the depths at which it disappeared upon lowering and reappeared when being raised (the cord attached to the secchi disk is marked in one tenth of a meter for the first half meter and in one-half meters thereafter). Water clarity was determined 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 to the top of the metalimnion (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 blue plastic 2.5

liter bottle and stored in the shade until chlorophyll filtration could be done.

Water samples for chlorophyll a filtration were filtered through a 0.45 micron membrane filter under low vacuum. Damp filters, containing chlorophyll-bearing algae, were air-dried for at least 15 minutes, in the dark, 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 the **FBG** team (see Methods of the Freshwater Biology Group).

To determine the alkalinity, lake water samples were titrated with 0.002 N sulphuric acid in the presence of the indicator methyl red/bromocresol green to a pH of 5.1 (grey endpoint) and 4.6 (pink endpoint). The amount of titrant used (dilute sulphuric acid) was recorded to the nearest 0.1 ml, equivalent to milligrams of calcium carbonate per liter. Values reported can be converted to microequivalents of calcium carbonate using a multiplication factor of 20.

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 (ie: sites along the shoreline, inlets or outlets), sub-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 of the Freshwater Biology Group).

## METHODS OF THE FRESHWATER BIOLOGY GROUP

The Freshwater Biology Group (FBG) research team took one trip to Conway Lake and conducted several tests which included measurements of sunlight penetration into the water, dissolved oxygen, temperature, alkalinity, free (unbound) carbon dioxide, pH, specific conductivity, chlorophyll a, dissolved color, total phosphorus, and a survey of the microscopic plants (phytoplankton) and animals (zooplankton). The FBG also processed chlorophyll a, dissolved color, and phosphorus samples provided by the lay monitors. The input, storage and analysis of all LLMP data is also the responsibility of the FBG.

### 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. The coefficient of light extinction was calculated from the relative light intensities measured.



Samples of lake water chemistry to be analyzed for 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) were determined chemically with the azide modification of the Winkler method (EPA 1979). The precision of the method provides a standard for the electronic probe. Water is collected in 350 ml biological oxygen demand (BOD) bottles and fixed with two reagents, manganese sulfate and alkali-iodine-azide. A loose precipitate (floc) of manganic hydroxide that is equivalent to all dissolved oxygen originally present in the sample. Concentrated sulphuric acid is added to the bottle which causes a stoichiometric release of dissolved iodine equal to the original amount of dissolved oxygen present. A known quantity of sample is then titrated to an equivalence point using .0250N phenylarsine oxide titrant (similar to, but more stable than, sodium thiosulphate which may also be used) and a starch indicator solution. The end-point is

reached when the purple colored iodine-starch complex is reduced and the solution becomes colorless. The amount of titrant added is recorded to the nearest 0.1 ml and concentrations are reported to the nearest 0.2 milligrams dissolved oxygen per liter.

To determine the alkalinity, lake water samples were titrated with 0.002 N sulphuric acid in the presence of the indicator methyl red/bromocresol green to a pH of 5.1 (grey endpoint) and 4.6 (pink endpoint). The amount of titrant used (dilute sulphuric acid) was recorded to the nearest 0.1 ml, equivalent to milligrams of calcium carbonate per liter. Values reported can be converted to microequivalents of calcium carbonate using a multiplication factor of 20.

"Free" carbon dioxide concentration was determined by titrating the fresh lakewater samples with 0.0027 N sodium hydroxide to a final endpoint pH of 8.3, in the presence of the indicator dye phenolphthalein.

Lakewater pH was measured with a digital pH meter (Beckman model phi 44 ) equipped with a combination probe (Orion Co.) and an automatic temperature compensating probe. The meter was calibrated with pH 4 and pH 7 buffer solutions and then the probe was allowed to equilibrate in the lake water for at least thirty minutes prior to sample analysis.

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 of potassium chloride solution conductivity versus temperature. Results are reported as micro-Siemens (uS; where uS equals  $\mu\text{mho cm}^{-2}$ ) standardized to 18<sup>o</sup> Centigrade.

Samples to be analyzed for chlorophyll a, total phosphorus, and phytoplankton were collected with a vertical tube sampler into a 2.5 liter dark plastic bottle. Chlorophyll samples were filtered through a 0.45 micron membrane filter and air-dried in the dark 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) with a Baush and Lomb model 710 spectrophotometer equipped with 50mm cuvettes. An absorptivity value of 84 gm liter<sup>-1</sup> cm<sup>-1</sup> (Vollenweider 1969) was used for calculating the concentrations.

Dissolved color samples of the filtrate from FBG and lay monitor chlorophyll filtrations was determined by reading the absorbance of the samples at two different wavelengths (440 and 493 nanometers) in a 50mm light path. The two readings were converted to the more widely used

platinum cobalt color values (ptu) using standard curves of the absorbance of chloroplatinate.

Phosphorus samples were preserved with 1.0 milliliter of concentrated sulphuric acid and 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 thirty minutes at 250 to 260 degrees C. Reagents included potassium antimony tartrate, ammonium molybdate, and a solution of ascorbic acid mixed fresh before each sample run (E.P.A. 1979). Absorbance of the blue phosphorus complex was measured with a spectrophotometer at 650 nanometers. A standard curve of the absorbance of a potassium phosphate (monobasic) solution to convert the readings to total phosphorus concentrations. Each sample was analyzed twice and an average of the two values taken as the phosphorus content in parts per billion (ppb).

