ENVIRONMENTAL PROTECTION BRANCH
ENVIRONMENTAL PROTECTION SERVICE
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The Impact of Sewage Disposal on the Water Quality and Standing Crop of Plankton in Lynx Lake

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by

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ABSTRACT

Water chemistry and biological indices did not indicate that the domestic sewage effluent entering Lynx Lake through an unnamed creek was having a detectable effect. It is theorized that nutrient regeneration within this type of small lake is a natural occurrence and, as evidenced in Erickson Lake, the control lake, can support algal blooms of 100 ug/l chlorophyll-a.

Although blue-green algae made up a dominant portion of the phytoplankton in both lakes, the overall variety of phytoplankton was greater in Lynx Lake. Zooplankton standing crop was also greater in Lynx Lake and this may be attributed to the more diverse phytoplankton flora.

It is felt that due to the naturally high productivity of these lakes and the development of anoxic conditions during the late summer, fish habitation would be restricted to the upper region of the water column.

RÉSUMÉ

Selon les indices de la composition chimique et biologique de l'eau, les effluents provenant des égouts et se déversant dans un ruisseau puis dans le lac Lynx, n'ont pas d'effet notable sur ce dernier. On admet que la régénération des substances nutritives dans ce type de lac aux dimensions réduites est un phénomène naturel et, comme le montre le lac Erickson, qui est un lac témoin, cette régénération explique pourquoi la production d'algues peut atteindre 100 ug/l de chlorophylle-a.

Bien que le phytoplancton ait été constitué en majeure partie de cyanophycées dans les deux lacs, on en a relevé une plus grande diversité dans le lac Lynx. On a d'autre part relevé une plus grande production de zooplancton dans ce même lac Lynx, ce que l'on peut attribuer à la plus grande diversité de la flore phytoplanctonique.

La grande productivité naturelle de ces lacs et l'apparition à la fin de l'été de conditions favorisant l'anoxie ont pour effet de réduire l'habitat du poisson aux régions supérieures de la nappe d'eau.

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SUMMARY AND CONCLUSIONS

The more eutrophic nature of Erickson Lake could be attributed to its landlocked nature while the defined inflow/outflow of Lynx Lake likely contributes to a less eutrophied system. The water quality of the north end of Lynx Lake was similar to the south end even though chlorinated secondary treated domestic sewage is discharged to the former.

Nutrient regeneration within the lakes sediment is theorized to be a natural characteristic of this type of lake and is capable of supporting algal blooms of 100 ug/l chlorophyll-a.

It is surmised that fish habitat is restricted to the upper two meters of the water column in the summer due to the low dissolved oxygen saturation levels below those depths.

Blue-green algae were common to the phytoplankton population of both lakes but even more so in Erickson Lake. The presence of Aphanizomenon in Erickson Lake during the summer period should be confirmed.

The larger standing crop of zooplankton in Lynx Lake could be attributed to a more diverse phytoplankton population as many blue-greens are not grazed upon, thus reducing the available food for zooplankton. In general, for both lakes, the dominant cladoceran was Daphnia and the dominant copepoda was Cyclops. The dipteran Chaeoborus was found in both basins. The large portion of Daphnia compared to Bosmina is an indication of low fish predation.

The fish population of these lakes has not been defined but trout could at times be close to their upper physiological tolerance in these types of lakes.

1 INTRODUCTION

Lynx Lake, located 39 km west of Prince George, British Columbia, is the receiving water body for chlorinated secondary treated domestic sewage effluent discharged into an unnamed creek from Canadian Forces Base, Baldy Hughes.

In order to document the possible impact of the C.F.B. Baldy Hughes Sewage Treatment Plant discharge on Lynx Lake, the Environmental Protection Service conducted water quality assessment surveys on June 11, 1975, and August 12, 1975. Erickson Lake, which is the C.F.B. Baldy Hughes water supply and is similar in location and morphometry to Lynx Lake but does not receive any form of discharge or recreational use, was monitored as a control.

The scope of the study included the measurement of the standing crop of phytoplankton and zooplankton and the chemical and physical water chemistry of the lakes.

2 DESCRIPTION OF STUDY AREA

Lynx Lake and Erickson Lake are located approximately 39 km west of Prince George in the Northern Interior Plateau limnological region of British Columbia (Northcote and Larkin, 1956) (Figure 1). The region consists mainly of sedimentary and volcanic rocks that are extensively glaciated and with a mantle of lucustine silts in many areas. The topography is mostly gently rolling uplands at elevations of 915 km to 1830 km.

Both lakes are humic in nature with a dark brown water coloration and are typical of small lakes of the area. The areas of Lynx Lake and Erickson Lake are approximately 24 ha and 28 ha respectively. The two lakes are morphometrically similar and are shown in Figure 2 along with the location of the sample stations. While Lynx Lake has a defined inflow and outflow, Erickson Lake appeared to be landlocked. Four sample stations were established on Lynx Lake, one in the deepest basin (E), one at an intermediate depth (D) and two at the shallow north end where an unnamed creek containing sewage effluent discharged from the C.F.B. Baldy Hughes secondary treatment plant enters the lake (B and C). Two stations were established on Erickson Lake, one in the deepest basin (G) and one at an intermediate depth (F).

Geff Chislet (personal communication, British Columbia, Fish and Wildlife Branch) reports that rainbow trout and coarse fish (Cyprinidae and Catostomidae) are thought to be resident in the small lakes such as Lynx Lake in the Prince George area.

