

JOB PROGRESS REPORT

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PROJECT TITLE: Statewide Fisheries Investigations
PROJECT NO.: F-78-R-3
STUDY TITLE: Survey and Inventory of Warmwater Streams
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JOB TITLE: Southeast Montana Warmwater Streams Investigations
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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. Additional sampling of the Lower Yellowstone included: Sauger and Walleye tagging in March and April, Pallid Sturgeon targeted sampling and telemetry from April to September, and native species telemetry (Rugg 2018b) from April to October. All species encountered are collected, enumerated, measured, and 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.

Environmental conditions have varied widely during the study period. Yellowstone River discharge in 2019 near Glendive, MT, was above the historic average from ice-out in late-March to the spring rise in early-May. Thereon, the discharge curve mirrored the historic trend, peaking at 60,900 cfs on June 10, 2019. The descending limb of the hydrograph occurred about two weeks later than normal, but by September the hydrograph reached historical averages. A pulse in September bumped the hydrograph about 3,000 cfs above normal for the remainder of the year, increasing turbidity levels throughout September and October (Figure 1). Additionally, early ice formation prevented trend sampling at Intake in October 2019.

STUDY AREA

The study area consists of the 473 km of the Yellowstone River downstream of the Big Horn River confluence (Figure 2). River geomorphology varies throughout the study area in direct response to valley geology; straight, sinuous, braided, and irregularmeander 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

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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 Dam (Intake), diverts about 1,374 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 impedes fish movement and migrations. Some species display limited seasonal passage ability while the dam acts as a nearly complete barrier to other species, most notably preventing the upstream migration of many 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 U.S. Bureau of Reclamation (Reclamation) 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 U.S. 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 40 mm total length. Restoration efforts to create fish passage at Intake Diversion Dam are ongoing. The Corps and Reclamation had identified a bypass channel design as their preferred action to improve passage for endangered Pallid Sturgeon and other native fish in the lower Yellowstone River (Corps 2014). Designs for the bypass channel alternative were completed and construction began in 2019 after a lengthy litigation process between the federal agencies and Defenders of Wildlife. The project includes the excavation of a bypass channel around Intake as well as a new concrete weir across the main channel of the Yellowstone River. The construction projected to be completed by 2023.

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Figure 1. Yellowstone River mean daily discharge for 2019 and historic median daily discharge near Glendive, MT (USGS gauging station 06327500). Data provided by USGS.



Figure 2. The Yellowstone River, its major tributaries, and diversion dams.

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, electrofishing, and angling gears have been used to capture and tag Sauger and Walleye. Pallid Sturgeon sampling using trammel nets occurred from April to October, with most of the netting effort occurring in August and September. Trend sampling was completed each August, September, and October, with boat-mounted electrofishing equipment. Coffelt electrofishing equipment with a single boom and cable dropper was used from 1998 to 2007 and in 2009. In 2008 and from 2010 to present, the electrofishing system changed to a Smith-Root unit with double boom cable droppers. 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 100 mm, 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 location relative to Intake (e.g. upstream or downstream). 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, Shovelnose Sturgeon, 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 of consistent timing, location, and methodology 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, 45 species have been captured on the Lower Yellowstone River during the annual autumn trend surveys. Catch by section during 2019 is summarized in Appendix I. 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.

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<u>Sauger</u>

Sauger continue to be one of the most commonly observed game fish during the annual Yellowstone River trend sampling. Catch rates from 1998 to 2007 averaged over 8 fish per hour. In recent surveys, the catch rates have trended upward and average nearly 16 fish per hr from 2008 to 2013. Catch rate of Sauger in 2019 (6.4 fish/hr) was however well below the long-term average (12.2 fish/hr) (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 predecline levels. In 9 of the last 10 years, catch rates of over 10 fish per hour have been observed, and 6 of the last 10 years catch rates have been 15 fish per hour or greater. Catch rates of about 10 fish per hour support a good Sauger fishery (McMahon 1999). In 2019, catch rates of Sauger decreased at all trend sections (Figure 4). Decreased catch rates in all sections were substantial; observed decreases were 59% at Hysham (4.1/hr in 2018 to 1.7/hr in 2019), 34% at Forsyth (11.5/hr in 2018 to 7.7/hr in 2019), 57% at Miles City (16.2/hr in 2018 to 7.0/hr in 2019), 60% at Fallon (16.9/hr in 2018 to 6.8/hr in 2019), and 58% at Intake (26.7/hr in 2018 to 11.2/hr in 2019). All trend sections, with the exception of Intake, dropped below the 10 fish per hour mark described by McMahon (1999) as a good Sauger Fishery (Figure 4). High fall discharge and associated high turbidity levels impairing capture efficiency, coupled with the inability to conduct an October trend at Intake (historically the trend reach with the highest abundance of Sauger) may explain the reduced catch rates in 2019. Close attention should be paid to Sauger catch rates in the upcoming years.



Figure 3. Catch per effort of Sauger in the Yellowstone River, 1998 to 2019.



Figure 4. Catch per effort of Sauger in the Yellowstone River by trend area, 1998 to 2019.

Population structure in 2019 was dominated by quality to memorable-sized Sauger. (Figure 5). Stock to quality-sized Sauger in 2011 (50%) and 2015 (37%) comprised a larger portion of the total Sauger catch. Historically, there have been several years where the Sauger catch was predominately stock to quality-sized individuals (i.e. 1999, 2001, 2002, 2004, 2011, 2015) and in subsequent years the quality to memorable-sized category has dominated the catch. This may be indicative of strong year-classes of Sauger persisting throughout the lower Yellowstone. The collection of aging structures from Sauger captured during the electrofishing trend efforts would provide valuable insights into the inter-annual periodicity of high recruitment and strong year-classes. Relative weight of all Sauger captured was 85. Size-specific relative weight was highest for memorable-sized fish (89) and sauger shorter than the memorable size all had similar relative weigth (83-85) (Figure 5). Relative weight from 2017 to 2019 decreased for stock-sized fish (102 to 84) and remained similar for all other incremental size groups (Figure 5).

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 trends in the Yellowstone River.



Figure 5. Incremental relative stock density (RSD) and relative weight (Wr) 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 2019.

