Fisheries Division
Federal Aid Job Progress Report

Montana Statewide Fisheries Management

Federal Aid Project Number: F-113

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Project Title: Montana Statewide Fisheries Management

Job Title: Southeastern Montana Warmwater Streams Investigations

Abstract: The Lower Yellowstone River fish assemblage has been sampled annually since 1998 with a suite of gears including boat-mounted electrofishing equipment, trammel nets, and trot lines. The Lower Yellowstone River was assigned trend areas consisting of five different locations that would be sampled annually: Forsyth (downstream of Cartersville Diversion), Miles City (above and below the Tongue River confluence), Fallon (above and below the O' Fallon Creek confluence), Intake (downstream of Intake Diversion) and since 2003, Hysham (downstream of Rancher diversion). Trend areas are approximately 9.6 river km in length and are sampled by means of single pass electrofishing in August, September and October. In addition, pallid sturgeon targeted sampling and telemetry took place from April to September. All species encountered are collected, enumerated, measured, and (except cyprinids) weighed. An

index of abundance (catch per effort) was calculated for all species captured.

Catch per effort was calculated by trend section for sauger, channel catfish, smallmouth bass, walleye, and northern pike. Indices of population structure (incremental relative stock density) and condition (relative weight) were calculated for sauger, channel catfish, smallmouth bass, shovelnose sturgeon, burbot, and walleye. Pallid sturgeon catch per effort was calculated to compare yearly catch trends as well as to compare catch between sites. Movements of a single, juvenile pallid sturgeon above Intake Diversion Dam were tracked using radio telemetry. Environmental conditions have varied widely during the study period; average flows occurred during 1998 and 1999, drought conditions and low flows occurred during 2000 to 2007 and average to above average flows returned in 2008 to 2010. Record high flows of 2011 were followed with below average flows in 2012 and 2013. It appears the fish assemblage has responded well to recent average/above average flows since 2008. Since 1998, 43 different species have been captured and abundances of commonly collected species from all trophic guilds have displayed stable or increased catch rate trends. Catch rates of multiple species including sauger and catfish have been above average in recent years. Angling opportunities currently exist for sauger, channel catfish, smallmouth bass, and shovelnose sturgeon.

STUDY AREA

The study area consists of the 473 km of the Yellowstone River downstream of the Big Horn River confluence (Figure 1). Mean annual discharge at the USGS gauging station in Miles City, Montana, is 11,389 cubic feet per second (cfs) and mean annual peak discharge is 19,780 cfs (Figure 2). River geomorphology varies throughout the study area in direct response to valley geology; straight, sinuous, braided, and irregular-meander channel patterns occur (Silverman and Tomlinsen 1984). The channel is often braided or split and long side channels are common. Islands and bars range from large vegetated islands to unvegetated point and mid-channel bars (White and Bramblett 1993). Substrate is primarily gravel and cobble upstream of river kilometer 50 and is primarily fines and sand below (Bramblett and White 2001).

The fish assemblage is comprised of 49 species from 15 families, including eight state-listed Species of Special Concern and one federally listed endangered species (White and Bramblett 1993; Carlson 2003). The primary deleterious anthropogenic effects on the fish assemblage are associated with water withdrawal for agriculture and associated entrainment of fish (White and Bramblett 1993). About 90% of all water use on the Yellowstone River is for irrigation, which corresponds to annual use of 1.5 million acre-feet (White and Bramblett 1993). Six mainstem low-head irrigation diversions dams occur in the study area. The largest and downstream-most of these, Intake Diversion, diverts about 1374 cfs at peak water demands and historically entrained about 600,000 fish of 34 species during the mid-May to mid-September irrigation season (Hiebert et al. 2000).

Intake Diversion Dam impedes fish movement and migration. Some species display limited seasonal passage ability while the dam acts as a complete barrier to other species most notably preventing the upstream migration of endangered pallid sturgeon. The pallid sturgeon was listed as an endangered species in 1990. The listing of the species initiated efforts to prevent entrainment and create passage at Intake Diversion. The Bureau of Reclamation (BOR) owns the diversion dam and canal structure; however, the Water Resources Development Act of 2007 SEC. 3109. LOWER YELLOWSTONE PROJECT, MONTANA stated, “The Secretary may use funds appropriated to carry out

the Missouri River recovery and mitigation program to assist the Bureau of Reclamation in the design and construction of the Lower Yellowstone project of the Bureau, Intake, Montana, for the purpose of ecosystem restoration" thereby the US Army Corps of Engineers (Corps) has funded recovery efforts. Construction of a new screened headworks structure to prevent entrainment was completed in 2012. Screens were designed to prevent the entrainment of fishes greater than 40mm total length. Restoration efforts to create fish passage at Intake Diversion Dam are ongoing. The Corps had identified a bypass channel design as their preferred action in an attempt to improve passage for endangered pallid sturgeon and other native fish in the lower Yellowstone River (Corps 2014). They primary feature of this design would be the construction of a bypass channel from the upper end of the existing, natural side channel, to just downstream of the existing diversion dam and associated rubble field. By locating the fish entrance to the bypass channel at the downstream end of the dam, fish are thought to be more likely to find the bypass channel and utilize it in their movement upstream. A new concrete weir would be constructed in order to provide adequate water surface elevations for water diversion into the new bypass channel and delivery of irrigation water (Corps 2014).

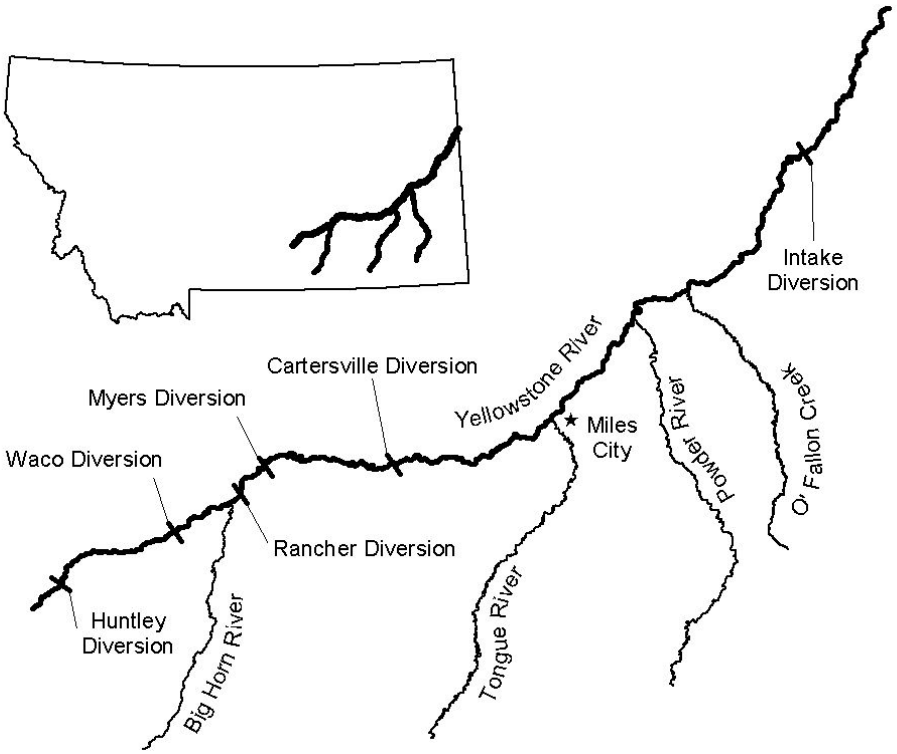

Figure 1. The Yellowstone River, its major tributaries, and diversion dams.

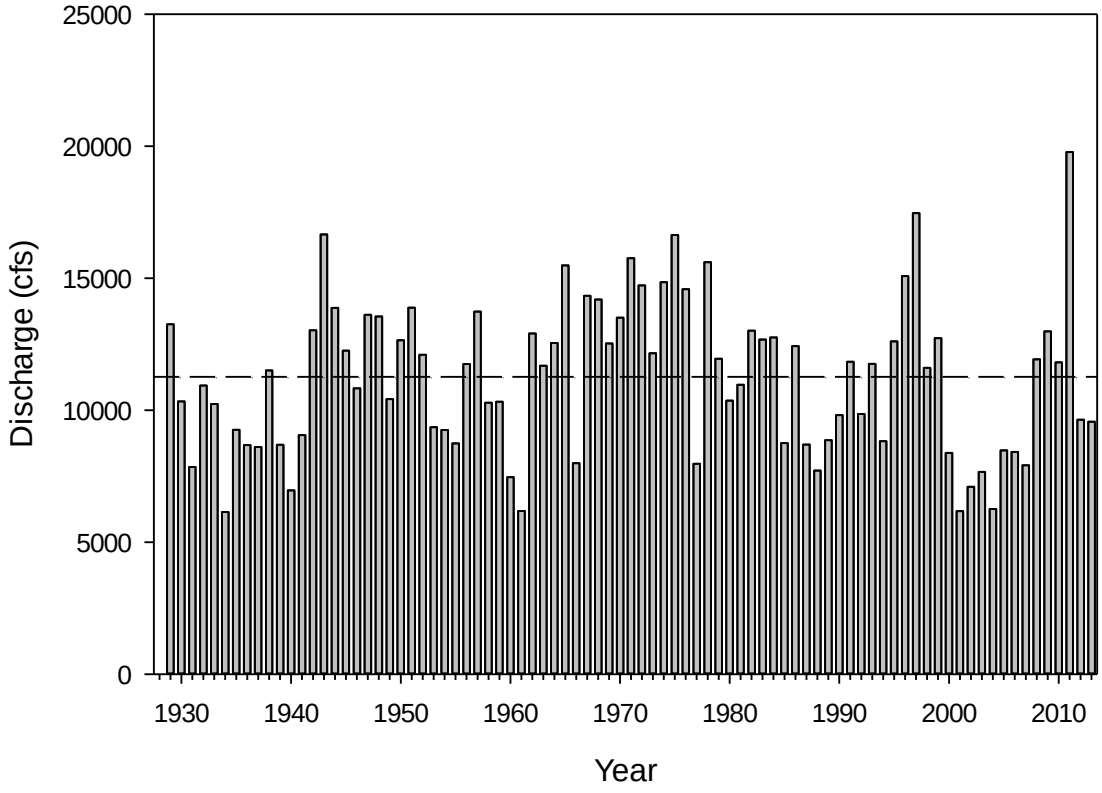

Figure 2. Mean annual discharge of the Yellowstone River at Miles City, 1929-2013. Dashed line represents mean annual discharge (11389 cfs) calculated since 1928. Data for 2013 is provisional data subject to revision.

METHODS

The Yellowstone River fish assemblage was sampled using a suite of gears each year between spring and autumn. At ice-off of each year, generally March, drifted trammel nets and electrofishing gears were used to capture and tag sauger and walleye. Pallid sturgeon sampling using trammel nets and trotlines occurred from April to September, with the majority of the netting effort occurring in August and September. Trend sampling was completed each September, October, and November with boat-mounted electrofishing equipment. Coffelt electrofishing equipment with a single boom and cable dropper was used in all years except when Smith-Root equipment with double boom cable droppers was used in 2008 and 2010-2013. Sampling occurred in the following five trend areas: Forsyth (downstream of Cartersville Diversion), Miles City

(above and below the Tongue River confluence), Fallon (above and below the O' Fallon Creek confluence), Intake (downstream of Intake Diversion) and since 2003, Hysham (downstream of Rancher diversion). Trend areas are approximately 9.6 river km in length. All fishes encountered were collected, identified to species, enumerated, measured (fork length for sturgeon and total length for all other species), and if length was greater than 100mm, weighed (cyprinids were not weighed).

An index of abundance (catch per effort) was calculated for all species captured. Catch per effort was also calculated by trend section for sauger, channel catfish, and smallmouth bass and by catches upstream and downstream of Intake Diversion Dam. Indices of population structure (incremental relative stock density) and condition (relative weight) were calculated for sauger, channel catfish, smallmouth bass, shovelnose sturgeon, burbot, and walleye (Anderson and Neuman 1996). Length frequency histograms were developed for sauger and shovelnose sturgeon to compare populations upstream and downstream of Intake Diversion. Population structure and condition for sauger, channel catfish, smallmouth bass, shovelnose sturgeon, burbot, and walleye were described using 1) only data from autumn trend sampling (autumn trend data) and 2) all data collected during a given year (all data). Autumn trend data are less biased and provide the best insight into population structure and condition among years because consistent timing, location, and methodology occurs during the study period. However, low catch rates of some species during autumn trend surveys preclude making inferences thus inclusion of all data was helpful.

RESULTS AND DISCUSSION

To date, 43 different species have been captured on the Lower Yellowstone River during the annual autumn trend surveys. Catch by section since 2001 is summarized in Appendix I. River flow conditions have varied widely throughout the study period; average to above average flows occurred in 1998, 1999 and from 2008 to 2010 with all time high flows observed in 2011. Drought conditions created below average flows from 2000 to 2007 and in 2012. In 2013, the mean annual discharge was slightly below the long-term average (Figure 2). The fish assemblage appeared to withstand drought

conditions well. Since initiation of the trend survey in 1998 the catch rate trends of commonly collected species from all trophic guilds remained stable or increased. Catch rates of multiple species including sauger and channel catfish have been above average in recent years.

It is important to note that electrofishing gear varied during the duration of the study. Due to gear variability and associated sampling efficiency between Coffelt and Smith-Root electro-fishers, direct comparison of catch rates between years of different gears is cautioned. High variability between sampling condition and year is inherent; therefore, trends observed for populations over time were more useful than trends in any given year. Beginning in 2009, as a result of the pallid sturgeon survival investigations conducted in August and September, inference accuracy for shovelnose sturgeon analysis were improved because of the substantial increase in the number of shovelnose sturgeon sampled.

Sauger

Sauger were the second most commonly observed game fish and catch rates from 1998 to 2007, averaging over 8 fish per hour. In recent surveys, the catch rates have trended upward and average nearly 16 fish per hr from2008 to 2013 (Figure 3). Catch rates averaged about 12 fish per hour in the 1970s and 1980s but declined to about 2 fish per hour from 1990 to 1997, leading to the listing of sauger as a Species of Special Concern in Montana (McMahon and Gardner 2001). Catch rates have since improved and are greater than pre-decline levels. Catch rates over 10 fish per hour were observed in eight of the last ten years and the population has trended upward in recent years. Catch rates of about 10 fish per hour support a good sauger fishery (McMahon 1999). Catch rates in 2012 and 2013 were over 19 and 13 fish per hour respectively. Sauger abundance has trended upward since 1998 when the trend survey began. In 2013, catch rates were above 10 fish per hour in all survey reaches except Ranchers trend area (Figure 4).

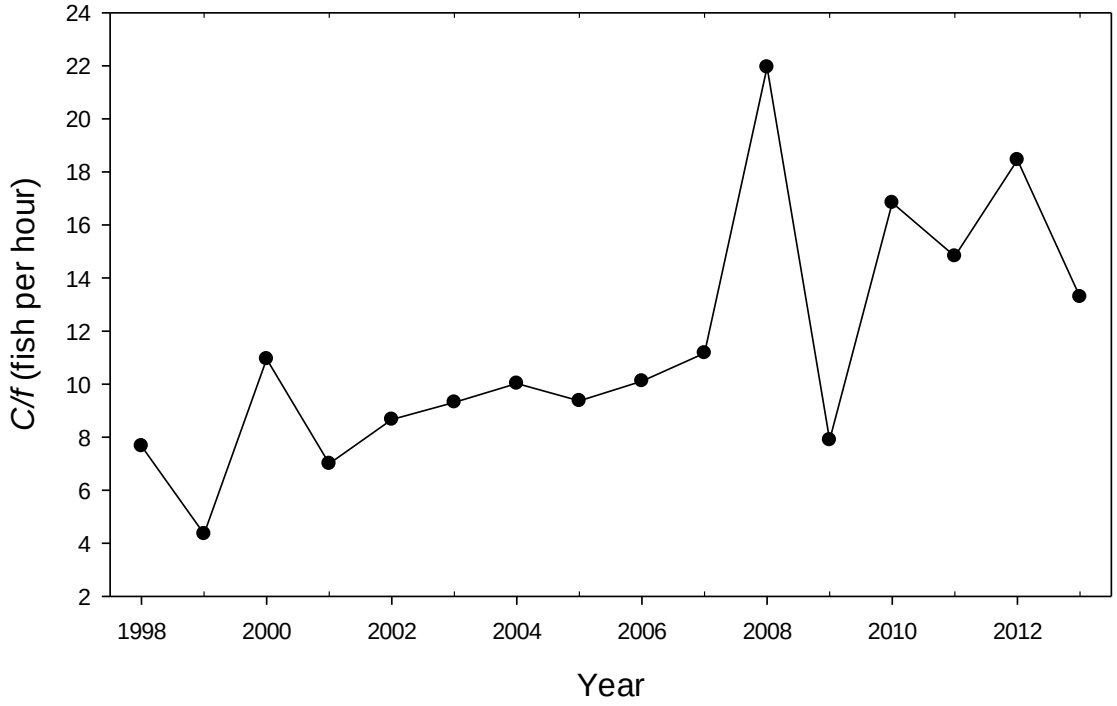

Figure 3. Catch per effort of sauger in the Yellowstone River, 1998 to 2013.

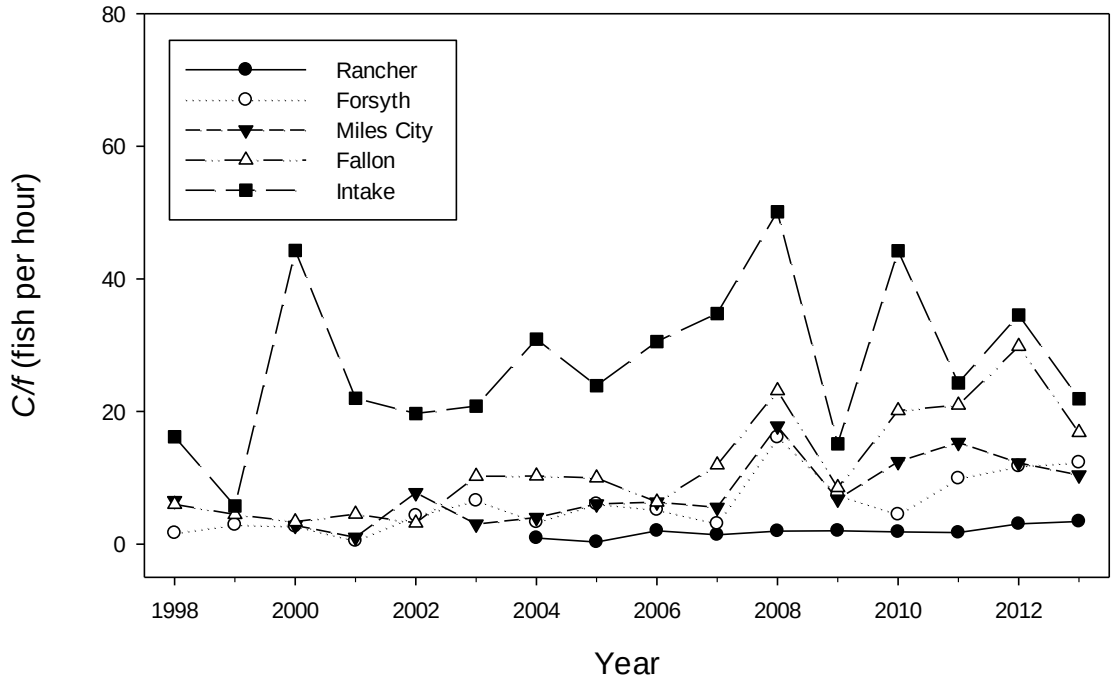

Figure 4. Catch per effort of sauger in the Yellowstone River by trend area, 1998 to 2013.

Population structure was dominated by stock to quality size fish in 2011, quality to preferred size fish in 2012, and preferred to memorable in 2013 (Figure 5A). This may be indication of a strong year-class in the system. Majority of additional data used for "all" analysis were collected during early spring efforts to capture spawning sauger and are biased proportionally towards large fish. Drifted trammel nets, drifted gill nets, boat electrofishing and hook and line were the dominant gear types utilized in the spring. Size-specific relative weight of quality-sized and larger fish has remained stable across years; however, stock to quality sized fish relative weight has been variable. (Figure 5 B, D).

Sauger are a highly sought after species on the Yellowstone River and despite the observed upward trend in catch rate, the population should continue to be monitored. Research concluding in 2004 documented that exploitation (18.6%) is unlikely to significantly affect this population during most years but is high enough that angler harvest should be closely monitored (Jaeger 2004). Additionally, anecdotal observations would indicate that the number of river boat owners has increased in recent years. The potential for increased fishing pressure and harvest further supports the need to closely monitor harvest trends in the Yellowstone River.

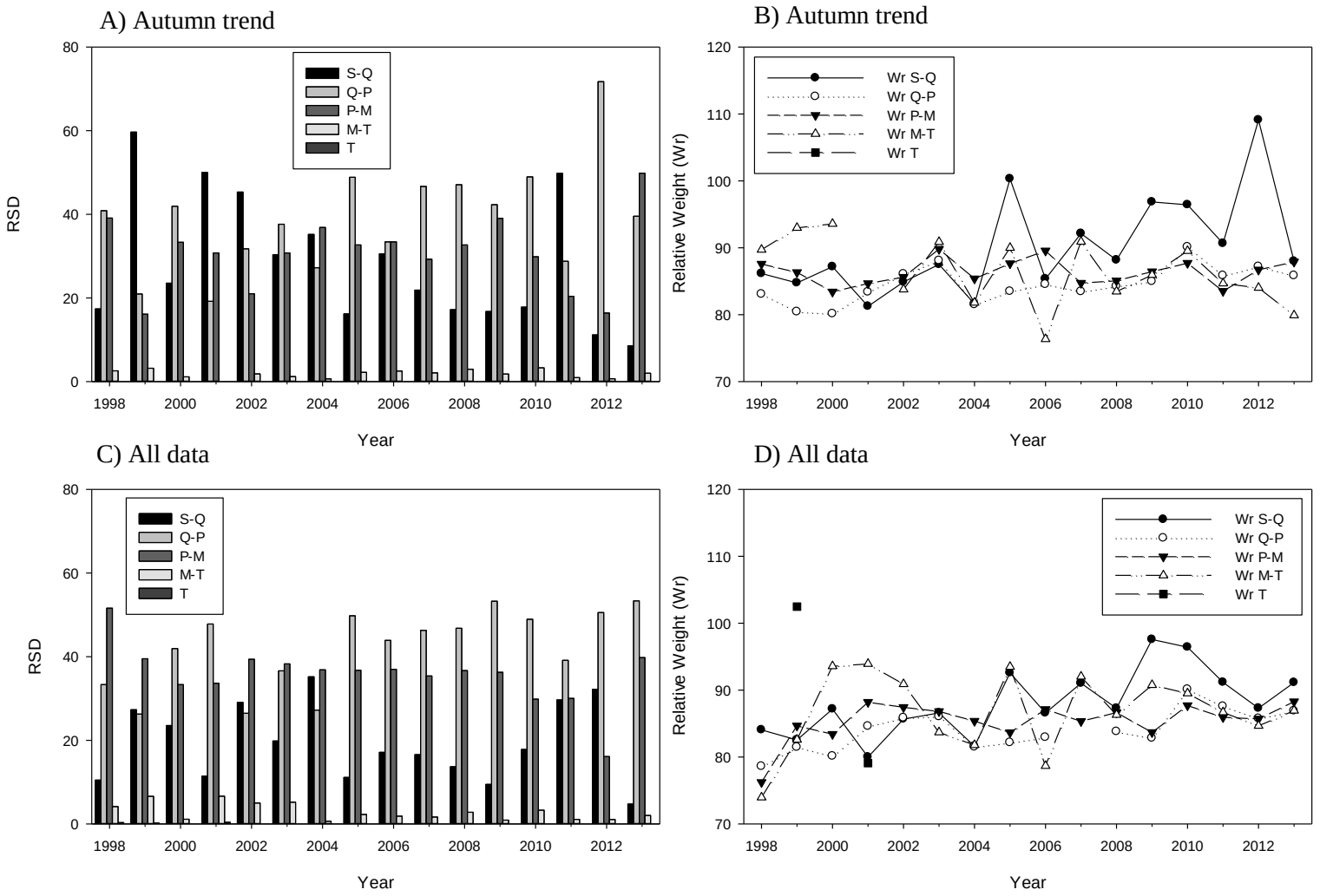

Figure 5. Incremental relative stock density (RSD) and relative weight (Wr) by length category of sauger captured during Autumn trend sampling (panels A and B) and by all sampling (panels C and D) in the Yellowstone River, 1998 to 2013.

Sauger have been marked with Floy T-bar tags since 1997. Tagging occurred during spring and fall from 1997 to 2004. Since 2005 sauger were only tagged during the spring spawning season. It was assumed that spring tagged fish randomly redistribute in the Yellowstone River, decreasing tag return bias. Since 2005, spring tagging efforts resulted in 4,423 tagged sauger. Voluntary angler tag return information documented that 273 tagged sauger were caught by anglers of which 196 (71%) of these fish were harvested (Table 1).

In 2012, prior to the onset of irrigation at Intake Diversion, a new Intake head gate structure with screens was constructed to prevent entrainment of fishes greater than 40 mm total length into the canal. It was estimated that about 600,000 fish of 34 species were entrained in Intake canal each year during the mid-May to mid-September irrigation season and sauger account for roughly 67,000 of the total number of fish entrained each year (Hiebert et al. 2000). Historically this would have corresponded to a loss of over 13,000 five-fish angler limits annually. Investigations of the screens entrainment protection efficiency were completed by the BOR in 2013, and these results should be available Spring 2014.

Entrainment protection was phase one of a two-phase fishery restoration effort at Intake Diversion. Phase two of the project, not yet completed, has two objectives 1) to provide fish passage at Intake Diversion Dam 2) and deliver the irrigation district their full water right. Sauger are found in aggregations from Miles City downstream to Glendive during the spawning season. Most juvenile sauger likely rear downstream of Intake Diversion (Penkal 1992). Intake Diversion Dam is a recognized barrier to fish movement and migrations most notably restricting adult pallid sturgeon to the lower river. Intake Diversion Dam is only a partial barrier to sauger passage but does appear to be impassable for smaller sauger less than 250mm. Length frequency analysis of 2013 autumn trend sampling reflects this. Sauger less than or equal to 250 mm only account for 0.6% of the total catch upstream while these smaller sauger represented approximately 13.1% of total catch downstream of Intake (Figure 6). This observed length dimorphism suggests the sustainable presence of sauger in the reach of river upstream of Intake Diversion Dam is dependent upon upstream migration of sauger from the reach of river

downstream of Intake Diversion Dam. The result of Intake Diversion Dam's influence on sauger movement is a tenuous link between the upstream reach of river containing important spawning and the lower reach of river where young sauger rear and grow to maturity. Exacerbation of passage problems at Intake would reduce or eliminate the ability of sauger to recruit upstream and would likely result in a swift and severe decline in the population. The future stability of the Lower Yellowstone Rivers robust sauger population depends on connectivity throughout the system and demonstrates the need to attain unimpeded passage at Intake Diversion Dam.

Table 1. The number of sauger tagged in the Yellowstone River that were recaptured by anglers from 1998-2013. The total number of tagged sauger recaptured by anglers and the total number of tagged sauger harvested by anglers (in parentheses) are listed.

