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Some Chemical Characteristics of Iowa Lakes and Reservoirs

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Abstract: Chemical analyses were made of the surface waters of 61 Iowa lakes and reservoirs during the summer of 1964. With the exception of one bog lake, they all had typical hard waters of the bicarbonate type. Their average composition was similar to the 10-year average compositions of the Iowa and Cedar rivers. There was a tendency for the lakes lying within the Wisconsin glacial drift sheet to have higher values for all parameters measured, although the differences were not considered biologically significant.

INTRODUCTION

Limnologists have long recognized the importance of water chemistry as a critical factor in the productivity and species composition of lakes and have routinely included chemical analyses in studies of regional limnology. Moyle (1956) has ably demonstrated the utility of such an approach in his studies of the distribution of fish and aquatic plants in Minnesota lakes in relation to the concentrations of various ions. For this reason, emphasis was placed on chemical parameters in this contribution to the regional limnology of Iowa. The primary objectives of this study were to determine the average chemical composition of Iowa lakes and reservoirs and to see if there were regional differences in composition which might be of some biological importance. Emphasis was placed on major cations and anions since their concentrations would be less subject to seasonal fluctuations than would nutrient elements such as phosphorus and nitrogen, or trace elements such as copper, lead or zinc. The sampling period was limited to 5 weeks (1 July 1964 to 4 August 1964) to further reduce the influence of seasonal variations. The locations of the lakes sampled are indicated on Fig. 1.

METHODS

Surface water samples were obtained from several lakes on a single day, and the chemical analyses were usually completed within the next 2 or 3 days. Electrical resistance was measured with an Industrial Intruments Inc. type RC conductivity bridge using a pipette cell electrode. The instrument was calibrated with 0.01 N KC1, and all readings were corrected for temperature effects and converted to specific conductance at 25°C. Total alkalinity was determined by titration with 0.02 N sulfuric acid by using a Beckman model GS pH meter for endpoint determination. Total hardness and calcium concentrations were

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determined by a complexometric titration with 1,2-cyclohexane-diaminetetraacetate-HexaVer® (Hach Chemical Co., Ames, Iowa). ManVer® and CalVer II® (Hach Chem. Co.) indicators were used for endpoint determination. Magnesium concentration was calculated from total hardness and calcium concentration. Chloride was determined by titration with mercuric nitrate by using a diphenyl carbazone indicator-buffer powder (Hach Chem. Co.). Sulfate was determined by titration following the method outlined by Fritz and Yamamara (1955).

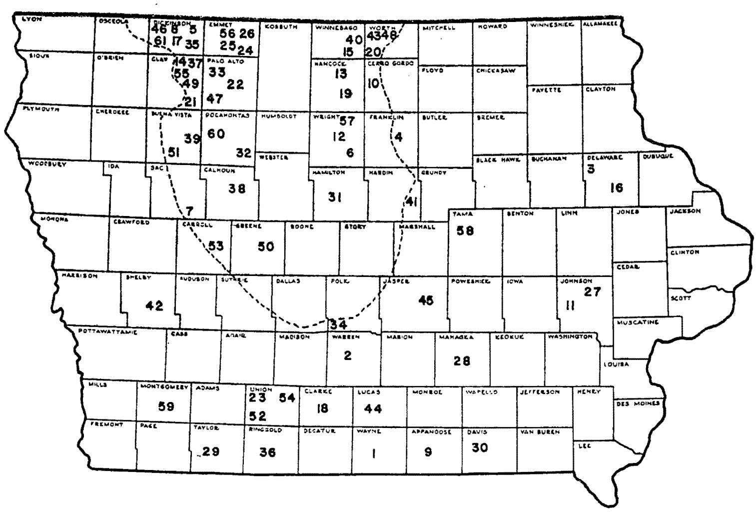

Figure 1. Location of lakes from which water samples were collected for this study. The numbers correspond to those given in Table 1. The dotted line indicates the boundary of the Wisconsin glacial drift sheet.

