FARM PONDS

IN DOUGLAS COUNTY, KANSAS

By
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and
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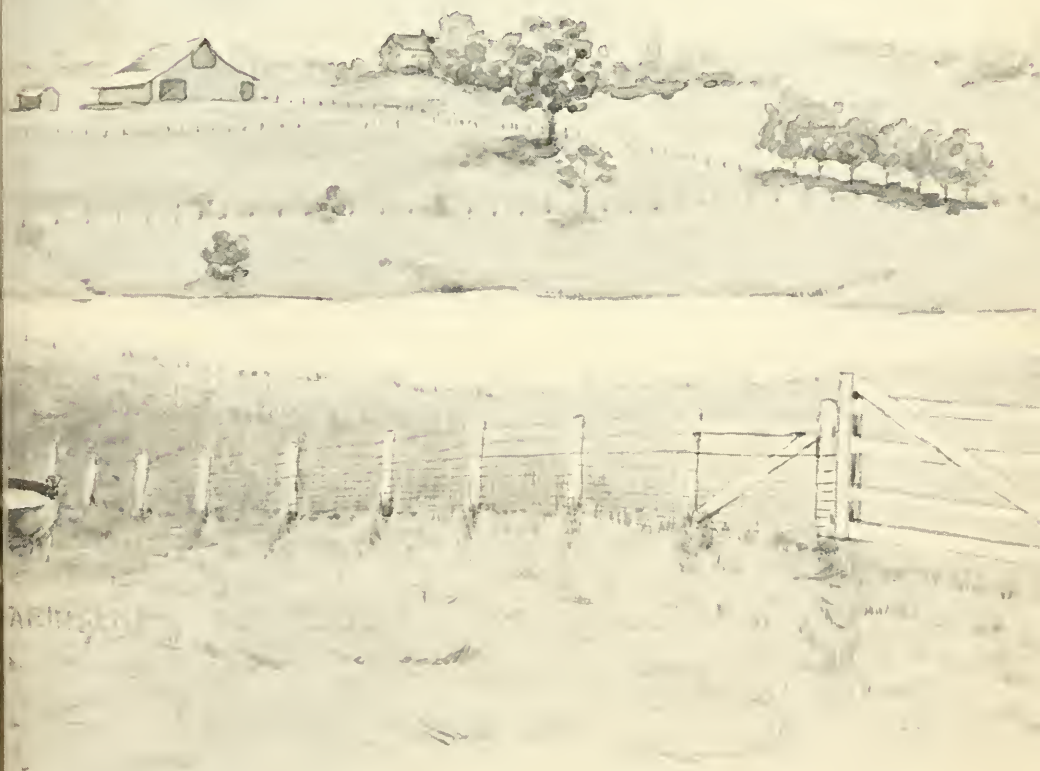

STATE BIOLOGICAL SURVEY OF KANSAS

Farm Ponds in Douglas County, Kansas, and Their Use in Fish-Production

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Introduction

This paper reports: (1) the number and sizes of farm ponds in Douglas County, Kansas, in 1954, as determined by means of aerial photographs, (2) additional information concerning these ponds gained from questionnaires in 1955 and 1956, and (3) information concerning species of fish and their growth-rates gained from sampling of 22 ponds in 1956.

Methods

The number, sizes, and locations of all farm ponds in Douglas County were ascertained in October, 1955, from aerial photographs taken for the U. S. Soil Conservation Service on June 29, 1954, and July 11, 1954.

In December, 1955, 100 of the 484 sections in Douglas County were randomly chosen for canvassing of pond-owners by questionnaires. All owners of ponds in these 100 sections were sent one questionnaire for each pond on their properties, plus an additional questionnaire to be used in the event that a pond not noticed on the aerial photographs was present. Questionnaires were accompanied by explanatory letters and stamped return-envelopes. In February, 1956, questionnaires were sent again to owners who had not responded previously.

From field studies of 22 ponds, the following data were obtained from each pond: (1) size of pond, (2) average depth—random measurements, (3) maximum depths, (4) turbidity—degree of muddiness, and (5) species, sizes, and ages of principal fishes. A Jackson turbidimeter was used for determining turbidities.

Samples of fishes were obtained from May 24, 1956, through October 3, 1956, by means of: seines (12 feet x 4 feet x ¼-inch mesh, 30 feet x 6 feet x ⅜-inch mesh, and 100 feet x 8 feet x 1-inch mesh); wire traps (6 feet x 2½ feet, 1-inch mesh); trot lines; hoop nets (3 feet diameter, double-throated, 1½-inch in fore-part of net and 1-inch mesh behind second throat); Fyke nets (8-foot wings, otherwise like hoop nets); gill nets (experimental and 150 feet x 6 feet x 1-inch mesh); and toxins (5 per cent rotenone). Seines were used most often. Wire traps and trotlines were ineffective in all ponds studied. Hoop nets and Fyke nets were ineffective in turbid ponds, but these nets and gill nets yielded larger samples than seines in one large, clear pond. Rotenone was used in three ponds with great effectiveness.

Total lengths, weights, and scales or pectoral spines were taken from fishes found in the 22 ponds. The scales and spines were used for age-determinations by means of equipment like that described by Van Oosten, Deason and Jobes (1934) and Leonard and Sneed (1951).

ACKNOWLEDGMENTS

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We thank the following persons: Melvon H. Wertzberger, Roy J. Huhn, and Leonard J. Kasky, U. S. Soil Conservation Service, Douglas County, Kansas, for assistance in ascertaining the number and sizes of farm ponds; owners of ponds, for their co-operation and keen interest in the project; George Harp, Clarence Harms, James Deacon, W. Jackson Davis, Joseph Davis, and Claud Ward (students of zoology at The University of Kansas), for assistance in field work; Jane Davis, for preparation of Figure 1; Shirley Hastings, for proofreading and typing of the manuscript; and Professor E. Raymond Hall (Director, State Biological Survey of Kansas) for editorial suggestions that improved the manuscript; Thomas H. Swearingen, Gene Pacheco, Francis A. Carmichael, and Victor Hogg for illustrations and art work.