Sauger have been marked with Floy T-bar tags since 1997. Tagging occurred during spring and fall from 1997 to 2004. Since 2005 Sauger have only been 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 have resulted in 7,527 tagged Sauger (Table 1). Voluntary angler tag return information documented that 24 tagged Sauger were caught by anglers during 2018 of which 19 (79%) of these fish were harvested. The original tagging date for 2018 recaptures ranged from 2006 to 2018 and the recapture locations include the Yellowstone River, Missouri River, Bighorn River, and Lake Sakakawea. During 2019, there were 18 tagged Sauger captured by anglers and 14 of these (78%) were harvested. Original tagging date for recapture Sauger in 2019 ranged from 2014-2019 and recapture locations included the Yellowstone River, Missouri River, and Lake Sakakawea (Table 1).

In 2012, prior to the onset of irrigation at Intake, a new 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 accounted 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 have been completed by the BOR from 2012-2019, and these results should be available by Horn et al. by Spring 2020.

Entrainment protection was phase one of a two-phase fishery restoration effort at Intake. Phase two of the project, of which construction began in 2019, has two objectives 1) to provide fish passage at Intake 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 is a recognized barrier to fish movement and migrations most notably restricting adult Pallid Sturgeon to the lower river. Evidence also suggests that the dam may restrict passage of Sauger (Rugg 2016), especially those less than 275 mm

in length. Length frequency analysis of 2018 autumn trend sampling reflects this. Sauger less than 275 mm only account for 7.8% of the total catch upstream of Intake while these smaller Sauger represented 28.4% of total catch downstream of Intake (Figure 6). This observed length dimorphism may suggest the sustainable presence of Sauger in the reach of river upstream of Intake is dependent upon upstream migration of Sauger from the reach of river downstream of Intake. A recent study (Rugg et al. 2019) demonstrated that 57-88% of Sauger encountering Intake successfully pass upstream. Sauger move upstream over the dam during times of low discharge; they move upstream through the existing side-channel during times of high discharge. However, with the beginning of phase two construction, this historic side-channel was filled with excavations from the soon-to-be Intake bypass channel. Until phase two construction is complete, Sauger passage upstream will be limited to over the dam. The result of Intake influence on Sauger movement is a tenuous link between the upstream reach of river containing important spawning habitat 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 River's robust Sauger population depends on connectivity throughout the system and demonstrates the need to attain unimpeded passage at Intake.

| Yr tagged | Number | | | | | | | | Angl | er Reca | ptures of ' | Fagged S | auger | | | | |
|--------------|--------|--------|--------|-------|--------|--------|--------|--------|-------|---------|-------------|----------|--------|-------|-------|-------|------|
| | tagged | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| 1997 | 39 | 0 | 2 (1) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 545 | 36 (5) | 14 (1) | 3 (2) | 3(2) | 1(1) | 1(1) | 0 | 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 | 0 |
| 2000 | 426 | - | - | 12(3) | 15(7) | 9(2) | 4(1) | 2(2) | 3(3) | 1(0) | 0 | 0 | 1(0) | 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 | 0 |
| 2002 | 621 | - | - | - | - | 62(39) | 46(38) | 13(12) | 10(9) | 3(1) | 1(1) | 1(0) | 0 | 0 | 0 | 0 | 0 |
| 2003 | 344 | - | - | - | - | - | 36(19) | 14(13) | 4(2) | 3(1) | 2(1) | 2(2) | 0 | 0 | 0 | 0 | 0 |
| 2004 | 44 | - | - | - | - | - | - | 0 | 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 | 0 |
| 2006 | 309 | - | - | - | - | - | - | - | - | 7(7) | 10(10) | 7(5) | 3(2) | 0 | 0 | 0 | 0 |
| 2007 | 734 | - | - | - | - | - | - | - | - | - | 23(21) | 16(8) | 15(10) | 8(5) | 5(4) | 0 | 0 |
| 2008 | 627 | - | - | - | - | - | - | - | - | - | - | 16(9) | 19(6) | 9(6) | 3(3) | 2(1) | 0 |
| 2009 | 596 | - | - | - | - | - | - | - | - | - | - | - | 20(12) | 12(8) | 5(3) | 1(0) | 0 |
| 2010 | 0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2011 | 682 | - | - | - | - | - | - | - | - | - | - | - | - | - | 13(9) | 12(7) | 0 |
| 2012 | 549 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6(4) | 8(6) |
| 2013 | 504 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3(2) |
| 2014 | 310 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2015 | 531 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2016 | 466 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Table 1. The number of Sauger tagged in the Yellowstone River that were recaptured by anglers from 1998-2019. The total number of tagged Sauger recaptured by anglers and the total number of tagged Sauger harvested by anglers (in parentheses) are listed.

| Yr | Number |
|--------|--------|
| tagged | number |

| aggeu | | | | | | | | |
|-------|--------|--------|--------|-------|------|--------|------|--|
| | tagged | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
| 1997 | 39 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1998 | 545 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1999 | 493 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2000 | 426 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2001 | 409 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2002 | 621 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2003 | 344 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2004 | 44 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2005 | 422 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2006 | 309 | 1(0) | 0 | 0 | 0 | 1(1) | 0 | |
| 2007 | 734 | 0 | 3(3) | 0 | 0 | 0 | 0 | |
| 2008 | 627 | 0 | 0 | 0 | 0 | 1(1) | 0 | |
| 2009 | 596 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2010 | 0 | - | - | - | - | 0 | 0 | |
| 2011 | 682 | 5(4) | 3(1) | 0 | 0 | 1(1) | 0 | |
| 2012 | 549 | 2(2) | 7(6) | 3(2) | 3(3) | 0 | 0 | |
| 2013 | 504 | 4(2) | 5(4) | 1(1) | 1(1) | 0 | 0 | |
| 2014 | 310 | 13(11) | 11(7) | 9(9) | 4(4) | 2(1) | 1(1) | |
| 2015 | 531 | - | 19(13) | 10(7) | 7(6) | 2(2) | 1(1) | |
| 2016 | 466 | - | - | 9(5) | 3(2) | 2(1) | 1(1) | |
| 2017 | 636 | - | - | - | 5(4) | 12(10) | 7(6) | |
| 2018 | 200 | - | - | - | - | 3(2) | 4(1) | |
| 2019 | 636 | - | - | - | - | - | 4(4) | |

Angler Recaptures of Tagged Sauger



Figure 6. Length frequency distribution of Sauger captured in the Yellowstone River during 2019 during fall electrofishing trends downstream and upstream of Intake Diversion Dam (Intake).