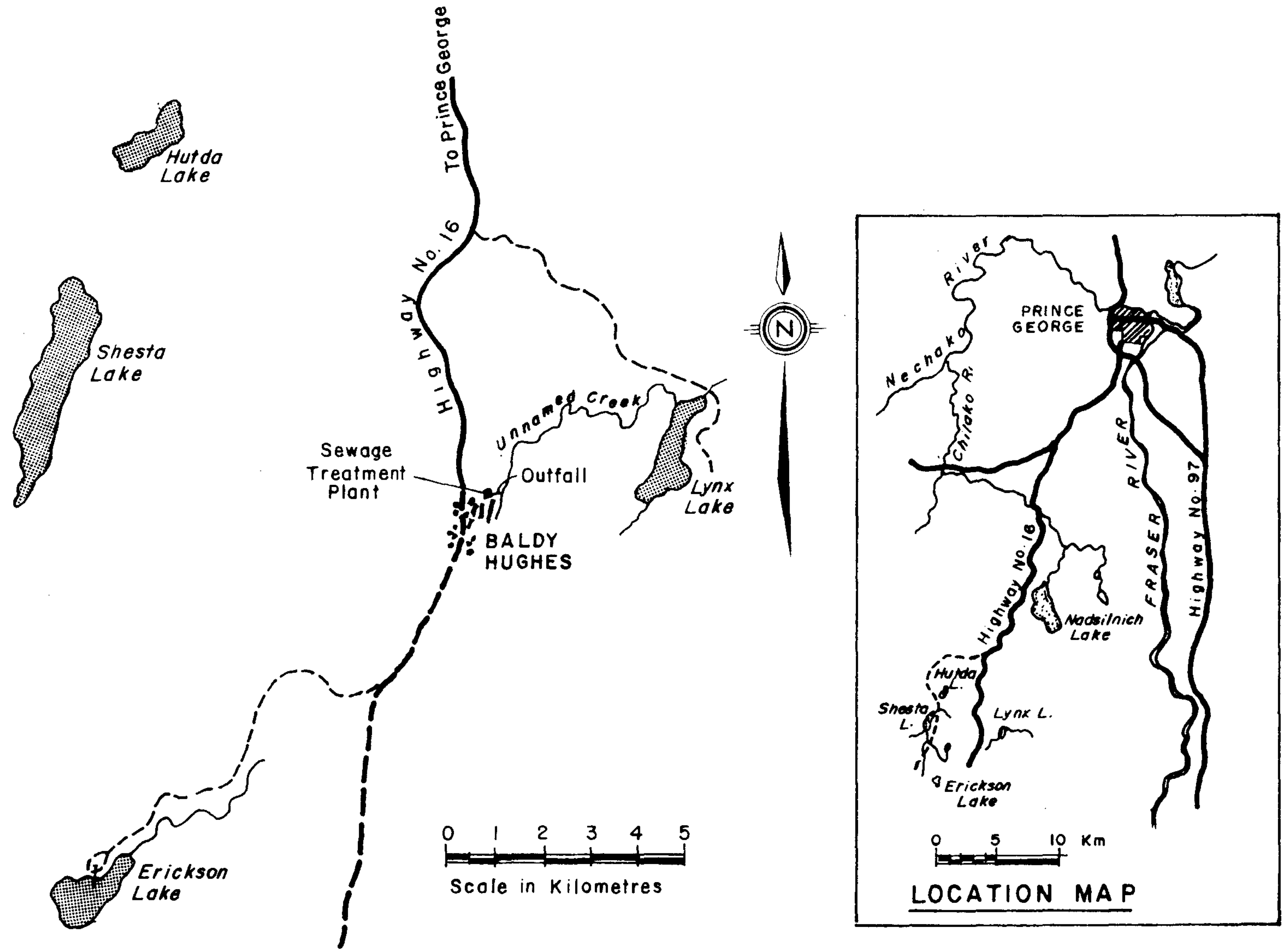

FIGURE 1 LOCATION MAP OF LYNX LAKE AND ERICKSON LAKE

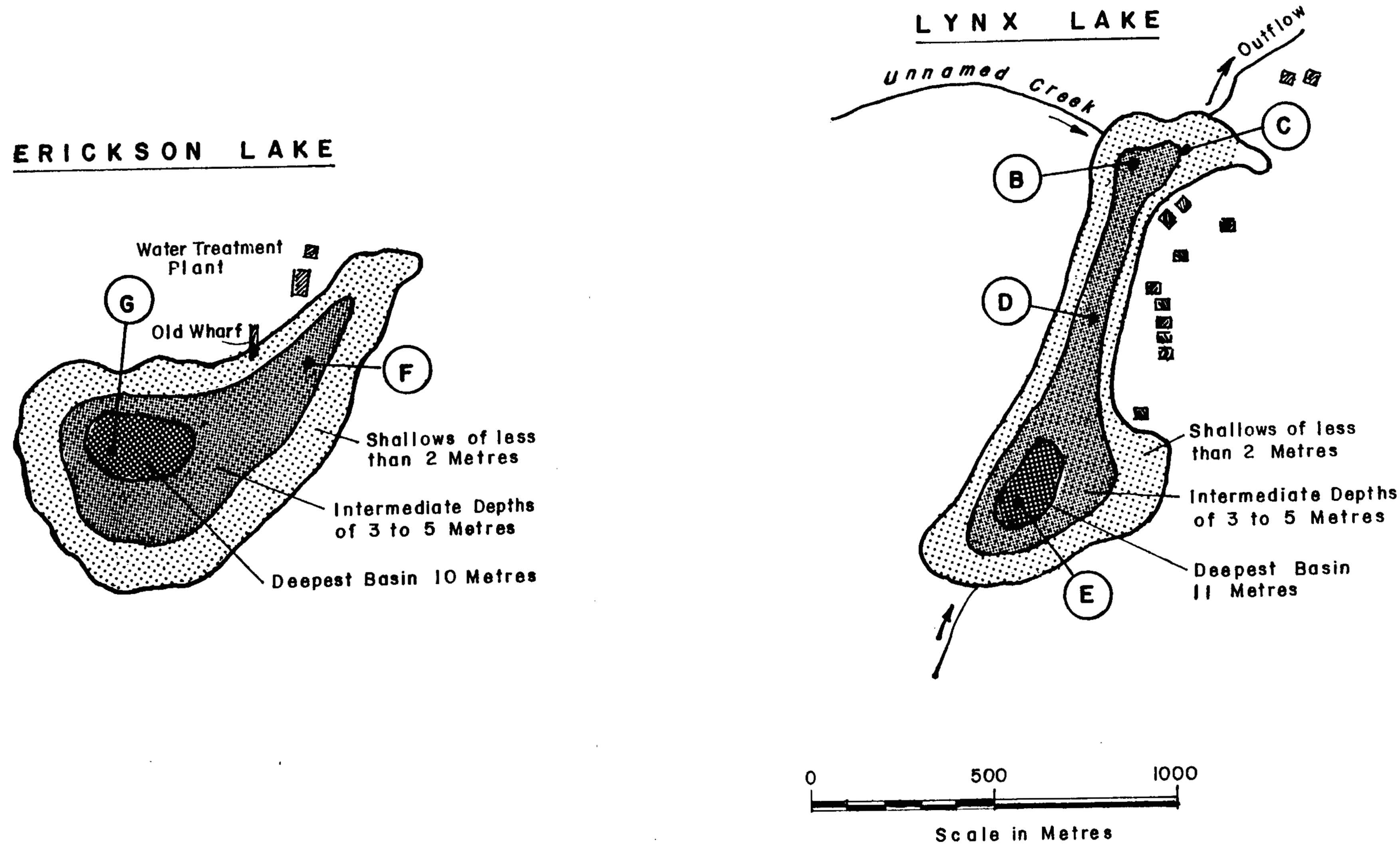

FIGURE 2 MORPHOMETRY OF LYNX AND ERICKSON LAKES AND SAMPLE STATION LOCATIONS

3 METHODS AND MATERIALS

3.1 Physical and Chemical

Temperature profiles were taken with a YS1 tele-thermometer and light penetration was measured with a standard Secchi disc.

Water samples were collected in 3 litre Van Dorn water bottles at 1 meter, 3 meters and at either 5 meters or 8 meters depending on the station. At each depth a 300 ml sample for dissolved oxygen was preserved immediately with manganous sulfate and alkali-iodide-azide reagents and titrated against a 0.025 N sodium thiosulphate solution within 8 hours. A sample for conductivity, turbidity and pH was stored in a 500 ml polyethylene sample bottle and was analyzed within 8 hours utilizing a Siebold Model LTB conductivity meter, Hach Model 1860A turbidimeter and a Radiometer Model 29 pH meter, respectively. Samples for total organic carbon (T.O.C.) and total inorganic carbon (T.I.C.) were stored in a 100 ml polyethylene bottle while samples for total phosphate (TPO_4), ammonia nitrogen (NH_3+NH_4^+), nitrate nitrogen (NO_3-N) and hardness were stored in a 500 ml polyethlene bottle. A sample for total dissolved phosphate was field filtered through a distilled water washed 0.45 u cellulose acetate filter and stored in a 125 ml polyethylene sample bottle. All samples were shipped in ice coolers to the E.P.S. laboratory in West Vancouver. Analyses were performed at the Fisheries and Environment Canada, Cypress Creek Laboratory (Anon., 1976).

3.2 Biological

Two one-litre samples and a 250 ml sample were collected at depth intervals of 0, 1, 2, 3, 4 or 5, 8 and 10 meters where possible for chlorophyll-a analysis, ash-free dry weight determination and algal identification and enumeration. The chlorophyll samples were kept in the dark and filtered within 8 hours through a 0.45 u cellulose nitrate membrane filter, treated with $MgCO_3$ and frozen over dry-ice. The ash-free dry weight samples were shipped in ice coolers to the E.P.S. - Fisheries laboratory in West Vancouver for analysis (Anon., 1976).

