Limnological Study of

Spring Lake, Oneida County

November 1990 - October 1991

Prepared by

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Introduction

The following is a description and results from the base line study of Spring Lake (1611100) performed by Northern Lake Service between November 1990 and October 1991. Spring Lake is located in section 35 of T39N and R 11E in northwestern Oneida County. It has an area of 89.5 acres, a maximum depth of 10 feet and 1.6 miles of shoreline. It is spring fed and has one outlet, Mosquito Creek. Its watershed 1 sq. mile in area. It is lightly developed.

The purpose of this study was to determine current water quality,to establish a base of information for comparison with future data,and to provide a basis for recommending improvement/preservation strategies.

Sampling Methods

Water samples were collected on 4 occasions; November 15, 1990, April 16, 1991, August 5, 1991 and October 2, 1991. These were collected from just below the surface near the middle of the lake using a 2 meter PVC column sampler. Since the lake is relatively small and shallow we feel this provided a representative sample of the water column. The samples were delivered to Northern Lake Service for analysis of total alkalinity, chloride, conductivity, ammonia as nitrogen, nitrogen as nitrate and nitrite, Kjeldahl as nitrogen, pH and total phosphorus. All samples <u>except</u> the one collected on August 5, 1991 were collected by Spring Lake Association members.

The August 5th sample was collected by NLS personnel. At that time we also conducted a general macrophyte survey. See Appendix 1 macrophyte survey for methods employed.

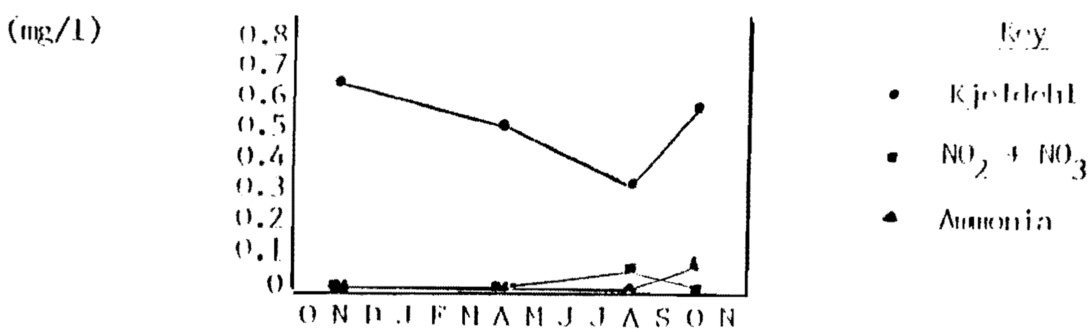
<u>Nutrients</u>

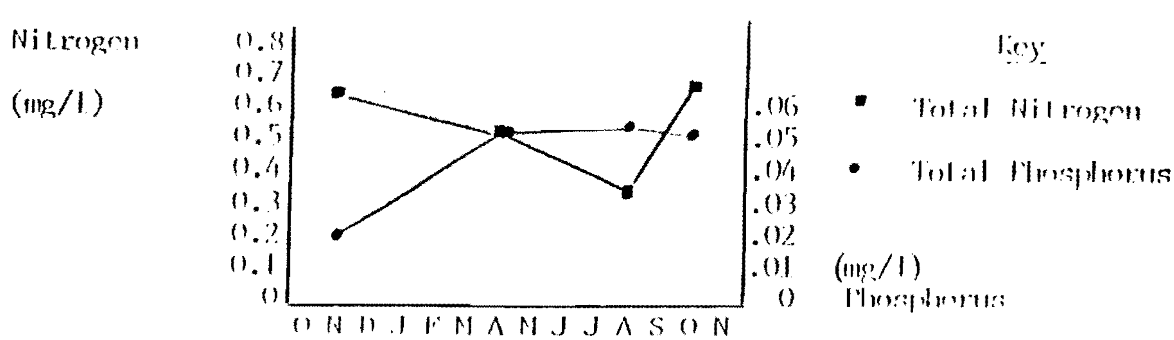
A nutrient is any element , ion or compound necessary for an organism's growth and other life processes. Most nutrients are required only in trace amounts, but some, the macronutrients are required in large enough amounts to dictate the productivity of a system. The macronutrients are carbon, nitrogen and phosphorus. Since carbon is so prevalent in a lake its levels do not get low enough to make it a limiting factor (the nutrient which exists in a quantity such that it dictated the extent of growth). Therefore nitrogen and phosphorus are considered the most important in terms of a lake's potential productivity.

Nuisance weeds or algae can be expected when total phosphorus levels exceed 15 $\mu g/l$. The levels in Spring Lake remain at or above 50 μg/1 throughout most of the year providing an abundance of this nutrient.

Nitrogen levels are not exceptionally high. The majority of total nitrogen was Kjeldahl or organic nitrogen, which is expected in lake water Analysis for ammonia (a constituent of total nitrogen) revealed low level relative to total nitrogen. This means there is probably not a problem with septic contamination.

