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RESEARCH PROJECT COMPLETION REPORT
OWRR PROJECT NO. A-026-OKLA.

RECREATIONAL USE OF AN OKLAHOMA SCENIC RIVER BISECTED BY A FLOOD CONTROL-HYDROELECTRIC IMPOUNDMENT (REVISED)

Submitted by

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ABSTRACT

A recreation-use survey of a smallmouth bass-scenic river was conducted above and below Broken Bow Reservoir on the flowing portions of the Mountain Fork River, McCurtain County, Oklahoma from 1 August 1970 through 31 July 1971. Only those people actively using the river were interviewed to determine amount of use, aspects of fisherman harvest and economic value of the resource. A total of 16,542 people (8,408 above and 8,134 below) spent $88,133 ($45,188 above and $42,945 below) and caught 31,442 of 17 species of fish (26,457 above and 4,985 below) weighing 13,584 pounds (11,580 above and 2,003 below). People being interviewed stated a preference for the free flowing portions of the river as opposed to the regulated flows below the reservoir and an observed man-day of recreation above was worth $5.37 for a 1.9-hour trip with a man-day of 2.1 hours worth $5.28 below (total river value was $5.33 for a 2.0-hour day). Conversion of these values to the standard 5-hour man-day showed the value above to be $14.13, $12.87 below and $13.48 for total river. These values indicate a need to re-evaluate the $3.00/man-day maximum amount allowed for a smallmouth bass fishery by federal law. Distribution of catch over time showed expected variation with few fish caught during the winter months and maximum catches occurring in the spring. Differences in catch above and below the reservoir were attributed to changes in the water quality below the reservoir.

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Introduction

River experiences like canoeing through white water are a unique recreational experience in Oklahoma and only a few of Oklahoma's rivers possess this attribute together with an associated smallmouth bass fishery and outstanding scenic, recreational, geologic and wildlife values. The Mountain Fork River is one of these resources and was included with the Illinois and Barren Fork Rivers under the protection of the Scenic Rivers Bill (Oklahoma House Bill 1152) to make future impoundment more difficult. The outstanding scenic and recreational value of certain rivers was also recognized by the 90th U. S. Congress which established the National Wild and Scenic Rivers System (P.L. 90-542, 1968).

The Mountain Fork River is bisected by a large impoundment (Broken Bow Reservoir). This limits navigation and has an impact on the productivity of the stream below the reservoir. Reservoir releases can influence recreational use and assessing these effects was one of the objectives of this study.

In order to provide an initial basis for predicting demand for water based recreation reflecting assumed relationships between population density and available recreational alternatives between reservoirs and scenic rivers, this project was initiated to provide base-line data for the flowing portions of the Mountain Fork River above and below Broken Bow Reservoir. The parameters selected for study and considered indicative of the direct recreational use of this stream resource were to estimate for a period of one year:

1. man-days of fishing and canoeing;

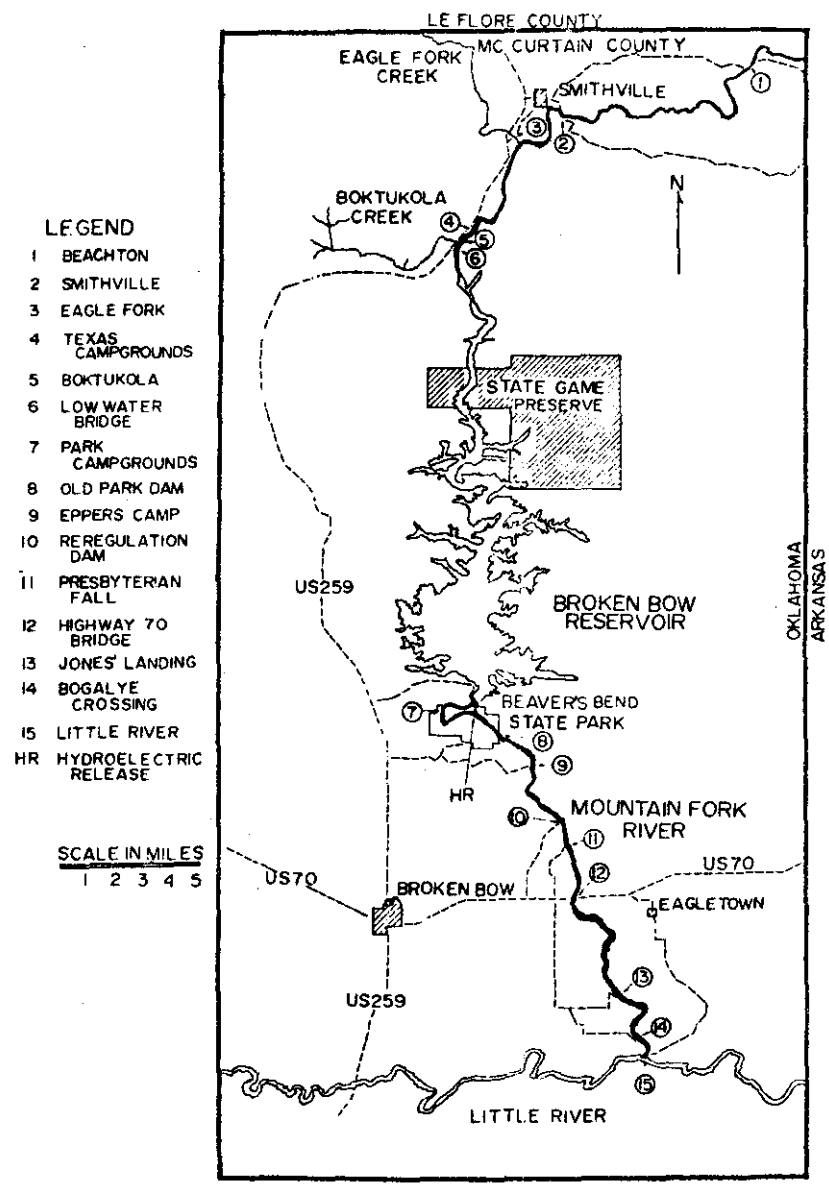
2. the economic value of this resource, determined by applying traditional values to estimates of man-days of fishing and canoeing;
3. actual expenditures per man-day of fishing and canoeing as determined from user interviews and compare this value with the estimates gained from 2 above;
4. fishing success (catch rate) as numbers and pounds per angler hour; and
5. the species of sport fishes appearing in the fishermen's creel, and total harvest by species, as numbers and pounds of fish, for each month.