Scouring spring ice flows and rocking of Intake Diversion Dam for water diversion have led to variable crest heights over the diversion dam. Historic river flows observed in the Yellowstone River during 2011 caused substantial scouring of the placed rock on the crest of Intake Diversion Dam. When combined with drought conditions in 2012 and the initial operation of the new screened head gate, this 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. Conversely, extreme ice flows during the spring of 2014 likely removed a substantial amount of rock from the crest of the dam and may have provided additional passage opportunity for fish capable of navigating the turbulent water between voids in the rock field. Yearly variation in crest height, due to the amount of rock on the crest, will be minimized when a new concrete weir is constructed in the mainstem of the Yellowstone River as a part of the Intake Diversion Dam Modification project.

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 Bighorn 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. Incremental relative stock density (RSD) and relative weight were compared between Sauger captured upstream and downstream of the Powder River (Figure 7). The size distribution and relative weight of Sauger downstream of the Powder River confluence was similar to that upstream of the Powder River (Figure 7). However, past years' comparisons of Sauger condition upstream and downstream of the Powder River confluence revealed differences between the two geographical locations. For example, in 2017 stock to quality-size sauger made up a larger portion of the sauger catch downstream of the Power River than upstream (Rugg 2018). It was hypothesized then that perhaps a high abundance of Smallmouth Bass in the trend sections upstream of the Powder River (18.1/hr at Hysham, 6.3/hr at Forsyth, and 3.5/hr at Miles City) was negatively affecting population size of small Sauger. Inter-specific competition between Sauger and Smallmouth does likely occur; however, other biotic and/or abiotic factors likely also play a role in Sauger condition in the Yellowstone River. The Smallmouth Bass daily bag limit on the entire Yellowstone River was increased to 10, from 5 in 2015,

for the 2016 fishing regulation season. The increased bag limit was aimed at reducing inter-specific competition between Smallmouth Bass and other native species, particularly Sauger, as well as providing additional opportunity for anglers wanting to harvest Smallmouth Bass.



Figure 7. Incremental relative stock density (RSD) and relative weight (Wr) of Sauger captured upstream and downstream of the Powder River confluence during 2019 sampling.

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 in Wyoming. 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). High catch rates of walleye downstream of Intake Diversion Dam during spring tagging efforts and subsequent tag returns indicate that there is a segment of the Lake Sakakawea walleye population that regularly uses the Yellowstone River for spawning.

<u>Channel Catfish</u>

Channel Catfish are among the most commonly sampled game fish during the autumn trend. Catch rates have decreased since the record high catch in 2011, yet the Channel Catfish catch rate remains above the historical average (Figure 8). 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 15 electrofisher and may be partly responsible for increased catch rates

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since 2008. Catch rates have been consistently highest in the Hysham trend area and lowest in the Intake trend area (Figure 9). In 2019, the catch rate in the Fallon section significantly increased from 2018 to 2019. This inflated catch was from a single event when 260 small (<300mm) Channel Catfish were captured in the 4th drift section of that trend.



Figure 8. Catch per effort of Channel Catfish in the Yellowstone River, 1998 to 2019.



Figure 9. Catch per effort of Channel Catfish in the Yellowstone River by trend area, 1998 to 2019.

Channel Catfish population structure remains stable (Figure 10). 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 approximately 6% were preferred to memorable (610-710 mm) and 1% were memorable to trophy size (710-910 mm). Relative weight of Channel Catfish in the Yellowstone River has displayed large inter-annual variation. Slight decreases in relative weights of all size categories were observed from 2018 to 2019 (Figure 10).



Figure 10. Incremental relative stock density (RSD) and relative weight (Wr) by length category of Channel Catfish captured during fall electrofishing trends in the Yellowstone River, 1998 to 2019.

<u>Smallmouth Bass</u>

Smallmouth Bass catch rate has been highly variable since the inception of the autumn trend monitoring, particularly from the mid 2000's to present (Figure 11). Relative abundance in each year appears to coincide with water levels that year. For example, with the return of above average flows in 2009, Smallmouth Bass catch rates trended downward. Below average flows and increased water clarity returned in 2012 and 2013 and again the Smallmouth Bass catch rate increased. Flows in 2014 were above average, and the Smallmouth Bass catch rate declined once again through 2015. Flows in the Yellowstone River during the fall of 2016 were near historic lows, and the Smallmouth Bass catch rate nearly doubled from 2015 to 2016. Discharge in 2017 was well above the historic average for much of the year, and the catch rate decreased significantly; the 2017 catch rate was the lowest observed in the past 15 years (Figure 11). In 2018 and 2019, average water years, the catch rate was near the longterm average catch-rate. This high variability in capture efficiency makes relative abundance metrics problematic when describing the actual abundance of Smallmouth Bass. Smallmouth Bass relative abundance decreases from upstream to downstream in the Lower Yellowstone River, and they are rarely captured in any trend section downstream of the confluence with the Powder River (Fallon section, and Intake section) (Figure 12). In 2019 the population structure was dominated by smaller size classes with most fish in the stock to quality (38%) and quality to preferred (48%) length categories (Figure 13). While sampling data suggests the size structure is dominated by shorter Smallmouth Bass, anecdotal evidence suggests Smallmouth Bass effectively avoid electrofishing gear when turbidity is low. Condition of Smallmouth Bass residing in the Yellowstone River is and has been consistently high for all size-classes (Figure 13). Exceptional lengthspecific weight of Smallmouth Bass in the Yellowstone River provides an excellent angling opportunity upstream of Miles City.



Figure 11. Catch per effort of Smallmouth Bass in the Yellowstone River, 1998 to 2019.



Figure 12. Catch per effort of Smallmouth Bass in the Yellowstone River by trend area, 1998 to 2019.



Figure 13. Incremental relative stock density (RSD) and relative weight (Wr) by length category of Smallmouth Bass captured in the Yellowstone River, 1998 to 2019.

Shovelnose Sturgeon

Shovelnose Sturgeon abundance during autumn trend surveys has been variable throughout the study period (Figure 14) 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.



