6. AQUATICS

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Within the GLEES boundary there are three alpine lakes and several streams and ponds. The selection of GLEES as a research site for investigating of the effects of chemical and physical climate change was in part based on the accessibility of these low alkalinity "sensitive" aquatic ecosystems. This chapter provides a brief description of the physical, chemical, and biological characteristics of the GLEES aquatic ecosystems.

Physical Limnology

Lake Morphometry

The lakes at GLEES were formed during the last glacial episode, are no more than 10,000 years old, and were probably formed by ice scour and moraine deposition. Bathymetric maps (figs. 6.1–6.3) were compiled in August of 1987 using a Leitz "Total Station Instrument" to map the location of each lake shoreline and points on each lake surface where depth was measured with either a weighted line or an acoustic depth sounder. Depth was measured with an accuracy of about +25 cm and coordinate locations were very precise (+20cm). Map areas of each iso-depth were digitized using a Numonics series 1200 electronic planimeter.

A summary of lake morphometry and the depth area and volume data are listed in table 6.1. East and West Glacier lakes have similar surface areas and volumes while Lost Lake is slightly more than twice as large. The mean depth of each lake (surface area/volume) is similar and less than 1.5 meters. Lake relative depth (maximum depth/surface area) of East and West Glacier Lakes is about half the relative depth of Lost Lake reflecting the greater maximum depth of Lost Lake (25 m). The shoreline development of each lake (length of shoreline/$[2(\sqrt{\pi}) * \mathit{surface\ area}]$) expresses the relative potential importance of littoral processes on each lake—the greater the shoreline development, the greater the relative importance of the littoral zone. The GLEES lakes have similarly developed shorelines with Lost Lake being the most sinuous and West Glacier Lake the most circular.

Lake and Stream Hydrology

Parshall flumes were installed on West Glacier Lake outlet in 1986 and on East Glacier Lake outlet and Meadow and Cascade Creeks in 1987. No flume has been installed on Lost Lake because of the decision to concentrate initial studies at East and West Glacier Lakes. Flow is measured continuously; data are averaged to estimate daily flow. In 1988 stream flow began at the onset of snowmelt, May 24 (Julian date 145), and continued in Meadow Creek, Cascade Creek, and West Glacier Lake outlet until about October 26 (Julian date 300). East Glacier Lake outlet flow began at about the same time but was not measured until June 18 (Julian date 170) due to problems with locating the flume and measurement errors associated with slush and ice flow in the flume itself. East Glacier Lake outlet flow ceased on August 5 (Julian date 218). During early snowmelt stream and, to a lesser extent, lake outlet flow is dominated by a strong diurnal pattern of flow associated with diurnal temperature fluctuation and snowmelt. Stream and lake outlet flows for 1988 are presented in figures 6.4 and 6.5. Weekly mean flow is also indicated in each figure. Stream flow is generated by snowmelt and is therefore strongly influenced by temperature (fig. 6.4).

Lake Thermal Properties

East and West Glacier Lakes are dimictic lakes that exhibit thermal stratification under the ice in winter but, due to their shallow depth and high wind velocities, rarely exhibit strong thermal stratification in the ice-free seasons. Lost Lake, with its greater depth, is also dimictic and exhibits strong thermal stratification in summer and winter. The fact that Lost Lake develops a thermocline, which divides the lake basin into an epilimnion, metalimnion, and hypolimnion, influences the chemical and biological characteristics of this lake. The temperature isopleths for 1988 are shown in figure 6.6 for East Glacier, West Glacier, and Lost Lakes. Ice cover begins in October, develops a maximum thickness of over 1 meter, and breaks up in early June.

Lake Optical Properties

Lake transparency varies between lakes and seasonally at GLEES. Weekly Secchi depth measurements display these differences (fig. 6.7). Vertical profiles of light extinction are also available for each lake; figure 6.8 provides an example.

Chemical Limnology

Precipitation

The chemistry of the GLEES aquatic ecosystem is strongly influenced by precipitation inputs that are modified by geologic, edaphic, and hydrologic processes. The chemistry of precipitation at GLEES is measured at the NADP site and through measurement of snowpack chemistry. The estimated volume-weighted concentration and deposition of major ions at GLEES is presented in table 6.2.

Snowmelt

The concentration of ions in snowmelt has been measured using various snow lysimeters. However, contamination of snowmelt with groundwater and surface runoff has been evident (Sanders 1988, Rochette et al. 1988). We have also observed contamination. A typical pattern of snowmelt from an uncontaminated site is shown in figure 6.9 for data collected in 1988.

Streams

Stream chemistry at GLEES varies with the relative amount of stream contact with mafic and nonmafic rock (Rochette et al. 1988). The average concentration of stream chemistry, weighted by flow, for the outlet streams at GLEES is presented in table 6.3 for data collected in 1988.

Lake Outlets

Significant differences exist in outlet chemistry concentrations between East and West Glacier Lakes. Figures 6.10 and 6.11 show the concentrations of base cations, acid anions, and alkalinity for the two outlets. Evidence exists for a slight episodic acidification (alkalinity depression) of about 10 to 20 µeq/l and a pH depression of over 0.5 pH units during snowmelt in West Glacier Lake outlet (Vertucci 1988).

Lake Profiles

Differences in thermal stratification and the amount of snow cover during ice cover primarily determine the differences in lake chemistry observed with depth in each GLEES lake. For example, West Glacier Lake develops high concentrations of ions and elevated alkalinity at the bottom of the lake during ice and snow cover (fig. 6.12). East Glacier Lake does not develop a significant snow cover over the ice. Lost Lake, during midsummer stratification, shows a clinograde change in constituent concentration with depth and evidence of hypolimnetic alkalinity generation.

Biological Limnology

The lakes at GLEES are oligotrophic, concentrations of both phosphorous and nitrogen are low, and algal biomass is subsequently low. On an annual basis production may be further limited by the short ice-free season.

Phytoplankton

Beginning in the winter of 1988, integrated water-column phytoplankton species abundance and biomass have been estimated on a monthly or weekly basis for East and West Glacier Lakes, with fewer data collected from Lost Lake. A list of species collected in 1988 is given in Appendix B. Species abundance and composition changes seasonally in each lake. Summaries of seasonal differences in species composition are given in tables 6.4–6.6. Lost Lake, during summer stratification, has evidenced a hypolimnetic peak in phytoplankton abundance. Vertical profiles of *in vivo* fluorescence and phytoplankton abundance at Lost Lake were measured during the summer of 1988. The potential use of deep-dwelling phytoplankton communities are being investigated as early indicators of lake acidification (de Noyelles et al. 1989).

Zooplankton

The GLEES lakes are dominated by only a few zooplankton species, and levels of abundance are low. A list of species identified in 1988 and their relative abundance is presented in table 6.7.

Benthos

A preliminary qualitative survey of the benthos of each lake was conducted in the summer of 1988. The littoral zones of each lake and each stream were sampled by hand-picking and with a triangle net. Ekman grab samples from the deepest point of each lake were also collected. The resulting species list is presented in Appendix C.

Nekton

The fisheries of the GLEES lakes are managed by the Wyoming Game and Fish Department. Each lake has an unnatural, stocked fishery population. The stocking history of each lake is presented in table 6.8.

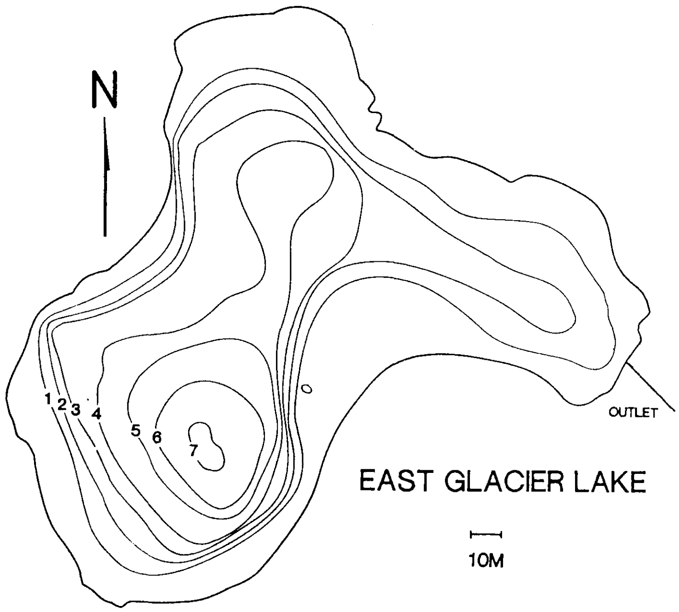

Figure 6.1.—Bathymetric map of East Glacier Lake. Contour numbers are depths in meters.

