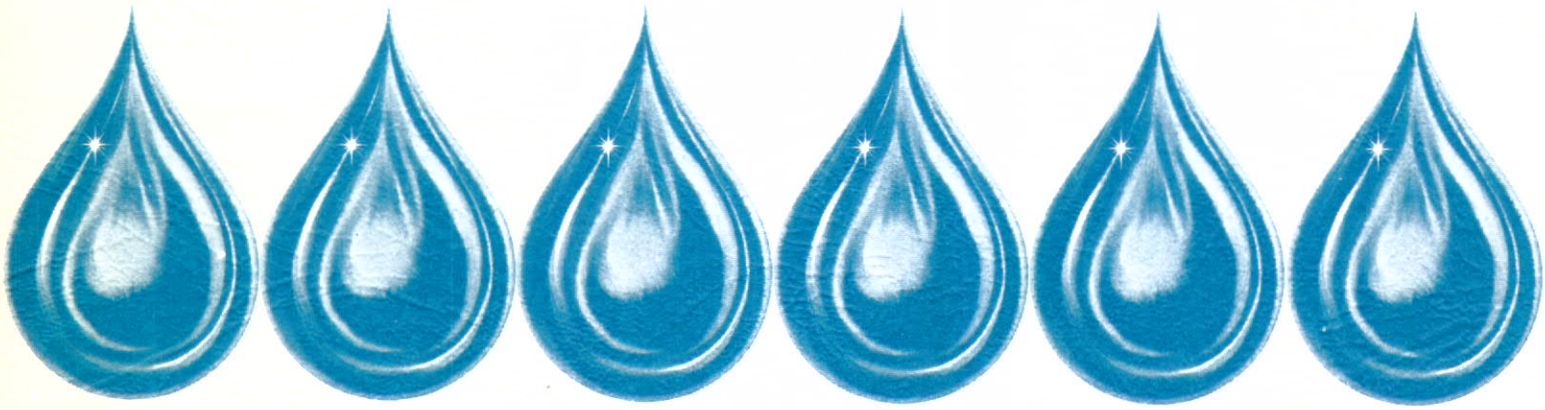

Water-Supply Bulletin 42, Part 4

DATA ON SELECTED LAKES IN WASHINGTON

Part 4

WASHINGTON STATE DEPARTMENT OF ECOLOGY ■ 1976
Prepared cooperatively by the
United States Department of the Interior
Geological Survey

STATE OF WASHINGTON
Daniel J. Evans, Governor

DEPARTMENT OF ECOLOGY
John A. Biggs, Director

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By

J. B. McConnell, G. C. Bortleson, and J. K. Innes

of the
United States Geological Survey

Prepared cooperatively by the
UNITED STATES GEOLOGICAL SURVEY

1976

CONTENTS

ILLUSTRATION

The following factors are provided for conversion of English values to metric values:

Multiply	By	To obtain
Feet (ft)	0.3048	metres (m)
Acres	.4047	hectares (ha)
Acres	.004047	square kilometres (km^2)
Square miles (sq mi)	2.590	square kilometres (km^2)
Acre-feet (acre-ft)	.001233	cubic hectometres (hm^3)
Cubic feet (ft^3)	.02832	cubic metres (m^3)
Cubic feet per second (ft^3/s)	.02832	cubic metres per second (m^3/s)
Pounds (lbs)	.4536	kilograms (kg)

DATA ON SELECTED LAKES IN WASHINGTON,

PART 4

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ABSTRACT

This report, the fourth in a series, contains chemical, biological, and physical data collected from 31 lakes in Washington during 1973. For each lake there is a description of the physical setting, a general discussion of water quality, a bathymetric map, and an aerial photograph. The basic data include depth profiles of dissolved-oxygen concentration and temperature. Each lake was sampled four times, from winter to late summer.

INTRODUCTION

Washington has more than 7,800 lakes, ponds, and reservoirs (Wolcott, 1964 and 1965), many of which provide exceptional recreational opportunities and supply water for agricultural, municipal, and industrial purposes. In addition, the lake shorelines attract ever-increasing home construction and recreational development. As more demands are placed on these lakes and their basins, potential problems of nutrient enrichment and water-quality deterioration may develop. In order to detect any present or potential conditions of water-quality impairment, it is essential that existing conditions in Washington's lakes be investigated and defined.

Purpose and Scope

Although both the importance and value of the Washington lakes are widely recognized, the quantity and type of information currently available for most of the lakes are not adequate to provide the understanding needed for wise management of the lakes. Thus, the need to obtain additional information about lakes resulted in the initiation in 1970 of a cooperative program between the Washington Department of Ecology and the U.S. Geological Survey, whereby selected lakes in Washington would be investigated.

In general, the study consists of a data-collection program designed to (1) document the present water quality and the overall status of the lakes, and (2) provide basic data pertaining to the physical, cultural, and water-quality characteristics of lakes in order to establish a base of reference that will allow future periodic reappraisals of lake conditions and evaluation of changes.

This is the fourth in a series of reports on selected lakes in Washington. The first three reports (Collings, 1973; Bortleson and others, 1974; and Bortleson and others, 1976) discuss 60 lakes throughout the State, and this report discusses an additional 31 lakes in the State (fig.1). One of the 31 lakes has arms joined by a narrow channel and each arm was discussed as an individual lake.

Acknowledgments

The authors gratefully acknowledge the assistance of the State of Washington Department of Game for permission to reproduce many of the lake bathymetric maps. Many other bathymetric maps were reproduced from reports by Wolcott (1964, 1965). Special appreciation is expressed to several lakeside residents for their diligence in reading staff gages for determining lake levels.

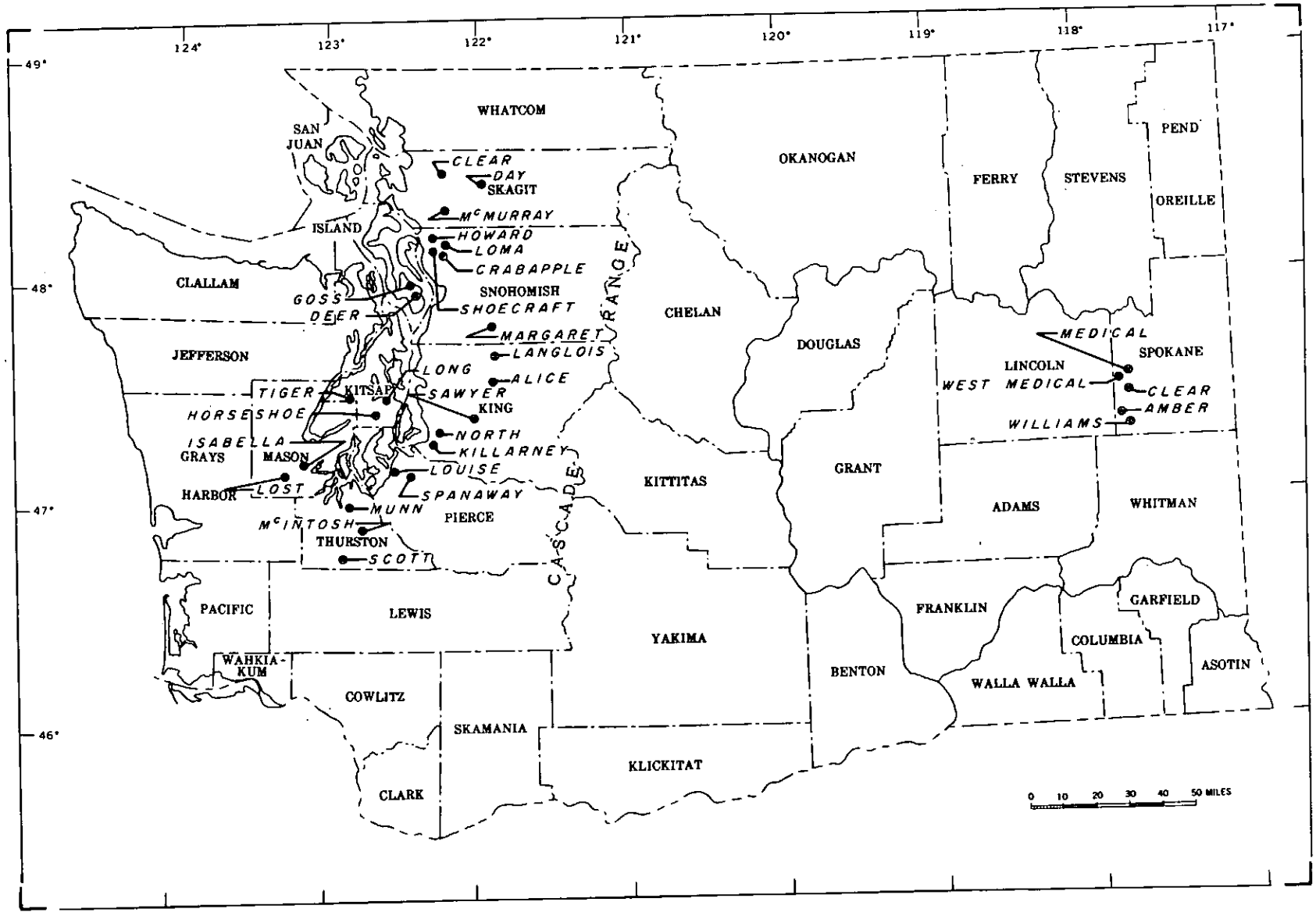

FIGURE 1.--Locations of lakes studied in 1973.

Data Collected and Definitions

In this report, the data collected provide a basis for evaluating future changes. Most of the field data were collected during (1) the winter water-mixing period; (2) spring, shortly after thermal stratification begins; (3) summer, during advanced thermal stratification; and (4) late summer, at maximum thermal stratification. The sample sites were generally near the deepest part of the lake and are considered to be reasonably representative of the physical and chemical characteristics of the entire lake. Data to define variations in temperature and dissolved oxygen (DO) concentration at different depths were collected in the field with portable instruments. Water samples for mineral, nutrient, pH, and color analyses were collected at depths of 3 feet below the water surface and 4 to 5 feet above the lake bottom. The mineral and nutrient analyses were performed by U.S. Geological Survey laboratories using procedures described by Brown, Skougstad, and Fishman (1970). Analyses for chlorophyll a and fecal-coliform bacteria were performed using procedures described by Slack and others (1973). Samples for phytoplankton identification were collected about 1 foot below the lake surface by use of a plankton net. The samples were preserved in Lugol's solution and stored in the dark until examined. The phytoplankton were identified by project personnel according to the descriptions of Smith (1950) and Prescott (1970).

Before presenting the results of each lake survey, an explanation of terms used in describing individual lakes is given below. The definitions of additional limnological and hydrological terms used throughout the report are found in the glossary (p.12). The parameters are discussed in the sequence they appear on the data sheets.

Lake name. The lake name was taken from U.S. Geological Survey topographic maps. In common usage the term "Lake" may either precede or follow the proper name. However, throughout this report, the lake name is given first, and the lakes discussed alphabetically.

Identification number. The lakes in this report are listed in alphabetical order. The number associated with each lake is in accordance with a numbering system used nationwide by the U.S. Geological Survey to designate data-collection stations in stream basins. Each lake has a unique number which, like the lake name, is a means of identification.

Location. Latitude, longitude, township, range, and section were determined from U.S. Geological Survey topographic maps. The location given is at the lake outlet. For lakes without outlets, the southernmost shoreline point is used. Directions and distances from prominent landmarks, such as towns, roads, and rivers, are included to aid in rapid, easy location. The major drainage system of each lake is indicated.

Physical characteristics of lake. From bathymetric maps of the lake and from topographic maps, the following physical parameters were determined:

Drainage area.--The surface-drainage area, in square miles (sq mi), is the area that contributes water to the lake. These areas were delineated on U.S. Geological Survey topographic maps and measured by planimeter.

Surface altitude.--A single altitude in feet (ft) above mean sea level (msl), obtained from topographic maps, is given for each of the lakes.

Surface area (A).--The surface area of the lake, in acres, was obtained from planimetry of the lake outline.

Volume (V).--Lake volume, in acre-feet, was obtained by computing and then summing the volumes of each stratum of water between successive contours on the bathymetric map. Because lake volume can vary between seasons and from year to year, the volume figures reported (as well as other morphometric data) are intended only to describe the general size of the lake.

Mean depth ($\bar{Z}$).--The mean depth, in feet, for a specified lake stage, is obtained by dividing the volume of the lake by its area.

Maximum depth (Z_m).--The difference, in feet of elevation, between the bottom and the surface of the lake.

Length of shoreline (L).--The distance around, or perimeter, in miles, of the water surface touching the shore at a specified lake stage.

Shoreline configuration (D_L).--A dimensionless ratio of length of shoreline to the circumference of a circle having an area equal to that of the lake, given as

$$D_L = \frac{L}{2\sqrt{\pi A}}$$

This quantity may be regarded as an index of the geological and littoral processes affecting the shape of the lake.

Nearly circular lakes have values near unity, subcircular lakes have slightly greater D_L values, and elongate lakes have the highest D_L values. High D_L values are common to lakes formed along old drainages or by the damming of streams to form a lake in the valley behind the dam.

High values for shoreline configuration suggest the presence of shallow water and protected bays--areas suitable for plant growth--and also indicate an increase in contact between land and water. Therefore, shoreline configuration is often an indirect indicator of plant growth capacity and enrichment potential from nearshore development and runoff.

Development of volume (D_V).--The development of volume is defined as the ratio of the mean depth ($\bar{Z}$) to maximum depth (Z_m). Thus, lakes with a low D_V ratio are usually conical depressions, whereas lakes with a high D_V ratio are steep-sided and have flat bottoms. Shallow lakes which have large D_V values tend to provide greater opportunity for exposure of bottom sediments to overlying water and for circulation of bottom nutrients.

Bottom slope (Z_r).--The slope profile of a lake bottom, expressed as a percentage ratio of the maximum depth to the mean lake diameter, referred to by Hutchinson (1957, p. 167) as relative depth, given as

$$Z_r = \frac{Z_m \times 50 \times \sqrt{\pi}}{\sqrt{A}} .$$

Rooted aquatic plants often grow more profusely in a lake with a gradually sloping basin (low Z_r) than in a deep lake with steep sides (high Z_r).

Basin geology and soils. Information on basin geology and soils was obtained from existing geologic maps and reports.

Land use. The drainage basins of the lakes were partitioned into various generalized land-use categories. Values given reflect the percentages of the basin used primarily for forests or for residential urban, residential suburban, or agricultural development. The lake surface is also given as a percentage of the total drainage basin. A general description of the land-use categories is as follows:

a. Residential urban.--Predominant use is for single-family residences on small lots, where apartment complexes and commercial or industrial activities also may be present.

b. Residential suburban.--Predominant use is single-family residences.

c. Agricultural.--Pasture or cropland.

d. Forest or unproductive.--Public and private forest lands and tree farms. Lands may include cleared or fallow unproductive land, meadows, wetlands, and seasonal recreational areas.

e. Lake surfaces.--Includes surface areas of the lake and upstream tributary lakes.

Nearshore residential development. The percentage of the shoreline occupied by residential development was determined from aerial photographs and by field observations.

Number of nearshore homes. The number of nearshore dwellings, and whether the homes were mostly seasonal or permanent, were determined from field observations.

Surface-water inflow and outflow. Miscellaneous measurements of outflow, reported in cubic feet per second (ft^3/s), are given for lakes in which the outflow is controlled by natural conditions. All discharge measurements made at inflow and outflow sites during the 1972 water year were published by the U.S. Geological Survey (1973).

Lake stage. The maximum variation in lake stage, in feet, is given for the period of observation.

Macrophytes. These are large plants that can be seen without magnification. The rooted aquatic-plant growth was assessed according to the percentage of the lakeshore and water-surface area covered by emersed and (or) floating plants and the percentage of the lake bottom covered by submersed plants. Examples of emersed plants include cattails and sedges in which the leaves or other structures extend above the water surface. In this report,

rooted aquatic plants with floating leaves, such as waterlilies and watershield, are considered emersed. Submersed plants, such as hornwort and pondweeds, complete their life cycle and live entirely under the surface of the water. The plants were identified according to the descriptions of Steward, Dennis, and Gilkey (1963) or Fassett (1969).

Bathymetric map. Depth-contour maps were prepared either by the State of Washington Department of Game from data obtained by sounding the lake or by the U.S. Geological Survey from data obtained by use of a recording-chart fathometer.

The water-quality sampling site (symbol ■) and fecal-coliform sampling sites (symbol ●) are shown on the bathymetric map of each lake. The presence and location of a public boat access (symbol ▲) is shown near the shoreline contour of the map. The location and direction of inflow and outflow streams is shown graphically.

Aerial photograph. A vertical-view, black-and-white aerial photograph is included for each lake. The approximate scale and the date of aerial photography is indicated.

Water-quality data. The water-quality variables measured are reviewed briefly for each parameter.

Major chemical constituents.--In freshwater, the major anions are bicarbonate, carbonate, sulfate, chloride, fluoride, and, to a lesser extent, nitrate nitrogen and orthophosphate phosphorus. These anions are associated with the principal cations--calcium, sodium, magnesium, and potassium, and, to a lesser extent, iron and aluminum. Silicon, too, is abundant in water but almost always occurs as the compound silicon dioxide (silica).

Nutrients.--A nutrient is any chemical element, ion, or compound that is required by an organism for the continuation of growth, reproduction, and other life processes. Many elements and compounds act as nutrients to supply the food for aquatic plants and algae. However, nitrogen and phosphorus usually are considered the limiting nutrients for plant growth and as such received the most emphasis in this study. Whatever nutrient is limiting algal growth, the concentrations of nitrogen and phosphorus are useful in evaluating the trophic conditions of a lake (Lee, 1970). The nutrient concentrations that were determined at top and bottom sampling depths included nitrate, nitrite, ammonia and organic nitrogen, total phosphorus, and orthophosphate phosphorus. Samples collected for

orthophosphate analysis were filtered immediately through a 0.45-µm (micrometre) Millipore[1] filter. The nutrient samples were iced in the field and later refrigerated at 4°C (Celsius) until analyzed.

Suspended solids.--Suspended solids are those retained on a 0.45-µm filter.

Hardness.--Water hardness is defined as the sum of the polyvalent cations expressed as the equivalent quantity of calcium carbonate ($CaCO_3$). As a general rule, hard-water lakes are more productive of plants and animals than soft-water lakes, but there are many exceptions.

Specific conductance.--Specific conductance is a measure of the water's ability to conduct an electric current and is used as an approximation of dissolved-solids concentration in the water.

pH.--pH is the negative logarithm of the effective hydrogen-ion concentration, expressed as a number from 0 to 14. A pH of 7 is neutral, a pH of less than 7 is acidic, and a pH of greater than 7 is basic.

Color.--Color is one control of light transmission through water. High color values in many lakes result from the decomposition of vegetation, which gives the water a brown, tea-like color. Color is determined by a comparison of the water with standardized colored-glass discs and is reported in platinum-cobalt (Pt-Co) units.

Chlorophyll a.--Chlorophyll a is a green photosynthetic pigment present in plant cells, including algae. The concentration of chlorophyll a in a water sample is a commonly accepted indicator of algal biomass (Lee, 1970). Samples for chlorophyll a (0.5-2 litres) were filtered immediately in the field using a 0.45-µm Millipore filter. The filters containing the pigment were stored immediately in a dessicator and iced in the field and later stored in a dessicator at -20°C. Analyses were performed on samples from 1 to 20 days after collection.

Fecal-coliform bacteria.--Fecal coliforms are that part of the total coliform group derived from feces of warmblooded animals, including man; their presence in water generally is accepted as an indicator of recent fecal-waste contamination. Samples were collected approximately 100 feet offshore at a depth of 1 foot at two to five stations

[1]The use of the brand names in the report is for identification purposes only and does not imply endorsement by the U.S. Geological Survey.

at each lake. The sample locations and number of sample sites are shown on the bathymetric map. The reporting unit is the number of colonies per 100 millilitres of water.

Total organic carbon.--The amount of organic carbon present in a lake often is related to the primary productivity of the lake. Organic carbon also may be derived from bottom sediments or it may be transported into the lake from outside sources.

Water-temperature profiles.--Water temperature, which varies in lakes with depth and time of year, is an important controlling factor for life processes and chemical-reaction rates as well as many physical events that occur in the aquatic environment.

Generally, the water-temperature profiles of the lakes studied show total mixing during the winter--nearly uniform temperatures from top to bottom--and thermal stratification during the summer. Temperature profiles in lakes during midsummer, when thermal stratification may be marked, follow one of two common patterns. In shallow lakes, well exposed to the wind, temperatures are practically constant from top to bottom. This uniformity of temperature indicates that the waters are well mixed throughout. The other common pattern occurs in deeper lakes, where three characteristic thermal layers are present: (1) an upper zone (epilimnion) of generally warmer water in which temperature is more or less uniform throughout; (2) an intermediate zone (metalimnion) in which temperature declines rapidly with depth; and (3) a lower zone (hypolimnion) of colder water in which temperature is again more or less uniform throughout.

. Of special significance is the temperature of the deep-water layer (hypolimnion) during midsummer because (1) temperature stratification and water circulation affect the vertical distribution of nutrients, and (2) water temperatures affect the potential of cold-water fisheries resources.

Secchi-disc visibility.--Secchi-disc visibility is the depth at which a white-and-black disc (8 inches in diameter) disappears from view when lowered into the water. Secchi-disc visibility depth is a measure of water transparency or clarity. Because changes in biological production can cause changes in the color and turbidity of a lake, Secchi-disc visibility often is used as a gross measure of the plankton in the water.

Dissolved-oxygen profiles.--The concentration of DO in a lake varies with time of year and depth of water and is a function of many factors including the water temperature, atmospheric pressure, and salinity of the water. Also, oxygen in water is continually being altered by life processes, such as photosynthesis and respiration, and by complex chemical reactions. Of special biological significance is the amount of DO in the deep water during midsummer. The organisms in the lighted upper layers of water produce organic matter which settles to the bottom where bacteria consume oxygen to degrade the organic materials, thereby reducing the DO concentration in the hypolimnion. The hypolimnetic-oxygen deficit frequently is related to the biomass or plant growth in the upper waters (Hutchinson, 1957). For good growth and general health of trout, salmon, and other species of cold-water biota, the DO concentrations should not be less than 6.0 mg/l (milligrams per litre) according to the Federal Water Pollution Control Administration (1968).

GLOSSARY OF LIMNOLOGICAL AND HYDROLOGICAL TERMS

Acre-foot. Volume of water required to cover 1 acre to a depth of 1 foot, and equal to 43,560 ft^3.

Algae. Simple plants, many microscopic; contain chlorophyll and lack roots, stems, and leaves. Most algae are aquatic and may become a nuisance when environmental conditions are suitable for prolific growth.

Algal bloom. A large number--often 0.5 to 1 million cells per litre--of a particular algal species which may form objectionable scums and odors upon decomposition.

Cultural eutrophication. The acceleration of the natural process of nutrient enrichment in a lake as a result of man's activities.

Ephemeral stream. Flows only in direct response to precipitation, it has no flow during periods of dry weather, and has a channel that is above the water table at all times. It receives little or no water from springs and no long-continued supply from melting snow or other sources.

Eutrophication, eutrophic. The enrichment of water, a natural process that may be accelerated by the activities of man; pertains to waters in which primary productivity is generally high as a consequence of a large supply of available nutrients.

Fall overturn. A natural mixing of thermally stratified waters that commonly occurs during the early autumn. The sequence of events leading to fall overturn includes (1) cooling of surface waters, (2) density change in surface waters that produce convection currents from top to bottom, and (3) circulation of the total water volume by wind action. The overturn generally results in a uniformity of the physical and chemical properties of the water.

Genus, genera. The taxonomic category below family, consisting of one to many species.

Glacial drift. Rock debris that has been transported by glaciers and deposited either directly from the ice or from the melt water. The debris may or may not be heterogeneous.

Glaciofluvial deposits. Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces.

Intermittent or seasonal stream. Flows at certain times of the year when it receives water from springs or from some surface source, such as melting snow in mountainous areas.

Littoral. The shoreward region of a body of water.

Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Marsh. Periodically wet or continually flooded areas where the land surface is not deeply submerged, covered dominantly with sedges, cattails, rushes, or other plants that require marshy areas to grow.

Morphometry. Definition of physical shape and size, as of a water body.

Muck. A mixture containing highly decomposed organic material in which the original plant parts are not recognizable. Contains more mineral matter, and is usually darker, than peat.

Plankton. Suspended organisms that drift with the water currents.

Production. The total amount of living matter produced in an area per unit time regardless of the fate of the living matter.

Runoff. That part of the precipitation that appears in surface streams.

Spring overturn. A natural mixing of thermally stratified water that commonly occurs during the early spring. The sequence of events leading to spring overturn includes (1) melting of ice cover, if present, (2) warming of surface water, (3) temperature change in surface waters that produces convection currents from top to bottom, and (4) circulation of the total water volume by wind action. The overturn results in a uniformity of the physical and chemical properties of the water.

Till. Unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel, and boulders intermixed in any proportion.

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L A K E D A T A

Alice Lake near Preston (12145490)

Location.
Southernmost shoreline point, at lat 47°31'52", long 121°53'24", in SE¼SE¼ sec.27, T.24 N., R.7 E., in King County, 1.9 miles northwest of Preston; Snohomish River basin. Fall City quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.24 sq mi	Mean depth	8.2 ft	Shoreline configuration	1.7		
Altitude	875 ft	Maximum depth	30 ft	Development of volume	0.27		
Surface area	32 acres	Length of shoreline	7,100 ft	Bottom slope	2.2 percent		
Lake volume	260 acre-ft						

Basin geology.
Glacial drift (Liesch and others, 1963).

Soils.
Gravelly sandy loam with peat deposits on southwest side of lake (Poulson and others, 1952).

Land use (percentage of drainage basin). Urban 0, suburban 10, agricultural 0, forest or unproductive 70, and lake surface 20.
Nearshore residential development. 66 percent.
Number of nearshore homes. 54.

Surface-water inflow and outflow.
A small tributary flows into south end of lake. An estimate of inflow on February 23 was 0.4 ft^3/s; May 8, 0.1 ft^3/s; and June 25, <0.1 ft^3/s. No inflow was observed on September 27. The outflow is regulated by a barrier and screen.

Lake stage.
Lake stage varied 1.0 foot between February 23 and September 27, 1973.
Macrophytes.
Shoreline covered by emersed plants, 76 to 100 percent.
Lake surface covered by emersed plants, 5 percent.
Lake bottom covered by submersed plants, 63 percent (thinly scattered).
Rooted aquatic plants observed were watershield (*Brasenia* sp.),* quillwort (*Isoetes* sp.),* cattail (*Typha* sp.), white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), and sedge (Cyperaceae).

Asterisk (*) indicates dominant aquatic plants.

Algae observed.
No data taken.

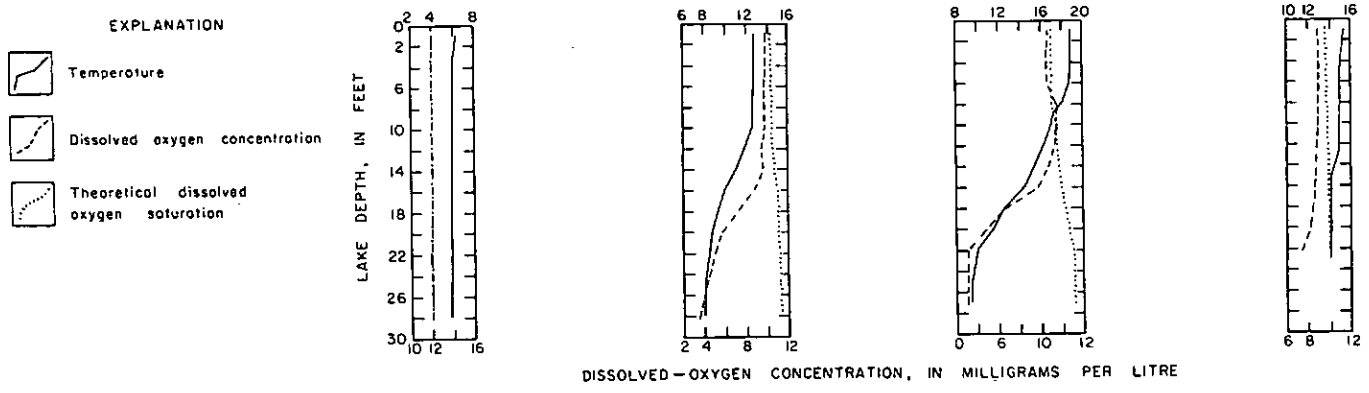
Summary and conclusions.
The lake is partially surrounded by bogs and marsh. The beach and littoral zone is mostly gravel and cobble but the lake bottom has a thin veneer of decayed organic material.

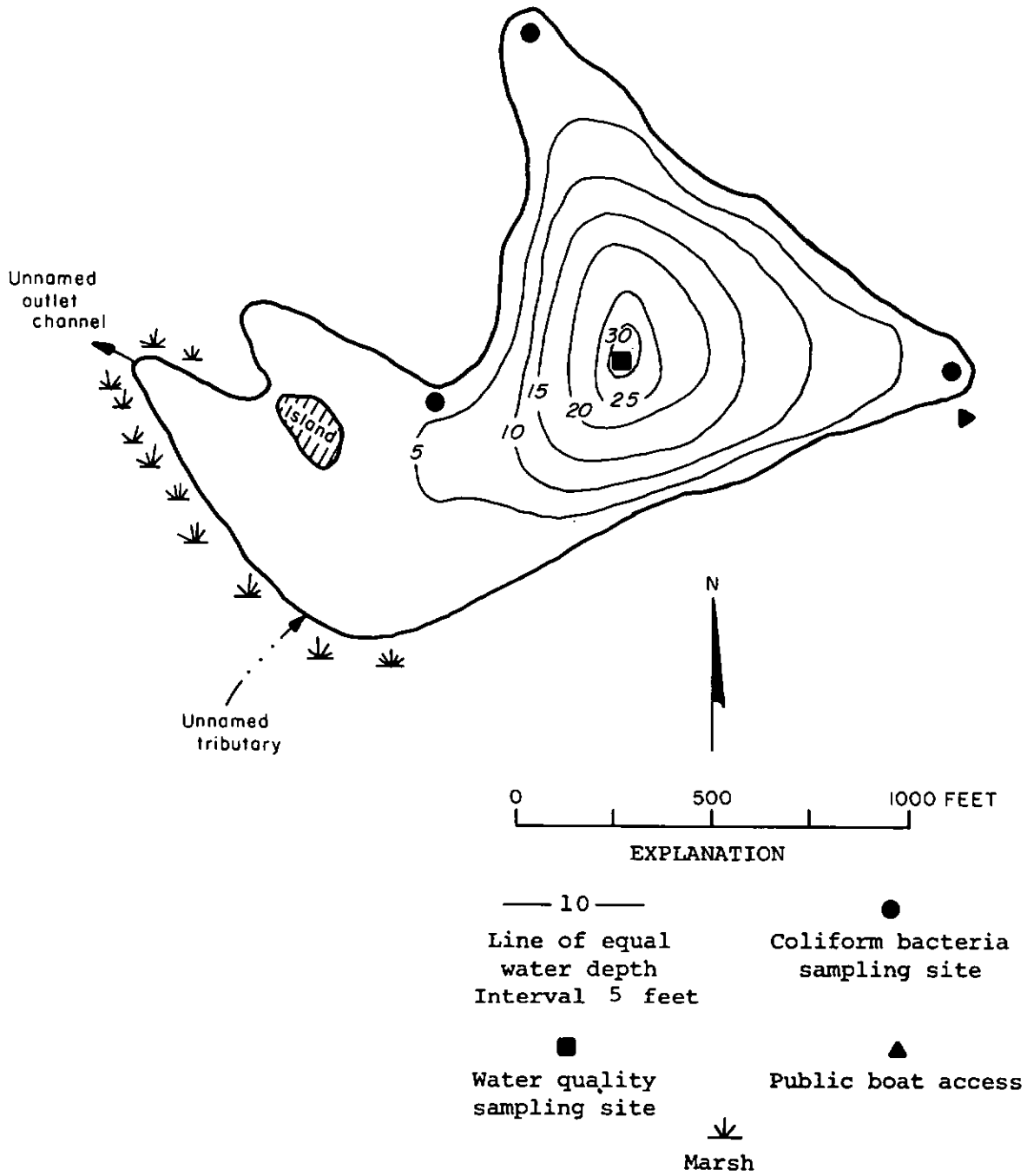
The lake is dilute in dissolved minerals and low in biological productivity. Chlorophyll *a* and nutrient concentrations were among the lowest of the lakes studied. The DO was depleted to nearly zero, but only near the lake bottom. A large percentage of the lake bottom is covered by water less than 5 feet deep which is often conducive to heavy rooted aquatic plant growth. However, the lake bottom supported mostly quillwort, a thinly scattered submersed plant. The nearshore homes occupied about 66 percent of the shoreline; this is about a 60 percent increase in nearshore residences since 1968. Fecal-coliform-bacteria counts were higher than most of the lakes studied. The highest counts were observed in June when the mean of three samples was 86 colonies per 100 ml.

Water-quality data for Alice Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	February 23		May 8		June 25		September 27	
Water depth (ft)	3	26	3	26	3	25	3	20
Silica (SiO_2)	1.3	1.3	0.5	1.1	0.4	0.7	0.3	0.2
Dissolved iron (Fe), in µg/l	50	30	40	40	40	220	80	50
Dissolved manganese (Mn) (in µg/l)	0	0	10	20	0	10	10	0
Calcium (Ca)	1.0	--	--	--	--	--	3.6	--
Magnesium (Mg)	.3	--	--	--	--	--	.3	--
Sodium (Na)	1.1	--	--	--	--	--	1.1	--
Potassium (K)	.3	--	--	--	--	--	.3	--
Bicarbonate (HCO_3)	2	6	7	6	8	10	8	9
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	2.7	--	--	--	--	--	2.8	--
Chloride (Cl)	1.7	--	--	--	--	--	1.5	--
Nitrate nitrogen (as N)	.08	.06	.01	.05	.01	.00	.03	.03
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.10	.09	.08	.15	.06	.19	.04	.06
Organic nitrogen (as N)	.19	.19	.25	.15	.11	.01	.24	.26
Total phosphorus (as P)	.016	.012	.018	.014	.011	.018	.008	.011
Orthophosphate (as P)	.002	.001	.007	.004	.002	.002	.006	.009
Suspended solids (110 °C)	3	--	--	--	--	--	9	--
Hardness as $CaCO_3$ (Ca,Mg)	4	--	--	--	--	--	10	--
Specific conductance (micromhos at 25 °C)	14	13	14	15	14	16	15	14
pH (pH units)	7.3	6.9	8.5	5.9	7.0	5.7	8.7	8.0
Water temperature (°C)	6.1	5.7	12.8	8.1	18.9	9.6	15.1	14.1
Color (Pt-Co scale)	15	15	5	5	10	15	0	0
Secchi-disc (ft)	11		8.5		14		12	
Dissolved oxygen (DO)	12.0	12.0	9.9	3.8	8.6	1.0	9.0	8.2
Chlorophyll a in photic zone (in µg/l)	2.6	--	2.4	--	.8	--	.7	--
Fecal coliform (col. per 100 ml) Range	<1-<1		9-63		3-125		<1-35	
Fecal coliform (col. per 100 ml) Mean	<1		31		86		12	
Total organic carbon (as C)	5.5	--	4.5	--	6.0	--	4.5	--





Alice Lake, King County. From Washington Department of Game, June 3, 1946.

Alice Lake, King County. May 17, 1973. Approx. scale 1:4800.

Amber Lake at Amber (13351520)

Location.
Southernmost shoreline point, at lat 47°20'35", long 117°43'15", in SW¼NE¼ sec.2, T.21 N., R.40 E., Spokane County, 0.8 mile southeast of Amber; Palouse River basin. Cheney quadrangle, 1:62,500.

Physical characteristics of lake.

Drainage area	2.56 sq mi	Mean depth	17 ft	Shoreline configuration	2.9
Altitude	2,160 ft	Maximum depth	40 ft	Development of volume	0.42
Surface area	120 acres	Length of shoreline	23,000 ft	Bottom slope	1.6 percent
Lake volume	2,000 acre-ft				

Basin geology.
Basalt (Huntting and others, 1961).

Soils.
Shallow, stony soils, stony silt loam, and local deposits of silty clay loam on north side of lake (Donaldson and Giese, 1968).
Land use (percentage of drainage basin). Urban 0, suburban <1, agricultural 93, forest or unproductive <1, and lake surface 7.
Nearshore residential development. 5 percent.
Number of nearshore homes. 4.

Surface-water inflow and outflow.
No inflow to Amber Lake was observed during April-October, 1973. A small outflow of less than 0.1 ft^3/s was present on April 4, but on subsequent visits the outlet was dry.

Lake stage.
Lake stage varied 2.8 feet between April 4 and October 1, 1973.
Macrophytes.
Shoreline covered by emersed plants, 1 to 25 percent.
Lake surface covered by emersed plants, 1 percent.
Lake bottom covered by submersed plants, 50 percent.
Rooted aquatic plants observed were pondweed (Potamogeton sp.),* yellow lily (Nuphar sp.), sedge (Cyperaceae), coontail (Ceratophyllum sp.), waterweed (Elodea sp.), muskgrass (Chara, sp.) and water milfoil (Myriophyllum sp.).

Algae observed.
May 22 - Predominantly diatoms (Dinobryon sp.,* Fragillaria sp., Synedra sp.).
July 10 - A mixed population of diatoms (Fragillaria sp., Tabellaria sp.,Synedra sp.) and blue-green algae (Anabaena sp.).
Oct. 2 - A mixed population of diatoms (Fragillaria sp.,* Synedra sp.) and blue-green algae (Aphanizomenon sp., Anabaena sp., Polycystis sp.).

Asterisk (*) indicates dominant aquatic plants.

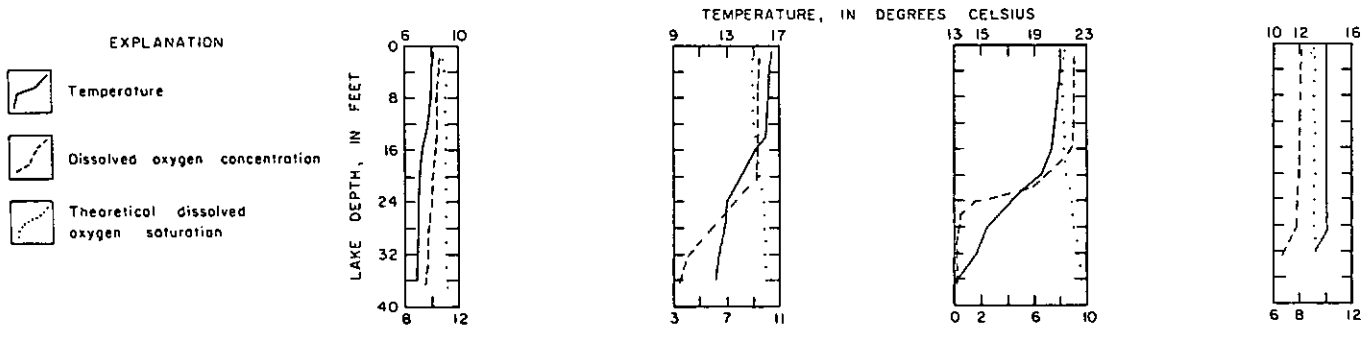
Summary and conclusions.
Amber Lake is a long narrow lake with steep basalt cliffs located in the eastern Washington channeled scablands. Most of the shore adjoins pasture and grazing land.

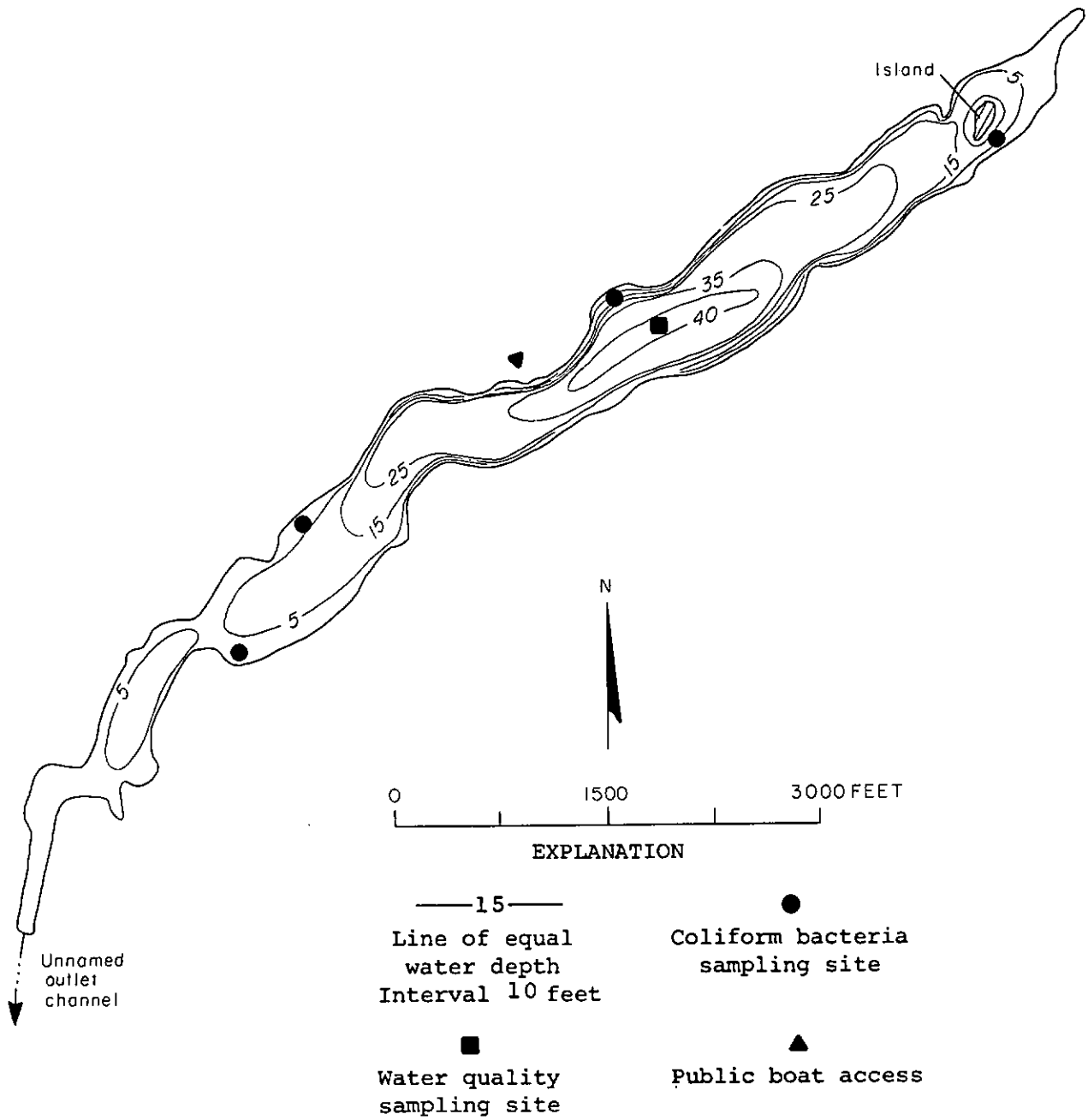
The lake appears high in biological productivity. The nutrient and chlorophyll a concentration were moderate, and dense blooms of diatoms and blue-green algae occurred during the summer. Much of the littoral zone is muck and supported a very heavy growth of aquatic macrophytes. The shallower southern end of the lake had an especially dense growth of pondweed.

Water-quality data for Amber Lake.

(Milligrams per litre unless otherwise indicated)

Date of collection (1973)	April 4		May 22		July 10		October 2	
Water depth (ft)	3	34	3	34	3	33	3	30
Silica (SiO_2)	1.2	1.3	2.0	4.0	2.6	9.6	8.6	9.1
Dissolved iron (Fe), in µg/l	40	50	40	60	30	150	60	70
Dissolved manganese (Mn) (in µg/l)	10	30	10	60	20	340	60	50
Calcium (Ca)	22	--	--	--	--	--	17	--
Magnesium (Mg)	12	--	--	--	--	--	13	--
Sodium (Na)	16	--	--	--	--	--	18	--
Potassium (K)	8.3	--	--	--	--	--	8.4	--
Bicarbonate (HCO_3)	158	160	162	161	147	166	163	163
Carbonate (CO_3)	--	--	--	--	7	--	0	--
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	6.1	--	--	--	--	--	4.7	--
Chloride (Cl)	5.1	--	--	--	--	--	4.9	--
Nitrate nitrogen (as N)	.02	.02	.04	.02	.02	.02	.02	.02
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.09	.11	.05	.14	.10	.11	.16	.18
Organic nitrogen (as N)	.22	.22	.66	.57	3.9	.10	.74	.78
Total phosphorus (as P)	.027	.034	.020	.065	.030	.054	.042	.040
Orthophosphate (as P)	.002	.001	.002	.003	.002	.018	.012	.011
Suspended solids (110°C)	2	--	--	--	--	--	3	--
Hardness as $CaCO_3$ (Ca,Mg)	100	--	--	--	--	--	96	--
Specific conductance (micromhos at 25°C)	250	240	268	264	260	272	249	255
pH (pH units)	6.9	7.2	8.2	7.6	8.8	7.4	9.4	8.9
Water temperature (°C)	8.0	7.0	16.3	12.3	21.0	14.7	14.0	13.8
Color (Pt-Co scale)	10	10	30	30	0	0	0	5
Secchi-disc (ft)	9.8		16		18		9.8	
Dissolved oxygen (DO)	10.5	9.6	9.6	4.1	9.0	0.1	7.0	6.6
Chlorophyll a in photic zone (in ug/l)	2.0	--	1.3	--	7.9	--	6.6	--
Fecal coliform (col. per 100 ml) Range	<1-<1		<1-<1		<1-1		<1-<1	
Fecal coliform (col. per 100 ml) Mean	<1		<1		<1		<1	
Total organic carbon (as C)	8.0	--	8.0	--	11	--	9.5	--





Amber Lake, Spokane County. From Washington Department of Game. February 7, 1947.

Amber Lake, Spokane County. July 25, 1974. Approx. scale 1:15,000.

Clear Lake at Clear Lake (12200020)

Location.
Southernmost shoreline point, at lat 48°27'15", long 122°13'26", in NW¼NW¼ sec.7, T.34 N., R.5 E., Skagit County, 0.8 mile southeast of town of Clear Lake; Skagit River basin. Clear Lake quadrangle, 1:62,500.

Physical characteristics of lake.

Drainage area	2.40 sq mi	Mean depth	23 ft	Shoreline configuration	1.2
Altitude	30 ft	Maximum depth	44 ft	Development of volume	0.52
Surface area	200 acres	Length of shoreline	13,000 ft	Bottom slope	1.3 percent
Lake volume	4,600 acre-ft				

Basin geology.
Sedimentary rocks, glacial drift, and alluvium (Huntting and others, 1961).

Soils.
Silt loam, gravelly loam, sandy loam, shallow stony soils, and local peat deposits on southeast side of lake (Ness and others, 1960).

Land use (percentage of drainage basin). Urban 5, suburban 4, agricultural 24, forest or unproductive 54, and lake surface 13.

Nearshore residential development. 25 percent.

Number of nearshore homes. 26.

Surface-water inflow and outflow.
Clear Lake is fed by a tributary on the northeast side of the lake. An estimate of inflow on March 20 was 1.5 ft^3/s; May 17, 1.0 ft^3/s; July 3, 1.0 ft^3/s; and Sept. 22, 0.3 ft^3/s. No outlet was observed on the lake.

