Montana Department of Fish, Wildlife and Parks
Fisheries Division

Job Progress Report

STATE: Montana **PROJECT TITLE: Statewide Fisheries Investigation**

PROJECT: F-78-R3 **STUDY TITLE: Survey and Inventory of Warmwater Streams**

JOB NO: III-B-ii **JOB TITLE: Southeastern Montana Warmwater Streams Investigation**

PROJECT PERIOD: April 1, 2010 through September 30, 2012

ABSTRACT

The Tongue River is a major tributary to the Yellowstone River. Anthropogenic activities, particularly dam building in the Tongue River watershed has affected the fish assemblage. A monitoring program was developed in 2003 to monitor relative abundance, size distribution, and body condition of fish populations through time. Annual trend sampling consists of electrofishing at six locations. Seining was part of annual trend sampling from 2003 to 2009. In 2007 a bypass channel (Muggli Bypass) was constructed to provide fish passage around T&Y (Tongue and Yellowstone) Dam. A modified fyke net and electrofishing gears were used to assess the success of the fish passage structure. Passage was evaluated in 2010 and 2012 but not in 2011 because of high flows and lack of staff. Since 2008, when Muggli Bypass monitoring began 20 fish species have been documented using the bypass channel. Shovelnose sturgeon and blue sucker, found in the Tongue River below T&Y Diversion Dam, have not yet been sampled in the bypass. Fish passage for most species was deemed successful whereas; quantities of fish sampled from the bypass channel were proportional to those in the river below the dam. Sampling efforts in 2010 captured brown trout, a species that had not previously been documented using the bypass channel. One shovelnose sturgeon was captured in the lower 1/3 of the bypass on June 3, 2010. Sampling effort in 2012 documented yellow bullhead, bigmouth buffalo and northern pike utilizing the bypass channel. All three species had not prior been documented using the bypass channel. Changes in sample design or alterations to the Muggli Bypass may be necessary in order to document shovelnose sturgeon passage.

INTRODUCTION

The Tongue River is a major tributary to the Yellowstone River in eastern Montana. It supports a rich assemblage of native warmwater fish and provides spawning habitat and fish production that contributes to Yellowstone River fish populations. Few long-term studies have focused on the status of the Tongue River fish assemblage despite a long history of human activity in the drainage. Although game fishes are present in the river, sport fishing is limited by access and flow conditions. The primary human activities in the Tongue River watershed are agriculture and the development of coal resources.

Agricultural is the primary land use practice in the Tongue River watershed. Water from the Tongue River is used to irrigate tens-of-thousands of acres of farmland. Irrigation projects have had and still have a substantial impact on the Tongue River fish assemblage. Water withdrawal is so extensive that reaches of the Tongue River are completely dewatered during low water years. Irrigation diversion dams are barriers to fish movement and have fragmented fish populations. Irrigation canals entrain fish, that are thereby lost from the fishery. Development of coal resources is another major industry in the watershed. Construction of a Tongue River Railroad has been proposed to facilitate increased coal extraction and transport. A proposed railroad route would be constructed along the banks of the Tongue River for approximately 16.6 miles of its course. Numerous sites in the Tongue River watershed have been permitted for the development of coal bed methane extraction. The extraction of coal bed methane involves pumping methane and groundwater from coal seams. The process increases the salinity and conductivity of the water that is discharged into the Tongue River above Tongue River Reservoir.

Although many of the changes occurring in the Tongue River drainage have the potential to negatively affect the fish assemblage there are ongoing projects intended to improve and protect the fishery. These projects have focused primarily on reducing entrainment and improving or creating fish passage at three major irrigation diversion dams on the Tongue River. In 1999, the T&Y canal head gate and louver structure was replaced with intent to reduce fish entrainment into the irrigation canal. In August 2007, a fish passage structure the Muggli Bypass was constructed around T&Y Diversion Dam (Figure 1). In October 2008 SH Diversion Dam upstream of T&Y was removed (Figure 1). In 2005 water withdrawals from the Mobley Diversion Dam were transferred to pumps. The dam is no longer maintained and damage from ice scour and high flow has created some fish passage opportunity. Mobley Diversion Dam is considered a partial fish barrier, impeding fish movement only during low water periods. Future efforts will focus on a more complete removal of Mobley Diversion Dam. Since its construction in the 1880's, the T&Y dam has prevented downstream fishes, including Yellowstone River fishes, from migrating above the dam. However with current fish passage at Muggli Bypass and removal of SH Dam, fish may now move upstream to the Tongue River Dam with little restriction.

Interest in industrial affects and fish passage opportunities prompted the development of a monitoring program in the Tongue River. The monitoring program began in 2003 to

assess the status of the Tongue River fish assemblage and evaluate fish populations trends.

Goals and Objectives

The purpose of this project is to monitor fish population trends in the Tongue River there are three objectives for this project.

These objectives are:

(1) Assess the current relative abundance, population structure, and body condition of fish populations in the Tongue River,

(2) Evaluate changes in relative abundance, population structure, and body condition through time,

(3) Evaluate the success of fish passage around T&Y dam.

Through carrying out these objectives Montana Fish, Wildlife & Parks will be able to identify concerns or benefits that activity in the Tongue River watershed may have and adjust management to ensure healthy fish populations.

STUDY AREA

The Tongue River originates on the eastern side of the Big Horn Mountains in north-central Wyoming. The Tongue River has a drainage area of 5,399 mi^2, approximately 70% occurring in Montana. The total length of river in Montana from the state line to its confluence with the Yellowstone River, near Miles City, is 234 miles (Figure 1). The Fort Union Coal Formation underlies the Tongue River watershed (Elser et al. 1977).

The Tongue River in Montana has been divided into five segments by four dams. There are three irrigation diversion dams: (1) Tongue and Yellowstone (T&Y) Diversion Dam (river mile 20), (2) SH Diversion Dam (river mile 51) (no longer exists), and (3) Mobley Diversion Dam (river mile 105), and one flood control dam, Tongue River Dam (river mile 189) (Figure 1). There is a thermally unique sixth river segment created by cold water released from the hypolimnial zone of Tongue River Reservoir. This segment is approximately ten river miles long and ends downstream of the dam near the Rosebud/Big Horn County line.

Average annual discharge in the Tongue River at Miles City from 1940 to 2012 was 409.6 cfs (Figure 2). Drought conditions from 2001 to 2006 resulted in below average flows in the Tongue River. During this period, drought and irrigation demand nearly dewatered the river during summer months. Flows were above average in 2007, 2008, 2010 and 2011, near average in 2009 and below average in 2012(USGS 2012). In recent

years the Montana Department of Natural Resources Conservation (DNRC) has increased spring discharge from Tongue River Reservoir to reduce the amount of high salt, coal bed methane water stored in the reservoir prior to the start of irrigation season.