NUMBER AND SIZES OF FARM PONDS

At the time aerial photographs were taken (1954), there were at least 1,316 ponds in Douglas County. According to Mr. Melvon H. Wertzberger, U. S. Soil Conservation Service, Douglas County, approximately 500 additional ponds were constructed between 1954 and 1960, resulting in an average of almost four ponds per square mile in Douglas County in 1960. The distribution of the 1,316 ponds observed on aerial photographs is shown in Figure 1, and the sizes of the ponds are shown in Table 1.

RESPONSES TO QUESTIONNAIRES

Questionnaires (see sample below) were sent to owners of 273 ponds. Items 1 and 2 were filled in before the questionnaires were mailed to the pond-owners. A total of 131 questionnaires (48.0 per cent) was returned (111 on first contact, 20 on second contact). Of those returned, 116 applied to ponds observed on the photographs, 11 applied to ponds constructed after the photographs were taken, and four applied to ponds outside the 100 sections selected for sampling. The following paragraphs summarize findings from the questionnaires.

There was a progressive but sporadic increase in the number of ponds built per year in Douglas County from 1915 to 1954. It was estimated that 329 ponds, one-fourth of all ponds in the county, were built in 1953. Soil Conservation Service officials in Douglas

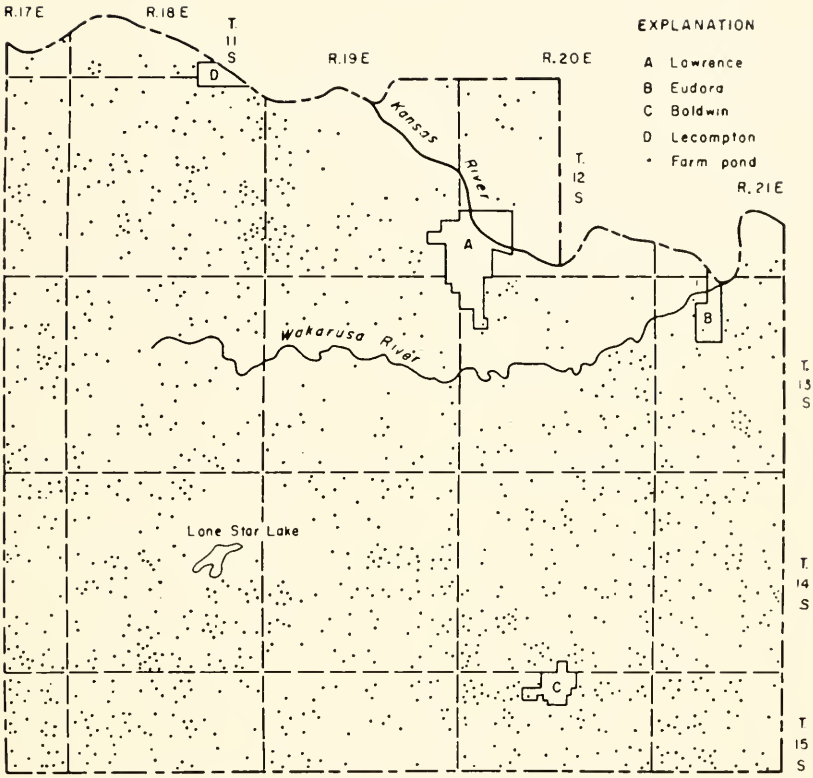


FIGURE 1. Distribution of Farm Ponds in Douglas County, Kansas, July, 1954.

TABLE 1. SIZES OF FARM PONDS IN DOUGLAS COUNTY, KANSAS, CONSTRUCTED PRIOR TO JULY 1, 1954, AS DETERMINED BY MEANS OF AERIAL PHOTOGRAPHS.

SIZE RANGE (Acres)	Number of ponds	Percent of total
0–¼	906	68.8
¼–½	272	20.7
½–¾	84	6.4
¾–1	19	1.5
1–1¼	13	1.0
1¼–1½	3	.2
1½–1¾	11	.8
1¾–2	3	.2
2–2¼	1	.1
2¼–2½	0	.0
2½–Over	4	.3
Totals	1,316	100.0

POND QUESTIONNAIRE

1. Owner:_____ Date:_____
2. Location of pond: Section_____, Township_____, Range_____
3. When was dam built?_____ When did pond fill?_____
4. Has pond ever gone dry?_____ Been intentionally drained?_____
5. Size of pond: Area (in acres)_____; greatest depth_____
6. Water source (check one or more): Surface drainage_____ stream_____, springs_____, other_____(If other, please explain) _____
7. Size of drainage area: Total_____; acres in pasture_____; acres in woodland_____; acres in cultivated fields_____
8. Are barn lots or feed lots for cattle or hogs in drainage area? _____
9. Purpose of pond (check one or more): Livestock water_____; erosion control_____; fishing_____; swimming_____; other_____.
10. Is pond fenced so that livestock cannot get into water?_____
11. Does pond have trickle-tube?_____; vertical overflow pipe?_____; surface spillway?_____; drainpipe through base of dam?_____.
12. Are plants growing in pond?_____
13. Has pond been fertilized?_____
14. Have fish been stocked?_____ Kinds and number of fish stocked (if known) _____ When stocked?_____ Where were fish obtained?_____ _____ Are any kinds of fish present other than kinds stocked?_____ If so, what kinds?_____
15. Are you interested in fish production in your pond?_____ Which are you more interested in: (1) fish for sport or (2) fish for food? _____
16. About how many times is the pond fished each year?_____
17. Do you feel that your pond is producing satisfactory fishing?_____
18. You may use the following space and the back of the questionnaire for any remarks you care to make.

