Proceedings of the Indiana
(1991) Volume 100 p. 23-3

WATER QU
J

ABSTRACT: Several
water quality of Spicer
baseline data and to ex
agricultural areas. Vert
1990. The parameters
demand (BOD), pH, Sec
phosphorus, and pestic
oxygen and nutrient lev
Runoff does not appea
significantly different f

Spicer Lake Nature
Indiana. This swamp f
rare plant species. Spic
6.1 m (Dineen, 1979).
wide, and is surrounded

Water quality may
should be monitored f
natural conditions and a
The objectives of this
surrounding agricultura
parameters measured v
temperature, biochemic
total phosphorus, and c
through December, 199

Samples were collec
of 1990 approximately 1
a vertical profile, three a

m, and 3 m) and two at the north edge (0 m and 2 m), for each date except for 12/13/90 when only the center samples were collected. The sampling locations shown in Figure 1 were chosen to determine possible effects of runoff entering the preserve through a culvert west of the southwest edge and the drainage way leading into the north edge of the lake. The farmland to the west of the preserve and pastureland to the north of the preserve caused concern that runoff may contain increased nutrient concentrations. Grab samples were taken at the surface, and a Lab-line Model 4197 sampler was used for all others. DO and temperature were monitored *in situ* at 0.5 m intervals with a portable Yellow Springs (Models 51B and 57) DO meter. Standard air calibration was used to calibrate the DO meter. A pHep Model 0624-00 meter was used to measure pH. A Secchi disk was used for transparency readings. Samples were placed in wet ice for transport back to the laboratory for analyses of BOD, nitrogen, and phosphorous compounds.BOD was obtained by shaking 300 mL of lake water in two BOD bottles for 2 minutes to aerate the sample, measuring the initial DO, measuring the final DO after 5 days of incubation at 20° C, and determining the DO loss. Initial and final DO were measured with a YSI BOD bottle probe. Water soluble ammonia and nitrate nitrogenwere

