SHORT TIME VARIATION OF TEMPERATURE IN LAKE MENDOTA, WISCONSIN[1]

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The bathythermograph can be adapted for use on small lakes. Lake Mendota's thermal differences were completely checked with 90 soundings in six hours. The variations found are much the same as those of other great lakes.

During the summer of 1949 over 500 soundings were made with a bathythermograph and more than 50 soundings were made with a Whitney electrical thermometer. The bathythermograph was by far the most advantageous instrument for the study, for it was possible to cover a large area within a short period of time. The Whitney thermometer had the property of being able to check the temperature of any desired depth for any length of time.

Table 1 shows the data pertinent to the cruises made. The wind and air temperature data were recorded from a station near the edge of the lake.

TABLE 1

Date	Time	Soundings	mph Wind	Wind mph Previous 24 hours
10 August 1949	1100–1500	90	SW 15	WSW 7
16 August 1949	0900–1700	100	E 12	E 10
19 August 1949	0930–1530	40	NE 13	NE 10–18
23 August 1949	0900–1500	90	S 13	W 6

CRUISES

On August 10, there was a surface variation of 4° F. with definite pockets of warm and less warm water (fig. 1). The warm water was on the east and northeast side of the lake, the wind from the southwest piled the warm water on the downwind side of the lake. Off the many points of land were tongues of homogeneous water jutting into the lake, they appear to be regions of very little current movement. The isotherms move out in bands toward the northeast, although pockets of cold water can be found on the downwind side of the lake.

Figure 2 shows the 20-foot level for the 10th of August. The tongues of water off points of land are still apparent in a few regions. This surface had a 7° F variation with the warm water still on the downwind side of the lake. In comparing the two figures, the thermal gradient on the southwest side of the lake was 2.5° F/20 feet and on the northeast side or downwind it was 0.5° F/20 feet. In some regions the temperature did not change.

In the large bay the tongues of water curved cyclonically around each other; this was probably an eddy as the bays appear to be a separate circulation from the main part of the lake. This pattern was shown in Lake Erie by Parmenter (1929). The tongues of water off points of land was also shown by Parmenter, although he did not describe it.

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By August 16, 1949, there was a complete change from the surface conditions of the 10th (fig. 3). The reversal of the thermal distribution was due to a steady east wind. The water had cooled slightly, but the variation still exceeded three degrees. Tongues of water off the points of land were still apparent.

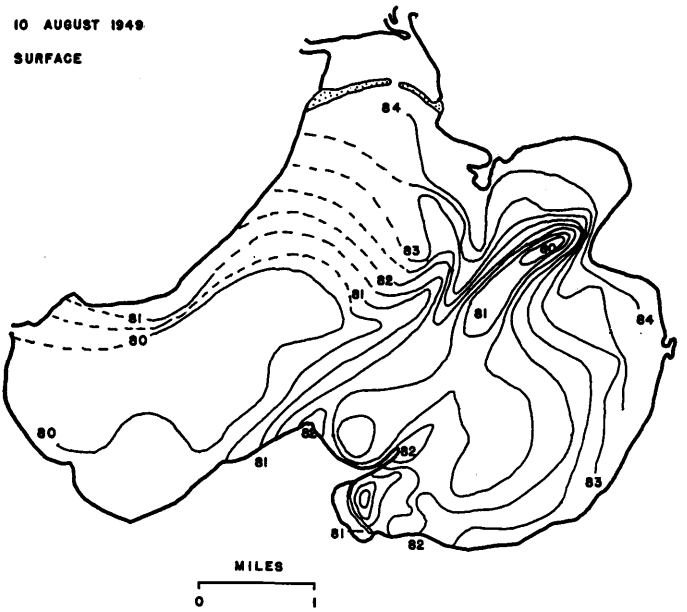

FIGURE 1. August 10, 1949. Isotherms are in degrees F. Surface.

