MONTANA FISH, WILDLIFE & PARKS

2021 Missouri River – Holter Dam Tailwater Monitoring

Status Report for NorthWestern Energy
FERC Project 2188

Project #2021-2

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At the November 2020 Missouri River Technical Advisory Committee (MoTAC) meeting, Montana Fish, Wildlife & Parks (FWP) was awarded $27,940 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 2021 monitoring.

Methods

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 halfway through the site. Jet propelled boats were equipped with headlights and fixed boom electrofishing systems using stainless steel cable droppers suspended from each boom. 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 3rd of May through the 19th 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 fall from the 28th of September through the 13th 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 which then makes 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 by year using the Chapman modification of the Petersen estimator for abundance from a single census. This method assumes that the population is closed. We implemented this method using the FSA package (Ogle 2018) in the R programming environment (R Core Team 2018). Abundance estimates are reported as number of trout per mile 10 inches long and greater with 95% confidence intervals.

Missouri River Population Monitoring

Rainbow trout and brown trout

The estimate of brown trout 10 inches long and greater in the Craig section was 362 (95% CI [312, 423]) per mile in spring 2021 (Figure 3). The 2021 estimate was 65% of the long-term average of 556 per mile for years when population estimates were calculated based on data since 1983 (n = 35) (Figure 3). While population estimates are only reported for fish 10 inches and greater, the most abundant size class of brown trout sampled was 6 to 9 inches in spring 2021, indicating a potential strong year class of juveniles.

The estimate of rainbow trout 10 inches long and greater in the Craig section was 6,611 (95% CI [5,669, 7,552]) per mile in fall 2021 (Figure 3). The estimate of 6,611 fish per mile was 189% of the long-term average of 3,490 fish per mile based on annual estimates since 1982 (n = 39) and the second highest on record. The most abundant size classes in 2021 were 9 to 14 inches and 19 to 22 inches. Rainbow trout less than 10 inches were extremely abundant during sampling in fall 2020, with the highest percentage of fish handled between 6 and 10 inches (primarily between 6 and 8 inches) over the period of record. This cohort made up a large proportion of the population estimate greater than 10 inches in 2021, resulting in the large increase in abundance.

The estimate of brown trout 10 inches long and greater in the Cascade section was 320 (95% CI [229, 459]) per mile in spring 2021 (Figure 4). The 2021 estimate was 86% of the long-term average of 372 per mile. The most abundant size class of brown trout was 13 to 14 inches and fish over 20 inches. Brown trout 6 to 8 inches were more common than in recent years, but much lower than densities observed in the Craig section.

The estimate of rainbow trout 10 inches long and greater in the Cascade section was 1,694 (95% CI [1,321, 2,066]) per mile in fall 2021 (Figure 4). This estimate was 102% of the long-term average of 1,658 per mile and similar to that observed in 2020. The most abundant size classes of rainbow trout were 8 to 11 inches and fish over 18 inches in 2021. While the increased abundance in the Craig rainbow trout population was somewhat expected given the densities of fish less than 10 inches in 2020, that cohort of fish was not observed in 2020 in the Cascade section and thus there was no marked increase in abundance from 2020 to 2021 in the Cascade section as was observed in the Craig section.

Flows were low in 2021 during spring electrofishing and ranged from approximately 3,500 to 4,000 cfs during sampling compared to high flows in spring 2019 ranging from 9,500 to 11,400 cfs, as measured at the gage below Holter Dam. Flows were also low during fall 2021 sampling, ranging between 3,000 and 3,200 cfs below Holter Dam.

Mountain whitefish

While mountain whitefish are also present in the Missouri River, they have typically not been handled during electrofishing surveys due to logistical constraints and the potential negative effects of stress from handling, which is greater than for trout. However, two surveys were conducted over the first 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 of mountain whitefish encountered resulted in poor estimates and the data being suitable only for general catch per unit effort (CPUE). A similar effort to evaluate CPUE of mountain whitefish was conducted beginning in 2020 and continued in 2021 during the spring sampling for brown trout. All mountain whitefish encountered 6 inches and greater during the first 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 average number of mountain whitefish counted per electrofishing run in 2004, 2005, 2020, and 2021 was 205, 183, 108, and 209, respectively. While the CPUE data cannot be interpreted with the same level of confidence as population estimates, CPUE was similar in 2004, 2005, and 2021 and lower in 2020. The size distribution of mountain whitefish was similar in 2004 and 2005, with fish between 15 and 18 inches most common. In 2020 and 2021, mountain whitefish less than 14 inches made up a greater proportion of the samples than earlier years, resulting in smaller average lengths (2004 – ave=15.7; 2005 – ave=16.6; 2020 – ave=14.0; 2021 – ave=13.1 inches) (Figure 5). 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 trend evaluation.

Burbot, walleye, and northern pike

Walleye *Sander vitreus* and burbot *Lota lota* are also handled during spring and fall electrofishing surveys. In the Craig Section, 9 burbot and 19 walleye were sampled in spring and 93 burbot and 5 walleye in fall. In the Cascade section, 9 burbot and 0 walleye were sampled in spring and 41 burbot and 35 walleye in fall. The largest burbot was 29.2 inches and 5.2 pounds, and the largest walleye was 29.8 inches and 10.9 pounds. Most walleye handled in the Craig section were greater than 14 inches, including numerous individuals greater than 20 inches. In contrast, all walleye handled in the Cascade section were less than 14 inches and most were between 6 and 9 inches.

Typically, more walleye and burbot are handled during fall surveys than spring surveys and in the Craig section than the Cascade section, thus only fall results from the Craig section are presented here. Burbot were most abundant from 1997 through 2001 and to a lesser degree from 2010 through 2014 during fall electrofishing surveys (Figure 6). In recent years, the number of burbot handled was at or above the long-term average of 75 in three of the last four years. Walleye were most abundant in the Missouri River in 2010 and 2011 following high flow events (Figure 6) 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 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 2020 and 2021 was below the long-term average of 27. 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 75 and 27, respectively, compared to a mean of 4,520 rainbow trout (during fall) and 1,677 brown trout (during spring) handled.

Most walleye harvest tag returns were reported by the year after tagging with few tags reported two years after tagging or longer (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 = 6%, max = 40%), excluding the tailrace section (Appendix A, Table A2). Despite relatively few walleye harvest tag returns beyond the year after tagging, the tagging program has allowed us to document walleye up to 23 years old in the Missouri River, based on the age of the fish at tagging and angler reported catch.

Walleye regulations 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 apparent 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 documented as harvested during the survey based on angler interviews, 8 total walleye (angler harvest of 6 to 8 walleye) were in excess of what the prior standard regulation allowed (Mullen and Schilz 2017). Four of 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 and 10 daily and 20 in possession from Cascade to Great Falls.

