Proceedings of the Iowa Academy of Science

Volume 79 | Number

Article 8

1973

The Current Status of the Limnology and Bottom Fauna of Lakes West and East Okoboji

David D. Gale
Harper College

Everette E. Drevs
Newton Senior High School

Michael P. Gross
Great Lakes Community College

Recommended Citation

Gale, David D.; Drevs, Everette E.; and Gross, Michael P. (1973) "The Current Status of the Limnology and Bottom Fauna of Lakes West and East Okoboji," *Proceedings of the Iowa Academy of Science, 79(1),* 17-24.
Available at: https://scholarworks.uni.edu/pias/vol79/iss1/8

The Current Status of the Limnology and Bottom Fauna of Lakes West and East Okoboji

DAVID D. GALE[1], EVERETTE E. DREVS[2] and MICHAEL P. GROSS[3]

SYNOPSIS: Lakes West and East Okoboji, Dickinson County, Iowa, were the site of a 1970 summer investigation on the density and diversity within the macroscopic bottom organisms, physical and chemical measurements of the water and substratum chemistry study. These data on Lake West Okoboji were compared with a 1918 and 1950 study of the macroscopic bottom fauna, water analyses dating from 1934, and oxygen and temperature data from as far back as 1915. The sparse species composition of the bottom fauna has remained unchanged; however, pollution indicator tubificid worms have increased in density. Water analysis, oxygen, and temperature data are little changed from earlier studies. Few data have been collected in previous years on Lake East Okoboji. Apparent cultural eutrophication has occurred in the last 60 years, causing extreme nuisance blooms of blue-green algae.

INTRODUCTION

In 1935 Bohumil Shimek reported the extermination or vast reduction in population density of many species of mollusks once common to the Iowa Great Lakes. He attributed this decimation to the dumping of sewage into the lakes, chiefly into East Okoboji Lake. Shimek (1935) concluded his report:

"A movement is on foot, through the efforts of the Iowa State Board of Conservation, to stop the discharge of sewage into the lakes. If this succeeds, and it must if the lakes are not to be completely ruined, the study of the come-back of the molluscan fauna, now so completely destroyed will be of exceeding interest."

Bovbjerg and Ulmer (1959) made a five year survey of the gastropods of Lake West Okoboji. They reported that the 11 species they observed were confined to less than ten meters in depth and no living specimens of *Valvata tricarinata* were found beyond this depth.

The great source of pollution cited by Shimek was removed from Lake West Okoboji in 1964 with the completion of the sewer line. The question as to whether or not the sewer line had caused a corresponding improvement in the quality of the water or some recovery of the fauna of the lake prompted our study. The study was begun in July, 1970 at the Iowa Lakeside Laboratory with the following objectives:

1) To repeat the study of Bardach, et al. (1950), of the bottom fauna of Lake West Okoboji. The goal was to relate changes in density or diversity to changes in water quality.

2) To analyze the water at various locations on Lake West Okoboji and compare the analyses with those done in previous years.

3) To collect samples of the bottom sediments for analysis, heretofore unknown. The purpose of this analysis was to relate these data to the density of bottom organisms and to provide a record for future reference.

4) To record water temperature and oxygen profiles in Lake West Okoboji for comparison with data collected in previous years.

5) To analyze the water, bottom sediments and bottom fauna of Lake East Okoboji. Too little work had been done on this lake in the past so it was our intention to provide a record for future reference.

Lake West Okoboji is one of the deepest mid-continental lakes short of the Great Lakes. Bachman, et al. (1966) report the lake has a maximum depth of 42.7 meters, a mean depth of 11.9 m and a length of shore line 30.0 km. Due to this great depth, stratification of temperature, oxygen, and other constituents can be observed with predictable seasonal fluctuation.

Lake East Okoboji is a very shallow contiguous lake with a maximum depth of around 10 meters. This lake does not thermally stratify and is fairly uniform top to bottom in all water constituents.

East Okoboji residents are in the process of installing a sewer line around the lake to carry the effluent away from the lake. At the present time, septic tanks largely handle the sewage load and in some rare cases discharge can be seen emitting from pipes on the lake shore.

METHODS AND PROCEDURES

Bottom samples were taken along three transects in Lake West Okoboji and Lake East Okoboji. In Lake West Okoboji samplings were made at approximately 5 meter depth intervals starting at 10 m. The study excluded the littoral benthic and vegetated zones described by Clampitt et al. (1969) (Figure 1). In Lake East Okoboji stations along these transects were spaced at intervals of 1/6 the length of the transect (Figure 2).