Results

The individual chemical analyses are presented in Table 1, and average values for all lakes together are summarized in Table 2 along with ten-year averages for the Iowa and Cedar rivers. It can be seen that the average lake water for the state is quite similar to these river waters, with the exception that the lakes tend to have higher concentrations of magnesium and lower concentrations of calcium. In general the Iowa lakes are typical of hard water lakes of the bicarbonate type (Hutchinson, 1957). With but one exception, the alkalinites are all above the 40 ppm concentration which Moyle (1965) used to separate the hard and soft water lakes of Minnesota. If the concentrations of the cations and anions are arranged in descending order, we find that Ca was greater than Mg and HCO_3 was greater than SO_4 which was greater than Cl, which is the typical order for the world's rivers and open lakes in general (Hutchinson, 1957).

At the extremes, Dead Man's Lake in the Pilot Knob State Park has the lowest values for every one of the parameters

Table 1. Chemical analyses of the surface waters of some Iowa lakes and reservoirs. Collections made between 1 July and 4 August, 1964

Lake	Specific conductance (micromhos at 25 C)	Alkalinity as ppm $CaCO_3$	Total hardness as ppm $CaCO_3$	Calcium ppm	Magnesium	Chloride ppm	Sulfate ppm
1. Allerton Res., Wayne Co.	186	63	76	23	5	2.4	23
2. Aquabi L., Warren Co.	240	105	109	29	9	3.9	13
3. Backbone L., Delaware Co.	358	153	181	42	19	5.0	33
4. Beeds L., Franklin Co.	370	164	184	37	22	6.4	29
5. Big Spirit L., Dickinson Co.	491	208	243	36	37	6.1	56
6. Big Wall L., Wright Co.	314	156	146	37	13	3.8	5
7. Blackhawk L., Sac Co.	430	153	206	37	27	1.9	61
8. Center L., Dickinson Co.	437	241	227	29	38	10.4	5
9. Centerville Res., Appanoose Co.	334	97	142	41	9	6.6	66
10. Clear L., Cerro Gordo Co.	306	143	146	23	22	7.8	13
11. Coralville Res., Johnson Co.	380	145	178	42	17	7.6	43
12. Cornelia L., Wright Co.	403	190	194	33	27	7.8	19
13. Crystal L., Hancock Co.	337	153	174	41	18	7.9	20
14. Dan Green Slough, Clay Co.	535	254	283	68	28	2.0	34
15. Dead Man's L., Winnebago Co.	61	26	29	7	3	0.7	2
16. Delhi L., Delaware Co.	143	67	65	15	7	2.4	4
17. East Okoboji, Dickinson Co.	452	209	221	34	33	7.7	31
18. East Osceola Res., Clarke Co.	363	97	113	31	9	39.8	19
19. East Twin L., Hancock Co.	314	128	171	41	17	8.4	38
20. Elk Cr. Refuge, Worth Co.	535	234	286	69	28	10.8	45
21. Elk L., Clay Co.	322	112	148	20	24	2.7	45
22. Five Islands L., Palo Alto Co.	327	136	151	28	20	14.9	14
23. Green Valley, Union Co.	243	93	105	29	8	3.6	25
24. High L., Clay Co.	582	114	273	36	45	10.8	172
25. Ingham L., Clay County	653	117	317	51	46	11.0	211
26. Iowa L., Emmet Co.	430	179	214	42	26	10.2	41
27. Lake McBride, Johnson Co.	246	97	111	27	11	5.4	23
28. Lake Keomah, Mahaska Co.	213	88	95	23	9	5.2	19
29. Lake of Three Fires, Taylor Co.	172	71	79	23	5	1.8	12
30. Lake Wapello, Davis Co.	212	66	92	26	7	2.1	37
31. Little Wall L., Hamilton Co.	508	250	256	40	38	3.1	17
32. Lizzard L., Pocahontas Co.	365	144	173	21	30	9.3	45
33. Lost Island L., Palo Alto Co.	480	224	240	29	41	1.9	36
34. Maffit Res., Polk Co.	309	135	141	31	16	6.2	25
35. Minnewashta, Dickinson Co.	494	210	232	39	33	7.1	42
36. Mt. Ayr Res., Ringgold Co.	229	100	103	31	6	2.9	15
37. Mud L., Clay Co.	602	243	314	58	41	2.5	81
38. North Twin L., Calhoun Co.	458	138	218	34	32	3.5	58
39. Pickerel L., Buena Vista Co.	320	153	167	32	21	1.4	25
40. Pilot Knob L., Winnebago Co.	176	53	53	17	3	1.5	5
41. Pine L., Hardin Co.	266	121	121	20	17	4.8	13
42. Prairie Rose L., Shelby Co.	332	150	152	38	14	5.1	12
43. Rice L., Worth Co.	239	127	135	33	13	5.6	6
44. Red Haw L., Lucas Co.	234	65	99	27	7	3.4	45
45. Rock Creek Lake, Jasper Co.	289	125	140	36	12	4.0	26
46. Silver L., Dickinson Co.	588	114	276	46	39	6.9	26
47. Silver L., Palo Alto Co.	448	177	228	44	29	2.2	104
48. Silver L., Worth Co.	271	125	130	24	17	7.8	18
49. Smiths Slough, Clay Co.	522	203	257	41	38	2.4	65
50. Spring L., Greene Co.	369	110	170	21	29	3.4	62
51. Storm L., Buena Vista Co.	541	136	236	47	29	5.3	108