Phytoplankton samples were preserved with iodine (Lugol's solution) immediately after collection. Algae were later identified and counted with an inverted microscope after settling for 24 hours in 5 or 10 ml counting chambers. At least 200 individual algal "units" were counted with a

modified scan technique (Baker, 1973). Phytoplankton are reported to species level whenever possible.

Zooplankton samples were collected with a plankton net (30 centimeter diameter, 150 micron porosity) towed vertically through the oxygenated portion of the water (>0.5 ppm oxygen). Samples were immediately preserved in a 4% formalin-sucrose solution (Haney and Hall, 1973). Organisms were identified to species whenever possible. Subsampling, whenever necessary, was done with a 1 ml Hensen-Stemple pipette. Repeated subsamples were analyzed until at least 100 organisms were counted.

#### Data analysis

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 concentrations, alkalinity, and color measurements, are filed and stored on the FBG computerized data-management system that utilizes a mainframe DEC VAX-8650 computer and an IBM compatible microcomputer (Zenith Data Systems 158). With full use of relational data bases, such as S1032 and Dbase III+ data can be easily retrieved by lake, date,

station or by parameter and used for individual reports and for each year.

Statistical treatment of the data from each lake, produced for level III reports, 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 are made on a yearly basis if the lake has been in the program for two years or more. Where sufficient data are available from several years, regression analyses and other statistical tests can be performed. Such analyses may identify trends and help explain variations in the data (eg. secchi disk depth, chlorophyll a, color). In addition, data from a lake may be compared with other lakes in the program, other computerized data bases (New Hampshire Water Supply and Pollution Control, New Hampshire Fish and Game, EPA Surface Water Survey and others) and to published water quality classifications.

Trophic boundaries of Forsberg and Ryding (1980) of transparency, chlorophyll a, and total phosphorus are used as criteria in discussions of the trophic state of the program lakes. Phytoplankton are reported both as species and classes. Crustacean zooplankton were classified into one of four categories depending on their size (large or small) and their feeding preferences (herbivore or predator) with a

modified version of criteria from Sprules (1980). The differences in abundance between the different groups allow for a more complete description of the zooplankton community and the trophic classification of lakes.

## RESULTS AND DISCUSSION OF LAY MONITOR DATA

Monitoring of Conway Lake was done at two locations, site 1 Andrew's Point with a maximum depth of 12 meters and site 2 Gull Rock with a maximum depth of 9.5 meters. This year, sampling for temperature, secchi disk depth, chlorophyll a, dissolved color, alkalinity and total phosphorus took place weekly from 1 July through 6 October. See figure 2 for the sampling site locations and Appendix A for the 1985-86 Lay monitor data.

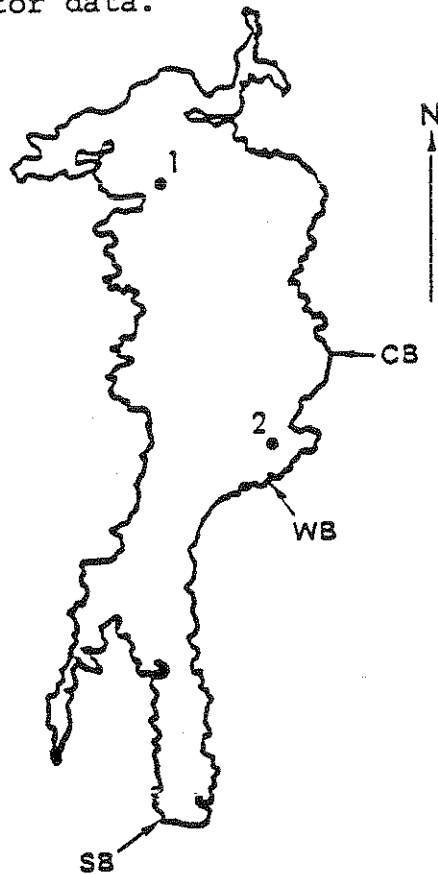


Figure 2. Location of sampling sites on Conway Lake, Town of North Conway, New Hampshire.



### Water Transparency

Secchi Disk depth is a measure of the water transparency. The deeper the depth of secchi disk disappearance, the more transparent the lake water; light penetrates deeper if there is little dissolved and/or particulate matter (which includes both living and non-living particles) to absorb and scatter it.

Site 1 Andrew's had an average secchi disk depth of 4.9 meters with a range of 3.8 to 5.8 meters. The Site 2 Gull transparency average was less, 5.2 meters, with a range of 3.5 to 5.0 meters. Large fluctuation of transparency values occurred this year (Fig. 3A). The transparency generally fell within the range for clear oligotrophic lakes but on certain certain dates reached into the mesotrophic range. Average transparency values for the lake in 1986 are lower than the averages of previous years (5.8 to 6.3 meters averages for site 1, 5.2 meters for site 2). Further monitoring of the lake will be important to see if this is just a short term phenomenon.

