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COMPARATIVE CHEMISTRY OF THERMALLY STRESSED NORTH LAKE AND ITS WATER SOURCE, ELM FORK TRINITY RIVER

THESIS

Presented to the Graduate Council of the
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Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

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Sams, Barry L., Comparative Chemistry of Thermally Stressed North Lake and Its Water Source, Elm Fork Trinity River. Master of Science (Biology), December, 1976, 112 pp., 45 Tables, 19 figures, bibliography, 49 titles.

To better understand abiotic dynamics in Southern reservoirs receiving heated effluents, water was analyzed before and after impoundment in 330 ha North Lake. Macro-nutrients, metals, and chlorinated hydrocarbons were measured. Concentrations of nutrients and metals in sediments were quantified in this 2 yr study.

River water prior to impoundment contained 16 times more total phosphorus, and supported 23 times more *Selenastrum capricornutum* cells in an algal assay than reservoir water.

The reservoir has essentially no drainage and since evaporation is high, the concentrations of many dissolved solids have increased since the reservoir was filled in 1958. North Lake is now phosphorus limited. Apparently altered chemical equilibria have caused precipation or adsorption of phosphorus with calcium and iron.

ACKNOWLEDGEMENTS

I express my gratitude to W. M. Byrd of Dallas Power and Light Co. for the hydrological data of North Lake, and G. B. Smith Jr. for his assistance in the analyses of chlorinated organics.

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CHAPTER I

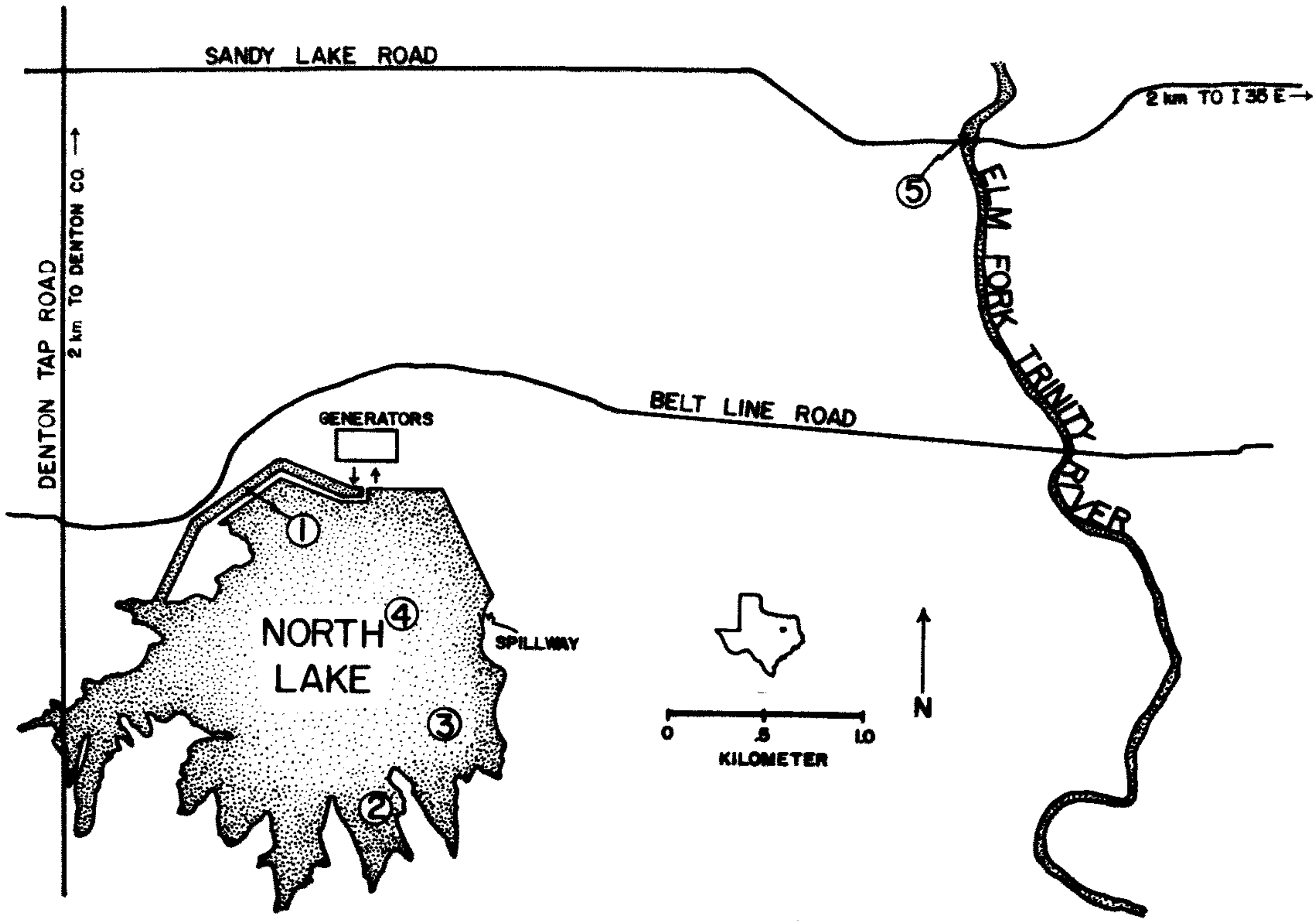
INTRODUCTION

The effects of cooling water on biota have been extensively researched and reviewed,[1,2] but abiotic investigations have often been limited to parameters such as pH, temperature and dissolved oxygen (DO). Investigations of cooling tower blowdown include more chemical data, but have often been conducted in the laboratory using synthetic, simulated effluent,[3] or limited to water in or very near the cooling tower.[4] Lee and Stratton[5] pointed out that there have been few and possibly no long-term investigations of cooling tower blowdown.

Power generation facilities are associated with at least 63 reservoirs in Texas,[6] many of which also serve as municipal water supplies. Surprisingly few of these reservoirs with power plants have had thorough chemical investigations, yet the electrical industry and its demand for cooling water continue to rapidly expand.[7]

North Lake is an artificial 330 ha reservoir located off channel in a comparatively unpopulated corner of northwest Dallas Co., Texas (Figure 1). The reservoir is located on a calcareous clay soil. Filling of the reservoir was completed in 1958. The water level is maintained at

Fig. 1--Map of North Lake, and vicinity showing sampling sites by number.


SANDY LAKE ROAD
2 km TO I 35 E →
DENTON TAP ROAD
2 km TO DENTON CO. →
ELM FORK TRINITY RIVER
BELT LINE ROAD
GENERATORS
NORTH LAKE
SPILLWAY
0
.5
1.0
KILOMETER
N
1
2
3
4
5

approximately 510 ft above mean sea level to facilitate intake of cooling water for a 700 Mw generating plant operated by Dallas Power and Light Co. The natural drainage area for the reservoir is only 8 sq km; therefore water must be periodically pumped into North Lake from the nearby Elm Fork, Trinity River.

Fisheries[8-14] and benthic[15] investigations of North Lake have revealed unusual distribution patterns, reduced species diversity, and 5 fish species with lower condition coefficients than those reported in other parts of the United States. Primary production as estimated by ^{14}C uptake studies has shown low assimilation rates (500 mg C/sq m/day) compared to the limited production data available for other Southwest reservoirs.[16]

Because general water quality information was available for North Lake since it was first filled, the author believed it was feasible to conduct one of the first thorough, long-term studies of a Southwestern cooling reservoir. I also hypothesized that many of the biotic variations observed in North Lake may have actually resulted in response to some chemical phenomena. Thus, the present study was undertaken to (a) investigate direct or indirect effects of the power plant on chemical dynamics in the reservoir; (b) compare the dynamics of chemical constituents in the water and sediments of North Lake to those in Elm Fork, Trinity River, which supplies the reservoir; and (c) delineate any specific abiotic factor(s) that might be either toxic to organisms or otherwise limiting production in the reservoir.

CHAPTER II

MATERIALS AND METHODS

Dallas Power and Light Co. provided unpublished chloride, hardness, and hydrological data of North Lake for the period from 1960 to 1975. Air temperature data were provided by the Department of Commerce.[17]

Monthly water samples were collected from 5 sampling stations on North Lake and Elm Fork, Trinity River (Figure 1) from October 1974 to September 1975. Station 1 was located in the cooling canal, 2 in a remote cove, while 3 and 4 were pelagic stations. Station 5 was located 3 km away from North Lake at the North Lake pumping station on the Elm Fork Trinity River. Water was 4 m deep at stations 1 and 2, and samples were obtained at the top (T=ca. 0.5 m) and bottom (B=ca. 3.0 m) of the water column. Stations 3 and 4 were deeper (8 and 15 m); therefore top, middle (M=ca. 4.0 and 7.5 m), and bottom (B=ca. 7.0 and 14.0 m) samples were obtained on each sampling occasion. Station 4 was located within the thermal plume[12] and in one of the deepest spots in the reservoir. Only top and bottom (B=ca. 3.0 m) samples were taken from the river since station 5 was only 4 m deep.

Temperature and DO were measured *in situ* twice monthly. Laboratory determinations of numerous parameters (Table II) in the water samples were generally conducted using "Standard Methods."[18] A 5-cm light path was used to enhance the sensitivity of photometric determinations.

A qualitative and quantitative comparison of total chlorinated organic carbon in North Lake and Elm Fork, Trinity River was made in April 1975. Composite 15-l samples were concentrated to 1 ml,[19,20] and the concentrated samples were analyzed with a temperature programed Hewlett Packard 5710 A gas chromatograph* connected to a Coulson detection system.

After the monthly water analyses were completed, a second sampling trip was made to collect sediment samples with an Ekman dredge. Samples were stored in polyethylene bags and kept on ice while returning to the laboratory. An aliquot of each sediment sample was dried at 105^{o}C for 5-7 days to determine water content and then ashed (550^{o}C/1 hr) to determine loss on ignition.

Analyses for organic nitrogen in sediments were initiated within 6 hr of sampling. Kjeldahl distillation apparatus was used to drive off free ammonia from 1.500 gm of undried sediment. The residue remaining in the distilling flask was then digested,[18] and the liberated ammonia

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*Avondale, Pa.

distilled into boric acid for a nesslerization. These data were then converted to a nitrogen/dried gm-weight basis.

Greater precision and accuracy was achieved in the monthly sediment phosphorus measurements by modifying and combining several methods.[21-23] One gm of oven dried (110^{o}C) sediment was shaken (125 oscillations/min) in 40 ml of a H_2SO_4-HCl mixture for 10 min. The slurry was filtered (0.45μ) and 10 ml of vanadomolybdophosphoric acid prepared with HCl was added to the filtrate. After 20 min absorption was measured at 420 mμ with a 5-cm light path.

Five gm of oven dried (105^{o}C) sediments were extracted bimonthly from all 5 stations by an aqua-regia method[24] to determine the concentrations of chromium, copper, iron, lead, manganese, zinc, calcium, and magnesium. After appropriate dilution or by using an alternate wavelength, sediment extracts were compared to composite digested standards using a Perkin Elmer 360 AA. Metal values and other sediment parameters were correlated[25] to elucidate significant associations which might affect nutrient dynamics.

To delineate if autotrophic, nutrient limitation was occurring in North Lake or Elm Fork, Trinity River, a 17-day <u>Selenastrum capricornutum</u> algal assay was conducted in March, 1976, using filtered water. Triplicate samples were maintained on a shaker table at 100 oscillations/min in cotton-stoppered 250-ml flasks. Experimental conditions and the design followed EPA recommendations.[26] Daily Coulter Counter* enumerations were made of all particles greater than 4.4 μ. Mean algal yields in various nutrient additions were analyzed for significant differences, using Student's t distribution.[25,27]

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*Hialeah, Fla.

CHAPTER III

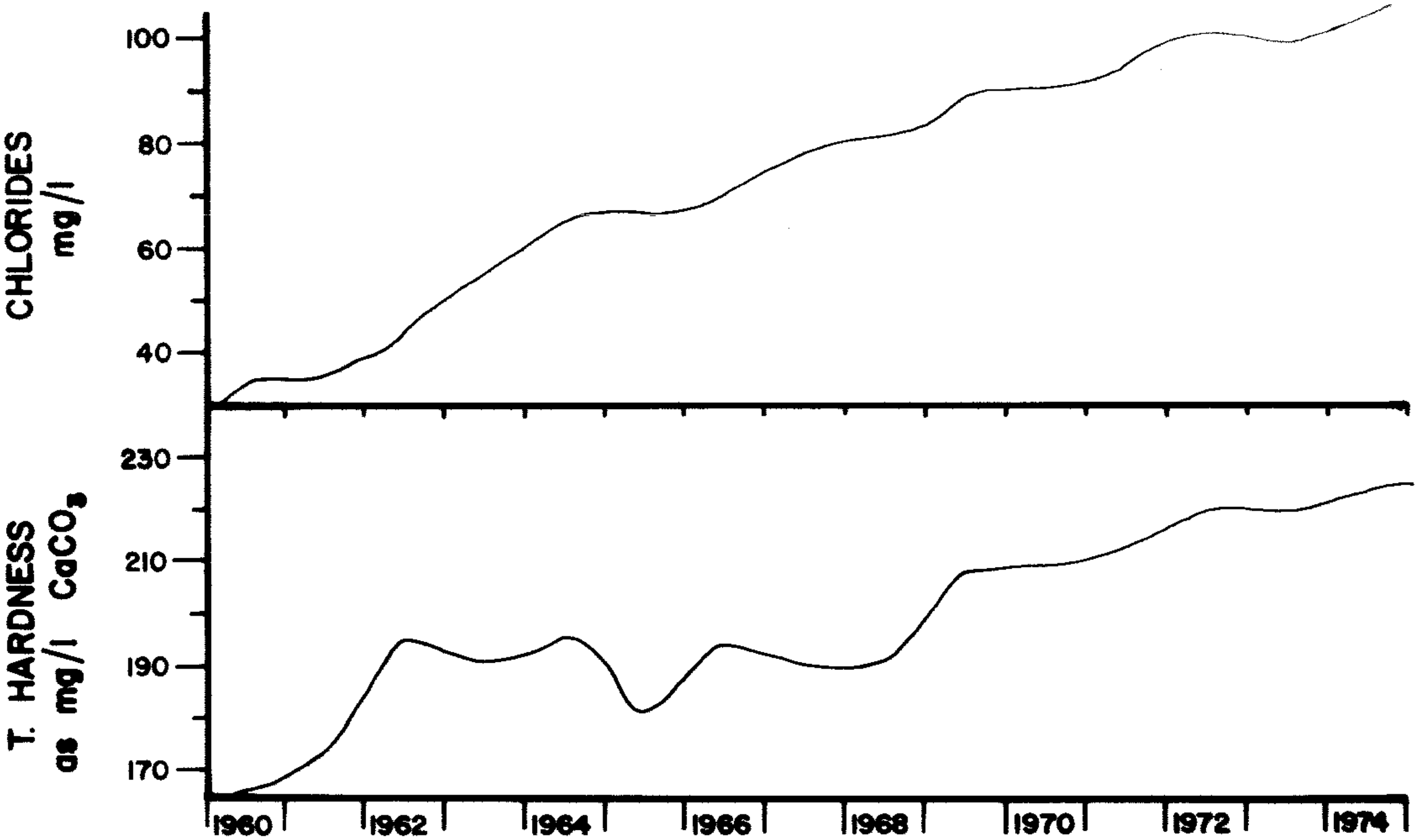
RESULTS

Significant changes in the concentration of dissolved solids have occurred in North Lake during the past 15 yr. Chlorides and hardness have increased 203 and 34 percent respectively (Figure II).

Ninety-eight percent of the water added to North Lake has been for replacement of water lost to evaporation (Table I). Approximately one-half of the evaporation from North Lake has been steam-electric forced[28] and probably resulted from the unusually high ratio of generating capacity to reservoir surface (2.1 Mw/ha). In maintaining a nearly constant water level, the reservoir has been essentially refilled 5.5 times during the last 15 yr; approximately 3.3 of these refillings have been of Elm Fork, Trinity River water, and the remainder from rainfall within the drainage basin (Table I).

The 1974-1975 temperature profile (Figure 3) revealed that the reservoir (sta 2-4) remained about 4^{o}C warmer than the river (sta 5), while the cooling canal (sta 1) averaged 9^{o}C above the river temperatures. Dissolved oxygen generally ranged from 5 to 11 mg/l except at sampling site 4B during the summer (Figure 4); values then were observed as low as 0.2 mg/l.

Fig. 2--North Lake chlorides and total hardness from 1960 through 1974.



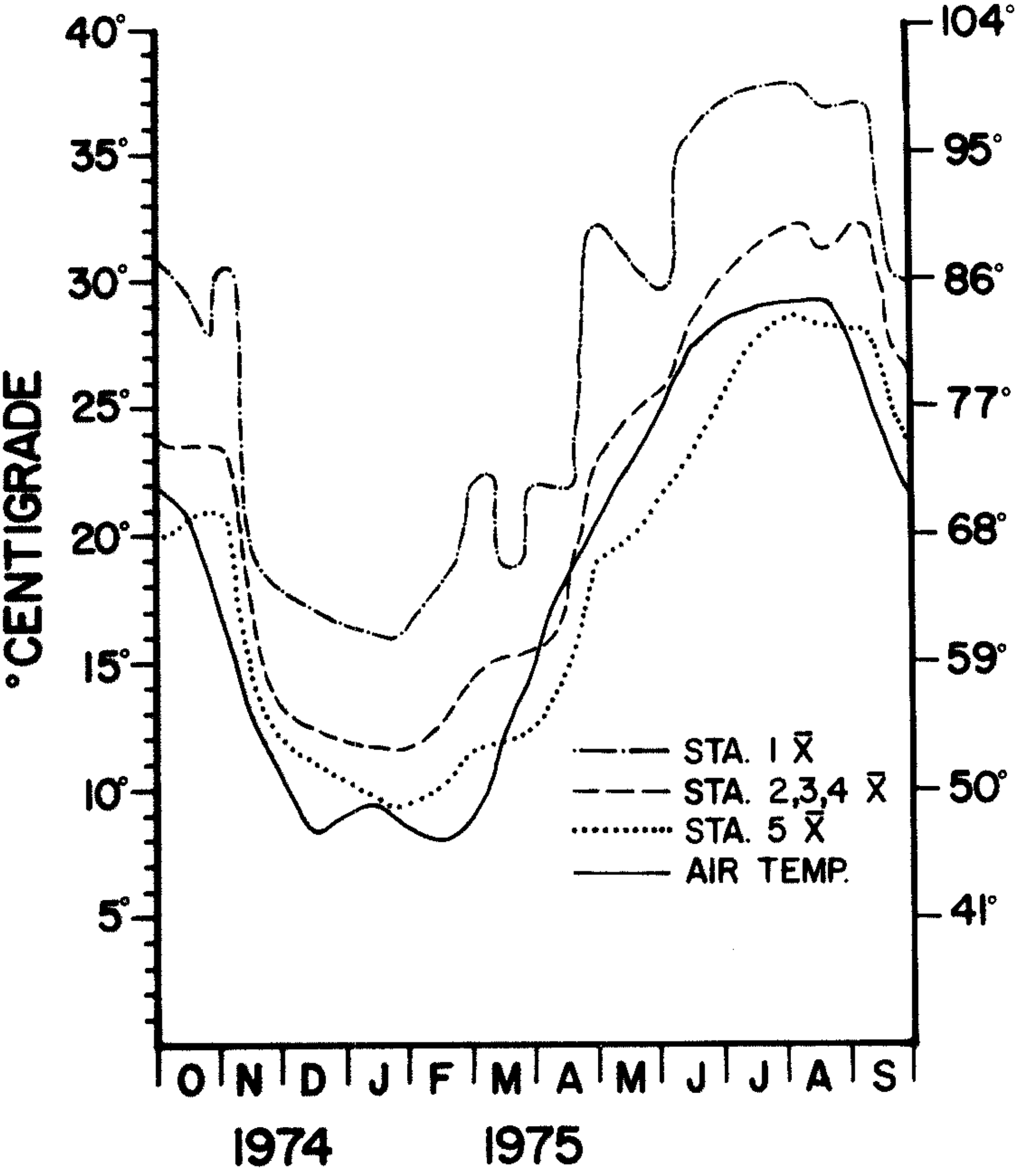
CHLORIDES
mg/l
100
80
60
40
T. HARDNESS
as mg/l $CaCO_3$
230
210
190
170
1960
1962
1964
1966
1968
1970
1972
1974

TABLE I

HYDROLOGICAL DATA NORTH LAKE 1960 TO 1975

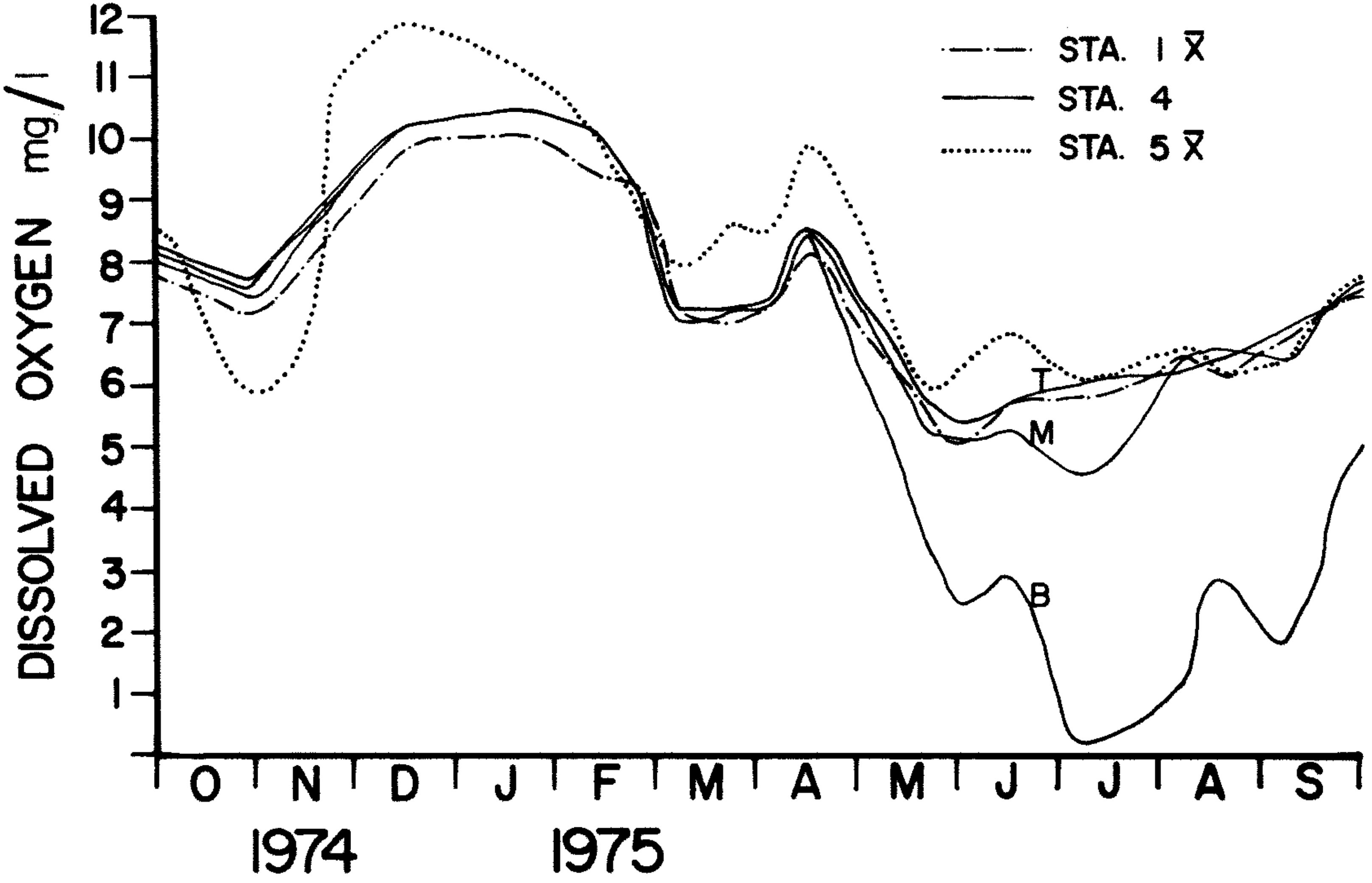
	Storage Acre-feet	Storage Million Gallons	Spillway Overflow Million Gallons	Evaporation Million Gallons	Pumped in Water Million Gallons	Direct Rain Million Gallons
1960	16855	5490	37	1522	363	1086
1961	16150	5264	0	1585	615	745
1962	17028	5545	5	1746	1039	933
1963	14448	4719	0	2067	909	333
1964	17325	5640	0	2021	1936	1006
1965	15648	5103	47	2048	818	740
1966	15978	5209	396	2173	1549	1126
1967	15768	5142	0	2156	1384	705
1968	15535	5067	0	1891	963	853
1969	15775	5144	120	2106	1485	819
1970	15768	5142	0	1981	1344	634
1971	17450	5680	74	1941	1701	852
1972	14020	4582	0	2273	700	476
1973	17035	5547	0	1572	1740	798
1974 Jan.	16923	5511	0	58	0	22
1974 Feb.	17200	5600	0	77	148	18
1974 Mar.	16788	5468	0	164	18	14
1974 Apr.	17133	5578	0	159	207	62
1974 May	16930	5514	0	136	40	31
1974 June	17043	5550	0	247	201	82
1974 July	16593	5406	0	296	144	8
1974 Aug.	17043	5550	0	243	261	127
1974 Sept.	17325	5640	0	143	75	159
1974 Oct.	17148	5670	0	146	56	120
1974 Nov.	17340	5645	1	100	0	76
1974 Dec.	17262	5620	0	66	0	41
1974 (Total)	17061	5563	1	1835	1150	760
1975 Jan.	17333	5642	0	24	0	46
1975 Feb.	17387	5660	1	55	0	74
1975 Mar.	17163	5588	0	91	0	19
1975 Apr.	17155	5586	0	74	0	71
1975 May	17216	5605	0	121	53	88
1975 June	17103	5569	0	178	96	46
Annual $\overline{X}$	16159	5267	44	1901	1151	788
% of Lake Vol.	100.0	100.0	0.8	36.1	21.9	15.0
% of Replaced H_2O	...	...	...	...	59.4	40.6

Fig. 3--Air and mean water column temperatures plotted against time.