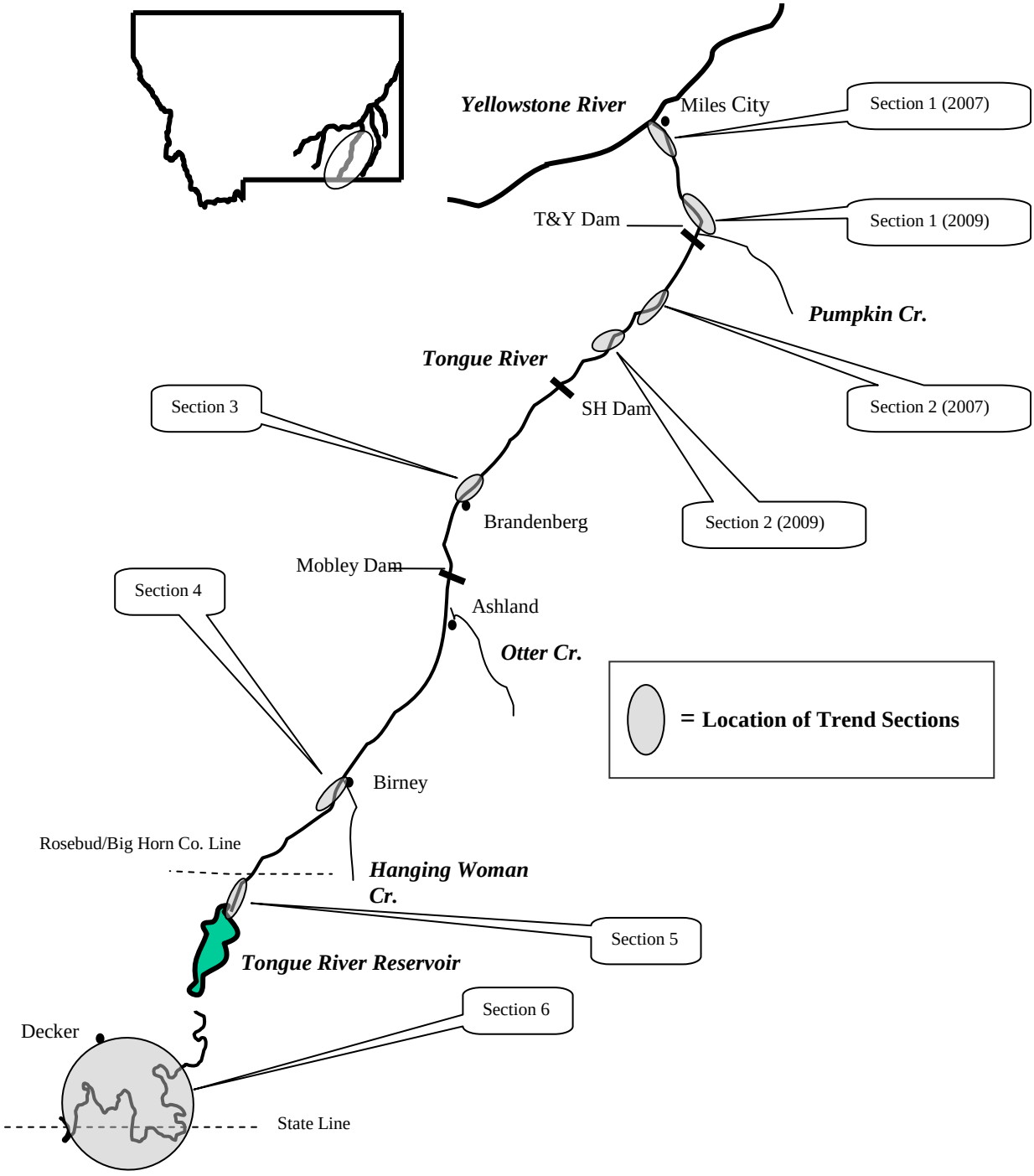


Figure 1. Tongue River, tributaries, diversion dams and trend sections.

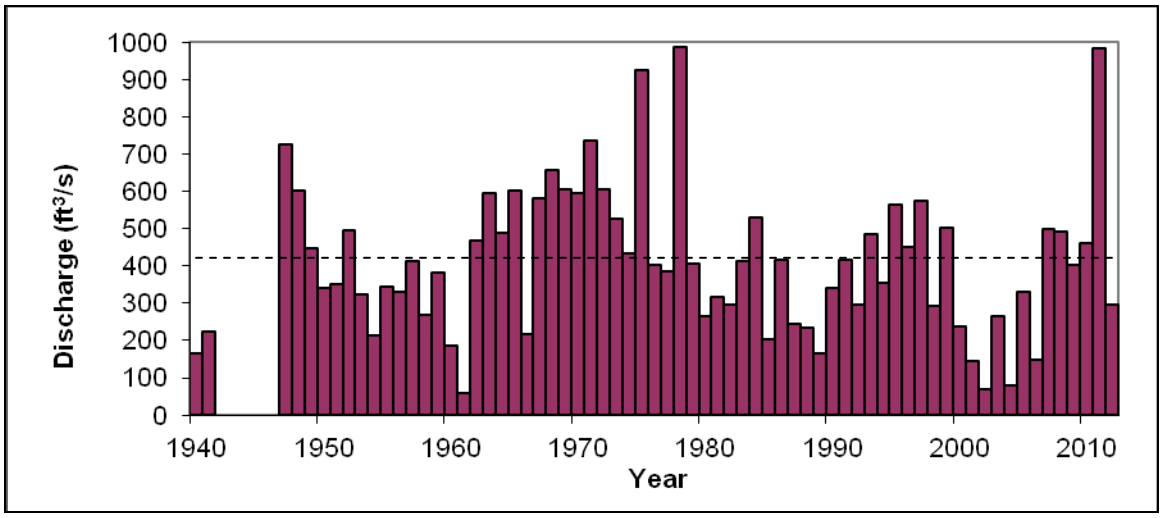


Figure 2. - Mean annual discharge of the Tongue River at Miles City, 1940-2012. Dashed line represents overall mean annual discharge for the period of record.

METHODS

Annual trend sampling

Six trend sections were established to represent the six segments of river (Figure 1). Annual electrofishing of the Tongue River began in 2003. Electrofishing gear included a 14-foot flat bottom boat, 3500-watt generator, Coffelt VVP-15, single boom anode, ½ inch-mesh dip net and a single netter. In 2012 the Coffelt VVP-15 was replaced with the Smith-Root VVP-15B model. One riverbank was continuously sampled in each section to reduce sampling bias and to include all habitat types. Seines were incorporated into annual trend sampling from 2003 to 2009. Trend sections were sampled in one-mile increments and for a total distance of 5 miles for the Birney and Hirsch sections while sampling 6 miles in the others.

The index catch per unit effort (C/f) (Fabrizio and Richards 1996; Hubert 1996; Ney 1996) was applied to describe the relative abundance of each fish species. The number of fish caught per hour of electrofishing was the unit of measure for C/f. Calculations of C/f were made for each species in each trend section

The index proportional size distribution (PSD) (Anderson and Neumann 1996; Guy et al. 2006 and 2007) was applied to describe the length structure of fish species sampled. This index was only applied to those species for that length categories have been established based on a percentage of the world record length (Anderson and Weithman 1978; Gabelhouse 1984). Calculations of PSD values were made for: brown trout (Milewski and Brown 1994), channel catfish, sauger, smallmouth bass, walleye (Gablehouse 1984), northern pike (Gablehouse 1984), rainbow trout (Anderson and Neumann 1996), river

carpsucker (Bister et al. 2000), shorthead redhorse sucker (Bister et al. 2000), and white sucker (Bister et al. 2000). Calculations of PSD values for brown trout and rainbow trout were made using data from sections five and six. Calculations of PSD values for the other species were made using all six sections combined. Comparisons of PSD values were made between years.

The index relative weight (Wege and Anderson 1978; Anderson and Neumann 1996; Blackwood et al. 2002) was applied to describe the body condition of fish species sampled. This index was only applied to those species for which standard weight (W_s) have been established. Calculations of W_r values were done for each fish from select species. The species for which W_r values were calculated were brown trout (Milewski and Brown 1994), channel catfish (Brown et al. 1995), northern pike (Anderson and Neumann 1996), rainbow trout, sauger (Anderson and Neumann 1996, river carpsucker, white sucker, shorthead redhorse sucker (Bister et al. 2000), smallmouth bass (Kolander et al. 1993), and walleye (Murphy et al 1990). Mean W_r values of each PSD length class were calculated for each species. Calculations of mean W_r were made using combined data from all six sections except for brown trout and rainbow trout where sections five and six data was used. Comparisons of mean W_r values were made between years.

Fish passage

Monitoring of the Muggli Bypass channel began in 2008 and has continued annually with the exception of 2011. A modified fyke net with additional block nets were used to monitor fish passage through the bypass channel. The fyke net was positioned at the uppermost portion of the bypass channel such that fish that successfully navigated the entire bypass channel were caught. Fyke net sampling was conducted one day per week for 24 hours from May to July. Electrofishing was conducted one day each week following fyke net sampling if adequate flows were available. Gear and methods used for weekly electrofishing were similar to that used for annual electrofishing.

Data analysis of the fish passage sampling was applied to determine the effectiveness of the Muggli Bypass channel. Total fish passed through the bypass channel was estimated by taking the 24-hr catch rate (fish/hour) of each fish species sampled and extrapolating out for the week. Weekly-extrapolated values were added to estimate the total number of fish that had passed through the bypass channel during the sampling season. Also, the C/f calculated from bypass and electrofishing data were plotted for each week of sampling to determine if relative abundance of fish sampled in the bypass net were correlated to the density of fish in the river below T&Y dam. If C/f values from both sampling methods followed similar patterns of increase, decrease, or stability along a temporal gradient then the fish passage was deemed equivalent to the density of fish in the river. Temporal gradient is used to estimate and compare average occupancy over two time intervals. Fish passage was deemed successful if; the number of fish sampled from the bypass channel with the modified fyke net were proportional to those in the river below the dam sampled with electrofishing.

Water Chemistry

Water chemistry and river flows were recorded on days that electrofishing and bypass sampling occurred. A handheld water meter (YSI model 85) was used to collect water temperature, dissolved oxygen, specific conductivity, and salinity data. A pH meter (Hanna pHep), turbidometer (Hach 2100P) and turbidity tube were used to collect pH and turbidity data. River discharge was obtained from the United States Geological Services web page (USGS 2012).

RESULTS

Annual trend sampling

All six trend sections were electrofished in 2010 and 2012. The locations of the trend sections were the same as in 2009(Figure 1). Section locations, lengths and sampling dates are provided in Appendix 1, Tables 1&2. Electrofishing catch rates by trend section for 2010 and 2012 are summarized in Appendix 1, Tables 3 & 4. Smallmouth bass and channel catfish were the only game species collected in all trend sections of the Tongue River. Shorthead redhorse suckers were the most abundant species sampled. A northern pike was sampled in section two, this was the first time a northern pike was recorded above T-Y Dam and below section five. No trends of increasing or decreasing PSD or W_r values were observed.