### Chlorophyll a

The chlorophyll a concentration is a measurement of the standing crop of phytoplankton and is often used to classify lakes into categories of productivity called trophic states. **Eutrophic** lakes are highly productive with large amounts of algae and aquatic plants due to nutrient enrichment.

Oligotrophic lakes have low productivity and low nutrient levels and mesotrophic lakes are intermediate in productivity.

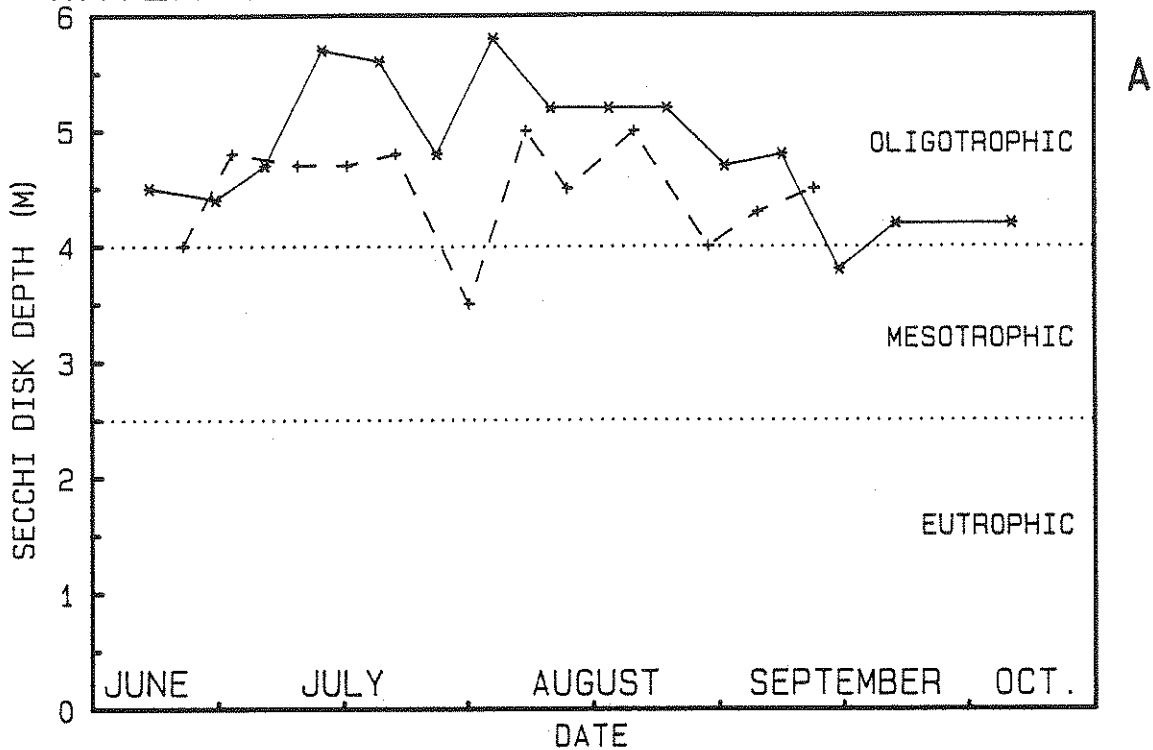
Site 1 chlorophyll a concentrations were in the range of 1.3 to 6.1 mg m<sup>-3</sup> with an average of 3.0 mg m<sup>-3</sup>. Site 2 had slightly lower concentrations with an average of 2.5 mg m<sup>-3</sup> and a range of 1.1 to 4.1 mg m<sup>-3</sup>. Both averages are approaching mesotrophic levels. Highest concentrations occurred during June to mid-July (when Site 1 concentration was just below eutrophic levels) and the end of August (Fig 3B). The increased chlorophyll concentrations could account for the decrease in water transparency. As with secchi disk the general water quality of the lake as measured by chlorophyll a was not as good as previous years. Comparison of the transparency and chlorophyll data between the sites suggests that transparency at Site 2 is dependent upon other factors along with chlorophyll since it has lower water transparency but lower chlorophyll concentrations.

#### Dissolved Color

The dissolved color of lakes is generally due to dissolved organic matter from humic substances, which are naturally-occurring polyphenolic compounds leached from decayed vegetation. Highly colored or "stained" lakes have a "tea" color. Such substances generally do not threaten water

