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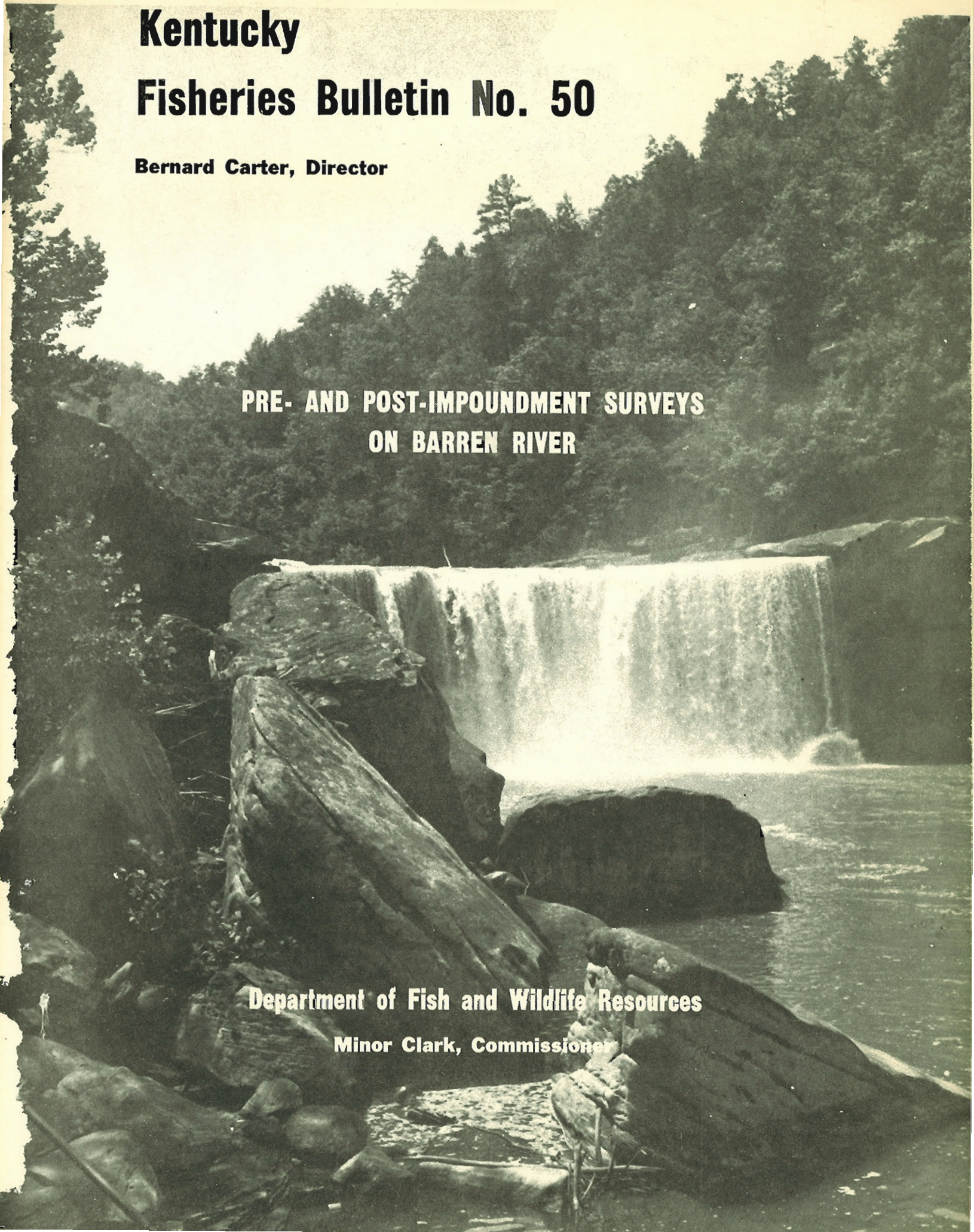
Bernard Carter, Director



PRE- AND POST-IMPOUNDMENT SURVEYS ON BARREN RIVER

Department of Fish and Wildlife Resources

Minor Clark, Commissioner

PRE- AND POST-IMPOUNDMENT SURVEYS

ON BARREN RIVER

By

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ABSTRACT

Investigations were conducted on Barren River during a three year period preceding impoundment and on Barren Reservoir the first three years of impoundment to determine and evaluate changes in the fish population composition, fishing intensity, creel composition and fishing success. Monthly water quality studies were conducted on the reservoir during 1965 and 1966.

Thermal stratification was evident by mid May both years and a metalimnion persisted throughout the reservoir until late September. Oxygen depletion (below 2.0 ppm) occurred in the hypolimnion of the upper two-thirds of the reservoir in June, but was not detected in the lower reservoir until July. Total alkalinities ranged from a late winter minimum of 46 ppm to a mid summer maximum of 140 ppm.

Fish populations were sampled with rotenone at a concentration of 1.0 ppm. The fish population of the inundated section of Barren River increased from an average of 522 fish per acre before impoundment to 5,705 fish per acre the first year of impoundment. Cyprinids numerically dominated the pre-impoundment studies whereas the gizzard shad was most abundant after impoundment.

The fish population biomass of the inundated section of Barren River increased from an average of 111 pounds per acre before impoundment, to 194 pounds per acre the first year of impoundment. The second and third years of impoundment the biomass averaged 201 and 241 pounds per acre respectively. Catostomids and ictalurids comprised a major portion of the biomass in Barren River, whereas centrarchids, clupeids and cyprinids dominated in the reservoir. Centrarchids comprised 36 per cent of the biomass the first year of impoundment, 24 per cent the second year, and 28 per cent the third year. The total weight of clupeids increased each successive year in the reservoir and by the third year of impoundment they comprised 46 per cent of the biomass.

Creel surveys were based on a stratified sampling schedule and the fishing effort was estimated by the mean count method. Creel surveys were conducted on Barren River for three consecutive years before impoundment and on Barren Reservoir during the second and third years of impoundment. The annual fishing effort increased from an average of 25,595 man-hours before impoundment to 115,496 man-hours (11.8 man-hours per acre) in 1965. In 1966 the total fishing effort decreased to 90,166 man-hours (10.7 man-hours per acre). The average rate of harvest ranged from 0.50 to 0.61 fish per hour on Barren River and from 0.93 to 0.97 fish per hour on the reservoir. The estimated annual harvest increased from an average of 13,507 pounds before impoundment to 38,719 pounds (4.0 pounds per acre) in 1965. In 1966, the total harvest was estimated at 30,656 pounds (3.6 pounds per acre). The pre-impoundment creel was numerically dominated by rock bass, black basses and catfishes, whereas after impoundment crappies, sunfishes and carp were most abundant.

INTRODUCTION

Barren River was one of four streams selected for study under Dingell-Johnson Project F-16-R, Pre- and Post-Impoundment Surveys. The Barren River study was initiated in 1959, five years prior to the impoundment of Barren Reservoir in 1964 by the U. S. Army Corps of Engineers. Post-impoundment studies were conducted the first three years of impoundment.

The specific objectives of this study were to determine pre- and post-impoundment fish population compositions; changes in fishing intensity and fishing success; the success of stocking various species of fish in the reservoir; and the water quality of the reservoir.

Mr. William R. Turner* served as project leader from 1959 until October, 1964, and the author completed the study.

ACKNOWLEDGEMENTS

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Dr. Don W. Hayne, North Carolina State University, provided technical assistance with the creel surveys.

The following employees of the Division of Fisheries served as fishery aides by assisting in all phases of the study: Eugene Bradley, William Caldwell, and Larry Neal. Harry Hargis served as assistant project leader in 1965.

