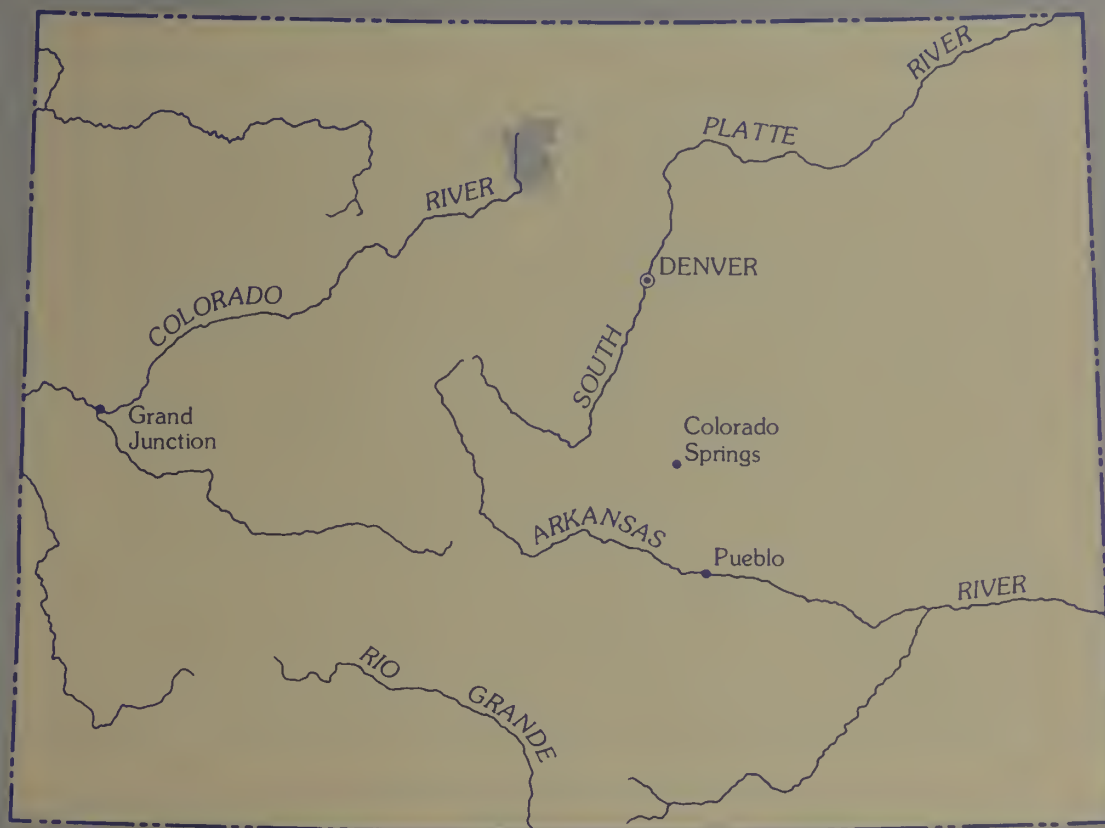


SEASONAL CHANGES IN PHYTOPLANKTON
POPULATIONS AND RELATED CHEMICAL AND
PHYSICAL CHARACTERISTICS IN LAKES IN
LOCH VALE, ROCKY MOUNTAIN NATIONAL
PARK, COLORADO

ROMO

U.S. GEOLOGICAL SURVEY



Water-Resources Investigations Report 86-4101



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By Diane McKnight, Mark Brenner, Richard Smith, and Jill Baron

U.S. GEOLOGICAL SURVEY

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1986



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CONVERSION FACTORS

For use of readers who prefer to use inch-pound units, conversion factors for terms used in this report are listed below:

<i>Multiply</i>	<i>By</i>	<i>To obtain</i>
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
hectare (ha)	2.471	acre
liter (L)	0.2642	gallon
cubic meter per second (m ³ /s)	35.31	cubic foot per second
nanometer (nm)	3.281×10^{-9}	foot
milligram (mg)	0.03527×10^{-3}	ounce, avoirdupois
milliliter (mL)	0.03382	ounce, fluid
centimeter (cm)	3.281×10^{-2}	foot
cubic meter (m ³)	35.32	cubic foot

Temperature in degree Celsius (°C) can be converted to degree Fahrenheit (°F) as follows:

$$^{\circ}\text{F} = 9/5 \text{ } ^{\circ}\text{C} + 32$$

The following terms and abbreviations are also used in this report:

micrograms per liter (µg/L)
micromolar (µM)
milligrams per liter (mg/L)
(relative) *in vivo* fluorescence (IVF) units



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SEASONAL CHANGES IN PHYTOPLANKTON POPULATIONS AND RELATED
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and Jill Baron

ABSTRACT

Phytoplankton populations and related chemical and physical characteristics were monitored in Sky Pond and The Loch in Loch Vale, Rocky Mountain National Park, Colorado, during the spring, summer, and fall of 1984, as part of a long-term study to determine the effects of precipitation chemistry on biogeochemical processes in high-elevation lakes and drainage basins that might be adversely affected by acid rain. Three distinct periods in the sequence of phytoplankton populations were observed: (1) A spring population peak that was dominated by diatoms, mainly *Asterionella formosa*, and some green algal species; (2) a midsummer population minimum, when the diatom populations decreased 10- to 100-fold; and (3) a fall population peak, which was almost unialgal, dominated by a filamentous blue-green alga, *Oscillatoria limnetica*. The spring diatom peak could have been caused by the two-fold increase in nitrate concentration during the spring snowmelt. The midsummer diatom decrease most likely was caused by zooplankton grazing, or photoinhibition, or both, rather than by phosphate depletion because orthophosphate concentrations increased at this time. It is further hypothesized that the rapid flushing rates during spring are an important factor regulating phytoplankton populations in these lakes.

INTRODUCTION

A study of phytoplankton populations and related chemical and physical characteristics in Sky Pond, Glass Lake, and The Loch in Loch Vale in Rocky Mountain National Park, Colorado, was begun in the spring of 1984. The purpose of this study was to describe the seasonal changes in phytoplankton abundance and species composition in relation to seasonal changes in nutrient concentrations [nitrate (NO_3), ammonia (NH_4), and phosphate (PO_4)] and in the physical characteristics of the lakes (flushing rate, light intensity, ice cover, and temperature, for example). This information will be used to compare the lakes in Loch Vale with other alpine and montane (subalpine) lakes where the phytoplankton has been studied and to design future onsite experiments to determine the response of the phytoplankton to potential increasing nitrate concentrations that could result from acid rain.

Purpose and Scope

This report presents the phytoplankton data collected at Sky Pond, Glass Lake, and The Loch from May 1984 through January 1985. Phytoplankton data for Sky Pond were collected on 11 days from May 29, 1984, to January 22, 1985. Phytoplankton data for Glass Lake only were collected on May 22, 1984. Phytoplankton data for the Loch were collected on 14 days from May 23, 1984, to January 22, 1985. Other data collected at Sky Pond and The Loch include concentrations of major cations and anions, nutrients, organic carbon, and chlorophyll. Some preliminary interpretations are made pertaining to the causes of the phytoplankton population peaks in the spring and fall of 1984 and of the substantial phytoplankton population decrease in midsummer.

Location and Description of the Study Area

The study area is the Loch Vale area in Rocky Mountain National Park, Colorado, which contains three lakes: Sky Pond, Glass Lake, and The Loch, which are drained by a perennial stream, Icy Brook (fig. 1). These lakes are all oligotrophic and dilute; the lakes occupy cirques formed during former advances and retreats of Taylor Glacier. Sky Pond (fig. 2) is classified as an alpine lake based on its elevation of 3,322 m; it is typical of other alpine lakes in Colorado with a rock-and-gravel drainage basin and year-round snowfields in the drainage basin (Pennak, 1963). Sky Pond has surface area of about 3.03 ha, a maximum depth of 7.3 m, an average depth of 4.5 m; the lake does not become thermally stratified during spring and summer. Glass Lake (fig. 3) has an elevation of 3,292 m; it is at treeline, surrounded by krummholtz, rocks, and meadows. Glass Lake has a surface area of 1.01 ha, a maximum depth of 4.7 m, and an average depth of 2.8 m. The Loch (fig. 4) has an elevation of 3,048 m; it is surrounded by a spruce-fir forest composed of Engleman spruce, subalpine fir, and a few limber pines. The Loch has a surface area of about 4.98 ha, and is shallower than Sky Pond, with a maximum depth of 4.7 m at a depression in the southeast part of the lake bed and an average depth of 1.5 m. Both Glass Lake and The Loch are classified as montane (or subalpine) lakes and do not become thermally stratified during spring and summer. These lakes are visited frequently by hikers and campers during the summer. The lowest lake in elevation, The Loch, is 2 km from the nearest parking lot road. The morphometric characteristics of the three lakes is summarized in table 1.

Acknowledgments

This study was conducted as part of the Acid Rain Program of the U.S. Geological Survey, with the collaboration and support of the National Park Service, Water Resources Laboratory, Rocky Mountain National Park, and the Natural Resources Ecology Laboratory of Colorado State University. We acknowledge the field assistance provided by Steven Zary, Brian Olver, Sarah Spaulding, and David Beeson of the National Park Service. Further, we acknowledge Steven Canton and James Chadwick (Chadwick and Associates) for identification and enumeration of algal species.

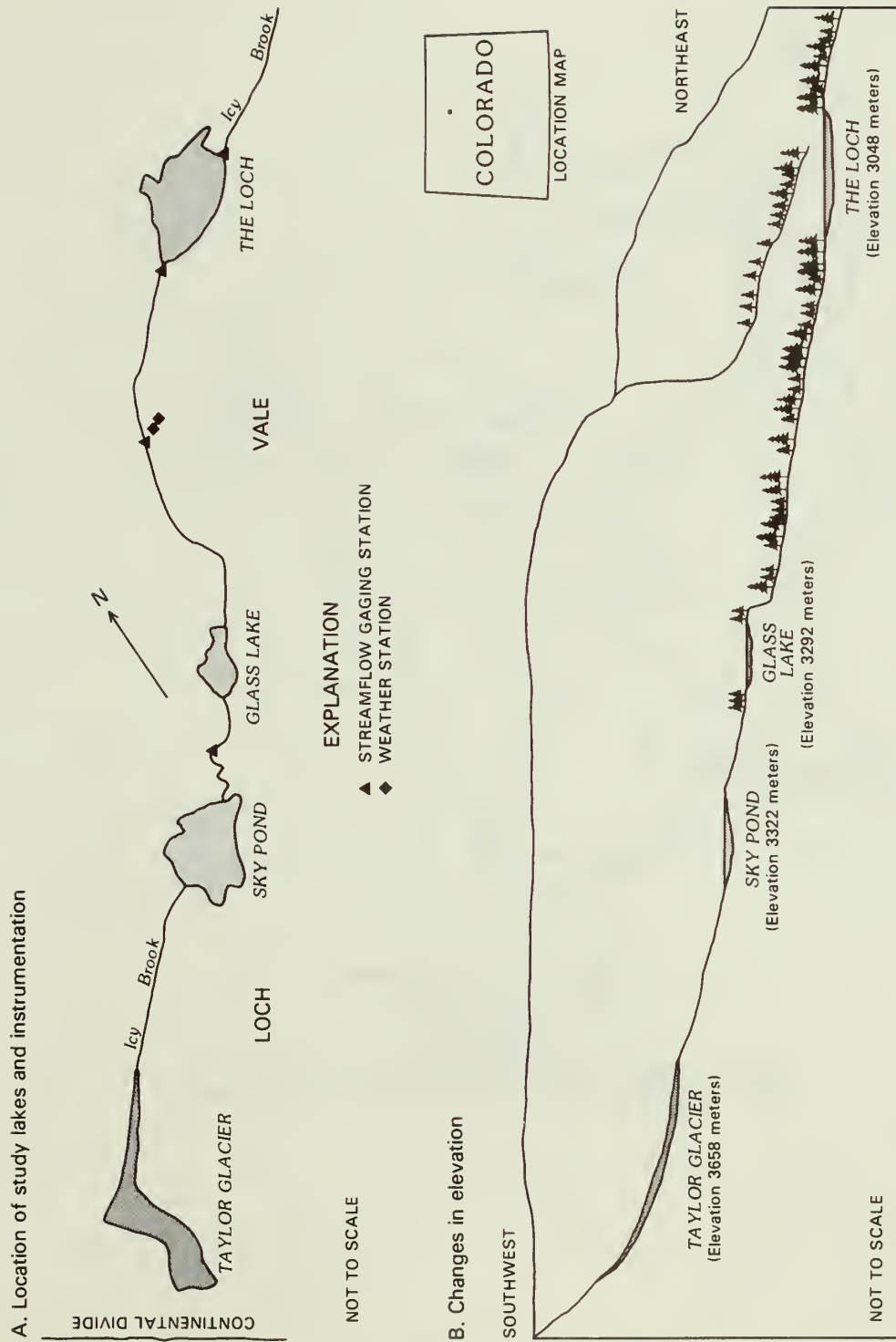


Figure 1.--Plan and cross-sectional views of the study area: A. Location of study lakes and instrumentation. B. Changes in elevation.

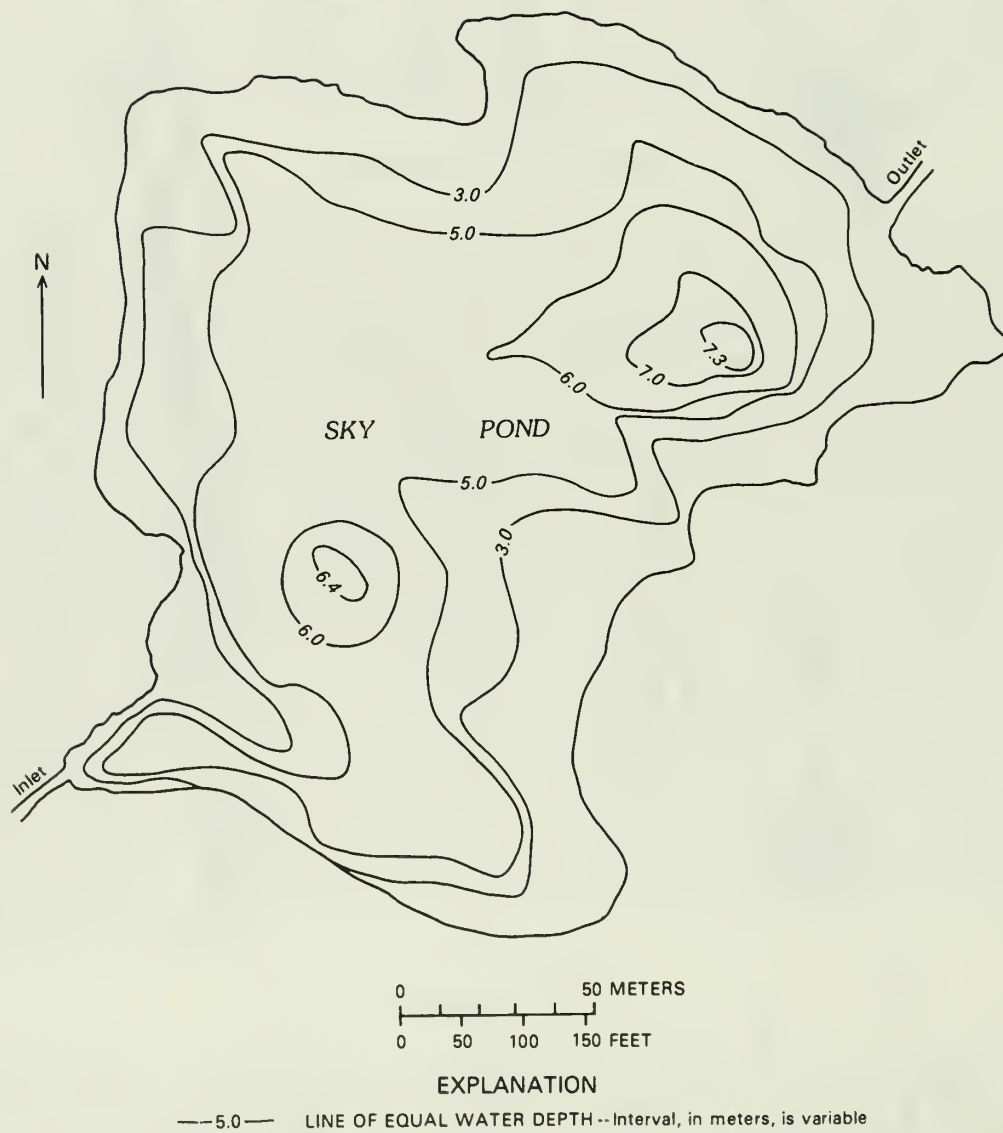


Figure 2.--Bathymetric map of Sky Pond.



