

Fisheries Monitoring in the Upper Clark Fork River Basin 2021 Report



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Abbreviations for fish species present in the Upper Clark Fork River.

Species	Species abbreviation
Brook Trout	EB
Brook Trout X Bull Trout Hybrid	EBxBULL
Brown Trout	LL
Brook Trout X Brown Trout Hybrid	EBxLL
Bull Trout	BULL
Central Mud Minnow	CM MN
Kokanee	KOK
Lake Trout	LT
Largemouth Bass	LMB
Largescale Sucker	LS SU
Longnose Sucker	LN SU
Longnose Dace	LN DC
Mountain Whitefish	MWF
Northern Pike Minnow	N PMN
Rainbow Trout	RB
Rainbow Trout X Westslope Cutthroat Trout	RBxWCT
Redside Shiner	RS SH
Rocky Mountain Sculpin	RM COT
Sculpin (unidentified)	COT
Slimy Scuplin	SL COT
Westslope Cutthroat Trout	WCT
Yellow Perch	YP

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 underway, 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 actions have been dramatic in Silver Bow Creek, where 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 may continue to change in response to improvements in water quality, maturation of riparian vegetation, natural changes in river morphology, tributary restoration projects, flow enhancements, 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).

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 as early as 2002 when the first suckers and sculpin were detected at the Rocker section. Silver Bow Creek surveys initially consisted of one-pass electrofishing conducted in the fall. In 2014, more sections were added, and sampling occurred in both 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 were conducted in summer and fall at six sections. The summer sampling is conducted during low flows and high-water temperatures. Low dissolved oxygen has been documented in the past during the summer and hypoxic areas of Silver 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. Larger streams (Warm Springs Creek, Little Blackfoot River, and Flint Creek) are now sampled semi-annually, while smaller tributaries are sampled periodically.

As restoration projects have been completed in the tributaries, there has been increased opportunities to evaluate these projects and their fisheries benefits. However, due to the sheer number of restoration projects in the UCFRB, not all projects can be specifically monitored. This limitation requires the careful prioritization of project-level monitoring effort. To date, project monitoring has focused on getting pre- and post- project fisheries data on large projects (i.e., the Allendale Canal), gathering data on different restoration approaches, or evaluating the potential for projects to provide benefits to fish. In this report, we describe project level monitoring in Basin Creek, Mill Creek, Spotted Dog Creek, and at the Allendale Canal fish screen project.

Clark Fork River Mainstem

Population surveys

Trout population estimates are conducted in spring 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, PH Shack to Perkins Lane, and PH Shack (Figure 1). In addition to the annual sampling sections, we were scheduled to complete population estimates for the entire river from Warm Springs to Rock Creek in 2020. Due to the pandemic, this “all river” sampling was not completed. Instead, we chose to conduct targeted sampling in three sections of reach A in areas of recent or upcoming remediation. The Perkins to Galen section was added in 2019 to provide additional baseline trout population in phases 3 and 4, which will be remediated in in the next few years. Perkins to Galen is also the section where a fish kill was documented in fall of 2019 (Cook and Elam 2019). The Galen to Racetrack section was added in 2019 to provide additional post-remediation data in phases 5 and 6. The Grant-Kohrs section was added in 2018 to provide data on the response of the trout fishery to current remedial activities. Perkins to Galen and Galen to Racetrack were sampled in the spring and Grant Kohrs was sampled in the fall.

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 recaptured (B. Liermann, Montana, Fish, Wildlife, and Parks, personal communication, 2014).

Annual Sections

The brown trout estimate at the PH Shack section in 2021 was 112 fish/km (Figure 2). The 2021 estimate was well below the 14-year average for this section of 359 fish/km. The highest estimate during the last 14 years at PH Shack occurred in 2013 when the brown trout population was at 1,167 fish/km. The brown trout population at PH Shack declined by 85% from 2013 to 2015 and has remained under 200 fish/km since 2017. At the PH-Shack-to-Perkins Lane section, the 2021 brown trout estimate was 97 fish/km, which was a significant increase from 8 fish/km in 2019 and up from 83 fish/km in 2020. At the below Sager Lane section, the 2021 estimate was 84 fish/km, which is double the estimate from 2020. At the Williams-Tavener section, the 2021 brown trout estimate was 108 fish/km, the lowest estimate since 2009, and significantly lower than the long term average of 192 fish/km at this section. Estimates were also able to be generated for westslope cutthroat trout in 2020 with 4 fish/km, and in 2021 with 11 fish/km. Brown trout numbers at Phosphate were 134 fish/km in 2021, which is lower than in 2020 and below the section average of 207 fish/km. An estimate for westslope cutthroat was also possible in 2021. The 21 fish/km estimate is the first valid estimate for westslope in the Phosphate section dating back to 2008. The 2021 brown trout estimate at the Morse Ranch section was 63 fish/km, which was significantly below the 2009-2020 average of 84 brown trout/km. The 2021 combined *Oncorhynchus* (WCT, RB, and hybrids) estimate at Morse Ranch was 9 fish/km, which is within the historical range of *Oncorhynchus* estimates for this section. At the Bearmouth section, the 2021 brown trout estimate was 23 fish/km, which is below the average estimate of 31 fish/km. The 2021 *Oncorhynchus* estimate at Bearmouth was 40 fish/km, almost double the long-term average of 24 fish/km.

Targeted Sampling

The Perkins to Galen section was sampled again in 2021 to continue to monitor this area in which the fish kill occurred in 2019 and where erosion control measures were installed on some sickens to help avoid future fish kills. There is also a need to continue monitoring this section to assess the remediation that began in 2021. The 2021 brown trout estimate for this section was 50 fish/km, which is about double the estimate from 2020, but below estimates done in 2009 and 2015 (Figure 3).

Remediation in the Galen to Racetrack section was completed in 2016. The 2021 population estimate for this section was 41 fish/km which is down slightly from 63 fish/km in 2020. Low sampling efficiency and low numbers of recaptured fish continue to complicate statistical comparisons to past estimates at this section, but brown trout numbers do appear down since 2015 (Figure 3).

The section in the Grant Kohrs Ranch was sampled in 2018 prior to remediation and 2020 during the late stages of remediation. The 2018 estimate was 154 fish/km and the 2020 estimate was

402 fish/km (Figure 3). The 2020 estimate should be interpreted with caution due to low capture efficiency and recapture rate. As a result of low sampling efficiency, the 95% confidence interval for the 2020 estimate at Grant Kohrs is 166-638 fish/km. For 2021, extra mark and recapture events were used to improve capture efficiency and recapture rate. The estimate for brown trout in 2021 was 67 fish/km with a 95% confidence interval of 48-97 fish/km. It should be noted that the 2018 and 2020 estimates were done in the fall while the 2021 estimate was done in the spring.

Discussion

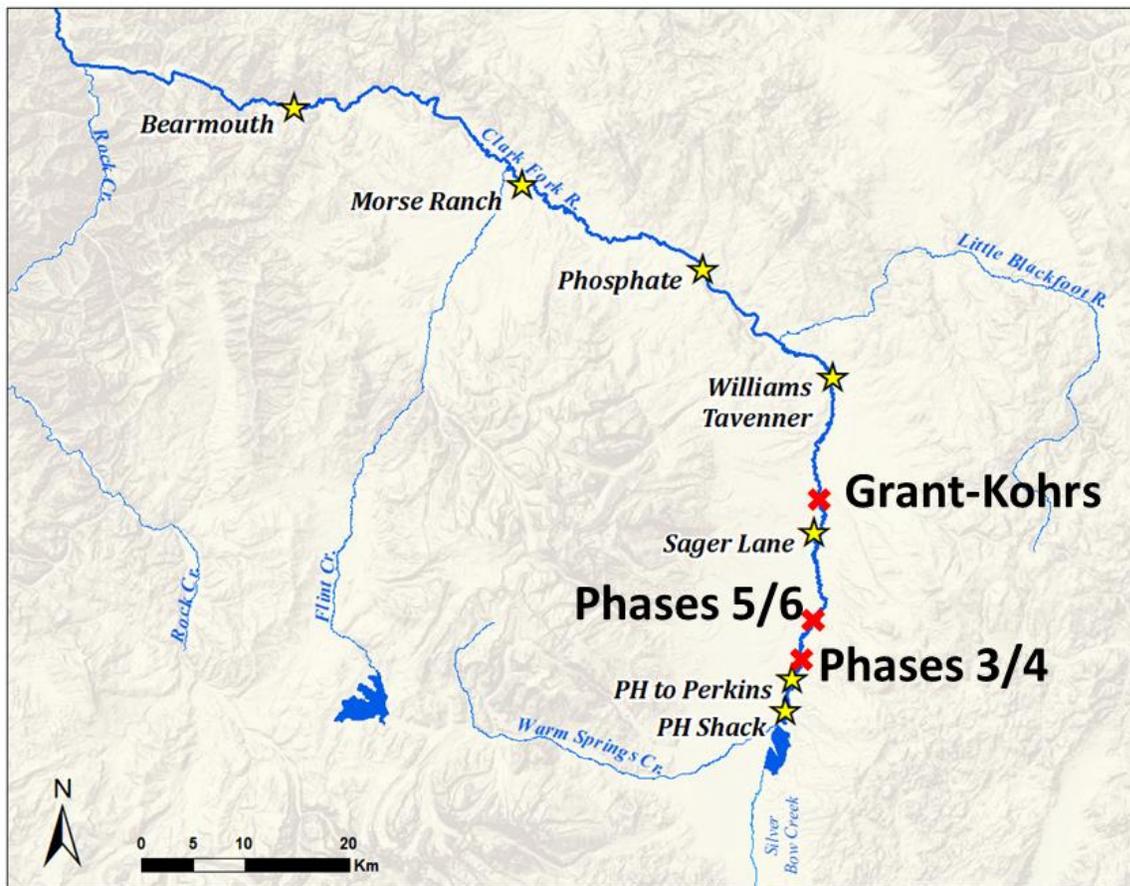
The brown trout population in the upper reaches of the Clark Fork River are near historic lows. The decline in brown trout numbers is particularly pronounced in sampling reaches upstream of Deer Lodge. It was noted in 2020 that estimates were closer to long term averages in lower reach B and reach C compared to reach A. But in 2021 estimates at Williams-Tavener, Phosphate, and Morse Ranch were also below average. The cause for the population crash is not fully understood. Based on an otolith microchemistry study (Cook et al. 2017), the brown trout population upstream of Deer Lodge is heavily dependent on recruitment of fish that were spawned and reared in the mainstem Clark Fork River. Historically, variations in the brown trout population in the upper reaches of the Clark Fork River were tied to flows. Prior to the last few years, the number of age 3 fish captured during electrofishing (an index of recruitment) at the PH Shack Section was strongly related to flow conditions three years prior (Figure 5). Minimum flow during the brown trout's first year of life apparently had a significant effect on their survival. From 2002 to 2017, recruitment of age 3 brown trout could be predicted based on previous flow conditions with high precision ($r^2=0.85$). However, since 2018 previous flow conditions are no longer a strong predictor of brown trout numbers in the UCFR.

Several recent developments could be impacting trout numbers in the upper reaches of the Clark Fork River. Reaches of the river above Deer Lodge have extensive slickens and the erosion of these slickens into the river has accelerated in recent years (MTFWP and Clark Fork Coalition 2020). The increased input of metal-laden slicken material into the river is likely deleterious effects on the population. The documented fish kill in 2019 confirmed the lethality of slicken material, not only to trout, but also to mountain whitefish and suckers. Erosion control measures that were installed in 2020 should help to buy time until mine tailings can be removed from the floodplain and banks. However, eroding slickens exist outside of phases 3 and 4 and remediation will not reach some of them for years. High risk slickens should continue to be monitored and mitigation measures should be considered to buy time until cleanup is completed.

Another recent development in the Clark Fork River above Deer Lodge is the remediation itself. Along with removing tailings material, remediation also removes most of the overhanging

vegetation and undercut banks. Overhanging vegetation and undercut banks provide cover for brown trout and other fish species. These habitat features will eventually reform after remediation, but it is possible that this habitat simplification is contributing to the decline in trout numbers in the UCFR. FWP has started doing more targeted sampling to understand changes in trout numbers in remediated and unremediated parts of the river. Our data show that declines in brown trout numbers have occurred in both remediated and unremediated reaches of the river. Compared to previous estimates, the 2021 estimates were lower than average at all but the PH to Perkins and Bearmouth sections. While habitat simplification will have an effect on fish, particularly at a local scale, it is apparent that other factors have contributed to a more widespread decline.

It is also possible that disease, a warming climate, or a combination of factors could be responsible for the decline in trout numbers in the upper Clark Fork River. Brown trout declines have also recently been reported on the Big Hole, Beaverhead, Ruby, Jefferson, and Madison rivers. FWP does not currently understand why brown trout declines are occurring at a regional, or even state-wide scale, but has formed a working group to look into factors such as drought, disease, angling pressure, high temperatures and other culprits. Whatever factors effecting other Montana brown trout fisheries, some challenges such as acute metal contamination and remedial habitat simplification are unique to the UCFR.



Map 1. Map of sections of the Upper Clark Fork River sampled in 2020. Established annual sections are denoted by the yellow stars and sections targeting remediation by the red Xs. The Perkins to Galen section is within phases 3/4, the Galen to Racetrack section is within 5/6, and the Grant Kohrs Ranch is within 15/16.

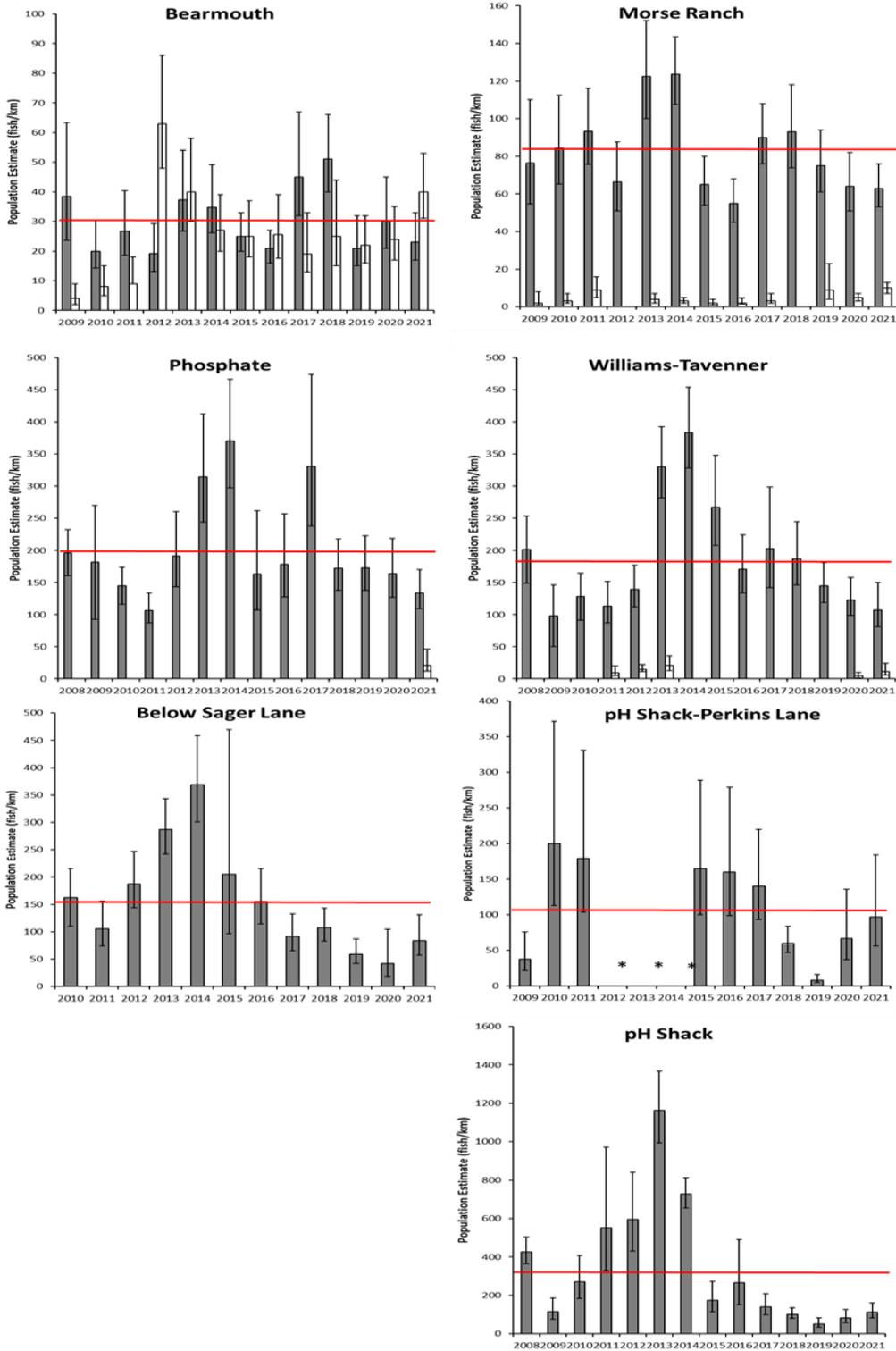


Figure 1. Clark Fork River brown trout (grey bars) and *Oncorhynchus sp.* (white bars) population estimates from 2008-2020 by sample section. Please note that axis values are not the same for every sample reach. The red line depicts the average brown trout population estimate for the section.

