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FISHERIES OF THE MISSOURI RIVER FROM GREAT FALLS TO FORT BENTON AND HISTORICAL DISCHARGES OF MORONY DAM

by

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and

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ABSTRACT

Historical discharge patterns of the Missouri River downstream from Morony Dam were analyzed for the 1977-89 water years to determine impact on fish populations. Large daily extremes were a common occurrence throughout the period with daily discharge changing as much as 16,300 cfs. The mean annual discharge was 7,790 cfs. The largest daily change in gage height was 3.55 feet. Changes in gage height were more extreme when river flow was low, given equal changes in discharge. Flow fluctuations of 90 percent in one day were not uncommon. Extremes occurred within a two to three hour time period for over half of the days plotted. An attenuation study showed that extremes are only slightly dampened downstream. This suggests that extreme discharge fluctuations may impact the entire 200 mile reach of the Middle Missouri.

Electrofishing surveys in 1990 indicated fish populations were dominated by four species: goldeye, shorthead redhorse, longnose suckers, and carp. Sauger, historically the most abundant gamefish, were much reduced in numbers when compared to previous years. Catch rates were as much as 20 fold higher in 1980 than in 1990. Extreme daily discharge fluctuations may have impacted sauger YOY survival in the lower reaches of the Middle Missouri in the last four years. River flows were below average in these years. Catch rates of nongame species, particularly redhorse suckers, were much higher during 1990 than in past years and may be related to reduced predation by sauger.

No pallid sturgeon were found in the study area but shovelnose sturgeon were collected two miles downstream from Morony Dam (the farther upstream recorded to date). Pallids may conceivably use this reach as these two species often overlap in habitat and pallids have been observed at Fort Benton in the past.

Gill netting of four Missouri River reservoirs near Great Falls indicate walleye have established populations in the lower two (Ryan and Morony). Several recommendations for the reservoir and river fishery were made.

ACKNOWLEDGEMENTS

Thanks are due to Brent Mabbitt, fisheries biologist for Montana Power Company, who assisted not only with EA's electrofishing, but also enthusiastically helped with sturgeon and brown trout sampling on the Missouri River and gill netting on the Great Falls reservoirs. Keith Binkley did the electrofishing for EA and provided the MDFWP the raw data for this report in a timely manner. Ed Chiotte, a volunteer from Great Falls, assisted with gill netting on the reservoirs. George Liknes and Bill Gardner of the MDFWP provided equipment (electrofishing gear, boats, nets, sonar, etc.), information, and technical help. Mel White from the USGS in Helena was very helpful in providing discharge data on the Missouri River. Steve Leathe, of the MDFWP, was supervisor for this portion of the study. It was a pleasure working as a team comprised of industry, private business, and a state agency. Working together developed relationships which can only benefit Montanans and Montana's resource.

INTRODUCTION

Montana Power Company (MPC) has seven hydropower projects on the Missouri and Madison rivers and was issued Federal Power Commission Project License No. 2188 on April 23, 1956. This license encompasses two projects on the Madison (Hebgen and Madison) and five on the Missouri (Hauser, Holter, Black Eagle, Rainbow, Cochrane, Ryan, and Morony). The license was due to expire on November 30, 1998 but the Federal Energy Regulatory Commission (FERC) allowed MPC to accelerate the expiration date to November 30, 1994. MPC sought the earlier relicense date to facilitate financing for rehabilitation and expansion work at some of the projects. Financing amounts were estimated at $120,000,000. MPC's application for the new license must be filed by November 30, 1992 (MPC 1989).

MPC hired EA Engineering, Science, and Technology (EA), a consulting firm from Redmond, Washington, to determine total biomass, population size, and related fishery information on the Missouri River from Morony Dam to Fort Benton (32 river miles). EA also collected instream flow data for fishery and waterfowl purposes. Field work was conducted from spring through fall, 1990. I was hired by the Montana Department of Fish, Wildlife and Parks (MDFWP) on contract with MPC to assist EA with fish sampling on this reach of river and provide the necessary fish collection permit. When not directly working with EA, I: (1) sampled this reach of river for pallid sturgeon (an endangered species), (2) located pools in the river which might contain sturgeon, (3) assessed daily discharge patterns from Morony Dam, (4) briefly summarized electrofishing data collected during 1990 to compare with previous MDFWP sampling, (5) compiled Fisherman Log Data from Morony Dam to Fort Benton, (6)sampled Belt and Highwood creeks (the only two perennial tributaries in this reach) and compared results

to previous MDFWP findings, (7) electrofished the Missouri at the mouth of Highwood Creek to monitor brown trout spawning use, (8) sampled fish populations in the reservoirs above Black Eagle, Cochrane, Ryan, and Morony dams and compared with previous MDFWP surveys and (9) tested a Smith Root Radio tag to determine range at which signals could be received at various depths. This report will list these findings and relate them to hydropower operations. EA will submit a detailed analysis of their electrofishing and instream flow data and to MPC and will report their findings as they relate to the Morony hydropower project.

STUDY AREA

The study area consisted of approximately 43 miles of the Missouri River from Great Falls to Fort Benton, Montana (Figure 1). This reach of the Missouri has an average annual daily discharge of 7,790 cfs at Morony Dam (USGS 1990). Water temperature taken once daily at Ryan Dam ranged from 32°F to 81°F from 1917 to 1964 (Table 1). Berg (1981) recorded a maximum water temperature of 68°F downstream from Morony Dam during 1977.

The upper 10.8 miles of study area are impacted by five hydropower projects operated by MPC (Figure 1). These dams were built from 1916 to 1958 and have a range of usable storage from 1,060 to 7,000 acre-ft (Table 2). They are usually operated as "run-of-river" but evidence indicates that daily load shaping has occurred. USGS records indicate extreme diurnal fluctuations occur at Fort Benton due to operations at the Morony power plant. Daily discharge through these reservoirs is dependent on inflow, which is largely controlled by discharges from Holter and Canyon Ferry dams. Holter is a MPC project completed in 1918 and located 95 river miles upstream from Great Falls. Holter Reservoir has 82,000 acre-ft of usable storage with inflow controlled by discharges from Canyon Ferry Dam. Canyon Ferry is a U.S. Bureau of Reclamation project completed in 1953 and located 42 river miles upstream from Holter Dam. Canyon Ferry has substantial storage capacity (2,043,000 acre-ft) and significantly modifies the natural flow regime of the Missouri River downstream. The five small Great Falls reservoirs range from approximately 1.6 to 4 miles long and 18 to 60 MW in generating capacity (Table 2).

The five reservoirs near Great Falls act as sediment basins which can, at times, limit turbidity and sediment downstream from Morony Dam. The Sun River, whose mouth is 3.8 miles upstream from Black Eagle Dam, carries heavy loads of sediment into the Missouri River. The Muddy Creek drainage (impacted from an irrigation project) transports approximately 200,000 tons of soil into the Sun River annually (Missouri River Basin Commission 1980). Sedimentation can be a problem through all five reservoirs. During the first week of November, 1990, water levels in Morony Reservoir were dropped to facilitate repairs on the head gates. A large sediment bar several feet thick was exposed in the middle section of Morony Reservoir. As water levels in the reservoir declined,

FIGURE 1. MAP OF THE MISSOURI RIVER FROM GREAT FALLS TO FORT BENTON. NUMBERS INDICATE RIVER MILES DOWNSTREAM FROM MORONY DAM.

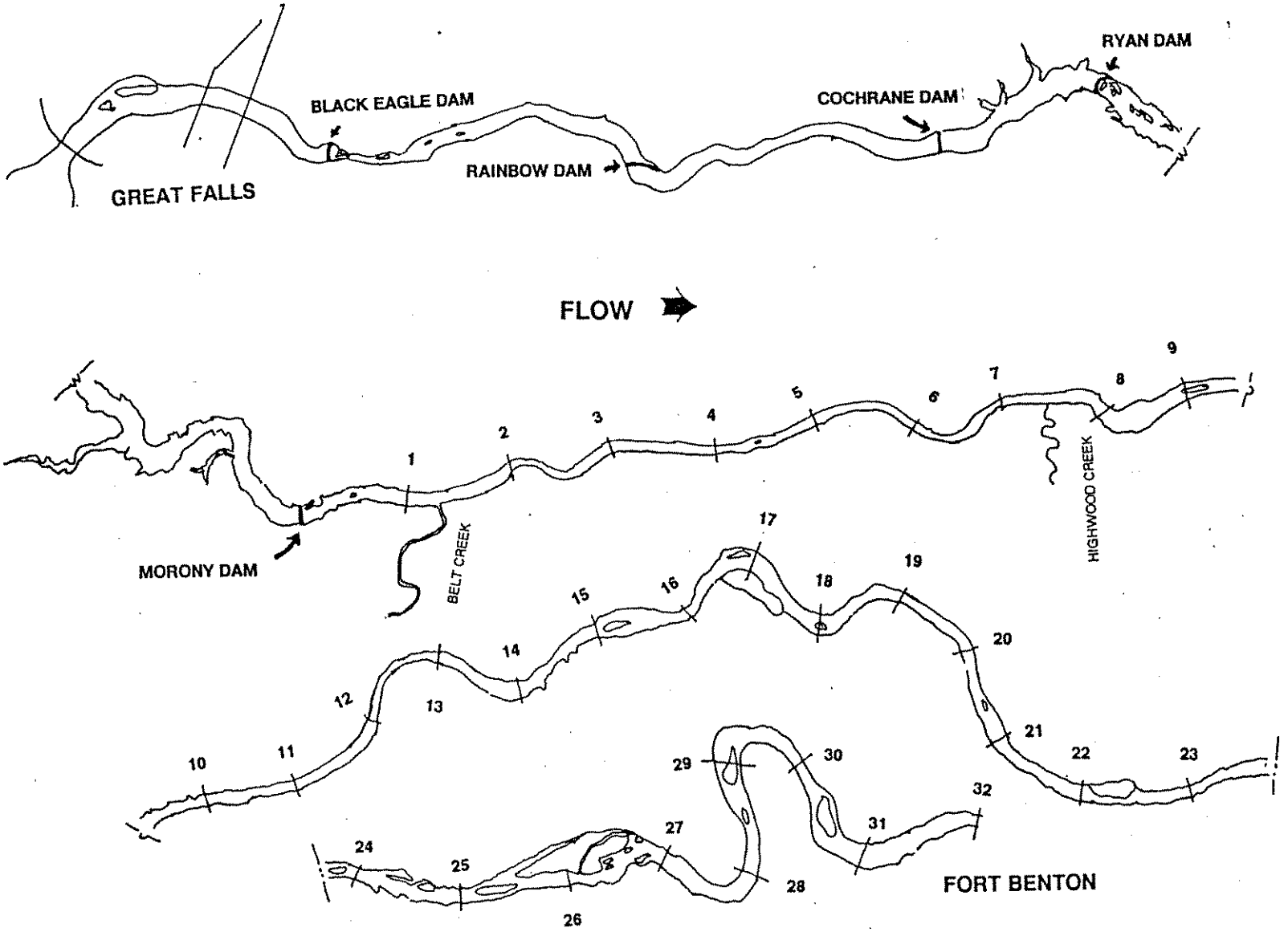


TABLE 1. SUMMARY OF ONCE DAILY WATER TEMPERATURES AT RYAN DAM (Aagaard 1969).

		Jan		Feb		Mar		Apr		May		June		July		Aug		Sept		Oct		Nov		Dec	
1917	Max	--		--	32	33	32	44	32	54	35	63	46	74	61	70	62	63	53	57	36	45	36	37	32
1918	Max	34	32	35	32	43	32	49	36	57	43	68	52	70	61	70	61	64	56	59	48	48	35	39	32
1919	Max	36	34	34	32	42	32	55	41	65	49	73	55	75	68	70	64	65	46	50	35	38	33	37	33
1920	Max	37	33	37	34	42	33	46	36	54	42	66	53	75	62	75	61	66	52	56	40	43	40	38	34
1921	Max	37	34	38	33	41	32	49	40	58	46	70	54	72	61	--	--	64	48	53	47	60	32	43	32
1922	Max	37	32	35	32	35	32	46	35	57	44	72	55	72	61	75	68	68	56	59	48	46	38	36	32
1923	Max	35	32	33	32	35	32	50	33	58	46	64	55	76	63	72	66	70	57	56	38	44	32	37	33
1924	Max	36	32	39	33	40	37	47	40	57	48	67	51	--	--	--	--	--	--	--	--	--	--	--	--
1925	Max	36	33	--	--	--	--	53	44	61	47	70	53	75	66	75	57	68	50	52	36	41	36	39	34
1926	Max	--	--	40	35	--	--	--	--	--	--	72	59	--	--	--	--	64	44	53	48	48	35	--	--
1927	Max	36	32	35	32	43	33	53	40	55	44	66	50	70	62	70	64	64	53	57	46	46	35	39	33
1928	Max	36	33	37	33	46	35	50	39	61	48	65	55	75	62	70	58	68	52	55	45	45	37	--	--
1929	Max	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1930	Max	36	33	37	35	43	34	54	43	64	53	69	58	76	68	76	56	66	53	58	36	50	36	39	32
1931	Max	39	34	40	36	48	35	56	36	64	50	70	59	75	61	71	63	68	50	57	41	49	34	39	35
1932	Max	39	34	43	34	--	--	59	--	64	46	71	59	71	--	74	--	68	--	--	40	--	--	46	--
1933	Max	45	--	45	--	50	36	58	--	--	47	70	--	75	64	71	54	65	50	58	43	49	35	38	34
1934	Max	37	34	45	34	50	36	54	36	68	54	68	53	75	67	72	61	64	43	62	46	52	39	40	34
1935	Max	37	33	41	35	42	35	53	37	61	48	68	57	77	64	72	64	64	54	59	36	41	35	39	35
1936	Max	37	35	37	33	43	35	56	35	71	53	76	57	81	69	75	66	68	55	58	46	46	36	39	35
1937	Max	36	34	37	35	43	36	55	42	66	54	75	57	77	70	72	63	68	54	57	50	53	39	39	35
1938	Max	39	34	39	35	46	34	55	37	61	49	68	54	75	65	72	64	72	62	64	48	52	36	40	35
1939	Max	37	35	37	35	46	36	59	39	66	53	75	57	75	68	75	61	68	54	57	45	49	39	45	34
1940	Max	37	35	38	35	46	37	53	41	68	52	72	59	77	68	75	68	72	61	63	50	52	36	41	36
1941	Max	39	36	40	36	47	37	57	45	64	54	74	63	79	65	78	61	66	52	56	46	48	38	46	37
1942	Max	39	36	39	36	44	37	54	42	62	51	65	56	76	66	76	55	69	58	62	45	47	39	39	37
1943	Max	40	33	39	36	42	36	53	42	62	48	65	51	75	60	75	67	68	59	63	47	50	41	46	34
1944	Max	39	35	39	35	44	35	54	46	68	51	66	55	74	66	72	64	71	56	59	54	54	42	44	35
1945	Max	39	37	39	33	50	33	51	41	61	51	66	52	73	60	75	66	67	50	59	45	48	35	37	33
1946	Max	35	32	37	30	47	39	57	45	64	50	68	54	73	60	72	64	66	51	57	38	46	35	40	34
1947	Max	39	36	39	35	46	35	57	41	60	52	64	58	75	64	72	52	68	50	59	50	52	38	41	36
1948	Max	39	34	39	35	42	35	50	41	67	48	66	59	71	66	74	65	68	54	59	48	50	37	38	34
1949	Max	36	34	37	34	42	36	54	43	64	52	68	57	75	60	75	66	69	54	61	40	48	42	42	34
1950	Max	38	34	39	36	44	36	51	43	59	44	67	49	73	63	71	63	71	52	57	48	48	37	41	35
1951	Max	--	--	39	36	38	32	53	35	58	45	64	41	74	59	74	57	66	50	57	41	44	37	41	33
1952	Max	37	34	37	34	37	34	55	36	60	51	64	57	71	63	75	67	66	59	61	50	48	37	37	34
1953	Max	39	34	38	35	45	34	51	40	57	48	63	50	75	62	74	65	67	56	57	48	54	41	43	36
1954	Max	39	33	43	37	46	35	50	35	63	43	66	53	74	62	70	64	64	54	54	46	50	38	44	35
1955	Max	39	34	39	34	39	35	50	37	59	48	70	57	75	60	72	64	70	50	55	46	48	36	39	32
1956	Max	39	34	39	34	46	32	49	46	57	46	68	54	75	66	69	64	64	55	57	39	50	37	42	35
1957	Max	40	33	37	34	40	35	50	40	70	48	64	54	75	63	70	57	68	49	60	44	46	35	41	34
1958	Max	39	34	36	34	49	33	49	43	66	51	65	53	72	60	75	63	70	54	55	48	50	37	42	35
1959	Max	37	32	37	34	46	35	50	43	58	50	64	54	75	61	72	63	64	54	54	48	48	32	44	37
1960	Max	41	35	41	32	45	34	54	40	59	48	66	54	74	65	75	61	66	53	59	48	50	40	40	33
1961	Max	35	32	39	32	44	32	48	41	66	48	72	58	72	64	76	64	67	48	61	38	46	33	35	32
1962	Max	35	32	36	32	38	32	53	39	55	47	68	56	75	68	73	62	59	53	55	48	49	37	39	32
1963	Max	36	32	33	32	43	33	52	33	59	50	65	57	72	61	73	63	68	56	57	42	46	36	39	32
1964	Max	35	30	35	33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Extremes for years 1917-28, 1930-64																									
	Max	45	30	45	30	50	32	59	32	71	35	76	41	81	59	78	52	72	43	64	35	60	32	46	32

the river began to cut through sediment deposits and turbidity levels in the river dramatically increased. MPC collected turbidity and dissolved oxygen data but results were not available at this writing.

TABLE 2. CHARACTERISTICS OF FIVE MPC DAMS ON THE MISSOURI RIVER NEAR GREAT FALLS, MT (MPC)1980).

PROJECT	RIVER MILE*	YEAR BUILT	GEN. CAP. (M.W.)	USABLE STOR-AGE(Ac.Ft.)	LENGTH
Black Eagle	2117.7	1927	18	1,700	4.0
Rainbow	2114.6	1917	35	1,060	1.6
Cochrane	2111.4	1958	55	2,700	3.2
Ryan	2109.5	1916	60	2,460	1.5
Morony	2105.6	1929	45	7,880	3.6

*Montana Dept. of Natural Resources (1979)

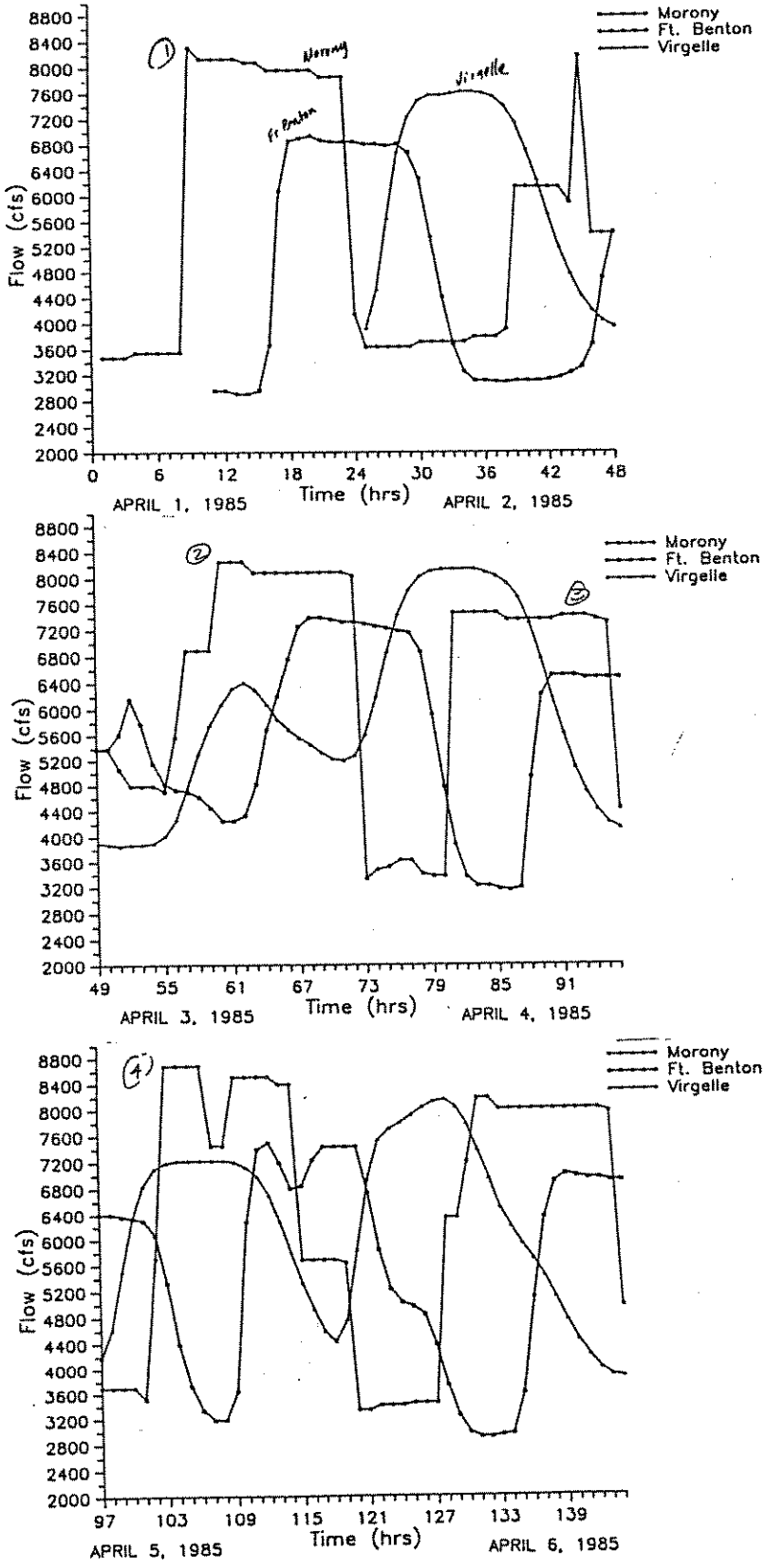
Morony Dam controls the bulk of the flow in the 200 mile reach leading to Fort Peck Reservoir (Middle Missouri River). An attenuation study (Pickett 1990) showed that extreme changes in flow at Morony are only dampened 16 percent at Fort Benton, 32 miles downstream, and 23 percent at Virgelle, 73 miles downstream (Table 3, Figure 2). Discharge patterns at Morony can have serious influence on the entire Middle Missouri including The Wild and Scenic reach between Fort Benton and Robinson Bridge (185 river miles downstream). Pallid sturgeon inhabit the Middle Missouri and were added to the endangered species list on October 9, 1990 (McMaster 1990). Paddlefish, a species of special concern in Montana, provide an important sport fishery in the Middle Missouri.