Forty stations were sampled along the six transects with four dredge hauls at each station totaling 160 samples. Samples were taken with an Ekman dredge (23.5 x 23.5 cm) washed on a graded series of screens (5 mm and 1.5 mm) and bolting cloth (.8 mm) except at stations with a gravel substratum. These samples were taken with a Peterson dredge (25 x 25 cm) and were washed and sorted in white pans.

Water samples were collected at the points marked W in Figures 1 and 2 with a 3 liter Kemmerer. These were analyzed by the State Hygienic Laboratory. The Winkler Method (Hach Chemical Co.) was employed for periodic oxygen sampling. Temperature profiles were run concurrently utilizing a Whitney's Underwater Resistance Thermometer. Bottom samples were collected at the points marked M on Figures 1 and 2. These samples were analyzed by the Minnesota Valley Testing Laboratories, Inc., New Ulm, Minn.

---

[1] Department of Biology, Harper College, Palatine, Illinois 60068
[2] Newton Senior High School, Newton, Iowa 50208
[3] Great Lakes Community College, Estherville, Iowa 51334

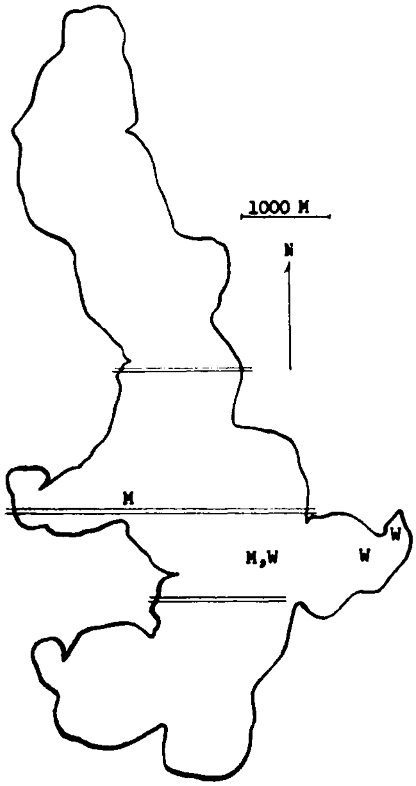

Fig. 1. Transects for sampling Lake West Okoboji in 1950 and 1970 are marked with a double line. Samples of water and mud substrata were collected at points W and M respectively in 1970.

Identification of organisms was made by John Downey, University of Northern Iowa, Henry Vander Shalie, University of Michigan, and Selwyn S. Roback, Academy of Natural Sciences, Philadelphia, Pennsylvania, with the exception of the Oligochaetes which were identified according to Pennak (1959) (Table 1).

RESULTS

Lake West Okoboji:

The same species found in the 1950 study are present and the only significant difference to be noted in the bottom fauna between 1950 and 1970 is the increase in the density of tubificid worms (Table 1).

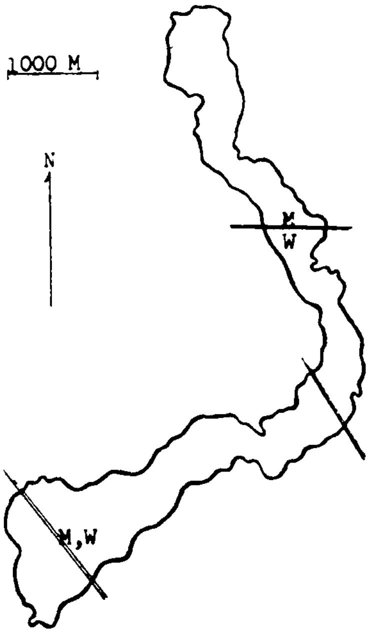

Fig. 2. Transects for sampling Lake East Okoboji in 1970 study are marked with a double line. Samples of water and mud substrata were collected at points W and M respectively in 1970.

TABLE 1. DISTRIBUTION OF MACROSCOPIC BOTTOM ORGANISMS ON A WEST TO EAST TRANSECT ACROSS WEST LAKE OKOBOJI, AUGUST 1950 AND AUGUST 1970

		Numbers of organisms per m^2													
Depth-Meters	*Year*	10	15	20	25	30	35	40	35	30	25	23	20	15	10
Sphaeriidae	1950	40	420	294	336	0	0	0	0	0	210	—	420	?	84
	1970	228	238	214	218	5	0	0	0	104	147	128	109	4	0
Valvata	1950	—	42	0	0	0	0	0	0	0	0	0	0	126	504
	1970	10	14	5	0	0	0	0	0	0	0	0	38	60	20
Chironomid larvae	1950	580	830	840	250	?	120	0	0	170	630	—	920	1010	43
	1970	1288	194	285	232	52	24	28	28	28	361	57	461	216	384
Tubificid worms	1950	0	50	420	630	2060	930	1560	—	750	820	—	130	0	0
	1970	575	1824	3876	5590	8360	2726	6052	4260	4115	5970	10161	270	128	4

The difference is of the order of magnitude of four times as great as in 1950. Sphaerid clams were found at a greater depth than in 1950 but the significance of this is questionable. In addition to the organisms listed on Table 1, specimens of the snail genus *Amnicola* and the leech genus *Helobdella* were collected at the 10 meter depth on gravel substratum.

