LAKE CHOCORUA

1991
NH LAKES LAY MONITORING PROGRAM
PRELIMINARY REPORT

by
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edited by

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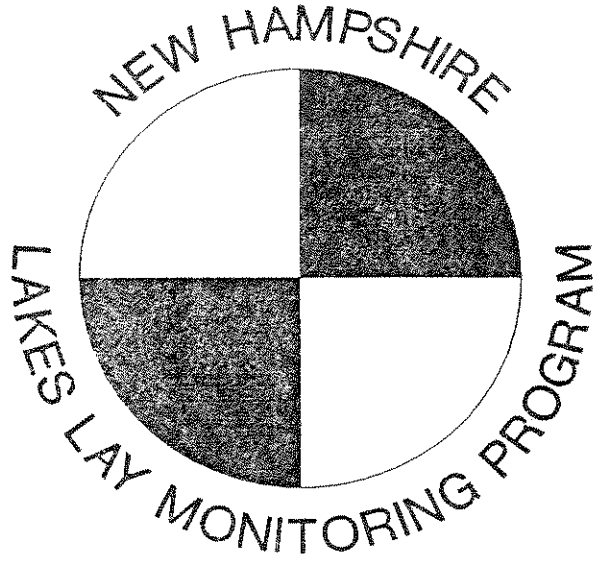

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University of New Hampshire
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UNIVERSITY OF
NEW HAMPSHIRE
COOPERATIVE EXTENSION

To obtain more information about the NH Lakes Monitoring Program
(NH LLMP) contact the Coordinator (J. Schloss) at 602-862-3848
Dr. Baker at 862-3845 or Dr. Haney at 862-2106

ACKNOWLEDGEMENTS

This was the tenth year of participation in the Lakes Lay Monitoring Program (LLMP) for the Lake Chocorua Monitor. The Lay Monitor and coordinator of Lake Chocorua was again Dr. Arthur Baldwin. The Freshwater Biology Group (FBG) congratulates Dr. Baldwin on the quality of his work, and the time and effort put forth. We encourage other interested members of the Lake Chocorua Association to continue monitoring during the 1992 season.

The Freshwater Biology Group is a not-for-profit research program co-supervised by Dr. Alan Baker and Dr. James Haney and coordinated by Jeffrey Schloss. Members of the FBG summer field team included Jeffrey Schloss, Robert Craycraft, John Ferraro, Sandy Weiss, John Hodsdon and Tracy Knight. Other FBG staff assisting in the fall were Eric Betke and Sean Proll.

The FBG acknowledges the University of New Hampshire Cooperative Extension for funding and furnishing office, laboratory and storage space. The College of Life Sciences and Agriculture provided accounting support and the UNH Office of Computer Services provided computer time and data storage allocations.

Participating groups in the LLMP include: The New Hampshire Audubon Society, Derry Conservation Commission, Dublin Garden Club, 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 Pemaquid Watershed Study Group, the associations of Baboosic Lake, Beaver Lake, Berry Bay, Big Island Pond, Bow Lake Camp Owners, Lake Chocorua, Crystal Lake, Dublin Lake, Glines Island, Goose Pond, Great East Lake, Lake Kanasatka Watershed, Langdon Cove, Long Island Landowners, Lovell Lake, Marchs Pond, Mascoma Lake, Mendum's Pond, Meredith Bay Rotary Club, Merrymeeting Lake, Milton Ponds Lake Lay Monitoring, Mirror Lake (Tuftonboro), Moultonbouro Bay, Lake Winnipesaukee, Naticook Lake, Newfound Lake, Nippo Lake, Perkins Pond, Pleasant Lake, Silver Lake (Hollis), Silver Lake (Harrisville), Silver Lake (Madison), Silver Lake (Tilton), Squam Lakes,

Lake Sunapee, Sunset Lake, Lake Waukewan, Lake Winona, Wentworth Lake and the towns of Alton, Amherst, Enfield, Hollis, Madison, Merrimack, Strafford and Wolfeboro.

LAKE CHOCORUA

1991 NON-TECHNICAL SUMMARY

Monitoring was undertaken at Lake Chocorua by the volunteer monitors from July 11 to October 12. A more in depth analysis of Lake Chocorua was preformed by the Lakes Lay Fish Condition Program on August 15.

1) Water transparency at Lake Chocorua was moderate to high, the sign of a relatively clear and unproductive lake. The secchi disk was visible as far down as 5.7 meters (18.5 feet) at site 1 South. This indicates the deepwater site on the lake has relatively low levels of dissolved color and suspended matter such as algae and particulates. Transparency averages were lower than the 1990 averages (i.e. the lake is less clear).

2) Chlorophyll a concentrations for the surface waters of Lake Chocorua were low. Concentrations in the mixed layer of water averaged 2.7 milligrams per cubic meter (mg m^{-3}, equivalent to about 2.7 parts chlorophyll per billion parts water) at site 1 South. Generally, concentrations below 3 mg m^{-3} are common to less productive clear lakes and values above 7 mg m^{-3} are common in productive lakes. Average chlorophyll levels decreased sligtly from levels seen in 1990.