Figure 3.--Bathymetric map of Glass Lake.

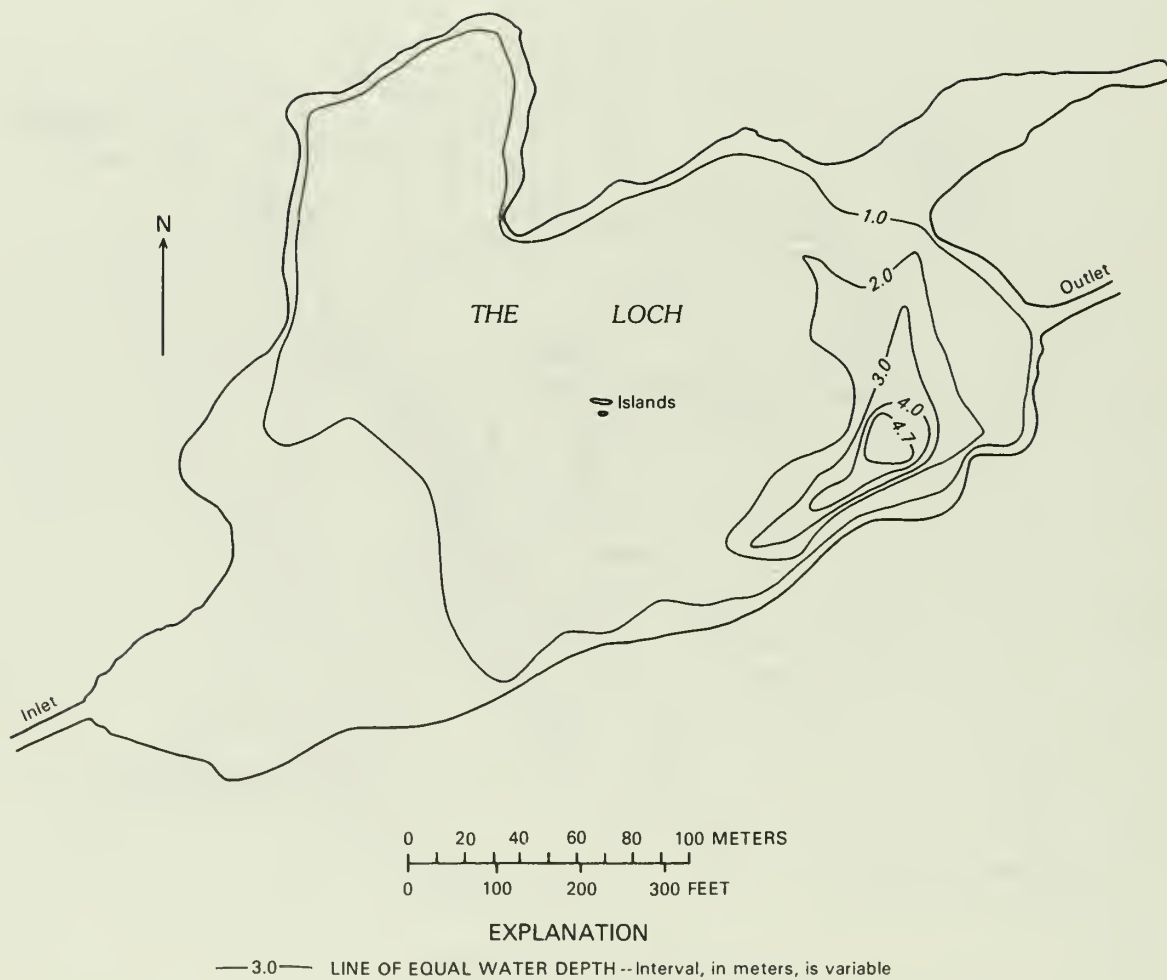


Figure 4.--Bathymetric map of The Loch.

Table 1.--*Morphometric characteristics of the study lakes*[m, meters; ha, hectares; m³, cubic meters]

Lake	Elevation (m)	Surface area (ha)	Lake volume (m ³)	Average depth (m)	Maximum depth (m)
Sky Pond	3,322	3.03	121,684	4.5	7.3
Glass Lake	3,292	1.01	25,690	2.8	4.7
The Loch	3,048	4.98	61,099	1.5	4.7

METHODS OF DATA COLLECTION AND ANALYSIS

Phytoplankton Populations

Discrete 1-L samples for determination of phytoplankton populations were collected at 3 depths in each lake using a VanDorn sampler¹. Phytoplankton also were collected using a Wildco 40-mesh size, 12.7-cm diameter net; tows were made from a small rubber raft over the deepest area of each lake; phytoplankton from 2 or 3 tows were analyzed as one sample. The abundance of the phytoplankton was estimated, based on the number of tows, the depth of the tows, and the area of net opening, assuming all water above the net passed through the net during the tow. Lugol's solution was added promptly as a preservative to the discrete and tow samples. Algal species were identified and counted by Chadwick and Associates, Littleton, Colorado, using settling columns and an inverted microscope.

Chlorophyll a, Phaeopigments, and Fluorescence

Samples from the same three VanDorn depth samples used for the discrete photoplankton samples also were filtered through GFC glass-fiber filters for analysis of chlorophyll a concentrations by extraction in acetone with a correction for phaeopigments using the method described by Strickland and Parsons (1972). The fluorescence of the living phytoplankton was measured using a Turner Designs model-10 series fluorometer in water samples from 1-m depth intervals within a few hours of sample collection.

Nutrients and Other Chemical Constituents

Samples for chemical analysis were collected using a VanDorn sampler, and were filtered through 0.4 µm Nuclepore filters into 250 mL plastic bottles. Nitrate, nitrite, ammonia, and orthophosphate concentrations were determined by various colorimetric methods, as described by Skougstad and others (1979). Color, pH, and silica, iron, calcium, and sulfate concentrations were determined by methods described by Skougstad and others (1979). Dissolved-organic-carbon (DOC) and suspended-organic-carbon (SOC) concentrations were determined using an Oceanographic International #524B-AA-303 Organic Carbon Analyzer. All analyses were performed by the U.S. Geological Survey central laboratory in Denver.

¹The use of trade names in this report is for identification only and does not constitute endorsement by the U.S. Geological Survey.

Selected Physical Characteristics

The intensity of photosynthetically active radiation (PAR: from 400 to 700 nm) and the temperature were measured at 0.5- or 1-m intervals in each lake, using a LI-COR lightmeter and a YSI Model 51B temperature/dissolved-oxygen meter. The extinction coefficient (E) was calculated from light-intensity data with depth by using linear regression of the equation:

$$\ln I = \ln I_0 + Ez \quad (1)$$

where

I=PAR intensity, in lux;

I_0 =PAR intensity at the lake surface, in lux;

E=extinction coefficient; and

z=depth, in meters.

SEASONAL CHANGES

One of the unique features of alpine and montane (subalpine) lakes and streams is a large increase in stream discharge during the spring snowmelt period. As indicated by the data for The Loch presented in table 2, during the spring and sometimes during the summer, the rate at which water is flushed from the lake increases to the point that almost all water in the lake is replaced every day. This rapid flushing rate is significant in terms of the dynamics of the resident phytoplankton populations. For the phytoplankton populations to maintain the same cell densities during this time of year, the algae must grow at a rate that matches the flushing rate, assuming that there is not a significant inflow of phytoplankton to the lake at the inlet. The algal growth rates necessary to match maximum flushing rates in the spring are close to one division per day, which is a very rapid growth rate compared with growth rates of algae grown in laboratory cultures under optimal light, temperature, and nutrient conditions.

Phytoplankton Populations

Seasonal changes in phytoplankton populations in 1-L discrete surface samples during the study period are summarized in table 3 for Sky Pond and table 4 for The Loch. The complete enumerations of algae in the 1-L discrete depth samples collected on different sampling dates are listed in tables 5-10 (spring and summer) and 11-13 (fall and winter) for Sky Pond, and in tables 14-21 (spring and summer) and 22-25 (fall and winter) for The Loch. The phytoplankton data from the net tows from all three lakes are presented in tables 26-33. Tables 5-33 are in the "Supplemental Data" section at the end of the report. Comparison of the data from the discrete samples with data from the net tows clearly indicates that the phytoplankton abundance is substantially underestimated by the net tows if the assumption is made that the volume filtered by the net tow was equal to the product of the entire depth of the water column and the area of the opening of the net. In all probability, the net clogged early on during the tows and water simply was displaced, rather than filtered, thereafter. Seasonal changes in the

Table 2.--Stream discharge of Icy Brook at the outlet of The Loch, and flushing and residence times calculated for The Loch

[m³/s, cubic meters per second; d, days]

Sampling date	Discharge ¹ (m ³ /s)	Flushing rate (d ⁻¹)	Residence time (d)
5-16-84	0.27	0.38	2.6
5-23-84	.54	.77	1.3
6-5-84	.37	.53	1.9
6-13-84	.64	.90	1.1
6-20-84	.65	.91	1.1
6-27-84	.65	.91	1.1
7-3-84	.82	1.16	.9
7-17-84	.33	.47	2.1
7-25-84	.94	1.33	.8
8-6-84	.47	.67	1.5
8-15-84	.50	.70	1.4
8-30-84	.40	.57	1.8
9-13-84	.32	.45	2.2
10-11-84	.21	.30	3.3

¹Average value for 24 hours was used.

²A constant lake volume of 61,099 cubic meters for the open-water period was assumed.

abundance of the major alga phyla in Sky Pond are presented in figure 5. From these data, three different periods can be identified: (1) A spring population peak that was dominated by diatoms, mainly *Asterionella formosa*, and some green algal species; (2) a midsummer population minimum, when diatom populations decreased 10- to 100-fold and green-algal populations increased; and (3) a fall population peak that was dominated by a filamentous blue-green alga, *Oscillatoria limnetica*.

Because of the greater cell volume of diatoms relative to blue-green algae, the spring diatom peak may correspond to a greater algal biomass than the fall blue-green algal peak. The same general pattern was observed in The Loch, with the exception that in The Loch filamentous blue-green algae were abundant in late May (5/23) and then decreased in abundance with the increase in the *Asterionella formosa* population. These blue-green algae may have bloomed under the ice and been flushed out of the lake with the spring snowmelt. The spring increase in the diatom populations indicates that these populations were growing at rates of about one division per day during this period of rapid flushing rates.

Examination of the data from the different depths indicates some interesting trends (tables 5-13 for Sky Pond and tables 14-25 for The Loch). In both lakes, the *Asterionella formosa* population had a uniform depth distribution during the summer; however, *A. formosa* had its greatest abundance

Table 3.--Seasonal changes in phytoplankton in surface samples from Sky Pond,
as collected in 1-liter discrete samples

[m, major species; e, equally distributed among listed species; 13,100, cell
density, in cells per milliliter]

Sampling date	Diatoms	Green algae	Chrysophytes (m. <i>Dinobryon</i> divergens)	Blue-green algae	Dino- flagellates
5-22-84	(m. <i>Asterionella</i> <i>formosa</i>)	(m. <i>Eudorina</i> <i>elegans</i>)	--	(<i>Aphanothece</i> sp.)	--
5-29-84	13,100 (m. <i>A. formosa</i>)	2,350 (m. <i>Nephrocytium</i> <i>limneticum</i>)	85	1,900 (m. <i>Oscillatoria</i> <i>limnetica</i>)	--
6-12-84	32,000 (m. <i>A. formosa</i>)	2,950 (m. <i>N. limneticum</i>)	--	680 (m. <i>O. limnetica</i>)	57 (m. <i>Peridinium</i> <i>inconspicua</i>)
6-26-84	6,300 (m. <i>A. formosa</i>)	1,000 (m. <i>Chlorella</i> <i>ellipsoidea</i>)	250	280 (m. <i>O. limnetica</i>)	--
7-10-84	1,200 (m. <i>A. formosa</i>)	2,700 (e. <i>Chlamydomonas</i> sp., <i>Octosporiella</i> <i>coloradensis</i> ; and <i>Chlorella ellip-</i> <i>soidea</i>)	--	7,100 (m. <i>O. limnetica</i>)	28 (m. <i>P. inconspicua</i>)
7-24-84	530 (m. <i>A. formosa</i>)	9,949 (m. <i>C. ellipsoidea</i>)	312	13,350 (m. <i>O. limnetica</i>)	--
8-14-84	511 (m. <i>A. formosa</i>)	12,300 (m. <i>C. ellipsoidea</i>)	--	58,700 (m. <i>O. limnetica</i>)	--
9-11-84	200 (m. <i>A. formosa</i>)	2,300 (e. <i>Chlamydomonas</i> sp., <i>Pandorina</i> <i>morum</i> , and <i>Chloro-</i> <i>cocum infusionum</i>)	--	160,200 (m. <i>O. limnetica</i>)	--
10-9-84	300 (m. <i>A. formosa</i>)	3,600 (m. <i>Chlamydomonas</i>)	--	197,400 (m. <i>O. limnetica</i>)	57 (m. <i>P. inconspicua</i>)
12-4-84	-- (m. <i>A. formosa</i>)	-- (m. <i>Chlamydomonas</i>)	-- (m. <i>Dino-</i> <i>bryon cy-</i> <i>lindricum</i>)	-- (m. <i>O. limnetica</i>)	--
1-22-85	(32,000 in hypo- limnion, m. <i>A.</i> <i>formosa</i>)	1,400	1,700 (m. <i>D. cy-</i> <i>lindricum</i>)	--	--

Table 4.--Seasonal changes in phytoplankton in surface samples from The Loch, as collected in 1-liter discrete samples

[m, major species; e, equally distributed among listed species; 880, cell density, in cells per milliliter]

Sampling date	Diatoms	Green algae	Chrysophytes (m. <i>Dinobryon divergens</i>)	Blue-green algae	Dino-flagellates
5-23-84	880 (m. <i>Asterionella formosa</i>)	400	200	14,700 (m. <i>Microcystis</i> sp. and <i>Aphanothece</i> sp.)	--
6-5-84	2,900 (m. <i>A. formosa</i>)	1,020 (distributed)	--	170 (m. <i>Chroococcus limneticus</i>)	--
6-13-84	-- (m. <i>A. formosa</i>)	-- (m. <i>E. elegans</i>)	--	--	--
6-20-84	3,400 (m. <i>A. formosa</i>)	600 (m. <i>Chlamydomonas</i> sp.)	28	--	--
6-27-84	2,200 (m. <i>A. formosa</i>)	350 (m. <i>Chlamydomonas</i> sp.)	--	--	--
7-3-84	860 (m. <i>A. formosa</i>)	790 (distributed)	85	85 (m. <i>C. limneticus</i>)	--
7-17-84	-- (e. <i>Melosira lirata</i> and <i>A. formosa</i>)	--	--	--	--
7-25-84	260 (m. <i>A. formosa</i>)	1,530 (distributed)	--	600 (m. <i>Oscillatoria limnetica</i>)	--
8-15-84	28 (m. <i>Navicula schassmanii</i>)	5,140 (m. <i>Chlamydomonas</i>)	--	200 (m. <i>Anabaena</i> sp.)	--
8-30-84	70 (m. <i>Fragilaria pinnata</i>)	6,034 (m. <i>Chlorella</i> sp.)	--	230 (m. <i>O. limnetica</i>)	--
9-13-84	19 (m. <i>A. formosa</i>)	2,500 (m. <i>Gonium</i> sp.)	--	20,300 (m. <i>O. limnetica</i>)	--
10-11-84	28 (m. <i>A. formosa</i>)	1,200 (distributed)	--	8,800 (m. <i>O. limnetica</i>)	--
12-6-84	340 (m. <i>Diatoma hiemale</i>)	910 (distributed)	230 (m. <i>Dinobryon cylindricum</i>)	795 (m. <i>O. limnetica</i>)	230 (m. <i>Peridinium</i> sp.)
1-22-85	1,590 (m. <i>A. formosa</i>)	400 (m. <i>Chlorococcum</i>)	230 (m. <i>D. cylindricum</i>)	2,590 (m. <i>C. limneticus</i>)	28 (m. <i>Peridinium bipes</i>)