40°
35°
30°
25°
20°
15°
10°
5°
°CENTIGRADE
104°
95°
86°
77°
68°
59°
50°
41°
°FAHRENHEIT
STA. 1 X̄
STA. 2,3,4 X̄
STA. 5 X̄
AIR TEMP.
O N D J F M A M J J A S
1974
1975

Fig. 4--Dissolved oxygen at stations 1, 4, and 5 plotted against time.


DISSOLVED OXYGEN mg/l
12
11
10
9
8
7
6
5
4
3
2
1
O
N
D
J
F
M
A
M
J
J
A
S
1974
1975
STA. 1 X̄
STA. 4
STA. 5 X̄
T
M
B

During the present study numerous differences between reservoir and river water quality were documented (Table II). Compared to the river, water quality parameters such as specific conductance, chloride, sulfate, residue, calcium, and magnesium were all notably higher in concentration within the reservoir, but silica, coliforms, iron, orthophosphate, and total phosphorus were significantly lower.

Nitrates averaged 14 percent higher in the cooling canal (sta 1) than in the rest of the reservoir (sta 2-4, Figure 5), while values were considerably higher in the river (Table II).

Determinations of total chlorinated organics, based on spectra peak location and height, suggested no difference between North Lake and Elm Fork, Trinity River.

Sediment values for water content, loss on ignition, organic nitrogen, phosphorus, and metals varied considerably according to sampling site (Table III). Correlations of several parameters were highly significant ($P<0.01$, Table IV).

S. capricornutum algal assays demonstrated phosphorus limitation in North Lake. Phosphorus additions of 0.015 and 0.050 mg/l to filtered reservoir water stimulated significant ($P<0.01$ and $P<0.05$) increases in cell counts (Figure 6). Nitrogen additions to reservoir water (Figure 7) did not affect cell counts. Algal growth in river water cultures was not stimulated by either phosphorus or nitrogen additions

TABLE II

MEANS OF SELECTED LAKE AND RIVER WATER QUALITY PARAMETERS AND DETERMINATION METHOD

Parameter	Lake $\overline{X}$	River $\overline{X}$	Determination Method
pH	8.2	7.9	Electrode
Total alkalinity as mg/l $CaCO_3$	98	115	Indicator BG-MR
Specific conductance mho/cm	1000	300	Conductivity meter
Chloride mg/l	111	23	Argentometric
Silica mg/l	3.1	7.3	Molybdosilicate
Sulfate mg/l	238	34	Turbidimetric
Confirmed coliforms MPN/100 ml	20	3400	Fermentation tubes
Total residue mg/l	642	278	200 ml dried at 105°C
Fixed total residue mg/l	568	216	550°C 1 hr
Filtrable residue (0.45µ) mg/l	623	230	200 ml filtered 0.45µ
Fixed filtrable residue mg/l	554	180	550°C 1 hr
% of total residue which is nonfiltrable	3	17	Calculation
Chromium mg/l	< 0.1	< 0.1	Atomic Absorption*
Copper mg/l	< 0.1	< 0.1	Atomic Absorption
Iron mg/l	0.5	2.4	Atomic Absorption
Lead mg/l	< 0.5	< 0.5	Atomic Absorption
Manganese mg/l	< 0.05	0.06	Atomic Absorption
Zinc mg/l	0.02	0.05	Atomic Absorption
Calcium mg/l	59	46	Atomic Absorption
Magnesium mg/l	17.7	4.3	Atomic Absorption
Hardness (Ca, Mg, Fe) as mg/l $CaCO_3$	220	137	Atomic Absorption
Total carbon mg/l	27.8	30.2	Carbon Analyzer**
Inorganic carbon mg/l	25.0	27.2	Carbon Analyzer
Organic carbon mg/l	2.8	3.0	Difference of TC-IC
Orthophosphate µg/l	5	65	Stannous chloride
Total phosphorus µg/l	5	82	H_2SO_4, HNO_3 - St. Chl.
Nitrates µg/l	130	220	Phenoldisulfonic acid

*Perkin Elmer 360, Norwalk, Conn.
**Beckman 915, Fullerton, Cal.

Fig. 5--Nitrate, and ammonia North Lake mean water column values plotted against time.

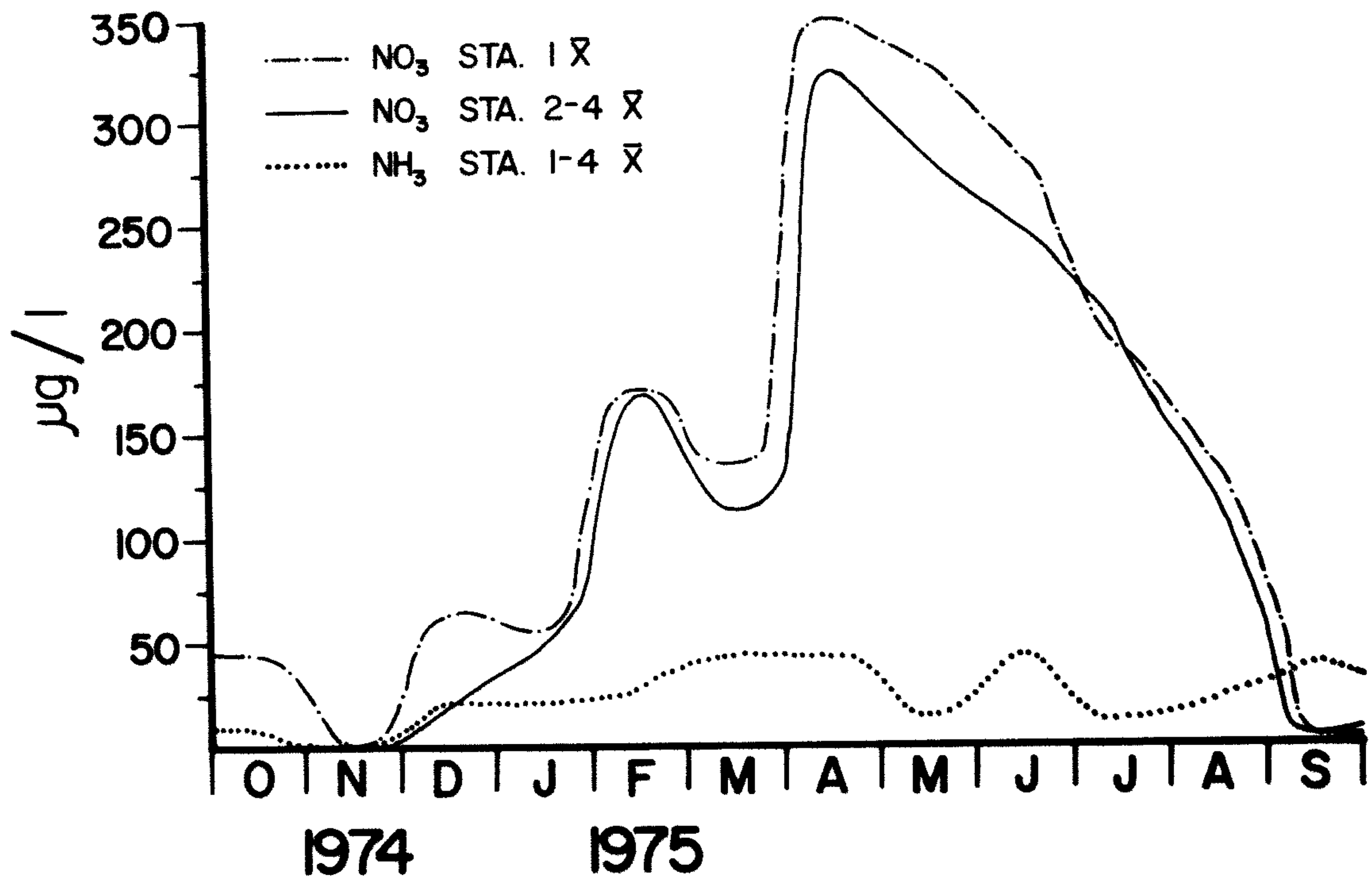

NO3 STA. 1 X̄
NO3 STA. 2-4 X̄
NH3 STA. 1-4 X̄
350
300
250
200
150
100
50
μg / l
O
N
D
J
F
M
A
M
J
J
A
S
1974
1975

TABLE III

MEANS OF SEDIMENT PARAMETERS BY STATION*

Sediment Parameter	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5
% Water (105°C)	38.41	54.19	52.92	73.90	48.79
% Loss on Ignition	3.67	6.86	7.61	9.28	5.96
Organic nitrogen µg/dried g	101	301	298	437	149
Phosphorus µg/dried g	128	169	169	142	151
Chromium µg/dried g	7	27	21	23	14
Copper µg/dried g	56	75	70	138	15
Iron µg/dried g X10^2	229	474	565	484	345
Lead µg/dried g	16	24	26	34	16
Manganese µg/dried g	183	240	276	354	471
Zinc µg/dried g	65	95	108	122	44
Calcium µg/dried g X10^2	532	441	291	438	421
Magnesium µg/dried g X10^1	212	474	506	444	202

*Tabular values represent the mean of 6-12 determinations from Oct. 1974 through Sept. 1975.

TABLE IV

SEDIMENT CORRELATION COEFFICIENTS FOR NORTH LAKE*

Sediment Parameter	Loss on Ignition	Organic Nitrogen	Phosphorus	Chromium	Copper	Iron	Lead	Manganese	Zinc	Calcium	Magnesium
Loss on Ignition	1.000 (28)	0.769 (28)	0.374 (28)	0.785 (16)	0.566 (16)	0.838 (16)	0.945 (16)	0.921 (16)	0.893 (16)	0.524 (16)	0.731 (16)
Organic Nitrogen	0.769 (28)	1.000 (48)	0.072 (48)	0.693 (24)	0.526 (24)	0.529 (24)	0.710 (24)	0.724 (24)	0.682 (24)	0.307 (24)	0.634 (24)
Phosphorus	0.374 (28)	0.072 (48)	1.000 (48)	0.557 (24)	0.018 (24)	0.660 (24)	0.335 (24)	0.143 (24)	0.422 (24)	0.547 (24)	0.711 (24)
Chromium	0.785 (16)	0.693 (24)	0.557 (24)	1.000 (24)	0.370 (24)	0.755 (24)	0.687 (24)	0.552 (24)	0.683 (24)	0.462 (24)	0.887 (24)
Copper	0.566 (16)	0.526 (24)	0.018 (24)	0.370 (24)	1.000 (24)	0.269 (24)	0.813 (24)	0.379 (24)	0.814 (24)	0.007 (24)	0.287 (24)
Iron	0.838 (16)	0.529 (24)	0.660 (24)	0.755 (24)	0.269 (24)	1.000 (24)	0.663 (24)	0.610 (24)	0.741 (24)	0.832 (24)	0.943 (24)
Lead	0.945 (16)	0.710 (24)	0.335 (24)	0.687 (24)	0.813 (24)	0.663 (24)	1.000 (24)	0.914 (24)	0.927 (24)	0.364 (24)	0.703 (24)
Manganese	0.921 (16)	0.724 (24)	0.143 (24)	0.552 (24)	0.379 (24)	0.610 (24)	0.914 (24)	1.000 (24)	0.782 (24)	0.348 (24)	0.618 (24)
Zinc	0.893 (16)	0.682 (24)	0.422 (24)	0.683 (24)	0.814 (24)	0.741 (24)	0.927 (24)	0.782 (24)	1.000 (24)	0.527 (24)	0.750 (24)

TABLE IV--Continued

Sediment Parameter	Loss on Ignition	Organic Nitrogen	Phosphorus	Chromium	Copper	Iron	Lead	Manganese	Zinc	Calcium	Magnesium
Calcium	0.524	0.307	0.547	0.462	0.007	0.832	0.364	0.348	0.527	1.000	0.755
	(16)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)
Magnesium	0.731	0.634	0.711	0.887	0.287	0.943	0.703	0.618	0.750	0.755	1.000
	(16)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)	(24)

*An underlined coefficient is significant (P<0.05) a double underlined coefficient is very significant (P<0.01), and the number in parenthesis is the number of analyzed pairs.

Fig. 6--The effect of phosphorus additions to North Lake water on algal cell counts.

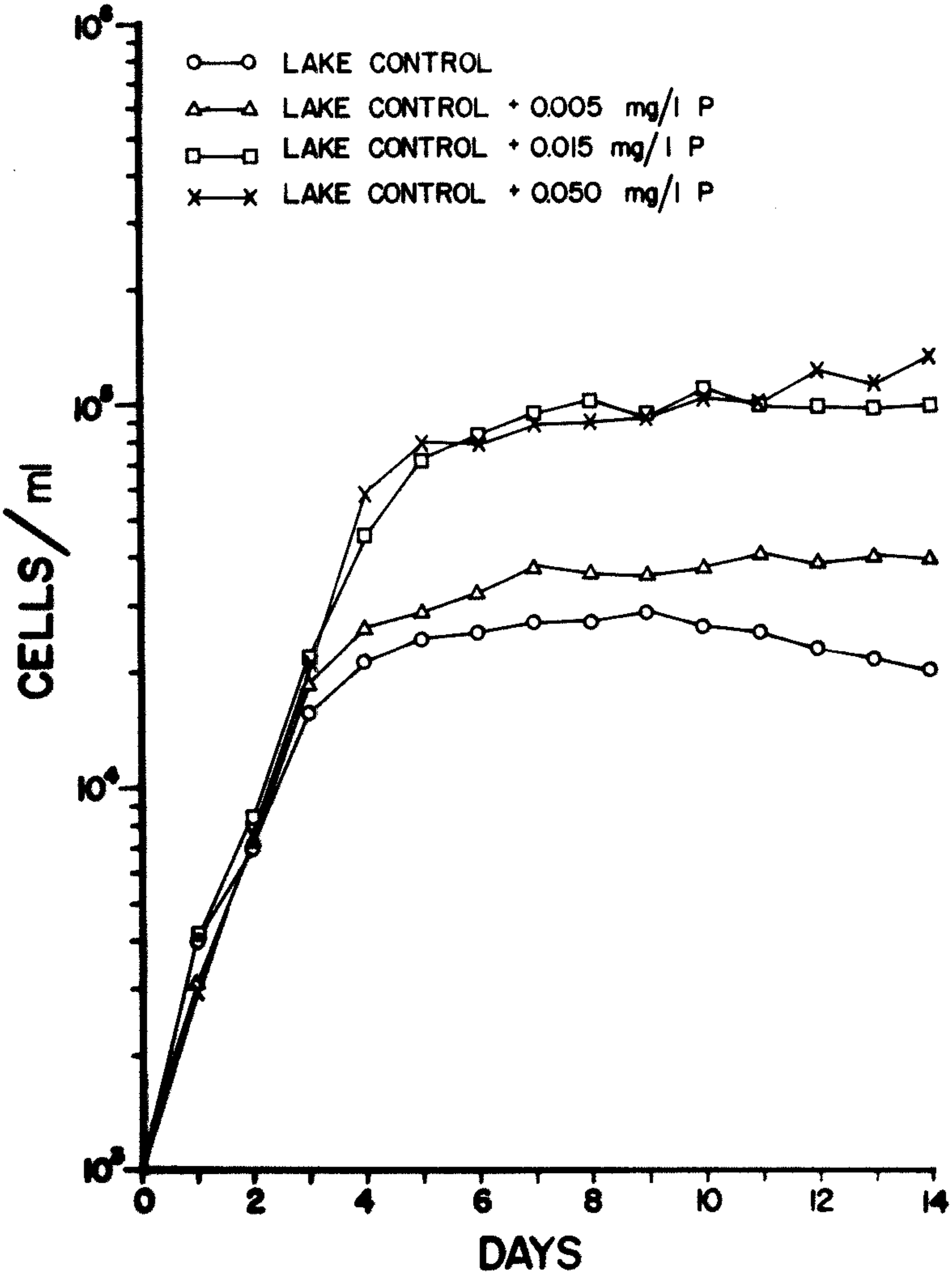
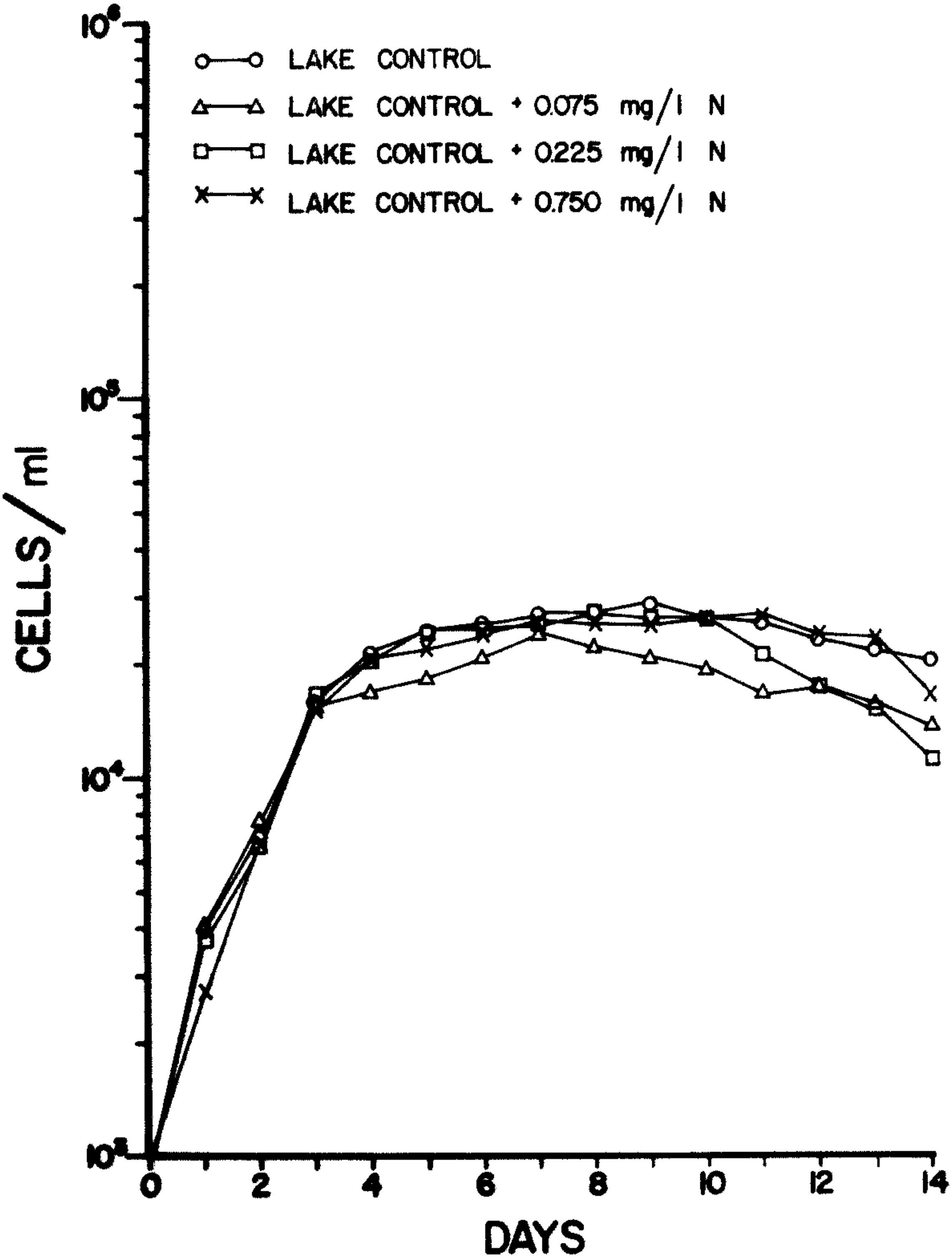

LAKE CONTROL
LAKE CONTROL + 0.005 mg/l P
LAKE CONTROL + 0.015 mg/l P
LAKE CONTROL + 0.050 mg/l P
CELLS/ml
DAYS
0
2
4
6
8
10
12
14

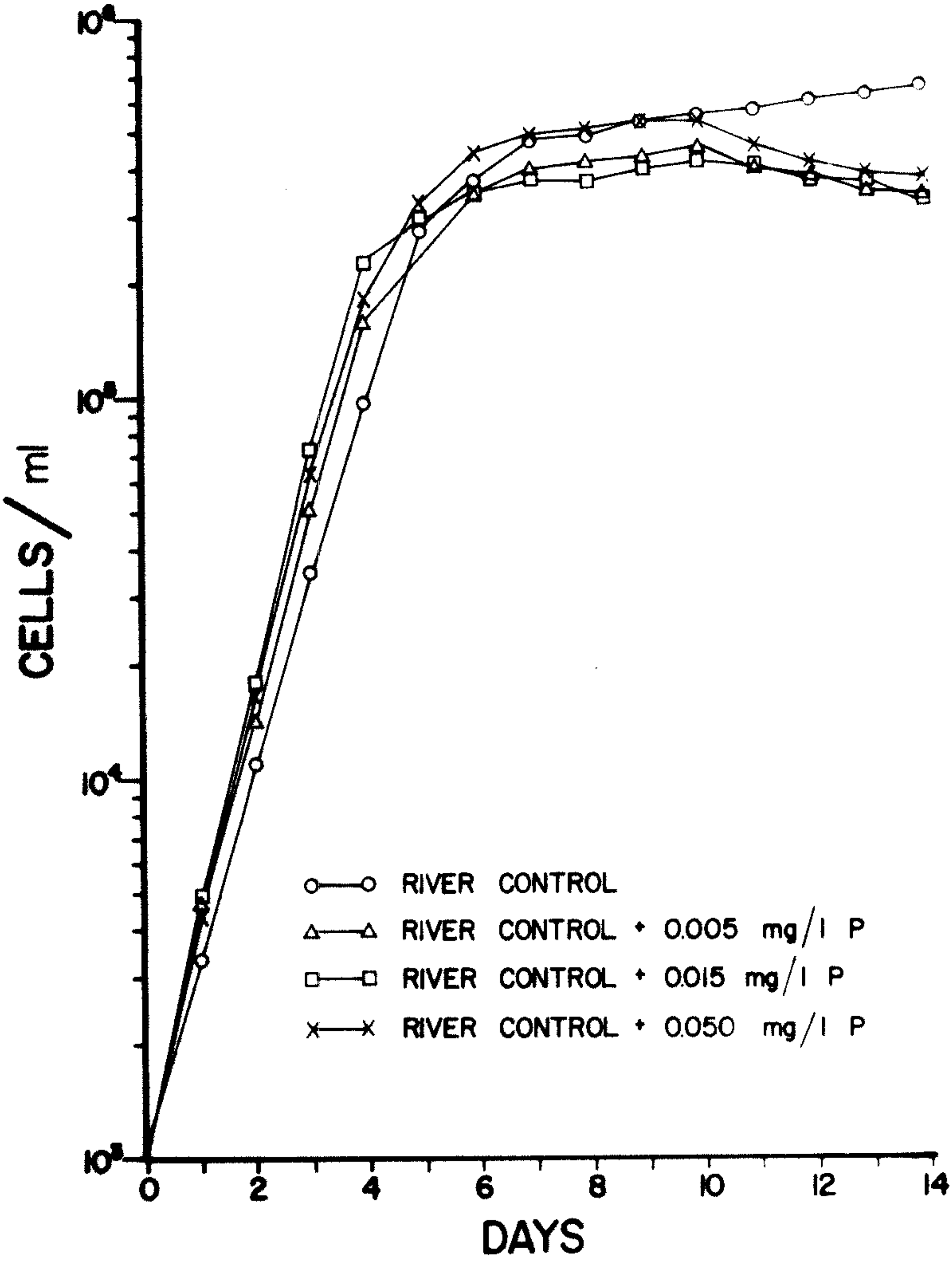
Fig. 7--The effect of nitrogen additions to North Lake water on algal cell counts.