Generally, in a lake of this region, phosphorus is the limiting factor, existing in a ratio of >13:1 nitrogen to phosphorus. However in Spring Lake the ratio at spring turnover was 10:1 meaning nitrogen is the limiting factor. Below are graphs of nitrogen component levels and nitrogen/phosphorus throughout the course of the study. See appendix 2 for all analytical results.





pH and Buffering Capacity

Total alkalinity (the measure of calcium carbonate) and pH are indicators of a lake's susceptibility to the effects of acid rain. pH is a measure of acidity with 7 being neutral, less than 7 indicates increasing acidity and higher numbers (up to 14) indicate the substance in more basic. This is a logarithmic scale. Alkalinity measures the ability of water to neutralize substances on the upper and lower ends of the pH scale before its own pH is changed. This process is known as buffering. Spring Lake is slightly acidic with a pH of 6.0 to 6.5. The alkalinity is fairly stable at about 20 mg/l. This is not as high as one would like but it should provide adequate buffering for the time being. Should this drop below 10 in the future remedial action may be necessary.

Macrophytes

Spring Lake supports extensive macrophyte growth. Rooted plants were observed growing over 90% to 95% of the lake out to depth of 10.5 feet. Twenty-four species were observed on August 5, 1991. (this includes quillwort, a bladderwort and a macrophytic algae, chara, which were keyed only to genus) While this excessive growth may not be popular to the human residents, it is important to the lake's other residents. One half the species observed are considered important wild fowl food. Others are important as food and/or shelter for fish, semi-aquatic mammals and scores of smaller prey organisms. (Fassett, N.C. 1957, A Manual of Aquatic Plants. pp 343-358.) For specific information on Macrophyte density and distribution see Appendix 1.

Summary and Recommendations

It is always nice to be able to tell a client what he wants to hear, unfortunately that becomes difficult at times. Spring Lake is undergoing a natural process called eutrophication or lake aging. The symptoms of this include heavy sediment deposition, increased weed and/or algae production and encroachment by woody vegetation. Often, the actions of man can have a dramatic accelerating effect on this process, but this is probably not the case on Spring Lake. It is simply a small, shallow, productive lake destined to age rapidly. The models below show where Spring Lake falls in terms of trophic state and water quality.

Water quality index	Approximate Total phosphorus equivalent (mg/l)	Approximate water clarity equivalent (Secchi-disc depth in ft)
Excellent	<0.001	>19.7
Very good	.001- .010	9.8-19.7
Good	.010-.030	6.6-9.8
Fair	.030-.050	4.6-6.6 Spring Lake
Poor	.050-.150 Spring Lake	3.3-4.9
Very Poor	>.150	<3.3

(Lillie, R.A. and Mason, J.W., 1983 Limnological characteristics of Wisconsin Lakes, Wisconsin Dept. of Natural Resources Technical Bulletin No. 138, 116 p.)

Trophic level	Trophic state index	Total phosphorus (μg/l)	Secchi disc (m)
Eutrophic			
	50	20	2.0
Mesotrophic			
	40	10	4.0
Oligotrophic			

(Carlson, R.E., 1977, A trophic state index for lakes: Limnology and Oceanography, March, v.22 (2), p. 361-369.)

It is unfortunate that Lillie and Mason use terms such as "poor" in their model. A lake in any condition should be appreciated for what it has to offer. It is probably a "very good" lake from a wildlife prospective. Spring Lake also offers peace and quiet and privacy which has become somewhat rare in this neck of the woods.

Of course, there are a number of methods for retarding eutrophication. Chemicals, mechanical weed harvesting and dredging have been used widely with varying degrees of success. More far-fetched methods such as screens and dyes have even been used to control nuisance weed growth. However, these methods are very expensive and considering the low number of residents on Spring Lake to share the cost, they are probably not economically feasible. The state is currently working up an implementation grant program (on a 50/50 matching fund basis) but as it now stands they will not share costs for chemicals or harvesting equipment. If you are interested in looking into the use of chemicals, the DNR publishes a number of information sheets on currently marketed weed control chemicals (PUBL-WR-135-90 through PUBL-WR145-90.)

Low cost, low impact weed control practices are probably the best bet on this lake. Raking is the most common of these practices, but this upsets the sediments and releases more nutrients into the water column. Recently, some study has been done on hand cutting weeds very close to the bottom. In the studies I have read, scuba divers did the cutting but in a shallower lake this would not be necessary. The results of these efforts have been quite promising with the cut off area persisting of 3 to 4 years. (These trials were done on Eurasian Milfoil; other weeds may respond differently.) Another important benefit of this method is an increase in open water/ heavy cover interface. This increases fish predation, decreasing the chances of uncontrolled populations of stunted panfish. While these low tech methods are somewhat time and labor intensive, they are much easier on the pocket book and the aesthetics.

Proper common-sense lake shore practices will help assure that eutrophication is not accelerated by residents. These include the following: maintaining buffer zones along the shore, carefully monitoring septic system performance, landscaping to decrease erosion, and avoiding the use of chemical fertilizers. Continuous education and self-monitoring by lake shore residents is of vital importance.

Finally, we recommend a long-term monitoring program. Frequent Secchi disk readings and one sample annually, preferably at spring turnover, are excellent indicators of changes in aging trends and responses to management strategies. A program of this sort would probably cost the association less than $150 per year.