The algal samples were preserved with Lugol's solution and identification and enumerations were determined on samples from stations B, E, G, and F. Samples from depths 0, 1, 2 and 3 meters were combined into one composite except for the June 11, 1975, station B sample which was made up of 0, 1 and 2 meter depths. The Utermohl inverted microscope technique was used in the identification and enumeration and the counts are the average of two fields extrapolated to cells per ml.

At each station three zooplankton samples were collected from a total vertical water column with a 25 cm diameter Wisconsin #20 net (76 u aperture). The samples were preserved with a 5% concentration of formalin. Due to the high algal content of the water and cell lysing with pigment release, it was necessary to wash all the samples on a #10 netting (158 u aperture) to remove some of the cloudiness. With the exception of the larger Asplanchna, the smaller rotifera would be washed through the netting thus, this group was excluded from the enumeration. The rotifera did not seem to be an important constituent of the zooplankton community in the two lakes, justifying to some extent their omission (A. Federenko, personal communication).

4 RESULTS AND DISCUSSION

4.1 Water Chemistry

4.1.1 Physical and Chemical. Thermal profiles of the deep basins of Lynx Lake (Stn. E) and Erickson Lake (Stn. G) show a summer thermal stratification with temperatures of 4-6°C below 5 meters (Figure 3). For shallower stations (4 m) in June, surface temperatures approximated 16°C decreasing to about 8°C at 4 meters. In August these stations were generally weakly stratified.

Secchi disc readings for Lynx Lake were relatively fixed at 1.3 meters in both June and August (Figure 3) while for Erickson Lake the Secchi disc reading of 2 meters in June was reduced to approximately 1 meter in August, the result of a heavy blue-green algal bloom.

The vertical distribution of dissolved oxygen in both lakes clearly shows that anoxic conditions develop (Figure 4). Oxic conditions appear to exist in the upper 1-2 meters in both lakes. The dissolved oxygen maxima (10.4-10.9 mg/l) at 1 meter in Erickson Lake in August coincided with a heavy blue-green algal bloom. Barcia (1975a) and Ayles *et al.* (1976) have reported that, prior to the collapse of an *Aphanizomenon* bloom in some small eutrophic lakes of central Canada, the algal collapse is preceded by a peak in chlorophyll-a and dissolved oxygen levels and is followed by a rapid drop in dissolved oxygen and a considerable release of toxic un-ionized ammonia. For Lynx Lake, the percent saturation of dissolved oxygen at 3 meters ranged between 0 to 43.8% and at 5-9 meters from 0 to 3.5%. For Erickson Lake, the percent saturation at 3 meters ranged between 7.5 to 19.8% and at 4-9 meters 0 to 11.8%.

For both lakes, dissolved oxygen percent saturation reached levels that are known to be stressful to trout (Davis, 1975). Low dissolved oxygen levels (below 60% saturation) are reported to reduce blood saturation with oxygen, reduce swimming speed and lower tolerance levels to several chemical parameters including ammonia (Davis, 1975). For both lakes in general, low oxygen levels would likely restrict fish inhabitation in the summer to the upper two meters of the water column.