The water analysis shows that there has been little change in water quality since 1934, the earliest record available on water quality (Table 2). Cooke (1964) sampled the water of Millers Bay, Lake West Okoboji during the summer of 1964. His preliminary analysis shows little change in water quality in comparison to the present study.

On the basis of the two bottom samples collected in Lake West Okoboji, the mineral content of the substratum appears to be quite uniform at varying depths (Table 3).

The water temperature and dissolved oxygen profiles of Lake West Okoboji compare very closely with profiles taken in previous years (Tables 4 and 5, Figures 3 and 4).

Lake East Okoboji:

Due to the uniformity of depth on any given transect across the lake, there is a corresponding uniformity in the distribution of bottom organisms (Tables 6, 7 and 8). The substratum where all samples were taken was a soft ooze; in some cases this was so heavily loaded with debris that counting was difficult. *Valvata tricarinata*, a small snail associated with gravel substratum, was virtually absent in this unfavorble substratum. In addition to the organisms found in Lake West Okoboji, Biting Midge Larvae of the genus *Palpomyia* and Burrowing Mayfly Larvae of the genus *Hexagenia* were found, the latter only in the middle transect.

The water analysis shows little difference from those of 1960 and 1964 (Table 9). The high BOD value for the upper transect is noteworthy. With this one exception the values for East Okoboji compare quite closely with West Okoboji.

The bottom analysis of Lake East Okoboji shows no major differences from Lake West Okoboji with two notable exceptions: The organic material and copper levels are considerably higher in Lake East Okoboji than in West (Table 10).

Oxygen and temperature profiles were taken on the upper and lower transect at six hour intervals on 27 July 1970. At all times sampled, both water temperature and dissolved oxygen were found to be uniform from top to bottom. Dissolved oxygen was found to be near saturation at all hours of collection.

DISCUSSION

I. *Lake West Okoboji*

Lake West Okoboji can best be characterized as relatively stable over the past fifty years for the factors studied.

The sampling of bottom organisms proved to be very similar to that of 1950. The increase in tubificid worms is of interest as an increase in the population of these anaerobes usually indicates an increase in pollution. This increase, if real, is difficult to interpret since the oxygen profiles in 1970 and 1950 are identical.

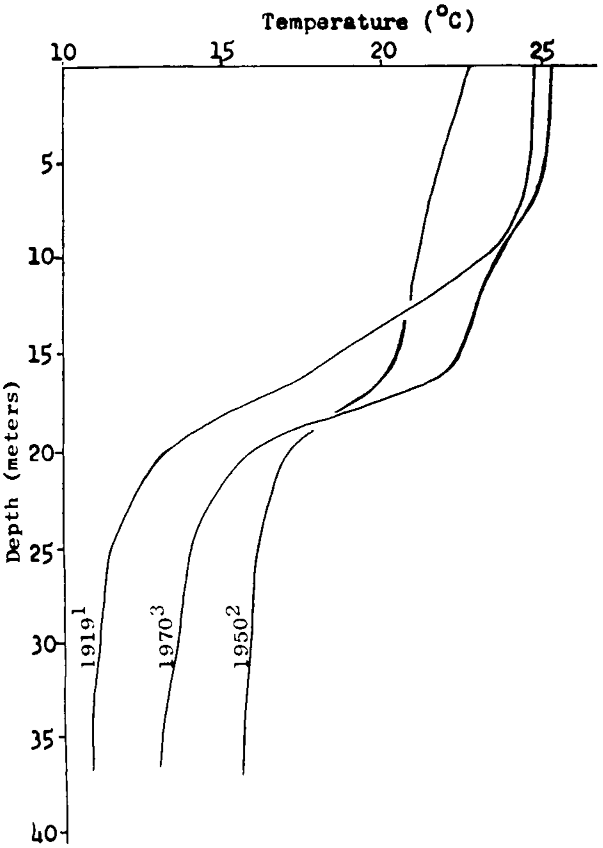

Fig. 3. Water temperatures measured July 31, 1919, 1950 and 1970 in Lake West Okoboji.