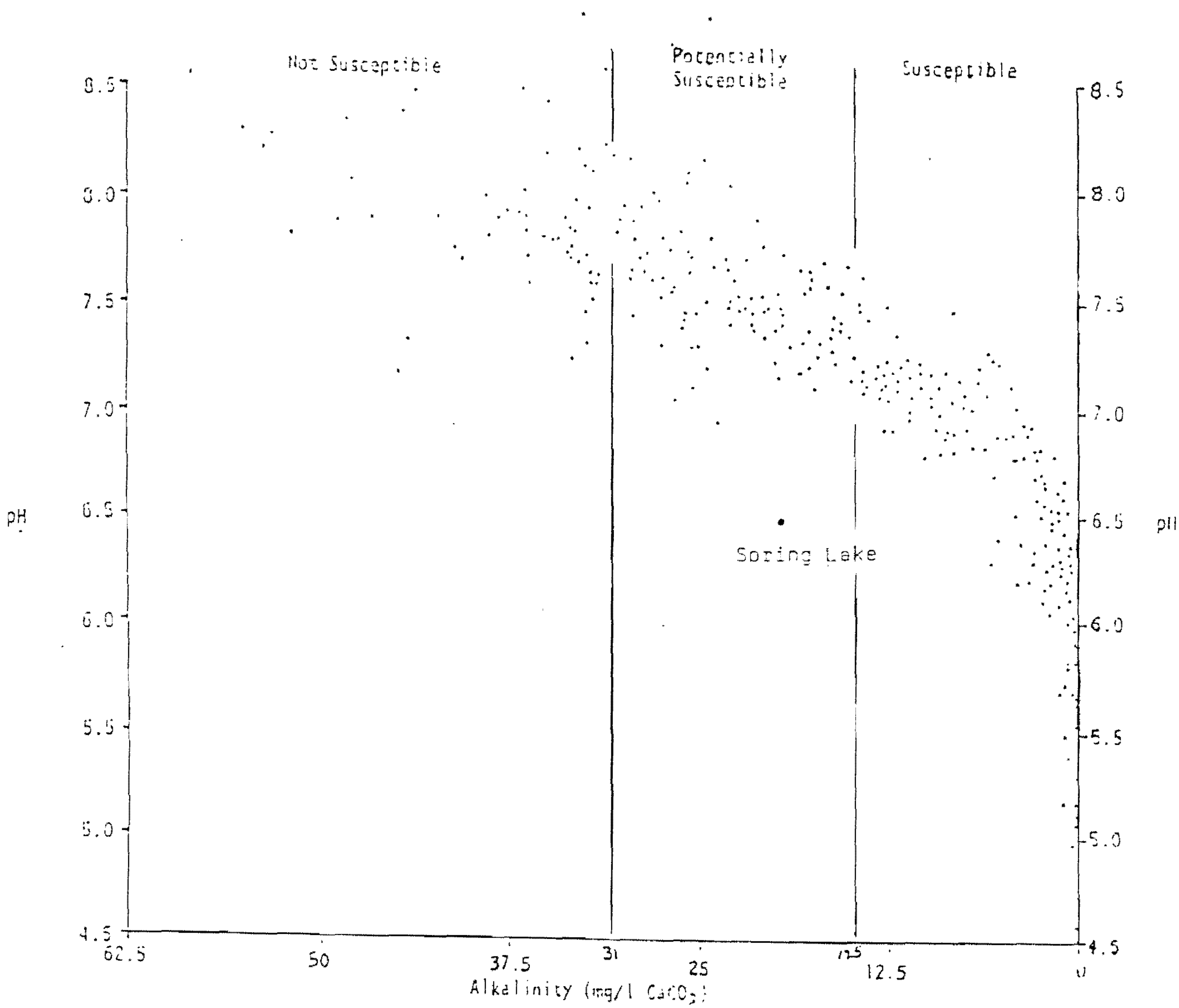
The following is an addendum to the report on the baseline planning grant study of Spring Lake (1611100) prepared in April of 1992. The initial report is entitled Limnological Study of Spring Lake, Oneida County November 1990 - October 1991. These pages contain comments on and comparisons of data covered in the initial report (from samples collected on 10/15/90, 4/16/91, 8/5/91, and 10/2/91), along with results generated since then (collected 4/30/92, 10/6/92, 4/30/93, and 10/12/93). All samples since the original report were collected by Spring Lake Association members and hand delivered to Northern Lake Service, where all analysis was performed. For a description of sampling procedures and an explanation of analytical parameters see the original report.
All analytical results are listed on page 7.

