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Annual Temperature Study of Five Northwest Arkansas Lakes

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AN ANNUAL TEMPERATURE STUDY OF FIVE NORTHWEST ARKANSAS LAKES

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Temperature records taken over a period of fifteen years from lakes in northwestern Arkansas show that lakes in this region normally differ from typically stratified lakes of the temperate zone in that they do not go through a winter stagnation period. Between the years 1938 and 1953 only one instance of freezing over was found; in 1940 the lakes of this region were covered with a thin coating of ice during the first week in January. In recent years a number of investigators have published reports on thermal conditions for lakes in southwestern United States. Some of these publications are: Harris and Silvey (1940) and Cheatum, Longnecker, and Metler (1942) for Texas; Moore (1950) for Louisiana; Irwin (1941) and Wallen (1951) for Oklahoma; and Hoffman (1951, 1952) for Arkansas. All of these investigators report thermal stratification in summer; and those which dealt with annual temperature studies show one continuous circulation period throughout the winter.

During the years 1949 and 1950 vertical series of temperatures were taken, using a Negretti and Zambra reversing thermometer, from five artificial lakes in northwestern Arkansas. These temperature records are presented here so that they may be compared with published accounts taken from lakes in neighboring states and from other areas. The five lakes studied ranged in depth from 5 to 20 meters, in area from 50 to 525.5 acres, and were located within a radius of 40 miles of Fayetteville, Arkansas (Table 1).

Table 1. General Data for Lakes.

Lake	Impounded	Maximum Depth in meters	Surface area in acres	Exposure to wind action
Fort Smith	1936	20	525.5	Moderate
Wedington	1937	12	81.5	Moderate
Atalanta	1937	11	77.0	Slight
Fayetteville	1950	12	170.0	Great
Hindsville	1950	5	50.0	Slight

STRATIFICATION PERIOD

Vertical series of temperature readings taken from five Northwest Arkansas lakes between July 1949 and June 1950 are presented in Table 2. In this table the extent of the termocline is indicated by numerals in italics, and a sudden drop in temperature between two adjacent meter levels is indicated by an underscore. Birge's rule, *i.e.*, a temperature drop of 1.0 °C or more per meter (Welch, 1952), was used to select the thermocline limits.

Table 2 shows that the five lakes were already stratified in July, 1949, when this investigation was begun, and all but two remained in this thermal state through October. Two lakes, Atalanta and Fayetteville, had no thermoclines in October, but a temperature gradient existed between the surface and the bottom levels. Chemical records taken during this time, but not presented in this paper, indicate that even though no thermoclines were present in Lakes Atalanta and Fayetteville during October 1949, chemical stagnation conditions still prevailed at the lower levels.

In the spring of 1950 all lakes showed stratification by the first week in May. The temperature of the water near the bottom when stratification was first recorded ranged from 10.8°C to 12.0°C. No definite stratification pattern was found as to thickness and position of thermoclines between spring and middle

Table 2. Vertical series of temperature readings for five Northwest Arkansas lakes from July, 1949 to June, 1950.

LAKE ATALANTA, BENTON COUNTY, ARKANSAS

Depth in Meters	Dates of Sampling																	
	7/5	7/21	8/1	8/14	9/24	10/9	10/24	11/7	11/26	12/12	1/6	2/17	3/2	3/29	4/10	4/24	5/8	5/23	6/18
1	26.4	22.8	24.3	23.0	20.1	18.5	18.3	15.0	8.2	5.0	4.2	4.6	10.6	11.4	11.0	14.3	18.6	23.7	21.0
2	24.0	21.0	23.1	19.3	19.4	18.2	18.0	14.8	- -	- -	- -	- -	- -	- -	- -	- -	18.6	22.9	20.8
3	24.0	20.4	20.1	18.9	19.0	17.8	17.6	14.8	- -	- -	- -	- -	- -	- -	- -	- -	18.6	20.0	18.4
4	16.4	19.4	19.2	18.4	18.5	17.1	17.4	14.8	- -	- -	- -	- -	10.4	- -	- -	- -	18.0	18.7	17.5*
5	15.6	17.0	17.1	18.2	17.8	16.8	16.5	14.8	8.2	4.7	4.2	4.6	8.0	11.4	10.9	14.2	16.2	16.8	16.7
6	14.5	15.8	15.6	16.7	16.5	16.2	15.6	14.8	- -	- -	- -	- -	7.0	10.6	- -	12.6	14.3	14.6	15.0
7	14.2	14.8	14.7	15.9*	15.3	15.5	15.0	14.7	- -	- -	- -	- -	6.4	9.7	- -	11.8	12.4	13.3	13.8
8	14.1	14.2	14.1	14.3	14.7	15.0	14.7	14.6	- -	- -	- -	- -	6.4	- -	10.5	11.5	11.4	11.9	13.0
9	- -	13.9	13.7	14.3	14.5	14.6	14.7	14.5	- -	- -	- -	- -	6.2	- -	9.8	- -	11.0	- -	12.7
10	- -	- -	13.6	14.3	14.3	14.2	14.2	- -	8.2	4.7	4.2	4.6	6.0	9.4	9.5	10.8	10.9	11.5	12.6