FWP has conducted seining annual 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. The protocol and site descriptions have been described by Grisak and Tribby (2011). In 2021, 45 seine hauls were conducted at 12 sites and no walleye were sampled. Overall, 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 7). In most other years, the number of YOY walleye has been approximately 50 or less with no individuals collected several 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 were generally highest with moderately high peak flows in 2009 and 2010 and lowest during the low flow years of 2013, 2015, 2016, and 2021. 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 *Esox lucius* was sampled in 2019 and one in 2020, representing the first northern pike sampled during these surveys. Several other northern pike have been observed by FWP personnel and anglers have also reported catching numerous adult northern pike from the Missouri River between Holter Dam and Rainbow Dam in 2018 through 2021. Most of the angling reports have come from between Cascade to Ulm, but a few reports have come from 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. 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 2018, 2019, 2020, and 2021 compared to mean daily flow for the period of record are shown in Figure 8. Overall, the mean daily flow, mean annual discharge, and the peak annual discharge was well below average in 2021 (Figures 8, 9, and 10) 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 9 and 10). The most recent four 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. A 2008 study documented that a flow of approximately 15,000 cfs was sufficient to mobilize streambed substrates in the Missouri River (Strainer and Grisak 2009). Over the last 21 years (2001 through 2021) 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 10).

For the 2021 calendar year, the Missouri River below Holter Dam had an estimated mean discharge of 3,466 cfs, which was 66% of the 75-year mean (Figure 9). The maximum discharge in 2021 occurred on

February 4th as a result of NorthWestern Energy calling on their water right and was 5,380 cfs (Figure 10), which was 39% of the 76-year mean.

Temperature Monitoring

When monitoring water temperature of the Missouri River, regional personnel rely on the information provided from the USGS gauging station for initial monitoring. When water temperature reaches the critical threshold of 70° F, or drought conditions warrant more detailed monitoring, thermographs are 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 "Hoot Owl" angling restrictions of certain fisheries to reduce stress from angling on the trout populations. It is the policy of FWP that such closure requests may be made when temperatures reach established thresholds, which for salmonids includes "…daily maximum water temperature reaches or exceeds 73°F (23°C) for at least some period of time during three consecutive days…" The drought policy also recognizes that some waters (e.g., Missouri River) will not reach the established threshold levels but may require action to protect the fisheries anyway.

In 2021, the USGS gauging station below Holter Dam recorded a maximum daily temperature of 69.1°F on August 4th (Figure 11, Table 1). However, given the low flow conditions, additional water temperature monitoring was conducted in the Missouri River at Craig, Mid-Canon, Pelican Point, and Cascade beginning June 8th. Water temperatures exceeded 73°F at Cascade on several days and routinely exceeded 70°F at Craig and Mid-Canon in 2021 (Figure 12). Maximum water temperatures were often 1-2°F cooler at Pelican Point than Craig or Mid-Canon (Figure 12). Although maximum water temperatures did not exceed 73°F for three consecutive days, given that water temperatures routinely exceeded 70°F as far upstream as Craig, high angling pressure, the potential for increased angling pressure as restrictions were implemented on other waterbodies throughout the state, and the continued hot forecast, "Hoot Owl" angling restrictions were implemented from July 20th to August 17th. Maximum water temperatures were cooler in mid-August in 2021 than in other recent years allowing restrictions to be lifted, but were higher in late September and October in 2021 than in other recent years (Figure 11).

"Hoot Owl" angling restrictions were last implemented on the Missouri River in 2000. Water temperatures were higher in 2021 than in 2000, including much earlier in the year, and flows were lower in 2021 than 2000 (Figures 13 and 14).

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Figures

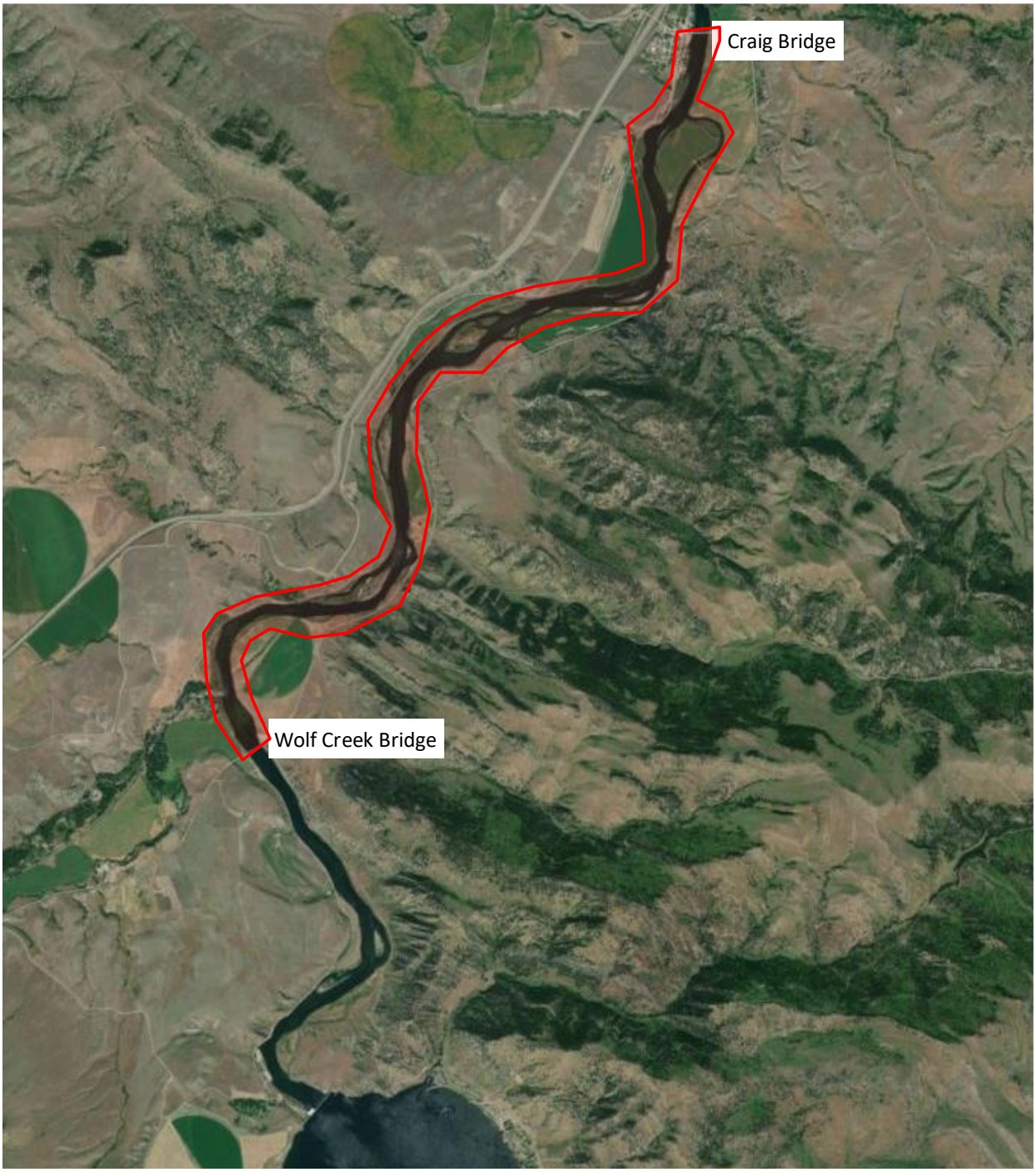

Figure 1. The Craig section (highlighted by the red polygon) of the Missouri River near Craig, Montana. This section is 5.6 miles long from Wolf Creek Bridge to Craig Bridge and is electrofished annually at night for brown trout and rainbow trout population estimates.

