# Fisheries Monitoring in the Upper Clark Fork River Basin
# 2018 Report


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For

The Natural Resource Damage Program

## Introduction

The Upper Clark Fork River (UCFR) was subject to extensive mining and mineral processing activities during the late 19th and early 20th centuries. Metal contamination from these activities have reduced habitat quality and altered the fishery in the UCFR. Fishery changes include reduced trout numbers and changes in species composition. Because of these negative impacts, angling use of the Clark Fork River is lower than other streams in western Montana. Extensive remediation and restoration efforts are under way and these efforts aim to mitigate historical mining and smelting damage to natural resources in the Upper Clark Fork River Basin (UCFRB). Effects of these action have been dramatic in Silver Bow Creek, where completed remedial activities have allowed the return of fish to a river where fish they were extirpated for more than a century (Naughton 2013). The Silver Bow Creek fishery will continue to change in response to improvements in water quality, maturation of riparian vegetation, natural changes in river morphology, tributary restoration projects, flow enhancement, etc. Remedial efforts on the mainstem of the Clark Fork River are more recent and the area slated for restoration projects is vast (see Saffel et al. 2018). Thus, monitoring fisheries responses to restoration needs to be done at multiple spatial and temporal scales (Geum Environmental, 2015). This monitoring program evaluates the UCFRB restoration program at the basin (mainstem river), watershed (i.e., individual tributaries), and project (site) scales.

In the past, fisheries data collection was conducted sporadically in the UCFRB. From 2008 to 2010, FWP biologists established long term monitoring sections on the mainstem UCFR. FWP has completed population estimates in these sections each of the subsequent years. These mainstem population surveys provide a dataset that can be used to evaluate the mainstem Clark Fork River fishery before, during, and after restoration and remediation actions. Annual fisheries surveys in Silver Bow Creek began on 2013. Silver Bow Creek surveys initially consisted of one-pass electrofishing conducted in the fall at four sections. In 2014, two more sections were added and sampling occurred in spring and fall. In 2015, the first fish population estimates were attempted on Silver Bow Creek, both in spring and fall. The spring sampling was shifted to summer from 2016-2018 and population estimates are now attempted summer and fall at six sections. The summer sampling is conducted during the period of low flows and high water temperatures. Low dissolved oxygen has been documented in the past during the summer and hypoxic areas of Sliver Bow Creek tend to be devoid of trout during this period (Naughton 2013). Fall sampling is focused on evaluating fish numbers and distribution when water temperatures have cooled and dissolved oxygen concentrations are more favorable to fish.

Multiple tributaries have been identified as priorities for restoration in the UCFRB (Saffel et al., 2018). Preliminary data on species composition and distribution were collected in multiple watersheds during the late 2000s (Lindstrom et al. 2008, Liermann et al. 2009). Population estimate sections were established in priority tributaries and these sections were sampled every year from 2015-2017. During the 2017 tributary sampling, brown trout were found in areas of the Warm Springs Creek watershed where they were not found previously. The Warm Springs

Creek watershed is an isolated bull trout stronghold. Meyers Dam is a complete barrier to upstream fish movement and provides protection from invasion from nonnative brown trout, which are abundant below the dam. Previous FWP sampling indicated that LL have a limited distribution above Meyers Dam. Above the dam, brown trout had only been documented in Warm Springs Creek at the sampling section just above the dam (Garrity). In 2017, LL were found at the Above Veronica Trail section, which is about 6 miles upstream of the Garrity Section. Brown trout were also first discovered in Twin Lakes Creek in 2017. In 2018, it was decided to resample the lower sections of tributaries in the upper Warm Springs Creek watershed to further investigate the potential upstream expansion of brown trout.

In early 2017 Fish, Wildlife, and Parks was contacted by Trout Unlimited and the Clark Fork Coalition because these groups were interested in pursing fish screening projects on various irrigation structures throughout the UCFRB. Documenting fish entrainment in these canals is a basic way to gather information about the potential value of screening projects. Trout Unlimited was also interested in pursuing restoration actions on a previously unsampled spring creek known as Beaver Dam Creek, a tributary to the Little Blackfoot River. Gathering fish data on this creek would provide insight into its fishery value and some of its habitat issues.

## Methods and Results

*Mainstem population monitoring*

Trout population estimates were conducted in spring 2018 at seven established sections on the Clark Fork River. These sections are sampled annually by FWP and are referred to as Bearmouth, Morse Ranch, Phosphate, Williams Tavenner, Below Sager Lane, and pH Shack. Population estimate are also conducted from the bottom of pH Shack to Perkins Lane. This electrofishing section was sampled from 2009-2012 and from 2015-present. Details such as section length and specific locations of population estimate sections can be found in the Figure 1 and the Appendix.

Fish were collected using aluminum drift boats with a mounted electrofishing unit and two front boom anodes and one netter. Estimates were made using two marking runs and two recapture runs. Recapture runs were completed roughly one week after marking runs. All captured trout were identified to species, weighed (g), measured (mm), and marked with a small fin clip. Population estimates for fish ≥ 175 mm (~7 in) were generated using the Chapman modification (Chapman 1951) of the Petersen method provided in Montana Fish, Wildlife and Park's Fisheries Information System. Estimates were calculated for trout species that had a minimum of 4 marked fish that were recaptured (B. Liermann, Montana, Fish, Wildlife, and Parks, personal communication, 2014). When comparing estimates between years, estimates with non-overlapping 95% confidence intervals were considered significantly different.

The brown trout population estimate at the pH Shack Section in 2018 was 104 fish/km, the lowest estimate since annual sampling began in 2008 (Table 1, Figure 2). The highest estimate during this period occurred in 2013 when the brown trout population was at 1167 fish/km. The brown trout population at pH Shack declined by 85% between 2013 to 2015 and has since remained relatively low. At the pH-Shack-to-Perkins Lane Section, the 2018 brown trout estimate was 60 fish/km, well below the 2009-2018 average. Brown trout numbers were also below average at the Sager Lane Section in 2018 at 108 fish/km. At the Williams-Tavenner Section, the 2018 brown trout estimate was 187 fish/km, near the average of 202 fish/km. Brown Trout numbers at Phosphate were 172 fish/km in 2018, which is not significantly lower statistically than the section average of 213 fish/km. The 2018 brown trout estimate at the Morse Ranch Section was 93 fish/km, which was near the average of 87 brown trout/km. No *Oncorhynchus* were recaptured at the Morse Ranch Section in 2018 so no estimate could be generated. At the Bearmouth Section, the 2018 brown rout estimate was 51 fish/km, which is significantly higher than the average estimate of 32 fish/km. The 2018 *Oncorhynchus* estimate was 25 fish/km which was the same as the long-term average of 25 fish/km.

In late September of 2018, a section of the Upper Clark Fork River through Phases 15/16 of the Clark Fork River Cleanup was sampled. This section, referred to as the Grant Kohrs Section, was 2.6 miles long and went from the Kohrs-Manning Diversion to the upstream end of the Deer Lodge waste water treatment plant. The Below Sager Lane Section was also sampled at this time to determine whether trout numbers where different in spring versus fall. Both sections were sampled with one marking and one recapture run. The brown trout population estimate at the Grant Kohrs Section was 144 fish/km (Table 2). The Fall Below Sager Lane Section estimate was 117 fish/km, which was similar to the spring estimate.

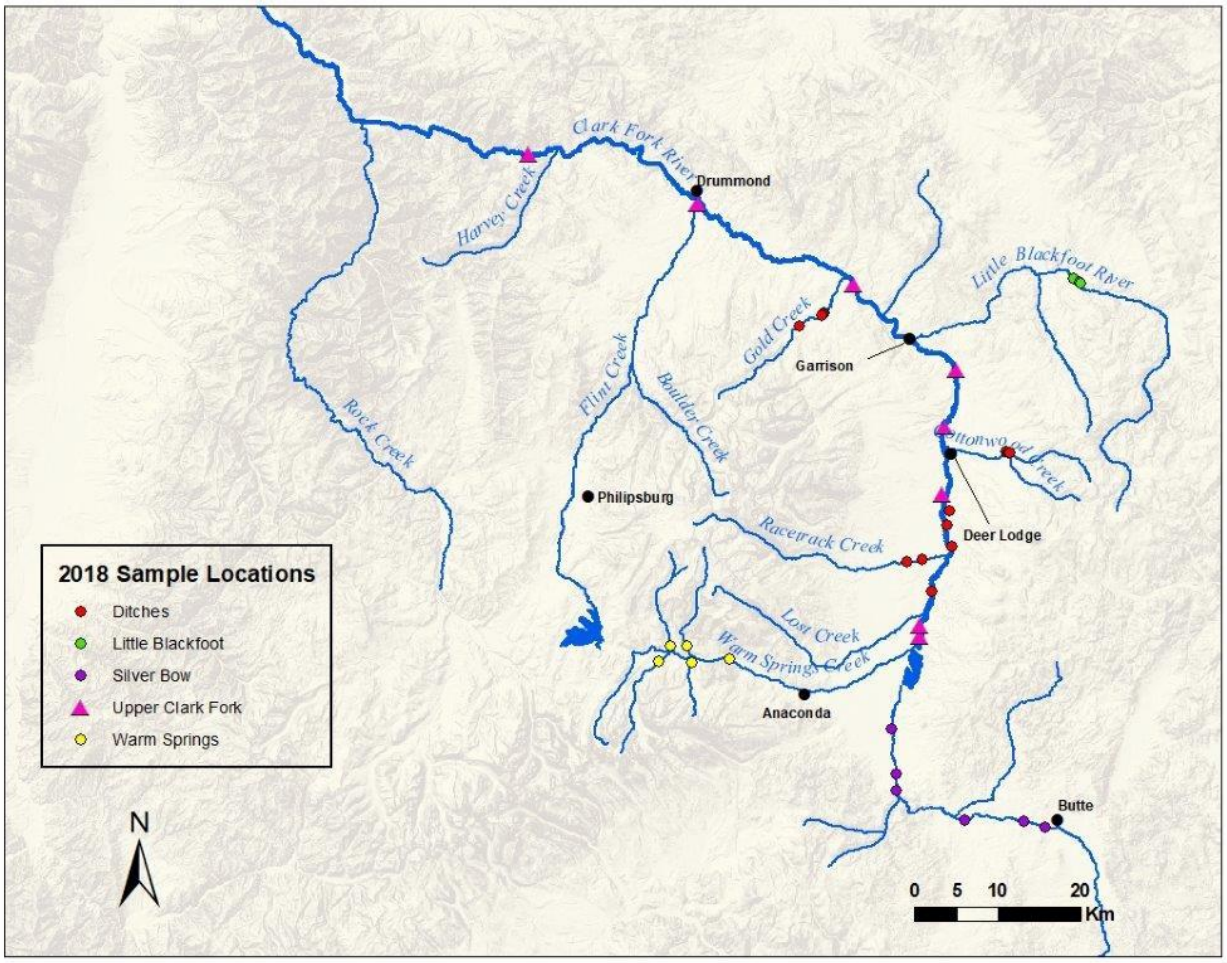


Figure 1. Map of 2018 fish sampling locations in the Upper Clark Fork River Basin.

