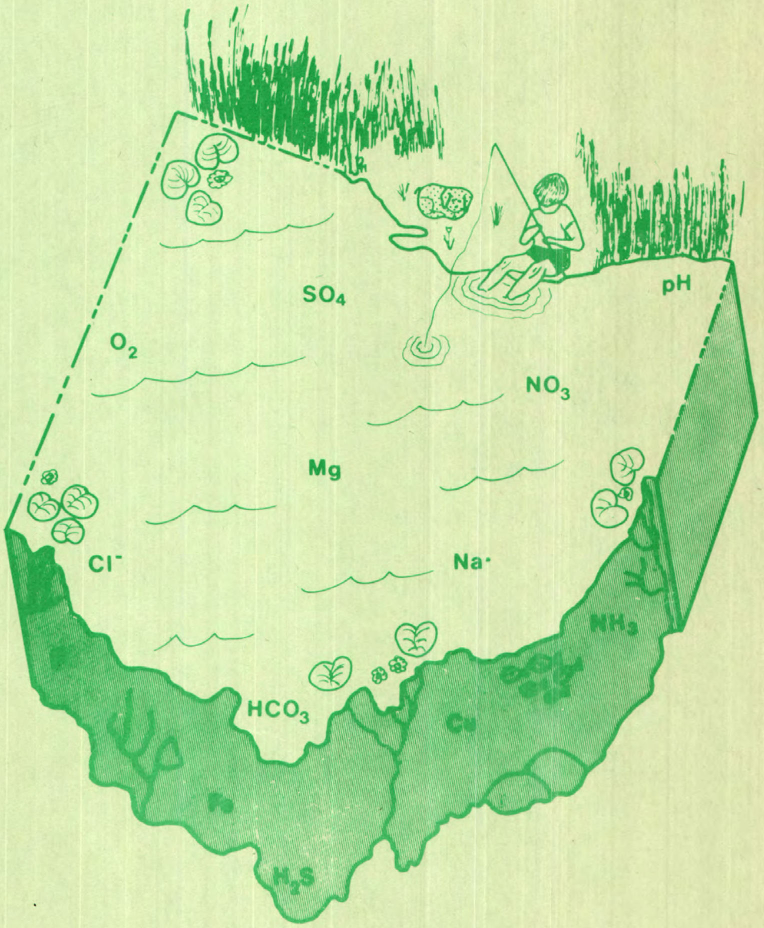
UNITED STATES GEOLOGICAL SURVEY
DEPARTMENT OF THE INTERIOR

Prepared in cooperation with
OHIO ENVIRONMENTAL PROTECTION AGENCY

LIMNOLOGY OF SELECTED LAKES IN OHIO-1975

Water-Resources Investigations 77-105
Open-File Report



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By Robert L. Tobin and John D. Youger

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September 1977

UNITED STATE DEPARTMENT OF THE INTERIOR

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CONTENTS

CONTENTS

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS

TABLES

TABLES

TABLES

TABLES

TABLES

Conversion Factors

Factors for converting English units to the International System of Units (SI) are given below. However, in the text the metric equivalents are shown only to the number of significant figures with the values for the English units.

Multiply English units	by	to obtain SI units
inches (in)	25.40	millimeters (mm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
acre-feet (acre-ft)	0.001233	cubic hectometers (hm^3)
square miles (mi^2)	2.590	square kilometers (km^2)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)
tons (short)	0.9072	metric tons (t)
tons per square mile per year [($tons/mi^2$)/yr]	0.3503	metric tons per square kilometer per year [($t/km^2/yr$]

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ABSTRACT

Water-quality reconnaissance by the U.S. Geological Survey and Ohio Environmental Protection Agency, to evaluate the status of Ohio's lakes and reservoirs was begun in 1975 with studies of 17 lakes. Spring and summer data collections for each lake included: profile measurements of temperature, dissolved oxygen, pH, and specific conductance; field and laboratory analyses of physical, biological, chemical (nutrient), and organic characteristics; concentrations of major and minor chemical constituents from composites of the water column; and physical and chemical data from major inflows.

Light penetration (secchi disk) ranged from 9.4 feet (2.9 meters) in Lake Hope to 0.4 feet (0.1 meter) in Acton Lake. Seasonal thermal stratification or stability is shown for 10 lakes deeper than 15 feet (4.6 meters). Unstable or modified temperature profiles were observed in shallow lakes (depths less than 15 feet) or lakes controlled through subsurface release valves.

Dissolved oxygen saturation ranged from 229 percent (20.8 milligrams per liter) in the epilimnion of Paint Creek Lake to zero in the bottom waters of all thermally stabilized lakes. Marked chemical and physical differences and nutrient uptake and recycling developed within different thermal strata. Anaerobic zones were frequently characterized by hydrogen sulfide and ammonia.

Calcium was the dominant or codominant cation, and bicarbonate and(or) sulfate were the major anions in all lakes sampled. Only Hope and Vesuvius Lakes had soft water (hardness less than 61 milligrams per liter as $CaCO_3$), and both lakes were further characterized by low pH (less than 7.0). Specific conductance ranged from 510 micromhos (Deer Creek and Salt Fork Lakes) to 128 micromhos (Lake Hope). Pesticide residues were detected in Acton Lake, and concentrations of one or more trace metals were at or above Ohio Environmental Protection Agency recommended limits in 11 lakes.

Fecal coliform colony counts were below 400 colonies per 100 milliliters in 13 lakes; higher counts were observed in Acton, Cowan, Harrison, and Paint Creek Lakes in samples taken during runoff events. Phytoplankton densities greater than 100,000 cells per milliliter were observed in 12 lakes and reached a maximum of over 2,800,000 cells per milliliter in Grand Lake St. Marys. Summer domination of the algal community by blue-green algae (Cyanophyta) was indicated for 16 of the 17 lakes.

Streams are a major source of macronutrients to Ohio's lakes. Concentrations of nitrite plus nitrate and total phosphorus in 38 inflow samples to the 17 lakes averaged 2.17 milligrams per liter as N and 0.29 milligrams per liter as P, respectively.

INTRODUCTION

Impoundment can produce significant chemical, physical, and biological changes in natural waters. Factors such as uneven solar heating and light, different sediment settling rates, biological preferences, and wind-driven currents can produce vertical and horizontal variation in temperature, chemical and sediment concentrations, biological populations, and dissolved gases within the lake.

Undesirable conditions, algae blooms and(or) anaerobic lake bottoms, can occur seasonally within certain nutrient enriched lakes, affecting the use or potential use of the water. Because lakes and reservoirs act as sediment traps, the downstream morphology and ecology can be altered from that before the impoundment (Mackenthun and Ingram, 1967, p. 28-30).

PURPOSE AND SCOPE

In 1975, the U.S. Geological Survey and the Ohio Environmental Protection Agency began a reconnaissance to gather baseline data useful in appraising and managing Ohio's lakes. Dynamic conditions within a lake can be assessed only from repeated on-site observation and collection of samples for analyses.

Seventeen lakes were selected, representing different physical settings (fig. 1). Each lake was visited twice; once in the spring and again in mid-to-late summer. Vertical profile measurements of temperature, dissolved oxygen, pH, and specific conductance were taken at a primary site (generally at the deepest point) in the spring and at several sites during the summer visit. Additional chemical and physical data were determined from water samples taken from the near surface, 2-ft (0.6 m) depth; near the bottom, 1 to 3 ft (0.3 to 0.9 m) from the bed; and from composites of the water column. All lake data were collected during the afternoon. A generalized schedule and list of constituents sampled are presented in table 1. Selected inflows were measured for temperature, dissolved oxygen, pH, and specific conductance. Samples were collected and analyzed for major nutrients, turbidity, and color.

Detailed profiles, data summaries, and a discussion of the individual lakes are presented for the first set of lakes in this report. A list of earlier investigations of one or more of the selected lakes is presented in table 2.

METHODS

Near maximum lake depths were located by a digital depth sounder. Lake water from selected depths was pumped through a rubber garden hose into an airtight PVC (polyvinyl chloride) manifold, which housed probes for determining dissolved oxygen, temperature, pH, and specific conductance. Profile parameters were continuously monitored with changes in depth, and water samples were withdrawn from desired depths through a PVC valve and hose at the manifold. Field instruments were frequently checked by independent methods against primary standards acceptable to the U.S. Geological Survey.

Samples collected for analysis of pesticide residues, MBAS (methylene blue active substances), and arsenic were submitted to the Ohio Health Department Laboratory. All other samples were analyzed by U.S. Geological Survey personnel by procedures described in Brown and others (1970). TOC (total organic carbon) was determined according to Goerlitz and Brown (1972, p. 4-6), and phytoplankton counts and identifications were based on methods listed in Slack and others (1973, p. 70-72). The 5-day BOD (biochemical oxygen demand) determination followed methods described in American Public Health Association (1971, p. 270).

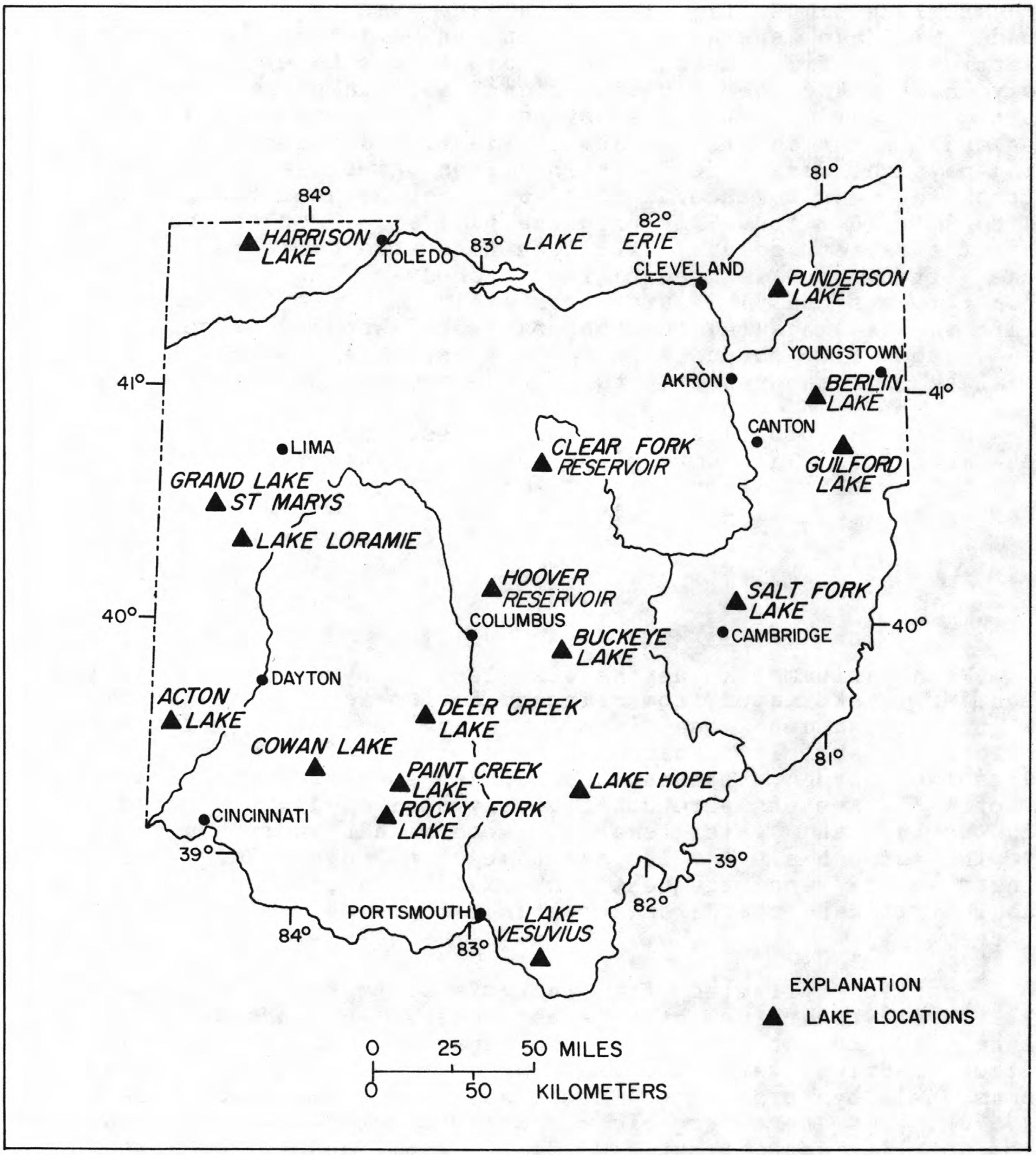


Figure 1.--Lakes sampled in Ohio during 1975.

Table 1.--Sampling schedule, 1975 Ohio lakes study

Season	Location within water column	Temperature; dissolved oxygen; pH; specific conductance *	Nutrients: Major	Nutrients: Trace	Oxygen demand: BOD	Oxygen demand: COD	Biological and physical characteristics: Fecal coliform and streptococci *	Phytoplankton identification and count	~~Turbidity~~ zoo plankton	Color	~~Suspended solids~~ odor	Light penetration *	Major chemical constituents	Toxic and undesirable substances: As, Ba, Cd, Cr, Pb, Hg, Ni, Se, Ag, MBAS	H_2S	Pesticides **
			HCO_3*, TOC, N, P, SiO_2	B, Co, Cu, Fe, Mn, Mo, Zn									Ca, Mg, K, Na, SO_4, Cl, F, DS			
Spring	Profile (continuous with depth)	x										x				
	Near surface (2-ft depth)		x		x	x	x		x	x					x	x
	Water column composite			x				x			x		x	x		
	Near bottom (1-3 ft from bed)		x		x	x	x		x	x					x	x
Late summer	Profile (continuous with depth)	x										x				
	Near surface (2-ft depth)		x		x	x	x	*** x	x	x					x	x
	Water column composite															
	Near bottom (1-3 ft from bed)		x	**** x	x	x	x		x	x				**** x	x	x

* Field determinations.
** Pesticides listed on page
*** Taken from the depth of maximum DO saturation.
**** Selected constituents taken for additional information.

Table 2.--Publications on selected lakes in Ohio

1. Acton Lake

   Fisher, 1960
   Winner, et al, 1962
   Winner, et al, 1967

2. Berlin Lake

   U.S. EPA, 1975

3. Buckeye Lake

   Bangham, 1930
   Detmers, 1912
   Handley, 1946
   Judd, 1971
   Judd, et al, 1973
   Salisbury, 1931
   Tressler, et al, 1940
   U.S. EPA, 1975

4. Deer Creek Lake

   U.S. EPA, 1975

5. Grand Lake St. Marys

   Clark, 1942
   Clark, 1945
   Clark, 1951
   Clark, 1960
   U.S. EPA, 1975

6. Hoover Reservoir

   U.S. EPA, 1975

7. Lake Hope

   Harris, 1973
   Koehrsen, 1969

8. Lake Loramie

   U.S. EPA, 1975

9. Lake Vesuvius

   Irwin, et al, 1969

10. Rocky Fork Lake

   U.S. EPA, 1975

11. General

   Hahn, 1955
   Ketelle, et al, 1971

Bacteria counts were based on immediate field filtration and incubation using the membrane filter procedure (Slack and others, 1973, p. 30-50). Lake transparency was determined by averaging the depth at which a standard black and white secchi disk, 0.66 ft (0.2 m) in diameter, disappeared from view while being observed through a shaded lake surface.

LIMNOLOGICAL SETTING IN OHIO

Climate and Hydrology

The climate in Ohio is characterized by moderate extremes of temperature and humidity. Mean minimum January temperatures range from -6.7°C in the north to -2.2°C along the southern boundary. Mean maximum temperatures in July vary throughout the State from 26.7°C to 32.2°C (Pierce, 1959).

The precipitation pattern in Ohio is irregular (fig. 2). Precipitation is generally greatest in the spring and least in the fall. Runoff averages 13 inches (0.33 m) per year (fig. 3) with approximately 30 percent of the land surface draining northward to Lake Erie and 70 percent southward to the Ohio River (Anttila, 1970, p. 4).

Geology and Sedimentation

Bedrock in Ohio is composed of carbonaceous and clastic sediments of the Paleozoic Era (Bownocker, 1947). Glacial activities during the Pleistocene epoch, however, have greatly altered the physiography in most of the State (fig. 4).

Most lakes in Ohio are man made and fall into the category described by Hutchinson (v. I, 1957, p. 1-163) as "Construction by higher organisms." There are only a few small natural lakes in Ohio, formed in glacial drift depressions. Of the 17 lakes investigated, only Punderson Lake is natural.

Soils generated within different physiographic environments have a profound influence on the amount and type of sediment transported in streams (Guy, 1970). Anttila and Tobin (1976) reported average fluvial sediment to be greater than 80 percent clay in northwest Ohio, compared with 30-65 percent clay in the eastern and southeastern parts. Figure 5, taken from the same report, shows the estimated annual sediment yield, in tons per square mile, of all major drainage basins in Ohio.

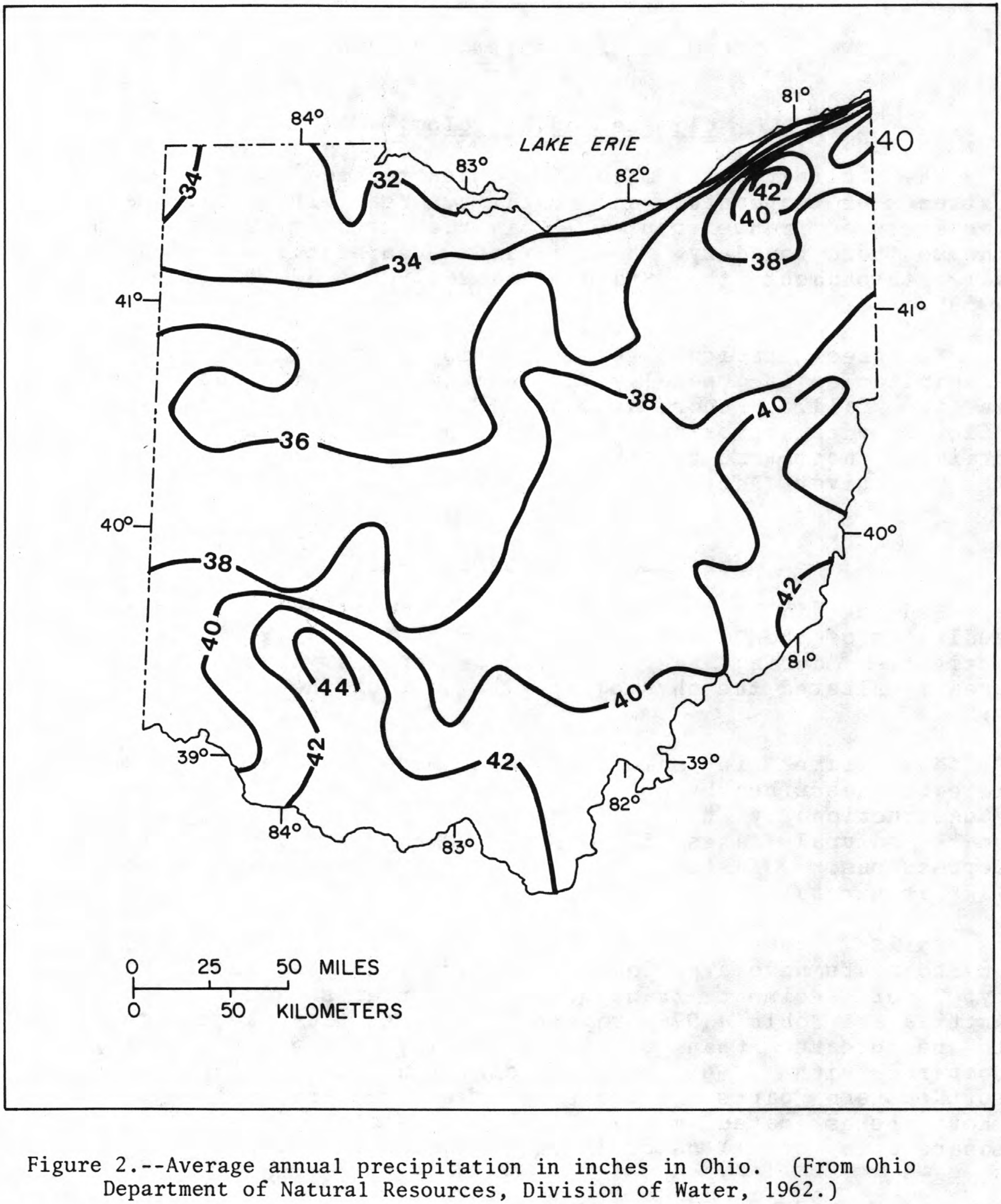


Figure 2.--Average annual precipitation in inches in Ohio. (From Ohio Department of Natural Resources, Division of Water, 1962.)

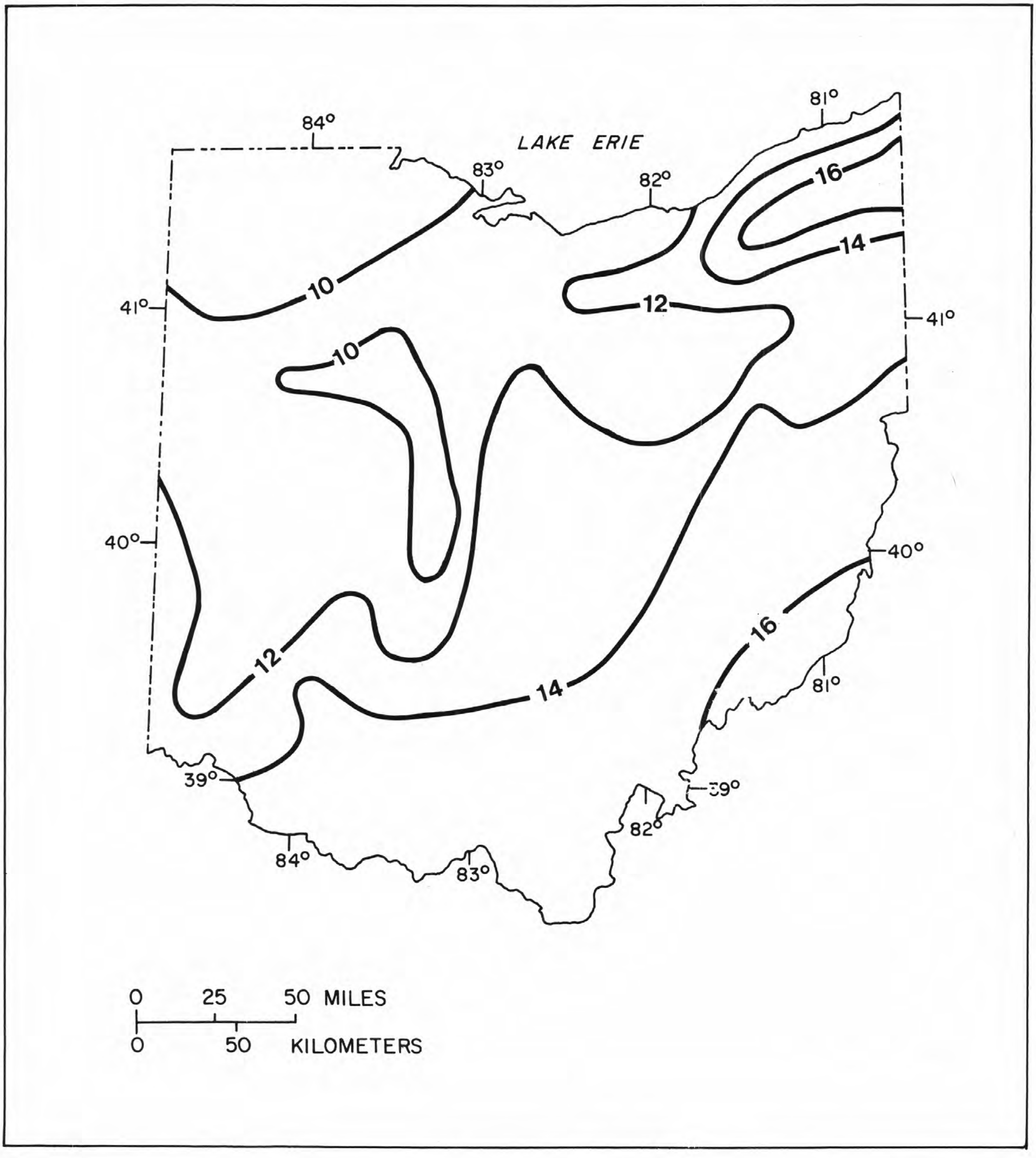


Figure 3.--Average annual runoff in inches in Ohio. (From Ohio Department of Natural Resources, Division of Water 1962.)

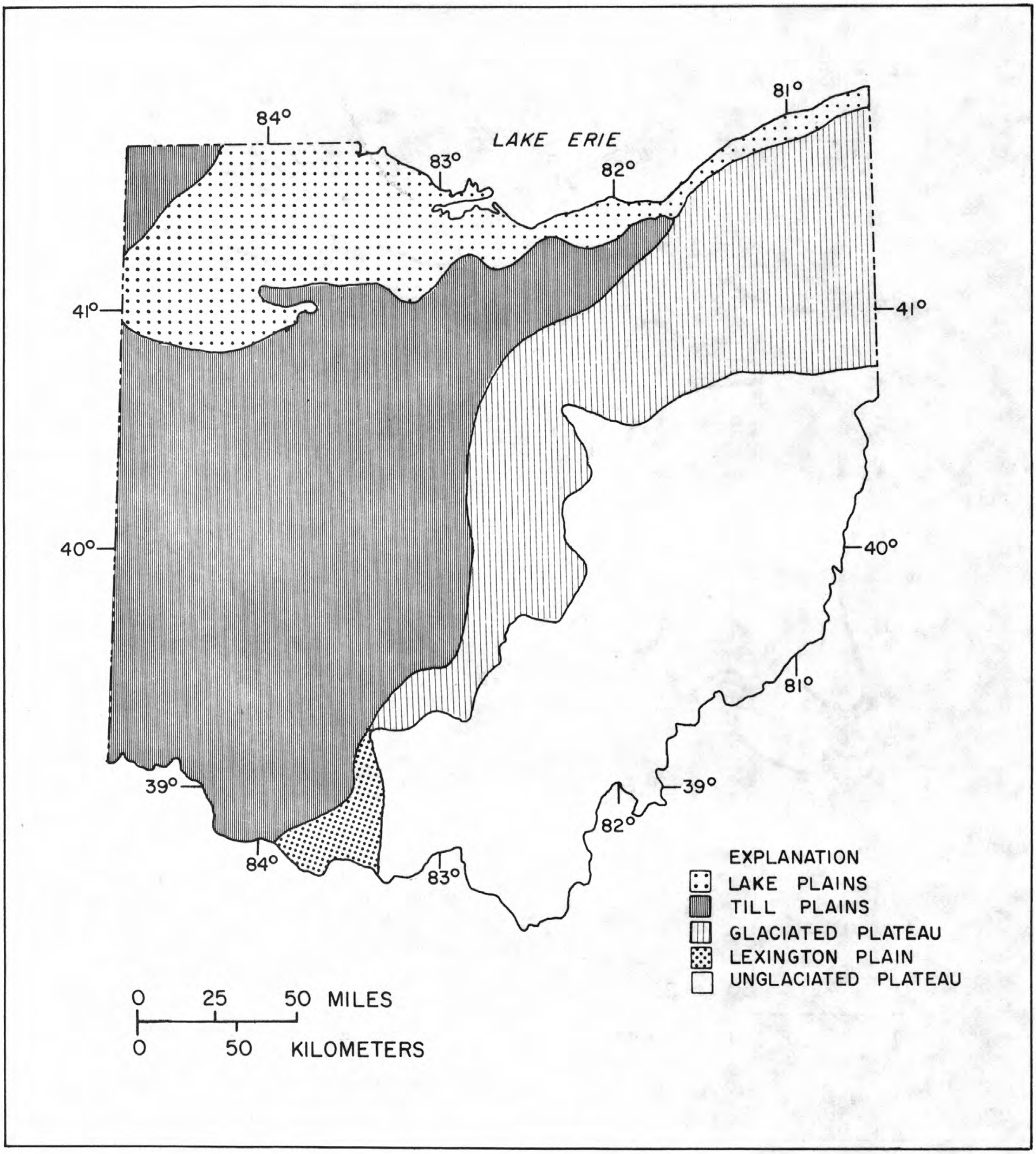


Figure 4.--Physiographic sections of Ohio. (From Ohio Division of Geological Survey, 1959).

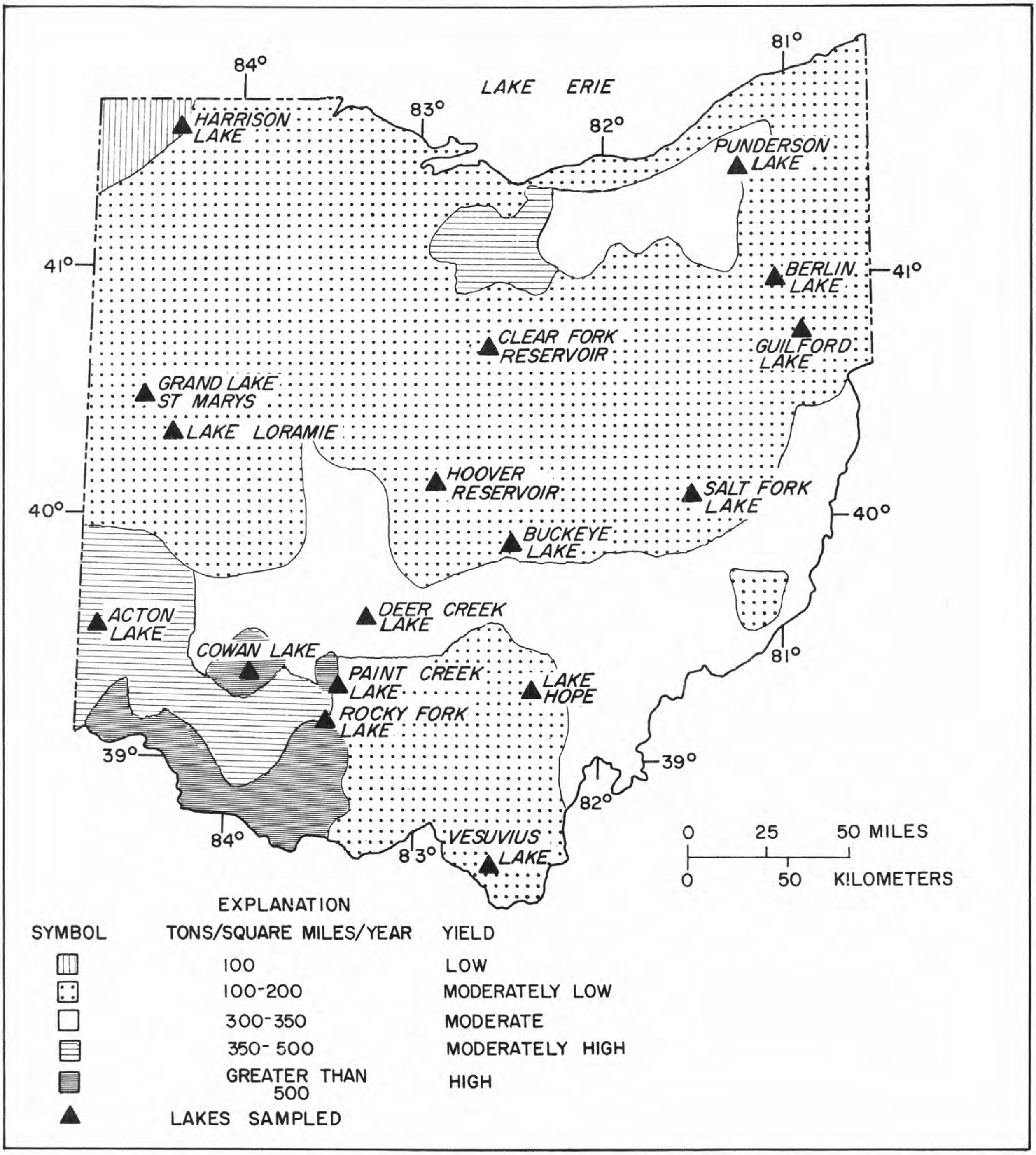


Figure 5.--Estimated sediment yields for major drainage basins in Ohio (modified from Anttila and Tobin, 1976).

The percentage of sediment input retained within a lake is known as the trap efficiency. A useful relationship between trap efficiency, sediment size, and the capacity - inflow ratio (C/I), is discussed by Brune (1953) and presented in fig. 6. If the trap efficiency is high and large quantities of sediment are discharged into a lake, it can rapidly reduce the anticipated life (fig. 7) of the lake or reservoir. Separate reports by Hahn (1955) and Anttila and Tobin (1976) show high trap efficiencies for the majority of reservoirs in Ohio.

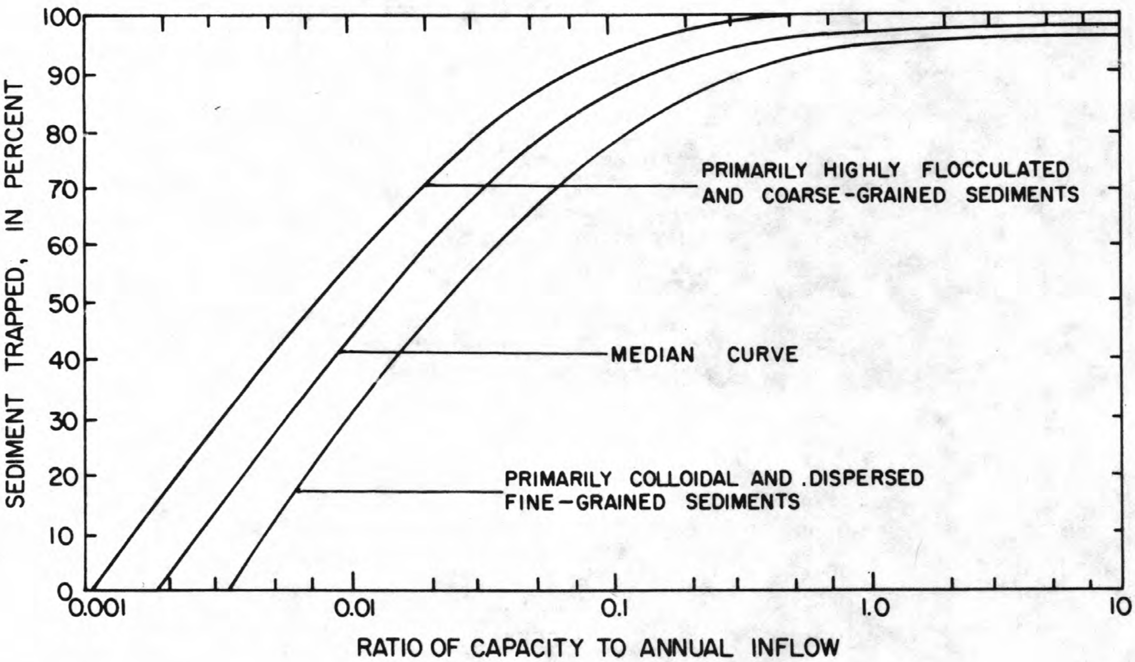


Figure 6.--Trap efficiency of reservoirs (modified from Brune, 1953, p. 414).

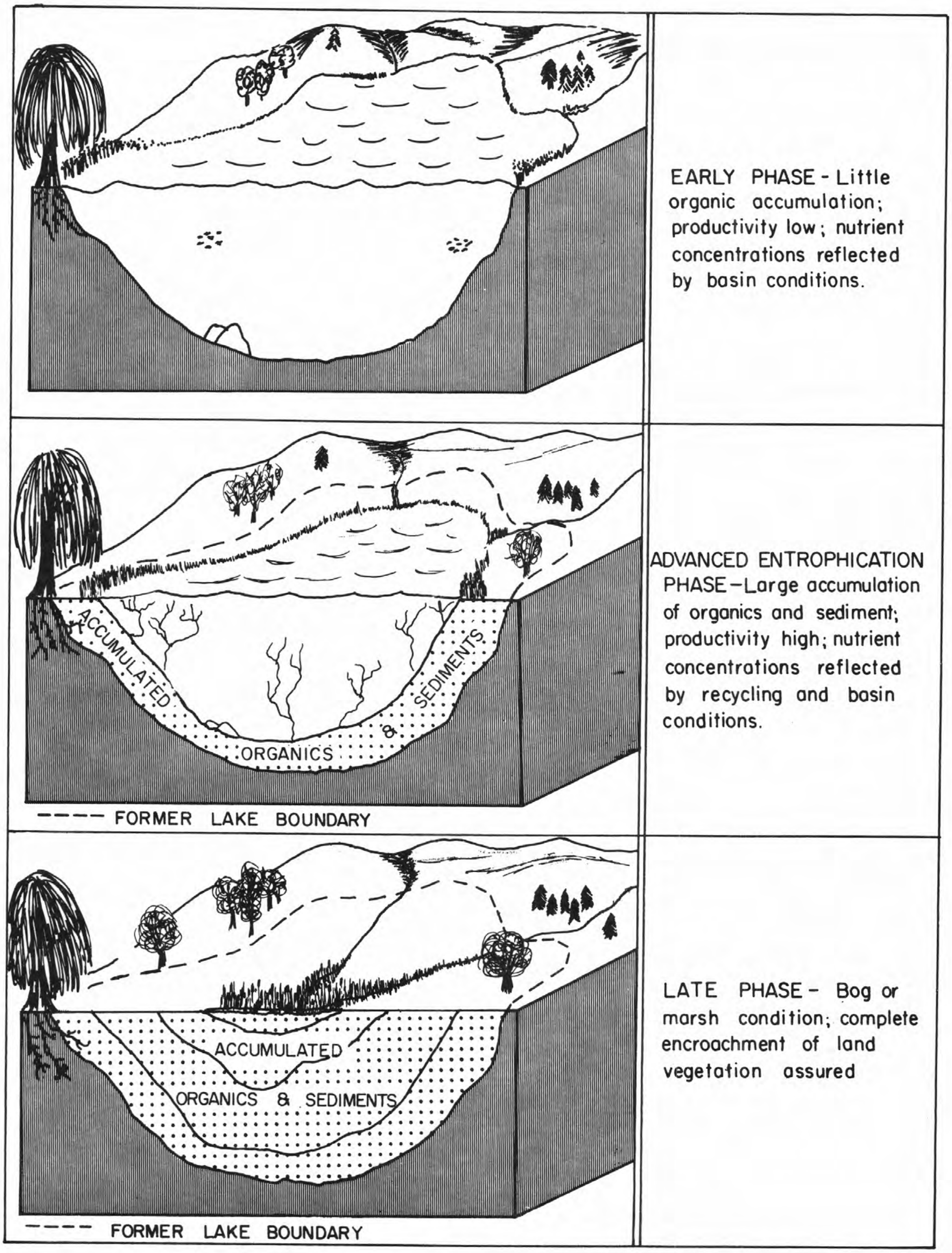


Figure 7.--Major phases in the history of a lake.

GENERAL DISCUSSION

Physical Measurements

Light Penetration

Nearly all biological activities in a lake depend directly or indirectly on sunlight. Photosynthesis by algae and other plants is related to the amount of available sunlight. The depth to which light penetrates a lake is dependent on latitude and season, surface area and physical condition, turbidity, and the transmitting and absorbing characteristics of the water and its dissolved material.

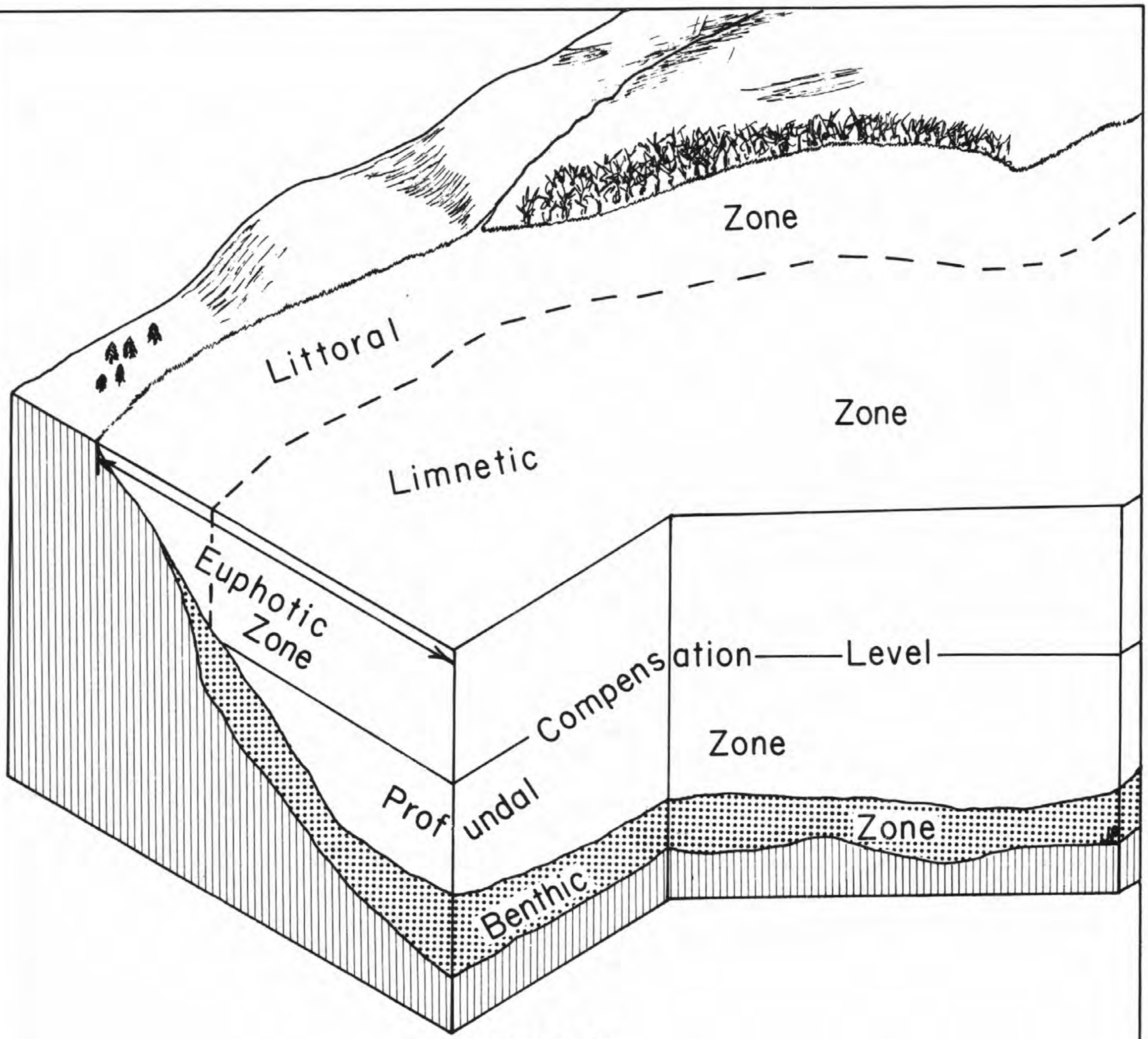
Major zones in lakes have been defined based on a combination of light penetration, biology, and morphology (fig. 8). Zonal extent will vary depending on lake basin slope gradients, wave action, and light intensity (Britton and others, 1975, p. 2).

Secchi disk observations are a relatively simple means of evaluating a lake's transparency. The average depth of several observations is used and roughly represents that depth receiving 5 percent of the surface light intensity (Yoshimura, 1938). The compensation level is estimated by multiplying the secchi disk extinction depth by a factor of 2.5 to 5.0 (Verduin, 1956).

Turbidity and Suspended Solids

Turbidity is a qualitative measure of the light reducing or scattering capabilities of the suspended and colloidal matter in water. If turbidity becomes excessive and reduces light penetration it may lower the bottom water temperature, reduce photosynthesis and primary production, disrupt fish feeding patterns and physiological functions, inhibit benthic dwelling organisms, and, at extreme concentrations, be directly lethal (McKee and Wolf, 1971, p. 290).

Suspended solids include all inorganic and organic particulate matter suspended in the water. Particulate matter commonly consists of silt and clay, biological organisms, and other detritus. Although contributing to the turbidity of water, suspended solids are not directly correlative with it. In a quiet environment much of the suspended material may settle out and blanket the bottom of the channel or lake. If the amount is high, detrimental effects to the aquatic organisms can occur (McKee and Wolf, 1971, p. 280).



EXPLANATION

Littoral Zone - Shallow water area with sufficient light to support attached vegetation.

Limnetic Zone - Open water area whose base is defined by the 1-percent light-intensity level.

Euphotic Zone - The combined littoral and limnetic zones.

Profundal Zone - Zone of deep water where the light intensity is less than 1 percent of the surface light. Little or no photosynthesis occurs in this zone.

Benthic Zone - Lake bottom.

Compensation Level - Level at which oxygen production equals oxygen uptake.

Figure 8.--Major zones in a lake (modified from Britton and others, 1975, p. 3).

Color

Color in water is usually caused by dissolved organic or inorganic compounds. They are leached from the sediments and (or) derived from decaying matter, or released through the metabolic activities of plankton.

Near surface color intensities in a lake may be lower than those at the bottom. This can result from photochemical decomposition in the euphotic zone (Whipple, 1899) or the diffusion of colored matter from the lake sediments (Hutchinson, 1957, p. 414).

Temperature

Temperature distribution is perhaps the single most important physical aspect of a lake. Temperature not only controls the rate of biological and chemical activity, but, because the density of water is a function of temperature (water is densest at approximately 4°C), it is the primary cause of most lake stratification. Figure 9 shows the seasonal thermal profiles and circulation patterns of a lake having an ice cover in winter. Hutchinson (1957, p. 438) termed lakes circulating twice a year in this manner as dimictic.

Chemical Characteristics

Major Constituents

The major constituents in natural waters are derived mainly from the action of water containing atmospheric and (or) biologically produced CO_2 (carbon dioxide) on minerals and rocks (Hem, 1970, p. 287). Carbon dioxide readily dissolves in water, lowering pH and increasing acidity. The mineral constituents are selectively dissolved into varying states of ionization with the most common major ions listed below.

Cations (positive charge)	Anicns (negative charge)
Calcium (Ca)	Bicarbonate (HCO_3)
Magnesium (Mg)	Carbonate (CO_3)
Potassium (K)	Sulfate (SO_4)
Sodium (Na)	Chloride (Cl)
	Fluoride (F)

Data on these ions provide a basis for the determination of hardness and the geochemical typing used in this report (table 3).

