New Hampshire Volunteer Lake Assessment Program

Annual Report 1994

Clough Pond Loudon

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ACKNOWLEDGEMENTS

The Coordinators of the New Hampshire Volunteer Lake Assessment Program owe the success of our program to the cooperation of many people. For the common vision and constant efforts of the following, we extend our sincere thanks:

- The volunteer monitors are the lifeblood of VLAP. Without their hard work and dedication to our environment, NH lakes would be at a loss.

- The commitment to volunteer efforts by Commissioner Bob Varney of NH Department of Environmental Services continues to be invaluable to survival of VLAP.

- All of the Biology Bureau staff who work daily to assist in sample analyses, field, and technical assistance. We extend special thanks to Missy Frasier and Dee Smith for their help throughout the summer, and to Nicole Burgher and Amy Wilson for their help in report preparation during a challenging period of transition.

- And finally, we are of course grateful to Natalie Landry, former VLAP Coordinator, for her dedication and guidance, past and present, making NHVLAP the nationally-recognized success it is today.

INTRODUCTION

With a new year on the horizon, New Hampshire Department of Environmental Services biologists extend their sincere thanks to all those volunteers who participated in NHVLAP and contributed to its success. We extend a special thanks and welcome to the volunteer monitors of five new VLAP lakes: Contoocook Lake (Jaffrey), de Rham Pond (Webster), Dudley Pond (Deering), Norway Pond (Hancock), and Rockwood Pond (Fitzwilliam). And, for the summer of 1994, we welcomed back the monitors at Cold Pond (Andover), Jenness Pond (Northwood), and Rand Pond (Goshen). At final count, our program encompassed 114 lake stations for the 1994 monitoring season.

As you all know, each year we strive to improve and strengthen VLAP for all involved. Please make note of the format change in the 1994 annual report. In hopes of making this year's report more useful to you, lake maps have been added. Each is labelled with this year's sampling stations, both for tributaries and in-lake. Our first objective is to create a reference for monitors and biologists. In this way, names used for the waterbody, town, and tributaries will be consistent, both in daily communications and in the VLAP database. Second, the map will be helpful to those unfamiliar with your lake and its watershed. Please contact the DES if any changes need to be made before the upcoming season.

Your concern for the lakes of New Hampshire has been essential in the past in gaining monetary support. Federal funding for the Clean Lakes Program has been difficult to obtain in the last eight years, and this next fiscal year will prove to be one of the poorest. In fact, there will be no money for Diagnostic/ Feasibility Studies and reduced funding for Lake Assessment grants. Our success in the past has been in part a result of your efforts to contact your Congressmen and Senators to let them know the importance of lakes and the need to support them. We were very fortunate this past fiscal year in obtaining the only Phase I Diagnostic/Feasibility Project in Region I. Because of the local concern and monitoring by volunteers in Kingston, Great Pond was recently approved by the EPA to obtain this funding. Biologists are currently at work implementing this study that will determine each source of phosphorus to Great Pond.

Please keep in mind that we have a new Congress this year whose stated goal is to make government leaner and meaner. Big cuts are expected at the EPA, which could possibly mean an end to the Clean Lakes Program. As you may know, both Senator Gregg and Congressman Zeliff have recently received promotions within the Republican Party. Write them and let them know that the popular Clean Lakes Program (Section 314 of the Clean Water Act) is having funding problems. Remember to copy us on the letters and send us a copy of the response.

Lastly, we want to pay special tribute to the person who made VLAP what it is today, one of the nation's top-rated Volunteer Programs. Although we are sad to see Natalie leave us, we are happy that she continues her protection efforts for New Hampshire's lakes, serving as our Shoreland Protection Coordinator. I'm sure all of you will miss her, we already do! We all wish her the best.

More good news and bad news! The good news is that we have found an excellent candidate for the VLAP Coordinator position. She is currently acting as the VLAP Interim Coordinator and has produced your annual report. Many of you have met Stephanie Moses this past summer or fall. Stephanie has a Bachelor of Science degree in Biology from Syracuse University (the Orangemen) and continues to impress us all with her ability to manage both VLAP and the Interactive Lake Ecology Program (ILE). Steph just can't wait to get out to the lakes this summer to meet you personally.

Now the bad news. Because of a statewide hiring freeze ordered by Governor Merrill, Natalie's now vacant position as VLAP Coordinator cannot be permanently filled. What this means is, we will try to obtain a waiver from the Governor to fill the position as soon as possible. However, if we fail in moving Steph into the position, we will have to go to Plan B--which, by the way, I'm still trying to think of.

Have a good winter, and make sure you not only read this report, but also report back to your associations on the health of your lake. Remember, if you need help, Steph and Jody will always be here to help you out.

How To Interpret Graphs and Tables

Graphs

Observation: sample or data point

There are two types of graphs in Appendix A of this report: a line chart and column chart. Each graph conveys much more to the reader than a table or verbal description; hence, it is important to be able to interpret it correctly. It must be stressed that a lower number of **observations** causes a corresponding decline in the reliability of the information.

Line Chart

Mean: average

The line chart summarizes sampling results for the years you have collected data. The graph shows the **mean** for a given year as an up turned or down turned triangle. The triangle points in the direction of more desirable values. For example, chlorophyll-a and total phosphorus have downward triangles (▼) indicating lower values are better, while transparency has upward triangles (▲) signifying higher values are more desirable.

Standard Deviation: a statistic measuring the spread of the data around the mean

Range: difference between the high and low values

A measure of the spread of the data around the mean or **standard deviation,** is shown as the vertical lines extending up and down from the mean. Standard deviation is similar to **range** except standard deviation is a more accurate estimate of variation.

Regression Line: a statistical tool used to predict trends in data.

Trends in the yearly data can be discerned by looking at the **regression line** and noting its direction and degree of slant (see example next page). If the line is slanted like this "\", it indicates an improving trend in chlorophyll-a and total phosphorus but a declining trend in transparency values. If the line is sloped the opposite way, (like this "/") it exhibits a worsening trend in chlorophyll-a and total phosphorus but an improving trend in transparency values. The steeper the regression line's slope, the stronger the trend. A horizontal regression line (—) indicates the parameter presented is stable, neither improving or worsening over time.

Caution is warranted when drawing absolute conclusions from yearly data with limited sampling observations. Don't panic if the line chart shows a parameter worsening — check your raw data first. Look for years with one extremely high or low sampling point, this could affect the trend line. Remember, you need four to five years of data before trends become apparent.

The last element in the line chart is a line representing the New Hampshire mean for that particular parameter taken from the table on page 6. Your data can be compared to this value.

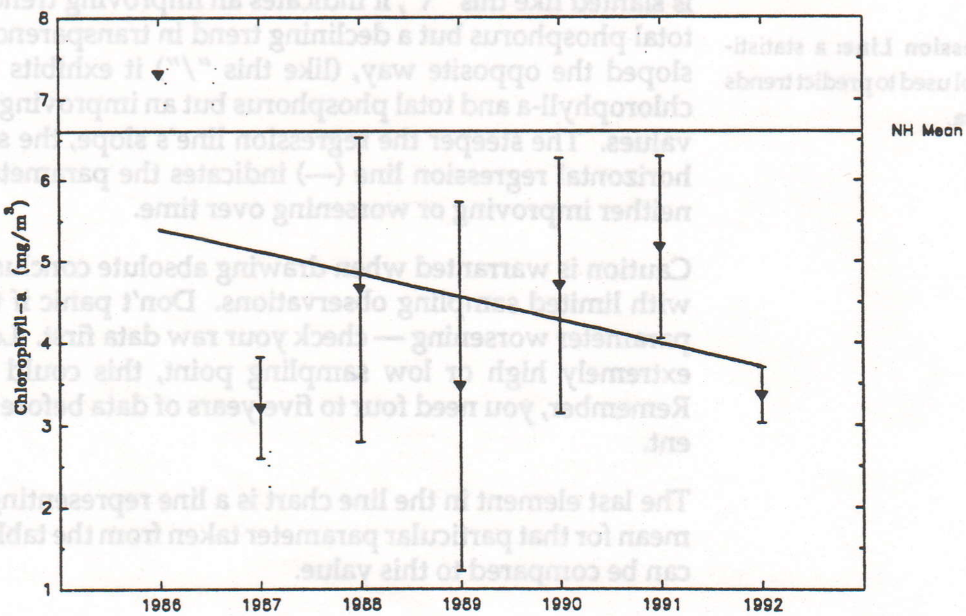
Column Chart

The second type of graph found in this report is the column chart. It presents this year's monthly data for a given parameter. The column chart emphasizes individual values for comparison rather than overall trends and allows easy comparisons of monthly data.