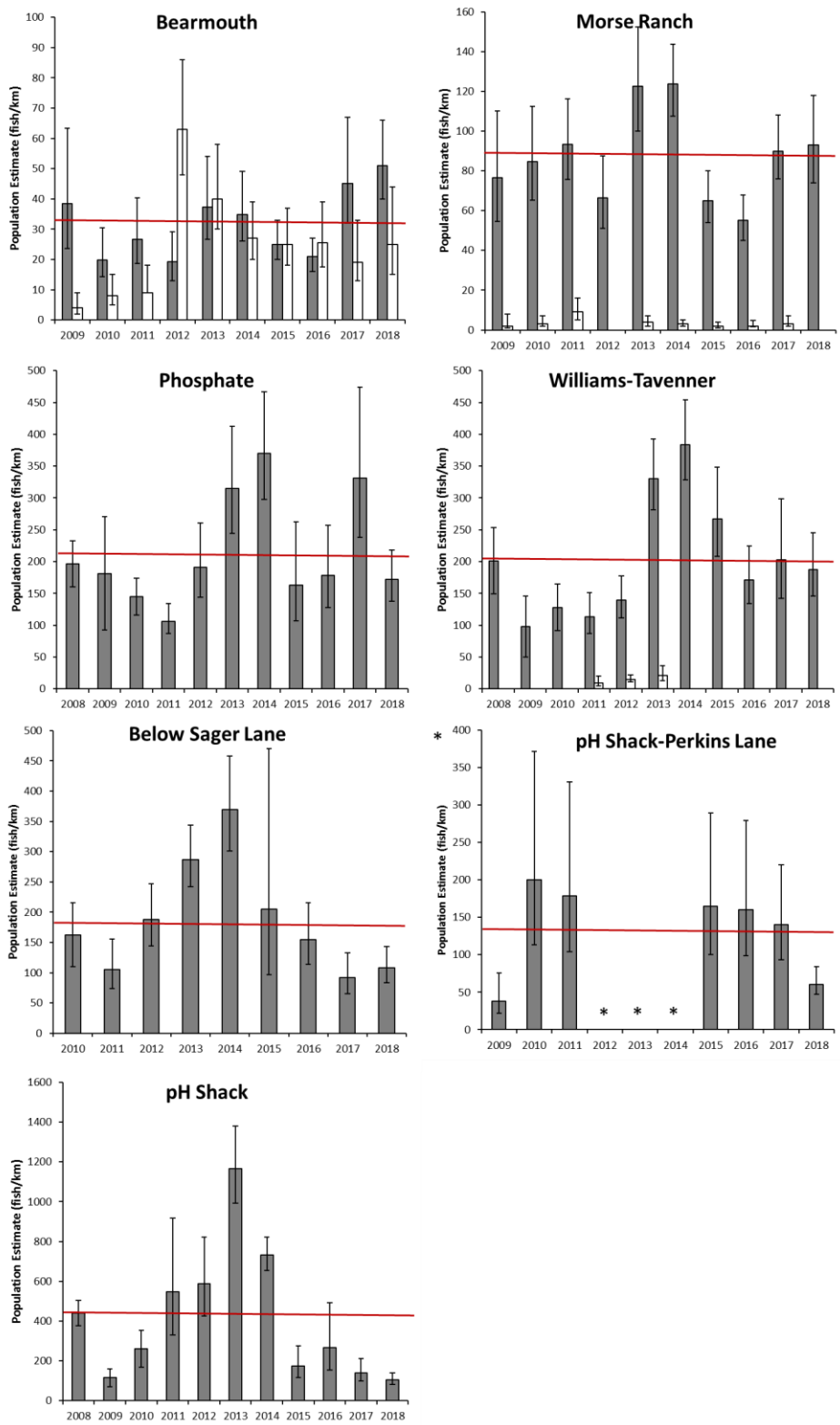


Figure 2. Clark Fork River brown trout (grey bars) and *Oncorhynchus sp.* (white bars) population estimates from 2008-2018 by sample section. Please note that axis values are not the same for every sample reach. The red line depicts the average brown trout population estimate for the section.

Table 1. Electrofishing data collected in Spring 2018 from annual sampling sections on the Upper Clark Fork River. Population estimates (95% confidence interval) are for trout greater than 175 mm (~ 7") in total length. Species abbreviations: LL = Brown Trout, WCT = Westslope Cutthroat Trout, RB = Rainbow Trout, BULL = Bull Trout, RBXWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

| Section | Species | Population Estimate (fish/Km) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Bearmouth | LL | 51(40-66) | 264 | 289 | 155-512 | 67 |
| | RB | 19(12-32) | 82 | 306 | 191-471 | 21 |
| | WCT | 6(3-12) | 32 | 333 | 192-422 | 8 |
| | RBxWCT | | 13 | 290 | 225-400 | 3 |
| | BULL | | 3 | 326 | 258-402 | 1 |
| Morse Ranch | LL | 93(74-118) | 438 | 331 | 176-498 | 98 |
| | WCT | | 5 | 299 | 255-341 | 1 |
| | RBxWCT | | 1 | 350 | 350 | <1 |
| Phosphate | LL | 172(139-218) | 298 | 339 | 104-477 | 99 |
| | WCT | | 4 | 319 | 215-397 | 1 |
| Williams Tavenner | LL | 187(146-245) | 321 | 382 | 110-552 | 98 |
| | WCT | | 3 | 313 | 293-329 | 1 |
| | EB | | 2 | 242 | 205-279 | 1 |
| Below Sager Lane | LL | 108(83-143) | 272 | 362 | 87-527 | 99 |
| | EB | | 1 | 407 | 407 | <1 |
| | WCT | | 1 | 176 | 407 | <1 |
| PH Shack to Perkins Ln. | LL | 60(47-84) | 123 | 296 | 87-517 | 98 |
| | RB | | 2 | 315 | 220-410 | 2 |
| PH Shack | LL | 104(82-140) | 182 | 342 | 98-522 | 97 |
| | RB | | 4 | 381 | 288-445 | 2 |
| | WCT | | 1 | 327 | 327 | 1 |

Table 2. Electrofishing data collected in Fall 2018 from sampling sections on the Upper Clark Fork River near the Grant-Kohrs Ranch. Population estimates (95% confidence interval) are for trout greater than 175 mm (~ 7") in total length. Species abbreviations: LL = Brown Trout, RB = Rainbow Trout.

| Section | Species | Population Estimate (fish/Km) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Below Sager | LL | 117(70-210) | 174 | 317 | 90-510 | 99 |
| Lane | RB | | 1 | 330 | 330 | <1 |
| Grant Kohrs | LL | 144(86-253) | 199 | 287 | 106-535 | 100 |

*Silver Bow Creek*

Silver Bow Creek was sampled at six sections using backpack electrofishing. Two or three pass depletion estimates (Zippin 1958) were conducted when enough numbers of fish were captured on the first pass and numbers of a particular species declined in subsequent electrofishing passes. Flows in Silver Bow Creek during the 2018 August Sampling were about 2X higher than average, which made it difficult to efficiently capture fish. Flows remained high throughout the fall and were about 1.5X the average flow during the October sampling. Therefore, population estimates and CPUE data for 2018 should be interpreted with caution. For the summer sampling, population estimates could be generated in all sections except Rocker (Table 3). Summer westslope cutthroat trout densities were estimated to be 3 fish/100 m at Fairmont, 11 fish/100 m at German Gulch, and 3 fish/100 m at Ramsay. From 2015-2018, summer WCT estimates averaged 9 fish/100 m (SD = 8.5) at Fairmont, 11 fish/100 m at German Gulch, and 5 fish/100 m (SD = 2.1) at Ramsay (see Figure 3). Brook trout were estimated at 2 fish/100 m at Fairmont, 6 fish/100 m at German Gulch, and 3 fish/100 m at LAO. From 2015-2018, summer EB estimates averaged 13 fish/ 100 m (SD = 9.7) at Fairmont and 6 fish/100 m (SD = 1.5) at German Gulch. During the fall sampling, estimates were generated for Fairmont, German Gulch, and Ramsay. Fall westslope cutthroat trout densities were estimated to be 5 fish/100 m at Fairmont, 3 fish/100 m at German Gulch, and 6 fish/100 m at Ramsay. From 2015-2018, fall WCT estimates averaged 6 fish/100 m (SD = 2.9) at Fairmont, 4 fish/100 m (SD = 2.2) at German Gulch, and 4 fish/100 m (SD = 1.8) at Ramsay (Figure 4). Brook trout were estimated at 2 fish/100 m at German Gulch, 2 fish/100 m at Ramsay, and 3 fish/100 m at LAO in the fall estimates.