3) Dissolved lakewater color levels for Lake Chocorua were moderate in 1991, 23.0 ptu (platinate color units), but slightly less than the average levels of 25 ptu in other program lakes. Small increases in water color from the natural breakdown of plant materials in and around a lake are not considered to be detrimental to water quality. However, increased color can lower water transparency, and hence, change the public perception of water quality.

4) Total phosphorus (nutrient) levels remained low at the deep site with a range of 1.0 to 4.9 parts per billion. Phosphorus samples were also collected at Stratton Brook, which remained low (6.2 ppb) and Br. Tributary, which, on the other hand, reached higher phosphorous levels (15.9 ppb) in late August. A concentration of the 15 ppb is commonly thought of as the boundary between less productive and more productive lakes.

5) The alkalinity of the lake; the lake's ability to buffer acid input is low, about 3 units (milligrams per liter of calcium carbonate) lower than the average alkalinity of 6 for LLMP program lakes. The alkalinity data indicate that Lake Chocorua seems to have a low buffering capacity at this time to resist fluctuations in pH due to acid loadings.

6) Specific conductivity levels were not assessed at Lake Chocorua in 1991. High conductivity values can indicate the presence of septic leachate or de-icing salt runoff.

7) Temperature profiles taken by the volunteer monitor disclosed the typical temperature stratification patterns for northern temperate lakes. With the depth of the upper mixed layer of water extending to 6.0 meters. Oxygen content of the bottom waters was low; bottom water oxygen concentration remained above 5 milligrams per liter (the minimum concentration required for successful reproduction and growth of most coldwater fish) only down to about 7.0 meters. Low oxygen in the bottom waters suggests accumulation of organic matter from lake algal and plant production as well as the possibility of watershed runoff.

8) For all measurements considered and averaged for the season, Lake Chocorua would be classified as having low productivity, a relatively clear, oligotrophic lake.

GRAPH SUMMARY

Secchi Disk Depth - 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. Dotted lines on the plots border the ranges common to oligotrophic, mesotrophic and eutrophic lakes.

Chlorophyll a Concentration - 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. Chlorophyll a concentrations in parts per billion (ppb) of chlorophyll a. Dotted lines on the plots border the ranges common to oligotrophic, mesotrophic and eutrophic lakes.

Dissolved Color Concentration - Seasonal trends for dissolved color concentration. Color expressed as platinum-cobalt units (ptu). 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. Such substances generally do not threaten water quality except as they diminish sunlight penetration into deep waters. Increase in dissolved watercolor can be an indication of increased development within the watershed as many land clearing activities (construction, deforestation, and the resulting increased run-off) add additional organic material to lakes.

The three graphs described above are placed on the same page to allow for the determination of how chlorophyll and color changes affect the water clarity measured with the secchi disk. Low occasions of water clarity shown correspond to high chlorophyll and/or color levels. If clarity is low yet chlorophyll and color are also low, than suspended sediment is the cause of low water clarity.

Chlorophyll Comparison Graphs - Comparison of 1991 Chlorophyll a averages to historical "pooled" averages. The pooled average statistic represents what would be considered as typical for the lake, while the minimum and maximum value measured for the lake sites indicate the record high and low for chlorophyll a. The vertical dotted lines on the plots border the ranges common to unproductive (oligotrophic), moderately productive (mesotrophic), and highly productive (eutrophic) lakes.

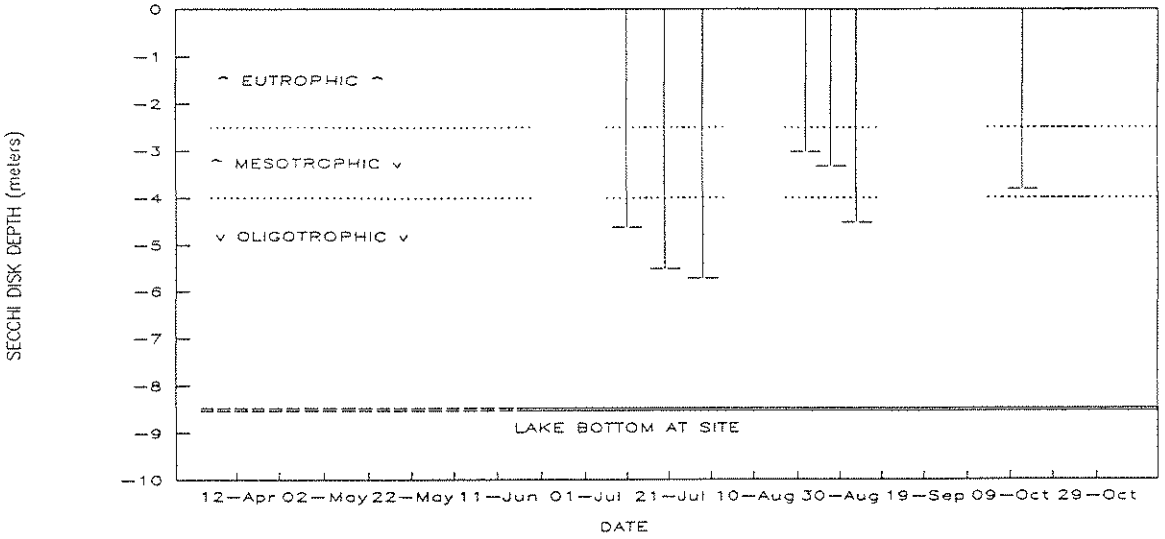
Secchi Disk Comparison Graphs - Comparison of 1991 Secchi Disk averages to historical "pooled" averages. The pooled average statistic represents what would be considered as typical for the lake, while the minimum and maximum value measured for the lake sites indicate the record high and low Secchi Disk depths. The vertical dotted lines on the plots border the ranges common to unproductive (oligotrophic), moderately productive (mesotrophic), and highly productive (eutrophic) lakes.