Figure 14. Autumn trend survey catch per effort of Shovelnose Sturgeon in the Yellowstone River during autumn trend survey, 1998 to 2019.

Trend sampling using more efficient gears, such as drifting trammel nets (e.g. Backes and Gardner 1994), allow for more robust estimates of population trends. Shovelnose Sturgeon sample size has increased beginning in 2009 with the onset of juvenile Pallid Sturgeon monitoring. This monitoring utilizes trammel nets, primarily in

August and September, to capture Pallid Sturgeon and as a byproduct efficiently sample Shovelnose Sturgeon. Most netting effort is conducted at sites downstream of Intake. However, sites as far upstream of Intake as Cartersville Diversion Dam at Forsyth have been 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 5,266 Shovelnose Sturgeon during 2018 and 4,083 during 2019. Catch per distance trended downward between 2009 and 2011 and has since remained relatively steady from 2011 to present (Figure 15). Pallid Sturgeon sampling traditionally had taken 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. During 2014, catch rates of Pallid Sturgeon were low in bluff pools; thus, netting effort was spread out across multiple habitat types including riffle and run habitat. Pallid sturgeon sampling in bluff pools during 2015 yielded many captures, and thus the sampling was directed at these habitats for much of the 2015 season. 2016 sampling efforts included a combination of bluff pool and riffle/run habitats. In 2019, the sampling regime was changed to a stratified random site selection. The Yellowstone River was stratified upstream and downstream of Intake Dam and sampling units (2 river miles starting from RM 0 at the Yellowstone-Missouri confluence) were randomly selected to be sampled. This random site selection will provide a better means to track the Shovelnose Sturgeon population through time by decreasing the effect of sampling design on catch metrics.



Figure 15. Catch rates of Shovelnose Sturgeon in the Yellowstone River from 2009 to 2019 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 16). 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 16). Sizespecific relative weight across all size-classes was near 100 (Figure 16). High abundance of large (memorable and trophy-sized) and high-condition Shovelnose Sturgeon offers a unique opportunity for Yellowstone River anglers.



Figure 16. Incremental relative stock density (RSD) and relative weight (Wr) by length category of Shovelnose Sturgeon captured in the Yellowstone River, 1998 to 2019.

As previously described, restoration efforts are currently underway to attain fish passage at Intake. Passage alternative exploration prompted investigative analysis of length frequency distribution of Shovelnose Sturgeon upstream of Intake compared to those downstream of Intake. In 2019, the total catch indicated a divergent size distribution between Shovelnose Sturgeon captured upstream and downstream of Intake Diversion Dam (Figure 17) similar to the trend observed in Sauger. Shovelnose Sturgeon shorter than 400 mm comprised 15% of the total catch downstream of Intake, while none shorter than 400mm were captured upstream (Figure 17). Rugg et al (2019) found that 13-25% of radio-telemetered Shovelnose Sturgeon that encountered Intake Dam successfully passed upstream over the dam or through the side-channel. It is possible that there are source/sink dynamics between the stocks upstream and downstream of Intake Diversion Dam.



Figure 17. Percentage of the total Shovelnose Sturgeon catch by length group upstream and downstream of Intake Diversion Dam during survival analysis sampling 2019. (Length groups are 200-299, 300-399, 400-499,...900-999 mm)

Pallid Sturgeon

Multiple Pallid Sturgeon research and recovery activities occurred on the Yellowstone River during 2019 including: telemetry tracking of adults and juveniles to assess spawning, habitat use, and passage limitations, and juvenile sampling to continue historical trend data and aid in the computation of survival estimates of hatchery stocked individuals. See Rugg 2020 for detailed report of Pallid Sturgeon recovery efforts in the Lower Yellowstone River, 2019.

<u>Burbot</u>

The total number of Burbot captured each year is low. The catch rate in 2019 was the greatest it has been in six years (Figure 18); however, catch rate calculations based on low sample sizes can be greatly affected by only minor changes in catch frequency. 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, especially in August when the natural water supply is lowest and withdraws for irrigation needs are greatest, 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 18. Autumn trend survey catch per effort of Burbot in the Yellowstone River, 1998 to 2019.

Low catch rates also preclude inferences related to population structure and condition. A total of 8 Burbot were captured during the trend sampling, but only 3 were were of at least stock length. Different gear types and sampling times are necessary to obtain an adequate sample size to characterize abundances, structure, and condition of this population. Research conducted in 2004 and 2005 to investigate the presence and distribution of Burbot in the Yellowstone River 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.

Walleye

Catch rates of Walleye have consistently trended upward since the inception of fall electrofishing trend sampling, with the exception of 2019 (Figure 19). The observed

catch rates coincide with anecdotal angler reports of Walleye abundances over the years. 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. Of the 210 Walleye tags returned from Yellowstone River tagging efforts during the period 2011 to 2015, 73% were returned on Lake Sakakawea, and only 21% were returned on the Yellowstone River. The increased catch rates of Walleye in the lower Yellowstone River 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 and booming Walleye population in Sakakawea Reservoir.

Catch rates of Walleye in all trend sections have generally trended upward since 2005 with the highest catch rates at Intake, the most downstream trend section (Figure 20). Particularly, the catch rate of Walleye at Intake has been very high from 2013-2018. It is assumed a large proportion of Walleye captured at Intake are moving upstream from Lake Sakakawea. Walleye tagged at Intake and subsequently recaptured in Lake Sakakawea supports this hypothesis. Elevated water levels and strong prey abundance 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 Lake Sakakawea.

However, from 2018 to 2019 Walleye catch rates at all trend sections decreased substantially. This is the same trend that was observed with Sauger catches and may just be a decrease in catchability rather than an abundance decrease. The Intake trend during October is typically the highest yielding Walleye catch, and sampling in October of 2019 was not completed due to ice flows at Intake. Walleye catch should be monitored closely in the upcoming years.



Figure 19. Catch per effort of Walleye in the Yellowstone River, 1998 to 2019.



Figure 20. Catch per effort of Walleye in the Yellowstone River by trend area, 2005 to 2019.

The Walleye population structure was unbalanced and skewed towards smaller fish when trend surveys began, but in recent years the population has become more balanced (Figure 21). The relative weight of all Walleye captured during the 2019 fall electrofishing trend sampling was 90. Size-specific condition of Walleye tends to increase as size-class increases. That is, stock to preferred-sized fish captured between 2010 and 2019 have generally had lower condition than preferred to trophy-sized fish (Figure 21).