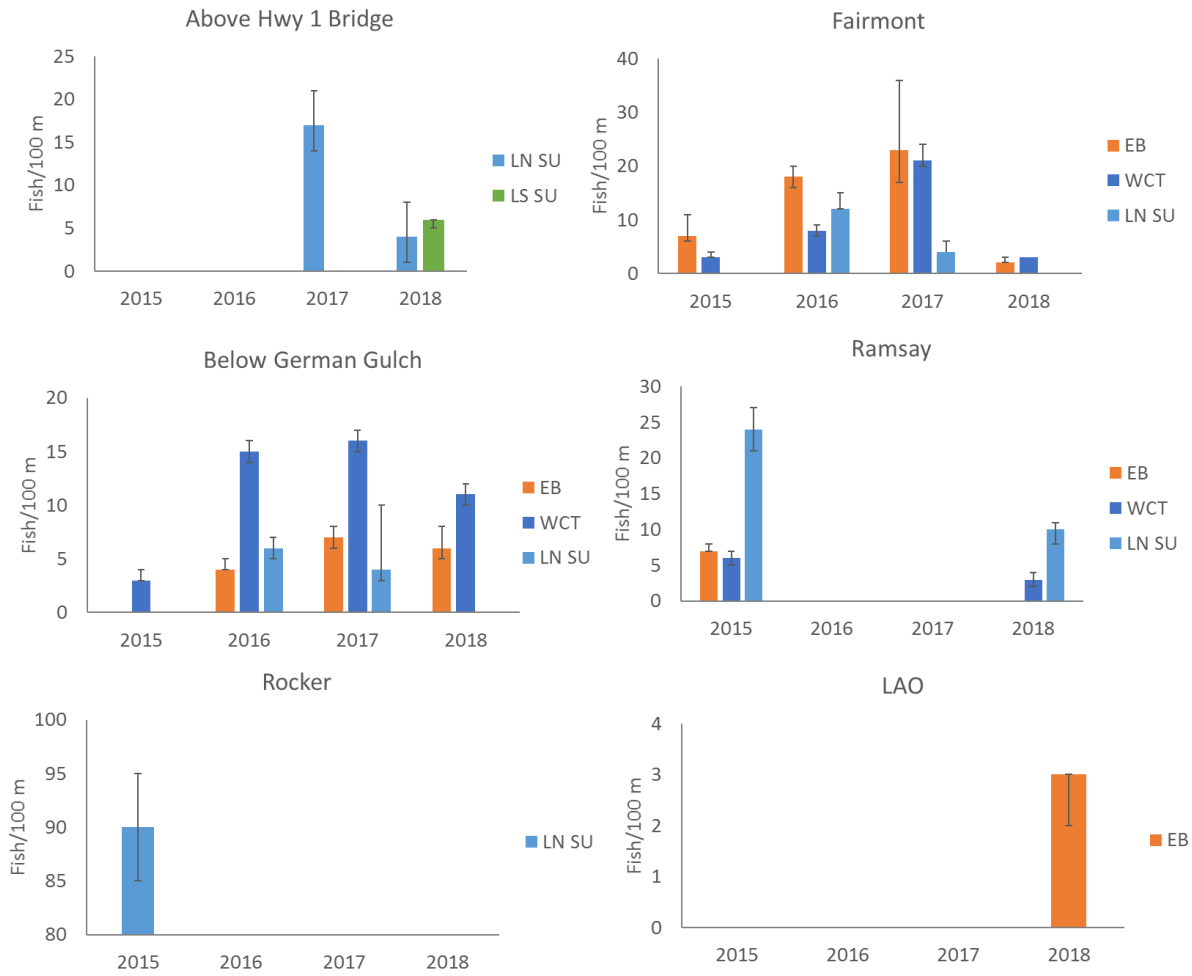


Figure 3. Summer population estimates for Silver Bow Creek sampling sections.

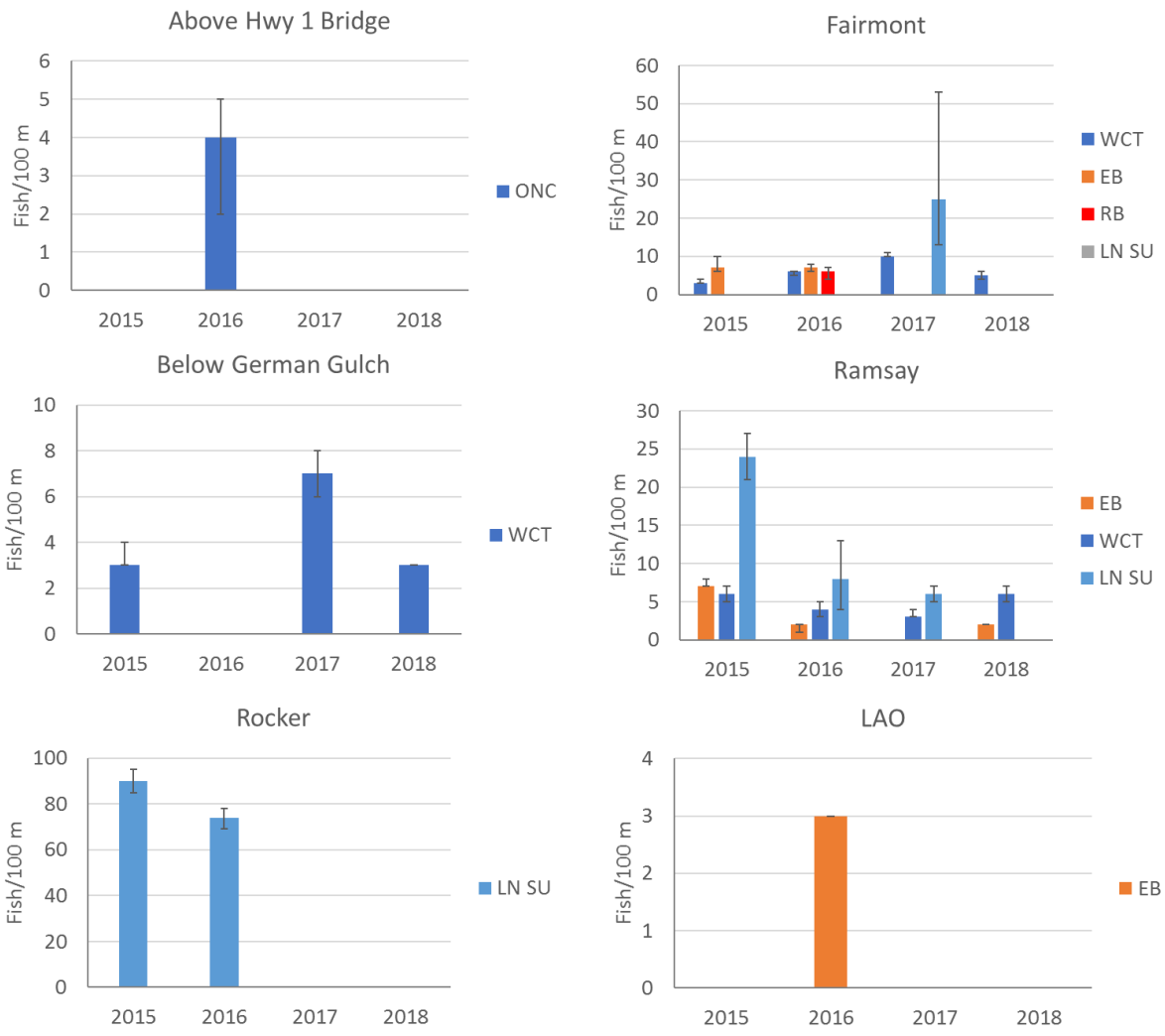


Figure 4. Fall population estimates for Silver Bow Creek sampling sections.

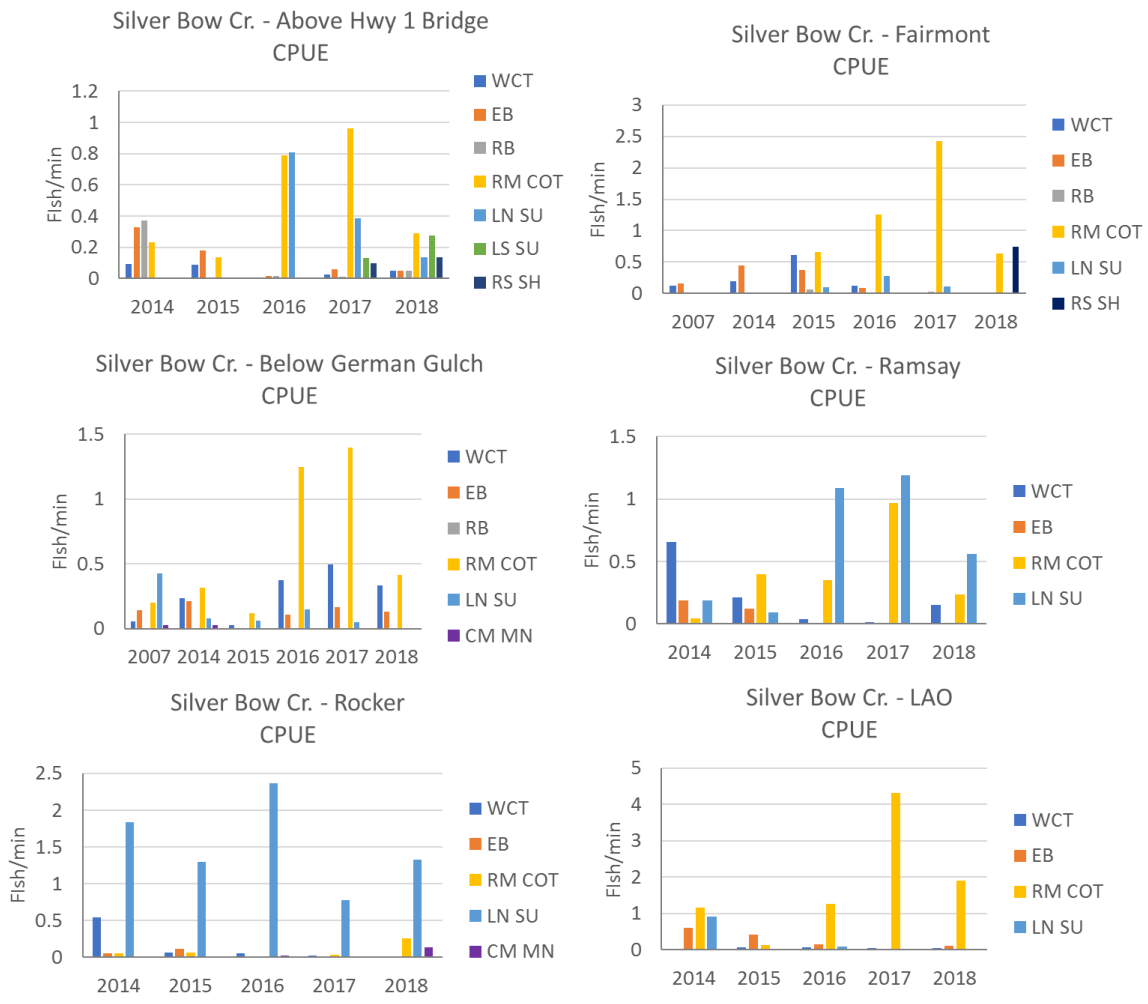


Figure 5. Fish catch per unit effort (CPUE) during summer electrofishing at six sections of Silver Bow Creek. The y-axis is number of fish caught per minute of electrofishing during the first pass.


Figure 6. Fish catch per unit effort (CPUE) during fall electrofishing at six sections of Silver Bow Creek. The y-axis is number of fish caught per minute of electrofishing during the first pass.

