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

STATE: MONTANA **PROJECT NO.: 3744**

PROJECT TITLE: YELLOWSTONE RIVER FISH PASSAGE - BOR

1997-98 Report

ABSTRACT

A study to evaluate the effects of irrigation structures and operations on the fisheries in the Yellowstone River was initiated in 1997. A total of 38,662 fish, representing 37 species, were sampled in the Yellowstone using electrofishing, trammel netting and seining methods during the 1997 and 1998 field seasons. Goldeye was especially abundant and a wide-ranging species sampled at abundance's of over 34 fish/hr at all sections. The trammel net sampling results were similar to electrofishing with goldeye and shorthead redhorse, the two most common species, both sampled at rates of 0.7 fish/drift or greater for all sections. Shovelnose sturgeon catchrates averaged 3.3 fish/hr. downstream of Cartersville Diversion Dam compared to average catchrates of 0.1 fish/hr. upstream of the dam. Emerald shiner, fathead minnow, flathead chub, *Hybognathus* and shorthead redhorse were the most common and wide-ranging species sampled by seining at average rates greater than 20 fish/haul. Larval fish sampling confirmed successful sauger spawning in the Powder River during 1998. Blue sucker and sturgeon chub were the only two species sampled that are on Montana Species of Special Concern List.

INTRODUCTION

The 678-mile long Yellowstone River is the longest free-flowing river in the contiguous United States (White and Bramblett 1993). The fish community is diverse comprised of 56 species, 6 of which are on the Montana Species of Special Concern List. The reach of Yellowstone River for this study lies within the lower 380 miles of river, from the confluence with the Clark's Fork River, near Billings, to its confluence with the Missouri River near the Montana/North Dakota border. This reach has experienced considerable irrigation development over the past 75 years, having numerous diversion dams and water intake structures, along with similar developments on the two the major tributary streams, the Bighorn and Tongue rivers. Irrigated agriculture is by far the largest user of water in the basin with an estimated water consumption of 2.1 million acre-ft per year (USGS; unpublished data; Ron Zelt) or about 23% of the mean annual flow. Total surface water with drawal for irrigation in the basin is 7.2 million acre-ft per year, or 78% of the mean annual flow. This level of water-use indicates that over appropriation of water resources may be a problem in the Yellowstone River Basin especially during drought years.

In addition to the dewatering effects on aquatic habitats, the irrigation structures associated with the numerous irrigation projects in this reach have caused major fisheries problems. There are six irrigation diversion dams located on the lower Yellowstone River; most of these low-head dams extending completely across the channel. These barriers impede, if not block, up river passage for most species of fish. About a dozen gravity flow irrigation intake canals with capacities greater than 100 cfs occur within the study area and their effects on fish entrainment has been largely unknown.

This study will provide information pertaining to the need for improving passage over diversion dams, baseline fisheries information in the general area of the dams and an evaluation of the effects some of the larger diversion intake canals may be having on the fisheries. Most of the work is centered in the Forsyth area, evaluating the Cartersville Irrigation Project. The study began in 1997 and will continue through 2001.

OBJECTIVES AND DEGREE OF ATTAINMENT

1. Describe the fish distribution and abundance relative to diversion dams in the 380-mile study area, with particular emphasis on shovelnose sturgeon and blue sucker. Trammel net sampling were completed at 2 sections near Huntley Dam and 3 sections near Ranchers Ditch, Yellowstone Irrigation District and Cartersville dams and results are presented. Electrofish sampling were completed at 5 sections near Ranchers Ditch, Yellowstone Irrigation District, Cartersville and Intake diversion dams and results are presented.

2. Seine a variety of fish communities to determine the distribution of small forage species in the study area. A total of 189 seine hauls were completed in the study reach. The results are presented.

3. Locate sauger spawning areas in spring by electrofish sampling for adults and larval fish sampling. One area was electrofished and 78 larval fish samples were collected while evaluating sauger spawning in the drainage and results are presented.

4. Locate early spring burbot concentrations. Only a few individuals were sampled and little can be determined from this information. I recommend that this objective be dropped so that more emphasis can be given to the objectives above.

PROCEDURES

Trammel nets were used to sample deep water fish habitats. The nets were 150 ft. long and 6 ft. deep. Two mesh sizes were used: 1 inch inner wall with 10 inch outer walls, and 2 inch inner wall with 12 inch outer walls. Mesh material for both 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 perpendicular in the channel in snag-free areas of the river and allowed to drift with the current along the bottom. Nets were drifted no longer than 7 minutes, usually a distance of about 300 yds. Catch per unit effort was expressed as number of fish caught per drift. Experimental gill nets were also used for capturing fish. The sinking net was 125 x 6 ft with graduated mesh size from ¾ to 2 inch square

measure. Overnight stationary sets with these nets in areas of the river with little or no current, generally produced good catches of a wide variety of fish species. Catch per unit effort was expressed as number of fish caught per overnight set.

Electrofish sampling was used to sample the mid to shallow water habitats. The system used was a dual boom-type and mounted to a 19-foot aluminum boat powered by a 105 hp outboard jet motor. Power was supplied by a 5,000-watt 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 stainless steel cables attached to the tip of each boom , with the cables partially submerged in 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 was expressed as number of fish caught per hour.

A 50 x 4 foot beach seine with ¼ -inch mesh was used to sample shallow peripheral habitats. The seine was dragged in a variety of shoreline habitats, typically for a distance of about 30 yards in areas with water depths generally less than 2½ feet. All captured fish were counted and identified, and associated habitat type was recorded. Catch per unit effort was expressed as number of fish caught per haul.

Larval fish sampling evaluated sauger and walleye (Stizostedion) spawning use in the Yellowstone, Tongue and Powder rivers. Yellowstone River larval samples were obtained using a boat and the sampling of the more shallow tributary rivers was accomplished by shoreline sets. When the boat was used round plankton nets were deployed in tandem (one attached on each side of the boat) so that duplicate samples could be taken simultaneously. The nets were positioned in the river near the surface while filtering river water in moderately fast current areas. Stizostedion larvae have been found almost equally at the surface and bottom locations of the water column (personal observation). The shoreline stationary larval net sets consisted of attaching the net with a 12 ft tether line to a metal post anchored in the channel at depths 2-3 ft. The round samplers for both methods consisted of a 6 ft long Nitex net (750 micron mesh) attached to a 20 inch diameter metal ring. The nets were positioned in the river usually for a duration of 7-15 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. Larval samples were preserved with formalin in the field and later sorted in the laboratory. Environmental conditions at the time and place of sampling were recorded. Larvae were identified to family using taxonomic keys by Auer (1982) and Wallus (1994). Sauger and walleye, 1 day post-hatch larvae were differentiated based on total length as described by Auer (1982); those larvae 5-6mm were denoted as sauger and larvae 7-8mm were denoted as walleye.

DESCRIPTION OF STUDY AREA

The middle and lower portions of the Yellowstone River where this fisheries study was conducted is a 380-mile reach of mostly free-flowing river from the Clark's Fork River to the Montana/North Dakota border. The physiography, geomorphology and hydrology have been thoroughly described by Koch et al. (1977) and Zelt et al.(1999). Major tributaries in this reach are Clarks Fork, Bighorn, Tongue and Powder rivers, all of which enter the Yellowstone from the south. The Clarks Fork, Bighorn and Tongue rivers have storage reservoir impoundments that

regulate streamflow in the Yellowstone Basin. These drainages comprise nearly 1/3 of the basin and therefore have probably reduced peak flows in the system (Koch et al. 1977). There are 6 low-head dams located on the Yellowstone River (Figure1.) These 2-6 feet high dams span the entire river channel and vary from rock dikes (Ranchers) to concrete structures (Huntley). All the dams undoubtedly restrict fish passage at low flows. The study sections and important reference sites are shown in Figure 1. Locations of sampling sites are given in Appendix A.

RESULTS

Summary flow statistics for the Yellowstone, Tongue and Powder rivers during 1997 and 1998 are given in Table 1 (USGS 1998-99). Runoff in the Yellowstone was considerably greater than normal in 1997 and less than normal for the spring months in 1998. During the spring period, April through June 1997, flows were between 158 and 174% of average, and 65 to 110% of average for 1998. Summer flows (July-Sept) for both years were good and ranged between 114 and 200% of average.

Runoff in the tributary streams, Tongue and Powder rivers resembled that of the Yellowstone River pattern except for the exceptionally low spring, 1998 Tongue River flows. During the spring period Tongue River flows were only between 24 and 82% of average, most likely resulting from the spring drought conditions.

Table 1. River discharge statistics (cfs) for the Yellowstone and Tongue rivers at Miles City and Powder rivers at Locate, MT, 1997-98. (USGS 1998-99).

