III. THE LAKES OF NORTHEASTERN INDIANA

By

Will Scott

(**The lakes of northeastern Indiana**. Dept. Conserr., Div. Fish and Game, State Ind. Pub. I07: 57-145. Scott, W., R. Hile, and HT Spieth. 1938.)

III. THE LAKES OF NORTHEASTERN INDIANA

by

WILL SCOTT

CONTENTS

INTRODUCTION

This study is concerned with the principal lakes of four counties of northeastern Indiana, i. e., Steuben, LaGrange, Noble, and Whitley. Not all the lakes of these counties have been examined, but the number studied includes all types and gives a fair and sound picture of conditions in this region. The summer of 1929 was devoted to the lakes of Steuben County. A temporary camp and laboratory was set up at the state park on Lake James. The central location of this point and the special interest attaching to Lake James made this location very advantageous. In 1930 the lakes of the other three counties were reached from the Biological Station of Indiana University. A smaller number of lakes were examined in 1930 because the lakes were farther apart and the consequent travel greater.

It is frankly an exploratory study. Dr. W. M. Tucker, working for the Department of Conservation, had mapped Lakes James, Snow, Crooked, Clear, and Gage in Steuben County; Adams and Oliver Lakes in Noble County; and Crooked, Shriner, and Round Lakes in Whitley County. Other than this nothing was known of this group except the incidental work done on them by Dayer in his work on the topography and glaciation of the region, and the mere superficial descriptions of some of them by various people.

It is well known that the summer temperature and the consequent distribution of dissolved oxygen, and carbon dioxide together with the amount of carbonates in a lake are fundamental elements in their economy. This together with the summer plankton gives a fair picture of the nature of any lake.

These facts have been determined and expressed in a series of 68 tables. These data are discussed in the body of the paper and some deductions are made. Certain difficulties have been met. The most important is the lack of topographic maps of the region. Problems connected with the carbonates are intimately related to the topography and their solution awaits the construction of such maps. A minor difficulty has been the naming of the lakes discussed in the paper. The same lake often has more than one name; for instance, Hamilton and Fish refer to the same lake, as do Garden and Golden. The same name is often applied to different lakes. The name Crooked is applied to rather important lakes in both Steuben and Whitley Counties. To obviate this difficulty a table is introduced giving the township, range, and sections occupied in part or in whole by each lake.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the hearty coöperation of the late George N. Mannfield, Superintendent of the Division of Fish and Game, and of his successor Walter Shirts, a man of sound judgment.

The field assistants in 1929 were Herman T. Spieth, Raymond J. Myers, and Ancil D. Holloway. In 1930 they were Raymond J. Myers and Mychyle W. Johnson. Their careful work adds much to the quality of the results.

In the laborious work of counting the plankton, I was assisted by Miss Mary I. Spilman and Miss Lois E. Smith. I am also indebted to Dr. Harold T. Davis and Miss Anna Mae Lescisin of the Department of Mathematics for calculating the coefficient of correlation between the carbonates and certain diatoms.

The Graduate School of Indiana University furnished funds for the apparatus and incidental expenses. I am especially grateful to Dr. Fernandus Payne, its Dean and my colleague, for his kindly encouragement.

TABLE No. 1. Location of lakes by township, range, and section. The serial numbers at the left correspond to the numbers on fig. 1, which is the map of the four counties.

Lake	TN	RE	Sec.
1. Adams, Lagrange	36	10	23-24-25-26
2. Cedar, Lagrange	38	10	21-22
3. Cedar, Whitley	32	9	2-11-12
4. Center, Steuben	37	13	22
5. Clear, Steuben	38	15	17-18-19-20-29-30
6. Crooked, Steuben	37 37	13 12	6-7-8-9-16-17 1
7. Crooked, Whitley	32 33	9 9	3-4 33-34
8. Fox, Steuben	37	13	28-33-34
9. Gage, Steuben	38 37	12 12	34-35 2
10. George, Steuben	38	13	14-15+Mich.
11. Golden, Steuben	36 36	12 12	1 5-6-8
12. Hamilton, Steuben	36	14	28-33-21-27
13. Hog, Steuben	38	13	17+Mich.
14. Hogback, Steuben	37 37	12 13	25-36 31
15. James, Steuben	38 37	13 13	28-33-34 3-4-10
16. Jimerson, Steuben	38 37	13 13	30-31-32 5
17. Lake Pleasant, Steuben	38 38	13 12	18- 12-13+Mich.
18. Long, Lagrange	36	11	22-26-27
19. Long, Steuben	36	13	15-16
20. Loon, Steuben	37	13	20
21. Marsh, Steuben	38	13	25
22. Oliver, Lagrange	36	10	17-18-19-20
23. Otter (L.), Steuben	38	13	26-27
24. Otter (U.), Steuben	38	13	26-27
25. Pleasant L., Steuben	36	13	22-23-14-15
26. Pretty, Lagrange	36	11	15-16
27. Round, Whitley	32	9	12
28. Shriner, Whitley	32	9	2-11-12
29. Silver, Steuben	37	13	29-30-31-32
30. Snow, Steuben	38	13	21-22-27-28
31. Big Turkey {Lagrange Steuben	36 36	12 11	7-18 13
32. Twin (N.), Lagrange	38	9	23
33. Twin (S.), Lagrange	38	9	26-27
34. Wallen, Noble	35	13	13

TN—Township North.
RE—Range East.
SEC.—Section.
Serial numbers indicate lake names on map No. 1.

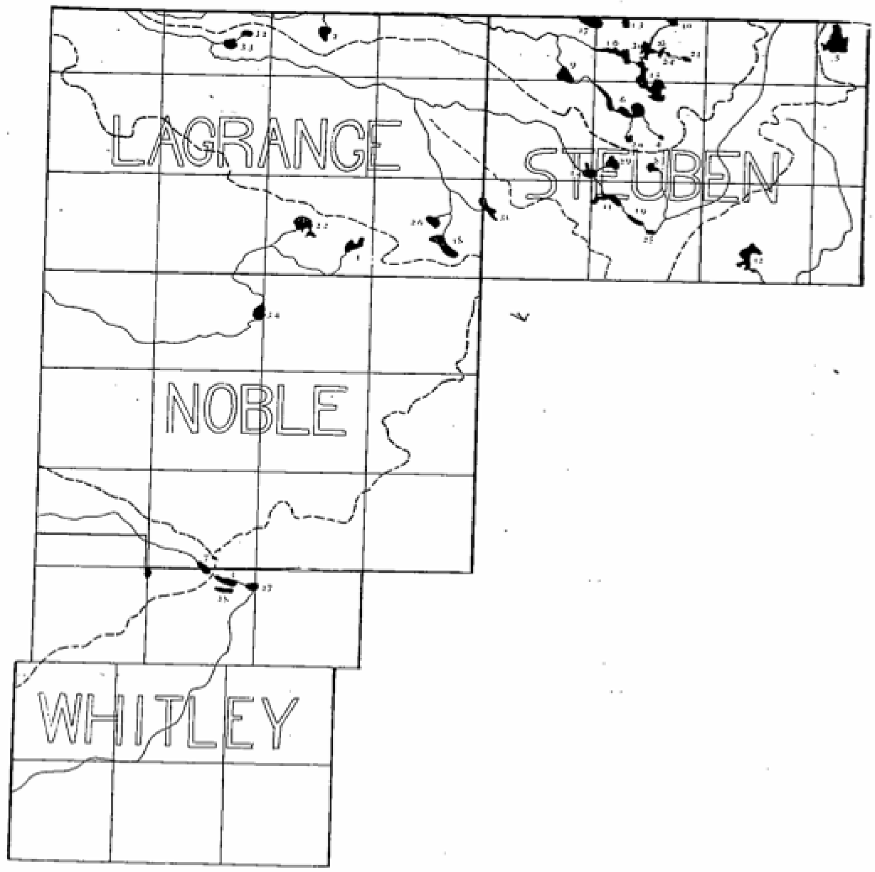

FIG. 1. Map of the area. Figures refer to lake names in Table No. 1.

DRAINAGE

The four counties Steuben, LaGrange, Noble, and Whitley, which include the lakes of this report, form a "parting of the ways" so far as surface drainage is concerned. From them the waters may go to Lake Erie through the Maumee, to Lake Michigan through the St. Joseph of Michigan, or to the Gulf of Mexico through the tributaries of the Wabash which in turn empties into the Ohio and thence to the Mississippi and the Gulf.

In Whitley County, Cedar, Shriner and Round Lakes are drained by the Eel River, which is tributary to the Wabash. Over a low divide is Crooked Lake of Whitley County, which empties into the Wabash through the Tippecanoe River.

Adams and Oliver Lakes of LaGrange County and Wallen Lake of Noble County are tributary to the Elkhart River. Fox, Pleasant, Long, Golden, and Silver Lakes of Steuben County; Big Turkey Lake of Steuben and LaGrange Counties; and Long, Pretty, North Twin, and South Twin Lakes of LaGrange County all empty into the Pigeon River.

Faun River drains two series in Steuben County. The first series is composed of Marsh, Upper Otter, Lower Otter, George, Snow, James, and Jimerson Lakes. The second consists of Center, Loon, Crooked, and Gage. In addition to this, the Faun River drains Cedar Lake of LaGrange County. These three rivers, the Elkhart, the Pigeon, and the Faun, are tributaries of the St. Joseph River of Michigan. The St. Joseph also drains Lake Pleasant and Hog Lake. The outlet of Clear Lake flows northwest and south through Michigan and Ohio to St. Joseph of the Maumee. Hamilton reaches the same stream through Fish Creek.

GLACIATION AND LAKE FORMATION

The lakes of this region are due to the Pleistocene glaciation. While much glacial drift was undoubtedly brought into Indiana by the earlier ice advances, the present distribution and topography are due to the last or Wisconsin ice sheet. This ice sheet advanced into Indiana in three great lobes, which were given direction by the basins of Lake Michigan, Saginaw Bay of Lake Huron, and the combined influences of Lakes Huron and Erie. Consequently, these lobes are called the Michigan, the Saginaw, and the Huron-Erie. Of these three lobes the Huron-Erie advanced into the northern part of eastern Indiana from the northeast; the Michigan lobe advanced into western Indiana from the north, and between these two came the Saginaw Lobe. The influence of the Michigan Lobe is outside the area considered in this paper and will not be discussed.

Leverett (1915) has determined that the Saginaw Lobe retreated first. The general climatic conditions at the same latitude must have been uniform over all three lobes. The early retreat of the Saginaw indicates that it had less mass and power than the other two. This fact and the form of the moraines (Leverett, L. C., map No. VI.) indicate that ice derived from the Saginaw lobe did not extend south of the present Wabash River nor its major tributary, the Eel River.

This massive system of moraines extends from the northeast corner of the state southwest for about seventy-five miles. In this mass occur the lakes which are discussed in this paper. While Dryer (1891, pp. 114-120) and Leverett (l. c.) attribute most of this material to the work of the Huron-Erie lobe, the region must be regarded as interlobate in the sense that both lobes influence it.

From this mass which coalesces in Steuben and a part of Noble and DeKalb Counties, there extends southwest three limbs. The eastern one is the ill defined Salamonie moraine, the middle one becomes the Mississinewa. Both of these are clearly terminal moraines of the Huron-Erie lobe.

The third and western of these three extends to the southwest, paralleling the Eel River from Whitley County to Logansport. It was along this western mass and in the coalesced moraines from Whitley County to the northeast that the great ice lobes were in contact at the time of the maximum development of the Saginaw lobe. Not only did each contribute material from its lateral and terminal moraine, but as the opposing masses varied both in thickness and force, there must have been local over-riding of one mass by the other. For reasons already given, the Huron-Erie usually did the overriding. This resulted in buried masses of ice which eventually, on melting, caused lake beds and outwash channels.

In the case of Tippecanoe Lake and the Barbee system, it was determined (Scott, 1915, p. 5) that the drainage lines were between finger-like lobes of ice. Great water-laid deposits were laid down between masses of ice. When the ice melted, the anomalous condition was produced, namely, lakes separated by water-laid ridges.

Dryer (1891, p. 133) accurately describes the condition in Steuben County as two great moraines running northeast to southwest and the streams running to the northwest. Three of these streams follow channels through the western and more massive of these two moraines. His interpretation that these channels antedate the moraines is incorrect. Also his interpretation that they formed outwash channels from the Huron-Erie Lobe is untenable, unless it is assumed that there were great masses of stagnant ice underlying these water courses and that the subsequent melting of these ice masses caused the lakes now found in these valleys.

The accurate interpretation of this whole interlobate region must await detailed studies. These studies must include the making of a topographic map, the correlation of the logs of wells, study of the water stratified drift, outwash channels, and the identification of the materials of the deposits and their point of origin. Until these data are at hand speculation as to details is futile.

CARBONATES

These lakes are all relatively hard water lakes. The "hardness" is due to carbonates, chiefly those of calcium, although a smaller amount of magnesium is usually present. These carbonates vary from 24.96 cc. of carbon dioxide per liter in Loon Lake to 54.73 in Golden Lake.

The carbonates are leached from the glacial deposits above the lake levels, and their primary source is the limestones and dolomites of the Devonian and

Silurian deposits to the northeast. They are found on the shores of Lakes Huron and Erie, on the east side of the "thumb" of Michigan, in Ohio, and in southern Ontario. These glacial deposits are very heterogenous. Many analyses will have to be made before any significant average is obtained. Collections fifteen to twenty feet below the surface in a fresh gravel pit near Winona Lake averaged 9.4% of calcium carbonate. Besides this little known factor, the amount of carbonate in the moraines, two processes seem to influence the amount of carbonates in a lake, namely, the leaching of the carbonates from the moraine above the lake level and the precipitation by photosynthesis of the carbonates from the lake water as marl. The first of the processes increases the carbonates while the second reduces it in amount. When a lake is perched high in the moraines, the water is softer than when the level of the lake is much lower than the surrounding moraines. For instance, near the divide between the Faun and Pigeon Rivers lie Center and Loon Lakes on one side, and Fox and Silver Lakes on the other. Their carbonates average respectively 31.92, 24.96, 29.72 and 31.26.

At lower elevations in this same moraine and river valleys lie Long, Garden, and Hogback Lakes on one side and Marsh, Otter and James on the other—whose carbonates average 52.39, 54,73, 44.49, 47.25, 45.96 and 38.00, respectively.

This is illustrated also in the series of lakes whose drainage unites to form the Faun River. The largest lake in one series is James Lake, and in the other is Crooked Lake. Approximately a mile apart they lie, but with a difference in elevation of 23.5 feet (Tucker, 1922, p. 400). The average carbonates for Crooked Lake is 26.37 while that for James is 38.00.

The James series, with their carbonates, consist of Marsh 48.95, Upper Otter 47.45, Lower Otter 41.02, Snow 41.00, James 38.00, Jimerson 36.67.

The Crooked Lake series follows: Center 31.92, Loon 24.96, Crooked 26.37, Gage 30.22. The arithmetical average for the perched lakes, i. e., the Crooked Lake series, is 28.36, while that for the lower lake series is 42.18.

The "softening" of lakes by photosynthesis is the result of the following well known facts. The carbonates in solution in lake water are in the form of the bicarbonate. In photosynthesis the plants not only use the free carbon dioxide in solution, but are also able to use the second radical of the bicarbonate, the so-called "half bound" carbon dioxide. This leaves the normal carbonate which is precipitated as "marl."

