MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS
FISHERIES DIVISION
JOB PROGRESS REPORT

STATE: Montana Project No.: F-78-R-4

PROJECT TITLE: Statewide Fisheries Investigations

JOB TITLE: Middle Missouri River Fisheries Evaluations

1997 Annual Report

ABSTRACT

A study to evaluate the effects on the Marias River fishery resulting from a new flow regime below Tiber Dam was continued. Marias River water temperatures at the two lowest stations averaged 52.8 and 61.3 F for the critical spawning months of May and June and appeared to be at near ambient temperatures. A total of 4,267 fish larvae were collected in the study area including 40 larval sauger/walleye. Six Scaphirhynchus larvae were collected in the Teton River, in addition to those found in the Marias and Missouri rivers, making this the first record of sturgeon spawning in the Teton. A total of 6,733 fish were sampled in the lower Marias River and the adjacent confluence area of the Missouri River and goldeye and mountain whitefish comprised 52% of the total. Sauger spring catch rates in the Marias confluence area have declined from an average of 18.6 fish/hr for the period 1979-88 compared to an average of 3.6 fish/hr measured for 1996-97. One pallid sturgeon was captured while conducting the biannual netting survey in the middle Missouri River. Fifty hatchery-reared juvenile shovelnose sturgeon were implanted with radio transmitters and released into the middle Missouri River; their movements and habitat use were monitored. Sturgeon downstream movement distance averaged 2.8 miles, and upstream movement averaged 0.5 miles. The transmittered shovelnose preferred deep, moderately slow areas with a sandy substrate; river conditions where the transmittered sturgeon were located averaged 9.1 feet deep, 74% relative depth and 2.1 fps column velocity.

INTRODUCTION

The lower Marias River downstream of Tiber Dam is completely regulated by the operations of the dam. At the FWP request, the U. S. Bureau of Reclamation (USBR), which manages Tiber, recently agreed to provide an annual spring pulse of high water from the dam to restore a more natural spring flow condition for the aquatic system downriver. It is believed this action will benefit both the resident and migratory fisheries. The Pallid Sturgeon Recovery Plan identified the need to implement operational alternatives for tributary dams that will emulate precontrol hydrographs so that seasonal habitat conditions are restored for pallid sturgeon and other native big river fishes (1.1.2 and 2.2.2) (Dryer and Sandvol 1993). The lower Marias River study was initiated in the spring, 1996 to evaluate the effects these higher spring flows were having on the fisheries in the area.

The middle Missouri River supports a diverse warmwater fishery. All of the native fish species that historically occurred here are still found in this reach because of the relatively unaltered state of the river. Berg (1981) conducted a planning and inventory study of the middle Missouri River 20 years ago and concluded that this reach supports a fishery with a substantial recreational value. He also established baseline biological measurements of the fish populations for future comparisons. Recently there has been concern that sauger, a popular native gamefish, has declined in numbers in the middle Missouri River since 1988 (Hill et al. 1996). It is the goal of this study to determine the extent of the sauger decline, evaluate the present status of sauger here, and compare the present abundances of other species to the baseline information reported in Bergs study.

Pallid sturgeon are found in the Wild and Scenic portions of the Missouri River in Montana. They exist in low numbers throughout their geographic range (Kallemeyn 1983) as is the case in this section of the Missouri River. In 1990 the U.S. Fish and Wildlife Service listed the pallid as endangered under the Endangered Species Act 1973. Reasons for listing are habitat modification and apparent lack of reproduction. Reports of pallid sturgeon sightings have also declined dramatically in the last 20 years (U.S. Fish and Wildlife Service, 1989). The pallid sturgeon has been listed as a class A "species of special concern" in Montana since 1973 (Holton, 1980).

The Montana Department of Fish Wildlife and Parks (FWP) has studied the middle Missouri River population for 6 years and have concluded that the population is endangered of going extinct within 10-20 years unless immediate actions are taken. Several years of study shows that only about 50 adult pallids remain and that the population is senescent. Moreover, there was no evidence of successful reproduction at least in the last 20 years.

The recovery plan calls for reintroducing pallid sturgeon in this area as a short term remedy with the anticipation that hatchery reared fish will eventually reproduce and maintain a reasonable population (Dryer and Sandvol 1993). Considering this information the original study objectives were modified to evaluating the success of the pallid sturgeon reintroduction.

OBJECTIVES AND DEGREE OF ATTAINMENT

1. **Evaluate the influence of improved springtime flow releases from Tiber Reservoir on migratory warm and coolwater fish spawning success in the Marias River and determine fish population response in adjacent areas of the Missouri River.** Electrofishing, drift netting and larval fish sampling were completed in 3 sections of the lower Marias and 2 sections in the Missouri River and results are presented.

2. **Determine the population status of sauger in the middle Missouri River. Establish population abundance trend areas, study seasonal movement patterns and evaluate reproduction success.** Four trend areas were electrofish sampled in the fall of 1997 and results will be reported in the 1999 report. Twelve sauger, 7 walleye and 8 northern pike were radio tagged for studying fish movements and species interactions. Results will be reported in the 1999 report.

3. **Evaluate pallid sturgeon reintroduction efforts. Develop a systematic standardized sampling plan for evaluating the success of reintroducing pallid sturgeon in the study area. Monitor movement patterns, habitat use and survival of the juvenile pallid sturgeon stocked in the middle Missouri River.** A standardized sampling plan was devised for monitoring changes in numbers of pallids in the trend area and the second standardized survey was completed and results are presented. A total of 50 hatchery-reared, juvenile shovelnose sturgeon were radio tagged and monitored. and results are presented.

4. **Review projects proposed by state, federal and local agencies and private parties which have the potential to affect fisheries resources and aquatic habitats. Provide technical advice or decisions to reduce or mitigate resource damage.** Attended the pallid sturgeon recovery team meeting at McCluskey, ND and provided information on radio telemetry studies and pallid status in Montana.

PROCEDURES

An electrofishing system was used to sample fish in the river. The system was a dual boom-type and mounted to a 17 or 19-foot aluminum boat powered by a 90 or 105 hp outboard jet motor. Power was supplied by a 4,000-watt AC generator. The alternating current was delivered to a Coffelt Model VVP-10 rectifying unit which changes the alternating current to pulsed-DC. The positive electrode setup consisted of two fiberglass booms with 4, 18 inch pieces of stainless steel cable attached to each boom that extended from the end of the boom and into the water. The boat hull served as the negative. The unit was typically operated at 2-7 amps, 100-215 volts. Catch per unit effort for electrofishing was expressed as number of fish caught per hour. Electrofishing was not used for capturing pallid sturgeon, nor was this method used in areas of known pallid sturgeon concentrations.

Trammel nets were also used to capture fish. Trammel nets used for pallid sturgeon sampling were 150 ft. long and 6 ft. deep and 100 x 6 ft. for all other sampling. Two mesh sizes were used: 1 inch inner walls with 10 inch outer walls, and 2 inch inner walls with 10 inch outer walls. Mesh material for both inner and outer walls were light-weight for better fish tangle characteristics and to insure that the net could be retrieved off submerged objects in the event that net material had to be torn free. The trammel nets were set in snag-free areas of the river and allowed to drift with the current along the bottom for a period of 3-7 minutes. Distances of the drift varied from 50 to 400 yds. Catch per unit effort for drift netting was expressed as number of fish caught per drift.

All fish were measured to the nearest 0.1 inch (fork length for sturgeon and total length for all other fish), and weighed to the nearest 0.01 pound. Blue suckers were tagged with a PIT tag, sturgeon with a plastic cinch tag and sauger and walleye with a metal monel jaw tag. A spiny dorsal fin ray was extracted from sauger and walleye for aging purposes.

Larval fish sampling was used to evaluate spawning use in the Marias, Missouri and Teton rivers. Larval samples were obtained using boat mounted round plankton net samplers. The round samplers consisted of a 6 foot long Nitex net (750 micron mesh) attached to a 20 inch diameter metal ring. Two nets were used in tandem (on each side of the boat) so that duplicate samples could be taken simultaneously. The nets had a 3-rope harness that were fastened to and suspended off a weighted line attached to each side of the bow of the boat. Samples were collected near the channel bottom and surface while drifting slightly downstream. This allowed the nets to filter the water without addition of excess weights. Most of the sampling occurred in strong current areas of the river, at a depth range of 3-12 feet, and therefore power was provided by an outboard motor to decrease the downstream drift rate. The nets were positioned and weighted in the river usually for a duration of 6-15 minutes, depending on the amount of debris suspended in the river. The volume of water filtered was determined using General Oceanic flow meters (Model 2030) tied to the front ring of the net and positioned at one-third of the net diameter.