	Apr	May	Jun	Jul	Aug	Sep	Peak flow
Yellowstone							
1997	14030	27880	61860	27780	16540	11020	82300
1998	9276	13460	22880	23560	11470	8325	39100
AVG	8367	17600	35470	20640	8265	7292	NA
Tongue							
1997	663	826	1746	686	482	367	2790
1998	377	235	312	333	247	531	985
AVG	459	733	1319	488	187	203	NA
Powder							
1997	1040	1174	2099	806	857	290	3900
1998	966	1317	992	719	614	339	1820
AVG	753	1166	1685	589	219	170	NA

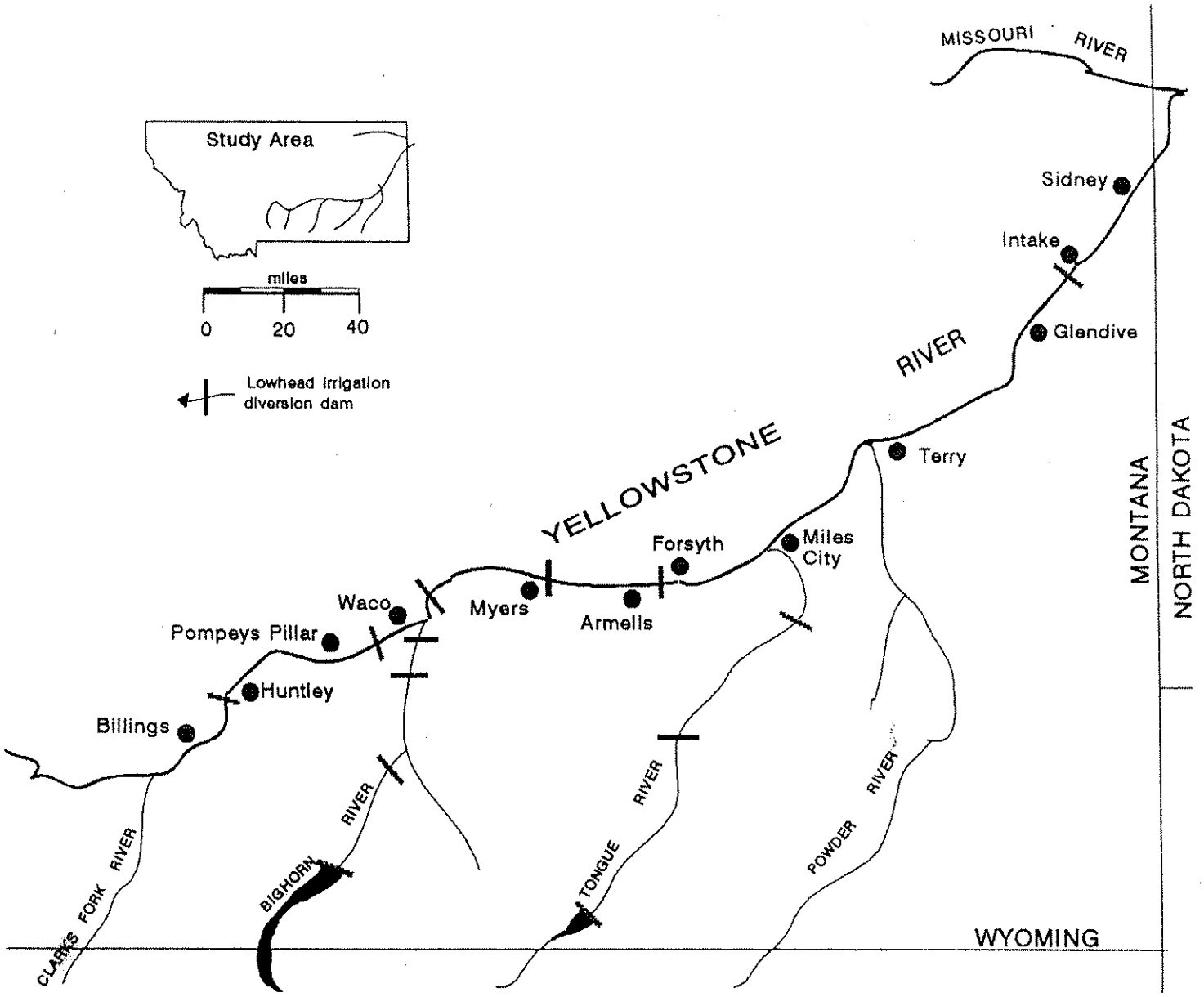

Figure 1. Map of the study area.

Fish Populations:

Eletrofish sampling:

Recent fisheries data is limited for the Yellowstone River especially for evaluating the effects of diversion dams and irrigation water intake structures on fish species distribution and abundance. Also, sauger, a native species found throughout the study area, is thought to be declining statewide (McMahon 1999) and very little is known about the factors causing this decline. More information on sauger is required to get a better understanding about its status in the Yellowstone. Species abundance and distribution, along with use by migratory species were the specific parameters that were investigated for evaluating the present fishery and assessing effects from irrigation developments.

A total of 6,184 fish were sampled in the Yellowstone using electrofishing and netting methods during the 1997 and 1998 field seasons. An additional 32,478 fish were sampled while seining during this same period. Average sizes for the sampled fish are calculated for each study section and reported in Appendix B - E. Seining results for specific habitat types are given in Appendix F-O.

Catch rates for electrofishing are given in Table 2. Goldeye was especially abundant and a wide-ranging species sampled at abundance's of over 34 fish/hr at all sections. Other species sampled at high catch rates in most sections were shorthead redhorse and carp. Channel catfish, sauger, burbot and walleye were the 4 most common gamefish of the 9 species in this category sampled in the Yellowstone. Channel catfish was the most abundant gamefish sampled in the upper sections (Myers, Armells and Terry) and exceeded 5 fish/hr at the Myers and Terry sections. Sauger was the most abundant gamefish sampled in the lower sections (Forsyth, Glendive and Intake) and exceeded 5 fish/hr only at Intake.

Table 3 is a summary of average fall catch rates for sauger over the past years measured at established trend areas (Stewart 1997 and Schmitz in press). Stewart stated in his 1997 report that "sauger catch rates are remaining well below the levels of the mid to late 1980's". It is apparent that sauger abundance at all sections declined drastically during the period 1992-97. The reason for this decline is not clear but it may be related to the drought conditions experienced throughout the eastern 2/3's of the state during the late 1980's. The sauger population in the middle Missouri has also experienced a sharp drop in numbers during this same period (Gardner 1998), suggesting that similar factors may be affecting both populations. Sauger is a native species and a popular gamefish; a major effort should be directed at determining the factors suppressing their numbers and preventing recovery back to the mid-1980 levels.

More recent (1998) surveys in the trend areas indicates there has been a rebound of sauger numbers (Schmitz in press). Catch rates in the Miles City, Terry/Glendive and lower Intake sections all exceeded 11 sauger/day and were some of the highest catch rates recorded in the past 9 years. Its still not clear that sauger populations are recovered in the Yellowstone because of the variability associatiated with using catch rates as an index of abundance. Another 2 successive years with increased catch rates are essential before sauger numbers can be considered on the rebound. It is my opinion that, for large rivers like the Yellowstone and Missouri, sauger populations are at more normal carrying capacities when average catch rates approximate 10 fish/hr (20 sauger/day, expressed in Stewart's unit of measure).

Table 2. Average catch rates (no./hour) and number of fish sampled by electrofishing in the Yellowstone River, MT, April-October, 1998.