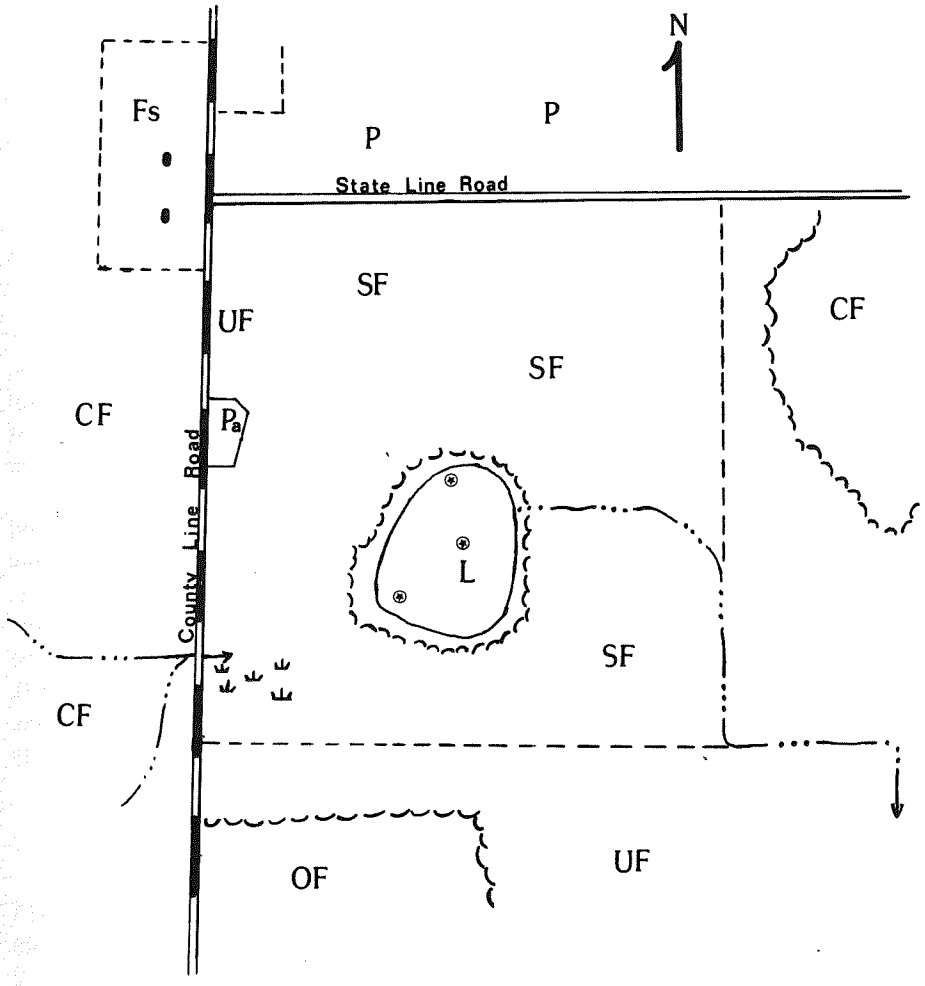

Figure 1. Location of Spicer Lake (L) and surrounding ecosystems, cultivated fields (CF), farmyard (Fs), old field (OF), pasture (P), swamp forest (SF), and upland forest (UF) with the lake sampling locations indicated by stars. The parking lot (Pa) and east and south boundaries (——) of Spicer Lake Nature Preserve, northwest corner of St. Joseph County, Indiana, are shown also.

Table 1. Chemical and physica

	Range
pH (standard units)	
7/19-9/11	6.6-7.9
9/25-12/13	6.1-7.3
Secchi (cm)	
7/19-9/11	41.0-66.0
9/25-12/13	46.0-66.0
BOD (ppm O2)	
7/19-9/11	6.0-9.1
9/25-12/13	2.2-8.0
NH_3-N (mg N/L)	
7/19-9/11	<0.01-0.06
9/25-12/13	<0.01-0.39
NO_3-N (mg N/L)	
7/19-9/11	<0.01-0.03
9/25-12/13	<0.01-0.01
Total dissolved N (mg/L)	
7/19-9/11	<0.01-0.06
9/25-12/1	<0.01-0.40
Total P (mg/L)	
7/19-9/11	0.044-0.098
9/25-12/13	0.050-0.099

*median

measured with an Orion Ammonia Ion Selective Electrode Model 95-12 using the low level procedure (Orion Research Inc., 1987). Persulfate digestion was used for total phosphorus. Total phosphorus and orthophosphate phosphorus were analyzed by the Ascorbic Acid Method (American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1989). A Bausch & Lomb Spectronic 21 spectrophotometer was used for the first three sets of samples and a Perkin Elmer Lambda 6 spectrophotometer was used for all other samples. Pesticide analysis by GC-MS was performed on the samples collected on 10/11/90 by Environmental Health Laboratories using EPA Method 525 (Environmental Protection Agency, 1986).

RESULTS AND DISCUSSION

The results of the sampling indicate slight stratification, low BOD and DO values, and high levels of nitrogen and phosphorous compounds at the bottom center of the lake. The lake water has a brown color and a strong hydrogen sulfide odor. There was no significant horizontal variation of the parameters, although there was variation with respect to depth. Fall turnover began in October and was complete by December. A summary of the results is presented in Table 1.

Temperature and dissolved oxygen. The temperature and DO data demonstrate a slight degree of stratification (Figs. 2 and 3). Although Figures 2 and 3 are for the center location, the same temperature and DO changes occur at the other sampling sites. The effect of the surrounding trees on the lake is evidenced in Figures 2 and 3. Due to the small size of the lake and the forested area close to the edge, there is minimal wind effect, and the epilimnion is shallow.

A close relationship between temperature and DO is evidenced by comparing Figures 2 and 3. Temperature and DO decline rapidly at 1-1.5 m during the summer. The DO values are low below 1.5 m with values of 1-2 ppm oxygen, which restricts the aerobic activity in the hypolimnion. The data from September to November indicate mixing of the lake, or the fall turnover. The sampling on 12/13/90 revealed that the turnover of the lake was complete as the temperature was a constant 4.0° C and the DO was a constant 4.6 ppm oxygen. This indicates that the lake is entering the winter season at 35.1% oxygen saturation. Therefore, after the ice forms on the lake, the oxygen content is expected to go to zero.

Biochemical oxygen demand. The mean BOD values were 7.8, 4.5, and 6.0 ppm oxygen for the surface, middle, and bottom, respectively, in the summer months, and means of 5.5, 5.9, and 5.8 ppm oxygen were recorded for the surface, middle, and bottom, respectively, in the fall. The BOD data versus depth displays a parabolic shape for each of the summer sampling dates. The BOD levels at the surface may be due to the stirred effect resulting in the suspension of more organic matter and the aggregation of plankton in this layer. The middle values are lower than those at the surface, indicating that more of the organic matter has settled out. The bottom BOD values are higher than the middle values, which may be due to very small suspended organic particulate matter. Based on the observation of the vertical homogeneity of the analytical results for December, the BOD values at the bottom are not due to disturbance of the bottom muck by the sampler.