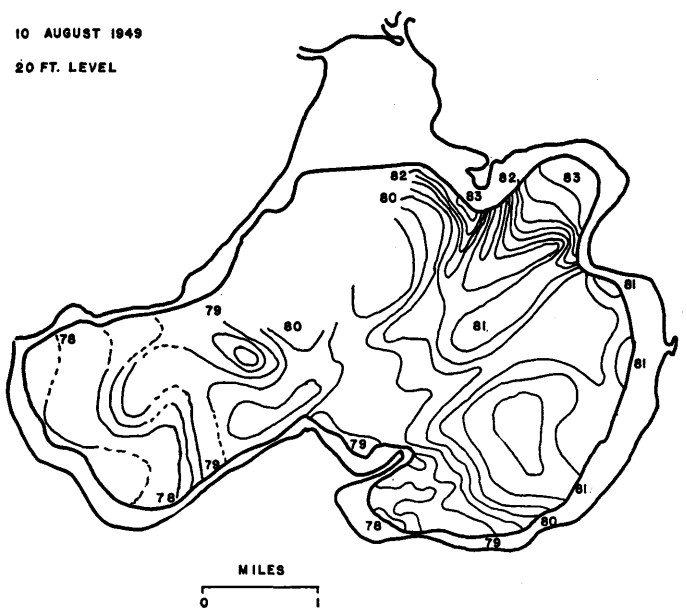

FIGURE 2. August 10, 1949. Isotherms are in degrees F. 20 foot level.

On August 19, the wind was from the northeast and there was considerable mixing within the epilimnion (fig. 4). The range of temperature was small but there was a steady increase of temperature from east to west, the warmer water being on the downwind side of the lake. The air was colder than the water and there was a good coupling between the wind and water.

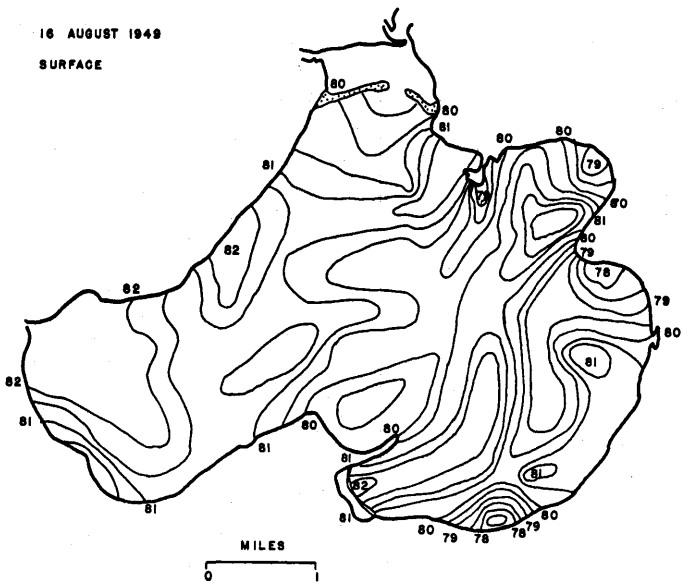

FIGURE 3. August 16, 1949. Isotherms are in degrees F. Surface.

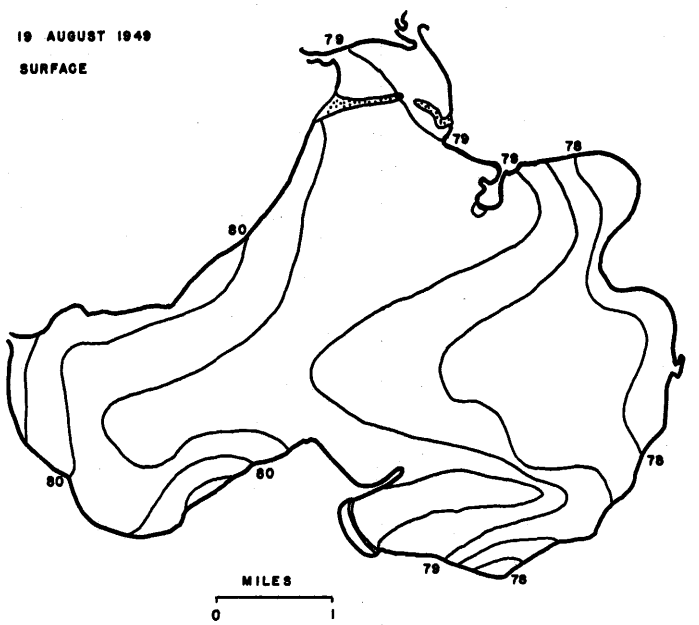

FIGURE 4. August 19, 1949. Isotherms are in degrees F. Surface.

On August 23rd, the horizontal variation of temperature on the surface is three degrees F (fig. 5). There had not been a complete change in the thermal condition of the lake from the previous day's west wind to the south wind of the 23rd. The points of land again showed tongues of water of uniform temperature. This map also brings out the shelter belt effect of a point of land, which breaks or slows down the wind, leaving the water in the lee of the land little disturbed.