	Myers	Armells	Forsyth	Terry	Glendive	Intake
Bigmouth buffalo		0.1				0.5
Black crappie	0.1	0.1	0.4			
Blue sucker			0.2		1.2	0.2
Brown trout	0.5	0.1	0.1		0.2	
Burbot	0.7	0.4	0.6		1.6	0.5
Carp	13.5	11.0	8.3	10.0	3.5	3.1
Channel catfish	9.8	1.7	1.4	5.5	0.8	0.5
Emerald shiner	10.6	0.4	0.7			
Flathead chub	3.0	1.3	2.9		17.3	3.2
Freshwater drum	0.4	0.4	0.2		0.2	0.8
Goldeye	71.2	53.4	41.8	38.1	43.5	34.2
Green sunfish	0.1	0.4	0.3			
Hybognathus	9.1	4.0	3.9			0.2
Largemouth bass		0.2	0.2			
Longnose sucker	20.8	4.5	5.4			0.3
Mountain sucker	0.5		0.1			
Mountain whitefish	0.1	0.2				
Northern pike		0.1	0.2			0.3
Rainbow trout	0.1		0.1	0.9		0.2
River carpsucker	12.6	6.2	6.9	18.2	0.4	1.8
Sauger	0.8	1.4	2.2	0.9	2.5	16.5
Saugeye		0.1	0.2		0.8	1.8
Shorthead redhorse	39.7	34.9	19.0	5.5	1.9	1.8
Shovelnose sturgeon			0.1			1.3
Smallmouth bass	0.8	0.7	4.9			
Smallmouth buffalo		0.3	0.4		0.2	0.3
Stonecat			0.6			0.2
Walleye	0.8	0.7	0.3		0.2	1.8
White crappie			0.4			
White sucker	15.6	8.5	6.3		1.0	0.5
Yellow perch		0.1				
Total no. of fish	1493	1443	1425	88	388	432
Total no. of hours	7.4	11.0	13.2	1.1	5.2	6.2

Trammel net sampling:

The trammel net sampling results were similar to electrofishing indicating that goldeye and shorthead redhorse were the two most common species in the deep-water areas of the river (Table 4). These two species were sampled at rates of 0.7 fish/drift or greater for all sections. Longnose suckers were the third most common species captured in the trammel nets. Channel catfish and shovelnose sturgeon were the only two game fish commonly sampled by the trammel nets. Channel catfish averaged 0.6 fish/net and were sampled in all the sections. Shovelnose sturgeon were only sampled in the lower two sections, where at Forsyth, they appeared to be especially abundant, with an average catch rate of 3.3 fish/net. This was 33 times greater than the average catch rate at the next upriver section, Armells. Cartersville Diversion Dam is situated between these two sections and is most likely a barrier for upriver shovelnose sturgeon migration and recolonization. Results from the 1997 gill net sampling are shown in Table 5.

Table 3. Average fall sauger densities (number/day) measured in Yellowstone River trend areas. (Stewart 1997 and Schmitz in press).

Year	Lower Forsyth	Miles City Area	Terry/ Glendive	Lower Intake
1985		27.0		119.3
1986				
1987	18.2			
1988	29.1			
1989				
1990	25.0	8.1		
1991				
1992	3.8	2.8	6.4	
1993	1.7	1.0	10.8	17.2
1994	2.0	1.2	5.0	11.0
1995	14.0	5.0	13.6	13.3
1996	4.0	7.3	2.0	3.0
1997	6.0	2.5	6.0	10.0
1998	3.2	12.0	11.4	28.9

Table 4. Average catch rates (no./drift) and number of fish sampled with trammel nets in the Yellowstone River, MT, 1997.

	Dover Island	Huntley	Myers	Armells	Forsyth
Blue sucker				0.2	
Burbot	0.6	0.4			
Carp	0.3	0.1	0.3	0.6	0.2
Channel catfish	0.2	0.2	1.7	0.4	0.5
Goldeye	4.2	4.4	1.0	0.8	0.9
Longnose sucker	6.8	2.1	0.2	0.5	0.4
Mountain whitefish	0.1				
River carpsucker	0.1		0.3	0.4	0.1
Shorthead redhorse	5.4	1.3	1.4	1.5	0.7
Shovelnose sturgeon				0.1	3.3
Smallmouth buffalo			0.9	0.8	
White sucker	2.1	2.2		0.4	0.1
Total no. of fish	174	166	109	129	161
Total no. of sets	9	16	22	26	26

Table 5. Average catch rates (no./set) and number of fish sampled with gill nets in the Yellowstone River, MT, 1997.

	Myers	Armells	Forsyth
Burbot			0.3
Channel catfish	2.0	16.0	16.0
Goldeye	8.0	1.5	14.0
Longnose sucker			0.3
Northern pike			0.3
Sauger		1.0	1.0
Shorthead redhorse	1.0	3.0	3.3
White sucker		5.0	1.3
Total no. of fish	11	53	112
Total no. sets	1	2	3

Seining:

Extensive sampling of the Yellowstone River shallow-water habitats was accomplished by seining. Emerald shiner, fathead minnow, flathead chub, *Hybognathus* (western silvery and plains minnows) and shorthead redhorse (young-of-the-year and juvenile stages) were the five most abundant and widespread species sampled (Table 6). Black crappie, lake chub, northern pike young-of-the-year (YOY), plains killifish, sauger/walleye (YOY), shovelnose sturgeon (juvenile), smallmouth buffalo (YOY) stonecat and yellow perch were the least abundant and location limited in the seine catches. The infrequent catches for northern pike and stonecat, were probably the result of sampling gear inefficiencies in these species habitats'.

A total of 29 species were identified in the seine samples. The greatest number of species, 17, was sampled at Armells and Glendive sections, and the least (8) was found at the Pompeys Pillar Section. The low number of species found at Pompeys Pillar was probably related to the fewer samples collected here compared to other sections. There appeared to be noticeable differences in minnow abundance's between the upper and lower reaches of the Yellowstone. The upper 7 sections all had average total catch rates of over 100 fish/haul compared to the lower 3 sections where average total catch rates were less than 73 fish/haul. Decreases in river gradients, smaller substrate sizes and increased turbidities downstream of Glendive may be some of the more obvious factors affecting the abundance of minnows. Total number of species were generally comparable between the upper and lower study sections, although there were substantial changes in species composition.

Young-of-the-year channel catfish, goldeye and sauger/walleye were only sampled in the lower 3 sections underscoring the importance of these downstream areas for rearing. Sauger/walleye YOY were sampled at a much lower rate than catfish and goldeye YOY, and it appears there was very little rearing of sauger/walleye occurring in this reach of the Yellowstone River during 1997-98.

Table 6. Average catch per seine haul for fish sampled in the Yellowstone River, 1997-98. (Only fish less than 8 inches were included. Yoy = young-of-year; ylg = yearling).

	Dover Island	Huntley	Pompey's Pillar	Waco	Myers	Arnells	Forsyth	Glendive	Intake	Sidney
Black crappie							0.2			
Carp		12.2				<0.1		0.1		
Channel catfish (yoy)								6.4	0.7	0.2
Emerald shiner	1.5	12.6	0.2	7.9	125.5	22.9	26.3	7.5	11.2	2.4
Fathead minnow	2.0	131.2	150.5	8.1	0.2	13.1	7.7	1.6	0.9	2.1
Flathead chub	2.4	6.6	44.0	133.5	26.6	25.0	109.9	9.0	10.9	8.1
Goldeye (yoy)								1.3	4.9	2.9
Green sunfish						4.0		<0.1		<0.1
Hybognathus	0.7	404.8	0.5	27.3	22.6	21.0	114.3	10.8	19.9	5.9
Lake chub								1.9		
Largemouth bass (yoy)		2.8				0.3				
Longnose dace	24.8	1.8	6.8	1.4	4.4	1.9	4.9	0.1	0.4	<0.1
Longnose sucker (yoy)	12.5	3.9	2.0	7.8	9.7	4.5	3.1	0.1		<0.1
Mountain sucker	0.3	0.4		0.1	0.1	0.7	0.4			
Northern pike (yoy)									<0.1	
Plains killifish						0.3				
River carpsucker (yoy)		0.1		0.8	0.4	5.3	24.8	3.6	0.9	2.7
Sand shiner				0.2	1.1	1.5	2.6			
Sauger/Walleye (yoy)								<0.1		0.4
Shorthead redhorse (yoy)	32.7	7.6	83.8	72.9	12.8	41.3	3.7	0.2	<0.1	
Shovelnose sturgeon (ylg)									<0.1	
Smallmouth bass (yoy)		0.4				0.4	1.0			
Smallmouth buffalo (yoy)				0.6						
Spottail shiner				0.1					<0.1	0.3
Stonecat								0.2	0.1	
Sturgeon chub								0.5	0.2	0.3
White crappie		0.4					0.5			0.1
White sucker (yoy)	1.7	1.9	0.5	28.2	0.9	0.8	2.0	<0.1		
Yellow perch		0.2				0.1				
Unidentified fish	21.5	26.2	0.5	2.4	17.2	21.0	27.9	27.1	21.0	8.1
Number of Hauls	12	9	4	12	20	26	29	31	23	23

Larval fish sampling:

Larval fish sampling was used to evaluate sauger spawning in the Yellowstone River system. A total of 58 samples from 4 stations were collected in the Yellowstone and 6 and 14 samples were collected in the Tongue and Powder rivers during the period May 6-28, 1998. The environmental conditions recorded at the time of sampling are given in Appendix Table P. From this effort only 13 larvae were collected in the Yellowstone and 33 and 59 larvae in the Tongue and Powder rivers (Table 7 and 8).

