Base Line Study of Lake Sno-Tip With Emphasis on Chemical Characteristics

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Abstract

Selected chemical and physical characteristics were routinely measured over the period of a year of Lake Sno-Tip, a five-acre lake located on the campus of Huntington College, Huntington, Indiana. Alkalinities, pH, Dissolved Oxygen, Nitrate-Nitrogen, and Total Phosphorus were among the chemical characteristics measured. A bathy-metric map and associated data were prepared, in addition to other physical measurements. The lake appears to exhibit stratification, high Total Phosphorus concentration, and other characteristics of an eutrophic lake.

Introduction

An important part of the early planning for Huntington College (called Central College, then) in 1896 was a lake 75 feet deep and one-half mile long. This lake was to be located along the north side of what is now known as Lake Street (3). In 1966, through the persistent efforts of two men, F. L. Tipmore and Gene Snowden, the lake became a reality. The lake, called Sno-Tip after its founders, falls considerably short of the original plans because it was built as a 1.98 hectare (4.89-acre) impoundment with a watershed of 155 acres.

The lake is surrounded by residential and forested areas. Water is supplied by five tiles, one of unknown origin and two creeks carrying run-off from forested, farming, commercial parking, and street areas. The lake bottom consists of clay and muck which had received considerable septic tank effluent for years prior to its construction.

Morphometry

A map of the lake showing sampling sites is presented in (Fig. 1). This map was prepared from an aerial photograph supplied by the U.S. Department of Agriculture. The depth contours were determined by taking soundings at specific locations on the lake. A range finder was used to determine the locations between two given points on opposite shores. Morphometric data will be found in Table I.

Methods

Temperature and Dissolved Oxygen measurements were made with an International Biophysics Corporation Field Model 490-051 meter. A homemade underwater photometer and a 20-cm. Secchi disk were used to measure light penetration. Nitrate-Nitrogen, pH, Alkalinity, and conductivity measurements were made in accordance with procedures found in "Standard

