IOWA CONSERVATION COMMISSION
FISHERIES SECTION

FEDERAL AID TO FISH RESTORATION

ANNUAL PERFORMANCE REPORT

MAN-MADE LAKE INVESTIGATIONS

PROJECT NO. F-88-R-1

Study No. 702-3 - Effects of Flood Water Management and Fish Species Introduction on Fish Populations in Large Reservoirs

Job 1. Vital Statistics of Fish Populations in Red Rock Reservoir and Rathbun Reservoir Following Initial Impoundment

Job 2. Determine the Impact of Reservoir Operations for Flood Water Management on Fish Populations

Job 3. Determine the Success of Introductions of Fish Species and Their Biological Impact Upon Indigenous Fish Populations

Period Covered 1 July, 1973 to 30 June, 1974

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ANNUAL PERFORMANCE REPORT

RESEARCH PROJECT SEGMENT

STATE: Iowa

PROJECT NO.: F-88-R-2

STUDY NO.: 702-3

JOB NO.: 1

NAME: Effects of Flood Water Management and Fish Species Introduction on Fish Populations in Large Reservoirs

TITLE: Vital statistics of fish populations in Red Rock Reservoir and Rathbun Reservoir following initial impoundment

Period Covered: 1 July, 1973 through 30 June, 1974

ABSTRACT: *The objective of this study was to measure changes in species composition, abundance, size distribution, age structure and growth of fish in Red Rock and Rathbun Reservoir. Adult fish populations were sampled by means of pound and experimental gill nets while younger fish were caught by seine net. During the first year of this study, 1972, 10,102 fish weighing 2,607 kg were caught at Red Rock Reservoir. Carp was the most abundant species contributing 30% of the numerical catch. Stocked sport fish including largemouth bass, walleye and northern pike, all contributed less than 1% of the total catch. The following year species composition of a total catch of 8,917 fish, weighing 2,880 kg, was similar while there was a substantial increase in the catch of sport fish. Mean weights of all non-sport fish were higher in 1973 than they were in 1972 while mean weights of some sport fish were less the second year. Within the first year of study seine hauls accounted for 8,954 young-of-the-year and Cyprinids. Gizzard shad was the species caught most frequently, 51%. The following year seine hauls caught 10,391 fish. The greatest proportion of the numerical catch was made up of bullhead, 67%. At Rathbun Reservoir pound and experimental gill nets caught 13,195 fish, weighing 2,974 kg, the first year. White crappie was the most abundant species contributing 41% of the catch. The following year 12,649 fish were caught weighing 3,494 kg. Carp surpassed all other species contributing 51% of the catch while white crappie fell to second in abundance. During both years of study stocked sport fish including walleye, white bass, largemouth bass, and channel catfish contributed a small portion of the total catch while introduced muskellunge and ocean striped bass were not seen. Mean weight for most sport fish were greater in 1973 than 1972 while slight variation was found for non-sport fish. Seine haul catches accounted for 2,644 0-age fish and several species of adult Cyprinids during 1972. Gizzard shad comprised 88% of the catch while bluegill was second in abundance. The following year 5,080 fish were caught in seine hauls of which 86% were gizzard shad. Length-weight relationships, K-factors, body-scale regression, length-frequency distributions and age class structure of important species of each reservoir are discussed in addition to statistical analysis of some of these parameters.*

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Date Prepared: 1 July, 1974

STUDY OBJECTIVE

To measure the changes in abundance, species composition, size distribution, age structure and growth in important fish populations following impoundment of Rathbun Reservoir and Red Rock Reservoir and evaluate the impact of reservoir operations for flood control on fish populations and determine the effects of stocking large numbers of predatory fish species on the indigenous fish populations.

JOB 1 OBJECTIVE

To measure changes in species composition, abundance, size distribution, age structure and growth of fish in Rathbun Reservoir and Red Rock Reservoir.

INTRODUCTION AND STUDY BACKGROUND

Large reserviors that were constructed for temporary flood water storage and control offer a substantial fishery resource to this state, particularly in the southern region where previously there was a dirth of large bodies of water. Unpredictable and instable water levels generally compound management of the sport fishery in these impoundments. For the most part sport fish populations were initially developed and are maintained by stocking hatchery reared fish. Further information is necessary, to develop a fishery management program, on the changes which occurred in the fish populations following impoundment and to what extent the populations are being influenced by flood water management and fish stocking programs.

DESCRIPTION OF RESERVOIRS

RED ROCK RESERVOIR

Red Rock Reservoir is a U.S. Corps of Army Engineer flood control and water conservation reservoir located on the Des Moines River in Marion County, Iowa (Figure 1). The project was authorized by the U.S. Congress in 1938 as a portion of the Upper Mississippi River basin flood control project. Construction of the, impervious fill, earthen dam began in September of 1960 and was finished in March, 1969. At conservation pool, 221 m MSL, the reservoir is about 17.7 km in length and has a surface area of about 3,622 ha, and a storage of 117 million m^3. At flood pool, 237.8 m MSL, the length is almost 58 km, an area of about 26,507 ha and storage capacity of 2,140 million m^3. Maximum depth of Red Rock Reservoir is 10.7 m at conservation pool and 27.4 m at flood pool.

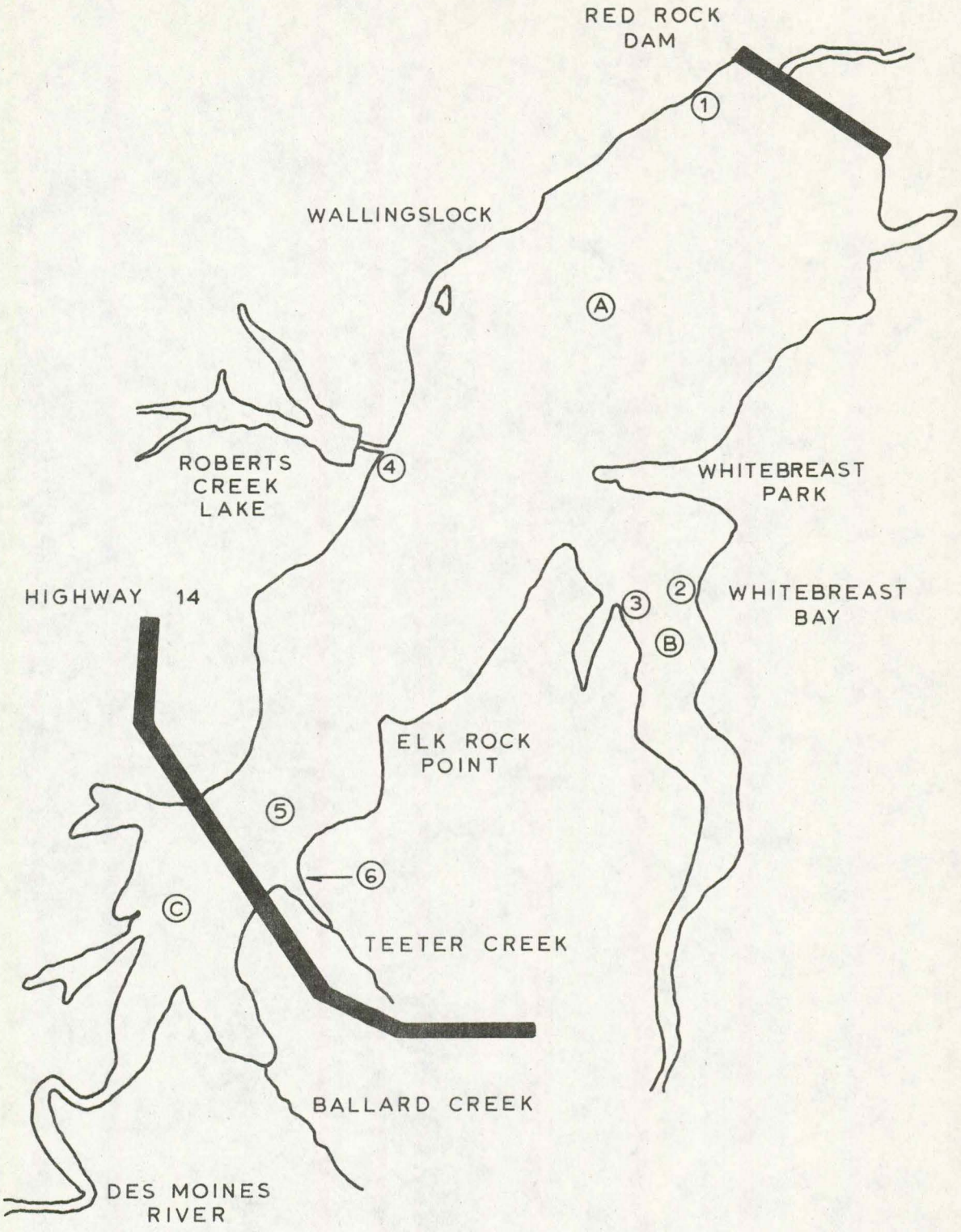

Figure 1. Red Rock Reservoir, sampling stations A, B and C and seine haul stations one through six.

In addition to the Des Moines River other lesser tributary rivers of the reservoir include: Whitebreast Creek, South River, North River, Middle River, and discharge from Roberts Creek Reservoir, a 101.2 ha subimpoundment of Red Rock Reservoir (Figure 1).

Frequency of flood stage elevation at 237.8 m MSL is approximately once in 100 years. The minimum discharge through the outlet structure is 8.5 cubic meters per second (CMS), but during maximum release it may range up to 3,687 CMS. The maximum value has been reached by the Des Moines River only twice in the past 125 years.

Quality of water chemistry parameters have been presented by Mayhew (1972). In general the overall water quality is poor. Turbidity is usually high due to the effects of prevailing wind action on the unstable banks and numerous shallow embayments. Suspended silt from land erosion is carried in by the tributary rivers while domestic and industrial waste also has a profound effect on dissolved oxygen and nutrient levels.

Pre-impoundment studies of fish populations were conducted in a 32.2 km stretch of the stream from 1966 through 1968. Species composition of the catch (Table 1) was dominated by channel catfish which comprised up to 88% of the numerical catch and 50% of the catch by weight. Carp and river carpsucker ranked second and third in numerical importance. Mean annual biomass of catfish in the study area was estimated at 5,354 fish weighing 1,092 kg (Mayhew 1972).

Table 1. Important fish species native to Red Rock Reservoir.

Common name	Genera and species
Bluegill	*Lepomis machrochirus*
Green sunfish	*L. cyanellus*
Pumpkinseed	*L. gibbosus*
Largemouth bass	*Micropterus salmoides*
Gizzard shad	*Dorosoma cepedianum*
Northern pike	*Esox lucius*
White sucker	*Catostomus commersoni*
Northern redhorse	*Moxostoma aureolum*
Golden redhorse	*M. erythrurum*
River carpsucker	*Carpiodes carpio*
Bigmouth buffalo	*Ictiobus cyprinellus*
Carp	*Cyprinus carpio*
Goldfish	*Carassius auratus*
Golden shiner	*Notemigonus crysoleucas*
Freshwater drum	*Aplodinotus grunniens*
White bass	*Morone chrysops*
Yellow bass	*M. interrupta*
Yellow perch	*Perca flavescens*
American eel	*Anguilla rostrata*
Channel catfish	*Ictalurus punctatus*
Black bullhead	*I. melas*
Flathead catfish	*Pylodictis olivaris*
Shortnosed gar	*Lepisosteus platostomus*

Following impoundment, stocking of game fish species at Red Rock Reservoir has been limited to walleye, northern pike and largemouth bass.

Net samples in the reservoir in the three years following impoundment indicated non-sport species dominated the catch (Mayhew 1972). Carp, river carpsucker and bigmouth buffalo made up nearly 83% of the numerical catch during the first three years. Population estimates of carp in 1969 revealed a density of about 2.8 million fish. The bigmouth buffalo population was estimated at 187,000 and the river carpsucker population was 319,000. Despite the intensive stocking efforts none of the game species has ever comprised more than 2% of the numerical catch.

RATHBUN RESERVOIR

Rathbun Reservoir is a U.S. Corps of Army Engineer flood control and water conservation reservoir located on the Chariton River in Appanoose County, Iowa (Figure 2). The project was authorized by the Flood Control Act of the United States Congress in 1954 as a segment of the Missouri River Basin Plan. Construction of two, impervious fill, earthen dams began in 1964. Impoundment commenced in November, 1969 and reached multipurpose pool elevation in October, 1970. Multipurpose conservation pool, 275.5 m MSL, has an area of 4,544 ha, pool length of 16 km, shoreline of nearly 230 km, maximum depth, 16 m, and a water storage of 283 million m^3. Flood pool stage at 282.2 m MSL has an area of 8,502 ha, maximum depth of 23 m, and a storage volume of 450 million m^3. Tributaries of Rathbun Reservoir include: Honey Creek, Buck Creek and South Fork of the Chariton River.