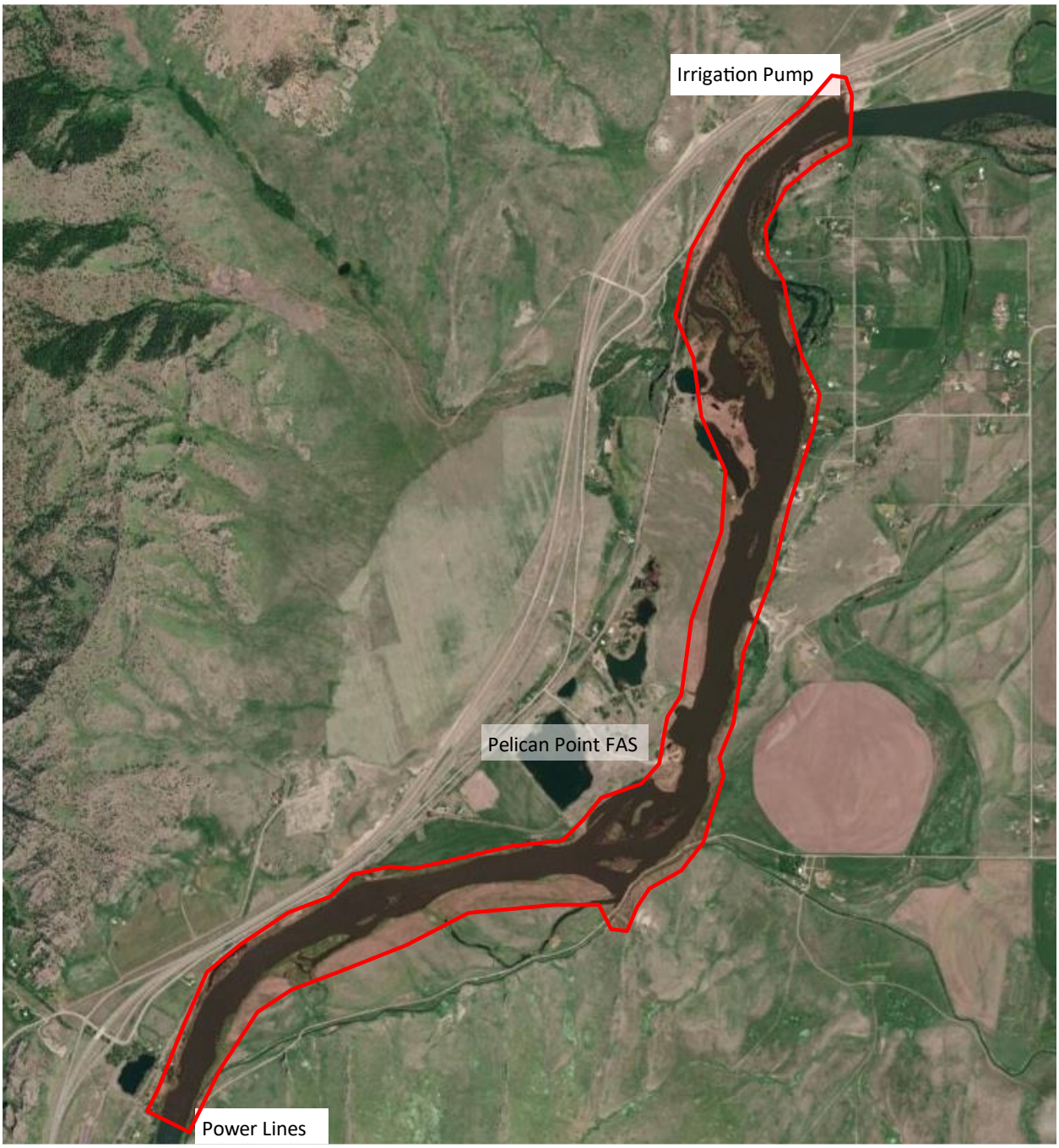

Figure 2. The Cascade section (highlighted by the red polygon) of the Missouri River near Cascade, Montana. This section is 4.1 miles long from the power lines to the irrigation pump and is electrofished annually at night for brown trout and rainbow trout population estimates.

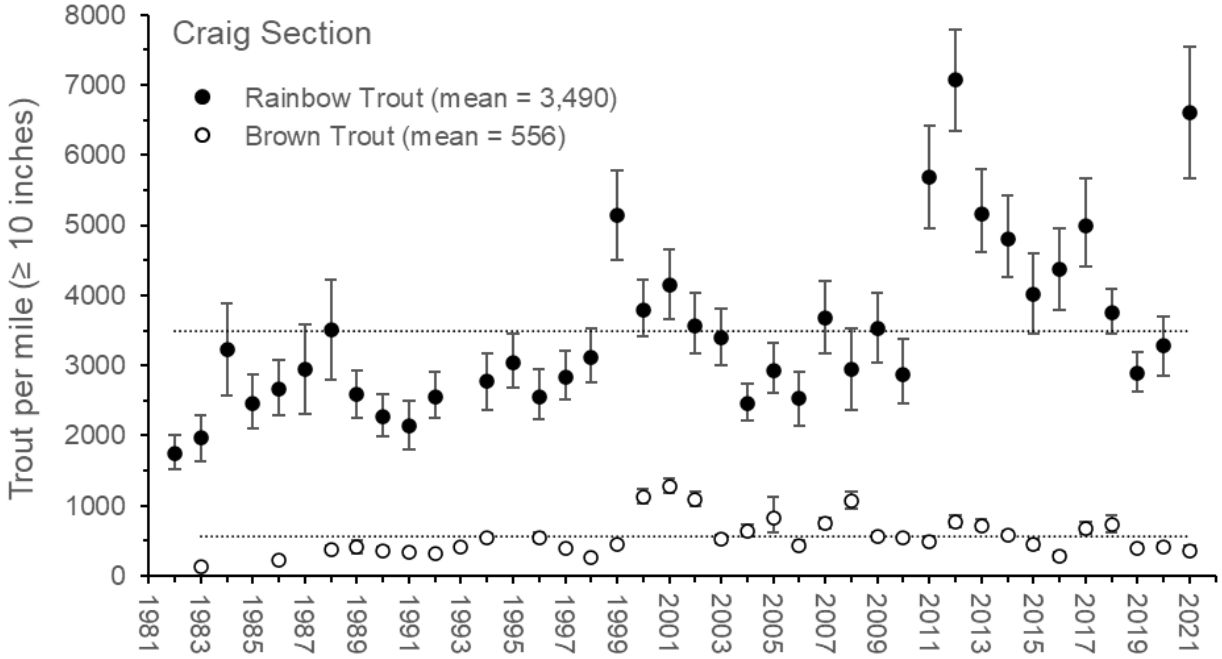

Figure 3. Population estimates of rainbow trout and brown trout (fish per mile) in the Missouri River, Montana within the Craig sampling section from 1982 through 2021. These estimates (mean and 95% confidence intervals) represent the model-averaged estimates across all length groups 10 inches and greater. Long-term average number of rainbow trout and brown trout per mile are designated by horizontal dashed lines and 2021 estimates were 6,611 and 362, respectively.