LAKE CONTROL
LAKE CONTROL + 0.075 mg/l N
LAKE CONTROL + 0.225 mg/l N
LAKE CONTROL + 0.750 mg/l N
CELLS/ml
DAYS

(Figures 8 and 9). However, unspiked river water (control) supported 23 times more cells than the reservoir control, and the difference was highly significant ($P<0.01$).

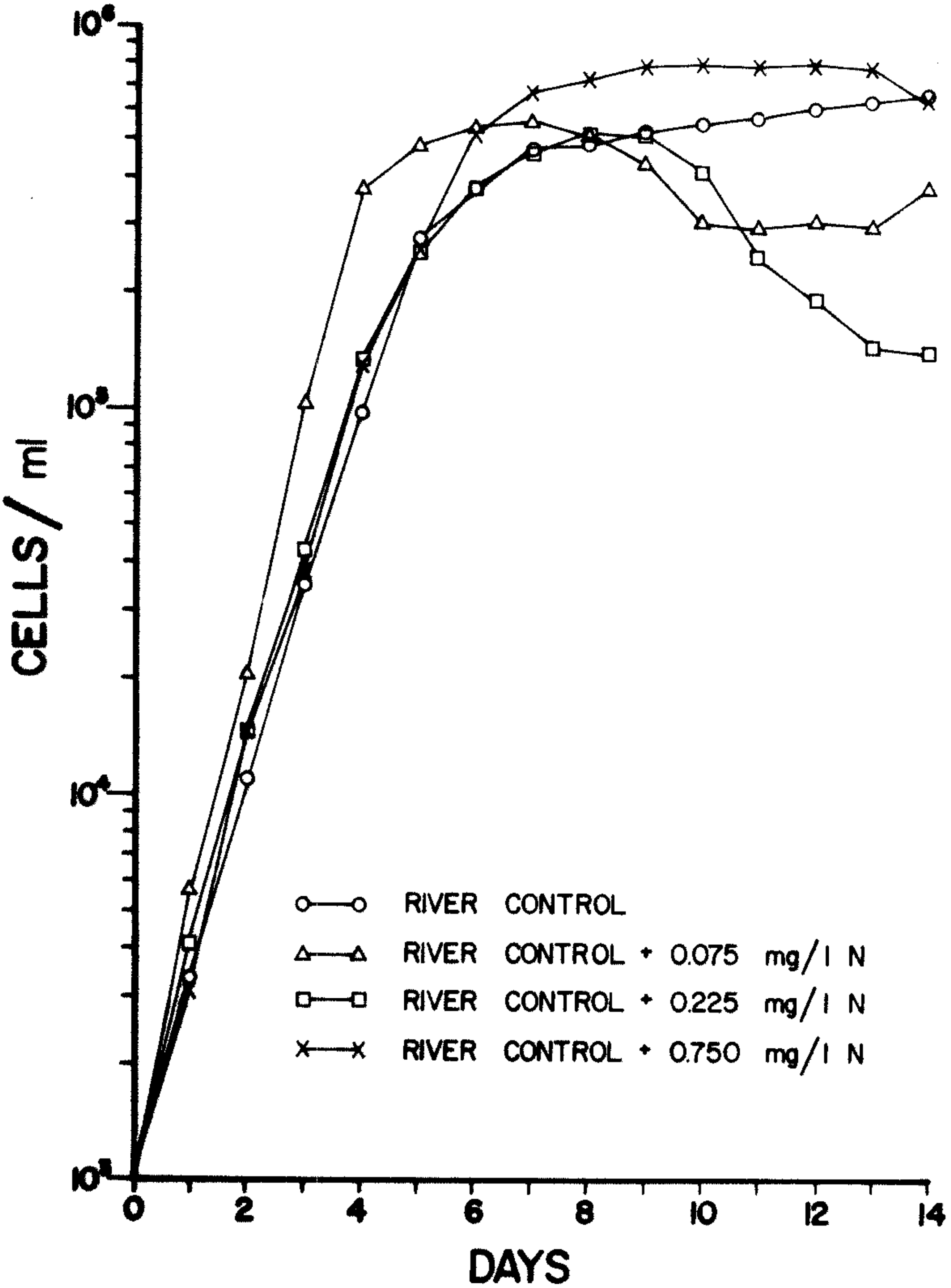
Detailed representations of other data are presented elsewhere.[29]

Fig. 8--The effect of phosphorus additions to Elm Fork Trinity River water on algal cell counts.



CELLS / ml
DAYS
RIVER CONTROL
RIVER CONTROL + 0.005 mg/l P
RIVER CONTROL + 0.015 mg/l P
RIVER CONTROL + 0.050 mg/l P

Fig. 9--The effect of nitrogen additions to Elm Fork Trinity River water on algal cell counts.



CELLS / ml
DAYS
RIVER CONTROL
RIVER CONTROL + 0.075 mg/l N
RIVER CONTROL + 0.225 mg/l N
RIVER CONTROL + 0.750 mg/l N

CHAPTER IV

DISCUSSION

Although North Lake was thermally altered (Figure 3), other Texas reservoirs have illustrated similar annual temperature ranges and profiles.[6,30-32]

The fact that nitrate was 14 percent higher in the cooling canal (sta 1) compared to the rest of the reservoir (sta 2-4) is very interesting. Other studies on cooling reservoirs have not mentioned such observations. Based on Q_{10} thermodynamics, the sudden temperature rise and ample DO could have caused a faster oxidation of nitrogen forms. Bacterial nitrification rates may have also been increased due to elevated temperatures. Increased nitrate concentrations could conceivably stimulate algal blooms in a nitrogen-limited cooling reservoir.

Little is known about the formation or biotoxicity of chlorinated organics produced by chlorination of potable, waste, or power plant condenser water, but techniques are being developed to identify the compounds produced.[20,33-35] Based on the method employed in this investigation, chlorinated organics were quantitatively and qualitatively similar in North Lake and the highly productive Elm Fork, Trinity River, and thus there was no reason to believe chlorinated organics were causing toxicological problems in North Lake.

Metal concentrations were not high enough to be toxic to the reservoir ecosystem, and all the nutrients measured were at a nonlimiting level except phosphorus. With total concentrations reduced from 82 ug/l before impoundment to 5 ug/l after impoundment, phosphorus appeared to be the abiotic factor controlling primary production in the water column of North Lake.

The algal assay statistically supported this contention, and in fact the Elm Fork, Trinity River supported 23 times more S. capricornutum cells than did North Lake. The fact that Elm Fork, Trinity River water which supplies North Lake was neither phosphorus- nor nitrogen-limited, but that North Lake was phosphorus-limited suggested a reservoir phosphorus precipation or sorption reaction. The ratio between total phosphorus in the reservoir water and that of the sediments (1:30,000) was unusual compared to the findings of other studies (1:4,000 and 1:5,000).[23,36] Extensive growth of the rooted aquatic plants Potamogeton sp. and Chara sp. occurred in North Lake during spring and late summer, indicating available sediment nutrients.

Several parameters have increased 3-7-fold in North Lake as a result of high evaporation and limited drainage. Phosphorus however, cycles very rapidly[37,38] and may chemically precipitate or combine with insoluble colloids and thus be quickly removed from solution. It is well known that iron is often responsible for phosphorus precipation or sorption. Because the concentration of iron in reservoir water was one-fifth of that found in Elm Fork, Trinity River, it is believed that an iron-phosphorus precipation was occurring in North Lake. This precipitation of iron was especially significant considering that additional iron flowed into the reservoir from the power plant blowdown of 26,000 gal/day.

Comparison of the sediment iron and phosphorus values at the pelagic stations 3 and 4 offered more evidence of their interaction. Iron and phosphorus concentrations were lower in station 4 sediments, probably as a result of the anaerobic period observed at station 4 during the summer. It is documented that during anaerobic periods ferric iron is reduced to ferrous iron and dissolves, thus releasing any bound phosphorus into the water.[39-41] The highly significant ($P<0.01$) correlation between sediment iron and phosphorus throughout the reservoir was indicative of their interaction.

Calcium may also have been responsible for phosphorus precipitation or sorption in North Lake. Calcium was 28 percent higher in the reservoir water compared to the river, but this was a small difference considering the 300-600 percent difference expected due to evaporation and concentration.

With the reservoir alkalinity 17 percent lower than that of the river, it seems feasible that some phosphorus precipitated with calcium carbonate. The summer increase of calcium at the deeper sampling sites indicated a precipation of calcium compounds, and the highly significant correlation ($P<0.01$) between sediment calcium and phosphorus supported this hypothesis.

Hepher[42] was probably the first to realize the role calcium rich alkaline water has on phosphorus concentration. Others[43-46] have since confirmed the precipation of phosphorus in waters of high alkalinity or calcium content.

Stumm and Morgan[47] calculated that with 40 mg/l of calcium and a pH of 7.0, total phosphate solubility is limited to approximately 10 μg/l. Considering the higher calcium concentration and pH in North Lake, phosphate solubility was theoretically, and observed to be less than 10 μg/l. Elm Fork, Trinity River, with its lower pH and calcium content, could support more soluble phosphate than North Lake. Elm Fork, Trinity River receives upstream sewage effluents, and, unlike North Lake, could support a large quantity of particulate phosphate with its continuous and often brisk velocity, thus perhaps accounting for the higher phosphorus values observed in the river.

Phosphorus limitation in association with thermal alteration in the North Lake water column could reflect trophic problems in the pelagic communities. This may explain many of the biotic anomalies observed in North Lake by other workers[8-16]. For example, certain reservoir fishes (i.e. shad, bluegill, bass, etc.) rely on production of planktonic forage items. Production of rooted plants probably functions as a buffer to complete trophic breakdown, but this requires further study.

CHAPTER V

CONCLUSION

Because of the limited drainage out of North Lake (<1 percent/yr), and the high evaporation rate (>36 percent/yr), the concentration of various dissolved solids have increased 3-7-fold during the past 19 yr. Phosphorus concentration, however, has decreased, and is now the limiting nutrient, as indicated by an algal assay. During the assay, North Lake's water source, the Elm Fork, Trinity River supported 23 times more *S. capricornutum* cells than did North Lake water. Elm Fork Trinity River water prior to impoundment typically contained 82 ug/l of phosphorus, while North Lake water contained 5 ug/l. Apparently chemical equilibria has shifted, and phosphorus is now precipating from the water column with calcium and iron, producing an uncommon oligothrophic Texas reservoir.

APPENDIX

To facilitate journal publication of research findings, the text, illustrations, tables, and references of this thesis were prepared according to the "Council of Biology Editors Style Manual"[48]; numerous tables and illustrations were deleted from Chapters I-V to produce a succinct but thorough article virtually ready for publication.

This appendix includes information not presented in detail in the text of this thesis. Inclusion of the information here makes it part of a readily available permanent record. This material should be of value to those conducting similar research, or to Texas limnologists and aquatic biologists desiring detailed information about North Lake or the Elm Fork, Trinity River. Some comments about these data are warranted.

Water hardness values determined by the EDTA titrimetric method (Table 13) and the atomic absorption (AA) calculation method (Table 23) agreed surprisingly well. The AA method however, was much more expensive and time consuming than the EDTA method. Even though the AA method was more accurate, the quick and inexpensive merits of EDTA far outweighted those of the AA.

North Lake total residue (Table 17) exceeded the 500 mg/l suggested for drinking water.[18] Generally 3 percent (19 mg/l) of North Lake total residue was nonfiltrable (0.45 μ) and 17 percent (48 mg/l) of Elm Fork Trinity River total residue was nonfiltrable (Figure 12). The lower filtrable rate of Elm Fork Trinity River was probably due to its higher silt and organic load.

Combination phosphorus (P) and nitrogen (N) spikes to filtered North Lake water resulted in erratic algal assay results (Tables 37 and 39, Figure 16). Some test cultures had extremely long lag times or increased very little in cell numbers, and replicate flasks often had quite different carrying capacities. Possibly phosphorus from the combination spike (P+N) was chemically complexed with something in the lake water. To test this hypothesis, phosphate concentration was determined in a 17-day-old spiked (0.050 mg/l P and 0.750 mg/l N) culture which had an unusually low carrying capacity of 3.41×10^3 cells/ml. Twenty two μg/l of phosphate were measured in the flask. Therefore, the phosphate remaining must have been in a form unavailable to S. capricornutum. In the cultures that grew, the unavailable phosphate may have been "turned over" by bacteria or hydrolyzed during the 17-day test, and thus made available to the alga.

Other data presented (Tables 5-45, Figures 10-19) are self-explanatory.

TABLE V

TEMPERATURE ^{o}C

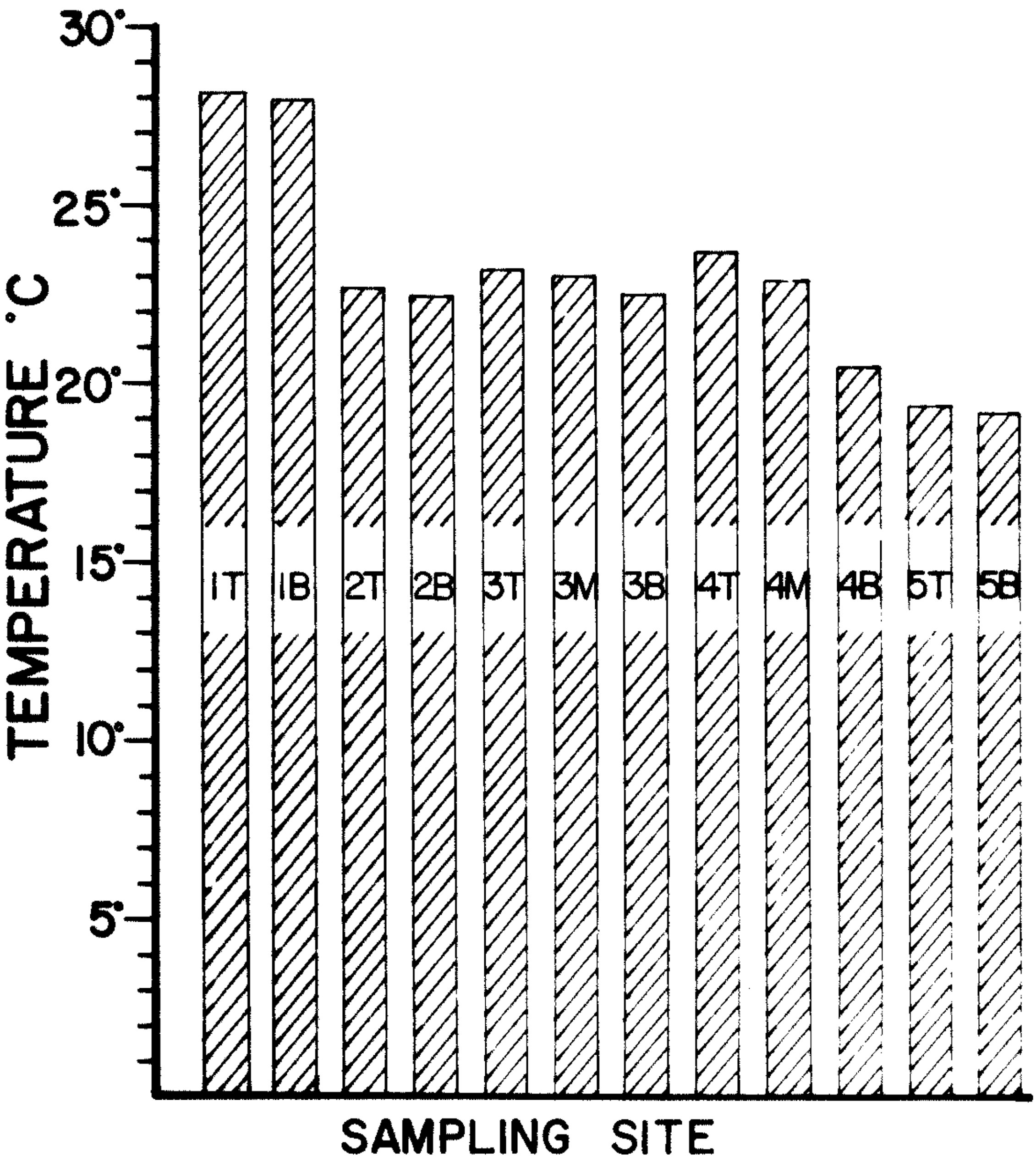
Station Depth	1974						1975					
	Oct		Nov		Dec		Jan		Feb		March	
	5	26	2	16	1	14	10	25	8	23	8	20
1T	31.0	27.9	30.5	22.0	17.8	16.9	16.1	16.1	18.0	19.0	22.6	18.8
1B	30.0	27.9	30.5	22.0	17.8	16.8	16.1	16.0	18.0	19.0	22.0	18.6
2T	23.5	23.4	23.2	17.3	12.0	11.9	11.1	11.9	10.4	12.5	11.8	15.3
2B	23.1	23.4	23.2	17.3	12.0	11.9	11.2	11.1	10.4	12.4	11.7	15.0
3T	23.9	23.3	23.2	17.9	13.1	..	12.2	12.1	11.4	13.4	16.0	15.5
3M	23.4	23.3	23.2	17.9	13.1	..	12.0	11.3	11.3	13.4	16.0	15.1
3B	23.2	23.2	23.1	17.9	13.1	..	12.1	10.9	11.3	13.4	16.0	14.9
4T	24.9	25.0	23.6	17.9	13.9	..	..	11.9	11.5	14.8	16.2	15.5
4M	23.6	23.6	23.5	..	13.9	..	..	11.8	11.4	14.6	16.2	15.4
4B	22.8	23.1	23.2	..	13.9	..	..	10.9	11.4	14.6	15.2	14.9
5T	20.0	21.2	21.0	..	12.0	..	..	9.5	..	10.8	11.9	11.8
5B	20.0	20.5	20.5	..	12.0	..	..	9.2	..	10.9	11.5	11.8

TABLE V--Continued

Station Depth	1975												Mean*
	April		May		June		July		August		September		
	3	19	2	24	1	13	7	11	8	19	7	21	
1T	21.9	22.1	32.2	30.4	30.0	35.4	37.2	36.5	37.8	36.7	36.9	30.3	28.1
1B	21.9	21.5	32.1	30.0	28.9	35.2	37.2	36.5	37.6	36.7	36.9	30.4	27.9
2T	15.2	18.9	23.3	26.3	26.4	28.1	31.4	32.8	33.6	31.9	33.4	27.1	22.6
2B	15.2	18.8	23.3	26.1	25.9	28.0	31.4	32.8	33.3	31.9	33.4	27.1	22.4
3T	15.6	18.9	23.7	25.9	26.2	29.0	32.2	..	33.8	32.1	33.2	27.7	23.1
3M	15.4	18.9	23.5	25.8	25.8	28.5	32.2	..	33.9	32.1	33.2	27.8	22.9
3B	15.3	18.6	22.7	25.8	25.5	27.8	29.8	..	31.5	31.6	32.0	27.6	22.4
4T	16.1	19.0	25.0	25.9	26.5	30.2	32.8	..	33.8	32.3	33.2	27.7	23.6
4M	15.8	18.6	22.4	25.2	25.7	27.7	30.0	..	33.0	32.0	31.9	27.5	22.8
4B	15.5	18.0	19.3	21.0	21.9	23.6	25.6	..	24.6	25.5	27.2	26.4	20.4
5T	12.8	15.2	19.0	20.7	21.3	22.8	26.8	..	28.5	28.1	28.0	24.8	19.3
5B	12.7	15.2	18.9	20.3	21.3	22.8	25.9	..	28.5	28.2	28.0	25.3	19.1

*Based on the nineteen dates when temperature values were obtained at all stations.

Fig. 10--Histogram of annual water temperatures by sampling site.



30°
25°
20°
15°
10°
5°
TEMPERATURE °C
1T
1B
2T
2B
3T
3M
3B
4T
4M
4B
5T
5B
SAMPLING SITE

TABLE VI

DISSOLVED OXYGEN mg/l

Station Depth	1974						1975					
	Oct		Nov		Dec		Jan		Feb		March	
	5	26	2	16	1	14	10	25	8	23	8	20
1T	7.3	7.2	7.3	8.1	8.9	9.8	9.7	10.0	..	9.1	7.2	7.0
1B	8.0	7.1	7.2	8.2	8.8	9.8	9.7	10.0	..	9.2	7.1	7.0
2T	7.9	7.5	7.5	8.6	9.9	10.0	10.5	10.3	..	9.7	7.3	7.0
2B	8.1	7.2	7.3	8.6	9.8	10.0	10.4	10.4	..	9.6	7.3	7.0
3T	7.6	7.0	7.4	8.4	9.7	10.1	10.3	10.5	..	9.5	7.2	7.2
3M	7.9	7.0	7.4	8.4	9.6	10.1	10.3	10.5	..	9.5	7.2	7.2
3B	7.6	7.0	7.3	8.7	9.6	10.1	10.3	10.4	..	9.4	7.2	7.2
4T	8.2	7.7	7.8	..	9.5	10.2	..	10.4	..	9.1	7.2	7.2
4M	8.1	7.5	7.8	..	9.4	10.2	..	10.4	..	9.1	7.2	7.2
4B	7.9	7.4	7.4	..	9.4	10.2	..	10.4	..	9.1	7.0	7.2
5T	8.4	7.6	6.0	..	11.2	11.8	..	10.6	..	8.9	7.9	8.6
5B	8.4	7.6	5.7	..	11.2	11.8	..	10.6	..	8.9	8.0	8.6

*Based on the twenty dates when DO values were obtained at all stations.