Chemical characteristics for three years of impoundment have been described by Mayhew (1974). Mayhew found a wide seasonal variation in turbidity, chemical oxygen demand, ammonia, nitrate and nitrite. Turbidity was influenced by inflow rate and wave action on numerous bare clay-silt banks. Generally thermal stratification was present from mid-June through late August. Pre-impoundment studies (Mayhew 1969) showed 36 species of fish from 10 families indigenous to the numerical catch at five sampling stations. Carp made up 19%; channel catfish, 14%; gizzard shad, 12%; and river carpsucker, 8%. Non-sport fish species dominated species composition in the Chariton River comprising 60% of the catch. Standing stock ranged from 123 kg per km in the upper reaches of the stream to 644 kg per km in lower basin segments.

Following impoundment walleye (*Stizostedion vitreum*), white bass, largemouth bass, channel catfish, ocean striped bass (*Morone saxatilis*) and muskellunge (*Esox masquinonge*) were stocked at varying rates.

METHODS AND PROCEDURES

Fish populations, including adult and young, were sampled with three different types of net gear. Adult fish were captured with four pound nets, .75 x 1.5 m frame, 13.7 m lead, .8 m diameter hoop, with 2.5 cm mesh bar measure and an experimental gill net, 45 x 2 m, containing five 9 m segments of 25, 38,

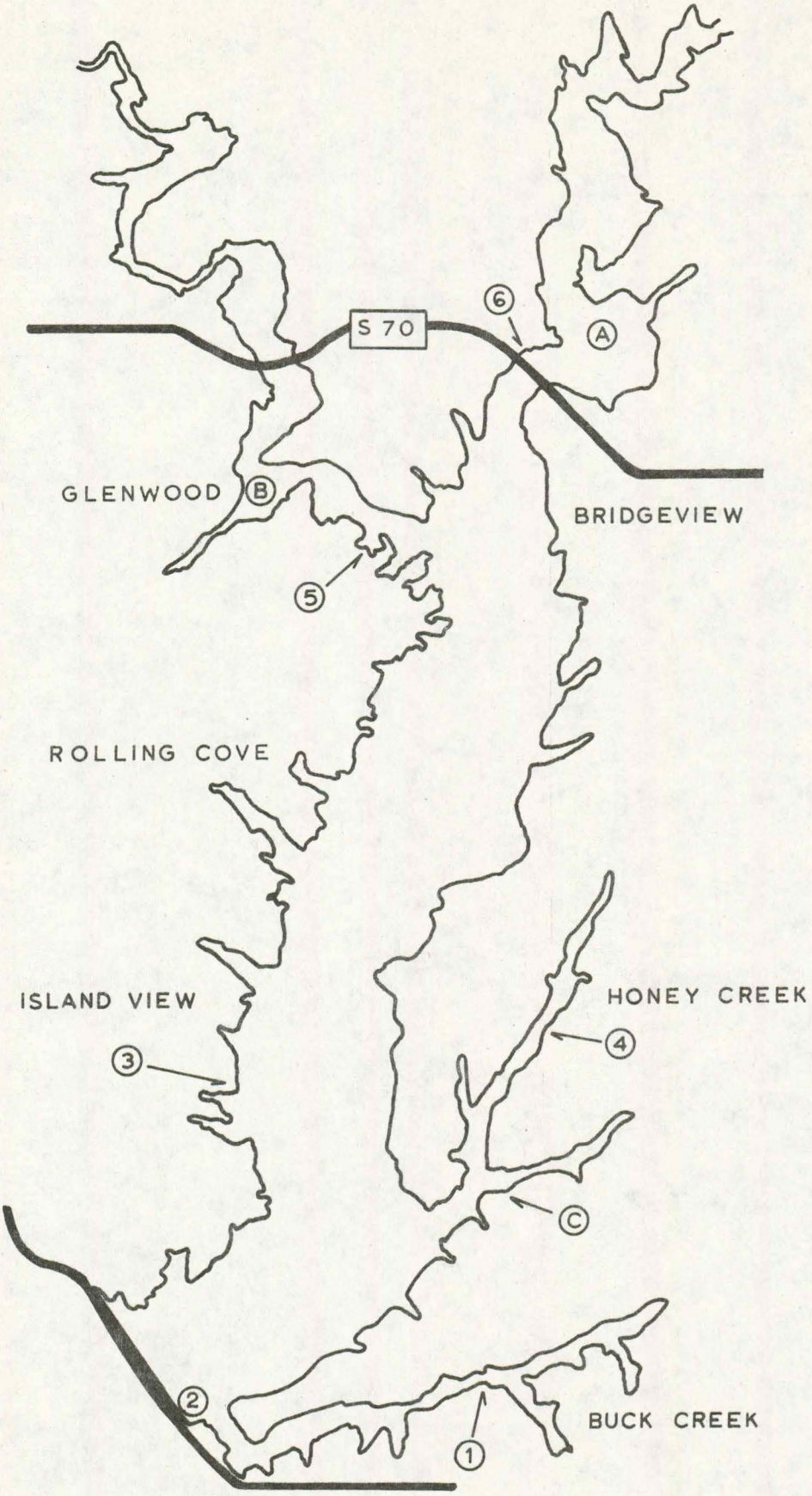

Figure 2. Rathbun Reservoir, sampling stations A, B and C and seine haul stations one through six.

51, 65 and 76 mm mesh bar measure, was used to capture adult and young. Young-of-the-year and forage species were sampled by means of a seine net 15.2 x 1.8 m with 6 mm mesh.

Monthly fish samples were collected at each reservoir from April through October at three stations (Figures 1 and 2). Each of these stations represented different reservoir habitat i.e., main pool and embayments. Pound nets and the experimental gill net were set for one net day, a 24 hour period, each month at each reservoir station. Bi-weekly seine hauls were also made at six stations from May through October. The seining procedure consisted of a 46 m haul followed immediately by a repetition through the same area.

Fish captured were identified, enumerated, weighed, measured in total length (TL) and a scale sample or spine from about 50 fish of each important species was collected from randomly chosen subsamples. Fish captured in seine hauls were identified, weighed and enumerated.

Data obtained from net catches were also used to calculate species composition i.e., percent of a species represented in the catch by number and weight, fish per net day (FND) and length-frequency distribution of each species.

Scales collected were pressed on cellulose acetate slides, .76 x 75 x 130 mm, at 3,000 psi on a thermo impression scale press. Scale impressions were viewed on a scale projector at a magnification of 40 X, annuli counted and measurements made along the anterior scale radius.

Numerical values tabulated for each species were processed through the SHAD age and growth program (Mayhew 1973). The program uses the standard procedures for computation of length-weight regression, body-scale relationship and condition factors.

Age class composition was determined from length-frequency distributions. Modes of length-frequency distributions were assigned ages of fish with similar back calculated lengths at last annulus.

FINDINGS

RED ROCK RESERVOIR STUDIES

Species Composition of Net Catches During the 1972 season 10,102 fish weighing 2,607 kg were captured in pound and experimental gill nets (Table 2). Carp was the most abundant species making up 30% of the numerical catch, 3,058 fish, and 38% of the weight, 981 kg. Black bullhead were second in abundance comprising 18% of the numerical catch, 1,861 fish, and 7% of the biomass, 169 kg; while river carpsucker was third, 17% of the catch or 1,736 fish weighing 467 kg, 18% of the biomass. The only important sport fish species was black crappie, 1,266, weighing 151 kg and 162 channel catfish with a combined weight of 67 kg.

Table 2. Combined catch composition of pound and experimental gill nets, Red Rock Reservoir, April through October, 1972.

Species	Number	Percent number	Weight (kg)	Percent weight	Mean weight (kg)
Carp	3,058	30.2	981.2	37.6	.32
B crappie	1,266	12.5	151.4	5.8	.12
B bullhead	1,861	18.4	169.1	6.5	.09
B buffalo	816	8.1	576.8	22.1	.71
R carpsucker	1,736	17.2	467.3	17.9	.27
C catfish	162	1.6	67.2	2.6	.41
G shad	558	5.5	73.4	2.8	.13
F drum	396	3.9	27.3	1.0	.07
Walleye	19	.2	20.9	.8	1.10
Bluegill	78	.8	4.7	.2	.06
G sunfish	12	.1	52.0	< .1	.04
N pike	16	.2	32.6	1.2	2.04
Lm bass	37	.4	12.5	.5	.34
Goldfish	10	< .1	1.8	< .1	.18
F catfish	7	< .1	2.6	.1	.38
N redhorse	22	.2	8.4	.3	.38
W bass	28	.3	3.9	.2	.14
Y bass	3	< .1	.3	< .1	.11
S gar	14	.1	4.9	.2	.35
Notropis sp.	3	< .1	.2	< .1	.12
Total	10,102		2,607.1		

Total catch by pound and experimental gill nets in 1973 was 8,917 fish weighing 2,880 kg (Table 3). Species composition in the 1973 catch was similar to 1972. Carp remained predominant contributing 31% of the numerical catch, 2,759 fish and 48% of the biomass, 1,376 kg. Black bullhead were second, 22%, 1,926 fish weighing 244 kg or 9% of the biomass and river carpsucker third in abundance contributing 17% of the catch, 1,517 fish and 22% of the biomass 643 kg. Black crappie continued as the dominant sport species making up 13% of the numerical catch, 1,188 fish weighing 180 kg. Numerical catch of sport species included 158 largemouth bass, 132 walleye, 123 northern pike, and 101 bluegill.

Table 3. Combined catch composition of pound and experimental gill nets, Red Rock Reservoir, April through October, 1973.

Species	Number	Percent number	Weight (kg)	Percent weight	Mean weight (kg)
Carp	2,759	30.9	1,357.9	47.8	.50
B crappie	1,188	13.3	179.5	6.2	.15
B bullhead	1,926	21.6	244.0	8.5	.13
B buffalo	217	2.14	186.7	6.5	.86
R carpsucker	1,517	17.0	642.8	22.3	.42
C catfish	90	1.0	34.9	1.2	.39
G shad	51	.6	3.8	.1	.07
F drum	321	3.6	38.4	1.3	.12
Walleye	132	1.5	10.1	.4	.77
Bluegill	101	1.1	7.9	.3	.08
G sunfish	105	1.2	7.6	.3	.07
N pike	123	1.4	47.9	1.7	.39
Lm bass	158	1.8	60.1	2.1	.38
Goldfish	58	.6	11.7	.4	.20
F catfish	3	< .1	1.0	< .1	.33
N redhorse	4	< .1	1.0	< .1	.26
W & Y bass	129	1.5	12.3	.4	.10
S gar	20	.2	13.8	.5	.69
Notropis sp.	7	< .1	.2	< .1	.02
Y perch	2	< .1	.1	< .1	.07
R sunfish[a]	4	< .1	.3	< .1	.07
W sucker	2	< .1	.4	< .1	.20
Total	8,917		2,880.4		

[a] *Lepomis microlophus.*

Catch success by pound and experimental gill nets decreased by 24% from 1972 to 1973 (Table 4). Sport and non-sport species abundant during 1972 decreased while sport species seldom caught in 1972 were caught more often in 1973. Carp decreased from 53 FND in 1972 to 39 FND in 1973, bigmouth buffalo decreased from 12 FND to 3 FND, river carpsucker declined from 29 FND to 23 FND, freshwater drum 12 FND to 9 FND, while bullhead catch success only dropped from 38 FND to 35 FND. Sport fish decreasing in abundance included black crappie 24 FND to 19 FND, channel catfish 5 FND to 2 FND and walleye .4 FND to .3 FND. Uncommon sport species of 1972 were still relatively rare in 1973 but their incidence of capture increased in the latter year. Northern pike catch success rose from .4 FND in 1972 to 4.5 FND in 1973, largemouth bass increased from .6 FND to 2 FND while bluegill increased from 1.1 FND to 1.4 FND.

Table 4. Catch success (FND) by pound net, experimental gill net and combined catch at Red Rock Reservoir, 1972 and 1973.

Species	Pound net (FND)		Experimental gill net (FND)		Combined catch (FND)	
	1972	1973	1972	1973	1972	1973
Carp	39.7	34.1	13.5	4.9	53.2	39.0
B crappie	15.6	13.8	8.7	5.6	24.3	19.4
B & Y bullhead	22.3	21.0	15.4	14.3	37.7	35.3
B.buffalo	11.3	2.7	.7	.4	12.0	3.0
R carpsucker	22.9	18.3	5.3	4.5	29.1	22.8
C catfish	1.4	.9	3.4	1.1	4.8	2.0
G shad	3.1	.2	18.7	2.0	21.8	2.1
F drum	3.3	2.5	9.2	6.2	12.4	8.7
Walleye	.2	.1	.2	6.2	.4	6.3
Bluegill	1.1	1.3	< .1	.2	1.1	1.4
G sunfish	< .1	.9	.5	1.9	.5	2.7
N pike	.2	.6	.3	3.9	.4	4.5
Lm bass	.4	1.4	.6	2.3	.9	3.7
Goldfish	.1	.6	< .1	.4	.1	1.0
F catfish	.1	< .1	.1	.1	.1	.1
N redhorse	.2	< .1	.3	.1	.5	.1
W & Y bass	.4	1.4	.2	1.1	.6	2.5
S gar	< .1	.2	.7	.2	.7	.4
Notropis sp.	< .1	< .1	.2	.4	.2	.4
R sunfish	< .1	.1	< .1	< .1	< .1	.1
W sucker	< .1	< .1	< .1	.1	< .1	.1
Y perch	< .1	< .1	< .1	.1	< .1	.1
Total	122.3	100.1	78.7	55.6	201.0	155.6
Mean	111.2		67.1			

Mean weights of all non-sport fish, caught by pound and experimental gill nets, were higher in 1973 than they were in 1972. Mean weight of carp in 1972 was .32 kg and increased to .50 kg in 1973, mean weight of bigmouth buffalo rose from .71 kg to .86 kg, river carpsucker increased from .27 kg to .42 kg while the mean weight of bullheads increased from .09 kg to .13 kg.