Fish passage

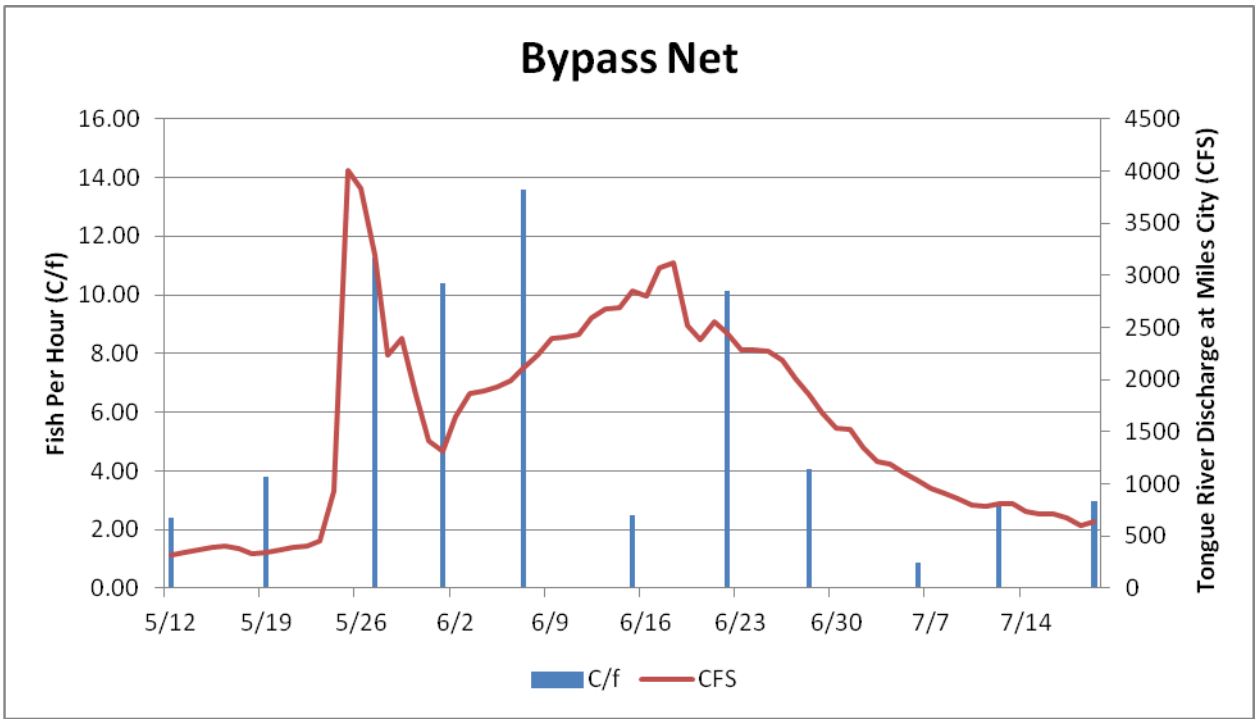
The Muggli Bypass was sampled 11days between May 12 and July 20 in 2010 for an average of 22.5 hours per 24-hour period and a total sample time of 247.6 hours. A total of 1,438 fish representing 20 species were collected. Eleven of the 20 species collected and 97% of the 1,438 fish collected were native species. Extrapolating the catch rate for days sampled in 2010 yielded an estimated passage of 10,903 fish through the bypass between May 12 and July 20 2010. The Muggli Bypass was not sampled in 2011 due to high flow and lack of staff. The Muggli Bypass was sampled 8 days between May 14 and July 3 in 2012 for an average of 23.8 hours per 24-hour period and a total sample time of 190.3 hours. A total of 891 fish representing 20 species were collected. Twelve of the 20 species collected and 94% of the 891 fish collected were native species. Extrapolating the catch rate for days sampled in 2012 yielded an estimated passage of 6,171 fish through the bypass between May 14 and July 3 2012. Fish species and number caught per hour from the bypass net are provided in Appendix 3, Table 1 for 2010 and Appendix 3, Table 3 for 2012.

In 2010, western silvery minnows and goldeye were the most abundant species sampled in the bypass at 32% and 31% of the total catch, respectively. Collectively, western silvery minnow, flathead chub, shorthead redhorse sucker, goldeye, stonecat and channel catfish made up 92% of the total catch. Flathead chub and goldeye were the most

frequently observed species. Flathead chub and goldeye were collected on all days sampled. Brown trout were caught in the bypass net for the first time in 2010. While draining the bypass channel on June 3, 2010 an adult shovelnose sturgeon was captured in the block net at lower 1/3 of bypass. This marked the first time a shovelnose was documented using the bypass channel. An angler caught and harvested this shovelnose sturgeon on June 12, 2010 just below the T&Y Diversion Dam. The bypass was not sampled in 2011. In 2012 at 41% of total catch channel catfish were the most abundant species sampled in the bypass. The channel catfish numbers were largely due to one days sampling of migrating adult fish, during our sampling period on May 31 224 of the 362 total channel catfish were sampled. Channel catfish, flathead chub, and goldeye were the most frequently observed species. Channel catfish, flathead chub and goldeye were collected on all days sampled. Bigmouth buffalo, northern pike and yellow bullhead were caught in the bypass net for the first time in 2012.

In 2010 weekly electrofishing of the Tongue River downstream of T&Y Diversion Dam collected 2613 fish from 21 species. Electrofishing occurred from June 2 through July 7. Electrofishing did not occur after this date. In 2012 electrofishing of the Tongue River downstream of T&Y Diversion Dam collected 1306 fish from 18 species. Electrofishing occurred from June 6 through June 19. River flows were inadequate to drift the electrofishing boat after these dates. Fish species and number caught per hour from electrofishing are provided in Appendix 3, Table 2 for 2010 and Appendix 3, Table 4 for 2012.

Comparison of bypass catch rates and weekly electrofishing samples downstream of T&Y Dam indicated that catch rates for electrofishing and bypass sampling followed a similar correlation (Figures 3 & 4). When river flow increased catch rates for both methods increased, when flows decreased catch rates for both methods decreased. Shovelnose sturgeon remain the only species observed in abundance below T&Y Diversion Dam during electrofishing that has not been observed in the bypass net or above the dam. In 2010 blue suckers were also observed in electrofishing but not in the bypass net. The Muggli Bypass channel was designed to pass shovelnose sturgeon. The successful passage of (# of species that have passed) other species but lack of documented shovelnose sturgeon passage is not fully understood. Multiple hypotheses include; 1) bypass channels are not an effective passage option for shovelnose sturgeon in the Tongue River 2) the steeper than designed lower third of the channel creates water velocities that preclude sturgeon passage 3) the current study design is not appropriate for documenting sturgeon passage.