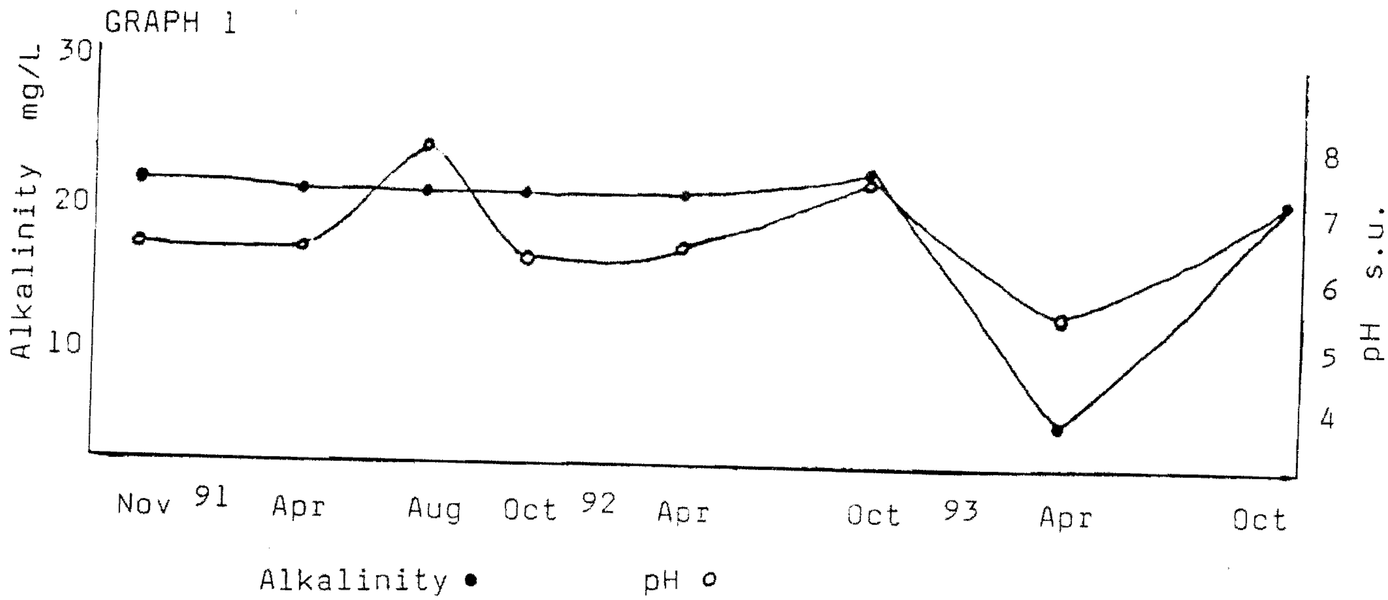
pH and Alkalinity

Alkalinity and pH on Spring Lake remain quite stable. Alkalinity varied by only 4 milligrams per liter over the three year period, with the exception of the April 1993 sampling. (This sample yielded unusual results on nearly every parameter. It contained sediments which probably caused the unusual results.) pH values ranged from 5.2 to 7.3. The low value recorded from the April 1993 sample is probably due to the sediment contamination. These values are very close to those reported in Surface Water Resources of Oneida County (Wisconsin Conservation Department, 1966), so it seems no real depletion has occurred over the last thirty years.

Graph 1 shows pH and alkalinity values throughout the study. The figure below shows Spring Lake's susceptibility to acid rain relative to other area lakes.

ACID RAIN EFFECT SUSCEPTIBILITY
(from Greater Bass Lake Langlade County Feasibility Results; Management Alternatives. by WDNR Bureau of Water Resources Management - Inland Lake Renewal Section; 1983, p17.)



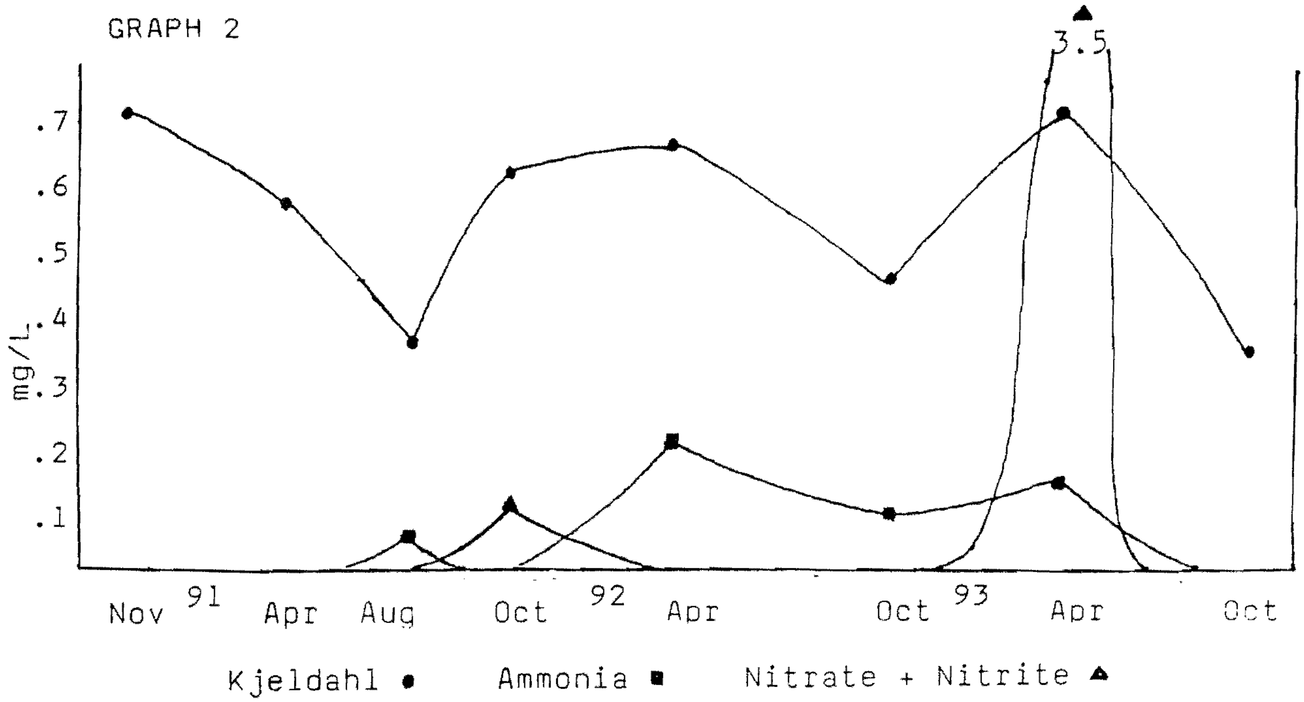


Nutrients

Phosphorus levels remained high enough throughout the study to support nuisance weed growth. They did however drop over the last two years. Initially high levels in 1991 may have been due to drought conditions in previous years.

