Northcentral Montana Westslope Cutthroat Trout Restoration Project

2024 Fisheries Monitoring Report

Fisheries Division Federal Aid Job Progress Report
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Region 4

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Introduction

Westslope cutthroat trout (WCT) *Oncorhynchus lewisi* have undergone reductions in distribution and abundance throughout their native range (Behnke 2002; Shepard et al. 2005; Heckel et al. 2020). The upper Missouri River drainage in Montana in particular has experienced marked reductions, with WCT occupying less than 5% of their historical range (Shepard et al. 1997; Shepard et al. 2003). Nonnative species introductions, habitat degradation, fragmentation, and overexploitation have been identified as factors leading to population declines (Shepard et al. 2005; Muhlfeld et al. 2016; Heckel et al. 2020). However, human-induced hybridization with nonnative trout has been especially detrimental causing widespread genomic extinction of WCT populations (Allendorf and Leary 1988; Muhlfeld et al. 2014, Bourret et al. 2022).

The declining status of WCT has led to its designation as a Species of Special Concern by the State of Montana, a Sensitive Species by the U.S. Forest Service (USFS), and a Special Status Species by the U.S. Bureau of Land Management (BLM). In addition, in 1997 a petition was submitted to the U.S. Fish and Wildlife Service (USFWS) to list WCT as "threatened" under the Endangered Species Act (ESA). A 2003 USFWS status reviews found that WCT are "not warranted" for ESA listing; however, this finding was in litigation until 2008 and additional efforts to list WCT under ESA are possible in the future.

In an effort to advance range wide WCT conservation efforts in Montana, a Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana was developed in 1999 by several federal and state resource agencies (including BLM, Montana Fish, Wildlife & Parks [FWP], USFS, and Yellowstone National Park), non-governmental conservation and industry organizations, tribes, resource users, and private landowners (FWP 1999: MOU). The MOU outlined goals and objectives for WCT conservation in Montana, which if met, would significantly reduce the need for special status designations and listing of WCT under the ESA. The MOU was revised and endorsed by signatories in 2007 (FWP 2007). As outlined in the MOU's, the primary management goal for WCT in Montana is to ensure the long-term self-sustaining persistence of the subspecies in its historical range. This goal can be achieved by maintaining, protecting, and enhancing all designated WCT "conservation" populations, and by reintroducing WCT to habitats where they have been extirpated.

A Federal Challenge Cost Share Agreement was established in 2001 between FWP and the USFS to implement and fund WCT restoration (Tews et al. 2000) as outlined by the MOU. Funding for the 2015 WCT restoration project was provided by the EPA and the State Wildlife Grants (SWG) program. In the 2016-2019 period, Northwestern Energy (formerly PPL Montana), Resource Development Grant Program (RDGP), and the Future Fisheries Program (FWP) provided additional funding for WCT restoration. At the November 2024 Missouri River Technical Advisory Committee (MoTAC) meeting, FWP was awarded $32,123 from Northwestern Energy to fund a fisheries technician to work directly with the FWP native species biologist on the Northcentral Montana WCT Restoration Project. This document specifically addresses work performed in 2024 for WCT restoration in northcentral Montana.

Study Area

The status of WCT in northcentral Montana is described in this document. The following major drainages are included in the general study area: Arrow Creek, Belt Creek, Judith River, Smith River, Sun River, Teton River, Two Medicine River, Upper Missouri River, and the upper Missouri-Dearborn River (Figure 1).

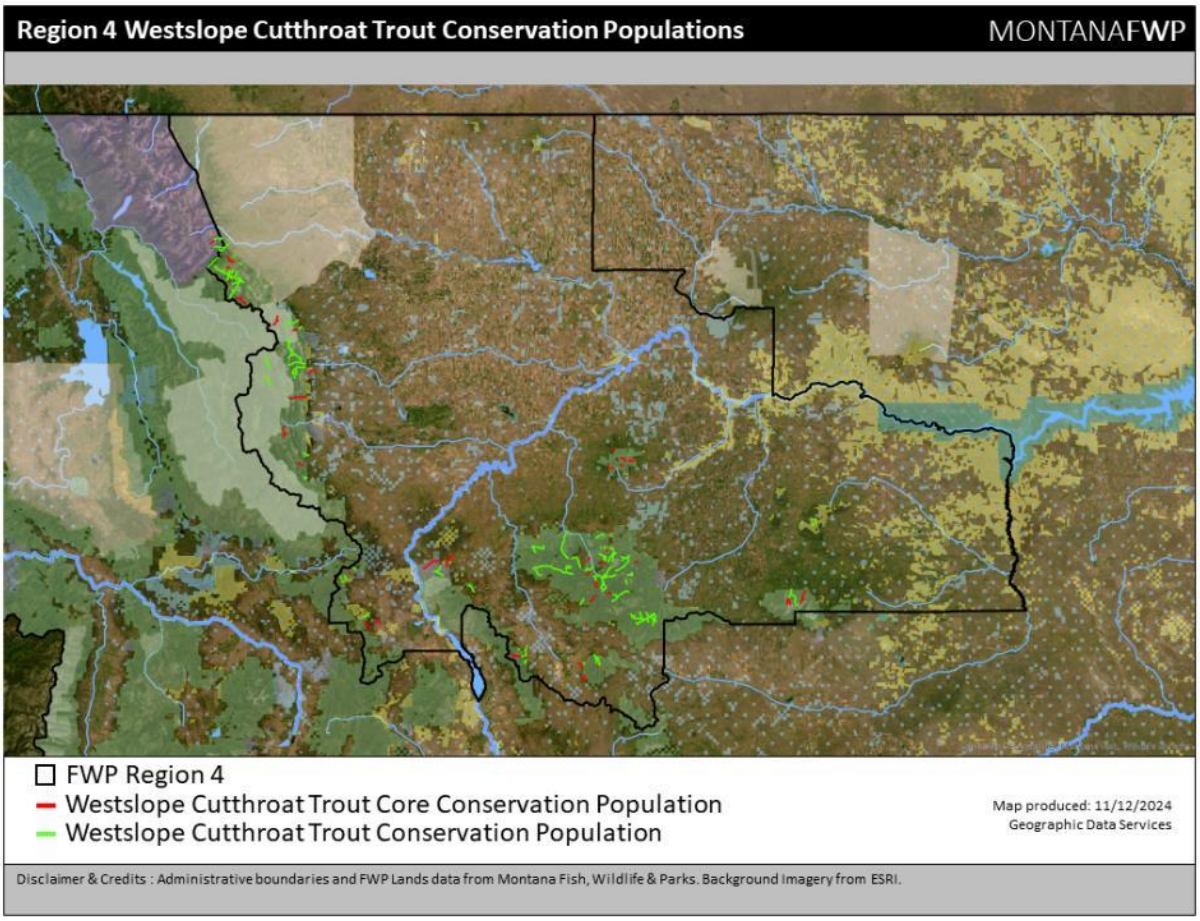

Figure 1. Study area in northcentral Montana with WCT conservation populations.

Methods

Sampling of stream fish populations was conducted with a Smith-Root™ model LR-20B and/or model LR-24 battery powered backpack electrofishing unit(s) set to 30 hertz (Hz) at approximately 0.8-1.6 amperes (A) and 100-900 volts (V) dependent on conductivity. Relatively smaller streams were sampled with one backpack electrofishing unit and two backpack electrofishing units were used in tandem in larger streams and rivers. Multiple pass depletion method was typically used to estimate WCT population abundance in sampled streams (Zippin 1958; Carle and Strub 1978). Mean wetted stream width was determined by measuring ten random transects within each survey section. Stream dimensions were combined with population estimates and mean trout weight to calculate trout density (fish/km, fish/hectare) and biomass (kg/ha). Genetic samples were collected and preserved in 95% ethanol to be sent to the University of Montana Fish Conservation Genetics Lab for genetic analysis. Genetic results

from samples collected in 2024 are pending unless otherwise noted. Total length of fish was measured to the nearest millimeter and weight was measured to the nearest gram using an electronic scale. Conductivity in microsiemens (μS) and temperatures in degrees Celsius (°C) was measured and recorded in sampled streams.

The "Westslope Cutthroat Trout Restoration Plan" (Tews et al. 2000), the 1999 and 2007 Conservation Agreements (FWP 1999, 2007), and the "Status and Conservation Needs Plan" (Moser et al. 2009) are documents that detail the conservation techniques. Efforts include the creation and maintenance of barriers to block upstream movement of nonnative/invasive fish species, decreasing the number of sympatric nonnative fish present through suppression and removal to assist WCT survival, and performing piscicide treatments to create a fishless habitat in which to reestablish WCT. Increasing the range of WCT populations is achieved through transfer of nonhybridized WCT to fishless headwater streams, either in the form of live fish transfers or gametes transferred to remote site incubators (RSIs).

Conservation techniques applied during the 2024 field season include: fish barrier maintenance, fish barrier survey and design, fishless habitat evaluation, mechanical removal of nonnative trout, WCT demographic and genetic monitoring, and wild fish transfer.

Restoration Efforts in Northcentral Montana

The scope of the work completed by FWP in 2024 is described in the following maps, text, figures and tables. The USFS and FWP worked cooperatively on many of the following projects. This report is organized by USGS hydrological unit code (HUC 8) subbasins where restoration efforts occurred and include: Arrow Creek, Belt Creek, Judith River, Smith River, Teton River, Two Medicine River, Upper Missouri River, and Upper Missouri-Dearborn River.

I. Arrow Creek Subbasin

Cottonwood Creek

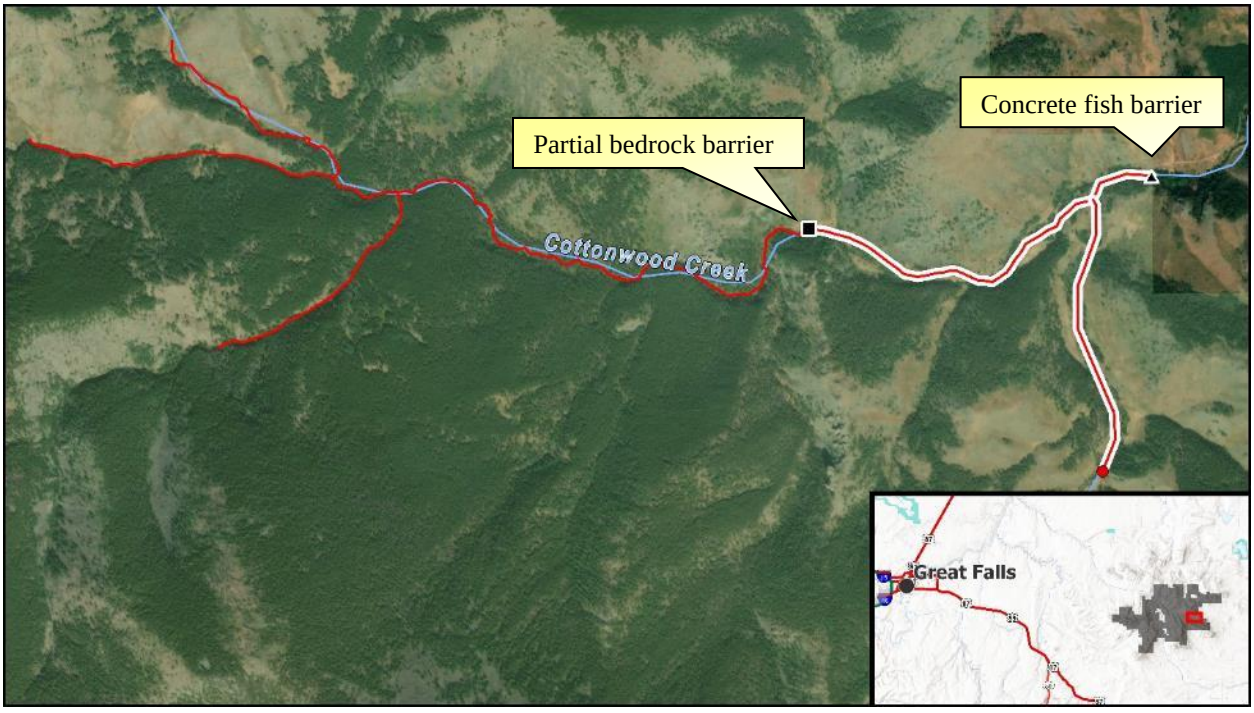

Figure 2. Cottonwood Creek in the Arrow Creek subbasin. Stream segments delineated in red indicate extent of WCT occupied habitat. The section highlighted in white indicates the area sampled in 2024.

Background

Cottonwood Creek contains a nonhybridized population of WCT protected by a natural bedrock barrier. In 2001, a concrete fish barrier was installed at the Lewis and Clark National Forest Service boundary (47.44472, -110.47552) to further protect and expand the WCT population (Figure 2). Brook trout removal was performed between the concrete barrier and bedrock barrier from 2000-2005 and appeared effective at removing all brook trout above the constructed fish barrier. Since 2005, monitoring has occurred periodically and in 2015 brook trout were detected upstream of the constructed fish barrier. The origin of these fish is unknown, as the barrier appeared structurally sound and functional during the 2015 sampling. Removals performed in the summer of 2016-2019 resulted in the removal of 34 brook trout. No brook trout were detected above the constructed fish barrier in 2020, a single brook trout was removed in 2021, and no brook trout were detected in 2022 and 2023.

2024 Monitoring

A single pass electrofishing monitoring effort was performed on Cottonwood Creek on September 11th, 2024. The mainstem of Cottonwood Creek was shocked from the constructed fish barrier to the partial waterfall barrier and the first tributary was shocked from its confluence with Cottonwood Creek upstream 250 m. Species and total number of fish were recorded. A total of 532 WCT were collected in the mainstem of Cottonwood Creek between the barriers and 284 WCT were collected in the 1st tributary. No brook trout were detected. Brook trout have not been detected for three consecutive years in Cottonwood Creek. eDNA monitoring should be implemented to achieve a brook trout detection probability of 100%.