Tables

Tables in Appendix B summarize data collected during 1994 and previous years. Maximum, minimum and mean are given for each station by sampling year except for dissolved oxygen, phytoplankton, and bacteria. Table 2 lists phytoplankton results gathered during 1994 and any past year. Table 9 shows the dissolved oxygen and temperature readings for 1994. Table 11 presents *E. coli* data, if applicable.

Sample Line Chart.



INTERPRETING DATA

Like all of us, lakes age over time. Lake aging is the natural process by which a lake fills in over geologic time. They fill in with erosional materials carried in by the tributary streams, with materials deposited directly through the air, and with materials produced in the lake itself. From the time that a lake is created, the aging or filling in process begins. Although New Hampshire lakes have the same chronological age, they age at different rates because of differences in runoff and watershed characteristics. Eutrophication is the process of increased nutrient input to a lake over the natural supply. This increased lake fertilization results in an increase in **biological production.** The **fertility** of the watershed determines the rate of lake aging.

Biological Production: total amount or weight of living plants and animals

Fertility: capacity to sustain plant growth

The key chemical in the eutrophication process is the nutrient phosphorus. Phosphorus is the limiting nutrient in New Hampshire lakes. The greater the phosphorus concentration in a lake the greater the biological production. Biological production can be measured in terms of weed growth, algal growth, decreased transparency and an overall decrease in lake quality.

It is very important to understand the meaning of biological production when referring to lakes. We often think of biological production as something good. For example, a productive garden yields an abundance of vegetables. But, when speaking about lake production, usually low biological production is the ideal condition. Fishermen, however may prefer a productive lake, especially if they are fishing for warm water species like bass. Warm water species thrive in productive lakes because of the abundance of food and presence of weeds used for hiding. Excessive weed growth and algae blooms are present in a highly productive lake.

When eutrophication is caused by human actvity it is termed cultural eutrophication. This accelerated aging results from activities such as fertilizing, converting forest or pasture to cropland, and creating **impervious** areas such as parking lots and driveways. Studies in New Hampshire have shown that phosphorus export from agricultural lands is at least 5 times greater than from forested lands, and urban areas may be more than 10 times greater. Phosphorus from faulty septic systems also plays a role in cultural eutrophication, along with washing in or near the lake, erosion into the lake, dumping or burning leaves in or near a lake, and feeding ducks.

Impervious: impenetrable

As you interpret the data on the following pages pay close attention to the trends. Look for increases or decreases in the **epilimnetic** and **hypolimnetic** phosphorus. If you observe an increase in hypolimnetic phosphorus as the summer progresses, a process called internal phosphorus loading is occurring. This means phosphorus that was tied up in the lake floor sediments is now able to enter the water column. **Anoxia** accelerates this process.

Epilimnetic: upper water layer

Hypolimnetic: lower water layer

Anoxia: no oxygen present

As you look at the data from the inlets notice if this year's data show an increase in phosphorus for a particular inlet. If the increase is significant, the new source of phosphorus should be investigated.

Transparency: water clarity

Chlorophyll-a: green pigment found in plants

Correlations between **transparency** and **chlorophyll-a** are important. If the chlorophyll-a increased and the Secchi disk transparency decreased, increased algae populations are affecting the water clarity. If the chlorophyll-a has not increased, but the transparency has undergone a decline (for example, a reading from 4 meters down to 2 meters), the reduced transparency could be attributed to turbidity caused by stream inputs, motorboat activity, shoreline construction, or disturbances of bottom sediments.

Color, conductivity, ANC and pH should also be examined. The lower the ANC value for your lake, the more vulnerable it is to acid precipitation. Conductivity is a good indicator of disturbance or non-point sources of pollution. A marked increase or decrease in any parameter should be investigated.

Epilimnion: upper water layer

Metalimnion: middle water layer

Hypolimnion: bottom water layer

All of the data might seem overwhelming to you at first. Take a look at the in-lake data. The tables will list in-lake data either as **Epilimnion, Metalimnion,** or **Hypolimnion** if your lake stratifies into three distinct layers. The data will simply be listed as Upper Layer and Lower Layer if the lake does not thermally stratify. Usually small bodies of water are listed as the latter. Follow the trends and note any changes for each parameter.

Tributary: stream, inlet

Then examine the **tributary** data. Take each inlet, one at a time. Some will reflect good conditions (low total phosphorus, low conductivity, and a pH between 6.0-7.0). Others might reflect poor tributary quality, sending off a warning light (high total phosphorus, high conductivity, or a low pH). List the possible problems you identified from your data and prioritize them according to your association's goals. Also, refer to the recommendations section of this report which discusses the basic trend data and also lists some suggestions for future sampling. Then formulate a plan. That's where we can help. Once you know where your concerns lie we will work with you to modify your current sampling program to address these goals. Take it slowly - you have all winter. But don't procrastinate too long. Summer will be here before you know it!

Biological: living plants or organisms

Physical: parameters related to the chemistry of water

To provide an understanding of how your waterbody compares to other New Hampshire lakes, the following table summarizes key **biological and physical** parameters for all the state's lakes surveyed since 1975.

Summary Statistics for New Hampshire Lakes and Ponds.

Parameter	Number	Min.	Max.	Mean	Median
pH (units)	590	4.4	9.6	**6.0	6.6
ANC (mg/L)	591	-1.3	77	6.5	5.0
Color (units)	580	< 5	250	----	25
Conductivity (µmhos/cm)	581	12.8	350.4	56.0	39.8
Turbidity (NTU)	272	<1	22	----	1.0
Total Phosphorus (ug/L)	579	< 1	121	----	11
Chlorophyll-a (mg/m3)	583	0.36	143.80	7.22	4.55
Secchi Disk (m)	529	0.25	13.0	3.8	3.4

* mg/L unless otherwise indicated
** true mean pH
Number = the number of lakes sampled

MONITORING PARAMETERS

Biological Parameters

Algal Abundance

Algae are photosynthetic plants that contain chlorophyll but do not have true roots, stems or leaves. They do, however, grow in many forms such as aggregates of cells (colonies), in strands (filaments) or microscopic single cells.

Photosynthesis: producing carbohydrates with the aid of sunlight

Oxygenated: holding oxygen in solution

The process of **photosynthesis** carried out by these primitive plants accomplishes two very important roles. First, inorganic material is converted to organic matter. And, second, the water is **oxygenated**. Algae require light, nutrients and certain temperatures to thrive. All these factors are constantly changing in a lake from day to day, season to season, and year to year. Therefore, the different algae populations appear in a succession determined by the environmental factors such as weather changes, storms, or an influx of nutrients.

