Limnological Observations On Some Flint Hills Farm Ponds[1]

OTTO W. TIEMEIER and ROBERT B. MOORMAN[2]

The number of farm ponds in Kansas is increasing each year. These ponds serve primarily as a source of water for farm livestock, however, many such ponds also have potentials for sport fishing and other recreation. Consequently a research program on the biology of farm ponds was inaugurated in the summer of 1953. Primary aims were to determine the production in pounds of fish that might be expected from an acre of average Kansas impounded water; to test the suitability of various species and species combinations of fishes; and to study the growth and suitability of channel catfish to farm pond conditions. Limnological studies resulted from the primary interest in fish production.

Surveys of 40 ponds within a 30-mile radius of Manhattan were made, 16 of which were chosen originally as potentially suitable for fish and for intensive limnological studies. The ponds varied from 6 to 20 feet deep when full, but none contained more than 14 feet of water during 1955.

The three summer months of 1955 were unusual in the three counties where the ponds are located. Average mean temperature for June was 70.9° F. or 3.8° F. less than average, for July 84.4° F. or 4.2° F. above average and for August 80.6° F. or [illegible] F. above average. For the entire three months the mean temperature averaged only 0.9° F. above average.

The average rainfall for the three summer months in this area is 12.3 inches. Four weather stations in the area where the ponds are located reported from 5.23 to 8.05 inches of rainfall during the summer months or 41 per cent to 66 per cent of average. Most of the data presented in this paper were obtained during this period of low rainfall and almost average temperature.

Methods

The techniques and equipment used in the oxygen determinations were those described by Swingle and Johnson, 1953. Temperatures were taken with a maximum-minimum thermometer. Turbidity readings were made with a platinum wire turbidimeter. Soil tests were made by the Kansas State College Soil Testing Laboratory. All pond readings were taken at three-foot intervals, starting at the surface.

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[1] Contribution Number 271, Department of Zoology, Kansas Agricultural Experiment Station, Manhattan, and Number 316, Department of Zoology, Kansas State College. In cooperation with the Kansas Forestry, Fish and Game Commission, Pratt, Kansas.

[2] Robert B. Moorman now at Department of Zoology, Iowa State College, Ames, Iowa.

SOIL ANALYSES

Since the inorganic nutrients of both the flora and fauna of pond waters must primarily be derived, directly or indirectly, from the soil floor of the pond the composition of such soil should give some indication of the pond's potential to support fish life.

Soil samples were taken in the spring of 1955 when the pond levels were low enough to permit sampling of areas that had been inundated around each pond the previous summer. The five or six samples from around each pond were mixed thoroughly and the mixture tested for organic matter as an index to nitrogen content, phosphorus and potash.

TABLE 1. S[illegible] 1955.

Pond	Organic matter percent	Rating	Phosphorus lb./A	Rating	Potash lb./A	Rating
Home No. 1	0.95	VL	12	L	400	VH
Home No. 3	3.2	H	42	M	520	VH
Home No. 5	1.0	VL	8	VL	370	VH
Home No. 6	0.65	VL	6	VL	195	M
Home No. 7	0.8	VL	6	VL	225	H
Home No. 9	1.3	1.	6	VL	195	M

VH—very high; H—high; M—medium; L—low; VL—very low.

Table 1 gives results obtained by testing soils taken from around six ponds of one owner in the bluestem pasture area south of Manhattan. These ponds were all within an area of one square mile and indicated the wide variation that may occur within a small area of apparently similar soil types and identical land use. The organic matter content of these pond soils—i.e. the potential source of nitrogen, was very low (1.0 per cent or less) in four instances; low in one (1.3 per cent); and high in only one (3.2 per cent).

Available phosphorus varied greatly in the bottom soils of these six ponds. Four of the six contained less than ten pounds of available phosphorus per acre (considered very low) ; one between 10 and 25 pounds per acre (low) ; and one contained between 25 and 50 pounds per acre, or a medium content of phosphorus.

The potash content of the bottom soils was 195 pounds per acre or more, considered adequate. Six of the soil samples taken from around the 16 ponds studied in the three counties contained more than 500 pounds of potash per acre.

These results indicated that soil tests should be made before a pond fertilization program is undertaken. They also indicate that in this portion of the state pond fertilizers generally should be relatively high in nitrogen and phosphorus and contain little or no potash. A new investigation has been undertaken to determine how much, if any difference there might be in the pounds of fish produced in ponds showing wide variations in the three primary soil elements.