In a series of lakes whose difference in level is slight and which are connected by streams of considerable volume, the amount of carbonate in solution is gradually reduced. This is best illustrated in the series Marsh, Upper Otter, Lower Otter, Snow, James, and Jimerson Lakes cited above.

In other instances variations in leaching caused by variation in the differential between the lake level and the level of the surrounding moraines overbalance the effect of photosynthesis. In the series of lakes which is tributary to the Pigeon River, Pleasant Lake is little below the level of the surrounding land while farther down lies Golden and Hogback surrounded by high moraines. The former has 27.15 cc. carbonates while the latter have 54.73 and 44.49, respectively. Golden is the highest in carbonates of any lake examined in this study.

Lake	Surface and Bottom								
	Depth	T		O_2		CO_2 Free		Cb	
1. Center	5. 5.	23.7 25.	18.9 24.4	3.57 5.38	0 0	0 .74	6.97 5.68	30.37 30.15	33.86 32.12
2. Clear	32.50 30.	22.2 24.2	10.4 10.2	5.71 6.41	.08 1.58	− .99 −1.23	5.72 4.94	24.40 24.96	28.18 27.18
3. Crooked	21. 23.	26.7 22.2	10.6 10.4	5.91 5.5	0 .8	0 0	7.85 1.5	22.93 24.63	28.79 28.11
4. Fox	17.5	24.4	10.8	6.2	0	−1.22	5.13	26.42	33.02
5. Golden	9.5	26.1	11.7	5.15	0	3.19	18.45	46.00	63.46
6. Gage	21. 21.5	24.4 22.2	10.6 10.6	5.31 5.9	0 0	0 −.99	8.46 5.47	26.64 28.86	39.59 31.39
7. George	25. 25.	25.6 23.3	11.1 11.1	6.23 5.7	.1 .9	0 0	6.47 5.47	27.63 30.60	34.86 33.09
8. Hamilton (Fish)	19. 19.	27.2 24.4	11.7 11.7	6.56 7.2	0 .05	− .73 −1.23	7.32 9.63	24.40 26.44	29.03 30.39
9. Hog	9.	26.6	13.3	6.09	.34	0	−7.03	27.92	36.54
10. Hogback	5.5 8.	24.4 24.4	15.6 13.9	6.03 5.05	0 0	0 0	17.25 16.79	40.86 40.17	58.21 48.12
11. Jimerson	17.	24.4	10.	5.57	.06	0	5.68	33.61	39.54
12. Lake Pleasant	10.	25.6	14.4	5.57	.21	0	4.54	24.97	28.60
13. Long	9.5	24.4	12.2	5.33	0	.6	5.74	47.72	57.07
14. Loon	4.	26.7	21.4	4.76	1.99	.98	3.93	24.10	25.83
15. Marsh	11.	25.6	10.	6.73	.10	0	9.27	50.75	44.16
16. (Lower) Otter	12.	24.8	10.	5.89	.11	0	6.92	42.01	40.03
17. (Upper) Otter	10.	25.6	10.6	6.20	.07	0	6.40	50.66	41.27
18. Pleasant Lake	13.	25.9	11.7	5.7	.67	0	5.13	24.40	29.84
19. Silver	11.	25.	11.7	5.00	.10	0	8.17	26.33	36.09

Depth 30+ Clear

20-29 Crooked, Gage, George.

10-19 Fox, Hamilton, Jimerson, L. Pleasant, L. Otter, U. Otter, Pleasant Lake, Silver.

10 Center, Golden, Hog, Hogback, Loon.

TABLE No. 2. Summary table for the lakes of Steuben County.

Birge and Juday (1911, p. 136) have shown that extremely soft water lakes such as those of northeastern Wisconsin are relatively poor in plankton especially phytoplankton. The above mentioned authors divide the lakes of Wisconsin into three classes with reference to carbonates, namely, soft, medium, and hard. The soft water lakes contain carbondioxide as carbonate in amounts less than 5 cc. per liter, the medium 5 cc. to 22 cc. per liter, and the hard water lakes above 22 cc. per liter. On this basis, all lakes considered in this paper are hard water lakes varying in carbonates from 24.96 cc. per liter to 54.73.

Theoretically the amount of phytoplankton should be roughly proportional to the amount of carbonates. Plant growth is also dependent upon other factors. The form of the basin is a potent factor. The shallower lakes generally produce more phytoplankton than the deeper lakes. For example, Hogback Lake with a depth of 8.5 meters has more phytoplankton than any other lake of the series, while Clear Lake of Steuben County, with a depth of 32 meters, is relatively low in phytoplankton.

Rice (1916) and others have shown that the amount and nature of nitrogen compounds are related to plant growth in water. Atkins (1924) has shown a similar relation for phosphorous. Allen (1914) finds some unknown organic compound necessary for the artificial culture of marine plankton.

In spite of these and other factors known to influence plant growth, it appeared probable from the inspection of our data that the number of certain diatoms was correlated with the amount of carbonates.

The average amount of carbonates in thirty-two lakes was determined by taking the arithmetical average of the maximum and minimum. (The volume of most of the lakes is unknown, so that the amount of the carbonates could not be more closely determined.) The coefficient of correlation between this average of the carbonates and the number of three phytoplanktons Fragillaria, Melosira, and Clathrocystis was .4549, .4559, and .0284, respectively.

It appears from this that in spite of other factors influencing plant growth, there is a significant correlation between the carbonates and diatoms, but not between carbonates and blue green algae. Correlations above .3 are usually regarded as significant. These diatom correlation factors are nearer .5 than .4.

OXYGEN

In discussing the distribution of oxygen, it is necessary to recall the thermal stratification during the summer of lakes in temperate latitudes. Due chiefly to thermal resistance to mixture, lakes become stratified during the warmer months into a warm upper layer, beneath which is a stratum whose temperature decreases rapidly as the depth increases, and below this is a region of relatively cold water. These are known respectively as the epilimnion thermocline (mesolimnion) and the hypolimnion. In these lakes the epilimnion is usually five or six meters thick. The thermocline extends from a depth of five or six meters to a depth of ten to twelve meters. The hypolimnion occupies the depth beyond ten or twelve meters. This stratification is usually established by the first of June and lasts until the middle of October in the shallower lakes, and about a month longer in the deeper lakes.

In addition to the thermal stratification of lakes, the amount of oxygen is influenced in the upper levels by photosynthesis which in turn is determined by the amount of incident solar energy and the depth to which the various wave lengths penetrate. The amount of incident energy at the equinox when the sun is at meridian varies with cosine of the latitude. This amount varies diurnally toward zero at sunrise and sunset. The long days of summer at high latitudes tend to offset the influence of the lower angle of incidence.

Birge and Juday (1921) using a thermocouple (bolometer) report that 5% of the sun's energy remains at 5 meters and about 1% at 10 meters. More refined results and very elaborate data are given in a later paper (Birge and Juday, 1929). In sea water Shelford and Gail (1922), using a photoelectric cell, found that about 10% of the light penetrating the surface remained at 10 meters. Klug (1925) using an instrument based on photographic emulsion found that 27% of the light which penetrated the surface remained at 5 meters and that 1.5% persisted at 10 meters. Shelford found 25% of the incident light reflected, Klug 33%.

From the above results it is evident that in our lakes whose transparency approximates that of the Wisconsin lakes, the epilimnion is well lighted and the thermocline receives light sufficient for photosynthesis especially in the upper half. In practically all our lakes the hypolimnion lies below 10 meters. From the results of Birge and Juday l. c. the hypolimnion never receives as much as one per cent of the incident solar energy.

The Hypolimnion

The hypolimnion is completely sealed from the air during the period of summer stagnation. It is cold and dark. This means that all the oxygen it has is that taken down with the water during the vernal circulation. This amount is gradually reduced. This reduction is due in part to the respiration of the organisms present, but usually the most important factor in its reduction is the decay of organic matter. There is always organic matter on the bottom of the lake. Its decay reduces the oxygen in a thin stratum of water in contact with it.

However, the organisms that live at and near the surface (in the epilimnion) die in large numbers and their remains slowly sink. As they pass through the lower strata of water, they slowly reduce the amount of oxygen. It is obvious that the rate of oxygen reduction depends on two factors, the amount of this organic matter present and the temperature of the water. The temperature of the water depends on the date of stratification. Some lakes stratify earlier than others and the same lake may stratify at different dates in different years.

Of the thirty-two lakes (excluding James and Snow), twelve had no oxygen at the bottom on the date examined. Seventeen others had less than 1 cc. per liter. Of the three that had an excess of 1 cc. per liter, two (Clear of Steuben and Crooked of Whitley County), are the deepest of the series, 32 and 30 meters respectively. Crooked of Whitley is cold on the bottom; its temperature, 6.1° C., is equaled only by Cedar of Whitley. Clear is moderately cold, 10.7° C., but is usually rather free from organic matter. Its littoral is especially free from plants. These two factors account for the persistence to mid-summer of considerable oxygen at the bottom.

Loon Lake on the other hand is the shallowest lake in the series. Its depth is only four meters. On the day the collection was made its surface temperature was 26.7 while the bottom was 21.4.

The temperatures clearly indicate that the lake is mixed to the bottom by the wind during the summer. A period of calm weather would rapidly reduce the oxygen in the lower layers because of the high temperature.

Lake	Date	S	2	4	6	8
1. James N	6–19	104	104	105	103	
2. James J	6–20	108	104	106	102	
3. James L	6–21	105	104	107	101	
4. James B	6–21	103	104	103		
5. Snow	6–22			100.7		
6. Snow	6–22			100.4		
7. James A	6–24	113	111	121	108	
8. James J	6–24	112	110	116	108	
9. James D	6–25	109	107	113	103	
10. James F	6–25		107	113	102	
11. James I	6–26	106	108	116	110	
12. James H	6–27	106	104			
13. James K	6–28		108	109	106	
14. James C	7–1	115	118	115	107	
15. James E	7–2	116	116	110	116	
16. James U	7–2			114	104	
20. James M	7–4			101		
22. Gage	7–6					158
23. Fox	7–10	106	106	102	123	
26. Hamilton	7–11	122	122	105		
27. Center	7–14		101			
28. Clear	7–15	107	107	110	107	139
29. U. Otter	7–17	108				
30. L. Otter	7–18	106	106			
32. Hog	7–23	106	102			
34. Silver	7–24			100		
35. Hogback	7–24	103				
39. Crooked	7–30	103	103	103		
40. Hamilton	7–31	106	115	103		
41. Marsh	8–1	115	112			
42. George	8–2	108	111	105		
44. Gage	8–3					153
45. Clear	8–5					134
50. James G	8–8	100	102			
51. James I	8–9	102	101	104		

TABLE No. 3. Oxygen supersaturations for the year 1929. All except those at 8 meters are in the epilimnion.

The Thermocline (mesolimnion)

The thermocline like the lower levels of the lake (hypolimnion) is sealed from the atmosphere during the period of stagnation but unlike the hypolimnion its temperature varies from that of the epilimnion above to that of the hypolimnion below. It often receives an appreciable amount of light. Its temperature facilitates both more rapid decay of organic material and more rapid metabolism in the living organism than occurs in the cooler waters beneath it.

The result is that when few chlorophyl bearing organisms are present the oxygen is often reduced more in the thermocline than it is in the upper part of the hypolimnion. This produces what might be called the thermoclinal oxygen notch. It regularly develops in Tippecanoe Lake. In these studies I have found it in station N of James Lake, and in Station O in Snow Lake.

Birge and Juday (1911) report it for lakes North, Green, and Knights. Litynske (1926) found it in Lake Wigvy. Lake Plön and "Schöhsee" according to Thienemann (1928) develop this condition.

This deficiency of oxygen in the thermocline is always subsequent to the establishment of the summer stratification. It usually develops in August and lasts into September. The earliest recorded date I have been able to find is July 12 in Plön, Thienemann (l. c., p. 168). However, in this instance the amount at 15 meters is only .56 cc. per liter less than the amount at 20 meters.

The biological significance of this will be discussed in its relation to the cisco (Argyrosomus artedi cisco Jordan).

Occasionally a rather dense flora of diatom or algae develops in the thermocline. When this occurs the water may become highly super-saturated. A super-saturation in the thermocline is much more permanent than one developed in the epilimnion because the water of the thermocline is not exposed to the air.

For instance, a super-saturation was found in Otter Lake in 1909 at 4 meters on July 2. This was still present on July 17 and August 13 (Birge and Juday, 1911, Figures 59, 60, 61).

In these lakes Gage had a super-saturation of 158% at 8 M. on July 6. On this date the 5 to 10 meter level had 74,135 Lyngbya per liter. On August 3 the saturation at 8 meters was 153% although the amount of phytoplankton had declined. In Clear Lake the saturation on July 15 was 139% and on August 5 it was 134%. The super-saturation that develops in the thermocline may persist more than a month and for a considerable period after the decline of the plankton flora that produced it as the data in Gage indicated.

In general the oxygen in the thermocline may reach a minimum as low as that of the hypolimnion or it may have a maximum exceeding that of the epilimnion. In either case the condition is very persistent usually lasting until the sinking of the thermocline restores the circulation of the water with that of the epilimnion.

	June	July	August
1929:			
Hours	354.3	368.3	299.9
Mean percent	78.	80.	70.
Normal percent	67.	70.	66.
1930:			
Hours	332.9	351.7	215.1
Mean percent	74.	77.	50.
Normal percent	67.	71.	66.
Excess Hours 1929 over 1930	21.4	16.6	84.8

TABLE No. 4. Sunshine records from the mc hly meterological summary, Ft. Wayne station.

Epilimnion

Oxygen in the epilimnion may change rapidly but rarely does the amount become excessively high or low. This region is influenced by the vicissitudes of the weather as well as the diurnal changes. When considerable phytoplankton is present a calm clear day will result in a super-saturation of oxygen. But a high wind will reduce this to about the saturation point.

Theoretically there should be a diurnal oxygen pulse in the epilimnion on clear days. This is, however, rarely detectable. Birge and Juday (1911, p. 43) found it in Mendota on September 21, 1908. It was demonstrated (Scott, 1923) on Winona Lake August 9, 1922. On Winona Lake it has been impossible to demonstrate this pulse except in very calm and clear weather.

However, even with slight breezes a super-saturation may be built up if there are successive days of sunshine. In 1929 there were 51 series of O_2 determination. In these 51 series there were 32 super-saturations in the epilimnion or 62% of the series. In 1930 there were 7 super-saturations in 24 series or 29% of the total.

An increase of the oxygen above the saturation point in the epilimnion can only be accomplished by photosynthesis. This in turn depends on the number of phytoplanktonts and the number of hours of sunshine. The number of phytoplanktonts varied from lake to lake, but there was no appreciable difference between the two years.

The sunshine records were obtained from Fort Wayne. The U. S. Weather Bureau Station at Fort Wayne is the nearest station to this group of lakes. The lakes average about 40 miles from Fort Wayne. They are arranged roughly in an arc from north to north of west.

These data appear in Table No. 3. There was more sunlight in each of the summer months in 1929 than there was in 1930. In 1929 this excess amounted to 21.4 hours, 16.6 hours, and 84.8 hours in June, July, and August. In 1930 most of our work was done in August, the month of the greatest excess. The normal percent of sunshine for August is 66. The mean for August, 1930, was 50 while the mean for August, 1929, was 70. That is, there was approximately 40% more hours of sunlight at Fort Wayne in August, 1929, than there was in 1930.