Food Chain: arrangement of organisms in a community according to the order of predation

These tiny plants form the base of a lake **food chain**. Microscopic animals (zooplankton) graze upon algae like cows graze in a field. Fish also feed on the algae along with other organisms.

Chlorophyll-a: a green pigment found in algae

Oligotrophic: low biological production

Eutrophic: high biological production, nutrient rich

Mean: average

NHVLAP uses the measure of **chlorophyll-a** as an indicator of the algae abundance. If the chlorophyll-a concentration increases, this indicates an increase in the algal population. Generally, a chlorophyll-a concentration of less than 4 mg/m3 indicates water quality conditions that are representative of **oligotrophic** lakes, while a chlorophyll-a concentration greater than 15 mg/m3 indicates **eutrophic** conditions.

The **mean** chlorophyll-a for New Hampshire lakes is 7.22 mg/m3. Figure 1 and Table 1 present the mean chlorophyll-a concentrations for each year of participation in NHVLAP. Table 1 also presents the minimum and maximum values recorded for the same years.

Chlorophyll-a Ranges for NH Lakes and Ponds

Category	Chlorophyll-a (mg/cubic meter)
Good	0 - 5
More Than Desirable	5.1 - 15
Nuisance Amounts	> 15

Phytoplankton

Phytoplankton: microscopic algae floating in the water column

Plankton Net: fine mesh net used to collect microscopic plants and animals

The type of **phytoplankton** present in a lake can be used as an indicator of general lake quality. The most direct way to obtain phytoplankton information involves collection of a sample with a **plankton net,** measurement of the quantity of phytoplankton contained in the sample, and identification of the species present. An abundance of blue-green algae such as Anabaena, Aphanizomenon, Oscillatoria, or Microcystis may indicate excessive phosphorus concentration. Diatoms such as Asterionella, Melosira, and Tabellaria or golden-brown algae such as Dinobryon or Chrysosphaerella are typical phytoplankton of New Hampshire's less productive lakes.

Succession: the dominant species of algae declining over a period of time as another species increases and becomes dominant.

Phytoplankton populations undergo a natural **succession** during the growing season. Many factors influence this succession: amount of light, availability of nutrients, temperautre of the water, and the amount of grazing occurring from zooplankton. As shown in the diagram on page 10, it is natural for diatoms to be the dominant species in the spring, then green algae peeks in the early summer, followed by dominating blue-green algae in mid-to-late summer. The plankton samples from your lake will show different dominant species, depending on when the samples were taken. Phytoplankton are identified in Table 2. Phytoplankton groups and species are shown on page 9.

Phytoplankton Groups and Species for New Hampshire Lakes and Ponds.

Greens

Actinastrum	Micractinium	Sphaerocystis
Arthrodesmus	Micrasterias	Spirogyra
Dictyosphaerium	Mougeotia	Spondylosium
Elakatothrix	Pandorina	Staurastrum
Eudorina	Pediastrum	Stigeoclonium
Kirchneriella	Scenedesmus	Ulothrix

Diatoms

Asterionella	Melosira	Surirella
Cyclotella	Pleurosigma	Tabellaria
Fragilaria	Rhizosolenia	Synedra

Dinoflagellates

Ceratium	Peridinium	Gymnodinium

Blue-Greens

Anabaena	Chroococcus	Lyngbya
Aphanizomenon	Coelosphaerium	Microcystis
Aphanocapsa	Gloeotrichia	Oscillatoria

Golden-Browns

Chrysosphaerella	Mallomonas	Synura
Dinobryon		Uroglenopsis

Secchi Disk Transparency

Color: apparent water color caused by dissolved organic compounds and suspended materials

The Secchi disk is a 20 centimeter disk with alternating black and white quadrants. It has been used since the mid-1800s to measure the transparency of water. The Secchi disk is named after the Italian professor P.A. Secchi whose early studies established the experimental procedures for using the disk. The disk is used to measure the depth that a person can see into the water. Transparency, a measure of the water clarity, is affected by the amount of algae, color, and particulate matter within a lake. In general, a transparency greater than 4 meters indicates oligotrophic conditions while a transparency of less than 2 meters is indicative of eutrophic conditions.

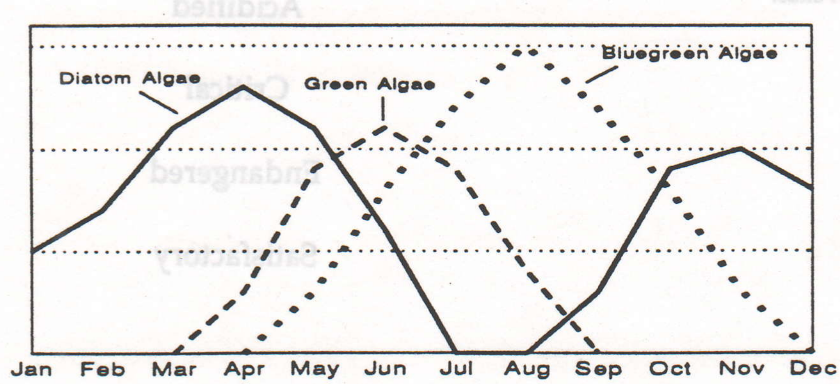
Mean: average

The mean transparency for New Hampshire lakes is 3.8 meters (one meter equals 3 feet, 4 inches). Figure 2 presents a comparison of the transparency values for each of the VLAP monitoring years while Table 3 shows minimum, maximum and mean values for all years of participation.

Water Clarity (Transparency) Ranges for Lakes and Ponds.

Category	Water Clarity (meters)
Poor	< 2
Good	2 - 4.5
Exceptional	> 4.5

A TYPICAL SEASONAL SUCCESSION OF LAKE ALGAE



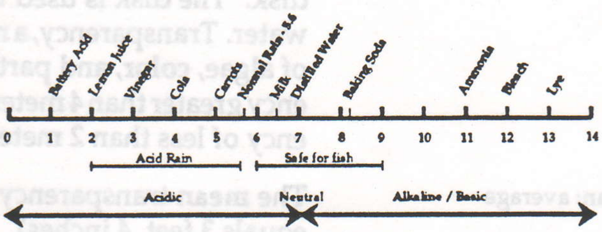
Source: Volunteer Lake Monitoring; EPA 440/4-91-002

Chemical Parameters

pH

pH is measured on a logarithmic scale of 0 to 14. The lower the pH, the higher the concentration of hydrogen ions and the more acid the solution. Acid rain typically has a pH of 2.0 to 5.5. In contrast, the median pH for New Hampshire lakes is 6.6.

pH Scale



Lake pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal.

Thermally Stratified: layered by temperature

Bacteria: tiny organisms that breakdown dead matter

Phytoplankton: microscopic algae floating in the water column

Many lakes exhibit lower pH values in the deeper waters than near the surface. This effect is greatest in the bottom waters of a **thermally stratified** lake. Decomposition carried out by **bacteria** in the lake bottom causes the pH to drop, while photosynthesis by **phytoplankton** in the upper layers can cause the pH to increase.

Table 4 presents the in-lake and tributary true mean pH data.

pH ranges for New Hampshire Lakes and Ponds.

Category	pH (units)
Acidified	< 5
Critical	5.0 - 5.4
Endangered	5.5 - 6.0
Satisfactory	6.0 - 8.0

Acid Neutralizing Capacity

Buffering capacity or Acid Neutralizing Capacity (ANC) refers to the ability of a solution to resist changes in pH by neutralizing acidic inputs. ANC acts like an antacid by neutralizing the acidic input to the lake. The higher the ANC, the greater the ability of the water to neutralize acids.