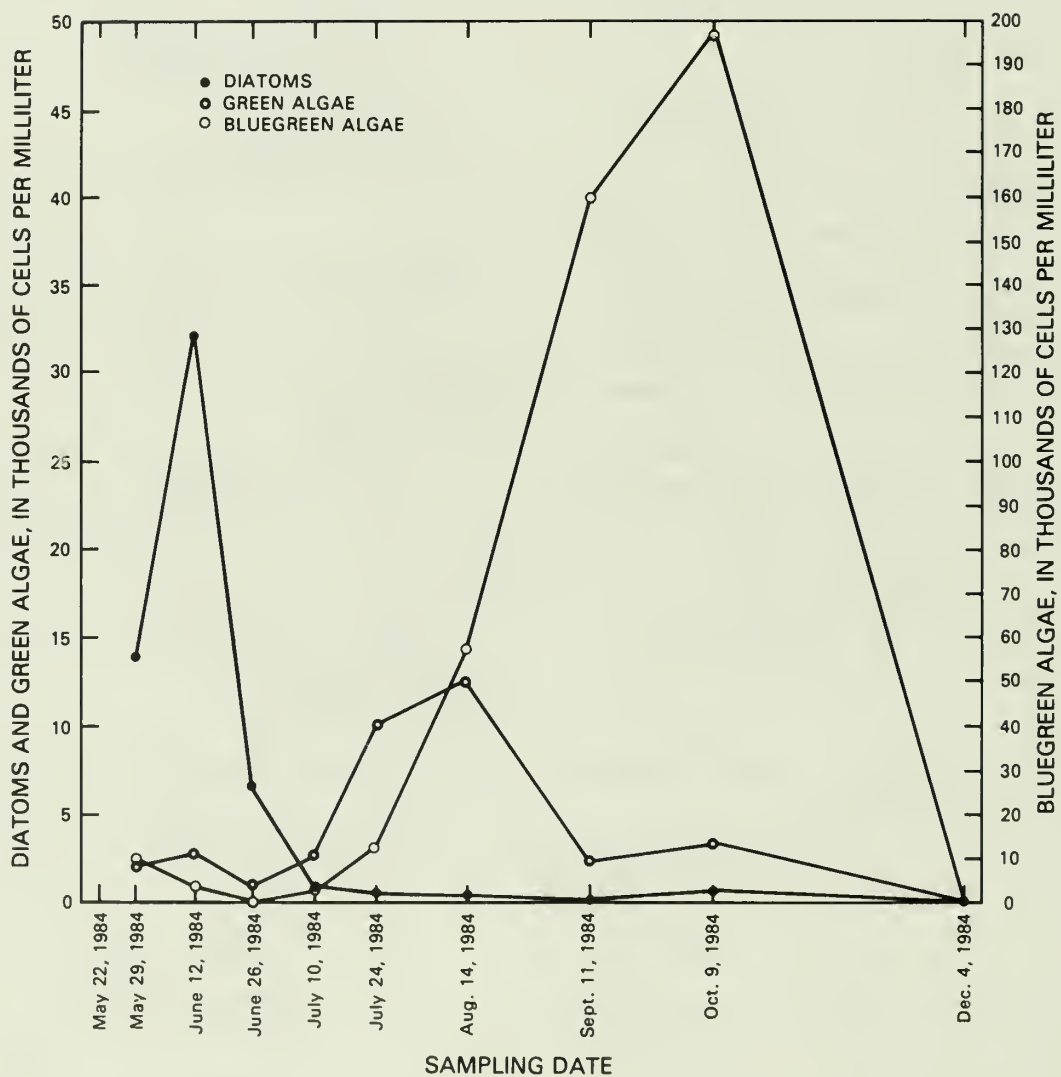


Figure 5.--Seasonal changes in phytoplankton populations in Sky Pond (see table 3).

at depth in the winter and in the first sample in May. Green algae were represented by the most species in both Sky Pond and The Loch; the distribution of different species with depth was variable. Another similarity in the data sets for Sky Pond and The Loch is the peak abundance of *Oscillatoria limnetica* in September (table 11 for Sky Pond and table 22 for The Loch). In both lakes, large differences in abundance between depths were observed; however, the location of the greatest abundance varied between lakes and sampling dates.

Concentrations of Chlorophyll a and Phaeopigment, and Fluorescence

The chlorophyll a and phaeopigment concentrations, as measured by extraction of glass-fiber filters, and the fluorescence of living phytoplankton are listed for the different sampling dates in table 34 for Sky Pond and in table 35 for The Loch in the "Supplemental Data" section at the end of the report. Seasonal changes in extracted chlorophyll a concentration in surface samples from Sky Pond are shown in figure 6. Comparison of figures 5 and 6 indicates that the same seasonal pattern occurred for algal abundance and chlorophyll a concentrations and provides further evidence of a greater algal biomass associated with the early spring diatom bloom than with the fall blue-green algal bloom. Little correspondence appears to occur between the extracted chlorophyll a concentration and the fluorescence data, either for the period of study, or for different depths on a single sampling date. The relation between the cellular chlorophyll a content and the fluorescence of living phytoplankton is known to vary significantly among algal species, and with changes in physiological status for a single algal species (Alpine and Cloern, 1985). Therefore the failure to observe a well-defined relation between these two characteristics in this study is consistent with the recorded changes in the phytoplankton-species composition.

Chlorophyll a concentrations measured in Sky Pond and The Loch are similar in magnitude to those measured by Ellsworth (1983) in another small Colorado mountain lake during the same season. Toetz and Windell (1983) measured chlorophyll a concentrations in 7 lakes in the nearby Green Lakes Valley in August; they measured concentrations of chlorophyll a ranging from 0.5 to 10 $\mu\text{g/L}$ (micrograms per liter), which is comparable to the range measured in Loch Vale lakes during August.

Concentrations of Nutrients and Other Chemical Constituents

Concentrations of nutrients and other chemical constituents are listed in table 36 for Sky Pond and in table 37 for The Loch. Seasonal changes in nitrate and orthophosphate concentrations in Sky Pond are shown in figure 7. Throughout the open-water period of this study, nutrient concentrations virtually were uniform with depth, which fact is explained by lack of temperature stratification in these lakes (fig. 8). Therefore, nutrients released from lake sediments would be available to phytoplankton in the water column. In both Sky Pond and The Loch, during the winter, under ice-cover, steep concentration gradients with depth occurred for several nutrients, with the greatest nitrate concentrations at the surface, and the greatest orthophosphate and iron concentrations at depth. These gradients may have reflected anaerobic microbial processes occurring in the lake sediments or in the

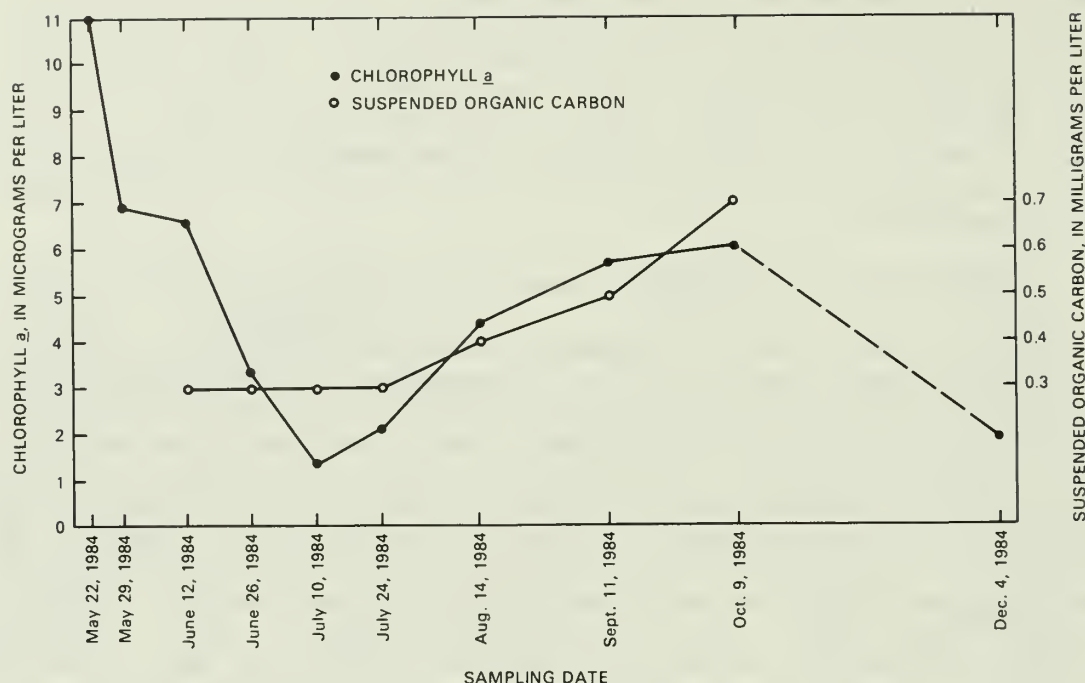


Figure 6.--Seasonal changes in chlorophyll *a* and suspended-organic-carbon concentrations in surface samples from Sky Pond (see table .34 and 39).

bottom waters. In early May, the concentration maximum in nitrate at the surface increased in magnitude, which was consistent with inflow of nitrate-enriched water from shallow subsurface runoff travelling under the snowpack, as snowmelt began. Development of this peak in surface nitrate concentration appeared to be delayed in Sky Pond, relative to The Loch, which is at a lower elevation.

The spring increase in nitrate concentration extended to depth as the lakes became ice-free, with the continuing spring runoff. Similar seasonal trends in nitrate concentration were determined in previous years of the study at Loch Vale. This trend of increasing nitrate concentrations with discharge in the spring runoff period is the opposite of the trend of decreasing spring nitrate concentrations determined by Lewis and Grant (1979) in Como Creek, a small Rocky Mountain stream draining a watershed only 40 km south of the Loch Vale area. However, the nitrate concentrations Lewis and Grant (1979) measured in Como Creek were in the range of 1 to 7 µg/L, more than 2 orders of magnitude less than those in Loch Vale surface waters. Toetz and Windell (1983, and written commun., 1984) measured nitrate concentrations in Albion Lake in the Green Lakes system ranging from 45 to 700 µg/L in the summers of 1983 and 1984, which is a more limited but comparable range to that measured in Loch Vale lakes.

Halterman and Toetz (1984) studied the kinetics of nitrate uptake by many freshwater algal species. They determined that several diatom species had half-saturation coefficients (K_s) for nitrate of 2.5 to 7 µM (micromolar) which were about the maximum for all algal species studied. If the

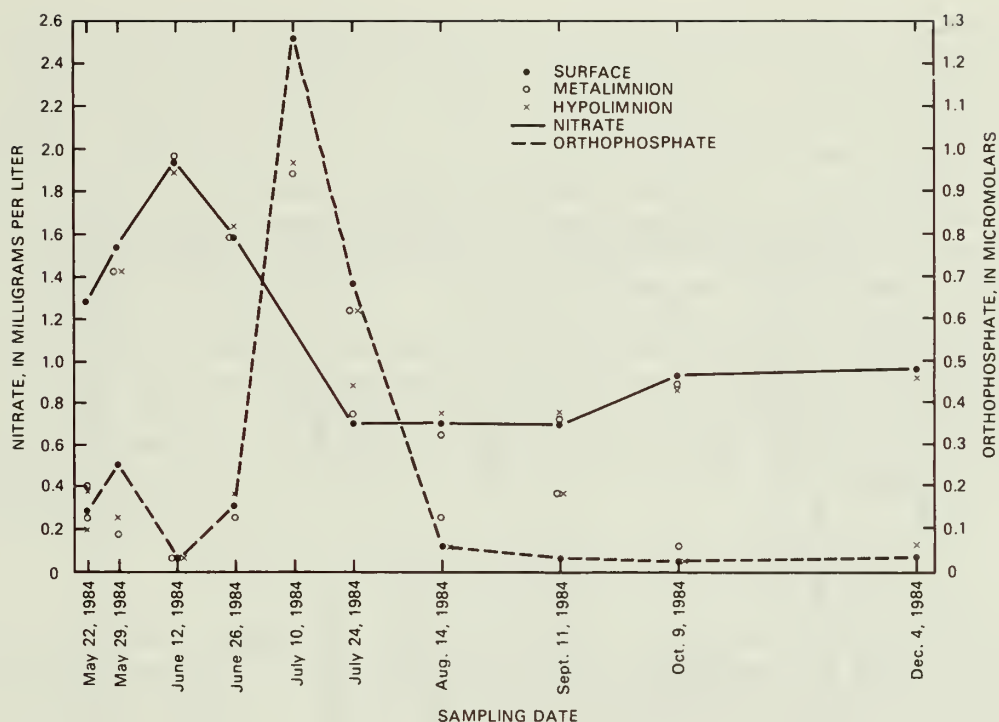


Figure 7.--Seasonal changes in nitrate and orthophosphate concentration in Sky Pond (see table 36).

Asterionella formosa populations in these lakes had K_S values of 7 to 10 μM , the spring increase in nitrate concentration, from 221 $\mu\text{g/L}$ (3.5 μM) on May 8, 1984, to 1,950 $\mu\text{g/L}$ (31.5 μM) on June 6, 1984, in Sky Pond, would result in an increased rate of nitrate uptake, if the concentrations of other nutrients were not limiting the growth of *A. formosa*. The enhanced nitrate uptake rates may have been an important factor in the rapid growth rates necessary to account for the increases in diatom abundance that occur during the periods of rapid flushing rates in the spring. The significance of these rapid flushing rates for alpine lakes was discussed by Keefer and Pennak (1977), who determined that 99 percent of the plankton in Long Lake, Colorado, was flushed out by excessive June runoff. A possibility also exists that increased nitrate concentrations are related to lower temperature optima for algal photosynthesis and respiration (Priscu and Goldman, 1984). Therefore, the nitrate peak may be a causal factor in the spring diatom-population peak (comparison of figs. 5 and 7).

During midsummer, the concentrations of dissolved orthophosphate increased substantially. With the exception of higher orthophosphate concentrations in July, the low concentrations of dissolved orthophosphate in Sky Pond and The Loch were similar to concentrations in lakes in the Green Lakes Valley (Toetz and Windell, 1983) and in Como Creek (Lewis and Grant, 1979). Phosphate may have been a limiting nutrient in these lakes. However, the increase in orthophosphate in July during midsummer phytoplankton minimum indicated that the decrease in phytoplankton abundance was not a result of phosphate depletion, but, conversely, that the increase in phosphate was a

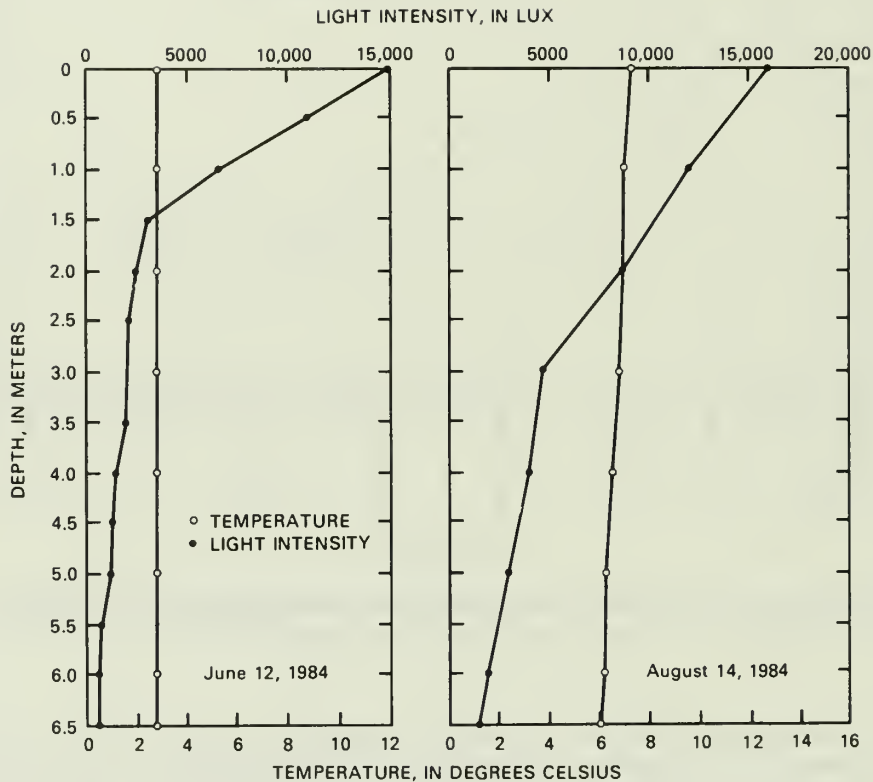


Figure 8.--Temperature and light-intensity profiles in Sky Pond during spring snowmelt (June 12, 1984) and midsummer (August 14, 1984)(see table 40).

result of phytoplankton decrease. This result further indicated that the phytoplankton decrease was caused by another process, such as zooplankton grazing or photoinhibition. Without additional data, both processes are considered as equally possible. Ellsworth (1983) determined maximum zooplankton abundance in midsummer in a study of another Colorado mountain lake. Fabris and Hammer (1975) determined maximum photosynthetic rates at depth in high-altitude lakes in the Canadian Rocky Mountains.

