MONTANA FISH, WILDLIFE & PARKS

2022 Missouri River – Holter Dam Tailwater Monitoring

Status Report for NorthWestern Energy
FERC Project 2188
Project #2022-2

and

Fisheries Division Federal Aid Job Progress Report
Federal Aid Project Number: F-113-R23
State Project Number: 3410
Project Title: Montana Statewide Fisheries Management

Prepared by:
Jason Mullen, Montana Fish, Wildlife & Parks

January 2023

At the November 2021 Missouri River Technical Advisory Committee (MoTAC) meeting, Montana Fish, Wildlife & Parks (FWP) was awarded $28,123 from NorthWestern Energy (NWE) for monitoring of the Missouri River and the fishery below Holter Dam as part of the Federal Energy Regulatory Commission (FERC) license 2188. This report summarizes the results of the 2022 monitoring.

Methods

Rainbow trout and brown trout

Two sections of the Missouri River downstream from Holter Dam were electrofished at night using aluminum jet boats. The Craig section is 5.6 miles long and located from river mile (RM) 2,199.5 (measuring from its confluence with the Mississippi River) at Wolf Creek Bridge to RM 2,193.9 at Craig Bridge (Figure 1). The Cascade section is 4.1 miles long and is located from the power lines at RM 2,177.6 to an irrigation pump at RM 2,173.5 (Figure 2). The Pelican Point Fishing Access Site is located approximately midway through the section. Jet boats equipped with headlights and fixed boom electrofishing systems using stainless steel cable droppers suspended from each boom were used. Electricity from generators was converted to smooth DC using Smith-Root rectifying units. Brown trout *Salmo trutta* estimates were conducted in each section in spring from the 25th of April through the 12th of May. Two jet boats were used in the Craig section, and one jet boat was used in the Cascade section with two nights of marking runs and two nights of recapture runs in each section. Rainbow trout *Oncorhynchus mykiss* estimates were conducted in autumn from the 3rd of October through the 18th of October and two jet boats were used in each section. Three nights of marking runs and two nights of recapture runs were completed in the Craig section, and two nights of marking and two nights of recapture runs were completed in the Cascade section.

Data were uploaded into the FWP Fisheries Information System making the data publicly available through the FWP FishMT website. Beginning with data collected in 2021, abundance estimates were calculated for all years utilizing a department repeatable reporting tool. Abundance was estimated using maximum likelihood estimation to allow the effects of covariates such as age class and/or length to be included on the probability of detection. This method assumes that the population is closed. We used the glm function from the stats package in the R programming environment to estimate the effects of length on the probability of detection, and to then calculate abundance (R Core Team 2018). Reported abundance estimates are based on model-averaged estimates. Chi-square goodness-of-fit tests were used to evaluate the adequacy of model fit (Williams et al. 2002) and the Akaike Information Criterion was used to assess the best predictive model (Akaike 1998). Abundance estimates are reported as number of trout per mile 10 inches long and greater with 95% confidence intervals.

Mountain whitefish

Mountain whitefish *Prosopium williamsoni* were not typically monitored during past electrofishing surveys due to logistical constraints and the potential negative effects of stress from handling, which is greater than that for trout. However, two surveys were conducted over the upper 2.5 miles of the Craig section in 2004 and 2005. While an effort was made to calculate a population estimate using Mark-Recapture techniques, the low abundance and poor recapture rates resulted in poor estimates and the data being suitable for only catch per unit effort (CPUE). A similar effort to evaluate CPUE of mountain whitefish was conducted beginning in 2020 and continued through 2022 during the spring sampling for brown trout. In 2020 and 2021, all mountain whitefish encountered 6 inches and greater in the upper 2.5 miles of the Craig section were netted, counted, and measured during the first marking run. For all subsequent runs (second marking run and two recapture runs), all mountain whitefish were counted, but not netted to reduce stress from handling. The same methods were employed in 2022 except only 129 mountain whitefish were measured from a portion of the first marking run to evaluate size

structure. The remainder of Run 1 and all subsequent runs were visually counted using the same methods as 2020 and 2021.

Catch per unit effort was evaluated as the average number of mountain whitefish per mile including all four runs for each year. All four runs were incorporated due the substantial variability among runs and there was no consistent decrease in abundance with subsequent runs, which would merit evaluating only Run 1 data. The size distribution was evaluated for each year as the proportion of individuals handled by 0.5-inch length group, due to the varying sample size of fish handled from the different methods among years.

Burbot, walleye, and northern pike

Walleye *Sander vitreus* and burbot *Lota* are also encountered during spring and fall electrofishing surveys and all individuals encountered are netted and counted to evaluate CPUE. Typically, more walleye and burbot are handled during fall surveys than spring surveys and in the Craig section than the Cascade section, thus only long-term results for fall data from the Craig section are presented here. Walleye encountered during electrofishing surveys of the Holter tailrace (from Holter Dam to Wolf Creek bridge) and within the Craig section are tagged with floy tags. Harvest returns of tagged fish are also reported here.

FWP has conducted annual seining surveys between Cascade and Great Falls since 2009 to evaluate young of year (YOY) walleye production in a 47-mile reach of the Missouri River between Cascade and Great Falls. Most recently the seining surveys have also served to monitor the presence and abundance of juvenile northern pike *Esox lucius*. The protocol and site descriptions are described in Grisak and Tribby (2011).

Flow monitoring

Missouri River flow data were monitored utilizing USGS gage 06066500 located below Holter Dam. Daily, mean annual flow, and peak annual flow data are summarized and reported here.

Water temperature monitoring

Water temperature data were also monitored utilizing USGS gage 06066500 below Holter Dam. Additional temperature loggers are periodically deployed and monitored at strategic locations in the Missouri River. These data are used in making management decisions that could include instituting time of day angling restrictions of certain fisheries to reduce stress from angling on the trout populations. It is the policy of FWP and adopted in rule (ARM 12.5.507) that such closure requests may be made when temperatures reach established thresholds, which for nonnative salmonids includes "…daily maximum water temperature reaches or exceeds 73°F at any time during the day for three consecutive days…" The policy and rule also recognize that some waters (e.g., Missouri River) will not reach the established threshold levels but may require action to protect the fisheries anyway due to a combination of stressors, including shifts in angling pressure due to fishing restrictions or closures on other waterbodies that could adversely impact the fishery.

Missouri River Population Monitoring

Rainbow trout and brown trout

The estimate of brown trout 10 inches long and greater in the Craig section was 1,595 (95% CI [1,518, 1,672]) per mile in spring 2022 (Figure 3). The 2022 estimate was 264% of the long-term average of 604 per mile based on estimates since 1983 (n = 36) and higher than the estimate for all prior years (Figure 3). While population estimates are only reported for fish 10 inches and greater, the most abundant size

class of brown trout sampled in 2021 was 6 to 9 inches (Figure 5), indicating a potential strong year class of juveniles. This cohort was apparent in 2022, with 11 to 15-inch fish by far the most abundant (Figure 5), explaining the large increase in the brown trout population estimate of fish 10 inches and greater from 2021.

The estimate of rainbow trout 10 inches long and greater in the Craig section was 6,132 (95% CI [5,713, 6,550]) per mile in fall 2022 (Figure 3). The 2022 estimate was 169% of the long-term average of 3,623 fish per mile based on annual estimates since 1982 (n = 40) and the third highest on record. The most abundant size class in 2022 was 14 to 17 inches (Figure 6). Small rainbow trout were extremely abundant during sampling in fall 2020, as demonstrated by the estimate of 6-inch rainbow trout, and smaller individuals that were observed but not marked. This cohort made up a large proportion of the population estimate greater than 10 inches in 2021 and 2022, resulting in the second and third highest estimates on record.

The estimate of brown trout 10 inches long and greater in the Cascade section was 566 (95% CI [472, 661]) per mile in spring 2022 (Figure 4). The 2022 estimate was 144% of the long-term average of 393 per mile (n = 37). The most abundant size classes of brown trout in the Cascade section were 12 to 14 inches and 17-inch fish (Figure 7). The 2022 estimate represents an increase compared to 2017 through 2021; however, the increase was modest compared to the large increase in the Craig section.

The estimate of rainbow trout 10 inches long and greater in the Cascade section was 1,265 (95% CI [1,063, 1,466]) per mile in fall 2022 (Figure 4). This estimate was 74% of the long-term average of 1,703 per mile (n = 40) and less than that observed in 2020 and 2021. The most abundant size class of rainbow trout was 13 to 15 inches in 2022 (Figure 8). The large cohort of 6-inch fish and smaller observed in the Craig section in 2020 was not observed in the Cascade section, thus there was no marked increase in abundance in 2021 and 2022 in the Cascade section.

The large increase in rainbow trout and brown trout in the Craig section in recent years appears to be related to the high flow event in 2018. Based on the recent size distribution of the populations, it appears there were two good years of reproduction and recruitment for rainbow trout and brown trout from fall 2018 through spring 2020. Increases in rainbow trout, brown trout, or both were documented following high flow events in 1996 through 1998, and 2010 and 2011 in both the Craig and Cascade sections (Figure 3, 4, and 15). This trend was evident for rainbow trout and brown trout in the Craig section following the 2018 high flow event but was only marginal for brown trout in the Cascade section and not documented for rainbow trout in the Cascade section.

Mountain whitefish

The observed average number of mountain whitefish per mile within the first 2.5 miles of the Craig section was 82, 73, 43, 84, and 138, in 2004, 2005, 2020, 2021, and 2022, respectively (Figure 9). While CPUE data cannot be interpreted with the same level of confidence as population estimates, CPUE was similar in 2004, 2005, and 2021, lower in 2020, and higher in 2022 (Figure 9). The size distribution of mountain whitefish was similar in 2004 and 2005, with fish between 15 and 18 inches most common and few fish less than 14 inches. In 2020, 2021, and 2022, mountain whitefish less than 14 inches made up a much greater proportion of the samples than earlier years, with 10.5 to 12.5-inch fish most abundant in 2022 (Figure 10). A yearlong creel survey was completed from March 2015 through February 2016 on the Missouri River (Mullen and Schilz 2017). Catch rates from the 2015 creel survey were similar to those observed in 1993, but less than rates observed in 2002 and 1988 (Leathe et al.