The following conservation officers of the Kentucky Department of Fish and Wildlife Resources, Law Enforcement Division, served as creel clerks and assisted during fish population studies: Jesse Lane, Roy Henry, Rex Brown, Wendell Stephens, and George Kidwell.

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DESCRIPTION OF AREA

The Barren River is the largest tributary of the Green River and encompasses a drainage area of approximately 1900 square miles. Barren River rises in north-central Tennessee and Monroe County, Kentucky and follows a northwesterly course for a distance of 158 miles. The watershed of the upper 125 miles of the stream is located in the Eastern Pennyroyal physiographic region which is characterized by hilly and karst topography. The underlying formations of this area are composed mainly of limestones, shales, and siltstones. Soils in this area are mostly Dixon and Baxter associations, which are derived from geodic or cherty impure limestones. Soil fertility is considered medium to low. The watershed of the lower 33 miles of the stream is rolling and hilly with sandstones and shales becoming most prominent.

The average gradient of the stream from its mouth to the city of Bowling Green is approximately 0.5 foot per mile. This section of the stream, which is approximately 29.0 miles in length, was formerly maintained for navigation. From Bowling Green, to a point 54 miles upstream, the average gradient of the stream rises to 1.8 feet per mile, and in the next 45 miles the gradient increases to 3.3 feet per mile. Above this point the average gradient is 20 feet per mile and more.

Barren Reservoir dam was constructed at mile 79.2 and the river was impounded in March, 1964. The dam is a rolled earth fill with random rock structure. The spillway is an uncontrolled type and is cut through rock.

The reservoir outlet design consists of two separate systems. The standard control gates, which are located near the bottom of the control tower, are supplemented by multi-level bypass outlets which permit the withdrawal of water from higher elevations. The control gates are used for reservoir water level control while the multi-level outlets are used for water quality control downstream during the seasonal pool period.

During the study period the normal operational schedule for Barren Reservoir was as follows: summer pool (515 msl) was scheduled for early May and maintained through August; drawdown began in early September and flood control pool or minimum pool (520 msl) was reached by December 1. At minimum pool level the surface area of Barren Reservoir is approximately 4,440 acres with a total volume of 46,000 acre feet; at seasonal pool level the surface area is approximately 10,000 acres with a total volume of 209,800 acre feet.

During the post-impoundment period of this investigation another study was being conducted on the Barren tailwater to evaluate water temperature manipulation techniques through the use of the multi-level release system (Carter 1968). The reader is referred to this report for details on the water quality of the tailrace. During the seasonal pool periods of 1964 - 1966, reservoir releases were made primarily at the 21-foot depth. Throughout the remainder of each year releases were made from either the lower gates or the multi-level outlets.

MATERIALS AND METHODS

Fish Population Sampling

The fish population sampling areas on Barren River were selected primarily on the basis of anticipated habitat changes and secondly on the basis of access. Samples of the fish population were obtained from three sections of the river designated as Section I, the headwater streams; Section II, the area to be impounded; and Section III, the future tailwater.

Both qualitative and quantitative estimates of the fish population were made. Qualitative sampling was restricted to the small tributary streams while quantitative estimates were made on the main stem and the two major tributaries. When quantitative samples were made the study area was delineated with small-mesh nets which were stretched across the width of the stream at each end of

the study area. The surface area encompassed by the block nets and the average depth of the area was determined from measurements with a calibrated hand line. Sample areas ranged from 0.2 to 2.0 surface acres.

After the volume of the study area had been determined the area was treated with a five-percent rotenone formulation at a concentration of 1.0 ppm. This was accomplished by diluting the required amount of toxicant with water and dispersing the mixture with a boat bailer attached to an outboard motor.

After application of the toxicant, fishes were recovered with dip nets and then identified, measured, and weighed. Easily-identified fishes were processed in the field, while small specimens were preserved in ten per cent formalin and later identified in the laboratory.

A granular form of potassium permanganate was used to oxidize the rotenone and prevent downstream fish kills. During the first year of studies detoxification was attempted by introducing the permanganate into the stream immediately downstream from the study area at a concentration of 2.0 ppm. After a number of downstream fish kills were experienced, the following modification of this method was used. In addition to the potassium permanganate introduced downstream from the sampling area, an equal amount was dispersed throughout the sampling area on completion of the study. No downstream fish kills were experienced after using this method of detoxification.

Fish population sampling in the reservoir was initiated in June after the surface water temperature reached 70° F., and was continued throughout the summer. Sampling areas were restricted to coves, or portions thereof, which could be isolated from the main body of the reservoir with a block net. The block net, a three-quarter-inch-mesh net which measured 300 feet in length and 20 feet in depth, was set between 7:00 a.m. and 9:00 a.m. The surface acreage of each study area was determined by using a transit and the average depth was determined with a calibrated hand line.

Study areas were treated with both liquid rotenone and powdered cubé at a concentration of 1.0 ppm (0.05 per cent actual rotenone). The powdered cubé was mixed with water to a "mud ball" consistency and applied to the deep sections of the study areas to assure penetration of the thermocline. Liquid rotenone was applied by the same method used during the stream studies.

Fishes were recovered from the study coves with dip nets and were processed in the same manner as before impoundment. Recovery operations extended over a three-day period.

Creel Surveys

Creel surveys were conducted by departmental conservation officers (subsequently referred to as creel clerks) who made direct contacts with fishermen on predetermined days. Survey schedules were designed to provide a stratified sample representative of each day of the week. This was accomplished by basing the survey on a 12-hour day (7:00 a.m. to 7:00 p.m.), dividing each day of the week into three 4-hour periods (7-11, 11-3, 3-7) and sampling each period an equal number of times throughout the survey period. This method provided samples for 21 complete days or three days for each day of the week during the survey period 1 April through 31 October.

During the pre-impoundment survey the creel clerks contacted fishermen by driving to designated check points; after impoundment fishermen were contacted by boating over a designated area. The creel clerks made fisherman counts as well as interviews and the counts were used to compute the fishing pressure. This method was described by Lambou in 1961:

$$f = c\bar{x}$$

where f = number of man-hours of fishing
c = number of hours in the population
$\bar{x}$ = mean number of fishermen per count.

Fisherman count methods used during the pre-impoundment survey were distinctly different from those made on the reservoir. During the pre-impoundment survey the creel clerk counted fishermen as he progressed with the interviews, whereas on the reservoir the counts were made as quickly as possible by cruising the survey area, either before or after interviewing.

The creel clerks interviewed as many fishermen as possible during the survey period and obtained information on the amount of time fished, the number and kinds of fish harvested, the average length of each kind of fish, and the method used. After the average rate of harvest and the average weight of fishes had been determined (the weight of fishes in the creel was obtained from fish population study data), an estimate of the total harvest was made by multiplying the rate of harvest by the total fishing effort.

Water Quality Determinations

Monthly physico-chemical analyses were made on the reservoir during 1965 and 1966. Samples were collected in mid-channel at three separate areas: Area I, 17.5 miles upstream from the dam, near the mouth of Walnut Creek; Area II, 10.4 miles upstream from the dam, near the mouth of Peter Creek; and Area III, 1000 feet above the dam.

Temperature measurements were made with a tele-thermometer at five-foot depth intervals from surface to bottom and recorded in Fahrenheit.

Water collected for chemical analyses was taken from a Kemmerer sampler at 10-foot depth intervals. Dissolved oxygen was determined by the Modified Winkler Method and total alkalinity determinations (expressed as $CaCO_3$) were made using methyl-orange-xylene-cyanol as an indicator and titrating with N/50 sulfuric acid.