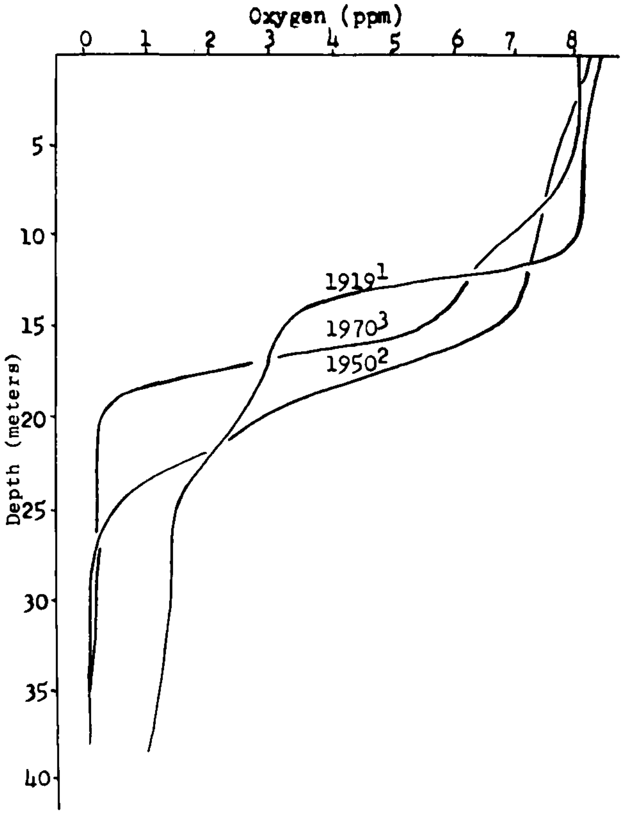

Fig. 4. Dissolved oxygen (ppm) measurements July 31, 1919, 1950 and 1970 in Lake West Okoboji.

Water chemistry has changed little from past years. Any differences may be attributed to seasonal fluctuations. Phosphates, nitrates, and chlorides, all constituents of sewage, have very low values. Since the vegetation is actively consuming these constituents, it is to be expected that these values will be low. It is worth mentioning, however, that the lake water during the entire summer of 1970 was relatively free of blue-green algae. This lack of a blue-green bloom could possibly be related more to low temperatures than to low phosphates and nitrates. There was such a bloom in 1969.

The fact that the waters of Lake West Okoboji have been so stable in recent years speaks well of the work of the Okoboji Protective Association. It has been through their efforts that the sewer line was established around the lake. They are supporting further studies on the lakes to seek new guidelines for pollution reduction.

Despite these efforts, however, exploitation of the lake resources is continuing to take its toll. Housing developments, roads and farm tiling are destroying the last sloughs and ponds connected to the lake. The value of these vegetation-choked bodies of water is inestimable in removal of the water nutrients and the subsequent retardation of lake eutrophication.

Many building projects on the lake shore were in progress during the summer. Vast quantities of soil washed into the lake while the ground was stripped of its vegetation. Other sources of concern were the many storm sewers that empty into the lake from the streets of Arnolds Park and from driveways around the lake. All of these sources of pollution only help speed up the natural processes of eutrophication and siltation and shorten the life of the lake.

It has been expressed by Richard V. Bovbjerg, Director of Iowa Lakeside Laboratory, that he would like to see a line of natural vegetation around the entire shoreline to filter all water entering the lake. Shimek urged long before that belts of natural vegetation be preserved so that their role of water quality control might continue and that there would be protection for all marshlands adjacent to the lake (Shimek, 1913-14, 1930).

Preservation is always less expensive than restoration. As is often the case, only after a particular species or group of species has been destroyed does its true value to the balance of nature come to light. In this case, massive development of the drainage basin of the lakes can only lead to a lessening of the value of the lake as a resource. It is toward the goal of preservation that we recommend all those concerned with the future of Lake West Okoboji to direct their efforts.

II. *Lake East Okoboji*

Lake East Okoboji also has changed little over the past several years. The sewage mentioned by Shimek still enters the lake via septic tank seepage. In some cases open lines can be seen emitting effluent into the lake. Livestock were still watering in the lake in 1970, almost 60 years after he first urged this practice cease.

Our study shows a paucity of bottom organisms to be found in all substrata more than 3 m from the shore. This low diversity of organisms certainly reflects the presence of pollution that has existed over the years. The only mollusks remaining of those found by Shimek prior to 1933 are *Valvata* and Sphaerids, and these were found in exceedingly low densities.

There are only two species of organisms to be found in addition to those found in Lake West Okoboji. It would not be expected that one would find great diversity in West Lake because of the natural anoxic conditions to be found in the deeps. But East Lake, with its uniform oxygen values surface to the bottom, should support a wide diversity of bottom organisms. The low numbers of mollusks and Burrowing Mayfly Larvae and the high numbers of other species are indicative of pollution.

