# COMPARISON OF MAN-DAYS OF FISHING AND FISH HARVEST ABOVE AND BELOW A FLOOD CONTROL HYDROLECTRIC IMPOUNDMENT BISECTING AN OKLAHOMA SCENIC RIVER

By

GARY A. EARLS

Bachelor of Science

Southeastern State College

Durant, Oklahoma

1970

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1973

# COMPARISON OF MAN-DAYS OF FISHING AND FISH HARVEST ABOVE AND BELOW A FLOOD CONTROL HYDROELECTRIC IMPOUNDMENT BISECTING AN OKLAHOMA SCENIC RIVER

Thesis Approved:

Quentin K. Andrews
Thesis Adviser

Robert C. Summerfelt

Ronald W. McNew

Dean of the Graduate College

# PREFACE

Objectives of this investigation were to estimate and compare sport fishermen use and harvest on an Oklahoma scenic river bisected by the 5,747 ha Broken Bow Reservoir. It is hoped that this study has contributed to a better understanding of the effects of an impoundment on a scenic river and that it has provided basic information for more effective river management.

Financial support for this study was provided by the Oklahoma Fish and Game Council in cooperation with the Oklahoma Department of Wildlife Conservation, the Office of Water Resources Research (Project A-026-Okla.), Dingell-Johnson Project F-31-1, and the Bureau of Sport Fisheries and Wildlife. Research facilities and equipment were furnished by the Oklahoma Cooperative Fishery Unit, and the Oklahoma Department of Wildlife. The Oklahoma State University Research Foundation and Zoology Department also provided financial support.

I would like to express my sincere appreciation to my committee chairman and adviser, Dr. A. K. Andrews, Assistant Unit Leader of the Oklahoma Cooperative Fishery Research Unit, for his patience and help while conducting the investigation and writing of the text. I would like to express my gratitude to Dr. R. C. Summerfelt for serving on my committee and for his invaluable suggestions in sampling design and constructive criticism during the preparation of this manuscript, and to Dr. Ronald McNew, who also served on my committee, for his guidance and

counsel in statistical procedures and for his comments during the editing of this paper. I would also like to thank Mr. John Jones, of Broken Bow, Oklahoma, for his assistance in collecting data.

Special recognition is due my wife, Jan, for her patience, encouragement, understanding, and assistance during the course of this study.

TABLE OF CONTENTS

LIST OF TABLES

Table | Page

Table | Page

LIST OF FIGURES

# CHAPTER I

## INTRODUCTION

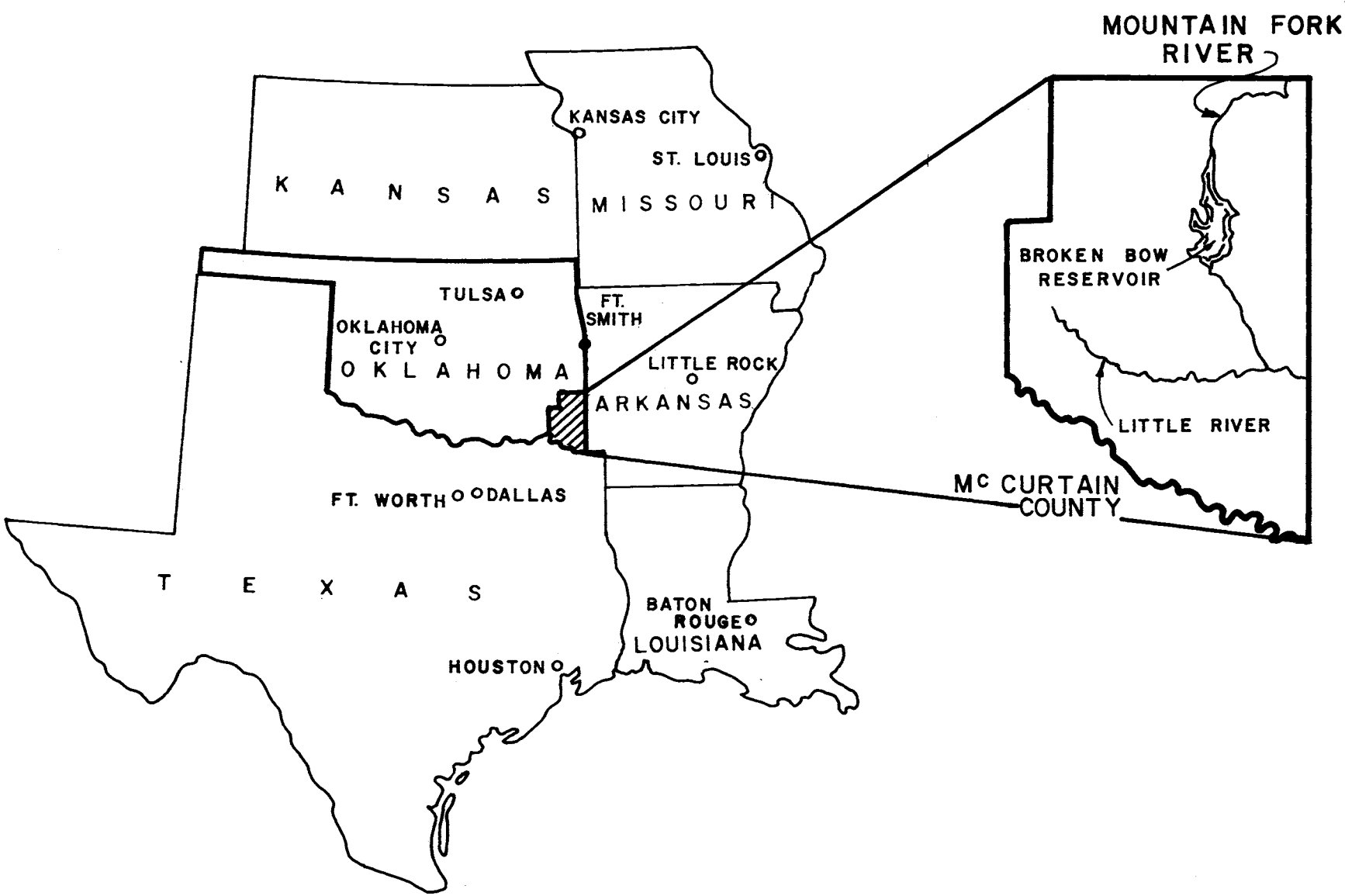
Traditionally, warm-water streams have provided the most easily accessible source for sport fishing in the United States (Funk 1970). In 1960, warm-water streams and rivers accounted for 16% of all fishing effort and harvest in inland waters of the United States (Outdoor Recreation Resources Review Commission 1962). Because numerous reservoirs are available to Oklahoma fishermen, the importance of river fishing has generally been neglected and fishing pressure and fish harvest for river fishing in Oklahoma is virtually unknown. Float fishing and recreational use of high quality smallmouth bass rivers in Oklahoma are a unique and aesthetic experience and with the increasing number of impoundments, the number of rivers has been reduced which can provide these experiences. The Mountain Fork River was categorized as an outstanding smallmouth bass fishery (Finnell, Jenkins and Hall 1956). Construction of Broken Bow dam bisected the Mountain Fork River, inundating 40.25 km of the river. However, the scenic and recreational value of the river was recognized by the Oklahoma legislature when they included the free flowing river above the reservoir in the Scenic Rivers Bill (Oklahoma House Bill 1152) to preserve this resource for the future.

Changes in fish composition of smallmouth bass streams and rivers downstream from impoundments have been documented (Carter 1969, 1968,

Carroll 1960, Chance 1958, Patriarche and Campbell 1957, Ruhr 1958, Hall and Jenkins 1953, and Kathrein 1953), but the effects of impoundment on sport fishermen harvest in the remaining river upstream from the impoundment has not been described. Although several creel surveys have been made on smallmouth bass tributaries (Fleener 1971a, 1968, Funk and Fleener 1966, Harrison 1962, and Funk 1957), there is no information available on the characteristics of the fishery for scenic rivers which are comparable to the Mountain Fork River. There is a need for information on utilization of warm-water rivers and stream fisheries to provide an assessment of the value of recreational fishing for use in evaluation of alternate uses of streams in planning for reservoirs and other water development projects and for planning fish management strategies (Funk 1970).

This report presents an estimation and comparison of fishermen use and fish harvest on Mountain Fork River above and below Broken Bow Reservoir based on fishermen interviewed from 1 August 1970 through 30 July 1971. Objectives of this study are to estimate (1) man-days use, (2) fishing success (catch rate) in numbers and kilograms per angler hour, (3) species composition of the harvest and total harvest (in number and kilograms) of fish appearing in the creel, and (4) compare these estimates for the flowing portions of the river above and below Broken Bow Reservoir. For statistical analysis, the null hypothesis was that there is no difference in the above parameters between the combined values for selected site groupings above and below the reservoir. The alternative hypotheses were that: (1) the measure of parameters was greater above than below the reservoir, and (2) the measure of parameters was greater below than above the reservoir.

Figure 1. — Relationship of the Mountain Fork River to McCurtain County, Oklahoma and and adjacent states


MOUNTAIN FORK RIVER
KANSAS CITY
ST. LOUIS
K A N S A S
MISSOURI
BROKEN BOW RESERVOIR
TULSA
FT. SMITH
OKLAHOMA CITY
O K L A H O M A
LITTLE ROCK
ARKANSAS
LITTLE RIVER
Mc CURTAIN COUNTY
FT. WORTH
DALLAS
T E X A S
BATON ROUGE
LOUISIANA
HOUSTON

# CHAPTER II

## DESCRIPTION OF STUDY AREA

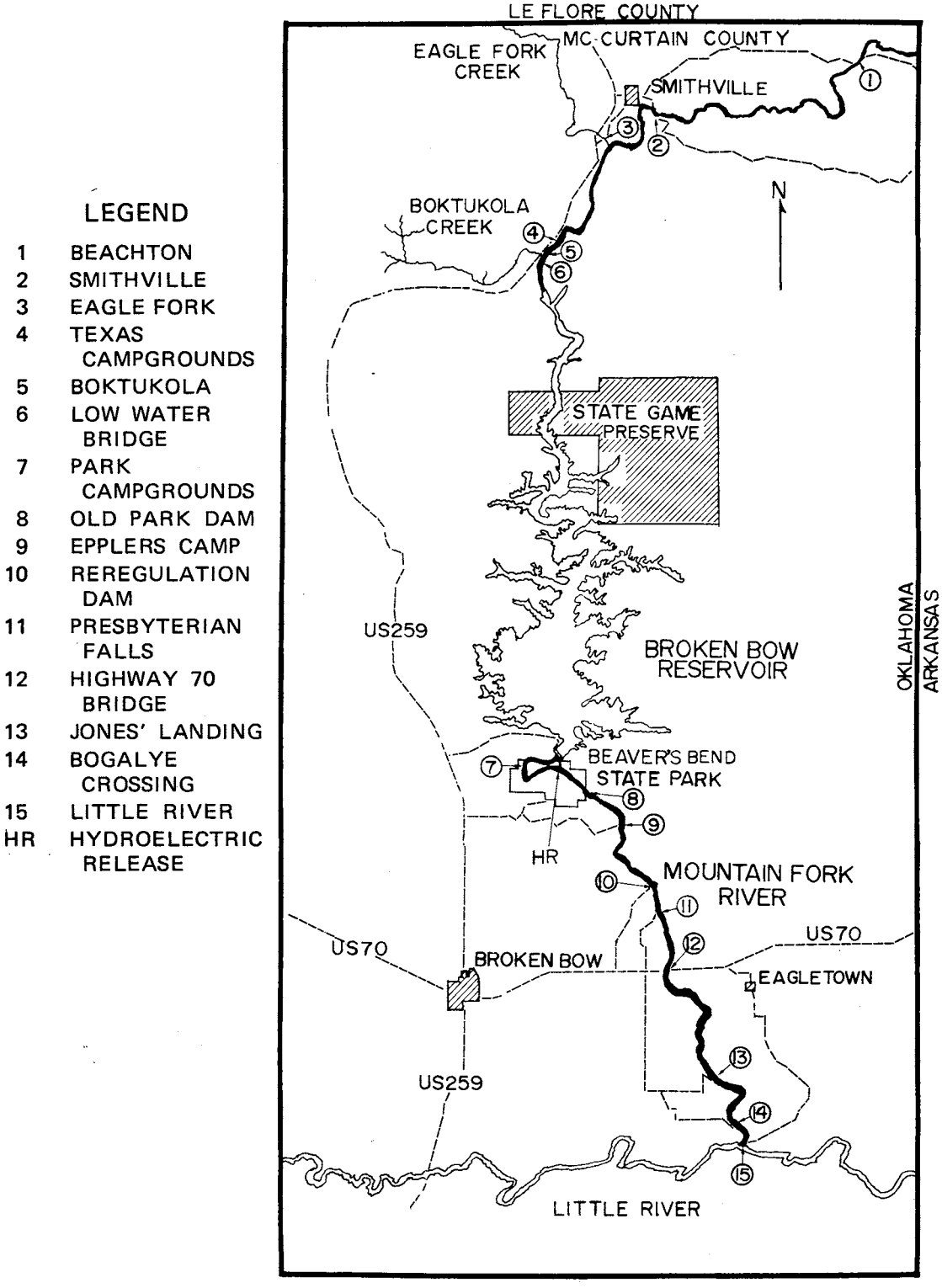
### General Characteristics

The Mountain Fork River, a tributary of the Little River (Figure 1), has a basin of 2,134 $km^2$ and an average gradient of 1.7 m/km (Oklahoma Water Resources Board 1969). The river originates in southeastern LeFlore County, Oklahoma, flows eastward into Polk County, Arkansas, where it receives Horse Pen Creek near the Oklahoma-Arkansas border, then flows west back into Oklahoma a few miles east of Beachton in McCurtain County, Oklahoma. The river's course is southwesterly from Beachton, changing to a southerly direction near Smithville. This course is then maintained until it empties into the Little River (Figure 2).

The Mountain Fork River is 136.8 km long. The length of river included in this study was from the Beachton entry point in Oklahoma to its confluence with the Little River. This portion of the river was 112.36 km long, but 40.25 km of river was inundated by filling of the 5,747 ha (182.7 m M.S.L.) Broken Bow Reservoir. A total of 72.21 km of river remains, with 38.98 km above the reservoir and 33.23 km below the reservoir (Table 1).

The river spans two distinct habitat types. The upper region, Beachton to Presbyterian Falls, is located in the Kiamichi Mountains (range of 228.6 to 430.5 m in altitude), one of the roughtest regions

Figure 2. Mountain Fork River and sampling locations




**Scale: 1 cm = 4235 m**

Table 1.—Location and spacing of the sample sites on the Mountain Fork River, McCurtain County, Oklahoma

| Site | Name | Range, Township Section | Distance (km) From site no | To site no | Between sites | Upstream from Little River |
|---|---|---|---|---|---|---|
| Sites Above Reservoir - 38.98 km of river | | | | | | |
| 1 | Beachton Crossing | R26E,T1S,S7 | Border | 1 | 3.22 | 112.46 |
| 2 | Smithville | R25E,T1S,S13 | 1 | 2 | 18.03 | 109.25 |
| 3 | Eagle Fork Creek | R25E,T2S,S23 | 2 | 3 | 6.73 | 91.68 |
| 4 | Texas Campgrounds | R25E,T2S,S4&9 | 3 | 4 | 7.4 | 84.49 |
| 5 | Boktukola Creek | R25E,T2S,S9 | 4 | 5 | 1.74 | 77.09 |
| 6 | Low Water Bridge | R25E,T2S,S16 | 5 | 6 | 0.27 | 75.35 |
| Low Water Bridge to Broken Bow Reservoir | | | | | 1.61 | 75.09 |
| Broken Bow Reservoir - Covers 40.25 km of river | | | | | 40.25 | 73.48 |
| Sites Below Reservoir - 33.23 km of river | | | | | | |
| 7 | Park Campbrounds | R25E,T5S,S4,5,8&9 | Res. Dam | 7 | 4.02 | 33.23 |
| 8 | Old Park Dam | R26E,T5S,S14 | 7 | 8 | 2.41 | 29.21 |
| 9 | Epplers Camp | R26E,T6S,S24 | 8 | 9 | 2.33 | 26.80 |
| 10 | Reregulation Dam | R26E,T6S,S31 | 9 | 10 | 4.09 | 24.46 |
| 11 | Presbyterian Falls | R26E,T6S,S6 | 10 | 11 | 1.79 | 20.38 |
| 12 | Highway 70 Bridge | R26E,T6S,S7 | 11 | 12 | 3.22 | 18.59 |
| 13 | Jones' Landing | R26E,T6S,S33 | 12 | 13 | 7.97 | 15.37 |
| 14 | Bogalye Crossing | R26E,T7S,S10 | 13 | 14 | 5.15 | 7.4 |
| 15 | Little River | R26E,T7S,S15 | 14 | 15 | 2.25 | --- |

of the Ouachita Mountain Range. The upper region is characterized by a succession of riffles interspaced with numerous rock outcroppings which impound extensive stretches into pools. The river in this region exhibits a relatively high gradient of 2.3 m/km. The average width of the upper portion of the river is 32.0 m with depths ranging to 2.9 m. The lower region, south of Presbyterian Falls to its confluence with the Little River, is located in the Gulf Coastal Plains (94.5 m in altitude) which is relatively flat bottom land and the river in this region has an average gradient of 0.4 m/km. The Gulf Coastal Plain region has a low gradient, few rock outcroppings or exposed bedrock, few pools (although long, deep, slow stretches are common), and more bottom deposits of sand, mud and debris. The lower portion of the river averages 67.6 m wide with depths to 5.5 m.

The upper portion of the Mountain Fork River is located northeast of the major population center of McCurtain County (45.2 people/sq km). Smithville, Oklahoma, population 144 (U. S. Dept. of Commerce 1972), was the only town in the immediate vicinity of the river while Broken Bow, Oklahoma, located 14.5 km west of the river, with a population of 2,980 (U. S. Dept. of Commerce 1972), was the largest town in the vicinity of the river (Figure 2).

There was a large difference in the recreational facilities located along the river above and below Broken Bow Reservoir. At the time of this study, river frontage above the reservoir lacked camp grounds, sanitation facilities, and picnic tables, and had only one access point with rental cabins. The river below the reservoir had a state park with modern cabins, shower-houses, sanitation and camping facilities and five of the nine access points below had picnic tables, trash facilities and

camping areas. Although boat launching areas were poorly developed on both sections of the river, four improved access sites were available for launching boats downstream from the reservoir while there were no improved launching areas above the reservoir.

Yearly mean water temperatures were 17.7 C (range in weekly means 3.4-31.7 C) and 13.9 C (range in weekly means 5.6-25.0 C) above and below the reservoir, respectively, with a difference in yearly mean temperature of 3.8 C. This large mean temperature difference was caused by cool water discharges from Broken Bow Reservoir during power generating periods. Discharges while generating were sufficient to raise the surface level about 0.8 m at the old park dam which is 45.7 m wide and located approximately 2.4 km below the stilling basin.

Due to the nature of terrain, dense vegetation, lack of roads, and few small private land holdings immediately adjacent to the Mountain Fork River, public access was limited to a few entry points. Six sample sites above (sites 1-6) and nine sample sites below (sites 7-15) Broken Bow Reservoir were identified which represented all major public access points to the river (Table 1, Figure 2, Figure 3). This allowed the creel clerk to contact all people entering or leaving a site during a sample period. Public access to the river at points other than at the designated sample sites was considered to be insignificant.