Lake stage.
Lake stage varied 1.0 foot between March 20 and September 22, 1973.

Macrophytes.
Shoreline covered by emersed plants, 76 to 100 percent.
Lake surface covered by emersed plants, 2 percent.
Lake bottom covered by submersed plants, 29 percent.
Rooted aquatic plants observed were pondweed (*Potomogeton* sp.),* cattail (*Typha* sp.), white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), sedge (Cyperaceae), watershield (*Brasenia* sp.), coontail (*Ceratophyllum* sp.), waterweed (*Elodea* sp.), muskgrass (*Chara* sp.), and wildcelery (*Vallisneria* sp.).

Asterisk (*) indicates dominant aquatic plants.

Algae observed.
May 18 - Predominantly flagellates (*Ceratium* sp.) and some diatoms (*Dinobryon* sp.).
July 2 - Predominantly diatoms (*Dinobryon* sp.) and some blue-green algae (*Anabaena* sp.).

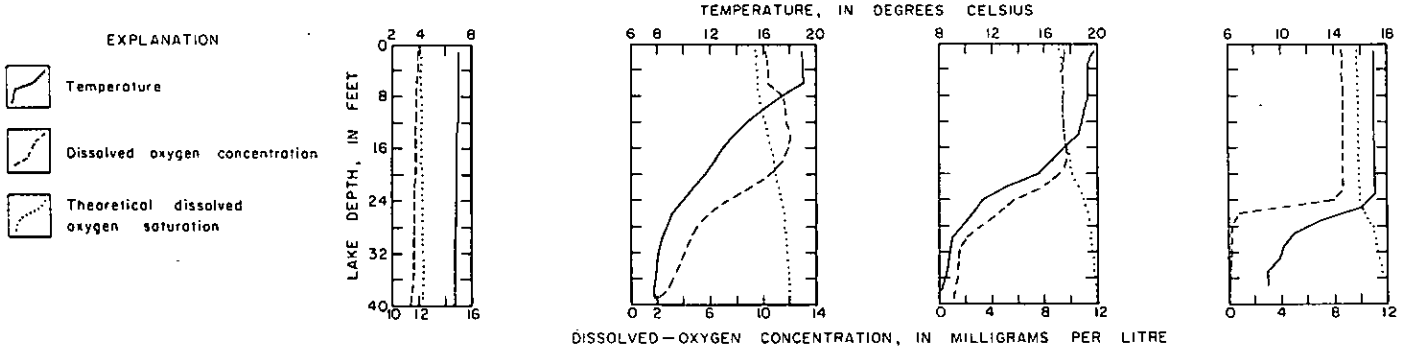
Summary and conclusions
The small town of Clear Lake is located on the west shore of the lake, but approximately 75 percent of the shoreline adjoins pasture and farmland.

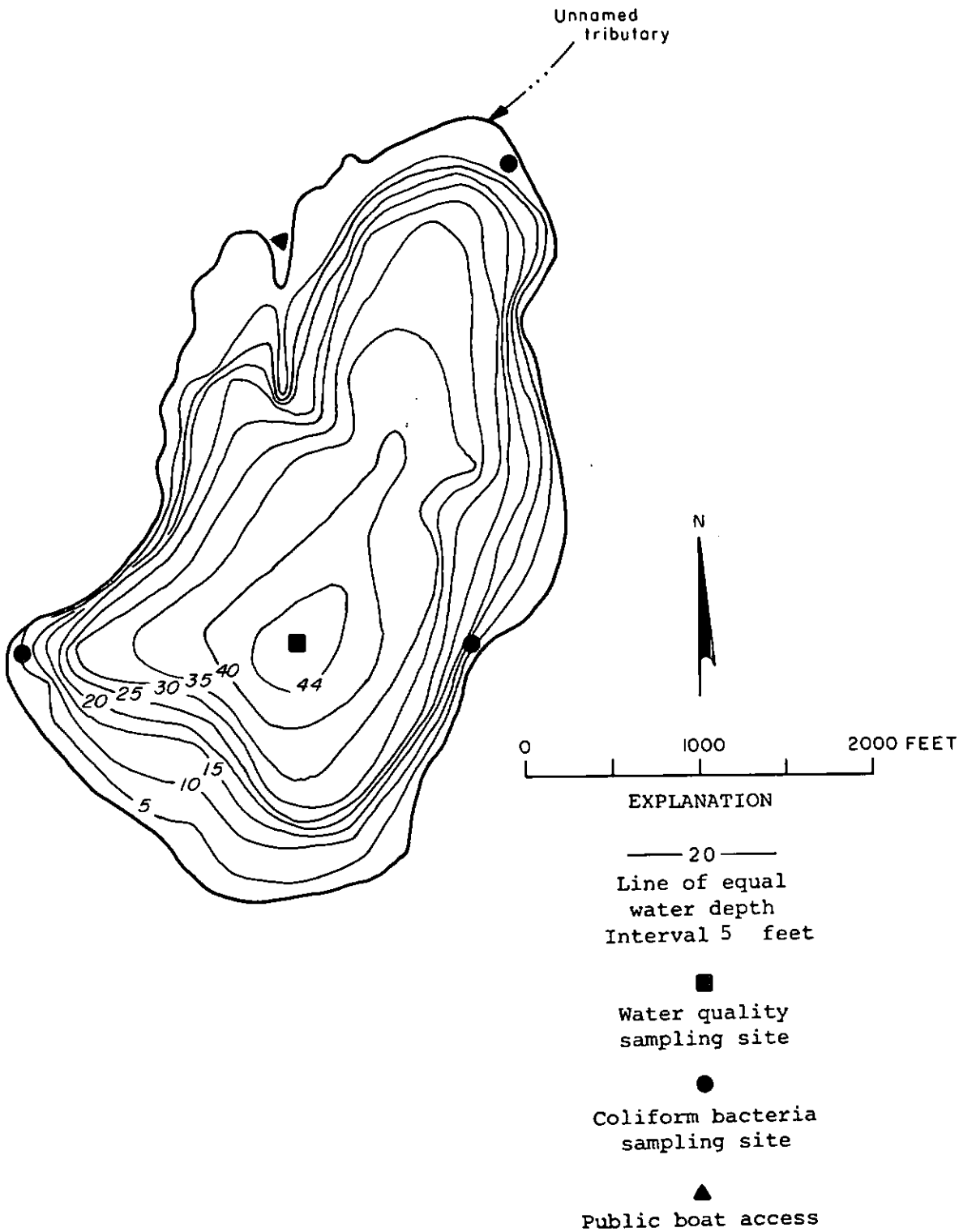
The lake is probably moderate in biological productivity. A high density of flagellates and diatoms was observed in May and July. The littoral zone supported a moderate growth of pondweed and other aquatic macrophytes. About one-third of the lake bottom was covered with submersed plants. The lake was vertically mixed in March. However, by July thermal stratification was well established and the oxygen was depleted to nearly zero in the hypolimnion.

Water-quality data for Clear Lake (Skagit County)

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 20		May 18		July 3		September 22	
Water depth (ft)	3	38	3	38	3	36	3	33
Silica (SiO_2)	3.9	4.0	0.1	5.7	0.4	6.9	1.5	7.1
Dissolved iron (Fe), in ug/l	240	270	120	260	90	580	120	1,300
Dissolved manganese (Mn) (in µg/l)	40	20	50	230	20	790	60	1,400
Calcium (Ca)	9.9	--	--	--	--	--	8.9	--
Magnesium (Mg)	2.7	--	--	--	--	--	2.9	--
Sodium (Na)	3.9	--	--	--	--	--	4.5	--
Potassium (K)	1.5	--	--	--	--	--	2.0	--
Bicarbonate (HCO_3)	38	39	41	39	44	50	46	59
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	4.5	--	--	--	--	--	4.6	--
Chloride (Cl)	4.8	--	--	--	--	--	4.3	--
Nitrate nitrogen (as N)	.22	.21	.02	.21	.01	.13	.01	.01
Nitrite nitrogen (as N)	.01	.01	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.11	.11	.07	.13	.03	.10	.04	.10
Organic nitrogen (as N)	.25	.21	.10	.06	.06	.00	.20	.29
Total phosphorus (as P)	.037	.034	.006	.013	.005	.016	.013	.018
Orthophosphate (as P)	.001	.002	.002	.002	.002	.003	.001	.000
Suspended solids (110°C)	4	--	--	--	--	--	3	--
Hardness as $CaCO_3$ (Ca,Mg)	36	--	--	--	--	--	34	--
Specific conductance (micromhos at 25°C)	85	85	89	85	87	94	88	109
pH (pH units)	6.3	6.5	7.6	6.9	7.2	6.4	7.9	7.1
Water temperature (°C)	7.0	6.7	19.0	7.8	19.3	8.5	17.0	9.8
Color (Pt-Co scale)	20	20	10	10	0	0	0	25
Secchi-disc (ft)	9.5		12		15		22	
Dissolved oxygen (DO)	11.9	11.5	10.3	2.9	9.4	1.4	8.6	.2
Chlorophyll a in photic zone (in ug/l)	4.6	--	1.7	--	2.3	--	1.2	--
Fecal coliform (col. per 100 ml) Range	2-2		8-14		<1-<1		1-7	
Fecal coliform (col. per 100 ml) Mean	2		7		<1		4	
Total organic carbon (as C)	5.5	--	6.0	--	5.5	--	4.0	--





Clear Lake, Skagit County. From Washington Department of Game, June 28, 1948.

Clear Lake, Skagit County. July 30, 1973. Approx. scale 1:12,000.

Clear Lake near Medical Lake (12464670)

Location.
Southernmost shoreline point, at lat 47°30'58", long 117°42'22", in SE¼NW¼ sec.1, T.23 N., R.40 E., Spokane County, 4.2 miles south of town of Medical Lake; Crab Creek basin. Medical Lake quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	9.51 sq mi	Mean depth	26 ft	Shoreline configuration	3.2
Altitude	2,342 ft	Maximum depth	110 ft	Development of volume	0.24
Surface area	410 acres	Length of shoreline	48,000 ft	Bottom slope	2.3 percent
Lake volume	11,000 acre-ft				

Basin geology.
Basalt (Huntting and others, 1961).

Soils.
Mostly stony silt loam (Donaldson and Giese, 1968).

Land use (percentage of drainage basin). Urban 1, suburban 0, agricultural 59, forest or unproductive 21, and lake surface 19.
Nearshore residential development. 23 percent.
Number of nearshore homes. 28.

Surface-water inflow and outflow.
A small inflow (less than 0.1 ft^3/s) to Clear Lake was observed on April 5 and May 21, 1973. On July 9 and October 1, the inlet was dry. No outflow was observed.

Lake stage.
Lake stage varied 2.6 feet between April 5 and October 1, 1973. Fragmentary lake-stage data can be obtained from a report by U.S. Geological Survey (1974).

Macrophytes.
Shoreline covered by emersed plants, 1 to 10 percent.
Lake surface covered by emersed plants, 0.5 percent.
Lake bottom covered by submersed plants, 27 percent.
Rooted aquatic plants observed were water milfoil (*Myriophyllum* sp.),* cattail (*Typha* sp.), sedge (Cyperaceae), coontail (*Ceratophyllum* sp.), waterweed (*Elodea* sp.), and pondweed (*Potamogeton* sp.).

Algae observed.
May 21 - A mixed population of diatoms (*Fragillaria* sp.)* and blue-green algae (*Oscillatoria* sp.).
July 9 - Predominantly blue-green algae (*Aphanizomenon* sp.,* *Anabaena* sp.) and some green algae (*Staurastrum* sp.)
Oct. 1 - Predominantly blue-green algae (*Aphanizomenon* sp.,* *Anabaena* sp.).

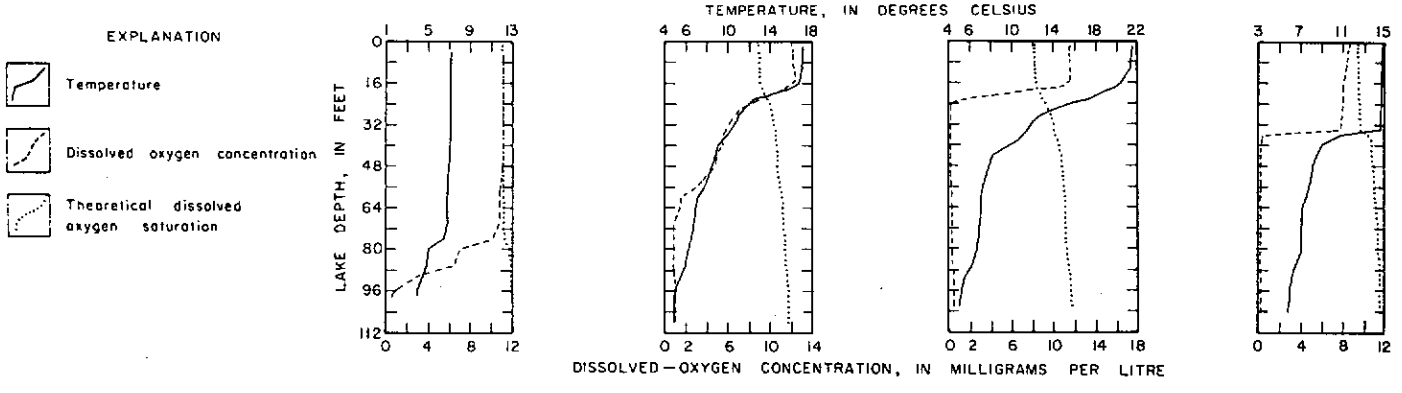
Asterisk (*) indicates dominant aquatic plants.

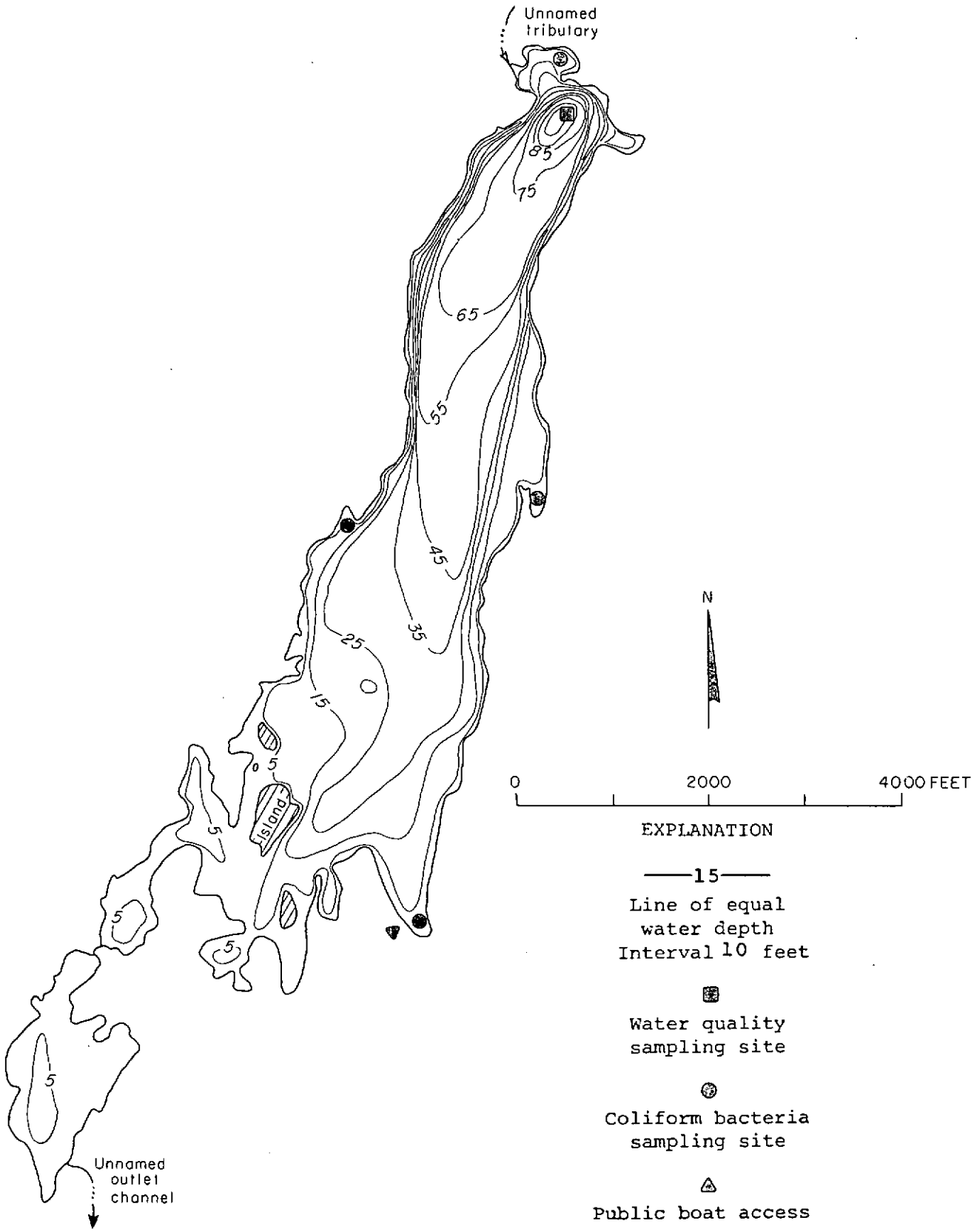
Summary and conclusions.
Clear Lake is a deep lake located in a basalt channel scoured by glacial floodwater. The lake appears high in biological productivity. An intense bloom of blue-green algae occurred in the spring and summer. The chlorophyll *a* concentration, which ranged from 6.6 to 12 µg/l, was among the highest of the lakes studied. The maximum depth of the lake is 110 feet, yet by midsummer the DO was entirely depleted below a depth of about 24 feet. The steep, rocky littoral zone along the eastern and northern shores supported only a sparse growth of aquatic macrophytes. Most of the aquatic plant growth occurred in the shallower southern part of the lake. Water milfoil was the predominant submersed plant.

Water-quality data for Clear Lake (Spokane County)

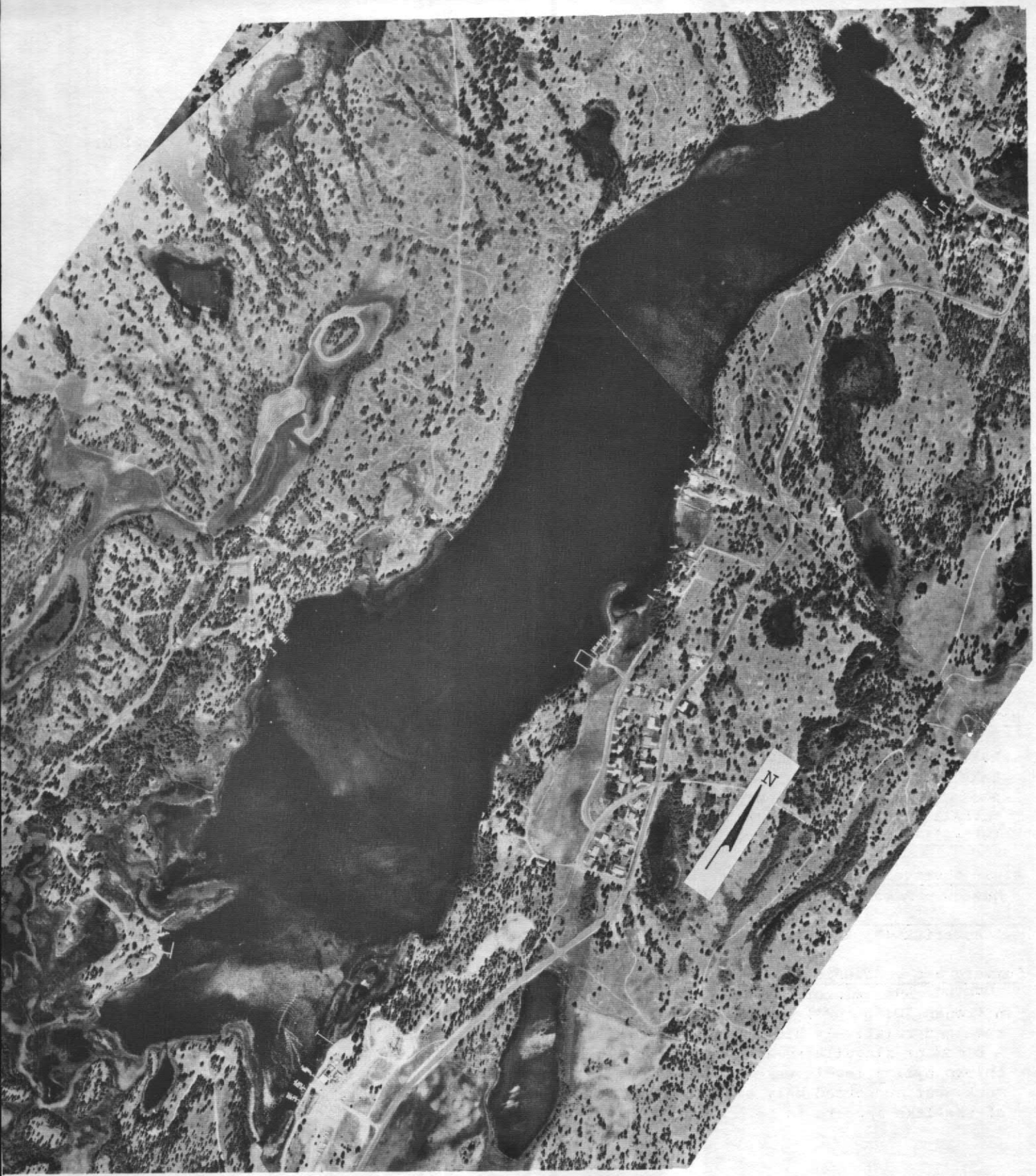
[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	April 5		May 21		July 9		October 1	
Water depth (ft)	3	98	3	105	3	105	3	102
Silica (SiO_2)	0.1	1.6	0.1	2.9	1.2	3.2	3.0	4.4
Dissolved iron (Fe), in ug/l	9	140	9	260	30	280	30	280
Dissolved manganese (Mn) (in µg/l)	10	530	20	1,000	30	780	33	670
Calcium (Ca)	18	--	--	--	--	--	16	--
Magnesium (Mg)	29	--	--	--	--	--	33	--
Sodium (Na)	99	--	--	--	--	--	100	--
Potassium (K)	17	--	--	--	--	--	20	--
Bicarbonate (HCO_3)	389	404	365	392	309	410	410	428
Carbonate (CO_3)	--	--	16	--	39	--	--	0
Sulfide (S)	--	0	--	1.5	--	2.0	--	4.0
Sulfate (SO_4)	5.9	--	--	--	--	--	5.4	--
Chloride (Cl)	43	--	--	--	--	--	47	--
Nitrate nitrogen (as N)	.04	.01	.02	.01	.02	.02	.02	.02
Nitrite nitrogen (as N)	.01	.01	.00	.01	.00	.00	.00	.00
Ammonia nitrogen (as N)	.16	1.5	.08	3.0	.09	3.2	.10	3.9
Organic nitrogen (as N)	1.6	1.0	1.6	.30	.39	3.0	1.7	2.3
Total phosphorus (as P)	.055	.18	.074	.32	.054	.32	.041	.56
Orthophosphate (as P)	.025	.020	.003	.16	.004	.32	.006	.45
Suspended solids (110°C)	62	--	--	--	--	--	3	--
Hardness as $CaCO_3$ (Ca,Mg)	160	--	--	--	--	--	180	--
Specific conductance (micromhos at 25°C)	641	650	680	667	670	660	640	660
pH (pH units)	8.6	8.4	8.8	7.5	9.2	7.6	8.5	7.4
Water temperature (°C)	7.3	4.0	17.2	4.9	21.3	5.0	14.7	5.8
Color (Pt-Co scale)	10	10	5	10	10	20	10	10
Secchi-disc (ft)	5.6		7.9		4.6		4.6	
Dissolved oxygen (DO)	11.1	.6	12.2	1.0	11.5	.5	8.4	.2
Chlorophyll a in photic zone (in ug/l)	6.6	--	9.2	--	11	--	12	--
Fecal coliform (col. per 100 ml) Range	<1-1		<1-<1		<1-2		1-8	
Fecal coliform (col. per 100 ml) Mean	<1		<1		1		3	
Total organic carbon (as C)	17	--	20	--	21	--	20	--





Clear Lake, Spokane County. From Washington Department of Game, February 8, 1956.



Clear Lake, Spokane County. July 25, 1974. Approx. scale 1:14,000.

Crabapple Lake near Tulalip (12157950)

Location.
Southernmost shoreline point, at lat 48°07'49", long 122°16'22", in SE¼SE¼ sec.34, T.31 N., R.4 E., Snohomish County, 4.9 miles north of Tulalip; Tulalip Creek basin. Stanwood quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	1.20 sq mi	Mean depth	18 ft	Shoreline configuration	1.4
Altitude	415 ft	Maximum depth	49 ft	Development of volume	0.37
Surface area	35 acres	Length of shoreline	6,000 ft	Bottom slope	3.5 percent
Lake volume	650 acre-ft				

Basin geology.
Glacial drift deposited principally as ground moraine (Newcomb, 1952).

Soils.
Gravelly sandy loam (Anderson and others, 1947).

Land use (percentage of drainage basin). Urban 0, suburban 4, agricultural 0, forest or unproductive 89, and lake surface 7.
Nearshore residential development. 53 percent.
Number of nearshore homes. 33.

Surface-water inflow and outflow.
During 1973, Crabapple Lake had an observed inflow and outflow only early in the year. On March 14, 1973, the inflow and outflow were estimated at 1.0 ft^3/s and 1.5 ft^3/s, respectively. Between May and September no inflow or outflow was observed.

Lake stage.
Lake stage varied 1.2 feet between March 14 and September 25, 1973.

Macrophytes.
Shoreline covered by emersed plants, 11 to 25 percent.
Lake surface covered by emersed plants, 0.8 percent.
Lake bottom covered by submersed plants, 2 percent.
Rooted aquatic plants observed were yellow lily (*Nuphar* sp.),* waterweed (*Elodea* sp.),* cattail (*Typha* sp.), white lily (*Nymphaea* sp.), pondweed (*Potamogeton* sp.), stonewort (*Nitella* sp.), and quillwort (*Isoetes* sp.).

Algae observed.
May 30 - A mixed population of flagellates (*Ceratium* sp.)* and blue-green algae (*Nostoc* sp.).

Asterisk (*) indicates dominant aquatic plants.

Summary and conclusions.
During the winter mixing period, Crabapple Lake had the highest concentration of nitrate nitrogen (0.86 mg/l) of the lakes studied, and throughout the summer the nitrate level remained relatively high. The total phosphorus concentration (0.022 mg/l) was also high. A bloom of flagellates and blue-green algae was observed in the spring. However, chlorophyll *a* levels were generally moderate. The littoral zone was composed primarily of muck, but supported only a light growth of aquatic macrophytes. The biological productivity of the lake appears to be moderate.

Water-quality data for Crabapple Lake

[Milligrams per litre unless otherwise indicated]

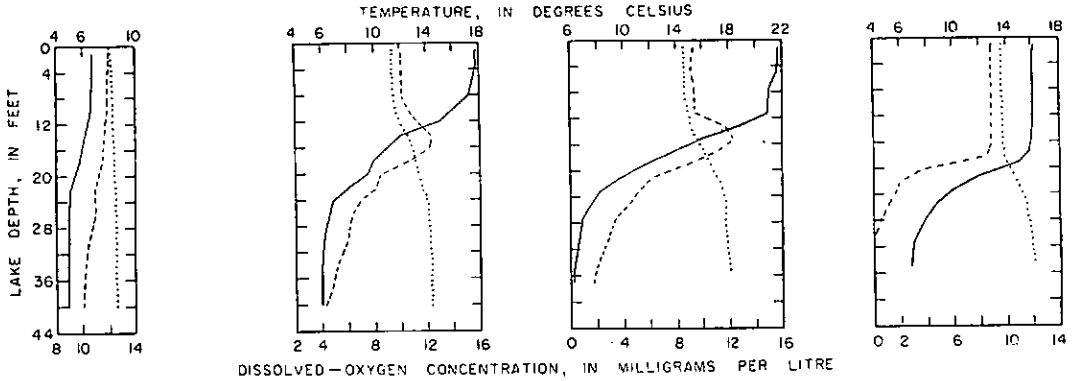
Date of collection (1973)	March 14		May 30		July 18		September 25	
Water depth (ft)	3	36	3	36	3	33	3	33
Silica (SiO_2)	1.6	2.0	1.3	2.1	1.1	--	0.7	2.1
Dissolved iron (Fe), in µg/l	30	40	30	30	50	--	80	110
Dissolved manganese (Mn) (in µg/l)	20	0	20	20	10	--	10	110
Calcium (Ca)	4.1	--	--	--	--	--	3.4	--
Magnesium (Mg)	1.2	--	--	--	--	--	1.4	--
Sodium (Na)	2.5	--	--	--	--	--	2.2	--
Potassium (K)	.6	--	--	--	--	--	.7	--
Bicarbonate (HCO_3)	10	9	--	10	16	--	12	17
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	4.2	--	--	--	--	--	5.5	--
Chloride (Cl)	3.6	--	--	--	--	--	4.2	--
Nitrate nitrogen (as N)	.86	.89	.72	.71	.43	.65	.21	.42
Nitrite nitrogen (as N)	.01	.00	.01	.00	.01	.00	.00	.00
Ammonia nitrogen (as N)	.06	.07	.04	.09	.06	.09	.06	.16
Organic nitrogen (as N)	.41	.30	.31	.19	.35	.22	.37	.20
Total phosphorus (as P)	.022	.016	.010	.014	.018	.015	.015	.015
Orthophosphate (as P)	.002	.001	.002	.002	.006	.003	.014	.006
Suspended solids (110°C)	3	--	--	--	--	--	7	--
Hardness as $CaCO_3$ (Ca,Mg)	15	--	--	--	--	--	14	--
Specific conductance (micromhos at 25°C)	46	46	44	42	59	56	41	41
pH (pH units)	7.0	6.9	6.8	6.3	6.3	--	8.1	7.6
Water temperature (°C)	6.8	4.9	17.8	6.0	21.8	6.4	16.0	6.9
Color (Pt-Co scale)	10	10	20	20	10	10	0	5
Secchi-disc (ft)	11		7.5		9.8		18	
Dissolved oxygen (DO)	12.0	10.1	10.1	4.8	9.2	2.2	9.0	2
Chlorophyll a in photic zone (µg/l)	4.2	--	1.7	--	2.0	--	1.4	--
Fecal coliform (col. per 100 ml) Range	1-7		--		4-33		<1-16	
Fecal coliform (col. per 100 ml) Mean	3		--		8		6	
Total organic carbon (as C)	5.0	--	6.5	--	6.0	--	5.5	--

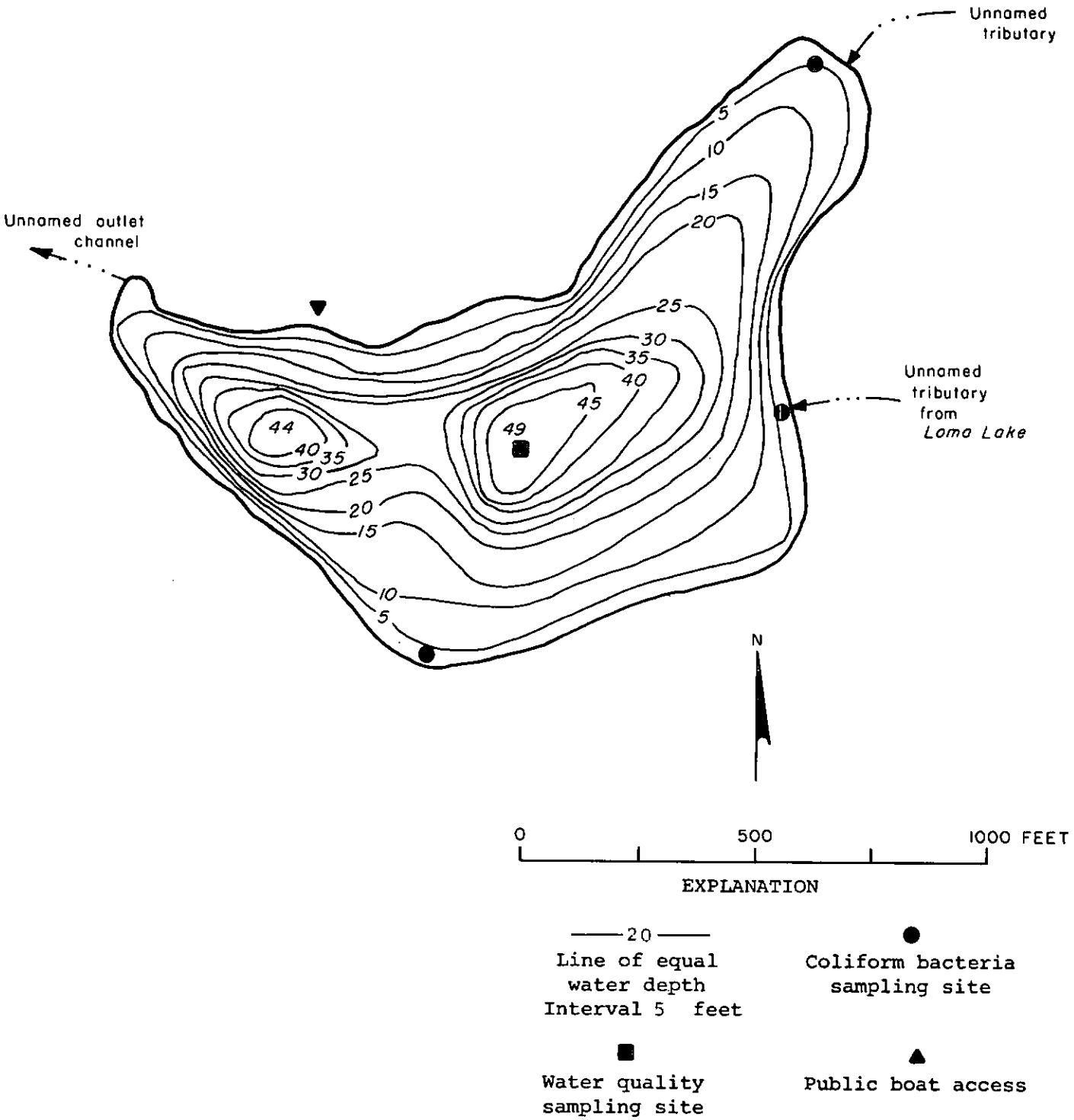
EXPLANATION

Temperature

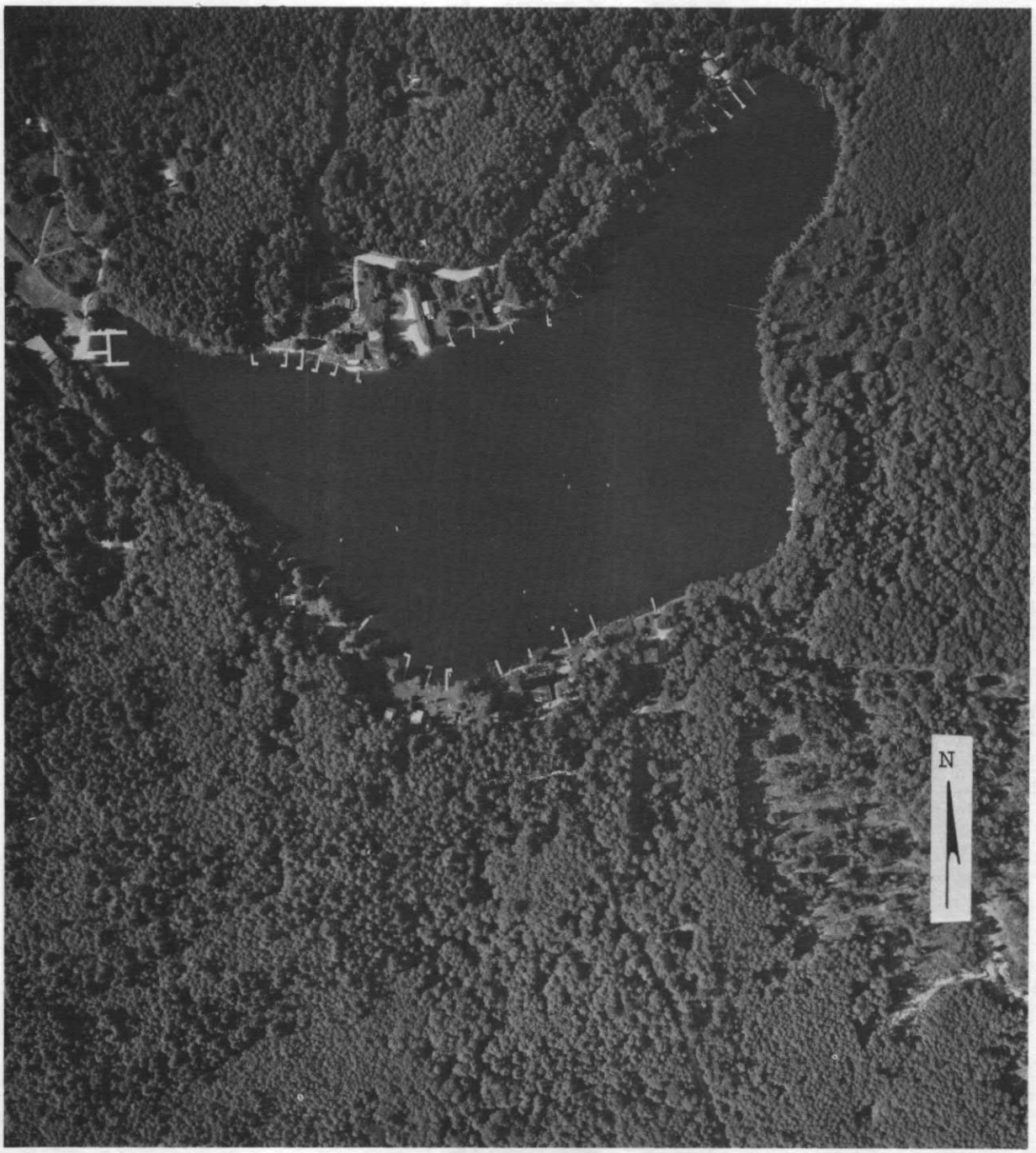
Dissolved oxygen concentration

Theoretical dissolved oxygen saturation





Crabapple Lake, Snohomish County.
From Washington Department of Game, July 11, 1952.



Crabapple Lake, Snohomish County. July 14, 1973. Approx. scale 1:4800.

Day Lake near Lyman (12196170)

Location.
Lat 48°24"26", long 121°58'34", in SE¼SW¼ sec.25, T.34 N., R.6 E., Skagit County, 12.5 miles south of Lyman; Skagit basin. Oso quadrangle, 1:62,500.

Physical characteristics of lake.

Drainage area	6.44 sq mi	Mean depth	23 ft	Shoreline configuration	2.0
Altitude	1,602 ft	Maximum depth	48 ft	Development of volume	0.49
Surface area	130 acres	Length of shoreline	16,500 ft	Bottom slope	1.8 percent
Lake volume	3,100 acre-ft				

Basin geology.
Metamorphic rocks in hills to east and west, and alluvium in valley (Huntting and others, 1961).

Soils.
Shallow, stony soils with local peat deposits (Ness and others, 1960).

Land use (percentage of drainage basin). Urban 0, suburban 0, agricultural 0, forest or unproductive 97, and lake surface 3.

Nearshore residential development. 0 percent.

Number of nearshore homes. 0.

Surface-water inflow and outflow.
Day Lake has several perennial inflows, the two largest being Fish Creek and the inflow at the southeast end of the lake. An estimate of total inflow on March 9 was 28 ft^3/s; May 17, 29 ft^3/s; July 2, 9 ft^3/s; and Sept. 20, 1 ft^3/s. Day Creek, the outlet, on the same dates had measured discharges of 50.0 ft^3/s, 46.8 ft /s, 15.0 ft^3/s, and 5.5 ft^3/s, respectively.

Lake stage.
Lake stage varied about 0.9 foot between March and September 1973.

Macrophytes.
Shoreline covered by emersed plants, 51 to 75 percent.
Lake surface covered by emersed plants, 1 percent.
Lake bottom covered by submersed plants, 8 percent.
Rooted aquatic plants observed were pondweed (*Potamogeton* sp.),* cattail (*Typha* sp.), yellow lily (*Nuphar* sp.), sedge (Cyperaceae), and water plaintain (*Alisms* sp.).

Algae observed.
May 17 - Predominantly diatoms (*Dinobryon* sp.* and *Asterionella* sp.).

Asterisk (*) indicates dominant aquatic plants.

Summary and conclusions.
Day Lake, a remote lake in the foothills of the Cascade Range, appears to be low in biological productivity. The chlorophyll *a* concentration (range from 0.8 to 1.5 µg/l) was the lowest for the lakes studied. A high cell density of diatoms was observed in the spring of the year. Aquatic macrophyte growth was light. Year-round surface inflow and outflow continually flushed the lake. Boating is hazardous because of many submersed upright snags in the lake that have either rotted or been cut off at the water line.

Water-quality data for Day Lake.

[Milligrams per litre unless otherwise indicated]

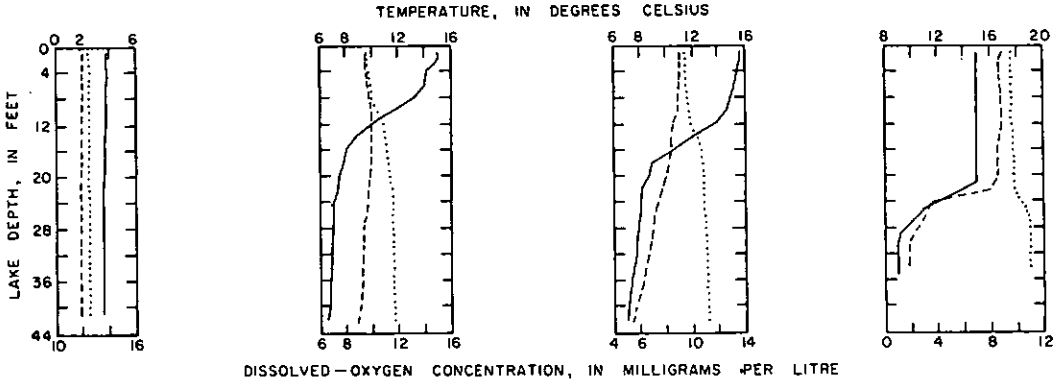
Date of collection (1973)	March 19		May 17		July 2		September 20	
Water depth (ft)	3	39	3	39	3	39	3	33
Silica (SiO_2)	3.9	3.9	3.8	3.8	4.3	4.1	4.1	4.6
Dissolved iron (Fe), in ug/l	170	130	130	200	200	460	280	790
Dissolved manganese (Mn) (in µg/l)	20	20	10	10	10	60	10	240
Calcium (Ca)	3.7	--	--	--	--	--	5.3	--
Magnesium (Mg)	.9	--	--	--	--	--	1.5	--
Sodium (Na)	.7	--	--	--	--	--	1.1	--
Potassium (K)	.2	--	--	--	--	--	1.4	--
Bicarbonate (HCO_3)	13	13	15	15	23	21	28	26
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	3.2	--	--	--	--	--	37	--
Chloride (Cl)	1.2	--	--	--	--	--	.8	--
Nitrate nitrogen (as N)	.02	.20	.13	.16	.07	.12	.02	.16
Nitrite nitrogen (as N)	.01	.01	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.05	.07	.06	.07	.06	.07	.04	.05
Organic nitrogen (as N)	.19	.16	.04	.04	.03	.01	.11	.11
Total phosphorus (as P)	.034	.021	.057	.004	.011	.011	.008	.013
Orthophosphate (as P)	.002	.001	.037	.003	.002	.004	.002	.002
Suspended solids (110°C)	6	--	--	--	--	--	1	--
Hardness as $CaCO_3$ (Ca,Mg)	13	--	--	--	--	--	19	--
Specific conductance (micromhos at 25°C)	29	30	32	29	36	31	40	33
pH (pH units)	6.8	6.8	8.0	7.5	6.6	6.1	8.3	7.9
Water temperature (°C)	3.8	3.5	14.6	6.7	15.5	8.1	14.9	9.0
Color (Pt-Co scale)	10	10	15	20	40	40	0	30
Secchi-disc (ft)	9.8		12		7.5		11	
Dissolved oxygen (DO)	11.9	11.8	9.5	9.1	9.1	5.7	8.6	1.8
Chlorophyll a in photic zone (µg/l)	1.5	--	.8	--	.8	--	1.2	--
Fecal coliform (col. per 100 ml) Range	<1-<1		<1-<1		<1-<1		<1-5	
Fecal coliform (col. per 100 ml) Mean	<1		<1		<1		2	
Total organic carbon (as C)	4.0	--	7.5	--	5.5	--	3.0	--

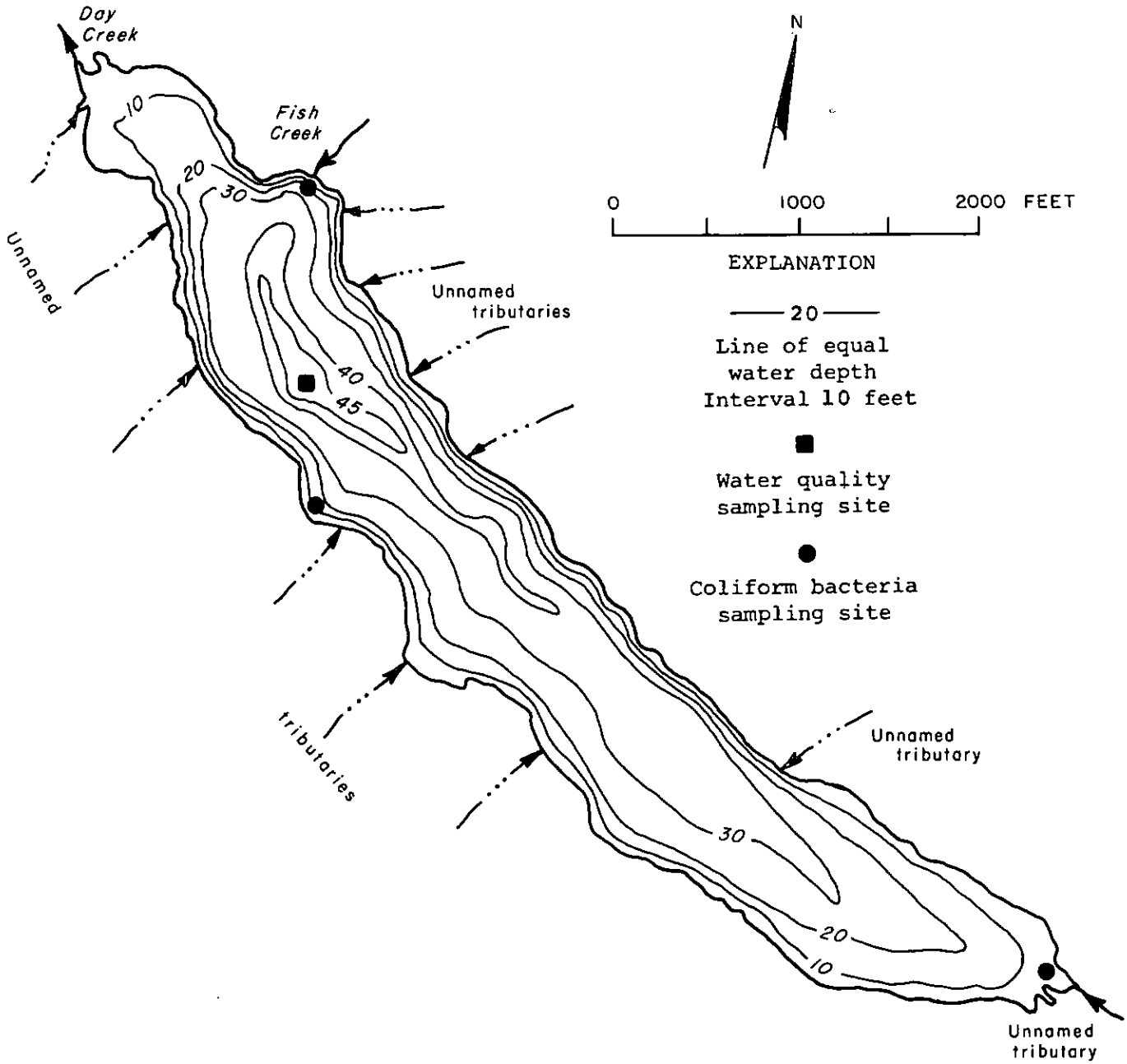
EXPLANATION

Temperature

Dissolved oxygen concentration

Theoretical dissolved oxygen saturation





Day Lake, Skagit County. From U.S. Geological Survey, August 23, 1973.