1988; Horton and Liknes 2003; Horton and Clark 2004). The recent mountain whitefish sampling effort will be continued in future years to collect more data for population trend evaluation.

Burbot, walleye, and northern pike

In the Craig Section, 16 burbot and 13 walleye were sampled in spring 2022 and 122 burbot and 30 walleye in fall 2022. In the Cascade section, 8 burbot and 1 walleye were sampled in spring 2022 and 44 burbot and 42 walleye in fall 2022. Burbot ranged from 8.1 to 29.2 inches and walleye ranged from 3.9 to 28.9 inches. More than half the walleye handled in the Craig section were 20 inches and greater. In contrast, most of the walleye handled in the Cascade section were less than 10 inches. The size distribution of burbot was relatively similar among sites, except smaller burbot less than 14 inches were more common in the Craig section.

Based on fall electrofishing data from the Craig section, burbot were most abundant from 1997 through 2001 and to a lesser degree from 2010 through 2014 (Figure 11). The number of burbot handled in 2022 was the highest since 2013 and has been at or above the long-term average of 76 in four of the last five years. Walleye were most abundant in the Missouri River in 2010 and 2011 following high flow events (Figure 11) and corresponding with a period of relatively abundant populations in Holter Reservoir. Somewhat higher numbers of walleye were collected in fall 2018 and 2019 following a high flow event in spring 2018, but densities in Holter Reservoir were lower at this time than around 2010 and 2011, which may explain the smaller increase in numbers. The number of walleye handled in 2022 was the highest since 2019 and above the long-term average of 28. The numbers of burbot and walleye handled are substantially less than the number of trout handled. The mean number of burbot and walleye handled during fall electrofishing in the Craig section is 76 and 28, respectively, compared to a mean of 4,534 rainbow trout (during fall) and 1,814 brown trout (during spring) handled.

Most walleye harvest tag returns were reported within a year of being tagged and few tags were reported two years or longer after being tagged (Appendix A, Tables A1 and A2). In the Holter tailrace section, since 2006, an average of 13% of tagged walleye were reported as harvested by the following year (min = 2%, max = 36%) (Appendix A, Table A1). Similarly, 17% of tagged walleye were reported as harvested by the following year in the Missouri River below Holter (min = 7%, max = 41%), excluding the tailrace section (Appendix A, Table A2). Despite relatively few walleye harvest tag returns beyond the year after tagging, the tagging program has documented walleye up to 23 years old in the Missouri River, based on the age of the fish when tagged and angler reported catch date.

Walleye regulations from Holter Dam to Cascade Bridge were changed by the FWP Commission from the standard 5 daily and 10 in possession regulation in 2010 to no limit in 2011 through 2019. While the percent of anglers reporting tagged fish is unknown, based on harvest tag return rates from walleye tagged in the Holter tailrace (Appendix A, Table A1) and those tagged primarily in the Craig section (Appendix A, Table A2), there was no increase in the harvest tag return rate with the change in regulations. In fact, walleye harvest return rates tended to be higher before 2011 than after with a combined 29% (50 of 175 tagged fish) returned as harvested within one year for fish tagged from 2004 through 2009 compared to 15% (137 of 924 tagged) returned as harvested within one year for fish tagged from 2011 through 2018 (Appendix A, Tables A1 and A2). A creel survey was completed from March 2015 through February 2016 (Mullen and Schilz 2017). Of the 75 walleye that were reported as harvested during angler interviews, 8 total walleye (angler harvest of 6 to 8 walleye per person) were in excess of what the prior standard regulation would have allowed (Mullen and Schilz 2017). Four of the twenty-five (16%) anglers who harvested walleye, harvested in excess of the old standard regulation (Mullen and Schilz 2017). The no limit regulation was removed in 2020 and replaced with 20 daily and 40

in possession from Holter Dam to Cascade Bridge and 10 daily and 20 in possession from Cascade Bridge to Black Eagle Dam.

In 2022, 48 seine hauls were conducted at 12 long-term monitoring sites from Cascade to Great Falls and no YOY walleye were sampled. Three additional sites were sampled between Cascade and Pelican Point and no walleye were collected. The number of YOY walleye has been highly variable, but relatively low in most years. The most YOY walleye were collected in the first two years of sampling in 2009 and 2010 with 213 and 235 individuals collected over the 12 sites (Figure 12). In most other years, the number of YOY walleye has been approximately 50 or less with 0 or 1 individual collected in 5 of the 14 years. Young of the year walleye abundance may be related to flow events that flush walleye into the Missouri River from Holter Reservoir and flows that provide suitable spawning and rearing conditions. Young of the year walleye abundances were generally highest with moderately high peak flows in 2009 and 2010 and lowest during the low flow years of 2013, 2015, 2016, 2021, and 2022. However, YOY walleye abundance was also relatively low during 2011, the year with the highest peak flow.

During the annual seining surveys for YOY walleye, one juvenile northern pike was sampled in 2019 and 2020, representing the first northern pike sampled during these surveys. No northern pike were collected in 2021, but in 2022, seven juvenile northern pike were collected from the standard 12 monitoring sites, with several adults also observed. Zero northern pike were collected from the three additional sites between Cascade and Pelican Point.

In recent years, several other northern pike have been observed by FWP personnel and beginning in 2018 anglers reported catching numerous adult northern pike in the Missouri River between Holter Dam and Rainbow Dam. Most of the angler reports of northern pike catch have come from the area between Cascade to Ulm, but some northern pike have been reported as caught immediately downstream of Holter Dam and more recently between Black Eagle and Rainbow dams. One northern pike was collected in the Craig section during spring 2020 electrofishing but was subsequently lost before measurements could be collected. This represents the first northern pike encountered during the annual monitoring surveys since that began in 1980. In 2022, one adult northern pike was collected from Rainbow Reservoir and one adult was collected from Ryan Reservoir, which represent the first northern pike collected from the Great Falls reservoirs that are sampled annually. Based on the increased reports from anglers and northern pike presence during sampling, including the documentation of juvenile northern pike, it appears northern pike have become established in the Missouri River downstream of Holter Reservoir. It is likely the high flows in 2018 resulted in northern pike being flushed into the river from Holter Reservoir. Northern pike abundance has also increased in Holter Reservoir in recent years and will likely continue to act as a source for northern pike in the river, particularly during high flow years, similar to what has been documented for walleye.

In 2019, the FWP Commission approved changes to the northern pike regulations downstream of Holter Dam that went into effect March 1, 2020. Northern pike regulations on the Missouri River from Holter Dam downstream to Black Eagle Dam were changed from the standard regulation of 10 daily and in possession to No Limit. This regulation change is intended to encourage harvest of northern pike given the increased abundance throughout the system and is consistent with regulations already in place in the Missouri River and reservoirs upstream of Holter Dam.

Flow Monitoring

Mean daily flow for calendar years 2018 through 2022 compared to mean daily flow for the period of record are shown in Figure 13. Overall, the mean daily flow, mean annual discharge, and the peak

annual discharge were well below average in 2021 and 2022 (Figures 13, 14, and 15) due to drought conditions. Flows in 2018 were well above average with a mean annual discharge of 6,963 cfs and a peak discharge of 20,000 cfs (Figures 14 and 15). The most recent five years illustrate the variability in the magnitude and timing of the peak discharge as the peak varied from the end of April to the beginning of July, with no runoff flow in 2021 and a minimal peak in 2022. Approximately 15,000 cfs results in mobilization of streambed substrates in the Missouri River (R2 1994; Strainer and Grisak 2009). Over the last 22 years (2001 through 2022) peak flows have met or exceeded 15,000 cfs only four times (2008, 2010, 2011, and 2018) compared to nine times from 1981 through 2000, and 12 times from 1961 through 1980 (Figure 15). A 1994 report found that a 15,000 cfs flow capable of mobilizing substrate occurred approximately once every three years (R2 1994). Over the last 22 years, flushing flows have occurred nearly half as often, once every 5.5 years.

For the 2022 calendar year, the Missouri River below Holter Dam had an estimated mean discharge of 3,677 cfs, which was 70% of the 76-year mean (Figure 14). The maximum discharge in 2022 occurred on June 16th and was 8,850 cfs (Figure 15), which was 64% of the 77-year mean.

Water Temperature Monitoring

In 2022, the USGS gauging station below Holter Dam recorded a maximum daily temperature of 69.6°F on August 13th (Figure 16, Table 1). Additional water temperature monitoring was conducted in the Missouri River at Craig, Mid-Canon, Pelican Point, and Cascade beginning June 1st. Water temperature exceeded 73°F at Cascade on one day (August 12th) and routinely peaked between 70°F and 72°F at Craig and Mid-Canon in late July through mid-August in 2022 (Figure 17). Maximum water temperatures were often about 1°F cooler at Pelican Point than Craig or Mid-Canon.

Time of day angling restrictions have occasionally been implemented on the Missouri River in the past to reduce stress on the trout population from a combination of warm water temperatures, low flows, and high angling pressure, often from shifts in angling pressure due to restrictions elsewhere. Time of day angling restrictions were last implemented in 2021 due to a combination of high water temperatures, low flows, high angling pressure, and numerous restrictions throughout the state. Although water temperatures in 2022 were similar to and later in the summer exceeded those observed in 2021 (Figure 18) angling restrictions were not implemented in 2022 as flows were maintained near the minimum flow recommendation for the Missouri River of 4,100 cfs in 2022 compared to the much lower flow of near 3,000 cfs in 2021 (Figure 13). Additionally, fewer restrictions were implemented through the state in 2022, resulting in less of a potential shift in angling pressure to the Missouri River in 2022 than in 2021. Water temperatures also did not warm until much later in the year in 2022 compared to 2021. Prior to 2021, 2000 was the last year that angling restrictions had been implemented.