PHYSICAL AND CHEMICAL CHARACTERISTICS

Pre-impoundment discharge records for Barren River show an average flow of 1,512 cfs with extremes ranging from 42 cfs in July, 1944 to 52,400 cfs in February 1962 (U. S. Geological Survey, 1962). Whitney, 1962, conducted monthly water quality studies on Barren River in 1961. He reported alkalinities which ranged from 86 ppm to 154 ppm (expressed as $CaCO_3$), with pH values which ranged from 7.2 to 8.9 during the period.

Although the reservoir was impounded in March 1964, the water level remained near the minimum pool level of 520 msl the following summer. Seasonal pool (552 msl) was reached on schedule in 1965, whereas in 1966 the average water level elevation was only 545 msl during the seasonal pool period. Reservoir volumes during the seasonal pool periods ranged from approximately 46,600 acre feet in 1964 to 209,800 acre feet in 1965, to 190,000 acre feet in 1966.

Surface water temperatures during the study period ranged from a minimum of 37° F. in February 1965, to a maximum of 85° F. in July 1966. Surface temperatures generally reached 50° F. by late March, 60° F. by late April and 75° F. by late May.

Dissolved oxygen and temperature profiles at mid-lake during May, August, and December of 1965 and 1966 are depicted in Figures 1 and 2. Thermal stratification became evident at each sampling station by the middle of May and persisted through August. The upper limit of the metalimnion was generally positioned at the 8-foot depth in May; at the 15-foot depth during June and July; and at the 20-foot depth in August.

Surface to bottom temperature gradients were greatest in late July or early August at the dam and ranged from 25° in 1965 to 31° in 1966.

Fall drawdown began during the second week of September both years and by the last week of September stratification was completely disrupted

Figure 1. Dissolved oxygen and temperature profiles at Area II on Barren River Reservoir during periods of early stratification, late summer stagnation, and winter circulation - 1965.

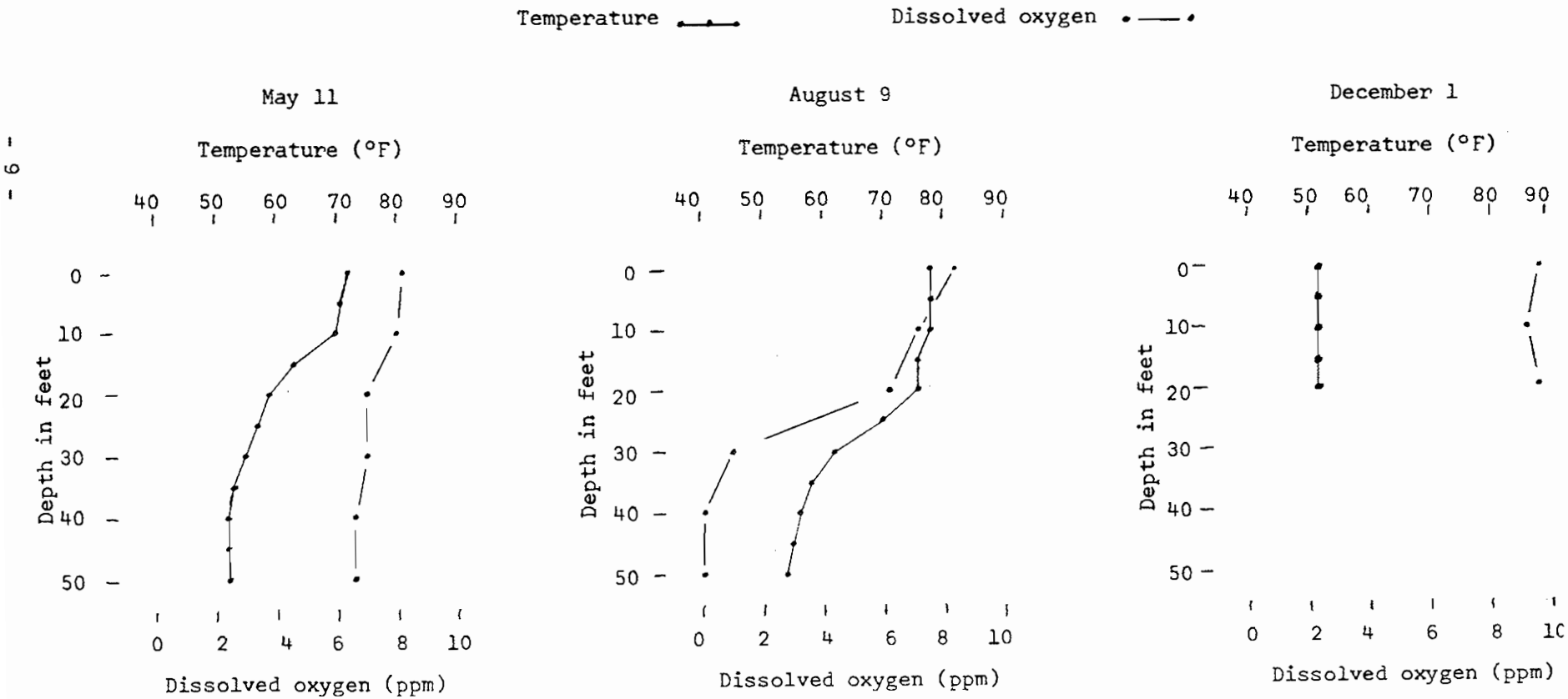
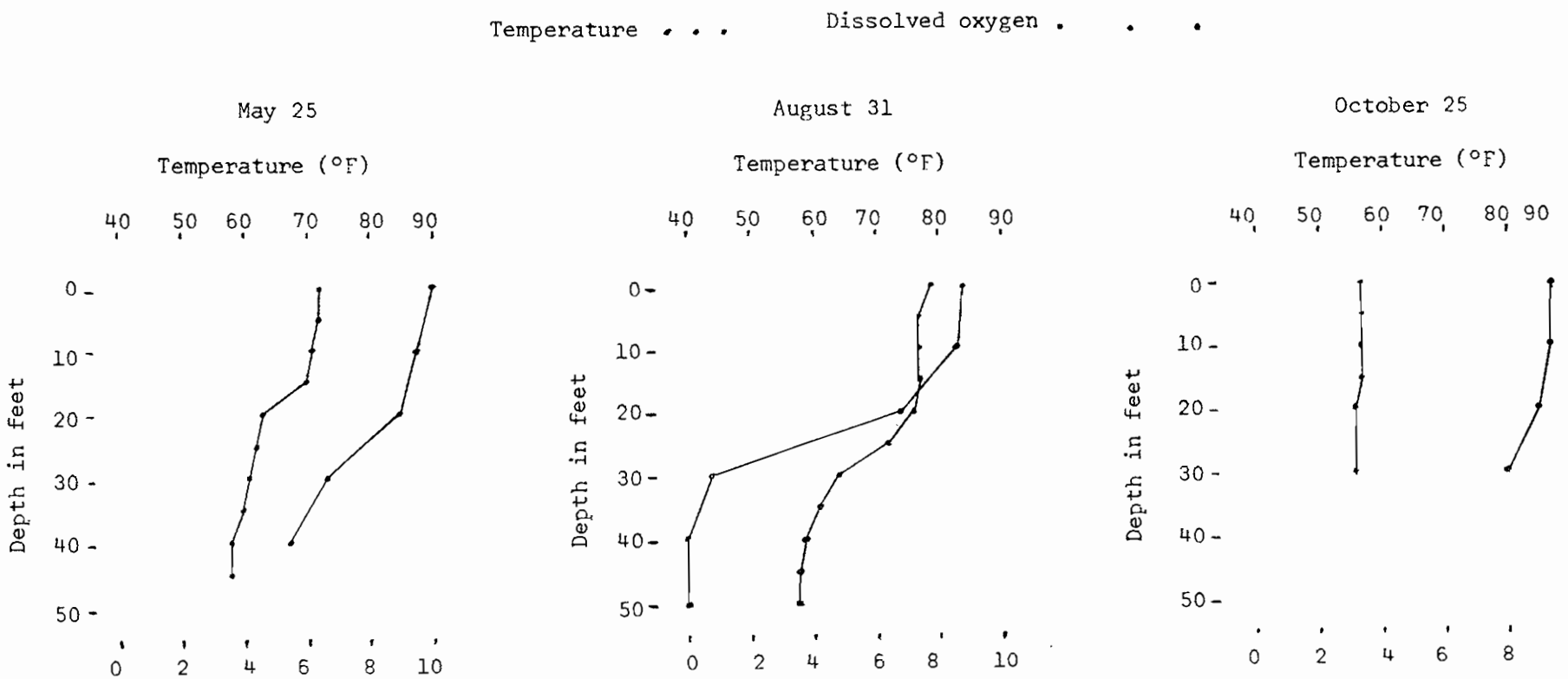