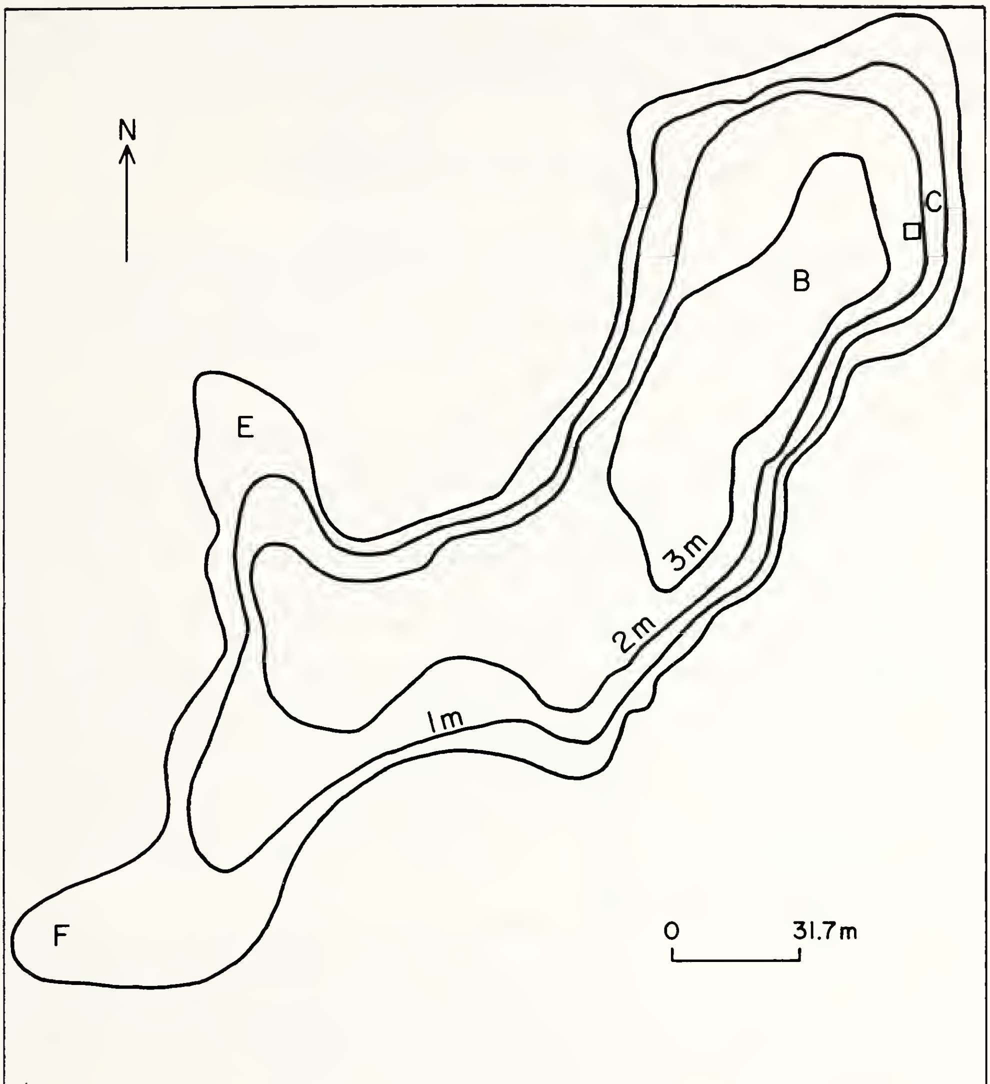

FIGURE 1.

TABLE I *Morphometry of Lake Sno-Tip, September — July 1978*

Maximum Length	325 meters
Maximum Breadth	140 meters
Surface Area	4.89 acres 1.98 hectares
Mean Width	61 meters
Length of Shoreline	840 meters
Shoreline Development Index	1.68
Maximum Depth	3.9 meters
Relative Depth	2.46%
Volume	28.85 acre-feet 35,622 cubic feet
Mean Depth	1.8 meters
Volume Development	1.38
Percent Slope	4.91%
Watershed Area	155 acres 62.75 hectares

Methods for the Examination of Water and Sewage" (5). Total Phosphorus was measured according to the method outlined in "Procedures for Wastewater Analysis" published by the Hach Chemical Company (2nd edition) (1).

Physical and Chemical Characteristics

Temperature

The temperature of the surface water followed a seasonal pattern for most of the year. However, the bottom water at 3.5 meters exhibited a difference of 8°C from surface water during the month of July 1978. Thermal stratification was evident between the spring (April) and fall (October) overturn.

Transparency

Secchi disk readings averaged 0.5 meters during September and October of 1977. During this period, tremendous amounts of phytoplankton were observed in the water. In June of 1978 after the addition of copper sulfate, Secchi depth reached a maximum of 2.75 meters. This indicates that light was reaching the bottom of most of the lake. Further, an underwater photometer revealed that on October 31, 1977, with a Secchi disk reading of 0.5 meters, one percent of the surface light reached a depth of one meter giving a factor of two times the Secchi depth. Using this factor of two, the Secchi depth of 2.75 meters observed in June would then yield a one-percent level at 5.5 meters. This depth is greater than the maximum depth of the lake; therefore, light in sufficient quantity for photosynthesis, did reach the entire bottom of the lake. This was confirmed by the pond weed (*Potamogeton* sp.) that appeared over the entire lake bottom.

Alkalinity, pH, and Conductivity

Alkalinity measurements along with pH and Conductivity will be found in Table II. The bottom water averaged lower in pH and higher in conductivity than did the surface water, thus indicating conditions of higher acidity and greater density. The high value of conductivity for the two sites E and F suggests that considerable dissolved ionic material and sediment is entering the lake through these inlets.

Dissolved Oxygen

Dissolved Oxygen measurements are shown in Table III for sampling site B. The ice was too thin in December to allow the Dissolved Oxygen to be determined. The data for that month, therefore, was taken from sampling site C (spillway). Ice covered the lake from early December through late March and reached a thickness of 46 cm. in early March. In every month except October (Fall overturn), bottom waters were much lower in Dissolved Oxygen than the first meter. These were definite signs of stagnation during stratification.