LAKE WEDINGTON, WASHINGTON COUNTY, ARKANSAS

Depth in Meters	Dates of Sampling																
	7/24	8/2	8/16	9/25	10/9	10/23	11/6	11/27	12/18	1/12	2/21	3/17	4/1	4/13	5/4	6/1
1	26.0	26.4	27.8	22.8	20.7	18.8	15.0	8.8	4.6	4.2	4.6	8.4	11.4	10.1	20.8	25.6
2	25.6	26.2	27.7	22.6	20.0	18.8	14.7	8.8	4.6	- -	- -	- -	11.3	- -	- -	25.4
3	25.0	25.8	27.6	22.4	19.2	18.6	14.7	8.8	4.6	4.0	4.4	- -	11.2	10.1	20.4	25.1
4	22.0	22.3	24.0	22.2	19.1	18.4	14.7	8.7	4.6	- -	- -	- -	11.2	- -	14.9	23.4
5	17.7	19.2	20.3	22.0	19.0	18.4	14.7	8.7	4.6	4.0	4.4	8.2	11.2	10.1	13.4	23.0
6	15.2	15.4	16.4	18.9	18.0	18.4	14.7	8.7	4.6	- -	- -	8.2	11.2	- -	12.4	19.6
7	14.6	14.2	14.5	15.0	16.4	18.4	14.6	8.7	4.6	4.0	4.4	8.2	11.2	10.1	11.2	19.2
8	13.7	13.4	13.4	13.7	14.4	14.6	14.5	- -	4.6	- -	- -	7.8	11.2	- -	- -	16.6
9	13.6	12.9	12.9	13.7	13.6	13.4	14.4	- -	4.6	- -	- -	- -	11.2	- -	11.2	11.2
10	13.6	12.8	12.4	- -	- -	13.4	14.4	7.9	4.6	4.0	4.4	7.6	11.2	10.1	11.2	11.2

LAKE HINDSVILLE, MADISON COUNTY, ARKANSAS

Dates of Sampling

Depth in Meters	7/13	8/11	9/28	10/16	10/31	11/10	12/11	2/23	3/15	3/30	4/12	4/30	5/17	5/30	6/22
1	25.6	26.2	23.2	20.4	20.8	12.6	4.5	10.2	6.5	10.4	9.2	19.6	22.2	23.7	27.2
2	22.8	22.7	21.3	19.4	20.1	12.6	4.5	8.8	6.1	9.8	9.2	18.6	21.8	22.8	25.2
3	19.0	21.7	21.1	18.4	18.9	12.6	4.5	5.8	6.0	9.1	9.2	15.7	18.5	20.5	22.2
4	15.1	20.7	20.6	18.1	17.8	12.6	4.5	5.8	5.9	7.8	9.2	11.8	14.2	19.5	19.7
5	15.1	20.0	19.6	17.5	17.8	12.5	4.5	5.2	5.8	7.4	9.2	10.8	11.2	14.8	16.0

LAKE FAYETTEVILLE, WASHINGTON COUNTY, ARKANSAS

Dates of Sampling

Depth in Meters	7/7	7/26	8/7	8/14	9/26	10/12	10/30	11.9	11/28	12/14	1/11	2/23	3/17	4/9	4/23	5/7	5/24	6/23
1	26.6	25.0	23.8	28.7	21.5	19.9	19.7	13.7	7.6	3.5	3.1	9.0	6.6	11.0	14.4	21.3	23.0	26.2
2	26.6	24.0	23.4	24.6	21.3	18.8	19.6	- -	- -	- -	- -	8.8	- -	- -	- -	19.1	23.0	24.8
3	25.2	22.2	21.4	23.1	20.8	18.6	19.4	- -	- -	- -	3.4	- -	- -	- -	13.6	18.7	23.0	21.9
4	22.0	22.2	20.4	21.0	20.5	18.5	18.6	- -	- -	- -	- -	- -	- -	- -	- -	18.3	21.2	18.0
5	18.2	22.2	19.5*	19.4	19.8	18.3	18.4	13.7	6.8	4.0	- -	8.0	6.5	11.0	13.3	15.8	18.2	17.4
6	16.0	18.1	17.8	18.3	18.8	17.9	18.2	- -	- -	- -	- -	- -	- -	- -	- -	14.0	16.0	16.6
7	15.8	17.2*	17.0	17.4	18.0	17.7	18.1	- -	- -	- -	3.7	- -	6.5	- -	12.7	13.3	14.8	15.6
8	15.8	16.2	16.9	17.0	17.6	17.5	17.9	- -	- -	- -	- -	8.0	- -	- -	12.0	22.8	13.4	15.6
9	15.2	16.0	16.4	16.6	17.3	17.4	17.5	- -	6.6	4.0	- -	- -	- -	- -	10.8	12.0	13.0	15.4
10	- -	15.6	16.6	16.4	17.0	17.2	17.4	13.7	- -	- -	- -	7.3	6.5	11.0	10.8	12.0	12.5	- -