There is evidence that records obtained at a station in the middle of a city differ from those taken in the open country. There is no evidence that this relation would vary from year to year.

The above data indicate something of the amplitude of seasonal variation in the epilimnion. How much this seasonal variation in photosynthesis and the consequent production of carbohydrates would affect the other life in the lake is unknown. It has been shown (Hjort, 1914 and others) that some marine fishes grow more rapidly one year than another. So far as I know this has not been clearly demonstrated for fresh water fish.

THE PLANKTON

The plankton is one of the most important elements in the economy of a lake and one of the most difficult to evaluate. It has been measured volumetrically, numerically, and gravimetrically. The volumetric and gravimetric methods are relatively rapid, but neither permits analysis of the components of the plankton. Plankton is studied as a mass and not as an association of organisms. The volumetric method also has e well known difficulty arising from the fact that different planktonts settle . : centrifuge at different rates.

By enumerating the different organisms it is possible to compare their relative abundance in different lakes and to determine their seasonal variations. The difficulty of this method is that neither the weight nor volume of any individual organism of the plankton is accurately known so that the weight or volume of plankton per unit cannot be calculated.

Another difficulty in evaluating plankton is that a few of the forms are probably end products, while many of them are not. The crustacea, especially the cladocera, eat the smaller phytoplankton and in turn are eaten by the fish. The number or amount present at a given time are those that have *not* been eaten or destroyed in some other way. The value of any organism is not a function of the number present at a given moment, but is a function of the reproductive capacity of this population.

Lake	Number Daphnids sq. M. Max. Depth	Food Available for Number gms. of Fish sq. M.	Pounds of Fish Per Acre Possible
Golden	150,000	1,442	12,872
Hogback	209,000	2,009	17,811
Long	246,000	2,365	21,049
George	52,000	500	4,452
Clear	36,000	346	3,076

TABLE No. 5. The number of units of fish that the summer daphnid population will support. The first three lakes are especially rich in daphnids and are probably out of balance. The last two are poorer in daphnids and are probably more nearly balanced.

Banta (1921) reared Daphnia in an unbroken line from April, 1912, until September, 1916, nearly four and one-half years. He determined a reproductive factor by dividing the number of young in a brood by the time between broods. In the "minus" line, the reproductive factor was .99 and in his plus line it was 1.08. This means that on the average each parthenogenic adult produced approximately one young per day. If a population remains constant, an amount equally this population will be produced and eaten daily.

While it is not possible to convert any number of Daphnia into gravimetric or volumetric units, it is possible to convert these numbers into fish food requirements by experimental methods. This work was begun by Miss Blanche E. Penrod. By direct observation in an aquarium, she was able to determine the number of daphnids eaten by a blue gill in a given period of time; these periods varied from 15 minutes to one hour. The counts were recorded by a "tallying machine." The work is to be continued, but the results already obtained help in the interpretation of the plankton counts.

In 39 series, blue gills, each weighing 16 grams, ate on an average 139 daphnids per hour. We do not know just how many hours per day a blue gill feeds. If we assume that it feeds for 12 hours a blue gill weighing 16 grams would consume 1668 daphnids, or 104 daphnids per gram of fish.

If this amount is divided into the number of daphnids present in a given column of water (which equals its productive capacity), the quotient represents the number of grams of fish that the daphnids present on that date would support.

In Table 4, this has been computed. Golden, Long, and Hogback Lakes are shallow, rich lakes. George and Clear are relatively deep lakes, not subject to such rapid changes in temperatures and biota as occur in the shallower lakes. The seasonal changes in daphnid populations are extreme. Especially is this true in shallow, rich lakes. The maxima occur during the spring, summer, or fall, when the fish feed most. The evidence from hatchery plants and from scale studies indicates that fish in inland waters feed little during the colder parts of the year. However, it is hardly likely that a lake would support a fish population indicated by the maximum daphnid population. The average for the warmer months would be a better basis for estimation.

It is also true that blue gills at times feed almost wholly on other organisms. In Wawasee Lake, Hile found them feeding at times almost wholly on chironomid larvae. When the seasonal variations in feeding are worked out, it may be that during daphnid minima, other foods make up the deficit. These questions must await further data.

Another bit of evidence that assists in this evaluation is some data on the contents of fish stomachs. During the studies of Dr. Hile on the fish scales, Mr. E. G. Thomas determined the contents of the stomachs of 412 fish of which 292 were blue gills. Of these blue gills, 138 had eaten daphnids. The work had to be done rapidly. The contents were fractionated and an aliquot part of the daphnids counted. Absolute accuracy was not attained but the results are a fair approximation. Some of the fish contained more daphnids than others. The average number per gram of fish for the 138 fish was 5.5. The maximum for a single fish was 26 daphnids per gram. This indicates that the estimate that daphnids may feed 12 hours per day is too high and consequently the estimate of the number of pounds of fish a lake will support is too low.

The food of the daphnids consists of the smaller forms in the plankton, the so-called nannoplankton. The amount of this that a daphnid requires is a rather difficult problem. The volume of the alimentary canal of Bosmina, Daphnia pulex and Daphnia retrocurva has been determined by making a model to scale and measuring this volume by water displacement. The volumes are .00109 cc., .00287 cc., and .00336 cc., respectively. Some data have been collected on the rate at which food passes through the alimentary tract of these forms. Although 144 readings have been made, some of the results are rather erratic. Consequently, they are withheld until the factors causing the variations are determined. It is hoped that this work will add one more link in the "food chains" in our lakes.

JAMES LAKE—ITS PECULIARITIES

James Lake has the most complex basin of any lake whose map or description I have been able to secure. It has three major basins designated first, second, and third, beginning at the south. Snow Lake, lying to the north of the third basin, is really a fourth basin of Lake James, although the channel connecting the third basin and Snow Lake is longer, narrower, and shallower than the channels connecting the other basins. These four basins lie in a great crescent with the convex side to the west (see map). The first and second basins are connected by a channel 800 feet (242 M.) wide and 27 feet (8.2 M.) deep. The channel connecting the second and third basin is 500 feet (152 M.) wide and 30 feet (9.1 M.) deep.

These four primary basins have twenty-one secondary basins or deeps distributed as follows. The first basin has eight, the second five, the third three, the fourth (Snow) five. These secondary basins differ from each other physically, chemically, and biologically. In Table 6 I have selected five pairs that have the same depth. The bottom temperatures of the basins having the same depth differ from .5 degrees C. in basins N and O to 2.8 degrees in basins E and K. This indicates that the basins stratify on different dates. Those with the colder water at the same depth stratify first.

Two factors influence the rate at which oxygen is depleted from the bottom. The higher the temperature and the more organic matter present, the more rapidly the oxygen is reduced. In the pairs CU, BJ, and NO, the temperature is the more potent factor. In the basins GP and EK, the oxygen is lowest at the bottom in the basin of each pair that has the lowest temperature indicating that more organic matter or more easily oxidized material is present in the basin with the minimum temperature.

Date	Station	D	T	O	CO_2	Cb
6-24	G	15	13.1	3.1	3.8	35.78
7-4	P	15	10.6	0	7.50	38.42
7-2	E	17	12.8	2.7	2.84	38.28
6-28	K	17	10.	1.3	7.52	31.82
7-1	C	18	11.7	1.5	4.90	39.30
7-2	U	18	10.0	4.1	4.12	38.78
6-21	B	20	11.7	2.0	1.38	39.18
6-21	J	20	9.2	2.6	1.64	38.42
6-19	N	25	6.7	2.3	3.52	38.92
6-22	O	25	7.2	0	7.70	42.42

TABLE 6. Comparison of Stations of the same depth in James Lake.

PLANKTON

Species	Sta.	0–5	5–10	10–15	15–20
Ceratium	N	2,448	332	284	11
	B	1,105	298	76	93
Dinobryum	N	19,051	288	136	21
	B	3,357	439	149	51
Daphnia	N	4.5	6	4	6
	B	8.	8.8	8.8	12.8
Holopedium	N	113	......	......	......
	B	0	......	......	......
Diaptomus	N	12	84	0	4
	B	8.8	4.8	14.4	10.4
Cyclops	N	13	64	......	5
	B	21.6	3.2	7.2	5.6
Nauplii	N	19	64	......	4
	B	42	29	4	29.6
Melosira	N	7,597	......	231	217
	B	422	51	119	294
Fragillaria	N	9,525	5,040	1,752	1,203
	B	849	772	1,186	2,709
Clathrocyctis	N	11,680	204	......	......
	B	1,809	430	221	264

DISSOLVED GASES

D		T	O	%	CO	Cb
S	N	24.4	6.1	104	0	19.98
	B	24.2	6.0	103	—.25	18.70
20	N	7.3	4.8	....	1.76	19.46
	B	2.	2.0	....	.69	19.59

N—Depth 25 M.—date 6-19-29
B—Depth 20 M.—date 6-21-29
TABLE No. 7. Comparison of Stations N and B James Lake.

LAKE: JAMES, STATIONS E AND U
Date: 7-2-1929—Aug. 1-18 M.

PLANKTON

Species	E	U
Ceratium	1,194	610
Dinobryum	8	74
Aneura	52	35
Polyarthra	13	11
Notholca	20	9
Daphnia	1.7	3.7
Diaptomus	18	14
Cyclops	19	13
Nauplii	19	13
Melosira	210	158
Fragillaria	4,222	3,011
Asterionella	722	389
Anabena	4	....
Clathrocyctis	56	37
Lyngbya	194	483

DISSOLVED GASES

D	Temperature		Oxygen	
	E	U	E	U
S	22.2	22.1	7.1	....
2	22.2	21.7	7.0	....
4	22.2	21.1	7.1	7.1
6	18.9	16.4	7.0	7.07
8	14.7	13.9	6.8	6.7
10	13.7	12.8	5.7	6.2
12	13.3	11.1	4.3	5.5
15	13.1	10.2	3.7	4.3
17	12.8	10.	2.7	4.1

TABLE 8. Comparison of collections taken at stations of the same depth on the same date.

Not only do these basins differ in temperature and the distribution of gases, but the planton is different. In Table 7 Stations N and B are compared. From the bottom temperatures, it is evident that Station N stratified later than Station B. Correlaed with this is a much richer plankton in the former than in the latter. At Station N, Ceratium, Dinobryum, Melosira, Fragillaria, and Clathrocystus are strikingly more numerous than at Station B.

There are 113 Holopedium per liter at N, while it is entirely absent from Station B.

There are two days difference in the dates of the collections at these two stations.

The collections at Stations E and U were made on August 18. The differences here are quite apparent.

Ceratium, the rotifers, and all the phytoplankton were more numerous at E than U, while the reverse was true of Dinobryum and Daphnia.

In this case, as in Stations B and N, the station that had stratified later as indicated by the higher bottom temperature had developed the more plankton.

The epilimnion beyond the littoral is usually regarded as a rather homogeneous association. It appears from these data that it is homogeneous only because the thermocline and hypolimnion beneath it are homogeneous. Where these lower depths are separated by barriers they develop different characteristics. They differ in temperature, in oxygen, in carbonates, and probably in organic matter.

It seems apparent that the lower levels of a lake have a much more intimate relation and direct influence on the epilimnion during the summer stratification than has heretofore been suspected.

I first noted differences in temperature and dissolved gases in the different secondary basin of Webster Lake (Scott, 1916, p. 17). Welch (1927) has noted marked differences in the physical and chemical characteristics of the seven secondary basins of Douglas Lake.

The next problem is the analysis of the biological peculiarities of each basin and their relation to the physical and chemical characteristics of the basin. What influence one basin may have on another is entirely unknown.

RELATION OF DISSOLVED OXYGEN AND CISCO

Early in September, usually between the first and tenth, the "cisco" (Argyrosomus artedi cisco Jordan) come to the surface of Snow Lake, struggle as if in discomfort, and then disappear. They have been described by local observers as "gasping for breath." When they begin to appear a maximum is soon reached, after which the number at the surface is rapidly reduced. The maximum rarely lasts more than a day and the whole phenomenon is over in less than a week. This has been observed on Snow Lake for at least thirty years. It occurs occasionally on the third basin of James Lake.

They have been examined repeatedly for parasites without success.

I suspected that the disappearance of the oxygen from the hypolimnion might be the cause.

In the fall of 1928 cisco were taken from Indian Village Lake, a small lake about four miles southeast of Lake Wawasee (Turkey Lake). A preliminary set of soundings indicated that its maximum depth was near six meters. It was possible that cisco taken in Indian Village Lake in November during the breeding "run" might have come from lakes farther up the chain. There are six lakes in the so-called Indian Village chain.

In 1929 a map was made of Indian Village Lake and the oxygen, carbonates, and temperature determined. The maximum depth was 6.4 meters. Only a trace of oxygen was found below 4 meters. Dr. Ralph Hile then set a 12 foot gill net in the deeper part of the lake, and took fish in the upper 2 feet only of the net.

The fish never appear at the surface except at the breeding "run" in November.

Tippecanoe Lake develops an oxygen "notch" in the thermocline, but the oxygen in the hypolimnion is rarely, if ever, reduced to a level dangerous to the "cisco."

The evidence from Indian Village Lake indicates that the mere disappearance of the oxygen from the hypolimnion causes no discomfort if the oxygen curve maintains a simple sigmoid form. The development of a thermoclinal notch in the oxygen curve is not in itself dangerous. However, if there is a thermoclinal notch developed in the oxygen curve and subsequently the oxygen is exhaused from the lower hypolimnion, the fish will be forced upward by the latter process until they reach the lower part of the thermocline. From this level they move into a region of less oxygen by going either up or down. They are trapped and remain at this level until they approach asphyxia. When they lose control of their hydrostatic apparatus, they float toward the surface. When this occurs in Snow Lake, they have 3 meters above them with little or no oxygèn. This increases their discomfort. Although there is much oxygen in the upper 7 meters the fish float to the surface before they make a complete recovery.