Changes in mean weights of most sport fish between 1972 and 1973 were not as favorable as they were for non-sport species. Mean weight of black crappie increased slightly from .12 kg in 1972 to .15 kg in 1973 and largemouth bass mean weight increased from .34 kg to .38 kg. Walleye decreased from a mean weight of 1.1 kg to .77 kg, northern pike decreased from 2.0 kg to .39 kg and channel catfish mean weight declined from .41 kg to .39 kg.

Most species were more susceptible to capture by pound nets, mean of 111 FND, than by the experimental gill net, mean of 57 FND, during the first two years of this study. Carp, black crappie, bullhead, bigmouth buffalo, river carpsucker, bluegill, and largemouth bass were all caught at higher catch rates by pound net while catch success of channel catfish, freshwater drum, and walleye were higher in experimental gill nets.

Within the first year of this study, 1972, seine haul catches at Red Rock Reservoir accounted for 8,954 young-of-the-year and Cyprinids (Table 5). Gizzard shad was the species most frequently caught comprising 51% of the total catch. Cyprinids other than carp were second in abundance, 34%; river carpsucker was third, 7%; while carp was next, 2%. 0-age sport species accounted for only 5% of the total catch in 1972. Black crappie was the most important, 2%; largemouth bass and white bass were represented equally, 1%; while channel catfish comprised only .7% of the total catch. Catches of other sport species such as bluegill and walleye were very low, .3 and .1%, respectively.

During 1973 seine hauls accounted for 10,391 young fish and Cyprinids (Table 6). The greatest proportion of the numerical catch was made up to bullhead, 67%; that species was followed in numerical occurrence by Cyprinids, 12%; gizzard shad, 9%; and bigmouth buffalo, .6%. 0-age sport species accounted for 10% of the total catch. Young largemouth bass comprised nearly 6% of the total seine catch while white bass representation was 2% and black crappie fell to third in importance, 1%. Other sport fish represented were bluegill, .8%; walleye, .2%; northern pike, .1%; and channel catfish, < .1%.

Species composition between stations, during 1972 and 1973, were similar even though mean FND were dissimilar (Table 7). Differences in species composition was tested by one-way classification of analysis of variance. On the basis of the results, catch success at Stations A, B and C during 1972 and 1973 was not significantly different at .01 level of sampling probability.

Age Structure and Growth

Carp Length-frequency distribution of carp population was compiled from April and May in both years (Table 8). Length distribution ranged from 150-576 mm.

Five modes were found within the 1972 length classes; 150 to 175 mm, 251 to 275 mm, 376 to 400 mm, 476 to 500 mm and 526 to 550 mm. Age class representation, assigned from back calculated total lengths at annulus, was 9%, age I - 150 to 200 mm; 30%, age II - 201 to 250 mm; 49%, age III - 251 to 300 mm; 3%, age IV - 301 to 350 mm; 1%, age V - 351 to 375 mm; 2%, age VI - 376 to 400 mm; 2%, age VII - 401 to 450 mm; < 1%, age VIII; and 3%, age IX and older - 476 to 576+ mm.

Two modes occurred in the 1973 length distribution of carp, 276 to 300 mm and 426 to 450 mm. Age class representation was 2%, age I; 12%, age II - 201 to 250 mm; 38%, age III - 251 to 300 mm; 25%, age IV - 301 to 375 mm; and 23%, age V, VI and older = 376 to 576+ mm.

Lengths, weights and scales were collected from 55 carp in 1972 and 42 in 1973. They ranged in TL of 142 to 521 mm and weights of 45 to 2,270 g in 1972 and 143 to 504 mm and weights of 91 to 2,223 g in 1973. Length-weight relationships for each year were best described by the equations

Table 5. Species composition of 0-age fish, by station, at Red Rock Reservoir, 1972, catches by seine net.

Species	Station 1		2		3		4		5		6		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Cyprinids[a]	142	12.6	465	49.2	428	57.5	604	36.5	1,116	33.0	315	28.6	3,070	34.3
Carp	31	2.7	1	.1	21	2.8	117	7.1	0		8	.7	178	2.0
R carpsucker	168	14.9	114	12.0	68	9.1	138	8.3	85	2.5	27	2.4	600	6.7
G shad	745	65.9	251	26.5	63	8.5	736	44.5	2,091	61.9	692	62.8	4,578	51.1
B crappie	17	1.5	53	5.6	52	7.0	1	70.1	18	.5	26	2.4	167	1.9
Lm bass	6	.5	11	1.2	5	.7	32	1.9	21	.6	12	1.1	87	1.0
Walleye									7	.2	1	.1	8	.1
Drum	8	.7	12	1.3	39	5.2	2	.1	4	.1	5	.4	70	.8
C catfish	2	.2	6	.6	34	4.6	9	.5	10	.3	2	.2	63	.7
W bass	5	.4	18	1.9	30	4.0	2	.1	24	.7	12	1.1	91	1.0
Bluegill	4	.4	11	1.2			7	.4	3	.1			25	.3
G sunfish											2	.2	2	< .1
Buffalo			1	.1	4	5.3	2	.1					7	< .1
Bullhead	2	.2					3	.2					5	< .1
Sucker			3	.3									3	< .1

[a]All Cyprinids other than carp.

Table 6. Species composition of 0-age fish, by station, at Red Rock Reservoir, 1973, catches by seine net.

Species	Station 1 N	%	2 N	%	3 N	%	4 N	%	5 N	%	6 N	%	Total N	%
Cyprinids[a]	294	20.3	60	13.2	350	10.8	390	54.6	75	2.9	115	4.7	1,284	12.4
Carp	1	.1	2	.4	1	< .1	7	1.0	5	.2	2	< .1	18	.2
R carpsucker	2	.2			1	< .1			1	< .1	2	< .1	5	< .1
G shad	104	10.7	155	34.0	64	2.0	139	19.5	128	5.0	362	14.8	952	9.2
B crappie	3	.3	19	4.2	11	< .3	38	5.3	14	.5	50	2.0	135	1.3
Lm bass	56	5.8	28	6.1	318	9.8	34	4.8	43	1.7	116	4.7	595	5.7
Walleye	2	.2	2	.4	4	.1	2	.3			10	.4	20	.2
Drum					1	< .1			3	.1	4	.2	8	< .1
C catfish					1	< .1	5	.7	2	< .1			8	< .1
W bass	173	17.8	4	.9	6	.2	4	.6	14	.5	2	< .1	203	2.0
N pike			2	.4					3	.1	10	.4	15	.1
Bluegill	5	.5	6	1.3	28	.9	5	.7	6	.2	29	1.2	79	.8
G sunfish	1	.1	4	.9							1	< .1	6	< .1
Bullhead	309	31.9	168	36.8	2,442	75.4	84	11.8	2,249	87.8	1,736	70.8	6,988	67.2
B buffalo	19	2.0	6	1.3	6	.2	6	.7	18	.7	10	.4	64	.6
Goldfish					7	.2					1	< .1	8	< .1
Logperch[b]					7	.2					1	< .1	1	< .1
Y perch							1	.1					1	< .1
F catfish									1	< .1			1	< .1

[a]All Cyprinids other than carp and goldfish.

[b]*Percina caprodes*.

Table 7. Combined catch success (FND) by pound and experimental gill net, for each station at Red Rock Reservoir.

	1972			1973		
	Station					
Species	A	B	C	A	B	C
Carp	51.0	53.6	54.6	25.8	51.9	37.3
B crappie	19.0	28.5	25.4	14.5	29.6	15.5
B bullhead	21.0	40.1	51.4	18.2	56.0	34.4
B buffalo	6.8	19.5	9.4	.7	6.5	1.8
R carpsucker	18.9	25.0	43.2	17.5	26.7	24.4
C catfish	4.9	5.5	4.0	2.3	1.7	1.9
G shad	19.8	26.1	19.5	1.7	3.2	1.3
F drum	13.3	9.3	10.5	10.7	9.3	5.7
Walleye	.3	.5	.7	4.9	11.5	1.7
Bluegill	2.2	.7	.4	.9	1.8	1.5
G sunfish	< .1	.3	1.2	.6	2.9	5.2
N pike	.4	.2	.6	2.0	9.2	1.8
Lm bass	.4	1.0	.4	2.2	4.9	4.2
Goldfish	< .1	.2	.2	.3	1.0	1.7
F catfish	.2	< .1	.1	.1	< .1	.2
N redhorse	.3	.5	.7	< .1	.3	< .1
W & Y bass	.9	.3	.6	3.4	1.8	1.2
S gar	< .1	< .1	2.2	.7	< .1	.5
Minnow	.3	< .1	< .1	< .1	.4	.7
R sunfish	< .1	< .1	< ..1	< .1	< .1	< .1
W sucker	< .1	< .1	.2	< .1	.1	< .1
Y perch	< .1	< .1	< .1	< .1	.1	.2
Mean	7.3	9.6	10.3	3.9	10.0	6.4
Grand Mean		9.1			6.8	

Table 8. Length-frequency distribution of carp at Red Rock Reservoir for April and May of 1972 and 1973.

TL (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
150-175	30	5.4	1	.3
176-200	22	3.9	6	1.7
201-225	21	3.7	18	5.2
226-250	146	26.1	25	7.2
251-275	225	40.2	60	17.4
276-300	48	8.6	73	21.2
301-325	12	2.1	54	15.6
326-350	6	1.1	18	5.2
351-375	4	.7	15	4.3
376-400	11	2.0	14	4.0
401-425	9	1.6	15	4.3
426-450	6	1.1	19	5.5
451-475	1	.2	11	3.2
476-500	7	1.2	6	1.7
501-525	6	1.1	3	.9
526-550	3	.5	3	.9
551-575	1	.2	2	.6
576+	1	.2	2	.6
Total	559		345	

1972 $\log_{10}W = -4.52 + 2.85 \log_{10}L$

1973 $\log_{10}W = -3.53 + 2.48 \log_{10}L$.

Statistical analysis of the length-weight relationships showed no significant difference ($P > .05$) between years.

K-factors in 1972 ranged from 1.09 to 1.51 with a mean of 1.22 while 1973 values were 1.16 to 2.62 with a mean of 1.60.

Body-scale relationships were described by the linear functions

$$L = 18.58 + 1.51\ ScR$$

in 1972 and

$$L = 22.42 + 1.51\ ScR$$

in 1973. From these relationships mean total lengths at each annulus were calculated as 148, 214, 271, 320, 362, 398, 421, 452, and 486 mm for ages I through IX in 1972 and 132, 214, 280, 333, 379 and 470 mm for ages I through VI in 1973 (Table 9).

Table 9. Average estimated total length (mm) at each annulus for carp in Red Rock Reservoir during 1972 and 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV	V	VI	VII	VIII	IX
1972	101								
1971	109	217							
1970	154	244	325						
1969	151	240	321	387					
1968	136	195	354	315	383				
1967	140	177	220	296	375	470			
Grand average (1973)	132 (42)	214 (40)	280 (26)	333 (19)	379 (5)	470 (1)			
Grand average (1972)	148 (55)	214 (49)	271 (35)	320 (23)	362 (18)	398 (15)	421 (8)	452 (5)	486 (3)

River Carpsucker A length-frequency distribution of river carpsucker, caught in April and May netting periods, was tabulated for 51 fish in 1972 and 81 in 1973 (Table 10). Size range of river carpsucker ranged from 151 to 425 mm TL for both years.

The length distribution in 1972 was bimodal with mode appearing at 176 to 200 mm and 226 to 250 mm. In that sample 55% of the fish were between 226 to 275 mm, age III and IV, while 11% were over 300 mm, age V and older. Age class representation in the 1972 catch was 16%, age II - 151 to 200 mm; 35%, age III - 201 to 250 mm; 37%, age IV - 251 to 300 mm; 6%, age V - 301 to 325 mm; and 6%, age VI and older - 301 to 425 mm.

Table 10. Length-frequency distribution of river carpsucker at Red Rock Reservoir for April and May of 1972 and 1973.

TL (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
151-175	3	5.9	1	1.2
176-200	5	9.8	1	4.2
201-225	3	5.9	4	4.9
226-250	15	29.4	6	7.4
251-275	13	25.5	11	13.6
276-300	6	11.8	18	22.2
301-325	3	5.9	14	17.3
326-350	2	3.9	10	12.3
351-375			11	13.6
376-400			2	2.4
401-425	1	2.0	2	2.4
Total	51		81	

Lengths, weights and scales were collected from 49 river carpsucker in 1972 and 45 in 1973. Body measurements ranged from 142 to 399 mm TL and 45 to 952 g in 1972 while those in 1973 were of 148 to 470 mm TL and weights of 113 to 1,406 g. Length-weight relationships were represented by the equations

1972 $\log_{10}W = -4.82 + 2.98 \log_{10}L$

1973 $\log_{10}W = -3.83 + 2.58 \log_{10}L$

A significant difference ($P < .05$) was found between the 1972 and 1973 length-weight realtionships (Table 11). At the same length the body weight of river carpsucker was greater. The mean K-factor of the 1972 sample was 1.31 with a range of 1.16 to 1.56 while the 1973 mean was 1.35 with a range of 1.17 to 1.76.