Table 3. Electrofishing data collected on Silver Bow Creek in August 2018. Population estimates (95% CI) are for fish greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, EB = Eastern Brook Trout, RB = Rainbow Trout, LNSU = Longnose Sucker, LS SU = Large Scale Sucker, RM COT = Rocky Mountain Sculpin, RS SH = Redside Shiner.

| Section | Species | Population Estimate (fish/100m) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Above Hwy 1 Bridge | WCT | | 3 | 253 | 191-345 | 4 |
| | EB | | 4 | 1252 | 230-262 | 5 |
| | RBxWCT | | 1 | 211 | 211 | 1 |
| | RB | | 3 | 275 | 215-385 | 4 |
| | LN SU | 4(2-6) | 12 | 148 | 99-184 | 16 |
| | LS SU | 6(5-6) | 18 | 167 | 90-500 | 23 |
| | RM COT | | 26 | 79 | 44-120 | 34 |
| | RS SH | | 10 | 87 | 35-115 | 13 |
| Fairmont | WCT | 3(3-3) | 10 | 245 | 159-354 | 5 |
| | EB | 2(2-3) | 8 | 149 | 97-214 | 4 |
| | RBxWCT | | 5 | 208 | 183-223 | 2 |
| | LN SU | | 20 | 168 | 132-198 | 10 |
| | LS SU | | 12 | 159 | 91-204 | 6 |
| | RM COT | | 69 | 76 | 31-101 | 33 |
| | RS SH | | 84 | 89 | 60-109 | 40 |
| Below German Gulch | WCT | 11(10-12) | 42 | 214 | 51-396 | 41 |
| | EB | 6(5-8) | 22 | 136 | 85-286 | 22 |
| | RM COT | | 38 | 70 | 40-106 | 37 |
| Ramsay | WCT | 3(2-4) | 10 | 263 | 189-351 | 14 |
| | LN SU | 10(8-11) | 40 | 119 | 44-175 | 57 |
| | RM COT | | 16 | 81 | 45-107 | 23 |
| | CM MN | | 4 | 79 | 69-92 | 6 |
| Rocker | LN SU | | 62 | 149 | 78-208 | 78 |
| | RM COT | | 12 | 98 | 55-117 | 15 |
| | CM MN | | 6 | 87 | 76-98 | 7 |
| LAO | WCT | | 2 | 306 | 276-335 | 2 |
| | EB | 3(2-3) | 6 | 300 | 233-342 | 5 |
| | LN SU | | 1 | 83 | 83 | 1 |
| | RM COT | | 122 | 92 | 37-120 | 91 |
| | CM MN | | 2 | 85 | 84-86 | 2 |

Table 4. Electrofishing data collected on Silver Bow Creek in October 2018. Population estimates (95% CI) are for fish greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, EB = Eastern Brook Trout, RB = Rainbow Trout, LL = Brown Trout, LN SU = Longnose Sucker, RM COT = Rocky Mountain Sculpin, CM MN = Central Mudminnow, LS SU = Large Scale Sucker, RS SH = Redside Shiner, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

| Section | Species | Population Estimate (fish/100m) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Above Hwy 1 Bridge | RB | | 3 | 292 | 242-393 | 60 |
| | RM COT | | 2 | 65 | 45-85 | 40 |
| Fairmont | WCT | 5(4-6) | 17 | 254 | 177-367 | 22 |
| | EB | | 14 | 154 | 108-255 | 18 |
| | LN SU | | 20 | 181 | 136-210 | 26 |
| | LS SU | | 10 | 191 | 175-230 | 13 |
| | RM COT | | 13 | 85 | 48-111 | 17 |
| | RS SH | | 2 | 104 | 98-111 | 3 |
| Below German Gulch | WCT | 3(3-3) | 13 | 183 | 66-297 | 37 |
| | EB | 2(1-2) | 7 | 121 | 103-164 | 20 |
| | RM COT | | 15 | 65 | 42-115 | 43 |
| Ramsay | WCT | 6(5-7) | 22 | 263 | 225-340 | 61 |
| | EB | 2(2-2) | 6 | 182 | 147-283 | 17 |
| | LN SU | | 7 | 130 | 98-173 | 19 |
| | RM COT | | 1 | 101 | 101 | 3 |
| Rocker | WCT | | 1 | 306 | 306 | 3 |
| | EB | | 2 | 198 | 189-206 | 5 |
| | LN SU | | 21 | 134 | 60-204 | 57 |
| | RM COT | | 12 | 104 | 50-211 | 32 |
| | CM MN | | 1 | 83 | 83 | 3 |
| LAO | EB | | 3 | 251 | 243-260 | 23 |
| | RM COT | | 9 | 91 | 52-109 | 69 |
| | CM MN | | 1 | 85 | 85 | 8 |

*Warm Springs Creek watershed monitoring*

2018 sampling in the Warm Springs Creek watershed focused on areas in or nearby sections above Meyers Dam in which brown trout were captured in the past. Sections sampled on mainstem Warm Springs Creek included the Garrity and Above Veronica Trail sections (Figure 7). The most downstream of the established population monitoring sections of Twin Lakes Creek (river mile 1.3), Foster Creek (river mile 1.0), and Barker Creek (river mile 0.5) were also sampled. A mark-recapture estimate consisting of one mark and one recapture run was conducted at the Garrity Section and depletion estimates were conducted on other sections. Only one pass was conducted on Foster Creek due to equipment malfunction.

At the mainstem Warm Springs Creek sections, WCT were the most commonly captured species (Table 5). At the Garrity section WCT were estimated at 32 fish/100 m, RBxWCT at 8 fish/100 m, LL at 7 fish/100 m, BULL at 4 fish/100 m, and RB at 4 fish/100 m. The 2018 LL estimate of 7 fish/100 m is the same as the 2015-2017 average. Brook trout X bull trout hybrids, brook trout, and slimy sculpin were also captured. At the Above Veronica Trail Section, westslope cutthroat trout were estimated at 21 fish/100 m and EB were estimated at 7 fish/100 m. Bull trout, brook trout X bull trout hybrids, slimy sculpin, and one brown trout were also captured. One brown trout was also captured Above Veronica Trail in 2017, which was the first time LL were captured at this section. Twin Lakes Creek was sampled at river mile 1.3. At his section, WCT were estimated at 20 fish/100 m and three BULL, one LL, two RM COT, and three SL COT were also captured (Table 6). Brown trout were first captured in Twin Lakes Creek in 2017 when three LL were found in the RM 1.3 Section. Foster Creek was sampled at river mile 1.0. At this section, WCT were estimated at 51 fish/100 m, BULL at 5 fish/100 m, and RBxWCT at 7 fish/100 m (Table 7). Brook trout, RM COT, and SL COT were also captured. Brown trout have never been captured in Foster Creek during FWP surveys. Barker Creek was sampled at river mile 0.5. Fifteen BULL and 5 WCT were captured in one electrofishing pass in 2018 (Table 8). Additional electrofishing passes were not attempted on Barker Creek because of equipment failure. Brown trout have not been captured in Barker Creek in any FWP surveys.

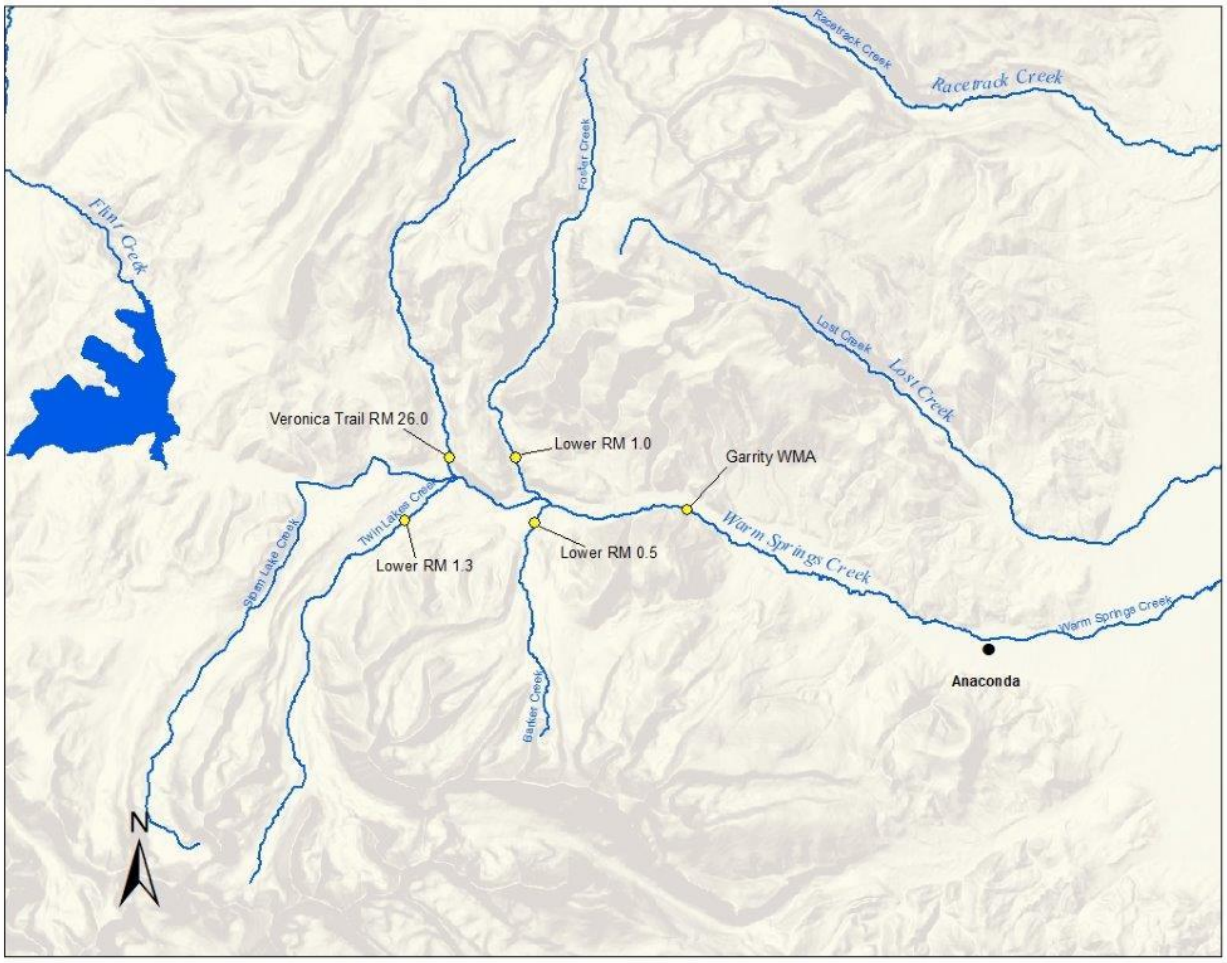


Figure 7. Fish sampling locations in the Warm Springs Creek Watershed.