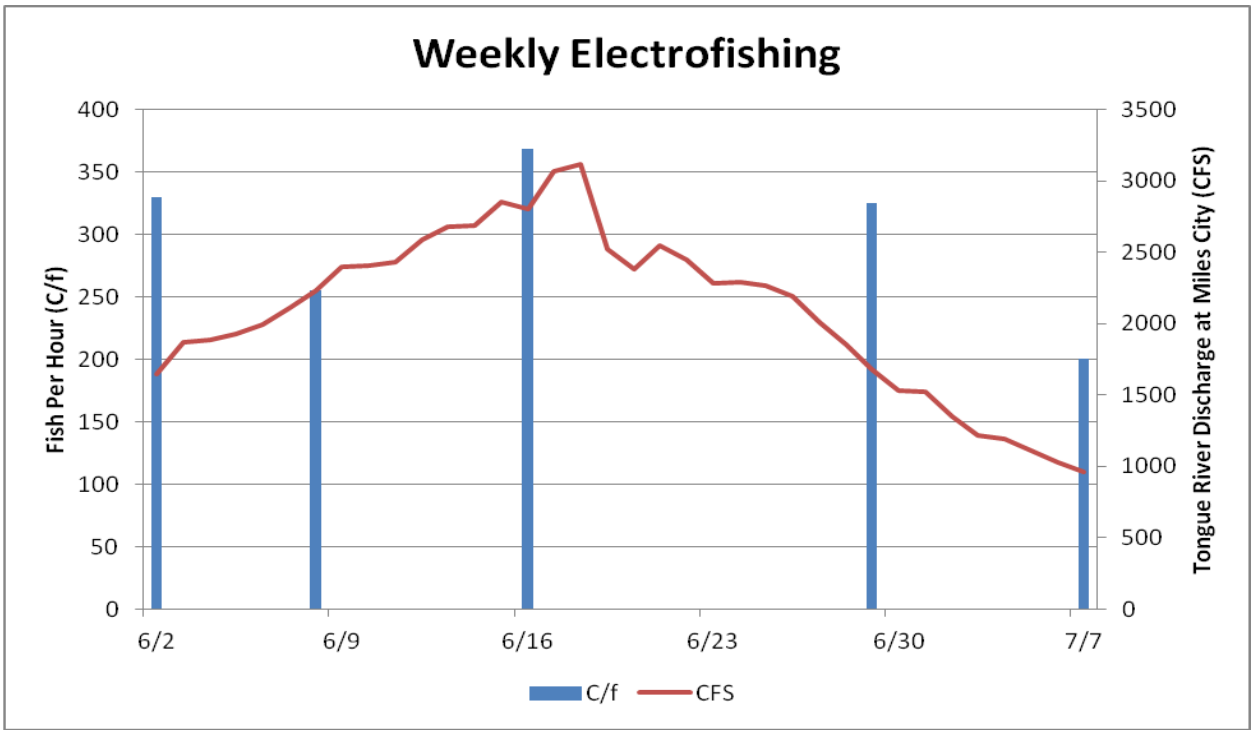
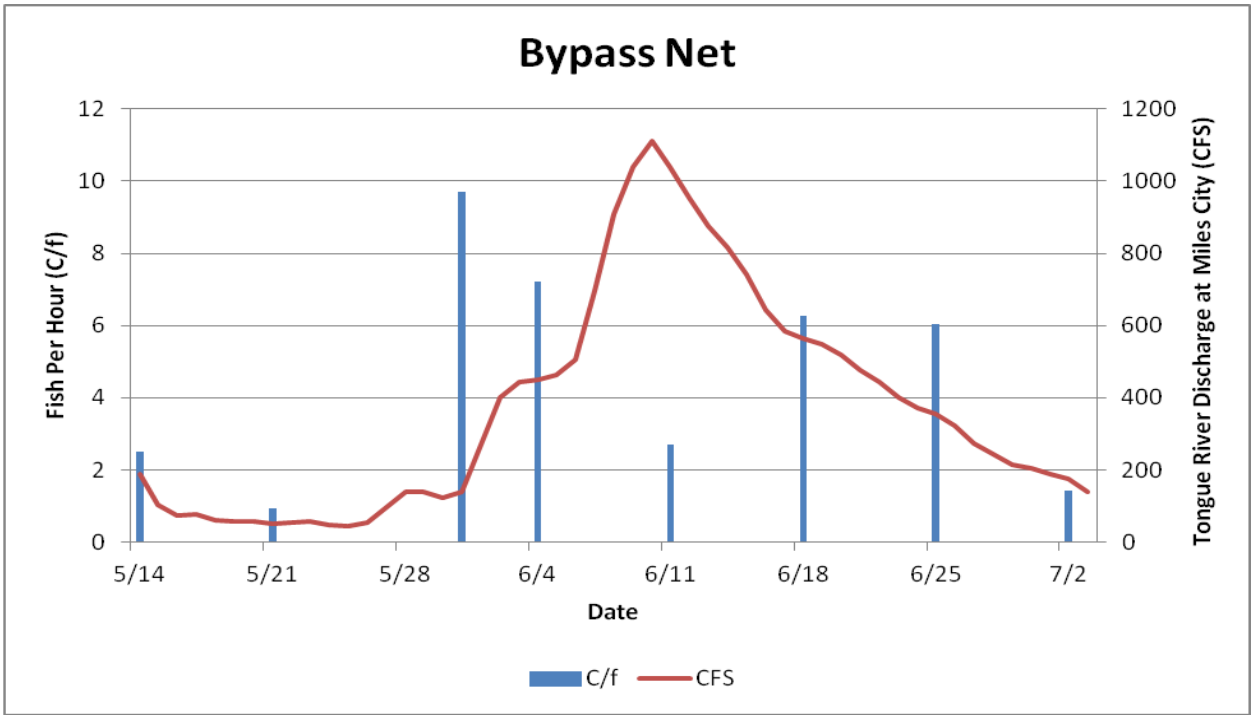


Figure 3. - Catch rates of the bypass channel net (top panel) and weekly electrofishing (bottom panel) for Tongue River compared against discharge of the Tongue River at Miles City, 2010.



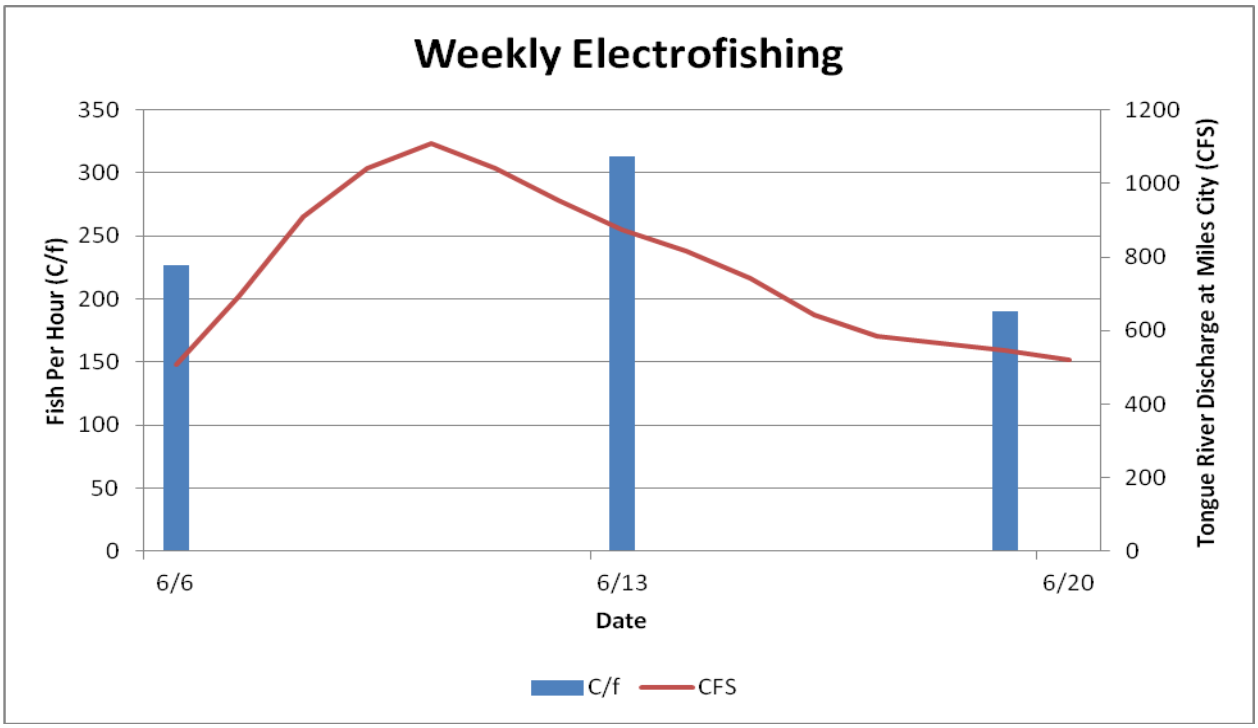


Figure 4. - Catch rates of the bypass channel net (top panel) and weekly electrofishing (bottom panel) for Tongue River compared against discharge of the Tongue River at Miles City, 2012.

DISCUSSION

There is currently no evidence to suggest that changes in irrigation or coal resource development activities are substantially affecting the Tongue River fish assemblage. The trend of increasing brown trout abundance is linked to discontinued annual plantings of rainbow trout planting from 2004 to 2010 reducing competition between the two species. Low sample sizes of minnow species preclude use for trend analysis. Mini-fyke nets may be implemented in the future to supplement our minnow species sampling size.

Results of this study must be viewed with some caution. The use of data combined from all trend sections and the variation inherent to prairie stream sampling will make detection of changes in fish populations difficult. Large sample sizes are needed to overcome the inherent variation in field data. Continued monitoring is recommended because of the potential for further increases in irrigation and mining activity.

The Muggli Bypass was successful in providing fish passage around T&Y Diversion Dam again in 2010 and 2012. One additional species, northern pike, was captured in the bypass fyke net. Relatively high numbers of northern pike were observed by anglers below T&Y Diversion Dam in the spring of 2012. The high numbers of northern pike below T&Y Diversion Dam may be, in part, due to high flows in 2011.

Despite the success of Muggli Bypass, improvements are needed to increase its effectiveness. Shovelnose sturgeon are the only species observed in abundance below the dam that have not been observed successfully navigating the bypass. This is a major concern because the bypass was designed specifically with intent to create shovelnose sturgeon passage. Water velocity is hypothesized to play a large role in preventing sturgeon from using the bypass. Water velocities in the lower third of the bypass were rarely below 7 ft/s during periods of high flow. Recommended water velocity for shovelnose sturgeon passage is between 3 and 4 ft/s (White and Medford 2002). The high water velocities in the bypass can be attributed to the steep gradient in the lower third of the bypass. Spacing of the boulders in the channel may also be a problem. Many of these boulders were placed with a gap of 8 to10 inches, which may be a barrier to the passage of large fish. The recommended boulder spacing is 24 inches (White and Medford 2002). The attraction velocities of 2 ft/s maintained from the bypass channel to the thalweg of the river were masked by turbulent flow of water flowing over T&Y Diversion Dam when discharge levels exceeded 800 cfs. During periods of high discharge fish may have difficulty finding the bypass fish entrance. To address velocity issues in the lower third of the bypass and the masking of attraction flows the channel was extended out into the river. Increasing the spacing between boulders should also be done.