TABLE VI--Continued

1975												
April		May		June		July		August		September		Mean*
3	19	2	24	1	13	7	11	8	19	7	21	
7.2	8.2	7.0	5.4	5.2	5.6	5.8	5.6	6.5	6.2	6.7	7.3	7.2
7.2	8.0	7.0	5.4	4.9	5.6	5.7	5.6	6.3	6.0	6.7	7.2	7.2
7.2	8.5	7.5	5.6	5.4	5.8	6.1	5.8	6.4	6.3	6.8	7.8	7.5
7.2	8.4	7.5	5.6	5.4	5.8	5.9	5.8	6.2	6.2	6.5	7.7	7.5
7.3	8.5	7.6	5.7	5.5	5.8	6.1	..	6.3	6.3	6.7	7.3	7.5
7.3	8.5	7.5	5.6	5.4	5.8	6.1	..	6.2	6.2	6.6	7.2	7.4
7.3	8.5	7.2	4.9	5.1	5.3	3.5	..	4.5	6.2	6.2	7.5	7.1
7.3	8.5	7.4	5.7	5.4	5.6	6.0	..	6.2	6.4	6.8	7.2	7.5
7.2	8.5	7.2	5.2	5.1	5.2	4.5	..	6.4	6.5	6.3	7.3	7.3
7.2	8.4	6.2	3.2	2.4	2.9	0.2	..	1.2	2.8	1.8	4.1	5.8
8.4	9.8	8.7	5.9	6.2	6.8	6.5	..	6.5	6.2	6.4	7.5	8.0
8.4	9.8	8.7	5.9	6.2	6.8	5.5	..	6.5	6.1	6.2	7.4	7.9

TABLE VII

PERCENT SATURATION OF DISSOLVED OXYGEN*

Station Depth	1974						1975					
	Oct		Nov		Dec		Jan		Feb		March	
	5	26	2	16	1	14	10	25	8	23	8	20
1T	100	93	99	95	96	103	101	104	..	100	85	77
1B	108	92	98	96	95	103	101	104	..	101	83	76
2T	95	89	90	92	94	94	97	97	..	93	69	71
2B	97	86	87	92	93	94	97	97	..	92	69	71
3T	92	84	88	91	94	..	98	100	..	93	75	74
3M	94	84	88	91	93	..	98	98	..	93	75	73
3B	91	84	87	94	93	..	98	96	..	92	75	73
4T	101	95	94	..	94	..	..	98	..	92	75	74
4M	97	90	94	..	93	..	..	98	..	91	75	74
4B	94	88	88	..	93	..	..	98	..	91	71	73
5T	94	87	69	..	106	..	..	95	..	82	75	81
5B	94	86	65	..	106	..	..	95	..	82	75	81

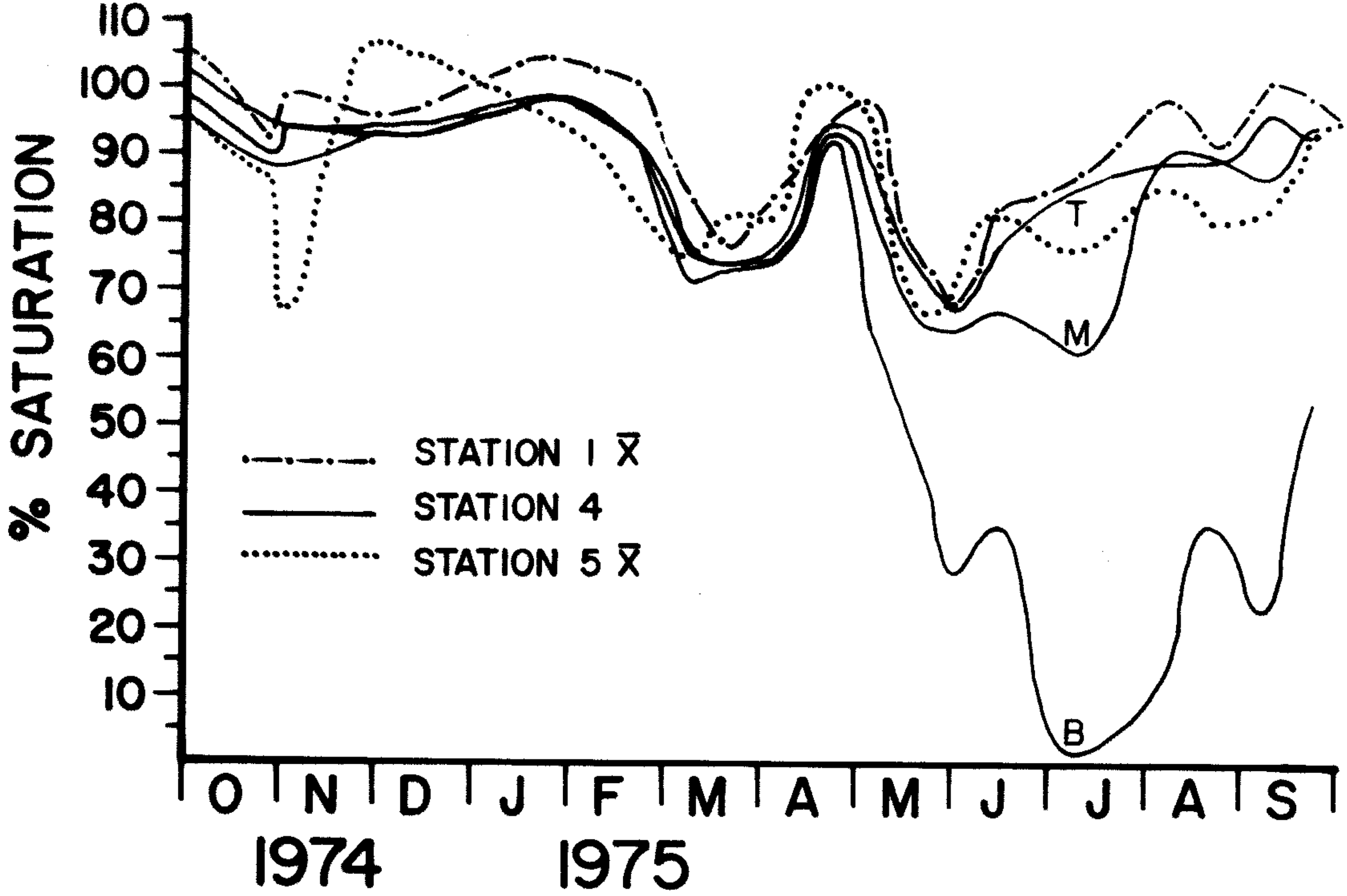
*Recent saturation based on IBP Handbook No. 8, and adjusted to 745 mm of mercury.

**Based on the nineteen dates when percent saturation values were obtained at all stations.

TABLE VII--*Continued*

1975												Mean**
April		May		June		July		August		September		
3	19	2	24	1	13	7	11	8	19	7	21	
84	96	98	73	70	82	88	84	100	93	101	99	91
84	92	98	73	65	82	86	84	96	90	101	98	91
73	93	90	71	68	76	84	82	91	87	97	100	86
73	92	90	70	68	75	81	82	88	86	93	99	85
75	93	92	71	69	77	85	..	90	88	93	94	86
75	93	90	70	68	76	85	..	89	86	92	93	85
74	93	85	61	64	69	47	..	62	85	86	97	80
76	94	91	71	68	76	85	..	89	89	96	93	87
74	93	85	64	64	67	61	..	91	90	87	94	83
74	91	69	37	28	35	2	..	15	35	23	52	61
81	100	96	67	71	81	83	..	85	81	83	92	85
81	100	96	67	71	81	69	..	85	80	81	92	84

Fig. 11--Percent saturation of dissolved oxygen for station 1, 4, and 5 plotted against time.



% SATURATION
110
100
90
80
70
60
50
40
30
20
10
STATION 1 $\bar{X}$
STATION 4
STATION 5 $\bar{X}$
T
M
B
O N D J F M A M J J A S
1974
1975

TABLE VIII

pH

Station & Depth	1974 Oct	Nov	Dec	1975 Jan	Feb	March	April	May	June	July	Aug	Sept	Mean±SD
1T	8.39	8.34	8.31	8.26	8.19	8.07	8.15	8.06	8.26	8.27	8.31	8.20	8.23±0.10
1B	8.39	8.30	8.32	8.25	8.19	8.07	8.14	8.06	8.24	8.31	8.32	8.20	8.23± .10
2T	8.36	8.30	8.31	8.28	8.19	8.21	8.12	8.06	8.25	8.32	8.37	8.21	8.25± .09
2B	8.32	8.22	8.31	8.30	8.19	8.18	8.12	8.08	8.24	8.25	8.37	8.22	8.23± .08
3T	8.33	8.30	8.31	8.30	8.19	8.21	8.12	8.10	8.25	8.26	8.40	8.24	8.25± .09
3M	8.33	8.29	8.30	8.30	8.20	8.28	8.12	8.10	8.25	8.37	8.38	8.24	8.26± .09
3B	8.28	8.28	8.30	8.32	8.20	8.22	8.11	8.08	8.22	8.34	8.21	8.00	8.21± .10
4T	8.41	8.35	8.23	8.32	8.20	8.19	8.11	8.09	8.23	8.38	8.39	8.24	8.26± .11
4M	8.36	8.34	8.22	8.34	8.20	8.21	8.15	8.11	8.20	8.28	8.26	8.11	8.23± .09
4B	8.29	8.25	8.22	8.33	8.19	8.23	8.10	7.96	7.83	7.62	7.40	7.40	7.98± .34
5T	7.98	7.69	7.78	8.17	8.09	7.97	8.05	7.95	7.94	7.87	7.90	7.70	7.92± .15
5B	7.98	7.68	7.89	8.18	8.09	7.97	8.04	7.93	7.94	7.89	7.92	7.68	7.93±0.15
Mean of Sta 1-4	8.35	8.30	8.28	8.30	8.19	8.19	8.12	8.07	8.20	8.24	8.24	8.11	...

TABLE IX

TOTAL ALKALINITY AS mg/l $CaCO_3$

Station & Depth	1974			1975									Mean±SD
	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	
1T	97	97	96	99	97	100	101	100	99	97	95	94	98± 2
1B	96	97	96	99	97	99	101	100	99	96	95	95	98± 2
2T	96	97	97	99	98	100	101	101	99	97	94	94	98± 2
2B	96	98	96	98	98	100	101	101	99	96	94	94	98± 2
3T	97	96	96	98	97	100	101	101	100	96	94	94	98± 3
3M	97	96	96	98	98	100	101	100	99	97	94	95	98± 2
3B	97	98	96	98	100	100	101	101	101	98	95	95	98± 2
4T	96	96	96	98	97	100	101	101	100	99	94	94	98± 3
4M	97	96	96	98	98	100	101	101	100	100	96	95	98± 2
4B	97	98	96	98	97	99	101	101	106	112	117	113	103± 7
5T	109	104	91	115	109	122	113	118	127	127	120	107	114±10
5B	109	104	93	110	110	132	113	117	126	146	120	110	116±14
Mean of Sta 1-4	97	97	96	98	98	100	101	101	100	99	97	96	...

TABLE X

CARBONATE AND BICARBONATE ALKALINITY AS mg/l $CaCO_3$

Station & Depth	1974			1975								
	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept
1T	0/97	0/97	0/96	0/99	0/97	0/100	0/101	0/100	2/97	0/97	2/93	2/92
1B	0/96	0/97	0/96	0/99	0/97	0/99	0/101	0/100	2/97	0/96	2/93	2/93
2T	0/96	0/97	0/97	0/99	0/98	0/100	0/101	6/95	2/97	0/97	4/90	4/90
2B	0/96	0/98	0/96	0/98	0/98	0/100	0/101	0/101	2/97	0/96	2/92	2/92
3T	0/97	0/96	0/96	0/98	0/97	0/100	0/101	4/97	4/96	0/96	4/90	4/90
3M	0/97	0/96	0/96	0/98	0/98	0/100	0/101	6/94	2/97	0/97	2/92	4/91
3B	0/97	0/98	0/96	0/98	0/100	0/100	0/101	6/95	2/99	0/97	2/93	2/93
4T	0/96	0/96	0/96	0/98	0/97	0/100	0/101	6/95	2/98	0/99	2/92	4/90
4M	0/96	0/96	0/96	0/98	0/98	0/100	0/101	6/95	2/98	0/100	2/94	2/93
4B	0/97	0/98	0/96	0/98	0/97	0/99	0/101	4/97	0/106	0/112	0/117	0/113
5T	0/109	0/104	0/91	0/115	0/109	0/122	0/113	6/112	0/127	0/127	0/120	0/107
5B	0/109	0/104	0/93	0/110	0/110	0/132	0/113	6/111	0/126	0/146	0/120	0/110

TABLE XI

CHLORIDES mg/l

Station	1974			1975									Mean
& Depth	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	
1T	113	109	105	112	107	110	109	111	110	112	114	121	111
1B	114	108	106	111	107	110	109	110	110	111	114	120	111
2T	114	108	106	111	107	110	109	110	110	112	114	120	111
2B	113	107	106	111	107	110	109	110	110	112	115	119	111
3T	114	109	105	111	107	110	109	110	109	111	115	120	111
3M	114	109	106	111	107	110	110	110	109	112	114	119	111
3B	114	109	105	111	107	110	110	111	109	112	114	119	111
4T	115	108	106	111	107	110	109	110	109	112	115	119	111
4M	113	109	106	111	107	110	110	111	109	111	114	119	111
4B	114	108	105	111	107	110	110	110	109	110	111	113	110
5T	32	17	13	19	19	24	23	28	26	26	23	24	23
5B	32	17	12	19	19	24	22	28	26	26	24	22	23
Mean of Sta 1-4	114	108	106	111	107	110	109	110	109	112	114	119	..

TABLE XII

SILICA mg/l

Station	1974			1975									
& Depth	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Mean±SD
1T	3.2	3.2	3.3	2.7	3.4	2.4	2.9	2.6	2.7	2.8	3.3	3.7	3.0±0.4
1B	2.6	3.2	3.4	2.7	3.4	2.3	2.9	2.6	2.8	2.6	3.2	3.6	2.9± .4
2T	2.6	3.3	3.6	3.3	3.4	2.5	2.9	2.6	2.9	2.9	3.2	3.6	3.1± .4
2B	2.6	4.1	3.7	2.9	3.6	2.5	2.9	2.6	3.3	3.1	3.4	3.5	3.2± .5
3T	2.7	3.2	3.4	2.6	3.3	2.4	2.8	2.5	2.7	2.7	3.2	3.6	2.9± .4
3M	2.8	3.3	3.7	2.8	3.3	2.5	2.9	2.5	2.8	2.7	3.2	3.6	3.0± .4
3B	3.5	3.3	3.4	2.9	3.4	2.3	3.1	3.2	3.2	3.0	3.2	3.7	3.2± .3
4T	3.1	3.6	3.4	2.8	3.4	2.3	3.0	2.6	3.8	2.7	3.0	3.6	3.0± .4
4M	3.2	3.6	3.4	2.7	3.2	2.3	3.1	2.6	3.0	3.0	3.2	3.6	3.1± .4
4B	3.7	3.7	3.5	3.0	3.4	2.5	3.1	3.2	4.0	4.6	4.7	4.9	3.7±0.7
5T	8.9	9.5	6.0	7.9	8.0	4.8	7.3	6.6	6.8	7.7	7.8	7.1	7.4±1.3
5B	8.6	9.6	5.9	7.8	7.7	4.7	7.1	6.5	6.8	7.0	7.9	7.2	7.2±1.3
Mean of Sta 1-4	3.0	3.4	3.5	2.8	3.4	2.4	3.0	2.7	3.0	3.0	3.4	3.7	....

TABLE XIII

EDTA HARDNESS mg/l $CaCO_3$

Station & Depth	1975		
	August	September	Mean
1T	226	234	230
1B	226	234	230
2T	226	234	230
2B	226	230	228
3T	226	234	230
3M	226	236	231
3B	226	234	230
4T	226	234	230
4M	226	234	230
4B	239	236	238
5T	136	126	131
5B	136	131	134
$\bar{X}$ Sta 1-4	227	234	...

TABLE XIV

SULFATES mg/l

Station & Depth	1975		
	August	September	Mean
1T	228	241	234
1B	228	253	240
2T	235	247	241
2B	230	249	240
3T	235	251	243
3M	233	248	240
3B	229	249	239
4T	238	251	244
4M	226	247	236
4B	218	231	224
5T	34	33	34
5B	35	32	34
$\bar{X}$ Sta 1-4	230	247	...

TABLE XV

STANDARD PLATE COUNT AT 35^{o}C*

Station & Depth	Dilution	Colony Counts of 3 Plates	# of Bacteria Per 100 ml
1T	10^{-1}	11- 4- 5	$6.7X10^{3}$
1B	10^{-1}	7- 6- 5	$6.0X10^{3}$
2T	10^{-1}	7- 8-13	$9.3X10^{3}$
2B	10^{-1}	26- 19- 8	$1.8X10^{4}$
3T	10^{-1}	0- 0- 1	$3.3X10^{2}$
3M	10^{-1}	14- 11-14	$1.3X10^{4}$
3B	10^{-1}	43-240-27	$1.0X10^{5}$
4T	10^{-1}	2- 8- 3	$4.3X10^{3}$
4M	10^{-1}	20- 9-12	$1.4X10^{4}$
4B	10^{-1}	47- 10-16	$2.4X10^{4}$
5T	10^{-2}	1- 7- 2	$3.3X10^{4}$
5B	10^{-2}	9- 7- 8	$8.0X10^{4}$

*Samples collected, and test initiated Sept. 7, 1975.

TABLE XVI

STANDARD MPN COLIFORM TEST*

Station & Depth	Presumptive Test (Lactose)			Confirmed Test (BG)	
	Dilution	# Postive Tubes	MPN For 100 ml	# Postive Tubes	MPN For 100 ml
1T	10°	4-2-0	22	4-1-0	17
1B	10°	5-1-0	33	5-1-0	33
2T	10°	5-1-0	33	5-1-0	33
2B	10°	4-2-0	22	4-2-0	22
3T	10°	4-0-3	..	4-0-3	..
3M	10°	5-1-0	33	3-0-0	8
3B	10°	5-0-0	23	5-0-0	23
4T	10°	5-0-0	23	5-0-0	23
4M	10°	5-2-0	49	5-1-0	33
4B	10°	5-0-0	23	1-0-0	2
5T	10^{-1}	5-5-2	5400	5-5-2	5400
5B	10^{-1}	5-5-2	5400	5-3-2	1400

*Samples collected, and test initiated Sept. 7, 1975.

TABLE XVII

TOTAL RESIDUE (105^{o}C), AND FIXED TOTAL RESIDUE mg/l

Station & Depth	Residue Type	1974	1975						% Loss on
		Nov	Jan	Mar	May	July	Sept	Mean	Ignition
1T	Total	604	633	616	658	626	668	634	
	Fixed total	504	572	566	572	570	590	562	11.4
1B	Total	662	663	624	648	623	677	650	
	Fixed total	578	581	570	582	554	577	574	11.7
2T	Total	643	631	648	650	660	695	654	
	Fixed total	544	614	574	596	584	603	586	10.4
2B	Total	662	666	637	634	638	680	653	
	Fixed total	545	598	561	565	576	582	571	12.6
3T	Total	627	670	637	648	628	681	648	
	Fixed total	574	616	570	559	530	592	574	11.4
3M	Total	662	594	627	646	625	683	640	
	Fixed total	572	573	574	560	508	594	564	11.9
3B	Total	690	575	649	652	640	678	647	
	Fixed total	598	510	593	572	548	599	570	11.9
4T	Total	698	592	652	638	628	674	647	
	Fixed total	556	532	589	560	549	584	562	13.1
4M	Total	582	620	628	613	647	676	628	
	Fixed total	538	532	554	542	571	607	557	11.3
4B	Total	556	610	624	626	656	658	622	
	Fixed total	532	550	552	553	575	584	558	10.3

TABLE XVII--Continued

Station & Depth	Residue Type	1974	1975					Mean	% Loss on Ignition
		Nov	Jan	Mar	May	July	Sept		
5T	Total Fixed total	342 252	228 175	277 231	316 225	275 200	248 208	281 215	23.5
5B	Total Fixed total	321 274	203 165	272 228	313 218	286 203	260 217	276 218	21.0
Mean of Sta 1-4	Total Fixed total	639 554	625 568	634 570	641 566	637 556	677 591	.. ..	.. ..
% Loss on Ignition	......	13.3	9.1	10.1	11.7	12.7	12.7	..	..
% Loss on Ignition Sta 5	......	20.8	21.3	16.1	29.3	27.9	16.5	..	..

TABLE XVIII

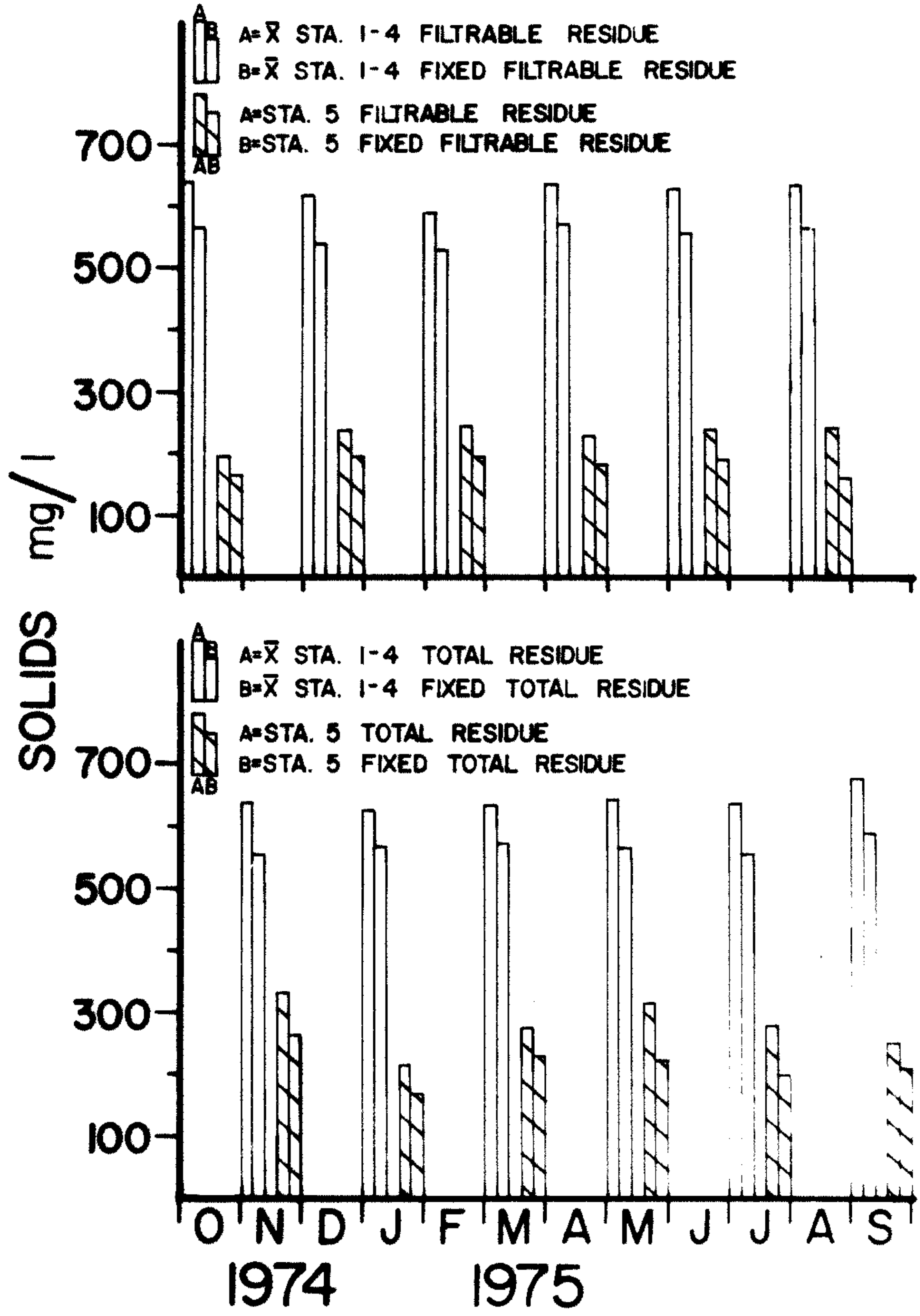
FILTRABLE RESIDUE (105°C), AND FIXED FILTRABLE RESIDUE mg/l

Station & Depth	Residue Type	1974		1975				Mean	% Loss on Ignition
		Oct	Dec	Feb	Apr	June	Aug		
1T	Filtrable	560	590	571	647	616	650	606	
	Fixed Filt.	536	556	531	552	553	572	550	9.2
1B	Filtrable	654	634	570	628	620	646	625	
	Fixed Filt.	612	470	532	558	552	556	547	12.5
2T	Filtrable	604	593	608	655	642	647	625	
	Fixed Filt.	542	530	509	567	580	576	551	11.8
2B	Filtrable	684	620	602	626	625	632	632	
	Fixed Filt.	586	545	503	543	576	556	552	12.7
3T	Filtrable	680	642	601	618	632	633	634	
	Fixed Filt.	539	572	592	598	546	566	558	12.0
3M	Filtrable	638	602	579	621	629	616	614	
	Fixed Filt.	569	539	521	594	542	550	552	10.1
3B	Filtrable	646	607	618	641	638	616	628	
	Fixed Filt.	558	546	588	610	574	572	575	8.4
4T	Filtrable	679	688	592	644	624	600	638	
	Fixed Filt.	616	580	564	595	552	572	580	9.1
4M	Filtrable	606	624	572	628	637	643	618	
	Fixed Filt.	506	580	515	553	536	578	545	11.8
4B	Filtrable	639	581	586	616	628	620	612	
	Fixed Filt.	573	475	502	533	545	546	529	13.6

TABLE XVIII--Continued

Station & Depth	Residue Type	1974		1975				Mean	% Loss on Ignition
		Oct	Dec	Feb	Apr	June	Aug		
5T	Filtrable	201	240	242	240	246	244	236	
	Fixed Filt.	192	194	212	192	193	160	190	19.5
5B	Filtrable	192	228	244	220	230	238	225	
	Fixed Filt.	140	189	172	168	187	159	169	24.9
Mean of Sta 1-4	Filtrable	639	618	590	632	629	630	..	
	Fixed Filt.	564	539	529	570	556	564	..	..
% Loss on Ignition Sta 1-4 $\overline{X}$	....	11.7	12.8	10.3	9.8	11.6	10.5	..	..
% Loss on Ignition Sta 5	....	15.3	18.0	20.0	21.7	20.2	33.6	..	..