TABLE 3. MISSOURI RIVER FLOW ATTENUATION FROM MORONY DAM(M) TO FORT BENTON(B) AND VIRGELLE(V), APRIL 1-6, 1985 (PICKETT 1990)

PEAK NO.	PERCENT FLOW ATTENUATION (MAX-MIN) M-B	M-V	TRAVEL TIME OF PEAK (HOURS) M-B	M-V
1	-17%	-22%	9	22
2	-12%	-17%	8	19
3	-18%	-24%	9	21
4	-18%	-28%	9	20
AVE.	-16%	-23%	8.8	20.5

The reservoirs are heavily laden with silt but do have areas of

FIGURE 2. MISSOURI RIVER FLOW MEASUREMENTS SHOWING ATTENUATION FROM MORONY TO VIRGELLE (Pickett 1990).



boulders and rubble, particularly in the areas immediately above and below each dam. The first three miles of river below Morony Dam consists of rapids with many angular boulders and bedrock. Substrate further downstream ranges from rubble to silt. The 16 mile reach from Morony to Carter Ferry contains only a few islands or side channel areas while this habitat is much more abundant from Carter Ferry to Fort Benton (Figure 1). Stream gradient ranged from 18.7 ft/mi near the mouth of Belt Creek to 4.0 ft/mi near Fort Benton (Berg 1981).

Berg (1981) found high potential for biological productivity in this area of the Missouri. During 1978-79 the concentration of total dissolved solids was 2 to 3 times higher than "average" river water. Calcium ion concentrations in the Middle Missouri River ranged from 1.796 to 3.942 me/l. At Morony Dam total nitrates/nitrites ranged from 0.04 to 0.23 mg/l and total phosphorous from 0.040 to 0.070 mg/l. Hauer and Stanford (1990) found nitrate/nitrite levels downstream from Morony Dam ranged from 0.05 to 0.30 mg/l and total phosphorous 0.04 to 0.09 mg/l during 1989. The large amounts of attached and floating filamentous algae observed during this study indicated high productivity. During summer and early fall, algae can become a nuisance for fishermen.

Berg (1981) found that the Missouri River from Morony Dam to Robinson Bridge had a wide variety of mayfly taxa in contrast to limited numbers of stonefly and caddisfly taxa. This was similar to the community structure on comparative reaches of the Yellowstone River. Berg found that the simplest and least diverse insect community occurred at Morony Dam and increased progressively in a downstream direction. He suggested the following explanations for lower insect diversity near Morony: (1) suitable substrate for insects may be scarce, (2) the Great Falls hydropower projects may act as barriers to insect colonization, and (3) diurnal fluctuations of stage height below Morony Dam may disrupt the macroinvertebrate community. The relative abundance of macroinvertebrates at the Morony site appeared to be similar to downstream sites.

Forty-two fish species were collected by Berg (1981) in the mainstem of the Missouri from Morony to Fort Peck. Of 41 species he showed a longitudinal distribution for, 26 were captured near Morony, 30 at Carter Ferry and 31 near Fort Benton. Berg considered the reach from Morony to the Marias River (54 river miles downstream) a transition zone for warmwater and coldwater fish communities.

Except for the upper two reservoirs (Black Eagle and Rainbow), public access to the reservoirs is limited. An access road is open to Ryan and Morony dams but boating or fishing access is only allowed below Morony Dam. No public access is available to Cochrane Dam or Reservoir. The MDFWP, sportsmen's groups, and MPC have discussed the possibliity of providing public access at Morony Reservoir in the past. In April of 1985 MPC granted MDFWP access to the reservoir to initiate a fish stocking program. Results of

the stocking were to be monitored over a three year period to determine if a walleye fishery could be established. Negotiations were to be initiated to obtain public access to Morony Reservoir, should results of the planting prove positive. Fish stocking records for the reservoirs are listed in Table 4.

TABLE 4. FISH PLANTING RECORDS FOR THE FIVE MISSOURI RIVER RESERVOIRS NEAR GREAT FALLS, MT. (MDFWP 1990).

RESERVOIR	YEAR	MONTH	SPECIES	SIZE (INCHES)	NUMBER
Black Eagle	1933	06	blk bullhead	2	17,280
Rainbow*	1975 -85	06-11	rainbow trout (Rb)	8-12	6,2000-18,000/yr.
Rainbow	1975	05	Rb	fry	200,000
Cochrane	1977	05	walleye	fry	200,000
Cochrane	1985	04	walleye	fry	100,000
Cochrane	1986	05	walleye	fry	100,000
Ryan	NO RECORDS OF ANY PLANTS				
Morony	1985	07	walleye	2	4,000
Morony	1986	05	walleye	fry	1000,000
Morony	1986	08	walleye	4	650
Morony	1987	08	walleye	3	14,080
Morony	1990	08	walleye	4.6	9,985

*Planting records show that rainbow trout were stocked beginning in 1937 but are not summarized in this table.

Public access to the river is limited to the following sites: (1) immediately downstream from Morony Dam (small boat and fishing access), (2) Carter Ferry (boat ramp) and (3) a boat ramp at Fort Benton. Floating use downstream from Morony Dam to Carter Ferry is light because of a hazardous reach of whitewater in the first two miles. Use by shore anglers is limited by the high bluff and breakland topography and a lack of accesible public lands.

METHODS

Three electrofishing sections were established by EA (Figure 1). Section 1 was the uppermost, beginning at Morony Dam and extending approximately three river miles (rm) downstream through the Big Eddy. Section 2 began 3.4 river miles below Morony, immediately upstream from Portage Coulee. Section 2 ended downstream from

Huntley Coulee at rm 8.9. The lower section (Section 3) began upstream from Short Coulee at rm 22.6 and extended downstream to the first bend below Cottonwood Bottom at rm 28.5. Because of rapids and sharp bedrock, the upper section could not be effectively sampled. This section was electrofished using a drift boat, on September 19, 1990 to determine species composition. The lower two sections were electrofished repeatedly during spring (April and May), summer (August to September 13), and fall (October 23 to November 14). Electrofishing was done from a boat with boom electrodes and two netters. Smith Root backpack electrofishing gear was used to sample Belt and Highwood Creeks.

A Lowrance chart recording depth sounder was used on August 2 and 6, 1990 to locate deep pools in the river from the Big Eddy to Fort Benton. River discharges ranged between 4765 and 5200 cfs (gage height of 3.23 to 3.26 ft) when this survey was performed.

Experimental 125 x 6'gill nets with five panels of 0.5 to 2.5 inch mesh were used to sample Black Eagle, Cochrane, Ryan and Morony reservoirs. Two sinking and two floating nets were set overnight in each reservoir from September 24-28. Rainbow Reservoir was not sampled because of time constraints and low water levels (due to dam repairs).

Setlines and trammel nets were used in attempts to capture pallid sturgeon. Set lines were 200 feet long with 10 hooks per line and were baited with minnows. Trammel nets were 150 x 6' with either 0.5" or two-inch interior mesh size. Trammel nets were drifted through slow runs/pools. Electrofishing gear and hook and line were also used in attempts to capture sturgeon.

Water temperature was recorded at Carter Ferry with a Taylor thermograph. Temperature data were also obtained using a hand held thermometer. Consultants working for MPC have also gathered water temperature data but the information was not available for this report.

Hourly, daily maximum-minimum, and mean daily discharge and gage height data for the Morony Gage Station were obtained from USGS records in Helena. Daily maximum-minimum discharge and gage height data had to be manually entered into the computer. The USGS only keeps these data in computer files for 18 months, however hardcopy records for as far back as 1977 were available. Information for years prior to 1977 is only available from the original charts stored in archives in Denver or Washington D.C.

Fisherman log information from Morony to Fort Benton was obtained from computer records kept at the MDFWP in Bozeman. These log books are available to fishermen who voluntarily keep and return personal records on fishing success.

A Smith Root radio tag, P-40-10001-6V, was submerged in Morony Reservoir to determine distances at which radio signals could be received. The tag was 5.5 inches in length, 0.88 inches in

diameter, had a stiffened antenna 5.8 inches long, and was powered by lithium batteries. Both an omni directional and a directional loop antenna, LA-40, were used with a Smith Root Model SR-40 Search Receiver.

Fish population estimates were calculated using the Adjusted Peterson Estimate (equation 3.7 in Ricker 1975). Variance was calculated using equation 3.8 in Ricker (1975).

FINDINGS

Historical Discharge Pattern, Morony Dam

Average monthly, yearly, and daily extreme discharge data for water years 1977-89 are summarized in Appendix Tables 1 through 13. Maximum, minimum, and average daily change in stage height is also summarized in these tables.

The average annual discharge of the Missouri River downstream from Morony Dam ranged from 4671 to 9331 cfs for the 1977 to 1989 water years. The lowest three average annual discharges were 5807, 4671, and 5881 cfs during the 1986, 1987, and 1988 water years, respectively (Figure 3, Appendix Tables 1-13). This compares to the average annual discharge of 7790 cfs for the 33 years of record (USGS 1990).

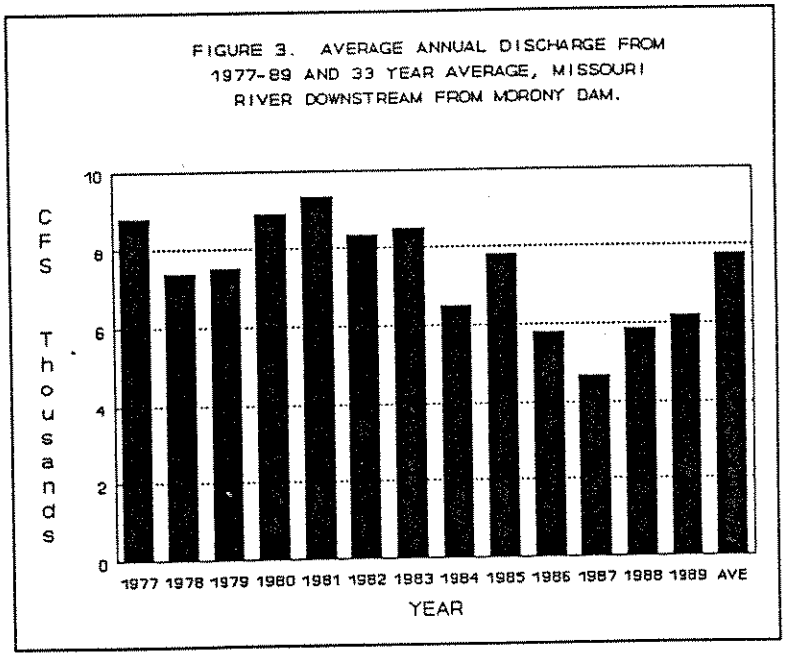


FIGURE 3. AVERAGE ANNUAL DISCHARGE FROM 1977-89 AND 33 YEAR AVERAGE, MISSOURI RIVER DOWNSTREAM FROM MORONY DAM.

Average monthly discharge is typically greatest in May or June during the mountain snow melt period. April and July are typically the next highest periods (Figure 4, Appendix Tables 1-13). This pattern does not always occur because of the large storage capacity in Canyon Ferry Reservoir located upstream. Storage has probably dampened extreme high and low discharges thus altering typical high summer and low winter flow patterns. For example, the highest discharge ever recorded at Fort Benton was 140,000cfs in 1908. This was prior to construction of the mainstem Missouri reservoirs. The next highest discharge ever recorded was 72,000 cfs in 1964. This flow was little more than half of the previous recorded high flow prior to construction of the dams. The minimum instantaneous discharge was one cfs on April 16, 1962 (power plant shutdown) and the minimum average daily

discharge was 1,760 cfs on April 16, 1961 (USGS 1990).

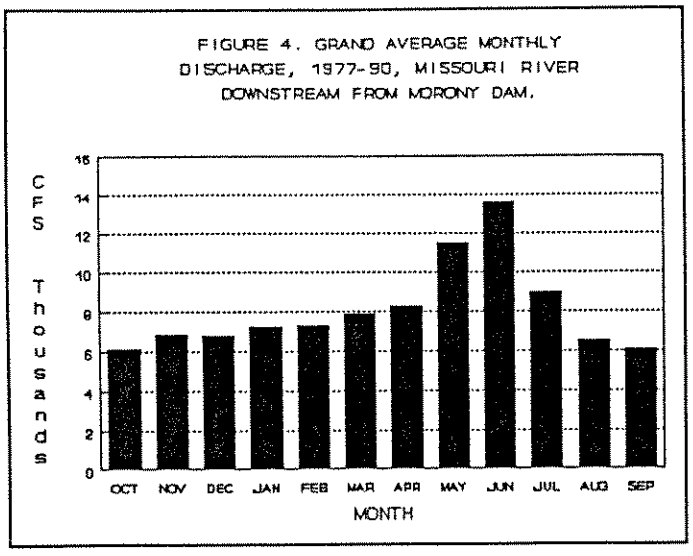


FIGURE 4. GRAND AVERAGE MONTHLY DISCHARGE, 1977-90, MISSOURI RIVER DOWNSTREAM FROM MORONY DAM.

The greatest daily flow fluctuation seen during the period 1977 through 1989 was 16,300 cfs. This occurred on June 17, 1980 and resulted in a gage height change of 1.87 ft. The greatest change in gage height during the period studied was 3.55 feet on April 13, 1988. Flows fluctuated between 685 and 8440 cfs on that date. The flow rating curve (Figure 5) indicates discharge fluctuations of equal amounts cause greater changes in gage height at low flows than when river flow is high. Monthly averages of daily flow fluctuations ranged from 1407 to 2593 cfs during the years 1977 through 1989. These fluctuations represent average daily flow changes of 17 to 25 percent (Figure 6). The highest average daily river flow fluctuations occurred in April, while percentage changes in flow were greatest in October.

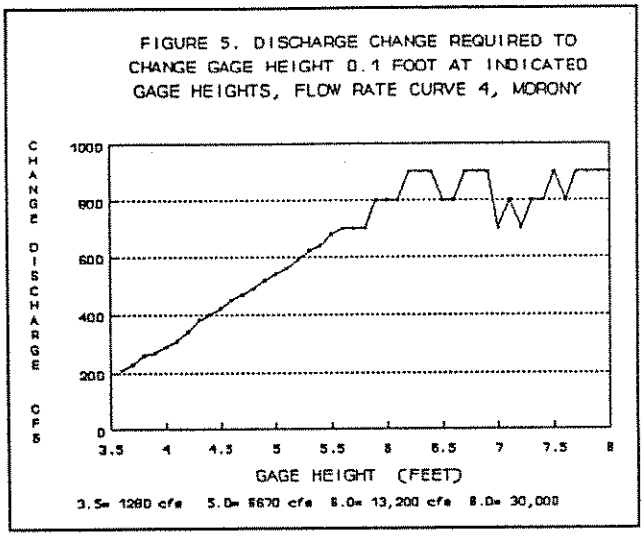
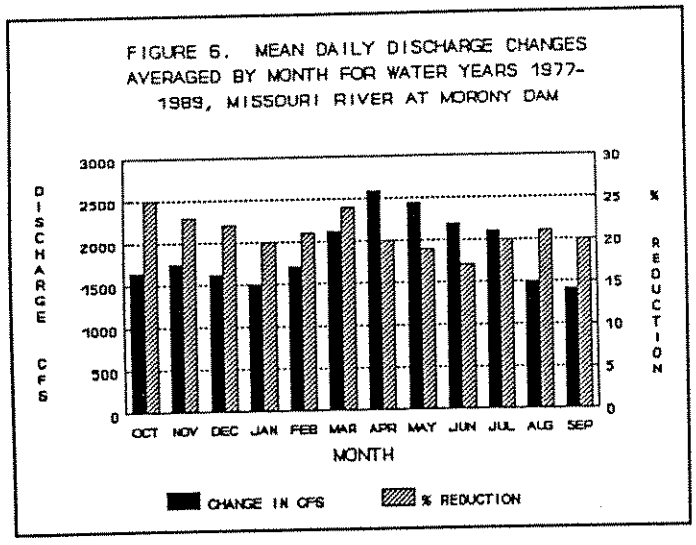


FIGURE 5. DISCHARGE CHANGE REQUIRED TO CHANGE GAGE HEIGHT 0.1 FOOT AT INDICATED GAGE HEIGHTS, FLOW RATE CURVE 4, MORONY

The number of days the stage height changed specified amounts are summarized by month in Appendix Tables 14 through 26. Monthly averages are shown in Figures 7 through 9. Virtually every year had at least one month when average daily gage height fluctuated at least 0.40 feet. Large fluctuations seemed more frequent in the years 1977, 1978, 1979, 1984, 1985, 1987, and 1988.

The 1987 water year appeared to have the most severe water level fluctuations. The highest monthly average of daily stage height changes observed during the entire eleven-year period was 1.08 feet in March of 1987. Twenty-five percent of the days of the 1987 water year had fluctuations of 1.0 to 1.5 ft (Appendix Table 24). The 1987 water year was also the year of lowest average annual discharge (4671 cfs).

Fluctuations during April/May and October/November were analyzed because of their importance as periods of spawning (Appendix Tables



27-52). All years except 1977 had fluctuations of at least 1.0 foot during the spring spawning period (Figures 10-12). Several years had springtime fluctuations exceeding 2.5 feet. Gage height fluctuations exceeded 1.0 foot 37 percent of the time during spring 1988.

Fluctuations of at least 1.0 foot occurred during the fall spawning period in every year except 1977 (Figures 13-15). Fall fluctuations in excess of 2.5 feet occurred in many years. River level fluctuations exceeding 1.0 foot occurred as frequently as 25-27% of the time in fall 1977 and 1979 (Appendix Tables 40-52).

There were many days when the difference in maximum and minimum discharge exceeded 90 percent (Appendix Tables 1-13). For example, on March 10, 1989, river flow changed 94 percent and river stage changed 3.23 ft (Figure 16). River flow averaged about 7300 cfs (gage height of 3.7 ft) from 1:00 a.m. to 11:00 a.m. on this date. At 11:30 a.m. the discharge dropped to 752 cfs (gage height of 1.53 ft) and then peaked at 12,400 cfs at 1:00 p.m. Flows then leveled off to approximately 8500 cfs at 2:00 p.m. (gage height of 3.98 ft). Hourly discharge pattern was plotted for 14 other days and 8 (57%) had most of the change in discharge occurring within a two to three hour time period (Appendix Figures 1-14). Three (21%) had discharge changes that occurred over a period of four to five hours and the remaining three had changes that occurred over a eight to nine hour period.

Water Temperature

Water temperatures were continuously recorded at Cater Ferry using a Taylor Thermograph from July 1 through November 14,1990. Problems with the stylus resulted in missing data for part of July and much of October (Table 5). The maximum temperature, 79°F, was recorded on July 11. Although several records were missing after this date, water temperature had declined to 72°F on July 19, indicating that 79°F was close to the maximum for the year. This is two degrees lower than the maximum observed at Ryan Dam for 37 years of record and eleven degrees warmer than the maximum observed in 1977 (Berg 1981). In 1990, July had the greatest average maximum water temperature (73.7° F) and August had the next highest (72°F, Table 5). This pattern was similar to historical records at Ryan Dam (Table 1). Depending on the month, there was a 1.8 to 6.6°F difference in average monthly maximums and minimums. July had the greatest daily extreme and November the lowest during 1990.

FIGURE 7. MEAN DAILY FLUCUATION IN RIVER STAGE BY MONTH, MISSOURI RIVER DOWNSTREAM MORONY DAM, 1977-81.

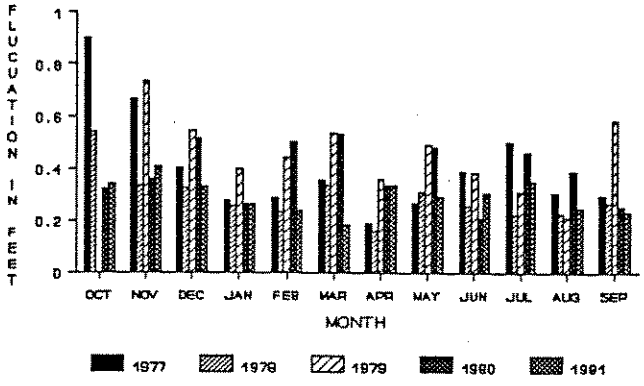


FIGURE 8. MEAN DAILY FLUCUATION IN RIVER STAGE BY MONTH, MISSOURI RIVER DOWNSTREAM MORONY DAM, 1982-85.

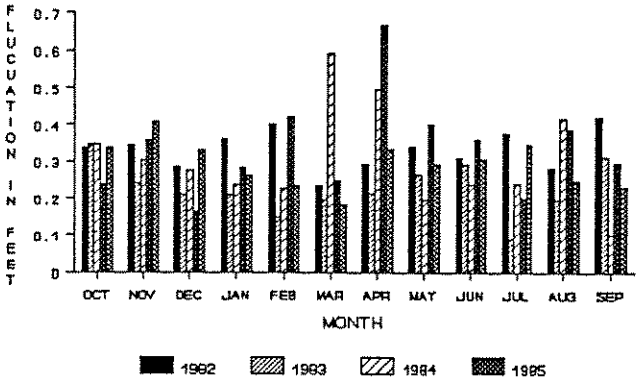


FIGURE 9. MEAN DAILY FLUCUATION IN RIVER STAGE BY MONTH, MISSOURI RIVER DOWNSTREAM MORONY DAM, 1986-89.

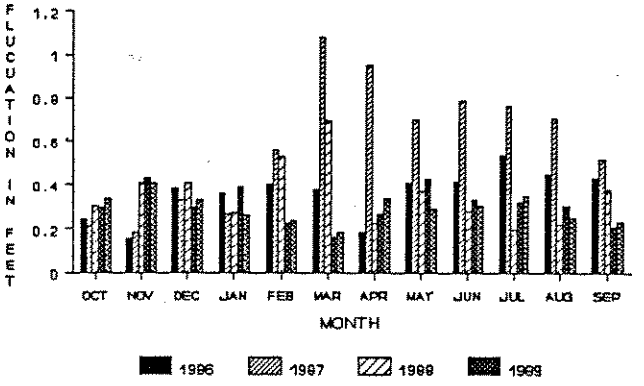


FIGURE 10. PERCENT OF DAYS RIVER STAGE CHANGED DAILY THE INDICATED AMOUNTS, APRIL 1- MAY 31, 1978-82, MORONY DAM.