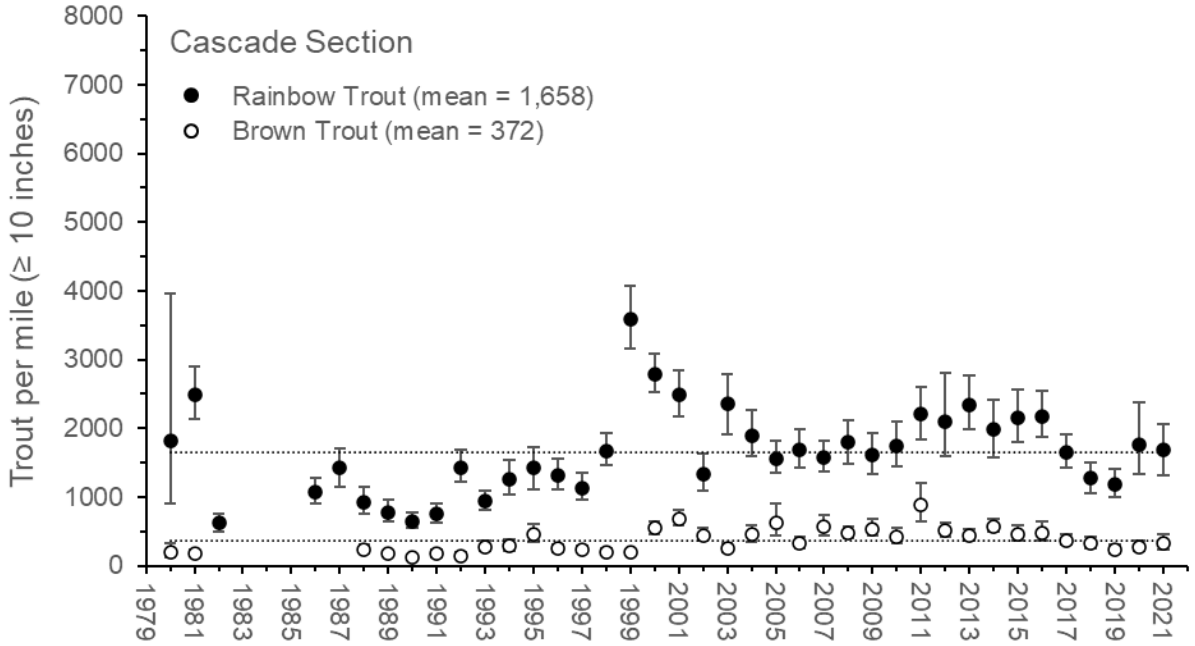

Figure 4. Population estimates of rainbow trout and brown trout (fish per mile) in the Missouri River, Montana within the Cascade sampling section from 1980 through 2021. These estimates (mean and 95% confidence intervals) represent the model-averaged estimates across all length groups 10 inches and greater. Long-term average number of rainbow trout and brown trout per mile are designated by horizontal dashed lines and 2021 estimates were 1,694 and 320, respectively.

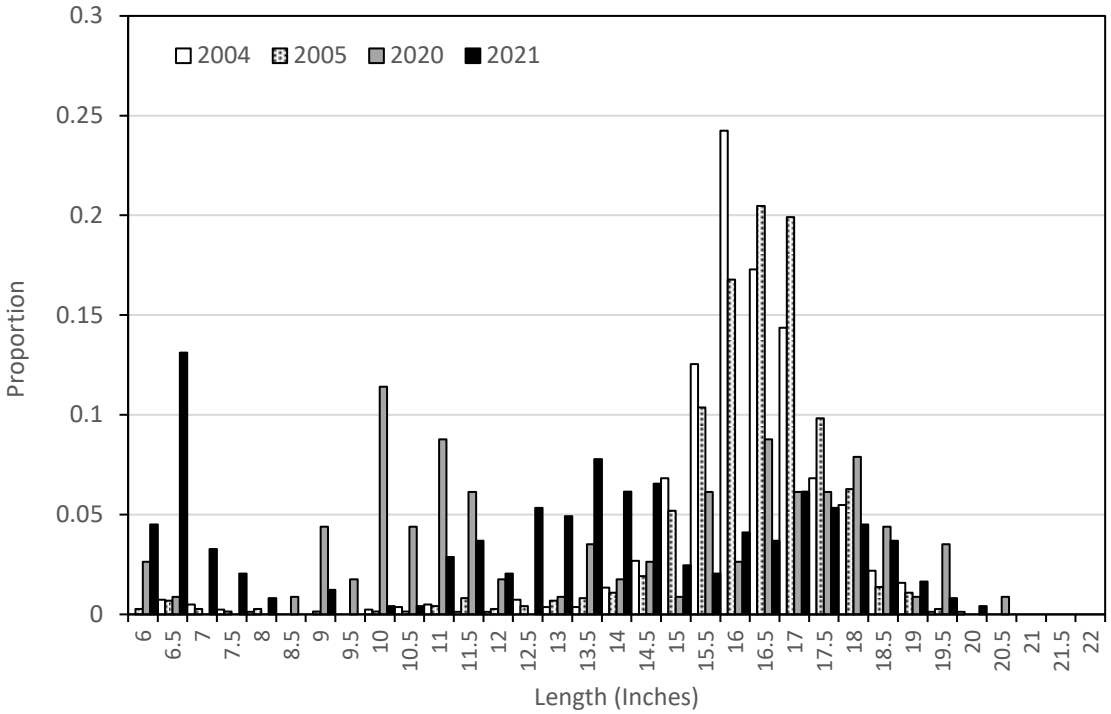

Figure 5. Length-frequency histogram for mountain whitefish collected in 2004 (n=821, 4 runs), 2005 (n=733, 4 runs), 2020 (n=114, 1 run) and 2021 (n=244, 1 run) during spring electrofishing of the first 2.5 miles of the Craig section of the Missouri River. Proportion of fish for each year is shown on the y-axis as a function of length (inches) on the x-axis.

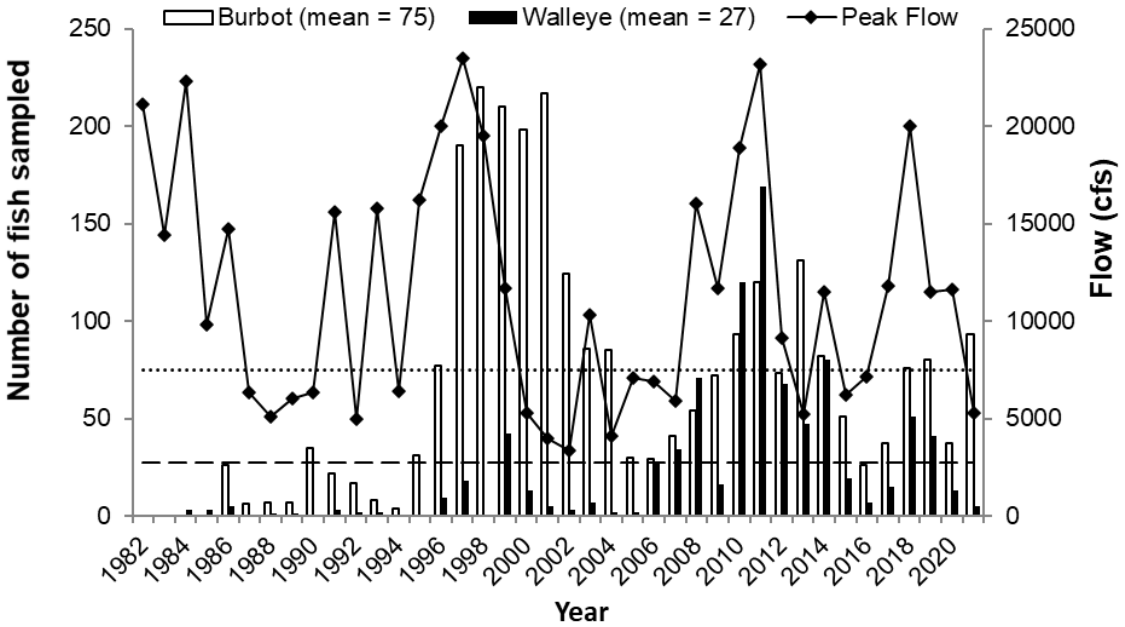

Figure 6. Number of burbot and walleye handled during standardized fall electrofishing surveys from 1982 through 2021 in the Craig section of the Missouri River. The peak annual flow of the Missouri River from USGS gage 06066500 (below Holter) is graphed on the right y-axis. The horizontal dotted line represents the mean number of burbot handled and the horizontal dashed line represents the mean number of walleye handled.