REFERENCES

Akaike, Hirotogu. 1998. “Information Theory and an Extension of the Maximum Likelihood Principle.” In *Selected Papers of Hirotugu Akaike*, 199–213. Springer.

Grisak, G. and B. Tribby. 2011. 2010 Missouri River – Holter Dam tailwater monitoring report. Status report for PPL-Montana FERC Project 2188. Montana Fish, Wildlife & Parks, Great Falls, MT.

Horton, T. B., and R. J. Clark. 2004. Statewide Fisheries Investigations. 2002 Missouri River Creel Survey. F-113-R3. Montana Fish, Wildlife and Parks, Fisheries Division Job Progress Report, Helena, Montana.

Horton, T. B., and G. A. Liknes. 2003. Statewide Fisheries Investigations. Missouri River creel surveys 1993 – 2001. F-46-R-6, F-46-R-7, F-78-R-1. Montana Fish, Wildlife and Parks, Fisheries Division Job Progress Report, Helena, Montana.

Leathe, S. A., W. J. Hill, and A. Wipperman. 1988. Statewide Fisheries Investigations. Survey and Inventory of Coldwater Streams. Northcentral Montana trout stream investigations. F-46-R-1. Montana Fish, Wildlife and Parks, Fisheries Division Job Progress Report, Helena, Montana.

Mullen, J. A., and M. E. Schilz. 2017. 2015 Missouri River creel survey. Montana Fish, Wildlife & Parks. Great Falls, MT.

Ogle, D. H. 2018. *FSA: Fisheries Stock Analysis. R Package Version 0.8. 20.9000*.

R Core Team. 2018. *R: A Language and Environment for Statistical Computing.* Vienna, Austria: R Foundation for Statistical Computing.

R2 Resource Consultants, Inc. (R2) 1994. Supplemental Report. Determination of Flushing Flow Needs. Madison and Upper Missouri Rivers. Prepared for Montana Power Company. Redmond, WA.

Strainer, A. C. and G. G. Grisak. 2009. An evaluation of trout spawning substrate composition and substrate changes following spring run-off in the Missouri River below Holter Dam. Status report for Northwestern Energy, FERC Project 2188. Montana Fish, Wildlife & Parks. Great Falls, MT.

Williams, Byron K., James D. Nichols, and Michael J. Conroy. 2002. *Analysis and Management of Animal Populations*. Academic Press.

Figures

Figure 1. The Craig section (highlighted by the red polygon) of the Missouri River near Craig, Montana. This section is 5.6 miles long from Wolf Creek Bridge to Craig Bridge and is electrofished annually at night for brown trout and rainbow trout population estimates.

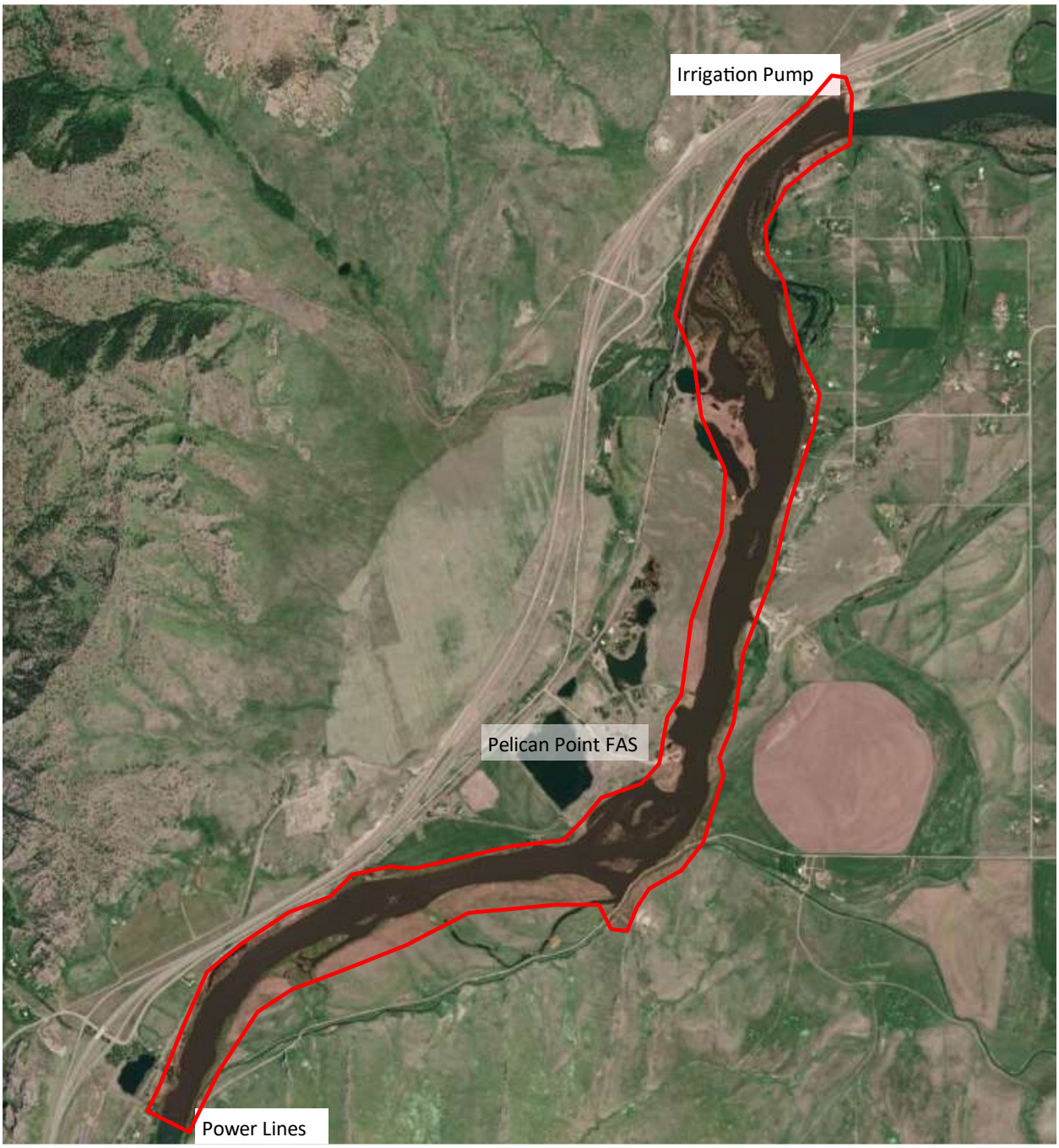

Figure 2. The Cascade section (highlighted by the red polygon) of the Missouri River near Cascade, Montana. This section is 4.1 miles long from the power lines to the irrigation pump and is electrofished annually at night for brown trout and rainbow trout population estimates.

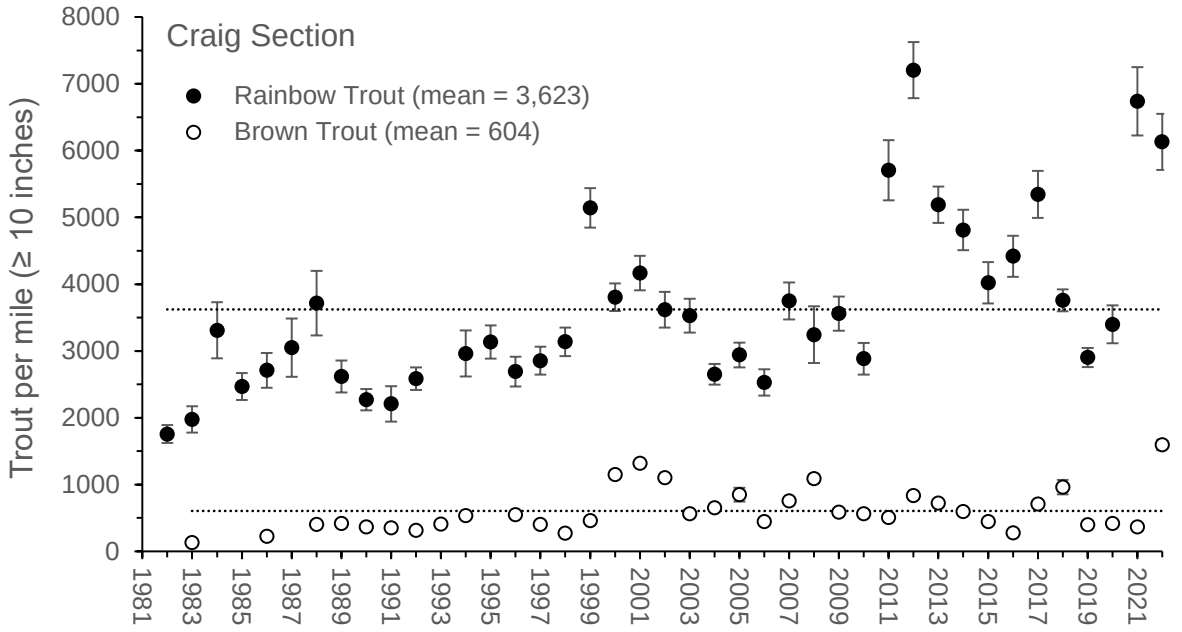

Figure 3. Population estimates of rainbow trout and brown trout (fish per mile) in the Missouri River, Montana within the Craig sampling section from 1982 through 2022. Estimates (mean and 95% confidence intervals) represent the model-averaged estimates for all trout 10 inches and greater using the maximum likelihood method. Long-term average number of rainbow trout and brown trout per mile are designated by horizontal dashed lines and 2022 estimates were 6,132 and 1,595, respectively.