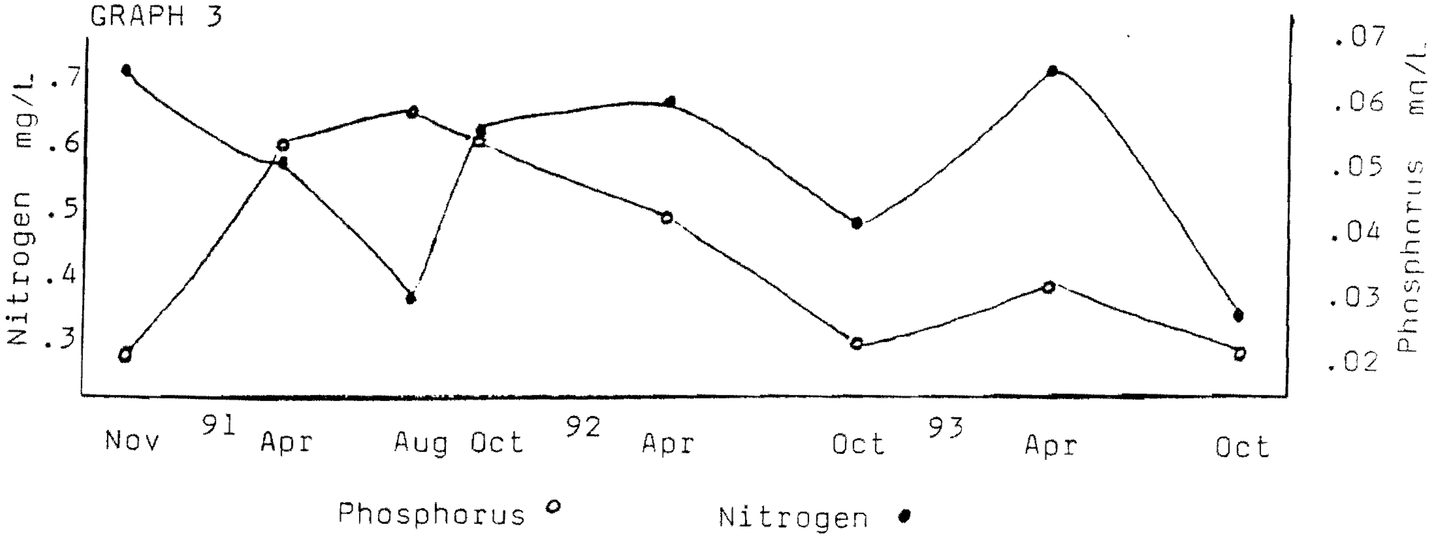
Nitrogen levels ranged from about .3 mg/l to .7 mg/l and remained quite consistent throughout the study. Nitrate + Nitrite and ammonia, which are components of total nitrogen that can indicate pollution problems, remained at or near detection limits throughout much of the study. Once again the high N+N value generated on the April '93 sample probably does not represent conditions in the water column at that time. Ammonia levels were significant in several samples. This is probably due to natural production. Graph 2 shows the nitrogen components throughout the study.

GRAPH 2



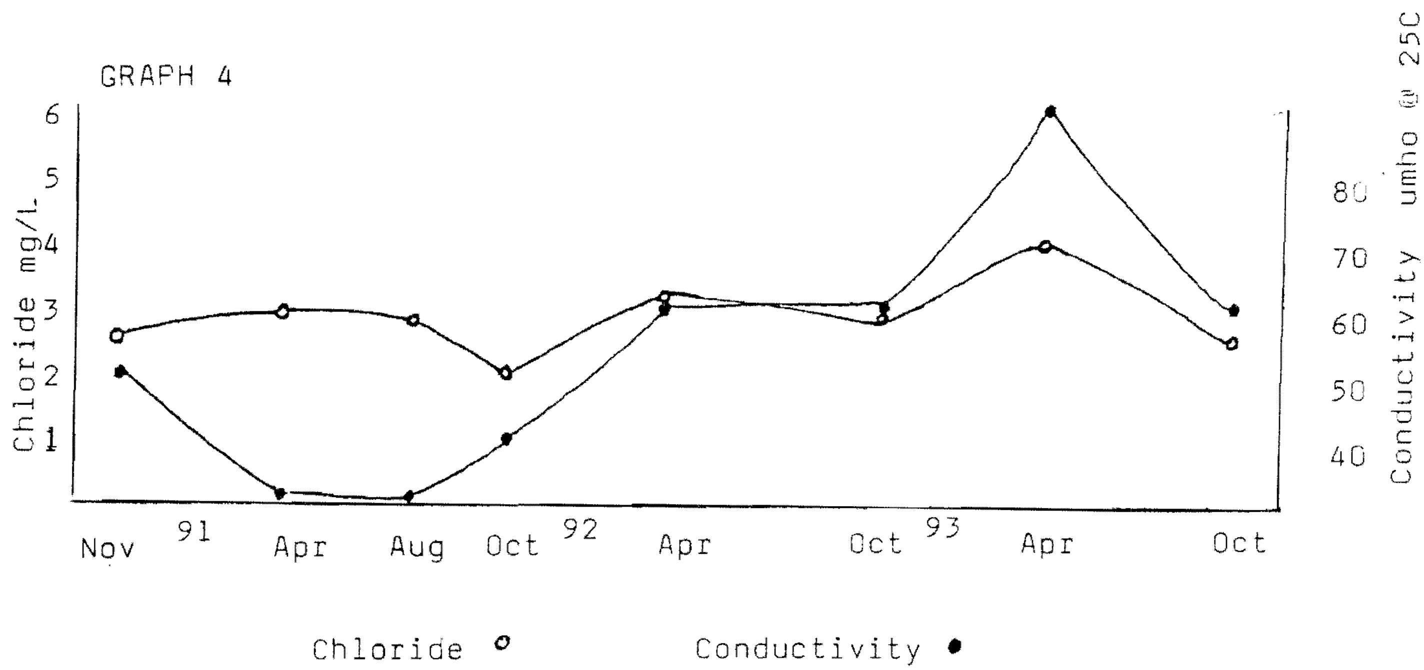
Total nitrogen and total phosphorus occur in ratios of 6:1 to 32:1 indicating that at specific times each acts as the limiting factor. Graph 3 shows nitrogen and phosphorus on a ten to one ratio.