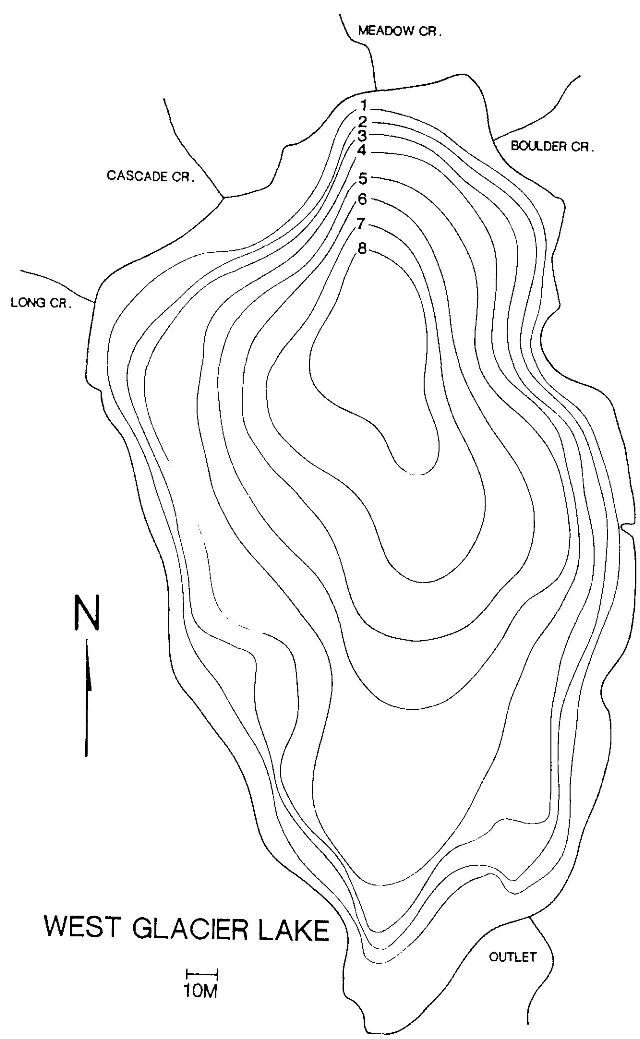

Figure 6.2.—Bathymetric map of West Glacier Lake. Contour numbers are depths in meters.

References

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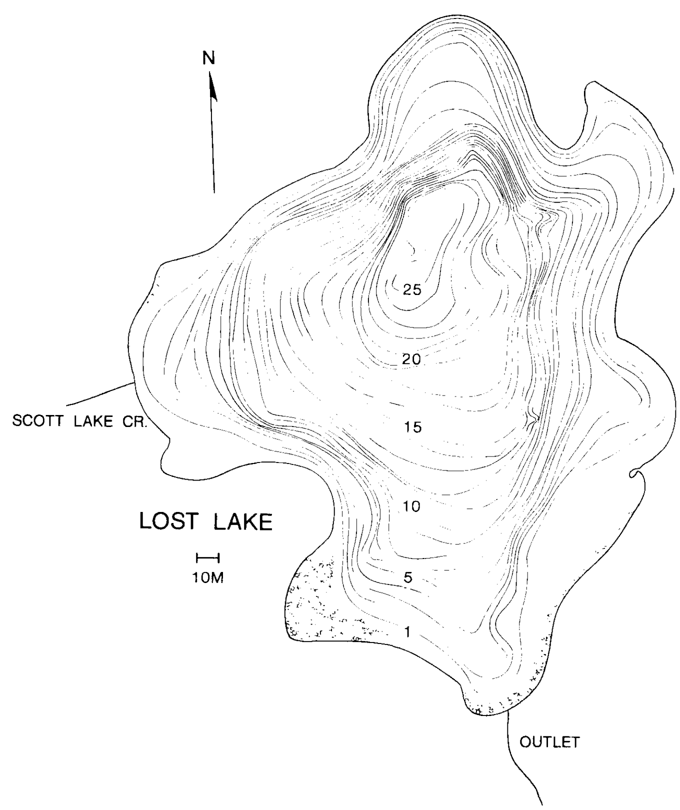

Figure 6.3.—Bathymetric map of Lost Lake. Contour numbers are depths in meters.

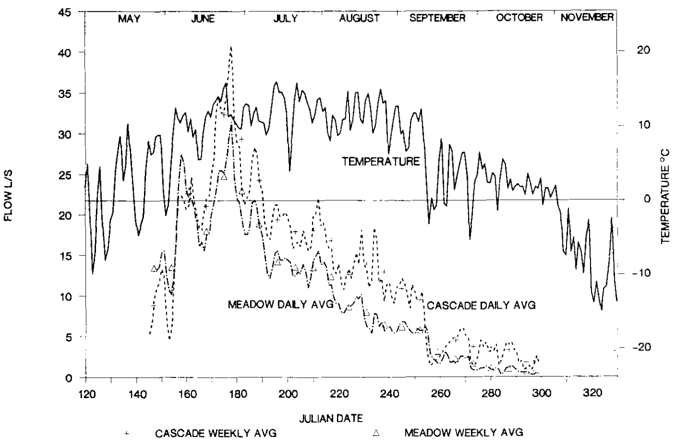

Figure 6.4.—Stream flow and mean daily air temperature for Meadow and Cascade Creeks, 1988.

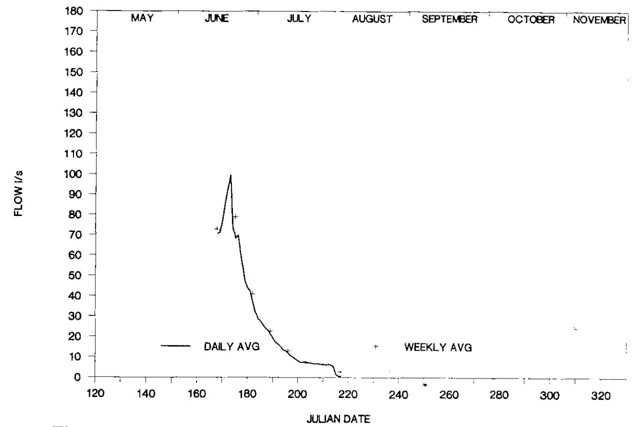

Figure 6.5A.—East Glacier Lake outlet flow for 1988.

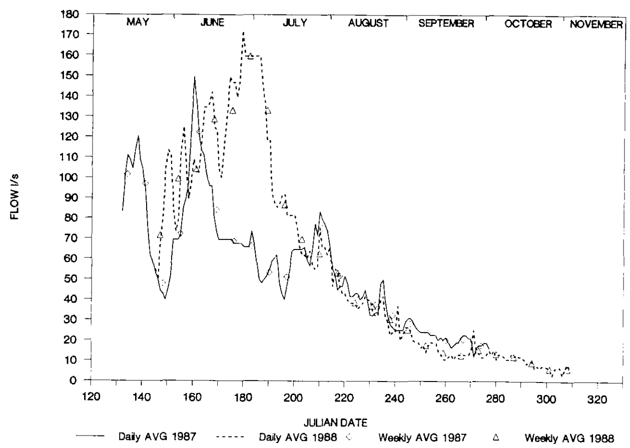

Figure 6.5B.—West Glacier Lake outlet flows for 1987, 1988.