The larval composition of the Yellowstone stations samples' contained only suckers. No sauger larvae were collected in these samples. Normal seasonally-low larval drift rate is the most probable explanation for the low numbers of larvae sampled. For northern climates, larval drift during May is typically low and comprised of the larvae from the few early spring spawners such as suckers and sauger. It is difficult to draw any conclusions concerning the lack of sauger larvae (evidence of sauger spawning) in the Yellowstone River samples because of the reduced sampling efficiency in large rivers.

The larval composition of the Tongue River samples was comprised of 73% suckers and 27% cyprinids. Similar to the Yellowstone river, no sauger larvae were collected here. I suspect that timing (date and/or time-of-day) or the limited effort may be the reason for the lack of certain species being collected. All of the collections were made during daylight hours and the degree of light intensity often governs the activity of larval fish drift. Gale and Mohr (1978) found 3.8 times more larvae in samples collected at night than during the daylight hours. Tongue River turbidities were usually somewhat clear, averaging 1.6 ft secchi depth. Therefore, sampling in the daylight probably reduced the number of larvae in the collections.

The larval composition of the Powder River samples was comprised of 73% goldeye, 12% cyprinid, 8% sucker, 5% sauger and 2% walleye. Larval densities were by far the greatest in the Powder River confluence station compared to any of the other 5 stations in the Yellowstone and Tongue rivers. Of the 3 sauger larvae collected, 1 was taken on May 14 and the other 2 taken on May 21. Larval sampling conditions were fairly good at the Powder River Confluence station. The river was only a moderate volume with flows between 1210 and 1660 cfs and therefore more of the river was effectively sampled. Also turbidities were high, always 0.1 ft secchi depth or less. Higher turbidities effectively block out light and reduce the diel drift rate differential that exists for clearer water conditions, therefore time-of-day becomes less of a factor influencing larval drift rates in turbid rivers.

Species of special concern sampled:

An important goal of FWP (Montana Fish Wildlife & Parks) is maintaining and enhancing Montana's native fish species and habitats. To help accomplish this goal, FWP, along with Montana Chapter of the American Fisheries Society, established a list of sensitive fish species that are limited in abundance and distribution. The 5 Species of Special Concern found in the study area are blue sucker, paddlefish, pallid sturgeon, sicklefin chub and sturgeon chub. Only blue sucker and sturgeon chub were sampled during the report period. A total of 15 blue sucker were sampled in the Armells, Forsyth, Glendive and Intake sections. A total of 27 sturgeon chub were seined in the Glendive, Intake and Sidney sections.

Table 7. Numbers and densities of larval fish collected with 1/2-meter plankton nets in the Yellowstone River, 1998.

Taxon	Armells	Forsyth	Miles City	Terry	Totals
Cyprinids	0	0	0	0	0
Goldeye	0	0	0	0	0
Goldeye egg[1/]	3	5	1	11	20
Sauger	0	0	0	0	0
Sucker	2	0	3	8	13
Walleye	0	0	0	0	0
Total # Larvae -	2	0	3	8	13
Catchrate (#/10,000 ft3)	0.4	0	0.6	2.8	0.8
Total # Samples -	16	16	16	10	58

1/ Goldeye eggs not included in the total number of larvae.

Table 8. Numbers and densities of larval fish collected with 1/2-meter plankton nets in the Tongue and Powder rivers, 1998.

Taxon	Tongue	Powder	Totals
Cyprinids	9	7	16
Goldeye	0	43	43
Goldeye egg[1/]	12	181	193
Sauger	0	3	3
Sucker	24	5	29
Walleye	0	1	1
Total # Larvae -	33	59	92
Catchrate (#/10,000 ft3)	19.0	38.0	28.2
Total # Samples -	6	14	20

1/ Goldeye eggs not included in the total number of larvae.

RECOMMENDATIONS

1. This study initiated work for evaluating the effects of irrigation structures and operations on the Yellowstone River fish populations. The Cartersville Diversion Dam appears to have measurable effects on at least two important fish species, shovelnose sturgeon and sauger. The average catch rate of shovelnose sturgeon was 33 times greater immediately downstream of the dam compared to upstream, strongly implicating the dam as an impediment for upstream passage by sturgeon. Upstream passage of sauger also is most likely limited by the diversion dam. Stewart (1990) estimated the sauger abundance's to be 108/mi. immediately above Cartersville and 780/mi. immediately downriver. It appears that not enough sauger are moving upriver over the dam for maintaining healthy populations in the upriver areas. Blue sucker and sturgeon chub may be two other species negatively affected by the dam. Additional information should be acquired to further assess the fishery impacts this dam is having on the fishery. Distribution and abundance of fish species found in the Forsyth area should continue to be quantified so that fish passage can be evaluated once future changes are made. Since catch rates will be the primary measure of comparison, it is important that an adequate effort be made sampling so that meaningful statistical comparisons can be applied.

The barrier that Cartersville creates should be remedied either by adding a by-pass channel around the dam or by removing part, or the entire dam. Since Cartersville Dam only provides a 100 cfs water diversion capacity, it may be feasible to replace this gravity flow system with a pumped irrigation system. Discussions with the Cartersville Irrigation District should be initiated concerning fish passage at the dam and possible remedies. Partnerships should be explored for funding potential projects that would improve fish passage and water delivery to the irrigation system.

2. An exceptionally high entrainment rate affecting several fish species at the Intake Irrigation Canal have been documented by Steve Hiebert, US Bureau of Reclamation. This ditch has a large water diversion capacity rated at 1,700 cfs. There are several other large irrigation systems diverting water from the Yellowstone upstream of Intake. Fisheries studies should be directed at evaluating the magnitude of fish losses, if any, at the other irrigation canals.

3. Sauger, once abundant in the Yellowstone River, continues to be found in very low numbers and may be in danger of extirpation in a 165-mile reach upstream of the Tongue River confluence. Presently, we do not know the factors that caused the decline and are preventing recovery. Efforts should be made at evaluating population parameters, spawning and rearing. The extent and magnitude of sauger spawning should be determined for the known spawning tributaries, the Tongue and Powder rivers. These streams should be electrofish sampled in the spring for evaluation and for future baseline comparisons. Mainstem and tributary sampling for drifting sauger larvae should continue as a second method for evaluating spawning occurrence. A greater effort at locating and evaluating sauger rearing habitat should be accomplished by seining in the known rearing areas downstream of Glendive.

4. Angler use information is particularly valuable for assessing if recreational fishery goals are being met and that fishing pressure is not adversely limiting fish populations. Very little Yellowstone River angler use information is available because of the low priority given for creel surveys in this light fishery use area. It would be prudent to conduct angler use surveys in the study area at least every 10 years for addressing the above concerns.

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Prepared by: William M. Gardner

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Appendix Table A. Locations of sampling stations on the Yellowstone River and tributaries. 1997-98.

Station	Sampling Boundary	Location	Lat/Long
Dover Island	RM 356.0 – 351.8	Downstream of Billings to Huntley Dam	45°52'26"N/108°20'53"W to 45°13'13"N/108°28'23"W
Huntley	RM 351.8 – 345.8	Huntley Dam to 0.3 mile downstream of Huntley Bridge	45°13'13"N/108°28'23"W to 45°56'18"N/108°17'41"W
Pompeys Pillar	RM 338.0 – 329.0	Worden to 2 mi. downstream of Pomeys P. Monument	45°59'38"N/108°10'47"W to 45°59'46"N/108° 0'46"W
Waco	RM 316.7 – 311.0	Waco Dam to 5 miles downstream of Waco	46° 2'32"N/107°48' 6"W to 46° 4'42"N/107°42'33"W
Myers	RM 293.0 – 284.3	Ranchers Ditch Dam downstream to YID Dam	46°10'46"N/107°26' 1"W to 46°15'16"N/107°20'44"W
Armells	RM 246.1 – 237.4	Big Porcupine Cr. To Cartersville Dam	46°16'48"N/106°48'23"W to 46°16'30"N/106°40'48"W
Forsyth	RM 237.4 – 230.6	Cartersville Dam to Little Porcupine Cr.	46°16'30"N/106°40'48"W to 46°17'47"N/106°33'23"W
Miles City	RM 185.3	Upstrm of Tongue R.	46°24'19"N/105°52'19"W
Terry	RM 149.5 – 137.6	1 mi upstream of Powder R. confl. To Terry Bdg.	46°43'39"N/105°26'26"W to 46°48'17"N/105°17'43"W
Glendive	RM 91.7 – 71.1	Glendive downstream to Intake Dam	47° 6'27"N/104°43'10"W to 47°16'49"N/104°31'48"W
Intake	RM 71.1 – 64.6	Intake Dam to Cottonwood Creek	47°16'49"N/104°31'48"W to 47°20' 2"N/104°25'56"W
Sidney	RM 39.3 – 25.6	Seven Sisters FAS to Bennie Peer Creek	47°34'20"N/104°13'16"W to 47°41'59"N/104° 5'37"W
Tongue River	RM 1.0	RR Brdg; 1 mi upstrm	46°23'55"N/105°51'16"W
Powder River	RM 1.0	Hwy 10 Bdg; 1mi upst	46°44'12"N/105°25'42"W

Appendix Table B. Summary size statistics for fish sampled by electro-fishing, in the Yellowstone River, MT, 1998.