GRAPH 3



Chloride and Conductivity

Chloride and conductivity which can be indicators of septic contamination were very stable and relatively low. Chloride ranged from <1 to 3 mg/l and conductivity from 50 to 61 umho. (This is excluding April '93 data which was 6 mg/l and 69 umho.) Conductivity was only slightly higher than that recorded in the 1960's. <u>Surface Water Resources of Oneida County</u> reported the conductivity of Spring Lake at 44 umho. Graph 4 shows these parameters.



Summary

As the initial report stated, Spring Lake is a highly productive system. This productivity is probably due mostly to natural lake aging processes (eutrophication). While there are many methods of slowing these processes and attacking the symptoms, the extent of eutrophication and the limited tax base, render most of them unfeasable. The Asssociation may want to look into a small scale weed havesting program. Traditional weed harvesting is very labor and cost intensive and would be innapropriate for Spring Lake, but a small weed cutter could improve recreational use and benefit the fishery. While this approach does not bring dramatic overnight improvements, it does preserve aesthetics and keep costs managable. This should be discussed further with the regional lake manager. Again, it should be stressed that residents must practice wise land use in order to avoid speeding up lake aging. These include the following:

* Maintain vegetated "buffer zones" along the shore
* Carefully monitor septic performance
* Landscape to decrease erision
* Divert runoff from construction sites
* Aviod the use of chemical fertilizers
* Keep lawn and garden wastes from washing into the lake
* Avoid burning on the lake
* Operate motorized water-craft slowly in shallow, heavily sedimented areas

The last thing a lake with naturally high productivity needs is an <u>aviodable</u> influx of nutrients.

Finally, the Association may want to continue with an annual sample to track trends and indicate any dramatic changes in water quality.

SPRING LAKE ANALYTICAL RESULTS

	* 11-90	4-91	8-91	10-91	4-92	10-92	4-93	10-93
Alk	22	20	20	20	20	24	4	20
Chl	2	<1	<1	1	3	3	6	3
Cond	55	59	57	50	61	58	69	55
Am as N	<.05	<.05	.05	<.05	.20	.09	.14	<.05
N+N	<.05	<.05	<.05	.10	<.05	<.05	3.5	<.05
K as N	.68	.55	.34	.60	.64	.46	.68	.33
pH	6.2	6.2	6.4	6.0	6.3	7.3	5.2	7.0
Phos	.021	.053	.058	.054	.042	.023	.031	.022

Note: All values listed as milligrams\liter except pH (standard units) and conductivity (umho@25°C).

* See page 1 for exact collection dates.

APPENDIX 1:

MACROPHYTE SURVEY

SPRING LAKE
ONEIDA COUNTY, WISCONSIN

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AUGUST 5, 1991

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SPRING LAKE MACROPHYTE SURVEY

Introduction

On August 5, 1991, a general macrophyte study was conducted on Spring lake in Onieda County to determine density, diversity, and distribution of aquatic plants. A general survey was performed on the entire lake with a more in-depth observation at each of 42 stations. These stations represent intersection points on a 300 ft. grid. We assume this number of stations gives a good representation of the lake as whole.

Methodology

At each numbered station a 10 foot circle is visualized and divided into 4 quadrants. Macrophytes are then collected, identified, and ranked as follows: 1 if present in 1 quadrant, 2 if present in 2 quadrants, etc... A ranking of 5 signifies complete or near complete dominance by one species, occupying a significant portion of the water column. If a species is observed growing outside the circle it is given a "p" for present. Species receiving only this designation are not considered when relative frequency, average density, and depth to growth are calculated, but are included on the species list. If a specimen cannot be identified to species it is referred to by the generic name followed by "sp". ("spp" indicates the presence of more than one unidentified species of the given genus). Water depth, depth to vegetation, percent open water, and bottom type (if depth permits) are also recorded at each station.

Bottom type descriptions are as follows: D=detritus, G=gravel, H=hard, clay like, M=muck, R=rocks, S=sand.