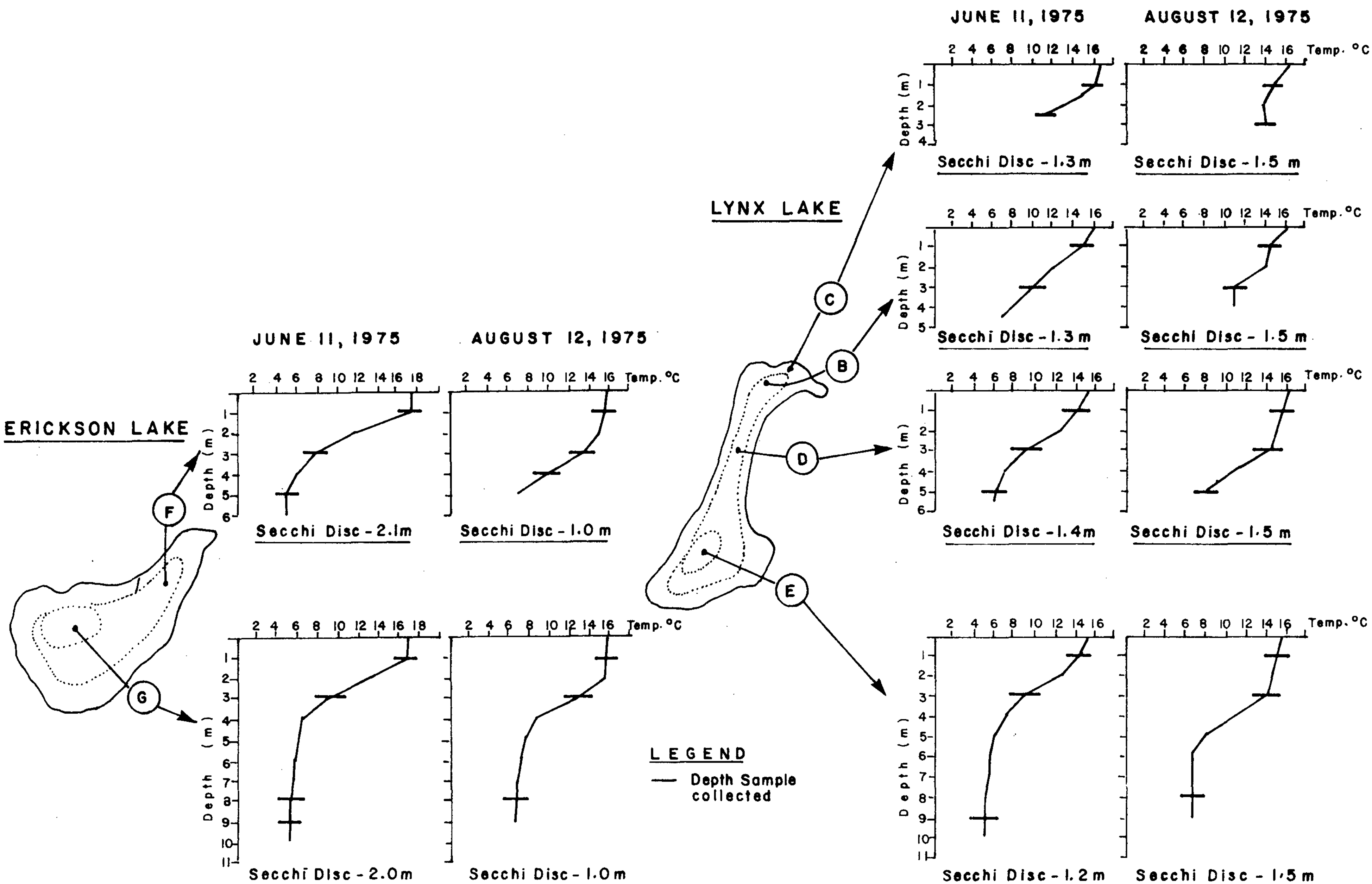

FIGURE 3 THERMAL PROFILES AND LIGHT PENETRATION FOR LYNX LAKE AND ERICKSON LAKE

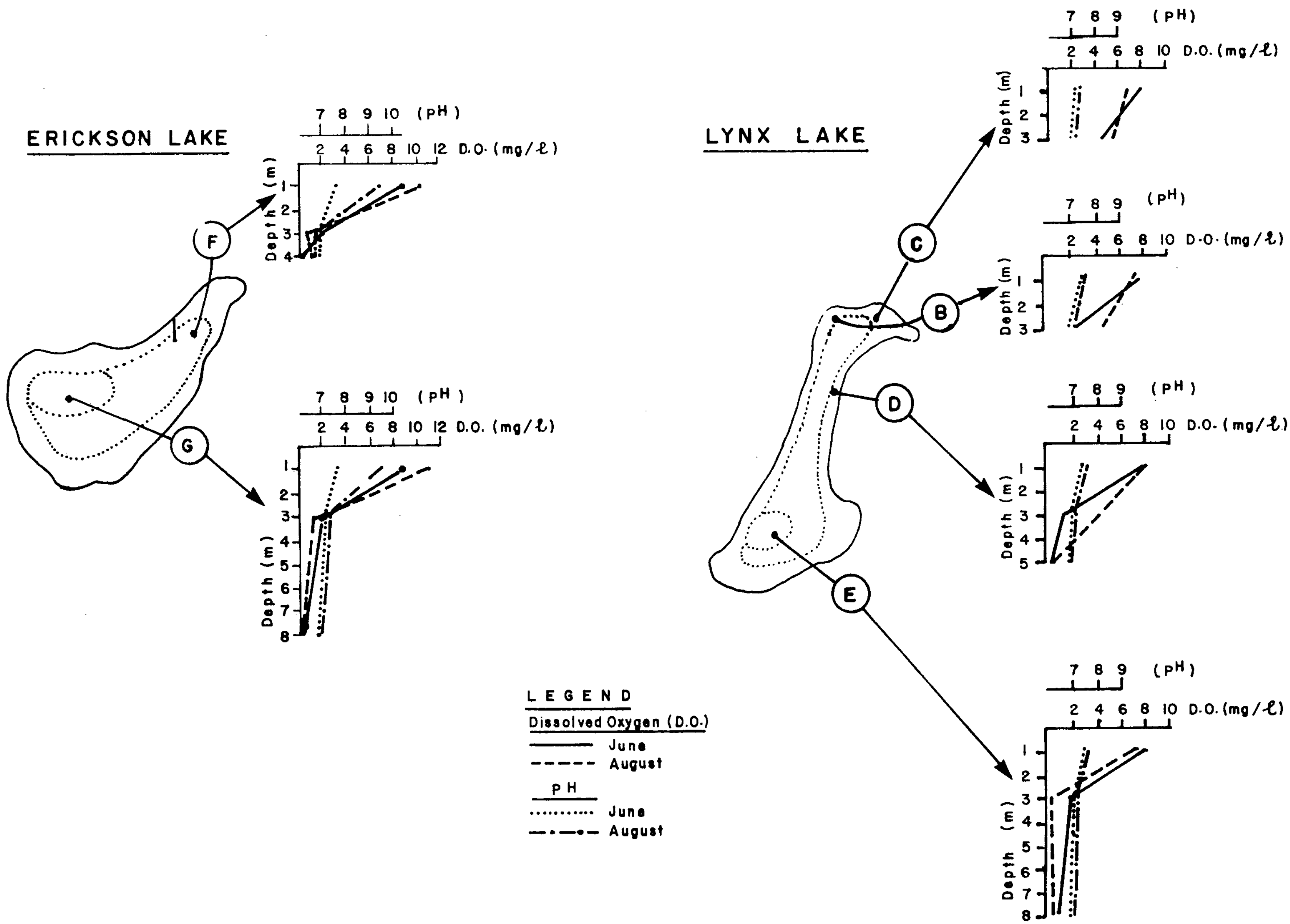

FIGURE 4 DISSOLVED OXYGEN AND pH PROFILES FOR LYNX LAKE AND ERICKSON LAKE

With the exception of Erickson Lake in August, when the pH increased to a high of 9.5 at 1 meter, both lakes had pH values ranging between 6.7 - 7.6 (Figure 4). The increased pH is attributed to a blue-green algal bloom where the CO_2 in the water is being assimilated into algal biomass at a rate faster than it can be replaced thus resulting in a re-adjustment of the solid carbonate equilibria and an increase in pH (Goldman, 1971).

Conductivity, turbidity and hardness showed little differences between stations or lakes. Conductivity values ranged from 97 to 126 umhos/cm, turbidity from 1.6 to 12 JTU and hardness from 51 to 95 mg/l (Table 1). Highest values of conductivity and hardness were reported in the deep basin of each lake (8 meters) and an increase in turbidity in Erickson Lake occurred at the 1 meter depth in August, corresponding with a blue-green algal bloom.

4.1.2 Nutrients. Total inorganic carbon (TIC) concentrations were similar for both lakes in June, with values generally within a range of 26-35 mg/l for Lynx Lake and 29-36 mg/l for Erickson Lake. High values of 84 mg/l and 44 mg/l for Lynx Lake and Erickson Lake, respectively, were detected at the 9 meter depth. The TIC concentrations in August were reduced by approximately one-half throughout the water column of both lakes (Figure 5). Total organic carbon (TOC) concentrations were also similar for both lakes in June with values ranging between 15-21 mg/l in Lynx Lake and 15-18 mg/l in Erickson Lake (Table 2). Total organic carbon concentrations in August were similar to the June levels for Lynx Lake but levels in Erickson Lake increased slightly to 17-25 mg/l.

For the deeper basin of each lake, the thermocline remained relatively fixed at the 3 meter depth (Figure 3). The mean total phosphate concentration for the upper water column (surface to 3 meter depth) in Lynx Lake and Erickson Lake, respectively, was 0.059 mg/l and 0.032 mg/l in June, and 0.041 mg/l (excluding 0.180 mg/l at 3 meter depth at station E) and 0.037 mg/l in August (Table 2). The mean total phosphate

TABLE 1 WATER CHEMISTRY - CONDUCTIVITY, TURBIDITY, HARDNESS, DISSOLVED OXYGEN AND pH

Parameter:		Depth (m)		Conductivity umhos/cm		Turbidity JTu's		Hardness (mg/l)		D.O. (mg/l)		pH		% Saturation	
Date (1975): STATION		Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12
Lynx	B	1	1	99	95	6.0	4.0	54	-	7.5	7.3	7.3	7.4	82.9	79.9
Lake		3	3	100	95	4.5	3.0	54	-	2.1	4.3	6.8	7.2	20.8	43.5
	C	1	1	98	94	3.4	4.0	54	-	7.7	6.7	7.2	7.4	87.3	74.1
		2.5	3	102	94	5.6	4.0	54	-	4.5	5.3	7.0	7.2	45.5	57.5
	D	1	1	102	94	3.5	4.0	54	-	8.1	7.7	7.3	7.5	88.7	86.1
		3	3	106	96	4.3	3.0	51	-	1.3	4.0	6.8	7.1	12.6	43.8
		5	5	114	102	11.0	8.0	73	-	0.0	0.0	6.7	6.9	0.0	0.0
	E	1	1	102	95	4.5	4.0	54	-	7.9	7.3	7.4	7.5	86.5	80.7
		3	3	100	105	4.4	8.0	55	-	1.5	0.0	6.8	6.8	14.5	0.0
		9	8	126	110	8.3	10.0	95	-	0.4	0.0	6.7	6.8	3.5	0.0
Erickson	F	1	1	98	87	1.8	12.0	55	-	8.8	10.4	7.6	9.5	102.4	116.2
Lake		3	3	102	92	4.5	5.0	59	-	2.1	0.7	6.9	6.8	19.8	7.5
		5	4	112	93	6.2	5.0	75	-	0.3	1.2	6.9	6.8	2.7	11.8
	G	1	1	97	87	1.6	8.0	57	-	8.9	10.9	7.6	9.5	102.6	121.8
		3	3	100	123	2.8	7.0	58	-	1.9	1.7	7.0	7.2	18.3	17.8
		9	8	116	107	6.0	4.0	85	-	0.1	0.0	6.8	6.8	0.9	0.0
Unnamed Creek				186	276	6.8	6.0	-	-	8.7	12.5	7.7	8.1	-	-