## Sites Above the Reservoir

### Site 1 (Beachton Crossing)

Beachton Crossing was located in the most mountainous terrain on the river. A pool 0.86 km long with a maximum depth of 2.4 m with a rock and gravel bottom was present in the immediate vicinity of the

Figure 3. Sample sites on the Mountain Fork River. a. Site 1, Beachton Crossing; b. Site 2, Smithville; c. Site 3, Eagle Fork River; d. Site 4, Texas Campgrounds; e. Site 5, Buktukola Creek; f. Site 6, Low Water Bridge; g. Broken Bow Dam and Reservoir; h. Site 7, Park Campgrounds; i. Site 8, Old Park Dam

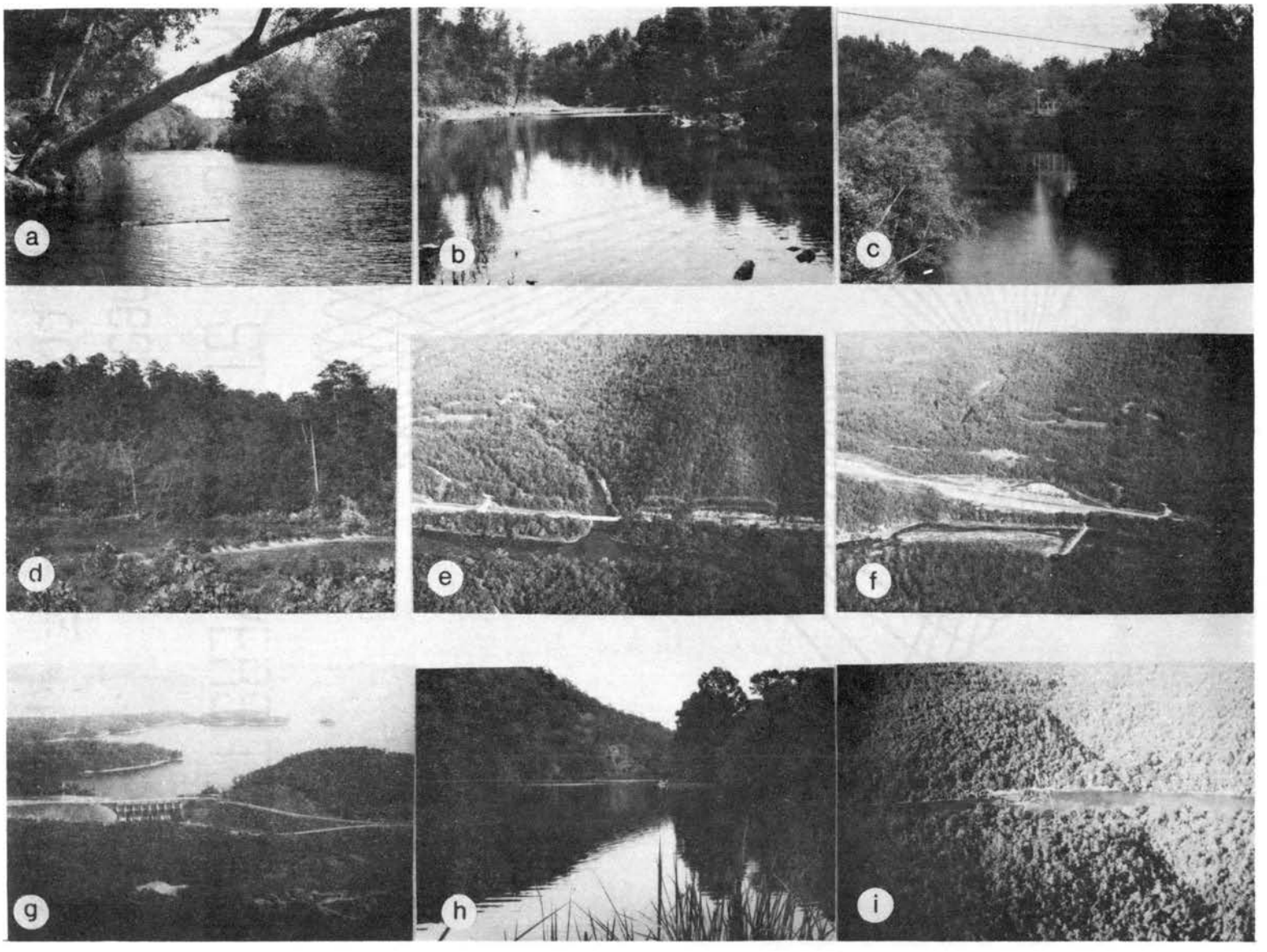
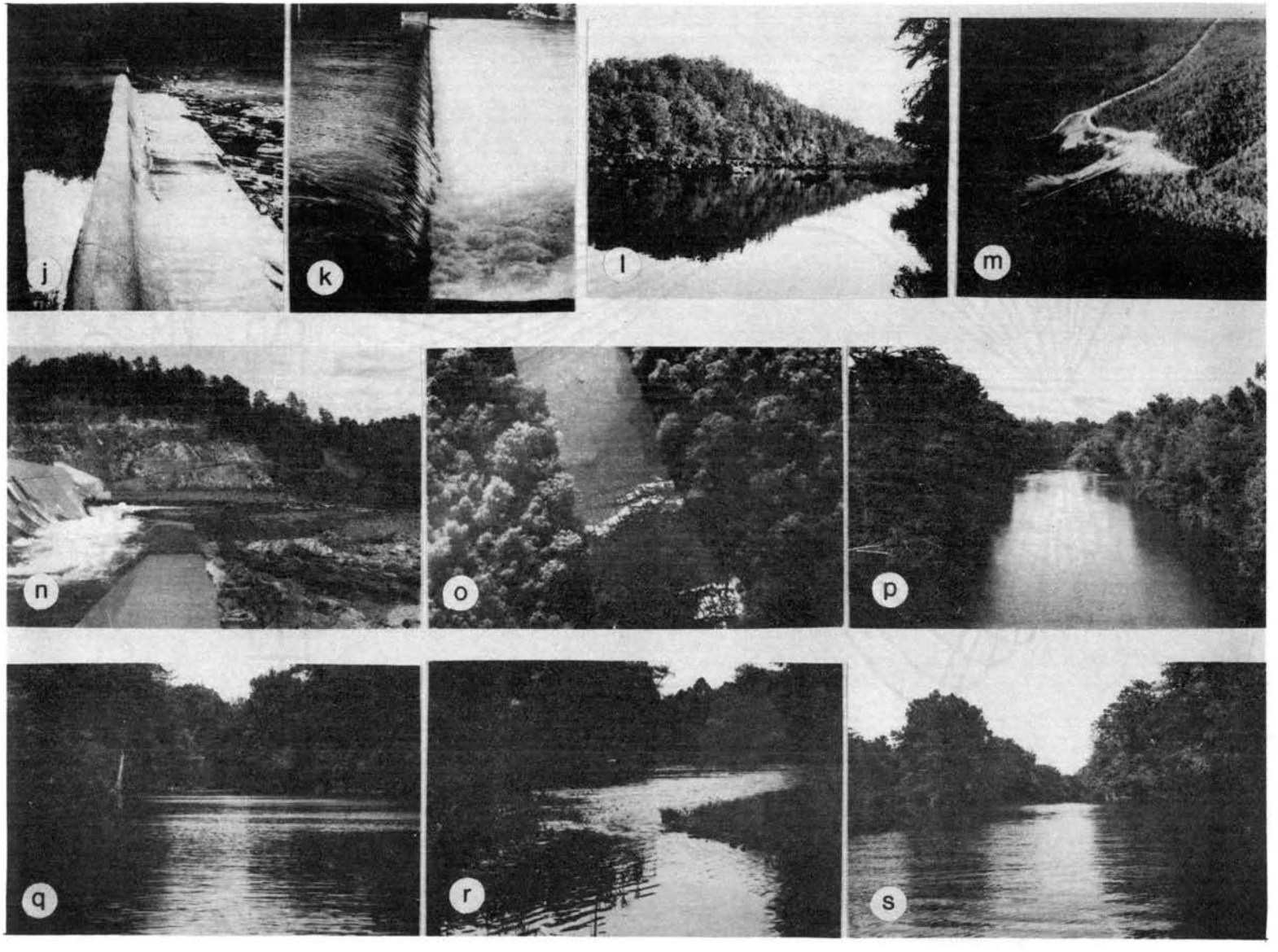

a
b
c
d
e
f
g
h
i

Figure 3 (continued). j. Site 8, Old Park Dam (normal low flow; k. Site 8, Old Park Dam (flow when generating at one-half capacity); l. Site 9, Epplers Camp; m. Site 10, Reregulation Dam; n. Site 10, Reregulation Dam; o. Site 11, Presbyterian Falls; p. Site 12, Highway 70 Bridge, q. Site 13, Jones Landing; r. Site 14, Bogalye Crossing; s. Site 15, Little River.


j
k
l
m
n
o
p
q
r
s

site. The natural scenic beauty of this site was attractive to campers and fishermen although there were no camping facilities. The mean water temperature was 17.7 C ranging from 5.4 C in January to 30.2 C in August.

Site 2 (Smithville)

This site was located 0.86 km southeast of the town of Smithville. This was the only site above Broken Bow Reservoir with tourist cabins on the river frontage. The river in this area formed a pool approximately 2.4 km long with a maximum depth of 2.1 m. This pool was relatively shallow with numerous shoals of rock and debris. Water temperatures ranged from 4.2 C in January to 30.2 C in August with a yearly mean temperature of 17.4 C.

Site 3 (Eagle Fork)

The Eagle Fork Creek site was located 0.2 km west of the confluence of Eagle Fork Creek and the Mountain Fork River. This particular location was selected because it was the only place in the vicinity where fishermen could enter or leave the river except by boat. A pool approximately 1 km long and 50 m wide, with large rock outcroppings occurred at the confluence of the Mountain Fork River and Eagle Fork Creek. The yearly mean water temperature at this site was 16.6 C (range 6.5 C in December to 32.8 C in August).

Site 4 (Texas Campgrounds)

This site had a succession of three pools, separated by riffles produced by faulting formations of the granitic bedrock. The length of

these pools was approximately 0.5 km each with depths of less than 1.8 m and a gravel/rock bottom. The close proximity to U. S. 259 and available river frontage for camping made this area one of the most accessible areas on the upper river. Because of heavy utilization and lack of trash barrels or regular service, this site was severely littered. Yearly mean water temperature was 17.2 C ranging from 4.9 C in January to 30.7 C in August. Immediately below this site the river formed a long pool extending to site 6.

Site 5 (Boktukola Creek)

Located at the confluence of Boktukola Creek and the Mountain Fork River, this site had good access from U. S. 259 and suitable river frontage on the west side of the river that was used for camping and facilitated boat launching. The river bed was composed of sediment and water depths ranged up to 2.9 m. Monthly mean water temperatures ranged from a low of 6.3 C in January to a high of 29.6 C in August, with a yearly mean temperature of 17.5 C.

Site 6 (Low Water Bridge)

The low water bridge provided fishermen with a unique fishing opportunity. Here fishermen could cross the river in automobiles. In the early summer this bridge forms a partial barrier to fish migrations, a condition that has been fully appreciated by river fishermen for many years. During this study the bridge served to concentrate small largemouth bass, presumably migrating upstream from Broken Bow Reservoir. In this area the river had a rocky bottom and was less than 1.5 m deep. Monthly mean water temperatures ranged from 6.2 C in December to 28.9 C

in August with a yearly mean temperature of 17.2 C. An overlook was built on U. S. 259 next to this site; it provided an area used for camping, although its purpose was as a rest area and scenic overlook.

## Sites Below the Reservoir

### Site 7 (Park Campgrounds)

This area was located immediately below Broken Bow Reservoir in Beavers Bend State Park. This section of the river was cut off from direct flow and, because the hydroelectric penstocks discharge below this site, this portion of the river was a series of oxbow lakes. Maintenance water was provided for these pools by a low flow sluice gate in the Broken Bow Dam. This site was planned and developed for camping, picnicking, and was the only area on the river which had boat rental and supervised swimming facilities. The river in this area had a silt and mud bottom and was surrounded by high bluffs and rocky outcroppings. The yearly mean water temperature at this site was 18.0 C, higher than any other site on the river. Monthly water temperatures ranged from 5.9 C in January to 28.9 C in June.

### Site 8 (Old Park Dam)

This site, within Beavers Bend State Park, was adjacent to more conveniences than any other site. Modern shower-houses, cabins, picnic tables, electrical outlets, a general store, and a restaurant were available. The old park dam, a low saddle-type dam (approximately 2 m high) built at least two decades prior to construction of the reservoir, was constructed for the purpose of providing fishing, swimming, and domestic water for the park facilities during periods of low flow.

Since completion of the reservoir, river levels fluxuate erratically (up to 0.8 m) due to releases during power generation. Because of extreme danger during periods of hydroelectric release, the river was fenced off above the old park dam and was used very little for fishing despite the excellent facilities. The Old Park Dam forms a pool approximately 2.41 km long with a maximum depth of 2.7 m and silt and rock bottom. Mean water temperatures ranged from 8.6 C in February to 20.6 C in September with a yearly mean temperature of 13.9 C. Water temperatures during power releases average 14.4 C throughout the summer.

Site 9 (Epplers Camp)

The road to Epplers Camp, a privately owned resort, provided public access to the river for fishing in an area otherwise lacking access by car. Here the river was narrow with a gravel and silt bottom, and large boulders protruded from the stream bed at various points. Releases from Broken Bow Reservoir during power generation caused the lower portion of this site to flood. The yearly mean water temperature was 12.3 C (monthly range of 7.8 C in February to 21.4 C in October).

Site 10 (Reregulation Dam)

The reregulation dam was built in conjunction with the construction of the reservoir for the purpose of decreasing downstream fluxuations in water levels between generating and non-generating periods. The river at the dam was approximately 161 m wide with a maximum depth of 3 m. Monthly mean water temperatures ranged from 8.9 C in January to 21.5 C in August, with a yearly mean temperature of 14.9 C. Below the dam, the river bed had large boulders throughout the channel with a rock

and sand bottom. Parking and picnicking facilities, built and maintained by the U. S. Army Corps of Engineers, were located adjacent to the reregulation dam. This site had the highest usage of all sites on the lower portion of the river.

Site 11 (Presbyterian Falls)

Presbyterian Falls is located in a remote area in the transition zone between the mountainous region and the Gulf Coastal Plains region. Access to this site was difficult due to erosion of the road and commercial logging operations in the area. The river here had boulders which formed a low falls. Immediately below the falls the river formed a pool approximately 1.8 km long and 64 m wide. The river had a sand and rock bottom with debris surrounding the rocky outcroppings. Mean yearly water temperature for this site was 16.0 C (ranging from 8.9 C in February to 22.8 C in August ).

Site 12 (Highway 70 Bridge)

This site was located in the Gulf Coastal Plains. The eastern river bank had a gentle gradient that facilitates boat launching. The river was approximately 73 m wide and had a maximum depth of 5.49 m. The monthly mean water temperatures for this site ranged from 8.0 C in February to 24.7 C in August (yearly mean 16.4C). Temperature measurements were obtained along the east shore because the main current of the river was inaccessible to the creel clerk, although it was probably somewhat cooler. This site provided easy accessibility to the river and was another popular area used by fishermen. Many boat fishermen used this area because of the long (approximately 2.33 km) pool.

Site 13 (Jones' Landing)

Sites 13 and 14 were not heavily used because of their remote location from the major highway (U. S. 70). The river had a mud-gravel bottom occasionally covered with waste material from a fiberboard plant. The outfall from the fiberboard plant was about 0.8 km above this site. The river channel at this site during high water level was divided forming small islands surrounded by dense growths of both aquatic vegetation and bald cypress. Water temperatures ranged from 7.8 C in February to 23.5 C in September with a yearly mean water temperature of 15.6 C.

Site 14 (Bogalye Crossing)

This site was located only 5.15 km from the confluence of Mountain Fork and Little River. Dense growths of pine and water oak lined the banks. The river had a gravel and mud bottom, and a pool 0.5 km in length with a maximum depth of less than 4 m. The yearly mean water temperature was 15.3 C (ranging from 11.1 C in December to 23.5 C in September).

Site 15 (Little River)

The Little River site was located on the Mountain Fork River at the confluence of Mountain Fork and Little River. Here the Mountain Fork River was approximately 91.3 m wide with depths exceeding 4.3 m. Entrance into this area other than by boat was difficult. During wet and rainy periods this site was inaccessible by automobile. Because no people were contacted at this site during the study, it has been excluded from further consideration in this paper.

# CHAPTER III

## SAMPLING DESIGN

### Stratified Random Sample

In determining reliable unbiased estimates of fishermen effort and catch, it is essential that random selection be involved in sampling design (Regier 1966, Robson 1960, and Funk 1958). Stratification of sampling periods in which random samples are taken from each segment (party and individual) or class (boat, bank, etc.) of fishermen can increase the accuracy of the results (Carlander and Di Constanzo 1958, Carlander 1956, Murphy 1955, Kathrein 1953, Tait 1953, Eschmeyer 1942, and Mottley and Embody 1940). Numerous creel studies have demonstrated the differences in fishing pressure between weekdays and weekends (Brown 1969, Churchill and Snow 1964, Gosslein 1961, Schmulback 1959, and Houser and Heard 1958), period of the day (Brown 1969, Alexander and Shetter 1967), and months of the year (Jarman, Bennett, Collins, and Brown 1969, Funk and Fleener 1966, and Towery 1963).

To compare man-days[1] use and catch on the Mountain Fork River above and below Broken Bow Reservoir, sample collections were scheduled for each day from 1 August 1970 through 31 July 1971. Sample effort at each site was stratified into (1) weekday mornings, (2) weekday afternoons,

---

[1]A man-day was defined as a day's fishing trip regardless of length of time spent; therefore, number of man-days equals number of fishermen.

(3) weekend mornings, and (4) weekend afternoons. Holidays were treated as weekend days. The morning sample period was from 10 am to 2 pm while the afternoon sample period was the four hours preceding darkness. Timing of morning and afternoon sample periods was based on the assumption that fishermen contacted during these hours would yield the maximum number of completed fishing trips. This assumption was validated by the results which show that completed trips comprised 71% of all interviews (Table 2).

Brown (1969) stated that sampling intensity should be related to distribution of fishing effort if a survey is primarily designated to estimate effort. The present study utilized a random sampling of strata to determine spatial and temporal distribution of fishermen use. Sampling for the initial month (August 1970) was determined from estimates of fishermen use obtained by conferring with a local fishing guide and from preliminary field observations. Sampling within the four time strata for each month after the initial month was determined by using data from the previous month as follows:

(1) Average number of people per site per sample period = $\frac{\text{number of people interviewed at the site during month}}{\text{number of times the site was sampled during month}}$.

(2) Total of the average number of people per site for each sample period = sum of (1) over all sites.

(3) Site weight = (1) ÷ (2).

(4) Number of sampling periods for a site during the next month = (3) X (number of sample periods in next month). There were always two sample periods per day.

After the proportional number of sample periods were allocated to each

Table 2.—Number and percent of complete and incomplete fishermen trips above and below Broken Bow Reservoir on the Mountain Fork River, 1 August 1970 through 31 July 1971

| | Above | | Below | | Total River | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| Individual complete | 142 | 77.2 | 85 | 79.4 | 227 | 78.0 |
| Individual incomplete | 42 | 22.8 | 22 | 20.6 | 64 | 22.0 |
| Party complete | 340 | 67.9 | 252 | 69.8 | 592 | 68.7 |
| Party incomplete | 161 | 32.1 | 109 | 30.2 | 270 | 31.3 |
| Total complete | 482 | 70.4 | 337 | 72.0 | 819 | 71.0 |
| Total incomplete | 203 | 29.6 | 131 | 28.0 | 334 | 29.0 |
| Total interviews | 685 | | 468 | | 1,153 | |

site (with at least one sample scheduled for each site during each month, Table 3), actual sample dates within the month were determined by using a random number table with the dates for morning, afternoon, weekday, and weekend samples determined separately.

## Interview Procedures

A creel clerk collected information from each fisherman or party of fishermen when they had finished fishing. At the end of the sample period, individuals and parties who had not completed fishing activities were interviewed. All fishermen were asked to estimate total hours actually fished to the nearest one-tenth hour (0.1). During this study, no estimate of error was made of fishermen estimates of the number of hours they had spent fishing; however, Johnson and Wrobewski (1962) and Grosslein (1961) found that although fishermen did err in their estimates of fishing time, with a large sample size, individual errors tended to be compensated. Radford (1973) also found no significant difference between actual and reported mean time spent angling by parties during each month of a creel survey on a lake in Alberta, Canada.

Data collected during each interview included: interview site; time of interview; date; number in party (actually fishing); place of residence; one-way distance traveled to reach fishing area; site entered and left (in case of float trips); whether or not fishing activity was completed; type of fishing (bank and wading, tubing, boat, and trotline); method of fishing (lure, fly, live bait, or dead bait); estimated expenditures for lodging, meals, tackle, bait, and guide fees considered by the fishermen as indigenous to that particular fishing trip; catch data; and air and water temperatures (Figure 4).

Table 3.—Hypothetical example of the method of stratifying sample effort used for the Mountain Fork River, 1 August 1970 through 31 July 1971

Previous Hypothetical Month: Number of days in month = 30, number of sample periods = 60

| Site | Number of times sampled | Number of people interviewed | Avg. no. of people/site | Site Weight |
|---|---|---|---|---|
| 1 | 13 | 21 | 1.62 | .178 |
| 2 | 23 | 37 | 1.61 | .176 |
| 3 | 9 | 34 | 3.78 | .414 |
| 4 | 7 | 14 | 2.00 | .219 |
| 5 | 8 | 1 | .12 | .013 |
| Total | 60 | | 9.13 | 1.000 |

Site Weight for site 1 (3) $= \frac{\text{Avg. no. of people/site}}{\text{Total avg. no. of people}} = \frac{(1)}{(2)} = \frac{1.62}{9.13} = .178$

No. times site sampled (4) = site weight X number weekday and/or weekend checks in new month.

(Site 1 weight) (number of weekday checks in month) = $.178 \times 48 = 8.54 \tilde{=} 9$

New Hypothetical Month: Number of days in month = 31, number of sample periods = 62

| | | No. Weekday Samples[a] | | | No. Weekend Samples[a] | | |
|---|---|---|---|---|---|---|---|
| Site | Weight | | A.M. | P.M. | | A.M. | P.M. |
| 1 | .178 | 8.5 = 9 | 5 | 4 | 2.5 = 2 | 1 | 1 |
| 2 | .176 | 8.4 = 8 | 4 | 4 | 2.5 = 2 | 1 | 1 |
| 3 | .414 | 19.9 = 19 | 9 | 10 | 5.8 = 6 | 3 | 3 |
| 4 | .219 | 10.5 = 11 | 6 | 5 | 3.1 = 3 | 1 | 2 |
| 5 | .013 | 0.6 = 1 | 0 | 1 | 0.2 = 1 | 1 | 0 |
| Number of samples | | 48 | 24 | 24 | 14 | 7 | 7 |

[a]Often in calculating the number of samples given to sites, rounding errors occur. When this happens the number of samples scheduled for the site (s) with the highest sample frequency was reduced to ensure that all sites were sampled at least once each month.

Figure 4. Creel survey form used for fisherman interviews on the Mountain Fork River

MOUNTAIN FORK RIVER, RECREATIONAL SURVEY

Interview No. [ ] [ ] [ ] [ ] Interview Site [ ] [ ] Date [ ] [ ] [ ] [ ] [ ] [ ] Time [ ] [ ] [ ] [ ] Day [ ]

No. in Party [ ] [ ] City _____ State [ ] [ ] Dist. Traveled [ ] [ ] [ ]

Site Entered [ ] [ ] Left [ ] [ ] Float Dist. [ ] [ ] [ ] Trip Completed: Yes [ 1 ] No [ 2 ]

No. of Hours: Fishing [1] [ ] [ ] [ ] Canoeing [2] [ ] [ ] [ ]

Type of Fishing: Bank & Wadding [ 1 ] Tubing [ 2 ] Boat [ 3 ] Trotline [ 4 ] Combination [ 5 ]

Method of Fishing: Lure [ 1 ] Fly [ 2 ] Live Bait [ 3 ] Dead Bait [ 4 ] Combination [ 5 ]

DAILY EXPENDITURES

Lodging [ ] [ ] [ ] Meals [ ] [ ] [ ] Tackle [ ] [ ] Bait [ ] [ ] Guide [ ] [ ] [ ] Total [ ] [ ] [ ]

CATCH DATA INDIVIDUAL [ 1 ] PARTY [ 2 ]

| Species | Code | No. Caught | Total Wgt. (lbs) | Individual Total Length (ins) |
|---|---|---|---|---|
| Largemouth Bass | 1 | | | |
| Smallmouth Bass | 2 | | | |
| Spotted Bass | 3 | | | |
| Warmouth Bass | 4 | | | |
| White Crappie | 5 | | | |
| Bluegill Sunfish | 6 | | | |
| Longear Sunfish | 7 | | | |
| Green Sunfish | 8 | | | |
| Channel Catfish | 9 | | | |
| Flathead Catfish | 10 | | | |
| Black Bullhead | 11 | | | |
| Black Crappie | 12 | | | |
| Redhorse | 13 | | | |
| Smallmouth Buffalo | 14 | | | |
| Yellow Bullhead | 15 | | | |
| | | | | |

Checked by _____ Remarks _____

Temperature: Air _____ Water _____

Catch was characterized on the interview form for total number and total weight of each species caught with individual fish length and weight measurements recorded whenever time permitted.

Data from the interview forms were key punched on automatic data processing cards and data summaries and analyses were performed by computer.