Yr tagged	Number tagged	Angler Recaptures of Tagged Sauger															
		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1997	39	0	0	2 (1) 14	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	545	-	36 (5)	(1)	3 (2)	3(2)	1(1)	1(1)	0	0	0	0	0	0	0	0	0
1999	493	-	-	52(8)	7(7)	2(10	2(1)	1(1)	1(1)	1(1)	0	0	0	0	0	0	0
2000	426	-	-	-	12(3)	15(7)	9(2)	4(1)	2(2)	3(3)	1(0)	0	0	1(0)	0	0	0
2001	409	-	-	-	-	49(21)	24(16)	9(5)	6(4)	2(1)	1(0)	0	1(0)	0	0	0	0
2002	621	-	-	-	-	-	62(39)	46(38)	13(12)	10(9)	3(1)	1(1)	1(0)	0	0	0	0
2003	344	-	-	-	-	-	-	36(19)	14(13)	4(2)	3(1)	2(1)	2(2)	0	0	0	0
2004	44	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
2005	422	-	-	-	-	-	-	-	-	3(3)	4(3)	3(3)	18(12)	2(0)	5(3)	0	0
2006	309	-	-	-	-	-	-	-	-	-	7(7)	10(10)	7(5)	3(2)	0	0	0
2007	734	-	-	-	-	-	-	-	-	-	-	23(21)	16(8)	15(10)	8(5)	5(4)	0
2008	627	-	-	-	-	-	-	-	-	-	-	-	16(9)	19(6)	9(6)	3(3)	2(1)
2009	596	-	-	-	-	-	-	-	-	-	-	-	-	20(12)	12(8)	5(3)	1(0)
2010	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	682	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13(9)	12(7)
2012	549	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6(4)
2013	504	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

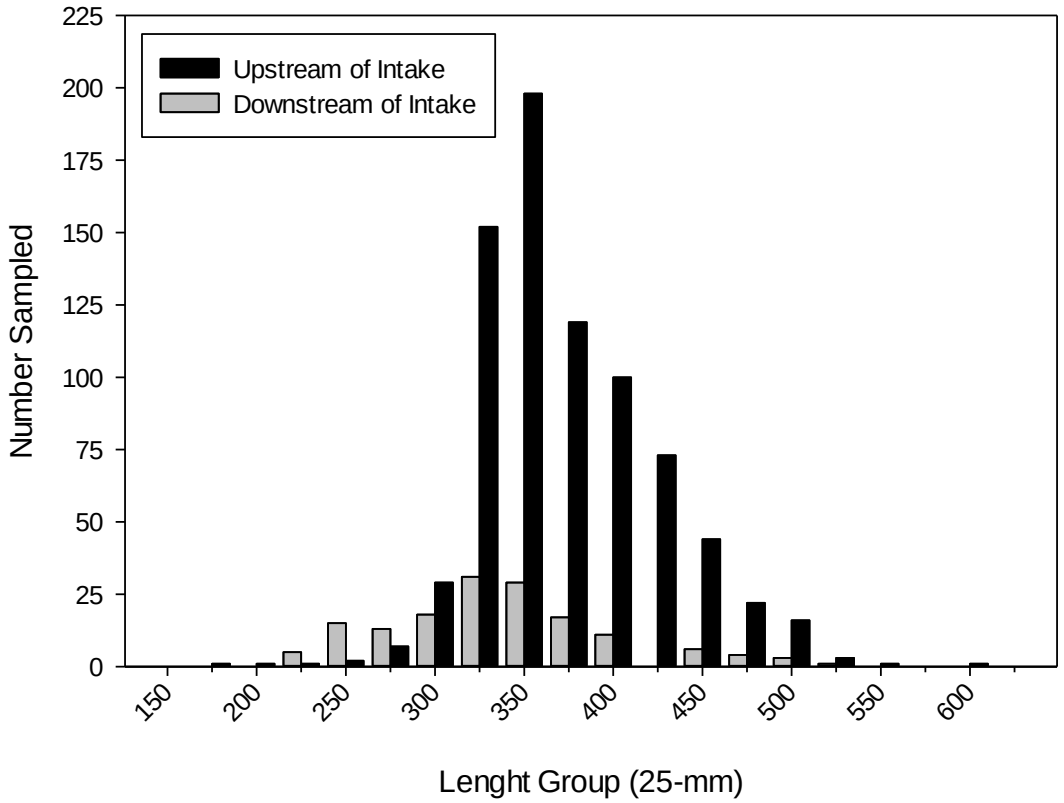

Figure 6. Length frequency distribution of sauger captured in the Yellowstone River during 2013 upstream and downstream of Intake Diversion Dam.

Ice flow and historic river flow observed in the Yellowstone River in 2011 caused substantial scouring of the placed rock on the crest of Intake Diversion Dam. This combined with drought conditions in 2012 and the initial operation of the new screened head gate required extensive addition of rock to the Intake Diversion Dam in July and August 2012 to deliver the Lower Yellowstone Irrigation Project's full water right. The irrigation district added rock to the crest of Intake Dam for 21 days resulting in 543 loads estimated to be 1900 cubic yards of rock. This effort and quantity of rock was about 3 to 4 times the amount of rock annually required. No pre and post crest elevations were documented but anecdotal reports and observations suggests this activity increased the dam's height. The impact to the historically limited amount of fish passage over the dam is unknown at this time but is cause for concern.

Another threat to the sauger population in the Yellowstone River is nonnative smallmouth bass. In other waters, populations of nonnative smallmouth bass adversely affected sauger relative abundance. Smallmouth bass replaced sauger as the most common top predator in the Tongue and upper Missouri rivers following impoundment as bass capitalized on decreases in turbidity and alteration of natural hydrographs (McMahon and Gardner 2001). Stable isotope analysis investigation on the Yellowstone River documented near identical carbon and nitrogen signatures that suggest very similar foraging habits between sauger and smallmouth bass (Rhoten 2010). Loss of the natural hydrograph and warm, turbid prairie stream character of the Big Horn River combined with increasing prevalence of stream bank armoring of the Yellowstone River likely create conditions that favor smallmouth bass over sauger upstream of the Powder River confluence.

The high sediment load and associated turbidity of the Powder River could likely act as a habitat barrier for further downstream expansion of smallmouth bass and provide valuable habitat for sauger and other native species. The Powder River is one of the last remaining tributaries to the Yellowstone River that has not been altered by a dam and maintains some semblance of its historic hydrograph. High catch abundances near the Powder River confluence likely reflect its significance to the Yellowstone River fish assemblage. For example, one sauger that was tagged in the Yellowstone River near the Powder River confluence in 2012 was recaptured in 2014 having moved over 233 river miles upstream in the Powder River and Clear Creek. This individual also managed to navigate past Kendrick Dam on Clear Creek. The near natural hydrograph of the Powder River plays an important role in the conservation of native species that have a life-history strategy reliant on these warm and highly turbid systems.

Hybridization with nonnative walleye represents another potential threat to the sauger population. Sauger/walleye hybridization has been documented on the Yellowstone River with highest frequency in the reach around the mouth of the Tongue River (Bingham et al 2012).

Channel catfish

Channel catfish have been the most commonly sampled game fish since 2010. Catch rates decreased in 2012 and 2013 from a record high relative abundance in 2011, yet channel catfish catch rate remains above the historical average (Figure 7). An increasing trend of catfish relative abundance is believed to be in response to relief of drought conditions and an increase in sampling efficiency resulting from the switch to Smith Root's GPP 5.0 electrofisher system. When tested side by side, the current electrofishing system a Smith Root GPP electrofisher appears to outperform the previously used Coffelt VVP 15B electrofisher and may be partly responsible for increased catch rates since 2008. Low flow conditions returned in 2012 and 2013 and decreased catch rates may reflect this condition. Catch rates have been consistently highest in the Rancher trend area and lowest in the Intake trend area (Figure 8).

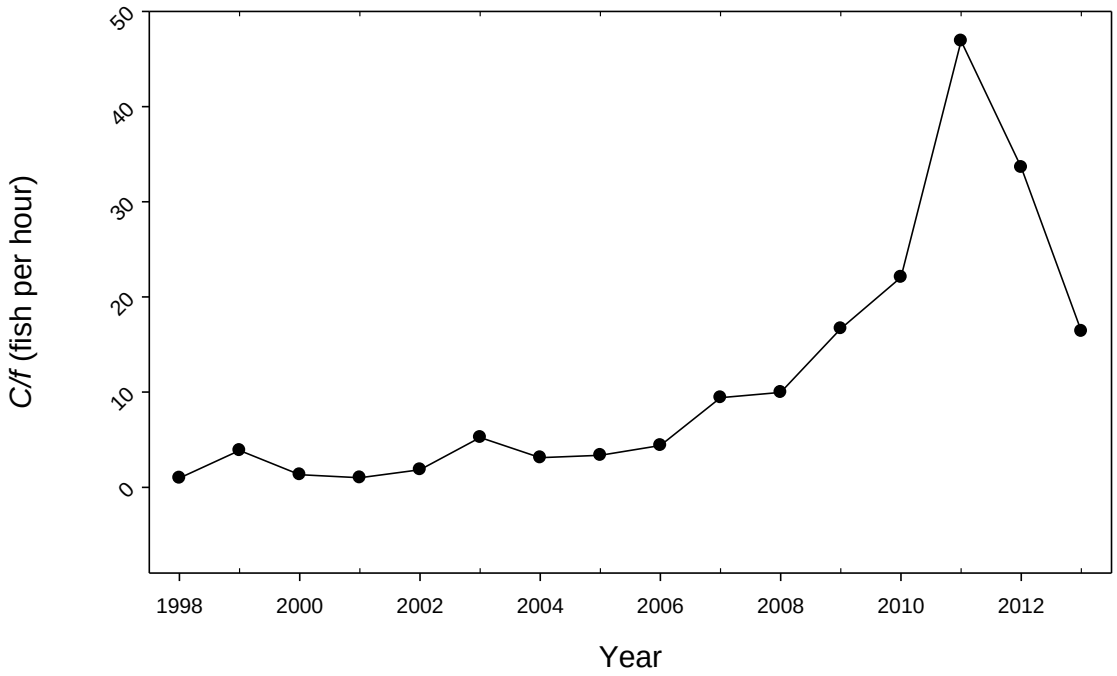

Figure 7. Catch per effort of channel catfish in the Yellowstone River, 1998 to 2013.

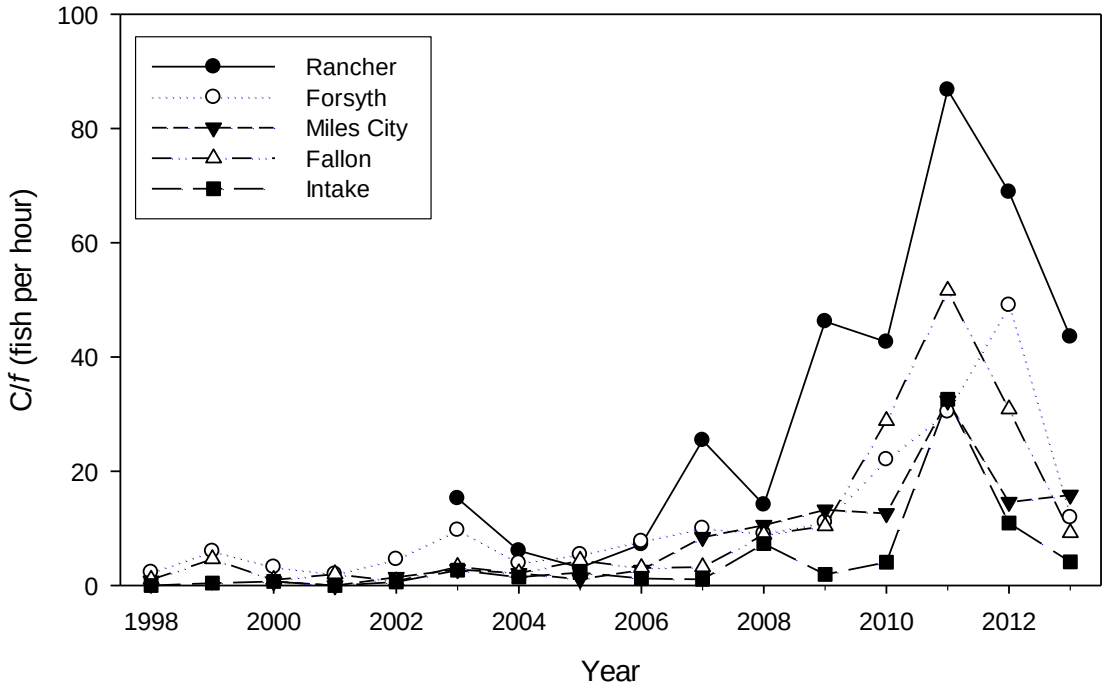

Figure 8. Catch per effort of channel catfish in the Yellowstone River by trend area, 1998 to 2013.

Population structure remains stable (Figure 9 A, C). Consistent low proportions of stock to quality size fish suggests that smaller size classes are not fully recruited to the sampling gear (i.e. larger fish are more susceptible to electrofishing) or rear in un-sampled areas (i.e. deep pools, tributaries). Nonetheless, the stability of the observed population structure suggests that recruitment is not limiting. Fish were predominately quality to preferred size (410-610 mm) but about 9% were preferred to memorable (610-710 mm) and about 1% were memorable to trophy size (710-910 mm). Condition of fish was high during all years but appears to trend downward since 2008 (Figure 9 B, D). Channel catfish of longer than 610 mm were in the best condition.

With the high abundances, large average size, and high length-specific weights of channel catfish, the Yellowstone River provides a high quality fishery for this species, especially in upstream reaches. Despite stable size structure, increasing relative abundance, and possible density dependant declines in condition factor of channel catfish in the Lower Yellowstone the daily bag limit was reduced from 20 daily and in possession to 10 daily and 20 in possession effective 2012.

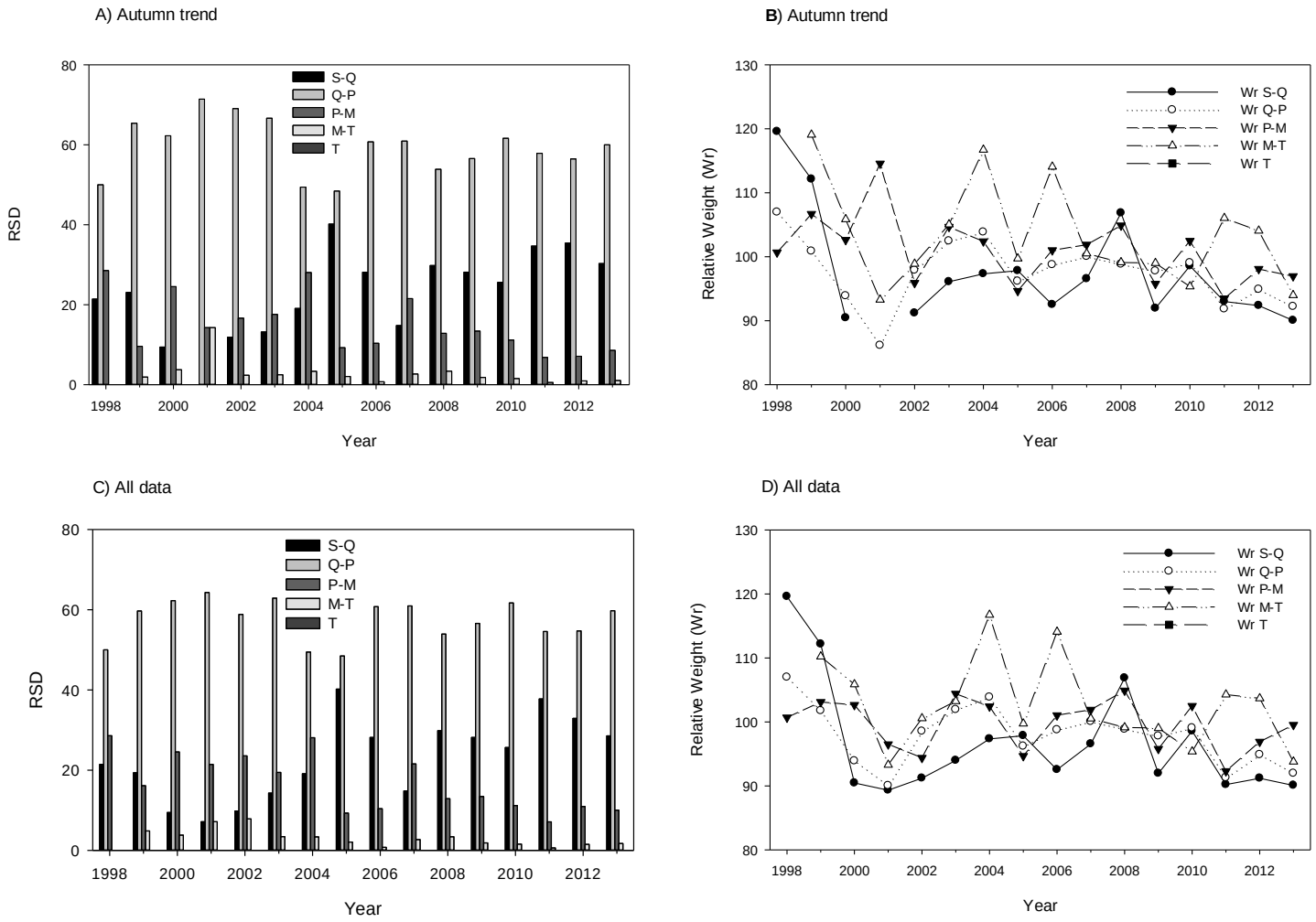

Figure 9. Incremental relative stock density (RSD) and relative weight (Wr) by length category of channel catfish captured in the Yellowstone River, 1998 to 2013.

Smallmouth bass

Smallmouth bass catch rates increased drastically from 1.5 fish per hour in 1998 to their peak of over 13.5 fish per hour in 2008 (Figure 10). Increased abundance coincided with the onset of drought conditions that decreased turbidity in the Lower Yellowstone upstream of the Powder River. With the return of above average flows in 2009, smallmouth bass catch rates trended downward. Below average flows and water clarity returned in 2012 and 2013 and again these conditions coincide with increased smallmouth bass catch rates. Smallmouth bass were the third most frequently encountered game species overall despite only being commonly observed in the trend sections upstream of Miles City (Figure 11). The population structure appears balanced but skewed towards smaller size classes with majority of fish in the stock to quality length category (Figure 12 A, C). Condition of smallmouth bass residing in the Yellowstone River is and has been consistently high for all size-classes (Figure 12 B, D).

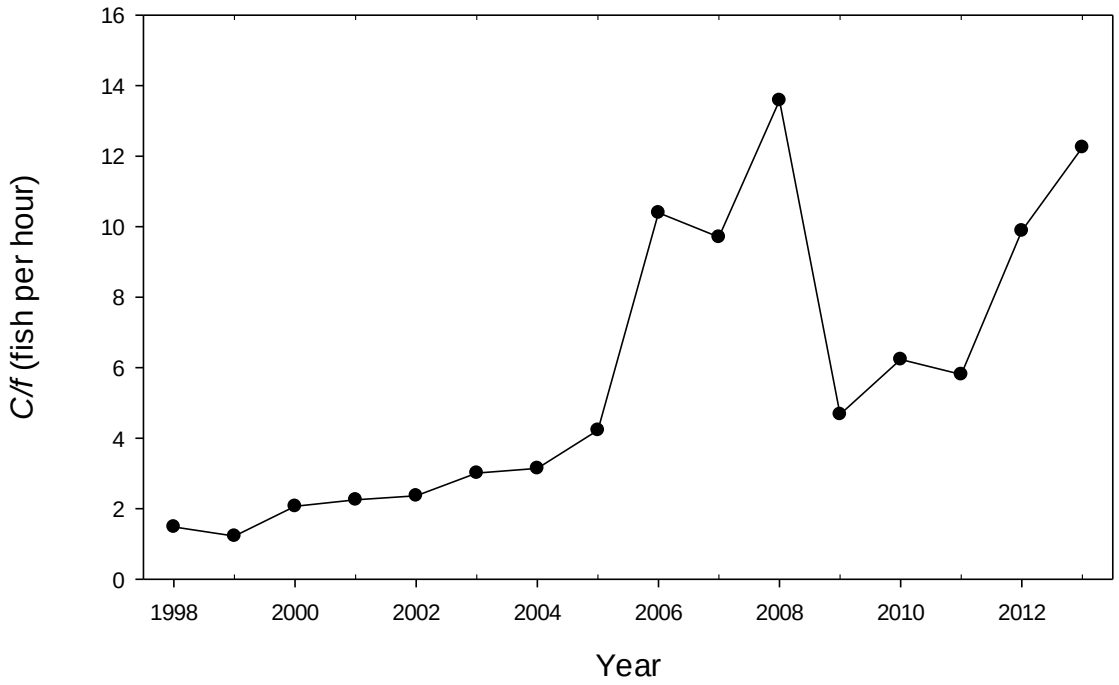

Figure 10. Catch per effort of smallmouth bass in the Yellowstone River, 1998 to 2013.

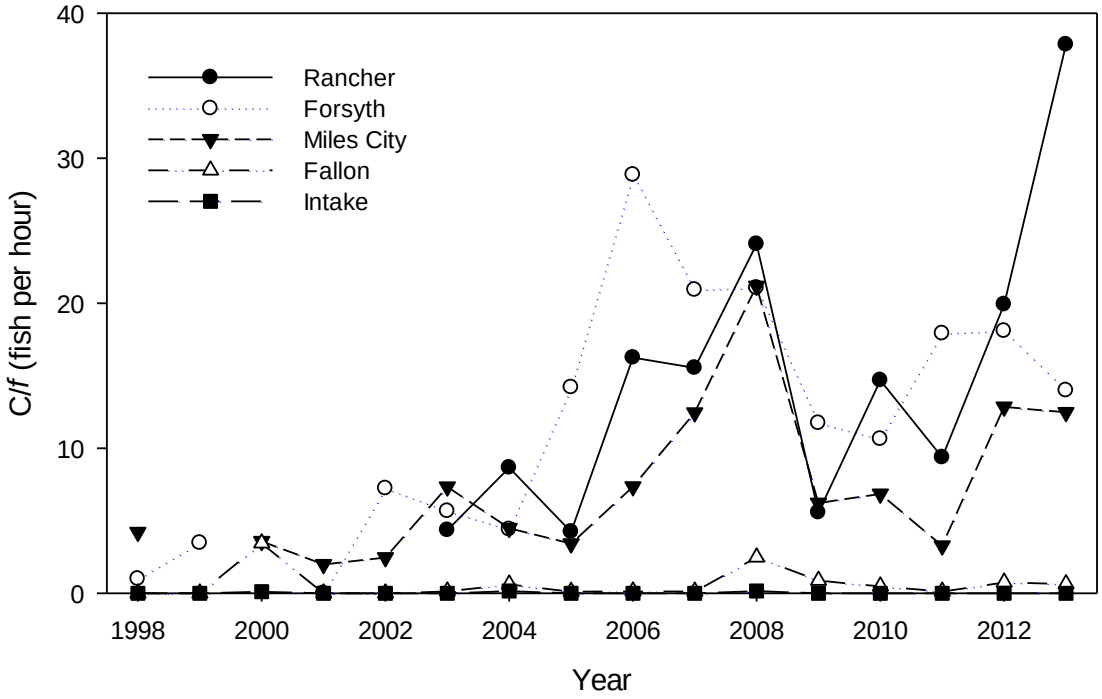

Figure 11. Catch per effort of smallmouth bass in the Yellowstone River by trend area, 1998 to 2013.

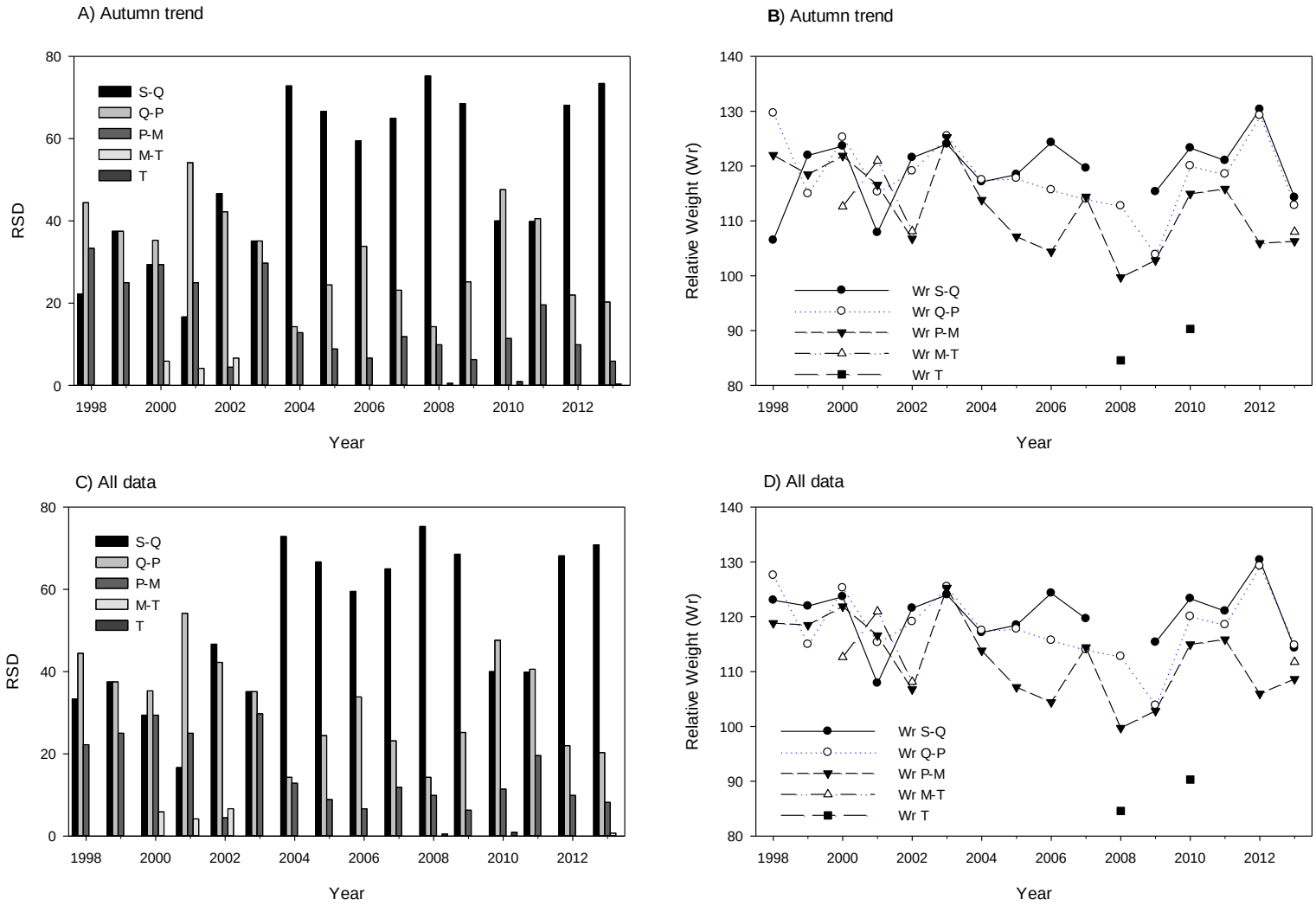

Figure 12. Incremental relative stock density (RSD) and relative weight (Wr) by length category of smallmouth bass captured in the Yellowstone River, 1998 to 2013.