Larval samples were preserved with formalin in the field and later sorted in the laboratory. Larvae were identified to family using taxonomic keys by Auer (1982) and Wallus (1990).

Forty-eight hatchery-reared juvenile shovelnose sturgeon (HRJSNS) were surgically implanted with small, 2.5 gm. radio transmitters so that movements and habitat use could be monitored daily. Small, yearling, HRJSNS averaging 16.0 inches fork length and 0.51 lbs. were used for the study as a surrogate species and obtained from the Bozeman Fish Technology Center (USFTC)(Yellowstone River stock). Additionally, two small wild shovelnose sturgeon were implanted with radio transmitters; their weights were 0.25 and 1.20 lb.

Conservation of the battery life was accomplished by using a transmitter with a microprocessor for time interval programming. The transmitters were programmed for a selected 6 hr daily signal transmission duration for 20 days, after which the transmitter was automatically deactivated for 20 days. The pattern was repeated for additional cycles, thereby enabling the sturgeon to be monitored during a 60-120 day period. The transmitter's on-time was staggered so that 12 transmitters were on 8AM - 2PM and 12 on from 1PM - 7PM, and therefore a sample of sturgeon were monitored throughout the day. Additionally, the transmitters were activated so that 24 began signal broadcast on July 14 (group #1) and the other 24 (group #2)activated on July 28. The transmittered fish were relocated from a boat or airplane.

Surgeries for the Group 2 fish were completed at the USFTC, while the surgeries for the Group 1 fish were done in the field near the release site. Micro habitat and biological measurements were collected at relocation sites. The measurements taken included depth, substrate type, water velocity, channel form and habitat associations. Biological measurements included fish species netted in the relocation area.

DESCRIPTION OF STUDY AREA

The Marias River fisheries study area consists of a 80 mile reach of the lower Marias River from the confluence with the Missouri upriver to Tiber Dam near Chester, Montana. The Teton River is the only major tributary entering the Marias, joining the Marias only one mile upriver from the Marias/Missouri confluence. Two study sections located on the Missouri River upstream and downstream of the Marias River confluence were included in the study area so that faunal changes above and below the confluence could be evaluated. The present flow regimen of the Marias River in the study area is completly regulated by Tiber Dam.

Sampling was conducted at 3 study sections on the Marias and 2 study sections on the Missouri River. These 5 sections are Pondera, Black Coulee, Confluence, Upper Missouri and Lower

Missouri and are shown in Figure 1. All 5 study sections were each 4 miles long.

The middle Missouri River study area consists of a 208-mile reach in northcentral Montana between Great Falls and the headwaters of Fort Peck Reservoir near Lewistown. There are two major tributaries entering the Missouri in this reach; the Marias River from the north and Judith River from the south. The present flow regimen of the Missouri River in the study area is not entirely natural because of regulation and storage at several upriver dams. All of the pallid sturgeon work was conducted in a 37-mile reach of Missouri River upstream from Fort Peck Reservoir (Figure 2).

FINDINGS

Marias River

Flow conditions in the lower Marias River have changed substantially since the USBR began providing a spring high water pulse flow below Tiber Dam in 1994. Figure 3 is a comparison of the 1994-97 mean monthly flows (years of the new flow plan) with that of flows prior to this change. The 1997 hydrographs for upstream and downstream of Tiber are plotted in Figure 4. It is fairly obvious that the lower Marias River now has a more natural flow pattern with higher peak flows occurring in June and lower base flows in late summer and fall. The 1997 peak flow of 4,510 cfs occurred on June 16 (USGS 1998) nearly reaching the estimated bankfull flow of 5,000 cfs for this reach. During 1997, early-spring, summer and fall flows were well above normal conditions.

Temperature conditions.

Along with unnatural flow conditions, altered water temperature regimes are also a concern downstream of a large dam (Ward and Stanford 1979). The concern about water temperatures in the study area is that the lower Marias River may be abnormally cooler because of hypolimnion releases dominating the dam discharge most of the time. The coolwater releases could affect spawning use by migratory fish from the Missouri River. The Marias River station near Shelby and the Missouri River station near Loma were used as comparative stations assuming these sites represent more normal conditions. Water temperatures were monitored at 6 sites and summary results are given in Table 1. Temperature curves for individual stations are shown in Appendix A.

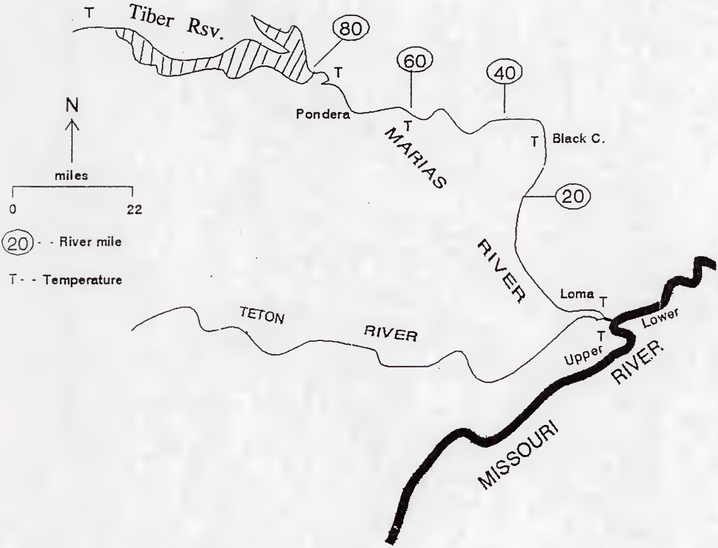


Figure 1. Map of the Marias River study area.

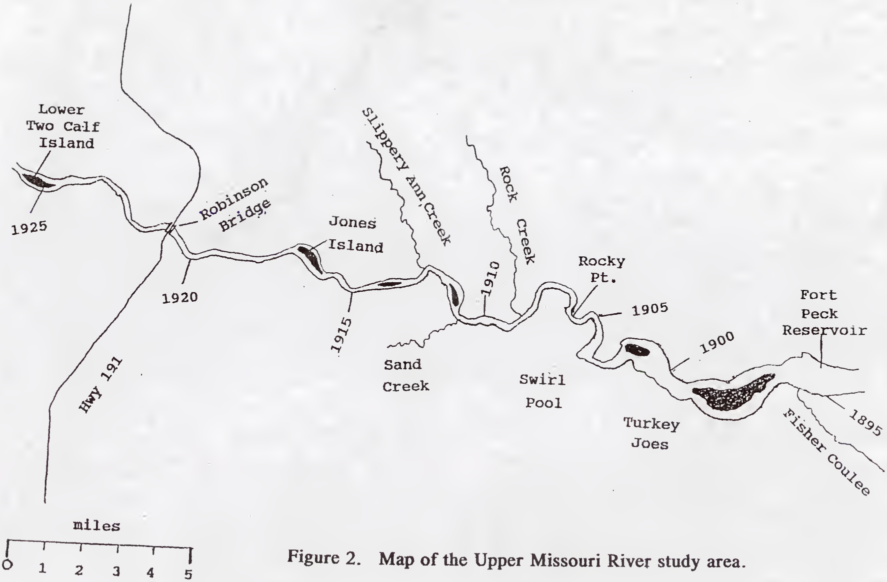


Figure 2. Map of the Upper Missouri River study area.

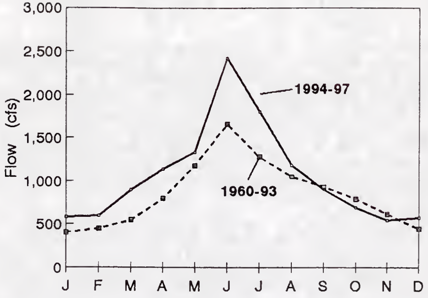


Figure 3. Marias River mean monthly flows downstream of Tiber Dam prior to 1994 compared with 1994-97 (USGS water resource data, 1963-98).

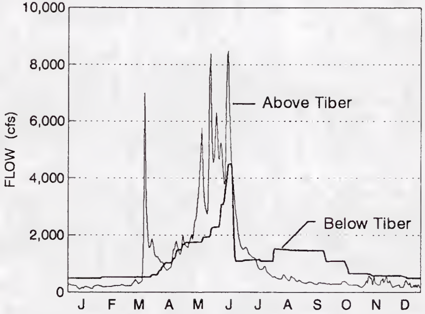


Figure 4. Marias River mean daily flows upstream and downstream of Tiber Dam, 1997. (USGS water resource data, 1998).

Average monthly temperatures were consistently the coolest at the Tiber Dam station from mid-April through August most likely as a result of the hypolimnion releases at Tiber Dam. Here average monthly temperatures never exceeded 56 F during the period. Circle Bridge temperatures were also cool, but not to the magnitude of Tiber. The Circle Bridge highest average monthly temperature reached 60.7 F for the month of July. Black Coulee and Confluence stations registered similar average monthly temperatures compared to those measured at Shelby and the Missouri River near Loma for the period April through July.