County believe this was due to the progressive increase in construction of ponds and deferred building of ponds in 1951 and 1952, caused by floods in 1951.

Ponds built from 1952 through 1954 (dry years) held water better than ponds built during previous (mostly wet) years. Of 72 ponds constructed in 1951 or before, 40 (55.6 per cent) dried in the years 1952-1956. Of 50 ponds built after 1951, only nine (18.0 per cent) dried. Probable reasons are that most ponds built in recent years are deeper than those built prior to 1951, and older ponds not only were less deep originally, but received much siltation, especially in 1951, a year of exceedingly high runoff in this area.

The average size of ponds, based on responses to questionnaires, was larger than the average size ascertained from aerial photographs. This probably resulted from (1) responses based upon maximum (spillway) levels, whereas most ponds were not full when aerial photographs were taken; (2) overestimations of pond-sizes by owners; and (3) a tendency of owners to return questionnaires only for their larger ponds.

Surface-drainage was the only source of water for 80.0 per cent of the ponds.

Permanent pastures comprised 75.2 per cent of the watersheds of ponds. Cultivated lands covered most of the remaining area, with woodlands insignificant. Piner (unpublished dissertation, Kansas State College, 1952) also reported that pastures predominate in watersheds of ponds in Riley County, Kansas.

One purpose in building 98.4 per cent of the ponds was the provision of water for livestock; this was the only purpose listed for 70 ponds (54.3 per cent). Fishing was listed as a purpose of 51 ponds (39.5 per cent), ranking second to provision of water for livestock. Only one pond (0.8 per cent) was built solely for recreational purposes.

Few (5.5 per cent) of the ponds were fenced to exclude livestock. Later, it was learned that livestock actually had access to some ponds listed as fenced.

Few ponds (18.5 per cent) had means of controlling overflow except by surface spillways. Four per cent had vertical overflow pipes, and 8.1 per cent drainpipes. Only eight ponds (7.5 per cent) had been drained intentionally, chiefly (perhaps all) for reconstruction.

Approximately 16 per cent (15.9) of the ponds had been fertilized, presumably to increase fish production.

Eighteen per cent of the ponds contained rooted aquatic vegetation. Because aquatic plants usually grow only in clear waters, it may be assumed that at least 18 per cent of the ponds were clear. Although factors other than turbidity may prevent establishment of rooted vegetation in ponds, we suspect that disturbance by livestock and excessive turbidity accounted for the scarcity of aquatic plants in most of the remaining 82 per cent of the ponds.

Approximately one-half (49.6 per cent) of the ponds contained fish. Sources of fish for stocking by pond-owners were (1) state and federal fish hatcheries (36.0 per cent), (2) streams (18.0 per cent), and (3) other ponds (46.0 per cent). The vernacular names of fishes that were stocked, as listed by the pond-owners, were bass, channel catfish, bluegill, crappie, catfish, bullheads, river cats, perch, sunfish, sunperch, minnows, carp, cat, mudcats, fish, and rock bass. Locally, the names perch, sunfish, and sunperch refer most often to the green sunfish (*Lepomis cyanellus*). Five species of catfish that grow large enough to interest anglers occur in streams of Douglas County, but only two of these, black bullhead (*Ictalurus melas*) and channel catfish (*Ictalurus punctatus*), occur commonly in ponds. In responses to questionnaires, distinction was not made between the two native bullheads (black bullhead and yellow bullhead, *Ictalurus natalis*), or between the two species of crappie (black crappie, *Pomoxis nigromaculatus,* and white crappie, *Pomoxis annularis*). Eighteen stocking-combinations were found in 33 ponds for which the combinations could be ascertained.

Approximately three-fourths (77.6 per cent) of the pond-owners were interested in producing fish in their ponds—15.6 per cent for sport, 46.6 per cent for food, and 37.8 per cent for both purposes. Some owners of more than one pond were not interested in fish-production in all of their ponds, and some wished to produce fish for different purposes in different ponds.

The number of times ponds were fished each year varied from zero (six ponds) to 100 times (two ponds). The average was approximately 10 times.

Approximately one-third (34.4 per cent) of the ponds were producing satisfactory fishing in the opinions of their owners.

DISCUSSION OF PONDS SAMPLED

Data on the 22 ponds sampled are shown in Table 2. In this report, ponds with turbidities of 50 parts per million (p. p. m.) or less are considered clear; those that exceed 50 p. p. m. are turbid.

TABLE 2. PHYSICAL CHARACTERISTICS, AND SPECIES AND NUMBERS OF FISH OBTAINED IN SAMPLES FROM PONDS IN DOUGLAS COUNTY, KANSAS, IN 1956. ASTERISKS (*) DESIGNATE SPECIES THAT ARE KNOWN TO HAVE BEEN STOCKED; pr = SPECIES PRESENT BUT NOT ENUMERATED. LETTERS FOLLOWING NAMES OF OWNERS OF PONDS REFER TO PARTICULAR PONDS: 11-A, IN 11-ACRE PASTURE; SW, SOUTHWEST; U, UPPER; M, MIDDLE; S, SOUTH; L, LOWER; W, WEST.