Table 5. Electrofishing data collected on Warm Springs Creek in 2018. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, LL = Brown Trout, RB = Rainbow Trout, EB = Eastern Brook Trout, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout, EBxBULL= phenotypic hybrid between Eastern Brook Trout and Bull Trout.

| Section | Species | Population Estimate (Fish/100m) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Garrity WMA | WCT | 32(27-40) | 207 | 191 | 44-354 | 57 |
| (Above Meyers | RBxWCT | 8(5-13) | 43 | 197 | 103-435 | 12 |
| Dam) | LL | 7(5-10) | 44 | 216 | 125-345 | 12 |
| | BULL | 4(3-6) | 30 | 208 | 115-295 | 8 |
| | RB | 4(3-8) | 25 | 221 | 111-350 | 7 |
| | EBxBULL | | 3 | 255 | 206-288 | <1 |
| | EB | | 2 | 222 | 166-278 | <1 |
| | SL COT | | 11 | 66 | 40-86 | 3 |
| Above Veronica | WCT | 21(20-22) | 25 | 137 | 56-246 | 49 |
| Trail | BULL | | 8 | 129 | 48-168 | 16 |
| | EB | 7(6-8) | 7 | 132 | 105-175 | 14 |
| | EBxBULL | | 1 | 341 | 341 | 2 |
| | LL | | 1 | 220 | 220 | 2 |
| | SL COT | | 9 | 82 | 34-105 | 18 |

Table 6. Electrofishing data collected on Twin Lakes Creek in 2018. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, LL = Brown Trout, RM COT = Rocky Mountain Sculpin, SL COT = Slimy Sculpin.

| Section | Species | Population Estimate (fish/100m) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Lower | WCT | 20(16-24) | 19 | 154 | 68-287 | 68 |
| RM 1.3 | BULL | | 3 | 147 | 104-215 | 11 |
| | LL | | 1 | 168 | 168 | 4 |
| | RM COT | | 2 | 99 | 11 | 5 |
| | SL COT | | 3 | 78 | 5 | 11 |

Table 7. Electrofishing data collected on Foster Creek in 2018. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, EB = Eastern Brook Trout, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout, RM COT = Rocky Mountain Sculpin, SL COT = Slimy Sculpin.

| Section | Species | Population Estimate (fish/100m) | # Fish handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Lower RM 1.0 | WCT | 51(46-56) | 49 | 159 | 64-310 | 73 |
| | BULL | 5(3-7) | 5 | 153 | 120-205 | 8 |
| | EB | | 3 | 130 | 115-160 | 4 |
| | RBxWCT | 7(4-9) | 7 | 99 | 82-130 | 7 |
| | RM COT | | 1 | 102 | 102 | 1 |
| | SL COT | | 2 | 64 | 44-97 | 3 |

Table 8. Electrofishing data collected on Barker Creek in 2018. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout.

| Section | Species | Population Estimate (fish/100m) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Lower RM 0.5 | BULL | Single pass | 15 | 143 | 53-201 | 75 |
| | WCT | | 5 | 163 | 70-216 | 25 |

*Little Blackfoot River spring creek (Beaver Dam Creek)*

On August 8, 2018 depletion-based population estimates were conducted on three sections of Beaver Dam Creek (Figure 8). The most upstream section was downstream of a large wetland area and irrigation diversion. The middle section was within a corral. The most downstream section was approximately 0.1 miles from the confluence of the Little Blackfoot River. EB, LL, LN SU, MWF, and SL COT were captured in all three sections (Table 9). One additional species, a hybrid between brook trout and brown trout (tiger trout; EBxLL) was captured in the most upstream section. Brown trout were the most common species, comprising 71% of the catch at the upstream section, 52% of the catch at the corral section, and 83% of the catch near the mouth. Brown trout abundance was 141 fish/100 m at the upstream section, 117 fish/100 m at the corral section, and 210 fish/100 m at the section near the mouth. Brown trout captured at the corral section tended to be smaller juvenile fish whereas LL near the mouth were the largest on average.

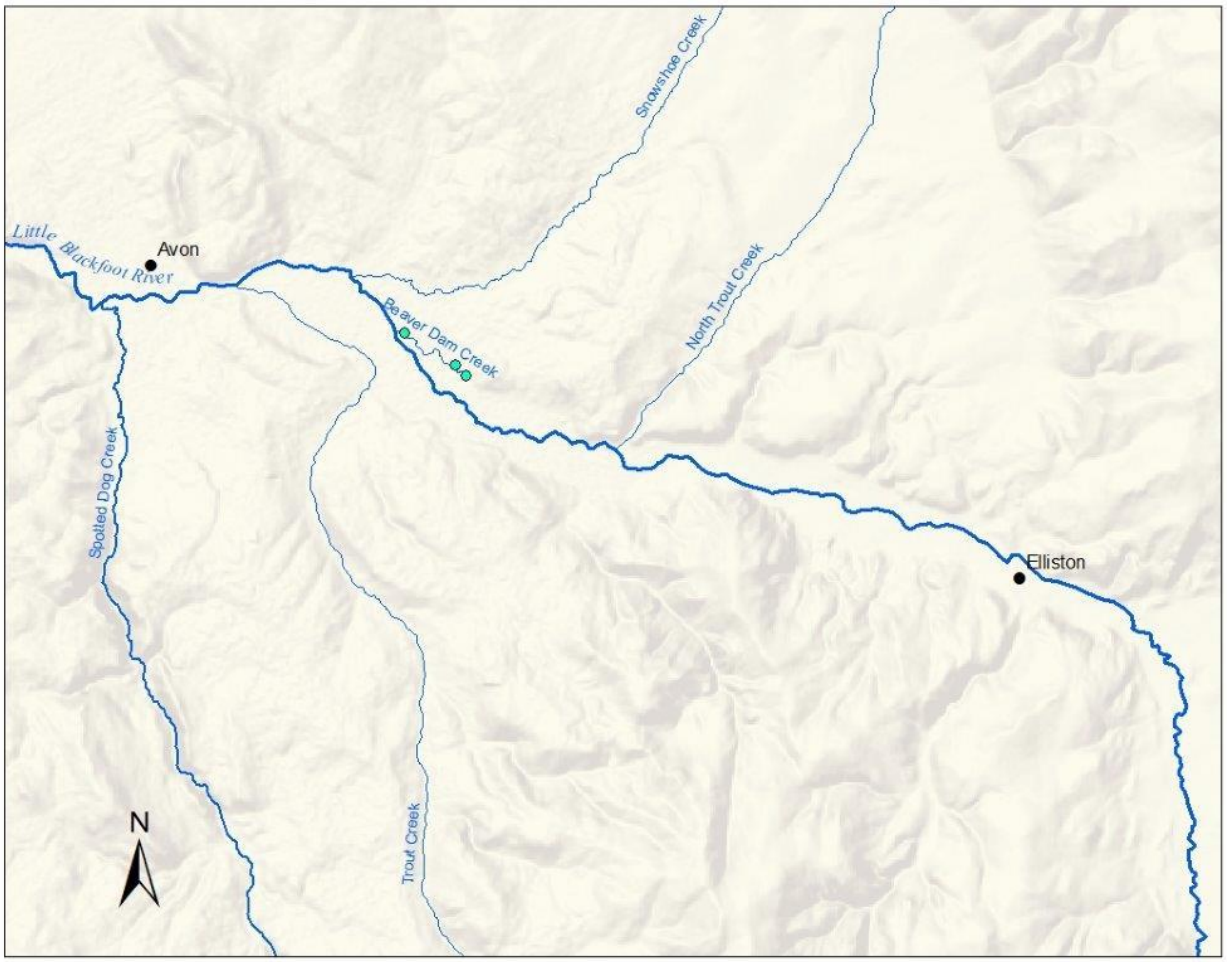

Figure 8. Fish sampling locations on Beaver Dam Creek, tributary to the Little Blackfoot River.

Table 9. Electrofishing data collected on Beaver Dam Creek in 2018. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, LL = Brown Trout, LN SU = Longnose Sucker, MWF = Mountain Whitefish, EB = Eastern Brook Trout, SL COT = Slimy Sculpin.

| Section | Species | Population Estimate (fish/100m) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Near Mouth | EB | | 4 | 206 | 114-254 | 2 |
| | LL | 210(200-220) | 200 | 170 | 75-450 | 83 |
| | LN SU | | 3 | 136 | 125-148 | 1 |
| | MWF | | 22 | 83 | 77-94 | 9 |
| | SL COT | | 13 | 96 | 85-110 | 5 |
| Corrals | EB | | 4 | 94 | 83-104 | 1 |
| | LL | 117(6-227) | 228 | 113 | 67-350 | 52 |
| | LN SU | | 1 | 132 | 132 | <1 |
| | MWF[1] | | 150 | | | 34 |
| | SL COT | | 55 | 64 | 29-105 | 13 |
| Below upper diversion | EB | | 2 | 228 | 189-266 | <1 |
| | EBxLL | | 1 | 188 | 188 | <1 |
| | LL | 141(97-185) | 204 | 148 | 69-313 | 71 |
| | LN SU | | 1 | 56 | 56 | <1 |
| | MWF | | 34 | 73 | 64-83 | 12 |
| | SL COT | | 47 | 75 | 29-105 | 16 |

[1]MWF were not measured in this section due to time constraints.

*Irrigation ditch sampling*

Backpack electrofishing was used to sample fish in irrigation ditches. The ditch sampling sections ranged from 40-200 m long and were sampled in one electrofishing pass to generate measures of catch per unit effort (CPUE, fish per minute of electrofishing; see tables A1-A14 for sampling details). Racetrack Creek ditch sampling was done with multi-pass electrofishing allowing for depletion-based population estimates.

Two ditches that convey water from the mainstem Clark Fork River to the east side of the Deer Lodge Valley were sampled on October 10, 2018. These two ditches were the Valiton East Side Ditch and the Alvi-Beck Ditch. The Valiton Diversion spans the width of the Clark Fork River and is located between the mouth of Racetrack Creek and Sager Lane bridge (Figure 9). Three sections of the Valiton Ditch were sampled, one near the headgate, one near an excavated pool (obviously a constructed swimming hole), and one just downstream of Sager Lane. Species

captured in all three sampled sections of the Valiton Ditch included brown trout, largescale sucker, and redside shiner (Table 10). One rocky mountain sculpin was captured in the section below the headgate. The Alvi-Beck Diversion is located near the confluence of Dry Cottonwood Creek and the Clark Fork River. The upstream end of the Alvi-Beck Ditch is within phases 5/6 of the remediation. Alvi-Beck Ditch was sampled in one section near the headgate. Redside shiner were the most commonly captured species in the Alvi-Beck Ditch. Brown trout (86-227 mm in length) and LS SU were also common (Table 11).

Two ditches off Racetrack Creek were sampled on July 12, 2018. The headgate for the Berg Diversion is approximately 3.2 miles upstream from the mouth of the Clark Fork River. A 100 m section was sampled in the Berg Ditch directly below the headgate. In this ditch, 17 LL and 3 RM COT were captured (Table 12). Brown trout density was estimated at 4 fish/100 m. Most LL at this section were juveniles and > 60 mm in length. The second Racetrack Creek ditch that was sampled was the Carl Johnson Ditch which has its diversion approximately 2.2 miles upstream from the confluence of Racetrack Creek and the Clark Fork River. Brown trout were the only species captured in the Carl Johnson Ditch. Most LL captured were > 60 mm. The estimate of LL > 75 mm was 8 fish/100 m.

Two Cottonwood Creek ditches were sampled on August 8, 2018. Two sections on the McQueary Ditch and one section of the Rock Creek Cattle Ditch was sampled (Figure 10). The McQueary Ditch was sampled above and below where it crossed Baggs Creek. Brook trout were the most common species in both sections of the McQueary Ditch (Table 13). Westslope cutthroat trout and scuplin were also captured in the two sections sampled. Brook and westslope cutthroat trout were also present in the Rock Creek Cattle Ditch, but sculpin were not found.