II. Belt Creek Subbasin

Big Timber Gulch

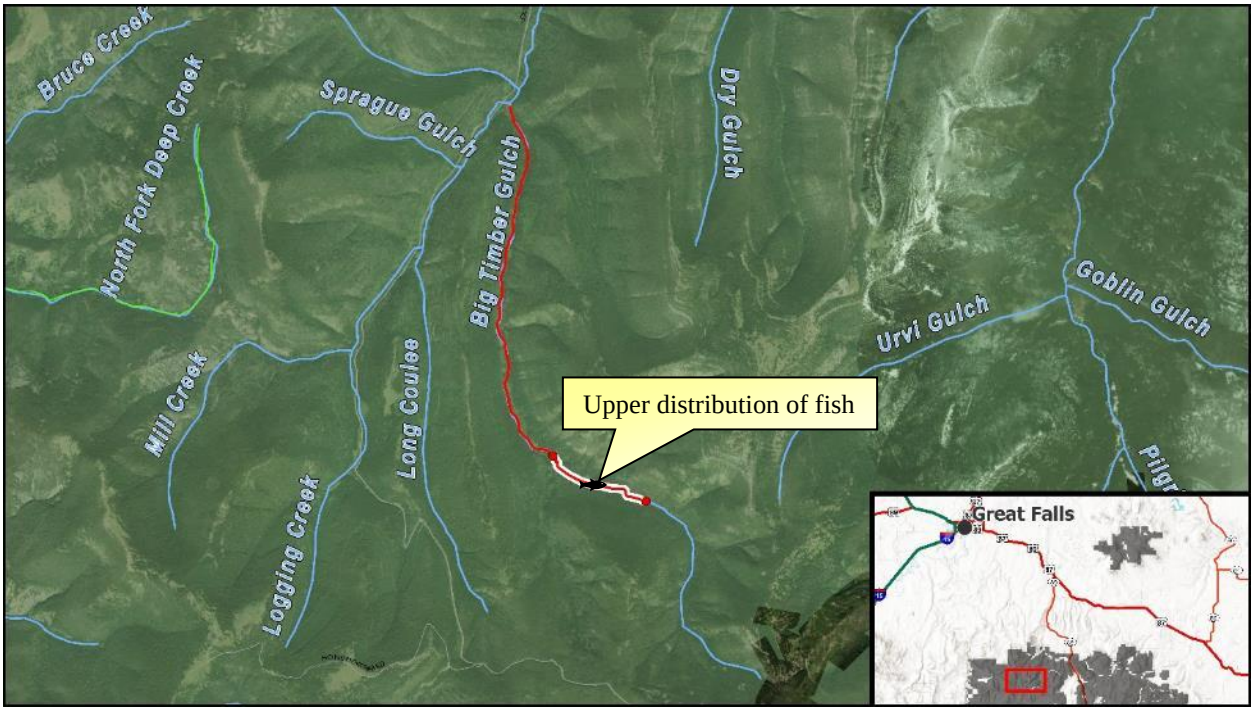

Figure 3. Big Timber Gulch in the Belt Creek subbasin. Stream segments highlighted in white indicate the area sampled in 2024.

Background

Big Timber Gulch is a tributary of Logging Creek located approximately 10 miles west of the community of Monarch, MT. WCT were detected in Big Timber Gulch for the first time in 2023 in the lower and middle sections along with brook trout.

2024 Monitoring

Big Timber Gulch was revisited on July 24th, 2024, to collect genetic samples and determine upstream WCT distribution. An approximately 800 m reach of stream was backpack electrofished in the headwaters of Big Timber Gulch. A total of 27 WCT were collected with genetic samples obtained from 20 individuals. No brook trout were detected. The upper distribution of fish was determined to be 47.0247, -111.0308. Big Timber Gulch appears to provide around 3.14 miles of habitat for WCT that likely fluctuates on an annual basis on the downstream end as the stream goes subsurface before it reaches Logging Creek under baseflow conditions.

Carpenter Creek

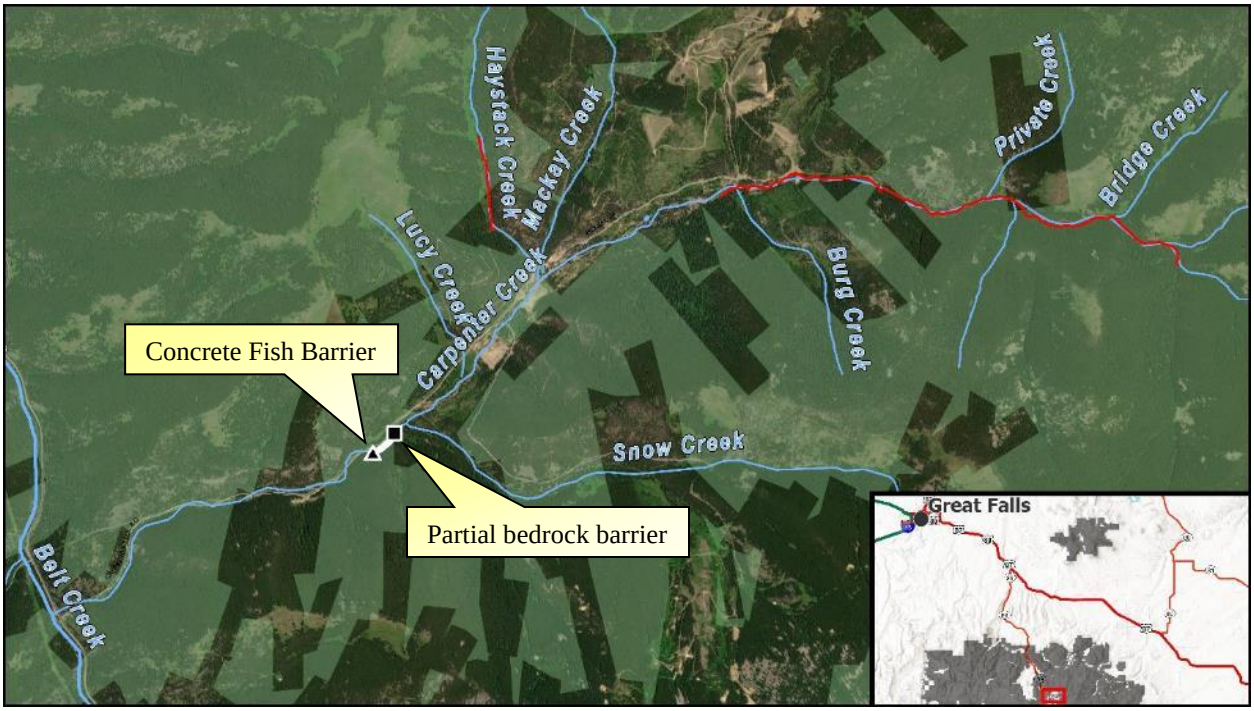

Figure 4. Carpenter Creek in the Belt Creek subbasin. The stream segments delineated in red indicate the areas occupied by nonhybridized WCT. The section highlighted in white indicates the area sampled in 2024.

Background

The Carpenter Creek drainage contains two nonhybridized populations of WCT; one in its headwaters and one in Haystack Creek. Both populations are currently isolated and protected from nonnative species invasions by a constructed concrete fish barrier completed in 2023. Prior to the completion of the barrier, rainbow trout were detected upstream of the barrier location but downstream of a partial bedrock barrier near the Snow Creek confluence in 2022. Annual monitoring has been performed in the reach between the barriers since construction was completed and no nonnative trout have been detected.

Demographic and genetic monitoring of the Carpenter Creek WCT population was performed most recently in 2018. A total of 591 fish 100 mm and greater were estimated in Carpenter Creek over approximately 2.5 kilometers of occupied habitat.

2024 Monitoring

Carpenter Creek was backpack electrofished from the constructed barrier to the partial bedrock barrier to monitor nonnative trout presence in a single pass effort on August 2nd, 2024. No fish were observed in the reach of Carpenter Creek sampled.

Dry Fork Belt Creek

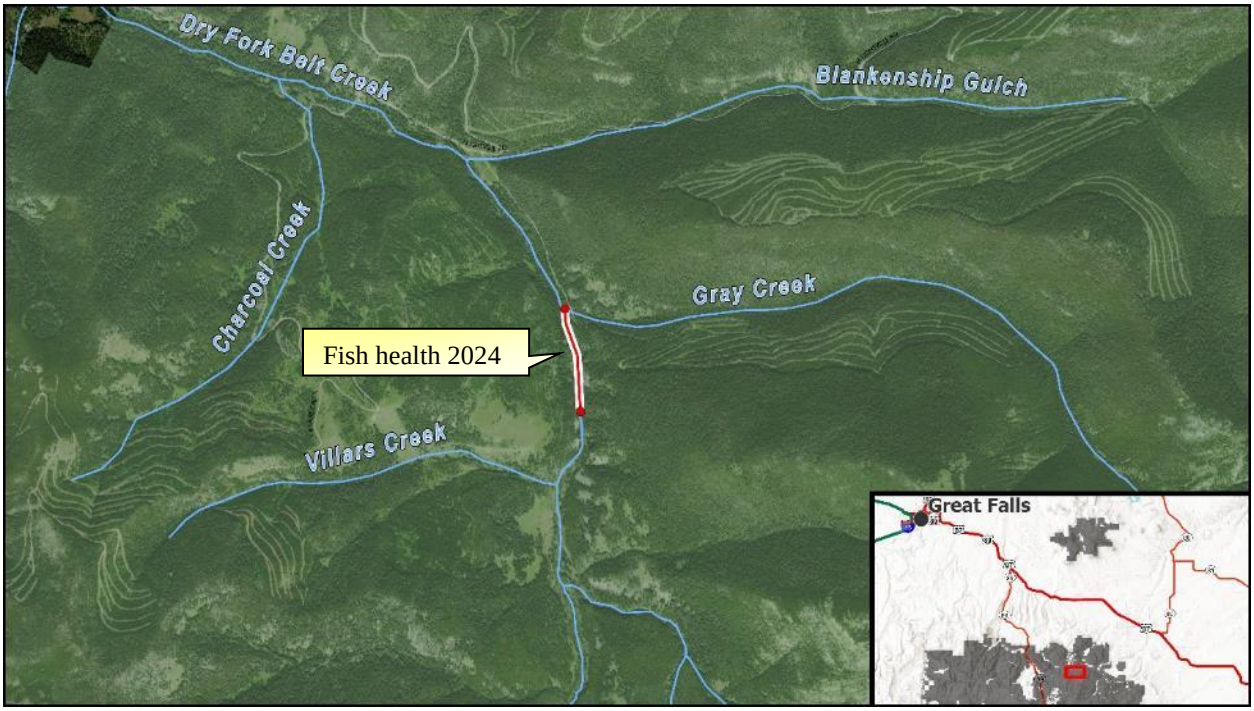

Figure 5. Dry Fork Belt Creek in the Belt Creek subbasin. The stream segment delineated in red indicates the area sampled in 2024.

Background

Several tributaries of Dry Fork Belt Creek contain core conservation populations of WCT including Bender Creek, Charcoal Creek, upper Dry Fork Belt Creek, Gold Run Creek, Henn Gulch, Oti Park Creek, Spruce Creek, and Villars Creek. These small populations vary in their level of security to nonnative trout invasion with several currently containing sympatric Brook Trout. Presently, opportunity exists to salvage nonhybridized and slightly hybridized individuals from some of these populations before being lost to genomic extinction.

2024 Fish Health Inspection

Dry Fork Belt Creek was sampled on September 9th, 2024, to collect fish for fish health analysis. A 550 m reach of stream was backpack electrofished between the Gray Creek and Villars Creek confluence. A total of 45 brook trout and 15 WCT were collected. All fish were lethally sampled and submitted for fish health analysis. No pathogens were detected in samples submitted for testing (Fish Health Inspection Report #240060).

Gold Run Creek

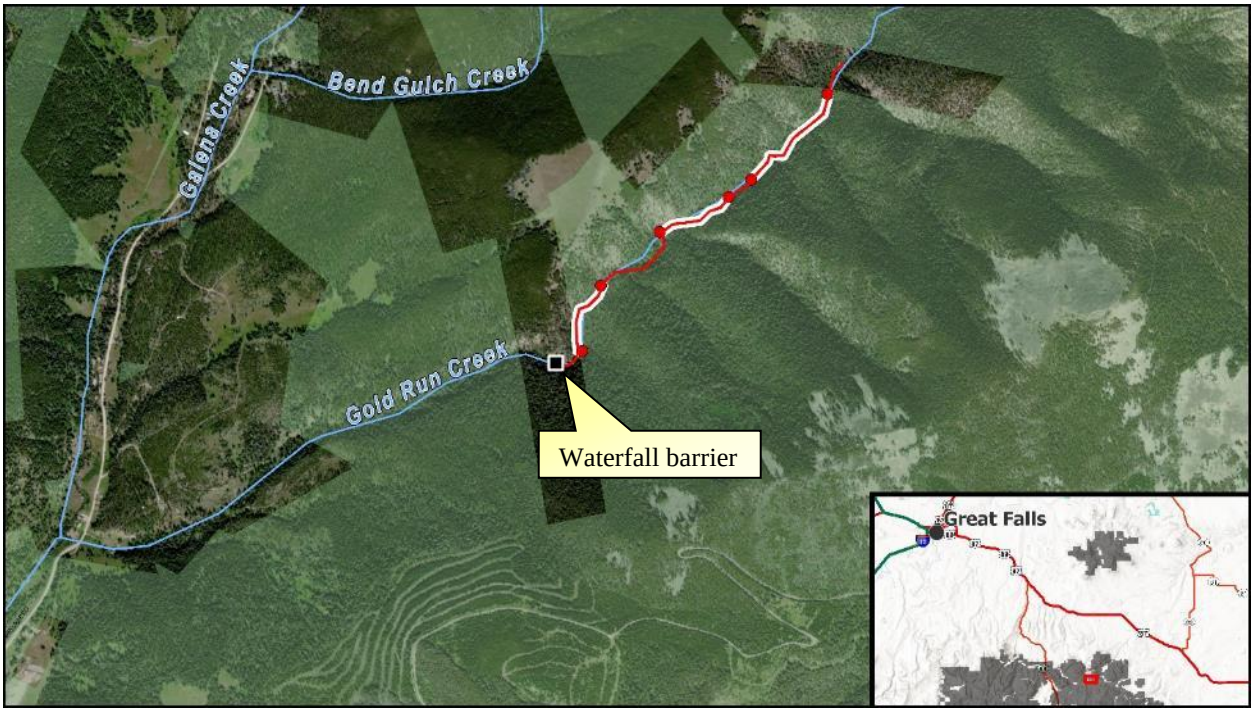

Figure 6. Gold Run Creek in the Belt Creek subbasin. The stream segment delineated in red indicates the area occupied by nonhybridized WCT. The sections highlighted in white indicate the areas sampled in 2024.