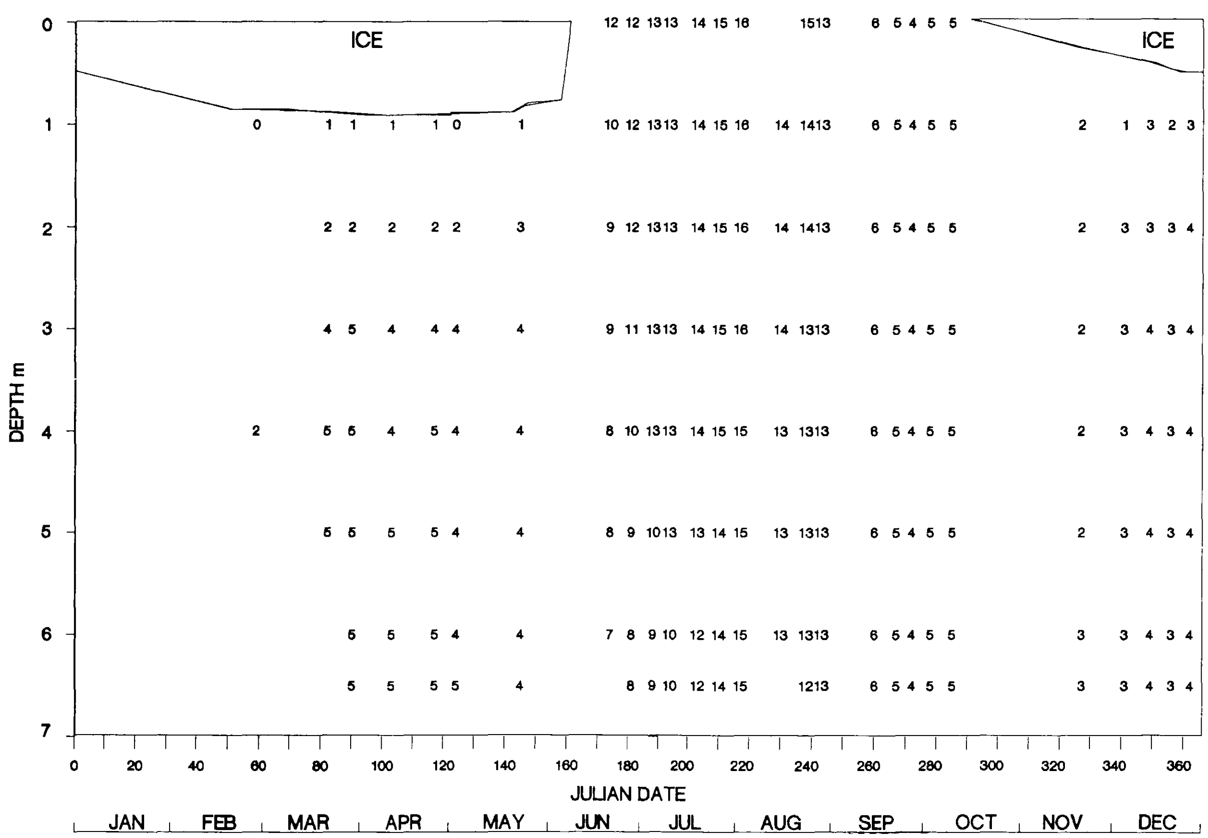

Figure 6.6A.—East Glacier Lake seasonal temperature profile for 1988.

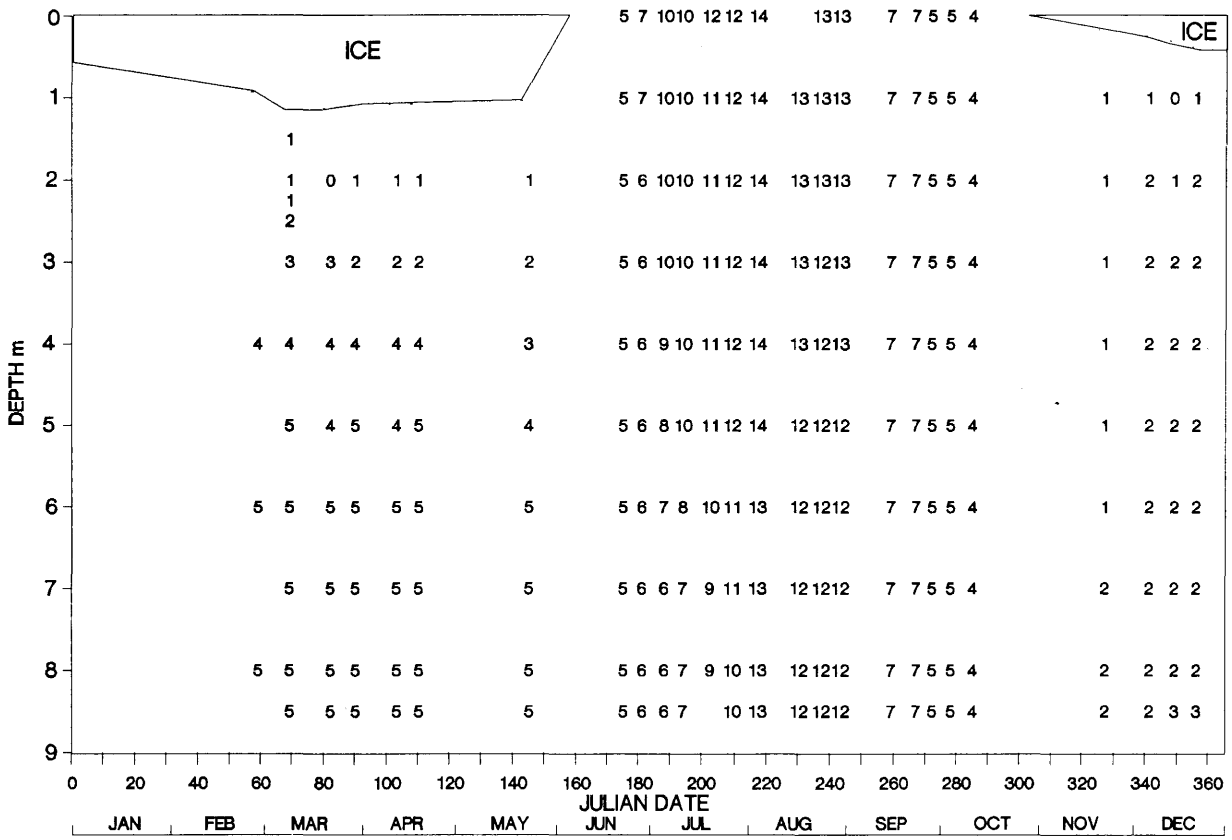

Figure 6.6B.—West Glacier Lake seasonal temperature profile for 1988.

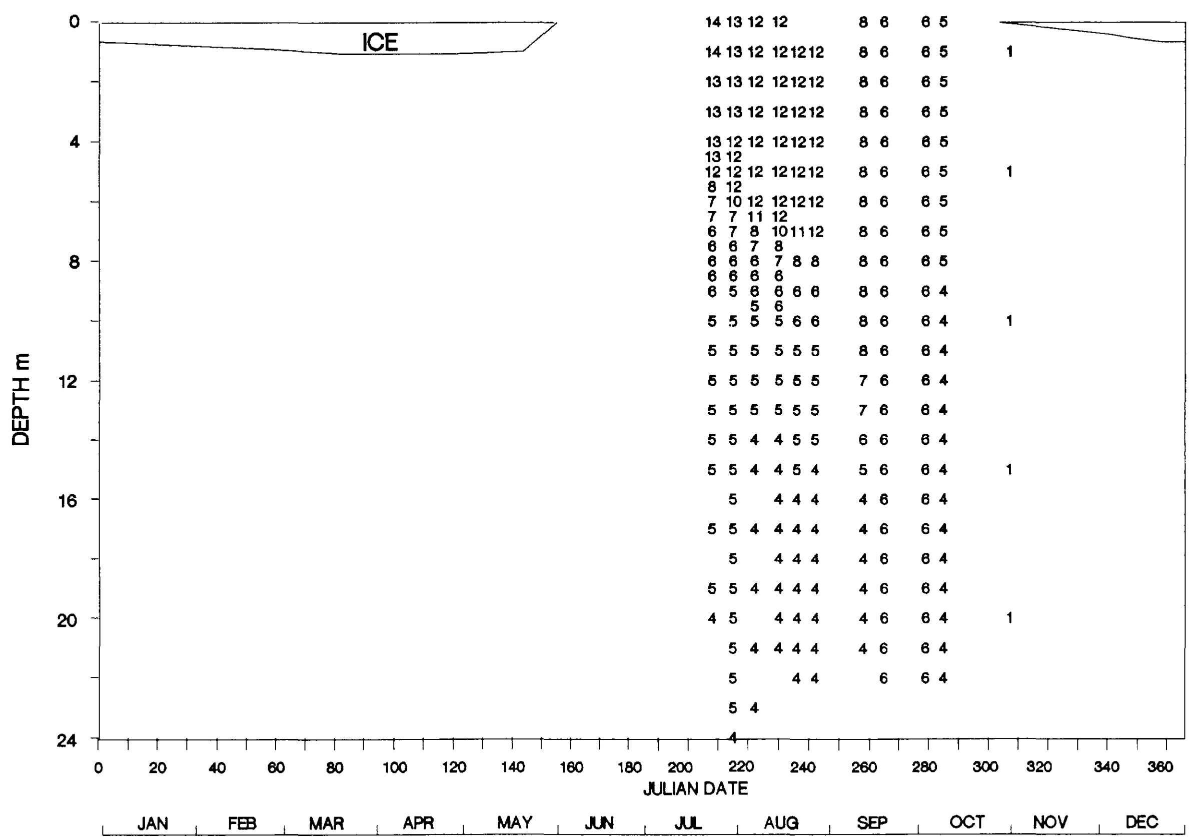

Figure 6.6C.—Lost Lake seasonal temperature profile for 1988.