Keywords:	Fish Passage, T&Y Dam, Coal Bed Methane, Tongue River Railroad, Tongue River Reservoir, Paddlefish, Shovelnose Sturgeon, Blue Suckers, Sauger
Prepared by:	Kevin P. McKoy
Date:	January 22, 2013

LITERATURE CITED

Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 477-482 *in* B.R. Murphy and D.W. Willis, editors. Fisheries Techniques. Second Edition. American Fisheries Society, Bethesda, Maryland USA.

Anderson, R. O., and A. S. Weithman. 1978. The concept of balance for coolwater fish populations. Pages 371–381 *in* R. L. Kendall, editor. Selected Coolwater Fishes of North America. American Fisheries Society, Special Publication 11, Bethesda, Maryland.

Bister, T. J., D. W. Willis, M. L. Brown, S. M. Jordon, R. M. Neumann, M. C. Quist, and C. S. Guy. 2000. Proposed standard weight (W_s) equations and standard length categories for 18 warmwater nongame and riverine fish species. North American Journal of Fisheries Management 20:570-574.

Blackwood, B. G., M. L. Brown, and D. W. Willis. 2002. Relative weight (W_r) status and current use in fisheries assessment and management. Reviews in Fisheries Science 8:1-44.

Brown, M. L., F. Jaramillo, Jr., D. M. Gatlin, III, and B. R. Murphy. 1995. A revised standard weight (Ws) equation for channel catfish. Journal of Freshwater Ecology 10:295-302.

Elser, A. A., R.C. McFarland and D. Schwehr 1977. The effects of altered streamflow on fish of the Yellowstone and Tongue Rivers, Montana. Yellowstone Impact Study. Technical Report No. 8. Water Resources Division. MT Dept. of Natural Resources and Conservation.

Fabrizio M. C., and R. A. Richards. 1996. Commericial fisheries surveys. Pages 625-650 *in* B.R. Murphy and D.W. Willis, editors. Fisheries Techniques. Second edition. American Fisheries Society, Bethesda, Maryland.

Gabelhouse, D. W. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Guy, C. S., R. M. Neumann, and D. W. Willis. 2006. New terminology for proportional stock density (PSD) and relative stock density (RSD): proportional size structure (PSS). Fisheries 31:86-87.

Guy, C. S., R. M. Neumann, D. W. Willis, and R. O. Anderson. 2007. Proportional size distribution (PSD): a further refinement of populations size structure index terminology. Fisheries 32:348

Hubert, W. A. 1996. Passive Capture Techniques. Pages 157-181 *in* B. R. Murphy and D. W. Willis, editors. Fisheries Techniques. Second edition. American Fisheries Society, Bethesda, Maryland.

Kolander, T. D., D. W. Willis, and B. R. Murphy. 1993. Proposed revision of the standard weight equation for smallmouth bass. North American Journal of Fisheries Management 13:398-400.

Milewski, C. L., and M. L. Brown. 1994. Proposed standard weight equation and length category standards for stream-dwelling brown trout. Journal of Freshwater Ecology 9:111-116.

Murphy, B. R., M. L. Brown, and T. A. Springer. 1990. Evaluation of the relative weight (Wr) index, with new applications to walleye. North American Journal of Fisheries Management 10-85-97.

Ney, J. J. 1996. Practical use of biological statistics. Pages 167-192 *in* C. C. Kohler and W. A. Hubert, editors. Inland Fisheries Management in North America. Second Edition. American Fisheries Society, Bethesda, Maryland.

USGS (United States Geological Services) 2012. Water Resources, Real-Time Data for Montana Report, United States Geological Services. http://waterdata.usgs.gov/mt/nwis/current/?type=flow

Wege, G. J., and R. O. Anderson. 1978. Relative weight (W_r); a new index of condition for largemouth bass. Pages 79-91 *in* G. D. Novinger and J. G. Dillard, editors. New Approaches to the Management of Small Impoundments. American Fisheries Society, Symposium 4, Bethesda, Maryland.

White, R.G., B. Mefford. 2002. Assessment of Behavior and Swimming Ability of Yellowstone River Sturgeon for Design of Fish Passage Devices. Unpublished Report. Joint Study by Montana State University in Bozeman, MT. and Bureau of Reclamation Water Resources Research Laboratory in Denver, CO.

Appendix 1.- Summary of Trend Sampling Data

Table 1. - Summary of Tongue River trend sampling sites and water quality data 2010.

	Section Number and Name					
	1 Miles City	**2 Hirsch**	**3 Brandenberg**	**4 Birney**	**5 TR Dam**	**6 State Line**
Date Sampled	7/20/2010	7/29/2010	7/28/2010	7/27/2010	7/26/2010	7/13/2010
Latitude Start	46.24504	46.04776	45.79156	45.29521	45.13530	44.99844
Longitude Start	105.75065	105.93979	106.26292	106.55942	106.77633	106.88072
Latitude Stop	46.30922	46.07293	45.82396	45.32077	45.17137	45.01210
Longitude Stop	105.76711	105.93435	106.23113	106.52109	106.72897	106.83141
River Mile Start/Stop	20-15	51-46	90-85	165-160	189-184	209-199
Water Temperature (Fahrenheit)	78.6	78.0	78.0	76.0	69.0	66.9
Specific Conductivity (mS/cm)	489	557	480	339	318	334
Salinity (ppt)	0.2	0.3	0.2	0.2	0.2	0.2
Turbidity (NTU)	203.0	18.6	18.3	6.6	6.5	23.1
pH	8.5	8.6	8.5	8.8	8.5	8.4
River Flow (cfs)	592	323	356	446	446	690

Appendix 1.- Summary of Trend Sampling Data

Table 2. - Summary of Tongue River trend sampling sites and water quality data 2012.

	Section Number and Name					
	1 Miles City	**2 Hirsch**	**3 Brandenberg**	**4 Birney**	**5 TR Dam**	**6 State Line**
Date Sampled	6/19/12	6/26/2012	6/27/12	5/25/12	5/23/12	5/18/12
Latitude Start	46.24504	46.04785	45.79156	45.30097	45.13826	44.99844
Longitude Start	105.75065	105.93961	106.26292	106.56568	106.76614	106.88072
Latitude Stop	46.30922	46.07306	45.82396	45.32077	45.17123	45.01210
Longitude Stop	105.76711	105.93441	106.23113	106.52109	106.73006	106.83141
River Mile Start/Stop	20-15	51-46	90-85	165-160	189-184	209-199
Water Temperature (Celsius)	24.3	28	22.1	13	16.7	15.8
Specific Conductivity (mS/cm)	646	630	600	695	640	348
Salinity (ppt)	0.3	0.3	0.3	0.3	0.3	0.2
Turbidity (cm)	13	27	32	60+	60+	20
pH	7.67	8.84	8.9	n/a	n/a	n/a
River Flow (cfs)	546	539	543	275	310	509

Appendix 1.

Table 3.-Summary of electrofishing data collected in 2010. Data is summarized by section.

Species	N	Catch/ Hour	Percent Catch	Length Mean (mm)	Length Range (mm)	Weight Mean (gm)	Weight Range (gm)
Section 1 Miles City (T&Y Dam - Yellowstone R.) - 138 minutes; 6 river miles							
channel catfish	38	16.5	11.1	328	191-735	539	60-4150
common carp	12	5.2	3.5	386	57-570	1109	160-2600
flathead chub	83	36.1	24.3	121	75-160	17	5-40
goldeye	31	13.5	9.1	326	293-361	241	160-380
longnose sucker	2	0.9	0.6	204	193-215	90	70-110
river carpsucker	6	2.6	1.8	320	270-393	467	210-960
sand shiner	3	1.3	0.9	59	53-63	---	---
sauger	2	0.9	0.6	405	361-448	550	350-750
shorthead redhorse sucker	132	57.4	38.7	240	147-343	157	40-410
smallmouth bass	4	1.7	1.2	262	200-297	233	120-300
stonecat	6	2.6	1.8	122	67-167	26	10-50
sturgeon chub	1	0.4	0.3	83	83-83	5	5-5
walleye	1	0.4	0.3	280	280-280	180	180-180
western silvery minnow	11	4.8	3.2	94	62-113	9	5-20
white sucker	9	3.9	2.6	285	170-364	287	60-560
subtotal	341	148.3					
Section 2 (Hirsch) - 128 minutes; 6 river miles							
channel catfish	37	17.3	9.9	302	206-670	378	60-3330
common carp	28	13.1	7.5	464	320-683	1300	400-4200
flathead chub	24	11.3	6.4	128	84-220	26	5-110
goldeye	29	13.6	7.7	331	298-360	250	160-340
longnose sucker	2	0.9	0.5	161	139-183	40	20-60
river carpsucker	15	7.0	4.0	287	249-331	285	180-420
rock bass	1	0.5	0.3	164	164-164	110	110-110
shorthead redhorse sucker	212	99.4	56.5	250	160-315	162	60-280
smallmouth bass	17	8.0	4.5	270	212-391	260	70-880
stonecat	2	0.9	0.5	155	152-158	25	20-30
sturgeon chub	1	0.5	0.3	98	98-98	5	5-5
white sucker	7	3.3	1.9	309	282-345	324	240-420
subtotal	375	175.8					

Appendix 1.