Dissolved Oxygen

The tolerance of fish to wide variations in dissolved oxygen has been discussed by many investigators. Moore, 1942, found that 4ppm or more was adequate for yellow perch. Swingle, 1947, found that adult bluegills were not killed until oxygen fell to 0.1 ppm. Byrd, 1952, believed that less than 0.4ppm was critical to bluegills. Undoubtedly there is considerable difference between the amount of oxygen necessary for survival and the oxygen level at which fishes, such as bluegills, largemouth bass, and channel catfish do well. We have arbitrarily assumed 4ppm as the critical point for good growth and reproduction of these three species.

Dissolved oxygen varied from 0.0 to a supersaturation of 11.1ppm at the surface between the last of May and the first of September (Table 2). Two of the 93 readings were below 4ppm. Wallen, 1955, found a variation of 3.0 to 32.3ppm while Ratzlaff, 1952, obtained a range from 2.6 to 18.0ppm with an average of 9.9ppm.

Table 2. Dissolved oxygen in pond waters at three depths in 1955.

Period	No. of tests 0 ft.	Range	Av.	No. of tests 3 ft.	Range	Av.	No. of tests 6 ft.	Range	Av.
5/30-6/5	12	2.0- 9.5	7.5	12	3.0- 0.5	6.7	12	0.3-7.6	4.7
6/14-6/18	9	0.0-11.1	7.4	9	1.5- 8.3	6.1	9	0.5-5.3	2.6
6/19-6/21	5	6.3- 9.2	7.4	5	0.5- 9.0	4.8	6	0.0-1.8	2.2
6/25-6/30	12	5.7- 8.7	7.0	12	0.6- 8.1	6.2	12	0.2-6.8	2.8
7/10-7/15	14	5.2-10.8	7.2	14	0.5-10.0	5.5	12	0.0-4.5	0.9
7/16-7/20	3	6.0-10	7.4	3	5.8- 9.5	7.2	2	0.0-2.0	1.0
7/22-7/29	14	5.2- 9.7	7.3	14	0.8- 8.3	6.0	11	0.2-8.3	3.2
8/7 -8/11	13	4.8- 8.3	6.5	13	0.3- 7.8	5.1	10	0.0-6.3	2.7
8/30-9/2	11	5.5-10.0	7.3	11	3.2- 7.2	5.6	10	0.0-8.0	4.7
Totals	93			93			84		

At three feet below the surface the 93 readings varied from 0.5 to a supersaturation of 15.4ppm. Seventeen of the 93 readings were below 4ppm. Averages of all readings were usually considerably below readings made at the surface (Fig. 1).

The 84 readings taken at a depth of six feet varied from 0.0 to a supersaturation of 10.5ppm. Fifty-four of the readings were below 4ppm, with 24 of the 54 below 0.5ppm. In Fig. 1 notice that the averages of dissolved oxygen were below 4ppm from June 7 to August 25 at the six-foot depth and that during some of July averages were 1.0ppm or less. Consequently, it may be assumed that during the summer months of 1955 the dissolved oxygen content at six feet and below generally was not conducive to good growth and reproduction of fishes.

The averages of dissolved oxygen at the surface were remarkably constant during the summer months (Fig. 1). There was more variation at the three-foot level and most pronounced differences were recorded at 6 feet. It was noted that pronounced stratification had already

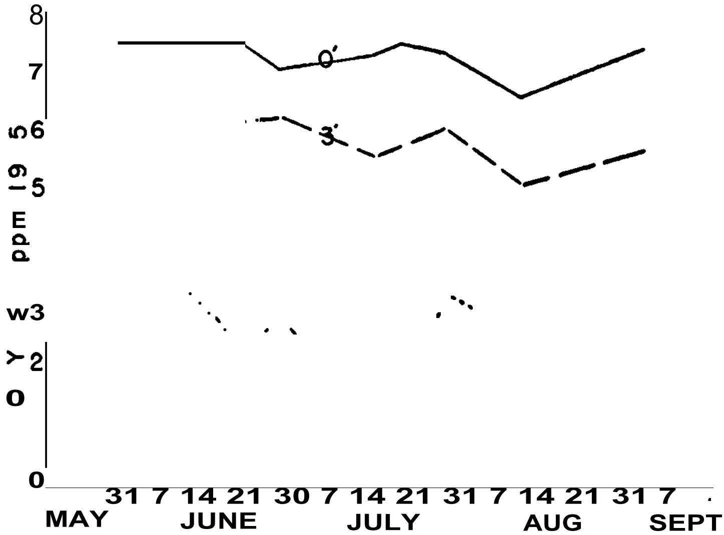

Fig. 1. Dissolved oxygen content of pond waters at 3 depths.

occurred by the end of May and continued until a mixing trend was noted in the last days of August. An exception was noted between the surface and three-foot depth during the middle of July when there was a difference of only 0.2ppm. This may have resulted because readings were taken from only three ponds on those dates.