Low ANC lakes are not well buffered. These lakes are often adversely affected by acid inputs.

Epilimnetic: upper water layer

Historically New Hampshire has had naturally low ANC waters because of granite bedrock. Average ANC for New Hampshire lakes is 6.5 mg/L. This makes them vulnerable to the effects of acid precipitation. Table 5 presents the mean **epilimnetic** ANC for each year your association has been involved in this program.

Acid neutralizing capacity ranges for New Hampshire Lakes and Ponds.

Sensivity Category	ANC (mg/L)
Acidified	< 0
Critical	0 - 2
Endangered	2 - 5
Highly Sensitive	5 - 10
Sensitive	10 - 20
Not Sensitive	> 20

Conductivity

Ionic Particles: an atom or group of atoms that carries an electric charge

Conductivity is the numerical expression of the ability of water to carry an electrical current. It is determined primarily by the number of **ionic particles** present. The soft waters of New Hampshire have had traditionally low conductivity values. High conductivity may indicate pollution from such sources as road salting, faulty septic systems or urban/agricultural runoff. Specific categories of good and bad levels cannot be constructed for conductivity because variations in watershed geology can result in natural fluctuations in conductivity. However, values in New Hampshire lakes exceeding 100 generally indicate cultural (man-made) sources of ions, such as salted highways and runoff from urbanized areas. The conductivity should remain fairly constant for a given lake throughout the year. Any major changes over a short period of time may indicate a significant amount of precipitation that results in **erosion** which may impact lake quality. Conductivity less than 50 uhmos/cm is typical of **oligotrophic** lakes. Conductivity greater than 100 uhmos/cm is more typical of **eutrophic** lakes.

Erosion: soil materials worn away by the action of water or wind

Oligotrophic: low biological production

Eutrophic: high biological production, nutrient rich

The mean conductivity for New Hampshire lakes is 56.0 uhmos/cm. Table 6 presents mean conductivity values for **tributaries** and in-lake data.

Tributaries: inlets, streams

Color

Color is a visual measure of the color of water. This color is generally caused by naturally occurring metals in soils, such as iron and manganese, dissolved organic compounds, and suspended matter. Swamps, marshes, and sediments rich with **organic matter** can all be significant sources of color. Color can also have an impact on the Secchi disk transparency. Color greater than 40 may result in a low Secchi disk reading, but may not necessarily indicate poor water quality. Color by itself usually does not indicate the quality of a particular waterbody. Lakes that appear clear yield values less than 25. Lakes that are visibly tea-colored yield values greater than 40. The median color of New Hampshire lakes is 25.

Organic matter: made up of carbon derived from decomposing plants and animals

Table 7 presents the mean color values for in-lake and tributary data.

Apparent Color Ranges for New Hampshire Lakes and Ponds.

Apparent Color	Units
Clear	0 - 25
Lightly Tea-colored	25 - 40
Tea-colored	40 - 75
Highly Colored	> 75

Phosphorus

Algal Bloom: massive population of algae

Epilimnetic: upper water layer

Oligotrophic: low biological production

Eutrophic: high biological production, nutrient rich

Hypolimnetic: bottom water layer

Median: a value in an ordered set of values below and above which there is an equal number of values

Phosphorus is the most important parameter measured. It is this nutrient which the algae utilize to maintain their growth and reproduction. If you limit the phosphorus concentration, you limit the algae. Increased phosphorus levels encourage excessive weed growth and **algal blooms**. Phosphorus occurs in many forms in a lake. It is absorbed by algae and becomes a part of a living cell. When the algae cells die, the phosphorus is still organically bound, even as the dead cells settle to the lake bottom.

An in-lake **epilimnetic** phosphorus concentration of less than 10 ug/L indicates **oligotrophic** conditions and a concentration greater than 20 ug/L in the upper water layer is indicative of **eutrophic** conditions. The **median** phosphorus concentration in the upper water layer of New Hampshire lakes is 11 ug/L.

Figure 3 shows the **epilimnetic** and **hypolimnetic** total phosphorus values for 1994 and historical data. Table 8 presents mean total phosphorus data for in-lake and tributary data.

Total Phosphorus Ranges for New Hampshire Lakes and Ponds (epilimnetic).

Category	TP (µg/L)
Low (good)	1 - 10
Average	10 - 20
High	20 - 40
Excessive	> 40

Dissolved Oxygen and Temperature

The presence of dissolved oxygen is vital to bottom dwelling organisms as well as fish. If the concentration of dissolved oxygen is low, species intolerant to this situation such as trout, will be forced to move.

Thermal Stratification: layering by temperature

Temperature is also a factor in the dissolved oxygen concentration. Oxygen is more soluble at colder temperatures than warmer temperatures. Therefore, a lake will typically have a higher concentration of dissolved oxygen during the winter, spring and fall than in summer.

At least once during this summer, a DES biologist measured dissolved oxygen and temperature at set intervals from the surface of the lake to the bottom. These measurements allow us to determine the extent of **thermal** stratification and the oxygen content of the lake. Many of the more productive lakes experience a drop in dissolved oxygen in the deeper waters as the summer progresses. The amount of oxygen depletion is a measure of the oxygen demand of the bacteria living in the bottom waters. Indirectly, this is a measure of the lake's biological production. Since more productive lakes tend to have organic-rich sediments, a severe dissolved oxygen deficit (less than 1 ppm) is associated with eutrophic conditions.

Dissolved oxygen percent saturation shows the percentage of oxygen that is dissolved in the water at a particular depth. Typically, the deeper the reading, the lower the percent saturation. A high reading at or slightly above the thermocline may be due to algae producing oxygen during photosynthesis. Warm water becomes saturated with oxygen more readily than cold water. The deeper the water, the colder the temperature. This means that deeper, colder waters have a greater capacity to hold dissolved oxygen. A reading of 9 mg/L of oxygen at the surface will yield a higher percent saturation than a reading of 9 mg/L at 25 meters, because of the difference in water temperature. Table 9 illustrates the Dissolved Oxygen/Temperature Profile(s) for 1994.

Statistical Summary of Turbidity Values for New Hampshire Lakes and Ponds:

	Value (NTU)
Minimum	< 0.1
Maximum	22.0
Median	1.0

Other Parameters

Turbidity

Samples taken to the Sunapee Region Laboratory were analyzed for turbidity instead of color. Turbidity in water is caused by suspended matter, such as clay, silt, algae and other materials which cause light to be scattered and absorbed, not transmitted in straight lines through the water. It has a major influence on Secchi disk transparency and therefore the clarity of the lake. High turbidity readings are often found in water adjacent to construction sites. During rain events, unstable soil erodes and causes turbid water downstream. The New Hampshire median for lake turbidity is 1.0 NTU. Table 10 lists turbidity data for 1994, if your samples were analyzed at the Sunapee Region Lab.

Bacteria

Most surface waters contain a variety of microorganisms including bacteria, fungi, protozoa and algae. Most of these occur naturally and have little or no impact on human health. Health risks associated with water contact occur generally when there is contamination from human sources. Therefore, water used for swimming should be monitored for indicators of possible human fecal contamination. Contamination arises most commonly from sources of human fecal waste such as failing or poorly designed septic systems, leaky sewage pipes or direct inputs from wastewater treatment plants.

Pathogens: disease causing organisms

Specific types of bacteria, called indicators, are the basis of bacterial monitoring because they tend to indicate human fecal contamination. Indicators estimate the presence and quantity of things that cannot be measured easily by themselves. We measure these sewage or fecal indicators rather than the **pathogens** in order to estimate sewage or fecal contamination and, therefore, the possible risk of disease associated with using the water.