Increased abundances and exceptional length-specific weight of smallmouth bass in the Yellowstone River provide an excellent angling opportunity upstream of Miles City. However, populations of native fishes, should continue to be closely monitored because these nonnative smallmouth bass appear to have similar prey preferences based on isotope analysis and are presumed to compete with native sauger (Rhoten 2010).

Shovelnose sturgeon

Shovelnose sturgeon abundance during autumn trend surveys has been variable throughout the study period (Figure 13), and limited inferences can be drawn from electrofishing trend data as the gear is a relatively inefficient sampling method for this species. Nonetheless, current trend sampling and incidental netting efforts suggest that shovelnose sturgeon are present and widely distributed downstream of Cartersville Diversion.

Trend sampling using more efficient gears, such as drifting trammel nets (e.g. Backes and Gardner 1994), would allow more robust estimates of population trends.

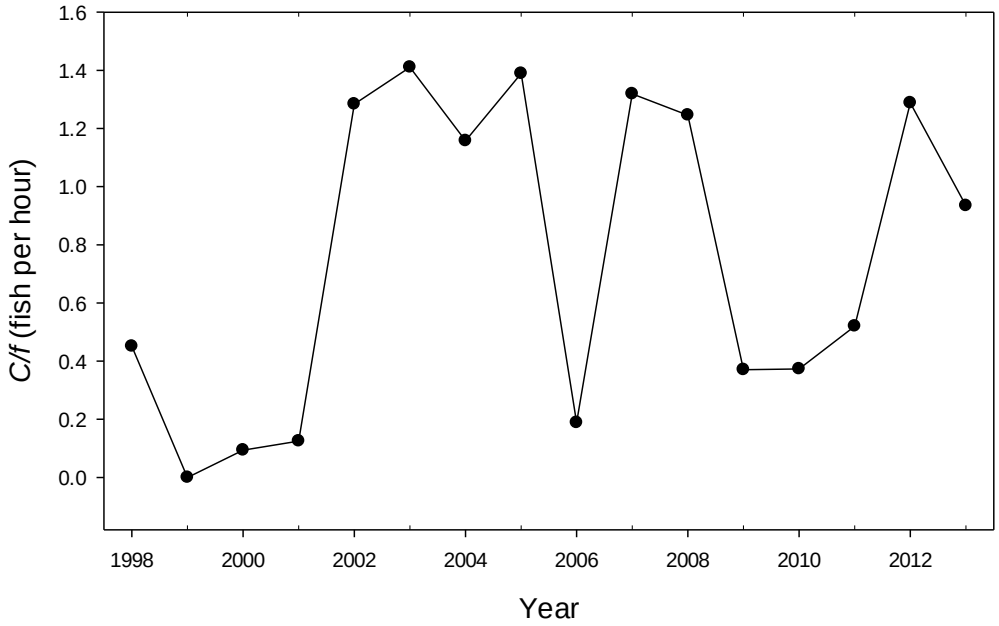

Figure 13. Autumn trend survey catch per effort of shovelnose sturgeon in the Yellowstone River during autumn trend survey, 1998 to 2013.

Shovelnose sturgeon sample size increased radically beginning in 2009 with the onset of juvenile pallid sturgeon monitoring. The monitoring utilizes trammel nets, primarily in August, to capture pallid sturgeon and as a byproduct efficiently sample shovelnose sturgeon. Most netting effort (71% of the total effort) is conducted at sites downstream of Intake Diversion Dam. However, sites as far upstream of Intake as Bonfield are also sampled. All shovelnose sturgeon are enumerated and a daily subsample are measured and weighed during the pallid sturgeon survival monitoring. One-inch trammel nets drifted during the survival analysis captured 1,202 and 1,206 shovelnose sturgeon during 2011 and 2012 respectively. Catch rates per hour and catch rates per river km both trended downward between 2009 and 2011, and have since increased (Figure 14). Pallid sturgeon survival analysis has become more targeted/proficient since 2009, thus providing some explanation for decreased shovelnose sturgeon catch rates since 2009. Pallid sturgeon sampling often takes place in large, bluff pools. Shovelnose sturgeon catch rates seem to be lower in these bluff pools and higher in habitats associated with riffles and runs (M. Backes, Montana FWP, *personal communication*). Additionally, sampling efficiencies are ever-changing with highly variable discharges across years. In 2011, above average discharge made it difficult and dangerous to sample some locations. Conversely, below average discharges during 2012 and 2013 hampered the ability to drift trammel nets because of low current velocity. If shovelnose sturgeon population monitoring is a management object, sampling protocols should be devised that would specifically target shovelnose sturgeon (e.g. repeated, yearly sampling in designated riffle and run habitats).

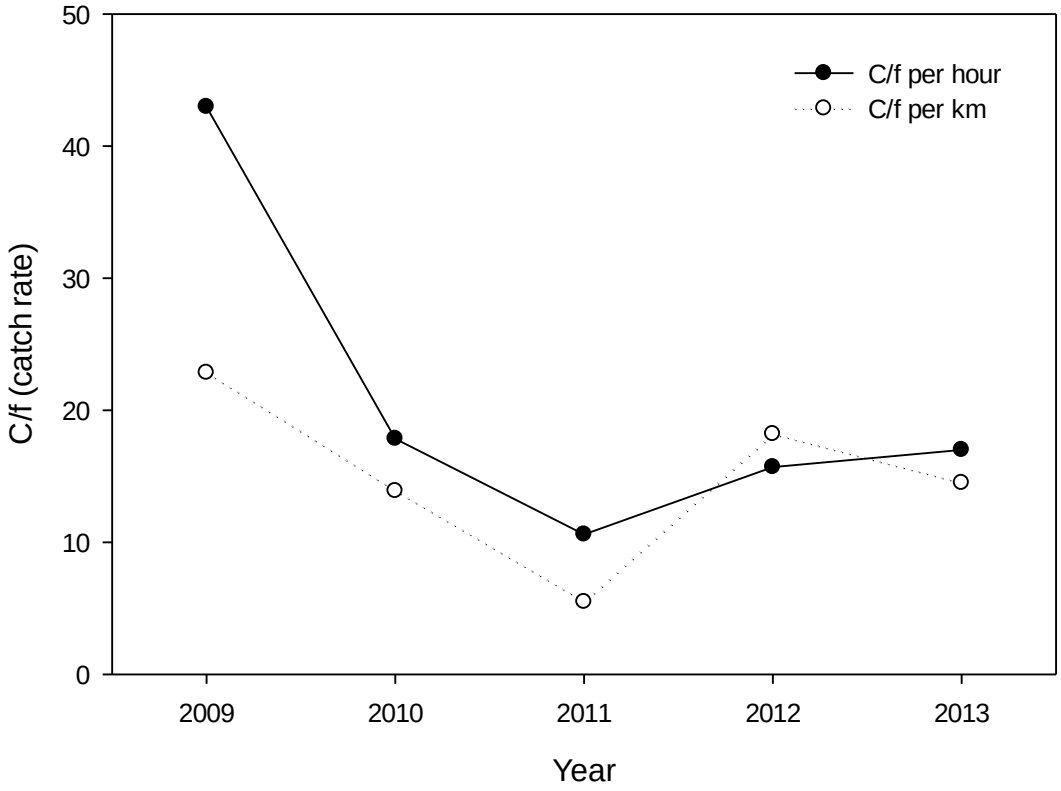

Figure 14. Catch rates of shovelnose sturgeon in the Yellowstone River from 2009 to 2013 during the pallid sturgeon survival analysis monitoring effort.

Highly variable catch rates and low sample size observed during trend sampling resulted in limited population structure and condition information precluding drawing inferences from shovelnose trend data (Figure 15 A, B). However, combining all available data for a given year significantly bolsters sample size and analysis of this more robust dataset indicates that population structure is stable and balanced (Figure 15 C). Size-specific condition was also stable and consistent among recent years (Figure 15 D).

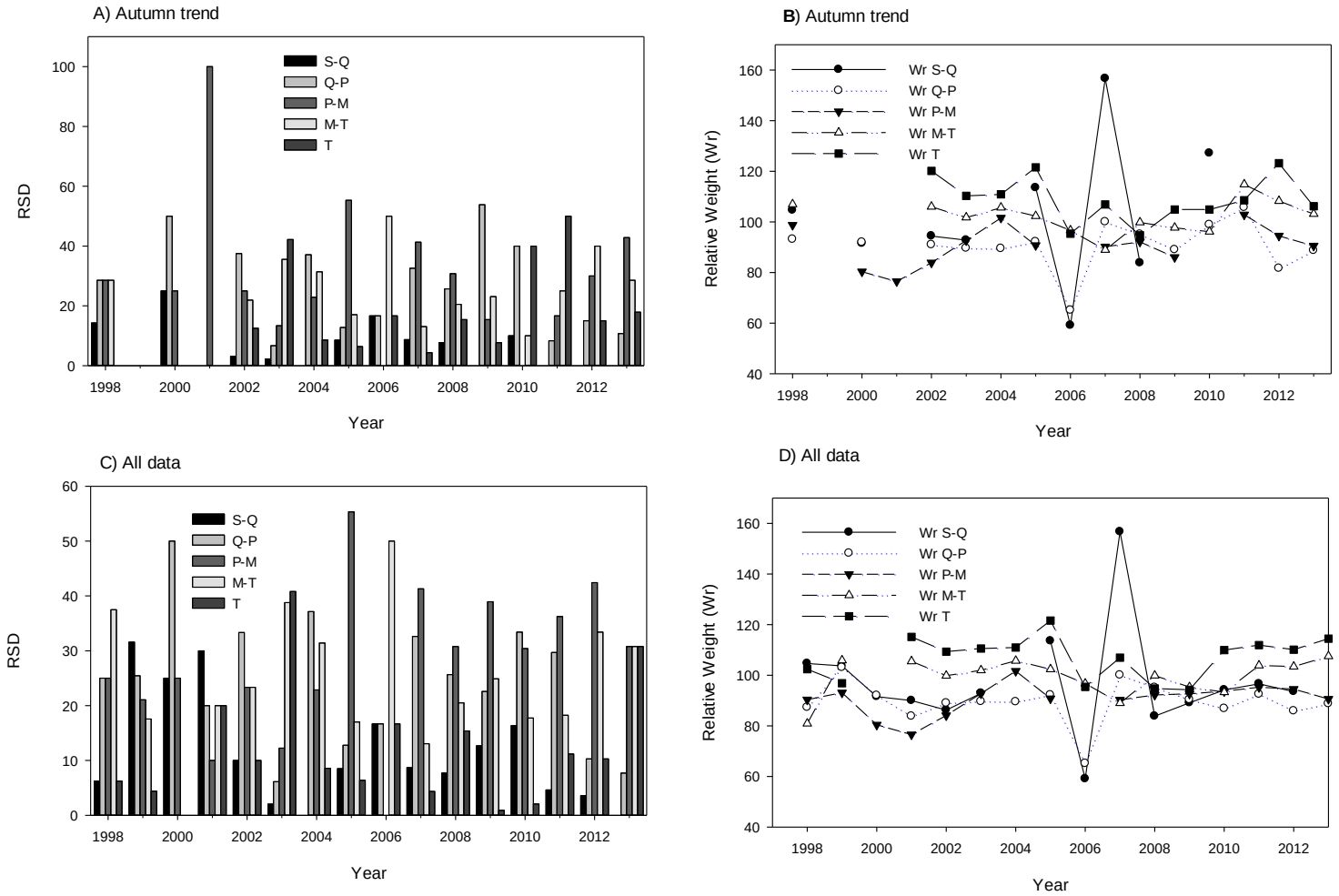

Figure 15. Incremental relative stock density (RSD) and relative weight (Wr) by length category of shovelnose sturgeon captured in the Yellowstone River, 1998 to 2013.

As previously described, restoration efforts are currently underway to attain fish passage at Intake Diversion Dam. Passage alternative exploration prompted investigative analysis of length frequency distribution of shovelnose sturgeon upstream of Intake compared to length frequency of shovelnose sturgeon downstream of Intake. In 2011 and 2012, the percentage of total catch indicated length dimorphism between shovelnose sturgeon captured upstream and downstream of Intake Diversion Dam similar to the trend observed in sauger. However, proportions of the total catch by length groups were similar upstream and downstream of Intake in 2013 (Figure 16). Shovelnose sturgeon used for this analysis were collected during the pallid sturgeon survival analysis and the length groups are divided into relative stock density size classifications.

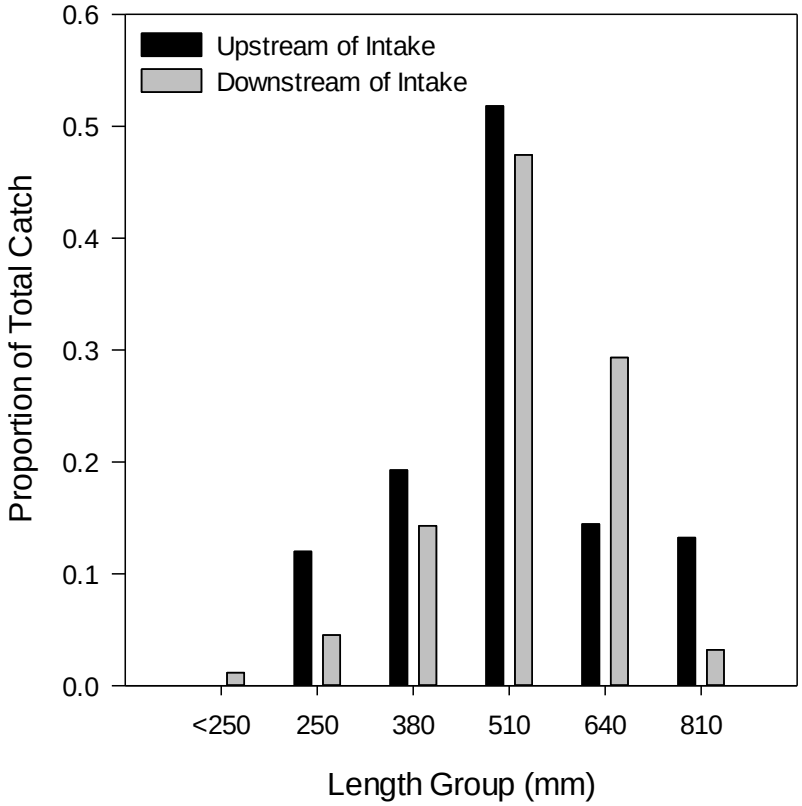

Figure 16. Proportion of the total shovelnose sturgeon catch by length group upstream and downstream of Intake Diversion Dam during survival analysis during 2013.

Pallid Sturgeon

PALLID STURGEON MONITORING

Annual targeted monitoring of hatchery-reared pallid sturgeon was conducted using primarily drifted trammel nets and some baited trotlines. The data derived from these efforts are used in multiple ways, but the most important is to estimate survival of stocked pallid sturgeon. Survival estimates are generated by Jay Rotella utilizing these data and by data collected by other field crews. Bluff pool habitats between Intake Diversion and the confluence with the Missouri River are traditional focal points of our efforts because prior research has demonstrated that juvenile pallid sturgeon positively select for bluff and terrace pool habitats (Fuller et al. 2007). In 2013, low flow conditions created low velocities within these habitats and subsequently these low velocities created difficult trammel netting conditions.

In 2013, 247 trammel nets were deployed, yielding a total netting effort of approximately 71 hours and 83 km drifted. Fourteen trotlines were set over a two day period. The average soak time for trotlines was 8 hours. Trammel nets accounted for all of the sampled sturgeon. A total of 93 hatchery-reared pallid sturgeon were captured ranging in size from 273 mm to 1420 mm, with the majority of the catch (75%) comprised of individuals between 350 and 450 mm (Figure 17). Pallid sturgeon catch rates by hour (1.3 fish/hr) and by distance (1.1 fish/km) were the lowest on record (Figure 18).

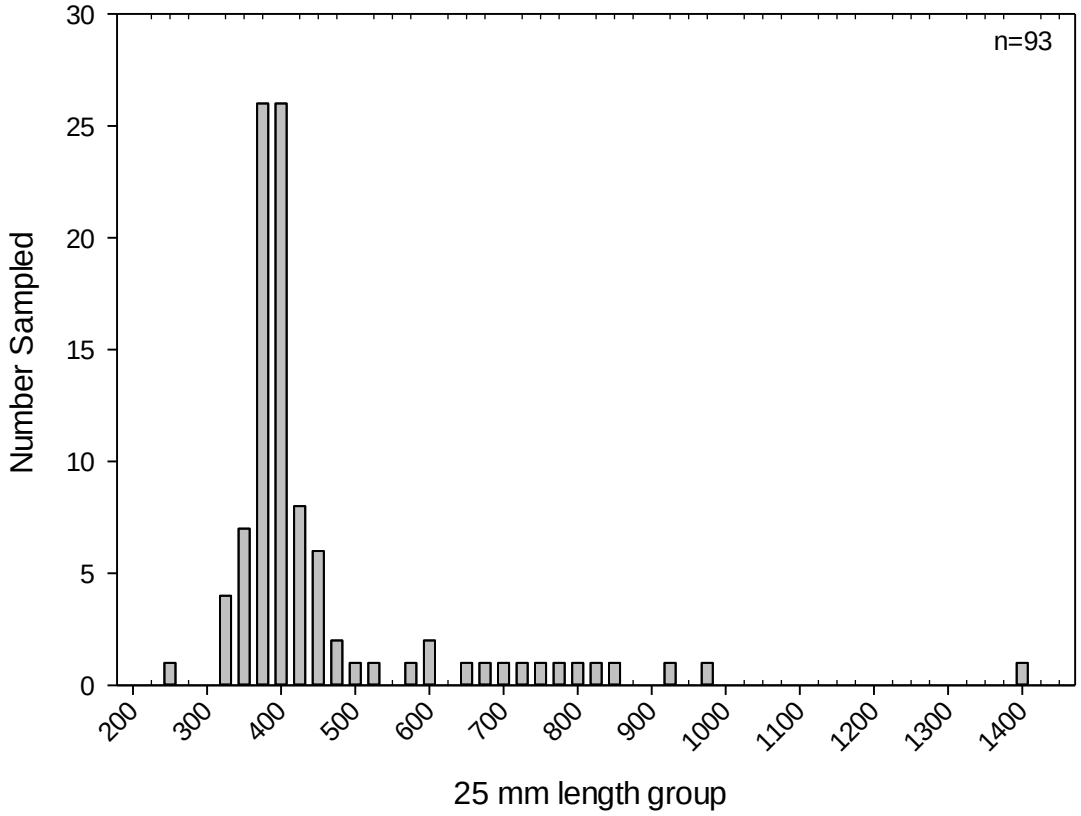

Figure 17. Length frequency histogram of pallid sturgeon captured in the Yellowstone River during 2013.

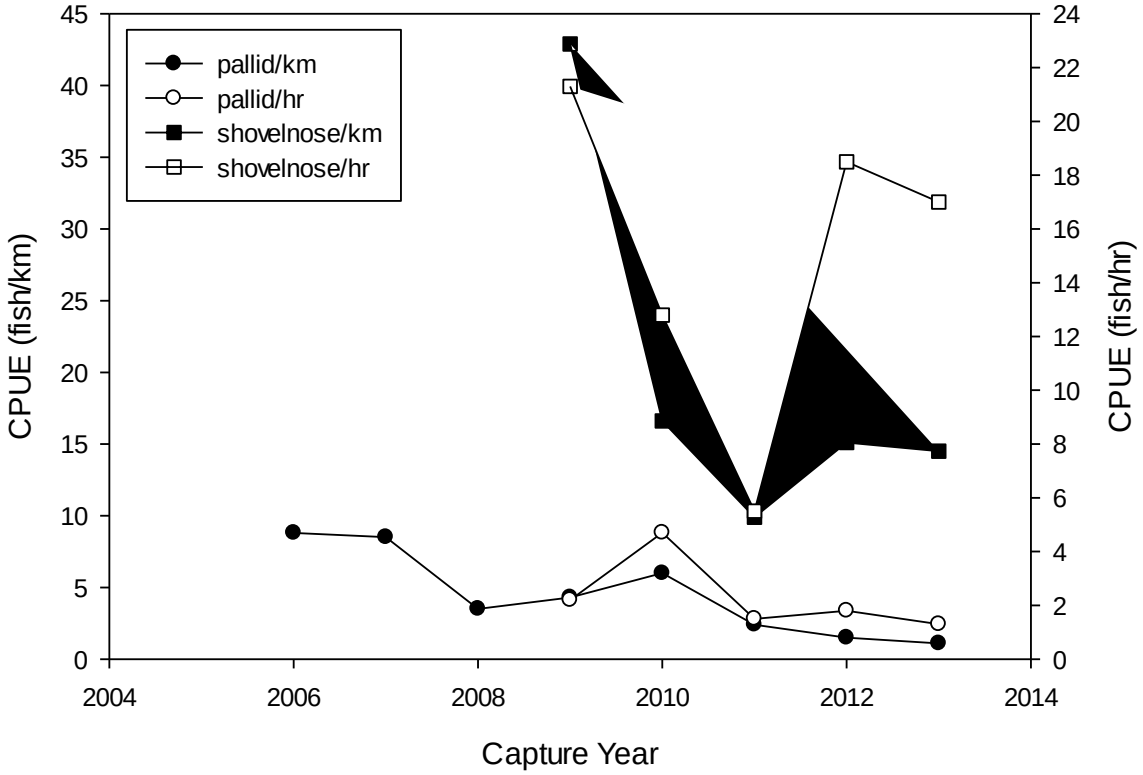

Figure 18. Yellowstone River catch per unit effort (fish per kilometer and fish per hour) for pallid and shovelnose sturgeon since 2006.

All captured pallid sturgeon were checked for any markings (e.g. PIT tag, scute removal, elastomers), and year-class and stocking location assignment were recorded for any individual that retained its marking/s. Data from the 2013 efforts revealed the largest proportion of pallid sturgeon captured consisted of the 2010 and 2012 year-classes (Figure 19). The 2008 and 2009 year-classes had the second highest proportion of pallid sturgeon captured. Pallid sturgeon stocked at Intake continued to represent the largest proportion of stocking location captures in 2013 (Figure 20). The upstream stocking location, Fallon, had the second highest proportion of individuals represented in the total captures.

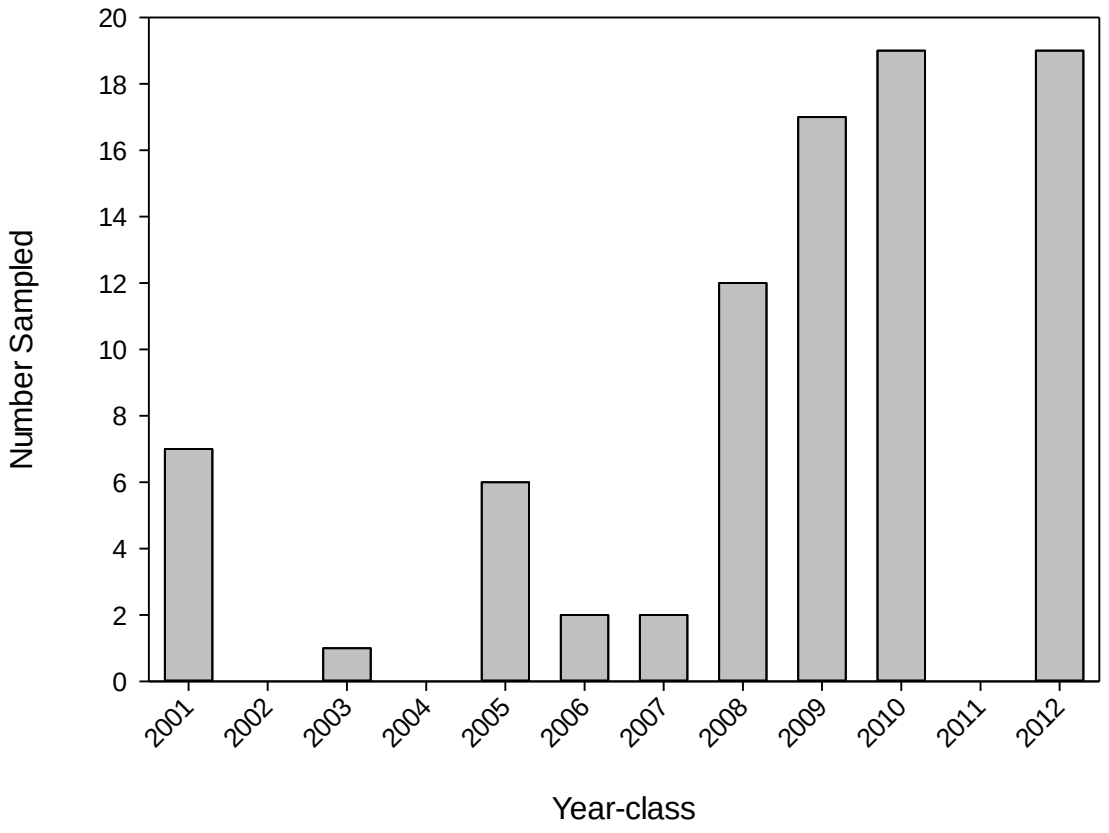

Figure 19. Year-class of pallid sturgeon captured in the Yellowstone River during 2013.

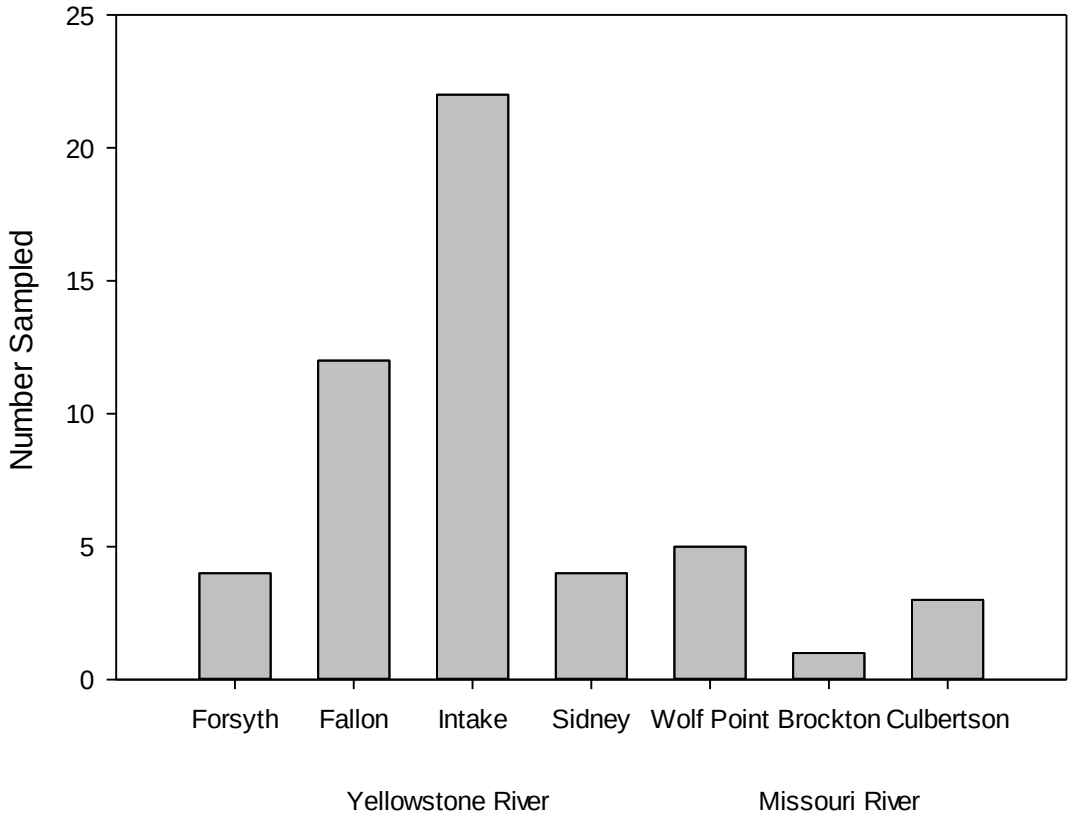

Figure 20. Stocking location of pallid sturgeon captured in the Yellowstone River during the 2013.