With these data it was hypothesized that improved projections for demand for stream resources and a better understanding of their true value could be gained for future evaluation of comparative uses of our aquatic resources. Presently, these value estimates are based on data from surrounding states and the data from this present study will provide a badly needed reference for recreational planners who need to evaluate present and future needs for road construction, sanitary facilities, garbage disposal, camp sites and fisheries management.

Procedures

Separate monthly estimates were made for public access points on the river above and below Broken Bow Reservoir (Fig. 1). These estimates were developed from a stratified random design to determine the spatial and temporal location of user interviews. Separate strata were weekdays (Monday through Friday), weekend days (Saturdays, Sundays, & holidays), mornings and afternoons. Within these strata all access points to the

Figure 1. The Mountain Fork River from the Arkansas border to its confluence with the Little River showing all public access sites which also served as data collection points. (Sites 1-6 are above the reservoir and sites 7-15 are below the reservoir.)


LE FLORE COUNTY
MC CURTAIN COUNTY
EAGLE FORK CREEK
SMITHVILLE
BOKTUKOLA CREEK
N
STATE GAME PRESERVE
US259
BROKEN BOW RESERVOIR
OKLAHOMA
ARKANSAS
BEAVER'S BEND STATE PARK
HR
MOUNTAIN FORK RIVER
US70
US70
BROKEN BOW
EAGLE TOWN
US259
LITTLE RIVER
LEGEND
1 BEACHTON
2 SMITHVILLE
3 EAGLE FORK
4 TEXAS CAMPGROUNDS
5 BOKTUKOLA
6 LOW WATER BRIDGE
7 PARK CAMPGROUNDS
8 OLD PARK DAM
9 EPPERS CAMP
10 REREGULATION DAM
11 PRESBYTERIAN FALL
12 HIGHWAY 70 BRIDGE
13 JONES' LANDING
14 BOGALYE CROSSING
15 LITTLE RIVER
HR HYDROELECTRIC RELEASE
SCALE IN MILES
1 2 3 4 5

river were weighted each month according to observed use the preceding month with estimates for the initial month's interviews based on data provided by local fisherman guides and people known to be heavy users of the resource. After the proportional use of each of the nine access points above the reservoir (hereafter referred to as above) and the six access points below the reservoir (hereafter referred to as below) were determined, the potential number of sample dates was assigned to each site based on this proportion (with at least one sample taken from each site) and actual sample dates within the month determined by use of a random number table with dates for morning and afternoon samples determined separately. The morning sample period was from 10 a.m. to 2 p.m. and the afternoon sample period was the four hours preceding darkness. These time periods were selected so that as many completed-trip interviews as possible could be gathered for each time period. Recreational use by entry at points on the river other than the designated access points was not considered because the nature of the terrain and the forest cover precludes significant use of areas other than the selected sites.

Information the creel clerk collected for each interview included identity of the fishermen as to boat, canoe, shore, number in party, where the trip began (in the case of float trips), species composition of the catch, total numbers of fish caught, weight of each species, total hours fished, place of residence, distance traveled to reach the fishing place and estimates of expenditures (other than travel) for lodging, meals, tackle, bait and any other expenditures that could be considered as necessary to the recreational experience. Interviews were conducted every day during the period 1 August 1970 through

31 July 1971.

Each access point was considered to be a complete sample of the area involved and an expansion factor was used to obtain representative values for the four time strata for each access point. The expansion factor was the ratio between number of sample periods and total possible sample periods separately for each strata with each month treated as a separate sample. For those persons refusing to cooperate in the interview, appropriate average values (e.g., individual or part, etc.) was assigned to their effort. All values reported are expanded estimates.

Various statistical procedures were used to compare the results of the survey and these will be discussed under the appropriate sections below.

Results and Discussion

A total of 16,542 people spent $88,133 for fishing recreation on the Mountain Fork River, with 8,408 individuals spending $45,188 to use the undeveloped access points on the undisturbed portion of the river above and 8,134 individuals spending $42,945 on the highly developed portion of the river below (Table 1). There were no significant differences by month in the above and below values when tested with a paired "t" test (individuals, $t_{11} = 0.058$; expenses, $t_{11} = 0.079$) or when tested with a Wilcoxon sign/rank test (individuals, $P_{12} - 29$; expenses, $P_{12} = 33$, $P_{.05(12)} = 14$).