Species/Station	Number	Total Length (inches)	Range	Weight (pounds)	Range
Bigmouth Buffalo					
Armells	1	21.0	--	5.75	--
Intake	3	30.0	(28.6 - 30.8)	17.80	(15.4 - 20.0)
Black Crappie					
Myers	1	5.6	--	0.10	--
Armells	1	6.3	--	0.18	--
Forsyth	6	7.6	(5.9 - 9.7)	0.32	(0.12 - 0.65)
Blue Sucker					
Forsyth	2	25.5	(23.3 - 27.6)	5.20	(4.60 - 5.80)
Glendive	6	25.9	(22.1 - 29.0)	5.0	(2.95 - 6.75)
Intake	1	28.0	--	5.8	--
Brown Trout					
Myers	4	11.4	(7.4 - 13.2)	0.65	(0.18 - 0.90)
Armells	1	13.3	--	1.05	--
Forsyth	1	6.8	--	0.14	--
Glendive	1	20.0	--	4.40	--
Burbot					
Myers	5	23.7	(15.5 - 33.0)	3.18	(0.62 - 6.80)
Armells	4	16.0	(10.2 - 23.4)	0.95	(0.36 - 2.15)
Forsyth	8	15.0	(.95 - 24.5)	0.78	(0.20 - 2.42)
Glendive	8	12.5	(9.0 - 16.5)	0.48	(0.15 - 0.95)
Intake	3	18.0	(15.4 - 22.7)	0.94	(0.62 - 2.20)

Appendix Table B. (continued)

Goldeye					
Myers	136	12.9	(10.3 - 15.5)	0.73	(0.22 - 1.60)
Armells	248	12.9	(8.7 - 15.1)	0.74	(0.25 - 1.25)
Forsyth	260	12.6	(10.1 - 15.1)	0.68	(0.34 - 1.20)
Terry	42	12.6	(5.2 - 14.3)	0.71	(0.07 - 1.02)
Glendive	223	11.1	(4.5 - 14.2)	0.45	(0.08 - 0.86)
Intake	213	11.6	(3.3 - 15.7)	0.62	(0.07 - 1.10)
Green Sunfish					
Myers	1	4.4	--	--	--
Armells	2	3.5	--	--	--
Forsyth	4	3.9	--	--	--
Hybognathus					
Armells	1	4.4	--	--	--
Forsyth	3	4.5	--	--	--
Intake	1	4.2	--	--	--
Largemouth Bass					
Armells	2	5.4	(5.2 - 5.7)	--	--
Forsyth	2	5.7	(5.0 - 6.4)	--	--
Longnose Sucker					
Myers	139	10.9	(4.2 - 16.6)	0.66	(0.04 - 2.0)
Armells	49	11.3	(2.5 - 17.0)	0.90	(0.06 - 2.36)
Forsyth	71	12.7	(5.0 - 18.8)	1.08	(0.08 - 3.0)
Terry	1	8.7	--	0.34	--
Intake	2	10.1	(9.8 - 10.4)	0.40	(0.29 - 0.50)
Mountain Whitefish					
Myers	1	12.2	--	0.55	--
Armells	2	12.5	(10.8 - 14.2)	0.69	(0.38 - 1.0)

Appendix Table B. (continued)

Mountain Sucker					
Myers	4	5.8	(4.0 - 8.3)	0.27	(0.20 - 0.35)
Forsyth	1	6.3	--	0.30	--
Northern Pike					
Armells	1	36.5	--	12.4	--
Forsyth	2	27.0	(23.4 - 30.6)	4.87	(2.90 - 6.85)
Intake	2	2.80	(24.8 - 31.2)	5.50	(3.50 - 7.60)
Rainbow Trout					
Myers	1	5.00	--	0.12	--
Forsyth	1	4.50	--	0.10	--
Terry	1	19.0	--	2.50	--
Intake	1	18.2	--	2.10	--
River Carpsucker					
Myers	79	15.4	(9.7 - 18.6)	1.86	(0.45 - 3.00)
Armells	68	15.8	(13.0 - 18.2)	1.96	(1.25 - 3.10)
Forsyth	91	15.1	(5.2 - 19.1)	1.82	(0.10 - 4.15)
Terry	20	16.4	(12.9 - 19.7)	2.36	(0.16 - 1.85)
Glendive	2	10.9	(6.6 - 15.2)	1.01	(0.16 - 1.85)
Intake	11	18.4	(16.0 - 22.5)	3.46	(2.60 - 6.20)
Sauger					
Myers	6	18.3	(16.7 - 19.6)	1.93	(1.43 - 2.40)
Armells	15	16.6	(13.0 - 20.8)	1.56	(0.60 - 2.95)
Forsyth	29	15.7	(10.9 - 20.0)	1.29	(0.41 - 2.65)
Glendive	13	12.9	(7.5 - 18.0)	0.78	(0.12 - 1.90)
Intake	102	14.4	(9.3 - 24.2)	0.93	(0.25 - 2.62)

Appendix Table B. (continued)

Saugeye					
Armells	1	18.9	--	2.05	--
Forsyth	2	18.9	(18.5 - 19.2)	1.85	(1.80 - 1.90)
Glendive	4	15.6	(11.5 - 19.5)	1.66	(0.45 - 3.60)
Intake	11	16.3	(11.6 - 19.9)	1.28	(0.43 - 2.48)
Shorthead redhorse					
Myers	187	13.0	(4.4 - 20.1)	1.28	(0.06 - 3.20)
Armells	221	14.6	(4.8 - 20.0)	1.56	(0.07 - 3.62)
Forsyth	176	13.9	(3.3 - 21.5)	1.33	(0.05 - 5.90)
Terry	6	10.7	(9.3 - 12.4)	0.53	(0.42 - 0.66)
Glendive	10	10.2	(6.0 - 18.0)	0.60	(0.11 - 1.94)
Intake	11	11.2	(9.0 - 13.3)	0.56	(0.37 - 1.50)
Shovelnose sturgeon *					
Forsyth	1	33.5	--	--	--
Intake	8	21.0	(13.3 - 32.8)	1.72	(0.30 - 6.20)
Stonecat					
Forsyth	6	6.0	(5.5 - 6.6)	0.16	(0.15 - .20)
Intake	1	2.7	--	--	--
Smallmouth Bass					
Myers	6	3.9	(2.8 - 5.0)	0.12	(0.07 - 0.18)
Armells	8	7.5	(3.5 - 13.5)	0.62	(0.10 - 1.80)
Forsyth	36	10.5	(2.8 - 16.5)	1.02	(0.10 - 3.10)

Appendix Table B. (continued)

Smallmouth buffalo					
Armells	3	24.4	(21.0 - 28.0)	8.04	(5.0 - 11.5)
Forsyth	6	21.1	(14.4 - 25.0)	5.89	(1.44 - 9.0)
Glendive	1	26.9	--	9.45	--
Intake	2	30.0	(28.0 - 32.0)	19.2	(12.7 - 25.7
Walleye					
Myers	6	20.3	(16.5 - 26.0)	3.67	(1.82 - 8.50)
Armells	8	11.9	(8.4 - 19.9)	0.96	(0.25 - 3.15)
Forsyth	4	12.9	(7.8 - 20.6)	1.14	(0.20 - 3.0)
Glendive	1	11.2	--	0.50	--
Intake	11	16.7	(12.7 - 23.0)	1.67	(0.70 - 4.05)
White Crappie					
Forsyth	4	2.8	(2.4 - 3.5)	--	--
White sucker					
Myers	98	12.1	(5.8 - 17.7)	0.92	(0.14 - 2.65)
Armells	94	13.5	(5.4 - 18.2)	1.23	(0.12 - 2.62)
Forsyth	82	13.9	(5.0 - 17.5)	1.32	(0.12 - 2.40)
Glendive	5	11.7	(10.6 - 12.3)	0.69	(0.60 - 0.74)
Yellow Perch					
Armells	1	7.0	--	0.15	--

* Shovelnose sturgeon length measurement is a fork length.

Appendix Table C. Summary size statistics for fish sampled with trammel nets, in the Yellowstone River MT, 1997.