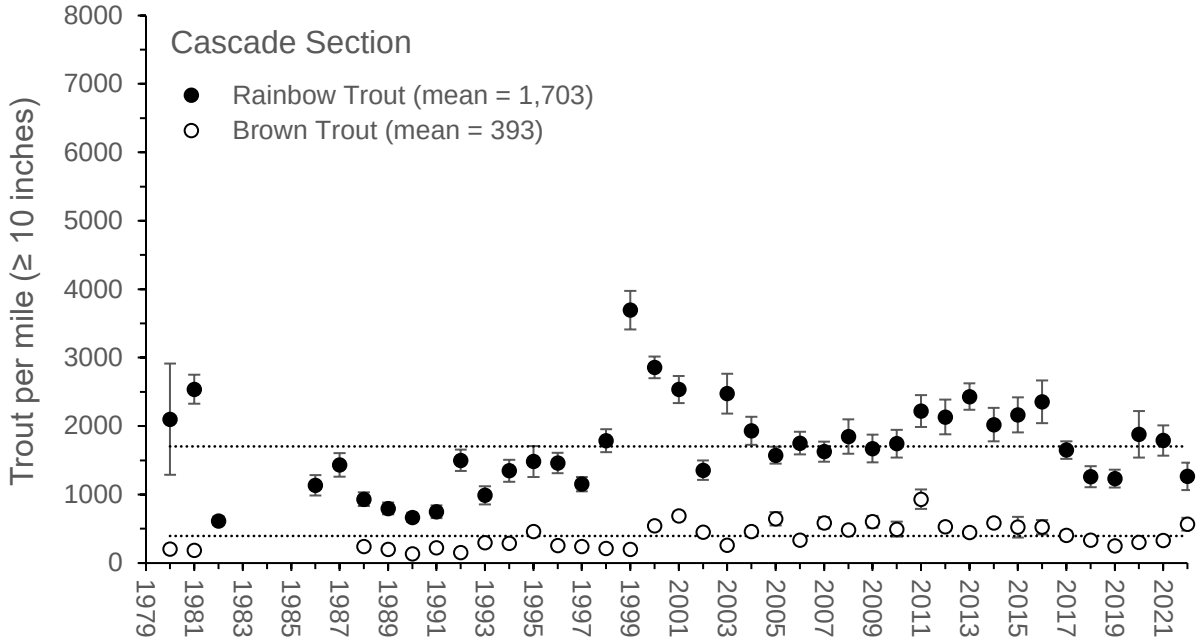

Figure 4. Population estimates of rainbow trout and brown trout (fish per mile) in the Missouri River, Montana within the Cascade sampling section from 1980 through 2022. Estimates (mean and 95% confidence intervals) represent the model-averaged estimates for all trout 10 inches and greater using the maximum likelihood method. Long-term average number of rainbow trout and brown trout per mile are designated by horizontal dashed lines and 2022 estimates were 1,265 and 566, respectively.

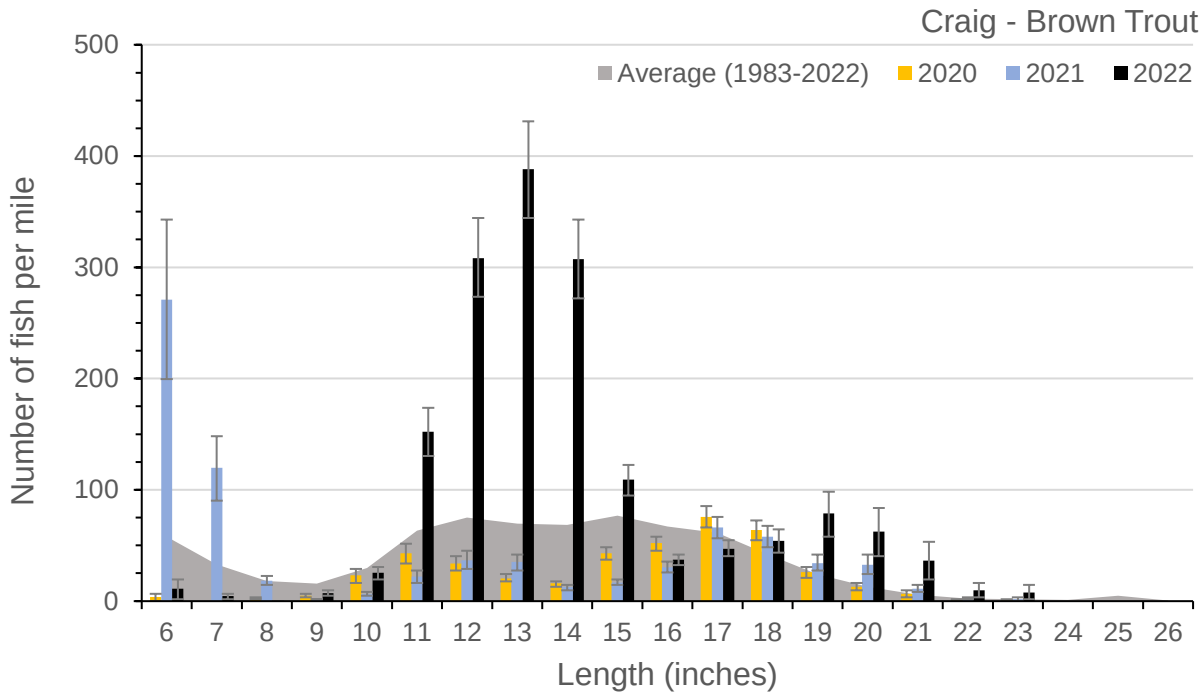

Figure 5. Length-frequency histogram of brown trout population estimates (fish per mile) by 1-inch length group for 2020, 2021, and 2022 for the Craig section of the Missouri River. The long-term average population estimate from 1983 through 2022 (n=36) by 1-inch length group is depicted by the gray shaded area.

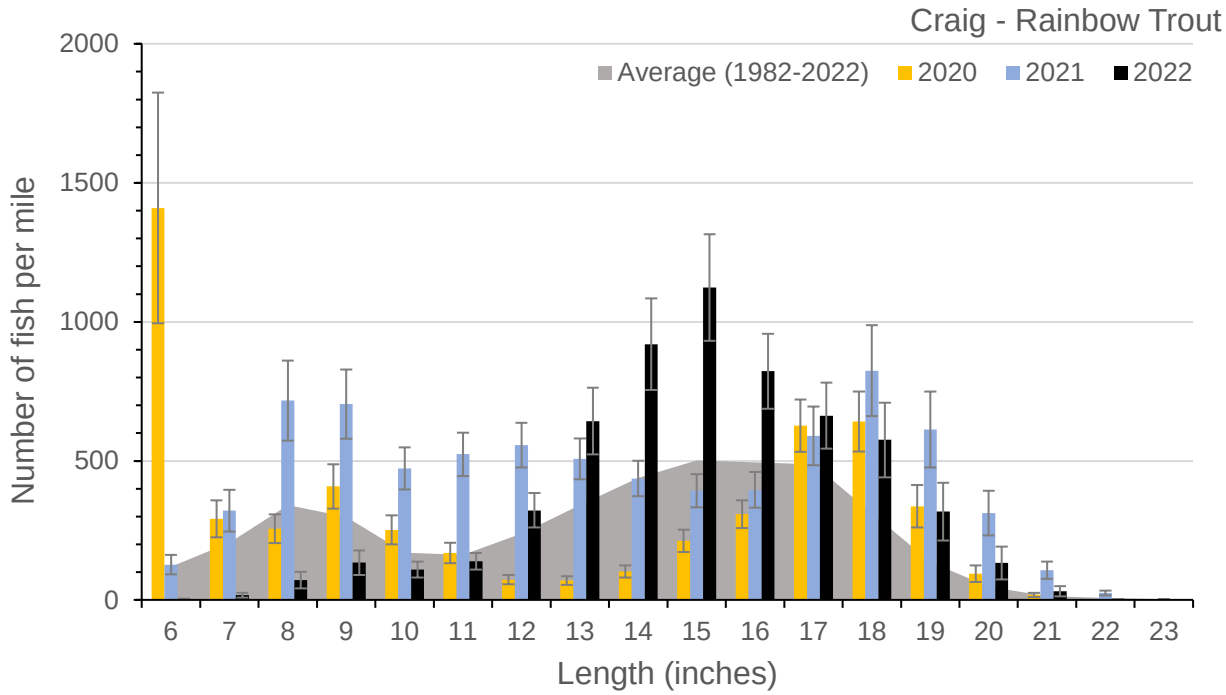

Figure 6. Length-frequency histogram of rainbow trout population estimates (fish per mile) by 1-inch length group for 2020, 2021, and 2022 for the Craig section of the Missouri River. The long-term average population estimate from 1982 through 2022 (n=40) by 1-inch length group is depicted by the gray shaded area.