Background

Gold Run Creek is a tributary of Galena Creek in the Dry Fork Belt Creek drainage. A nonhybridized WCT population is present above a 90 ft waterfall barrier located at 47.06454, -110.62597. This population was expanded into upstream fishless habitat from 2001-2006 and now currently occupies approximately 0.88 miles of habitat. Gold Run Creek was included in a University of Montana (UM) genetic rescue study that began in 2017. As part of this study, intensive annual demographic and genetic monitoring of this population has been performed since 2017 by UM researchers.

2024 Monitoring

FWP staff assisted UM researchers in collecting genetic samples from Gold Run Creek as part of the long-term monitoring of the genetic rescue study. Three reaches of Gold Run Creek were sampled (Lower, Middle, and Upper) until 50 previously untagged individual WCT were collected. Genetic tissue samples were collected from untagged WCT and tagged WCT were released after recording tag information. A total of 347 WCT were collected, of which 235 were untagged and 112 were previously tagged. Data collected in 2024 will help inform demographic and genetic models for Gold Run Creek allowing for a detailed examination of genetic rescue techniques on isolated WCT populations.

Graveyard Gulch

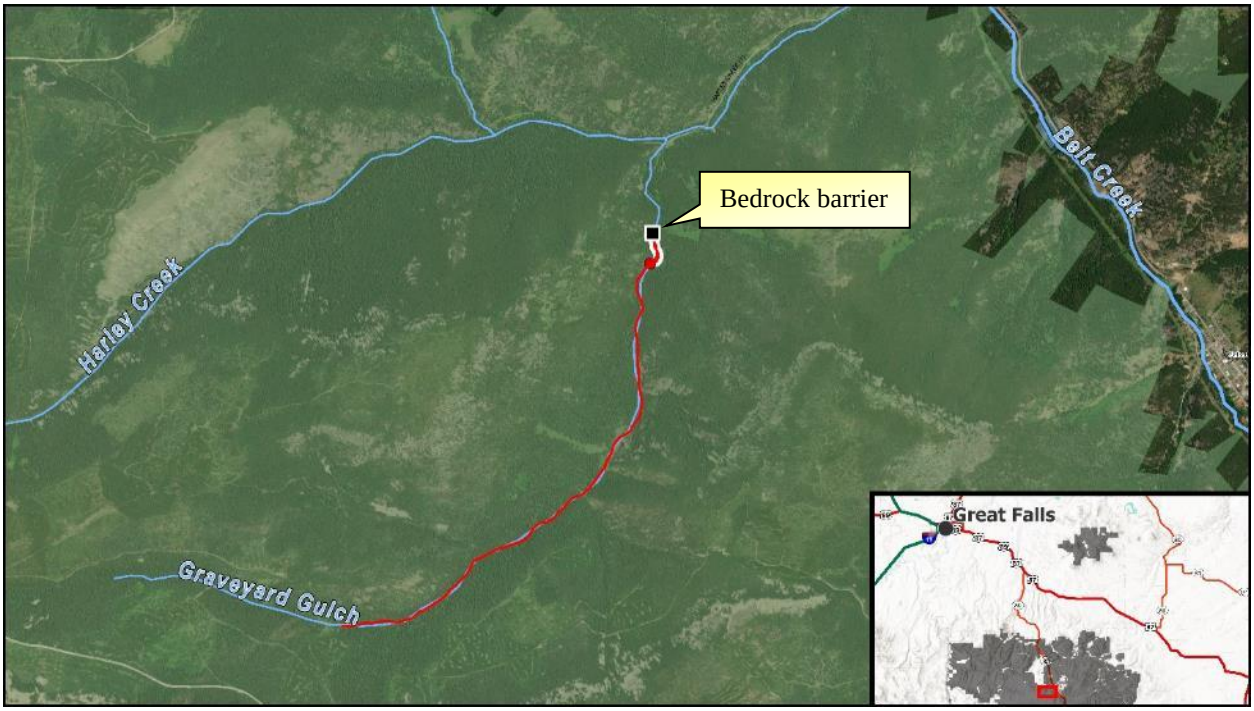

Figure 7. Graveyard Gulch in the Belt Creek subbasin. The stream segment delineated in red indicates the area occupied by nonhybridized WCT. The section highlighted in white indicates the area sampled in 2024.

Background

Graveyard Gulch contains a nonhybridized population of WCT protected from nonnative trout invasion by a small waterfall barrier located about 0.63 km above its confluence with Harley Creek (46.93949, -110.77791; Figure 7). To date, no brook trout have been found upstream of the waterfall during periodic monitoring. However, brook trout are present immediately downstream of the waterfall barrier. The drop of the waterfall appears to lack sufficient height to be secure under all flow conditions, yet nonnative trout appear to be precluded from upstream movement. The buildup of sediment and rocks directly downstream of the waterfall were removed in 2016, 2018, 2019, and 2020 to reduce the depth and size of the jump pool with intent to further reduce the likelihood of nonnative trout invasion.

2024 Monitoring

A single pass electrofishing monitoring effort was performed on Graveyard Gulch on August 28th, 2024. A 200 m reach was backpack electrofished starting from the bedrock barrier moving upstream. A total of 54 WCT were collected ranging in size from 67-203 mm in this effort. No brook trout were detected.

The Graveyard Gulch drainage was impacted by the large snowstorm of May 7-8, 2024. A large Douglas fir was downed by the heavy snowfall and was bridging the creek at the outlet of the barrier pool located at 46.93949, -110.77791. This tree was removed on 5/21/2025 before it fully incorporated into the stream and potentially increased the barrier pool height.

Lost Creek

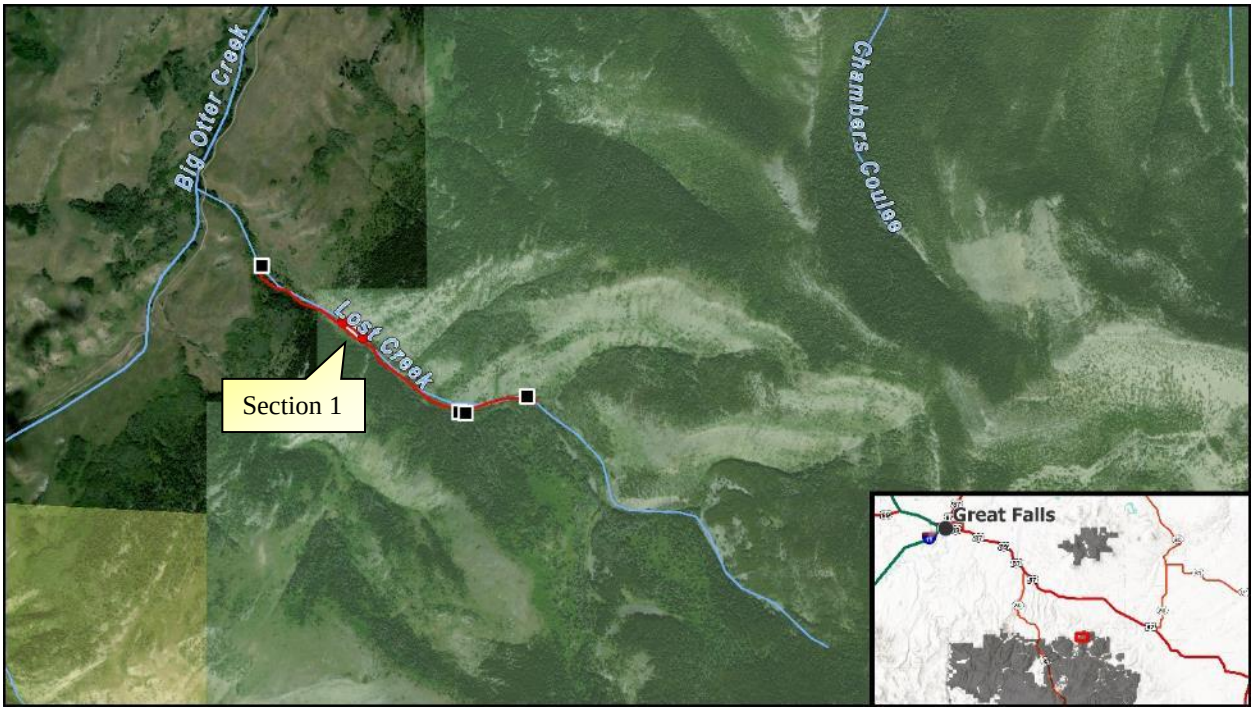

Figure 8. Lost Creek in the Belt Creek subbasin. The stream segment delineated in red indicates the area occupied by WCT. The section highlighted in white indicates the long-term monitoring reach sampled in 2024.

Background

Lost Creek contains a small population of WCT isolated from Big Otter Creek by a natural bedrock barrier and a seasonal intermittent flow barrier. Previous genetic analysis of the Lost Creek WCT population has produced conflicting results. Allozyme analysis of fish collected in 1996 and 2005 found no evidence of nonnative alleles. However, PINEs analysis of 49 fish collected in 2002 indicated the population appeared to contain a 94.5% WCT and 5.5% YCT genetic contribution.

2024 Monitoring

Lost Creek was revisited on July 31st, 2024, to perform demographic and genetic monitoring. The 100-m long-term monitoring site established by the Forest Service was resampled to obtain a population estimate as well as updated genetic samples. Multiple pass depletion methods were used to estimate population abundance. An estimated density of 180 fish/km were found based on the results of the population estimate (Figure 9). When extrapolated to the entire length of the occupied habitat (1.17 km), a total of 211 WCT are estimated to be present. Updated genetic samples (n=25) were also collected from the throughout the length of occupied habitat to determine present genetic status.

The long-term monitoring site on Lost Creek should be moved upstream based on the findings of the 2024 population estimate. The majority of the fish sampled in the 100 m reach were collected all in the upper 25 m. of the section. This area appears to be the downstream end of fish distribution, although some fish were observed below this point. Spot shocking above the long-term monitoring reach found higher densities of WCT.

Lost Creek —NATIVE TROUT POPULATION SURVEY

1. General Information— Date: **July 31, 2024** Biologist: **A. Poole**
2. Stream Information—
   Name, section, county: **Lost Creek, 29, Judith Basin**
3. Survey Site Information (see attached map)—
   Upstream range of native trout (general description and GPS): **Bedrock slide (47.12234, -110.60846)**
   Downstream range of native trout (general description and GPS): **Bedrock barrier #1 (47.12659, -110.62108)**
   Location (GPS) and description of barriers:
   Bedrock barrier #1 (**47.12659, -110.62108; isolates nonhybridized WCT population)**
   Bedrock barrier #2 (47.12185, -110.61168; old upstream distribution of WCT)
   Bedrock barrier #3 (47.12182, -110.61138; additional barrier in occupied reach)
   Bedrock slide (47.12234, -110.60846; present upstream distribution of WCT)
   Stream Length—Occupied habitat: **1.17 km (0.73 mi)** Available habitat: **1.17 km (0.73 mi)**
   Survey method & equipment: **backpack battery electrofisher; two-pass depletion**
   Survey sites (general description and UTM)—
   Section 1: **Lost Creek – 50 m above FS boundary; 47.12476, -110.6172**

Parameter	**Section 1**
Section length (m)	100 m
Mean stream width (m) (n)	2.35 m (10)
Section area (hectares)	0.024 ha
WCT	
Removal Pattern	16 2
Population estimate	18 (±1)
Capture probability	0.900
Mean length (mm) (n)	142 (18)
Mean weight (g) (n)	35 (18)
Mean KTL (n)	0.94 (18)
Number fish per km (95 % CI)	180 (±10)
Number fish per ha (95 % CI)	750 (±42)
Biomass (kg per ha) (95 % CI)	26 (±1)

Figure 9. Lost Creek fish population estimate results.