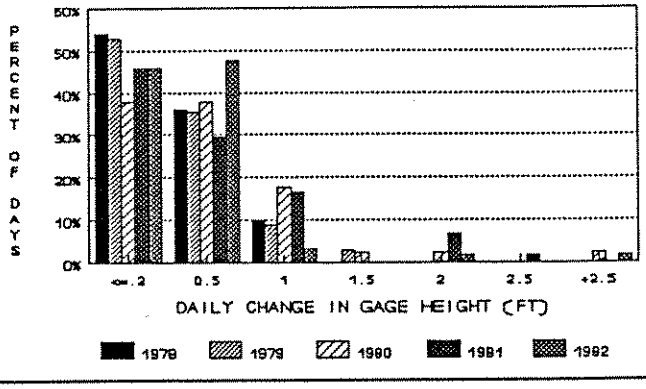


FIGURE 11. PERCENT OF DAYS RIVER STAGE CHANGED DAILY THE INDICATED AMOUNTS, APRIL 1- MAY 31, 1983-86, MORONY DAM.

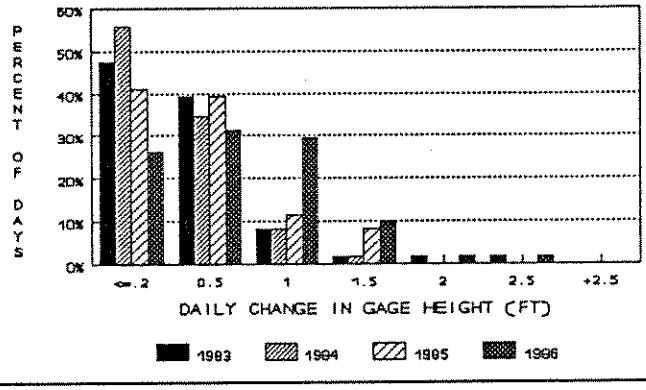


FIGURE 12. PERCENT OF DAYS RIVER STAGE CHANGED DAILY THE INDICATED AMOUNTS, APRIL 1- MAY 31, 1987-90, MORONY DAM.

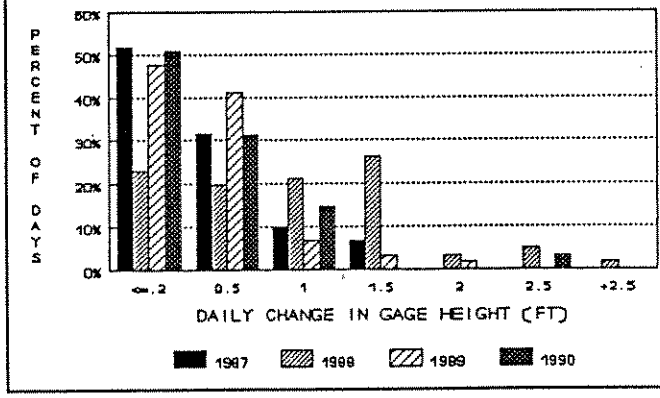


FIGURE 13. PERCENT OF DAYS RIVER STAGE CHANGED DAILY THE INDICATED AMOUNTS, OCT 1- NOV 30, 1977-81, MORONY DAM.

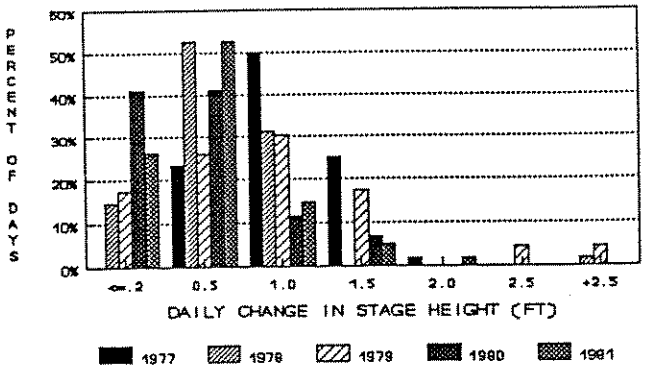


FIGURE 14. PERCENT OF DAYS RIVER STAGE CHANGED DAILY THE INDICATED AMOUNTS, OCT 1- NOV 30, 1982-85, MORONY DAM.

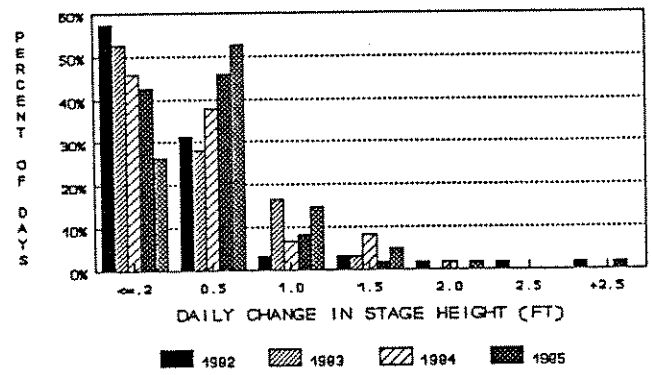


FIGURE 15. PERCENT OF DAYS RIVER STAGE CHANGED DAILY THE INDICATED AMOUNTS, OCT 1- NOV 30, 1986-89, MORONY DAM.

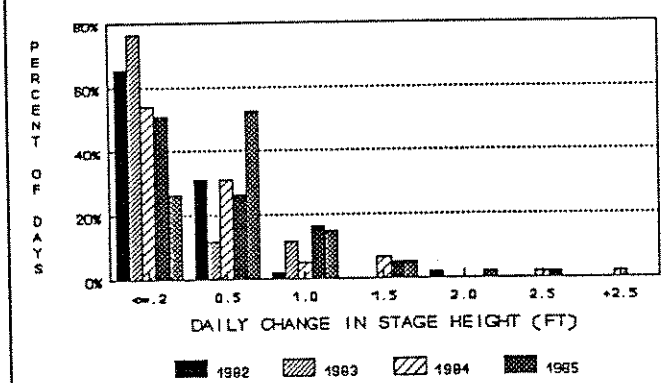


FIGURE 16. MISSOURI RIVER STAGE HEIGHT
DOWNSTREAM MORONY DAM - MARCH 10, 1989
(3.23 ft fluctuation)

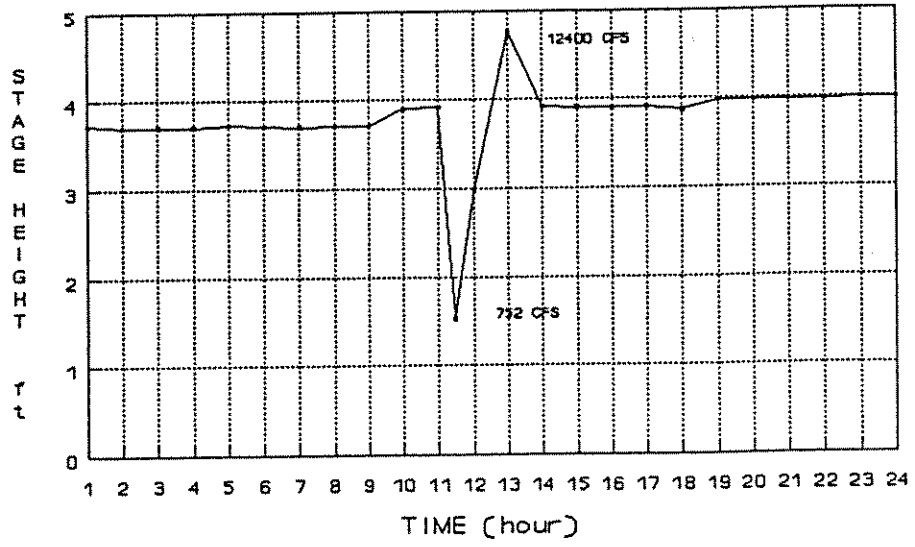


TABLE 5. DAILY MAX-MIN WATER TEMPERATURES, MISSOURI RIVER AT CARTER, 1990.
* indicates spot reading with hand-held thermometer

	APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV	
DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1							77	71	76	70	69	62	58	56	47	46
2							77	69	76	70	69	62	57	54	47	46
3							78	67	76	69	69	63	57	54	45	43
4							72	66	76	69	69	64			44	43
5							72	66	76	69	69	65			41	40
6							72	66	77	70	71	65			40	38
7							71	66	77	71	70	64			38	37
8							74	67	75	69	69	64			39	37
9							75	67	73	69	70	64			40	37
10							76	68	74	70	69	64			42	40
11							79	69	74	69	70	63			43	39
12									74	68	69	64			45	42
13									74	68	68	63			45	43
14									75	68	68	61			45	44
15									75	69	67	61			43	42
16									75	70	67	62				
17		47 *	59 *	59 *					74	70	66	61				
18		49 *	57 *	57 *					75	69	66	60	45 *			
19							72 *	68 *	71	68	65	60	43 *			
20	57 *								71	68	64	60				
21			57 *						71	66	63	58				
22				55 *					68	65	64	58				
23			59 *						69	64	64	58				
24							73	68	67	64	64	58				
25	59 *	55 *					73	67	65	63	64	60				
26	55	*			73 *	71 *	72	67	65	62	65	59				
27	*	52					70	66	66	61	64	59				
28							71	66	66	61	62	58				
29							72	65	67	61	62	58				
30							74	66	67	62	62	58	49	46		
31							74	67	68	62			47	46		
AVERAGE	57	50.8	58	57	73	71	73.7	67.1	72	66.9	66.6	61.2	50.9	51.2	42.9	41.1

Location of Pools in River

Eight significant pools (holes) deeper than ten feet were located between Morony Dam and Fort Benton (Table 6). The deepest hole was 19 feet, located at the "Big Eddy" two miles downstream from Morony Dam. One hole was located above the Big Eddy but its depth was not measured. Pools can be located using river mile markers shown in Figure 1. The Big Eddy pool was unique because it covered the entire width of the river and extended downstream continuously for over half a mile. The bottom of the Big Eddy pool was flat to gradually sloping with mostly gravel substrate. Other holes displayed very irregular bottoms with more bedrock and boulders.

TABLE 6. MAJOR HOLES IN THE MISSOURI RIVER FROM MORONY DAM TO FORT BENTON (RM= miles below dam).

RM	LOCATION	BANK	MAX DEPTH
1.6-1.8	Across Belt Creek	Left	?
2.0-2.6	Big Eddy	Both	19
7.9	Up Huntley Coulee	Left	12
8.3-8.7	Huntley Coulee	Right	17
15.5-16.4	Up Carter Ferry	Both	15
26.8-27.0	Up Cottonwood Bot	Left	11.5
27.8-28.7	Cottonwood Bottom	Right	13
29.5-30.0	Cottonwood Bottom	Left	17

Pallid Sturgeon Sampling

Set Lines

Fourteen overnight setlines were fished in an area from 2 to 23 miles downstream from Morony Dam between May 30 and June 28, 1990. The first four were set using 100 ft of line while all subsequent lines were set with 200 ft of line. Ten hooks were placed on each setline and baited with plains minnows, emerald shiners, flathead chubs, small suckers, cut goldeye, or cut carp. Setlines were fished a total of 277 hours and only 2 fish were captured, both goldeye. One hook had impaled a mostly digested stonecat which may have been regurgitated by a predacious fish. Many of the hooks were cleaned of bait, perhaps by goldeye which were usually too small to be caught by the large hooks. Setlines fishing was discontinued after June 28 because large amounts of floating filamentous algae rendered the setlines ineffective by surrounding the lines, hooks, and bait. The last two sets were only fished for two to three hours yet they still collected enough algae to cover

the bait.

Four setlines were again fished on October 30, after the amount of floating algae appeared to decline. Two lines were fished in the Big Eddy and no fish were caught. One line had moderate amounts of algae while the other was completely fouled by algae. Half of the hooks had bait missing but it could not be determined if fish or the algae were responsible. The other two lines were set near Huntley Coulee, 8.5 miles downstream from Morony. Both of these lines were fouled by extremely heavy amounts of algae.

Hook and Line

Hook and line was used on June 26 in an attempt to catch sturgeon in the Big Eddy pool. Minnows and small suckers were used for bait. Three lines were fished from 3:30 p.m. until 7:00 p.m. No sturgeon were caught but one smallmouth bass, one walleye, one rainbow trout, 15 goldeye, and one sauger were captured. One channel catfish was also observed.

A pool 17.5 miles downstream from Carter Ferry was fished with three lines on June 28. Three goldeyes and one carp were caught between 3:00 p.m. and 6:00 p.m. Floating and attached algae made fishing difficult.

Electrofishing

Sections 2 and 3, totaling 11.4 river miles, were electrofished repeatedly during spring, summer, and fall. A total of 67.05 actual electrofishing hours were spent on these sections, representing 203.1 river miles of effort. Only one sturgeon, a shovelnose, was captured. This sturgeon was captured on August 16 at the lower end of Section 3 at river mile 28. No sturgeon were captured in 0.76 hours of electrofishing in the three miles of Section 1 on September 19.

The Missouri River from Carter Ferry (river mile 16.5) to 3.5 miles upstream from Fort Benton (river mile 28.5) was electrofished on July 24, 1990 in an attempt to locate sturgeon. No sturgeon were seen during three hours of actual electrofishing. Similarly, no sturgeon were seen during 7.5 miles of electrofishing effort (2.7 hrs. day and night) downstream from Carter Ferry on July 26, 1990.

Drift Nets

A four-inch mesh gill net was drifted downstream from Carter Ferry (river mile 17.2) for 30 minutes on July 11. Algae was so dense that even short drifts resulted in the net being quickly clogged. Trammel nets were drifted for sturgeon beginning September 26 when the amount of drifting algae appeared to be declining. A

total of six shovelnose sturgeon were captured during 13 separate drifts (Table 7). All the sturgeon were collected in the pool at Big Eddy (river mile 2.1). Total drifting effort was 2.75 hours and 2650 yards. Because of the gravel substrate and uniform bottom, the Big Eddy was ideally suited to this type of sampling. Sites sampled further downstream had rough bottoms with rocks and boulders and nets tended to snag quickly. No pallid sturgeon were seen or captured in these areas. Average total length and weight of the shovelnose sturgeon captured was 35.5 inches and 7.1 pounds, respectively.

TABLE 7. DRIFT NET SUMMARY MISSOURI RIVER, DOWNSTREAM MORONY, 1990, AND CATCH STATISTICS FOR SHOVELNOSE STURGEON (SNS).

DATE	RM	DRIFT NO	DRIFT MIN	DRIFT LENGTH (YDS)	NO. SNS	AVERAGE TOTAL LENGTH (IN)	AVERAGE TOTAL WT. LBS
7-11	17.2	2	30	200	0		
9-26	15.9	1	15	250	0		
9-26	2.1	4	51	875	2	34.2	6.2
10-10	2.1	3	35	600	2	36.2	7.9
10-10	8.0	2	12	200	0		
10-30	2.1	3	22	525	2	36.10	7.3
TOTAL		15	165	2650	6		
AVE.			11	177	.4	35.5	7.1

Test of Radio Tags

Although no sturgeon were radio tagged during this study, some testing was done in anticipation of future work and to help determine why transmitters placed on pallid sturgeon by other workers could not be relocated. Ryan Reservoir offered an ideal place to test the transmitters because: (1) the relatively calm water allowed transmitters to be submerged to necessary depths without fear of loosing them, (2) open water allowed a boat to test signal strength in all directions, (3) conductivity of the water (often cited as a limitation of signal strength) was similar to the river downstream, and (4) cliffs along the edge of the reservoir allowed gaining some altitude to determine if signal strength was greater some distance above the water.

When the transmitter was submerged in five feet of water, the signal could be picked up from a boat 0.75 and 1.25 miles from the

TABLE 8. ELECTROFISHING CATCH STATISTICS SECTIONS 2 AND 3, MISSOURI RIVER DOWNSTREAM MORONY DAM, SPRING, 1990.

	SECTION 2 (14.47 hours and 35.4 miles effort)				SECTION 3 (10.28 hours and 33.0 miles effort)			
SPECIES	NUMBER CAUGHT	FISH/ HOUR	FISH/ MILE	PERCENT TOTAL	NUMBER CAUGHT	FISH/ HOUR	FISH/ MILE	PERCENT TOTAL
Rainbow Trout	15	1.04	.42	.49	0	.00	.00	.00
Cutthroat Trout	0	.00	.00	.00	0	.00	.00	.00
Brown Trout	16	1.11	.45	.53	1	.10	.03	.04
Yellow Perch	0	.00	.00	.00	0	.00	.00	.00
Channel Catfish	0	.00	.00	.00	0	.00	.00	.00
Burbot	3	.21	.08	.10	0	.00	.00	.00
Carp	147	10.16	4.15	4.84	117	11.38	3.55	4.67
Goldeye	1570	108.50	44.35	51.68	1813	176.36	54.94	72.43
Freshwater Drum	0	.00	.00	.00	0	.00	.00	.00
River Carpsucker	7	.48	.20	.23	6	.58	.18	.24
Longnose Sucker	162	11.20	4.58	5.33	105	10.21	3.18	4.19
White Sucker	78	5.39	2.20	2.57	59	5.74	1.79	2.36
Blue Sucker	7	.48	.20	.23	2	.19	.06	.08
Smallmouth Buffalo	3	.21	.08	.10	0	.00	.00	.00
Shorthead Redhorse	946	65.38	26.72	31.14	371	36.09	11.24	14.82
Smallmouth Bass	1	.07	.03	.03	0	.00	.00	.00
Sauger	4	.28	.11	.13	7	.68	.21	.28
Walleye	15	1.04	.42	.49	5	.49	.15	.20
Mountain Whitefish	64	4.42	1.81	2.11	17	1.65	.52	.68
Shovelnose Sturgeon	0	.00	.00	.00	0	.00	.00	.00
TOTAL	3038	209.95	85.82	100.00	2503	243.48	75.85	100.00

TABLE 9. ELECTROFISHING CATCH STATISTICS SECTIONS 2 AND 3, MISSOURI RIVER DOWNSTREAM MORONY DAM, SUMMER, 1990.

	SECTION 2 (12.59 hours and 33.0 miles effort)				SECTION 3 (15.55 hours and 53.1 miles effort)			
SPECIES	NUMBER CAUGHT	FISH/ HOUR	FISH/ MILE	PERCENT TOTAL	NUMBER CAUGHT	FISH/ HOUR	FISH/ MILE	PERCENT TOTAL
Rainbow Trout	43	3.42	1.30	1.11	1	.06	.02	.04
Cutthroat Trout	0	0.00	0.00	0.00	1	.06	.02	.04
Brown Trout	10	.79	.30	.26	3	.19	.06	.11
Yellow Perch	2	.16	.06	.05	2	.13	.04	.08
Channel Catfish	0	.00	.00	.00	2	.13	.04	.08
Burbot	0	.00	.00	.00	0	.00	.00	.00
Carp	200	15.89	6.06	5.18	219	14.13	4.12	8.23
Goldeye	806	64.05	24.42	20.88	921	59.42	17.34	34.60
Freshwater Drum	191	15.18	5.79	4.95	64	4.13	1.21	2.40
River Carpsucker	45	3.58	1.36	1.17	63	4.06	1.19	2.37
Longnose Sucker	510	40.53	15.45	13.21	159	10.26	2.99	5.97
White Sucker	97	7.71	2.94	2.51	98	6.32	1.85	3.68
Blue Sucker	0	0.00	0.00	0.00	0	0.00	0.00	0.00
Smallmouth Buffalo	15	1.19	.45	.39	14	.90	.26	.53
Shorthead Redhorse	1815	144.24	55.00	47.01	1022	65.94	19.25	38.39
Smallmouth Bass	2	.16	.06	.05	0	.00	.00	.00
Sauger	100	7.95	3.03	2.59	61	3.94	1.15	2.29
Walleye	19	1.51	.58	.49	24	1.55	.45	.90
Mountain Whitefish	6	.48	.18	.16	7	.45	.13	.26
Shovelnose Sturgeon	0	0.00	0.00	0.00	1	.06	.02	.04
TOTAL	3861	306.84	117.00	100.00	2662	171.74	50.13	100.00

tag with the unidirectional (whip) and ommidirectional (loop) antennae, respectively. When the tags were submerged to 19 feet, maximum distances the signal could be detected from a boat were 200 and 120 yards for the whip and loop antennae, respectively. The RF gain was full in all cases. Increasing altitude approximately 40 feet did not increase distance at which the signal could be detected when the transmitter was in 19 feet of water.

River Electrofishing Survey

Twenty-eight fish species were collected from Morony Dam to Fort Benton. Twenty are listed in Table 8. The additional species collected include: longnose dace, flathead chub, mottled sculpin, stonecat, mountain sucker, emerald shiner, western silvery minnow, and lake chub.

Nongame Species

Fish collections in Sections 2 and 3 were dominated by four species: goldeye, shorthead redhorse, longnose suckers, and carp. These four species comprised 86 to 97 percent of the sample during all three seasons (Tables 8, 9, and 10). When white suckers were added to the list, the percent comprised by these five species ranged from 89 to 99 percent.

Goldeye were the most abundant species in the sample in both sections during spring when they comprised 52-72% of all fish collected. They were the second most abundant fish in the sample in both sections during summer (21-35% of total) and were the third or forth most abundant during fall (6-20% of total). Goldeye catch rates declined progressively from highs of 109 to 176 fish per hour in the spring to 19 to 50 fish per hour in the autumn. Catch rates in Section 3 were higher than in Section 2 during both spring and autumn. Catch rates were similar in both sections during summer (Tables 8, 9, and 10). Goldeye comprised only 3 percent of the fish observed and the catch rate was only 9.2/hr in Section 1 (the uppermost section) on September 19, 1990 (Table 11).

Population catch statistics are summarized in Appendix Tables 53, 54, and 55. Although recapture rates were usually low, these estimates can probably be used as gross estimators of population size. Population estimates may be inflated due to fish movement through the sections as exemplified by seasonal changes in goldeye catch rates.