The Marias River serves as an important spawning tributary for several Missouri River fish species and a change of water temperature patterns in the Marias could negatively impact the migratory fisheries. Most of the migratory spawning use in the Marias occurs from April through June. The temperatures measured in 1997 for the lower two sites in the Marias (Black Coulee and Confluence) appeared to be well within the desirable ranges for spawning for species such as sauger, shovelnose and blue suckers. Moreover, the temperatures measured at Black Coulee and Confluence appeared to be very similar to the temperatures at Shelby and the Missouri at Loma, the controls. The exception to this is for the month of August when the average August temperatures for the two were about 5 and 6 degrees cooler than the Shelby site.

Fish populations.

Significant changes in the Marias Rivers' flow and temperature regimes have most likely affected fish populations in the river. Species abundance and distribution, along with use by migratory species for spawning, are the specific parameters that were investigated for evaluating the present fishery and for assessing if the new operations at the dam were affecting the downstream fishery.

An investigation of the early life history stages of the fish species found in the Marias River was conducted for a more comprehensive understanding of this important tributary. Collection of larval fish can be used to confirm spawning use and intensity and evaluate the impacts associated with the operations of Tiber Dam.

Larval fish were sampled in the lower Marias River, confluence of the Teton River and adjacent reach of Missouri River from early-May through mid-July, 1996 and 1997. Total volumes of 448,327 ft^3 and 662,500 ft^3 of water were filtered at the 4 sites during 1996 and 1997, respectively. A total of 4,267 larvae were collected in 323 samples representing 9 taxonomic families for both years combined (Table 2). The sucker and minnow families were the most common groups sampled during both years averaging 88% of all the larvae collected.

Table 1. Mean monthly water temperatures for the Marias River upriver of Tiber Reservoir (RM 116.8), below Tiber Dam (RM 75.1), Circle Bridge (RM 57.9), Black Coulee (RM 28.5) and Confluence (RM 1.0) and Missouri River near Loma (RM 2052.8) stations, 1997.

	April	May	June	July	Aug	Sept	Oct	Total # temp. meas.
Above Tiber Reservoir	48.4	52.3	59.4	68.0	68.0	57.1	42.8	4776
Below Tiber Dam	40.4	46.6	55.7	55.9	54.1	57.4	54.3	1491
Circle Bridge	43.2	49.1	58.0	60.7	57.6	58.1	52.4	4809
Black Coulee	--	52.6	60.7	65.7	61.9	59.0	49.8	4082
Confluence abv Teton R.	48.0	53.2	61.9	67.4	63.3	59.4	48.0	1507
Missouri R. abv Marias	48.6	53.8	61.6	68.5	69.2	62.5	50.2	4786

Table 2. Numbers of larval fish collected with the round plankton net in the Marias, Teton and Missouri rivers, 1996-97. The 1997 numbers are in parentheses.

Taxon	Marias R. Confluence	Missouri Upstream	Missouri Downstream	Teton R. Confluence	Totals
SGR/WE	18 (22)	0 (0)	5 (4)	0 (0)	23 (26)
STURG.	4 (5)	0 (0)	8 (2)	2 (4)	14 (11)
GOLDEYE	10 (8)	6 (2)	5 (1)	7 (9)	28 (20)
SUCKER	515 (824)	191 (152)	209 (165)	606 (164)	1521(1295)
MINNOW	102 (149)	79 (52)	171 (131)	71 (169)	423 (501)
OTHER	2 (3)	1 (0)	2 (0)	0 (2)	5 (5)
Total # Larvae -	649(1011)	277(206)	402(303)	1084(338)	2412(1855)
Average Density (#/10,000 ft3)	35.7(34.5)	14.6(8.7)	19.4(14.5)	318.5(96.0)	53.8(28.0)
Total # Samples -	48 (72)	38 (42)	47 (44)	15 (17)	148(175)

Sauger and walleye are important gamefish found in the study area and the abundance and distribution of their larvae are of particular interest. Sauger/walleye larvae were only sampled at the Marias confluence and Missouri downstream stations during both years. This would implicate the Marias River as the only sauger/walleye spawning area in this reach and underscores the Marias as critical sauger/walleye habitat. Berg (1981) also noted that sauger, originating from a variety of locations in the Missouri River, intensively use the lower Marias River for spawning.

Table 3 shows the temporal densities of sauger/walleye larvae sampled in the Marias River for both years. Ninety-three to 100 percent of the larvae were sampled during the period 5/15 - 6/7. Assuming a 12 - 18 day incubation period (Brown 1971), spawning occurred within the period 4/28 - 5/20. An attempt was made to separate sauger and walleye larvae. Auer (1982) describes 1-day post-hatch sauger larvae as ranging 5 - 6 mm total length and 1-day post-hatch walleye larvae ranging in size 7 - 8 mm. Total length of the sauger/walleye larvae of the 1-day post-hatch stage were measured and assigned species based on size criteria. A total of 13 were sauger and 4 were walleye in the 1996 samples and 8 were sauger and 11 were walleye in the 1997 samples. (The remaining sgr/we larvae could not be separated because of their advanced development).

Table 3. Seasonal abundance of sauger/walleye larvae sampled in the Marias River, Confluence Section, 1996 and 1997.

Date	Abundance (#/10,000m3) 1996	Abundance (#/10,000m3) 1997
May 9	0	0
May 15-17	0.4	2.7
May 22-24	3.4	0.4
May 30-31	2.2	0.7
June 5-7	3.3	0
June 12-14	0	0
June 20	0	0.1
July 3	0	0
July 17	0	0
Total # of Sgr/We larvae -	18	22

Scaphirhynchus larvae (most likely shovelnose sturgeon) were collected in the Marias, Missouri downstream, and Teton confluence sites both years. This was the first known record of Scaphirhynchus spawning in the Teton River.

A total of 6,733 fish were sampled in the study area using electrofishing and netting methods, from April 29 - July 2, 1997. More effort was directed at electrofishing compared to drift netting because netting is more difficult and less productive in small shallow rivers like the Marias compared to electrofishing. Average sizes for the sampled fish are calculated for each study section and reported in Appendix B and C.

Catch rates for electrofishing are given in Table 4. Shorthead redhorse was a common, wide-ranging species sampled at abundances over 10 fish/hr. at all Marias River stations. The Pondera Coulee Section contained a fish community more typical of coolwater streams. This is because the section is within the tailwater zone of Tiber Dam. Here, mountain whitefish were fairly abundant and catch rates averaged 94.9 fish/hr Brown trout, a gamefish, was the 4th most abundant species in the sample averaging 10.3 fish/hr The Black Coulee and Confluence sections are located well within the warmwater zone of the Marias River and the fish communities found here reflect the water temperature change. Especially abundant numbers of goldeye were sampled in these 2 sections with average catch rates of at least 57 goldeye/hr being recorded.

Table 4. Average catch rates (no./hour) and number of fish sampled by electrofishing in the upper Missouri and Marias rivers, MT, 1997.

	Pondera Coulee	Black Coulee	Confl- uence	Upper Missouri	Lower Missouri	Teton River	Total Number
Bigmouth buffalo	0.1	3.2	0.6	1.0	3.8		68
Blue sucker	0.2		1.0	0.5	2.1		36
Brown trout	10.3	1.2	0.3	0.3	0.1		118
Burbot	0.1	0.5	0.3	0.1	1.2	0.5	20
Carp	14.9	6.9	6.0	12.4	11.5	2.0	491
Channel catfish			0.2	0.4	0.8		13
Cisco					0.1		1
Emerald shiner				0.2			2
Flathead chub		1.2	0.3	1.1	1.8	3.0	43
Freshwater drum		0.3	0.4	1.6	0.8		30
Goldeye	9.0	67.2	57.8	34.7	86.5	10.0	2368
Longnose sucker	4.3	3.8	4.7	1.5	1.8	3.5	171
Longnose dace				0.1			1
Mountain whitefish	94.9	6.6	4.1	0.8	1.5		1052
Northern pike	1.0	0.9	0.6	0.7	2.1		47
Rainbow trout	2.8		0.1	0.1	0.4		32
River carpsucker	1.6	6.8	26.7	14.6	10.8		678
Sauger	0.1	5.2	4.1	3.0	6.0		170
Sculpin			0.1	0.1			2
Shorthead redhorse	16.3	30.5	15.1	11.1	26.5	11.0	905
Shovelnose sturgeon	0.1	0.2	0.9	0.1	0.4		19
Smallmouth bass			0.3	0.1	0.1		7
Smallmouth buffalo			0.1	1.0	0.6		16
Spottail shiner				0.1			1
Walleye	0.2	2.9	1.6	3.6	5.7		121
White sucker	2.0	3.7	1.2	1.6	1.7	1.0	92
Yellow perch			0.3		0.1		5
Total no. fish	1548	918	1866	915	1200	62	6509
Total no. hours	9.8	6.5	14.7	10.1	7.2	2.0	50.3

The most abundant gamefish sampled in both Black Coulee and Confluence sections were sauger and mountain whitefish at the relatively low abundances of approximately 4-5 fish/hr. Other species sampled at high catch rates in most of the areas were shorthead redhorse, river carpsucker and carp.