Table 3.-Summary of electrofishing data collected in 2010. Data is summarized by section (continued).

Species	N	Catch/ Hour	Percent Catch	Length Mean (mm)	Length Range (mm)	Weight Mean (gm)	Weight Range (gm)
Section 3 (Brandenberg) - 139 minutes; 6 river miles							
channel catfish	43	18.6	10.5	319	211-659	367	70-3220
common carp	26	11.2	6.4	432	210-525	1052	160-1640
goldeye	23	9.9	5.6	338	309-362	292	220-380
river carpsucker	7	3.0	1.7	282	263-302	283	220-340
rock bass	2	0.9	0.5	167	156-178	120	100-140
sauger	1	0.4	0.2	410	410-410	580	580-580
shorthead redhorse sucker	227	98.0	55.6	285	170-389	240	60-520
smallmouth bass	27	11.7	6.6	252	191-351	228	100-540
walleye	2	0.9	0.5	408	380-436	710	540-880
western silvery minnow	1	0.4	0.2	153	153-153	40	40-40
white sucker	46	19.9	11.3	315	239-385	347	150-580
yellow bullhead	3	1.3	0.7	202	186-225	127	100-150
subtotal	408	176.1					
Section 4 (Birney) - 139 minutes; 6 river miles							
black crappie	1	0.4	0.2	242	242-242	240	240-240
channel catfish	22	9.5	4.0	464	320-667	1321	360-3130
common carp	33	14.2	6.0	586	376-785	2878	740-6600
goldeye	35	15.1	6.4	336	295-375	317	240-490
green sunfish	2	0.9	0.4	103	70-135	33	5-60
longnose sucker	1	0.4	0.2	432	432-432	860	860-860
pumpkinseed	1	0.4	0.2	98	98-98	20	20-20
river carpsucker	35	15.1	6.4	365	277-463	658	260-1300
rock bass	10	4.3	1.8	173	151-205	119	70-180
shorthead redhorse sucker	225	97.1	41.2	399	222-471	659	140-1080
smallmouth bass	114	49.2	20.9	195	93-452	122	5-1240
stonecat	3	1.3	0.5	162	151-170	43	30-60
white sucker	64	27.6	11.7	278	122-480	373	20-1120
subtotal	546	235.7					

Appendix 1.

Table 3.-Summary of electrofishing data collected in 2010. Data is summarized by section (continued).

Species	N	Catch/ Hour	Percent Catch	Length Mean (mm)	Length Range (mm)	Weight Mean (gm)	Weight Range (gm)
Section 5 (Tongue River Dam) - 138 minutes; 6 river miles							
black bullhead	2	0.9	0.5	212.5	162-263	180.00	60-300
brown trout	13	5.7	3.0	283.1	92-432	339.62	5-960
channel catfish	66	28.7	15.0	512	263-645	1812	160-4300
common carp	72	31.3	16.4	596	496-710	3058	1950-5000
goldeye	12	5.2	2.7	346	316-370	326	230-400
longnose sucker	8	3.5	1.8	404	244-482	848	180-1360
rainbow trout	1	0.4	0.2	550	550-550	1800	1800-1800
river carpsucker	70	30.4	15.9	422	356-468	970	660-1350
shorthead redhorse sucker	78	33.9	17.8	447	331-517	1078	400-1570
smallmouth bass	25	10.9	5.7	248	85-378	240	5-800
stonecat	1	0.4	0.2	168	168-168	60	60-60
walleye	1	0.4	0.2	207	207-207	80	80-80
white sucker	90	39.1	20.5	330	125-465	606	20-1250
subtotal	439	190.9					
Section 6 (Stateline) - 208 minutes; 10 river miles							
black bullhead	1	0.3	0.2	215	215-215	160	160-160
black crappie	1	0.3	0.2	246	246-246	230	230-230
brown trout	1	0.3	0.2	287	287-287	230	230-230
channel catfish	4	1.2	0.6	628	468-720	3020	1060-4200
common carp	74	21.3	11.5	550	508-611	2150	1520-3260
flathead chub	1	0.3	0.2	182	182-182	70	70-70
longnose sucker	4	1.2	0.6	297	163-454	440	40-1160
rock bass	5	1.4	0.8	141	82-165	72	10-100
sauger	1	0.3	0.2	345	345-345	340	340-340
shorthead redhorse sucker	189	54.5	29.4	384	74-490	717	5-1350
smallmouth bass	134	38.7	20.8	196	75-430	134	10-1100
spottail shiner	23	6.6	3.6	86	46-106	---	---
stonecat	2	0.6	0.3	150	145-155	35	30-40
walleye	1	0.3	0.2	190	190-190	50	50-50
white crappie	1	0.3	0.2	151	151-151	40	40-40
white sucker	198	57.1	30.8	180	88-460	179	5-1230
yellow bullhead	3	0.9	0.5	219	210-230	160	150-180
subtotal	643	185.5					

Appendix 1.

Table 4.-Summary of electrofishing data collected in 2012. Data is summarized by section.

Species	N	Catch/ Hour	Percent Catch	Length Mean (mm)	Length Range (mm)	Weight Mean (gm)	Weight Range (gm)
Section 1 Miles City (T&Y Dam - Yellowstone R.) - 117 minutes; 6 river miles							
channel catfish	12	6.2	3.4	385	294-604	665	180-2320
common carp	10	5.1	2.8	445	276-605	1286	330-3020
emerald shiner	2	1.0	0.6	58	55-60		
flathead chub	26	13.3	7.4	146	104-201	36	10-80
freshwater drum	2	1.0	0.6	381	380-382	685	610-760
goldeye	18	9.2	5.1	323	226-360	279	180-330
longnose dace	3	1.5	0.9	80	68-96	7	5-10
longnose sucker	1	0.5	0.3	315	315	360	360
northern pike	2	1.0	0.6	603	593-613	1105	1100-1110
river carpsucker	83	42.6	23.6	386	296-550	800	330-2220
sauger	2	1.0	0.6	241	213-268	115	80-150
shorthead redhorse sucker	125	64.1	35.6	288	181-383	274	70-620
shovelnose sturgeon	5	2.6	1.4	822	775-937	2982	2180-5300
smallmouth bass	1	0.5	0.3	203	203	110	110
stonecat	2	1.0	0.6	119	115-123	13	5-20
walleye	5	2.6	1.4	374	256-522	608	140-1300
western silvery minnow	43	22.1	12.3	138	90-185	31	5-70
white sucker	9	4.6	2.6	318	252-388	379	150-660
subtotal	351	180.0					
Section 2 (Hirsch) - 90 minutes; 6 river miles							
channel catfish	7	4.7	3.0	378	265-471	511	160-960
common carp	15	10.0	6.5	444	249-545	1360	240-2440
flathead chub	24	16.0	10.4	145	90-187	34	10-60
goldeye	14	9.3	6.1	334	310-368	289	240-380
northern pike	1	0.7	0.4	733	733	2100	2100
river carpsucker	17	11.3	7.4	313	273-368	407	280-640
sauger	1	0.7	0.4	261	261	160	160
shorthead redhorse sucker	128	85.3	55.7	300	172-354	297	80-460
smallmouth bass	4	2.7	1.7	297	229-362	395	180-600
western silvery/plains minnow	6	4.0	2.6	124	100-142	22	10-40
white sucker	13	8.7	5.7	282	215-335	255	100-440
subtotal	230	153.3					

Appendix 1.

Table 4.-Summary of electrofishing data collected in 2012. Data is summarized by section (continued).

Species	N	Catch/ Hour	Percent Catch	Length Mean (mm)	Length Range (mm)	Weight Mean (gm)	Weight Range (gm)
Section 3 (Brandenberg) - 109 minutes; 6 river miles							
channel catfish	4	2.2	1.1	468	410-550	825	560-1300
common carp	19	10.5	5.4	465	325-608	1438	480-2800
flathead chub	1	0.6	0.3	191	191	80	80
goldeye	8	4.4	2.3	361	330-380	390	300-440
longnose sucker	1	0.6	0.3	175	175	60	60
river carpsucker	13	7.2	3.7	322	276-392	468	320-900
Sauger	1	0.6	0.3	224	224	80	80
shorthead redhorse sucker	239	131.6	68.5	306	161-390	317	40-500
smallmouth bass	10	5.5	2.9	213	122-352	211	20-600
walleye	2	1.1	0.6	478	464-491	1140	1060-1220
white sucker	51	28.1	14.6	328	251-387	403	160-580
subtotal	349	192.1					
Section 4 (Birney) - 103 minutes; 6 river miles							
channel catfish	76	44.3	11.7	489	295-671	1445	230-3840
common carp	31	18.1	4.8	613	360-732	3315	670-5850
goldeye	57	33.2	8.8	348	321-375	380	300-540
longnose sucker	2	1.2	0.3	489	465-512	1335	1050-1620
river carpsucker	33	19.2	5.1	377	323-446	748	420-1080
rock bass	4	2.3	0.6	160	131-203	102	40-200
shorthead redhorse sucker	293	170.7	45.0	414	321-473	754	380-1180
smallmouth bass	45	26.2	6.9	239	146-376	230	40-750
stonecat	2	1.2	0.3	158	154-162	40	40
walleye	2	1.2	0.3	574	460-687	2330	940-3720
white sucker	102	59.4	15.7	363	209-479	619	150-1300
subtotal	651	379.2					

Appendix 1.