The water analysis data are little different from those taken on Lake West Okoboji. There are slightly higher values for the total nitrogen, phosphates, BOD, COD to indicate pollution. What is more indicative of pollution is the tremendous blue-green bloom throughout the lake. The depth of light penetration as measured with the Secchi disk never exceeded 1.5 meters on East Okoboji during our study as compared to a reading of 3.5 to 4.5 meters on West Okoboji. East Okoboji is at a more advanced stage of eutrophication than West Okoboji due to its shallower basin, larger watershed, and greater effluent.

Heavy blue-green blooms have existed in East Okoboji for many years. Earl Rose of the State Department of Fisheries and Wildlife can recall being unable to swim in East Okoboji in 1920 due to the high concentration of blue-green algae. How much more prevalent the blue-greens are today than previously is only a matter of speculation. That it is certainly greater is immediately apparent from the 1913-14 paper by Shimek:

"... the changes of the past twenty years warrant the fear that as the population of both the lake shore and the prairie increases the natural beauties of the lake region will be marred or disappear. Already in the latter part of the summer season the shallow East Lake, which communicates with the West Lake, becomes discolored, and the last year much of the life which ordinarily abounds in East Lake and in Gar Lakes was destroyed, evidently by the befouled waters" (Shimek, 1913-14).

Robert W. Wylie, a former director at Iowa Lakeside Laboratory, makes no reference to blue-green algal blooms just two years prior to Shimek's observation:

"The yellowish tinge of the waters of East Okoboji Lake in mid-summer is due primarily to the myriads of tiny one-celled algae, Diatoms, present in the water" (Wylie, 1911). If blue-green were predominant in the waters at this time he almost certainly would have made reference to them. The blue-green nuisance appears to have developed between 1910 and 1920.

A "nuisance condition" due to the blue-green algae was called in 1929 and a program to eradicate the blue-greens using copper sulfate was implemented (Lonergan, 1930). This attempt to eradicate a condition of pollution by chemicals failed.

The bottom sample analysis of East Okoboji differs from West Okoboji on two points: 1) the high organic content 2) the high copper content. The high copper content reflects the period of treatment of the lake to remove the algae. The high organic content reflects the advanced eutrophication stage of East Lake. Much organic debris is left behind by the vast quantities of decaying blue-green algae and debris washed into the lake from the adjacent watershed.

A brief survey of the cobbles and gravel in the shallow water along the shore near the middle transect revealed a wide diversity of organisms. The diversity was estimated to be almost as great as that of the study conducted by Clampitt et al. (1959) at Millers Bay in West Okoboji. Most of these species require the conditions offered by the cobbles and gravel and therefore they would not be expected to be found on the soft substratum where our other samples were taken. The fact that there is such a wide diversity along the shore does indicate that the pollution of East Lake has not advanced to a critical stage. That pollution does exist is evidenced by the destruction of the pollution sensitive mollusks and Mayfly larvae and by the tremendous algal blooms which make their presence known in a most unpleasant manner every summer.

The East Okoboji Lakes Improvement Corporation is following the example of West Lake Okoboji's organization in attempting to curb pollution. Some siltation dams have been constructed in streams entering the lake and a sewer line has been constructed around a small portion of the lake. In addition to this the other organizations of the Iowa Great Lakes have implemented a Water Quality Survey Plan with the goal to test and monitor water quality and to perform a complete watershed survey in order to better control the pollutants entering the lake. It is recommended that the East Okoboji organization direct future activities toward the restriction of livestock from the lake shore and to the establishment of unhampered vegetation around the lake. All of these activities begun or recommended will certainly prolong the life of the lake as a recreational resource.

APPENDIX

TABLE I. BOTTOM ORGANISMS COLLECTED IN EAST AND WEST OKOBOJI

Insecta
Family Ephemeridae
    Hexagenia sp. (Burrowing Mayfly)
Family Ceratopogonidae
    Palpomyia sp. (biting Midge)[a]
Family Chironomidae (incomplete list)[b]
    Chironomus plumosus
    Chironomus attenuatus
    Tribelus jucundus
    Cladotanytarsus (2 sp.)
Pelecypoda[c]
    Sphaerium sp.
    Pisidium sp.
Oligochaeta
Family Tubificidae[d]
    Tubifex sp.
    Limnodrilus sp.

Identification made by:
[a]John Downey, UNI
[b]Selwyn S. Roback, Academy of Natural Sciences, Philadelphia, Pa.
[c]Henry Vander Schalie, U. of Michigan
[d]Pennak (1959)

TABLE 2. WATER ANALYSIS OF WEST OKOBOJI FROM 1934 TO 1970.