## Estimation Methodology

Procedures used to estimate the desired total within a particular stratum followed the method described by Brown (1969). The following example given for the estimation of hours fished was used for other fishery parameters such as total number and weight (by species) of fish caught, and man-days (number of fishermen). Total hours fished within a strata were estimated by the formula:

$$\sum^{*} \left[ X_h = \left( \frac{N_h}{n_h} \right) x_h \right]$$

where: $X_h$ = total estimated hours fished in month h;

$n_h$ = number of observed sample periods in month h;

$N_h$ = total number of sampling periods in month h

*summed for weekday and weekend mornings and afternoons;

$$x_h = \sum_{i=1}^{n_h} x_{hi}$$

$x_{hi}$ = the observed number of hours fished in stratum i (weekday mornings or afternoons and weekend mornings or afternoons).

Variances of fishermen harvest and use were calculated with the following formula (example shown is of the variance for annual hours fished for a particular site):

$$VAR(X_j) = \sum_{h=1}^{12} \sum_{i=1}^{4} n_{jhi} \, s^2_{jhi}$$

where: $X_j$ = hours fished at site j

$n_{jhi}$ = number of sample periods in month and stratum i.

$s^2_{jhi}$ = variance of hours in month and stratum i.

## Catch Per Unit of Effort

The estimate of the average catch per unit of effort in number of fish/hour and kg/hour[2] is an important index of fishing quality, and is particularly important when estimates of total number and weight of fish harvested are based on mean catch rate times total hours fished.

Two methods used to report mean catch rate in creel surveys are (1) the mean-of-the-ratios in which catch rate is calculated by dividing catch by hours fished for each angler and finding the mean of that ratio for all anglers' catch rates and (2) the ratio-of-the-totals which is calculated by dividing total catch by total hours fished. Although both methods are used to report fishing quality, each yields a different catch rate from the same data (except in cases where all fishermen fished for the same length of time or have the same catch rate).

---

[2]Abbreviations used in the remainder of this paper are:

CRT = Catch rate for either number of fish/hour or kg/hour (usually used when reference is to both parameters).
CRN = Catch rate for number of fish/hour.
CRW = Catch rate for weight of fish/hour.

It should be pointed out that neither method is unbiased although both methods yield ratios. Tait (1953), in dealing with sampling problems in Michigan creel surveys, implied that the mean of the ratios was more useful in reporting catch rates because the variability of catch rates could be measured by conventional statistical methods. Carlander and DiConstanzo (1958) stated that the mean-of-the-ratios was an unbiased estimate of the catch rate when there is no correlation between catch rate and hours fished, but a more realistic estimate of catch rates could be derived by using the ratio-of-the-totals.

In the present study, the ratio-of-the-totals was used. Although the mean-of-the-ratio is representative of the catch per unit of effort of the sample drawn (in this case the actual fishermen interviewed), it may not be a true indication of the catch rate for the population from which the sample was drawn. The ratio-of-the-totals gives a better indication of the catch per unit of effort for the population because it is more sensitive to the number of unsuccessful fishermen (fishermen who caught no fish).

Variance of the ratio-of-the-totals, $Var(\hat{R})$, can be determined by the following formula (DiConstanzo, 1956):

$$VAR(\hat{R}) = \frac{\Sigma Y^2 + (\hat{R})^2 \Sigma X^2 - 2(\hat{R}) \Sigma XY}{\frac{(\Sigma X^2)}{n} (n-1)}$$

where: $Y$ = number of fish caught each interview;

$X$ = number of hours fished each interview;

$\hat{R} = \frac{\Sigma Y}{\Sigma X}$ = catch rate or number of fish/hour;

$n$ = number of interviews.

Therefore, CRT between any two groups can be tested for differences by:

$$t = \frac{\hat{R}_1 - \hat{R}_2}{\sqrt{VAR(\hat{R}) + VAR(\hat{R}_2)}}.$$

In determining CRT, Lambou (1966) has suggested that the effort (hours) directed toward a particular species be used in calculating the catch rate for that species. Although this procedure is sensitive to changes in fishing success for a particular species, fishermen encountered on the Mountain Fork River often fished for and caught any and all species. Because the primary objective in this study was to determine overall characteristics of the fishery, total catch was regarded as the best measure.

CRT values were calculated for each species by dividing total catch of that species by total effort according to the method used by Fleener (1971a, b, c), Hanson (1970), Carter (1957), and Funk (1953). Although species catch rates are biased downward for any particular species in a mixed creel, this method produces an unbiased estimate of the catch rates when all species are combined. This method also allows participation of all fishermen in the catch statistics as opposed to the method proposed by Rupp (1961) in which he attempted to remove bias of those individuals in the fishermen population who caught less than 50% of the total catch. For this study, Rupp's procedure was considered biased as it would not give a true indication of the nature of the Mountain Fork River fishery. The same conclusion was reached by Lambou (1966) while considering alternative methods of analyzing catch data. As recommended by Lambou (1966), average weight of all species combined and each

species separately was calculated to provide an index of the relative quality of the sport-fisherman catch.

## Estimation of Total Harvest

Estimates of sport-fisherman-harvest (hereafter referred to as "harvest") and effort calculated from completed-fishing-trips (hereafter referred to as "completes") are more accurate than estimates made from incompleted-fishing-trips (hereafter referred to as "incompletes"). However, some investigators have utilized incompletes in estimating angler harvest and fishing pressure (Lambou and Stern 1958, Gasaway 1957, DiCostanzo 1956, Jessen 1956, and Tait 1953). If estimates of total harvest are based on information collected from incompletes, total harvest is underestimated because only a minimum estimate of catch is derived from incompletes. Even for an intensive creel survey which allows sampling to be restricted to a limited number of access sites, as was the case for the Mountain Fork River, it was found that of the 1,153 total interviews 29.6% of the above and 28.0% of the below fishermen interviews were incompletes (Table 2). In the above and below portions of the river, trip lengths of completed and incompleted individual and party fishermen were compared and in all cases incomplete trip length was shorter than complete trip length (Table 4). Although total harvest and hours fished from incompletes is not known, it appears that an adjustment of estimates of total harvest will yield more realistic results by using trip length of completes and the catch rate of incompletes according to the method described by Fleener (1952):

$$EH_{IC} = (EHF_{IC}) \text{ X } (CR_{IC}),$$

Table 4.—Comparison of complete and incomplete trip length of party and individual fishermen, above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971

| Trip Length | Complete | Incomplete | Difference |
|---|---|---|---|
| | ABOVE | | |
| Individual | 1.36 | 1.32 | 0.04 |
| Party | 2.07 | 1.79 | 0.28 |
| | BELOW | | |
| Individual | 1.66 | 1.49 | 0.17 |
| Party | 2.40 | 1.46 | 0.94 |

where: $EH_{IC}$ = Estimated harvest of incompletes.

$CR_{IC}$ = Catch rate of incompletes.

$EHF_{IC} = (N_{IC}) \times (TL_C)$ = Estimated hours fished by incompletes.

$N_{IC}$ = Number of incompletes.

$TL_C$ = Trip length of completes.

This requires that one accept the assumptions that (1) incompletes behave like completes with respect to trip length, and (2) the CRT of incompletes is not correlated with the number of hours fished. Although the first assumption could not be tested in this study, correlations between trip length and catch rate for incompletes for sites above and below the reservoir were found to be insignificant (above: $r = -0.004$, $n = 203$ and below: $r = 0.040$, $n = 131$).

Fleener's method of adjusting the harvest of incomplete fishermen trips may cause CRT's to change. This is particularly apparent in situations where large numbers of unsuccessful incompletes are included in computations. Estimated hours fished by unsuccessful incompletes are increased, but since the fishermen were unsuccessful, the expanded harvest remains zero. When total harvest and total hours of fished are used to determine the catch rate, the resulting catch rates will be lower than the overall unadjusted catch rates.

When adjusted annual harvest of incompletes is compared to estimates derived for incompletes without adjustments, estimated annual harvest is increased by approximately 25% in total number of fish, 37% in total weight of fish, and 21% in total hours fished (Table 5). Using the adjustment method, both above and below river portions showed increased estimates in number, weight, and hours fished. The above portion had a larger percentage increase in number and weight of fish

Table 5.—Comparison of adjusted and unadjusted annual harvest of incomplete fishing trips on the Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parentheses is the percent of increase or decrease)

| Site | Unadjusted | | | Adjusted | | |
|---|---|---|---|---|---|---|
| | Hours Fished | Number of Fish | Weight of Fish | Hours Fished | Number of Fish | Weight of Fish |
| | | | | ABOVE | | |
| 1 | 132 | 0 | 0 | 160(21.2) | 0 | 0 |
| 2 | 86 | 0 | 0 | 160(86.0) | 0 | 0 |
| 3 | - | - | - | - | - | - |
| 4 | 137 | 0 | 0 | 184(34.3) | 0 | 0 |
| 5 | 2,773 | 18 | 3.2 | 1,808(-34.8) | 43(138.9) | 5.9(84.4) |
| 6 | 1,963 | 3,118 | 544.3 | 3,046(55.2) | 4,152(33.2) | 773.8(42.2) |
| Total | 5,091 | 3,136 | 547.5 | 5,358(5.2) | 4,195(33.8) | 779.7(42.4) |
| | | | | BELOW | | |
| 7 | 1,060 | 390 | 99.8 | 1,886(77.9) | 432(10.8) | 134.7(35.0) |
| 8 | 2 | 0 | 0 | 2(0.0) | 0 | 0 |
| 9 | 280 | 0 | 0 | 164(-70.7) | 0 | 0 |
| 10 | 1,552 | 991 | 93.4 | 1,930(24.4) | 1,045(5.4) | 104.3(11.7) |
| 11 | 13 | 0 | 0 | 278(2,038.4) | 0 | 0 |
| 12 | 129 | 28 | 7.3 | 232(79.8) | 27(-3.6) | 6.8(-6.8) |
| 13 | - | - | - | - | - | - |
| 14 | 218 | 44 | 10.0 | 218(0.0) | 44(0.0) | 10.0(0.0) |
| Total | 3,254 | 1,453 | 210.5 | 4,710(44.7) | 1,548(6.5) | 255.8(21.5) |
| Overall | 8,345 | 4,589 | 757.9 | 10,068(20.6) | 5,743(25.1) | 1,035.5(36.6) |

caught than the percentage increase in the below area (Table 5). This difference was due to a combination of a larger number of successful (catching one or more fish) incompletes above combined with a larger number of unsuccessful incompletes below. Incompletes below had a greater increase in estimated hours fished than above (1,456 hours below and 267 hours above) due to trip length of incompletes below being comparatively shorter than below completes trip length and the small difference between trip length for completes and incompletes above (Table 4).

The effect of adjusted estimates on total harvest (combined completes and incompletes above and below) was to increase number of fish by 3.2% (Table 6), weight of fish by 3.0% (Table 7), and number of hours fished by 5.2% (Table 8). Total harvest above increased 3.4% in number of fish (Table 9), 2.7% in weight of fish (Table 10), and 1.6% in total hours fished (Table 8) while estimates below were increased by 2.0%, 4.8%, and 8.6% in number (Table 11), weight (Table 12), and hours fished (Table 8), respectively.

CRT's above and below were tested using the ratio of the totals for unadjusted and adjusted incompletes combined with completes. In all cases, the differences between adjusted and unadjusted CRT's (Table 13) were not statistically significant ($P > 0.50$, Snedecor and Cochran 1967). The largest difference between any of the CRT's was 0.036 fish/hr for the above sites. Apparently with the large number of fishermen interviewed on the Mountain Fork River, the difference between complete and incomplete fishermen trips for CRT's tended to be compensated.

Effects of adjusting incomplete fishermen harvest on the species

Table 6.—Effects of adjustment of catch by incompletes on species composition by total number of fish harvested on the Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis is percent increase or decrease between unadjusted and adjusted methods)

| Species[a] | Frequency in Catch | | | Relative Percent Contribution to Catch | | |
|---|---|---|---|---|---|---|
| | Unadjusted | Adjusted | Difference | Unadjusted | Adjusted | Difference |
| Largemouth bass | 10,274 | 10,556 | 282(3) | 32.5 | 32.4 | -0.1 |
| Smallmouth bass | 471 | 468 | -3(<-1) | 1.5 | 1.4 | -0.1 |
| Spotted bass | 861 | 939 | 78(9) | 2.7 | 2.9 | 0.2 |
| White crappie | 746 | 552 | -194(-26) | 2.4 | 1.7 | -0.7 |
| Black crappie | 321 | 321 | 0 | 1.0 | 1.0 | 0.0 |
| Bluegill | 679 | 665 | 114(-17) | 2.2 | 2.0 | -0.2 |
| Longear sunfish | 14,153 | 14,238 | 85(1) | 44.9 | 43.7 | -1.2 |
| Green sunfish | 2,228 | 2,395 | 167(7) | 7.1 | 7.4 | 0.3 |
| Warmouth | 11 | 11 | 0 | <0.1 | <0.1 | 0.0 |
| Flathead catfish | 447 | 535 | 88(20) | 1.4 | 1.6 | 0.2 |
| Channel catfish | 300 | 410 | 110(37) | 1.0 | 1.3 | 0.3 |
| Black bullhead | 968 | 1,384 | 416(43) | 3.1 | 4.3 | 1.2 |
| Yellow bullhead | 8 | 4 | -4(-50) | <0.1 | <0.1 | 0.0 |
| Redhorse Spp | 37 | 34 | -3(-8) | 0.1 | 0.1 | 0.0 |
| Spotted sucker | 3 | 3 | 0 | <0.1 | <0.1 | 0.0 |
| Smallmouth buffalo | 23 | 23 | 0 | 0.1 | 0.1 | 0.0 |
| Carp | 16 | 16 | 0 | <0.1 | <0.1 | 0.0 |
| Total | 31,546 | 32,554 | 1,008 | 100.0 | 100.0 | |
| Percent increase | | 3.20 | | | | |

[a]Common names of fishes follows usage by Bailey (1970).

Table 7.—Effects of adjustment of catch by incompletes on species composition by total weight (kg) of sport-fishermen harvest on the Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis is the percent of increase or decrease between unadjusted and adjusted methods)

| Species | Frequency in Catch | | | Relative Percent Contribution to Catch | | |
|---|---|---|---|---|---|---|
| | Unadjusted | Adjusted | Difference | Unadjusted | Adjusted | Difference |
| Largemouth bass | 2,472.1 | 2,536.0 | 63.9(3) | 40.1 | 40.0 | -0.1 |
| Smallmouth bass | 269.9 | 269.9 | 0 | 4.4 | 4.3 | -0.1 |
| Spotted bass | 155.1 | 169.6 | 14.5(9) | 2.5 | 2.7 | 0.2 |
| White crappie | 110.7 | 96.6 | -14.1(-13) | 1.8 | 1.5 | -0.3 |
| Black crappie | 50.8 | 51.7 | 0.9(2) | 0.8 | 0.8 | 0.0 |
| Bluegill | 108.9 | 72.1 | -36.8(-34) | 1.8 | 1.1 | -0.7 |
| Longear sunfish | 1,658.3 | 1,652.4 | -5.9(<1) | 26.9 | 26.0 | -0.9 |
| Green sunfish | 271.2 | 294.4 | -23.2(-9) | 4.4 | 4.6 | 0.2 |
| Warmouth | 1.4 | 1.4 | 0 | <0.1 | <0.1 | 0.0 |
| Flathead catfish | 561.5 | 567.4 | 5.9(1) | 9.1 | 8.9 | -0.2 |
| Channel catfish | 244.9 | 316.6 | 71.7(29) | 4.0 | 5.0 | 1.0 |
| Black bullhead | 139.7 | 204.1 | 64.4(46) | 2.3 | 3.2 | 0.9 |
| Yellow bullhead | 3.6 | 0.9 | -2.7(-75) | <0.1 | <0.1 | 0.0 |
| Redhorse Spp | 14.5 | 13.6 | -0.9(-6) | 0.2 | 0.2 | 0.0 |
| Spotted sucker | 2.3 | 2.3 | 0 | <0.1 | <0.1 | 0.0 |
| Smallmouth buffalo | 58.5 | 58.5 | 0 | 1.0 | 0.9 | -0.1 |
| Carp | 38.1 | 38.1 | 0 | 0.6 | 0.6 | 0.0 |
| Total | 6,161.6 | 6,345.7 | 184.2 | 100.0 | 100.0 | |
| Percent increase | | 2.99 | | | | |

Table 8.—Comparison of unadjusted and adjusted harvest and hours fished for combined completes and incompletes on the Mountain Fork River, 1 August 1970 through 31 July 1971

| | Unadjusted | Adjusted | Relative % Increase |
|---|---|---|---|
| | Hours Fished | | |
| Above | 15,993 | | 1.6 |
| Below | 16,691 | 18,260 | 8.6 |
| Total | 32,684 | 34,386 | 5.2 |
| | No. of Fish | | |
| Above | 26,567 | 27,470 | 3.4 |
| Below | 4,984 | 5,079 | 2.0 |
| Total | 31,551 | 32,549 | 3.2 |
| | Fish Weight (kg) | | |
| Above | 5,252.3 | 5,394.1 | 2.7 |
| Below | 909.7 | 952.5 | 4.7 |
| Total | 6,162.0 | 6,346.6 | 3.0 |

Table 9.—Effects of adjustment of catch by incompletes on species composition by total number for sport-fishermen harvest above Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis is the percent of increase or decrease between unadjusted and adjusted methods)

| Species | Frequency in Catch | | | Relative Percent Contribution to Catch | | |
|---|---|---|---|---|---|---|
| | Unadjusted | Adjusted | Difference | Unadjusted | Adjusted | Difference |
| Largemouth bass | 9,402 | 9,660 | 258(3) | 35.4 | 35.2 | -0.2 |
| Smallmouth bass | 379 | 376 | -3(-1) | 1.4 | 1.4 | 0.0 |
| Spotted bass | 842 | 919 | 71(8) | 3.2 | 3.3 | 0.1 |
| White crappie | 160 | 57 | -103(-64) | 0.6 | 0.2 | -0.4 |
| Black crappie | 59 | 59 | 0 | 0.2 | 0.2 | 0 |
| Bluegill | 178 | 184 | 6(3) | 0.7 | 0.7 | 0 |
| Longear sunfish | 12,439 | 12,426 | -13(<1) | 46.8 | 45.2 | -1.6 |
| Green sunfish | 1,772 | 1,949 | 177(10) | 6.7 | 7.1 | 0.4 |
| Warmouth | 11 | 11 | 0 | <0.1 | <0.1 | 0 |
| Flathead catfish | 414 | 501 | 87(21) | 1.6 | 1.8 | 0.2 |
| Channel catfish | 115 | 204 | 89(77) | 0.4 | 0.7 | 0.3 |
| Black bullhead | 779 | 1,117 | 338(43) | 2.9 | 4.1 | 1.2 |
| Yellow bullhead | 8 | 4 | -4(-50) | <0.1 | <0.1 | 0 |
| Redhorse Spp | 0 | 0 | 0 | - | - | - |
| Spotted sucker | 3 | 3 | 0 | <0.1 | <0.1 | 0 |
| Smallmouth buffalo | 0 | 0 | 0 | - | - | - |
| Carp | 0 | 0 | 0 | - | - | - |
| Total | 26,561 | 27,470 | 909 | 100.0 | 100.0 | |
| Percent increase | | 3.42 | | | | |

Table 10.—Effects of adjustment of catch by incompletes on species composition by total weight (kg) for sport-fishermen harvest above Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis is the percent of increase or decrease between unadjusted and adjusted methods)

| Species | Frequency in Catch | | | Relative Percent Contribution to Catch | | |
|---|---|---|---|---|---|---|
| | Unadjusted | Adjusted | Difference | Unadjusted | Adjusted | Difference |
| Largemouth bass | 2,230.3 | 2,294.7 | 64.4(3) | 42.5 | 42.5 | 0.0 |
| Smallmouth bass | 247.7 | 248.1 | 0.6(<1) | 4.7 | 4.6 | -0.1 |
| Spotted bass | 150.6 | 165.6 | 15.0(10) | 2.9 | 3.1 | 0.2 |
| White crappie | 15.4 | 14.1 | -1.3(-8) | 0.3 | 0.3 | 0.0 |
| Black crappie | 9.1 | 10.0 | 0.9(10) | 0.2 | 0.2 | 0.0 |
| Bluegill | 59.4 | 24.9 | -34.5(-58) | 1.1 | 0.5 | -0.6 |
| Longear sunfish | 1,518.2 | 1,493.2 | -25.0(-2) | 28.9 | 27.7 | -1.2 |
| Green sunfish | 224.1 | 249.0 | 24.9(11) | 4.3 | 4.6 | 0.3 |
| Warmouth | 1.4 | 1.4 | 0.0 | <0.1 | <0.1 | 0.0 |
| Flathead catfish | 532.5 | 530.7 | -1.8(<1) | 10.1 | 9.8 | -0.3 |
| Channel catfish | 151.5 | 192.3 | 40.8(27) | 2.9 | 3.6 | 0.7 |
| Black bullhead | 109.3 | 167.4 | 58.1(53) | 2.1 | 3.1 | 1.0 |
| Yellow bullhead | 0.9 | 0.9 | 0.0 | <0.1 | <0.1 | 0.0 |
| Redhorse Spp | - | - | - | - | - | - |
| Spotted sucker | 2.3 | 2.3 | 0.0 | <0.1 | <0.1 | 0.0 |
| Smallmouth buffalo | - | - | - | - | - | - |
| Carp | - | - | - | - | - | - |
| Total | 5,252.6 | 5,394.5 | 141.9 | 100.0 | 100.0 | |
| Percent increase | | 2.70 | | | | |

Table 11.—Effects of adjustment of catch by incompletes on species composition by total number for sport-fishermen harvest below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis is the percent of increase or decrease between unadjusted and adjusted methods)

| Species | Frequency in Catch | | | Relative Percent Contribution to Catch | | |
|---|---|---|---|---|---|---|
| | Unadjusted | Adjusted | Difference | Unadjusted | Adjusted | Difference |
| Largemouth bass | 872 | 896 | 24(3) | 17.5 | 17.6 | 0.1 |
| Smallmouth bass | 92 | 92 | 0 | 1.8 | 1.8 | 0.0 |
| Spotted bass | 19 | 20 | 1(5) | 0.4 | 0.4 | 0.0 |
| White crappie | 586 | 495 | -91(-16) | 11.8 | 9.7 | -2.1 |
| Black crappie | 262 | 262 | 0 | 5.3 | 5.1 | -0.2 |
| Bluegill | 501 | 481 | -20(-4) | 10.0 | 9.5 | -0.5 |
| Longear sunfish | 1,714 | 1,812 | 98(6) | 34.4 | 35.6 | 1.2 |
| Green sunfish | 456 | 446 | -10(-2) | 9.1 | 8.8 | -0.3 |
| Warmouth | - | - | - | - | - | - |
| Flathead catfish | 33 | 34 | 1(3) | 0.7 | 0.7 | 0.0 |
| Channel catfish | 185 | 206 | 21(11) | 4.0 | 4.1 | 0.3 |
| Black bullhead | 189 | 267 | 78(41) | 3.8 | 5.3 | 1.5 |
| Yellow bullhead | - | - | - | - | - | - |
| Redhorse Spp | 37 | 34 | -3(-8) | 0.7 | 0.7 | 0.0 |
| Spotted sucker | - | - | - | - | - | - |
| Smallmouth buffalo | 23 | 23 | 0 | 0.5 | 0.5 | 0.0 |
| Carp | 16 | 16 | 0 | 0.3 | 0.3 | 0.0 |
| Total | 4,985 | 5,084 | 99 | 100.0 | 100.0 | |
| Percent increase | | 1.99 | | | | |