Fig. 12--Total, fixed total, filtrable, and fixed filtrable residue for stations 1-4 and station 5 by months.



A=X̄ STA. 1-4 FILTRABLE RESIDUE
B=X̄ STA. 1-4 FIXED FILTRABLE RESIDUE
A=STA. 5 FILTRABLE RESIDUE
B=STA. 5 FIXED FILTRABLE RESIDUE
A=X̄ STA. 1-4 TOTAL RESIDUE
B=X̄ STA. 1-4 FIXED TOTAL RESIDUE
A=STA. 5 TOTAL RESIDUE
B=STA. 5 FIXED TOTAL RESIDUE
SOLIDS mg/l
700
500
300
100
O N D J F M A M J J A S
1974
1975

TABLE IXX

COPPER IN SOLUTION mg/l*

Station	1974			1975									
& Depth	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Mean
1T	BL**	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
1B	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
2T	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
2B	BL	BL	BL	BL	BL	BL	BL	BL	BL	0.10	BL	BL	BL
3T	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
3M	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
3B	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
4T	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
4M	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
4B	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL
5T	0.10	BL	BL	BL	BL	BL	BL	BL	0.16	BL	BL	BL	BL
5B	BL	BL	BL	BL	BL	BL	BL	BL	0.25	BL	BL	BL	BL
Mean of Sta 1-4	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	..

*Tabular values are the average of four readings.
**BL=Below limit of detection, i.e. <0.10 mg/l Cu.

TABLE XX

IRON IN SOLUTION mg/l*

Station & Depth	1974 Oct	1974 Nov	1974 Dec	1975 Jan	1975 Feb	1975 March	1975 April	1975 May	1975 June	1975 July	1975 Aug	1975 Sept	Mean
1T	0.24	0.34	0.51	0.46	0.78	0.62	0.76	0.34	0.43	0.27	0.24	0.26	0.44
1B	0.24	0.53	0.49	0.48	0.86	0.62	0.76	0.40	0.42	0.26	0.24	0.28	0.46
2T	0.20	0.42	0.80	2.27	0.85	1.00	0.83	0.50	0.61	0.54	0.27	0.29	0.72
2B	0.22	1.26	0.77	0.69	1.44	1.04	0.84	0.44	1.14	0.70	0.38	0.30	0.77
3T	0.24	0.37	0.53	0.55	0.73	0.70	0.66	0.24	0.32	0.26	0.27	0.26	0.43
3M	0.20	0.36	0.51	0.57	0.72	0.74	0.74	0.33	0.36	0.26	0.25	0.26	0.44
3B	0.52	0.42	0.58	0.53	0.72	0.70	0.77	1.02	0.76	0.40	0.40	0.32	0.60
4T	0.20	0.23	0.53	0.48	0.68	0.62	0.63	0.28	0.36	0.24	0.20	0.26	0.39
4M	0.32	0.30	0.52	0.51	0.69	0.68	0.72	0.33	0.52	0.40	0.30	0.26	0.46
4B	1.10	0.38	0.71	0.55	0.70	0.71	0.67	0.78	0.88	0.36	0.25	0.21	0.60
5T	1.77	4.67	3.38	1.74	3.45	1.77	2.44	2.41	3.41	1.84	0.80	0.94	2.38
5B	1.70	5.20	3.34	1.77	3.54	1.81	2.49	2.31	3.54	1.56	0.93	1.42	2.47
Mean of Sta 1-4	0.35	0.46	0.60	0.71	0.82	0.74	0.74	0.47	0.58	0.37	0.28	0.28	...

*Tabular values are the average of four readings.

TABLE XXI

CALCIUM IN SOLUTION mg/l*

Station & Depth	1974 Oct	1974 Nov	1974 Dec	1975 Jan	1975 Feb	1975 March	1975 April	1975 May	1975 June	1975 July	1975 Aug	1975 Sept	Mean
1T	54	58	56	56	60	60	59	59	58	58	58	58	58
1B	56	58	59	57	60	61	60	60	58	58	57	58	58
2T	56	59	61	57	61	64	59	60	59	58	59	60	59
2B	54	58	60	56	61	61	59	60	60	58	59	60	59
3T	55	59	62	57	57	61	59	61	61	58	57	58	59
3M	54	60	60	56	57	61	60	59	61	58	57	58	58
3B	55	59	61	56	56	61	60	59	60	59	55	60	58
4T	54	59	60	58	57	61	60	61	61	58	56	60	59
4M	54	60	62	56	58	61	59	59	59	59	59	58	59
4B	56	60	61	56	58	60	60	60	62	62	61	61	60
5T	41	47	40	40	44	52	48	49	50	52	44	43	46
5B	40	48	39	40	44	51	47	51	50	56	45	44	46
Mean of Sta 1-4	55	59	60	56	58	61	60	60	60	59	58	59	..

*Tabular values are the average of four readings.

TABLE XXII

MAGNESIUM IN SOLUTION mg/l*

Station & Depth	1974			1975									
	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Mean
1T	17.1	17.0	16.8	17.6	17.1	17.6	17.6	17.5	18.0	17.6	18.5	19.2	17.6
1B	17.5	16.8	17.2	17.7	17.1	17.7	17.7	17.9	17.8	17.8	18.6	19.1	17.7
2T	17.5	17.3	17.4	17.8	17.3	17.6	17.6	18.0	17.7	17.9	18.6	19.2	17.8
2B	17.4	17.0	17.3	17.6	17.3	17.7	17.4	18.0	17.8	17.6	18.7	19.6	17.8
3T	17.1	17.3	17.7	17.6	17.2	17.6	17.8	17.8	17.7	17.6	18.1	19.2	17.7
3M	17.0	17.7	17.2	17.3	17.0	17.4	17.6	17.5	17.6	17.8	18.3	19.2	17.6
3B	17.2	17.6	17.5	17.7	17.0	17.4	17.7	17.8	17.8	17.6	18.0	19.1	17.7
4T	17.3	17.4	17.5	17.4	17.1	17.5	17.4	18.0	18.1	17.8	18.0	19.3	17.7
4M	17.2	17.6	17.3	17.6	17.0	17.6	17.4	17.4	17.6	17.8	18.2	19.1	17.6
4B	17.5	17.5	17.4	17.6	17.5	17.4	17.6	17.6	17.8	17.7	17.9	18.4	17.7
5T	4.3	4.3	2.9	4.6	4.1	4.2	4.0	4.5	4.4	4.5	5.0	4.0	4.2
5B	4.3	4.3	2.7	4.5	4.2	4.2	3.9	4.8	4.3	5.7	5.0	4.6	4.4
Mean of Sta 1-4	17.3	17.3	17.3	17.6	17.2	17.6	17.6	17.8	17.8	17.7	18.3	19.1	...

*Tabular values are the average of four readings.

TABLE XXIII

HARDNESS (Ca, Mg, Fe) AS mg/l $CaCO_3$

Station & Depth	1974			1975									Mean
	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	August	Sept	
1T	206	215	210	213	222	223	221	220	220	218	221	224	218
1B	212	215	219	216	222	226	224	224	219	219	219	224	220
2T	212	219	225	220	225	234	221	225	221	219	224	229	223
2B	207	217	222	214	226	227	220	225	225	219	225	231	222
3T	208	219	229	216	214	226	222	226	226	218	217	224	220
3M	205	223	222	212	214	225	224	220	225	219	218	224	219
3B	209	221	225	214	211	225	224	222	224	220	212	229	220
4T	206	219	223	217	214	225	223	227	227	219	214	230	220
4M	206	223	227	213	216	226	220	220	221	221	223	224	220
4B	214	222	225	213	218	223	223	224	230	228	226	228	223
5T	123	143	118	122	133	150	141	145	149	152	132	126	136
5B	121	147	114	122	134	148	138	151	149	166	135	131	138
Mean of Sta 1-4	208	219	223	215	218	226	222	223	224	220	220	227	...

TABLE XXIV

CARBON mg/l

Station & Depth	Type of Carbon*	1974 Oct	1974 Nov	1974 Dec	1975 Jan	Mean
1T	TC	28.2	27.0	28.2	26.2	27.4
	IC	25.1	23.8	26.0	24.7	24.9
	OC	3.1	3.2	2.2	1.5	2.5
1B	TC	28.2	27.8	28.2	26.6	27.7
	IC	24.7	23.8	26.4	24.7	24.9
	OC	3.5	4.0	1.8	1.9	2.8
2T	TC	29.0	26.6	28.6	27.0	27.8
	IC	25.5	24.2	26.4	24.7	25.2
	OC	3.5	2.4	2.2	2.3	2.6
2B	TC	28.6	26.6	28.6	27.0	27.7
	IC	25.1	23.8	26.4	25.5	25.2
	OC	3.5	2.8	2.2	1.5	2.5
3T	TC	28.2	27.0	28.6	26.6	27.6
	IC	24.2	23.8	25.1	25.1	24.6
	OC	4.0	3.2	3.5	1.5	3.0
3M	TC	28.6	27.0	28.6	27.0	27.8
	IC	25.1	24.2	26.0	24.7	25.0
	OC	3.5	2.8	2.6	2.3	2.8
3B	TC	29.0	27.4	28.2	27.0	27.9
	IC	25.1	25.1	26.0	25.1	25.3
	OC	3.9	2.3	2.2	1.9	2.6
4T	TC	29.0	27.0	28.6	27.0	27.9
	IC	25.5	24.2	26.4	25.1	25.3
	OC	3.5	2.8	2.2	1.9	2.6
4M	TC	29.0	27.0	28.2	27.4	27.9
	IC	25.1	24.2	26.0	25.1	25.1
	OC	3.9	2.8	2.2	2.3	2.8
4B	TC	29.0	27.0	29.0	26.6	27.9
	IC	24.2	24.7	26.4	24.7	25.0
	OC	4.8	2.3	2.6	1.9	2.9
5T	TC	35.8	31.4	27.0	29.0	30.8
	IC	30.0	27.3	24.2	27.8	27.3
	OC	5.8	4.1	2.8	1.2	3.5
5B	TC	31.4	32.2	26.2	29.0	29.7
	IC	29.1	27.3	24.7	27.8	27.2
	OC	2.3	4.9	1.5	1.2	2.5

*TC=Total Carbon; IC=Inorganic Carbon; and OC=Organic Carbon (determined by subtraction).

TABLE XXV

ORTHOPHOSPHATE AS µg/l PO_4

Station & Depth	1974			1975									$\overline{X}$ with Tr considered as	
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	1µg/l	2µg/l
1T	3	4	3	6	Tr	6	6	4	5	Tr	Tr	Tr	3	4
1B	Tr*	6	6	6	3	6	6	Tr	3	3	3	Tr	4	4
2T	Tr	6	8	6	4	10	6	4	6	7	3	Tr	5	5
2B	Tr	13	10	10	4	10	7	8	8	8	4	Tr	7	7
3T	0	8	4	7	Tr	7	7	8	3	3	3	Tr	4	4
3M	0	9	5	7	3	8	6	3	4	10	4	0	5	5
3B	15	Tr	7	3	3	8	6	5	4	6	3	Tr	5	5
4T	4	3	8	7	4	6	4	4	Tr	8	Tr	3	4	5
4M	11	3	8	4	0	7	5	3	3	8	Tr	Tr	4	5
4B	5	5	11	6	5	8	6	8	8	7	3	3	6	6
5T	95	191	71	42	75	90	68	27	40	0	14	53	64	64
5B	95	193	68	42	79	90	79	26	40	38	16	34	67	67
$\overline{X}$ Sta 1-4 Tr as 1µg/l	4	6	7	6	3	8	6	5	4	6	3	1	..	..
$\overline{X}$ Sta 1-4 Tr as 2µg/l	4	6	7	6	3	8	6	5	5	6	3	2	..	..

*Trace (Tr) values are >0µg/l<3µg/l PO_4.

TABLE XXVI

TOTAL PHOSPHORUS AS µg/l PO_4

Station & Depth	1974			1975								$\overline{X}$ with Tr considered as	
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	1µg/l	2µg/l
1T	4	0	Tr	5	18	0	0	0	0	0	0	12	3	3
1B	6	9	Tr	5	8	21	0	0	0	0	0	28	6	7
2T	Tr*	0	8	10	15	4	0	0	0	0	0	16	4	5
2B	0	0	13	8	Tr	0	0	0	0	0	0	0	2	2
3T	9	3	12	20	9	0	0	0	0	0	0	9	5	5
3M	6	0	11	8	0	0	0	0	0	8	0	0	3	3
3B	77	20	14	Tr	0	0	0	0	0	0	0	0	9	9
4T	33	0	23	13	0	0	0	0	0	0	0	0	6	6
4M	10	23	15	8	0	0	0	0	0	0	0	3	5	5
4B	16	0	15	11	0	0	0	0	0	0	0	0	4	4
5T	93	252	95	54	75	90	61	40	46	120	21	66	84	84
5B	100	254	97	45	106	87	62	54	42	36	22	53	80	80
$\overline{X}$ Sta 1-4 Tr as 1µg/l	16	6	11	9	5	2	0	0	0	1	0	7	..	..
$\overline{X}$ Sta 1-4 Tr as 2µg/l	16	6	12	9	5	2	0	0	0	1	0	7	..	..

*Trace (Tr) values are >0µg/l<3µg/l PO_4.

TABLE XXVII

AMMONIA NITROGEN μg/l

Station & Depth	1974			1975									$\overline{X}$ with Tr considered as	
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	1μg/l	9μg/l
1T	0	0	22	17	65	30	43	15	62	11	Tr	14	23	24
1B	0	0	85	99	11	50	57	15	33	Tr	0	21	31	32
2T	0	12	Tr*	43	56	43	41	12	49	0	0	22	23	24
2B	0	0	0	12	18	31	25	12	65	Tr	0	50	18	18
3T	0	0	Tr	Tr	0	30	24	Tr	23	0	Tr	15	8	11
3M	0	0	24	Tr	21	37	28	11	30	12	Tr	32	16	18
3B	0	0	51	Tr	0	23	31	23	26	16	11	15	16	17
4T	18	0	Tr	Tr	0	147	55	0	18	0	0	28	22	24
4M	0	0	Tr	0	0	28	11	27	52	28	16	Tr	22	23
4B	62	0	Tr	15	111	15	17	29	59	45	172	187	59	60
5T	82	53	36	58	62	178	124	74	124	0	39	31	72	72
5B	14	54	38	42	83	126	89	80	127	Tr	31	16	58	59
$\overline{X}$ Sta 1-4 Tr as 1μg/l	8	1	19	19	28	43	43	14	42	11	20	38	..	..
$\overline{X}$ Sta 1-4 Tr as 9μg/l	8	1	23	22	28	43	43	15	42	13	23	39	..	..

*Trace (Tr) values are >0μg/l<10μg/l NH_3.

TABLE XXVIII

NITRATE NITROGEN mg/l

Station & Depth	1974			1975			
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1T	0.029	0.000	0.090	0.069	0.185	0.132	0.375
1B	.015	.000	.036	.043	.159	.138	.319
2T	.000	.000	.013	.072	.115	.053	.203
2B	.000	.000	Tr*	.051	.132	.094	.186
3T	.000	.000	.023	.073	.170	.071	.339
3M	.000	.000	.041	.071	.196	.205	.333
3B	.000	.000	.026	.031	.163	.151	.411
4T	.000	.000	.038	.011	.168	.113	.356
4M	.000	.000	.011	.055	.162	.112	.344
4B	.000	.000	.000	.041	.234	.101	.403
5T	.109	.200	.248	.214	.456	.334	.072
5B	0.060	0.130	0.211	0.305	0.162	0.264	0.074
Tr as 0.001 $\bar{X}$ Sta 1-4 ± SD	0.004 0.010	0.000 0.000	0.028 0.026	0.052 0.020	0.168 0.033	0.117 0.043	0.327 0.076
Tr as 0.009 $\bar{X}$ Sta 1-4 ± SD	0.004 0.010	0.000 0.000	0.029 0.026	0.052 0.020	0.168 0.033	0.117 0.043	0.327 0.076

*Trace (Tr) values are >0 mg/l<0.010 mg/l NO_3.

TABLE XXVIII--Continued

1975					$\overline{X}$ mg/l with Tr Considered as	
May	June	July	Aug	Sept	0.001	0.009
0.323	0.280	0.225	0.112	Tr	0.152	0.152
.330	.280	.152	.151	0.000	.135	.135
.270	.290	.135	.124	Tr	.106	.107
.285	.290	.208	.133	.026	.117	.118
.291	.261	.197	.126	.000	.129	.129
.180	.240	.201	.126	.000	.133	.133
.320	.219	.163	.084	.000	.131	.131
.364	.226	.163	.138	.000	.131	.131
.264	.249	.142	.073	Tr	.118	.118
.286	.212	.346	.110	.000	.144	.144
.640	.392	.373	.000	.020	.255	.255
0.487	0.328	0.177	0.000	0.013	0.184	0.184
0.291	0.255	0.193	0.118	0.003	..	..
0.050	0.030	0.062	0.024	0.008	..	..
0.291	0.255	0.193	0.118	0.005	..	..
0.050	0.030	0.062	0.024	0.008	..	..

Fig. 13--Nitrate, and ammonia values of station 5 plotted against time.

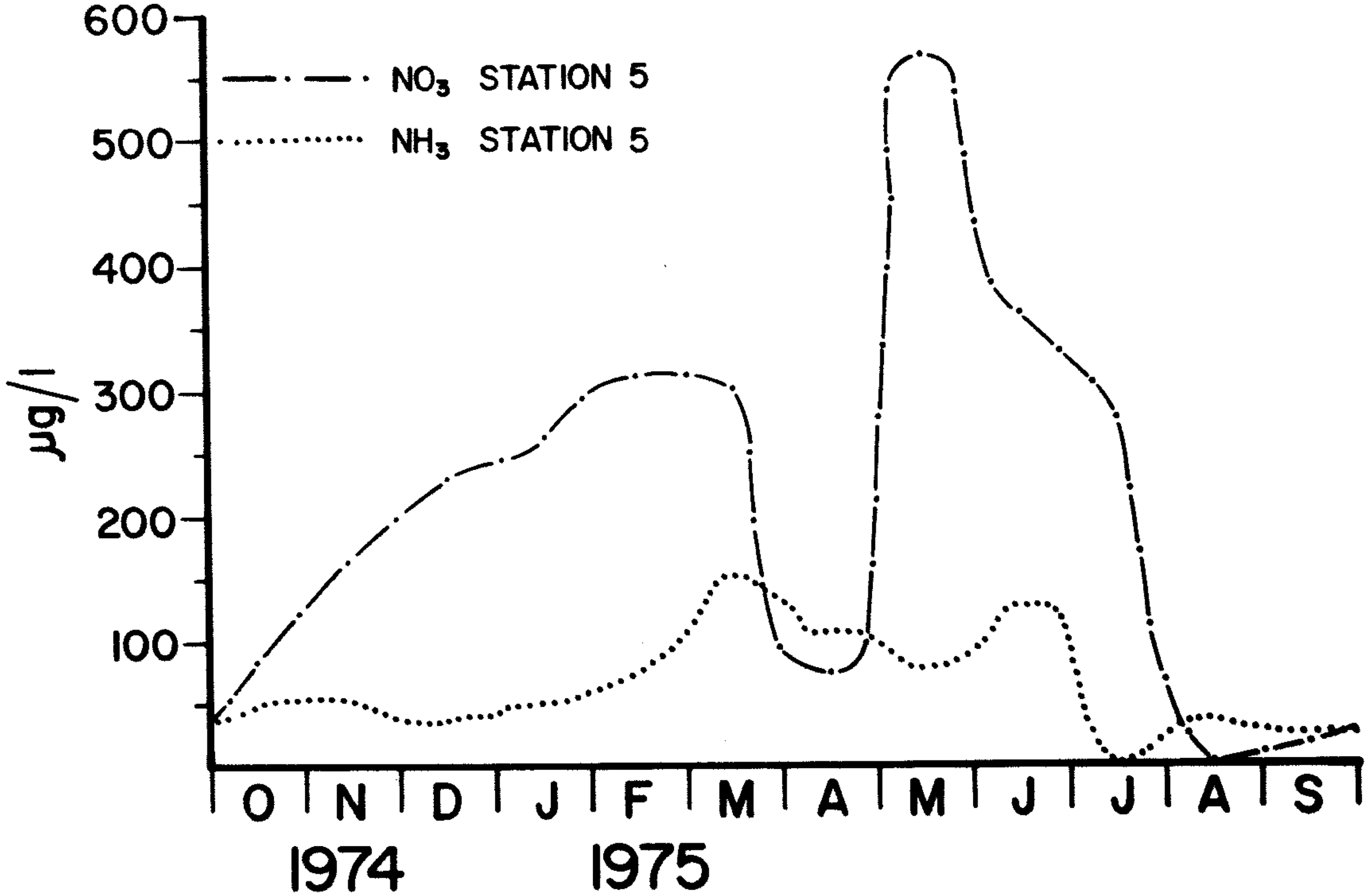

600
500
400
300
200
100
µg/l
NO3 STATION 5
NH3 STATION 5
O N D J F M A M J J A S
1974
1975

Fig. 14--Coulometric results of April 1975 for a composite 1-4 and a station 5 water sample.