* The forementioned graphs reflect the parameters collected by various lakes in the LLMP. Inclusion of the graphs is a reflection of the parameters collected at the respective lake. Thus, all graphs are not necessarily included for your lake.

* Comparison graphs are present in lakes which participated in the LLMP prior to 1991, but may be absent from new participant in the LLMP. In subsequent years, comparison graphs will be included for these lakes, as a historical database is developed and yearly comparisons can then be made.

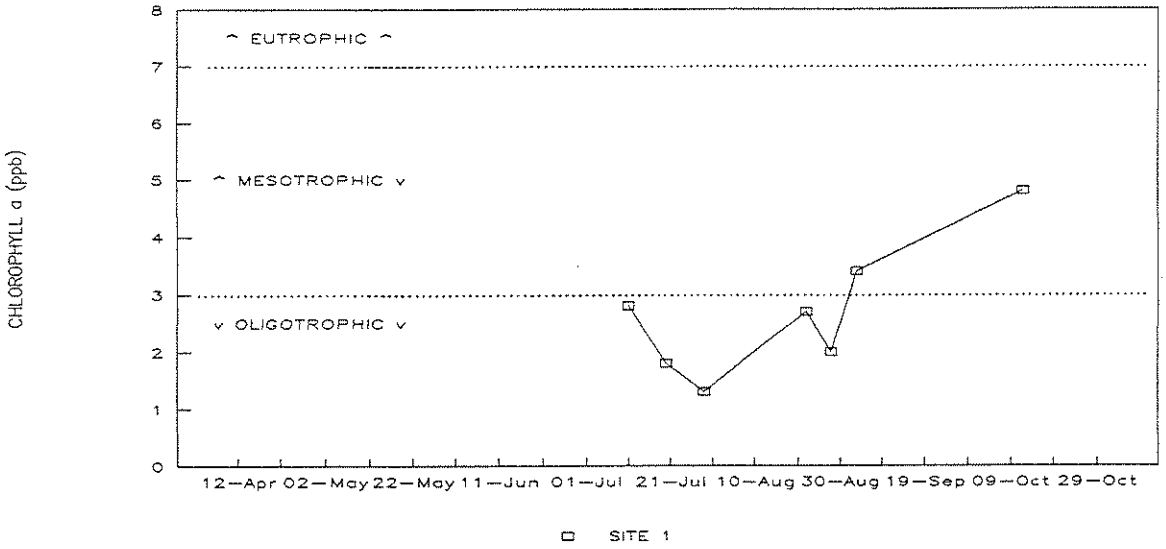
LAKE CHOCORUA — SITE 1 SOUTH

SECCHI DISK TRANSPARENCY 1991



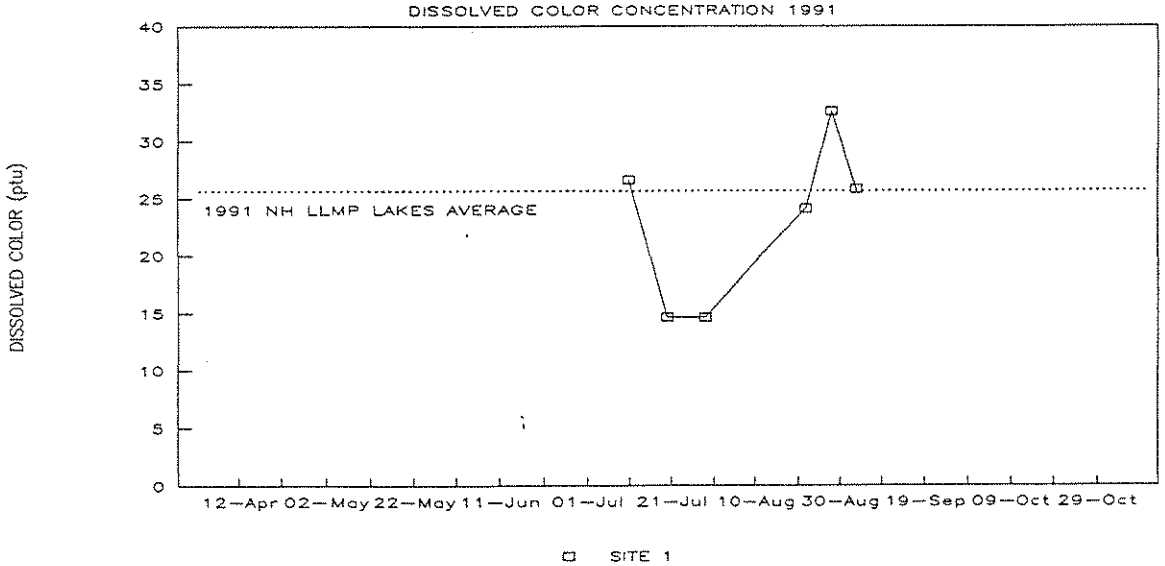
LAKE CHOCORUA

CHLOROPHYL CONCENTRATION 1991

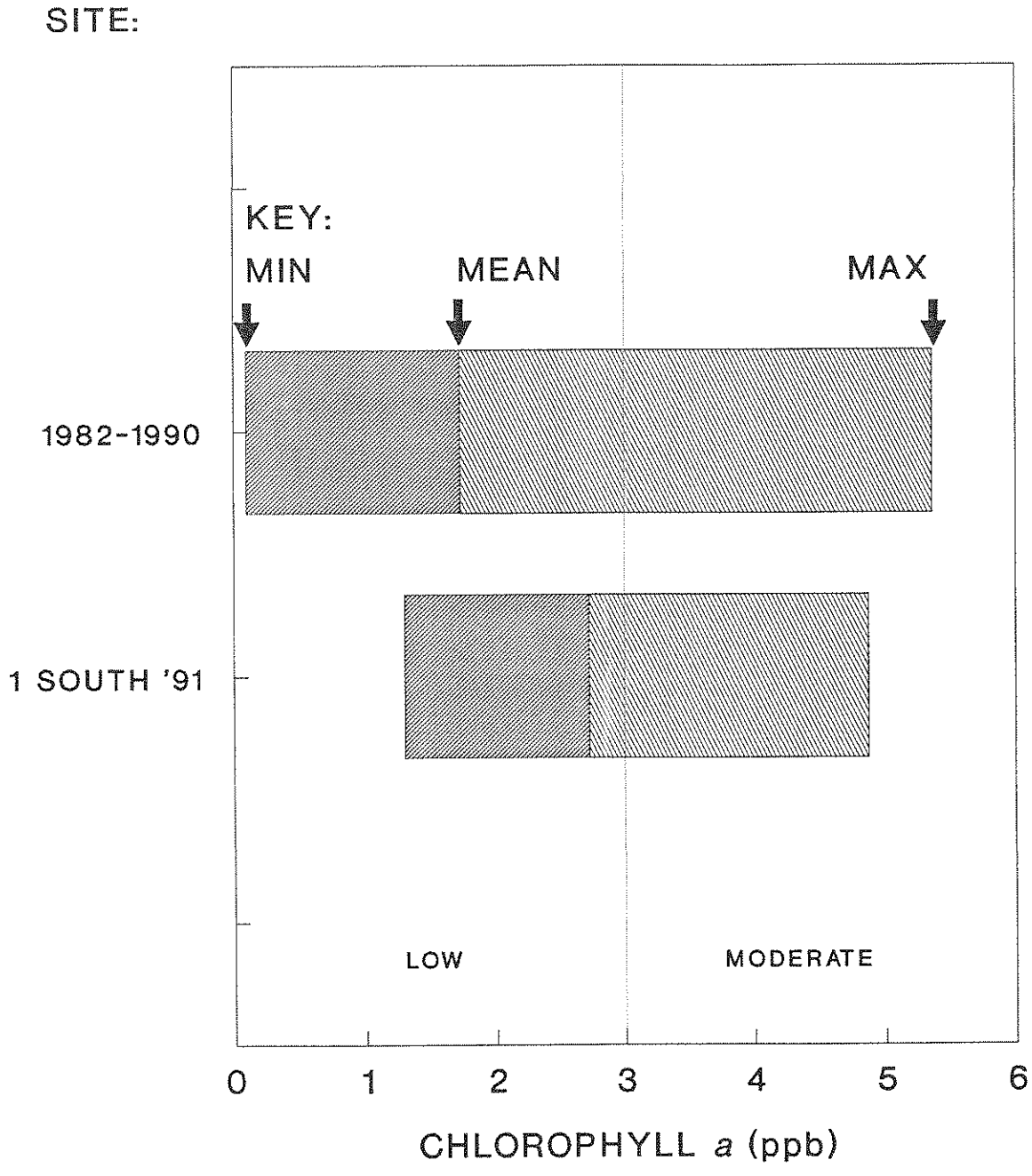


LAKE CHOCORUA