Table 12.—Effects of adjustment of catch by incompletes on species composition by total weight (kg) for sport-fishermen harvest below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis is the percent of increase or decrease between unadjusted and adjusted methods)

| Species | Frequency in Catch | | | Relative Percent Contribution to Catch | | |
|---|---|---|---|---|---|---|
| | Unadjusted | Adjusted | Difference | Unadjusted | Adjusted | Difference |
| Largemouth bass | 241.8 | 241.3 | 0.5(<1) | 26.6 | 25.4 | -1.2 |
| Smallmouth bass | 22.2 | 21.8 | -0.6(-3) | 2.4 | 2.3 | -0.1 |
| Spotted bass | 4.5 | 4.1 | -0.4(-9) | 0.5 | 0.4 | -0.1 |
| White crappie | 95.3 | 82.6 | -12.7(-13) | 10.5 | 8.7 | -1.8 |
| Black crappie | 41.7 | 41.7 | 0.0 | 4.6 | 4.4 | -0.2 |
| Bluegill | 49.4 | 47.2 | -2.2(-4) | 5.4 | 4.9 | -0.5 |
| Longear sunfish | 140.2 | 159.2 | 19.0(14) | 15.4 | 16.7 | 1.3 |
| Green sunfish | 47.2 | 45.4 | -1.8(-4) | 5.2 | 4.8 | -0.4 |
| Warmouth | - | - | - | - | - | - |
| Flathead catfish | 29.0 | 36.7 | 7.7(27) | 3.2 | 3.9 | 0.7 |
| Channel catfish | 93.4 | 124.3 | 30.9(33) | 10.3 | 13.1 | 2.8 |
| Black bullhead | 33.1 | 36.7 | 3.6(11) | 3.7 | 3.9 | 0.2 |
| Yellow bullhead | - | - | - | - | - | - |
| Redhorse Spp | 14.5 | 13.6 | -0.9(-6) | 1.6 | 1.4 | -0.2 |
| Spotted sucker | - | - | - | - | - | - |
| Smallmouth buffalo | 58.5 | 58.1 | 0.0 | 6.4 | 6.1 | -0.3 |
| Carp | 38.1 | 38.1 | 0.0 | 4.2 | 4.0 | -0.2 |
| Total | 908.1 | 951.2 | 42.2 | 100.0 | 100.0 | |
| Percent increase | | 4.75 | | | | |

Table 13.—Comparison of adjusted and unadjusted catch rates in number and kg/hour, Mountain Fork River, 1 August 1970 through 31 July 1971

| | Unadjusted | Adjusted | Difference | Probability | df |
|---|---|---|---|---|---|
| Fish/hr | | | | | |
| Above | 1.654 | 1.690 | 0.036 | P >0.50 | 503 |
| Below | 0.299 | 0.280 | 0.019 | P >0.50 | 313 |
| Kg/hr | | | | | |
| Above | 0.328 | 0.337 | 0.009 | P >0.50 | 503 |
| Below | 0.054 | 0.054 | 0.000 | P >0.50 | 313 |
| Above and Below Combined | | | | | |
| Fish/hr | 0.962 | 0.947 | 0.015 | P >0.50 | 816 |
| Kg/hr | 0.189 | 0.185 | 0.004 | P >0.50 | 816 |

composition was examined for above, below, and combined river estimates. Species composition was calculated by two methods (1) combining the harvest of unadjusted incomplete with complete and (2) combining the harvest of adjusted incomplete with completes. After comparing differences in species composition derived by methods 1 and 2 (above), it was found that relative percentage contribution of each species changed only slightly (Tables 6, 7, 9, 10, 11, 12).

Of the 17 species appearing in the creel, 7 species remained unchanged in relative percentage contribution in number and the maximum difference in species composition between methods 1 and 2 for the combined river estimates was 1.2% for black bullhead and -1.2% for longear sunfish (Table 6).

Six of the 14 species remained unchanged in relative percentage contribution by weight for combined river estimates with a maximum difference of 0.9% (Table 7).

When the difference in species composition is examined separately above and below, 6 of 14 species remained unchanged in relative percentage composition in numbers and weight above, and numbers below. The maximum relative percentage change in species composition above between methods 1 and 2 was -1.6% in number and -1.2% in weight (Tables 9 and 10). Relative percentage change in species composition between methods 1 and 2 below, was -2.1% by number and 2.8% by weight (Tables 11 and 12).

# CHAPTER IV

## ANNUAL HARVEST AND CATCH RATES

### Comparison of Above and Below Sections

Man-days of fishermen use on the Mountain Fork River 1 August 1970 through 31 July 1971 was estimated at 16,485 trips (Table 14). Fishermen fished 34,386 hours and caught 32,549 fish weighing 6,346.6 kg (Table 14). The percentage successful fishermen (catching one or more fish) was 37%. Of the anglers fishing above, 50% were successful while 24% of the anglers below were successful. Catch was greater above than below with above fishermen catching 27,470 fish (84%), weighing 5,394.1 kg (85%) while below fishermen caught 5,079 fish (16%) weighing 952.5 kg (15%) (Table 14).

Man-days use was slightly higher above (8,403, 51%) than below (8,082, 49%), but total hours fished were greater below (18,126, 53%) than above (16,260, 47%) (Table 14). The greater number of hours fished below is due to the longer trip length of 2.24 hrs/trip compared to 1.94 hrs/trip above. The difference in 0.30 hrs/trip between above and below was highly significant ($P < 0.001$, with 816 df). Factors judged to account for this difference were better camping facilities and access in the below area, and the fact that the below area was closer to local population concentrations. However, there was a non-significant correlation between trip length and hours fished by successful fishermen in

Table 14.—Man-days use hours fished and harvest by site above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis is the confidence interval at P = 0.05)

| Site | Man-days | Hours Fished | Fishermen Harvest: Number of Fish | Fishermen Harvest: Weight (kg) | Fishermen Harvest: Average Weight | Catch Rate: Fish/ Hour | Catch Rate: kg/ Hour |
|---|---|---|---|---|---|---|---|
| | | | ABOVE | | | | |
| 1 | 189 (±114) | 794 (±2,177) | 1,269 (±2,271) | 688.5 (±939.2) | 0.54 | 1.60 | 0.87 |
| 2 | 587 (±289) | 1,350 (±1,121 | 1,457 (±1,433) | 599.6 (±557.9) | 0.41 | 1.08 | 0.44 |
| 3 | 64 (±216) | 106 (±234) | 680 (±5,744) | 65.3 (±452.4) | 0.10 | 6.42 | 0.62 |
| 4 | 421 (±312) | 864 (±478 | 227 (±656) | 47.6 (±115.0) | 0.21 | 0.26 | 0.05 |
| 5 | 1,800 (±392) | 2,971 (±687) | 473 (±341) | 160.1 (±129.6) | 0.34 | 0.16 | 0.05 |
| 6 | 5,342 (±280) | 10,175 (±865) | 23,364 (±3,422) | 3,832.8 (±631.7) | 0.16 | 2.30 | 0.38 |
| | | | BELOW | | | | |
| 7 | 3,561 (±357) | 7,112 (±1,185) | 1,006 (±528) | 327.0 (±229.3) | 0.33 | 0.14 | 0.05 |
| 8 | 90 (±26) | 115 (±111) | 9 - | 1.4 - | 0.14 | 0.08 | 0.01 |
| 9 | 275 (±99) | 569 (±211) | 163 (±480) | 78.9 (±314.1) | 0.49 | 0.29 | 0.14 |
| 10 | 2,857 (±261) | 6,110 (±807) | 3,016 (±1,391) | 387.8 (±156.5) | 0.13 | 0.49 | 0.06 |
| 11 | 336 (±161) | 2,082 (±2,063) | 0 - | 0 - | - | - | - |
| 12 | 772 (±237) | 1,461 (±428) | 624 (±1,867) | 108.9 (±99.7) | 0.17 | 0.43 | 0.07 |
| 13 | 125 (±41) | 459 (±220) | 217 (±9) | 38.6 (±13.7) | 0.18 | 0.47 | 0.09 |
| 14 | 66 | 218 | 44 | 10.0 | 0.23 | 0.20 | 0.05 |
| Totals | | | | | | | |
| Above | 8,403 (±705) | 16,260 (±1,786) | 27,470 (±4,851) | 5,394.1 (±1,413.6) | 0.20 | 1.69 | 0.33 |
| Below | 8,082 (±623) | 18,126 (±2,925) | 5,079 (±1,562) | 952.5 (±290.2) | 0.19 | 0.28 | 0.05 |
| Combined | 16,485 (±665) | 34,386 (±2,423) | 32,549 (±3,603) | 6,346.6 (±1,020.3) | 0.20 | 0.95 | 0.19 |

either river location (r = 0.003 above and r = 0.002 below).

A catch rate of 1 fish/hr has been proposed as a measure of high quality fishing (Rose 1956). The observed CRN for the entire river was 0.95 fish/hr which indicates the Mountain Fork River provides high quality fishing using Rose's criterion. The catch in kg/hr was 0.19 and the average weight was 0.20 kg. The difference between CRT's of 1.69 fish/hr and 0.33 kg/hr above and 0.28 fish/hr and 0.05 kg/hr below was significant at P = 0.001 (df = 816). Although average fish weight (kg) was greater above than below, 0.20 and 0.19, respectively, the difference of 0.01 kg was not significant ($P > 0.50$, df = 816).

Species composition of the catch for the entire river in number of fish was dominated by longear sunfish (44%) and largemouth bass (33%), while composition of the catch by weight (kg) was dominated by largemouth bass (40%) and longear sunfish (26%) (Table 15). Harvest of smallmouth bass for which the Mountain Fork is noted (Finnell et al. 1956), ranked ninth by number (1%) and sixth by weight (4%).

Longear sunfish and largemouth bass contributed 45% and 35%, respectively, of the total number of fish caught above. Harvest below was dominated by longear sunfish, 36%, and largemouth bass, 18% (Table 16). Species composition by weight above was dominated by largemouth bass, 43%, and longear sunfish, 28%, while species composition by weight below was dominated by largemouth bass, 25%, longear sunfish, 17%, and channel catfish, 13% (Table 17).

Species composition of above and below harvest in number and weight were tested for the eleven species that occurred in both river portions. The computed chi-square ($\chi^2$) of 14,253 for number (10 df) was highly significant at ($P < 0.0005$). The mean difference of 406.46 kg/species

Table 15.—Species composition by number and weight for sport-fishermen catch on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Number | % | Rank | Weight | % | Rank |
|---|---|---|---|---|---|---|
| Largemouth bass | 10,556 | 32.5 | 2 | 2,536.0 | 40.0 | 1 |
| Smallmouth bass | 468 | 1.4 | 9 | 269.0 | 4.3 | 6 |
| Spotted bass | 939 | 2.9 | 5 | 157.4 | 2.7 | 8 |
| White crappie | 552 | 1.6 | 7 | 96.6 | 1.5 | 9 |
| Black crappie | 321 | 1.0 | 11 | 51.7 | 0.8 | 12 |
| Bluegill | 665 | 2.0 | 6 | 72.1 | 1.1 | 10 |
| Longear sunfish | 13,238 | 43.7 | 1 | 1,652.4 | 26.0 | 2 |
| Green sunfish | 2,395 | 7.4 | 3 | 294.4 | 4.6 | 5 |
| Warmouth | 11 | 0.1 | 15 | 1.4 | 0.1 | 16 |
| Flathead catfish | 535 | 1.6 | 8 | 567.4 | 8.9 | 3 |
| Channel catfish | 410 | 1.3 | 10 | 316.6 | 5.0 | 4 |
| Black bullhead | 1,384 | 4.3 | 4 | 204.1 | 3.2 | 7 |
| Yellow bullhead | 4 | 0.1 | 16 | 0.9 | 0.1 | 17 |
| Redhorse Spp | 34 | 0.1 | 12 | 13.7 | 0.2 | 14 |
| Spotted sucker | 3 | 0.1 | 17 | 2.3 | 0.1 | 15 |
| Smallmouth buffalo | 23 | 0.1 | 13 | 58.5 | 0.9 | 11 |
| Carp | 16 | 0.1 | 14 | 38.1 | 0.6 | 13 |
| Total | 32,554 | | | 6,345.7 | | |

Table 16.—Species composition by number for sport-fishermen catch above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Above | | | Below | | |
|---|---|---|---|---|---|---|
| | Number | % | Rank | Number | % | Rank |
| Largemouth bass | 9,660 | 35.2 | 2 | 896 | 17.6 | 2 |
| Smallmouth bass | 376 | 1.4 | 7 | 92 | 1.8 | 9 |
| Spotted bass | 919 | 3.3 | 5 | 20 | 0.4 | 13 |
| White crappie | 57 | 0.2 | 11 | 495 | 9.7 | 3 |
| Black crappie | 59 | 0.2 | 10 | 262 | 5.1 | 7 |
| Bluegill | 184 | 0.7 | 9 | 481 | 9.5 | 4 |
| Longear sunfish | 12,426 | 45.2 | 1 | 1,812 | 35.6 | 1 |
| Green sunfish | 1,949 | 7.1 | 3 | 446 | 8.8 | 5 |
| Warmouth | 11 | 0.1 | 12 | 0 | 0.0 | |
| Flathead catfish | 501 | 1.8 | 6 | 34 | 0.7 | 10 |
| Channel catfish | 204 | 0.7 | 8 | 206 | 4.1 | 8 |
| Black bullhead | 1,117 | 4.1 | 4 | 267 | 5.3 | 6 |
| Yellow bullhead | 4 | 0.1 | 13 | 0 | 0.0 | |
| Redhorse Spp | 0 | 0.0 | | 34 | 0.7 | 11 |
| Spotted sucker | 3 | 0.1 | 14 | 0 | 0.0 | |
| Smallmouth buffalo | 0 | 0.0 | | 23 | 0.5 | 12 |
| Carp | 0 | 0.0 | | 16 | 0.3 | 14 |
| Total | 27,470 | | | 5,084 | | |

Table 17.—Species composition by weight for sport-fishermen catch above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Above | | | Below | | |
|---|---|---|---|---|---|---|
| | Weight | % | Rank | Weight | % | Rank |
| Largemouth bass | 2,294.7 | 42.5 | 1 | 241.3 | 25.4 | 1 |
| Smallmouth bass | 248.1 | 4.6 | 5 | 21.8 | 2.3 | 12 |
| Spotted bass | 165.6 | 3.1 | 8 | 4.1 | 0.4 | 14 |
| White crappie | 14.1 | 0.3 | 10 | 82.6 | 8.7 | 4 |
| Black crappie | 10.0 | 0.2 | 11 | 41.7 | 4.4 | 8 |
| Bluegill | 24.9 | 0.5 | 9 | 47.2 | 5.0 | 6 |
| Longear sunfish | 1,439.2 | 27.7 | 2 | 159.2 | 16.7 | 2 |
| Green sunfish | 249.0 | 4.6 | 4 | 45.4 | 4.8 | 7 |
| Warmouth | 1.4 | 0.1 | 13 | 0.0 | 0.0 | |
| Flathead catfish | 506.7 | 9.8 | 3 | 36.7 | 3.9 | 10 |
| Channel catfish | 192.3 | 3.6 | 6 | 124.3 | 13.1 | 3 |
| Black bullhead | 167.4 | 3.1 | 7 | 36.7 | 3.9 | 11 |
| Yellow bullhead | 0.9 | 0.1 | 14 | 0.0 | 0.0 | |
| Redhorse Spp | 0.0 | 0.0 | | 13.6 | 1.4 | 13 |
| Spotted sucker | 2.3 | 0.1 | 12 | 0.0 | 0.0 | |
| Smallmouth buffalo | 0.0 | 0.0 | | 58.5 | 6.2 | 5 |
| Carp | 0.0 | 0.0 | | 38.1 | 4.0 | 9 |
| Total | 5,394.5 | | | 951.2 | | |

was not significant ($t = 1.852$, $P = 0.082$, $df = 18$). The degree of association between relative percent rank for number and weight, above and below, were tested by using Kendall's coefficient of concordance (Conover 1971, and Siegal 1956). Kendall's coefficient of concordance for number of fish $\tau = 0.1273$ and weight $\tau = 0.2727$ between above and below portions revealed that the respective ranking of species caught were not related.

## Comparison of Selected Site Groupings

The river above Broken Bow Reservoir accounted for 84% and 85% of the total harvest in number and weight while receiving only 47% of the total hours fished. Although comparison above and below with all sites included indicates overall man-days use and harvest on the river, it does not give a true indication of the effects of impoundment on the fishery. Inclusion of site 6 in the totals for the above group tends to bias evaluation of the sites above which are independent of reservoir influence. Site 6, immediately above the reservoir, accounted for 72% and 60% of total fishermen harvest by number and weight while receiving 32% of the man-days and 30% of the total hours fished annually on the Mountain Fork River. Site 7 immediately below the reservoir was essentially a series of three oxbow lakes and accounted for 22% and 21% of the man-days and hours fished, respectively. Finally, sites 12 through 14 were located in the Gulf Coastal region which is a different habitat from that portion of the river located in the mountainous region.

To better examine the effects of impoundment on sport fishermen use and harvest, sample collection sites were arranged into groups

representing distinct habitat types.

(1) Sites 1-5 represented the unchanged river portions.

(2) Site 6 was separated from the other above sites because of its close proximity to Broken Bow Reservoir (1.61 km) and the large annual harvest (Table 14) at this site which probably was influenced by the reservoir.

(3) Site 7 was separated from the below river sites due to the physical conditions created after impoundment. This section of the river was cut off from direct flows and had become a series of oxbow lakes with water temperatures higher than any other site on the river.

(4) Sites 8-11 were grouped because their geographic location in the mountainous river habitat below Broken Bow Reservoir was comparable to the general habitat type in which sites 1-5 were located.

(5) Sites 12-14 were grouped due to their location in the Gulf Coastal Plains habitat which was totally different from the mountainous habitat of sites 1-11.

Comparison of Sites 1-5 With Site 6

Catch at site 6 appeared to be influenced by upriver migrations of fish from the reservoir due to the partial barrier created by the low water bridge at site 6 and its close proximity to Broken Bow Reservoir. Man-days use and harvest at site 6 was greater than at sites 1-5 combined (Table 14). Site 6 accounted for 64%, 63%, 82%, and 71% of the total man-days, hours fished, number of fish and weight of all fish caught above, respectively. The difference in trip length between sites

1-5 (1.988 hrs/man-day) and site 6 (1.905) of 0.083 hrs/man-day was not significant ($P > 0.50$, df = 503).

In both of these site groupings, the species caught were dominated by longear sunfish and largemouth bass at site 6 and the reverse order at sites 1-5 (Table 18). Species composition by weight at sites 1-5 was dominated by largemouth bass and flathead catfish, while site 6 was dominated by longear sunfish and largemouth bass (Table 19).

Relative percent species composition (in number) of the 10 species caught at sites 1-5 and site 6 were significantly different ($P < 0.01$, $\chi^2 = 14{,}238$; df = 10). The relative abundance by weight between the two river groupings was not significant ($t = 1.161$, df = 18). Although differences in species composition in number but not weight between sites 1-5 and site 6 were significant, the rankings of species abundance appearing in the respective groupings were related. Kendall's $\tau$ values of 0.644 for number and 0.500 for weight were significant at $P < 0.05$, with 10 df. These results indicate that the relative rank of species abundance for sites 1-5 and site 6 was approximately the same.