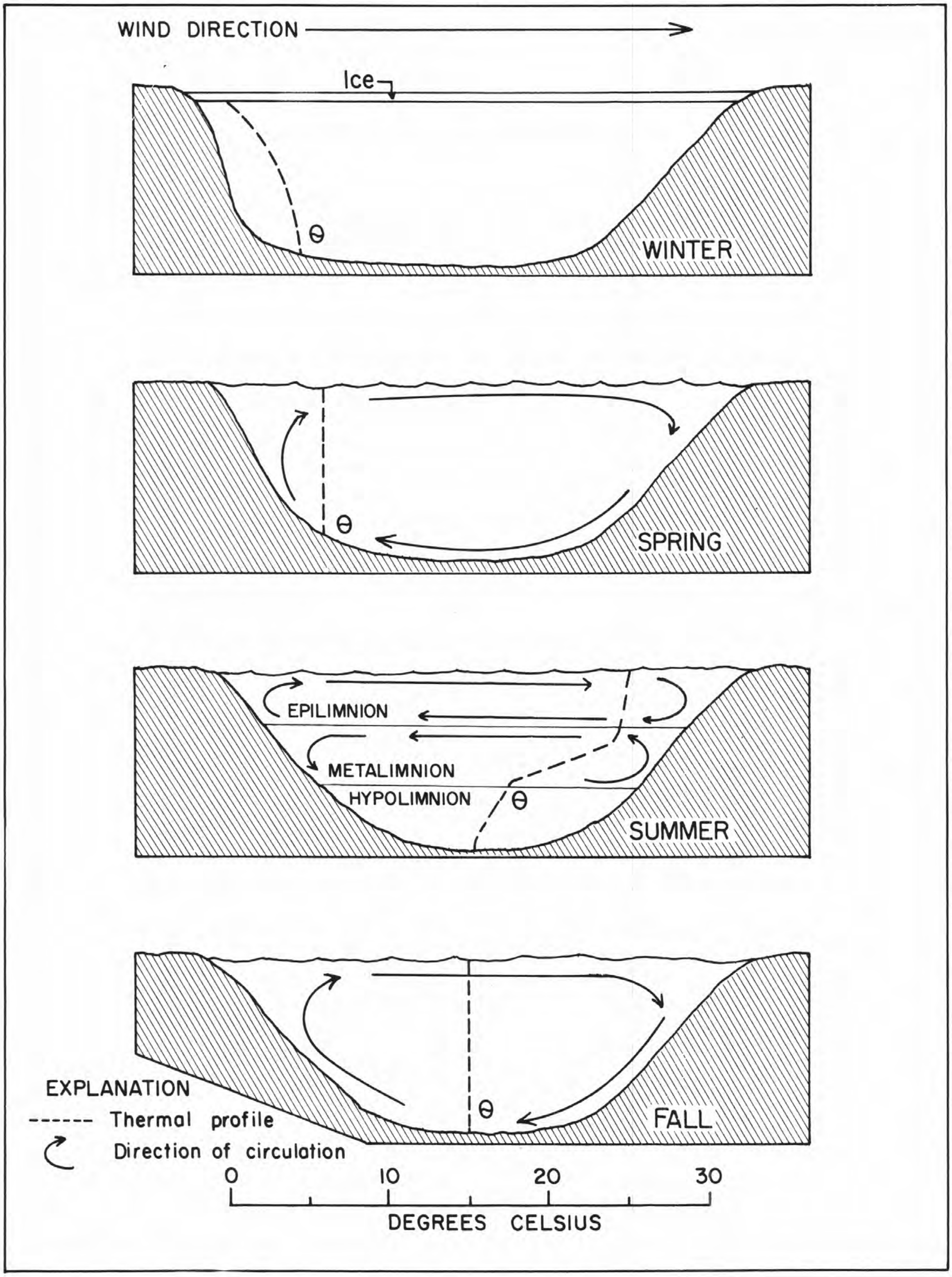


Figure 9.--Seasonal thermal profiles (Θ) and circulation patterns in a temperate zone lake (modified from Britton and others, 1975, p. 4).

Table 3.--Criteria used in the chemical classification of Ohio's lakes

Hardness (modified from Durfor and Becker, 1964, p. 27)		Major ions (modified from Piper and others, 1953, p. 26)	
Description	Bivalent cations (mg/L as $CaCO_3$)	Cations (in me/l)	Anions (in me/l)
soft	0- 60	Single cation used when it amounts to 50 percent or more of the total cations ....when the above does not exist then the highest two cations are used	Single anion used when it amounts to 50 percent or more of the total anions ....when the above does not exist then the highest two anions are used.
moderately hard	61-120		
hard	121-180		
very hard	>180		

An example might be ....a very hard calcium bicarbonate sulfate water

General Organic Indicators

Organic substances are built around the carbon atom. They are produced primarily by the metabolic activities of biological communities or as byproducts of man. Organic substances are extremely complex, and many diverse forms are found in natural waters. For many, only recent advances in analytical techniques have made detection and quantification in water possible.

Individual organic levels in natural waters are generally far below inorganic quantities and are normally reported in ug/L (micrograms per liter). The TOC (total organic carbon) analysis can approximate the organic content in water and, under certain circumstances, may correlate with BOD and COD (Helms, 1970).

Specific Conductance

Specific conductance is a measure of the ability of water to conduct an electric current and is reported in micromhos per centimeter at 25° C. Specific conductance can be used to estimate the dissolved-solids content of similar water types (Hem, 1970, p. 99). It may range from a few micromhos per centimeter in very dilute waters to several hundred thousand micromhos per centimeter in briny lakes (Robinove and others, 1958, p. 3). Chemical, hydrological, and biological activities continuously alter specific conductance through chemical solution or precipitation, dilution and evaporation, and metabolic uptake and release of chemicals.

Hydrogen Ion Activity

Hydrogen ion activity (pH) is a measure of the acid-base characteristics of water. Water that is free of dissolved matter has a pH of 7.0, but natural waters containing dissolved constituents normally range between 5.0 and 9.0 and most frequently between 6.5 and 8.5. The constituents CO_2-HCO_3-CO_3 strongly influence or buffer pH in natural waters (Hem, 1970, p. 86-96).

Water having high biological production and low ionic concentration can develop diurnal (diel) shifts in pH (Allen, 1972). Seasonal shifts in pH occur when certain constituents, such as CO_2, accumulate in poorly mixed water. If exposure time is sufficient, these environmental changes may be harmful or lethal to some aquatic life (National Academy of Sciences, 1972, p. 141).

Nutrients

All living organisms can be divided into two basic categories; the autotrophs, capable of synthesizing organic material from simple inorganic substances, and the heterotrophs or those that obtain nourishment from the ingestion and breakdown of existing organic matter. Algae and vascular plants are autotrophs; worms, fish, and man are heterotrophs. All heterotrophic organisms are directly or indirectly dependent on autotrophs for food.

The biological productivity in lakes is dependent first on the autotrophic community, which, in turn, is controlled by the availability of nutrients within the aquatic system. Table 4 lists the common nutrients generally considered necessary for plant and algae growth. Those elements essential in large quantities for plant growth, such as nitrogen and carbon, are termed major nutrients or macronutrients. Those needed in minute amounts, i.e. molybdenum and zinc, are classified as trace nutrients or micronutrients.

Table 4.--Common forms, minimum requirements, and some sources of elements essential for the growth of algae (from Britton and others, 1975, p. 7)

[The minimum nutrient requirements of algae in the aquatic environment are difficult to determine, and this uncertainty is shown by the wide range of concentrations in the table. "Trace" quantities generally refer to concentrations less than 1 mg/l, and more exact concentration requirements for these elements have not been determined. "Quantities always sufficient in surrounding medium" refers to those elements that are never below minimum concentrations so as to limit algal growth]

Element[1]	Symbol	Some common forms in water[1, 2]	Minimum requirements[3]	Examples of natural sources[1, 4]	Examples of manmade sources[5, 6, 7]
Aluminum....	Al	Al^{+3}, $AlSO_4$, AlO_2, (salts of aluminum)	Probably trace quantities	Clay minerals, silicate rock minerals	Domestic sewage, industrial wastes, mine drainage.
Boron	B	B, H_3BO_3	100 μg/l	Evaporite deposits, igneous rock minerals, springs, volcanic gases	Cleaning aids, detergents, industrial wastes, irrigation, sewage.
Calcium	Ca	Ca^{+2}, $CaCO_3$, $CaSO_4$	20 mg/l	Igneous rock minerals, rainwater, sedimentary rocks, soil	Industrial wastes (metallurgy, steelmaking), treatment plant wastes.
Carbon	C	CO_2, CO_3, HCO_3, H_2CO_3, $CaCO_3$	Quantities always sufficient in surrounding medium	Atmosphere, organic compounds and decay products, rainwater, soil	Industrial wastes (carbonation, metallurgy, pulp and paper, soda, and steelmaking), domestic sewage.
Chlorine	Cl	Cl^{-1}, (oxides of chlorine)	Trace quantities	Evaporite deposits, igneous rock minerals, ocean water, rainwater, sedimentary rocks, volcanic gases	Chlorinated hydrocarbon process, cleaning aids, industrial wastes (petroleum and refining), irrigation, salt mining.
Cobalt	Co	Co	500 μg/l	Coal ash, soil, ultramafic rocks	Manufacturing wastes (tools and instruments), metallurgy.
Copper	Cu	Cu^{+2}, Cu, $CuSO_4$	6.0 μg/l	Crustal rocks, ground water, marine animals	Industrial wastes (fabrication of pipes, refining, smelting), manufacturing wastes (electrical, foods), mill tailings, mine wastes, ore dumps, treatment plant wastes.
Hydrogen	H	H^+, H_2S, H_2O, HCO_3, H_2CO_3, OH	Quantities always sufficient in surrounding medium	Atmosphere, oxidation processes, rainwater, volcanic activity	Industrial wastes (hydrocarbon process), oils.
Iron.........	Fe	Fe^{+2}, Fe^{+3}, $FeSO_4$, $Fe(OH)_2$	0.65–6,000 μg/l	Ground water, igneous rock minerals, iron minerals, organic decomposition, soil	Acid drainage from mines, industrial wastes (steelmaking), iron ore mining, manufacturing wastes, oxides of iron metals (car bodies, refigerators).
Magnesium ...	Mg	Mg^{+2}, $MgSO_4$	Trace quantities	Igneous rock minerals, ground water, rainwater, sedimentary rocks	Irrigation, manufacturing wastes (transportation vehicles).
Manganese ...	Mn	Mn^{+2}, MnO_2	5.0 μg/l	Ground water, plants, rocks, soil, tree leaves	Acid drainage from coal mines, industrial wastes (steelmaking).

Table 4.--Common forms, minimum requirements, and some sources of elements essential for the growth of algae (from Britton and others, 1975, p. 7)--Continued

Element[1]	Symbol	Some common forms in water[1, 2]	Minimum requirements[3]	Examples of natural sources[1, 4]	Examples of manmade sources[5, 6, 7]
Molybdenum . .	Mo	Mo, MoO_4	Trace quantities	Ground water, rocks, soil	Industrial wastes (electrical devices, metallurgy, steelmaking), manufacturing wastes (alloys).
Nitrogen	N	N, NO_2, NO_3, organic nitrogen, NH_3	Trace quantities to 5.3 mg/l	Atmosphere, bacterial and plant fixation, limestone, rainwater, soil	Agricultural wastes (feedlots, fertilizers), domestic sewage, industrial wastes, storm drainage.
Oxygen	O	O_2, H_2O, oxides	Quantities always sufficient in surrounding medium	Atmosphere, oxidation processes, photosynthesis, rainwater	Industry (metallurgy).
Phosphorus . . .	P	P^{+5}, PO_4, HPO_3, organic phosphorus	0.002–0.09 mg/l	Ground water, igneous and marine sediments, rainwater, soil, waterfowl	Agricultural wastes (feedlots, fertilizers), domestic sewage (detergents), industrial wastes.
Potassium	K	K^+ (salts of potassium)	Trace quantities	Evaporite deposits, igneous rock minerals, plant ash, sedimentary rocks	Agricultural wastes (feedlots, fertilizers), industrial wastes (preservatives, pulp ash).
Silicon	Si	Si^{+4}, SiO_2	0.5–0.8 mg/l	Diatom shells, igneous rock minerals, metamorphic rocks	Domestic sewage, industrial wastes.
Sodium	Na	Na^+, Na salts (NaCl, $NaCO_3$	5.0 mg/l	Ground water, igneous rock minerals, ocean water, soil	Industrial wastes (paper and pulp, rubber, soda, water softeners), manufacturing wastes (dyes and drugs).
Sulfur	S	SO_2, HS, H_2S, SO_4	5.0 mg/l	Animal and plant decomposition, igneous rocks, rainwater, sedimentary rocks, springs, volcanic activity	Agricultural wastes (fertilizers), industrial wastes (fuels, paper and pulp).
Vanadium	V	V^{+2}, V^{+3}, V^{+4}, V^{+5} (salts and oxides of vanadium)	Trace quantities	Ground water, plant ash	Industrial wastes.
Zinc.	Zn	Zn^{+2} (salts of zinc), ZnO_2	10–100 µg/l	Igneous and carbonate rock minerals	Industrial wastes (piping, refining), mine wastes.

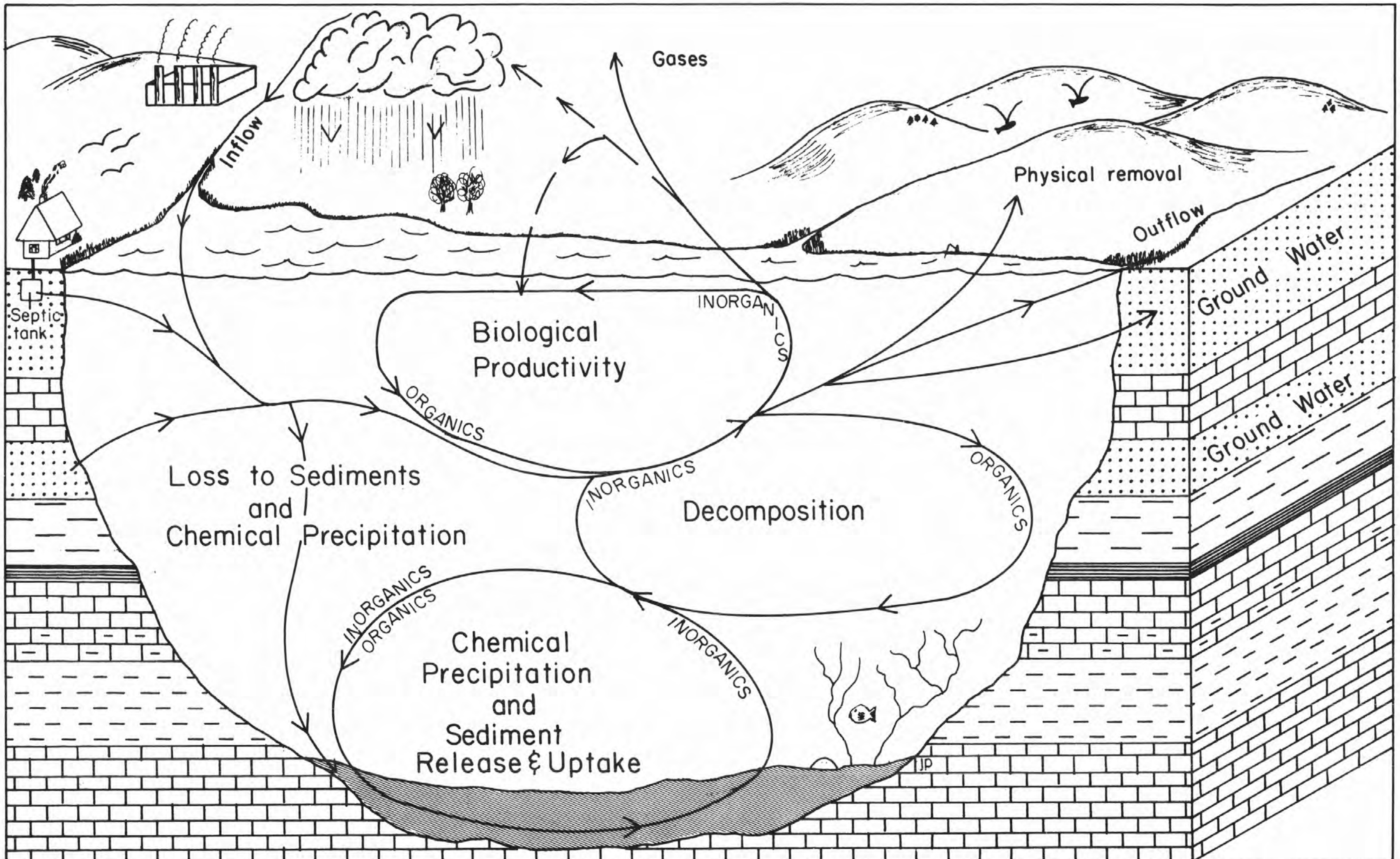
1. Hem (1970).
2. McKee and Wolf (1971).
3. Greeson (1971).
4. Reid (1961).
5. Gurnham (1965).
6. Nebergall, Schmidt, and Holtzclaw (1963).
7. Sawyer and McCarty (1967).

The processes by which nutrients enter and leave a lake are complex. Figure 10 represents a simplified illustration showing the major nutrient pathways in a lake system. Once in the lake, nutrients are subjected to various removal and (or) recycling functions. Chemical reactions, sediment uptake and subsequent burial, and biological utilization tend to remove large quantities of nutrients from the water. These processes may be reversed, however, through biochemical action. The conversion of inorganic nutrients into biomass within a zone of high algae productivity may be reversed in the profundal zone having active decomposition or changing chemical conditions. These activities often develop uneven nutrient distributions when the lake is stratified (fig. 11).

Although there are several ways for nutrients to enter a lake, surface-water inflow and cultural input, such as septic tank discharge, are the major sources. The rate of enrichment of a lake is referred to as the eutrophication rate; the enrichment status, relative to the lake's total existence or history, is the trophic level (fig. 12). Generally, as the nutrient concentrations increase within a lake, plant and algae productivity also increase. If sufficient amounts of the needed nutrients are available and physical conditions are favorable, algae blooms having counts of 500-1000 cells per milliliter or greater may occur (Lackey, 1949). When high algae densities persist, especially blue-green algae, eutrophic conditions are indicated.

Attempts to classify lakes into trophic categories are frequently based on the concentrations of growth-stimulating macronutrients, particularly nitrogen and phosphorus. Much controversey has been generated in recent years as to which nutrients limit growth or are environmentally controllable. This topic is discussed in Likens (ed. 1972). Sawyer (1947) states that nuisance algal conditions can occur when inorganic nitrogen and phosphorus levels exceed 0.3 and 0.01 mg/L, respectively.

Vollenweider (1968) compared the input of nitrogen and phosphorus with lake mean depth and found shallow lakes to be more sensitive to nuisance conditions than deeper lakes. A short hydraulic residence time (low C/I ratio), however, may control algal production by maintaining high turbidity and flushing rates (Welch, 1969). Many attempts made to control the rate and undesirable effects of eutrophication are summarized by Dunst and others (1974).



NUTRIENTS ENTERING THE LAKE FROM THE LEFT MAY BE PERMANENTLY OR TEMPORARILY TRAPPED IN THE BENTHIC ZONE OR MAY BE INCORPORATED WITHIN THE LAKES BIOCHEMICAL CYCLES (INDICATED BY ARROWS). AVENUES OF NUTRIENT REMOVAL FROM THE LAKE ARE SHOWN AT THE RIGHT.

Figure 10.--Simplified diagram of nutrient pathways within a lake system.

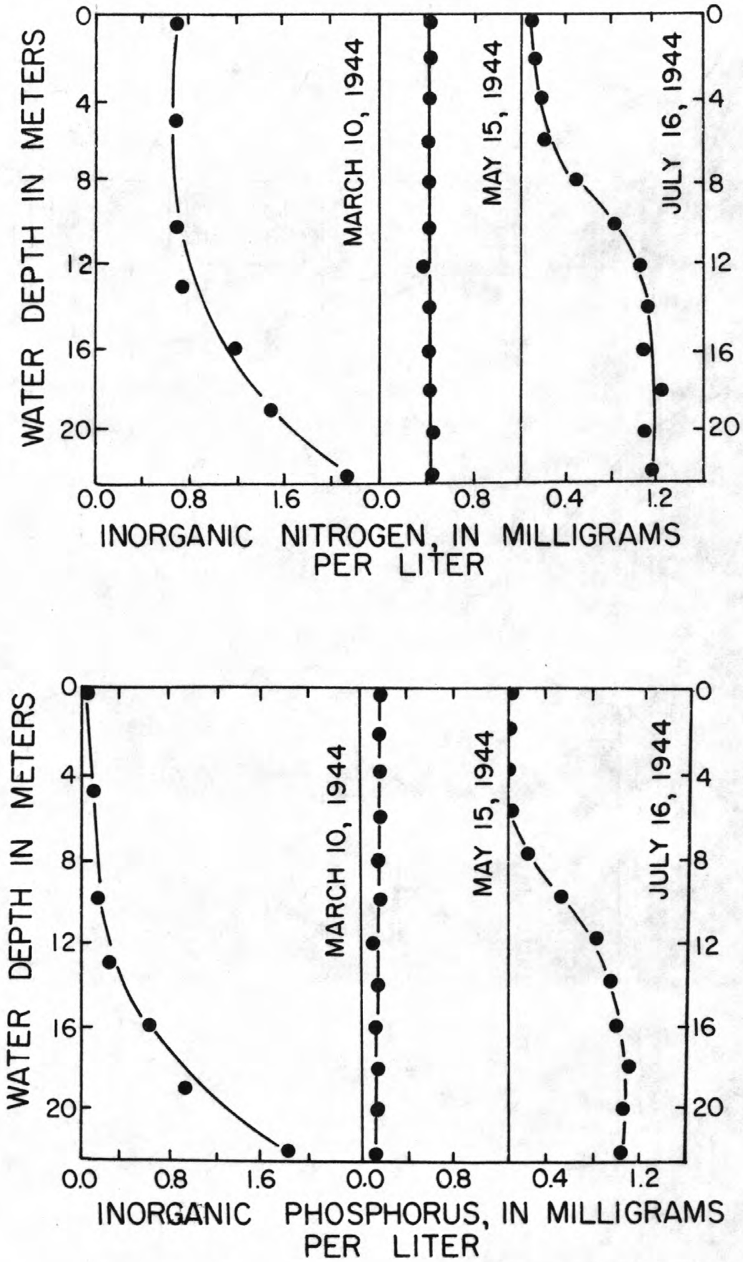
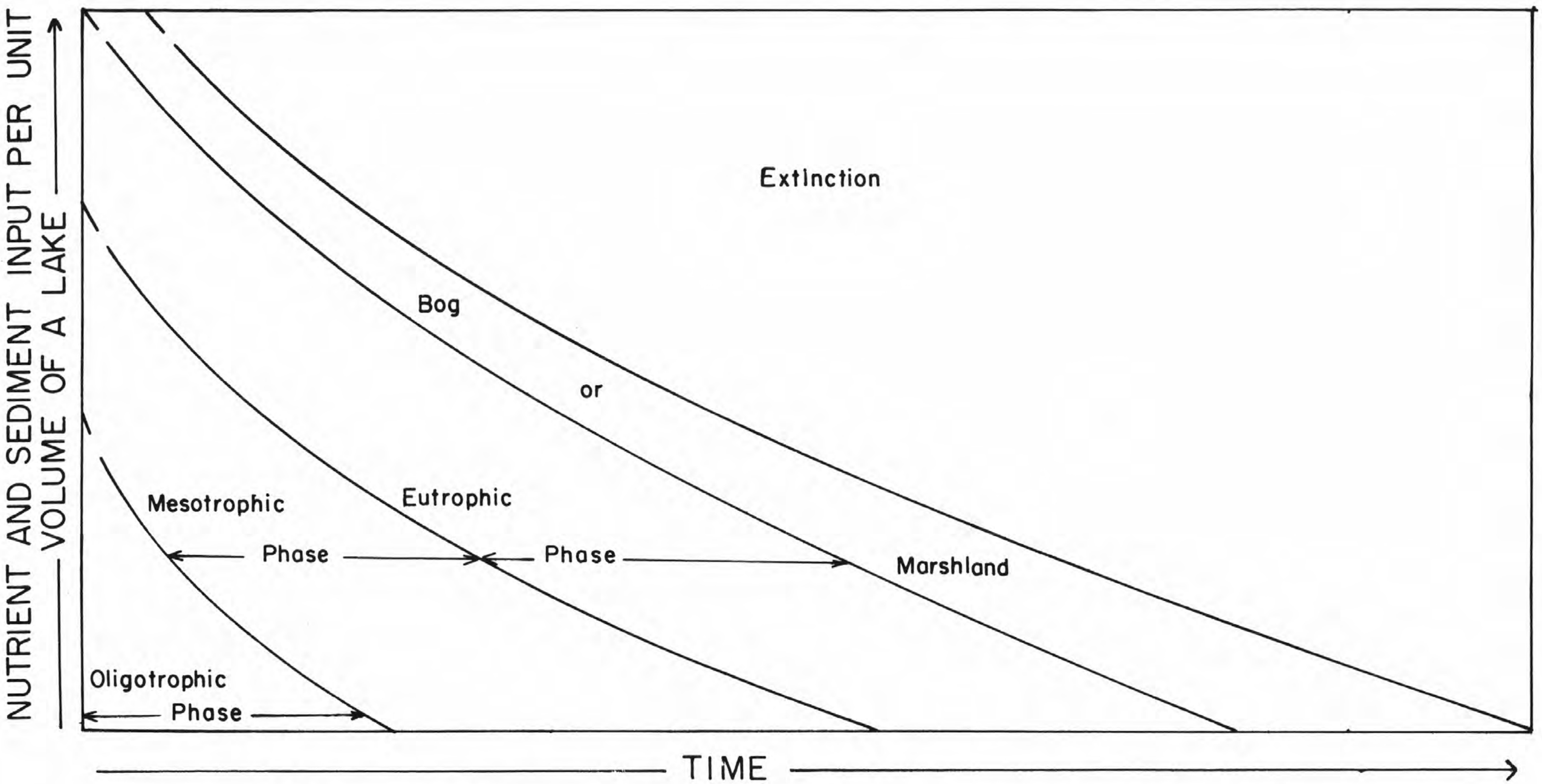


Figure 11.--Vertical distribution of nutrient elements in Lake Monona, Wisconsin (modified from Sawyer, 1947, p. 121).



Lake nutrient and sediment inputs, maintained at some given level (vertical axis), show their time related effects on the lake's trophic phases (horizontal direction).

Figure 12.--Time effects of sustained nutrient and sediment inputs on the trophic phases of a lake.

Toxic and Undesirable Substances

Toxic substances in water are those constituents which, singularly or collectively, can produce harmful effects on organisms that either live in or use the water. Undesirable substances, such as chloride, iron, and MBAS, are not normally toxic except at high concentrations, but they may restrict the usability of the water or reduce its esthetic quality. Toxicant limits are frequently determined through bioassy procedures, as described in American Public Health Association (1971, p. 562-577), and listed in various state and federal publications (McKee and Wolf, 1971, and National Academy of Sciences, 1972). The Ohio Environmental Protection Agency (1975), in its "Water Quality Standards for Ohio," has set forth the following criteria on selected constituents in water:

The following chemical pollutants shall not exceed the specified concentrations at any time:

Constituent*	Concentration mg/L	Concentration ug/L
Ammonia	1.5	-
Arsenic	-	50
Barium	-	800
Cadmium	-	5
Chloride	250	-
Chromium	-	300
Chromium (hexavalent)	-	50
Cyanide (free)	0.005	-
Cyanide	0.2	-
Fluoride	1.3	-
Foaming agents (MBAS)	0.5	-
Iron (dissolved)	-	1000
Lead	-	40
Manganese (dissolved)	-	1000
Mercury	-	.5
Oil and grease (hexane soluble)	5.	-
Phenols	-	10
Selenium	-	5
Silver	-	1

In addition, total copper and total zinc shall not exceed the following specified concentrations at any time:

	Hardness as mg/L of $CaCO_3$ 0-80	80-160	160-240	240-320	>320
Copper in ug/L	5	10	20	50	75
Zinc in ug/L	75	100	200	400	500

---
* Total unless otherwise indicated.

Dissolved Oxygen

Oxygen dissolves in water to a concentration controlled by the atmospheric partial pressure of the gas and the temperature and salinity of the water. Calculated equilibrium values of dissolved oxygen, extrapolated from the sea level data of Whipple and Whipple (1911), for a range of elevations and temperatures are presented (fig. 13).

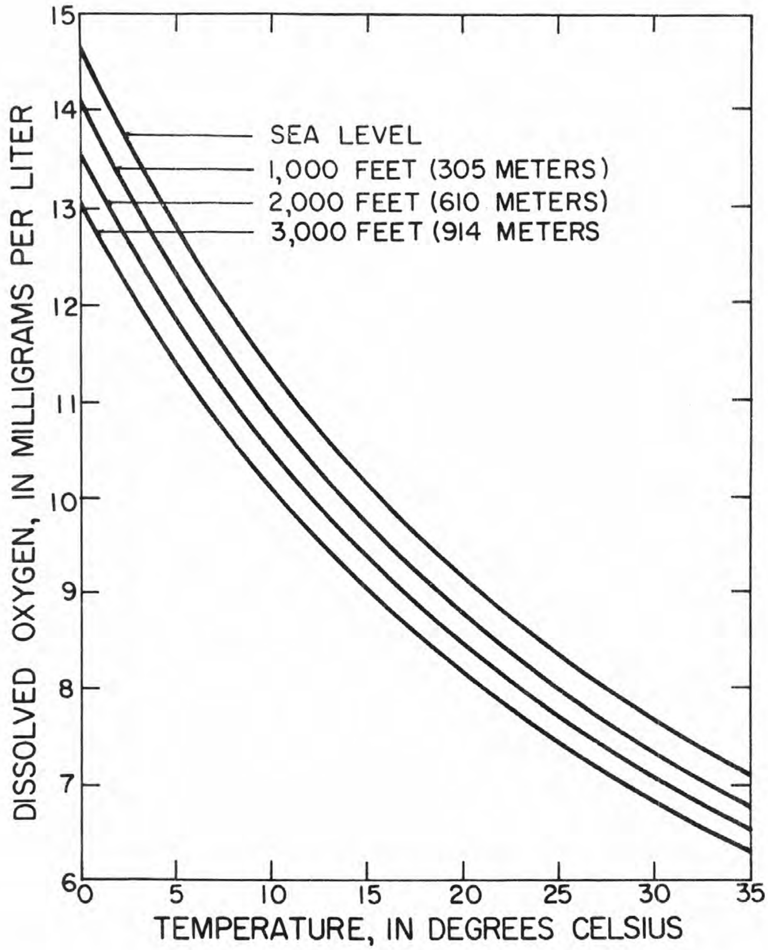


Figure 13.--Equilibrium values of dissolved-oxygen concentrations in low saline (less than 300 mg/L Cl^-) water at different elevations (pressures) and temperatures, based on values of Whipple and Whipple, (1911).

Except for photosynthesis, almost all oxygen transfer to the water occurs at the air-water interface. Because oxygen diffuses very slowly in water (Hutchinson, 1957, p. 587), winds, water turbulence, and currents play a major role in the aeration of a water body.

The concentration of dissolved oxygen is the single most important symptomatic property used by limnologists in the evaluation of a lake or stream. Seasonal and daily variations of dissolved oxygen in a water body are indirect measures of the internal metabolism and oxygen demand of the system. If metabolic activities are high during thermal stratification, separate biological zones or systems developing different chemical characteristics may evolve. In lakes, the epilimnion is typically a zone of active biomass (algae) production, marked by nutrient uptake and daytime oxygen production. When ample nutrients and good lighting conditions exist, zones of oxygen supersaturation may develop.

Conversely, the hypolimnion may become the graveyard for the overlying biomass. As organisms die and settle downward they are decomposed by bacteria and fungi. During decomposition, nutrients are returned to the water and oxygen is consumed. If large amounts of organic matter are present with little or no lake mixing, the dissolved oxygen concentrations in the lower levels may be reduced to zero.

The biological dependence on oxygen is well established. Fish, in particular, are sensitive to oxygen concentrations (Warren and others, 1973; Prescott, 1939; Rudolfs and Heukelekian, 1967). Recent research reviews and recommended oxygen levels are presented in National Academy of Sciences (1972), and a "floor level" concentration of 4.0 mg/L dissolved oxygen is suggested for all waters supporting fish life.

The amount of oxygen consumed by indigenous processes in an isolated water sample held in the dark at 20°C for five days is termed the 5-day BOD (biochemical oxygen demand). It is an artificial measurement of the biological and chemical activities existing in the sample and includes respiration, decomposition, and chemical oxidation.

The COD (chemical oxygen demand) is a measure of all readily oxidizable material in the water sample (Brown and others, 1970, p. 124). It involves a high temperature refluxing operation in the presence of an oxidizing material and represents the total oxygen demand in the water parcel under extreme conditions.

Other Dissolved Gases

Other gases known to affect water quality are CO_2 (carbon dioxide), NH_3 (ammonia), and H_2S (hydrogen sulfide). Their chemistry in natural waters is complex and the reader should refer to Hem (1970) and Stumm and Morgan (1970) for a more detailed discussion.

Carbon dioxide is soluble in water but will degas to the atmosphere to an equilibrium value of less than 1.0 mg/L in chemically pure water. Natural waters, however, having high rates of respiration and decomposition may reach much higher values of CO_2. Waters rich in CO_2 are corrosive to cement (Terzaghi, 1949) and may be detrimental to certain species or life stages of aquatic life (Silvey, 1967 and McKee and Wolf, 1971, p. 156).

Ammonia readily dissolves in water forming ammonium ions ($NH_4{}^+$) and undissociated ammonium hydroxide (NH_4OH). Ammonia is an important part of the nitrogen cycle and its most common source in natural water is from the breakdown of nitrogenous organic matter or the cultural by-products of man. Ammonia is biochemically oxidized to NO_2 (nitrite) and NO_3 (nitrate) and is seldom found in unpolluted rivers above 0.3 mg/L as N (Klein, 1959). The amount and ratio of the ionic form $NH_4{}^+$ to the undissociated molecule, NH_4OH, is critical to some aquatic animals (McKee and Wolf, 1971, p. 133). The ratio is directly related to pH with the toxic form, NH_4OH, increasing with increasing pH values.

Hydrogen sulfide is readily soluble in water, but its concentration level in natural waters is attenuated by other ions in solution, degassing, and biogeochemical recycling (Odum, 1971, p. 91). The rotten egg odor, detectable at concentrations of 0.1 - 0.2 mg/L, signifies the presence of H_2S. The gas originates principally from anaerobic decomposition of organic substances, the reduction of sulfate by bacteria, and industrial wastes. When dissolved, it assumes the un-ionized form of H_2S at low pH but ionizes to HS^- and $S^=$ with increasing pH. Hydrogen sulfide has been shown to be toxic at the 0.1 mg/L concentration level in the un-ionized state; the degree of toxicity varies with water temperature, oxygen levels, and life stages (National Academy of Sciences, 1972, p. 193).

Biological Determinations

Lake biota is complex and includes bacteria, plants (particularly algae), zooplankton, insects and other invertebrates, and vertebrates such as fish and water fowl (Odum, 1971; Hutchinson, 1967). The biological distributions and densities vary greatly with season, physical conditions, and nutrient availability. Lakes presented in this report were sampled for phytoplankton (open-water algae), and fecal coliforms and streptococci (sanitary indicator bacteria). Data from additional biological field observations are included.

Phytoplankton

Biological studies of lakes frequently begin with an investigation of the phytoplankton biomass. As the primary producers in the lake's ecosystem, these organisms are fundamental to general productivity. The taxonomy or classification of algae varies somewhat among taxonomists. In this report the following divisions or phyla, taken from Prescott, (1970) are used:

Chlorophyta	- green algae
Cyanophyta	- blue-green algae
Chrysophyta	- yellow-green or yellow-brown algae (includes diatoms)
Euglenophyta	- Euglenoids
Cryptophyta	- Cryptomonads (Cryptophyceae of some authors)
Pyrrhophyta	- Dinoflagellates
Rhodophyta	- red algae
Chloromonadophyta	- Chloromonads
Phaeophyta	- brown algae, almost entirely marine

Algae are identified to the generic level and fall most frequently into the first three phyla listed above.

Algal densities will vary considerably from lake to lake, and commonly show seasonal fluxuations or progressions within a given lake (Greeson, 1971) (fig. 14). The ratios and dominance and (or) persistence of algae groups are sometimes used as an aid in lake classification (Hutchinson, 1967, p. 355-394). Other investigators may use a diversity index such as that proposed by Wilhm and Dorris (1968, p. 478) and discussed in Slack and others (1973, p. 24). The diversity index per individual ($\bar{d}$) is formulated as:

$$\bar{d} = \sum_{i=1}^{s} \frac{n_i}{n} \log \frac{n_i}{n}$$

and is based on the relationship of individuals per taxon (n_i), the total number of individuals in the sample (n), and the total number of taxa or identifiable groups in the sampled community (s). The diversity index $\bar{d}$ relates the community tolerance (increases with $\bar{d}$) directly with overall water quality conditions.

Bacteria

Fecal coliforms and fecal streptococci bacteria are natural inhabitants of the intestinal tract of man and other animals. As such they are excreted in large numbers. A healthy person would not normally excrete pathogenic organisms; however, should illness develop these would appear in his feces. The presence of large numbers of fecal coliform and fecal streptococci in water bodies provides warning of the potential presence of water borne pathogenic organisms (Federal Water Quality Administration, 1971). The Ohio Environmental Protection Agency (1975) has set forth the following criteria for recreational waters designated for primary contact activities:

> "Bacteria: The fecal coliform content (either MPN or MF count) not to exceed 200 per 100 ML as a monthly geometric mean based on not less than five samples per month; nor exceed 400 per 100 ML in more than ten percent of all samples taken during a month."

Knowing whether the fecal coliforms originated from human or other animals would be helpful in interpreting or locating the source of contamination. As an aid for making this determination the ratio of FC/FS (fecal coliform to fecal streptococci) sometimes is used. A ratio greater than 4.0 strongly suggests a human waste source; a ratio less than 1.0 indicates a predominantly livestock and (or) poultry source (Federal Water Quality Administration, 1971, p. 1-16).

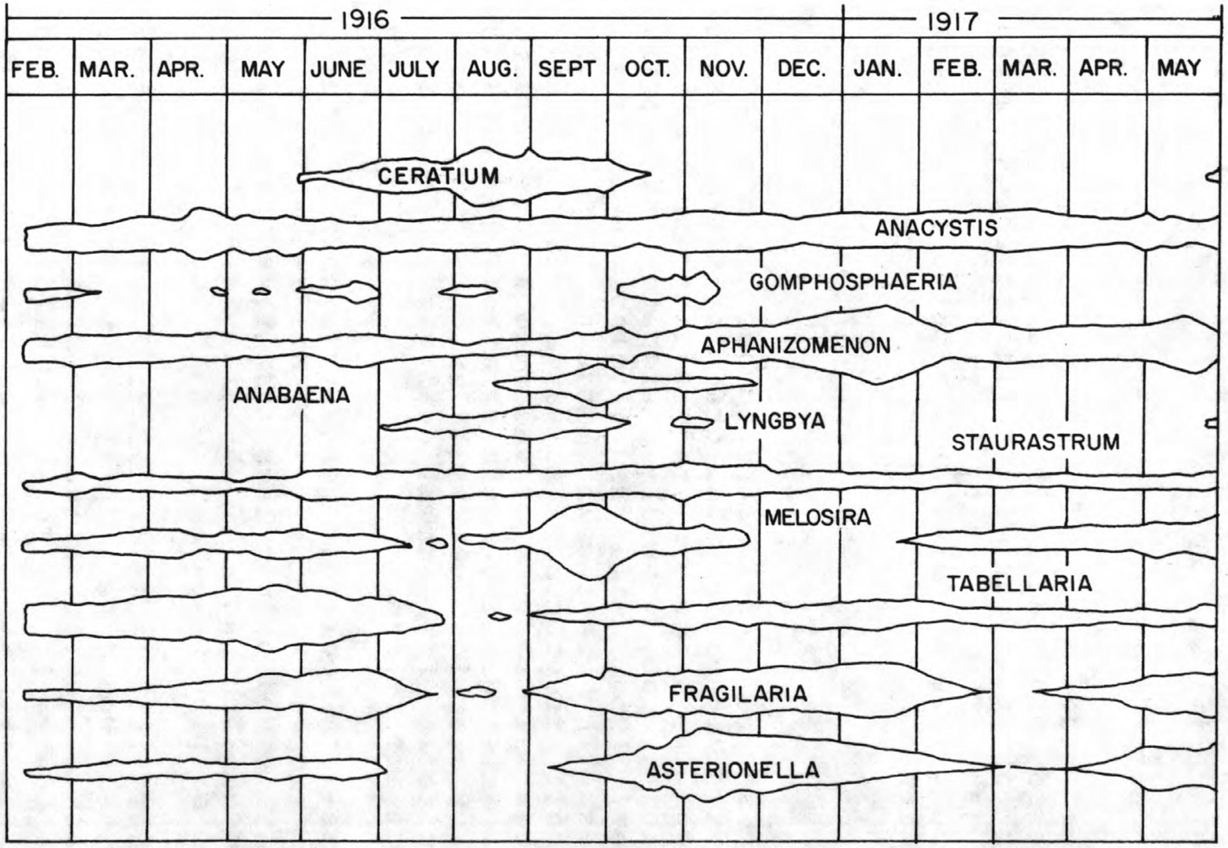


Figure 14.--Seasonal variation of selected phytoplankton in Lake Mendota, Wisconsin 1916-17, relative abundances plotted in proportion to the cubic roots of concentration, (modified from Birge and Juday, 1922).

DATA PRESENTATION

Seventeen Ohio lakes were surveyed for water-quality characteristics during the spring and summer of 1975. The lakes are listed alphabetically in table 5. The physical data were taken from various state and federal reports, U.S. Geological Survey topographic maps, or estimated. Primary lake and inflow site identification numbers are based on the latitude and longitude of their locations, i.e., 410202080595100 is the identification number for a site, located at 41°02'02" latitude 080°59'51" longitude. The last two digits are sequential identifiers for additional sites at that location and will be shown as 00 for all sites in this report. For convenience, however, primary lake sites will be identified as, L-1, and secondary sites as, L-2, L-3, etc.

Spring sampling was done to gather data from well mixed lakes subsequent to winter and early spring runoffs. Late summer sampling tested the same lakes for the effects of summer stresses and (or) stratification and stagnation.

Data from primary lake sites are presented in depth-related profiles, and as tabulations for discrete water samples or water column composites. Data from secondary sites are shown in profile form only. Computed saturation values for dissolved oxygen $(O_2)_s$ also are included for comparison.

Data from the water column composites were used for general classification purposes, and as indicators of background concentration levels of selected constituents. The bicarbonate values used in the classification of the water column are adjusted from the near surface and near bottom concentrations. Unfiltered water samples were taken from the top and bottom of each lake during both visits and analyzed for the following pesticides:

Aldrin	Chlordane	Methoxychlor
DDD	Endrin	Malathion
DDE	Heptachlor	Parathion
DDT	Heptachlor-Epozide	Methyl Parathion
Dieldrin	Lindane	BHC

Except at Acton Lake, no detectable concentrations (>0.005 ug/L) of the above pesticide residues were found.

Table 5.--Morphometric data for lakes sampled in Ohio, 1975

Type: Re - Reservoir; Lk - Lake.
Use: Fc - flood control; Ws - water supply; Rec - recreation.
C/I ratio: Capacity divided by mean annual inflow - decreasing values indicate shorter hydraulic retention time.

Name and primary site identification number	Location county(ies)	Type	Date of origin	Use	Morphology					Drainage area (miles)	Mean annual inflow (acre-feet)	Capacity inflow ratio C/I
					Surface area (acres)	Depth		Shoreline (miles)	Capacity (acre-feet)			
						Maximum (feet)	Mean (feet)					
Acton Lake 393333084441400	Preble Butler	Re	1956	Rec	625	36	15	8.0	9400	98.9	71,600	0.13
Berlin Lake 410202080595100	Stark Portage Mahoning	Re	1942	Fc, Ws,Rec	5500 3590	74 66	17 16	68.5	91,150 56,600	248	163,600	0.56 0.35
Buckeye Lake 395548082274300	Licking Fairfield Perry	Re	1832	Rec	3140	13	8.7	32	27,300	47	30,700	0.89
Clearfork Reservoir 404152082363300	Morrow Richland	Re	1949	Ws,Rec	977	23	11	14	10,740	33.7	23,320	0.46
Cowan Lake 392317083552100	Clinton	Re	1948	Rec	648	40	19	17	12,000	50.5	43,800	0.27
Deer Creek Lake 393717083130200	Fayette Pickaway	Re	1968	Fc, Rec,Ws	4046 1277	79 45	25 16	-- 19.4	102,540 21,030	277	196,900	0.52 0.11
Grand Lake St.Marys 403135084291400	Auglaize Mercer	Re	1841	Rec	13,440	10	6.8	52	92,000	112	69,000	1.3
Guilford Lake 404746080520900	Columbiana	Re	1932	Rec	380	25	--	6.4	--	11.2	7340	--
Harrison Lake 413819084214500	Fulton	Re	1941	Rec	97	24	10	3.5	991	37.2	18,600	0.05
Hoover Reservoir 400636082530200	Delaware Franklin	Re	1954	Ws,Rec	2825	63	21	45	60,340	190	131,800	0.46
Lake Hope 391914082211800	Vinton	Re	1939	Rec	126	20	12	5.4	1555	10	7750	0.20
Lake Loramie 402201084212800	Auglaize Shelby	Re	1844	Rec	1700	8	7.6	30	13,000	77.7	48,570	0.27
Lake Vesuvius 383624082375300	Lawrence	Re	1937	Rec	125	28	12	6.4	1489	10.9	8850	0.17
Paint Creek Lake 391450083212200	Ross Highland	Re	1974	Fc, Rec	4760 1190	97 50	30 17	-- 30	145,000 20,310	570	422,100	0.34 0.05
Punderson Lake 412718081122600	Geauga	Lk	--	Rec	101	60	--	2.6	--	1.27	960	--
Rocky Fork Lake 391111083263200	Highland	Re	1952	Rec	2000	45	17	30	34,100	114	86,900	0.39
Salt Fork Lake 400617081331600	Guernsey	Re	1967	Fc,Rec	2952	38	15	74	43,200	159	120,000	0.36

Reconnaissance data for phytoplankton identification and counts for each lake are included. Spring data represent water column composite samples from the euphotic zone; the late summer samples were taken from zones of maximum dissolved oxygen concentration. Individual plankton cell size varies greatly among different phyla and within a given phylum. Consequently, the small cell size common in the phylum, Cyanophyta, may account, in part, for the very high algae densities observed in some lakes.

Acton Lake

Location and inflow data

Acton Lake is in Preble and Butler Counties 40 mi (64 km) northwest of Cincinnati (figs. 1 and 15). The lake was formed in 1956 by damming Four Mile Creek, and lies entirely within the boundries of Hueston Woods State Park. The lake is owned by the State and is used principally for recreation.

Four Mile and Little Four Mile Creeks contribute most of the surface inflow to the lake. They drain rural and agricultural lands within an area of moderately high sediment yield (fig. 5), and have drainage areas at the lake of 54.9 mi^2 (142 km^2) and 30.4 mi^2 (79 km^2), respectively.

High flows in April were sampled at sites I-1 and I-2 (fig. 15). Nutrient concentrations (table 6) were high in both creeks, particularly nitrate nitrogen. The September sample from Four Mile Creek represents a time of low flow and was low in phosphorus and nitrogen. The September sample from Little Four Mile Creek represents discharge from a sewage treatment plant which was the only flow in the creek at the time. A wide variety of invertebrate benthic organisms were observed in Four Mile Creek and Little Four Mile Creek, including mayflies (Ephemeroptera), caddisflies (Trichoptera), crayfish (Decapoda), and water pennies (from Coleoptera). Stoneflies (Plecoptera) were seen in Four Mile Creek.