TARGETED PALLID STURGEON MONITORING UPSTREAM OF INTAKE DIVERSION DAM

Monitoring of hatchery-reared pallid sturgeon upstream of Intake Diversion Dam began in 2011 and was repeated in 2012 and 2013. Previous telemetry investigations (Fuller et al. 2007) suggested suitable pallid sturgeon habitat is available upstream of Intake Diversion Dam. In addition to annual spring sauger and walleye tagging efforts, targeted sampling was conducted to document presence of juvenile pallid sturgeon above Intake Diversion Dam. Trammel net sampling focused on bluff pools and relatively deep runs between Intake Diversion and Terry Bridge.

Eight days of netting effort upstream of Intake Diversion Dam resulted in 71 total trammel net drifts that equated to 17 netting hours and 18.4 km drifted. The effort resulted in the capture of two pallid sturgeon and 91 shovelnose sturgeon. The two captured pallid sturgeon were both caught on April 18th, during sampling aimed at catching walleye and sauger. The resultant pallid sturgeon catch rate upstream of Intake Diversion Dam was 0.12 fish/hr and 0.11 fish/km while shovelnose sturgeon catch rate was 5.3 fish/hr and 4.9 fish/km (Figure 21). Both pallid sturgeon and shovelnose sturgeon catch rates were lower upstream of Intake than downstream (Figure 21).

One of the pallid sturgeon sampled upstream of Intake, near Calypso (RM 142), was a 2010 year-class individual that was originally stocked near Fallon, Montana as a yearling. The second pallid sturgeon captured upstream of Intake, near Powder River Depot (RM 146), was a 2001 year-class individual that was originally stocked near Sidney, Montana (RM 31) as a yearling. Upon recapture in 2013, the 2001 year-class individual had a fork-length of 792 mm and a weight of 1785 g. This individual was of special interest as it had passed upstream of the Intake Diversion Dam at some time after being stocked downstream of the dam. Thus, the fish was equipped with a radio telemetry tag so as to monitor the movements and river use of a juvenile, hatchery-reared pallid sturgeon that is nearing maturity. A total of 16 relocation events took place, with at least one relocation occurring each month through December (Figure 22). The fish was relocated consistently at or below the Powder River confluence (RM 147) through April and early May. From mid-May through early July, the fish was relocated directly upstream of Wolf Rapids (RM 151). Subsequently the fish moved back downstream to the Powder River confluence from mid-July through early September. In late October, the individual was relocated near the Kinsey bridge (RM 170), and the remainder of relocations for 2013 were in this same vicinity.

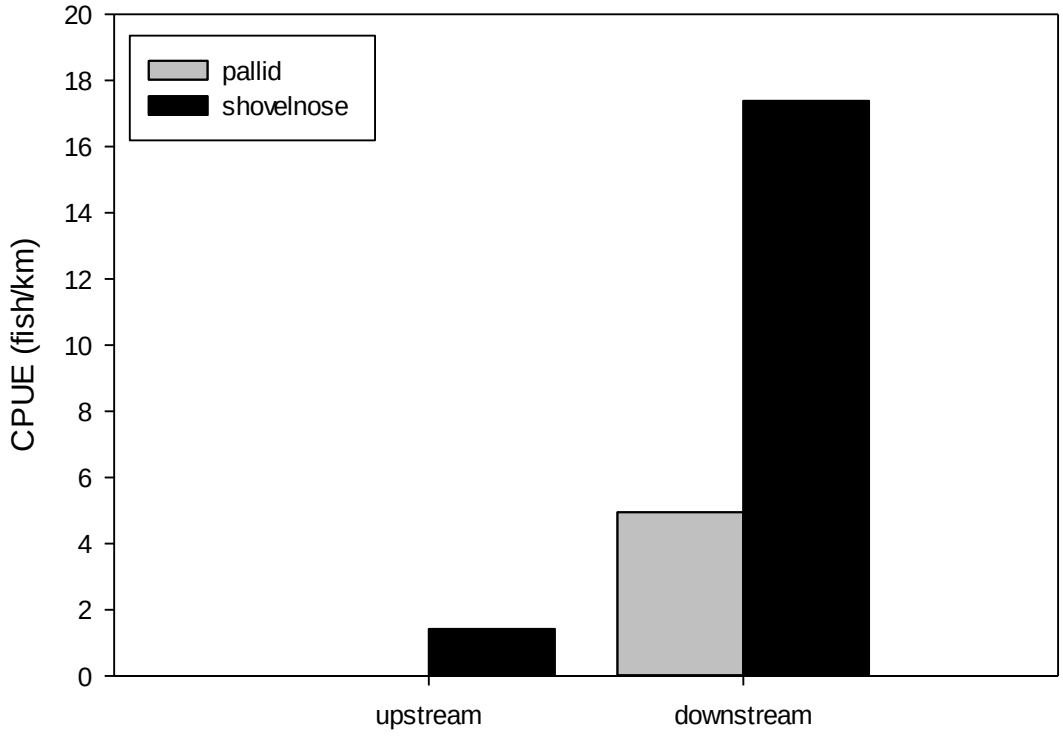

Figure 21. Relative abundance of pallid sturgeon and shovelnose sturgeon captured on the Yellowstone River upstream and downstream of Intake Diversion Dam in 2013.

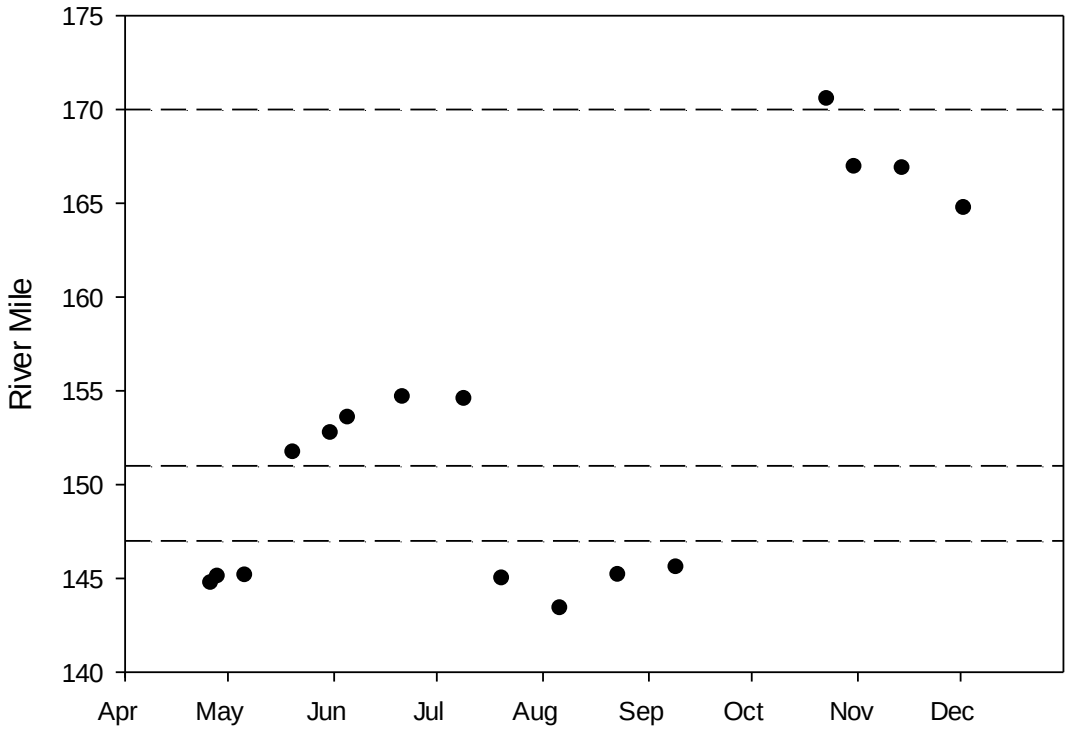

Figure 22. Relocation sites for juvenile pallid sturgeon (PIT 435F176246) in the Yellowstone River during 2013. The dashed lines represent the Powder River confluence (RM 147), Wolf Rapids (RM 151), and Kinsey bridge (RM 170).

MIGRATION PATHEWAYS, HABITAT USE, AND REPRODUCTION OF PALLID STURGEON

This was year two of a collaborative effort between USGS and Montana FWP investigating and assessing migration pathways, habitat use and reproduction of pallid sturgeon in the Yellowstone River. The research need stems from recovery efforts to attain passage at Intake Diversion Dam, where limited data are available regarding migrations and reproduction of pallid sturgeon. Additionally, the data will be utilized to derive comparison of pallid sturgeon migrations in the natural Yellowstone River to those of the lower channelized Missouri River. Efforts to monitor pallid sturgeon reproduction in the Yellowstone River is warranted to examine temporal periodicity of spawning events in relation to environmental conditions and to quantify specific habitat on spawning grounds in a natural system. Objectives of the research were 1) examine

migration pathways-timing, extent, main and side channel use and approach to Intake 2) analyze habitat use-depths and velocities 3) document spawning-timing, habitat and location 4) document the hatch of embryos.

Beginning in early April, we conducted manual tracking runs for telemetered adult fish on the Yellowstone River at intervals ranging from once per week to once per day. Tracking data was supplemented with telemetry ground stations. Depth and velocity of pallid sturgeon migration pathways were quantified using an acoustic Doppler current profiler (ADCP). Blood and gonad samples were submitted to Molly Webb for verification of spawning or atresia. Larval trawls were conducted in attempt to capture embryos.

Average river discharge during telemetered pallid sturgeons' initial approach to Intake Diversion Dam between 2005 and 2013 was 31,092 cfs (range: 8,844 – 76,700 cfs). Three pallid sturgeon arrived at Intake prior to May 1, three arrived between May 1 and May 15, and 21 arrived after May 15 (Table 2). Complete results of this research will be available by Braaten et al. in early 2014.

Table 2. Discharge and date of initial arrival for all pallid sturgeon approaching in Intake Diversion Dam on the Yellowstone River between 2005 and 2013.

				Prior to 1st Arrival	
Year	Code	Initial Arrival Date	Discharge (cfs)	Peak Flow	Date
2005	97	5/23/2005	24582	26800	14-May
2006	79	4/27/2006	9433	15000	21-Apr
2007	70	4/25/20007 [1]	9060	10200	24-Apr
	155	5/18/2007	25581		
2008	70	5/14/2008	8844	8870	12-May
	42	5/29/2008	36572		
2009	70	4/24/2009	10700	12300	18-Apr
2010	70	5/7/2010	9013	10500	28-Apr
2011	142	5/6/2011	13200	20300	25-Apr
	16	5/16/2011	23900		
	105	5/16/2011	23900		
	70	5/21/2011	48300		
	11	5/28/2011	76700		
	117	5/28/2011	76700		
	19	6/9/2011	56700		
	80 [2]	6/7/2011	55300		
2012	42	5/2/2012	18300	20400	14-Apr
	52	6/9/2012	39600		
	72	6/13/2012	30000		
	76	6/22/2012	23600		
	69	6/22/2012	23600		
2013	42	5/22/2013	26100	25500	21-May
	61	5/23/2013	25600		
	179	5/23/2013	25600		
	68	6/2/2013	48600		
	83	6/3/2013	38500		
	40	6/4/2013	32000		
	76	6/13/2013	30600		

[1] = fish located at rm 64.6, did not show up at Intake base station at rm 71

[2] = pallid caught by paddlefish angler, the radio (code 80) was inactive

Burbot

Burbot catch rates are consistently low but have trended upward in recent years, and reached a record high in 2013 (Figure 23). Low catch rates are attributed to the timing and gear used for trend sampling; burbot are most effectively sampled with baited hoop nets in the early spring and late autumn (Jones-Wuellner and Guy 2004). However, it is also possible that burbot are limited by the relatively high summer temperatures of the lower Yellowstone River (e.g. Nikcevic et al. 2000) and the low catch rates observed accurately reflect low abundances. These autumn trend data likely only provide an indication of presence or absence since electrofishing is an inefficient method for capturing burbot.

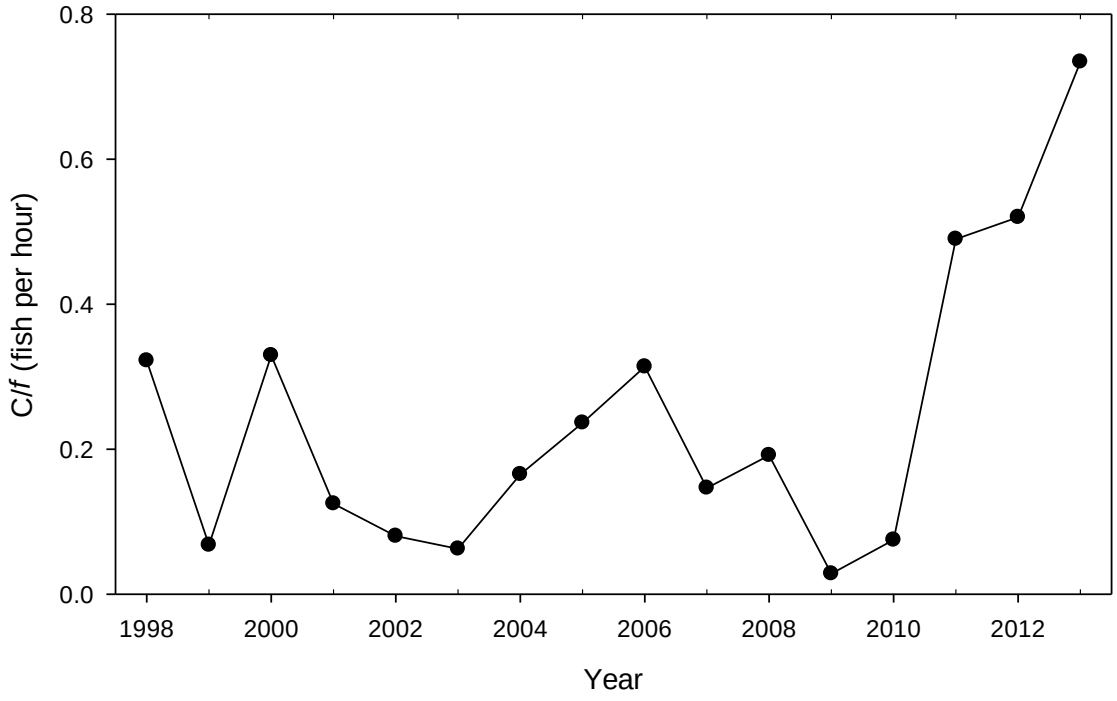

Figure 23. Autumn trend survey catch per effort of burbot in the Yellowstone River, 1998 to 2013.

Low catch rates also preclude inferences related to population structure and condition. Most burbot sampled during the autumn trend surveys were relatively small and of poor condition (Figure 24A, B). Despite the addition of all length and weight data the number

of burbot sampled remains low and limits inferences from this data set (Figure 24 C, D). Different gear types and sampling times are necessary to obtain an adequate sample size to characterize abundances, structure, and condition of this population. Research was conducted in 2004 and 2005 investigating the presence and distribution of burbot in the Yellowstone River. The investigation documented that burbot catch rates increased as river km increased (Rhoten 2010). Additional efforts are warranted to develop sampling methods that allow for population trend and size structure comparisons between collection years, and to determine the function of the Yellowstone River in the life-history of burbot.

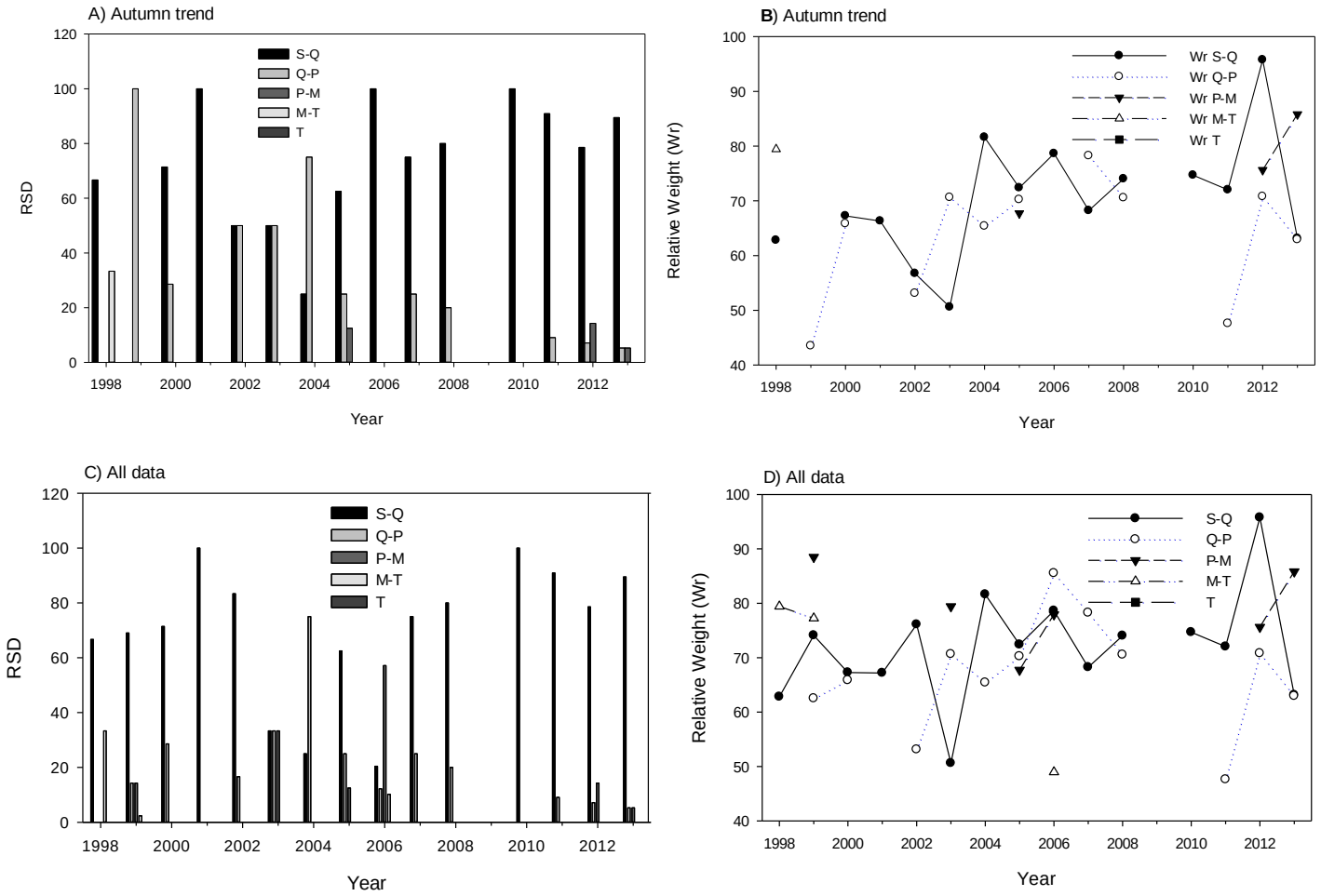

Figure 24. Incremental relative stock density (RSD) and relative weight (Wr) by length category of burbot captured in the Yellowstone River, 1998 to 2013.

Walleye

Catch rates of walleye were consistently low from 1998 to 2007 and then trend upward beginning in 2007 and was at an all time high in 2013 (Figure 25). The observed catch rate coincides with anecdotal angler reports of increased walleye abundances. Most walleye in the Yellowstone River were thought to be part of an adfluvial population residing in Sakakawea Reservoir (Penkal 1992). Adults move into the Yellowstone River from late autumn to early spring, spawn during April, and return to the reservoir (Penkal 1992). Recent floy tag return data supports these hypotheses.

Catch rates of walleye in all trends have trended upward since 2005 with 2011, 2012, and 2013 catch rates highest in the Intake trend section (Figure 26). The increased catch rates coincide with increased water levels of Sakakawea Reservoir, therefore it has been hypothesized that recent Yellowstone River upward trends may be resultant of elevated water levels in Sakakawea Reservoir. The elevated water levels put reservoir headwaters in closer than normal proximity to the Yellowstone River confluence. It is probable that the increased proximity to Sakakawea Reservoir headwaters has influenced the upward trend of walleye in autumn trend surveys. In addition, the elevated reservoir water levels increased productivity and as a result, catch rates within the Yellowstone River may simply reflect increased abundances within Sakakawea Reservoir. This upward trend should be monitored closely and is of concern because of potential sauger/walleye hybridization and increased competition with native sauger.

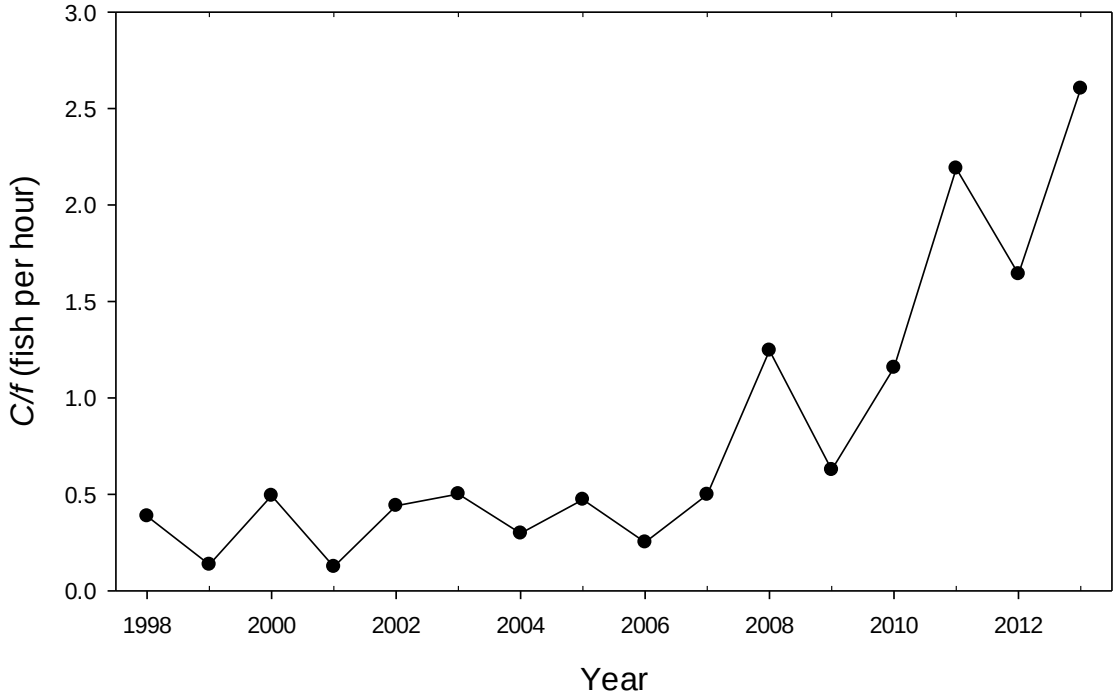

Figure 25. Catch per effort of walleye in the Yellowstone River, 1998 to 2013.

The walleye population structure was unbalanced and skewed towards smaller fish when trend surveys began, but in recent years the population has shifted towards larger fish (Figure 27 A, C). Size-specific condition of small walleye is less than sauger of the same size but as walleye increase in length their size-specific condition is greater than that observed for sauger of the same size (Figure 27 B, D).

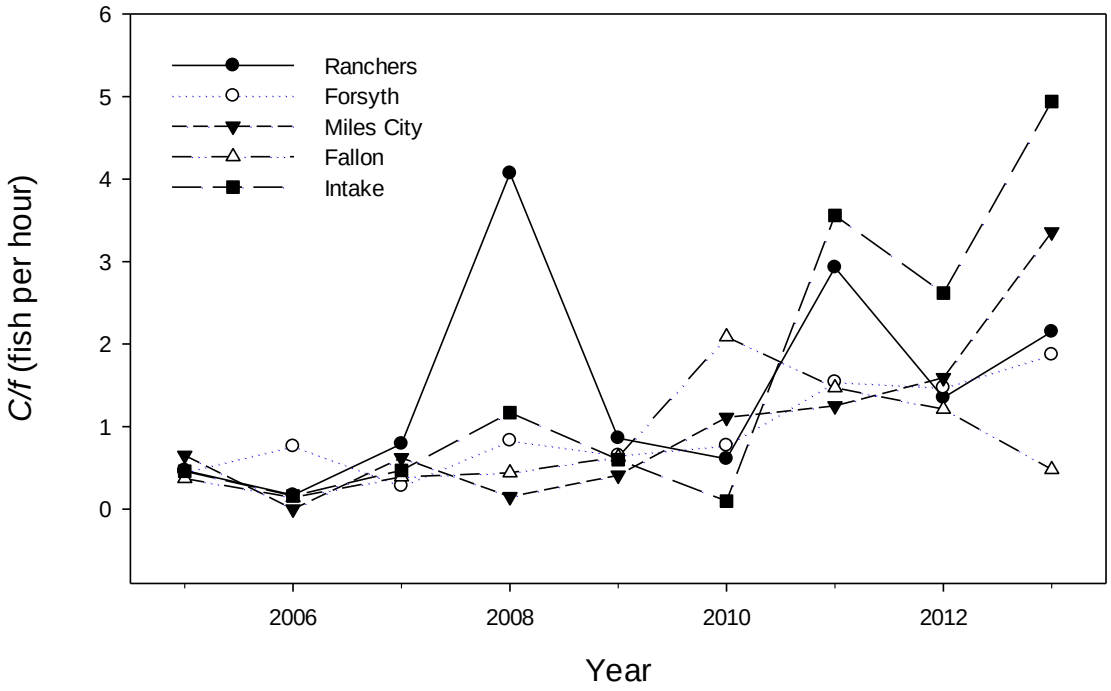

Figure 26. Catch per effort of walleye in the Yellowstone River by trend area, 2005 to 2013.