Average weight of fish caught at sites 1-5 (0.380) was the highest reported for any site grouping (Table 20) and was significantly greater than the 0.167 average weight of fish caught at site 6 ($P = 0.004$, df = 503). The difference in average weight of 0.213 kg between the groupings is probably caused by the large number of largemouth bass which made up 62% of the catch at sites 1-5 and 30% of the catch at site 6 (Table 18). The difference in average weight of individual species between sites 1-5 and site 6 was significant ($P = 0.025$) for 6 of the 10 species, while site differences in average weight of 3 species (black crappie, bluegill, and black bullhead) could not be adequately tested

Table 18.—Species composition by number for sport-fishermen catch by site groupings on the Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis refers to the relative percent species harvest for site grouping)

| Species | Sites 1-5 | Site 6 | Site 7 | Sites 8-11 | Sites 12-14 |
|---|---|---|---|---|---|
| Largemouth bass | 2,556(62) | 7,104(30) | 217(22) | 558(18) | 121(14) |
| Smallmouth bass | 225(6) | 151(1) | - | 61(2) | 31(4) |
| Spotted bass | 84(2) | 835(4) | 4(<1) | 16(1) | - |
| White crappie | - | 57(<1) | 65(7) | 32(1) | 398(45) |
| Black crappie | 10(<1) | 49(<1) | 13(1) | 29(1) | 220(25) |
| Bluegill | 50(1) | 134(1) | 87(9) | 384(12) | 10(1) |
| Longear sunfish | 651(16) | 11,775(50) | 133(13) | 1,655(52) | 24(3) |
| Green sunfish | 301(7) | 1,648(7) | 83(8) | 331(10) | 32(4) |
| Warmouth | - | 11(<1) | - | - | - |
| Flathead catfish | 120(3) | 381(2) | 22(2) | 13(<1) | - |
| Channel catfish | 68(2) | 136(1) | 92(9) | 64(2) | 49(6) |
| Black bullhead | 42(1) | 1,075(5) | 252(25) | 15(1) | - |
| Yellow bullhead | - | 4(<1) | - | - | - |
| Redhorse Spp | - | - | 11(1) | 23(1) | - |
| Spotted sucker | - | 3(<1) | - | - | - |
| Smallmouth buffalo | - | - | 12(1) | 11(<1) | - |
| Carp | - | - | 16(2) | - | - |
| Total | 4,106 | 23,364 | 1,006 | 3,188 | 885 |

Table 19.—Species composition by weight for sport-fishermen catch by site groupings on the Mountain Fork River, 1 August 1970 through 31 July 1971 (Number in parenthesis refers to the relative percent species harvest for site groupings)

| Species | Sites 1-5 | Site 6 | Site 7 | Sites 8-11 | Sites 12-14 |
|---|---|---|---|---|---|
| Largemouth bass | 905.4(58) | 1,389.8(36) | 67.1(21) | 140.2(30) | 34.5(22) |
| Smallmouth bass | 149.7(10) | 98.9(3) | - | 15.0(3) | 6.8(4) |
| Spotted bass | 13.2(<1) | 152.4(4) | 0.5(<1) | 3.6(1) | - |
| White crappie | - | 14.1(<1) | 10.0(3) | 9.1(2) | 63.5(42) |
| Black crappie | 2.3(<1) | 7.7(<1) | 3.2(1) | 5.0(1) | 33.6(21) |
| Bluegill | 5.9(<1) | 19.1(1) | 8.6(3) | 37.2(8) | 1.4(1) |
| Longear sunfish | 54.4(4) | 1,438.3(38) | 9.5(3) | 147.4(32) | 1.8(1) |
| Green sunfish | 52.6(3) | 196.4(5) | 10.0(3) | 31.8(7) | 4.1(3) |
| Warmouth | - | 1.4(<1) | - | - | - |
| Flathead catfish | 245.4(16) | 285.3(7) | 30.4(9) | 6.8(2) | - |
| Channel catfish | 122.5(8) | 69.9(2) | 82.1(25) | 30.8(7) | 11.3(7) |
| Black bullhead | 10.9(1) | 156.5(4) | 29.9(9) | 6.8(2) | - |
| Yellow bullhead | - | 0.9(<1) | - | - | - |
| Redhorse Spp | - | - | 6.8(2) | 6.8(2) | - |
| Spotted sucker | - | 2.3(<1) | - | - | - |
| Smallmouth buffalo | - | - | 30.4(9) | 28.1(6) | - |
| Carp | - | - | 38.1(12) | - | - |
| Total | 1,562.2 | 3,832.8 | 326.6 | 468.6 | 156.9 |

Table 20.—Average weight of species harvested by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 1-5 | Site 6 | Site 7 | Sites 8-11 | Sites 12-14 |
|---|---|---|---|---|---|
| Largemouth bass | 0.345 | 0.195 | 0.310 | 0.252 | 0.283 |
| Smallmouth bass | 0.665 | 0.654 | - | 0.246 | 0.227 |
| Spotted bass | 0.155 | 0.182 | 0.182 | 0.246 | - |
| White crappie | - | 0.250 | 0.152 | 0.286 | 0.160 |
| Black crappie | 0.277 | 0.148 | 0.246 | 0.172 | 0.153 |
| Bluegill | 0.119 | 0.142 | 0.098 | 0.096 | 0.136 |
| Longear sunfish | 0.083 | 0.122 | 0.073 | 0.089 | 0.076 |
| Green sunfish | 0.175 | 0.119 | 0.123 | 0.097 | 0.125 |
| Warmouth | - | 0.119 | - | - | - |
| Flathead catfish | 2.043 | 0.749 | 1.406 | 0.513 | - |
| Channel catfish | 1.800 | 0.512 | 0.890 | 0.479 | 0.231 |
| Black bullhead | 0.259 | 0.146 | 0.118 | 0.453 | - |
| Yellow bullhead | - | 0.272 | - | - | - |
| Redhorse Spp | - | - | 0.635 | 0.290 | - |
| Spotted sucker | - | 0.816 | - | - | - |
| Smallmouth buffalo | - | - | 2.456 | 2.676 | - |
| Carp | - | - | 2.381 | - | - |
| Overall | 0.380 | 0.167 | 0.325 | 0.147 | 0.177 |

due to the small number of observations (Table 21). Average weights of the smallmouth bass appearing in the catch at sites 1-5 and site 6 were not significantly different (P = 0.319, df = 9).

CRT's of 2.30 fish/hr and 0.386 kg/hr at site 6 were higher than at any other site or group of sites. Fishermen rates of harvest at sites 1-5 were 0.675 fish/hr and 0.257 kg/hr (Tables 22 and 23). Differences in CRT's between these site groupings were 1.625 fish/hr and 0.129 kg/hr, but only the difference in CRN's was significant (P = 0.01, df = 685). In comparing species CRN's between sites 1-5 and site 6, only smallmouth bass were caught at a higher rate, 0.037 fish/hr at sites 1-5 compared with 0.015 fish/hr at site 6, while CRN's for the remaining 9 species were greater at site 6 (Table 22). CRW's of large-mouth bass, smallmouth bass, flathead catfish,and channel catfish was greater at sites 1-5 (Table 23) than at site 6.

Comparison of Sites 1-5 With Sites 8-11

Site groupings 1-5 and 8-11 were compared because they offer the best comparison between similar river habitat above and below the reservoir. Both site groupings are located in mountainous habitat but sites 8-11 are influenced by water releases during periods of power generation.

Number of man-days was 3,558 and number of hours fishing was 8,875 at sites 8-11 which was greater than 3,061 man-days and 6,035 hours at sites 1-5; however, neither difference was significant (trips, P = 0.127; and hours, P = 0.061; with 321 df). Trip length (Table 24) of anglers at sites 8-11 (2.494 hrs/trip) was not significantly greater than at sites 1-5 (1.988 hrs/trip) at P = 0.091, df = 321. The difference

Table 21.—Comparison of average weight of species at sites 1-5 and site 6 above Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 1-5 | Site 6 | Difference | Probability | df |
|---|---|---|---|---|---|
| Largemouth bass | 0.354 | 0.195 | 0.159 | $P < 0.001$ | 243 |
| Smallmouth bass | 0.656 | 0.654 | 0.002 | $P > 0.50$ | 9 |
| Spotted bass | 0.155 | 0.182 | 0.027 | $P = 0.009$ | 95 |
| Black crappie | 0.227 | 0.143 | 0.084 | $P > 0.50$ | 2 |
| Bluegill | 0.119 | 0.142 | 0.023 | $P > 0.50$ | 1 |
| Longear sunfish | 0.083 | 0.122 | 0.039 | $P < 0.001$ | 176 |
| Green sunfish | 0.175 | 0.119 | 0.056 | $P < 0.001$ | 50 |
| Flathead catfish | 2.043 | 0.749 | 1.294 | $P < 0.001$ | 21 |
| Channel catfish | 1.800 | 0.512 | 1.288 | $P < 0.001$ | 11 |
| Black bullhead | 0.261 | 0.146 | 0.115 | $P > 0.50$ | 2 |
| Average weight | 0.380 | 0.167 | 0.231 | $P = 0.004$ | 503 |

Table 22.—Catch per unit of effort in fish/hour by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 1-5 | Site 6 | Site 7 | Sites 8-11 | Sites 12-14 |
|---|---|---|---|---|---|
| Largemouth bass | 0.420 | 0.698 | 0.031 | 0.066 | 0.057 |
| Smallmouth bass | 0.037 | 0.015 | - | 0.007 | 0.015 |
| Spotted bass | 0.014 | 0.082 | 0.001 | 0.002 | - |
| White crappie | - | 0.006 | 0.009 | 0.004 | 0.186 |
| Black crappie | 0.002 | 0.005 | 0.002 | 0.003 | 0.103 |
| Bluegill | 0.008 | 0.013 | 0.012 | 0.043 | 0.005 |
| Longear sunfish | 0.107 | 1.157 | 0.019 | 0.186 | 0.011 |
| Green sunfish | 0.049 | 0.162 | 0.012 | 0.037 | 0.015 |
| Warmouth | - | 0.001 | - | - | - |
| Flathead catfish | 0.020 | 0.037 | 0.003 | 0.001 | - |
| Channel catfish | 0.011 | 0.013 | 0.013 | 0.007 | 0.023 |
| Black bullhead | 0.007 | 0.106 | 0.035 | 0.002 | - |
| Yellow bullhead | - | <0.001 | - | - | - |
| Redhorse Spp | - | - | 0.002 | 0.003 | - |
| Spotted sucker | - | 0.001 | - | - | - |
| Smallmouth buffalo | - | - | 0.002 | 0.001 | - |
| Carp | - | - | 0.002 | - | - |
| Overall | 0.675 | 2.300 | 0.142 | 0.359 | 0.414 |

Table 23.—Catch per unit of effort in kg/hour by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 1-5 | Site 6 | Site 7 | Sites 8-11 | Sites 12-14 |
|---|---|---|---|---|---|
| Largemouth bass | 0.149 | 0.137 | 0.010 | 0.016 | 0.016 |
| Smallmouth bass | 0.024 | 0.010 | - | 0.002 | 0.003 |
| Spotted bass | 0.002 | 0.015 | <0.001 | 0.001 | - |
| White crappie | - | 0.001 | 0.001 | 0.001 | 0.030 |
| Black crappie | 0.001 | 0.001 | 0.001 | 0.001 | 0.016 |
| Bluegill | 0.001 | 0.002 | 0.001 | 0.004 | 0.001 |
| Longear sunfish | 0.009 | 0.142 | 0.001 | 0.017 | 0.001 |
| Green sunfish | 0.009 | 0.020 | 0.001 | 0.004 | 0.002 |
| Warmouth | - | <0.001 | - | - | - |
| Flathead catfish | 0.040 | 0.028 | 0.004 | 0.001 | - |
| Channel catfish | 0.020 | 0.007 | 0.011 | 0.004 | 0.005 |
| Black bullhead | 0.002 | 0.015 | 0.004 | 0.001 | - |
| Yellow bullhead | - | <0.001 | - | - | - |
| Redhorse Spp | - | - | 0.001 | 0.001 | - |
| Spotted sucker | - | <0.001 | - | - | - |
| Smallmouth buffalo | - | - | 0.004 | 0.003 | - |
| Carp | - | - | 0.005 | - | - |
| Overall | 0.257 | 0.386 | 0.046 | 0.053 | 0.073 |

Table 24.—Man-days use and harvest by site grouping above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1972 (Number in parenthesis is the percent contribution of each site grouping to total river)

| | Above | | Below | | | Total River |
|---|---|---|---|---|---|---|
| | Sites 1-5 | Site 6 | Site 7 | Sites 8-11 | Sites 12-14 | |
| River distance (km) | 37.24 | 1.74 | 4.02 | 12.26 | 15.85 | 72.23 |
| Total fishermen | 3,061(18.6) | 5,342(32.4) | 3,561(21.6) | 3,558(21.6) | 963(5.8) | 16,485 |
| Total hours fished | 6,085(17.7) | 10,175(29.6) | 7,112(20.7) | 8,875(25.8) | 2,137(6.2) | 34,386 |
| Trip length | 1.988 | 1.905 | 2.000 | 2.494 | 2.222 | 2.086 |
| Total number of fish | 4,106(12.6) | 23,408(71.9) | 1,006(3.1) | 3,188(9.8) | 885(2.7) | 32,549 |
| Total weight (kg) of fish | 1,561.3(24.6) | 3,922.6(61.8) | 327.0(5.2) | 468.1(7.4) | 156.9(2.5) | 6,346.6 |
| Average weight | 0.380 | 0.167 | 0.325 | 0.147 | 0.177 | 0.195 |
| Fish/hour | 0.675 | 2.300 | 0.141 | 0.359 | 0.414 | 0.949 |
| Kg/hour | 0.257 | 0.386 | 0.046 | 0.053 | 0.073 | 0.186 |
| % successful fishermen | 28.1 | 62.5 | 21.7 | 25.2 | 27.9 | 37.2 |

in hrs/trip between these two site groupings is probably due to the well developed facilities at sites 8-11 which encourage longer outings.

Although man-days use was greater at sites 8-11, fishermen harvest at sites 1-5 was greater. Fishermen at sites 1-5 harvested 4,106 fish weighing 1,561 kg compared to 3,188 fish weighing 468 kg at sites 8-11 (Table 24). Comparison of harvest between these two site groupings showed that the differences in number and weight of fish harvested was not significant ($P > 0.50$, 321 df for number of fish and $P = 0.095$, 321 df for weight of fish).

Differences in total harvest, by number (98 more fish/species at sites 1-5) and by weight (113.77 more kg/species at sites 1-5) of the species composing the catch, between sites 1-5 and sites 8-11 were significant for number and not significant for weight ($\chi^2 = 3,046$, $P < 0.001$, df = 9 for number and $t = 1.284$, $P = 0.220$, df = 18 for weight). The two principle species in the catch at sites 1-5 were by number, largemouth bass and longear sunfish and by weight, largemouth bass and flathead catfish. Both in number and weight, the two principle species in the catch at sites 8-11 were longear sunfish and largemouth bass (Tables 18 and 19).

Relative rank of species abundance between sites 1-5 and sites 8-11 was tested by using Kendall's coefficient of concordance. Relative rank in both number and weight between these two sections of the river was significantly different ($P = 0.05$, df = 10, $\tau = 0.345$).

Average weight of fish caught at sites 1-5 was 0.380 kg compared with 0.147 kg at sites 8-11 (Table 20). The difference of 0.233 kg/fish was significant ($P = 0.002$, 321 df). Comparison of the average weights

of the species occurring at both site groups showed significant differences only for smallmouth bass and channel catfish (Table 25).

For fish that occurred in the creel at both site groupings, catch for sites 1-5 was 0.675 fish/hr compared with 0.359 fish/hr at sites 8-11. The difference of 0.316 fish/hr was not statistically significant (Table 26). The CRW of 0.257 at sites 1-5 for all species occuring in the creel was significantly greater than the 0.051 kg/hr at sites 8-11 (Table 27). Individual species CRT's were greater at sites 1-5 than at sites 8-11 for 7 of the 10 species (Tables 26 and 27). CRN's for largemouth bass, green sunfish, and flathead catfish were significantly ($P < 0.05$) greater at sites 1-5 (Table 26).

Comparison of Sites 8-11 With Sites 12-14

Sites 8-11 and sites 12-14 are located in different habitats below Broken Bow Reservoir. They were compared because both site groupings are influenced by cool water discharges during periods of electrical production.

Ue at sites 8-11 was 3,558 man-days and 8,875 hours fished. Sites 12-14 had 963 man-days and 2,137 hours fished (Table 24). The difference in visitations of 2,595 trips and 5,738 hours fished between these site groupings was significant ($P < 0.001$, with 259 df). Accessibility to sites 12-14 was the probable major causal factor for the differences. Access to sites 9, 13, and 14 was restricted to logging roads and unmarked section roads while sites 8 and 10 had well designated points of access. The difference in trip length of 0.272 hrs/trip between sites 8-11 (2.494) and sites 12-14 (2.222) was not statistically significant ($P > 0.50$, df = 25).

Table 25.—Comparison of average weight of species at sites 1-5 with sites 8-11, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 1-5 | Sites 8-11 | Difference | Probability | df |
|---|---|---|---|---|---|
| Largemouth bass | 0.354 | 0.252 | 0.102 | P > 0.50 | 44 |
| Smallmouth bass | 0.656 | 0.246 | 0.410 | P = 0.013 | 9 |
| Spotted bass | 0.155 | 0.246 | 0.091 | P > 0.50 | 4 |
| Black crappie | 0.277 | 0.172 | 0.105 | P > 0.50 | 2 |
| Bluegill sunfish | 0.119 | 0.096 | 0.023 | P > 0.50 | 15 |
| Longear sunfish | 0.083 | 0.089 | 0.006 | P > 0.50 | 27 |
| Green sunfish | 0.175 | 0.097 | 0.078 | P > 0.50 | 20 |
| Flathead catfish | 2.043 | 0.513 | 1.530 | P > 0.50 | 5 |
| Channel catfish | 1.800 | 0.479 | 1.321 | P = 0.001 | 12 |
| Black bullhead | 0.261 | 0.453 | 0.192 | -[a] | -[a] |
| Overall | 0.380 | 0.147 | 0.233 | P = 0.002 | 321 |

[a]Insufficient number to test.

Table 26.—Comparison of catch rates in number/hour by species for sites 1-5 with sites 8-11, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 1-5 | Sites 8-11 | Difference | Probability | df |
|---|---|---|---|---|---|
| Largemouth bass | 0.420 | 0.066 | 0.354 | P = 0.004 | 270 |
| Smallmouth bass | 0.037 | 0.007 | 0.030 | P = 0.100 | 235 |
| Spotted bass | 0.014 | 0.002 | 0.012 | P > 0.50 | 230 |
| Black crappie | 0.002 | 0.003 | 0.001 | P > 0.50 | 224 |
| Bluegill | 0.008 | 0.043 | 0.035 | P = 0.075 | 241 |
| Longear sunfish | 0.107 | 0.816 | 0.079 | P = 0.293 | 253 |
| Green sunfish | 0.049 | 0.037 | 0.012 | P = 0.031 | 246 |
| Flathead catfish | 0.020 | 0.001 | 0.019 | P = 0.028 | 231 |
| Channel catfish | 0.011 | 0.007 | 0.004 | P > 0.50 | 233 |
| Black bullhead | 0.007 | 0.002 | 0.005 | -[a] | -[a] |
| Overall | 0.675 | 0.359 | 0.316 | P = 0.278 | 314 |

[a]Insufficient sample size to test.

Table 27.—Comparison of catch rates in kg/hour by species at sites 1-5 with sites 8-11, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 1-5 | Sites 8-11 | Difference | Probability | df |
|---|---|---|---|---|---|
| Largemouth bass | 0.149 | 0.016 | 0.133 | P = 0.003 | 270 |
| Smallmouth bass | 0.024 | 0.002 | 0.022 | P = 0.093 | 235 |
| Spotted bass | 0.002 | 0.001 | 0.001 | P > 0.50 | 230 |
| Black crappie | 0.001 | 0.001 | 0.000 | P > 0.50 | 224 |
| Bluegill | 0.001 | 0.004 | 0.001 | P > 0.50 | 241 |
| Longear sunfish | 0.009 | 0.017 | 0.008 | P = 0.164 | 253 |
| Green sunfish | 0.009 | 0.004 | 0.005 | P = 0.197 | 246 |
| Flathead catfish | 0.040 | 0.001 | 0.039 | P > 0.50 | 231 |
| Channel catfish | 0.020 | 0.004 | 0.016 | P > 0.50 | 233 |
| Black bullhead | 0.002 | 0.001 | 0.001 | [a] | [a] |
| Overall | 0.257 | 0.051 | 0.206 | P = 0.042 | 314 |

[a]Insufficient sample size to test.

The two principle species in the catch, by number and weight, at sites 8-11 were longear sunfish and largemouth bass. At sites 12-14, the principle species were white crappie, black crappie, and largemouth in number and weight (Tables 18 and 19). Comparing total harvest by species for the two site groupings showed that the mean difference of 279 more fish/species at sites 8-11 was significant ($\chi^2$ = 3462, $P < 0.001$, df = 9) and the mean difference of 32.44 more kg/species at sites 8-11 was not significant ($t = 1.482$, $P = 0.167$, df = 14). Relative rank of species harvested between sites 8-11 and sites 12-14 was significantly different ($P = 0.05$, with 8 df) using Kendall's correlation of concordance for both number ($\tau = 0.134$) and weight ($\tau = 0.264$).

Although average weight of fish caught (0.177 kg) at sites 12-14 was greater than the average weight (0.147 kg) at sites 8-11, the difference of 0.030 kg/fish was not significant ($P > 0.50$, df = 259, Table 28). In comparing the average weight of individual species for the 8 species appearing in both site groupings, only largemouth bass, bluegill, and green sunfish were of greater average size at sites 12-14 (Table 20).

CRT's were low for both site groupings (Tables 22 and 23). Fishermen in the Gulf Coastal Plains region (sites 12-14) had higher CRT's (0.414 fish/hr and 0.073 kg/hr) compared to fishermen in the mountainous region (0.359 fish/hr and 0.053 kg/hr). Differences in CRT's between these two habitats, 0.055 fish/hr and 0.020 kg/hr, were not statistically significant ($P$ 0.50, df = 259). Individual differences in species catch rates (Tables 29 and 30) were not significant. Fishermen at sites 8-11 caught longear sunfish at much higher CRT's than at sites

Table 28.—Comparison of average weight of species at sites 8-11 with sites 12-14, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 8-11 | Sites 12-14 | Difference | Probability | df |
|---|---|---|---|---|---|
| Largemouth bass | 0.252 | 0.283 | 0.031 | P >0.50 | 32 |
| Smallmouth bass | 0.246 | 0.227 | 0.019 | P >0.50 | 4 |
| White crappie | 0.286 | 0.160 | 0.126 | P >0.50 | 6 |
| Black crappie | 0.172 | 0.153 | 0.019 | P >0.50 | 5 |
| Bluegill sunfish | 0.096 | 0.136 | 0.040 | P >0.50 | 14 |
| Longear sunfish | 0.089 | 0.076 | 0.013 | P >0.50 | 23 |
| Green sunfish | 0.097 | 0.125 | 0.028 | P >0.50 | 16 |
| Channel catfish | 0.479 | 0.231 | 0.248 | P >0.50 | 4 |
| Overall | 0.147 | 0.177 | 0.030 | P >0.50 | 259 |

Table 29.—Comparison of catch rates in fish/hour by species for sites 8-11 with sites 12-14, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 8-11 | Sites 12-14 | Difference | Probability | df |
|---|---|---|---|---|---|
| Largemouth bass | 0.066 | 0.057 | 0.009 | $P > 0.50$ | 32 |
| Smallmouth bass | 0.007 | 0.015 | 0.008 | $P > 0.50$ | 4 |
| White crappie | 0.004 | 0.186 | 0.182 | $P > 0.50$ | 6 |
| Black crappie | 0.003 | 0.103 | 0.100 | $P > 0.50$ | 5 |
| Bluegill | 0.043 | 0.005 | 0.038 | $P > 0.50$ | 14 |
| Longear sunfish | 0.186 | 0.011 | 0.175 | $P = 0.44$ | 23 |
| Green sunfish | 0.037 | 0.015 | 0.032 | $P > 0.50$ | 16 |
| Channel catfish | 0.007 | 0.023 | 0.016 | $P > 0.50$ | 4 |
| Overall | 0.359 | 0.414 | 0.055 | $P > 0.50$ | 259 |

Table 30.—Comparison of catch rates in kg/hour by species for sites 8-11 with sites 12-14, Mountain Fork River, 1 August 1970 through 31 July 1971

| Species | Sites 8-11 | Sites 12-14 | Difference | Probability | df |
|---|---|---|---|---|---|
| Largemouth bass | 0.016 | 0.016 | 0.000 | $P > 0.50$ | 32 |
| Smallmouth bass | 0.002 | 0.003 | 0.001 | $P > 0.50$ | 4 |
| White crappie | 0.001 | 0.030 | 0.029 | $P > 0.50$ | 6 |
| Black crappie | 0.001 | 0.016 | 0.015 | $P > 0.50$ | 5 |
| Bluegill | 0.004 | 0.001 | 0.003 | $P > 0.50$ | 14 |
| Longear sunfish | 0.017 | 0.001 | 0.016 | $P = 0.38$ | 23 |
| Green sunfish | 0.003 | 0.002 | 0.001 | $P > 0.50$ | 16 |
| Channel catfish | 0.004 | 0.001 | 0.003 | $P > 0.50$ | 4 |
| Overall | 0.053 | 0.073 | 0.020 | $P > 0.50$ | 259 |

12-14, while the latter had much higher CRT's for black and white crappie.