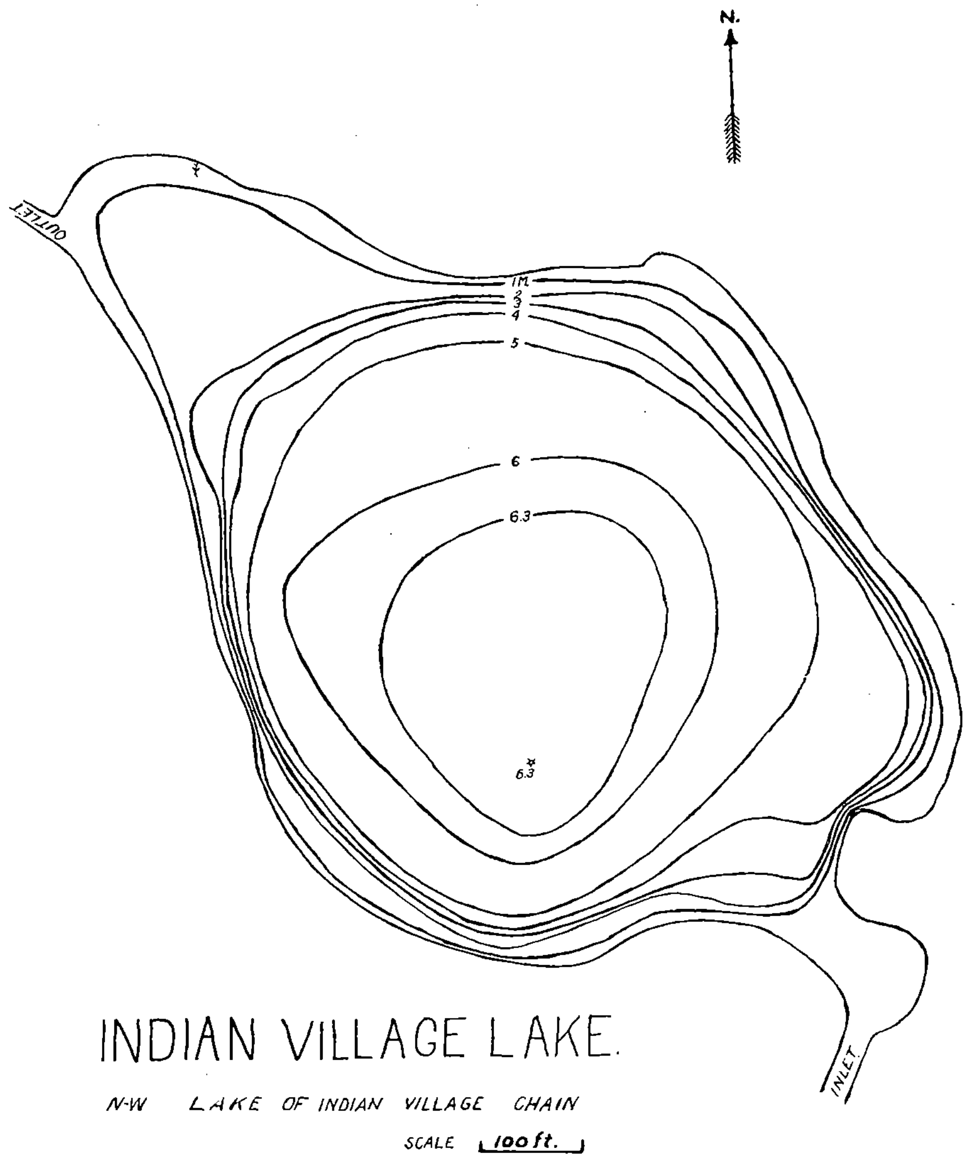

FIG. 2.

In Figure 3, the curve for Tippecanoe Lake has an oxygen notch with plenty of oxygen remaining in the hypolimnion. The curve for Indian Village Lake is a simple sigmoid curve. The curve for Snow Lake dated 9-7-30 shows the notch developed. In the curve for 9-14-29, the water is near oxygen saturation for the first 7 meters. At 8 meters there is approximately one-half as much as at 7. At 9, 10, and 11 meters there is no oxygen but at 12 meters it appears again. This is the point just below the thermoclinal notch. So far high winds have prevented quantitative collections to demonstrate the accumulation of fish just below the thermoclinal notch. After they disappear from the surface they remain in the epilimnion. This has been demonstrated by netting. The other facts connected with this suggestion are well established.

For many years the fish have been gathered with dipnets in Snow Lake during the time when they come to the surface. With hand propelled craft they seem to have held their own. However, the increased us of the outboard motor has resulted in nearly every fish that reaches the surface during daylight hours being captured. The catch in 1929 and in 1930 is reported to be much below the normal. *The present regulation* should probably be modified in order that *sufficient stock be preserved for breeding.*

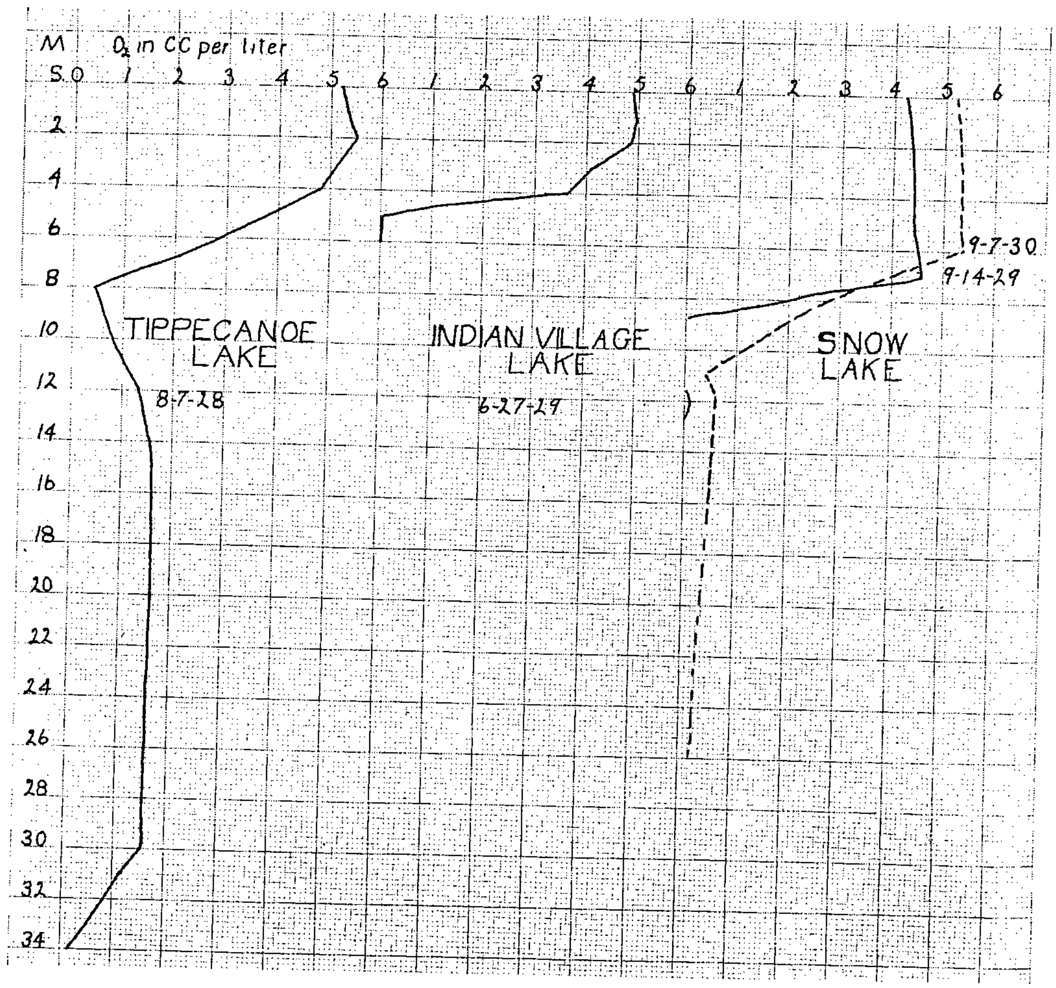

FIG. 3. Oxygen curves for Tippecanoe, Indian Village, and Snow Lakes.

LITERATURE CITED

ATKINS, W. R. G.
1924. The phosphate content of fresh and salt waters in its relation to the growth of the algal plankton. Jour. of Marine Biol. Assoc. 13:119-150.

BANTA, A. M.
1921. Selection in cladocera on basis of a physiological character. Carnegie Inst. of Wash. Pub. 305:1-170.

BIRGE, E. A., AND C. JUDAY.
1911. Inland lakes of Wisconsin. The dissolved gases of the water and their biological significance. Wis. Geol. and Nat. Hist. Surv. Bul. 22:1-259.
1921. Further limnological observations on the Finger Lakes of New York. Bul. Bur. Fish. 37:211-252.
1929. The transmission of solar radiation by the waters of inland lakes. Trans. Wis. Acad. Sci. Arts and Letters 24:510-580.

DOMGALLA, B. P., FRED, E. B. AND PETERSON, W. H.
1926. Seasonal variation in ammonia and nitrate content of lake waters. Jour. Am. Water Works Assoc. 15, No. 4.

DRYER, CHAS. R.
1891. Report on the geology of Steuben County. Ind. Dept. Geol. Nat. Res., 17th Ann. Rept., pp. 114-159.

HJORT, JOHAN.
1914. Fluctuations of the great herring fisheries of northern Europe. Cons. Int. Perm. Exp. Mer. Rap. et Proc., Verb., 20.

LEVERETTE, FRANK, AND TAYLOR, FRANK B.
1915. The Pleistocene of Indiana and Michigan and the history of the Great Lakes. Monog. U. S. Geol. Surv., 53, pp. 1-529.

LITYNSKI, A.
1026. Limnological studies Lake Wigry I. Arch. d. Hydrobiol. et Ichthyol. I:1,2.

RICE, THURMAN B.
1916. A study of the relation between plant growth and combined nitrogen in Winona Lake. Proc. Ind. Acad. Sci. 1916:333-362.

SCOTT, WILL.
1915. Report on the lakes of the Tippecanoe Basin. Ind. Univ. Stud. 31:1-39.

SHELFORD, V. E., AND GAIL, F. W.
1922. A study of light penetration into sea water made with a Kunz photo-electric cell with particular reference to the distribution of plants. Pub. Puget Sound Biol. Sta. 1922:141-176.

THINEMANN, A.
1928. Der Sauerstoff im eutrophen und oligotrophen See. Die Binnengewasser, B. IV, pp. 1-175. Stuttgart.

TUCKER, W. M.
1922. Hydrology of Indiana. Handbook of Indiana Geology, pp. 261-402.

WELCH, PAUL S.
1927. Limnological investigations on northern Michigan lakes. Mich. Acad. Arts, Science, and Letters, 8:421-451.

EXPLANATION OF TABLES

The figures 0-5, 5-10, 10-15, and 15-20 are depth in meters. D—Depth. T—Temperature. O—Oxygen. %—Percent of saturation. CO_2—Carbon-dioxide. Cb—Carbonates.

TABLE 9.

LAKE: ADAMS (LaGrange)
Date: 9/6/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	519	110	17	4
Dinobryum		4		
Aneura	59	21	4	8
Polyarthra	12	4		
Asplancna				4
Noltholca			.8	
Daphnia	4.8	.8	3.2	
Diaptomus	13.6	3.2	1.6	
Cyclops	20.8	10.4	2.4	1.6
Nauplii	12.8	10.4		
Corethra		.8		
Melosira	115	46	17	4
Fragillaria	554	64	81	21
Asterionella				
Anabena	353	76	4	4
Clathrocyctis	2,197	806	174	307
Oscillatoria	1,216	401	123	128
Lyngbya	12			

Dissolved Gases

D	T	O	%	CO_2	Cb	pH
S	22.7	6.52	100	—1.4	25.4	8.3
2	22.4	5.48		—1.6	25.8	
4	22.3	5.27		—2.2	26.2	
6	21.1	4.41		—1.0	26.0	
8	13.	.12		1.4	33.0	
10	10.3	.17		1.6	33.2	
12	9.7	.07		1.6	32.0	
15	8.9	.06		1.4	32.4	
20	8.8	0		2	32.8	
25	8.8	0		3.2	33.0	

TABLE 10.

LAKE: BIG CEDAR (LaGrange)
Date: 9/2/30

Plankton						Dissolved Gases						
Species	0-5	5-8	10-15	15-20		D	T	O	%	CO_2	Cb	pH
Ceratium	1,055	307				S	24.4	5.33		—1.4	31.6	8.3
Dinobryum	465	128				2	24.4	5.88	101	—2.4	31.8	8.2
Aneura	64	64				4	23.8	5.93	191	—2.0	32.4	8.1
Polyarthra	17					6	22.0	2.75		0	33.4	7.6
Noltholca	4.2					8	21.1	.12		0	34.8	7.5
Daphnia	1.6	10										
Ostracoda		8.8										
Diaptomus	20	12										
Cyclops	28	6.4										
Nauplii	30	11.2										
Melosira	8	4										
Fragillaria	3,878	2,235										
Asterionella	4											
Anabena	46											
Clathrocyctis	2,073	1,024										
Oscillatoria	21	21										
Lyngbya												

TABLE 11.

LAKE: BIG CEDAR (Whitley)
Date: 8/12/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium........	4.2	8.5		12.8
Dinobryum......		4.2		
Aneura..........				
Noltholca		12.8	4.2	
Polyarthra				
Asplancna	8.5	4.2		
Hexarthra	4.2		8.5	12.8
Daphnia	2.4	10.4	15	28.8
Diaptomus	5.6	16	.8	
Cyclops	3.2	14.4	14.4	11.2
Nauplii	17	46.9	76	81
Corethra		21	4.2	
Melosira		4.2		
Fragillaria	25	25	64	110
Asterionella		12.8	59	42
Anabena	68	136	29	29
Clathrocyctis	21	298	89	153
Oscillatoria		8.5	4	
Lyngbya	12.7	119	21	12

Dissolved Gases

D	T	O	%	CO_2	Cb
S	26.1	5.38		—1.4	28.8
2	25	5.35		—1.4	29.2
4	24.4	5.69		—1.0	28.2
6	17.7	6.71		—1.4	29.2
8	13.3	7.10		—1.4	31.8
10	10.3	5.97		—1.0	31.8
12	8.8	4.57		.4	32.0
14	7.2	2.90		2.0	31.6
21.5	6.1	40		2,0	31.6

TABLE 12.

LAKE: CENTER
Date: 7/14/29

Plankton — Dissolved Gases

Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	29					S	25	5.48		—.74	30.14
Dinobryum						2	25	5.85	101	—.74	29.90
Aneura	145					4	24.7	.55		4.20	31.14
						5	24.4	0		5.78	32.12
Polyarthra											
Asplancna	42										
Hexarthra	12										
Daphnia											
Bosmina	72										
Ostracod	.8										
Diaptomus											
Cyclops	96										
Nauplii	72										
Corethra	.8										
Melosira	768										
Fragillaria	68										
Tabellaria	12										
Asterionella											
Anabena	51										
Clathrocyctis	1,211										
Oscillatoria	665										
Lyngbya	1,715										

TABLE 13.

LAKE: CENTER
Date: 8/3/29

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	196					S	23.3	3.85		0	30.36
Dinobryum	435					1	23.3	3.79		0	31.36
Aneura	64					2	23.3	3.74		0	30.12
Hexarthra	106					3	22.8	4.05		0	30.36
Polyarthra						4	20.3	0		5.18	31.62
Noltholca	4					5	18.9	0		6.96	33.96
Asplancna	119										
Daphnia	2.4										
Bosmina	110										
Ostracod	8.8										
Diaptomus	2.4										
Cyclops	208										
Nauplii	123										
Melosira	580										
Fragillaria	537										
Asterionella	17										
Anabena	38										
Clathrocyctis	1,111										
Oscillatoria	533										
Lyngbya											

TABLE 14.

LAKE: CROOKED (Steuben)
Date: 7/5/29

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	780	243	21	25		S	22.2	5.5		0	24.62
Dinobryum	55	21	4			2	22.2	5.5		0	24.14
Aneura	12.8	21		8.5		4	21.7	5.6		0	24.14
Polyarthra						6	18.3	5.0		0	24.88
Noltholca	8.5	8	8.5			8	15.6	2.0		3.72	27.86
Asplancna	12.8		8.5								
Hexarthra	17	8									
Daphnia	14	4	1.6	4		10	13.1	2.1		3.72	27.86
Ostracod	4.2					12	11.5	2.9		3.98	28.36
						15	10.4	2.1		3.98	27.86
Diaptomus	35	.8	.8								
Cyclops	8	4.8	.8	11							
Nauplii	29	17	4.2	4		20	10.6	1.4		4.86	27.86
						23	10.4	.84		5.22	28.10
Melosira	72	243	192	862							
Fragillaria	315	119	81	25							
Asterionella	76	29	12	4							
Anabena											
Clathrocyctis	524	311	55	162							
Oscillatoria	8	72	21	29							
Lyngbya											

TABLE 15.