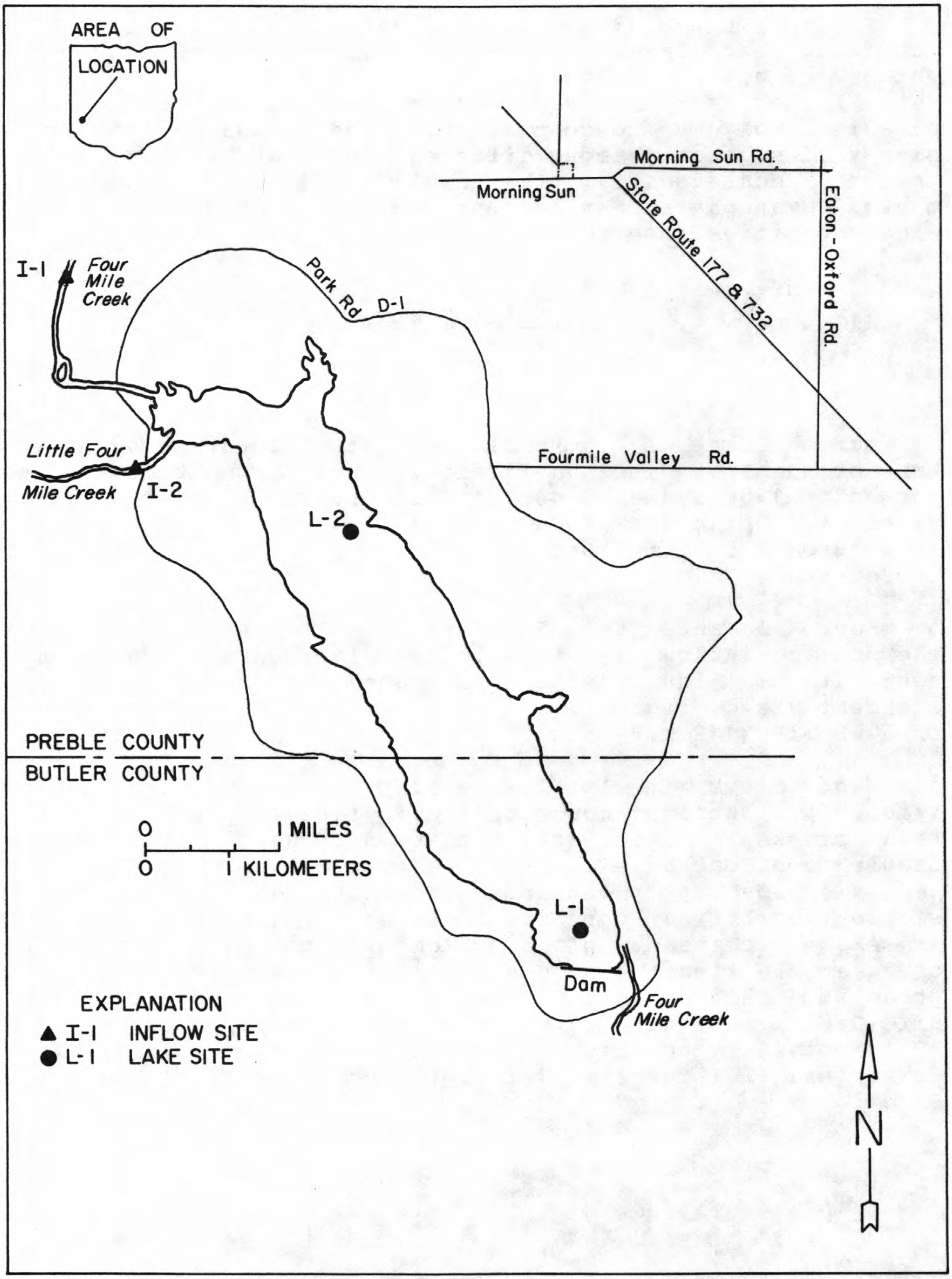


Figure 15.--Acton Lake and inflow sampling sites.

Table 6.--Physical and chemical data for selected inflows, Acton Lake, Ohio

393530084461500 - Four Mile Creek above Acton Lake at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN-TANEOUS DIS-CHARGE (CFS)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)
APR 30...	1040	143	12.0	10.1	8.0	567	25	50	5.2	7.7	.49	.09
SEP 09...	1345	<1.0	24.0	9.3	7.8	472	5	10	5.8	.00	.41	.05

393456084455400 - Little Four Mile Creek above Acton Lake at site (I-2)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN-TANEOUS DIS-CHARGE (CFS)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)
APR 30...	0920	132	11.5	10.3	7.9	522	30	60	--	8.9	.50	.15
SEP 09...	1415	<.50	24.5	--	7.6	930	6	30	12	23	2.7	2.9

Lake data

Acton Lake was sampled under overcast skies in April. The high turbidity values and low secchi disk transparencies (tables 7 and 9) possibly reflect storm effects. Minor stratification at site L-1 (fig. 15) is indicated by slight decreases in temperature and specific conductance (fig. 16 and table 7) between 5 and 10 ft (1.5 to 3.0 m). Dissolved oxygen was close to saturation throughout the water column, and organic material (TOC and organic nitrogen) and oxygen demand analyses (BOD, COD) were higher in the hypolimnion than at the surface (table 9).

The bicarbonate values (table 7) and analyses of water column composite samples (table 8) show that the lake water was a hard, calcium magnesium bicarbonate type. Except for copper, iron, and manganese, selected trace elements were present in low quantities. The copper concentrations of 10 ug/L were at the State accepted limit. The pesticide aldrin (see page 33) was detected at a concentration of 0.051 ug/L (micrograms per liter) in the bottom water in April, but no residue was found in September. A limit of 0.01 ug/L is recommended by the National Academy of Sciences (1972, p. 186). Nitrogen, especially nitrate, and phosphorus (table 9) were well above minimum requirements for plant growth.

The fecal coliform and fecal streptococii counts in April (table 9) were high and probably related to agricultural runoff (FC/FS<1). The water column composite taken for algae identification in April (table 10) shows a cell density of 1,600 cells/ml dominated by diatoms.

A warm dry period preceded the sampling in early September. Water turbidity was less than in the spring but light penetration, based on secchi disk observations under clear skies, was less than 3 ft (0.9 m). Thermal stratification is evident from the profile data at site L-1. The thermocline between 20 and 25 ft (6.1 and 7.6 m) effectively separated the lake into two chemically different water bodies. Profile data from the north end of the lake at site L-2 (figs. 15, 16) correlate well with that at site L-1 and show some chemical evidence for a laterally homogeneous lake.

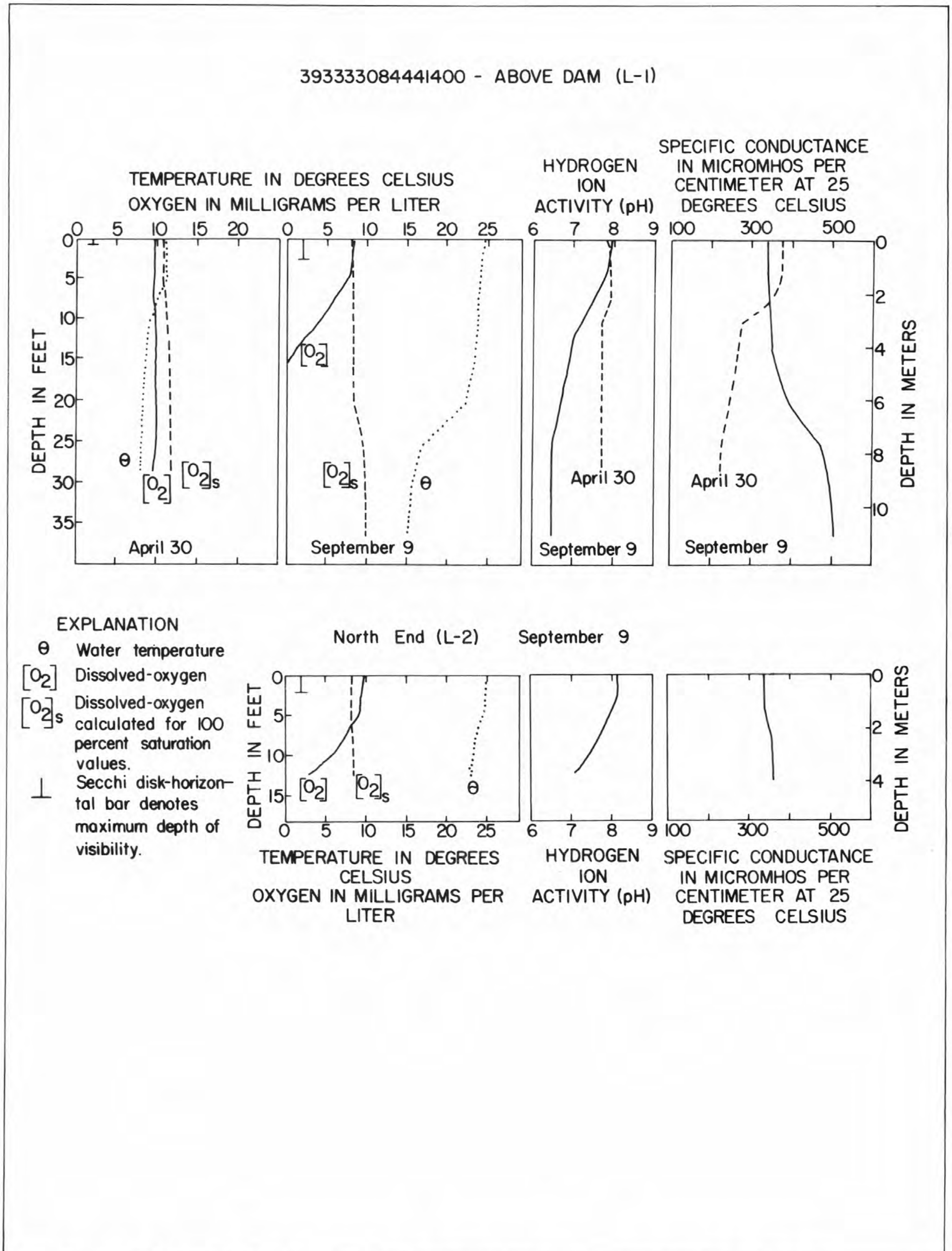


Figure 16.--Data profiles for Acton Lake on selected days in 1975.

Table 7.--Profile data for the primary lake site, Acton Lake, Ohio

393333084441400 - Acton Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
APR												
30...	1355	.0	11.0	9.6	90	377	7.8	--	--	--	--	--
30...	1400	2.0	11.0	9.6	90	377	7.9	0	157	3.1	.0	5.0
30...	1405	4.0	11.0	9.7	91	377	7.9	--	--	--	--	--
30...	1410	7.0	10.0	9.4	85	357	7.9	--	--	--	--	--
30...	1415	10	9.0	9.7	87	277	7.7	--	--	--	--	--
30...	1420	15	8.5	9.8	86	267	7.7	--	--	--	--	--
30...	1425	20	8.2	9.8	85	242	7.7	--	--	--	--	--
30...	1430	25	8.0	9.8	85	227	7.7	--	--	--	--	--
30...	1435	28	8.0	9.5	83	227	7.7	0	84	2.7	.0	--
SEP												
09...	1515	.0	24.6	8.2	101	337	7.9	--	--	--	--	--
09...	1520	2.0	24.2	8.0	98	337	7.9	0	150	3.0	.0	28
09...	1525	4.0	24.0	7.8	95	337	7.8	--	--	--	--	--
09...	1530	7.0	23.8	6.1	74	342	7.5	--	--	--	--	--
09...	1535	10	23.8	4.1	50	344	7.2	--	--	--	--	--
09...	1537	12	23.5	2.1	25	347	7.0	--	--	--	--	--
09...	1540	15	23.2	.0	0	357	6.9	--	--	--	--	--
09...	1545	20	22.1	.0	0	392	6.7	--	--	--	--	--
09...	1550	25	16.8	.0	0	472	6.5	--	--	--	--	--
09...	1555	30	15.5	.0	0	492	6.5	--	--	--	--	--
09...	1600	34	15.2	.0	0	500	6.5	0	311	156	.4	--
09...	1605	36	15.2	.0	0	502	6.5	--	--	--	--	--

Table 8.--Chemical analyses of water column composite samples, Acton Lake, Ohio

393333084441400 - Acton Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
APR 30...	1420	33	13	2.6	2.7	20	7.2	.4	140	160	342	502

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
APR 30...	1420	100	0	20	9	<.5	7	1	0	<10	.1
*SEP 09...	1600	--	--	<10	9	--	--	--	--	--	--

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
APR 30...	1420	60	3	10	9000	240	4	40
*SEP 09...	1600	--	--	10	2300	3200	--	10

*Water sample taken 1 to 3 ft from the lake bottom.

Table 9.--Chemical, physical, and biological analyses of water samples from selected depths, Acton Lake, Ohio

393333084441400 - Acton Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
APR											
30...	1400	2.0	.09	5.4	5.5	.30	.70	1.0	.09	.21	4.1
30...	1435	28	.21	2.6	2.8	.81	1.2	2.0	.12	.54	3.2
SEP											
09...	1520	2.0	.00	.00	.00	.09	1.1	1.2	.01	.06	1.9
09...	1600	34	.00	.00	.00	6.0	3.9	9.9	.20	.55	7.2

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
APR									
30...	1400	2.0	75	150	6.3	1.7	18	1900	4050
30...	1435	28	340	1200	15	3.2	48	B12500	B12500
SEP									
09...	1520	2.0	4	30	4.8	4.0	20	3	2
09...	1600	34	30	70	11	>7.9	27	<2	5

B Results based on a colony count outside the ideal range.

Table 10.--Phytoplankton in Acton Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Location	Date	Location water column					
Site L-1 above dam ---------	4-30-75	Euphotic zone composite	1600	-	Chrysophyta	95	Cyclotella (50); Melosira (30); Nitzschia (10); Navicula (5)
					Chlorophyta	5	Ankistrodesmus (5)
Site L-1 above dam ---------	9-9-75	2-ft depth	660,000	1.274	Cyanophyta	99	Raphidiopsis (61); Phormidium (32); Agmenellum (3); Gomphosphaeria (1)
					Chlorophyta	<1	Crucigenia
					Chrysophyta	<1	Achnanthes; Navicula
Site L-2 North end ---------	9-9-75	2-ft depth	590,000	1.381	Cyanophyta	99	Raphidiopsis (56); Agmenellum (31); Oscillatoria (12)
					Chrysophyta	<1	Achnanthes

* Less than 1 percent not given.

The rapidly decreasing values of dissolved oxygen and pH with depth do not coincide with the thermocline, but developed within the epilimnion. This region at the base of the epilimnion may delineate the upper zonal limit of significant decomposition and (or) respiration effects within the lake. The anaerobic conditions prevailing below 15 ft (4.6 m) would be lethal for any oxygen dependent organism.

Additional data review suggests that extensive biological uptake and conversion of inorganic nutrients into organic matter occurred above the thermocline between April and August. Recycling of organic and nitrate nitrogen to ammonia nitrogen through decomposition and (or) chemical reduction also is indicated near the lake bottom. A H_2S odor was noticed at the 15 ft (4.6 m) level and confirmed in the bottom water. The high concentrations of ammonia, hydrogen sulfide, and high oxygen demand in the hypolimnion are indicative of a strongly reducing condition, an environment favorable for the release of sorbed ions from the sediment.

The bacteria counts during September were several magnitudes lower than those of the spring and approximate the low background densities of other Ohio lakes. The diatoms and green algae observed in April were replaced at the 2-ft (0.6-m) depth by high concentrations of blue-green algae. The supersaturated zone of dissolved oxygen at site L-2 could indicate higher algae activities at the northern end of the lake than at the southern end (site L-1).

Berlin Lake

Location and inflow data

Berlin Lake is in Stark, Portage, and Mahoning Counties 4 mi (6.4 km) north of Alliance (figs. 1 and 17). The lake was formed by damming the Mahoning River in 1942, and is used for flood control and water supply. Lake levels may fluctuate 50 ft (15.3 m) within a year. Stage is normally controlled through a conduit near the bottom of the dam.

Inflows to Berlin Lake drain agricultural, rural, and urban lands within an area of moderately low sediment yield (fig. 5). The Mahoning River, sampled above the lake at site I-1 (fig. 17), represents drainage from 90 mi^2 (233 km^2) or 36 percent of the total drainage area of the lake. Water-quality samples were taken during relatively stable flow conditions in spring and late summer. Stream macronutrient concentrations (table 11), compared with similar lake data (table 14), indicate that the stream contributes a significant amount of nutrients to the lake. Periphytic (attached) diatoms and green algae were noted, but no benthic invertebrates were observed.

Lake data

Data were collected above the dam at site L-1 (fig 17, 18;table 12) on a sunny day in May. Thermal stratification is marked by a thermocline between 10 and 20 ft (3 and 6.1 m). Dissolved oxygen was near saturation within the epilimnion, decreased with depth to about 40 percent saturation through the thermocline, and remained at this level throughout the hypolimnion. Slight chemical stratification is suggested by changes in pH and specific conductance.

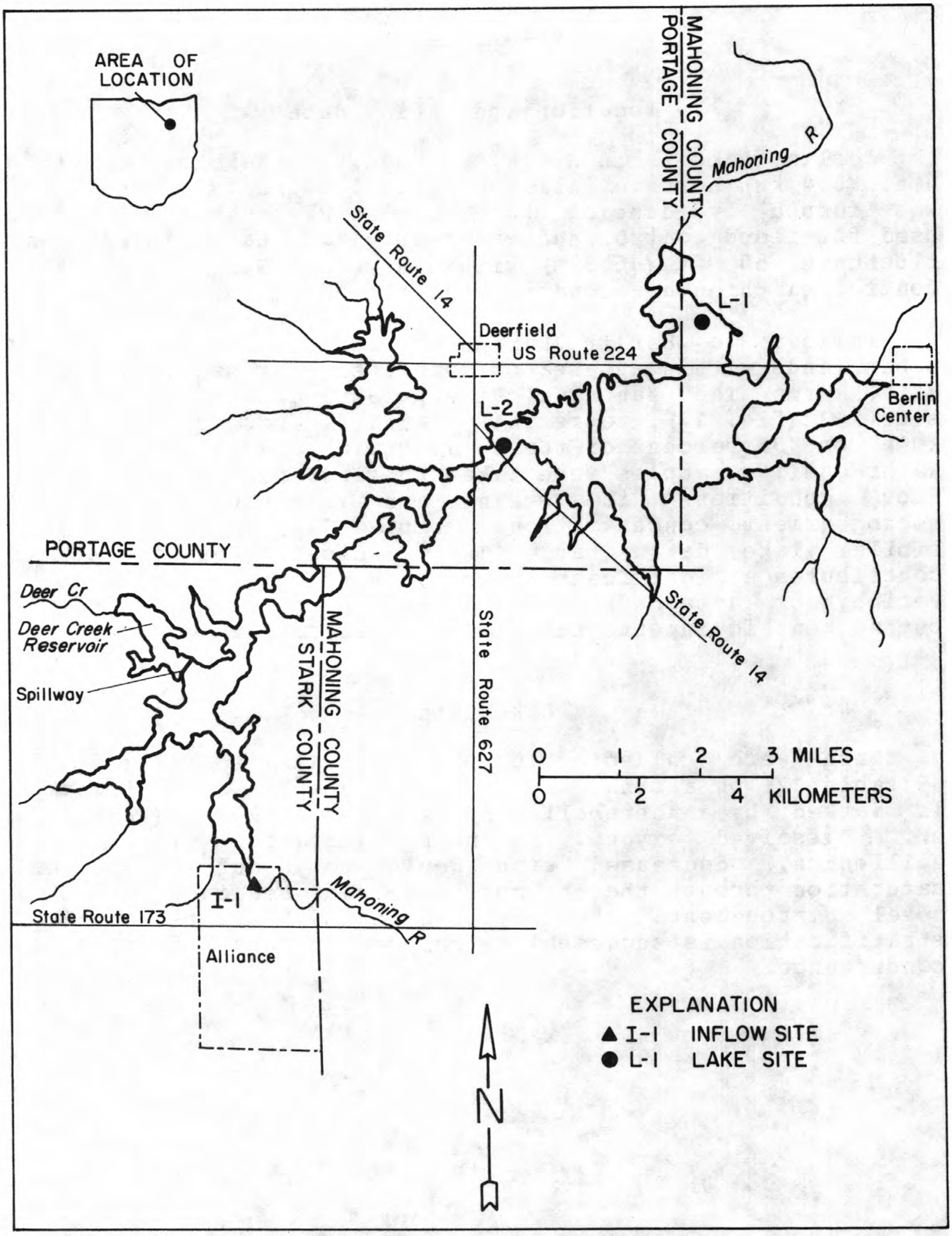


Figure 17.--Berlin Lake and inflow sampling sites.

Table 11.--Physical and chemical data for selected inflows, Berlin Lake, Ohio

405553081060700 - Mahoning River above Berlin Lake at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
MAY												
28...	1010	52	21.0	6.5	7.3	500	20	70	11	1.5	1.0	.27
AUG												
27...	1025	52	23.0	6.0	7.2	655	20	40	24	.90	.84	.16

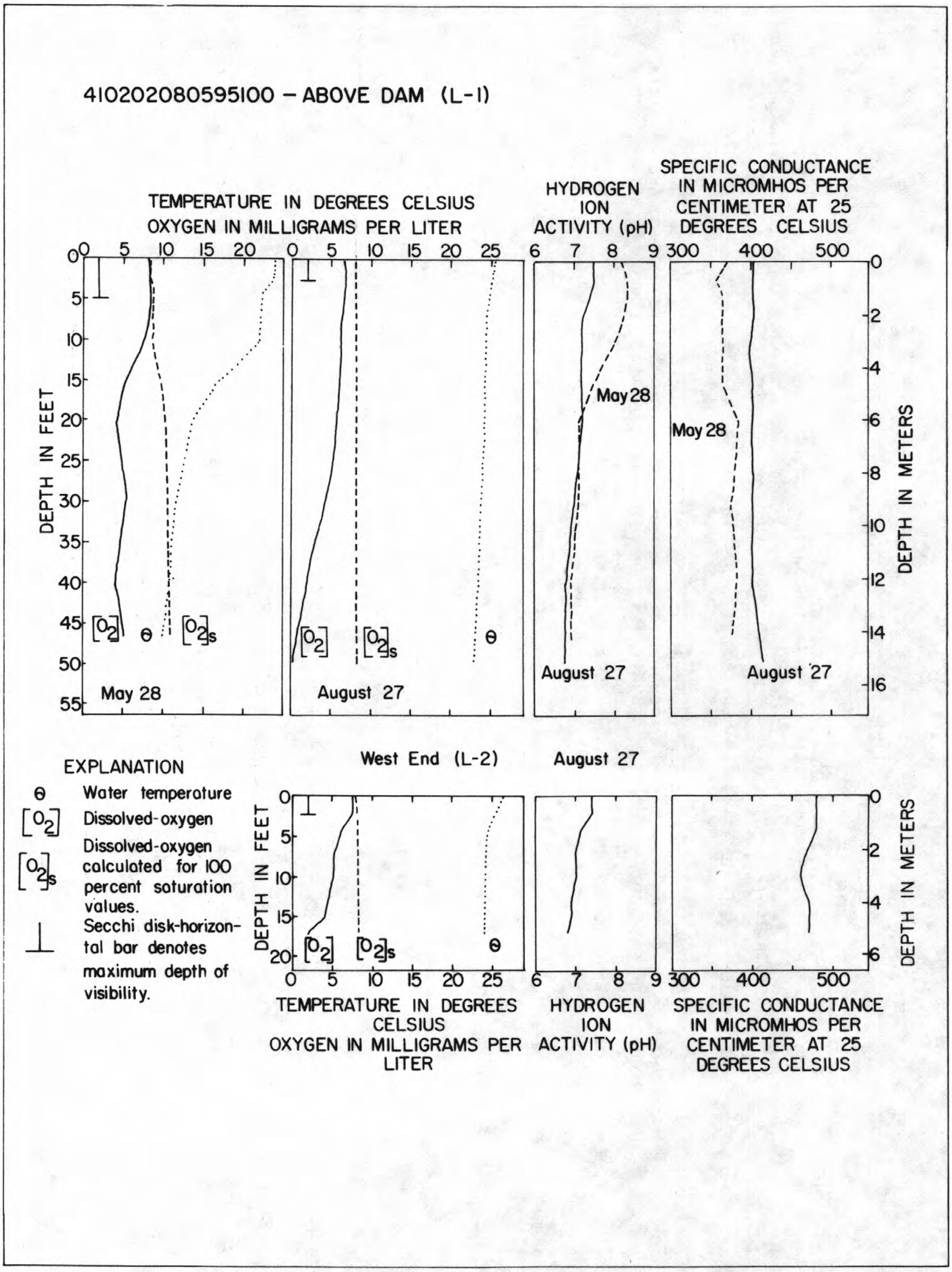


Figure 18.--Data profiles for Berlin Lake on selected days in 1975.

Table 12.--Profile data for the primary lake site, Berlin Lake, Ohio

410202080595100 - Berlin Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
28...	1210	.0	24.0	8.0	98	367	8.2	--	--	--	--	--
28...	1215	2.0	23.8	8.1	99	357	8.3	0	64	.5	.0	59
28...	1220	4.0	22.5	8.2	98	363	8.3	--	--	--	--	--
28...	1225	7.0	22.2	8.0	95	363	8.2	--	--	--	--	--
28...	1230	10	22.0	7.2	85	363	8.0	--	--	--	--	--
28...	1235	15	17.0	5.1	54	363	7.5	--	--	--	--	--
28...	1240	20	13.7	4.1	41	382	7.1	--	--	--	--	--
28...	1250	30	11.7	5.3	50	375	7.1	--	--	--	--	--
28...	1255	40	10.8	4.0	37	381	6.9	--	--	--	--	--
28...	1300	47	10.0	5.0	46	375	6.9	0	70	14	.0	--
AUG												
27...	1415	.0	25.5	6.6	84	403	7.5	--	--	--	--	--
27...	1420	2.0	25.2	6.7	84	403	7.5	0	90	4.5	.0	30
27...	1425	4.0	24.9	6.6	83	403	7.4	--	--	--	--	--
27...	1430	7.0	24.5	6.1	75	403	7.2	--	--	--	--	--
27...	1435	10	24.5	6.0	74	400	7.2	--	--	--	--	--
27...	1440	15	24.4	5.9	73	403	7.2	--	--	--	--	--
27...	1445	20	24.3	5.6	69	403	7.2	--	--	--	--	--
27...	1500	25	24.1	5.1	62	403	7.1	--	--	--	--	--
27...	1505	30	23.8	4.0	49	403	7.0	--	--	--	--	--
27...	1510	40	23.5	1.8	22	403	6.8	--	--	--	--	--
27...	1515	50	23.0	.0	0	415	6.8	0	90	23	.2	--

Analyses of the water column composites (table 13) and bicarbonate values (table 12) show that the lake water was a hard, calcium sulfate type. Except for copper, the trace and toxic constituents were within Ohio water-quality standards. (See page 26.) The concentration of copper (20 ug/L) was 10 ug/L above State standards for a water hardness of 80 to 160 mg/L. Pesticides (listed on page 33) in May and August were below detection limits. Nitrogen ($NO_2+NO_3+NH_3$ as N) in May was above the potential nuisance producing level of 0.3 mg/L, but orthophosphorus was less than 0.015 mg/L (table 14).

Fecal coliform colony counts at site L-1 (table 14) were within the Ohio water-quality standard. (See page 31.) The algal counts (table 15) were the lowest of the 17 lakes sampled in spring and may be due, in part, to the high copper concentrations observed in the water column. Diatoms were the only algae identified in the spring.

The August profiles were collected under clear skies. The light penetration was less than in May by 2.4 ft (0.7 m), possibly reflecting increased phytoplankton densities. The cool bottom waters in May apparently were removed through bottom releases at the dam, thus eliminating the thermocline. Dissolved oxygen concentrations were below saturation levels for the entire water column but only approached biologically significant low levels (less than 4.0 mg/L) below 30 ft (9.1 m) at site L-1 and below 14 ft (4.3 m) at site L-2 (figs. 17 and 18). Based on specific conductance and pH values, the concentrations of major constituents in the lake varied little with depth at site L-1 but did show increases and irregularities at the upstream lake site L-2.

Macronutrient levels were low when compared with most Ohio lakes. A comparison of top and bottom nutrient data indicates that some nutrient recycling had occurred. Silica uptake by diatoms within the surface waters is suggested by the significantly lower concentrations of silica within this region.

Bacteria colony counts in August were low and similar to those in spring. The algae counts from the 2-ft depth in August were dominated by the blue-green genus, Lyngbya, and indicate a change from the diatoms observed in May.

Table 13.--Chemical analyses of water column composite samples, Berlin Lake, Ohio

410202080595100 - Berlin Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY 28...	1240	40	12	3.3	15	92	25	.2	150	280	19	299

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY 28...	1240	0	0	<10	2	<.5	11	0	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY 28...	1240	50	0	20	380	130	0	10
*AUG 27...	1515	--	--	10	--	--	--	--

* Taken from a water sample 1 to 3 ft from the lake bottom.

Table 14.--Chemical, physical, and biological analyses of water samples from selected depths, Berlin Lake, Ohio

410202080595100 - Berlin Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
28...	1215	2.0	.04	.33	.37	.07	.40	.47	.01	.02	1.0
28...	1300	47	.02	.62	.64	.22	.27	.49	.01	.03	2.4
AUG											
27...	1420	2.0	.01	.15	.16	.05	.40	.45	.01	.03	.1
27...	1515	50	.01	.16	.17	.35	1.2	1.5	.03	.08	1.8

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
28...	1215	2.0	7	30	16	1.1	12	3	<3
28...	1300	47	6	30	4.2	.5	4	<3	<3
AUG									
27...	1420	2.0	8	30	10	1.4	15	<2	<2
27...	1515	50	50	100	--	3.5	26	6	3

Table 15.--Phytoplankton in Berlin Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Location	Date	Location water column					
Site L-1 above dam ----------	5-28-75	Euphotic zone composite	150	-	Chrysophyta	100	Cyclotella (89); Navicula (5); Synedra (5)
Site L-1 above dam ---------	8-27-75	2-ft depth	2300	1.608	Cyanophyta	95	Lyngbya (58); Agmenellum (29); Aphanizomenon (8)
					Chrysophyta	3	Achnanthes (1); Nitzschia (1); Cyclotella (1); Melosira
					Chlorophyta	1	Scenedesmus (1); Tetraedron

* Less than 1 percent not given.

Buckeye Lake

Location and inflow data

Buckeye Lake is in Licking, Fairfield, and Perry Counties 28 mi (45 km) east of Columbus (figs. 1 and 19). The lake was formed in 1832 when several tributaries of the South Fork Licking River were dammed to provide a feeder reservoir for the Ohio State Canal. Buckeye Lake has since become a popular center for various water sport activities and is owned and operated by the State.

Two major inflows were sampled: The Reservoir Feeder at site I-1, draining 16.8 mi^2 (43.5 km^2); and Honey Creek at site I-2, draining 6.8 mi^2 (17.5 km^2) (fig. 19). They drain predominately rural and agricultural lands within an area of moderately low sediment yield (fig. 5), and represent 50 percent of the total drainage for Buckeye Lake.

Both creeks were sampled in May during steady flow conditions. Nitrogen concentrations (table 16) in both inflows were higher than in the lake (table 19). The Reservoir Feeder was turbid and snail eggs were the only aquatic fauna observed. Darters and caddisfly larvae (Trichoptera) were observed in Honey Creek. A red algae, *Batrachiospermum*, was collected in Honey Creek.

Lake data

Data for Buckeye Lake were collected May 2 under clear skies. The secchi disk extinction depth was less than 2 ft (0.6 m) at site L-1 (fig. 19). Data profiles (fig. 20 and table 17) show a temporary thermocline between 2 and 4 ft (0.6 and 1.2 m). Dissolved oxygen was above saturation and pH was high (8.8 to 9.0) in the upper 10 ft (3 m) , but both declined rapidly near the lake bottom. These relationships, the BOD and COD (table 19), and the high phytoplankton densities (table 20) suggest that the lake had an upper zone of high algae productivity and a bottom characterized by respiration and (or) decomposition.

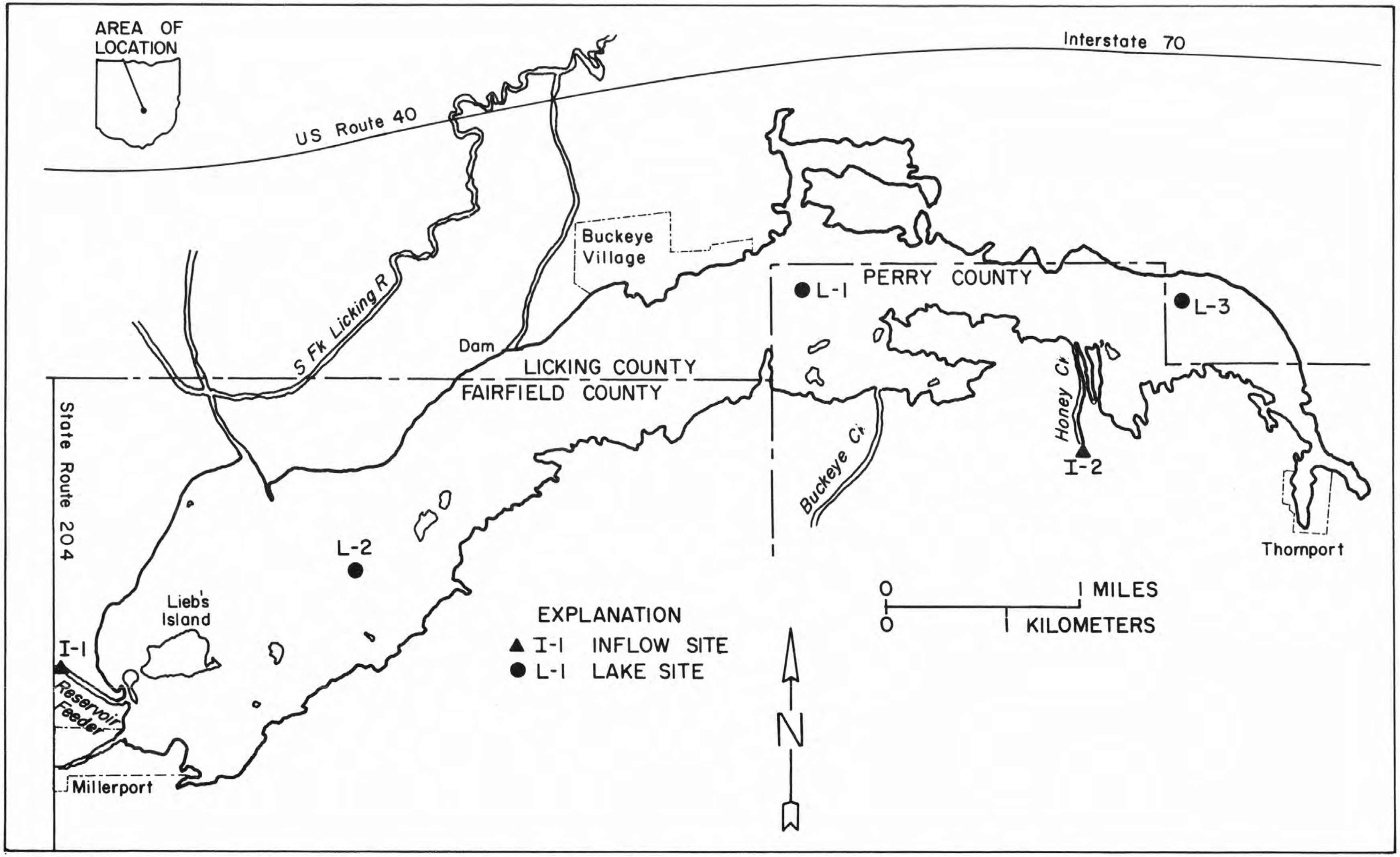


Figure 19.--Buckeye Lake and inflow sampling sites.

Table 16.--Physical and chemical data for selected inflows, Buckeye Lake, Ohio

395426082320300 - Reservoir feeder above Buckeye Lake at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN-TANEOUS DIS-CHARGE (CFS)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)
MAY												
02...	0950	E10	12.5	8.6	7.2	422	25	50	--	2.5	.71	.10
AUG												
16...	1235	E15	22.0	3.4	7.1	305	120	150	11	.90	1.3	.13

395501082260200 - Honey Creek above Buckeye Lake at site (I-2)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN-TANEOUS DIS-CHARGE (CFS)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)
MAY												
02...	1040	E6.0	12.0	13.0	8.9	490	3	10	--	.97	.24	.08
AUG												
16...	1055	E15	21.0	6.8	7.5	390	180	200	16	.96	1.7	.32

E Estimated.

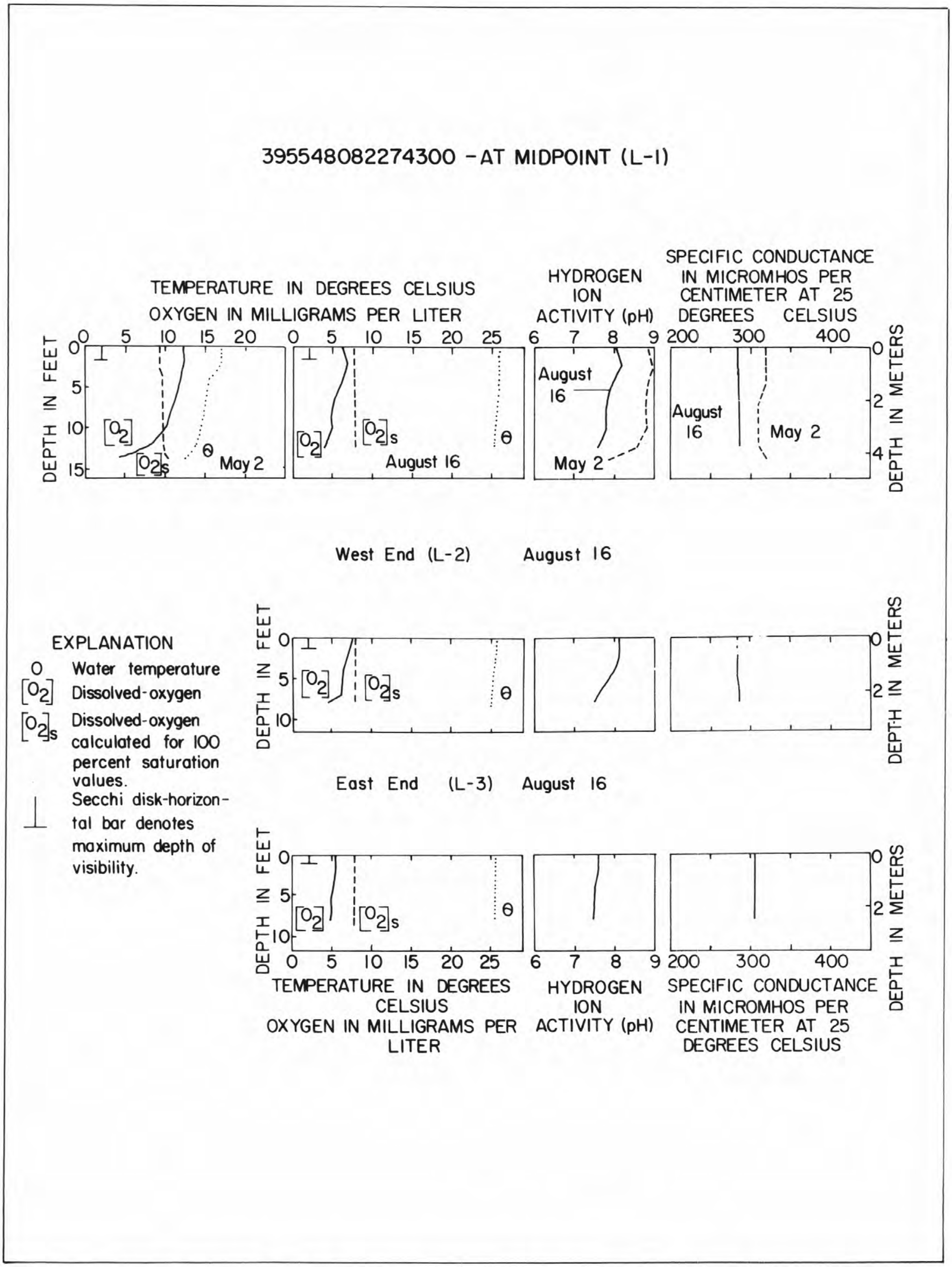


Figure 20.--Data profiles for Buckeye Lake on selected days in 1975.

Table 17.--Profile data for the primary lake site, Buckeye Lake, Ohio

395548082274300 - Buckeye Lake at midpoint at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
02...	1310	.0	17.0	12.3	131	320	8.9	--	--	--	--	--
02...	1320	2.0	17.0	12.3	131	320	9.0	16	85	.2	.0	19
02...	1330	4.0	15.5	11.9	123	320	8.9	--	--	--	--	--
02...	1340	7.0	15.0	11.0	112	310	8.8	--	--	--	--	--
02...	1350	10	14.5	10.2	103	310	8.8	--	--	--	--	--
02...	1400	12	14.0	8.2	82	310	8.6	6	106	.4	.0	--
02...	1410	13	12.7	4.5	44	320	7.9	--	--	--	--	--
AUG												
16...	1405	.0	26.0	6.4	81	285	8.1	--	--	--	--	--
16...	1410	2.0	26.0	7.0	87	285	8.2	0	99	1.0	.0	17
16...	1415	4.0	25.9	6.3	80	287	8.1	--	--	--	--	--
16...	1420	7.0	25.7	5.2	65	287	7.8	--	--	--	--	--
16...	1425	10	25.5	5.0	62	287	7.8	--	--	--	--	--
16...	1430	12	25.5	4.2	52	287	7.6	0	100	4.0	.0	--

Water column composite data (table 18) and bicarbonate values (table 17) show that the lake water was a hard, calcium bicarbonate sulfate type. The trace and toxic constituents were within State standards. (See page 23 .) The copper concentration (10 ug/L) was at the State accepted limit for a water having a hardness of 80 to 160 mg/L, and pesticides (listed on page 33) in May and August were below detection limits. A review of the major nutrients (table 19) shows that most of the nitrogen was organic. Silica concentrations were low in May compared with other lakes.

Fecal coliform colony counts from selected depths at site L-1 (table 19) were within State limits. (See page 31 .) Algae counts and identification from the euphotic zone (table 20) were dominated by blue-green genera. High photosynthetic activity during May is indicated by the dissolved oxygen supersaturation in the top 10 ft (3 m). Emergent aquatic macrophytes, Nelumbo lutea, Nuphar, and Typha were noted in the shallower areas of Buckeye Lake.

The August profiles were measured during a rainy period. The secchi disk transparency and turbidity were approximately the same as those observed in May. The lake was apparently mixed, but some variation in dissolved oxygen and pH occurred with depth at sites L-1 and L-2, and a slightly higher overall conductance existed at the east end at site L-3 (figs. 19 and 20). Dissolved oxygen was below saturation throughout the lake and may reflect the cumulative effects of planktonic metabolism during cloudy weather.

The nutrient data from selected depths in August show the almost complete uptake of inorganic nitrogen forms except ammonia. Organic nitrogen had almost doubled since May and orthophosphorus was reduced to detection limits. The increase of dissolved silica from that in May could represent siliceous recycling from diatoms and other plants, or could result from streamflow inputs.

Fecal coliform colony counts at site L-1 were higher in August than in May. This difference could be attributed to the higher runoffs in August and corresponds well with bacteria increases seen in other Ohio lakes sampled during similar flow conditions. (See Acton, Cowan, Harrison, Paint Creek, and Rocky Fork Lakes.) All counts were within Ohio water-quality standards. Phytoplankton counts and identification from the 2-ft depth were dominated by the blue-green genus, Anacystis.

Table 18.--Chemical analyses of water column composite samples, Buckeye Lake, Ohio

395548082274300 - Buckeye Lake at midpoint at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY												
02...	1340	37	12	2.2	9.2	46	18	.3	140	203	24	227

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY											
02...	1340	200	0	<10	3	<.5	0	0	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY								
02...	1340	40	1	10	410	150	4	10

Table 19.--Chemical, physical, and biological analyses of water samples from selected depths, Buckeye Lake, Ohio

395548082274300 - Buckeye Lake at midpoint near Buckeye Lake, Ohio

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
02...	1320	2.0	.03	.18	.21	.17	1.3	1.5	.03	.10	.1
02...	1400	12	.05	.33	.38	.27	1.2	1.5	.03	.10	.1
AUG											
16...	1410	2.0	.01	.00	.01	.16	2.3	2.5	.01	.10	1.2
16...	1430	12	.01	.00	.01	.24	2.4	2.6	.01	.14	1.5

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
02...	1320	2.0	15	60	7.5	5.0	34	4	2
02...	1400	12	15	70	9.8	6.1	36	6	<3
AUG									
16...	1410	2.0	15	80	11	7.4	51	29	3
16...	1430	12	15	80	9.2	6.7	47	48	6

Table 20.--Phytoplankton in Buckeye Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Location	Date	Location water column					
Site L-1 at midpoint ----	5-2-75	Euphotic zone composite	190,000	-	Cyanophyta	79	Aphanizomenon (49); Lyngbya (21); Agmenellum (4); Gomphosphaeria (4); Anabaena (1); Anacystis
					Chlorophyta	13	Scenedesmus (5); Actinastrum (2); Tetrastrum (2); Dictyosphaerium (1); Crucigenia (1); Ankistrodesmus (1); Coelastrum (1); Golenkinia
					Chrysophyta	8	Cyclotella (6); Melosira (1); Nitzschia (1); Synedra
Site L-1 at midpoint ----	8-16-75	2-ft depth	1,200,000	2.306	Cyanophyta	94	Anacystis (48); Oscillatoria (21); Lyngbya (10); Agmenellum (9); Aphanizomenon (3); Spirulina (2); Anabaena (1)
					Chlorophyta	3	Scenedesmus (2); Dictyosphaerium (1); Kirchneriella
					Chrysophyta	2	Nitzschia (2); Melosira

* Less than 1 percent not given.

Clear Fork Reservoir

Location and inflow data

Clear Fork Reservoir is in Richland and Morrow Counties 8 mi (12.9 km) southwest of Mansfield (figs 1 and 21). The reservoir was formed in 1949 following the construction of a multilevel release structure across the Clear Fork Branch of the Mohican River. The lake serves as a water supply for Mansfield, although restricted recreational activities are permitted.

Clear Fork Creek and an unnamed tributary were sampled at sites I-1 and I-2 (fig. 21). Clear Fork Creek drains mostly rural lands and the unnamed tributary represents flow from an agricultural and rural basin. Both basins lie within an area of moderately low sediment yield (fig. 5). Sampling in May and August was of low flows. The data (table 21) show varying degrees of macronutrient enrichment (nitrogen and phosphorus) to the reservoir. Both inflows contained a variety of benthic organisms including mayflies (Ephemeroptera), caddisflies (Trichoptera), Bryozoans, and leeches (Hirudinea). Small fish, including darters, also were observed.

Lake data

Clear Fork Reservoir was sampled above the dam at site L-1 (fig. 21) in May during cloudy weather. The secchi disk transparency was less than 4 ft (1.3 m). Chemical and thermal stratification (fig. 22 and table 22) are shown with a thermocline existing between 10 and 13 ft (3 and 4 m). High photosynthetic rates in the epilimnion are suggested by high dissolved oxygen and pH. Cummulative effects of respiration and (or) decomposition are indicated in the hypolimnion, characterized by low dissolved oxygen and pH. The higher values of TOC, BOD, and COD (table 24) in the epilimnion than in the hypolimnion likely were related to uneven plankton distribution.