The silica concentration in Sky Pond generally was between 0.5 and 1.5 mg/L (milligrams per liter); the silica concentration in The Loch was somewhat larger, between 1.5 and 3.0 mg/L. At these concentrations, silica limitation of diatom growth was unlikely to be a factor in the ecology of these lakes. A decrease in silica concentration occurred in both lakes during the spring snowmelt period. This decrease may have been a result of hydrologic factors, such as dilution of dissolved silica by snowmelt, or, possibly, the decrease may have been a result of the concurrent peak in diatom abundance.

The DOC and SOC concentrations in the Sky Pond and The Loch are listed in tables 38 and 39 in the "Supplemental Data" section at the end of the report. DOC concentrations in these two lakes consistently were less than 1.0 mg C/L (milligrams carbon per liter). The trend of decreasing DOC through the summer probably was related to the decreasing surface runoff entering these lakes. For both lakes, DOC concentrations were very similar at all sampling depths. The minimum DOC concentrations were in samples from the small inlet to Sky Pond during snowmelt and the maximum DOC concentrations were in samples from a small stream entering The Loch. The SOC concentrations also were low, and were comparable in magnitude to DOC concentrations. As shown in figure 6, for Sky Pond, the increase in SOC concentrations in the fall appeared to parallel the increase in chlorophyll a associated with the blue-green algal peak. In The Loch, no relation between SOC and chlorophyll a concentrations was apparent, which can be interpreted as indicating that the lesser algal abundance in The Loch, relative to Sky Pond, does not contribute significantly to the SOC in The Loch.

Values of Selected Physical Characteristics

Data for pH, temperature, and intensity of PAR are listed in table 40 for Sky Pond and in table 41 for The Loch in the "Supplemental Data" section at the end of the report. Temperature and light profiles in Sky Pond during the peak in diatom abundance (6-12-84), and during the midsummer minimum in algal abundance (8-14-84), are presented in figure 8. These data indicate that the attenuation of PAR with depth is less during midsummer than during the spring or fall. The decrease in light attenuation can be quantified by fitting the data in tables 40 and 41 to the following equation:

$$I = I_0 e^{-Kz} \quad (2)$$

The extinction coefficient and Secchi depth in Sky Pond during the period of study are shown in figure 9 and are compared with measurements of color by comparison with standard platinum solutions in table 42 in the "Supplemental Data" section at the end of the report.

Two explanations are possible for the seasonal change in extinction coefficient: (1) At the end of the spring runoff period, the extinction coefficient decreased because of settling of suspended material and decreases in concentration of humic substances in lake inflow, at which point the greater light intensity at depth caused a decrease in photosynthesis rate (photoinhibition) and in phytoplankton abundance; or (2) the extinction coefficient primarily was affected by the phytoplankton abundance, and, in midsummer, some other factor, such as zooplankton grazing, decreased the phytoplankton abundance and caused the extinction coefficient to decrease concurrently.

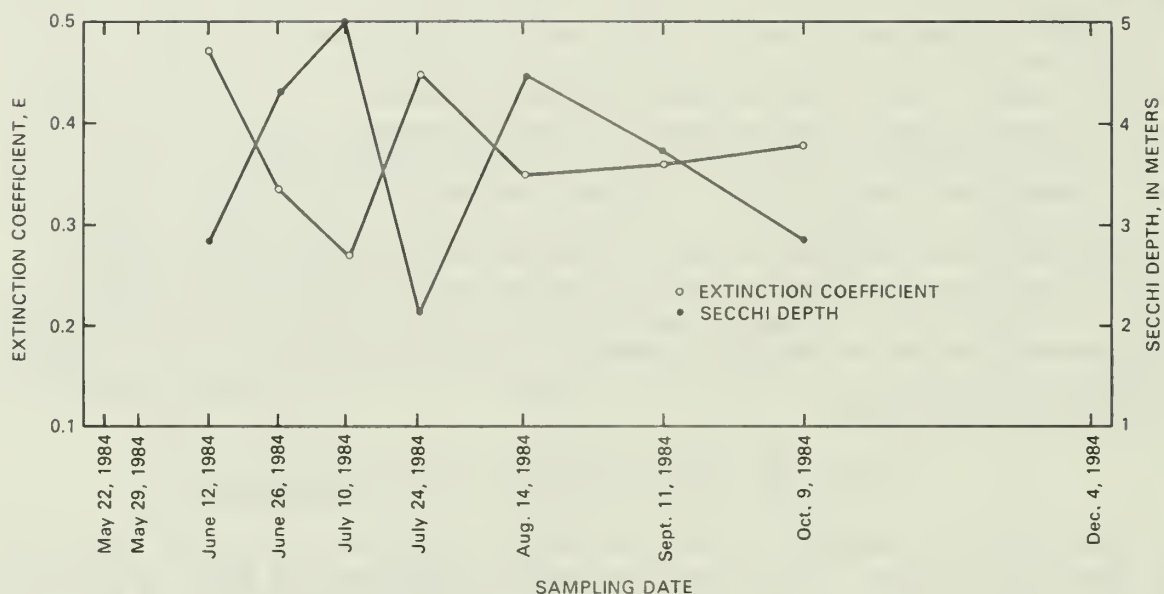


Figure 9.--Seasonal changes in extinction coefficient and Secchi depth in Sky Pond.

SUMMARY

The purpose of the study reported here was to identify important seasonal changes in the phytoplankton populations in Loch Vale lakes in order to design experiments to study the effects of potential nitrate-concentration increases resulting from acid rain. Three periods were identified in the phytoplankton succession in the lakes: (1) A spring diatom bloom; (2) a midsummer algal minimum; and (3) a fall blue-green algal bloom.

Although the seasonal changes in phytoplankton populations in the Loch Vale lakes resembled the general pattern observed in temperate lakes, these lakes are probably different in several ways from temperate lakes at lower elevations. Thermal stratification in the summer did not occur; therefore, the summer decrease in phytoplankton abundance was most likely a result of zooplankton grazing or photoinhibition, and not a result of phosphate depletion as occurs in typical temperate lakes. In fact, phosphate concentrations increased during the decrease in phytoplankton, indicating that the lake bottom or the dead phytoplankton are a source of phosphate at this time. The spring diatom bloom occurred at times of rapid flushing rates, resulting from rapid melting of the substantial snowpack. The diatom bloom during a period of rapid flushing rates implies a rapid phytoplankton growth rate. Rapid growth rate, in turn, may have been stimulated by the concurrent two-fold increase in nitrate concentrations, if the nitrate-uptake kinetics of the diatom populations in the Loch Vale lakes are similar to those of freshwater diatoms studied by Halterman and Toetz (1984).

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SUPPLEMENTAL DATA

Table 5.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from Sky Pond, May 29, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Melosira lirata</i>	85	57	--
Order Pennales			
<i>Achnanthes linearis</i>	57	--	--
<i>Asterionella formosa</i>	20,107	15,535	13,092
<i>Fragilaria crotonensis</i>	170	--	57
<i>Synedra rumpens</i>	--	28	--
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	256	114	142
<i>Chlamydomonas</i> sp. 1	28	--	--
<i>Chlorogonium</i> sp.	85	--	57
<i>Closterium</i> sp.	--	57	--
<i>Eudorina elegans</i>	568	511	--
<i>Gloeococcus tetrasporus</i>	--	227	--
<i>Gonium</i> sp.	--	--	85
<i>Nephrocytium limneticum</i>	4,004	2,925	1,079
<i>Octosporiella coloradensis</i>	--	114	256
<i>Pandorina smithii</i>	--	909	--
<i>Scenedesmus</i> sp.	511	341	369
<i>Ulothrix</i> sp.	--	341	454
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	28	28	85
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	284	--	1,505
<i>Chroococcus</i> sp.	28	114	369
<i>Oscillatoria limnetica</i>	625	--	--
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	3,465	1,676	170
<i>Cryptomonas</i> sp.	--	28	--
Total cells per milliliter	30,301	23,005	17,720
Number of species	15	16	13

Table 6.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from Sky Pond, June 12, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Melosira lirata</i>	454	--	--
Order Pennales			
<i>Asterionella formosa</i>	26,639	30,502	30,786
<i>Fragilaria pinnata</i>	--	--	398
<i>Synedra rumpens</i>	284	170	341
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i>			
var. <i>acicularis</i>	170	--	227
<i>Chlamydomonas</i> sp. 1	--	114	--
<i>Chlorella ellipsoidea</i>	341	398	227
<i>Chlorococcum</i> sp.	--	57	--
<i>Closterium</i> sp.	--	114	--
<i>Gonium</i> sp.	170	--	398
<i>Nephrocytium limneticum</i>	2,840	1,477	1,704
<i>Octosporiella coloradensis</i>	284	682	170
<i>Scenedesmus</i> sp.	341	341	227
<i>Schroederia setigera</i>	57	682	--
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	199	--	--
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	454	--	--
<i>Oscillatoria limnetica</i>	--	909	682
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium inconspicua</i>	--	--	57
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	3,010	3,238	1,988
<i>Cryptomonas ovata</i>	57	--	--
Total cells per milliliter	35,300	38,684	37,205
Number of species	14	12	12

Table 7.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from Sky Pond, June 26, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Melosira lirata</i>	227	--	--
Order Pennales			
<i>Asterionella formosa</i>	6,674	7,270	6,248
<i>Synedra rumpens</i>	256	170	114
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i>			
var. <i>acicularis</i>	227	57	142
<i>Chlamydomonas</i> sp. 1	227	85	228
<i>Chlamydomonas</i> sp. 2	142	28	57
<i>Chlorella ellipsoidea</i>	738	966	511
<i>Closterium</i> sp.	85	57	57
<i>Gloeococcus tetrasporus</i>	85	85	28
<i>Gonium</i> sp.	--	--	57
<i>Nephrocytium limneticum</i>	142	85	28
<i>Octosporiella coloradensis</i>	--	57	--
<i>Scenedesmus</i> sp.	--	170	--
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	909	426	256
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	142	--	--
<i>Oscillatoria limnetica</i>	909	--	284
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	1,818	1,619	1,704
<i>Cryptomonas marsonii</i>	57	--	28
Total cells per milliliter	12,638	11,075	9,742
Number of species	15	13	14

Table 8.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from Sky Pond, July 10, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Cyclotella stelligera</i>	28	--	--
<i>Melosira lirata</i>	170	--	--
Order Pennales			
<i>Asterionella formosa</i>	1,221	1,505	1,164
<i>Diatoma niemale</i> var. <i>mesodon</i>	--	28	--
<i>Fragilaria crotonensis</i>	--	57	--
<i>Navicula schmassmannii</i>	28	--	--
<i>Synedra radians</i>	--	28	85
<i>Synedra rumpens</i>	57	--	--
<i>Synedra rumpens</i> var. <i>familiaris</i>	--	--	57
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	28	--	--
<i>Chlamydomonas</i> sp. 1	170	57	1,051
<i>Chlamydomonas</i> sp. 2	114	511	85
<i>Chlamydomonas</i> sp. 3	--	142	426
<i>Chlorella ellipsoidea</i>	4,487	3,749	369
<i>Gloeococcus tetrasporus</i>	--	28	--
<i>Gonium</i> sp.	142	--	568
<i>Octosporiella coloradensis</i>	114	568	312
<i>Scenedesmus</i> sp.	57	57	--
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	852	1,278	--
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	--	114	--
<i>Dactylococcopsis acicularis</i>	28	85	85
<i>Oscillatoria limnetica</i>	3,522	2,755	7,128
PYRRROPHYTA (Dinoflagellates)			
<i>Peridinium inconspicua</i>	--	28	28
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	511	1,079	284
<i>Rhodomonas minuta</i>	--	--	256
Total cells per milliliter	11,529	12,069	11,898
Number of species	16	17	14

Table 9.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from Sky Pond, July 24, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Cyclotella stelligera</i>	28	--	85
Order Pennales			
<i>Asterionella formosa</i>	683	1,306	483
<i>Fragilaria pinnata</i>	57	--	--
<i>Synedra radians</i>	--	114	57
<i>Synedra rumpens</i> var. <i>familiaris</i>	--	170	--
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus facatus</i> var. <i>acicularis</i>	--	57	--
<i>Chlamydomonas</i> sp. 1	199	2,442	341
<i>Chlamydomonas</i> sp. 2	483	398	824
<i>Chlamydomonas</i> sp. 3	540	738	596
<i>Chlorella ellipsoidea</i>	4,004	21,300	7,924
<i>Chlorococcum infusionum</i>	--	--	28
<i>Eudorina elegans</i>	1,903	966	85
<i>Gonium</i> sp.	28	227	85
<i>Spirogyra</i> sp.	57	--	--
Zoospores	142	--	57
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	170	114	312
CYANOPHYTA (Blue-green algae)			
<i>Oscillatoria limnetica</i>	8,350	29,422	13,348
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium inconspicua</i>	85	--	--
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	--	114	--
Total cells per milliliter	16,699	57,368	24,225
Number of species	14	13	13

Table 10.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from Sky Pond, August 14, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
<i>Asterionella formosa</i>	707	682	511
<i>Navicula schmassmannii</i>	28	--	--
<i>Synedra radians</i>	114	--	--
<i>Synedra rumpens</i> var. <i>familiaris</i>	--	57	57
CHLOROPHYTA (Green algae)			
<i>Chlamydomonas</i> sp. 1	398	1,250	170
<i>Chlamydomonas</i> sp. 2	1,250	114	2,357
<i>Chlamydomonas</i> sp. 3	568	114	85
<i>Chlorella ellipsoidea</i>	9,315	7,668	8,974
<i>Chlorococcum infusionum</i>	3,324	682	--
<i>Eudorina elegans</i>	--	--	511
<i>Gonium</i> sp.	284	170	--
<i>Scenedesmus</i> sp.	--	--	57
Zoospores	--	170	142
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	710	--	540
<i>Oscillatoria limnetica</i>	29,337	31,354	58,731
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	85	57	28
Total cells per milliliter	46,120	42,318	72,163
Number of species	12	11	12

Table 11.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, September 11, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Melosira lirata</i>	28	--	57
Order Pennales			
<i>Asterionella formosa</i>	57	341	85
<i>Synedra rumpens</i>	--	--	57
<i>Synedra rumpens</i> var. <i>familiaris</i>	28	57	--
CHLOROPHYTA (Green algae)			
<i>Chlamydomonas</i> sp. 1	28	966	284
<i>Chlamydomonas</i> sp. 2	--	568	85
<i>Chlamydomonas</i> sp. 3	--	--	28
<i>Chlorococcum infusionum</i>	341	--	312
<i>Gonium sociale</i>	--	398	--
<i>Gonium</i> sp.	880	227	511
<i>Pandorina morum</i>	--	682	1,079
<i>Scenedesmus</i> sp.	57	114	--
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	--	--	114
<i>Oscillatoria limnetica</i>	371,023	315,341	160,233
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	227	114	--
<i>Rhodomonas minuta</i>	--	114	28
Total cells per milliliter	372,669	318,922	162,873
Number of species	9	11	12

Table 12.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from Sky Pond, October 9, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Melosira lirata</i>	--	57	--
Order Pennales			
<i>Asterionella formosa</i>	114	114	312
<i>Synedra rumpens</i> var. <i>familiaris</i>	114	114	57
CHLOROPHYTA (Green algae)			
<i>Chlamydomonas</i> sp. 1	1,448	3,578	2,755
<i>Chlamydomonas</i> sp. 2	85	398	767
<i>Chlamydomonas</i> sp. 3	--	57	--
<i>Chlorococcum infusionum</i>	1,931	--	14
<i>Cosmarium</i> sp.	--	--	57
<i>Eudorina elegans</i>	284	--	--
<i>Gonium</i> sp.	284	--	114
<i>Nephrocytium limneticum</i>	28	57	--
<i>Scenedesmus</i> sp.	--	227	--
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	--	--	28
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	170	114	--
<i>Oscillatoria limnetica</i>	264,688	453,636	197,437
<i>Synechococcus linearis</i>	--	--	28
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium inconspicua</i>	--	--	57
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	625	114	312
<i>Rhodomonas minuta</i>	--	57	--
Total cells per milliliter	269,771	458,523	201,938
Number of species	11	12	12