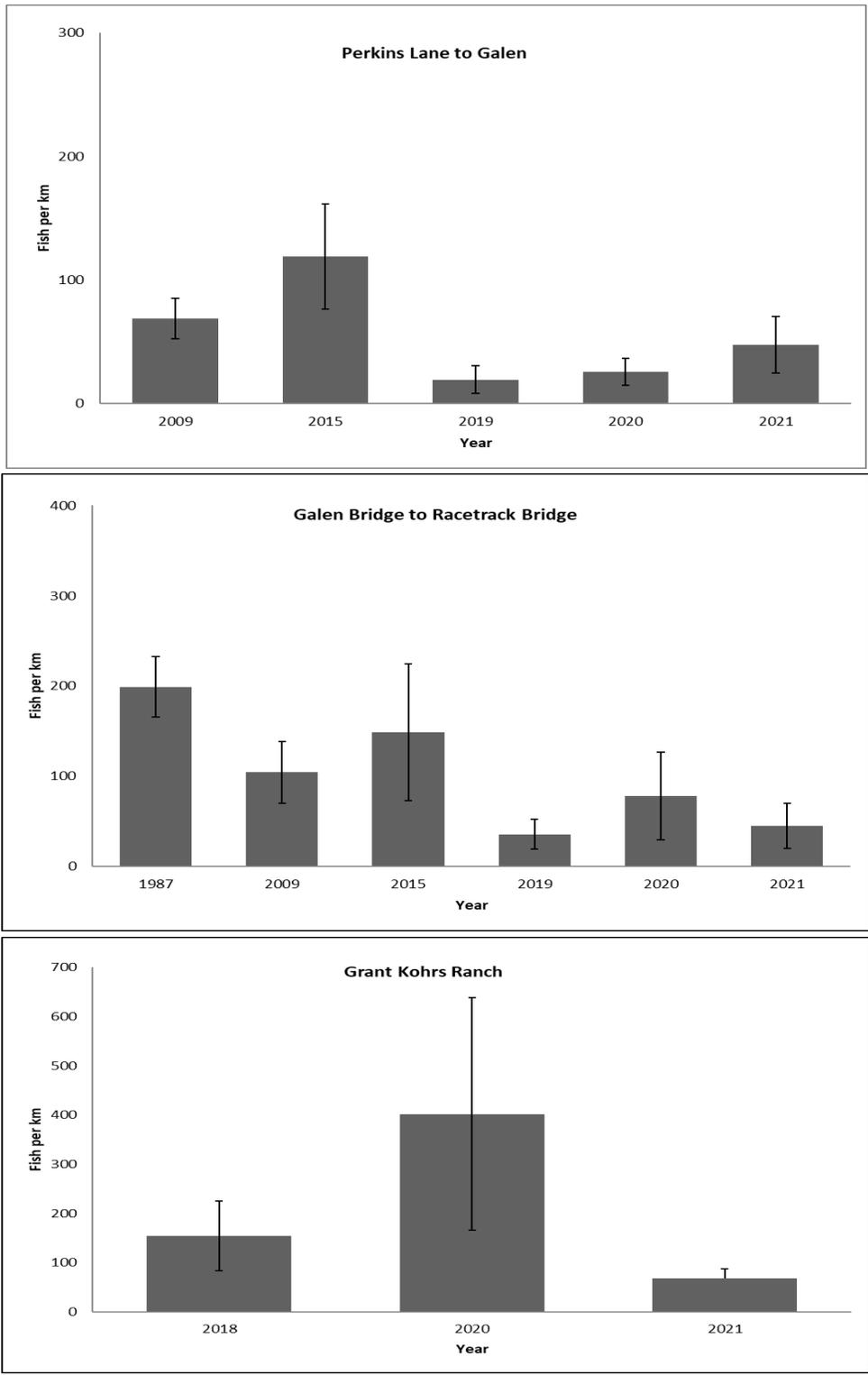


Figure 2. Brown trout population estimates at three sampling reaches targeting remediation in the Upper Clark Fork River.

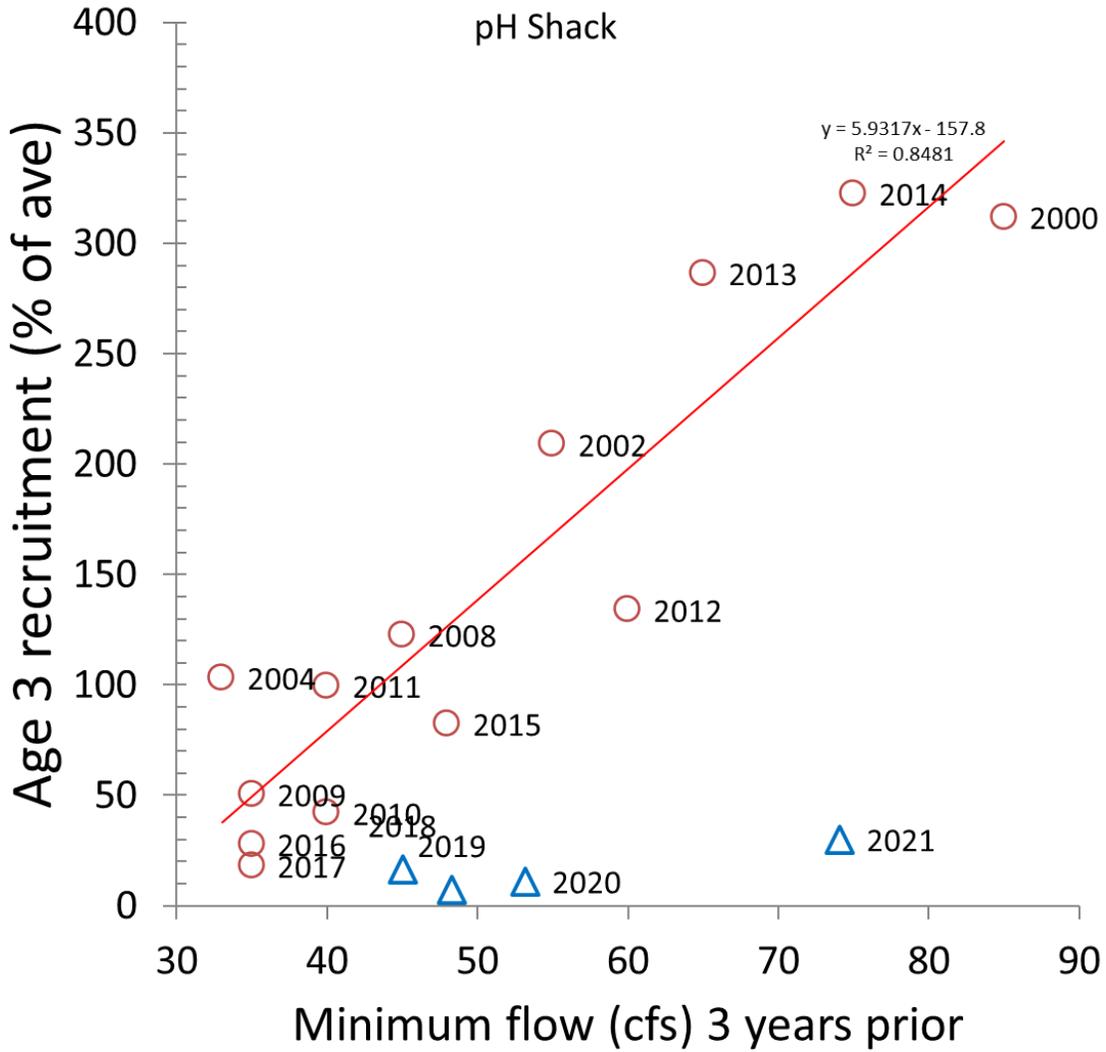


Figure 3. Linear regression of recruitment of age 3 brown trout recruitment versus minimum flow three years prior to sampling. Percent of average of age 3 brown trout captured during electrofishing was considered an index of fish recruitment. Minimum flow was measured at the Clark Fork River at Galen USGS gauge. Data labels are the year fish were sampled. Recruitment data from 2018-2021 were not used in the regression but are included in the chart to show divergence from the model.

Silver Bow Creek

Sampling strategy

Fisheries monitoring in Silver Bow Creek began in earnest when the first fish (sucker and sculpin) were documented near Rocker in 2002. As fish populations expanded in response to remediation, fish monitoring efforts also expanded. Over the years most fish surveys have occurred during the fall. However, spring surveys were conducted at the Father Sheehan Section in 2005 and 2007-2014 and in the summer of 2015. Both spring and fall surveys were conducted at multiple sections in 2014 and 2015. Spring sampling was moved to summer starting in 2016. Summer sampling was done to document fish numbers and distribution during the period of warm water temperatures. The fall sampling was designed to represent a period when high water temperatures were no longer limiting to trout. Since 2015, sampling was conducted using two backpack electrofishers. From 2015-2018, we attempted to get population estimates (Zippin 1958) in both summer and fall, but this proved difficult in some sections due to low fish densities and deep water. Instead, we report counts of fish captured, standardized by electrofishing time (referred to as Catch Per Unit Effort or CPUE). CPUE through time can be found in Tables 1 and 2. Starting in 2019, fish sampling was further complicated by an increase in water conductivity caused by releases of treated mine water in Butte. The high conductivity is due to the addition of lime during the treatment process and this increase was significant enough to reduce the efficacy of using electrofishing to capture fish. Thus, fish capture data from 2019 on may not be directly comparable to previous years for sections downstream of Butte. In order to increase capture efficiency in 2020, a generator-powered, barge-mounted electrofishing unit was used on the German Gulch and Fairmont sections instead of backpack electrofishers. These two sections have especially fast water and deep pools that, combined with increased water conductivity, were very difficult to sample with backpack units.

Sampling summary

For the 2021 monitoring year, only four sections were sampled in Silver Bow creek. The sections sampled were HWY 1, Ramsay, Rocker and LAO. All four sections were sampled in the summer and fall. Catch per unit effort data for the summer sampling are presented in Table 1 and fall sampling in Table 2. The most downstream section is just above the HWY 1 bridge.

The HWY 1 section is characterized by consistently low trout densities, comprised of RB, WCT, and EB. Longnose and largescale suckers, rocky mountain sculpin, and redbside shiners have also been captured at this section. Rainbow trout, longnose suckers, and sculpin were first detected at his section in 2008. Westslope cutthroat were first detected in 2010 at HWY 1. No trout were captured in the section in summer of 2021, which is not common for this section. CPUE of trout during the fall (RB, WCT, and EB) were generally lower than in previous years. However, sucker catch rates were relatively high in both summer and fall compared to previous years.

The Fairmont Section was first sampled in 2014. The trout population in this section is comprised of westslope cutthroat trout, rainbow trout, a few brook trout. Longnose and largescale suckers, rocky mountain sculpin, and redbreast shiners have also been captured at this section. A mark-recapture estimate was done in September 2020 in an expanded section at Fairmont. This sampling yielded an estimate of 108 WCT/km (65-209 95% CI). Estimates of other species could not be generated due to low numbers of recaptures. No sampling of the Fairmont Section was done in 2021.

The German Gulch section has the highest densities of WCT during the summer of all Silver Bow Creek sampling sections. Catch rates of both WCT and EB in the fall tend to be lower in the German Gulch Section compared to summer. This fall reduction in trout catch rates can be attributed to fish redistributing to other parts of Silver Bow Creek (such as the Ramsay area) as water temperatures cool down. Other species captured in the German Gulch Section of Silver Bow Creek include longnose suckers, rocky mountain sculpin, and central mudminnow. A mark-recapture estimate was done in September 2020 in an expanded section below German Gulch. This sampling yielded an estimate of 148 WCT/km (113-205 95% CI) and 51 EB/km (27-115 95% CI). Estimates of other species could not be generated due to low numbers of recaptures. The German Gulch section was not sampled in 2021.

Suckers and sculpin were first found in the Ramsay section in 2005 and trout were first captured in fall 2007. Summer sampling at Ramsay was started in 2016. The Ramsay section is characterized by moderately high trout densities during the fall and low densities during the summer. Trout catch rates during the fall (2016-2019) at Ramsay are similar to catch rates at the sampling section below German Gulch (Figure X). However, during summer sampling trout catch rates at Ramsay go down while catch rates go up at German Gulch during summer sampling. One brown trout was captured in the Ramsay section in fall of 2016, which is the only documented occurrence of brown trout in the Silver Bow basin upstream of the fish barrier. Although the Ramsay section has held relatively high numbers of WCT in the past during the fall, WCT CPUE was down dramatically in fall of 2020 and no WCT were captured in the section in 2021. Summer CPUE of WCT was also 0 in 2021 at Ramsay. The increase in water conductivity following the discharge of treated Berkeley Pit water began in 2019 brings into question whether reduced catch rates of WCT could be attributed to a reduction in electrofishing efficiency. However, CPUE of EB was higher in summer 2021 than any previous summer sampling and both fall and summer catch rates of LN SU and RM COT in 2021 were within range of previous sampling events.

At the Rocker section, low numbers of trout are typically captured in both the spring and fall sampling. However, no trout were captured at Rocker in the fall of 2021. Westslope cutthroat trout were first captured at the Rocker section in 2010 and brook trout were first captured in

2011. Summertime capture rates of longnose suckers have decreased from 2016 to 2021, while catch rates of sculpin have generally increased over this time. Central mudminnow have also been captured at the Rocker section.

Longnose suckers, sculpin, and central mudminnow were captured during the first survey of the LAO section in 2005. Brook trout were first captured at LAO in 2007 and westslope cutthroat in 2009. Brook trout tend to outnumber westslope cutthroat trout in this section. Trout catch rates are higher during the fall sampling compared to summer sampling, suggesting trout move in and out of this part of Silver Bow Creek as conditions change with the seasons. Catch rates of EB, WCT, LN SU, and RM COT in both summer and fall of 2021 were within range of previous years' surveys.

Brook trout, longnose suckers, and sculpin were first captured in the Father Sheehan section of Blacktail Creek in 2005. Despite sampling nearly every fall, westslope cutthroat trout were not captured at Father Sheehan until 2013. This section of Blacktail Creek currently contains small numbers of native cutthroat trout. However, it does support a robust brook trout population. Brook trout population estimates were generated from 2015-2017 and again in 2020. These estimates ranged from 75-185 fish/100m. Longnose suckers, sculpin, central mudminnow, and one goldfish have also been captured at Father Sheehan. This section was not sampled in 2021.