Middle Fork Little Belt Creek

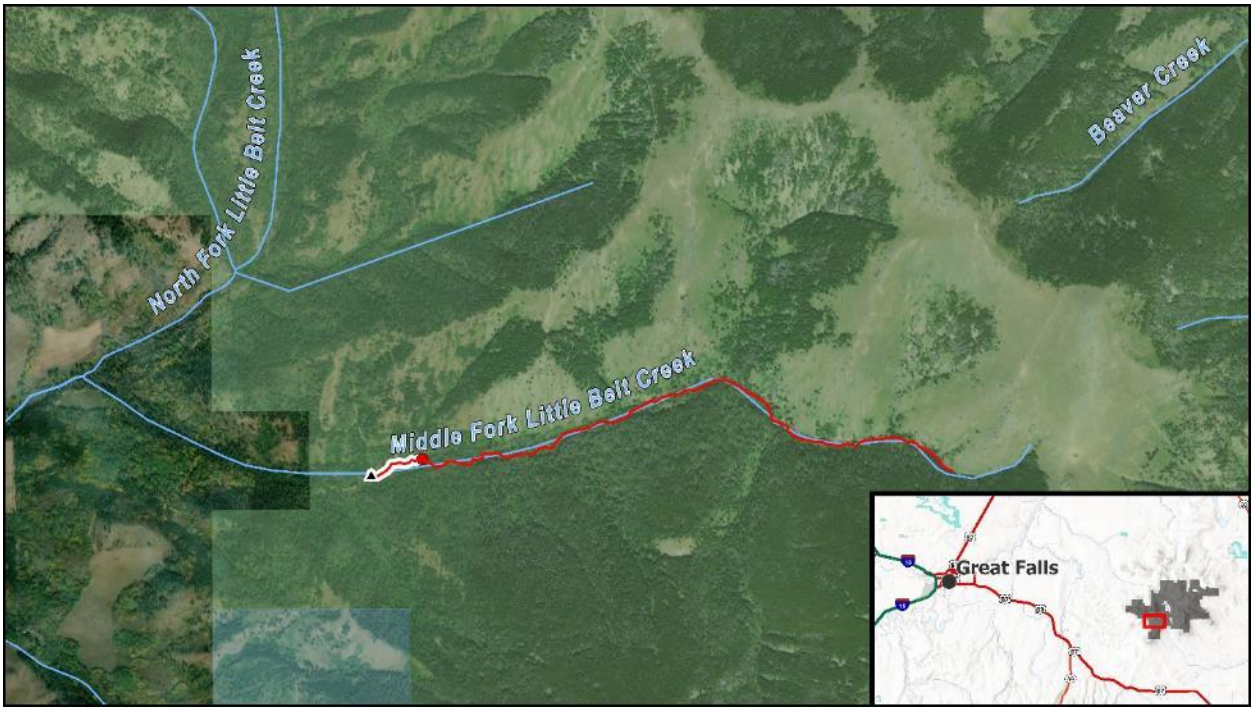

Figure 10. Middle Fork Little Belt Creek in the Belt Creek subbasin. The stream segment delineated in red indicates the area occupied by WCT. The section highlighted in white indicates the area sampled in 2024.

Background

Middle Fork Little Belt Creek contains a slightly hybridized population of WCT protected from nonnative trout invasion by a culvert barrier at the FS RD 8830 crossing. A sympatric Brook Trout population was mechanically removed from 1997 to 2004. Since 2004, no Brook Trout have been detected above the barrier during monitoring efforts.

2024 Monitoring

Middle Fork Little Belt Creek was sampled on September 10th, 2024, to perform presence/absence monitoring following high flow events during spring runoff. A 275 m reach of stream was backpack electrofished to monitor for nonnative trout presence above the culvert barrier. A total of 76 WCT were collected ranging in size from 73-266 mm in length. No nonnative trout were detected.

North Fork Little Belt Creek

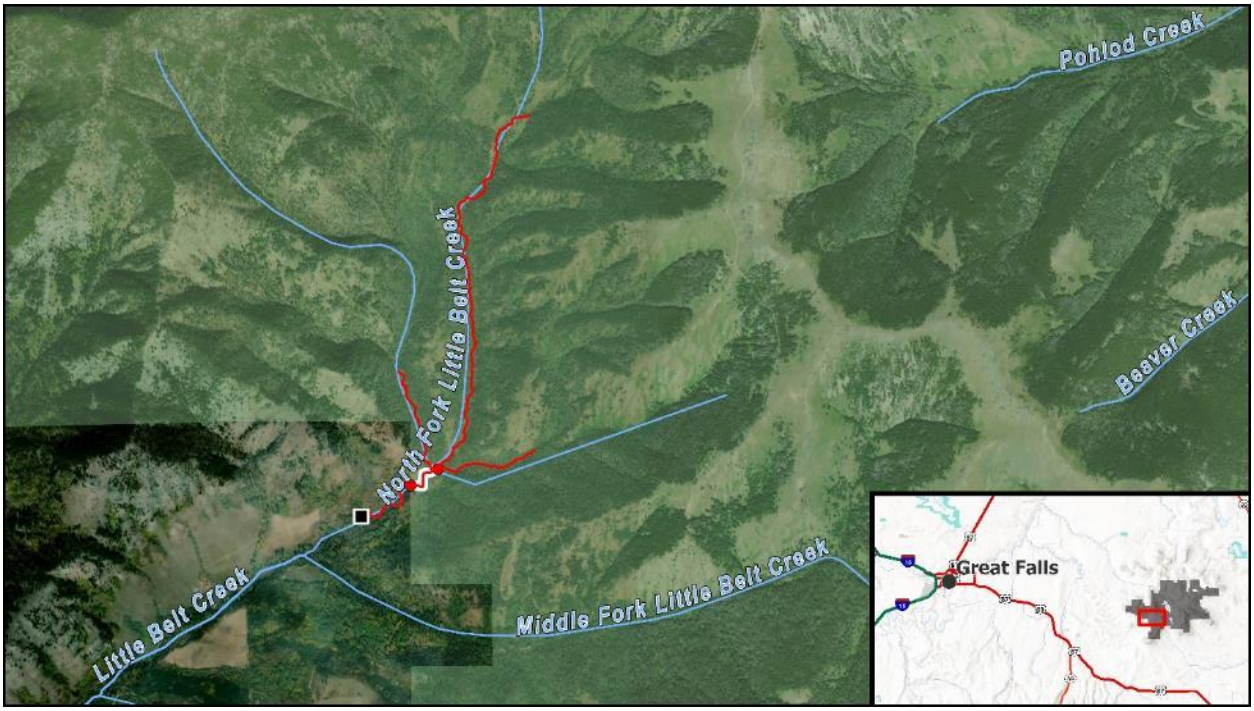

Figure 11. North Fork Little Belt Creek in the Belt Creek subbasin. The stream segment delineated in red indicates the area occupied by WCT. The section highlighted in white indicates the area sampled in 2024.

Background

North Fork Little Belt Creek is a tributary of Little Belt Creek in the Highwood Mountains located approximately 13 miles east of the community of Belt, MT. A natural bedrock barrier isolates a nonhybridized WCT population in the upper 2.4 miles of the stream. North Fork Little Belt was included as a study site in the UM genetic rescue study. In 2020, UM researchers collected a single brook trout above the bedrock barrier during annual sampling. This was the first collection record of a brook trout above the bedrock barrier.

2024 Monitoring

North Fork Little Belt Creek was sampled on September 10th, 2024, to perform presence/absence monitoring following high flow events during spring runoff. A 550 m reach of stream was backpack electrofished to monitor for nonnative trout presence above the bedrock barrier. A total of 129 WCT were collected ranging in size from 75-245 mm in length. No nonnative trout were detected.

Pilgrim Creek

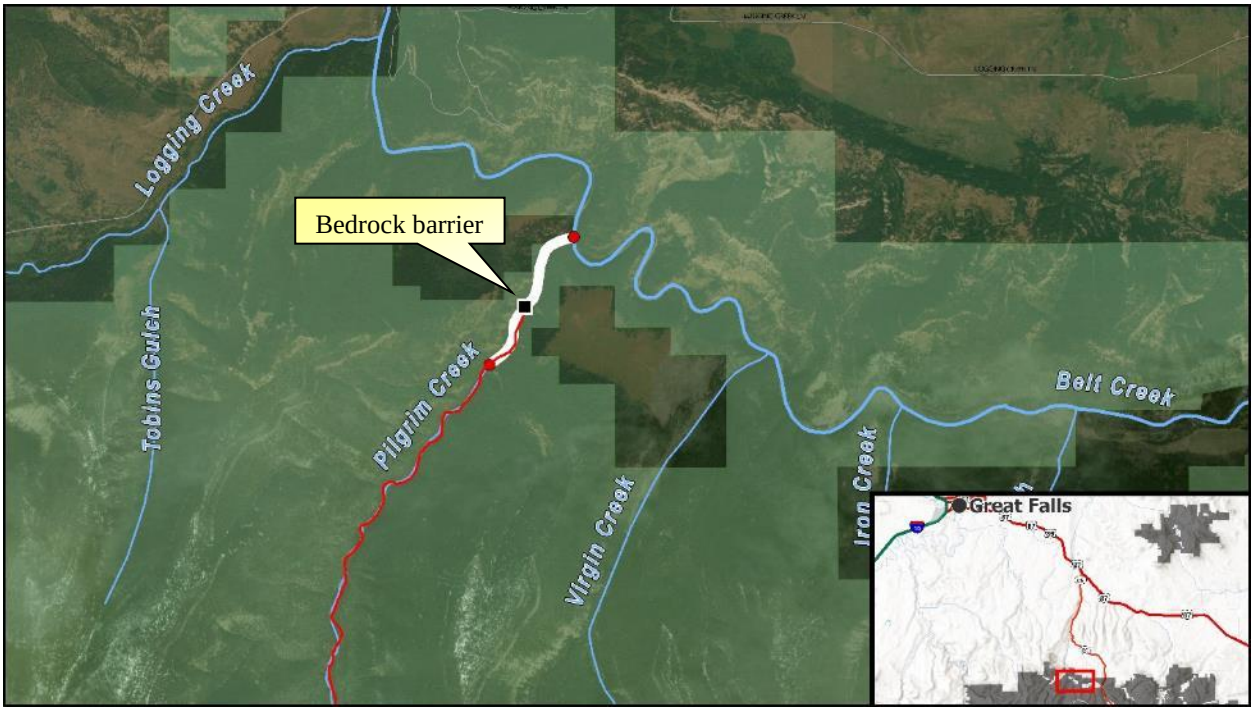

Figure 12. Pilgrim Creek in the Belt Creek subbasin. The stream segment delineated in red indicates the area occupied by WCT. The section highlighted in white indicates the area sampled in 2024.

Background

Pilgrim Creek contains a WCT population of mixed genetic status with predominately nonhybridized fish occupying the headwaters of the creek and hybridized fish becoming more prevalent in downstream reaches. A small natural bedrock barrier located approximately 700 m upstream of the confluence of Belt Creek was enhanced in 2003 with native rock to increase drop height (Figure 12). The enhanced bedrock barrier appears to be somewhat effective in restricting the upstream movement of nonnative fish. However, the appearance of a marked WCTxRB hybrid above the barrier in 2020 indicates that larger fish can negotiate the barrier under certain flow conditions. Presently, opportunity exists to salvage nonhybridized and slightly hybridized individuals from the headwaters of Pilgrim Creek before being lost to genomic extinction.

2024 Fish Health Inspection

Pilgrim Creek was sampled on September 3rd, 2024, to collect fish for fish health analysis. A 700 m reach of stream was backpack electrofished below the bedrock barrier and a 300 m reach was electrofished above. A total of 4 brook trout, 17 rainbow trout, 10 WCTxRB hybrids, and one WCT were collected below the barrier. Eight WCTxRB hybrids and 24 WCT were collected above the barrier. All fish were lethally sampled and submitted for fish health analysis. Lots were split and analyzed separately based on above/below barrier status. *Myxobolus cerebralis* was suspected positive via PT digest and confirmed by PCR in 4/6 pools of fish collected below the barrier. No pathogens were detected in fish collected above the bedrock barrier (Fish Health Inspection Report #240059).

Villars Creek

Figure 13. Villars Creek in the Belt Creek subbasin. The stream segment delineated in red indicates the area sampled in 2023.

Background

Villars Creek is a small tributary of Dry Fork Belt Creek in the Belt Creek subbasin located approximately 11 miles southeast of the community of Monarch, MT. The creek contains 0.25-miles of fish bearing habitat and contains both WCT and brook trout. A 21 fish sample collected in 2012 indicated that the WCT population in Villars Creek was nonhybridized at that time. An updated 20 fish sample collected in 2022 indicated that most individuals had <1% non-native ancestry, and over 50% of the fish had <0.5% non-native ancestry. Presently, opportunity exists to salvage nonhybridized and slightly hybridized individuals from Villars Creek before being lost to genomic extinction.

2024 Monitoring

The entire fish bearing reach of Villars Creek was backpack electrofished on August 1st, 2024, to PIT tag WCT and collect genetic samples for genomic analysis for future wild fish transfer. A total of 34 brook trout and 64 WCT were collected. Of the 64 WCT collected, 45 were large enough (>70 mm) for PIT tagging. PIT tagged fish ranged in size from 70-210 mm in length. Genomic analysis of tagged fish will inform future plans for transfer of WCT from Villars Creek to fishless habitat elsewhere.