Figure 2. Dissolved oxygen and temperature profiles at Area II on Barren River Reservoir during periods of early stratification, late summer stagnation, and winter circulation - 1966.



throughout the reservoir. Surface water temperatures cooled to about 70° F. by late September and at that time the surface to bottom temperature gradient had decreased to 10°. The temperature gradient ranged from 1° to 2° during October and November and isothermy was evident in December.

The dissolved oxygen content near the surface ranged from 9.0 ppm to 11.0 ppm during the winter and from 7.9 ppm to 9.2 ppm during the summer. Oxygen depletion (below 2.0 ppm) occurred in the lower limit of the metalimnion at the upper end of the reservoir in June, but was not detected in the lower reservoir until July. By late August, depletion was acute in the lower limit of the metalimnion throughout the reservoir. At that time the dissolved oxygen concentrations in the metalimnion ranged from 0 to 0.6 ppm at the head of the reservoir; 0 to 3.3 ppm at mid-lake; and 0.2 ppm to 5.2 ppm near the dam. Oxygen depletion was detected in the hypolimnion of the upper two-thirds of the reservoir in June, and at all three sampling stations in July. By late August dissolved oxygen concentrations in the hypolimnion ranged from 0 to 1.0 ppm at the dam but no oxygen was detected in the hypolimnion of the upper two-thirds of the reservoir.

Total alkalinities (expressed as $CaCO_3$) varied considerably with depth, area location, and reservoir volume. Concentrations generally increased with depth at all three areas throughout the year. During the seasonal pool period the greatest values were recorded at the head of the reservoir, whereas after drawdown concentrations were highest near the dam. Maximum concentrations ranged from 115 ppm to 140 ppm and these values were recorded in the upper two-thirds of the reservoir during July and August.

FISH DISTRIBUTION AND ABUNDANCE

The fish population of Barren River and tributaries was sampled on 23 separate occasions (12 quantitative and 11 qualitative samples) during the

pre-impoundment period from 1959 - 1963, and the fish population of the reservoir was sampled each year during the first three years of impoundment.

The studies conducted in each of the three sections of the river previously described were combined separately on a fish-per-acre basis, and then the weighted mean for all three sections was computed (Table 1). The post-impoundment studies were similarly combined to provide a weighted mean for all collections made during a given year. To facilitate discussion of the abundance of various fishes, arbitrary terms denoting numerical abundance are used as follows: rare <0.5 fish per acre; scarce 0.5 - 1.9 per acre; frequent 2 - 10.0 per acre; common >10.0 per acre.

Eighty-five species of fishes were recorded before impoundment and four additional species were recorded in the reservoir. The total number of species recorded within each section of the river decreased from the headwaters downstream and ranged from 70 in Section I, to 59 in Section II, to 38 in Section III.

The per-acre abundance of fishes likewise decreased from the headwaters downstream and ranged from 1,476 per acre in Section I, to 522 per acre in Section II to 356 per acre in Section III. An average of 723.4 fish per acre was collected from the river, whereas the per-acre abundance in the reservoir was estimated at 5,705 fishes in 1964, 3,370 in 1965, and 4,138 in 1966.

Petromyzontidae

Both the northern brook lamprey and American brook lamprey were rare in Barren River. The distribution of each species was limited to the tributaries of Section I. No lampreys were recorded after impoundment.

Table 1. Relative abundance of fishes collected from Barren River before impoundment and from Barren Reservoir during the first three years of impoundment.

Species	Barren River				Barren Reservoir		
	Section			Weighted			
	I	II	III	mean	1964	1965	1966
(Sample area in surface acres)	4.2	5.4	2.0		6.1	10.0	6.0
Petromyzontidae							
Northern brook lamprey - *Icthyomyzon fossor* Reighard & Cummins	0.3			tr.			
American brook lamprey - *Lampetra lamottei* (LeSueur)	0.3			tr.	0.1		
Total	0.6			tr.	0.1		
Lepisostidae							
Longnose gar - *Lepisosteus osseus* (Linnaeus)	1.6	2.1	1.0	1.6	5.2		
Clupeidae							
Gizzard shad - *Dorosoma cepedianum* (LeSueur)	1.0	3.3	2.5	2.3	3295.7	1215.8	2144.3
Threadfin shad - *Dorosoma petenense* (Günther)						6.3	9.8
Total	1.0	3.3	2.5	2.3	3295.7	1222.1	2154.1
Hiodontidae							
Goldeye - *Hiodon alosoides* (Rafinesque)		0.5		0.3			
Esocidae							
Grass pickerel - *Esox americanus vermiculatus* LeSueur	0.2	0.7		0.4	5.8		
Ohio muskellunge - *Esox masquinongy ohioensis* Kirtland		0.5		0.2			
Total	0.2	1.2		0.6	5.8		

Table 1. (continued)

Species	Barren River				Barren Reservoir		
	Section			Weighted			
	I	II	III	mean	1964	1965	1966
(Sample area in surface acres)	4.2	5.4	2.0		6.1	10.0	6.0
Cyprinidae							
Stoneroller - *Campostoma anomalum* (Rafinesque)	58.8	24.2	6.0	33.6	42.3	0.3	0.3
Goldfish - *Carassius auratus* (Linnaeus)						1.0	
Southern redbelly dace - *Chrosomus erythrogaster* (Rafinesque)	0.7			0.3			
Carp - *Cyprinus carpio* Linnaeus					495.6	158.7	95.3
Speckled chub - *Hybopsis aestivalus* (Girard)			0.5	0.1			
Bigeye chub - *Hybopsis amblops* (Rafinesque)	55.9	40.7	1.5	39.5	9.9		
Hornyhead chub - *Hybopsis biguttata* (Kirtland)	2.4			0.9			
Streamline chub - *Hybopsis dissimilis* (Kirtland)	10.7	10.5	37.5	15.2			
River chub - *Hybopsis micropogon* (Cope)	1.7	6.1		3.4	1.8		
Golden shiner - *Notemigonus crysoleucas* (Mitchill)	0.2			0.1	3.4	1.3	0.5
Rosefin shiner - *Notropis ardens* (Cope)	179.0	6.5	5.0	68.7	4.5		
Popeye shiner - *Notropis ariommus* (Cope)	0.5	0.5		0.3			
Emerald shiner - *Notropis atherinoides* Rafinesque		2.8	7.0	2.5	12.6		
Bigeye shiner - *Notropis boops* Gilbert	1.7	0.5	0.5	0.9			
Common shiner - *Notropis cornutus* (Mitchill)	50.7	25.5	50.0	28.5	6.3	1.0	
Tennessee shiner - *Notropis leuciodus* (Cope)	9.5			3.4			
Silver shiner - *Notropis photogenis* (Cope)	74.5	22.2	3.5	30.6	2.7		
Rosyface shiner - *Notropis rubellus* (Agassiz)	21.4	9.4		12.1		0.1	0.3
Spotfin shiner - *Notropis spilopterus* (Cope)	33.8	26.8	26.5	29.3	3.6		
Mimic shiner - *Notropis volucellus* (Cope)	23.8	17.9	2.5	17.4			
Steelcolor shiner - *Notropis whipplei* (Girard)	0.9	0.4	1.0	0.7			
Stargazing minnow - *Phenacobius uranops* Cope	0.7	0.7		0.6			
Bluntnose minnow - *Pimephales notatus* (Rafinesque)	167.1	27.4	20.0	76.7	69.0	2.2	0.7
Bullhead minnow - *Pimephales vigilax* (Baird and Girard)	2.1	1.5	5.5	2.4		0.4	
Blacknose dace - *Rhinichthys atratulus* (Hermann)	0.6						
Creek chub - *Semotilus atromaculatus* (Mitchill)	3.1						
Total	699.8	223.6	167.0	363.5	651.7	165.0	97.1