DISSOLVED COLOR CONCENTRATION 1991

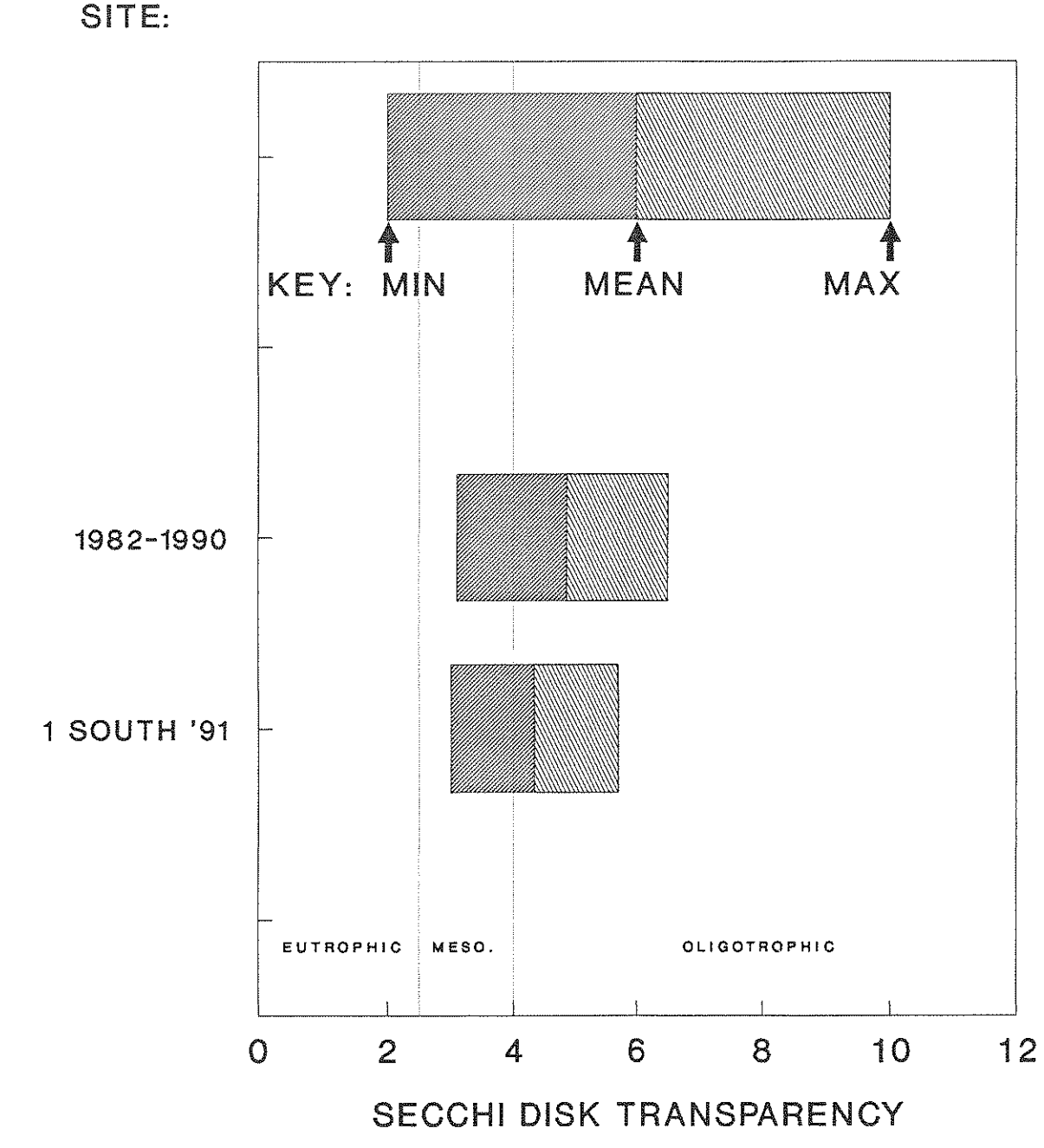


COMPARISON: 1991 TO HISTORICAL CHL DATA
LAKE CHOCORUA
CHLOROPHYLL CONCENTRATION



THE HIGHER NUMBER = HIGHER ALGAL LEVELS

COMPARISON: 1991 TO HISTORICAL SD DATA
LAKE CHOCORUA
BAR INDICATES MIN, MEAN AND MAX



THE HIGHER NUMBER = CLEARER WATER

Lake Chocorua Data on file as of 01/24/1992

Lakes Lay Monitoring Program, U.N.H.