Minerals	8/8/34[a]	1/20/47[a]	8/9/55[a]	July '54[b]	7/27/70[c] (5 m)	7/27/70[c] (20 m)	7/27/70[c] (31 m)	7/27/70[d]	7/27/70[e]
Cr	—	—	—	—	0.01	—	0.01	—	0.01
Ni	—	—	—	—	0.01	—	0.01	—	0.01
Pb	—	—	—	—	0.01	—	0.01	—	0.01
K	—	—	7.0	—	8.7	8.8	9.0	8.8	8.8
Ca	26.1	33.3	25.0	27.0	36.8	35.2	35.2	36.8	36.8
Mg	34.9	31.5	33.0	34.0	30.1	31.1	33.0	34.0	34.0
Mn	0.04	0.0	0.0	—	0.05	0.21	0.13	0.05	0.05
Zn	—	—	—	—	0.03	—	0.02	—	0.04
Cu	—	—	—	—	0.01	—	0.01	—	0.01
Fe	0.0	0.0	0.0	—	0.02	0.1	0.08	0.06	0.06
Cd	—	—	—	—	0.01	—	0.01	—	0.01
Ba	—	—	—	—	0.10	—	0.1	—	0.1
Na	18.2	16.9	7.0	—	8.3	8.3	8.4	8.6	8.6
Al	1.6	—	—	—	—	—	—	—	—
F	0.0	0.4	0.35	—	0.35	0.35	0.35	0.15	0.35
CL	10.0	9.0	9.0	6.2	7.0	7.0	7.0	7.0	7.0
SO_4	19.3	25.9	20.6	29.0	36.0	33.0	37.0	36.0	36.0
HCO_3	214.7	253.76	187.9	—	224.0	254.0	256.0	239.0	239.0
CO_3	14.4	0.0	15.6	—	9.6	0.0	0.0	9.6	9.6

[a]Public Health Records, State Department of Public Health, Des Moines, Iowa.
[b]Bachman (1965).
[c]State Hygienic Laboratory, R. Shobe Collector.
[d]State Hygienic Laboratory, sample taken in Smiths Bay.
[e]State Hygienic Laboratory, sample taken near bridge over inlet joining East and West Okoboji.
[f]All values expressed in ppm unless otherwise indicated.

TABLE 2. (*Continued*)

Minerals	8/8/34[a]	1/20/47[a]	8/9/55[a]	July '54[b]	7/27/70[c] (5 m)	7/27/70[c] (20 m)	7/27/70[c] (31 m)	7/27/70[d]	7/27/70[e]
N	–	–	–	–	0.69	0.71	0.64	0.75	0.84
NH_3	–	–	–	–	0.01	0.04	0.24	0.01	0.01
NO_2	Tr.	–	–	–	0.006	0.013	0.049	0.007	0.012
NO_3	0.0	0.2	0.0	–	0.1	0.1	0.1	0.1	0.1
PO_4	0.0	–	–	–	0.1	0.1	0.3	0.1	0.1
SiO_2	–	–	–	–	5.6	7.6	8.4	7.2	7.2
$CaCO_3$	–	–	11.6	–	12.6	12.6	13.1	13.5	13.5
Hardness	208.0	213.0	198.2	205.0	216.0	316.0	224.0	232.0	232.0
Estimated Turbidity	–	–	–	–	7.0	9.0	10.0	9.0	8.0
Total Solids	260.0	245.0	228.0	–	275.0	270.0	273.0	273.0	274.0
Dissolved Oxygen	–	–	–	–	9.2	2.7	0.7	9.2	7.3
B.O.D.	–	–	–	–	2.0	1.0	10.0	2.0	3.0
C.O.D.	–	–	–	–	33.5	29.3	23.0	25.1	39.7
pH	8.2	8.2	8.5	–	8.35	7.9	7.6	8.45	8.3
P Alkalinity	12.0	–	13.0	–	8.0	0.0	0.0	8.0	8.0
T Alkalinity	200.0	208.0	180.0	199.0	208.0	208.0	210.0	212.0	212.0
Specific Conductivity (x10-5)	–	37.5	39.8	42.1	54.0	54.0	54.0	54.0	54.0

TABLE 3. ANALYSIS OF THE SUBSTRATUM, LAKE WEST OKOBOJI*, JULY, 1970.