Species/Station	Number	Total Length (inches)	Range	Weight (pounds)	Range
Burbot					
Huntley	1	22.8	--	2.50	--
Myers	1	22.4	--	2.45	--
Carp					
Dover Island	3	16.7	(14.4 - 19.1)	2.35	(1.60 - 3.50)
Huntley	2	22.2	(19.7 - 24.8)	2.50	(2.40 - 7.28)
Myers	6	22.7	(19.9 - 26.2)	5.56	(3.60 - 7.80)
Armells	16	20.5	(14.8 - 24.8)	4.43	(1.54 - 7.00)
Forsyth	5	21.0	(16.6 - 26.4)	4.51	(2.23 - 7.50)
Channel Catfish					
Dover Island	2	21.0	(19.5 - 22.5)	3.05	(2.45 - 3.65)
Huntley	3	18.1	(16.9 - 18.8)	2.10	(1.80 - 2.25)
Myers	37	15.4	(11.0 - 24.8)	1.37	(.42 - 5.30)
Armells	9	13.5	(10.0 - 16.5)	.73	(.22 - 1.18)
Forsyth	13	17.0	(9.7 - 27.4)	2.47	(.24 - 8.84)
Goldeye					
Dover Island	38	12.7	(9.3 - 14.7)	.64	(.32 - 2.40)
Huntley	70	12.7	(11.2 - 18.6)	.62	(.46 - .90)
Myers	21	12.3	(11.2 - 13.6)	.65	(.48 - .78)
Armells	21	12.7	(12.0 - 13.7)	.59	(.50 - .80)
Forsyth	24	12.2	(9.7 - 13.3)	.57	(.31 - .80)

Appendix Table C. (Continued)

Longnose Sucker					
Dover Island	61	12.7	(9.2 - 18.0)	.90	(.32 - 2.40)
Huntley	34	12.3	(9.4 - 18.5)	.80	(.35 - 2.40)
Myers	5	18.0	(15.9 - 19.4)	2.41	(1.64 - 2.82)
Armells	14	14.6	(7.7 - 19.4)	1.42	(.25 - 3.00)
Forsyth	9	14.3	(11.8 - 18.9)	1.66	(.64 - 3.00)
Mountain Whitefish					
Dover Island	1	12.2	--	.57	--
River Carpsucker					
Dover Island	1	16.2	--	2.15	--
Myers	7	15.2	(13.7 - 17.1)	1.59	(1.30 - 1.90)
Armells	10	15.1	(12.5 - 18.2)	1.75	(1.05 - 3.50)
Forsyth	3	16.4	(14.5 - 18.5)	.95	(1.32 - 1.54)
Sauger					
Armells	1	18.2	--	1.85	--
Shorthead Redhorse					
Dover Island	49	16.0	(12.3 - 19.6)	1.59	(.74 - 2.75)
Huntley	21	14.5	(9.0 - 19.4)	1.33	(.25 - 2.47)
Myers	30	17.6	(15.2 - 19.0)	2.13	(1.56 - 3.18)
Armells	39	17.2	(13.5 - 19.2)	1.92	(.94 - 2.85)
Forsyth	19	15.3	(10.3 - 19.0)	1.42	(.45 - 2.55)
Shovelnose Sturgeon *					
Armells	3	30.4	(27.4 - 32.6)	4.68	(3.32 - 6.00)
Forsyth	85	31.7	(23.7 - 38.7)	6.21	(1.95 - 11.85)

Appendix C. (Continued)

Smallmouth Buffalo					
Myers	2	27.2	(26.0 - 28.4)	9.53	(9.15 - 9.91)
Armells	2	16.6	(12.2 - 21.2)	5.58	(.75 - 10.40)
White Sucker					
Dover Island	19	11.8	(8.4 - 16.9)	.81	(.26 - 1.90)
Huntley	35	12.2	(8.8 - 17.2)	.77	(.26 - 2.02)
Armells	9	13.6	(12.5 - 15.0)	1.19	(.95 - 1.80)
Forsyth	3	14.7	(13.4 - 17.0)	1.33	(.91 - 2.05)

* Shovelnose Sturgeon length measurement is a fork length.

Appendix Table D. Summary size statistics for fish sampled with trammel nets on the Yellowstone River, MT, 1998.

Species/Station	Number	Total Length (inches)	Range	Weight (pounds)	Range
Burbot					
Intake	1	26.6	--	4.80	--
Goldeye					
Intake	37	12.2	(9.0 - 14.5)	0.56	(.22 - .90)
Glendive	1	13.8	--	0.88	--
River Carpsucker					
Intake	11	17.6	(15.1 - 20.2)	3.19	(1.70 - 5.15)
Sauger					
Intake	4	10.3	(10.0 - 10.4)	0.33	(0.30 - .36)
Shorthead Redhorse					
Intake	1	10.1	--	0.38	--
Sovelnose Sturgeon *					
Intake	24	17.7	(10.8 - 29.3)	1.02	(0.18 - 3.60)

* Shovelnose Sturgeon length is a fork length

Appendix Table E. Summary size statistics for fish sampled with gill nets in the Yellowstone River, MT, 1997.

Species/Station	Number	Total Length (inches)	Range	Weight (pounds)	Range
Burbot					
Forsyth	1	32.5	--	5.25	--
Channel Catfish					
Myers	2	15.4	(14.6 - 16.2)	1.25	(1.05 - 1.45)
Armells	32	15.1	(9.4 - 18.8)	1.15	(.24 - 2.30)
Forsyth	48	15.4	(11.0 - 22.6)	1.29	(.40 - 4.80)
Goldeye					
Myers	8	12.2	(10.0 - 13.5)	.68	(.47 - 1.00)
Armells	3	13.0	(12.6 - 13.5)	.72	(.65 - .75)
Forsyth	42	12.7	(11.2 - 14.1)	.68	(.50 - .95)
Longnose Sucker					
Forsyth	1	10.6	--	.52	--
Northern Pike					
Forsyth	1	26.9	--	5.35	--
Sauger					
Armells	2	13.7	(13.5 - 13.8)	.81	(.80 - .82)
Forsyth	3	14.6	(11.2 - 16.7)	1.12	(.40 - 1.60)

Appendix Table E. (Continued)

Shorthead Redhorse					
Myers	1	15.1	--	1.30	--
Armells	6	15.6	(10.3 - 18.1)	1.71	(.47 - 2.45)
Forsyth	10	10.2	(8.3 - 11.6)	.45	(.25 - .70)
Walleye					
Forsyth	2	15.2	(14.0 - 16.5)	1.35	(.85 - 1.85)
White Sucker					
Armells	10	13.4	(12.0 - 15.4)	1.14	(.87- 1.70)
Forsyth	4	14.6	(12.7 - 16.6)	1.39	(.90 - 1.90)

Appendix Table F. Average catch per seine haul (and total number) for fish sampled in the Dover Island Section, Yellowstone River MT, 1997. (Only fish less than 8 inches were included.)

	Main Channel Pool	Main Channel Border	Side Channel Pool	Total
Emerald shiner	0	0.5 (35)	2.7 (13)	1.5 (95)
Fathead minnow	0	0	4.0 (12)	2.0 (12)
Flathead chub	(29)	0	0	(29)
Hybognathus	0	0.5 (1)	1.0 (3)	0.7 (4)
Longnose dace	(94)	0	18.3 (55)	24.8 (149)
Longnose sucker	0	0	25.0 (75)	12.5 (75)
Mountain sucker	0	0	0.7 (2)	0.3 (2)
Shorthead redhorse	0	0	65.3 (196)	32.7 (196)
White sucker	0	0	3.3 (10)	1.7 (10)
Unidentified minnow	(47)	5.0 (10)	24.0 (72)	21.5 (129)
Number of hauls	1	2	3	6

Appendix Table G. Average catch per seine haul (and total number) for fish sampled in the Huntley Section, Yellowstone River MT, 1997. (Only fish less than 8 inches were included.)

	Main Channel Pool	Main Channel Border	Side Channel Pool	Back Water	Total
Carp		0	0	27.5 (110)	12.2 (110)
Emerald shiner		0	6.5 (13)	25.0 (100)	12.6 (113)
Fathead minnow		0	8.0 (16)	291.2 (1165)	131.2 (1181)
Flathead chub		4.7 (14)	15.0 (30)	3.8 (15)	6.6 (59)
Hybognathus		0.3 (1)	134.5 (269)	843.2 (3373)	404.8 (3643)
Largemouth bass		0	0	6.2 (25)	2.8 (25)
Longnose dace		4.3 (13)	1.5 (3)	0	1.8 (16)
Longnose sucker		7.7 (23)	6.0 (12)	0	3.9 (35)
Mountain sucker		0	2.0 (4)	0	0.4 (4)
River carpsucker		0	0	0.2 (1)	0.1 (1)
Shorthead redhorse		1.0 (3)	5.0 (10)	13.7 (55)	7.6 (68)
Smallmouth bass		0	0	1.0 (4)	0.4 (4)
White crappie		0	0	1.0 (4)	0.4 (4)
White sucker		0	3.5 (7)	2.5 (10)	1.9 (17)
Yellow perch		0	1.0 (2)	0	0.2 (2)
Unidentified minnow		3.7 (11)	0	56.2 (225)	26.2 (236)
Number of hauls	0	3	2	4	9

Appendix Table H. Average catch per seine haul (and total number) for fish sampled in the Pompey's Pillar Section, Yellowstone River MT, 1997. (Only fish less than 8 inches were included.)