[Lay Monitor Data]

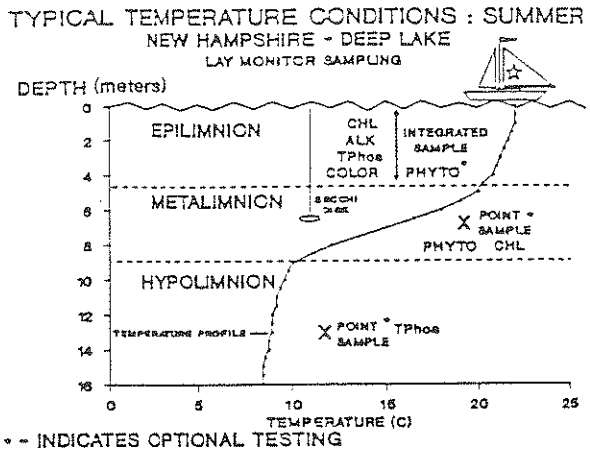
Lake Chocorua, NH
-- subset of trophic indicators, all sites, 1991

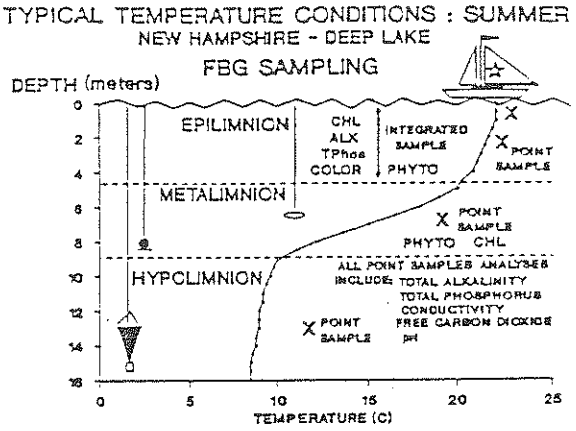
1991 SUMMARY

Average transparency:	4.3	(1991:	7	values;	3.0	-	5.7	range)
Average chlorophyll:	2.7	(1991:	7	values;	1.3	-	4.8	range)
Average phosphorus:	3.0	(1991:	2	values;	1.0	-	4.9	range)
Average alk (gray):	3.0	(1991:	7	values;	2.2	-	3.6	range)
Average alk (pink):	4.7	(1991:	7	values;	4.2	-	5.6	range)
Average color, 440:	23.0	(1991:	6	values;	14.6	-	32.6	range)
Average Trib. phos:	11.1	(1991:	2	values;	6.2	-	15.9	range)

Site	Date	Trans-parency (m)	Chl a (ppb)	Total Phos (ppb)	Alk. (gray) ph 5.1	Alk. (pink) ph 4.6	Color Pt-Co units
1 South	07/11/1991	4.6	2.8	---	2.9	5.2	26.6
1 South	07/20/1991	5.5	1.8	---	3.0	4.3	14.6
1 South	07/29/1991	5.7	1.3	---	3.6	5.6	14.6
1 South	08/15/1991	---	---	1.0	---	---	---
1 South	08/22/1991	3.0	2.7	---	3.0	4.3	24.1
1 South	08/28/1991	3.3	2.0	---	3.2	4.8	32.6
1 South	09/03/1991	4.5	3.4	4.9	2.2	4.2	25.8
1 South	10/12/1991	3.8	4.8	---	2.9	4.3	---
Br. Trib	08/22/1991	---	---	15.9	---	---	---
Stratton	08/22/1991	---	---	6.2	---	---	---