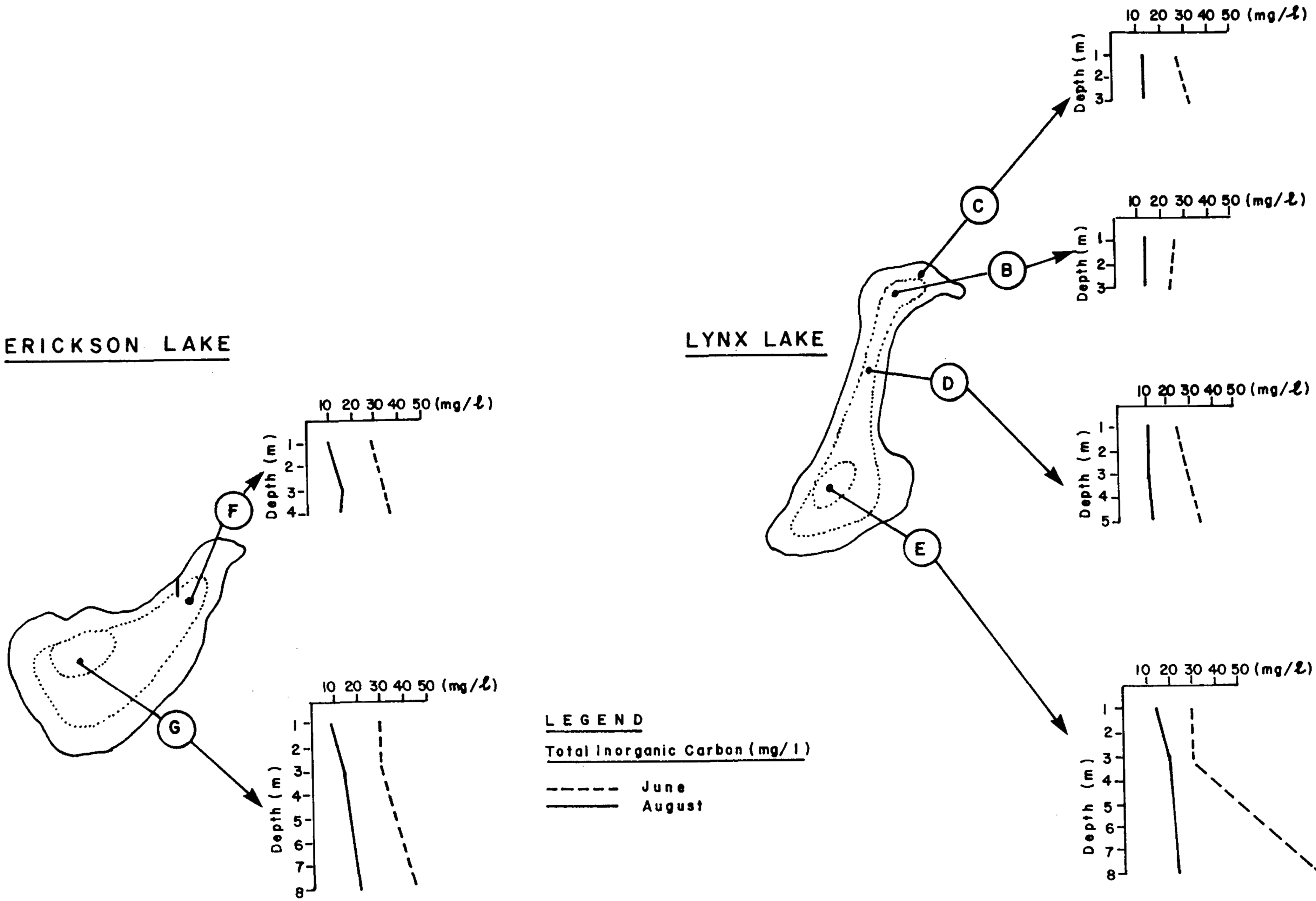

FIGURE 5 TOTAL INORGANIC CARBON PROFILE FOR LYNX LAKE AND ERICKSON LAKE

TABLE 2 WATER CHEMISTRY - NITROGEN, PHOSPHATE AND TOTAL INORGANIC AND TOTAL ORGANIC CARBON

Parameter:		Depth (m)		TOC (mg/l)		TIC (mg/l)		TPO_4 diss. (mg/l)		TPO_4 (mg/l)		NH_3N (mg/l)		NO_3N (mg/l)	
Date (1975): STATION		Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12	Jun.11	Aug.12
Lynx Lake	B	1	1	18	21	26	13	.024	.020	.058	.060	.010	.009	L.01	L.01
		3	3	16	20	24	14	.022	.020	.047	.030	.010	.018	L.01	L.01
	C	1	1	20	22	28	13	.022	.020	.057	.050	L.010	.010	L.01	L.01
		2.5	3	19	19	33	14	.020	.020	.053	.030	.010	.014	L.01	L.01
	D	1	1	20	21	26	13	.026	.020	.054	.060	.010	.009	.01	L.01
		3	3	20	18	30	14	.031	.020	.072	.030	.010	.013	L.01	L.01
		5	5	21	19	35	19	.210	.120	.210	.220	.020	.340	L.01	L.01
	E	1	1	20	20	30	13	-	.020	-	.030	.030	.011	L.01	L.01
		3	3	15	19	31	19	.026	.150	.074	.180	.020	.340	L.01	L.01
		9	8	16	17	84	22	.370	.480	.400	.560	.320	1.300	L.01	L.01
Erickson Lake	F	1	1	18	25	29	10	.020	.020	.024	.050	L.010	.027	L.01	L.01
		3	3	16	19	34	17	.025	.020	.035	.030	.150	.058	.01	L.01
		5	4	17	22	36	16	.100	.010	.150	.020	.680	.060	L.01	L.01
	G	1	1	15	25	29	8	.018	.010	.031	.030	L.010	.026	L.01	L.01
		3	3	15	24	31	14	.024	.010	.038	.040	.110	.026	L.01	L.01
		9	8	16	17	44	20	-	.080	.240	.110	.550	1.250	L.01	L.01
Unnamed Creek				16	15	112	29	.250	.110	.280	.160	.020	.019	.79	1.0

L = less than

concentration for the bottom water column (below 3 meters) in Lynx Lake and Erickson lake, respectively, was 0.305 mg/l and 0.195 mg/l in June and 0.390 mg/l and 0.065 mg/l in August. Dissolved phosphate concentrations reflected a similar pattern but concentrations were approximately one-half that of total phosphate concentrations in the upper water column. The mean dissolved phosphate concentrations for the upper water column in Lynx Lake and Erickson Lake, respectively, was 0.024 mg/l and 0.022 mg/l in June, and 0.020 mg/l (excluding 0.150 mg/l at 3 meter depth at station E) and 0.015 mg/l in August. For the lower water column, the mean dissolved phosphate concentration for Lynx Lake and Erickson Lake, respectively, was 0.290 mg/l and 0.100 mg/l (one value) in June and 0.300 mg/l and 0.045 mg/l in August. The higher phosphate concentrations at the 3 meter depth of Lynx Lake reflected water quality similar to the bottom samples.