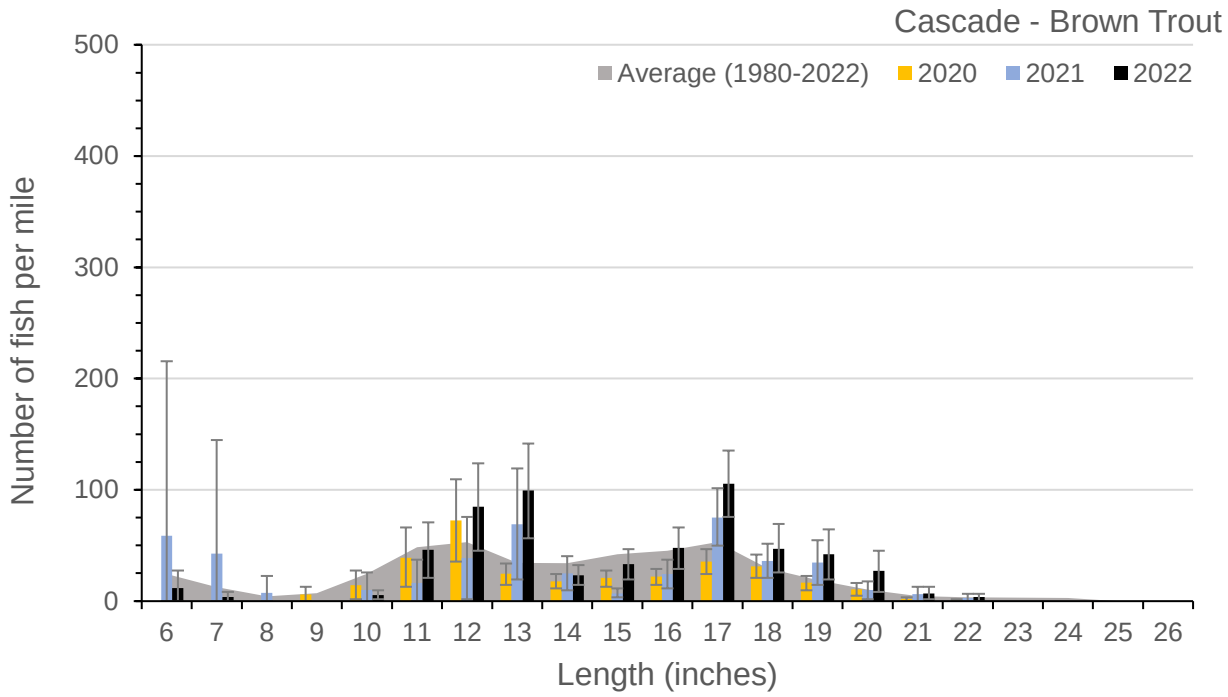

Figure 7. Length-frequency histogram of brown trout population estimates (fish per mile) by 1-inch length group for 2020, 2021, and 2022 for the Cascade section of the Missouri River. The long-term average population estimate from 1980 through 2022 (n=37) by 1-inch length group is depicted by the gray shaded area.

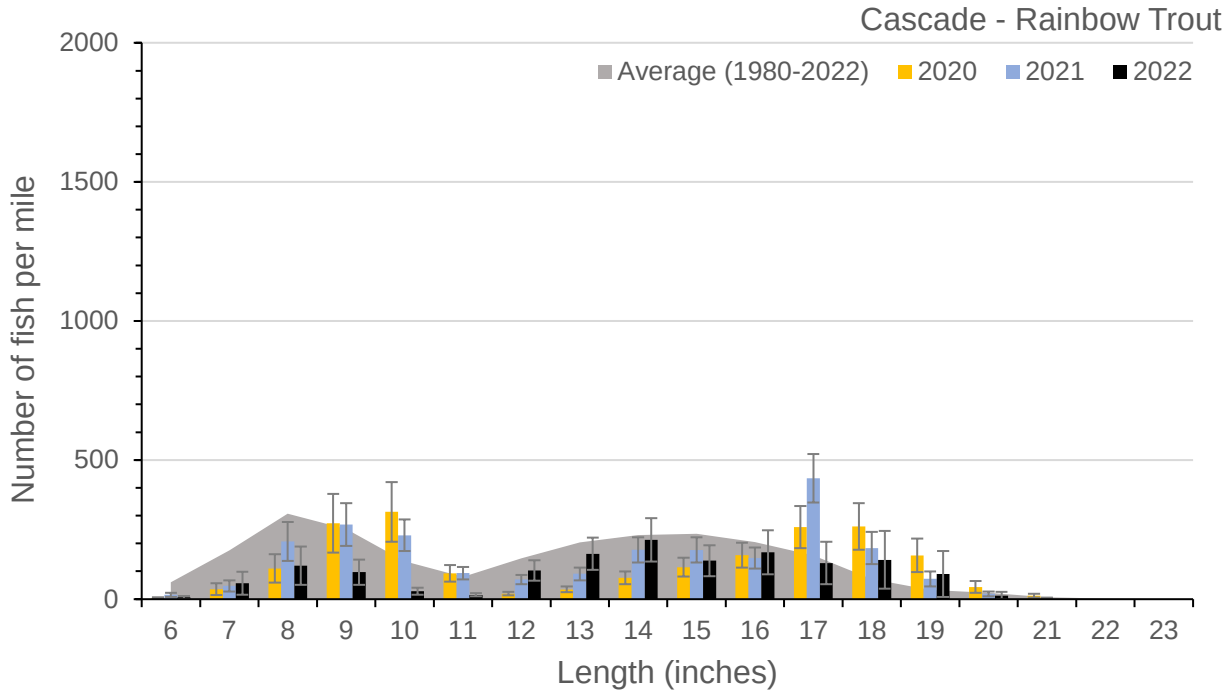

Figure 8. Length-frequency histogram of rainbow trout population estimates (fish per mile) by 1-inch length group for 2020, 2021, and 2022 for the Cascade section of the Missouri River. The long-term average population estimate from 1980 through 2022 (n=40) by 1-inch length group is depicted by the gray shaded area.

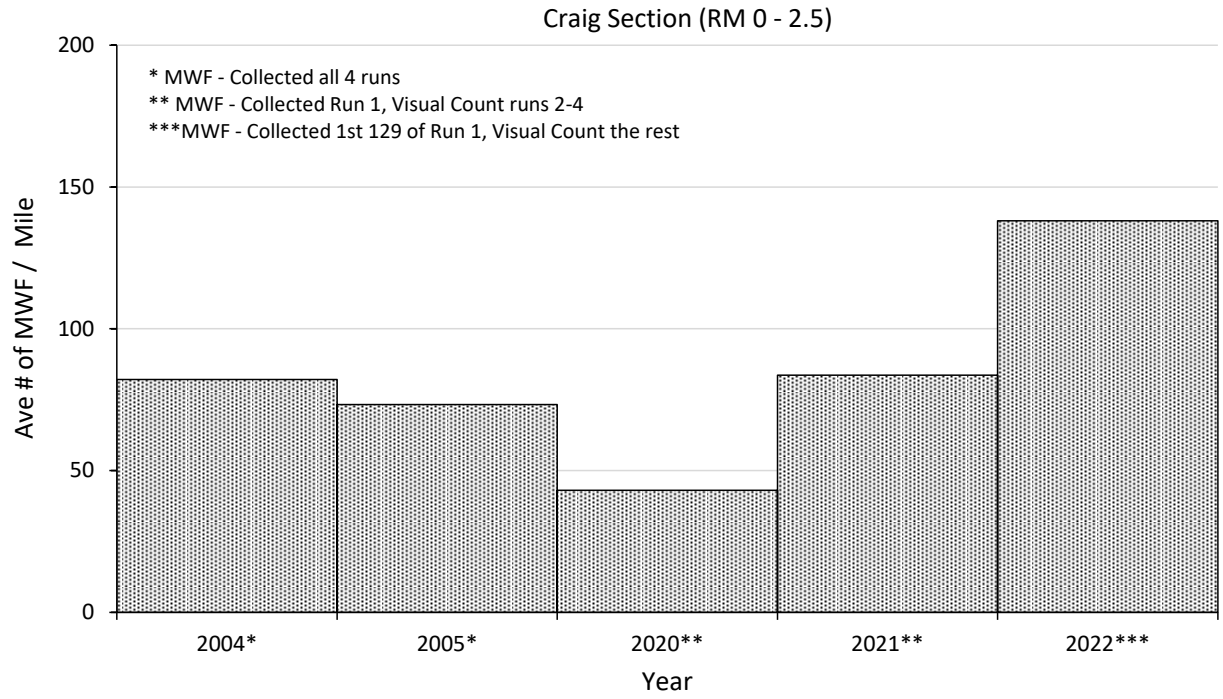

Figure 9. Average number of mountain whitefish (6 inches and greater) per mile handled or visually counted from electrofishing four runs of the first 2.5 miles of the Craig Section.

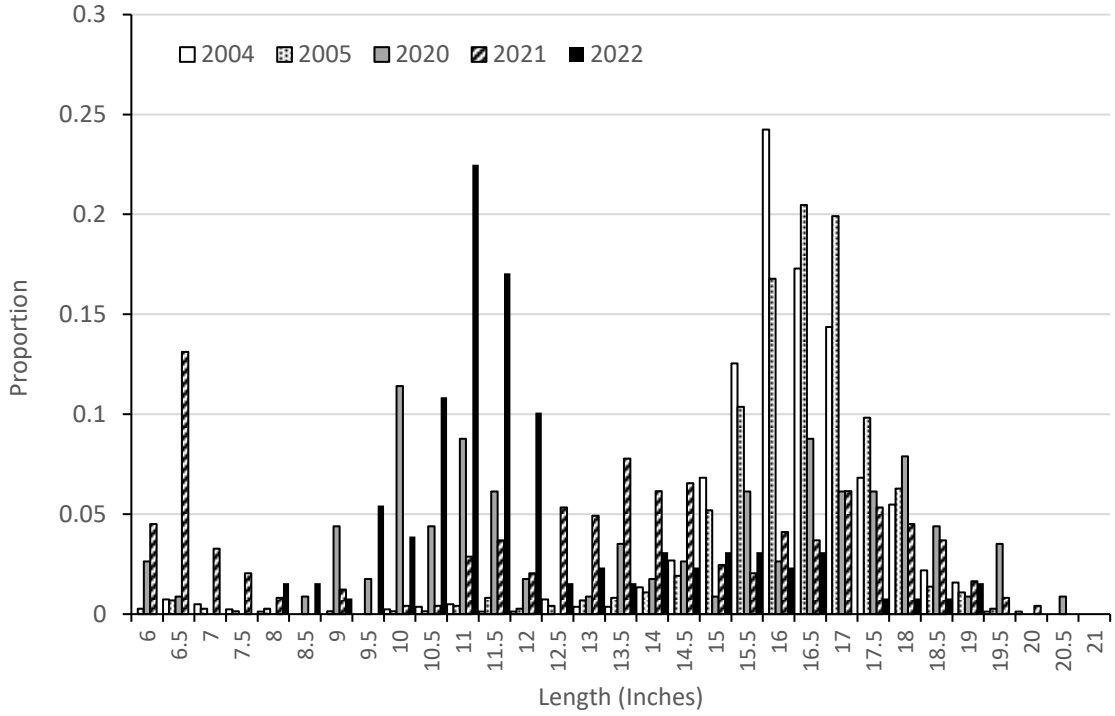

Figure 10. Length-frequency histogram for mountain whitefish collected in 2004 (n=821, 4 runs), 2005 (n=733, 4 runs), 2020 (n=114, 1 run), 2021 (n=244, 1 run), and 2022 (n=129, portion of 1 run) during spring electrofishing of the first 2.5 miles of the Craig section of the Missouri River. Proportion of fish for each year is shown on the y-axis as a function of length (inches) on the x-axis.