The $88,133 spent by the 16,542 individuals was allocated to man-days of effort as observed and according to the 5-hour man-day utilized by Branch of River Basins, U.S.D.I. in their impact studies (Table 2). An average observed trip length of 2.0 hours differed considerably from the

Table 1. Estimated numbers of individuals (Ind.) and the expenses (Exp.) of persons engaged in water-based recreation above and below Broken Bow Reservoir, Mountain Fork River, 1 August 1970 - 31 July 1971.

Month	Above		Below		Toral for River		Estimated Differences		% Individuals		% Expenses		% Difference	
	Ind.	Exp.	Ind.	Exp.	Ind.	Exp.	Ind.	Exp.	Above	Below	Above	Below	Ind.	Exp.
Aug '70	545	4,330	514	3,459	1,059	7,789	31A[1]	871A[1]	51.46	48.54	55.59	44.41	2.92A[1]	11.18A
Sep	458	2,877	595	2,377	1,053	5,254	137B[2]	500A	43.49	56.51	54.76	45.24	13.02B[2]	9.52A
Oct	356	1,898	350	1,893	706	3,791	6A	5A	50.42	49.58	50.07	49.93	0.84A	0.14A
Nov	106	361	40	470	146	831	66A	109B[2]	72.60	27.40	43.44	56.56	45.20A	13.12B[2]
Dec	86	161	27	18	113	179	59A	143A	76.11	23.89	89.94	10.06	52.22A	79.88A
Jan '71	57	240	33	22	90	262	24A	218A	63.33	36.67	91.60	8.40	26.66A	83.20A
Feb	323	1,112	209	372	532	1,484	114A	740A	60.71	39.29	74.93	25.07	21.42A	49.86A
Mar	714	1,841	473	587	1,187	2,428	241A	1254A	60.15	39.85	75.82	24.18	20.30A	51.64A
Apr	1658	6,405	1622	3,075	3,280	9,480	36A	3330A	50.55	49.45	67.56	32.44	1.10A	35.12A
May	2193	6,909	1229	3,677	3,422	10,586	964A	3232A	64.09	35.91	65.27	34.73	28.18A	30.54A
Jun	1340	12,573	1613	14,129	2,953	26,702	273B	1556B	45.38	54.62	47.09	52.91	9.24B	5.82B
Jul	572	6,481	1429	12,866	2,001	19,347	857B	6385B	28.59	71.41	33.50	66.50	42.82B	33.00B
Tot/Avg	8408	45,188	8134	42,945	16,542	88,133	274A	2243A	50.83	49.17	51.27	48.73	1.66A	2.54A

[1]A = Above

[2]B = Below

Table 2. Calculations of man-days of activity and associated expenditures for individuals interviewed on the Mountain Fork River above and below Lake Bow Reservoir, 1 August 1970 - 31 July 1971.

	Number of Individuals	Number of hours	Avg. time/trip in hours	Number of man-days (observed)	Number of man-days based on 5 hrs./man-day[1]
Above	8,408	15,996.89	1.9026	8,408	3,199
Below	8,134	16,686.57	2.0515	8,134	3,337
Total	16,542	32,683.46	1.9758	16,542	6,536

	Total Expenses	Amt. spent/ man-day (observed)	Amt. spent/man-day (5 hr. man-day)	Amt. allowed/ man-day by law
Above	45,188	$ 5.37	$ 14.13	$ 3.00
Below	42,945	5.28	12.87	3.00
Total	88,133	$ 5.33	$ 13.48	$ 3.00

[1]The 5 hour man-day is recommended and usually used by personnel in the Division of River Basins, U.S.D.I.

5-hour trip commonly used. Even so, the average expenditure per 2.0 hour man-day of $5.33 was substantially higher than the $3.00/man-day allowed by law for a smallmouth bass fishery ($t_{(23)}$= 2.882, P<0.005). The 8,408 people using the upstream, non-regulated portion of the river, were willing to invest $5.37/1.90-hour man-day while the 8,134 people using the below access points were willing to pay $5.28/2.05-hour man-day. Reducing these values to a common base shows that the below recreational hour is worth $2.57 and the above recreational hour is worth $2.83 or 1.10 times as much for the opportunity to use a natural, free-flowing stream. The amount spent/man-day above exceeded expenditures/man-day below every month except October and November. This trend was significant at P=.05 when tested with the Wilcoxon sign-rank method (t_{12}= 13, $t_{.05(12)}$= 14). However, the unweighted average amount of the difference ($0.08) was not significantly different between the two areas (t_{11}= 0.827).

Of course, if the expenditures are reported on the basis of the 5-hour man-day mentioned above, the figures are even more dramatic. A 5-hour man-day of recreation on the above portion of the river is worth $14.13 and the below man-day is worth $12.87 with a whole river value of $13.48/5-hour man-day. When these values are compared to the $3.00/man-day allowed for this fishery, the difference of $10.48/man-day is highly significant (t_{23}= 3.891, P<0.001).

There were 17 species of fish encountered in the fishermen's creels representing a total catch for the river of 31,442 fish weighing 13,584 pounds (Table 3). Of these fish, 26,457 fish with a weight of 11,580 pounds were caught above and 4,985 fish weighing 2,003 pounds were caught below. Although smallmouth bass ranked eighth in total number caught (471) and fifth in total weight (595 pounds), most fishermen who were interested

Table 3. Annual harvest of species by sample sites, Mountain Fork River, 1 August 1970 - 31 July 1971.