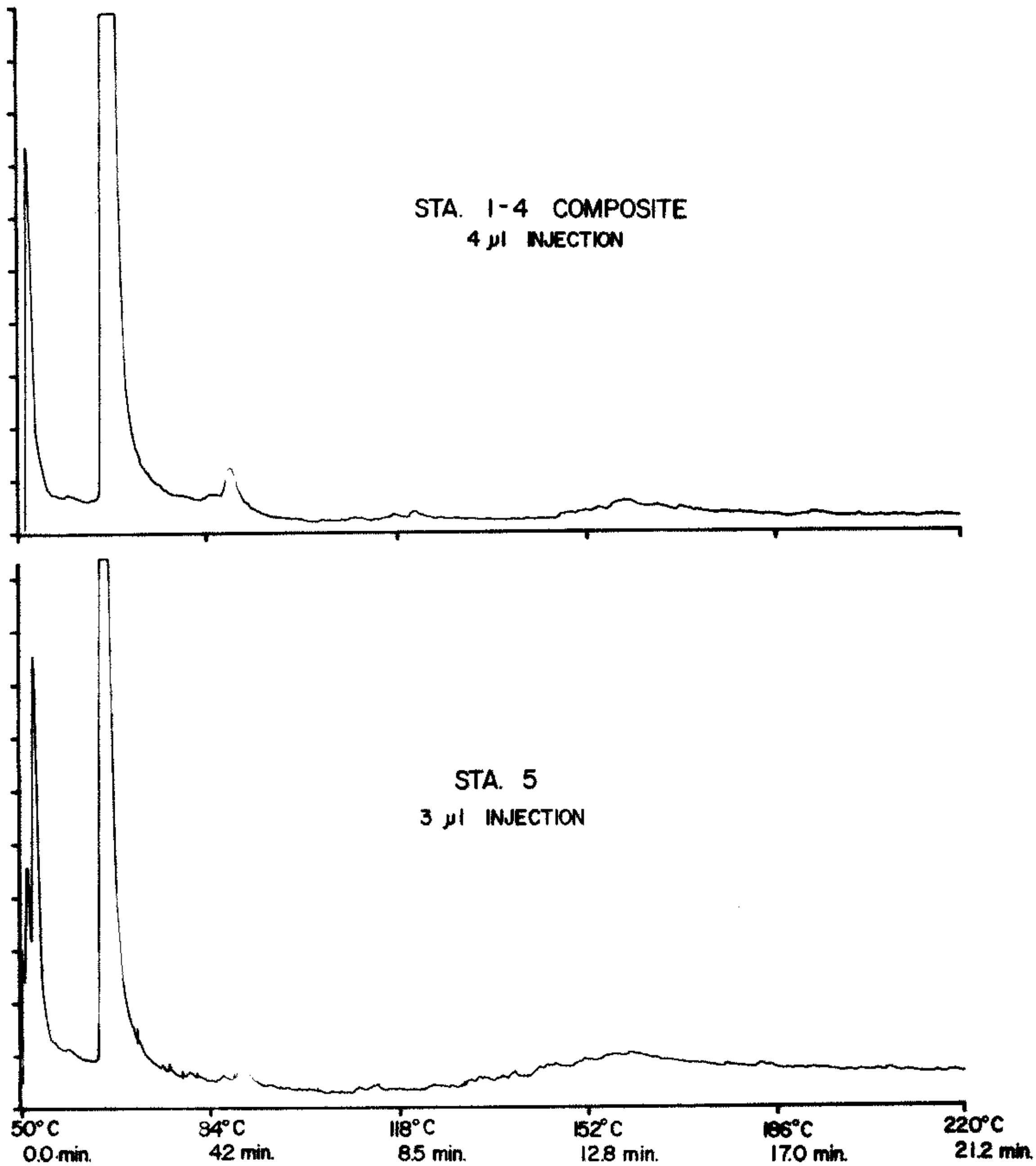
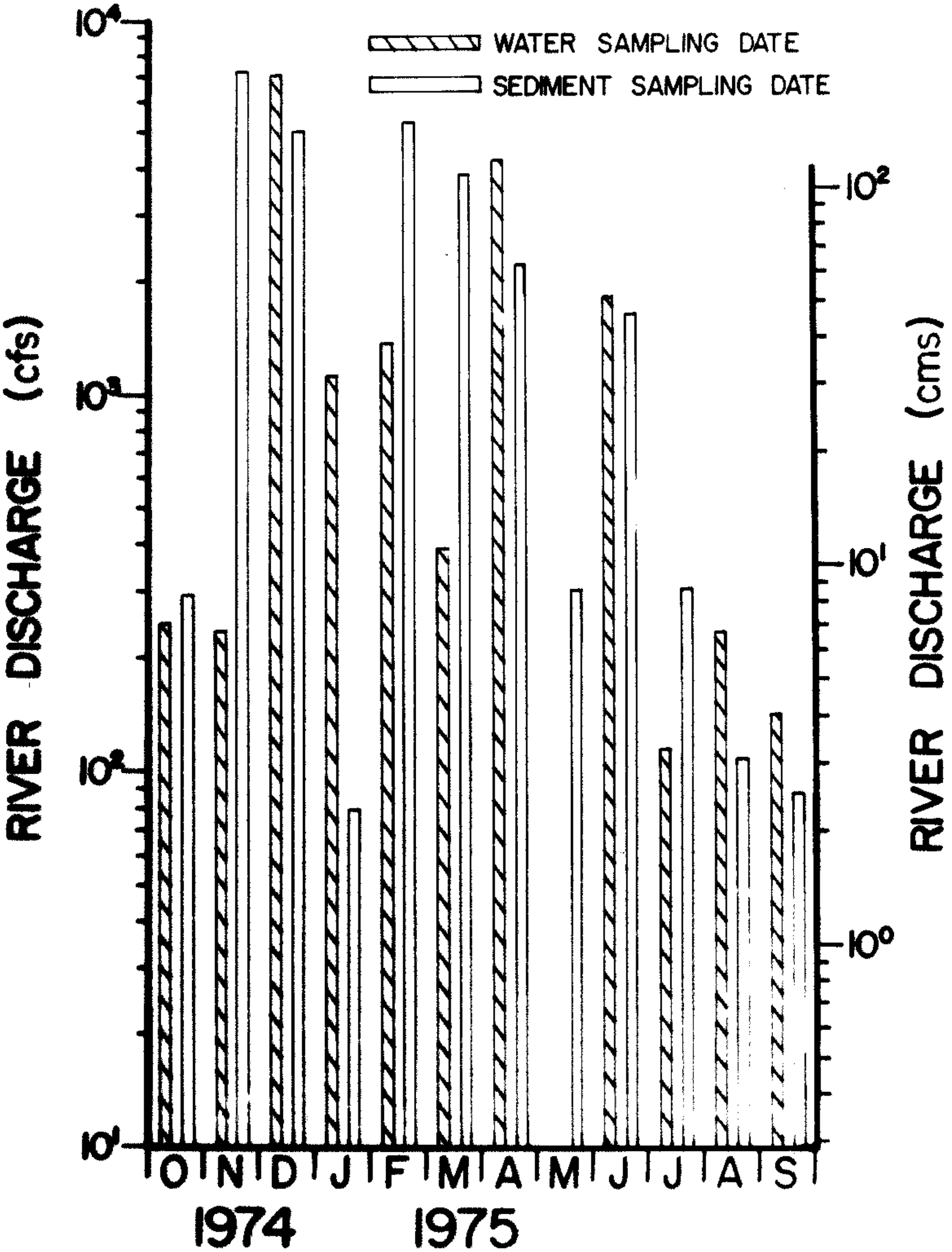

STA. 1-4 COMPOSITE
4 µl INJECTION
STA. 5
3 µl INJECTION
50°C
0.0 min.
84°C
42 min.
118°C
8.5 min.
152°C
12.8 min.
186°C
17.0 min.
220°C
21.2 min.

Fig. 15--Elm Fork Trinity River discharge on sampling dates.[49]



WATER SAMPLING DATE
SEDIMENT SAMPLING DATE
RIVER DISCHARGE (cfs)
RIVER DISCHARGE (cms)
10⁴
10³
10²
10¹
10²
10¹
10⁰
O N D J F M A M J J A S
1974
1975

TABLE XXIX

% WATER (105°C) AND LOSS ON IGNITION (550°C) OF SEDIMENTS

Station	Parameter	1975							Mean±SD
		March	April	May	June	July	August	Sept	
1	% Water	38.39	42.14	34.34	31.67	40.72	38.36	43.22	38.41± 4.17
	% Loss on Ign.	3.81	3.07	3.80	3.51	3.88	4.08	3.57	3.67± 0.33
2	% Water	56.39	55.22	50.93	50.38	58.21	53.59	54.64	54.19± 2.82
	% Loss on Ign.	7.02	5.85	6.38	6.66	7.51	7.07	7.55	6.86± 0.61
3	% Water	52.14	58.79	49.19	47.62	51.13	54.04	57.54	52.92± 4.14
	% Loss on Ign.	7.53	6.92	7.97	7.70	7.18	8.12	7.87	7.61± 0.43
4	% Water	73.92	73.00	73.90	73.75	74.00	73.49	75.25	73.90± 0.68
	% Loss on Ign.	8.26	9.98	9.10	9.47	9.39	9.98	8.78	9.28± 0.63
5	% Water	54.76	54.62	55.26	60.35	51.32	25.61	40.84	48.79±11.92
	% Loss on Ign.	6.40	7.62	6.78	8.75	6.85	1.51	3.80	5.96± 2.47
Mean of Sta 1-4	% Water	55.21	57.29	52.09	50.86	56.02	54.87	57.66	...
	% Loss on Ign.	6.66	6.46	6.81	6.84	6.99	7.31	6.94	...

TABLE XXX

AMMONIA, ORGANIC, AND KJELDAHL NITROGEN CONTENT OF OVEN DRIED (105°C) SEDIMENTS AS μg N/GRAM*

Type of Nitrogen	Station	1974 Oct	1974 Nov	1974 Dec	1975 Jan	1975 Feb	1975 Mar	1975 Apr	1975 May	1975 June	1975 July	1975 Aug	1975 Sept	$\overline{X}$ with Tr as 1μg/g	$\overline{X}$ with Tr as 4μg/g
Ammonia	1	Tr**	Tr	9	0	8	12	Tr	5	10	21	9	Tr	6	8
	2	Tr	95	26	Tr	41	19	10	36	20	38	44	15	29	29
	3	6	38	50	Tr	54	20	24	35	8	34	51	14	28	28
	4	166	363	120	174	128	69	161	140	38	110	128	33	136	136
	5	21	Tr	13	Tr	160	76	26	61	34	27	25	5	38	38
Organic	1	57	89	116	93	150	127	119	67	62	146	111	77	101	101
	2	186	544	291	329	359	336	228	266	298	288	342	144	301	301
	3	239	394	337	367	387	276	269	296	235	314	329	127	298	298
	4	567	605	577	524	488	258	508	304	217	503	506	192	437	437
	5	185	23	91	61	279	168	258	145	98	249	147	85	149	149
Kjeldahl***	1	59	91	125	93	158	139	121	72	72	167	120	79	108	108
	2	188	639	317	331	400	355	238	302	218	326	386	159	322	322
	3	245	432	387	369	441	296	293	331	243	348	380	141	326	326
	4	733	968	697	698	616	327	669	444	255	613	634	225	573	573
	5	206	25	104	63	439	244	284	206	132	276	172	90	187	187

*Tabular values are based on 2-4 replicates.

**Trace (Tr) values are >0 μg<5 μg N/1.000 gram of oven dried sediment.

***Determined by summing ammonia and organic N. All Tr ammonia values were considered as 2 μg N in calculating kjeldahl N.

TABLE XXXI

PHOSPHORUS CONTENT OF OVEN DRIED (105^{o}C) SEDIMENTS AS μg/g*

Station	1974			1975									Mean±SD
	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	
1	120	130	80	130	150	130	180	110	120	130	140	120	128±24
2	130	150	120	160	170	190	190	180	190	180	180	190	169±24
3	130	180	120	140	200	170	120	170	170	230	200	200	169±36
4	110	130	100	140	140	150	140	150	160	160	160	170	142±21
5	150	60	100	70	190	200	220	190	200	90	150	190	151±57

*Each tabular value represents the average of two independent determinations.

TABLE XXXII

CHROMIUM, COPPER, IRON, AND LEAD CONTENT OF OVEN DRIED (105°C) SEDIMENTS*

Metal µg/g	Station	1974	1975					Mean±SD
		Nov	Jan	March	May	July	Sept	
Chromium	1	6	8	8	8	6	4	7± 2
	2	26	32	26	30	23	26	27± 3
	3	24	20	21	20	20	19	21± 2
	4	28	23	22	22	22	20	23± 3
	5	2	4	22	16	20	18	14± 9
Copper	1	28	43	38	24	112	88	56± 36
	2	78	70	86	56	77	82	75± 11
	3	92	56	76	61	56	80	70± 15
	4	144	142	136	136	134	133	138± 4
	5	4	6	22	18	24	16	15± 8
Iron	1	17100	19000	29800	26900	17800	26700	22900± 5500
	2	43500	46200	47600	50800	47500	48600	47400± 2400
	3	46700	61400	55400	64600	57800	53000	56500± 6300
	4	46100	47200	47800	49500	50100	50000	48400± 1700
	5	11500	27100	43800	39500	51800	33200	34500±14100
Lead	1	16	16	16	14	16	16	16± 1
	2	25	24	26	22	25	24	24± 1
	3	30	25	26	24	25	28	26± 2
	4	36	35	34	33	34	34	34± 1
	5	6	8	20	18	23	20	16± 7

*Tabular values are based on 4 replicates.

TABLE XXXIII

MANGANESE, ZINC, CALCIUM, AND MAGNESIUM CONTENT OF OVEN DRIED (105°C) SEDIMENTS*

Metal µg/g	Station	1974	1975					Mean±SD
		Nov	Jan	March	May	July	Sept	
Manganese	1	230	180	194	194	138	164	183± 31
	2	284	208	238	217	258	238	240± 28
	3	280	302	258	292	254	267	276± 19
	4	407	340	332	348	366	334	354± 29
	5	118	328	362	295	1084	638	471± 344
Zinc	1	50	62	60	48	86	83	65± 16
	2	96	96	99	90	92	99	95± 4
	3	118	104	109	106	103	110	108± 5
	4	128	124	119	123	120	119	122± 4
	5	7	19	67	57	59	55	44± 25
Calcium	1	51100	59900	55400	50900	51800	50100	53200± 3768
	2	45200	39100	44500	39000	51000	45700	44083± 4529
	3	38100	24100	25900	25400	28500	32800	29133± 5366
	4	44800	45900	42700	42600	43800	43000	43800± 1319
	5	16900	49100	32500	28000	76700	49600	42133±21111
Magnesium	1	2220	2080	2220	2410	1940	1850	2120± 205
	2	4780	4750	4770	4760	4550	4860	4745± 103
	3	4960	5160	4960	5230	5140	4930	5063± 128
	4	4660	4430	4280	4420	4500	4320	4435± 136
	5	300	530	3130	2810	2720	2620	2018± 1256

*Tabular values are based on four replicates.

TABLE XXXIV

SEDIMENT CORRELATION COEFFICIENTS FOR ELM FORK TRINITY RIVER*

Sediment Parameter	Loss on Ignition	Organic Nitrogen	Phosphorus	Chromium	Copper	Iron	Lead	Manganese	Zinc	Calcium	Magnesium	River Discharge
River Discharge	0.460 (7)	0.118 (12)	0.191 (12)	0.401 (6)	0.409 (6)	0.598 (6)	0.506 (6)	0.556 (6)	0.475 (6)	0.678 (6)	0.422 (6)	1.000 (12)
Loss on Ignition	1.000 (7)	0.280 (7)	0.263 (7)	0.170 (4)	0.719 (4)	0.778 (4)	0.115 (4)	0.004 (4)	0.459 (4)	0.012 (4)	0.490 (4)	0.460 (7)
Organic Nitrogen	0.280 (7)	1.000 (12)	0.465 (12)	0.808 (6)	0.924 (6)	0.953 (6)	0.846 (6)	0.753 (6)	0.795 (6)	0.626 (6)	0.771 (6)	0.118 (12)
Phosphorus	0.263 (7)	0.465 (12)	1.000 (12)	0.750 (6)	0.611 (6)	0.476 (6)	0.658 (6)	0.005 (6)	0.798 (6)	0.158 (6)	0.821 (6)	0.191 (12)
Chromium	0.170 (4)	0.808 (6)	0.750 (6)	1.000 (6)	0.970 (6)	0.886 (6)	0.977 (6)	0.599 (6)	0.988 (6)	0.992 (6)	0.983 (6)	0.401 (6)
Copper	0.719 (4)	0.924 (6)	0.611 (6)	0.970 (6)	1.000 (6)	0.949 (6)	0.970 (6)	0.672 (6)	0.959 (6)	0.485 (6)	0.951 (6)	0.409 (6)
Iron	0.778 (4)	0.953 (6)	0.476 (6)	0.886 (6)	0.949 (6)	1.000 (6)	0.908 (6)	0.728 (6)	0.897 (6)	0.642 (6)	0.860 (6)	0.598 (6)
Lead	0.115 (4)	0.846 (6)	0.658 (6)	0.977 (6)	0.970 (6)	0.908 (6)	1.000 (6)	0.729 (6)	0.963 (6)	0.539 (6)	0.958 (6)	0.506 (6)
Manganese	0.004 (4)	0.753 (6)	0.005 (6)	0.599 (6)	0.672 (6)	0.728 (6)	0.729 (6)	1.000 (6)	0.540 (6)	0.933 (6)	0.504 (6)	0.556 (6)

TABLE XXXIV--Continued

Sediment Parameter	Loss on Ignition	Organic Nitrogen	Phosphorus	Chromium	Copper	Iron	Lead	Manganese	Zinc	Calcium	Magnesium	River Discharge
Zinc	0.459	0.795	0.798	0.988	0.959	0.897	0.963	0.540	1.000	0.367	0.994	0.475
	(4)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
Calcium	0.012	0.626	0.158	0.992	0.485	0.642	0.539	0.933	0.367	1.000	0.301	0.678
	(4)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
Magnesium	0.490	0.771	0.821	0.983	0.951	0.860	0.958	0.504	0.994	0.301	1.000	0.422
	(4)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)

*An underlined coefficient is significant (0.05), a double underlined coefficient very significant (0.01), and the number in parenthesis is the number of analyzed pairs.

TABLE XXXV

THE EFFECT OF PHOSPHORUS ADDITIONS TO NORTH LAKE WATER ON ALGAL CELL COUNTS

Time (Days)	Average Number of Cells Per Milliliter ± One Standard Deviation*			
	Lake Control	Lake Control + 0.005 mg/l P	Lake Control + 0.015 mg/l P	Lake Control + 0.050 mg/l P
1	$4.01 \times 10^3 \pm 0.29 \times 10^3$	$3.10 \times 10^3 \pm 0.57 \times 10^3$	$4.17 \times 10^3 \pm 0.63 \times 10^3$	$2.94 \times 10^3 \pm 0.40 \times 10^3$
2	$7.03 \times 10^3 \pm 0.51 \times 10^3$	$7.11 \times 10^3 \pm 2.18 \times 10^3$	$8.42 \times 10^3 \pm 3.84 \times 10^3$	$7.50 \times 10^3 \pm 1.13 \times 10^3$
3	$1.58 \times 10^4 \pm 0.28 \times 10^4$	$1.87 \times 10^4 \pm 1.05 \times 10^4$	$2.19 \times 10^4 \pm 0.68 \times 10^4$	$2.12 \times 10^4 \pm 1.25 \times 10^4$
4	$2.14 \times 10^4 \pm 0.24 \times 10^4$	$2.60 \times 10^4 \pm 1.43 \times 10^4$	$4.56 \times 10^4 \pm 1.81 \times 10^4$	$5.86 \times 10^4 \pm 4.33 \times 10^4$
5	$2.44 \times 10^4 \pm 0.17 \times 10^4$	$2.85 \times 10^4 \pm 1.53 \times 10^4$	$7.12 \times 10^4 \pm 1.81 \times 10^4$	$7.82 \times 10^4 \pm 5.42 \times 10^4$
6	$2.53 \times 10^4 \pm 0.27 \times 10^4$	$3.22 \times 10^4 \pm 1.63 \times 10^4$	$8.27 \times 10^4 \pm 1.48 \times 10^4$	$7.85 \times 10^4 \pm 5.04 \times 10^4$
7	$2.69 \times 10^4 \pm 0.31 \times 10^4$	$3.76 \times 10^4 \pm 1.97 \times 10^4$	$9.43 \times 10^4 \pm 1.50 \times 10^4$	$8.81 \times 10^4 \pm 5.45 \times 10^4$
8	$2.71 \times 10^4 \pm 0.28 \times 10^4$	$3.60 \times 10^4 \pm 1.91 \times 10^4$	$1.01 \times 10^5 \pm 0.12 \times 10^5$	$8.83 \times 10^4 \pm 5.34 \times 10^4$
9	$2.87 \times 10^4 \pm 0.26 \times 10^4$	$3.55 \times 10^4 \pm 1.83 \times 10^4$	$9.34 \times 10^4 \pm 0.84 \times 10^4$	$9.19 \times 10^4 \pm 5.40 \times 10^4$
10	$2.63 \times 10^4 \pm 0.13 \times 10^4$	$3.73 \times 10^4 \pm 1.78 \times 10^4$	$1.09 \times 10^5 \pm 0.12 \times 10^5$	$1.04 \times 10^5 \pm 0.57 \times 10^5$
11	$2.55 \times 10^4 \pm 0.24 \times 10^4$	$4.04 \times 10^4 \pm 1.85 \times 10^4$	$9.88 \times 10^4 \pm 1.58 \times 10^4$	$1.00 \times 10^5 \pm 0.51 \times 10^5$
12	$2.30 \times 10^4 \pm 0.56 \times 10^4$	$3.81 \times 10^4 \pm 1.73 \times 10^4$	$9.75 \times 10^4 \pm 1.63 \times 10^4$	$1.22 \times 10^5 \pm 0.61 \times 10^5$
13	$2.17 \times 10^4 \pm 0.80 \times 10^4$	$3.96 \times 10^4 \pm 1.69 \times 10^4$	$9.66 \times 10^4 \pm 2.39 \times 10^4$	$1.13 \times 10^5 \pm 0.55 \times 10^5$
14	$2.03 \times 10^4 \pm 0.97 \times 10^4$	$3.90 \times 10^4 \pm 1.59 \times 10^4$	$9.90 \times 10^4 \pm 3.75 \times 10^4$	$1.32 \times 10^5 \pm 0.64 \times 10^5$
15	......	......	......	$1.42 \times 10^5 \pm 0.69 \times 10^5$
16	......	......	......	......
17	......	......	......	......

*Averages and standard deviations are based on three flasks with three cell counts per flask, except lake control values which are based on four flasks.

TABLE XXXVI

THE EFFECT OF NITROGEN ADDITIONS TO NORTH LAKE WATER ON ALGAL CELL COUNTS

Time (Days)	Average Number of Cells Per Milliliter $\pm$ One Standard Deviation*			
	Lake Control	Lake Control + 0.075 mg/l N	Lake Control + 0.225 mg/l N	Lake Control + 0.750 mg/l N
1	$4.01X10^3 \pm 0.29X10^3$	$4.11X10^3 \pm 0.25X10^3$	$3.77X10^3 \pm 0.46X10^3$	$2.72X10^3 \pm 1.01X10^3$
2	$7.03X10^3 \pm 0.51X10^3$	$7.73X10^3 \pm 2.43X10^3$	$6.64X10^3 \pm 1.35X10^3$	$6.70X10^3 \pm 1.23X10^3$
3	$1.58X10^4 \pm 0.28X10^4$	$1.54X10^4 \pm 0.73X10^4$	$1.66X10^4 \pm 0.42X10^4$	$1.50X10^4 \pm 0.41X10^4$
4	$2.14X10^4 \pm 0.24X10^4$	$1.69X10^4 \pm 0.67X10^4$	$2.07X10^4 \pm 0.32X10^4$	$2.08X10^4 \pm 0.06X10^4$
5	$2.44X10^4 \pm 0.17X10^4$	$1.82X10^4 \pm 0.72X10^4$	$2.47X10^4 \pm 0.29X10^4$	$2.18X10^4 \pm 0.06X10^4$
6	$2.53X10^4 \pm 0.27X10^4$	$2.05X10^4 \pm 0.65X10^4$	$2.47X10^4 \pm 0.26X10^4$	$2.38X10^4 \pm 0.11X10^4$
7	$2.69X10^4 \pm 0.31X10^4$	$2.38X10^4 \pm 0.63X10^4$	$2.54X10^4 \pm 0.22X10^4$	$2.56X10^4 \pm 0.05X10^4$
8	$2.71X10^4 \pm 0.28X10^4$	$2.20X10^4 \pm 0.58X10^4$	$2.74X10^4 \pm 0.20X10^4$	$2.53X10^4 \pm 0.09X10^4$
9	$2.87X10^4 \pm 0.26X10^4$	$2.07X10^4 \pm 0.37X10^4$	$2.62X10^4 \pm 0.07X10^4$	$2.50X10^4 \pm 0.21X10^4$
10	$2.63X10^4 \pm 0.13X10^4$	$1.91X10^4 \pm 0.40X10^4$	$2.63X10^4 \pm 0.16X10^4$	$2.60X10^4 \pm 0.06X10^4$
11	$2.55X10^4 \pm 0.24X10^4$	$1.66X10^4 \pm 0.51X10^4$	$2.10X10^4 \pm 0.75X10^4$	$2.68X10^4 \pm 0.11X10^4$
12	$2.30X10^4 \pm 0.56X10^4$	$1.72X10^4 \pm 0.79X10^4$	$1.73X10^4 \pm 0.91X10^4$	$2.37X10^4 \pm 0.08X10^4$
13	$2.17X10^4 \pm 0.80X10^4$	$1.55X10^4 \pm 0.79X10^4$	$1.51X10^4 \pm 0.95X10^4$	$2.31X10^4 \pm 0.29X10^4$
14	$2.03X10^4 \pm 0.97X10^4$	$1.37X10^4 \pm 0.84X10^4$	$1.12X10^4 \pm 0.81X10^4$	$1.65X10^4 \pm 0.79X10^4$
15	......	......	......	......
16	......	......	......	......
17	......	......	......	......