Catch rates for electrofishing in the two nearby Missouri River sections indicate that fish populations in the Missouri are similar to the Marias River (Table 4). Most of the species sampled were found in both rivers with the exception of cisco, emerald shiner, longnose dace and spottail shiner being sampled only in the Missouri. Sauger and walleye were the most abundant gamefish, sampled at low densities of approximately 3-6 fish/hr.

Sauger, blue sucker, paddlefish, shovelnose and pallid sturgeon are 5 species of particular interest to this study. The sauger is a native game species that has declined in abundance over the last 10 years; blue sucker and paddlefish are state Species of Special Concern; shovelnose sturgeon is a species sensitive to habitat alterations and over exploitation; and pallid sturgeon is a federally listed endangered species. All these species are known to migrate to the confluence area or ascend the Marias River. Changes in Marias River flow conditions could affect the migratory use by these species.

Berg (1981) recorded that significant numbers of sauger from the Missouri River ascend the Marias to spawn. This spawning run has been monitored in a 4-mile trend area, intermittently over the past 18 years so that population abundance patterns can evaluated. Table 5 summarizes the average catch rates and shows there has been a serious decline in numbers of sauger spawners in the trend area for the 1996 and 1997 spring surveys. Catch rates averaged 18.6 fish/hr. for the six years of survey data prior to 1996 compared to an average catch rate of 3.6 fish/hr. for 1996-97.

Table 5. Spring catch rates (CPUE= #/hr) of sauger electrofished in the Marias River - Confluence Section, 1979-97.

Date	1979				
CPUE	18.2				
Date	1982	1985	1986	1987	1988
CPUE	39.2	12.3	12.7	16.5	12.9
Date	1996	1997			
CPUE	3.1	4.1			

Unfortunately, there is an eight year data gap between these two periods so it is difficult to know when the decline first occurred. A more complete record of sauger population trends in the Missouri upriver of the study area was reported by Hill et al.(1996). They reported the decline to first occur in 1989. The specific reasons for this decline is unknown.

Berg (1981) found that the Marias River was a very important spawning area for sauger spawning. Changes in the Marias River flows resulting from the change in operation of Tiber Dam probably are not the cause of the sauger decline. Changes in operations were first initiated during the late spring, 1994, 5 years after the decline was first noticed. Since 1988 lower Marias River flows have be maintained at or above the 500 cfs recommended minimum instream during the sauger spawning and incubation period, April 20 to June 7 (Berg 1981 and this report). Tiber Dam releases water from the hypolimnion which substantially depresses the normal water temperature of the river downstream. However, as reported in a previous section of this report, the temperatures recorded in the lower reach (Black Coulee and Confluence) appeared to be well within the preferred temperature range for sauger during the spawning season. During the usual sauger spawning period in this area, April 20 to May 25 (Berg 1981), average daily water temperatures at the Confluence site exceeded 50 F, the preferred sauger spawning temperature (Brown 1971), 55% of the days and ranged between 45.9 and 59.6 F. It appears the low numbers of spawning sauger found in the Marias is only a symptom of the sauger decline and not a reason for the decline.

A total of 26 blue suckers and 16 shovelnose sturgeon were sampled in the Marias and 20 blue suckers and 4 shovelnose sampled in the Missouri River in the vicinity of the Marias confluence. Paddlefish and pallid sturgeon were not sampled or observed in the Marias River during 1997.

Based on the limited information collected over the past 2 years it can be concluded that the changes in flow patterns from Tiber Dam did not cause any negative effects on the fishery that was present prior to the change. I did not collect any fisheries information that indicated a positive effect from the change in flows, however, there may be other more influential factor(s) that is holding down a response to the expected improvements. For example higher spring flows may have attracted pallid sturgeon to the Marias confluence area if there were greater numbers of adult pallids in the system. Because present pallid numbers are extremely low there probably will not be any detectable migration to the Marias confluence until first there is improvements in their numbers. Another reason why it was difficult to determine if the flow change improved fishery conditions was the lack of a comparison to the pre-condition. This study collected fishery information that will now enable comparisons for future studies.

Pallid Sturgeon

A sampling plan was developed for evaluating the success of pallid sturgeon reintroduction in the study area. The plan requires sampling a designated 17 mile reach from RM 13 to RM 30 (Rock Creek to Upper Two Calf). Within this reach was where the majority of pallid observations were recorded in the past 6 years. It was assumed that a total of 50 trammel net drifts would be an adequate effort to survey the reach for pallid sturgeon.

Selection of drift sites were assigned using a stratified-random process. The reach was divided into 170, 0.2-mile sites. A total of 30 sampling sites were randomly drawn reach-wide, and an additional 20 sites were selected based on records of previous pallid sturgeon captures at the site. These sites were sampled during the period 9/21 - 10/15.

Only one pallid sturgeon was captured during the survey. The measurements are given below. This fish had never been captured before and therefore there has been a total of 31 different pallid sturgeon captured in the study area since the study began in 1990. Statistics for the survey:

Number of pallids captured = 1
Number of pallids/drift = 0.02
Number of shovelnose captured = 131
Number of shovelnose/drift = 2.6
Average drift duration = 6.5 minutes
Average drift distance = 294 yd
Average depth of drift site = 8.3 ft

Pallid #31 record:

PIT1 # 17598354362	Depth (ft) = 9.0
PIT2 # 17600715255	Substrate = sand
Fork length = 52.5 in.	Velocity = moderate
Weight (lbs)= 40.6	Temperature = 59 F
Sex = ?	Secchi (ft) = 2.0
Capture date = 10/2/97	Recap record = new fish
Method = 2in. Tram.	

Reintroduction study.

Reintroduction of pallid sturgeon in the Recovery-Priority Management Areas (RPMA) is short-term recovery objective 3.3 listed in the recovery plan. Stocking of hatchery-reared juvenile (HRJ) pallid sturgeon in RPMAs #1 and #2 is tentatively planned for summer, 1998. It would be beneficial to know the locations of juvenile sturgeon habitat areas so that juvenile pallid sturgeon could be released directly in preferred habitat areas, thereby improving survival of stocked pallids.

Present knowledge of habitat use and important environmental conditions for juvenile sturgeon is lacking. This study is designed to provide information on juvenile sturgeon habitat use, location of important areas and other environmental requirements using radio telemetry to track individual fish. Additionally, the release of transmittered sturgeon was viewed as a "trial run" for evaluating the efficacy of stocking HRJ pallids in the RPMAs.

The radio telemetry system used in this study performed adequately for monitoring the HRJ shovelnose as initially intended. The maximum number of transmitters that were available for detecting at one time was 24, although only 6 could be effectively scanned at one time. It took about 6 hours to effectively survey the 25-30 mile study area by boat. Once radios were located and recorded on the river map a return visit was necessary to determine precise locations and collect microhabitat information. Microhabitat data collection took about one hour/fish. Flying the radios was also effective for determining shovelnose locations. Flights were usually scheduled during periods when Group 1 and 2 were on at the same time or when both AM and PM radios could be monitored on the same flight. (This required surveys to begin in late morning and continue into early afternoon). Typically a maximum of 24 radios could be monitored during one flight. Flights averaged about 3½ hours because scanning limitations usually required 4 passes through the study area.

Transmitters were detected in water depths up to 20 ft, however, under this circumstance we had to be within 200 yds of the transmitter. From the boat we had no problems locating transmittered fish that were in waters less than 15 ft. Airplane surveys were flown at heights of 400 ft above the river, and most transmittered fish at depths of 15 ft or less were also readily detected. From mid-July to mid-November at least a portion of the transmitters were on for a total of 125 days or 90% of the days. During this period 42 searches for these transmittered fish were completed using boat or plane. With this effort a total of 442 relocations (radio contacts) were logged (Table 5). Most transmitters lasted through 2 on/off cycles (60+ days) (Table 6). However, only 36 of the 49 transmittered fish were relocated consistently for at least 14 days and demonstrated up or downstream movement. The remaining 13 transmittered fish were lost for a variety of reasons. Seven of the fish were suspected mortalities based on the relocations at the same site for several weeks. Many of these sites were in depositional areas and at shallow depths uncharacteristic of the other transmittered sturgeon. On one occasion the transmitter, without the fish, was retrieved from a sand bar. The fate of the remaining six sturgeon was undetermined because in all cases these sturgeon were never relocated after their release. It is suspected that they either resided at water depths greater than 20 ft., and therefore could not be located, they moved out of the study area, or the transmitter failed.