III. Judith River Subbasin

Running Wolf Creek

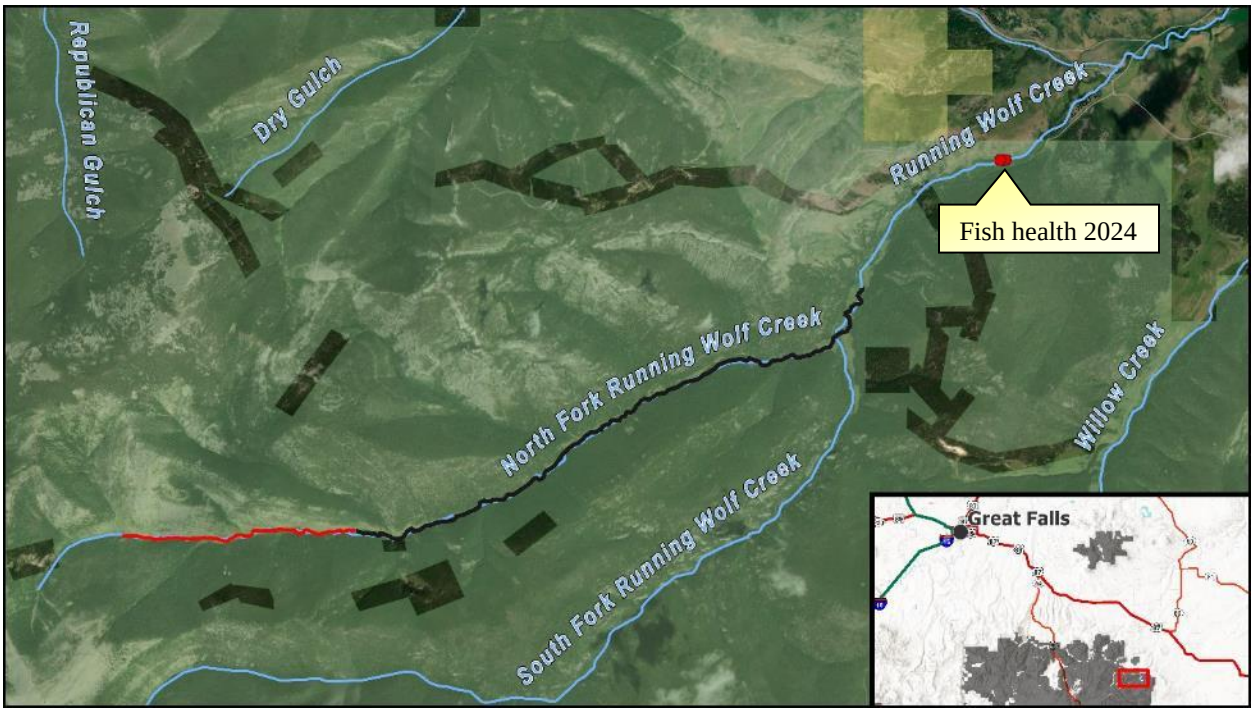

Figure 14. Running Wolf Creek in the Judith River subbasin. The stream segment delineated in red indicates the nonhybridized WCT population of North Fork Running Wolf Creek. The stream segment in black indicates the dry reach separating the WCT population from downstream brook trout populations.

Background

Running Wolf Creek is a 12.4-mile-long tributary of Wolf Creek in the Judith River subbasin located approximately 5 miles southwest of Stanford, MT. A headwater tributary, North Fork Running Wolf Creek, contains a population of nonhybridized WCT separated from downstream nonnative trout populations by a 3.6-mile intermittent flow barrier. This population inhabits a very small perennial reach of stream approximately 1.4 mi in length (Figure 14). The WCT population in North Fork Running Wolf Creek is a candidate for replication as the likelihood of extirpation of isolated cutthroat trout populations in small stream fragments is high due to random environmental events (e.g., drought, fire; Roberts et al. 2013).

2024 Monitoring

Running Wolf Creek was sampled on July 29th, 2024, to collect fish for fish health analysis. A 300 m reach of stream was backpack electrofished above the Forest Service boundary and a total of 62 brook trout were collected. All fish were lethally sampled and submitted for fish health analysis. *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease, was observed with direct fluorescent antibody test and confirmed by PCR in 6 of 12 brook trout kidney pools. *Myxobolus cerebralis* was also suspect positive by PT digest in 1/12 pools and confirmed by PCR (Fish Health Inspection Report #240052).

Weatherwax Creek

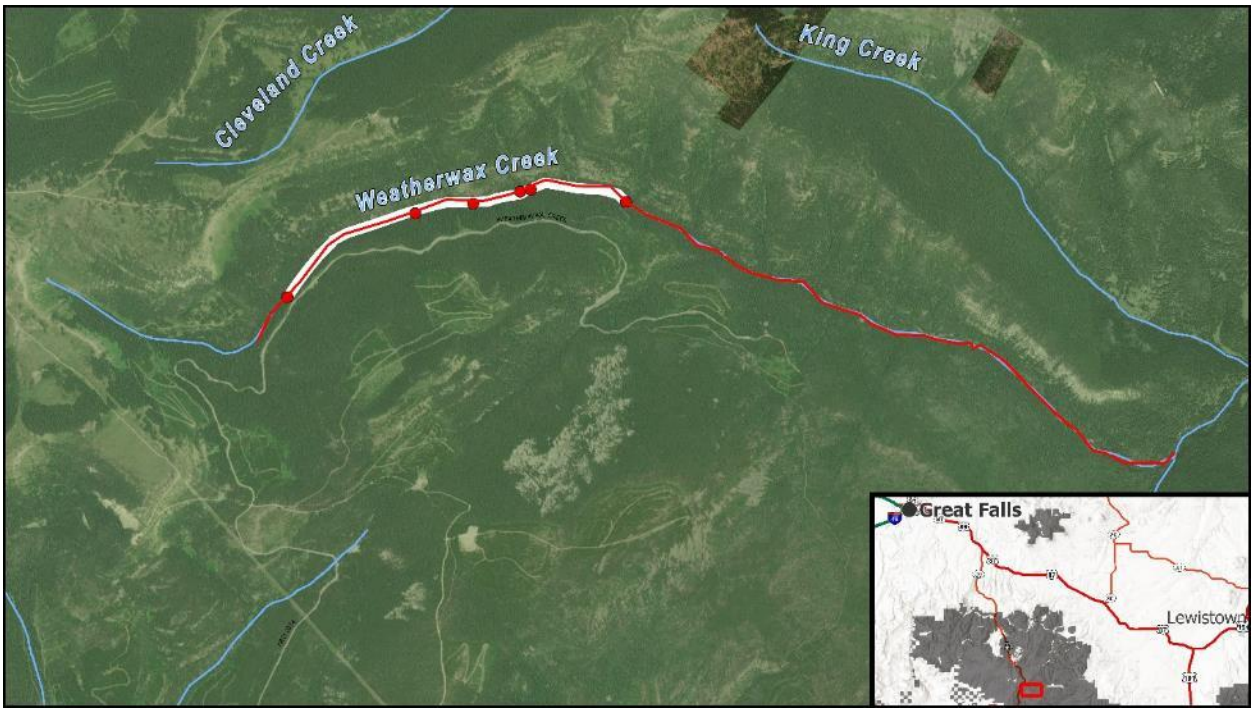

Figure 15. Weatherwax Creek in the Judith River subbasin. The stream segments delineated in red indicate areas occupied by WCT. The section highlighted in white indicates the area sampled in 2024.

Background

Weatherwax Creek is a headwater tributary of the Middle Fork Judith River located just east of Kings Hill Pass southeast of the town of Neihart, MT. The stream contains both WCT and brook trout. Periodic demographic and genetic monitoring have occurred in the drainage since 1996. Genetic samples collected in 2003 from 25 fish approximately 2 miles upstream of the Harrison Creek confluence indicated a nonhybridized population of WCT still inhabited that reach of the stream at that time. No known barriers to fish movement exist in the drainage. Updated genetic samples collected in 2021 from the headwaters of Weatherwax Creek found that hybridization had spread upstream. However, there was a substantial excess of fish in the sample with little or no rainbow trout ancestry. In 2022, 98 WCT were tagged in the upper 1.28 miles of Weatherwax Creek and genetic samples were taken for genomic analysis for future wild fish transfer. Of the 98 tagged WCT, 41 were ultimately approved for transfer (<1.5% nonnative ancestry).

2024 Wild Fish Transfer

The 1.28-mile headwater reach of Weatherwax Creek was backpack electrofished on September 30th and October 1st, 2024, to relocate and transfer PIT tagged WCT cleared for wild fish transfer. A total of 20 previously tagged WCT were collected, 10 of which were on the approved transfer list. One mortality occurred while the approved fish were held overnight in livecars within the stream. On October 2nd, 2024, the nine approved WCT were transferred to Little Camas Creek in the Smith River subbasin. In the two-day search for previously tagged fish, an additional 85 WCT were PIT tagged and sampled for genomic analysis. Wild fish transfer efforts will continue in 2025.

IV. Smith River Subbasin

Camas Lake and Big Camas Creek

Figure 16. Camas Lake and Big Camas Creek in the Smith River subbasin. The section highlighted in white indicates the area sampled in 2024.

Background

Camas Lake and upper Big Camas Creek were likely historically fishless above a series of natural waterfall barriers located upstream of the confluence of Little Camas Creek. Yellowstone cutthroat trout *Oncorhynchus virginalis bouvieri* (YCT) were stocked in Camas Lake in 1938 and 1940 and subsequently established a self-sustaining population. Extensive surveys of the Big Camas Creek drainage were conducted in the early 2000's and the area was identified as a high priority WCT restoration site. In 2014, Camas Lake and Big Camas Creek were chemically treated with rotenone to remove nonnative fish. Approximately 3,600 WCT embryos from Lone Willow Creek (Smith River drainage) were planted in remote site incubators (RSI) in Big Camas Creek in 2015 following the previous year's treatment. Additionally, triploid WCT were planted in Camas Lake to establish a recreational fishery while the wild fish population expanded.

During the 2015 RSI installation in Big Camas Creek, nonnative trout were detected above Camas Lake indicating an incomplete chemical treatment in 2014. Gill netting results from Camas Lake confirmed that YCT had survived the treatment. Backpack electrofishing of the inlet stream was initiated and nonnative trout as well as wild WCT derived from the RSIs were removed to reduce the likelihood of future hybridization. Gill netting was implemented in the summer of 2016 and angling was used 2016-2018 as additional removal methods. The installation of modified a fyke net in the Camas Lake inlet was used from 2017-2020 in conjunction with electrofishing to remove YCT entering the stream during the spring spawning season.

2024 Monitoring

The Camas Lake inlet trap was installed June 10th, 2024. In total, the Camas Lake trap was checked 8 times during the 2024 field season. Big Camas Creek above Camas Lake was electrofished 3 times in 2024. A total of 28 fish were collected in the inlet trap in 2024: 12 YCT were caught and removed and 15 WCT were trapped and passed upstream. Four YCT were caught and removed by backpack electrofishing upper Big Camas Creek and two YCT were caught and removed by angling Camas Lake. Total catch of YCT (n=18) was similar when compared to 2022 (n=18) and 2023 (n=20). Unidentified cutthroat trout under 120 mm were also collected and removed while backpack electrofishing (n=64). The inlet trap was removed on July 17th, 2024, following two consecutive visits with no fish captured.

Hybrid WCTxYCT were noted as becoming increasingly present in 2024. One suspected hybrid was caught in the inlet trap, 23 were captured during backpack electrofishing passes of Big Camas Creek, and 2 were captured by angling on Camas Lake. Genetic results of age-1 cutthroat trout collected in Big Camas Creek above Camas Lake in 2023 corroborate this observation; 11 of the 19 fish sampled were found to be F1 hybrids (Appendix A).

Twenty YCT and suspected WCTxYCT collected by backpack electrofishing and at the inlet trap were lethally sampled. Fish ranged from 150 mm to 442 mm in total length. Otoliths were extracted for aging. Ages ranged from 2-6 years, with the majority being age 5. Given the presence of these age classes, the increase in hybrid individuals, and similar total catch of YCT in 2024 to previous years, this indicates that mechanical suppression efforts of nonnative fish have been ineffective.

Fourmile Creek

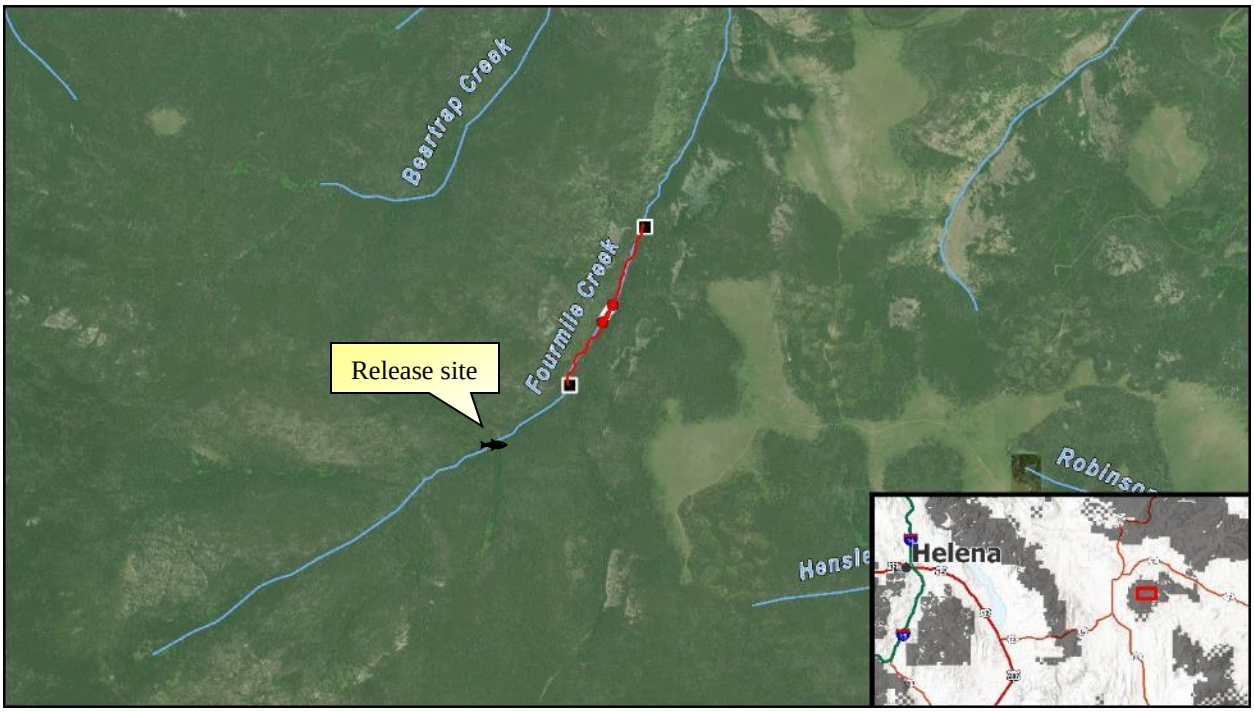

Figure 17. Fourmile Creek in the Smith River subbasin. The stream segment delineated in red indicates the area occupied by nonhybridized WCT. The section highlighted in white indicates the 2024 fish collection area. Black squares represent presence of bedrock barriers.