*Averages, and standard deviations are based on three flasks with three cell counts per flask, except lake control values which are based on four flasks.

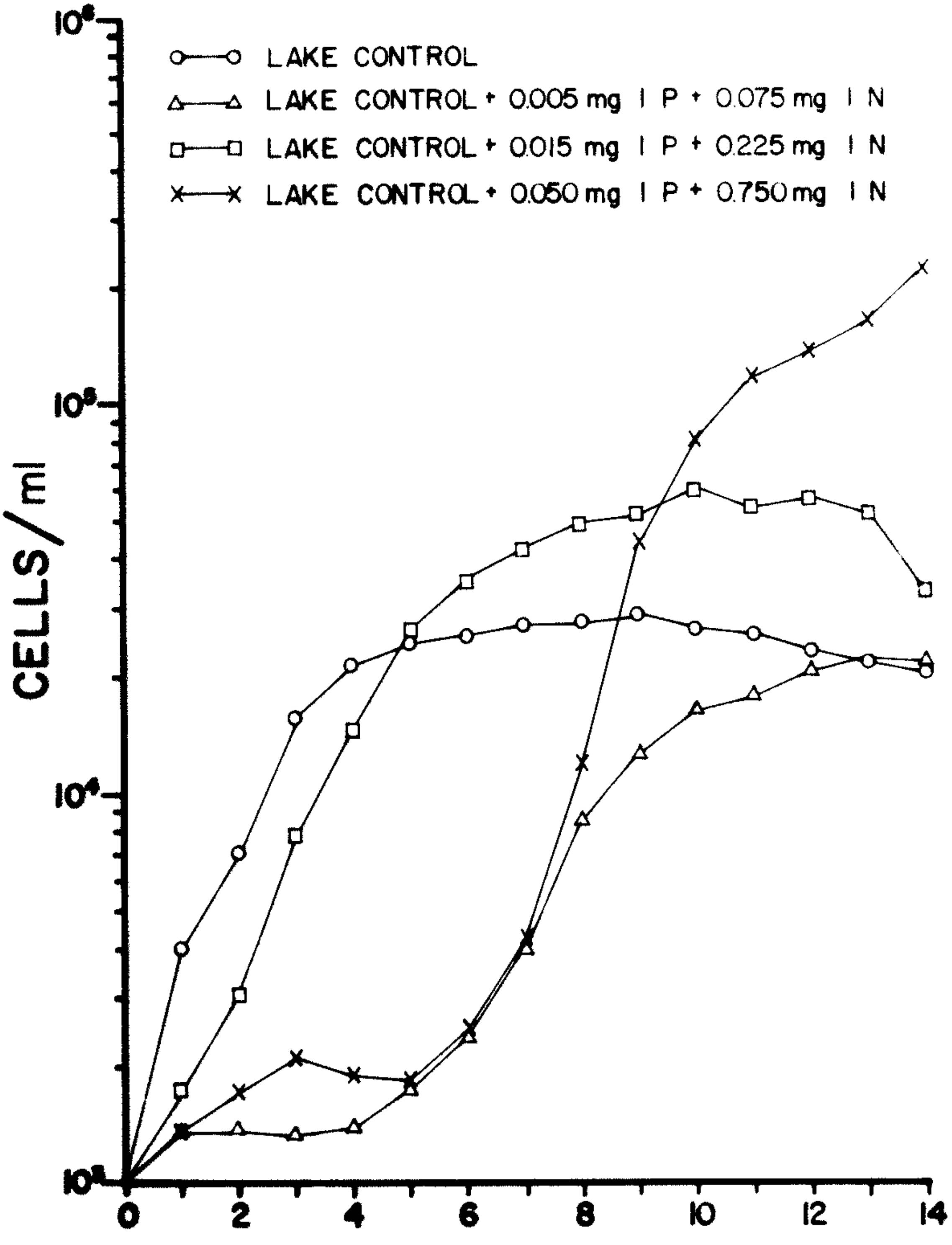
TABLE XXXVII

THE EFFECT OF COMBINED PHOSPHORUS AND NITROGEN ADDITIONS TO NORTH LAKE WATER ON ALGAL CELL COUNTS

Time (Days)	Average Number of Cells Per Milliliter ± One Standard Deviation*			
	Lake Control (LC)	LC + 0.005 mg/l P + 0.075 mg/l N	LC + 0.015 mg/l P + 0.225 mg/l N	LC + 0.050 mg/l P + 0.750 mg/l N
1	$4.01X10^3 \pm 0.29X10^3$	$1.36X10^3 \pm 0.05X10^3$	$1.73X10^3 \pm 0.64X10^3$	$1.36X10^3 \pm 0.31X10^3$
2	$7.03X10^3 \pm 0.51X10^3$	$1.37X10^3 \pm 0.03X10^3$	$3.06X10^3 \pm 2.71X10^3$	$1.73X10^3 \pm 0.37X10^3$
3	$1.58X10^4 \pm 0.28X10^4$	$1.32X10^3 \pm 0.17X10^3$	$7.75X10^3 \pm 1.10X10^4$	$2.10X10^3 \pm 0.50X10^3$
4	$2.14X10^4 \pm 0.24X10^4$	$1.39X10^3 \pm 0.21X10^3$	$1.47X10^4 \pm 2.29X10^4$	$1.89X10^3 \pm 0.51X10^3$
5	$2.44X10^4 \pm 0.17X10^4$	$1.78X10^3 \pm 0.41X10^3$	$2.62X10^4 \pm 4.27X10^4$	$1.84X10^3 \pm 0.82X10^3$
6	$2.53X10^4 \pm 0.27X10^4$	$2.40X10^3 \pm 1.13X10^3$	$3.46X10^4 \pm 5.64X10^4$	$2.50X10^3 \pm 1.54X10^3$
7	$2.69X10^4 \pm 0.31X10^4$	$4.01X10^3 \pm 4.10X10^3$	$4.20X10^4 \pm 6.76X10^4$	$4.29X10^3 \pm 4.83X10^3$
8	$2.71X10^4 \pm 0.28X10^4$	$8.58X10^3 \pm 1.12X10^4$	$4.86X10^4 \pm 7.65X10^4$	$1.19X10^4 \pm 1.62X10^3$
9	$2.87X10^4 \pm 0.26X10^4$	$1.27X10^4 \pm 1.84X10^4$	$5.13X10^4 \pm 7.86X10^4$	$4.38X10^4 \pm 7.03X10^4$
10	$2.63X10^4 \pm 0.13X10^4$	$1.63X10^4 \pm 2.42X10^4$	$5.94X10^4 \pm 8.81X10^4$	$8.00X10^4 \pm 1.31X10^5$
11	$2.55X10^4 \pm 0.24X10^4$	$1.76X10^4 \pm 2.64X10^4$	$5.36X10^4 \pm 7.67X10^4$	$1.17X10^5 \pm 1.89X10^5$
12	$2.30X10^4 \pm 0.56X10^4$	$2.05X10^4 \pm 3.17X10^4$	$5.62X10^4 \pm 7.88X10^4$	$1.36X10^5 \pm 2.07X10^5$
13	$2.17X10^4 \pm 0.80X10^4$	$2.20X10^4 \pm 3.31X10^4$	$5.16X10^4 \pm 6.81X10^4$	$1.63X10^5 \pm 2.27X10^5$
14	$2.03X10^4 \pm 0.97X10^4$	$2.17X10^4 \pm 3.35X10^4$	$3.43X10^4 \pm 3.74X10^4$	$2.20X10^5 \pm 2.57X10^5$
15	......	$2.42X10^4 \pm 3.76X10^4$	$1.97X10^4 \pm 1.04X10^4$	$2.57X10^5 \pm 2.67X10^5$
16	......	$2.49X10^4 \pm 3.81X10^4$	$1.64X10^4 \pm 0.70X10^4$	$2.90X10^5 \pm 2.88X10^5$
17	......	$2.67X10^4 \pm 4.06X10^4$	$1.65X10^4 \pm 0.77X10^4$	$2.99X10^5 \pm 2.88X10^5$

*Averages and standard deviations are based on three flasks with three cell counts per flask, except lake control values which are based on four flasks.

Fig. 16--The effect of combined phosphorus and nitrogen additions to North Lake water on algal cell counts.



LAKE CONTROL
LAKE CONTROL + 0.005 mg l P + 0.075 mg l N
LAKE CONTROL + 0.015 mg l P + 0.225 mg l N
LAKE CONTROL + 0.050 mg l P + 0.750 mg l N
CELLS/ml
DAYS

TABLE XXXVIII

ALGAL ASSAY MEDIUM PHOSPHORUS GROWTH REFERENCE VALUES

Time (Days)	Average Number of Cells Per Milliliter $\pm$ One Standard Deviation*			
	(Medium-P)	(Medium-P) + 0.005 mg/l P	(Medium-P) + 0.015 mg/l P	(Medium-P) + 0.050 mg/l P
1	$1.31X10^{3} \pm 0.19X10^{3}$	$8.45X10^{2} \pm 0.48X10^{2}$	$1.06X10^{3} \pm 0.09X10^{3}$	$9.04X10^{2} \pm 1.35X10^{2}$
2	$1.27X10^{3} \pm 0.15X10^{3}$	$8.29X10^{2} \pm 0.59X10^{2}$	$1.56X10^{3} \pm 0.99X10^{3}$	$9.48X10^{2} \pm 1.24X10^{2}$
3	$1.48X10^{3} \pm 0.42X10^{3}$	$9.52X10^{2} \pm 0.49X10^{2}$	$3.70X10^{3} \pm 3.60X10^{3}$	$1.11X10^{3} \pm 0.22X10^{3}$
4	$1.70X10^{3} \pm 0.55X10^{3}$	$1.13X10^{3} \pm 0.12X10^{3}$	$7.97X10^{3} \pm 4.97X10^{3}$	$1.12X10^{3} \pm 0.06X10^{3}$
5	$1.80X10^{3} \pm 0.78X10^{3}$	$1.36X10^{3} \pm 0.29X10^{3}$	$1.89X10^{4} \pm 1.45X10^{4}$	$1.27X10^{3} \pm 0.27X10^{3}$
6	$1.72X10^{3} \pm 0.78X10^{3}$	$1.33X10^{3} \pm 0.30X10^{3}$	$2.18X10^{4} \pm 1.56X10^{4}$	$2.95X10^{3} \pm 1.24X10^{3}$
7	$1.80X10^{3} \pm 0.78X10^{3}$	$1.21X10^{3} \pm 0.34X10^{3}$	$3.01X10^{4} \pm 1.38X10^{4}$	$9.15X10^{3} \pm 3.87X10^{3}$
8	$1.88X10^{3} \pm 0.84X10^{3}$	$1.41X10^{3} \pm 0.34X10^{3}$	$3.64X10^{4} \pm 1.21X10^{4}$	$3.69X10^{4} \pm 1.38X10^{4}$
9	$1.69X10^{3} \pm 0.72X10^{3}$	$1.42X10^{3} \pm 0.60X10^{3}$	$3.69X10^{4} \pm 1.02X10^{4}$	$1.32X10^{5} \pm 0.67X10^{5}$
10	$1.83X10^{3} \pm 0.78X10^{3}$	$1.56X10^{3} \pm 0.52X10^{3}$	$4.04X10^{4} \pm 1.29X10^{4}$	$2.93X10^{5} \pm 1.90X10^{5}$
11	$1.83X10^{3} \pm 0.78X10^{3}$	$1.41X10^{3} \pm 0.42X10^{3}$	$4.49X10^{4} \pm 1.37X10^{4}$	$4.73X10^{5} \pm 3.76X10^{5}$
12	$1.79X10^{3} \pm 0.80X10^{3}$	$1.44X10^{3} \pm 0.41X10^{3}$	$4.66X10^{4} \pm 1.37X10^{4}$	$5.99X10^{5} \pm 5.31X10^{5}$
13	$1.81X10^{3} \pm 0.78X10^{3}$	$1.32X10^{3} \pm 0.40X10^{3}$	$4.10X10^{4} \pm 1.20X10^{4}$	$7.08X10^{5} \pm 6.01X10^{5}$
14	$2.28X10^{3} \pm 0.88X10^{3}$	$1.52X10^{3} \pm 0.34X10^{3}$	$4.44X10^{4} \pm 1.49X10^{4}$	$8.07X10^{5} \pm 7.15X10^{5}$
15	$2.15X10^{3} \pm 0.88X10^{3}$	$1.61X10^{3} \pm 0.62X10^{3}$	$4.89X10^{4} \pm 1.56X10^{4}$	$8.84X10^{5} \pm 7.78X10^{5}$
16	$1.97X10^{3} \pm 0.83X10^{3}$	$1.91X10^{3} \pm 0.60X10^{3}$	$4.82X10^{4} \pm 1.62X10^{4}$	$9.83X10^{5} \pm 8.92X10^{5}$
17	$2.27X10^{3} \pm 0.87X10^{3}$	$1.70X10^{3} \pm 0.56X10^{3}$	$4.95X10^{4} \pm 1.82X10^{4}$	$9.56X10^{5} \pm 8.73X10^{5}$

*Averages and standard deviations are based on three flasks with three cell counts per flask.

Fig. 17--Phosphorus growth reference curves for algal assay medium.

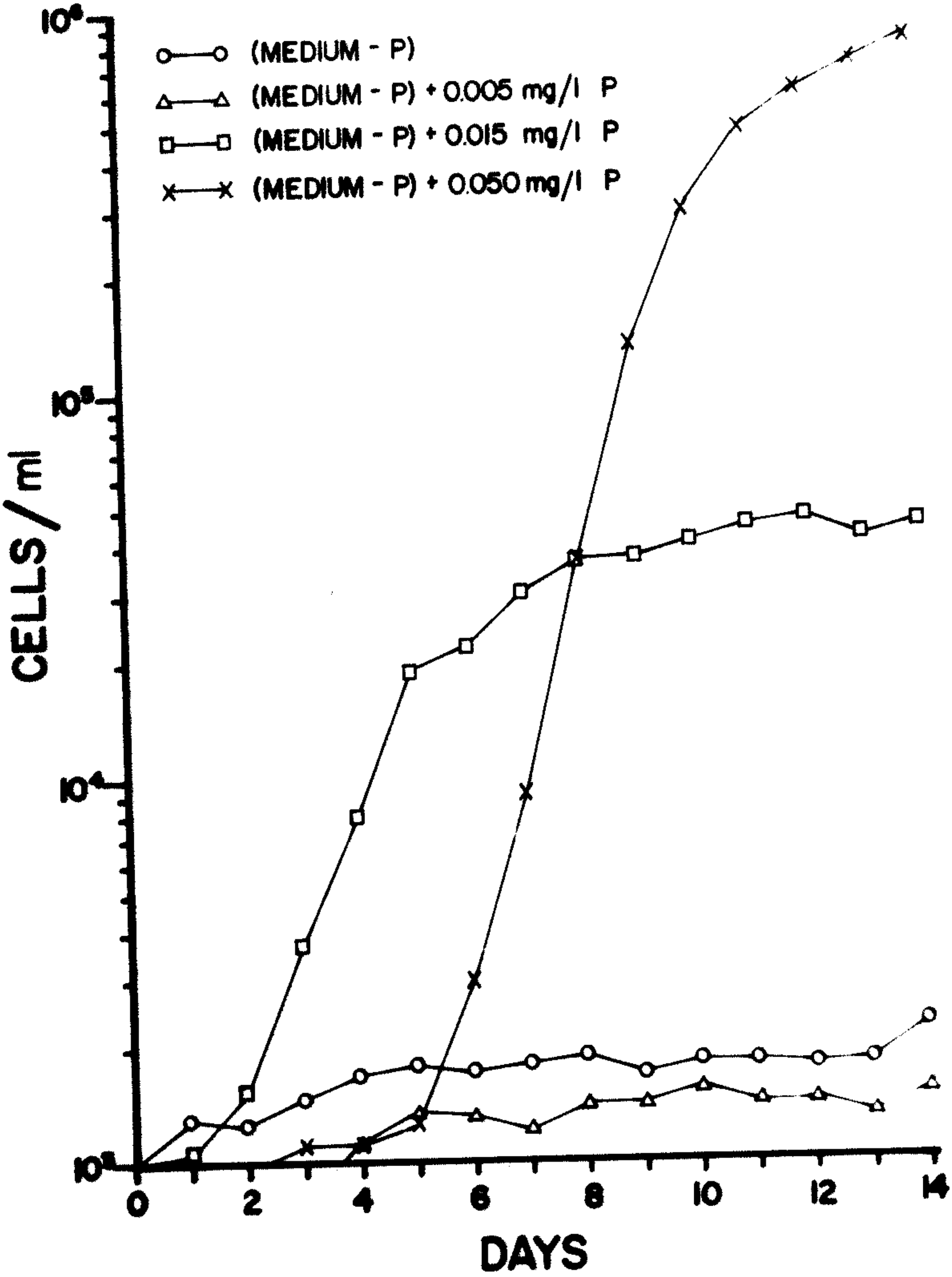

(MEDIUM - P)
(MEDIUM - P) + 0.005 mg/l P
(MEDIUM - P) + 0.015 mg/l P
(MEDIUM - P) + 0.050 mg/l P
CELLS / ml
DAYS
0
2
4
6
8
10
12
14

TABLE XXXIX

MAXIMUM SPECIFIC GROWTH RATES FOR NORTH LAKE AND PHOSPHORUS GROWTH REFERENCE ALGAL ASSAY

Flask	Maximum Specific Growth Rate														
	North Lake										Phosphorus Growth Reference				
	Lake Control	Lake Control + 0.005 mg/l P	Lake Control + 0.015 mg/l P	Lake Control + 0.050 mg/l P	Lake Control + 0.075 mg/l N	Lake Control + 0.225 mg/l N	Lake Control + 0.750 mg/l N	Lake Control + 0.005 mg/l P + 0.075 mg/l N	Lake Control + 0.015 mg/l P + 0.225 mg/l N	Lake Control + 0.050 mg/l P + 0.750 mg/l N	(Medium-P)	(Medium-P) + 0.005 mg/l P	(Medium-P) + 0.015 mg/l P	(Medium-P) + 0.050 mg/l P	Full Strength Medium (w/0.186 mg/l P)
1	1.32	1.27	1.31	1.13	1.37	1.29	1.06	0.30	1.20	0.86	0.37	0.30	1.07	1.32	1.76
2	1.34	1.31	1.36	1.20	1.39	1.22	1.00	0.32	0.42	0.57	0.33	0.29	1.39	1.37	1.61
3	1.47	1.19	1.59	1.32	1.48	1.45	1.36	0.90	0.46	1.41	0.27	0.34	0.97	1.55	1.78
4	1.41	..	..	..	..	..	..	..	..	..	..	..	..	..	..
$\overline{X}$ ±	1.38	1.26	1.42	1.22	1.41	1.32	1.14	0.51	0.69	0.95	0.32	0.31	1.14	1.41	1.72
SD	0.07	0.06	0.15	0.10	0.06	0.12	0.19	0.34	0.44	0.43	0.05	0.03	0.22	0.12	0.09

TABLE XXXX

ALGAL ASSAY FULL STRENGTH MEDIUM GROWTH REFERENCE VALUES

Time (Days)	$\bar{X}$ Cell Counts/ml $\pm$ SD*
1	$1.36X10^3 \pm 0.43X10^3$
2	$1.66X10^3 \pm 0.37X10^3$
3	$2.94X10^3 \pm 1.69X10^3$
4	$1.10X10^4 \pm 1.05X10^4$
5	$5.94X10^4 \pm 6.66X10^4$
6	$2.18X10^5 \pm 2.33X10^5$
7	$5.75X10^5 \pm 4.14X10^5$
8	$1.22X10^6 \pm 0.55X10^6$
9	$1.63X106 \pm 0.25X10^6$
10	$2.34X10^6 \pm 0.09X10^6$
11	$2.31X10^6 \pm 0.08X10^6$
12	$2.38X10^6 \pm 0.02X10^6$
13	$2.53X10^6 \pm 0.11X10^6$
14	$2.84X10^6 \pm 0.08X10^6$
15	$2.97X10^6 \pm 0.02X10^6$
16	$3.26X10^6 \pm 0.05X10^6$
17	$3.13X10^6 \pm 0.06X10^6$

*$\bar{X}$ and SD based on three flasks with three cell counts per flask.

TABLE XXXXI

THE EFFECT OF PHOSPHORUS ADDITIONS TO ELM FORK TRINITY RIVER WATER ON ALGAL CELL COUNTS

Time (Days)	Average Number of Cells Per Milliliter $\pm$ One Standard Deviation*			
	River Control	River Control + 0.005 mg/l P	River Control 0.015 mg/l P	River Control 0.050 mg/l P
1	$3.38X10^{3}\pm1.67X10^{3}$	$4.75X10^{3}\pm1.28X10^{3}$	$4.95X10^{3}\pm0.62X10^{3}$	$4.36X10^{3}\pm1.86X10^{3}$
2	$1.11X10^{4}\pm0.66X10^{4}$	$1.43X10^{4}\pm0.58X10^{4}$	$1.80X10^{4}\pm0.65X10^{4}$	$1.67X10^{4}\pm0.85X10^{4}$
3	$3.48X10^{4}\pm2.10X10^{4}$	$5.21X10^{4}\pm3.09X10^{4}$	$7.45X10^{4}\pm5.08X10^{4}$	$6.39X10^{4}\pm4.49X10^{4}$
4	$9.71X10^{4}\pm3.97X10^{4}$	$1.59X10^{5}\pm0.98X10^{5}$	$2.29X10^{5}\pm1.61X10^{5}$	$1.80X10^{5}\pm0.99X10^{5}$
5	$2.77X10^{5}\pm1.10X10^{5}$	$2.72X10^{5}\pm1.84X10^{5}$	$2.99X10^{5}\pm2.18X10^{5}$	$3.28X10^{5}\pm1.06X10^{5}$
6	$3.73X10^{5}\pm0.64X10^{5}$	$3.47X10^{5}\pm2.31X10^{5}$	$3.47X10^{5}\pm2.39X10^{5}$	$4.40X10^{5}\pm0.32X10^{5}$
7	$4.75X10^{5}\pm0.43X10^{5}$	$3.99X10^{5}\pm2.82X10^{5}$	$3.76X10^{5}\pm2.56X10^{5}$	$4.94X10^{5}\pm0.17X10^{5}$
8	$4.84X10^{5}\pm0.29X10^{5}$	$4.15X10^{5}\pm2.94X10^{5}$	$3.69X10^{5}\pm2.59X10^{5}$	$5.06X10^{5}\pm0.41X10^{5}$
9	$5.29X10^{5}\pm0.34X10^{5}$	$4.29X10^{5}\pm2.87X10^{5}$	$3.97X10^{5}\pm2.79X10^{5}$	$5.22X10^{5}\pm0.31X10^{5}$
10	$5.50X10^{5}\pm0.36X10^{5}$	$4.49X10^{5}\pm3.06X10^{5}$	$4.08X10^{5}\pm2.93X10^{5}$	$5.34X10^{5}\pm0.35X10^{5}$
11	$5.73X10^{5}\pm0.42X10^{5}$	$3.91X10^{5}\pm2.50X10^{5}$	$4.00X10^{5}\pm2.95X10^{5}$	$4.57X10^{5}\pm0.35X10^{5}$
12	$6.02X10^{5}\pm0.54X10^{5}$	$3.77X10^{5}\pm2.45X10^{5}$	$3.72X10^{5}\pm2.90X10^{5}$	$4.09X10^{5}\pm0.96X10^{5}$
13	$6.27X10^{5}\pm0.68X10^{5}$	$3.41X10^{5}\pm2.45X10^{5}$	$3.60X10^{5}\pm3.11X10^{5}$	$3.87X10^{5}\pm1.46X10^{5}$
14	$6.57X10^{5}\pm0.79X10^{5}$	$3.36X10^{5}\pm2.68X10^{5}$	$3.26X10^{5}\pm3.38X10^{5}$	$3.78X10^{5}\pm1.56X10^{5}$
15	......	......	......	......
16	......	......	......	......
17	......	......	......	......