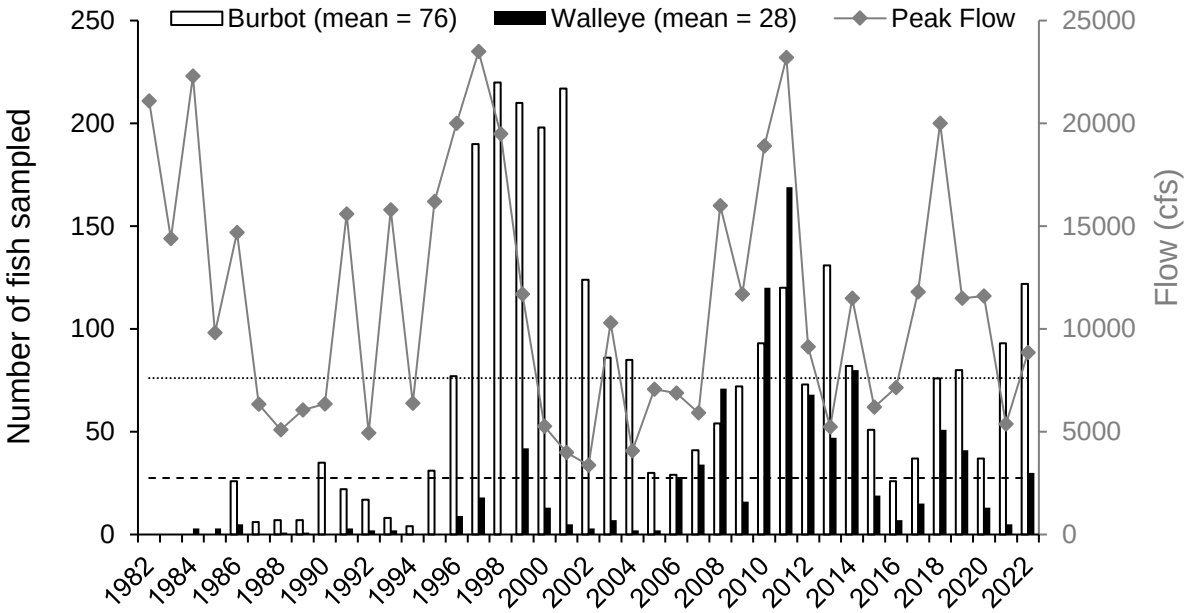

Figure 11. Number of burbot and walleye handled during standardized fall electrofishing surveys from 1982 through 2022 in the Craig section of the Missouri River. The peak annual flow of the Missouri River from USGS gage 06066500 (below Holter) is graphed in gray on the right y-axis. The horizontal dotted line represents the mean number of burbot handled and the horizontal dashed line represents the mean number of walleye handled.

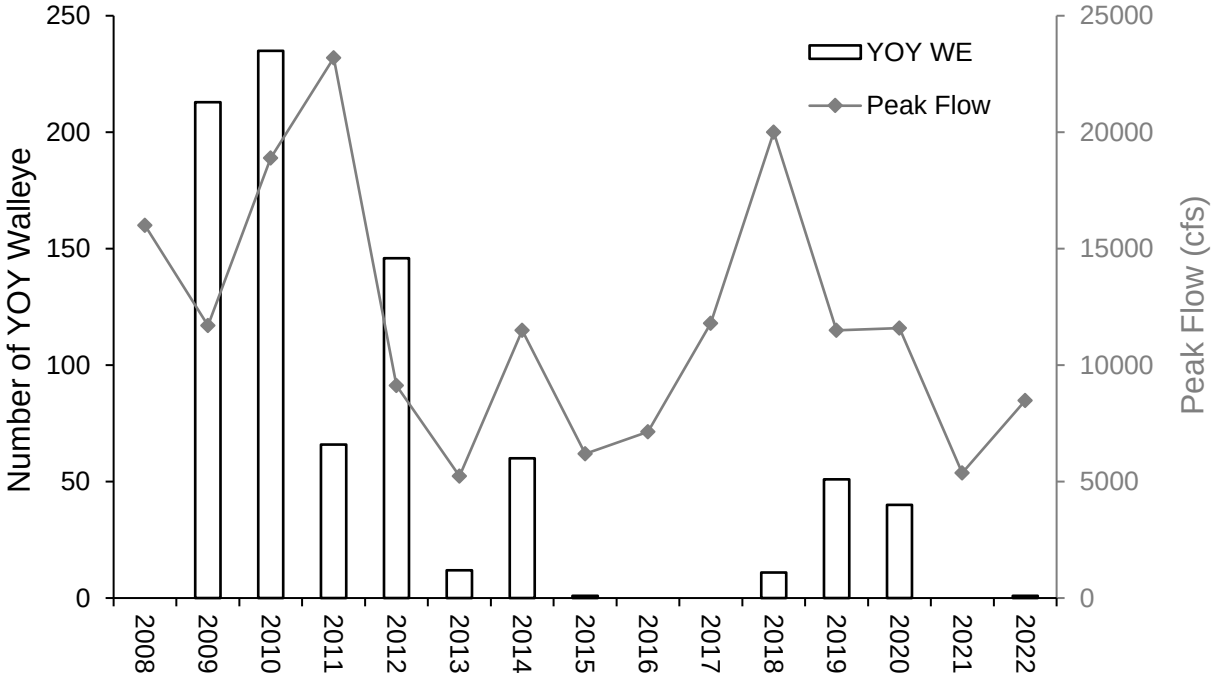

Figure 12. Total abundance of young of the year walleye from seining sites along the Missouri River from Cascade to Great Falls from 2009 through 2022 (left y-axis) and the peak annual flow of the Missouri River from USGS gage 06066500 from 2008 through 2022 (right y-axis). Zero young of the year walleye were collected in 2016, 2017, and 2021.

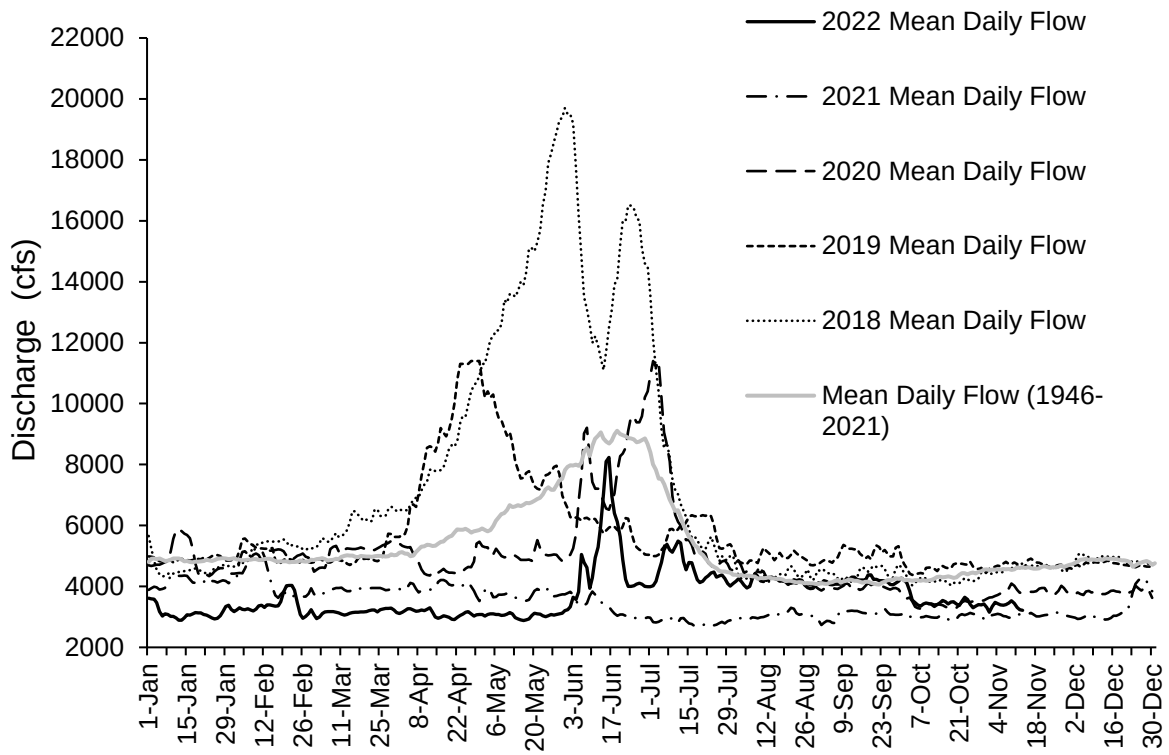

Figure 13. Mean daily flow for the Missouri River below Holter Dam at USGS gaging station 06066500 (below Holter Dam) for 2018 through 2022, and for the period of record from 1946 through 2021.