Figure 21. Incremental relative stock density (RSD) and relative weight (Wr) by length category of Walleye captured in the Yellowstone River, 1998 to 2019.

Rare game fishes

Abundances of game fish that were traditionally rarely captured appear consistently low throughout all years with the exception of Northern Pike (Figure 22). Recent (2011-2018) 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 suggesting abnormal increased Northern Pike abundances. The catch rates in 2012 and 2013 were the two highest on record for Northern Pike. Catch rates decreased through 2018 but remained well above those observed at the early onset of trend sampling (Figure 22). Northern Pike catch rates are typically highest at Intake and Fallon, and lower at Miles City, Forsyth, and Hysham trend sections (Figure 23). In 2019, only a single Northern Pike was captured during the autumn trend work. That individual was captured in the Fallon trend section. The cause for near absence of Northern Pike in the catch is unclear, and the status of the species should be re-evaluated after 2020 trend work is completed.

Northern Pike abundances are continually the highest at the Intake trend section. It is assumed the 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 was hypothesized that the observed population increase would 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.



Figure 22. Catch per effort of rare game fishes in the Yellowstone River, 1998 to 2019.



Figure 23. Catch per effort of Northern Pike in the Yellowstone River by trend area, 2001 to 2019.

Common non-game fishes

The majority of common non-game fishes abundances have experienced a trend increase or relatively stability (Figure 24). Shorthead Redhorse Sucker has remained the most abundant species sampled since 2007. The abundance of Shorthead Redhorse Sucker, Goldeye and River Carpsucker began to trend upward in 2004 and has remained at the relatively high abundance since that time.



Figure 24. Catch per effort of common non-game fishes in the Yellowstone River, 1998 to 2019.

Rare non-game fishes

Most rare, non-game fish abundances have remained low but stable since 1998 (Figure 25). However, Freshwater Drum catch rates have increased in abundance from 2006 to present. Relative abundance of Freshwater Drum was below one fish per hour

until 2008. The 2017 trend survey catch rate of Freshwater Drum was near the record high, and relative abundance has remained high through 2019. Abundances of Blue Sucker, a Species of Special Concern in Montana, exhibited proportionally large fluctuations from 1998 to 2000 and displayed the second highest catch rate on record in 2012. The catch rate of Blue Sucker decreased by over 50 percent from 2012 to 2014, yet still remained above the historic average. Catch rates increased to record highs from 2015 to 2016 (1.7 fish/ hr), and have remained high through 2019 (Figure 25). The small sample size of Blue Sucker captured during fall electrofishing precludes drawing many conclusions about the population. Opportunistic bycatch of Blue Sucker during Pallid Sturgeon survival netting does however provide a larger sample size to make inferences about the population. For example, during the fall netting effort 87 and 73 Blue Sucker were captured in 2018 and 2019, respectively (Figure 26). Catch rates during the netting effort have not shown any distinct trends, but the effort is relatively new for a long-lived species. Continued netting efforts will however provide a better means to track the population of Blue Sucker than current electrofishing does. The length distribution of Blue Sucker captured is dominated by larger individuals (Figure 28) and the lack of smaller (i.e. young) Blue Sucker should be closely monitored. Little is known about the rate of Blue Sucker recruitment and where those young might rear. 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 between 2012 and 2014 trend sampling. However, anglers near Miles City have reported catching gar from 2011 to 2013. A single Shortnose Gar was captured in the Intake trend section during 2015 sampling. No shortnose Gar have been captured during fall sampling efforts since 2015.



Figure 25. Catch per effort of rare non-game fishes in the Yellowstone River, 1998 to 2019.



Figure 26. Catch per effort and total catch of Blue Sucker during fall Pallid Sturgeon survival netting efforts, 2012-2019.



Figure 27. Blue Sucker proportionate length frequency distribution by 50-mm length group captured in the Yellowstone River during fall netting, 2012-2019.

Cyprinids

Only three cyprinids (Flathead Chub, *Hybognathus spp.*, and Emerald Shiner) are commonly encountered during the annual trend sampling. Catch rates of these species has been variable from year-to-year (Figure 28). Electrofishing is an inefficient method to accurately track abundance trends in these small-bodied species. The mesh size of the dip nets used precludes the capture of the vast majority of individuals observed. Seining, trawling, and/or mini-fyke nets should be added to the standard gear if reliable relative abundance estimates are desired for small-bodied fish.



Figure 28. Catch per effort of cyprinids in the Yellowstone River, 1998 to 2019.

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Key words:

Population abundance, structure, and condition.

Sauger, Channel Catfish, Smallmouth Bass, Shovelnose Sturgeon, Burbot, Walleye, game fish, non-game fish, cyprinids.

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Date: April 1, 2020

APPENDIX I

SUMMARY OF ANNUAL CATCH BY TREND SECTION

Table 1. Summarized results of Yellowstone River trend sampling,2018.

| Species | Ν | C/f (fish/hour) | Mean Length (mm) | Mean Weight (g) |
|---|--|---|--|--|
| | | Н | ysham | |
| Pigmouth Puffalo | 1 | 0.19 | 610 | 2550 |
| Biginouti Bunaio | 1 | 0.10 | 212 | 160 |
| | 1 | 0.10 | 120 | 100 |
| Brown Trout | 1 2 | 0.10 | 224 | 40 |
| Channel Catfish | 2/12 | 61 39 | 234 170 | 1152 |
| Common Carn | 542 | 9.16 | 47 <i>5</i> 551 | 2508 |
| Emerald Shiner | 3 | 0.54 | 88 | - |
| Elathead Chub | 8 | 1 44 | 127 | - |
| Freshwater Drum | 8 | 1 44 | 351 | 574 |
| Goldeve | 149 | 26.75 | 346 | 354 |
| Hybognathus spp. | 66 | 11.85 | 92 | - |
| Longnose Sucker | 58 | 10.41 | 310 | 413 |
| Mountain Whitefish | 2 | 0.36 | 164 | 40 |
| Northern Pike | 4 | 0.72 | 354 | 408 |
| River Carpsucker | 128 | 22.98 | 406 | 871 |
| Sand Shiner | 1 | 0.18 | 62 | - |
| Sauger | 23 | 4.13 | 406 | 598 |
| Shorthead Redhorse Sucker | 452 | 81.14 | 362 | 565 |
| Smallmouth Bass | 69 | 12.39 | 260 | 422 |
| Smallmouth Buffalo | 5 | 0.90 | 595 | 2998 |
| Walleye | 25 | 4.49 | 447 | 1446 |
| White Sucker | 112 | 20.11 | 386 | 677 |
| Yellow Perch | 1 | 0.18 | 90 | - |
| Sauger Shorthead Redhorse Sucker Smallmouth Bass Smallmouth Buffalo Walleye White Sucker Yellow Perch | 23 452 69 5 25 112 1 | 4.13 81.14 12.39 0.90 4.49 20.11 0.18 | 406 362 260 595 447 386 90 | 598 565 422 2998 1446 677 |