Site	Species											
	Largemouth bass		Smallmouth bass		Spotted bass		Bluegill sunfish		White crappie		Black crappie	
	No.	Wt.[1]	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
1	1033	873	110	136	0	0	0	0	0	0	0	0
2	1259	942	74	136	0	0	0	0	0	0	0	0
3	0	0	10	8	44	11	0	0	0	0	0	0
4	77	32	10	20	0	0	0	0	0	0	0	0
5	192	151	21	29	40	18	21	4	0	0	10	5
6	6841	2919	154	217	758	303	157	127	60	34	49	15
7	199	142	0	0	2	2	91	20	156	50	13	7
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	40	20	0	0	0	0	0	0	0	0
10	551	315	21	13	16	8	400	86	32	20	29	11
11	0	0	0	0	0	0	0	0	0	0	0	0
12	111	61	31	16	0	0	10	3	192	71	220	74
13	11	15	0	0	0	0	0	0	206	69	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0
A[2]	9402	4917	379	546	842	332	178	131	60	34	59	20
B[3]	872	533	92	49	19	10	501	109	586	210	262	92
Total	10,274	5450	471	595	861	342	679	240	646	244	321	112

[1]Weight in pounds

[2]Above the reservoir

[3]Below the reservoir

Table 3. (Continued)

Site	Species											
	Longear sunfish		Green sunfish		Warmouth sunfish		Channel catfish		Flathead catfish		Black bullhead	
	No.	Wt.[1]	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
1	21	4	0	0	0	0	21	74	84	431	0	0
2	0	0	80	46	0	0	33	154	11	44	0	0
3	506	86	110	31	0	0	0	0	10	8	0	0
4	61	21	79	32	0	0	0	0	0	0	0	0
5	63	8	32	7	0	0	14	42	15	58	42	24
6	11,788	3228	1471	378	11	3	47	64	294	633	737	217
7	121	20	87	23	0	0	71	113	20	50	155	46
8	9	3	0	0	0	0	0	0	0	0	0	0
9	10	2	20	5	0	0	52	59	10	13	0	0
10	1550	280	317	67	0	0	13	9	3	1	26	21
11	0	0	0	0	0	0	0	0	0	0	0	0
12	24	4	32	9	0	0	5	3	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	44	22	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0
A[2]	12,439	3347	1772	494	11	3	115	334	414	1174	779	241
B[3]	1,714	309	456	104	0	0	185	206	33	64	181	67
Total	14,153	3656	2228	598	11	3	300	540	447	1238	960	308

[1]Weight in pounds

[2]Above the reservoir

[3]Below the reservoir

Table 3. (Continued)

Site	Carp		River redhorse		Smallmouth Buffalo		Yellow bullhead		Black buffalo		Site Total	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
1	0	0	0	0	0	0	0	0	0	0	1,269	1,518
2	0	0	0	0	0	0	0	0	0	0	1,457	1,322
3	0	0	0	0	0	0	0	0	0	0	680	144
4	0	0	0	0	0	0	0	0	0	0	227	105
5	0	0	0	0	0	0	0	0	0	0	450	346
6	0	0	0	0	0	0	4	2	3	5	22,374	8,145
7	16	84	11	15	12	67	8	6	0	0	962	645
8	0	0	0	0	0	0	0	0	0	0	9	3
9	0	0	21	14	11	62	0	0	0	0	164	175
10	0	0	5	3	0	0	0	0	0	0	2,963	834
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	625	241
13	0	0	0	0	0	0	0	0	0	0	217	84
14	0	0	0	0	0	0	0	0	0	0	44	22
15	0	0	0	0	0	0	0	0	0	0	0	0
A[2]	0	0	0	0	0	0	4	2	3	5	26,457	11,580
B[3]	16	84	37	32	23	129	8	6	0	0	4,985	2,003
Total	16	84	37	32	23	129	12	8	3	5	31,442	13,584

[1]Weight in pounds

[2]Above the reservoir

[3]Below the reservoir

in catching a particular species of fish had come to the Mountain Fork River because of the presence of the smallmouth and the fact that the average weight of this fish (kept) was acceptable to them (1.26 lbs. each) and better than many other places. Many fishermen indicated that while they came with a primary intention of fishing, the species of fish caught was not as important as the general environment in which they fished with the term "natural stream" often being used.

Total harvest of all species annually (Table 4) and by month (Table 5) was examined to determine the distribution of effort and catch in time and space. The mean difference in average number of fish caught per site annually above and below of 321/site more above was tested with a "t" test which gave a value of t_{22}= 1.995, P=0.061 (Table 6). A "t" test of the difference in average weight of fish caught per site annually above and below yielded a t_{22} value of 2.344, P=0.030 for a mean difference of 142.27 pounds/site more above (Table 7). Finally, average catch rates, in number of fish/hour, were compared for the average annual site values and the t_{22} value is 4.222, P<0.001 for the mean difference of 1.03 more fish/hour above (Table 8). Observed average differences in catch/site above and below were strongly influenced by two sites, site 6 above and site 10 below. Fish being caught at site 6 (located at the head of the reservoir) may actually have been reservoir fish. Site 10 was the re-regulation dam which served as a partial barrier to normal fish movements and therefore caused some degree of fish concentration that would not have been experienced without the presence of this structure. In addition, picnic tables and parking facilities had been installed at site 10 which drew many visitors to this site and the combination of concentrating both fish and people enhanced the catch at this site.