As with catch rates, population estimates for goldeye in Sections 2 and 3 were highest during spring and declined as the year progressed. Estimates ranged from 16,804 per mile in Section 3 in the spring to 916 in the same section in the fall. The spring goldeye estimate for Section 2 was 5,218 fish per mile. Goldeye estimates were similar in both sections in the summer, 3,155 and 3,476 fish per mile in Sections 2 and 3 respectively. No goldeye

TABLE 10. ELECTROFISHING CATCH STATISTICS SECTIONS 2 AND 3, MISSOURI RIVER DOWNSTREAM MORONY DAM, AUTUMN, 1990

	SECTION 2 (7.32 hours and 22.0 miles effort)				SECTION 3 (6.08 hours and 23.6 miles effort)			
SPECIES	NUMBER CAUGHT	FISH/ HOUR	FISH/ MILE	PERCENT TOTAL	NUMBER CAUGHT	FISH/ HOUR	FISH/ MILE	PERCENT TOTAL
Rainbow Trout	31	4.23	1.41	1.31	0	.00	.00	.00
Cutthroat Trout	0	0.00	0.00	0.00	0	.00	.00	.00
Brown Trout	28	3.83	1.27	1.19	4	.66	.17	.27
Yellow Perch	1	.14	.05	.04	2	.33	.08	.13
Channel Catfish	0	.00	.00	.00	0	.00	.00	.00
Burbot	0	.00	.00	.00	2	.33	.08	.13
Carp	237	32.38	10.77	10.04	137	22.53	5.81	9.13
Goldeye	137	18.72	6.23	5.81	307	50.49	13.01	20.45
Freshwater Drum	0	.00	.00	.00	0	.00	.00	.00
River Carpsucker	27	3.69	1.23	1.14	24	3.95	1.02	1.60
Longnose Sucker	445	60.79	20.23	18.86	332	54.61	14.07	22.12
White Sucker	86	11.75	3.91	3.64	79	12.99	3.35	5.26
Blue Sucker	0	0.00	0.00	0.00	0	0.00	0.00	0.00
Smallmouth Buffalo	9	1.23	.41	.38	0	.00	.00	.00
Shorthead Redhorse	1290	176.23	58.64	54.66	566	93.09	23.98	37.71
Smallmouth Bass	0	.00	.00	.00	0	.00	.00	.00
Sauger	9	1.23	.41	.38	17	2.80	.72	1.13
Walleye	13	1.78	.59	.55	9	1.48	.38	.60
Mountain Whitefish	47	6.42	2.14	1.99	22	3.62	.93	1.47
Shovelnose Sturgeon	0	.00	.00	0.00	0	.00	.00	.00
TOTAL	2360	322.40	107.27	100.00	1501	246.88	63.60	100.00

TABLE 11. ELECTROFISHING SUMMARY FOR SECTION ONE, DOWNSTREAM MORONY DAM, SEPTEMBER 19, 1990. TOTAL HOURS ELECTROFISHED WAS 0.76 AND LENGTH 3.0 MILES.

SPECIES	NUMBER OBSERVED	FISH/ HOUR	FISH/ MILE	PERCENT TOTAL
Rainbow Trout	5	6.58	1.67	2.10
Cutthroat Trout	0	.00	.00	.00
Brown Trout	2	2.63	.67	.84
Yellow Perch	0	.00	.00	.00
Channel Catfish	0	.00	.00	.00
Burbot	0	.00	.00	.00
Carp	25	32.89	8.33	10.50
Goldeye	7	9.21	2.33	2.94
Freshwater Drum	13	17.11	4.33	5.46
River Carpsucker	2	2.63	.67	.84
Longnose Sucker	35	46.05	11.67	14.71
White Sucker	17	22.37	5.67	7.14
Smallmouth Buffalo	1	1.32	.33	.42
Shorthead Redhorse	119	156.58	39.67	50.00
Smallmouth Bass	0	.00	.00	.00
Sauger	2	2.63	.67	.84
Walleye	5	6.58	1.67	2.10
Mountain Whitefish	5	6.58	1.67	2.10
Shovelnose Sturgeon	0	.00	.00	.00
TOTAL	238	313.16	79.33	100.00

were recaptured in Section 2 in the autumn (Tables 12, 13, and 14).

Shorthead redhorse suckers were the most numerous fish sampled in Sections 2 and 3 during both summer and autumn. Redhorse comprised 47 and 55 percent of the sample in Section 2 during spring and fall, respectively. Redhorse comprised 38 percent of the catch in Section 3 during both summer and autumn. Shorthead redhorse were the second most numerous species captured during spring, comprising 31 and 16 percent of the catch in Sections 2 and 3, respectively. Catch rates increased in both sections as the year progressed. In Section 2 the catch rate was 27, 144, and 176 fish per hour during spring, summer, and autumn, respectively. Corresponding catch rates in Section 3 were 36, 66, and 93 fish per hour (Tables 8, 9, 10). Redhorse were the most numerous fish observed in Section 1 on September 19, 1990. This species comprised 50% of the sample in Section 1 with a catch rate of 157 fish per hour (Table 11).

In contrast to catch rates, population estimates for shorthead redhorse in Section 3 declined progressively from 1,934 fish per mile in spring to 1,442 per mile in autumn. Section 2 estimates were highest during spring (4,391 per mile), lowest during summer (1,751 per mile), and intermediate during autumn (2,582 per mile; Tables 12, 13, and 14).

Longnose sucker catches in Section 2 increased progressively from 10 fish per hour in spring to 41/hr in summer and 61/hr in autumn. Corresponding catch rates in Section 3 were 10/hr, 10/hr, and 55 fish per hour. This species comprised 5% of all fish captured in spring and 19 to 22 percent of the autumn catch (Tables 8, 9, and 10). Longnose suckers were the second most numerous species observed while electrofishing Section 1 on September 19. They comprised 15% of the total catch in Section 1 where the catch rate was 46/hr (Table 11).

Population estimates for longnose suckers in Section 2 from spring to autumn were: 284, 2887, and 772 fish per mile. The autumn estimate for Section 3 (559 fish per mile) was similar to the fall estimate in Section 2 (Tables 12, 13, and 14).

Catch rates for carp ranged from 5 to 10 fish per hour in Sections 2 and 3 during spring and summer. This represented 5 to 8 percent of the total fish collected. Catch rate of carp increased in fall to 32 fish/hr in Section 2 and 51/hr in Section 3, accounting for 10 and 20 percent of the total catches, respectively (Tables 8, 9, and 10).

Carp were caught at the rate of 33/hr in Section 1 on September 19,1990. Carp were the third most abundant species and comprised 11% of the total catch in this section (Table 11). Population estimates of carp in Section 2 were 195, 423, and 1,284 fish per mile during spring, summer, and autumn, respectively. Carp estimates in Section 3 were 249/mile in spring and 177/mile in autumn (Tables 12 and 14).

TABLE 12. PETERSEN POPULATION ESTIMATES, MISSOURI RIVER DOWNSTREAM FROM MORONY DAM, SPRING, 1990.

SPECIES	SECTION 2 NUMBER RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I LOWER	UPPER	FISH/ MILE	SECTION 3 NUMBER RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I LOWER	UPPER	FISH/ MILE
Brown Trout	1	42	2	82	7.6	0				
Carp	2	1071	81	2061	194.7	1	1470	-145	3085	249.2
Goldeye	20	28697	16865	40530	5217.7	4	99145	20403	177888	16804.3
Longenose Sucker	3	1560	239	2881	283.6	0				
White Sucker	1	599	-46	1243	108.8	0				
Shorthead Redhorse	4	24149	5140	43158	4390.7	2	11412	329	22494	1934.2
Sauger	1	4	1	7	0.7	0				
Walleye	1	28	1	55	5.1	0				
All Fish Combined	33	61101	41179	81023	11109.3	7	145304	50989	239618	24627.7

TABLE 13. PETERSEN POPULATION ESTIMATES, MISSOURI RIVER DOWNSTREAM FROM MORONY DAM, SUMMER, 1990.

SPECIES	SECTION 2 NUMBER RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I LOWER	UPPER	FISH/ MILE	SECTION 3 NUMBER RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I LOWER	UPPER	FISH/ MILE
Carp	3	2325	342	4308	422.7	0	-	-	-	-
Goldeye	5	17353	4733	29972	3155.0	4	20509	4403	36615	3476.1
Freshwater Drum	2	2367	118	4615	430.3	1	450	-33	933	76.3
River Carpsucker	1	224	-21	469	40.7	0	-	-	-	0.0
Longnose Sucker	3	15876	2090	29662	2886.5	0	-	-	-	0.0
White Sucker	1	851	-69	1771	154.7	1	1054	-100	2208	178.6
Smallmouth Buffalo	0	-	-	-	-	1	20	-	-	3.3
Shorthead Redhorse	80	9630	7665	11595	1750.9	18	10459	6036	14882	1772.7
Sauger	7	264	115	413	48.0	2	267	26	508	45.2
Walleye	0	-	-	-	-	1	72	0	144	12.2
All Fish Combined	102	32130	26196	38063	5841.8	28	43770	28457	59083	7418.6

TABLE 14. PETERSEN POPULATION ESTIMATES, MISSOURI RIVER DOWNSTREAM FROM MORONY DAM, AUTUMN, 1990.

SPECIES	SECTION 2 NUMBER RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I LOWER	UPPER	FISH/ MILE	SECTION 3 NUMBER RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I LOWER	UPPER	FISH/ MILE
Carp	1	7062	-869	14993	1284.0	3	1045	149	1941	177.1
Goldeye	0	-	-	-	-	2	5405	141	10668	916.0
River Carpsucker	1	104	-6	214	18.9	0	-	-	-	-
Longnose Sucker	9	4247	1778	6716	772.2	5	3298	884	5713	559.0
White Sucker	2	484	21	947	88.0	2	486	23	949	82.4
Shorthead Redhorse	26	14202	9028	19377	2582.2	8	8507	3303	13711	1441.8
Mountain Whitefish	1	284	-22	589	51.5	0	-	-	-	-
TOTAL	40	30838	21636	40039	5606.8	20	22707	13314	32100	3848.6

White sucker catches ranged from 6 to 13/hr in Sections 2 and 3 during all three seasons and this species comprised 2 to 5% of the total catch (Tables 8, 9, and 10). Population estimates for Section 2 ranged from 88 to 154 fish per mile from spring through autumn. Population estimates in Section 3 were 178 and 82/mile during summer and autumn, respectively . This was very similar to estimates for Section 2 (Tables 13 and 14).

Two fish species were only collected in specific seasons. Blue suckers were only collected in the spring and river carpsuckers only in the spring and summer. Carpsuckers were the fifth most numerous species captured in Section 2 during summer.

Game Species

Rainbow trout, brown trout, mountain whitefish, sauger, and walleye accounted for almost all the gamefish collected. Together these five species accounted for only 1.2 to 5.4 percent of the total catch, depending on season and section. The only other gamefish caught were a single cutthroat trout and one shovelnose sturgeon.

Catch rate of rainbow trout in Section 2 increased from 1.0/hr in spring to 3.4/hr in summer and 4.2/hr in fall. Rainbow comprised from 0.5 to 1.3 percent of total catch in Section 2, depending on season. Only one rainbow trout was captured in Section 3 during the entire year (Tables 8, 9, and 10). Rainbow trout catch rate was highest in Section 1 (6.6/hr) where they comprised 2.1 percent of the sample (Table 11).

Catch rate of brown trout in Section 2 was 1.1/hr in spring, 3.4/hr in summer, and 3.8/hr in autumn. Brown trout made up 0.3 to 1.3 percent of the total seasonal catches in this section. Only 8 brown trout were captured in Section 3 the entire year. Four were captured during autumn, representing a catch rate of 0.7 fish per hour (Tables 8, 9, and 10). Catch rate of brown trout in Section 1 on September 19 was 2.6 fish per hour, representing 0.8 percent of the sample (Table 11).

The Missouri River was electrofished in autumn near the mouth of Highwood Creek (river mile 7.6) to estimate numbers of mature brown trout which appeared to use this area for spawning. Ripe males and gravid females were collected on the first sample date, October 23, 1990. Ripe females were collected on November 1 and thereafter until the end of sampling on November 13. A total of 25 fish were marked during marking runs. Thirty-seven brown trout were captured during recapture runs and 14 were recaptures. The population estimate was 66 fish with 95 percent confidence interval of 41 to 85 fish. Of the 48 individual fish examined, 18 (38 percent) were males and 30 (62 percent) were females. Average total length was 19.3 inches and average weight was 2.85 pounds. The largest individual captured was a 25.4 inch female which weighed 6.55 pounds.

Catch rates for sauger were 0.3, 8.0, and 1.2 fish per hour in Section 2 during spring, summer, and autumn (Tables 8, 9, and 10). Corresponding catch rates for Section 3 were 0.7, 3.9, and 2.8. Catch rates in both sections were highest in summer, intermediate in autumn, and lowest in spring. Catch rates were higher in Section 2 than 3 during summer but were slightly higher in Section 3 during spring and autumn. Sauger comprised 0.1 to 2.6 percent of the total seasonal catches in these two sections. Population estimates were similar in Section 2 (48/mi) and 3 (45/mi) during summer (Tables 12, 13, and 14).

Catch rates for walleye in Section 2 increased slightly from 1.0/hr in spring to 1.5/hr in summer and 1.8/hr in fall. Catch rate in Section 3 was 0.5/hr in spring, 1.6/hr in summer and 1.5/hr in fall (Tables 8, 9, and 10). The highest walleye catch (6.6/hr) was found in Section 1 (Table 11). Walleye population estimates (based on one recapture each) were 5.1/mi in Section 2 during spring and 12.2/mi in Section 3 during summer (Tables 12 and 13).

Seasonal catch rate trends for mountain whitefish were similar in Sections 2 and 3. Catches were highest in autumn, lowest in summer, and intermediate in spring. Whitefish catch rates ranged from 0.5 to 6.4 fish per hour and were consistently highest in Section 2 (Tables 8, 9, and 10).

Night Versus Day Electrofishing

A 2.5 mile section immediately downstream from Carter Ferry was electrofished during daylight and dark on July 26,1990 to determine if some fish species could be more effectively sampled at night. Both sides of the river were electrofished starting at 11:30 a.m. and ending at 4:30 p.m. The night electrofishing run started at 9:30 p.m. and ended at 11:14 p.m. Only the left side of the river was electrofished at night because algae continually clogged the jet pump of the outboard motor, making operations hazardous. Algae was more of a problem at night because it was more difficult for the boat operator to avoid shallow areas containing algae. A drop in river flow just prior to the night run compounded the problem.

A total of 195 and 151 fish were collected on the left and right side of the river, respectively, during the day. Only 116 fish were captured along the left bank during the night; 40 percent fewer fish than along the same side during the day. Goldeye and shorthead redhorse numbers were dramatically lower during the night effort and this accounted for most of the difference (Table 15). Longnose suckers were more numerous in the night sample. No river carpsuckers were captured at night and no stonecat were collected during the day. This may be due to these species using the shoreline habitat more during a particular time of the day. However, electrofishing the same stretch of river a second time within 24 hours may also have influenced the nighttime catch rate. Sauger and walleye catch rates were similar in day and night. Catch per electrofishing hour for sauger was 6.1, 3.2, and 4.2 for

TABLE 15. NUMBER OF FISH CAPTURED WHILE ELECTROFISHING THE MISSOURI RIVER NEAR CARTER, JULY 26, 1990.

SPECIES	LEFT BANK DAY	%	RIGHT BANK DAY	%	LEFT BANK NIGHT	%
SHRH	70	35.9	70	46.4	24	20.7
GE	76	39.0	54	35.8	40	34.5
CARP	14	7.2	7	4.6	2	1.7
LnSu	9	4.6	1	.7	25	21.6
WSu	4	2.1	7	4.6	8	6.9
Drum	6	3.1	4	2.6	11	9.5
LL	0	0.0	1	.7	0	0.0
Rb	0	0.0	1	.7	0	0.0
SGR	5	2.6	3	2.0	4	3.4
WE	2	1.0	1	.7	0	0.0
RCSu	7	3.6	2	1.3	0	0.0
Sm Buff	1	.5	0	0.0	0	0.0
Mt Su	1	.5	0	0.0	0	0.0
Stonecat	0	0.0	0	0.0	2	1.7
TOTAL	195	100.0	151	100.0	116	100.0

TABLE 16. RESULTS OF ELECTROFISHING BELT AND HIGHWOOD CREEKS, NEAR THEIR MOUTHS, NOVEMBER 1 AND 2, 1990.

SPECIES	HIGHWOOD (100 YDS)	BELT (MOUTH) (275 YDS)	BELT (1.5 MILES UP-475 YDS)
MWF	0	7	0
Rb	1	5	15 (3 to 10")
LL (brown trout)	3	2	0
FHC	several	1	0
Carp	few	0	1
YOY suckers	many	0	20+
WSu	few	0	1
LnSu	few	1	1
LnDace	0	0	20
WSMinnow	several	1	0
Lake Chub	several	0	0

the left bank day, right bank day, and left bank night, respectively. Night electrofishing appears to offer little advantage for capturing these two species during summer in this portion of the Missouri River.

Highwood and Belt Creeks

Highwood Creek was electrofished near its mouth on November 1, 1990 to search for spawning salmonids. The creek was split into two channels at this time and both had wetted widths of only a few yards. The dry portion of the channel was quite wide, however, indicating extensive flows during high water periods. The west channel had an very large beaver dam just a few yards upstream from its mouth which was a barrier to fish movement at this time of year. The north channel had a beaver dam 100 yards upstream which also was a barrier. The 100 yards of stream downstream from the dam on the north channel was electrofished and YOY brown trout, YOY rainbow trout, western silvery minnows, carp, flathead chubs, longnose suckers, white suckers, and lake chubs were collected (Table 16).

Two sections on lower Belt Creek were electrofished on November 2, 1990. The lower section extended from the mouth to a point 275 yards upstream. The upper section began at the bridge on the Salem Road (approximately 1.5 miles upstream from the mouth) and extended 400 yards upstream. Only two brown trout were collected in the lower section, one of which was a 19.5 inch ripe female on a redd. Five rainbow trout ranging from 7.5 to 10.3 inches in length were also captured. Seven mountain whitefish were captured, six of which were approximately 13.5 inches in length and one 6.8 inches. In addition one longnose sucker, one flathead chub, and one western silvery minnow were collected (Table 16). Over 18 inches of silt covered the bottoms of pools in the lower end of this section. Although silt was extensive in the pools in the upper part of the section, the riffles appeared fairly clean.

No brown trout or mountain whitefish were collected in the upper section on Belt Creek, however, 15 rainbow trout ranging from 3 to 10 inches were captured. Suckers, longnose dace, and carp were also collected (Table 16). This section had large pools and areas with boulders, rocks, and gravel. Although the riffles were fairly clean, sediment levels were high in the remainder of the section.

Fishermen Logs

Fishermen log data was analyzed for the "winter" months (December through April) and the "summer" (May through November). The average catch rate for all fish was 1.54 and 1.34 fish per hour for the winter and summer periods, respectively (Table 17). Catch rates for sport/game species was 1.28/hr for both time periods. Mountain whitefish and goldeye were the two most frequently caught species in the winter, with average catch rates of 0.53/hr and

TABLE 17. FISHERMAN LOG DATA (FISH PER HOUR) FOR THE MISSOURI RIVER FROM MORONY DAM TO FORT BENTON, MT, 1966-8
W-Sp = Dec.-April, Su-F = May-Nov.; Sport/game fish = all trout, sauger, walleye, sturgeon, northern pike, channel catfish, mountain whitefish.

	1989		1987		1986		1985		1983		1982	
SPECIES	W-Sp	Su-F	W-Sp	Su-F	W-Sp	Su-F	W-Sp	Su-F	W-Sp	Su-F	W-Sp	Su-F
Rainbow Trout		0.14			0.22	0.06	0.40	0.13			0.59	
Brown Trout		0.08	0.18	0.29	0.11	0.03	0.80			0.03	0.24	
Trout											0.12	
Mt. Whitefish												
Channel Catfish	0.22	0.36										
Stonecat	2.22											0.02
Goldeye	2.22	0.80			0.67	0.03		2.31		0.50		1.09
Shoveln Sturgeon												
Sauger		1.05				0.66		0.88	0.06	0.24		0.52
Walleye		1.85				0.02		0.06		0.26		0.11
Sauger/Walleye												
Bigmouth Buffalo		0.05										
Shorthead Redhorse												0.02
White Sucker									0.06			0.02
Sucker			0.09			0.01						
Freshwater Drum		0.19				0.01				0.13		0.07
Flathead Chub												0.02
Carp									0.06			0.03
Northern Pike									0.11			
TOTAL FISH	43	266	3	1	9	56	3	54	5	44	8	116
TOTAL HOURS	9.0	59.0	11.0	3.5	9.0	67.0	2.5	16.0	18.0	38.2	8.5	61.5
TOTAL FISH/HR	4.78	4.51	0.27	0.29	1.00	0.84	1.20	3.38	0.28	1.15	0.94	1.89
SPORT FISH/HR	2.60	1.10	0.20	0.30	1.00	0.80	1.20	3.38	0.20	1.00	0.90	1.80

TABLE 17 (CONTINUED). FISHERMAN LOG DATA...

SPECIES	1974 W-Sp	1974 Su-F	1973 W-Sp	1973 Su-F	1969 W-Sp	1969 Su-F	1968 W-Sp	1968 Su-F	1966 W-Sp	1966 Su-F	SUMMARY W-Sp	SUMMARY Su-F
Rainbow Trout											0.097	0.047
Brown Trout											0.078	0.030
Trout											0.010	0.003
Mt. Whitefish											0.532	0.079
Channel Catfish											0.058	0.065
Stonecat											0.194	0.004
Goldeye										1.50	0.448	0.702
Shovelnose Sturgeon											0.000	0.000
Sauger		1.33						0.25			0.010	0.580
Walleye				0.50				0.25			0.000	0.406
Sauger/Walleye						1.50					0.000	0.027
Bigmouth Buffalo											0.000	0.009
Shorthead Redhorse											0.000	0.004
White Sucker											0.010	0.004
Sucker											0.059	0.011
Freshwater Drum								0.13			0.000	0.074
Flathead Chub											0.000	0.004
Carp											0.010	0.015
Northern Pike											0.019	0.000
TOTAL FISH		4		1		9		5		3	158	676
TOTAL HOURS		3.0		2.0		6.0		8.0		2.0	109.0	328.9
TOTAL FISH/HR		1.33		0.50		1.50		0.63		1.50	1.544	2.060
SPORT FISH/HR		1.33		0.50		1.50		0.50		1.50	1.279	1.379

TABLE 17 (CONTINUED). FISHERMAN LOG DATA...