Body-scale relationships were best described by the equations

1972 $L = - 0.57 + 1.90\ ScR$

1973 $L = 11.13 + 1.98\ ScR.$

These relationships were used to back calculate total lengths at annulus formation for each respective age (Table 12). The grand average for the 1972 sample was 101, 156, 224, 262, 301 and 333 for ages I through VI while the means for 1973 were 121, 215, 290, 337, 375, 403 and 434 for ages I through VII.

Table 11. Statistical comparison of length-weight relationship of river carpsucker in 1972 and 1973.

	b	S_b	N	t	SD
1972	2.98	.07	49	2.00	.14
1973	2.58	.11	45	2.02	.22

Table 12. Average estimated total length (mm) at each annulus for river carpsucker in Red Rock Reservoir in 1972 and 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV	V	VI	VII
1972	133						
1971	108	203					
1970	125	226	296				
1969	132	207	284	329			
1968	151	251	317	358	387		
1967	105	201	272	338	378	403	
1966	91	199	281	323	359	403	434
Grand average (1973)	121 (45)	215 (44)	290 (32)	337 (20)	375 (11)	403 (4)	434 (1)
Grand average (1972)	101 (49)	156 (46)	224 (37)	263 (28)	301 (16)	333 (3)	

Bigmouth Buffalo In the time span of April and May, 1972, a length-frequency distribution of 115 bigmouth buffalo were tabulated while a length distribution was recorded of only 20 fish in 1973 (Table 13). Size structure of the populations were 200 to 550 mm in 1972 and 326 to 450 mm in 1973.

Table 13. Length-frequency distribution of bigmouth buffalo at Red Rock Reservoir for April and May of 1972 and 1973.

TL (mm)	1972 Numbe Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
200-225	1	.9		
226-250				
251-275	1	.9		
276-300	10	8.7		
301-325	26	22.6		
326-350	47	40.9	3	15.0
315-375	22	19.1	3	15.0
376-400	3	2.6	5	25.0
401-425	1	.9	7	35.0
426-450	1	.9	2	10.0
451-475				
476-500				
501-525	2	1.7		
526-550	1	.9		
551-575				
576-600				
Total	115		20	

In 1972 samples from one mode, the 1970 year class, was recorded. Age class structure was 1%, age I - 200 to 225 mm; 91%, age II - 251 to 375 mm; 3%, age III - 376 to 400 mm; and 5%, age IV and older - 401 to 550.

The 1970 bigmouth buffalo year class continued to dominate the entire catch in 1973. No other year classes were apparent in the length frequency sample.

Body measurements and scales were collected from 29 bigmouth buffalo in 1972 and 28 in 1973. The fish sampled ranged from 239 to 521 mm TL and 181 to 1,814 g in 1972 and 149 to 614 mm TL and 36 to 3,402 g in 1973.

The length-weight relationships for the two years are represented by the linear equations

1972 $\log_{10}W = -4.97 + 3.05 \log_{10}L$

1973 $\log_{10}W = -5.35 + 3.22 \log_{10}L$

Length-weight regressions for 1972 and 1973 samples were tested by comparing 95% confidence intervals set around respective slopes of these regression lines, and no difference was found.

K-factors in 1972 ranged from 1.25 to 1.54 and had a mean of 1.41 while in 1973 the range was 1.34 to 2.07 with a mean of 1.71.

Body-scale relationship was described by the equations

1972 $L = 126.44 + 1.32\ ScR$

1973 $L = 4.28 + 1.85\ ScR$

From these relationships the estimated length at each annulus was 255, 325, 380, 422 and 472 mm for ages I through V in 1972 and 175, 299, 374, 431, 497 and 645 mm for ages I through VI in 1973 (Table 14).

Table 14. Average estimated total length (mm) at each annulus for bigmouth buffalo in Red Rock Reservoir in 1972 and 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV	V	VI
1972	73					
1971	176	311				
1970	177	286	367			
1969	178	276	363	421		
1968	159	231	311	366	392	
1967	286	388	453	505	603	645
Grand average (1973)	175 (28)	299 (23)	374 (21)	431 (10)	497 (2)	645 (1)
Grand average (1972)	255 (53)	325 (50)	380 (33)	422 (7)	472 (4)	

Channel Catfish Channel catfish were not caught in sufficient quantity during any period of 1972 or 1973 to provide a true length-frequency distribution of the population. Body measurements and pectoral spines were collected from 37 channel catfish in 1972 and 28 in 1973. They ranged in TL from 223 to 691 mm and weighed from 68 to 1,261 g in 1973. The length-weight relationship were as follows:

1972 $\log_{10}W = -5.71 + 3.24 \log_{10}L$

1973 $\log_{10}W = -6.53 + 3.58 \log_{10}L$.

Statistical analysis of length-weight relationship revealed no significant difference ($P > .05$) between 1972 and 1973. K-factors in 1972 ranged from .58 to 1.17 with a mean of .86 while in 1973 they ranged from .64 to 1.18 and had an average of .86.

The body pectoral spine relationship were described by the functions

1972 $L = 3.08\ SpR$

1973 $L = 3.00\ SpR$

From these relationships back calculations at annulus were 70, 148, 220, 316, 408, 480 and 499 mm for ages I through VII in 1972 and 48, 157, 250, 320 and 361 mm for ages I through V in 1973 (Table 15).

Table 15. Average estimated total length (mm) at each annulus for channel catfish in Red Rock Reservoir in 1972 and 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV	V	VI	VII
1972	---						
1971	60	153					
1970	59	164	253				
1969	57	162	264	327			
1968	62	151	232	314	367		
Grand average (1973)	48 (28)	157 (28)	250 (19)	320 (4)	361 (3)		
Grand average (1972)	70 (37)	148 (37)	220 (37)	316 (25)	408 (10)	480 (5)	499 (4)

Black Crappie A length-frequency distribution of 272 black crappie was tabulated in April and May of 1972 and for 30 fish in the same months of 1973 (Table 16). Black crappie size range was 101 to 350 mm TL in 1972. Age class representation, projected from back calculations at annulus, were comprised of 15%, age I - 101 to 150 mm; 32%, age II - 151 to 225 mm; 40%, age III and IV - 226 to 275 mm; and 2%, age V and older - 276 mm and over. In 1973 the black crappie measured ranged from 126 to 300 mm and age class representation was 10%, age I - 126 to 150 mm; 83%, age II - 151 to 225 mm; and 7%, age V - 276 to 300 mm.

Table 16. Length-frequency distribution of black crappie at Red Rock Reservoir for April and May of 1972 and 1973.

TL (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
101-125	14	5.2		
126-150	27	9.9	3	10.0
151-175	45	16.5	17	56.7
176-200	38	14.0	4	13.3
201-225	32	11.8	4	13.3
226-250	52	19.1		
251-275	56	20.6		
276-300	4	1.5	2	6.7
301-325	2	.7		
326-350	2	.7		
Total	272		30	

In 1973 body measurements and scales were collected from 36 black crappie ranging from 134 to 343 mm TL and weights of 23 to 760 g. Length-weight relationship was represented by

$$\log_{10} W = -4.99 + 3.08 \log_{10} L.$$

K-factors ranged from 1.15 to 2.10 and had a mean of 1.71.

Body-scale relationship was described by

$$L = 53.42 + 1.65\ ScR$$

This relationship was used to back calculate total lengths at annulus formation (Table 17). The grand average total length was 141, 193, 235, 262 and 277 mm for ages I through V.

Table 17. Average estimated total length (mm) at each annulus for black crappie in Red Rock Reservoir, 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV	V
1972	136				
1971	132	184			
1970	139	194	232		
1969	161	215	244	274	
1968	135	181	229	250	277
Grand average (1973)	141 (36)	193 (27)	235 (15)	262 (6)	277 (2)

Black Bullhead In 1972 a length-frequency distribution of 399 black bullhead, caught in April and May, was compiled while a second distribution was made in 1973 from 343 fish (Table 18). Bullheads caught in 1972 ranged in length from 101 to 250 mm and nearly 70% were between 126 to 150 mm indicating a strong year 1971 class. The following year, 1973, the 1971 year class was still dominant when 76% of the fish caught were in the 176 to 200 mm and 201 to 225 mm size ranges. Bullhead spines were not aged, ages were assigned from back calculated lengths for bullhead found in Carlander (1969).

Largemouth Bass Catches of largemouth bass in 1972 and 1973 were insufficient to compile a representative length-frequency distribution. During 1973 lengths, weights and scales were collected from 20 largemouth bass ranging in total lengths from 241 to 434 mm and weights from 181 to 1,542 g. K-factors during 1973 ranged from 1.58 to 1.79 and a mean of 1.70.

Average estimated total length at each annulus for largemouth bass ages I through VII was 127, 201, 254, 284, 322, 330 and 319 mm (Table 19).

Gizzard Shad Length-frequency distribution in the spring of 1972 was compiled for 90 gizzard shad, 176 to 275 mm, while an autumn sample of only 21 fish, 126 to 300 m, was collected in 1973. Scales were not collected for aging, but ages were assigned from back calculated lengths at annulus found in Carlander (1969). Age structure in 1972 was entirely age I, 176 to 275 mm, while in 1973 it was 86%, age 0 - 126 to 175 mm; and 14%, age I and II - 226 to 300 mm (Table 20).

Table 18. Length-frequency distribution of black bullhead at Red Rock Reservoir for April and May of 1972 and 1973.

TL (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
76-100				
101-125	64	16.0	1	.3
126-150	279	69.9	10	2.9
151-175	39	9.8	37	10.8
176-200	12	3.0	95	27.7
201-225	4	1.0	166	48.4
226-250	1	.2	29	8.4
251-275			5	1.4
Total	399		343	

Table 19. Average estimated total length (mm) at each annulus for largemouth bass in Red Rock Reservoir, 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV	V	VI	VII
1972	99						
1971	105	194					
1970	133	218	274				
1969	139	191	248	288			
1968	169	233	295	324	351		
1967	144	209	256	295	334	362	
1966	101	162	195	231	280	298	319
Grand average (1973)	127 (20)	201 (19)	254 (15)	284 (11)	322 (8)	330 (7)	319 (1)

Table 20. Length-frequency distribution of gizzard shad at Red Rock Reservoir for April and May, 1972 and September, 1973.

TL (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
126-150			13	61.9
151-175			5	23.8
176-200	10	11.1		
201-225	50	55.6		
226-250	23	25.6	1	4.8
251-275	7	7.8		
276-300			2	9.5
301-325				
326-350				
Total	90		21	

RATHBUN RESERVOIR STUDIES

Species Composition of Net Catches Pound and experimental gill net catches in 1972 were 13,195 fish weighing 2,974 kg (Table 21). White crappie was the most abundant species contributing 41% of the numerical catch, 5,354 fish, and 22% of the weight, 657 kg. Carp was second in abundance comprising 20% of the catch, but contributed the greatest proportion of the biomass, 38% or 1,140 kg. Black bullhead were third in numerical abundance contributing 11% of the catch, 1,478 fish, and 7% of the biomass, 206 kg. Channel catfish ranked fourth (7%), 942 fish and 10% of the biomass, 204 kg. Other common species included gizzard shad, walleye, and bluegill.

The total numerical catch of 12,649 fish, by pound and experimental gill net, in 1973 was slightly less than 1972; however, the biomass comprised primarily of non-sport fish was greater, 3,494 kg (Table 22). Carp surpassed all other species in abundance, 51% of the catch and comprised 51% of the biomass. White crappie declined to second (37%) of the numerical catch, and 20% of the weight. Bullheads ranked third (13%) by numerical catch and gizzard shad fourth in abundance. Other important fish included channel catfish, walleye, bigmouth buffalo and bluegill.

Catch success (FND) in pound and experimental gill net decreased only slightly from 1972 to 1973, but included a decrease in sport fish while some non-sport species increased (Table 23). White crappie, the most important sport fish, decreased from 79 FND in 1972 to 65 FND in 1973 while the walleye decreased from 24 FND to 11 FND. Channel catfish also decreased from 20 FND to 17 FND, while bluegill declined from 7 FND to 2 FND. A drop in abundance was also recorded for largemouth bass and green sunfish. The only sport fish that increased in abundance was the white bass, .2 to 1.4 FND, while bullhead catch success remained nearly the same, 14 to 13 FND.

Table 21. Species composition in catches of fish by pound and experimental gill nets in Rathbun Reservoir from April through October, 1972.