Table 13.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from Sky Pond, January 22, 1985

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
<i>Asterionella formosa</i>	32,092	114	--
<i>Syndera rumpens</i> var. <i>familiaris</i>	28	--	--
 CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	568	170	28
<i>Chlamydomonas</i> sp. 1	114	28	682
<i>Chlorogonium</i> sp.	--	--	28
<i>Chlorococcum</i> sp.	3,493	--	--
<i>Nephrocytium</i> sp.	199	1,732	682
<i>Scenedesmus</i> sp.	227	57	--
 CHRYSOPHYTA (Golden-brown algae)			
<i>Dinobryon cylindricum</i> var. <i>alpinum</i>	1,619	1,818	28
Unicellular flagellate	--	--	227
 CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	85	1,136	--
Total cells per milliliter	38,425	5,055	1,675
Number of species	9	7	6

Table 14.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from The Loch, May 23, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Cyclotella stelligera</i>	57	--	--
Order Pennales			
<i>Asterionella formosa</i>	3,578	824	880
<i>Pinnularia borealis</i>	--	--	28
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	57	114	28
<i>Ankistrodesmus nannoselene</i>	--	114	256
<i>Chlamydomonas</i> sp. 1	--	--	57
<i>Chlamydomonas</i> sp. 2	57	199	--
<i>Chlorogonium</i> sp.	57	--	--
<i>Eudorina elegans</i>	--	852	--
<i>Oocystis</i> sp.	--	28	--
<i>Scenedesmus</i> sp.	909	57	57
<i>Schroederia setigera</i>	--	--	28
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	114	57	--
Unicellular flagellate	--	385	199
CYANOPHYTA (Blue-green algae)			
<i>Aphanothece</i> sp.	18,627	20,107	11,076
<i>Chroococcus limneticus</i>	227	--	--
<i>Chroococcus</i> sp.	852	--	227
<i>Lyngbya nana</i>	682	--	--
<i>Microcystis</i> sp.	--	--	3,408
<i>Oscillatoria augustissima</i>	568	--	--
<i>Oscillatoria limnetica</i>	--	85	--
<i>Oscillatoria</i> sp.	--	398	--
<i>Synechococcus elongatus</i>	--	7,100	85
<i>Synechococcus linearis</i>	114	1,761	--
<i>Synechocystis</i> sp.	4,317	--	142
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium inconspicua</i>	284	--	--
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	114	28	170
<i>Cryptomonas</i> sp.	341	28	--
Total cells per milliliter	30,955	32,137	16,641
Number of species	17	16	14

Table 15.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, June 13, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)	
	H	M
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
<i>Melosira lirata</i>	227	--
Order Pennales		
<i>Asterionella formosa</i>	2,840	2,868
<i>Meridion circulare</i>	--	28
<i>Navicula viridula</i>	28	--
CHLOROPHYTA (Green algae)		
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	28	57
<i>Ankistrodesmus nannoselene</i>	28	227
<i>Chlamydomonas</i> sp. 1	568	227
<i>Chlamydomonas</i> sp. 2	57	142
<i>Chlorogonium</i> sp.	--	57
<i>Eudorina elegans</i>	426	--
<i>Gloeococcus tetrasporus</i>	341	--
<i>Gonium</i> sp.	--	28
<i>Octosporiella coloradensis</i>	256	170
<i>Scenedesmus</i> sp.	57	114
CHRYSTOPHYTA (Golden-brown algae)		
<i>Dinobryon divergens</i>	--	426
CYANOPHYTA (Blue-green algae)		
<i>Chroococcus limneticus</i>	199	170
CRYPTOPHYTA (Cryptomonads)		
<i>Cryptomonas</i> sp.	--	170
<i>Rhodomonas minuta</i>	57	57
Total cells per milliliter	5,112	4,741
Number of species	13	14

Table 16.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from The Loch, June 20, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Cyclotella stelligera</i>	--	28	57
<i>Melosira lirata</i>	227	--	--
Order Pennales			
<i>Asterionella formosa</i>	5,566	3,436	3,436
<i>Navicula minima</i>	--	28	--
<i>Navicula pseudoscutiformis</i>	28	--	--
<i>Synedra radians</i>	28	28	--
<i>Synedra rumpens</i>	--	28	28
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	28	57	57
<i>Ankistrodesmus nannoselene</i>	85	--	114
<i>Chlamydomonas</i> sp. 1	454	738	369
<i>Chlamydomonas</i> sp. 2	114	--	28
<i>Chlorella ellipsoidea</i>	--	284	--
<i>Eudorina elegans</i>	--	57	--
<i>Gonium</i> sp.	--	28	--
<i>Octosporiella coloradensis</i>	284	--	28
<i>Scenedesmus</i> sp.	57	114	--
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	--	57	--
Unicellular flagellate	--	--	28
CYANOPHYTA (Blue-green algae)			
<i>Aphanocapsa delicatissima</i>	1,221	--	--
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium inconspicua</i>	28	--	--
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	284	57	483
<i>Rhodomonas minuta</i>	--	57	--
Total cells per milliliter	8,404	5,054	4,628
Number of species	13	15	10

Table 17.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, June 27, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
<i>Asterionella formosa</i>	1,179	5,112	2,215
<i>Navicula notha</i>	--	--	28
<i>Synedra radians</i>	--	57	28
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	--	57	57
<i>Ankistrodesmus nannoselene</i>	--	227	--
<i>Chlamydomonas</i> sp. 1	142	114	227
<i>Chlamydomonas</i> sp. 2	--	170	28
<i>Chlorogonium</i> sp.	--	57	--
<i>Closterium</i> sp.	--	57	--
<i>Eudorina elegans</i>	170	1,590	--
<i>Octosporiella coloradensis</i>	--	57	--
<i>Scenedesmus</i> sp.	28	114	57
CHRYSOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	71	284	--
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	185	568	341
Total cells per milliliter	1,775	8,464	2,981
Number of species	6	13	8

Table 18.--Species list and density of phytoplankton taxa collected in
1-liter discrete samples from The Loch, July 3, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Cyclotella stelligera</i>	19	--	--
<i>Melosira lirata</i>	76	--	--
Order Pennales			
<i>Achnanthes detha</i>	--	19	57
<i>Asterionella formosa</i>	718	624	795
<i>Synedra radians</i>	--	--	28
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	38	38	28
<i>Ankistrodesmus nannoselene</i>	--	--	28
<i>Chlamydomonas</i> sp. 1	208	95	227
<i>Chlamydomonas</i> sp. 2	57	19	28
<i>Chlamydomonas</i> sp. 3	38	19	--
<i>Chlorella ellipsoidea</i>	284	132	199
<i>Chlorogonium</i> sp.	19	--	--
<i>Eudorina elegans</i>	138	--	85
<i>Gonium sociale</i>	--	--	114
<i>Gonium</i> sp.	--	19	28
<i>Scenedesmus</i> sp. 2	38	--	57
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	76	76	57
<i>Dinobryon pediforme</i>	--	19	28
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	57	--	85
<i>Oscillatoria limnetica</i>	548	--	--
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium</i> sp.	--	19	--
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	435	246	256
<i>Rhodomonas minuta</i>	19	--	--
Total cells per milliliter	2,768	1,325	2,100
Number of species	16	12	16

Table 19.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, July 25, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Cyclotella stelligera</i>	28	--	--
<i>Melosira lirata</i>	--	43	--
Order Pennales			
<i>Asterionella formosa</i>	--	--	244
<i>Fragilaria pinnata</i>	28	--	--
<i>Hannaea arcus</i>	--	14	28
<i>Meridion circulare</i>	--	43	--
<i>Nitzschia paleacea</i>	14	--	--
<i>Synedra rumpens</i> var. <i>familiaris</i>	28	--	--
CHLOROPHYTA (Green algae)			
<i>Chlamydomonas</i> sp. 1	383	185	142
<i>Chlamydomonas</i> sp. 2	85	256	256
<i>Chlamydomonas</i> sp. 3	43	--	170
<i>Chlorella ellipsoidea</i>	511	454	852
<i>Eudorina elegans</i>	--	57	85
<i>Gonium</i> sp.	--	--	28
<i>Scenedesmus</i> sp.	--	28	--
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	142	99	28
<i>Lyngbya nana</i>	540	--	--
<i>Oscillatoria limnetica</i>	--	43	568
<i>Phormidium</i> sp.	--	454	--
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium inconspicua</i>	--	14	--
<i>Peridinium</i> sp.	--	14	--
CRYPTOPHYTA (Cryptomonads)			
<i>Chilomonas</i> sp.	--	14	--
Total cells per milliliter	1,802	1,718	2,401
Number of species	10	14	10

Table 20.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, August 15, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Melosira lirata</i>	--	99	--
Order Pennales			
<i>Cymbella minuta</i>	28	--	--
<i>Diatoma niemale</i> var. <i>mesodon</i>	28	--	--
<i>Navicula schmassmannii</i>	--	--	28
CHLOROPHYTA (Green algae)			
<i>Chlamydomonas</i> sp. 1	2,670	--	511
<i>Chlamydomonas</i> sp. 2	5,936	4,658	4,317
<i>Chlorella ellipsoidea</i>	57	28	199
<i>Scenedesmus</i> sp.	--	--	114
CYANOPHYTA (Blue-green algae)			
<i>Anabaena</i> sp.	--	--	170
<i>Chroococcus limneticus</i>	--	28	28
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium inconspicua</i>	28	--	--
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	28	--	--
Total cells per milliliter	8,775	4,813	5,367
Number of species	7	4	7

Table 21.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, August 30, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Cyclotella stelligera</i>	--	--	14
Order Pennales			
<i>Achnanthes detha</i>	28	14	--
<i>Asterionella formosa</i>	--	14	--
<i>Diatoma niemale</i> var. <i>mesodon</i>	28	114	--
<i>Eunotia</i> sp.	--	14	--
<i>Fragilaria pinnata</i>	14	--	57
<i>Hannaea arcus</i>	--	14	--
CHLOROPHYTA (Green algae)			
<i>Chlamydomonas</i> sp. 1	71	14	227
<i>Chlamydomonas</i> sp. 2	14	--	--
<i>Chlorella ellipsoidea</i>	170	28	14
<i>Chlorella</i> sp.	--	--	4,984
<i>Gonium</i> sp.	4,524	6,248	809
<i>Scenedesmus</i> sp.	28	28	--
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	57	43	--
<i>Chroococcus varius</i>	--	--	28
<i>Oscillatoria limnetica</i>	--	284	199
CRYPTOPHYTA (Cryptomonads)			
<i>Cryptomonas marsonii</i>	--	--	14
<i>Cryptomonas</i> sp.	--	14	--
Total cells per milliliter	5,934	6,829	6,346
Number of species	9	12	9

Table 22.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, September 13, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Melosira lirata</i>	--	114	--
Order Pennales			
<i>Asterionella formosa</i>	--	--	19
<i>Fragilaria pinnata</i>	--	57	--
<i>Navicula minima</i>	28	--	--
CHLOROPHYTA (Green algae)			
<i>Chlamydomonas</i> sp. 1	284	398	142
<i>Chlamydomonas</i> sp. 3	114	--	341
<i>Gonium</i> sp.	3,692	2,048	2,073
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus</i> sp.	28	170	596
<i>Oscillatoria limnetica</i>	6,333	19,028	19,710
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	28	57	28
Total cells per milliliter	10,507	21,872	22,909
Number of species	7	7	7

Table 23.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, October 11, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
<i>Asterionella formosa</i>	--	--	28
<i>Diatoma hiemale</i> var. <i>mesodon</i>	--	57	--
CHLOROPHYTA (Green algae)			
<i>Chlamydomonas</i> sp. 1	312	2,556	426
<i>Chlamydomonas</i> sp. 2	--	--	227
<i>Chlamydomonas</i> sp. 3	1,562	142	312
<i>Scenedesmus serratus</i>	--	--	114
<i>Scenedesmus</i> sp.	--	--	114
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon divergens</i>	--	653	170
CYANOPHYTA (Blue-green algae)			
<i>Aphanothece</i> sp.	--	--	1,079
<i>Chroococcus</i> sp.	142	--	--
<i>Oscillatoria limnetica</i>	13,774	7,952	7,725
CRYPTOPHYTA (Cryptomonads)			
<i>Chroomonas</i> sp.	--	--	256
Total cells per milliliter	15,790	11,360	10,451
Number of species	4	5	10

Table 24.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, December 6, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
<i>Asterionella formosa</i>	--	28	--
<i>Diatoma hiemale</i> var. <i>mesodon</i>	1,732	1,846	341
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	28	227	28
<i>Chlamydomonas</i> sp. 1	2,102	312	426
<i>Chlamydomonas</i> sp. 2	227	--	57
<i>Chlamydomonas</i> sp. 3	--	824	199
<i>Chlorella ellipsoidea</i>	--	114	170
<i>Chlorogonium</i> sp.	341	--	--
<i>Cosmarium</i> sp.	--	28	--
<i>Gonium</i> sp.	--	--	28
<i>Nephrocytium</i> sp.	--	28	--
<i>Scenedesmus</i> sp.	57	256	--
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon</i> sp.	653	1,335	227
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus</i> sp.	511	28	--
<i>Oscillatoria limnetica</i>	1,278	2,698	795
<i>Synechococcus</i> sp.	--	28	--
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium</i> sp.	369	738	227
CRYPTOPHYTA (Cryptomonads)			
<i>Cryptomonas marsonii</i>	28	--	--
Total cells per milliliter	7,326	8,490	2,498
Number of species	11	14	10

Table 25.--Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, January 22, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter)		
	H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
<i>Cyclotella stelligera</i>	28	--	--
Order Pennales			
<i>Asterionella formosa</i>	4,090	4,317	1,590
CHLOROPHYTA (Green algae)			
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	57	114	28
<i>Chlamydomonas</i> sp. 1	--	28	--
<i>Chlorococcum</i> sp.	256	682	227
<i>Nephrocytium</i> sp.	57	257	85
<i>Scenedesmus</i> sp.	57	57	57
CHRYSTOPHYTA (Golden-brown algae)			
<i>Dinobryon cylindricum</i> var. <i>alpinum</i>	256	511	227
<i>Dinobryon statospore</i>	28	28	--
CYANOPHYTA (Blue-green algae)			
<i>Chroococcus limneticus</i>	710	4,175	2,589
<i>Synechococcus elongatus</i>	57	--	--
PYRROPHYTA (Dinoflagellates)			
<i>Peridinium bipes</i> var. <i>travectum</i>	28	142	28
Dinoflagellate			
CRYPTOPHYTA (Cryptomonads)			
<i>Cryptomonas erosa</i>	--	57	--
<i>Cryptomonas marsonii</i>	28	--	--
<i>Cryptomonas</i> sp.	28	--	--
Total cells per milliliter	5,680	10,368	4,831
Number of species	13	11	8

Table 26.--Species list and density of phytoplankton taxa collected in net tows from Sky Pond, May 22 and 29, June 12 and 26, July 10 and 24, and August 14, 1984