LAKE FORT SMITH, CRAWFORD COUNTY, ARKANSAS **

Dates of Sampling

Depth in Meters	7/12	7/19	8/9	9/23	10/7	10/22	11/4	11/25	12/9	1/6	2/24	3/11	4/1	4/20	5/5	5/19	6/12
1	25.6	25.3	25.8	23.1	20.4	19.4	17.2	10.8	7.0	5.0	10.0	11.2	10.8	14.4	18.4	20.8	26.2
2	25.6	25.2	25.2	23.0	20.4	19.4	- -	- -	- -	- -	- -	- -	- -	14.2	- -	20.8	*23.4*
3	25.6	25.2	*23.6*	23.0	20.4	19.4	- -	- -	- -	- -	- -	- -	- -	13.5	18.4	20.8	*21.4*
4	25.1	25.0	22.5	23.0	20.4	19.4	- -	- -	7.0	5.0	- -	- -	- -	12.6	*17.2*	20.4	*19.6*
5	*20.0*	*23.8*	21.6	22.8	20.4	19.4	17.4	10.8	- -	- -	9.8	11.2	10.8	11.9	*15.8*	*17.8*	16.8
6	*17.0*	*20.8*	21.4	21.0	20.4	19.4	- -	- -	- -	- -	- -	11.2	- -	- -	*14.8*	*14.8*	16.6
7	15.6	*19.8*	20.9	20.2	20.3	19.2	- -	- -	- -	- -	8.6	11.2	10.7	- -	12.7	13.4	15.8
8	15.4	*17.2*	*18.6*	19.8	19.0	19.0	- -	- -	- -	- -	8.4	11.2	10.7	- -	- -	12.6	15.6
9	- -	15.2	16.3	19.0	18.9	19.0	- -	- -	- -	- -	7.6	11.2	10.7	- -	11.8	12.0	14.8
10	14.8	15.0	16.0	*17.8*	18.8	18.9	17.4	10.6	7.0	5.0	7.2	8.0	9.4	11.2	- -	11.8	14.4
11	14.0	14.6	14.4	*26.2*	*16.7*	18.2	17.4	- -	7.0	5.0	- -	7.6	- -	- -	11.3	11.8	14.2
12	- -	- -	- -	*15.0*	*15.4*	*15.5*	- -	- -	- -	- -	- -	7.2	- -	- -	- -	11.4	13.8
13	13.2	13.7	13.7	13.8	14.3	14.4	17.4	- -	7.0	- -	7.0	- -	9.0	- -	10.9	10.8	13.2
14	- -	- -	- -	13.3	13.5	13.8	13.8	- -	- -	- -	- -	- -	- -	- -	- -	11.0	12.8
15	12.6	12.8	12.9	13.2	13.4	13.4	13.4	10.4	7.0	5.0	6.7	7.1	8.8	10.8	10.8	11.0	12.4

* Less than 1.0°C per meter

** 15 meter depth station

Numerals in italics = Limits of thermocline

Underscore = Drop in temperature between adjacent meters

summer. However, records for 1949 (Table 2) indicate that the thermoclines became thinner and their upper limits deeper between late summer and the end of the stratification period in autumn. A phenomenon often encountered in this study was a sudden drop in temperature between two adjacent horizontal meter levels. In some instances this condition was found above the thermocline (Lake Atalanta in July and August), below the thermocline (Lake Fort Smith on August 9, 1949), or in place of a thermocline (Lake Fort Smith on November 4, 1949 and in Lake Atalanta on April 24, 1950). Secondary thermoclines (at least one meter in thickness) were preeent in Lake Fayetteville on July 26, 1949, and in Lake Fort Smith on August 9, 1949.

CIRCULATION PERIOD

Table 2 shows that, with a few exceptions, the lakes were unstratified from November into April. In two instances, thermal stratification occurred during the winter in the two lakes with the greatest wind protection; Lake Atalanta stratified on March 2, 1950, and Lake Hindsville on February 23, 1950. In general, the vertical temperatures during this time were either homothermal or had such a slight gradient that a small amount of wind was able to initiate circulation. Because it is possible for the lake to overturn at any time from November into April it is here considered as the circulation period. Chemical records taken from November into April show that dissolved oxygen, carbon dioxide, and pH readings were nearly uniform from surface to bottom on each sampling date. This would seem to indicate that the temporary thermal stratifications that appear during this time are not of sufficient duration to allow a chemical differentiation between levels.

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