Discussion

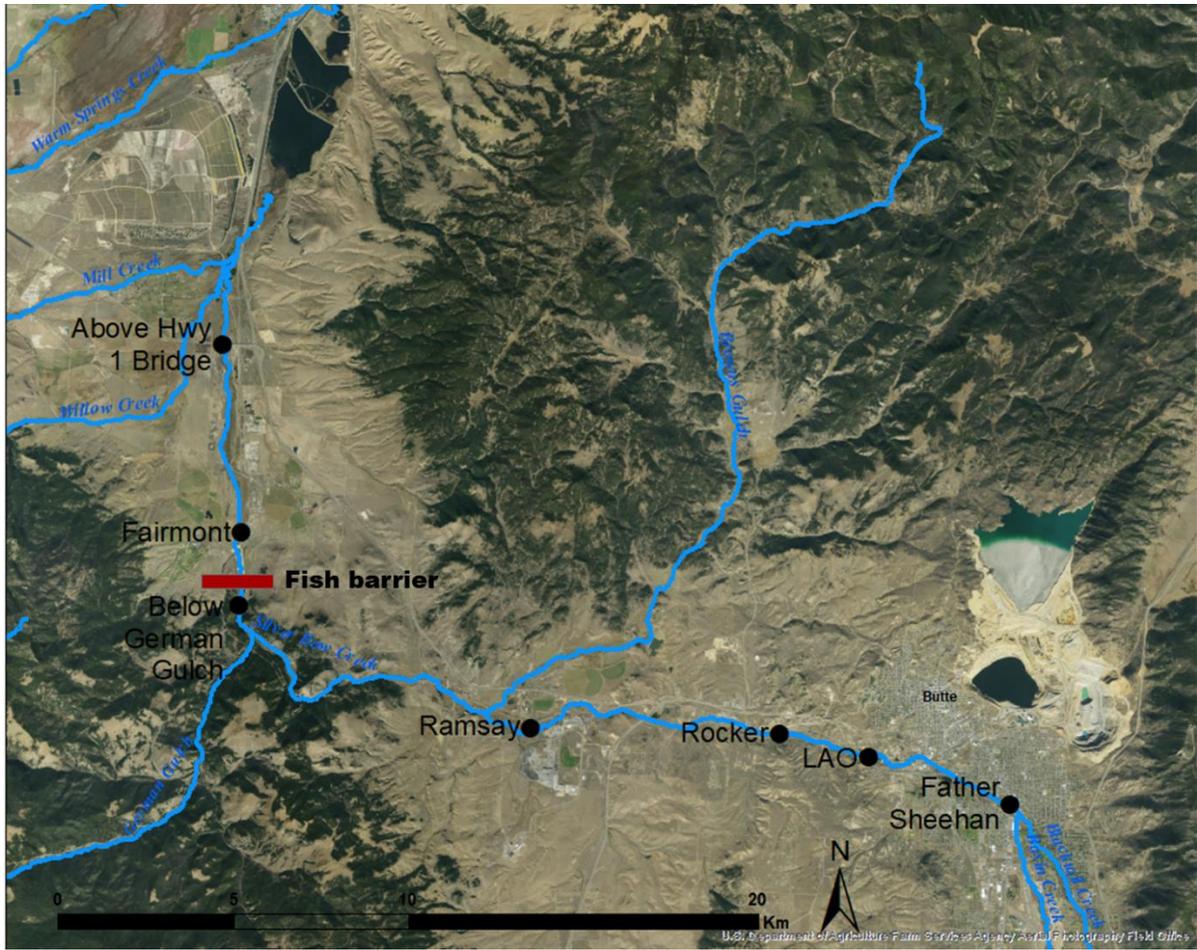
Prior to the start of remedial actions in 1999, Silver Bow Creek was considered fishless. Suckers and sculpin first recolonized Silver Bow Creek followed by brook trout and westslope cutthroat trout. Tributaries were less impacted by mine waste and metals contamination and have served as a source of fish recruitment to mainstem Silver Bow Creek. German Gulch in particular is a critical spawning stream for westslope cutthroat trout and brook trout. Given the high numbers of brook trout in the Father Sheehan section, it is clear that Blacktail Creek is a source of trout to the upper reaches of Silver Bow Creek. Blacktail Creek is also a likely source of westslope cutthroat trout, which are common in the upper areas of the tributary. Compared to Father Sheehan, the LAO section holds far fewer trout, even though it is only about 3 miles downstream. At the Rocker section, which is about 2 miles downstream of LAO, trout are even less abundant. Cleanup of metals contamination has allowed fish to become established throughout Silver Bow Creek and enabled the establishment of substantial trout populations in certain parts of the creek (i.e., immediately downstream of German Gulch). However, it is clear that habitat conditions in Silver Bow Creek within and immediately downstream of Butte are not conducive to supporting trout fisheries year-round.

The Silver Bow Creek trout fishery is characterized by fish that concentrate near the mouths of German Gulch and Blacktail Creek. Westslope cutthroat trout especially concentrate in Silver

Bow Creek near German Gulch in the summer because this tributary is a primary source of cold water. Westslope cutthroat trout disperse away from German Gulch into areas such as Ramsay as water cools off during the fall. In the past, areas of Silver Bow Creek downstream of Butte have had low dissolved oxygen during hot summer nights (Naughton 2013), although DO conditions appear to have improved since the Butte wastewater treatment plant was improved in 2015 and 2016 (Nagisetty et al. 2019). However, nighttime DO concentrations are likely dipping below water quality standards for typical trout bearing streams (i.e., 8 mg/L for class B streams: MT DEQ 2017). Limiting conditions in mainstem Silver Bow Creek should be investigated and eventually addressed to maximize the benefits of tributary restoration efforts on the mainstem fishery.

At the Ramsay section, fall catch rates of WCT and EB in 2020 and 2021 were well below average. In fact, no WCT were captured in 2021, which was the first fall sampling at Ramsay without WCT since 2007. This section has had high trout numbers during previous fall sampling periods, approaching numbers of the section below German Gulch (Figure 4). It is unclear if reduced electrofishing efficiency due to a 3-4X increase in specific conductivity is responsible for the reduction in CPUE. It is also possible that trout are avoiding this part of Silver Bow Creek due to changes in water chemistry. During baseflow conditions, flows in this part of Silver Bow Creek are approximately 50% treated water, much of which is treated Berkley Pit water. The effects of the Berkley Pit effluent, as well as effluent from municipal wastewater treatment should be thoroughly investigated.

Migratory fish, especially westslope cutthroat trout, provide a significant portion of the overall trout fishery in Silver Bow Creek. The importance of German Gulch as a source of migratory fish has been well established by tagging studies and population sampling. However, contributions of migratory individuals from other tributaries is not as well understood. As restoration efforts progress on Brown's Gulch, Basin Creek, and Blacktail Creek, monitoring could be conducted to determine the prevalence of migratory fish from these tributaries and identify remaining impediments to fish passage.



Map 2. Map of seven annual fish sampling sections on Silver Bow Creek.

Table 1. Fish captured per minute of electrofishing in six sampling sections on Silver Bow Creek during spring and summer. Data from spring surveys are in grey, summer in white. *2020 sampling at the German Gulch and Fairmont sections were done with a barge-mounted electrofisher and throwable anodes. As a result, fish capture efficiency is likely much higher for these surveys compared to other Silver Bow Creek surveys that were conducted with backpack electrofishing.

Section	Species	Summer	Spring		Summer					
		2007	2014	2015	2016	2017	2018	2019	2020	2021
LAO	WCT	n/a	0	0.058	0.055	0.032	0.045	0.078	0.064	0.040
	EB	n/a	0.600	0.404	0.137	0.016	0.112	0.078	0.236	0.081
	LN SU	n/a	0.917	0.029	0.082	0.016	0.022	0	0	0.020
	RM COT	n/a	1.164	0.115	1.261	4.319	1.902	2.685	3.997	3.937
	CM	n/a	0	0	0	0	0.045	0.103	0	0.020
Rocker	WCT	n/a	0.539	0.059	0.054	0.016	0	0	0.016	0
	EB	n/a	0.054	0.118	0	0	0	0	0.016	0.023
	LN SU	n/a	1.831	1.298	2.370	0.774	1.331	0.939	0.247	0.296
	RM COT	n/a	0.054	0.059	0	0.033	0.258	2.782	3.079	3.689
	CM	n/a	0	0	0.018	0	0.129	0.759	0	0.023
Ramsay	WCT	n/a	0.654	0.214	0.039	0.014	0.153	0	0.017	0
	EB	n/a	0.187	0.123	0	0	0	0	0.052	0.212
	LN SU	n/a	0.187	0.092	1.090	1.190	0.561	0.376	0.155	0.388
	RM COT	n/a	0.047	0.398	0.350	0.969	0.238	0.716	1.690	0.916
	CM	n/a	0	0	0	0	0.051	0	0	0.018
German Gulch	WCT	0.057	0.235	0.029	0.372	0.492	0.335	0.466	1.097	n/a
	EB	0.143	0.209	0	0.107	0.164	0.129	0.380	0.627	n/a
	LN SU	0.429	0.078	0.059	0.149	0.048	0	0.012	0	n/a
	RM COT	0.200	0.313	0.117	1.247	1.400	0.412	0.761	n/a	n/a
	CM	0.029	0.026	0	0	0	0	0	0	n/a
Fairmont	WCT	n/a	n/a	0.126	0.198	0.610	0.119	0.264	0.516	n/a
	EB	n/a	n/a	0.157	0.446	0.376	0.089	0.081	0.129	n/a
	RB	n/a	n/a	0.063	0	0.023	0	0	0.086	n/a
	LN SU	n/a	n/a	0.094	0.278	0.106	0.015	0.020	0.172	n/a
	LS SU	n/a	n/a	0	0	0	0	0.020	0	n/a
	RM COT	n/a	n/a	0.659	1.259	2.430	0.637	2.298	n/a	n/a
	RS SH	n/a	n/a	0	0.020	0.012	0.741	0.692	0	n/a
HWY 1	WCT	n/a	0.093	0.090	0	0.024	0.051	0.022	0.115	0
	EB	n/a	0.327	0.180	0.017	0.060	0.051	0	0.066	0
	RB	n/a	0.373	0	0.017	0.012	0.051	0	0.033	0.018
	LN SU	n/a	0	0	0.808	0.384	0.137	0.022	0.066	0.128
	LS SU	n/a	0	0	0	0.132	0.274	0.022	0.016	0.935
	RM COT	n/a	0.233	0.135	0.791	0.961	0.292	0.811	0.640	1.485
	RS SH	n/a	0	0	0	0.096	0.137	0	0.016	0.715

Table 2. Fish captured per minute of electrofishing in seven sampling sections on Silver Bow Creek during fall surveys. Although it is not sampled in the fall and it is not within Silver Bow Creek, data from the Father Sheehan section of Blacktail Creek is included in this table to allow for comparison to other long-term datasets. Surveys at Father Sheehan were in done in spring prior to 2015 (spring data in grey), but were more recently conducted during August (bold). Catch rates at the Ramsay section were likely reduced in 2020 due to high water conductivity (~1200 $\mu\text{c}/\text{cm}$).

Section	Species	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Father Sheehan 2002-2014 Spring After 2015 Summer	WCT	n/a	n/a	n/a	0	n/a	0	0	0	0	0	0	0.054	0	0	0.012	0.012	n/a	0	0.029	n/a
	EB	n/a	n/a	n/a	1.140	n/a	1.398	2.154	3.528	3.876	3.438	7.080	7.621	3.337	3.194	2.386	1.485	n/a	3.190	2.942	n/a
	LN	n/a	n/a	n/a	0.600	n/a	1.290	0.306	0.042	0.408	0.186	0.192	0.027	0	0.132	0.136	0.344	n/a	0.394	0.108	n/a
	RM COT	n/a	n/a	n/a	2.280	n/a	2.910	2.154	1.548	1.122	1.242	1.440	0.403	0.303	0.015	0.049	0.196	n/a	1.241	0.902	n/a
	CM	n/a	n/a	n/a	0	n/a	0.852	0.408	0.258	0.168	0.078	0.030	0	0	0	0.037	0.012	n/a	0.197	0.039	n/a
	GDF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.020										
LAO	WCT	n/a	n/a	n/a	0	0	0	0	0.030	0	0.042	0	0	0.037	0.026	0.081	0.083	0	0.071	0.102	0.049
	EB	n/a	n/a	n/a	0	0	0.060	0	0.066	0.570	0.438	0.198	0.117	0.225	0.103	0.190	0.083	0.092	0.024	0.102	0.073
	LN	n/a	n/a	n/a	7.200	1.860	0.846	0.996	0.618	0.258	0.042	1.512	0.381	0.037	0	0.027	0.111	0.642	0	0	0.024
	RM COT	n/a	n/a	n/a	0.444	4.140	4.668	2.772	2.256	0.858	0.120	2.778	2.490	0	1.806	1.520	0.473	0.275	0.686	1.223	1.168
	CM	n/a	n/a	n/a	0.096	0.084	0.204	0.144	0.228	0	0.042	0	0	0.037	0	0	0	0	0.024	0	0.073
Rocker	WCT	0	0	0	0	0	0	0	0	0.120	0.072	0	0.064	0	0.037	0	0.058	0.030	n/a	n/a	0
	EB	0	0	0	0	0	0	0	0	0	0.138	0	0	0.048	0.037	0.045	0.019	0.060	n/a	n/a	0
	LN	2.940	1.800	0.720	2.820	5.220	2.610	5.352	1.362	8.238	6.564	13.038	2.708	3.033	3.164	3.048	0.637	0.060	n/a	n/a	0.450
	RM COT	0.060	0.036	0.036	0	0.096	0.120	0	0.036	0.060	0	0.186	0	0	0.037	0	0.039	0.360	n/a	n/a	1.520
	CM	0	0	0	0	0	0	0	0	0	0	0	0	0	0.389	0.045	0	0	n/a	n/a	0
Ramsay	WCT	n/a	0	0	n/a	0	0	0.078	0.174	0.312	0.624	0.360	0.692	0.460	0.214	0.284	0.155	0.387	0.234	0.048	0
	EB	n/a	0	0	n/a	0	0.030	0.036	0	0.036	0	0	0.099	0.276	0.300	0.109	0	0.129	0.039	0.097	0.018
	LL	n/a	0	0	n/a	0	0	0	0	0	0	0	0	0	0	0.000	0	0	0	0	0
	LN	n/a	0	0	n/a	4.320	1.206	1.212	0.300	0.156	0.228	0.450	0.395	0.046	0.815	0.327	0.291	0	0.098	0.072	0.328
	RM COT	n/a	0	0	n/a	0.060	0.084	0.192	0.042	0	0	0.048	0.049	0.092	0.129	0.851	0.310	0.022	0.176	0.387	1.493
CM	n/a	0	0	n/a	0	0	0	0	0	0	0	0	0.046	0	0	0	0	0	0	0	0
German	WCT(w/RB)	n/a	0	0	0	0	0.048	0.066	0.042	0.072	0.078	0.564	n/a	0.499	0.081	0.146	0.362	0.280	n/a	n/a	n/a
	EB	n/a	0	0	0	0.030	0.906	0.066	0.126	0.570	0.360	0.390	n/a	0.160	0.067	0.063	0.019	0.117	n/a	n/a	n/a
	LN (w/LS)	n/a	0	0	0.030	0.300	1.068	1.128	0.192	1.278	0.150	0.486	n/a	0.120	0.054	0	0	0	n/a	n/a	n/a
	RM COT	n/a	0	0	0.090	0.084	0.420	0.126	0	0.180	0.036	1.356	n/a	0.619	0.364	0.335	0.133	0.280	n/a	n/a	n/a
CM	n/a	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0	0	0	n/a	n/a	n/a	
Fairmont	RB	n/a	n/a	0	0	0.147	0.016	0	n/a	n/a	n/a										
	WCT	n/a	n/a	0.402	0.091	0.213	0.441	0.221	n/a	n/a	n/a										
	EB	n/a	n/a	0.369	0.195	0.213	0.063	0.080	n/a	n/a	n/a										
	LN (w/LS)	n/a	n/a	0.168	0.052	0.295	0.409	0	n/a	n/a	n/a										
	RM COT	n/a	n/a	0.067	0.507	0.950	0.063	0.080	n/a	n/a	n/a										
	RS SH	n/a	n/a	0	0	0	0.110	0	n/a	n/a	n/a										
HWY 1 (new section in 2012)	RB	n/a	n/a	n/a	n/a	n/a	n/a	0.072	0.108	0.192	0.042	0.048	0.272	0.036	0.019	0.116	0.083	0.068	n/a	n/a	0.040
	WCT	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0.048	0	0	0	0.109	0	0.116	0.062	0	n/a	n/a	0
	EB	n/a	n/a	n/a	n/a	n/a	n/a	0	0.036	0	0.078	0.198	0.194	0	0.057	0.070	0.041	0	n/a	n/a	0.040
	LN (w/LS)	n/a	n/a	n/a	n/a	n/a	n/a	0.420	0.036	0	0.078	0.048	0	0.036	0.057	0.046	0.021	0	n/a	n/a	1.943
	RM COT	n/a	n/a	n/a	n/a	n/a	n/a	0.534	0.216	1.998	0.312	1.080	0.155	0.253	0.439	0.279	0.021	0.045	n/a	n/a	0.341
	CM	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	0	0	0	0	0	0	0	0	n/a	n/a	0
RS SH	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	0	0	0	0	0	0.023	0	0	n/a	n/a	0.561	

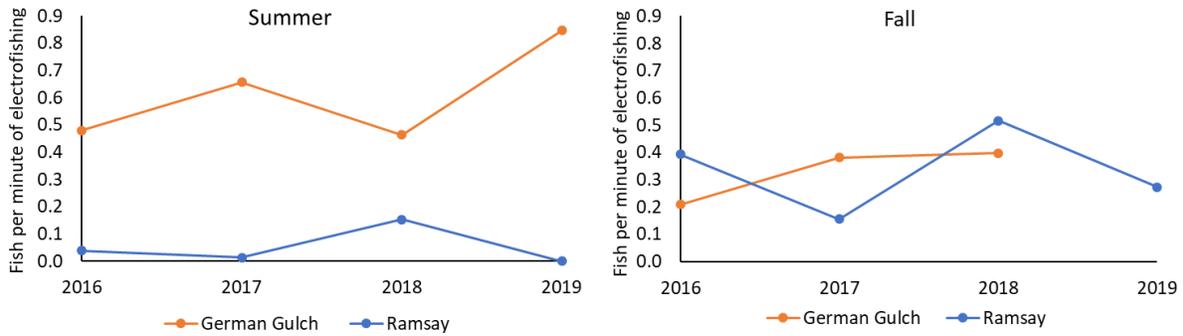


Figure 4. Catch rates (trout captured per minute of electrofishing) at the German Gulch and Ramsay sections of Silver Bow Creek. Catch rates of westslope cutthroat trout and brook trout are combined. The German Gulch section was not sampled in fall 2019.