| | Forsyth | | | | | | |
|------------------|---------|------|-----|------|--|--|--|
| Bigmouth Buffalo | 1 | 0.20 | 843 | 8225 | | | |
| Blue Sucker | 5 | 0.98 | 764 | 3755 | | | |

| Duston Transf | 4 | 0.20 | FFO | 1520 |
|---------------------------|-----|--------|------------|------|
| Brown Trout | T | 0.20 | 550 | 1530 |
| Channel Catfish | 68 | 13.30 | 461 | 1006 |
| Common Carp | 37 | 7.23 | 526 | 1962 |
| Emerald Shiner | 54 | 10.56 | 86 | - |
| Flathead Chub | 16 | 3.13 | 135 | - |
| Freshwater Drum | 22 | 4.30 | 341 | 517 |
| Goldeye | 159 | 31.09 | 338 | 324 |
| Hybognathus spp. | 35 | 6.84 | 89 | - |
| Longnose Sucker | 32 | 6.26 | 301 | 375 |
| Northern Pike | 32 | 6.06 | 301 | 375 |
| River Carpsucker | 271 | 52.99 | 398 | 820 |
| Sand Shiner | 1 | 0.20 | 57 | - |
| Sauger | 59 | 11.54 | 359 | 366 |
| Shorthead Redhorse Sucker | 559 | 109.30 | 339 | 470 |
| Shovelnose Sturgeon | 1 | 0.20 | 785 | 2150 |
| Smallmouth Bass | 50 | 9.78 | 266 | 344 |
| Smallmouth Buffalo | 11 | 2.15 | 566 | 2890 |
| Sturgeon Chub | 1 | 0.20 | 95 | - |
| Walleye | 8 | 1.56 | 449 | 1028 |
| White Sucker | 40 | 7.82 | 363 | 562 |
| Yellow Perch | 1 | 0.20 | 77 | - |

| | | Miles City | | | | | |
|---------------------------|-----|------------|-----|------|--|--|--|
| | | | | | | | |
| Blue Sucker | 12 | 2.25 | 728 | 3493 | | | |
| Burbot | 1 | 0.19 | 115 | 10 | | | |
| Channel Catfish | 90 | 16.90 | 461 | 1042 | | | |
| Common Carp | 39 | 7.32 | 507 | 1844 | | | |
| Emerald Shiner | 17 | 3.19 | 84 | - | | | |
| Flathead Chub | 13 | 2.44 | 165 | - | | | |
| Freshwater Drum | 32 | 6.01 | 338 | 538 | | | |
| Goldeye | 161 | 30.24 | 339 | 339 | | | |
| Hybognathus spp. | 33 | 6.20 | 97 | - | | | |
| Longnose Sucker | 54 | 10.14 | 338 | 475 | | | |
| Northern Pike | 1 | 0.19 | 515 | 880 | | | |
| River Carpsucker | 179 | 33.62 | 406 | 910 | | | |
| Sauger | 86 | 16.15 | 348 | 375 | | | |
| Shorthead Redhorse Sucker | 381 | 71.56 | 345 | 487 | | | |
| Shovelnose Sturgeon | 1 | 0.19 | 910 | 4169 | | | |
| Smallmouth Bass | 28 | 5.26 | 294 | 526 | | | |
| Smallmouth Buffalo | 5 | 0.94 | 551 | 2947 | | | |
| Walleye | 15 | 2.82 | 389 | 749 | | | |
| White Crappie | 1 | 0.19 | 150 | 40 | | | |

| White Sucker | 20 | 3.76 | 353 | 500 |
|---------------------------|-----|-------|-------|------|
| | | | | |
| | | F | allon | |
| | _ | | | |
| Blue Sucker | 9 | 1.69 | 736 | 3778 |
| Channel Catfish | 87 | 16.33 | 399 | 658 |
| Common Carp | 40 | 7.51 | 567 | 2608 |
| Emerald Shiner | 3 | 0.56 | 96 | - |
| Flathead Chub | 39 | 7.32 | 142 | - |
| Freshwater Drum | 39 | 7.32 | 352 | 618 |
| Goldeye | 219 | 41.11 | 314 | 303 |
| Hybognathus spp. | 1 | 0.19 | 140 | - |
| Longnose Dace | 1 | 0.19 | 82 | - |
| Longnose Sucker | 19 | 3.57 | 280 | 294 |
| Northern Pike | 1 | 0.19 | 1010 | 8250 |
| River Carpsucker | 70 | 13.14 | 405 | 956 |
| Sauger | 90 | 16.89 | 367 | 433 |
| Shorthead Redhorse Sucker | 280 | 52.56 | 319 | 415 |
| Shovelnose Sturgeon | 1 | 0.19 | 585 | 760 |
| Smallmouth Buffalo | 9 | 1.69 | 567 | 3498 |
| Stonecat | 1 | 0.19 | 137 | 30 |
| Walleye | 9 | 1.69 | 424 | 713 |
| White Bass | 1 | 0.19 | 322 | 520 |
| White Sucker | 7 | 1.31 | 326 | 423 |
| | | | | |