Species	Number	Percent number	Weight (kg)	Percent weight	Mean weight (kg)
W crappie	5,354	40.6	657.1	22.1	.12
Carp	2,581	19.6	1,140.2	38.4	.44
B bullhead	1,478	11.2	206.1	6.9	.13
B buffalo	280	2.1	228.3	7.7	.81
R carpsucker	59	.4	33.4	1.1	.56
C catfish	942	7.1	303.6	10.2	.47
Walleye	892	6.8	263.2	8.9	.29
G shad	914	6.9	73.8	2.5	.08
Bluegill	520	3.9	40.8	1.4	.07
G sunfish	108	.8	6.8	.2	.06
Lm bass	36	.3	12.4	.4	.34
W bass	14	< .1	3.8	< .1	.27
W sucker	17	< .1	3.2	< .1	.18
Total	13,195		2,972.4		

Table 22. Species composition in catches of fish by pound and experimental gill nets in Rathbun Reservoir from April through October, 1973.

Species	Number	Percent number	Weight (kg)	Percent weight	Mean weight (kg)
Carp	4,216	37.6	1,782.6	51.0	.42
W crappie	4,100	36.6	699.3	20.0	.17
B bullhead	1,630	14.5	148.3	4.2	.09
C catfish	726	6.5	246.8	7.1	.34
Walleye	422	3.8	183.7	5.2	.44
G shad	832	7.4	74.6	2.1	.09
W bass	57	.5	10.3	.3	.18
R carpsucker	37	.3	22.6	.6	.61
B buffalo	333	3.0	286.5	8.2	.86
Bluegill	186	1.6	17.7	.5	.10
G sunfish	78	.7	5.7	.2	.07
Lm bass	24	.2	14.3	.4	.59
W sucker	5	< .1	1.1	< .1	.22
Notropis sp.	3	< .1	< .1	< .1	
Total	12,649		3,493.5		

Table 23. Catch success (FND) by pound net, experimental gill net and combined catch at Rathbun Reservoir, 1972 and 1973.

Species	Pound net (FND)		Experimental gill net (FND)		Combined catch (FND)	
	1972	1973	1972	1973	1972	1973
Carp	30.2	51.2	6.3	3.2	36.5	54.5
W crappie	61.8	45.7	16.7	19.0	78.5	64.7
Bullhead	13.7	13.3	4.0	26.4	17.7	39.7
B buffalo	3.4	4.1	.2		3.6	4.1
R carpsucker	.7	.4		.1	.7	.5
C catfish	8.7	6.1	11.4	11.1	20.1	17.2
Walleye	6.4	3.3	17.9	7.4	24.3	10.7
G shad	4.7	8.6	25.4	6.6	30.1	15.2
Bluegill	6.4	2.3	.1	.1	6.4	2.4
G sunfish	12.9	.8	1.1	.8	14.0	1.6
Lm bass	.3	.2	.7	.3	1.0	.5
W bass	.2	.5	.1	.9	.2	1.4
W sucker	.1	.1	.7	.2	.7	.2
G shiner				.1		.1
Total	137.4	136.4	98.3	76.2	235.7	212.7
Mean	136.9		87.25			

Catch success of most non-sport fish during the study period remained nearly the same; however, there was a substantial increase in the catch of carp. Carp were caught at 37 FND during 1972 and 55 FND in 1973, bigmouth buffalo were captured at 4 FND for each of those same years, while river carpsucker decreased from .7 FND in 1972 to .5 FND in 1973. Gizzard shad, an important forage species, declined from 30 FND to 15 FND.

Mean weight of most sport fish were greater in 1973 than in 1972. Mean weight of white crappie in 1972 was .12 kg and increased to .17 kg in 1973, mean weight of walleye rose from .29 to .44 kg, bluegill increased from .07 to .10 kg and largemouth bass increased from .34 to .59 kg. Channel catfish decreased from .47 to .34 kg.

Changes in mean weights of non-sport fish between 1972 and 1973 showed slight variation. Carp mean weights decreased from .44 to .42 kg and bullheads declined from .13 to .09 kg while river carpsucker increased from .56 to .61 kg and bigmouth buffalo increased from .81 to .86 kg.

Seine haul catches at Rathbun Reservoir accounted for 2,644 0-age fish and several species of adult Cyprinids during 1972 (Table 24). Gizzard shad was the most frequently caught fish species comprising 88% of the numerical catch. Cyprinids, including several species of *Notropis*, were second in abundance with 9%. Bluegill was the most abundant sport fish caught, 2%, while largemouth bass comprised .6% of the catch. Other less frequently caught sport fish included green sunfish, white crappie, white bass and ocean striped bass.

In 1973 seine haul samples produced a sample of 5,080 young-of-the-year and Cyprinids (Table 25). Species representation in the total seine catch of 1973 was similar to 1972. Gizzard shad was the dominant species representing 86% of the catch while Cyprinids were second in importance, 9%. Bluegill and largemouth bass were the most frequently caught sport species contributing 1.8 and 1.6% of the catch. Green sunfish, white crappie, white bass and bullheads all represented < 1% of the catch.

Species composition between netting stations were similar during 1972 and 1973 (Table 26). Differences in the numerical density of fish between sampling stations were evaluated by analysis of variance in a fixed model one-way classification. The results showed no significant difference in either sampling year ($P > .01$).

Age Structure and Growth

White Crappie In the time span of April and May, 1972, a length-frequency distribution for 506 white crappie were tabulated while a length distribution was compiled for 370 crappie during the same periods of 1973 (Table 27). Size range of the sample was 101 to 300 mm in 1972 and 75 to 325 mm in 1973.

A single mode from the 1970 year class was present between 151 and 225 mm and dominated the distribution. Age class representation within that year was 2%, age I - 101 to 150 mm; 86%, age II - 151 to 200 mm; and a few age III and older crappie, 13%, - 201 to 300 mm.

Continued domination of the 1970 year class was still evident in the results of 1973. Age calss representation was 2%, age I - 75 to 100 mm; 20%, age II - 126 to 200 mm; 95%, age III - 201 to 275 mm; and 3%, age III and older - 276 to 325 mm.

Lengths, weights, and scales were collected from 33 white crappie in 1972 and 27 in 1973. White crappie ranged in total lengths of 160 to 312 mm and weights of 45 to 408 g in 1972; and lengths of 164 to 315 mm and weights of 45 to 385 g in 1973. Length-weight relationship was best represented by the linear equations

1972 $\log_{10}W = -6.16 + 3.52 \log_{10}L$

1973 $\log_{10}W = -4.92 + 3.02 \log_{10}L$

Statistical analysis of white crappie length-weight relationship showed no significant difference ($P > .05$) between sample years.

Table 24. Species composition of 0-age fish, by station, at Rathbun Reservoir, 1972, catches by seine net.

Species	Station 1		2		3		4		5		6		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
G shad	169	87.6	305	96.2	264	95.6	9	27.3	1,417	92.5	168	57.3	2,332	88.2
Cyprinids	1	.5	8	2.5	4	1.4			109	7.1	116	39.6	238	9.0
Lm bass	3	1.6	2	.6	3	1.1	5	15.2	2	.1	2	.7	17	.6
Bluegill	16	8.3	1	.3	4	1.4	17	51.5	1	< .1	5	1.7	44	1.7
G sunfish	2	1.0					2	6.1					4	.2
Crappie	2	1.0											2	< .1
W bass									3	.2	2	.7	5	.2
S bass			1	.3	1	.4							2	< .1

Table 25. Species composition of 0-age fish, by station, at Rathbun Reservoir, 1973, catches by seine net.

Species	Station 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %	6 N	6 %	Total N	Total %
G shad	393	75.0	2,991	90.7	646	92.4	74	56.0	577	85.8	569	75.2	5,250	86.3
Cyprinids	1	.1	293	8.8	22	3.1	2	1.5	80	11.9	158	20.8	556	9.1
Lm bass	41	7.8	3	< .1	5	.7	29	21.9	5	.7	12	1.5	95	1.6
Bluegill	72	13.7			4	.5	25	18.9	7	1.0	4	.5	112	1.8
G sunfish	3	.5							1	.1			4	< .1
W crappie	12	2.2	4	.1			1	.7			9	1.1	26	.4
W bass	2	.3	4	.1	21	3.0			1	.1	5	.6	33	.5
Bullhead					1	.1	1	.7	1	.1	1	.1	4	< .1

Table 26. Combined catch success (FND) by pound and experimental gill net, for each station at Rathbun Reservoir.

	1972			1973		
	Station					
Species	A	B	C	A	B	C
Carp	23.8	24.6	27.5	39.1	80.6	43.5
W crappie	39.5	49.8	68.2	40.5	66.8	85.2
Bullhead	16.3	10.7	16.5	22.8	34.4	61.4
B buffalo	2.5	2.4	3.3	.8	3.4	7.9
R carpsucker	.7	.7	.3	.3	.4	.6
C catfish	7.0	5.4	15.8	16.3	12.4	22.7
Walleye	6.1	9.8	10.3	8.0	11.7	12.3
G sahd	7.8	8.9	10.2	12.0	10.8	22.0
Bluegill	7.0	4.1	4.2	2.6	1.5	3.0
G sunfish	.9	1.6	.7	2.0	.5	2.2
Lm bass	.3	.4	.4	.7	.3	.5
W bass	< .1	.2	.2	.2	2.7	1.1
W sucker	< .1	.3	.2	.1	.1	.4
Notropis sp.	< .1	< .1	< .1	< .1	.4	< .1
Mean	8.0	8.5	11.3	10.4	16.1	18.8
Grand mean		9.3			15.1	

Table 27. Length-frequency distribution of white crappie at Rathbun Reservoir for April and May of 1972 and 1973.

	1972		1973	
TL (mm)	Number	Percent occurrence	Number	Percent occurrence
75-100			5	1.6
101-125	1	.2		
126-150	7	1.4	4	1.3
151-175	112	22.1	25	8.1
176-200	322	63.6	33	10.7
201-225	58	11.5	107	34.8
226-250	4	.8	145	47.2
251-275			40	13.0
276-300	2	.4	9	2.9
301-325			2	.6
Total	506		370	

The mean K-factor of the 1972 sample was 1.33 and ranged from 1.04 to 2.31, while the average in 1973 was 1.40 and ranged from 1.23 to 2.00.

Body-scale relationship for the two year was described by

1972 $L = 68.17 + 1.61\ ScR$

1973 $L = 2.94 + 2.17\ ScR$

These relationships were used to back calculate total lengths at annulus for each respective age group (Table 28). The grand average for the 1972 sample was 136, 176, 222 and 270 mm for ages I through IV, and the grand average for 1973 was 90, 186, 248 and 315 mm for ages I through IV.

Table 28. Average estimated total length (mm) at each annulus for white crappie in Rathbun Reservoir in 1972 and 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV
1972	116			
1971	103	176		
1970	91	166	216	
1969	48	217	280	315
Grand average (1973)	90 (27)	186 (26)	248 (13)	315 (1)
Grand average (1972)	136 (33)	176 (25)	222 (15)	270 (4)

Carp During the 1972 sample in early spring a length-frequency distribution was compiled from 389 carp and from 414 fish in 1973 (Table 29). Carp length ranged from 201 to 500 mm in 1972 with the greatest proportion from 251 to 350 mm. Lengths of fish in the second year ranged from 226 to 525 mm with the majority from 251 to 325 mm.

Table 29. Length-frequency distribution of carp at Rathbun Reservoir for April and May of 1972 and 1973.

TL (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
201-225	2	.5		
226-250	12	3.1	1	.2
251-275	72	18.5	89	21.5
276-300	68	17.5	192	46.4
301-325	68	17.5	67	16.2
326-350	46	11.8	22	5.3
351-375	22	5.6	10	2.4
376-400	33	8.5	6	1.4
401-425	34	8.7	11	2.6
426-450	20	5.1	7	1.7
451-475	10	2.6	5	1.2
476-500	2	.5	2	.5
501-525			2	.5
Total	389		414	

Nearly 82% of the age class distribution in 1972 was comprised of the 1970, 1969 and 1968 year classes. Age I carp, 201 to 225 mm, contributed < 1% of the catch, 22% were age II from 226 to 275 mm, 37% were age III from 276 to 350 mm, 23% were age IV from 351 to 425 mm, and 8% were age V and older from 426 to 500 mm. The 1973 catch consisted almost entirely (89%) of the 1971 and 1970 year classes. Age class representation was 22%, age II - 226 to 275 mm; 68%, age III - 276 to 350 mm; 6%, age IV - 351 to 425 mm; and 4%, age V and older - 426 to 525 mm.

Body measurements and scales were collected from 72 carp in 1972 and 43 in 1973. Carp ranged in total lengths from 226 to 502 mm and weighed 136 to 1,361 g in 1972 compared to 240 to 468 mm and weighed from 136 to 1,225 g the following year.

Length-weight relationships were best represented by the linear equations

$$1972 \quad \log_{10} W = -4.56 + 2.86 \log_{10} L$$

$$1973 \quad \log_{10} W = -4.30 + 2.75 \log_{10} L$$

Length-weight regressions for 1972 and 1973 samples were tested by comparing 95% confidence intervals set around their respective regression lines, and no difference in slope was found.

The mean K-factor of the 1972 sample was 1.22 and ranged from .97 to 1.36, while the average in 1973 was 1.17 and ranged from .85 to 1.36.