Table 4. Aspects of total annual harvest, of all species, Mountain Fork River 1 August 1970 - 31 July 1971.

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	1269.00	1517.90	765.80	1.66	1.98	1.20	189.00
2	1457.00	1322.20	1276.80	1.14	1.04	.91	587.00
3	680.00	143.60	106.00	6.42	1.35	.21	64.00
4	227.00	105.10	817.30	.28	.13	.46	421.00
5	449.30	347.20	3936.50	.11	.09	.77	1800.00
6	22372.49	8143.29	9094.49	2.46	.90	.36	5348.39
7	964.00	644.30	6286.20	.15	.10	.67	3575.20
8	9.00	2.70	114.70	.08	.02	.30	90.00
9	163.00	174.20	684.80	.24	.25	1.07	275.00
10	2962.40	834.60	5743.19	.52	.15	.28	2865.40
11	0.00	0.00	1817.00	0.00	0.00	0.00	336.00
12	625.00	240.30	240.30	.46	.18	.38	771.70
13	217.00	84.80	84.80	.47	.18	.39	125.00
14	44.00	22.00	217.80	0.20	.10	.50	66.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	26454.79	11579.29	15996.89	-	-	-	8409.39
Total Below	4984.40	2002.90	16684.57	-	-	-	8104.30
Yearly Total	31439.19	13582.18	32681.46	-	-	-	16513.69
Avg./site Above	4409.13	1929.88	32681.46	1.65	.72	.44	1401.57
Avg./site Below	553.82	222.54	1853.84	.30	.12	.40	900.48
Avg./site Yearly	2095.95	905.48	2178.76	.96	.42	.43	1100.99

Table 5. Aspects of total monthly harvest, all species, Mountain Fork River, 1 August 1970 - 31 July 1971 (5 hr. man-days).

AUGUST 1970 HARVEST

Site	Number	Weight	Hours	No/Hr	Wt/Hr	lbs/Fish	Man-days/site
1	21.00	4.20	37.80	0.56	0.11	0.20	21.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	20.00	16.00	40.00	0.50	0.40	0.80	20.00
4	20.00	23.00	148.10	0.98	0.14	0.16	98.00
5	208.50	101.50	441.80	0.47	0.23	0.49	280.50
6	0.00	0.00	228.90	0.00	0.00	0.00	126.00
7	0.00	0.00	404.00	0.00	0.00	0.00	121.00
8	0.00	0.00	72.00	0.00	0.00	0.00	41.00
9	163.0	174.2	188.80	0.86	0.92	1.07	103.00
10	78.0	50.60	273.10	0.29	0.19	0.65	82.00
11	0.00	0.00	13.00	0.00	0.00	0.00	50.00
12	213.00	82.10	278.00	0.77	0.30	0.39	96.00
13	0.00	0.00	14.70	0.00	0.00	0.00	21.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	269.50	144.70	896.60	-	-	-	545.50
Total Below	454.00	306.90	1243.60	-	-	-	514.00
Total for Mo.	723.50	451.60	2140.20	-	-	-	1059.50
Avg./site Above	44.92	24.12	149.43	0.30	0.16	0.54	90.92
Avg./site Below	50.44	34.10	138.18	0.37	0.25	0.68	57.11
Avg./site for Mo.	48.23	30.11	142.68	0.34	0.21	0.62	70.63

Table 5. (Continued)

SEPTEMBER 1970 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	330.00	0.00	0.00	0.00	132.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	53.30	19.60	319.60	0.17	0.06	0.37	150.00
6	176.00	80.30	176.00	0.46	0.21	0.46	176.00
7	87.30	65.80	680.10	0.13	0.10	0.75	296.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	33.0	24.20	172.70	0.19	0.14	0.73	88.00
11	0.00	0.00	22.00	0.00	0.00	0.00	44.00
12	312.00	125.60	373.60	0.84	0.34	0.40	137.00
13	107.00	47.40	106.80	1.00	0.44	0.44	30.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	229.30	99.90	1030.20	-	-	-	458.00
Total Below	539.30	263.00	1355.20	-	-	-	595.00
Total for Mo.	768.60	362.90	2385.40	-	-	-	1053.00
Avg./site Above	38.22	16.65	171.70	0.22	0.10	0.44	76.33
Avg./site Below	59.92	29.22	150.58	0.40	0.19	0.49	66.11
Avg./site for Mo.	51.24	24.19	159.03	0.32	0.15	0.47	70.20

Table 5. (Continued)

OCTOBER 1970 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	117.00	91.80	382.50	0.31	0.24	0.78	99.00
6	310.00	245.40	416.20	0.74	0.59	0.79	257.00
7	14.70	15.40	136.90	0.11	0.11	1.05	91.20
8	9.00	2.70	40.50	0.22	0.07	0.30	27.00
9	0.00	0.00	372.00	0.00	0.00	0.00	66.00
10	9.00	4.50	415.80	0.02	0.01	0.50	155.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	110.00	37.40	22.00	5.00	1.70	0.34	11.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	427.00	377.20	798.70	-	-	-	356.00
Total Below	142.70	60.00	747.20	-	-	-	350.00
Total for Mo.	569.70	397.20	1545.90	-	-	-	706.20
Avg./site Above	71.17	56.20	133.12	0.53	0.42	0.79	59.33
Avg./site Below	15.86	6.67	83.02	0.19	0.08	0.42	38.91
Avg./site for Mo.	37.98	26.48	103.06	0.37	0.26	0.70	47.08