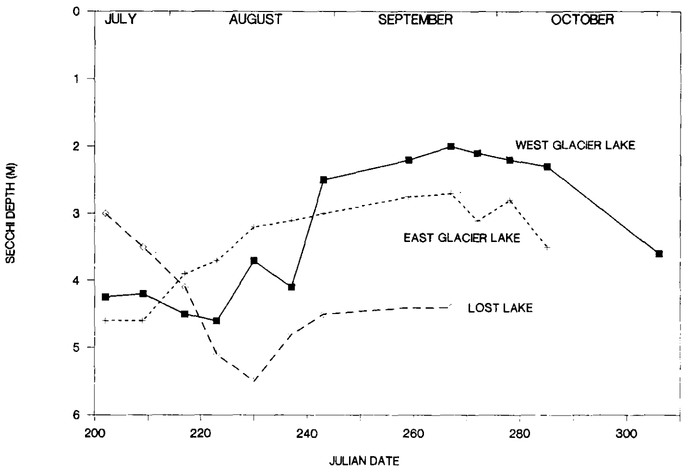

Figure 6.7.—GLEES lakes Secchi depths.

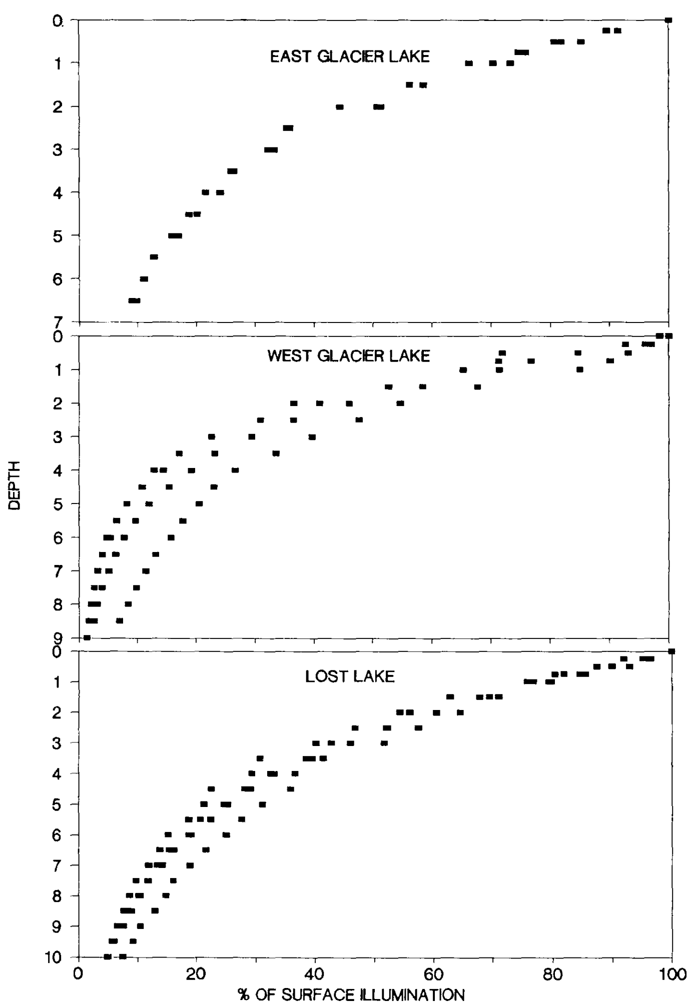

Figure 6.8.—GLEES lakes illumination curves.

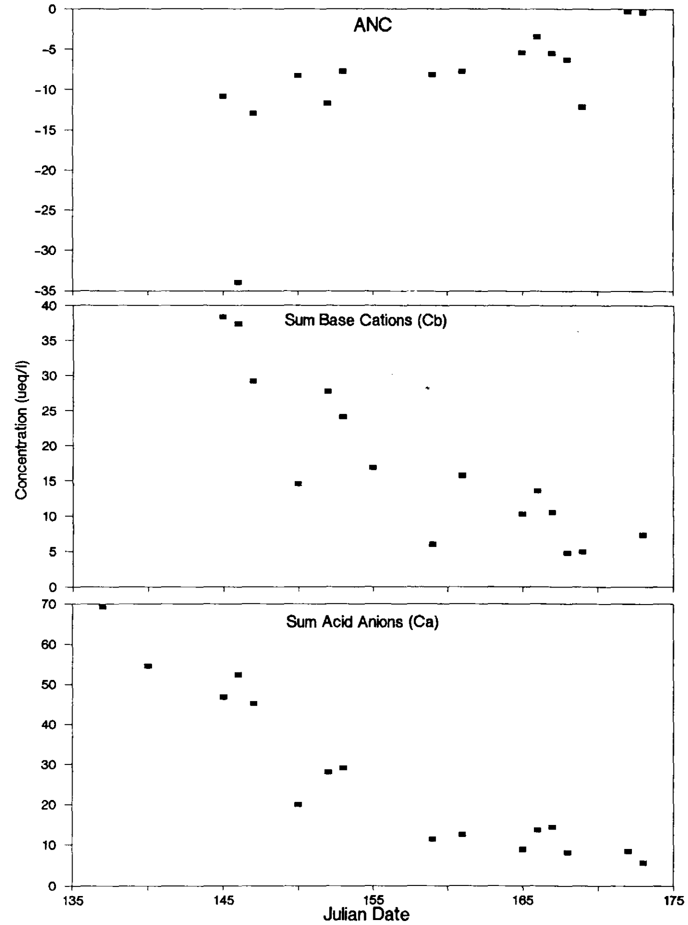

Figure 6.9.—Snowmelt chemistry, East Glacier Lake watershed. The hill snow lysimeter site is located north of East Glacier Lake between East Glacier Lake and Boulder Pond.

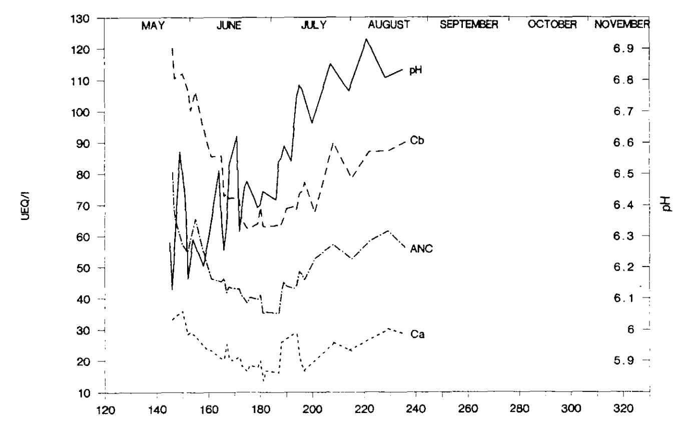

Figure 6.10.—East Glacier lake outlet chemistry 1988.

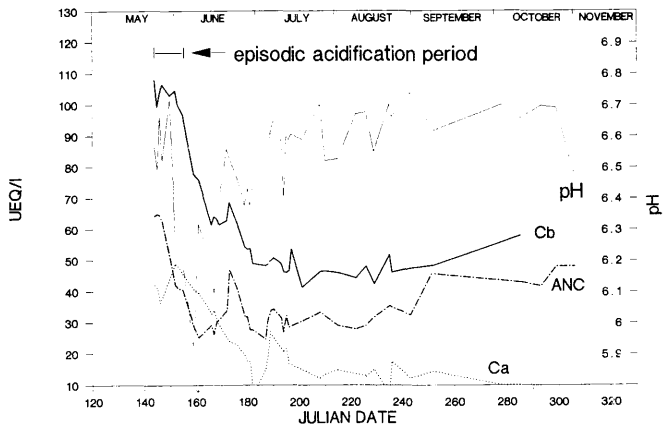

Figure 6.11.—West Glacier lake outlet chemistry exhibiting episodic acidification at snowmelt, 1988.