Nitrate (NO_3) concentrations were below the detection limit of 0.01 mg/l throughout the water column of both lakes in both June and August (Table 2). In June the ammonia (NH_3+NH^+) concentrations in the upper 5 meters ranged between less than 0.01 to 0.03 mg/l for Lynx Lake and at 9 meters a value of 0.320 mg/l was detected (Figure 6). Unlike Lynx Lake, in June Erickson Lake had ammonia levels of less than 0.01 mg/l at 1 meter increasing to 0.11 - 0.15 mg/l at 3 meters and 0.55 - 0.68 mg/l at 8 meters. In August ammonia levels in Lynx Lake remained relatively unchanged in the upper 3 meters (0.009 - 0.018 mg/l), with the exception of the deep basin (station E, 3 meters) where the concentration increased to 0.34 mg/l reflecting water quality similar to the deeper samples. At the 5 - 8 meter depths concentrations increased over June levels to 0.34 - 1.3 mg/l. Unlike Lynx Lake, for Erickson Lake in August the total ammonia levels at the 1 meter depth appeared to increase (0.020 - 0.027 mg/l) while at 3 - 4 meters, concentrations decreased substantially to 0.026 - 0.060 mg/l. Concentrations again increased at the 8 meter depth to levels greater than in June (1.25 mg/l).

Stations B and C, at the north end of Lynx Lake, where the unnamed creek containing the secondary treated sewage enters, did not indicate any appreciable difference from other areas of the lake with respect

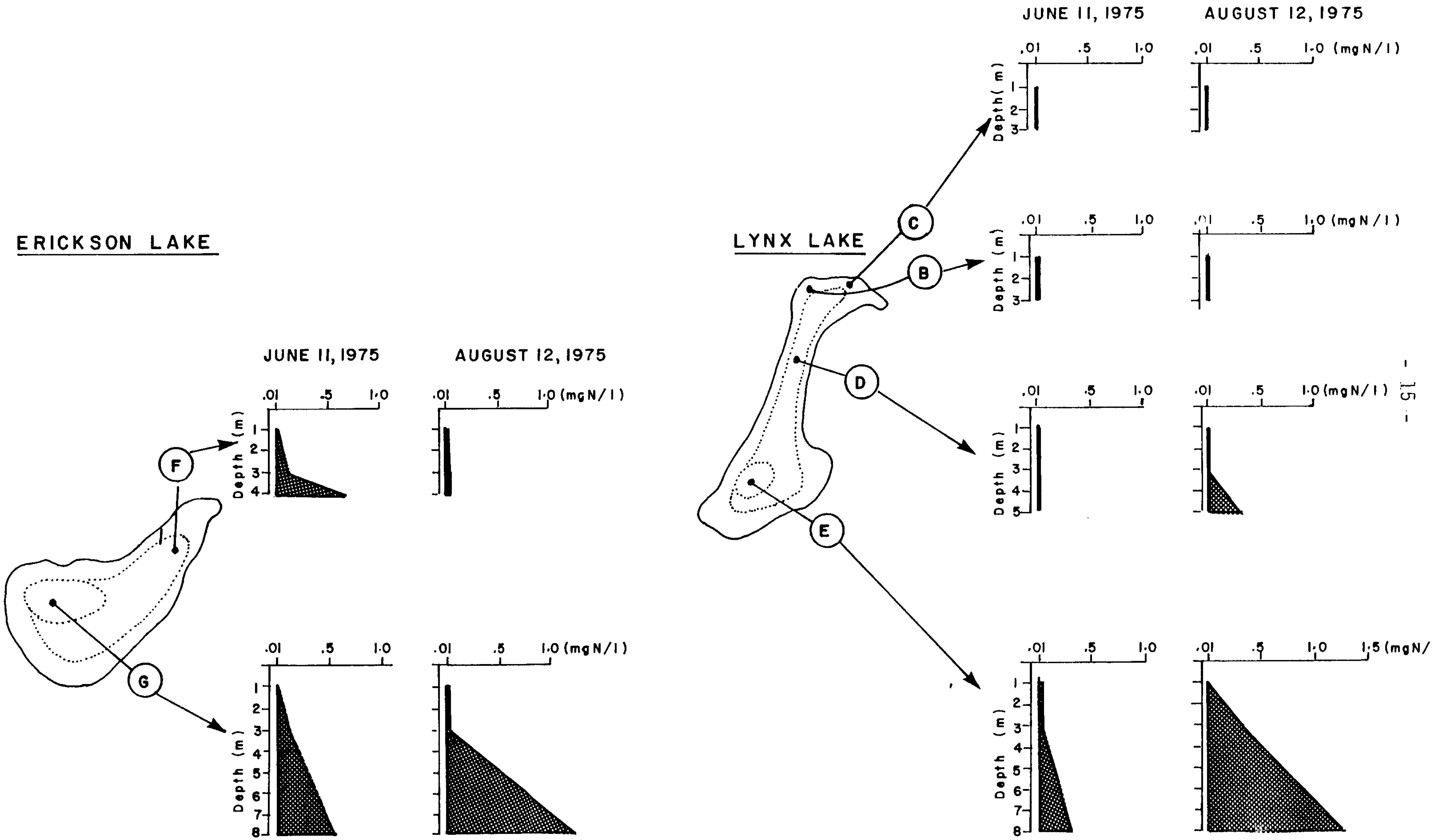

FIGURE 6 TOTAL AMMONIA PROFILE FOR LYNX LAKE AND ERICKSON LAKE

to water quality. In fact, dissolved oxygen levels were comparable at the 1 meter depth and were generally greater at 3 meters compared to other areas of Lynx Lake.

The large increase in ammonia and phosphorus concentrations in the lower portion of the water column of both lakes offers presumptive evidence of nutrient regeneration within the lakes (Golterman, 1977; Barica, 1975(b); Griffith et al., 1973; Austin and Lee, 1975; and Kamp-Nielsen and Anderson, 1977). The high nutrient levels likely result primarily from the decomposition of dead plankton that have settled. The high levels of ammonia in particular would result from the continuous accumulation of nitrogen in the lakes through its fixation by blue-green algae. These lakes appear to be similar in nature to the shallower prairie pothole type lake described by Barica, 1975(a).

4.2 Biological

4.2.1 Phytoplankton - Standing Crop. Chlorophyll-a levels in June were quite comparable between lakes, with an overall photic zone (approx. 2.5 x Secchi) mean of 11.1 ug/l and 7.3 ug/l for Lynx Lake and Erickson Lake, respectively. An appreciable increase in chlorophyll-a occurred in both lakes by August with Erickson Lake reporting very high levels. In August the overall mean photic zone levels of chlorophyll-a were 18.6 ug/l (max. 39.8 ug/l) and 68.1 ug/l (max. 104 ug/l) for Lynx Lake and Erickson Lake, respectively (Table 3, Figure 7). Chlorophyll-a levels at stations B and C were comparable with other areas of Lynx Lake for both months. The high cholorophyll-a levels are comparable to values reported by Barica, 1975 (c) for small pothole prairie lakes. Pheopigment concentrations (degradation product of chlorophyll) were greatest in the bottom of the deep basins indicating the sedimenting of plankton cells.

Ash-free dry weight levels showed the same pattern as chlorophyll-a. A multiple linear regression analysis of the data gave a multiple correlation coefficient of r= 0.83. Values at stations B and C were comparable to other areas of Lynx Lake for both months. For Erickson Lake, in August an algal bloom was recorded with a resulting increase in ash-free dry weight.