Five ditches that divert water from Gold Creek were sampled on August 1, 2018 (Figure 11). Westslope cutthroat trout were the most common species in the most upstream ditch (Upper Beck Ditch; Table 14). Brown trout were also found in the Upper Beck Ditch. The Upper Beck Ditch is 2.3-2.5 miles upstream of the other diversions sampled. The points of diversion of the other four ditches are within a quarter mile of each other. Brown trout were the most commonly captured species in all of the lower ditches. Most of LL captured in the lower ditches were juveniles (< 100 mm). Westslope cutthroat trout and slimy sculpin were also captured in the lower four ditches.

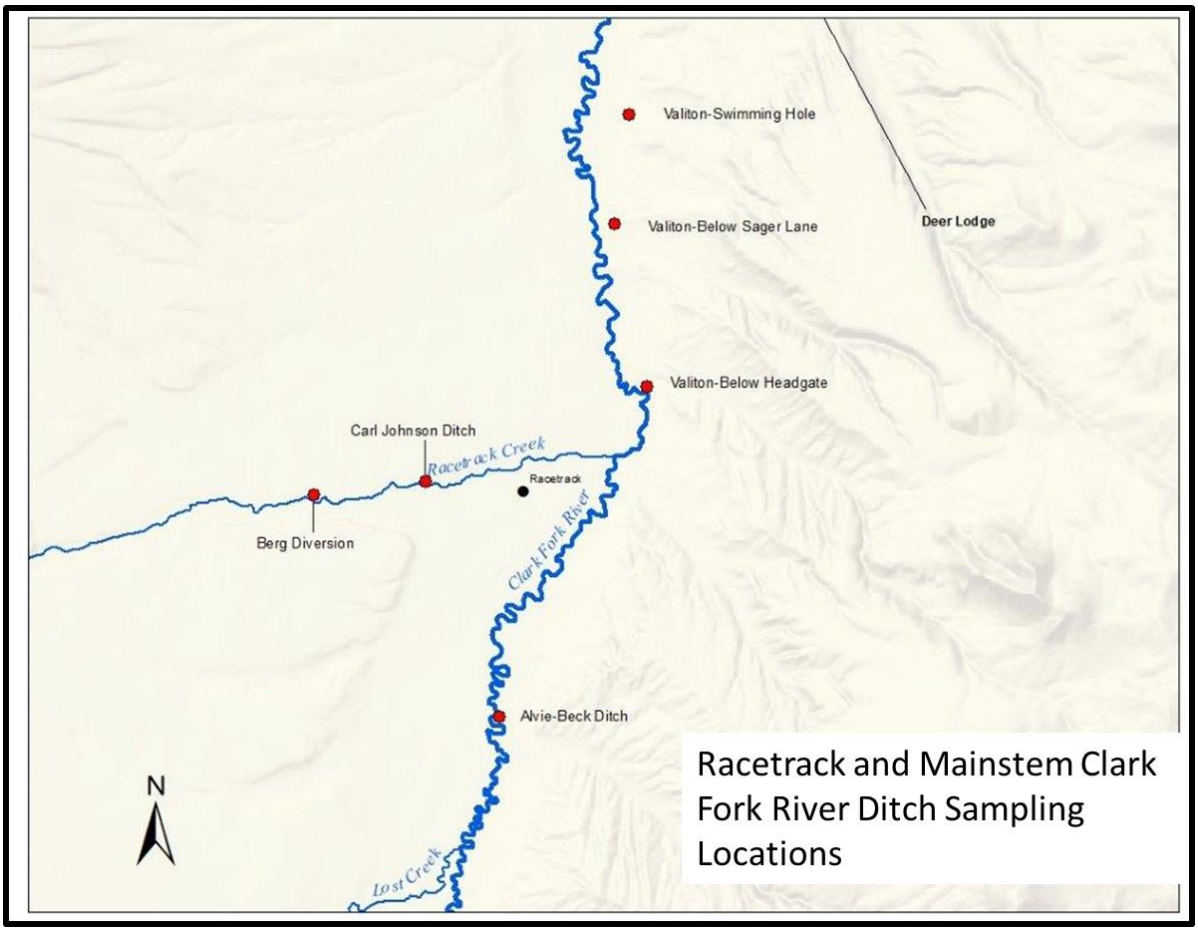


Figure 9. Fish sampling locations on irrigation ditches off Racetrack Creek and the mainstem Clark Fork River.

Table 10. Electrofishing data collected on Valiton East Side Ditch of the Clark Fork River upstream of Deer Lodge in 2018. CPUE of fish/minute are for fish greater than 75 mm (~ 3") in total length. Species abbreviations: RM COT = Rocky Mountain Sculpin, LN SU = Longnose Sucker, LS SU = Large Scale Sucker, RS SH = Redside Shiner, LL = Brown Trout.

| Section | Species | CPUE (fish/min) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Below Headgate | LL | 1.4 | 19 | 122 | 91-214 | 43 |
| | LS SU | 0.11 | 15 | 59 | 36-123 | 34 |
| | RM COT | 0.07 | 1 | 54 | 54 | 2 |
| | RS SH | 0.66 | 9 | 65 | 53-96 | 21 |
| Swimming hole area | LL | 0.13 | 2 | 125 | 106-143 | 14 |
| | LN SU | 0.06 | 1 | 298 | 298 | 7 |
| | LS SU | 0.50 | 8 | 108 | 65-180 | 57 |
| | RS SH | 0.19 | 3 | 65 | 62-68 | 21 |
| Below Sager Lane | LL | 0.01 | 1 | 91 | 91 | 8 |
| | LS SU | 0.50 | 4 | 41 | 36-50 | 31 |
| | RS SH | 1.00 | 8 | 71 | 57-86 | 61 |

Table 11. Electrofishing data collected on the Alvie-Beck Ditch of the Clark Fork River upstream of Deer Lodge in 2018. CPUE of fish/minute are for fish greater than 75 mm (~ 3") in total length. Species abbreviations: RM COT = Rocky Mountain Sculpin, LN SU = Longnose Sucker, LS SU = Large Scale Sucker, RS SH = Redside Shiner, LL = Brown Trout.

| Section | Species | CPUE (fish/min) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Below Headgate | LL | 1.8 | 28 | 124 | 86-227 | 26 |
| | LS SU | 1.8 | 28 | 85 | 35-140 | 26 |
| | MWF | 0.26 | 4 | 123 | 106-129 | 4 |
| | RM COT | 0.77 | 12 | 68 | 51-112 | 11 |
| | RS SH | 2.3 | 36 | 69 | 54-90 | 33 |

Table 12. Electrofishing data collected on ditches of Racetrack Creek in 2018. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: RM COT = Rocky Mountain Sculpin, LL = Brown Trout.

| Section | Species | Population Estimate (fish/100m) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Berg Diversion | LL | 4(3-5) | 17 | 64 | 35-161 | 85 |
| | RM COT | | 3 | 102 | 95-110 | 15 |
| Carl Johnson Ditch | LL | 8(6-60) | 32 | 69 | 32-164 | 100 |

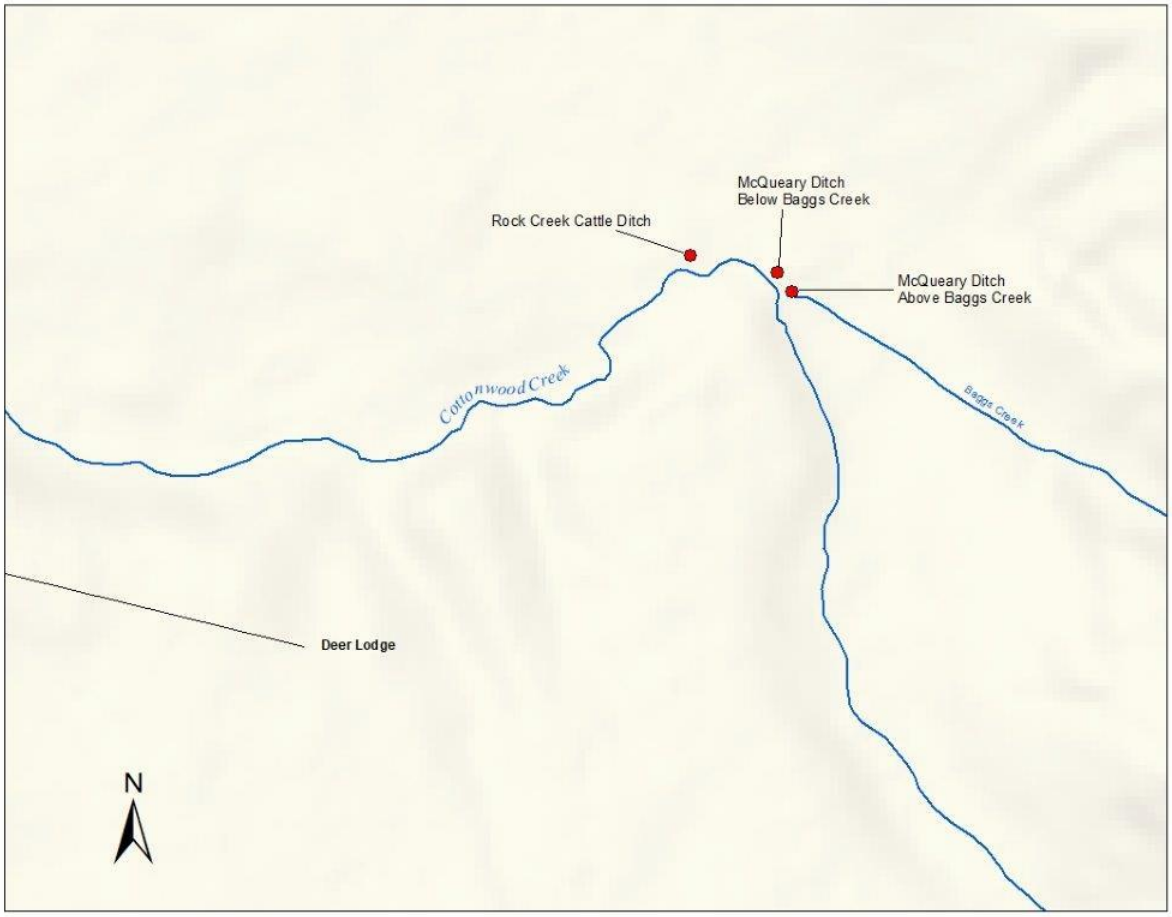


Figure 10. Map of ditch sampling locations near Cottonwood Creek.