LAKE: CROOKED (Whitley)
Date: 7/30/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	692	217	17	42
Dinobryum	4			
Aneura			4.2	
Polyarthra				
Noltholca	34			
Asplancna	5			
Hexarthra	8	4		4
Daphnia	8	3	2.4	3.2
Diaptomus	16	3	2.4	
Cyclops	1.6	7	2.4	3.8
Nauplii	4	8	4.2	4.2
Corethra				18
Melosira	34	64	140	128
Fragillaria	516	166	51	51
Asterionella	85	136	51	4
Anabena				
Clathrocyctis	866	507	264	183
Oscillatoria	162	42	29	34
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	26.7	5.84	103	0	22.92
2	26.1	5.89	103	0	22.44
4	23.9	6.11	103	0	23.42
6	21.1	4.44		2.44	23.18
8	16.7	.30		6.82	27.56
10	13.3	.61		5.02	28.54
12	11.7	1.33		4.88	26.84
15	10.9	.87		6.34	27.56
20	10.6	0		7.80	28.78
21	10.6	0		5.84	28.78

TABLE 16.

LAKE: CROOKED (Whitley)
Date: 8/15/30

Plankton

Species	0-5	5-10	10-30	15-30	
Ceratium	55	42	4		
Dinobryum	8				
Aneura			166		
Polyarthra	102		46		
Noltholca		12.8	17		
Daphnia	.8	2.4	1.6		
Holopedium	4	4	.8		
Diaptomus	21	16	9.6		
Cyclops	22	12	29.6		
Nauplii	11.2	2	61		
Melosira		4.2			
Fragillaria	8.5	4.2			
Asterionella					
Anabena					
Clathrocyctis	785	1,147	354		
Oscillatoria	64	29	13		
Lyngbya					

Dissolved Gases

D	T	O	%	CO_2	Cb
S	26.1	5.56		—1.4	25.8
2	25	5.54		—1.0	25.8
4	24.4	5.28		—1.0	25.8
6	21.6	5.28		—1.6	25.8
8	13.5	5.15		—1.0	25.2
10	10	8.40	108	—1.4	29.0
12	8.5	7.29		—1.0	29.2
15	7.5	4.76		0	29.2
20	6.6	4.0		1.0	27.2
25	6.1	3.23		1.0	29.6
30	6.1	1.63		2.4	29.6

TABLE 17.

LAKE: CLEAR (Steuben)
Date: 7/15/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	965	596	34	17
Dinobryum	64	25		
Aneura	9.6	3.2	3.2	4
Polyarthra			.8	1.6
Noltholca			.8	1.6
Triarthra			3.2	5.6
Daphnia	2.4	2.4	1.6	.8
Holopedium	1.6	.8		
Diaptomus	20	10	14	13.6
Cyclops	26	18	6	2.4
Nauplii	56	28	2.4	7.2
Melosira	328	3,672	132	114
Fragillaria				
Asterionella				
Anabena				
Clathrocyctis	2,406	529	104	136
Oscillatoria	64		4	
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	24.2	6.37	107	.02	24.96
2	23.7	6.51	107	.98	24.46
4	23.3	6.56	110	.98	24.98
6	21.1	6.57	107	.74	24.70
8	15.2	9.65	139	1.72	24.18
10	12.7	5.79		1.62	27.18
12	11.7	4.16		2.96	26.92
15	11.1	3.30		2.70	27.98
20	10.6	2.77		2.94	27.42
25	10.6	2.48		2.94	26.68
30		1.65		2.94	27.18
32	10.2				

TABLE 18.

LAKE: CLEAR
Date: 8/5/29

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	320	72	25	8		S	22.2	5.65		—.98	24.40
Dinobryum	4					2	22.2	5.82		—.98	23.90
Aneura	76	32	21	17		4	22.	5.88		—.74	24.40
Polyarthra			4			6	21.7	5.79		—.74	24.14
Noltholca	.8			4		8	14.7	9.38	134	—1.74	26.38
Daphnia	1.6	4	1.6	3.2		10	12.5	4.25		2.98	27.38
						12	11.7	2.44		3.48	27.62
						15	10.9	1.60		4.22	28.38
Diaptomus	2.4	16.8	15	8.8							
Cyclops	6.4	10.4	5.6	5.6							
Nauplii	16.8	10.2	11	5.6		20	10.6	1.19		4.72	27.38
Melosira	68	12	46	128							
Fragillaria	46	17	17	12		25	1.6	.70		4.98	28.62
Asterionella											
Anabena	106	25	8								
Clathrocyctis	3,200	473	273	93		30		.08		5.72	28.18
Oscillatoria	153	136	102	68		32	10.4				
Lyngbya	537	1,036	209								

TABLE 19.

LAKE: FOX

Date: 7/10/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	891	234	145	
Dinobryum	8.5	8		
Aneura	12			
Polyarthra Asplancna	25	12.8	4.2	
Daphnia	4 .	4.8	5.6	
Diaptomus	20		2.4	
Cyclops	8		.8	
Nauplii	25			
Corethra		192		
Melosira	51	12	8	
Fragillaria	17	85	349	
Asterionella	4	4	17	
Anabena	102		4	
Clathrocyctis	1,262	550	422	
Oscillatoria	686	256	8	
Lyngbya	31,091			

Dissolved Gases

D	T	O	%	CO_2	Cb
S	24.4	6.2	106	1.22	26.42
2	24.2	6.2	106	.72	25.92
4	21.9	6.2	102	.96	25.68
6	15.0	8.6	123		39.28
8	12.8	1.8		4.40	31.06
10	11.1	.32		6.84	32.28
12	11.1	0		7.32	32.52
15	11.1	0		6.10	33.12
17.5	10.8	0		5.12	33.12

TABLE 20.

LAKE: GAGE
Date: 7/6/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	477	128	140	46
Dinobryum	1,710	46	499	72
Aneura	8	38	42	
Hexarthra	29	4.2	17	4.2
Polyarthra				
Noltholca	25	42	34	17
Asplancna	21			4.2
Daphnia	13	5.6	.8	.8
Bosmina	1.6			
Diaptomus	36	4.8	1.6	
Cyclops	16	24	3.2	1.6
Nauplii	55	12.8	4	
Corethra		1.6	.8	
Melosira	157	4	55	25
Fragillaria	857	170	392	157
Asterionella	106		17	4.2
Anabena	42	12		
Clathrocyctis	1,608	302	226	38
Oscillatoria				
Lyngbya	1,220	74,133	1,933	200

Dissolved Gases

D	T	O	%	CO_2	Cb
S	22.2	5.9		.98	28.86
2	22.2	5.9		.48	28.60
4	20.9	6.1		.48	28.60
6	20.6	6.0		.48	28.60
8	14.4	11.2	158	2.98	28.86
10	12.5	4.3		2.48	29.34
12	11.5	4.0		4.96	30.34
15	10.9	.03		4.46	31.48
21.5	10.6	0		5.46	31.48

TABLE 21.

LAKE: GAGE
Date: 8/3/29

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium		153.6	51	51		S	24.4	5.31		0	26.64
Dinobryum		332.8	332	92		2	24.4	5.16		0	27.63
Aneura		45	10	15		4	23.9	5.17		0	26.89
Polyarthra						6	20.4	5.05		0	27.39
Noltholca		81.9	20	5		8	15	10.64	153	—1.24	24.65
Daphnia		7.6				10	12.8	1.31		3.98	29.88
Asplancna		35				12	11.7	.27		5.00	30.37
Diaptomus		.9		.9		15	11.1	0		4.98	30.87
Cyclops		4.8	8	.9							
Nauplii		29.4	5	.9							
Corethra		2	5			21	10.6	0		8.46	39.54
Melosira		225	122	9.2							
Fragillaria		40	5	20							
Asterionella		35									
Anabena		5									
Clathrocyctis		97	302	97							
Oscillatoria				5							
Lyngbya		43,950	936	424.9							

TABLE 22.

LAKE: GEORGE
Date: 7/8/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	2,056	413	59	8
Dinobryum	93	17	4	
Aneura	8.5	4.2		
Noltholca		8.5		
Polyarthra				
Asplancna	8.5			
Hexarthra	34	4.2		
Daphnia	1.6	9.6	23	6
Diaptomus	17	12	3	
Cyclops	3.2	2.4	4.8	2
Nauplii	34	8	17	3
Corethra		1		
Melosira	55	25	85	64
Fragillaria	1,373	149	136	17
Asterionella	34	8	29.8	4
Anabena				
Clathrocyctis	469	597	213	123
Oscillatoria	110	51	21	17
Lyngbya Spir	21	8	8	

Dissolved Gases

D	T	O	%	CO_2	Cb
S	23.35	5.7			30.60
2	23.1	5.7			28.86
4	23.0	5.7			28.60
6	21.1	5.4			29.34
8	15.9	4.2		1.76	31.94
10	13.9	4.1		3.22	32.34
12	12.5	3.2		2.72	30.60
15	12.0	2.0		5.96	33.32
20	11.1	1.2		4.26	33.32
25	11.1	.93		5.46	33.08

TABLE 23.

LAKE: GEORGE
Date: 8/2/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	341	42	12.8	34
Dinobryum	29			
Aneura	28	59	2.4	
Polyarthra	2	1.6		
Daphnia	.8	2.4	1.6	5.6
Holopedium	.8		–	
Diaptomus	4.8	11.2	.8	4
Cyclops	6.4	13.5	3.2	4.8
Nauplii	16		2.4	4
Corethra			.8	
Melosira				
Fragillaria	1,211	281	133	93
Asterionella				
Anabena				
Clathrocyctis	859	1,156	1,830	204
Oscillatoria				
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	25.6	6.22	108	0	27.62
2	25.4	6.36	111	0	27.38
4	25.4	6.02	105	0	28.12
6	21.7	5.21		0	28.88
8	17	1.45		3.98	30.86
10	13.9	2.01		4.22	31.86
12	12.5	1.62		5.98	32.36
15	11.7	.41		5.98	33.00
20	11.1	.06		6.72	33.36
25	11.1	.10		6.42	34.86

TABLE 24.

LAKE: GOLDEN
Date: 7/25/29

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	891	153.6				S	26.1	5.07		3.18	46.0
Dinobryum	46	93				2	23.9	4.92		4.42	48.6
Aneura	81	17				4	18.9	.89		13.28	46.74
Polyarthra						6	13.7	.09		13.76	48.70
Noltholca	123	8									
Asplancna	85	4									
Hexarthra	34					9.5	11.7	0		18.44	63.46
Daphnia	25	5									
Diaptomus	3										
Cyclops	16										
Nauplii	48	8									
Pediastrum	8.5										
Melosira	3,784	878									
Fragillaria	6,417	768									
Asterionella	9,975	2,551									
Anabena											
Clathrocyctis	405	145									
Oscillatoria	1,331	29									
Lyngbya	550	102									

TABLE 25.

LAKE: HAMILTON
Date: 7/11/29

Plankton

Species	0-5	5-10	10-15	15-19
Ceratium	729	64	25	17
Dinobryum	51	4		
Aneura	85	17	4	
Hexarthra	46.9			
Polyarthra				
Noltholca	8.5	4		
Asplancna	42	17		29
Triarthra	4.2			4
Daphnia	7.5	14	6	8.8
Pediastrum		8.5		
Diaptomus	28	4.8		
Cyclops	2	12	13	
Nauplii	123	49		15
Melosira	209	243	192	64
Fragillaria	4,501	823	460	260
Asterionella	307	72	4	
Anabena	273	4		
Clathrocyctis	3,426	964	354	217
Oscillatoria	42	8	21	
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	24.4	7.1	122	1.22	26.44
2	24.4	7.1	122	.98	25.20
4	23.1	6.3	105	.48	25.96
6	18.9	4.3		.98	27.18
8	14.4	1.42		5.18	28.66
10	13.6	1.28		6.92	29.64
12	13.3	1.20		6.92	29.64
15	12.5	.7		6.16	29.64
19	11.7	.0		9.62	30.38

TABLE 26.

LAKE: HAMILTON
Date: 7/31/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	174	25	4.6	12
Dinobryum	2.8			
Aneura				
Polyarthra				4.6
Daphnia pulex	1	4		1.6
D. retrocurva	28			
Diaptomus	4		5.6	
Cyclops	8.8	17	4.8	2.4
Nauplii	61	40		7.2
Melosira	51	102	21	
Fragillaria	256	68		46.9
Asterionella	38	89	12.8	12.8
Anabena	332	38		
Clathrocyctis	3,306	1,079	294	273
Oscillatoria	17			
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	27.2	6.48	116	—.72	24.40
2	26.9	6.47	115	—.48	23.42
4	23.9	6.08	103	0	24.4
6	20	2.74		2.68	26.58
8	15.4	.31		5.60	28.78
10	13.9	.31		8.28	29.76
12	13.3	.06		6.40	30.00
15	12.8	0		7.32	29.02
19	11.7	0			

TABLE 27.

LAKE: HOG

Date: 7/23/29

Plankton

Species	0-5	5-9	10-15	15-20
Ceratium	1,058	268		
Dinobryum	4,151	529		
Aneura	8			
Polyarthra				
Asplanena	51	25		
Hexarthra	128	21		
Daphnia	5.6	4.8		
Diaptomus	6.4	4.8		
Cyclops	12	4.8		
Nauplii	24.8	28		
Melosira	17	12		
Fragillaria	2,124	419		
Asterionella		8		
Anabena		4		
Clathrocyctis	1,356	435		
Oscillatoria				
Lyngbya		268		

Dissolved Gases

D	T	O	%	CO_2	Cb
S	26.6	5.98	106	0	27.80
2	26.6	5.76	102	0	28.24
4	23.9	6.25	106	0	28.60
6	19.4	5.21		3.40	31.32
9	13.3	.34		6.62	38.54

TABLE 28.

LAKE: HOG BACK.
Date: 7/24/29

Plankton						Dissolved Gases					
Species	0-5	5-8	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	3,741	567				S	24.7	4.90		0	40.28
Dinobryum	89	21				2	23.6	5.01		0	40.74
Aneura	179	12.8				4	19.4	.54		5.90	42.44
Polyarthra		51				6	14.4	0		12.02	44.94
Hexarthra	46	4									
Noltholca	140					8	13.9	0		16.78	48.12
Asplancna	200	25									
Daphnia	40	3									
Diaptomus	4.8	.8									
Cyclops	56	1.6									
Nauplii	115	12.8									
Melosira	4,906	503									
Fragillaria	1,463	512									
Tabellaria	55										
Asterionella	13,644	2,990									
Anabena	34										
Clathrocyctis	1,288	277									
Oscillatoria		213									
Pediastrum	38										
Lyngbya	3,946	750									

TABLE 29.