Body-scale relationships for the two years was described by

1972 $L = 8.46 + 1.48\ ScR$

1973 $L = 12.79 + 1.42\ ScR$

These relationships were used to estimate total lengths at annulus for each age group (Table 30). The grand average for the 1972 sample was 162, 245, 328, 381, and 439 for ages I through V, and the grand average for 1973 was 202, 252, 312, 361, and 413 mm for ages I through V.

Table 30. Average estimated total length (mm) at each annulus for carp in Rathbun Reservoir in 1972 and 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV	V	VI	VIII
1972	219						
1971	187	262					
1970	198	273	328				
1969	207	275	327	360			
1968	101	198	281	362	413		
Grand average (1973)	202 (38)	252 (31)	312 (17)	361 (9)	413 (5)		
Grand average (1972)	162 (72)	245 (58)	328 (27)	381 (11)	439 (8)		

Walleye A length-frequency distribution for 82 walleye, caught in the spring of 1972, was recorded and the distribution of 71 were tabulated during time in 1973 (Table 31). Walleye length in 1972 ranged from 176 to 400 mm with the major proportion from 251 to 325 mm. The next year's walleye ranged from 301 to 425 mm with the highest occurrence in the 301 to 400 mm class.

Table 31. Length-frequency distribution of walleye at Rathbun Reservoir for April and May of 1972 and 1973.

TL (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
176-200	1	1.2		
201-225	4	4.9		
226-250	7	8.5		
251-275	19	23.2		
276-300	22	26.8		
301-325	14	17.1	11	15.5
326-350	9	11.0	28	39.4
351-375	4	4.9	22	31.0
376-400	2	2.4	8	11.3
401-425			2	2.8
Total	82		71	

One uniform mode comprised of the 1970 and 1971 walleye year classes was found in the 1972 sample. Age class representation within that sample was 64%, age I; and 36%, age II.

Class intervals between 301 and 425 mm were represented by one mode in the 1973 catch. The sample was dominated entirely by the 1970 and 1971 year classes while the 1972 year class was not recorded. Representation by age class that year was 55%, age II; and 45%, age III.

Body measurements and scales were collected from 52 walleye in 1972 and 29 in 1973. Walleye ranged in total length from 241 to 513 mm and weighed from 113 to 1,225 g in 1972. In 1973 the range in total length was 288 to 492 mm and weight from 222 to 1,089 g. Length-weight relationships for the two years were best represented by the linear functions

$$1972 \quad \log_{10} W = -5.60 + 3.20 \log_{10} L$$

$$1973 \quad \log_{10} W = -5.07 + 3.01 \log_{10} L$$

Statistical analysis of walleye length-weight relationship ($P > .05$) revealed no significant difference between 1972 and 1973.

The mean K-factor of the 1972 sample was .87 and ranged from .78 to 1.04, while the average in 1973 was .89 and ranged from .81 to 1.02.

Body-scale relationship for each of the two years was described by

1972 $L = 253.19 + 1.26\ ScR$

1973 $L = 50.48 + 2.69\ ScR$

These relationships were used to back calculate total lengths at annulus for each respective age group (Table 32). The grand average for the 1972 sample was 317 and 347 mm for ages I and II, and the grand average for 1973 was 199, 280, and 332 mm for ages I, II and III.

Table 32. Average estimated total length (mm) at each annulus for walleye in Rathbun Reservoir in 1972 and 1973. Sample size is listed in parenthesis.

Year class	Age I	Age II	Age III
1972			
1971	217	303	
1970	180	257	337
Grand average (1973)	199 (24)	280 (24)	332 (17)
Grand average (1972)	317 (49)	347 (36)	

Channel Catfish In the period of April and May, 1972, a length-frequency distribution for 49 channel catfish were tabulated while a length distribution was compiled for 96 catfish during the same period in 1973 (Table 33). Channel catfish ranged in length from 201 to 575 mm in 1972 and length from 201 to 400 mm in 1973 while a single fish was measured at 675 mm that same year.

Three modes were present in the 1972 length distribution, comprised of the 1970, 1969 and 1968 year classes. Age class representation within the 1972 sample was 65%, age II - 201 to 375 mm; 23%, age III - 426 to 500 mm; and 12%, age IV and older - 476 to 575 mm.

Table 33. Length-frequency distribution of channel catfish at Rathbun Reservoir for April and May of 1972 and 1973.

Tl (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
201-225	4	8.2	5	5.2
226-250	14	28.6	25	26.0
251-275	9	18.4	22	22.9
276-300	2	4.1	17	17.7
301-325	1	2.0	14	14.6
326-350	1	2.0	5	5.2
351-375	1	2.0	2	2.1
376-400			2	2.1
401-425				
426-450	6	12.2		
451-475	5	10.2		
476-500	1	2.0		
501-525	4	8.2		
526-550				
551-575	1	2.0		
576-600				
601-625				
626-650				
651-675			1	1.0
Total	49		96	

The 1973 length distribution showed two modes coming from the 1971 and 1972 year classes. Age class representation within that year was 70%, age II - 201 to 300 mm; 29%, age III - 301 to 400 mm; and 1%, age V and older fish.

Lengths, weights and spines were collected from 47 channel catfish in 1972 and 55 in 1973. Channel catfish ranged in total lengths from 140 to 559 mm and weighed from 73 to 2,223 g in 1972; and lengths from 200 to 640 mm and weighed from 68 to 3,493 g in 1973. Length-weight relationship was best described by the linear equations

$$1972 \quad \log_{10} W = -4.91 + 2.96 \log_{10} L$$

$$1973 \quad \log_{10} W = -5.32 + 3.11 \log_{10} L.$$

Statistical analysis of channel catfish length-weight relationship showed no significant difference ($P > .05$) between years.

The average K-factor of the 1972 sample was .99 and ranged from .77 to 1.28 while the mean value in 1973 was .97 and ranged from .83 to 1.33.

Body-scale relationship for the two years was described by

1972 $L = 3.16\ SpR$

1973 $L = 3.13\ SpR$

These relationships were used to back calculate total lengths at annulus for each respective age group (Table 34). The grand average for the 1972 sample was 95, 189, 307, 346 and 433 mm for ages I through V, and the grand average for 1973 was 118, 253, 379 and 554 mm for ages I through IV.

Table 34. Average estimated total length (mm) at each annulus for channel catfish in Rathbun Reservoir in 1972 and 1973. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV	V
1972					
1971	123	356			
1970	109	242	339		
1969	122	260	420	554	
Grand average (1973)	118 (55)	253 (55)	379 (33)	554 (1)	
Grand average (1972)	95 (38)	189 (38)	307 (17)	346 (3)	433 (1)

Bigmouth Buffalo Lengths, weights, and scales were collected from 41 bigmouth buffalo in 1972; however, the 1973 sample was insufficient to provide any valid population characteristics. Bigmouth buffalo ranged in total lengths from 309 to 476 mm and weighed from 399 to 1,724 g. Length-weight relationship was best described by the equation

$$\log_{10} W = -4.33 + 2.81 \log_{10} L.$$

The mean K-factor of the 1972 sample was 1.55 and ranged from 1.35 to 1.66 while in 1973 the average was 1.42 and ranged from .84 to 1.62.

Body-scale relationship in 1972 was

$$L = 3.30 + 1.87\ ScR$$

From this relationship estimated total length at each annulus was 204 and 341 mm for ages I and II (Table 35).

Table 35. Average estimated total length (mm) at each annulus for bigmouth buffalo in Rathbun Reservoir, 1972. Sample size is listed in parenthesis.

Year class	Age I	Age II
1972	199	
1971	209	341
Grand average	204 (40)	341 (22)

River Carpsucker In 1972 body measurements and scales were collected from 33 river carpsucker ranging in total length from 254 to 386 mm and weighed from 213 to 862 g. The 1973 collection was insufficient in sample size to provide valid growth information.

The length-weight relationship in 1972 was best described by the linear model

$$1972 \quad \log_{10} W = -5.24 + 3.15 \log_{10} L.$$

The mean K-factor of the 1972 sample was 1.39 and ranged from 1.26 to 1.54, while the average in 1973 was 1.37 and ranged from 1.18 to 1.49.

Body-scale relationship for 1972 was described by

$$1972 \quad L = 1.99\ ScR.$$

This relationship was used to back calculate total lengths at each annulus by age group (Table 36). The grand average for the 1972 sample was 105, 202, 274 and 303 mm for ages I through IV.

Table 36. Average estimated total length (mm) at each annulus for river carpsucker in Rathbun Reservoir, 1972. Sample size is listed in parenthesis.

Year class	Age I	II	III	IV
1972				
1971	92	201		
1970	116	223	302	
1969	108	182	245	303
Grand average	105 (33)	202 (33)	274 (19)	303 (2)

Black Bullhead During collection in the spring of 1972 a length-frequency distribution from 338 black bullhead was recorded while a length distribution of 596 was tabulated during the same period in 1973 (Table 37). Bullhead ranged in total lengths from 126 to 325 mm in both years.

Table 37. Length-frequency distribution of black bullhead at Rathbun Reservoir for April and May of 1972 and 1973.

TL (mm)	1972 Number	1972 Percent occurrence	1973 Number	1973 Percent occurrence
126-150	42	12.4	184	30.9
151-175	33	9.8	223	37.4
176-200	30	8.9	126	21.1
201-225	65	19.2	27	4.5
226-250	90	26.6	13	2.2
251-275	58	17.1	16	2.7
276-300	18	5.3	3	.5
301-325	2	.6	4	.7
Total	338		596	

Bullhead spines were not aged but their length-frequency distribution provided evidence of two strong year classes in 1970 and 1971. Projected age class representation, from data in Carlander (1969), was 32%, age I - 126 to 200 mm; and 68%, age II and older fish - 201 to 325 mm. In 1973 a single dominant mode, the 1972 year class was recorded from 126 to 200 mm. Age II and older age groups extended beyond 201 mm to 325 mm.

Gizzard Shad In April and May sampling in 1972 a length-frequency distribution was recorded for 267 gizzard shad while collections during the same time of 1973 accounted for 114 shad (Table 38). The 1972 collection ranged in total length from 126 to 350 mm while in 1973 they were 151 to 300 mm.

Table 38. Length-frequency distribution of gizzard shad at Rathbun Reservoir for April and May of 1972 and 1973.

TL (mm)	1972		1973	
	Number	Percent occurrence	Number	Percent occurrence
75-100				
101-125				
126-150	34	12.7		
151-175	153	57.3	1	.9
176-200	66	24.7	68	59.6
201-225	7	2.6	38	33.3
226-250			4	3.5
251-275			2	1.7
276-300	1	.4	1	.9
301-325	5	1.9		
326-350	1	.4		
Total	267		114	

One dominant mode and a second minor mode was recognized in the 1972 distribution coming mainly from the 1971 and 1972 year classes. Age class representation was 98%, age I - 126 to 225 mm; and 2%, age II - 276 to 350 mm. In 1973 a single mode of age I fish was found representing 93% of the sample. Older and larger shad were not caught during this period.

DISCUSSION OF FINDINGS

RED ROCK RESERVOIR

Catches by pound and experimental gill nets during 1972 and 1973 were dominated by non-sport fish. In both years carp dominated not only the numerical catch but also contributed the greatest proportion by weight. Mayhew (1972) reported the carp was the predominant species caught and contributed 69% of the weight in his net catches during a commercial food fish population study. Bullhead ranked second in numerical catch both years but was third and fourth in importance by weight. River carpsucker ranked third in numerical abundance each study year and usually was equally important by weight while bigmouth buffalo ranked fifth and sixth in each year of study. The numerical importance of buffalo underestimates their importance by weight because they ranked second and fourth in that category.

Sport fish represented a small portion of the numerical catch during each year but their representation increased from 14% of the total catch in 1972 to 21% in 1973. Black crappie, the most abundant sport fish, and channel catfish declined from 1972 to 1973, but their decrease in relative abundance was overshadowed by a dramatic increase of other populations. Catch successin 1973 of northern pike, walleye, white bass and largemouth bass increased by as much as fifteenfold.

Catch success of non-sport fish decreased from 1972 to 1973 but their mean weights increased, contrary, many sport fish increased in FND and some experienced a decline in their mean weights. Carp, bigmouth buffalo and river carpsucker declined in numerical catch from 1972 to 1973 and each showed an increase in mean weight within the same period. Bullheads not only increased in relative abundance but also increased in mean weight.

Considerable variation was exhibited by sport fish in their relationship of relative abundance to individual mean weight. Black crappie decreased in FND and had a slight increase in mean weight while largemouth bass increased in both categories. Northern pike and walleye increased in catch success from 1972 to 1973 but decreased in mean weight.

Generally, adult or heavy bodied fish species were selected and caught at higher catch rates by the pound net than the experimental gill net. The main reason was attributed to large mesh size in the pound net as opposed to the wide range of mesh sizes in the experimental gill net. The experimental gill net may not have caught as many FND but it caught a greater range of sizes, of the same species, and some small fish not seen in the pound net. Pound nets were the most effective gear for catching carp, bigmouth buffalo, river carpsucker, bullheads and black crappie while the experimental gill net caught more channel catfish, walleye, northern pike, largemouth bass and gizzard shad.