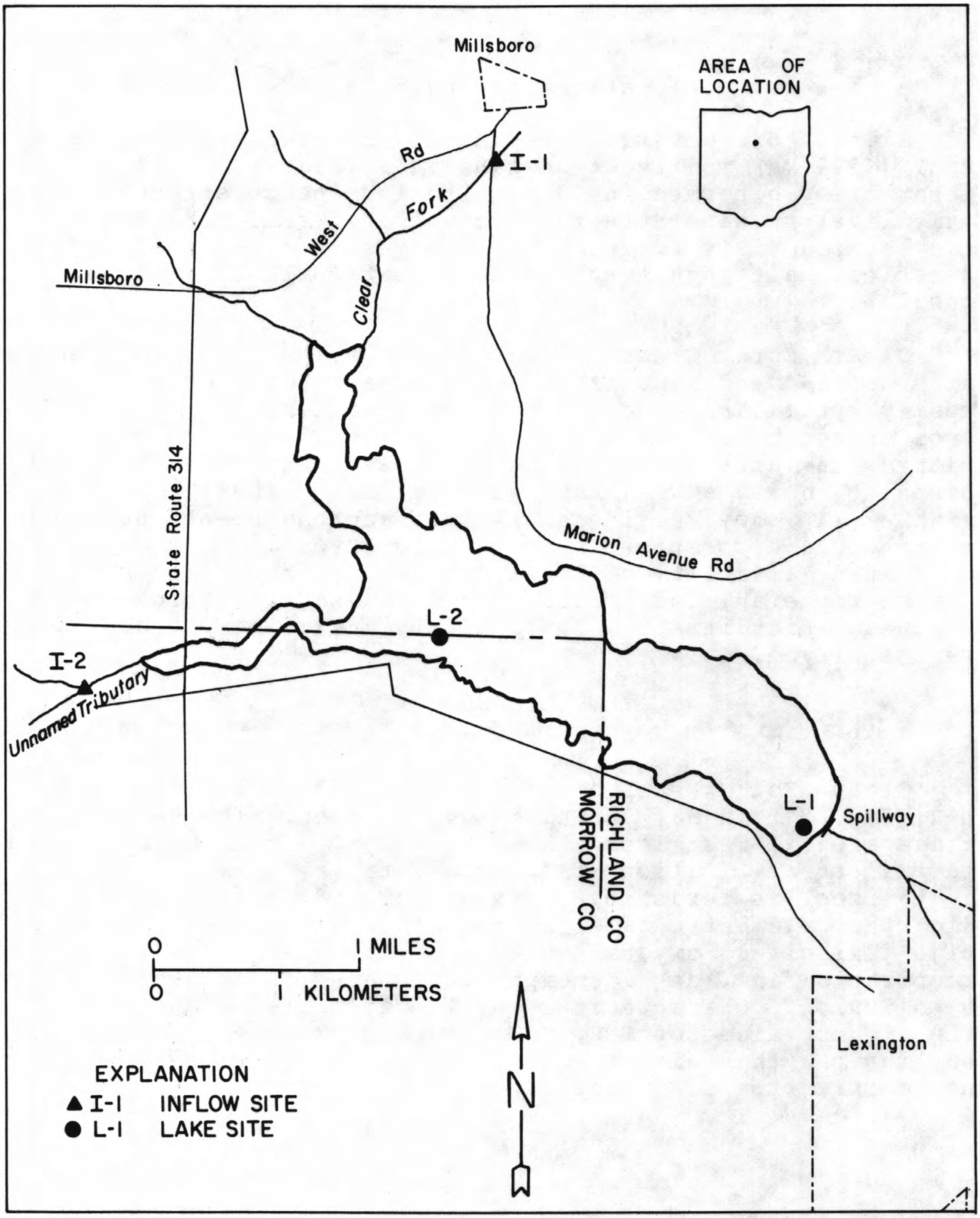


Figure 21.--Clear Fork Reservoir and inflow sampling sites.

Table 21.--Physical and chemical data of selected inflows, Clear Fork Reservoir, Ohio

404436082382100 - Clear Fork above Clear Fork Reservoir at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN-TANEOUS DIS-CHARGE (CFS)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)
MAY 23...	1200	E2.0	17.5	8.2	7.6	632	2	20	3.9	.71	.47	.14
AUG 20...	1200	E1.5	18.0	10.1	7.7	652	2	5	4.6	.08	.21	.03

404223082403200 - Unmamed tributary to Clear Fork Reservoir at site (I-2)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN-TANEOUS DIS-CHARGE (CFS)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)
MAY 23...	1110	E2.0	18.0	6.2	7.4	487	6	40	4.0	.28	.63	.05
AUG 20...	1140	<1.0	19.0	7.0	7.6	502	4	20	6.0	.23	.38	.05

E Estimated.

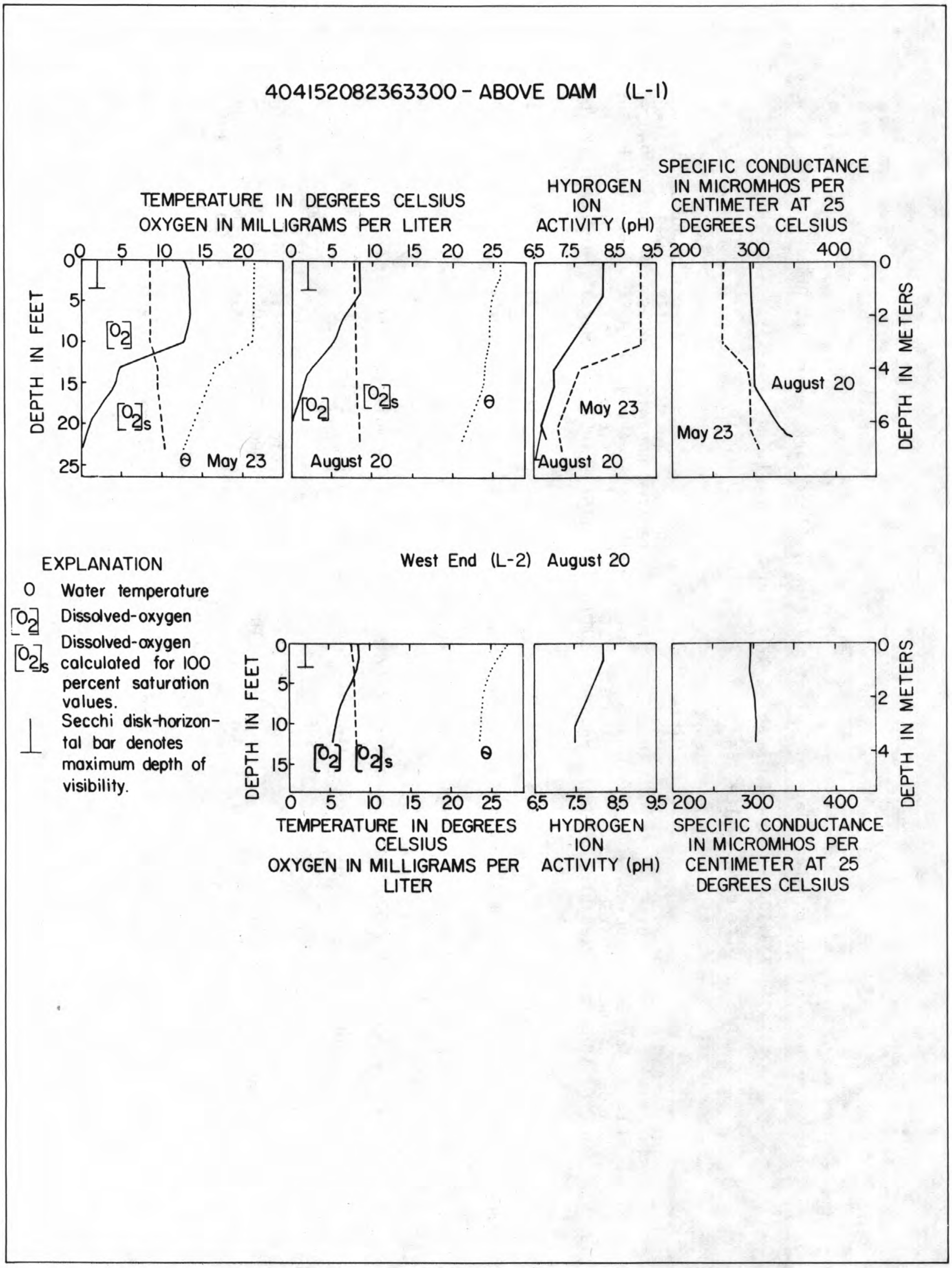


Figure 22.--Data profiles for Clear Fork Reservoir on selected days in 1975.

Table 22.--Profile data for the primary lake site, Clear Fork Reservoir, Ohio

404152082363300 - Clear Fork Reservoir above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER- ATURE (DEG C)	DIS- SOLVED OXYGEN (MG/L)	PER- CENT SATUR- ATION	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH (UNITS)	CAR- BONATE (CO3) (MG/L)	BICAR- BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO- GEN SULFIDE (MG/L)	TRANS- PAR- ENCY (SECCHI DISK) (IN)
MAY												
23...	1420	.0	21.3	12.8	149	262	9.1	--	--	--	--	--
23...	1425	2.0	21.3	13.2	153	262	9.1	13	58	.1	.0	41
23...	1430	4.0	21.3	13.2	153	262	9.1	--	--	--	--	--
23...	1435	7.0	21.3	13.2	153	262	9.1	--	--	--	--	--
23...	1440	10	21.1	12.7	148	262	9.1	--	--	--	--	--
23...	1443	13	16.7	4.8	51	292	7.6	--	--	--	--	--
23...	1446	15	15.8	4.1	43	297	7.5	--	--	--	--	--
23...	1450	20	13.7	1.0	10	297	7.1	--	--	--	--	--
23...	1455	23	12.8	.0	0	310	7.2	0	120	12	.0	--
AUG												
20...	1335	.0	25.9	8.5	109	297	8.2	--	--	--	--	--
20...	1340	2.0	25.8	8.5	108	297	8.2	0	111	1.1	.0	41
20...	1345	4.0	25.0	8.5	106	297	8.2	--	--	--	--	--
20...	1350	7.0	24.6	6.4	80	299	7.8	--	--	--	--	--
20...	1355	10	24.5	5.2	64	299	7.4	--	--	--	--	--
20...	1357	13	24.0	2.5	38	299	7.0	--	--	--	--	--
20...	1400	15	23.8	1.6	20	299	7.0	--	--	--	--	--
20...	1405	20	22.0	.0	0	332	6.7	0	152	48	<.1	--
20...	1410	21	21.3	.0	0	347	6.8	--	--	--	--	--

The analytical results of the water column composites (table 23) and bicarbonate values (table 22) indicate the water was a moderately hard, calcium bicarbonate sulfate type. Except for copper, the trace and toxic constituents were within Ohio water-quality standards. (See page 23 .) Pesticides (listed on page 33) in May and August were below analytical detections limits. The concentration of copper (20 ug/L) was 10 ug/L above State standards. Near-surface nutrient concentrations in May were low, except for ammonia, and may reflect the the effects of an earlier, nutrient depleting, biomass.

The fecal coliform colony counts (table 24) were within State standards. (See page 31 .) The phytoplankton community in May (table 25) was predominately blue-green algae (64 percent) with *Anacystis* as the dominant genus (45 percent).

The thermal stratification observed in May was absent on August 20. Its disappearance likely was due to solar heating, wind action, and dam release patterns . The August profiles at site L-1 were made during clear weather and show slowly decreasing temperatures and increases in specific conductance with depth. The dissolved oxygen profile displays a slight supersaturation in the top 4 ft (1.2 m), then gradually decreases to a biologically significant low limit (<4.0 mg/L) at 12 ft (3.7 m) and drops to zero near the lake bottom. The pH shows a similar profile configuration. A comparison of data profiles at the west end of the reservoir at site L-2 (figs. 21 and 22) with those at site L-1 suggests a laterally homogeneous water body.

The August concentrations of inorganic nitrogen and phosphorus were low at the 2-ft (0.6-m) depth, although silica was higher than in May. The decompositional byproducts, ammonia and carbon dioxide, were high in the bottom samples. Fecal coliform colony counts were within Ohio water-quality standards. The phytoplankton cell count at 4 ft (1.3 m) was greater than 100,000 cells per milliliter, 96 percent of which were blue-green algae.

Table 23.--Chemical analyses of water column composite samples, Clear Fork Reservoir, Ohio

404152082363300 - Clear Fork Reservoir above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY 23...	1440	27	8.2	1.9	12	37	20	.1	100	193	17	210

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY 23...	1440	200	0	<10	1	<.5	5	1	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY 23...	1440	30	1	20	290	490	1	10

Table 24.--Chemical, physical, and biological analyses of water samples from selected depths, Clear Fork Reservoir, Ohio

404152082363300 - Clear Fork Reservoir above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
23...	1425	2.0	.00	.00	.00	.16	.70	.86	.01	.04	.1
23...	1455	23	.05	.04	.09	.35	.44	.79	.01	.04	2.5
AUG											
20...	1340	2.0	.01	.01	.02	.03	.57	.60	.01	.03	2.3
20...	1405	20	.01	.01	.02	1.2	.40	1.6	.03	.21	6.6

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
23...	1425	2.0	4	30	11	5.7	23	<3	3
23...	1455	23	15	50	4.0	1.1	12	<3	<3
AUG									
20...	1340	2.0	4	20	2.6	2.3	15	<2	<2
20...	1405	20	50	100	9.2	2.5	27	3	<2

Table 25.--Phytoplankton in Clear Fork Reservoir, Ohio

Sample description: Location	Sample description: Date	Sample description: Location water column	Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Site L-1 above dam ---------	5-23-75	Euphotic zone composite	12,000	-	Cyanophyta	64	Anacystis (45); Lyngbya (19)
					Chlorophyta	18	Scenedesmus (10); Ankistrodesmus (3); Tetrastrum (3); Chodatella (1); Tetraedron (1)
					Chrysophyta	16	Synedra (10); Nitzschia (5); Cyclotella (1)
					Euglenophyta	2	Euglena (1); Trachelomonas (1)
					Pyrrhophyta	1	Glenodinium
Site L-1 above dam ---------	8-20-75	4-ft depth	140,000	1.895	Cyanophyta	96	Agmenellum (57); Cylindrospermum (19); Lyngbya (14); Anabaena (6)
					Chrysophyta	3	Melosira (1); Achnanthes (1); Nitzschia (1)
					Chlorophyta	<1	Dictyosphaerium; Chlamydomonas
					Euglenophyta	<1	Trachelomonas
					Pyrrhophyta	<1	Peridinium

* Less than 1 percent not given.

Cowan Lake

Location and inflow data

Cowan Lake is in Clinton County 6 mi (9.7 km) southwest of Wilmington (figs. 1 and 23). The lake was formed in 1948 by damming Cowan Creek and is owned and operated by the State for recreational purposes.

Cowan Creek was sampled at site I-1 (fig. 23) above the lake. The drainage area at site I-1 is 40 mi^2 (104 km^2), representing 80 percent of the total drainage to Cowan Lake. The drainage basin lies within a high sediment yield area (fig. 5) of mostly agricultural and rural lands.

Water samples were taken in April at site I-1 from runoff of a storm a day earlier. A comparison of nitrogen values (table 26) with those in Cowan Lake (table 29) indicates nutrient enrichment from Cowan Creek. The analyses of low flow samples taken on September 10 indicate similar nitrogen and phosphorus concentrations with those observed in the epilimnion of Cowan Lake. Mayflies (Ephemeroptera) and caddisflies (Trichoptera) were observed in Cowan Creek.

Lake data

The visibility of the secchi disk in April, observed under clear skies, was less than 1 ft (0.3 m) at site L-1 (fig. 23). The profile data (fig. 24 and table 27) vary little with depth and show a well mixed water column with dissolved oxygen near 100 percent saturation.

The analyses of the major constituents (tables 27 and 28) indicate that the water was a hard, calcium bicarbonate type. Except for iron and manganese, trace elements were low. Analyses for pesticides (listed on page 33) show that residues were either absent or below analytical detection limits. Nitrogen and phosphorus (table 29) exceeded minimum levels reported as producing nuisance algal conditions and display little variation between samples.

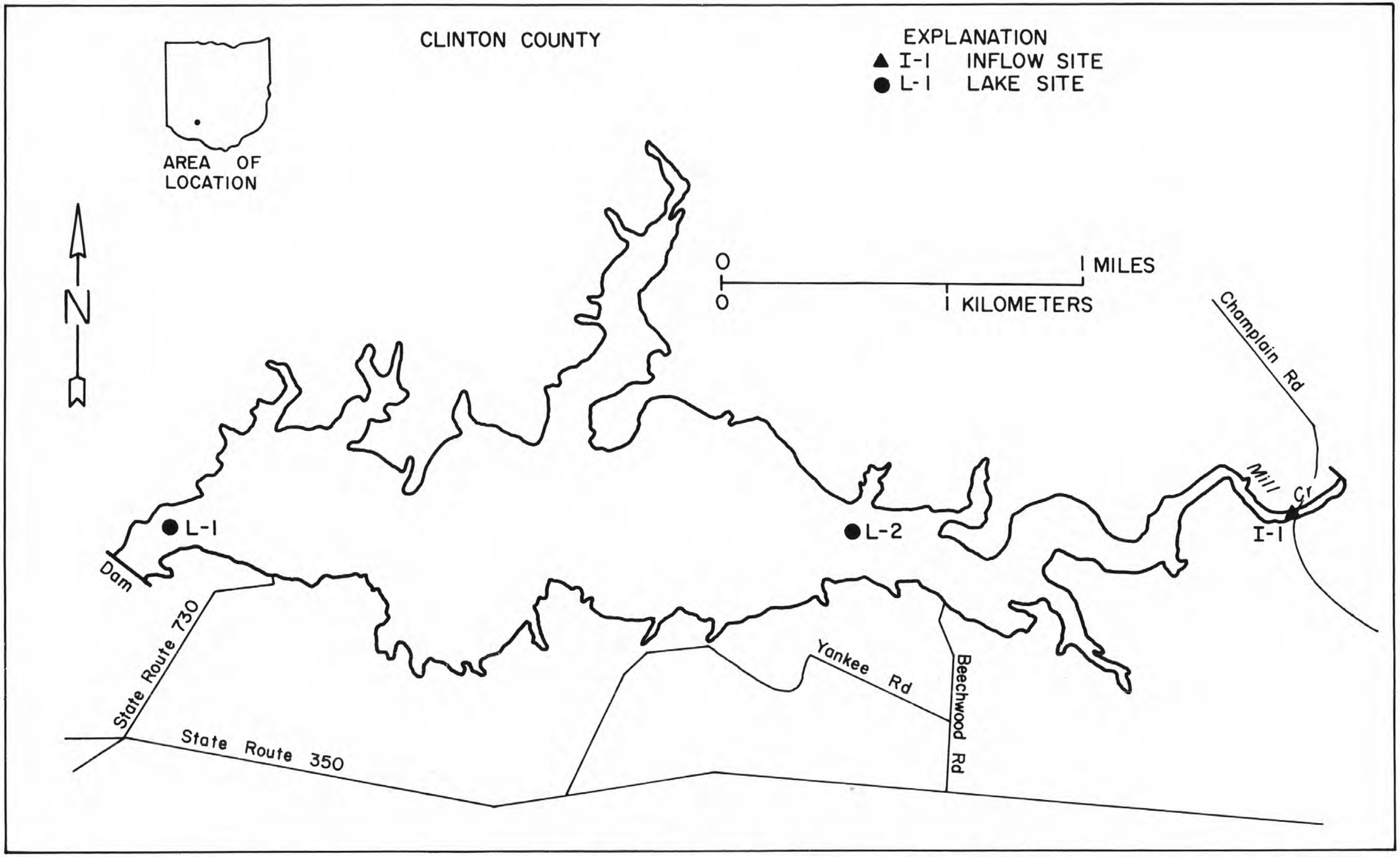


Figure 23.--Cowan Lake and inflow sampling sites.

Table 26.--Physical and chemical data for selected inflows, Cowan Lake, Ohio

392252083515800 - Cowan Creek above Cowan Lake at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
APR												
29...	1145	73	12.0	10.2	7.8	513	25	50	--	3.8	.70	.11
SEP												
10...	1210	<.50	19.5	7.0	7.8	533	15	30	10	.01	.59	.05

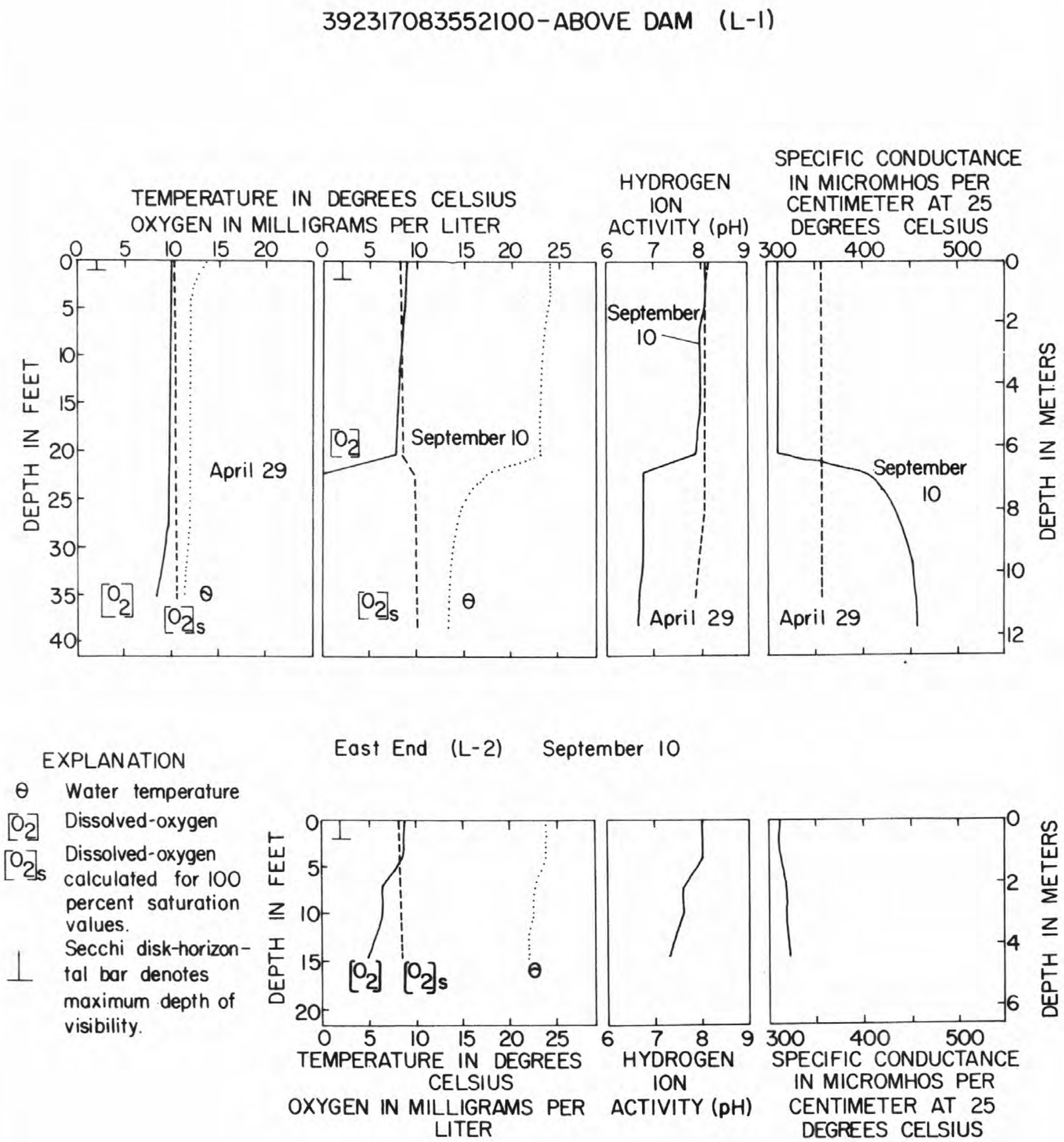


Figure 24.--Data profiles for Cowan Lake on selected days in 1975.

Table 27.--Profile data for the primary lake site, Cowan Lake, Ohio

392317083552100 - Cowan Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
APR												
29...	1515	.0	13.5	9.9	98	358	8.2	--	--	--	--	--
29...	1520	2.0	12.5	9.9	96	358	8.1	0	161	2.1	.0	11
29...	1525	4.0	12.0	9.9	95	358	8.1	--	--	--	--	--
29...	1530	7.0	12.0	9.9	95	358	8.1	--	--	--	--	--
29...	1535	10	12.0	9.9	95	358	8.1	--	--	--	--	--
29...	1545	15	12.0	9.8	94	358	8.1	--	--	--	--	--
29...	1550	20	12.0	9.8	94	358	8.1	--	--	--	--	--
29...	1555	25	12.0	9.8	94	358	8.1	--	--	--	--	--
29...	1600	30	11.8	9.4	90	358	8.0	--	--	--	--	--
29...	1605	35	11.5	8.7	82	358	7.9	0	161	3.2	.0	--
SEP												
10...	1415	.0	24.0	8.8	107	311	8.1	--	--	--	--	--
10...	1420	2.0	24.0	8.8	107	311	8.1	0	140	1.8	.0	23
10...	1425	4.0	23.9	8.7	106	311	8.1	--	--	--	--	--
10...	1430	7.0	23.4	8.3	100	311	8.0	--	--	--	--	--
10...	1435	10	23.2	8.3	100	311	8.0	--	--	--	--	--
10...	1440	15	23.0	8.0	95	311	8.0	--	--	--	--	--
10...	1445	20	23.0	7.8	93	311	7.9	--	--	--	--	--
10...	1447	22	17.3	.0	0	405	6.8	--	--	--	--	--
10...	1450	25	15.0	.0	0	430	6.8	--	--	--	--	--
10...	1455	30	13.9	.0	0	448	6.8	--	--	--	--	--
10...	1500	38	13.4	.0	0	458	6.7	0	287	91	1.0	--

Table 28.--Chemical analyses of the water column composite samples, Cowan Lake, Ohio

392317083552100 - Cowan Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
APR 29...	1545	42	15	2.2	4.8	29	12	.1	170	206	69	275

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
APR 29...	1545	100	0	0	1	<.5	0	1	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
APR 29...	1545	60	1	10	1900	90	4	20
*SEP 10...	1500	--	--	--	1100	2600	--	--

* Taken from a water sample 1 to 3 ft from the lake bottom.

Table 29.--Chemical, physical, and biological analyses of water samples from selected depths, Cowan Lake, Ohio

392317083552100 - Cowan Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
APR											
29...	1520	2.0	.04	1.6	1.6	.23	.38	.61	.06	.12	4.4
29...	1605	35	.06	1.5	1.6	.31	.42	.73	.05	.14	4.6
SEP											
10...	1420	2.0	.00	.00	.00	.06	1.0	1.1	.01	.06	1.8
10...	1500	38	.01	.00	.01	3.7	3.3	7.0	.06	.24	7.5

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
APR									
29...	1520	2.0	35	80	6.6	1.6	12	500	170
29...	1605	35	60	140	11	1.4	12	600	300
SEP									
10...	1420	2.0	6	30	5.7	4.4	18	2	<2
10...	1500	38	40	60	9.1	4.4	20	8	<2

The bacteria counts in April (table 29) were higher than in most lakes sampled and probably were related to the storm runoff. The phytoplankton community (table 30) at site L-1 was composed entirely of members from the phylum, Chrysophyta, and was dominated by the genera, _Cyclotella_ and _Melosira_.

The September data were gathered in clear warm weather. Light penetration at site L-1 and site L-2 (figs. 23 and 24) had increased slightly from that in April. The profiles at site L-1 show a sharp thermocline between 20 and 23 ft (6.1 and 7.0 m), with rapid changes in dissolved oxygen, pH, and conductance. Thermal stratification was not detected at site L-2 , but specific conductance data suggest similar chemical concentrations within the epilimnion at both ends of the lake. The anaerobic conditions and high concentrations of hydrogen sulfide, carbon dioxide, and ammonia in the hypolimnion at L-1 suggest a biologically hazardous condition for oxygen-dependent or chemically sensitive organisms below 22 ft (6.7 m).

The ratios of the nitrogen species in September suggest an almost complete uptake and conversion of inorganic nitrogen to organic nitrogen within the epilimnion and an anaerobic recycling of organic nitrogen to ammonia in the hypolimnion. A similar recycling pattern is suggested for silica and phosphorus.

The bacteria counts were several magnitudes lower than in April and approximate the background levels of other lakes. The phytoplankton community apparently changed from diatoms in April to blue-green algae in fall. _Raphidiopsis_ was the dominant genus in the September sample (counts >300,000 cells/ml) from the 2 ft (0.6 m) depth.

Table 30.--Phytoplankton in Cowan Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Location	Date	Location water column					
Site L-1 above dam ----------	4-29-75	Euphotic zone composite	2700	-	Chrysophyta	100	Cyclotella (47); Melosira (45); Nitzschia (5); Navicula (3)
Site L-1 above dam ----------	9-10-75	2-ft depth	360,000	1.304	Cyanophyta	97	Raphidiopsis (75); Phormidium (9); Agmenellum (9); Oscillatoria (4)
					Chlorophyta	2	Crucigenia (2); Chlamydomonas
					Chrysophyta	<1	Nitzschia; Navicula
					Pyrrhophyta	<1	Glenodinium

* Less than 1 percent not given.

Deer Creek Lake

Location and inflow data

Deer Creek Lake is in Fayette and Pickaway Counties 28 mi (45 km) south-southwest of Columbus and 7 mi (11.3 km) south of Mount Sterling (figs. 1 and 25). The lake was formed in 1968 after construction of a multilevel release dam built and operated by the U.S. Army Corps of Engineers. The lake is used for flood control, recreation, and water supply.

Deer Creek, which provides most of the inflow, was sampled at site I-1 (fig. 25). A minor inflow, Clark Run, was sampled at site I-2 (fig. 25). Deer Creek represents drainage from approximately 250 mi^2 (648 km^2) of agricultural and mixed urban and rural lands. Clark Run represents agricultural runoff from 8.5 mi^2 (22 km^2). Both basins lie within an area of moderate sediment yield for Ohio (fig. 5).

Samples were taken April 25 during storm runoff. Total phosphorus was similar in both creeks (table 31), but nitrogen was higher in Deer Creek than in Clark Run. Data from both samples show nutrient enrichment to the lake. The September samples, taken from low-flows show Clark Run with significantly higher macronutrient concentrations than Deer Creek. Crayfish (Decapoda) and mayflies (Ephemeroptera) were the only benthic invertebrates observed in Deer Creek.

Lake data

Deer Creek Lake was sampled in April between thundershowers. Secchi disk transparency was less than 2 ft (0.6 m), and data profiles (fig. 26 and table 32) show an oxygen saturated, well mixed, and thermally unstable water column at site L-1 (fig. 25). The specific conductance profile has the highest overall values of the 17 lakes sampled.

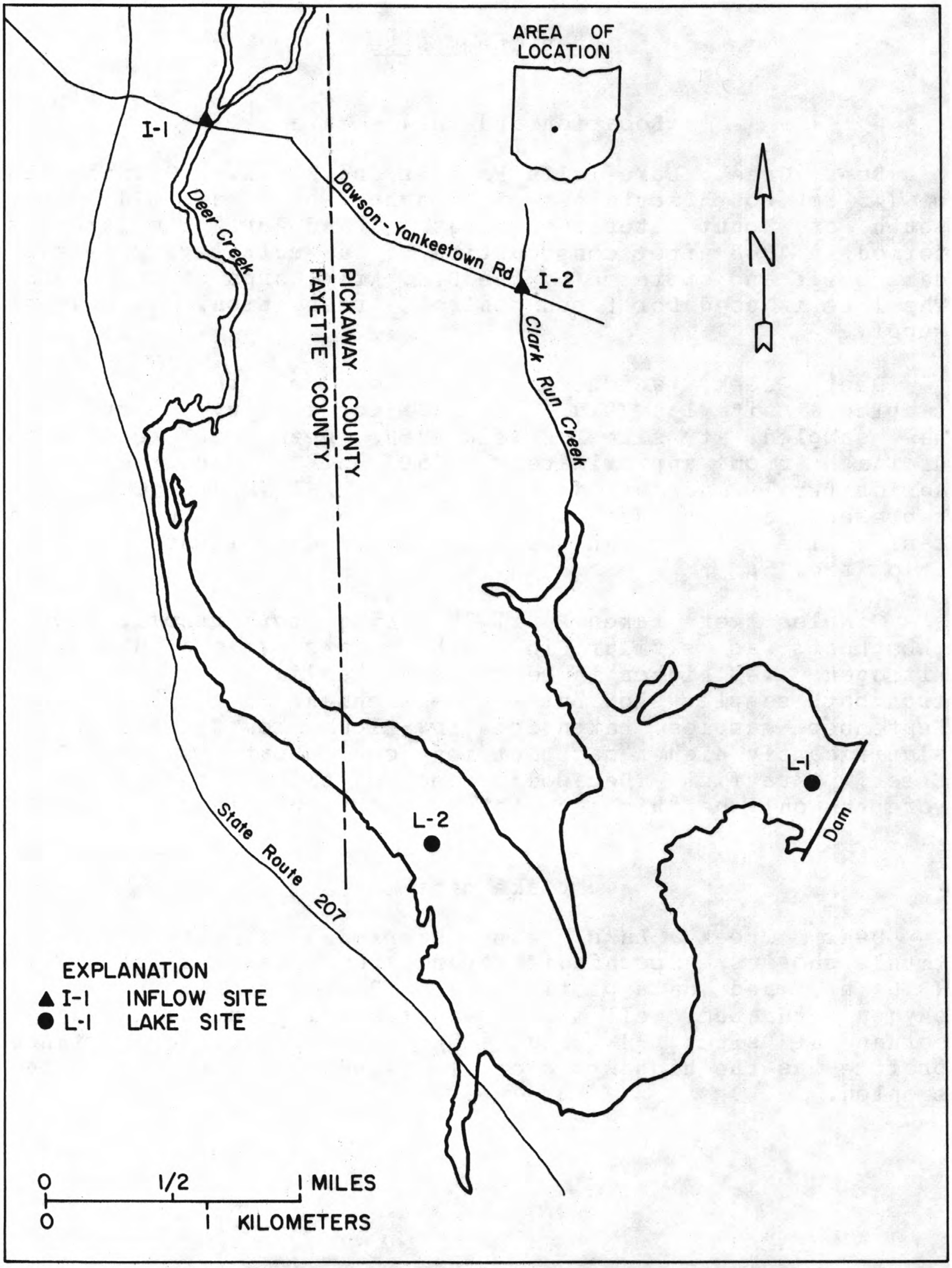


Figure 25.--Deer Creek Lake and inflow sampling sites.

Table 31.--Physical and chemical data of selected inflows, Deer Creek Lake, Ohio

393935083154700 - Deer Creek at Dawson Yankeetown Road at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
APR 25...	1115	E950	12.0	9.0	7.3	495	75	140	13	5.3	1.5	.22
SEP 12...	1050	E50	19.0	6.6	7.7	585	30	40	6.5	.47	.66	.12

393900083141900 - Clark Run Creek at Dawson Yankeetown Road at site (I-2)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
APR 25...	1145	E25	10.0	9.3	7.2	480	45	120	--	3.9	1.3	.22
SEP 12...	1120	<1.0	17.5	6.0	7.5	620	25	50	15	1.2	1.6	.63

E Estimated.

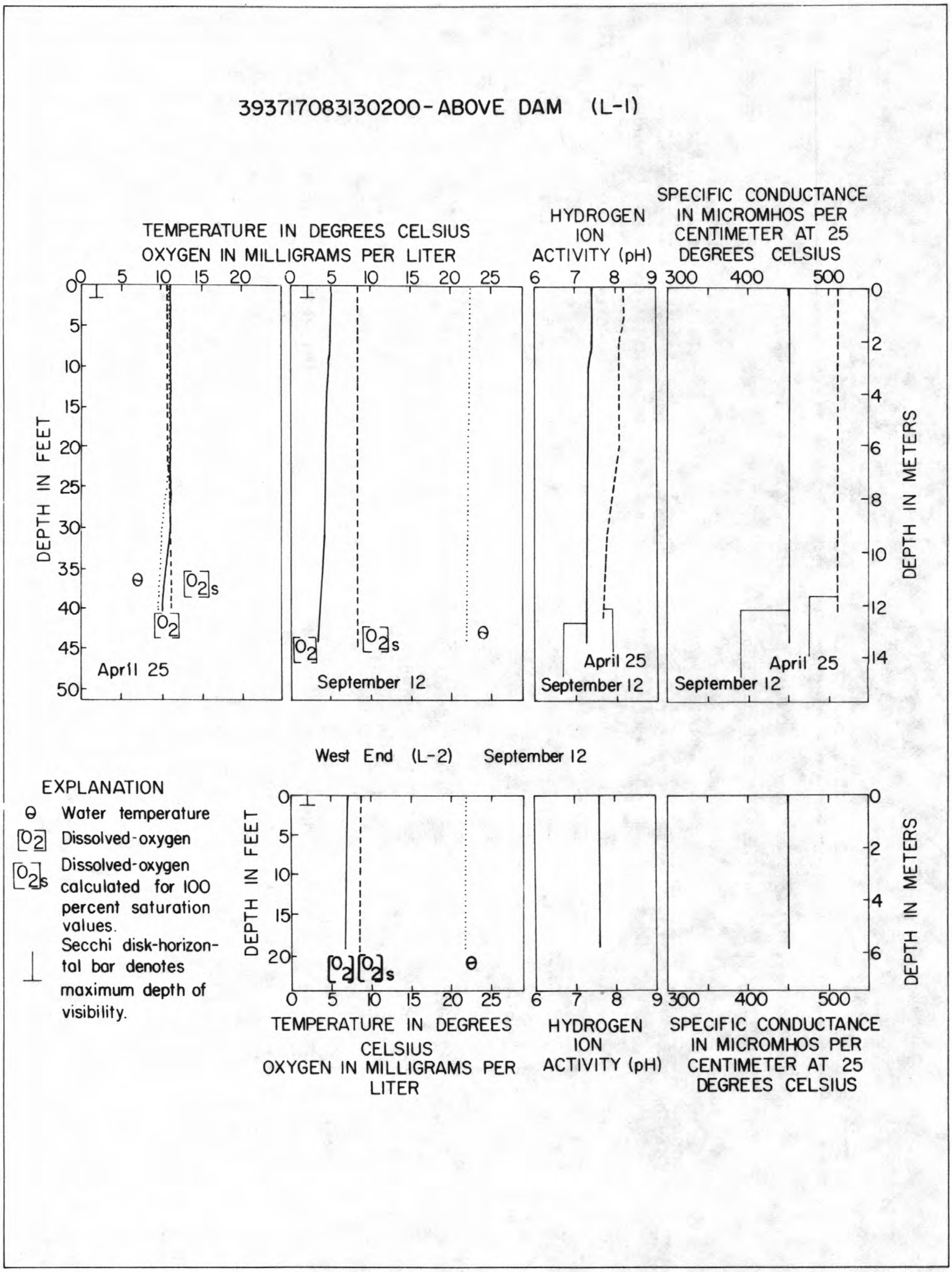


Figure 26.--Data profiles for Deer Creek Lake on selected days in 1975

Table 32.--Profile data for the primary lake site, Deer Creek Lake, Ohio

393717083130200 - Deer Creek Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
APR												
25...	1535	.0	11.0	10.9	102	510	8.2	--	--	--	--	--
25...	1540	2.0	11.0	10.9	102	510	8.2	0	165	1.6	.0	19
25...	1545	4.0	11.0	11.0	103	510	8.2	--	--	--	--	--
25...	1550	7.0	11.0	11.0	103	510	8.1	--	--	--	--	--
25...	1600	10	11.0	11.0	103	510	8.1	--	--	--	--	--
25...	1610	15	11.0	11.0	103	510	8.1	--	--	--	--	--
25...	1615	20	11.0	11.0	103	510	8.1	--	--	--	--	--
25...	1625	30	10.0	10.9	100	510	7.8	--	--	--	--	--
25...	1635	40	9.5	9.7	87	510	7.7	0	165	5.3	.0	--
SEP												
12...	1430	.0	22.5	5.0	59	450	7.4	--	--	--	--	--
12...	1435	2.0	22.5	5.0	59	450	7.4	0	218	14	.0	18
12...	1440	4.0	22.5	5.0	59	452	7.4	--	--	--	--	--
12...	1445	7.0	22.5	4.9	58	452	7.4	--	--	--	--	--
12...	1450	10	22.5	4.8	56	452	7.3	--	--	--	--	--
12...	1455	15	22.3	4.5	53	452	7.3	--	--	--	--	--
12...	1500	20	22.2	4.4	52	452	7.3	--	--	--	--	--
12...	1505	25	22.2	4.4	52	452	7.3	--	--	--	--	--
12...	1510	30	22.2	4.4	52	452	7.3	--	--	--	--	--
12...	1515	40	22.1	4.0	47	452	7.3	0	220	18	.0	--
12...	1520	44	22.1	3.7	44	452	7.3	--	--	--	--	--

Data from the water column composites (table 33) and bicarbonate values (table 32) classified the water as a very hard, calcium bicarbonate type. The samples contained low or undetectable concentrations of trace and toxic constituents. Pesticides (listed on page 33) were not found in April or September. Nitrate (table 34) was higher than the other major nitrogen forms available but lower than the input concentrations.

The fecal coliform counts in April (table 34) were within Ohio water-quality standards (see page 31) and were slightly lower than the streptococci counts. The diatom genera, Nitzschia, Melosira, and Cyclotella dominated the phytoplankton from the euphotic zone (table 35).

The September sampling was done under clearing afternoon skies. Profile configurations and secchi disk measurements were similar to those observed in April, although temperatures were higher and dissolved oxygen and specific conductance were lower throughout the water column. A comparison of the profile data from site L-1 with that from site L-2 (figs. 25 and 26) indicate a well mixed lake, both vertically and laterally. The water releases from the bottom of the dam, the lake's high flushing rate (C/I = 0.11, table 5), and wind produced mixing, apparently controlled the lakes thermal structure and related chemical characteristics. Despite high nutrient input, the potential organic accumulation and recycling seen in other Ohio lakes (see Cowan Lake) were absent.

Selective nutrient uptake or recycling is not apparent, although organic nitrogen and phytoplankton concentrations were somewhat higher in September than in April. Bacteria counts and ratios are of the same magnitudes as those in April, and the near surface phytoplankton community apparently had changed from diatoms to the blue-green genus, Agmenellum.

Table 33.--Chemical analyses of water column composite samples, Deer Creek Lake, Ohio

393717083130200 - Deer Creek Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
APR 25...	1600	63	27	1.5	6.7	44	13	.6	270	319	45	364

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
APR 25...	1600	100	0	0	0	<.5	0	1	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
APR 25...	1600	60	0	20	800	40	5	20
* SEP 12...	1515	--	--	10	--	--	--	30

* Taken from a water sample 1 to 3 ft from the lake bottom.

Table 34.--Chemical, physical, and biological analyses of water samples from selected depths, Deer Creek Lake, Ohio

393717083130200 - Deer Creek Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
APR											
25...	1540	2.0	.04	2.2	2.2	.03	.49	.52	.04	.07	4.7
25...	1635	40	.03	2.3	2.3	.09	.54	.63	.07	.12	5.1
SEP											
12...	1435	2.0	.01	.70	.71	.00	.55	.55	.01	.06	2.0
12...	1515	40	.01	.72	.73	.01	.62	.63	.01	.06	2.0

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
APR									
25...	1540	2.0	15	50	8.0	1.9	14	18	28
25...	1635	40	25	60	8.5	1.2	16	8	84
SEP									
12...	1435	2.0	25	40	4.8	2.0	12	26	56
12...	1515	40	50	80	5.7	2.0	16	9	100

Table 35.--Phytoplankton in Deer Creek Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Location	Date	Location water column					
Site L-1 above dam ----------	4-25-75	Euphotic zone composite	13,000		Chrysophyta	77	Nitzschia (28); Melosira (28); Cyclotella (18); Navicula (2); Gomphonema (1)
					Chlorophyta	10	Actinastrum (7); Ankistrodesmus (3)
					Cyanophyta	9	Lyngbya (9)
					Euglenophyta	3	Euglena (3)
					Cryptophyta	1	Cryptomonas (1)
Site L-1 above dam ----------	9-12-75	2-ft depth	48,000	1.438	Cyanophyta	78	Agmenellum (76); Raphidiopsis (2)
					Chlorophyta	13	Scenedesmus (9); Tetraedron (3); Ankistrodesmus (1)
					Chrysophyta	10	Cyclotella (3); Melosira (3); Achnanthes (3); Nitzschia (1)
					Euglenophyta	<1	Euglena

* Less than 1 percent not given.

Grand Lake St. Marys

Location and inflow data

Grand Lake St. Marys is in Mercer and Auglaize Counties 22 mi (35 km) southwest of Lima (figs. 1 and 27). The lake was created in 1841 to store water for the Miami-Erie Canal system, but is now used for recreation. The lake was formed on the headwaters of two major drainage systems and discharges to both the Lake Erie and Ohio River drainage basins. Grand Lake St. Marys is the largest (surface area) inland lake in Ohio. It is bordered by the cities of Celina and nearby St. Marys and lies within a moderately low sediment yield area (fig. 5). Because of the diversity of input sources, inflow samples were not taken.

Lake data

The spring data were collected in Grand Lake St. Marys on May 16 under a hazy sun. The secchi disk transparency was less than 1.5 ft (0.5 m). Profiles and water-quality samples taken near the middle of the lake at site L-1 (fig. 27) show a generally well mixed water column (fig. 28 and table 36). Dissolved oxygen varied from slightly oversaturated near the surface to slightly undersaturated near the bottom of the lake. The BOD values (table 38) were high compared with other lakes sampled and most likely reflect the respiration and (or) decomposition of a dense algal population (table 39).

The water column composite data and bicarbonate values from site L-1 (tables 36 and 37) indicate that the lake water was a moderately hard, magnesium calcium sulfate bicarbonate type. Except for iron, concentrations of trace and toxic substances were low. Samples taken for pesticides (listed on page 33) in May and August were below detection limits. Concentrations of inorganic nitrogen and orthophosphorus in May (table 38) were low. (See table 4.) Higher levels, however, may have existed earlier in the season, but were incorporated into biomass.

