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PHYSICOCHEMICAL LIMNOLOGY OF FOUR RESERVOIRS IN SOUTHWEST NEBRASKA

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ABSTRACT

Physicochemical data from four reservoirs in Nebraska taken within a 30-hour period in August, revealed moderate thermal stratification, closely associated in two reservoirs with the functioning low-level outlet. The reservoirs with thermoclines exhibited greater temperature ranges and contained cooler waters than did reservoirs without thermoclines. The distribution of fish as detected on sonar often revealed the presence and location of a thermocline prior to physical or chemical data verification.

Without exception, the larger the reservoir and the lower the outlet, the better the reservoir fishery. Downstream fisheries ranked the same with one exception.

Introduction

THE primary purpose of this work was to evaluate physicochemical data collected under similar conditions from four different reservoirs within a period of 30 hours, August 15-16, 1962.

All four are man-made reservoirs located on the Great Plains in the Republican River drainage within a 60-mile radius of Indianola, Nebraska.

The reservoirs provide fishing for catfish, crappie, bluegill, white bass, walleye, largemouth bass, and northern pike. Before the physicochemical data were analyzed, Bob Thomas, the senior state fishery biologist of the area for many years, was asked to rank all four reservoir and downstream fisheries as to their order of importance on the basis of productivity and fisherman success.

Methods

Temperature ($^{\circ}$ F.) and dissolved oxygen (p.p.m.) profile data were collected at 5-foot intervals or less from top to bottom in the deepest waters of all four reservoirs. A portable sonar device, the Lowrance Fish Lo-K-Tor, enabled quick, accurate depth readings. Determination of dissolved oxygen was by the Alsterberg (Azide) modification of the Winkler method and water temperatures were taken

with a Taylor thermometer as soon as samples were brought to the surface with a one-liter Kemmerer water sampler.

Results

Harlan County Reservoir was completed in 1951 and is the largest of the four reservoirs studied, having a conservation pool of 13,240 acres.

On August 15, 1962, at 5:30 p.m. the air temperature was 86° F., with a light wind blowing. Water temperatures varied from 78.5° F. near the surface to 75.5° F. near the bottom, a range of only 3° F. in 55 feet. The reservoir surface was at elevation 1946.2 feet m.s.l. No thermocline was evident in this large, wind-swept impoundment. Previous surveys on this reservoir also revealed relatively isothermal conditions.

Dissolved oxygen was above the super-saturated level near the surface, exceeded 5 p.p.m. to a depth of 40 feet, then rapidly dropped to 2.4 p.p.m. at 50 feet and 0.5 p.p.m. at 60 feet. Sixty feet was the deepest water we could find on the sonar, indicating that 10 feet of silt had accumulated in the 11-year period since impoundment in 1951.

The intake to the low-level outlet was also 60 feet below the surface, and 2,000 c.f.s. were being discharged downstream from this level into a 16-foot deep stilling basin. An irrigation release of 165 c.f.s. was being made near elevation 1920, a depth of about 26 feet.

Biologist Thomas rated Harlan County Reservoir No. 1, both for reservoir and downstream fishing.

Swanson Lake on the Republican River was completed in 1953. This Bureau of Reclamation reservoir is the second largest of those studied, having a conservation pool of 4,974 acres.

On August 16, 1962, at 2:00 p.m. the air temperature was 84° F., and wind velocity was light. Reservoir water temperature varied from 77° F. near the surface to 63° F. near the bottom, a range of 14° F. in 55 feet. A thermocline was present at the 35 to 40 foot depth, just above the intake of the low-level outlet.

Dissolved oxygen was above the super-saturated level near the surface, in excess of 4 p.p.m. to a depth of 35 feet, a point just above the top of the thermocline and the outlet intake. At the 40-foot depth, dissolved oxygen measured 2 p.p.m. and at the 50-foot depth there was no dissolved oxygen. The sonar revealed many fish at various depths down to 35 feet, especially near the top of the thermocline and none below this level.

A flow of approximately 1,000 c.f.s. was being released downstream through the low-level outlets approximately 42 feet below the surface.

This reservoir was rated No. 2 for fishing above the dam and No. 3 for downstream fishing.

Harry Strunk Lake, completed in 1949 on Medicine Creek, a tributary to the Republican River, is third in size with a conservation pool of 1,850 acres.

On August 15, 1962, at 9:30 a.m. the air temperature was 75° F. and wind velocity was light. Reservoir surface-to-bottom water temperatures ranged from 77° F. to 66° F., a change of 11° F. in 50 feet. A thermocline was present between the 25 and 30 foot depths and as in Swanson Lake, it was situated just above the intake to the low-level outlet.

Dissolved oxygen was above the super-saturated level near the surface, exceeded 4.5 p.p.m. to a depth of 30 feet—just below the thermocline, and then rapidly dropped to 0.9 p.p.m. at 40 feet and to zero at 50 feet. No fish were detected on the sonar, and the maximum depth of 50 feet indicated 15 feet of siltation.

Four hundred c.f.s. were being released downstream through the lowest outlet at elevation 2335 feet m.s.l., about mid-depth in the reservoir, into a stilling basin 16 feet deep. Nineteen c.f.s. were spilling through the notch in the spillway at elevation 2366.1 m.s.l.

The reservoir was ranked No. 3 for reservoir fishing and No. 2 for downstream fishing.

Enders Reservoir was completed in 1950 on Frenchman Creek, a tributary to the Republican River. It is the smallest of the four reservoirs studied, with a conservation pool of 1,707 acres.

On August 16, 1962, at 4:00 p.m. the air temperature was 82° F. and wind was light. Reservoir water temperatures ranged from 75° F. near the surface to 68° F. near the bottom, a difference of 7° F. in 60 feet. No thermocline was present.

Dissolved oxygen exceeded 4.4 p.p.m. to the 40-foot depth, and then rapidly declined to 2.8 p.p.m. at 45 feet and zero at 60 feet. Sixty feet was the greatest depth found, indicating 10 feet of siltation. Many fish were detected on the sonar down to 35 feet.

Three hundred and forty c.f.s. were being discharged downstream through the outlet high in this reservoir, from a depth of about 25 feet into a stilling basin 9 feet deep.

The fishery was rated No. 4 for both the reservoir and the stream below.

Discussion

There was a close correlation between the size of the reservoir, the depths of the intake to the low-level outlet, and the value of both the reservoir and tailwater fishery. Without exception, the larger the reservoir and the lower the outlet, the better the reservoir fishery. Downstream fishing ranked the same with the single exception that the second and third largest reservoir ratings were reversed.

There was a substantially greater proportion of water suitable for fish life (O_2 above 4-5 p.p.m.) in the reservoirs with the lower outlets. Dissolved oxygen exceeded the super-saturated level near the surface in three of the four reservoirs.

The two reservoirs with thermoclines exhibited greater ranges of temperature (13° F. and 11° F. as compared to 70° F. and 3° F.) and

contained cooler waters (63° F. and 66° F. as compared to 68° F. and 75.5° F.) than did the reservoirs without thermoclines. The distribution of fish as detected by sonar often revealed the presence and location of a thermocline.

The thermocline in both reservoirs was closely associated with the intake to the functioning low-level outlet, one between the 35- and 40-foot and the other between the 25- and 30-foot depth. If the depth of stratification can be influenced by varying the depth of the outlet works, this may be a practical means of increasing reservoir habitat capable of supporting fish life.