Day Lake, Skagit County. June 5, 1970. Approx. scale 1:12,000.

Deer Lake near Clinton (12128150)

Location.
Lat 47°58'28", long 122°22'41", in NE¼NE¼ sec.26, T.29 N., R.3 E., Island County, 1.2 miles west of Clinton; unnamed tributary to Possession Sound. Maxwelton quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	1.19 sq mi	Mean depth	20 ft	Shoreline configuration	1.3
Altitude	352 ft	Maximum depth	50 ft	Development of volume	0.40
Surface area	81 acres	Length of shoreline	8,900 ft	Bottom slope	2.4 percent
Lake volume	1,700 acre-ft				

Basin geology.
Glacial drift (Huntting and others, 1961).

Soils.
Gravelly sandy loam with some loamy sand (Ness and Richins, 1958).

Land use (percentage of drainage basin). Urban 0, suburban 5, agricultural 15, forest or unproductive 69, and lake surface 11.
Nearshore residential development. 67 percent.
Number of nearshore homes. 43.

Surface-water inflow and outflow.
No inflow to Deer Lake was observed between March and September 1973. The outflows on March 16 and May 15, 1973 were estimated to be 0.3 ft^3/s and less than 0.1 ft^3/s, respectively. On June 26 and September 19, the outlet was dry.

Lake stage.
Lake stage varied 0.5 foot between March 16 and September 19, 1973.

Macrophytes.
Shoreline covered by emersed plants, 26 to 50 percent.
Lake surface covered by emersed plants, 2 percent.
Lake bottom covered by submersed plants, 5 percent.
Rooted aquatic plants observed were sedge (Cyperaceae),* muskgrass (*Chara* sp.),* cattail (*Typha* sp.), yellow lily (*Nuphar* sp.), and quillwort (*Isoetes* sp.).

Algae observed.
June 26 - A mixed population of diatoms (*Dinobryon* sp.,* and *Asterionella* sp.) and blue-green algae (*Nostoc* sp.).

Asterisk (*) indicates dominant aquatic plants.

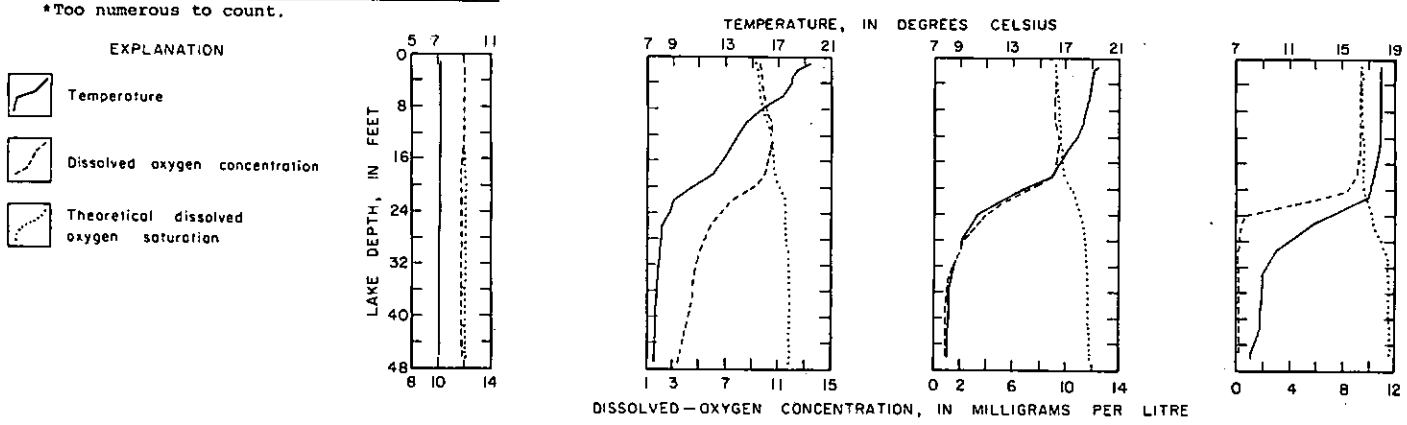
Summary and conclusions.
Deer Lake appears to be low to moderate in biological productivity. The chlorophyll *a* concentrations during the spring and summer were low. The lake was vertically mixed in March. By June, strong thermal stratification had developed and the DO was depleted to nearly zero in the hypolimnion. During a visit to the lake in June, a bloom of blue-green algae and diatoms was observed. Aquatic macrophyte growth was sparse. Residential development around the lake has doubled since 1953. About 43 homes now occupy the nearshore area of the lake.

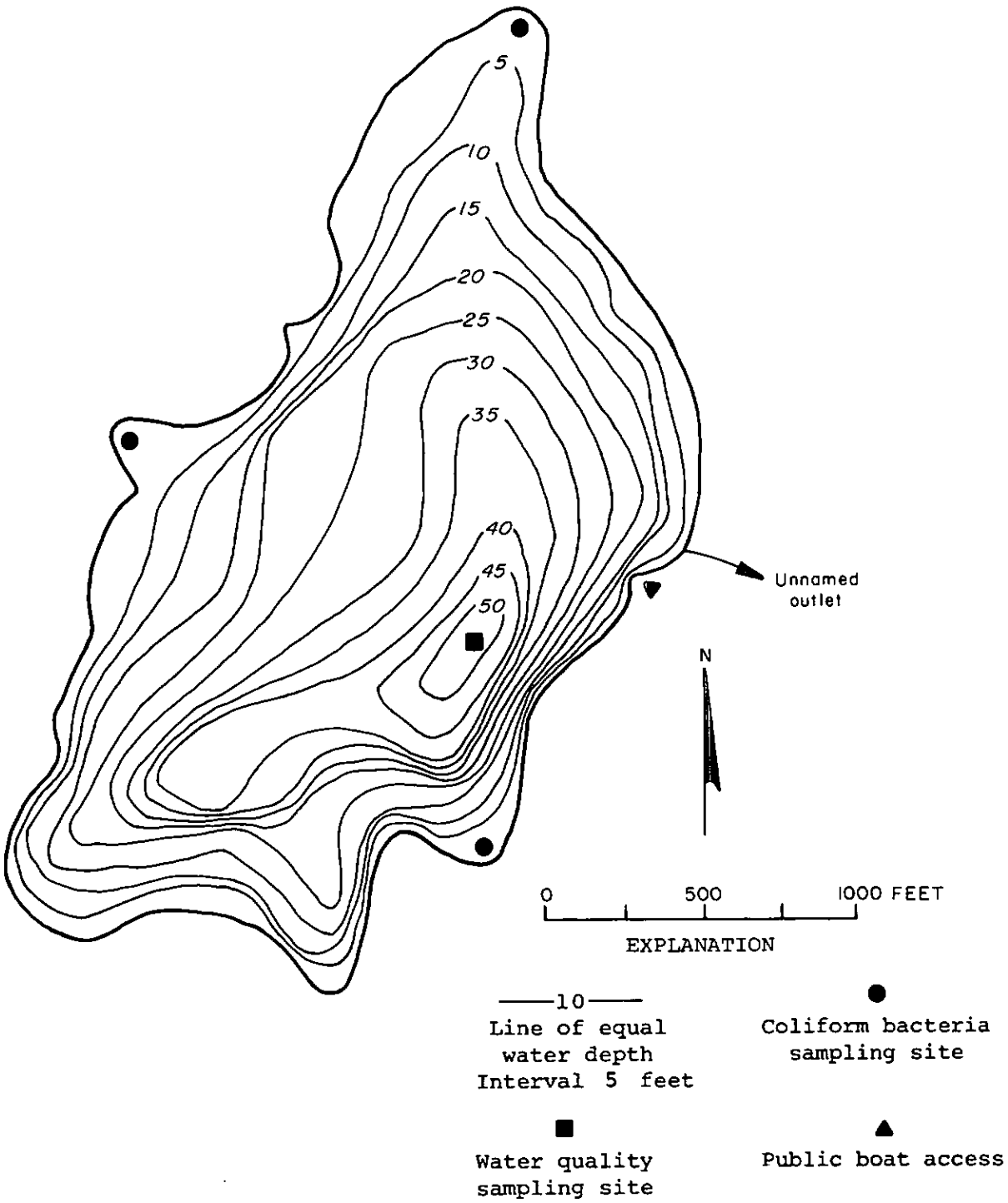
Water-quality data for Deer Lake.

[Milligrams per litre unless otherwise indicated]

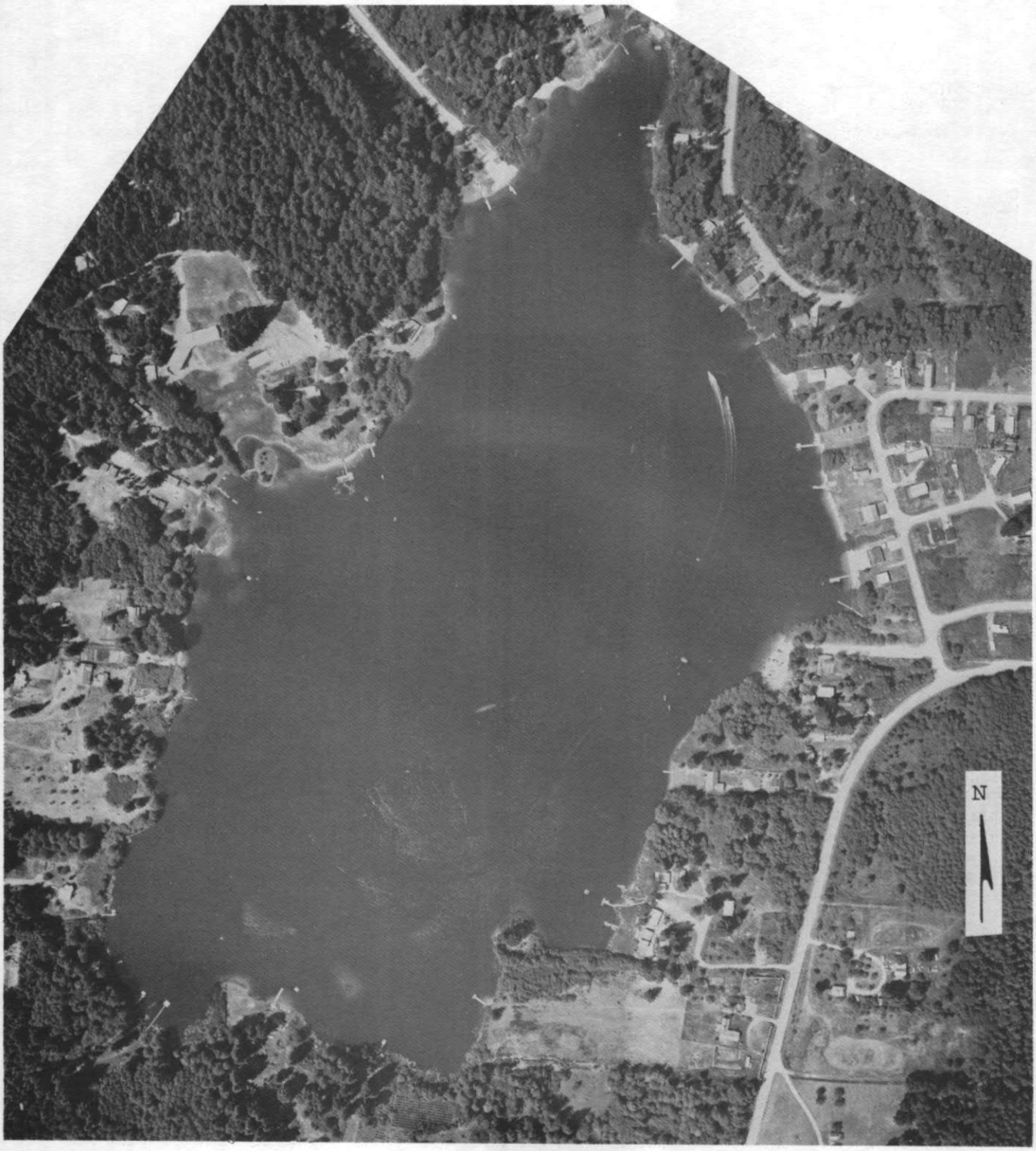
Date of collection (1973)	March 16		May 15		June 26		September 19	
Water depth (ft)	3	46	3	46	3	44	3	43
Silica (SiO_2)	1.0	1.0	0.5	1.4	0.5	1.6	0.5	2.0
Dissolved iron (Fe), in µg/l	40	40	30	100	20	440	20	1,500
Dissolved manganese (Mn) (in µg/l)	20	0	0	60	10	110	0	250
Calcium (Ca)	4.2	--	--	--	--	--	3.8	--
Magnesium (Mg)	2.6	--	--	--	--	--	2.7	--
Sodium (Na)	4.6	--	--	--	--	--	5.1	--
Potassium (K)	1.2	--	--	--	--	--	1.3	--
Bicarbonate (HCO_3)	16	16	16	17	21	25	22	29
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	2.0
Sulfate (SO_4)	9.1	--	--	--	--	--	9.1	--
Chloride (Cl)	5.8	--	--	--	--	--	6.3	--
Nitrate nitrogen (as N)	.01	.01	.02	.03	.00	.00	.01	.01
Nitrite nitrogen (as N)	.01	.01	.00	.00	.00	.00	.00	.01
Ammonia nitrogen (as N)	.08	.06	.09	.13	.05	.01	.05	.27
Organic nitrogen (as N)	.39	.40	.35	.05	.08	.15	.35	.25
Total phosphorus (as P)	.059	.025	.013	.015	.011	.026	.015	.020
Orthophosphate (as P)	.002	.007	.002	.002	.002	.005	.002	.020
Suspended solids (110°C)	4	--	--	--	--	--	4	--
Hardness as $CaCO_3$ (Ca,Mg)	21	--	--	--	--	--	21	--
Specific conductance (micromhos at 25°C)	66	66	69	63	66	64	67	72
pH (pH units)	7.0	6.9	6.6	6.6	6.6	5.7	7.3	7.8
Water temperature (°C)	7.2	7.1	18.1	7.6	19.0	8.0	17.8	8.5
Color (Pt-Co scale)	10	10	5	10	10	10	0	15
Secchi-disc (ft)	7.9		11		14		14	
Dissolved oxygen (DO)	12.0	11.8	9.7	3.6	9.2	.9	9.4	.2
Chlorophyll a in photic zone (µg/l)	6.4	--	.7	--	2.1	--	1.3	--
Fecal coliform (col. per 100 ml) Range	<1-1		1-4		<1-8		<1-*TNTC	
Fecal coliform (col. per 100 ml) Mean	<1		2		3		--	
Total organic carbon (as C)	7.5	--	9.0	--	9.5	--	7.0	--

*Too numerous to count.





Deer Lake, Island County. From Washington Department of Game, July 11, 1949.



Deer Lake, Island County. July 30, 1973. Approx. scale 1:4800.

Goss Lake near Langley (12128300)

Location.
Lat 48°02'04", long 122°28'48", in NW¼NW¼ sec.6, T.29 N., R.3 E., Island County, 3.1 miles west of Langley; unnamed tributary to Holmes Harbor. Langley quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	1.41 sq mi	Mean depth	32 ft	Shoreline configuration	1.2
Altitude	130 ft	Maximum depth	60 ft	Development of volume	0.53
Surface area	47 acres	Length of shoreline	6,300 ft	Bottom slope	3.7 percent
Lake volume	1,500 acre-ft				

Basin geology.
Glacial drift (Huntting and others, 1961).

Soils.
Gravelly sandy loam and loamy sand with local peat deposits around perimeter of lake (Ness and Richins, 1958).

Land use (percentage of drainage basin). Urban 0, suburban 4, agricultural 1, forest or unproductive 90, and lake surface 5.

Nearshore residential development. 85 percent.

Number of nearshore homes. 36.

Surface-water inflow and outflow.
Early in the year three unnamed tributaries contributed minor inflow to the lake. From May through September no inflow was observed. No outlet was observed.

Lake stage.
Lake stage varied 2.8 feet between March 15 and September 19, 1973.

Macrophytes.
Shoreline covered by emersed plants, 11 to 25 percent.
Lake surface covered by emersed plants, 0.5 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were sedge (Cyperaceae),* cattail (*Typha* sp.), smartweed (*Polygonum* sp.), and waterweed (*Elodea* sp.).

Asterisk (*) indicates dominant aquatic plant.

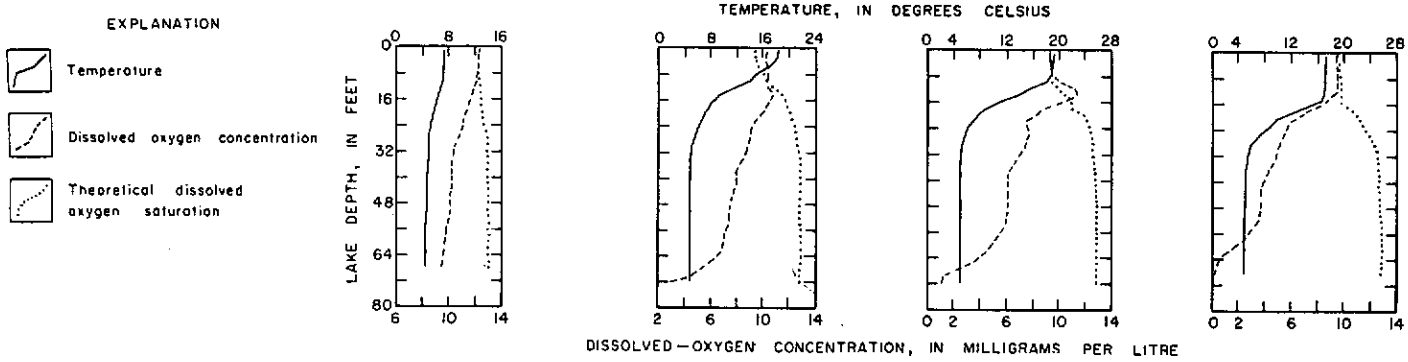
Algae observed.
May 15 - Predominantly blue-green algae (*Polycystis* sp.).

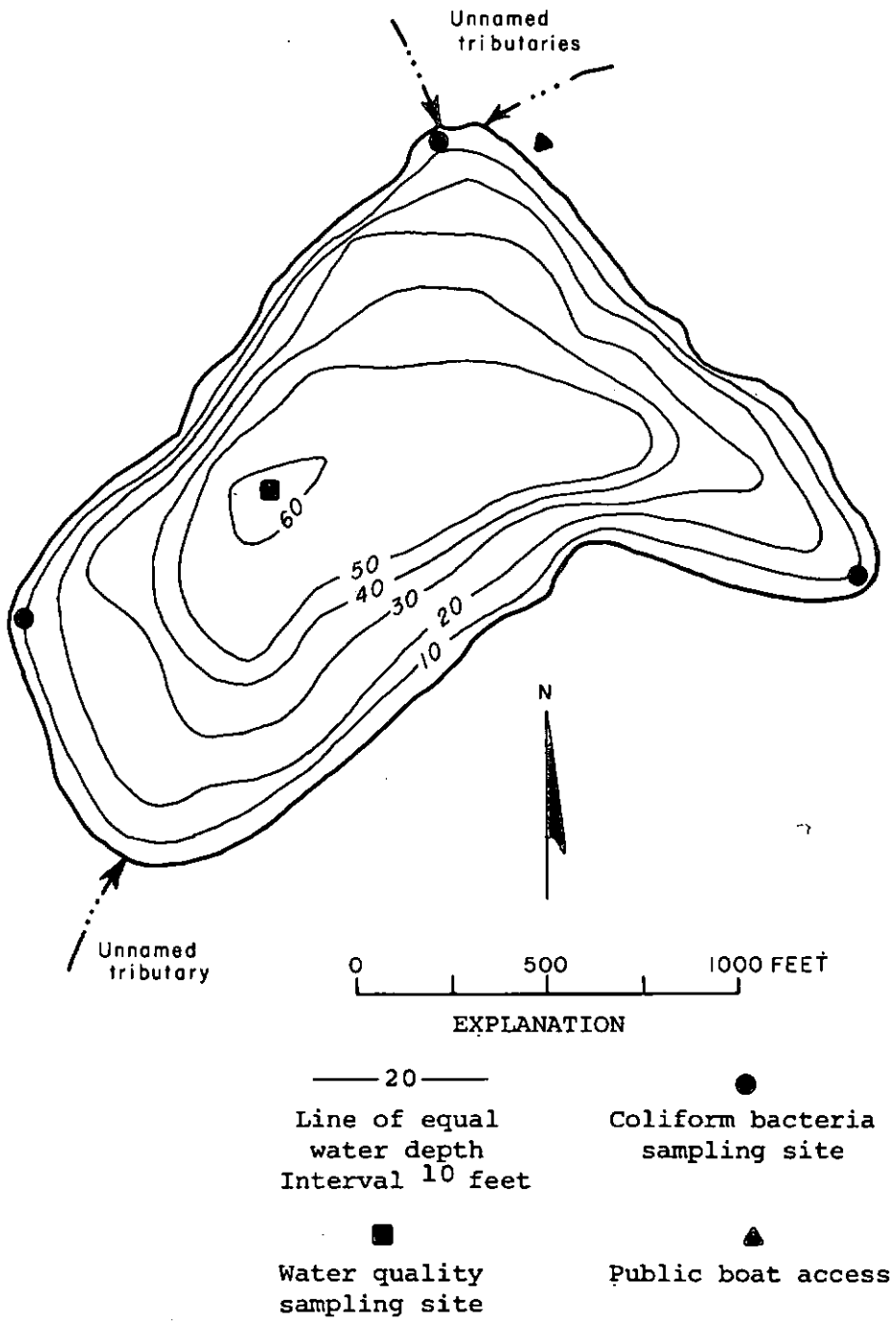
Summary and conclusions.
Goss Lake is a deep, sheltered lake that appears to have a low to moderate biological productivity. A high cell density of blue-green algae was observed during a visit to the lake in May. The steep-sided littoral zone contained only a light growth of aquatic macrophytes. DO remained high in the epilimnion, but was depleted to nearly zero in the hypolimnion by mid-June. The number of nearshore homes has increased from 9 homes in 1956 to about 43 homes in 1973.

Water-quality data for Goss Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 15		May 15		June 26		September 19	
Water depth (ft)	3	67	3	69	3	69	3	66
Silica (SiO_2)	3.0	4.0	2.6	4.4	0.1	4.9	0.5	5.4
Dissolved iron (Fe), in ug/l	50	50	60	60	40	110	50	150
Dissolved manganese (Mn) (in µg/l)	20	20	10	20	0	70	0	100
Calcium (Ca)	5.1	--	--	--	--	--	4.7	--
Magnesium (Mg)	4.8	--	--	--	--	--	5.2	--
Sodium (Na)	7.4	--	--	--	--	--	7.7	--
Potassium (K)	1.4	--	--	--	--	--	2.1	--
Bicarbonate (HCO_3)	21	22	23	25	30	30	30	30
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	14	--	--	--	--	--	14	--
Chloride (Cl)	9.6	--	--	--	--	--	10	--
Nitrate nitrogen (as N)	.21	.30	.13	.32	.01	.30	.01	.30
Nitrite nitrogen (as N)	.01	.00	.01	.00	.00	.00	.00	.01
Ammonia nitrogen (as N)	.09	.08	.09	.08	.06	.06	.05	.07
Organic nitrogen (as N)	.31	.39	.43	.39	.07	.04	.33	.29
Total phosphorus (as P)	.029	.019	.010	.013	.011	.031	.019	.022
Orthophosphate (as P)	.003	.003	.004	.004	.002	.007	.002	.009
Suspended solids (110°C)	4	--	--	--	--	--	2	--
Hardness as $CaCO_3$ (Ca,Mg)	33	--	--	--	--	--	33	--
Specific conductance (micromhos at 25°C)	98	100	105	95	105	94	107	93
pH (pH units)	7.2	7.0	7.6	6.9	6.7	6.1	7.0	6.8
Water temperature (°C)	7.5	4.4	18.2	4.7	19.3	4.8	17.3	4.8
Color (Pt-Co scale)	20	20	5	15	5	5	5	5
Secchi-disc (ft)	7.9		14		14		19	
Dissolved oxygen (DO)	12.2	9.4	10.2	4.5	9.4	1.7	9.5	.5
Chlorophyll a in photic zone (µg/l)	5.0	--	2.2	--	5.4	--	1.5	--
Fecal coliform (col. per 100 ml) Range	<1-<1		<1-<1		3-9		<1-3	
Fecal coliform (col. per 100 ml) Mean	<1		<1		5		1	
Total organic carbon (as C)	7.5	--	9.0	--	8.5	--	7.0	--





Goss Lake, Island County. From Washington Department of Game, January 23, 1949.

Goss Lake, Island County. July 30, 1973. Approx. scale 1:4800.

Horseshoe Lake near Burley (12073505)

Location.
Southernmost shoreline point, at lat 47°24'20", long 122°39'48", in SE¼SW¼ sec.10, T.22 N., R.1 E., Kitsap County, 1.7 miles southwest of Burley; Burley Creek basin. Burley quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.48 sq mi	Mean depth	12 ft	Shoreline configuration	1.4
Altitude	270 ft	Maximum depth	20 ft	Development of volume	0.60
Surface area	40 acres	Length of shoreline	6,800 ft	Bottom slope	1.3 percent
Lake volume	470 acre-ft				

Basin geology.
Glacial drift (Sceva, 1957).

Soils.
Gravelly sandy loam, loamy sand, with local alluvial deposits (Wildermuth and others, 1939).

Land use (percentage of drainage basin). Urban 0, suburban 5, agricultural 4, forest or unproductive 78, and lake surface 13.
Nearshore residential development. 75 percent.
Number of nearshore homes. 38.

Surface-water inflow and outflow.
No inflow to Horseshoe Lake was observed between March and September 1973. The outflow on March 1, 1973 was estimated to be 0.6 ft^3/s; no outflow was observed during the summer months.

Lake stage.
Lake stage varied 2.6 feet between March 1 and September 5, 1973.

Macrophytes.
Shoreline covered by emersed plants, 26 to 50 percent.
Lake surface covered by emersed plants, 16 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were white lily (*Nymphaea* sp.),* quillwort (*Isoetes* sp.),* cattail (*Typha* sp.), sedge (Cyperaceae), watershield (*Brasenia* sp.), and pondweed (*Potamogeton* sp.).

Asterisk (*) indicates dominant aquatic plants.

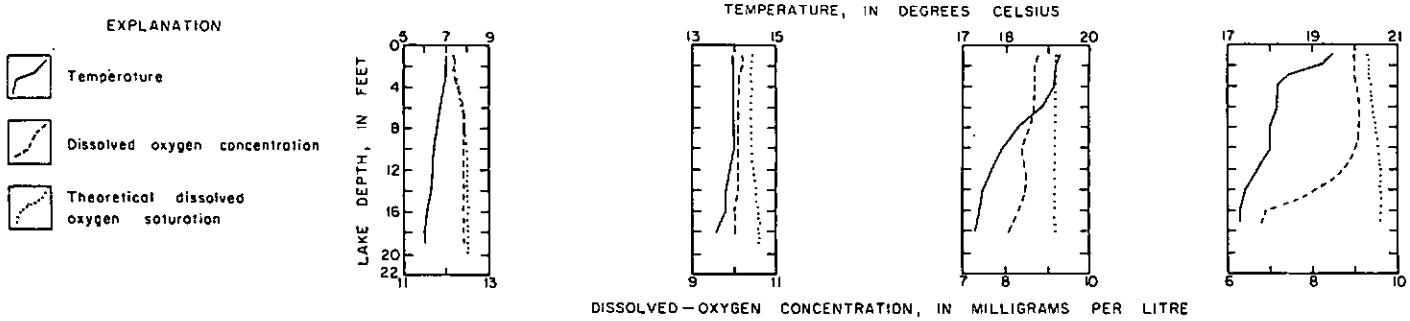
Algae observed.
No data.

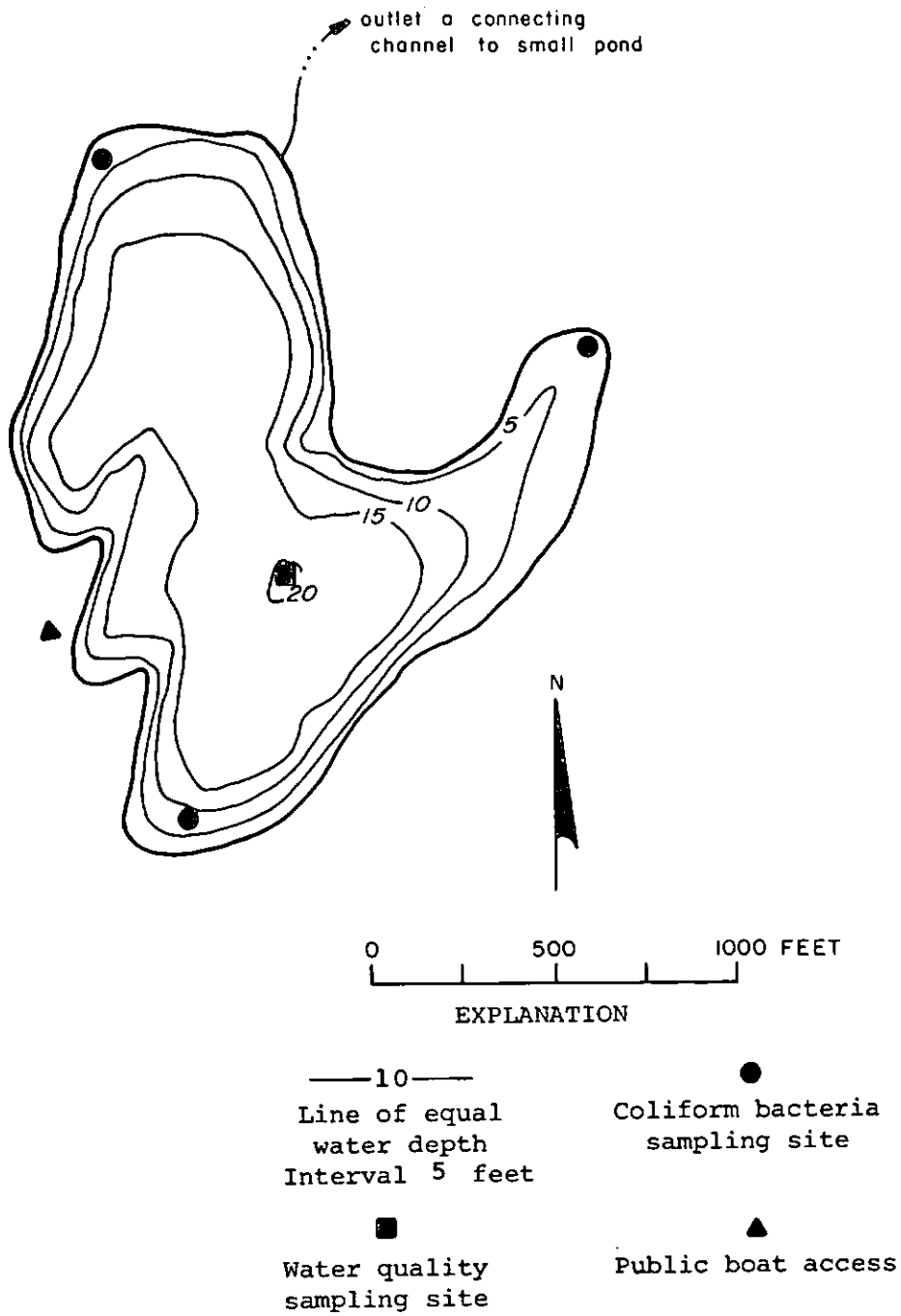
Summary and conclusions.
Horseshoe Lake is low in dissolved-mineral concentration and in biological productivity. The nutrient concentrations were among the lowest of the lakes studied. The DO concentration remained high at all depths throughout the summer and only very weak thermal stratification of the lake occurred. The lake bottom was sparsely covered by submersed macrophytes but about 16 percent of the lake surface was covered by white lilies. Residential homes have increased from about 58 homes in 1958 to about 121 homes in 1973.

Water-quality data for Horseshoe Lake.

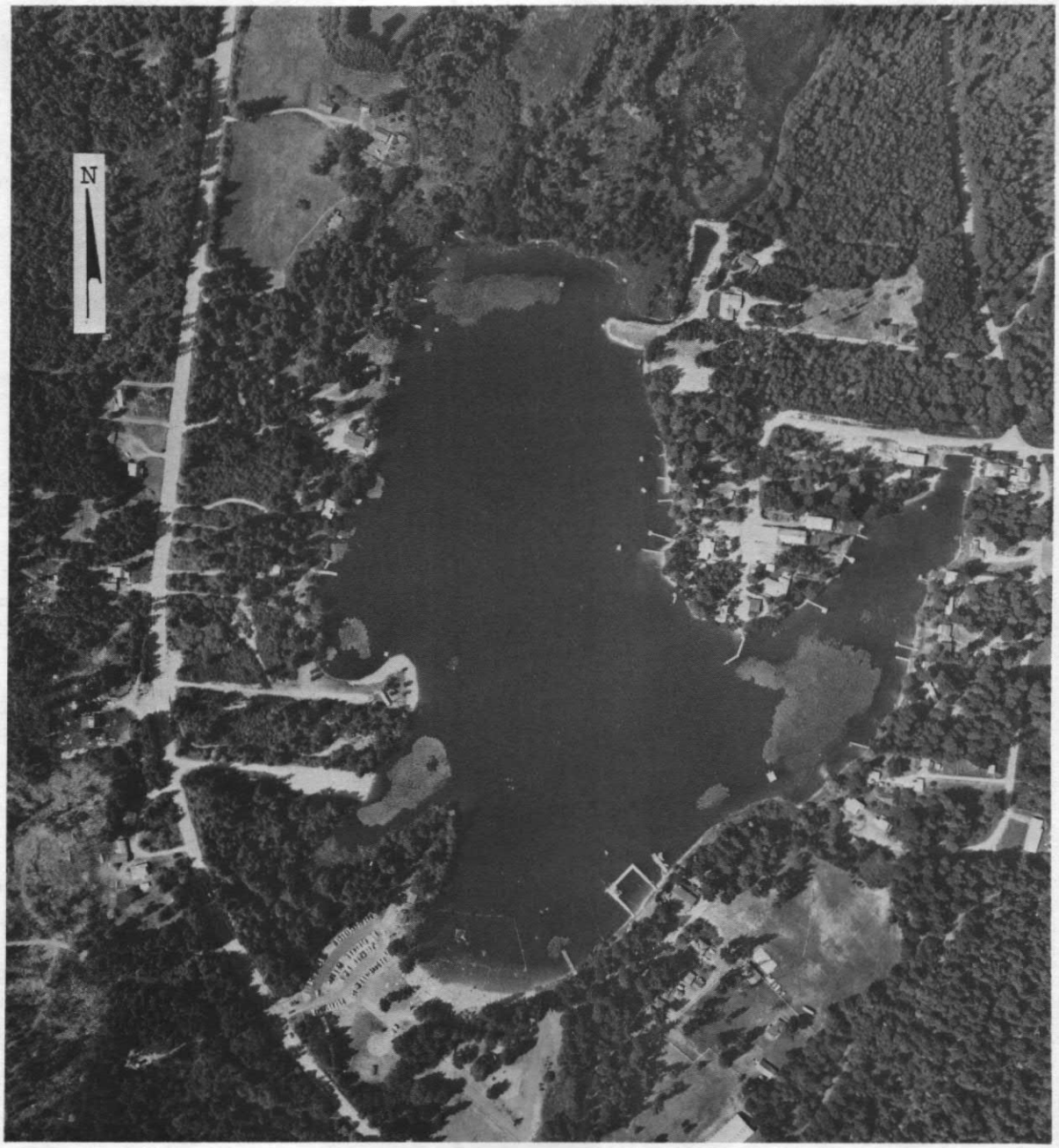
[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 1		May 7		June 20		September 5	
Water depth (ft)	3	16	3	16	3	15	3	15
Silica (SiO_2)	0.4	0.3	0.0	0.2	0.1	0.1	0.3	0.4
Dissolved iron (Fe), in ug/l	20	40	20	9	30	30	80	100
Dissolved manganese (Mn) (in µg/l)	0	10	0	0	0	0	0	0
Calcium (Ca)	1.8	--	--	--	--	--	1.8	--
Magnesium (Mg)	.3	--	--	--	--	--	.5	--
Sodium (Na)	2.0	--	--	--	--	--	2.4	--
Potassium (K)	.2	--	--	--	--	--	.3	--
Bicarbonate (HCO_3)	5	6	7	8	13	11	7	11
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	2.5	--	--	--	--	--	2.7	--
Chloride (Cl)	3.5	--	--	--	--	--	2.6	--
Nitrate nitrogen (as N)	.01	.00	.01	.01	.00	.01	.01	.01
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.06	.06	.04	.03	.04	.06	.06	.07
Organic nitrogen (as N)	.20	.22	.22	.29	.08	.11	.41	.44
Total phosphorus (as P)	.009	.009	.007	.007	.007	.005	.016	.007
Orthophosphate (as P)	.000	.000	.004	.004	.001	.002	.006	.001
Suspended solids (110°C)	2	--	--	--	--	--	5	--
Hardness as $CaCO_3$ (Ca,Mg)	6	--	--	--	--	--	7	--
Specific conductance (micromhos at 25°C)	19	19	20	20	20	20	22	22
pH (pH units)	7.1	6.8	7.8	7.6	6.5	6.5	6.7	6.8
Water temperature (°C)	7.0	6.1	14.0	13.8	19.2	17.4	18.4	17.4
Color (Pt-Co scale)	10	10	20	20	5	5	5	5
Secchi-disc (ft)	11		12		16		6.6	
Dissolved oxygen (DO)	12.2	12.4	10.1	10.0	8.7	8.4	9.0	8.0
Chlorophyll a in photic zone (µg/l)	4.0	--	1.9	--	1.6	--	4.2	--
Fecal coliform (col. per 100 ml) Range	--		<1-2		2-18		<1-4	
Fecal coliform (col. per 100 ml) Mean	--		1		6		2	
Total organic carbon (as C)	5.5	--	6.0	--	9.0	--	6.0	--





Horseshoe Lake, Kitsap County. From Washington Department of Game, June 21, 1949.



Horseshoe Lake, Kitsap County. July 30, 1973. Approx. scale 1:4800.

Howard Lake near Sylvana (12158070)

Location.

Lat 48°09'30", long 122°19'42", in NE¼SW¼ sec.20, T.31 N., R.4 E., Snohomish County, 4.7 miles southwest of Sylvana; unnamed tributary to Puget Sound. Stanwood quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.46 sq mi	Mean depth	29 ft	Shoreline configuration	1.2
Altitude	238 ft	Maximum depth	50 ft	Development of volume	0.56
Surface area	28 acres	Length of shoreline	4,600 ft	Bottom slope	4.0 percent
Lake volume	790 acre-ft				

Basin geology.

Glacial drift deposited principally as ground moraine (Newcomb, 1952).

Soils.

Gravelly sandy loam (Anderson and others, 1947).

Land use (percentage of drainage basin). Urban 0, suburban 4, agricultural 4, forest or unproductive 83, and lake surface 9.

Nearshore residential development. 65 percent.

Number of nearshore homes. 22.

Surface-water inflow and outflow.

No inflow to Howard Lake was observed from March through September 1973. Outflow was observed only early in the year and was estimated to be 0.2 ft^3/s on both Mar. 8 and May 29, 1973. The outlet was dry on July 18 and September 24.

Lake stage.

Lake stage varied 1.0 foot between March 8 and September 24, 1973.

Macrophytes.

Shoreline covered by emersed plants, 11-25 percent.
Lake surface covered by emersed plants, 0.3 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were cattail (*Typha* sp.), white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), and sedge (Cyperaceae).

Algae observed.

May 29 - Predominantly diatoms (*Dinobryon* sp.,* *Fragillaria* sp.) and some blue-green algae (*Anabaena* sp.).

Asterisk (*) indicates dominant aquatic plant.

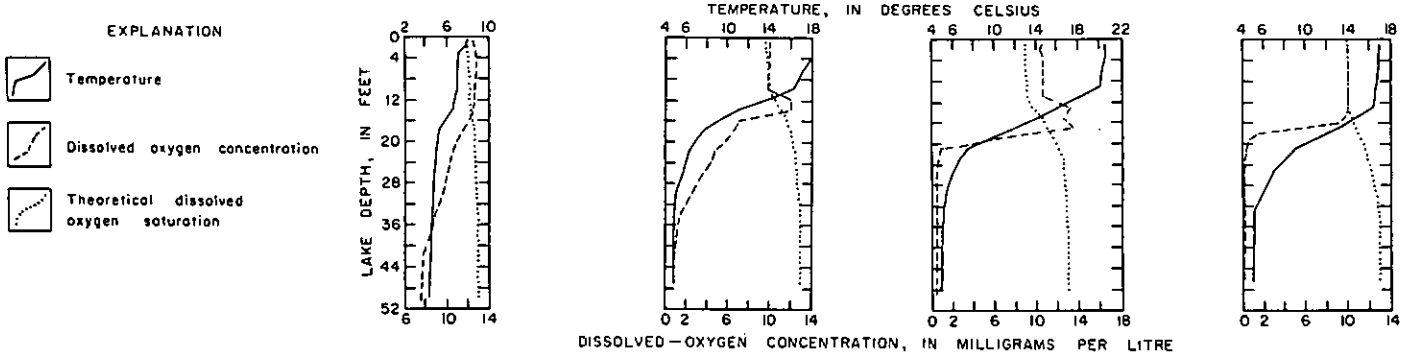
Summary and conclusions.

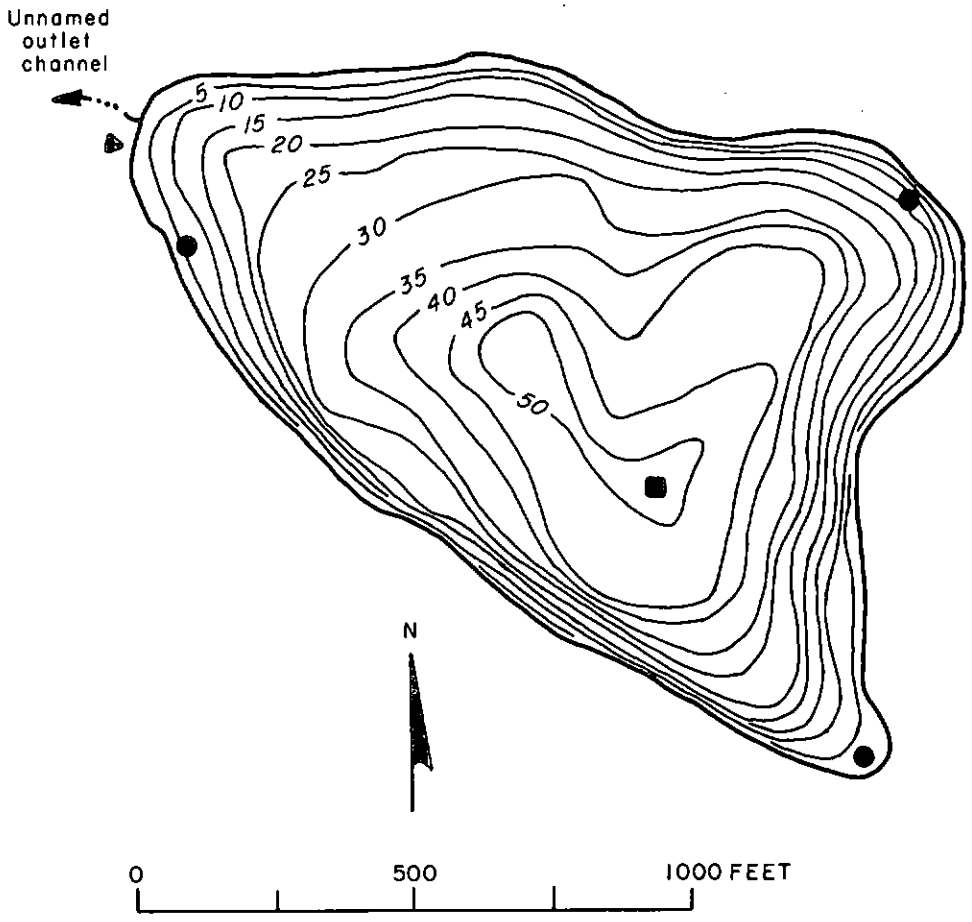
Howard Lake is relatively deep and has a conical-shaped bottom. The biological productivity appears to be moderate. The organic nitrogen concentration (0.50 mg/l) was among the highest of the lakes studied. A high cell density of diatoms and blue-green algae was observed in the spring. Strong thermal stratification developed by late spring and by mid-July the DO was entirely depleted below a depth of 20 feet. Aquatic macrophyte growth was light.

Water-quality data for Howard Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 8		May 29		July 18		September 24	
Water depth (ft)	3	49	3	48	3	44	3	44
Silica (SiO_2)	0.0	0.7	0.5	2.1	0.2	2.5	0.7	2.9
Dissolved iron (Fe), in µg/l	210	200	70	400	80	670	70	610
Dissolved manganese (Mn) (in µg/l)	30	40	0	130	10	140	10	150
Calcium (Ca)	5.8	--	--	--	--	--	5.8	--
Magnesium (Mg)	3.9	--	--	--	--	--	4.1	--
Sodium (Na)	4.0	--	--	--	--	--	4.9	--
Potassium (K)	1.0	--	--	--	--	--	1.3	--
Bicarbonate (HCO_3)	34	35	33	34	40	42	35	43
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	0	--	0	--	2.0
Sulfate (SO_4)	5.0	--	--	--	--	--	5.3	--
Chloride (Cl)	5.3	--	--	--	--	--	6.0	--
Nitrate nitrogen (as N)	.18	.23	.30	.26	.01	.08	.02	.02
Nitrite nitrogen (as N)	.01	.01	.01	.00	.00	.01	.00	.00
Ammonia nitrogen (as N)	.24	.37	.04	.31	.06	.58	.06	.95
Organic nitrogen (as N)	.50	.33	.43	.31	1.8	1.2	.51	.15
Total phosphorus (as P)	.025	.035	.023	.11	.060	.19	.014	.15
Orthophosphate (as P)	.002	.006	.001	.059	.005	.13	.006	.15
Suspended solids (110 °C)	4	--	--	--	--	--	1	--
Hardness as $CaCO_3$ (Ca,Mg)	31	--	--	--	--	--	31	--
Specific conductance (micromhos at 25 °C)	80	84	83	78	85	80	83	83
pH (pH units)	7.3	5.6	7.0	6.5	--	--	7.6	8.1
Water temperature (°C)	7.2	4.4	17.9	5.0	21.3	5.0	16.8	5.0
Color (Pt-Co scale)	20	30	10	20	10	20	0	15
Secchi-disc (ft)	10		8.5		7.5		8.9	
Dissolved oxygen (DO)	12.7	7.6	9.9	1.0	10.4	.4	9.9	.2
Chlorophyll a in photic zone (µg/l)	8.1	--	1.9	--	1.8	--	2.0	--
Fecal coliform (col. per 100 ml) Range	<1-1		<1-1		<1-6		13-27	
Fecal coliform (col. per 100 ml) Mean	<1		<1		4		19	
Total organic carbon (as C)	9.0	--	11	--	8.0	--	8.5	--





EXPLANATION

——10——
Line of equal
water depth
Interval 5 feet

■
Water quality
sampling site

●
Coliform bacteria
sampling site

▲
Public boat access

Howard Lake, Snohomish County. From Washington Department of Game, July 30, 1947.