Table 6 summarizes the length of time the transmitters lasted. Of the 36 radios listed as active, 58% continued to broadcast a signal during the 3rd turn-on cycle (>81 days), however, 42% of radios ended during the 2nd cycle (60 days). The transmitters were guaranteed for 41 days (their ½-life). The overall average life of these transmitters (the 36 active ones), as determined by this study, was 82.9 days.

Table 5. Radio transmitting days, radio search effort and number of radio contacts and micro-habitat measurements scheduled for the juvenile shovelnose radio telemetry study, Upper Missouri River, 1997.

	- # days radios on -			No. of	No. of	No. of
	Group 1	Group 2	Combined	Searches	Contacts	Hab meas
July	18	4	18	8	109	17
August	11	16	26	15	179	42
September	10	20	25	10	102	16
October	20	17	31	5	28	4
November	20	9	25	4	24	3

Table 6. Percent of transmittered juvenile shovelnose relocated in the study area for the indicated duration, Upper Missouri River, 1997.

	- Specific transmitter group -				
# Days	1-A	1-P	2-A	2-P	Avg
20 >	100	100	73	73	89
41 >	100	100	73	73	89
60 >	50	83	54	46	58
81 >	50	83	54	46	58
100 >	50	83	36	18	42
121 >	50	67	36	0	33
Avg # days @ large -	92.6 (42-135)	114.8 (51-135)	78.5 (15-121)	63.0 (17-99)	
# radios*	8	6	11	11	

* Only includes the 36 transmitters that were found for at least 14 days and appeared to be active.

A portion of this study was directed at investigating the effects of different strategies for releasing the hatchery reared sturgeon. Table 7 lists the conditions for the groups of released sturgeon. The first test for releasing sturgeon was to determine if location of the release site affected the success of released sturgeon. The 3 release sites were LeClair Bottoms (upriver site), Kipp boat ramp, and Slippery Ann Creek site (downriver site). For the immediate releases, the Kipp boat ramp site releases did best with an 80% success (16 active radios vs. 4 lost or mortality radios). The Slippery Ann Creek site had only 40% of the transmittered fish reported as successful.

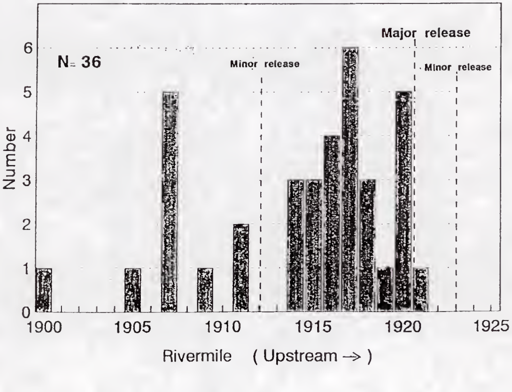
Table 7. Results for transmittered shovelnose released under different conditions, Upper Missouri River, 1997.

Condition	Category		
	Active	Lost	Mort
• 1-A Released immed. @ Kipp ramp Rm 1920.4 -	6	1	0
• 1-A Released immed. @ Slip. A. Ck Rm 1911.7 -	2	2	1
• 1-P Delayed release 18hr @ Kipp ramp Rm 1920.4 -	4	1	1
• 1-P Delayed release 18hr @ LeClair Rm 1922.4 -	2	0	4
• 2-A Released immed. @ Kipp ramp Rm 1920.4 -	9	3	0
• 2-P Released immed. @ Kipp ramp Rm 1920.4 -	11	0	0

* Active= radio fish that was contacted > 2 times. Lost = fish that was contacted 2 or < times (could have died, stayed in deep-water places or transmitter failure). Mort = fish that was determined as being dead (based on: habitat location, no change in position location, or retrieval of radio).

Twelve transmittered sturgeon were held overnight in cages so that mortality associated with surgery could be evaluated. Additionally, this would also test whether holding the fish over in cages would help acclimate the fish better. No mortality of the 12 fish held over for 18 hours was observed. All fish appeared to be in good post-operation condition. Monitoring these transmittered fish over a period of time revealed that the holdovers did not fare as well as those fish immediately released. For the Kipp boat ramp fish, the immediately released group had an 86% "success rate" compared to 67% "success rate" for the holdovers. The worst release scheme was holding over the fish and then moving them upriver 2 miles; this yielded a 33% success rate. Sturgeon that were implanted with a transmitter at the USFTC (indoors) and released a day later (2-A and 2-P, released immediately @ Kipp ramp) had the highest success rate, 91%.

Figure 2. Distribution of transmittered juvenile shovelnose sturgeon locations in the Upper Missouri River, 1997. Individual locations were assigned a river mile that represented the sturgeons location after it was acclimated to its surroundings which typically occurred August 10-30.



Most of the 36 transmittered juvenile sturgeon moved only short distances during the study period. Seventy-seven percent of the sturgeon moved less than 10 miles in total, while 43% moved less than 5 miles. A possible reason for the short travel distances for most of the released sturgeon could be related to the presence of nearby suitable habitat, and therefore, a lack of need to search for better sites. Figure 3 shows the general location of the transmittered sturgeon. There probably is suitable habitat for HRJSNS at rivermile 1907 and rivermiles 1914 - 1920 based on the observations of several radio sturgeon at these locations. The majority of these preferred sites are located in close proximity to the Kipp boat ramp release site.

Table 8 summarizes the sturgeon travel distances on a monthly basis. The greatest travel distances occurred in July, most likely as a result of moving from the release site and acclimating to a new environment. During this month all sturgeon movement was downstream and averaged 4.0 miles/fish. During August downstream sturgeon decreased to an average of 2.6 miles, with 5 fish moving upstream an average of 1.3 miles and 3 fish remaining stationary. September was the month where upstream movement surpassed the downstream movement, however, these travel distances were considerably reduced compared to previous months, averaging only 1.1 miles for all 23 fish combined. For the remaining two months the transmittered sturgeon generally moved short distances and mostly downstream.

Table 8. Monthly average and minimum/maximum (in parentheses) distances moved (miles) for 36 active transmittered hatchery-reared juvenile shovelnose sturgeon monitored in the upper Missouri River, July 15 - November 26, 1997.

	Downstream Move			Upstream Move			Stationary
	N	Avg. Dist.	Min/Max	N	Avg. Dist.	Min/Max	N
July	27	4.0	(0.1-12.1)	0	--	--	0
August	20	2.6	(0.1-13.6)	5	1.3	(0.1- 4.3)	3
September	7	1.8	(0.1- 6.3)	11	1.2	(0.1- 3.0)	5
October	9	1.4	(0.1- 5.8)	4	0.8	(0.1- 1.6)	1
November	9	1.8	(0.2- 9.1)	0	--	--	1

A total of 82 microhabitat measurements were taken on the 36 active sturgeon. Monthly average values for each habitat parameter are reported in Table 9. Transmittered sturgeon were mostly found in deep water areas. Average depths of the sturgeon locations ranged from 8.2 to 10.4 feet. Gardner (1994) reported that channel depths in this area averaged 7.6 feet; so it appears that transmittered sturgeon were probably selecting for deep water sites. Average percent of maximum depth category is a parameter that considers the relative depth where the sturgeon was located. For example, the sturgeon may be located in a reach that is characteristically shallow but in the deepest site available in that particular area. If the cross-section ranges in depth from 2 to 6 feet and the sturgeon was located at 6 feet, then it would be at 100% of the maximum depth. The average percent of maximum depth ranged from 72 to 78 percent indicating that transmittered sturgeon preferred the deeper sites within the cross-section of the river channel.

Table 5. Summary Microhabitat Statistics for transmittered juvenile Shovelnose Sturgeon, Upper Missouri River, 1997.

	ALL	JUL	AUG	SEP	OCT/NOV
Number Observ.	82	17	42	16	7
Average Depth (ft)	9.1 (2.0-20.4)	8.2 (4.5-16.0)	9.2 (20-20.4)	9.0 (3.0-20.0)	10.4 (5.7-20.2)
Average % of Max Dep	74% (19-100)	77% (34-100)	72% (19-100)	73% (30-100)	78% (60-83)
Average Column Velocity (fps)	2.1 (0.4-3.5)	2.3 (0.6-3.5)	2.0 (0.4-2.7)	1.9 (0.9-3.0)	2.5 (1.9-3.3)
Habitat Type	71% MCR	82% MCR	67% MCR	63% MCR	85% MCR
Habitat Assoc.	84% OPEN	64% OPEN	83% OPEN	100% OPEN	100% OPEN

The transmittered fish preferred slower current areas reflecting their preference for deep pool areas. Column velocity averages ranged between 1.9 and 2.5 ft/sec. Gardner (1994) reported that the column velocities averaged 3.0 in this area, so it appears the transmittered sturgeon were avoiding the faster water areas.