PONDS	Area (acres)	Turbidity (p.p.m.)	Average depth (feet)	Maximum depth (feet)	Maximum possible depth (feet)	Largemouthed Bass	Bluegill	Crappie	Channel Catfish	Green Sunfish	Black Bullhead
					Clear Ponds						
Walburn	1/12	50	3.0	4.5	11.0	...	* 88	*104	*14	25	...
Booth 11-A	1/6	25-	2.5	3.5	7.5	...	...	...	*24	...	...
Booth SW	1/5	25-	4.0	5.5	8.5	* 3	...	...	*36	101	...
Booth U	1/4	25-	3.0	4.5	6.5	*pr	...	* pr	*	* pr	...
Booth M	1/3	25-	6.0	11.0	14.5	*pr	* pr	* pr	*pr	* pr	...
Butell	1/2	45	5.0	8.0	11.0	* 7	* 62	* 96	*	...	*
Holloway	1	25-	3.5	7.0	10.5	* 2	*100	* 28	*	* 2	* 1
Sportsmen's	4 1/2	25-	8.0	15.5	20.5	* 6	*165	*213	* 1	9	*11
					Turbid Ponds						
Gabriel	1/15	115	1.5	2.0	4.0	...	* 1	* 3	*1	...	*39
Rodewald S	1/13	51	3.0	5.0	6.0	...	...	...	...	*110	*24
Kern SW	1/11	423	2.0	3.0	8.5	...	...	...	...	*826	* 1
Churchbaugh U	1/4	138	3.0	4.5	4.5	...	...	...	...	4	* 6
Churchbaugh L	1/4	112	3.0	4.5	4.5	...	...	...	...	...	*19
Kerns S	1/3	375	4.0	5.5	7.5	*	...	...	*3	*16	*16
J. Beeghley	1/3	260	3.0	5.5	5.5	...	...	...	...	...	37
Riepen W	1/3	125	4.5	10.0	10.0	*8	...	* 1	...	...	...
D. Beeghley	1/3	93	3.0	4.5	7.0	*	*	...	*4	1521	564
Rodewald L	1/2	100	4.5	7.0	8.0	*	...	*	...	21	*19
Detwiler	2/3	525	5.0	9.5	9.5	*3	*23	*49	*	* 1	* 3
Stough	3/4	100+	2.5	3.0	4.0	*	*	...	*	2	27
Anderson	1	145	3.5	8.0	8.0	*1	* 1	...	*	44	1
Fawl	1	58	3.5	6.0	7.5	...	...	...	...	...	*42

Fishes found most often were green sunfish and black bullhead (each in 15 ponds). In eight ponds no other species were taken. The ponds may be divided into two general groups—one in which black bullhead and/or green sunfish predominated (14 ponds), and another in which sport-fishes—bluegill (*Lepomis macrochirus*), large-mouthed bass (*Micropterus salmoides*), and/or crappie—predominated (seven ponds). Channel catfish predominated in one pond (Booth 11-A), which had been stocked solely with that species approximately one year before the sample was obtained. Although the samples from Booth U Pond and Booth M Pond were not enumerated (Table 2), green sunfish predominated in the former pond and white crappie in the latter. Black crappie (found in seven ponds) and white crappie (six ponds) are not differentiated in the tables, because the species used in initial stocks were unknown. In addition to species tabulated, the following were found: carp, *Cyprinus carpio;* river carpsucker, *Carpiodes carpio;* fat-headed minnow, *Pimephales promelas;* golden shiner, *Notemigonus crysoleucas;* creek chub, *Semotilus atromaculatus;* flathead, *Pylodictis olivaris;* freshwater drum, *Aplodinotus grunniens* (each in one pond); and orange-spotted sunfish, *Lepomis humilis* (2 ponds).

Relationships between initial stocks, sizes of ponds, depths, turbidities, and predominate species are discussed below.

Initial Stocks

Most ponds were stocked with a combination of (1) largemouth, bluegill (and/or crappie), and channel catfish, or (2) green sunfish and black bullhead. The species stocked are indicated by asterisks in Table 2. Bluegill, black crappie, and white crappie were not distinguished in stocking records obtained from hatcheries that provided the stocks; often, all were found in samples. Owners of the ponds added green sunfish and black bullhead to several ponds that had been stocked with other species, and green sunfish and black bullhead were found in ponds not known to have been stocked with those species. Large-mouthed bass, bluegill, crappie, and channel catfish were found only where they were known to have been stocked.

Green sunfish or black bullhead predominated in nine of 15 ponds in which one or both of those species were stocked, in four ponds in which neither was stocked, and in one pond for which the kinds of fish stocked are not known (total of 14 ponds). Bass, bluegill,

crappie, or channel catfish predominated in eight of 16 ponds stocked with those species. Except for the fact that stocks comprised solely of black bullhead and green sunfish assured predominance by those species, there was little correlation between species of fish initially stocked and species that later predominated.

Size

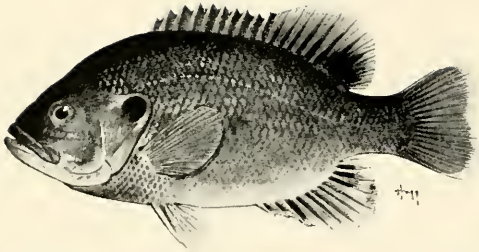
The surface areas of the 22 ponds were as follows: ¼ acre or less, nine ponds; ⅓ acre, five ponds; ½ to ¾ acre, four ponds; one acre, three ponds; and 4½ acres, one pond. Six ponds were full when areas were ascertained. The remainder varied from 1.0 to 6.5 feet below spillway levels.

Black bullhead and green sunfish predominated in 10 of 14 ponds smaller than ½ acre, and in four of eight ponds with areas of ½ acre or more. The correlation between size of pond and predominant species was due in part to differences in initial stocks. Four of the 14 smallest ponds were stocked only with green sunfish and black bullhead, whereas seven of the eight largest ponds were stocked with additional species of fish. However, one of the smallest ponds (Walburn Pond, 1/12 acre) contained the most species (11) found. Small pond-size seemingly does not limit the species of fish that a pond will contain; nevertheless, species other than green sunfish and black bullhead probably are rare in the smaller ponds of Douglas County.