52. Summit L., Union Co.	259	100	115	32	8	4.4	27
53. Swan L., Carroll Co.	341	144	159	33	19	1.8	28
54. Thayer L., Union Co.	191	81	88	26	6	4.8	13
55. Trumbull L., Clay Co.	404	162	192	21	34	3.1	64
56. Tuttle L., Emmet Co.	513	154	245	50	30	12.6	101
57. Twin Sisters L., Wright Co.	257	93	102	21	12	10.1	20
58. Union Grove L., Tama Co.	318	133	145	34	15	4.2	24
59. Viking L., Montgomery Co.	221	102	101	27	8	2.8	10
60. Virgin L., Palo Alto Co.	336	168	171	19	30	1.8	18
61. West Okoboji, Dickinson Co.	421	199	205	27	34	6.2	29

[1] ppm bicarbonate = alkalinity × 1.22.

measured while Ingham Lake has the maximum values for specific conductance, total hardness, and sulfate concentration. The low values in Dead Man's Lake are not unexpected since it has been described as a true bog lake (Smith and Bovbjerg, 1958) and as such should be low in total dissolved solids.

A preliminary analysis of the data for regional differences indicated a relationship between water chemistry and the location of lakes with respect to the area of most recent glaciation. This is illustrated by Fig. 2 in which frequency distributions are presented of the various chemical parameters with respect to location. With the exception of the calcium and chloride concentrations, there is a distinct tendency for the higher values to be found in lakes lying within the boundaries of the Wisconsin glacial drift sheet (Fig. 1). The average values for these two regions, as summarized in Table 2, illustrate the same point with the highest values in each case occurring in lakes within the most recent glacial lobe. These differences might be a reflection of the younger soils within the Wisconsin glacial sheet which have not leached to the same extent as the older soils without. Also, most of the lakes within this area are natural lakes, generally without active outlets, while those lakes sampled in other parts of the state are artificial reservoirs with streams

Table 2. Average water chemistry of Iowa lakes and reservoirs and the Iowa and Cedar rivers

	Iowa[1] River at Iowa City	Cedar[1] River at Cedar Rapids	Iowa lakes (average and coefficient of variation) N = 61	Iowa lakes within Wisconsin glacial drift sheet N = 39	Iowa lakes outside Wisconsin glacial drift sheet N = 22
Specific conductance micromhos at 25 C	362	363	356 ± 36%	409	261
Total alkalinity as ppm $CaCO_3$	142	140	139 ± 38%	160	102
Total hardness as ppm $CaCO_3$	182	174	169 ± 40%	199	116
Calcium ppm	48	48	33 ± 35%	35	30
Magnesium ppm	15	14	21 ± 57%	27	10
Chloride ppm	4.6	9.3	5.9 ± 92%	5.9	5.8
Sulfate ppm	38	32	38 ± 99%	46	24

[1] Calculated from yearly weighted averages (Jan. 1944-Sept. 1951) as published in Water-Supply Bulletin No. 5, Iowa Geological Survey.