Background

Fourmile Creek is a tributary of the North Fork Smith River draining the north slope of the Castle Mountains east of the community of White Sulphur Springs (Figure 17). The perennial reach of Fourmile Creek located upstream of the Lewis and Clark National Forest boundary contains hybridized WCT and brook trout. The headwaters of Fourmile Creek were historically fishless upstream of a series of natural bedrock barriers. In 2000, 50 nonhybridized WCT from nearby Richardson Creek were transferred upstream of the lowest natural waterfall barrier. However, subsequent sampling of upper Fourmile Creek failed to detect the transferred WCT and identified additional upstream barriers. In 2020, upper Fourmile Creek was surveyed again to evaluate habitat for potential WCT transfer opportunities. A 0.75-mile section of Fourmile Creek was found to support a population of nonhybridized WCT isolated between two bedrock barriers. In 2021, an estimated 240 fish/km were found based on the results of a two-pass depletion population estimate, putting the total nonhybridized WCT population at 283 (±12) individuals.

2024 Wild Fish Transfer

A headwater expansion effort of the nonhybridized WCT population in upper Fourmile Creek was continued on September 16th, 2024. A total of 50 WCT ranging in size from 74-238 mm in total length were collected by backpack electrofishing, placed in fish transfer bags with supplemental oxygen, and hiked upstream into the fishless headwaters of Fourmile Creek. All fish were released below the Woodchuck Trail crossing (FS TR 725). This represents the second year of a three-year effort to expand the distribution of the nonhybridized WCT population in the headwaters of Fourmile Creek and achieve the goals of the original 2000 environmental assessment.

Nugget Creek

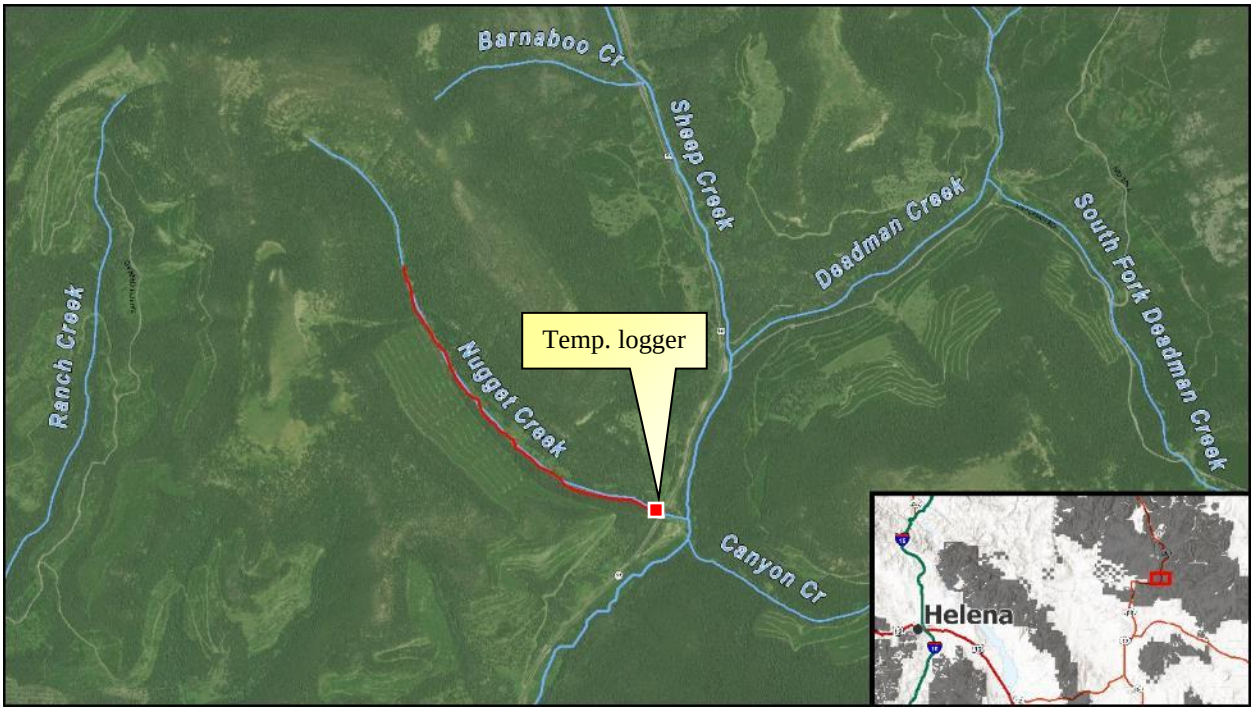

Figure 18. Nugget Creek in the Smith River subbasin. The stream segments delineated in red indicates the fishless habitat upstream of HWY 89.

Background

Nugget Creek is a tributary of Sheep Creek in the Smith River drainage located approximately 18 miles northeast of White Sulphur Springs, MT. Previous sampling in 2011 and 2023 found that the reach of Nugget Creek above the US 89 was fishless.

2024 Monitoring

Stream temperature monitoring of Nugget Creek was performed in 2024 to assess suitability for WCT. A temperature logger was deployed at 46.7752, -110.70198 just upstream of the US 89 crossing on June 17th and recovered on August 30th. The mean July stream temperature was 7.80°C and the mean August stream temperature was 7.88°C (Figure 19). Summer stream temperatures in Nugget Creek are at the minimum required for successful cutthroat trout reproduction and recruitment (Harig and Fausch 2002). Nugget Creek should be considered as a marginal candidate for translocation of at-risk WCT populations.

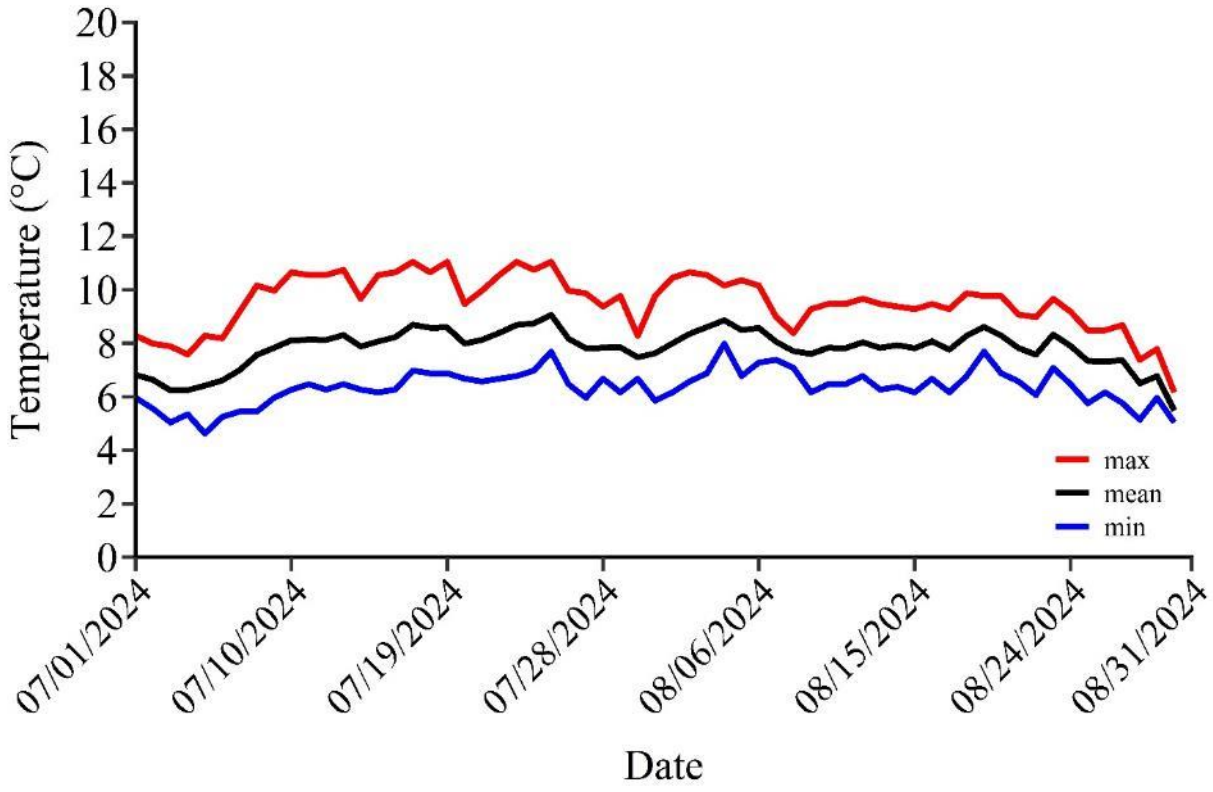

Figure 19. Daily maximum (red line), mean (black line), and minimum (blue line) stream temperatures from Nugget Creek. Temperature logger was deployed on June 17, 2024 and collected August 30, 2024. The mean July stream temperature was 7.80°C and the mean August stream temperature was 7.88°C.

Little Camas Creek

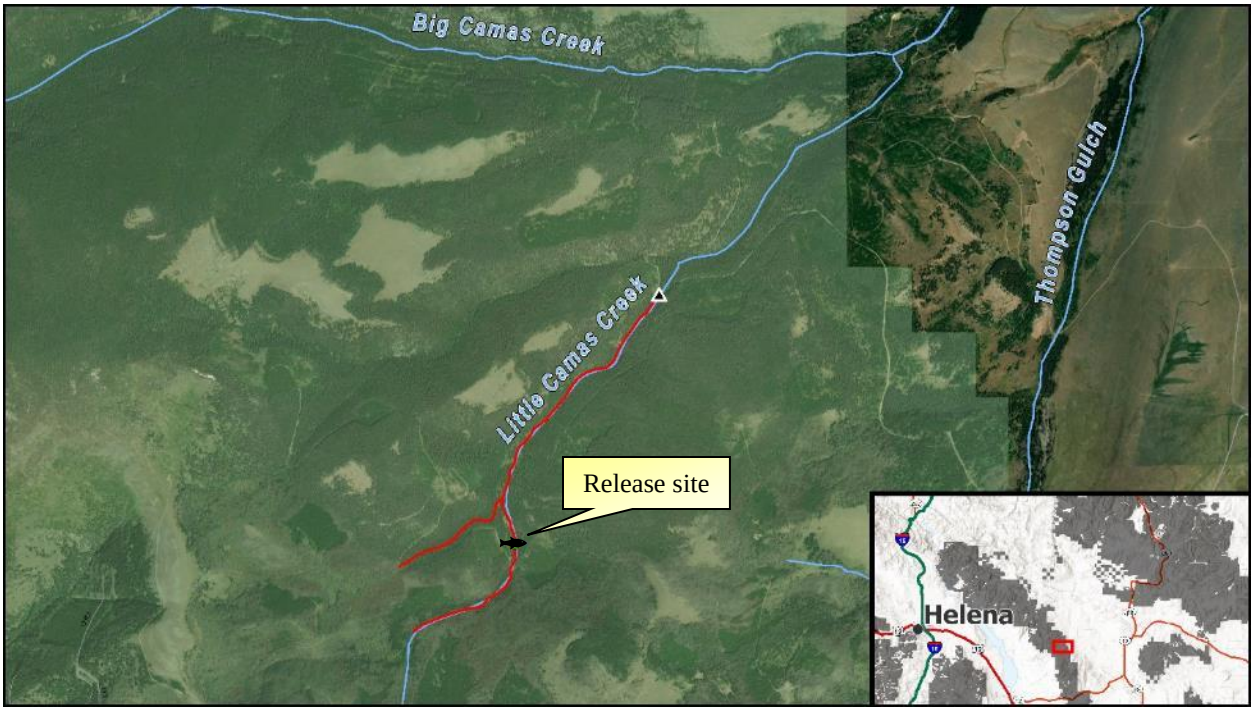

Figure 20. Little Camas Creek in the Smith River subbasin. The stream segment delineated in red indicates the fishless habitat upstream of FS RD 383.

Background

Little Camas Creek is a tributary of Camas Creek in the Smith River Drainage located approximately 15 miles west of White Sulphur Springs, MT. Fisheries surveys performed in the late 1990s and early 2000s found that the upper 2.4 miles of fish habitat located above FS RD 383 (Camas Road) were fishless while brook trout and WCTxRB hybrids were present below this road crossing (Tews et al. 2000). Evidence of historic placer mining exists in this reach and may explain the absence of fish (Phillips and Humphrey 1987). Habitat and temperature evaluation of the fishless reach Little Camas Creek was performed in 2023 and was determined to be a candidate for translocation of at-risk WCT populations.

2024 Wild Fish Transfer

On October 2nd, 2024, 9 WCT from Weatherwax Creek in the Judith River subbasin were transferred to the fishless reach of Little Camas Creek. Fish were transferred by truck in a 75 qt cooler with 4 aerators from the livecar holding location in Weatherwax Creek (46.83381, -110.6557) to the turnoff for the Thompson Guard Station (46.51332, -111.20262) on the Townsend Ranger District of the Helena National Forest. From there, WCT were transferred to 25-liter backpack coolers and driven to the release site (46.5168, -111.24928) by ATV. All fish appeared to be in excellent condition upon release.

Table 1. Genomic based analysis of WCT transferred from Weatherwax Creek to Little Camas Creek in 2024.