SPECIES	1981 W-Sp	1981 Su-F	1980 W-Sp	1980 Su-F	1979 W-Sp	1979 Su-F	1978 W-Sp	1978 Su-F	1977 W-Sp	1977 Su-F	1976 W-Sp	1976 Su-F
Rainbow Trout			0.08			0.05	0.04					
Brown Trout					0.67	0.05						
Trout						0.05						
Mt. Whitefish						0.05	2.15	1.67				
Channel Catfish			0.33									
Stonecat												
Goldeye	5.00		0.17			1.48	0.12	0.60		0.11		0.88
Shoveln Sturgeon												
Sauger										0.22		1.02
Walleye						0.11						
Sauger/Walleye												
Bigmouth Buffalo												
Shorthead Redhorse												
White Sucker												
Sucker			0.17		0.67	0.05	0.08	0.07				0.05
Freshwater Drum						0.05		0.07				
Flathead Chub												
Carp						0.05		0.07				0.05
Northern Pike												
TOTAL FISH	15		9		2	36	61	37	0	3		41
TOTAL HOURS	3.0		12.0		1.5	18.2	25.5	15.0	3.0	9.0		20.5
TOTAL FISH/HR	5.00		0.75		1.33	1.98	2.39	2.47	0.00	0.33		2.00
SPORT FISH/HR	5.00		0.60		0.70	1.80	2.30	2.30	0.00	0.33		1.90

0.45/hr, respectively. All the whitefish reported were caught in 1977 and 1978. Average sauger catch rate was only 0.1/hr in the winter while no walleye were reported caught during this time period. The catch rate for all trout combined during the winter was 0.18/hr.

Goldeye dominated the summer fishery, with an average catch of 0.46 fish per hour. Sauger and walleye were the next most frequently caught, with summer catch rates of 0.38 and 0.26/hr respectively. The summer catch rate for all trout species combined was only 0.04/hr (Table 17).

Gill Net Results - Great Falls Reservoirs

Nine fish species were collected in gill nets set in four of the Great Falls reservoirs in 1990 (Table 18). Four species (mountain whitefish, crappie, stonecat, and pumpkinseed) collected in previous years were absent in the 1990 catch. The greatest number of species were captured in Cochrane Reservoir and the fewest in Ryan. White suckers were the most abundant species caught in all the reservoirs except Ryan (Table 19). Walleye were the most abundant fish captured in Ryan and second most abundant in Morony. Walleye were not captured in the other reservoirs. The greatest number of trout was caught in Cochrane Reservoir, while none were captured in Ryan.

Walleye were not netted in Morony Reservoir during 1984 but numbers have increased from 0.7/net in 1988 to 2.0 and 2.3/net in 1989 and 1990 respectively (Table 19). White suckers declined from 172/net in 1984 to 20-23/net in 1989 and 1990. Ryan had the lowest white sucker catch of all the reservoirs sampled in 1990 (2.5/net). Ryan also had the highest walleye catch, 3.5 fish per net.

Average length of walleye in Morony Reservoir has increased since 1988 (Table 20). Length of walleye in Morony was greater than in Ryan while condition factors of walleye in the two reservoirs were similar (Table 20, Figure 17). Length distribution information indicates that small suckers were proportionally less abundant in the two reservoirs that contained walleye (Figure 18).

DISCUSSION

Missouri River Downstream From Morony Dam

Discharge Pattern

Extreme and sudden changes in discharge downstream from Morony Dam was evident during all years examined during the period 1977 through 1990. Daily change in discharge averaged from 17 to 31 percent for water years 1977 to 1989 and gage height changed as much as 3.4 feet in one day. These changes often began with a

TABLE 18. FISH SPECIES COLLECTED WHILE GILL NETTING MORONY (M), RYAN (R), COCHRANE (C), AND BLACK EAGLE (B) RESERVOIRS, 1990.

SPECIES	M	R	C	B
White Sucker	*	*	*	*
Longnose Sucker	*	*	*	*
Walleye	*	*		
Yellow Perch	*	*	*	*
Brown Trout	*		*	*
Rainbow Trout			*	*
Black Bullhead			*	
Carp	*		*	
Flathead Chub	*		*	

TABLE 19. GILL NET CATCH RATES FROM THE MISSOURI RIVER RESERVOIRS NEAR GREAT FALLS, 1978-90.

MORONY RESERVOIR

	WSu	LNSu	WE	YP	LL	Rb	BBH	Carp	PumS	MWF	Crap	FHC	SCat	TOTAL	No. NETS	Ave #/ NET
1978																
#	737	41	1	13	1	2	1	1	1	1	0	0	0	799	6	133.2
%TL	92.2	5.1	.1	1.6	.1	.3	.1	.1	.1	.1	.0	.0	.0			
#/net	122.8	6.8	.2	2.2	.2	.3	.2	.2	.2	.2	.0	.0	.0			
1984																
#	344	3	0	19	0	0	0	0	0	0	0	0	0	366	2	183.0
%TL	94.0	.8	.0	5.2	.0	.0	.0	.0	.0	.0	.0	.0	.0			
#/net	172.0	1.5	.0	9.5	.0	.0	.0	.0	.0	.0	.0	.0	.0			
1988																
#	329	4	2	2	1	0	0	7	0	0	0	1	0	346	3	115.3
%TL	95.1	1.2	.6	.6	.3	.0	.0	2.0	.0	.0	.0	.3	.0			
#/net	109.7	1.3	.7	.7	.3	.0	.0	2.3	.0	.0	.0	.3	.0			
1989																
#	61	5	6	0	3	2	0	0	0	0	0	0	0	77	3	25.7
%TL	79.2	6.5	7.8	.0	3.9	2.6	.0	.0	.0	.0	.0	.0	.0			
#/net	20.3	1.7	2.0	.0	1.0	.7	.0	.0	.0	.0	.0	.0	.0			
1990																
#	90	0	9	5	1	0	0	1	0	0	0	1	0	107	4	26.8
%TL	84.1	.0	8.4	4.7	.9	.0	.0	.9	.0	.0	.0	.9	.0			
#/net	22.5	.0	2.3	1.3	.3	.0	.0	.3	.0	.0	.0	.3	.0			

RYAN RESERVOIR

	WSu	LNSu	WE	YP	LL	Rb	BBH	Carp	PumS	MWF	Crap	FHC	SCat	TOTAL	No. NETS	Ave #/ NET
1990																
#	10	3	14	2	0	0	0	0	0	0	0	0	0	29	4	7.3
%TL	34.5	10.3	48.3	6.9	.0	.0	.0	.0	.0	.0	.0	.0	.0			
#/net	2.5	.8	3.5	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0			

TABLE 19 (CONTINUED). GILL NET CATCH RATES FROM THE MISSOURI RIVER RESERVOIRS NEAR GREAT FALLS, 1978-90.

COCHRANE RESERVOIR

	WSu	LNSu	WE	YP	LL	Rb	BBH	Carp	PumS	MWF	Crap	FHC	SCat	TOTAL	No. NETS	Ave #/ NET
1978																
#	276	54	0	6	5	3	0	1	0	1	0	0	1	346	5	69.2
%TL	79.8	15.6	.0	1.7	1.4	.9	.0	.3	.0	.3	.0	.0	.3			
#/net	55.2	10.8	.0	1.2	1.0	.6	.0	.2	.0	.2	.0	.0	.2			
1981																
#	163	97	0	4	10	0	0	0	0	8	0	0	0	282	5	56.4
%TL	57.8	34.4	.0	1.4	3.5	.0	.0	.0	.0	2.8	.0	.0	.0			
#/net	32.6	19.4	.0	.8	2.0	.0	.0	.0	.0	1.6	.0	.0	.0			
1984																
#	150	35	0	45	3	0	0	0	0	1	1	0	0	235	3	78.3
%TL	63.8	14.9	.0	19.1	1.3	.0	.0	.0	.0	.4	.4	.0	.0			
#/net	50.0	11.7	.0	15.0	1.0	.0	.0	.0	.0	.3	.3	.0	.0			
1990																
#	271	10	0	29	2	5	11	8	0	0	0	1	0	337	4	84.3
%TL	80.4	3.0	.0	8.6	.6	1.5	3.3	2.4	.0	.0	.0	.3	.0			
#/net	67.8	2.5	.0	7.3	.5	1.3	2.8	2.0	.0	.0	.0	.3	.0			

BLACK EAGLE RESERVOIR

	WSu	LNSu	WE	YP	LL	Rb	BBH	Carp	PumS	MWF	Crap	FHC	SCat	TOTAL	No. NETS	Ave #/ NET
1990																
#	26	1	0	4	0	2	0	0	0	0	0	0	0	33	4	8.3
%TL	78.8	3.0	.0	12.1	.0	6.1	.0	.0	.0	.0	.0	.0	.0			
#/net	6.5	.3	.0	1.0	.0	.5	.0	.0	.0	.0	.0	.0	.0			

TABLE 20. AVERAGE LENGTH (L), WEIGHT (W), AND CONDITION (C) OF FISH CAPTURED IN GILL NETS IN FOUR MISSOURI RIVER RESERVOIRS NEAR GREAT FALLS, 1978-90.

MORONY RESERVOIR

		WSu	LNSu	WE	YP	LL	Rb
1978	n					2	5
	L					6.9	16.2
	W					.14	1.54
	C					42.62	34.8
1988	n	25		2			
	L	10.1		13.8			
	W	.58		.96			
	C	46.7		35.92			
1989	n	36	5	7		3	2
	L	12.9	14.0	14.0		18.2	15.8
	W	.98	1.00	1.08		2.35	1.50
	C	43.3	34.4	38.3		34.5	37.9
1990	n	89		9	5	1	
	L	11.9		14.7	6.6	24.0	
	W	.81		1.28	.18	4.36	
	C	45.1		36.8	62.9	31.5	

COCHRANE RESERVOIR

		WSu	LNSu	WE	YP	LL	Rb	Carp	BBH
1978	n	35	17		4	3	3		
	L	11.7	9.9		6.7	10.9	15.0		
	W	.84	.46		.19	.63	1.26		
	C	47.89	40.90		63.6	39.89	35.9		
1981	n					8			
	L					17.2			
	W					1.93			
	C					36.9			
1984	n					3			
	L					17.1			
	W					2.21			
	C					38.0			
1990	n	72	10		29	2	5	8	11
	L	9.6	8.5		6.6	18.9	14.1	7.9	8.2
	W	.55	.30		.15	2.90	1.24	1.07	.27
	C	43.5	39.4		46.7	42.6	40.2	67.1	47.6

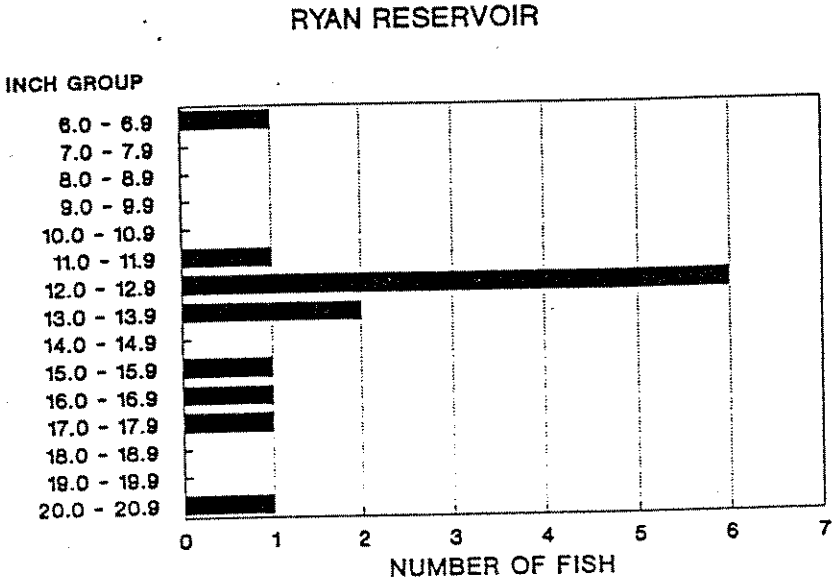
RYAN RESERVOIR

		WSu	LNSu	WE	YP	LL	Rb
1990	n	10	3	14	2		
	L	10.8	12.9	13.6	7.7		
	W	.68	.88	1.03	.29		
	C	42.3	40.22	36.25	51.9		

BLACK EAGLE RESERVOIR

		WSu	LNSu	WE	YP	LL	Rb	Carp	BBH
1990	n	26	1		17		2		
	L	10.9	15.9		6.7		9.8		
	W	.86	2.29		.16		.30		
	C	43.3	57.0		48.5		31.3		

FIGURE 17. LENGTH FREQUENCY DISTRIBUTION OF WALLEYE CAPTURED IN MORONY AND RYAN RESERVOIRS, 1990.



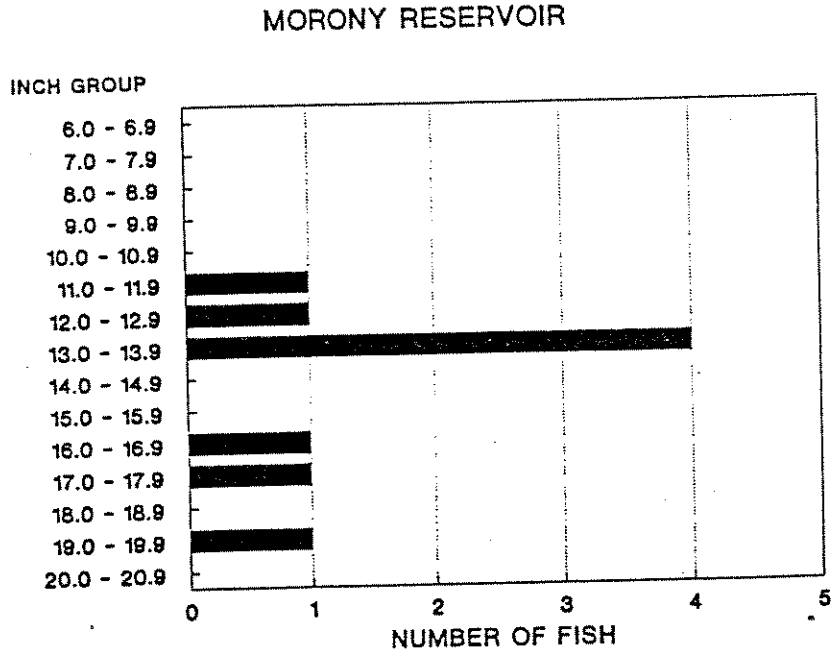
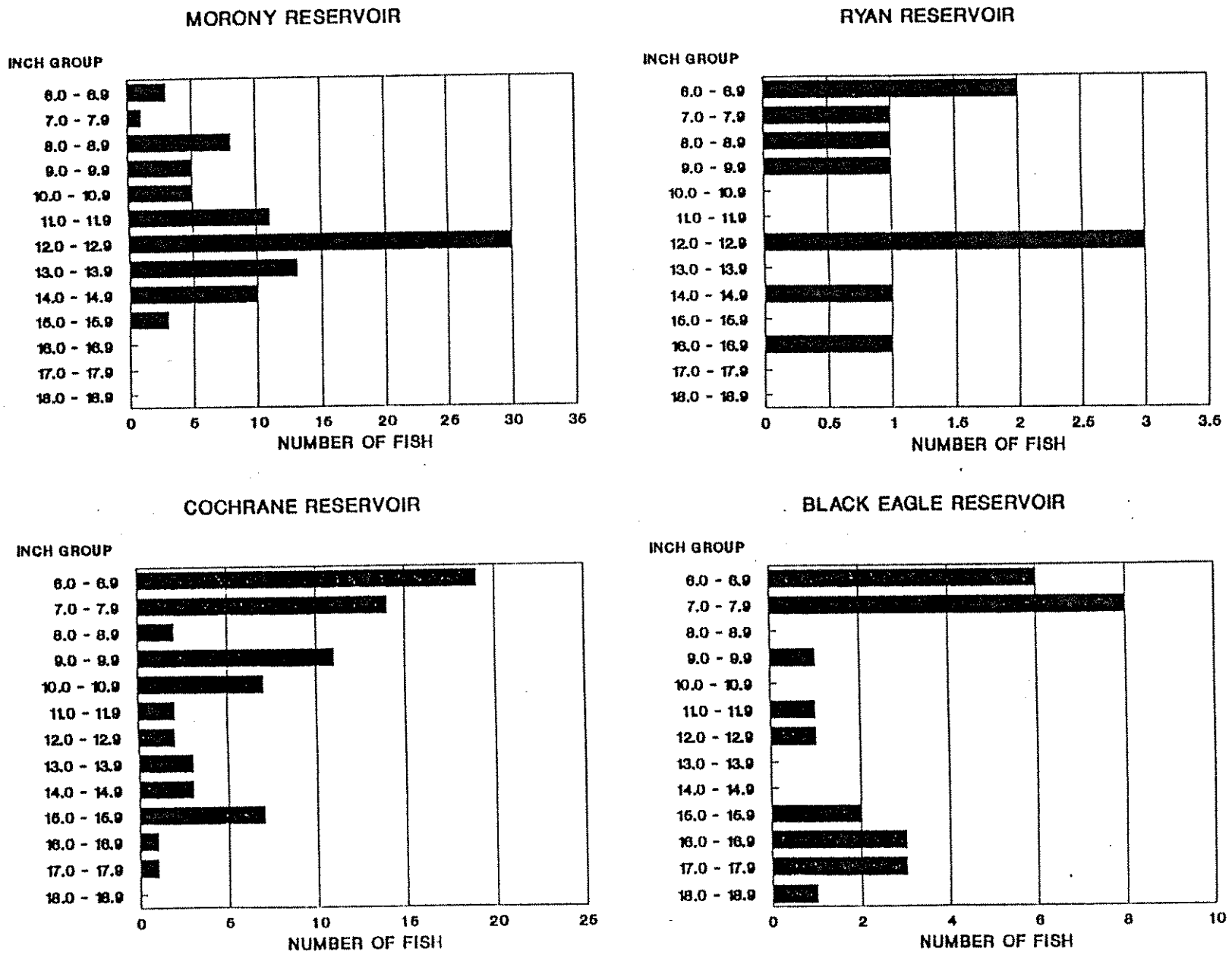


FIGURE 18. LENGTH FREQUENCY OF WHITE SUCKERS CAPTURED IN FOUR MISSOURI RIVER RESERVOIRS NEAR GREAT FALLS, 1990.



sudden drop in flow followed by a surge in discharge. These sudden flow changes have probably had an adverse impact on the aquatic ecosystem for many miles downstream. Pickett (1990) found that fluctuations were only dampened 23 percent at Virgelle, located 72 miles downstream. Sudden flow reductions can expose shallow riffle areas where most aquatic insect production occurs and where many fish species spawn. Sudden flow increases can dislodge and displace insects, fish, fish eggs, and fish larvae. Low flows may result in higher water temperatures and high discharges may increase sedimentation. Equivalent flow changes cause greater changes in gage height when the river is at low flow than when flow is high. This indicates that discharge fluctuation will impact the streambed and aquatic ecosystem more significantly during periods or years of low flow.

Pallid and Shovelnose Sturgeon

Pallid sturgeon are a rare species which inhabit the Missouri River, including the reach between Morony Dam and Fort Peck Reservoir. Gardner (1990) was able to document 35 sightings as far upstream as Fort Benton from the late 1800s through 1989. In addition, 5 were collected by MDFWP fisheries personnel and 4 were reported by fishermen in 1990 (Gardner, personal communication). The last pallid captured near Fort Benton was reported in 1964. No pallids were collected in the Morony-Fort Benton study area in 1990, but shovelnose sturgeon were collected at the Big Eddy pool two miles downstream from Morony Dam. This is the farthest upstream this species has been documented by MDFW&P survey crews. Berg (1981) recorded collecting shovelnose at Carter Ferry (river mile 17) but his data (MDFWP unpublished data) indicate an observation downstream from Portage Coulee (river mile 3.5).

Since shovelnose sturgeon were captured in the study area, it is entirely possible that pallids may use the area also. Areas with significant depth that may hold pallid sturgeon include: 1) an area immediately downstream from Morony Dam at river mile (rm) 1.6, 2) rm 2 (Big Eddy), 3) rm 7.9-8.8, 4) rm 15.5-16.9, 5) rm 26.8, 6) rm 28.2-28.7, and 7) rm 29.4-30.1 (Figure 1). Gardner found pallids frequented holes with a depth of 10 to 20 feet or more (Gardner personal communication).

Since pallid sturgeon are so rare, it is difficult to determine the impact of the operation of Morony Dam on this species. It would probably be safe to assume that extreme daily discharge fluctuations which adversely affect other species would at least indirectly impact pallid sturgeon through effects on food supply and habitat. Gardner (1990) suggested that the construction and operation of Tiber Dam on the Marias River may have adversely affected pallid use of this tributary and their distribution in the Missouri River.

Sampling for sturgeon in this section of the river would

probably be best accomplished using set lines, trammel nets and gill nets from ice out until mid June. Trammel nets or gill nets can probably be drifted again after mid-September when drifting algae declines. Setlines were not effective in autumn 1990 because of drifting algae.

The results of radio testing indicate that at depths of 19 feet, tracking of sturgeon would have to be accomplished from a boat. Airplanes would probably fly too high to detect the signal or would pass by so quickly that locating the radio would be difficult. Gardner (personal communication) had problems tracking radio tagged sturgeon from the air but did manage to locate them with antennae mounted in a boat.

Cold Water Fish

The Missouri River downstream from Morony Dam is a transition zone between a cold and warm water environment (Berg 1981). The area supports rainbow trout, brown trout and whitefish (cold water species). Although water temperatures are not ideal for trout, small self-sustaining populations inhabit the reach downstream from Morony. Apparently the mouth of Highwood Creek is an important area for trout spawning because large ripe brown trout were collected during this study and previous sampling by the MDFWP (Berg 1982, MDFWP 1988 and 1989). In addition, large ripe and spent rainbow trout were collected in Belt Creek near its mouth in 1979 and 1980 (Berg 1982, Lockard 1980) and in the Missouri near the mouth of Highwood Creek (Berg 1982). A substantial run of whitefish was observed in Belt Creek near its mouth from mid- to late October in 1981 when about 1000 large fish (2.1 to 2.8 pounds) were observed in a 5,000 foot section of stream (Berg 1982). Very few whitefish were found in Belt Creek during sampling in November of 1990.

Although the Missouri at Carter reached a maximum temperature of 79°F in 1990, this is less than the critical lethal temperatures of 85.7°F for brown trout and 84.8°F for rainbow trout (Lee and Rinne 1980). Vincent (Bozeman Chronicle 1988) documented a fish kill in the lower Madison when maximum temperatures reached 82.5°F and when temperatures over 80°F were sustained for seven hours. The maximum temperature ever recorded in the Morony area was 81°F and the highest water temperature recorded during 1990 was 79 degrees F on July 11. However, the minimum temperature on that date was ten degrees cooler. Vincent (1984) reported 4,600 trout per mile in April of 1983 in the Norris section of the lower Madison River. Water temperature in this section often reaches 82°F (Vincent 1982). The average maximum and minimum daily temperature in the Norris section during August of 1983 was 73.8°F and 65.9°F, respectively (Vincent 1984). The average maximum and minimum temperatures during July 1990 at Carter were approximately 73.7 and 67.1°F, respectively. Other factors such as reproductive success, competition, and predation are probably more important than temperature in regulating trout numbers downstream from Morony Dam.