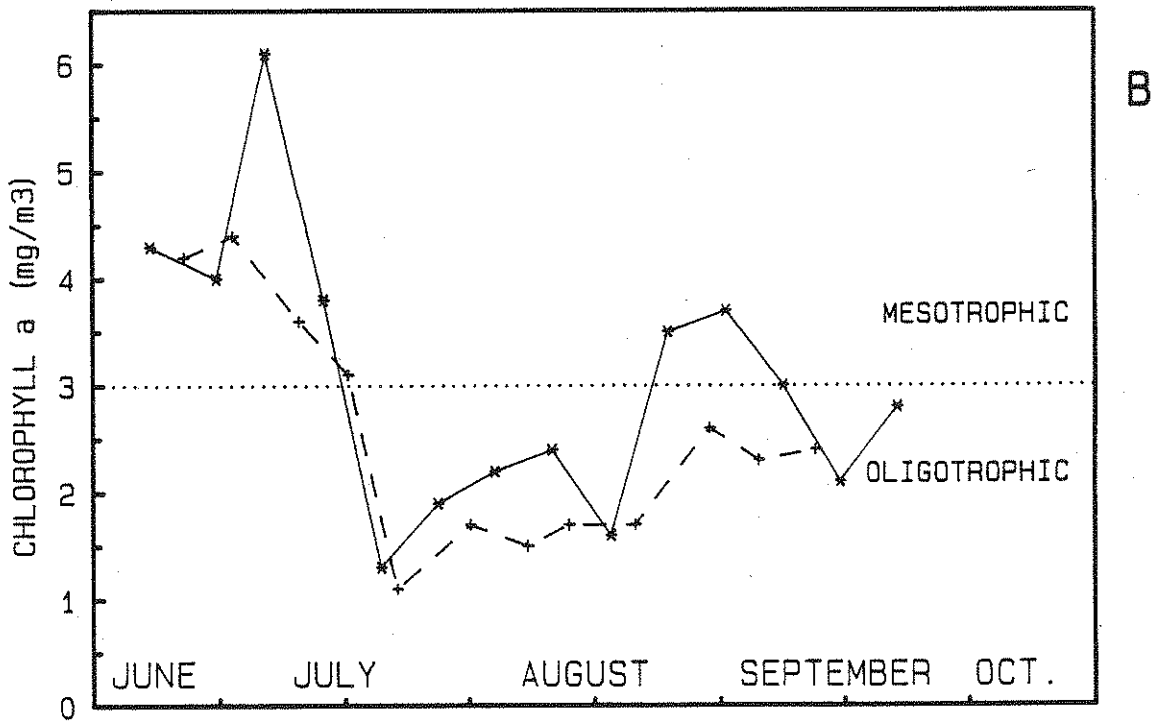
Figure 3. - Seasonal trends for secchi disk depth (water transparency) (A) and chlorophyll a concentration (B) at Conway Lake sites 1 Andrew's Point (solid line with asterisks) and 2 Gull Rock (dashed line with crosses) determined from lay monitor data. Dotted lines on the plots border the ranges common to oligotrophic, mesotrophic and eutrophic lakes.

# WATER TRANSPARENCY CONWAY LAKE 1986



Sites: \*—\* = Andrew's Pt., +---+ = Gull Rock

# CHLOROPHYLL a CONWAY LAKE 1986



quality except as they diminish sunlight penetration into deep waters.

Both lake sites had an average dissolved color of 20 ptu with a range of 15 to 24 ptu. This is a slightly higher average than in previous years. Greater than normal precipitation during the summer of 1986 or increased phytoplankton (as indicated by chlorophyll) might account for the slightly higher water color. To put the color level in perspective, dissolved color concentrations of all lakes participating in the LLMP in 1986 were in the range <1 to 117 ptu with an average of 18.5. Thus, Conway Lake color was average compared to all lakes in the program.

#### Total Phosphorus

Of the two "nutrients" most important to the growth of aquatic plants, nitrogen and phosphorus, it is generally observed that phosphorus is the more limiting to plant growth, and therefore the more important to monitor and control. Phosphorus is generally present in lower concentrations, and its sources include primarily anthropogenic activity in a watershed. Nitrogen can be fixed from the atmosphere by many bloom-forming blue-green bacteria, and thus it is difficult to control. The total phosphorus includes all dissolved phosphorus as well as phosphorus contained in or adhered to suspended particulates such as sediment and plankton.

Total phosphorus samples were taken in the spring (April 17) at the tributaries. As in previous years, Willey Brook had higher concentrations than other sites sampled. The range of concentrations, 7.0 to 11.0 ppb, is within oligotrophic levels (less than 15 ppb) indicating no great phosphorus loading from the tributaries at this time

### Alkalinity

Alkalinity is a measure of the buffering capacity of the lake water. The higher the value the more acid that can be neutralized. Typically lakes in New Hampshire have low alkalinities due to the absence of carbonates and other natural buffering minerals in the bedrock of lake watersheds.

Site 2 showed slightly higher alkalinity than Site 1 and the lake average for 1986 was 3.8 (grey endpoint) and 4.3 (pink endpoint) total alkalinity as mg CaCO<sub>3</sub> liter<sup>-1</sup>. The results of this year are similar to values measured last year indicating that alkalinity is at a very low level but has remained constant in the two years this parameter has been measured by the lay monitors.



## RESULTS AND DISCUSSION OF FBG DATA

Chlorophyll a, water transparency and dissolved color measured during the FBG field team visit on 1 August fall within the ranges found by the lay monitors throughout the sampling season (Table 1). Results from lay monitor data collected at Site 1 Andrew's Point on 28 July and at Site 2 Gull Rock on 1 August also compare well to the FBG data.

