PRELIMINARY RECORDS OF PHYSICO-CHEMICAL FEATURES OF GRAND LAKE, OKLAHOMA[1]

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Physico-chemical records based on three vertical series of temperature readings and water samples from Grand Lake, Oklahoma, are presented. Lakes of this depth have not previously been available in southwestern United States (Welch 1935, Harris and Silvey 1940). Grand Lake, or Lake of the Cherokees, in northeastern Oklahoma, presents an interesting problem regarding thermal and chemical stratification owing to its great depth, large size, enormous water exchange, location, and its recent and rapid formation. The lake is 65 miles long, and has a surface area of 52,000 acres, a shore line of 1,500 miles, (Oklahoma Game and Fish Commission, 1941) and a depth of 36 meters or more. The lake first began to fill in the summer of 1940 and by early spring, 1941, it was completely filled. Further information is restricted by Federal defense regulations.

During the spring of 1941 continued water inflow necessitated the opening of flood gates for a continuous period of several weeks. Since the lower portions of these gates are several meters below the upper level of the lake, and since the heavy spring runoff was of warmer water then that remaining in the lake over winter, the bulk of water flow to and from the lake must have been in an upper stratum comprising about one-third of the lake's depth.

Two visits were made to the lake in 1941. Temperatures were recorded for intervals of depth to show possible thermal stratification. Samples of water for analyses were taken at intervals of 5 meters from top to bottom to detect possible chemical stratification. Analytical methods used were those described in *Standard Methods for the Examination of Water and Sewage* (1936). The cooperation of the Oklahoma Game and Fish Commission in providing a boat and information concerning the location of the deeper spots made this investigation possible.

The first series of records was made May 3, at a point about one mile above the dam. On July 26, samples were taken at station 1, about a mile above the dam, and station 2, located about 8—9 miles up the lake near the mouth of Honey Creek.

On May 3, thermal stratification was manifested by the existence of a thermocline between 21 and 23 meters (table 1). The total drop in temperature from top to bottom was 8.6°C, with 40 percent of this change in the 2 meter thermocline. The data on dissolved oxygen, free carbon dioxide, methyl orange alkalinity and phenolphthalein alkalinity show no indications of stratifications.

The July 26 records exhibit evidence of more advanced thermal, and the presence of chemical stratification. At station 1, 3 narrow thermoclines were present at depths of 10—11, 17—18, and 21—22 meters (table II), totaling 17.4° C. drop in temperature from top to bottom, with 40 percent

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of the change occurring within the thermoclines. Chemical stratification began above the upper thermocline, between 5 and 10 meters in depth. Dissolved oxygen decreased greatly at about 10 meters and was nearly absent at 15 and 20 meters but was somewhat higher at lower levels. Free carbon dioxide showed an increase beginning between 5 and 10 meters and continuing through the lower waters. Hydrogen-ion concentration showed an increase in the region of 5—10 meters but leveled off to a pH of 7 from 15 meters down. Station 2 exhibited conditions closely similar to those at station 1, except that dissolved oxygen was more depleted at the lake bottom (table III).

It seems logical to assume that the unusual depth of the thermocline in May was in part due to the extensive early spring water exchange. Hydrogen-ion concentration readings from top to bottom are reversed from conditions in most lakes, probably owing to the above mentioned water exchange. The distribution of dissolved oxygen in July at station 1 offers material for speculation which can be best considered following future investigations.

LITERATURE CITED

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TABLE I

Physico-chemical features of Grand Lake, Oklahoma
May 3, 1941. 1 mile above dam

Turbidity: surface, 96; 25 m., less than 25 ppm.

Depth	Temp.	pH	O_2	Alk.[1]	Alk.[2]	Free CO_2
meters	*°C.*		*cc./l*	*ppm.*	*ppm.*	*ppm.*
0	17.2	7.0	4.7	54.5	0.0	2.4
1	17.2					
2	17.3					
3	17.0					
4	16.9					
5	16.7	7.0	4.6	58.0	0.0	2.2
6	16.3					
7	16.3					
8	16.2					
9	15.9					
10	15.9	7.1	4.5	58.0	0.0	2.0
11	15.8					
12	15.5					
13	15.4					
14	15.4					
15	15.4	7.2	4.7	66.0	0.0	2.0
16	15.4					
17	15.2					
19	15.2					
20	14.3	7.2	5.6	78.5	0.0	2.2
21	14.3					
22	11.9					
23	10.8					
24	10.7					
25	10.0	7.2	5.1	77.0	0.0	3.0
26	9.9					
27	9.9					
28	9.9					
29	9.0					
30	8.6					
35	8.6					
36	8.6	(In the mud)				

[1]Methyl orange
[2]Phenolphthalein

TABLE II

Physico-chemical features of Grand Lake, Oklahoma July 26, 1941. Station 1, 1 mile above dam

Surface turbidity: less than 25 ppm.

Depth	Temp.	pH	O_2	Alk.[1]	Alk.[2]	Free CO_2
meters	*°C.*		*cc./l*	*ppm.*	*ppm.*	*ppm.*
0	27.8	7.9	4.9	71.0	0.0	0.1
5	26.8	7.9	4.6	74.0	0.0	0.1
9	25.6					
10	24.9	7.2	1.1	70.5	0.0	3.0
11	22.4					
12	21.6					
15	20.6	7.0	0.5	69.5	0.0	5.0
17	20.6					
18	17.2					
19	16.4					
20	16.0	7.0	0.9	63.5	0.0	6.0
21	15.2					
22	14.1					
24	13.2					
25	12.6	7.0	2.3	79.0	0.0	7.0
27	11.6					
30	10.4	7.0	2.3	91.0	0.0	7.0
31	10.4	7.0	2.1	87.0	0.0	7.0

[1]Methyl orange
[2]Phenolphthalein

TABLE III

Physico-chemical features of Grand Lake, Oklahoma
July 26, 1941. Station 2, 8 miles above dam

Surface turbidity: less than 25 ppm.

Depth	Temp.	pH	O_2	Alk.[1]	Alk.[2]	Free CO_2
meters	*°C.*		*cc./l*	*ppm.*	*ppm.*	*ppm.*
0	29.4	8.0	5.7	66.5	0.0	0.0
5	27.0	7.5	4.1	70.0	0.0	2.0
7	25.7					
8	24.3					
9	24.2					
10	24.2	7.2	1.9	69.0	0.0	5.0
11	22.8					
12	22.0					
13	21.4					
15	20.8	7.1	0.5	71.0	0.0	5.0
16	19.9					
17	19.0					
18	17.2					
19	16.3					
20	15.6	7.0	0.3	70.0	0.0	6.0
20.5	15.6	6.9	0.3	69.0	0.0	7.0

[1]Methyl orange
[2]Phenolphthalein