| | _ | Intake | | | | | |
|---------------------------|-----|--------|-----|------|--|--|--|
| | | | | | | | |
| Bigmouth Buffalo | 1 | 0.19 | 762 | 6700 | | | |
| Black Crappie | | | | | | | |
| Burbot | 2 | 0.38 | 184 | 45 | | | |
| Channel Catfish | 18 | 3.41 | 502 | 1239 | | | |
| Chinook Salmon | 1 | 0.04 | 591 | 2150 | | | |
| Common Carp | 8 | 1.52 | 509 | 1766 | | | |
| Emerald Shiner | 184 | 34.86 | 81 | - | | | |
| Flathead Chub | 49 | 9.28 | 151 | | | | |
| Freshwater Drum | 10 | 1.89 | 335 | 572 | | | |
| Goldeye | 102 | 19.33 | 285 | 263 | | | |
| Hybognathus spp. | 61 | 11.56 | 100 | | | | |
| Northern Pike | 4 | 0.76 | 789 | 2973 | | | |
| River Carpsucker | 125 | 23.68 | 428 | 1319 | | | |
| Sauger | 141 | 26.71 | 312 | 258 | | | |
| Shorthead Redhorse Sucker | 70 | 13.26 | 266 | 244 | | | |
| Shovelnose Sturgeon | 16 | 3.03 | 530 | 741 | | | |

| Smallmouth Buffalo | 6 | 1.14 | 656 | 4654 |
|--------------------|----|------|-----|------|
| Stonecat | 1 | 0.19 | 160 | 20 |
| Walleye | 43 | 8.15 | 408 | 695 |
| White Bass | 1 | 0.19 | 420 | 980 |
| White Sucker | 4 | 0.76 | 271 | 270 |
| Yellow Perch | 1 | 0.19 | 85 | - |

Table 2. Summarized results of Yellowstone River trend sampling,2019.

| Species | Ν | C/f (fish/hour) | Mean Length (mm) | Mean Weight (g) |
|---------------------------|-----|--------------------|------------------------|-----------------------|
| | | F | lysham | |
| Bigmouth Buffalo | 4 | 0.7 | 634 | 4207 |
| Black Crappie | 0 | 0 | - | - |
| Blue Sucker | 0 | 0 | _ | - |
| Bluegill | 0 | 0 | - | - |
| Brown Trout | 0 | 0 | - | - |
| Burbot | 4 | 0.7 | 151 | 35 |
| Channel Catfish | 368 | 64.0 | 489 | 1173 |
| Common Carp | 85 | 14.8 | 499 | 1882 |
| Emerald Shiner | 31 | 5.4 | 82 | - |
| Flathead Chub | 3 | 0.5 | 127 | - |
| Freshwater Drum | 7 | 1.2 | 385 | 856 |
| Goldeye | 70 | 12.2 | 334 | 337 |
| Hybognathus spp. | 45 | 7.8 | 91 | - |
| Longnose Dace | 2 | 0.4 | 73 | - |
| Longnose Sucker | 53 | 9.2 | 328 | 446 |
| Mountain Sucker | 2 | 0.4 | 113 | 20 |
| Mountain Whitefish | 0 | 0 | - | - |
| Northern Pike | 0 | 0 | - | - |
| Rainbow Trout | 0 | 0 | - | - |
| River Carpsucker | 153 | 26.6 | 400 | 851 |
| Sand Shiner | 0 | 0 | - | - |
| Sauger | 10 | 1.7 | 376 | 499 |
| Shorthead Redhorse Sucker | 251 | 43.6 | 370 | 599 |
| Shovelnose Sturgeon | 0 | 0 | - | - |
| Smallmouth Bass | 77 | 13.4 | 252 | 434 |
| Smallmouth Buffalo | 18 | 3.1 | 545 | 2783 |
| Stonecat | 2 | 0.4 | 151 | 60 |

| Walleye | 15 | 2.6 | 520 | 1808 |
|---------------|----|------|-----|------|
| White Bass | 0 | 0 | - | - |
| White Crappie | 0 | 0 | - | - |
| White Sucker | 78 | 13.6 | 377 | 638 |
| Yellow Perch | 1 | 0.2 | 132 | 40 |
| | | | | |

| | Forsyth | | | | |
|---------------------------|---------|------|-----|------|--|
| Bigmouth Buffalo | 0 | 0 | - | - | |
| Black Crappie | 0 | 0 | - | - | |
| Blue Sucker | 2 | 0.4 | 723 | 3425 | |
| Bluegill | 0 | 0 | - | - | |
| Brown Trout | 0 | 0 | - | - | |
| Burbot | 0 | 0 | - | - | |
| Channel Catfish | 55 | 11.1 | 435 | 816 | |
| Common Carp | 67 | 13.6 | 514 | 1955 | |
| Emerald Shiner | 0 | 0 | - | - | |
| Flathead Chub | 10 | 2.0 | 126 | - | |
| Freshwater Drum | 16 | 3.2 | 356 | 624 | |
| Goldeye | 181 | 36.6 | 326 | 304 | |
| Hybognathus spp. | 4 | 0.8 | 101 | - | |
| Longnose Dace | 0 | 0 | - | - | |
| Longnose Sucker | 25 | 5.1 | 329 | 439 | |
| Mountain Sucker | 0 | 0 | - | - | |
| Mountain Whitefish | 0 | 0 | - | - | |
| Northern Pike | 0 | 0 | - | - | |
| Rainbow Trout | 0 | 0 | - | - | |
| River Carpsucker | 164 | 33.2 | 393 | 796 | |
| Sand Shiner | 0 | 0 | - | - | |
| Sauger | 38 | 7.7 | 329 | 298 | |
| Shorthead Redhorse Sucker | 384 | 77.7 | 342 | 451 | |
| Shovelnose Sturgeon | 2 | 0.4 | 882 | 3450 | |
| Smallmouth Bass | 21 | 4.3 | 259 | 428 | |
| Smallmouth Buffalo | 14 | 2.8 | 560 | 2789 | |
| Stonecat | 0 | 0 | - | - | |
| Walleye | 2 | 0.4 | 455 | 830 | |
| White Bass | 0 | 0 | - | - | |
| White Crappie | 0 | 0 | - | - | |
| White Sucker | 47 | 9.5 | 368 | 595 | |
| Yellow Perch | 0 | 0 | - | - | |