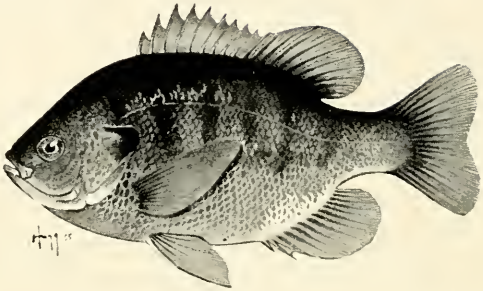
Depth

In sixteen ponds the average depth did not exceed 4.0 feet; none had an average depth greater than 8.0 feet. In fourteen ponds the maximum depth did not exceed 6.0 feet; none was deeper than 15.5 feet. Most ponds were not full when we measured their depths. Converted to spillway levels (maximum possible depths—Table 2), six ponds were 6.0 feet deep or less; 11 ponds, 6.0 to 10.0 feet deep; and five ponds, more than 10.0 feet deep. Because of dry weather, few of the ponds had maximum depths of eight to ten feet, as recommended by Davison (1955) for this region.

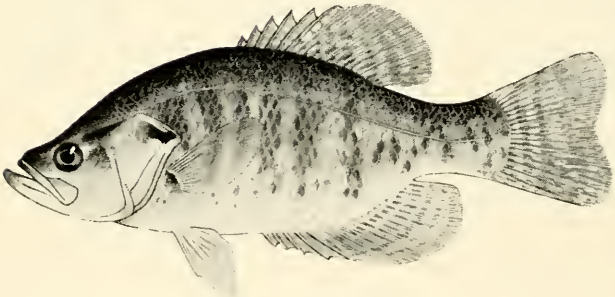
Survival and reproduction of bass, bluegill, and crappie were better in deep than in shallow ponds. Among ponds stocked with those species, one or more of them persisted in nine of ten ponds that had maximum possible depths of 8.0 to 20.5 feet (average 11.2 feet). The same species seemingly had disappeared from three of five ponds that had maximum possible depths of approximately 4.0 to 8.0 feet (average 5.2 feet). Larger numbers of crappie, bluegill,