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984						
	5-22	5-29	6-12	6-26	7-10	7-24	8-14 ¹
BACILLARIOPHYTA (Diatoms)							
Order Centrales							
<i>Cyclotella stelligera</i>	--	37	--	--	75	--	68
<i>Melosira lirata</i>	154	263	97	523	205	48	31
Order Pennales							
<i>Achnanthes affinis</i>	3	--	--	--	24	--	--
<i>Achnanthes detha</i>	5	--	--	38	72	--	--
<i>Achnanthes linearis</i>	--	223	--	--	--	--	--
<i>Achnanthes linearis</i> <i>f. curta</i>	--	--	--	8	--	--	--
<i>Achnanthes marginulata</i>	2	--	97	8	8	36	--
<i>Achnanthes</i> sp.	--	--	97	--	8	12	--
<i>Asterionella formosa</i>	37,968	65,272	125,127	47,076	13,768	7,814	2,918
<i>Caloneis bacillum</i>	--	--	--	--	19	--	--
<i>Cymbella minuta</i>	--	--	21	4	8	--	--
<i>Cymbella minuta</i> <i>f. latens</i>	--	--	--	--	24	--	--
<i>Diatoma anceps</i>	--	--	--	--	--	5	--
<i>Eunotia incisa</i>	--	--	--	--	4	--	--
<i>Eunotia pectinalis</i>	--	--	--	--	15	--	--
<i>Fragilaria capucina</i>	--	--	--	4	--	12	12
<i>Fragilaria construens</i> var. <i>venter</i>	--	--	--	26	--	12	--
<i>Fragilaria crotonensis</i>	--	223	--	4	--	--	--
<i>Fragilaria pinnata</i>	8	--	843	37	75	189	6
<i>Frustula rhomboides</i>	--	--	--	4	--	--	--
<i>Meridion circulare</i>	--	--	--	26	--	77	6
<i>Navicula contenta</i> var. <i>biceps</i>	--	--	--	--	--	5	--
<i>Navicula minima</i>	--	--	--	11	8	--	6
<i>Navicula</i> <i>psuedoscutiformis</i>	--	--	--	--	16	--	6
<i>Navicula schmassmannii</i>	--	--	--	4	1	31	--
<i>Navicula subbacillum</i>	--	--	--	--	24	--	--
<i>Navicula</i> sp.	--	--	--	4	--	--	--
<i>Nitzschia frustulum</i>	--	--	--	--	--	--	12
<i>Nitzschia linearis</i>	--	--	--	4	--	6	6
<i>Pinnularia borealis</i>	--	--	10	--	19	--	--
<i>Surirella</i> sp.	--	--	--	--	--	--	6

Table 26.--Species list and density of phytoplankton taxa collected in net tows from Sky Pond, May 22 and 29, June 12 and 26, July 10 and 24, and August 14, 1984--Continued

Taxa	Density (cells per milliliter) for indicated days in 1984						
	5-22	5-29	6-12	6-26	7-10	7-24	8-14 ¹
BACILLARIOPHYTA (Diatoms)--Continued							
Order Pennales--Continued							
<i>Synedra radians</i>	--	--	--	--	--	157	12
<i>Synedra rumpens</i>							
var. <i>familiaris</i>	--	--	--	--	--	5	9
<i>Synedra</i> sp.	--	--	--	26	--	--	--
CHLOROPHYTA (Green algae)							
<i>Ankistrodesmus falcatus</i>							
var. <i>acicularis</i>	--	112	48	--	--	--	--
<i>Chlamydomonas dinobryon</i>	--	598	--	--	--	--	--
<i>Chlamydomonas</i> sp. 1	--	784	145	680	--	2,762	50
<i>Chlamydomonas</i> sp. 2	--	4,898	24	78	280	2,134	6
<i>Chlamydomonas</i> sp. 3	--	--	72	--	--	314	31
<i>Chlorella ellipsoidea</i>	--	--	--	--	467	879	87
<i>Chlorogonium</i> sp.	--	--	--	52	--	--	--
<i>Closterium</i> sp.	--	--	24	--	--	--	--
<i>Corone</i> sp.	--	--	--	--	--	--	12
<i>Cosmarium</i> sp. 1	19	--	--	--	--	--	--
<i>Cosmarium</i> sp. 2	19	--	--	--	--	--	--
<i>Eudorina elegans</i>	42,350	24,173	9,801	2,275	--	2,605	--
<i>Gloeococcus</i>							
<i>tetrasporus</i>	3,536	336	483	16,372	243	345	--
<i>Gonium</i> sp.	77	--	--	--	--	188	--
<i>Nephrocytium limneticum</i>	--	150	--	--	--	--	--
<i>Octosporiella</i>							
<i>coloradensis</i>	346	224	531	--	654	--	--
<i>Pandorina morum</i>	192	--	--	--	--	--	--
<i>Pandorina smithii</i>	4,881	2,391	--	--	--	439	--
<i>Pandorina</i> sp.	2,345	--	--	--	--	--	--
<i>Pleodorina</i>							
<i>californicum</i>	11,760	2,616	--	418	--	--	--
<i>Scenedesmus</i> sp.	--	150	--	--	--	--	--
<i>Schroederia setigera</i>	--	--	386	--	--	--	--
Zoospores	--	--	772	--	243	126	--
CHRYSOPHYTA (Golden-brown algae)							
<i>Dinobryon divergens</i>	77	189	410	4,551	2,298	220	12

Table 26.--Species list and density of phytoplankton taxa collected in net tows from Sky Pond, May 22 and 29, June 12 and 26, July 10 and 24, and August 14, 1984--Continued

Taxa	Density (cells per milliliter) for indicated days in 1984						
	5-22	5-29	6-12	6-26	7-10	7-24	8-14 ¹
CYANOPHYTA (Blue-green algae)							
<i>Aphanothece</i> sp.	692	--	--	--	--	--	--
<i>Chroococcus limneticus</i>	--	37	--	--	--	188	--
<i>Dactylococcopsis</i>							
<i>acicularis</i>	--	24	--	--	--	--	--
<i>Dactylococcopsis</i>							
<i>fasciculatus</i>	--	24	--	--	--	--	--
PYRROPHYTA (Dinoflagellates)							
<i>Peridinium inconspicua</i>	--	--	--	52	--	--	--
CRYPTOPHYTA (Cryptomonads)							
<i>Chroomonas</i> sp.	--	--	121	--	--	--	19
<i>Cryptomonas marsonii</i>	--	--	--	78	--	--	--
<i>Cryptomonas</i> sp.	--	--	48	--	--	--	--
<i>Rhodomonas minuta</i>	--	--	--	--	19	--	--
Total cells per milliliter							
	104,434	103,044	139,785	73,828	20,632	28,621	8,607
Number of species							
	18	19	23	27	26	26	21

¹Sample not well preserved.

Table 27.--Species list and density of phytoplankton taxa collected
in net tows from Sky Pond, September 11 and October 9, 1984

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984	
	9-11	10-9
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
<i>Melosira lirata</i>	23	71
Order Pennales		
<i>Achnanthes affinis</i>	1	--
<i>Achnanthes detha</i>	<1	--
<i>Achnanthes levanderi</i>	1	
<i>Achnanthes linearis</i>	1	--
<i>Anomoeoneis serians</i>		
var. <i>brachysira</i>	<1	--
<i>Asterionella formosa</i>	598	875
<i>Caloneis bacillum</i>	--	1
<i>Cymbella minuta</i> f. <i>latens</i>	6	--
<i>Fragilaria crotonensis</i>	2	--
<i>Fragilaria leptostauron</i>		
var. <i>dubia</i>	4	13
<i>Fragilaria pinnata</i>	25	79
<i>Fragilaria virescens</i>	--	7
<i>Navicula elginensis</i>		
var. <i>lata</i>	<1	--
<i>Navicula luzonensis</i>	<1	--
<i>Navicula minima</i>	1	1
<i>Navicula minuscula</i>	--	1
<i>Navicula schmassmanii</i>	<1	--
<i>Nitzschia frustulum</i>	<1	7
<i>Nitzschia linearis</i>	<1	--
<i>Nitzschia microcephala</i>	<1	--
<i>Syndera rumpens</i>		
var. <i>familiaris</i>	15	12
CHLOROPHYTA (Green algae)		
<i>Chlamydomonas</i> sp. 1	18	2,170
<i>Chlamydomonas</i> sp. 2	--	173
<i>Chlamydomonas</i> sp. 3	--	74
<i>Chlorococcum infusionum</i>	375	--
<i>Dictyosphaerium</i> sp.	--	99
<i>Eudorina</i> sp.	94	444
<i>Gloeocystis</i> sp.	--	99
<i>Gonium sociale</i>	23	--
<i>Gonium</i> sp.	463	2,565
<i>Octosporiella coloradensis</i>	--	99
<i>Pandorina morum</i>	70	--
CYANOPHYTA (Blue-green algae)		
<i>Oscillatoria limnetica</i>	75,633	133,283
Total cells per milliliter	77,355	140,048
Number of species	26	19

Table 28.--Species list and density of phytoplankton taxa
collected in net tows from Glass Lake, May 22, 1984

Taxa	Density (cells per milliliter) for 5-22-84
BACILLARIOPHYTA (Diatoms)	
Order Pennales	
<i>Asterionella formosa</i>	97,704
CHLOROPHYTA (Green algae)	
<i>Ankistrodesmus falcatus</i>	
var. <i>acicularis</i>	143
<i>Eudorina</i> sp.	31,563
<i>Gonium</i> sp.	574
<i>Nephrocytium</i> sp.	430
CHRYSOPHYTA (Golden-brown algae)	
<i>Dinobryon divergens</i>	10,184
CYANOPHYTA (Blue-green algae)	
<i>Aphanothece</i> sp.	47,633
<i>Chroococcus dispersus</i>	143
Total cells per milliliter	188,374
Number of species	8

Table 29.--Species list and density of phytoplankton taxa collected in net tows from The Loch, May 23, 1983, and June 5, 13, 20, and 27, 1984

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1983 and 1984				
	1983	1984			
	5-22	6-5	6-13	6-20	6-27
BACILLARIOPHYTA (Diatoms)					
Order Centrales					
<i>Cyclotella stelligera</i>	36	15	30	1,049	--
<i>Melosira lirata</i>	--	--	81	29	454
Order Pennales					
<i>Achnanthes affinis</i>	--	5	--	--	2
<i>Achnanthes austriaca</i>	--	--	--	--	1
<i>Achnanthes clevei</i>	--	--	--	--	2
<i>Achnanthes detha</i>	24	5	3	--	18
<i>Achnanthes linearis</i>	--	21	--	--	1
<i>Achnanthes marginulata</i>	--	26	--	--	1
<i>Asterionella formosa</i>	2,726	20,153	6,880	22,119	6,893
<i>Caloneis</i> sp.	--	--	--	--	17
<i>Cymbella lunata</i>	--	--	--	--	1
<i>Cymbella minuta</i>	--	--	--	--	1
<i>Cymbella minuta</i> var. <i>silesica</i>	--	--	--	--	2
<i>Diatoma anceps</i>	--	--	--	--	34
<i>Diatoma hiemale</i> var. <i>mesodon</i>	4	15	10	9	--
<i>Eunotia pectinalis</i>	--	--	--	--	1
<i>Fragilaria capucina</i>	8	--	101	--	9
<i>Fragilaria construens</i> var. <i>venter</i>	--	--	--	--	8
<i>Fragilaria crotonensis</i>	--	--	--	18	--
<i>Fragilaria pinnata</i>	--	51	--	--	45
<i>Frustula rhomboides</i>	4	--	3	--	--
<i>Hannaea arcus</i>	12	10	6	--	--
<i>Hannaea arcus</i> var. <i>amphioxys</i>	--	--	--	--	1
<i>Hantzschia amphioxys</i>	--	--	--	--	1
<i>Meridion circulare</i>	--	10	10	--	17
<i>Navicula arvensis</i>	--	--	--	--	2
<i>Navicula contenta</i> var. <i>biceps</i>	4	--	3	--	--
<i>Navicula minima</i>	--	--	--	--	2
<i>Navicula pseudoscutiformis</i>	8	--	3	--	--
<i>Navicula schmassmannii</i>	12	--	--	--	2
<i>Navicula viridula</i>	--	--	--	--	1
<i>Navicula</i> sp.	--	--	--	--	1
<i>Nitzschia frustulum</i>	--	--	10	--	--
<i>Nitzschia paleacea</i>	--	--	--	--	1
<i>Pinnularia borealis</i>	4	--	--	--	1
<i>Rhopalodia gibba</i>	4	--	--	--	--

Table 29.--Species list and density of phytoplankton taxa collected in net tows from The Loch, May 23, 1983, and June 5, 13, 20, and 27, 1984--
Continued

Taxa	Density (cells per milliliter) for indicated days in 1983 and 1984				
	1983	1984			
	5-22	6-5	6-13	6-20	6-27
BACILLARIOPHYTA (Diatoms)--Continued					
Order Pennales--Continued					
<i>Synedra pmansitica</i>	--	5	--	--	--
<i>Synedra radians</i>	12	--	10	87	50
CHLOROPHYTA (Green algae)					
<i>Ankistodesmus convolutus</i>	--	33	--	--	--
<i>Ankistrodesmus falcatus</i>	--	--	--	--	34
<i>Ankistrodesmus falcatus</i> var. <i>acicularis</i>	12	33	--	29	--
<i>Ankistrodesmus nannoselene</i>	24	--	--	--	--
<i>Chlamydomonas</i> sp. 1	--	--	20	50	--
<i>Chlamydomonas</i> sp. 2	24	520	--	175	--
<i>Cosmarium</i> sp.	--	--	--	58	--
<i>Eudorina elegans</i>	--	2,702	787	4,925	--
<i>Gloeococcus tetraspora</i>	18	585	222	--	--
<i>Octosporiella coloradensis</i>	--	--	222	495	--
<i>Pandorina morum</i>	--	--	--	29	--
<i>Scenedesmus abundans</i>	--	--	--	--	67
<i>Scenedesmus serratus</i>	--	--	--	--	67
<i>Scenedesmus</i> sp.	24	195	--	--	--
CHRYSTOPHYTA (Golden-brown algae)					
<i>Dinobryon divergens</i>	24	--	293	262	605
CYANOPHYTA (Blue-green algae)					
<i>Anabaena</i> sp.	--	--	--	--	--
<i>Aphanocapsa delicatissima</i>	--	--	--	--	960
<i>Aphanotheca</i> sp.	--	193	--	--	--
<i>Lyngbya nana</i>	--	--	--	--	269
<i>Microcystis</i> sp.	598	--	--	--	--
<i>Oscillatoria limnetica</i>	--	488	--	700	--
<i>Synechococcus linearis</i>	36	--	--	--	--
<i>Synechocystis</i> sp.	60	--	--	--	--
PYRROPHYTA (Dinoflagellates)					
<i>Peridinium inconspicua</i>	72	--	--	--	--
CRYPTOPHYTA (Cryptomonads)					
<i>Rhodomonas</i> sp.	--	5	--	--	--
Total cells per milliliter	3,750	25,070	8,704	30,034	9,606
Number of species	23	20	18	15	36

Table 30.--Species list and density of phytoplankton taxa collected in net
tows from The Loch, July 3, 17, and 25, and August 15, and 30, 1984

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984				
	7-3	7-17	7-25	8-15	8-30
BACILLARIOPHYTA (Diatoms)					
Order Centrales					
<i>Cyclotella stelligera</i>	--	5	--	5	74
<i>Melosira lirata</i>	169	225	233	193	50
Order Pennales					
<i>Achnanthes affinis</i>	--	2	--	--	--
<i>Achnanthes austriaca</i>	--	--	--	5	--
<i>Achnanthes detha</i>	--	17	6	16	21
<i>Achnanthes lanceolata</i>	--	--	--	11	--
<i>Achnanthes linearis</i>	--	1	2	--	--
<i>Achnanthes marginulata</i>	--	1	2	--	--
<i>Achnanthes minutissima</i>	5	--	--	--	--
<i>Asterionella formosa</i>	1,290	188	174	11	--
<i>Caloneis</i> sp.	--	--	--	5	--
<i>Cymbella minuta</i>	--	5	--	11	--
<i>Cymbella minuta</i> var. <i>silesica</i>	--	--	--	5	--
<i>Diatoma anceps</i>	5	16	--	--	--
<i>Diatoma hiemale</i> var. <i>mesodon</i>	10	31	23	16	74
<i>Fragilaria construens</i> var. <i>venter</i>	--	--	2	--	--
<i>Fragilaria crotonensis</i>	--	--	2	--	--
<i>Fragilaria pinnata</i>	--	5	9	55	74
<i>Fragilaria vaucheriae</i>	--	--	--	16	--
<i>Hannaea arcus</i>	5	21	12	22	21
<i>Hannaea arcus</i> var. <i>amphioxys</i>	5	--	--	11	--
<i>Meridion circulare</i>	10	31	233	22	--
<i>Navicula arvensis</i>	--	--	--	5	--
<i>Navicula cryptocephala</i> var. <i>venta</i>	--	--	--	5	--
<i>Navicula cuspidata</i>	--	5	--	--	--
<i>Navicula notha</i>	--	--	--	11	--
<i>Navicula pseudoscutiformis</i>	--	2	--	--	--
<i>Navicula pupula</i>	--	2	--	--	--
<i>Navicula radiosa</i>	5	--	--	--	--
<i>Navicula schmassmanni</i>	10	--	--	22	9
<i>Navicula</i> sp.	5	--	--	--	--
<i>Pinnularia abaujensis</i> var. <i>rostrata</i>	--	--	--	5	--
<i>Pinnularia borealis</i>	--	--	--	5	--
<i>Stauroneis smithii</i>	--	--	--	5	--