Temperature

A total of 288 temperature readings were taken at the three depths in 16 ponds investigated. Temperatures at the surface varied from 68° to 92° F. from May 30 to September 3 (Table 3). Wallen, 1955, found a maximum surface temperature of 96.5° F. in Oklahoma ponds. The temperature readings at the three-foot depth ranged from 64° to 84° F. and averaged the highest during the middle of July (Fig. 2). At six feet the temperature ranged between 62 and 81° F. and the highest averages came about one week later than at the surface and at three-foot levels. Water temperatures at all three levels fell sharply the first two weeks of June, probably because of more than two inches of rainfall June 4 and 5 accompanied by a mean temperature of almost 5° F. below the average.

By the end of May the ponds showed a marked thermocline. This condition remained for most of the summer, except for. a short time during the middle of July when readings of only two ponds were taken. About the middle of August it became apparent that most of the pond waters had begun to mix quite well so that by August 7 to 10 an average

Table 3. Fahrenheit temperatures of pond waters at three depths, 1955.

Period	No. of tests 0 ft.	Range	AV.	No. of tests 3 ft.	Range	Av.	No. of tests 6 ft.	Range	Av.
5/30-6/5	12	70-78	74.0	12	66-76	72.2	11	62-72	67.7
6/14-6/18	9	68-76	71.6	9	64-69	67.1	9	62-66	63.2
6/19-6/21	5	76-87	82.3	5	73-77	75.6	5	66.74	68.6
6/25-6/30	13	72-82	75.3	13	68-78	73.8	13	64-78	70.6
7/10-7/15	16	72-92	84.4	16	69-84	80.6	16	70-80	74.3
7/16-7/20	2	77-84	80.5	2	77-80	78.5	2	77	77.0
7/22-7/29	15	78-87	82.9	15	77-84	81.0	15	73-81	76.7
8/7 -8/11	13	76-85	79.9	12	75-80	77.9	11	75-79	77.0
8/30-9/2	13	68-79	74.1	13	66-74	72.0	11	66-74	71.3
Totals	98			97			93		

difference in temperature of only 2.8° F. was noted between the surface and the six-foot depth. This mixing occurred when the average mean temperature for August was 80.6° F. compared with 84.4° F. for July. The August temperatures were 2.1° F. above the average mean for that month.

The largemouth bass spawned by the end of May and had begun to appear in our seines by June 10 and 12. The average temperature of the water down to three feet was then above 70° F. (Fig. 2). Bluegills in some of the ponds had spawned by June 28 after surface temperatures above 80° F. were reached around the 20th of the month.

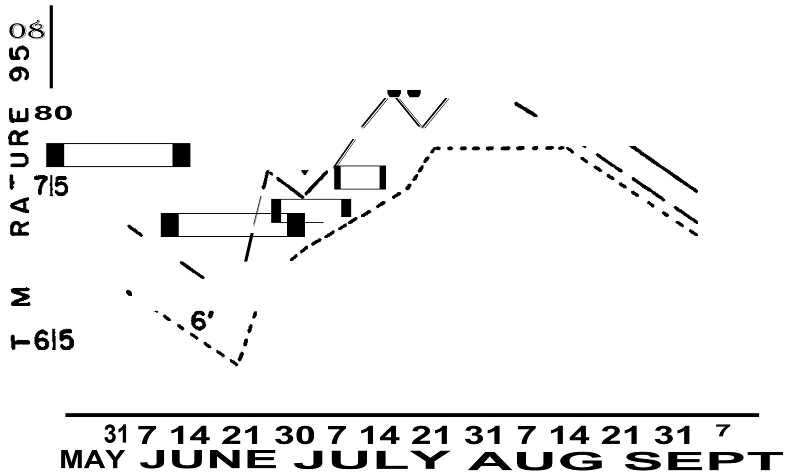

Fig. 2. Average temperatures of pond waters at 3 depths.

Turbidity

Generally waters with turbidity readings of 25ppm or less are arbitrarily regarded as clear. About half of the ponds were dear at times and most of them were muddy (over 100 ppm) for short periods following the few rains of 1955.

Buck, 1956, classified Oklahoma ponds as clear if the average turbidity was less than 25ppm; those having average turbidities of 45 to 100ppm as intermediate; and those averaging more than 100ppm as muddy. If turbidity readings averaging 25 to 40ppm were caused by plankton populations (as in the case of the Avery and Home ponds (Table 4) the ponds were classified as clear. Those with average turbidities between 40 and 100ppm were classified as intermediate in clarity; and those of over 100ppm as muddy. Therefore, four were considered clear, six intermediate, and six muddy in this study.