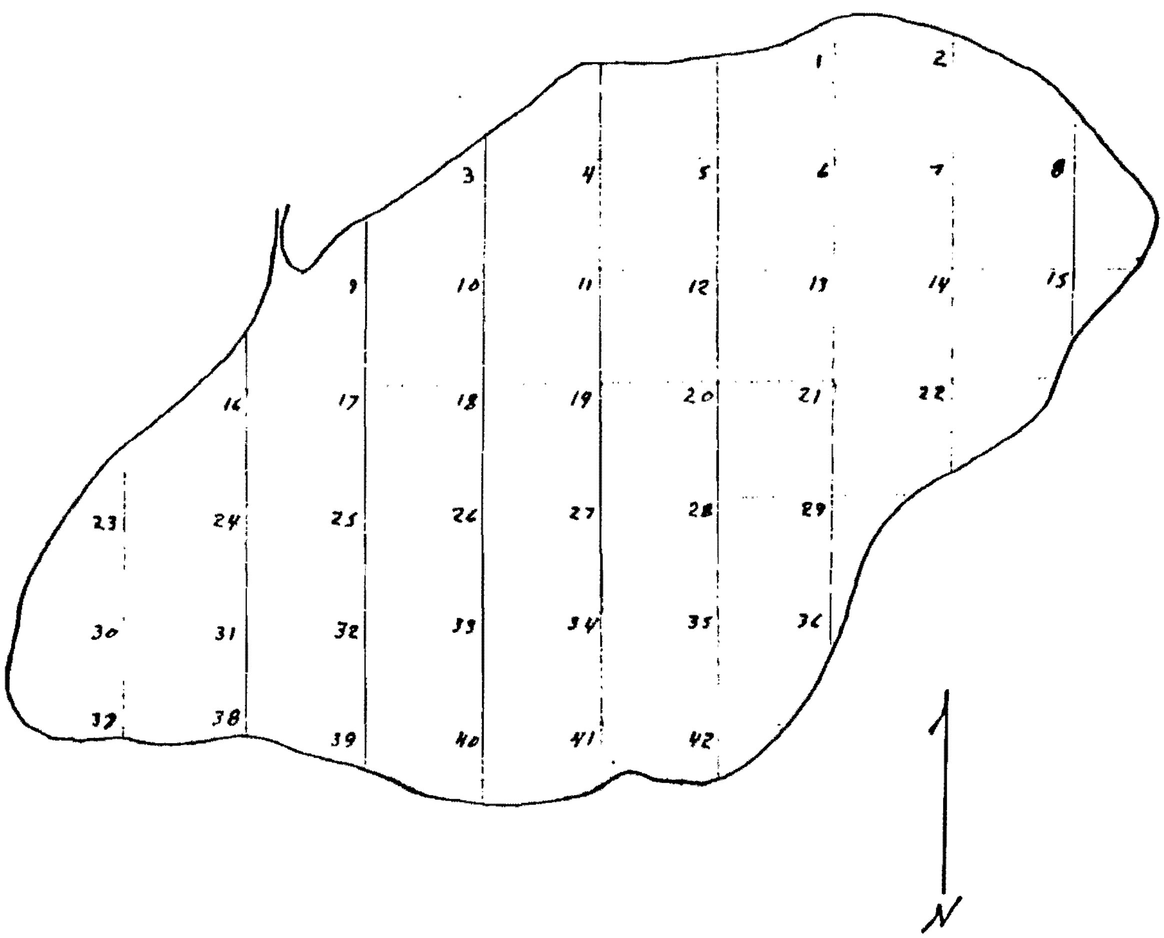
Survey Findings

As the macrophyte community map shows, 90-95% of the surface area of Spring Lake supported macrophyte growth and approximately 40% of the surface was covered by floating leaf vegetation. The floating vegetation consisted of *Brasenia shreberi, Nuphar variegatum* and *N. rubrodiscum, Nymphaea odorata* and to a lesser extent *Sparganium* *eurycarpum*.

Emergent vegetation was quite limited. It consisted of one bed of *Pontederia cordata* near the outlet, scattered growth of *Eriocaulon septengulare* just north and east of that, and a small bed of *Sagittaria* sp. near station 15.

Submergent vegetation grew extensively throughout most of the lake including areas indicated on the map as supporting floating leaf communities. The dominant species of submergents was *Elodea canadensis* and *Potamogeten robbinsii*. Most stations did show some diversity, with scattered specimens of *Ceratophyllum demersum, Megalodonta beckii, Najas flexilis* and several species of Potamogeten present. Two species of *Utricularia* were found scattered throughout the floating leaf community on the south shore of the lake. *Potamogeten amplifolius* was able to establish a significant bed above the thick *Elodea* and *P. robbinsii* growth near station 29. Also, *Chara* or muskwort, a large rigid algae, was present in small dense beds under opening in the floating vegetation at stations 30, 33, and 39.

Macrophyte Sampling Stations



SPRING LAKE
Oneida Co.