Morony Reservoir was reduced to low pool for repairs during the brown trout spawning season in fall 1990. During drawdown, river turbidities increased dramatically and the water had a swampy odor. In addition, water levels in the river were probably fluctuating when the reservoir was being drawn down and refilled. Spawning success could be impacted by sedimentation of redds, low dissolved oxygen, reduction in water level, or extreme flushing flows. Records show that fluctuations during November are not uncommon. Apparently, this drawdown procedure has been an annual event during autumn to facilitate sealing of spill gates (Frank Pickett, MPC, personal communication).

Documented extreme river fluctuations probably impact survival of young fish which depend on shallow areas for security and food. A number of young-of-year mountain whitefish were captured while electrofishing, indicating limited successful reproduction. Apparently, large numbers of whitefish were present in past years as indicated by the spawning run observed in Belt Creek in 1981 (Berg 1982). Fisherman log data (Table 17) indicated catch rates as high as 2.2 fish per hour in 1978. Perhaps river fluctuation is limiting recruitment of young fish into the population.

Sauger And Walleye

Sauger numbers appear depressed in recent years. Berg (1981) reported an average catch rate of 20 sauger per hour from 1976 to 1979 when electrofishing the equivalent of Morony Section 2 (Table 21). Catch rates in the same reach in 1980 were higher for every time period when compared to 1990 (Table 22). Catch rates during 1988 and 1989 in Section 2 were similar to 1990 and much lower than previous years. Catch rates in Section 3 were as much as twenty fold higher in 1980 than 1990 (Table 22). Comments from fishermen also suggest low sauger densities in 1990 (Appendix Figure 15). Population estimates of sauger in the Yellowstone River were 200 to 400 fish per mile (Stewart 1990) compared to 48 in Morony Section 2 during summer, 1990.

The combination of low water years and excessive daily discharge fluctuations may be responsible for the recent decline in sauger populations below Morony. Sauger recruitment is dependent on successful spawning and maintenance of young-of-year (YOY) habitat in side channel and side channel pool areas. Gardner (1982) found that most YOY sauger were collected in these peripheral areas of the river. Most YOY sauger captured in 1979 were found in the reach from the "Hole in the Wall" to Robinson Bridge (100 to 185 miles downstream from Morony Dam, Gardner 1982). The same study recommended minimum flows of 4500 cfs at the Fort Benton gaging station to maintain necessary habitat in these areas. Mean monthly flow from May through September during 1978-90 was above 4500 cfs, except during July through September of 1985 and 1988 (Appendix Tables 1-13). However, every year except 1984 had minimum daily flows less than 4500 cfs during this time period, often less than 1000 cfs (Appendix Tables 1-13). Gardner (1982) found that YOY

TABLE 21. CATCH RATE SUMMARY FOR ELECTROFISHING SURVEYS CONDUCTED ON THE MIDDLE MISSOURI RIVER FROM 1976 THROUGH 1979, EXPRESSED AS NUMBER OF FISH SAMPLED PER ELECTROFISHING HOUR (BERG 1981).

Fish species	Morony Dam	Carter Ferry	Fort Benton	Loma Ferry	Coal Banks Landing	Hole-in-the-wall	Judith Landing	Stafford Ferry	Cow Island	Robinson Bridge	Turkey Joe
Pallid sturgeon					tr[1/]				0.1		
Shovelnose sturgeon		0.1	0.4	1.9	2.3	1.4	1.2	0.8	2.0	1.8	0.3
Goldeye	22.7	41.7	13.2	24.9	29.3	14.0	13.9	5.5	11.6	19.5	10.3
Mountain whitefish	1.0	0.2	1.2	0.4	0.1				tr		
Rainbow trout	0.5	tr	tr				tr				
Brown trout	0.5	0.2	0.1	tr							
Brook trout			tr								0.3
Northern pike	tr	tr		tr	tr		tr				
Carp	1.5	0.7	3.7	3.7	6.5	0.6	3.2	1.9	6.3	2.2	4.1
Flathead chub	tr	tr	0.4	1.7	0.7	0.3	0.8	0.3	0.5	0.9	
Emerald shiner	0.2	0.1	0.1	0.3	tr		0.1			0.5	
Western silvery minnow	4.7	0.2	0.1	tr	0.1		0.2		tr	0.7	0.3
Longnose dace	0.3	0.2	0.1	tr							
River carpsucker	0.3	0.7	0.9	2.9	2.2	0.6	3.0	0.5	1.2	0.9	0.8
Blue sucker	0.1	0.4	0.3	1.1	0.9	0.9	1.0	1.7	1.3	0.6	
Smallmouth buffalo	0.9	0.7	0.6	1.3	0.9	0.2	0.4	0.1	0.5	0.1	
Bigmouth buffalo	0.1	tr	0.2	0.3	0.2	0.1	0.2	0.1	tr	tr	
Shorthead redhorse	7.3	14.5	22.0	15.2	21.4	2.3	16.5	3.4	3.4	2.1	
Longnose sucker	17.9	16.2	11.9	14.7	8.0	0.9	4.3	0.6	0.1	0.1	
White sucker	1.8	0.2	1.0	0.4	0.3		0.5		0.1		
Mountain sucker	0.6	tr	0.1	tr	tr						
Channel catfish					tr		0.2		tr	tr	
Stonecat			0.1		tr		tr				
Burbot	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	tr	0.1	1.0
White crappie						0.1				tr	
Yellow perch		tr		0.1							
Sauger	20.1	6.1	6.7	4.8	3.6	0.6	3.6	0.7	0.9	2.9	7.9
Walleye	0.3	tr	0.1	0.2	tr		tr			tr	
Freshwater drum	2.6	0.6	0.3	0.5	0.2	tr	0.2		0.1	0.1	
Mottled sculpin	0.5	0.1	0.1	tr	tr	tr	tr				
Total	84.2	83.1	63.7	74.7	76.8	22.1	49.8	15.7	28.2	32.6	25.0

1/ tr - trace (less than 0.05 fish per electrofishing hour)

TABLE 22. CATCH RATES OF SAUGER IN TWO SECTIONS OF THE MISSOURI RIVER. THE FIGURES FROM 1976 THROUGH 1989 ARE FROM MDFWP UNPUBLISHED DATA.

	MORONY SECTION (Morony Section Two)				
	1976-79	1980	1988	1989	1990
APRIL		0-0.5			.10
MAY		10.1			.72
AUGUST	18.7	27.0		6.5	7.95
SEPTEMBER		20.0	6.8		7.68
OCTOBER	7.5	19.0			.03
NOVEMBER		9.0	2.3	2.3	.01

	CARTER SECTION (Morony Section Three)	
	1980	1990
APRIL	2-8.3	.45
MAY	9.3	.85
AUGUST	18.0	3.92
SEPTEMBER	13.0	
OCTOBER	25.0	1.12
NOVEMBER	32.0	3.82

sauger reared farther downstream in the Missouri River during years having higher flows in late May and June. This was probably due to greater downstream drift of larval and young sauger. Gardner inferred that maintenance of side channel/pool habitat was even more important during normal to low flow years. Extreme daily fluctuation from Morony Dam may have impacted these areas and YOY survival to a greater extent since 1985 because of poor water years. All of the last 6 water years were below average except 1985-86 which was average (7800 cfs). The daily discharge during 1987-88 averaged only 4671 cfs and the August minimum was 802 cfs.

Sauger appear to use the Morony reach as a feeding area. Catch rates for Section 2 in this study and from previous electrofishing surveys (Table 22) were lowest in spring, highest during summer, and declined in fall. Catch rates in Section 3 were lowest in spring but did not decline in fall as happened in Section 2. Berg (1981) noted this movement pattern and suggested it was for feeding purposes. He noted that sauger using the Morony-Fort Benton area originated from throughout the Middle Missouri as far downstream as the headwaters of Fort Peck Reservoir. Increased numbers in Section 3 in November may be due to downstream movement from Section 2 and upstream movement from areas below Section 3.

Sculpins, longnose dace, and "shoal minnows" (western silvery minnow, emerald shiner, fathead minnow, and flathead minnow) were the most important items in the diet of sauger in the Morony section (Gardner and Berg 1982). These species are riffle dwellers and are most likely to be impacted by drastic daily changes in flow. Densities of forage fish may have been low in recent years limiting use of this reach by sauger. Most fish captured while electrofishing during this study were large adults. The few large schools of minnows observed were often accompanied by sauger or walleye. Berg (1981) noted that forage species, including longnose dace, mottled sculpin, mountain suckers, and juvenile shorthead redhorse, were very abundant in the Missouri between Morony Dam and Fort Benton. He stated they were significantly more abundant in this reach than downstream. Numbers of small fish observed during electrofishing in 1990 were not considered high.

Sauger spawn during April and May (Berg 1981) and their scarcity during these months in 1990 suggest the Morony to Fort Benton portion of the river is not being used to any great extent for spawning. Berg (1981) believed this portion of the river was important for spawning. Low sauger numbers, daily fluctuations in water levels or other unknown factors may be impacting spawning use in this reach.

Berg (1981) identified the Marias River (54 miles downstream of Morony Dam) as an important spawning tributary used by sauger residing in the Missouri River from Morony Dam to Fort Peck Reservoir. Penkal (1981) noted that sauger from throughout the Yellowstone River used two tributaries extensively for spawning. Catch rates in 1990 indicate few sauger were present in the reach from Morony Dam to Fort Benton during spring but increased in

numbers after the spawning period. Sauger using this area for feeding and rearing may migrate to downstream spawning areas and then return. Tag returns indicate this movement pattern does exist at least to some degree (Berg 1981).

Past work has shown that sauger from the Missouri inhabit Belt Creek during a portion of the year. Sauger were captured from August 16 to September 25 in 1963 in Belt Creek as they returned to the river. Farthest upstream movement documented in Belt Creek was 31 miles from its mouth (Berg 1982). Walleye catch rates were fairly consistent during this study, ranging between 0.49 and 1.78 fish per hour. Walleye catch rate was only 0.3/hr during 1976-79 (Table 21). Recent walleye stocking in Morony and Cochrane reservoirs may have increased walleye numbers in the river.

Nongame Species

The catch rate of nongame species was generally greater during 1990 than in 1976-79 (Tables 8 through 10 and 21). Shorthead redhorse appeared substantially more numerous than in the late 1970's. Catch rates in 1990 ranged from 36 to 176 fish per hour while catches ranged from 7 to 22/hr during 1976-79. If these rates indicate real differences, reproductive success or survival of nongame species may be greater in recent years. High densities of nongame fish may reflect low densities of sauger and associated reduction in predation. Berg (1990) did not sample nongame species systematically hence may not have collected fish during periods or at locations of highest abundance.

Great Falls Reservoirs

Gill netting results indicate that planting of walleye in Cochrane and Morony reservoirs has established this species in Ryan and Morony reservoirs (the lower two reservoirs). The fry planted in Cochrane Reservoir in 1977, 1985, and 1986 apparently drifted downstream out of the reservoir and established themselves in the lower two reservoirs. This suggests that the fry planted in Morony during 1986 may have drifted into the Missouri River. Walleye stocked in Morony in other years were 2 to 4.6 inches long. One walleye fingerling believed to be a Morony plant was captured in the Missouri River after Morony Reservoir was drafted in November of 1990.

Walleye condition appears good in both reservoirs and walleye appear to be impacting the number and size of other species present, particularly in Ryan Reservoir. Catch of all fish was 3.7 times greater in Morony than Ryan and 3.1 times greater in Cochrane (where no walleye were collected) than Morony. Of the lower three reservoirs Ryan not only had the lowest numbers of fish caught but also the lowest number of species. White suckers of all sizes were scarce in Ryan, while numbers of small suckers were low in Morony. Catch of white suckers was greatest in Cochrane and the population

was dominated by small fish. Catch of trout was greatest in Cochrane, intermediate in Morony, while none were captured in Ryan. One YOY walleye was captured in Ryan Reservoir, indicating some natural reproduction has occurred. No walleye have been stocked in Cochrane since 1986 and Ryan was never stocked (Table 5).

Black Eagle Reservoir (particularly the north side) is severely impacted by sediment inputs from the Sun River. Gill nets set on the south side of the reservoir collected much algae while those on the turbid north side did not. Spindler (1957) noted that natural biological productivity was severely impaired in Black Eagle because of sedimentation from the Sun River and industrial and sewage outfalls. Since his study, pollutants have been reduced but sedimentation from the Sun River has not. Only 33 fish were captured in four gill nets in Black Eagle Reservoir, 10 percent of the number captured in Cochrane. Spindler (1957) noted:

> "The resulting turbidity of the Sun River renders this stream practically void of plant and animal life. No plankton was collected and no benthic life was found in the Sun River. This colloidal clay hugs the western and northern shore of the Missouri and affects the ecology of the latter for many miles downstream. The exclusion of sunlight from the Sun River and along the northern shore of the Missouri inhibits the natural recuperative (from pollution) powers of the latter and the only plant life on this shore was a filamentous algae in the shoal areas above Rainbow Dam."

RECOMMENDATIONS

1. Eliminate the extreme changes in daily discharge below Morony Dam, patterning daily extremes to no more than what would occur naturally at that time of year. A free flowing river system such as the Yellowstone might be used as a model. Instream flow recommendations developed through interagency cooperation for various species should be met. Instream flow data developed by EA might be used to determine the allowable daily extremes to lessen impacts on the river and aquatic ecosystem.

2. Upgrade Morony Dam to eliminate annual drawdowns for repair. Biological windows of time should be developed if drawdown for repair must continue.

3. Reduction of sediment loads from the Sun River, particularly Muddy Creek, should be a top priority. Sedimentation adversely impacts aquatic resources in all five reservoirs and the river downstream from Morony Dam.

4. After daily flows have been stabilized, the fishery in the Morony-Fort Benton area should be monitored to determine if populations respond positively to the new flow regime. A minimum time period to assess changes in the sauger population would be six

years. Since sauger that use this area are older, mature individuals (probably four years or older), this time period would allow assessment of three year classes. Because this an important feeding area for sauger, forage fish populations should be investigated for flow requirements and methods developed for monitoring abundance. Future fishery management activities such as planting fish or introducing new species would benefit from a good understanding of forage base. This area (including Belt Creek) should be monitored for spawning use by sauger during April and May.

5.. Cold water and rough fish populations should be monitored to assess their response to stabilized flows. Supplemental planting of rainbow and brown trout, particularly from stock that have acclimated to this area, might be considered. Highwood and Belt creeks should continue to be monitored for spawning use. Beaver dams at the mouth of Belt Creek might be removed to provide access to spawning rainbow trout.

6. Decisions concerning introduction of new species (such as smallmouth bass) into either the reservoirs or river should be delayed until response of the fishery to stabilized flows have been assessed.

7. Monitoring for pallid sturgeon in the area should continue. Scuba diving might be considered if water clarity is good enough in spring. The study area was not sampled for sturgeon during spring, 1990 and more effort is needed during autumn.

8. Recreational use of much of the area is limited because there is no public access upstream from Carter Ferry, except immediately below Morony Dam. The existence of rapids the first three miles below the dam discourages use of the river by boaters. An access site should be obtained below the rapids where boats could be safely launched and operated.

9. Monitoring of walleye populations in Morony and Ryan reservoirs should continue. The degree of successful natural reproduction should be assessed and stocking rates should be adjusted as necessary. The need for and methods of improving the forage base should be investigated. Smallmouth bass might be a viable option for introduction but they would likely compete for the limited forage present and would gain access to the river downstream. They would utilize crayfish which are in abundant supply. Smallmouth have also been known to tolerate extreme water fluctuations in reservoirs. Water temperature appears to be within the range of other smallmouth waters in the Pacific Northwest but suitable spawning and wintering substrate (gravel and rubble) might be limiting (Dunsmoor et. al 1990). Further assessment is needed.

10. Continued development of the fisheries in the lower reservoirs is futile without public access. Effects of reservoir operations on potential recreation and fishery resources in the reservoirs needs to be evaluated.

11. Trout populations and reproduction in the Great Falls reservoirs should be monitored. Rainbow Reservoir was not sampled in 1990 and should be inventoried, especially for trout. The Giant Springs State fish hatchery is nearby and several natural springs occur in this reach of river.

12. Stream flow data which may be important to resource managers in the future is being regularly eliminated from computer files. USGS hourly flow records are only stored on computer for the most recent 18 months. A system of long term computer data storage should be developed.

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APPENDIX TABLE 1. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1977-78. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	4626	20	6642	760	5882	89	5882	1046	3765	58	1.69	.27	.90
NOVEMBER	5593	4	7877	1644	6233	79	6233	1046	3227	42	1.49	.23	.67
DECEMBER	6255	11	6747	110	6637	98	6637	416	1891	26	2.23	.08	.40
JANUARY	6771	24	8002	2803	5199	65	5199	353	1679	22	.87	.06	.28
FEBRUARY	7650	18	8477	480	7997	94	7967	120	1479	18	2.23	.02	.29
MARCH	9846	3	9308	2094	7214	78	12750	126	2713	21	1.63	.02	.35
APRIL	8975	5	10740	5489	5251	49	5251	0	1198	12	.86	.00	.19
MAY	14740	26	17800	12810	4990	28	6410	90	2279	14	.67	.01	.27
JUNE	13800	4	15220	4839	10381	68	10738	730	3201	20	1.55	.09	.39
JULY	12380	3	18610	4443	14167	76	14167	80	3318	26	2.03	.01	.50
AUGUST	7676	1	6582	1903	4679	80	7679	239	1753	20	1.65	.04	.30
SEPTEMBER	7270	22	8255	3937	4318	52	4318	606	1641	21	.85	.09	.30
YEAR	8807								2350	25			.41

APPENDIX TABLE 2. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1978-79. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	5911	30	9651	400	9251	96	9251	276	2635	34	2.73	.06	.54
NOVEMBER	6828	21	7754	3051	4703	61	4703	52	1812	23	1.00	.01	.34
DECEMBER*	6792	29	7940	3385	4555	57	4555	318	1759	22	.94	.05	.32
JANUARY	7201	12	7269	3127	4142	57	4142	177	1543	20	.79	.03	.26
FEBRUARY	6920	7	8708	5206	3502	40	3502	0	1251	17	.63	.00	.23
MARCH*	8653	2	8002	2666	5336	67	5336	0	1968	21	1.15	.00	.33
APRIL*	9365	23	12070	9860	2210	18	2210	554	1172	11	.29	.08	.16
MAY*	11760	26	22900	13230	9670	42	9670	66	2545	16	1.08	.01	.31
JUNE	9385	23	13480	8642	4838	36	4838	138	1818	16	.64	.02	.26
JULY	5733	11	7692	1984	5708	74	5708	0	1149	17	1.33	.00	.22
AUGUST	5296	26	8512	5206	3306	39	3306	0	1096	17	.60	.00	.23
SEPTEMBER	4716	3	5299	2351	2948	56	4046	87	1204	20	.80	.02	.27
YEAR	7382								1651	20			.29

APPENDIX TABLE 3. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1979-80. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER*	4580	-	-	-	-		-	-	-	-	-	-	-
NOVEMBER*	4416	20	7950	500	7450	94	7680	40	3073	42	2.50	.01	.73
DECEMBER	5526	8	8060	2570	5490	68	9450	50	2605	35	1.40	.01	.54
JANUARY	6156	29	7370	2160	5210	71	5210	590	1919	27	1.26	.11	.40
FEBRUARY	5643	4	13000	600	12400	95	12400	70	2058	27	3.04	.02	.44
MARCH	5921	4	8180	1820	6360	78	6360	150	2714	36	1.53	.03	.53
APRIL	7020	17	7150	620	6530	91	6530	150	1669	22	2.55	.03	.36
MAY	9374	26	27800	11900	15900	57	15900	170	3845	22	1.70	.03	.49
JUNE	21520	27	23100	11100	12000	52	12000	400	3130	14	1.47	.06	.39
JULY	9710	18	12500	4360	8140	65	11090	0	2013	18	1.45	.00	.31
AUGUST	6159	13	8420	4830	3590	43	3590	0	1045	15	.69	.08	.21
SEPTEMBER	4508	24	8060	450	7610	94	7610	380	2362	37	2.57	.09	.58
YEAR	7535								2322	27			.45

APPENDIX TABLE 4. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1980-81. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	5919	1	8420	2920	5500	65	5500	170	1536	22	1.19	.03	.32
NOVEMBER	6432	23	7260	2250	5010	69	7180	60	1848	23	1.31	.01	.36
DECEMBER	6496	19	7370	2250	5120	69	5270	670	2579	32	1.23	.12	.51
JANUARY	6884	15	8240	5100	3140	38	3140	60	1465	18	.60	.01	.26
FEBRUARY	7429	23	14600	500	14100	97	14100	60	2679	28	3.34	.01	.50
MARCH	7389	14	8610	300	8310	97	10800	430	2730	28	2.74	.07	.53
APRIL	6102	9	7210	400	6810	94	6810	250	1567	22	2.11	.05	.34
MAY	15970	21	16900	4200	12700	75	14400	220	3922	21	1.72	.04	.48
JUNE	24900	18	26500	21300	5200	20	5200	100	1790	7	.68	.04	.21
JULY	8697	22	14000	3080	10920	78	10920	370	2829	25	1.93	.06	.46
AUGUST	6092	30	6720	900	5820	87	5820	0	1795	25	1.95	.00	.39
SEPTEMBER	4681	10	7320	300	7020	96	7020	0	989	17	2.35	.00	.25
YEAR	8911								2146	22			.38

APPENDIX TABLE 5. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1981-82. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	4520	12	5280	523	4757	90	4757	0	1346	25	1.69	.00	.34
NOVEMBER	5562	14	6770	2540	4230	62	4810	0	1913	28	1.02	.00	.41
DECEMBER	6144	30	8060	2950	5110	63	5110	270	1588	22	1.12	.05	.33
JANUARY	7172	10	7770	3610	4160	54	4160	110	1352	18	.88	.02	.26
FEBRUARY	8120	25	9040	4830	4210	47	4210	170	1385	16	.79	.03	.24
MARCH	8139	11	11100	7830	3270	29	3270	0	1109	12	.51	.00	.18
APRIL	9076	8	14500	279	14221	98	14221	710	2054	19	3.36	.11	.33
MAY	12440	29	23500	8360	15140	64	15140	450	2229	15	1.90	.06	.29
JUNE	22050	17	27700	11400	16300	59	16300	400	2620	11	1.87	.04	.30
JULY	15240	16	18800	8670	10130	54	10130	820	2649	18	1.31	.12	.35
AUGUST	7587	6	10800	3960	6840	63	6840	110	1327	16	1.27	.02	.25
SEPTEMBER	5979	27	5700	3610	2090	37	2670	0	944	15	1.20	.00	.23
YEAR	9331								1710	18			.29