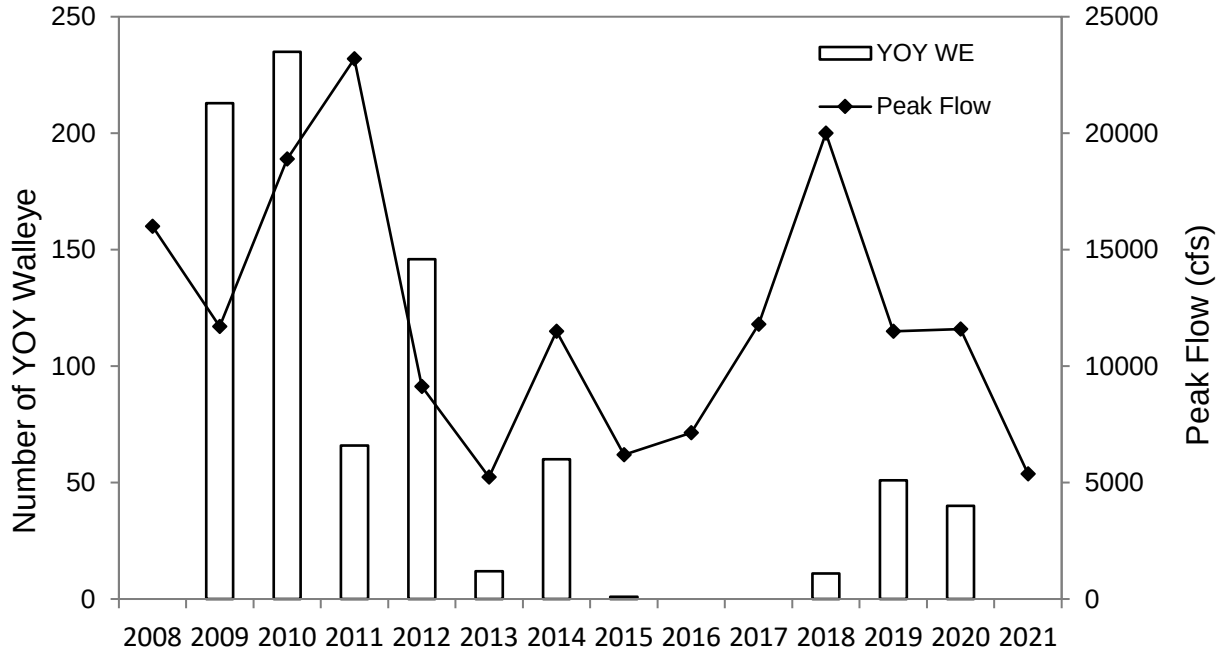

Figure 7. Total abundance of young of the year walleye from seining sites along the Missouri River from Cascade to Great Falls from 2009 through 2021 (left y-axis) and the peak annual flow of the Missouri River from USGS gage 06066500 from 2008 through 2021 (right y-axis). Zero young of the year walleye were collected in 2016, 2017, and 2021.

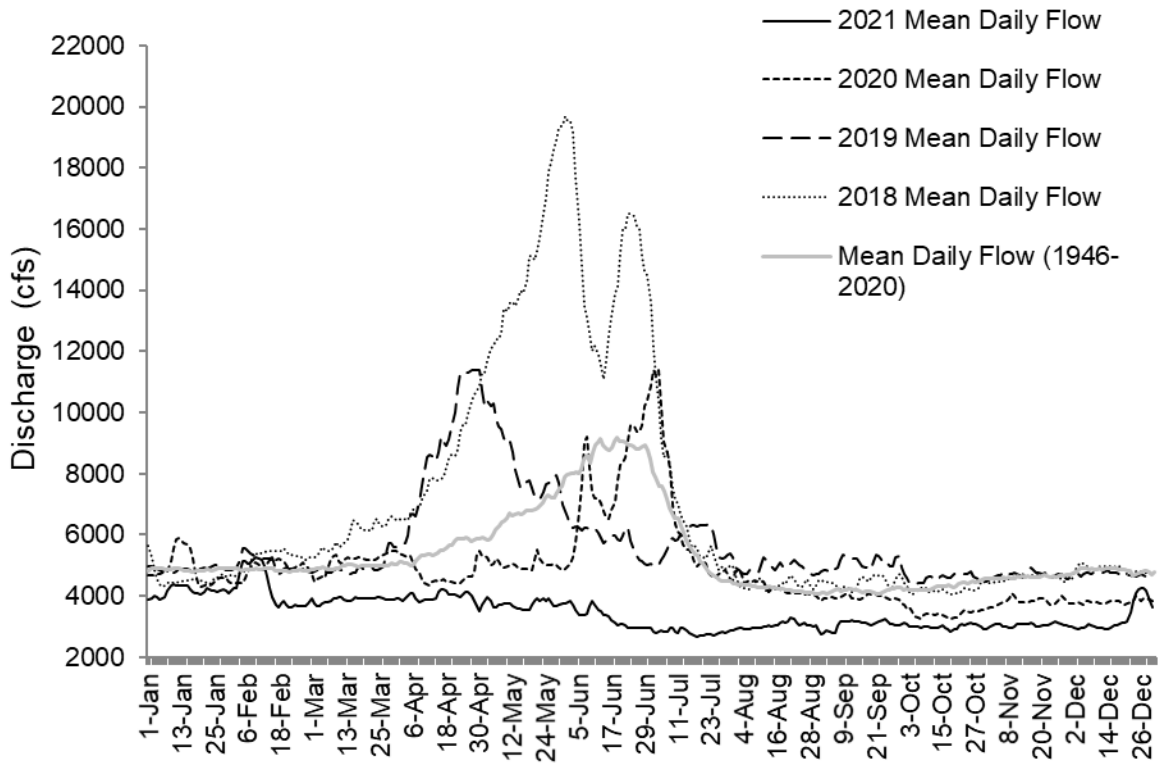

Figure 8. Mean daily flow for the Missouri River below Holter Dam at USGS gaging station 06066500 (below Holter Dam) for 2018, 2019, 2020, and 2021, and for the period of record from 1946 through 2020.