	Main Channel Pool	Main Channel Border	Side Channel Pool	Back Water	Total
Emerald shiner	0	0		1.5 (1)	0.2 (1)
Fathead minnow	(1)	0 (1)		300.0 (600)	150.5 (602)
Flathead chub	(52)	(77)		23.5 (47)	44.0 (176)
Hybognathus	0	0 (1)		1.0 (2)	0.5 (2)
Longnose dace	(7)	0		10.0 (20)	6.8 (27)
Longnose sucker	(5)	(3)		0	2.0 (8)
Shorthead redhorse	(9)	(1)		162.5 (325)	83.8 (335)
White sucker	0	(2)			0.5 (2)
Unidentified minnow	0	0		1.0 (2)	0.5 (2)
Number of hauls	1	1	0	2	4

Appendix Table I. Average catch per seine haul (and total number) for fish sampled in the Waco Section, Yellowstone River MT, 1997. (Only fish less than 8 inches were included.)

	Main Channel Pool	Main Channel Border	Side Channel Pool	Total
Emerald shiner	(47)	7.0 (35)	2.2 (13)	7.9 (95)
Fathead minnow	0	17.8 (89)	1.3 (8)	8.1 (97)
Flathead chub	(50)	24.2 (121)	238.5 (1431)	133.5 (1602)
Hybognathus	(128)	39.6 (198)	0.3 (2)	27.3 (328)
Longnose dace	(1)	2.8 (14)	0.3 (2)	1.4 (17)
Longnose sucker	0	0	15.5 (93)	7.8 (93)
Mountain sucker	0	0.2 (1)	0	0.1 (1)
River carpsucker	0	0	1.5 (9)	0.8 (9)
Sand shiner	0	0	0.3 (2)	0.2 (2)
Shorthead redhorse	0	0.4 (2)	145.5 (873)	72.9 (875)
Smallmouth buffalo	0	0	1.2 (7)	0.6 (7)
Spottail shiner	0	0	0.2 (1)	0.1 (1)
White sucker	0	8.8 (44)	49.1 (295)	28.2 (339)
Unidentified minnow	0	0.6 (3)	4.3 (26)	2.4 (29)
Number of hauls	1	5	6	12

Appendix Table J. Average catch per seine haul (and total number) for fish sampled in the Myers Section Yellowstone River MT, 1997-98. (Only fish less than 8 inches were included.)

	Main Channel Pool	Main Channel Border	Side Channel Pool	Side Channel Border	Total
Emerald shiner	179.8 (1079)	7.6 (53)	8.2 (33)	30.0 (90)	125.5 (1255)
Fathead minnow	0	0.6 (4)	0	0	0.2 (4)
Flathead chub	7.7 (76)	13.6 (95)	94.0 (376)	5.3 (16)	26.6 (533)
Hybognathus	27.5 (165)	1.1 (8)	63.5 (254)	8.3 (25)	22.6 (452)
Longnose dace	4.0 (24)	6.4 (45)	3.2 (13)	2.3 (7)	4.4 (89)
Longnose sucker	22.0 (132)	5.9 (41)	4.2 (17)	1.3 (4)	9.7 (194)
Mountain sucker	0	0	0.2 (1)	0	0.1 (1)
River carpsucker	0.8 (5)	0	0	0.7 (2)	0.4 (7)
Sand shiner	0	2.0 (14)	2.0 (8)	0	1.1 (22)
Shorthead redhorse	14.0 (84)	1.6 (11)	40.0 (160)	0	12.8 (255)
White sucker	1.7 (10)	0.7 (5)	0.8 (3)	0	0.9 (18)
Unidentified minnow	40.5 (243)	3.9 (27)	18.8 (75)	0	17.2 (345)
Number of hauls	6	7	4	3	20

Appendix Table K. Average catch per seine haul (and total number) for fish sampled in the Armells Section, Yellowstone River MT, 1997-98. (Only fish less than 8 inches were included.)

	Main Channel Pool	Main Channel Border	Side Channel Pool	Side Channel Border	Total
Carp	0	0	0	0.2 (1)	<0.1 (1)
Emerald shiner	11.2 (56)	16.8 (185)	16.5 (66)	48.2 (289)	22.9 (596)
Fathead minnow	21.0 (105)	3.5 (38)	23.0 (92)	17.7 (106)	13.1 (341)
Flathead chub	8.2 (41)	37.2 (409)	10.8 (43)	26.2 (157)	25.0 (650)
Green sunfish	2.4 (12)	0.1 (1)	22.5 (90)	0	4.0 (103)
Hybognathus	2.8 (14)	17.8 (196)	3.2 (13)	57.7 (334)	21.0 (557)
Largemouth bass	1.6 (8)	0	0	0	0.3 (8)
Longnose dace	1.2 (6)	4.0 (44)	0	0	1.9 (50)
Longnose sucker	2.2 (11)	3.0 (33)	14.5 (58)	2.3 (14)	4.5 (116)
Mountain sucker	0	0	3.0 (12)	1.0 (6)	0.7 (18)
Plains killifish	1.0 (5)	0.4 (4)	0	0	0.3 (9)
River carpsucker	3.8 (19)	0.5 (5)	26.5 (106)	1.3 (8)	5.3 (138)
Sand shiner	0	3.4 (37)	0.2 (1)	0.3 (2)	1.5 (40)
Shorthead redhorse	16.4 (82)	13.6 (150)	175.0 (700)	23.7 (142)	41.3 (1074)
Smallmouth bass	1.2 (6)	0.2 (2)	0.2 (1)	0.3 (2)	0.4 (11)
White sucker	0	0.9 (10)	0	1.8 (11)	0.8 (21)
Yellow perch	0	0	0.2 (1)	0.2 (1)	0.1 (2)
Unidentified minnow	6.0 (30)	42.6 (469)	10.2 (41)	1.0 (6)	21.0 (546)
Number of hauls	5	11	4	6	26

Appendix Table L. Average catch per seine haul (and total number) for fish sampled in the Forsyth Section, Yellowstone River MT, 1997-98. (Only fish less than 8 inches were included.)

	Main Channel Pool	Main Channel Border	Side Channel Pool	Side Channel Border	Total
Black crappie	1.2 (6)	0	0	0	0.2 (6)
Emerald shiner	23.4 (117)	34.1 (375)	29.2 (263)	1.8 (7)	26.3 (762)
Fathead minnow	3.2 (16)	5.7 (63)	13.7 (123)	5.2 (21)	7.7 (223)
Flathead chub	164.6 (823)	60.2 (662)	155.4 (1399)	75.8 (303)	109.9 (3187)
Hybognathus	58.6 (293)	76.4 (840)	219.4 (1975)	51.5 (206)	114.3 (3314)
Longnose dace	4.4 (22)	10.3 (113)	0.7 (6)	0.2 (1)	4.9 (142)
Longnose sucker	0	0.7 (8)	8.9 (80)	0.5 (2)	3.1 (90)
Mountain sucker	2.4 (12)	0	0	0	0.4 (12)
River carpsucker	13.0 (65)	2.6 (29)	68.8 (619)	1.8 (7)	24.8 (720)
Sand shiner	3.6 (18)	4.8 (53)	0.3 (3)	0	2.6 (74)
Shorthead redhorse	7.2 (36)	1.9 (21)	4.1 (37)	3.0 (12)	3.7 (106)
Smallmouth bass	5.2 (26)	0.2 (2)	0.1 (1)	0	1.0 (29)
White crappie	2.2 (11)	0.2 (3)	0	0	0.5 (14)
White sucker	0	0	6.6 (59)	0	2.0 (59)
Unidentified minnow	0	72.4 (796)	1.6 (14)	0	27.9 (810)
Number of hauls	5	11	9	4	29

Appendix Table M. Average catch per seine haul (and total number) for fish sampled in the Glendive Section, Yellowstone River MT, 1998. (Only fish less than 8 inches were included)