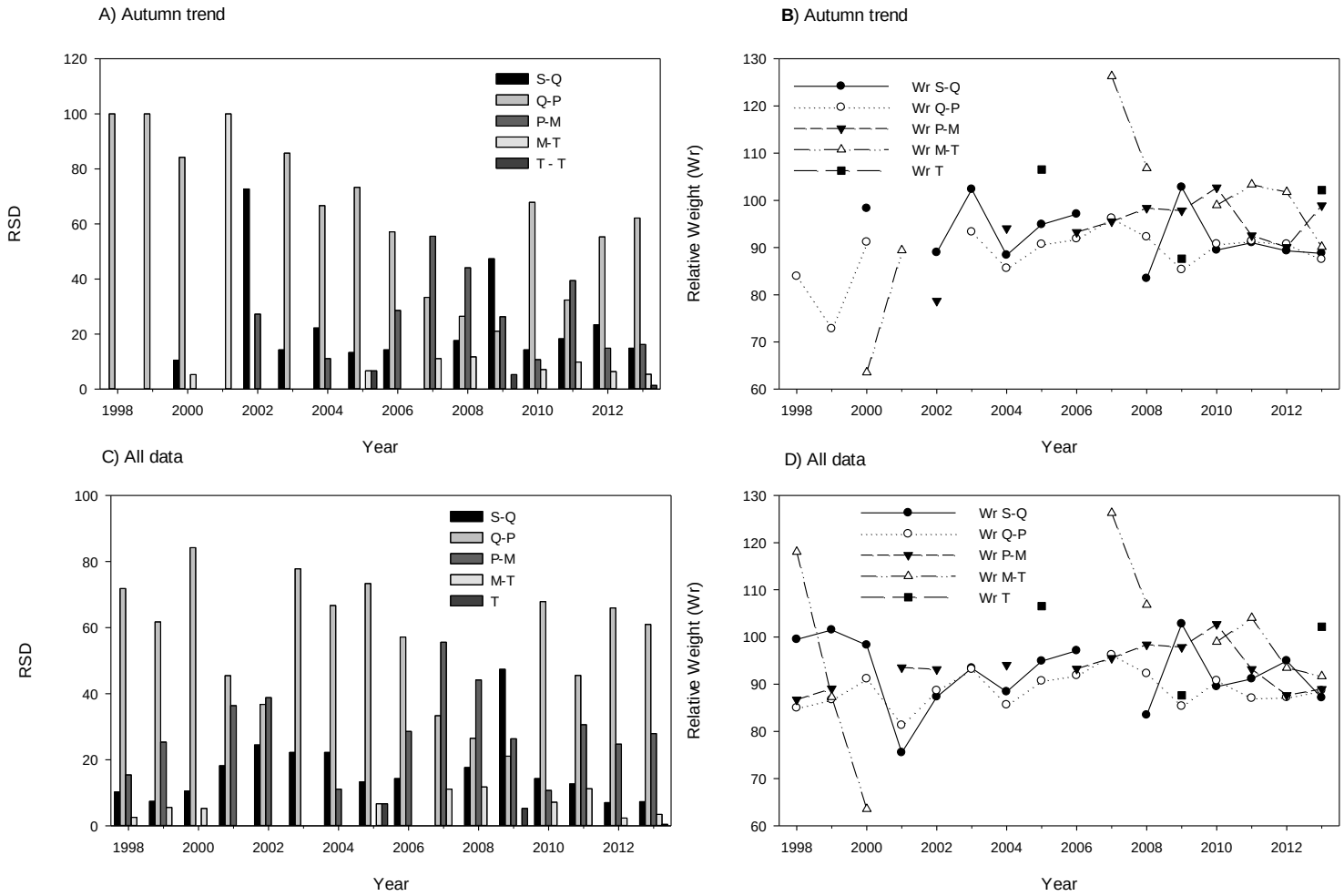

Figure 27. Incremental relative stock density (RSD) and relative weight (Wr) by length category of walleye captured in the Yellowstone River, 1998 to 2013.

Rare game fishes

Abundances of most rarely encountered game fish appear consistently low throughout all years with the exception of northern pike (Figure 28). Northern pike catch rates have increased two to five times that of historic catch rates between 1998 and 2009. Increased catches during trend sampling mimic anecdotal reports from anglers suggested abnormal increased northern pike abundances. The catch rates in 2012 and 2013 were the two highest on record for northern pike. Northern pike catch rates have been highest in the Intake trend area, the lower most trend section, from 2011 to 2013 (Figure 29).

Northern pike abundance increased in all trend areas but the most substantial increased occurred in the Intake trend area. It is assumed majority of northern pike are visitors to the Yellowstone River who originated in Sakakawea Reservoir. To investigate such assumptions 56 northern pike were equipped with floy tags in 2012. A very limited number of tags have been returned, thus the small sample size and short duration at large limits inferences at this time. It is hypothesized that the observed population increase will not persist for a number of reasons but mainly because the lotic and seasonally high turbidity waters in the Yellowstone River create unfavorable conditions for the species. Hypotheses associated with increased northern pike abundances echo those for increased walleye abundance. As mentioned above, the elevated water levels in recent years bolstered the reservoir fishery and as a result, it is probable, catch rates within the Yellowstone River simply reflect increased abundances within Sakakawea Reservoir. Additionally, a North Dakota biologist reported that with rapid water elevation loss, Sakakawea was not as productive in 2012. It is probable low productivity and increased predator abundance may have resulted in increased reservoir emigration, thereby increased northern pike catch rates in the Yellowstone River. Future trend surveys should help further explain catch rate fluctuations.

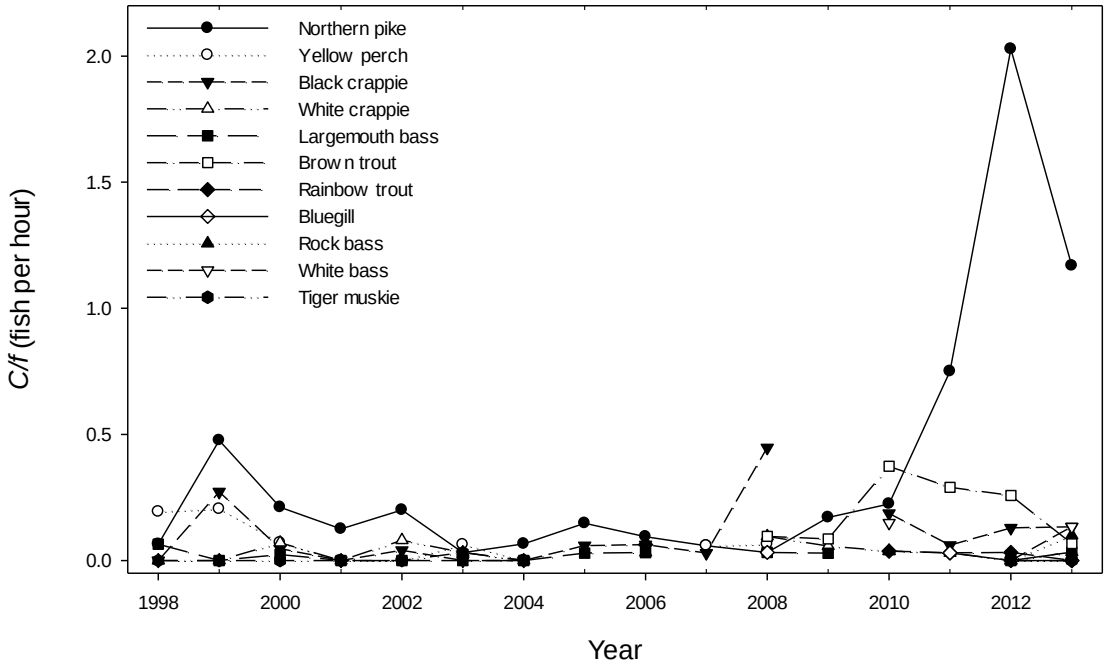

Figure 28. Catch per effort of rare game fishes in the Yellowstone River, 1998 to 2013.

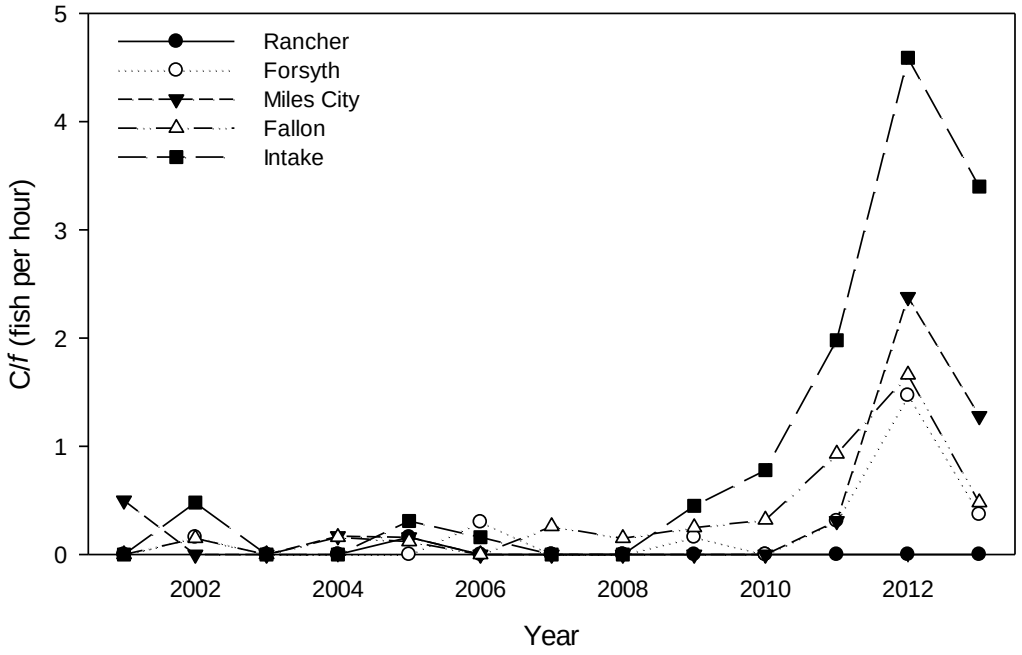

Figure 29. Catch per effort of Northern Pike in the Yellowstone River by trend area, 2001 to 2013. .

Common non-game fishes

Majority of common non-game fishes abundances have experienced a trend increase and others have remained relatively stable (Figure 30). Shorthead redhorse sucker and goldeye were the two most abundant species sampled. The abundance of shorthead redhorse sucker, goldeye and river carpsucker began to trend upward in 2004 and have remained at the relatively high abundance since that time.

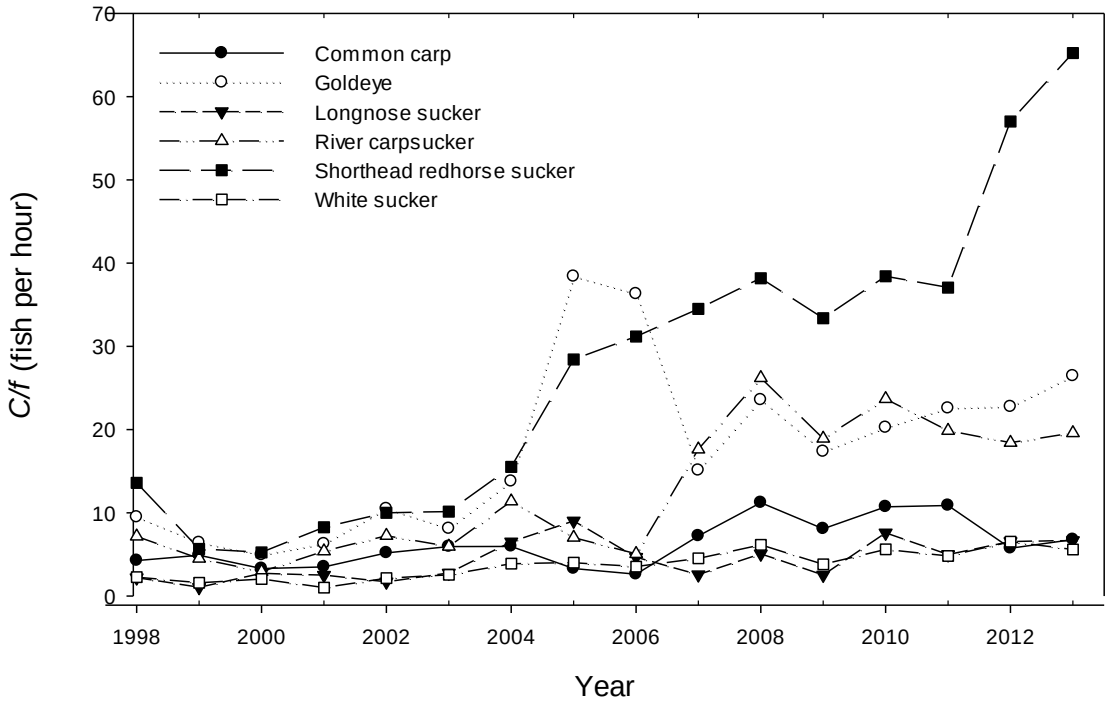

Figure 30. Catch per effort of common non-game fishes in the Yellowstone River, 1998 to 2013.

Rare non-game fishes

The majority of rare, non-game fish abundances have remained stable since 1998 (Figure 31). However, freshwater drum and smallmouth buffalo have increased in abundance from 2006 to present. Freshwater drum were the most abundant rare non-game fish captured. Abundance of freshwater drum catch per effort was below one fish

per hour until 2008. The 2013 trend survey catch rate of freshwater drum was slightly below the all-time high abundance of 4.4 fish per hour in 2012. Abundances of blue sucker, a Species of Special Concern in Montana, exhibited proportionally large fluctuations from 1998 to 2000 and displayed a historic high catch rate in 2012. The catch rate of blue sucker in 2013 decreased by over 50 percent from 2012, yet still remained above the historic average. Interest into the ecology and management of blue suckers in the Yellowstone River prompted an investigation into the precision of age estimates of blue suckers from calcified structures (Pearson et al. 2014, Appendix III). In short, two independent readers assigned age to 35 blue suckers using scales, fin rays, and opercles. Agreement was greatest between the two readers using left fin rays (26% exact agreement, 71% agreement within 2 years) and scales (14% exact agreement, 71% agreement within 2 years). However, the coefficient of variation (CV) was lowest for opercles (6.81). Pearson et al. reported that age estimates of blue suckers from the Yellowstone River should be used with extreme caution. Shortnose gar, also a Species of Special Concern in Montana, are rarely sampled during the trend survey. In 2011 the catch rate of shortnose gar was an all time high of 0.17 fish per hour. Interestingly, all six shortnose gar captures in 2011 occurred downstream of Intake on September 26, 2011. No shortnose gar were captured during 2013 sampling. However, anglers near Miles City have reported catching gar from 2011 to 2013. Additionally, three gar were collected in a fyke net set at Spotted Eagles reservoir in Miles City. Although the origin of these three gar is uncertain, it is likely that they came from the Yellowstone River downstream of Intake Diversion Dam (M. Backes, Montana FWP, *personal communication*).

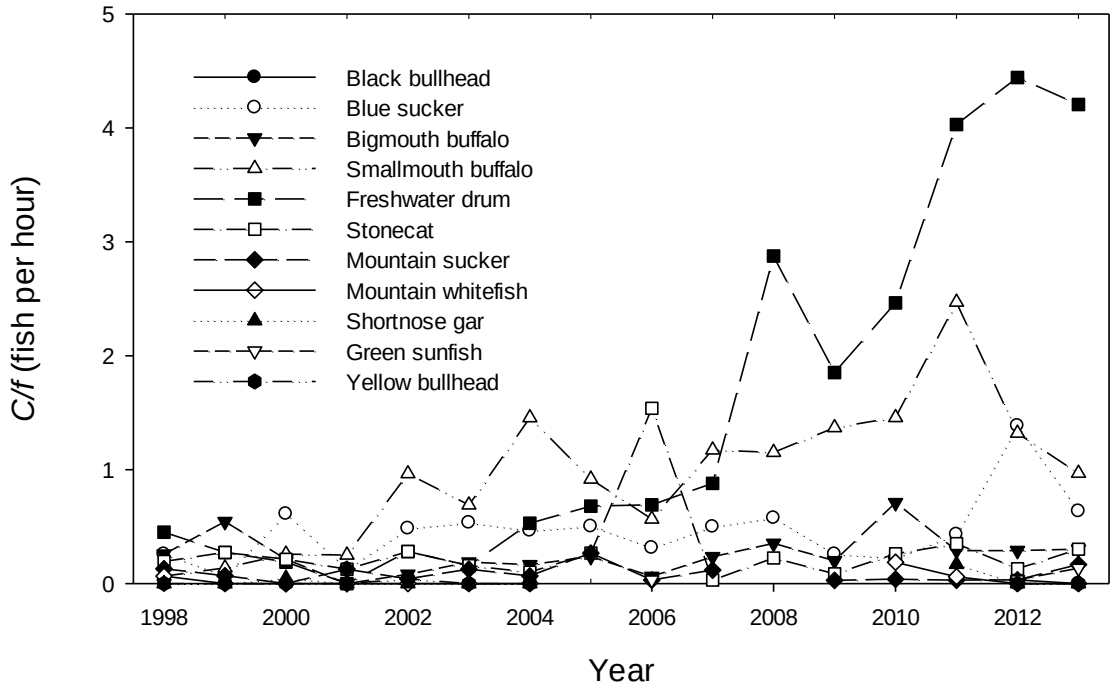

Figure 21. Catch per effort of rare non-game fishes in the Yellowstone River, 1998 to 2013.

Cyprinids

Only three cyprinids (flathead chub, Hybognathus spp., emerald shiner) were commonly encountered and catch rates of these species have continued a general upward trend (Figure 32). Catch rates in 2011 for emerald shiner and Hybognathus were at an all time high, likely a response to high Yellowstone River flows. Low river flows of 2012 and 2013 likely attributed to decreased catch rates of the three common cyprinids. Although electrofishing is an inefficient sampling method for most cyprinids, seine surveys found similar relative abundances among species in the Yellowstone River (Stewart 1997). Sturgeon chub, a Species of Special Concern, were not captured in the 2013 trend survey. However, electrofishing is an inefficient sampling method for this species (Stewart 1996).

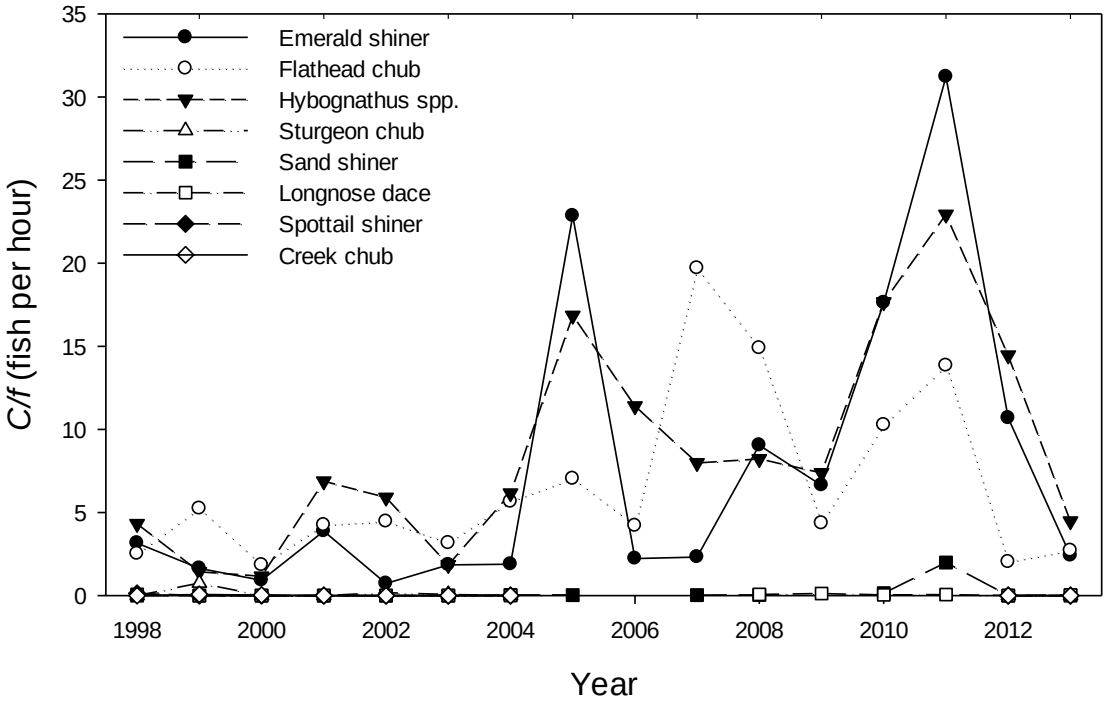

Figure 32. Catch per effort of cyprinids in the Yellowstone River, 1998 to 2013.

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Prepared by: Mathew Rugg

Date: January 21, 2014

APPENDIX I

SUMMARY OF ANNUAL CATCH BY TREND SECTION

Table 1. Results of trend sampling in the Yellowstone River, 2001.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Forsyth			
Channel catfish	4	2.00	552	422-733	1798	620-4050
Emerald shiner	10	5.00	65	37-98	--------	--------
Goldeye	5	2.50	336	320-360	302	280-330
Hybognathus spp	20	10.00	106	89-125	--------	--------
Longnose sucker	3	1.50	193	140-223	90	30-120
River carpsucker	8	4.00	405	390-438	913	760-1100
Sauger	1	0.50	465	--------	830	-------
Shorthead redhorse	17	8.50	346	136-497	553	30-1250
Smallmouth buffalo	21	10.50	323	190-433	643	110-1550
Walleye	1	0.50	512	--------	1300	--------
White sucker	7	3.50	355	197-438	586	130-870
			Miles City			
Blue sucker	1	0.50	753	--------	4000	--------
Carp	24	12.00	493	125-616	1673	25-3080
Flathead chub	4	2.00	150	124-163	30	--------
Goldeye	5	2.50	280	116-362	206	10-360
Hybognathus spp	20	10.00	105	82-127	--------	-------
Longnose sucker	14	7.00	242	180-407	190	50-800
Mountain sucker	1	0.50	148	--------	20	--------
Northern pike	1	0.50	457	--------	630	-------
River carpsucker	9	4.50	406	353-455	952	570-1440
Sauger	2	1.00	354	309-398	370	240-500
Shorthead redhorse	20	10.00	247	163-417	207	50-810
Smallmouth bass	4	2.00	225	125-300	228	10-500
White sucker	1	0.50	222	--------	110	--------
			Fallon			
Burbot	1	0.50	337	--------	190	--------
Carp	3	1.50	440	277-565	1243	310-2100
Channel catfish	4	2.00	460	204-635	1318	70-3100
Emerald shiner	14	7.00	78	70-93	--------	--------
Flathead chub	10	5.00	137	110-183	19	5-50

Goldeye	20	10.00	200	98-335	94	5-270
Hybognathus spp	8	4.00	102	82-142	20	-------
Longnose sucker	2	1.00	210	200-219	100	80-120
River carpsucker	6	3.00	418	352-467	1057	560-1480
Sauger	9	4.50	370	280-470	431	150-900
Shorthead redhorse	20	10.00	279	174-468	279	50-1050
Smallmouth buffalo	1	0.50	522	-------	2010	-------
			Intake			
Carp	1	0.50	617	--------	2200	-------
Emerald shiner	7	3.50	81	64-91	-------	-------
Flathead chub	20	10.00	139	112-187	26	10-60
Goldeye	20	10.00	218	111-395	114	10-610
Hybognathus spp	7	3.50	100	86-117	10	-------
Longnose sucker	1	0.50	176	--------	70	--------
River carpsucker	20	10.00	388	201-468	958	100-1500
Sauger	44	22.00	195	135-404	67	15-440
Shorthead redhorse	9	4.50	192	135-235	77	30-150
Shovelnose sturgeon	1	0.50	563	--------	570	--------
Smallmouth Buffalo	1	0.50	702	--------	5000	--------
Stonecat	1	0.50	96	--------	5	--------

Table 1 (*cont.*)

Table 2. Results of trend sampling in the Yellowstone River, 2002.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Weight Range (g)
			Forsyth			
Blue sucker	3	0.49	775	745-800	4085	3575-4500
Burbot	1	0.16	285	--------	100	--------
Carp	57	9.38	534	405-678	2082	910-4550
Channel catfish	28	4.61	529	302-726	1638	220-4160
Emerald shiner	6	0.99	74	64-86	5	--------
Flathead chub	6	0.99	125	104-165	14	5-30
Freshwater drum	1	0.16	360	--------	530	-------
Goldeye	70	11.51	317	193-363	270	70-400
Hybognathus spp	17	2.80	94	78-117	7	5-20
Longnose sucker	13	2.14	358	203-668	425	50-800
Mountain sucker	1	0.16	147	-------	60	-------
Northern pike	1	0.16	620	--------	1610	--------
River carpsucker	56	9.21	388	126-445	781	20-1140
Sauger	26	4.28	388	287-614	535	160-1960
Shorthead redhorse	92	15.13	298	143-498	339	40-1200
Shovelnose sturgeon	7	1.15	828	751-920	3280	2300-5550
Smallmouth bass	44	7.24	264	76-467	463	10-1640
Smallmouth buffalo	7	1.15	471	408-535	1570	990-2240
Sturgeon chub	1	0.16	80	--------	5	--------

Walleye	4	0.66	441	332-583	853	320-1820
White sucker	43	7.07	321	130-428	435	20-860
Yellow bullhead	1	0.16	230	--------	160	--------

Table 2 (*cont.*)

			Miles City			
Bigmouth buffalo	2	0.33	566	557-574	2925	2680-3170
Black crappie	1	0.16	208	--------	150	--------
Blue sucker	5	0.82	717	663-795	3172	2530-4300
Burbot	1	0.16	400	--------	250	--------
Carp	50	8.24	476	324-576	1488	310-2940
Channel catfish	9	1.48	534	344-690	1673	310-2930
Emerald shiner	8	1.32	77	72-86	--------	--------
Flathead chub	67	11.04	130	95-190	23	5-80
Freshwater drum	3	0.49	427	367-494	1083	640-1550
Goldeye	58	9.56	304	106-374	255	5-410
Hybognathus spp	81	13.34	111	87-150	13	5-30
Longnose sucker	25	4.12	333	205-425	431	80-830
River carpsucker	67	11.04	376	74-498	750	5-1320
Sauger	47	7.74	367	237-528	437	110-1150
Shorthead redhorse	50	8.24	304	175-440	337	70-850
Smallmouth bass	15	2.47	247	56-348	286	5-650
Smallmouth buffalo	16	2.64	512	303-721	2016	300-5000
Sturgeon chub	1	0.16	89	--------	5	--------
Walleye	5	0.82	328	307-341	324	280-380
White crappie	2	0.33	268	194-342	395	100-690
White sucker	6	0.99	287	230-385	290	170-580
			Fallon			
Blue sucker	2	0.30	732	721-742	3310	3300-3320
Carp	12	1.82	485	200-615	1590	120-2850
Channel catfish	5	0.76	324	145-654	672	30-2800
Emerald shiner	1	0.15	73	--------	--------	-------
Flathead chub	8	1.21	146	121-171	30	20-50
Freshwater drum	1	0.15	447	--------	1240	-------
Goldeye	65	9.85	272	108-358	185	15-410
Hybognathus spp	10	1.52	104	77-140	10	5-20
Longnose sucker	3	0.45	342	304-366	433	310-510
Northern pike	1	0.15	536	--------	990	--------
River carpsucker	17	2.58	366	178-459	724	70-1220
Sauger	21	3.18	372	169-565	453	30-1440
Shorthead redhorse	65	9.85	304	163-485	317	40-1040
Shovelnose sturgeon	4	0.61	602	457-690	978	320-1450
Smallmouth buffalo	1	0.15	494	--------	1650	--------
Stonecat	7	1.06	116	92-144	11	5-20
Sturgeon chub	2	0.30	73	69-77	5	--------
White sucker	2	0.30	300	251-349	270	110-430
			Intake			
Carp	10	1.61	442	186-710	1728	100-4540

Channel catfish	4	0.65	474	235-580	1218	120-1800
Emerald shiner	3	0.48	82	77-87	5	--------
Flathead chub	30	4.84	167	124-210	44	10-80

Table 2 (*cont*.)