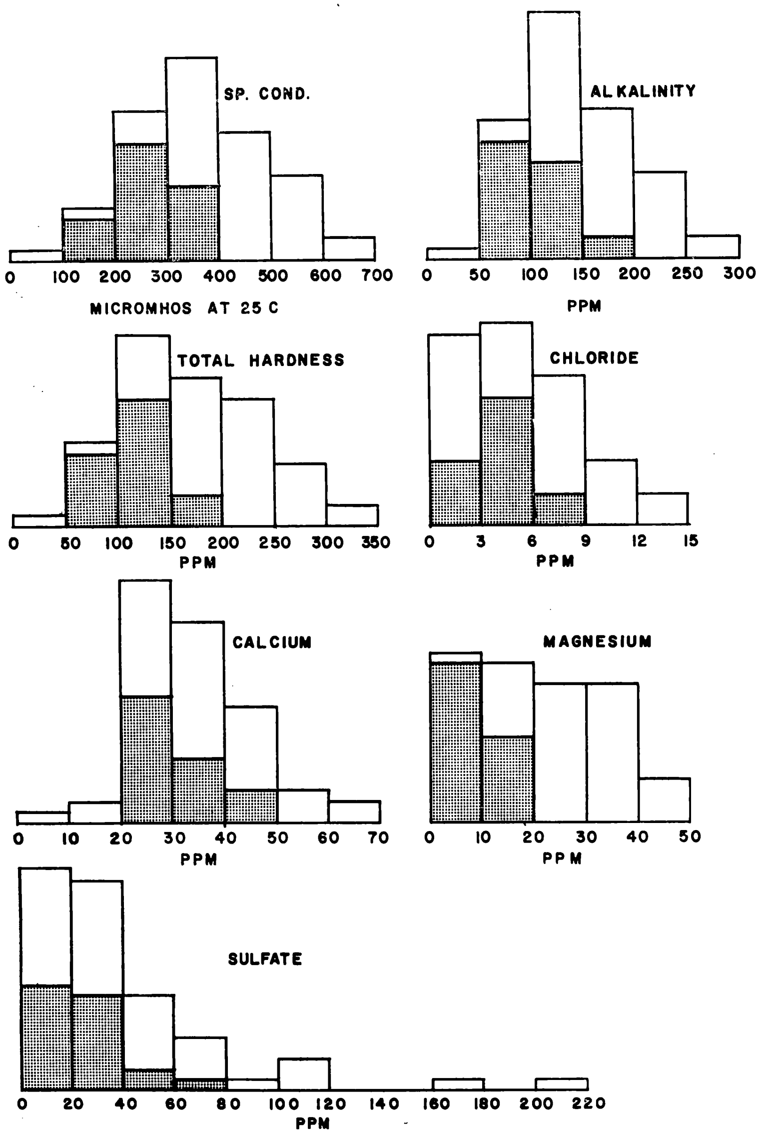

Figure 2. Frequency distributions of various chemical parameters in Iowa lakes and reservoirs. The stippled areas represent lakes lying outside of the Wisconsin glacial drift sheet.

or rivers flowing through them. There should thus be a tendency for evaporation to play a greater role in concentrating the ions in the natural lakes. The measured chemical differences between these two regions, however, are not great, and, with the exception of Dead Man's Lake and perhaps a few of the lakes with high sulfate contents all the lakes and reservoirs covered in this study can be considered as typical hard-water lakes. The differences found are not considered of great biological significance.

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Factors Affecting Winter Fish Kills in the Coralville Reservoir, Iowa

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Abstract: The Coralville Reservoir, located on the Iowa River just upstream from Iowa City, has as its primary purpose the control of floods on the rivers downstream. A conservation pool is maintained for recreational purposes. During December 1964 and January 1965, a combination of rather unusual circumstances caused an almost complete depletion of oxygen in the reservoir and resulted in a fish kill. Oxygen demand of the incoming water from a sudden winter rain greatly exceeded the available oxygen dissolved in the lake. A heavy ice cover prevented the renewal of oxygen by wind action. The depletion continued until warm rains, melting snow, warmer weather, and the partial drainage of the lake to provide for the flood storage level resulted in the complete replacement of the contents.

INTRODUCTION

The Coralville Flood Control Reservoir is located on the Iowa River several miles upstream from Iowa City, Iowa. Authorized by an act of Congress in 1938, it was placed in operation by the Corps of Engineers, Rock Island District, in 1958.

Details of the Reservoir and Contributing Area. The reservoir is of irregular shape, filling the valley and tributaries of the Iowa River above the dam. At spillway elevation, a condition that will occur only during the most extreme flood, it has a length of 35 miles, an area of 24,800 acres, and a storage of 475,000 acre feet. The contributing area above the reservoir is 3084 square

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