## Comparison of All Site Groupings

Evaluation of the effects of Broken Bow Reservoir on use and harvest above and below the impoundment was made by comparing site groupings.

Fishermen at sites 1-5 accounted for 19% and 18% of the man-days and hours fished, respectively. They also accounted for 12.6% of the total number of the fish caught and 25% of the total weight of fish harvested on the river.

Site 6 had the highest use and harvest of any site grouping on the river (Table 14). This site received 32% of the man-days and 30% of the hours fished while accounting for 72% of the total number and 60% of the total weight of fish harvested on the river.

Although site 7 received 22% and 21% of the total use and hours fished, only 3% of the harvest in number and 5% of the harvest by weight were taken here. The heavy use of site 7 is probably due to the excellent facilities available to campers.

Sites 8-11, which represent the mountainous habitat below the reservoir, received 22% and 26% of the man-days use and hours fished, respectively, while accounting for 10% and 8% of the fish harvested in number and weight, respectively.

Sites 12-14, located in the Gulf Coastal Plains habitat, received 6% of the man-days use and 6% of the hours fished and 3% of the harvest in both number and weight, respectively.

Species composition by number was different for all site groupings

with the exception of sites 1-5 and site 6 in which largemouth bass and longear sunfish made up 78% and 80% of the catch for these two site groupings, respectively. Principle species in the harvest at site 7 were black bullhead, largemouth bass, and longear sunfish representing 60% of all fish harvested at the site. Harvest from the mountainous habitat below the reservoir (sites 8-11) was dominated by longear sunfish, largemouth bass, bluegill, and green sunfish (92%). Harvest from sites 12-14, the Gulf Coastal Plains habitat, was entirely different from any other site grouping. White and black crappie and largemouth bass represented 84% of the harvest at these sites (Table 18).

Seventy-four percent of the weight of all species caught at sites 1-5 was contributed by largemouth bass and flathead catfish (Table 19). At site 6, 74% of the total weight of the catch was longear sunfish and largemouth bass. The two dominant species by weight at site 7 were channel catfish (25%) and largemouth bass (21%). Sixty-two percent of the weight harvested at sites 8-11 was longear sunfish and largemouth bass. Species composition at sites 12-14 in the Gulf Coastal Plains habitat was dominated by white crappie, largemouth bass and black crappie which made up 85% of the weight of fish harvested.

The site grouping with the highest average weight of fish in the creel was sites 1-5 where the average weight was 0.380 kg. Despite the large total weight of fish caught at site 6, average weight was only 0.167 kg. Average weight of fish caught at site 7 was 0.325, second highest of any site grouping. Sites 8-11 exhibited the lowest average weight of any site grouping (0.147 kg). The large number of longear sunfish and bluegill caught at sites 8-11 lowered average fish weight.

At sites 12-14, located in the Gulf Coastal Plains portion of the river, average fish weight was 0.177 kg (Table 20).

CRT's at site 6 were 2.300 fish/hr and 0.386 kg/hr. Sites 1-5 had CRT's of 0.675 and 0.257 in number and weight per hour and was second to site 6 in these parameters. Site 7 exhibited the lowest CRT's for the entire river (0.141 fish/hr and 0.046 kg/hr). In the mountainous habitat below the reservoir, sites 8-11 had CRT's of 0.359 fish/hr and 0.053 kg/hr. Fishermen at sites 12-14 had the third highest CRT's with anglers in this portion of the river catching 0.414 fish/hr and 0.073 kg/hr (Tables 22 and 23).

## Harvest by Species

Species composition of fishes captured by sport-fishermen are tabulated and comparisons made of the composition from comparable site groupings from the above and below portions of the river. To obtain an additional perspective on possible effects of the reservoir on the fish population of the river, the percentage composition of the catch in the creel is compared with collections made by Finnell et al. (1956). The latter's survey of the Little River drainage system during June and July of 1955 preceded impoundment. In their study, fish populations were sampled by gillnet, rotenone, seining, and hook-and-line. Finnell et al. (1956) estimated standing crop and relative abundance of game, pan, rough, and forage fishes for the Mountain Fork River which they divided into three principal sections: an upper section which is equivalent to the above area in this study, a middle section that consists of that part of the original streambed inundated by the Broken Bow Reservoir plus the remaining river to site 8, and a lower section which

corresponds to the remaining river from site 8 to its confluence with Little River. This comparison assumes that creel surveys reflect the relative abundance of at least those members of the population susceptible to angling. Comparison with the preimpoundment study assumed that species composition and standing crop of game species in the Mountain Fork River would not have changed appreciably if the reservoir had not been constructed.

Largemouth Bass

Largemouth bass was the second most abundant species in the creel. A total of 10,556 largemouth bass weighing 2,537 kg were caught of which 9,660 (92%) in number and 2,295 kg (90%) were harvested above (Table 31). A major contribution to above harvest was the catch at site 6 which accounted for 7,104 (74%) in number and 1,390 kg (61%) of all largemouth bass caught above.

Largemouth bass composed a substantial percentage of the species composition in number and weight for each site grouping (Tables 18 and 19). Finnell et al. (1956) found an increase in abundance of largemouth bass in the lower section of the river and regarded it as the dominant game fish in the lower river. Findings in the present study show a decrease in relative contribution of largemouth bass to the creel, in number and weight, going downstream (Table 32). Average weight of largemouth bass did not decline progressively going downstream. The low average weight of largemouth bass from site 6 was apparently due to migration of fish from the reservoir. Average weight of bass from all site groupings below the reservoir were smaller than average weight of

Table 31.—Annual harvest of six species of fishes in number and weight (kg) by site above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971

| | Largemouth bass | | Smallmouth bass | | Spotted bass | | White crappie | | Black crappie | | Bluegill | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | No | kg | No | kg | No | kg | No | kg | No | kg | No | kg |
| 1 | 1,033 | 396.0 | 110 | 61.9 | | | | | | | | |
| 2 | 1,259 | 427.8 | 74 | 61.9 | | | | | | | | |
| 3 | | | 10 | 3.6 | 44 | 5.0 | | | | | | |
| 4 | 77 | 14.5 | 10 | 9.1 | | | | | | | | |
| 5 | 187 | 67.1 | 21 | 13.2 | 40 | 8.2 | | | 10 | 2.3 | 50 | 5.9 |
| 6 | 7,104 | 1,389.8 | 151 | 98.9 | 835 | 152.4 | 57 | 14.1 | 49 | 7.7 | 134 | 19.1 |
| 7 | 217 | 67.1 | | | 4 | 0.5 | 65 | 10.0 | 13 | 3.2 | 87 | 8.6 |
| 8 | | | | | | | | | | | | |
| 9 | | | 40 | 9.1 | | | | | | | | |
| 10 | 558 | 140.2 | 21 | 5.9 | 16 | 3.6 | 32 | 9.1 | 29 | 5.0 | 384 | 37.2 |
| 11 | | | | | | | | | | | | |
| 12 | 110 | 27.7 | 31 | 6.8 | | | 192 | 32.2 | 220 | 33.6 | 10 | 1.4 |
| 13 | 11 | 6.8 | | | | | 206 | 31.3 | | | | |
| 14 | | | | | | | | | | | | |
| Total Above | 9,660 | 2,295.2 | 376 | 248.6 | 919 | 165.6 | 57 | 14.1 | 59 | 10.0 | 184 | 25.0 |
| Total Below | 896 | 241.8 | 92 | 21.8 | 20 | 4.1 | 495 | 82.6 | 262 | 41.8 | 481 | 47.2 |
| Grand Total | 10,556 | 2,537.0 | 468 | 270.4 | 939 | 169.7 | 552 | 96.7 | 321 | 51.8 | 665 | 72.2 |

Table 32.—Summary of catch statistics for largemouth bass by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| | | | ABOVE | | |
| 1-5 | 62 | 58 | 0.345 | 0.420 | 0.149 |
| 6 | 30 | 36 | 0.195 | 0.698 | 0.137 |
| | | | BELOW | | |
| 8-11 | 18 | 30 | 0.252 | 0.066 | 0.016 |
| 12-14 | 14 | 22 | 0.283 | 0.057 | 0.016 |

[a]Percentage of the total catch/site group contributed by largemouth bass.

bass from sites 1-5. In all cases, fishermen above exhibited much higher CRT's for largemouth bass than did fishermen below (Table 32).

Smallmouth Bass

Smallmouth bass ranked 9th in number caught (468 fish) and 6th in weight caught (270 kg). The above sites accounted for 80% (376) of the total number of smallmouth bass caught and 92% (248 kg) of the total weight of smallmouth bass caught (Tables 18 and 19). Smallmouth bass were caught at all above sites but at only three below sites (Table 31).

Finnel et al. (1956) reported that smallmouth bass were more abundant in the upper regions of the river and decreased in abundance with increasing distance downstream. Observations from this study corroborate his findings. Average weight of smallmouth bass decreased progressively by site grouping going downstream (Table 33). Based on the insignificant difference in average weight ($P > 0.50$, $df = 9$) between values observed at sites 1-5 and site 6, it is concluded that the bass harvested at site 6 were not reservoir fish. In all cases, fishermen above exhibited higher CRT's than did fishermen below with fishermen from sites 1-5 recording CRT's of from 2.5 to 12 times greater harvest rates than fishermen from other site groupings (Table 33).

Spotted Bass

Fishermen at the above site groupings accounted for 98% of both total number (919) and total weight (166 kg) of the 939 spotted bass weighing 170 kg harvested during the study (Tables 18 and 19). Spotted bass ranked 5th in number and 8th in weight in relation to the other species harvested on the Mountain Fork River. Fishermen above caught

Table 33.—Summary of catch statistics for smallmouth bass by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 6 | 10 | 0.665 | 0.037 | 0.024 |
| 6 | 1 | 3 | 0.654 | 0.015 | 0.010 |
| 8-11 | 2 | 3 | 0.246 | 0.007 | 0.002 |
| 12-14 | 4 | 4 | 0.227 | 0.015 | 0.003 |

[a]Percentage of the total catch/site groups contributed by smallmouth bass.

more spotted bass than fishermen below. Spotted bass harvest from sites 1-5 alone accounted for 4 times the number and 3 times the weight of the catch of spotted bass from the below site groupings.

The distribution of the catch of spotted bass was different from the expected distribution as Finnell et al. (1956) reported spotted bass more abundant in the lower region of the river. Several facts suggest that the upstream harvest of spotted bass was influenced by reservoir fish, and the poor downstream catch might have resulted from the impact of discharge from electrical generation. Catch at site 6, the first site upstream from the reservoir, contributed 91% (835) of the number and 92% (152 kg) of the weight of all spotted bass caught and the average weight of spotted bass taken at sites 1-5 was significantly different from the average weight of spotted bass harvested at site 6 (Table 21). As noted by Finnell et al. (1956), the preference of spotted bass for deeper and more stabilized water levels (formerly found in the lower sections of the river) suggests quick adaptation to the reservoir and an apparent inability to similarly adapt to the fluctuating water levels which prevailed below the reservoir. In all cases, fishermen at the above site groupings recorded higher CRT's than fishermen below (Table 34).

Longear Sunfish

Longear sunfish ranked 1st in number and 2nd in weight of the total catch (Table 35). Of 14,238 fish weighing 1,652 kg, the above fishermen harvested 87% (12,426) of the total number of longear sunfish and 90% (1,493 kg) of the total weight for this species. This species was recorded in the creel at five sites both above and below the reservoir.

Finnell et al. (1956) found that longear sunfish were one of the

Table 34.—Summary of catch statistics for spotted bass by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 2 | <1 | 0.155 | 0.014 | 0.002 |
| 6 | 4 | 4 | 0.182 | 0.082 | 0.015 |
| 8-11 | 1 | 1 | 0.246 | 0.002 | 0.001 |
| 12-14 | 0 | 0 | 0 | 0 | 0 |

[a]Percentage of the total catch/site group contributed by spotted bass.

Table 35.—Annual harvest of six species of fishes in number and weight (kg) by site above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971

| | Longear sunfish | | Green sunfish | | Warmouth | | Flathead catfish | | Channel catfish | | Black bullhead | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | No | kg | No | kg | No | kg | No | kg | No | kg | No | kg |
| 1 | 21 | 1.8 | | | | | 84 | 195.5 | 21 | 33.6 | | |
| 2 | | | 80 | 20.9 | | | 11 | 19.5 | 33 | 69.8 | | |
| 3 | 506 | 39.5 | 110 | 14.1 | | | 10 | 3.6 | | | | |
| 4 | 61 | 10.0 | 79 | 14.5 | | | | | | | | |
| 5 | 63 | 3.6 | 32 | 3.2 | | | 15 | 26.8 | 14 | 19.1 | 42 | 10.9 |
| 6 | 11,775 | 1,438.3 | 1,648 | 196.4 | 11 | 1.4 | 381 | 285.3 | 136 | 69.9 | 1,075 | 156.5 |
| 7 | 133 | 9.5 | 83 | 10.0 | | | 21 | 30.4 | 92 | 82.1 | 252 | 29.9 |
| 8 | 9 | 1.4 | | | | | | | | | | |
| 9 | 10 | 0.9 | 20 | 2.3 | | | 10 | 5.9 | 52 | 26.8 | | |
| 10 | 1,636 | 145.6 | 311 | 29.5 | | | 3 | 0.9 | 13 | 4.0 | 15 | 6.8 |
| 11 | | | | | | | | | | | | |
| 12 | 24 | 1.8 | 32 | 3.6 | | | | | 5 | 1.3 | | |
| 13 | | | | | | | | | | | | |
| 14 | | | | | | | | | 44 | 10.0 | | |
| Total Above | 12,426 | 1,493.2 | 1,949 | 249.1 | 11 | 1.4 | 501 | 530.7 | 204 | 192.4 | 1,117 | 167.4 |
| Total Below | 1,812 | 159.2 | 446 | 45.4 | 0 | 0 | 34 | 37.2 | 206 | 124.2 | 267 | 36.7 |
| Grand Total | 14,238 | 1,652.4 | 2,395 | 294.5 | 11 | 1.4 | 535 | 567.9 | 410 | 316.6 | 1,384 | 204.1 |

most abundant species in the Mountain Fork River, especially in the portion of the river inundated by the reservoir. Therefore, it is not surprising that catch of longear sunfish at site 6 accounted for 95% of the number and 96% of the weight for longear sunfish from all the above sites and catch at sites 8-11 accounted for 91% of the number and 93% of the weight of the below harvest of this species. Average weights of this species showed no upstream/downstream pattern of change. Fish caught at site 6 were larger than at any other site grouping; however, the difference was not statistically significant. Catch of longear sunfish at site 6 is probably influenced by migrations of larger fish from the reservoir based on the observed average weights at all site groupings (Table 36). The CRN of 1.157 fish/hr at site 6 was the highest recorded for any species, any site grouping (Table 22). Although CRT's were higher at sites 8-11 than at sites 1-5, the differences were not significant (Tables 26 and 27).

Green Sunfish

Green sunfish ranked 3rd in number and 5th in weight of the total catch. Fishermen above caught 81% (1949) of the number and 85% (249 kg) of the 2,395 green sunfish which weighed 294 kg (Table 35).

Finnell et al. (1956) found green sunfish more abundant in the lower reaches of the river; however, in the present study, harvest of green sunfish from sites 12-14 was the lowest of any site grouping (Tables 35 and 37). Based on the facts that green sunfish catch at site 6 represented 69% of the number and 67% of the weight of all green sunfish harvested and the very low catch from the below site groupings, it is felt that the reservoir has influenced the catch of this species

Table 36.—Summary of catch statistics for longear sunfish by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 16 | 4 | 0.083 | 0.107 | 0.009 |
| 6 | 50 | 38 | 0.122 | 1.157 | 0.142 |
| 8-11 | 52 | 32 | 0.089 | 0.186 | 0.017 |
| 12-14 | 3 | 1 | 0.076 | 0.011 | 0.001 |

[a]Percentage of the total catch/site group contributed by longear sunfish.

Table 37.—Summary of catch statistics for green sunfish by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 7 | 3 | 0.175 | 0.049 | 0.009 |
| 6 | 7 | 5 | 0.119 | 0.162 | 0.020 |
| 8-11 | 10 | 7 | 0.097 | 0.037 | 0.004 |
| 12-14 | 4 | 3 | 0.125 | 0.015 | 0.002 |

[a]Percentage of the total catch/site contributed by green sunfish.

both above and below the reservoir. The upstream effect is probably due to migrations from the reservoir and the downstream effect is probably due to the cool, intermittent hydroelectric discharges. The green sunfish that were caught at sites 1-5 had the highest average weight of any site grouping (Table 37). The second highest average weight for this species was recorded at sites 12-14 where, based on general habitat, one would have expected the highest average weight to have been produced. CRT's were highest at site 6 and lowest at sites 12-14 (Table 37). This is again contrary to expected values based on the findings of Finnell et al. (1956).

Bluegill

Bluegill ranked 6th in number and 10th in weight of the total fish harvest on the Mountain Fork River. Fishermen below caught 72% (481) of the number and 65% (47 kg) of the weight of the 665 bluegill weighing 72 kg which were harvested from the entire river (Table 31).

Bluegill contributed a significant percentage of the species composition only at site groupings 7 and 8-11 (Tables 18 and 19). In percentage of the catch from the compared site groupings, bluegill accounted for greater than 1% of the number and weight only at sites 8-11 (Table 38).

Finnell et al. (1956) reported that bluegill were a rare occurrence in the river above the present location of the reservoir. Although no bluegill were reported in the catch at sites 1-4, sites 5 and 6 accounted for 28% by number and 35% by weight of the total catch. In addition, site 6 accounted for 20% and 26% of the number and weight, respectively, of the above contribution to the catch all of which leads to the

Table 38.—Summary of catch statistics for bluegill by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971.

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 1 | <1 | 0.119 | 0.008 | 0.001 |
| 6 | 1 | 1 | 0.142 | 0.013 | 0.002 |
| 8-11 | 12 | 8 | 0.096 | 0.043 | 0.004 |
| 12-14 | 1 | 1 | 0.136 | 0.005 | 0.001 |

[a]Percentage of the total catch/site group contributed by bluegill.

inference that the bluegill found in the above catch were reservoir fish. Average weights at the various site groupings ranged from 0.096 kg (sites 8-11) to 0.142 kg (site 6). No pattern of change occurred for average weights (Table 38) and there were no significant differences in average weights between the various site groupings (Tables 21, 25, and 28). CRT's at all site groupings were low but the CRN at sites 8-11 were approximately 5 times greater than at sites 1-5 and CRW's for these two site groupings showed a similar pattern with the CRW at sites 8-11 being 4 times greater than the CRW at sites 1-5 (Table 38). The observed differences in CRT's were not statistically significant (Tables 26, 27, 29, and 30).

## White and Black Crappie

White crappie ranked 7th and 9th in number and weight, respectively, for the total harvest from the Mountain Fork River. Black crappie were 11th in number and 12th in weight when ranked in the total harvest for all species. Whole river catch of white crappie was 552 fish weighing 97 kg (Table 31). Fishermen at below sites caught 90% (495) of the number and 85% (83 kg) of the weight of the total harvest of white crappie and fishermen at sites 12-14 accounted for 72% and 66% of the total catch of the species in number and weight, respectively. Fishermen below caught 82% (262) and 81% (42 kg) of the total harvest of 321 black crappie weighing 52 kg (Table 31). Black crappie harvest, like white crappie harvest, was concentrated at sites 12-14 where fishermen caught 69% and 65% of the total harvest in number and weight, respectively. White crappie were caught only at site 6 (57 fish) above and black crappie were caught only at sites 5 (10 fish) and 6 (49 fish) above.

Finnel et al. (1956) reported that white and black crappie were found only in the lower reaches of the Mountain Fork River (Gulf Coastal Plains habitat). The observed catch at sites 12-14 was expected; the catch at site 10 was probably due to the creation of favorable crappie habitat in the water impounded behind the reregulation dam and the few fish that were caught at sites 5 and 6 were probably reservoir fish. Although none of the observed differences in white crappie or black crappie average weights were statistically significant (Tables 21, 25, and 28), the lowest observed average weight for white crappie was at sites 12-14 (Table 39). The average weight for black crappie at sites 12-14 was lower than average weights recorded at sites 1-5 and 8-11 (Table 40). Although CRT's at sites 12-14 were much higher than any other site grouping (Tables 39 and 40), the differences were not statistically significant (Tables 26, 27, 29, and 30).

Black Bullhead

In the total catch, black bullhead ranked 4th (1384) in number and 7th (204 kg) in weight. Fishermen above harvested 81% (1117) of the total number and 82% (167 kg) of the total weight with the catch at site 6 representing 78% of the number and 76% of the weight (Table 35).

Black bullhead were described as "rare" by Reeves (1950), although he found this species in both upper and lower regions of the river. Finnell et al. (1956) did not collect black bullhead from the Mountain Fork River. Catch of this species was greatest at sites with a barrier and relatively warm water temperatures (sites 6 and 7, Table 35). Construction of Broken Bow Dam has apparently created at least limited habitat for this species in the reservoir and at site 7. The latter is

Table 39.—Summary of catch statistics for white crappie by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 0 | 0 | 0 | 0 | 0 |
| 6 | <1 | <1 | 0.250 | 0.006 | 0.001 |
| 8-11 | 1 | 2 | 0.286 | 0.004 | 0.001 |
| 12-14 | 45 | 42 | 0.160 | 0.186 | 0.030 |

[a]Percentage of the total catch/site group contributed by white crappie.

Table 40.—Summary of catch statistics for black crappie by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage [a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | <1 | <1 | 0.277 | 0.002 | 0.001 |
| 6 | <1 | <1 | 0.148 | 0.005 | 0.001 |
| 8-11 | 1 | 1 | 0.172 | 0.003 | 0.001 |
| 12-14 | 25 | 21 | 0.153 | 0.103 | 0.016 |

[a]Percentage of total catch/site group contributed by black crappie.

the old bend in the river modified by placement of three low dams creating a series of three pools. Water level at site 7 was maintained by releases from the low flow sluice gate in Broken Bow Dam. Fish taken at sites 8-11 had much higher average weights than the black bullhead caught at sites 1-5 and 6 (Table 41), however, none of the differences were statistically significant. CRT's were highest at site 6 (Table 41).

Flathead Catfish

Although flathead catfish harvest ranked 8th (535) in number, they ranked 3rd (568 kg) in weight of the total harvest (Table 35). Fishermen above caught 94% of both the number (501) and weight (531 kg) of all flathead catfish caught. Harvest of this species by fishermen at site 6 accounted for 71% of the total number and 50% of the total weight.