Freshwater drum	1	0.16	295	--------	300	--------
Goldeye	61	9.84	243	104-362	145	10-400
Hybognathus spp	39	6.29	106	91-128	9	5-20
Longnose sucker	1	0.16	267	--------	200	--------
Northern pike	3	0.48	679	568-889	1833	920-3530
River carpsucker	40	6.45	408	168-520	1130	90-2320
Sauger	122	19.68	286	190-475	198	60-830
Shorthead redhorse	42	6.77	253	180-378	195	70-600
Shovelnose sturgeon	21	3.39	499	331-738	512	120-1700
Walleye	2	0.32	402	293-510	730	210-1250
White sucker	2	0.32	281	264-298	210	120-300

Table 3. Results of trend sampling in the Yellowstone River, 2003.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Carp	42	22.91	551.8	355-660	2355.5	640-3920
Channel catfish	28	15.28	561.9	423-710	2108.9	620-5300
Flathead chub	20	10.91	124.5	93-174	18	10-50
Freshwater drum	2	1.09	453.5	390-517	1440	710-2170
Goldeye	23	12.55	327	284-378	310.9	200-470
Longnose sucker	17	9.27	281.1	196-407	248.8	60-600
River carpsucker	15	8.18	396.8	282-450	793.3	290-1050
Shorthead redhorse	93	50.74	342.1	153-507	495	40-1240
Smallmouth bass	8	4.36	260.1	112-380	431.3	20-1060
Smallmouth buffalo	2	1.09	698.5	645-752	5650	4300-7000
Western silvery minnow	2	1.09	111	110-112	10	---
White sucker	10	5.46	345.5	235-432	476	120-920
			Forsyth			
Bigmouth buffalo	4	0.58	611.5	481-806	3445	210-7090
Blue sucker	2	0.29	735.5	715-756	3875	3000-4750
Burbot	1	0.15	430	---	410	---
Carp	83	12.06	515.2	316-702	1853.7	300-5000
Channel catfish	67	9.74	508.9	295-741	1587.8	240-5020
Emerald shiner	8	1.16	78.3	68-94	10	---
Flathead chub	9	1.31	120.2	95-176	29.4	10-50
Freshwater drum	1	0.15	430	---	1130	---
Goldeye	115	16.72	314.4	272-355	287.3	200-370
Longnose sucker	22	3.20	250.2	88-450	299.5	20-950
Mountain sucker	4	0.58	131.5	112-163	31.3	20-50
River carpsucker	68	9.88	382	225-520	760.2	120-2580
Sauger	45	6.54	361	164-552	456	20-1620

Shorthead redhorse	202	29.36	337.4	142-453	439.3	30-950
Shovelnose sturgeon	14	2.03	810.4	573-915	2700.7	680-4900
Smallmouth bass	39	5.67	223.2	68-403	417.7	10-1280

Table 3 (*cont.*)

Smallmouth buffalo	11	1.60	531.5	389-722	2588.2	900-6200
Walleye	4	0.58	379	223-446	612.5	110-890
Western silvery minnow	4	0.58	105.5	90-112	12.5	10-20
White crappie	1	0.15	172	---	80	---
White sucker	37	5.38	349.3	171-450	534.6	70-900
			Miles City			
Blue sucker	7	1.05	695.3	610-738	3162.9	2020-3840
Carp	39	5.85	515.7	309-670	2021.7	380-5000
Channel catfish	19	2.85	505.2	69-688	1737.8	380-4800
Emerald shiner	79	11.84	86.4	75-105	5	---
Flathead chub	24	3.60	143.8	110-170	35.7	10-60
Goldeye	55	8.25	307.8	140-307.8	290.2	20-460
Longnose sucker	24	3.60	310.8	125-445	360.8	20-780
River carpsucker	32	4.80	39706	227-458	827.5	150-1200
Sauger	20	3.00	381.4	265-507	508.5	170-1150
Shorthead redhorse	159	23.84	304.9	92-465	368.5	60-1130
Shovelnose sturgeon	3	0.45	796.3	684-868	2853.3	1510-3870
Smallmouth bass	49	7.35	130.5	80-384	87.5	5-1100
Smallmouth buffalo	3	0.45	583.7	480-636	3603.3	1720-5000
Stonecat	2	0.30	134.5	129-140	10	---
Tiger musky	1	0.15	864	---	5100	---
Walleye	1	0.15	208	---	110	---
Western silvery minnow	21	3.15	104.9	83-139	18.6	10-40
White sucker	4	0.60	353	328-399	530	450-700
			Fallon			
Blue sucker	5	0.72	660	466-757	3052	750-4550
Burbot	1	0.14	370	---	190	---
Carp	30	4.32	444.3	88-710	1566.9	10-4600
Channel catfish	23	3.31	393.4	70-601	1267.8	20-2270
Flathead chub	28	4.03	139.6	98-207	30	10-80
Freshwater drum	2	0.29	467	394-540	1475	820-2130
Goldeye	37	5.32	197.5	84-327	222.4	10-360
Longnose sucker	4	0.58	264.3	116-371	376.7	270-560
River carpsucker	13	1.87	351.4	72-475	872.7	280-1700
Sauger	71	10.22	380.1	174-549	502.8	40-1460
Shorthead redhorse	66	9.50	335.7	68-480	576.2	20-1350
Shovelnose sturgeon	18	2.59	743.8	584-867	2188.3	770-3930
Smallmouth bass	1	0.14	126	---	30	---
Smallmouth buffalo	2	0.29	300	110-490	1760	---
Stonecat	3	0.43	114.7	106-128	---	---
Walleye	1	0.14	200	---	50	---
Western silvery minnow	4	0.58	102.8	96-117	---	---

			Intake			
Blue sucker	3	0.41	730	711-750	3690	3380-4010
Carp	7	0.95	42634	187-521	1234.3	100-2000

Table 3 (*cont.*)

Channel catfish	20	2.70	544	132-704	1823.5	100-4500
Emerald shiner	19	2.57	84.7	72-101	---	---
Flathead chub	20	2.70	147	84-217	36.3	10-110
Goldeye	69	9.32	266.9	100-393	192.3	10-400
Longnose sucker	5	0.68	214.6	110-265	124	10-230
River carpsucker	68	9.19	434	213-624	1340.9	100-3050
Sauger	154	20.81	265.7	161-512	172.2	20-1040
Shorthead redhorse	34	4.59	260.9	160-360	220.6	40-500
Shovelnose sturgeon	10	1.35	587.3	315-830	1154	100-2820
Smallmouth buffalo	4	0.54	516	468-575	1892.5	1250-2420
Sturgeon chub	2	0.27	98.5	82-97	---	---
Walleye	5	0.68	217.2	210-228	86	70-110
Western silvery minnow	24	3.24	102.8	57-135	11.5	5-20
White sucker	1	0.14	322	---	380	---

Table 4. Results of trend sampling in the Yellowstone River, 2004.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Blue sucker	1	0.18	683	---	2490	---
Burbot	1	0.18	330	---	220	---
Carp	78	14.39	595.9	379-706	2958.8	680-4200
Channel catfish	33	6.09	576.1	323-752	2336.1	270-5900
Flathead chub	4	0.74	121.8	106-147	30	---
Freshwater drum	1	0.18	378	---	740	---
Goldeye	29	5.35	327.2	297-344	305.2	210-360
Longnose sucker	143	26.38	243.5	70-482	193.6	10-1180
Mountain sucker	1	0.18	118	---	---	---
River carpsucker	86	15.87	403.5	343-457	881.1	530-1420
Sauger	5	0.92	387	336-454	498	250-860
Shorthead redhorse	356	65.68	339.8	149-508	489.8	40-1520
Smallmouth bass	47	8.67	208.8	141-345	176.1	40-770
Smallmouth buffalo	6	1.11	616	483-750	4151.7	1720-8040
Stonecat	1	0.18	104	---	---	---
Western silvery minnow	124	22.88	99.6	79-145	15	10-20
White sucker	53	9.78	343.5	104-451	520.9	170-1070
			Forsyth			
Bigmouth buffalo	2	0.32	572	528-616	3510	2320-4700
Blue sucker	2	0.32	729	706-752	3715	3250-4180

Burbot	1	0.16	435	---	270	---
Carp	65	10.27	543.7	245-684	2207.5	250-3810

Table 4 (*cont.*)

Channel catfish	25	3.95	537.3	266-711	1994.4	190-3720
Emerald shiner	43	6.79	73.1	56-98	---	---
Flathead chub	6	0.95	141.2	132-159	22	10-40
Freshwater drum	5	0.79	417.4	378-472	924	760-1210
Goldeye	125	19.75	316.1	195-379	275.6	60-450
Longnose sucker	44	6.95	277.8	115-452	322.1	30-920
Mountain sucker	1	0.16	130	---	60	---
River carpsucker	84	13.27	395	268-460	803.9	250-1200
Sand shiner	1	0.16	68	---	---	---
Sauger	21	3.32	372.9	158-489	482.4	20-1100
Shorthead redhorse	269	42.50	349.9	150-505	514.3	50-1180
Shovelnose sturgeon	3	0.47	772	750-803	2430	1780-3310
Smallmouth bass	28	4.42	240.4	129-394	302.9	30-1120
Smallmouth buffalo	16	2.53	549.3	335-665	2682.5	640-5000
Walleye	2	0.32	425.5	387-464	765	530-1000
Western silvery minnow	8	1.26	79.4	74-85	---	---
White sucker	48	7.58	323.9	98-423	468.5	10-850
				Miles City		
Blue sucker	10	1.67	713.2	678-770	3069	2350-3990
Carp	53	8.83	529.9	260-1495	1906	300-3600
Channel catfish	13	2.17	416.4	256-625	810.8	140-2380
Emerald shiner	5	0.83	76.2	55-93	---	---
Flathead chub	52	8.67	146	106-196	33.3	10-80
Freshwater drum	4	0.67	404.8	372-463	972.5	780-1370
Goldeye	67	11.17	296.2	103-346	265.8	10-360
Longnose sucker	26	4.33	307	209-452	373.5	80-960
Northern pike	1	0.17	617	---	1520	---
River carpsucker	64	10.67	390.6	251-513	831.4	100-1930
Sauger	24	4.00	395	290-485	539.6	130-1070
Shorthead redhorse	260	43.33	332.1	135-494	484.9	20-1310
Shovelnose sturgeon	1	0.17	913	---	4400	---
Smallmouth bass	27	4.50	221.6	92-410	277	10-1140
Smallmouth buffalo	8	1.33	518.8	324-720	2405	250-6100
Walleye	3	0.50	468	393-526	993.3	490-1490
Western silvery minnow	26	4.33	121.3	98-146	21.3	10-60
White sucker	12	2.00	333.8	240-400	495	120-780
				Fallon		
Carp	22	3.42	536.9	383-652	2133.6	770-3880
Channel catfish	14	2.18	478.8	315-662	1153.6	260-3090

Flathead chub	77	11.98	132.1	92-233	33.3	5-120
Freshwater drum	3	0.47	333.7	287-392	490	320-740

Table 4 (*cont.*)

Goldeye	143	22.24	273.7	86-347	238.9	60-350
Longnose sucker	6	0.93	269.7	202-350	250	80-520
Northern pike	1	0.16	827	---	4150	---
River carpsucker	51	7.93	391.1	133-530	891	20-2330
Sauger	66	10.26	405.9	239-560	568.3	120-1320
Shorthead redhorse	146	22.71	261.2	148-487	293.6	30-1280
Smallmouth bass	4	0.62	167.3	65-207	133.3	120-150
Smallmouth buffalo	8	1.24	429.8	198-582	1530	130-3120
Stonecat	2	0.31	114	86-142	30	---
Walleye	1	0.16	384	---	520	---
Western silvery minnow	85	13.22	103	86-140	---	---
White sucker	3	0.47	336.3	270-428	486.7	220-900
			Intake			
Bigmouth buffalo	3	0.50	646	591-700	4150	3340-5080
Blue sucker	1	0.17	733	---	3280	---
Burbot	3	0.50	375.7	167-527	361.7	15-680
Carp	15	2.48	460.4	324-603	1424.7	490-2780
Channel catfish	9	1.49	479.9	225-668	1641.1	160-3170
Emerald shiner	9	1.49	77.9	69-86	---	---
Flathead chub	32	5.29	149.9	93-198	37.3	10-70
Freshwater drum	3	0.50	308.3	290-320	390	350-460
Goldeye	200	33.06	273.3	110-372	195.7	10-370
Longnose sucker	2	0.33	273.5	237-310	215	80-350
River carpsucker	118	19.50	415	149-560	1187.2	50-3250
Sauger	187	30.91	313.5	197-500	253.5	50-1000
Shorthead redhorse	54	8.93	271.8	130-392	280.4	30-700
Shovelnose sturgeon	31	5.12	569.8	405-861	952.6	170-3280
Smallmouth bass	1	0.17	214	---	180	---
Smallmouth buffalo	6	0.99	416.3	189-528	1201.7	100-2160
Walleye	3	0.50	363.3	298-473	480	210-920
Western silvery minnow	35	5.79	100	84-128	10	---
White sucker	2	0.33	286	260-312	295	210-380

Table 5. Results of trend sampling in the Yellowstone River, 2005.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Bigmouth Buffalo	1	0.16	601	---	3560	---

Burbot	1	0.16	336	---	240	---
Carp	19	2.99	589	498-679	2820	1570-4020

Table 5 (*cont.*)

Channel catfish	20	3.15	497	365-638	1365	430-3130
Emerald Shiner	139	21.89	78	58-91	4	---
Flathead chub	9	1.42	140	82-206	40	4-90
Freshwater drum	2	0.31	430	420-439	1060	960-1160
Goldeye	108	17.01	323	285-360	305	200-420
Longnose sucker	211	33.23	297	128-417	331	50-730
Mountain Sucker	6	0.94	177	158-205	81	55-130
Northern Pike	1	0.16	635	---	1500	---
River carpsucker	16	2.52	395	338-430	786	460-990
Sand Shiner	1	0.16	60	---	2	---
Sauger	2	0.31	373	350-395	370	320-420
Shorthead redhorse	174	27.40	366	140-475	591	40-1260
Smallmouth bass	27	4.25	270	112-387	393	30-1070
Smallmouth buffalo	5	0.79	646	501-700	4148	1940-4800
Stonecat	1	0.16	170	---	70	---
Walleye	3	0.47	562	475-716	2150	970-4200
Western silvery minnow	424	66.77	99	74-129	9	4-25
White sucker	69	10.87	341	128-435	539	24-1020
				Forsyth		
Bigmouth buffalo	1	0.15	559	---	2630	---
Burbot	1	0.15	583	---	950	---
Carp	32	4.84	519	313-705	2007	350-5000
Channel catfish	36	5.44	395	239-794	778	120-6150
Emerald shiner	212	32.04	82	62-105	4	---
Flathead chub	8	1.21	156	116-197	38	14-68
Freshwater drum	6	0.91	388	366-442	738	560-1110
Goldeye	333	50.33	317	228-382	298	200-520
Largemouth Bass	1	0.15	122	---	20	---
Longnose sucker	48	7.25	326	198-485	401	90-980
Mountain sucker	3	0.45	185	175-194	80	60-110
River carpsucker	47	7.10	387	315-460	763	430-1250
Sauger	40	6.05	368	265-477	423	128-920
Shorthead redhorse	295	44.58	331	150-523	435	40-1300
Shovelnose sturgeon	1	0.15	792	---	2430	---
Smallmouth bass	94	14.21	258	83-413	325	9-1150
Smallmouth buffalo	3	0.45	545	488-591	2667	1700-3540
Walleye	3	0.45	531	405-767	2303	630-5600
Western silvery minnow	69	10.43	107	84-138	11	4-24

White sucker	40	6.05	330	181-434	484	90-970

Table 5 (*cont*.)

			Miles City			
Black Crappie	2	0.33	185	184-185	100	100
Blue sucker	7	1.14	702	640-780	2947	2010-3880
Burbot	1	0.16	430	---	390	---
Carp	17	2.78	547	436-648	2239	1150-3650
Channel catfish	7	1.14	486	192-701	1516	50-3900
Emerald shiner	97	15.86	80	67-101	4	---
Flathead chub	16	2.62	144	113-182	31	11-65
Freshwater Drum	1	0.16	380	---	730	---
Goldeye	159	25.99	319	265-397	311	180-410
Longnose sucker	24	3.92	336	223-412	470	140-870
Northern Pike	1	0.16	692	---	2050	---
River carpsucker	34	5.56	379	164-470	777	60-1580
Sauger	37	6.05	381	287-574	483	180-1580
Shorthead redhorse	183	29.92	329	148-495	427	40-1230
Smallmouth bass	21	3.43	272	101-400	406	30-1150
Smallmouth buffalo	5	0.82	554	394-691	2606	810-4000
Stonecat	2	0.33	165	145-185	45	30-60
Walleye	4	0.65	446	430-465	818	800-930
Western silvery minnow	13	2.13	152	49-410	158	1-930
White sucker	15	2.45	322	201-425	421	100-840
			Fallon			
Bigmouth Buffalo	1	0.12	725	---	6600	
Blue sucker	9	1.10	694	588-753	3008	1390-4010
Burbot	2	0.24	372	248-495	365	90-640
Carp	33	4.02	528	295-706	2239	400-4150
Channel catfish	36	4.38	390	166-726	787	60-3810
Emerald Shiner	4	0.49	84	72-98	4	---
Flathead chub	160	19.47	144	78-222	31	4-118
Freshwater drum	12	1.46	355	920-494	693	324-1560
Goldeye	270	32.86	293	105-353	241	14-430
Longnose Dace	1	0.12	80	---	6	---
Longnose sucker	17	2.07	272	209-445	267	100-950
Northern pike	1	0.12	548	---	1040	---
River carpsucker	20	2.43	381	311-467	756	430-1300
Sauger	82	9.98	396	242-595	579	100-1910
Shorthead redhorse	205	24.95	309	92-492	423	5-1390
Shovelnose sturgeon	5	0.61	786	658-905	2878	1390-4150

Smallmouth bass	1	0.12	311	---	570	---
Smallmouth buffalo	10	1.22	582	331-776	3468	510-7050

Table 5 (*cont*.)

Stonecat	5	0.61	134	108-151	24	8-32
Walleye	3	0.37	382	212-498	683	90-1080
Western silvery minnow	18	2.19	117	85-135	17	5-22
White Sucker	4	0.49	288	229-342	318	150-470
			Intake			
Bigmouth Buffalo	5	0.77	593	500-678	3444	1910-4600
Blue sucker	1	0.15	633	---	2160	---
Burbot	3	0.46	262	240-308	97	70-140
Carp	10	1.53	541	338-788	2004	900-3710
Channel catfish	15	2.30	429	244-615	827	100-2190
Emerald shiner	321	49.13	79	59-105	4	---
Flathead chub	45	6.89	135	68-214	28	4-100
Freshwater Drum	2	0.31	313	301-324	475	440-510
Goldeye	429	65.66	273	117-347	212	10-420
Longnose sucker	4	0.61	272	208	253	100
Northern Pike	2	0.31	536	440-632	900	570-1230
Plains Minnow	3	0.46	57	55-57	---	---
River carpsucker	120	18.37	401	195-582	1106	140-3260
Sauger	156	23.88	332	170-507	303	30-1000
Shorthead redhorse	104	15.92	247	125-390	179	30-850
Shovelnose sturgeon	41	6.28	552	339-802	741	160-2680
Smallmouth buffalo	8	1.22	649	470-765	3711	1350-5300
Stonecat	1	0.15	100	---	20	---
Walleye	3	0.46	375	360	533	450-640
Western silvery minnow	43	6.58	99	77-126	8	2-17
White sucker	7	1.07	299	270-328	301	210-380

Table 6. Results of trend sampling in the Yellowstone River, 2006.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Bigmouth Buffalo	1	0.17	592	---	3500	---
Carp	26	4.36	574	400-658	2597	570-4500
Channel catfish	43	7.21	515	357-712	1610	370-4500
Emerald Shiner	1	0.17	73	---	---	---
Flathead chub	6	1.01	122	106-145	18	10-25

Freshwater drum	3	0.50	380	362-392	747	640-840
Goldeye	111	18.60	325	238-373	307	140-460

Table 6 (*cont*.)

Longnose sucker	61	10.22	303	125-432	332	20-800
Mountain Sucker	1	0.17	150	---	55	---
River carpsucker	41	6.87	399	344-456	826	430-1250
Sauger	12	2.01	452	346-586	882	320-1750
Shorthead redhorse	265	44.41	303	137-482	386	20-1290
Smallmouth bass	97	16.26	201	85-429	222	10-1520
Smallmouth buffalo	7	1.17	540	470-664	2503	1650-5000
Stonecat	1	0.17	138	---	20	---
Walleye	1	0.17	452	---	930	---
Western silvery minnow	27	4.53	107	80-133	18	10-30
White sucker	52	8.72	323	175-463	453	60-1120
				Forsyth		
Bigmouth buffalo	1	0.15	492	---	1920	---
Black crappie	1	0.15	200	---	140	---
Blue sucker	4	0.61	728	628-775	3695	1980-4600
Burbot	3	0.46	327	294-348	163	120-210
Carp	22	3.34	528	371-650	2040	900-3020
Channel catfish	51	7.75	440	244-639	956	110-3420
Emerald shiner	65	9.87	83	68-100	---	---
Flathead chub	39	5.92	126	88-162	24	10-50
Freshwater drum	10	1.52	358	322-423	666	360-1210
Goldeye	273	41.47	322	281-377	312	230-520
Longnose sucker	28	4.25	321	227-416	367	100-800
Northern pike	2	0.30	741	682-799	2640	2160-3120
River carpsucker	47	7.14	379	146-426	743	30-1110
Sauger	34	5.16	411	265-600	599	120-1580
Shorthead redhorse	299	45.42	271	100-490	286	10-1210
Shovelnose sturgeon	4	0.61	788	747-835	2218	1750-2640
Smallmouth bass	190	28.86	186	70-394	256	10-1000
Smallmouth buffalo	8	1.22	529	482-636	2104	1550-3700
Walleye	5	0.76	456	223-570	1178	120-2150
Western silvery minnow	280	42.53	96	38-125	12	---
White sucker	38	5.77	333	115-424	477	20-900
				Miles City		
Black Crappie	1	0.17	266	---	350	---
Blue sucker	5	0.86	703	656-758	3010	2310-3780
Burbot	1	0.17	235	---	60	---

Carp	19	3.26	524	125-626	2134	30-3230
Channel catfish	16	2.74	452	244-642	1040	130-2640

Table 6 (*cont.*)

Emerald shiner	3	0.51	87	84-90	---	---
Flathead chub	21	3.60	154	108-216	40	10-90
Freshwater Drum	5	0.86	377	341-410	782	880-490
Goldeye	144	24.69	314	218-383	302	70-480
Largemouth bass	1	0.17	210	---	180	---
Longnose sucker	48	8.23	346	236-448	452	190-830
River carpsucker	43	7.37	391	238-448	799	160-1370
Sauger	37	6.34	404	282-530	580	160-1310
Shorthead redhorse	282	48.34	286	115-468	322	20-1180
Smallmouth bass	43	7.37	276	99-394	421	10-910
Stonecat	3	0.51	153	143-163	37	30-40
Western silvery minnow	32	5.49	106	93-130	12	10-20
white crappie	1	0.17	192	---	90	---
White sucker	17	2.91	316	191-448	403	70-800
				Fallon		
Blue sucker	1	0.14	712	---	2740	---
Burbot	1	0.14	302	---	130	---
Carp	12	1.69	485	240-646	1593	210-3450
Channel catfish	22	3.09	444	291-610	899	210-2420
Emerald Shiner	1	0.14	78	---	---	---
Flathead chub	51	7.17	155	92-225	41	10-100
Freshwater drum	1	0.14	372	---	680	---
Goldeye	181	25.43	300	130-376	258	20-410
Green sunfish	1	0.14	100	---	10	---
Longnose sucker	11	1.55	320	230-410	378	130-720
Rainbow trout	1	0.14	484	---	970	---
River carpsucker	12	1.69	371	227-503	755	150-1660
Sauger	45	6.32	400	285-507	586	180-1200
Shorthead redhorse	103	14.47	325	100-494	444	10-1280
Smallmouth bass	1	0.14	336	---	840	---
Walleye	1	0.14	253	---	150	---
Western silvery minnow	24	3.37	116	91-150	14	10-20
White Sucker	5	0.70	340	284-393	504	310-720
				Intake		
Burbot	5	0.79	273	215-348	202	60-610
Carp	4	0.63	490	366-576	1605	630-2350
Channel catfish	8	1.26	419	64-616	1204	140-2480

Emerald shiner	1	0.16	76	---	5	---
Flathead chub	17	2.68	150	120-212	31	10-60

Table 6 (*cont*.)