The highest turbidity found was 1500ppm and this same pond had a low reading of 45ppm. The highest average turbidity was 523ppm and the lowest 34ppm.

Wallen, 1951, has shown that lethal turbidities probably do not occur naturally for species of fish commonly stocked in farm ponds. Buck, 1956, showed that "the average total weight of fish in clear farm ponds was approximately 1.7 times greater than in ponds of intermediate

Table 4. Summary of turbidity readings on pond waters.

Pond	No. Readings	Range	Average	
Home No. 9 -----------	7	28-85	34	Clear
Home No. 6 -----------	10	11-85	39	
Home No. 1 -----------	6	9-70	40	
Avery ---	15	14-70	40	
Burgess No. 4	9	35-110	54	Intermediate
Burgess No. 1	9	28-120	56	
Burgess No. 5	7	35-110	66	
Home No. 7 -----------	8	22-120	73	
Burgess No. 3	9	28-160	74	
Henry ---	11	20-160	81	
Oman ---	10	30-180	112	Muddy
Schurle No. 2	9	60-200	117	
Dugan --	13	90-500	227	
Akin ----	9	160-400	260	
Prestwood	9	45-1500	365	
Renz ----	10	80-1000	523	

turbidity and approximately 5.5 times greater than in muddy ponds." He further stated that "high turbidities reduced growth and total yield of bass and bluegill but increased channel catfish production. Individual catfish grew faster in clear ponds, but muddy ponds yielded much greater total weights of channel catfish than either clear or intermediate ponds." The Kansas Agricultural Experiment Station has been recommending that ponds with average turbidities greater than 100ppm should not be stocked with bass or bluegills. Some of the muddy ponds have been stocked with channel catfish and have yielded good crops of this species but not of bluegills or bass.

Summary

1. These investigations were made during the summer of 1955 when the average mean temperature was 0.9° F. above average and the rainfall 41 per cent to 66 per cent of average.

2. Wide variations in the organic matter, phosphorus and potash contents of pond soils may occur within a restricted area.

3. Dissolved oxygen content of the pond waters at six feet and below was too low most of the summer months to be conducive to good growth and reproduction of fishes.

4. Pond waters were strongly stratified by the first of June and this condition remained until mixing occured about mid-August. This mixing apparently was not caused by low air temperatures.

5. Four of the 16 ponds were clear; six intermediate in turbidity; and six muddy.

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Notes on the Development of a Brood of Mississippi Kites in Barber County, Kansas

THANE S. ROBINSON
University of Kansas, Lawrence

The Mississippi Kite *(Ictinia misisippiensis)* was considered a rare summer resident in Kansas by Goss (1886:22). Some 27 years later, Bunker (1913:146) termed it a common summer resident in Barber and Comanche counties in south-central Kansas, where I also found it to be common in 1952 and 1953. In the late spring and summer of 1952, I observed the successful nesting of a pair of Mississippi Kites in northeastern Barber County, Kansas, when, through the kindness of Messrs. Floyd and Henry Amsden, I was conducting research at Plum Thicket Farm. Mr. Laverne Winter, a farm boy, helped me gather information at the nest, which I visited 24 times.

Northeastern Barber County is on the eastern edge of the high plains-low plains ecotone. It is typically an area of tall grass prairies, the dominant plant species being bluestem grasses (principally *Andropogon hallii*). Trees usually are limited to the banks of flood plains of the intermittent streams, although introduced and native species of trees planted as shelter belts are common on the north and south borders of cultivated fields, and adjacent farm buildings.

Nesting and Incubation

I first noticed Mississippi Kites in the area, in 1952, on May 11. Goss (1887:25) reported seeing "quite a number" of these birds on May 9, in north-central Barber County, Kansas. Sutton (1939:42) listed May 7 as the date of arrival of Mississippi Kites in western Oklahoma in 1936, and Bent (1937:64) considered the period May 1-15 as including the time of arrival of these birds in northern Oklahoma. The completely constructed nest, situated in a black locust tree *(Robinia pseudo-acacia),* was first observed by me on May 22, 1952. The nest-tree is one of a series of black locust trees planted as a shelter belt along the north side of the NE 1/4, Sec. 9, T32S, R10W, Barber County, Kansas. This location is approximately two miles north and one mile east of the town of Sharon. Judging from reports in the literature, the Mississippi Kite is not selective in its choice of tree for a nesting site; most kinds of trees, and a few shrubs, which occur within