Table 1. COMPARISON OF 1986 FBG AND LAY MONITOR RESULTS

<u>Site/Date/Group</u>	<u>Secchi Disk</u>	<u>Chlorophyll</u>	<u>Color</u>
1 1 AUG FBG	5.2m	2.0 mg m <sup>-3</sup>	20 ptu
1 28 JUL Lay Monitor	4.8	1.9	---
1 Lay Monitor Range	3.8 - 5.8	1.3 - 6.1	15 - 23
2 1 AUG FBG	5.1	1.4	20
2 1 AUG Lay Monitor	5.0	1.7	22
2 Lay Monitor Range	3.5 - 5.0	1.1 - 4.4	15 - 24

### Total Phosphorus

Phosphorus concentration on 1 August was 3.5 ppb at Site 1 and 6.0 ppb at Site 2, both low values. Concentrations of total phosphorus at both sites were greater than 1985 values but less than August 1983 and 1984 values. No evidence of gulls was apparent on Gull Rock and



the lower concentrations there compared to previous years might be due to their decline.

### Specific Conductivity

The specific conductance of a water sample indicates concentrations of dissolved salts. Leaking septic systems and de-icing salt runoff from highways can cause high conductivity values. Conductivity values at Conway Lake had a range of 31 to 35 uS suggesting that the lake is receiving low inputs of road salts and /or raw sewage at the two deep sites.

### Stratification in the Deep Water Sites

Profiles of temperature for the two deep sites studied (Fig. 4) show distinct patterns of temperature stratification where a layer of warmer water (the epilimnion) overlies a deeper layer of cold water (hypolimnion). The layer that separates the two regions characterized by a sharp drop in temperature with depth is called the thermocline or metalimnion.

Oxygen concentrations were high in the upper waters with a decline down to about 2 mg liter<sup>-1</sup> in the hypolimnion. Carbon dioxide in the hypolimnion was moderate. Thus the temperature and dissolved gas profiles of Conway Lake are similar to those of low to moderately productive lakes. Slight increases in oxygen at the thermocline suggest

the presence of a metalimnetic layer of algae. The development of this layer should be monitored in future studies.