APPENDIX TABLE 6. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1982-83. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	6690	22	8920	369	8551	96	9344	0	1524	18	2.54	.00	.34
NOVEMBER	7315	15	8670	1010	7660	88	7660	170	1731	21	1.99	.03	.35
DECEMBER	6941	10	6720	4360	2360	35	2810	280	1565	20	.53	.05	.29
JANUARY	7625	9	9750	3730	6020	62	6020	560	2261	25	.90	.09	.36
FEBRUARY	7592	17	8670	399	8271	95	8271	0	1988	24	2.43	.00	.40
MARCH	8121	31	9110	6400	2710	30	2710	430	1394	16	.47	.07	.24
APRIL	8019	22	13100	2820	10280	78	10280	60	1686	18	1.89	.01	.29
MAY	10900	10	16400	3580	12820	78	12820	60	2606	19	2.03	.01	.34
JUNE	10100	21	13200	6510	6690	51	6690	670	2123	18	1.03	.10	.31
JULY	12970	27	8980	2850	6130	68	9660	430	2842	19	1.30	.07	.38
AUGUST	7591	3	15600	5800	9800	63	9800	50	1645	18	1.46	.01	.28
SEPTEMBER	6249	22	10000	511	9489	95	9489	120	2073	25	2.54	.02	.42
YEAR	8353								1953	20			.33

APPENDIX TABLE 7. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1983-84. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	6984	18	8420	4360	4060	48	4530	50	1892	24	.84	.01	.35
NOVEMBER	8896	7	12100	4960	7140	59	7140	180	1317	13	1.45	.03	.24
DECEMBER	6960	18	5510	3190	2320	42	2740	110	1121	15	.54	.02	.21
JANUARY	7765	14	8610	4650	3960	46	3960	190	1222	14	.76	.03	.21
FEBRUARY	7487	2	8420	6610	1810	21	1810	0	822	10	.32	.00	.15
MARCH	7751	19	9430	3540	5890	62	5890	0	1105	13	1.17	.00	.20
APRIL	8468	21	12900	4650	8250	64	8250	130	1242	13	1.38	.02	.21
MAY	11840	17	14300	9040	5260	37	5260	700	1941	15	.73	.08	.26
JUNE	17700	21	19900	9620	10280	52	10280	0	2486	13	1.29	.00	.29
JULY	12310	16	13600	4960	8640	64	8640	0	564	5	1.40	.00	.09
AUGUST	8253	10	9430	5610	3820	41	3820	250	1198	13	.68	.04	.20
SEPTEMBER	9992	12	10700	6250	4450	42	4450	310	1418	13	.74	.05	.21
YEAR	8510								1361	13			.22

APPENDIX TABLE 8. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1984-85. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	8165	29	11100	2390	8710	78	8710	190	1590	17	1.76	.04	.35
NOVEMBER	7346	7	8180	2880	5300	65	5300	60	1595	19	1.16	.01	.30
DECEMBER	6955	18	7770	4480	3290	42	3290	10	1552	20	.66	.01	.28
JANUARY	7023	17	8790	5230	3560	41	3560	50	1277	16	.66	.01	.24
FEBRUARY	6938	12	9360	6050	3310	35	3310	0	1195	15	.58	.00	.23
MARCH	6793	19	13300	708	12592	95	12592	740	3076	35	2.84	.07	.59
APRIL	7392	10	8300	2140	6160	74	6160	60	2687	32	1.43	.00	.50
MAY	8789	23	10200	7150	3050	30	3050	240	1241	13	.50	.04	.20
JUNE	5757	7	9040	5420	3620	40	3620	90	1187	18	.66	.02	.24
JULY	3904	25	8240	3150	5090	62	5090	100	942	20	1.09	.03	.24
AUGUST	4345	6	5470	944	4526	83	6090	160	1661	30	1.44	.04	.42
SEPTEMBER	4467	28	6000	3020	2980	50	3550	0	441	8	.72	.00	.10
YEAR	6488								1540	20			.31

APPENDIX TABLE 9. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1985-86. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	7130	10	10300	4000	6300	61	6300	170	1339	17	1.18	.03	.24
NOVEMBER	7493	1	9360	894	8466	90	8466	150	1750	20	2.67	.03	.36
DECEMBER	6654	5	8010	5800	2210	28	2210	220	854	12	.41	.04	.16
JANUARY	6576	27	7890	499	7391	94	7391	50	1296	17	2.21	.01	.28
FEBRUARY	7034	3	8550	442	8108	95	8600	110	2222	25	2.37	.02	.42
MARCH	7665	5	11400	5850	5550	49	5550	110	1438	16	.92	.02	.25
APRIL	8351	13	8980	944	8036	89	8840	240	3832	34	2.08	.04	.67
MAY	11750	16	14800	6670	8130	55	8130	100	2708	21	1.50	.02	.40
JUNE	11540	24	15300	4530	10770	70	10770	230	2707	19	1.70	.04	.36
JULY	7344	1	11600	4610	6990	60	6990	260	1274	15	.55	.04	.20
AUGUST	6128	12	8360	2110	6250	75	6250	390	1899	25	1.45	.08	.39
SEPTEMBER	5945	19	7540	4320	3220	43	3750	520	1538	22	.70	.11	.30
YEAR	7801								1896	20			.33

APPENDIX TABLE 10. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1986-87. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	5655	15	7830	845	6985	89	6985	140	1118	17	1.95	.03	.24
NOVEMBER	7299	20	8420	4960	3460	41	3460	60	850	11	.66	.01	.16
DECEMBER	7027	19	8010	6400	1610	92	6915	60	1805	22	2.05	.01	.38
JANUARY	6856	11	13300	4610	8690	65	8690	510	1822	22	1.44	.10	.36
FEBRUARY	5813	26	10400	4040	6360	61	6360	140	2047	26	1.18	.03	.40
MARCH	5578	4	9750	1260	8490	87	8490	140	1792	23	2.03	.03	.38
APRIL	6159	8	8850	5610	3240	37	3260	100	950	13	.59	.02	.19
MAY	5970	20	9620	3290	6330	66	6330	240	1976	25	1.27	.06	.41
JUNE	4772	5	8980	3730	5250	58	5250	100	1556	24	1.31	.03	.41
JULY	5253	24	9690	136	9554	99	9554	210	2082	29	3.01	.04	.54
AUGUST	4638	31	8430	3530	4900	58	4900	80	1666	26	1.25	.05	.45
SEPTEMBER	4655	9	8080	1460	6620	82	6620	110	1704	26	1.90	.03	.43
YEAR	5807								1611	22			.36

APPENDIX TABLE 11. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1987-88. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	4238	1	4270	2670	1600	37	1600	30	646	16	.54	0	.22
NOVEMBER	5001	20	6460	3250	3210	50	3490	40	663	11	.92	0	.18
DECEMBER	4815	15	5080	2310	2770	55	3410	130	1144	21	.92	0	.33
JANUARY	5159	6	8440	4200	4240	50	4240	70	988	16	1.08	.02	.27
FEBRUARY	5039	25	8390	2000	6390	76	6390	340	2065	29	1.87	.04	.56
MARCH	4706	3	8390	2310	6080	72	6080	340	3960	50	1.73	.10	1.08
APRIL	4795	13	8440	685	7755	92	7755	170	2988	40	2.55	.05	.85
MAY	5915	25	8440	1020	7420	88	7420	400	2575	33	2.36	.10	.70
JUNE	4708	3	7900	2970	4930	62	5330	70	2960	38	1.41	.02	.79
JULY	4014	1	8720	2970	5750	66	5750	210	2749	39	1.55	.07	.76
AUGUST	3719	15	7440	802	6638	89	7007	100	2402	36	2.29	.03	.71
SEPTEMBER	3962	23	8080	3200	4880	60	4880	150	1855	27	1.33	.05	.52
YEAR	4671								2239	31			.62

APPENDIX TABLE 12. FLOW DATA FOR THE MISSOURI RIVER BELOW MORONY DAM, 1988-89. FLOW DATA FOR LESS THAN 1000 CFS MAY NOT BE ACCURATE. *INDICATES DATA FOR MONTH INCOMPLETE. (U.S. GEOLOGICAL SURVEY WATER RESOURCES DATA, MT; PERSONAL COMMUNICATION MEL WHITE, HELENA, USGS OFFICE)

	MONTHLY MEAN(CFS) DISCHARGE	EXTREME DISCHARGES (CFS),DIFFERENCES IN EXTREMES, % REDUCTION OF FLOW DURING DAY OF GREATEST EXTREME					EXTREME AND AVERAGE CHANGE IN DAILY DISCHARGE (CFS), AVERAGE PERCENT DAILY REDUCTION IN FLOW				DAILY CHANGE IN STAGE HEIGHT (FT)		
		DATE	MAX	MIN	DIF	%RED	MAX	MIN	AVE	%RED	MAX	MIN	AVE
OCTOBER	3829	26	3840	362	3478	91	5660	30	1221	21	1.48	.01	.30
NOVEMBER	4245	16	7510	177	7333	98	7333	70	1287	23	2.62	.02	.41
DECEMBER	4036	16	4260	362	3898	92	5730	110	1624	28	1.47	.03	.41
JANUARY	4854	9	5420	2310	3110	57	3920	200	1016	18	.97	.05	.28
FEBRUARY	5337	1	6730	719	6011	89	6011	190	1901	27	2.08	.05	.53
MARCH	6972	10	12400	752	11648	94	13560	210	2891	30	3.23	.05	.69
APRIL	7445	26	13700	8150	5550	41	5550	120	1024	12	1.09	.03	.22
MAY	10670	17	16500	8060	8440	51	8800	330	2047	15	1.58	.07	.37
JUNE	8624	23	12500	5900	6600	53	9450	210	1376	12	1.69	.05	.28
JULY	5057	10	6270	4400	1870	30	1870	120	746	13	.48	.03	.19
AUGUST	4815	6	7600	4120	3480	46	3480	70	853	14	.87	.02	.22
SEPTEMBER	4685	14	5540	2130	3410	62	3410	70	1302	22	1.08	.02	.38
YEAR	5881								1439	20			.36

APPENDIX TABLE 17. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1980-81.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	11	14	6	12	5	9	12	16	18	16	13	16	148	41%
.5	16	9	12	16	16	15	14	4	10	6	11	13	142	39%
1.0	2	5	9	3	5	3	3	7	2	4	5	0	48	13%
1.5	2	2	4	0	1	1	0	0	0	4	1	0	15	4%
2.0	0	0	0	0	0	1	0	4	0	1	1	0	7	2%
2.5	0	0	0	0	0	0	1	0	0	0	0	1	2	1%
+2.5	0	0	0	0	1	2	0	0	0	0	0	0	3	1%
													365	

APPENDIX TABLE 18. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1981-82.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	10	6	14	17	15	20	13	15	19	6	19	14	168	46%
.5	15	17	11	11	11	10	16	13	7	21	8	14	154	42%
1.0	4	5	4	3	2	1	0	2	2	3	3	1	30	8%
1.5	1	2	2	0	0	0	0	0	0	1	1	1	8	2%
2.0	1	0	0	0	0	0	0	1	2	0	0	0	4	1%
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
+2.5	0	0	0	0	0	0	1	0	0	0	0	0	1	0%
													365	

APPENDIX TABLE 19. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1982-83.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	21	14	7	7	11	11	12	17	8	13	13	13	147	40%
.5	7	12	23	18	10	20	15	9	17	12	14	9	166	45%
1.0	1	1	1	6	4	0	2	3	4	3	3	6	34	9%
1.5	0	2	0	0	2	0	0	1	1	3	1	0	10	3%
2.0	0	1	0	0	0	0	1	0	0	0	0	1	3	1%
2.5	1	0	0	0	1	0	0	1	0	0	0	0	3	1%
+2.5	1	0	0	0	0	0	0	0	0	0	0	1	2	1%
													365	

APPENDIX TABLE 20. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1983-84.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	10	22	18	18	22	21	19	15	16	28	20	19	228	62%
.5	13	4	12	11	7	9	9	12	9	2	10	7	105	29%
1.0	8	2	1	2	0	0	1	4	3	0	1	4	26	7%
1.5	0	2	0	0	0	1	1	0	2	1	0	0	7	2%
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
+2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
													366	

APPENDIX TABLE 21. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1984-85.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	16	12	10	11	15	3	8	17	14	17	6	26	155	42%
.5	10	13	18	18	11	16	10	14	15	12	17	2	156	43%
1.0	1	3	3	2	2	8	7	0	1	1	6	2	36	10%
1.5	3	2	0	0	0	3	5	0	0	1	2	0	16	4%
2.0	1	0	0	0	0	0	0	0	0	0	0	0	1	0%
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
+2.5	0	0	0	0	0	1	0	0	0	0	0	0	1	0%
													365	

APPENDIX TABLE 22. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1985-86.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	18	8	21	18	7	17	5	11	10	19	13	12	159	44%
.5	10	18	10	9	14	10	8	11	17	11	9	13	140	38%
1.0	2	3	0	3	5	4	10	8	1	1	6	5	48	13%
1.5	1	0	0	0	1	0	5	1	1	0	3	0	12	3%
2.0	0	0	0	0	0	0	1	0	1	0	0	0	2	1%
2.5	0	0	0	1	1	0	1	0	0	0	0	0	3	1%
+2.5	0	1	0	0	0	0	0	0	0	0	0	0	1	0%
													365	

APPENDIX TABLE 23. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1986-87.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	17	23	13	9	11	15	23	8	7	11	11	14	162	45%
.5	12	7	12	17	9	9	2	17	15	8	8	6	122	34%
1.0	0	1	3	4	6	5	5	1	6	7	7	7	52	14%
1.5	0	0	2	1	2	1	0	4	2	2	2	2	18	5%
2.0	1	0	0	0	0	0	0	0	0	1	1	1	4	1%
2.5	0	0	1	0	0	1	0	0	0	0	0	0	2	1%
+2.5	0	0	0	0	0	0	0	0	0	1	1	0	2	1%
													362	

APPENDIX TABLE 24. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1987-88.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	6	20	5	17	7	4	6	8	5	4	10	14	106	33%
.5	1	3	11	11	12	3	6	6	8	10	6	4	81	25%
1.0	1	3	2	2	4	3	4	9	1	4	4	3	40	12%
1.5	0	0	0	1	3	16	11	5	16	12	9	9	82	25%
2.0	0	0	0	0	3	5	1	1	0	1	0	0	11	3%
2.5	0	0	0	0	0	0	1	2	0	0	2	0	5	2%
+2.5	0	0	0	0	0	0	1	0	0	0	0	0	1	0%
													326	

APPENDIX TABLE 25. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1988-89.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	18	15	15	14	11	8	17	12	20	17	20	12	179	49%
.5	9	10	9	13	7	10	11	14	6	14	8	8	119	33%
1.0	0	3	2	4	5	5	1	3	2	0	3	9	37	10%
1.5	4	0	5	0	4	6	1	1	1	0	0	1	23	6%
2.0	0	0	0	0	0	0	0	1	1	0	0	0	2	1%
2.5	0	1	0	0	1	0	0	0	0	0	0	0	2	1%
+2.5	0	1	0	0	0	2	0	0	0	0	0	0	3	1%
													365	

APPENDIX TABLE 26. NUMBER OF DAYS THE STAGE HEIGHT OF THE MISSOURI RIVER BELOW MORONY DAM FLUCUATED THE FOLLOWING AMOUNTS WITHIN ONE DAY, 1989-90.

RANGE (FEET)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	(%)
(=.2	19	12	13	15	15	23	19	12	15	15	13	15	186	52%
1	5	11	14	8	10	7	10	9	12	11	14	8	119	33%
1.0	7	3	3	6	3	1	0	9	0	3	4	1	40	11%
1.5	0	3	1	1	0	0	0	0	1	2	0	1	9	3%
2.0	0	0	0	0	0	0	0	0	2	0	0	0	2	1%
2.5	0	1	0	0	0	0	1	1	0	0	0	0	3	1%
+2.5	0	0	0	1	0	0	0	0	0	0	0	0	1	0%
													360	

APPENDIX TABLE 27. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1978, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	21	12	33	54%
.5	7	15	22	36%
1.0	2	4	6	10%
1.5	0	0	0	0%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 28. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1979, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	10	8	18	53%
.5	3	9	12	35%
1.0	0	3	3	9%
1.5	0	1	1	3%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	13	21	34	100%

APPENDIX TABLE 29. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1980, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	12	5	17	38%
.5	14	3	17	38%
1.0	3	5	8	18%
1.5	0	1	1	2%
2.0	0	1	1	2%
2.5	0	0	0	0%
+2.5	1	0	1	2%
TOTAL	30	15	45	100%

APPENDIX TABLE 40. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1977, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	0	0	0	0%
.5	3	11	14	23%
1.0	18	12	30	50%
1.5	9	6	15	25%
2.0	1	0	1	2%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	31	29	60	100%

APPENDIX TABLE 41. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1978, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	3	6	9	15%
.5	15	17	32	52%
1.0	12	7	19	31%
1.5	0	0	0	0%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	1	0	1	2%
TOTAL	31	30	61	100%

APPENDIX TABLE 42. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1979, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2		4	4	17%
.5		6	6	26%
1.0		7	7	30%
1.5		4	4	17%
2.0		0	0	0%
2.5		1	1	4%
+2.5		1	1	4%
TOTAL	0	23	23	100%

APPENDIX TABLE 30. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1981, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	12	16	28	46%
.5	14	4	18	30%
1.0	3	7	10	16%
1.5	0	0	0	0%
2.0	0	4	4	7%
2.5	1	0	1	2%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 31. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1982, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	13	15	28	46%
.5	16	13	29	48%
1.0	0	2	2	3%
1.5	0	0	0	0%
2.0	0	1	1	2%
2.5	0	0	0	0%
+2.5	1	0	1	2%
TOTAL	30	31	61	100%

APPENDIX TABLE 32. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1983, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	12	17	29	48%
.5	15	9	24	39%
1.0	2	3	5	8%
1.5	0	1	1	2%
2.0	1	0	1	2%
2.5	0	1	1	2%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 43. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1980, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	11	14	25	41%
.5	16	9	25	41%
1.0	2	5	7	11%
1.5	2	2	4	7%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	31	30	61	100%

APPENDIX TABLE 44. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1981, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	10	6	16	26%
.5	15	17	32	52%
1.0	4	5	9	15%
1.5	1	2	3	5%
2.0	1	0	1	2%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	31	30	61	100%

APPENDIX TABLE 45. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1982, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	21	14	35	57%
.5	7	12	19	31%
1.0	1	1	2	3%
1.5	0	2	2	3%
2.0	0	1	1	2%
2.5	1	0	1	2%
+2.5	1	0	1	2%
TOTAL	31	30	61	100%

APPENDIX TABLE 33. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1984, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	19	15	34	56%
.5	9	12	21	34%
1.0	1	4	5	8%
1.5	1	0	1	2%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 34. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1985, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	8	17	25	41%
.5	10	14	24	39%
1.0	7	0	7	11%
1.5	5	0	5	8%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 35. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1986, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	5	11	16	26%
.5	8	11	19	31%
1.0	10	8	18	30%
1.5	5	1	6	10%
2.0	1	0	1	2%
2.5	1	0	1	2%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 46. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1983, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	10	22	32	52%
.5	13	4	17	28%
1.0	8	2	10	16%
1.5	0	2	2	3%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	31	30	61	100%

APPENDIX TABLE 47. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1984, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	16	12	28	46%
.5	10	13	23	38%
1.0	1	3	4	7%
1.5	3	2	5	8%
2.0	1	0	1	2%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	31	30	61	100%

APPENDIX TABLE 48. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1985, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	18	8	26	43%
.5	10	18	28	46%
1.0	2	3	5	8%
1.5	1	0	1	2%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	1	1	2%
TOTAL	31	30	61	100%

APPENDIX TABLE 36. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1987, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	23	8	31	52%
.5	2	17	19	32%
1.0	5	1	6	10%
1.5	0	4	4	7%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	30	30	60	100%

APPENDIX TABLE 37. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1988, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	6	8	14	23%
.5	6	6	12	20%
1.0	4	9	13	21%
1.5	11	5	16	26%
2.0	1	1	2	3%
2.5	1	2	3	5%
+2.5	1	0	1	2%
TOTAL	30	31	61	100%

APPENDIX TABLE 38. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1989, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	17	12	29	48%
.5	11	14	25	41%
1.0	1	3	4	7%
1.5	1	1	2	3%
2.0	0	1	1	2%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 49. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1986, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	17	23	40	66%
.5	12	7	19	31%
1.0	0	1	1	2%
1.5	0	0	0	0%
2.0	1	0	1	2%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 50. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1987, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	6	20	26	76%
.5	1	3	4	12%
1.0	1	3	4	12%
1.5	0	0	0	0%
2.0	0	0	0	0%
2.5	0	0	0	0%
+2.5	0	0	0	0%
TOTAL	8	26	34	100%

APPENDIX TABLE 51. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1988, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	18	15	33	54%
.5	9	10	19	31%
1.0	0	3	3	5%
1.5	4	0	4	7%
2.0	0	0	0	0%
2.5	0	1	1	2%
+2.5	0	1	1	2%
TOTAL	31	30	61	100%

APPENDIX TABLE 39. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR APRIL AND MAY, 1990, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	APR	MAY	TOTAL	PERCENT
(=.2	19	12	31	51%
.5	10	9	19	31%
1.0	0	9	9	15%
1.5	0	0	0	0%
2.0	0	0	0	0%
2.5	1	1	2	3%
+2.5	0	0	0	0%
TOTAL	30	31	61	100%

APPENDIX TABLE 52. NUMBER OF DAYS THE STAGE HEIGHT CHANGED THE FOLLOWING AMOUNTS FOR OCT. AND NOV., 1989, MISSOURI RIVER BELOW MORONY DAM

RANGE (FEET)	OCT	NOV	TOTAL	PERCENT
(=.2	19	12	31	51%
.5	5	11	16	26%
1.0	7	3	10	16%
1.5	0	3	3	5%
2.0	0	0	0	0%
2.5	0	1	1	2%
+2.5	0	0	0	0%
TOTAL	31	30	61	100%

APPENDIX TABLE 53. CATCH STATISTICS FOR PETERSEN ESTIMATES IN THE MISSOURI RIVER DOWNSTREAM FROM MORONY DAM, SPRING, 1990.