New Hampshire surface water bacteriological standards were recently changed. As of September 1991, the indicator organism changed from total coliform to *Escherichia coli* (*E.coli*). The new standards for Class B waters specify that no more than 406 *E.coli*/100mL or a geometric mean based on at least 3 samples obtained over a sixty day period be greater than 126 *E.coli*/100mL. Designated beach areas have more stringent standards: 88 *E.coli*/100mLs in any one sample or a geometric mean of three samples over sixty days of 47 *E.coli*/100mL. Table 11 shows bacteria (*E. coli*) results for 1994.

RECOMMENDATIONS

After reviewing data collected from CLOUGH POND, the program coordinators recommend the following actions.

- Figure 3 shows a stable trend for phosphorus. The less phosphorus available to the algae, the lower the biological production. To ensure a continuation of this trend, educate lakeshore owners and visitors about the lake protection do's and don'ts (Lake Protection Tips - DES Fact Sheet NHDES-WSPCD-1989-12).

- Figure 1 shows a stable but slightly increasing trend in chlorophyll-a (chl). Chl is an indicator of biological production. Keeping chl at a low concentration increases the chances of a clear waterbody, free of nuisance algae blooms. Reducing the amount of phosphorus to the waterbody encourages a continuation of this trend.

- Figure 2 shows a stable trend in transparency. The clarity of the water is an indicator of the amount of suspended material in the water column. In addition to biological production, sediment can cause a decrease in transparency. Buffer strips should be established to protect surface water from land use activities such as roadways and construction sites. Buffer strips can be grasses, shrubs or trees planted or allowed to grow at the water's edge. Buffer strips will filter out sediment and other substances such as nutrients, pesticides and heavy metals. For more information contact NHDES.

- Greater oxygen saturation in the metalimnion (middle water layer) may be indicative of an algal bloom. Watch for phosphorus sources to the lake.

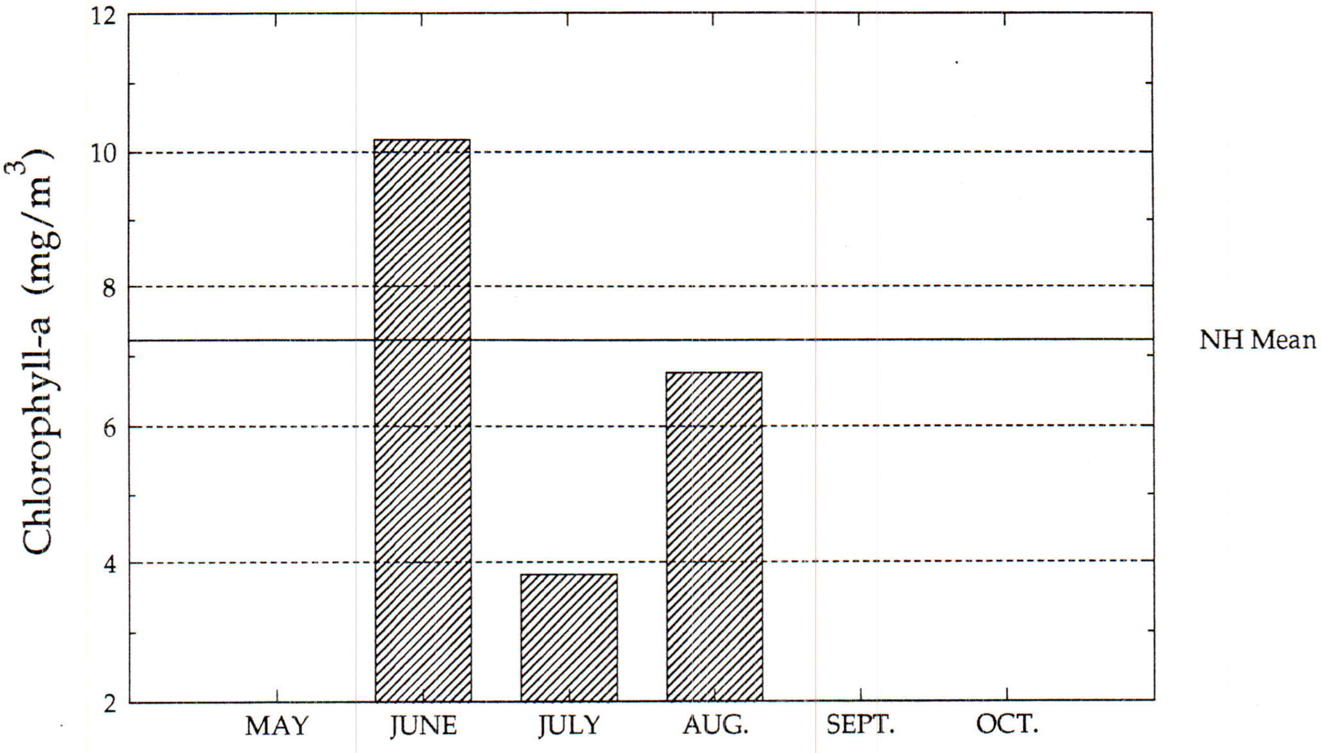
- Total phosphorus levels in the Inlet were 96 ug/L, their highest since 1989. Coupled with the low dissolved oxygen in the hypolimnion (lower water layer), the lake may have the potential for internal loading of phosphorus from the sediments to occur. Phosphorus sources should be identified in the watershed and attention paid to hypolimnetic levels of phosphorus in the coming year.
- Monitor's Note (8/22/94): Rainy week.

Appendix A:

Graphs

Clough Pond

1994 Chlorophyll-a Results



Historical Chlorophyll-a Results

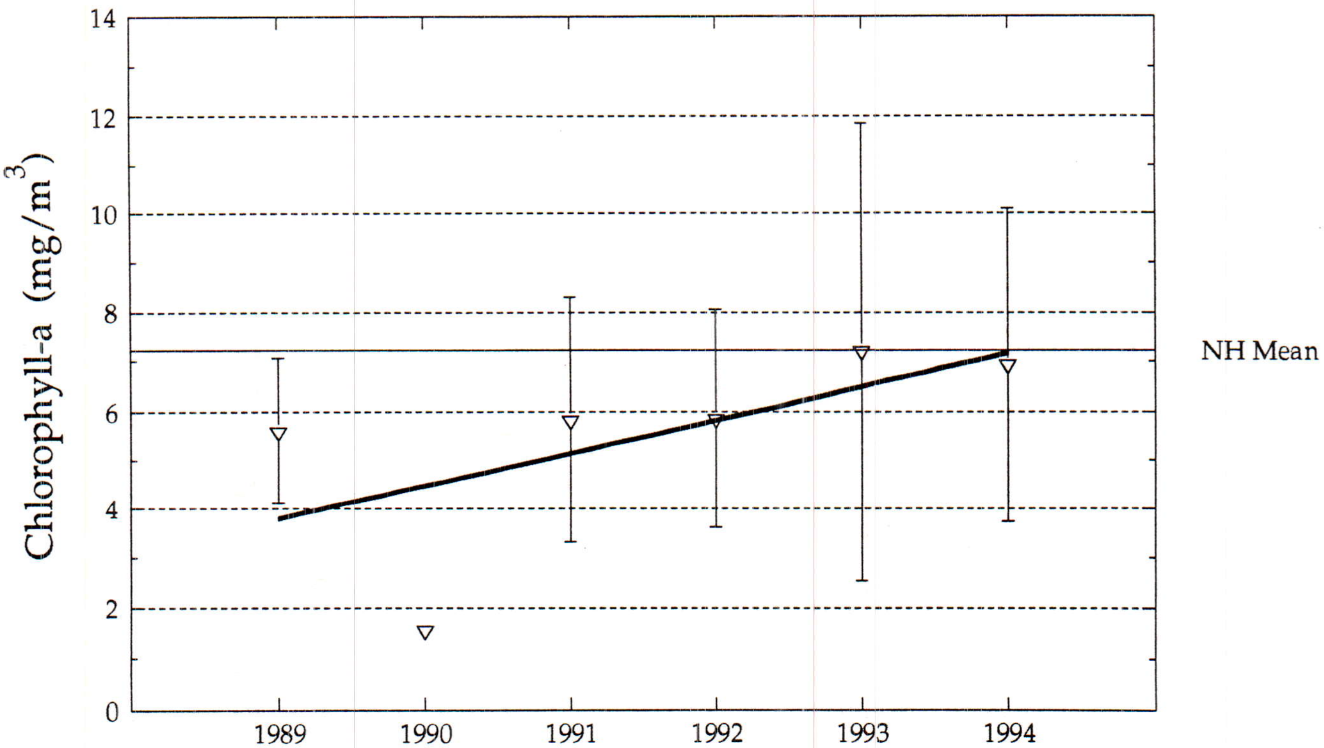
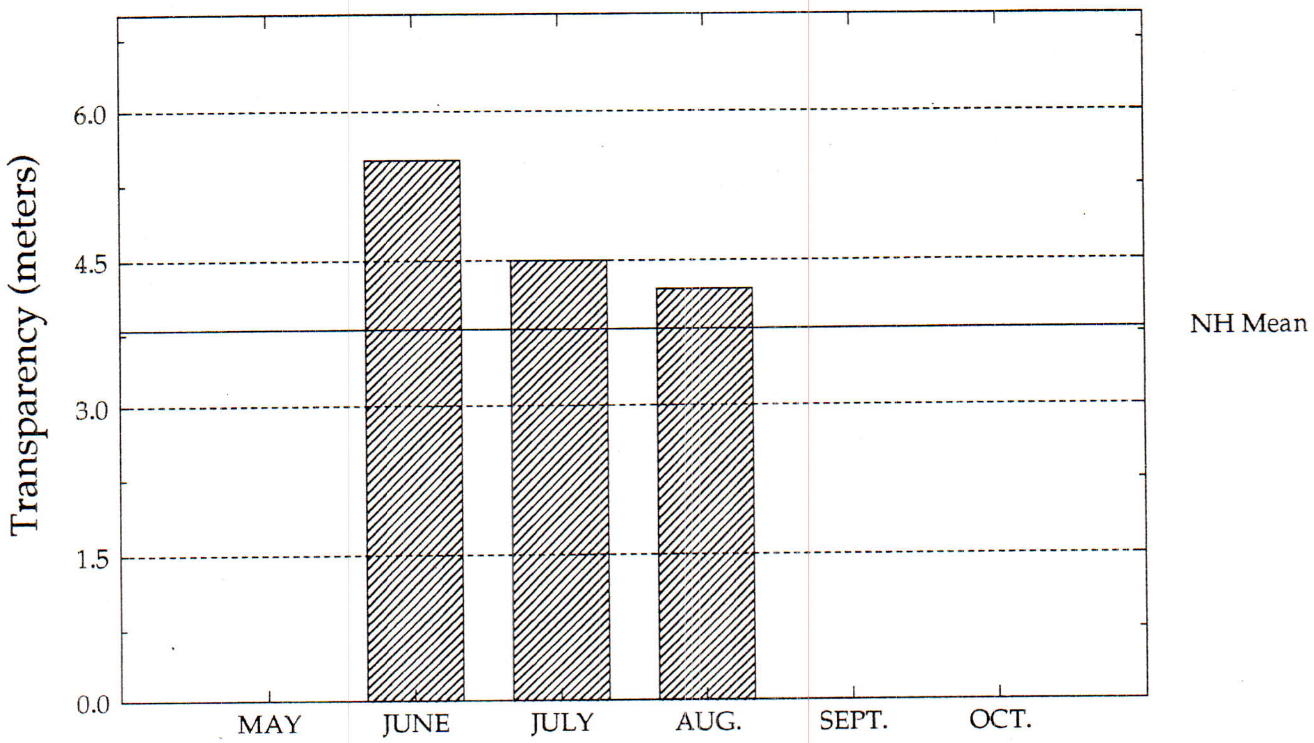