Howard Lake, Snohomish County. July 14, 1973. Approx. scale 1:4800.

Isabella Lake near Shelton (12077490)

Location.
Lat 47°10'36", long 123°06'17", in NW¼SE¼ sec.31, T.20 N., R.3 W., Mason County, 2.3 miles south of Shelton; Mill Creek basin. Shelton quadrangle, 1:62,500.

Physical characteristics of lake.

Drainage area	17.5 sq mi	Mean depth	16 ft	Shoreline configuration	1.2
Altitude	150 ft	Maximum depth	23 ft	Development of volume	0.70
Surface area	200 acres	Length of shoreline	13,000 ft	Bottom slope	0.70 percent
Lake volume	3,200 acre-ft				

Basin geology.
Volcanic rock and glacial drift in low hills southwest of lake and alluvium in valley (Molenaar and Noble, 1970).

Soils.
Mostly gravelly sandy loam and peat with a large variety of other soils including loam, silt loam, and sandy loam (Ness and Fowler, 1960).

Land use (percentage of drainage basin). Urban 0, suburban 1, agricultural 5, forest or unproductive 92, and lake surface 2.
Nearshore residential development. 28 percent.
Number of nearshore homes. 38.

Surface-water inflow and outflow.
Mill (Gosnell) Creek provided the main inflow and outflow of Isabella Lake. An inflow measurement on Feb. 27 was 50.7 ft^3/s; Apr. 26, 260.0 ft^3/s; June 21, 17.2 ft^3/s; and Sept. 6, 10.0 ft^3/s. Mill Creek, the outlet, for the same dates, had measured discharges of 68.9 ft^3/s, 37.4 ft^3/s, 23.1 ft^3/s, and 10.3 ft^3/s, respectively.

Lake stage.
Lake stage varied 1.0 foot between February 27 and September 6, 1973.

Macrophytes.
Shoreline covered by emersed plants, 76 to 100 percent.
Lake surface covered by emersed plants, 4 percent.
Lake bottom covered by submersed plants, 27 percent.
Rooted aquatic plants observed were cattail (Typha sp.), white lily (Nymphaea sp.), yellow lily (Nuphar sp.), sedge (Cyperaceae), waterweed (Elodea sp.), and pondweed (Potamogeton sp.).

Algae observed.
June 21 - Predominantly blue-green algae (Nostoc sp.) and some diatoms (Dinobryon sp.).

Summary and conclusions.
Isabella Lake probably has a moderate to high biological productivity. A bloom of blue-green algae and diatoms was observed during visits to the lake in June and September. A relatively large drainage area as compared to the lake volume increases the natural eutrophication factor of the lake, but, conversely, a large natural year-round outflow from the lake helps maintain circulation within the lake. The DO levels remained high at all depths throughout the summer. The littoral zone consists of large areas of muck that supported a heavy growth of submersed plants. Plant growth (both emersed and submersed) was especially heavy at the northeast (outlet) and southwest (inlet) ends of the lake. These ends of the lake also contain large wetland areas.

Water-quality data for Isabella Lake.

[Milligrams per litre unless otherwise indicated]

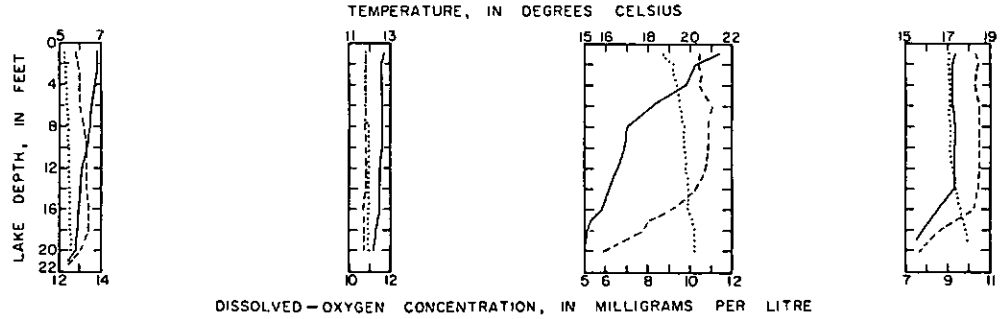
Date of collection (1973)	February 27		April 26		June 21		September 6	
Water depth (ft)	3	20	3	18	3	16	3	16
Silica (SiO_2)	13	13	11	11	14	15	18	17
Dissolved iron (Fe), in µg/l	150	150	160	150	110	130	110	--
Dissolved manganese (Mn) (in µg/l)	10	10	10	0	0	20	20	--
Calcium (Ca)	8.2	--	--	--	--	--	9.6	--
Magnesium (Mg)	2.6	--	--	--	--	--	3.9	--
Sodium (Na)	2.8	--	--	--	--	--	3.8	--
Potassium (K)	.1	--	--	--	--	--	.2	--
Bicarbonate (HCO_3)	34	37	39	39	49	49	51	55
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	3.0	--	--	--	--	--	2.0	--
Chloride (Cl)	4.2	--	--	--	--	--	3.7	--
Nitrate nitrogen (as N)	.21	.21	.06	.01	.01	.01	.01	.01
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.07	.06	.07	.07	.08	.09	.10	.10
Organic nitrogen (as N)	.32	.20	.12	.19	.07	.03	.41	.46
Total phosphorus (as P)	.007	.011	.009	.009	.010	.024	.019	.013
Orthophosphate (as P)	.000	.000	.002	.001	.001	.047	.003	.004
Suspended solids (110°C)	2	--	--	--	--	--	0	--
Hardness as $CaCO_3$ (Ca,Mg)	31	--	--	--	--	--	40	--
Specific conductance (micromhos at 25°C)	62	61	71	71	78	78	88	88
pH (pH units)	7.6	7.7	6.0	6.3	7.9	7.5	7.9	8.0
Water temperature (°C)	6.8	5.8	12.6	12.3	20.0	15.3	17.2	17.1
Color (Pt-Co scale)	15	15	10	10	10	10	5	5
Secchi-disc (ft)	8.9		6.6		10		5.9	
Dissolved oxygen (DO)	13.0	13.2	10.8	10.7	10.5	8.5	10.3	10.2
Chlorophyll a in photic zone (µg/l)	7.4	--	2.5	--	3.5	--	9.1	--
Fecal coliform (col. per 100 ml) Range	<1-25		<1-3		<1-2		<1-1	
Fecal coliform (col. per 100 ml) Mean	11		1		<1		<1	
Total organic carbon (as C)	2.5	--	3.0	--	5.0	--	5.5	--

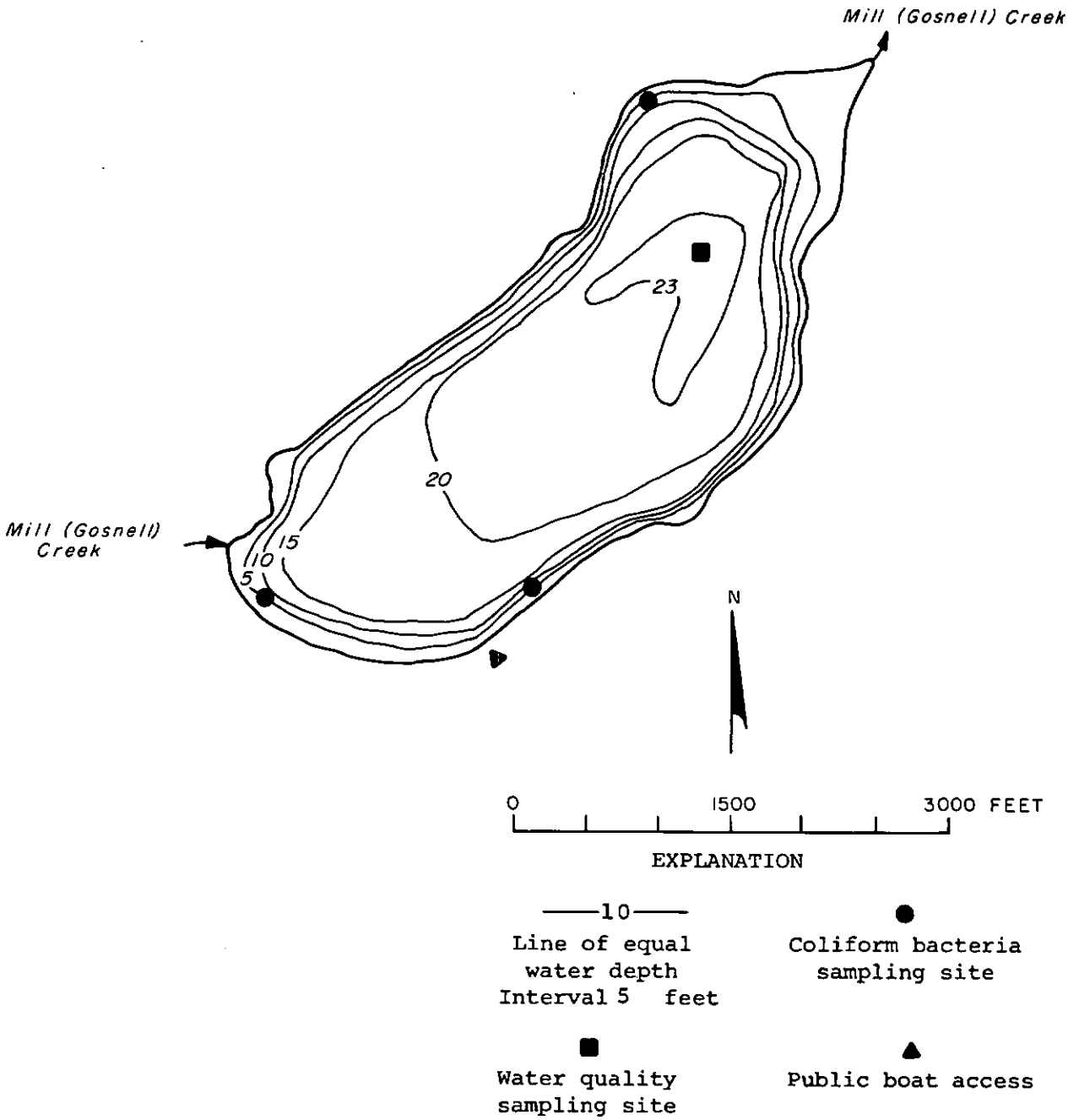
EXPLANATION

Temperature

Dissolved oxygen concentration

Theoretical dissolved oxygen saturation





Isabella Lake, Mason County. From Washington Department of Game, June 25, 1952.

Isabella Lake, Mason County. May 19, 1972. Approx. scale 1:12,000.

Killarney Lake (North Arm) near Algona (12102760)

Location.
Lat 47°17'16", long 122°17'19", in SW¼SW¼ sec.22, T.21 N., R.4 E., King County, 2.0 miles northwest of Algona; Hylebos Creek basin. Poverty Bay quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.12 sq mi	Mean depth	5.7 ft	Shoreline configuration	1.5
Altitude	368 ft	Maximum depth	13 ft	Development of volume	0.44
Surface area	11 acres	Length of shoreline	3,600 ft	Bottom slope	1.7 percent
Lake volume	60 acre-ft				

Basin geology.
Glacial drift with local peat and muck deposits (Luzier, 1969).

Soils.
Gravelly sandy loam with muck deposits on north side of lake (Poulson and others, 1952).

Land use (percentage of drainage basin). Urban 0, suburban 11, agricultural 0, forest or unproductive 75, and lake surface 14.
Nearshore residential development. 56 percent.
Number of nearshore homes. 6.

Surface-water inflow and outflow.
Killarney Lake (north arm) had no observed inflow. A narrow channel connects the north and south arms of Lake Killarney.

Lake stage.
Lake stage varied 1.8 feet between March 9 and August 29, 1973.

Macrophytes.
Shoreline covered by emersed plants, 76 to 100 percent.
Lake surface covered by emersed plants, 23 percent.
Lake bottom covered by submersed plants, 72 percent.
Rooted aquatic plants observed were yellow lily (*Nuphar* sp.),* white lily (*Nymphaea* sp.), sedge (Cyperaceae), and coontail (*Ceratophyllum* sp.).

Asterisk (*) indicates dominant aquatic plant.

Algae observed.
No data.

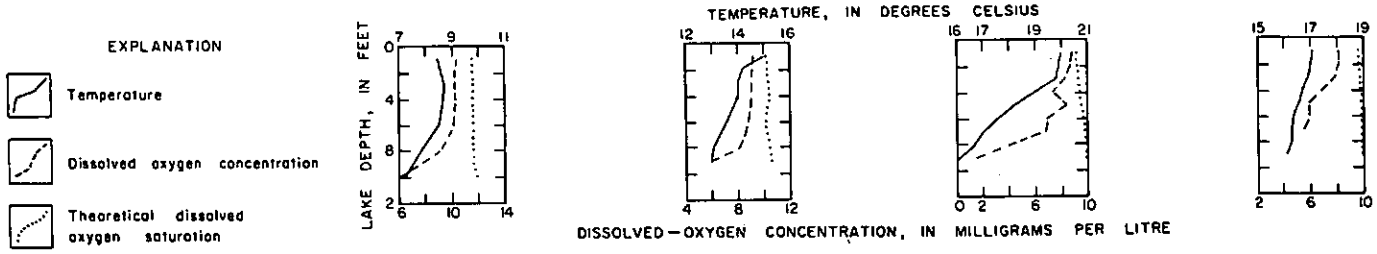
Summary and conclusions.
Killarney Lake (north arm) is connected by a narrow, shallow channel to the larger south arm. The littoral zone which is composed entirely of muck supported a heavy growth of submersed and emersed aquatic macrophytes. About 23 percent of the lake surface was covered with yellow and white lilies. DO in the hypolimnion was depleted to nearly zero during the summer. Resident waterfowl inhabit the lake.

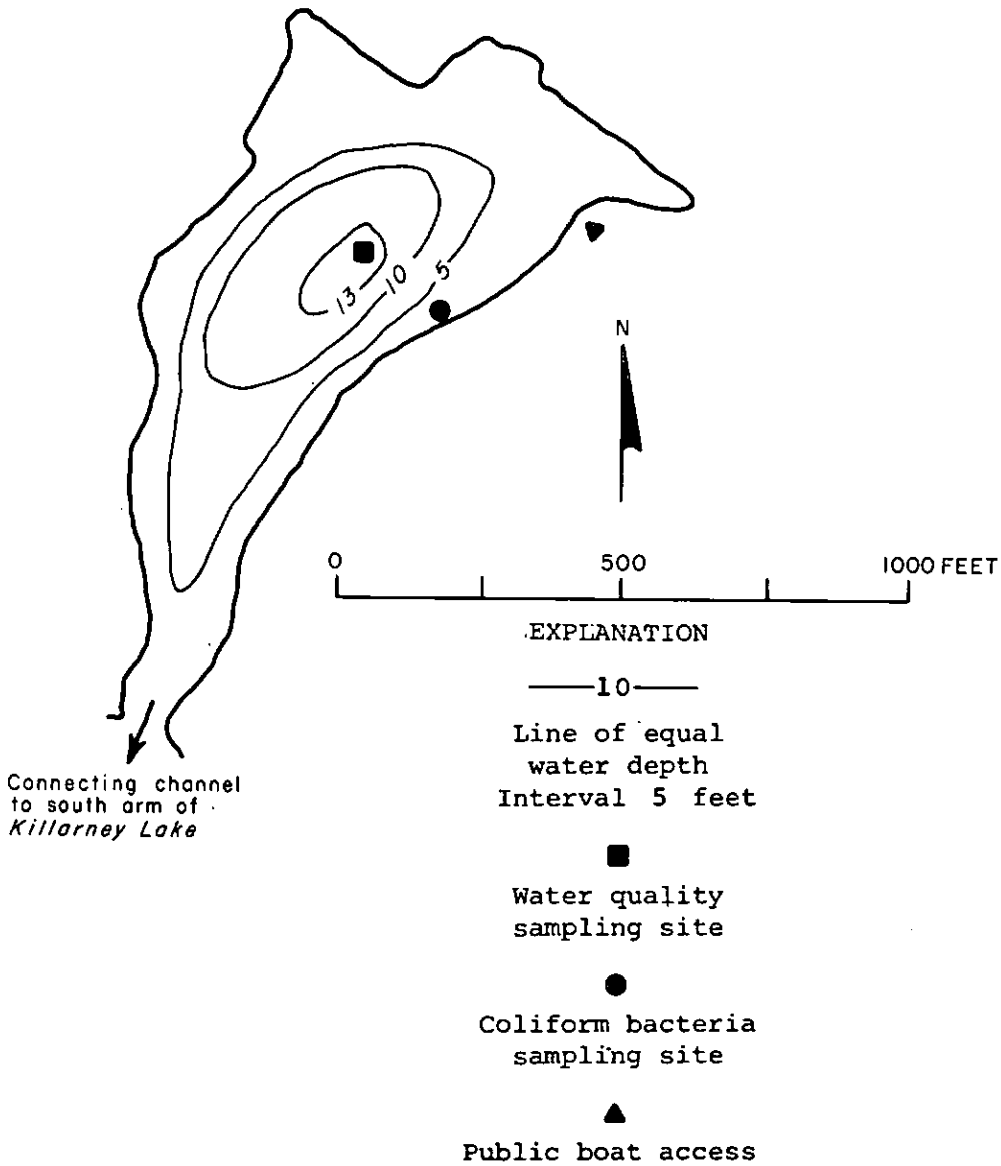
Water-quality data for Killarney Lake (North Arm).

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 9		May 11		July 5		August 29	
Water depth (ft)	3	8	3	7	3	7	3	7
Silica (SiO_2)	2.1	2.1	0.3	0.2	0.2	0.3	0.2	0.1
Dissolved iron (Fe), in µg/l	100	100	170	30	220	310	190	310
Dissolved manganese (Mn) (in µg/l)	30	40	10	0	20	20	40	10
Calcium (Ca)	4.6	--	--	--	--	--	4.1	--
Magnesium (Mg)	1.3	--	--	--	--	--	1.4	--
Sodium (Na)	4.2	--	--	--	--	--	4.2	--
Potassium (K)	.8	--	--	--	--	--	6.4	--
Bicarbonate (HCO_3)	14	14	13	10	16	16	11	14
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	5.4	--	--	--	--	--	6.4	--
Chloride (Cl)	9.9	--	--	--	--	--	9.2	--
Nitrate nitrogen (as N)	.06	.06	.02	.02	.01	.01	.01	.01
Nitrite nitrogen (as N)	.01	.01	.00	.00	.00	.00	.01	.01
Ammonia nitrogen (as N)	.017	.18	.17	.20	.15	.14	.18	.19
Organic nitrogen (as N)	.33	.37	.33	.29	.02	.04	.50	.23
Total phosphorus (as P)	.019	.016	.022	.032	.029	.036	.013	.013
Orthophosphate (as P)	.000	.000	.005	.005	.003	.007	.006	.004
Suspended solids (110°C)	6	--	--	--	--	--	7	--
Hardness as $CaCO_3$ (Ca,Mg)	17	--	--	--	--	--	16	--
Specific conductance (micromhos at 25°C)	62	61	58	58	55	56	59	59
pH (pH units)	6.3	6.1	6.6	7.1	6.3	6.2	6.7	6.5
Water temperature (°C)	8.7	7.8	14.0	13.3	19.8	17.0	16.9	16.4
Color (Pt-Co scale)	20	20	35	30	30	30	25	25
Secchi-disc (ft)	4.9		6.6		5.9		7.9	
Dissolved oxygen (DO)	10.2	9.1	9.1	8.4	8.2	6.8	7.9	5.4
Chlorophyll a in photic zone (µg/l)	11	--	1.7	--	2.1	--	3.9	--
Fecal coliform (col. per 100 ml) Range	--		--		--		--	
Fecal coliform (col. per 100 ml) Mean	*0		*8		*31		*42	
Total organic carbon (as C)	8.5	--	8.0	--	9.0	--	8.0	--

*One sample.





Killarney Lake (North Arm), King County.
From Washington Department of Game, February 1, 1949.

Killarney Lake (North Arm), King County. May 17, 1973. Approx. scale 1:4800.

Killarney Lake (South Arm) near Algona (12102760)

Location.
Lat 47°17'01", long 122°17'36", in NE¼NE¼ sec.28, T.21 N., R.4 E., King County, 2.0 miles northwest of Algona; Hylebos Creek basin. Poverty Bay quadrangle, 1:24,000

Physical characteristics of lake.

Drainage area	0.24 sq mi	Mean depth	9.3 ft	Shoreline configuration	1.8
Altitude	368 ft	Maximum depth	15 ft	Development of volume	0.62
Surface area	24 acres	Length of shoreline	6,600 ft	Bottom slope	1.3 percent
Lake volume	230 acre-ft				

Basin geology.
Glacial drift (Luzier, 1969).

Soils.
Gravelly sandy loam (Poulson and others, 1952).

Land use (percentage of drainage basin). Urban 0, suburban 23, agricultural 19, forest or unproductive 42, and lake surface 16.
Nearshore residential development. 100 percent.
Number of nearshore homes. 47.

Surface-water inflow and outflow.
Killarney Lake (south arm) had no observed inflow or outflow from March through August 1973.

Lake stage.
Lake stage varied 1.8 feet between March 9 and August 29, 1973.

Macrophytes.
Shoreline covered by emersed plants, 26 to 50 percent.
Lake surface covered by emersed plants, 7 percent.
Lake bottom covered by submersed plants, 38 percent.
Rooted aquatic plants observed were white lily (*Nymphaea* sp.),* pondweed (*Potamogeton* sp.),* cattail (*Typha* sp.), yellow lily (*Nuphar* sp.), coontail (*Ceratophyllum* sp.), waterweed (*Chara* sp.), stonewort (*Nitella* sp.), and wildcelery (*Vallisneria* sp.).

Asterisk (*) indicates dominant aquatic plants.

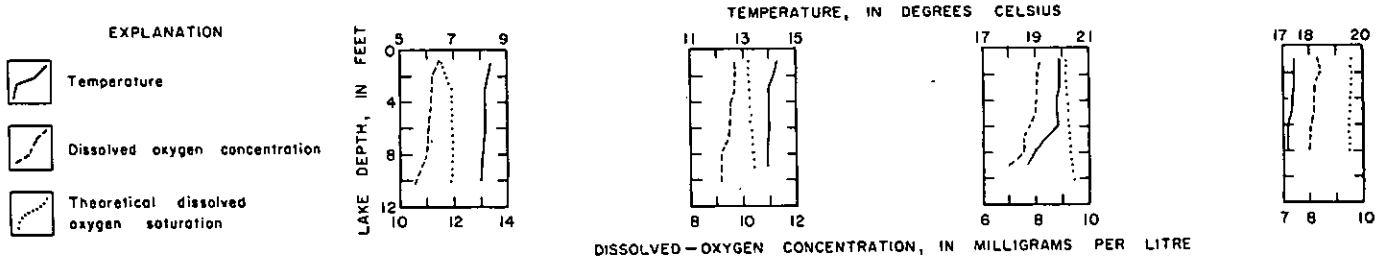
Algae observed.
No data.

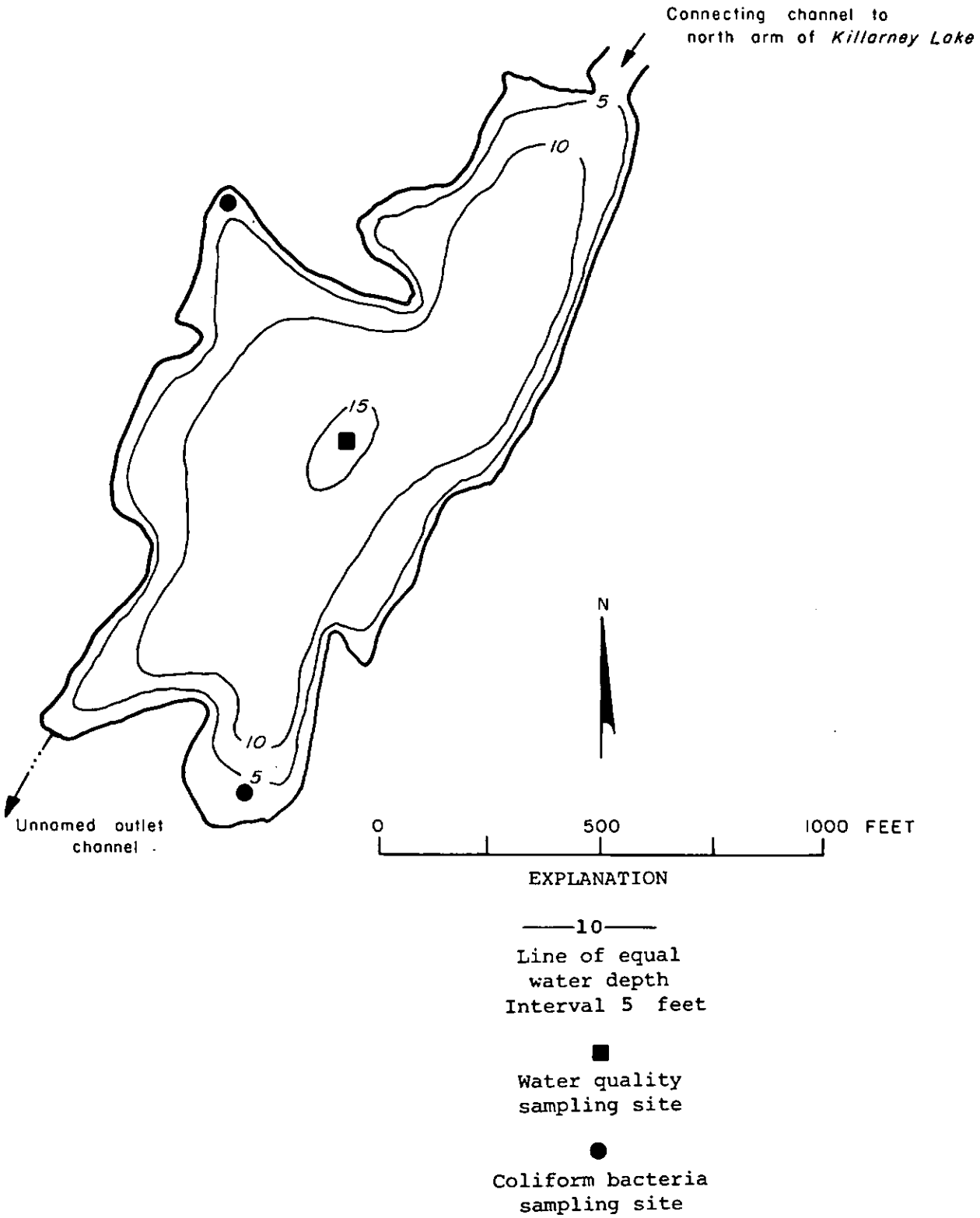
Summary and conclusions.
Killarney Lake (south arm) has about twice the surface area of the smaller north arm. The biological productivity appears to be moderate. The lake is rather shallow and thermal stratification was slight, thus the DO at all depths remained high during the summer. The littoral zone, composed primarily of cobbles, gravel, and sand, supported a moderate growth of aquatic macrophytes, mainly white lilies and pondweed. Coliform-bacteria counts ranged from less than 1 to 57 colonies per 100 ml from nearshore sampling sites around the lake. Total lakeside residential development and the relatively small lake volume indicate a high potential for cultural eutrophication.

Water-quality data for Killarney Lake (South Arm).

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 9		May 11		July 5		August 29	
Water depth (ft)	3	8	3	7	3	7	3	7
Silica (SiO_2)	0.7	0.7	0.2	0.1	0.2	0.2	0.1	0.1
Dissolved iron (Fe), in µg/l	70	70	80	90	160	190	280	380
Dissolved manganese (Mn) (in µg/l)	20	20	20	20	30	40	50	30
Calcium (Ca)	4.5	--	--	--	--	--	4.0	--
Magnesium (Mg)	1.2	--	--	--	--	--	1.4	--
Sodium (Na)	3.9	--	--	--	--	--	4.2	--
Potassium (K)	.8	--	--	--	--	--	.6	--
Bicarbonate (HCO_3)	14	10	9	11	16	16	15	16
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	7.1	--	--	--	--	--	6.7	--
Chloride (Cl)	7.0	--	--	--	--	--	8.1	--
Nitrate nitrogen (as N)	.16	.16	.02	.02	.01	.01	.01	.01
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.01
Ammonia nitrogen (as N)	.12	.12	.10	.11	.01	.09	.15	.20
Organic nitrogen (as N)	.41	.32	.38	.29	.14	.04	.29	.35
Total phosphorus (as P)	.016	.016	.025	.030	.022	.018	.015	.015
Orthophosphate (as P)	.001	.000	.006	.004	.005	.005	.008	.008
Suspended solids (110°C)	5	--	--	--	--	--	0	--
Hardness as $CaCO_3$ (Ca,Mg)	16	--	--	--	--	--	16	--
Specific conductance (micromhos at 25°C)	57	56	56	56	53	54	56	56
pH (pH units)	6.8	6.5	6.6	6.6	6.4	6.3	7.2	6.9
Water temperature (°C)	8.2	8.1	14.0	14.0	19.9	19.3	17.4	17.2
Color (Pt-Co scale)	10	10	20	25	15	15	20	25
Secchi-disc (ft)	6.6		8.9		8.5		7.9	
Dissolved oxygen (DO)	11.2	11.0	9.7	9.4	8.1	7.6	8.2	8.1
Chlorophyll a in photic zone (µg/l)	4.5	--	1.0	--	1.4	--	6.0	--
Fecal coliform (col. per 100 ml) Range	<1-5		4-16		21-32		39-57	
Fecal coliform (col. per 100 ml) Mean	3		10		27		48	
Total organic carbon (as C)	6.5	--	7.5	--	7.0	--	6.5	--





Killarney Lake (South Arm), King County.
From Washington Department of Game, February 1, 1949.

Killarney Lake (South Arm), King County. May 17, 1973. Approx. scale 1:4800.

Langlois Lake near Carnation (12148790)

Location.
Southernmost shoreline point, at lat 47°38'08", long 121°53'03", in NE¼SE¼ sec.22, T.25 N., R.7 E., King County, 1.6 miles southeast of Carnation; Snohomish River basin. Carnation quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.37 sq mi	Mean depth	53 ft	Shoreline configuration	1.3
Altitude	122 ft	Maximum depth	98 ft	Development of volume	0.54
Surface area	39 acres	Length of shoreline	5,800 ft	Bottom slope	6.7 percent
Lake volume	2,000 acre-ft				

Basin geology.
Glacial drift (Liesch and others, 1963).

Soils.
Shallow, stony soils and gravelly fine sandy loam (Poulson and others, 1952).

Land use (percentage of drainage basin). Urban 0, suburban 1, agricultural 0, forest or unproductive 83, and lake surface 16.
Nearshore residential development. 11 percent.
Number of nearshore homes. 2.

Surface-water inflow and outflow.
Langlois Lake is fed by a small spring on the east side of the lake. The estimates of inflow on Mar. 7, May 9, and June 28, 1973 were 0.2 ft^3/s on each date. No outflow was observed between March and September 1973.

Lake stage.
Lake stage varied 1.0 foot between March 7 and September 26, 1973.

Macrophytes.
Shoreline covered by emersed plants, 11 to 25 percent.
Lake surface covered by emersed plants, 0.9 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were cattail (*Typha* sp.), watershield (*Brasenia* sp.).

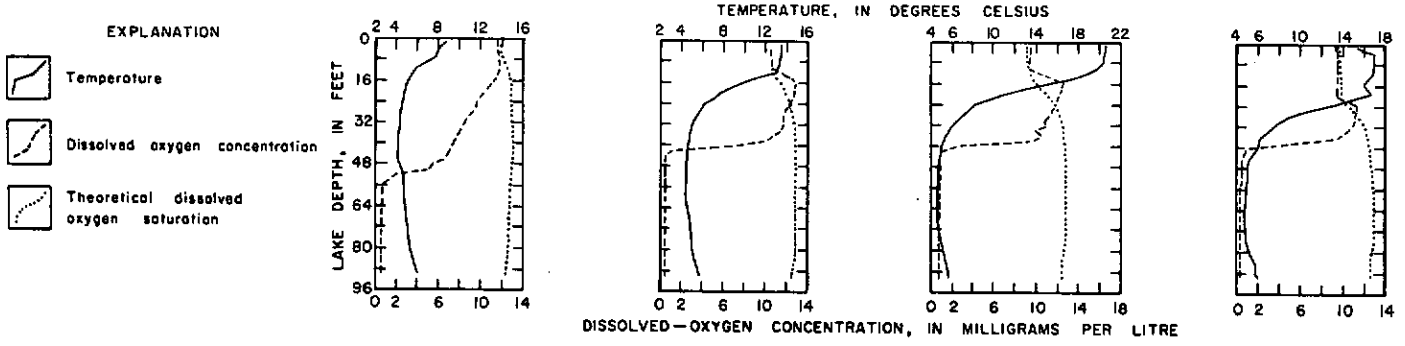
Algae observed.
No data.

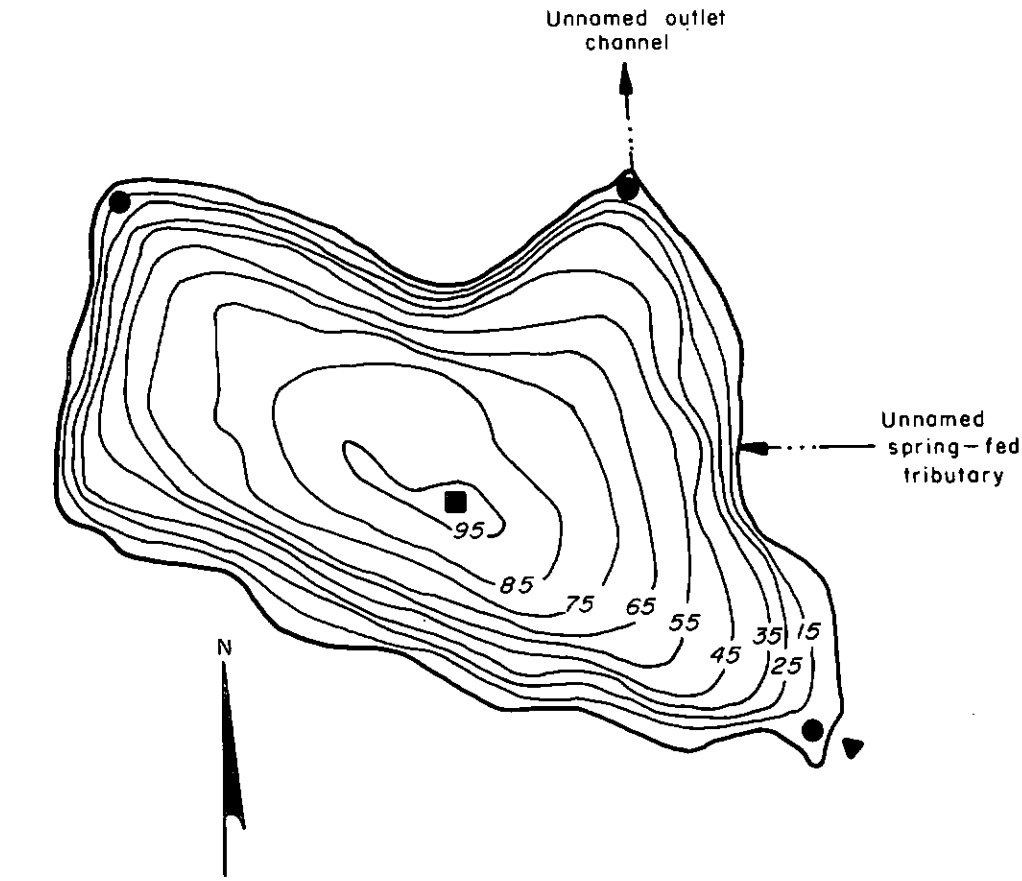
Summary and conclusions.
Langlois Lake is a relatively small but deep, well-sheltered lake that becomes only partially mixed during the winter. A density barrier, caused by an increase of dissolved minerals at about 70 feet below the water surface, prevents the deeper water from mixing with the upper waters. Below 70 feet the water had a stable temperature and was devoid of oxygen. The nutrient concentration was extremely high, especially ammonia (140 mg/l). The ammonia is formed from the decomposition of organic material trapped in the deep waters. The upper water, however, contained few nutrients and was low in biological productivity.

Water-quality data for Langlois Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 7		May 9		June 28		September 26	
Water depth (ft)	3	89	3	89	3	89	3	89
Silica (SiO_2)	2.6	35	2.4	29	1.8	40	1.5	38
Dissolved iron (Fe), in µg/l	9	3,100	9	2,200	9	200	30	34,000
Dissolved manganese (Mn) (in µg/l)	20	1,300	0	950	0	1,600	0	1,300
Calcium (Ca)	5.7	--	--	--	--	--	6.0	--
Magnesium (Mg)	1.4	--	--	--	--	--	.4	--
Sodium (Na)	2.6	--	--	--	--	--	2.8	--
Potassium (K)	.5	--	--	--	--	--	.5	--
Bicarbonate (HCO_3)	30	536	30	364	33	643	28	594
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	3.0	--	3.0	--	1.5	--	3.0
Sulfate (SO_4)	2.5	--	--	--	--	--	2.5	--
Chloride (Cl)	1.9	--	--	--	--	--	1.8	--
Nitrate nitrogen (as N)	.13	.01	.14	.09	.01	.12	.01	.17
Nitrite nitrogen (as N)	.00	.01	.00	.01	.00	.00	.00	.02
Ammonia nitrogen (as N)	.07	140	.02	69	.08	140	.05	126
Organic nitrogen (as N)	.31	60	.26	3	.07	0	.23	26
Total phosphorus (as P)	.016	7.4	.043	5.7	.011	13.0	.004	11.0
Orthophosphate (as P)	.000	.86	.002	3.8	.001	.50	.003	.36
Suspended solids (110°C)	2	--	--	--	--	--	4	--
Hardness as $CaCO_3$ (Ca,Mg)	20	--	--	--	--	--	17	--
Specific conductance (micromhos at 25°C)	50	400	49	1,110	50	890	49	1,080
pH (pH units)	7.5	6.2	7.0	6.0	6.8	5.9	7.6	6.4
Water temperature (°C)	8.1	6.0	13.4	5.7	20.4	5.8	17.0	5.8
Color (Pt-Co scale)	10	45	15	45	5	45	5	55
Secchi-disc (ft)	15		18		14		23	
Dissolved oxygen (DO)	11.6	.6	10.6	.6	9.3	.9	9.7	.2
Chlorophyll a in photic zone (µg/l)	3.3	--	.9	--	1.7	--	1.2	--
Fecal coliform (col. per 100 ml) Range	<1-<1		1-9		2-3		<1-2	
Fecal coliform (col. per 100 ml) Mean	<1		4		3		1	
Total organic carbon (as C)	4.0	--	4.0	--	5.0	--	3.0	--





Langlois Lake, King County. From Washington Department of Game, August 28, 1947.

Langlois Lake, King County. May 17, 1973. Approx. scale 1:4800.

Loma Lake near Tulalip (12157900)

Location.
Lat 48°08'03", long 122°15'15", in NW¼NE¼ sec. 35, T.31 N., R.4 E., Snohomish County, 5.0 miles northeast of Tulalip; Tulalip Creek basin. Arlington West and Stanwood quadrangles, 1:24,000.

Physical characteristics of lake.

Drainage area	0.15 sq mi	Mean depth	11 ft	Shoreline configuration	1.4
Altitude	565 ft	Maximum depth	28 ft	Development of volume	0.39
Surface area	21 acres	Length of shoreline	4,900 ft	Bottom slope	2.3 percent
Lake volume	230 acre-ft				

Basin geology.
Glacial drift deposited principally as ground moraine (Newcomb, 1952).

Soils.
Gravelly sandy loam with peat deposits on north side of the lake (Anderson and others, 1947).

Land use (percentage of drainage basin). Urban 0, suburban 17, agricultural 0, forest or unproductive 61, and lake surface 22.
Nearshore residential development. 96 percent.
Number of nearshore homes. 53.

Surface-water inflow and outflow.
Loma Lake had no observed inflow between March and September 1973. A small outflow was estimated to be 0.4 ft^3/s and less than 0.1 ft^3/s on March 8 and May 30, respectively. The outlet was dry on June 27 and September 25, 1973.

Lake stage.
Lake stage varied 1.7 feet between March 8 and September 25, 1973.

Macrophytes.
Shoreline covered by emersed plants, 76 to 100 percent.
Lake surface covered by emersed plants, 7 percent.
Lake bottom covered by submersed plants, 30 percent.
Rooted aquatic plants observed were yellow lily (Nuphar sp.),* coontail (Ceratophyllum sp.),* cattail (Typha sp.), and sedge (Cyperaceae).

Asterisk (*) indicates dominant aquatic plants.

Algae observed.
May 30 - A mixed population of flagellates (Ceratium sp.) and blue-green algae (Anabaena sp.).

Summary and conclusions.
Loma Lake is a highly colored (tea-colored) lake. A high concentration of organic material in the lake water, presumably derived from nearby peat deposits is responsible for the color of the water. Relatively high nutrient and chlorophyll a concentrations, a heavy growth of aquatic macrophytes,and the depletion of DO in the hypolimnion indicate a high level of biological productivity. The number of residential homes increased from about 17 in 1956 to about 53 in 1973. A large percentage of residential lakeshore development and the small lake volume suggest a high potential for cultural eutrophication.

Water-quality data for Loma Lake.

[Milligrams per litre unless otherwise indicated]

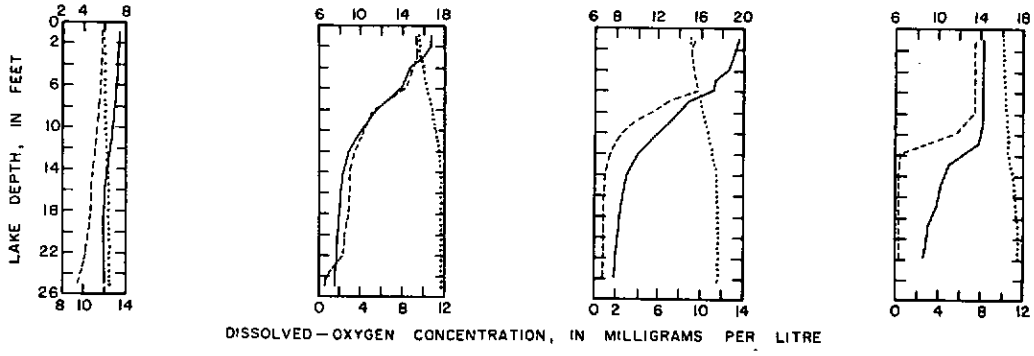
Date of collection (1973)	March 8		May 30		June 27		September 25	
Water depth (ft)	3	23	3	23	3	23	3	18
Silica (SiO_2)	0.4	0.9	0.1	1.5	0.3	1.8	0.5	2.1
Dissolved iron (Fe), in µg/l	140	170	130	400	110	580	160	1,100
Dissolved manganese (Mn) (in µg/l)	20	20	10	100	10	100	50	160
Calcium (Ca)	3.2	--	--	--	--	--	2.9	--
Magnesium (Mg)	1.0	--	--	--	--	--	1.1	--
Sodium (Na)	2.5	--	--	--	--	--	2.2	--
Potassium (K)	.5	--	--	--	--	--	.8	--
Bicarbonate (HCO_3)	9	6	6	7	7	15	8	16
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	1.5
Sulfate (SO_4)	5.6	--	--	--	--	--	5.3	--
Chloride (Cl)	4.1	--	--	--	--	--	4.7	--
Nitrate nitrogen (as N)	.52	.53	.27	.30	.00	.13	.01	.01
Nitrite nitrogen (as N)	.00	.01	.00	.01	.01	.01	.01	.01
Ammonia nitrogen (as N)	.18	.19	.10	.27	.21	.44	.18	.62
Organic nitrogen (as N)	.23	.39	.45	.30	.09	.04	.47	.27
Total phosphorus (as P)	.029	.034	.019	.024	.030	.032	.030	.039
Orthophosphate (as P)	.010	.004	.000	.009	.004	.008	.022	.022
Suspended solids (110 °C)	3	--	--	--	--	--	10	--
Hardness as $CaCO_3$ (Ca,Mg)	12	--	--	--	--	--	12	--
Specific conductance (micromhos at 25 °C)	38	39	36	36	34	37	35	41
pH (pH units)	7.2	6.6	7.1	6.8	6.6	5.7	7.6	7.8
Water temperature (°C)	7.2	6.0	16.0	7.8	19.0	8.0	14.2	9.4
Color (Pt-Co scale)	100	100	150	150	150	150	55	85
Secchi-disc (ft)	3.9		3.6		3.6		4.6	
Dissolved oxygen (DO)	11.7	10.2	9.4	2.4	9.1	.9	7.4	.2
Chlorophyll a in photic zone (µg/l)	7.6	--	2.2	--	8.5	--	6.3	--
Fecal coliform (col. per 100 ml) Range	2-4		--		26-36		18-61	
Fecal coliform (col. per 100 ml) Mean	3		--		30		37	
Total organic carbon (as C)	12	--	15	--	15	--	14	--

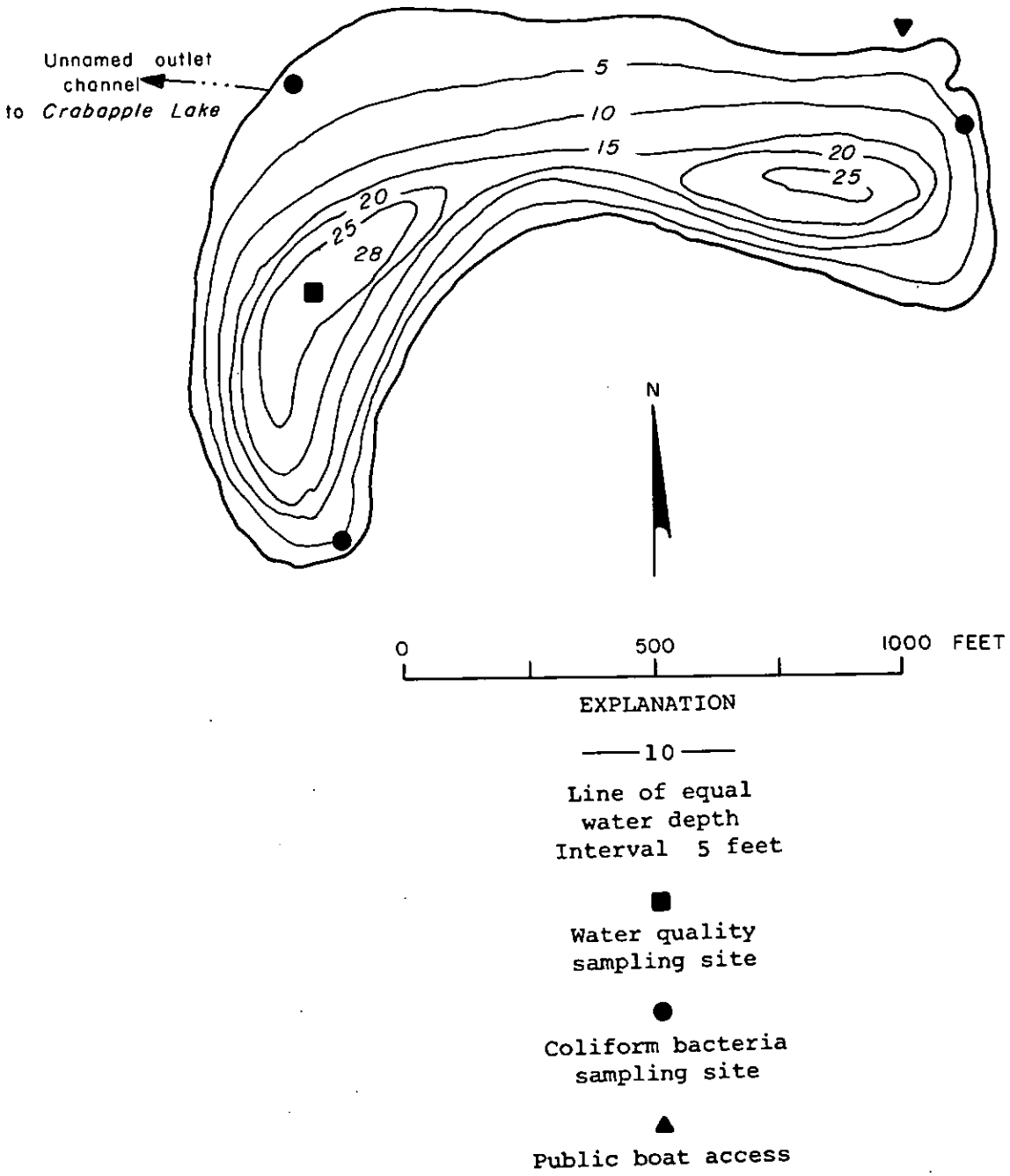
EXPLANATION

Temperature

Dissolved oxygen concentration

Theoretical dissolved oxygen saturation





Loma Lake, Snohomish County. From Washington Department of Game, July 10, 1952.