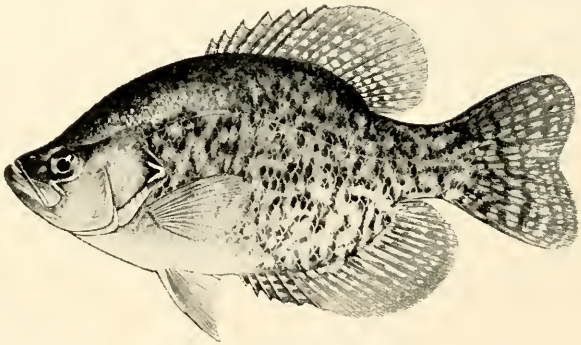
Green Sunfish, × ⅓



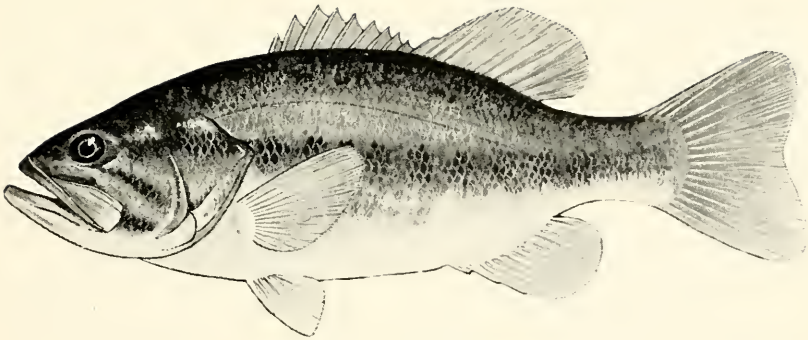
Bluegill, × ⅓



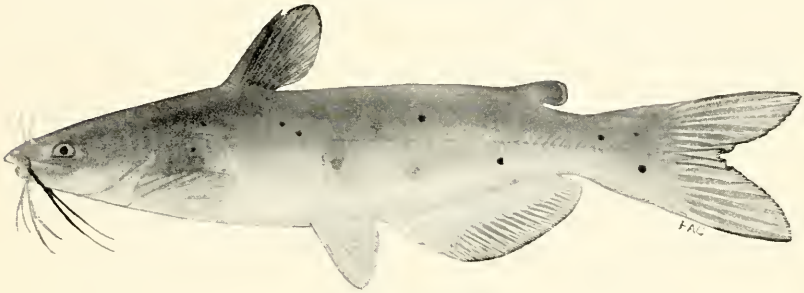
White Crappie, × ⅓



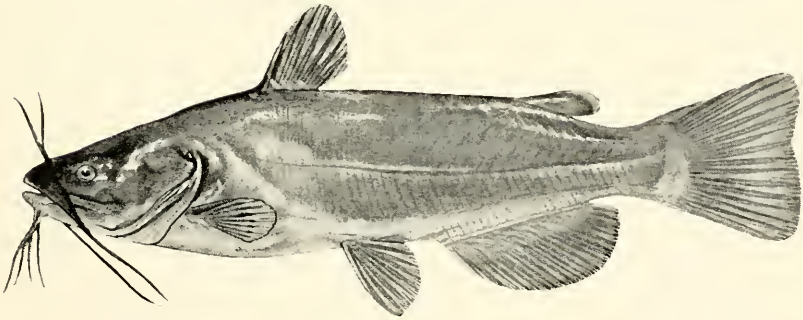
Black Crappie, × ⅓



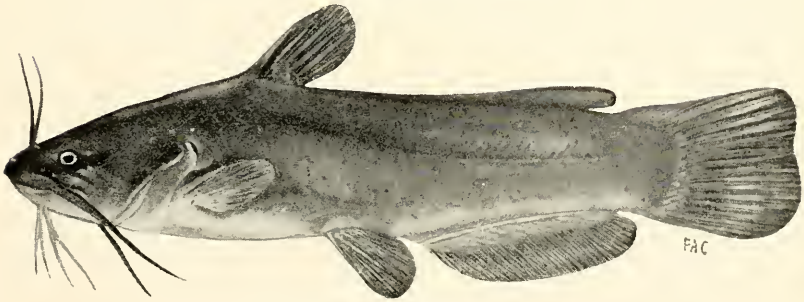
Large-mouthed Bass, × 1/4



Channel Catfish, × 1/3



Black Bullhead, × 2/5



Yellow Bullhead, × 2/5

and bass were found in deep ponds that were low, as the result of drought, than in deep ponds that remained full despite the drought. The latter ponds received excessive runoff and were turbid.

Turbidity

Turbidities of the 22 ponds varied from less than 25 p. p. m. (shown as 25— in Table 2) to 525 p. p. m. Turbidities of 25— p. p. m. are not measurable by means of a Jackson turbidimeter. The values listed in Table 2 are averages of one to four turbidity-readings made in different months, except those in ponds where fish populations were eradicated between dates of turbidity-readings. Detwiler Pond had a turbidity of 525 p. p. m. in July, 1956, but cleared after eradication of fish by means of rotenone (25— p. p. m. in August and September, 1956; 30 p. p. m. in October, 1956). According to Mr. Detwiler, his pond had never been clear. The turbidity of Walburn Pond dropped from 50 p. p. m. to 25— p. p. m. after fish were eradicated with rotenone in September, 1956. When full, Walburn Pond usually is clear, except for algal blooms.

Nearly all ponds that had less than 100 p. p. m. of silt in suspension contained emergent or submerged aquatic plants, or both. Exceptions were Booth 11-A Pond (recently constructed), Walburn Pond (extremely low when sampled, normally with algal blooms in summer), and Fawl Pond. Among ponds with turbidities exceeding 100 p. p. m., only Gabriel Pond (115 p. p. m.) had rooted vegetation.

Green sunfish and black bullhead predominated in most turbid ponds, and crappie or bluegill predominated in most clear ponds. Although large-mouthed bass and crappie predominated in the turbid Riepen W Pond, it contained no bullhead or green sunfish and only survivors from the initial stock were present; reproduction had not occurred. Crappie and bluegill were abundant in Detwiler Pond despite its exceptionally high turbidity (525 p. p. m.), but these and all other fishes were stunted.

Turbidity seemed to be the best single indicator of the species of fish to be expected in ponds of Douglas County. High turbidities were caused by (1) shallow depth associated with wave-action and use of the ponds by cattle; (2) small size, associated with use of the ponds by cattle; and (3) excessive or poorly-vegetated watersheds. Any of these three factors may influence the kinds of fish that a pond will support. Buck (1956) demonstrated that high turbidity severely limits growth and reproduction of bluegill and large-mouthed bass in ponds in Oklahoma. Numerous writers, including Tiemeier (1954) and most contributors to a *Symposium on*

Farm Fish Ponds and Management held by the Wildlife Society (Jour. Wildlife Management 16:233-288, 1952), have stressed the importance of relatively large size, deep water, exclusion of livestock, and well-vegetated watersheds to the production of satisfactory fish populations in farm ponds.

DISCUSSION OF SPECIES FOUND

In the following discussion, the survival and abundance of each principal species of fish is compared in turbid and clear ponds. Fourteen of the ponds were turbid and eight were clear. Growth rates of each species are shown in Table 3. Each pond that contained fish of a certain age contributed equally to the average length listed for that species and age in Table 3, regardless of the number of fish taken. Sizes listed under each age are averages for the ponds, not averages for all the fish obtained in samples.

Large-mouthed bass. Bass were found in three of seven turbid ponds that had been stocked with that species. In one of these (Riepen W, 125 p. p. m.) eight bass of the original stock were the only bass taken. In the other two ponds (Anderson, 145 p. p. m., and Detwiler, 525 p. p. m.), one bass and three bass, respectively, were taken in samples. When all fish were eradicated from the Detwiler Pond (area ⅔ acre), eight bass weighing a total of 7.16 pounds were found.

Bass were found in all six clear ponds stocked with that species. Three of these (Booth M, Butell, Sportsmen's) produced satisfactory fishing for bass.

Bass grew more rapidly in clear than turbid ponds (Table 3) despite their greater abundance in clear ponds. The maximum age attained was six years.

Bluegill. Bluegill were found in three of five turbid ponds that had been stocked with bluegill. Only one bluegill was taken in Gabriel Pond (115 p. p. m.), and one in Anderson Pond (145 p. p. m.). The Detwiler Pond (525 p. p. m.) contained numerous small bluegill, but only three of usable size (total weight 0.75 pound) were obtained when all fish were eradicated. Bluegill did not predominate in any turbid pond.

Bluegill were found in all five clear ponds stocked with that species. Samples indicated that each of these had more bluegill than did any of the turbid ponds. Bluegill predominated in one pond (Holloway, 25— p. p. m.). All but one pond that contained bluegill also contained crappie, and most contained green sunfish.

The growth-rate of bluegill was better in clear ponds than in

TABLE 3. AGES AND SIZES OF FISHES FROM 22 PONDS IN DOUGLAS COUNTY, KANSAS, IN 1956. NUMBERS WITH DECIMALS REPRESENT THE AVERAGE TOTAL LENGTHS IN INCHES AT EACH AGE (1-6). NUMBERS IN PARENTHESES, BELOW EACH AVERAGE LENGTH, INDICATE THE NUMBER OF FISH AND THE NUMBER OF PONDS ON WHICH THE AVERAGE LENGTH IS BASED.