Minerals	10 Meters	30 Meters
P	7.5 ppm	7.5 ppm
K	240.0 ppm	155.0 ppm
Ca	2500.0 ppm	2000.0 ppm
Mg	775.0 ppm	525.0 ppm
Mn	126.0 ppm	146.5 ppm
Zn	3.3 ppm	4.4 ppm
Cu	4.5 ppm	2.5 ppm
Fe	258.0 ppm	195.5 ppm
S	10.0 ppm	11.0 ppm
Na	150.0 ppm	100.0 ppm
B	0.92 ppm	0.95 ppm
pH(Reg.)	7.6	7.6
pH (Buf.)	7.3	7.4
Organic Material	6.4	6.5

*Samples analyzed by Minnesota Valley Testing Laboratories, Inc., New Ulm, Minn.

TABLE 4. WATER TEMPERATURES OF WEST LAKE OKOBOJI SINCE 1915 (°C).

Depth in Meters	July 26 1916[a]	July 30 1919[b]	July 28 1923[c]	July 27 1925[d]	July 26 1950[e]	July 31 1969[f]	July 31 1970
Surface	26.5	24.7	25.3	21.6	22.7	23.4	25.2
5	26.3	24.4	24.4	21.6	21.8	23.3	25.0
10	24.7	23.2	23.9	21.4	21.2	22.8	23.2
15	18.6	18.8	13.0	21.0	20.4	19.1	22.4
20	17.2	13.1	11.3	17.6	17.0	16.8	16.0
25	16.2	11.6	10.6	16.1	–	15.0	13.9
30	15.4	11.1	10.3	15.8	15.3	13.4	13.6
35	15.2	10.9	10.0	–	15.0	13.2	13.1

[a] Bardach et al. (1951) Collected by John L. Tilton
[b] Birge and Juday (1920)
[c] Bardach et al. (1951) Collected by Frank A. Stromsten
[d] Bardach et al. (1951) Collected by Frank A. Stromsten
[e] Bardach et al. (1951)
[f] Bachman (unpublished data)

TABLE 5. DISSOLVED OXYGEN PROFILES OF WEST LAKE OKOBOJI SINCE 1919.

Depth in meters	July 31 1919[a]	July 26 1950[b]	July 31 1969[c]	July 31 1970
Surface	8.4 ppm	8.3 ppm	8.6 ppm	8.1 ppm
5	8.1	7.7	8.5	8.1
10	8.1	–	7.7	6.9
15	3.2	6.8	2.0	5.4
20	2.6	3.0	0.1	0.2
25	1.3	0.3	0.0	0.1
30	1.3	0.0	0.0	0.1
35	1.2	0.0	0.0	0.0
40	–	0.0	0.0	0.0

[a] Birge and Juday (1920)
[b] Bardach et al. (1951)
[c] Bachman (unpublished data)

TABLE 6. DISTRIBUTION OF MACROSCOPIC BOTTOM ORGANISMS ON A TRANSECT ACROSS THE LOWER PORTION OF LAKE EAST OKOBOJI, AUGUST, 1970.

Number of Organisms per m²

Depth in Meters	N. West		S. East		
	6	6	6	6	6
Name of organism					
Sphaeriidae	0	5	33	14	14
Valvata	0	5	0	0	0
Chironomid Larvae	556	332	195	1434	1710
Tubificid Worms	0	57	214	228	437

TABLE 7. DISTRIBUTION OF MACROSCOPIC BOTTOM ORGANISMS ON A TRANSECT ACROSS THE MIDDLE PORTION OF LAKE EAST OKOBOJI, AUGUST, 1970.

Numbers of Organisms per m²

Depth in Meters	N. West		S. East		
	2½	2½	3	2½	2
Name of organism					
Sphaeriidae	14	66	119	95	52
Chironomid Larvae	756	1112	1373	1183	1316
Tubificid Worms	294	400	332	356	446
Palpomyia Larvae	104	33	57	28	124
Hexagenia Larvae	19	0	0	0	28

TABLE 8. DISTRIBUTION OF MACROSCOPIC BOTTOM ORGANISMS ON A TRANSECT ACROSS THE UPPER PORTION OF LAKE EAST OKOBOJI, AUGUST, 1970.

Numbers of Organisms per m²

Depth in Meters	West		East		
	2	2	1½	1½	1
Name of organism					
Sphaeriidae	38	24	14	40	95
Chironomid Larvae	422	1857	1444	835	418
Tubificid Worms	112	238	185	156	147
Palpomyia Larvae	114	80	62	176	166

TABLE 9. WATER ANALYSIS OF EAST OKOBOJI FROM 1960 THROUGH 1970.