TABLE 3 STANDING CROP - CHLOROPHYLL AND ASH-FREE DRY WEIGHT

Parameter:			Chlorophyll-a (ug/l)		Pheopigments (ug/l)		Ash Free Weight (mg/l)	
Date:			11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75
STATION		Depth (m)						
Lynx Lake	B	0	8.8	29.0	3.7	7.1	2.6	3.8
		1	9.6	25.7	L0.2	L0.2	2.4	4.5
		2	6.2	12.9	L0.2	6.4	2.4	1.9
		3	10.4	-	L0.2	-	2.4	-
		4	-	31.1	-	28.5	-	3.9
	C	0	9.3	4.5	L0.2	0.7	2.6	4.4
		1	9.5	28.8	L0.2	L0.2	2.5	4.6
		2	10.8	13.6	6.1	3.5	2.6	2.1
	D	0	10.7	10.8	L0.2	3.9	2.6	3.0
		1	16.0	39.8	9.5	2.8	2.8	2.6
		2	15.8	9.4	L0.2	5.9	2.8	1.2
		3	14.4	-	L0.2	-	2.7	-
		4	-	9.4	-	6.5	-	1.9
		5	6.7	-	1.3	-	1.9	-
	E	0	5.5	13.0	-	3.3	2.4	2.2
		1	9.5	13.4	-	2.3	2.9	2.0
		2	18.9	21.6	-	5.0	3.0	3.3
		3	12.9	17.6	-	3.9	2.0	2.6
		8	4.8	19.4	-	18.6	7.1	2.7
		10	12.4	-	-	-	4.0	-
Erickson Lake	F	0	6.8	35.4	L0.2	1.2	1.9	5.5
		1	5.8	74.9	L0.2	L0.2	1.7	5.6
		2	8.8	78.6	L0.2	L0.2	1.4	11.1
		3	5.4	89.6	3.5	5.9	2.5	8.7
		4	-	33.5	-	12.0	-	4.8
		5	6.0	-	L0.2	-	2.0	-
	G	0	-	45.9	-	L0.2	1.9	4.9
		1	6.6	104.0	L0.2	L0.2	1.8	17.1
		2	4.6	95.1	L0.2	13.2	1.9	14.3
		3	12.6	21.8	8.7	8.9	2.3	3.7
		8	3.9	13.4	L0.2	10.2	4.3	3.7
		10	4.2	-	L0.2	-	4.8	-

L = less than

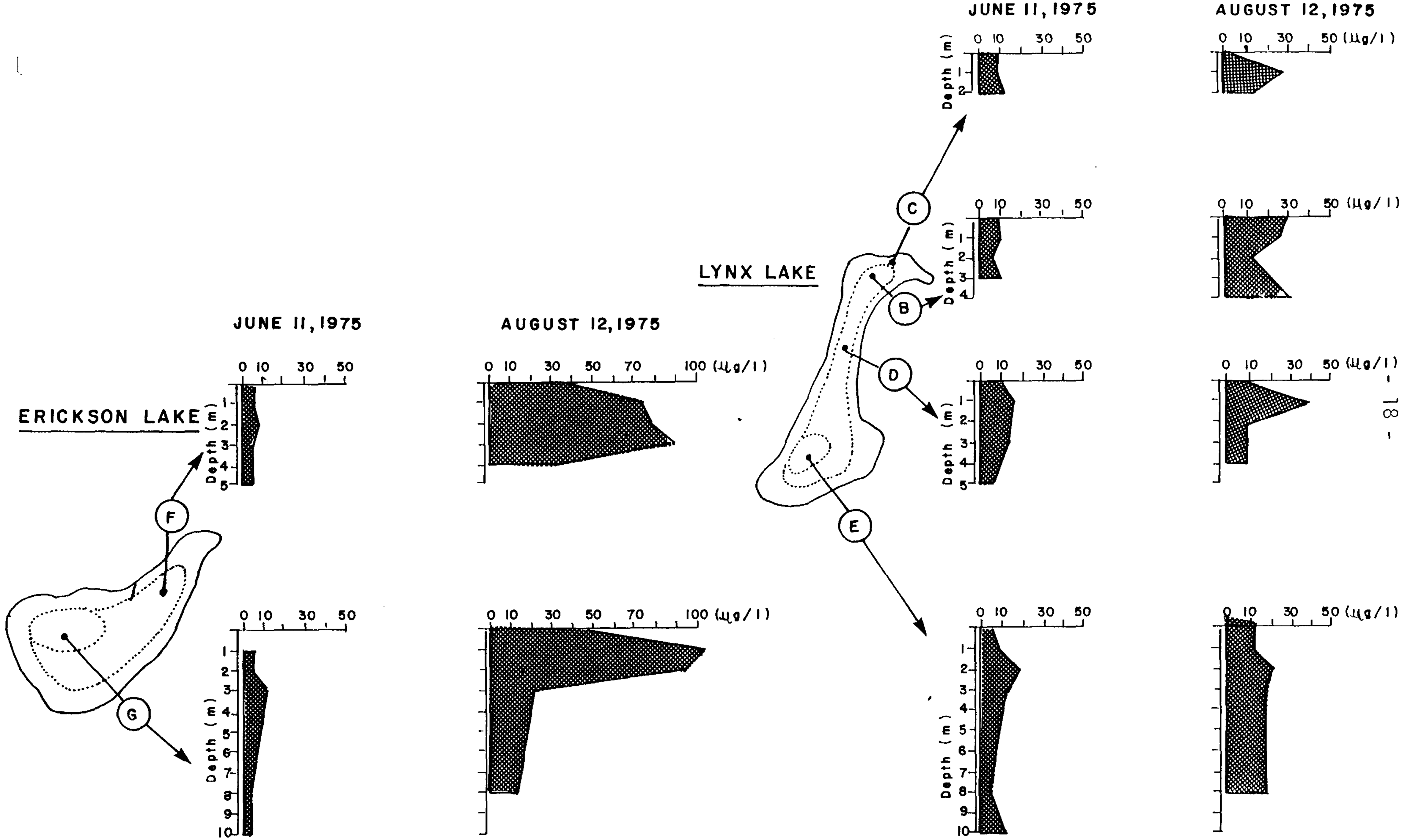

FIGURE 7 CHLOROPHYLL 'A' STANDING CROP PROFILE FOR LYNX LAKE AND ERICKSON LAKE

Chlorophyta (green algae) did not constitute a significant part of the phytoplankton in Lynx Lake and were not recorded at all in Erickson Lake (Appendix I). For Lynx Lake, in June the Cyanophyta (blue-green algae) made up 53-97% of the total algae and this consisted of Anabaena and Oscillatoria (Appendix I and III). The dominant Bacillariophyceae (diatoms) were Synedra and Dinobryon. For Erickson Lake, in June the blue-greens consisted of Aphanizomenon (unconfirmed), Anabaena and Oscillatoria and the dominant diatom was Dinobryon. The dominant blue-green in Lynx Lake for August was Anabaena and the dominant diatoms were Asterionella and Nitzschia. Aphanizomenon (unconfirmed) was the only alga identified in the August sample from Erickson Lake.

Nutrient levels indicate an ample source of phosphate and carbon for algal growth but possibly a depleted nitrate pool (less than 0.01 mg/liter). It appears that the phytoplankton population is favoured by typical nitrogen fixing forms of blue-greens such as Anabaena and possibly Aphanizomenon. It seems realistic that due to the weak stratification in summer, nutrient rich deeper waters could be easily circulated within the lakes to sustain a high level of primary production. For comparative purposes several characteristics of Lynx Lake and Erickson Lake are compared with two pothole lakes that form a partial thermocline (Barica, 1974) and an experimental lake (Lake 227) of northwestern Ontario (Schindler, 1971). The similarity of the eutrophic nature of these lakes is quite evident (Table 4).