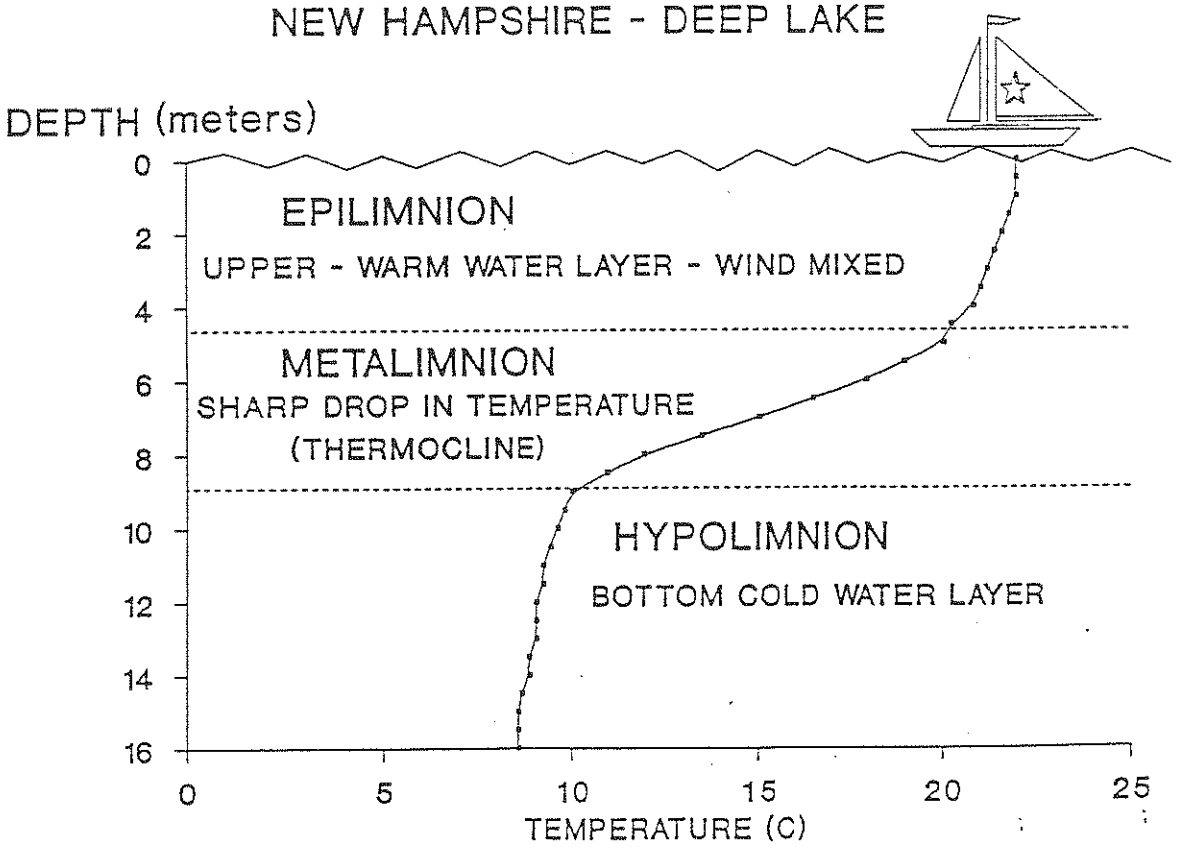
<< End of 1991 listing, 10 records >>





TYPICAL TEMPERATURE CONDITIONS : SUMMER

NEW HAMPSHIRE - DEEP LAKE



APPENDIX C

GLOSSARY OF LIMNOLOGICAL TERMS

Aerobe- Organisms requiring oxygen for life. All animals, most algae and some bacteria require oxygen for respiration.

Algae- See phytoplankton.

Alkalinity- Total concentration of bicarbonate and hydroxide ions (in most lakes).

Anaerobe- Organisms not requiring oxygen for life. Some algae and many bacteria are able to respire or ferment without using oxygen.

Anoxic- A system lacking oxygen, therefore incapable of supporting the most common kind of biological respiration, or of supporting oxygen-demanding chemical reactions. The deeper waters of a lake may become anoxic if there are many organisms depleting oxygen via respiration, and there is little or no replenishment of oxygen from photosynthesis or from the atmosphere.

Benthic- Referring to the bottom sediments.

Bacterioplankton- Bacteria adapted to the "open water" or "planktonic" zone of lakes, adapted for many specialized habitats and include groups that can use the sun's energy (phytoplankton), some that can use the energy locked in sulfur or iron, and others that gain energy by decomposing dead material.

Bicarbonate- The most important ion (chemical) involved in the buffering system of New Hampshire lakes.

Buffering- The capacity of lakewater to absorb acid with a minimal change in the pH. In New Hampshire the chemical responsible for buffering is the bicarbonate ion. (See pH.)

Chloride- One of the components of salts dissolved in lakewater. Generally the most abundant ion in New Hampshire lakewater, it may be used as an indicator of raw sewage or of road salt.

Chlorophyll a- The main green pigment in plants. The concentration of chlorophyll a in lakewater is often used as an indicator of algal abundance.

Circulation- The period during spring and fall when the combination of low water temperature and wind cause the water column to mix freely over its entire depth.

Density- The weight per volume of a substance. The more dense an object, the heavier it feels. Low-density liquids will float on higher-density liquids.

Dimictic- The thermal pattern of lakes where the lake circulates, or mixes, twice a year. Other patterns such as polymictic (many periods of circulation per year) are uncommon in New Hampshire. (See also meromictic and holomictic).

Dystrophy- The lake trophic state in which the lakewater is highly stained with humic acids (reddish brown or yellow stain) and has low productivity. Chlorophyll a concentration may be low or high.

Epilimnion- The uppermost layer of water during periods of thermal stratification. (See lake diagram).

Eutrophy- The lake trophic state in which algal production is high. Associated with euthrophy is low Secchi disk depth, high chlorophyll a, and low total phosphorus. From an esthetic viewpoint these lakes are "bad" because water clarity is low, aquatic plants are often found in abundance, and cold-water fish such as trout and salmon are usually not present. A good aspect of eutrophic lakes is their high productivity in terms of warm-water fish such as bass, pickerel, and perch.

Free CO2- Carbon dioxide that is not combined chemically with lake water or any other substances. It is produced by repiration, and is used by plants and bacteria for photosynthesis.

Holomixis- The condition where the entire lake is free to circulate during periods of overturn. (See meromixis.)

Humic Acids-Dissolved organic compounds released from decomposition of plant leaves and stems. Humic acids are red, brown, or yellow in color and are present in nearlu all lakes in New Hampshire. Humic acids are consumed only by fungi, and thus are relatively resistant to biological decomposition.

Hydrogen Ion- The "acid" ion, present in small amounts even in distilled water, but contributed to rain-water by atmospheric processes, to ground-water by soils, and to lakewater by biological organisms and sediments. The active component of "acid rain". See also "pH" the symbolic value inversely and exponentially related to the hydrogen ion.