Minerals	8/9/60[a]	8/9/60[a]	July '64[b]	7/27/70[c]	7/27/70[d]
Cr	–	–	–	0.01	–
Ni	–	–	–	0.01	–
Pb	–	–	–	0.01	–
K	–	–	–	8.5	–
Ca	–	–	34.0	48.0	–
Mg	–	–	33.0	31.1	–
Mn	–	–	–	0.05	–
Zn	–	–	–	0.02	–
Cu	–	–	–	0.03	–
Fe	0.0	0.0	–	0.04	–
Cd	–	–	–	0.01	–
Ba	–	–	–	–	–
Na	–	–	–	8.6	–
Al	–	–	–	–	–
F	–	–	–	0.35	–
Cl	–	10.0	7.7	8.0	–
SO_4	36.0	25.0	31.0	47.0	–
HCO_3	–	–	–	237.0	–
CO_3	–	–	–	14.4	–
N	–	–	–	1.2	3.1
NH_3	–	–	–	0.2	0.17
NO_2	–	–	–	0.017	0.011
NO_3	0.07	0.05	–	0.01	0.01
PO_4	0.0	0.0	–	0.5	0.6
SiO_2	14.0	16.0	–	15.0	–
Total Hardness	200.0	205.0	221.0	248.0	–
Hardness ppm	–	–	–	14.5	–
Total Solids	–	–	–	366.0	419.0
DO	–	–	–	7.2	9.8
BOD	–	–	–	4.0	20.0
COD	–	–	–	54.4	77.4
pH	–	–	–	8.45	8.85
P Alkalinity	20.0	–	–	12.0	–
T Alkalinity	186.0	195.0	209.0	218.0	–
Specific Conductance ($\times 10^{-5}$)	–	–	452	54.0	–

[a] Adapted from Volker (1962)
[b] Bachman (1965)
[c] Sample taken by R. Shobe on the lower transect. Analyzed by State Hygienic Laboratory.
[d] Sample taken by R. Shobe on upper transect. Analyzed by State Hygienic Laboratory.
[e] All values in ppm unless otherwise indicated.

TABLE 10. ANALYSIS OF THE MUD SUBSTRATUM, LAKE EAST OKOBOJI*.

Minerals	2 Meters Depth Upper Transect	6 Meters Depth Lower Transect
P	5.5 ppm	8.5 ppm
K	190.0	235.0
Ca	2250.0	2250.0
Mg	725.0	675.0
Mn	199.0	220.0
Zn	6.2	1.9
Cu	11.0	6.5
Fe	155.0	48.0
S	7.5	9.5
B	1.8	1.0
Na	125.0	125.0
pH (Reg.)	7.6	7.4
pH (Buf.)	7.4	7.4
Organic Material	9.0+	9.0+

*Samples analyzed by Minnesota Valley Testing Laboratories, Inc., New Ulm, Minn.

LITERATURE CITED

BACHMAN, R. W. 1965. Some chemical characteristics of Iowa lakes and reservoirs. *Proc. Iowa Acad. Sci.* 72:238-243.

BACHMAN, R. W., BOVBJERG, R. V. and HALL, J. D. 1965. The morphometry of Lake West Okoboji. *Proc. Iowa Acad. Sci.* 72:165-167.

BARDACH, J. E., MORRILL, J. and GAMBONY, F. 1951. Preliminary report on the distribution of botttom organisms in West Okoboji Lake, Iowa. *Proc. Iowa Acad. Sci.* 58:405-414.

BIRGE, E. A., and JUDAY, C. 1920. A limnological reconnaissance of West Okoboji. *University of Iowa Studies in Natural History,* 9(1):3-56.

BOVBJERG, R. V. and ULMER, M. J. 1959. An ecological catalog of the Lake Okoboji gastropods. *Proc. Iowa Acad. Sci.,* 67:569-577.

CLAMPITT, P. T., WAFFLE, E. L. and BOVBJERG, R. V. 1959. An ecological reconnaissance of the bottom fauna, Millers Bay, Lake Okoboji. *Proc. Iowa Acad. Sci.,* 67:553-568.

LONERGAN, M. J. 1930. Report on nuisance condition, Upper Gar Lake, Dickinson County. Bul: Okoboji Protective Association, 26:100-106.

SHIMEK, B. 1913-14. Report on nuisance condition, Upper Gar Lake, Dickinson County. Bul: Okoboji Protective Association, 9:30-35.

_____. 1930. Can We Improve on Nature? Bul: Okoboji Protective Association, 26:72-77.

_____. 1935. The effect of pollution on mollusks in Iowa. *The Nautilus.* XLVIII No. 4:104-111.

VOLKER, R. 1962. Preliminary aspects of an ecological investigation of Lake East Okoboji, Iowa.

WYLIE, R. B. 1911. The aquatic gardens of Lake Okoboji. Bul: Okoboji Protective Association, 7:10-20.