Table 5. (Eontinued)

NOVEMBER 1970 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	20.00	113.00	20.00	1.00	5.65	5.65	20.00
6	91.00	40.40	120.80	0.73	0.33	0.44	85.70
7	0.00	0.00	45.00	0.00	0.00	0.00	40.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	111.00	153.40	140.80	-	-	-	105.70
Total Below	0.00	0.00	45.00	-	-	-	40.00
Total for Mo.	111.00	153.40	185.80	-	-	-	145.70
Avg./site Above	18.50	25.57	23.47	0.79	1.09	1.38	17.62
Avg./site Below	0.00	0.00	5.00	0.00	0.00	0.00	4.44
Avg./site for Mo.	7.40	10.23	12.39	0.60	0.83	1.38	9.71

Table 5. (Continued)

DECEMBER 1970 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	18.00	0.00	0.00	0.00	9.00
6	258.20	126.50	94.60	2.73	1.34	0.49	76.60
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	40.50	0.00	0.00	0.00	27.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	258.20	126.50	112.60	-	-	-	85.60
Total Below	0.00	0.00	40.50	-	-	-	27.00
Total for Mo.	258.20	126.50	153.10	-	-	-	112.60
Avg./site Above	43.03	21.08	18.77	2.29	1.12	0.49	14.27
Avg./site Below	0.00	0.00	4.50	0.00	0.00	0.00	3.00
Avg./site for Mo.	17.21	8.43	10.21	1.69	0.83	0.49	7.51

Table 5. (Continued)

JANUARY 1971 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	5.50	0.00	0.00	0.00	5.50
6	58.20	21.80	27.40	2.12	0.80	0.37	51.10
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	33.00	0.00	0.00	0.00	33.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	58.20	21.80	32.90	-	-	-	56.60
Total Below	0.00	0.00	33.00	-	-	-	33.00
Total for Mo.	58.20	21.80	65.90	-	-	-	89.60
Avg./site Above	9.70	3.63	5.48	1.77	0.66	0.37	9.43
Avg./site Below	0.00	0.00	3.67	0.00	0.00	0.00	3.67
Avg./site for Mo.	3.88	1.45	3.39	0.88	0.33	0.37	5.97

Table 5. (Continued)

FEBRUARY 1971 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	7.20	0.00	0.00	0.00	24.00
5	0.00	0.00	38.00	0.00	0.00	0.00	66.00
6	811.00	280.70	361.10	2.25	0.78	0.35	233.00
7	10.00	5.00	46.00	0.22	0.11	0.50	60.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	4.00	0.40	252.80	0.02	0.01	0.10	134.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	10.30	0.00	0.00	0.00	14.70
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	811.00	280.70	406.30	-	-	-	323.00
Total Below	14.00	5.40	309.10	-	-	-	208.70
Total for Mo.	825.00	286.10	715.40	-	-	-	531.70
Avg./site Avove	135.17	46.78	67.72	2.00	0.69	0.35	53.83
Avg./site Below	1.56	0.60	34.34	0.05	0.02	0.39	23.19
Avg./site for Mo.	55.00	19.07	47.69	1.15	0.40	0.35	35.45

Table 5. (Continued)

MARCH 1971 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	18.40	0.00	0.00	0.00	46.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	23.00	0.00	0.00	0.00	23.00
5	34.50	14.90	133.70	0.26	0.11	0.43	116.00
6	1958.40	794.40	757.20	2.59	1.05	0.41	530.40
7	39.00	18.00	315.50	0.12	0.06	0.46	150.30
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	21.30	10.70	256.80	0.08	0.04	0.50	181.40
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	161.00	0.00	0.00	0.00	138.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	1992.90	809.30	932.30	-	-	-	715.40
Total Below	63.30	228.70	733.30	-	-	-	469.70
Total for Mo.	2053.20	838.00	1665.60	-	-	-	1185.10
Avg/site Above	332.15	134.88	155.38	2.14	0.87	0.41	119.23
Avg./site Below	6.70	3.19	81.48	0.08	0.04	0.48	52.19
Avg./site for Mo.	136.88	55.87	111.04	1.23	0.50	0.41	79.01

Table 5. (Continued)

APRIL 1971 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt/Hr	lbs/Fish	Man-days/site
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	52.80	0.00	0.00	0.00	66.00
3	660.00	127.60	66.00	10.00	1.93	0.19	44.00
4	0.00	0.00	107.00	0.00	0.00	0.00	54.00
5	0.00	0.00	1271.00	0.00	0.00	0.00	374.00
6	5660.30	2026.00	2314.90	2.45	0.88	0.36	1120.40
7	195.00	171.40	1352.30	0.14	0.13	0.88	744.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	264.00	0.00	0.00	0.00	66.00
10	409.00	165.10	781.10	0.52	0.21	0.40	575.50
11	0.00	0.00	704.00	0.00	0.00	0.00	88.00
12	0.00	0.00	209.60	0.00	0.00	0.00	148.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	6320.30	2153.60	3811.70	-	-	-	58.40
Total Below	604.00	336.50	3311.00	-	-	-	1621.50
Total for Mo.	6924.30	2490.10	7122.69	-	-	-	3279.97
Avg./site Above	1053.38	358.93	635.28	1.66	0.56	0.34	276.40
Avg./site Below	67.39	37.39	367.89	0.18	0.10	0.56	180.17
Avg./site for Mo.	461.62	166.01	474.85	0.97	0.35	0.36	218.66