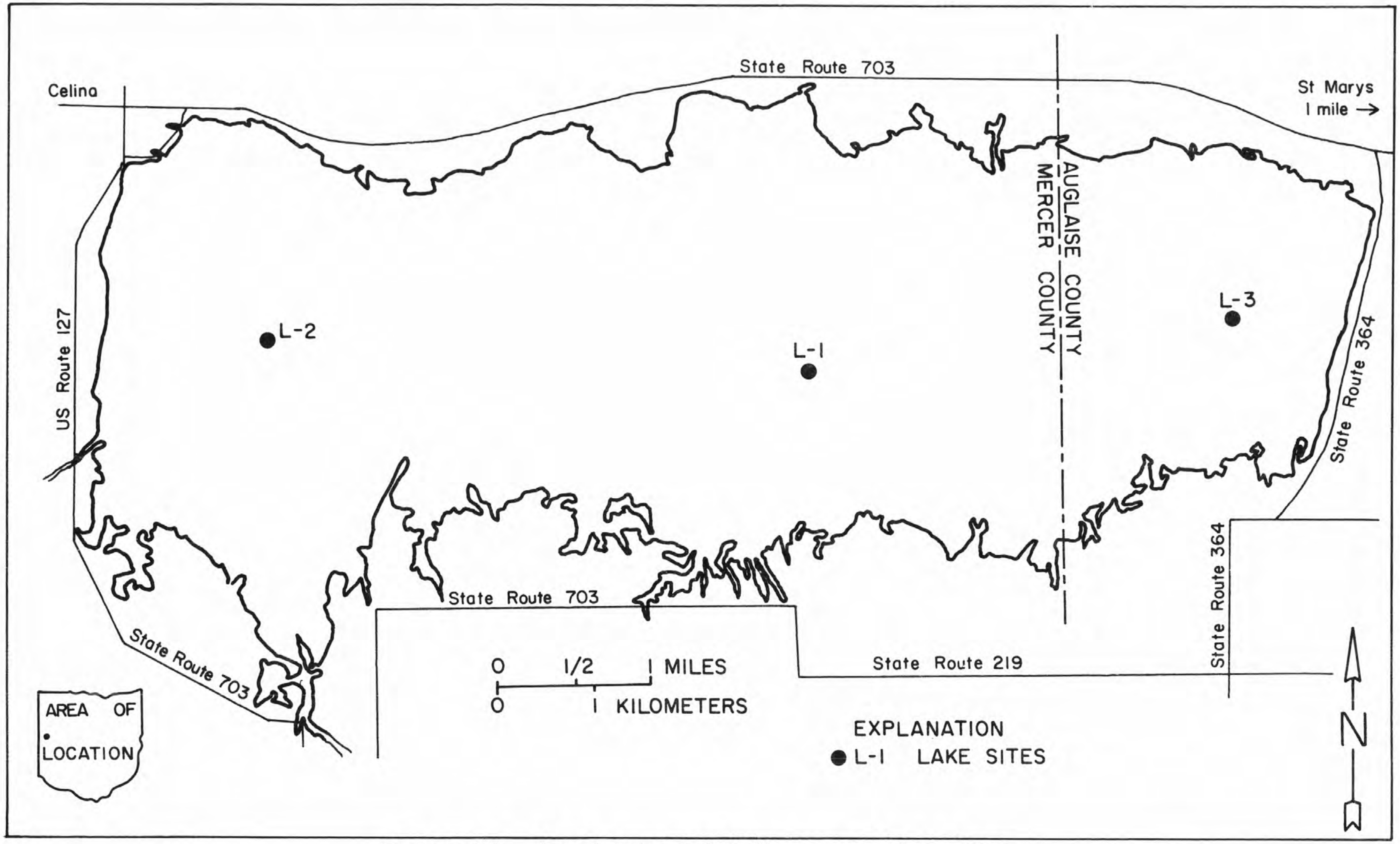


Figure 27.--Grand Lake Saint Marys sampling sites.

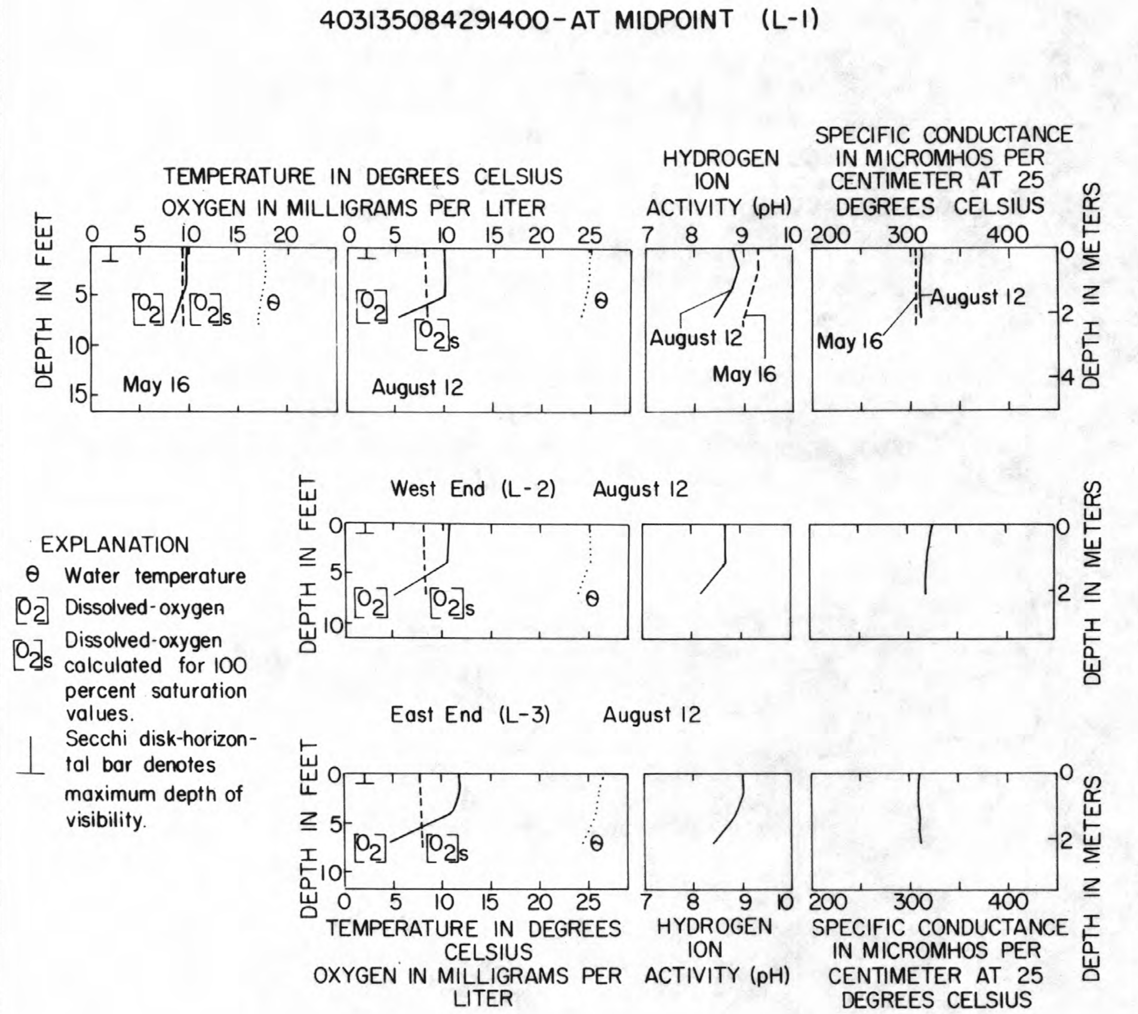


Figure 28.--Data profiles for Grand Lake St. Martys on selected days in 1975.

Table 36.--Profile data for the primary lake site, Grand Lake St. Marys, Ohio

403135084291400 - Grand Lake St. Marys near midpoint at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER- ATURE (DEG C)	DIS- SOLVED OXYGEN (MG/L)	PER- CENT SATUR- ATION	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH (UNITS)	CAR- BONATE (CO3) (MG/L)	BICAR- BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO- GEN SULFIDE (MG/L)	TRANS- PAR- ENCY (SECCHI DISK) (IN)
MAY												
16...	1330	.0	17.7	9.6	103	304	9.3	--	--	--	--	--
16...	1335	2.0	17.7	9.6	103	304	9.3	16	42	.0	.0	17
16...	1340	4.0	17.5	9.6	103	304	9.2	--	--	--	--	--
16...	1345	7.0	17.0	8.6	91	304	9.0	--	--	--	--	--
16...	1350	8.0	17.0	8.2	87	304	9.0	12	52	.1	.0	--
AUG												
12...	1410	.0	24.8	10.0	123	311	8.8	--	--	--	--	--
12...	1415	2.0	24.8	10.2	126	311	8.9	8	64	.2	.0	13
12...	1420	4.0	24.7	9.9	122	308	8.8	--	--	--	--	--
12...	1425	7.0	24.0	5.4	66	311	8.4	1	78	.5	.0	--

Table 37.--Chemical analyses of water column composite samples, Grand Lake St. Marys, Ohio

403135084201400 - Grand Lake St Marys near midpoint at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY 16...	1340	21	16	3.3	10	63	19	.3	120	194	33	227

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY 16...	1340	100	0	<10	3	<.5	1	1	0	<10	.0

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY 16...	1340	40	1	0	1000	60	9	10

Table 38.--Chemical, physical, and biological analyses of water samples from selected depths, Grand Lake St. Marys, Ohio

403135084201400 - Grand Lake St Marys near midpoint at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
16...	1335	2.0	.01	.07	.08	.05	1.2	1.2	.01	.15	.1
16...	1350	8.0	.01	.00	.01	.05	1.3	1.3	.01	.19	.2
AUG											
12...	1415	2.0	.01	.00	.01	.13	2.4	2.5	.01	.13	.4
12...	1425	7.0	.01	.00	.01	.32	3.0	3.3	.01	.16	.5

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
16...	1335	2.0	15	100	12	7.9	64	<3	<3
16...	1350	8.0	40	100	20	>8.0	71	3	<3
AUG									
12...	1415	2.0	15	100	12	15	63	<3	<3
12...	1425	7.0	35	100	13	7.5	76	<3	<3

The fecal coliform counts were within sanitary limits set for Ohio. (See page 31.) The phytoplankton cell count in May (2,830,000 cells/ml shown in table 39) was the highest recorded for the 17 lakes sampled. The blue-green genus, *Lyngbya*, dominated the the water column at site L-1.

The August profiles, taken under a hazy sun, indicate a warmer, but similar, lake condition to that observed in May. The degree of oxygen supersaturation had intensified over that observed May 16, although the pH in August was slightly lower. The BOD at the 2-ft (0.6-m) level was twice that at the bottom, the difference probably reflecting the phytoplankton distribution within the lake. Comparison of data taken at the three sites L-1, L-2, and L-3 (figs. 27 and 28) indicate that some lateral variation occurred in temperature and specific conductance.

Except for increases in ammonia and organic nitrogen and a decrease in the near-surface nitrate, the macronutrient levels (carbon, phosphorus, and silica) and bacterial counts were about the same as those observed in May. The phytoplankton count at the 2 ft (0.6 m) depth was the highest recorded (2,400,00 cells/ml) for an individual sample in 1975 and consisted almost entirely of blue-green algae.

Table 39.--Phytoplankton in Grand Lake St. Marys, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Location	Date	Location water column					
Site L-1 at midpoint -----	5-16-75	Euphotic zone composite	2,830,000	-	Cyanophyta	99	Lyngbya (93); Oscillatoria (3); Agmenellum (2); Anacystis (1); Aphanizomenon
					Chrysophyta	<1	Melosira
					Chlorophyta	<1	Tetrastrum; Scenedesmus
Site L-1 at midpoint -----	8-12-75	2-ft depth	2,400,000	2.721	Cyanophyta	99	Anacystis (28); Cylindrospermum (19); Lyngbya (19); Agmenellum (10); Gomphosphaeria (9); Aphanizomenon (7); Oscellatoria (7)
					Chlorophyta	<1	Scenedesmus (1); Dictyosphaerium
					Chrysophyta	<1	Melosira; Nitzschia

* Less than 1 percent not given.

Guilford Lake

Location and inflow data

Guilford Lake is in Columbiana County 7 mi (11.3 km) south of Salem (figs. 1 and 29). The lake was formed in 1932 by damming the West Fork Branch of Little Beaver Creek. Guilford Lake is owned and operated by the State for recreation. It is in an agricultural basin within an area of moderately low sediment yield (fig. 5). Inflows were not sampled because of the diversity of the input sources.

Lake data

Guilford Lake was sampled at site L-1 (fig. 29) in May on a bright sunny day. The secchi disk disappeared at 2.8 ft (0.85 m). Data profiles (fig. 30 and table 40) display a weakly defined thermal structure with rapidly decreasing dissolved oxygen and pH, and increasing specific conductance, between 7 and 10 ft (2.1 and 3.0 m). Significant algal activities within the euphotic zone are indicated by a pH of 9.8 (highest observed of the lakes sampled) and a supersaturation of dissolved oxygen (>180 percent). The BOD (table 42) was considerably higher at the surface than at the bottom and most likely reflects respiration of the phytoplankton community.

The analyses of the water column composites (table 41) and bicarbonate values (table 40) indicate that the lake water was a moderately hard, calcium bicarbonate sulfate type. Except for copper, the trace and toxic constituents were low, and pesticides (listed on page 33) in May and August were below detection limits. The copper concentration (10 ug/L) was at the maximum acceptable level for surface water having a hardness of 100 mg/L. The macronutrient concentrations of nitrogen, silica, and carbon (table 42) were sufficient for biomass growth. (See table 4.) The orthphosphorus levels in May were low and may have been approaching a limiting value. Higher inorganic nutrient levels earlier in the season are indicated by high algal density.

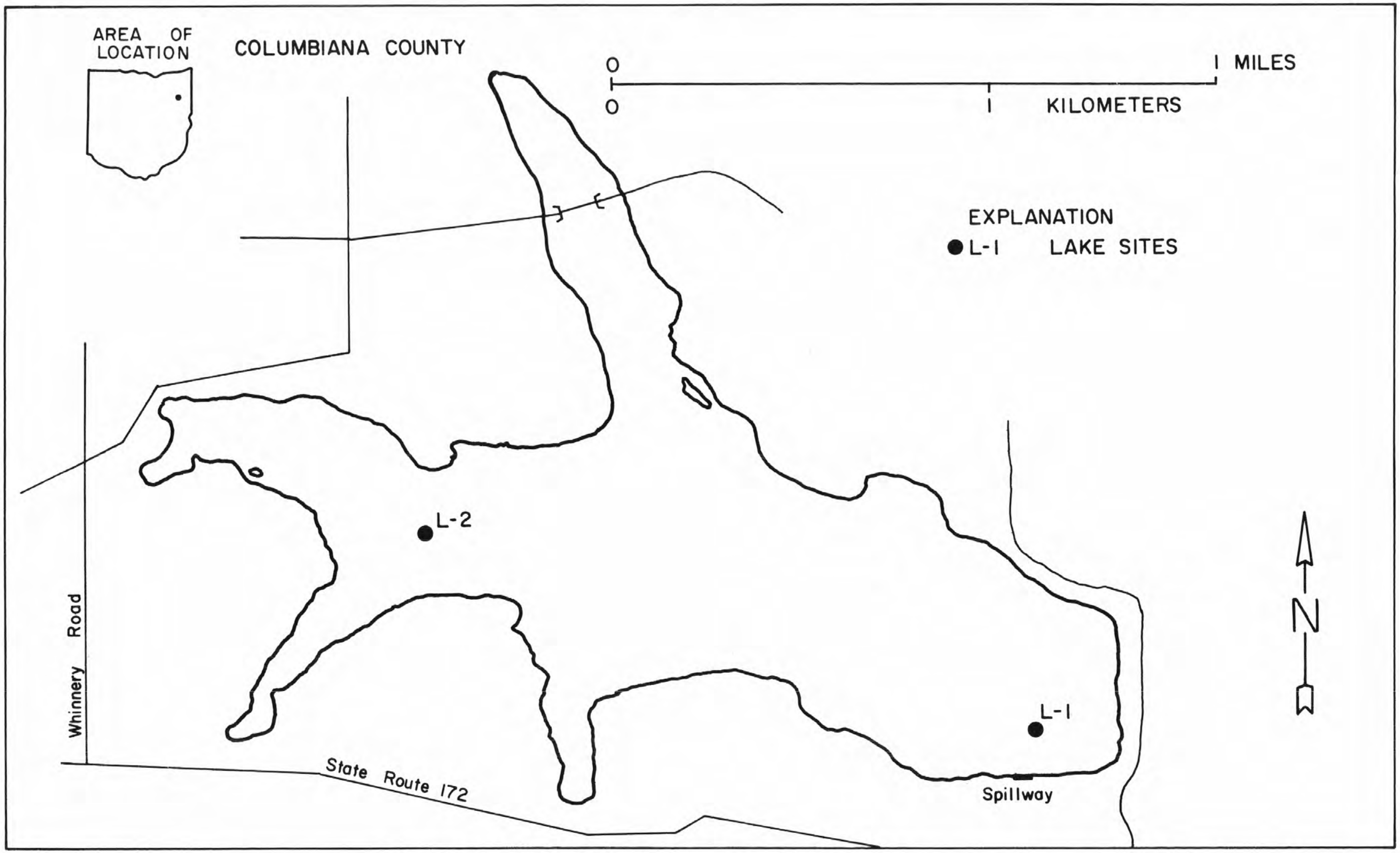


Figure 29.--Guilford Lake sampling sites.

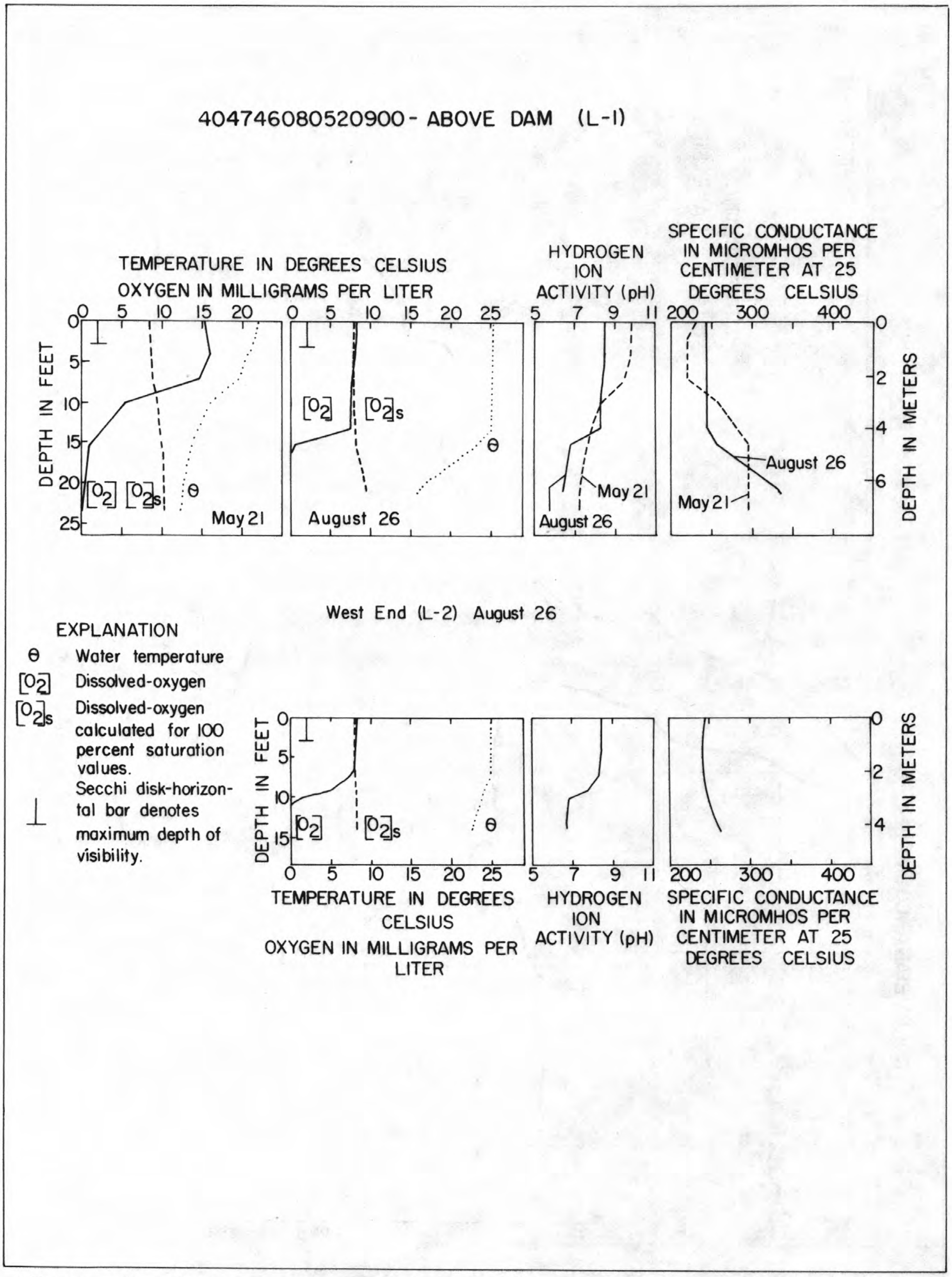


Figure 30.--Data profiles for Guilford Lake on selected days in 1975.

Table 40.--Profile data for the primary lake site, Guilford Lake, Ohio

404746080520900 - Guilford Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
21...	1115	.0	22.0	15.3	180	230	9.8	--	--	--	--	--
21...	1120	2.0	21.7	15.7	185	220	9.8	14	18	.0	.0	34
21...	1125	4.0	20.8	15.8	184	220	9.8	--	--	--	--	--
21...	1130	7.0	19.5	14.7	165	220	9.5	--	--	--	--	--
21...	1135	10	16.0	5.5	58	260	8.3	--	--	--	--	--
21...	1140	15	13.8	1.1	11	295	7.6	--	--	--	--	--
21...	1145	20	12.8	.4	4	295	7.3	--	--	--	--	--
21...	1155	23	12.3	.0	0	295	7.3	0	98	7.8	.2	--
AUG												
26...	1530	.0	25.2	8.1	101	243	8.5	--	--	--	--	--
26...	1535	2.0	25.2	8.2	102	243	8.5	3	64	.3	.0	36
26...	1540	4.0	25.2	8.1	101	243	8.5	--	--	--	--	--
26...	1545	7.0	25.1	7.7	96	243	8.4	--	--	--	--	--
26...	1550	10	25.0	7.7	96	243	8.3	--	--	--	--	--
26...	1553	13	25.0	7.6	95	243	8.3	--	--	--	--	--
26...	1555	15	23.2	.6	7	255	6.8	--	--	--	--	--
26...	1600	20	16.4	.0	0	330	6.5	0	175	88	2.0	--
26...	1605	21	15.8	.0	0	335	6.5	--	--	--	--	--

Table 41.--Chemical analyses of water column composite samples, Guilford Lake, Ohio

404746080520900 - Guilford Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY 21...	1135	28	7.2	1.9	8.1	44	17	.1	100	184	16	200

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY 21...	1135	400	1	10	1	<.5	3	0	0	<10	.0
*AUG 26...	1600	100	--	--	--	--	--	--	--	--	--

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY 21...	1135	20	0	10	110	710	0	10
*AUG 26...	1600	--	--	10	840	4800	--	--

* Taken from a water sample 1 to 3 ft from the lake bottom.

Table 42.--Chemical, physical, and biological analyses of water samples from selected depths, Guilford Lake, Ohio

404746080520900 - Guilford Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)	TOTAL ORGANIC NITROGEN (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL ORTHO PHOSPHORUS (P) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)	DISSOLVED SILICA (SIO2) (MG/L)
MAY											
21...	1120	2.0	.03	.83	.86	.22	.58	.80	.01	.04	2.1
21...	1155	23	.09	.65	.74	.49	.43	.92	.00	.04	3.7
AUG											
26...	1535	2.0	.00	.01	.01	.15	.70	.85	.01	.05	1.7
26...	1600	20	.01	.00	.01	4.2	4.4	8.6	.18	.34	8.2

DATE	TIME	DEPTH (FT)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEMICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLIFORM (COL. PER 100 ML)	STREPTOCOCCI (COLONIES PER 100 ML)
MAY									
21...	1120	2.0	4	35	6.8	7.2	15	<3	<3
21...	1155	23	3	30	3.5	1.7	15	<3	3
AUG									
26...	1535	2.0	3	30	9.5	3.5	23	4	6
26...	1600	20	40	60	7.4	2.5	18	8	4

Fecal coliform counts (table 42) were well within Ohio water-quality standards. (See page 31). Blue-green algae (table 43) dominated the May sample with the genus, Anacystis, representing 59 percent of the count.

The hypolimnion had disappeared by late August. The epilimnion and thermocline (metalimnion), however, were well defined by the rapid changes in temperature, dissolved oxygen, specific conductance, and pH that occurred at the 13 ft (4.0 m) depth. Similar relationships are seen at site L-2 (fig. 29 and 30), although the top of the thermocline was at 7 ft (2.1 m). The well mixed epilimnion, with lower oxygen and pH values than those observed in spring, may have been influenced by a brief, but severe, thunderstorm immediately prior to sampling. The storm had little effect on the anaerobic zone in the bottom third of the lake.

Macronutrient recycling in Guilford Lake is similar to that observed in Cowan Lake. The conversion of available inorganic nutrients into biomass, and subsequent decomposition of the biomass into carbon dioxide (lowering the pH) and ammonia in the lower depths of the lake is evident. The presence of the hydrogen sulfide most likely reflects biogeochemical recycling by bacteria. Chemical recycling within this reducing environment is suggested by increasing specific conductance and high concentrations of phosphorus, iron, and manganese in the bottom samples.

The fecal coliform colony counts in August were low and within standards set for Ohio. Blue-green algae were the most abundant phytoplankton group with Lyngbya as the the dominant genus at the 2-ft (0.6-m) depth. Submerged macrophytes, chiefly Myriophllum, were common in the shallows of the lake.

Table 43.--Phytoplankton in Guilford Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Location	Date	Location water column					
Site L-1 above dam ----------	5-21-75	Euphotic zone composite	19,000	-	Cyanophyta	66	Anacystis (59); Agmenellum (7)
					Chlorophyta	18	Scenedesmus (9); Coelastrum (3); Crucigenia (2); Chodatella (2); Ankistrodesmus (2)
					Chrysophyta	16	Synedra (4); Diatoma (3); Melosira (3); Nitzschia (2); Asterionella (2); Navicula (1); Cyclotella (1)
Site L-1 above dam ----------	8-26-75	2-ft depth	160,000	1.959	Cyanophyta	85	Lyngbya (53); Anacystis (23); Raphidiopsis (9)
					Chlorophyta	13	Ankistrodemus (7); Scenedesmus (5); Chodatella (1)
					Chrysophyta	3	Nitzschia (2); Cyclotella (1)

* Less than 1 percent not given.

Harrison Lake

Location and inflow data

Harrison Lake is in Fulton County 42 mi (68 km) west of Toledo (figs. 1 and 31). The lake was formed across a section of the Mill Creek drainage basin in 1941 and is owned and operated by the State for recreation.

Harrison Lake receives most of its inflow from Mill Creek. The creek drains 31 mi^2 (80 km^2) of agricultural land of generally low sediment yield (fig. 5). Mill Creek was sampled at site I-1 (fig. 31) in May and August during periods of intermittent rain. Analytical results (table 44) show generally higher phosphorus concentration in Mill Creek than in the lake (table 47). Bryozoans, mayflies (Ephemeroptera), leeches (Hirudinea), limpets (Gastropoda), and crayfish (Decapoda) were observed at site I-1.

Lake data

Harrison Lake was sampled at site L-1 (fig. 31) in late May under partly cloudy skies. The secchi disk disappeared at an average depth of 2.1 ft (0.6 m). A thermocline and changing water chemistry (fig. 32 and table 45) existed below the 4 ft (1.2 m) depth. The oxygen demands (BOD and COD shown in table 47) appear high and could account for the early depletion of oxygen in the hypolimnion. High photosynthetic rates (166 percent dissolved oxygen saturation) in the epilimnion and biological respiration and (or) decomposition rates in the hypolimnion (low dissolved oxygen and pH levels) are indicated.

Analyses of the water column composites and bicarbonate values (tables 45 and 46) show that the lake water was a very hard, calcium bicarbonate type. Mercury and silver, detected at 1.0 ug/L in May, were not confirmed in an August sample taken near the lake bottom. The copper concentration (20 ug/L) in May was at the acceptable limit (see page 23), and pesticides (see page 33). were not detected. Macronutrient concentrations (table 47) reveal an ample supply of nitrogen and phosphorus for plant growth. (See table 4.)

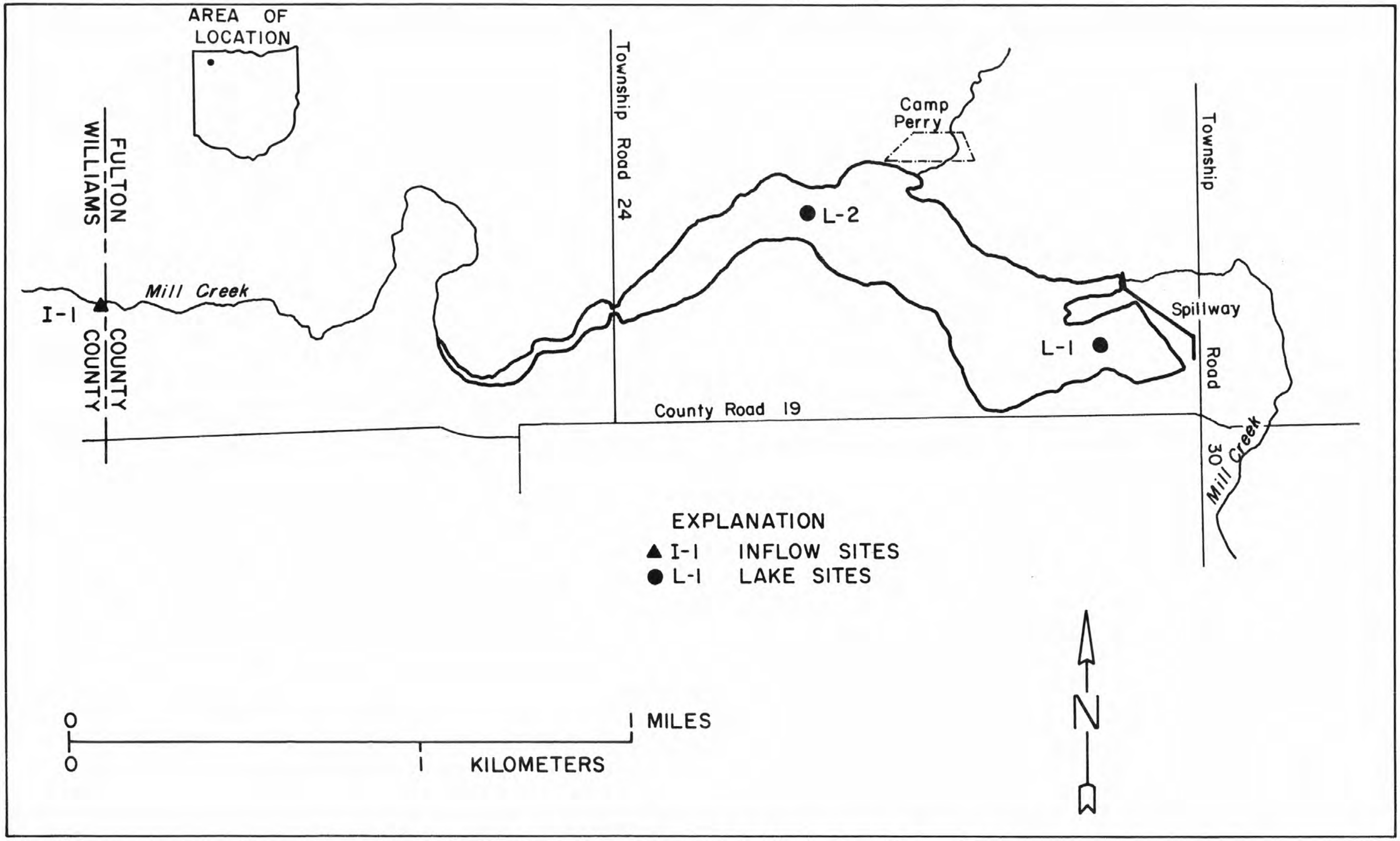


Figure 31.--Harrison Lake and inflow sampling sites.

Table 44.--Physical and chemical data for selected inflows, Harrison Lake, Ohio

413830084235600 - Mill Creek above Harrison Lake at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
MAY												
30...	1455	E10	22.0	7.2	7.7	670	50	140	14	2.2	.85	.17
AUG												
22...	1350	E20	20.5	6.3	7.4	485	90	80	14	1.0	1.1	.22

E Estimated.

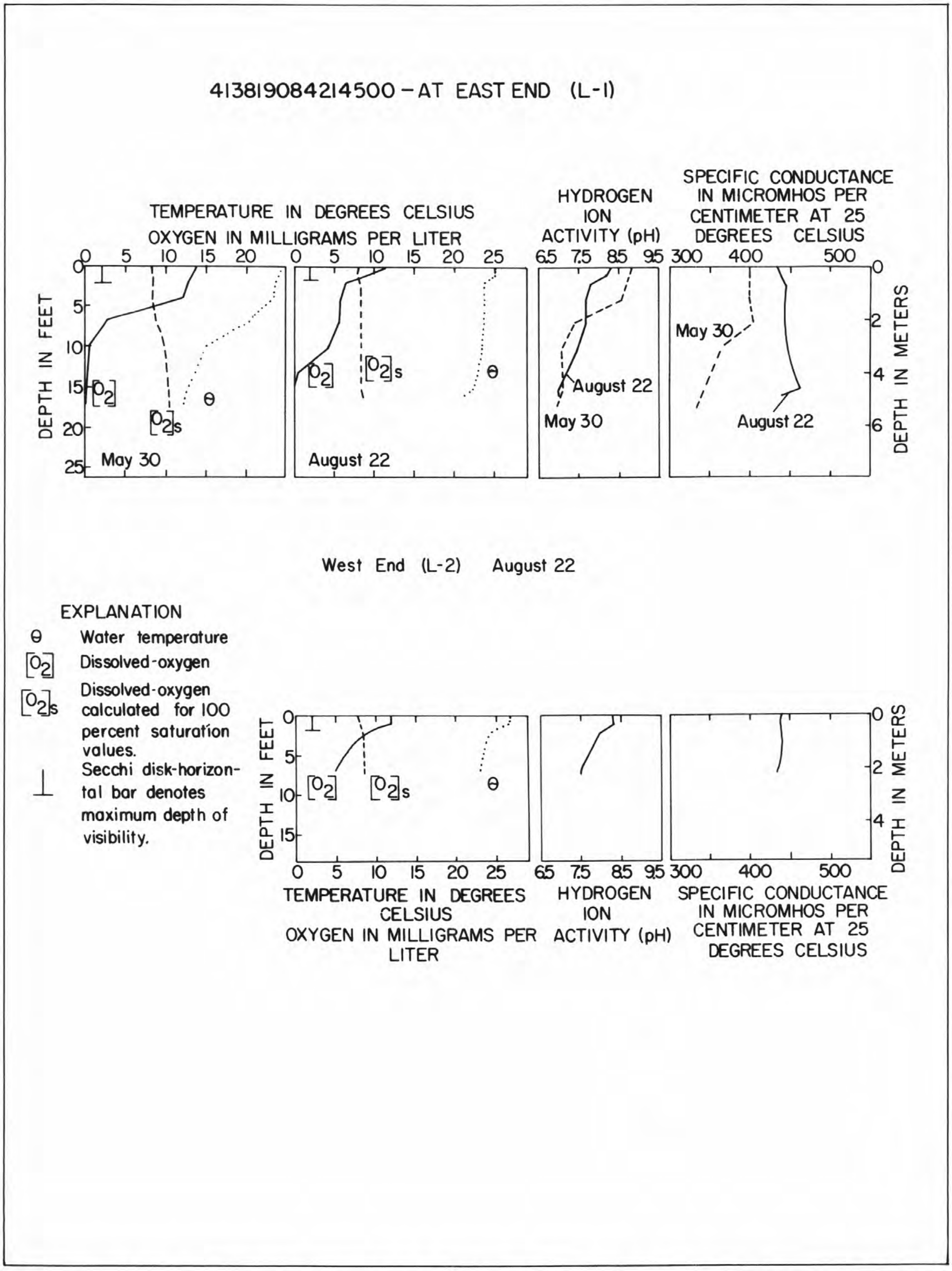


Figure 32.--Data profiles for Harrison Lake on selected days in 1975.

Table 45.--Profile data for the primary lake site, Harrison Lake, Ohio

413819084214500 - Harrison Lake at east end at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
30...	1605	.0	24.5	13.6	166	400	8.8	--	--	--	--	--
30...	1610	2.0	23.7	12.7	153	400	8.7	13	130	.4	.0	25
30...	1615	4.0	23.4	12.1	146	400	8.6	--	--	--	--	--
30...	1620	7.0	20.2	2.5	28	405	7.4	--	--	--	--	--
30...	1625	10	15.0	.4	4	365	7.1	--	--	--	--	--
30...	1630	15	12.8	.1	1	345	7.1	--	--	--	--	--
30...	1635	17	12.2	.0	0	336	7.0	0	146	23	.0	--
AUG												
22...	1515	.0	25.1	11.7	144	435	8.3	0	186	1.5	--	--
22...	1517	1.0	25.0	9.4	116	438	8.2	--	--	--	--	--
22...	1520	2.0	23.8	6.4	77	445	7.8	--	--	--	.0	20
22...	1525	4.0	23.8	5.8	70	445	7.7	--	--	--	--	--
22...	1530	7.0	23.7	5.6	67	445	7.7	--	--	--	--	--
22...	1535	10	23.5	4.3	52	448	7.5	--	--	--	--	--
22...	1537	13	23.0	.5	6	455	7.2	--	--	--	--	--
22...	1540	15	22.4	.0	0	465	7.0	0	222	35	.0	--
22...	1545	16	21.0	.0	0	440	7.0	--	--	--	--	--

Table 46.--Chemical analyses of water column composite samples, Harrison Lake, Ohio

413819084214500 - Harrison Lake at east end at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY 30...	1625	55	12	3.2	6.0	50	14	.2	190	290	103	393

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY 30...	1625	0	0	10	4	1.0	16	1	1	<10	.1
* AUG 22...	1540	--	--	--	30	<.5	17	--	0	--	--

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY 30...	1625	40	1	20	3300	140	3	10
* AUG 22...	1540	--	--	10	5500	970	--	20

* Taken from a water sample 1 to 3 ft from the lake bottom.

Table 47.--Chemical, physical, and biological analyses of water samples from selected depths, Harrison Lake, Ohio

413819084214500 - Harrison Lake at east end at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
30...	1610	2.0	.11	3.5	3.6	.03	.26	.29	.01	.09	3.8
30...	1635	17	.14	2.2	2.3	.42	.33	.75	.02	.21	4.7
AUG											
22...	1520	2.0	.02	1.4	1.4	.13	.97	1.1	.03	.05	1.7
22...	1540	15	.01	.69	.70	.62	1.2	1.8	.01	.04	2.9

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
30...	1610	2.0	10	80	9.5	5.8	36	16	20
30...	1635	17	150	300	12	3.5	28	400	1100
AUG									
22...	1520	2.0	15	40	10	4.3	27	100	100
22...	1540	15	95	100	13	6.5	34	152	160

The bacteria counts (table 47) from the bottom sample in May were high and probably reflect the runoff from agricultural lands (FC/FS ratio <1). Green algae and diatoms (table 48) were dominant in the spring collection.

The summer profiles show the almost complete elimination of the spring thermocline. Incomplete mixing within the lake is shown by the comparison of dissolved oxygen, pH, and specific conductance profiles at site L-1 and L-2 (fig. 31 and 32). Inorganic macronutrient levels within the lake were lower than those found in May and conversion to organic forms (organic nitrogen) is suggested. A more important factor in nutrient availability and uptake in the lake may be the short hydraulic residence time indicated by the C/I ratio of 0.05 (table 5). This high flushing rate also would influence temperature profile stability.

The bacteria colony counts of fecal coliforms and streptococci were among the highest observed during the summer reconnaissance, but the fecal coliform counts were within Ohio water-quality standards. The algal community apparently changed from mixed green algae and diatoms in spring to a low diversity ($\bar{d}$) blue-green community in August. Extensive beds of the aquatic plants, *Nymphaea* and *Nuphar*, were observed in shallow areas at the west end of the lake.

Table 48.--Phytoplankton in Harrison Lake, Ohio

Sample description: Location	Date	Location water column	Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Site L-1 above dam ----------	5-30-75	.Euphotic zone composite	19,000	-	Chlorophyta	53	Micractinium (32); Pandorina (21)
					Chrysophyta	43	Cyclotella (31); Nitzschia (12)
					Euglenophyta	3	Euglena (3)
					Pyrrhophyta	1	Glenodinium (1)
Site L-1 above dam ----------	8-22-75	Surface	130,000	0.345	Cyanophyta	97	Agmenellum (96); Anacystis (1)
					Euglenophyta	1	Euglena (1); Trachelomonas
					Chlorophyta	1	Scenedesmus; Chlamydomonas; Schroederia
					Chrysophyta	<1	Nitzschia
					Pyrrhophyta	<1	Peridinium

* Less than 1 percent not given.

Hoover Reservoir

Location and inlow data

Hoover Reservoir is in Delaware and Franklin Counties (figs. 1 and 33) 12 mi (19 km) northeast of downtown Columbus. The reservoir was filled in 1955 after the damming of Big Walnut Creek in 1954. The reservoir is owned and operated by the city of Columbus and is used primarily for municipal water supply, although restricted recreational activities are permitted.

Two inflows were sampled for selected chemical inputs; Big Walnut Creek, site I-1 (fig. 33), and Little Walnut Creek, site I-2. Both creeks drain agricultural and urban land within an area of moderately low sediment yield (fig. 5). Their combined drainage area of 143 mi^2 (370 km^2) represents 75 percent of the drainage basin for Hoover Reservoir. The creeks were sampled in May and August during steady flow conditions. The data (table 49) show low inputs of macronutrients to Hoover Reservoir except for the August 29 nitrogen and phosphorus concentrations in Big Walnut Creek. Mayflies (Ephemeroptera), caddisflies (Trichoptera), water pennies (frcm Coleoptera), and the alga, *Lemanea annulata*, were observed at site I-1.

Lake data

Gradually decreasing temperatures with depth, with little variation in dissolved oxygen, pH, and specific conductance, characterize the profiles at site L-1 (fig. 33) in May (fig. 34 and table 50). The secchi disk transparency, observed under sunny skies, was less than 2 ft (0.6 m).

Data from the water column composites (table 51) and bicarbonate values (table 50) show that the lake water was a moderately hard, calcium bicarbonate type. Except for copper, Hoover Reservoir had low or undetectable amounts of trace and toxic substances. The copper concentration (10 ug/L) met Ohio standards for waters having a hardness between 80 to 160 mg/L. Pesticies (see page 33) were below detectable limits. Macronutrient concentrations in the lake (table 52) were well above minimum levels necessary for plant growth. (See table 4.)

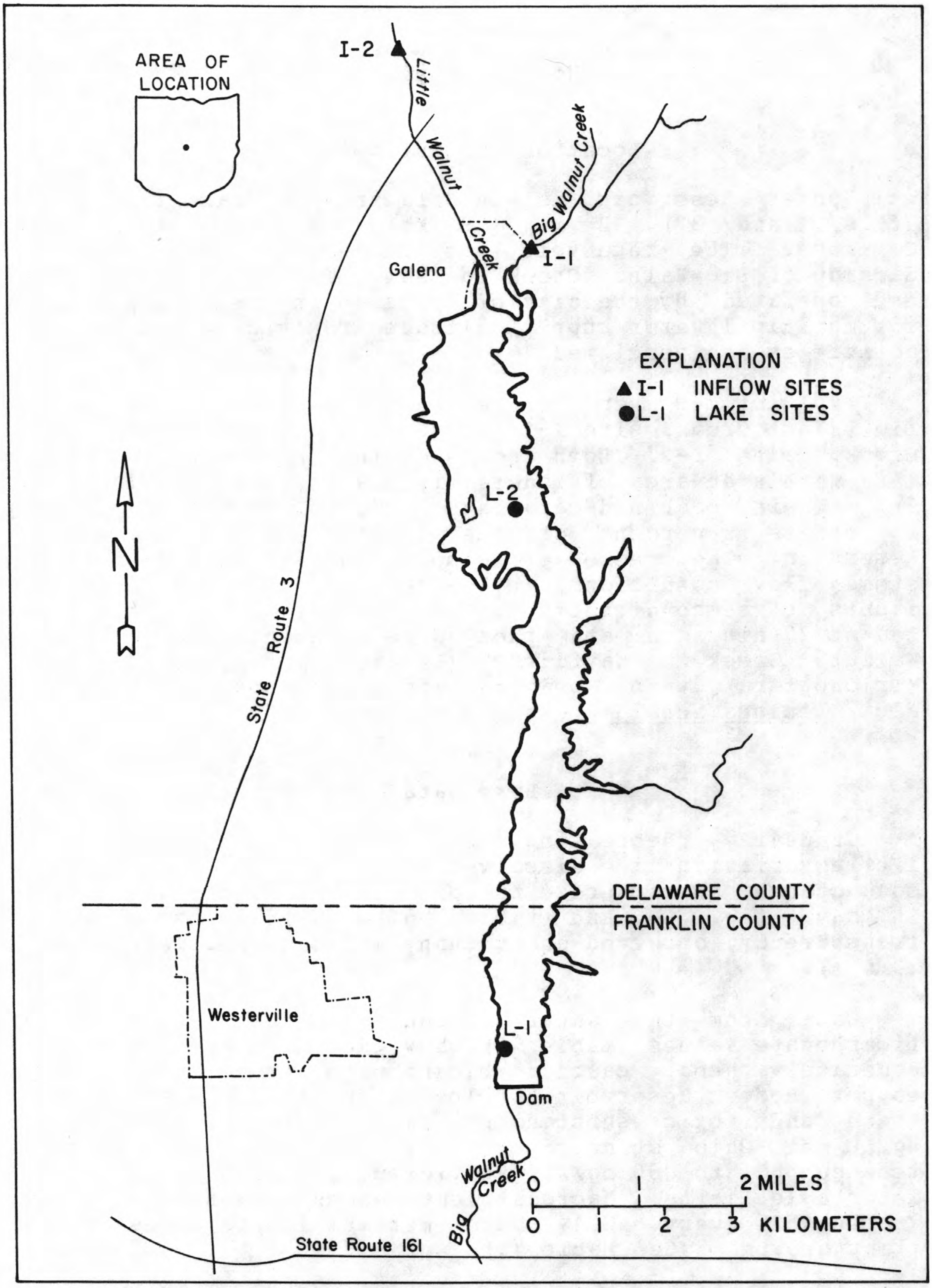


Figure 33.--Hoover Reservoir and inflow sampling sites.

Table 49.--Physical and chemical data for selected inflows, Hoover Reservoir, Ohio

401304082524100 - Big Walnut Creek above Hoover Reservoir at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
MAY												
09...	1015	E35	15.5	10.0	7.9	525	4	20	5.0	.13	.07	.08
AUG												
29...	1210	E2.0	24.5	7.7	7.7	790	20	40	6.2	1.2	.77	1.7

401412082534200 - Little Walnut Creek above Hoover Reservoir at site (I-2)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
MAY												
09...	1100	<10	16.0	7.6	7.5	660	15	50	4.7	.11	.35	.05
AUG												
29...	1125	<1.0	22.0	3.9	7.3	715	5	20	6.8	.09	.33	.05

E Estimated.