Basin Creek

One section was sampled on Basin Creek in 2021. This section was completed to get pre-project data in a reach that will be accessible for spawning and rearing for cutthroat in Lower Basin Creek Reservoir after a planned passage project is completed. A depletion estimate was completed and only WCT were captured. The WCT estimate for 2021 was 95 fish/100m (69-121) which is near the average of 92 fish/100m since 2018.

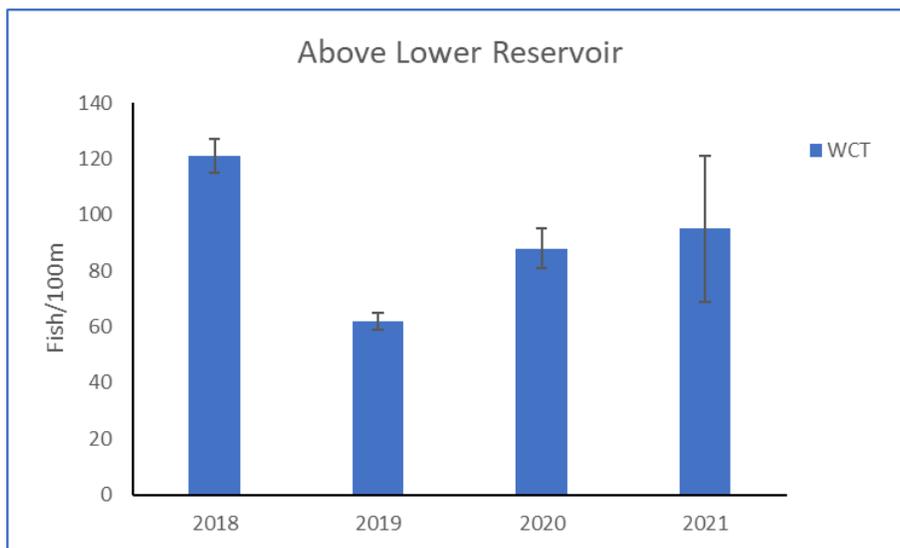
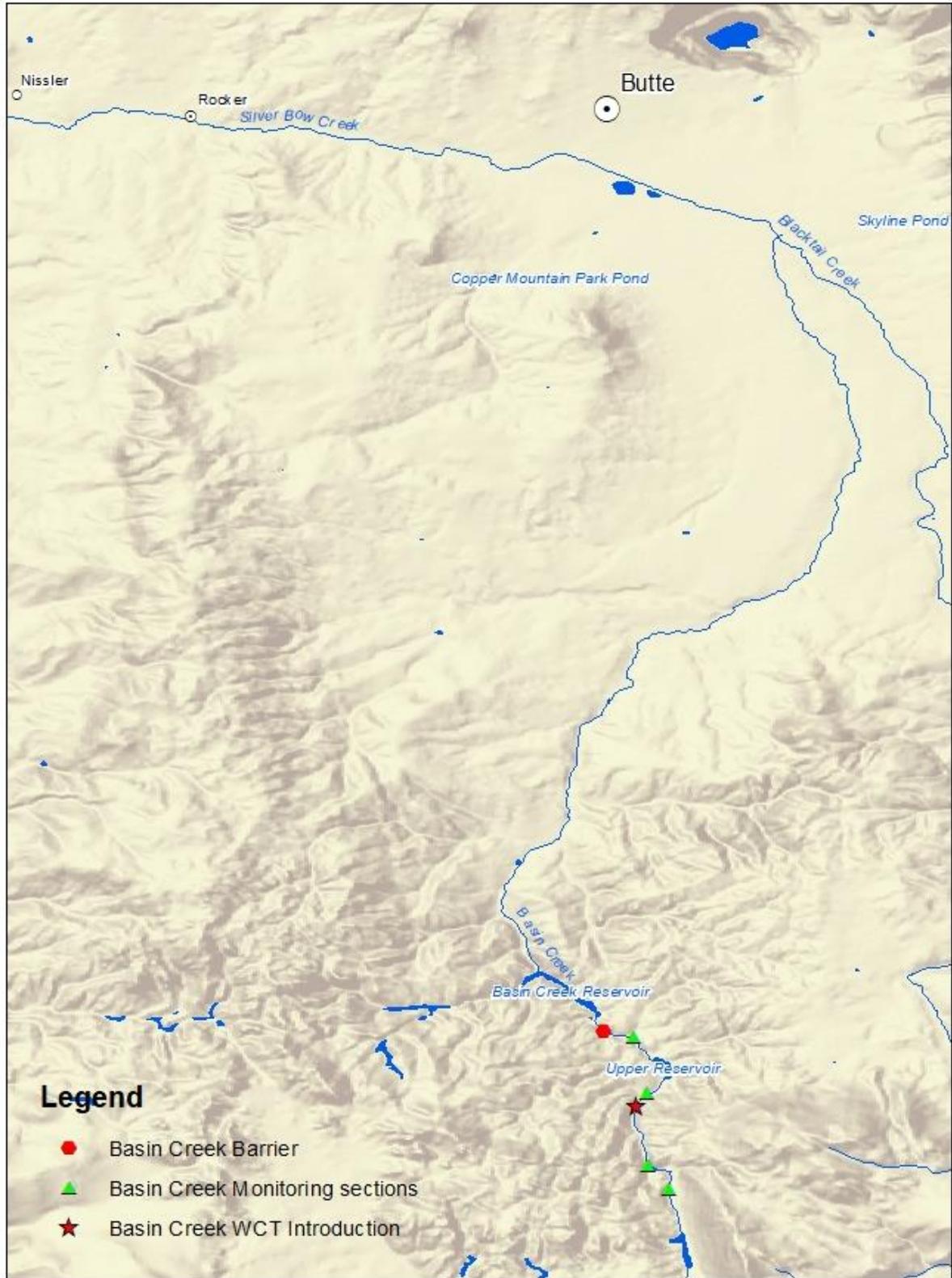


Figure 5. Westslope cutthroat trout estimates on one section of Basin Creek.

Table 3. Data collected for Basin Creek in 2021. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
Above Lower Reservoir	WCT	78	100	42-240	117	18	95(69-121)



Map 3. Map of Basin Creek with locations of a barrier, WCT introduction site and monitoring sites. The only monitoring site done in 2021 was above Basin Creek Reservoir.

Warm Springs Creek Watershed

Throughout the summer and fall of 2021, 21 sections in the Warm Springs Creek watershed were sampled, including six sections of the mainstem. Mark-recapture estimates consisting of one marking run and one recapture run were done on the three lower sections of Warm Springs Creek (WMA, Below Meyers Dam, and Garrity). Fish were captured for the mark recapture estimates using a tote-barge mounted electrofisher with one or two throwable electrodes. Mark-recapture estimates were generated for fish ≥ 150 mm. Prior to 2018, fish were captured in these sections using backpack electrofishers. Prior to the 2018 survey of the Garrity section, we determined that flows were too high to be effective with backpack units, so we decided to try the tote barge. We found the tote barge to be effective, especially in elevated flow conditions, so we transitioned to using it at all of the mark recapture sections in 2019. The other 18 sections in the Warm Spring watershed were sampled using backpack electrofishers. Population estimates were generated using the depletion method for fish ≥ 75 mm on 15 of those sections. A single pass was conducted at three sites because fish capture numbers were too low to have the possibility of a viable depletion estimate.

Mainstem Warm Springs Creek

The LL estimate at the WMA section was 500 fish/km (436-583 95% CI). This is slightly below the long term average of 582 fish/km. The highest estimates for this section occurred in 2007 and 2008. No westslope cutthroat were captured in 2021. Longnose suckers and Rocky Mountain Sculpin were present, and one rainbow X cutthroat trout hybrid was captured.

At the Below Meyers Dam section, the LL estimate was 577 fish/km (522-647). This is near the long term average of 605 fish/km since 2013. The WCT estimate was 99 fish/km (81-131) which is well above the historic average of 43 fish/km. The estimate for RB was 25 fish/km (16-54) which is near the long term average of 32 fish/km. The estimate for RBXWCT was 73 fish/km (59-99), slightly above the long term average of 50 fish/km. Bull trout, Brook trout and Slimy sculpin were also captured but estimates were not possible. There were no estimates for RB and RBXWCT in 2019 due to low capture and recapture numbers.

At the Garrity WMA section, WCT comprise the majority of fish with an estimate of 258 fish/km (233-294). This is above the long term average and over double the estimate from 2019. The LL estimate was 57 fish/km (46-78), near the average of 49 fish/km. The estimate for BULL was 49 (34-84), near the average of 41. The estimate for EB and EBXBULL hybrids was 14 fish/km (11-24) combined. The estimate for RB and RBXWCT hybrids was 47 fish/km (41-60) combined. Slimy sculpins were also present.

A depletion estimate was done at the Above Veronica Trail site. The estimate in this section for BULL is 15 fish/100m (11-19). 2021 was the first time a valid estimate could be produced for BULL since data collection started. The WCT estimate was 15 fish/100m (14-16) which is below the long term average of 27 fish/100m. The EB estimate was 13 fish/100m (12-14), the long term average is 11 fish/100m. RB, RBXWCT and Slimy sculpins were also captured at this site.

A single pass was conducted at the two upper most sites on Warm Springs Creek. At the Below upper bridge site, BULL (2), EB (7) and WCT (6) were captured. At the Below upper forks site, BULL (4) and WCT (4) were captured. We shoot for a minimum number of 10 fish per species on the first pass to perform a depletion estimate. Since population estimates were not possible in all years, CPUE was calculated for all years (Table 4).

A depletion estimate was also done on the West Fork of Warm Springs Creek. The estimate for WCT on this section was 29 fish/100m (25-33). Which is near the historical average of 32 fish/100m. One BULL was also captured at this site and an estimate has not been possible for BULL since 2010.

Table 4. CPUE for the upper two sections on Warm Springs Creek. Estimates were not possible in 2007 and 2021.

Section	Species	2007	2010	2013	2015	2016	2017	2019	2021
Below Upper Bridge RM 27.4	BULL	0.7921	0.9693	0.5607	0.1696	0.0609	n/a	0.0455	0.0634
	EB	0.5941	0.4362	0.3505	0.2422	0.2434	0.5526	0.1364	0.2219
	EBXBULL	0.066	0.0485	n/a	0.0242	0.0609	0.0291	n/a	n/a
	WCT	0.5281	0.8239	0.5607	0.2422	0.213	0.1745	0.1136	0.1902
Below Confluence of upper forks	BULL	0.0912	0.9687	n/a	n/a	n/a	0.0438	0.1086	0.103
	WCT	0.6383	0.8476	0.4358	1.3961	1.3486	1.2691	0.8082	0.103

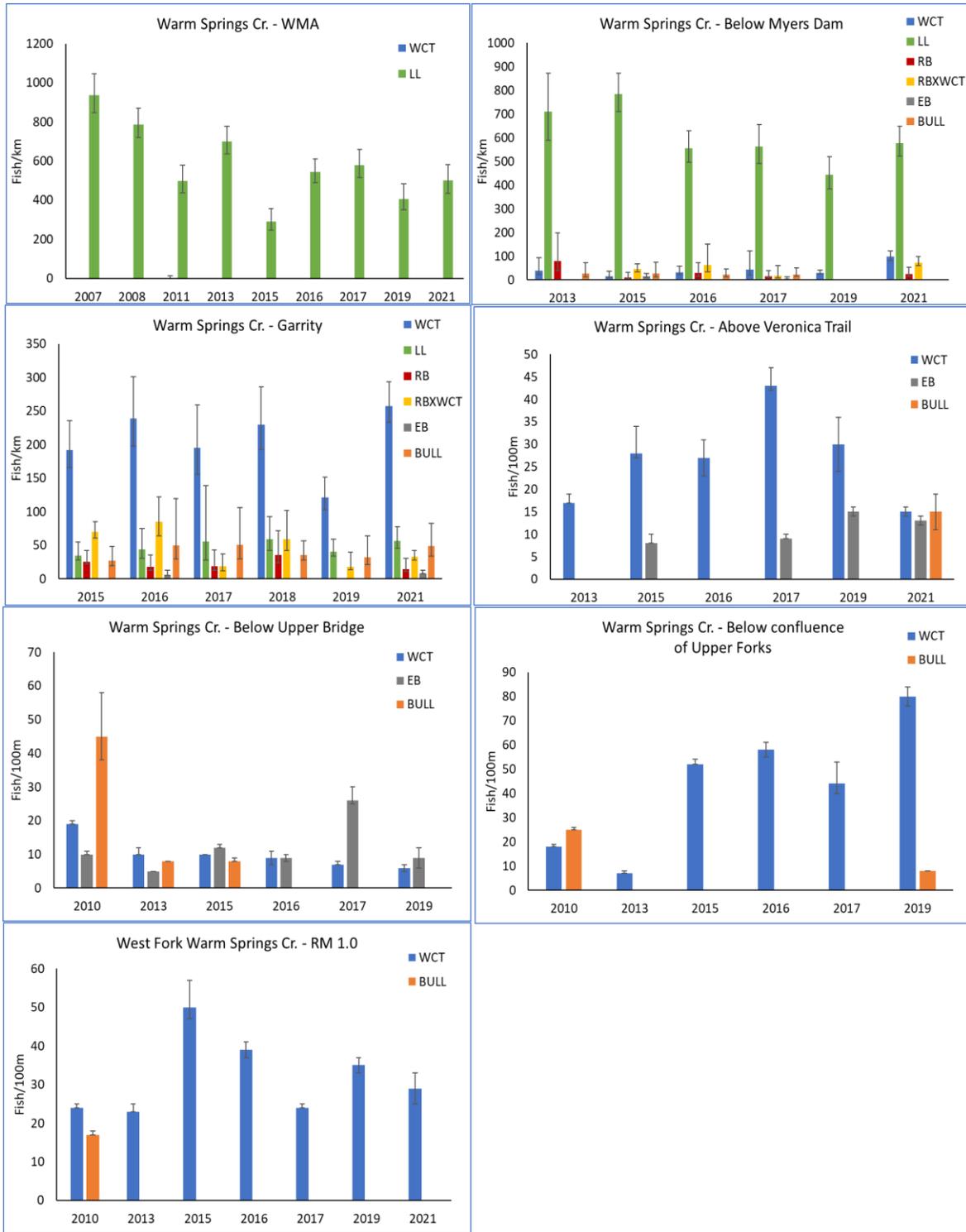


Figure 6. Trout estimates for six sections on Warm Springs Creek and one on West Fork Warm Springs Creek. The lower three sections are mark/recapture estimates with a tote barge. The upper three and the West Fork site are depletion estimates with backpack electrofishers.