Loma Lake, Snohomish County. July 30, 1973. Approx. scale 1:4800.

Long Lake near Port Orchard (12072615)

Location.
Lat 47°28'58", long 122°35'12", in SW¼NW¼ sec.8, T.23 N., R.2 E., Kitsap County, 3.5 miles southeast of Port Orchard; Curley Creek basin. Olalla quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	9.36	sq mi	Mean depth	6.5	ft	Shoreline configuration	2.0
Altitude	118	ft	Maximum depth	12	ft	Development of volume	0.54
Surface area	340	acres	Length of shoreline	27,000	ft	Bottom slope	0.28 percent
Lake volume	2,200	acre-ft					

Basin geology.
Glacial drift (Sceva, 1957).

Soils.
Mostly gravelly loamy sand with large variety of other soils, including peat, shallow, stony soils, alluvium, silt loam, loam, loamy sand, gravelly sandy loam, and fine sandy loam (Wildermuth and others, 1939).

Land use (percentage of drainage basin). Urban 0, suburban 5, agricultural 20, forest or unproductive 69, and lake surface 6.

Nearshore residential development. 67 percent.

Number of nearshore homes. 121.

Surface-water inflow and outflow.
Salmonberry Creek, the main tributary to Long Lake, enters the lake on the west side. An estimate of inflow on Mar. 5 was 11.2 ft^3/s; May 10, 6.5 ft^3/s; June 22, 3.8 ft^3/s; and Sept. 7, 2.0 ft^3/s. Curley Creek, the outlet, for the same dates had discharges of 20 ft^3/s (estimated), 13.6 ft^3/s, 9.75 ft^3/s, and 5.46 ft^3/s, respectively.

Lake stage.
Lake stage varied 1.0 foot between March 5 and September 7, 1973.

Macrophytes.
Shoreline covered by emersed plants, 26 to 50 percent.
Lake surface covered by emersed plants, 8 percent.
Lake bottom covered by submersed plants, 41 percent.
Rooted aquatic plants observed were cattail (*Typha* sp.), white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), sedge (Cyperaceae), watershield (*Brasenia* sp.), waterweed (*Elodea* sp.), and pondweed (*Potamogeton* sp.).

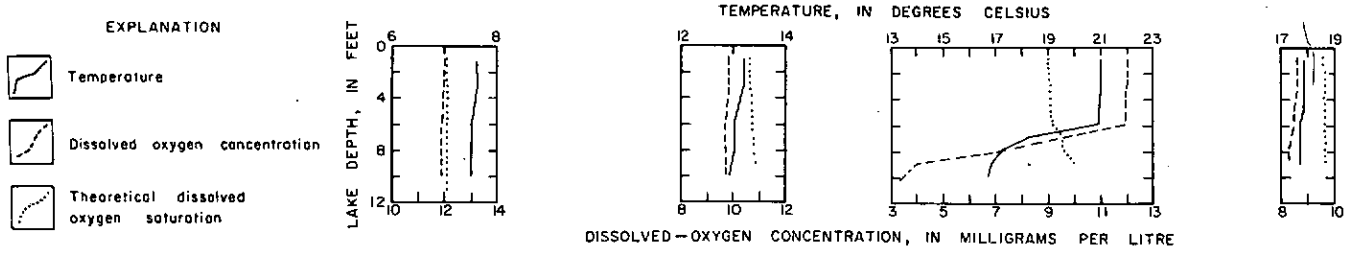
Algae observed.
May 10 - A mixed population of blue-green and green algae and diatoms.
June 22 - Predominantly blue-green algae (*Aphanizomenon* sp.).

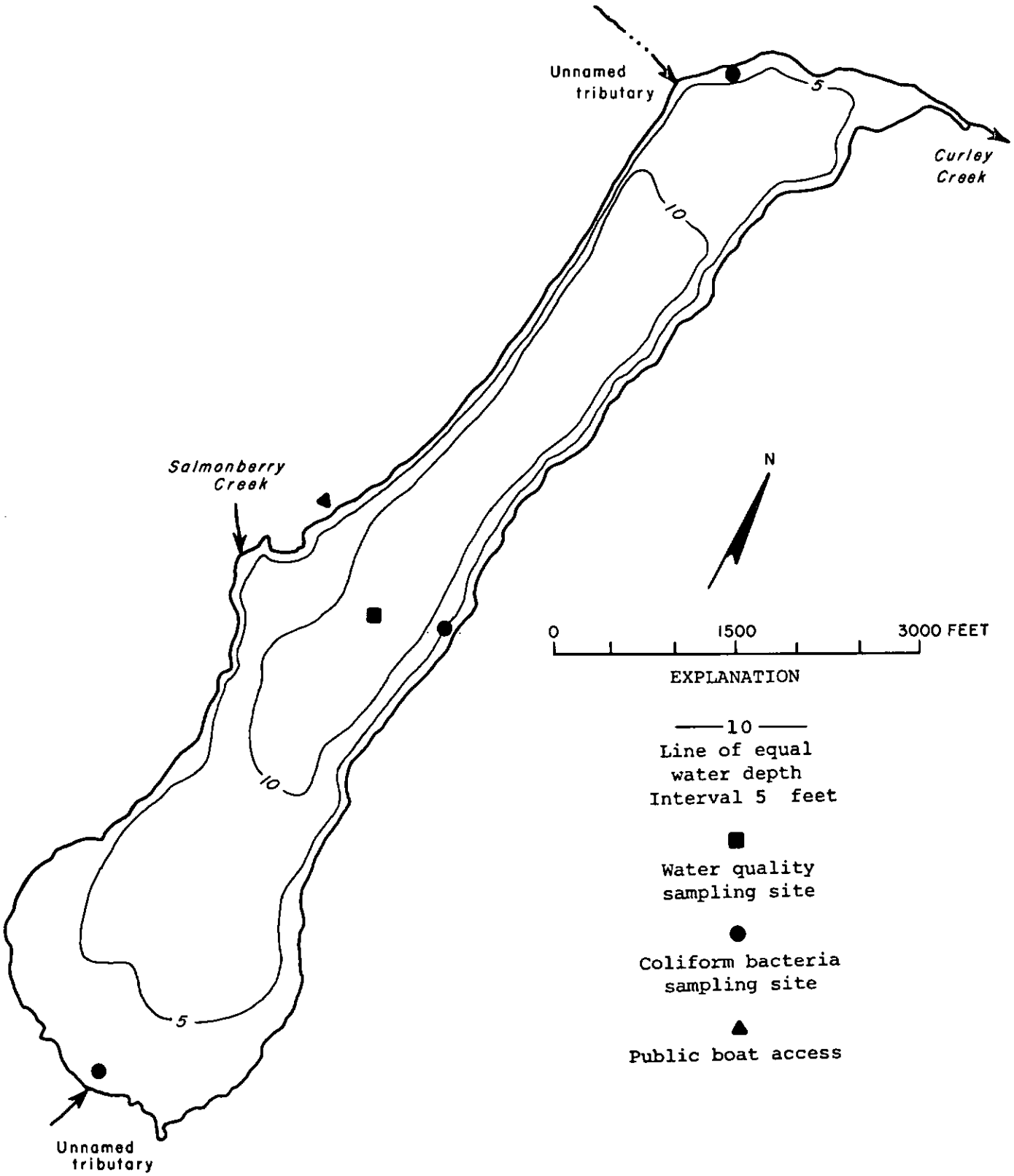
Summary and conclusions.
Long Lake is a large, shallow lake with a moderate to high biological productivity. An intense bloom of blue-green algae was observed on visits to the lake in May and June. The chlorophyll *a* concentration, which ranged from 2.6 to 20 µg/l, was among the highest of the lakes studied. Fecal-coliform-bacteria counts were exceptionally high at the time of sampling in June. The counts ranged from <1 to 400, with a mean of 207 colonies/100 ml. The lake supported a heavy growth of aquatic macrophytes, especially at the southern end. The shallowness of the lake, its exposure to the wind, and the rather large year-round inflow and outflow allowed DO levels to remain high at all depths for most of the summer.

Water-quality data for Long Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 5		May 10		June 22		September 7	
Water depth (ft)	3	8	3	7	3	7	3	7
Silica (SiO_2)	9.9	9.8	5.1	5.0	6.3	6.3	12	13
Dissolved iron (Fe), in µg/l	200	200	210	260	190	190	150	190
Dissolved manganese (Mn) (in µg/l)	20	20	20	30	10	20	20	10
Calcium (Ca)	5.7	--	--	--	--	--	6.5	--
Magnesium (Mg)	2.9	--	--	--	--	--	3.8	--
Sodium (Na)	3.1	--	--	--	--	--	4.7	--
Potassium (K)	.8	--	--	--	--	--	.3	--
Bicarbonate (HCO_3)	33	32	41	38	45	46	47	48
Carbonate (CO_3)	0	0	0	0	--	--	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	5.1	--	--	--	--	--	3.4	--
Chloride (Cl)	3.1	--	--	--	--	--	2.6	--
Nitrate nitrogen (as N)	.27	.28	.02	.02	.01	.02	.04	.05
Nitrite nitrogen (as N)	.01	.01	.00	.00	.00	.00	.01	.01
Ammonia nitrogen (as N)	.10	.22	.19	.19	.41	.40	.10	.12
Organic nitrogen (as N)	.41	.47	.28	.22	.09	.07	.40	.57
Total phosphorus (as P)	.029	.032	.030	.033	.041	.022	.027	.026
Orthophosphate (as P)	.003	.003	.008	.008	.005	.005	.008	.007
Suspended solids (110°C)	5	--	--	--	--	--	0	--
Hardness as $CaCO_3$ (Ca,Mg)	26	--	--	--	--	--	32	--
Specific conductance (micromhos at 25°C)	59	59	74	74	74	74	72	72
pH (pH units)	7.3	7.1	6.7	6.6	9.1	9.0	7.7	7.6
Water temperature (°C)	7.6	7.5	13.2	13.0	21.0	18.3	17.8	17.7
Color (Pt-Co scale)	65	65	55	50	30	30	10	20
Secchi-disc (ft)	3.0		6.6		4.6		10	
Dissolved oxygen (DO)	12.0	11.9	9.8	9.7	12.0	9.4	8.6	8.4
Chlorophyll a in photic zone (µg/l)	20	--	2.6	--	8.5	--	3.6	--
Fecal coliform (col. per 100 ml) Range	3-6		1-4		<1-400		<1-78	
Fecal coliform (col. per 100 ml) Mean	4		3		207		20	
Total organic carbon (as C)	9.5	--	6.5	--	12	--	6.5	--





Long Lake, Kitsap County. From U.S. Geological Survey, September 13, 1973.

Long Lake, Kitsap County. July 14, 1971. Approx. scale 1:14,000.

Lost Lake near Shelton (12076100)

Location.

Southernmost shoreline point, at lat 47°09'16", long 123°14'51", in NW¼ sec.12, T.19 N., R.5 W., Mason County, 7.3 miles southwest of Shelton; Goldsborough Creek basin. Shelton and Elma quadrangles, 1:62,500.

Physical characteristics of lake.

Drainage area	1.08 sq mi	Mean depth	28 ft	Shoreline configuration	2.1
Altitude	480 ft	Maximum depth	65 ft	Development of volume	0.42
Surface area	120 acres	Length of shoreline	17,000 ft	Bottom slope	2.5 percent
Lake volume	3,400 acre-ft				

Basin geology.

Glacial drift, with small part of basin underlain by volcanic rock (Molenaar and Noble, 1970).

Soils.

Mostly gravelly sandy loam with local peat deposits on north side of lake (Ness and Fowler, 1960).

Land use (percentage of drainage basin). Urban 0, suburban 12, agricultural 0, forest or unproductive 70, and lake surface 18.

Nearshore residential development. 95 percent.

Number of nearshore homes. 114.

Surface-water inflow and outflow.

Lost Lake had no observed inflow or outflow between February and September 1973.

Lake stage.

Lake stage varied 2.1 feet between February 26 and September 6, 1973.

Macrophytes.

Shoreline covered by emersed plants, <1 percent.
Lake surface covered by emersed plants, <0.1 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were none.

Algae observed.

No data.

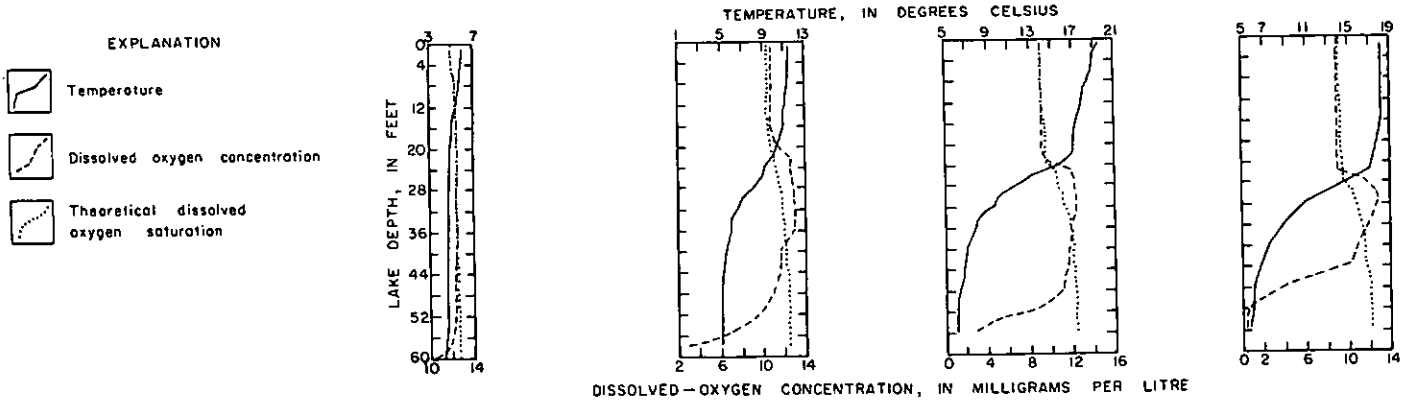
Summary and conclusions.

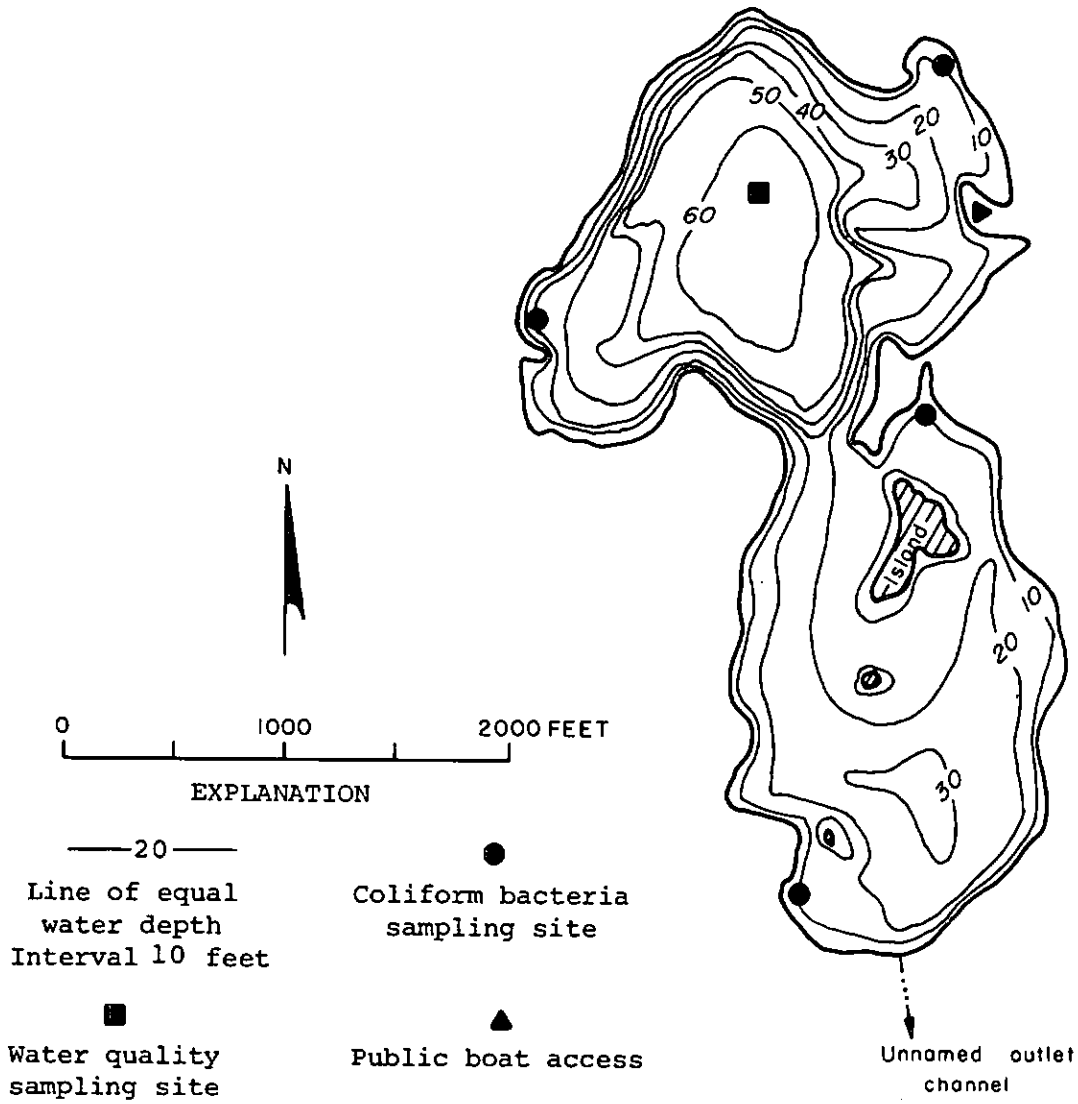
Lost Lake is a rather deep, well-sheltered lake that is low in dissolved minerals and in biological productivity. Both the nutrient and chlorophyll a concentrations were among the lowest of the lakes studied. The shoreline and generally steep littoral zone were nearly devoid of aquatic macrophytes. The lake waters were mixed vertically during the winter and, because the lake is deep and sheltered, strong thermal stratification occurred early in the summer. The DO in the hypolimnion was depleted to nearly zero by mid-June. Nearly all the shoreline is occupied by seasonal and permanent homes. However, this cultural impact probably is lessened by the dilution effects of the relatively large lake volume.

Water-quality data for Lost Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	February 26		April 26		June 21		September 6	
Water depth (ft)	3	59	3	57	3	54	3	54
Silica (SiO_2)	0.9	1.1	0.6	1.0	0.3	0.9	0.4	1.3
Dissolved iron (Fe), in µg/l	40	110	100	150	40	190	50	540
Dissolved manganese (Mn) (in µg/l)	0	20	0	10	0	30	0	83
Calcium (Ca)	1.9	--	--	--	--	--	1.9	--
Magnesium (Mg)	.6	--	--	--	--	--	.7	--
Sodium (Na)	1.4	--	--	--	--	--	1.8	--
Potassium (K)	.0	--	--	--	--	--	.1	--
Bicarbonate (HCO_3)	9	14	11	11	15	15	14	18
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	1.8	--	--	--	--	--	1.3	--
Chloride (Cl)	3.2	--	--	--	--	--	2.0	--
Nitrate nitrogen (as N)	.06	.04	.01	.01	.01	.01	.01	.01
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.04	.18	.02	.26	.05	.01	.04	.14
Organic nitrogen (as N)	.16	.04	.15	.11	.06	.12	.27	.29
Total phosphorus (as P)	.009	.016	.004	.015	.007	.016	.004	.012
Orthophosphate (as P)	.000	.000	.002	.005	.001	.001	.000	.003
Suspended solids (110°C)	1	--	--	--	--	--	0	--
Hardness as $CaCO_3$ (Ca,Mg)	7	--	--	--	--	--	8	--
Specific conductance (micromhos at 25°C)	20	21	22	26	--	--	22	25
pH (pH units)	7.6	7.2	6.0	6.2	7.4	6.5	7.5	7.3
Water temperature (°C)	6.0	4.3	12.3	5.0	19.1	6.0	18.2	5.8
Color (Pt-Co scale)	0	10	10	5	5	10	0	10
Secchi-disc (ft)	20		22		21		27	
Dissolved oxygen (DO)	12.1	11.0	10.8	3.0	9.1	4.4	9.0	.4
Chlorophyll a in photic zone (µg/l)	2.3	--	.8	--	1.9	--	.8	--
Fecal coliform (col. per 100 ml) Range	<1-<1		<1-1		<1-2		<1-1	
Fecal coliform (col. per 100 ml) Mean	<1		1		<1		1	
Total organic carbon (as C)	3.0	--	2.5	--	3.0	--	3.5	--





Lost Lake, Mason County. From Washington Department of Game, February 12, 1952.

Lost Lake, Mason County. May 19, 1972. Approx. scale 1:12,000.

Louise Lake near Steilacoom (12090288)

Location.
Lat 47°09'36", long 122°34'00", in NW¼SW¼ sec.4, T.19 N., R.2 E., Pierce County, 1.6 miles southeast of Steilacoom; Puget Sound basin.
Steilacoom quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.34 sq mi	Mean depth	22 ft	Shoreline configuration	1.0
Altitude	230 ft	Maximum depth	35 ft	Development of volume	0.63
Surface area	39 acres	Length of shoreline	4,800 ft	Bottom slope	2.4 percent
Lake volume	860 acre-ft				

Basin geology.
Glacial drift (Walters and Kimmel, 1968).

Soils.
Gravelly loamy sand and gravelly sandy loam (Anderson and others, 1955).

Land use (percentage of drainage basin). Urban 8, suburban 41, agricultural 21, forest or unproductive 12, and lake surface 18.
Nearshore residential development. 100 percent.
Number of nearshore homes. 74

Surface-water inflow and outflow.
No inflow was observed and the lake has no surface-water outlet.

Lake stage.
Lake stage varied 2.3 feet between February 16 and August 30, 1973.

Macrophytes.
Shoreline covered by emersed plants, 11 to 25 percent.
Lake surface covered by emersed plants, 8 percent.
Lake bottom covered by submersed plants, 64 percent.
Rooted aquatic plants observed were white lily (*Nymphaea* sp.), sedge (Cyperaceae), coontail (*Ceratophyllum* sp.), pondweed (*Potamogeton* sp.), muskgrass (*Chara* sp.), and wildcelery (*Vallisneria* sp.).

Algae observed.
April 23 - Predominantly green algae (*Protococcus* sp.).

Summary and conclusions.
Louise Lake is a relatively small, circular lake that has no surface inflow or outflow. The biological productivity appears to be low to moderate. A littoral zone composed of mainly gravel and cobbles supported a heavy growth of submersed aquatic macrophytes. The high density of residential homes around the lake, the absence of an outflow and the moderate volume of the lake tend to provide a high potential for cultural eutrophication.

Water-quality data for Louise Lake.

[Milligrams per litre unless otherwise indicated]

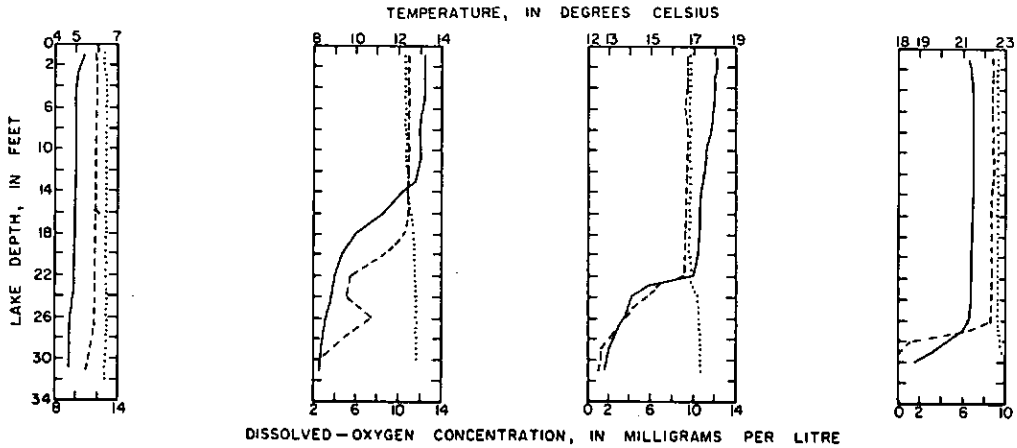
Date of collection (1973)	February 16		April 23		June 18		August 30	
Water depth (ft)	3	30	3	30	3	28	3	26
Silica (SiO_2)	0.1	0.1	0.1	0.2	0.0	0.0	0.4	0.4
Dissolved iron (Fe), in µg/l	140	40	30	40	50	170	50	70
Dissolved manganese (Mn) (in µg/l)	20	10	10	40	10	120	40	45
Calcium (Ca)	10	--	--	--	--	--	5.8	--
Magnesium (Mg)	2.3	--	--	--	--	--	1.7	--
Sodium (Na)	4.7	--	--	--	--	--	5.1	--
Potassium (K)	.9	--	--	--	--	--	.7	--
Bicarbonate (HCO_3)	23	26	23	23	30	31	28	28
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	9.7	--	--	--	--	--	9.0	--
Chloride (Cl)	4.9	--	--	--	--	--	3.6	--
Nitrate nitrogen (as N)	.09	.09	.01	.05	.04	.01	.01	.01
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.01
Ammonia nitrogen (as N)	.06	.11	.06	.10	.03	.14	.11	.11
Organic nitrogen (as N)	.30	.25	.24	.20	.12	.03	.51	.38
Total phosphorus (as P)	.012	.010	.012	.008	.009	.024	.009	.003
Orthophosphate (as P)	.002	.002	.005	.002	.002	.002	.001	.001
Suspended solids (110°C)	0	--	--	--	--	--	0	--
Hardness as $CaCO_3$ (Ca,Mg)	34	--	--	--	--	--	21	--
Specific conductance (micromhos at 25°C)	65	66	72	71	74	74	72	74
pH (pH units)	7.5	7.3	6.4	6.4	7.2	6.7	7.4	7.3
Water temperature (°C)	5.1	4.7	13.2	8.4	18.0	13.2	21.4	21.3
Color (Pt-Co scale)	0	0	10	10	5	10	5	5
Secchi-disc (ft)	18		19		20		22	
Dissolved oxygen (DO)	12.0	11.0	10.9	3.7	9.4	2.0	8.9	8.7
Chlorophyll a in photic zone (µg/l)	4.8	--	1.6	--	.9	--	1.3	--
Fecal coliform (col. per 100 ml) Range	<1-2		<1-1		3-18		4-6	
Fecal coliform (col. per 100 ml) Mean	1		<1		8		5	
Total organic carbon (as C)	5.0	--	4.5	--	5.0	--	4.0	--

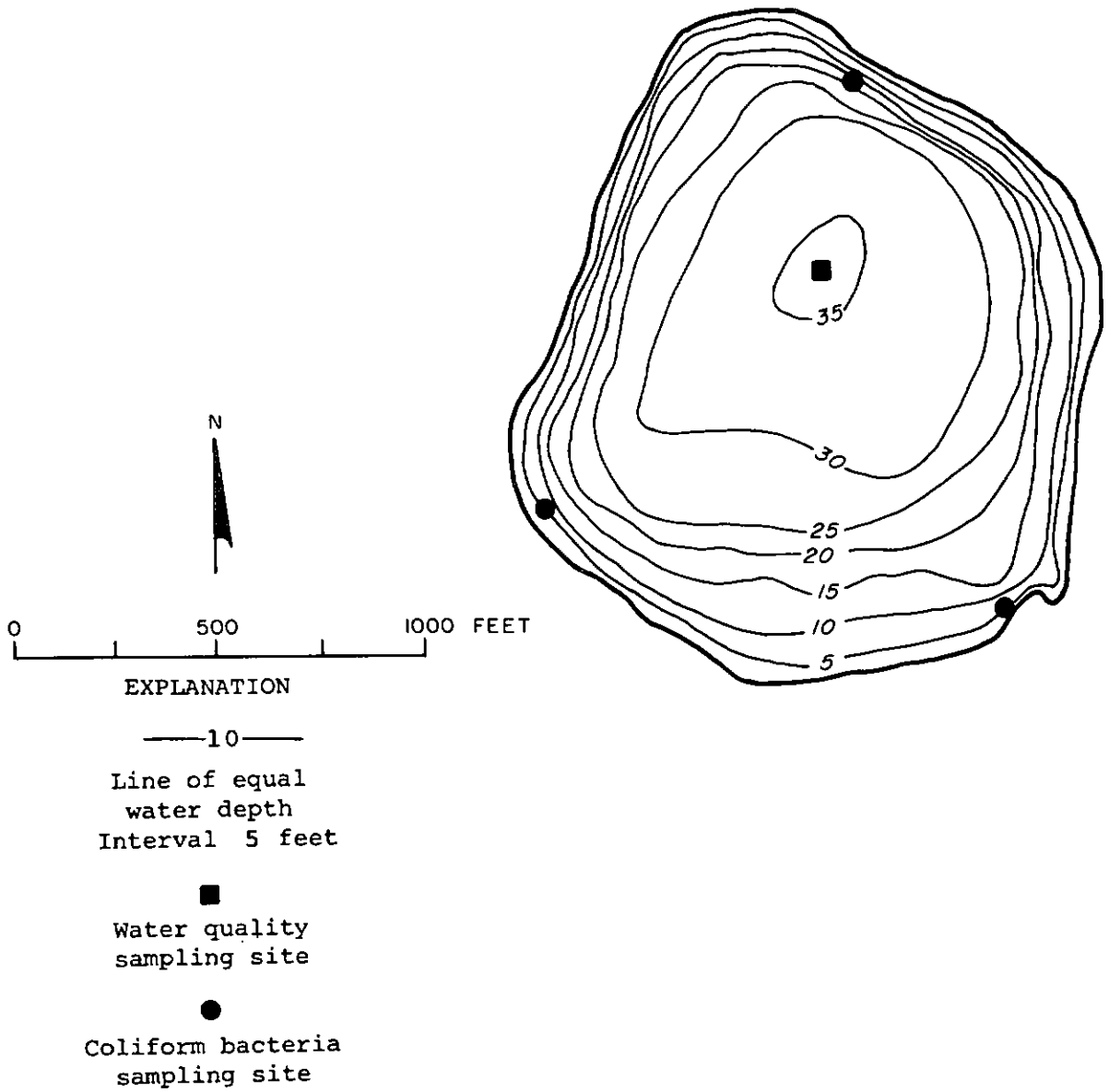
EXPLANATION

Temperature

Dissolved oxygen concentration

Theoretical dissolved oxygen saturation





Louise Lake, Pierce County. From Washington Department of Game, June 5, 1950.

Louise Lake, Pierce County. April 3, 1973. Approx. scale 1:4800.

Margaret Lake near Duvall (12150480)

Location.
Lat 47°46'02", long 121°53'59", in SW¼NW¼ sec.3, T.26 N., R.7 E., King County, 4.3 miles northeast of Duvall; Snohomish River basin.
Monroe quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	2.38 sq mi	Mean depth	17 ft	Shoreline configuration	1.6
Altitude	798 ft	Maximum depth	43 ft	Development of volume	0.39
Surface area	55 acres	Length of shoreline	8,900 ft	Bottom slope	2.4 percent
Lake volume	940 acre-ft				

Basin geology.
Glacial drift (Huntting and others, 1961).

Soils.
Gravelly sandy loam, gravelly loam, and shallow stony soils (Poulson and others, 1952).

Land use (percentage of drainage basin). Urban 0, suburban 1, agricultural 0, forest or unproductive 94, and lake surface 5.
Nearshore residential development. 94 percent.
Number of nearshore homes. 52.

Surface-water inflow and outflow.
Two small inflows enter the north end of Margaret Lake. An estimate of inflow on Mar. 7 was 4.5 ft^3/s; May 9, 2.2 ft^3/s; June 28, 1.3 ft^3/s; and Sept. 25, 1.0 ft^3/s. The outflow to Margaret Creek is regulated by a box-culvert overflow.

Lake stage.
Lake stage varied 1.3 feet between March 7 and September 25, 1973.

Macrophytes.
Shoreline covered by emersed plants, 1 to 10 percent.
Lake surface covered by emersed plants, 0.2 percent.
Lake bottom covered by submersed plants, 5 percent.
Rooted aquatic plants observed were coontail (*Ceratophyllum* sp.),* cattail (*Typha* sp.), sedge (Cyperaceae), pondweed (*Potamogeton* sp.), quillwort (*Isoetes* sp.), and muskgrass (*Chara* sp.).

Asterisk (*) indicates dominant aquatic plant.

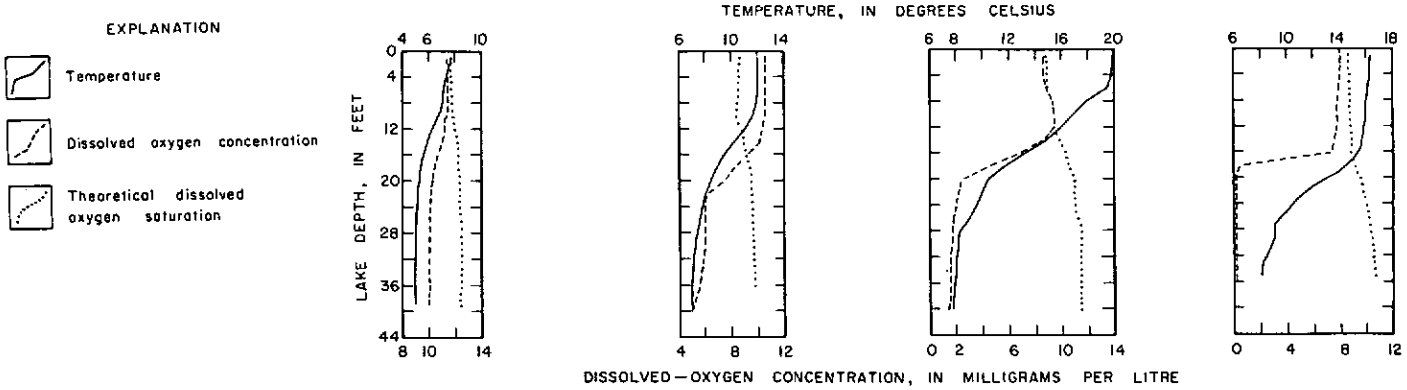
Algae observed.
No data.

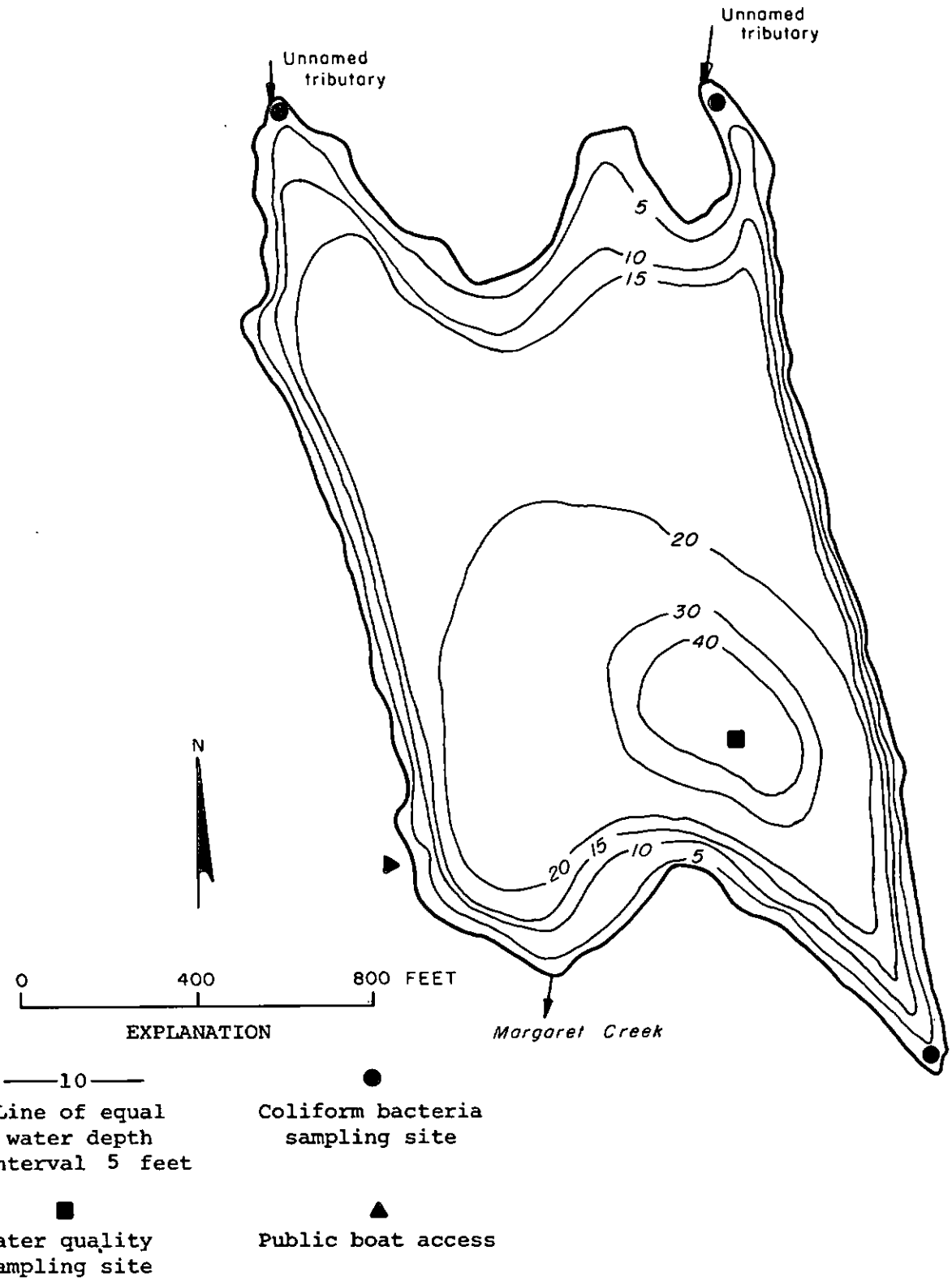
Summary and conclusions.
Margaret Lake was originally a natural lake but is now enlarged by a dam and has a regulated outflow. The biological productivity of the lake appears to be low. At the time of winter mixing of the lake waters the nitrate nitrogen concentration reached a high value of 0.59 mg/l and then decreased to 0.02 mg/l in the epilimnion by late September. The total phosphorus concentration in the epilimnion was relatively low (0.015 to 0.006 mg/l) during the periods of sampling. The DO was depleted to nearly zero in the hypolimnion by July. Aquatic macrophyte growth was light.

Water-quality data for Margaret Lake.

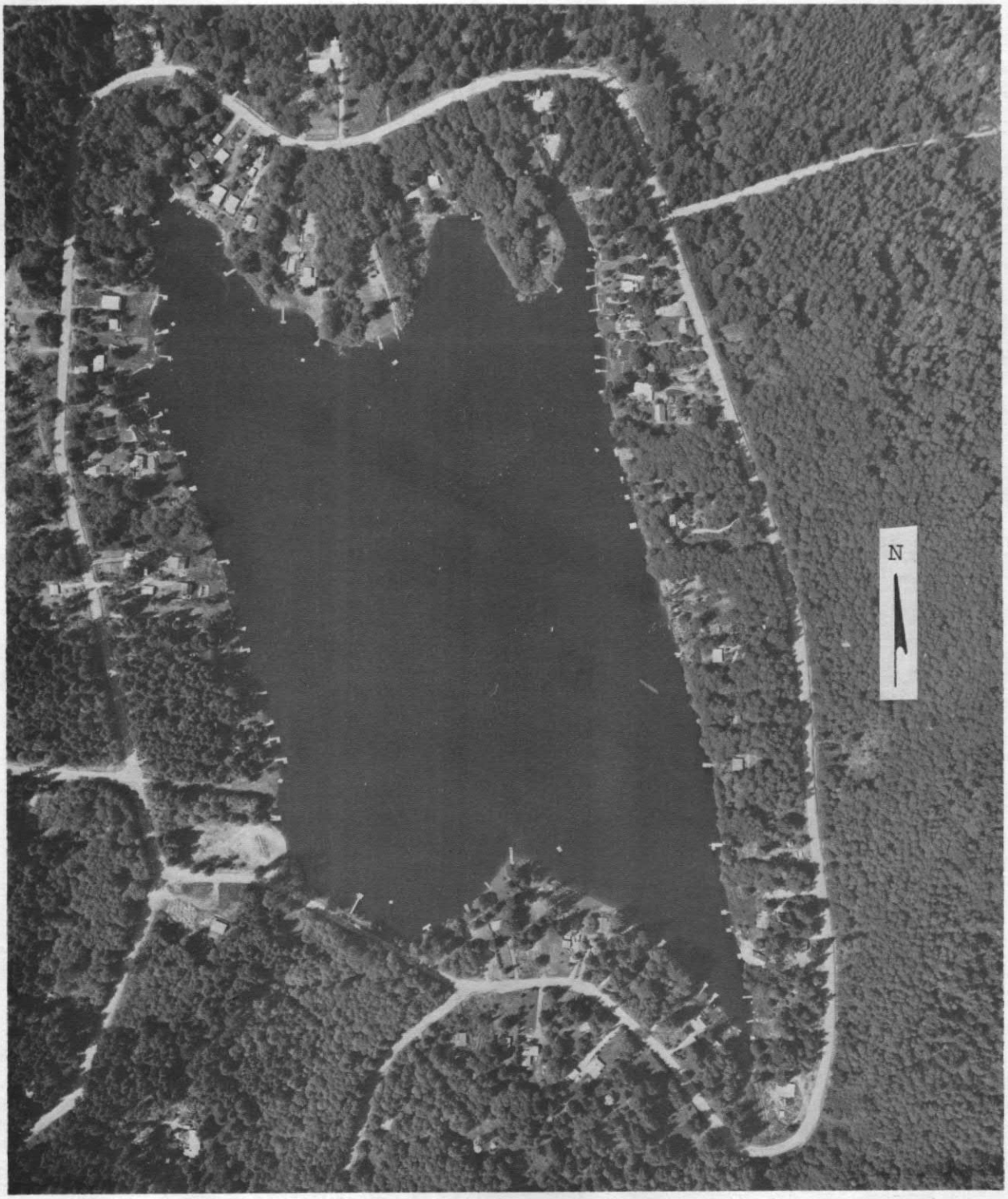
[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 7		May 9		June 28		September 25	
Water depth (ft)	3	36	3	36	3	36	3	33
Silica (SiO_2)	6.5	7.0	5.2	6.5	4.2	6.8	3.5	6.8
Dissolved iron (Fe), in µg/l	120	150	110	150	150	370	440	4,700
Dissolved manganese (Mn) (in µg/l)	40	20	10	30	10	260	120	1,400
Calcium (Ca)	3.0	--	--	--	--	--	4.0	--
Magnesium (Mg)	.6	--	--	--	--	--	.8	--
Sodium (Na)	2.1	--	--	--	--	--	2.2	--
Potassium (K)	.2	--	--	--	--	--	.3	--
Bicarbonate (HCO_3)	14	13	15	11	20	19	17	19
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	.3
Sulfate (SO_4)	3.2	--	--	--	--	--	2.7	--.
Chloride (Cl)	1.8	--	--	--	--	--	1.9	--
Nitrate nitrogen (as N)	.59	.61	.38	.41	.17	.28	.02	.02
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.01
Ammonia nitrogen (as N)	.06	.06	.04	.13	.10	.06	.07	.58
Organic nitrogen (as N)	.10	.15	.20	.09	.09	.04	.28	.04
Total phosphorus (as P)	.011	.009	.006	.009	.015	.020	.009	.024
Orthophosphate (as P)	.000	.000	.004	.004	.005	.005	.006	.022
Suspended solids (110 °C)	3	--	--	--	--	--	6	--
Hardness as $CaCO_3$ (Ca,Mg)	10	--	--	--	--	--	13	--
Specific conductance (micromhos at 25 °C)	32	31	30	28	31	29	33	47
pH (pH units)	7.2	7.2	8.1	7.4	6.9	6.0	7.5	7.2
Water temperature (°C)	7.5	5.0	12.0	7.0	19.8	7.9	16.2	8.3
Color (Pt-Co scale)	20	20	15	30	5	--	5	20
Secchi-disc (ft)	13		13		13		8.5	
Dissolved oxygen (DO)	11.4	10.1	10.5	5.4	8.6	1.6	8.0	.2
Chlorophyll a in photic zone (µg/l)	2.7	--	.9	--	1.0	--	1.4	--
Fecal coliform (col. per 100 ml) Range	<1-<1		1-3		2-5		3-15	
Fecal coliform (col. per 100 ml) Mean	<1		2		4		8	
Total organic carbon (as C)	3.5	--	4.0	--	5.0	--	3.5	--





Margaret Lake, King County. From U.S. Geological Survey, June 26, 1973.



Margaret Lake, King County. May 17, 1973. Approx. scale 1:4800.

McIntosh Lake near Tenino (12079300)

Location.

Southernmost shoreline point, at lat 46°51'41", long 122°46'29", in NW¼NW¼ sec.23, T.16 N., R.1 W., Thurston County, 3.6 miles east of Tenino; Deschutes River basin. Bucoda and East Olympia quadrangles, 1:24,000.

Physical characteristics of lake.