Average weight of flathead catfish caught at sites 1-5 was much greater than the average weights recorded at sites 6 and 8-11 (no flathead catfish were caught at sites 12-14, Table 42). Average weight of flathead catfish at sites 1-5 was significantly different from average weight at site 6 (Table 21), but average weight at sites 1-5 was not statistically different from average weight at sites 8-11 (Table 25). The fish appearing in the catch at site 6 were considered to be reservoir fish based on the large difference in average weight from other above flathead catfish (Table 42) and on the fact that the timing of the harvest at site 6 coincided with the timing of the harvest of this species directly below site 6 in Broken Bow Reservoir. Although CRT's were much higher at the sites 1-5 compared with the below sites 8-11, only the difference in CRN was significant (Tables 26 and 27).

Table 41.—Summary of catch statistics for black bullhead by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 1 | 1 | 0.259 | 0.007 | 0.002 |
| 6 | 5 | 4 | 0.146 | 0.106 | 0.015 |
| 8-11 | 1 | 2 | 0.453 | 0.002 | 0.001 |
| 12-14 | 0 | 0 | 0 | 0 | 0 |

[a]Percentage of the total catch/site group contributed by black bullhead.

Table 42.—Summary of catch statistics for flathead catfish by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 3 | 16 | 2.043 | 0.020 | 0.040 |
| 6 | 2 | 7 | 0.749 | 0.037 | 0.028 |
| 8-11 | <1 | 2 | 0.513 | 0.001 | 0.001 |
| 12-14 | 0 | 0 | 0 | 0 | 0 |

[a]Percentage of the total catch/site group contributed by flathead catfish.

## Channel Catfish

Channel catfish ranked 10th and 4th in the total catch in number and weight, respectively. The harvest by number was split equally between above (204 fish) and below (206 fish), but the above sites accounted for 61% (192 kg) of the weight harvested (Table 35). Channel catfish occurred in the catch at 9 of the 14 sites sampled (Table 35).

Finnell et al. (1956) reported that channel catfish were found only in the lower river, which is called the Gulf Coastal Plains habitat type. Certain observations suggest that the reservoir has apparently had the effect of extending the range of channel catfish throughout the river above the reservoir. Channel catfish were caught at 4 of the 6 above sites and site 6 accounted for 67% (36% by weight) of the above catch. The much higher average weight recorded at sites 1-5 (Table 43) were found to be significantly different than the average weights recorded at sites 6 (Table 21) and 8-11 (Table 25). The highest CRN was observed at sites 12-14 and the highest CRW was observed at sites 1-5, however, none of the observed differences in CRT's were statistically significant (Tables 26, 27, 29, and 30).

## Other Species

Due to the varied fishing gear used by sport fishermen, catch of redhorse species, spotted sucker and smallmouth buffalo was considered to be incidental (Table 44). Although these species were reported to occur throughout the river by Finnell et al. (1956), no sport fishermen were interviewed that indicated they were actively seeking these species.

Fishermen caught yellow bullhead and warmouth only at site 6. In

Table 43.—Summary of catch statistics for channel catfish by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Site Grouping | Percentage[a] | | Average Weight (kg) | Catch/hour | |
|---|---|---|---|---|---|
| | No. | Weight | | No. | Weight |
| 1-5 | 2 | 8 | 1.800 | 0.011 | 0.020 |
| 6 | 1 | 2 | 0.512 | 0.013 | 0.007 |
| 8-11 | 2 | 7 | 0.479 | 0.007 | 0.004 |
| 12-14 | 6 | 7 | 0.231 | 0.023 | 0.005 |

[a]Percentage of the total catch/site group contributed by channel catfish.

Table 44.—Annual harvest of five species of fishes and total harvest in number and weight (kg) by site above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 through 31 July 1971

| | Yellow Bullhead | | Redhorse Spp | | Spotted sucker | | Smallmouth buffalo | | Carp | | Total Catch | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | No | kg | No | kg | No | kg | No | kg | No | kg | No | kg |
| 1 | | | | | | | | | | | 1,269 | 688.5 |
| 2 | | | | | | | | | | | 1,457 | 599.6 |
| 3 | | | | | | | | | | | 680 | 65.8 |
| 4 | | | | | | | | | | | 227 | 48.1 |
| 5 | | | | | | | | | | | 474 | 159.7 |
| 6 | 4 | 0.9 | | | 3 | 2.3 | | | | | 23,363 | 3,832.8 |
| 7 | | | 11 | 6.8 | | | 12 | 30.4 | 16 | 38.1 | 1,006 | 326.6 |
| 8 | | | | | | | | | | | 9 | 1.4 |
| 9 | | | 21 | 6.4 | | | 11 | 28.1 | | | 161 | 79.4 |
| 10 | | | 2 | 0.5 | | | | | | | 3,020 | 387.8 |
| 11 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | 624 | 108.0 |
| 13 | | | | | | | | | | | 217 | 38.1 |
| 14 | | | | | | | | | | | 44 | 10.0 |
| Total Above | 4 | 0.9 | 0 | 0 | 3 | 2.3 | 0 | 0 | 0 | 0 | 27,470 | 5,394.5 |
| Total Below | 0 | 0 | 34 | 13.6 | 0 | 0 | 23 | 58.5 | 16 | 38.1 | 5,084 | 951.2 |
| Grand Total | 4 | 0.9 | 34 | 13.6 | 3 | 2.3 | 23 | 58.5 | 16 | 38.1 | 32,554 | 6,345.7 |

the pre-impoundment study by Finnell et al. (1956), yellow bullhead were found throughout the river, while warmouth although present in middle sections were most abundant in the Gulf Coastal Plains section of the river.

Fishermen at site 7 (the series of artificial pools) caught 16 carp weighing 38 kg. Prior to this study, carp were not known to occur in the Mountain Fork River.

# CHAPTER V

## COMPARISONS OF MAN-DAYS USE AND HARVEST ABOVE AND BELOW BROKEN BOW RESERVOIR

Man-days use and harvest were compared above and below the reservoir. Quantification of information collected on the Mountain Fork River not only aids in better understanding the influence of impoundment on the river, but also allows the information collected in this study to be compared to other studies. Funk (1970) pointed out the need for use and harvest records for more effective management and evaluation of warm-water streams and rivers.

Use and harvest on streams and rivers have been evaluated based on river length (Elser 1960, and Schmulback 1959) and surface area (Fleener 1971a, 1971b, 1971c; Hanson 1969; Alexander and Shetter 1967; and DiConstanzo 1956). Surface acres of the river above and below the reservoir were calculated by using a mean width of 33.48 m above and a mean width of 68.88 m below. Length of the river allocated each site was calculated using the distance above and below a site from the mid-point between sites. For example, the river length at site 4 of 4.58 km (Table 45) was the sum of distance from the mid-point between site 3 to site 4 (3.7 km) and the distance from site 4 to the mid-point between sites 4 and 5 (0.88 km), therefore, the river length at site 4 = 3.7 km + 0.88 km = 4.58 km. A man-day of use in this study was defined as a

Table 45.—Man-days use and fish harvest above and below Broken Bow Reservoir on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Sites | River Distance (km) | Fishing Pressure/km | | Harvest/km/hr | |
|---|---|---|---|---|---|
| | | Man-days | Hours Fished | Fish | Weight (kg) |
| | | ABOVE | | | |
| 1 | 12.23 | 15.5 | 61.2 | 0.13 | 0.07 |
| 2 | 12.38 | 47.4 | 109.0 | 0.09 | 0.04 |
| 3 | 7.07 | 9.1 | 15.0 | 0.90 | 0.09 |
| 4 | 4.58 | 91.9 | 188.6 | 0.06 | 0.01 |
| 5 | 1.00 | 1,800.0 | 2,971.0 | 0.34 | 0.25 |
| 6 | 1.74 | 3,070.1 | 5,847.7 | 1.32 | 0.22 |
| | | BELOW | | | |
| 7[a] | 4.02 | 885.8 | 1,769.2 | 0.04 | 0.01 |
| 8 | 3.59 | 25.1 | 32.0 | 0.02 | 0.01 |
| 9 | 3.20 | 85.9 | 177.8 | 0.09 | 0.03 |
| 10 | 2.95 | 968.5 | 2,071.2 | 0.17 | 0.02 |
| 11 | 2.51 | 133.9 | 829.5 | 0.00 | 0.00 |
| 12 | 5.60 | 137.9 | 252.9 | 0.01 | 0.01 |
| 13 | 6.55 | 19.1 | 70.1 | 0.07 | 0.01 |
| 14 | 3.70 | 17.8 | 58.9 | 0.05 | 0.01 |
| Above | 38.99 | 215.5 | 417.0 | 0.040 | 0.009 |
| Below | 28.10 | 160.8 | 392.0 | 0.008 | 0.002 |
| Overall | 71.11 | 231.8 | 483.6 | 0.013 | 0.003 |

[a]Due to physical characteristics created after impoundment, data from site 7 were not included in the totals for below portion of the river.

fishing trip regardless of trip length. Therefore, total man-days of use equals total fishermen.

Neither expression of harvest (use/km nor use/ha) are without inherent biases. Both expressions assume that fishermen have access to and fish the entire section of the river included in the distances and that the surface area remains the same throughout investigation. Evaluation of the fishing on the Mountain Fork River on a per km or per ha basis could meet neither of these assumptions since access and movement along the river was restricted, in most cases, to less than 100 m above and below the point of entry by dense vegetation on the river frontage. River width above varied due to natural fluctuations and the river below exhibited daily fluxuations of water levels due to power discharges. Because over 90% of the fishermen interviewed were bank fishermen, long stretches both above and below the reservoir were not easily accessible to fishermen. Although neither method (per km or per ha) yields a true indication of man-days use, harvest and pressure (hours fished) per km estimates were used for comparative purposes because this appeared to have the least bias while still providing data for comparing the Mountain Fork River with other streams and rivers reported in the literature. Fishermen harvest was quantitifed on a fish/km/hr and kg/km/hr basis so that above and below river portions would be placed on a relative basis free from differences in total surface area or river distance.

Site 7 was omitted from comparisons of above and below sections because of physical changes in this site after completion of Broken Bow Reservoir.

Catch above and below the reservoir were first computed on a per

ha and per km basis (Tables 46 and 47), then transformed to a value/ha (or km)/hr for further comparisons (Table 48).

Above sites received 216 man-days/km and 417 hours/km fishing pressure while below received 161 man-days/km and 392 hours/km (Table 47). Fishermen above harvested 0.040 fish/km/hr and 0.009 kg/km/hr while anglers below were harvesting 0.008 fish/km/hr and 0.002 kg/km/hr (Table 48). Harvest above was approximately five times the harvest below.

Although man-days use and harvest above exceeded below, both sections of the river were heavily influenced by a single site; site 6 above and site 10 below (Table 48). Site 6 immediately above the reservoir had good accessibility and formed a partial barrier to fish migrations and accounted for 72% of the annual fish harvest. Site 10 had good parking and picnic facilities in addition to clean camping areas. This site was very similar to site 6 in that upstream fish migrations were hindered and tended to concentrate fish, thus providing fishermen with an excellent area to fish. Because of these inherent biases both above and below river portions were compared by previously described site groupings.

## Comparison of Sites 1-5 with Site 6

Man-days use and harvest at site 6 greatly exceeded any other site or group of sites (Table 48). This site received 3,070 man-days/km and 5,848 fishing hrs/km, while sites 1-5 above received 82 man-days/km and 163 hrs/km. Angler harvest at site 6 was 1.32 fish/km/hr and 0.22 kg/km/hr. Catch at site 6 greatly exceeded the harvest at sites 1-5 of 0.018 fish/km/hr and 0.007 kg/km/hr. Comparatively site 6 received

Table 46.—Annual man-days use and harvest per kilometer and per hactare on the Mountain Fork River, 1 August 1970 through 31 July 1971

| Sites | River Distance (km) | /km | | | | Surface area (ha) | /ha | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Man-days | Hours | Fish | Weight | | Man-days | Hours | Fish | Weight |
| | | | | | ABOVE | | | | | |
| 1 | 12.23 | 15.5 | 61.2 | 103.8 | 56.3 | 37.27 | 5.0 | 20.1 | 34.0 | 18.5 |
| 2 | 12.38 | 47.4 | 109.0 | 117.7 | 48.4 | 37.72 | 15.6 | 35.8 | 38.6 | 15.9 |
| 3 | 7.07 | 9.1 | 15.0 | 96.2 | 9.2 | 21.53 | 3.0 | 4.9 | 31.6 | 3.0 |
| 4 | 4.58 | 91.9 | 188.6 | 49.6 | 10.4 | 13.92 | 30.2 | 60.8 | 16.3 | 3.4 |
| 5 | 1.00 | 1,800.0 | 2,971.0 | 473.0 | 160.1 | 3.04 | 592.1 | 997.3 | 155.6 | 52.7 |
| 6 | 1.74 | 3,070.1 | 5,847.7 | 13,427.6 | 2,202.8 | 5.03 | 1,062.0 | 1,919.8 | 4,408.3 | 723.2 |
| | | | | | BELOW | | | | | |
| 7 | 4.02 | 885.8 | 1,769.2 | 250.2 | 81.3 | 27.60 | 129.0 | 257.7 | 36.4 | 11.8 |
| 8 | 3.59 | 25.1 | 32.0 | 2.5 | 0.4 | 24.60 | 3.7 | 4.7 | 0.4 | 0.1 |
| 9 | 3.20 | 85.9 | 177.8 | 50.9 | 24.7 | 22.06 | 12.5 | 25.8 | 7.4 | 3.6 |
| 10 | 2.95 | 968.5 | 2,071.2 | 1,022.4 | 131.5 | 20.19 | 141.5 | 302.6 | 149.4 | 19.2 |
| 11 | 2.51 | 133.9 | 829.5 | 0.0 | 0.0 | 17.20 | 19.5 | 121.0 | 0.0 | 0.0 |
| 12 | 5.60 | 137.9 | 252.9 | 111.4 | 19.4 | 38.40 | 20.1 | 38.0 | 16.3 | 2.8 |
| 13 | 6.55 | 19.1 | 70.1 | 33.1 | 5.9 | 44.92 | 2.8 | 10.2 | 4.8 | 0.9 |
| 14 | 3.70 | 17.8 | 58.9 | 11.9 | 2.7 | 25.37 | 2.6 | 8.6 | 1.7 | 0.4 |
| Total Above | 33.99 | 215.5 | 417.0 | 704.5 | 138.3 | 118.78 | 70.7 | 136.9 | 231.3 | 45.4 |
| Total Below | 32.12 | 251.6 | 564.3 | 158.1 | 29.7 | 220.34 | 36.7 | 82.3 | 23.1 | 4.3 |
| Total River | 71.11 | 231.8 | 483.6 | 457.7 | 89.2 | 339.12 | 48.6 | 101.4 | 96.0 | 18.7 |

Table 47.—Annual man-days use and harvest per kilometer and per hectare by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| | /km | | | | /ha | | | | Trip |
|---|---|---|---|---|---|---|---|---|---|
| | Man-days | Hours | Fish | Weight (kg) | Man-days | Hours | Fish | Weight | Length |
| Above | 215.5 | 417.0 | 704.5 | 138.3 | 70.7 | 136.9 | 231.3 | 45.4 | 1.94 |
| Below | 251.6 | 564.3 | 158.1 | 29.7 | 36.7 | 82.3 | 23.1 | 4.3 | 2.24 |
| Sites 1-5 | 82.2 | 163.4 | 110.2 | 41.9 | 26.9 | 53.6 | 36.2 | 13.8 | 1.99 |
| Site 6 | 3,070.1 | 5,847.7 | 13,427.6 | 2,202.8 | 1,062.0 | 1,919.8 | 4,408.3 | 723.2 | 1.90 |
| Site 7 | 885.8 | 1,769.2 | 250.2 | 81.3 | 129.0 | 257.7 | 36.4 | 11.8 | 2.00 |
| Sites 8-11 | 290.4 | 724.6 | 260.2 | 38.2 | 42.3 | 105.6 | 37.9 | 5.6 | 2.49 |
| Sites 1-5 | 82.2 | 163.4 | 110.2 | 41.9 | 26.9 | 53.6 | 36.2 | 13.8 | 1.99 |
| Sites 8-11 | 290.4 | 724.6 | 260.2 | 38.2 | 42.3 | 105.6 | 37.9 | 5.6 | 2.49 |
| Sites 8-11 | 290.4 | 724.6 | 260.2 | 38.2 | 42.3 | 105.6 | 37.9 | 5.6 | 2.49 |
| Sites 12-14 | 50.8 | 134.9 | 55.8 | 9.9 | 8.9 | 19.7 | 8.1 | 1.4 | 2.22 |

Table 48.—Man-days use and fish harvest by site grouping on the Mountain Fork River, 1 August 1970 through 31 July 1971

| | Use/km | | Harvest/km/hr | |
|---|---|---|---|---|
| | Man-days | Hours Fished | Number | kg |
| Above (Sites 1-6) | 215.5 | 417.0 | 0.040 | 0.009 |
| Below (Sites 8-14) | 160.8 | 392.0 | 0.008 | 0.002 |
| Sites 1-5 | 82.2 | 163.4 | 0.018 | 0.007 |
| Site 6 | 3,070.1 | 5,847.7 | 1.320 | 0.216 |
| Sites 8-11 | 290.4 | 724.6 | 0.029 | 0.004 |
| Sites 12-14 | 50.8 | 134.9 | 0.026 | 0.005 |

37.3 times more man-days use and 35.8 times more hours fished per km while accounting for 73.7 times and 31.4 times the harvest in number and weight, respectively, on a per km/hr basis than at sites 1-5.

The greater man-days use and harvest per km/hr at site 6 was not unexpected because the river distance used in calculating these estimates at site 6 was only 1.74 km yet this site accounted for 63%, 64%, 82%, and 71% of the total man-days use, hours fished, number of fish and weight of all fish caught above while the distance used in calculating fishermen use and harvest at sites 1-5 was 37.25 km.

### Comparison of Sites 1-5 with Sites 8-11

The best comparison between above and below with the least amount of bias between groups is sites 1-5 above and sites 8-11 below. Fishermen use and rate of harvest in number was greater for sites 8-11 which received 290 man-days use/km and 725 hrs/km (Table 48). In part, the difference of 208 man-days use/km and 561 hrs/km between the above and below site groupings may be attributable to the contrast in availability of camping and picnic facilities at sites 8-11 compared to sites 1-5. In addition to facility development, sites 8-11 were located in the more populous portion of McCurtain County.

Although rate of harvest below the reservoir (sites 8-11) of 0.029 fish/km/hr exceeded that above the reservoir (sites 1-5) of 0.018 fish/km/hr, the latter exceeded the former in weight harvested. Anglers at sites 1-5 harvested 0.007 kg/km/hr while anglers at sites 8-11 harvested 0.004 kg/km/hr. The greater harvest in number at sites 8-11 was influenced by site 10 which accounted for 96% of all fish harvested at sites 8-11 (59% of all fish caught below).

## Comparison of Sites 8-11 with Sites 12-14

There was a large difference in man-days use and harvest between the mountainous habitat (sites 8-11) and the Gulf Coastal Plains habitat (sites 12-14) (Table 48). Sites 8-11 received 290 man-days/km while sites 12-14 received 51 man-days/km. Hours fished at sites 8-11 of 725 hr/km was also greater than the number of hours fished at sites 12-14 of 135 hr/km. However, fishermen harvest between the site groupings was similar. Fishermen at sites 8-11 caught 0.029 fish/km/hr and 0.004 kg/km/hr, while fishermen at sites 12-14 caught 0.026 fish/km/hr and 0.005 kg/km/hr. Comparatively, man-days use and hours fished were approximately five times greater in the below mountainous region than the Gulf Coastal Plains region. The lesser man-days use and hours fished at sites 12-14 is probably due to poor road access and site development in the Gulf Coastal Plains portion.

# CHAPTER VI

## COMPARISON OF THE MOUNTAIN FORK RIVER WITH OTHER WARM-WATER RIVERS

Man-days use and harvest on the Mountain Fork River above and below Broken Bow Reservoir was combined for the purpose of comparison with other studies. Intensive literature search did not yield many previous reports for comparative purposes (Table 49). Rivers used for comparison varied in length from 8.6 km, Huzzard Creek in Missouri, to 220.2 km, Shenandoah River in Kentucky (Table 49).

Comparing rivers of similar length shows that man-days use on the Mountain Fork River of 16,485 trips for 34,386 hours was exceeded only by the Platte River (located near a highly populated area) with an annual use of 37,253 trips for 131,179 hours (Table 49).

Mean angler trip length of 2.06 hrs/trip on the Mountain Fork River was considerably less than that reported for the Current River; Huzzard Creek; Courtois Creek or Platte River (Table 49). Probable cause for a shorter trip length on the Mountain Fork River was due to a high percentage of the use being contributed by local fishermen (fishing briefly and returning home). On the Mountain Fork River, local fishermen comprised more than 60% of the fishermen interviewed. Similarly, a trip length of 2.30 hours was also noted on the Des Moines River, Iowa, where there was heavy participation by local fishermen (Harrison 1960).

Total harvest from the Mountain Fork River was exceeded only by the

Table 49. — Man-days use and harvest of other warm-water tributaries compared to the Mountain Fork River, Oklahoma

| Variable | | Smallmouth Bass Streams and Rivers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mountain Fork River | Courtois Creek Ozarks Mo. | Current River Missouri | Huzzard Creek Ozarks Mo. | Shenandoah River Virginia | Platte River Missouri[a] | Nolin River Kentucky | Des Moines River Iowa |
| Investigator | | | Fleener 1971c | Fleener 1971a | Fleener 1971b | Surber 1970 | Fleener 1972 | Carter 1968 | Harrison 1962 |
| Area | km | 71.1 | 10.1 | 103.0 | 8.6 | 220.2 | 91.7 | 77.0 | 160.9 |
| Surveyed | ha | 339.1 | 19.7 | 673.4 | 20.6 | | 243.8 | | |
| Angler trips | | 16,485 | 1,620 | 7,500 | 1,870 | | 37,253 | | 886 |
| Angler hours | | 34,386 | 5,766 | 32,400 | 7,467 | 341,284 | 131,179 | 7,250 | 1,950 |
| Trip length | | 2.06 | 3.50 | 4.32 | 3.99 | | 3.52 | | 2.30 |
| Angler trips/ | km | 231.9 | 160.4 | 2.8 | 217.4 | | 406.2 | | 5.5 |
| | ha | 48.6 | 82.3 | 11.1 | 90.8 | | 152.8 | | |
| Angler hours | km | 483.6 | 570.9 | 314.6 | 868.3 | 1,550.2 | 1,430.5 | 94.2 | 12.1 |
| | ha | 101.4 | 292.7 | 48.1 | 362.5 | | 538.1 | | |
| Angler | no | 32,549 | 6,588 | 13,181 | 5,818 | 159,362 | 21,647 | 1,344 | 872 |
| harvest | kg | 6,346.6 | 589.7 | 5,179 | 801.3 | | | 413.7 | |
| Fish/km | no | 457.8 | 652.3 | 128.0 | 576.5 | 723.8 | 236.1 | 17.5 | 5.4 |
| | kg | 89.3 | 58.4 | 50.3 | 93.2 | | | 5.4 | |
| Fish/ha | no | 86.0 | 334.4 | 19.6 | 282.5 | | 88.8 | | |
| | kg | 18.7 | 29.9 | 7.7 | 43.6 | | | | |
| Catch | fish/hr | 0.95 | 1.14 | 0.41 | 0.78 | 0.47 | 0.17 | 0.17 | 0.45 |
| | kg/hr | 0.19 | 0.10 | 0.16 | 0.11 | | | 0.06 | |
| Average weight | kg/fish | 0.18 | 0.09 | 0.39 | 0.14 | | | 0.31 | |

[a]Estimated fisherman use and harvest by setline fishermen not included.