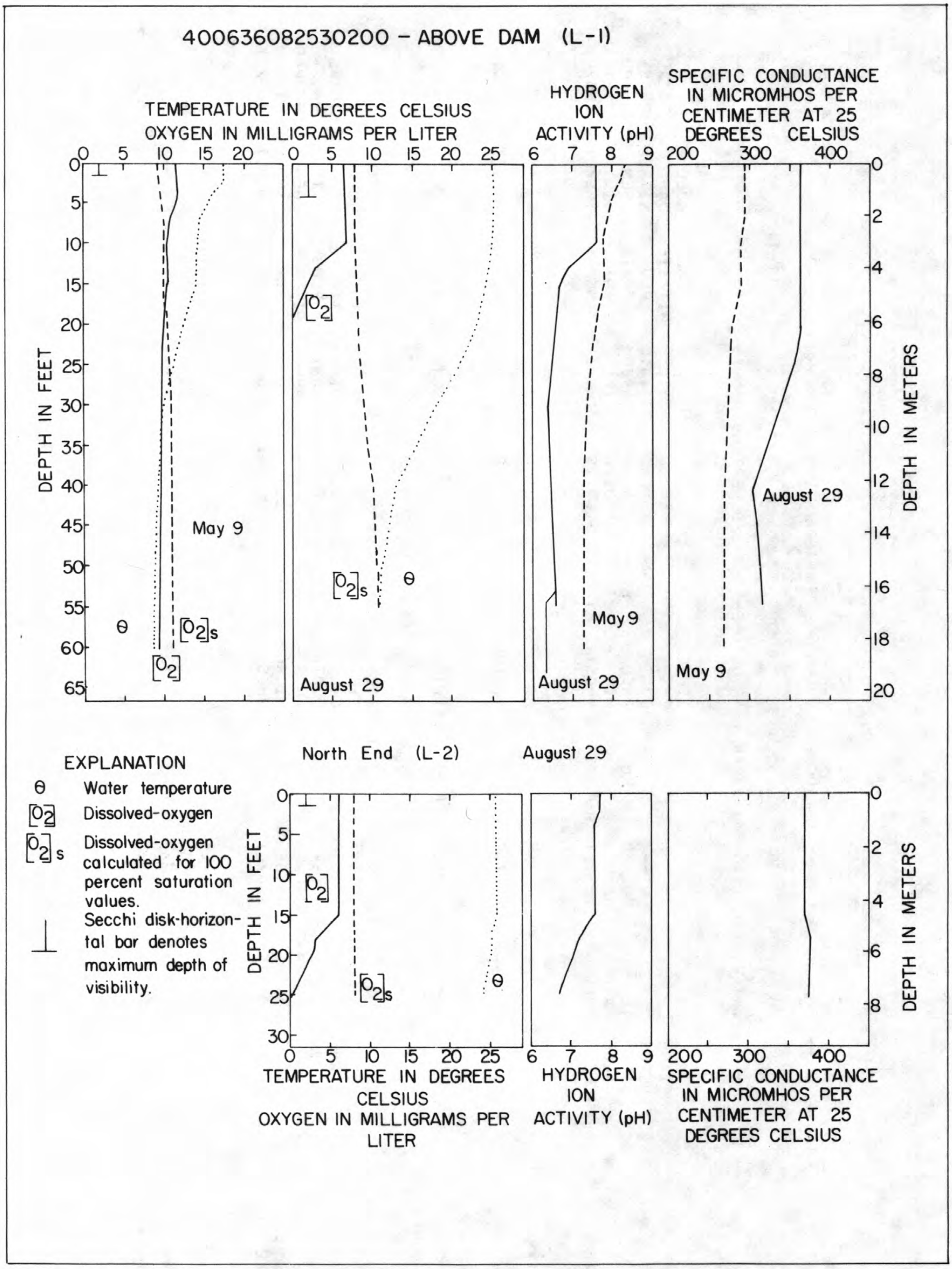


Figure 34.--Data profiles for Hoover Reservoir on selected days in 1975.

Table 50.--Profile data for the primary lake site, Hoover Reservoir, Ohio

40063608253020O - Hoover Reservoir above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
09...	1345	.0	17.5	11.4	123	295	8.3	--	--	--	--	--
09...	1350	2.0	17.5	11.5	124	295	8.2	0	98	1.0	.0	18
09...	1355	4.0	16.0	11.6	121	295	8.0	--	--	--	--	--
09...	1400	7.0	14.5	10.7	108	295	7.9	--	--	--	--	--
09...	1405	10	14.2	10.3	103	290	7.8	--	--	--	--	--
09...	1410	15	14.0	10.5	105	290	7.8	--	--	--	--	--
09...	1415	20	12.5	10.0	96	280	7.6	--	--	--	--	--
09...	1425	30	10.0	9.8	89	275	7.4	--	--	--	--	--
09...	1430	40	9.5	9.7	87	270	7.3	--	--	--	--	--
09...	1435	50	9.0	9.5	85	270	7.3	--	--	--	--	--
09...	1440	60	8.8	9.4	84	270	7.3	0	90	7.2	.0	--
AUG												
29...	1500	.0	25.1	6.6	82	363	7.6	--	--	--	--	--
29...	1505	2.0	25.1	6.7	84	363	7.6	0	121	4.8	.0	49
29...	1510	4.0	25.1	6.8	85	363	7.6	--	--	--	--	--
29...	1515	7.0	25.1	6.8	85	363	7.6	--	--	--	--	--
29...	1520	10	25.1	6.8	85	363	7.6	--	--	--	--	--
29...	1523	13	24.5	3.1	38	363	6.9	--	--	--	--	--
29...	1525	15	24.2	2.1	26	363	6.7	--	--	--	--	--
29...	1530	20	23.1	.0	0	363	6.6	--	--	--	--	--
29...	1535	25	21.0	.0	0	355	6.5	--	--	--	--	--
29...	1540	30	17.8	.0	0	338	6.4	--	--	--	--	--
29...	1545	40	13.0	.0	0	305	6.5	--	--	--	--	--
29...	1550	50	11.2	.0	0	315	6.6	--	--	--	--	--
29...	1555	55	10.8	.0	0	315	6.6	0	124	49	.0	--

Table 51.--Chemical analyses of water column composite samples, Hoover Reservoir, Ohio

400036082530200 - Hoover Reservoir above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY												
09...	1425	31	9.0	2.3	7.7	42	14	.2	110	171	38	209

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY											
09...	1425	100	0	<10	3	<.5	3	1	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY								
09...	1425	30	1	10	840	30	3	20

Table 52.--Chemical, physical, and biological analyses of water samples from selected depths, Hoover Reservoir, Ohio

400636082530200 - Hoover Reservoir above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
09...	1350	2.0	.07	1.6	1.7	.10	.54	.64	.03	.10	3.1
09...	1440	60	.03	1.9	1.9	.04	.34	.38	.04	.10	4.6
AUG											
29...	1505	2.0	.03	1.4	1.4	.01	.39	.40	.01	.03	.9
29...	1555	55	.01	.41	.42	.29	.81	1.1	.01	.09	7.5

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
09...	1350	2.0	20	60	7.9	3.3	23	6	3
09...	1440	60	40	80	5.9	.9	19	<3	3
AUG									
29...	1505	2.0	3	10	9.8	1.3	13	2	<2
29...	1555	55	120	200	7.6	3.1	23	168	60

The bacteria results for May (table 52) were low, with fecal coliform counts well within Ohio standards. (See page 31.) The lake phytoplankton at site L-1 (table 53) consisted entirely of diatoms, with Cyclotella and Melosira as the dominant genera. High photosynthetic activity by these algae is indicated by the oxygen supersaturation within the upper 10 ft (3.0 m) of the lake, and their respiration effects are reflected in the BOD results from the 2 ft (0.6 m) depth.

The late summer profiles display a gradual thermocline between 10 and 40 ft (3.0 and 12.2 m). The secchi disk visibility, measured under partly cloudy skies after a thundershower, had increased from the May value of 1.5 ft (0.5 m) to over 4 ft (1.3 m). The reduction in dissolved oxygen and pH at the base of the epilimnion suggest significant biological decomposition or respiration and a slow mixing rate within this zone. Some chemical differences between the epilimnion and hypolimnion are indicated by the specific- conductance profile. Comparison of profiles from site L-1 with those from L-2 (figs. 33 and 34) shows a generally similar chemical condition at both sites.

The concentrations and ratios of nitrate in the epilimnion and hypolimnion were different than those of other lakes sampled in Ohio during 1975. The higher concentration of nitrate (1.4 mg/L as N) at the 2 ft (0.6 m) depth compared with the bottom water sample (0.41 mg/L as N) might indicate: nitrate reduction in the hypolimnion and(or) a nitrate input to the epilimnion; or a limiting or controlling influence on the uptake of nitrate by the aquatic flora. Silica uptake by diatoms is suggested on the basis of reduction in the epilimnion from 3.1 mg/L in May to 0.9 mg/L in August.

The fecal coliform densities were within Ohio water-quality standards. The bottom counts when compared with the surface are of interest, and the ratio FC/FS = 2.8 could indicate some source other than agricultural. The diatoms that dominated the euphotic zone in spring were replaced at the 7-ft (2.1-m) depth by blue-green algae in August.

Table 53.--Phytoplankton in Hoover Reservoir, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Location	Date	Location water column					
Site L-1 above dam ---------	5-9-75	.Euphotic zone composite	10,000	-	Chrysophyta	100	Cyclotella (53); Melosira (45): Nitzschia (3)
Site L-1 above dam ---------	8-29-75	7-ft depth	3500	1.154	Cyanophyta	92	Lyngbya (82); Anacystis (7); Aphanizomenon (3)
					Chlorophyta	6	Scenedesmus (3); Crucigenia (2); Euastrum (1); Kirchneriella
					Chrysophyta	2	Nitzschia (2); Cyclotella
					Euglenophyta	<1	Trachelomonas

* Less than 1 percent not given.

Lake Hope

Location and inflow data

Lake Hope is in Vinton County (figs. 1 and 35) 55 mi (88.5 km) southeast of Columbus. The lake was formed in 1939 after damming Sandy Run, 0.25 mi (0.40 km) upstream from the confluence with Raccoon Creek. The lake is owned and operated by the State and is used almost exclusively for recreation.

Sandy Run drains 5.3 mi^2 (13.7 km^2) of intermittently mined, rural and forested lands within an area of moderately low sediment yield (fig. 5). The stream, representing 53 percent of the drainage area for Lake Hope, was sampled at site I-1 (fig. 35). The chemical data (table 54) taken in May show the inflow was acidic with slightly different macronutrient concentrations than those observed in the lake. *Nuphar* and *Typha* were seen growing in and along Sandy Run at the collection site. Sandy Run had no detectable flow at the sampling site in September.

Lake data

Profile measurements were made of Lake Hope under a sunny May sky. The data (fig. 36 and table 55) taken at site L-1 (fig. 35) indicate an early thermal stratification. The secchi disk disappeared at a depth of 3.5 ft (1.1 m). Oxygen concentrations, near saturation in the upper 10 ft (3 m), decreased with depth. The pH values were the lowest of the 17 lakes sampled. The oxygen demand (BOD, COD) (table 57) in the lake water also was low; the near surface and bottom BOD values of 0.4 and 0.3 mg/L, respectively, were lower in this lake than the other 16 lakes.

The analyses for general constituents (tables 55 and 56) show that the lake water was a soft, calcium sulfate type. The concentrations of most trace and toxic substances were low. Iron and manganese, present in concentrations less than 700 ug/L in the May composite sample, were detected at high concentrations (23,000 and 2400 ug/L, respectively) at the 20 ft (6.1 m) depth in September. Pesticide residues were below detectable limits. (See page 33.) The inorganic nutrient concentrations of nitrogen and phosphorus were lower in the epilimnion than in the hypolimnion (table 57), likely reflecting biological uptake. Phosphorus was especially low in the upper zone and may have been approaching a growth-limiting level.

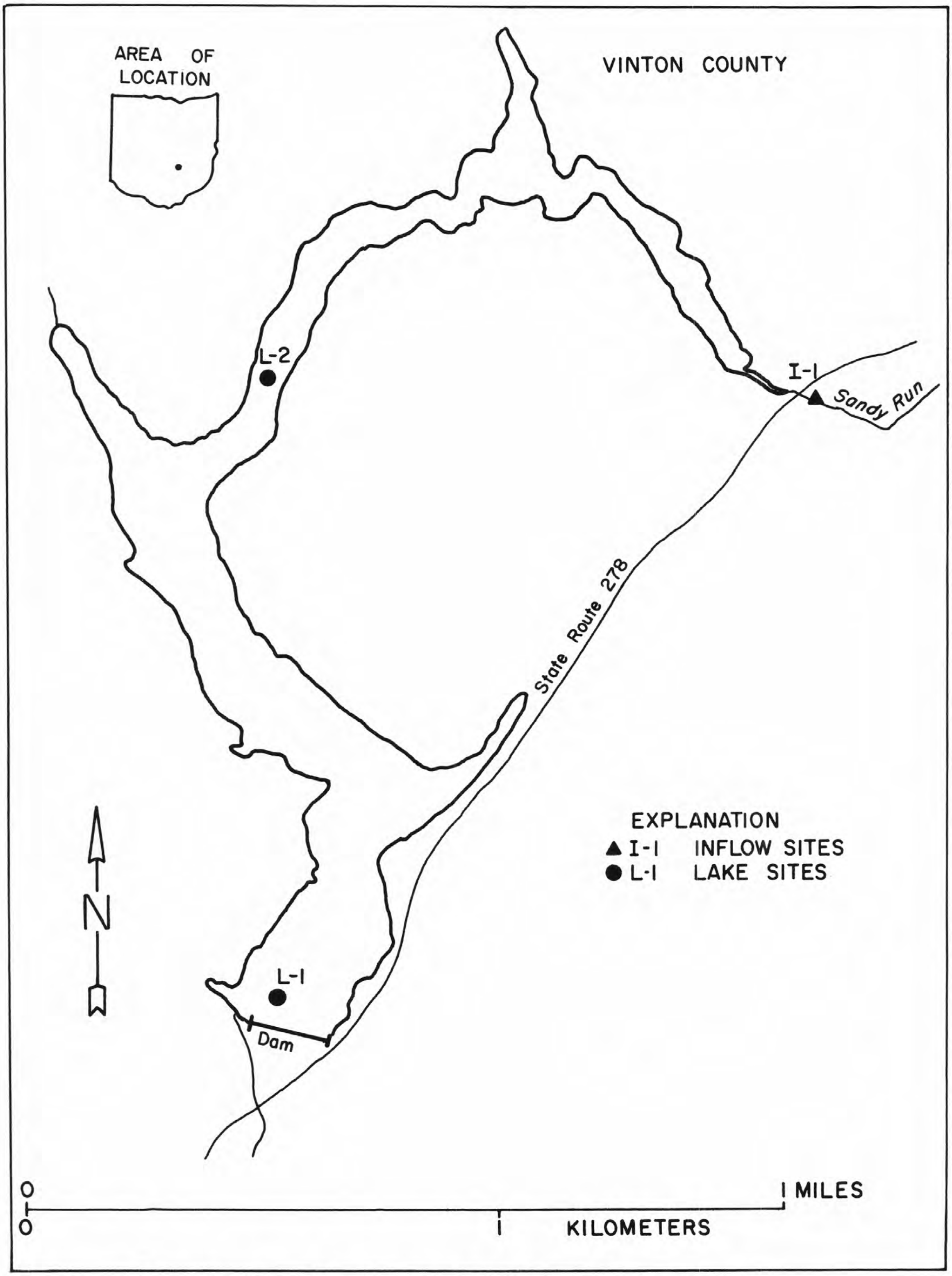


Figure 35.--Lake Hope and inflow sampling sites.

Table 54.--Physical and chemical data for selected inflows, Lake Hope, Ohio

391952082202500 - Sandy Run above Lake Hope at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN- TANEOUS DIS- CHARGE (CFS)	TEMPER- ATURE (DEG C)	DIS- SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	TUR- BID- ITY (JTU)	COLOR (PLAT- INUM- COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL- DAHL NITRO- GEN (N) (MG/L)	TOTAL PHOS- PHORUS (P) (MG/L)
MAY												
14...	0955	E4.5	11.5	9.6	4.9	224	3	5	7.9	.09	.79	.01

E Estimated.

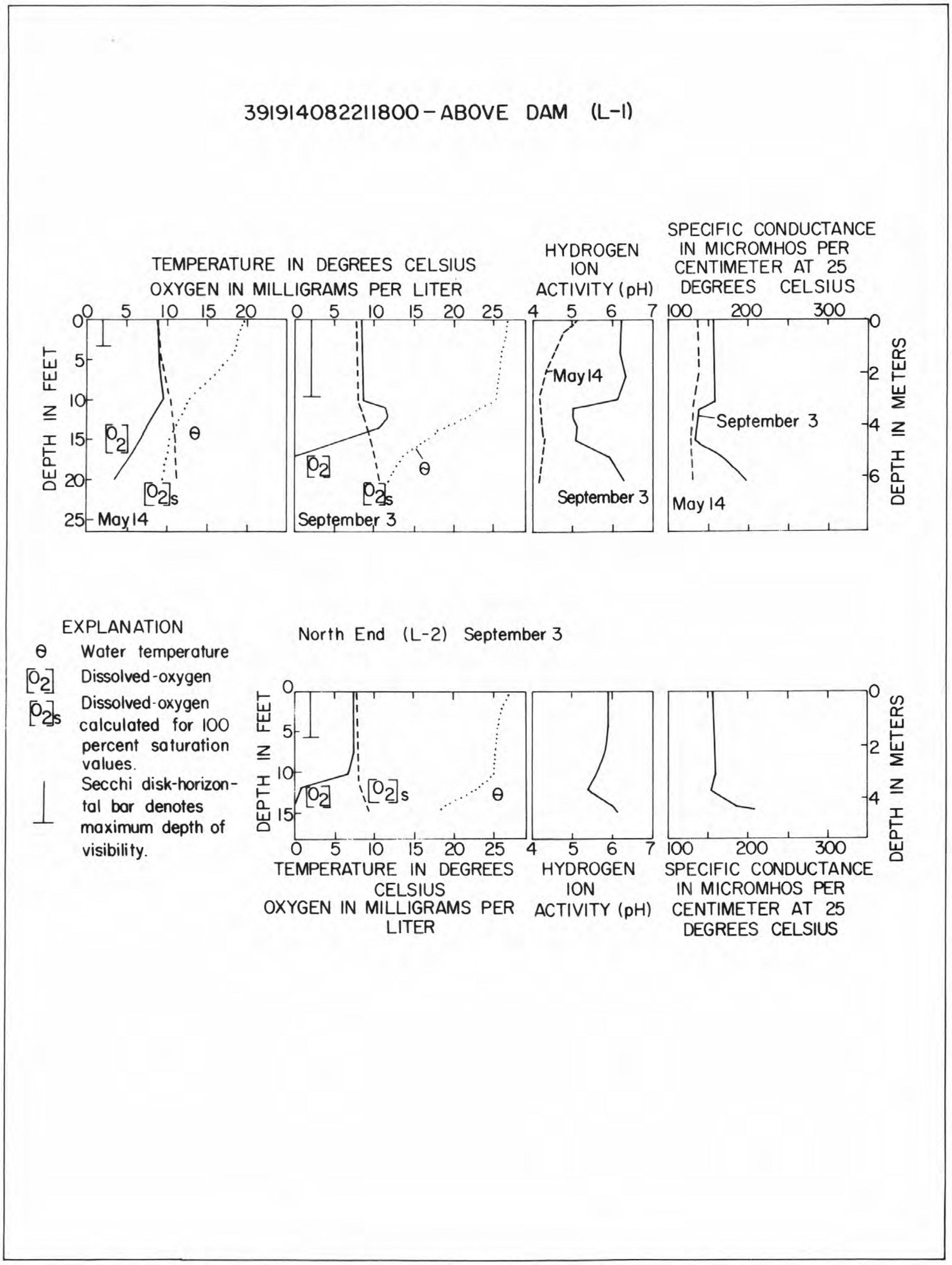


Figure 36.--Data profiles for Lake Hope on selected days in 1975.

Table 55.--Profile data for the primary lake site, Lake Hope, Ohio

391914082211800 - Lake Hope above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
14...	1315	.0	19.8	8.9	100	137	5.1	--	--	--	--	--
14...	1320	2.0	19.0	8.9	98	137	4.7	0	<1	.0	.0	41
14...	1325	4.0	18.5	9.0	98	137	4.6	--	--	--	--	--
14...	1330	7.0	16.0	9.4	97	137	4.3	--	--	--	--	--
14...	1335	10	12.8	9.5	92	132	4.2	--	--	--	--	--
14...	1340	15	10.4	6.8	62	128	4.3	--	--	--	--	--
14...	1345	20	9.5	3.2	29	131	4.2	0	0	.0	.2	--
SEP												
03...	1400	.0	26.7	8.4	108	157	6.2	--	--	--	--	--
03...	1405	2.0	26.6	8.4	106	157	6.2	0	4	4.0	.0	113
03...	1410	4.0	26.0	8.5	108	157	6.2	--	--	--	--	--
03...	1415	7.0	25.6	8.5	106	157	6.3	--	--	--	--	--
03...	1420	10	25.2	8.4	105	157	6.1	--	--	--	--	--
03...	1422	12	21.8	11.6	135	137	5.0	--	--	--	--	--
03...	1425	15	16.3	6.2	65	134	5.1	--	--	--	--	--
03...	1427	17	13.4	.0	0	166	5.9	--	--	--	--	--
03...	1430	20	11.8	.0	0	199	6.3	0	95	76	.2	--

Table 56.--Chemical analyses of water column composite samples, Lake Hope, Ohio

391914082211800 - Lake Hope above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY												
14...	1335	11	4.7	1.4	3.0	51	2.2	.1	47	81	21	102

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY											
14...	1335	100	0	<10	2	<.5	6	0	0	<10	.0
*SEP											
03...	1430	--	--	--	9	--	19	--	--	--	--

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY								
14...	1335	20	5	0	630	410	1	30
*SEP								
03...	1430	--	12	0	23000	2400	--	10

* Taken from a water sample 1 to 3 ft from the bottom of the lake.

Table 57.--Chemical, physical, and biological analyses of water samples from selected depths
Lake Hope, Ohio

391914082211800 - Lake Hope above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
14...	1320	2.0	.01	.12	.13	.04	.36	.40	.00	.01	9.9
14...	1345	20	.01	.12	.13	.27	.06	.33	.02	.03	9.4
SEP											
03...	1405	2.0	.00	.00	.00	.02	.23	.25	.01	.03	2.0
03...	1430	20	.00	.45	.45	1.4	.50	1.9	.01	.01	9.6

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
14...	1320	2.0	6	10	4.0	.4	12	<3	<3
14...	1345	20	20	40	7.1	.3	12	12	30
SEP									
03...	1405	2.0	2	5	4.7	1.1	12	2	26
03...	1430	20	40	800	13	.5	29	3	<3

The bacteria colony counts in May (table 57) were higher near the bottom of the lake than at the top, but all fecal coliform counts were well within Ohio water-quality standards (See page 31.) The phytoplankton composite from the euphotic zone (table 58) consisted mostly of the green algae, Quadrigula (87 percent), and the dinoflagellate, Peridinium (11 percent).

The summer profiles displayed a complex stratification. Water transparency had greatly increased over that of May, and a thermocline extended from the 10 ft (3.0 m) depth to the bottom of the lake. The isolated zone of oxygen supersaturation within the upper metalimnion (positive heterograde) is commonly characteristic of wind-protected, clear-water, dimictic, or warm monomictic lakes having a phytoplankton community.

Three chemically distinct zones are shown within the water column. The epilimnion was aerobic and when compared to the other zones is marked by high transparency (turbidity and color are low), conductance, and pH, and by low alkalinity, COD, and macronutrient levels. The upper metalimnion data shows lower conductance and pH values. The lower metalimnion was anaerobic and turbid and is characterized by; increasing specific conductance and pH with depth; high alkalinity, COD, iron, and manganese; and comparatively high concentrations of inorganic nitrogen and silica. Similar profile data are seen in the north end of the lake at site L-2 (figs. 35 and 36). These relationships suggest that bottom mud may play a significant role in the lake chemistry, especially during periods of oxygen depletion followed by holomictic (complete) mixing.

The bacteria counts were similar to those observed in May, and fecal coliform counts were within Ohio water-quality standards. Separate collections for phytoplankton at 7 and 12 ft (2.1 and 3.7 m) showed a green algal dominance by the genera, Quadrigula and Arthrodesmus. The order of dominance, however, changed from the 7 ft (2.1 m) to the 12 ft (3.7 m) depth. Addition replacements, or exclusions of other algae, especially the blue-green algae, also are shown.

Table 58.--Phytoplankton in Lake Hope, Ohio

Sample description: Location	Sample description: Date	Sample description: Location water column	Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Site L-1 above dam ----------	5-14-75	Euphotic zone composite	2200	-	Chlorophyta	90	Quadrigula (87); Tetraedron (3)
					Pyrrhophyta	11	Peridinium (11)
Site L-1 above dam ----------	9-3-75	7-ft depth	3400	1.986	Chlorophyta	79	Quadrigula (47); Arthrodesmus (23) Gloeocystis (9)
					Chrysophyta	14	Nitzschia (14)
					Pyrrhophyta	7	Peridinium (7)
Site L-1 above dam ---------	9-3-75	12-ft depth	4200	1.825	Chlorophyta	95	Arthrodesmus (53); Quadrigula (26); Dictyosphaerium (9); Ankistrodesmus (7)
					Chrysophyta	2	Nitzschia (2)
					Pyrrhophyta	2	Peridinium (2)

* Less than 1 percent not given.

Lake Loramie

Location and inflow data

Lake Loramie is in Shelby and Auglaize Counties 28 mi (45 km) south-southwest of Lima (figs. 1 and 37). The lake was formed by damming Loramie Creek in 1844 to serve as a feeder for the Miami-Erie Canal. Presently, the area is owned and operated by the State for recreation.

Loramie Creek provides most of the inflow to Lake Loramie. Site I-1 (fig. 37) represents drainage from 44 mi^2 (114 km^2) of agricultural and rural lands within an area of moderately low sediment yield (fig. 5). The May data (table 59) demonstrate that a chemical (specific conductance) and macronutrient enrichment to the lake was occurring. The low flow samples in August show higher chemical concentrations in the stream than in the lake, but the macronutrient input was negligible. Loramie Creek was turbid and had a mud bottom; no benthic organisms were observed, although a large school of gizzard shad was noted in summer.

Lake data

Lake Loramie was the shallowest lake sampled in 1975. A maximum depth for the lake of 6 ft (1.8 m) was observed at site L-1 (fig 37). The early May secchi disk extinction occurred at 0.9 ft (0.3 m) under slightly hazy skies. Except for dissolved oxygen, profile data (fig. 38 and table 60) show only slight differences between the top and bottom of the water column. The general oxygen demand (BOD, COD) was high (table 62), and its effects on the lake are indicated by the declining oxygen values with depth.

The bicarbonate values and the analyses of the water column composite sample (tables 60 and 61) show that the lake water was a hard, calcium magnesium sulfate bicarbonate type. Except for iron, Lake Loramie had low or undetected levels of trace and toxic constituents. Pesticides (listed on page 33) were below limits. The nitrate nitrogen concentration (table 62) at site L-1, when compared with that of the inflow at site I-1, suggests significant uptake of this nutrient form by the lake biology.

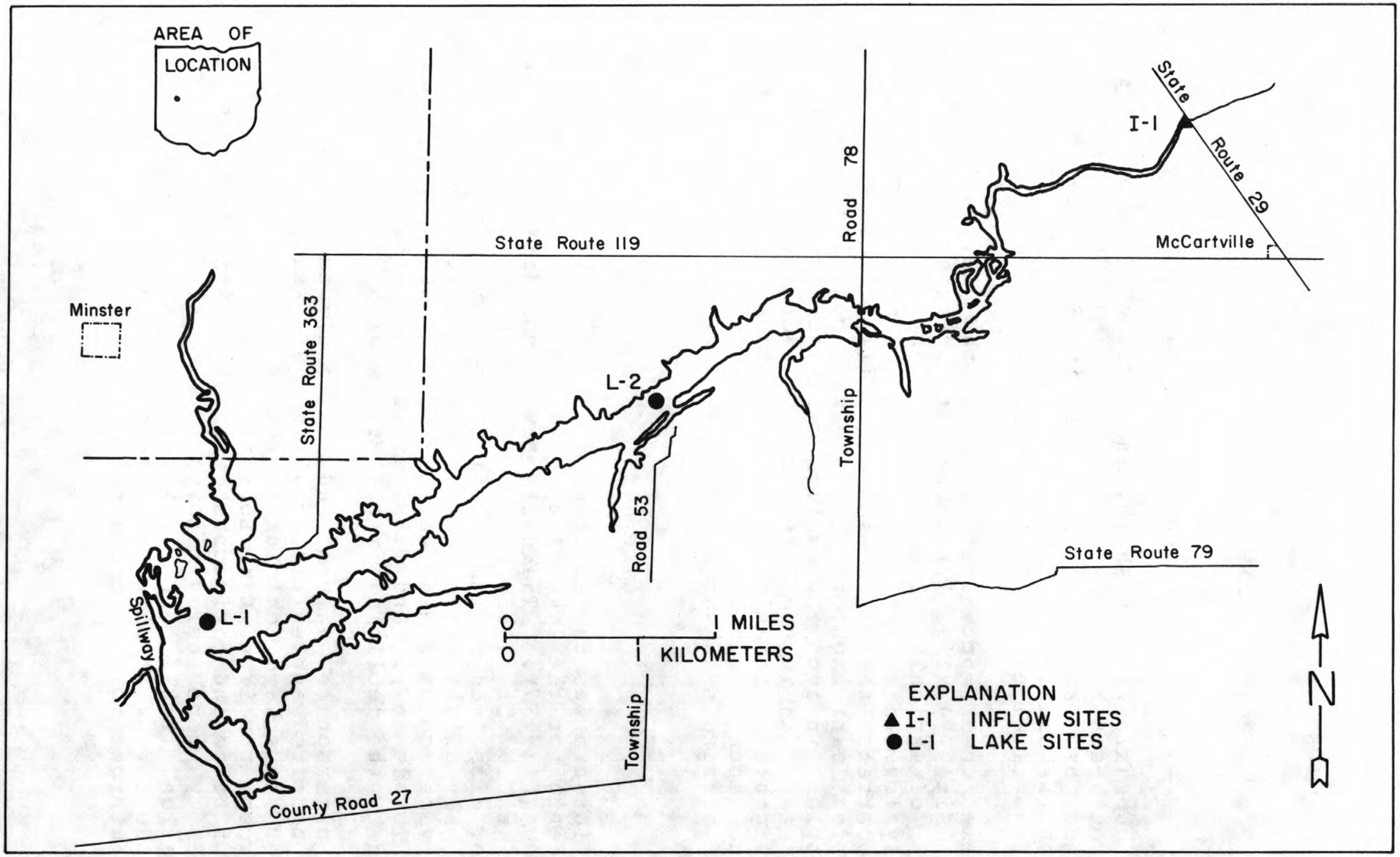


Figure 37.--Lake Loramie and inflow sampling sites.

Table 59.--Physical and chemical data for selected inflows, Lake Loramie, Ohio

402423084153500 - Loramie Creek above Lake Loramie at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN-TANEOUS DIS-CHARGE (CFS)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)
MAY												
17...	0945	E30	16.0	8.6	7.6	835	25	80	12	.83	2.8	.29
AUG												
13...	1120	<5.0	26.5	10.3	8.0	960	30	80	9.0	.01	1.3	.17

E Estimated.

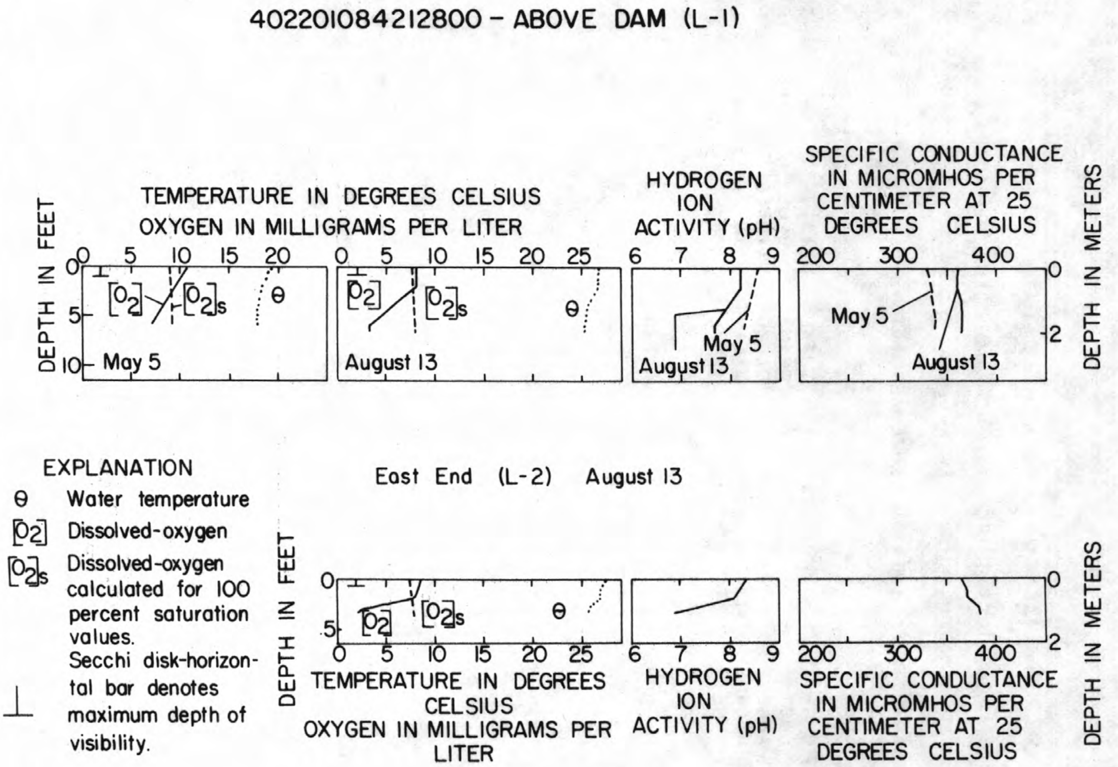


Figure 38.--Data profiles for Lake Loramie on selected days in 1975.

Table 60.--Profile data for the primary lake site, Lake Loramie, Ohio

402201084212800 - Lake Loramie above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
17...	1115	.0	19.3	10.9	121	331	8.6	--	--	--	--	--
17...	1120	2.0	18.5	9.4	103	335	8.5	12	84	.4	.0	11
17...	1125	4.0	18.0	8.3	90	338	8.4	--	--	--	--	--
17...	1130	6.0	18.0	7.2	78	338	8.3	0	108	.9	.0	--
AUG												
13...	1345	.0	26.7	8.1	104	360	8.2	--	--	--	--	--
13...	1350	2.0	26.7	8.1	104	360	8.2	0	140	1.4	.0	8.0
13...	1355	4.0	25.6	5.5	69	365	7.7	--	--	--	--	--
13...	1400	6.0	25.3	3.5	44	365	7.5	0	142	7.1	.0	--

Table 61.--Chemical analyses of water column composite samples, Lake Loramie, Ohio

402201084212800 - Lake Loramie above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY												
17...	1125	33	18	2.8	10	57	20	.3	160	206	80	286

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY											
17...	1125	100	0	0	3	<.5	1	1	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY								
17...	1125	40	1	0	1600	140	8	10

Table G2.--Chemical, physical and biological analyses of water samples from selected depths, Lake Loramie, Ohio

402201084212800 - Lake Loramie above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
17...	1120	2.0	.03	.00	.03	.41	1.4	1.8	.05	.24	.1
17...	1130	6.0	.04	.00	.04	.35	.47	.82	.02	.25	.2
AUG											
13...	1350	2.0	.01	.00	.01	.14	1.9	2.0	.05	.23	1.5
13...	1400	6.0	.03	.06	.09	.23	2.0	2.2	.06	.22	1.9

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
17...	1120	2.0	25	100	8.3	7.0	50	<3	<3
17...	1130	6.0	45	120	13	5.6	46	<3	3
AUG									
13...	1350	2.0	40	120	13	6.7	47	3	320
13...	1400	6.0	75	160	17	5.8	47	9	328

The counts for fecal coliform in May (table 62) were well within Ohio standards. (See page 31 .) The euphotic zone composite for phytoplankton (table 63) shows a dense population dominated by diatoms and green algae, and an apparent absence of blue-green algae.

The summer data collection in August was made under weather conditions similar to those in the spring. A May-August data comparison shows a slight chemical (specific conductance) enrichment and a general lake warming in August. Organic concentrations (TOC, organic nitrogen) and silica levels also were higher in August. The profiles at site L-2 (figs. 37 and 38) show rapidly decreasing dissolved oxygen and pH values near the lake bottom, indicating significant respiration in or near the benthic mud.

The fecal coliform counts were low and well within Ohio water-quality standards. The higher density of the streptococci group was likely related to an agricultural or natural habitat source (FC/FS<1.0). The phyoplankton results from the 2 ft (0.6 m) depth indicate a change from a mixed community in May to a very high-density, blue-green domination in August. Emergent rooted aquatic plants, including <u>Nelumbo</u> and <u>Nuphar</u>, were noted along the shore in protected areas.

Table 63.--Phytoplankton in Lake Loramie, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Location	Date	Location water column					
Site L-1 above dam ----------	5-17-75	Euphotic zone composite	46,000	-	Chrysophyta	49	Cyclotella (45); Nitzschia (4)
					Chlorophyta	42	Micractinium (11); Crucigenia (10); Actinastrum (8); Scenedesmus (7); Ankistrodesmus (4); Tetraedron (1); Kirchneriella (1)
					Pyrrhophyta	6	Glenodinium (6)
					Euglenophyta	4	Euglena (3); Phacus
Site L-1 above dam ----------	8-13-75	2-ft depth	450,000	1.422	Cyanophyta	91	Lyngbya (79); Agmenellum (7); Anacystis (2); Aphanizomenon (2) Cylindrospermum (2); Anabaenopsis (1)
					Chrysophyta	5	Nitzschia (3); Cyclotella (2)
					Chlorophyta	4	Scenedesmus (1); Crucigenia (1); Actinastrum (1); Dictyosphaerium (1)

* Less than 1 percent not given.

Lake Vesuvius

Location and inflow data

Lake Vesuvius is 8 mi (13 km) north of Ironton in Lawrence County (fig. 1 and 39). The lake was formed by damming Storms Creek in 1937 and is managed by the U.S. Forest Service as part of Wayne National Forest. Lake Vesuvius was the southernmost lake sampled in Ohio during 1975.

Storms Creek was sampled at site I-1 (fig. 39). The data (table 64) represent runoff from 9.7 mi^2 (25 km^2) of rural and forested lands within an area of moderately low sediment yield (fig. 5). Water discharge was low in spring, and the data show only minor macronutrient loading to the lake. The stream was dry at site I-1 on September 2, 1975. Mayflies (Ephemeroptera) and snails (Gastropoda) were the only invertebrates seen in Storms Creek.

Lake data

Lake Vesuvius was sampled in May under partly cloudy skies. The secchi disk extinction depth was 2.7 ft (0.8 m) at site L-1 (fig. 39). The lake was thermally stratified (fig. 40 and table 65) and showed signs of related chemical (pH, dissolved oxygen, and specific conductance) differentiation (tables 65 and 67) between the epilimnion and hypolimnion. The BOD was lower in the bottom water stratum than near the surface.

Chemical analyses of the water column composite (table 66) and bicarbonate values (table 65) show that the lake water was a soft, calcium sulfate type. The composite concentrations of iron and manganese were nearly 1000 ug/L, and copper concentration (20 ug/L) was 15 ug/L above Ohio water-quality standards for soft water. (See page 23). All other trace and toxic constituents were low. Pesticides (listed on page 33) were below detection limits. Inorganic forms of nitrogen and phosphorus (table 67) were present, although a comparison of surface and bottom data suggests probable biological conversion of available nitrogen into organic forms within the epilimnion.

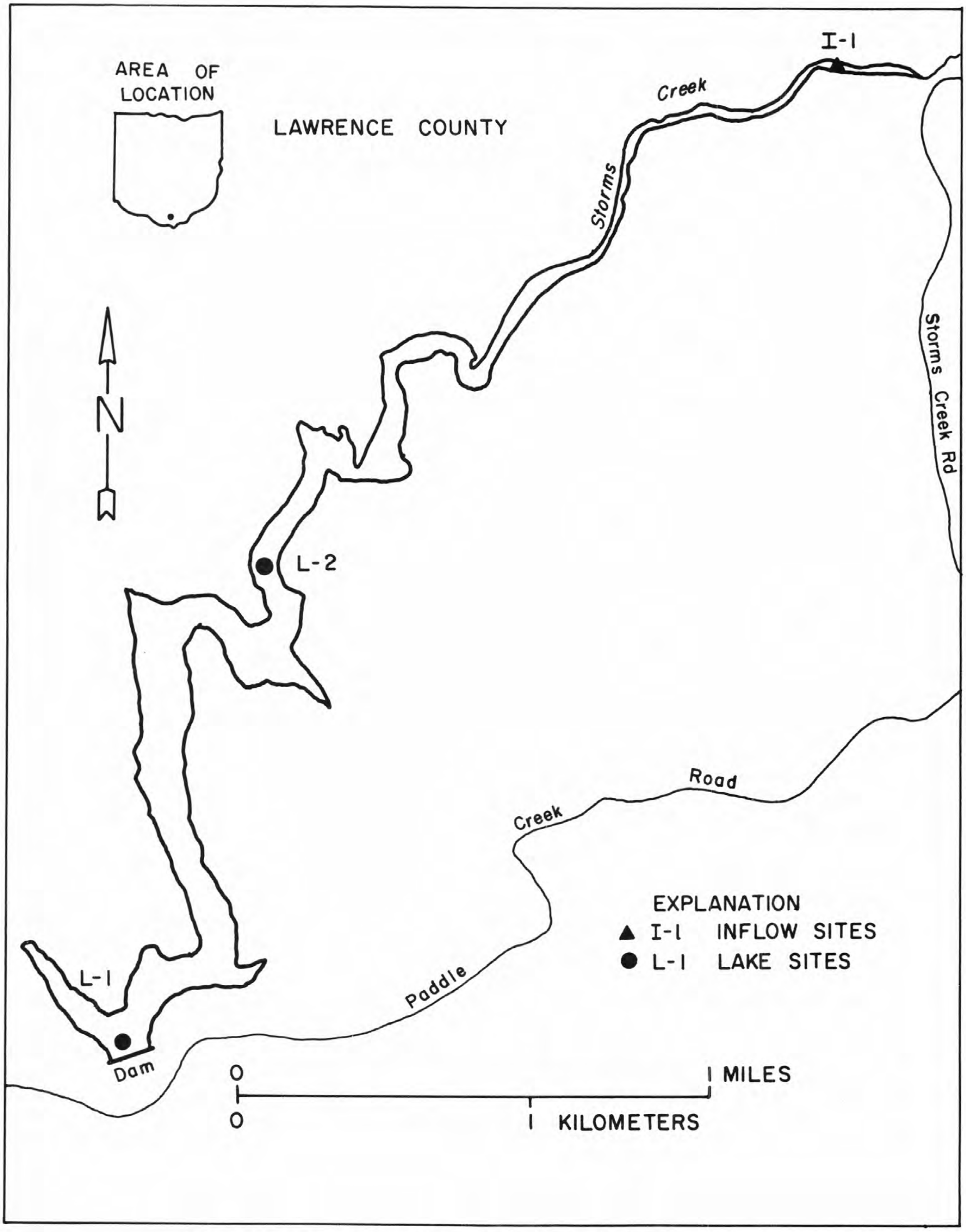


Figure 39.--Lake Vesuvius and inflow sampling sites.

Table 64.--Physical and chemical data for selected inflows, Lake Vesuvius, Ohio

383759082355800 - Storms Creek above Lake Vesuvius at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTAN- TANEOUS DIS- CHARGE (CFS)	TEMPER- ATURE (DEG C)	DIS- SOLVED OXYGEN (MG/L)	PH (UNITS)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	TUR- BID- ITY (JTU)	COLOR (PLAT- INUM- COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJEL- DAHL NITRO- GEN (N) (MG/L)	TOTAL PHOS- PHORUS (P) (MG/L)
MAY												
13...	1700	E2.0	18.0	9.2	7.3	252	20	40	3.1	.14	.69	.03

E Estimated.

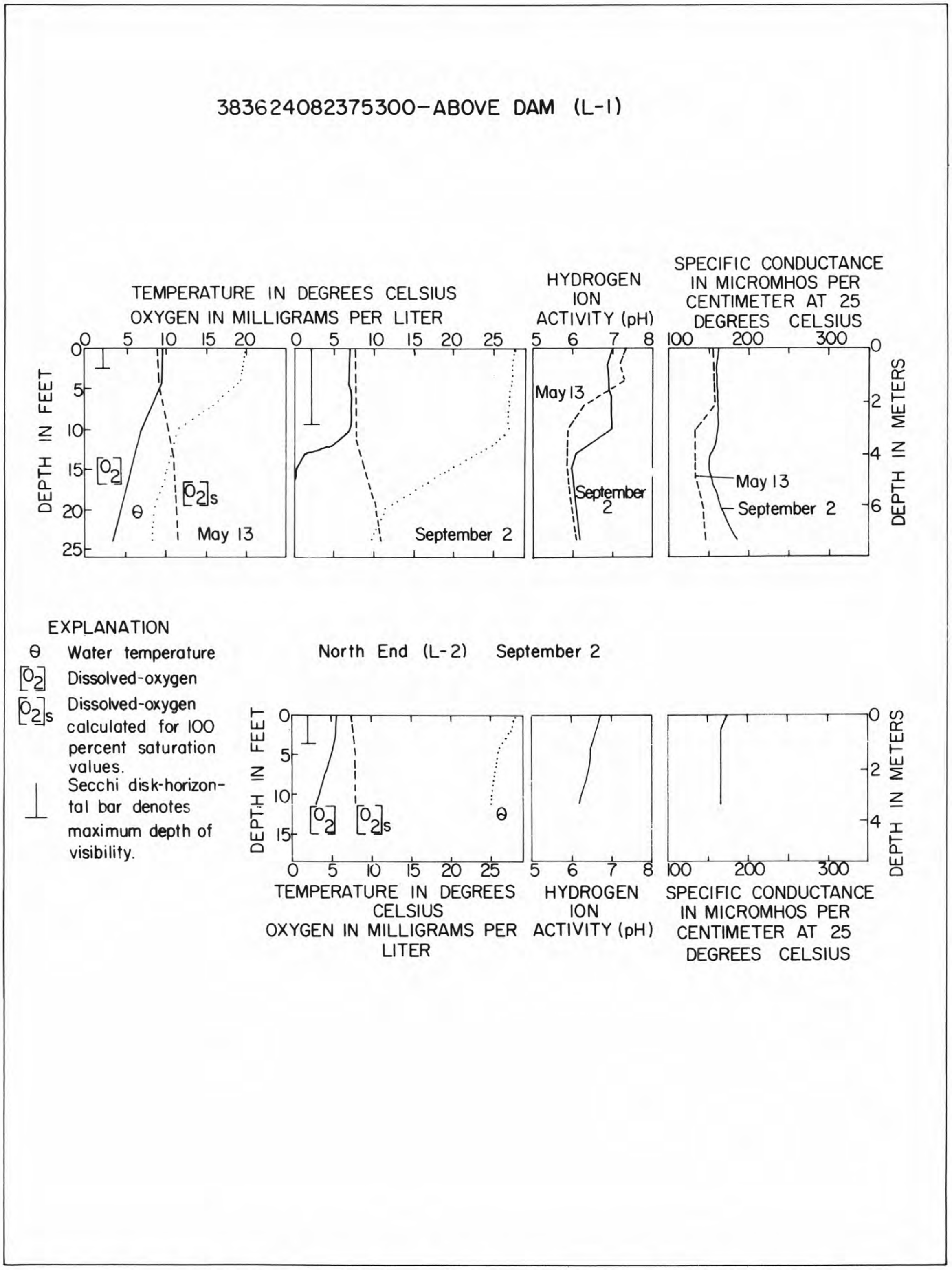


Figure 40.--Data profiles for Lake Vesuvius on selected days in 1975.