Hypolimnion-The deepest layer of lakewater during periods of thermal stratification. (See lake diagram)

Lake- Any "inland" body of relatively "standing" water. Includes many synonyms such as ponds, tarns, lochs, billabongs, bogs, marshes, etc.

Lake Morphology- The shape and size of a lake and its basin.

Littoral- The area of a lake shallow enough for submerged aquatic plants to grow.

Meromixis- The condition where the entire lake fails to circulate to its deepest points; caused by a high concentration of salt in the deeper waters, and by peculiar landscapes (small deep lakes surrounded by hills and/or forests. (Contrast holomixis.)

Mesotrophy- The lake trophic state intermediate between oligotrophy and eutrophy. Algal production is moderate, and chlorophyll a, Secchi disk depth, and total phosphorus are also moderate. These lakes are esthetically "fair" but not as good as oligotrophic lakes.

Metalimnion-The "middle" layer of the lake during periods of summer thermal stratification. Usually defined as the region where the water temperature changes at least one degree per meter depth. Also called the thermocline.

Mixis- Periods of lakewater mixing or circulation.

Mixotrophy- The lake condition where the water is highly stained with humic acids, but algal production and chlorophyll a values are also high.

Oligotrophy- The lake trophic state where algal production is low, Secchi disk depth is deep, and chlorophyll a and total phosphorus are low. Esthetically these lakes are the "best" because they

are clear and have a minimum of algae and aquatic plants. Deep oligotrophic lakes can usually support cold-water fish such as lake trout and land-locked salmon.

Overturn- See circulation or mixis

pH- A measure of the hydrogen ion concentration of a liquid. For every decrease of 1 pH unit, the hydrogen ion concentration increases 10 times. Symbolically, the pH value is the "negative logarithm" of the hydrogen ion concentration. For example, a pH of 5 represents a hydrogen ion concentration of 10^{-5} molar. [Please thank the chemists for this lovely symbolism -- and ask them to explain it in lay terms!] In any event, the higher the pH value, the lower the hydrogen ion concentration. The range is 0 to 14, with 7 being neutral 1 denoting high acid condition and 14 denoting very basic condition.

Photosynthesis- The process by which plants convert the inorganic substances carbon dioxide and water into organic glucose (sugar) and oxygen using sunlight as the energy source. Glucose is an energy source for growth, reproduction, and maintenance of almost all life forms.

Phytoplankton- Microscopic algae which are suspended in the "open water" zone of lakes and ponds. A major source of food for zooplankton. Common examples include: diatoms, euglenoids, dinoflagellates, and many others. Usually included are the blue-green bacteria.

Parts per million- Also known as "ppm". This is a method of expressing the amount of one substance (solute) dissolved in another (solvent). For example, a solution with 10 ppm of oxygen has 10 pounds of oxygen for every 999,990 pounds (500 tons) of water. Domestic sewage usually contains from 2 to 10 ppm phosphorus.

Parts per billion- Also known as "ppb". This is only 1/1000 of ppm, therefore much less concentrated. As little as 1 ppb of phosphorus will sustain growth of algae. As little as 10 ppb phosphorus will cause algal blooms! Think of the ratio as 1 milligram (1/28000 of an ounce) of phosphorus in 25 barrels of water (55 gallon drums)! Or, 1 gallon of septic waste diluted into 10,000 gallons of lakewater. It adds up fast!

Plankton- Community of microorganisms that live suspended in the water column, not attached to the bottom sediments or aquatic plants. See also "bacterioplankton" (bacteria), "phytoplankton" (algae) and "zooplankton" (mocrocrustaceans and rotifers).

Saturated- When a solute (such as water) has dissolved all of a substance that it can. For example, if you add table salt to water, a point is reached where any additional salt fails to dissolve. The water is then said to be saturated with table salt. In lakewater, gaseous oxygen can dissolve, but eventually the water becomes saturated with oxygen if exposed sufficiently long to the atmosphere or another source of oxygen.

Specific Conductivity- A measure of the amount of salt present in lakewater. As the salt concentration increases, so does the specific conductivity (electrical conductivity).

Stratum- A layer or "blanket". Can be used to refer to one of the major layers of lakewater such as the epilimnion, or to any layers of organisms or chemicals that may be present in a lake.

Thermal Stratification- The process by which layers are built up in the lake due to heating by the sun and partial mixing by wind.

Thermocline- Region of temperature change. (See metalimnion.)

Total Phosphorus- A measure of the concentration of phosphorus in lakewater. Includes both free forms (dissoved), and chemically combined form (as in living tissue, or in dead but suspended

organisms).

Trophic Status- A classification system placing lakes into similar groups according to their amount of algal production. (See Oligotrophy, Mesotrophy, Eutrophy, Mixotrophy, and Dystrophy for definitions of the major categories)

Z- A symbol used by limnologists as an abbreviation for depth.

Zooplankton- Microscopic animals in the planktonic community. Some are called "water fleas", but most are known by their scientific names. Scientific names include: Daphnia, Cyclops, Bosmina, and Kellicottia.