Secchi and pH. There was minimal variation in the Secchi or pH values (Table 1). The Secchi readings averaged 55.8 cm in the summer and 58.4 cm in the fall. The dark color of the water restricted the depth of light penetration which may reduce productivity. The Secchi values observed in this study are less than those reported by Dineen(1979),

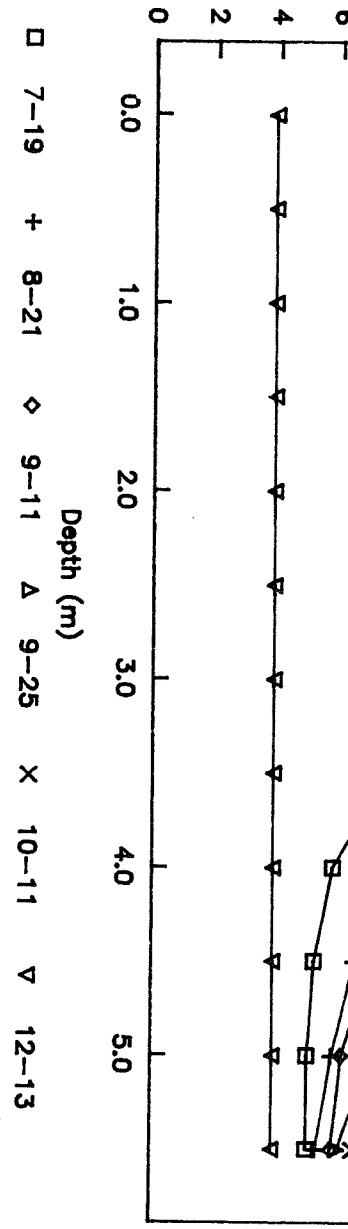

Figure 2. Temperature versus depth pr

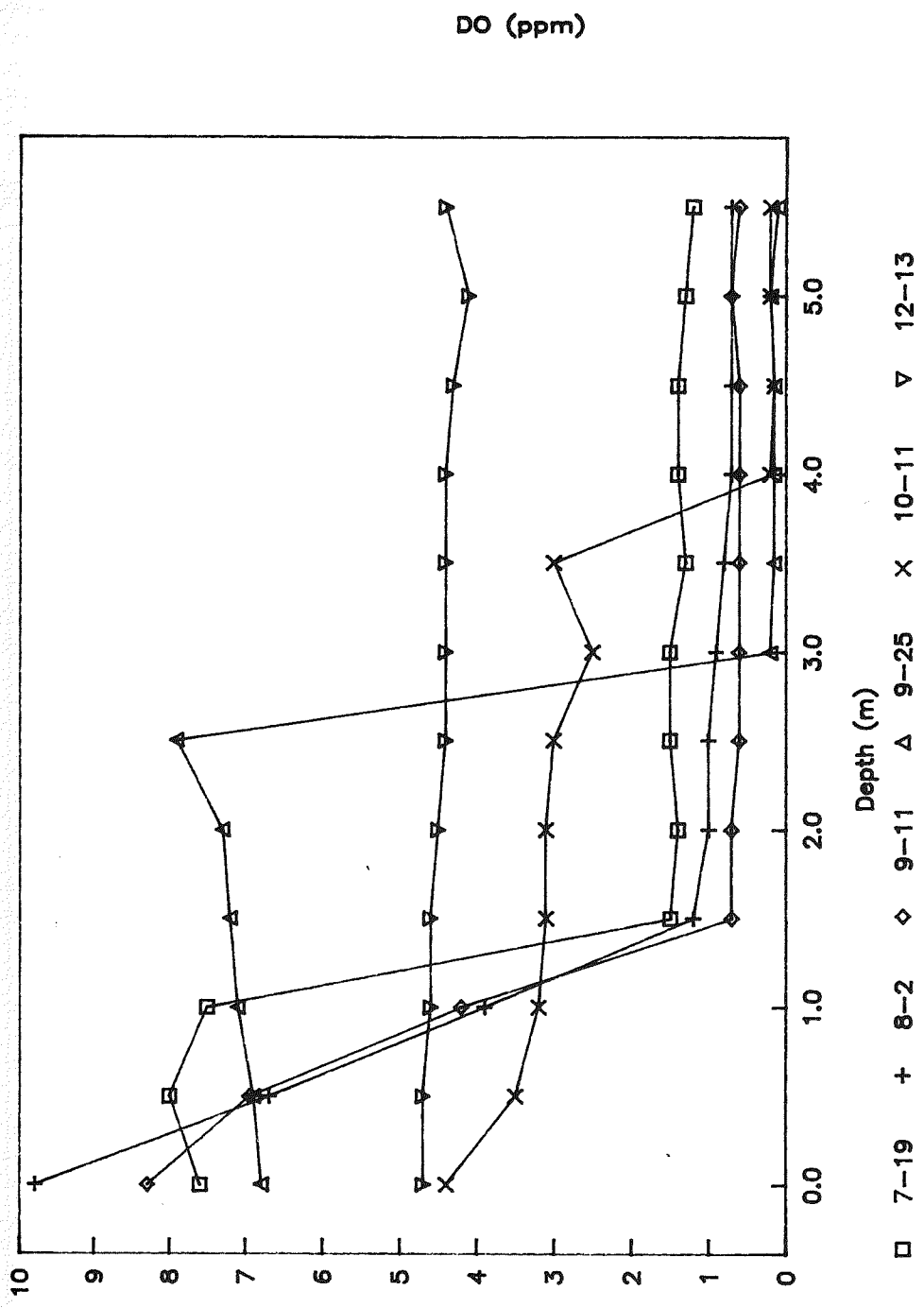

Figure 3. Dissolved oxygen versus depth profile for the central location at Spicer Lake from 7/19/90 to 12/13/90.

which suggests an increase in
6.6-7.6, 6.2-7.6, and 6.2-6.6 f
summer and 6.1-7.3, 6.0-7.6,
tively, in the fall. The median
and are slightly acidic at the b

Phosphorus and nitroge
the bottom center, where value
greater than 0.1 mg P/L occu
exhibit evidence of the mixing
P/L for the surface, middle, an
of most unpolluted surface w
Orthophosphate phosphorus w
limits of detectability (0.005 m
contained in organic matter.

Both ammonia and nitra
bottom center of the lake, but e
range of ammonia nitrogen (0.
L which may be present in the
The high ammonia-nitrogen
reducing environment at the bo
bacteria. The range of nitrate
mg N/L. Values of nitrate nitr
L and are frequently less than

The nutrient values in Sp
EPA studies of lakes in north
(Steuben County), Westler L
County) (U.S. Environmental
rus values obtained at Spicer

The high phosphorus an
decomposition without utiliza
growth at the bottom of the
ammonia nitrogen and 60 mg
which may indicate that the se
the bottom of the lake.

Pesticides and herbicide
various chlorinated pesticides
only once, the results are valid
tions were found in the sample
pesticide input from the neigh
after a heavy rain which had re
the preserve.

The results indicate that
nutrients, minimal cycling, an
cient consistency to be consid
of runoff from the surroundin

did not vary between the center and edge locations nor between samples collected after heavy rains and rainless periods. The possibility exists that runoff containing high concentrations of nutrients entering the preserve could be filtered by the swamp forest, since this area is typically nutrient poor. Sampling the water in the swamp forest area would be required to determine if this area is receiving excessive nutrient concentrations. The accumulation of nutrients at the bottom of this lake may be due to decomposition without utilization, nutrient release from the sediments, and particle settling from the water column.