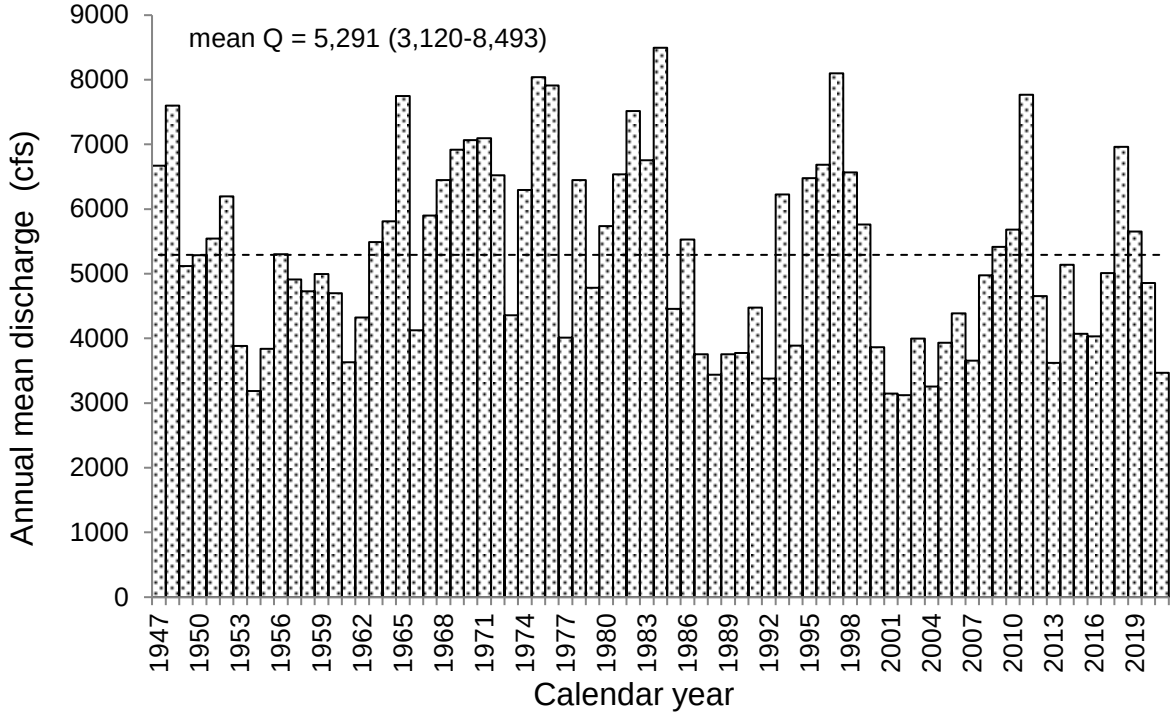

Figure 9. Mean annual flow for the Missouri River below Holter Dam at USGS gaging station 06066500 from 1947 through 2021, by calendar year. Horizontal dashed line represents the mean annual flow.

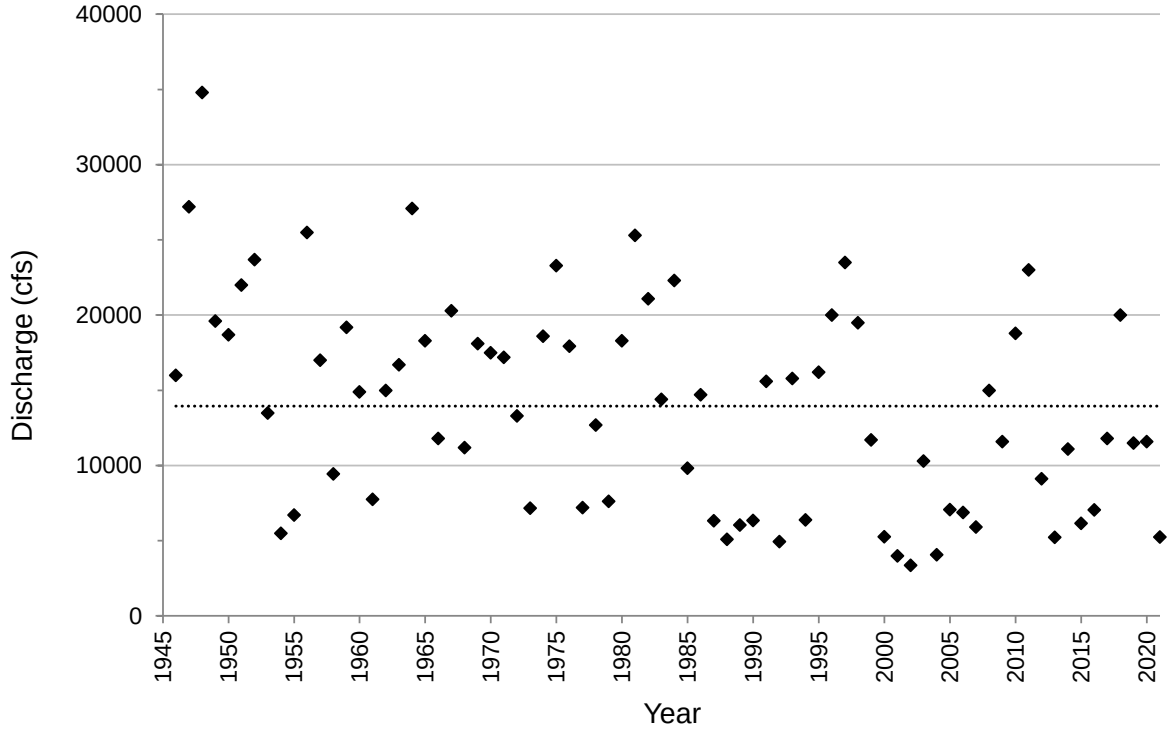

Figure 10. Peak annual flow for the Missouri River below Holter Dam at USGS gaging station 06066500 from 1947 through 2021. Horizontal dotted line represents the mean annual peak flow of 13,948 cfs.

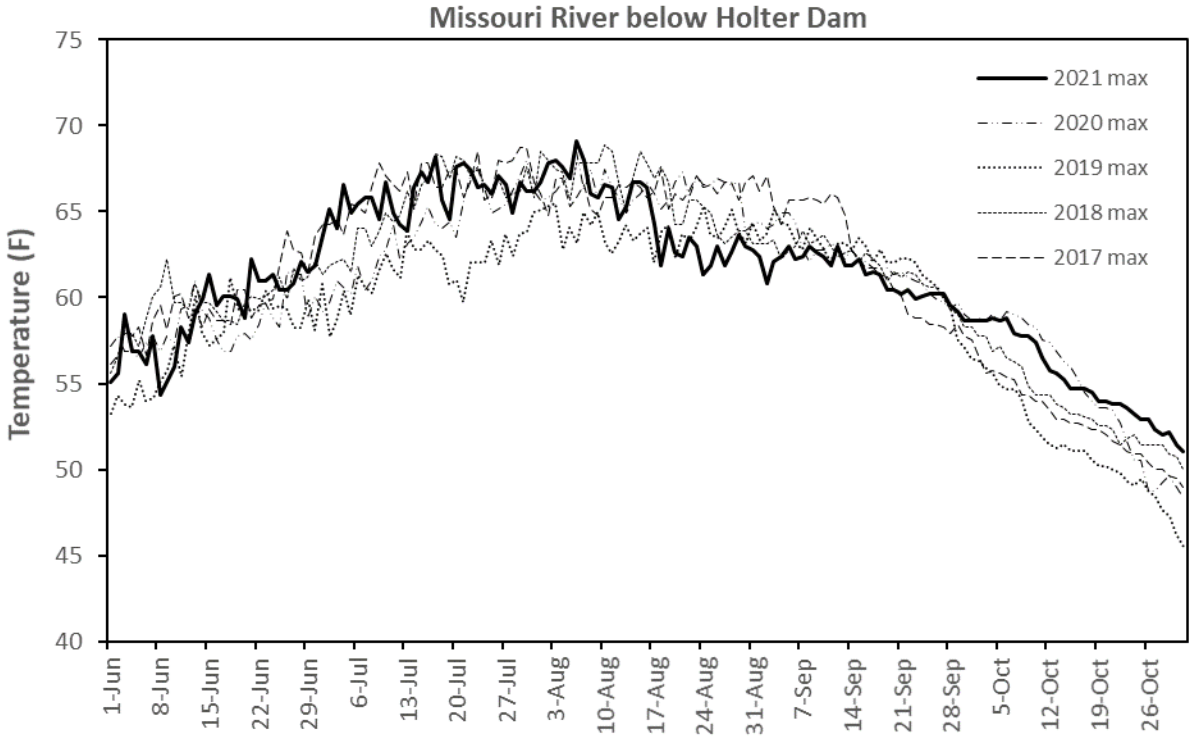

Figure 11. Maximum daily water temperatures for the Missouri River below Holter Dam at USGS gaging station 06066500 for 2017, 2018, 2019, 2020, and 2021.