AGE IN YEARS	0	1	2	3	4	5	6
Large-mouthed Bass							
Clear ponds	.....	6.3	11.6	11.8	.....	.....	.....
		(14,3)	(2,1)	(3,2)	.....	.....	.....
Turbid ponds	.....	.....	.....	11.0	.....	11.6	17.7
				(3,2)		(8,1)	(1,1)
Bluegill							
Clear ponds	2.7	4.5	4.9	5.6	6.2	6.3	6.1
	(2,1)	(40,3)	(15,2)	(8,2)	(4,1)	(2,1)	(1,1)
Turbid ponds	.....	2.9	4.2	5.4	.....	.....	.....
		(7,2)	(3,2)	(9,1)			
Black Crappie							
Clear ponds	.....	6.2	10.3	8.1	8.1	.....	.....
		(30,3)	(4,1)	(8,4)	(1,1)		
Turbid ponds	.....	.....	5.0	9.0	8.2	.....	.....
			(15,1)	(3,1)	(3,1)		
White Crappie							
Clear ponds	.....	5.4	6.5	7.5	6.9	6.9	.....
		(31,4)	(33,5)	(28,3)	(12,1)	(4,1)	
Turbid ponds	.....	.....	.....	.....	11.8	.....	.....
					(1,1)		
Channel Catfish							
Clear ponds	2.3	8.4	9.8	13.0	13.1	13.9	.....
	(13,1)	(28,2)	(1,1)	(3,2)	(3,1)	(4,1)	
Turbid ponds	.....	.....	.....	.....	12.2	20.9	16.9
					(1,1)	(1,1)	(6,2)
Green Sunfish							
Clear ponds	.....	3.7	3.9	5.3	5.7	.....	.....
		(17,4)	(14,4)	(13,4)	(6,2)		
Turbid ponds	.....	3.4	3.9	5.1	5.0	6.5	.....
		(32,4)	(33,7)	(16,2)	(4,1)	(5,5)	
Black Bullhead							
Clear ponds	.....	.....	11.9	10.3	.....	12.5	12.6
			(1,1)	(1,1)		(3,1)	(3,1)
Turbid ponds	1.3	6.0	6.2	7.5	8.3	10.3	9.4
	(1,1)	(45,5)	(90,9)	(38,10)	(7,4)	(7,3)	(1,1)

turbid ones (Table 3), but was not fast enough to provide good fishing in any pond. One-year-old bluegill were found most often. The maximum age was six years.

Black crappie. Black crappie occurred in two of four turbid ponds that had been stocked with crappie. Species were not designated in stocking-records. Three black crappie, each three years

old (average length 9.0 inches), were found in Gabriel Pond (115 p. p. m.). Black crappie predominated in Detwiler Pond (525 p. p. m.); however, only six of usable size (total weight 2.08 pounds) were found in that pond when all fish were eradicated.

Black crappie occurred in five of six clear ponds that had been stocked with crappie. They predominated and grew most rapidly in Butell Pond (45 p. p. m.). The average lengths in October were: one-year-old, 7.0 inches, and two-year-old, 10.3 inches. Butell Pond and Gabriel Pond were the only ponds containing black crappie that did not also contain white crappie and/or green sunfish. The other species present in Butell Pond—large-mouthed bass and bluegill—also grew faster than in any other pond. Butell Pond was probably the best of three ponds, among the 22 that were sampled, which offered satisfactory fishing.

Two- and three-year-old black crappie were most numerous in our samples. The maximum age was four years.

White crappie. White crappie occurred in one of four turbid ponds that were stocked with crappie (species not designated). In Riepen W Pond (125 p. p. m.), one crappie, four years old and 11.8 inches long, was taken.

White crappie occurred in five of six clear ponds stocked with crappie, and were predominant in three. They exceeded the black crappie in abundance where the two species were found together. White crappie grew more slowly than black crappie (Table 3), and few white crappie more than seven inches in length were taken.

One- and two-year-old white crappie were taken most often. The maximum age was five years.

Channel catfish. Channel catfish were found in three of six turbid ponds that had been stocked with that species. One was obtained from Gabriel Pond (115 p. p. m.), three from Kerns S Pond (375 p. p. m.), and four from D. Beeghley Pond (98 p. p. m.) where fish were eradicated and a complete count was attempted.

Channel catfish were found in five of eight clear ponds stocked with that species. In one of these (Walburn, 50 p. p. m.), 14 channel catfish were found when fish were eradicated. Walburn Pond has been stocked several times with channel catfish from a nearby creek. Their growth-rates, which influence averages listed in Table 3, reflect growths made in the creek as well as in the pond. Twenty-four channel catfish were taken from Booth 11-A Pond, which had been stocked with 150 fingerling catfish approximately one year previously. Thirty-six young-of-the-year channel catfish were taken

in samples from Booth SW Pond. Booth SW Pond was the only pond in which reproduction of channel catfish was known to have occurred. The pond was stocked in 1954 with three channel catfish (six to seven pounds per fish). In May, 1956, spawning in a 55-gallon metal drum was observed.

Our evidence on growth-rates of channel catfish in clear and turbid ponds is inconclusive. Davis (1959) found that this species grew faster in clear impoundments than in muddy ones in Kansas. The oldest individual obtained of this species was six years old.

Green sunfish. The green sunfish was found in all four turbid ponds stocked with that species and in five turbid ponds where it was not known to have been stocked. It predominated or shared dominance with the black bullhead in six turbid ponds.