Drainage area	2.26 sq mi	Mean depth	7.5 ft	Shoreline configuration	2.0
Altitude	332 ft	Maximum depth	11 ft	Development of volume	0.68
Surface area	93 acres	Length of shoreline	14,000 ft	Bottom slope	0.48 percent
Lake volume	700 acre-ft				

Basin geology.

Glacial drift and sedimentary rocks,with alluvium on southeast side of lake (Noble and Wallace, 1966).

Soils.

Silty clay loam, fine sandy loam, gravelly loam, and clay loam (Ness, 1958).

Land use (percentage of drainage basin). Urban 0, suburban 5, agricultural 0, forest or unproductive 89, and lake surface 6.

Nearshore residential development. 44 percent.

Number of nearshore homes. 55.

Surface-water inflow and outflow.

McIntosh Lake had no observed inflow or outflow between February and September 1973.

Lake stage.

Lake stage varied 1.7 feet between February 20 and September 17, 1973.

Macrophytes.

Shoreline covered by emersed plants, 1-10 percent.
Lake surface covered by emersed plants, 0.4 percent.
Lake bottom covered by submersed plants, 55 percent.
Rooted aquatic plants observed were cattail (*Typha* sp.), white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), sedge (Cyperaceae), waterweed (*Elodea* sp.), pondweed (*Potamogeton* sp.), and muskgrass (*Chara* sp.).

Algae observed.

June 19 - A mixed population of flagellates (*Ceratium* sp.)* and blue-green algae (*Nostoc* sp., *Oscillatoria* sp.).

Asterisk (*) indicates dominant aquatic plant.

Summary and conclusions.

McIntosh Lake is a long, shallow lake with no significant surface-water inflow or outflow. The lake appears to be moderate to high in biological productivity. The nutrient concentration was moderate. A high cell density of flagellates and blue-green algae was observed in June. The shallowness of the lake allowed DO concentrations to remain high throughout the summer. A lake bottom composed of mainly sand, gravel, and cobbles supported a heavy growth of submersed macrophytes. About 55 percent of the bottom was covered primarily with waterweed and pondweed, and the growth was heaviest at the ends of the lake. Submersed wood debris and logs were scattered on the lake bottom near the east shore.

Water-quality data for McIntosh Lake.

[Milligrams per litre unless otherwise indicated]

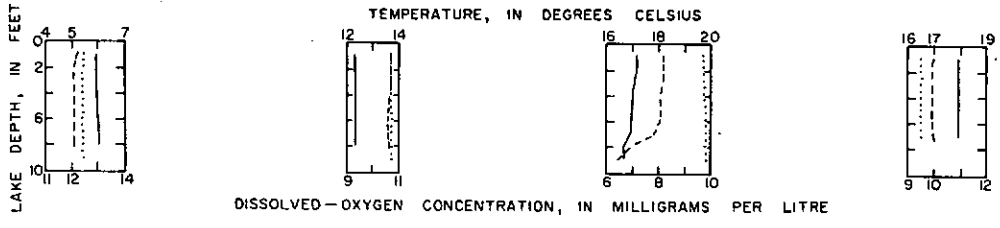
Date of collection (1973)	February 20		April 24		June 19		September 17	
Water depth (ft)	3	7	3	7	3	7	3	5
Silica (SiO_2)	10	10	6.5	6.5	5.8	5.8	8.1	8.2
Dissolved iron (Fe), in µg/l	190	190	150	170	210	240	220	290
Dissolved manganese (Mn) (in µg/l)	0	10	10	30	40	30	20	60
Calcium (Ca)	5.3	--	--	--	--	--	5.7	--
Magnesium (Mg)	1.6	--	--	--	--	--	1.9	--
Sodium (Na)	4.2	--	--	--	--	--	5.0	--
Potassium (K)	.5	--	--	--	--	--	1.4	--
Bicarbonate (HCO_3)	25	25	26	27	36	36	36	36
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	5.5	--	--	--	--	--	3.8	--
Chloride (Cl)	4.2	--	--	--	--	--	2.3	--
Nitrate nitrogen (as N)	.49	.48	.02	.02	.01	.01	.00	.01
Nitrite nitrogen (as N)	.00	.01	.00	.00	.00	.00	.00	.01
Ammonia nitrogen (as N)	.11	.14	.11	.08	.20	.18	.08	.05
Organic nitrogen (as N)	.28	.18	.19	.22	.09	.02	.36	.57
Total phosphorus (as P)	.027	.018	.012	.013	.038	.040	.066	.068
Orthophosphate (as P)	.003	.003	.006	.004	.002	.002	.004	.004
Suspended solids (110°C)	3	--	--	--	--	--	3	--
Hardness as $CaCO_3$ (Ca,Mg)	20	--	--	--	--	--	22	--
Specific conductance (micromhos at 25°C)	57	57	59	59	63	63	61	61
pH (pH units)	7.6	7.2	7.7	6.9	7.0	7.0	5.7	--
Water temperature (°C)	5.9	6.0	12.3	12.3	17.1	16.9	17.9	17.9
Color (Pt-Co scale)	15	20	5	5	20	35	10	10
Secchi-disc (ft)	8.5		8.6		7.9		8.5	
Dissolved oxygen (DO)	12.1	12.1	10.7	10.6	8.2	7.8	9.9	9.9
Chlorophyll a in photic zone (µg/l)	3.2	--	.7	--	4.9	--	1.3	--
Fecal coliform (col. per 100 ml) Range	<1-4		<1-1		<1-5		<1-5	
Fecal coliform (col. per 100 ml) Mean	1		<1		2		2	
Total organic carbon (as C)	5.0	--	4.5	--	5.0	--	4.0	--

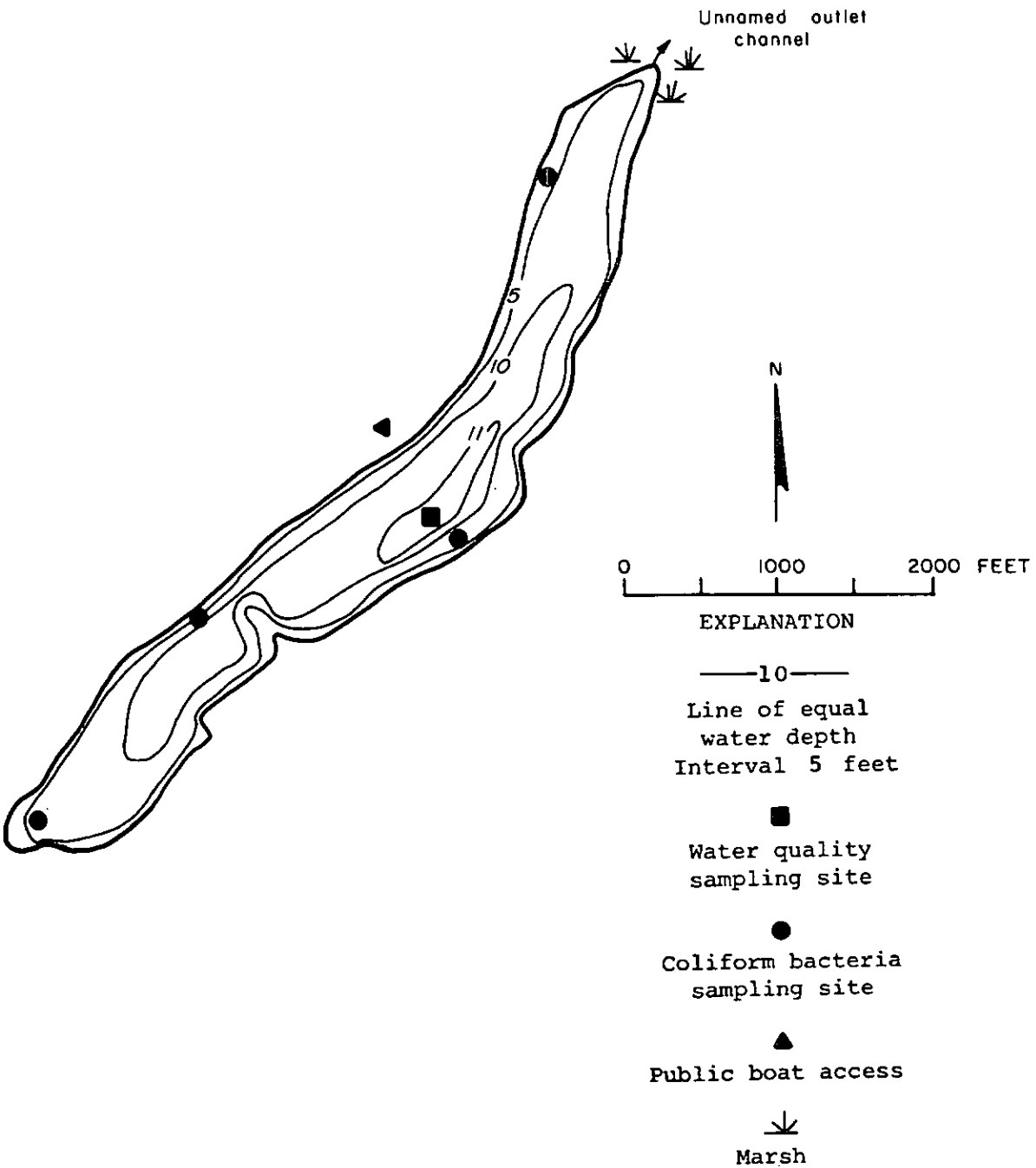
EXPLANATION

Temperature

Dissolved oxygen concentration

Theoretical dissolved oxygen saturation





McIntosh Lake, Thurston County. From Washington Department of Game, December 14, 1949.

McIntosh Lake, Thurston County. May 12, 1972. Approx. scale 1:12,000.

McMurray Lake at McMurray (12199200)

Location.
Lat 48°19'28", long 122°13'22", in NW¼NW¼ sec.30, T.33 N., R.5 E., Skagit County, 0.9 mile northeast of McMurray; Skagit River basin.
Clear Lake quadrangle, 1:62,500.

Physical characteristics of lake.

Drainage area	3.25 sq mi	Mean depth	29 ft	Shoreline configuration	1.5
Altitude	225 ft	Maximum depth	52 ft	Development of volume	0.56
Surface area	160 acres	Length of shoreline	14,000 ft	Bottom slope	1.8 percent
Lake volume	4,500 acre-ft				

Basin geology.
Sedimentary rocks and alluvium (Huntting and others, 1961).

Soils.
Gravelly sandy loam, loam, gravelly loam, silty clay, silt loam, and local muck (Ness and others, 1960).

Land use (percentage of drainage basin). Urban 0, suburban 3, agricultural 11, forest or unproductive 79, and lake surface 7.

Nearshore residential development. 48 percent.

Number of nearshore homes. 64.

Surface-water inflow and outflow.
McMurray Lake has 13 small inflows, mostly along the west side of the lake. The estimated inflow on Mar. 20 was 8 ft^3/s; May 18, 1.5 ft^3/s; July 2, 1 ft^3/s, and Sept. 22, 0.5 ft^3/s. The outflow is regulated by a concrete weir with flashboards.

Lake stage.
Lake stage varied 1.4 feet between March 20 and September 22, 1973.

Macrophytes.
Shoreline covered by emersed plants, 11 to 25 percent.
Lake surface covered by emersed plants, 0.2 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were cattail (*Typha* sp.), white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), sedge (Cyperaceae), and waterweed (*Elodea* sp.).

Algae observed.
May 18 - Predominantly diatoms (*Fragillaria* sp.,* *Asterionella* sp.,* *Tabellaria* sp., *Synedra* sp.).
July 3 - A mixed population of blue-green (*Polycystis* sp.)* and green (*Volvox* sp.) algae and diatoms (*Fragillaria* sp.).
Sept.22 - A mixed population of diatoms (*Fragillaria* sp.),* blue-green algae (*Nostoc* sp., *Oscillatoria* sp.), and flagellates (*Ceratium* sp.).

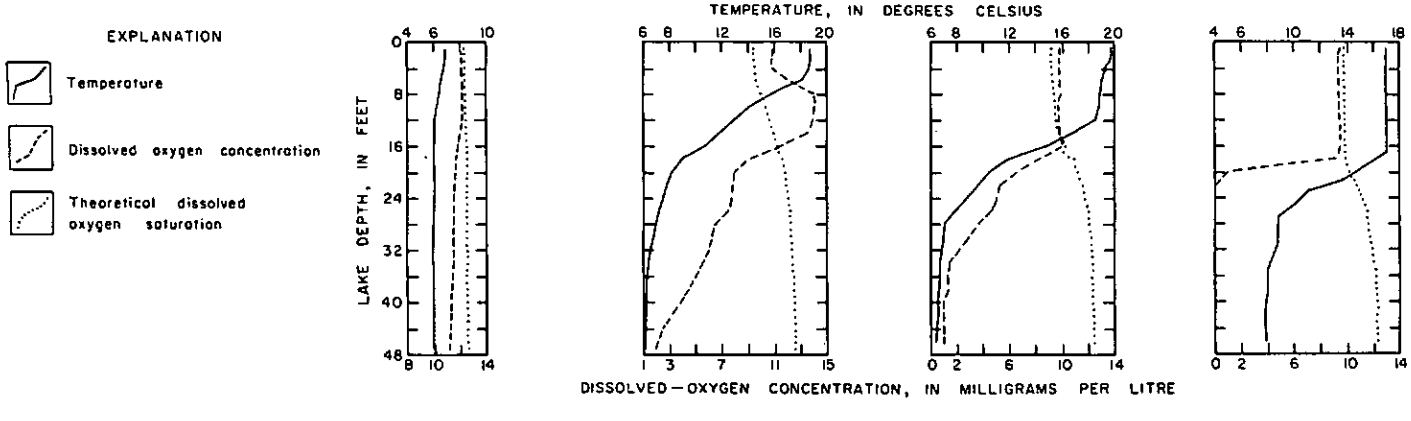
Asterisk (*) indicates dominant aquatic plants.

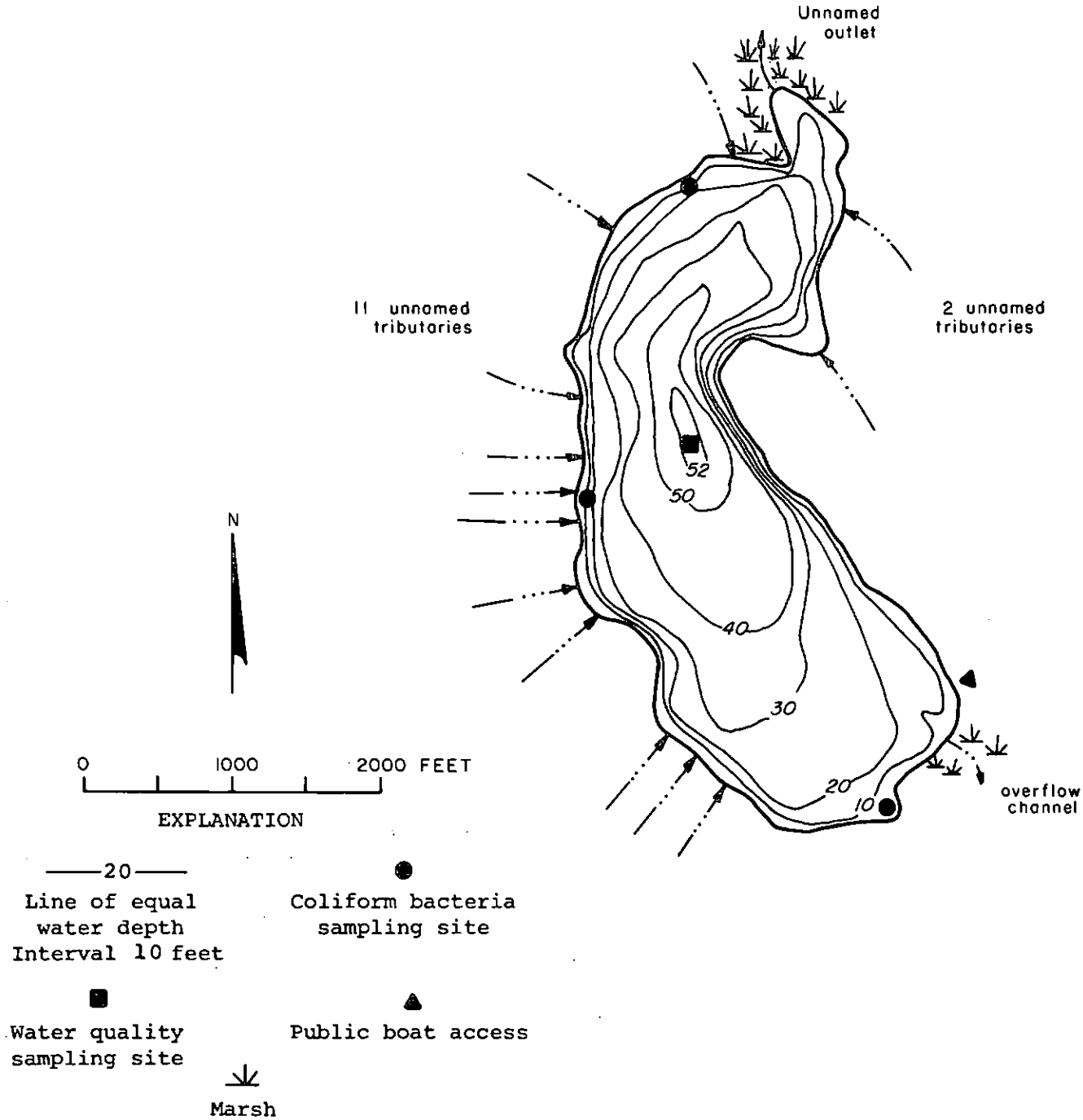
Summary and conclusions.
McMurray Lake appears to be moderate in biological productivity. The nitrate nitrogen, total phosphorus, and chlorophyll *a* concentrations were relatively high. A bloom of blue-green algae and diatoms was observed during visits to the lake in May and July. The lake was completely mixed vertically in late March. By mid-June strong thermal stratification was established and the DO was depleted to nearly zero in the hypolimnion. By mid-September all water below a depth of 20 feet was devoid of oxygen. A littoral bottom composed of sand, gravel, and cobbles supported a light growth of aquatic macrophytes. About 48 percent of the nearshore area is now occupied by homes. Nearshore homes increased from 14 homes in 1956 to 64 homes in 1973.

Water-quality data for McMurray Lake.

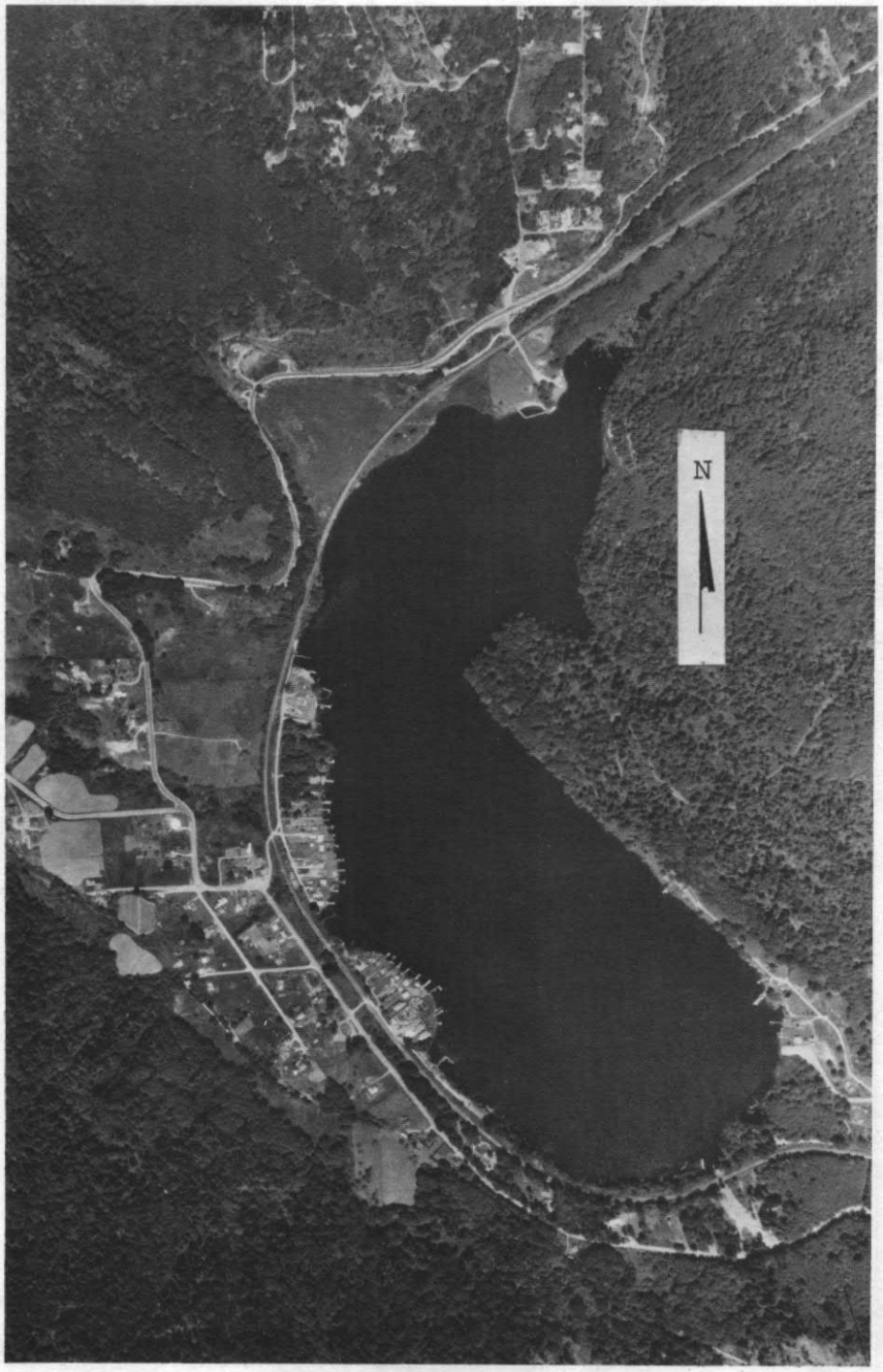
[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 20		May 18		July 3		September 22	
Water depth (ft)	3	43	3	46	3	43	3	43
Silica (SiO_2)	8.2	8.4	2.5	9.8	1.4	12	2.5	13
Dissolved iron (Fe), in µg/l	220	262	110	990	50	12,000	120	8,600
Dissolved manganese (Mn) (in µg/l)	120	110	20	430	10	1,100	10	1,200
Calcium (Ca)	7.4	--	--	--	--	--	6.6	--
Magnesium (Mg)	2.7	--	--	--	--	--	2.9	--
Sodium (Na)	6.1	--	--	--	--	--	6.5	--
Potassium (K)	.7	--	--	--	--	--	1.6	--
Bicarbonate (HCO_3)	30	31	32	33	38	48	42	62
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	.5
Sulfate (SO_4)	7.9	--	--	--	--	--	7.6	--
Chloride (Cl)	4.0	--	--	--	--	--	3.4	--
Nitrate nitrogen (as N)	.77	.75	.59	.78	.42	.14	.01	.01
Nitrite nitrogen (as N)	.04	.04	.02	.01	.01	.01	.00	.01
Ammonia nitrogen (as N)	.14	.15	.09	.14	.04	.82	.05	1.6
Organic nitrogen (as N)	.26	.37	.10	.10	.04	.08	.32	1.1
Total phosphorus (as P)	.041	.034	.015	.034	.017	.17	.018	.39
Orthophosphate (as P)	.003	.003	.003	.008	.004	.077	.000	.34
Suspended solids (110°C)	5	--	--	--	--	--	2	--
Hardness as $CaCO_3$ (Ca,Mg)	30	--	--	--	--	--	28	--
Specific conductance (micromhos at 25°C)	82	82	86	84	84	110	85	131
pH (pH units)	6.7	6.5	7.2	6.6	7.8	6.6	6.8	6.4
Water temperature (°C)	6.8	5.9	18.7	6.2	19.5	6.4	17.0	6.8
Color (Pt-Co scale)	25	25	15	20	0	15	0	80
Secchi-disc (ft)	5.9		6.6		14		11	
Dissolved oxygen (DO)	12.1	11.2	10.8	2.3	9.8	1.1	9.4	.2
Chlorophyll a in photic zone (µg/l)	11.2	--	4.1	--	2.9	--	3.3	--
Fecal coliform (col. per 100 ml) Range	1-3		5-22		1-17		<1-19	
Fecal coliform (col. per 100 ml) Mean	2		15		9		8	
Total organic carbon (as C)	8.5	--	6.0	--	6.0	--	4.0	--





McMurray Lake, Skagit County. From Washington Department of Game, March 10, 1956.



McMurray Lake, Skagit County. June 2, 1970. Approx. scale 1:12,000.

Medical Lake at Medical Lake (12425000)

Location.
Southernmost shoreline point, at lat 47°33'48", long 117°41'21", in NW¼NW¼ sec.19, T.24 N., R.41 E., Spokane County, 0.8 mile southwest of Town of Medical Lake; Spokane River basin. Medical Lake quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	1.35 sq mi	Mean depth	32 ft	Shoreline configuration	1.8
Altitude	2,394 ft	Maximum depth	60 ft	Development of volume	0.53
Surface area	160 acres	Length of shoreline	17,000 ft	Bottom slope	2.0 percent
Lake volume	5,000 acre-ft				

Basin geology.
Basalt (Huntting and others, 1961).

Soils.
Mostly silt loam and stony silt loam (Donaldson and Giese, 1968).

Land use (percentage of drainage basin). Urban 47, suburban 4, agricultural 0, forest or unproductive 31, and lake surface 18.
Nearshore residential development. 36 percent.
Number of nearshore homes. 26.

Surface-water inflow and outflow.
No inflow was observed and the lake has no surface-water outlet.

Lake stage.
Lake stage varied 1.6 feet between April 5 and October 2, 1973.

Macrophytes.
Shoreline covered by emersed plants, 11 to 25 percent.
Lake surface covered by emersed plants, 5 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were cattail (*Typha* sp.), sedge (Cyperaceae), and pondweed (*Potamogeton* sp.).

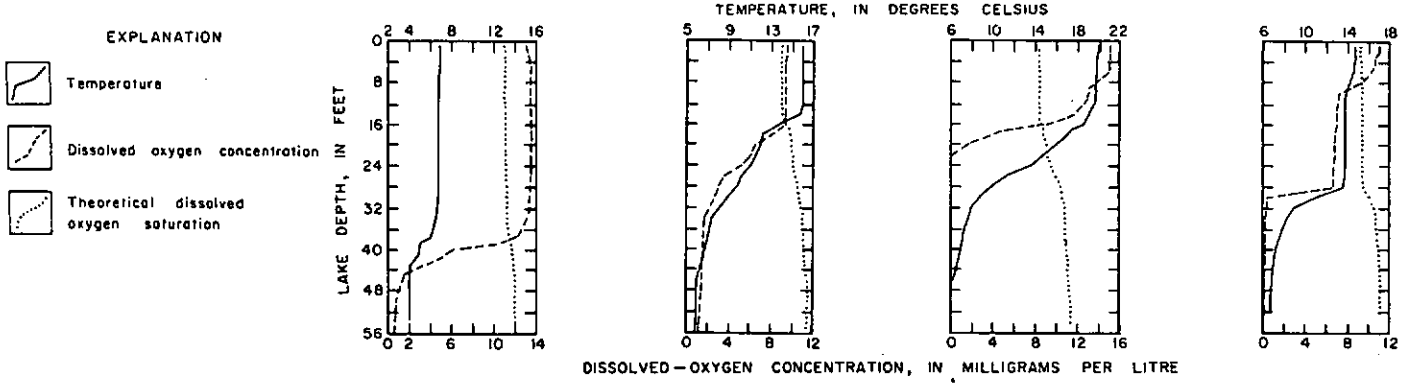
Algae observed.
May 23 - Predominantly blue-green algae (*Anabaena* sp., Polycystis sp.).
July 11 - Predominantly blue-green algae (*Aphanizomenon* sp.).
Oct. 2 - Predominantly blue-green algae (*Aphanizomenon* sp.).

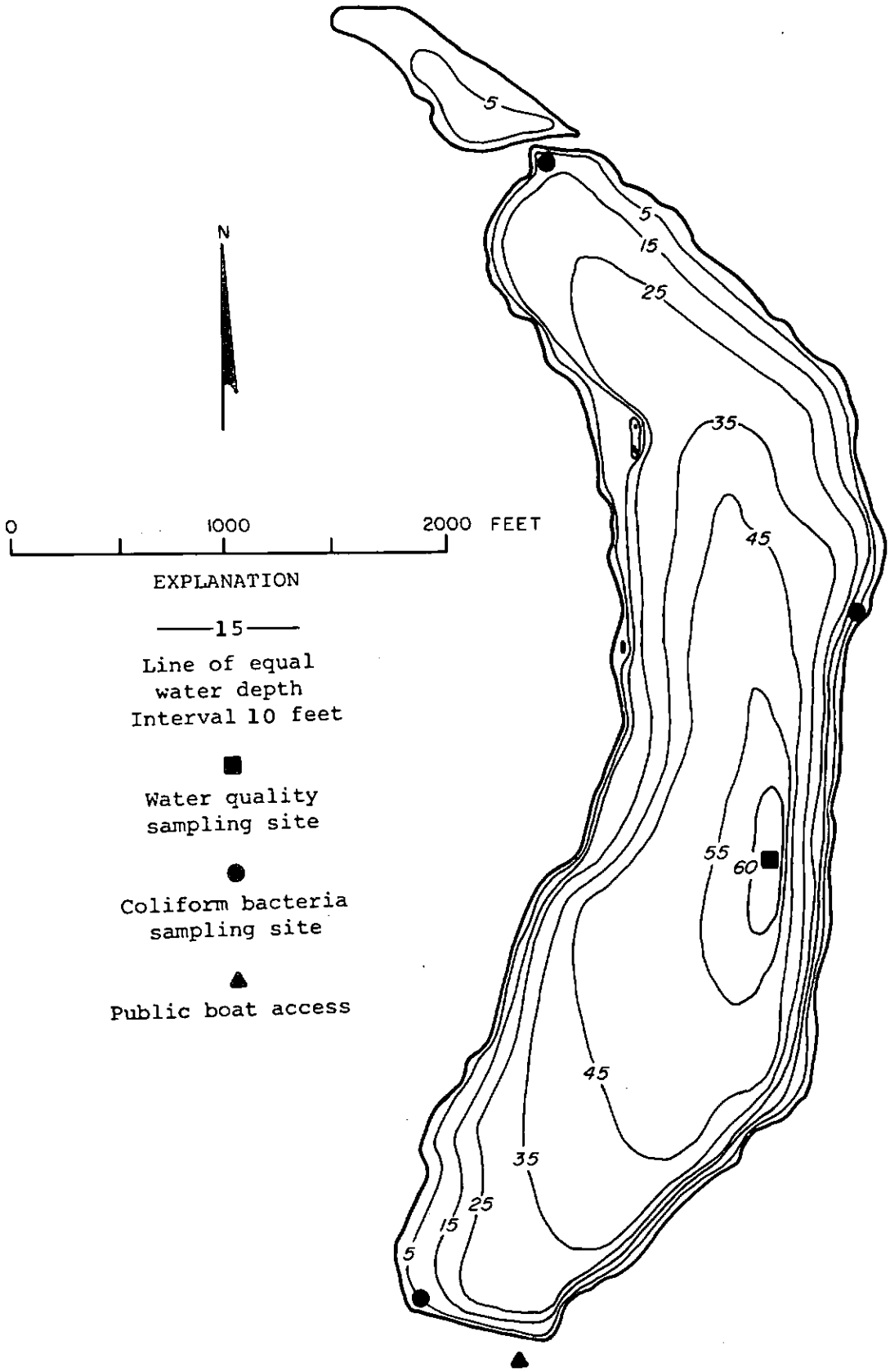
Summary and conclusions.
Medical Lake in eastern Washington has a high biological productivity. The chlorophyll *a* concentration (a range of 0.9 to 53 µg/l) and dissolved-mineral concentration were the highest of the lakes studied, and the nutrient concentration was among the highest of the lakes studied. The total phosphorus and organic nitrogen concentrations in the epilimnion ranged from 0.31 to 0.45 mg/l and 1.7 to 3.7 mg/l, respectively. During the summer a "pea soup" bloom of blue-green algae was observed, accompanied by a supersaturated DO condition in the epilimnion. The DO was entirely depleted in the hypolimnion. The rocky littoral zone supported only a light growth of aquatic macrophytes.

Water-quality data for Medical Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	April 5		May 23		July 11		October 2	
Water depth (ft)	3	52	3	54	3	52	3	52
Silica (SiO_2)	3.9	8.9	5.1	9.9	3.2	12	7.1	16
Dissolved iron (Fe), in µg/l	9	20	20	9	20	20	20	30
Dissolved manganese (Mn) (in µg/l)	0	40	0	40	20	30	20	40
Calcium (Ca)	14	--	--	--	--	--	12	--
Magnesium (Mg)	18	--	--	--	--	--	20	--
Sodium (Na)	400	--	--	--	--	--	450	--
Potassium (K)	29	--	--	--	--	--	35	--
Bicarbonate (HCO_3)	988	843	761	822	690	909	1,070	1,060
Carbonate (CO_3)	--	93	119	114	168	56	--	--
Sulfide (S)	--	--	--	2.0	--	75	--	>5
Sulfate (SO_4)	33	--	--	--	--	--	37	--
Chloride (Cl)	140	--	--	--	--	--	130	--
Nitrate nitrogen (as N)	.10	.02	.15	.02	.01	.02	.01	.01
Nitrite nitrogen (as N)	.02	.03	.02	.00	.01	.00	.01	.01
Ammonia nitrogen (as N)	.64	2.4	.28	2.5	1.5	4.0	.30	7.1
Organic nitrogen (as N)	3.5	2.0	2.1	1.6	1.7	1.0	3.7	3.9
Total phosphorus (as P)	.44	.75	.45	.79	.31	1.4	.36	1.8
Orthophosphate (as P)	.32	.60	.35	.72	.16	.98	.24	1.7
Suspended solids (110°C)	--	--	--	--	--	--	3	--
Hardness as $CaCO_3$ (Ca,Mg)	110	--	--	--	--	--	110	--
Specific conductance (micromhos at 25°C)	1,800	1,900	1,800	1,800	1,800	1,850	1,850	1,850
pH (pH units)	9.3	9.3	9.3	9.1	9.2	8.8	8.6	7.8
Water temperature (°C)	6.9	4.0	16.0	6.0	19.9	6.1	14.7	6.8
Color (Pt-Co scale)	10	15	0	0	20	15	10	10
Secchi-disc (ft)	7.9		19		2.6		7.5	
Dissolved oxygen (DO)	13.3	.7	9.5	1.2	15.0	.2	10.6	.2
Chlorophyll a in photic zone (µg/l)	6.1	--	.9	--	17	--	53	--
Fecal coliform (col. per 100 ml) Range	<1-<1		<1-2		<1-1		<1-<1	
Fecal coliform (col. per 100 ml) Mean	<1		1		<1		<1	
Total organic carbon (as C)	30	--	28	--	41	--	43	--





Medical Lake, Spokane County. From Washington Department of Game, February 12, 1955.

Medical Lake, Spokane County. July 27, 1967. Approx. scale 1:12,000.

Medical, West Lake, near Medical Lake (12464669)

Location.
Southernmost shoreline point, at lat 47°33'42", long 117°42'06", in SW¼NE¼ sec.24, T.24 N., R.40 E., Spokane County, 1.2 miles southwest of town of Medical Lake; Crab Creek basin. Medical Lake quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	1.84 sq mi	Mean depth	22 ft	Shoreline configuration	1.9
Altitude	2,423 ft	Maximum depth	35 ft	Development of volume	0.63
Surface area	220 acres	Length of shoreline	21,000 ft	Bottom slope	1.0 percent
Lake volume	4,900 acre-ft				

Basin geology.
Basalt and metamorphic rocks (Huntting and others, 1961).

Soils.
Mostly silt loam and stony silt loam (Donaldson and Giese, 1968).

Land use (percentage of drainage basin). Urban 1, suburgan 0, agricultural 59, forest or unproductive 21, and lake surface 19.
Nearshore residential development. 0 percent.
Number of nearshore homes. 0.

Surface-water inflow and outflow.
West Medical Lake receives waste effluent from the Eastern Washington State Hospital. The lake has no surface outlet.

Lake stage.
Lake stage varied 1.5 feet between April 3 and October 3, 1973. Daily lake-stage data can be obtained from a report by U.S. Geological Survey (1973).

Macrophytes.
Shoreline covered by emersed plants, 26 to 50 percent.
Lake surface covered by emersed plants, 0.9 percent.
Lake bottom covered by submersed plants, 16 percent.
Rooted aquatic plants observed were pondweed (Potamogeton sp.),* cattail (Typha sp.), sedge (Cyperaceae), coontail (Ceratophyllum sp.), waterweed (Elodea sp.), and water milfoil (Myriophyllum sp.).

Algae observed.
May 23 - Predominantly green algae (Pediastrum sp.) and some blue-green algae (Polycystis sp.)
July 11 - Predominantly blue-green algae (Polycystis sp.,* Aphanizomenon sp.).
Oct. 3 - Predominantly blue-green algae (Aphanizomenon sp.).

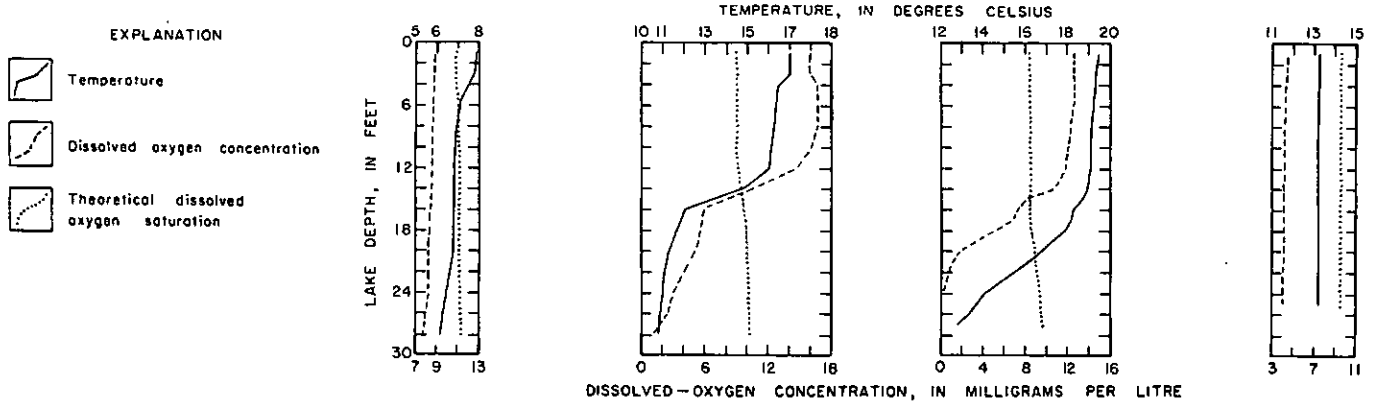
Asterisk (*) indicates the dominant aquatic plants.

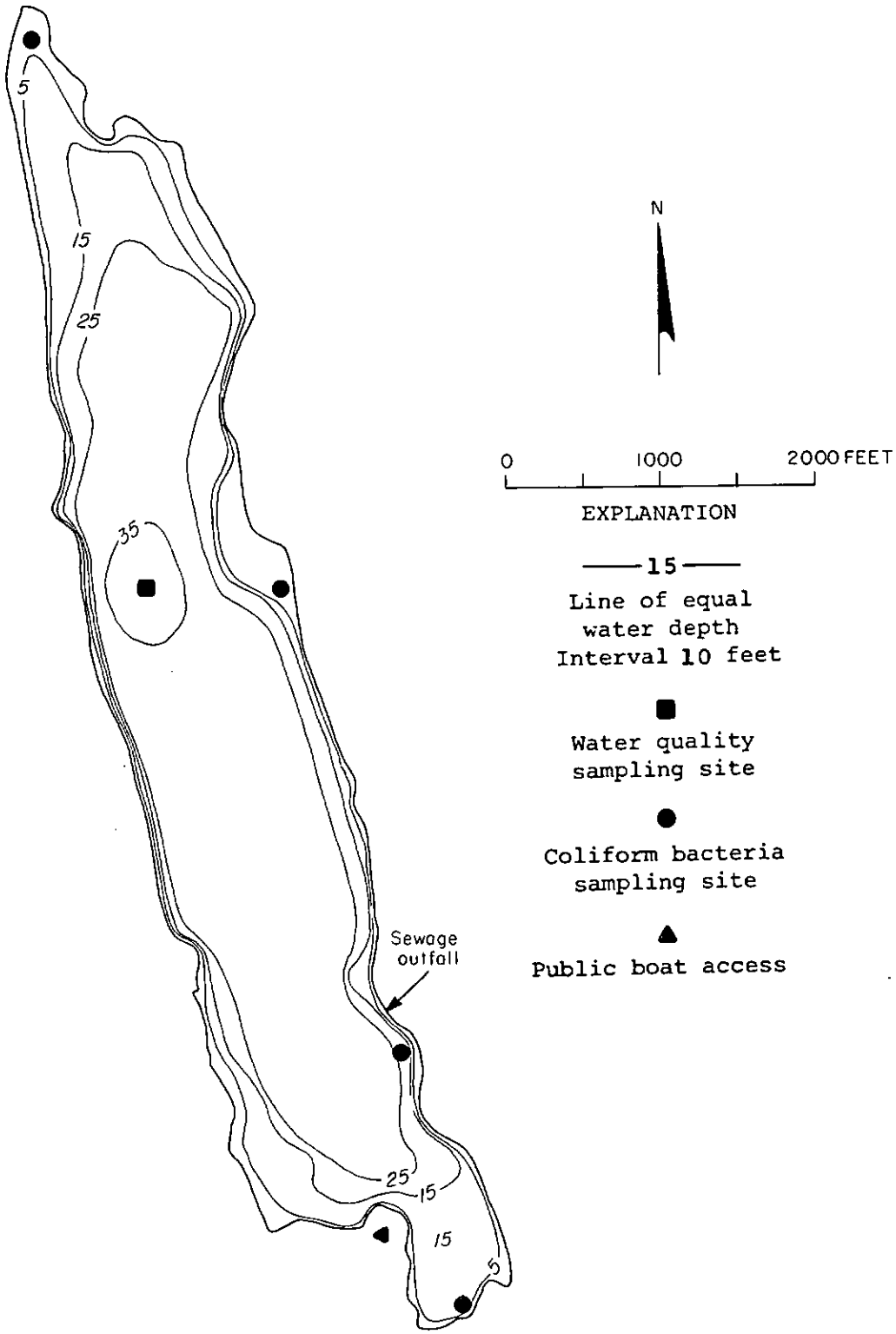
Summary and conclusions.
West Medical Lake is one of the most biologically productive lakes in the State. The lake receives secondary-treated sewage effluent, that is high in nutrients, from Eastern State Hospital. The phosphorus concentration was the highest of the lakes studied. Total phosphorus and orthophosphorus (soluble) in the epilimnion ranged from 1.8 to 2.1 mg/l and 2.4 to 3.2 mg/l, respectively. Dense blooms of blue-green algae caused a supersaturated DO condition in the epilimnion during the summer, and in the hypolimnion the DO was entirely depleted. In the fall, when the lake mixes vertically, the DO at all depths was depleted to 4 mg/l. The littoral zone supported a heavy growth of aquatic macrophytes, primarily pondweed.

Water-quality data for Medical, West Lake

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	April 3		May 23		July 11		October 3	
Water depth (ft)	3	26	3	26	3	25	3	21
Silica (SiO_2)	20	20	18	21	19	19	--	20
Dissolved iron (Fe), in µg/l	90	90	90	120	50	90	50	70
Dissolved manganese (Mn) (in µg/l)	120	110	120	260	120	220	140	130
Calcium (Ca)	36	--	--	--	--	--	38	--
Magnesium (Mg)	18	--	--	--	--	--	19	--
Sodium (Na)	110	--	--	--	--	--	120	--
Potassium (K)	15	--	--	--	--	--	18	--
Bicarbonate (HCO_3)	356	363	326	352	291	372	384	385
Carbonate (CO_3)	--	--	19	--	37	--	--	--
Sulfide (S)	--	--	--	--	--	.5	--	--
Sulfate (SO_4)	15	--	--	--	--	--	14	--
Chloride (Cl)	72	--	--	--	--	--	81	--
Nitrate nitrogen (as N)	.25	.22	.20	.14	.01	.02	.01	.02
Nitrite nitrogen (as N)	.03	.03	.05	.03	.00	.01	.05	.05
Ammonia nitrogen (as N)	2.1	2.2	.53	2.2	1.7	1.2	1.1	1.2
Organic nitrogen (as N)	2.1	1.6	1.5	.60	.80	.80	1.8	1.6
Total phosphorus (as P)	2.6	2.6	3.2	8.0	3.0	3.4	3.0	3.0
Orthophosphate (as P)	2.4	2.4	3.2	4.1	2.9	3.4	2.9	2.9
Suspended solids (110°C)	17	--	--	--	--	--	5	--
Hardness as $CaCO_3$ (Ca,Mg)	160	--	--	--	--	--	170	--
Specific conductance (micromhos at 25°C)	705	705	763	767	749	784	778	784
pH (pH units)	7.6	7.9	8.9	8.1	9.2	8.3	8.1	8.4
Water temperature (°C)	7.8	6.3	17.0	10.9	19.3	14.1	13.2	13.2
Color (Pt-Co scale)	10	20	10	10	15	15	5	5
Secchi-disc (ft)	4.6		5.6		5.6		12	
Dissolved oxygen (DO)	8.7	7.9	15.9	2.4	12.6	.2	4.4	4.1
Chlorophyll a in photic zone (µg/l)	4.7	--	6.1	--	9.2	--	1.9	--
Fecal coliform (col. per 100 ml) Range	<1-<1		<1-15		<1-2		<1-3	
Fecal coliform (col. per 100 ml) Mean	<1		5		1		1	
Total organic carbon (as C)	17	--	20	--	19	--	21	--





Medical, West Lake, Spokane County. From Washington Department of Game, February 3, 1955.

Medical, West Lake, Spokane County. July 25, 1974. Approx. scale 1:14,000.

Munn Lake near Olympia (12079900)

Location.
Lat 46°58'56", long 122°52'49", in SW¼SW¼ sec.1, T.17 N., R.2 W., Thurston County, 1.6 miles southeast of Tumwater; Deschutes River basin.
Maytown quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.67 sq mi	Mean depth	10 ft	Shoreline configuration	1.3
Altitude	142 ft	Maximum depth	19 ft	Development of volume	0.53
Surface area	34 acres	Length of shoreline	5,700 ft	Bottom slope	1.4 percent
Lake volume	350 acre-ft				

Basin geology.
Glacial drift deposited primarily as recessional outwash (Noble and Wallace, 1966).

Soils.
Mostly loamy fine sand with local peat deposits on north and south side of lake (Ness, 1958).

Land use (percentage of drainage basin). Urban 3, suburban 4, agricultural 42, forest or unproductive 42, and lake surface 9.
Nearshore residential development. 33 percent.
Number of nearshore homes. 9.

Surface-water inflow and outflow.
Munn Lake received some surface-water inflow from Trails End Lake early in the year. On February 22 and April 24, 1973, the inflow was estimated to be 0.1 ft^3/s. On June 19 and September 17, 1973, no inflow was observed. The lake has no surface-water outlet.

Lake stage.
Lake stage varied 2.6 feet between February 22 and September 17, 1973.