Table 5. Electrofishing data collected on Warm Springs Creek and West Fork Warm Springs Creek, 2019. Population estimates are presented in figures above.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)
WMA	LL	350	95	126-475	201	106
	LN SU	1	<1	200	200	92
	RBXWCT	1	<1	220	220	96
	RM COT	17	5	63-94	79	
Below Meyers Dam	BULL	18	2	134-683	277	101
	EB	10	1	86-217	178	73
	EBXBULL	1	<1	510	510	962
	LL	594	71	63-426	206	130
	RB	17	2	175-429	233	159
	RBXWCT	67	8	105-445	213	126
	SL COT WCT	30 104	4 6	55-98 50-424	77 196	
Garrity WMA	BULL	42	8	106-331	202	86
	EB	10	2	107-220	184	68
	EBXBULL	4	<1	196-236	210	78
	LL	63	13	75-383	206	127
	RB	13	3	128-346	253	183
	RBXWCT	36	7	107-366	204	105
	SL COT WCT	38 147	8 59	44-100 42-350	72 179	
Veronica Trail	BULL	14	26	93-183	134	30
	EB	13	24	100-220	160	44
	RB	1	2	216	216	99
	RBXWCT	1	2	246	246	138
	SL COT	10	18	55-85	70	
	WCT	15	28	124-303	190	83
Upper Bridge	BULL	2	13	175-550	363	6952
	EB	7	47	94-184	144	39
	WCT	6	40	24-305	203	173
Below upper forks	BULL	4	50	180-235	202	71
	WCT	4	50	188-220	204	87
West Fork RM 1.0	BULL	1	3	194	194	56
	WCT	33	97	48-195	124	27

Barker Creek

Depletion estimates were conducted at two sites in Barker creek in 2021. Estimates were possible at both sites for BULL and WCT. At the lower site, RM 0.5, the BULL estimate was 33 fish/100m (28-38), and the WCT estimate was 5 fish/100m (4-6). At the upper site, RM 1.5, the BULL estimate was 44 fish/100m (34-55), and the WCT estimate was 5 fish/100m (4-6).

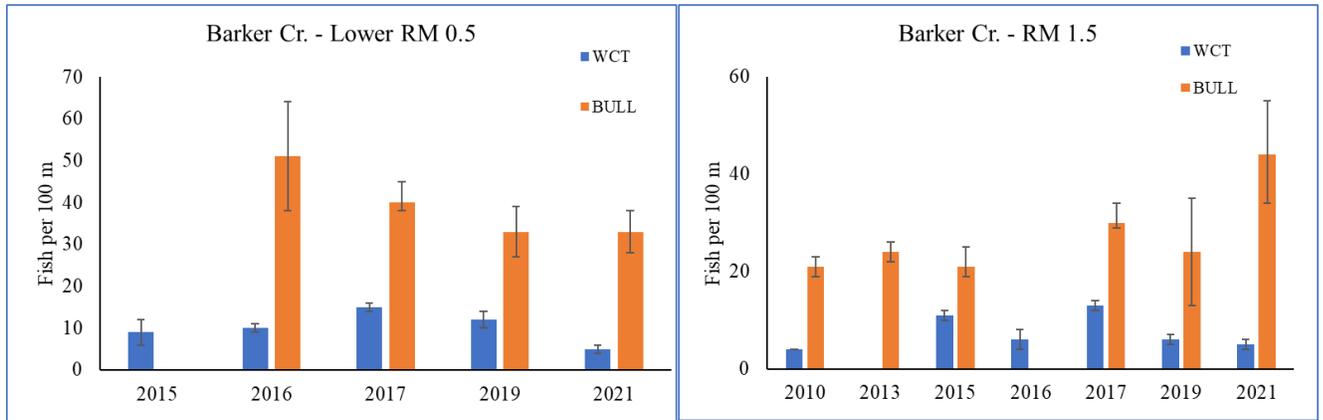


Figure 7. Estimates for two sections on Barker Creek. In 2015 at RM 0.5, BULL were captured but a valid estimate could not be produced. The same is true at RM 1.5 for WCT in 2013 and BULL in 2016.

Table 6. Data collected for Barker Creek in 2021. Population estimates (95% CI) are for trout greater than 75 mm (~ 3”) in total length.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
Lower RM 0.5	BULL	31	79	83-218	154	39	33(28-38)
	WCT	8	21	49-245	135	69	5(4-6)
Upper RM 1.5	BULL	54	87	35-284	141	41	44(34-55)
	RBXWCT	1	2	298	298	238	
	WCT	7	11	80-265	141	46	5(4-6)

Foster Creek

Three sections were sampled in Foster Creek in 2021. Depletion estimates were completed at all three sites. The lower site, RM 1.0, had the most fish species present. The estimate for WCT was 98 fish/100m (86-110). BULL, EB and Slimy sculpin were present but an estimate was not possible. At the middle site, RM 2.3, the WCT estimate was 27 fish/100m (21-33). EB were also present but a valid estimate was not possible. At the upper site, RM 3.8, the WCT estimate was 45 fish/100m (40-49). One EB was also captured.

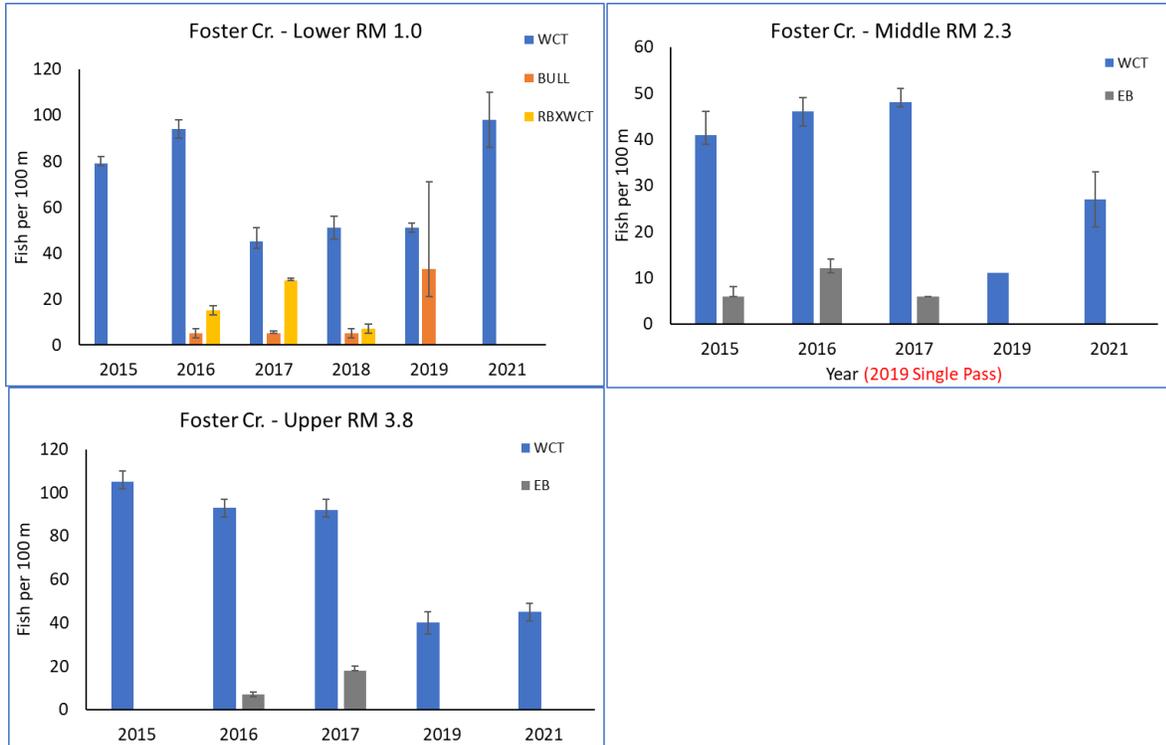


Figure 8. Estimates for three sections on Foster Creek. Estimates are for fish >75 mm. At the middle section, only a single pass was completed at the RM 2.3 section in 2019 due to low fish numbers.

Table 7. Electrofishing data collected from Foster Creek in 2021. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
Lower RM 1.0	BULL	2	1	190-212	201	71	
	EB	3	2	99-179	129	32	
	EBXBULL	1	1	403	403	475	
	SL COT	39	26	27-87	57		
	WCT	105	70	57-282	135	40	98(86-110)
Middle RM 2.3	EB	9	24	109-162	131	26	
	WCT	29	76	52-233	125	34	27(21-33)
Upper RM 3.8	EB	1	1	80	80	5	
	WCT	66	99	45-225	128	35	45(40-49)

Twin Lakes Creek

Five sections were sampled in Twin Lakes Creek in 2021. The lower section, RM 1.3, had a WCT estimate of 21 fish/100m (20-22). BULL, EB and Rocky Mountain sculpin (RM COT) were also present (Table 7). At the meadow section, RM 2.8, the WCT estimate was 15 fish/100m (14-16) and the EB estimate was 23 fish/100m (22-24). BULL, RM COT and Slimy sculpin (SL COT) were also present. At the upstream of old bridge section, RM 4.6, the WCT estimate was 18 fish/100m (16-20). EB, RM COT and SL COT were present. At the downstream of lower lake section, RM 7.2, only a single pass survey was completed. WCT, EB, RM COT and SL COT were all present. At the upstream of upper lake section, RM 8.5, the BULL estimate was 32 fish/100m (31-33) and the WCT estimate was 24 fish/100m (22-26). RM COT were present.

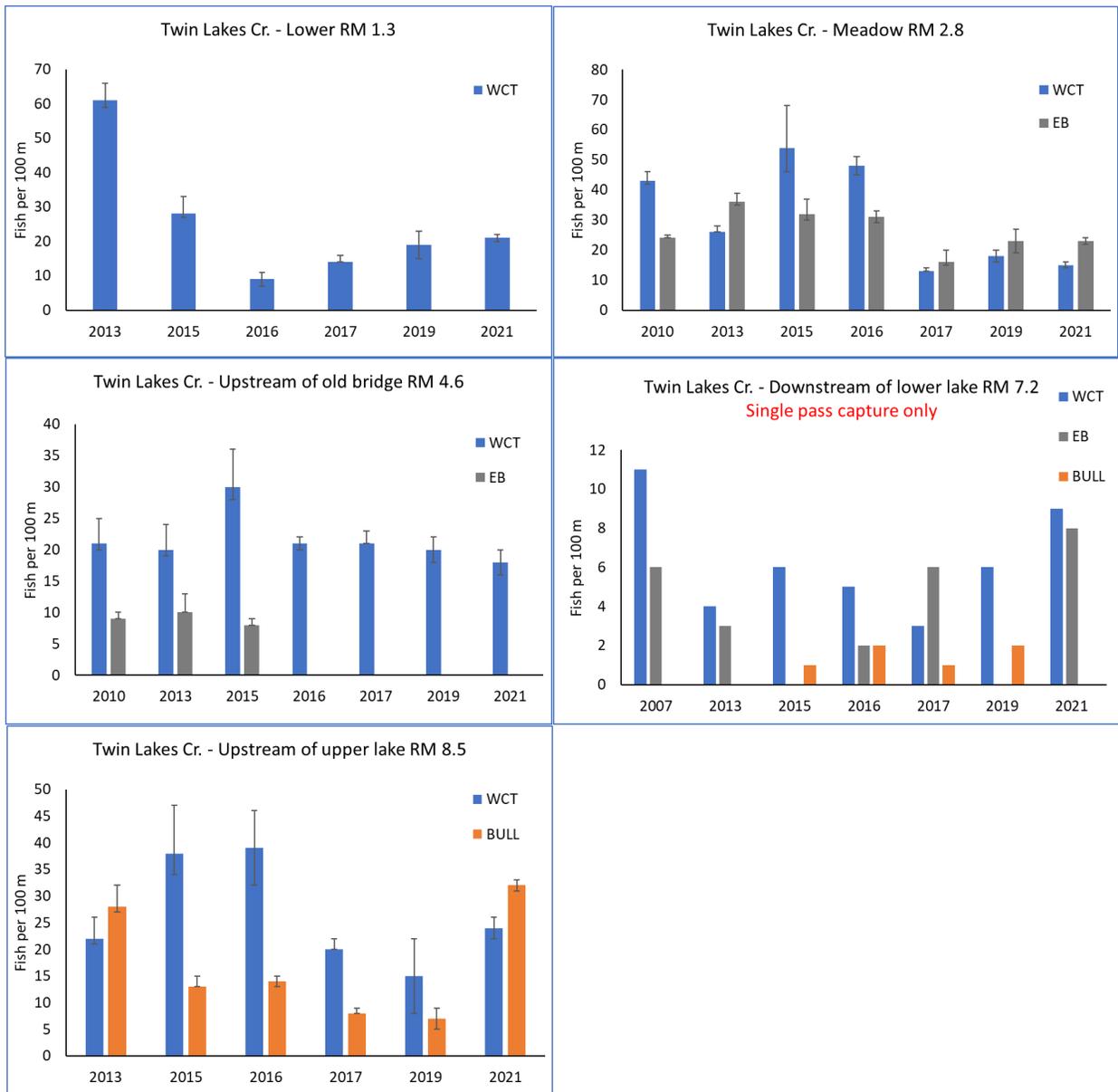


Figure 9. Trout estimates on four sections of Twin Lakes Creek. RM 7.2 is a single pass section due to low fish numbers.

Table 8. Electrofishing data collected from Twin Lakes Creek in 2021. Population estimates (CI 95%) are for fish >75 mm (~3”) in total length. Only a single pass survey was conducted at RM 7.2.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
Lower RM 1.3	BULL	3	10	145-270	187	79	
	EB	2	6	152-164	158	34	
	RM COT	2	6	109-125	117		
	WCT	24	78	48-256	132	33	21(20-22)
Meadow RM 2.8	BULL	1	2	66	66		
	EB	25	43	40-206	128	27	23(22-24)
	RM COT	9	15	77-125	101		
	SL COT	2	3	109-119	114		
Upstream of old bridge RM 4.6	WCT	22	37	56-222	115	28	15(14-16)
	COT	1	3	47	47		
	EB	5	14	36-188	112	44	
	RM COT	4	12	90-105	99		
Downstream of lower lake RM 7.2	SL COT	3	9	66-105	86		
	WCT	21	62	64-211	114	23	18(16-20)
	COT	27	47				
	EB	8	14	64-110	92		
Upstream of upper lake RM 8.5	RM COT	10	17	47-106	77		
	SL COT	4	6	76-96	86		
	WCT	9	16	88-172	114		
	BULL	52	39	66-722	127		32(31-33)
	RM COT	49	36	56-110	83		
	WCT	34	25	75-197	126		24(22-26)

Storm Lake Creek

Four sections were sampled in Storm Lake Creek in 2021. Depletion estimates were completed for each section. At the lower section, RM 0.6, the EB estimate was 14 (13-15) and the WCT estimate was 8 (6-10). BULL were also captured at this site. At the above first crossing section, RM 1.4, The EB estimate was 20 (16-24) and the WCT estimate was 12 (11-13). BULL were also present here. At the lower end of meadow site, RM 4.2, the BULL estimate was 11 (10-12) and the WCT estimate was 10 (9-11). EB were also captured in this section. At the upper most section, RM 6.3, the BULL estimate was 13 (8-18) and the WCT estimate was 17 (16-18). One EB and one RBXWCT were captured in this section.