*Averages, and standard deviations are based on three flasks with three cell counts per flask, except river control values which are based on four flasks.

TABLE XXXXII

THE EFFECT OF NITROGEN ADDITIONS TO ELM FORK TRINITY RIVER WATER ON ALGAL CELL COUNTS

Time (Days)	Average Number of Cells Per Milliliter ± One Standard Deviation*			
	River Control	River Control + 0.075 mg/l N	River Control + 0.225 mg/l N	River Control + 0.750 mg/l N
1	$3.38 \times 10^{3} \pm 1.67 \times 10^{3}$	$5.61 \times 10^{3} \pm 0.29 \times 10^{3}$	$4.11 \times 10^{3} \pm 0.44 \times 10^{3}$	$3.09 \times 10^{3} \pm 0.55 \times 10^{3}$
2	$1.11 \times 10^{4} \pm 0.66 \times 10^{4}$	$2.06 \times 10^{4} \pm 0.34 \times 10^{4}$	$1.46 \times 10^{4} \pm 0.23 \times 10^{4}$	$1.45 \times 10^{4} \pm 0.12 \times 10^{4}$
3	$3.48 \times 10^{4} \pm 2.10 \times 10^{4}$	$1.04 \times 10^{5} \pm 0.22 \times 10^{5}$	$4.30 \times 10^{4} \pm 1.70 \times 10^{4}$	$3.79 \times 10^{4} \pm 0.89 \times 10^{4}$
4	$9.71 \times 10^{4} \pm 3.97 \times 10^{4}$	$3.74 \times 10^{5} \pm 0.86 \times 10^{5}$	$1.34 \times 10^{5} \pm 0.77 \times 10^{5}$	$1.31 \times 10^{5} \pm 0.60 \times 10^{5}$
5	$2.77 \times 10^{5} \pm 1.10 \times 10^{5}$	$4.83 \times 10^{5} \pm 0.54 \times 10^{5}$	$2.56 \times 10^{5} \pm 1.59 \times 10^{5}$	$2.63 \times 10^{5} \pm 0.70 \times 10^{5}$
6	$3.73 \times 10^{5} \pm 0.64 \times 10^{5}$	$5.38 \times 10^{5} \pm 0.60 \times 10^{5}$	$3.74 \times 10^{5} \pm 2.45 \times 10^{5}$	$4.60 \times 10^{5} \pm 0.60 \times 10^{5}$
7	$4.75 \times 10^{5} \pm 0.43 \times 10^{5}$	$5.59 \times 10^{5} \pm 0.46 \times 10^{5}$	$4.33 \times 10^{5} \pm 2.72 \times 10^{5}$	$6.63 \times 10^{5} \pm 0.39 \times 10^{5}$
8	$4.84 \times 10^{5} \pm 0.29 \times 10^{5}$	$5.12 \times 10^{5} \pm 0.28 \times 10^{5}$	$4.59 \times 10^{5} \pm 2.85 \times 10^{5}$	$7.19 \times 10^{5} \pm 0.21 \times 10^{5}$
9	$5.29 \times 10^{5} \pm 0.34 \times 10^{5}$	$4.32 \times 10^{5} \pm 0.61 \times 10^{5}$	$4.55 \times 10^{5} \pm 2.63 \times 10^{5}$	$7.74 \times 10^{5} \pm 0.43 \times 10^{5}$
10	$5.50 \times 10^{5} \pm 0.36 \times 10^{5}$	$3.03 \times 10^{5} \pm 0.69 \times 10^{5}$	$4.17 \times 10^{5} \pm 2.20 \times 10^{5}$	$7.79 \times 10^{5} \pm 0.28 \times 10^{5}$
11	$5.73 \times 10^{5} \pm 0.42 \times 10^{5}$	$2.95 \times 10^{5} \pm 0.51 \times 10^{5}$	$2.48 \times 10^{5} \pm 1.06 \times 10^{5}$	$7.77 \times 10^{5} \pm 0.50 \times 10^{5}$
12	$6.02 \times 10^{5} \pm 0.54 \times 10^{5}$	$3.07 \times 10^{5} \pm 0.80 \times 10^{5}$	$1.91 \times 10^{5} \pm 0.49 \times 10^{5}$	$7.81 \times 10^{5} \pm 0.82 \times 10^{5}$
13	$6.27 \times 10^{5} \pm 0.68 \times 10^{5}$	$2.97 \times 10^{5} \pm 0.93 \times 10^{5}$	$1.45 \times 10^{5} \pm 0.24 \times 10^{5}$	$7.63 \times 10^{5} \pm 0.87 \times 10^{5}$
14	$6.57 \times 10^{5} \pm 0.79 \times 10^{5}$	$3.71 \times 10^{5} \pm 1.03 \times 10^{5}$	$1.40 \times 10^{5} \pm 0.15 \times 10^{5}$	$6.31 \times 10^{5} \pm 2.19 \times 10^{5}$
15	......	......	......	......
16	......	......	......	......
17	......	......	......	......

*Averages, and standard deviations are based on three flasks with three cell counts per flask, except river control values which are based on four flasks.

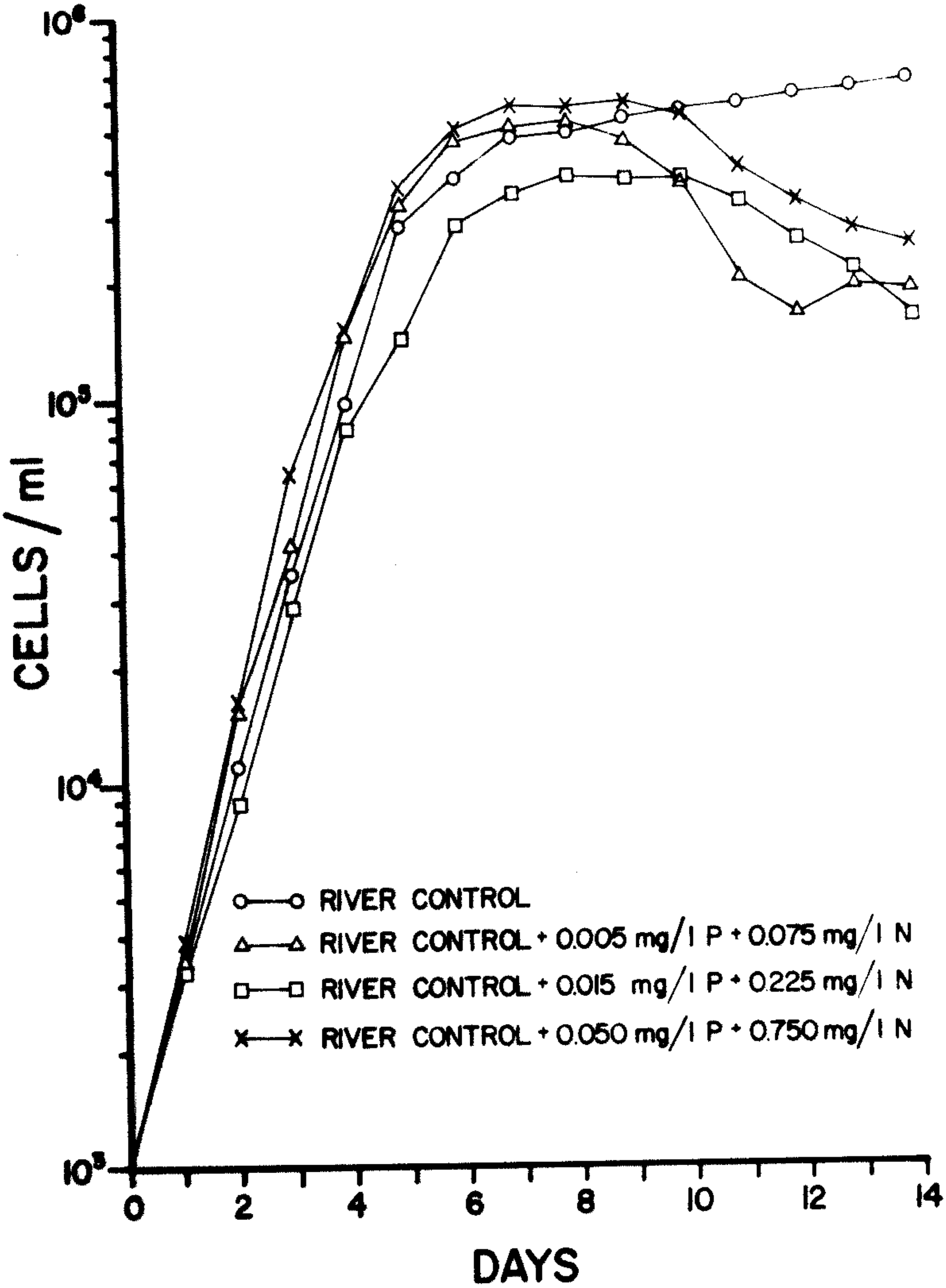
TABLE XXXXIII

THE EFFECT OF COMBINED PHOSPHORUS AND NITROGEN ADDITIONS TO ELM FORK TRINITY RIVER WATER ON ALGAL CELL COUNTS

Time (Days)	Average Number of Cells Per Milliliter ± One Standard Deviation*			
	River Control (RC)	RC + 0.005 mg/l P + 0.075 mg/l N	RC + 0.015 mg/l P + 0.225 mg/l N	RC + 0.050 mg/l P + 0.750 mg/l N
1	$3.38\times10^{3}\pm1.67\times10^{3}$	$3.46\times10^{3}\pm1.39\times10^{3}$	$3.28\times10^{3}\pm1.12\times10^{3}$	$3.92\times10^{3}\pm1.30\times10^{3}$
2	$1.11\times10^{4}\pm0.66\times10^{4}$	$1.55\times10^{4}\pm0.37\times10^{4}$	$8.91\times10^{3}\pm2.68\times10^{3}$	$1.62\times10^{4}\pm0.82\times10^{4}$
3	$3.48\times10^{4}\pm2.10\times10^{4}$	$4.16\times10^{4}\pm1.42\times10^{4}$	$2.85\times10^{4}\pm0.45\times10^{4}$	$6.40\times10^{4}\pm4.86\times10^{4}$
4	$9.71\times10^{4}\pm3.97\times10^{4}$	$1.47\times10^{5}\pm0.49\times10^{5}$	$8.29\times10^{4}\pm3.30\times10^{4}$	$1.50\times10^{5}\pm0.72\times10^{5}$
5	$2.77\times10^{5}\pm1.10\times10^{5}$	$3.17\times10^{5}\pm0.77\times10^{5}$	$1.44\times10^{5}\pm0.84\times10^{5}$	$3.53\times10^{5}\pm1.31\times10^{5}$
6	$2.73\times10^{5}\pm0.64\times10^{5}$	$4.66\times10^{5}\pm0.82\times10^{5}$	$2.81\times10^{5}\pm2.27\times10^{5}$	$5.00\times10^{5}\pm1.31\times10^{5}$
7	$4.75\times10^{5}\pm0.43\times10^{5}$	$5.05\times10^{5}\pm0.69\times10^{5}$	$3.37\times10^{5}\pm2.66\times10^{5}$	$5.72\times10^{5}\pm1.29\times10^{5}$
8	$4.84\times10^{5}\pm0.29\times10^{5}$	$5.14\times10^{5}\pm0.56\times10^{5}$	$3.74\times10^{5}\pm2.80\times10^{5}$	$5.66\times10^{5}\pm1.16\times10^{5}$
9	$5.29\times10^{5}\pm0.34\times10^{5}$	$4.61\times10^{5}\pm0.96\times10^{5}$	$3.70\times10^{5}\pm2.90\times10^{5}$	$5.82\times10^{5}\pm1.27\times10^{5}$
10	$5.50\times10^{5}\pm0.36\times10^{5}$	$3.57\times10^{5}\pm1.24\times10^{5}$	$3.65\times10^{5}\pm2.89\times10^{5}$	$5.38\times10^{5}\pm2.39\times10^{5}$
11	$5.73\times10^{5}\pm0.42\times10^{5}$	$1.99\times10^{5}\pm0.73\times10^{5}$	$3.19\times10^{5}\pm2.58\times10^{5}$	$3.88\times10^{5}\pm3.10\times10^{5}$
12	$6.02\times10^{5}\pm0.54\times10^{5}$	$1.61\times10^{5}\pm0.54\times10^{5}$	$2.51\times10^{5}\pm2.25\times10^{5}$	$3.16\times10^{5}\pm3.44\times10^{5}$
13	$6.27\times10^{5}\pm0.68\times10^{5}$	$1.90\times10^{5}\pm0.71\times10^{5}$	$2.10\times10^{5}\pm2.24\times10^{5}$	$2.68\times10^{5}\pm3.58\times10^{5}$
14	$6.57\times10^{5}\pm0.79\times10^{5}$	$1.85\times10^{5}\pm0.54\times10^{5}$	$1.57\times10^{5}\pm1.76\times10^{5}$	$2.43\times10^{5}\pm3.31\times10^{5}$
15	......	......	......	......
16	......	......	......	......
17	......	......	......	......

*Averages, and standard deviations are based on three flasks with three cell counts per flask, except river control values which are based on four flasks.

Fig. 18--The effect of combined phosphorus and nitrogen addition to Elm Fork Trinity River water on algal cell counts.



CELLS / ml
DAYS
10^6
10^5
10^4
10^3
0
2
4
6
8
10
12
14
RIVER CONTROL
RIVER CONTROL + 0.005 mg/l P + 0.075 mg/l N
RIVER CONTROL + 0.015 mg/l P + 0.225 mg/l N
RIVER CONTROL + 0.050 mg/l P + 0.750 mg/l N

TABLE XXXXIV

MAXIMUM SPECIFIC GROWTH RATES FOR ELM FORK TRINITY RIVER AND NITROGEN GROWTH REFERENCE ALGAL ASSAY

Flask	Maximum Specific Growth Rate														
	Elm Fork Trinity River										Nitrogen Growth Reference				
	River Control	River Control + 0.005 mg/l P	River Control + 0.015 mg/l P	River Control + 0.050 mg/l P	River Control + 0.075 mg/l N	River Control + 0.225 mg/l N	River Control + 0.750 mg/l N	River Control + 0.005 mg/l P + 0.075 mg/l N	River Control + 0.015 mg/l P + 0.225 mg/l N	River Control + 0.050 mg/l P + 0.750 mg/l N	(Medium-N)	(Medium-N) + 0.075 mg/l N	(Medium-N) + 0.225 mg/l N	(Medium-N) + 0.750 mg/l N	Full Strength Medium (w/4.200 mg/l N)
1	1.48	1.75	1.55	1.40	1.68	1.37	1.73	1.62	1.37	1.38	1.44	1.52	1.70	1.63	1.76
2	1.09	1.64	1.73	1.78	1.78	1.35	1.55	1.65	1.32	1.29	1.45	1.15	1.28	1.61	1.61
3	1.57	1.48	1.50	1.57	1.73	1.53	1.38	1.61	1.50	1.68	1.15	1.20	1.55	1.88	1.78
4	1.64	..	..	..	..	..	..	..	..	..	..	..	..	..	..
$\bar{X}$ ±	1.44	1.62	1.59	1.58	1.73	1.42	1.55	1.63	1.40	1.45	1.35	1.29	1.51	1.71	1.72
SD	0.25	0.14	0.12	0.19	0.05	0.10	0.18	0.02	0.09	0.20	0.17	0.20	0.21	0.15	0.09

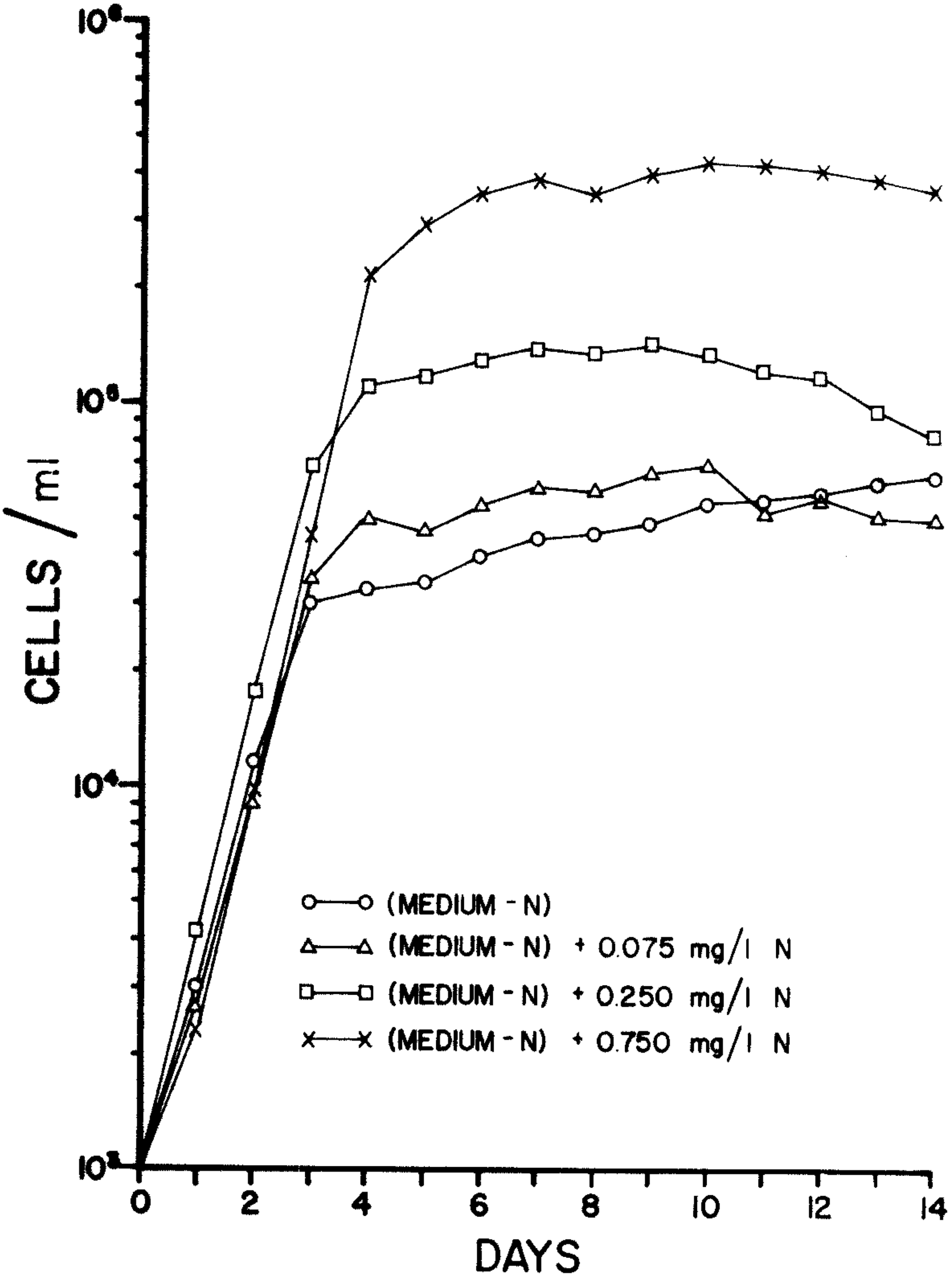
TABLE XXXXV

ALGAL ASSAY MEDIUM NITROGEN GROWTH REFERENCE VALUES

Time (Days)	Average Number of Cells Per Milliliter ± One Standard Deviation*			
	(Medium-N)	(Medium-N) + 0.075 mg/l N	(Medium-N) + 0.225 mg/l N	(Medium-N) + 0.750 mg/l N
1	$3.01 \times 10^3 \pm 0.72 \times 10^3$	$2.56 \times 10^3 \pm 1.03 \times 10^3$	$4.25 \times 10^3 \pm 0.88 \times 10^3$	$2.31 \times 10^3 \pm 1.54 \times 10^3$
2	$1.17 \times 10^4 \pm 0.35 \times 10^4$	$9.19 \times 10^3 \pm 5.84 \times 10^3$	$1.78 \times 10^4 \pm 0.82 \times 10^4$	$9.76 \times 10^3 \pm 9.04 \times 10^3$
3	$3.01 \times 10^4 \pm 0.63 \times 10^4$	$3.50 \times 10^4 \pm 2.81 \times 10^4$	$6.81 \times 10^4 \pm 5.19 \times 10^4$	$4.51 \times 10^4 \pm 5.02 \times 10^4$
4	$3.29 \times 10^4 \pm 1.16 \times 10^4$	$5.01 \times 10^4 \pm 0.96 \times 10^4$	$1.11 \times 10^5 \pm 0.12 \times 10^5$	$2.14 \times 10^5 \pm 2.12 \times 10^5$
5	$3.41 \times 10^4 \pm 1.47 \times 10^4$	$4.62 \times 10^4 \pm 1.25 \times 10^4$	$1.18 \times 10^5 \pm 0.23 \times 10^5$	$2.92 \times 10^5 \pm 0.59 \times 10^5$
6	$3.99 \times 10^4 \pm 1.99 \times 10^4$	$5.42 \times 10^4 \pm 1.53 \times 10^4$	$1.30 \times 10^5 \pm 0.26 \times 10^5$	$3.52 \times 10^5 \pm 0.58 \times 10^5$
7	$4.44 \times 10^4 \pm 2.54 \times 10^4$	$6.01 \times 10^4 \pm 1.98 \times 10^4$	$1.39 \times 10^5 \pm 0.25 \times 10^5$	$3.84 \times 10^5 \pm 0.56 \times 10^5$
8	$4.57 \times 10^4 \pm 2.73 \times 10^4$	$5.86 \times 10^4 \pm 2.23 \times 10^4$	$1.35 \times 10^5 \pm 0.24 \times 10^5$	$3.51 \times 10^5 \pm 0.51 \times 10^5$
9	$4.87 \times 10^4 \pm 3.21 \times 10^4$	$6.60 \times 10^4 \pm 2.59 \times 10^4$	$1.41 \times 10^5 \pm 0.34 \times 10^5$	$3.98 \times 10^5 \pm 0.64 \times 10^5$
10	$5.49 \times 10^4 \pm 3.68 \times 10^4$	$6.95 \times 10^4 \pm 3.58 \times 10^4$	$1.32 \times 10^5 \pm 0.44 \times 10^5$	$4.23 \times 10^5 \pm 0.91 \times 10^5$
11	$5.59 \times 10^4 \pm 3.85 \times 10^4$	$5.15 \times 10^4 \pm 4.92 \times 10^4$	$1.19 \times 10^5 \pm 0.58 \times 10^5$	$4.17 \times 10^5 \pm 1.08 \times 10^5$
12	$5.80 \times 10^4 \pm 3.82 \times 10^4$	$5.69 \times 10^4 \pm 5.51 \times 10^4$	$1.16 \times 10^5 \pm 0.62 \times 10^5$	$4.01 \times 10^5 \pm 1.56 \times 10^5$
13	$6.22 \times 10^4 \pm 4.34 \times 10^4$	$5.08 \times 10^4 \pm 6.63 \times 10^4$	$9.47 \times 10^4 \pm 5.59 \times 10^4$	$3.82 \times 10^5 \pm 2.07 \times 10^5$
14	$6.46 \times 10^4 \pm 4.41 \times 10^4$	$4.98 \times 10^4 \pm 7.73 \times 10^4$	$8.13 \times 10^4 \pm 6.79 \times 10^4$	$3.58 \times 10^5 \pm 2.19 \times 10^5$
15	......	......	......	......
16	......	......	......	......
17	......	......	......	......

*Averages and standard deviations are based on three flasks with three cell counts per flask.

Fig. 19--Nitrogen growth reference curves for algal assay medium.



10⁶
10⁵
10⁴
10³
CELLS /ml
0
2
4
6
8
10
12
14
DAYS
(MEDIUM - N)
(MEDIUM - N) + 0.075 mg/l N
(MEDIUM - N) + 0.250 mg/l N
(MEDIUM - N) + 0.750 mg/l N

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