Table 1. (continued)

Species	Barren River				Barren Reservoir		
	Section			Weighted			
	I	II	III	mean	1964	1965	1966
(Sample area in surface acres)	4.2	5.4	2.0		6.1	10.0	6.0
Catostomidae							
White sucker - *Catostomus commersoni* (Lacépède)	0.2			0.1		0.5	tr.
Northern hogsucker - *Hypentelium nigricans* (LeSueur)	22.2	7.6	1.0	11.8	3.1	4.1	tr.
Spotted sucker - *Minytrema melanops* (Rafinesque)	1.4	3.9	3.5	2.9	44.5	47.6	19.4
Silver redhorse - *Moxostoma anisurum* (Rafinesque)	2.1	4.3	0.5	2.8	6.1	1.0	1.0
Blackfin sucker - *Moxostoma atripinne* Bailey	1.7			0.6			
Shorthead redhorse - *Moxostoma breviceps* (Cope)	11.6	10.2	16.5	11.8	5.0	0.6	1.3
River redhorse - *Moxostoma carinatum* (Cope)	104.0	1.7		0.8			
Black redhorse - *Moxostoma duquesnei* (LeSueur)	44.8	37.5		33.7			
Golden redhorse - *Moxostoma erythrurum* (Rafinesque)	104.0	105.7	39.5	93.7	44.1	30.0	17.7
Total	292.0	170.9	61.0	177.9	102.8	83.8	39.4
Ictaluridae							
Black bullhead - *Ictalurus melas* (Rafinesque)	0.5			0.2	91.5	5.1	21.0
Yellow bullhead - *Ictalurus natalis* (LeSueur)	0.7	0.2		0.3	200.1	20.0	11.0
Channel catfish - *Ictalurus punctatus* (Rafinesque)	16.9	23.8	46.0	25.2	4.8	0.5	0.1
Slender madtom - *Noturus exilus* Nelson	0.2			0.1	0.3		
Brindled madtom - *Noturus miurus* Jordan	12.6	5.2	3.0	7.5	1.4	0.8	0.3
Freckled madtom - *Noturus nocturnus* Jordan & Gilbert	0.5		5.5	1.1			
Noturus sp. (Green River system)	31.4		1.1	11.9			
Flathead catfish - *Pylodictis olivaris* (Rafinesque)	9.7	4.1	35.5	11.5	1.5	0.8	0.1
Total	72.5	33.3	81.6	62.5	299.6	27.2	32.5
Cyprinodontidae							
Northern studfish - *Fundulus catenatus* (Storer)	4.7	0.2		1.8	0.6		
Blackstripe topminnow - *Fundulus notatus* (Rafinesque)						0.1	0.3
Total	4.7	0.2		1.8	0.6	0.1	0.3

Table 1. (continued)

Species	Barren River				Barren Reservoir		
	Section			Weighted			
	I	II	III	mean	1964	1965	1966
(Sample area in surface acres)	4.2	5.4	2.0		6.1	10.0	6.0
Serranidae							
White bass - *Roccus chrysops* (Rafinesque)						0.9	1.3
Centrarchidae							
Rock bass - *Ambloplites rupestris* (Rafinesque)	32.4	16.8	1.0	19.7	20.0	4.9	0.8
Warmouth - *Chaenobryttus gulosus* (Cuvier)		0.6		0.3	18.1	138.5	81.2
Green sunfish - *Lepomis cyanellus* Rafinesque	0.2			0.1	0.1	1.8	tr.
Orangespotted sunfish - *Lepomis humilis* (Girard)		1.0		0.1		0.2	tr.
Bluegill - *Lepomis macrochirus* Rafinesque	4.0	3.7	1.5	3.4	159.0	1197.2	861.6
Longear sunfish - *Lepomis megalotis* (Rafinesque)	56.7	34.8	7.0	37.9	259.5	237.3	167.0
Redear sunfish - *Lepomis microlophus* (Gunther)		0.2		0.1		0.7	0.1
Smallmouth bass - *Micropterus dolomieui* Lacépède	8.8	2.4		4.3	0.3	0.2	
Spotted bass - *Micropterus punctulatus* (Rafinesque)	6.2	7.4	15.0	8.3	451.8	49.9	391.6
Largemouth bass - *Micropterus salmoides* (Lacépède)	1.7			0.6	208.9	64.7	160.8
White crappie - *Pomoxis annularis* Rafinesque		0.2		0.1	174.7	40.2	25.8
Black crappie - *Pomoxis nigromaculatus* (LeSueur)			1.0	0.2	41.7	112.4	75.1
Total	110.0	67.1	25.5	67.5	1334.1	1848.9	1765.3
Percidae							
Greenside darter - *Etheostoma blennioides* Rafinesque	55.0	1.7		20.7			
Rainbow darter - *Etheostoma caeruleum* Storer	77.8	0.4		28.4			
Bluebreast darter - *Etheostoma camurum* (Cope)	31.4			11.4			
Fantail darter - *Etheostoma flabellare* Rafinesque	29.0	0.6		10.8			
Stripetail darter - *Etheostoma kennicotti* (Putnam)		0.1		tr.			
Spotted darter - *Etheostoma maculatum* Kirtland	1.9			0.7			
Johnny darter - *Etheostoma nigrum* Rafinesque	0.2	0.4		0.2	0.2		
Emerald darter - *Etheostoma* sp. (Ulocentra)	3.3			1.2			

Table 1. (continued)