	Back Water	Main Channel Pool	Main Channel Border	Side Channel Pool	Side Channel Border	Total
Carp	0.1 (1)	0	0	0.2 (2)	0	0.1 (3)
Channel catfish	1.7 (12)	3.2 (16)	2.7 (19)	15.0 (150)	0.5 (1)	6.4 (198)
Emerald shiner	11.4 (80)	4.6 (23)	12.1 (85)	3.6 (36)	5.0 (10)	7.5 (234)
Fathead minnow	0.3 (2)	0.4 (2)	5.1 (36)	0.7 (7)	1.0 (2)	1.6 (49)
Flathead chub	2.4 (17)	20.6 (103)	7.3 (51)	7.4 (74)	17.0 (34)	9.0 (279)
Goldeye (YOY)	2.7 (19)	0.8 (4)	1.3 (9)	1.1 (11)	0	1.3 (43)
Green sunfish	0	0.2 (1)	0	0	0	<0.1 (1)
Hybognathus	15.6 (109)	9.0 (45)	8.3 (58)	10.9 (109)	7.5 (15)	10.8 (336)
Lake chub	12.0 (60)	0	0	0	0	1.9 (60)
Longnose dace	0	0.4 (2)	0.3 (2)	0	0	0.1 (4)
Longnose sucker	0.4 (3)	0	0	0	0	0.1 (3)
River carpsucker	3.6 (25)	8.8 (44)	0.4 (3)	3.5 (35)	0	3.6 (107)
Sauger/walleye-YOY	0.4 (2)	0	0	0	0	<0.1 (2)
Shorthead redhorse	0.3 (2)	0.2 (1)	0.3 (2)	0	0	0.2 (5)
Stonecat	0	0.4 (2)	0.4 (3)	0.1 (1)	0	0.2 (6)
Sturgeon chub	0	1.8 (9)	0.4 (3)	0.3 (3)		0.5 (15)
White sucker	0.1 (1)	0	0.1 (1)	0	0	<0.1 (2)
Unidentified Minnow	46.7 (327)	41.8 (209)	5.1 (36)	23.7 (237)	16.0 (32)	27.1 (841)
Number of hauls	7	5	7	10	2	31

Appendix Table N. Average catch per seine haul (and total number) for fish sampled in the Intake Section, Yellowstone River MT, 1998. (Only fish less than 8 inches were included.)

	Back Water	Main Channel Pool	Main Channel Border	Side Channel Pool	Side Channel Border	Total
Channel catfish	0	0.4 (2)	0.8 (3)	2.0 (12)	0	0.7 (17)
Emerald shiner	22.0 (88)	8.4 (42)	0.8 (3)	16.5 (66)	9.8 (59)	11.2 (258)
Fathead minnow	3.5 (14)	0	1.5 (6)	0	0.2 (1)	0.9 (21)
Flathead chub	3.3 (13)	12.4 (62)	12.3 (49)	11.8 (47)	13.3 (80)	10.9 (251)
Goldeye (YOY)	17.5 (70)	2.2 (11)	0.3 (1)	6.3 (25)	0.8 (5)	4.9 (112)
Hybognathus	22.8 (91)	17.4 (87)	22.5 (90)	16.0 (64)	21.0 (126)	19.9 (458)
Longnose dace	0	0	0.3 (1)	0.2 (8)	0	0.4 (9)
Northern pike	0.3 (1)	0	0	0	0	<0.1 (1)
River carpsucker	0.5 (2)	0.2 (1)	0.5 (2)	0.2 (1)	2.5 (15)	0.9 (21)
Shorthead redhorse	0	0.2 (1)	0	0	0	<0.1 (1)
Shovelnose sturgeon	0	0	0.3 (1)	0	0	<0.1 (1)
Spottail shiner	0	0 (2)	0 (3)	0 (1)	0.2	<0.1 (6)
Stonecat	0	0	0.8 (3)	0	0	0.1 (3)
Sturgeon Chub	0	0	1.0 (4)	0	0	0.2 (4)
Unidentified Minnow	9.3 (37)	13.0 (65)	15.0 (60)	36.3 (145)	29.5 (177)	21.0 (484)
Number of hauls	4	5	4	4	6	23

Appendix Table O. Average catch per seine haul (and total number) for fish sampled in the Sidney Section, Yellowstone River MT, 1998. (Only fish less than 8 inches were included.)

	Back Water	Main Channel Pool	Main Channel Border	Side Channel Pool	Side Channel Border	Total
Channel catfish	0	0.2 (1)	0	0.5 (2)	0.5 (1)	0.2 (4)
Emerald shiner	2.0 (8)	2.3 (14)	4.4 (31)	0.8 (3)	0	2.4 (56)
Fathead minnow	0	2.3 (14)	3.6 (25)	2.3 (9)	0	2.1 (48)
Flathead chub	11.3 (45)	6.0 (36)	8.3 (58)	8.3 (33)	7.0 (14)	8.1 (186)
Goldeye (YOY)	1.5 (6)	5.5 (33)	3.0 (21)	1.5 (6)	0	2.9 (66)
Green sunfish	0	0	0.1 (1)	0	0	<0.1 (1)
Hybognathus	16.3 (65)	2.8 (17)	3.7 (26)	2.8 (11)	8.0 (16)	5.9 (135)
Longnose dace	0	0	0.1 (1)	0	0	<0.1 (1)
Longnose sucker	0	0	0.3 (1)	0	0	<0.1 (1)
River carpsucker	0.8 (3)	0.7 (4)	5.1 (36)	0	9.5 (19)	2.7 (62)
Sauger/walleye(YOY)	0	1.5 (9)	0	0	0	0.4 (9)
Spottail shiner	1.3 (5)	0	0.3 (2)	0	0	0.3 (7)
Sturgeon Chub	1.3 (5)	0	0.1 (1)	0	0	0.3 (6)
White crappie	0	0	0.3 (1)	0.3 (1)	0	0.1 (2)
Unidentified Minnow	6.3 (25)	5.8 (35)	12.8 (90)	5.0 (20)	8.0 (16)	8.1 (186)
Number of hauls	4	6	7	4	2	23

Appendix Table P. Average environmental conditions measured while collecting larval fish samples in the Yellowstone River and tributaries, 1998.

Station	Number Samples	Avg. Depth at Station (ft.)	Average Net Velocity (ft/s)	Average Net Volume (ft^3)	Average River Flow (cfs)	Avg. Temp. (F)	Avg. Secchi (ft)
Armells (R)	8	19.5 (9.0 - 24.3)	3.3 (2.8 - 4.3)	2,920 (2482 - 3812)	11,508 (8880 - 16000)	61 (56-66)	0.8 (0.8)
Armells (L)	8	9.8 (6.6 - 12.0)	3.2 (2.6 - 4.4)	2,853 (2320 - 3902)	11,508 (8880 - 16000)	61 (56-66)	0.8 (0.8)
Forsyth (R)	8	5.2 (4.5 - 6.0)	3.0 (2.5 - 3.5)	2,624 (2263 - 3019)	11,508 (8880 - 16000)	61 (56-66)	0.8 (0.8)
Forsyth (L)	8	6.0 (3.5 - 7.9)	2.9 (2.5 - 3.3)	2,574 (2246 - 2888)	11,508 (8880 - 16000)	61 (56-66)	0.8 (0.8)
Miles C. (R)	8	9.9 (6.0 - 15.0)	3.1 (2.7 - 3.8)	3,178 (2511 - 4156)	11,422 (8880 - 16000)	62 (58-66)	1.0 (0.9-1.0)
Miles C. (L)	8	9.6 (7.0 - 13.0)	3.3 (2.5 - 4.4)	3,563 (2525 - 5176)	11,422 (8880 - 16000)	62 (58-66)	1.0 (0.9-1.0)
Terry (R)	4	15.0 (10.0 - 20.0)	2.8 (1.8 - 3.5)	3,587 (2839 - 4982)	10,815 (9030 - 12600)	61 (55-67)	0.4 (0.3-0.4)
Terry (L)	6	7.0 (4.0 - 8.5)	2.6 (1.6 - 3.1)	2,302 (1427 - 2772)	10,247 (9030 - 12600)	62 (55-68)	0.4 (0.3-0.4)
Tongue R. (R)	6	2.9 (2.5 - 3.5)	1.5 (0.7 - 2.5)	2,892 (1331 - 4703)	239 (58 - 440)	64 (59-75)	1.6 (0.2-3.0)
Powder R. (R)	8	2.8 (2.5 - 3.0)	1.2 (0.9 - 1.5)	1,374 (812 - 2747)	1,410 (1210 - 1660)	63 (54-73)	0.1 (0.1)
Powder R. (L)	6	2.8 (2.5 - 3.0)	0.8 (0.6 - 1.2)	752 (572 - 1098)	1,327 (1210 - 1460)	66 (60-73	0.1 (0.1)