An assessment was made regarding selection of the general habitat types. Possibilities of habitat types include main channel pool, main channel run, main channel tailpool or side channel area. The preferred habitat type was main channel run where observation averages ranged from 63 to 85 percent. Habitat associations were also evaluated. Possibilities of habitat associations include cutbank, sandbars, snags, back eddy or open. Most observations (64-100%) occurred in open channel areas. The transmittered sturgeon were always found in areas with a sandy substrate. This is the primary substrate type found in the study and comprises 73% of all types (Gardner 1994). Based on these observations, it appears that the transmittered HRJSNS in the upper Missouri River used habitats similar to resident adult shovelnose and pallid sturgeon. Like the wild sturgeon, they were not found in shallow peripheral areas of the river.

An attempt was made to capture transmittered fish so that their condition could be checked for evaluating physical effects of the radio implant. Additionally, I was interested to see if these hatchery-reared shovelnose sturgeon used similar habitats to that of the wild resident shovelnose. If wild shovelnose were captured while attempting to net the transmittered shovelnose, it could be concluded that the transmittered fish was in close proximity to wild fish, using similar habitats and behaving like its wild counterpart. Five different transmittered sturgeon were sampled for and none were netted. The small size of these sturgeon make them more difficult to net then the larger ones. Each drift was short, usually only 75-100 yards, and therefore, catch rates were lower than normal. Wild shovelnose were captured in most of the drifts directed at sampling a relocated transmittered sturgeon (Table 10). They ranged in size from 1.68 - 4.21 lbs. and appeared to be average size for this area. Other species caught in addition to shovelnose were shorthead redhorse, flathead chub, goldeye, sauger and longnose sucker. From this limited effort, it appears that the transmittered shovelnose were located in similar habitats as that of the wild resident shovelnose.

Table 10. Number of fish caught while drifting a trammel net over a located transmittered sturgeon in the upper Missouri River, August - September, 1997.

Fish #	Date	# Taxa	# SNS	# Drifts	River mile
741-P	8/28	3	6	2	1917.5
721-A	9/9	5	6	3	1912.1
681-P	9/9	3	3	3	1922.9
801-P	9/23	0	0	2	1911.4
781-P	9/23	2	2	2	1911.2

RECOMMENDATIONS

1. The effects of Tiber Dam operation changes should continued to be studied. The fisheries should be monitored again in two years to ensure that undesirable effects are not occurring and to record the fishery improvements (if any) that can be attributed to the flow changes. The USBR should investigate what the effects of the operation changes are having on the floodplain and adjacent landowners. The USBR should continue to provide high spring-time flow releases from Tiber Dam contingent upon an available water supply.

2. This study further documented the decline in the sauger population. A more detailed and extensive study on the sauger population in the middle Missouri River is warranted. Population trend areas should be established and surveyed. Additionally, life history information should be gathered so that causes for the decline can be determined. An experimental stocking of 20,000 hatchery-reared fingerling sauger into Morony Reservoir should be attempted for improving the numbers of sauger in the upper river. This effort will be subject to a successful collection of sauger eggs.

3. Continue with the pallid sturgeon reintroduction effort. This includes releasing 500 - 1,000 juvenile pallids annually into the study area, and, beginning in 1998, evaluate habitat preferences and survival. Juvenile hatchery reared pallids stocked in the upper Missouri River should be closely monitored so that the results of the stocking program can be immediately evaluated. Radio telemetry methodology should be used for this evaluation. Continue with the systematic standardized sampling for adults, biannually, beginning 1997.

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LITERATURE CITED

Auer, N.A., editor. 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Great Lakes Fishery Commission Special Publication 82-3, Ann Arbor, MI.

Berg, R. K. 1981. Fish populations of the Wild and Scenic Missouri River, Montana. Mont. Dept. of Fish, Wildlife & Parks. Helena. Fed. Aid to Fish & Wildlife Rest. Proj. FW-3R. Job Ia. 242 pp.

Brown, C.J.D. 1971. Fishes of Montana. Big Sky Books, MSU, Bozeman, MT 207pp.

Dryer, M. P. and A. J. Sandvol. 1993. Recovery plan for the pallid sturgeon (*Scaphirhynchus albus*). U S Fish and Wildlife Service. Bismarck, ND. 55 pp.

Gardner, W.M. and R. K. Berg. 1983. Instream flow requirements for the Marias River fishery downstream of Tiber Dam. Mont. Dept. Fish, Wildlife & Parks. Helena.

______________. 1991. Northcentral Montana Fisheries Study, Missouri River Pallid Sturgeon Inventory. Mont. Dept. of Fish, Wildlife & Parks. Helena. Fed. Aid to Fish and Wildlife Rest. Proj. F-46-R-4. Study No. III, Job D. 13pp.

______________. 1994. Northcentral Montana Fisheries Study, Missouri River Pallid Sturgeon Inventory. Mont. Dept. of Fish, Wildlife and Parks. Helena. Fed. Aid to Fish and Wildlife Rest. Proj. F-46-R-7. Study No. III, Job D. 16pp.

Hill, William J., George A. Liknes, Anne Tews and Paul Hamlin. 1995. Statewide fisheries investigations, Northcentral Montana warm and coolwater ecosystems. Mont. Dept. of Fish Wildlife and Parks. Helena. Fed. Aid to Fish and Wildlife Rest. Proj. F-78-R-1. 31 pp.

_______________., George A. Liknes, Anne Tews and Paul Hamlin. 1996. Statewide fisheries investigations, Northcentral Montana warm and coolwater ecosystems. Mont. Dept. of Fish Wildlife and Parks. Helena. Fed. Aid to Fish and Wildlife Rest. Proj. F-78-R-2. 31 pp.

Holton, G. 1980. The riddles of existence: fishes of "special concern". Montana Outdoors 11(1): 26 pp.

Kallemeyn, L.W. 1983. Status of the pallid sturgeon(Scaphirhynchus albus). Fisheries 8(1):3-9.

Liknes, George A., William J. Hill and Stephen A. Leathe. 1989. Statewide fisheries investigations, Northcentral Montana warmwater streams investigations. Mont. Dept. of Fish Wildlife and Parks. Helena. Fed. Aid to Fish and Wildlife Rest. Proj. F-46-R-2. 3 pp.

_________________. and William J. Hill. 1993. Statewide fisheries investigations, Northcentral Montana warmwater streams investigations. Mont. Dept. of Fish Wildlife and Parks. Helena. Fed. Aid to Fish and Wildlife Rest. Proj. F-46-R-6. 3 pp.

_________________. and William J. Hill 1994. Statewide fisheries investigations, Northcentral Montana warmwater streams investigations. Mont. Dept. of Fish Wildlife and Parks. Helena. Fed. Aid to Fish and Wildlife Rest. Proj. F-46-R-7. 3 pp.

Montana Dept. of Natural Resc. and Conservation. 1991. Missouri Basin, environmental impact statement for water reservation applications above Fort Peck Dam. Helena. 435 pp.

Tyus, H.M. 1988. Acquisition of habitat preference data by radio telemetry. In: K.D. Bovee and J.L. Zuboy (editors). 1988. Proceedings of a workshop on the development and evaluation of habitat suitability criteria. USFWS, Biological Report 88.

U.S. Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants; rule to list the pallid sturgeon as an endangered species. Federal Register. Vol. 55, No. 173. pp 36641 - 36647.