### Phytoplankton

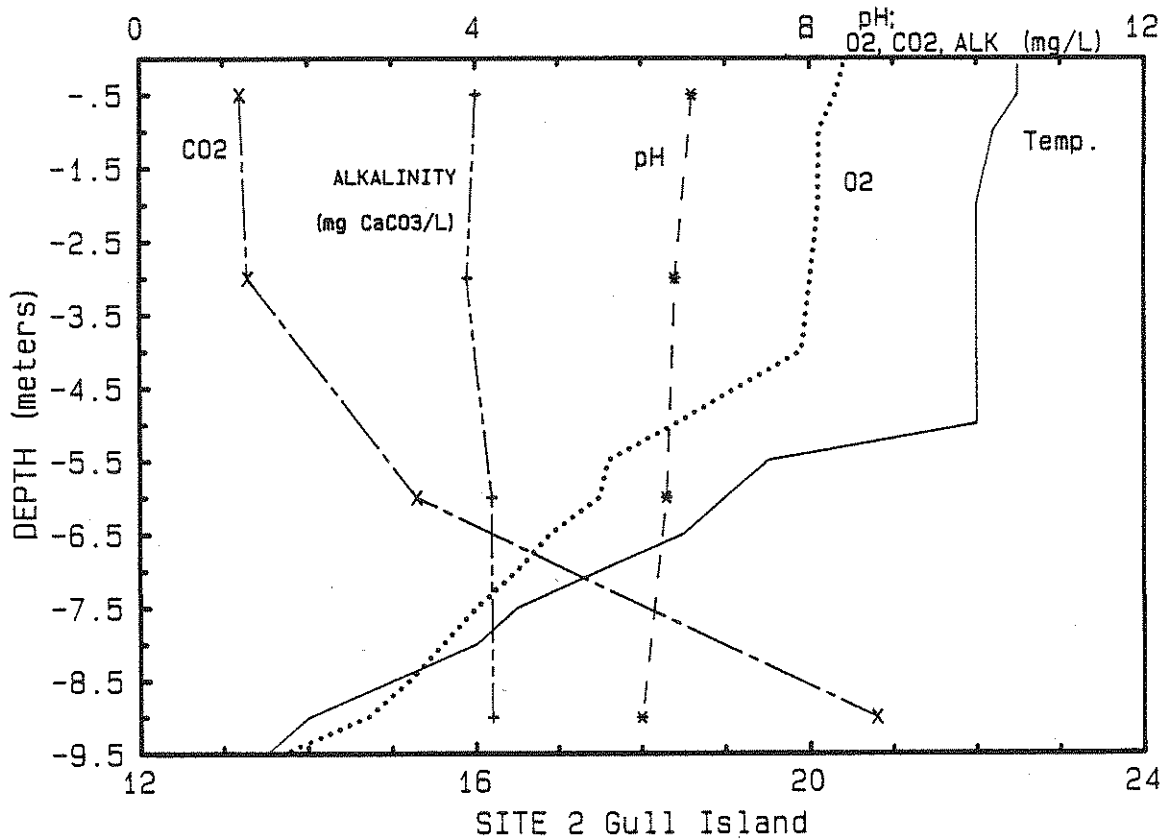
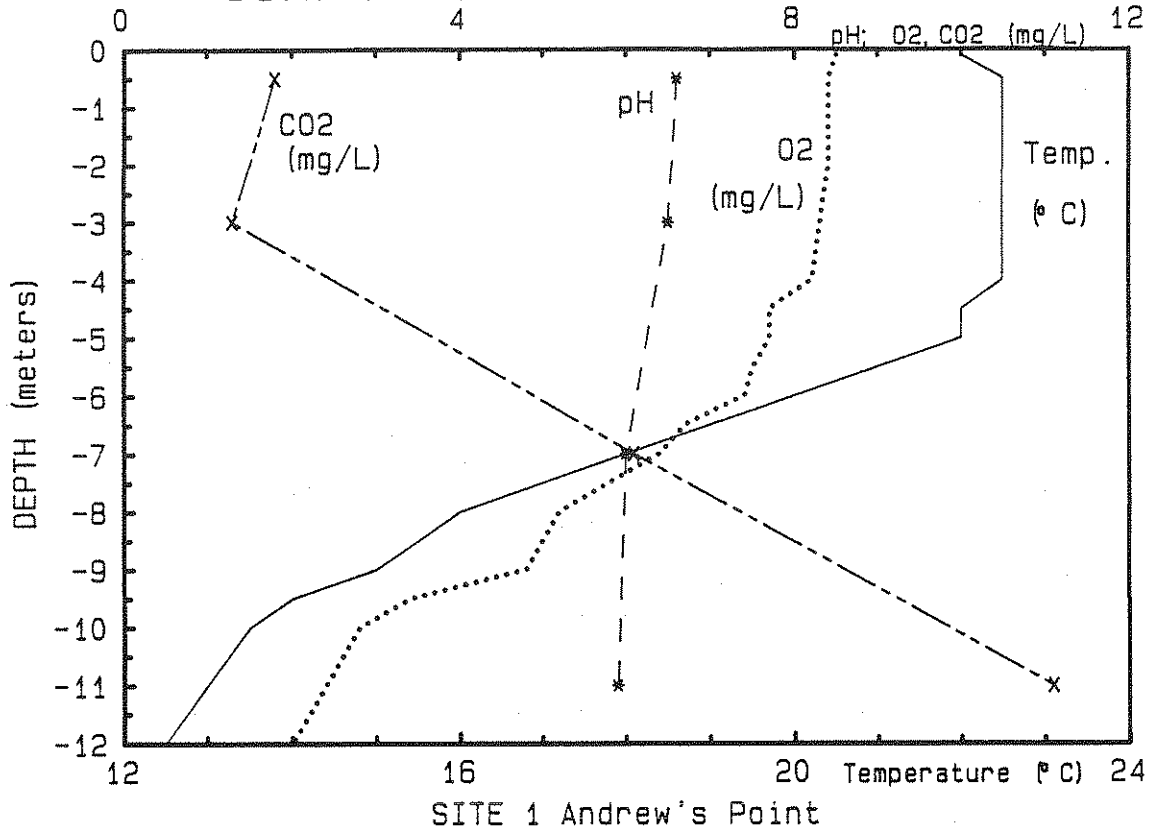
Concentration of phytoplankton at both sites, 3144 organisms per ml at Site 1 and 2292 per ml at Site 2, suggest the lake has become more productive than in previous years. Numbers and types of organisms suggest that Conway Lake is moderately productive (mesotrophic). Concentrations of algae correspond to the higher chlorophyll levels encountered this year. Dominant phytoplankton at both sites are golden algae. Blue-green bacteria were subdominant and found in higher numbers at Site 1 than Site 2.

### Zooplankton

Macrozooplankton (caught using a 150 micrometer mesh net) were at moderate concentrations. The Site 1 with a concentration of 5.3 organisms per liter was dominated by small herbivorous cladocerans such as Bosmina and Diaphanosoma. At Site 2, the concentration was 3.0 per liter and Bosmina was the dominant form. The dominance of smaller herbivores in a lake compared to larger forms may suggest the presence of planktivorous fish such as perch.

**Figure 4** - Profiles of temperature (temp.), dissolved oxygen (O<sub>2</sub>), "free" carbon dioxide (CO<sub>2</sub>), pH, and total alkalinity on 1 August 1986 at Conway Lake sites 1 Andrew's Point (top plot) and 2 Gull Rock (bottom plot). Units of measurement are as indicated. Note that the temperature scale shown at the bottom of each plot starts at 12 degrees C. Other parameters are scaled 0 to 12 by the uppermost horizontal axis. Oxygen and temperature were measured at one-half meter intervals, other parameters were sampled at the discrete depths indicated by the x's, asterisks and crosses.

# CONWAY LAKE 1 AUGUST 1986





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Appendix A --- Data Listing

Lakes Lay Monitoring Program, U. N. H.