Shenandoah River (Surber 1970) which is approximately three times longer. Fishermen on the Mountain Fork River harvested more fish in number and weight than anglers on the highly esteemed current or the heavily used Platte Rivers of Missouri (Table 49). When compared with other rivers of similar length on a fish/km basis, harvest on the Mountain Fork River was approximately four times greater than that recorded for the Current River and approximately two times greater than that for Platte River. Weight of fish harvested was 89.3 kg/km on the Mountain Fork River while the Current River had 50.3 kg/km.

Although Courtois and Huzzard Creek anglers harvested considerably more fish in number and weight/ha than anglers on the Mountain Fork River (Table 49), the area sampled on the former two streams represents only selected sections and not the total length of the streams. Harvest from the Mountain Fork River of 86.0 fish/ha was approximately equal to sport fishermen harvest of 88.8 fish/ha harvested from the heavily fished Platte River and approximately four times greater than the 19.6 fish/ha harvest from the Current River. The 18.7 kg/ha harvested from the Mountain Fork River was 2.4 times greater than the 7.7 kg/ha reported for the Current River in Missouri.

When compared to other warm-water studies, the CRN of 0.95 fish/hr on the Mountain Fork River was exceeded only by the Courtois Creek catch rate of 1.4 fish/hr, while the CRW from Mountain Fork River of 0.19 kg/hr was greater than that reported for any other stream. Compared to rivers of similar or greater length, sport-fishermen catch rates (fish/hr) on the Mountain Fork River were twice as great as that reported for Current, Shenandoah or Des Moines River and five times greater than that reported for Platte River in Missouri and the Nolin

River in Kentucky. However, the average weight of fish harvested on the Mountain Fork River (0.18 kg/fish) was only about one-half that reported for the Current River (0.39) and Nolin River (0.31).

The high CRN for the entire Mountain Fork River was strongly influenced by influx of yearling largemouth bass and black bullheads from the reservoir, especially at site 6. These small fish also reduced the average weight for all fish. As the reservoir matures, it is expected that the number of small, largemouth bass from the reservoir will be reduced but the average size will increase.

# CHAPTER VII

## SUMMARY

Estimates of man-days use and harvest of warm-water streams are needed to evaluate the effects of impoundment and provide basic information to manage warm-water streams. Therefore, objectives of this study were to evaluate and compare man-days use and fish harvest above and below Broken Bow Reservoir which bisects the Mountain Fork River, an Oklahoma scenic river.

A creel survey was conducted from 1 August 1970 through 31 July 1971 on the Mountain Fork River, a tributary of the Little River drainage system which is located in sparsely populated southeastern Oklahoma. The length of river used in this study was from the northern McCurtain County line to the confluence with the Little River. This portion of the river was 112.36 km long, however, 40.25 km were inundated by the 5,747 ha Broken Bow Reservoir leaving 38.98 km above and 33.23 km below the reservoir. There are two distinct habitat types on the Mountain Fork River, a relatively high gradient section located in the Ouachita Mountains from the northern entry point of the river into Oklahoma to Presbyterian Falls, and the remaining river located in the relatively flat Gulf Coastal Plains.

A stratified random sampling design was used by dividing each week into weekday, weekend days, morning and afternoon strata. Due to the nature of terrain and private land holdings immediately adjacent to the

river, public access was restricted to a limited number of access points. Thus six sampling sites above and eight sampling sites below Broken Bow Reservoir were selected which represented all major public access points to the river.

Annual man-days use and fish harvest were estimated to be 16,485 fishermen trips for 34,386 hrs fished with a total harvest of 32,549 fish, weighing 6,347 kilograms; of which above accounted for 8,403 man-days use and 16,260 hrs, with a catch of 27,470 fish, weighing 5,394 kg. Fishermen below the reservoir accounted for 8,082 man-days use and 18,126 hrs, and a catch of 5,079 fish weighing 953 kg. Fishermen above the reservoir accounted for 51% of the man-days use and 47% of the total hours fished while harvesting 84% in number and 85% by weight of the annual harvest.

Fishermen trip length was significantly greater below (2.24 hr/trip) than above (1.94 hrs/trip). The greater trip length below was attributed to the availability of developed camping and picnicking areas below the dam.

Only 37% of the fishermen were successful in catching one or more fish, however, overall CRT's were relatively high (0.95 fish/hr and 0.19 kg/hr) with an average weight of 0.20 kg/fish. CRT's above the reservoir of 1.69 fish/hr and 0.33 kg/hr were significantly greater than the CRT's below the reservoir of 0.28 fish/hr and 0.05 kg/hr.

The reservoir influenced sport-fishermen harvest on the river both above and below the reservoir. Site 6 immediately above Broken Bow Reservoir accounted for 33% and 30% of the annual fishermen man-days use and hours fished while accounting for 72% and 60% of the annual harvest in numbers and weight, respectively. Catch at site 6 was believed to be

influenced by fish migrating upstream from Broken Bow Reservoir because: (1) fishermen catch rates of 2.30 fish/hr and 0.38 kg/hr being the highest recorded for any river portion; (2) the average weight of 0.167 kg/fish at site 6 was significantly less than that for the sites immediately above this site (sites 1-5); and (3) the dominant species caught at site 6, longear sunfish, largemouth bass, and green sunfish, were caught in the spring.

Reservoir influence, evidenced at site 6, was thought to be a major factor in the harvest of spotted bass, bluegill, and black bullhead. According to the pre-impoundment study in 1956, spotted bass and bluegill were rare in occurrence in the upper river portions, and black bullhead were not collected. However, black bullhead was the fourth most abundant species harvested by number and fifth by weight of all species caught at site 6. This site accounted for 78% in number and weight of all black bullheads harvested on the Mountain Fork River.

After construction of Broken Bow Reservoir, site 7 immediately below the reservoir was transformed into a series of three pools, with water levels maintained by discharge from a low-flow sluice gate. Although site 7 accounted for 22% and 21% of the annual man-days use and hours fished, respectively, this site accounted for only 3% and 5% of the annual harvest in number and weight. The CRT's at site 7 were one of the poorest of any area surveyed with 0.142 fish/hr and 0.046 kg/hr.

Due to the influence of the reservoir on sites 6 (and indirectly on 7), and on the below river section in the mountainous river habitat, sample collecting sites were arranged into groups for comparison based on habitat type.

Sites 1-5 and sites 8-11 were compared because they were similar

habitats. Man-days use, hours fished and trip length at sites 8-11 were significantly greater than at sites 1-5. However, harvest in number, weight, and average weight of fish caught at sites 1-5 were significantly greater than at sites 8-11. CRT's at sites 1-5 were 0.67 fish/hr and 0.26 kg/hr while fishermen at sites 8-11 caught 0.36 fish/hr and 0.05 kg/hr. The significantly greater man-days use at sites 8-11 is probably due to site development which encouraged fishermen use while sites 1-5 were totally undeveloped for camping or picnicking. The only obvious factor which might have caused lower harvest figures at sites 8-11 was the release of cool water during power generation.

Below the reservoir, sites 8-11 were compared to sites 12-14 in the Gulf Coastal Plains portion of the river. Man-days use and harvest (in both number and weight) was greater at sites 8-11; but average weight of fish caught and catch rates were greater in the Gulf Coastal Plains region (sites 12-14). Composition of the catch by species at sites 12-14 was significantly different from species composition recorded at sites 8-11. At sites 12-14, harvest was dominated by white crappie and black crappie while sites 8-11 were dominated by longear sunfish and largemouth bass.

Species composition of the catch was also influenced by the reservoir. Above, harvest at site 6 was influenced by up-river migration of largemouth bass, spotted bass, bluegill, longear sunfish, green sunfish, white crappie, black crappie, flathead catfish, and black bullhead from Broken Bow Reservoir. Smallmouth bass harvested at site 6 were probably not reservoir fish based on an average weight similar to that for smallmouth bass at sites 1-5 and site 6. Prior to construction of Broken Bow Reservoir, black bullhead were rare in the Mountain Fork River,

however, black bullhead were the fourth most abundant species harvested. Fishermen at site 6 harvested 78% of the number and 76% of the weight of black bullhead taken from the river.

Large differences in total harvest, average weight and catch rates between above and below sites with similar habitat suggest an influence of the periodic, cool water discharges from Broken Bow Reservoir on the below fishery. There was a significantly greater harvest in number and weight and a higher average weight at sites 1-5 above compared with sites 8-11 below. CRT's at sites 1-5 were from two to six times higher than CRT's at sites 8-11. Before impoundment (1956 pre-impoundment study) species composition and standing crop of largemouth bass, spotted bass, channel catfish, white crappie, black crappie, bluegill, and warmouth were reported to be most abundant in what is now downstream from the dam. However, of the 11 species appearing both above and below in the present study only bluegill and white and black crappie were caught in greater numbers below.

Species composition of the harvest was dominated in number by longear sunfish (44%), and largemouth bass (33%), and in weight by largemouth bass (40%) and longear sunfish (26%). Although the Mountain Fork River has been recognized as an outstanding smallmouth bass fishery, smallmouth bass harvest ranked ninth in number (1%) and sixth in weight (4%) of the species caught.

Above and below (site 7 excluded from below) comparisons of man-days use and hours fished were made on a per km basis, while angler harvest in number and weight comparisons were made on a per km/hour basis to help remove biases of unused river portions. Man-days use (215.5 man-days/km), fishing pressure (417.0 hr/km), and harvest (0.040

fish/km/hr and 0.009 kg/km/hr) was greater above than below (160.8, 392.0, 0.008, and 0.002, respectively). Comparing similar site groups from similar habitats above (sites 1-5) and below (sites 8-11) the reservoir, showed that use, in number of man-days and hours fished, and total harvest in number (fish/kg/hr), were greater in the below mountainous habitat portion. Site 10, accounted for 88% of the man-days of use, 69% of the total hours fished, 95% of the number of fish caught, and 83% of the weight of all fish harvested from the below mountainous habitat.

Compared to other warm-water rivers of similar length, man-days of use of the Mountain Fork River was exceeded only by the heavily used Platte River located near Kansas City, Missouri; however, annual harvest on the Mountain Fork River was approximately equal to that of the Platte River. Compared to warm-water rivers of similar habitat and length, man-days use and fish harvest were greater on the Mountain Fork River than the Current River, Missouri, or the Nolin River, Kentucky. Catch rates on the Mountain Fork River of 0.95 fish/hr and 0.19 kg/hr were among the highest catch rates reported for warm-water rivers.

## LITERATURE CITED


Alexander, R. and D. S. Shetter. 1967. Fishing and boating on portions of the Au Sable River in Michigan, 1960-63. Trans. Amer. Fish. Soc. 96(3):257-267.

Bailey, R. M. 1970. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society, Washington, D. C., Special Publication No. 6.

Brown, B. E. 1969. An analysis of the Oklahoma State Lake creel survey to improve creel survey design. Ph.D. Thesis, Oklahoma State University, Stillwater. 164 pp.

Carlander, K. D. (ed.) 1956. Symposium on sampling problems in creel census. Iowa Cooperative Fishery Research Unit, Iowa State University, Ames. 80 pp.

_____, and C. J. DiCostanzo. 1958. Sampling problems in creel census. Prog. Fish-Cult. 20(2):73-81.

Carroll, B. B. 1960. Population studies-Storage and upper mainstream reservoirs in East Tennessee. TVA Rept., Mimeo, 99 pp.

Carter, E. R. 1957. Investigations and management of the Dewey Lake fishery. Proc. S.E. Assoc. Game and Fish Comm. 10(1957):254-270.

Carter, J. P. 1968. Pre- and Post-impoundment surveys on Nolin River, Kentucky. Kentucky Fisheries Bull. 48. 28 pp.

_____. 1969. Pre- and Post-impoundment surveys on Barren River. Kentucky Fisheries Bull. 50. 33 pp.

Chance, C. J. 1958. History of fish and fishing in Norris, a TVA tributary reservoir. Proc. S.E. Assoc. Game and Fish Comm. 12(1958):116-127.

Churchill, W. and H. Snow. 1964. Characteristics of the sport fishery in some northern Wisconsin lakes. Wisconsin Cons. Dept. Tech. Bull. pp. 182-188.

Conover, W. J. 1971. Practical nonparametric statistics. John Wiley & Sons Inc. New York. 462 pp.

DiCostanzo, C. J. 1956. Creel census techniques and harvest of fishes in Clear Lake, Iowa. Ph.D. Thesis, Iowa State University, Ames. 107 pp.

_____. 1958. Clear Lake creel census and evaluation of sampling techniques, pp. 17-29. In Symposium on sampling problems in creel census, Iowa Coop. Fish. Res. Unit, Ames.

Elser, H. J. 1960. Creel census results on the Northwest River, Maryland, 1958. Chesapeake Sci., 1(1):41-48.

Eschmeyer, R. W. 1942. The catch, abundance, and migration of game fishes in Norris Reservoir, Tennessee, 1940. Jour. Tenn. Acad. Sci. 17(1):90-115.

Finnell, J. C., R. M. Jenkins and G. E. Hall. 1956. The fishery resources of the Little River system, McCurtain County, Oklahoma. Oklahoma Fish. Res. Lab. Rep. 55. 82 pp.

Fleener, G. G. 1952. An intensive creel census of two similar small-mouth bass streams in the Missouri Ozarks. Presented at the Fourteenth Midwest Wildlife Conference, Des Moines, Iowa. 11 pp.

Fleener, G. G. 1968. A quantitative creel census of Pool 26, Mississippi River. Missouri Dept. of Conservation, D-J Project No. F-1-R-17. Work Plan No. 22, Job no. 1.

_____. 1971a. Harvest of fish from the Current River, Missouri Dept. of Conservation, D-J Project F-1-R-20. 10 pp.

_____. 1971b. Harvest of fish from Huzzard Creek. Missouri Dept. of Conservation, D-J Project F-1-R-20. 5 pp.

_____. 1971c. Harvest of fish from Courtois Creek. Missouri Dept. of Conservation, D-J Project F-1-R-20, F-11: 5 pp.

_____. 1972. Recreational use of the Platte River. Missouri Dept. of Conservation, D-J Project F-1-R-21. 33 pp.

Funk, J. L. 1953. Management and utilization of the fishery of Black River, Missouri. pp. 113-122. In The Black River Studies. University of Missouri Studies, Columbia.

_____. 1957. Movement of stream fishes in Missouri. Trans. Amer. Fish. Soc. 85(1955):39-57.

_____. 1958. Missouri creel censuses on streams and impoundments, pp. 30-38. In Symposium on Sampling Problems in Creel Census, Iowa Coop. Fish. Res. Unit, Ames.

_____ and G. G. Fleener. 1966. Evaluation of a year-round open fishing season upon an Ozark smallmouth bass stream, Niangua River, Missouri. Missouri Dept. of Conservation. 21 pp.

_____. 1970. Warm-water streams, pp. 141-152. In N. G. Benson (ed.) A Century of Fisheries in North America. American Fisheries Society, Washington, D. C., Special Publication No. 7.

Gasaway, C. R. 1957. The sport fishery of Tenkiller Ferry Reservoir, Oklahoma. Oklahoma Fish. Res. Lab. Bull. 7. 20 pp.

Grosslein, M. D. 1961. Estimation of angler harvest on Oneida Lake, New York. Ph.D. Thesis, Cornell Univ., Ithaca. 296 pp.

Hall, G. E. and R. M. Jenkins. 1953. Continued fisheries investigation of Tenkiller Reservoir, Oklahoma, during its first year of impoundment. Oklahoma Fish. Res. Lab. Rept. No. 33. 54 pp.

Hanson, W. D. 1970. Harvest of fish in Pomme de Terre Reservoir. Missouri Dept. of Conservation, D-J Project F-1-R-19. 7 pp.

Harrison, H. M. 1962. Creel census of Des Moines River fishermen in Boone, Dallas, and Polk Counties, Iowa. Iowa Acad. Sci. 69:277-285.

Houser, A. and W. R. Heard. 1958. A one-year creel census on Fort Gibson Reservoir. Oklahoma Acad. Sci. 38(1957):137-146.

Jarman, R., C. Bennett, C. Collins and B. E. Brown. 1968. Angling success and recreational use on twelve state-owned lakes in Oklahoma. Proc. S.E. Assoc. Game and Fish Comm. 21(1967):484-494.

Jessen, R. J. 1956. Comments and suggestions on designing creel censuses, pp. 50-56. In Symposium on creel censuses, Iowa Coop. Fish. Res. Unit, Ames.

Johnson, M. W. and L. Wroblewski. 1962. Errors associated with a systematic sampling creel census. Trans. Amer. Fish. Soc. 91(2):201-207.

Kathrein, J. W. 1953. An intensive creel census of Clearwater Lake, Missouri, during its first four years of impoundment, 1949-1952. Trans. N. Amer. Wild. Conf. 18:283-295.

Lambou, V. W. 1966. Recommended method of reporting creel survey data for reservoirs. Oklahoma Fish. Res. Lab. Bull. 4. 40 pp.

Lambou, V. W. and H. Stern, Jr. 1958. Creel census methods used on Clear Lake, Richland Parish, Louisiana. Proc. S.E. Assoc. Game and Fish Comm. 12(1958):169-175.

Mottley, C. M. and D. R. Embody. 1940. An efficient sampling method for taking a creel census. Progr. Fish-Cult. 49(1):21-22.

Murphy, L. W. 1955. Two-year creel census of the Little Salmon River, Idaho. Trans. Amer. Fish. Soc. 84:200-206.

Oklahoma Water Resources Board. 1969. Appraisal of the water and related land resources of Oklahoma. Regions five and six. Okla. Water Res. Board. Pub. 27.

Outdoor Recreation Resources Review Commission. 1962. Sport fishing-today and tomorrow. Bureau of Sport Fisheries and Wildlife. Study Report No. 7. Washington, D. C. 127 pp.

Patriarche, M. H. and R. S. Campbell. 1957. The development of the fish population in a new flood control reservoir in Missouri, 1948 to 1954. Trans. Amer. Fish. Soc. 87:240-258.

Radford, D. S. 1973. A comparison between actual and reported angling times. Trans. Amer. Fish. Soc. 102(3):641-643.

Reeves, J. D. 1950. The fishes of the Mountain Fork River in Arkansas and Oklahoma with description of two new percid fishes. M.S. Thesis, Oklahoma State Univ., Stillwater. 56 pp.

Regier, H. A. 1966. Some creel census designs utilizing randomization. N. Y. Coop. Fish. Unit Rept., Ithaca. 9 pp.

Robson, D. S. 1960. An unbiased sampling and estimation procedure for creel census of fishermen. Biometrics. 16(2):261-277.

Rose, E. T. 1956. The year-round creel census of Spirit and Okoboji Lakes, pp. 8-13. In Symposium on sampling creel census, Iowa Coop. Fisheries Res. Unit, Ames.

Rühr, C. E. 1956. Effect of stream impoundment in Tennessee on the fish populations of tributary streams. Trans. Amer. Fish. Soc. 86:144-157.

Rupp, R. S. 1961. Measurement of potential fishing quality. Trans. Amer. Fish. Soc. 90(2):165-169.

Schmulback, J. C. 1959. Factors affecting the harvest of fish in the Des Moines River, Boone County, Iowa. Ph.D. Thesis, Iowa State Univ., Ames. 200 pp.

Siegel, S. 1956. Nonparametric statistics. McGraw-Hill Book Co., Inc. New York. 312 pp.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical methods. The Iowa State Univ. Press, Ames. 593 pp.

Surber, E. W. 1970. Smallmouth bass stream investigations. Virginia Dept. Cons. D-J Project F-14-R. Final Report, Job no. 2. 21 pp.

Tait, H. D. 1953. Some sampling problems in a Michigan creel census. Ph.D. Thesis, Univ. Mich. (L.C. Card No. Mic A54-1078) 143 p. Univ. Microfilms, Ann Arbor, Mich. (Dissr. Abstr. 14:745).

Towery, B. A. 1963. Fisheries investigation on flood control reservoirs. Mississippi Game and Fish Comm. D-J Project F-6-R. Job no. 7. 24 pp.

U. S. Dept. of Commerce. 1972. 1970 census of population. Bureau of Census. Vol. 1, part a, section 2.

VITA

Gary A. Earls

Candidate for the Degree of

Master of Science

Thesis: COMPARISON OF MAN-DAYS OF FISHING AND FISH HARVEST ABOVE AND BELOW A FLOOD CONTROL HYDROELECTRIC IMPOUNDMENT BISECTING AN OKLAHOMA SCENIC RIVER

Major Field: Zoology

Biographical:

Personal Data: Born in Sebastopol, California, June 28, 1947, the son of Virgil A. and Jewel M. Earls; married Janet Marie Cornish on December 31, 1969.

Education: Graduated from North Kansas City High School, North Kansas City, Missouri in 1965; received Associate Arts degree at Northeastern Oklahoma A & M, Miami, Oklahoma in 1968; received Bachelor of Science degree from Southeastern State College, Durant, Oklahoma in 1970; completed the requirements for the Master of Science degree in December, 1973, at Oklahoma State University, Stillwater, Oklahoma.

Professional Experience: Fish Hatchery Aid, Oklahoma Department of Wildlife Conservation, 1969; Museum Curator at Southeastern State College, 1970; Oklahoma Fish and Game Council Fellowship, Oklahoma Cooperative Fishery Unit, September, 1970 through August, 1972; Graduate Research Assistant, Oklahoma Cooperative Fishery Unit, September, 1972 to February, 1973; Environmental Planner, R. W. Booker and Associates, St. Louis, Missouri, March, 1973 to present.

Member: American Fisheries Society; Oklahoma Academy of Science; Phi Theta Kappa.