Table 13. Electrofishing data collected on ditches of Cottonwood Creek in 2018. CPUE of fish/minute are for fish greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, RM COT = Rocky Mountain Sculpin, COT = Unidentified Sculpin, SL COT = Slimy Sculpin, LL = Brown Trout, EB = Eastern Brook Trout.

| Section | Species | CPUE (fish/min) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| McQueary | EB | 1.5 | 99 | 114 | 50-212 | 77 |
| Ditch above | SL COT | 0.23 | 27 | 66 | 45-89 | 21 |
| Baggs Creek | WCT | 0.1 | 3 | 159 | 115-185 | 2 |
| | | | | | | |
| McQueary | COT | 0.06 | 16 | 57 | 46-75 | 11 |
| Ditch below | EB | 4.3 | 123 | 158 | 59-290 | 81 |
| Baggs Creek | RM COT | 0.13 | 2 | 93 | 92-94 | 1 |
| | SL COT | 0.27 | 7 | 78 | 72-86 | 5 |
| | WCT | 0.2 | 3 | 144 | 90-234 | 2 |
| | | | | | | |
| Rock Creek | EB | 0.9 | 83 | 91 | 50-189 | 83 |
| Cattle Ditch | WCT | 0.5 | 17 | 112 | 88-187 | 17 |

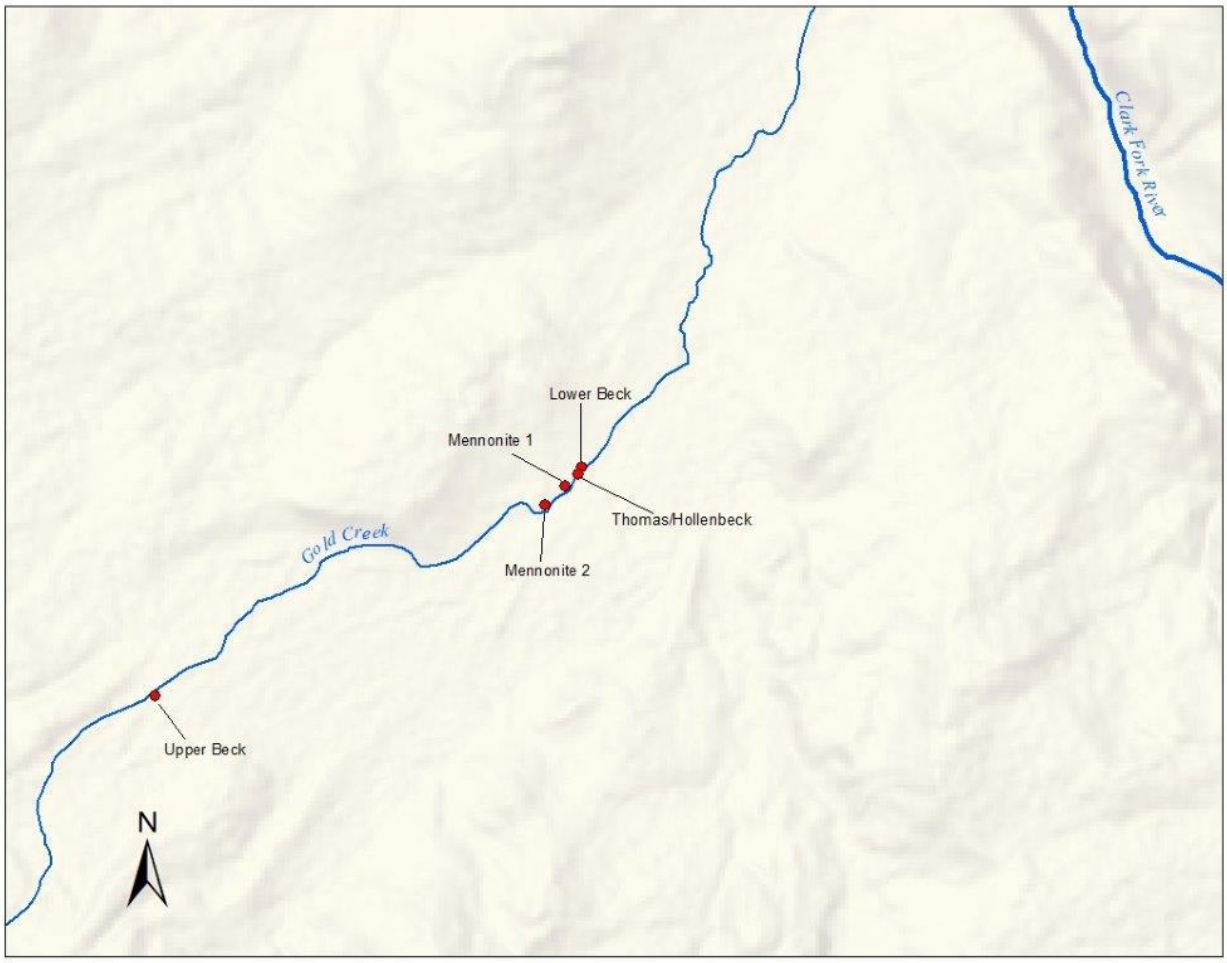


Figure 11. Map of ditch sampling locations near Gold Creek.

Table 14. Electrofishing data collected on ditches of Gold Creek in 2018. CPUE of fish/minute are for fish greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, SL COT = Slimy Sculpin, LL = Brown Trout.

| Section | Species | CPUE (fish/min) | # Fish Handled | Mean Length (mm) | Length Range (mm) | Species Composition (%) |
|---|---|---|---|---|---|---|
| Lower Beck Ditch | LL | 1.46 | 31 | 67 | 41-127 | 80 |
| | SL COT | 0.19 | 4 | 89 | 83-96 | 10 |
| | WCT | 0.19 | 4 | 99 | 85-115 | 10 |
| Thomas/Hollenbeck Ditch | LL | 1.95 | 30 | 93 | 38-165 | 75 |
| | SL COT | 0.52 | 8 | 72 | 45-95 | 20 |
| | WCT | 0.13 | 2 | 141 | 94-187 | 5 |
| Mennonite 1 Ditch | LL | 1.70 | 30 | 98 | 40-125 | 77 |
| | SL COT | 0.11 | 2 | 78 | 60-95 | 5 |
| | WCT | 0.40 | 7 | 97 | 83-112 | 18 |
| Mennonite 2 Ditch | LL | 3.72 | 62 | 65 | 39-136 | 71 |
| | SL COT | 0.60 | 10 | 58 | 43-90 | 12 |
| | WCT | 0.90 | 15 | 94 | 73-168 | 17 |
| Upper Beck Ditch | LL | 0.56 | 11 | 148 | 93-301 | 27 |
| | WCT | 1.54 | 30 | 128 | 63-239 | 73 |

## Discussion

Brown trout abundance in 2018 at the pH Shack Section was at or near a historic low. Population estimates decreased significantly at this section after 2014 and in 2018 were about one quarter of the 11-year average. The Below Sager Lane Section and the pH Shack-Perkins Lane Section also had lower brown trout abundances in 2018 compared to recent years. These three sections are in the most upstream reaches of the Clark Fork River. In contrast, brown trout estimates at sections downstream of Deer Lodge were near section averages, or in the case of the Bearmouth Section, above average. Brown trout in the UCFR are not fully vulnerable to capture by boat electrofishing until they reach age 3 and age 3 fish typically comprise the bulk of the population estimates (Cook et al. 2015). The number of age 3 fish captured during electrofishing (an index of recruitment) at the pH shack Section is strongly related to flow conditions three years prior (Figure 12). Prolonged drought conditions, characterized by low mid-summer flows

and high water temperatures, have had deleterious effects on the brown trout population in the upper sections of the UCFR. It is hopeful that higher than average late season flows in 2018 increased brown trout survival and will lead to increased recruitment in the next few years. The reason for above average abundance at Bearmouth is not fully known, but it could be that some brown trout from more upstream sections of the river moved downstream to Bearmouth. It also appears that RB abundance has been increasing in the Bearmouth Section in recent years. The rainbow trout population has increased in the lower reaches of Rock Creek (Brad Liermann FWP, personal communication), so RB emigration from Rock Creek to portions of the Clark Fork River may have also increased.

Fish sampling in the Grant Kohrs Section suggests that trout numbers are within a range that is typical for the surrounding area of the Clark Fork River. The brown trout estimate for Grant Kohrs was between the spring estimates for Sager Lane (108 fish/km) and Williams-Tavenner (187 fish/km). These sections are upstream (Sager Lane) and downstream (Williams-Tavenner) of Grant Kohrs. The similarity of the spring and fall estimates at Sager Lane suggest that brown trout numbers did not change significantly between seasons in 2018. The 2018 estimate for Grant Kohrs provides a baseline that can be used to compare future estimates as the cleanup activities in phases 15 and 16 progress. The estimate for this section (144 fish/km) is not particularly high, but FWP did receive several reports of exceptional fishing through this area in 2018.

The Fairmont and Below German Gulch sections support the highest densities of WCT in Silver Bow Creek during the summer. During fall sampling, WCT are present in the Ramsay Section in numbers similar to Below German Gulch and Fairmont. Naughton (2013) found that WCT in Silver Bow Creek dispersed in the fall from the area around German Gulch into other areas. This dispersal is facilitated by lower water temperatures and increases in dissolved oxygen in the fall months. It appears that the distribution of the Silver Bow Creek WCT population is centered around German Gulch and expands upstream to Ramsay during the cooler months. Individual WCT are occasionally caught in other Silver Bow Sections (i.e., Highway 1, Rocker, and LAO), but WCT have yet to establish a true population in these areas. Westslope cutthroat have also been captured in another Silver Bow Creek sampline section. This section, not sampled in 2018, is located near Father Sheehan Park in the city of Butte. WCT from the Father Sheehan section are thought to be from Blacktail Creek, which is another potential source of WCT recruitment for Silver Bow Creek (Jason Lindstrom, personal communication).

In the upper Warm Springs Creek watershed, brown trout were again found in the same locations in 2018 where they were found in 2017. These data indicate that brown trout have expanded upstream of their previously known distribution. At this point, just a few individuals have been captured in these new locations, so it is unclear whether these fish are pioneering new habitat, or if these fish were spawned in areas previously unoccupied by brown trout. There is no evidence that the brown trout population at the Garrity Section has increased. The 2018 population estimate for that section was the same as the 2015-2017 average. In other areas of Montana, brown trout distributions have expanded into bull trout habitats as water temperatures

have increased (e.g., Al-Chokhachy et al. 2016). Warmer water temperatures also cause a contraction of the size of bull trout habitats. The distribution and abundance of brown trout above Meyers Dam should be monitored. However, if brown trout are expanding due to climate warming, there may be few options to slow down this spread. Restoration actions that decrease water temperatures would hold the most promise for maintaining bull trout habitat and slowing the spread of brown trout.

Fish sampling on Beaver Dam Creek, a short spring creek tributary to the Little Blackfoot River, revealed significant numbers of brown trout and native species such as mountain whitefish and sculpin. This creek is probably a source of brown trout recruitment to the Little Blackfoot River and is a potential source of cool clean water. There are opportunities for riparian enhancement on this stream, particularly in the middle reaches around the corrals. This part of the stream is overwide and shallow, characteristics that contribute to warmer water temperatures and provide little habitat for adult trout.