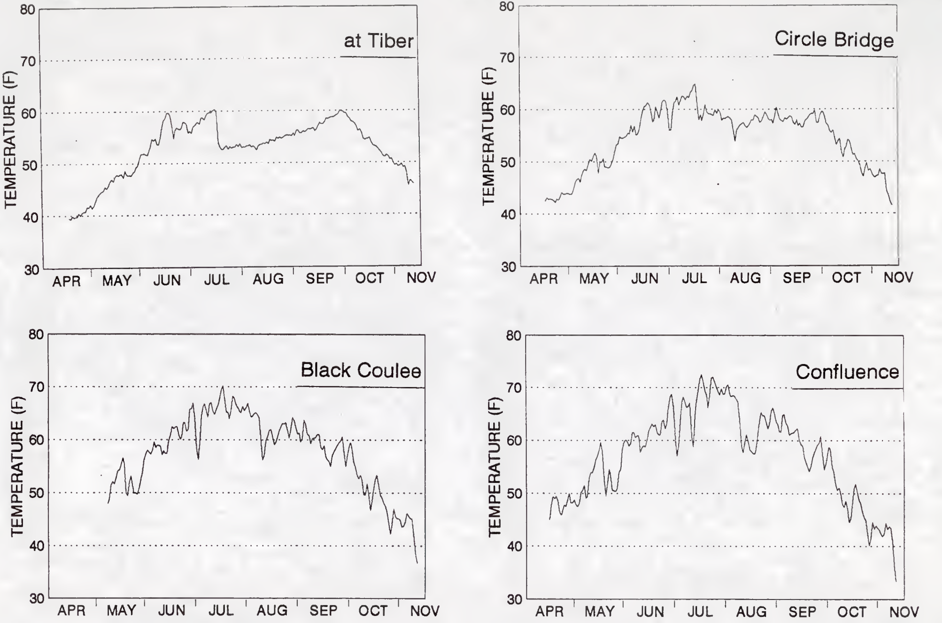
U.S. Geological Service. 1997. Water Resources for Montana. Helena.

Wallus, R. 1990. Reproductive biology and early life history of fishes in the Ohio River Drainage. Volume 1. Tennessee Valley Authority. Chattanooga, TN. 273 pp.

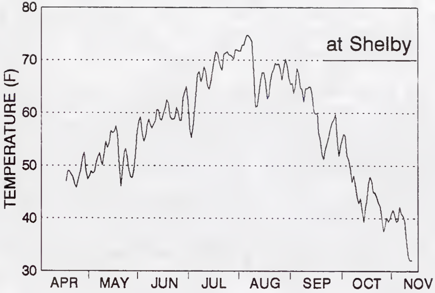
Ward, J. V. and J. A. Stanford (eds.). 1979. The Ecology of Regulated Streams. Plenum Press, New York. 398 pp.

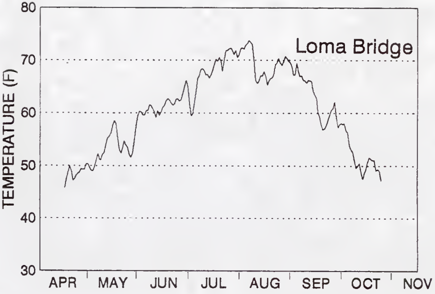
Prepared by: William M. Gardner

Date: November, 1998



Appendix A. Average daily water temperatures for the Marias and Missouri rivers, 1997. (Marias River stations are: Tiber @ RM 75.1; Circle @ RM 57.9; Black Coulee @ RM 28.5; Confluence @ RM 1.0; Shelby @ RM 116.8. Missouri River station is Loma @ RM 2052.8).





Appendix A. (Continued)

Appendix B. Summary size statistics for fish sampled with electrofishing in the upper Missouri and Marias rivers, MT, 1997.

Species/Station	Number	Total Length (inches)	Range	Weight (pounds)	Range
Bigmouth buffalo					
Tiber	18	29.8	(29.4 - 30.5)	15.50	(14.00 - 17.50)
Pondera C.	1	30.0		13.00	
Circle Bridge	3	33.8		24.00	
Black C.	21	28.8	(27.5 - 30.0)	13.00	(10.90 - 15.30)
Sheep C.	3	30.5		15.00	
Confluence	10	29.6	(29.4 - 29.8)	14.40	(13.50 - 15.00)
Upper Missouri	10	29.7	(26.5 - 33.5)	16.80	(10.50 - 25.30)
Lower Missouri	27	32.2	(28.6 - 36.5)	21.20	(13.40 - 31.30)
Blue sucker					
Tiber	9	27.9	(26.4 - 29.9)	6.36	(5.85 - 7.20)
Pondera C.	2	30.2	(28.6 - 31.9)	7.92	(5.40 - 10.45)
Sheep C.	1	29.3		7.00	
Confluence	14	29.4	(23.7 - 35.0)	8.47	(3.57 - 13.50)
Upper Missouri	5	29.3	(25.2 - 32.7)	7.79	(4.86 - 9.77)
Lower Missouri	15	29.8	(26.2 - 34.8)	8.99	(5.80 - 16.30)
Brown trout					
Pondera C.	101	15.0	(5.1 - 26.9)	1.73	(0.11 - 5.80)
Circle Bridge	14	14.3	(5.2 - 19.9)	1.36	(0.10 - 2.58)
Black C.	8	13.9	(6.0 - 20.4)	1.16	(0.15 - 2.50)
Sheep C.	2	9.4	(6.4 - 12.3)	0.38	(0.10 - 0.65)
Confluence	5	5.9	(4.1 - 7.3)	0.07	(0.05 - 0.15)
Upper Missouri	3	8.6	(6.4 - 12.1)	0.31	(0.15 - 0.64)
Lower Missouri	1	6.0		0.15	

Appendix Table B. (continued)

Burbot					
Pondera C.	1	12.0		0.40	
Circle Bridge	3	14.2	(5.7 - 21.0)	0.97	(0.00 - 1.80)
Confluence	5	13.0	(11.0 - 18.0)	0.63	(0.30 - 1.55)
Upper Missouri	1	15.5		0.72	
Lower Missouri	9	12.2	(9.3 - 17.5)	0.52	(0.25 - 1.20)
Carp					
Tiber	12	19.8	(6.8 - 26.6)	3.55	(0.15 - 5.20)
Pondera C.	91	21.8	(16.8 - 28.8)	5.06	(2.50 - 13.00)
Circle Bridge	24	21.8	(18.8 - 27.0)	4.60	(3.20 - 9.15)
Black C.	45	20.1	(15.6 - 25.0)	3.92	(3.00 - 6.50)
Sheep C.	18	21.0	(17.8 - 23.0)	4.51	(2.80 - 6.10)
Confluence	88	21.1	(12.2 - 27.2)	4.75	(0.69 - 10.50)
Upper Missouri	125	22.2	(14.0 - 28.2)	5.61	(1.52 - 11.00)
Lower Missouri	83	21.9	(15.7 - 28.2)	5.17	(2.00 - 8.00)
Channel catfish					
Confluence	4	19.8	(17.1 - 22.2)	4.99	(1.70 - 5.45)
Upper Missouri	4	19.0	(12.9 - 26.8)	4.01	(0.70 - 10.40)
Lower Missouri	6	19.9	(16.6 - 25.9)	3.73	(1.70 - 9.15)
Cisco					
Lower Missouri	1	9.7		0.27	
Emerald shiner					
Upper Missouri	3				
Flathead chub					
Circle Bridge	2				
Pondera C.	1				

Appendix Table B. (continued)

Black C.	8				
Sheep C.	4				
Confluence	26	6.6	(2.5 - 9.5)		(0.00 - 0.30)
Upper Missouri	11	6.5	(4.2 - 10.5	0.12	(0.00 - 0.30)
Lower Missouri	13	5.7	(3.6 - 9.8)	0.10	(0.00 - 0.40)
Freshwater drum					
Black C.	2	16.8	(15.4 - 18.2)	2.40	(1.75 - 3.05)
Sheep C.	1	12.8		0.90	
Confluence	6	10.6	(6.0 - 13.2)	0.67	(0.30 - 1.10)
Upper Missouri	16	12.1	(9.9 - 18.0)	0.88	(0.50 - 3.00)
Lower Missouri	5	15.5	(12.2 - 19.2)	1.59	(0.80 - 3.05)
Goldeye					
Pondera C.	87	12.2	(10.4 - 14.4)	0.64	(0.37 - 1.00)
Circle Bridge	22	12.3	(11.4 - 14.6)	0.70	(0.55 - 1.05)
Black C.	437	12.2	(10.9 - 14.1)	0.75	(0.45 - 1.10)
Sheep C.	113	12.0	(10.8 - 13.2)	0.58	(0.43 - 0.70)
Confluence	850	12.2	(10.1 - 14.5)	0.61	(0.30 - 0.93)
Upper Missouri	350	12.0	(8.6 - 16.2)	0.59	(0.20 - 1.70)
Lower Missouri	623	11.9	(9.7 - 13.7)	0.54	(0.28 - 0.92)
Lake chub					
Pondera C.	2				
Longnose dace					
Upper Missouri	1				
Longnose sucker					
Tiber	5	17.8	(13.5 - 21.7)	2.37	(1.35 - 2.80)
Pondera C.	42	13.9	(4.1 - 20.4)	1.68	(0.05 - 4.06)
Circle Bridge	8	13.4	(4.8 - 19.6)	1.44	(0.05 - 3.20)

Appendix Table B. (continued)