LAKE: JAMES LAKE, Station N.
Date: 6/19/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	2,448	332	284	11
Dinobryum	19,051	288	136	21
Aneura	25	3	7	12
Triarthra				8
Polyarthra		1		
Noltholca	1		2	
Asplancna				1
Daphnia	4.5	6	4	6
Holopedium	113			
Diaptomus	12	89		4
Cyclops	13	64		5
Nauplii	19	64		4
Melosira	7,597		236	217
Fragillaria	9,525	5,040	1,752	1,203
Asterionella	567	226	106	196
Anabena				179
Clathrocyctis	11,680	204		
Oscillatoria	226		12	
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	24.4	6.1	104		39.96
2	23.3	6.2	104		38.42
4	20.8	6.5	105		37.92
6	17.8	6.8	103		37.40
8	13.75	6.3		1.26	38.92
10	12.8	5.1		1.50	38.92
12	11.4	5.4		1.50	37.92
15	10	5.2		1.50	38.92
20	7.3	4.8		1.50	38.42
25	6.7	2.3		3.52	38.92

TABLE 30.

LAKE: JAMES, Station B.
Date: 6/21/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	1,105	298	76	93
Dinobryum	3,357	439	149	51
Aneura	42	4.2	17	49
Hexarthra			4.2	
Polyarthra				4.2
Noltholca	8	12.8	4	4.8
Triarthra		8.5	1.6	12
Asplancna				4.2
Daphnia	8	8.8	8.8	12.8
Diaptomus	8.8	4.8	14.4	10.4
Cyclops	21.6	3.2	7.2	5.6
Nauplii	42	29	4	29.6
Melosira	422	51	119	294
Fragillaria	849	772	1,186	2,769
Asterionella	273	435	362	593
Anabena				
Clathrocyctis	1,809	430	221	264
Oscillatoria	38	55	221	12
Lyngbya	558	98	72	25

Dissolved Gases

D	T	O	%	CO_2	Cb
S	24.2	6.0	103	—.50	37.40
2	23.9	6.1	104	—.74	36.90
4	21.4	6.3	103	—.74	36.40
6	16.9	6.4		—.50	37.66
8	14.4	6.1		0	37.40
10	14.2	5.8		1.50	38.42
12	13.3	4.7		.50	37.66
15	13.1	4.0		.62	37.92
20	11.7	2.0		1.38	39.18

TABLE 31.

LAKE: JAMES, Station I.
Date: 6/26/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	2,321	422	179	51
Dinobryum	977	166	17	21
Aneura	38	17	38	51
Polyarthra				
Noltholca	12	8	8	
Triarthra	4		8	21
Hexarthra	4	4	8	
Daphnia	20	4	7.2	8
Diaptomus	15	11	10	4.8
Cyclops	82	6	9	4.8
Nauplii	11	34	6	11.2
Corethra		.8	[illegible]	
Melosira	64	68	102	435
Fragillaria	2,180	1,326	1,258	2,112
Asterionella	256	422	170	136
Anabena				
Clathrocyctis	5,491	1,160	516	733
Oscillatoria	81	64	8.5	46
Lyngbya	226	631	388	51

Dissolved Gases

D	T	O	%	CO_2	Cb
S	23.3	6.3	106	1.21	35.76
2	23.3	6.4	108	.98	35.76
4	20.6	7.2	116	.72	35.76
6	16.7	7.4	110	0	36.0
8	13.9	6.9		.98	36.50
10	12.8	5.9		2.20	36.50
12	11.7	4.8		4.40	37.91
15	10.3	5.4		3.42	36.74
20	8.9	2.6		4.90	37.24
22	8.9	1.5		5.62	37.24

TABLE 32.

LAKE: JAMES, Station E.
Date: 7/2/29

Plankton

Species	0-18	5-10	10-15	15-20
Ceratium	1,194			
Dinobryum	8			
Aneura	52			
Polyarthra	13			
Noltholca	20			
Daphnia	1.7			
Diaptomus	18.7			
Cyclops	19.5			
Nauplii	19.3			
Melosira	210			
Fragillaria	4,222			
Asterionella	722			
Anabena	4			
Clathrocyctis	56			
Oscillatoria				
Lyngbya	194			

Dissolved Gases

D	T	O	%	CO_2	Cb
S	22.2	7.1	116	—1.55	36.21
2	22.2	7.0	116	—1.03	36.72
4	22.2	7.2	116	—1.03	36.46
6	18.9	7.0	109	0	36.98
8	14.7	6.8		1.29	37.76
10	13.7	5.7		1.81	38.03
12	13.3	4.3		3.10	38.53
15	13.1	3.7		2.30	38.02
17	12.8	2.7		2.84	38.28

TABLE 33.

LAKE: JAMES, Station U.
Date: 7/2/29

Plankton						Dissolved Gases					
Species	0-18	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	610					S	22.1				
Dinobryum	74					2	21.7				
Aneura	35					4	21.1	7.01	114	—1.03	37.50
Polyarthra	11					6	16.4	7.07	104	— .26	38.02
Noltholca	9					8	13.9	6.7		1.03	39.05
Daphnia	3.7					10	12.8	6.2		1.55	39.57
						12	11.1	5.5		1.81	38.02
Diaptomus	14					15	10.2	4.3		3.10	38.28
Cyclops	13					18	10	4.1		4.13	38.79
Nauplii	13										
Melosira	158										
Fragillaria	3,011										
Asterionella	389										
Anabena											
Clathrocyctis	37										
Oscillatoria											
Lyngbya	483										

TABLE 34.

LAKE: JAMES, Station M.
Date: 7/4/29

Plankton / Dissolved Gases

Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	648					S	21.4				
Dinobryum	76					2	21.4				
Aneura	39					4	21.4	6.2	101	—.75	37.16
Polyarthra	14					6	18.9	6.0		—.50	36.90
Noltholca	11					8	14.7	6.3		1.26	37.66
Daphnia	4					10	13.7	5.4		1.76	39.67
						12	11.7	4.7		1.76	37.66
						15	10	3.7		2.52	38.42
Diaptomus	13.9										
Cyclops	12.6					19	9.7	3.2		3.53	39.17
Nauplii	27.0										
Melosira	176										
Fragillaria	3,450										
Asterionella	436										
Anabena	1										
Clathrocyctis	90										
Oscillatoria	34										
Lyngbya	614										

TABLE 35.

LAKE: JAMES, Station N.
Date: 8/6/29

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	1,271	234	85	140		S	22.8	5.90		0	34.36
Dinobryum	21	17	4			2	22.2	5.80		0	33.86
Aneura	243	38		12		4	22.2	5.90		0	32.10
Polyarthra	12					6	20.9	5.74		0	32.16
Noltholca		4	4			8	15.5	5.79		.98	37.10
Daphnia	4	6	2.4	2.4		10	13.3	3.59		3.22	38.34
						12	11.7	2.71		4.22	37.58
						15	10.6	2.59		5.22	38.34
Diaptomus	3.2	4.8		8							
Cyclops	18.4	12	2.4	5.6							
Nauplii	53.6	15.2	4	5.6		20	8.3	2.77		5.46	38.34
Melosira	42	42	25	38							
Fragillaria	533	315	149	179		25 26	7.1	.06		7.96	40.08
Asterionella											
Anabena	21	51		12							
Clathrocyctis	256	793	170	64							
Oscillatoria	183	332	76	128							
Lyngbya											

TABLE 36.

LAKE: JAMES, Station L.
Date: 8/7/29

Plankton						Dissolved Gases					
Species	0-5	5-12	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	115	136				S	22.2	5.82		0	35.10
Dinobryum	8.5	21				2	22.2	5.66		0	34.60
Aneura	42	.8				4	22.2	5.73		0	34.10
Polyarthra						6	21.7	5.36		0	34.10
						8	15.3	4.0		2.72	37.34
Daphnia	14	9.6				10	13.7	2.54		4.72	39.08
						12	11.9	2.43		4.48	38.34
Diaptomus	5.6	9.6									
Cyclops	29.6	16									
Nauplii	64	12.8									
Melosira	25	17									
Fragillaria	149	213									
Asterionella		4									
Anabena	8										
Clathrocyctis	55	388									
Oscillatoria	149	46									
Lyngbya	4	59									

TABLE 37.

LAKE: JAMES, Station B.

Date: 8/7/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	435	256	68	42
Dinobryum	12			
Aneura	85	25	8.5	8.5
Hexarthra		12.8		
Polyarthra				
Noltholca	4			
Triarthra			4.2	
Daphnia	4	3.2		
Diaptomus	7	8.8	10	.8
Cyclops	8	7.2	5.6	1.6
Nauplii	34	29	4	.8
Corethra			4	
Melosira	68	25	17	12.8
Fragillaria	209	285	72	119
Asterionella				
Anabena				
Clathrocyctis	563	742	247	226
Oscillatoria	64	42	21	46
Lyngbya	59	90	8	17

Dissolved Gases

D	T	O	%	CO_2	Cb
S	22.5	5.70		0	34.98
2	22.2	5.94		0	34.22
4	22.2	5.33		0	33.86
6	21.4	5.51		0	34.48
8	16.1	4.43		3.98	38.08
10	13.9	2.35		4.72	39.08
12	13.3	1.34		4.98	38.08
15	13.3	.58		6.22	38.34
20	12.2	.09		6.22	39.58

TABLE 38.

LAKE: JAMES, Station J.
Date: 8/8/29

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	465	200	51	12		S 2	22.8 22.8	5.99 6.09	100 102	0 0	34.60 33.10
Dinobryum	12		4			4	22.5	5.68		0	33.36
Aneura	42	8	8	17		6	20	5.35		0	33.86
Polyarthra Noltholca	4.2		4	8		8	15.6	4.32		.24	33.84
Hexarthra	4.2					10	13.1	3.68		4.72	38.58
Daphnia	14.4	4	.8	14		12	11.9	2.97		4.48	37.84
						15	10.3	2.70		6.72	37.34
Diaptomus	13	9.6	4.8	8							
Cyclops	32	6.4	6.4	5.6		20 21	8.9	.13		7.96	39.58
Nauplii	16	4.8	2.4	2.4							
Melosira	68	8	46	64							
Fragillaria	196	149	55	81							
Asterionella	8	4									
Anabena	29										
Clathrocyctis	435	1,181	516	554							
Oscillatoria	776	25	25	17							
Lyngbya	12	25	17	17							
Synedra			17	4							

TABLE 39.

LAKE: JAMES, Station I.
Date: 8/9/29

Plankton						Dissolved Gases					
Species	0-23	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	345					S	23	6.12	102	0	34.12
Dinobryum						2	23	6.01	101	0	33.62
Aneura	41					4	22.6	6.24	104	0	33.38
Polyarthra Noltholca	4.7 7.1					6	20.9	5.70		0	33.62
						8	15	4.05		4.0	27.30
Daphnia	5.9					10	13.3	3.80		5.14	29.02
						12	11.9	2.58		5.88	37.56
Diaptomus	9.9					15	10	2.12		5.88	38.54
Cyclops	16.9										
Nauplii	12.8										
Melosira	58					23	8.6	.17		8.34	40.26
Fragillaria	402										
Asterionella											
Anabena	2										
Clathrocyctis	48										
Oscillatoria	42										
Lyngbya	61										

TABLE 40.

LAKE: JAMES, Station N.
Date: 8/14/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	887	149	55	21
Mallomonas	4		8.5	
Dinobryum	21	8	4	
Aneura	149	29	4	17
Polyarthra	29	51		
Noltholca		12		4
Asplancna	4			
Daphnia		6.4	.8	4
Diaptomus	14	20	.8	1.6
Cyclops	47	12	2.4	3.2
Nauplii	857	7	.8	9.6
Melosira	81	51	12	46
Fragillaria	529	247	38	
Asterionella				
Anabena	12	8	4	
Clathrocyctis	588	337	64	59
Oscillatoria	81	136	25	59
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	24.4	5.42		—1.2	33.2
2	23.6	5.45		—2.4	35.6
4	23.3	5.39		—2.6	34.8
6	23.3	5.13		—2.0	35.6
8	15	3.67		0	40.0
10	11.5	3.25		1.0	41.4
12	9.1	2.97		1.0	40.8
15	8.1	2.71		1.0	41.4
20	6.6	2.44		1.4	41.4
25	6.1	.08		1.4	42.8

TABLE 41.

LAKE: JAMES (3rd Basin)
Date: 8/22/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	1,032	204	145	145
Mallomonas	140	17	17	
Dinobryum	34	12	21	
Uroglea	89	29		8
Aneura	68	46	29	46
Difflugia	138		17	25
Polyarthra	21	4		
Noltholca	12		21	34
Daphnia	4.8	1.6	2.4	10.4
Diaphanosoma	2.4	2.4		3.2
Diaptomus	27	7.2	8.8	14
Cyclops	25	26.4	12.8	18.4
Nauplii	56	11.2	23.2	26.4
Melosira	174	76	136	140
Fragillaria	840	282	187	174
Asterionella				
Anabena	46	8.5	4	
Clathrocyctis	465	541	401	264
Oscillatoria	106	17	25	128
Lyngbya	132		46	81

Dissolved Gases

D	T	O	%	CO_2	Cb	pH
S	22.2	5.71		—1.4	34.4	8.3
2	22.2	5.80		—2.0	34.6	8.3
4	22.2	5.92		—1.4	34.0	8.3
6	22.2	5.83		—2.0	33.8	8.3
8	15.2	5.61		.4	35.8	7.8
10	11.6	2.90		.6	40.4	7.6
12	9.4	2.72		1.0	41.0	7.6
15	7.9	2.11		1.6	40.4	7.5
20	7.2	2.45		2.0	40	7.5
25	6.2	.06		2.4	41.4	7.2

TABLE 42.

LAKE: JAMES (3rd Basin)
Date: 8/30/30

Plankton						Dissolved Gases						
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb	pH
Ceratium						S	23.3	5.71		—2.2	33.8	8.3
Dinobryum						2	23	6.42	107	—2.4	33.6	
Aneura						4	22.4	6.07	101	—2.6	34.4	
Polyarthra						6	21.6	5.73		—2.0	34.4	
						8	16.1	3.39		1.2	37.8	
Daphnia						10	11.7	2.56		2.8	40.4	
						12	9.7	2.07		2.8	44	
						15	7.8	2.18		2.8	40.4	
Diaptomus												
Cyclops												
Nauplii						20	6.9	2.42		2.0	40.4	
Melosira						25.5	6.2	.10		2.8	43.6	7.5
Fragillaria												
Asterionella												
Anabena												
Clathrocyctis												
Oscillatoria												
Lyngbya												

TABLE 43.

LAKE: JAMES (3rd Basin)

Date: 9/7/30

Plankton

Species	0-5	5-10	10-15	15-25
Uroglea	691	81		
Ceratium	1,484	328	106	145
Dinobryum	55	29	4	
Mallomonas	110	34	17.1	21
Aneura	85	8	4.2	59
Polyarthra		38	17.1	12
Triarthra	12.8			
Noltholca		8	8.5	8
Daphnia	4	1.6	7.2	6.2
Bosmina	2.4			
Diaphanosma		.8	12.8	.8
Diaptomus	4.8	8		
Cyclops	16.8	9.6	8	5.6
Nauplii	21.6	10.8	12.8	9.6
Melosira	85	72	81	85
Fragillaria	1,766	814	405	192
Asterionella				
Anabena	354	25	46	
Clathrocyctis	98	477	106	264
Oscillatoria	106	72	72	46
Lyngbya		166		

Dissolved Gases

D	T	O	%	CO_2	Cb
S	22.2	5.88		—1.6	33.4
2	22.2	6.11	101	—1.6	34.2
4	22.2	6.06	100	—2.4	32.8
6	21.6	5.82		—2.4	32.8
8	16.1	3.70		0	35.6
10	11.6	2.10		.4	37.0
12	10	1.95		1.4	39.6
15	8.0	1.76		1.4	41.0
20	6.9	1.72		2.0	42.0
25	6.6	.07		2.4	42.0

TABLE 44.