4.2.2 Zooplankton. Copepoda made up the greater portion of the zooplankton for both lakes in June and for Erickson Lake in August. Cyclops was the dominant genus in Lynx Lake while Diaptomus was for Erickson Lake in June (Appendix II). Cladocera were present at all stations and Daphnia was the dominant genus. Bosmina was present only in Lynx Lake for June. Diptera (Chaeoborus) were present only at the deep basin (station E) in Lynx Lake but were evident at both stations on Erickson Lake. For Lynx Lake, in August the Cladocera generally increased in number and consisted solely of Daphnia. Cyclops was still the dominant Copepoda and Chaeoborus

TABLE 4 LAKE COMPARISON

Parameter	Experimental Lake (Schlindler 1971)		Erickson Lake	Lynx Lake	Prairie Pothole Lakes (Barica 1974)	
	Lake 227 before Fertilization	Lake 227 after Fertilization			Lake 302	Lake 154
Area (ha)	3-5	3-5	28	24	17.3	9.2
Max. depth (m)	6-10	6-10	10	11	5.3	5.1
Secchi (m)	3.0	0.7-0.95	1.2-1.5	0.9-2.0	0.6-4.5	0.7-3.5
pH	6.3-6.8	9.3-10.2	6.8-9.5	6.7-7.5	7.8-9.1	7.8-9.1
Chlorophyll-a (ug/l)	2-3	48-92	3.9-104	4.8-39.8	5.2-114	0.9-228
Dominant	Cryptomonas	Oscillatoria	Aphanizomenon (unconfirmed)	Oscillatoria	Aphamizomenon	Aphanizomenon
Phytoplankton in the summer	Mallomonas	Lyngba Pseudoanabaena	Oscillatoria	Anabaena Nitzschia Asterionella	Anabaena	Cryptomonas

was found at all stations with increased counts at station E. For Erickson Lake, in August the Cladocera greatly increased in numbers and Bosmina was reported at station G. Cyclops made up the dominant portion of copepoda and the Diaptomus population declined. The number of Chaeoborus declined slightly.

The rotifer Asplanchna was recorded in both lakes in June but was not found in Erickson Lake in August. To the generic level there appears to be be little difference in the zooplankton population of the two lakes.

The total number of organisms per m^3 was greater in June than in August at all stations but G and values in Lynx Lake were greater than those for Erickson Lake. Little difference in the zooplankton population was noted at station B where the unnamed creek enters the lake, except in June when the percent Cladocera was approximately 5 times greater than at D and E (Appendix III).

The smaller zooplankton population in Erickson Lake can likely be attributed to the fact blue-green algae make up a dominant portion of the phytoplankton. As blue-greens are not grazed upon at all, this reduces the available food. Richardson, 1971, and Brooks, 1969, reported that intense fish predation lowers the size and composition of the zooplankton population, large Daphnia being replaced with smaller Bosmina. Generally, the larger Daphnia have a greater feeding effectiveness thus suppressing the population of smaller Bosmina. Bosmina did not make up a dominant portion of the zooplankton in either lake and was not reported at all in Lynx Lake in August. This suggests a low rate of fish predation for Lynx Lake and Erickson Lake. Most freshwater fish (excluding freshwater populations of anadromous marine species) are facultative planktivores, they feed on zooplankton when large forms (especially Daphnia) are plentiful, but switch to some other food source (small fish or benthic invertebrates) when the supply of large zooplankters fails (Brooks, 1969). In general, large zooplankters are preferred to small ones, Cladocera are preferred to calanoid copepods of the same visual size, and cyclopoids are an intermediate choice (Brooks, 1969).

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APPENDICES

APPENDIX I

PHYTOPLANKTON IDENTIFICATION (# cells/ml)

APPENDIX I PHYTOPLANKTON IDENTIFICATION (# cells/ml)

	LYNX LAKE				ERICKSON LAKE			
Station:	B		E		F		G	
Date:	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75
IDENTIFICATION								
CHLOROPHYTA								
Staurastrum	-	-	-	23	-	-	-	-
Scenedesmus	10	-	72	-	-	-	-	-
CHRYSOPHYTA								
Bacillariophyceae								
Achnanthes	-	-	62	-	-	-	-	-
Asterionella	73	2 650	-	64	-	-	55	-
Cymbella	-	-	36	-	18	-	-	-
Diploneis	-	-	-	156	-	-	-	-
Fragilaria	44	220	-	120	P	-	-	-
Navicula	9	-	36	-	18	-	-	-
Synedra	120	9	250	25	-	-	10	-
Surirella	-	-	-	P	-	-	-	-
Tabellaria	-	-	-	-	-	-	10	-
Melosica	-	-	36	-	-	-	-	-
Nitzschia	-	-	-	1 100	-	-	-	-
Dinobryon	120	27	72	-	395	-	165	-
CYANOPHYTA								
Anabaena	920	990	18 800	740	280	-	-	-
Aphanizomenon (unconfirmed)	-	-	-	-	-	45 000	740	800
Oscillatoria	-	-	4 140	-	-	-	1 560	-
EUGLENOPHYTA	36	1060	110	-	-	-	-	-
PYRROPHYTA								
Ceratium	9	211	-	23	-	-	-	-
Total Number	1 711	5 167	23 633	2 251	720	45 000	2 540	800

APPENDIX II

ZOOPLANKTON IDENTIFICATION

APPENDIX II ZOOPLANKTON IDENTIFICATION* (# organisms/m^3)

	LYNX LAKE						ERICKSON LAKE			
Station:	B		D		E		F		G	
Haul Depth (m):	3	3	4.5	4	8	8	4.5	4	8	8
Date:	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75
IDENTIFICATION										
CLADOCERA										
Daphnia	49 898	32 141	23 674	45 762	8 701	34 326	9 145	60 060	3 397	32 354
Bosmina	7 377	0	3 198	0	1 778	0	0	0	0	412
COPEPODA										
Diatomus	3 753	2 748	512	2 761	768	1 394	25 389	8 283	6 442	2 211
Cyclops	30 553	28 890	304 438	18 047	178 214	16 971	4 322	8 973	1 589	28 124
Nauplii	135 067	126 021	143 964	113 073	68 122	56 569	93 275	5 621	52 498	11 201
DIPTERA										
Chaeoborus	0	2	0	2	95	277	40	23	34	8
ROTIFERA										
Asplanchna	2 752	1 249	2 304	1 578	1 153	1 442	1 729	0	872	0
Kellicottia**	-	P	-	-	-	P	-	-	-	-
Keratella**	P	-	-	-	-	-	-	-	-	-
Total	229 400	191 051	478 090	181 128	269 310	110 979	133 900	82 960	64 832	74 310

* mean, based on two subsamples each of 3 vertical hauls.

** P, present, based on inverted microscope phytoplankton analyses.

APPENDIX III

PERCENT DISTRIBUTION OF MAJOR ORDERS - PHYTOPLANKTON AND ZOOPLANKTON

APPENDIX III PERCENT DISTRIBUTION OF MAJOR ORDERS

	PHYTOPLANKTON							
	B		E		F		G	
	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75
Chlorophyta	L1	0	L1	1	0	0	0	0
Chrysophyta	43	56	2.1	65	61	0	9	0
Cyanophyta	53	20	97	33	39	100	91	100
Euglenophyta	2	20	L1	0	0	0	0	0
Pyrrophyta	L1	4	0	1	0	0	0	0

	ZOOPLANKTON									
	B		D		E		F		G	
	11/06/75	12/08/57	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75	11/06/75	12/08/75
Cladocera	24.9	16.8	5.6	25.3	3.9	30.1	6.3	72.4	5.2	44.1
Copepoda	73.8	83.5	93.9	73.9	95.6	67.5	91.8	27.6	93.4	55.9
Diptera	0	L0.5	0	L0.5	L0.5	L0.5	L0.5	0.8	L0.5	L0.5
Rotifera	1.2	0.6	L0.5	0.9	L0.5	1.3	1.3	0	1.3	0

L = less than