Electrofishing surveys of irrigation canals off of the mainstem Clark Fork River revealed that both the Valiton and Alvi-Beck ditches entrain brown trout, suckers, sculpin, and other fishes. Juvenile and adult/catchable brown trout were found in these ditches. Fish screens on these diversions would reduce or eliminate entrainment in these systems. Brown trout, primarily juveniles, were also found in ditches that divert water from Racetrack Creek. Racetrack Creek was found to be an important location of brown trout spawning (Mayfield 2013) and recruitment (Cook et al. 2017) for the UCFR population. Surveys of Cottonwood Creek ditches revealed entrainment of trout (westslope cutthroat trout and brook trout) and sculpins. Cottonwood and Baggs creeks are known spawning locations for Clark Fork River westslope cutthroat trout. Gold Creek ditches sampled in 2018 contained numerous WCT and LL. The most upstream ditch contained the largest fish and the most WCT of all Gold Creek ditches sampled. The four downstream ditches have points of diversion that are within a quarter mile of each other. All of these diversions would need to be screened to ensure fish bypassed at an upstream screen are not entrained in an unscreened diversion downstream. Furthermore, Gold Creek is effectively dewatered downstream of the lowest diversion due to irrigation withdrawal and natural infiltration during the summer and early fall. Enhancement of summer flows in the dewatered reaches of Gold Creek would enhance the potential for fish movements between upper and lower Gold Creek and the Clark Fork River.

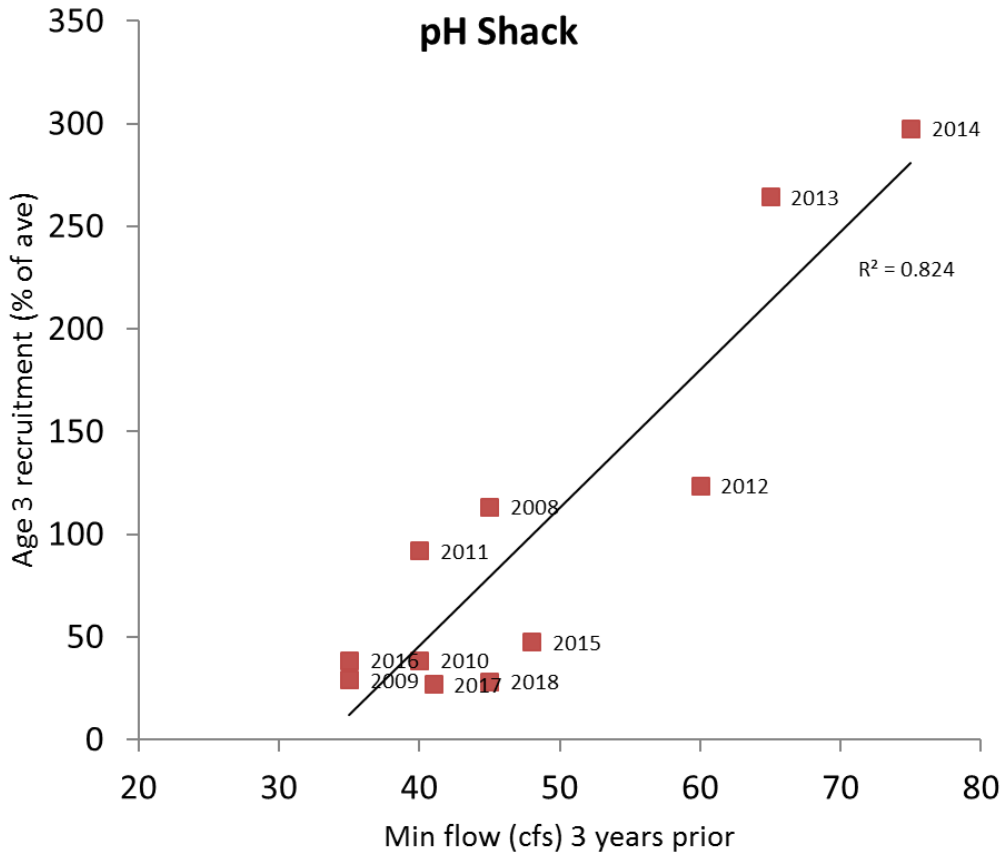


Figure 12. Linear regression of recruitment of age 3 brown trout recruitment versus minimum flow (as measured at the Clark Fork River at Galen USGS gauge) three years prior to sampling. Recruitment was calculated as the number of age three fish captured during population estimates, standardized to the average number from 2008-2018. Data labels are the year fish were sampled.

**References**


Al-Chokhachy, R., D. Schmetterling, C. Clancy, P. Saffel, R. Kovach, L. Nyce, B. Liermann, W. Fredenberg, and R. Pierce. 2016. Are brown trout replacing or displacing bull trout populations in a changing climate? Canadian Journal of Fisheries and Aquatic Sciences 73:1395-1404.

Cook, N. A., P. Saffel, B. Liermann, J. Lindstrom, and T. Selch. 2015. Upper Clark Fork River Fisheries Monitoring Study: 2015 Annual Report. Montana Fish Wildlife and Parks, Helena, Montana.

Cook, N. A., T. Elam, B. Liermann, J. Lindstrom, and P. Saffel. 2017. Fisheries Monitoring in the Upper Clark Fork River Basin: 2017 Report. Montana Fish Wildlife and Parks, Helena, Montana.

Geum Environmental. 2015. Upper Clark Fork River Basin Aquatic Resources Restoration Plan Monitoring and Maintenance Plan. Prepared for the Natural Resource Damage Program, Montana Department of Justice, Helena, Montana.

Mayfield, M.P. 2013. Limiting factors for trout populations in the upper Clark Fork River Superfund site, Montana. M.S. Thesis, Montana State University, Bozeman, Montana. Available: http://etd.lib.montana.edu/etd/view/item/1883.

Naughton, J.P. 2013. Salmonid response to superfund remediation in Silver Bow Creek, Montana. M.S. Thesis, Montana State University, Bozeman, Montana.

Saffel, P., N. Cook, B. Liermann, J. Lindstrom, L. Knotek, D. Martin, and B. Downing. 2018. Prioritization of Areas in the Upper Clark Fork River Basin for Fishery Enhancement. Montana Fish, Wildlife and Parks, Missoula, MT and Natural Resource Damage Program, Helena, MT.

Zippin, C. 1958. The removal method of population estimation. Journal of Wildlife Management 22: 82-90.

## Appendix. Fish sampling section locations and types.

Table A1. Locations for monitoring sections on Barker Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Lower RM 0.5 | 100 m | Depletion | 46.15737 | -113.12189 |

Table A2. Locations for monitoring sections on Boulder Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| RM 6.5 Princeton Bridge | 120 m | Depletion | 46.41325 | -113.16090 |

Table A3. Locations for monitoring sections on Foster Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Lower RM 1.0 | 100 m | Depletion | 46.17497 | -113.13055 |

Table A4. Locations for monitoring sections on Silver Bow Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Hwy 1 Bridge | 325 m | Depletion | 46.09515 | -112.80497 |
| Fairmont | 338 m | Depletion | 46.04733 | -112.79514 |
| Below German Gulch | 388 m | Depletion | 46.02852 | -112.79500 |
| Ramsay | 365 m | Depletion | 46.00009 | -112.68518 |
| Rocker | 250 m | Depletion | 46.00108 | -112.59348 |
| LAO | 237 m | Depletion | 45.99606 | -112.56037 |

Table A5. Locations for monitoring sections on Twin Lakes Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Lower RM 1.3 | 96 m | Depletion | 46.15655 | -113.17270 |

Table A6. Locations for long term monitoring sections on the Upper Clark Fork River.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| PH Shack | 2.57 Km | Mark/Recapture | 46.19658 | -112.76772 |
| Bottom of PH Shack to Perkins Lane | 2.41 Km | Mark/Recapture | 46.20856 | -112.76762 |
| Below Sager Lane | 5.15 Km | Mark/Recapture | 46.35108 | -112.74109 |
| Williams Tavenner | 4.02 Km | Mark/Recapture | 46.48631 | -112.72647 |
| Phosphate | 3.38 Km | Mark/Recapture | 46.57443 | -112.89466 |
| Morse Ranch | 12.3 Km | Mark/Recapture | 46.65427 | -113.14620 |
| Bearmouth | 10.6 Km | Mark/Recapture | 46.69818 | -113.41624 |

Table A7. Locations for monitoring sections on Warm Springs Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Garrity WMA | 970 m | Mark/Recapture | 46.1627 | -113.06291 |
| Veronica Trail RM 26.0 | 100 m | Depletion | 46.17413 | -113.15636 |

Table A8. Locations for monitoring sections on Beaver Dam Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Near Mouth | 100 m | Depletion | 46.59088 | -112.54892 |
| Corrals | 100 m | Depletion | 46.58709 | -112.53894 |
| Below upper diversion | 100 m | Depletion | 46.58566 | -112.53698 |

Table A9. Locations for monitoring sections of ditches of Cottonwood Creek 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Rock Creek Cattle Ditch | 100 m | Single pass | 46.39983 | -112.64392 |
| McQueary Ditch Below Baggs Creek | 41 m | Single pass | 46.39936 | -112.63961 |
| McQueary Ditch Above Baggs Creek | 100 m | Single pass | 46.39874 | -112.63883 |

Table A10. Locations for monitoring sections on Valiton Ditch of UCFR in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Below Headgate | 100 m | Single pass | 46.29493 | -112.72375 |
| Swimming Hole area | 200 m | Single pass | 46.33434 | -112.72991 |
| Below Sager Lane | 100 m | Single pass | 46.3184 | -112.73185 |

Table A11. Locations for monitoring sections on Alvie-Beck Ditch of UCFR in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Below Headgate | 100 m | Single pass | 46.24585 | -112.75172 |

Table A12. Locations for monitoring sections on UCFR outside of long term monitoring sites 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Grant Kohrs | 4.18 Km | Mark/Recapture | 46.42401 | -112.74286 |
| Below Sager Lane | 5.15 Km | Mark/Recapture | 46.35108 | -112.74109 |

Table A13 . Locations for monitoring sections on ditches of Racetrack Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Berg Diversion Ditch | 100 m | Depletion | 46.27713 | -112.79255 |
| Carl Johnson Ditch | 100 m | Depletion | 46.27967 | -112.7692 |

Table A14. Locations for monitoring sections on ditches of Gold Creek in 2018.

| Section Name | Section Length | Estimate Type | Downstream Lat | Downstream Long |
|---|---|---|---|---|
| Lower Beck Ditch | 100 m | Single Pass | 46.54231 | -112.93884 |
| Thomas/Hollenbeck Ditch | 100 m | Single Pass | 46.54189 | -112.93915 |
| Mennonite 1 Ditch | 100 m | Single Pass | 46.54105 | -112.94033 |
| Mennonite 2 Ditch | 100 m | Single Pass | 46.53974 | -112.94212 |
| Upper Beck Ditch | 100 m | Single Pass | 46.52624 | -112.97804 |