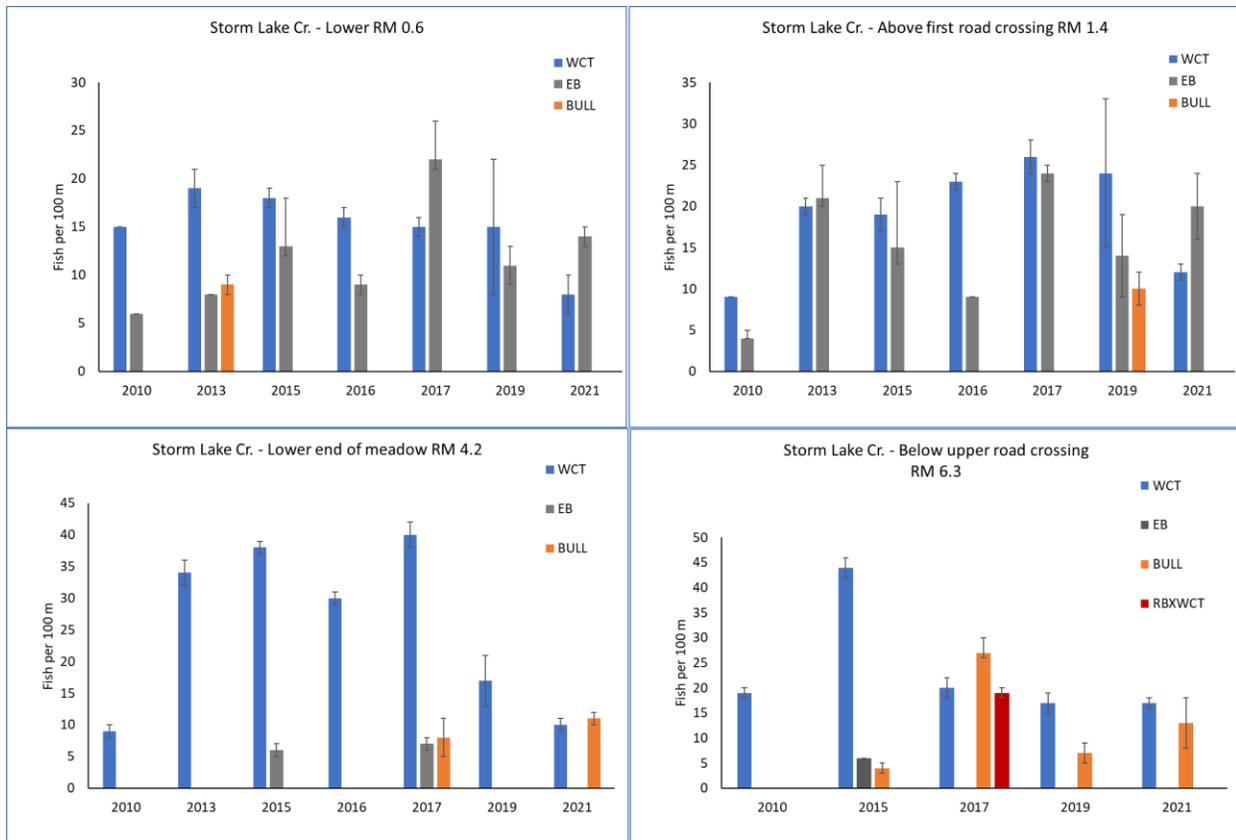


Figure 10. Trout estimates on four sections of Storm Lake Creek.

Table 9. Electrofishing data collected from Storm Lake Creek in 2021. Population estimates (CI 95%) are for fish >75 mm (~3”) in total length.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
Lower RM 0.6	BULL	2	6	134-166	150	31	
	EB	18	58	61-193	114	26	14(13-15)
	WCT	11	36	61-147	95	14	8(6-10)
Above first road crossing RM 1.4	BULL	2	6	123-177	150	31	
	EB	19	54	87-191	154	35	20(16-24)
	WCT	14	40	60-243	173	60	12(11-13)
Lower end of meadow RM 4.2	BULL	16	55	62-174	113	21	11(10-12)
	EB	2	7	142-148	145	30	
	WCT	11	38	67-232	160	50	10(9-11)
Below upper road crossing RM 6.3	BULL	15	39	64-167	122	21	13(8-18)
	EB	1	3	138	138	25	
	RBXWCT	1	3	198	198	78	
	WCT	21	55	47-195	125	26	17(16-18)

Lost Creek

Five sections were sampled in Lost Creek in 2021. Three of these sites were previously surveyed in 2008. The section at the state park entrance was also sampled in 2014. A single pass survey was done at all five sites in 2021. At the Atlantic Richfield bridge site 151 LL and 1 EB were captured. The Lower ARCO site had 29 LL and 13 Rocky Mountain sculpin. The below Gardner diversion section had 142 LL and 5 EB. This is significantly higher than 2008 when only 16 LL were captured. The State Park entrance site was moved in 2021 because of beaver activity. The section length stayed the same and the new end point is within the old section boundaries. This section was comprised of mostly EB, followed by WCT and LL in all years sampled. In 2021 64 EB were captured along with 16 WCT, 5 LL and 3 slimy sculpins. Seven EB were captured at the Above Falls site, which is down from 23 in 2008.

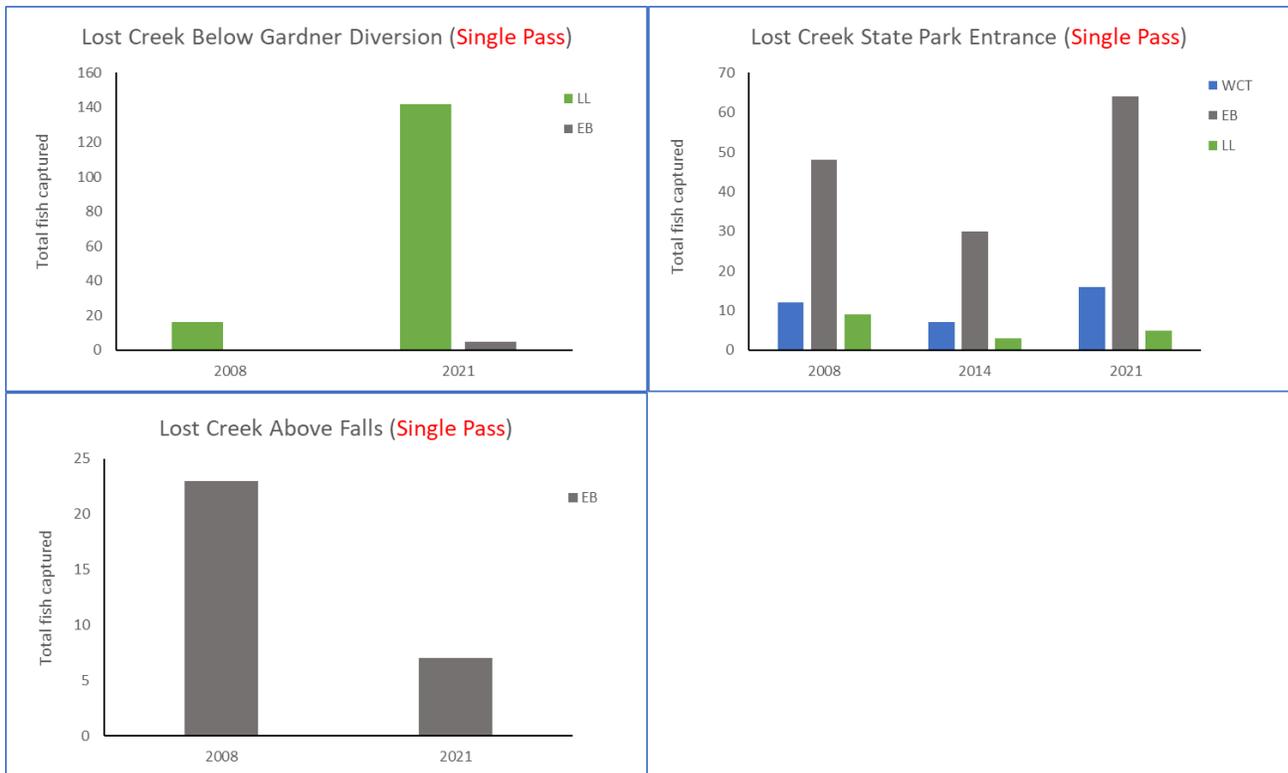


Figure 11. Single pass fish numbers on three sections of Lost Creek that were sampled in 2008 and 2021.

Table 10. Electrofishing data collected from Lost Creek in 2021. Single pass fish surveys were completed at each section.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)
Atlantic Richfield	LL	151	99	68-463	153	77
	EB	1	1	235	235	138
Lower ARCO	LL	112	69	62-370	146	66
	RM COT	13	31	41-101		
Below Gardner Diversion	LL	142	97	62-286	146	40
	EB	5	3	163-191	176	51
State Park Entrance	EB	64	73	47-236	139	36
	LL	5	6	136-273	209	108
	SL COT	3	3	70-75	72	4
	WCT	16	18	58-280	188	90
Above Falls	EB	7	100	52-206	138	45

Willow Creek

Two sections were sampled in Willow Creek in 2021. Two sections were also done in 2014. The lower powerline crossing section was done at the same location both years. The estimate for EB in 2021 was 78 fish/100m (77-79), which is significantly higher than the estimate of 25 in 2014. The WMA section was moved about half a mile upstream from where it was in 2014 due to beaver activity. The WCT estimate in 2021 was 149 fish/100m (146-152), which is significantly higher than the estimate of 68 in 2014. The EB estimate in 2021 was 29 fish/100m (28-30) which is close to the estimate of 24 in 2014.

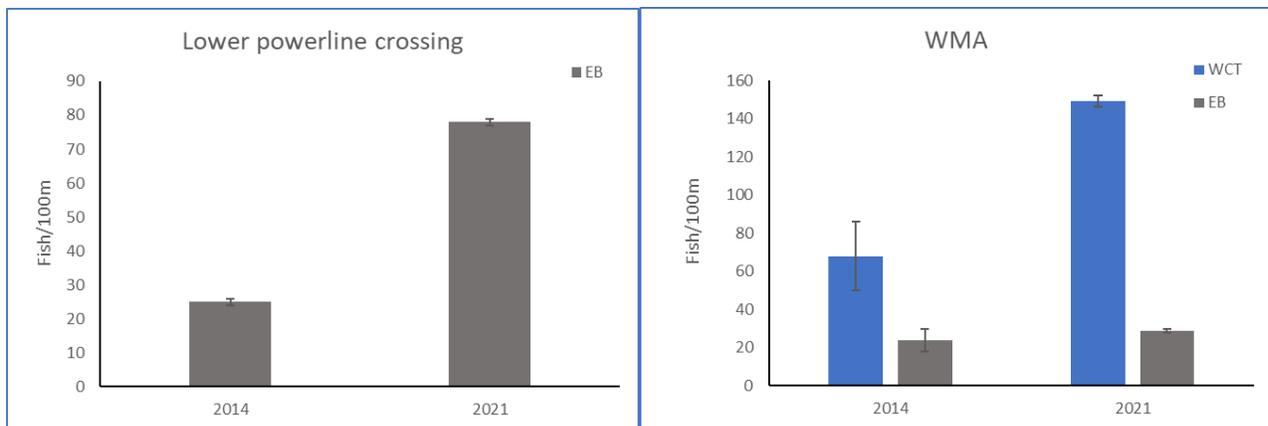


Figure 12. Estimates for two sections on Willow Creek.

Table 11. Electrofishing data collected from Willow Creek in 2021. Population estimates (95% CI) are for trout greater than 75 mm (~ 3”) in total length.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
Lower powerline crossing	EB	150	73	51-285	127	39	78(77-79)
	LL	9	4	45-220	99	55	
	LN SU	7	3	92-155	129	25	
	RM COT	40	19	55-102			
	WCT	1	1	226	226	117	
WMA	EB	106	35	51-197	124	30	29(28-30)
	RM COT	45	15	47-119	83		
	WCT	151	50	62-235	121	31	149(146-152)

Mill Creek

Three sections of Mill Creek were sampled in 2021. All three sections were sampled in 2008 as well but only a single pass survey was completed. These sections were repeated in 2021 to get updated fisheries information and to accompany diversion inventory data collected by NRDP and Trout Unlimited. Depletion estimates were completed at all three sections in 2021. At the below golf course section, the EB estimate was 43 fish/100m (39-47) and the LL estimate was 35 fish/100m (34-36). This section is immediately downstream of a fish screen and streambank improvement project completed in 2021. Mountain whitefish and RM COT were also captured. At the below diversion site, the LL estimate was 31 fish/100m (23-39) and the WCT estimate was 7 fish/100m (5-9). RM COT were also captured here. At the below falls Amorex site, the WCT estimate was 50 fish/100m (47-53) and the EB estimate was 8 fish/100m (7-9). LL, RM COT and SL COT were also captured.

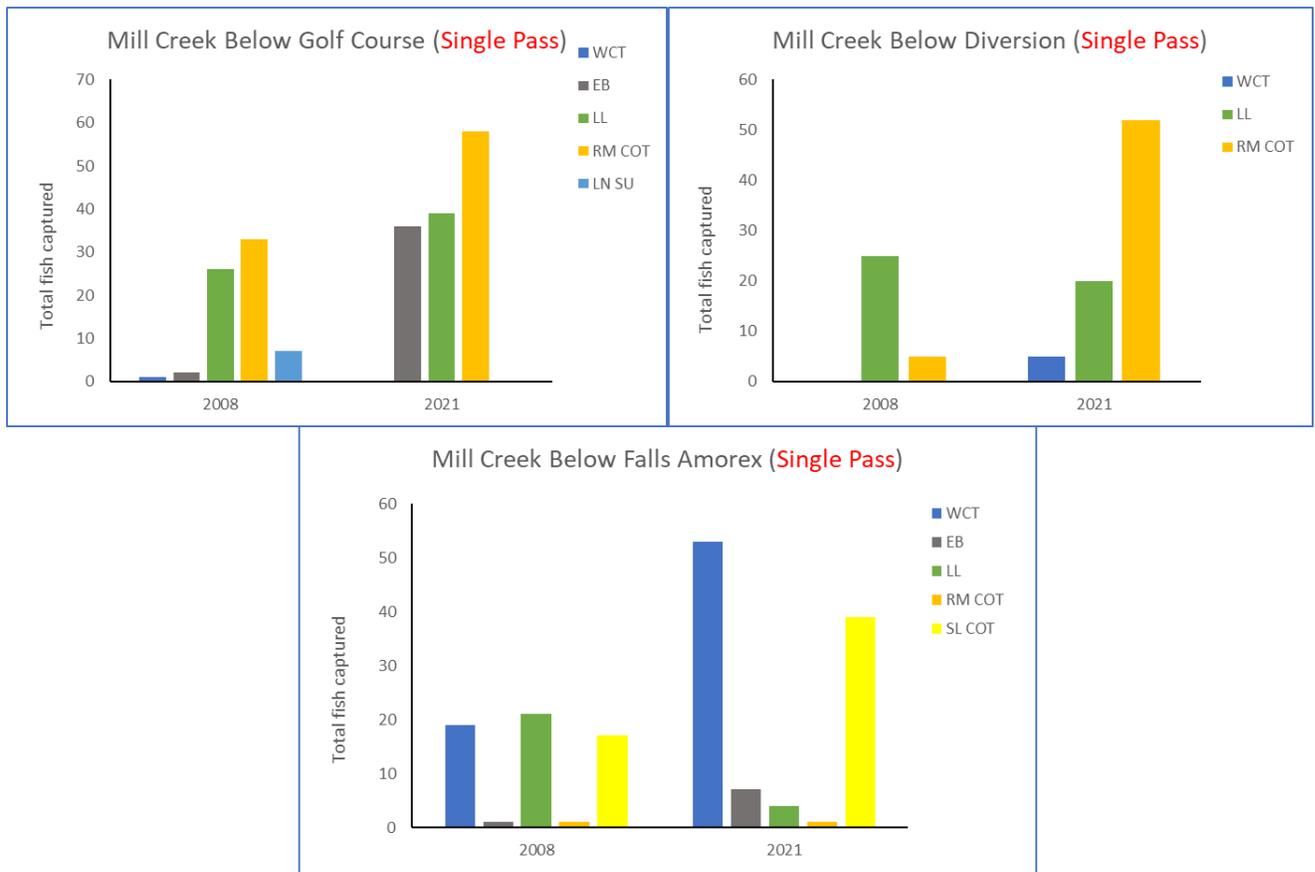


Figure 13. Single pass fish numbers on three sections of Mill Creek.

Table 12. Electrofishing data collected from Mill Creek in 2021. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
Below Golf Course	EB	44	29	61-242	150	50	43(39-47)
	LL	43	28	48-288	152	60	35(34-36)
	MWF	6	4	138-252	197	78	
	RM COT	58	39	49-108	79		
Below Diversion	LL	28	32	110-305	166	65	31(23-39)
	RM COT	52	60	47-112	80		
	WCT	7	8	188-298	237	144	7(5-9)
Below Falls Amorex	EB	8	7	125-212	152	42	8(7-9)
	LL	4	4	81-247	170	71	
	RM COT	1	<1	120	120		
	SL COT	39	35	50-103	77		
	WCT	61	54	39-240	130	36	50(47-53)

O'Neill Creek

Two sections of O'Neill Creek were sampled in 2021. These two sections are within the Spotted Dog WMA and have been surveyed 3-4 times since 2015. At the Above Road Crossing Section (RM 1.7), the WCT estimate was 52 fish/100 m (49-55). The most upstream section is at RM 2.9 and is just below a large waterfall. The WCT estimate at the Below Falls Section was 140 fish/100 m (136-144). This population estimate was in the range of previous estimates at both sections.