Figure 1. Monthly and Historical Chlorophyll-a Results

Clough Pond

1994 Transparency Results



Historical Transparency Results

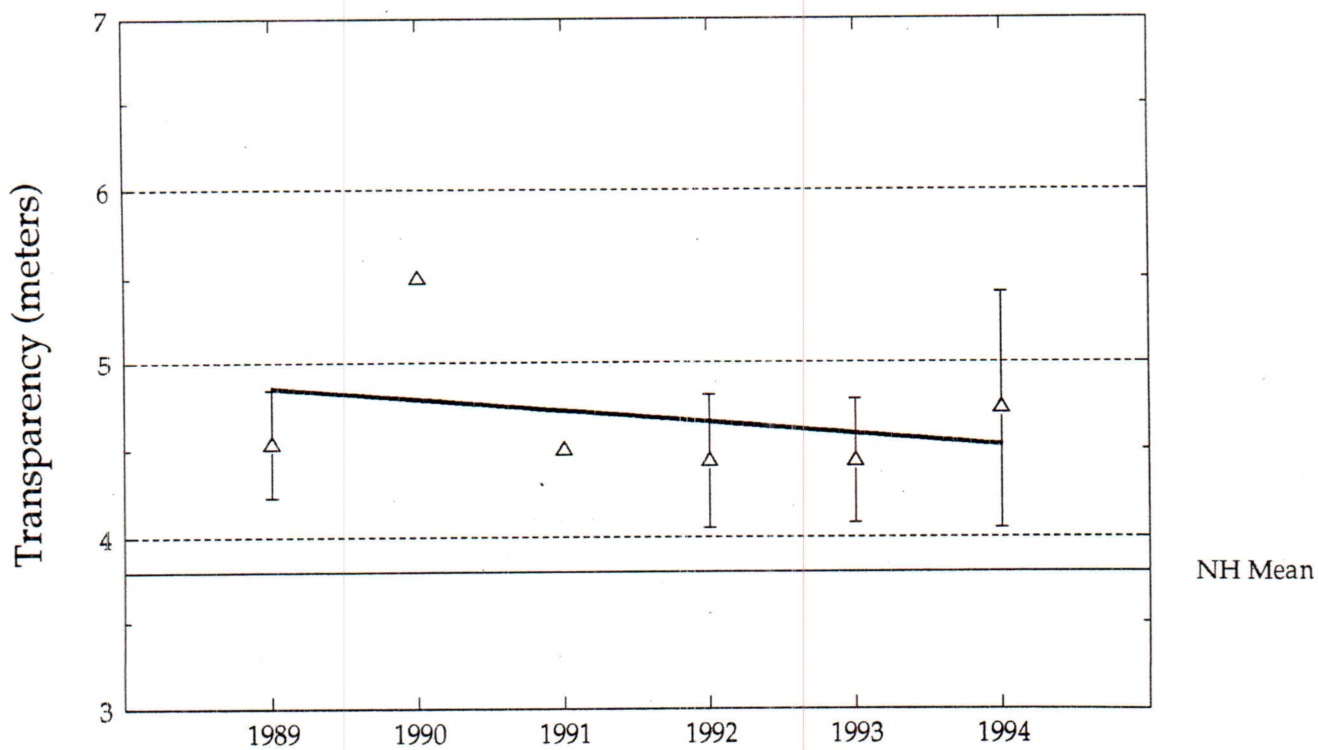


Figure 2. Monthly and Historical Transparency Results

Clough Pond

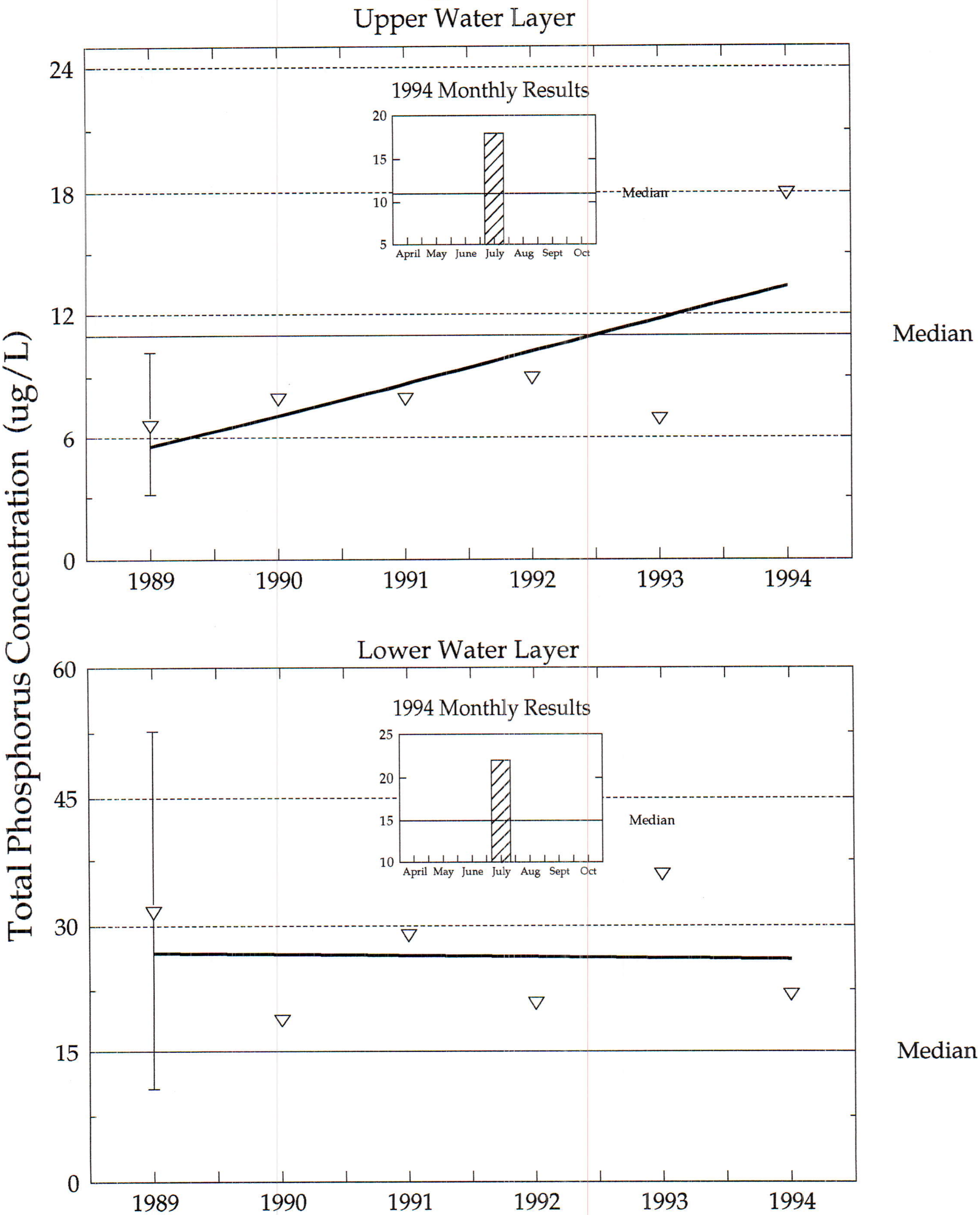


Figure 3. Monthly 1994 and Historical Total Phosphorus Data.

APPENDIX B:

TABLES

Table 1.

Chlorophyll-a results (mg/m) from 1994 and historical sampling periods.

Year	Minimum	Maximum	Mean
1989	4.36	7.23	5.59
1990	1.54	1.54	1.54
1991	3.22	8.20	5.81
1992	4.38	8.39	5.83
1993	3.82	12.51	7.19
1994	3.82	10.17	6.91

Table 2.

Phytoplankton species and relative percent abundance.
Summary for current and historical sampling seasons.

Date of Sample	Species Observed	Relative % Abundance
06/29/89	SPHAEROCYSTIS	8
	TABELLARIA	55
	CHRYSOSPHAERELLA	17
07/17/90	CERATIUM	42
	DINOBRYON	30
07/17/91	DINOBRYON	49
	CERATIUM	45
07/23/92	ASTERIONELLA	68
	DINOBRYON	12
	TABELLARIA	12
07/16/93	UROGLENOPSIS	40
07/20/94	DINOBRYON	88

Table 3.

Summary of current and historical Secchi Disk transparency results (in meters).

Year	Minimum	Maximum	Mean
1989	4.2	4.8	4.5
1990	5.5	5.5	5.5
1991	4.5	4.5	4.5
1992	4.0	4.7	4.4
1993	4.1	4.8	4.4
1994	4.2	5.5	4.7

Table 4.

pH summary for current and historical sampling seasons.
Values in units, listed by station and year.

Station	Year	Minimum	Maximum	Mean
EPILIMNION				
	1989	7.04	7.25	7.14
	1990	7.10	7.10	7.10
	1991	4.43	7.15	4.91
	1992	5.05	6.71	5.51
	1993	6.86	7.42	7.08
	1994	7.03	7.10	7.07
HYPOLIMNION				
	1989	6.27	6.51	6.38
	1990	6.11	6.11	6.11
	1991	6.13	6.40	6.23
	1992	5.53	6.32	5.87
	1993	6.19	6.32	6.26
	1994	5.88	6.32	6.08
INLET				
	1989	6.41	6.49	6.45
	1990	6.69	6.69	6.69
	1991	6.70	7.00	6.83
	1992	5.90	6.67	6.22
	1993	6.64	6.87	6.74
	1994	6.17	6.52	6.31
METALIMNION				
	1989	6.79	7.27	7.04
	1990	7.06	7.06	7.06
	1991	6.14	7.25	6.53
	1992	6.35	7.04	6.60
	1993	6.61	6.83	6.74
	1994	6.16	6.93	6.40
OUTLET				
	1989	6.52	7.00	6.75
	1990	6.88	6.88	6.88
	1991	6.81	7.10	6.90
	1992	6.50	6.71	6.58
	1994	6.64	7.16	6.83

Table 5.

Summary of current and historical Acid Neutralizing Capacity.
Values expressed in mg/L as CaCO .

Epilimnetic Values

Year	Minimum	Maximum	Mean
1989	4.90	5.90	5.53
1990	6.40	6.40	6.40
1991	5.10	12.90	7.97
1992	4.50	5.10	4.80
1993	6.20	6.40	6.30
1994	6.30	7.40	6.80

Table 6.

Specific conductance results from 1994 and historic sampling seasons. Results in uMhos/cm.