Black C.	25	10.7	(4.0 - 18.4)	0.76	(0.00 - 2.30)
Sheep C.	1	7.9		0.30	
Confluence	90	13.6	(5.6 - 19.4)	1.32	(0.08 - 3.25)
Upper Missouri	15	12.0	(4.0 - 17.7)	0.99	(0.05 - 2.40)
Lower Missouri	13	13.5	(5.0 - 19.3)	1.29	(0.05 - 2.92)
Mountain whitefish					
Tiber	2	18.3	(17.6 - 19.0)	2.42	(2.20 - 2.65)
Pondera C.	930	11.2	(5.6 - 19.4)	0.75	(0.10 - 2.90)
Circle Bridge	24	12.3	(6.7 - 19.3)	1.03	(0.20 - 2.95)
Black C.	43	14.0	(6.9 - 18.2)	1.15	(0.17 - 2.10)
Sheep C.	1	18.7		1.80	
Confluence	60	15.4	(6.7 - 21.0)	1.65	(0.10 - 3.40)
Upper Missouri	8	15.9	(14.2 - 19.3)	1.70	(1.30 - 2.48)
Lower Missouri	11	16.5	(7.7 - 19.3)	1.84	(0.20 - 2.30)
Northern Pike					
Tiber	9	29.5	(25.0 - 32.8)	5.66	(3.80 - 8.20)
Pondera	9	28.1	(23.6 - 32.0)	5.06	(3.60 - 8.80)
Black C.	6	25.0	(13.9 - 31.5)	4.30	(0.80 - 7.00)
Sheep C.	4	29.9	(28.8 - 31.3)	5.94	(4.46 - 7.00)
Confluence	9	29.8	(22.9 - 36.2)	7.91	(2.80 - 6.80)
Upper Missouri	7	27.4	(21.6 - 34.4)	5.04	(1.93 - 8.90)
Lower Missouri	15	24.9	(13.0 - 32.5)	4.12	(0.50 - 7.50)
Rainbow trout					
Tiber	1	22.3		3.90	
Pondera	24	11.1	(4.7 - 19.2)	0.94	(0.05 - 2.60)
Circle Bridge	2	16.1	(15.7 - 16.5)	1.60	(1.50 - 1.70)
Confluence	1	14.6		1.20	
Upper Missouri	1	18.0		1.45	
Lower Missouri	1	7.0		0.15	

Appendix Table B. (continued)

River carpsucker					
Tiber	12	18.7	(16.6 - 21.0)	3.31	(2.70 - 4.20)
Pondera C.	16	18.6	(16.5 - 22.2)	3.35	(1.90 - 5.20)
Circle Bridge	13	18.6	(13.7 - 20.4)	3.36	(1.60 - 4.65)
Black C.	40	18.2	(15.0 - 21.6)	2.99	(1.90 - 5.20)
Sheep C.	13	18.1	(3.0 - 22.9)	3.53	(0.00 - 6.46)
Confluence	372	19.0	(15.5 - 23.3)	3.40	(1.85 - 6.70)
Upper Missouri	157	18.6	(12.5 - 23.8)	3.58	(0.35 - 8.00)
Lower Missouri	77	19.8	(13.8 - 23.8)	4.08	(1.60 - 7.10)
Sauger					
Pondera C.	1	13.6		0.90	
Circle Bridge	12	14.6	(11.9 - 18.2)	1.01	(0.50 - 1.85)
Black C.	34	14.7	(10.4 - 25.1)	1.14	(0.40 - 4.80)
Sheep C.	14	13.3	(10.1 - 21.1)	0.73	(0.38 - 2.10)
Confluence	61	13.6	(9.6 - 22.4)	0.81	(0.30 - 3.63)
Upper Missouri	31	13.4	(10.2 - 21.3)	0.73	(0.30 - 2.30)
Lower Missouri	43	12.6	(9.2 - 19.8)	0.62	(0.25 - 2.10)
Saugeye					
Black C.	1	20.8		3.00	
Sheep C.	1	17.9		1.58	
Confluence	2	27.4	(26.8 - 28.0)	8.05	(7.60 - 8.50)
Lower Missouri	1	19.5		21.0	
Sculpin					
Confluence	1				
Upper Missouri	1				
Shorthead redhorse					
Tiber	15	17.1	(14.0 - 19.7)	2.32	(1.00 - 3.85)
Pondera C.	160	16.6	(5.4 - 20.1)	2.13	(0.10 - 2.60)

Appendix Table B. (continued)

Circle Bridge	43	18.4	(16.3 - 21.8)	2.74	(1.85 - 4.30)
Black C.	202	17.5	(4.7 - 22.2)	2.50	(0.00 - 4.35)
Sheep C.	10	16.6	(6.0 - 19.6)	2.15	(0.15 - 3.50)
Confluence	377	15.7	(4.1 - 21.8)	2.02	(0.05 - 5.25)
Upper Missouri	114	14.9	(6.0 - 21.0)	1.63	(0.16 - 3.48)
Lower Missouri	191	13.3	(5.1 - 19.9)	1.28	(0.10 - 2.95)
Shovelnose sturgeon *					
Pondera	1	33.6		9.70	
Black C.	1	36.2		10.45	
Confluence	13	28.1	(22.2 - 34.7)	4.26	(1.60 - 9.80)
Upper Missouri	1	35.0		7.91	
Lower Missouri	3	28.9	(25.0 - 31.6)	4.45	(2.30 - 6.70)
Smallmouth bass					
Confluence	5	14.6	(12.0 - 17.2)	1.73	(1.09 - 2.00)
Upper Missouri	1	15.8		2.05	
Lower Missouri	1	7.4		0.27	
Smallmouth buffalo					
Circle Bridge	1	25.8		9.30	
Confluence	2	15.0	(14.9 - 15.0)	1.95	(1.90 - 2.00)
Upper Missouri	10	25.3	(22.0 - 31.2)	8.09	(5.25 - 11.40)
Lower Missouri	4	21.7	(9.5 - 26.8)	7.05	(0.60 - 26.80)
Spottail shiner					
Tiber	4				
Upper Missouri	1				
Walleye					
Pondera C.	2	14.4	(10.8 - 17.2)	1.14	(0.79 - 1.50)
Circle Bridge	8	10.4	(5.0 - 14.3)	0.51	(0.05 - 1.10)

Appendix C. Average catch rates (no./drift) and number of fish sampled with trammel nets in the middle Missouri and Marias rivers, MT, 1997.

	Pondera Coulee	Black Coulee	Confluence	Upper Missouri	Lower Missouri	Total Number
Blue Sucker			0.1	0.1		4
Carp	0.3	0.1		0.1	0.1	6
Channel catfish			0.1			2
Goldeye	2.4	5.8	5.8	2.6	2.2	318
Largemouth buffalo			tr.	0.1		2
Longnose sucker	0.9	0.9	0.5	0.6	2.1	73
Mountain whitefish	1.1	0.2	0.1			17
River carpsucker		0.4	0.6		0.4	25
Sauger			tr.			1
Shorthead redhorse	0.8	0.5	1.2	0.6	1.1	62
Shovelnose sturgeon		0.9	0.5	0.3	1.9	58
White sucker	0.3	0.1				5
Total no. fish	63	126	215	61	108	573
Total no. sets	11	14	24	16	14	79

Appendix Table B. (continued)

Black C.	19	14.5	(5.5 - 25.5)	1.25	(0.05 - 5.40)
Sheep C.	8	12.4	(9.5 - 16.5)	0.72	(0.42 - 1.40)
Confluence	23	16.7	(5.4 - 30.6)	3.10	(0.05 - 11.40)
Upper Missouri	36	12.3	(9.1 - 28.4)	0.75	(0.25 - 6.85)
Lower Missouri	41	13.5	(8.5 - 29.0)	1.34	(0.16 - 9.00)
White sucker					
Tiber	3	13.5	(6.4 - 18.4)	1.62	(0.10 - 2.85)
Pondera	20	15.2	(9.1 - 18.5)	1.82	(0.31 - 2.95)
Circle Bridge	17	13.8	(5.4 - 17.1)	1.44	(0.10 - 2.15)
Black C.	24	14.0	(8.4 - 18.4)	1.27	(0.26 - 2.26)
Confluence	18	12.9	(8.7 - 16.5)	1.04	(0.38 - 2.20)
Upper Missouri	16	9.2	(5.9 - 15.9)	0.50	(0.05 - 1.80)
Lower Missouri	12	12.9	(7.5 - 18.0)	1.06	(0.21 - 1.90)
Yellow perch					
Confluence	4	5.8	(5.2 - 6.2)	0.07	(0.05 - 0.10)
Lower Missouri	1	4.7		0.05	

* Shovelnose sturgeon length measurement is a fork length.