The green sunfish was found in all three clear ponds stocked with that species and in three others not known to have been stocked. It predominated in two clear ponds (Booth U and Booth SW). Growth of green sunfish (Table 3) was better in clear than in turbid ponds and was better in ponds that contained large-mouthed bass and crappie than in ponds lacking those species. The largest green sunfish (8.3 inches, five years old) was taken from a turbid pond (Kerns SW, 423 p. p. m., 1/11 acre). Most green sunfish in that pond were less than four inches long. Few green sunfish of usable size were found in any of the ponds.

Most green sunfish in samples were one or two years old; the maximum age was five years.

Black bullhead. The black bullhead was found in 13 of the 14 turbid ponds; it had been stocked in only nine of these ponds. It was the predominant species, or shared dominance with green sunfish, in seven turbid ponds. Few black bullhead of usable size were found in any of the turbid ponds. None of the turbid ponds produced satisfactory bullhead-fishing. One bullhead of usable size (8.5 inches) was found in D. Beeghley Pond when fish were eradicated, and six of usable size (total weight 2.23 pounds) were found in Detwiler Pond when its fish were eradicated.

Black bullhead were found in two clear ponds, but predominated in neither. Growth was faster in clear ponds than in turbid ones (Table 3), and Sportsmen's Pond contained enough large bullheads to produce satisfactory fishing for that species.

The average size of four-year-old black bullhead (all ponds) was 8.3 inches and .25 pound. Five- and six-year-old bullhead were large enough to be used as food, but few were found. Two- and

three-year-old bullhead were taken most often. The maximum age was six years.

STANDING CROPS OF FISH

Standing crops (the number of pounds of fish that a body of water contains) were estimated after eradication of fishes from D. Beeghley Pond and Walburn Pond, and after seining of Kerns SW Pond. The three ponds were low when standing crops were ascertained, and had been low for several months. Although below spillway levels, D. Beeghley Pond (2.5 feet low) and Walburn Pond (6.5 feet low) had little reduction in surface areas. Kerns SW Pond (5.5 feet low) was reduced to approximately one-half of its normal area.

In D. Beeghley Pond (area ⅓ acre, turbidity 93 p. p. m.), 142.60 pounds of fish were found (equivalent to 428 pounds per acre). Four channel catfish, each six years old and approximately 20 inches long, contributed 10.90 pounds to the total. Black bullhead (564) weighed 69.70 pounds, but only one (8.5 inches) was of usable size. Green sunfish (1521) weighed 62.00 pounds; none was of usable size (largest 5.9 inches). No other species was present, although the pond had been stocked with large-mouthed bass, bluegill, and crappie six years previously.

In Walburn Pond (1/12 acre, turbidity 50 p. p. m.), 238 fish weighing 33.36 pounds were picked up after eradication (equivalent to 400 pounds per acre). Of the 11 species found, nine channel catfish, one flathead, one black crappie, one freshwater drum, and one carp were of usable size.

In Kerns SW Pond (1/11 acre, turbidity 423 p. p. m.), intensive seining yielded 37.17 pounds of fish (equivalent to 409 pounds per acre). Probably one-third to one-half of the original population remained in the pond. All but two of the 828 fish seined were green sunfish, of which one (8.3 inches) was of usable size. One bullhead, 14.0 inches long, and one creek chub were the only other fishes found.

Standing crops in pounds per acre do not seem to differ greatly between clear and turbid ponds, but as stated previously, the kinds of fish present and their growth-rates do differ greatly in relation to turbidity.

SUMMARY

Of 1,316 farm ponds in Douglas County, Kansas (in 1954), 89.5 per cent were ½ acre or less in size. Only 2.6 per cent of the ponds had a surface area exceeding one acre.

A high degree of expressed interest in fish-production in farm ponds of Douglas County had not resulted in equivalent use of the ponds for that purpose. Only one-half of the ponds had been stocked and few of those that had been stocked were fished often. Only three of 22 ponds that were sampled provided satisfactory fishing.

Few farm ponds possessed the necessary requirements for successful management of diversified sport-fish populations: one acre or more in size; eight feet or more in depth; low turbidity (less than 50 p. p. m.) associated with stabilized watersheds of the proper size; proper initial stocks of fish; proper drainage facilities for ponds; and fences to exclude livestock from ponds.

In a majority of ponds, the fish stocked by pond-owners were obtained from streams or other ponds rather than from state or federal hatcheries, and the fish stocked included kinds not recommended as pond-fish by conservation agencies.

High turbidity of water in farm ponds seemed to be the most important factor limiting the growth of most species of fish and the survival of sport-fishes.

The green sunfish or the black bullhead predominated in a majority of the ponds that were sampled.

Recommendations

1. Additional research is needed to determine what species of food-fishes and bait-fishes would be suitable for the typical small, turbid pond of Douglas County. When food-fishes are the chief wants of pond-owners, the raising of "rough" fish such as small-mouthed buffalo, *Ictiobus bubalus,* should be attempted. A much greater yield (Hendricks, 1956) might be realized with that species than with species now being stocked, and surplus crops might be sold. Channel catfish can be grown in small ponds. In recent experiments conducted by the State Biological Survey, ponds stocked exclusively with channel catfish have had annual productions of 100 to 2,000 pounds per acre. High productions were obtained by means of supplemental feeding and fertilization in ponds only 1/10-acre in area.

2. Pond-owners whose ponds meet the requirements mentioned below, and who are interested in the production of sport-fishes, should obtain the advice of state or federal fishery biologists concerning the management of fish-populations in ponds. Stocks of fish should be those recommended by state or federal conservation agencies.

3. In order to provide satisfactory sport-fishing, farm ponds should meet the following requirements: (1) one acre or more in size; (2) eight feet (preferably 10 feet) or more in maximum depth; (3) drainage facilities; (4) fences to exclude livestock from the water; (5) permanently-grassed watersheds of sufficient size to assure adequate, but not excessive, runoff into the pond.

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