Species	Barren River				Barren Reservoir		
	Section			Weighted			
	I	II	III	mean	1964	1965	1966
(Sample area in surface acres)	4.2	5.4	2.0		6.1	10.0	6.0
Orangethroat darter - *Etheostoma spectabile* (Agassiz)		1.8		0.8			
Speckled darter - *Etheostoma stigmaeum* (Jordan)	10.9	0.6	1.0	4.4			
Banded darter - *Etheostoma zonale* (Cope)	6.7	0.4		2.6			
Logperch - *Percina caprodes* (Rafinesque)	12.6	2.2		5.6	0.7	14.2	33.8
Bluestripe darter - *Percina cymatotaenia* (Gilbert and Meek)	10.0	1.7		4.4			
Gilt darter - *Percina evides* (Jordan and Copeland)	0.5			0.2			
Longhead darter - *Percina macrocephala* (Cope)	17.1	2.2	1.0	7.6	0.3	0.1	
Blackside darter - *Percina maculata* (Girard)	5.2	1.8	0.5	2.8	0.3	0.7	7.1
Slenderhead darter - *Percina phoxocephala* (Nelson)	1.0	1.1	0.5	0.9	0.2		
Dusky darter - *Percina sciera* (Swain)	1.2	1.3	1.5	1.3			
Walleye - *Stizostedion vitreum vitreum* (Mitchill)		0.7		0.3	0.1	0.1	0.1
Total	263.8	16.3	4.5	94.8	1.8	15.1	40.9
Scienidae							
Freshwater drum - *Aplodinotus grunniens* Rafinesque		1.3	11.0	2.5			
Cottidae							
Banded sculpin - *Cottus carolinae* (Gill)	29.5	2.6	2.0	12.2			
Atherinidae							
Brook silverside - *Labidesthes sicculus* (Cope)	0.7			0.3	7.5	6.9	7.8
GRAND TOTAL PER ACRE	1476.4	521.9	356.1	723.4	5704.9	3369.8	4137.5

Lepisostidae

The longnose gar was frequent in each section of the river before impoundment and it increased from an average of 2 per acre before impoundment to 5 per acre the first year of impoundment.

Although gar were absent from the reservoir studies in 1965 and 1966, this does not necessarily reflect a reduction in their numbers because gar are generally not well represented in reservoir cove studies in Kentucky, even in reservoirs where they are known to abound.

Clupeidae

The gizzard shad was frequent in each section of the river and averaged 2 per acre in the combined sample. Gizzard shad was the most abundant species in the reservoir after impoundment and averaged 3,296 per acre in 1964, 1,222 per acre in 1965, and 2,154 per acre in 1966.

Threadfin shad were not recorded in Barren River before impoundment but 1,000 adults were released in the reservoir in 1965 and an additional 1,672 adults were introduced in 1966. Each of these introductions was successful and their numbers increased from 6 per acre to 10 per acre during the period.

Hiodontidae

The goldeye was rare in Barren River and was not recorded after impoundment.

Esocidae

The grass pickerel was scarce in Barren River but was recorded in both upstream sections. Although this species increased in abundance the first year of impoundment, it was not recorded thereafter.

The Ohio muskellunge was also scarce in Barren River. Only two specimens were recorded before impoundment, and both were from a single study area in Section II. This excellent game fish was not recorded in the reservoir.

Cyprinidae

The cyprinids ranked first in order of abundance in each section of the river and averaged 364 per acre in the combined collection. Twenty-six species were represented before impoundment and the total number of species decreased from Section I downstream.

The bluntnose minnow was the most abundant species in this family before impoundment and the rosefin shiner ranked second in order of abundance. Six species in this family, southern redbelly dace, hornyhead chub, golden shiner, Tennessee shiner, blacknose dace, and creek chub were limited to Section I. Each of the 17 species recorded in Section II were also recorded either above or below this section and only one species, the speckled chub, was limited to Section III. Three species of fishes in addition to the speckled chub were considered rare in the drainage; the southern redbelly dace, golden shiner, and popeye shiner.

Fourteen of the 26 species of cyprinids recorded from Barren River were collected in Barren Reservoir, but each of these species decreased numerically after impoundment.

The carp was not recorded in Barren River but it became well established in the reservoir the first year of impoundment. Carp reproduction was limited after the first year of impoundment however, and their numbers were reduced thereafter.

After impoundment the total number of species in this family was reduced to ten in 1964, six in 1965, and four in 1966.

Catostomidae

This family ranked second in order of abundance before impoundment and averaged 292 per acre in Section I, 171 per acre in Section II, and 61 per acre in Section III. After impoundment its numbers were reduced to 103 per acre in 1964, 84 per acre in 1965, and 39 per acre in 1966, and its rank in the combined sample was lowered to fifth.

The golden redhorse was the most abundant species in this family before impoundment, whereas the spotted sucker was most numerous in the reservoir. The spotted sucker was the only member of this family which increased numerically after impoundment. The blackfin sucker, river redhorse, and black redhorse were not recorded after impoundment. The white sucker was rare in the river but a few specimens were recorded in the reservoir in 1965 and 1966.

Ictaluridae

Eight representatives of this family were recorded in Barren River, but only three, the channel catfish, flathead catfish, and brindled madtom were well distributed in the drainage.

The per acre abundance of ictalurids increased from 63 before impoundment to 300 the first year of impoundment as a result of bullhead reproduction. This increase was only temporary however, as ictalurids averaged only 27 per acre and 33 per acre the two years following.

Channel catfish and flathead catfish were common in the river, but their numbers were substantially reduced each succeeding year after impoundment.

Four species of madtom were recorded before impoundment and two species, the slender madtom and brindled madtom, were recorded in the reservoir. The brindled madtom was collected each year after impoundment but its numbers gradually decreased each succeeding year.

Cyprinodontidae

The northern studfish was frequent in the combined collections from Barren River and was recorded in Sections I and II. This species was also recorded in the reservoir in 1964, but did not appear in subsequent studies.

The blackstripe topminnow was not recorded in Barren River but it appeared in the post-impoundment collections of 1965 and 1966.

Serranidae

The white bass was not recorded during the pre-impoundment surveys but its presence in the drainage was documented during a creel survey on Barren tailwater in 1964.

The fish management section of the Kentucky Division of Fisheries released 360 adult white bass in Barren Reservoir in the spring of 1965, and white bass reproduction was found that same year. Since the completion of this study a white bass fishery of some significance has developed in Barren Reservoir, presumably from this introduction.

Centrarchidae

Twelve species of centrarchids were recorded before impoundment and each of these was collected from the reservoir.

Centrarchids ranked fourth in abundance before impoundment and averaged 68 per acre. Centrarchid abundance substantially increased after impoundment and they averaged 1,334 per acre in 1964, 1,849 per acre in 1965, and 1,765 fish per acre in 1966. Centrarchids ranked second in order of abundance in 1964, first in 1965, and second in 1966.

Rock bass were common in Sections I and II, frequent in Section III and averaged 20 per acre in the combined collection from the river. The per acre abundance of rock bass remained at 20 the first year of impoundment but their numbers were substantially reduced the two years following.

The warmouth was scarce in Barren River and was recorded only in Section II. This species increased numerically in the reservoir and became well established the second year of impoundment.

Green sunfish, redear sunfish, and orangespotted sunfish were rare in the river and these three species were scarce in the reservoir.

Bluegill were well distributed in Barren River and were frequent in the combined collections. This popular panfish became well established in the reservoir the first year of impoundment, was the most abundant species of fish in the reservoir the second year of impoundment, and ranked second numerically the third year of impoundment. Bluegill averaged 3 per acre in the river; 159 per acre in 1964; 1,197 per acre in 1965; and 862 per acre in 1966.

The longear sunfish was common in each section of Barren River and ranked first in abundance among the centrarchids. Although longear increased from an average of 40 per acre before impoundment to 260 per acre after impoundment, there were slight reductions in their abundance during the second and third years of impoundment.

The smallmouth bass was frequent in Sections I and II but was unrecorded in Section III of Barren River. This excellent game fish averaged 4 per acre in the river but its numbers were drastically reduced after impoundment.

The spotted bass was the most abundant of the three black basses recorded in the Barren River. This species was frequent in Sections I and II, common in Section III, and averaged 8 per acre in the combined collections from the river. The spotted bass increased in abundance after impoundment and remained the most numerous of the black basses. This game fish averaged 452 per acre in 1964; 50 per acre in 1965; and 392 per acre in 1966.