Table 30.--Species list and density of phytoplankton taxa collected in net
tows from The Loch, July 3, 17, and 25, and August 15, and 30, 1984--
Continued

Taxa	Density (cells per milliliter) for indicated days in 1984				
	7-3	7-17	7-25	8-15	8-30
BACILLARIOPHYTA (Diatoms)--Continued					
Order Pennales--Continued					
<i>Synedra radians</i>	10	--	12	11	--
<i>Synedra rumpens</i> var. <i>familiaris</i>	--	--	12	3	--
CHLOROPHYTA (Green algae)					
<i>Chlamydomonas</i> sp. 1	--	--	58	44	1,270
<i>Chlamydomonas</i> sp. 2	--	--	12	208	25
<i>Chlorella ellipsoidea</i>	--	--	23	--	--
<i>Cosmarium</i> sp.	--	5	--	--	--
<i>Eudorina elegans</i>	179	--	--	--	--
<i>Gonium</i> sp.	--	--	--	27	100
<i>Pteromonas</i> sp.	--	--	12	27	--
<i>Scenedesmus abundans</i>	--	--	--	22	--
<i>Scenedesmus quadricauda</i> var. <i>maximum</i>	--	--	--	22	--
<i>Scenedesmus serratus</i>	--	--	--	22	--
<i>Spirogyra</i> sp.	5	--	--	55	--
<i>Staurostrum</i> sp.	--	5	--	--	--
CHRYSTOPHYTA (Golden-brown algae)					
<i>Dinobryon divergens</i>	95	141	--	--	--
<i>Dinobryon pediforme</i>	15	--	--	--	--
CHYANOPHYTA (Blue-green algae)					
<i>Anabaena</i> sp.	120	--	--	175	--
<i>Aphanotheca</i> sp.	--	--	--	--	1,021
<i>Chroococcus limneticus</i>	--	--	12	5	50
<i>Chroococcus varius</i>	--	--	--	--	100
<i>Lyngbya nana</i>	--	--	116	66	--
<i>Lyngbya</i> sp.	--	--	--	55	--
<i>Oscillatoria limnetica</i>	--	--	--	--	349
<i>Oscillatoria</i> sp.	--	--	--	55	--
PYRROPHYTA (Dinoflagellates)					
<i>Peridinium inconspicua</i>	5	--	--	--	--
<i>Peridinium</i> sp.	--	5	56	--	--
CRYPTOPHYTA (Cryptomonads)					
<i>Chilomonas</i> sp.	--	--	12	--	--
Total cells per milliliter	1,948	714	1,023	1,270	3,241
Number of species	18	20	21	37	15

Table 31.--Species list and density of phytoplankton taxa collected in net tows from The Loch, September 13 and October 11, 1984

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984	
	9-13	10-11
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
<i>Melosira lirata</i>	368	--
Order Pennales		
<i>Achnanthes detha</i>	15	10
<i>Achnanthes</i> sp.	5	--
<i>Asterionella formosa</i>	90	186
<i>Diatoma hiemale</i> var. <i>mesodon</i>	1	10
<i>Fragilaria construens</i> var. <i>venter</i>	43	--
<i>Fragilaria pinnata</i>	129	39
<i>Fragilaria virescens</i>	32	--
<i>Meridion circulare</i>	164	--
<i>Navicula minima</i>	20	20
<i>Tabellaria flocculosa</i>	--	10
CHLOROPHYTA (Green algae)		
<i>Chlamydomonas</i> sp. 1	41	20
<i>Chlamydomonas</i> sp. 3	286	29
<i>Closterium</i> sp.	24	--
<i>Elakotothrix viridis</i>	--	20
<i>Gonium</i> sp.	980	--
<i>Sphaeroszma</i> sp.	41	--
CYANOPHYTA (Blue-green algae)		
<i>Anabaena</i> sp.	204	--
<i>Nostoc paludosum</i>	164	--
<i>Oscillatoria limnetica</i>	10,519	15,143
PYRROPHYTA (Dinoflagellates)		
<i>Peridinium inconspicua</i>	--	20
Total cells per milliliter	13,126	15,507
Number of species	18	11

Table 32.--Species list and density of phytoplankton taxa collected in net tows from Sky Pond, December 4, and The Loch, December 6, 1984

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984	
	Sky Pond 12-4	The Loch 12-6
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
<i>Cyclotella stelligera</i>	17	14
<i>Melosira lirata</i>	50	14
Order Pennales		
<i>Anomoeoneis serians</i> var. <i>brachysira</i>	--	14
<i>Asterionella formosa</i>	290	8,453
<i>Fragilaria pinnata</i>	17	--
<i>Fragilaria vaucheriae</i>	--	2
<i>Hannaea arcus</i>	--	3
<i>Navicula radiosa</i>	2	--
<i>Navicula viricula</i> var. <i>aveame</i>	--	21
<i>Navicula</i> sp.	8	--
<i>Nitzschia dissipata</i>	--	3
<i>Pinnularia borealis</i>	--	2
CHLOROPHYTA (Green algae)		
<i>Ankistodesmus falcatus</i> var. <i>acicularis</i>	--	14
<i>Chlamydomonas</i> sp. 1	12	307
<i>Chlamydomonas</i> sp. 2	--	7
<i>Chlamydomonas</i> sp. 3	4	--
<i>Chlamydomonas</i> sp. 4	--	7
<i>Gonium</i> sp.	12	--
<i>Scenedesmus</i> sp.	8	70
CHRYSTOPHYTA (Golden-brown algae)		
<i>Dinobryon cylindricum</i> var. <i>alpinum</i>	103	4,129
CYANOPHYTA (Blue-green algae)		
<i>Gloeotheca</i> sp.	--	42
<i>Oscillatoria limnetica</i>	14,655	586
<i>Oscillatoria</i> sp.	--	112
PYRROPHYTA (Dinoflagellates)		
<i>Peridinium</i> sp.	--	1,381
Total cells per milliliter	15,178	15,181
Number of species	12	19

Table 33.--Species list and density of phytoplankton taxa collected from Sky Pond, and The Loch, January 22, 1985

[--, indicates species not found]

Taxa	Density (cells per milliliter) for 1-22-85	
	Sky Pond	The Loch
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
<i>Melosira lirata</i>	--	67
Order Pennales		
<i>Asterionella formosa</i>	3,837	14,351
<i>Fragilaria pinnata</i>	18	--
CHLOROPHYTA (Green algae)		
<i>Ankistrodesmus falcatus</i>		
var. <i>acicularis</i>	50	59
<i>Eudorina elegans</i>	114	--
CHRYSTOPHYTA (Golden-brown algae)		
<i>Dinobryon cylindricum</i>		
var. <i>alpinum</i>	5,660	1,353
CYANOPHYTA (Blue-green algae)		
<i>Synechococcus</i> sp.	--	134
PYRROPHYTA (Dinoflagellates)		
<i>Peridinium bipes</i>		
var. <i>travectum</i>	14	849
Total cells per milliliter	9,693	16,813
Number of species	6	6

Table 34.--Seasonal changes in concentrations of chlorophyll a and phaeopigments, and in fluorescence data for Sky Pond

[S, surface; M, metalimnion; H, hypolimnion; C, chlorophyll a, in micrograms per liter; P, phaeopigments, in micrograms per liter; F, fluorescence of living phytoplankton, in relative in vivo fluorescence units; --, indicates no data]

Sampling date	Characteristic	Depth (meters)							
		S 0.5	1.0	2.0	M 3.0	4.0	5.0	6.0	H 6.5
5-22-84	C	11.0	--	--	--	--	--	--	--
	P	2.5	--	--	--	--	--	--	--
5-29-84	C	6.9	--	--	6.7	--	--	--	9.4
	P	.84	--	--	1.8	--	--	--	2.5
6-12-84	C	6.6	--	--	6.4	--	--	--	7.0
	P	.70	--	--	.36	--	--	--	.62
6-26-84	C	3.3	--	--	3.2	--	--	--	2.6
	P	.07	--	--	.16	--	--	--	.38
	F	6.2	2.3	2.5	2.4	2.3	2.4	2.6	--
7-10-84	C	1.38	--	--	1.76	--	--	--	1.7
	P	.43	--	--	.41	--	--	--	.3
	F	1.84	1.80	1.74	1.99	1.77	1.65	1.87	--
7-24-84	C	2.2	--	--	2.1	--	--	--	2.3
	P	.68	--	--	.65	--	--	--	.67
	F	3.6	3.8	3.5	3.4	3.3	3.3	3.1	2.8
8-14-84	C	4.4	--	--	3.8	--	--	--	4.0
	P	.65	--	--	1.1	--	--	--	1.0
	F	3.1	3.0	2.8	2.9	3.0	2.8	2.8	2.8
9-11-84	C	5.73	--	--	5.8	--	--	--	6.3
	P	.34	--	--	.5	--	--	--	0
	F	1.68	1.84	1.84	1.77	1.77	1.9	1.71	1.77
10-9-84	C	6.15	--	--	5.22	--	--	--	6.6
	P	.81	--	--	--	--	--	--	.5
12-4-84	C	1.9	--	--	--	--	--	--	1.6
	P	1.1	--	--	--	--	--	--	3.7

Table 35.--Seasonal changes in concentrations of chlorophyll a and phaeopigments, and in fluorescence data for The Loch

[S, surface; M, metalimnion; H, hypolimnion; C, chlorophyll a, in micrograms per liter; P, phaeopigments, in micrograms per liter; F, fluorescence of living phytoplankton, in relative in vivo fluorescence units; --, indicates no data]

Sampling date	Characteristic	Depth (meters)					
		S 0.5	1.0	M 2.0	3.0	H 4.0	H 4.8
5-23-84	C	0.34	--	0.75	--	--	--
	P	.21	--	.19	--	--	--
6-5-84	C	1.30	--	1.76	--	1.04	--
	P	.33	--	.18	--	0	--
6-13-84	C	1.47	--	1.57	--	1.43	--
	P	.28	--	.23	--	.49	--
6-27-85	C	.74	--	.43	--	--	--
	P	.12	--	.14	--	--	--
	F	1.08	1.14	1.20	1.20	1.17	--
7-3-84	C	.29	--	.22	--	.33	--
	P	.14	--	.12	--	.11	--
	F	.76	.79	.76	.79	.76	--
7-17-84	C	.23	--	.25	--	.61	--
	P	--	--	.27	--	.36	--
	F	1.17	1.20	1.36	1.30	1.30	--
7-25-84	C	.53	--	.63	--	.72	--
	P	.39	--	.41	--	.44	--
	F	1.33	1.23	1.14	1.27	1.08	--
8-15-84	C	.63	--	2.03	--	--	2.86
	P	.29	--	.63	--	--	.58
	F	1.33	.6	2.09	2.12	3.1	2.0
8-30-84	C	2.75	--	3.52	--	--	2.89
	P	.19	--	.15	--	--	.20
	F	2.4	2.2	2.6	2.9	2.5	2.5
9-13-84	C	1.74	--	2.02	--	--	1.69
	P	.61	--	.43	--	--	.61
	F	1.74	1.96	1.96	1.96	1.96	1.30
10-11-84	C	.77	--	0.81	--	--	0.58
	P	.16	--	.21	--	--	.22
	F	1.04	1.11	1.17	1.14	1.14	1.08
12-6-84	C	6.1	--	7.7	--	4.45	--
	P	.71	--	1.93	--	2.00	--

Table 36.--Seasonal changes in concentrations of nutrients and other chemical constituents in Sky Pond

[S, surface at 0.5 meter; M, metalimnion at 3 meters; H, hypolimnion at 6.5 meters; NO₃, nitrate; NO₂, nitrite; NH₄, ammonia; PO₄, phosphate; P, phosphorous; SiO₂, silica; Fe, iron; Ca, calcium; SO₄, sulfate; µg/L, microgram per liter; µM, micromolar; mg/L, milligrams per liter; --, indicates no data]

Sampling date	Depth (S,M,H)	NO ₃ (µg/L)	NO ₂ (µg/L)	NH ₄ (µg/L)	Total		SiO ₂ (mg/L)	Fe (µg/L)	Ca (mg/L)	SO ₄ (mg/L)
					PO ₄ (µM)	P (mg/L)				
1-9-84	S	532	--	11.5	0.06	--	1.3	13	1.3	1.72
	M	532	--	7.7	.06	--	1.6	16	1.4	1.76
	H	266	--	20	.06	--	.58	23	1.3	1.86
2-28-84	S	930	--	288	.29	--	1.6	21	1.8	2.09
	M	433	--	282	.23	--	1.0	16	1.4	1.67
	H	266	--	300	.29	--	1.3	280	1.6	1.49
5-8-84	S	221	--	27	.03	--	.7	--	1.5	1.73
	M	--	--	5	.09	--	.3	25	1.6	1.77
	H	221	--	75	.16	--	1.8	390	1.8	1.68
5-15-84	S	886	--	101	.06	--	.6	35	1.5	.89
	M	89	--	28	.03	--	.3	20	1.4	1.84
	H	44	--	14	.23	--	.1	71	1.5	1.73
5-22-84	S	1,285	--	69	.13	--	.76	32	1.4	1.89
	M	399	--	41	.13	--	.4	38	1.6	1.98
	H	177	--	51	.19	--	.37	58	1.6	1.98
5-29-84	S	1,550	--	68	.26	--	1.0	38	1.5	1.88
	M	1,420	--	83	.09	--	1.0	35	1.5	1.82
	H	1,420	--	61	.13	--	--	39	1.5	1.85
6-12-84	S	--	--	--	.03	0.01	--	--	--	--
	M	1,950	--	51	.03	.01	.8	19	1.6	1.95
	H	1,900	--	57	.03	.01	--	13	--	1.95
6-26-84	S	1,595	--	23	.16	.01	1.0	14	1.2	1.53
	M	1,595	--	27	.13	.01	1.0	17	1.3	1.5
	H	1,640	--	29	.19	--	1.0	26	1.3	1.56
7-10-84	S	--	--	--	1.26	.01	--	--	--	--
	M	--	6.6	10	.94	.01	--	--	--	--
	H	--	6.6	11	.97	.01	--	--	--	--
7-24-84	S	709	10	22	.68	.01	1.1	26	.8	.84
	M	757	10	40	.62	.01	--	--	--	--
	H	886	6.6	27	.62	.02	1.1	29	.8	.88
8-14-84	S	709	12	--	.06	.01	--	11	--	.92
	M	660	10	28	.13	.01	--	--	--	--
	H	753	6.6	10	.06	.01	1.1	6	.08	.95
9-11-84	S	709	23	19	6.0	.01	1.4	25	1.0	--
	M	731	23	22	.19	.01	--	--	--	--
	H	753	23	22	.19	.01	1.4	13	1.0	--
10-9-84	S	930	--	6	.03	.01	--	6	--	1.4
	M	886	10	9	.06	.01	--	--	--	--
	H	886	--	6	.06	.01	--	12	--	1.4
12-4-84	S	1,950	--	24	.06	2	--	12	--	2.4
	M	--	--	--	--	--	--	--	--	2.4
	H	930	--	41	.06	.01	--	35	--	1.7

Table 37.--Seasonal changes in concentrations of nutrients and other chemical constituents in The Loch

[S, surface at 0.5 meter; M, metalimnion at 2 meters; H, hypolimnion at 4 meters; NO₃, nitrate; NO₂, nitrite; NH₄, ammonia; PO₄, phosphate; P, phosphorous; SiO₂, silica; Fe, iron; Ca, calcium; SO₄, sulfate; µg/L, microgram per liter; µM, micromolar; mg/L, milligrams per liter; --, indicates no data]