Freshwater Drum	3	0.47	171	167-176	33	25-50
Goldeye	447	70.39	273	104-361	212	20-450
Northern Pike	1	0.16	630	---	1150	---
Rainbow trout	1	0.16	438	---	850	---
River carpsucker	18	2.83	327	185-470	634	70-1590
Sauger	194	30.55	309	165-523	255	10-1250
Shorthead redhorse	44	6.93	260	151-395	217	40-450
Shovelnose sturgeon	2	0.31	352	293-411	110	50-170
Smallmouth buffalo	3	0.47	513	473-557	1992	1350-2425
Stonecat	45	7.09	122	103-150	10	10
Walleye	1	0.16	426	---	620	---

Table 7. Results of trend sampling in the Yellowstone River, 2007.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Blue Sucker	3	0.47	739	691-781	3953	2960-5000
Bigmouth Buffalo	3	0.47	614	403-840	4230	1030-8200
Burbot	1	0.16	295	---	110	---
Carp	96	15.08	598	352-706	2933	210-7720
Channel catfish	162	25.44	566	341-763	2112	390-5900
Emerald Shiner	24	3.77	89	---	---	---
Flathead chub	530	83.25	132	105-160	25	10-50
Freshwater drum	2	0.31	402	369-435	965	640-1290
Goldeye	47	7.38	328	300-360	322	250-430
Longnose sucker	61	9.58	258	125-431	209	10-810
Mountain Sucker	2	0.31	163	158-167	60	60-60
River carpsucker	163	25.60	395	226-450	809	190-1250
Sauger	9	1.41	427	314-536	774	240-1700
Shorthead redhorse	456	71.62	322	128-512	434	20-1360
Smallmouth bass	99	15.55	177	70-374	228	10-1050
Smallmouth buffalo	12	1.88	581	452-716	3009	1310-5100
Walleye	5	0.79	604	510-743	3048	1460-6000
Western silvery minnow	92	14.45	111	80-199	13	10-30
White sucker	82	12.88	328	138-446	437	30-1000
Yellow perch	2	0.31	175	172-177	60	50-70

Table 7 (*cont.*)

				Forsyth		
Blue Sucker	1	0.14	712	---	4200	---
Bigmouth Buffalo	1	0.14	753	---	4500	---
Burbot	1	0.14	310	---	120	---
Carp	68	9.49	497	140-651	1788	30-4000
Channel catfish	72	10.05	474	225-713	1198	90-4120
Emerald Shiner	6	0.84	89	75-102	---	---
Flathead chub	12	1.67	148	116-192	38	10-100
Freshwater drum	2	0.28	353	325-380	570	460-680
Goldeye	100	13.95	326	220-376	333	170-470
Longnose sucker	13	1.81	291	187-415	303	80-730
Mountain Sucker	2	0.28	169	163-175	85	80-90
River carpsucker	152	21.21	393	267-501	781	250-1970
Sauger	22	3.07	358	173-554	452	40-1810
Shorthead redhorse	298	41.58	280	124-435	296	30-860
Shovelnose sturgeon	2	0.28	895	840-950	3810	2920-4700
Smallmouth bass	150	20.93	203	68-407	234	10-1180
Smallmouth buffalo	16	2.23	564	461-675	2786	1280-5000
Walleye	2	0.28	201	166-235	85	40-130
Western silvery minnow	17	2.37	112	80-130	16	10-30
White sucker	49	6.84	337	210-426	455	120-850
				Miles City		
Black Crappie	1	0.15	230	---	200	---
Blue sucker	6	0.92	741	693-785	3775	2520-4800
Bigmouth buffalo	2	0.31	563	352-774	4350	2700-6000
Carp	52	8.00	510	242-754	1998	230-5300
Channel catfish	55	8.46	464	285-690	1076	200-3700
Emerald shiner	2	0.31	86	84-87	---	---
Flathead chub	20	3.08	150	122-200	33	10-70
Freshwater Drum	7	1.08	406	337-590	907	270-2740
Goldeye	126	19.38	304	120-367	283	10-420
Longnose sucker	10	1.54	340	304-380	370	250-480
River carpsucker	122	18.77	381	96-462	769	270-1400
Sand shiner	1	0.15	60	---	---	---
Sauger	36	5.54	394	204-544	548	70-1340
Shorthead redhorse	225	34.62	327	170-491	437	60-1350
Shovelnose sturgeon	1	0.15	796	---	2250	---
Smallmouth bass	81	12.46	193	65-423	290	10-1420

Smallmouth buffalo	10	1.54	599	455-740	3679	1350-7000
Walleye	4	0.62	493	472-527	1243	1090-1510

Table 7 (*cont.*)

Western silvery minnow	2	0.31	123	115-130	15	10-20
White sucker	19	2.92	342	179-420	505	60-850
				Fallon		
Blue sucker	7	0.91	692	527-833	2776	1280-4200
Burbot	1	0.13	525	---	2310	---
Carp	27	3.51	445	100-612	1459	20-3410
Channel catfish	25	3.25	446	76-662	1267	50-3180
Emerald Shiner	13	1.69	85	78-96	---	---
Flathead chub	79	10.26	140	83-225	31	10-110
Freshwater drum	10	1.30	318	242-405	450	180-830
Goldeye	167	21.69	247	74-365	184	10-370
Longnose sucker	3	0.39	304	210-357	337	110-460
Northern Pike	2	0.26	517	515-518	820	780-860
River carpsucker	71	9.22	381	117-755	828	10-1940
Sauger	92	11.95	387	215-520	507	90-1160
Shorthead redhorse	152	19.74	308	145-437	377	30-900
Smallmouth bass	1	0.13	300	---	450	---
Smallmouth buffalo	2	0.26	435	296-573	1425	440-2410
Walleye	3	0.39	322	170-565	493	70-1300
Western silvery minnow	78	10.13	111	87-140	12	10-30
White Sucker	3	0.39	290	220-345	327	140-480
				Intake		
Bigmouth buffalo	2	0.31	359	60-658	5000	---
Burbot	2	0.31	347	300-393	260	170-350
Carp	3	0.47	473	403-550	1287	850-1860
Channel catfish	7	1.10	472	258-732	1229	140-3840
Emerald shiner	34	5.33	85	78-95	---	---
Flathead chub	31	4.86	148	102-205	34	10-70
Freshwater Drum	9	1.41	360	260-456	686	210-1410
Goldeye	75	11.75	251	77-366	199	10-480
River carpsucker	93	14.57	388	150-595	990	90-2750
Sauger	222	34.78	325	195-491	276	60-860
Shorthead redhorse	46	7.21	263	131-714	400	20-6200
Shovelnose sturgeon	42	6.58	516	305-708	584	90-1340
Stonecat	1	0.16	155	---	90	---
Western silvery minnow	83	13.00	108	70-127	13	10-20
White Sucker	1	0.16	220	---	450	---

Walleye	3	0.47	217	213-221	80	70-90

Table 8. Results of trend sampling in the Yellowstone River, 2008.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Bigmouth Buffalo	6	1.06	490	83-627	2828	1890-3780
Black crappie	1	0.18	248	---	250	---
Brown trout	1	0.18	125	---	20	---
Burbot	1	0.18	335	---	180	---
Carp	74	13.10	578	377-708	2554	510-4900
Channel catfish	80	14.16	563	394-754	2251	640-6620
Emerald Shiner	33	5.84	71	51-95	---	---
Flathead chub	27	4.78	123	89-180	23	10-70
Freshwater drum	13	2.30	389	315-458	726	120-1200
Goldeye	81	14.34	331	234-395	318	140-450
Largemouth bass	1	0.18	98	---	10	---
Longnose dace	1	0.18	72	---	---	---
Longnose sucker	112	19.83	303	135-480	354	30-1320
River carpsucker	115	20.36	387	133-452	770	40-1170
Sauger	11	1.95	450	370-613	840	390-2160
Shorthead redhorse	313	55.41	334	107-500	483	10-1320
Smallmouth bass	136	24.08	192	68-412	162	10-1160
Smallmouth buffalo	7	1.24	593	505-790	3366	2040-7500
Walleye	23	4.07	540	160-735	2047	30-5200
Western silvery minnow	97	17.17	91	58-147	18	5-115
White sucker	94	16.64	356	119-467	557	10-1150
			Forsyth			
Bigmouth buffalo	1	0.17	543	---	2340	---
Blue sucker	5	0.83	754	688-796	3452	2370-4600
Brown trout	1	0.17	234	---	100	---
Burbot	1	0.17	358	---	230	---
Carp	84	13.94	533	272-2030	1828	320-4100
Channel catfish	55	9.13	464	236-820	1163	100-6400
Emerald shiner	9	1.49	85	56-109	---	---
Flathead chub	15	2.49	152	101-192	41	Oct-80
Freshwater drum	20	3.32	359	260-456	643	210-1330
Goldeye	200	33.19	327	233-400	306	140-570
Longnose sucker	23	3.82	326	135-421	457	20-1010
Plains Minnow	1	0.17	66	---	---	---

River carpsucker	250	41.48	375	213-495	702	120-1400
Sauger	97	16.10	364	248-568	408	100-1740

Table 8 (*cont.*)

Shorthead redhorse	282	46.79	307	147-520	356	40-1480
Shovelnose sturgeon	7	1.16	826	785-868	2640	2350-3240
Smallmouth bass	127	21.07	273	120-679	654	20-5000
Walleye	5	0.83	439	302-587	1032	230-1970
Western silvery minnow	5	0.83	91	74-111	10	10
White sucker	56	9.29	359	225-432	578	110-980
				Miles City		
Bigmouth buffalo	3	0.44	641	492-837	3953	1550-7100
Black Crappie	11	1.62	208	128-246	135	10-220
Blue sucker	5	0.74	762	686-824	3983	2925-4500
Bluegill	1	0.15	93	---	10	---
Carp	82	12.06	528	255-715	2149	240-4700
Channel catfish	72	10.59	465	300-840	1143	220-6500
Emerald shiner	15	2.21	90	72-100	---	---
Flathead chub	15	2.21	148	102-211	66	25-110
Freshwater Drum	28	4.12	354	262-588	648	260-2430
Goldeye	144	21.19	317	113-355	315	160-460
Longnose dace	1	0.15	77	---	---	---
Longnose sucker	20	2.94	343	212-412	492	100-820
River carpsucker	283	41.64	377	180-471	721	70-1450
Sauger	121	17.80	376	234-554	453	120-1430
Shorthead redhorse	283	41.64	333	138-497	474	20-1360
Smallmouth bass	144	21.19	198	116-597	177	20-3030
Smallmouth buffalo	22	3.24	570	405-760	3014	880-7700
Stonecat	2	0.29	149	138-160	35	30-40
Walleye	1	0.15	470	---	1050	---
Western silvery minnow	34	5.00	101	74-144	13	10-15
White sucker	30	4.41	351	130-445	562	30-1200
Yellow perch	2	0.29	174	157-190	65	30-100
				Fallon		
Black crappie	2	0.29	235	233-237	205	180-230
Blue sucker	6	0.88	702	653-793	2960	2320-4600
Brown trout	1	0.15	543	---	1850	---
Carp	84	12.30	511	332-712	1918	100-5200
Channel catfish	61	8.93	438	53-736	1179	10-5300
Emerald Shiner	26	3.81	86	60-100	---	---
Flathead chub	207	30.31	119	72-217	27	10-110

Freshwater drum	14	2.05	343	274-495	584	260-1440
Goldeye	167	24.45	269	72-364	263	10-460

Table 8 (*cont.*)

Longnose sucker	1	0.15	370	---	620	---
Northern pike	1	0.15	826	---	4300	---
River carpsucker	103	15.08	348	160-506	638	45-1880
Sauger	158	23.13	397	185-589	533	60-1510
Shorthead redhorse	225	32.94	260	110-452	268	15-980
Smallmouth bass	17	2.49	441	153-690	2078	50-5500
Stonecat	3	0.44	102	82-132	20	20-20
Walleye	3	0.44	334	165-490	527	60-1180
Western silvery minnow	50	7.32	95	71-135	18	10-30
White crappie	3	0.44	169	153-182	83	70-100
White Sucker	6	0.88	346	286-463	470	270-700
				Intake		
Bigmouth Buffalo	1	0.17	700	---	6400	---
Blue sucker	2	0.33	750	730-770	3825	3800-3850
Burbot	4	0.67	304	162-470	215	20-530
Carp	27	4.51	550	395-695	2162	260-4400
Channel catfish	44	7.35	358	66-752	666	10-3940
Emerald shiner	200	33.41	83	57-100	---	---
Flathead chub	202	33.74	130	42-243	33	5-110
Freshwater Drum	15	2.51	322	250-437	454	190-1130
Goldeye	145	24.22	290	110-385	264	10-440
Longnose sucker	2	0.33	274	250-298	265	220-310
River carpsucker	69	11.53	357	125-543	757	40-2620
Sand Shiner	1	0.17	57	---	---	---
Sauger	300	50.11	304	147-555	251	20-1330
Shorthead redhorse	92	15.37	244	127-500	188	20-540
Shovelnose sturgeon	32	5.35	542	267-850	746	50-2660
Smallmouth bass	1	0.17	220	---	190	---
Smallmouth buffalo	7	1.17	659	531-750	3829	1500-6000
Stonecat	2	0.33	115	95-135	20	10-30
Walleye	7	1.17	275	163-470	239	30-900
Western silvery minnow	70	11.69	82	64-119	---	---
White sucker	6	1.00	347	304-418	488	320-830

Table 9. Results of trend sampling in the Yellowstone River, 2009.

Species	N	(fish/hour)	Length (mm)	Range (mm)	Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Bigmouth Buffalo	2	0.29	582	563-600	2870	2830-2910
Brown trout	2	0.29	110	93-127	---	---
Carp	98	14.03	585	453-717	2727	1200-5300
Channel catfish	323	46.25	522	292-800	1652	200-6400
Emerald Shiner	24	3.44	84	69-102	---	---
Flathead chub	6	0.86	123	99-162	20	10-40
Freshwater drum	8	1.15	384	345-412	723	440-890
Goldeye	71	10.17	337	285-368	331	200-440
Largemouth bass	1	0.14	182	---	90	---
Longnose dace	3	0.43	87	52-106	15	10-20
Longnose sucker	38	5.44	204	93-430	172	10-1140
River carpsucker	61	8.74	410	288-598	887	320-2100
Sauger	14	2.00	417	317-581	723	240-2400
Shorthead redhorse	278	39.81	351	90-498	547	10-1330
Smallmouth bass	39	5.58	227	105-380	283	20-1120
Smallmouth buffalo	12	1.72	578	453-684	3148	1580-5300
Walleye	6	0.86	578	405-777	2260	560-4800
Western silvery minnow	191	27.35	97	74-130	13	10-20
White sucker	60	8.59	339	116-476	526	10-1220
			Forsyth			
Bigmouth buffalo	3	0.49	549	517-602	2547	2020-3280
Blue sucker	2	0.33	740	702-778	3945	3290-4600
Carp	77	12.55	524	311-752	2028	460-5400
Channel catfish	68	11.09	473	244-742	1201	100-4700
Emerald shiner	18	2.93	80	74-92	---	---
Flathead chub	5	0.82	149	90-233	93	30-160
Freshwater drum	21	3.42	310	273-384	392	250-660
Goldeye	178	29.02	331	228-385	324	90-510
Northern pike	1	0.16	659	---	1770	---
Longnose sucker	43	7.01	139	71-432	258	10-830
Mountain sucker	1	0.16	109	---	10	---
River carpsucker	238	38.80	375	297-453	687	330-1330
Sauger	45	7.34	364	247-494	402	130-1110
Shorthead redhorse	405	66.03	332	118-470	423	110-1160
Shovelnose sturgeon	1	0.16	815	---	2680	---
Smallmouth bass	72	11.74	237	100-417	260	10-1240

Smallmouth buffalo	21	3.42	557	444-752	2764	1350-6900

Table 9 (*cont.*)

Walleye	4	0.65	408	281-627	933	200-2540
Western silvery minnow	19	3.10	103	86-117	11	10-15
White sucker	47	7.66	382	310-438	667	330-950
				Miles City		
Blue sucker	4	0.54	681	610-732	2645	1810-3410
Carp	69	9.35	514	321-660	1889	510-4100
Channel catfish	98	13.27	450	210-722	971	80-4180
Emerald shiner	6	0.81	78	74-86	---	---
Flathead chub	26	3.52	129	90-192	29	10-70
Freshwater Drum	11	1.49	319	285-380	409	280-620
Goldeye	92	12.46	329	266-368	328	180-440
Longnose sucker	5	0.68	335	244-426	460	170-770
River carpsucker	159	21.53	385	185-480	754	100-1430
Sauger	50	6.77	384	264-528	491	140-1380
Shorthead redhorse	216	29.26	309	110-496	386	10-1240
Smallmouth bass	46	6.23	244	72-376	262	70-810
Smallmouth buffalo	7	0.95	583	484-703	3136	1620-5800
Stonecat	1	0.14	153	---	40	---
Walleye	3	0.41	271	194-333	197	90-310
Western silvery minnow	24	3.25	99	68-167	15	10-20
White crappie	1	0.14	215	---	120	---
White sucker	13	1.76	370	323-420	587	360-810
				Fallon		
Blue sucker	3	0.38	589	518-640	1577	1060-1880
Carp	33	4.13	499	292-670	1758	320-3990
Channel catfish	83	10.40	349	145-728	712	20-4700
Emerald Shiner	14	1.75	78	67-88	---	---
Flathead chub	38	4.76	161	91-245	48	10-130
Freshwater drum	10	1.25	371	278-497	852	290-2796
Goldeye	181	22.67	309	95-386	310	20-560
Longnose dace	1	0.13	108	---	---	---
Longnose sucker	2	0.25	212	180-244	85	60-110
Northern pike	2	0.25	835	798-872	3790	2880-4700
River carpsucker	94	11.77	381	208-547	778	110-2450
Sauger	68	8.52	377	154-524	443	20-1050
Shorthead redhorse	219	27.43	273	116-428	259	10-900
Smallmouth bass	7	0.88	268	224-314	297	140-520
Smallmouth buffalo	3	0.38	654	530-765	4620	2060-6300

Stonecat	1	0.13	133	---	30	---

Table 9 (*cont.*)

Walleye	5	0.63	324	221-404	322	100-540
Western silvery minnow	10	1.25	94	73-136	17	10-30
White Sucker	11	1.38	319	92-390	440	5-710
			Intake			
Bigmouth Buffalo	2	0.30	587	581-592	3660	3600-3720
Brown trout	1	0.15	494	---	1230	---
Burbot	1	0.15	167	---	20	---
Carp	6	0.91	565	468-692	2502	1260-4500
Channel catfish	13	1.96	413	53-591	928	50-2120
Emerald shiner	171	25.84	77	56-95	---	---
Flathead chub	78	11.79	140	77-243	35	10-130
Freshwater Drum	15	2.27	309	260-387	392	250-760
Goldeye	87	13.15	292	96-374	281	20-610
Northern pike	3	0.45	549	494-603	1117	840-1520
River carpsucker	112	16.93	413	128-588	1221	20-2760
Sauger	100	15.11	326	191-521	302	70-1270
Shorthead redhorse	53	8.01	241	105-380	171	20-520
Shovelnose sturgeon	12	1.81	527	403-770	673	210-2040
Smallmouth buffalo	5	0.76	498	330-680	2198	490-4600
Stonecat	1	0.15	195	---	60	---
Walleye	4	0.60	325	202-418	478	80-740
Western silvery minnow	15	2.27	109	92-120	10	10
White crappie	1	0.15	285	---	310	---
White sucker	2	0.30	224	102-345	490	---

Table 10. Results of trend sampling in the Yellowstone River, 2010.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Bigmouth Buffalo	2	0.41	655	558-752	4315	2580-6050
Brown trout	8	1.63	252	201-299	183	110-290
Carp	84	17.14	581	432-783	2925	1380-6260
Channel catfish	209	42.65	477	257-764	1338	80-4250
Emerald Shiner	206	42.04	82	45-96	---	---
Flathead chub	31	6.33	113	55-163	19	10-40
Freshwater drum	6	1.22	365	351-393	740	600-990
Goldeye	60	12.24	339	289-382	398	260-580

Longnose dace	1	0.20	68	---	---	---

Table 10 (*cont.*)

Longnose sucker	156	31.84	244	85-414	195	20-820
Mountain sucker	1	0.20	115	---	20	---
Mountain whitefish	5	1.02	181	138-273	68	30-170
River carpsucker	116	23.67	394	309-462	822	440-1230
Sand Shiner	4	0.82	64	56-70	---	---
Sauger	9	1.84	461	373-601	1009	430-2040
Shorthead redhorse	350	71.43	375	114-491	643	20-1430
Smallmouth bass	72	14.69	213	56-402	319	20-1270
Smallmouth buffalo	14	2.86	621	460-750	4243	1520-8850
Walleye	3	0.61	574	440-685	2627	1120-3660
Western silvery minnow	220	44.90	91	80-125	---	---
White sucker	76	15.51	323	120-465	491	20-1170
				Forsyth		
Bigmouth buffalo	1	0.19	567	---	2210	---
Blue sucker	1	0.19	201	---	100	---
Brown trout	1	0.19	667	---	1990	---
Burbot	1	0.19	300	---	150	---
Carp	60	11.61	531	268-690	2083	300-4300
Channel catfish	114	22.06	462	298-754	1163	220-5520
Emerald shiner	69	13.35	82	61-97	---	---
Fathead minnow	1	0.19	62	---	---	---
Flathead chub	27	5.23	106	77-144	17	10-40
Freshwater drum	6	1.16	350	317-407	595	400-970
Goldeye	95	18.39	343	310-376	396	280-540
Longnose sucker	8	1.55	299	204-443	398	100-1100
River carpsucker	154	29.81	379	306-450	723	320-1220
Sauger	23	4.45	361	305-475	408	240-920
Shorthead redhorse	252	48.77	328	115-494	470	20-1200
Shovelnose sturgeon	4	0.77	858	818-900	3198	2600-3890
Smallmouth bass	55	10.65	224	75-424	282	30-1030
Smallmouth buffalo	15	2.90	583	415-718	3175	1040-5750
Walleye	4	0.77	413	362-467	690	500-1040
Western silvery minnow	128	24.77	91	76-124	---	---
White sucker	41	7.94	355	93-448	635	40-1140
				Miles City		
Bigmouth buffalo	6	1.11	643	554-741	4133	2100-6300
Black crappie	3	0.56	161	145-190	57	20-80
Blue sucker	2	0.37	761	740-782	3925	3450-4400

Brown trout	1	0.19	252	---	170	---

Table 10 (*cont.*)

Carp	75	13.91	529	301-698	2161	380-4400
Channel catfish	68	12.62	498	196-687	1367	60-3310
Emerald shiner	60	11.13	87	78-108	---	---
Flathead chub	66	12.24	112	83-180	22	10-50
Freshwater Drum	22	4.08	351	315-430	566	400-950
Goldeye	126	23.38	331	121-380	367	20-570
Longnose sucker	38	7.05	290	191-431	349	70-980
River carpsucker	249	46.20	387	284-515	763	320-2200
Rock bass	1	0.19	146	---	80	---
Sauger	67	12.43	346	152-471	364	30-890
Shorthead redhorse	316	58.63	308	115-445	359	10-1020
Shovelnose Sturgeon	1	0.19	772	---	2050	---
Smallmouth bass	37	6.86	261	96-368	378	20-880
Smallmouth buffalo	2	0.37	654	562-745	5225	2550-7900
Stonecat	2	0.37	116	111-120	20	20
Walleye	6	1.11	415	124-708	1358	300-4000
Western silvery minnow	93	17.25	104	81-136	20	---
White crappie	1	0.19	282	---	260	---
White sucker	28	5.19	2	190-441	327	40-960
				Fallon		
Black crappie	1	0.16	176	---	90	---
Blue sucker	3	0.48	733	717-750	3533	3000-4080
Carp	51	8.21	551	260-702	2437	260-4900
Channel catfish	179	28.82	448	62-723	1142	20-4400
Emerald Shiner	112	18.04	90	76-104	---	---
Flathead chub	75	12.08	147	81-217	42	10-110
Freshwater drum	24	3.86	353	310-474	634	400-1600
Goldeye	83	13.37	302	105-371	332	20-550
Longnose sucker	1	0.16	172	---	60	---
Northern pike	2	0.32	616	582-650	1200	780-1620
River carpsucker	69	11.11	379	225-560	729	160-2550
Sauger	125	20.13	316	137-626	345	10-1400
Shorthead redhorse	84	13.53	304	140-479	343	30-1240
Smallmouth bass	3	0.48	348	212-533	987	170-2250
Smallmouth buffalo	7	1.13	510	284-771	3088	320-9000
Stonecat	5	0.81	126	73-144	30	20-40
Walleye	13	2.09	399	204-558	705	80-1590
Western silvery minnow	9	1.45	105	84-116	---	---
White Sucker	2	0.32	370	365-375	560	500-620

Table 10 (*cont.*)

				Intake		
Bigmouth Buffalo	10	1.95	719	637-843	6981	3575-12000
Black crappie	1	0.19	245	---	250	---
Burbot	1	0.19	240	---	80	---
Carp	17	3.31	466	318-665	1623	460-3880
Channel catfish	21	4.09	482	293-731	1211	200-5240
Emerald shiner	25	4.87	88	62-102	---	---
Flathead chub	76	14.81	133	79-225	37	10-100
Freshwater Drum	8	1.56	361	253-505	743	280-1420
Goldeye	178	34.70	272	72-382	294	10-580
Northern pike	4	0.78	556	464-670	1108	620-1820
Rainbow trout	1	0.19	500	---	1200	---
River carpsucker	46	8.97	379	55-510	926	180-2040
Sauger	227	44.25	202	126-535	109	10-1290
Shorthead redhorse	27	5.26	224	123-374	146	20-600
Shovelnose sturgeon	5	0.97	389	268-445	236	80-320
Smallmouth buffalo	1	0.19	670	---	4800	---
Walleye	5	0.97	476	436-518	1074	660-1430
Western silvery minnow	23	4.48	101	81-120	---	---
White bass	4	0.78	121	100-157	30	10-60
White sucker	3	0.58	175	134-216	60	20-100

Table 11. Results of trend sampling in the Yellowstone River, 2011.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Bigmouth Buffalo	1	0.15	792	---	8300	---
Black crappie	2	0.29	138	138	30	20-40
Brown trout	9	1.32	324	202-391	400	100-700
Carp	56	8.21	596	460-732	3035	1300-5300
Channel catfish	592	86.80	476	306-780	1123	240-5950
Emerald Shiner	63	9.24	86	60-107	---	---
Fathead Minnow	2	0.29	48	45-51	---	---
Flathead chub	94	13.78	115	72-150	---	---
Freshwater drum	9	1.32	382	345-420	743	510-1000
Goldeye	136	19.94	345	308-410	402	220-1900
Longnose dace	2	0.29	80	75-85	---	---

Longnose sucker	105	15.40	244	58-452	265	10-1030

Table 11 (*cont.*)

Mountain sucker	1	0.15	145	---	20	---
Mountain whitefish	2	0.29	216	176-255	125	60-190
River carpsucker	122	17.89	433	325-685	1183	400-4250
Sand Shiner	69	10.12	59	50-75	---	---
Sauger	12	1.75	361	270-490	425	160-1030
Shorthead redhorse	307	45.01	358	100-490	573	10-1300
Smallmouth bass	64	9.38	258	125-414	382	20-1000
Smallmouth buffalo	20	2.93	601	451-750	3253	1320-5925
Stonecat	2	0.29	191	185-197	85	80-90
Walleye	20	2.93	581	423-733	2382	710-4925
Western silvery minnow	476	69.79	80	35-110	---	---
White crappie	1	0.15	185	---	100	---
White sucker	88	12.90	303	62-460	435	30-1220
				Forsyth		
Bigmouth buffalo	2	0.31	652	490-814	6300	---
Blue sucker	2	0.31	740	690-790	3845	3090-4600
Bluegill	1	0.15	194	---	200	---
Burbot	4	0.62	168	97-353	78	5-280
Carp	125	19.31	529	270-765	2148	260-6075
Channel catfish	197	30.43	463	205-706	1091	120-4450
Emerald shiner	289	44.64	83	60-106	---	---
Flathead chub	44	6.80	151	92-215	34	10-100
Freshwater drum	16	2.47	362	320-473	663	400-1560
Goldeye	148	22.86	341	200-405	370	60-680
Longnose sucker	33	5.10	301	157-430	350	40-920
Northern pike	2	0.31	774	772-776	2760	2600-2920
Rainbow trout	1	0.15	448	---	720	---
River carpsucker	225	34.76	379	112-511	733	20-2040
Sauger	64	9.89	343	246-490	343	100-930
Shorthead redhorse	351	54.22	323	112-576	455	10-1500
Shovelnose sturgeon	3	0.46	800	692-878	2700	1680-3380
Smallmouth bass	116	17.92	237	70-396	353	20-1140
Smallmouth buffalo	21	3.24	595	452-763	3197	1400-7125
Walleye	10	1.54	417	265-526	796	180-1400
Western silvery minnow	192	29.66	73	63-88	---	---
White sucker	44	6.80	307	105-449	433	10-1100
				Miles City		
Blue sucker	6	0.94	736	682-785	3298	2580-3700
Carp	53	8.28	528	324-700	2106	140-4675

Channel catfish	207	32.35	422	221-688	785	90-3980

Table 11 (*cont.*)

Emerald shiner	107	16.72	83	70-100	---	---
Flathead chub	46	7.19	155	80-215	40	20-100
Freshwater Drum	39	6.10	354	256-488	639	230-1800
Goldeye	134	20.94	331	155-385	348	30-580
Longnose sucker	27	4.22	309	151-450	374	30-1000
Northern pike	2	0.31	651	488-815	1965	770-3160
River carpsucker	158	24.69	389	270-590	790	280-3070
Sauger	98	15.32	334	230-523	337	100-1140
Shorthead redhorse	349	54.55	304	155-482	357	40-1080
Shovelnose Sturgeon	2	0.31	847	819-874	3350	3080-3620
Smallmouth bass	21	3.28	295	100-403	563	20-1100
Smallmouth buffalo	17	2.66	563	392-733	2867	950-6150
Stonecat	3	0.47	150	135-175	33	20-60
Walleye	8	1.25	378	190-585	688	70-1960
Western silvery minnow	14	2.19	82	73-94	---	---
White sucker	23	3.59	328	209-444	439	50-1020

				Fallon		
Bigmouth buffalo	2	0.27	680	675-685	5738	5125-6350
Blue sucker	7	0.93	755	682-822	3832	2720-5050
Burbot	3	0.40	239	182-318	87	30-190
Carp	84	11.21	515	235-750	2052	180-5175
Channel catfish	387	51.64	416	182-710	779	50-4425
Emerald Shiner	166	22.15	84	67	---	---
Flathead chub	133	17.75	152	80-247	42	10-170
Freshwater drum	32	4.27	375	280-589	735	320-2840
Goldeye	229	30.55	319	110-398	343	10-600
Longnose sucker	7	0.93	280	175-420	306	50-800
Northern pike	7	0.93	591	550-737	1356	1060-2420
River carpsucker	93	12.41	386	126-520	828	20-1900
Sauger	157	20.95	343	223-533	364	80-1240
Shorthead redhorse	230	30.69	317	142-466	381	20-960
Smallmouth bass	1	0.13	326	---	600	---
Smallmouth buffalo	6	0.80	671	587-818	4243	525-9600
Stonecat	7	0.93	125	70-165	20	10--40
Walleye	11	1.47	384	249-545	671	120-1610
Western silvery minnow	96	12.81	91	70-120	---	---
White Sucker	5	0.67	364	292-412	554	280-730

Table 11 (*cont*.)