Total catch of seine hauls in 1972 was similar to 1973 but year class strength of the various species caught was entirely different. Gizzard shad was the most abundant species seen during 1972, however, catch success of young shad in 1973 decreased fivefold. River carpsucker was caught at the second highest frequency in 1972 yet there was a profound decrease in 1973. Catches of carp, freshwater

drum, channel catfish, and black crappie were similar in that fewer young-of-the-year were caught in 1973. On the other hand young bullhead seldom observed in 1972 were the most abundant species caught in the 1973 seine hauls.

Year class strength of many sport fish were higher in 1973 than they were the previous year. Largemouth bass, bluegill, walleye, white bass and northern pike all produced a stronger year class in 1973. However, success of walleye, largemouth bass and northern pike year classes may be a reflection of stocking efforts and not natural reproduction.

Sampling error due to differences in species composition between netting stations was found to be negligible. One way classification of analysis of variance testing provided statistical evidence that species composition of the total catch at each station were from the same population.

The age class structure of carp was comprised of more young fish in 1972 than it was in 1973. Strong 1971 and 1970 year classes, observed in 1972, carried on into 1973 and were responsible for the high proportion of fish age III and IV seen in the length frequency. In addition more fish age V and older were caught in 1973. Statistical analysis provided no evidence of a difference in length-weight relationships of 1972 and 1973 despite the fact condition was higher in 1972.

River carpsucker age class structure were similar both years; however, fish caught in 1973 tended to be larger. The greatest portion of the river carpsucker caught in both years were ages II to IV. Few fish older than age V were recorded in the length distribution. Length-weight relationship was significantly higher in 1973 than it was in 1972. This finding conformed with the higher condition factor of 1973.

A strong 1970 bigmouth buffalo year class dominated the length-frequency sample of 1972 and comprised the entire sample of 1973. However, a lower catch success of buffalo during 1973 was responsible for a small length-distribution sample.

Insufficient numbers of channel catfish were caught during either season to describe age class structure. Mean K-factors of channel catfish were the same both years while no statistical difference was found in length-weight relationship.

Age II black crappie dominated the age structure of length-frequency samples of 1972 and 1973. Few crappie older than age II were seen during 1973 while many age III, IV, and V fish were seen in 1972.

The length-frequency distribution of bullhead was dominated by the 1971 year class. Other age groups of bullhead were seen but not as frequently.

Catches of largemouth bass in 1972 and 1973 were insufficient to compile a representative length-frequency distribution of that population. Only larger catches in future years will provide more information on this species.

Age structure of gizzard shad in 1972 was wholly comprised of age I fish. In 1973 gizzard shad were not seen in nets until September when only a few were captured. The autumn age structure of gizzard shad was dominated by 0-age fish and represented by few age I and II fish.

RATHBUN RESERVOIR

Sport fish including white crappie, bluegill, walleye and channel catfish, comprised nearly 60% of the total numerical catch.during 1972. The following year these sport fish decreased in importance while non-sport fish, carp and bigmouth buffalo, increased in abundance. During the first year of study white crappie dominated the numerical catch while carp was second in importance. Carp contributed the greatest proportion by weight in both years and surpassed crappie, which fell to second,in 1973. Bullheads ranked third in numerical importance and sixth in importance by weight both years. Channel catfish was fourth and fifth in numerical abundance.

Sportfish contributed a large proportion of the numerical catch each year but their relative abundance decreased in the second year. White crappie, the most abundant sport fish, catch success declined from 1972 to 1973 as did channel catfish, walleye, bluegill, and largemouth bass. White bass was the only sport species that exhibited an increase in population size.

Mean weights of most sport fish increased each year. While the relative abundance of white crappie, bluegill, largemouth bass and walleye stocks were decreasing their mean weight increased. This is an indication of populations with a lowered seasonal recruitment of younger fish. Channel catfish not only decreased in catch success but also decreased in mean weight while white bass increased in catch success and decreased in mean weight.

Differences between 1972 and 1973 mean weights of non-sport fish showed only slight variation. Mean weight of carp and bullhead were only a few grams lower in 1973 than in 1972 while weights of river carpsucker and bigmouth buffalo were slightly higher.

Most species were more susceptible to capture by pound net than the experimental gill net but catch variation was usually due to abundance of young. Carp, white crappie, bigmouth buffalo, river carpsucker, and bluegill were always caught more frequently by the pound net. Channel catfish and walleye were caught most often in the experimental gill net. The experimental gill net documented the abundance of younger fish more precisely than the pound net because of the variety of mesh sizes, including several mesh sizes smaller than that of the pound net. Increase or decrease in abundance of younger bullhead, gizzard shad, and to a lesser degree white crappie caused variation in catch success from year to year between gear. For example, gizzard shad were caught in 1972 at 5 FND by pound net and 25 FND by experimental gill net. The following year abundant young fish of 1972 recruited into the mesh size of pound nets for 9 FND and fewer small fish were caught by the experimental gill net, 7 FND.

Sampling error due to differences in species composition between netting stations A, B, and C was found to be negligible. One way classification of analysis of variance testing provided statistical evidence that species comprising the total catch at each station were of the same population.

Nearly twice as many young-of-the-year were seen in 1973 seine hauls as were the previous year. In addition, species comprising the total catch of each year was nearly identical. Gizzard shad, the dominant species, white crappie, bluegill and largeouth bass were caught at a greater rate in 1973. These findings conformed

with those of Mayhew (1973) in that the peak year of abundance of young white crappie and gizzard shad, during his three years of study, was the latter year. Walleye and channel catfish, important sport fish, and non-sport fish including carp, bigmouth buffalo and river carpsucker were not seen in seine hauls.

The white crappie population was dominated by the 1970 year class. Few younger or older crappie were seen either year. White crappie were native to the Chariton River prior to impoundment. Natural reproduction of this species after initial impoundment of Rathbun Reservoir was very successful, as evidenced by the 1970 year class. Statistical analysis provided no evidence of a difference in length-weight relationships of 1972 and 1973. K-factor was slightly higher in 1973.

During both years of this study the carp age class structure was dominated by the 1969 and 1970 year classes. Apparently conditions were conducive for high survival of young carp during both years. Initial reservoir impoundment commenced in November, 1969, and multipurpose pool elevation was not reached until October, 1970. The mean K-factor of 1973 was slightly less than 1972, but statistical analysis of length-weight relationship showed no difference in the slope of the regression lines.

Walleye age class structure was comprised entirely of the year classes stocked in 1970 and 1971. During 1973 poor survival of the 1972 stocking was apparent since none of the fish stocked that year were recorded in the length distribution. Mean K-factors of walleye were similar for both years and no difference was found between length-weight relationships of 1972 and 1973.

Young channel catfish, age II and III, comprised most of the catch of 1972 and 1973. Older fish were commonly caught in 1972 but very few were seen in 1973. Mean K-factors of channel catfish were very similar each year of study and no difference was found between length-weight relationships of 1972 and 1973.

Data for bigmouth buffalo and river carpsucker was generally insufficient to determine population characteristics. Scales and spines were not collected from gizzard shad or bullhead, for age and growth determination, but age structure was easily recognized by length-frequency distributions and data in Carlander (1969).

Age class structure of bullhead was dominated by fish age I and II during each year of study. Only a few older fish were seen. Gizzard shad populations were comprised almost entirely of age I fish. Fish age II and older were seldom caught during 1972 or 1973. Several reasons may be responsible for the low catches of older fish; (1) gizzard shad is the primary forage species; (2) gizzard shad progressively occupy deeper water as they age, thereby avoiding capture by nets (Cross 1969); and (3) shad are not hardy and often succumb to massive die-offs in the autumn after extreme temperature changes.

RECOMMENDATIONS

Analysis of variance showed sampling sites and number of daily samples could be reduced by two-thirds without lowering accuracy or precision.

A minimum quota of 100 scales should be collected from a random sample of each important species. Scales would then be aged for determination of age class structure and would eliminate the necessity of collecting length frequencies.

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ANNUAL PERFORMANCE REPORT

RESEARCH PROJECT SEGMENT

STATE: Iowa

PROJECT NO.: F-88-R-2

STUDY NO.: 702-3

JOB NO.: 2

NAME: Effects of Flood Water Management and Fish Species Introduction on Fish Populations in Large Reservoirs

TITLE: Determine the impact of reservoir operations for flood water management on fish populations

Period Covered: 1 July, 1973 through 30 June, 1974

ABSTRACT: *The objective of this study was to determine the impact of reservoir operations for flood water management on fish populations in Red Rock and Rathbun Reservoir. Daily reservoir elevation and discharge data were obtained from U.S. Corps of Army Engineers project offices. Water level elevation and discharge rates of both reservoirs were higher in 1973 than 1972. At Red Rock Reservoir, 1972, deviation from multipurpose pool ranged from +.2 m to +1.8 m, the sum of monthly devaitions was +5.0 m, mean discharge rate was 196 CMS, mean flushing rate was 45 days, while in 1973 deviation from multipurpose pool ranged from +.6 m to +15.4 m, the sum of deviations was +72.3 m, mean discharge rate was 491 CMS, and mean flushing rate was 105 days. At Rathbun Reservoir, 1972, deviation from multipurpose pool ranged from 0 to +.7 m, the sum of deviations was 1.5 m, mean discharge rate was 2.5 CMS, mean flushing rate was 710 days, while in 1973 deviation from multipurpose pool ranged from +.9 m to 4.1 m, sum of deviations was +17.6 m, mean discharge rate was 21.1 CMS and mean flushing rate was 208 days. These data collected to date are insufficient to provide a valid statistical analysis of their relation or relationships to fish populations. Further study is planned.*

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Date Prepared: 1 July, 1974

JOB 2 OBJECTIVE

To determine the impact of reservoir operations, for flood water management, on fish populations and their reproduction. Reservoir operation parameters of importance are; (1) reservoir elevation and deviation from authorized multi-purpose pool, (2) discharge rate, and (3) flushing rate.

INTRODUCTION AND STUDY BACKGROUND

The primary objective of this portion of study is to document reservoir operations and their relation to changes or trends occurring in reservoir fish populations.

Profound changes in the physical environment of most aquatic ecosystems produces a succession in species composition. Those species that find the reservoir conditions suitable or tolerable survive while others that do not expire. Generally reservoir conditions that are responsible for high flushing rates and discharge create conditions conducive to river or stream species. Likewise, low discharge and flushing rates can provide excellent habitat for lake species. Often fluctuations in water level during critical pre- or post-spawning are directly responsible for year class success. Walburg (1972) reported year class success of sauger in Lewis and Clark Reservoir, South Dakota, was influenced by operations of the Fort Randall Dam during the spawning and incubation period. Jester (1971) found changes in water level of Elephant Butte Reservoir, New Mexico, seemed to have little effect upon spawning success of crappie, but adult populations varied with large fluctuations in the volume of stored water. Following impoundment of Lake Sharpe, South Dakota, Elrod and Hassler (1971) reported species that preferred quiet waters such as goldeye, carp, bigmouth buffalo and smallmouth buffalo increased in abundance. Blue sucker were taken most frequently in the headwaters while river carpsucker and redhorse were most prevalent in moderate current regions. Growth rates of river carpsucker, goldeye and redhorse were accelerated in the first year but slowed substantially in subsequent years. Stucky and Klaassen (1971) reported growth of river carpsucker was slightly greater in Cedar Bluff Reservoir, Kansas, than those of the tributary Smokey Hill River. They also found condition coefficients of carp in the river were significantly higher than those of the reservoir.

METHODS AND PROCEDURES

Daily reservoir elevation and discharge data were obtained from U.S. Corps of Army Engineers project offices, located at Red Rock and Rathbun Dam sites. Reservoir data of primary interest are listed for the seven month sampling period, April through October, in each year of study. Flushing rate, storage time, was calculated as the quotient of storage volume and discharge rate and estimated in days. Discharge rate is expressed as cubic meters per second, CMS.

FINDINGS

RED ROCK RESERVOIR

Relatively stable reservoir conditions of 1972 contrasted the high water elevations of 1973. Deviation from multipurpose pool in 1972 ranged from +.2 m, recorded in April, June, July and October, to a peak elevation of +1.8 m recorded in May (Table 39). The sum of the monthly deviations was +5.0 m. Discharge rates during 1972 ranged from 73 CMS in April to a season high of 271 CMS registered in May while the monthly mean was 196 CMS. Flushing rate ranged from 28 to 102 days with a mean of 45 days.

Reservoir operations during 1973 were characterized by unstable above multipurpose pool elevations and high discharge rates (Table 39). Deviation from multipurpose pool elevation ranged from a near normal elevation of +.6 m, during September, to a high of +15.4 m recorded in May while the sum of deviations for the seven month period was +72.3. Discharge rates ranged from 211 CMS, recorded for September, to 662 CMS, registered for April, and the season mean was 491 CMS. Flushing rate during 1973 ranged from 34 to 167 days and had a mean of 105 days.