Table 65.--Profile data for the primary lake site, Lake Vesuvius, Ohio

383624082375300 - Lake Vesuvius above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
13...	1410	.0	20.0	9.5	106	155	7.3	--	--	--	--	--
13...	1415	2.0	19.8	9.6	107	155	7.2	0	34	3.4	.0	32
13...	1420	4.0	19.5	9.5	104	157	7.3	--	--	--	--	--
13...	1425	7.0	16.0	8.2	85	157	6.3	--	--	--	--	--
13...	1430	10	11.5	7.0	65	132	5.9	--	--	--	--	--
13...	1435	15	10.2	5.9	54	132	5.9	--	--	--	--	--
13...	1440	20	8.8	4.4	39	142	6.0	0	33	52	.0	--
13...	1445	24	8.4	3.6	31	147	6.1	--	--	--	--	--
SEP												
02...	1615	.0	27.8	7.1	92	162	7.0	--	--	--	--	--
02...	1620	2.0	27.5	7.0	90	160	6.9	0	51	10	.0	110
02...	1625	4.0	27.4	7.0	89	160	6.9	--	--	--	--	--
02...	1630	7.0	26.0	7.3	91	162	7.0	--	--	--	--	--
02...	1635	10	25.9	7.2	90	162	7.0	--	--	--	--	--
02...	1638	12	24.8	4.8	59	160	6.4	--	--	--	--	--
02...	1643	15	19.5	.4	4	152	6.0	--	--	--	--	--
02...	1645	20	11.5	.0	0	167	6.1	0	74	93	.0	--
02...	1650	24	9.8	.0	0	185	6.2	--	--	--	--	--

Table 66.--Chemical analyses of water column composite samples, Lake Vesuvius, Ohio

383624082375300 - Lake Vesuvius above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY												
13...	1430	15	4.3	1.6	2.2	37	1.2	.2	55	103	34	137

147

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY											
13...	1430	100	0	0	3	<.5	1	0	0	<10	.0

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY								
13...	1430	20	1	20	1200	740	1	20

Table 67.--Chemical, physical, and biological analyses of water samples from selected depths, Lake Vesuvius, Ohio

383624082375300-- Lake Vesuvius above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
13...	1415	2.0	.01	.10	.11	.05	.45	.50	.01	.02	6.7
13...	1440	20	.03	.31	.34	.09	.18	.27	.01	.05	6.1
SEP											
02...	1620	2.0	.00	.01	.01	.02	.20	.22	.02	.02	3.8
02...	1645	20	.00	.00	.00	.03	.45	.48	.01	.05	7.6

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
13...	1415	2.0	10	40	3.6	1.3	13	3	<3
13...	1440	20	45	100	5.7	.5	15	36	32
SEP									
02...	1620	2.0	1	5	5.5	.8	11	<2	2
02...	1645	20	9	50	8.1	1.0	22	5	14

The bacteria samples (table 67) from the water column indicate higher counts near the bottom of the lake, but all fecal coliform counts were within Ohio standards. (See page 31.) The phytoplankton community (table 68) within the euphotic zone was composed mostly of the blue-green genus, *Anacystis*, and various diatom genera. The total cell count (420 cells per milliliter) was among the lowest of the lakes sampled in 1975 and may reflect the effects of the copper concentration.

The September data were gathered under clear skies. Light penetration had greatly increased over the May condition. The lake was still thermally stratified, but the depths of both the epilimnion and metalimnion zones had doubled. The dissolved oxygen concentrations were near saturation levels in the epilimnion, but rapidly decreased below 10 ft (3.0 m). The pH profile displays a similar pattern in the upper half of the lake, declining to 6.0 at the 15 ft (4.6 m) depth and increasing slightly toward the bottom of the lake. The specific conductance and alkalinity also were highest at the lake bottom. These increases may be due to the solution of chemicals from the benthic mud. Profile data at site L-2 (figs. 39 and 40), compared with that at site L-1, show reduced levels of visibility and dissolved oxygen but a similar specific conductance.

The bacteria counts were lower than those in May, and fecal coliforms were well within Ohio standards. The phytoplankton sample from the 7 ft (2.1 m) depth shows a mixed community dominated by the blue-green genera, *Agmenellum* and *Anacystis*. Submerged vascular plants were observed in the littoral zones of the lake.

Table 68.--Phytoplankton in Lake Vesuvius, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Location	Date	Location water column					
Site L-1 above dam ---------	5-13-75	Euphotic zone composite	420	-	Cyanophyta	73	Anacystis (73)
					Chrysophyta	27	Synedra (14); Cyclotella (5); Nitzschia (4); Navicula (1); Achnanthes (1); Tabellaria (1)
Site L-1 above dam ---------	9-2-75	7-ft depth	13,000	2.213	Cyanophyta	80	Agmenellum (41); Anacystis (31); Lyngbya (8)
					Chlorophyta	17	Dictyosphaerium (8); Cyclotella (7); Melosira (1); Selenastrum (1)
					Chrysophyta	4	Dinobryon (3); Ophiocytium (1)

* Less than 1 percent not given.

Paint Creek Lake

Location and inflow data

Paint Creek Lake is in Highland and Ross Counties (figs. 1 and 41) 54 mi (87 km) southwest of Columbus. The lake was filled in 1974 after completion of a multi-level release dam across Paint Creek 4 mi (6.4 km) downstream from Rattlesnake Creek. The dam was built by the U.S. Army Corps of Engineers for flood control and recreation.

Paint and Rattlesnake Creeks provide most of the surface inflow, draining 272 mi² (704 km²) and 255 mi² (660 km²), respectively, of agricultural and rural lands within an area having moderate to high sediment yields (fig. 5). The creeks were sampled for selected parameters at sites I-1, and I-2 (fig. 41).

The chemical analyses (table 69) of moderate flow conditions in May show substantial nutrient input to Paint Creek Lake. A comparison of the data with macronutrient concentrations in September, when the flows were lower, indicates that Paint Creek could be a major source of nitrogen and phosphorus to the lake. Mayflies (Ephemeroptera) and caddisflies (Trichoptera) were observed at both inflow sites.

Lake data

Clear weather prevailed when the data were collected in Paint Creek Lake in May. The secchi disk disappeared at 2.2 ft (0.7 m) in dark-green water at site L-1 (fig. 41). Figure 42 and table 70 show a lake weak in thermal structure. The dissolved oxygen was over 20 mg/L (>200 percent saturation) in the top 3 ft (0.9 m) and over 17 mg/L throughout the upper 15 ft (4.6 m). Oxygen demand (BOD) in this supersaturated zone also was high (>8.2 mg/L) and most likely represented the respiration of a very active phytoplankton community. The specific conductance profiles at sites L-1 and L-2 (figs. 41 and 42) show increasing chemical concentrations with depth and a lateral increase toward the inflow end of the lake.

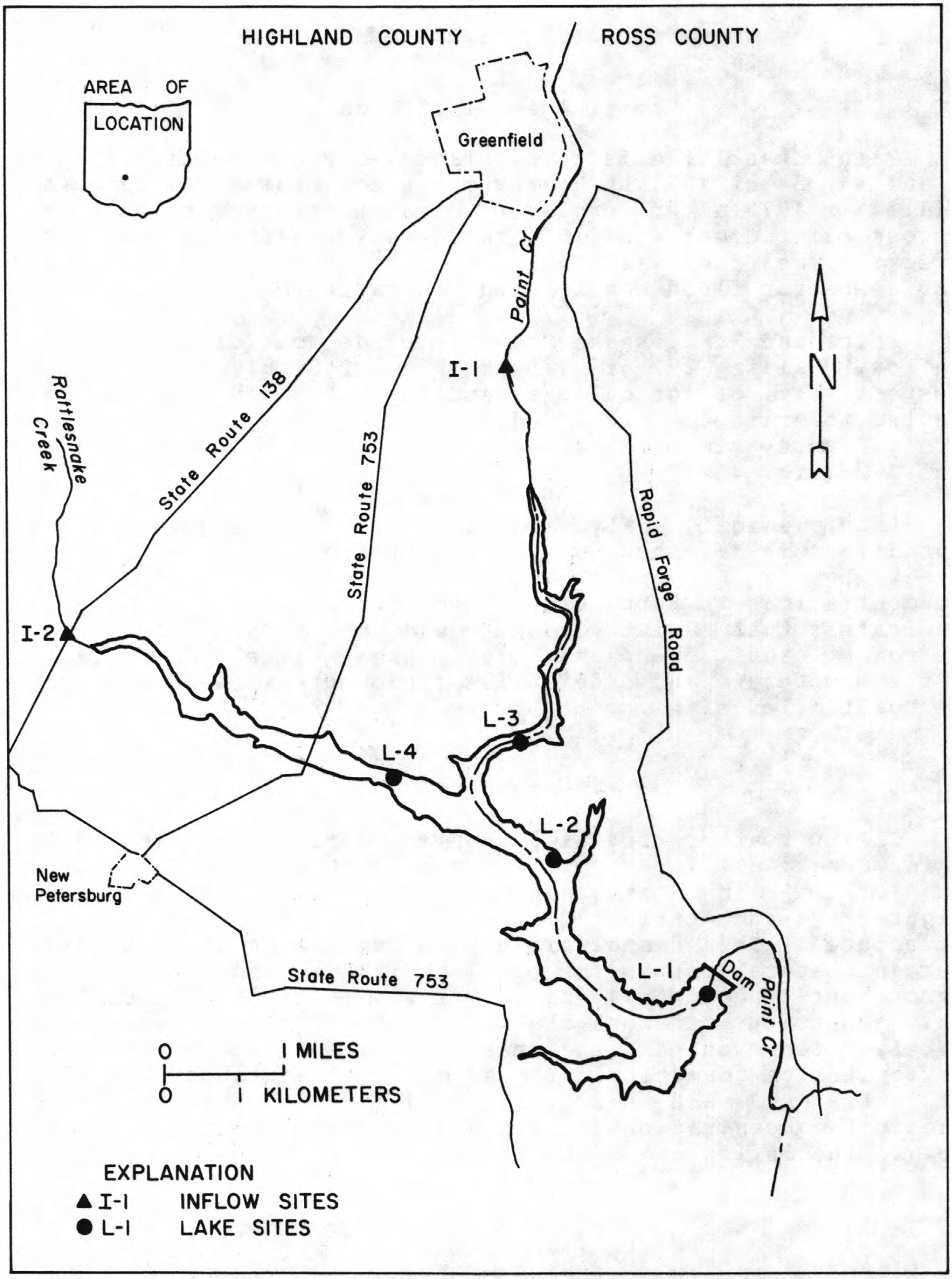


Figure 41.--Paint Creek Lake and inflow sampling sites.

Table 69.--Physical and chemical data for selected inflows, Paint Creek Lake, Ohio

391928083231200 - Paint Creek above Paint Creek lake at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
MAY												
06...	1115	E230	16.0	10.6	8.0	615	4	10	--	3.1	.51	.14
SEP												
05...	1105	E13	21.5	7.0	7.5	665	8	30	9.5	4.6	1.8	1.6

391728083272400 - Rattlesnake Creek above Paint Creek Lake at site (I-2)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
MAY												
06...	1250	E155	17.5	11.0	8.1	565	2	10	--	2.1	.30	.03
SEP												
05...	1315	E3.5	23.0	7.9	7.4	500	35	40	6.4	.35	.50	.05

E Estimated.

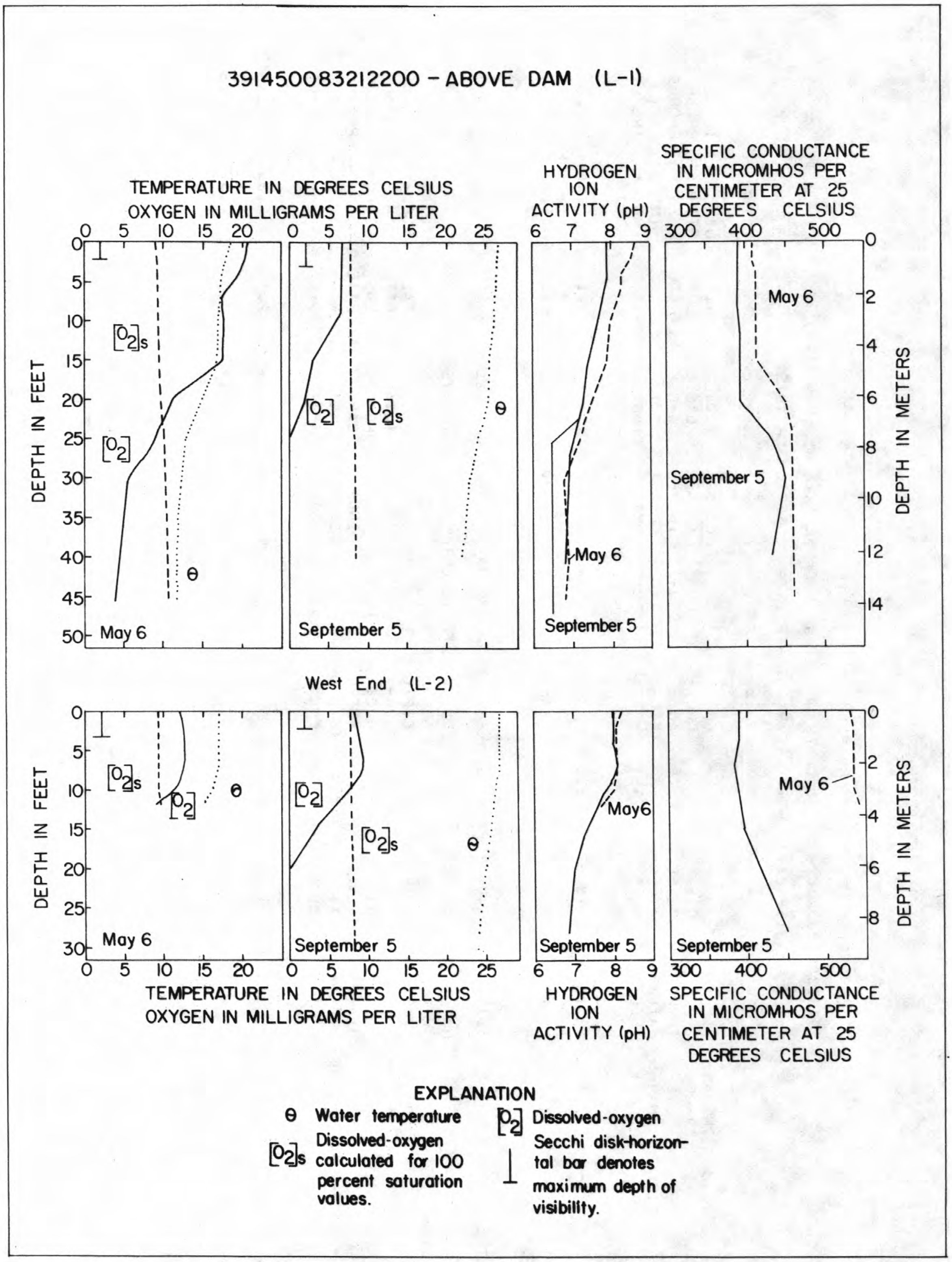


Figure 42.--Data profiles for Paint Creek Lake on selected days in 1975.

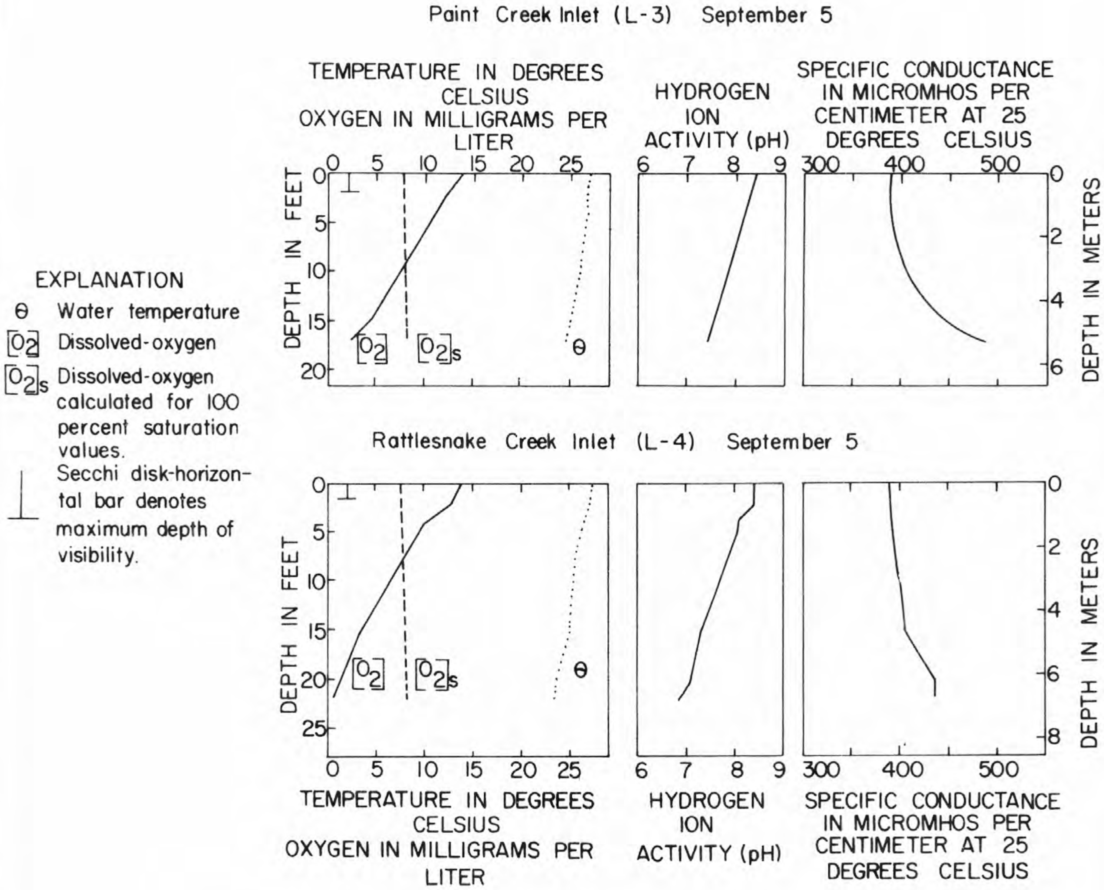


Figure 42.--Continued.

Table 70.--Profile data for the primary lake site, Paint Creek Lake, Ohio

391450083212200 - Paint Creek Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER- ATURE (DEG C)	DIS- SOLVED OXYGEN (MG/L)	PER- CENT SATUR- ATION	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH (UNITS)	CAR- BONATE (CO3) (MG/L)	BICAR- BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO- GEN SULFIDE (MG/L)	TRANS- PAR- ENCY (SECCHI DISK) (IN)
MAY												
06...	1505	.0	18.5	20.8	229	410	8.6	--	--	--	--	--
06...	1510	2.0	18.0	20.4	222	410	8.5	7	196	1.0	.0	26
06...	1515	4.0	17.5	19.6	211	415	8.3	--	--	--	--	--
06...	1520	7.0	17.2	17.3	184	415	8.2	--	--	--	--	--
06...	1525	10	17.0	17.7	188	415	8.0	--	--	--	--	--
06...	1530	15	16.8	17.4	183	415	7.9	--	--	--	--	--
06...	1535	20	15.0	11.1	113	450	7.5	--	--	--	--	--
06...	1540	25	13.0	8.8	86	460	7.2	--	--	--	--	--
06...	1545	30	12.5	5.7	55	460	6.8	--	--	--	--	--
06...	1550	40	11.7	4.5	43	460	6.9	0	256	65	.0	--
06...	1555	45	11.7	4.1	39	460	6.8	--	--	--	--	--
SEP												
05...	1515	.0	26.5	6.8	86	390	7.9	--	--	--	--	--
05...	1520	2.0	26.4	6.8	86	390	7.9	0	186	3.7	.0	36
05...	1525	4.0	26.4	6.8	86	390	7.9	--	--	--	--	--
05...	1530	7.0	26.2	6.8	86	390	7.8	--	--	--	--	--
05...	1535	10	26.1	6.3	80	393	7.7	--	--	--	--	--
05...	1540	15	25.4	3.0	38	393	7.4	--	--	--	--	--
05...	1545	20	25.3	2.1	26	393	7.3	--	--	--	--	--
05...	1550	25	24.0	.0	0	435	7.0	--	--	--	--	--
05...	1555	30	22.9	.0	0	450	6.9	--	--	--	--	--
05...	1600	40	22.0	.0	0	432	6.8	0	262	66	.1	--

Chemical results (tables 70 and 71) of the composite samples and bicarbonate values from the near surface and near bottom waters indicate that the lake water was a very hard, calcium bicarbonate type. Trace and toxic substances were low, and pesticides (listed on page 33) were below detection limits. Macronutrients (table 72) in the lake were high (see table 4) and can be considered a major cause for the highly stimulated activities of the algae.

The bacteria counts (table 72) were higher in the bottom sample than at the surface, but all fecal coliform counts were within Ohio water-quality standards. (See page 31.) The phytoplankton composite from the euphotic zone (table 73) was dominated by the biflagellate chrysophyte, Chlorochromonas, which accounted for 88 percent of the 70,000 cells/ml in the sample.

The summer profiles were made under partly cloudy skies. Secchi disk visibility had slightly improved over the May value. Thermal stratification was practically nonexistent, probably because of the water release patterns at the dam. A thermal gradient, however, combined with the increasing chemical content in the water below 20 ft (6.1 m) evidently had imparted a degree of stability to the lower depths. The dissolved oxygen was depleted from the bottom 15 ft (4.6 m) at site L-1. Sustained reducing conditions are indicated by hydrogen sulfide, high ammonia concentration, and the absence of oxidized inorganic nitrogen.

Profiles at site L-2 and in the two inflow inlets, sites L-3 and L-4 (figs. 41 and 42), show photosynthetic activity in the surface waters, and rapidly decreasing oxygen values toward the lake bottom. The general chemical concentration (specific conductance) increased with depth at all sites sampled, although similar values in the surface waters at all four sites suggest lateral mixing within the upper levels of the lake.

Table 71.--Chemical analyses of water column composite samples, Paint Creek Lake, Ohio

391450083212200 - Paint Creek Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY												
06...	1535	61	25	1.7	5.7	40	17	.3	260	291	58	349

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY											
06...	1535	100	0	<10	2	<.5	0	0	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY								
06...	1535	50	0	0	270	60	0	10

Table 72.--Chemical, physical, and biological analyses of water samples from selected depths, Paint Creek Lake, Ohio

391450083212200 - Paint Creek Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
06...	1510	2.0	.08	2.5	2.6	.33	1.4	1.7	.03	.14	2.2
06...	1550	40	.19	3.8	4.0	.43	.77	1.2	.08	.17	6.5
SEP											
05...	1520	2.0	.02	.28	.30	.13	.60	.73	.02	.04	1.8
05...	1600	40	.00	.00	.00	1.8	1.4	3.2	.08	.14	6.6

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
06...	1510	2.0	5	50	11	>8.2	36	3	<3
06...	1550	40	25	60	9.9	2.5	16	36	28
SEP									
05...	1520	2.0	4	20	6.5	3.2	15	2	2
05...	1600	40	60	200	13	1.7	18	72	52

Table 73.--Phytoplankton in Paint Creek Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)*of total cell count
Location	Date	Location water column					
Site L-1 above dam ---------	5-6-75	Euphotic zone composite	70,000		Chrysophyta	92	Chlorochromonas (88); Cyclotella (4)
					Chlorophyta	8	Pandorina (7); Scenedesmus (1)
Site L-1 above dam ---------	9-5-75	4-ft depth	420,000	0.525	Cyanophyta	97	Lyngbya (93); Oscillatoria (2); Aphanizomenon (2)
					Chrysophyta	3	Achnanthes (1); Synedra (1); Nitzschia (1)
Site L-3 Paint Creek inlet -	9-5-75	Surface	170,000	1.991	Cyanophyta	88	Agmenellum (47); Raphidiopsis (28) Oscillatoria (12); Anacystis (1)
					Chrysophyta	6	Achnanthes (5); Nitzschia (1)
					Chlorophyta	4	Scenedesmus (4); Staurastrum
Site L-4 Rattle-snake Creek inlet -------	9-5-75	Surface	100,000	2.099	Cyanophyta	77	Raphidiopsis (50); Oscillatoria (20); Anacystis (7)
					Chrysophyta	14	Achnanthes (12); Nitzschia (2)
					Chlorophyta	9	Scenedesmus (7); Selenastrum (1); Chlamydomonas (1)

* Less than 1 percent not given.

The bacteria counts at site L-1 were higher at the bottom than at the surface. Additional samples were taken at selected depths near sites L-2, L-3, and L-4, and the results are shown below:

Site	Depth	Colonies per 100 ml Fecal coliform	Fecal streptococci
L-2	surface	4	8
	23 ft	620	480
L-3	surface	16	64
L-4	surface	404	100

The phytoplankton results from zones of maximum dissolved oxygen at sites L-1, L-3, and L-4 show lakewide domination by blue-green algae but with lateral changes in community composition.

Punderson Lake

Location and inflow data

Punderson Lake, the only natural lake surveyed in Ohio in 1975, is in Geauga County 20 mi (32 km) east of Cleveland (figs. 1 and 43). The lake basin is a natural pot-hole depression of glacial origin. The 1.27 mi^2 (3.29 km^2) of poorly defined drainage to the lake is in an area of moderate sediment yield for Ohio (fig. 5). Punderson Lake and surrounding area is managed by the State for recreation purposes.

Lake data

Punderson Lake was sampled in late May under clear skies. The secchi disk extinction depth of 7.6 ft (2.3 m) was the deepest observed during the spring reconnaissance. The temperature data at site L-1 (fig. 43) shows three thermal strata (fig . 44 and table 74). Data profiles further illustrate a marked zone of oxygen supersaturation within the metalimnion (positive heterograde) with related pH modification. Oxygen demands (BOD, COD) were similar in the surface and bottom waters (table 76) but may have been greater near the 10 ft (3 m) depth. The specific conductance profile displays little variation with depth.

Chemical analyses from the water column composite and bicarbonate determinations (tables 75 and 74) show that the water was a hard, calcium bicarbonate type, but with notable amounts of sodium and chloride. Except for copper, trace and toxic subtances were low (see page 23), and pesticides (listed on page 33) were below detection limits. The copper concentration was 10 ug/L, which was at the accepted Ohio standard. The inorganic concentrations of nitrogen and phosphorus (table 76) were considerably less in the epilimnion than in the hypolimnion and most likely reflect biological uptake. The fecal coliform samples (table 76) were within Ohio water-quality standards. (See page 31.) The phytoplankton composite (table 77) shows almost complete community dominance by the blue-green algae, *Oscillatoria*.

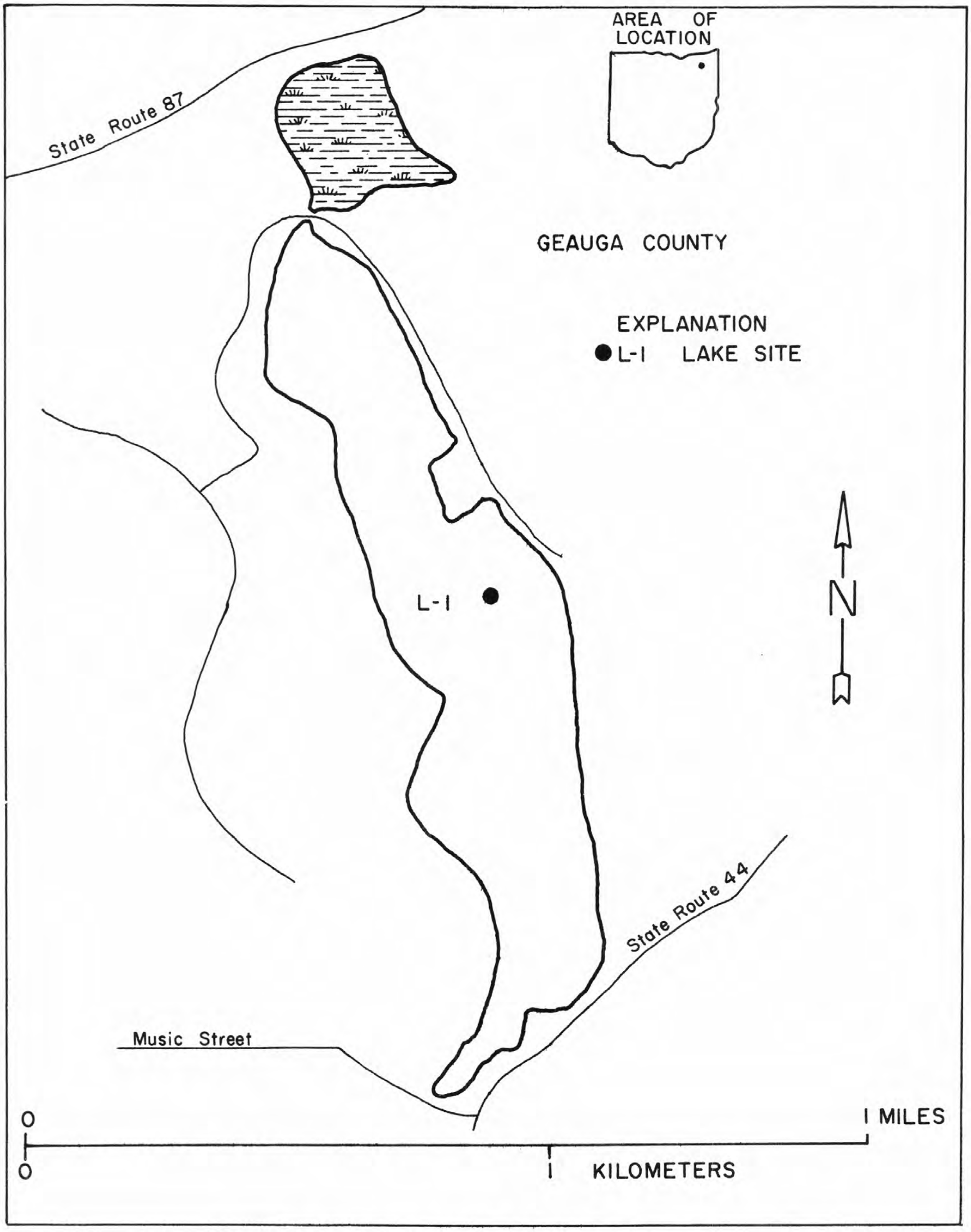


Figure 43.--Punderson Lake sampling site.

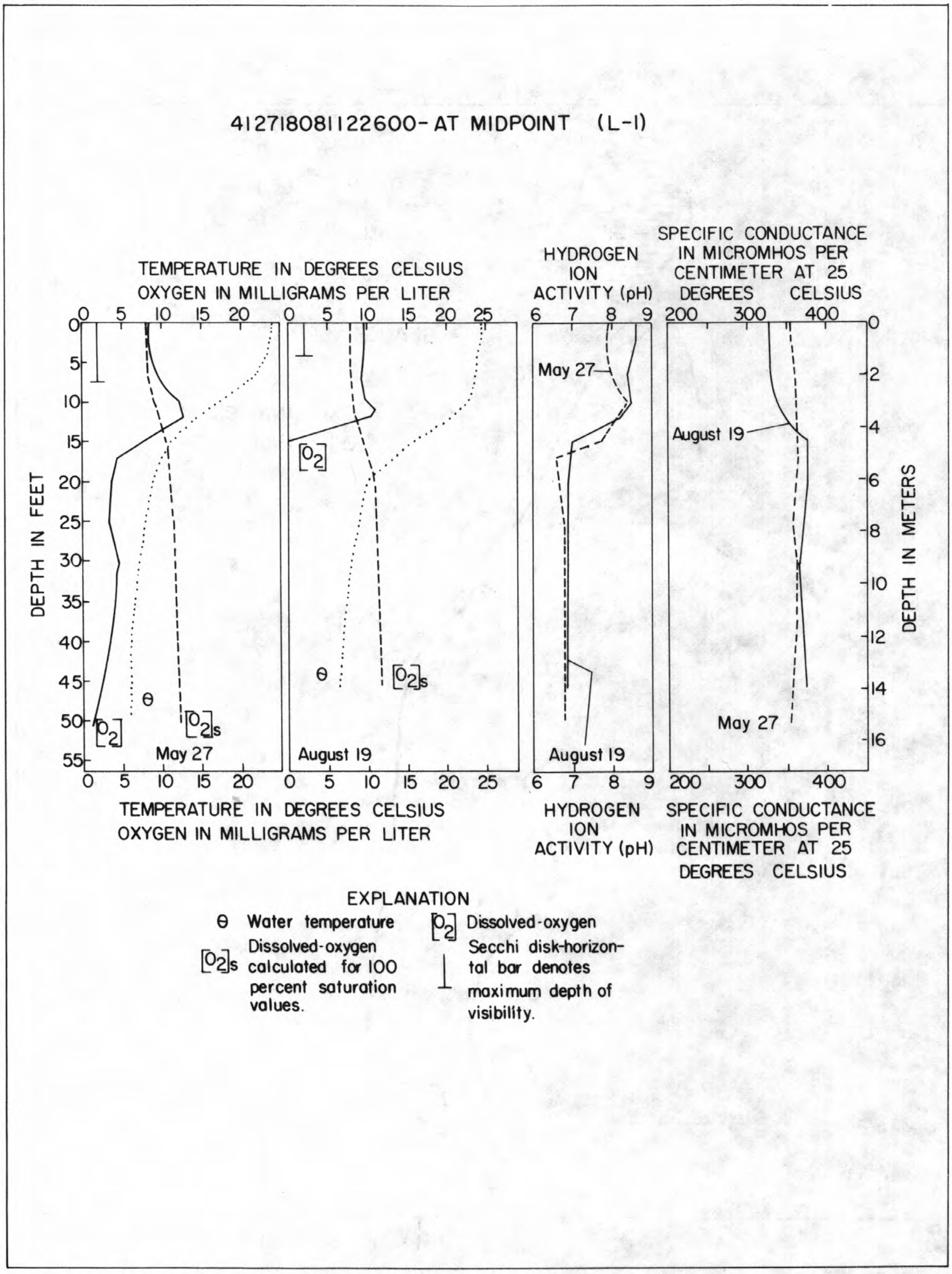


Figure 44.--Data profiles for Punderson Lake on selected days in 1975.

Table 74.--Profile data for the primary lake site, Punderson Lake, Ohio

412718081122600 - Punderson Lake at midpoint at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
27...	1430	.0	24.0	8.4	102	355	7.9	--	--	--	--	--
27...	1435	2.0	23.8	8.4	102	355	7.9	0	115	2.3	.0	91
27...	1440	4.0	23.3	8.8	106	360	7.9	--	--	--	--	--
27...	1445	7.0	21.7	9.5	112	361	8.0	--	--	--	--	--
27...	1448	10	17.3	12.2	131	363	8.4	--	--	--	--	--
27...	1451	12	14.3	12.8	129	361	8.1	--	--	--	--	--
27...	1454	15	11.2	7.7	73	365	7.7	--	--	--	--	--
27...	1457	17	10.0	4.4	40	365	6.6	--	--	--	--	--
27...	1500	20	8.9	3.7	33	363	6.7	--	--	--	--	--
27...	1503	25	8.0	3.4	30	358	6.8	--	--	--	--	--
27...	1506	30	7.2	4.4	38	362	6.8	--	--	--	--	--
27...	1510	40	6.1	3.6	30	362	6.8	--	--	--	--	--
27...	1515	50	6.1	1.1	9	355	6.8	0	132	33	.0	--
AUG												
19...	1445	.0	24.5	9.5	117	330	8.6	--	--	--	--	--
19...	1450	2.0	24.5	9.6	119	330	8.6	4	96	.4	.0	52
19...	1455	4.0	24.0	9.7	120	330	8.5	--	--	--	--	--
19...	1500	7.0	23.7	9.3	113	330	8.4	--	--	--	--	--
19...	1504	10	23.0	9.9	119	335	8.5	--	--	--	--	--
19...	1507	11	21.8	11.1	131	340	8.4	--	--	--	--	--
19...	1509	12	20.9	10.4	121	345	8.2	--	--	--	--	--
19...	1512	15	16.0	.0	0	375	7.0	--	--	--	--	--
19...	1515	20	10.0	.0	0	375	6.9	--	--	--	--	--
19...	1520	30	7.9	.0	0	365	6.9	--	--	--	--	--
19...	1525	40	6.9	.0	0	370	6.8	--	--	--	--	--
19...	1530	46	6.5	.0	0	375	6.8	0	165	42	2.2	--

Table 75.--Chemical analyses of water column composite samples, Punderson Lake, Ohio

412718081122600 - Punderson Lake at midpoint at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY												
27...	1500	37	8.9	2.0	24	29	39	.2	130	251	2	253

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY											
27...	1500	0	0	10	4	<.5	2	0	0	<10	.1

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY								
27...	1500	50	0	10	100	510	1	10

Table 76.--Chemical, physical, and biological analyses of water samples from selected depths, Punderson Lake, Ohio

412718081122600 - Punderson Lake at midpoint at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
27...	1435	2.0	.01	.02	.03	.03	.73	.76	.00	.03	.6
27...	1515	50	.02	.07	.09	1.0	.90	1.9	.16	.29	2.0
AUG											
19...	1450	2.0	.01	.00	.01	.00	.74	.74	.01	.03	1.3
19...	1530	46	.01	.00	.01	2.2	1.0	3.2	.41	.55	3.2

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
27...	1435	2.0	3	20	9.9	1.6	15	24	8
27...	1515	50	3	30	5.8	2.2	17	2	<3
AUG									
19...	1450	2.0	5	15	11	2.2	27	2	2
19...	1530	46	25	30	9.0	2.2	23	<2	<2

Table 77.--Phytoplankton in Punderson Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Location	Date	Location water column					
Site L-1 at midpoint -----	5-27-75	Euphotic zone composite	52,000	-	Cyanophyta	99	Oscillatoria (96); Aphanizomenon (3)
					Chrysophyta	1	Fragilaria (1); Cocconeis; Cyclotella
Site L-1 at midpoint -----	8-19-75	4-ft depth	78,000	2.516	Cyanophyta	88	Anacystis (38); Oscillatoria (18); Gomphosphaeria (15); Aphanizomenon (11); Anabaena (6)
					Chlorophyta	7	Sphaerocystis (4); Dictyosphaerium (3)
					Chrysophyta	3	Fragilaria (3); Navicula
Site L-1 at midpoint -----	8-19-75	11-ft depth	300,000	0.859	Cyanophyta	100	Ocilatoria (86); Anacystis (7); Aphanizomenon (3); Gomphosphaeria (3); Anabaena (1)
					Chrysophyta	<1	Melosira

* Less than 1 percent not given.

Intermittent rains and partly cloudy skies preceded the August data collection. The secchi disk light penetration was reduced to 57 percent of the May value, although the temperature profiles remained similar. The positive heterograde seen in the oxygen profile in May still existed in August. Anaerobic conditions and low pH characterized the lower metalimnion and entire hypolimnion. The specific conductance profile shows a sharply defined chemical stratification in the lake. The high concentrations of hydrogen sulfide, ammonia, and phosphorus near the lake bottom, and the septic odor from the hypolimnetic waters, suggest nutrient and chemical recycling in a reduced environment.

Bacteria densities were low and fecal coliform counts were well within Ohio standards. The blue-green algae, *Oscillatoria*, dominated the phytoplankton community in the zone of oxygen supersaturation at 11 ft (3.4 m). A second sample at 4 ft (1.2 m) showed a greater diversity of algae ($\bar{d}$ = 2.516) and a lower cell density.

A wide variety of higher aquatic plants were noted in the lake. Emergent, floating, and submerged species were common in the littoral zone along the shore. Among the genera noted were *Myriophyllum*, *Potamogeton*, *Anacharis*, *Nymphaea*, *Ceratopyllum* and *Vallisneria*.

Rocky Fork Lake

Location and inflow data

Rocky Fork Lake is in Highland County 55 mi (88 km) east of Cincinnati (figs. 1 and 45). The lake was formed in 1952 by damming Rocky Fork Creek and is owned and managed by the State for recreation.

Rocky Fork Creek and Clear Creek account for most of the surface inflow. Both creeks drain agricultural lands within an area of moderately high sediment yield (fig. 5). Rocky Fork and Clear Creeks have drainage basins at their confluence of 43.6 mi^2 (113 km^2) and 45.3 mi^2 (117 km^2), respectively.

A comparison of data (table 78), collected under steady flow conditions at site I-1 and site I-2 (fig. 45), shows higher chemical and macronutrient inputs from Clear Creek. A similar relationship, but with increased macronutrient concentrations, is shown for September. Several days of thundershowers however, preceded the September sampling. Mayflies (Ephemeroptera) and caddisfly (Trichoptera) larvae were common benthic organisms observed in Clear Creek.

Lake data

Rocky Fork Lake was sampled in May under partly cloudy skies. Secchi disk transparency at site L-1 (fig. 45) was 2.1 ft (0.6 m). The profile data (fig. 46 and table 79) show a weak temperature gradient with gradually decreasing dissolved oxygen and pH, and slightly increasing specific conductance with depth. Oxygen demand and TOC (table 81) were higher near the surface than at the bottom.

Data from the water column composite (table 80) and bicarbonate values (table 79) classified the lake water as a very hard, calcium bicarbonate type. Except for silver, the trace and toxic substances were low. Silver was detected at

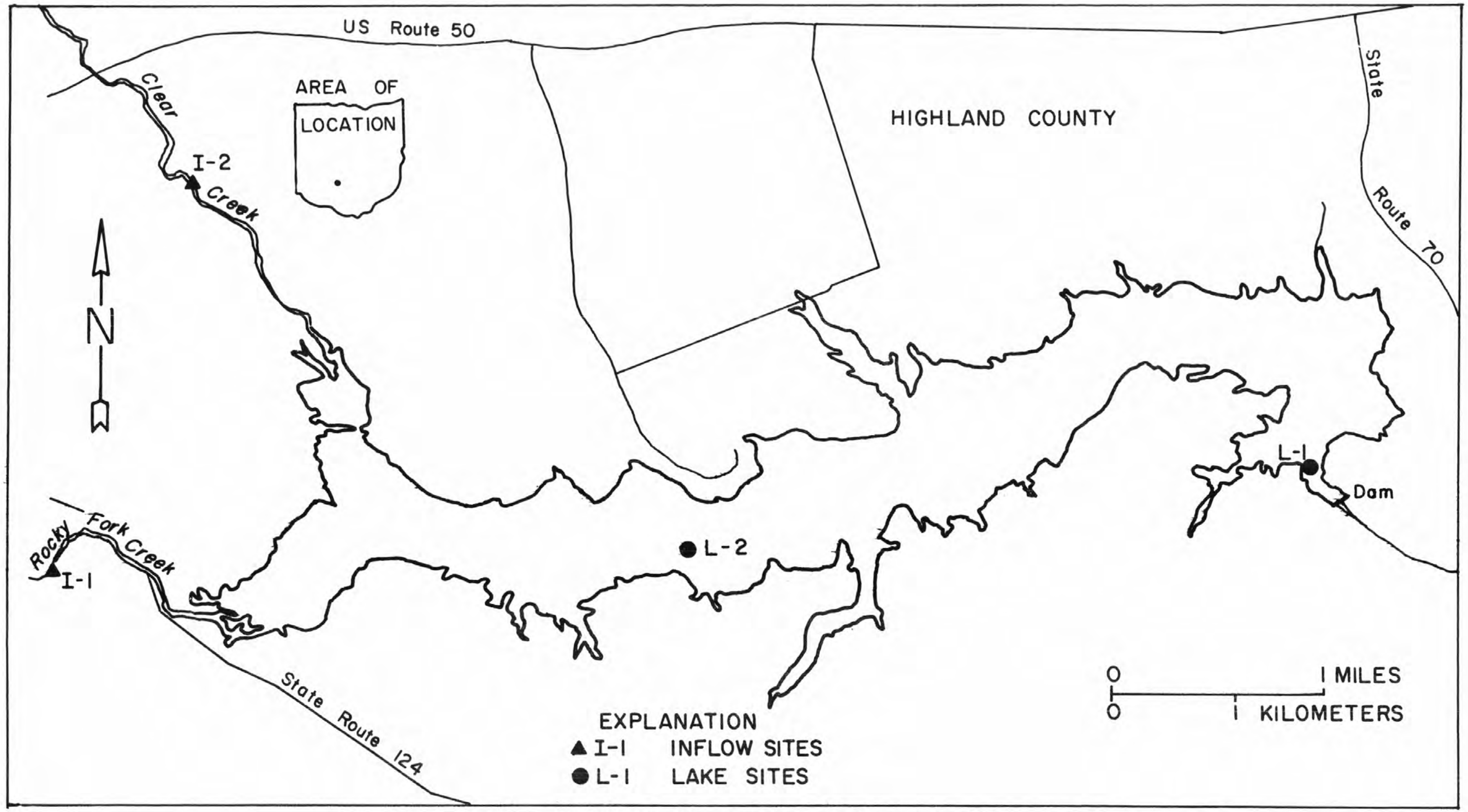


Figure 45.--Rocky Fork Lake and inflow sampling sites.

Table 78.--Physical and chemical data for selected inflows, Rocky Fork Lake, Ohio

391045083330600 - Rocky Fork Creek above Rocky Fork Lake at site (I-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
MAY												
07...	0920	E30	14.5	9.0	7.8	488	4	10	--	.37	.25	.02
SEP												
06...	1045	E35	20.0	6.7	7.5	383	130	150	17	.54	.45	.06

391215083322500 - Clear Creek above Rocky Fork Lake at site (I-2)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PH (UNITS)	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)
MAY												
07...	1030	E40	14.5	9.5	7.8	530	2	5	--	1.1	.32	.21
SEP												
06...	1130	E35	20.0	6.4	7.3	400	120	200	20	1.3	.93	.42

E Estimated.