Table 5. (Continued)

MAY 1971 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt./Hr	lbs/Fish	Man-days/site
1	0.00	0.00	132.00	0.00	0.00	0.00	40.00
2	33.00	95.70	337.60	0.10	0.28	2.90	113.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	143.00	51.70	397.00	0.36	0.13	0.36	135.00
5	0.00	0.00	715.00	0.00	0.00	0.00	214.00
6	10,938.00	3622.40	2907.30	3.76	1.25	0.33	1690.60
7	149.70	87.90	669.00	0.22	0.13	0.59	555.50
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	100.00	0.00	0.00	0.00	40.00
10	639.30	207.10	1109.40	0.58	0.19	0.32	531.50
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	135.10	0.00	0.00	0.00	102.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	11,114.00	3769.80	4488.90	-	-	-	2192.60
Total Below	789.00	295.00	2013.50	-	-	-	1229.00
Total for Mo.	11,903.00	4064.80	6502.60	-	-	-	3421.60
Avg./site Above	1,852.33	628.30	748.15	2.48	0.84	0.34	365.43
Avg./site Below	87.67	32.78	223.72	0.39	0.15	0.37	136.56
Avg./site for Mo.	793.53	270.99	433.49	1.83	0.63	0.34	228.11

Table 5. (Continued)

JUNE 1971 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt./Hr	lbs/Fish	Man-days/site
1	1122.00	1007.60	176.00	6.38	5.73	0.90	44.00
2	1254.00	1039.50	242.00	5.18	4.30	0.83	99.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	64.00	30.40	72.00	0.89	0.42	0.47	24.00
5	16.00	6.40	493.40	0.03	0.01	0.40	406.00
6	1579.10	756.20	1166.00	1.35	0.65	0.48	767.10
7	66.80	132.40	1104.70	0.06	0.12	1.98	695.20
8	0.00	0.00	2.20	0.00	0.00	0.00	22.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	1402.00	276.40	1096.80	1.28	0.25	0.20	540.00
11	0.00	0.00	1078.00	0.00	0.00	0.00	154.00
12	100.00	32.60	194.80	0.51	0.17	0.33	136.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	44.00	22.00	217.80	0.20	0.10	0.50	66.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	4035.10	2840.10	2149.40	-	-	-	1340.10
Total Below	1612.80	463.40	1613.20	-	-	-	1613.20
Total for Mo.	5647.92	3303.50	5843.30	-	-	-	2953.30
Avg./site Above	672.52	473.35	358.23	1.88	1.32	0.70	223.35
Avg./site Below	179.20	51.49	410.48	0.44	0.13	0.29	179.24
Avg./site for Mo.	376.53	220.23	389.58	0.97	0.57	0.58	196.89

Table 5. (Continued)

JULY 1971 HARVEST

Site	Number	Weight	Hours	No./Hr	Wt./Hr	lbs/Fish	Man-days/site
1	126.00	560.10	420.00	0.30	1.20	4.02	84.00
2	170.00	187.00	296.00	0.57	0.63	1.10	131.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	63.00	0.00	0.00	0.00	63.00
5	0.00	0.00	98.00	0.00	0.00	0.00	60.00
6	532.30	149.20	319.50	1.67	0.47	0.28	254.50
7	401.50	148.40	1532.70	0.26	0.10	0.37	822.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	366.80	95.60	1311.20	0.28	0.07	0.26	518.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	315.00	0.00	0.00	0.00	63.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Above	828.30	842.30	1196.50	-	-	-	572.50
Total Below	768.30	224.00	3158.90	-	-	-	1403.00
Total for Mo.	1596.60	1086.30	4355.40	-	-	-	1975.00
Avg./site Above	138.05	140.38	199.42	0.69	0.70	1.02	95.42
Avg./site Below	85.37	27.11	350.99	0.24	0.08	0.32	155.89
Avg./site for Mo.	106.44	72.42	290.36	0.37	0.25	0.68	131.70

Table 6. Test of difference in average number of fish caught per site, by month and annually, above and below Broken Bow Reservoir.

Month	Avg. No./site above	Avg. No./site below	Differences	t_{13}
8/70	44.92	50.44	5.52	0.127
9/70	38.22	59.92	21.70	0.447
10/70	71.17	15.86	55.31	1.264
11/70	18.50	0.00	18.50	1.555
12/70	43.03	0.00	43.03	1.249
1/71	9.70	0.00	9.70	1.249
2/71	135.17	1.56	133.61	1.234
3/71	332.15	6.70	325.45	1.249
4/71	1053.38	67.39	985.99	1.323
5/71	1852.33	87.67	1764.66	1.211
6/71	672.52	179.20	493.32	1.626
7/71	138.05	85.37	52.68	0.541
Mean	367.43	46.18	321.25	t_{22}= 1.955*

*$t_{.1(22)} = 1.717$

Table 7. Test of difference in average weight (in pounds) of fish caught per site, by month and annually, above and below Broken Bow Reservoir.