				Intake		
Bigmouth Buffalo	5	0.66	736	677-794	7102	4700-8570
Brown trout	1	0.13	440	---	730	---
Burbot	10	1.32	261	91-480	163	60-380
Carp	60	7.92	561	357-747	2669	660-7100
Channel catfish	247	32.61	455	51-746	1028	160-4600
Emerald shiner	460	60.73	83	61-109	---	---
Flathead chub	164	21.65	137	86-210	34	5-100
Freshwater Drum	44	5.81	349	180-503	640	90-1720
Goldeye	137	18.09	252	88-387	211	10-630
Longnose sucker	1	0.13	265	---	200	---
Northern pike	15	1.98	640	357-763	1689	290-3230
River carpsucker	92	12.15	436	310-575	1279	450-3010
Sauger	184	24.29	285	147-521	211	30-1160
Shortnose gar	6	0.79	528	511-565	508	420-560
Shorthead redhorse	51	6.73	282	130-412	297	30-810
Shovelnose sturgeon	7	0.92	695	497-824	1809	520-2800
Smallmouth buffalo	22	2.90	618	397-713	3655	1080-5750
Walleye	27	3.56	479	182-715	1254	50-4200
Western silvery minnow	19	2.51	84	67-131	---	---
White sucker	7	0.92	282	260-311	274	200-360

Table 12. Results of trend sampling in the Yellowstone River,2012.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (gm)	Weight Range (gm)
			Downstream of Rancher Diversion Dam			
Black bullhead	1	0.17	218	---	140	---
Bigmouth Buffalo	2	0.34	451	338-564	3130	2460-3800
Black crappie	1	0.17	207	---	190	---
Brown trout	7	1.18	315	190-415	376	80-800
Burbot	2	0.34	612	600-624	1225	110-1340
Carp	27	4.56	555	170-671	2462	60-3900
Channel catfish	408	68.89	457	257-735	1095	140-5300
Emerald Shiner	33	5.57	89	72-105	---	---
Flathead chub	3	0.51	110	94-125	15	10--20
Freshwater drum	9	1.52	384	351-414	802	540-1100
Goldeye	96	16.21	356	320-394	430	320-540
Green Sunfish	1	0.17	105		20	

Longnose sucker	118	19.92	254	116-497	233	20-1300

Table 12 (*cont.*)

Mountain sucker	1	0.17	215	---	140	---
Pumpkinseed	1	0.17	110	---	20	---
River carpsucker	163	27.52	407	345-575	907	560-2280
Sauger	18	3.04	385	291-555	584	300-1570
Shorthead redhorse	406	68.55	363	183-515	614	80-1340
Smallmouth bass	118	19.92	196	55-417	304	10-1360
Smallmouth buffalo	3	0.51	581	462-677	3490	1420-5450
Walleye	8	1.35	567	418-740	2379	880-4800
Western silvery minnow	98	16.55	96	80-122	---	---
White sucker	106	17.90	339	95-483	518	20-1060
				Forsyth		
Black crappie	2	0.33	209	168-250	175	100-250
Blue sucker	2	0.33	806	760-851	5225	4150-6300
Brown Trout	1	0.16	242	---	140	---
Carp	39	6.36	490	238-640	1834	200-3840
Channel catfish	301	49.09	468	285-710	1053	200-4600
Emerald shiner	109	17.78	93	77-110	---	---
Freshwater drum	19	3.10	308	228-408	398	180-930
Goldeye	243	39.63	352	230-456	415	210-600
Longnose sucker	28	4.57	268	125-480	304	10-1080
Northern pike	9	1.47	715	647-781	2279	1400-3580
River carpsucker	171	27.89	386	174-530	754	100-1780
Sauger	72	11.74	357	280-490	382	160-870
Shorthead redhorse	575	93.77	350	210-503	494	100-1270
Shovelnose sturgeon	6	0.98	825	756-950	3403	2400-5300
Smallmouth bass	111	18.10	232	77-413	318	10-1220
Smallmouth buffalo	8	1.30	587	493-705	2950	1780-5500
Walleye	9	1.47	382	175-502	639	20-1220
Western silvery minnow	152	24.79	106	90-134	---	---
White sucker	59	9.62	347	80-450	543	120-1080
				Miles City		
Black crappie	1	0.16	260	---	300	---
Bigmouth buffalo	2	0.32	618	580-655	4150	3000-5300
Blue sucker	22	3.49	753	668-845	3936	2260-5500
Burbot	3	0.48	214	186-230	57	40-70

Table 12 (*cont.*)

Carp	30	4.76	549	422-670	2323	960-3780
Channel catfish	92	14.61	467	50-735	1289	200-4250
Emerald shiner	96	15.24	91	57-108	---	---

Flathead chub	8	1.27	164	105-210	38	10-50
Freshwater Drum	26	4.13	346	234-450	617	160-1100
Goldeye	27	4.29	352	330-382	420	320-540
Longnose sucker	42	6.67	346	162-490	524	40-1240
Northern pike	15	2.38	626	553-695	1399	960-2040
River carpsucker	95	15.08	384	180-522	779	60-2140
Sauger	77	12.23	371	320-491	435	260-1060
Shorthead redhorse	410	65.10	333	118-517	455	10-1310
Shovelnose Sturgeon	1	0.16	940	---	5400	---
Smallmouth bass	81	12.86	154	73-422	199	10-1460
Smallmouth buffalo	16	2.54	584	425-785	3096	1180-7700
Stonecat	1	0.16	193	---	60	---
Walleye	10	1.59	413	320-570	806	310-2080
Western silvery minnow	91	14.45	99	80-137	---	---
White sucker	28	4.45	237	45-440	319	10-980
				Fallon		
Blue sucker	19	2.88	714	528-792	3482	1140-5100
Burbot	8	1.21	276	180-426	155	20-400
Carp	52	7.87	557	250-800	2694	330-7200
Channel catfish	204	30.87	413	57-738	767	10--4800
Emerald Shiner	35	5.30	91	73-115	---	---
Flathead chub	23	3.48	131	86-230	42	10-130
Freshwater drum	68	10.29	323	215-530	534	100-2160
Goldeye	129	19.52	326	110-408	325	10-540
Longnose sucker	13	1.97	225	175-420	231	10-570
Northern pike	11	1.66	627	514-814	1644	1120-3200
Pallid sturgeon	1	0.15	812	---	2240	---
River carpsucker	42	6.36	414	166-572	1078	40-2250
Sauger	197	29.81	354	208-517	373	150-1160
Shovelnose sturgeon	9	1.36	713	496-896	1973	260-4000
Shorthead redhorse	314	47.51	335	145-467	441	30-1180
Smallmouth bass	5	0.76	123	105-136	34	20-50
Smallmouth buffalo	7	1.06	611	458-695	3977	1480-5900
Stonecat	3	0.45	160	150-170	23	10--40
Walleye	8	1.21	413	210-577	819	80-1860
Western silvery minnow	60	9.08	100	48-140	---	---
White Sucker	7	1.06	298	82-362	430	280-570

Table 12 (*cont.*)

				Intake		
Bigmouth Buffalo	5	0.82	747	638-844	7860	5000-11700

Burbot	3	0.49	304	250-340	210	180-240
Carp	30	4.91	572	363-738	2557	570-4425
Channel catfish	67	10.97	430	63-709	900	140-3500
Emerald shiner	59	9.66	85	47-105	---	---
Flathead chub	29	4.75	151	92-215	41	10-100
Freshwater Drum	16	2.62	280	158-440	339	50-1000
Goldeye	211	34.56	291	165-396	249	20-560
Longnose sucker	2	0.33	167	94-240	140	---
Northern pike	28	4.59	594	495-805	1224	660-3760
Rainbow trout	1	0.16	650	---	2200	---
River carpsucker	101	16.54	430	160-593	1393	40-2740
Sauger	211	34.56	320	200-526	265	80-1080
Shorthead redhorse	66	10.81	238	116-350	173	20-460
Shovelnose sturgeon	24	3.93	598	415-758	1001	220-2160
Smallmouth buffalo	7	1.15	696	445-870	5693	1280-10700
Walleye	16	2.62	427	215-544	798	40-1600
Western silvery minnow	48	7.86	73	40-113	---	---
White sucker	2	0.33	353	304-401	495	310-680

Table 13. Results of trend sampling in the Yellowstone River, 2013.

Species	N	C/*f* (fish/hour)	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Weight Range (g)
	Downstream of Rancher Diversion Dam					
Black crappie	2	0.36	190	172-207	100	60-140
Brown trout	2	0.36	347	280-413	450	180-720
Burbot	2	0.36	246	242-250	65	60-70
Carp	49	8.79	215	215-721	2008	450-5020
Channel catfish	243	43.57	475	297-720	1085	180-4200
Emerald Shiner	26	4.66	83	65-105	-	-
Flathead chub	31	5.56	121	70-185	18	10-70
Freshwater drum	24	4.30	392	304-507	863	430-1760
Goldeye	117	20.98	355	253-390	386	160-540
Green Sunfish	2	0.36	89	88-90	-	-
Longnose sucker	126	22.59	325	145-490	393	20-800
Mountain sucker	5	0.90	172	124-212	56	10-100
Pumpkinseed	2	0.36	78	75-80	-	-
River carpsucker	157	28.15	393	218-470	826	150-1500
Sauger	19	3.41	423	330-484	680	320-960
Shorthead redhorse	553	99.16	342	145-487	514	30-1300
Smallmouth bass	211	37.84	208	72-423	226	10-1300

Smallmouth buffalo	8	1.43	548	413-732	2639	980-4550

Table 13 (*cont.*)

Walleye	12	2.15	559	368-790	2276	500-5900
Western silvery minnow	47	8.43	112	88-140	-	-
White crappie	1	0.18	255	255	300	300
White sucker	118	21.16	350	200-466	506	270-1100
				Forsyth		
Bigmouth buffalo	1	0.19	634	634	3900	3900
Black crappie	1	0.19	261	261	320	320
Blue sucker	1	0.19	772	772	3300	3300
Carp	73	13.62	485	321-666	1744	500-4370
Channel catfish	64	11.94	505	312-730	1410	250-4000
Emerald shiner	10	1.87	88	57-150	-	-
Flathead chub	19	3.54	140	110-202	22	10-70
Freshwater drum	16	2.98	366	280-460	699	330-1650
Goldeye	151	28.17	348	143-400	398	20-610
Longnose sucker	36	6.72	277	200-408	256	80-770
Northern pike	2	0.37	769	760-777	2710	2500-2920
River carpsucker	132	24.62	390	131-465	828	20-1510
Sauger	66	12.31	404	184-552	597	40-1600
Shorthead redhorse	621	115.83	311	150-482	382	40-1220
Shovelnose sturgeon	1	0.19	662	662	1380	1380
Smallmouth bass	75	13.99	217	82-400	187	10-420
Smallmouth buffalo	10	1.87	544	398-693	2766	980-5350
Walleye	10	1.87	466	250-610	1052	130-2120
Western silvery minnow	48	8.95	102	60-130	-	-
White sucker	23	4.29	352	217-463	556	100-1010
				Miles City		
Bigmouth buffalo	1	0.16	740	740	700	700
Blue sucker	8	1.28	726	590-881	3818	1650-7100
Burbot	5	0.80	212	193-234	52	40-70
Carp	39	6.25	528	368-748	2341	700-6400
Channel catfish	99	15.86	447	318-707	935	200-4850
Emerald shiner	17	2.72	83	67-102	-	-
Flathead chub	11	1.76	156	120-205	36	10-80
Freshwater Drum	44	7.05	327	252-453	501	210-1260
Green sunfish	2	0.32	127	75-104	-	-
Goldeye	162	25.95	339	104-390	368	10-540
Longnose dace	1	0.16	87	87	-	-
Longnose sucker	31	4.97	382	223-465	607	100-1040
Northern pike	8	1.28	664	580-752	1826	1170-2720

River carpsucker	160	25.63	386	130-520	830	20-1840
Rock bass	3	0.48	158	139-181	83	50-120
Sauger	65	10.41	408	325-515	579	240-1180
Shorthead redhorse	507	81.20	345	117-506	485	20-1300
Smallmouth bass	78	12.49	226	80-460	275	10-1680
Smallmouth buffalo	7	1.12	647	566-726	4807	3000-7150
Stonecat	6	0.96	105	50-192	-	-
Walleye	21	3.36	448	185-738	1054	60-3840
Western silvery minnow	32	5.13	115	76-155	-	-
White sucker	16	2.56	362	231-420	572	140-820
				Fallon		
Bigmouth buffalo	2	0.32	672.5	644-701	4850	4450-5250
Black crappie	1	0.16	234	234	240	240
Blue sucker	9	1.43	707	638-793	3306	2360-4450
Burbot	5	0.79	285	208-462	138	25-450
Carp	24	3.81	534	238-685	2262	200-3700
Channel catfish	58	9.21	336	80-712	622	60-3970
Emerald Shiner	6	0.95	84	70-103	-	-
Flathead chub	2	0.32	141	112-170	25	10-40
Freshwater drum	32	5.08	301	210-523	447	110-2000
Goldeye	192	30.48	317	116-381	284	10-480
Longnose sucker	6	0.95	323	160-445	440	50-870
Northern pike	3	0.48	659	603-697	1560	1200-1760
River carpsucker	57	9.05	410	195-554	1030	120-2280
Sauger	106	16.83	403	262-526	542	140-1160
Shovelnose sturgeon	5	0.79	778	630-873	2484	1140-3630
Shorthead redhorse	222	35.25	328	164-477	419	40-1080
Smallmouth bass	4	0.64	266	225-291	5	160-420
Smallmouth buffalo	4	0.64	609	506-690	4094	2400-6000
Stonecat	3	0.48	111	90-144	-	-
Walleye	3	0.48	403	381-445	593	460-840
Western silvery minnow	3	0.48	102	98-104	-	-
White Sucker	10	1.59	358	267-387	530	200-760
				Intake		
Bigmouth Buffalo	5	0.77	680	620-747	5920	4200-7250
Blue sucker	1	0.15	708	708	3050	3050
Burbot	10	1.54	285	185-579	202	40-1180
Carp	18	2.78	476	273-653	1616	320-3700
Channel catfish	27	4.17	431	273-632	836	140-2380
Emerald shiner	13	2.01	75	58-97	-	-
Flathead chub	18	2.78	159	66-212	45	10-80

Freshwater Drum	10	1.54	297	240-408	384	140-1000
Goldeye	170	26.24	288	80-422	249	10-700
Largemouth bass	1	0.15	132	132	40	40
Northern pike	22	3.40	642	525-838	1481	600-322-
River carpsucker	86	13.28	396	150-552	1115	50-2450
Sauger	142	21.92	345	230-530	331	100-1140
Shorthead redhorse	51	7.87	241	117-368	169	20-530
Shovelnose sturgeon	22	3.40	627	472-914	1235	390-3630
Walleye	32	4.94	405	183-725	686	40-3540
Western silvery minnow	4	0.62	89	62-110	-	-
White bass	4	0.62	311	232-367	508	160-820

APPENDIX II
CATFISH TRAPPING REPORT

APPENDIX III

Precision and bias of blue sucker age estimates derived from scales, fin rays, otoliths and opercula

Drew Pearson, Matt Jaeger, Mathew Rugg

INTRODUCTION

The blue sucker *Cycleptus elongates* is a large catostomid native to mainstem rivers throughout the Mississippi River basin (Bessert & Orti 2008) Blue sucker were historically abundant from Montana east to Pennsylvania and from Wisconsin south to Mexico (Bednarski & Scarnecchia 2006, Hand & Jackson 2003). However, their range has drastically diminished over the past 100 years presumably from the impoundment of main stem rivers and their tributaries (McInerny & Held 1991, Robison & Buchanan 1998, Boschung & Mayden 2004). Blue sucker are now considered in need of conservation in 23 states within their range (Eitzmann et al. 2007). Specifically, Montana has classified blue sucker as a species of special concern, meaning that the species is at-risk due to declining population trends, threats to habitat, and/or restricted distribution.

Estimating fish age using calcified structures is a common practice in fisheries management. Age estimates are used to calculate population dynamic rate functions such as growth, mortality, age-frequencies, and recruitment. Inaccurate age estimates may lead to miscalculation of these dynamic rate functions and misguided management decisions. Structures previously used to estimate age of blue sucker have included scales (Beal 1967, Rupprecht & Jahn 1980, Moss et al. 1983, Hand & Jackson 2003, Morey & Berry 2003, Vokoun et al. 2003), fin rays (Rupprecht & Jahn 1980, Bednarski & Scarnecchia 2006, Eitzman et al. 2007, Bacula et al. 2009), opercles (Bacula et al. 2009), and otoliths (Adams et al. 2006). However, the structure that provides the greatest precision may vary among geographic location (DeVries & Frie 1996, Jackson et al. 2007). Proper management of blue sucker in Montana requires a basic understanding of age and growth information derived from an effective method of age estimation.

Recent studies have revealed greater longevity for blue sucker than previously thought (Bednarski & Scarnecchia 2006; Eitzmann et al. 2007; Vokoun et al. 2003). Depending on the aging structure used, estimates of older blue sucker may be questionable. Opercula may provide more accurate age estimates of older aged blue sucker than scales or fin rays (Peterson et al. 1999; Scoppettone 1988). Our objectives were to compare age estimates from scales, fin rays, and opercula, illuminate bias between aging structures, and to assemble a population age structure.

METHODS

Thirty-five blue suckers were collected and euthanized from the Lower Yellowstone River during the spring and fall of 2009. Fish were captured using drifted trammel nets and boat-mounted electrofishing gear (7-11A; 300-600V; 35-60Hz) in deep riffles with rocky substrates associated with terrace and bluff pools. For each individual, total length (TL) was measured to the nearest millimeter and mass was measured to the nearest gram. Additionally, ten scales per individual were removed between the dorsal fin and the lateral line (Rupprecht and Jahn, 1980). Both left and right pectoral fin rays

and the dorsal fin ray were removed as close to the body wall as possible (Devries and Frie, 1996, Rupprecht and Jahn 1980, Sylvester and Berry, 2006). Structures were then folded in a sheet of wax paper to avoid adhering to the fibers of the coin envelope in which they were placed, labeled, and allowed to dry (Mann, 2004). All individuals were brought back to the laboratory, frozen, and opercula and otoliths were later removed. To prepare samples for viewing, the opercula were removed, boiled, and stripped clean of flesh using a scalpel. The fenestrations of the hyomandibular socket were ground down using a dremel tool to reveal hidden annuli (Scoppettone 1988). Otoliths were removed using techniques similar to the 'open-the-hatch' method (Secor et al. 1992), and they were then set in epoxy. Fin rays were prepared using techniques outlined in Koch & Quist 2007, where the fin rays are embedded in an epoxy and then cross-sectioned once the epoxy had hardened. Cross-sections were cut at a thickness of approximately 0.5mm using a Buehler Isomet low speed saw.

Scales and fin rays were examined under a compound microscope equipped with a Pixera Viewfinder 3.0 digital camera system and Image View computer software. Samples were viewed under projected light with a black background; mineral oil was added to fin ray sections to increase clarity. Since it is assumed that transparent bone accumulates in the winter and opaque bone in the summer, (Scoppettone 1988) annuli were defined as transparent rings. All structures were counted without knowledge of age estimates from other structures or the other reader as in Quist et al. (2007). If any discrepancies existed in age estimates derived from scales and fin rays between readers, a consensus was made and an agreed upon age was determined. Opercula were examined with a dissecting scope under projected light. Age estimates of opercula were averaged between readers for an estimated age value.

Age bias plots were created as a measure of agreement among structures. A coefficient of variation (CV) was calculated for each aging structure then averaged across individuals to provide a measure of between-reader precision (Quist et al. 2007 & Campana et al. 1995).

RESULTS

A total of 35 blue suckers were captured in the spring and fall of 2009 ranging from 540mm to 802mm in fork length and 1165g to 5225g in total weight. The sample was composed of 25 females, 9 males, and 1 individual of unknown sex.

Estimated ages ranged from 7-22 years for scales, 7-41 years for left pectoral fin rays, 7-41 years for right pectoral fin rays, 7-41 years for dorsal fin rays, and 7-66 years for opercula (Figure 1). Otoliths were not successfully removed and/or prepared for age estimation and were thus not examined for precision. Agreement was greatest between the two readers using left fin rays (26% exact agreement, 71% agreement within 2 years) and scales (14% exact agreement, 71% agreement within 2 years). However, the coefficient of variation (CV) was lowest for opercles (6.81) (Table 1).

DISCUSSION

Use of inaccurate ages has caused serious errors in the management and understanding of fish populations (Beamish and McFarlane 1983). For example, underestimation of ages of razorback sucker in lower Colorado River resulted in 30 years of unsuccessful recruitment going unnoticed (Minckley 1983; McCarthy and Minckley

1987 in Scoppettone 1988). Also, Cui-ui were once thought to be a short-lived species, but in reality experienced a similar period of unsuccessful recruitment lasting 18 years (Scoppettone 1988).

Validating a method of age determination is as important in fisheries biology as standardizing solutions or calibrating instruments are in other sciences (Beamish & McFarlane 1983). Sylvester and Berry (2006) stated that comparison of age estimates between structures is an alternative to validation that may provide useful information on the accuracy and bias of age-estimating structures. If validation is not possible fish should be aged by several methods, and the possibility for errors in age estimates must be considered (Beamish & McFarlane 1983).

We observed a high variability in age estimates among structures. Left fin rays and scales had the best between reader agreement, but opercles had the lowest CV. It is likely that pectoral fin rays and scales will remain a popular and practical method for aging blue suckers as they are easily removed and are non-lethal. However, it is important that age validation experiments be conducted and an understanding of potential bias in the results be considered. Techniques used to estimate ages that have not yet been validated need be used with extreme caution. Accurate age estimates are essential for estimated growth, mortality, age frequencies, and year-class assignment. Inaccuracies in age estimates can lead to misguided management decisions. A rigorous evaluation of age estimates from calcified structures (e.g. mark recapture, rearing known-age fish) should be conducted. The current use of blue sucker age estimates should only be used with a clear understanding of the implications of erroneous estimates.

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Table 1. Between reader agreement of age estimates of blue suckers captured in the Yellowstone River during spring and fall of 2009.

Ageing Structure	Percent Agreement			
	Exact	Within 1 yr	Within 2 yr	CV
Scales	0.14	0.40	0.71	11.26
Left Fin Ray	0.26	0.46	0.71	7.85
Right Fin Ray	0.09	0.43	0.63	8.75
Dorsal Fin Ray	0.12	0.35	0.56	9.21
Opercle	0.09	0.29	0.49	6.81

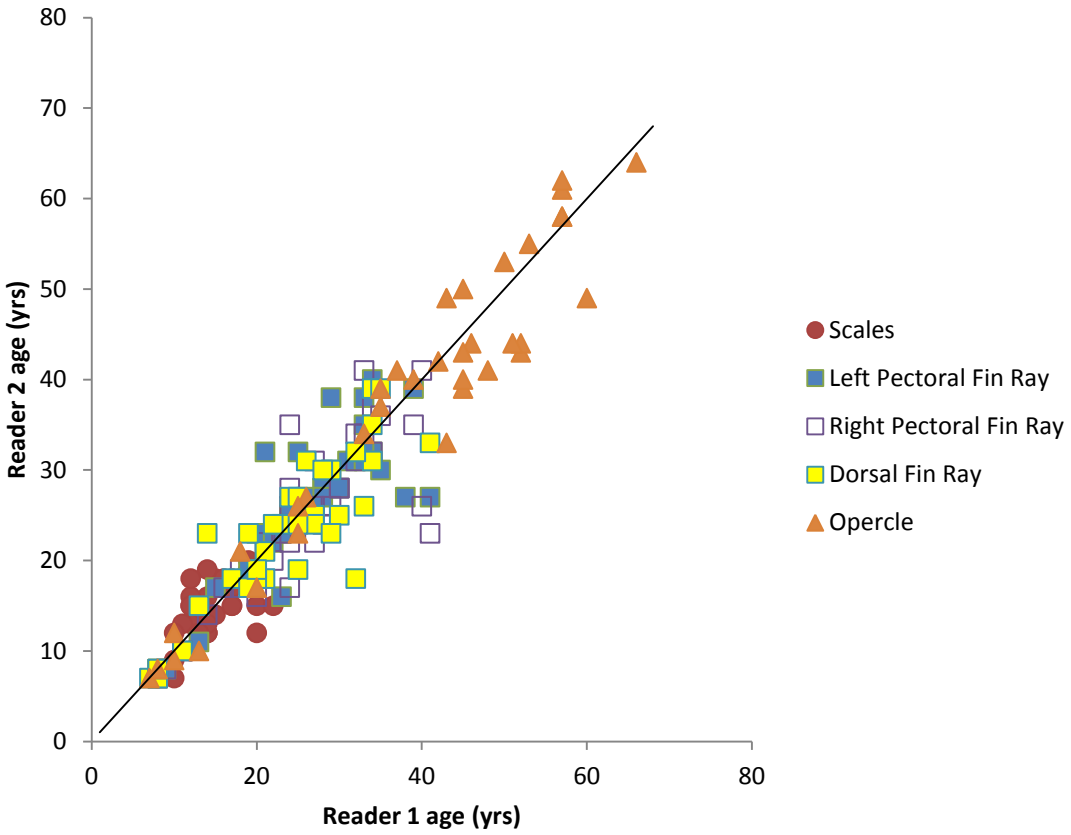

Figure 1. Precision plot of age estimates from two indpendent readers of blue suckers captured in the Yellowston River during spring and fall of 2009. The solid line represents exact age agreement.