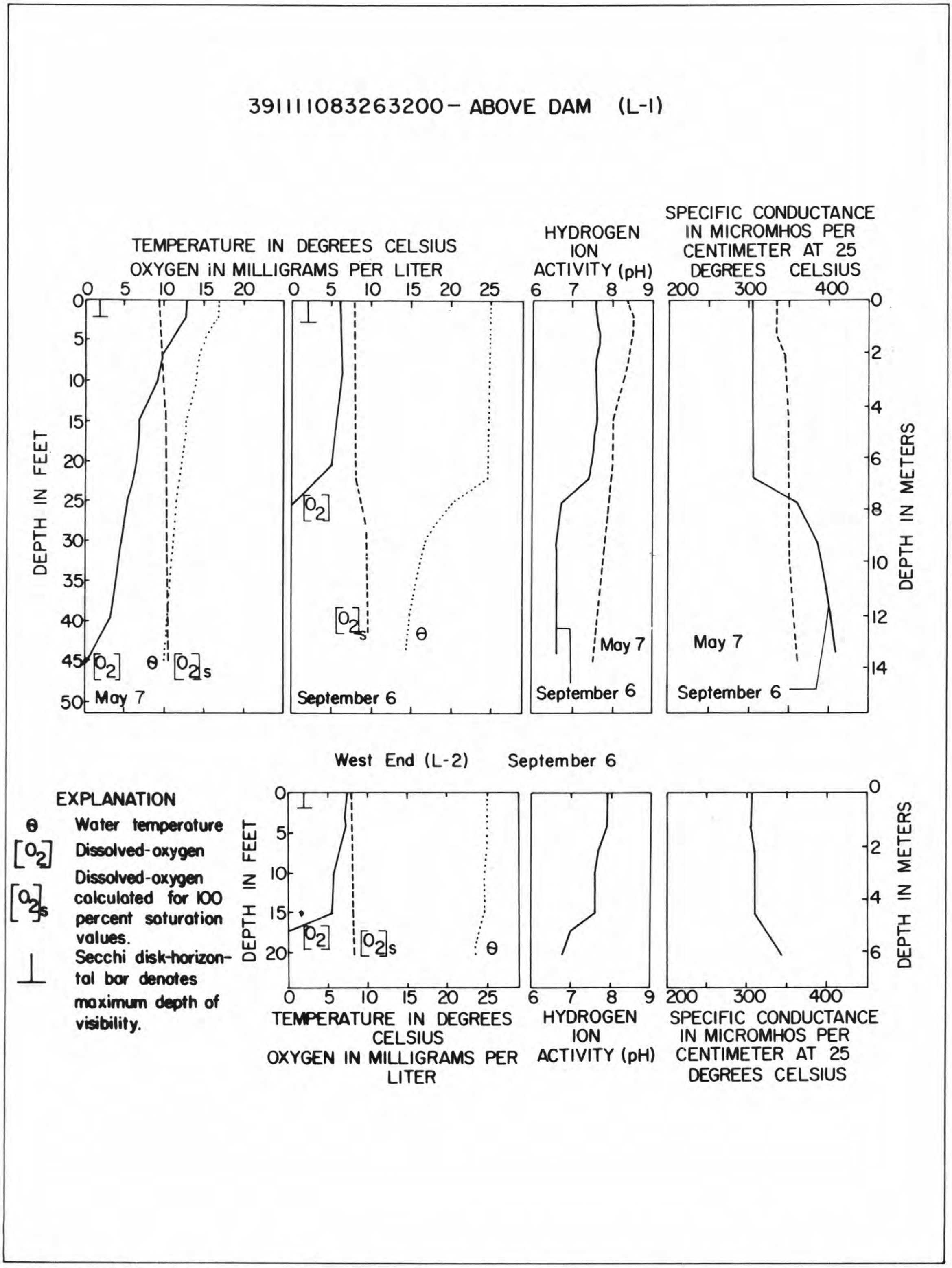


Figure 46.--Data profiles for Rocky Fork Lake on selected days in 1975.

Table 79.--Profile data for the primary lake site, Rocky Fork Lake, Ohio

391111083263200 - Rocky Fork Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
07...	1430	.0	17.0	12.9	137	335	8.4	--	--	--	--	--
07...	1435	2.0	16.8	12.8	135	335	8.5	8	168	.8	.0	25
07...	1440	4.0	15.8	11.7	122	335	8.5	--	--	--	--	--
07...	1445	7.0	14.5	10.0	101	343	8.4	--	--	--	--	--
07...	1450	10	14.2	9.4	94	345	8.3	--	--	--	--	--
07...	1455	15	13.0	7.2	70	350	8.0	--	--	--	--	--
07...	1500	20	12.5	7.0	67	350	8.0	--	--	--	--	--
07...	1505	25	11.8	5.6	53	350	7.9	--	--	--	--	--
07...	1510	30	11.5	4.9	46	350	7.8	--	--	--	--	--
07...	1515	40	10.8	3.4	32	355	7.6	0	210	8.4	.0	--
07...	1520	45	10.3	.8	7	360	7.5	--	--	--	--	--
SEP												
06...	1335	.0	25.0	6.1	76	305	7.6	--	--	--	--	--
06...	1340	2.0	25.0	6.2	78	305	7.6	0	164	6.6	.0	34
06...	1345	4.0	25.0	6.2	78	305	7.7	--	--	--	--	--
06...	1350	7.0	25.0	6.2	78	305	7.6	--	--	--	--	--
06...	1355	10	24.8	6.2	76	305	7.6	--	--	--	--	--
06...	1400	15	24.8	5.6	69	305	7.6	--	--	--	--	--
06...	1405	20	24.8	5.1	63	305	7.5	--	--	--	--	--
06...	1408	22	24.6	3.5	43	308	7.4	--	--	--	--	--
06...	1410	25	20.0	.0	0	360	6.7	--	--	--	--	--
06...	1415	30	16.8	.0	0	385	6.6	--	--	--	--	--
06...	1420	40	14.8	.0	0	403	6.6	0	264	105	.6	--
06...	1425	44	14.5	.0	0	407	6.6	--	--	--	--	--

Table 80.--Chemical analyses of water column composite samples, Rocky Fork Lake, Ohio

391111083263200 - Rocky Fork Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY												
07...	1500	43	22	2.1	4.2	23	9.1	.3	200	201	48	249

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY											
07...	1500	100	0	0	7	<.5	0	0	1	<10	.1
* SEP											
06...	1420	--	--	--	10	--	--	--	1	--	--

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY								
07...	1500	30	1	10	250	210	1	10

* Taken from a water sample 1 to 3 ft from the lake bottom.

1.0 ug/L in spring and confirmed at the same concentration at the lake bottom in September. Pesticides (listed on page 33) were not detected in either the May or September samples. The orthophosphorus concentration was less than detectable limits, and silica was low in the epilimnion (table 81), possibly reflecting diatom uptake of these macronutrients.

The fecal coliform counts (table 81) were well within limits set by Ohio water-quality standards. (See page 31.) The phytoplankton community (table 82) from the euphotic zone shows a dominance by diatoms (84 percent) and an absence of blue-green algae.

The late summer profiles, taken under partly cloudy skies, disclose three chemically different water bodies. A warm, well mixed epilimnion existed above 22 ft (6.7 m) at site L-1 and 15 ft (4.6 m) at site L-2 (figs. 45 and 46). Below these levels, temperature, dissolved oxygen, and pH rapidly decreased and specific conductance increased. A low pH, anaerobic condition, with significant amounts of organic nitrogen, ammonia, TOC, and total phosphorus, is shown in the hypolimnion at site L-1. A hydrogen sulfide odor was first detected at 30 ft (9.1 m) and confirmed in the near bottom water. These conditions indicate accumulation and anaerobic decomposition of organic matter.

Although the fecal coliforms were within Ohio standards, the bacteria counts were higher than in May and probably reflect the effects of inflow from earlier storms. Blue-green algae accounted for 93 percent of the phytoplankton at 4 ft (1.2 m) and indicate a major change from the spring community of mixed diatoms and green algae.

Table 81.--Chemical, physical, and biological analyses of water samples from selected depths, Rocky Fork Lake, Ohio

391111083263200 - Rocky Fork Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
07...	1435	2.0	.02	.40	.42	.41	.47	.88	.00	.05	.2
07...	1515	40	.02	.40	.42	.01	.58	.59	.01	.05	3.0
SEP											
06...	1340	2.0	.00	.00	.00	.07	.57	.64	.02	.04	2.2
06...	1420	40	.00	.00	.00	3.4	5.7	9.1	.08	.18	6.6

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
07...	1435	2.0	7	30	12	4.2	20	3	<3
07...	1515	40	7	40	7.9	1.5	8	3	<3
SEP									
06...	1340	2.0	4	30	12	3.3	15	90	40
06...	1420	40	25	80	21	2.7	17	70	24

Table 82.--Phytoplankton in Rocky Fork Lake, Ohio

Sample description: Location	Sample description: Date	Sample description: Location water column	Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Site L-1 above dam ----------	5-7-75	Euphotic zone composite	14,000	-	Chrysophyta	84	Melosira (30); Cyclotella (30); Synedra (22); Nitzschia (2)
					Chlorophyta	14	Tetrastrum (5); Scenedesmus (3); Oocystis (3); Dictyosphaerium (3)
					Euglenophyta	2	Trachelomonas (2)
Site L-1 above dam ----------	9-6-75	4-ft depth	160,000	1.981	Cyanophyta	93	Ocillatoria (34); Raphidiopsis (33); Agmenellum (24); Anacystis (2)
					Chrysophyta	6	Nitzschia (6); Cyclotella
					Chlorophyta	1	Scenedesmus (1)

* Less than 1 percent not given.

Salt Fork Lake

Location and inflow data

Salt Fork Lake is in Guernsey County 7 mi (11 km) northeast of Cambridge (figs. 1 and 47). Filling of the lake began in late 1967 after completion of an earthfill dam across Salt Fork Creek 0.8 mi (1.3 km) upstream from Wills Creek. Inflows represent drainage from mixed agricultural and rural lands within a moderately low sediment yield area (fig. 5). The lake is owned and operated by the State for recreation and flood control. Because of the morphometric complexity of the lake, additional lake sites were sampled in lieu of inflow sampling.

Lake data

Salt Fork Lake was sampled during clear, stable weather in May. Secchi disk extinction depths were greatest at site L-1 and least in the south inlet at site L-3 (figs. 47, and 48). Oxygen supersaturation at the three lake sites (fig 48 and tables 83, 86, and 87) developed in the warm, euphotic zone. Deeper waters were characterized by decreasing temperatures, pH, and dissolved oxygen. Specific conductance was least in the north inlet (L-2) and greatest in the south inlet (L-3), suggesting a generally greater chemical enrichment from the southern drainage basin.

Data from the water column composite (table 84) and bicarbonate values (table 83) show that the lake water was a moderately hard, calcium sulfate type with generally low or sub-detectable concentrations of trace and toxic substances. The copper concentration of 10 ug/L was at the State's accepted limit for a water hardness of 95 mg/L. Pesticides (listed on page 33) were below detection limits. Macronutrient data at all three sites (tables 85, 86, and 87) indicate a generally even distribution of nitrogen and phosphorus throughout the lake. Some ammonia generation in the bottom waters and nitrate conversion to organic nitrogen in the surface waters is suggested by the data collected at site L-1.

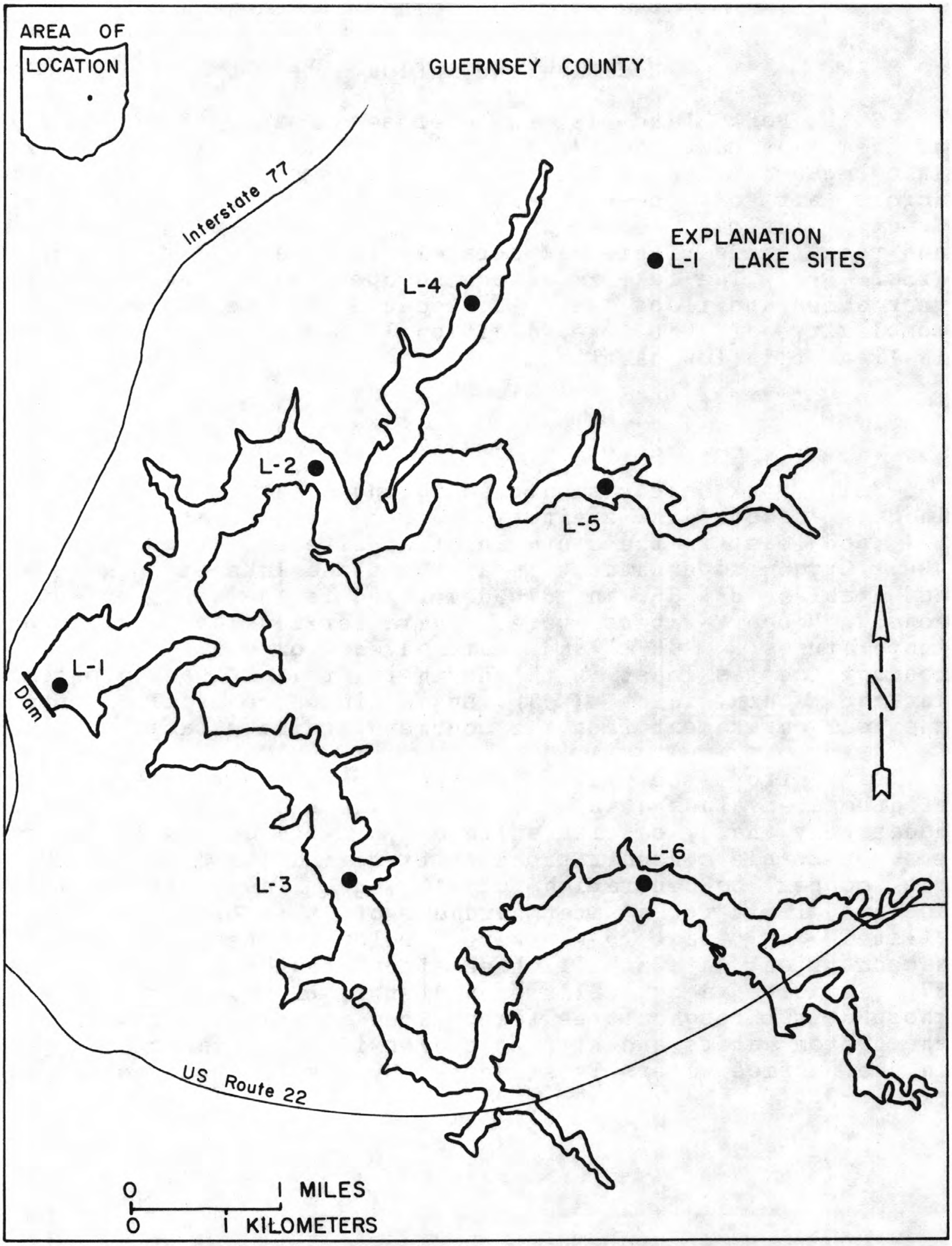


Figure 47.--Salt Fork Lake sampling sites.

Table 83.--Profile data for the primary lake site, Salt Fork Lake, Ohio

400617081331600 - Salt Fork Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
20...	1440	.0	19.5	10.4	116	235	7.7	--	--	--	--	--
20...	1445	2.0	19.5	10.5	117	235	7.8	0	44	1.1	.0	65
20...	1450	4.0	18.7	10.6	116	235	7.7	--	--	--	--	--
20...	1455	7.0	16.5	9.3	98	240	6.8	--	--	--	--	--
20...	1500	10	15.5	7.5	77	255	6.5	--	--	--	--	--
20...	1505	15	12.2	5.8	56	245	6.3	--	--	--	--	--
20...	1510	20	10.4	5.4	50	240	6.3	--	--	--	--	--
20...	1515	25	9.8	3.6	33	240	6.3	--	--	--	--	--
20...	1520	30	9.4	1.9	17	240	6.3	--	--	--	--	--
20...	1525	38	9.2	1.3	12	240	6.2	0	48	48	.0	--
AUG												
15...	1500	.0	25.6	9.4	118	250	8.4	--	--	--	--	--
15...	1505	2.0	25.6	9.6	120	250	8.4	2	60	.4	.0	36
15...	1510	4.0	25.6	9.6	120	250	8.4	--	--	--	--	--
15...	1515	7.0	25.3	9.0	112	250	8.3	--	--	--	--	--
15...	1520	10	24.5	7.2	88	253	7.4	--	--	--	--	--
15...	1525	15	22.0	.5	6	260	6.5	--	--	--	--	--
15...	1530	20	15.5	.0	0	273	6.6	--	--	--	--	--
15...	1535	25	12.5	.0	0	287	6.8	--	--	--	--	--
15...	1540	30	11.8	.0	0	287	6.9	--	--	--	--	--
15...	1545	38	11.5	.0	0	287	6.9	0	109	22	.2	--

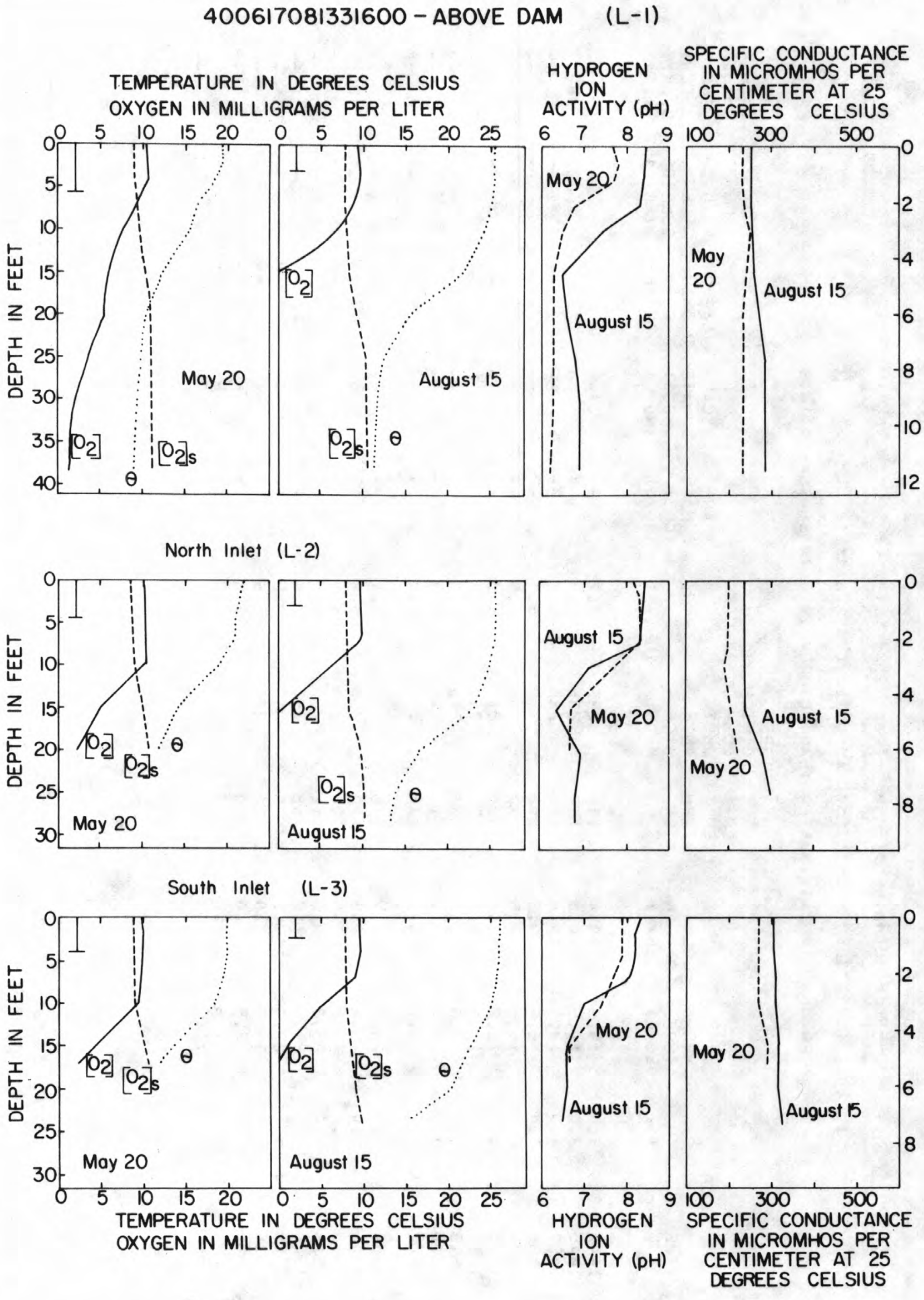


Figure 48.--Data profiles for Salt Fork Lake on selected days in 1975.

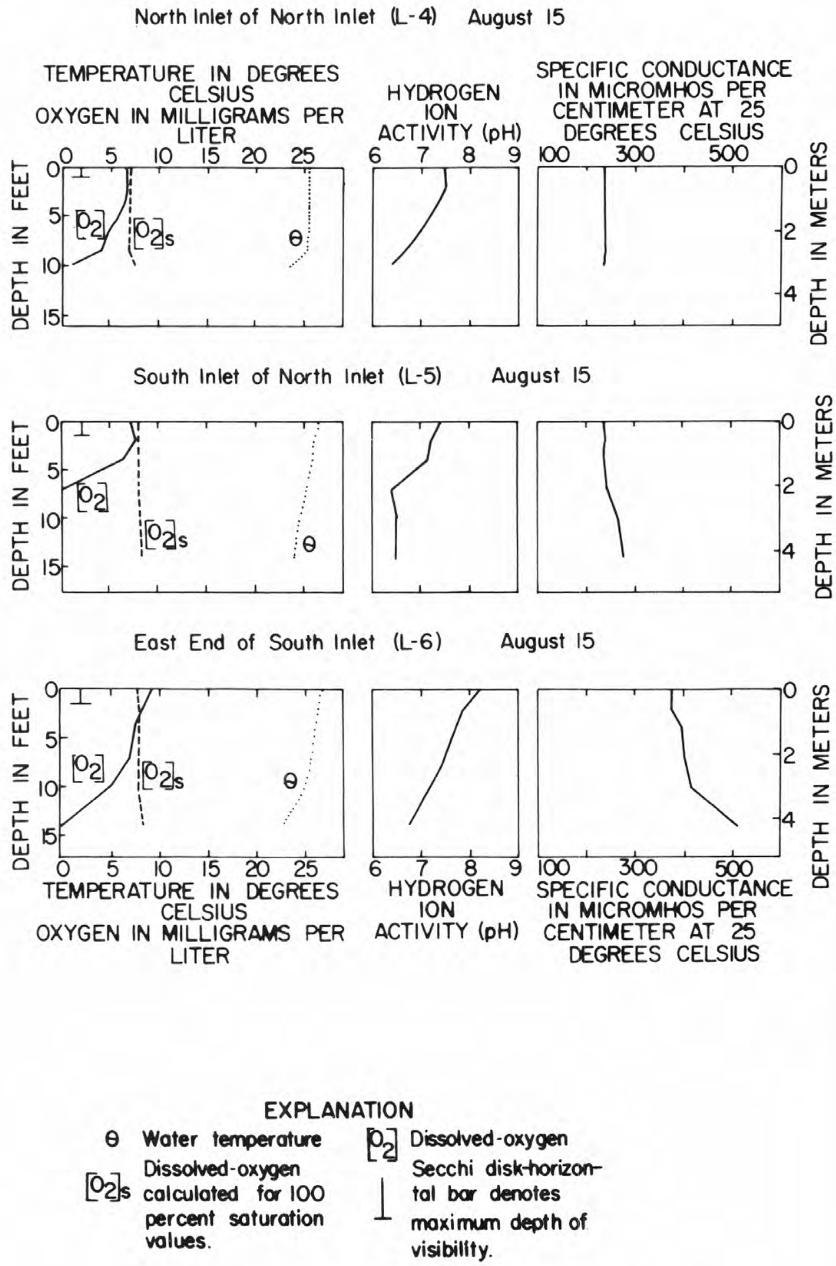


Figure 48.--Continued.

Table 84.--Chemical analyses of water column composite samples, Salt Fork Lake, Ohio

400617081331600 - Salt Fork Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	HARD-NESS (CA,MG) (MG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL RESI-DUE (MG/L)
MAY 20...	1510	25	7.9	1.7	6.0	66	8.9	.1	95	168	21	189

DATE	TIME	TOTAL BARIUM (BA) (UG/L)	TOTAL CAD-MIUM (CD) (UG/L)	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL SELE-NIUM (SE) (UG/L)	TOTAL SILVER (AG) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)
MAY 20...	1510	200	1	20	1	<.5	5	0	0	<10	.0

DATE	TIME	TOTAL BORON (B) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	TOTAL MOLYB-DENUM (MO) (UG/L)	TOTAL ZINC (ZN) (UG/L)
MAY 20...	1510	10	0	10	150	480	0	10

Table 85.--Chemical, physical, and biological analyses of water samples from selected depths, Salt Fork Lake, Ohio

400617081331600 - Salt Fork Lake above dam at site (L-1)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
20...	1445	2.0	.01	.19	.20	.01	.35	.36	.00	.02	5.3
20...	1525	38	.01	.31	.32	.16	.21	.37	.00	.03	6.2
AUG											
15...	1505	2.0	.01	.00	.01	.07	.56	.63	.01	.03	4.2
15...	1545	38	.01	.00	.01	.99	.81	1.8	.03	.13	8.6

DATE	TIME	DEPTH (FT)	TUR-BID-ITY (JTU)	COLOR (PLAT-INUM-COBALT UNITS)	TOTAL ORGANIC CARBON (C) (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)
MAY									
20...	1445	2.0	2	15	8.1	1.3	12	<2	<2
20...	1525	38	5	30	4.9	1.2	12	<2	<2
AUG									
15...	1505	2.0	3	20	4.8	2.6	21	<2	2
15...	1545	38	15	100	4.4	2.4	21	5	2

Table 86.--Profile data and chemical analyses of water column composite samples, north inlet, Salt Fork Lake, Ohio

400749081312900 - Salt Fork Lake in north inlet at site (L-2)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	PERCENT SATURATION	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	CARBONATE (CO3) (MG/L)	BICARBONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDROGEN SULFIDE (MG/L)	TRANSPARENCY (SECCHI DISK) (IN)
MAY												
20...	1550	.0	21.8	10.0	116	200	8.2	--	--	--	--	--
20...	1555	2.0	21.5	10.2	119	200	8.3	--	--	--	--	54
20...	1600	4.0	21.0	10.3	118	200	8.3	--	--	--	--	--
20...	1605	7.0	20.8	10.3	118	200	8.3	--	--	--	--	--
20...	1610	10	19.0	10.1	112	190	7.7	--	--	--	--	--
20...	1615	15	14.0	5.0	50	205	6.7	--	--	--	--	--
20...	1620	20	11.7	2.2	21	220	6.7	--	--	--	--	--
AUG												
15...	1415	.0	25.6	9.7	121	240	8.4	--	--	--	--	--
15...	1420	2.0	25.6	9.8	122	240	8.4	--	--	--	--	35
15...	1425	4.0	25.6	9.9	124	240	8.4	--	--	--	--	--
15...	1430	7.0	25.5	9.6	120	240	8.3	--	--	--	--	--
15...	1435	10	24.8	6.5	80	240	7.1	--	--	--	--	--
15...	1440	15	23.0	.5	6	242	6.4	--	--	--	--	--
15...	1445	20	16.5	.0	0	283	6.9	--	--	--	--	--
15...	1450	25	13.7	.0	0	300	6.8	--	--	--	--	--
15...	1455	28	13.2	.0	0	300	6.8	--	--	--	--	--

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)	TOTAL ORGANIC NITROGEN (N) (MG/L)	TOTAL KJELDAHL NITROGEN (N) (MG/L)	TOTAL ORTHO PHOSPHORUS (P) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)	DISSOLVED SILICA (SIO2) (MG/L)
MAY											
20...	1610	COMPOSITE	--	--	.21	.06	.39	.45	.00	.03	--
AUG											
15...	1440	COMPOSITE	--	--	.01	--	--	.97	--	.06	--

Table 87.--Profile data and chemical analyses of water column composite samples, south inlet, Salt Fork Lake, Ohio

400522081304800 - Salt Fork Lake in south inlet at site (L-3)

WATER QUALITY DATA, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DATE	TIME	DEPTH (FT)	TEMPER-ATURE (DEG C)	DIS-SOLVED OXYGEN (MG/L)	PER-CENT SATUR-ATION	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CAR-BONATE (CO3) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	HYDRO-GEN SULFIDE (MG/L)	TRANS-PAR-ENCY (SECCHI DISK) (IN)
MAY												
20...	1700	.0	20.0	9.9	111	270	7.9	--	--	--	--	--
20...	1705	2.0	20.0	10.0	112	270	7.9	--	--	--	--	48
20...	1710	4.0	20.0	10.0	112	270	7.9	--	--	--	--	--
20...	1715	7.0	19.5	9.8	109	270	7.7	--	--	--	--	--
20...	1720	10	18.5	9.3	101	270	7.4	--	--	--	--	--
20...	1725	15	13.5	4.3	42	290	6.7	--	--	--	--	--
20...	1730	17	12.0	2.7	26	290	6.7	--	--	--	--	--
AUG												
15...	1630	.0	26.2	9.4	119	305	8.3	--	--	--	--	--
15...	1635	2.0	26.0	9.5	120	305	8.2	--	--	--	--	28
15...	1640	4.0	26.0	9.6	122	305	8.2	--	--	--	--	--
15...	1645	7.0	25.8	8.9	111	308	8.1	--	--	--	--	--
15...	1650	10	25.2	5.5	69	308	7.0	--	--	--	--	--
15...	1655	15	22.5	1.0	12	315	6.6	--	--	--	--	--
15...	1700	20	20.2	.0	0	315	6.6	--	--	--	--	--
15...	1705	24	15.0	.0	0	324	6.5	--	--	--	--	--

DATE	TIME	DEPTH (FT)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE PLUS NITRATE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL KJEL-DAHL NITRO-GEN (N) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)
MAY											
20...	1720	COMPOSITE	--	--	.19	.07	.28	.35	.00	.02	--
AUG											
15...	1655	COMPOSITE	--	--	.01	--	--	1.1	--	.04	--

The bacteria densities in the May samples (table 85) were very low, and fecal coliform counts were well within Ohio waterquality standards. (See page 31.) The phytoplankton composite from the euphotic zone at site L-1 (table 88) revealed a dominant, blue-green genus, Oscillatoria, in an otherwise diversified algal community. A sample taken at site L-2 shows fewer cells/ml and a blue-green codominance by the genera, Lyngbya and Anacystis. The south inlet sample at site L-3 was completely void of blue-green algae and was composed mostly of mixed diatoms and green algae.

The August data were collected under partly cloudy skies, following early morning rains. Secchi disk values exhibited an approximate 40 percent reduction from those in May. Thermal structure was well defined at L-1 and gradually diminished toward the inflow ends at sites L-4, L-5, and L-6 (figs 47 and48).The hypolimnion at sites L-1, L-2, and L-3 was anaerobic and had a hydrogen sulfide odor below 20 ft (6.1 m) at all three sites. Oxygen depletion also occurred in the bottom waters at sites L-4, L-5, and L-6 with anaerobic conditions prevailing below 7 ft (2.1 m) at site L-5.

The pH and specific conductance profiles show decreases in pH and increases in chemical concentrations with depth. Profiles in the south inlet (sites L-3 and L-6) further demonstrate a significant chemical enrichment eastward, with values increasing to 510 umho in the bottom waters at site L-6.

The near-surface macronutrient distributions at site L-1, when compared with those of the hypolimnion, revealed an epilimnion comparatively low in inorganic nitrogen and orthophosphorus. Nitrogen and phosphorus concentrations from the water column composites at sites L-2 and L-3 were similar.

Bacteria counts were similar to those in May. The phytoplankton communities sampled at 4 ft (1.2 m) at sites L-1, L-2, and L-3 show high cell densities and a complete domination by the blue-green genera, Lyngbya and Cylindrospermum.

Table 88.--Phytoplankton in Salt Fork Lake, Ohio

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Location	Date	Location water column					
Site L-1 above dam ---------	5-20-75	Euphotic zone composite	21,000	-	Cyanophyta	81	Oscillatoria (81)
					Chrysophyta	12	Synedra (4); Melosira (3); Cyclotella (1); Nitzschia (1); Cymbella (1); Navicula (1); Achnanthes (1)
					Chlorophyta	8	Ankistrodesmus (4); Scenedesmus (2); Chodatella (1); Tetraedron (1)
Site L-2 north inlet -------	5-20-75	Euphotic zone	9700	-	Cyanophyta	69	Lyngbya (41); Anacystis (28)
					Chrysophyta	15	Synedra (8); Achnanthes (3); Melosira (2); Nitzschia (1); Dinobryon (1); Navicula
					Chlorophyta	14	Ankistrodesmus (10); Scenedesmus (2); Chodatella (2); Tetraedron
					Euglenophyta	<1	Trachelomonas

See footnote at end of table.

Table 88.--Phytoplankton in Salt Fork Lake, Ohio.--Continued

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Location	Date	Location water column					
Site L-3 south inlet --------	5-20-75	Euphotic zone	3500	-	Chlorophyta	55	Chodatella (15); Ankistrodesmus (13); Tetrastrum (7); Scenedesmus (7); Crucigenia (7); Tetraedron (4); Chlamydomonas (2)
					Chrysophyta	40	Synedra (13); Nitzschia (9); Achnanthes (9); Melosira (5); Cyclotella (4); Navicula (2)
					Euglenophyta	5	Trachelomonas (5)
Site L-1 above dam ---------	8-15-75	4-ft depth	410,000	1.465	Cyanophyta	100	Lyngbya (57); Cylindrospermum (30); Aphanizomenon (12); Anabaena (1); Oscillatoria (1)
					Chlorophyta	<1	Crucigenia; Chlamydomonas

See footnote at end of table.

Table 88.--Phytoplankton in Salt Fork Lake, Ohio.--Continued

Sample description			Total cells (per ml)	Diversity index (genus) $\bar{d}$	Phylum(a) (order of dominance)	Percent of total cell count	Dominant genera within phylum and percent (%)* of total cell count
Location	Date	Location water column					
Site L-2 north inlet --------	8-15-75	4-ft depth	310,000	1.202	Cyanophyta	99	Cylindrospermum (67); Lyngbya (28); Aphanizomenon (2); Anabaena (1); Anacystis (1); Agmenellum
					Chlorophyta	<1	Oocystis; Scenedesmus; Chlamydomonas
					Chrysophyta	<1	Melosira; Cyclotella
					Euglenophyta	<1	Trachelomonas
Site L-3 south inlet -------	8-15-75	4-ft depth	660,000	0.729	Cyanophyta	99	Lyngbya (88); Cylindrospermum (8); Aphanizomenon (2); Anabaena (1); Anacystis; Anabaenopsis
					Chlorophyta	<1	Pandorina; Ankistrodesmus; Crucigenia; Schroederia; Chodatella; Chlamydomonas
					Chrysophyta	<1	Nitzschia
					Euglenophyta	<1	Trachelomonas

* Less than 1 percent not given.

SUMMARY AND CONCLUSIONS

A review of the data for the 17 lakes (38 inflow sites) surveyed in Ohio during 1975 and the partial summary in tables 89 and 90 indicate the following:

(1) Lake depth has a major controlling influence on water quality conditions. Shallow lakes (maximum depth <15 ft (4.6 m)) do not develop stable thermal controls and, therefore, remain generally mixed (polymictic). Buckeye, Grand St. Marys, and Loramie Lakes are examples. Lakes of intermediate depths (15 ft (4.6 m) to 30 ft (9.1 m)) tend to thermally stratify but with subsequent reduction or elimination of the hypolimnion during the summer. Lakes Guilford, Harrison, Hope, Vesuvius, and Clear Fork Reservoir are examples. The thermal structure of Clear Fork Reservoir also is influenced by low level water withdrawals at the dam. Lakes deeper than 30 ft (9.1 m) and not controlled through bottom release valves exhibit classic seasonal thermal stratification, as shown in the Acton, Cowan, and Punderson Lake profiles. Lakes of similar depths but controlled by multi-level release ports may become only partly stabilized or show an almost complete absence of thermal stratification. Berlin and Paint Creek Lakes are examples of the former; Deer Creek Lake is an example of the latter condition.

(2) Light penetration determined by secchi disk observations ranged from 0.4 ft (0.1 m) to 9.4 ft (2.9 m). Maximum visibilities of 3.0 ft (0.9 m) or less are shown for 10 lakes.

(3) Lakes that tend to develop stable stratification will undergo oxygen depletion in the lcwer levels of the lake. Hydrogen sulfide generation was common within sustained anaerobic zones.

Table 89.--Summary of physical and chemical characteristics for the primary sites of selected lakes in Ohio, 1975

Lake name and site location	Maximum observed depth (feet)	Secchi disk transparency (inches)		Thermal stratification		Dissolved oxygen ranges* (mg/L)		pH range*		BOD ranges* (mg/L)	
		spring	summer	spring	summer	spring	summer	spring	summer	spring	summer
Acton Lake above dam (L-1)	36	5	28	partial	yes	9.8-9.4	8.2-0.0	7.9-7.7	7.9-6.5	1.7-3.2	4.0->7.9
Berlin Lake above dam (L-1)	50	59	30	yes	no	8.2-4.0	6.7-0.0	8.3-6.9	7.5-6.8	1.1-0.5	1.4-3.5
Buckeye Lake at midpoint (L-1)	13	19	17	partial	no	12.3-4.5	7.0-4.2	9.0-7.9	8.2-7.6	5.0-6.1	7.4-6.7
Clear Fork Reservoir above dam (L-1)	23	41	41	yes	partial	13.2-0.0	8.5-0.0	9.1-7.1	8.2-6.7	5.7-1.1	2.3-2.5
Cowan Lake above dam (L-1)	38	11	23	no	yes	9.9-8.7	8.8-0.0	8.2-7.9	8.1-6.7	1.6-1.4	4.4
Deer Creek Lake above dam (L-1)	44	19	18	no	no	11.0-9.7	5.0-3.7	8.2-7.7	7.4-7.3	1.9-1.2	2.0
Grand Lake St.Marys near midpoint (L-1)	8	17	13	no	no	9.6-8.2	10.2-5.4	9.3-9.0	8.9-8.4	7.9->8.0	15-7.5
Guilford Lake above dam (L-1)	23	34	36	yes	yes	15.8-0.0	8.2-0.0	9.8-7.3	8.5-6.5	7.2-1.7	3.5-2.5
Harrison Lake at east end (L-1)	17	25	20	yes	partial	13.6-0.0	11.7-0.0	8.8-7.0	8.3-7.0	5.8-3.5	4.3-6.5
Hoover Reservoir above dam (L-1)	60	18	49	partial	yes	11.6-9.4	6.8-0.0	8.3-7.3	7.6-6.4	3.3-0.9	1.3-3.1
Lake Hope above dam (L-1)	20	41	113	yes	yes	9.5-3.2	11.6-0.0	5.1-4.2	6.3-5.0	0.4-0.3	1.1-0.5
Lake Loramie above dam (L-1)	7	11	8	no	no	10.9-7.2	8.1-3.5	8.6-8.3	8.2-7.5	7.0-5.6	6.7-5.8
Lake Vesuvius above dam (L-1)	24	32	110	yes	yes	9.6-3.6	7.3-0.0	7.3-5.9	7.0-6.0	1.3-0.5	0.8-1.0
Paint Creek Lake above dam (L-1)	45	26	36	partial	partial	20.8-4.1	6.8-0.0	8.6-6.8	7.9-6.8	>8.2-2.5	3.2-1.7
Punderson Lake at midpoint (L-1)	50	91	52	yes	yes	12.8-1.1	11.1-0.0	8.4-6.6	8.6-6.8	1.6-2.2	2.2
Rocky Fork Lake above dam (L-1)	45	25	34	partial	yes	12.9-0.8	6.2-0.0	8.5-7.5	7.7-6.6	4.2-1.5	3.3-2.7
Salt Fork Lake above dam (L-1)	38	65	36	yes	yes	10.6-1.3	9.6-0.0	7.8-6.2	8.4-6.5	1.3-1.2	2.6-2.4

* Water column data - near surface values shown first.
** National Academy of Sciences, 1972.
*** Ohio EPA Regulation EP-1 Water Quality Standards.

(4) Dissolved oxygen supersaturations within the euphotic zones were frequent, especially during spring, when a maximum level of 229 percent was recorded in Paint Creek Lake. The BOD ranged from 0.3 mg/L in Lake Hope to 15 mg/L in Grand Lake St. Marys.

(5) The pH of the shallow lakes was greater than 7.0 and varied only slightly between the surface and bottom waters. The pH of thermally controlled, hard-water lakes ranged from 6.2 to 9.8 and varied up to 2.5 pH units within the water column.

Table 89.--Continued.

TOC range* (mg/L)		Specific conductance range* (umho)		Chemical typing (spring only)		Substances at or above accepted limits		Total N (maximum concentration in mg/L)	Total P (maximum concentration in mg/L)	H_2S present
spring	summer	spring	summer	hardness	major ions	pesticides**	metals***			
6.3-15	4.8-11	377-227	337-502	hard	Ca Mg HCO_3	yes (Aldrin)	yes (Cu)	9.9	0.55	yes
16-4.2	10	357-382	403-415	hard	Ca SO_4	no	yes (Cu)	1.7	0.08	yes
7.5-9.8	11-9.2	320-310	285-287	hard	Ca HCO_3 SO_4	no	yes (Cu)	2.6	0.14	no
11-4.0	2.6-9.2	262-310	297-347	mod. hard	Ca HCO_3 SO_4	no	yes (Cu)	1.6	0.21	yes
6.6-11	5.7-9.1	358	311-458	hard	Ca HCO_3	no	no	7.0	0.24	yes
8.0-8.5	4.8-5.7	510	450-452	very hard	Ca HCO_3	no	no	2.9	0.12	no
12-20	12-13	304	311-308	mod. hard	Mg Ca SO_4 HCO_3	no	no	3.3	0.19	no
6.8-3.5	9.5-7.4	220-295	243-335	mod. hard	Ca HCO_3 SO_4	no	yes (Cu)	8.6	0.34	yes
9.5-12	10-13	405-336	435-465	very hard	Ca HCO_3	no	yes(Cu Hg Ag)	3.9	0.21	no
7.9-5.9	9.8-7.6	295-270	363-305	mod. hard	Ca HCO_3	no	yes (Cu)	2.3	0.10	no
4.0-7.1	4.7-13	137-128	134-199	soft	Ca SO_4	no	no	2.4	0.03	yes
8.3-13	13-17	331-338	360-365	hard	Ca Mg SO_4 HCO_3	no	no	2.3	0.25	no
3.6-5.7	5.5-8.1	157-132	152-185	soft	Ca SO_4	no	yes (Cu)	0.61	0.05	no
11-9.9	6.5-1.3	410-460	390-450	very hard	Ca HCO_3	no	no	5.2	0.17	yes
9.9-5.8	11-9.0	355-365	330-375	hard	Ca HCO_3	no	yes (Cu)	3.2	0.55	yes
12-7.9	12-21	335-360	305-407	very hard	Ca HCO_3	no	yes (Ag)	9.1	0.18	yes
8.1-4.9	4.8-4.4	235-255	250-287	mod. hard	Ca SO_4	no	yes (Cu)	1.8	0.13	yes

(6) Fifteen of the 17 lakes had moderately hard to very hard water. Calcium was the most common cation and bicarbonate and sulfate the most common anions. Magnesium is shown as a codominant cation in three lakes in western Ohio. Copper was observed at or above State standards in 10 lakes.

(7) The specific conductance of all lakes sampled was below 600 umho; profiles and other data (alkalinity, nutrients, trace substances, etc.) show significant change with depth during thermal stratification and suggest that major chemical differences may develop between thermally stabilized zones.

(8) Macronutrient availability and recycling were sufficient in most of the lakes surveyed to support high concentrations of algae and other flora. The highest concentration of total nitrogen (9.9 mg/L as N) was in the hypolimnion of Acton Lake; the lowest (0.61 mg/L as N) was in Lake Vesuvius. Total phosphorus was highest (0.55 mg/L) in the bottom waters of Acton and Punderson Lakes and the least (0.03 mg/L as P) in Lake Hope.

(9) The bacteria counts for fecal coliform at the primary sampling sites of most lakes sampled were well within State standards. Those counts exceeding the recommended limits followed runoff events.

Table 90.--Summary of biological characteristics for the primary sites of selected lakes in Ohio, 1975

Lake name and site location	Bacteria*				Phytoplankton			
	Fecal coliform (colonies per 100 ml)		Fecal streptococci (colonies per 100 ml)		Composites from euphotic zone (spring)		Samples from zones of maximum dissolved oxygen (summer)	
	spring	summer	spring	summer	Cells per ml	Dominant phylum and percent (%) of total cell count	Cells per ml	Dominant phylum and percent (%) of total cell count
Acton Lake above dam (L-1)	1900-12,500	3-<2	4050-12,500	2-5	1600	Chrysophyta (95)	660,000	Cyanophyta (99)
Berlin Lake above dam (L-1)	3-<3	<2-6	<3	<2-3	150	Chrysophyta (100)	2300	Cyanophyta (95)
Buckeye Lake at midpoint (L-1)	4-6	29-48	2-<3	3-6	190,000	Cyanophyta (79)	1,200,000	Cyanophyta (94)
Clear Fork Reservoir above dam (L-1)	<3	<2-3	3-<3	<2	12,000	Cyanophyta (64)	140,000	Cyanophyta (96)
Cowan Lake above dam (L-1)	500-600	2-8	170-300	<2	2700	Chrysophyta (100)	360,000	Cyanophyta (97)
Deer Creek Lake above dam (L-1)	18-8	26-9	28-84	56-100	13,000	Chrysophyta (77)	48,000	Cyanophyta (78)
Grand Lake St. Marys near midpoint (L-1)	<3-3	<3	<3	<3	2,830,000	Cyanophyta (99)	2,400,000	Cyanophyta (99)
Guilford Lake above dam (L-1)	<3	4-8	<3-3	6-4	19,000	Cyanophyta (66)	160,000	Cyanophyta (85)
Harrison Lake at East end (L-1)	16-400	100-152	20-1100	100-160	19,000	Chlorophyta (53)	130,000	Cyanophyta (97)
Hoover Reservoir at dam (L-1)	6-<3	2-168	3	<2-60	10,000	Chrysophyta (100)	3500	Cyanophyta (92)
Lake Hope above dam (L-1)	<3-12	2-3	<3-30	26-<3	2200	Chlorophyta (90)	4200	Chlorophyta (95)
Lake Loramie above dam (L-1)	<3	3-9	<3-3	320-328	46,000	Chrysophyta (49)	450,000	Cyanophyta (91)
Lake Vesuvius above dam (L-1)	3-36	<2-5	<3-32	2-14	420	Cyanophyta (73)	13,000	Cyanophyta (80)
Paint Creek Lake above dam (L-1)	3-36	2-72	<3-28	2-52	70,000	Chrysophyta (92)	420,000	Cyanophyta (97)
Punderson Lake at midpoint (L-1)	24-2	2-<2	8-<3	2-<2	52,000	Cyanophyta (99)	300,000	Cyanophyta (100)
Rocky Fork Lake above dam (L-1)	3	90-70	<3	40-24	14,000	Chrysophyta (84)	160,000	Cyanophyta (93)
Salt Fork Lake above dam (L-1)	<2	<2-5	<2	2	21,000	Cyanophyta (81)	410,000	Cyanophyta (100)

* Water column data - near surface values shown first.

(10) Very high densities (up to 2,830,000 cells/ml) of phytoplankton were observed in most lakes. Blue-green algae (Cyanophyta) dominated the late summer communities of all lakes except in the soft, low pH waters of Lake Hope. Seasonal succession from Chlorophytes and (or) Chrysophytes in the spring to Cyanophytes in the late summer are indicated for nine lakes.

(11) Inflow data suggest high inputs of macronutrients to Ohio's lakes. Stream samples taken for analyses of nitrite plus nitrate averaged 2.17 mg/L as N and had an estimated discharge-weighted mean concentration of 4.19 mg/L. Similar calculations for total phosphorus showed an average concentration of 0.29 mg/L as P and a discharge-weighted mean concentration of 0.18 mg/L.

The reconnaissance data were sampled from two seasons only, and may reflect representative spring and late summer conditions during 1975. The varying chemical distributions observed in many of the lakes demonstrate that care must be exercised when using data from a single point source or within a given zone for water-quality assessment. More intensive studies are suggested before any goal-oriented decisions are made.

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