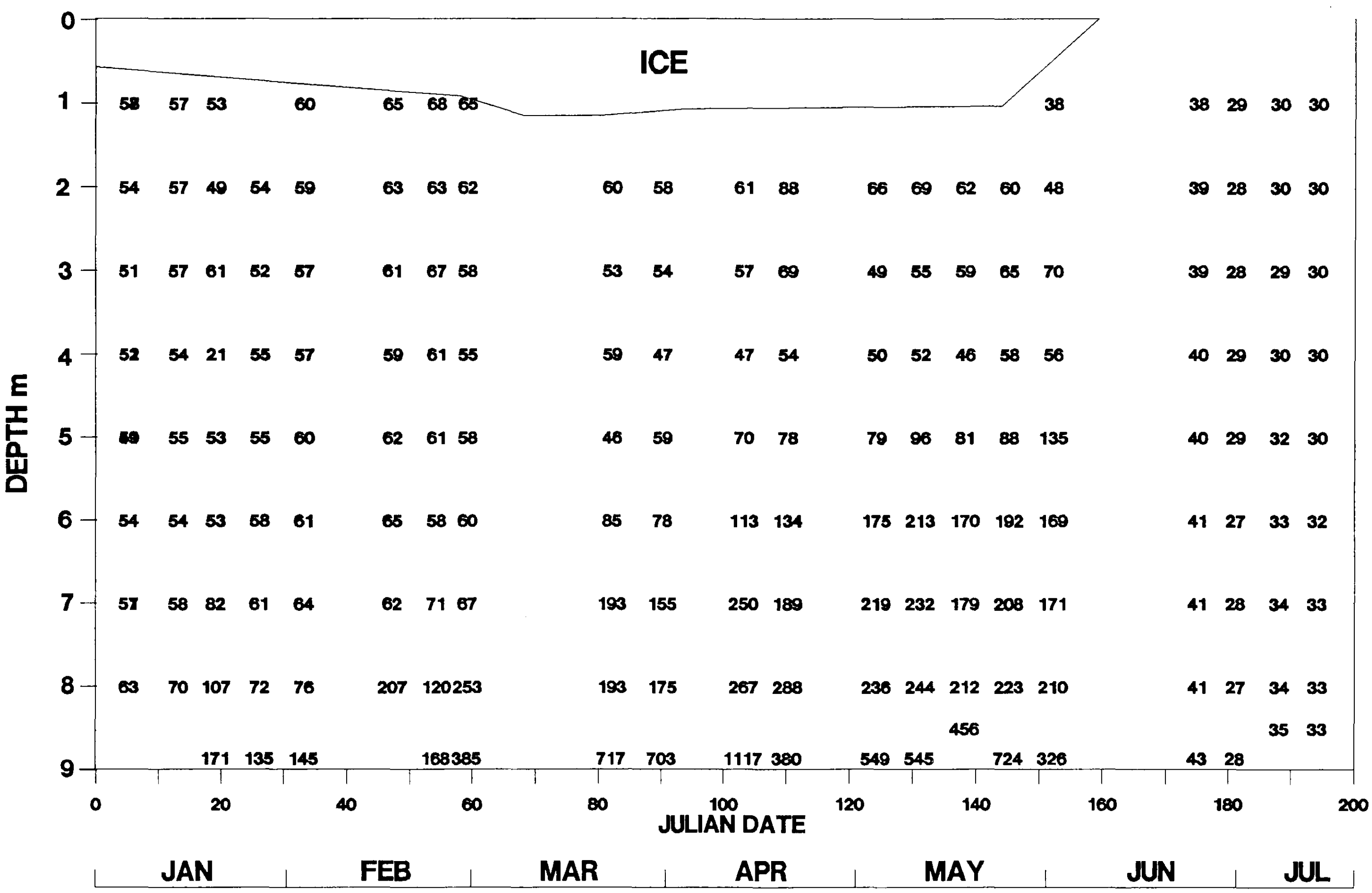

Figure 6.12.—West Glacier lake seasonal alkalinity profile.

Table 6.1A.—Summary of GLEES lakes morphometry.

		Lost	West Glacier	East Glacier
Watershed area	(ha)	51	61	29
Surface area	(m^2)	67086	32869	28805
Surface/watershed		.13	.05	.10
Volume	(m^3)	80111	45162	41345
Mean annual discharge	(m^3)		965 x 10^3	192 x 10^3
Max depth	(m)	25.0	8.5	7.0
Mean depth	(m)	1.19	1.37	1.43
Relative depth	(m)	8.55	4.15	3.66
Shoreline development		1.38	1.21	1.34
Hydrologic residence	(yr)		0.046	0.215

Table 6.1B.—Hypsographic curve data for GLEES lakes.

	Lost		West Glacier		East Glacier	
Depth (m)	Surface area (m^2)	(Volume) (m^3)	Surface area (m^2)	(Volume) (m^3)	Surface area (m^2)	(Volume) (m^3)
0–25	67086	(80111)	32869	(45162)	28805	(41346)
1	11948	(35782)	5620	(17360)	10543	(18925)
2	4918	(8177)	2785	(4121)	13886	(7237)
3	4220	(4564)	3048	(2916)	10378	(3934)
4	4542	(4380)	4739	(3862)	6015	(3928)
5	3008	(3748)	5398	(5065)	2851	(3747)
6	2550	(2776)	3662	(4502)	1441	(2229)
7	2877	(2712)	3214	(3436)	1282	(1345)
8	2970	(2923)	2648	(2926)		
8.5			1323	(974)		
9	2600	(1391)				
10	2068	(1164)				
11	2137	(1051)				
12	1713	(961)				
13	2157	(965)				
14	2327	(1121)				
15	1831	(1037)				
16	2080	(977)				
17	1419	(870)				
18	1936	(835)				
19	2477	(1101)				
20	1059	(859)				
21	1163	(555)				
22	1199	(591)				
23	1003	(550)				
24	1234	(558)				
25	643	(461)				

Table 6.2.—Volume weighted concentration and deposition of major ions in precipitation during the snowpack accumulation period of November 1987 to April 1988 for the East Glacier Lake watershed and the NADP site.

Concentration mg/l	pH	Ca	Mg	Na	K	NH_4	Cl	SO_4	NO_3
Snow survey	+5.21	0.23	0.02	0.26	0.18	0.07	0.26	0.5	0.56
Mean +/- 95% C.I.	5.03	0.18	0.02	0.19	0.14	0.04	0.22	0.46	0.50
	–4.85	0.13	0.02	0.15	0.10	0.01	0.18	0.33	0.44
NADP Nov87-Apr88[1]	5.42	0.14	0.02	0.08	0.06	0.03	0.11	0.48	0.32
Deposition[2] kg/ha	**pH**	**Ca**	**Mg**	**Na**	**K**	**NH_4**	**Cl**	**SO_4**	**NO_3**
Snow survey	+0.10	2.00	0.21	1.97	1.58	0.60	2.22	5.12	4.80
(total)	0.07	1.44	0.16	1.52	1.12	0.32	1.76	3.68	4.00
Mean +/- 95% C.I.	–0.05	0.94	0.11	1.12	0.71	0.08	1.34	2.41	3.27
NADP Nov87-Apr88 (wet only)	0.03	1.12	0.16	0.64	0.48	0.24	0.88	3.84	2.56
Concentration mg/ll	**pH**	**Ca**	**Mg**	**Na**	**K**	**NH_4**	**Cl**	**SO_4**	**NO_3**
Total - Wet Only	+0.07	0.74	0.04	1.19	0.99	0.32	1.19	0.92	1.90
("dry deposition")	0.04	0.32	0.00	0.88	0.64	0.08	0.88	–0.16	1.44
Mean +/- 95% C.I.	–0.02	-0.10	–0.04	0.57	0.29	-0.16	0.57	–1.24	0.98
% Dry of wet	+244	66	24	186	206	132	135	24	74
Deposition	145	29	0	138	133	33	100	– 4	56
Mean +/- 95% C.I.	–75	-9	-24	89	61	-66	65	–32	38

[1] Precipitation weight average.
[2] Calculated using 80 cm H_2O.