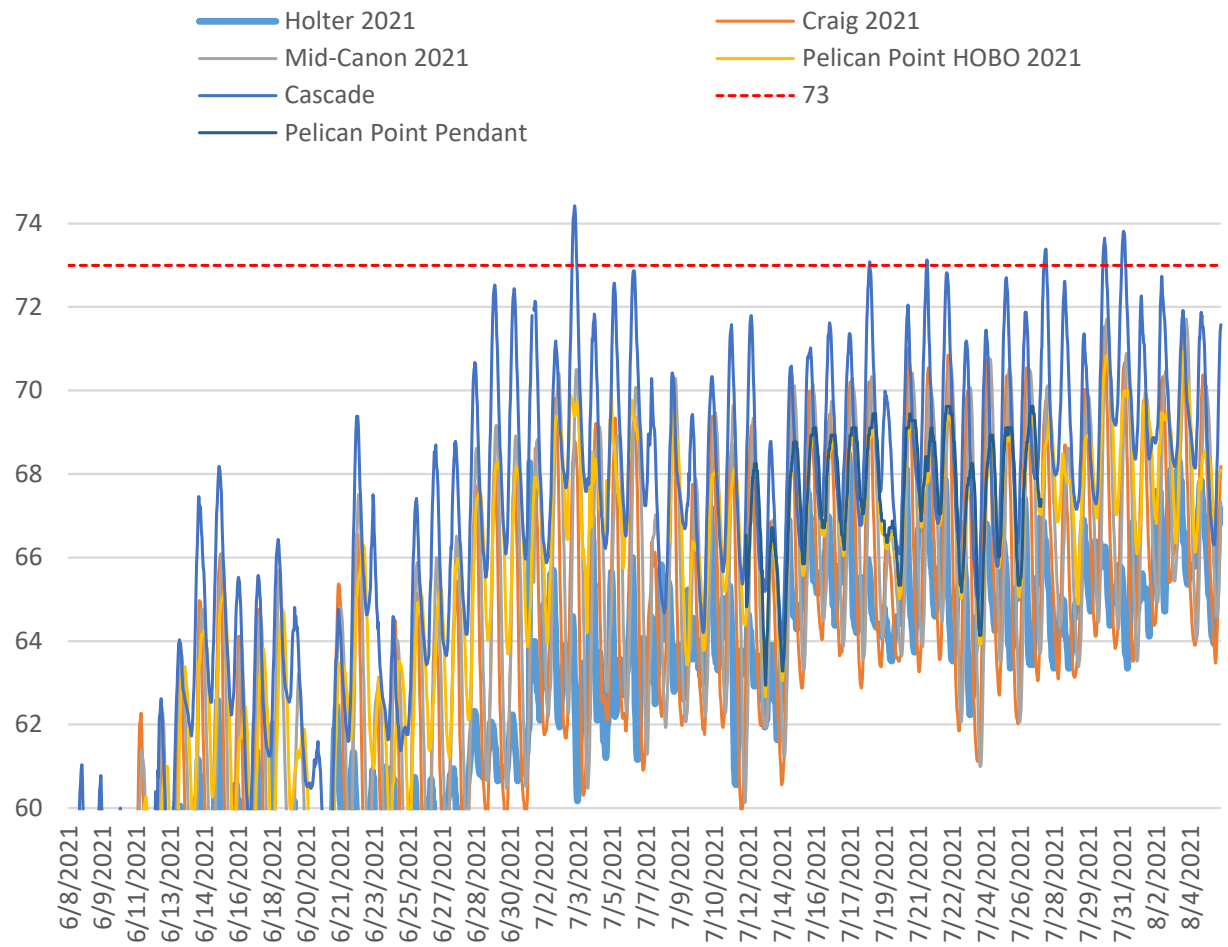

Figure 12. Missouri River water temperatures from below Holter Dam to Cascade in 2021.