| | Miles City | | | | |
|---------------------------|------------|------|-----|------|--|
| Bigmouth Buffalo | 4 | 1.2 | 606 | 4180 | |
| Black Crappie | 0 | 0 | - | - | |
| Blue Sucker | 2 | 0.6 | 728 | 3490 | |
| Bluegill | 0 | 0 | - | - | |
| Brown Trout | 0 | 0 | - | - | |
| Burbot | 1 | 0.3 | 195 | 40 | |
| Channel Catfish | 30 | 9.2 | 431 | 921 | |
| Common Carp | 21 | 6.4 | 505 | 1804 | |
| Emerald Shiner | 4 | 1.2 | 94 | - | |
| Flathead Chub | 15 | 4.6 | 121 | - | |
| Freshwater Drum | 26 | 7.9 | 339 | 516 | |
| Goldeye | 193 | 59.0 | 335 | 324 | |
| Hybognathus spp. | 0 | 0 | - | - | |
| Longnose Dace | 0 | 0 | - | - | |
| Longnose Sucker | 30 | 9.2 | 351 | 476 | |
| Mountain Sucker | 0 | 0 | - | - | |
| Mountain Whitefish | 0 | 0 | - | - | |
| Northern Pike | 0 | 0 | - | - | |
| Rainbow Trout | 0 | 0 | - | - | |
| River Carpsucker | 95 | 29.0 | 398 | 799 | |
| Sand Shiner | 0 | 0 | - | - | |
| Sauger | 23 | 7.0 | 361 | 417 | |
| Shorthead Redhorse Sucker | 173 | 52.9 | 336 | 456 | |
| Shovelnose Sturgeon | 2 | 0.6 | 805 | 2640 | |
| Smallmouth Bass | 27 | 8.3 | 270 | 382 | |
| Smallmouth Buffalo | 4 | 1.2 | 507 | 2000 | |
| Stonecat | 1 | 0.3 | 120 | 10 | |
| Walleye | 5 | 1.5 | 443 | 1154 | |
| White Bass | 0 | 0 | - | - | |
| White Crappie | 0 | 0 | - | - | |
| White Sucker | 13 | 4.0 | 362 | 535 | |
| Yellow Perch | 0 | 0 | - | - | |

| | Fallon | | | |
|------------------|--------|-----|-----|------|
| Bigmouth Buffalo | 6 | 1.1 | 712 | 6246 |
| Black Crappie | 0 | 0 | - | - |
| Blue Sucker | 8 | 1.5 | 772 | 4331 |
| Bluegill | 0 | 0 | - | - |

| Brown Trout | 0 | 0 | - | - |
|---------------------------|-----|------|-----|------|
| Burbot | 2 | 0.4 | 304 | 155 |
| Channel Catfish | 293 | 53.6 | 407 | 857 |
| Common Carp | 12 | 2.2 | 517 | 2204 |
| Emerald Shiner | 27 | 4.9 | 87 | - |
| Flathead Chub | 12 | 2.2 | 154 | - |
| Freshwater Drum | 18 | 3.3 | 325 | 471 |
| Goldeye | 234 | 42.8 | 319 | 305 |
| Hybognathus spp. | 3 | 0.6 | 111 | - |
| Longnose Dace | 0 | 0 | - | - |
| Longnose Sucker | 4 | 0.7 | 238 | 170 |
| Mountain Sucker | 0 | 0 | - | - |
| Mountain Whitefish | 0 | 0 | - | - |
| Northern Pike | 1 | 0.2 | 550 | 1000 |
| Rainbow Trout | 0 | 0 | - | - |
| River Carpsucker | 29 | 5.3 | 408 | 923 |
| Sand Shiner | 0 | 0 | - | - |
| Sauger | 37 | 6.8 | 383 | 495 |
| Shorthead Redhorse Sucker | 124 | 22.7 | 335 | 452 |
| Shovelnose Sturgeon | 1 | 0.2 | 825 | 3120 |
| Smallmouth Bass | 0 | 0 | - | - |
| Smallmouth Buffalo | 3 | 0.6 | 650 | 4522 |
| Stonecat | 4 | 0.7 | 119 | 23 |
| Walleye | 4 | 0.7 | 443 | 823 |
| White Bass | 0 | 0 | - | - |
| White Crappie | 0 | 0 | - | - |
| White Sucker | 2 | 0.4 | 368 | 565 |
| Yellow Perch | 0 | 0 | - | - |

| | Intake | | | |
|------------------|--------|-----|-----|------|
| Bigmouth Buffalo | 6 | 1.9 | 659 | 5302 |
| Black Crappie | 2 | 0.6 | 121 | 20 |
| Blue Sucker | 0 | 0 | - | - |
| Bluegill | 0 | 0 | - | - |
| Brown Trout | 0 | 0 | - | - |
| Burbot | 1 | 0.3 | 257 | 120 |
| Channel Catfish | 15 | 4.7 | 525 | 1651 |
| Common Carp | 15 | 4.7 | 413 | 1114 |
| Emerald Shiner | 11 | 3.4 | 80 | - |
| Flathead Chub | 25 | 7.8 | 148 | - |
| Freshwater Drum | 12 | 3.7 | 343 | 595 |

| Goldeye | 78 | 24.3 | 284 | 272 |
|---------------------------|----|------|-----|------|
| Hybognathus spp. | 3 | 0.9 | 102 | - |
| Longnose Dace | 0 | 0 | - | - |
| Longnose Sucker | 0 | 0 | - | - |
| Mountain Sucker | 0 | 0 | - | - |
| Mountain Whitefish | 0 | 0 | - | - |
| Northern Pike | 0 | 0 | - | - |
| Rainbow Trout | 0 | 0 | - | - |
| River Carpsucker | 34 | 10.6 | 411 | 1122 |
| Sand Shiner | 0 | 0 | - | - |
| Sauger | 36 | 11.2 | 320 | 260 |
| Shorthead Redhorse Sucker | 24 | 7.5 | 247 | 195 |
| Shovelnose Sturgeon | 20 | 6.2 | 547 | 866 |
| Smallmouth Bass | 0 | 0 | - | - |
| Smallmouth Buffalo | 11 | 3.4 | 578 | 3621 |
| Stonecat | 0 | 0 | - | - |
| Walleye | 10 | 3.1 | 341 | 435 |
| White Bass | 0 | 0 | - | - |
| White Crappie | 0 | 0 | - | - |
| White Sucker | 4 | 1.3 | 298 | 345 |
| Yellow Perch | 0 | 0 | - | - |
| | | | | |