Month	Avg. wt./site above	Avg. wt./site below	Difference	t_{13}
8/70	24.12	34.10	9.98	0.356
9/70	16.65	29.22	12.57	0.602
10/70	56.20	6.67	49.53	1.501
11/70	25.57	0.00	25.57	1.709
12/70	21.08	0.00	21.80	1.249
1/71	3.63	0.00	3.63	1.248
2/71	46.78	0.60	46.18	1.233
3/71	134.88	3.19	131.69	1.246
4/71	358.93	37.39	321.54	1.194
5/71	628.30	32.78	595.52	1.239
6/71	473.35	51.49	421.86	2.443*
7/71	140.38	27.11	113.27	1.515
Mean	160.82	18.55	142.27	t_{22} =2.344**

*$t_{.05(13)}$ = 2.160

**$t_{.05(22)}$ = 2.074

Table 8. Test of difference in catch rate (number/hour) per site, by month and annually, above and below Broken Bow Reservoir.

Month	Avg. catch rate/ site, above	Avg. catch rate/ site, below	Difference	t_{13}
8/70	0.30	0.37	0.07	0.367
9/70	0.22	0.40	0.18	1.035
10/70	0.53	0.19	0.34	0.491
11/70	0.79	0.00	0.79	5.315****
12/70	2.29	0.00	2.29	6.286****
1/71	1.77	0.00	1.77	6.257****
2/71	2.00	0.05	1.95	6.462****
3/71	2.14	0.08	2.06	6.043****
4/71	1.66	0.18	1.48	1.129
5/71	2.48	0.39	2.09	4.194***
6/71	1.88	0.44	1.44	1.563*
7/71	0.69	0.24	0.45	2.056**
Mean	1.23	0.20	1.03	t_{22} = 4.222*****

*$t_{.2(13)}$ = 1.350

**$t_{.1(13)}$ = 1.771

***$t_{.005(13)}$ = 3.372

****$t_{.001(13)}$ = 4.221

*****$t_{.001(22)}$ = 3.119

The greatest amount of fishing effort occurred in April (7122.69 hours), but the greatest harvest occurred in May (11,903 fish weighing 4,064.80 pounds; Table 5). The highest catch rate was observed during May (1.83 fish/hour) although the December catch rate was a close second (1.69 fish/hour; Table 5). In order to compare the catch statistics above and below by month, a series of "t" tests were run for observed average site differences in number of fish caught (Table 6), weight of fish caught (Table 7) and catch rate (Table 8). In all three instances mean annual values derived from the monthly averages were significantly different, but few of the individual months were found to differ significantly at the P=0.1 level.

Conclusions

The reason that the large differences between average site values above and below were usually not significant (at least at the levels of probability usually selected for rejection, e.g., P = .10 or .05) was due mainly to the high variation in parameter values (number of individuals, expenses, catch, etc.). However, these large variance values were not unexpected because use-patterns, catch, etc. were expected to change very greatly with the different seasons. For instance, we expected very little use or harvest in January either above or below and the opposite results were expected from interviews taken in May. The data did follow these seasonal patterns; however, even non-parametric tests were unable to detect the observed differences with significance because there was a lack of consistency in the relative position of the values for the various sites (or months).

I hope that sometime in the future money can be obtained for a mathematical/statistical consultant to thoroughly investigate these data with some of the analysis-of-variance techniques now available to handle data with these kinds of predictable variances. Then, perhaps we can attach statistical significance to a difference such as the 26,455 fish caught above as opposed to the 4,984 fish caught below by approximately equal numbers of fishermen. This study did not point out why the large difference in catch occurred. At the present time, I would hypothesize that the major detrimental influences on the downstream fishery are nearly continuous and major water level fluctuations, and constant flushing with cold water so that downstream water temperatures rarely rose as high as 70F after power generation was continued on a regular basis.

From these data we also get th- hint that an unaltered stream is more valuable than on which is no longer controlled by natural environmental factors since our interviewed recreationists were willing to pay $14.13/man-day above as opposed to $12.87/man-day below (based on 5-hour man-day). Since three different cost figures were derived for cost/man-day depending on whether the amount allowed by law ($3.00/man-day), the amount per actual man-day ($5.83/2.0-hour man-day) or the cost as usually would have been applied in an impact study ($13.48/5-hour man-day) if not limited by law, it becomes obvious that good statistics must be derived for each situation when the value of a resource is being estimated.

To determine the capital value of this resource, the formula that is: Interest/Rate = Capital Value.

In our case the interest is the estimated expenditures for use of the resource ($88,133), the interest rate is 5.5% and therefore the resource capital value is $1,602,418. The free flowing upstream portion has a capital value of $821,600 and the altered downstream section has a capital value of $780,818. The amazing thing about these figures is that the values of the unaltered portion of the river is actually greater than the value of the river below the dam because the downstream portion has a state park (Beavers Bend State Park) and extensive provisions for stream-side recreation in the form of parking areas, picnic tables, trash facilities and toilets while the upstream access sites are totally undeveloped and after a summer of heavy use are little more than trash heaps. Even so, people who were interviewed during June and July 1971 (the peak tourist months) often indicated that they had been to one of the below access sites but had moved to the above access site where they were being interviewed because of one or more of the following reasons (listed by

order of implied importance): 1) the fishing had been extremely poor at the below site with the individuals often seeing fish but being unable to catch any; 2) large fluctuations in water level; and/or 3) cold water temperatures which discourage swimming and wading.

Finally, based on the above expenditures/mile of $1,865.73, the expected expenditures for that portion of the river inundated by Broken Bow Dam would have been $46,662. This gives a computed capital value of $848,400. This estimate may be considered conservative according to reports from local residents about the relative use patterns that existed before construction of the dam, i.e., this was the most scenic part of the river and it received the heaviest use.