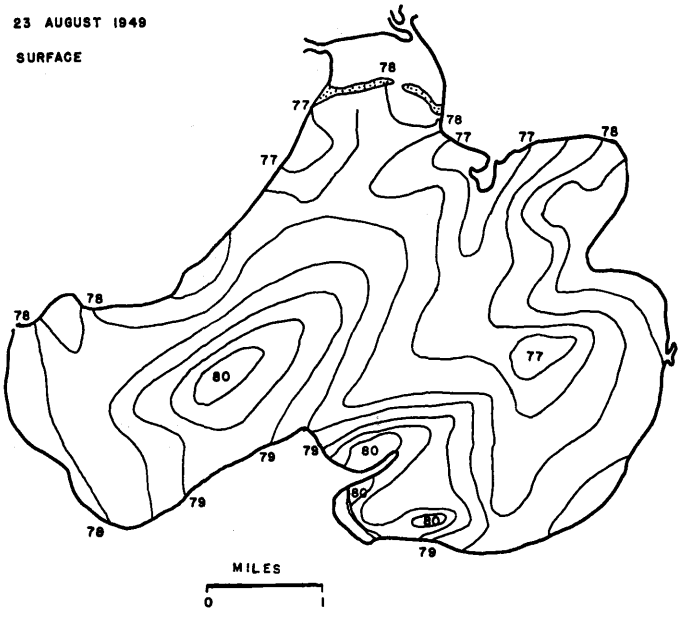

FIGURE 5. August 23, 1949. Isotherms are in degrees F. Surface.

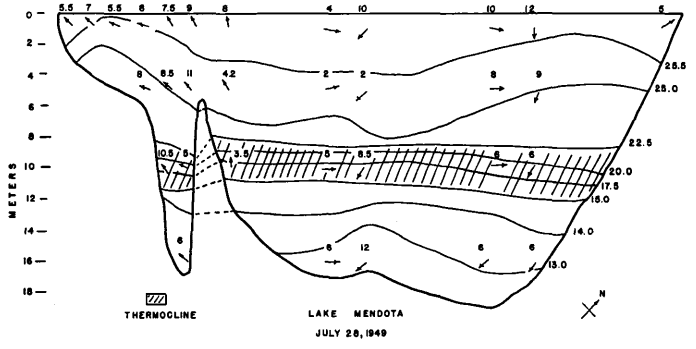

FIGURE 6. Section across the entrance to the large bay, wind was south-southwest 16.4 mph. Isotherms in degrees C. All numbers after the current arrows are in meters per minute.

When the warm water is piled to considerable depth on one side of the lake it produces pressure-temperature solenoids. This unbalanced condition can and does cause strong currents toward the downwind side of the lake in the hypolimnion, reverse to the surface currents.

Current measurements, using free floating vanes, were made throughout the month of July, and temperature profiles were made with the Whitney thermometer.

Figure 3 shows a striking example of the reversal of deformation in the epilimnion and the hypolimnion. This has been found in several profiles. Note that the fastest currents recorded, 12 meters per minute, were observed at the bottom and at the surface.

Rawson (1950) showed that there was a 4° F change or more in the 7 miles across McLeod bay in Great Slave Lake during August, 1945. These changes compare to those found in Mendota.

SUMMARY

A random sounding is hardly representative of the thermal structure of a lake. The fluctuations of temperature from day to day is not due to heating and cooling alone but mostly, at this season, to the movement of water within the lake. Thermal variations and patterns present in Lake Mendota are also found in other great lakes. An intensive study of the thermal structure of a small lake may give valuable clues to the thermal patterns present in larger lakes.

In an analysis of the four cruises, certain patterns are apparent. (1) The temperature of the lake surface is not horizontally uniform. (2) Deeper layers within the epilimnion show a greater variation of temperature than does the surface. (3) At any given point there is a great short time variation of temperature. (4) The changes can best be accounted for by wind-driven currents within the lake.

REFERENCES

Parmenter, R. 1929. Hydrography of Lake Erie. Bull. Buffalo Soc. Nat. Sci., 14: 25–49.
Rawson, D. S. 1950. The physical limnology of Great Slave Lake. Jour. Fish. Res. Board of Canada, 8: 1–64.