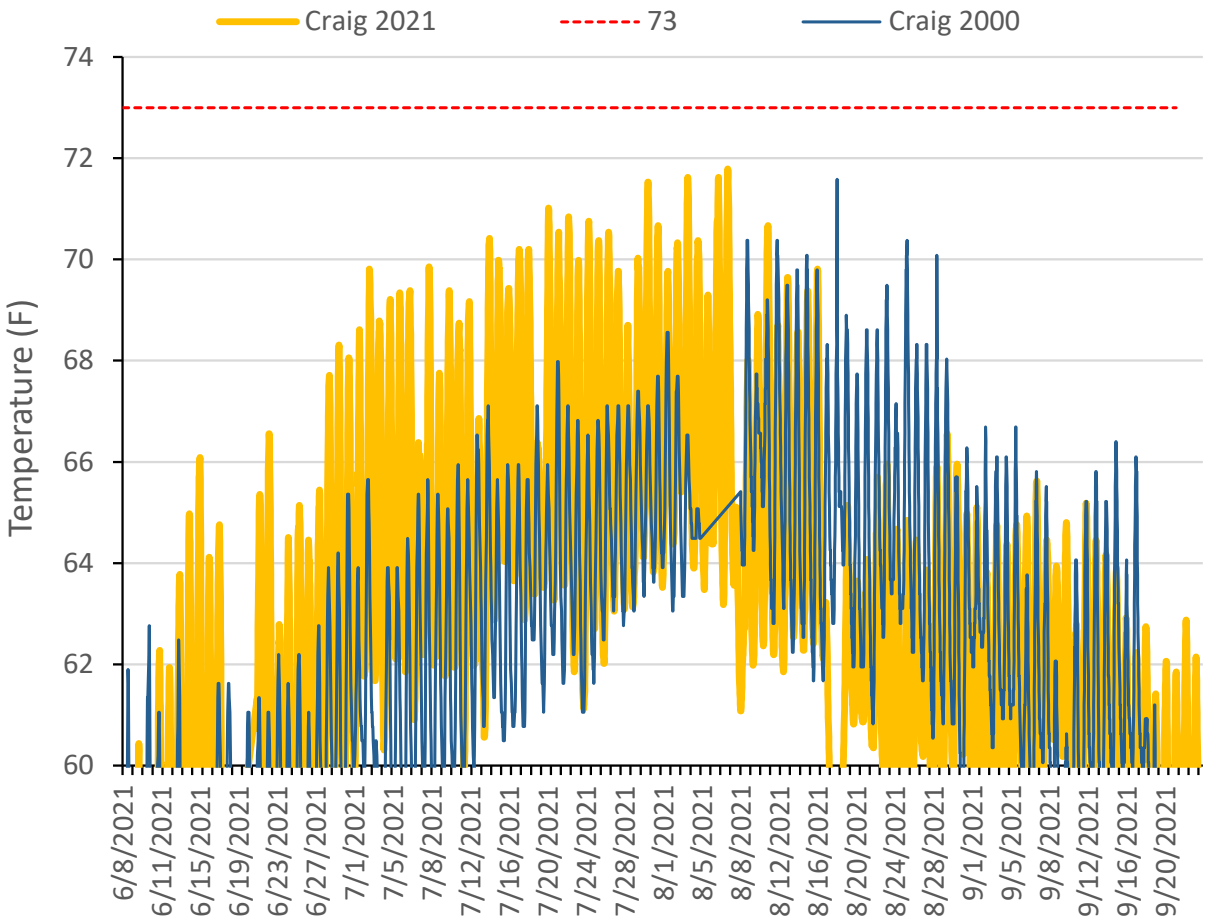

Figure 13. Missouri River water temperatures at Craig in 2021 and 2000.

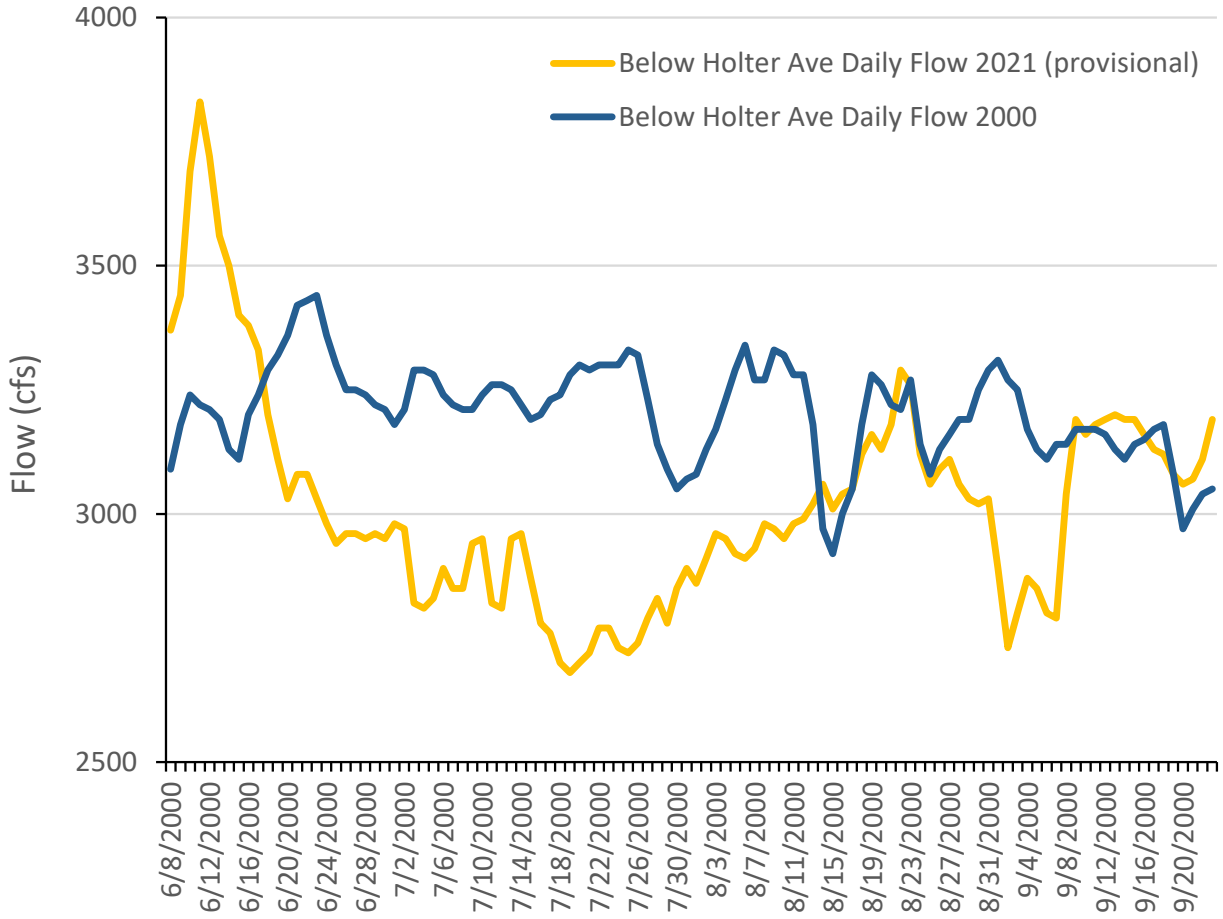

Figure 14. Missouri River flows below Holter in 2021 and 2000.

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 2021 (USGS Gauge 06066500). All temperature data is approved. Flow data is approved through November 22nd and provisional from November 23rd through December.

Missouri River		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean	34.9	34.9	36.9	42.2	48.4	57.1	64.3	63.5	60.4	54.8	46.9	38.9
Temperature (°F)	Min	31.8	34.0	34.9	38.8	43.7	49.5	60.3	59.9	57.7	50.4	42.8	33.4
	Max	46.6	36.1	39.7	46.9	57.0	62.2	38.2	69.1	63.0	58.8	50.7	43.7
	Mean	4,149	4,307	3,879	3,981	3,731	3,327	2,825	3,088	3,067	3,015	3,055	3,290
Discharge (cfs)	Min	3,880	3,620	3,670	3,670	3,520	2,940	2,680	2,890	2,900	2,850	2,910	2,910
	Max	4,380	5,250	3,960	4,210	3,960	3,830	2,980	3,310	3,220	3,140	3,160	4,280

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**		**Totals**	
Year	**# Tagged**	*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%
2006	**11**			4	36%	0	0%	1	9%	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%	10	24%
2010	**57**							5	9%	6	11%	0	0%	0	0%	0	0%	0	0%	11	19%
2012	**52**									9	17%	1	2%	0	0%	0	0%	0	0%	10	19%
2014	**43**											3	7%	0	0%	0	0%	0	0%	3	7%
2016	**35**													2	6%	2	6%	0	0%	4	11%
2018	**48**															1	2%	0	0%	1	2%
2020	**17**																	1	6%	1	6%
Total	**309**			**4**		**9**		**6**		**15**		**4**		**2**		**4**		**1**		**45**	**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		Totals	
Year	# Tagged	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
2008	**61**	20	32%	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	43%
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	23%
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	12%	18	10%	8	4%	1	1%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	37	27%
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	29%
2016	**21**																	3	14%	0	0%	0	0%	0	0%	0	0%	0	0%	3	14%
2017	**30**																			0	0%	2	6%	0	0%	0	0%	1	1%	3	7%
2018	**91**																					6	7%	7	8%	1	1%	0	0%	14	16%
2019	**94**																							8	9%	3	3%	0	0%	11	12%
2020	**54**																									4	7%	0	0%	4	7%
2021	**24**																											2	8%	2	8%
Total	**1143**	**20**		**17**		**7**		**14**		**42**		**29**		**22**		**21**		**5**		**0**		**9**		**15**		**8**		**2**		**211**	**18%**