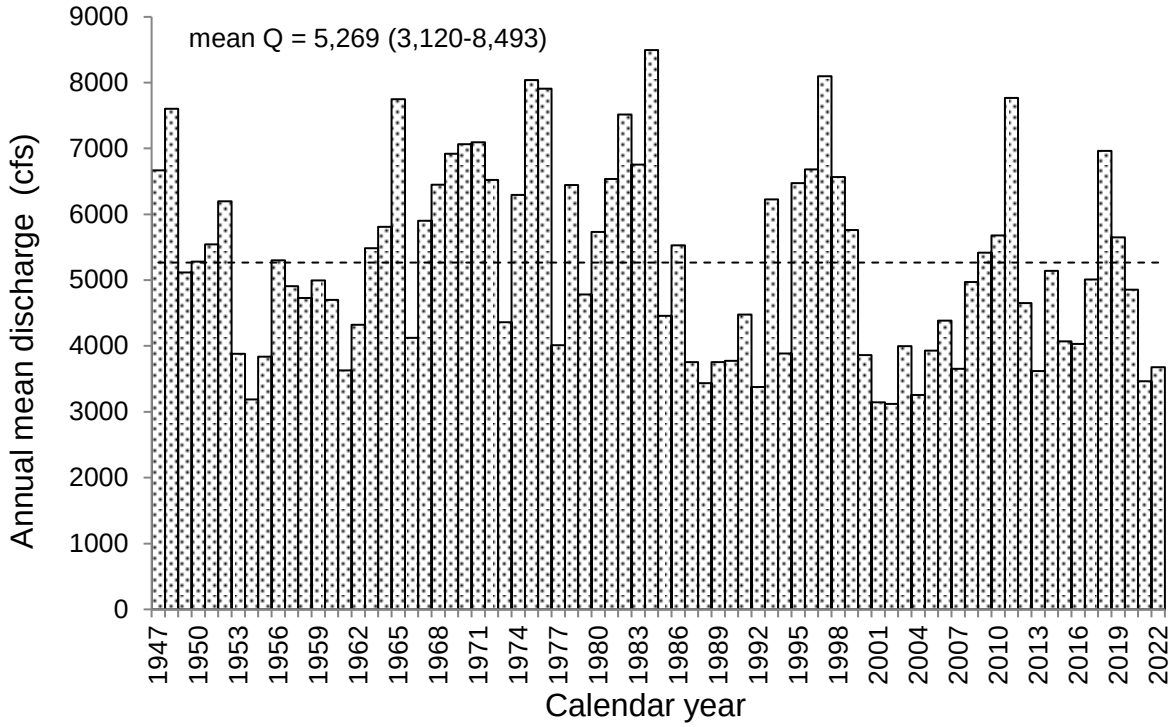

Figure 14. Mean annual flow by calendar year for the Missouri River below Holter Dam at USGS gaging station 06066500 from 1947 through 2022. Horizontal dashed line represents the mean annual flow.

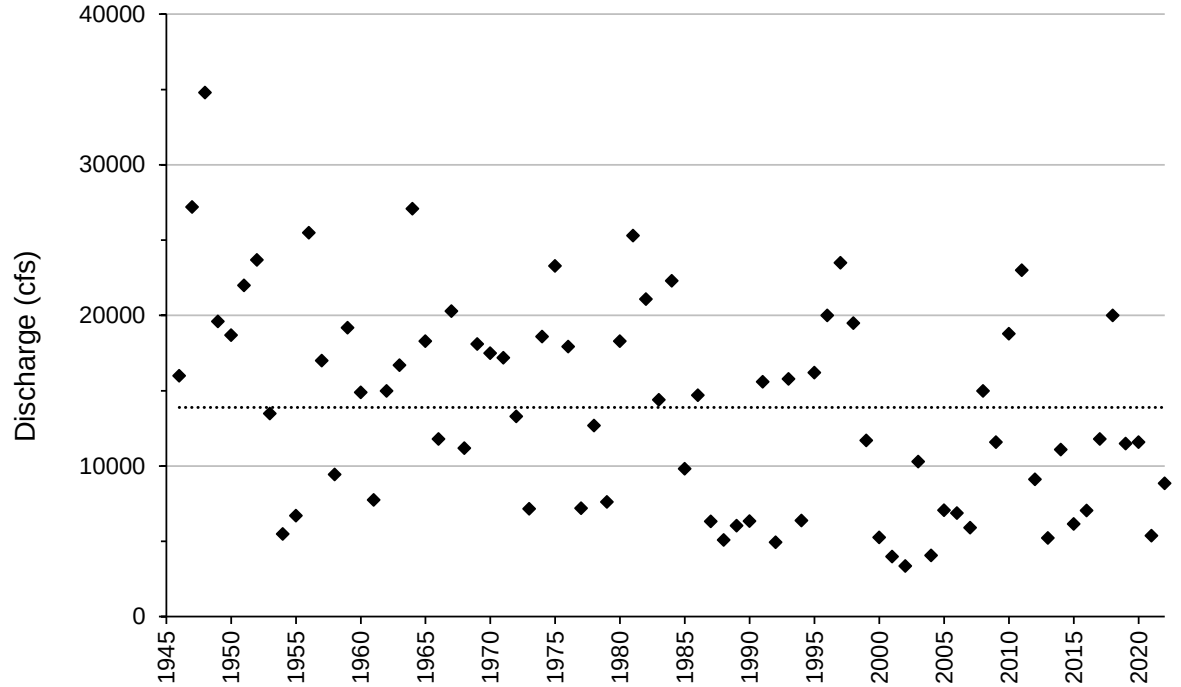

Figure 15. Peak annual flow for the Missouri River below Holter Dam at USGS gaging station 06066500 from 1947 through 2022. Horizontal dotted line represents the mean annual peak flow of 13,883 cfs.

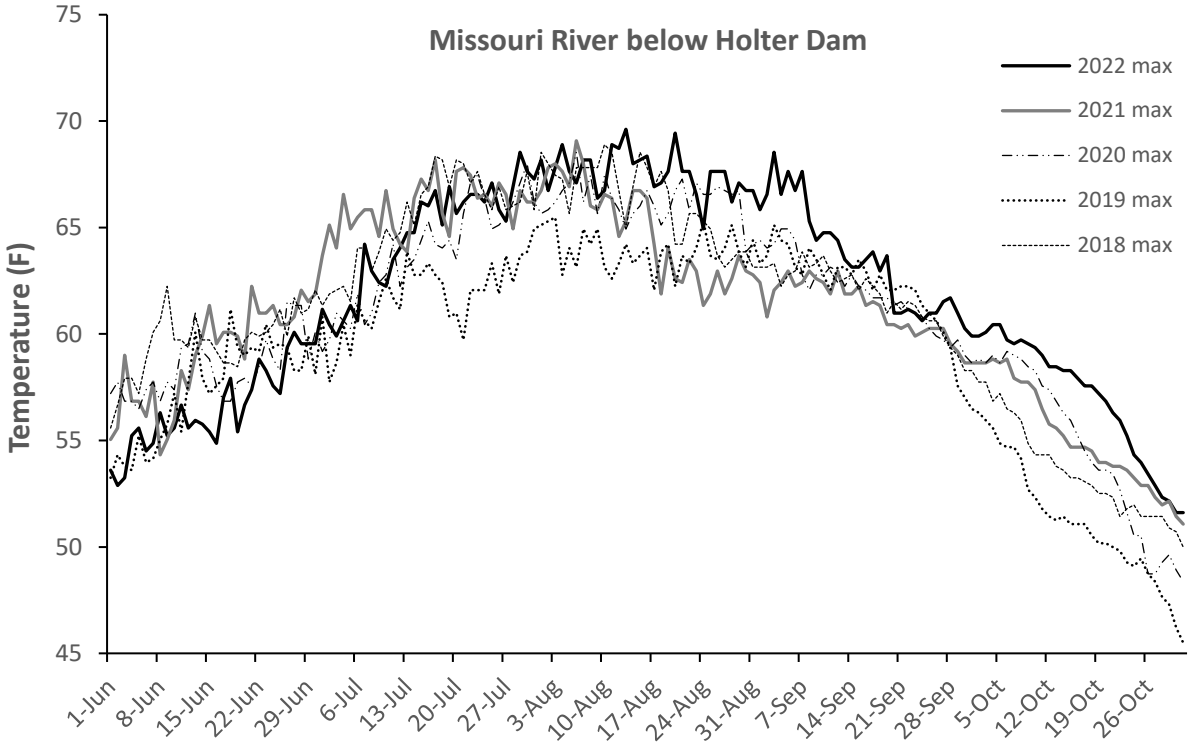

Figure 16. Maximum daily water temperatures (°F) from June through October for the Missouri River below Holter Dam at USGS gaging station 06066500 for 2018 through 2022.