Macrophytes.
Shoreline covered by emersed plants, 51 to 75 percent.
Lake surface covered by emersed plants, 9 percent.
Lake bottom covered by submersed plants, 62 percent.
Rooted aquatic plants observed were white lily (Nymphaea sp.),* coontail (Ceratophyllum sp.),* cattail (Typha sp.), yellow lily (Nuphar sp.), sedge (Cyperaceae), watershield (Brasenia sp.), stonewort (Nitella sp.), and water milfoil (Myriophyllum sp.).

Algae observed.
June 19 - Predominantly blue-green algae (Aphanizomenon sp.).
Sept.17 - Predominantly blue-green algae (Anabaena sp.,* and Aphanizomenon sp.).

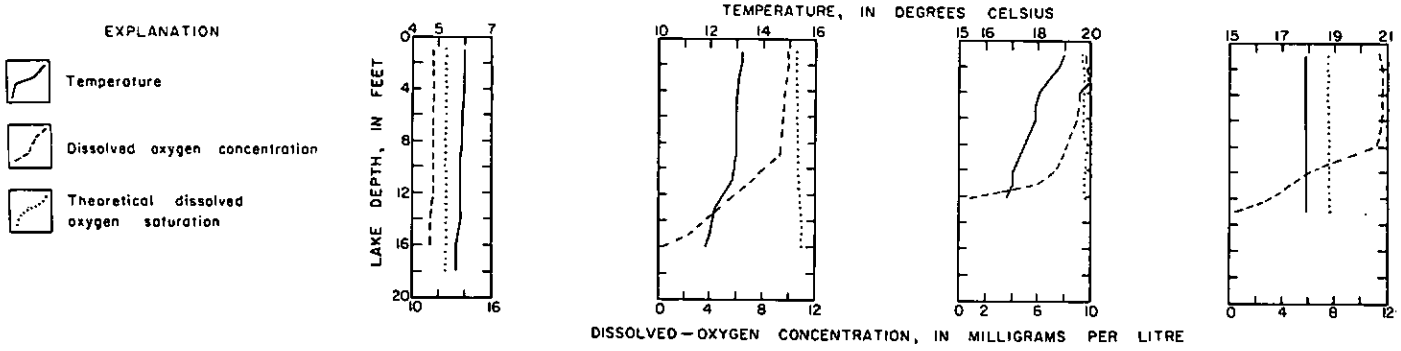
Asterisk (*) indicates dominant aquatic plants.

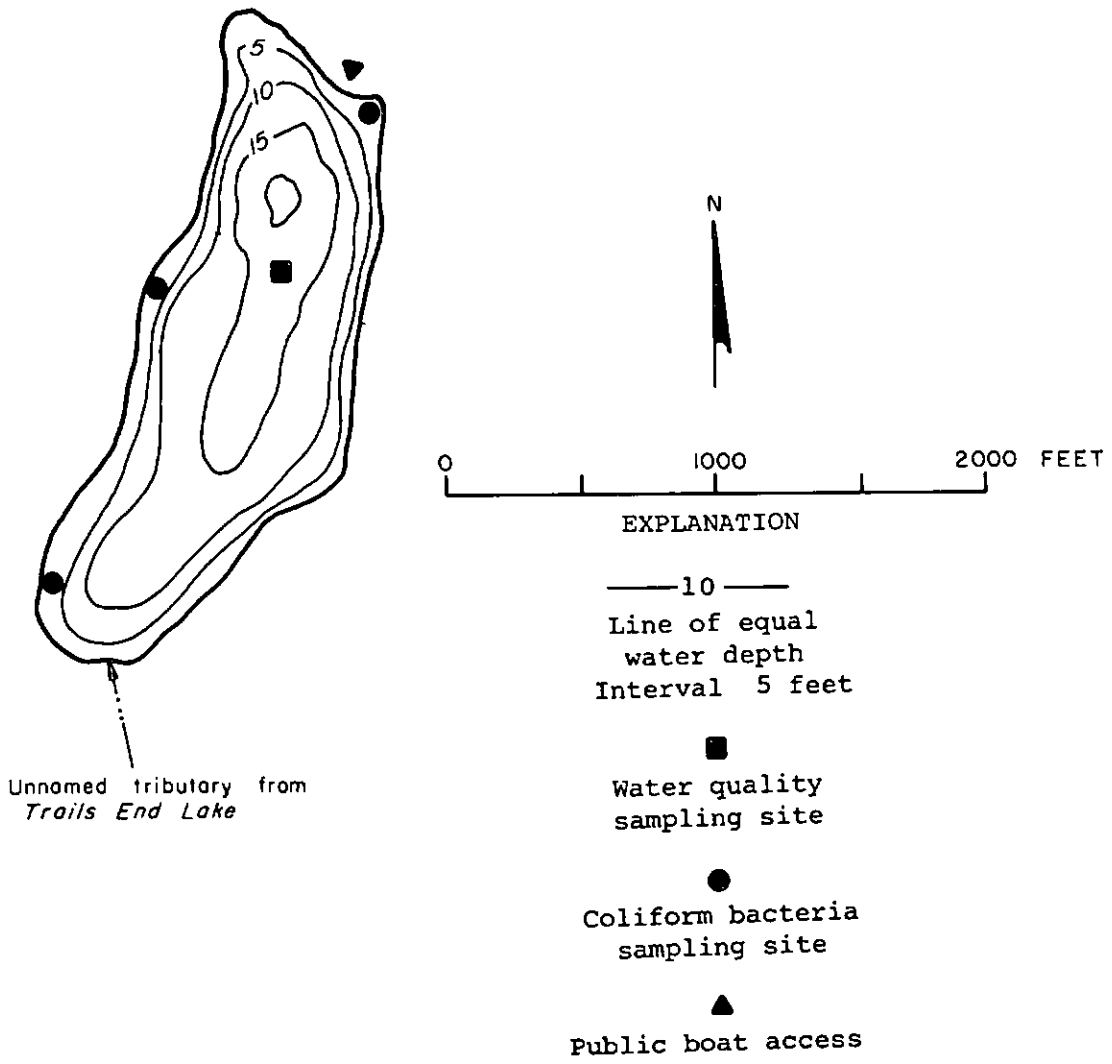
Summary and conclusions.
Munn Lake probably can be considered moderate to high in biological prodictivity. A bloom of blue-green algae was observed during visits to the lake in June and September. The chlorophyll a concentration ranged from 5.6 to 30 µg/l throughout the summer and was among the highest for the lakes studied. The littoral zone, composed primarily of muck, supported a heavy growth of emersed and submersed aquatic macrophytes. The DO was depleted to zero only near the lake bottom.

Water-quality data for Munn Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	February 22		April 24		June 19		September 17	
Water depth (ft)	3	16	3	13	3	10	3	10
Silica (SiO_2)	0.5	0.4	0.2	0.3	0.3	0.4	0.6	0.5
Dissolved iron (Fe), in µg/l	90	230	90	100	110	160	170	170
Dissolved manganese (Mn) (in µg/l)	0	10	10	10	0	10	10	30
Calcium (Ca)	2.1	--	--	--	--	--	1.9	--
Magnesium (Mg)	.9	--	--	--	--	--	.8	--
Sodium (Na)	1.7	--	--	--	--	--	1.8	--
Potassium (K)	.7	--	--	--	--	--	1.6	--
Bicarbonate (HCO_3)	16	9	11	12	17	15	15	14
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	1.8	--	--	--	--	--	2.4	--
Chloride (Cl)	3.1	--	--	--	--	--	1.6	--
Nitrate nitrogen (as N)	.30	.31	.01	.03	.01	.01	.01	.01
Nitrite nitrogen (as N)	.01	.00	.00	.00	.00	.00	.01	.01
Ammonia nitrogen (as N)	.26	.28	.25	.34	.25	.22	.35	.26
Organic nitrogen (as N)	.36	.40	.47	.32	.01	.04	1.4	1.1
Total phosphorus (as P)	.025	.029	.031	.035	.049	.045	.081	.054
Orthophosphate (as P)	.004	.004	.005	.005	.002	.004	.004	.002
Suspended solids (110°C)	6	--	--	--	--	--	1	--
Hardness as $CaCO_3$ (Ca,Mg)	9	--	--	--	--	--	8	--
Specific conductance (micromhos at 25°C)	25	26	26	28	--	--	28	27
pH (pH units)	7.2	7.1	6.5	6.4	6.8	6.8	5.9	5.6
Water temperature (°C)	6.0	5.8	13.1	12.1	18.4	17.1	17.9	17.9
Color (Pt-Co scale)	30	25	20	20	30	55	--	--
Secchi-disc (ft)	8.5		5.6		6.9		2.0	
Dissolved oxygen (DO)	11.6	11.4	9.8	3.7	9.9	7.2	11.8	6.0
Chlorophyll a in photic zone (µg/l)	9.8	--	6.1	--	5.6	--	30	--
Fecal coliform (col. per 100 ml) Range	<1-2		<1-6		<1-<1		<1-<1	
Fecal coliform (col. per 100 ml) Mean	1		2		<1		<1	
Total organic carbon (as C)	9.0	--	9.0	--	12	--	11	--





Munn Lake, Thurston County. From Washington Department of Game, May 31, 1950.

Munn Lake, Thurston County. July 31, 1973. Approx. scale 1:4800.

North Lake near Federal Way (12102750)

Location.
Southernmost shoreline point, at lat 47°18'00", long 122°17'30", in NE¼NE¼ sec.21, T.21 N., R.4 E., King County, 1.8 miles southeast of Federal Way; Hylebos Creek basin. Poverty Bay quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.76 sq mi	Mean depth	14 ft	Shoreline configuration	1.6
Altitude	392 ft	Maximum depth	34 ft	Development of volume	0.40
Surface area	56 acres	Length of shoreline	9,000 ft	Bottom slope	1.9 percent
Lake volume	770 acre-ft				

Basin geology.
Glacial drift with local peat and muck deposits (Luzier, 1969).

Soils.
Gravelly sandy loam with some local muck deposits on north side of lake (Poulson and others, 1952).

Land use (percentage of drainage basin). Urban 2, suburban 10, agricultural 3, forest or unproductive 73, and lake surface 12.

Nearshore residential development. 57 percent.

Number of nearshore homes. 58.

Surface-water inflow and outflow.
An unnamed tributary contributed minor inflow early in the year. The outflow on March 5 was estimated to be 0.3 ft^3/s; May 11, 0.1 ft^3/s, and July 5, less than 0.1 ft^3/s. The outlet was dry on September 13, 1973.

Lake stage.
Lake stage varied 1.4 feet between March 5 and September 13, 1973.

Macrophytes.
Shoreline covered by emersed plants, 51 to 75 percent.
Lake surface covered by emersed plants, 16 percent.
Lake bottom covered by submersed plants, 40 percent.
Rooted aquatic plants observed were white lily (Nymphaea sp.),* pondweed (Potamogeton sp.),* Yellow lily (Nuphar sp.), sedge (Cyperaceae), watershield (Brasenia sp.) and stonewort (Nitella sp.).

Asterisk (*) indicates dominant aquatic plants.

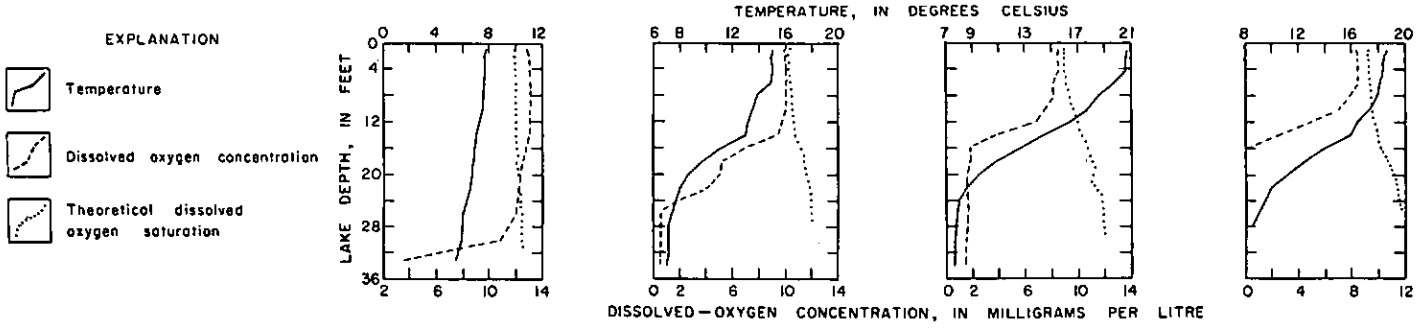
Algae observed.
May 11 - Predominantly blue-green algae (Nostoc sp.).

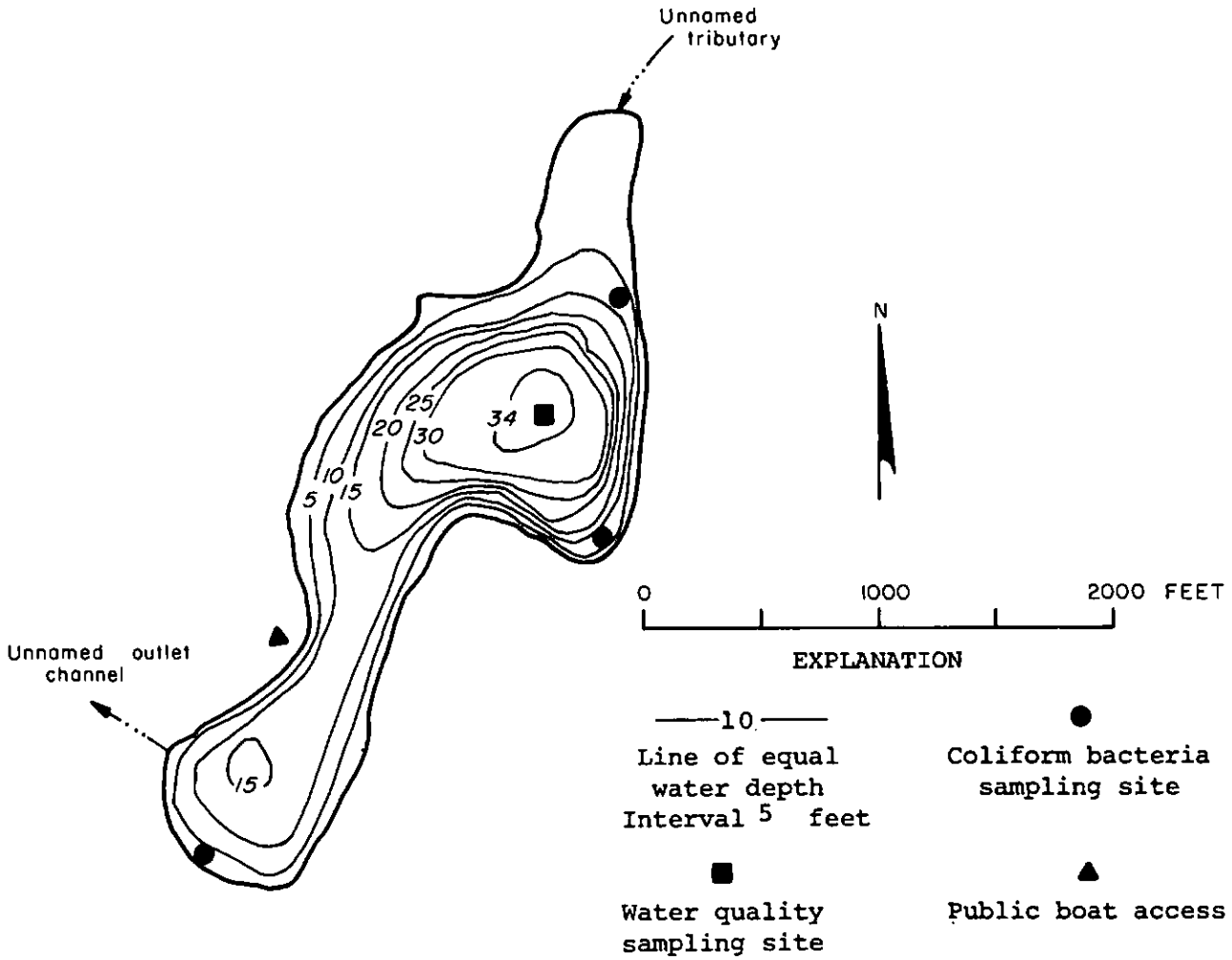
Summary and conclusions.
North Lake appears to have a moderate to high biological productivity. An intense bloom of blue-green algae was observed during a visit to the lake in May. Strong thermal stratification was established early in the spring. By May the DO in the hypolimnion was depleted to zero and by September all water below a depth of 16 feet was without oxygen. Fecal-coliform-bacteria counts were among the highest of the lakes studied. The May and September sampling periods had the highest counts, with mean values of 33 and 36 colonies per 100 ml, respectively. The littoral zone is composed primarily of muck and supported a heavy growth of submersed plants. About 16 percent of the lake surface was covered with white lilies and pondweed. The minimal amount of lake flushing increases the potential for eutrophication.

Water-quality data for North Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 5		May 11		July 5		September 13	
Water depth (ft)	3	31	3	33	3	33	3	28
Silica (SiO_2)	2.2	2.7	0.2	2.1	0.3	2.9	0.7	2.8
Dissolved iron (Fe), in µg/l	60	150	50	680	80	1,400	80	1,900
Dissolved manganese (Mn) (in µg/l)	20	30	0	110	10	160	10	210
Calcium (Ca)	4.9	--	--	--	--	--	4.7	--
Magnesium (Mg)	1.4	--	--	--	--	--	1.5	--
Sodium (Na)	3.6	--	--	--	--	--	3.8	--
Potassium (K)	1.0	--	--	--	--	--	.8	--
Bicarbonate (HCO_3)	18	18	14	19	20	30	22	30
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	.2	--	>5	--	3
Sulfate (SO_4)	8.9	--	--	--	--	--	8.3	--
Chloride (Cl)	4.2	--	--	--	--	--	4.1	--
Nitrate nitrogen (as N)	.25	.27	.02	.05	.01	.00	.01	.00
Nitrite nitrogen (as N)	.01	.01	.00	.01	.00	.01	.00	.01
Ammonia nitrogen (as N)	.18	.30	.21	.82	.08	1.7	.10	1.8
Organic nitrogen (as N)	.56	.44	.27	.38	.07	.10	1.0	.2
Total phosphorus (as P)	.028	.023	.014	.039	.012	.092	.012	.050
Orthophosphate (as P)	.001	.001	.001	.009	.004	.049	.002	.010
Suspended solids (110°C)	1	--	--	--	--	--	0	--
Hardness as $CaCO_3$ (Ca,Mg)	18	--	--	--	--	--	18	--
Specific conductance (micromhos at 25°C)	54	54	55	62	55	66	59	80
pH (pH units)	7.2	7.1	6.6	6.6	6.6	6.0	7.9	8.1
Water temperature (°C)	7.7	5.9	15.0	7.2	20.7	7.7	18.4	8.5
Color (Pt-Co scale)	45	45	35	50	25	55	25	55
Secchi-disc (ft)	4.6		7.9		9.5		9.5	
Dissolved oxygen (DO)	13.0	8.4	10.0	.5	8.4	1.5	8.5	.2
Chlorophyll a in photic zone (µg/l)	18	--	3.3	--	2.7	--	3.1	--
Fecal coliform (col. per 100 ml) Range	5-8		22-52		6-28		14-53	
Fecal coliform (col. per 100 ml) Mean	7		33		15		36	
Total organic carbon (as C)	9.5	--	8.5	--	8.5	--	9.0	--





North Lake, King County. From Washington Department of Game, March 7, 1950.

North Lake, King County. May 17, 1973. Approx. scale 1:4800.

Sawyer Lake near Black Diamond (12111000)

Location.
Lat. 47°20'03", long 122°02'24", in NE¼SE¼ sec.4, T.21 N., R.6 E., King County, 2.5 miles northwest of Black Diamond; Duwamish River basin. Black Diamond quadrangle,, 1:24,000.

Physical characteristics of lake.

Drainage area	13.0 sq mi	Mean depth	25 ft	Shoreline configuration	2.8
Altitude	495 ft	Maximum depth	58 ft	Development of volume	0.43
Surface area	310 acres	Length of shoreline	36,000 ft	Bottom slope	1.4 percent
Lake volume	7,700 acre-ft				

Basin geology.
Glacial drift deposited primarily as recessional outwash (Luzier, 1969).

Soils.
Gravelly fine sandy loam with peat and muck on southeast side of lake (Poulson and others, 1952).

Land use (percentage of drainage basin). Urban 2, suburban 2, agricultural 5, forest or unproductive 87, and lake surface 4.
Nearshore residential development. 83 percent.
Number of nearshore homes. 291.

Surface-water inflow and outflow.
Sawyer Lake has two main perennial inflows, Beaver Creek and Rock Creek. An estimate of inflow from Beaver Creek on Mar. 5 was 10 ft^3/s; May 11, 8 ft^3/s; July 5, 6 ft^3/s; and Sept. 13, 4 ft^3/s. For the same dates the estimates of inflow from Rock Creek were 12 ft^3/s, 10 ft^3/s, 10 ft^3/s, and 1 ft^3/s, respectively. The outflow is controlled at low lake stages by a concrete dam at the outlet.

Lake stage.
Lake stage varied 2.5 feet between March 6 and September 13, 1973.

Macrophytes.
Shoreline covered by emersed plants, 11 to 25 percent.
Lake surface covered by emersed plants, 1 percent.
Lake bottom covered by submersed plants, 33 percent.
Rooted aquatic plants observed were water milfoil (*Myriophyllum* sp.),* cattail (*Typha* sp.), white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), sedge (Cyperaceae), watershield (*Brasenia* sp.), waterweed (*Elodea* sp.), pondweed (*Potamogeton* sp.), and muskgrass (*Chara* sp.).

Algae observed.
June 25 - Predominantly diatoms (*Asterionella* sp.,* and *Fragillaria* sp.).

Asterisk (*) indicates dominant aquatic plants.

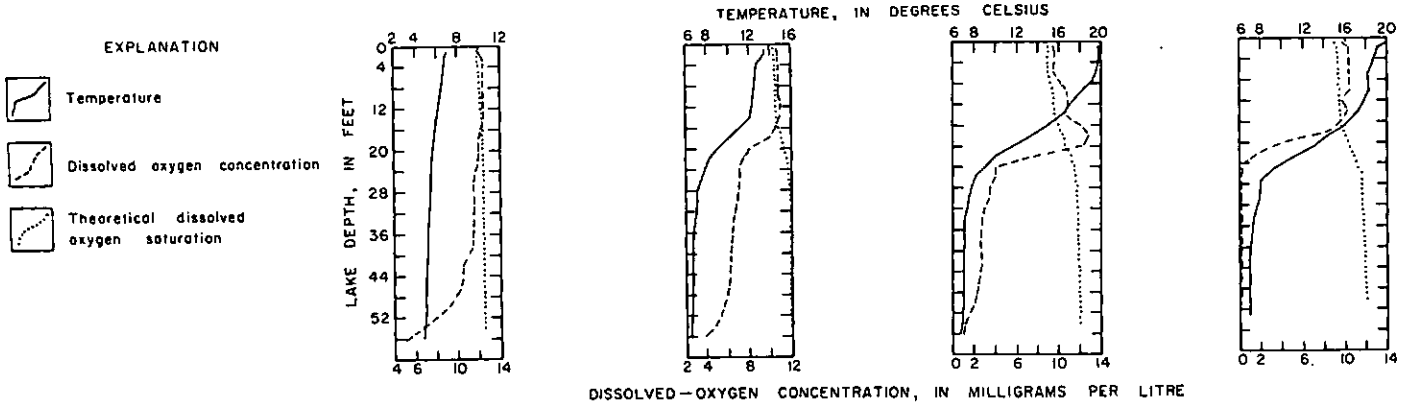
Summary and conclusions.
Sawyer Lake is a large lake that appears low to moderate in biological productivity. The nitrate nitrogen concentration in late winter (0.65 mg/l), when the lake water was mixed, was the highest of the lakes studied. By fall, the nitrate nitrogen concentration in the epilimnion had decreased to 0.01 mg/l. The total phosphorus concentration was not especially high. Strong thermal stratification developed early in the year and by fall the DO below a depth of 24 feet was depleted to zero. A mild bloom of diatoms was observed during a visit to the lake in September.

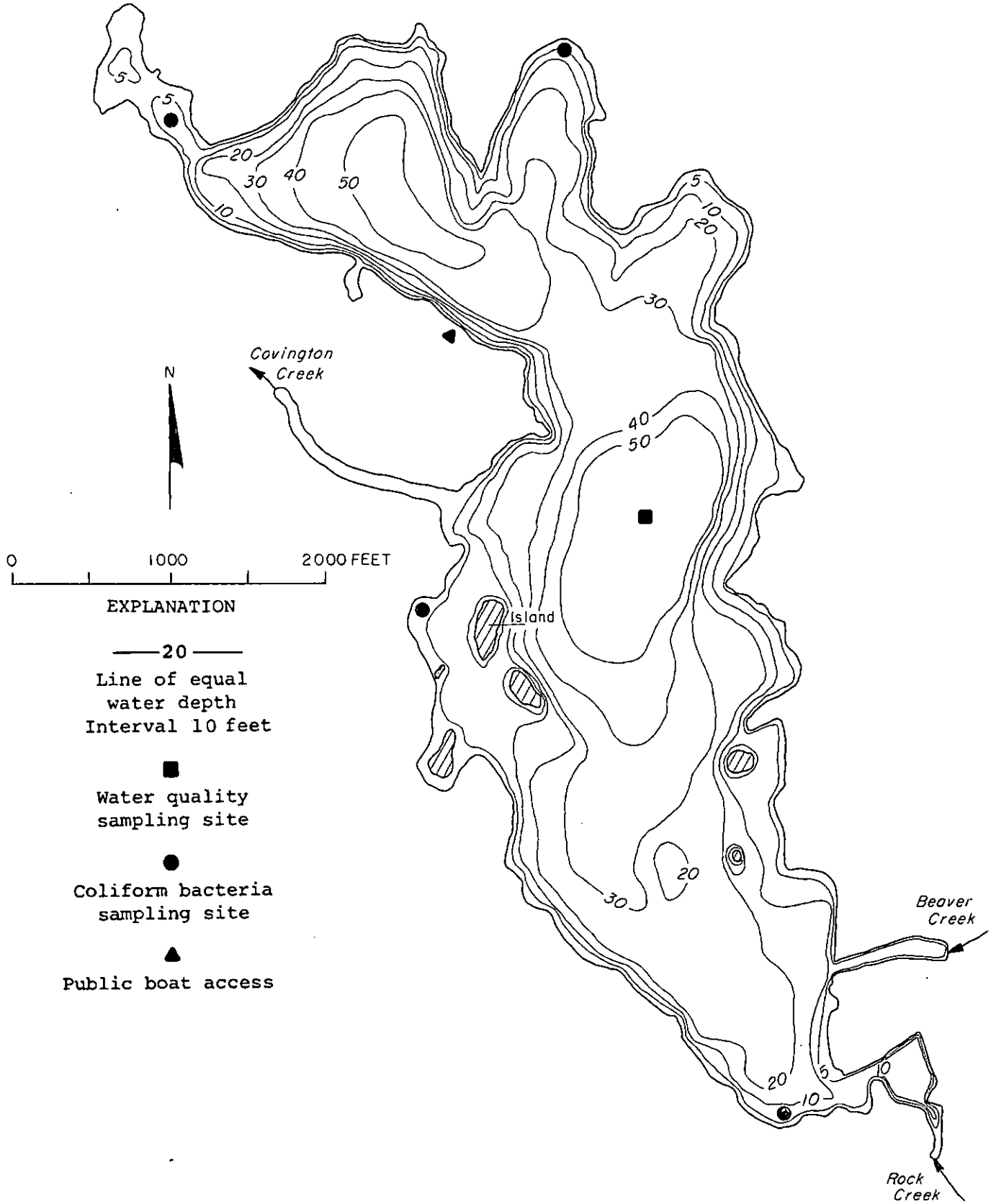
Fecal-coliform bacteria sampled from the various sites were highest in June, ranging from 10 to 142 and with a mean of 71 colonies per 100 ml. Most of the lakeshore is residentially developed; however, the cultural impact is probably lessened by the dilution capacity of the large lake volume.

Water-quality data for Sawyer Lake.

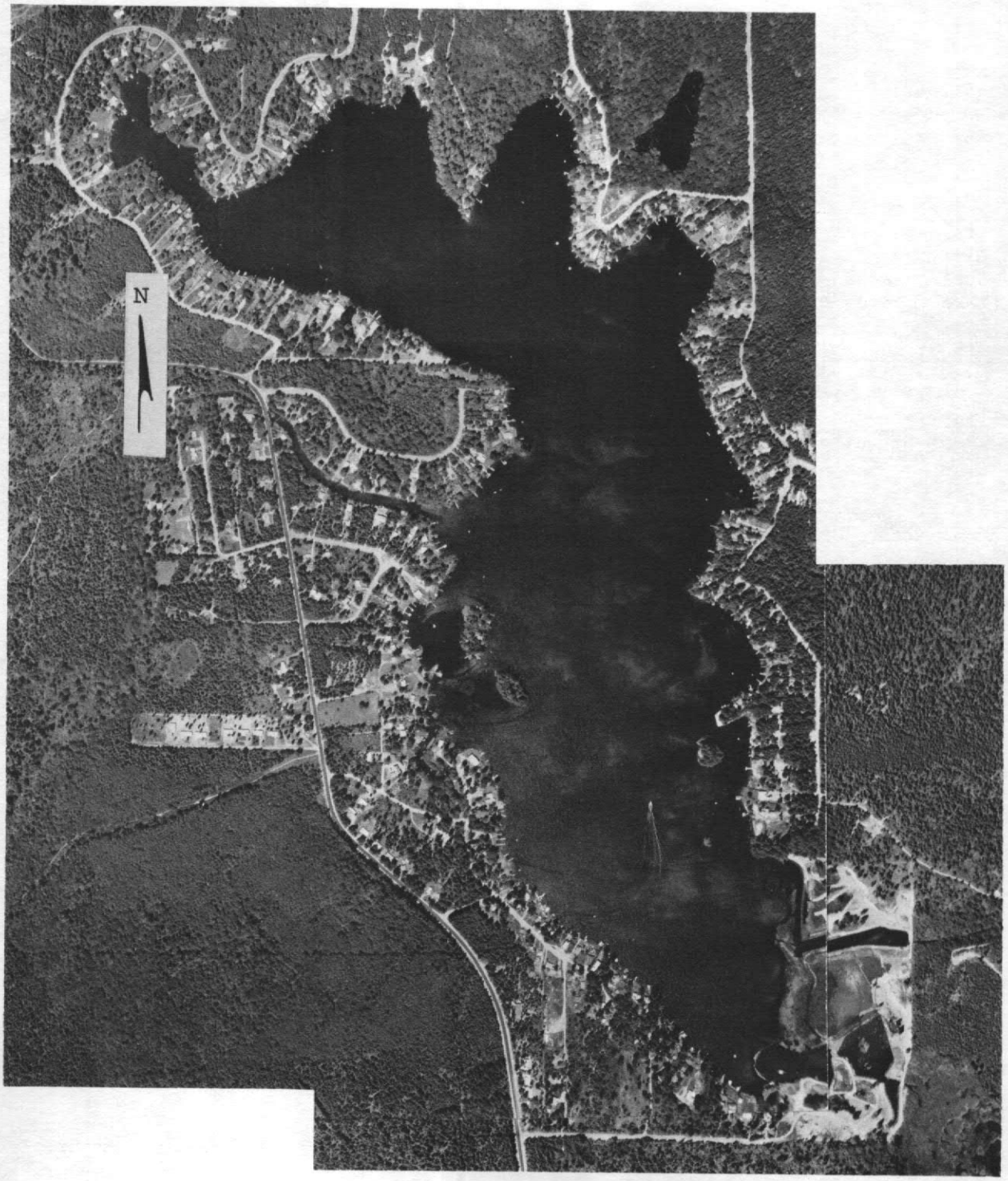
[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	March 6		May 10		June 25		September 13	
Water depth (ft)	3	54	3	54	3	54	3	49
Silica (SiO_2)	8.6	10	6.7	11	5.3	12	6.9	12
Dissolved iron (Fe), in µg/l	60	140	30	150	20	370	40	900
Dissolved manganese (Mn) (in µg/l)	10	60	0	110	10	250	0	510
Calcium (Ca)	12	--	--	--	--	--	9.4	--
Magnesium (Mg)	5.0	--	--	--	--	--	5.3	--
Sodium (Na)	8.6	--	--	--	--	--	11	--
Potassium (K)	.7	--	--	--	--	--	.6	--
Bicarbonate (HCO_3)	61	80	64	62	71	72	73	75
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	17	--	--	--	--	--	15	--
Chloride (Cl)	2.5	--	--	--	--	--	2.2	--
Nitrate nitrogen (as N)	.65	.60	.41	.58	.11	.46	.01	.07
Nitrite nitrogen (as N)	.01	.01	.00	.00	.00	.00	.00	.01
Ammonia nitrogen (as N)	.05	.12	.05	.08	.07	.06	.06	.34
Organic nitrogen (as N)	.25	.19	.22	.20	.06	.01	.25	.03
Total phosphorus (as P)	.011	.012	.007	.17	.022	.023	.008	.049
Orthophosphate (as P)	.000	.000	.001	.002	.002	.005	.002	.029
Suspended solids (110°C)	1	--	--	--	--	--	1	--
Hardness as $CaCO_3$ (Ca,Mg)	51	--	--	--	--	--	45	--
Specific conductance (micromhos at 25°C)	125	150	138	131	139	134	143	130
pH (pH units)	7.5	7.3	6.5	6.6	7.8	6.7	7.4	7.3
Water temperature (°C)	6.8	4.8	13.0	6.5	19.8	6.9	18.9	7.0
Color (Pt-Co scale)	10	15	30	35	10	15	5	35
Secchi-disc (ft)	14		15		14		13	
Dissolved oxygen (DO)	12.4	6.8	10.8	4.8	9.6	1.2	10.3	.2
Chlorophyll a in photic zone (µg/l)	2.2	--	1.3	--	2.1	--	2.5	--
Fecal coliform (col. per 100 ml) Range	<1-<1		<1-1		10-142		<1-3	
Fecal coliform (col. per 100 ml) Mean	<1		<1		71		1	
Total organic carbon (as C)	3.5	--	3.0	--	6.0	--	4.5	--





Sawyer Lake, King County. From U.S. Geological Survey, June 6, 1973.



Sawyer Lake, King County. June 1, 1970. Approx. scale 1:12,000.

Scott Lake near Maytown (12029050)

Location.
Lat 46° 55'12", long 122°56'07", in NE¼NE¼ sec.33 T.17 N., R.2 W., Thurston County, 1.7 miles north of Maytown; Chehalis River basin. Maytown quadrangle 1:24,000.

Physical characteristics of lake.

Drainage area	2.52 sq mi	Mean depth	11 ft	Shoreline configuration	1.1
Altitude	189 ft	Maximum depth	18 ft	Development of volume	0.69
Surface area	69 acres	Length of shoreline	6,700 ft	Bottom slope	0.92 percent
Lake volume	760 acre-ft				

Basin geology.
Glacial drift deposited primarily as recessional outwash and alluvial deposits of peat and muck (Noble and Wallace, 1966).

Soils.
Mostly gravelly sandy loam and peat (Ness, 1958).

Land use (percentage of drainage basin). Urban 0, suburban 1, agricultural 26, forest or unproductive 65, and lake surface 8.

Nearshore residential development. 72 percent.

Number of nearshore homes. 26.

Surface-water inflow and outflow.
Scott Lake is fed by a perennial stream that originates from springs and from the outflow of Deep Lake. An estimate of inflow on February 21 was 7.7 ft^3/s; April 25, 6.4 ft^3/s; June 29, 4.8 ft^3/s; and September 17, 1.4 ft^3/s. The measured lake outflow on the same dates were 10.0 ft^3/s, 8.35 ft^3/s, 6.92 ft^3/s and 1.82 ft^3/s, respectively.

Lake stage.
Lake stage varied 0.5 foot between February 28 and September 5, 1973.

Macrophytes.
Shoreline covered by emersed plants, 26 to 50 percent.
Lake surface covered by emersed plants, 5 percent.
Lake bottom covered by submersed plants, 36 percent.
Rooted aquatic plants observed were yellow lily (Nuphar sp.),* waterweed (Elodea sp.),* cattail (Typha sp.), sedge (Cyperaceae), and pondweed (Potamogeton sp.).

Asterisk (*) indicates dominant aquatic plants.

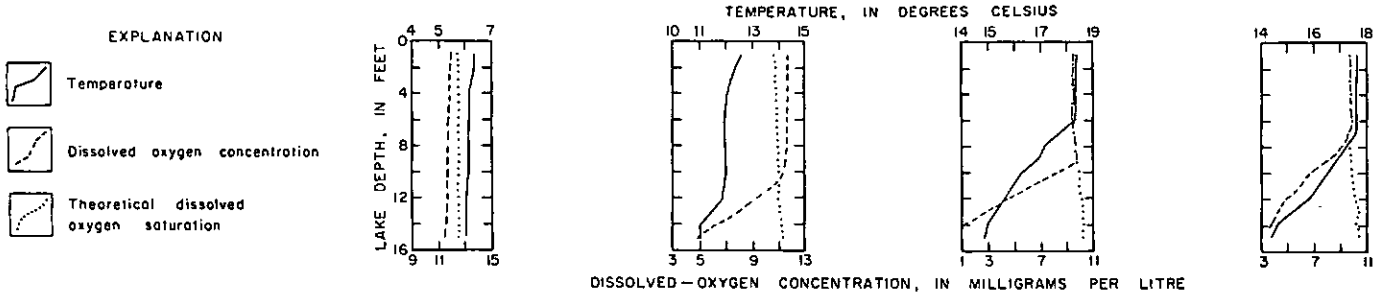
Algae observed.
April 25 - A mixed population of green algae and diatoms.
June 29 - A mixed population of blue-green algae (Nostoc sp.) and diatoms (Asterionella sp.).

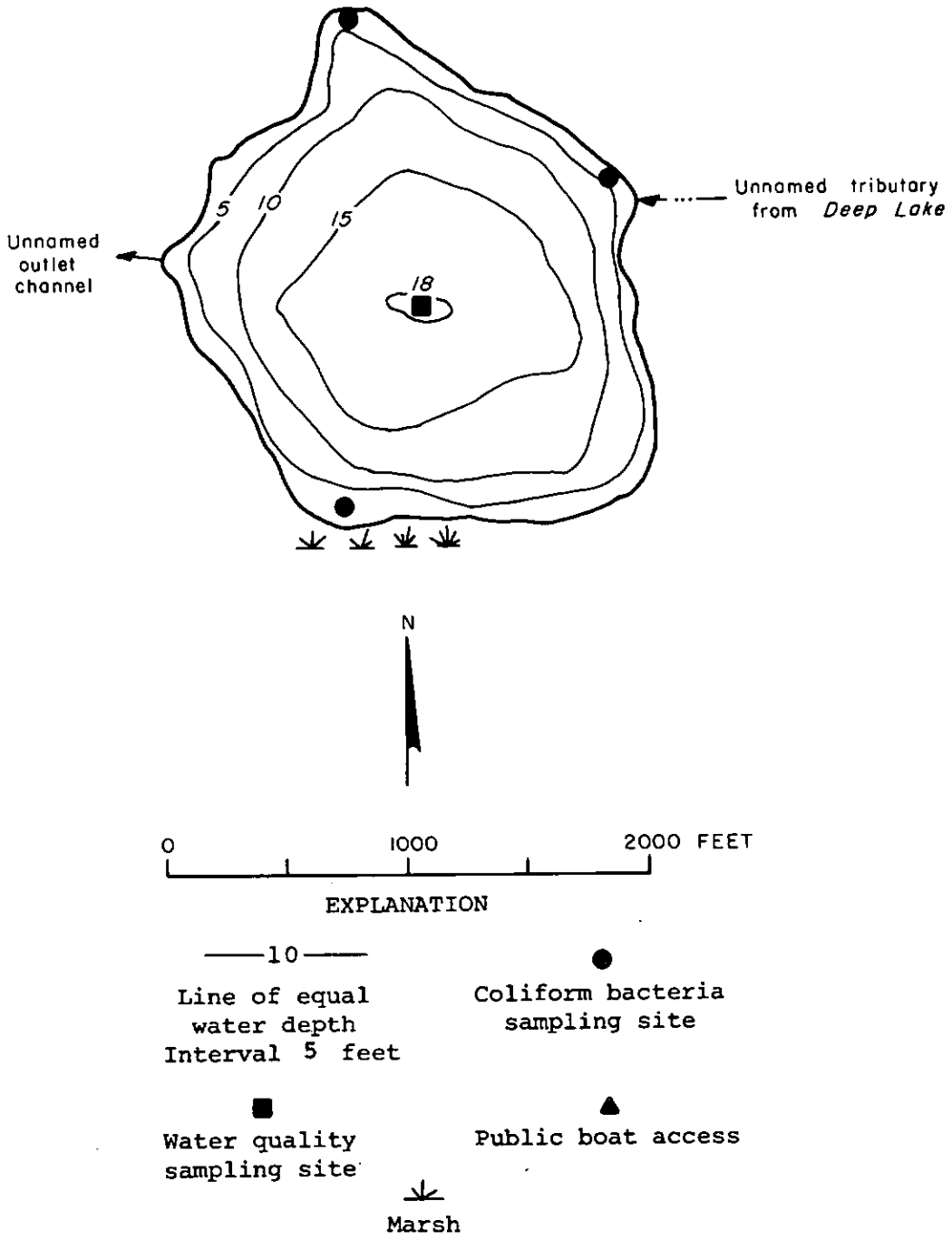
Summary and conclusions.
Scott Lake appears to be moderate in biological productivity. Total phosphorus, nitrate nitrogen, and chlorophyll a concentrations were high when the lake was vertically mixed in late winter. A bloom of predominantly blue-green algae and diatoms was observed during visits to the lake in the spring and early summer. The DO content in the epilimnion remained near saturation throughout the summer and was only partially depleted near the lake bottom. The mucky littoral bottom supported a heavy growth of submersed macrophytes, primarily waterweed. About one-third of the lake is bordered by a golf course and private park. Surface runoff from the golf course and the existing nearshore homes increases the potential for cultural eutrophication. Conversely, the flushing action of the year-round inflow and outflow probably lessen the impact of cultural eutrophication.

Water-quality data for Scott Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	February 21		April 25		June 29		September 17	
Water depth (ft)	3	13	3	11	3	11	3	11
Silica (SiO_2)	19	19	15	16	16	18	12	15
Dissolved iron (Fe), in µg/l	250	250	180	240	100	190	130	540
Dissolved manganese (Mn) (in µg/l)	10	10	20	20	0	10	10	40
Calcium (Ca)	8.5	--	--	--	--	--	11	--
Magnesium (Mg)	2.6	--	--	--	--	--	3.0	--
Sodium (Na)	4.7	--	--	--	--	--	5.6	--
Potassium (K)	.8	--	--	--	--	--	1.6	--
Bicarbonate (HCO_3)	32	30	33	32	38	40	44	46
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	14	--	--	--	--	--	14	--
Chloride (Cl)	4.8	--	--	--	--	--	3.8	--
Nitrate nitrogen (as N)	.22	.22	.01	.04	.02	.02	.01	.04
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.01	.01
Ammonia nitrogen (as N)	.17	.21	.18	.22	.21	.15	.70	.11
Organic nitrogen (as N)	.31	.16	.22	.20	.16	.10	.31	.37
Total phosphorus (as P)	.021	.021	.021	.019	.031	.042	.025	.047
Orthophosphate (as P)	.002	.004	.003	.003	.005	.005	.002	.004
Suspended solids (110°C)	0	--	--	--	--	--	0	--
Hardness as $CaCO_3$ (Ca,Mg)	32	--	--	--	--	--	40	--
Specific conductance (micromhos at 25°C)	81	81	90	92	94	96	104	108
pH (pH units)	7.2	7.1	6.8	6.8	7.0	6.6	5.5	5.5
Water temperature (°C)	6.2	6.0	12.2	11.8	18.3	15.8	17.6	15.8
Color (Pt-Co scale)	30	30	55	45	5	10	10	10
Secchi-disc (ft)	4.9		4.9		6.6		8.9	
Dissolved oxygen (DO)	11.8	11.6	11.8	9.1	9.5	4.6	9.8	4.9
Chlorophyll a in photic zone (µg/l)	19	--	5.8	--	3.9	--	3.7	--
Fecal coliform (col. per 100 ml) Range	<1-2		<1-7		10-58		1-18	
Fecal coliform (col. per 100 ml) Mean	1		3		29		9	
Total organic carbon (as C)	7.0	--	5.5	--	4.5	--	3.5	--





Scott Lake, Thurston County. From Washington Department of Game, May 27, 1950.

Scott Lake, Thurston County. July 31, 1973. Approx. scale 1:4800.

Shoecraft Lake near Tulalip (12158000)

Location.
Lat 48°07'34", long 122°18'20", in SE¼SW¼ sec.33, T.31 N., R.4 E., Snohomish County, 4.2 miles north of Tulalip; Tulalip Creek basin. Stanwood and Tulalip quadrangles, 1:24,000.

Physical characteristics of lake.

Drainage area	6.02 sq mi	Mean depth	18 ft	Shoreline configuration	1.5
Altitude	324 ft	Maximum depth	35 ft	Development of volume	0.51
Surface area	130 acres	Length of shoreline	13,000 ft	Bottom slope	1.3 percent
Lake volume	240 acre-ft				

Basin geology.
Glacial drift deposited principally as ground moraine (Newcomb, 1952).

Soils.
Gravelly sandy loam with local peat deposits (Anderson and others, 1947).

Land use (percentage of drainage basin). Urban 0, suburban 7, agricultural 3, forest or unproductive 72, and lake surface 18.
Nearshore residential development. 100 percent.
Number of nearshore homes. 100.

Surface-water inflow and outflow.
Shoecraft Lake receives surface-water inflow from Goodwin Lake. The outflow from Shoecraft Lake is regulated by a concrete weir and flashboards.

Lake stage.
Lake stage varied 1.1 feet between March 14 and September 24, 1973. Daily lake-stage data can be obtained from a report by the U.S. Geological Survey (1973).

Macrophytes.
Shoreline covered by emersed plants, 1 to 10 percent.
Lake surface covered by emersed plants, 0.1 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were muskgrass (*Chara* sp.),* white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), sedge (Cyperaceae), smartweed (*Polygonum* sp.), and waterweed (*Elodea* sp.).

Asterisk (*) indicates dominant aquatic plant.

Algae observed.
May 29 - Predominantly blue-green algae (*Nostoc* sp.) and some green algae (*Pediastrum* sp.).

Summary and conclusions.
Shoecraft Lake has a relatively small volume and the entire shoreline is occupied by residences. In addition, Goodwin Lake drains into the lake. These factors suggest a high potential for cultural eutrophication. The lake appears to be moderate in biological productivity. The chlorophyll a and nutrient concentrations were moderate. The littoral zone is composed of mostly sand, gravel, and cobbles and supported only a light growth of aquatic macrophytes.

Water-quality data for Shoecraft Lake.