Lab_ID	Tag #	Length_mm (Tagging)	Length (Recapture)	% RBT	% YCT	% WCT
WWCK_22_17_1	384.349EBF7742	183	204	0	0	100
WWCK_22_18_1	384.349EBF76DB	214	232	0	0.60423	99.37388
WWCK_22_31_1	384.349EBF76D6	202	232	0.138504	0.779221	99.45313
WWCRLW_22_20_1	384349EBA6054	233	248	0	0.162338	99.7006
WWCRLW_22_23_1	384349EBA6068	190	217	0.432432	0	99.1018
WWCRUP_22_05_1	384349EBA602F	200	215	0.048263	0.56338	99.91468
WWCRUP_22_14_1	384349EBA5FDD	207	227	0.045746	0.631313	99.4582
WWCK_22_19_1	384349EBA5FE7	252	270	0	0.373134	99.6189
WWCRLW_22_39_1	384349EBA5FF5	203	220	0.091743	0.129199	98.96825
			Average:	0.084076	0.360313	**99.50994**

South Fork Willow Creek

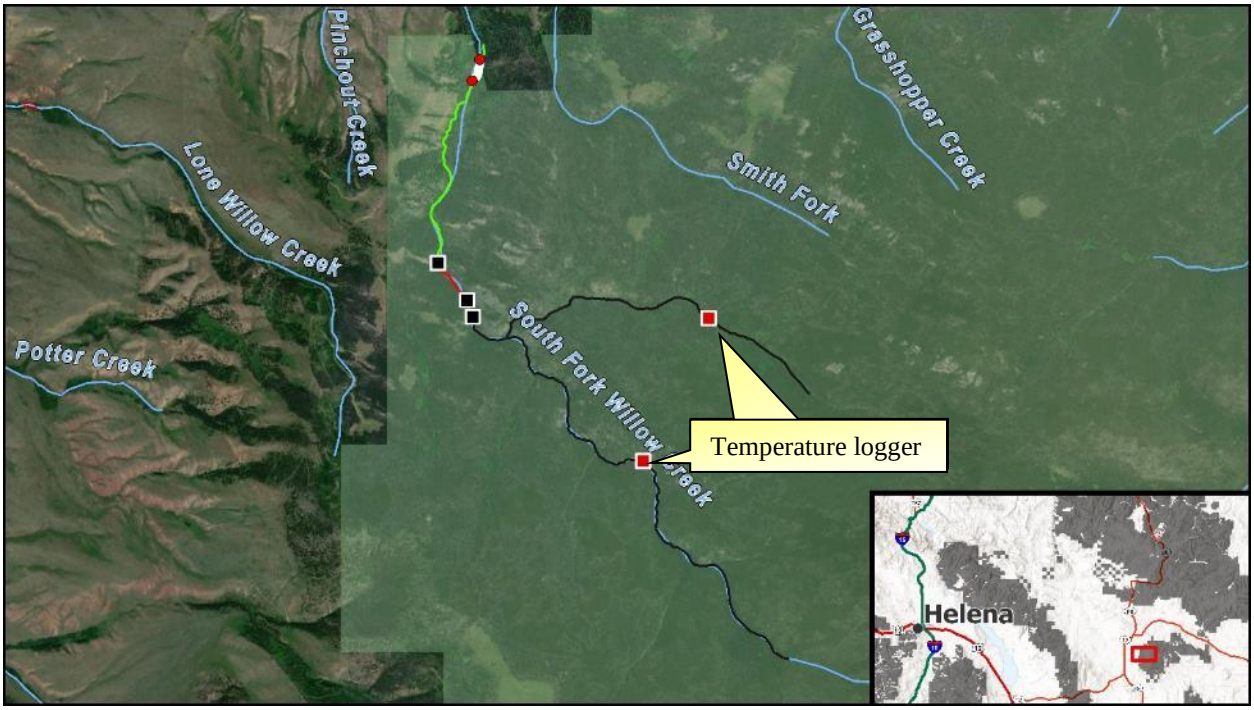

Figure 21. South Fork Willow Creek in the Smith River subbasin. The stream segments delineated in green indicate the area occupied by hybridized WCT and brook trout, the area in red indicates the area occupied by nonhybridized WCT, and the area in black represents fishless habitat. Black squares represent the presence of bedrock fish barriers.

Background

The South Fork Willow Creek WCT population occupies 1.5 miles of habitat located above Willow Creek Reservoir, the municipal water supply reservoir for White Sulphur Springs, MT. The 1.2-mile reach immediately above the reservoir contains nonnative brook trout and slightly hybridized WCT (99.1% WCT 0.9% RB). A natural bedrock barrier isolates an additional 0.25 miles of habitat above this reach occupied by nonhybridized WCT. WCT from South Fork Willow Creek were used as one of three sources in the mixed source reintroduction of Jumping Creek in 2010. Demographic and genetic monitoring of the nonhybridized WCT population in 2023 found that the population remains nonhybridized with an estimated 103 fish occupying the 0.25 mi reach.

2024 Monitoring

Habitat evaluation of the fishless reach located upstream of the present WCT distribution was continued in 2024. Stream temperature monitoring of upper South Fork Willow Creek and its unnamed tributary was performed to assess suitability for WCT expansion. A temperature logger was deployed at 46.48936, -110.79503 on South Fork Willow Creek just downstream of the FS Trail #719 crossing on July 2nd and recovered on August 29th. The mean July stream temperature was 6.94°C and the mean August stream temperature was 7.72°C (Figure 22). A temperature logger was also deployed and recovered concurrently on the unnamed tributary to South Fork Willow Creek at 46.49942, -110.78832 just below the FS Trail #716 crossing. The mean July stream temperature was 7.84°C and the mean August stream temperature was 8.81°C (Figure 23). Summer stream temperatures in South Fork Willow Creek appear to be at the minimum that is required for successful cutthroat trout reproduction and recruitment (Harig and Fausch 2002). Expansion should still be pursued to alleviate extirpation risk because of the populations extremely limited distribution.

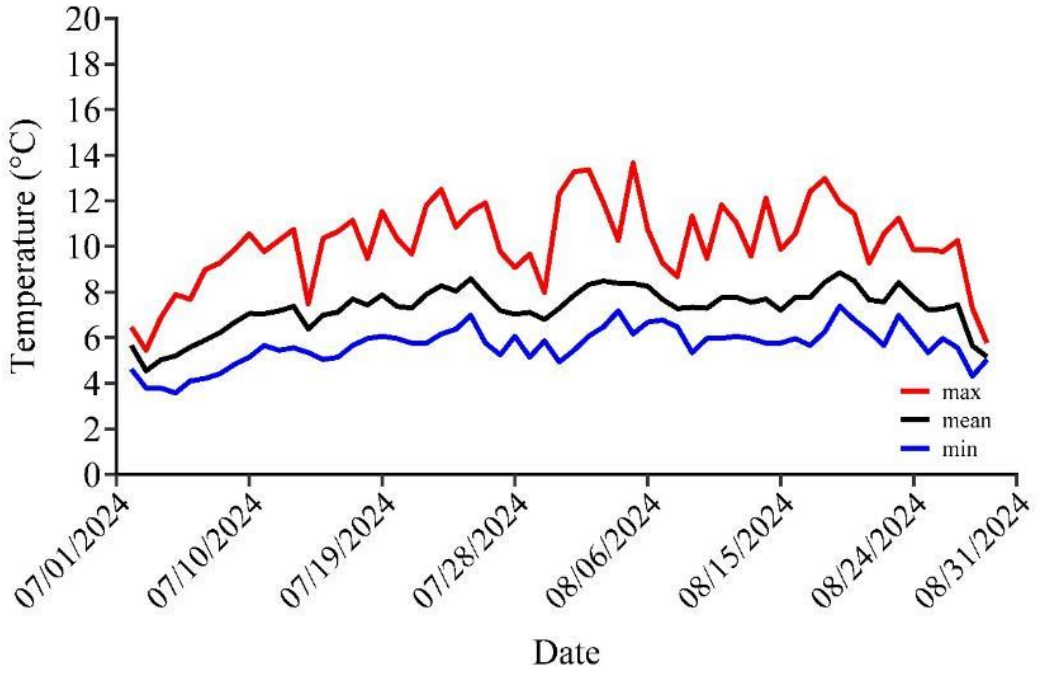

Figure 22. Daily maximum (red line), mean (black line), and minimum (blue line) stream temperatures from South Fork Willow Creek. Temperature logger was deployed on July 2, 2024, and collected August 29, 2024. The mean July stream temperature was 6.94°C and the mean August stream temperature was 7.72°C.

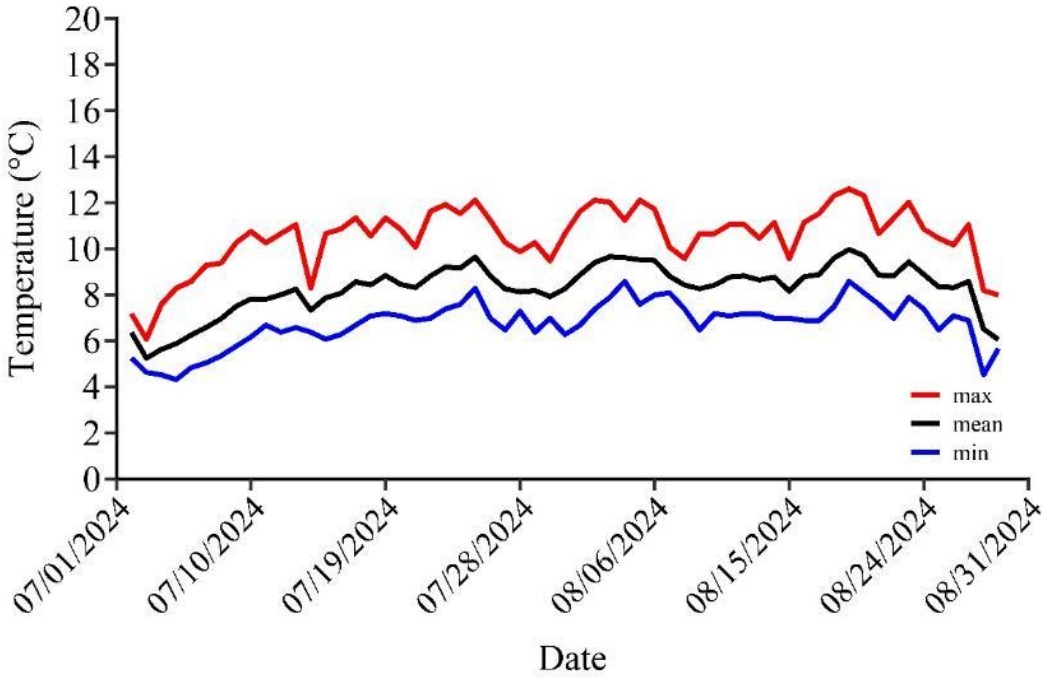

Figure 23. Daily maximum (red line), mean (black line), and minimum (blue line) stream temperatures from the unnamed tributary to South Fork Willow Creek. Temperature logger was deployed on July 2, 2024, and collected August 29, 2024. The mean July stream temperature was 7.84°C and the mean August stream temperature was 8.81°C.

Tyrell Creek

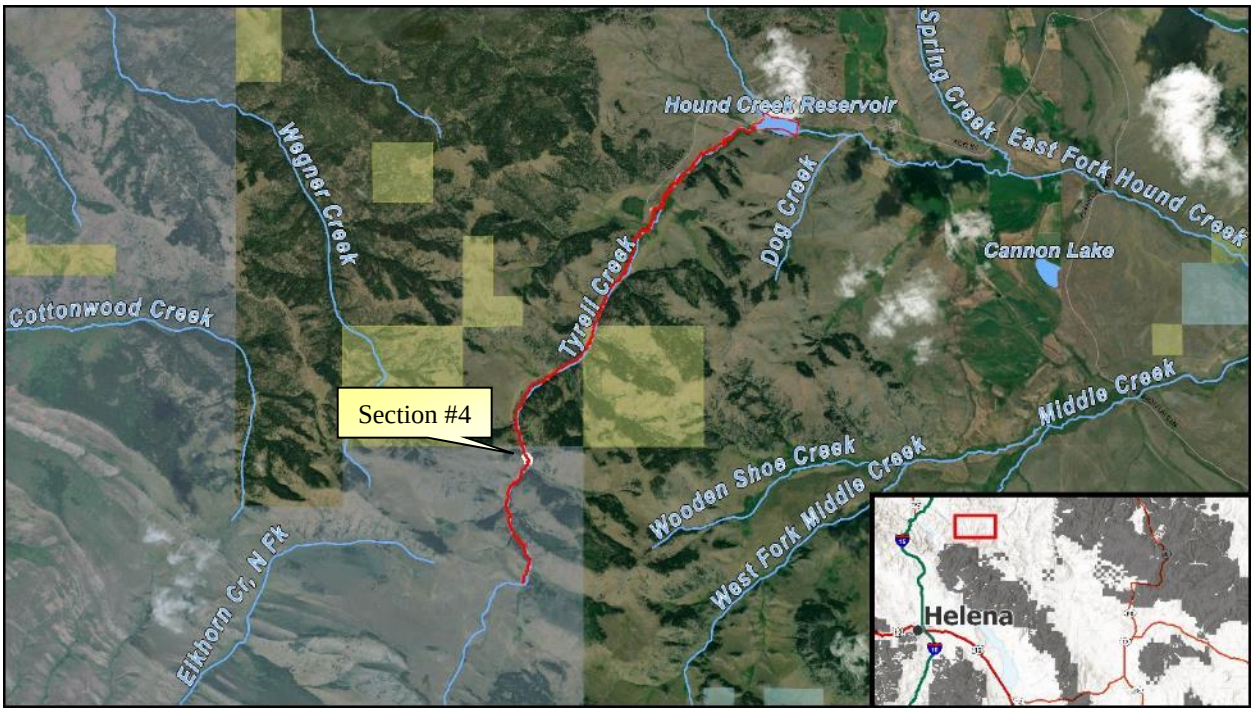

Figure 24. Hound Creek Reservoir and Tyrell Creek in the Smith River subbasin. The stream segments delineated in red indicate areas occupied by WCT. The section highlighted in white indicates the area sampled in 2024.