Despite its small size, O'Neill Creek is a highly productive source of westslope cutthroat trout. Juvenile WCT are very abundant in all sections of O'Neill Creek. Except for one brook trout captured in 2020 in the most downstream section, WCT are the only species that have been captured in O'Neill Creek. The general absence of nonnative fishes is rare in tributaries of the Clark Fork River. It is also rare for tributaries to lack species such as sculpin. It may be worthwhile to investigate the mechanisms that keep fishes other than WCT out of O'Neill Creek. A culvert that goes under I-90 is a potential barrier, but telemetry studies have shown WCT can navigate this structure and move upstream to spawn (Mayfield 2013).

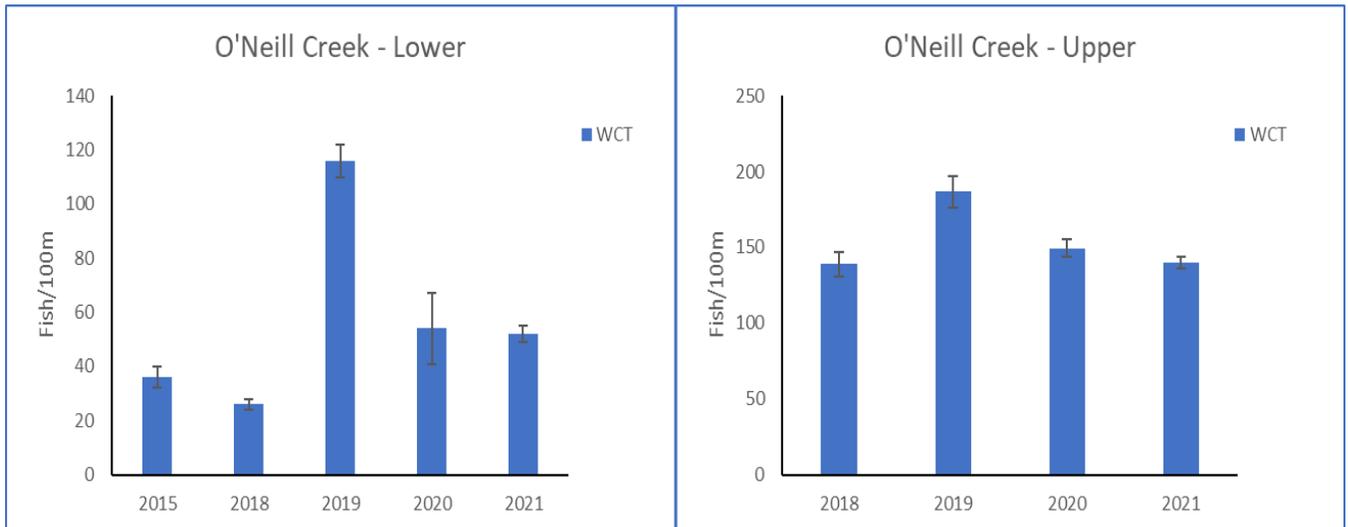
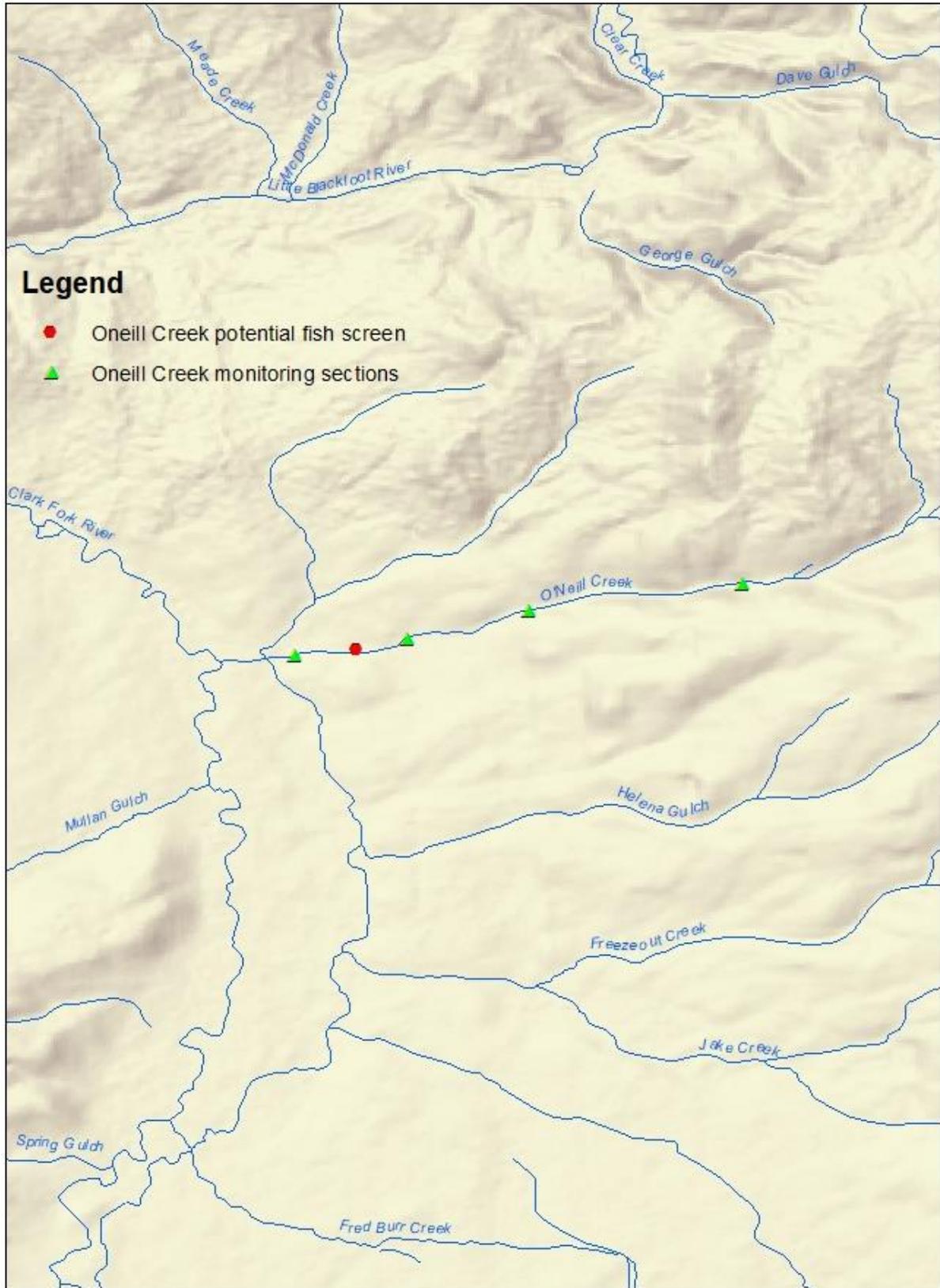


Figure 14. Westslope Cutthroat estimates for two sections on O'Neill Creek.

Table 13. Electrofishing data collected from O'Neill Creek in 2021. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length.

Section Name/RM	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
Above Road Crossing	WCT	53	100	37-166	105	14	52 (49-55)
Below Falls	WCT	112	100	31-206	102	13	140 (136-144)



Map 4. Map of O'Neill Creek with monitoring sites and a potential fish screen site.

Spotted Dog Creek

Six sections of Spotted Dog Creek were sampled in 2021. Four of these were sections in the upper reaches of the creek within the WMA and USFS land. The upper four sections were sampled in an effort to evaluate fisheries response to restoration actions. The Restoration Phase 2 section was sampled to get baseline fish data prior to a stream channel and floodplain restoration project completed in fall 2021. The next upstream section was sampled to get the first year of post project data on a beaver restoration project completed in fall 2020. The upper two sections are outside of the two restoration areas and data from these upper sections were collected to provide control or reference data. Two sections were sampled in the lower reaches of the creek. The lowest section was done at RM 1.1 and had been previously sampled from 2014-2017. The next section upstream was done at RM 2.5 above the upper diversion. Only a single pass survey was conducted here due to the landowner draining a pond above the section while the survey was taking place. This section was also done in 2014.

At the most downstream section, RM 1.1, the brown trout estimate was 208 fish/100 m (95% CI = 207-209) and the westslope cutthroat estimate was 9 fish/100 m (8-10). This was the first time enough WCT were captured to provide an estimate. At RM 2.5, more fish were captured on a single pass in 2021 (92 fish) than in four passes in 2014 (30 fish). In 2021, 29 LL and 16 WCT were captured in a single pass whereas 24 LL and zero WCT were captured in four passes in 2014. At the lowest section in the project area, Restoration Phase 2, the brook trout estimate was 113 fish/100 m (109-117) and the westslope cutthroat trout estimate was 66 fish/100m (65-67). These fish numbers are significantly higher than what was seen in 2020 (Figure 15). This section is in an area that will undergo channel realignment in the future. The next section upstream is in an area of the stream that was enhanced with beaver dam analogues (BDAs). The EB estimate in this section post project was 113 fish/100 m (109-117) and the WCT estimate was 38 fish/100 m (37-39). EB numbers in this section were higher than in 2020 and the WCT numbers were similar. Longnose suckers were also captured in both restoration area sections. Of the two sections that are outside the area of future restoration projects, the Below Forest Service Section is the most downstream. The EB estimate at this section was 42 fish/100m (37-47) and the WCT estimate was 124 fish/100m (112-136). Slimy sculpins were also captured. At the section above the North Fork of Spotted Dog Creek, the EB estimate was 11 fish/100 m (10-12) and the WCT estimate was 43 fish/100 m (36-50). Slimy sculpins were also observed here.

In addition to these sections, two entrainment surveys were conducted on two diversions to assess the possible need for fish screens. These were diversion #1 and diversion #4. The ditch below diversion #4 had no fish in a 100 m section. An 80 m section was sampled below diversion #1. There were 30 brown trout, 20 westslope cutthroat, and 5 unidentified sculpins.

FWP will continue to monitor these sections on upper Spotted Dog Creek for fisheries response to restoration activities. Specifically, we will be looking for changes in trout abundance and species composition.

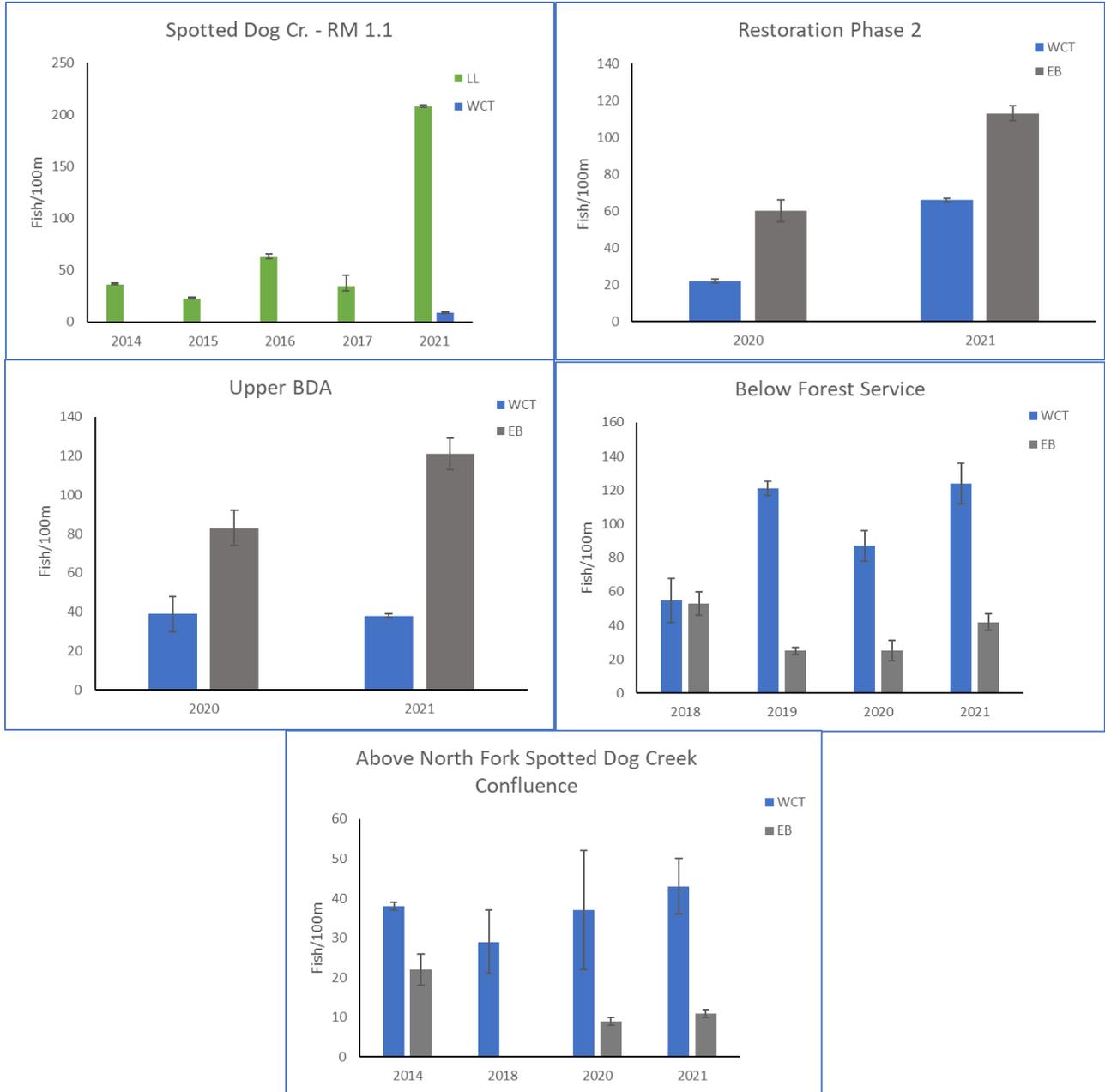
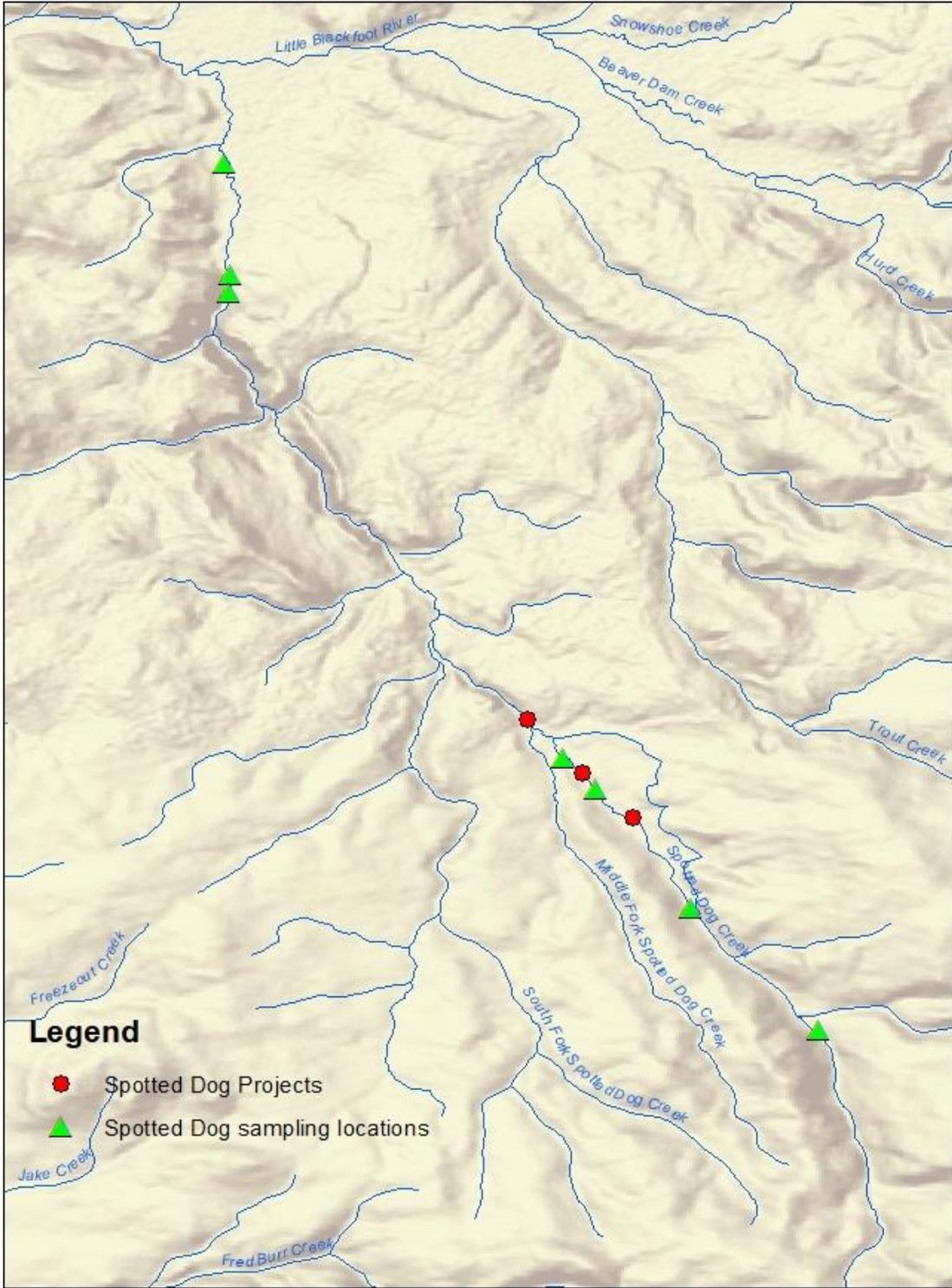


Figure 15. Trout estimates on five sections of Spotted Dog Creek.