Table 6.3.—Average stream chemistry of GLEES aquatic ecosystems.

Site	pH	Ca	Mg	Na	K	NH$_4$	Cl	SO$_4$	NO$_3$	HCO$_3$	SiO$_2$	P	Al
		ueq/l									mg/l		
East Glacier Lake Outlet													
Mean	6.65	46.44	18.07	9.64	2.57	0.32	4.77	12.38	0.91	48.11	1.55	0.01	0.03
STD	0.19	7.01	2.49	2.16	1.21	0.40	3.38	6.77	1.85	7.12	0.16	0.00	0.02
N	89	89	89	89	89	89	89	89	89	89	89	88	89
West Glacier Lake Outlet													
Mean 6.54	31.28	13.12	6.65	2.17	0.59	4.93	13.68	1.83	33.87	1.08	0.01	0.02	
STD	0.14	9.69	3.87	2.32	1.21	1.78	4.36	5.55	3.99	9.08	0.32	0.01	0.02
N	127	127	127	127	127	127	127	127	127	127	126	126	126
Boulder Creek													
Mean	6.46	35.68	14.87	7.34	3.12	0.58	3.52	12.24	5.47	37.93	1.36	0.01	0.03
STD	0.25	13.02	5.63	2.58	1.53	0.69	2.98	5.53	4.12	22.95	0.21	0.01	0.03
N	33	34	34	34	34	34	34	34	34	33	33	32	33
Long Creek													
Mean	6.69	39.91	21.23	10.12	2.43	0.46	1.58	17.83	8.18	47.62	2.73	0.03	0.02
STD	0.11	18.95	10.80	4.94	1.43	0.38	1.33	11.79	5.22	13.92	1.00	0.02	0.01
N	12	14	14	14	14	14	14	14	14	12	13	13	13
Upper Meadow													
Mean	5.78	12.34	4.86	3.65	0.88	0.56	0.93	8.15	7.36	2.85	0.84	0.01	0.03
STD	0.26	7.39	3.33	2.68	0.50	0.30	1.04	6.39	3.43	6.02	0.68	0.01	0.02
N	11	12	12	12	12	12	12	12	12	11	11	12	11
Meadow Creek													
Mean	5.83	20.47	7.33	4.71	1.73	0.29	3.12	12.67	8.39	8.56	0.76	0.01	0.03
STD	0.11	14.66	5.72	3.32	1.69	0.30	3.49	9.90	6.18	6.63	0.39	0.00	0.03
N	64	65	65	65	65	65	65	65	65	64	65	64	65
Upper Cascade													
Mean	5.92	14.24	5.37	2.95	1.00	0.65	1.03	7.52	8.38	4.85	0.84	0.02	0.03
STD	0.13	4.25	1.68	0.93	0.49	0.47	0.63	2.42	3.36	2.51	0.36	0.01	0.02
N	11	12	12	12	12	12	12	12	12	11	12	12	12
Cascade Creek													
Mean	5.84	21.79	7.97	4.66	1.54	0.46	3.31	13.27	9.41	5.55	0.88	0.01	0.03
STD	0.12	17.98	6.82	3.67	1.65	0.47	3.34	11.95	9.88	4.90	0.47	0.00	0.03
N	67	68	68	68	68	68	68	68	68	67	68	68	68
Lost Lake Outlet													
Mean	6.67	65.19	36.80	11.96	6.54	0.21	5.30	22.66	4.52	63.51	2.33	0.01	0.05
STD	0.07	13.30	4.48	1.55	3.52	0.15	7.10	19.49	5.75	7.77	1.84	0.00	0.09
N	7	11	11	11	11	11	11	11	11	7	11	10	11
Lost Lake Inlet													
Mean	6.70	49.62	24.61	9.25	3.42	0.37	2.10	20.28	0.15	49.22	0.84	0.01	0.03
STD	0.04	20.80	7.01	0.55	1.57	0.34	1.15	7.94	0.27	4.31	1.76	0.01	0.07
N	6	10	10	10	10	10	10	10	10	6	10	9	10

Table 6.4.—East Glacier Lake seasonal phytoplankton communities, 1988. (Taxon were identified and density and volume were determined by Richard Dufford, Fort Collins, Colorado.)

		% Composition by		
	Division	Density cell/ml	Volume $\mu m^3/ml$	Dominant algae
Winter	Bacillariophyta	8	15	*Melosira lirata*
	Chlorophyta	17	6	*Chlamydomonas* spp.
(Feb–April)	Chrysophyta	18	13	*Chrysolykos skujae*
	Cryptophyta	<1	<1	
	Cyanophyta	55	1	*Chroococcus* sp.
	Pyrrophyta	<1	65	*Peridinium willei*
Spring	Bacillariophyta	2	<1	*Rhizosolenia eriensis & Synedra*
	Chlorophyta	55	2	*Chlamydomonas* spp.
(April–May)	Chrysophyta	25	2	*Chrysolykos skujae & Kephyrion*
	Cryptophyta	<1	<1	
	Cyanophyta	17	<1	*Aphanocapsa & Aphanothece*
	Pyrrophyta	1	96	*Peridinium willei*
Early summer	Bacillariophyta	2	1	*R.eriensis* & *Tabellaria fenestrata*
	Chlorophyta	71	2	*Dictyosphaerium elegans*
	Chrysophyta	5	<1	*Dinobryon bavaricum*
(June–July)	Cryptophyta	<1	<1	
	Cyanophyta	21	<1	*Chroococcus* sp.
	Pyrrophyta	1	96	*Peridinium willei*
Summer	Bacillariophyta	2	3	*R.eriensis* & *Synedra incisa*
	Chlorophyta	73	17	*Dictyosphaerium elegans*
(Aug–Sept)	Chrysophyta	7	76	*Dinobryon bavaricum*
	Cryptophyta	<1	<1	
	Cyanophyta	18	<1	*Chroococcus*
	Pyrrophyta	<1	4	*Peridinium inconspicuum*
Fall	Bacillariophyta	<1	5	*R. eriensis* & *Tabellaria*
	Chlorophyta	88	77	*Dictysophaerium elegans*
(Sept–Oct)	Chrysophyta	<1	<1	*Bitrichia* (*Diceras*) *phaseolus*
	Cryptophyta	<1	<1	
	Cyanophyta	11	<1	*Aphanocapsa*
	Pyrrophyta	<1	17	*Peridinium inconspicuum*

Table 6.5.—West Glacier lake seasonal phytoplankton communities, 1988. (Taxon were identified and density and volume were determined by Richard Dufford, Fort Collins, Colorado.)

		% Composition by		
	Division	Density cell/ml	Volume $\mu m^3/ml$	Dominant algae
Winter	Bacillariophyta	1	10	*Asterionella formosa*
	Chlorophyta	6	45	*Chlamydomonas* spp.
(Feb–April)	Chrysophyta	6	38	*Chrysolykos & Mallomonas* spp.
	Cryptophyta	<1	<1	
	Cyanophyta	87	7	*Anabaena* & *Planklolyngbya subtiiis* (*Lyngbya limnetica*)
Spring	Bacillariophyta	2	27	*Asterionella formosa*
	Chlorophyta	59	38	*Chlorella* & *Chlamydomonas*
(April–May)	Chrysophyta	2	14	*Chrysolykos*
	Cryptophyta	<1	<1	
	Cyanophyta	37	19	*Rhabdogloea ellipsoidea*
	Euglenophyta	<1	2	*Euglena* sp.
Early summer	Bacillariophyta	6	7	*Asterionella formosa*
	Chlorophyta	49	10	*Chlamydomonas*
	Chrysophyta	20	78	*Dinobryon bavaricum*
(June–July)	Cryptophyta	11	5	*Rhodomonas minuta*
	Cyanophyta	14	<1	*Anabaena inaequalis*
Late summer	Bacillariophyta	<1	11	*A.formosa* & *Rhizosolenia eriensis*
	Chlorophyta	48	41	*Dictyosphaerium elegans*
	Chrysophyta	<1	<1	
(Aug–Sept)	Cryptophyta	<1	<1	
	Cyanophyta	51	47	*Anabaena inaequalis*
	Pyrrophyta	<1	<1	*Peridinium inconspicuum*
Fall	Bacillariophyta	2	45	*A.formosa* & *R.eriensis*
	Chlorophyta	2	1	*Chlorella* & *Chlamydomonas*
(Sept–Oct)	Chrysophyta	31	29	*Chrysolykos* & *Mallomonas*
	Cryptophyta	<1	<1	
	Cyanophyta	65	24	*Anabaena inaequalis*
	Pyrrophyta	<1	1	*Peridinium inconspicuum*

Table 6.6.—Lost Lake seasonal phytoplankton communities, 1988. (Taxon were identified and density and volume were determined by Richard Dufford, Fort Collins, Colorado.)