Largemouth bass were recorded only in Section I of Barren River and they were scarce in the combined collection. This important game fish achieved significant increases in abundance after impoundment. Although the fecundity

of the native river stock may account for the increases in abundance after impoundment, the river population may have been supplemented from the inundation of farm ponds. In any case the largemouth bass became well established after impoundment and averaged 209 per acre in 1964; 65 per acre in 1965; and 161 per acre in 1966.

White crappie and black crappie were rare in the combined collections from Barren River and their distribution was limited to Sections II and III respectivaly. Both species became well established in the reservoir the first year of impoundment however, and in 1966 there occurred a significant crappie "run".

Percidae

This family was represented by no less than 19 different species of fishes. Percids ranked third in order of abundance in the combined sample from the river but their numerical importance decreased after impoundment.

Darters which were considered rare in Barren River were the stripetail, spotted, Johnny, emerald, orangethroat, and gilt.

The longhead darter, considered by some authorities to be one of the rarest in existence, ranked frequent in the combined samples.

The most abundant fish in this family before impoundment was the rainbow darter and it was followed in order of decreasing abundance by the greenside darter, bluebreast darter, and fantail darter.

Percids decreased from an average of 95 per acre in Barren River to 2 per acre the first year of impoundment. The Percidae averaged 15 per acre in 1965 and further increased to 41 per acre in 1966. This slight recovery during 1965 and 1966 was attributed to increases among two species, logperch and blackside darter.

The walleye was rare in the combined collections from the river and its distribution was limited to Section II. One young-of-the-year walleye was

recorded in Barren Reservoir the first year of impoundment and another intermediate sized specimen was collected the following year. In an effort to supplement the native walleye population a stocking program was initiated in 1966. A total of 4,150,000 walleye fry obtained from the New York Department of Conservation were stocked in the reservoir in April, 1966 and three intermediate sized walleye were collected in the reservoir the following summer.

Sciaenidae

The freshwater drum was frequent in the combined collections from Barren River but was found only in Sections II and III. This species was not recorded after impoundment.

Cottidae

The banded sculpin was common in Section I, and frequent in Sections II and III. No sculpin were recorded after impoundment.

Atherinidae

Brook silverside were rare in Barren River and were recorded only in Section I. This species increased from an average of 0.3 per acre in the combined collections before impoundment to 7.5 per acre the first year of impoundment. The abundance of brook silverside fluctuated little during the second and third years of impoundment.

FISH POPULATION BIOMASS

Fish productivity estimates for Barren River were considerably greater than estimates made for two other rivers in the Pennyroyal physiographic region of Kentucky (Turner 1959). The biomass in Section II of Barren River averaged 111 pounds per acre, whereas estimates for Rough River and Nolin River were 40 and 30 pounds per acre respectively.

The biomass of Section I, including the main stem of Barren River, East Fork of Barren River, and Long Creek, averaged 73 pounds per acre. The biomass increased to 111 pounds per acre in Section II, which included the main stem and Skaggs Creek; the single 2.0 acre area in Section III yielded 166 pounds per acre (Table 2).

Table 2. The total weight of fishes per acre collected from Barren River before impoundment. Weight per acre is followed by per cent of total weight in parentheses.

Section	I		II		III	
Surface area sampled	4.2		5.4		2.0	
Petromyzontidae	0.01	(tr.)	-	(-)	-	(-)
Lepisostidae	0.11	(10.2)	0.15	(0.1)	0.56	(-)
Clupeidae	0.97	(1.3)	4.29	(3.9)	3.25	(2.0)
Hiodontidae	-	(-)	0.28	(0.3)	-	(-)
Esocidae	0.06	(0.1)	0.24	(0.2)	-	(-)
Cyprinidae	5.31	(7.3)	2.14	(1.9)	1.88	(1.1)
Catostomidae	25.63	(35.3)	54.40	(49.0)	45.41	(27.4)
Ictaluridae	27.48	(37.8)	32.56	(29.4)	78.66	(47.5)
Cyprinodontidae	tr.	(tr.)	tr.	(tr.)	-	(-)
Centrarchidae	11.23	(15.5)	7.84	(7.2)	5.23	(3.2)
Percidae	1.63	(2.2)	3.46	(3.1)	0.10	(0.1)
Sciaenidae	-	(-)	5.50	(4.9)	30.51	(18.4)
Cottidae	0.22	(0.3)	0.03	(tr.)	tr.	(tr.)
Atherinidae	tr.	(tr.)	-	(-)	-	(-)
TOTAL	72.65	(100.0)	110.89	(100.0)	165.60	(100.0)

The fish population biomass of Barren River was dominated by catostomids and ictalurids. These two groups combined represented 73 per cent of the biomass in Section I, 78 per cent in Section II, and 75 per cent in Section III. Golden redhorse comprised a major portion of the catostomid biomass while channel catfish was the dominant ictalurid.

Centrarchids ranked third in total weight in Sections I and II and fourth in Section III. The biomass of freshwater drum increased substantially from Section II to Section III and this species ranked third in the latter section of the river.

The fish population biomass in Section II of Barren River increased from 111 pounds per acre before impoundment to 194 pounds per acre in 1964, the first year of impoundment. In 1965, the biomass increased to 201 pounds per acre and the following year it averaged 241 pounds per acre (Table 3).

There were marked changes in the composition of the biomass from pre-impoundment to post-impoundment and additional changes occurred during the first three years of impoundment.

The biomass of catostomids decreased from 54 pounds per acre in Section II of the river to 16 pounds per acre in 1964. Little fluctuation occurred in the biomass of catostomids during 1965 and 1966 and they ranked fourth in importance each year.

Ictalurid biomass decreased from 33 pounds per acre in Section II of the river to 6 pounds per acre in 1964. Ictalurids ranked second in importance in the river and fifth after impoundment.

The biomass of clupeids (gizzard shad) increased from 4 pounds per acre in Section II of the river to 54 pounds per acre in 1964. Gizzard shad reproduction was not as great the two years following but the initial spawn of this species was so successful that their biomass was more than doubled by the third year of impoundment. Threadfin shad contributed less than 0.5 pound per acre to the biomass of clupeids in 1965 and 1966.

Table 3. Biomass of fishes collected from Barren Reservoir during the first three years of impoundment. Weight per acre is followed by per cent of total weight in parentheses.

Study year	1964		1965		1966	
Sample size (surface acres)	6.0		10.0		6.9	
Petromyzontidae	tr.	(tr.)	-	(-)	-	(-)
Lepisostidae	0.45	(0.1)	-	(-)	-	(-)
Clupeidae	54.40	(28.1)	78.80	(39.1)	111.59	(46.4)
Esocidae	0.19	(0.1)	-	(-)	-	(-)
Cyprinidae	45.10	(23.3)	50.20	(25.0)	37.54	(15.6)
Catostomidae	16.40	(8.5)	19.80	(9.8)	16.61	(6.9)
Ictaluridae	6.00	(3.1)	3.90	(2.1)	5.65	(2.3)
Cyprinodontidae	0.01	(tr.)	tr.	(tr.)	tr.	(tr.)
Serranidae	-	(-)	0.17	(0.2)	0.17	(0.1)
Centrarchidae	70.20	(36.3)	48.20	(23.9)	68.91	(28.6)
Percidae	0.78	(0.5)	tr.	(tr.)	0.24	(0.1)
Atherinidae	0.03	(tr.)	0.22	(tr.)	0.04	(tr.)
TOTAL	193.56	(100.0)	201.29	(100.0)	240.85	(100.0)

Most of the cyprinids which were recorded in Barren River were not recorded after impoundment but their absence from or scarcity in the reservoir was more than compensated for by an abundance of carp. Cyprinids averaged 2 pounds per acre in the river and this biomass was composed entirely of minnows. In 1964 the cyprinid biomass was 45 pounds per acre and carp comprised 44 pounds of this total. Carp reproduction was extremely limited in 1965 and 1966 and their biomass decreased both years.