[Lay Monitor Data]

Conway Lake of Center Conway, NH

-- subset of trophic indicators, all sites, 1983

1983 SUMMARY

Average transparency: 5.6 (1983: 27 values)  
 Average chlorophyll: 1.2 (1983: 27 values)

SITE	DA	SDD	CHL	TOT_PHOS_PPB	ALK_GRAY	ALK_PINK	COLOR440
1 Andrews	06/19/1983	4.9	1.4	---	---	---	-----
1 Andrews	07/07/1983	---	1.6	---	---	---	-----
1 Andrews	07/14/1983	4.7	1.1	---	---	---	-----
1 Andrews	07/21/1983	5.5	0.8	---	---	---	-----
1 Andrews	07/28/1983	6.5	1.1	---	---	---	-----
1 Andrews	08/05/1983	6.2	1.1	---	---	---	-----
1 Andrews	08/11/1983	6.1	1.0	---	---	---	-----
1 Andrews	08/18/1983	5.8	0.6	---	---	---	-----
1 Andrews	08/25/1983	5.7	---	---	---	---	-----
1 Andrews	09/01/1983	6.6	2.3	---	---	---	-----
1 Andrews	09/09/1983	7.5	2.6	---	---	---	-----
1 Andrews	09/15/1983	7.4	1.0	---	---	---	-----
1 Andrews	09/22/1983	6.0	1.0	---	---	---	-----
1 Andrews	10/06/1983	5.8	1.5	---	---	---	-----
1 Andrews	10/19/1983	4.3	1.2	---	---	---	-----
2 Gull	06/19/1983	5.6	1.0	---	---	---	-----
2 Gull	07/11/1983	4.8	0.8	---	---	---	-----
2 Gull	07/16/1983	4.8	1.0	---	---	---	-----
2 Gull	07/23/1983	4.6	0.6	---	---	---	-----
2 Gull	07/31/1983	5.2	0.9	---	---	---	-----
2 Gull	08/05/1983	5.5	0.4	---	---	---	-----
2 Gull	08/14/1983	5.1	1.5	---	---	---	-----
2 Gull	08/21/1983	4.0	1.2	---	---	---	-----
2 Gull	08/27/1983	4.5	2.5	---	---	---	-----
2 Gull	09/04/1983	4.9	1.1	---	---	---	-----
2 Gull	09/20/1983	6.8	0.9	---	---	---	-----
2 Gull	09/27/1983	5.8	1.3	---	---	---	-----
2 Gull	10/04/1983	6.1	0.9	---	---	---	-----

<< End of 1983 listing, 28 records >>



Lakes Lay Monitoring Program, U. N. H.

[Lay Monitor Data]

Conway Lake of Center Conway, NH

-- subset of trophic indicators, all sites, 1984

1984 SUMMARY

Average transparency: 5.5 (1984: 18 values)  
 Average chlorophyll: 1.1 (1984: 18 values)

SITE	DA	SDD	CHL	TOT_PHOS_PPB	ALK_GRAY	ALK_PINK	COLOR440
1 Andrews	07/11/1984	5.0	1.3	---	---	---	---
1 Andrews	07/18/1984	4.8	1.4	---	---	---	---
1 Andrews	07/25/1984	5.3	2.3	---	---	---	---
1 Andrews	08/01/1984	5.5	2.8	---	---	---	---
1 Andrews	08/08/1984	6.3	0.8	---	---	---	---
1 Andrews	08/15/1984	6.4	0.6	---	---	---	---
1 Andrews	08/22/1984	6.1	0.8	---	---	---	---
1 Andrews	08/30/1984	6.4	0.6	---	---	---	---
1 Andrews	09/05/1984	6.7	1.5	---	---	---	---
2 Gull	07/26/1984	4.5	1.9	---	---	---	---
2 Gull	08/01/1984	4.8	0.4	---	---	---	---
2 Gull	08/09/1984	5.8	0.6	---	---	---	---
2 Gull	08/15/1984	5.5	0.4	---	---	---	---
2 Gull	08/22/1984	5.8	1.1	---	---	---	---
2 Gull	08/29/1984	5.2	0.7	---	---	---	---
2 Gull	09/06/1984	4.4	0.8	---	---	---	---
2 Gull	09/13/1984	5.5	1.1	---	---	---	---
2 Gull	09/20/1984	5.0	1.5	---	---	---	---

<< End of 1984 listing, 18 records >>

Lakes Lay Monitoring Program, U. N. H.

[Lay Monitor Data]

Conway Lake of Center Conway, NH

-- subset of trophic indicators, all sites, 1985

1985 SUMMARY

Average transparency:	5.8	(1985:	28	values)
Average chlorophyll:	0.8	(1985:	28	values)
Average alk (gray):	3.8	(1985:	15	values)
Average alk (pink):	4.4	(1985:	15	values)