RATHBUN RESERVOIR

Rathbun Reservoir was generally near authorized multipurpose pool elevation throughout 1972 but was above multipurpose pool during 1973 (Table 40). Deviations from multipurpose pool elevation during the 1972 season ranged from 0, during July, to +.7 m, recorded in October, and the sum of deviations during the seven month period was +1.5 m. Mean monthly discharge rates ranged from .3 CMS, recorded in July, to 7.5 CMS, for September, and the mean was 2.7 CMS. Flushing rates ranged from 203 to over 5,000 days and the 1972 mean was 710 days.

During 1973 reservoir elevations rose above the 10-year flood frequency and varied more than it did in 1972 (Table 40). Deviations from multipurpose pool elevation during the 1973 season ranged from +.9 m, recorded for September, to a high mark of +4.1 m for May. The sum of deviations during the period was +17.6 m. Mean monthly discharge rates ranged from 11.3 CMS, recorded in October, to a high of 28.6 CMS during May, and the mean was 21.1 CMS. Flushing rate ranged from 88 to 2,652 days with a mean of 208 days.

DISCUSSION OF FINDINGS

It was apparent that the three reservoir water management parameters are directly associated with each other. For example, flushing rate is determined by discharge and reservoir elevation, or volume, while discharge is related to proxcimity of the reservoir elevation to authorized multipurpose pool elevation. However, these data collected to date are insufficient to provide a valid statistical analysis of their relation or relationships to fish populations.

Table 39. Monthly water level elevations, deviation in meters from multipurpose pool elevation, and discharge at Rathbun Reservoir, 1972 and 1973. Authorized multipurpose pool elevation is 275.3 m MSL.

Sampling period	1972			1973		
	Elevation	Deviation (CMS)	Discharge (CMS)	Elevation	Deviation	Discharge (CMS)
April	-----	----	.8	278.7	+3.4	18.3
May	275.4	+ .1	1.7	279.4	+4.1	28.6
June	275.5	+ .2	4.8	278.9	+3.6	21.3
July	275.3	0	.3	278.0	+2.7	26.2
August	275.5	+ .2	2.1	277.2	+1.9	27.4
September	275.6	+ .3	7.5	276.2	+ .9	14.4
October	276.0	+ .7	2.0	276.3	+1.0	11.3
Max. elevation	276.0			279.4		
Min. elevation	275.3			276.2		
Mean elevation	275.5			277.9		
Mean discharge			2.7			21.1
Sum of deviations		+1.5			+17.6	

Table 40. Monthly water level elevations, deviation in meters from multipurpose pool elevation, and discharge at Red Rock Reservoir, 1972 and 1973. Authorized multipurpose pool elevation is 221 m.

Sampling period	1972			1973		
	Elevation	Deviation	Discharge (CMS)	Elevation	Deviation	Discharge (CMS)
April	221.2	+ .2	73	235.0	+14.0	662
May	22.8	+1.8	271	236.4	+15.4	638
June	221.2	+ .2	232	235.8	+14.8	499
July	221.2	+ .2	172	235.1	+14.1	503
August	222.0	+1.0	241	228.4	+ 7.4	475
September	222.4	+1.4	214	221.6	+ .6	211
October	221.2	+ .2	165	226.8	+ 5.8	451
Max. elevation	222.8			236.4		
Min. elevation	221.2			221.6		
Mean elevation	221.7			231.3		
Mean discharge			195			491
Sum of deviations		+5.0			+72.3	

RECOMMENDATIONS

Collection of water management operation data should continue to define their assocaition with reservoir species population characteristics.

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ANNUAL PERFORMANCE REPORT

RESEARCH PROJECT SEGMENT

STATE: Iowa

PROJECT NO.: F-88-R-1

STUDY NO.: 702-3

JOB NO.: 3

NAME: Effects of Flood Water Management and Fish Species Introduction on Fish Populations in Large Reservoirs

TITLE: Determine the success of introductions of fish species and their biological impact upon indigenous fish populations

Period Covered: 1 July, 1973 through 30 June, 1974

ABSTRACT: *The objective of this study was to determine the success of introductions of sport fish species and their biological impact upon indigenous fish populations in Red Rock and Rathbun Reservoirs. Catch statistics of pound and experimental gill nets, of Job 1, documented survival to adult sizes while young fish were caught in seine hauls. Fish Hatchery Branch records provided stocking information. The only young sport fish stocked to date at Red Rock Reservoir have been northern pike at rates of 800,000 to 2,250,000; largemouth bass, 335,000 to 163,500; and walleye, 7,000,000 to 8,200,000. Young-of-year fish species stocked in Rathbun Reservoir have included channel catfish at rates of 200,000 to 202,000; walleye, 3,400,000 to 11,000,000; largemouth bass, 63,335 to 496,000; muskellunge, 1,010 to 35,500; ocean striped bass, 2,800; and 2,800 adult white bass. At Red Rock Reservoir young largemouth bass and walleye were caught at significantly higher rates during seasons they were stocked. Gear selectivity and stocking size attributed to the fact young northern pike were only seen in seine hauls during 1973. At Rathbun Reservoir 0-age largemouth bass were caught at a significantly higher rate the year they were stocked and young white bass were caught at a higher rate during the latter season of two successive years after adults were stocked. Other species stocked including walleye and muskellunge were not seen in seine hauls while only 2 young striped bass were captured during 1972.*

Author: Vaughn L. Paragamian
Fisheries Research Biologist

Date Prepared: 1 July, 1974

JOB 3 OBJECTIVE

Determine the success of introductions of fish species and their biological impact upon indigenous fish populations.

INTRODUCTION AND STUDY BACKGROUND

Millions of sport fish are stocked annually in several large reservoirs and numerous small impoundments throughout Iowa. Several reasons have necessitated stocking of sport and non-sport fish; (1) stocking of recently renovated waters where the indigenous species have been removed, (2) introduction of new species to improve ecosystem, (3) introduction of a trophy fish, and (4) stocking to facilitate natural reproduction.

Large reservoirs provide a potential sport fishery resource that usually can be obtained through stocking many predatory sport fish. Without initial or supplemental stocking the species found would almost be entirely non-sport fish.

Simply stocking large quantities of sport fish is not the solution. Many attempts are very successful while others are futile and further fluctuations often appear between year classes stocked at similar intensities. An evaluation must be designed to determine the extent of success of various species stocked, their effect on native fish populations, value of different stocking rates, size of fish stocked and when to stock in relation to water management.

Five nonendemic fish species have been stocked into Rathbun Reservoir and three in Red Rock Reservoir, at varying rates, since they were impounded. In both impoundments the success of these stockings has been sufficient to alter species composition.

METHODS AND PROCEDURES

The Fish Hatchery Branch of the Iowa Conservation Commission maintains complete stocking records for all Iowa waters. Information on stocking of Red Rock and Rathbun Reservoirs as to species stocked, size, number and date is forwarded to all fisheries section offices.

Success of sport fish stocking is documented by catch statistics of Job 1 of this study. Survival to adult size is recorded by pound and experimental gill nets while young fish are caught in seine hauls.

FINDINGS

RED ROCK RESERVOIR

Northern pike, largemouth bass and walleye have been the only sport fish stocked to date at Red Rock Reservoir (Table 41). After initial impoundment northern pike were stocked at rates varying from 800,000 to 2,250,000. Largemouth bass were first stocked in 1971 at 335,000 fry and were stocked again as fry and fingerling in 1973 at combined total of 163,500. Walleye were first stocked in 1970 as sac fry and fingerling for a total of 8,200,000. A second walleye stocking of 7,000,000 fry occurred in 1973.

Table 41. Fish species stocked into Red Rock Reservoir since impoundment.

Year	Fish species	Number stocked	Size
1970	Northern pike	400,000	Fry
	Northern pike	400,000	Fingerling 50-100 mm
	Walleye	8,000,000	Sac fry
	Walleye	200,000	Fingerling 50-100 mm
1971	Largemouth bass	335,000	Fry
1972	Northern pike	600,000	Fry
	Northern pike	1,000,000	Fingerling
1973	Largemouth bass	133,500	Fry
	Largemouth bass	30,000	Fingerling
	Northern pike	2,250,000	Fry
	Walleye	7,000,000	Fry

At Red Rock Reservoir young largemouth bass and walleye were caught in seine hauls at significantly higher rates during seasons they were stocked. A t-test was used to compare the total catch at each of six seine haul stations between two sampling years, 1972 and 1973. Young walleye and largemouth bass were caught at higher rates in 1973, a year each species was stocked ($P < .05$, $t_{5df} = 2.57$, problem $t = 2.65$ for walleye and 4.52 for bass). Northern pike were stocked in 1972 and 1973 but were seen in seine hauls during the latter year only. The intensity of stocking differed between years, 1,600,000 fry and fingerling stocked in 1972 and 2,250,000 fry in 1973.

RATHBUN RESERVOIR

Fish species stocked in Rathbun Reservoir have included channel catfish, walleye, muskellunge, largemouth bass, white bass and ocean striped bass (Table 42). Channel catfish were first stocked in 1969 as fingerling, 202,000, and stocked in 1970 as fingerling and adult, 200,000. Walleye have been stocked as sac fry and fry each year since 1970 and the rate has ranged from 3,400,000 to 11,000,000. Largemouth bass have been stocked as advanced fry in 1970, 1971 and 1973 at rates of 63,335 to 496,000. Muskellunge sac fry, 35,500, were introduced in 1970 and a second stocking of 1,010 fingerling occurred in 1971. Adult white bass totaling 2,800 were stocked in 1971 while striped bass were introduced as sac fry, 500,000, in 1971 and stocked again as fingerling, 2,174, in 1972.

Table 42. Fish species stocked into Rathbun Reservoir since impoundment.

Year	Fish species	Number stocked	Size
1969	Channel catfish	202,000	Fingerling 50-75 mm
1970	Channel catfish	200,000	Fingerling 50-75 mm Sub-adult 175-250 mm
	Walleye	3,400,000	Sac fry
	Muskellunge	34,500 1,000	Sac fry Fingerling 150-200 mm
	Largemouth bass	424,000	Advanced fry 25-50 mm
1971	Largemouth bass	496,000	Advanced fry 25-50 mm
	Walleye	11,000,000	Fry
	Muskellunge	1,010	Fingerling 150-250 mm
	White bass	2,800	Adult 300-375 mm
	Striped bass	500,000	Sac fry
1972	Walleye	9,000,000	Sac fry
	Striped bass	2,174	Fingerling 75-100 mm
1973	Walleye	9,000,000	Sac fry
	Largemouth bass	63,335	Advanced fry 25-50 mm

At Rathbun Reservoir 0-age largemouth bass were caught at a significantly higher rate in 1973, a year they were stocked, and young white bass were caught at a higher rate during the latter season of two successive years after adults were stocked. 0-age largemouth bass were caught at a higher rate during 1973, a year they were stocked, as compared to 1972, a year they were not stocked ($P < .05$, $t = 4.97$, 5_{df}). Adult white bass were stocked in 1971. Young-of-the-year were present during the two following years but were significantly higher in 1973 ($P < .05$, $t = 3.52$, 5_{df}). Other species stocked including walleye and muskellunge were not seen in seine hauls while only 2 young striped bass were captured during 1972.

DISCUSSION OF FINDINGS

The catch of young-of-the-year largemouth bass and walleye was significantly higher at Red Rock Reservoir in years these species were stocked. Northern pike were stocked in 1972 and 1973 but were captured only during 1973. The 1973 stocking rate of northern pike was 20% higher than that in 1972. The majority of the fish stocked the earlier year were fingerlings as compared to 1973 when fry were the sole size stocked. Klingbiel (1966) concluded stocking of large muskellunge fingerling, a species related to northern pike, would provide a greater survival than smaller fish. The findings from seine hauls not only contradict Klingbiel's four year study but also FND netting records of 1972 and 1973. Apparently survival was not an important factor but the age at which most of the northern pike were stocked at in 1973 was and created an overriding effect. Northern pike fingerling were too large to be caught by the seine net, effective for smaller fish, and were too small to be captured effectively by the pound and experimental gill net.

All sport fish were intensively stocked into Rathbun Reservoir during 1971 while only walleye and ocean striped bass were released in 1972. Mean FND and species representation of all sport fish, excepting white bass, declined from a total representation of 43% to 33%, from 1972 to 1973.

Despite the 1972 stocking the catch success of walleye declined in 1973. The exact cause for the decline of walleye is not known at this time. Possible factors that may be invovled include: availability of zooplanktors for food items and the presence of predators. The abundance of zooplankton has systematically declined since 1971 (Mayhew 1973) and a variety of piscivorous fish have been introduced. Forney (1973) studied survival of walleye fry in aquariums subjected to varying temperatures and zooplankton densities. He concluded the tests suggested zooplankton density and temperature may be less critical in local lakes than predation and other factors in determining early survival. Cannabalism by adult walleye was a direct cause of year class failure at Oneida Lake, New York (Chevalier 1973). The previous information may or may not be applicable to walleye survival at Rathbun Reservoir. Further study should reveal important information governing walleye survival and that of other sport fish.

Young largemouth bass were caught at a significantly higher rate during a year they were stocked and young white bass increased substantially in each successive year after adults were stocked. On the other hand survival of 0-age walleye and striped bass was poor.

RECOMMENDATIONS

Continuation of the project to determine the effects of fish stocking on endemic fish populations.

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