Centrarchid biomass increased from 8 pounds per acre in the river to 70 pounds per acre in 1964, then fluctuated from 48 to 69 pounds per acre the two years following. The decrease shown from 1964 to 1965 was attributed to a reduction in the biomass of black basses whereas the increase which occurred in 1966 was attributed to bluegill.

The biomass of largemouth bass was greater than that of spotted bass each year after impoundment, but spotted bass reproduction was generally greater.

White crappie and black crappie averaged 0.5 pound per acre each in Section II of the river and both species increased to 1 pound per acre in 1964. Substantial reproduction of both species occurred in 1964 but the black crappie dominated in 1965 and 1966.

Bluegill increased from less than 0.5 pound per acre in the river to 20 pounds per acre in 1964. Their biomass remained at this level until 1966 when it jumped to 44 pounds per acre.

Longear sunfish increased from 1 pound per acre in the river to 14 pounds per acre in 1964, but their biomass was reduced to 7 pounds per acre in 1965, then to 6 pounds per acre in 1966.

THE SPORT FISHERY

Pre-impoundment creel surveys were made on Barren River during 1959, 1960, and 1961, whereas post-impoundment surveys were made during 1965 and 1966, the second and third years of impoundment.

The total fishing effort increased from an average of 25,595 man-hours before impoundment to 115,496 man-hours in 1965. In 1966, the total fishing effort was estimated at 90,166 man-hours (Table 4). On a per acre basis, the fishing intensity on the reservoir was 11.8 and 10.7 man-hours per acre, respectively, during 1965 and 1966.

Prior to the impoundment of Barren River the catch rate ranged from 0.50 fish per hour (0.32 pound per hour) to 0.61 fish per hour (0.58 pound per hour)

Table 4. Estimated fishing effort and fisherman success as determined by creel surveys.

	Pre-impoundment			Post-impoundment	
	1959	1960	1961	1965	1966
Survey period (days)	215	204	214	214	214
Stream miles	81	81	81	60	60
Fishing effort:					
total man-hours	38,744	18,948	22,005	115,496	90,166
man-hours/acre				11.8	10.7
Total harvest:					
fish/mile	239	122	166	1,867	1,398
fish/acre				11.4	10.1
pounds/mile	268	75	158	654.4	510.9
pounds/acre				4.0	3.6
Rate of harvest:					
fish/hour	0.50	0.52	0.61	0.97	0.93
pounds/hour	0.56	1.32	0.58	0.33	0.34

and the average weight of fish in the creel was 0.87 pound. After impoundment the catch rate increased but the average weight of fish in the creel decreased. Barren Reservoir fishermen averaged 0.97 fish per hour (0.33 pound per hour) in 1965, and 0.93 fish per hour (0.34 pound per hour) in 1966. The average weight of the fish harvested after impoundment was 0.35 pound.

The annual sport fishing harvest increased from an average of 14,215 fishes (13,507 pounds) before impoundment to 110,575 fishes (38,719 pounds) in 1965. In 1966, the estimated harvest was 83,854 fishes or 30,656 pounds (Tables 5 and 6).

Post-impoundment increases in the sport fishing harvest were accompanied by marked changes in the creel composition. The annual harvest of black basses, white bass, crappies, sunfishes, and carp, all increased from pre-impoundment to post-impoundment while the annual harvest of suckers decreased.

Table 5. The numerical composition of the total estimated harvest from Barren River before and after impoundment.

Species	Pre-impoundment								Post-impoundment			
	1959		1960		1961		Average annual harvest		1965		1966	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Black basses	3,700	19.1	2,177	22.1	3,920	29.2	3,265	22.9	18,261	16.5	13,417	16.0
White bass					41	0.3	14	0.1	336	0.3	1,509	1.8
Crappies	97	0.5	79	0.8	953	7.1	376	2.6	25,319	22.9	45,700	54.5
Walleye	77	0.4	20	0.2	54	0.4	50	0.3				
Muskellunge	77	0.4			94	0.7	57	0.4				
Catfishes	6,858	35.4	1,823	18.5	872	6.5	3,184	22.4	4,033	3.6	2,851	3.4
Rock bass	4,204	21.7	2,168	22.0	4,362	32.5	3,578	25.2	4,145	3.7	168	0.3
Other sunfish	988	5.1	2,660	27.0	1,463	10.9	1,704	12.0	28,344	25.7	16,100	19.1
Drum	77	0.4					26	0.3				
Suckers	3,293	17.0	857	8.7	1,664	12.4	1,938	13.6	784	0.7		
Carp			69	0.7			23	0.2	29,352	26.5	4,109	4.9
TOTAL	19,371	100.0	9,853	100.0	13,423	100.0	14,215	100.0	110,575	100.0	83,854	100.0

Table 6. The weight composition of the total estimated harvest from Barren River before and after impoundment.

Species	Pre-impoundment								Post-impoundment			
	1959		1960		1961		Average annual harvest		1965		1966	
	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%	Wt.	%
Black basses	4,838	22.3	1,934	31.9	4,531	35.5	3,767	27.9	17,985	46.4	15,481	50.5
White bass					26	0.2	9	0.6	39	0.1	674	2.2
Crappies	260	1.2	67	1.1	1,136	8.9	487	3.6	5,733	14.8	11,496	37.5
Walleye	130	0.6	24	0.4	140	1.1	98	0.7				
Muskellunge	369	1.7			408	3.2	259	1.9				
Catfishes	6,921	31.9	1,510	24.9	1,417	11.1	3,282	24.2	1,610	4.2	215	0.7
Rock bass	3,537	16.3	1,249	20.6	2,476	19.4	2,420	17.8	668	1.7	31	0.1
Other sunfish	87	0.4	261	4.3	89	0.7	146	1.0	2,081	5.3	1,441	4.7
Drum	108	0.5					36	0.1				
Suckers	5,446	25.1	940	15.5	2,540	19.9	2,975	22.0	432	1.2		
Carp			79	1.3			26	0.2	10,171	26.2	1,318	4.3
TOTAL	21,696	100.0	6,064	100.0	12,763	100.0	13,507	100.0	38,719	100.0	30,656	100.0

Three species of fishes which were recorded in the creel before impoundment, walleye, muskellunge, and drum, were not recorded in the reservoir creel.

The numerical composition of the harvest before impoundment was chiefly comprised of rock bass, black basses, and catfish; these three species combined constituted over 70 per cent of the average annual harvest. In 1965, the three most abundant species in the creel were carp, sunfishes, and crappies, in that order. In 1966, crappies were most abundant while sunfishes and black basses ranked second and third, respectively. Despite a 25 per cent reduction in the total harvest from 1965 to 1966, there was a substantial increase in the abundance of both white bass and crappies during the period.

Black basses constituted the greatest percentage of the weight composition both before and after impoundment. This group comprised 28 per cent of the harvest weight before impoundment, 46 per cent in 1965, and 50 per cent in 1966. Catfishes and suckers each comprised over 20 per cent of the harvest weight before impoundment but they decreased in importance after impoundment. In 1965, carp comprised 26 per cent of the harvest weight and ranked second to black basses whereas in 1966, crappies ranked second and comprised 37 per cent of the weight composition.

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