Sampling date	Depth (S,M,H)	NO ₃ (µg/L)	NO ₂ (µg/L)	NH ₄ (µg/L)	PO ₄ (µM)	Total P (mg/L)	SiO ₂ (mg/L)	Fe (µg/L)	Ca (mg/L)	SO ₄ (mg/L)
12-27-83	S	1,373	--	--	--	--	3.2	82	2.1	2.41
	M	532	--	--	--	--	2.1	110	2.4	1.98
	H	399	--	--	--	--	2.2	130	2.0	1.96
3-06-84	S	399	--	26	--	--	2.6	91	2.1	2.18
	M	443	--	27	0.16	--	2.6	96	2.1	2.23
	H	88	--	27	--	--	2.1	100	2.2	2.35
4-17-84	S	975	--	35	.10	--	3.0	120	2.1	2.4
	M	797	--	41	.19	--	1.9	100	2.1	2.35
	H	133	--	9	--	--	1.9	140	2.3	2.22
5-07-84	S	1,063	--	60	.03	--	3.9	240	2.4	2.27
	M	310	--	65	--	--	2.3	180	2.3	2.28
	H	177	--	72	.03	--	2.7	220	2.4	2.12
5-16-84	S	1,640	--	70	.03	--	2.4	99	1.6	1.97
	M	975	--	80	.03	--	2.4	100	1.7	2.19
	H	310	--	72	.03	--	2.3	400	2.4	2.18
5-23-84	S	1,420	--	61	.13	--	2.0	65	1.4	1.81
	M	1,420	--	61	.13	--	2.0	79	1.4	1.96
	H	1,063	--	58	.03	--	2.0	200	1.9	2.09
6-05-84	S	1,370	--	47	.03	0.03	1.7	31	1.4	1.6
	M	1,470	--	42	.03	.02	1.7	37	1.3	1.59
	H	1,420	--	70	.03	.02	1.7	33	1.4	1.62
6-13-84	S	1,595	--	45	.03	.01	2.0	36	1.5	1.72
	M	1,640	--	46	.03	.01	2.0	36	1.6	1.73
	H	1,595	--	44	.03	.01	2.0	37	1.5	1.73
6-20-84	S	1,329	--	40	.16	--	1.6	18	1.1	1.42
	M	1,329	--	42	.16	--	1.7	30	1.3	1.43
	H	1,373	--	33	.19	--	1.7	30	1.3	1.43
6-27-84	S	1,285	--	51	.39	--	1.5	21	1.2	1.35
	M	1,240	--	37	.16	--	1.5	20	1.2	1.31
	H	--	--	--	.19	--	--	--	--	--
7-03-84	S	--	--	43	.19	.01	--	--	--	--
	M	--	--	--	--	--	--	--	--	--
	H	--	--	41	--	.02	--	--	--	--
7-17-84	S	--	10	19	--	.01	--	--	--	--
	M	--	--	--	--	.01	--	--	--	--
	H	--	6.6	9	.64	.01	--	--	--	--
7-25-84	S	930	6.6	39	.68	.01	1.5	20	1.0	1.14
	M	--	3.3	32	.61	.02	--	--	--	--
	H	930	6.6	36	.64	.01	1.5	21	1.0	1.08

Table 37.--Seasonal changes in concentrations of nutrients and other chemical constituents in The Loch--Continued

Sampling date	Depth (S,M,H)	NO ₃ (µg/L)	NO ₂ (µg/L)	NH ₄ (µg/L)	PO ₄ (µM)	Total P (mg/L)	SiO ₂ (mg/L)	Fe (µg/L)	Ca (mg/L)	SO ₄ (mg/L)
8-06-84	S	44	--	10	0.07	--	--	--	0.02?	0.01?
	M	--	--	--	--	--	--	--	--	--
	H	--	--	--	--	--	--	--	--	--
8-15-84	S	665	10	13	.07	.01	1.5	26	1.0	1.14
	M	691	6.6	4	.19	.01	--	--	--	--
	H	--	--	--	.23	.01	--	--	--	--
8-30-84	S	--	--	--	--	--	--	--	--	--
	M	483	6.6	4	.10	.01	--	--	--	--
	H	496	6.6	10	.07	.01	--	--	--	--
9-13-84	S	886	26	22	.19	.01	1.9	21	1.2	1.4
	M	837	23	27	.19	.01	--	--	--	--
	H	890	23	20	.19	.01	1.8	3	1.1	1.4
10-11-84	S	975	--	7	.07	.01	--	--	--	--
	M	1,020	--	10	.07	.01	--	--	--	--
	H	1,060	--	7	.07	.01	--	--	--	--
12-6-84	S	1,150	--	6	.07	2.0	--	--	--	--
	M	841	--	6	.07	--	--	--	--	--
	H	709	--	6	.07	.01	--	--	--	--

Table 38.--*Seasonal changes in concentrations of dissolved organic carbon in surface waters in Loch Vale*

[S, surface; M, metalimnion; H, hypolimnion; --, indicates no data]

Samp- ling date	Concentration of dissolved organic carbon (milligrams carbon per liter)										Loch Creek
	Sky Pond					The Loch					
	Inlet	Mid-lake station			Outlet	Inlet	Mid-lake station			Outlet	
		Depth (meters)					Depth (meters)				
		S	M	H			S	M	H		
		0.5	3	6			0.5	2	4		
7-3-84	--	--	--	--	--	0.7	0.9	0.8	0.7	0.8	3.6
7-10-84	--	0.6	0.4	0.4	0.4	--	--	--	--	--	--
7-17-84	--	--	--	--	--	.8	1.0	.9	.8	.9	--
7-24-84	--	.5	.5	.5	.5	--	--	--	--	--	--
7-25-84	--	--	--	--	--	.7	.9	.8	.9	.9	2.7
8-14-84	0.2	.3	.4	.4	.4	--	--	--	--	--	--
8-15-84	--	--	--	--	--	.4	.6	.6	.6	.6	2.7
9-11-84	.3	.4	.4	.4	.4	--	--	--	--	--	--
9-13-84	--	--	--	--	--	.6	.8	.8	--	.7	--
10-11-84	--	--	--	--	--	1.3	1.8	2.0	1.8	2.2	--

Table 39.--Seasonal changes in concentrations of suspended organic carbon in surface waters in Loch Vale

[S, surface; M, metalimnion; H, hypolimnion; --, indicates no data]

Samp- ling date	Concentration of suspended organic carbon (milligrams carbon per liter)										Loch Creek
	Sky Pond					The Loch					
	Inlet	Mid-lake station			Outlet	Inlet	Mid-lake station			Outlet	
		Depth (meters)					Depth (meters)				
		S	M	H			S	M	H		
	0.5	3	6		0.5	2	4				
6-5-84	--	--	--	--	--	0.3	0.5	--	1.0	0.2	--
6-12-84	--	0.3	--	--	--	--	--	--	--	--	--
6-20-84	--	--	--	--	--	.1	.2	0.2	.5	.2	--
6-26-84	--	.3	0.4	0.5	0.3	--	--	--	--	--	--
6-27-84	--	--	--	--	--	.2	.1	.2	.2	.2	0.1
7-3-84	--	--	--	--	--	.2	.1	.2	.2	.1	.2
7-10-84	--	.3	.2	.2	.2	--	--	--	--	--	--
7-17-84	--	--	--	--	--	.2	.2	.2	.1	.1	--
7-24-84	--	.3	--	.4	.4	--	--	--	--	--	--
7-25-84	--	--	--	--	--	.2	.3	.2	.2	.2	.1
8-14-84	0.1	.4	.4	.4	--	--	--	--	--	--	--
8-15-84	--	--	--	--	--	.2	.1	.3	.3	.1	.2
8-30-84	--	--	--	--	--	.2	--	--	.2	--	--
9-11-84	--	.5	.5	.5	.3	--	--	--	--	--	--
9-13-84	--	--	--	--	--	.2	.3	.3	.3	.3	--
10-9-84	--	.7	.7	.7	.7	--	--	--	--	--	--
10-11-84	--	--	--	--	--	--	.2	.1	.1	.1	--

Table 40.--Seasonal changes in pH, temperature, and light intensity in Sky Pond
[S, surface; M, metalimnion; H, hypolimnion; T, temperature, in degrees celsius;
LI, light intensity, in lux; --, indicates no data]

Sampling date	Char-acter-istic	S	Depth (meters)														H	
			0	0.5	1.0	1.5	2.0	2.5	M			3.5	4.0	4.5	5.0	5.5		6.0
5-29-84	pH	6.53	--	--	--	--	--	--	6.67	--	--	--	--	--	--	--	6.70	--
	T	2.0	--	--	--	--	--	--	4.0	--	--	4.0	--	4.0	--	--	4.0	--
	LI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6-12-84	pH	6.59	--	--	--	--	--	--	--	6.5	--	--	--	--	--	--	--	6.59
	T	2.8	--	2.8	--	2.8	--	2.8	2.8	--	--	2.8	--	2.8	--	2.8	2.8	2.8
	LI	15,000	11,000	6,500	3,100	2,400	2,000	1,900	1,900	1,800	1,400	1,200	1,200	900	600	550	600	550
6-26-84	pH	6.70	--	--	--	--	--	--	--	6.69	--	--	--	--	--	--	--	6.80
	T	5.8	--	5.8	--	5.6	--	--	5.6	--	--	5.6	--	5.6	--	5.5	5.5	5.5
	LI	8,000	--	4,200	--	2,700	--	--	2,300	--	--	1,500	--	1,200	--	1,800	1,500	1,500
7-10-84	pH	6.4	--	--	--	--	--	--	6.44	--	--	--	--	--	--	6.45	--	--
	T	6.3	--	6.2	--	6.2	--	--	6.2	--	--	6.2	--	6.2	--	6.2	--	--
	LI	2,900	--	2,100	--	1,900	--	--	1,600	--	--	1,200	--	730	--	550	--	--
7-24-84	pH	6.61	--	--	--	--	--	--	6.38	--	--	--	--	--	--	--	--	6.54
	T	6.8	--	6.0	--	5.0	--	--	5.0	--	--	5.0	--	5.0	--	5.0	5.0	5.0
	LI	16,000	--	8,400	--	7,300	--	--	4,100	--	--	2,800	--	1,700	--	1,000	850	850
8-14-84	pH	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	T	7.2	--	7.0	--	7.0	--	--	6.8	--	--	6.5	--	6.2	--	6.2	6.1	6.1
	LI	16,000	--	12,000	--	8,700	--	--	4,700	--	--	4,000	--	2,900	--	2,000	1,600	1,600
9-11-84	pH	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	T	5.5	--	5.3	--	5.2	--	--	5.2	--	--	5.1	--	5.1	--	5.0	5.0	5.0
	LI	3,500	--	2,600	--	1,700	--	--	1,300	--	--	840	--	580	--	420	360	360
10-9-84	pH	7.24	--	--	--	--	--	--	7.23	--	--	--	--	--	--	7.27	--	--
	T	2.0	--	2.0	--	2.10	--	--	2.0	--	--	2.0	--	2.0	--	2.0	2.0	2.0
	LI	2,600	--	1,600	--	1,100	--	--	760	--	--	480	--	340	--	240	220	220
12-4-84	pH	5.83	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.82
	T	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0
	LI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-22-85	pH	6.40	--	--	--	--	--	--	6.41	--	--	--	--	--	--	6.35	--	--
	T	1.0	--	--	--	--	--	--	1.0	--	--	--	--	--	--	4.0	--	--
	LI	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 41.--Seasonal changes in pH, temperature, and light intensity in The Loch

[S, surface; M, metalimnion; H, hypolimnion; T, temperature, in degrees celsius; LI, light intensity, in lux; --, indicates no data]

Sampling date	Characteristic	Depth (meters)									
		S	M								H ¹
		0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.2-4.8
5-23-84	pH	6.0	--	--	--	5.97	--	--	--	--	6.10
	T	3.5	--	4.0	--	4.0	--	4.0	--	4.0	4.0
	LI	--	--	--	--	--	--	--	--	--	--
6-5-84	pH	6.35	--	--	--	6.37	--	--	--	--	6.38
	T	4.0	--	4.0	--	4.0	--	4.0	--	4.0	4.0
	LI	--	--	--	--	--	--	--	--	--	--
6-13-84	pH	6.3	--	--	--	--	6.33	--	--	--	6.34
	T	6.8	--	6.3	--	4.6	--	4.3	--	4.3	4.3
	LI	13,000	9,800	7,500	5,200	4,200	4,000	3,500	3,000	2,300	1,700
6-20-84	pH	6.29	--	--	--	6.30	--	--	--	--	6.28
	T	6.0	--	6.0	--	6.0	--	6.0	--	6.0	6.0
	LI	--	--	--	--	--	--	--	--	--	--
6-27-86	pH	6.63	--	--	--	6.59	--	--	--	--	6.57
	T	6.0	--	6.0	--	6.0	--	6.0	--	6.0	--
	LI	14,000	12,000	9,500	8,500	6,500	5,500	4,500	3,500	3,000	--
7-3-84	pH	6.51	--	--	--	6.43	--	--	--	6.47	--
	T	6.8	--	6.4	--	6.4	--	6.3	--	6.2	--
	LI	15,000	--	10,000	--	7,000	--	5,400	--	4,000	--
7-17-74	pH	6.33	--	--	--	--	6.47	--	--	--	6.38
	T	8.8	--	7.5	--	7.4	--	7.3	--	7.2	7.2
	LI	18,000	--	13,000	--	10,000	--	6,500	--	6,000	5,500 (4.5m)
7-25-84	pH	6.47	--	--	--	6.48	--	--	--	--	6.49
	T	7.2	--	6.9	--	6.9	--	6.8	--	6.7	6.6
	LI	--	--	--	--	--	--	--	--	--	--
8-15-84	pH	6.78	--	--	--	--	--	--	--	6.59	--
	T	11	--	9.0	--	8.8	--	8.5	--	8.2	8.2
	LI	5,000	--	2,800	--	2,100	--	1,500	--	11,000	1,000 (4.8m)
8-30-84	pH	6.53	--	--	--	6.58	--	--	--	--	6.43
	T	8.9	--	8.7	--	8.5	--	8.5	--	8.5	8.5
	LI	15,000	--	12,000	--	8,000	--	5,000	--	3,700	3,200 (4.5m)
9-13-84	pH	--	--	--	--	--	--	--	--	--	--
	T	7.0	--	6.5	--	6.2	--	6.2	--	6.0	6.0
	LI	1,500	--	1,100	--	820	--	600	--	450	300 (4.5m)
10-11-84	pH	6.81	--	--	--	6.81	--	--	--	6.84	--
	T	3.0	--	3.0	--	3.0	--	3.0	--	3.0	3.0
	LI	8,500	--	6,500	--	3,500	--	2,500	--	1,400	900 (4.5m)
12-6-84	pH	6.2	--	--	--	6.2	--	--	--	6.38	--
	T	1	--	--	--	--	--	--	--	--	--
	LI	900	--	130	--	62	--	32	--	15	13 (4.5m)
1-22-85	pH	6.52	--	--	--	6.44	--	--	--	6.36	--
	T	.5	--	1.0	--	3.0	--	3.9	--	4.0	4.0
	LI	--	--	--	--	--	--	--	--	--	--

¹Actual depth of samples and temperature and light measurements indicated in parenthesis.

Table 42.--Seasonal extinction coefficient, Secchi depth, and color in Sky Pond and The Loch

[E, extinction coefficient, Pt, platinum units; m, meters; --, indicates no data]

Sampling date	Sky Pond			The Loch		
	E	Color ¹ (Pt)	Secchi depth (m)	E	Color ¹ (Pt)	Secchi depth (m)
5-22-84	--	7	--	--	--	--
5-23-84	--	--	--	--	11.3	--
5-29-84	--	6.7	--	--	--	--
6-5-84	--	--	--	--	9	4.2
6-12-84	0.47	4.0	2.8	--	--	--
6-13-84	--	--	--	0.43	9	4.6 - bottom
6-20-84	--	--	--	--	7.3	4.3 - bottom
6-26-84	.36	6.3	4.3	--	--	--
6-27-84	--	--	--	.38	8	4.3 - bottom
7-03-84	--	--	--	.33	--	4.8 - bottom
7-10-84	.27	--	5.0	--	--	--
7-17-84	--	--	--	.27	--	4.8 - bottom
7-24-84	.45	2.0	2.1	--	--	--
7-24-85	--	--	--	--	3.5	4.9 - bottom
8-6-84	--	--	--	--	1.0	--
8-14-84	.35	1.0	4.5	--	--	--
8-15-84	--	--	--	.33	4	4.8 - bottom
8-30-84	--	--	--	.36	--	4.8 - bottom
9-11-84	.36	5.0	3.7	--	--	--
9-13-84	--	--	--	.34	5	4.7 - bottom
10-9-84	.38	--	2.8	--	--	--
10-11-84	--	--	--	.493	--	4.5 - bottom
12-4-84	--	--	--	--	--	--
12-6-84	--	--	--	.88	--	--
1-22-85	--	--	--	--	--	--

¹Average color values for surface, metalimnion and hypolimnion.