0 300
scale

NLS/RLL

SPRING LAKE MACROPHYTE SPECIES LIST

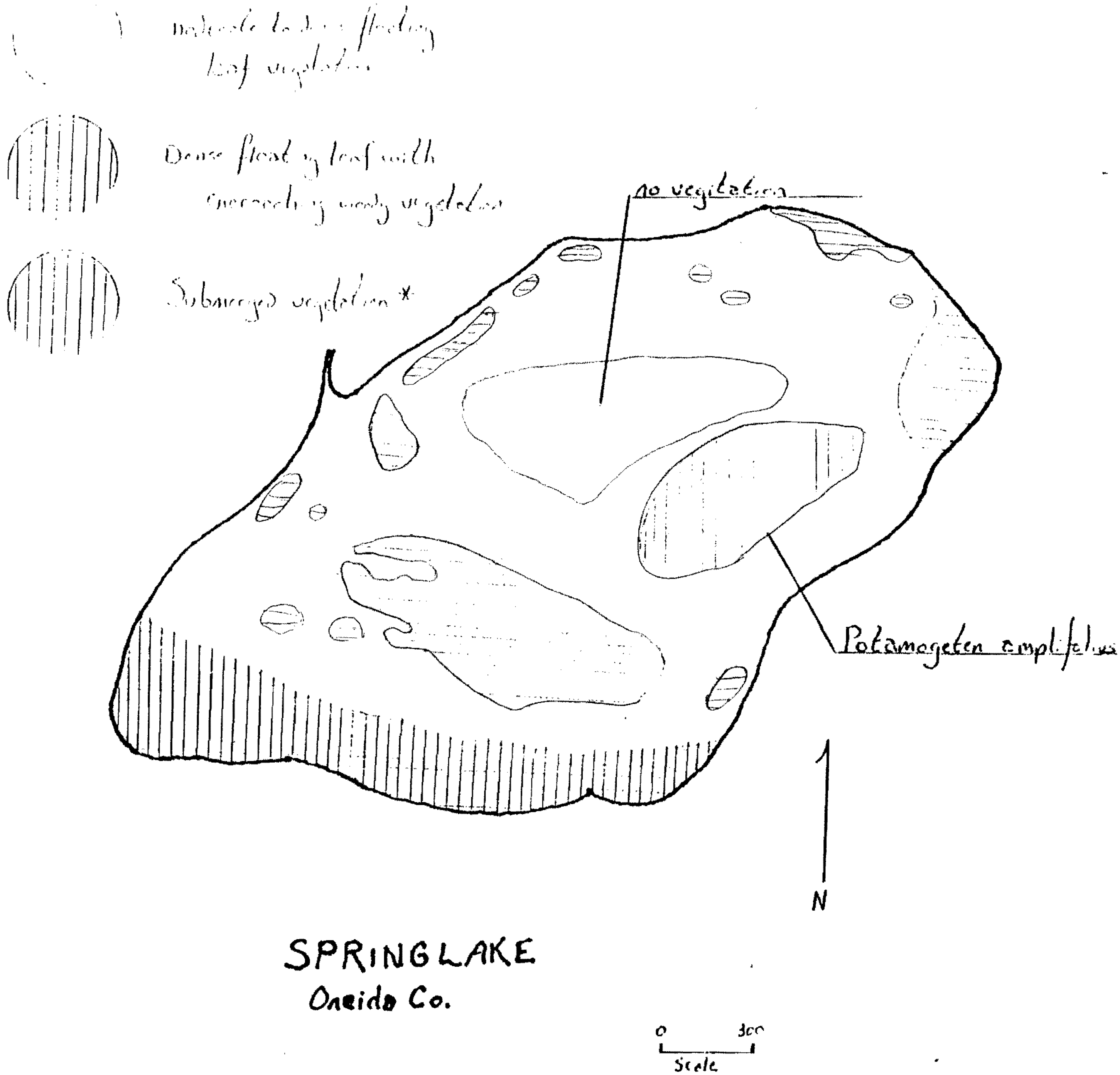
Species (common name)	Relative Frequency(%)	Average Density	Depth of Growth(ft.)
Brasenia shreberi (water shield)	16.7	3.0	3.5 - 8
Ceratophyllum demersum (coontail)	28.6	2.3	3 - 8.5
Chara (muskwort)	7.1	3.7	3.5 - 6
Elodea canadensis (American elodea)	76.2	3.4	3 - 10.5
Eriocaulon septengulare (pipewort)	p	p	p
Isoetes sp. (quillwort)	p	p	p
Megalodonta beckii (water marigold)	4.8	2.0	4
Najas flexilis (slender naiad)	11.9	2.4	3 - 6.5
Nitella (nitella)	p	p	p
Nuphar variegatum (yellow pond lily, spatterdock)	19.0	3.3	3 - 8.5
N. rubrodiscum (yellow pond lily)	p	p	p
Nymphaea odorata (white water lily)	11.9	2.8	3 - 8.5
Pontedaria cordata (pickerel weed)	p	p	p
Potamogeten amplifolius (large leaf pondweed)	23.8	1.9	4 - 8.5
P. epihydrus (ribbon leaf pondweed)	p	p	p
P. foliosus (leafy pondweed)	p	p	p
P. natans (floating leaf pondweed)	7.1	3.0	3.5 - 4.5
P. praelongus (white stem pondweed)	14.3	1.5	5 - 8

SPRING LAKE MACROPHYTE SPECIES LIST

Species (common name)	Relative Frequency(%)	Average Density	Depth of Growth(ft.)
P. pulcher (heartleaf pondweed)	2.4	2	9
P. robbinsii (Robbins pondweed)	59.5	3.6	3 - 10.5
Sparganium eurycarpum (tent) (Giant bur-reed)	2.4	4	3
Utricularia intermedia (bladderwort)	2.4	2	3.5 - 4
Utricularia sp. (bladderwort)	4.8	2.5	3.5 - 4
Vallisneria americana (eelgrass, wild celery)	p	p	p

Note: p=present, but not found at any numbered station.

Macrophyte Community Map



* [illegible]

APPENDIX 2:

ANALYTICAL RESULTS

	11/5/90	4/16/91	8/5/91	10/2/91
Alkalinity (mg/l)	22	20	20	20
Chloride (mg/l)	2	<1	<1	1
Conductivity (umho@25C)	55	59	57	50
Nitrogen				
Ammonia as N (mg/l)	<0.05	<0.05	<0.05	<0.05
NO2+NO3 as N (mg/l)	<0.05	<0.05	<0.05	0.10
Kjeldahl as N (mg/l)	0.68	0.55	0.34	0.60
pH (s.u.)	6.2	6.2	6.4	6.0
Phosphorus (mg/l)	0.021	0.053	0.058	0.054