	SECTION 2							SECTION 3						
SPECIES	NUMBER MARKED	NUMBER CAPTURED	NUMBER RECAPS	PERCENT RECAPS	POPULATIO ESTIMATE	95 % CONFIDENCE I. LOWER	UPPER	NUMBER MARKED	NUMBER CAPTURED	NUMBER RECAPS	PERCENT RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I. LOWER	UPPER
Brown Trout	11	6	1	16.7	42	2	82							
Carp	118	26	2	7.7	1071	81	2061	83	34	1	2.9	1470	-145	3085
Goldeye	758	793	20	2.5	28697	16865	40530	1470	336	4	1.2	99145	20403	177888
Longenose Sucker	103	59	3	5.1	1560	239	2881							
White Sucker	56	20	1	5.0	599	-46	1243							
Shorthead Redhorse	778	154	4	2.6	24149	5140	43158	204	166	2	1.2	11412	329	22494
Sauger	1	3	1	33.3	4	1	7							
Walleye	7	6	1	16.7	28	1	55							
All Fish Combined	1919	1081	33	3.1	61101	41179	81023	1883	616	7	1.1	145304	50989	239618

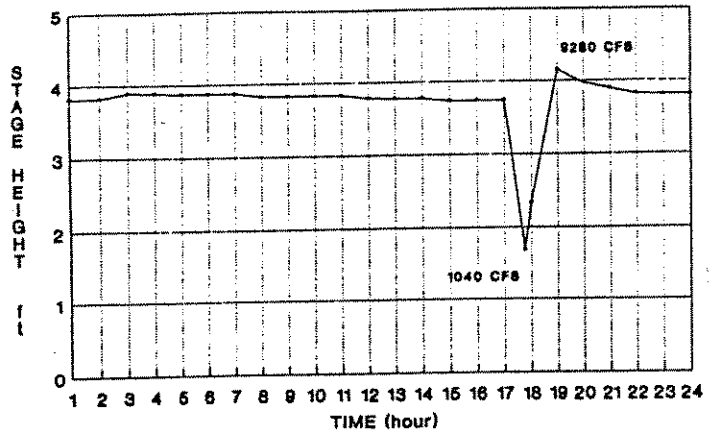
APPENDIX TABLE 54. CATCH STATISTICS FOR PETERSEN ESTIMATES IN THE MISSOURI RIVER DOWNSTREAM FROM MORONY DAM, SUMMER, 1990.

	SECTION 2							SECTION 3						
SPECIES	NUMBER MARKED	NUMBER CAPTURED	NUMBER RECAPS	PERCENT RECAPS	POPULATIO ESTIMATE	95 % CONFIDENCE I. LOWER	UPPER	NUMBER MARKED	NUMBER CAPTURED	NUMBER RECAPS	PERCENT RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I. LOWER	UPPER
Rainbow Trout	32	8	0	0.0	-	-	-	0	0	0	-	-	-	-
Cutthroat Trout	0	0	0	0.0	-	-	-	0	0	0	-	-	-	-
Brown Trout	4	4	0	0.0	-	-	-	0	3	0	0.0	-	-	-
Yellow Perch	0	0	0	-	-	0	0	1	1	0	0.0	-	-	-
Channel Catfish	0	0	0	-	-	0	0	1	1	0	0.0	-	-	-
Burbot	0	0	0	-	-	0	0	0	0	0	-	-	-	-
Carp	123	74	3	4.1	2325	342	4308	148	71	0	0.0	-	-	-
Goldeye	630	164	5	3.0	17353	4733	29972	753	135	4	3.0	20509	4403	36615
Freshwater Drum	141	49	2	4.1	2367	118	4615	44	19	1	5.3	450	-33	933
River Carpsucker	13	31	1	3.2	224	-21	469	37	26	0	0.0	-	-	-
Longnose Sucker	293	215	3	1.4	15876	2090	29662	94	65	0	0.0	-	-	-
White Sucker	73	22	1	4.5	851	-69	1771	67	30	1	3.3	1054	-100	2208
Smallmouth Buffalo	6	9	0	0.0	-	-	-	12	2	1	50.0	20	-	-
Shorthead Redhorse	1069	728	80	11.0	9630	7665	11595	719	275	18	6.5	10459	6036	14882
Smallmouth Bass	1	0	0	-	-	0	0	0	0	0	-	-	-	-
Sauger	65	31	7	22.6	264	115	413	39	19	2	10.5	267	26	508
Walleye	13	6	0	0.0	-	-	-	15	8	1	12.5	72	0	144
Mountain Whitefish	2	0	0	-	-	-	-	0	1	0	0.0	-	-	-
Shovelnose Sturgeo	0	0	0	0.0	-	-	-	1	0	0	-	-	-	-
TOTAL	2465	1341	102	7.6	32130	26196	38063	1931	656	28	4.3	43770	28457	59083

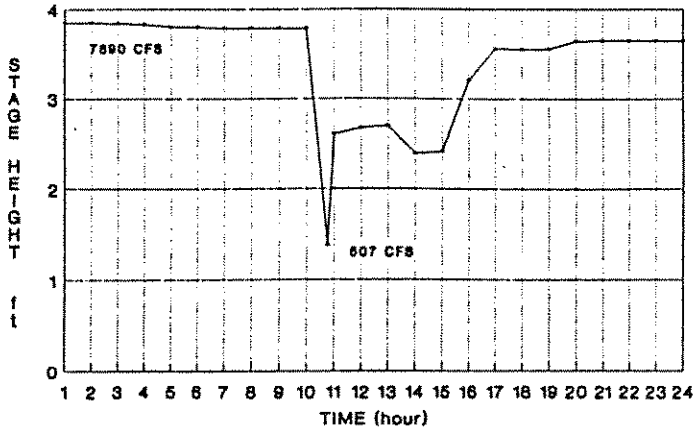
APPENDIX TABLE 55. CATCH STATISTICS FOR PETERSEN ESTIMATES IN THE MISSOURI RIVER DOWNSTREAM FROM MORONY DAM, AUTUMN, 1990.

	SECTION 2							SECTION 3						
SPECIES	NUMBER MARKED	NUMBER CAPTURED	NUMBER RECAPS	PERCENT RECAPS	POPULATIO ESTIMATE	95 % CONFIDENCE I. LOWER	UPPER	NUMBER MARKED	NUMBER CAPTURED	NUMBER RECAPS	PERCENT RECAPS	POPULATION ESTIMATE	95 % CONFIDENCE I. LOWER	UPPER
Rainbow Trout	13	18	0	0.0	-	-	-	0	0	0	-	-	-	-
Cutthroat Trout	0	0	0	0.0	-	-	-	0	0	0	-	-	-	-
Brown Trout	10	18	0	0.0	-	-	-	1	3	0	-	-	-	-
Yellow Perch	0	1	0	0.0	-	-	-	2	0	0	-	-	-	-
Channel Catfish	0	0	0	-	-	-	-	0	0	0	-	-	-	-
Burbot	0	0	0	-	-	-	-	0	2	0	-	-	-	-
Carp	106	131	1	0.8	7062	-869	14993	43	94	3	3.2	1045	149	1941
Goldeye	12	125	0	0.0	-	-	-	66	241	2	0.8	5405	141	10668
Freshwater Drum	0	0	0	-	-	-	-	0	0	0	-	-	-	-
River Carpsucker	12	15	1	6.7	104	-6	214	3	21	0	0.0	-	-	-
Longnose Sucker	136	309	9	2.9	4247	1778	6716	76	256	5	2.0	3298	884	5713
White Sucker	21	65	2	3.1	484	21	947	26	53	2	3.8	486	23	949
Smallmouth Buffalo	9	0	0	-	-	-	-	0	0	0	-	-	-	-
Shorthead Redhorse	461	829	26	3.1	14202	9028	19377	219	347	8	2.3	8507	3303	13711
Smallmouth Bass	0	0	0	-	-	-	-	0	0	0	-	-	-	-
Sauger	7	2	0	0.0	-	-	-	4	13	0	-	-	-	-
Walleye	7	6	0	0.0	-	-	-	3	6	0	-	-	-	-
Mountain Whitefish	26	20	1	5.0	284	-22	589	11	11	0	-	-	-	-
Shovelnose Sturgeo	0	0	0	-	-	-	-	0	0	0	-	-	-	-
TOTAL	820	1539	40	2.6	30838	21636	40039	454	1047	20	1.9	22707	13314	32100

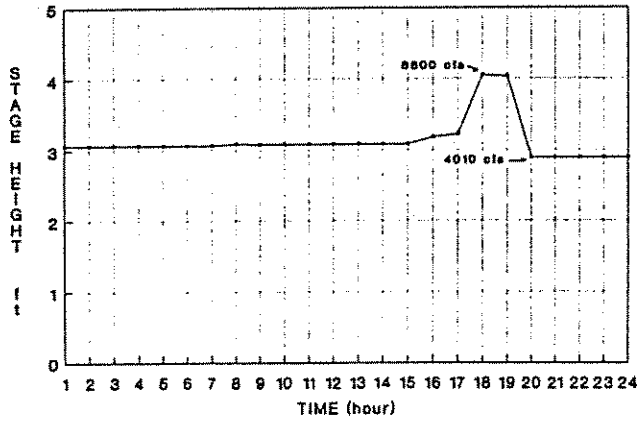
APPENDIX FIGURE 1.
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - MAY 25, 1990
(2.46 ft fluctuation)



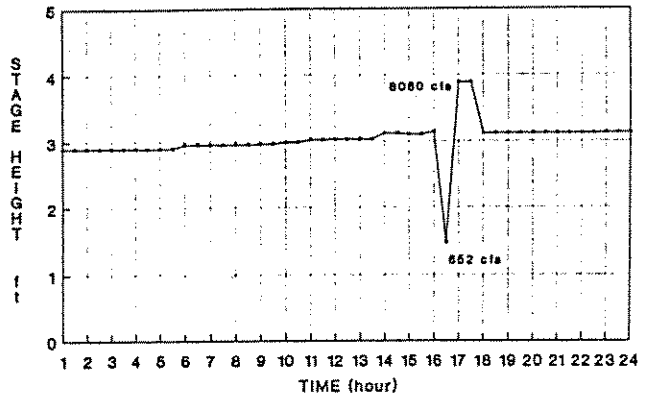
APPENDIX FIGURE 2.
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - APRIL 13, 1990
(2.47 ft fluctuation)



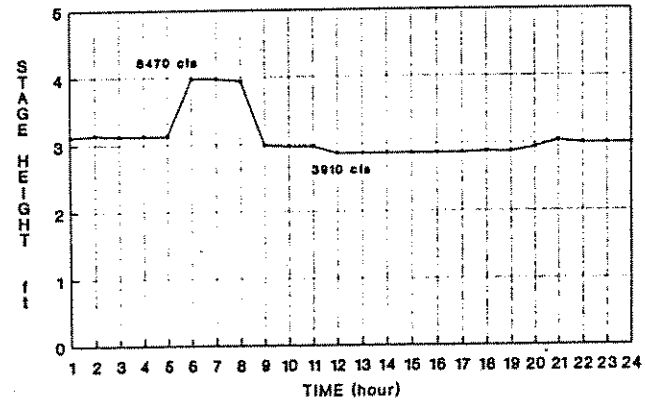
APPENDIX FIGURE 3.
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
NOVEMBER 7, 1989 (1.16 ft fluctuation)



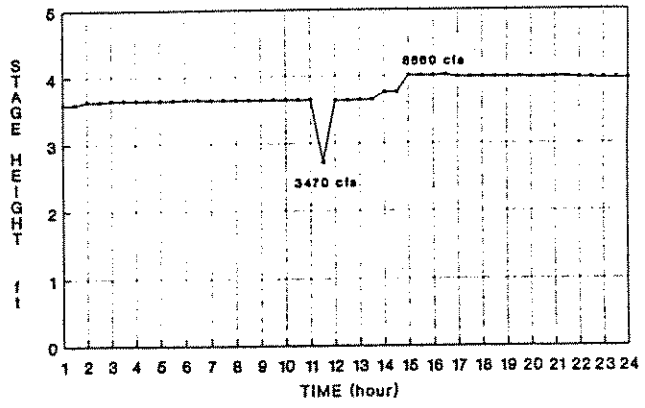
APPENDIX FIGURE 4.
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - NOVEMBER 8, 1989
(2.42 ft fluctuation)



APPENDIX FIGURE 5.
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - NOVEMBER 9,1989
(1.12 ft fluctuation)

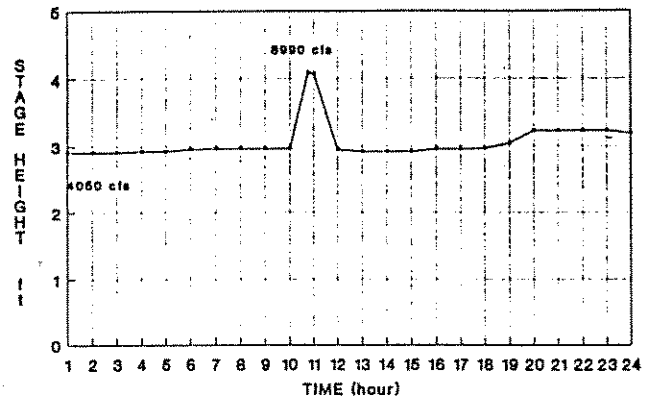


APPENDIX FIGURE 6.
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - NOVEMBER 20, 1989
(1.30 ft fluctuation)



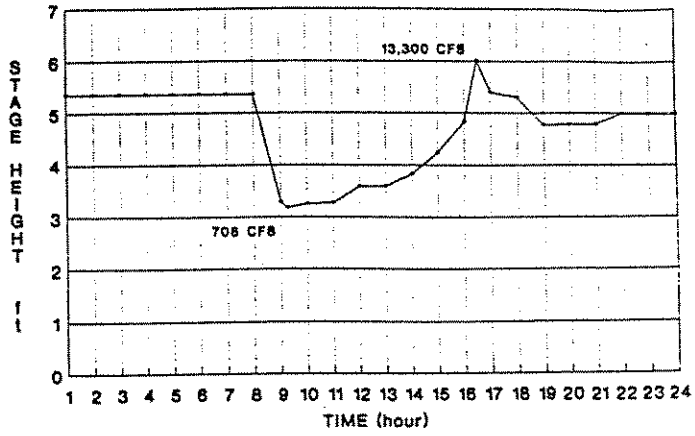
APPENDIX FIGURE 7.

MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - DECEMBER 20,1989
(1.19 ft fluctuation)



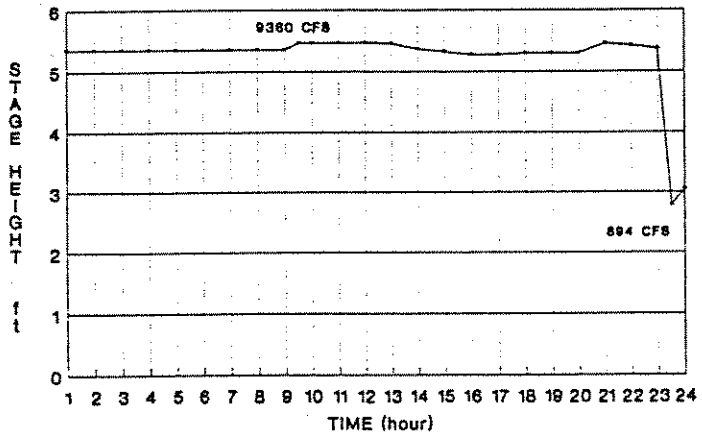
APPENDIX FIGURE 8.

MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - MARCH 19, 1985
(2.84 ft fluctuation)



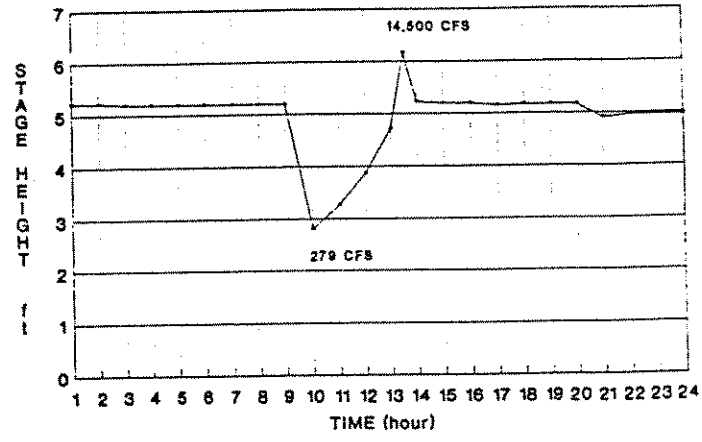
APPENDIX FIGURE 9.

MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - NOVEMBER 1, 1985
(2.67 ft fluctuation)



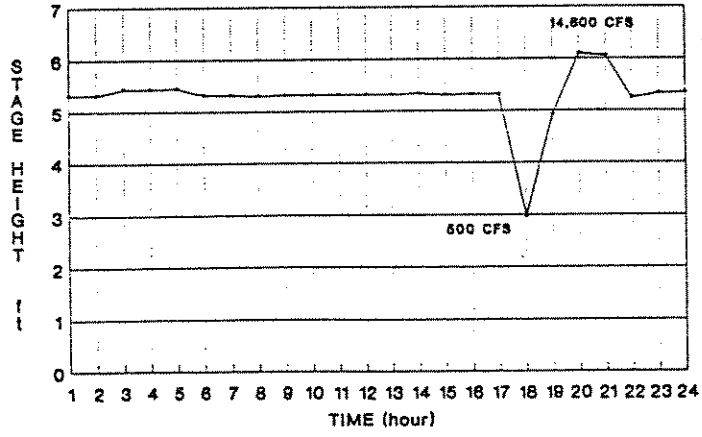
APPENDIX FIGURE 10.

MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - APRIL 8, 1982
(3.36 ft fluctuation)



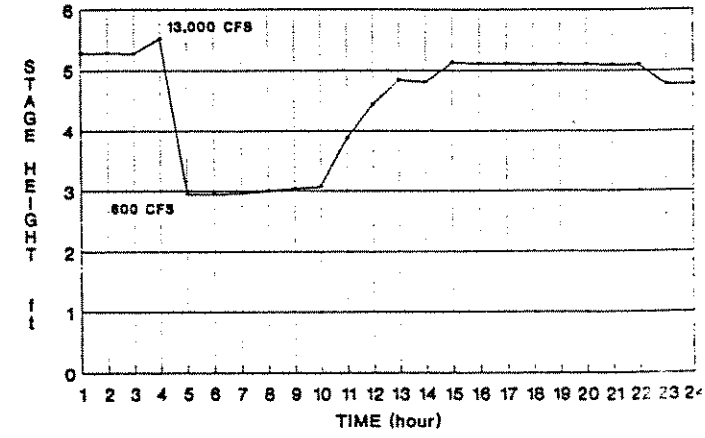
APPENDIX FIGURE 11.

MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - FEBRUARY 23, 1981
(3.34 ft fluctuation)

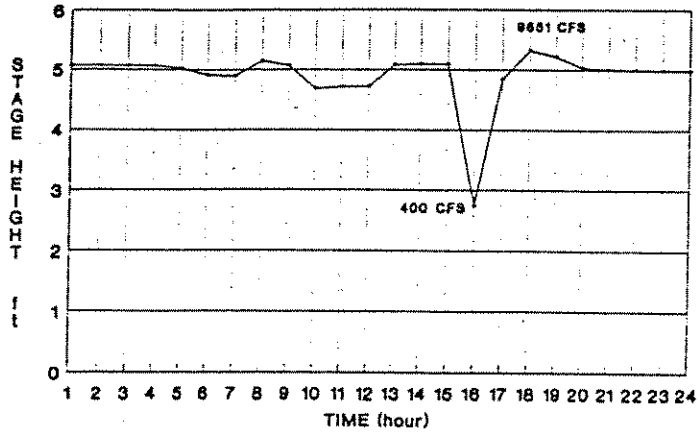


APPENDIX FIGURE 12.

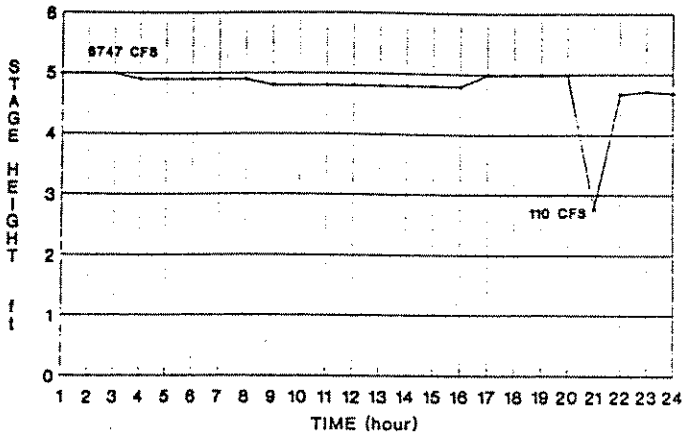
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - FEBRUARY 4, 1980
(3.04 ft fluctuation)



APPENDIX FIGURE 13.
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - OCTOBER 30, 1978
(2.73 ft fluctuation)



APPENDIX FIGURE 14.
MISSOURI RIVER STAGE HEIGHT DOWNSTREAM
MORONY DAM - DECEMBER 11, 1977
(2.23 ft fluctuation)



APPENDIX FIGURE 15. FISHERMAN'S LETTER MAILED TO THE MDFWP CONCERNING POOR CATCHES OF SAUGER BELOW MORONY DAM.

Note:
Catch on Sauger was only 20-30% of Normal in my case. The catch over the past 9 years has been reasonably consistent for me by number although not necessarily by size.
Other fisherman on the Missouri between Canter & Morony Dam above reported no better luck. Most had quit trying by August. River levels were near normal on a monthly basis although water levels were not especially high during early June
Something happened to the sauger on the river this year - they just weren't there! Any ideas? LV

Montana Department of Fish, Wildlife & Parks

P.O. Box 6609
Great Falls, MT 59406

May 3, 1990

Lynn E. Valtinson
2406 5th St. N.W.
Great Falls, MT 59404

Dear Mr. Valtinson:

I recently received a note you had included with your fisherman's log regarding the sauger catch on the Missouri River. We have been aware of the decrease in sauger caught downstream from Morony Dam. In fact, we also had problems obtaining sauger with the electrofishing boat last year. Although we can only speculate, the lack of high spring flows may have resulted in reduced concentrations in this reach of the river. However, power-peaking operations at Morony Dam in previous years or other factors may have been the cause of the drop-off in sauger catch-rates. Montana Power Company is currently sponsoring a study on this stretch of the river. Hopefully, this will provide some answers to your questions. Please contact our office if you have any additional questions.

Sincerely,

George Liknes

George Liknes
Fisheries Biologist

GL/hv