SITE	DA	SDD	CHL	TOT_PHOS_PPB	ALK_GRAY	ALK_PINK	COLOR440
1 Andrews	07/02/1985	5.5	0.6	---	---	---	---
1 Andrews	07/08/1985	5.5	0.6	---	---	---	---
1 Andrews	07/15/1985	5.7	0.6	---	---	---	0.015
1 Andrews	07/22/1985	6.0	0.7	---	---	---	0.020
1 Andrews	07/29/1985	6.5	0.9	---	---	---	0.008
1 Andrews	08/04/1985	6.7	0.7	---	---	---	0.022
1 Andrews	08/12/1985	7.2	0.3	---	3.6	4.8	---
1 Andrews	08/19/1985	6.8	0.4	---	3.9	4.4	---
1 Andrews	08/26/1985	7.2	0.9	---	3.8	4.5	---
1 Andrews	09/02/1985	7.5	0.9	---	3.5	4.0	---
1 Andrews	09/09/1985	7.5	0.7	---	3.1	4.2	---
1 Andrews	09/16/1985	6.3	0.8	---	4.1	4.6	---
1 Andrews	09/23/1985	6.7	0.4	---	3.6	4.0	---
1 Andrews	09/30/1985	4.8	0.9	---	4.6	4.9	---
1 Andrews	10/07/1985	5.0	0.8	---	3.7	4.1	---
2 Gull	06/21/1985	5.0	2.9	---	---	---	---
2 Gull	06/29/1985	4.0	3.2	---	---	---	---
2 Gull	07/06/1985	4.5	0.5	---	---	---	---
2 Gull	07/12/1985	5.0	0.6	---	---	---	0.023
2 Gull	07/20/1985	4.2	0.5	---	---	---	0.018
2 Gull	07/27/1985	4.7	0.7	---	---	---	0.016
2 Gull	07/31/1985	5.2	0.8	---	---	---	0.026
2 Gull	08/10/1985	5.5	0.4	---	4.4	4.8	---
2 Gull	08/16/1985	5.1	0.6	---	3.9	4.3	---
2 Gull	08/23/1985	6.2	0.6	---	3.9	4.5	---
2 Gull	09/01/1985	6.8	0.9	---	3.9	4.4	---
2 Gull	09/15/1985	5.4	0.4	---	3.8	4.3	---
2 Gull	10/08/1985	5.6	0.6	---	3.9	4.3	---

<< End of 1985 listing, 28 records >>

Lakes Lay Monitoring Program, U. N. H.

[Lay Monitor Data]

Conway Lake of Center Conway, NH

-- subset of trophic indicators, all sites, 1986

1986 SUMMARY

Average transparency:	4.7	(1986:	27	values)
Average chlorophyll:	2.8	(1986:	26	values)
Average phosphorus:	7.9	(1986:	5	values)
Average alk (gray):	3.8	(1986:	26	values)
Average alk (pink):	4.3	(1986:	26	values)

SITE	DA	SDD	CHL	TOT_PHOS_PPB	ALK_GRAY	ALK_PINK	COLOR440
1 Andrews	06/23/1986	4.5	4.3	---	3.7	4.2	-----
1 Andrews	07/01/1986	4.4	4.0	---	3.9	4.4	-----
1 Andrews	07/07/1986	4.7	6.1	---	3.8	4.2	0.029
1 Andrews	07/14/1986	5.7	3.8	---	3.6	4.1	-----
1 Andrews	07/21/1986	5.6	1.3	---	4.0	4.5	0.024
1 Andrews	07/28/1986	4.8	1.9	---	4.1	4.6	-----
1 Andrews	08/04/1986	5.8	2.2	---	3.7	4.2	0.031
1 Andrews	08/11/1986	5.2	2.4	---	3.6	4.0	0.025
1 Andrews	08/18/1986	5.2	1.6	---	3.6	3.9	0.027
1 Andrews	08/25/1986	5.2	3.5	---	3.9	4.3	-----
1 Andrews	08/28/1986	---	---	---	---	---	0.022
1 Andrews	09/01/1986	4.7	3.7	---	3.5	4.0	0.026
1 Andrews	09/08/1986	4.8	3.0	---	3.9	4.3	0.028
1 Andrews	09/15/1986	3.8	2.1	---	3.9	4.4	-----
1 Andrews	09/22/1986	4.2	2.8	---	4.0	4.4	-----
1 Andrews	10/06/1986	4.2	---	---	---	---	-----
2 Gull	06/27/1986	4.0	4.2	---	4.5	5.0	-----
2 Gull	07/03/1986	4.8	4.4	---	4.0	4.5	-----
2 Gull	07/11/1986	4.7	3.6	---	3.8	4.4	0.022
2 Gull	07/17/1986	4.7	3.1	---	4.1	4.5	-----
2 Gull	07/23/1986	4.8	1.1	---	3.7	4.1	0.027
2 Gull	08/01/1986	3.5	1.7	---	4.0	4.4	0.030
2 Gull	08/01/1986	---	---	6.0	---	---	-----
2 Gull	08/08/1986	5.0	1.5	---	3.5	4.0	-----
2 Gull	08/13/1986	4.5	1.7	---	3.8	4.1	0.028
2 Gull	08/21/1986	5.0	1.7	---	3.9	4.2	0.032
2 Gull	08/30/1986	4.0	2.6	---	4.1	4.5	0.029
2 Gull	09/05/1986	4.3	2.3	---	2.5	3.0	-----
2 Gull	09/12/1986	4.5	2.4	---	4.1	4.6	0.025
T-1 Snow	04/17/1986	---	---	7.0	---	---	-----
T-2 Unkwn	04/17/1986	---	---	7.5	---	---	-----
T-3 Brdg1	04/17/1986	---	---	8.0	---	---	-----
T-4 Willey	04/17/1986	---	---	11.0	---	---	-----