Table 14. Electrofishing data collected from Spotted Dog in 2020. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length.

Section Name	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)	Estimate per 100m
RM 1.1	EB	4	1	152-286	213	126	208(207-209)
	LL	312	90	102-405	321	347	
	RM COT	19	6	50-96	73		
	SL COT	1	<1	99	99	13	
	WCT	9	3	156-335	239	153	
Restoration Phase 2	EB	74	77	45-216	102	20	60 (54-66)
	WCT	22	23	77-187	126	25	22 (21-23)
Upper BDA	EB	80	69	47-224	113	19	83 (74-92)
	SL COT	1	1	67			
	WCT	35	30	77-198	118	21	39 (30-48)
Below Forest Service	EB	28	22	46-216	144	45	25 (19-31)
	SL COT	7	6	45-109			
	WCT	91	72	32-215	107	17	87 (78-96)
Above N. Fork Spotted Dog Ck.	EB	10	16	73-171	99	18	9 (8-10)
	WCT	53	84	28-153	83	13	37 (22-52)



Map 5. Map of Spotted Dog Creek with Monitoring sections and restoration projects. A Beaver Dam Analog project was completed between the most downstream and most upstream red points and a stream channel and floodplain restoration project took place between the most downstream and middle red point.

Flint Creek

Three sampling sections were sampled on Flint Creek in 2021. These sections were sampled annually from 2014-2017 and since have been done every other year. Fish were collected using a barge mounted electrofishing unit with a throwable anode. Mark-recapture population estimates were calculated for trout ≥ 150 mm.

At the Hall section, the 2021 brown trout estimate was 554 fish/km (499-621). This estimate is similar to the 2019 estimate (599) which was the highest recorded for the Hall Section. The estimate for WCT in 2021 was 9 fish/km (6-19). This is the first time an estimate has been possible for WCT in the Hall section. One BULL (399 mm) was also captured. One BULL was also captured at the Hall section in 2016, 2017 and 2019. The LL estimate for the Johnson Tuning Fork section was 505 fish/km (454-571). This estimate is similar to the 2019 estimate (528) which was the highest brown trout estimate recorded at Johnson Tuning Fork. An estimate was completed for combined *Oncorhynchus* sp. (WCT, RB & RBxWCT). The estimate was 17 fish/km (14-34). Two BULL were also captured in this section. At the Chor section, the LL estimate was 712 fish/km (677-753) and the EB estimate was 49 fish/km (32-91). The 2021 estimates are significantly higher than past estimates. The previous high for LL estimates was 350 fish/km and for EB 7 fish/km. Ten RB and one WCT were also captured at the Chor section.

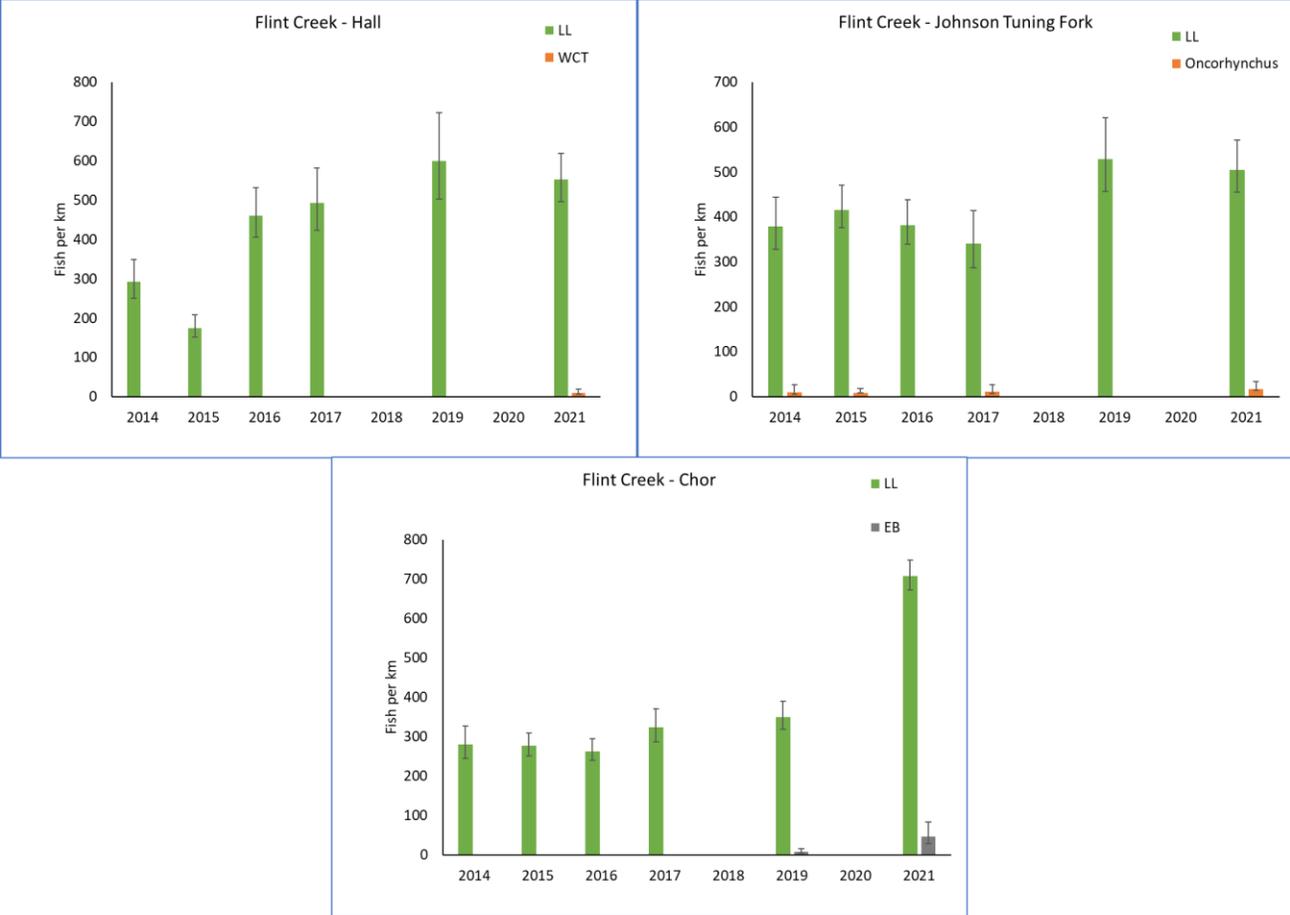


Figure 16. Mark/Recapture estimates for three sections of Flint Creek.

Table 15. Electrofishing data collected from Flint Creek in 2021. Population estimates (95% CI) are for trout greater than 150 mm (~ 6”) in total length.

section Name	Species	# Fish Handled	Species Composition (%)	Length Range (mm)	Average Length (mm)	Average Weight (g)
Hall	BULL	1	<1	399	399	526
	LL	606	98	165-520	270	229
	WCT	11	2	249-380	321	338
Johnson Tuning Fork	BULL	2	<1	215-348	282	195
	EB	3	1	222-263	247	152
	LL	475	95	175-495	253	181
	RB	14	2	176-356	270	203
	RBXWCT	3	1	365-411	384	555
	WCT	3	1	301-325	315	322
Chor	EB	39	4	169-316	220	115
	LL	894	95	167-602	252	181
	RB	10	1	180-294	210	89
	WCT	1	<1	289	289	244

Allendale – Private Users Diversion Upstream Fish Passage Study

Fall 2021

Installation of fish screens at the Allendale Canal and Private Users diversions will reduce the entrainment of trout and non-game fishes in Flint Creek. Improvements to headgates, diversions, and other infrastructure will also help sustain irrigation in the Flint Creek valley into the future. As part of these improvements, the old rock and tarp diversions are being replaced with notched concrete dams with low flow, fish passage channels leading downstream from the dam notch through a constructed riffle (Photo 1). Two of these constructed riffles with fishways will be completed; one on the Private Users diversion and one at the Allendale diversion. These kinds of diversions are a rather novel design, and although they will be a significant improvement for fish passage, information about the ability of fish to swim upstream through these structures is needed.

To assess upstream fish passage, two Positive Integrated Transponder (PIT) antennas were installed in the fishway of the Private Diversion on September 10th (Photo 1). One PIT antenna was placed near the bottom of the structure and one antenna was placed at the top. At the time of this study, construction of the Private Users diversion was complete while construction on the Allendale Diversion is underway. On September 13th, 113 fish were collected from Flint Creek downstream of the Private Diversion with backpack electrofishing units. These fish included 88 brown trout, 20 longnose suckers, three westslope cutthroat trout, one rainbow/cutthroat trout hybrid, and one bull trout. On September 14th, 34 additional fish were collected, this time from upstream of the Allendale Canal headgate and angling was used. Fish collected above Allendale included 27 brown trout, three rainbow/cutthroat trout hybrids, and four westslope cutthroat trout. In total 147 fish were captured ranging from 145-381 mm.

All fish were implanted with 23 mm PIT tags and released into the pool just downstream of the Private Diversion. We considered fish detected at the lower antenna to have entered the fishway and fish detected at the upper antenna to have moved upstream through the fishway. We considered a fish to have completely moved up and over the diversion if it was last detected at the upper antenna (and not moved back downstream to show up at the lower antenna).

Of the 147 fish tagged, 102 were detected at the lower antenna. Of the fish detected at the lower antenna, 81 were detected at the upper antenna. Only one fish, a longnose sucker, was detected at the lower antenna *after* being picked up at the upper antenna suggesting this fish did not successfully pass over the diversion structure. Two brown trout were detected at the upper antenna without being detected at the lower antenna indicating that these fish swam around the fishway. However, we would still consider this behavior to be rare.

There appeared to be differences between species in the time it took fish to move through the fishway. The two longnose suckers that successfully ascended the fishway both took over three hours to make the journey. Brown trout averaged 96 minutes to pass over the diversion, but individual brown trout ranged from 9 minutes to over six days to ascend the structure. Brown trout as small as 145 mm and as large as 381 mm passed through the fishway. There did appear to be a tendency for small brown trout to take longer to ascend the fishway compared to larger fish (Figure 18).

The two westslope cutthroat trout and two rainbow/cutthroat trout hybrids passed through the fishway in less than 21 minutes (19 minutes average). The single bull trout that we tagged was in the fishway for nearly eight hours before we ended up manually moving this fish over the diversion after it became stranded in the fishway when the fishway was temporarily dewatered for upstream construction.



Photo 1. The fishway and constructed riffle at the Private Users diversion. The PIT antennas are housed in PVC pipe and can be seen near the bottom and top of the fishway.

Table 16. Number of fish tagged, number of fish that passed through the upper and lower antennas, passed over the whole diversion structure, and average time to pass over the structure.

Species	No. Tagged	Lower Ant.	Upper ant.	Over diversion	Average time to pass (min)
Brown trout	115	91	73	73	96
Cutthroat and hybrids	11	4	4	4	19
Bull trout	1	1	1	1	480
Longnose sucker	20	6	3	2	221
<i>Total</i>	147	102	81	80	99

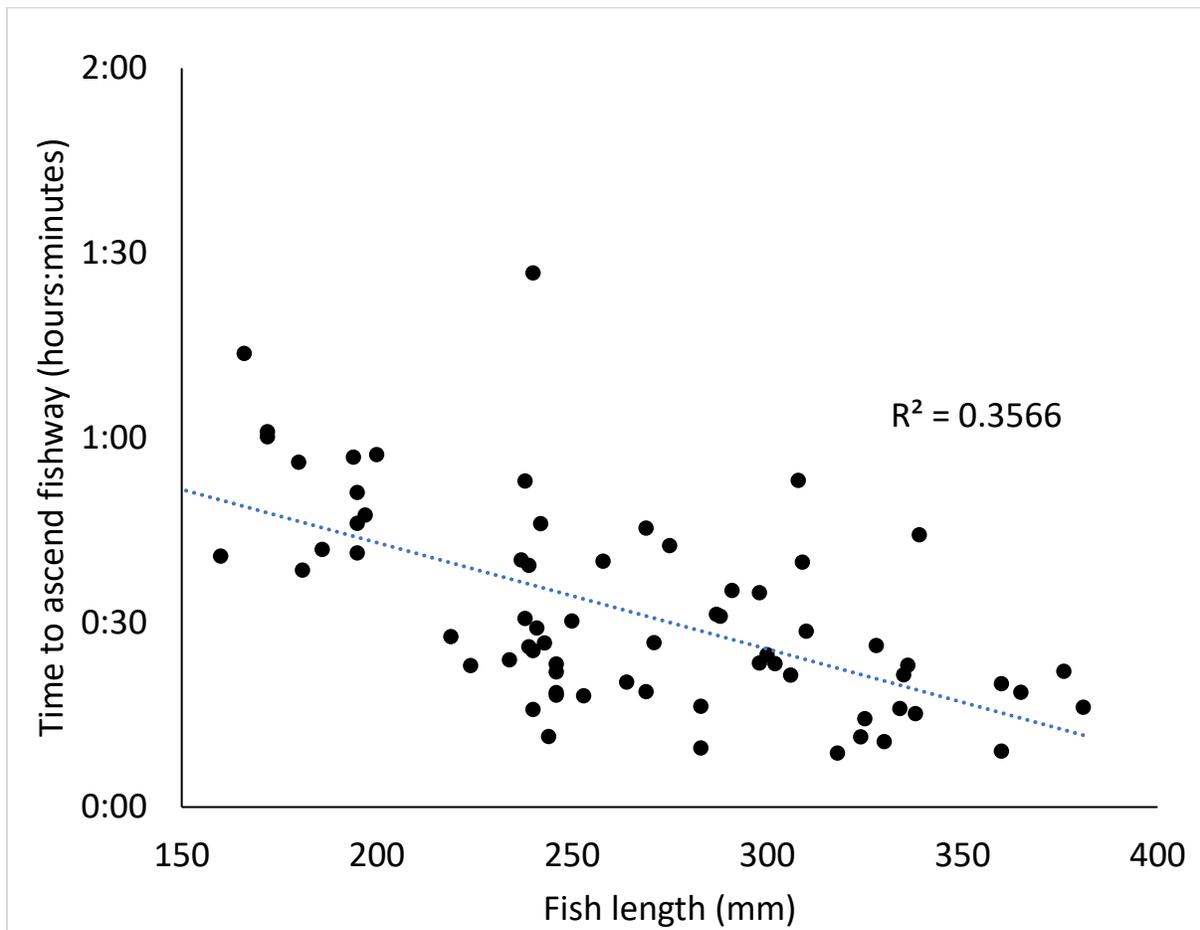


Figure 17. Time that fish took to ascend the fishway versus fish length for brown trout at the Private Users diversion. Four brown trout that took more than four hours to ascend the fishway are not included in this chart.

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