		% Composition by		
	Division	Density cell/ml	Volume µm³/ml	Dominant algae
Summer	Bacillariophyta	28	82	*Asterionella formosa & Tabellaria*
	Chlorophyta	42	16	*Dictyosphaerium elegans*
(July–Aug)	Chrysophyta	<1	<1	
	Cryptophyta	<1	<1	
	Cyanophyta	30	2	*Anabaena inaequalis*
Fall	Bacillariophyta	3	73	*Asterionella formosa & Tabellaria*
	Chlorophyta	4	17	*Dictyosphaerium elegans*
(Sept–Oct)	Chrysophyta	<1	3	*Mallomonas & Kephyrion*
	Cryptophyta	<1	<1	
	Cyanophyta	93	7	*Anabaena inaequalis*
	Pyrrophyta	<1	<1	

Table 6.8.—Fish stocking history of East Glacier, Lost, and West Glacier Lakes (from Wyoming Game and Fish records).

Lake	Date	Species[1]	Number	Number Per #	Length
East Glacier	08/05/38	BKT	4000	—[2]	2"
East Glacier	10/11/57	CUT	2100	300/#	1–3"
East Glacier	08/15/59	CUT	2000	2000/#	1"
East Glacier	08/16/62	CUT	2500	5000/#	.5-1"
East Glacier	07/30/64	CUT	1830	610/#	1–2"
East Glacier	09/24/67	CUT	2750	1100/#	1"
East Glacier	09/18/75	CUT	4000	2000/#	1"
East Glacier	09/06/78	SRC	1680	20/#	—
East Glacier	07/15/80	SRC	990	55/#	—
East Glacier	07/15/82	SRC	500	40/#	—
East Glacier	08/06/84	YSC	1080	90/#	—
East Glacier	08/07/86	YSC	1050	175/#	—
East Glacier	08/04/88	YSC	3500	—	1"
Lost	08/03/33	BKT	12000	—	—
Lost	09/16/37	CUT	30000	—	—
Lost	07/27/38	BKT	12000	—	2"
Lost	07/27/39	BKT	6000	—	2.5"
Lost	07/22/40	BKT	3300	—	2"
Lost	08/28/41	BKT	2240	—	3"
Lost	08/18/42	BKT	4040	—	2–3"
Lost	10/15/51	CUT	3250	650/#	1.5"
Lost	10/07/53	CUT	7200	1800/#	1"
Lost	08/19/60	CUT	4000	2000/#	1"
Lost	06/16/62	CUT	5000	5000/#	.5-1"
Lost	07/30/64	CUT	3660	610/#	1–2"
Lost	09/24/67	CUT	5500	1100/#	1–2"
West Glacier	08/28/47	BKT	4320	254/#	3"
West Glacier	09/29/47	CUT	2760	1104/#	1.5"

[1] BKT=Brook Trout, CUT=Cutthroat Trout; YSC=Yellowstone Cutthroat, SRC=Snake River Cutthroat.
[2] — means no data available.

Table 6.7.—1988 zooplankton species abundance in East Glacier Lake integrated samples.

					Rotaria					Entomostraca									
										Copepodites State									
Date	Julian Date	Lake	Sample Depth M	Sample Vol L	Kellicottia longispina	Polyarthra dolichopter	Keratella sp.	Lecane sp.	Cyclopoid nauplii	I	II	III	IV	V	Total I-V	Diacyclops thomasi	Ceriodaphnia sp.	Daphnia ambigua	Total
3-9-88	69	EGL	0-7	6.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	2.5
3-22-88	82	EGL	0-7	8.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	2.1
3-30-88	90	EGL	0-7	8.0	8.4	0.0	0.0	0.0	1.0	6.1	0.0	0.0	0.0	0.0	6.1	0.0	0.0	0.1	15.6
4-12-88	103	EGL	0-7	8.0	52.5	0.0	0.1	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	65.0
4-19-88	110	EGL	0-7	8.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	7.8	7.8	0.0	0.0	0.0	8.8
5-3-88	124	EGL	0-7	8.0	172.8	7.8	0.0	0.0	4.7	0.0	0.0	3.1	15.8	20.5	39.4	0.1	0.0	3.2	228.0
5-3-88	124	EGL	0-7	8.0	256.3	0.3	0.0	0.0	2.3	0.0	0.0	0.0	8.5	29.9	38.4	0.1	0.0	0.0	307.4
5-3-88	124	EGL	0-7	8.0	123.5	1.8	0.0	0.0	1.9	0.0	0.0	0.0	1.0	2.6	3.6	0.0	0.0	0.0	130.8
5-10-88	131	EGL	0-7	8.0	129.7	27.2	0.0	0.0	50.9	0.0	0.0	0.0	3.3	5.3	8.6	0.0	0.0	0.3	216.7
5-17-88	138	EGL	0-7	8.0	198.4	2.4	0.0	0.0	0.5	0.4	0.5	0.5	0.5	3.1	5.0	0.1	0.0	0.0	206.4
5-24-88	145	EGL	0-7	8.0	119.5	0.1	0.0	0.0	0.3	0.1	0.5	0.1	0.6	2.8	4.1	0.1	0.0	0.1	124.2
6-29-88	181	EGL	0-7	16.0	86.5	0.0	0.0	0.0	57.7	0.2	0.3	0.5	0.3	0.2	1.5	0.2	0.0	0.1	146.0
7-12-88	194	EGL	0-7	16.0	2.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1	5.7	0.2	0.0	8.4
7-20-88	202	EGL	0-7	16.0	95.6	4.8	0.0	0.0	28.8	19.2	33.6	28.8	33.6	19.2	134.4	38.5	3.8	57.7	363.6
7-26-88	208	EGL	0-7	16.0	721.4	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	12.8	12.8	16.3	3.1	0.0	754.2
8-4-88	217	EGL	0-7	10.0	6.1	0.1	0.0	0.0	15.4	0.0	0.1	0.0	0.1	0.8	1.0	70.2	0.0	55.4	148.2
8-4-88	217	EGL	0-7	10.0	10.5	0.0	0.0	0.0	8.3	0.2	0.1	0.1	0.1	2.9	3.4	55.9	0.0	112.8	190.9
8-4-88	217	EGL	0-7	10.0	45.2	0.0	0.0	0.0	17.3	0.0	0.1	0.2	7.7	16.8	24.8	52.3	0.0	92.3	231.9
8-11-88	224	EGL	0-7	10.0	5.3	30.8	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	27.7	0.0	150.8	222.3
8-17-88	230	EGL	0-7	8.0	19.2	0.0	0.0	0.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	22.3	0.0	0.8	50.1
8-25-88	238	EGL	0-7	8.0	48.1	28.8	0.0	0.5	38.5	0.0	0.0	0.5	0.5	1.0	2.0	4.7	0.0	0.1	122.7
8-30-88	243	EGL	0-7	8.0	28.8	0.0	0.0	0.0	1.5	1.5	3.4	0.0	2.9	1.6	9.4	46.2	0.0	0.1	86.0
9-16-88	260	EGL	0-7	8.0	0.0	50.0	0.0	0.0	38.5	0.0	0.0	1.6	0.0	1.6	3.2	4.4	0.0	0.5	96.6
9-16-88	260	EGL	0-7	8.0	34.6	43.3	0.0	0.0	9.6	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	0.1	90.8
9-23-88	267	EGL	0-7	18.0	24.3	16.2	0.0	0.0	20.2	0.0	0.0	1.9	0.0	1.9	3.8	1.1	0.0	0.0	65.6
9-28-88	272	EGL	0-7	10.0	15.4	35.4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	51.8

Table 6.7.—(Continued)