LAKE: JAMES (3rd Basin) N.
Date: 9/20/30

Plankton

Species	0-5	5-10	10-15	15-20
Difflugia	59	17	17	
Ceratium	704	311	81	76
Uroglea	302	38	12	8
Dinobryum	132	46	17	30
Mallomonas	21	33	25	8
Aneura	81	61	34	38
Polyarthra	34		12	
Noltholca	4.2			8
Asplancna	4.2			
Daphnia	.8	.8	2.4	2.4
Bosmina		.8		
Diaphanosoma		1.6		
Diaptomus	.8	13.6	4	4
Cyclops	7.2	14.4	9.6	3.2
Nauplii	14.4	13.6	14.4	8
Melosira	64	38	38.4	30.8
Fragillaria	1,339	1,651	494	264
Asterionella				
Anabena	21		8.5	
Clathrocyctis	252	512	166	187
Oscillatoria	140	93	17	30
Lyngbya	115	106	57	

Dissolved Gases

D	T	O	%	CO_2	Cb
S	21.1	5.11		—1.25	33.4
2					
4					
6	20.5	5.56		0	33.4
8	16.3	4.21		1.0	34.8
9	13.8				
10	12.2	1.19		7.10	50.4
12	9.4	1.10		1.50	40.0
15	8	1.61		3.02	40.4
20	7.0	1.55		3.02	40.4
24.5	6.6	.12		4.06	41.8

TABLE 45.

LAKE: JIMMERSON

Date: 7/19/29

Plankton

Species	0-5	5-10	10-17	15-20
Ceratium	2,205	588	76	
Dinobryum	302	46	4	
Aneura	247	51	8	
Polyarthra				
Noltholca				
Asplancna	4.2	12	4	
Hexarthra	59	29	8	
Daphnia	6.4	6	2.4	
Bosmina	.8			
Diaptomus	8	33		
Cyclops	21.6	14	1.6	
Nauplii	46	34	4.8	
Corethra	.8			
Melosira	136	136	85	
Fragillaria	3,200	1,557	242	
Asterionella	55	29	12	
Anabena	8	8		
Clathrocyctis	682	576	614	
Oscillatoria	72	21	17	
Lyngbya	115	413	136	

Dissolved Gases

D	T	O	%	CO_2	Cb
S	24.4	5.57		0	33.10
2	24.4	5.57		0	32.62
4	24.2	4.53		0	32.38
6	17.2	4.99		2.70	34.10
8	13.9	3.26		2.70	37.56
10	12.2	1.77		4.94	39.54
12	11.1	.47		6.92	38.54
17	10	.06		5.68	39.56

TABLE 46.

LAKE: LONG (Steuben)
Date: 7/25/29

Species	0-5	5-9	10-15	15-20		D	T	O	%	CO_2	Cb
	Plankton					Dissolved Gases					
Ceratium	1,493	362				S	24.4	5.33		4.18	47.72
Dinobryum	435	119				2	21.9	5.24		5.40	48.94
Aneura	119	29				4	17.2	1.16		7.04	49.44
Polyarthra						6	14.4	.11		11.56	47.46
Noltholca	29	12				8					
Hexarthra	4	4									
Daphnia	48	1.6				9.5	12.2	0		15.74	57.06
Diaptomus	14	1.6									
Cyclops	24	2.4									
Nauplii	68	10									
Melosira	10,146	2,986									
Fragillaria	8,072	3,566									
Asterionella	4,962	4,232									
Anabena											
Clathrocyctis	170	64									
Oscillatoria											
Lyngbya	998	298									

TABLE 47.

LAKE: LOON
Date: 7/26/29

Plankton

Species	0-4	5-10	10-15	15-20
Ceratium	823			
Dinobryum	17			
Aneura	174			
Polyarthra				
Triarthra	17			
Hexarthra	12			
Daphnia	30			
Diaptomus	11			
Cyclops	3.2			
Nauplii	47			
Melosira	4			
Fragillaria	8			
Asterionella	221			
Anabena				
Clathrocyctis	563			
Oscillatoria				
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	26.7	4.76		1.98	24.10
2	25.6	4.42		1.16	23.86
4	21.4	1.99		3.92	25.82

TABLE 48.

LAKE: LONG LAKE (N. Basin)
Date: 8/20/30

Plankton

Species	0-5	5-10	10-18	15-20
Ceratium	51	34	8	
Dinobryum	209	4,364	665	
Aneura	8	4		
Polyarthra		4.2		
Hexarthra	8			
Noltholca	8		4	
Daphnia	6.4	19	2.4	
Diaptomus	37	12		
Cyclops	15	52	6.4	
Nauplii	55	115	2.4	
Melosira	4	64	17	
Fragillaria	4	4		
Asterionella				
Anabena	170	81	8	
Clathrocyctis	4,535	2,905	401	
Oscillatoria	89	76	25	
Lyngbya	341	746	17	

Dissolved Gases

D	T	O	%	CO_2	Cb
S	23.8	4.43		—1.0	23.2
2	23.8	4.51		—2.4	23.2
4	23.5	4.43		—2.4	23.2
6	21.3	4.85		—1.4	23.2
8	13.3	1.95		.4	30.4
10	10.5	.35		1.2	29.8
12	10	.17		1.0	30.8
15	9.4	.05		.6	30.8
18	8.8	.05		1.4	32.2

TABLE 49.

LAKE: LONG LAKE (S. Basin) (LaGrange)
Date: 8/20/30

Plankton						Dissolved Gases						
Species	0-5	5-10	10-15	15-21		D	T	O	%	CO_2	Cb	pH
Ceratium	140	42	8.5	2		S	23.8	5.03		—1.6	23.8	8.3
Dinobryum	311	759	657	106		2	23.8	5.15		—1.6	22.6	8.3
Aneura		8.5				4	23.5	5.13		—1.2	23.2	8.3
Polyarthra												
Asplancna	4					6	21.6	4.51		—1.0	23.6	8.3
Noltholca				4		8	12.7	1.53		1.0	29.6	7.5
Daphnia	8	.8	12	1.6		10	10.5	.31		1.0	29.8	7.1
Leptodera	.8					12	10	.34		2.0	29.8	7.1
Diaptomus	16	4	1.6	.8		15	9.0	.08		2.0	30.2	7.1
Cyclops	24	18	12	1.6								
Nauplii	98	55	23	1.6								
						22	8.8	.005		2.2	31.2	7.1
Melosira	8	21	17									
Fragillaria	38	12	85	4								
Asterionella												
Anabena	234	55	12									
Clathrocyctis	3,549	1,267	652	251								
Oscillatoria	123	38	34	25								
Lyngbya	311	499	136	25								

TABLE 50.

LAKE: OLIVER (LaGrange)
Date: 9/6/30

Plankton					Dissolved Gases						
Species	0-5	5-10	10-15	15-25	D	T	O	%	CO_2	Cb	pH
Ceratium	1,083	1,024	251	51	S	25	5.53		— .6	32.8	8.2
Dinobryum	21				2	22.2	6.10	101	—3.0	33.6	8.2
Aneura	76	34		21	4	22.2	6.07	100	—3.2	33.8	8.2
Hexarthra	8.5										
Polyarthra	51	4.2		12	6	21.2	5.09		—2.0	33.8	8.2
Noltholca	4.2	4.2	2.4	12							
Asplancna	4.2				8	15.5	5.33		0	37.4	7.9
Daphnia	3.2	3.2	.8	8.8	10	10.5	4.51		.6	40.4	7.6
Bosmina	4				12	8.8	3.84		1.2	39.4	7.6
Holopedium	3.2										
					15	8.3	2.81		1.0	40.4	7.5
Diaptomus	9.6	5.6	8.8	4.8							
Cyclops	5.6	17	23	24							
Nauplii	24	16	28	76	20	7.7	1.03		1.0	41.8	7.5
Melosira	17	162	311	678							
					25	7.7	.21		2.2	41.8	7.5
Fragillaria	234	128	106	64							
Asterionella	4	21									
Anabena	4	34	128								
Clathrocyctis	260	371	166	140							
Oscillatoria	85	38	64	25							
Lyngbya											

TABLE 51.

LAKE: LOWER OTTER
Date: 7/18/29

Plankton

Species	0-5	5-12	10-15	15-20
Ceratium	68	16		
Dinobryum	162			
Aneura	12.8			
Polyarthra Noltholca	.8			
Daphnia	8	3.2		
Diaptomus	4.8			
Cyclops	19.2	9.6		
Nauplii	19.2	17.6		
Melosira		76		
Fragillaria	2,606	3,140		
Asterionella		40		
Anabena				
Clathrocyctis	904	1,975		
Oscillatoria	89	294		
Lyngbya				

Dissolved Gases

D	T	O	%	CO_2	Cb
S	24.8	6.15	106	.0	42.00
2	24.8	6.10	106	.0	42.00
4	21.7	5.78		.0	41.52
6	14.7	4.11		2.20	40.02
8	10.9	3.36		3.56	39.54
10	10.6	.57		7.52	39.54
12	10	.11		6.92	40.02

TABLE 52.

LAKE: PLEASANT
Date: 7/9/29

Plankton

Species	0-5	5-10	10-13	15-20	
Ceratium	9,464	38,451	18,278		
Dinobryum	396	64	196		
Aneura	12.8	25	.		
Polyarthra					
Hexarthra	4	8	4		
Daphnia	8	4.8	2.4		
Diaptomus	12	4			
Cyclops	1.6	.8			
Nauplii	4	25	8.5		
Corethra		4	.8		
Melosira	200	294	110		
Fragillaria	51	8	17		
Tabellaria	1,506	332	631		
Asterionella		4	4		
Anabena	524	38	4		
Clathrocyctis	277	128	251		
Oscillatoria	38	8	8		
Lyngbya	42	64			

Dissolved Gases

D	T	O	%	CO_2	Cb
S	23.9	5.7		0	24.46
2	23.6	5.6		0	24.22
4	23.3	5.6		0	23.72
6	20	6.1		0	24.42
8	15.6	6.3		1.46	28.36
10	12.8	2.9		4.64	28.12
12					
13	11.7	67		5.12	29.84
15					
20					
25					
30					

TABLE 53.

LAKE: PLEASANT LAKE

Date: 7/23/29

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	136	21				S	25.6	5.57		0	24.96
Dinobryum						2	25	5.42		0	25.06
Aneura						4	23	5.74		0	24.38
Polyarthra											
Noltholca	1.6	4				6	22	4.60		1.80	24.50
Hexarthra	12.8	4				8	17.2	.37		4.98	27.24
Daphnia	25	2.4				10	14.4	.09		4.54	28.60
Diaptomus	32	.8									
Cyclops	4	2.4									
Nauplii	38	29									
Melosira		12									
Fragillaria	81	25									
Asterionella		12									
Anabena Clathrocyctis	1,472	247									
Oscillatoria	17	12									
Lyngbya	17	42									

TABLE 54.

LAKE: PRETTY
Date: 8/18/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	2,948	102	72	128
Dinobryum	1,966	42	25	34
*	106	68		25
Aneura	264	12	4	5.6
Hexarthra	17	12.8	4.2	
Polyarthra				
Noltholca	8.5	1.6	8.5	8
Asplancna	21	8.5		
Daphnia	12	3.2	1.6	
Diaptomus	44	4	2.4	.8
Cyclops	18	12	3.2	1.6
Nauplii	332	50	10.4	4
Melosira	12	29	21	17
Fragillaria	4,083	334	162	98
Asterionella	4	4		4.2
Anabena	42			4
Clathrocyctis	563	742	115	102
Oscillatoria	132	29	12	4
Lyngbya	25	1,036	55	81

Dissolved Gases

D	T	O	%	CO_2	Cb
S	23.8	5.18		—2.4	26.8
2	23.8	5.24		—1.4	27.6
4	23.3	5.16		—1.6	27.8
6	21.8	4.64		— .8	27.8
8	14.7	1.62		.4	32.2
10	10	.85		1.0	33.0
12	9.4	.45		1.0	32.6
15	8.8	.35		1.0	31.8
20	8.3	.03		1.0	32.2
24.5	8.3	.04		1.0	31.8

TABLE 55.

LAKE: ROUND
Date: 8/12/30

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	243	46	4.2			S	25	5.05	0	—1.0	22.4
Dinobryum	25.6					2	24.4	5.44		—1.0	21.6
Aneura	17	4.2				4	23.6	5.03		—1.4	21.6
Polyarthra						6	20.5	4.90		— .4	21.2
Asplancna	21										
Hexarthra	42	12.8				8	13.8	.24		3.0	28.8
Daphnia	7.2	1.6	1.6			10	10.5	.335		3.0	28.8
Bosmina		.8									
Diaptomus	14.4		.8								
Cyclops	20.8	3.2	.8			18	9.4	.0		3.0	31.2
Nauplii	68.2	25.6									
Melosira	38.4	38.4	64								
Fragillaria	2,517	409	132								
Asterionella		4.2									
Anabena	755	55	17								
Clathrocyctis	729	554	204								
Oscillatoria	98	25	85								
Lyngbya	17,937	742	593								

TABLE 56.

LAKE: SHRINER
Date: 8/15/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	4	12	1	
Dinobryum	17	25	4	
Aneura		2,201	42	
Noltholca			.8	
Polyarthra		38		
Triarthra			2.4	
Hexarthra	17			
Asplancna		4		
Daphnia	14	24	4.8	
Diaptomus	6.4	52	8	
Cyclops	1.6	19	2.4	
Nauplii	34	25	10	
Corethra		4		
Melosira		25	25	
Fragillaria	418	209	46	
Asterionella				
Anabena	132	277	34	
Clathrocyctis	341	725	358	
Oscillatoria	8		405	
Lyngbya		2,926	59	

Dissolved Gases

D	T	O	%	CO_2	Cb
S	26.6	5.25		—1.4	23.6
2	25.3	5.32		—1.0	24.2
4	25	5.33		—1.4	24.2
6	19.6	5.29		—1.2	23.6
8	12.7	6.63		0	26.2
10	10.5	2.39		1.0	26.8
12	7.77	1.23		2	26.8
15	8.8	.14		2	27.6
18	8.6	.06		3.0	28.0

TABLE 57.

LAKE: SILVER
Date: 7/24/29

Plankton

Species	0-5	5-11	10-15	15-20
Ceratium	315	55		
Dinobryum	264	64		
Aneura	21			
Polyarthra				
Noltholca	25			
Hexarthra	8			
Asplanena		4		
Daphnia	12	4		
Diaptomus	9.6	1.6		
Cyclops	4	.8		
Nauplii	47	4.2		
Melosira	140	217		
Fragillaria	102	17		
Asterionella	704	119		
Anabena	8			
Clathrocyctis	768	341		
Oscillatoria	140	34		
Lyngbya	17	320		

Dissolved Gases

D	T	O	%	CO_2	Cb
S	25	5.15		0	26.22
2	24.7	5.06		0	26.54
4	23.1	4.94		0	26.78
6	17.7	.22		4.88	31.32
8	13.9	.10		6.34	31.32
10					
11	11.7	.0		8.16	36.08

TABLE 58.