Table 4.-Summary of electrofishing data collected in 2012. Data is summarized by section (continued).

Species	N	Catch/ Hour	Percent Catch	Length Mean (mm)	Length Range (mm)	Weight Mean (gm)	Weight Range (gm)
Section 5 (Tongue River Dam) - 106 minutes; 6 river miles							
brown trout	22	12.5	5.9	358	180-505	745	60-1980
channel catfish	74	41.9	19.8	565	384-793	2012	420-6015
common carp	88	49.8	23.6	508	274-686	2270	300-5450
longnose sucker	3	1.7	0.8	285	158-405	390	40-800
rainbow trout	31	17.5	8.3	304	233-408	476	150-1040
river carpsucker	11	6.2	2.9	410	328-482	979	500-1410
shorthead redhorse sucker	52	29.4	13.9	450	396-527	1135	700-1840
smallmouth bass	9	5.1	2.4	222	155-326	179	40-520
stonecat	3	1.7	0.8	192	157-224	93	40-140
walleye	2	1.1	0.5	298	277-318	245	200-290
white sucker	77	43.6	20.6	378	135-472	844	20-1380
yellow perch	1	0.6	0.3	140	140	20	20
subtotal	373	211.1					
Section 6 (Stateline) - 184 minutes; 10 river miles							
brown trout	9	2.9	2.6	265	189-317	229	80-340
channel catfish	1	0.3	0.3	818	818	6400	6400
common carp	40	13.0	11.4	586	484-669	2904	1700-4300
longnose dace	1	0.3	0.3	70	70	---	---
longnose sucker	9	2.9	2.6	255	205-304	233	120-380
mountain sucker	1	0.3	0.3	130	130	40	40
rainbow trout	1	0.3	0.3	200	200	80	80
rock bass	2	0.7	0.6	147	122-172	85	40-130
sauger	5	1.6	1.4	280	117-645	722	40-3400
shorthead redhorse sucker	112	36.5	32.0	436	192-540	1011	100-1640
smallmouth bass	17	5.5	4.9	218	125-334	176	20-500
spottail shiner	42	13.7	12.0	97	60-130	18	10-20
walleye	11	3.6	3.1	299	170-556	557	40-1900
white sucker	99	32.3	28.3	278	74-486	371	70-1400
subtotal	350	114.1					

Appendix 2

Summary of proportional size distribution and mean relative weight analysis for the Tongue River trend sampling. Values were calculated using data from combined all six trend sections.

		Size Distribution					Body Condition				
Year	N	PSD_{S-Q}	PSD_{Q-P}	PSD_{P-M}	PSD_{M-T}	PSD_{T}	W_rS-Q	W_rQ-P	W_rP-M	W_rM-T	W_rT
						Brown Trout					
2003	2	0	50	0	50	0	---	112	---	97	---
2004	0	---	---	---	---	---	---	---	---	---	---
2005	3	67	33	0	0	0	105	119	---	---	---
2006	10	50	20	30	0	0	97	91	128	---	---
2007	3	67	0	0	33	0	81	---	---	52	---
2008	10	0	22	11	56	11	---	82	176	129	123
2009	7	0	67	14	17	0	---	129	127	189	---
2010	14	0	77	8	15	0	---	107	117	116	---
2012	31	23	10	39	16	13	113	112	120	127	129
						Channel Catfish					
2003	215	29	50	19	3	0	96	95	88	126	96
2004	177	24	61	1	13	0	89	108	93	103	---
2005	341	42	54	4	0	0	94	101	89	---	---
2006	118	16	79	5	0	0	95	106	96	---	---
2007	472	29	35	29	7	0	92	96	100	102	---
2008	124	39	48	11	3	0	96	114	99	96	---
2009	191	41	48	10	1	0	95	110	110	99	---
2010	210	37	55	6	2	0	102	120	110	95	---
2012	197	16	63	20	1	0	104	104	106	105	---
						Northern Pike					
2003	0	---	---	---	---	---	---	---	---	---	---
2004	0	---	---	---	---	---	---	---	---	---	---
2005	1	0	0	100	0	0	---	---	96	---	---
2006	0	---	---	---	---	---	---	---	---	---	---
2007	1	0	0	100	0	0	---	---	95	---	---
2008	1	0	0	0	100	0	---	---	---	103	---
2009	0	---	---	---	---	---	---	---	---	---	---
2010	0	---	---	---	---	---	---	---	---	---	---
2012	3	0	67	33	0	0	---	75	77	---	---
						Rainbow Trout					
2003	43	71	24	5	0	0	133	113	106	---	---
2004	58	83	17	0	0	0	123	106	---	---	---
2005	29	41	59	0	0	0	109	108	---	---	---
2006	9	89	11	0	0	0	113	96	---	---	---
2007	0	0	0	0	0	0	---	---	---	---	---
2008	8	0	50	50	0	0	---	81	94	---	---
2009	2	0	100	0	0	0	---	104	---	---	---
2010	1	0	0	100	0	0	---	---	98	---	---
2012	42	92	8	0	0	0	136	139	---	---	---

Appendix 2. - Continued

		Size Distribution					Body Condition				
Year	N	PSD_{S-Q}	PSD_{Q-P}	PSD_{P-M}	PSD_{M-T}	PSD_T	W_rS-Q	W_rQ-P	W_rP-M	W_rM-T	W_rT
						River Carpsucker					
2003	154	5	24	57	6	0	88	81	93	93	---
2004	120	3	43	51	4	0	182	87	97	88	---
2005	174	8	19	61	12	0	86	83	93	87	---
2006	39	19	30	51	0	0	96	92	98	---	---
2007	1602	6	20	61	13	1	92	93	98	98	83
2008	144	30	33	35	1	0	84	89	95	85	---
2009	144	16	30	52	3	0	85	85	93	94	---
2010	133	15	33	46	5	0	89	91	93	87	---
2012	168	1	49	45	5	0	99	96	97	99	---
						Sauger					
2003	5	20	40	40	0	0	97	88	91	---	---
2004	8	13	0	38	50	0	46	---	86	101	---
2005	9	13	50	25	13	0	63	82	79	67	---
2006	8	0	25	75	0	0	---	83	88	---	---
2007	58	29	43	26	2	0	84	86	83	98	---
2008	2	0	0	100	0	0	---	---	99	---	---
2009	8	0	29	57	14	0	---	71	86	94	---
2010	4	0	50	50	0	0	---	87	90	---	---
2012	8	80	0	0	0	20	96	---	---	---	128
						Shorthead Redhorse Sucker					
2003	249	16	61	23	0	0	85	81	78	---	---
2004	877	8	24	31	37	1	75	88	89	93	76
2005	1080	16	9	40	34	0	84	85	87	89	80
2006	431	27	8	30	34	0	94	86	95	94	94
2007	644	19	17	33	6	0	103	90	94	99	56
2008	932	38	24	13	26	0	81	88	93	97	100
2009	798	32	23	15	30	1	89	85	97	97	94
2010	1063	22	29	16	32	0	79	70	76	79	82
2012	895	9	33	17	40	2	84	75	75	83	79
						Smallmouth Bass					
2003	149	81	15	4	0	0	104	89	79	---	---
2004	143	83	14	3	0	0	91	96	74	---	---
2005	264	87	11	2	1	0	87	80	105	67	93
2006	277	88	8	3	1	0	92	85	93	11	---
2007	112	42	49	9	0	0	89	97	102	---	---
2008	304	87	11	2	1	0	94	87	53	86	---
2009	262	85	10	2	3	0	93	92	82	92	---
2010	321	82	13	4	1	0	92	90	79	87	---
2012	81	73	20	8	0	0	105	91	85	---	---

Appendix 2. – Continued

		Size Distribution					Body Condition				
Year	N	PSD_{S-Q}	PSD_{Q-P}	PSD_{P-M}	PSD_{M-T}	PSD_T	W_rS-Q	W_rQ-P	W_rP-M	W_rM-T	W_rT
						Walleye					
2003	4	0	50	25	25	0	---	99	112	100	---
2004	1	---	---	---	---	---	---	---	---	---	---
2005	7	17	50	33	0	0	82	85	91	---	---
2006	1	---	---	---	---	---	---	---	---	---	---
2007	55	15	67	17	0	0	92	91	96	---	---
2008	8	43	29	14	14	0	87	148	94	80	---
2009	7	83	17	0	0	0	91	88	---	---	---
2010	5	33	67	0	0	0	84	98	---	---	---
2012	23	33	40	20	7	0	93	97	94	100	---
						White Sucker					
2003	258	39	35	23	3	0	94	89	98	84	---
2004	354	37	12	36	14	0	99	97	99	103	---
2005	127	26	12	38	25	0	84	84	96	97	---
2006	127	46	34	20	0	0	87	102	99	---	---
2007	231	38	47	13	6	0	98	88	85	91	---
2008	243	25	31	26	17	1	94	93	99	101	27
2009	253	21	29	30	22	0	109	87	97	102	---
2010	414	19	31	35	15	0	89	90	95	97	---
2012	361	18	31	27	25	0	100	97	97	100	---

Appendix 3. Fish passage data, 2010.