Station	Year	Minimum	Maximum	Mean
EPILIMNION				
	1989	47.8	49.8	48.9
	1990	53.2	53.2	53.2
	1991	50.0	51.5	50.7
	1992	49.5	53.2	51.9
	1993	51.9	59.4	54.5
	1994	54.4	55.0	54.6
HYPOLIMNION				
	1989	50.2	59.0	53.5
	1990	52.5	52.5	52.5
	1991	51.4	54.9	52.8
	1992	46.1	56.4	52.3
	1993	63.9	74.9	68.5
	1994	59.7	68.9	63.3
INLET				
	1989	34.1	38.0	36.2
	1990	40.5	40.5	40.5
	1991	44.5	49.6	47.7
	1992	26.8	48.4	36.9
	1993	43.1	51.8	47.4
	1994	35.3	45.3	40.3
METALIMNION				
	1989	47.2	47.9	47.5
	1990	53.8	53.8	53.8
	1991	49.8	52.2	51.3
	1992	45.9	52.7	50.1
	1993	48.3	59.8	53.3
	1994	50.4	55.5	53.4
OUTLET				
	1989	36.3	50.0	45.0
	1990	53.0	53.0	53.0
	1991	49.6	55.3	51.9
	1992	50.0	58.9	54.3
	1993	51.5	51.5	51.5
	1994	55.7	57.0	56.3

Table 7.

**Summary of 1994 and historical apparent color data.
Results in color units.**

Station	Year	Minimum	Maximum	Mean
EPILIMNION				
	1989	11	16	13
	1990	11	11	11
	1991	6	12	8
	1992	6	11	8
	1993	10	32	18
	1994	7	16	10
HYPOLIMNION				
	1989	14	37	22
	1990	24	24	24
	1991	16	30	24
	1992	18	28	22
	1993	47	65	55
	1994	20	37	27
INLET				
	1989	60	70	63
	1990	88	88	88
	1991	10	130	51
	1992	20	90	61
	1993	17	110	63
	1994	47	90	68
METALIMNION				
	1989	13	17	14
	1990	14	14	14
	1991	9	15	11
	1992	11	20	15
	1993	10	34	18
	1994	12	17	13
OUTLET				
	1989	11	28	19
	1990	13	13	13
	1991	10	18	13
	1992	8	27	15
	1993	10	10	10
	1994	12	12	12

Table 8.

Summary historical and 1994 sampling season Total Phosphorus data. Results in ug/L.

Station	Year	Minimum	Maximum	Mean
EPILIMNION				
	1989	3	10	6
	1990	8	8	8
	1991	8	8	8
	1992	9	9	9
	1993	7	7	7
	1994	18	18	18
HYPOLIMNION				
	1989	11	53	31
	1990	19	19	19
	1991	29	29	29
	1992	21	21	21
	1993	36	36	36
	1994	22	22	22
INLET				
	1989	38	47	42
	1990	38	38	38
	1991	71	71	71
	1992	51	51	51
	1993	65	65	65
	1994	96	96	96
METALIMNION				
	1989	13	17	15
	1990	12	12	12
	1991	14	14	14
	1992	17	17	17
	1993	8	8	8
	1994	15	15	15
OUTLET				
	1989	1	43	18
	1990	17	17	17
	1991	28	28	28
	1992	7	7	7
	1994	14	14	14

Table 9.

Current year dissolved oxygen and temperature data.

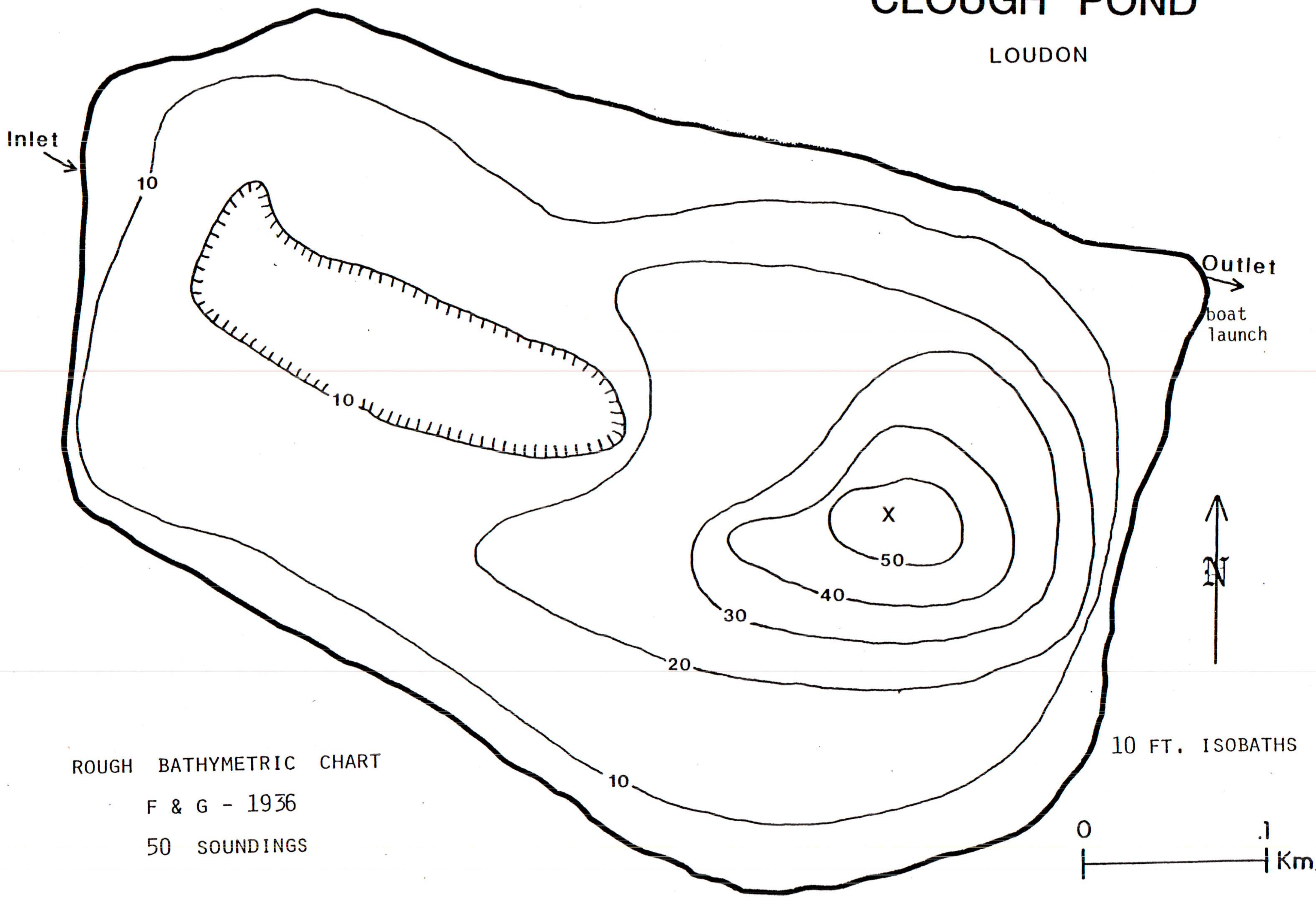
Depth (meters)	Temperature (celsius)	Dissolved Oxygen (mg/L)	Saturation (%)
	July 20, 1994		
0.1	27.4	8.7	108.0
1.0	26.1	8.8	107.0
2.0	25.6	8.9	106.0
3.0	25.4	8.9	106.0
4.0	24.2	10.2	121.0
5.0	18.9	12.1	128.0
6.0	14.6	12.8	122.0
7.0	10.9	10.4	91.0
8.0	8.8	3.4	28.0
9.0	7.2	0.7	6.0
10.0	6.8	0.1	1.0
11.0	6.7	0.1	1.0
12.0	6.4	0.1	1.0
13.0	6.3	0.1	1.0
14.0	6.2	0.1	1.0
14.0	6.2	0.2	1.0
15.0	6.2	0.2	1.0

Appendix C:

Lake Maps

CLOUGH POND

LOUDON



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