LAKE: SNOW, Station O.
Date: 6/22/29

Plankton					Dissolved Gases					
Species	0-5	5-10	10-15	15-20	D	T	O	%	CO_2	Cb
Ceratium	640	55	42	38	S	24.7	5.6		.74	36.92
Dinobryum	38	8.5	4	4.2	2	24.2	5.6		.74	36.40
Aneura	72	4.2	12	17	4	19.4	6.4	100.7	.60	38.42
Hexarthra	21	4.2								
Polyarthra					6	15.6	5.5		.50	38.42
Noltholca	12	17	17	4.2						
Asplanena	12	4.2	4	12.8	8	13.7	4.9		.74	38.42
Daphnia	10	4	2.4	1.6	10	12.2	4.1		1.50	38.92
					12	11.1	3.7		2,26	38.66
					15	10.6	3.1		2.62	38.92
Diaptomus	13	22	5.6	1.6						
Cyclops	37	3.2	1.6	.8						
Nauplii	44	25	25	10	20	8.3	.15		3.02	37.92
Melosira	529	469	725	1,821						
					25	7.2	0		6.66	40.44
Fragillaria	733	297	460	384						
Tabellaria			110							
Asterionella	85	98	34	140						
Anabena	17	8								
Clathrocyctis	2,444	439	640	145						
Oscillatoria	157	17		12						
Lyngbya	315	34	59	46						

TABLE 59.

LAKE: SNOW, Station Q.
Date: 7/3/29

Plankton						Dissolved Gases					
Species	0-18	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	382					S	22.2	6.04		—.75	35.64
Dinobryum	192					2	22.2	6.07		—.50	36.80
Aneura	31					4	20.9	6.0		—.50	37.41
Polyarthra	15					6	15.6	5.4		1.01	37.92
Noltholca	5					8	13.7	4.3		3.03	38.67
Daphnia	3.9					10	12.2	3.5		3.28	39.43
						12	11.1	3.3		3.53	38.67
Diaptomus	13.9					15	10.6	2.9		4.04	39.43
Cyclops	9.7					18	10.4	1.8		5.50	39.43
Nauplii	30.8										
Melosira	168										
Fragillaria	925										
Asterionella	53										
Anabena	7.8										
Clathrocyctis	132										
Oscillatoria	66										
Lyngbya	218										
Tabellaria	5.6										

TABLE 60.

LAKE: SNOW, Station S.
Date: 7/3/29

Plankton						Dissolved Gases					
Species	0-10	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	324					S	21.7	6.1		—.5	36.15
Dinobryum	25					2	21.7	6.1		—.75	36.4
Aneura	25					4	20.9	6.1		—.25	36.15
Polyarthra	61					6	16.1	4.8		.75	38.42
Noltholca	8.5					8	14.2	2.5		3.28	38.93
Daphnia	5.6					10	12.8	1.03		5.30	39.94
Diaptomus	13.2										
Cyclops	8										
Nauplii	31.6										
Melosira	115										
Fragillaria	961										
Asterionella	121										
Anabena	8.5										
Clathrocyctis	140										
Oscillatoria	113										
Lyngbya	63										

TABLE 61.

LAKE: SNOW, Station P.
Date: 7/4/29

Plankton						Dissolved Gases					
Species	0-15	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	238					S	21.4	6.0		—1.01	35.89
Dinobryum	133					2	21.1	6.0		— .50	36.15
Aneura	186					4	20	5.8		— .5	36.90
Polyarthra	14					6	15.8	4.8		1.51	36.65
Triarthra	7.9										
Noltholca	1.3					8	14.2	2.9		2.78	37.92
Daphnia	2.2					10	12.8	2.1		4.04	37.66
						12	11.4	.89		6.06	37.66
						15	10.6	.09		7.58	38.42
Diaptomus	17.5										
Cyclops	8.7										
Naupli	26.2										
Melosira	56										
Fragillaria	754										
Asterionella	59										
Anabena											
Clathrocyctis	159										
Oscillatoria	50										
Lyngbya	186										

TABLE 62.

LAKE: SNOW, Station O.
Date: 8/6/29

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	840	106	51	34
Dinobryum	516	12	8	12
Aneura	76	17	38	
Asplancna			4	
Polyarthra				
Noltholca	4.2	4		
Hexarthra	4.2			
Daphnia				1.6
Diaptomus	5.6	4	3.2	3.2
Cyclops	12.8	9.6	1.6	1.6
Nauplii	16	8	1.6	5.6
Corethra	42		1.6	
Melosira	183	213	72	38
Fragillaria	435	226	157	320
Asterionella	4	8	8	
Anabena	25			
Clathrocyctis	686	297	401	234
Oscillatoria	115	29	42	38
Lyngbya	64	149	12	8

Dissolved Gases

D	T	O	%	CO_2	Cb
S	22	5.50			36.34
2	22	5.49			35.34
4	22	5.43			35.34
6	18.2	3.69		3.48	36.34
8	13.7	2.69		3.98	38.34
10	12	2.12		6.96	37.58
12	11	1.99		5.22	38.84
15	10.6	1.68		5.46	39.34
20	8.6	.97		6.22	38.84
25	7.5	.06		7.70	42.42

TABLE 63.

LAKE: SNOW LAKE

Date: 8/14/30

Plankton						Dissolved Gases					
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb
Ceratium	832	80	25	110		S	23.8	5.31		—2.2	36.6
Dinobryum	119		4	21		2	23.3	5.22		—2.2	36.6
Aneura	68		8.5	21		4	23.3	5.56		—1.4	35.8
Polyarthra						6	20	3.87		—1.0	35.8
						8	12.2	2.34		1.0	42.0
Daphnia	4.8	3.2		17		10	9.4	2.55		1.0	42.4
						12	8.8	1.50		1.0	42.4
Diaptomus	8.8	88	3.2	6.4		15	8.3	1.31		1.0	42.4
Cyclops	28	18.4	6.4	20							
Nauplii	16	6.4	4	8.8		20	6.8	1.16		1.0	42.4
Melosira	46	64	146	123		24	6.3	.05		4.0	55.4
Fragillaria	115		29	46							
Asterionella											
Anabena											
Clathrocyctis	5,824	1,191	824	1,467							
Oscillatoria	149	128	16	76							
Lyngbya											

TABLE 64.

LAKE: SNOW LAKE
Date: 8/22/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	1,877	337	127	38
Acinetaetis		213	81	
Dinobryum	1,838	349	89	17
Aneura	128	38	17	12
Triarthra	8	25		
Polyarthra	179	68	34	
Asplancna	12			
Noltholca	4			2
Daphnia		2.4	3.2	8
Diaptomus		9.6	4.8	8.8
Cyclops	23	32	5.6	4
Nauplii	36	14.4	4.8	17
Corethra				.8
Melosira	115	64	162	115
Fragillaria	366	123	123	25
Asterionella				
Anabena	46	89		12
Clathrocyctis	17,412	3,468	806	302
Oscillatoria	456	221	93	162
Lyngbya		75	119	

Dissolved Gases

D	T	O	%	CO_2	Cb
S	22.2	5.03		— .60	13.80
2	22.2	5.69		—2.4	34.8
4	22	5.99		—2.0	35.2
6	21.2	5.92		—1.4	35.4
8	12.7	3.00		2.0	41.6
10	9.8	2.51		1.4	42.0
12	8.9	1.47		2.0	42.2
15	8.3	1.23		1.4	42.0
20	7.2	1.11		2.4	41.4
24.5	6.6	.09		3.0	44.0

TABLE 65.

LAKE: SNOW LAKE

Date: 8/30/30

Plankton					Dissolved Gases						
Species	0-5	5-10	10-15	15-24	D	T	O	%	CO_2	Cb	pH
Ceratium	341	345	64	21	S	22.7	6.50	108	—1.4	35.0	8.3
Dinobryum	180	196	132	21	2	22.8	6.47	108	—2.2	35.2	
Aneura	42	25	4		4	22.2	5.91		—2.4	34.4	
Polyarthra	52	46	8.5		6	20.6	4.85		0	45.8	
					8	12.2	2.50		1.4	44.0	
Daphnia		2.4	6		10	9.5	1.60		2.0	41.6	
					12	8.8	1.10		1.4	42.6	
Diaptomus	10	6.4	8	1.6	15	8.3	.95		1.4	43.8	
Cyclops	36	16	4								
Nauplii	24	49	4.8		20	7.2	.92		3.4	43.0	
Melosira	25	30	68	4	24.5	6.6	.05		3.4	45.4	7.5
Fragillaria	217	320	64	17							
Asterionella											
Anabena	8	12									
Clathrocyctis	5,004	1,612	935	614							
Oscillatoria	324	345	196	59							
Lyngbya	55	1,207	72								

TABLE 66.

LAKE: SNOW LAKE

Date: 9/2/30

Plankton

Species	0-5	5-10	10-15	15-24
Difflugia	38	17	8	
Ceratium	1,400	469	200	55
Uroglea	247	12		
Dinobryum	1,156	204	85	42
Mallomonas	836	162	38	
Aneura	153	38	29	25
Polyarthra	102	8		
Triarthra	21			
Noltholca		4.2		
Daphnia	.8			5.6
Bosmina	.8			
Diaptomus	.8	12	3.2	1.6
Cyclops	12.8	55	12.8	11.2
Nauplii	16.8	27	8	8.8
Corethra				1.6
Melosira	128	115	81	89
Fragillaria	7,436	1,416	430	17
Asterionella				
Anabena	238	149		4
Clathrocyctis	1,587	473	1,320	115
Oscillatoria	793	349	45	16
Lyngbya	499	281	13	76

Dissolved Gases

D	T	O	%	CO_2	Cb
S	20.2	5.40		0	35.8
2					
4					
6	20	5.44		0	35.8
7	18.3				
8	16.3	2.70		—1.50	36.8
9	11.1	.42		3.02	41.4
10	10	.63		4.52	41.8
12	9.4	.42		3.02	41.8
15		.11		4.02	42.4
20		.06		4.52	42.4
24.5	6.7				

TABLE 67.

LAKE: SNOW LAKE
Date: 9/7/30

Plankton

Species	0-5	5-10	10-15	15-20
Difflugia			4.2	17
Ceratium	1,011	456	123	30
Uroglea	951	217	6.4	1.7
Dinobryum	399	81	17	4.2
Mellomonas	512	55	55	12
Aneura	179	12.8		8.5
Polyarthra	42	29.8		
Triarthra	17	8.5		
Daphnia		1.6	4	4
Ostracod				.8
Diaptomus	3.2	4.8	8	1.6
Cyclops	21.6	26.4	11.2	1.6
Nauplii	36	24	6.4	4.8
Corethra			.8	
Melosira	59	115	217	85
Fragillaria	311	477	159	29
Asterionella				
Anabena	119	85		17
Clathrocyctis	247	421	571	166
Oscillatoria	328	324	294	123
Lyngbya		960	793	55

Dissolved Gases

D	T	O	%	CO_2	Cb
S	22.2	5.45		—1.4	33.8
2	21.6	5.58		—3.2	34.2
4	21.9	5.40		—1.4	33.8
6	20.3	4.66		— .4	34.8
8	13	1.87		1.4	40.8
10	10	1.37		1.8	40.8
12	8.9	.70		1.6	42
15	8.3	.50		2	41.6
20	7.3	.62		2.4	42
24	6.6	.09		2.2	44

TABLE 68.

LAKE: TURKEY (Big) (LaGrange and Steuben)
Date: 8/18/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	1,105	157		
Dinobryum	1,177	64		
*	25			
Aneura	123	8.5		
Hexarthra	8.5			
Polyarthra				
Noltholca	8.5	4.2		
Daphnia	20	8		
Diaptomus	14	3.2		
Diaptomus	14	3.2		
Cyclops	16	4		
Nauplii	115	12.8		
Melosira	951	358		
Fragillaria	21			
Asterionella	12			
Anabena	21	8		
Clathrocyctis	166	166		
Oscillatoria	1,122	302		
Lyngbya		34		

Dissolved Gases

D	T	O	%	CO_2	Cb
S	23.5	4.70		—1.6	33.8
2	23.4	5.07		—2.0	34.6
4	23.3	5.19		—1.4	33.4
6	18.3	2.61		0	38.8
8	12.5	.21		.4	46.8
10	11.5	.10		.4	46.8
12.5	11.1	.08		.4	49.0

TABLE 69.

LAKE: NORTH TWIN
Date: 9/2/30

Plankton						Dissolved Gases						
Species	0-5	5-10	10-15	15-20		D	T	O	%	CO_2	Cb	pH
Ceratium	495	98				S	23.8	6.16	105	—3.0	31.0	8.2
Dinobryum	861	209				2	23.8	6.13	104	—3.0	31.0	8.2
Aneura	72	46				4	23.3	6.36	107	—2.8	31.4	8.2
Polyarthra	81	8				6	21.3	5.50		—1.0	31.4	8.2
Noltholca		38				8	15.5	.41		0	38.2	7.5
Daphnia	6.4											
						11	12.2	.32		1.0	21.6	7.4
Diaptomus	24	4										
Cyclops	15	4.8										
Nauplii	21											
Melosira	34	76										
Fragillaria	1,501	631										
Asterionella												
Anabena	25	25										
Clathrocyctis	1,280	678										
Oscillatoria	76	640										
Lyngbya		115										

TABLE 70.

LAKE: SOUTH TWIN
Date: 9/2/30

Plankton

Species	0-5	5-10	10-15	15-20
Ceratium	482	162	42	
Dinobryum	55	16	17	
Aneura	46	68	25	
Polyarthra	166	42	8	
Noltholca			12	
Daphnia	5.6	4		
Diaptomus	17	11.2	2.4	
Cyclops	57	24	6.4	
Nauplii	44	12	5.6	
Melosira	34	89	38	
Fragillaria	349	243	101	
Asterionella		12		
Anabena	55	106	12	
Clathrocyctis	712	307	200	
Oscillatoria	230	153	46	
Lyngbya	4			

Dissolved Gases

D	T	O	%	CO_2	Cb
S	23.8	6.25	106	—3.2	29.8
2	23.8	6.18	105	—2	29.6
4	23.3	6.18	104	—2.4	29.8
6	21.66	6.26	102	—2.0	30.0
8	19.4	6.12		0	36.8
10	11	1.86		1.0	38.4
12	9.4	.38		1.2	39.6
15	9.1	0		1.6	44.4

TABLE 71.

LAKE: WALLEN LAKE
Date: 8/24/30

Plankton

Species	0-5	5-13	10-15	15-20
Ceratium	1,361	341		
Difflugia	81	25		
Dinobryum	4	4		
*	136			
Aneura	153	34		
Polyarthra				
Hexarthra	21	4		
Noltholca		4		
Daphnia	13.6	5.6		
Diaphonosona	6.4			
Diaptomus	13.6	.8		
Cyclops	56	12		
Nauplii	110	29		
Corethra		102		
Melosira	4,906	541		
Fragillaria	183	29		
Asterionella	12			
Anabena	208	63		
Clathrocyctis	2,338	2,453		
Oscillatoria	780	294		
Lyngbya	59	3,366		

Dissolved Gases

D	T	O	%	CO_2	Cb	pH
S	23.4	5.69		—2.0	39.4	8.3
2	22.3	5.67		—1.4	39.6	8.2
4	22.2	5.68		—2.0	39.4	8.2
6	16.9	23.8		1.0	50.0	7.7
8	11.9	0		2.4	51.0	7.7
10	11.1	0		4.0	51.0	7.1
13.5	10.5	0		.2	52.4	7.1