Nitrate-Nitrogen and Total Phosphate

Various phosphate parameters are usually defined by the method used for analysis (5). In this case the whole water sample was digested with persulfate followed by analysis for orthophosphate. The Nitrate-Nitrogen was measured by the cadium reduction technique. Values beyond two decimal places were not considered significant due to limitations in the techniques and equipment used and were reported as less than 0.01 ppm concentration. Copper sulfate and Diquat were added during June and July of 1978. It is not known whether these

TABLE II *pH, Alkalinity, and Conductivity Measurements of Lake Sno-Tip from September to July 1977-78*

Sampling Site	Mean pH	Range	Conductivity 25°C u-mhos/cm	Range	Alkalinity ($ppmCa\ CO_3$) Mean Carbonate	Mean Bicarbonate
B Surface	8.4	9.2 (Oct) — 7.2 (Feb)	446	722 (Feb) — 277 (Sept)	14	126
B Bottom	7.8	9.2 (Oct) — 7.2 (April, Sept)	502	930 (Jan) — 298 (Oct)	12	172
C	8.5	9.2 (Oct) — 7.8 (Dec)	392	543 (May) — 272 (Sept)	15	116
E	8.5	9.8 (Dec) — 7.7 (Nov)	495	952 (Jan) — 272 (Sept)	25	151
F	8.5	9.6 (Dec) — 7.6 (Nov)	542	992 (Dec) — 283 (Sept)	30	174

TABLE III *Dissolved Oxygen (site B) of Lake Sno-Tip from September 1977 — July 1978*

	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July
Surface	12.7 ppm	10.7	9.6	9.6*	7.1	1.4	0.7	15.0	12.5	8.7	6.1
0.5m											
1.0		10.5	9.7		4.0	1.0	0.5		12.5	9.6	6.2
1.5											
2.0		10.2			1.3	0.6	0.4		8.0	7.2	4.9
2.5				2.8*							
3.0		9.8	6.2		0.5	0.4	0.3			1.4	1.8
3.5	0.7							2.0	4.8		

*Taken from site C

TABLE IV *Total Phosphorus and Nitrate Nitrogen of Lake Sno-Tip from September 1977 — July 1978*

Sampling Site	Mean Total Phosphorus (ppm)	Range	Mean NO3-N (ppm)	Range
B Surface	0.07	0.13 (Nov) — 0.03 (July)	0.08	0.64 (Jan) — <0.01 (June)
B Bottom	0.11	0.27 (Oct, Apr) — 0.05	0.15	0.64 (Jan) — <0.01 (June)
C	0.07	0.13 (Dec) — 0.01 (Oct)	0.13	0.60 (Dec) — <0.01 (June)
E	0.07	0.17 (Nov) — <0.01 (July)	0.23	0.74 (Jan) — <0.01 (June)
F	0.09	0.20 (Oct, Dec) — <0.01 (July)	0.12	0.66 (Dec) — <0.01 (June)

have an effect on the analytical method. The average Total Phosphate concentration does appear to be excessive when compared to other water systems (2). Sawyer reports that the phosphorus content should not exceed 0.015 ppm in "well behaved lakes" (4). The surface water of Lake Sno-Tip averaged 0.07 ppm with some values reaching as high as 0.20 ppm. Therefore, the lake can be expected to experience excessive algae and macrophyte growth. The stagnant bottom water is higher in phosphorus (0.11 ppm average) than the surface (0.07 ppm average). In addition, this water reached a value of 0.27 ppm just prior to the Spring overturn. Creek E contributes slightly less phosphorus (0.02 ppm) and approximately twice as much Nitrate-Nitrogen than does creek F. The watershed areas are somewhat different, creek E drains more agricultural and forested areas than does F. The watershed area of F is largely parking and residential. Significant amount of erosion occurs in both watershed areas.

Conclusions

From the results of this study, it can be stated that:

1. A stable condition of stratification exists between May and October.
2. The bottom water is rich in Total Phosphorus.
3. The contribution of Total Phosphorus is greater at creek F than E.
4. The Total Phosphorus concentration appears to be high enough (0.07 ppm average) to cause nuisance algae blooms and/or macrophyte problems.
5. The contribution of Nitrate-Nitrogen is greater at creek E than F.
6. Some effort needs to be made to control erosion in the watershed.

Acknowledgments

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