Date	Julian Date	Lake	Sample Depth M	Sample Vol L	Rotaria: Kellicottia longispina	Polyarthra dolichopter	Keratella sp.	Lecane sp.	Entomostraca: Cyclopoid nauplii	Copepodites State: I	II	III	IV	V	Total I–V	Diacyclops thomasi	Ceriodaphnia sp.	Daphnia ambigua	Total
10-4-88	278	EGL	0-7	10.0	26.9	76.9	15.4	0.0	46.7	0.0	0.0	0.0	0.0	0.3	0.3	0.4	0.0	0.1	166.7
10-11-88	285	EGL	0-7	10.0	10.2	33.8	3.8	0.1	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	56.2
3-9-88	69	WGL	0-8	8.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	3.4
3-22-88	82	WGL	0-8	8.0	5.4	0.0	0.0	0.0	4.0	0.5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	9.9
3-30-88	90	WGL	0-8	8.0	6.5	0.0	0.0	0.0	2.9	1.5	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	10.9
4-12-88	103	WGL	0-8	8.0	4.3	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4
4-19-88	110	WGL	0-8	8.0	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.6
5-3-88	124	WGL	0-8	8.0	196.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	2.6	28.4	31.0	0.6	0.0	0.0	228.1
5-3-88	124	WGL	0-8	8.0	92.6	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.8	0.0	0.0	0.0	114.8
5-3-88	124	WGL	0-8	8.0	277.9	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	282.0
5-10-88	131	WGL	0-8	8.0	339.6	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.2	0.2	2.0	0.0	0.0	343.2
5-17-88	138	WGL	0-8	8.0	308.8	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	309.6
5-24-88	145	WGL	0-8	8.0	398.3	0.0	0.0	0.0	3.1	0.3	0.0	0.0	0.0	1.5	1.8	0.3	0.0	0.0	403.5
6-29-88	181	WGL	0-8	16.0	9.6	0.0	0.0	0.0	19.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	28.9
7-12-88	194	WGL	0-8	16.0	0.0	0.0	0.0	0.0	9.6	4.8	0.0	0.0	14.5	21.6	40.9	0.0	0.1	0.0	50.6
7-20-88	202	WGL	0-8	16.0	177.9	3.2	0.0	0.0	0.0	39.2	77.0	87.6	79.6	115.4	398.8	96.2	0.0	0.3	676.4
7-26-88	208	WGL	0-8	16.0	336.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.3	57.3	47.8	0.1	0.0	441.8
8-4-88	217	WGL	0-8	10.0	24.6	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	81.6	0.0	8.7	125.4
8-4-88	217	WGL	0-8	10.0	7.8	15.3	0.0	0.0	5.6	0.1	0.2	0.2	0.1	0.3	0.9	123.1	0.0	0.0	152.7
8-4-88	217	WGL	0-8	10.0	61.6	0.0	0.0	0.0	24.6	0.0	0.0	0.2	0.0	15.3	15.5	46.7	0.0	0.1	148.5
8-10-88	223	WGL	0-8	10.0	23.1	61.5	0.0	18.5	35.4	0.0	0.0	0.0	15.3	0.0	15.3	53.8	0.0	0.0	207.6
8-17-88	230	WGL	0-8	10.0	84.6	35.4	0.0	0.0	6.3	0.0	0.0	0.0	10.3	11.9	22.2	115.4	0.0	15.4	279.3
8-24-88	237	WGL	0-8	10.0	135.4	169.3	0.0	0.0	33.8	9.3	8.8	1.5	1.5	0.4	21.5	70.8	0.0	0.0	430.8
8-30-88	243	WGL	0-8	10.0	43.1	7.8	0.0	0.0	0.8	0.0	0.0	2.3	2.3	1.4	6.0	138.5	0.0	0.0	196.2
9-15-88	259	WGL	0-8	8.0	38.5	96.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	57.6	0.0	0.0	192.6
9-15-88	259	WGL	0-8	8.0	115.4	76.9	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	22.3	0.0	0.0	216.5
9-15-88	259	WGL	0-8	8.0	336.6	269.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.3	17.1	0.0	0.0	623.6
9-23-88	267	WGL	0-8	12.0	115.4	51.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	167.5
9-23-88	267	WGL	0-8	10.0	138.5	58.3	15.4	0.0	2.4	0.0	0.0	2.4	0.0	0.0	2.4	4.8	0.0	0.0	221.8
9-23-88	267	WGL	0-8	10.0	277.0	53.9	16.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0	0.0	352.4
9-28-88	272	WGL	0-8	10.0	86.2	54.8	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.1	149.9
9-28-88	272	WGL	0-8	10.0	153.9	30.8	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	189.1
9-28-88	272	WGL	0-8	10.0	148.3	46.2	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	200.2
10-4-88	278	WGL	0-8	10.0	184.7	52.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.0	0.1	237.6
10-11-88	285	WGL	0-8	10.0	67.3	14.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	88.7
8-2-88	215	LOST	0-5	16.0	118.1	0.0	0.0	0.0	0.0	0.0	0.0	11.4	0.0	11.4	22.8	33.5	0.0	39.3	223.7
8-2-88	215	LOST	9-23	16.0	98.2	136.5	31.5	0.0	41.4	20.9	20.9	10.5	10.5	10.5	73.3	147.0	0.0	0.0	527.9
8-2-88	215	LOST	5-9	16.0	435.8	0.0	0.0	0.0	11.4	0.0	0.0	0.0	0.0	0.0	0.0	50.1	0.0	31.5	528.8
8-9-88	222	LOST	6-10	10	90.2	0.0	0.0	0.0	15.3	1.1	1.8	1.8	7.9	3.3	15.9	7.3	0.0	0.0	128.7
8-9-88	222	LOST	10-23	10	137.6	50.8	0.0	0.0	246.2	7.4	3.9	2.7	8.4	9.6	32.0	85.7	0.0	0.0	552.3
8-9-88	222	LOST	0-6	10	114.0	46.7	0.0	0.0	30.8	0.9	1.3	1.3	3.4	1.2	8.1	4.2	0.0	0.4	204.2
8-16-88	229	LOST	6-10	10.0	32.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	69.2	0.0	2.4	105.3
8-16-88	229	LOST	10-23	10.0	30.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.4	18.4	123.1	0.0	0.3	172.5
8-16-88	229	LOST	0-6	10.0	461.7	8.9	1.7	0.0	20.0	3.1	11.2	7.6	18.0	8.3	48.2	76.9	0.0	7.3	624.7
8-23-88	236	LOST	0-6	10.0	15.2	0.1	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	16.8	36.1
8-23-88	236	LOST	10-23	10.0	169.3	0.8	0.3	0.0	107.1	0.0	0.0	0.0	0.0	0.0	0.0	76.9	0.0	30.6	385.0
8-23-88	236	LOST	6-10	10.0	38.4	0.0	0.0	0.0	61.6	0.0	0.0	0.0	0.0	0.2	0.2	24.6	0.0	46.7	171.5
8-29-88	242	LOST	10-23	10.0	15.0	0.2	0.0	0.0	15.3	0.0	0.0	0.0	0.0	0.0	0.0	41.6	0.0	15.3	87.4
8-29-88	242	LOST	7-10	10.0	61.6	0.0	0.0	0.0	30.7	0.0	0.0	0.0	0.0	0.0	0.0	77.0	0.0	92.3	261.6
8-29-88	242	LOST	0-7	10.0	103.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.3	0.0	69.3	204.9
9-14-88	258	LOST	16-21	10.0	0.0	0.0	46.2	0.1	35.4	0.0	0.0	0.0	0.0	0.0	0.0	64.7	0.0	19.9	166.3
9-14-88	258	LOST	0-12	10.0	53.9	30.8	24.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	111.3
9-14-88	258	LOST	0-21	10.0	43.7	60.0	0.0	0.1	38.3	0.0	0.0	0.0	0.0	0.0	0.0	50.8	0.0	6.1	199.0
9-14-88	258	LOST	12-16	10.0	38.2	46.2	11.5	0.0	15.4	0.0	0.0	0.0	0.0	0.0	0.0	56.5	0.0	15.3	183.1
9-21-88	265	LOST	0-25	4.0	38.5	42.3	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	9.0	94.4
9-21-88	265	LOST	0-25	4.0	9.6	15.4	9.4	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	8.5	59.5
9-21-88	265	LOST	0-25	4.0	21.5	19.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	5.8	0.0	6.5	53.3
10-5-88	279	LOST	0-25	4.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	7.0	8.6
10-11-88	285	LOST	0-25	4.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	4.0	7.1