Table 1. - Summary of fish sampled from the fyke net at Muggli Bypass.

Species	5/12	5/19	5/27	6/1	6/7	6/15	6/22	6/28	7/6	7/12	7/19	Total	%	Avg/ day	Days Found
Black Bullhead				1								1	0.07	1.0	1
Brown Trout *			1	1								2	0.14	1.0	2
Channel Catfish	1		4	2	2	3	4	1	3	9	25	54	3.76	5.4	10
Common Carp			1			3	3	1			1	9	0.63	1.8	5
Flathead Chub	2	42	27	51	39	5	28	28	10	9	2	243	16.90	22.1	11
Freshwater Drum										2	2	4	0.28	2.0	2
Goldeye	4	1	3	74	241	31	21	20	2	25	30	452	31.43	41.1	11
Green Sunfish	9		1					1		1		12	0.83	3.0	4
Longnose Sucker	1											1	0.07	1.0	1
River Carpsucker	1			3	3	2	23	15	2	5		54	3.76	6.8	8
Rock Bass				1			1					2	0.14	1.0	2
Sauger									1		4	5	0.35	2.5	2
Shorthead Redhorse Sucker	7	1	5	3	5	6	2		1	1	3	34	2.36	3.4	10
Smallmouth Bass	1					1		1				3	0.21	1.0	3
Stonecat		5	29	12	1		18	1	1	8	2	77	5.35	8.6	9
Walleye				1				1				2	0.14	1.0	2
Western Silvery Minnow	29	35	168	88	2	2	115	24		4		467	32.48	51.9	9
White Crappie										1		1	0.07	1.0	1
White Sucker	1		1				1		1	1		5	0.35	1.0	5
Yellow Bullhead			7				3					10	0.70	5.0	2
Total	56	84	247	237	293	53	219	93	21	66	69	1438		130.7	
Hours Sampled	23.55	22.23	21.92	22.77	21.55	21.28	21.57	22.83	23.9	22.8	23.2				
Fish per Hour - combined	2.38	3.78	11.27	10.41	13.60	2.49	10.15	4.07	0.88	2.89	2.98				
fish per hour - minus wsm	1.06	0.31	2.37	4.30	11.69	2.16	3.52	1.80	0.46	2.32	2.89				
Flow- Miles City (cfs)	321	351	3300	1170	2020	2820	2280	1880	1030	808	627				
Water Temp - Avg (C)	13.1	20.3	17.1	17.4	18.4	19.6	19.8	22.1	21.2	21.6	23.1				
Turbidity (NTU)	43	82.7	---	174	272	233	290	126	71.8	64.4	64.6				

* first time caught in bypass net

Appendix 3. Fish passage data, 2010.

Table 2. - Summary of fish sampled during weekly electrofishing below T & Y Dam.

Species	6/2	6/8	6/16	6/29	7/7	Total	%	Avg/ day	Days Found
Bigmouth Buffalo *	5	1	10	3		19	0.73	3.8	4
Blue Sucker *			5	7	2	14	0.54	2.8	3
Brown Trout	1	1				2	0.08	0.4	2
Channel Catfish	8	20	8	8	27	71	2.72	14.2	5
Common Carp	7	7	4	15	10	43	1.65	8.6	5
Emerald Shiner			1			1	0.04	0.2	1
Flathead Chub	6	21	9	20	24	80	3.06	16.0	5
Freshwater Drum	1					1	0.04	0.2	1
Goldeye	228	201	261	104	64	858	32.84	171.6	5
Longnose Sucker		1	3	2		6	0.23	1.2	3
Northern Pike *					1	1	0.04	0.2	1
River Carpsucker	215	132	259	289	108	1003	38.38	200.6	5
Rock Bass				1		1	0.04	0.2	1
Sauger	1		2	2	4	9	0.34	1.8	4
Shorthead Redhorse Sucker	106	69	48	74	101	398	15.23	79.6	5
Smallmouth Bass	3	8		2	4	17	0.65	3.4	4
Shovelnose Sturgeon *	12	5	5	16	4	42	1.61	8.4	5
Stonecat		4	1	2		7	0.27	1.4	3
Walleye	1			1		2	0.08	0.4	2
Western Silvery Minnow		2		13		15	0.57	3.0	2
White Sucker	7	3		4	9	23	0.88	4.6	4
Total	601	475	616	563	358	2613		522.6	
Hours Sampled	1.82194	1.86361	1.67333	1.73138	1.78166				
Fish per Hour - combined	329.8682	254.8817	368.1282	325.1741	200.9362				
Flow- Miles City (cfs)	1750	2110	2780	1750	958				
Water Temp - Avg (C)	19.3	17.7	19.6	23.9	20				
Turbidity (NTU)	412	293	233	140	207				

* Not caught in bypass net

Appendix 3. Fish passage data, 2012.

Table 3. - Summary of fish sampled from the fyke net at Muggli Bypass.

Species	5/14	5/21	5/31	6/4	6/11	6/18	6/25	7/2	Total	%	Avg/ day	Days Found
Bigmouth Buffalo *						2			2	0.22	2.0	1
Channel Catfish	2	1	224	18	13	44	55	5	362	40.63	45.3	8
Common Carp	2			1	1	2	2		8	0.90	1.6	5
Flathead Chub	33	5	12	32	13	4	16	7	122	13.69	15.3	8
Freshwater Drum							1	2	3	0.34	1.5	2
Goldeye	1	5	3	18	11	35	28	4	105	11.78	13.1	8
Green Sunfish	1	1		4		1	10	3	20	2.24	3.3	6
Longnose Sucker	1					1			2	0.22	1.0	2
Northern Pike *				3		2			5	0.56	2.5	2
River Carpsucker			4	1	1	16	2		24	2.69	4.8	5
Sauger		1			2	1	4		8	0.90	2.0	4
Shorthead Redhorse Sucker	3		14	4	5	13	1	4	44	4.94	6.3	7
Smallmouth Bass					3	3	3		9	1.01	3.0	3
Stonecat	3	8		4	2			3	20	2.24	4.0	5
Walleye	3	1		1	3	2			10	1.12	2.0	5
Western Silvery Minnow	4		8	73	2	9	15	4	115	12.91	16.4	7
White Crappie							1		1	0.11	1.0	1
White Sucker	6		1		4	12	3	2	28	3.14	4.7	6
Yellow Bullhead							2		2	0.22	2.0	1
Yellow Perch				1					1	0.11	1.0	1
Total	59	22	266	160	60	147	143	34	891		111.4	
Hours Sampled	23.58	23.73	27.45	22.21	22.33	23.48	23.68	23.88				
Fish per Hour - combined	2.50	0.93	9.69	7.20	2.69	6.26	6.04	1.42				
fish per hour - minus wsm	0.93	0.72	8.96	2.48	2.02	5.71	4.73	0.96				
Flow- Miles City (cfs)	200	46	136	441	1040	576	361	194				
Water Temp - Avg (C)	18.6	20.1	20.1	22.5	16.5	19.4	23.9	23				
Turbidity (NTU)	22	30	36.5	63	186.5	80	42	37.5				

* first time caught in bypass net

Appendix 3. Fish passage data, 2012.

Table 4. - Summary of fish sampled during weekly electrofishing below T & Y Dam.

Species	6/6	6/13	6/19	Total	%	Avg/ day	Days Found
Channel Catfish	10	4	12	26	1.99	8.7	3
Common Carp	11	5	10	26	1.99	8.7	3
Emerald Shiner *	1		2	3	0.23	1.0	2
Flathead Chub	56	20	29	105	8.04	35.0	3
Freshwater Drum		1	2	3	0.23	1.0	2
Goldeye	26	17	21	64	4.90	21.3	3
Longnose Dace *			3	3	0.23	1.0	1
Longnose Sucker		1	1	2	0.15	0.7	2
Northern Pike		1	2	3	0.23	1.0	2
River Carpsucker	173	295	87	555	42.50	185.0	3
Sauger	4	2	2	8	0.61	2.7	3
Shorthead Redhorse Sucker	131	145	129	405	31.01	135.0	3
Smallmouth Bass			1	1	0.08	0.3	1
Shovelnose Sturgeon *		3	5	8	0.61	2.7	2
Stonecat			2	2	0.15	0.7	1
Walleye	4	1	5	10	0.77	3.3	3
Western Silvery/Plains Minnow	13		48	61	4.67	20.3	2
White Sucker	7	4	10	21	1.61	7.0	3
Total	436	499	371	1306		435.3	
Hours Sampled	1.91916	1.59266	1.95216				
Fish per Hour - combined	227.183	313.312	190.046				
Flow- Miles City (cfs)	505	633	546				
Water Temp - Avg (C)	22.9	20.1	24.3				
Turbidity (NTU)	60	135	75				

* Not caught in bypass net