[Milligrams per litre unless otherwise indicated]

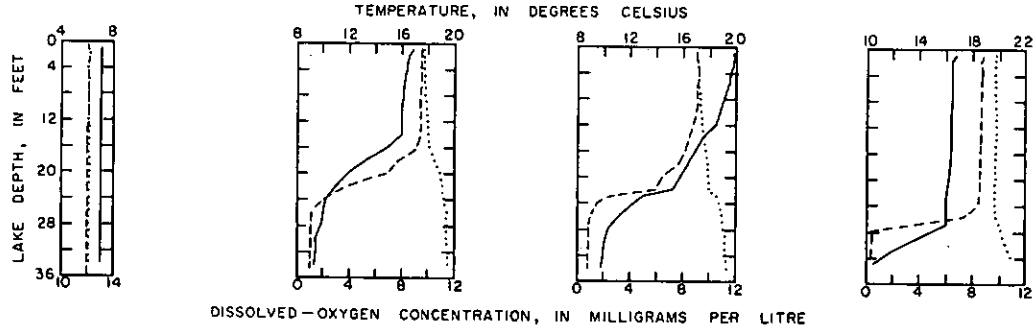
Date of collection (1973)	March 14		May 29		June 27		September 24	
Water depth (ft)	3	31	3	33	3	31	3	30
Silica (SiO_2)	0.6	0.5	0.4	1.3	0.7	1.5	1.6	2.1
Dissolved iron (Fe), in µg/l	30	9	20	720	20	930	110	900
Dissolved manganese (Mn) (in µg/l)	20	20	0	280	0	370	40	570
Calcium (Ca)	5.1	--	--	--	--	--	5.0	--
Magnesium (Mg)	3.1	--	--	--	--	--	3.4	--
Sodium (Na)	3.9	--	--	--	--	--	3.8	--
Potassium (K)	1.0	--	--	--	--	--	1.0	--
Bicarbonate (HCO_3)	26	26	27	32	33	42	30	34
Carbonate (CO_3)	--	--	--	--	--	--	--	--
Sulfide (S)	--	--	--	0	--	0	--	0
Sulfate (SO_4)	5.5	--	--	--	--	--	5.2	--
Chloride (Cl)	4.8	--	--	--	--	--	5.4	--
Nitrate nitrogen (as N)	.02	.01	.01	.01	.00	.01	.02	.02
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.11	.11	.04	.10	.09	.21	.08	.62
Organic nitrogen (as N)	.33	.33	.32	.35	.06	.18	.36	.34
Total phosphorus (as P)	.11	.21	.018	.034	.014	.057	.041	.038
Orthophosphate (as P)	.002	.002	.003	.002	.004	.002	.008	.004
Suspended solids (110 °C)	5	--	--	--	--	--	1	--
Hardness as $CaCO_3$ (Ca,Mg)	26	--	--	--	--	--	26	--
Specific conductance (micromhos at 25 °C)	67	67	70	75	69	78	72	86
pH (pH units)	7.3	7.3	6.8	7.2	6.9	6.1	7.3	--
Water temperature (°C)	7.0	7.0	16.4	9.4	19.7	10.0	16.5	13.9
Color (Pt-Co scale)	20	20	5	5	15	30	0	25
Secchi-disc (ft)	4.9		9.8		12		13	
Dissolved oxygen (DO)	12.1	12.0	9.5	1.0	9.2	.8	8.7	.4
Chlorophyll a in photic zone (µg/l)	12	--	1.7	--	3.8	--	2.0	--
Fecal coliform (col. per 100 ml) Range	2-11		<1-1		5-8		1-7	
Fecal coliform (col. per 100 ml) Mean	7		1		6		3	
Total organic carbon (as C)	6.5	--	6.5	--	8.0	--	6.0	--

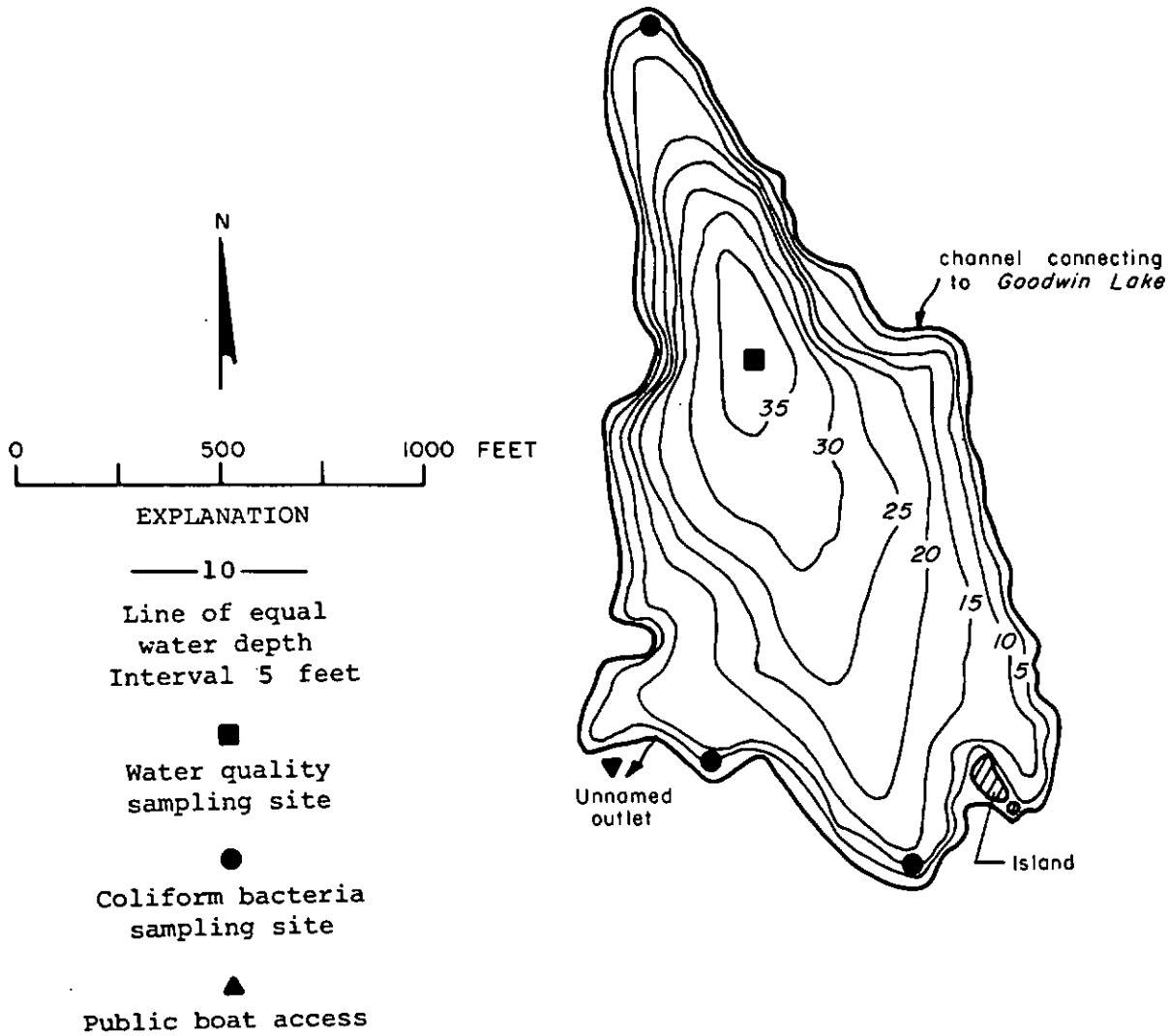
EXPLANATION

Temperature

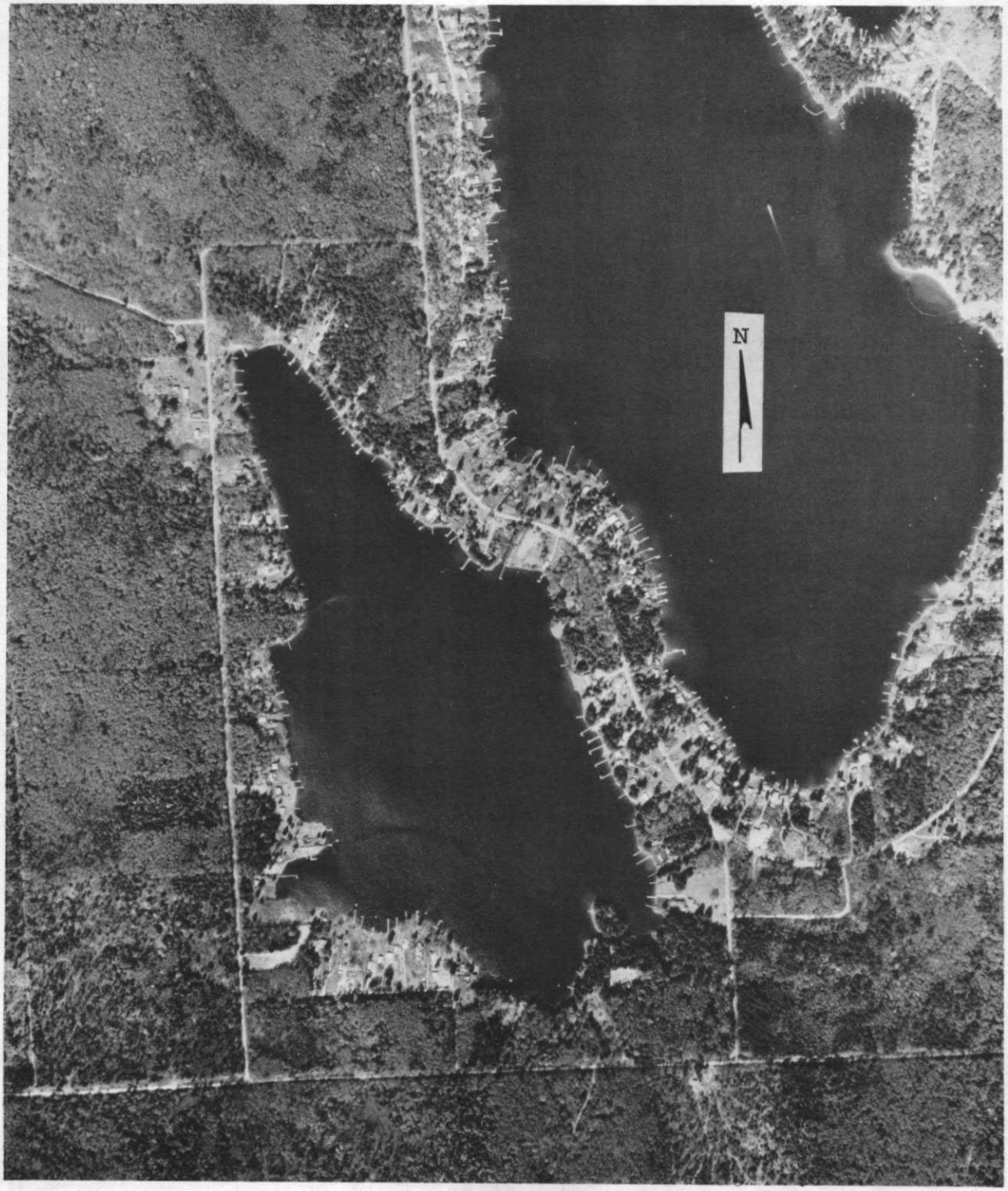
Dissolved oxygen concentration

Theoretical dissolved oxygen saturation





Shoecraft Lake, Snohomish County. From Washington Department of Game, May 22, 1952.



Shoecraft Lake, Snohomish County. April 16, 1970. Approx. scale 1:12,000.

Spanaway Lake near Spanaway (12090450)

Location.
Lat 47°07'11",long 122° 26'45", in SE¼NE¼ sec.20, T.19 N., R.3 E., Pierce County, 1.2 miles northwest of Spanaway; Chambers Creek basin. Spawnaway quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	17.0 sq mi	Mean depth	16 ft	Shoreline configuration	1.9
Altitude	318 ft	Maximum depth	28 ft	Development of volume	0.57
Surface area	280 acres	Length of shoreline	23,000 ft	Bottom slope	0.71 percent
Lake volume	4,600 acre-ft				

Basin geology.
Glacial drift with some local peat and muck deposits (Walters and Kimmel, 1968).

Soils.
Mostly gravelly sandy loam and peat deposits on west-central side of the lake (Anderson and others, 1955).

Land use (percentage of drainage basin). Urban 5, suburban 38, agricultural 0, forest or unproductive 54, and lake surface 3.

Nearshore residential development. 80 percent.

Number of nearshore homes. 220.

Surface-water inflow and outflow.
Spanaway Lake has a perennial inflow and outflow located at the north and south end of the lake, respectively. An estimate of inflow on Feb. 16 was 6.4 ft^3/s; Apr. 23, 3.5 ft^3/s; June 18, 6.5 ft^3/s; and Aug. 28, 1.8 ft^3/s. The measured lake outflows on the same dates were 18.6 ft^3/s, 14.6 ft^3/s, 9.7 ft^3/s, and 3.9 ft^3/s, respectively.

Lake stage.
Lake stage varied 0.6 foot between February 16 and August 28, 1973.

Macrophytes.
Shoreline covered by emersed plants, 26 to 50 percent.
Lake surface covered by emersed plants, 1 percent.
Lake bottom covered by submersed plants, 11 percent.
Rooted aquatic plants observed were cattail (Typha sp.), white lily (Nymphaea sp.), yellow lily (Nuphar sp.), sedge (Cyperaceae), watershield (Brasenia sp.), coontail (Ceratophyllum sp.), waterweed (Elodea sp.), and pondweed (Potamogeton sp.).

Algae observed.
April 23 - A mixed population of green algae and diatoms.
June 18 - Predominantly diatoms (Fragillaria sp.) and some blue-green algae (Anabaena sp.).

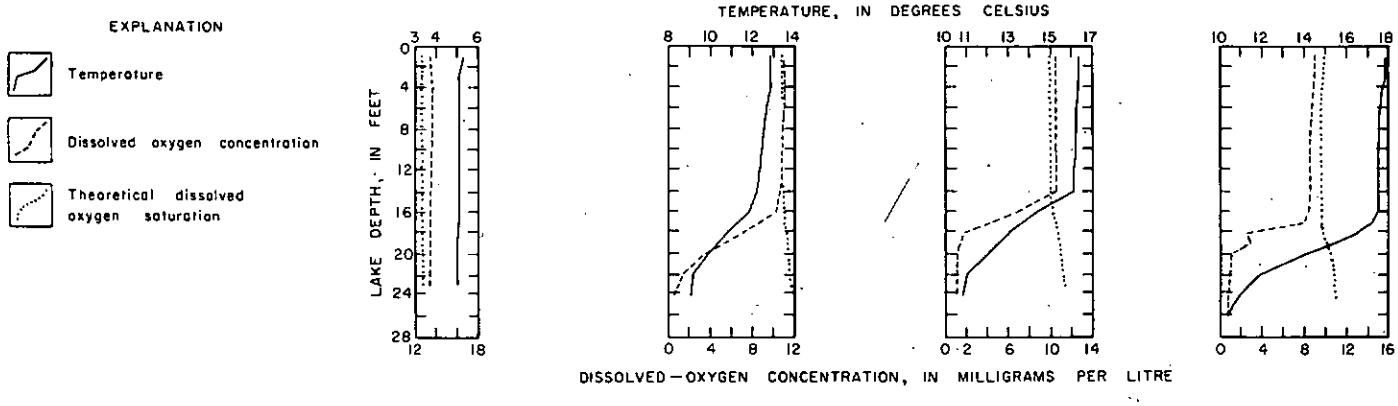
Summary and conclusions.
Spanaway Lake appears to be moderate to high in biological productivity. During the winter mixing period the concentration of nitrate nitrogen was very high (0.60 mg/l), but by mid-June had decreased to 0.02 mg/l. The DO was depleted to nearly zero in the hypolimnion by mid-June. A bloom of blue-green algae and diatoms was observed during visits to the lake in April and June.

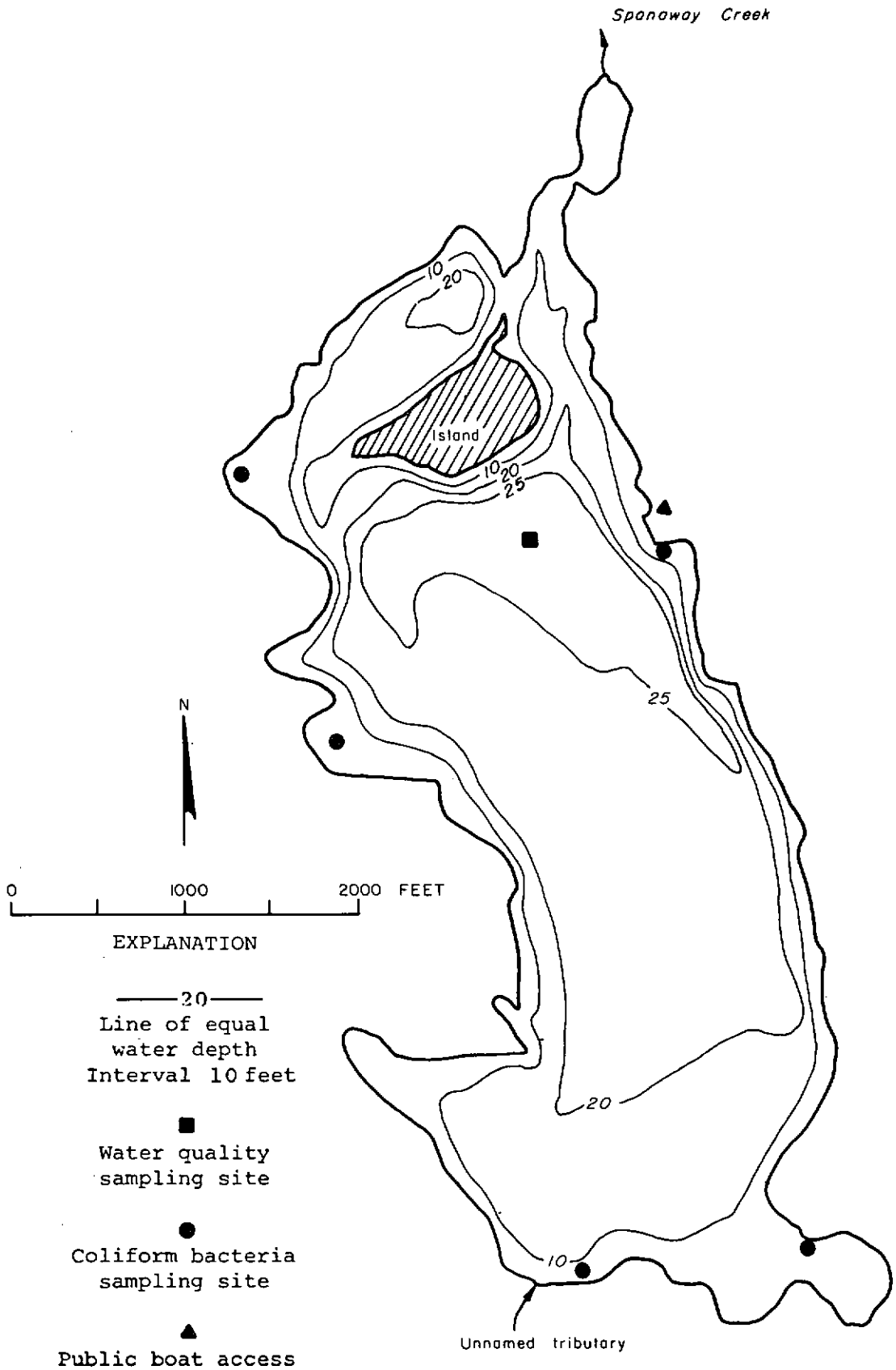
About 80 percent of the lakeshore is occupied by residential homes. The number of nearshore homes increased from about 122 to 220 between 1959 and 1973. Summertime recreational use of the lake is heavy. These cultural factors plus a naturally large drainage area increase the potential for eutrophication. A continued flushing of the lake by the year-round inflow and outflow, however, does aid in the removal of nutrients from the lake.

Water-quality data for Spanaway Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	February 15		April 23		June 18		August 28	
Water depth (ft)	3	23	3	21	3	21	3	23
Silica (SiO_2)	12	12	11	13	6.2	18	9.3	27
Dissolved iron (Fe), in µg/l	220	230	120	590	210	4,900	250	23,000
Dissolved manganese (Mn) (in µg/l)	30	20	10	70	0	530	45	1,000
Calcium (Ca)	8.9	--	--	--	--	--	10	--
Magnesium (Mg)	3.1	--	--	--	--	--	3.3	--
Sodium (Na)	4.5	--	--	--	--	--	4.8	--
Potassium (K)	.9	--	--	--	--	--	.9	--
Bicarbonate (HCO_3)	41	45	44	43	51	64	50	86
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	0	--	0
Sulfate (SO_4)	5.0	--	--	--	--	--	4.7	--
Chloride (Cl)	5.4	--	--	--	--	--	5.4	--
Nitrate nitrogen (as N)	.60	.60	.49	.37	.04	.01	.02	.06
Nitrite nitrogen (as N)	.01	.01	.01	.01	.01	.01	.01	.01
Ammonia nitrogen (as N)	.13	.12	.13	.31	.11	1.1	.14	3.1
Organic nitrogen (as N)	.57	.31	.24	.10	.08	.00	.10	.20
Total phosphorus (as P)	.022	.020	.015	.046	.028	.25	.022	.85
Orthophosphate (as P)	.005	.003	.005	.017	.001	.070	.002	.029
Suspended solids (110°C)	4.0	--	--	--	--	--	1.0	--
Hardness as $CaCO_3$ (Ca,Mg)	35	--	--	--	--	--	39	--
Specific conductance (micromhos at 25°C)	94	95	91	94	93	116	106	199
pH (pH units)	8.3	8.2	6.4	6.2	8.0	6.8	6.8	6.7
Water temperature (°C)	5.1	5.0	12.8	9.2	16.3	11.0	17.9	11.4
Color (Pt-Co scale)	15	15	29	40	5	50	7	375
Secchi-disc (ft)	4.9		8.5		7.9		7.9	
Dissolved oxygen (DO)	13.6	13.4	11.0	1.5	10.4	11.1	9.1	.9
Chlorophyll a in photic zone (µg/l)	9.5	--	2.7	--	7.3	--	5.8	--
Fecal coliform (col. per 100 ml) Range	<1-69		<1-4		1-12		1-24	
Fecal coliform (col. per 100 ml) Mean	17		1		4		54	
Total organic carbon (as C)	7.0	--	3.5	--	7.5	--	4.0	--





Spanaway Lake, Pierce County. From Washington Department of Game, February 2, 1950.

Spanaway Lake, Pierce County. May 15, 1970. Approx. scale 1:12,000.

Tiger Lake near Belfair (12065020)

Location.
Southernmost shoreline point, at lat 47°30'31", long 122°50'08", in SE¼SW¼ sec.5, T.23 N., R.1 W., Mason County, 4.1 miles north of Belfair; Mission Creek basin. Wildcat Lake quadrangle, 1:24,000.

Physical characteristics of lake.

Drainage area	0.70 sq mi	Mean depth	19 ft	Shoreline configuration	1.7
Altitude	496 ft	Maximum depth	40 ft	Development of volume	0.48
Surface area	110 acres	Length of shoreline	13,000 ft	Bottom slope	1.6 percent
Lake volume	2,200 acre-ft				

Basin geology.
Glacial drift (Huntting and others, 1961).

Soils.
Mostly gravelly sandy loam (Ness and Fowler, 1960).

Land use (percentage of drainage basin). Urban 0, suburgan 14, agricultural 0, forest or unproductive 61, and lake surface 25.

Nearshore residential development. 100 percent.

Number of nearshore homes. 80.

Surface-water inflow and outflow.
Minor inflow was observed from two unnamed tributaries (dry in summer). The outflow was estimated at 1.0 ft^3/s on February 28, but was dry on subsequent visits.

Lake stage.
Lake stage varied 2.5 feet between February 28 and September 5, 1973.

Macrophytes.
Shoreline covered by emersed plants, 11 to 25 percent.
Lake surface covered by emersed plants, 4 percent.
Lake bottom covered by submersed plants, <1 percent.
Rooted aquatic plants observed were cattail (*Typha* sp.), white lily (*Nymphaea* sp.), yellow lily (*Nuphar* sp.), pondweed (*Potamogeton* sp.), and quillwort (*Isoetes* sp.).

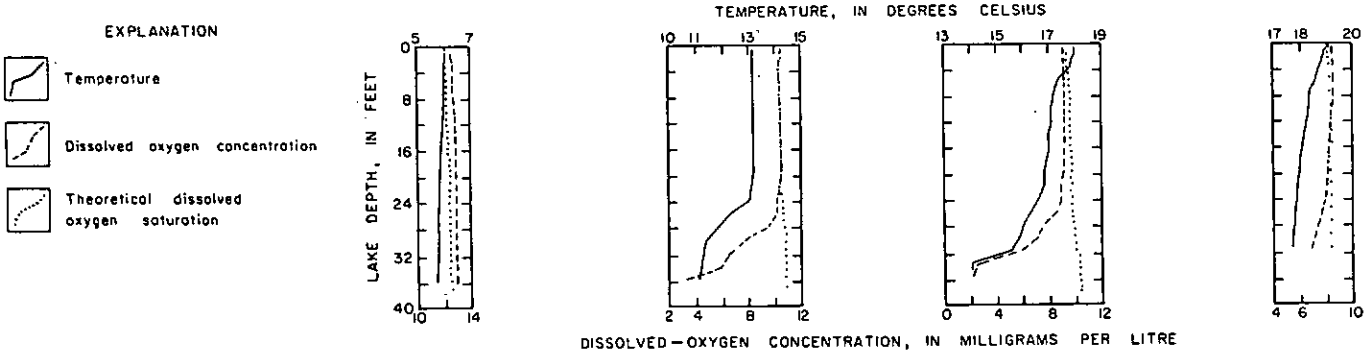
Algae observed.
No data.

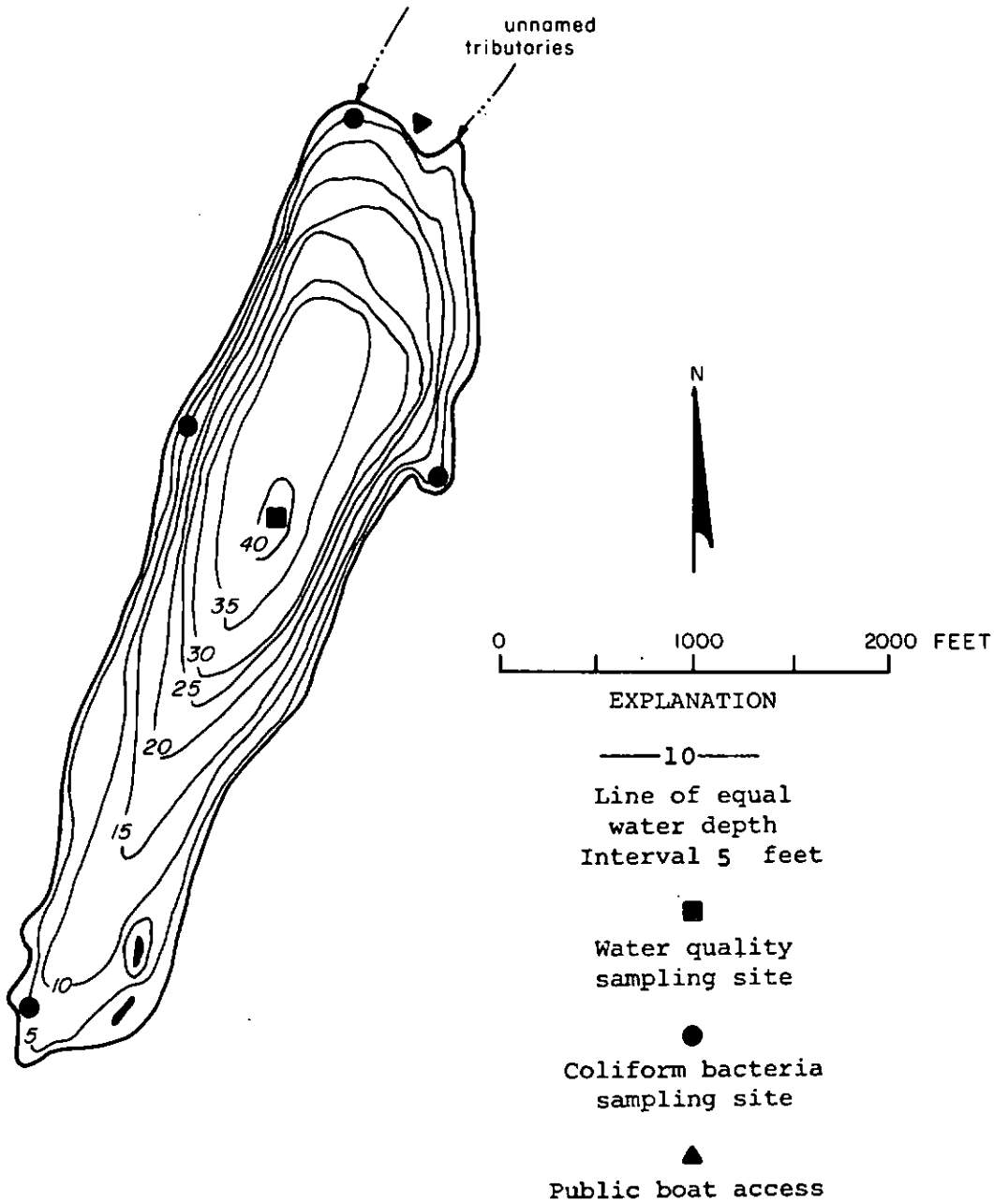
Summary and conclusions.
Tiger Lake is a soft-water lake low in dissolved minerals and biological productivity. The chlorophyll *a* and nutrient concentrations were low throughout the summer. The gravelly, sandy littoral zone supported only a light growth of aquatic macrophytes. Nearly all the shoreline is occupied by seasonal and permanent homes and the lake has a high summertime recreational use. Although the overall water quality conditions of Tiger Lake are excellent, the potential for cultural eutrophication is relatively high.

Water-quality data for Tiger Lake.

[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	February 28		May 7		June 20		September 5	
Water depth (ft)	3	34	3	34	3	33	3	31
Silica (SiO_2)	1.4	1.4	1.3	1.3	1.0	1.0	0.7	1.0
Dissolved iron (Fe), in µg/l	9.0	20	100	40	20	60	50	80
Dissolved manganese (Mn) (in µg/l)	10	0	0	0	0	0	0	0
Calcium (Ca)	1.8	--	--	--	--	--	1.5	--
Magnesium (Mg)	.4	--	--	--	--	--	.4	--
Sodium (Na)	1.2	--	--	--	--	--	1.4	--
Potassium (K)	.0	--	--	--	--	--	.2	--
Bicarbonate (HCO_3)	6	7	12	8	11	12	9	13
Carbonate (CO_3)	0	0	0	0	0	0	0	0
Sulfide (S)	--	--	--	--	--	--	--	--
Sulfate (SO_4)	1.8	--	--	--	--	--	1.8	--
Chloride (Cl)	2.3	--	--	--	--	--	1.3	--
Nitrate nitrogen (as N)	.21	.19	.05	.07	.01	.01	.01	.01
Nitrite nitrogen (as N)	.00	.00	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.04	.05	.03	.10	.03	.07	.04	.06
Organic nitrogen (as N)	.13	.17	.25	.25	.07	.06	.26	.25
Total phosphorus (as P)	.009	.007	.006	.011	.004	.061	.011	.007
Orthophosphate (as P)	.000	.000	.006	.007	.001	.002	.005	.002
Suspended solids (110 °C)	3	--	--	--	--	--	0	--
Hardness as $CaCO_3$ (Ca,Mg)	6	--	--	--	--	--	5	--
Specific conductance (micromhos at 25 °C)	16.4	16.2	17.5	17.5	--	--	17.8	17.8
pH (pH units)	7.1	7.3	8.5	8.2	6.5	6.4	7.3	7.1
Water temperature (°C)	6.1	5.4	13.2	11.2	17.8	15.5	18.8	17.8
Color (Pt-Co scale)	0	0	15	15	0	5	5	5
Secchi-disc (ft)	21		16		12		16	
Dissolved oxygen (DO)	12.7	12.8	10.4	5.9	9.2	5.7	8.6	7.0
Chlorophyll a in photic zone (µg/l)	2.0	--	1.8	--	2.2	--	6.0	--
Fecal coliform (col. per 100 ml) Range	<1-18		<1-9		<1-30		<1-6	
Fecal coliform (col. per 100 ml) Mean	5		3		10		3	
Total organic carbon (as C)	3.5	--	3.5	--	5.0	--	4.0	--





Tiger Lake, Mason County. From Washington Department of Game, June 18, 1952.

Tiger Lake, Mason County. May 28, 1972. Approx. scale 1:12,000.

Williams Lake near Amber (13351500)

Location.
Southernmost shoreline point, at lat 47°19'02", long 117°42'28", in NE¼NW¼ sec.13, T.21 N., R. 40 E., Spokane County, 2.5 miles south of Amber; Palouse River basin. Cheney quadrangle, 1:62,500.

Physical characteristics of lake.

Drainage area	21.8 sq mi	Mean depth	37 ft	Shoreline configuration	2.1
Altitude	2,052 ft	Maximum depth	115 ft	Development of volume	0.32
Surface area	320 acres	Length of shoreline	28,000 ft	Bottom slope	2.7 percent
Lake volume	12,000 acre-ft				

Basin geology.
Basalt (Huntting and others, 1961).

Soils.
Shallow, stony soils and stony silt loam (Donaldson and Giese, 1968).

Land use (percentage of drainage basin). Urban 0, suburban <1, agricultural 77, forest or unproductive 21, and lake surface 2.
Nearshore residential development. 24 percent.
Number of nearshore homes. 25.

Surface-water inflow and outflow.
The lake receives minor inflow early in the year from an unnamed tributary. The outflow on April 4 was 0.4 ft^3/s; May 22, 0.1 ft^3/s; July 10, 0.1 ft^3/s; and Oct. 2, 0.1 ft^3/s.

Lake stage.
Lake stage varied 2.1 feet between April 4 and October 2, 1973. Fragmentary lake-stage data can be obtained from a report by the U.S. Geological Survey (1973).

Macrophytes.
Shoreline covered by emersed plants, 26 to 50 percent.
Lake surface covered by emersed plants, 2 percent.
Lake bottom covered by submersed plants, 9 percent.
Rooted aquatic plants observed were cattail (Typha sp.), sedge (Cyperaceae), coontail (Ceratophyllum sp.), waterweed (Elodea sp.), pondweed (Potamogeton sp.), and water milfoil (Myriophyllum sp.).

Algae observed.
May 22 - A mixed population of blue-green algae (Oscillatoria sp.), diatoms (Tabellaria sp.), and green algae (Spirogyra sp.).
July 10 - A mixed population of flagellates (Ceratium sp.), diatoms (Fragillaria sp.), and blue-green algae (Oscillatoria sp., Polycystis sp.).
Oct. 2 - A mixed population of flagellates (Ceratium sp.),* diatoms (Asterionella sp., Flagillaria sp.), blue-green algae (Oscillatoria sp., Anabeana sp.), and green algae (Staurastrum sp.).

Asterisk (*) indicates dominant aquatic plant.

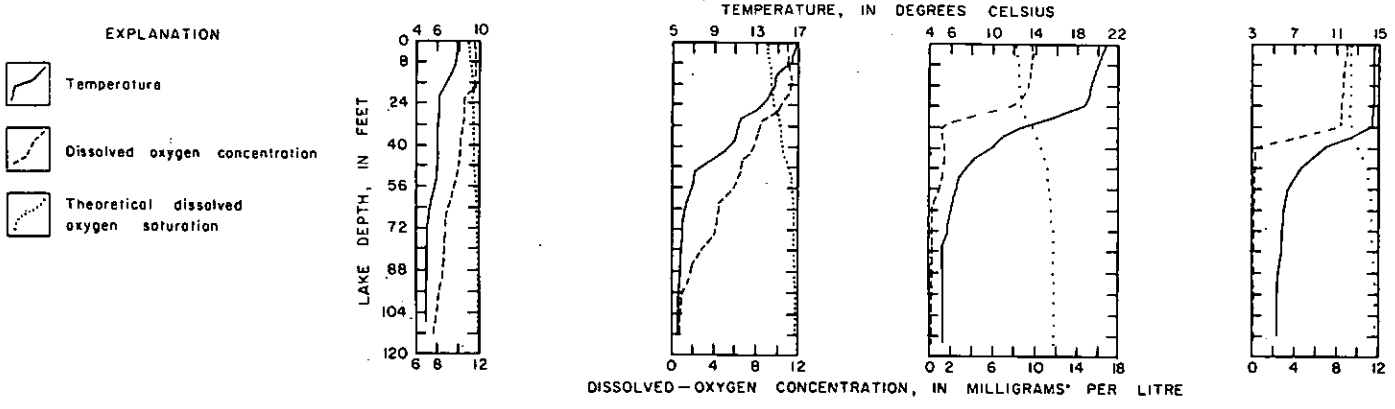
Summary and conclusions.
Williams Lake appears moderate to high in biological productivity. Moderate concentrations of chlorophyll a were observed during the four visits to the lake and total phosphorus concentrations were relatively high. A bloom of flagellates, diatoms, and blue-green algae occurred during the spring and summer. Generally, the aquatic macrophyte growth was light; however, areas of dense plant growth were present. The DO during the summer was entirely depleted below a depth of about 25 feet.

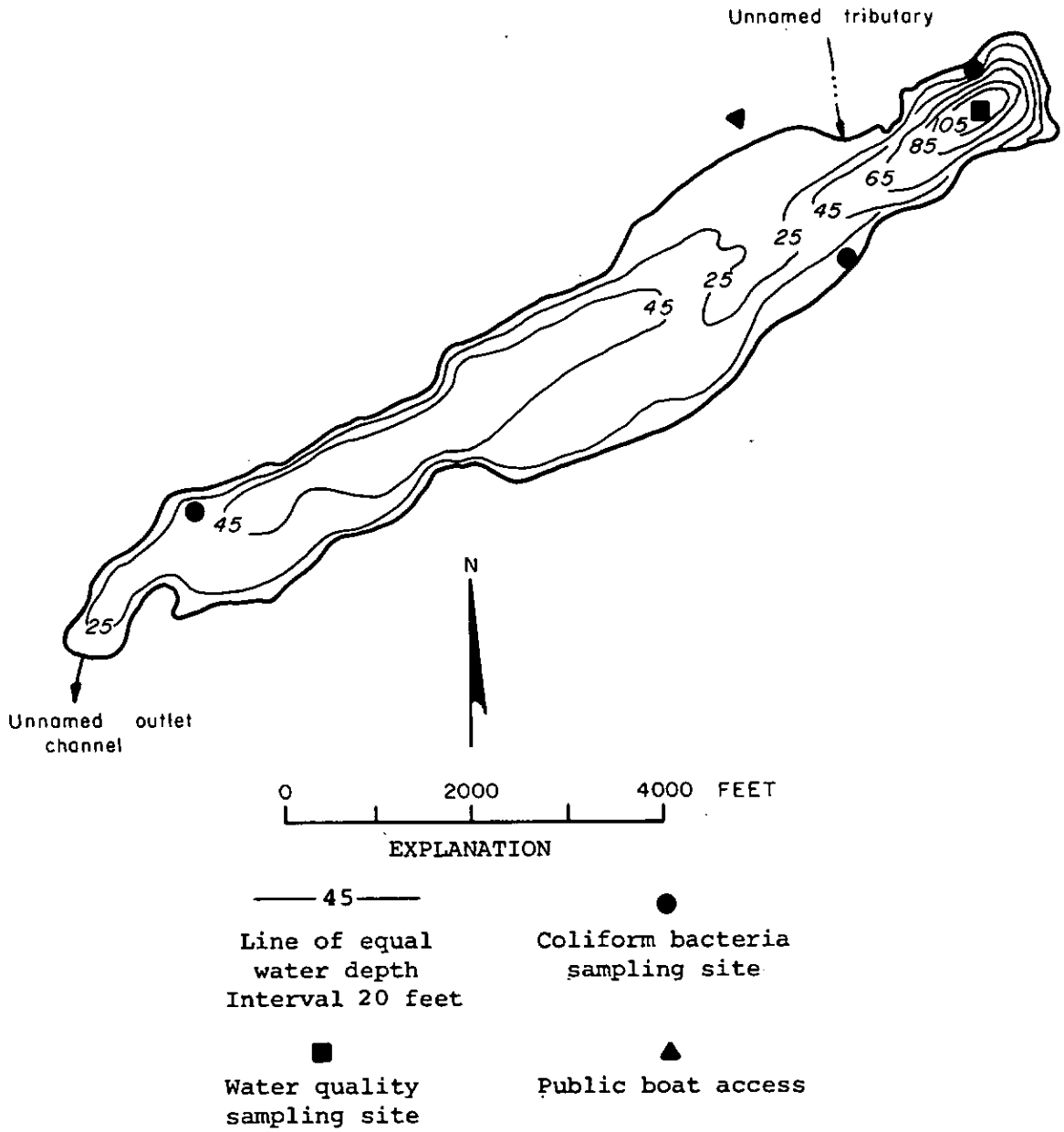
Nearshore residential development is limited to areas along the northeastern and northwestern shorelines of the lake.

Water-quality data for Williams Lake.

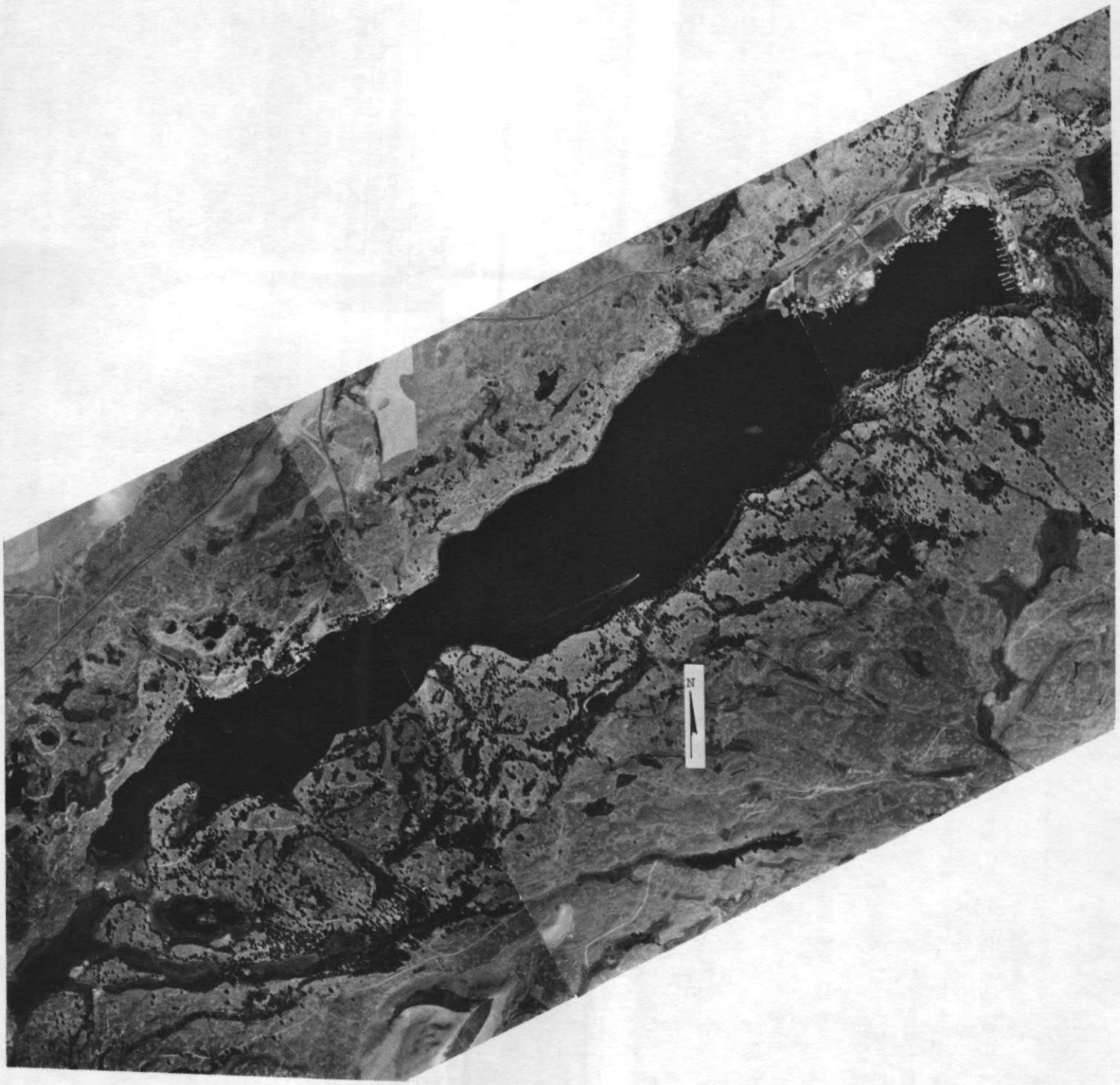
[Milligrams per litre unless otherwise indicated]

Date of collection (1973)	April 4		May 22		July 10		October 2	
Water depth (ft)	3	110	3	112	3	112	3	110
Silica (SiO_2)	0.1	0.7	0.2	2.1	0.3	3.0	2.0	4.4
Dissolved iron (Fe), in µg/l	20	70	30	290	30	1,400	10	1,500
Dissolved manganese (Mn) (in µg/l)	50	220	20	1,400	40	1,400	50	1,400
Calcium (Ca)	21	--	--	--	--	--	17	--
Magnesium (Mg)	13	--	--	--	--	--	13	--
Sodium (Na)	15	--	--	--	--	--	17	--
Potassium (K)	7.0	--	--	--	--	--	7.0	--
Bicarbonate (HCO_3)	162	163	164	165	147	169	162	178
Carbonate (CO_3)	--	--	--	--	7	--	--	--
Sulfide (S)	--	--	--	--	--	0	--	1.5
Sulfate (SO_4)	5.2	--	--	--	--	--	4.3	--
Chloride (Cl)	3.2	--	--	--	--	--	3.3	--
Nitrate nitrogen (as N)	.08	.14	.02	.20	.02	.06	.00	.01
Nitrite nitrogen (as N)	.01	.01	.00	.00	.00	.00	.00	.00
Ammonia nitrogen (as N)	.12	.20	.06	.82	.03	1.3	.04	1.8
Organic nitrogen (as N)	.26	.21	.49	.38	.09	1.3	.47	.90
Total phosphorus (as P)	.045	.044	.026	.11	.027	.23	.016	.31
Orthophosphate (as P)	.003	.003	.003	.048	.002	.18	.005	.28
Suspended solids (110 °C)	8	--	--	--	--	--	1	--
Hardness as $CaCO_3$ (Ca,Mg)	110	--	--	--	--	--	96	--
Specific conductance (micromhos at 25 °C)	240	235	255	255	250	250	240	260
pH (pH units)	6.6	6.7	8.2	7.1	8.8	7.2	8.0	7.6
Water temperature (°C)	7.9	5.0	16.6	5.7	20.7	5.2	14.8	5.5
Color (Pt-Co scale)	5	10	35	35	0	0	10	10
Secchi-disc (ft)	12		7.9		5.9		12	
Dissolved oxygen (DO)	11.5	7.7	10.9	.8	9.7	.1	9.0	.2
Chlorophyll a in photic zone (µg/l)	5.3	--	2.4	--	3.2	--	3.8	--
Fecal coliform (col. per 100 ml) Range	<1-<1		<1-<1		<1-2		<1-<1	
Fecal coliform (col. per 100 ml) Mean	<1		<1		1		<1	
Total organic carbon (as C)	6.0	--	7.5	--	8.0	--	6.5	--





Williams Lake, Spokane County. From Washington Department of Game, January 1948.



Williams Lake, Spokane County. July 25, 1974. Approx. scale 1:16,000.