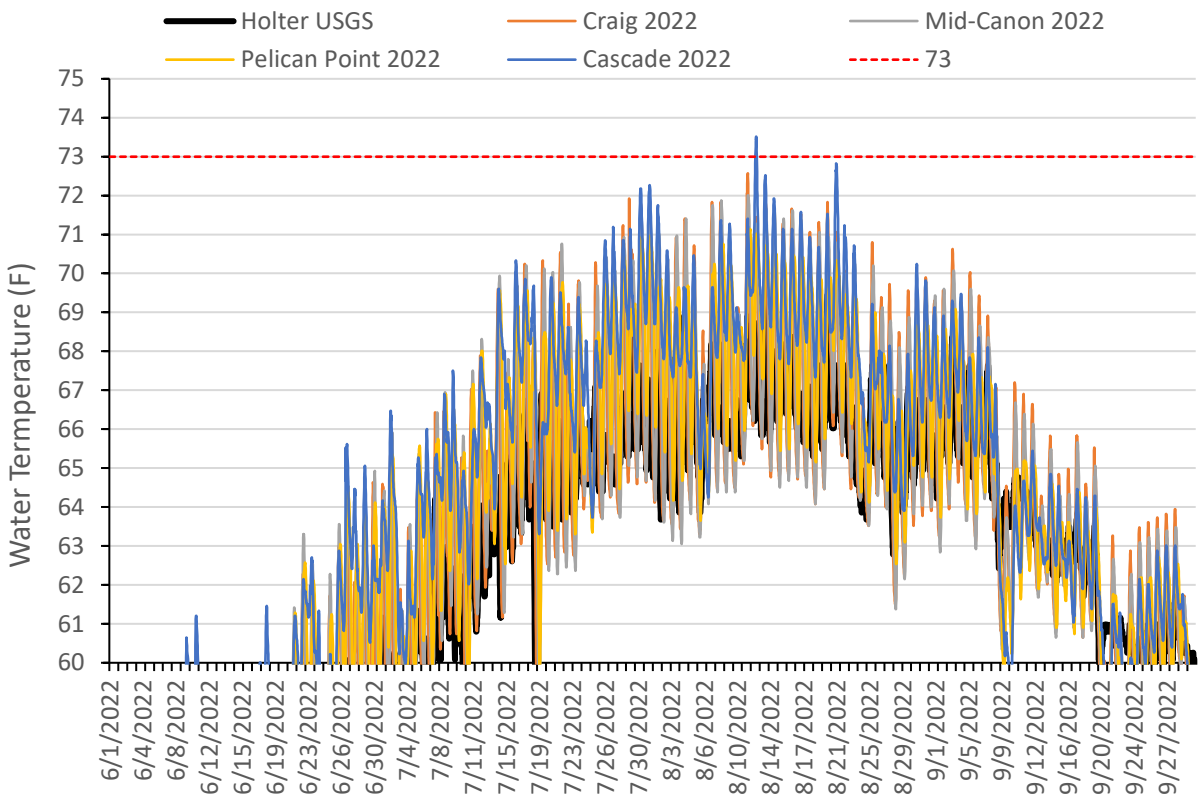

Figure 17. Missouri River water temperatures (°F) from below Holter Dam to Cascade in 2022.

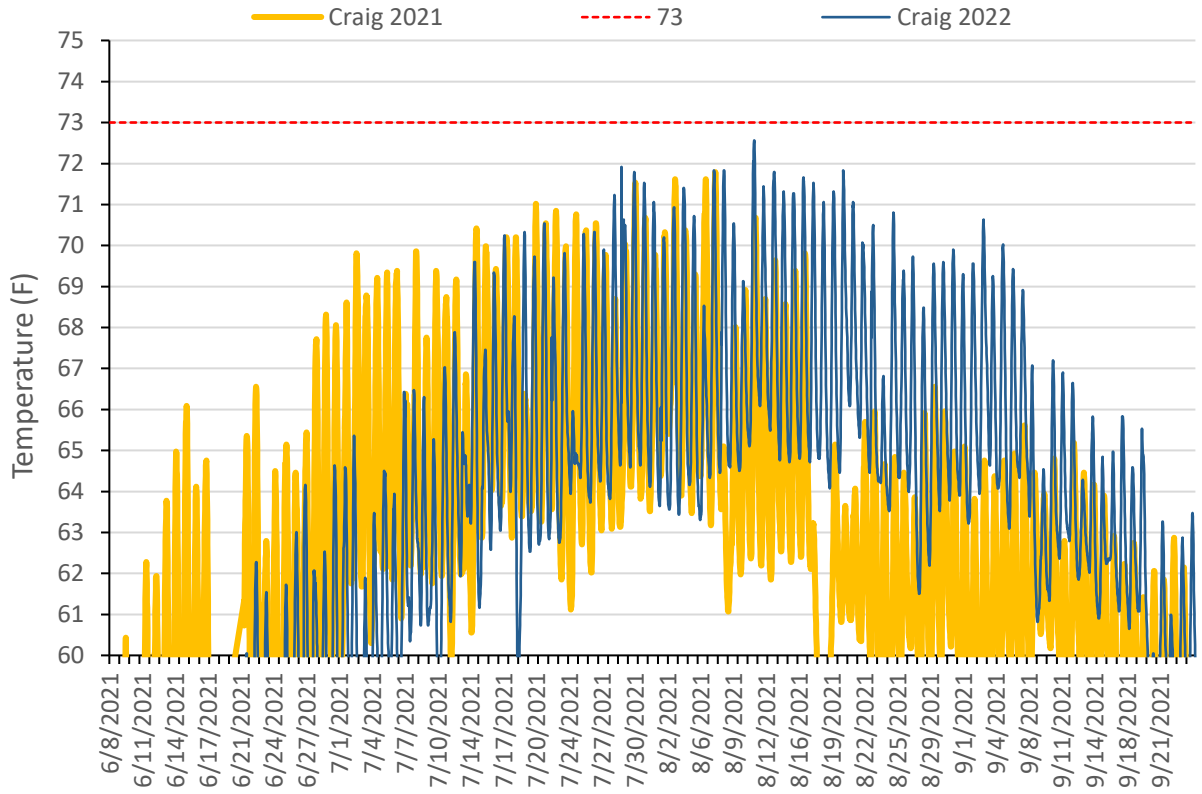

Figure 18. Missouri River water temperatures (°F) at Craig in 2021 and 2022.

Tables

Table 1. Mean, min, and max of daily mean temperature (°F) and daily river discharge (cfs) of the Missouri River below Holter Dam, Montana by month for 2022 (USGS Gauge 06066500). All flow data is provisional. Temperature data is approved through October 4th and provisional from October 5th through December.

Missouri River		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean	33.9	34.5	36.0	40.0	47.4	55.1	63.1	66.2	62.9	56.6	42.5	33.8
Temperature (°F)	Min	33.3	33.8	34.5	37.6	41.7	51.3	57.0	62.8	59.7	51.1	34.7	33.3
	Max	34.7	35.6	38.7	43.7	53.1	60.1	68.5	69.6	68.5	60.4	51.4	35.2
	Mean	3132	3387	3157	3107	3044	4851	4559	4153	4172	3525	3431	3603
Discharge (cfs)	Min	2890	2950	2940	2910	2880	3200	3990	3920	4050	3290	3150	3220
	Max	3610	4030	3280	3300	3140	8230	5490	4430	4370	4270	3620	4290

Appendix A – Missouri River Walleye Tagging Harvest Tables

Table A1. Number and percent of walleye harvested (columns) and number tagged (rows) by year in the Missouri River Holter tailrace section (Holter Dam to Wolf Creek Bridge).

Tagging Year		Harvest Year																					
		2004-2005		2006-2007		2008-2009		2010-2011		2012-2013		2014-2015		2016-2017		2018-2019		2020-2021		2022-2023		Totals	
Year	# Tagged	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
2004	**4**	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
2006	**11**			4	36%	0	0%	1	9%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	5	45%
2008	**42**					9	21%	0	0%	0	0%	0	0%	0	0%	1	2%	0	0%	0	0%	10	24%
2010	**57**							5	9%	6	11%	0	0%	0	0%	0	0%	0	0%	0	0%	11	19%
2012	**52**									9	17%	1	2%	0	0%	0	0%	0	0%	0	0%	10	19%
2014	**43**											3	7%	0	0%	0	0%	0	0%	0	0%	3	7%
2016	**35**													2	6%	2	6%	0	0%	1	3%	5	14%
2018	**48**															1	2%	0	0%	1	2%	2	4%
2020	**17**																	1	6%	0	0%	1	6%
2022	**18**																			2	11%	2	11%
Total	**327**			**4**		**9**		**6**		**15**		**4**		**2**		**4**		**1**		**4**		**49**	**15%**

Table A2. Number and percent of walleye harvested (columns) and number tagged (rows) by year in the Missouri River below Holter Dam. Most walleye were tagged during monitoring in the Craig section. Table excludes tags from the Holter tailrace (Holter Dam to Wolf Creek Bridge) section.

Tagging Year		Harvest Year																											
		2008		2009		2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		Totals	
Year	# Tagged	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
2008	**61**	20	33%	5	8%	0	0%	2	3%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	27	44%
2009	**57**			12	21%	0	0%	0	0%	1	1%	1	1%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	14	25%
2010	**107**					7	6%	2	2%	2	2%	2	2%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	13	12%
2011	**185**							10	5%	18	10%	8	4%	1	1%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	37	20%
2012	**140**									21	15%	2	1%	5	4%	0	0%	1	1%	0	0%	0	0%	0	0%	0	0%	0	0%	29	21%
2013	**93**											16	17%	2	2%	1	1%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	19	20%
2014	**142**													14	10%	9	6%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	23	16%
2015	**44**															11	25%	1	2%	0	0%	1	2%	0	0%	0	0%	0	0%	13	30%
2016	**21**																	3	14%	0	0%	0	0%	0	0%	0	0%	0	0%	3	14%
2017	**30**																			0	0%	2	7%	0	0%	0	0%	1	1%	3	10%
2018	**91**																					6	7%	7	8%	1	1%	0	0%	14	15%
2019	**94**																							8	9%	3	3%	0	0%	11	12%
2020	**54**																									4	7%	0	0%	4	7%
2021	**24**																											2	8%	4	17%
2022	**42**																											4	10%	4	10%
Total	**1185**	**20**		**17**		**7**		**14**		**42**		**29**		**22**		**21**		**5**		**0**		**9**		**15**		**8**		**3**		**6**		**218**	**18%**