ACKNOWLEDGMENTS

This research was supported by grants from the Indiana University at South Bend Undergraduate Research Program and the Howard Hughes Medical Institute Undergraduate Initiative, Bloomington, Indiana. Pesticide analyses were provided by the Environmental Health Laboratories, South Bend, Indiana, through an *Endowment of Resources Award.* Appreciation is expressed to the St. Joseph County Parks and Recreation Department for providing a canoe for sampling and to the Indiana Division of Nature Preserves for granting permission to work in the Preserve.

LITERATURE CITED

American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 1989. Standard methods for the examination of water and waste water. American Public Health Association, American Water Works Association, and Water Pollution Control Board, New York, 1460 pp.

Dineen, C.F. 1979. Plankton and benthos of Spicer Lake. Proc. Indiana Acad. Sci. 89: 173-179.

Environmental Protection Agency. 1986. Test methods for evaluating solid waste. Environmental Protection Agency, Washington, D.C., 1748 pp.

Lind, O.T. 1979. Handbook of common methods in limnology. C.V. Mosby Co., St. Louis, 199 pp.

Orion Research Incorporated. 1987. Model 95-12 ammonia electrode instruction manual. Orion, Inc., Boston, 37 pp.

U.S. Environmental Protection Agency. 1976a. National eutrophication survey: Report on Bass Lake. Working Paper Ser. 323, Environmental Protection Agency, Washington, D.C., 14 pp.

_____. 1976b. National eutrophication survey: Report on Crooked Lake. Working Paper Ser. 325, Environmental Protection Agency, Washington, D.C., 23 pp.

_____. 1976c. National eutrophication survey: Report on Webster Lake. Working Paper Ser. 345, Environmental Protection Agency, Washington, D.C., 16 pp.

_____. 1976d. National eutrophication survey: Report on Westler Lake. Working Paper Ser. 346, Environmental Protection Agency, Washington, D.C., 15 pp.

Wetzel, R.G. 1983. Limnology. Saunders College Publ., Philadelphia, 767 pp.