Background

Tyrell Creek and Hound Creek Reservoir contain a restored WCT population founded by mixed source reintroduction from Jumping and Lone Willow Creeks in the Smith River subbasin and O'Brien Creek in the Belt Creek subbasin. Demographic monitoring of Tyrell Creek performed at three long-term monitoring sites in the lower drainage in 2023 found low densities of WCT at all three sites. Additionally, the majority of WCT sampled in Hound Creek Reservoir in 2023 appeared to be hatchery triploids (evidence of fin erosion) which were last stocked in 2015. Otolith analysis of 8 WCT lethally sampled from Hound Creek Reservoir corroborated this observation with 7 of the 8 fish in the 8–9-year age range. Further monitoring of the Tyrell Creek drainage was suggested to get a better understanding of the current status of the restored WCT population.

2024 Monitoring

An additional 100-m long-term monitoring reach was established on Tyrell Creek just upstream of the Beartooth Wildlife Management Area boundary in 2024. Multiple pass depletion methods were used to estimate population abundance. Fish densities were much higher when compared to the lower reaches sampled in 2023 with an estimated 310 fish/km (Figure 25). Location of long-term monitoring sites for future demographic monitoring of Tyrell Creek should be adjusted to better reflect densities of WCT. The previous long-term monitoring reaches established on the Sieben Livestock property were initially intended to monitor the success of remote site incubators that were used to populate the stream following nonnative removals. Section 1 should be moved upstream to the previous Section 2 (site at cabins). A new Section 2 should be established on the BLM reach (northwest corner Section 10). Finally, the site monitored in 2024 on the Beartooth WMA should be retained as Section 3 moving forward.

Tyrell Creek —NATIVE TROUT POPULATION SURVEY

1. General Information— Date: **August 15, 2024** Biologist: **A. Poole**
2. Stream Information—
   Name, section, county: **Tyrell Creek, 16, Cascade**
3. Survey Site Information (see attached map)—
   Upstream range of native trout (general description and GPS): **Section 21 (46.95489, -111.74003; estimate, based on satellite imagery)**
   Downstream range of native trout (general description and GPS): **Hound Creek Reservoir (47.00911, -111.69182)**
   Location (GPS) and description of barriers: **Hound Creek Dam (47.00911, -111.69182)**
   Stream Length—Occupied habitat: **10.24 km (6.36 mi)** Available habitat: **10.24 km (6.36 mi)**
   Survey method & equipment: **backpack battery electrofisher; two-pass depletion**
   Survey sites (general description and UTM)—
   Section 4: **Above Beartooth WMA boundary; 46.97007, -111.73936**

Parameter	**Section 4**
Section length (m)	100 m
Mean stream width (m) (n)	1.71 m (10)
Section area (hectares)	0.017 ha
WCT	
Removal Pattern	26 5
Population estimate	31 (±3)
Capture probability	0.861
Mean length (mm) (n)	153 (31)
Mean weight (g) (n)	41 (31)
Mean KTL (n)	0.91 (31)
Number fish per km (95 % CI)	310 (±30)
Number fish per ha (95 % CI)	1,824 (±176)
Biomass (kg per ha) (95 % CI)	75 (±7)

4. Comments: YOY WCT observed in section. Rocky Mountain Sculpin abundant with 30 caught on the Pass 1 and 28 on Pass 2.

Figure 25. Tyrell Creek fish population estimate results.

Urvi Creek

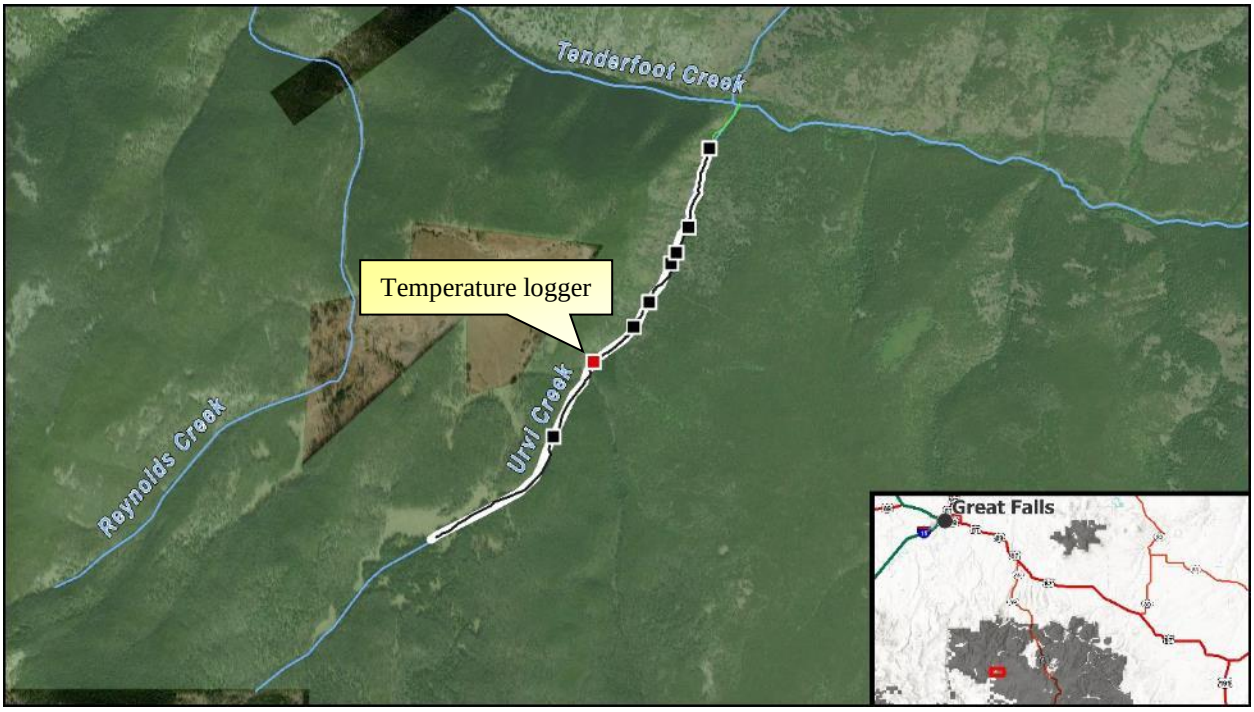

Figure 26. Urvi Creek in the Smith River subbasin. The stream segment delineated in black indicates the fishless area surveyed. Black squares represent presence of bedrock barriers.

Background

Urvi Creek is a tributary of Tenderfoot Creek in the Smith River drainage located approximately 13 miles west of the community of Neihart, MT. Previous sampling conducted in the early 2000s found Urvi Creek to be fishless above a bedrock barrier located upstream of the confluence with Tenderfoot Creek (Figure 26). A 23 fish sample collected from lower Urvi Creek in 2001 found a 93.7% WCT x 6.3% RB population present at that time.

2024 Monitoring

Habitat evaluation and temperature monitoring of the fishless reach of Urvi Creek was performed in 2024 to assess suitability for WCT translocation. Urvi Creek was accessed by FS RD 3472 on June 24th, 2024, and spot shocked downstream until fish were detected. Fish habitat quality and barriers were recorded while shocking. A total of 1.4 miles of fish bearing habitat appears to be fishless in Urvi Creek. The upper most fish detected was just below the bedrock barrier located at 46.94321, -111.01002, approximately 250 m upstream of the Tenderfoot Creek confluence. At least 6 suspected complete bedrock barriers were detected in the survey of Urvi Creek, highly fragmenting the available fishless habitat (Figure 27). A temperature logger was launched at 46.93794, -111.0155 and retrieved on August 30th, 2024. The mean July stream temperature was 7.83°C and the mean August stream temperature was 7.56°C (Figure 28). Summer stream temperatures in Urvi Creek appear to be at the minimum that is required for successful cutthroat trout reproduction and recruitment (Harig and Fausch 2002). Urvi Creek is unlikely a candidate for translocation of at-risk WCT populations due to its cold temperatures and fragmented habitat.

Figure 27. Bedrock barriers encountered in survey of Urvi Creek. Panel D represents barrier currently limiting upstream movement of fish from Tenderfoot Creek.

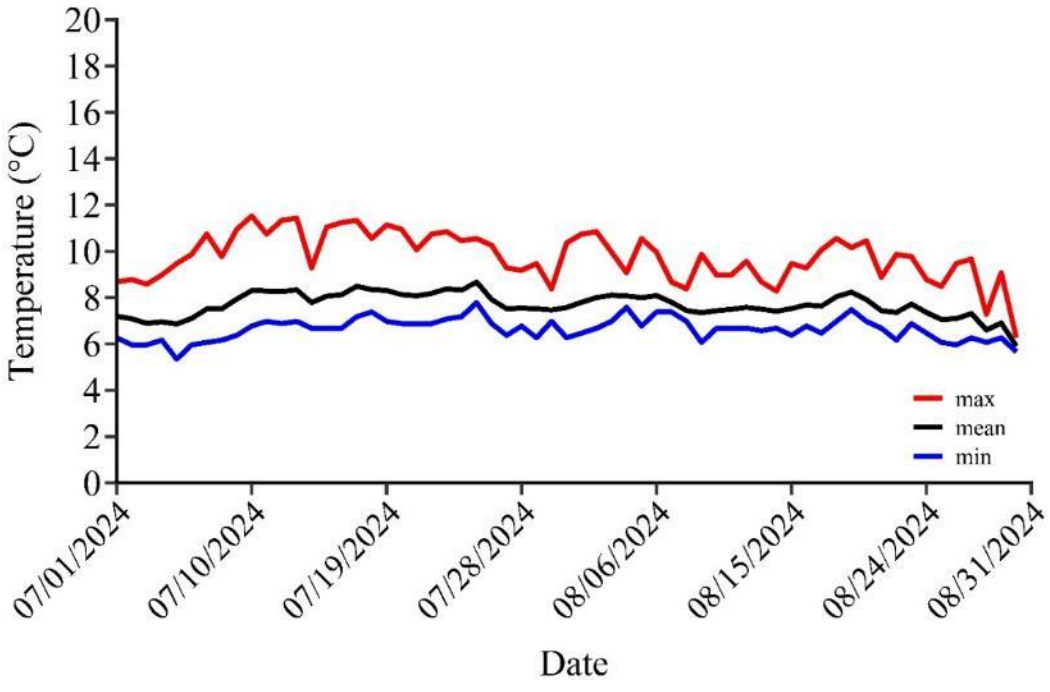

Figure 28. Daily maximum (red line), mean (black line), and minimum (blue line) stream temperatures from Urvi Creek. Temperature logger was deployed on June 24, 2024, and collected August 30, 2024. The mean July stream temperature was 7.83°C and the mean August stream temperature was 7.56°C.

VI. Teton River Subbasin

North Fork Teton River

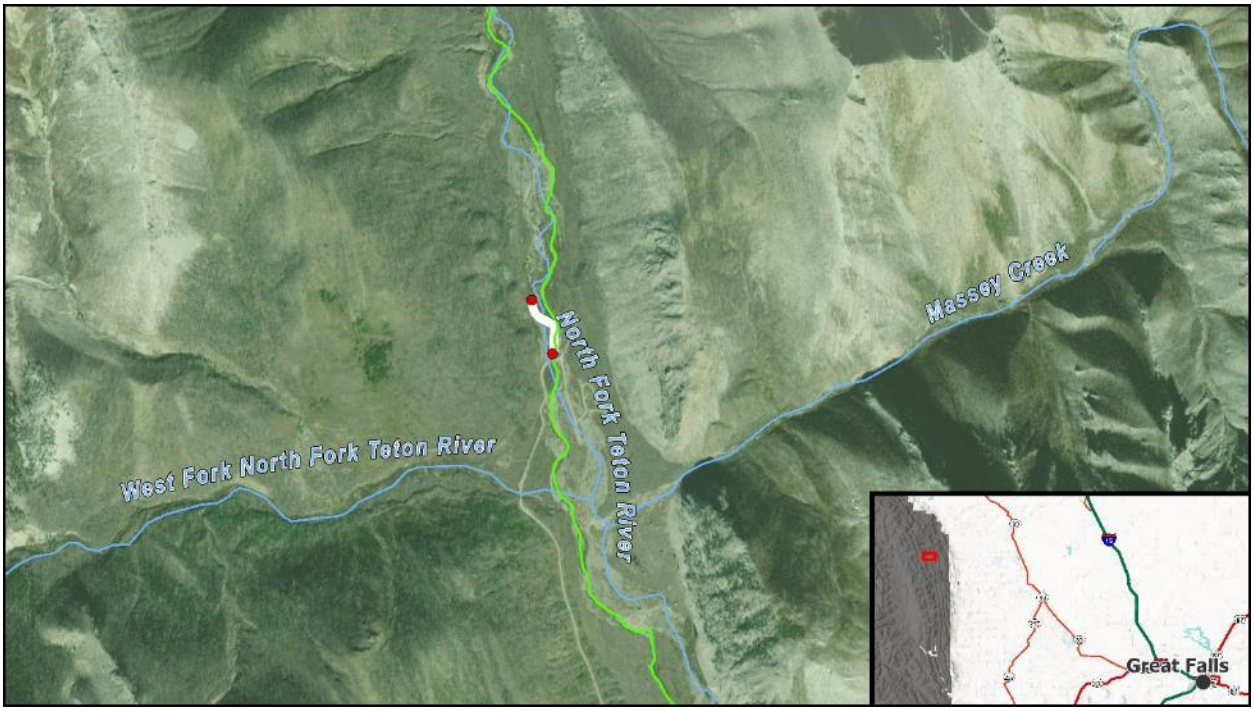

Figure 29. North Fork Teton River in the Teton River subbasin. The stream segment highlighted in white indicates the area sampled in 2024.

Background

The North Fork Teton River is a 20-mile-long headwater tributary to the Teton River located approximately 21 miles west of Choteau, MT. Major fish bearing tributaries include Middle Fork Teton River, Waldron Creek, West Fork North Fork Teton River, East Fork North Fork Teton River, and Bruce Creek. Previous genetic samples from WCT collected throughout the North Fork drainage and major tributaries from 1990-2000 found the genetic status of populations to vary from 94-99% WCT genetic ancestry.

2024 Monitoring

Several attempts were made in 2024 to collect updated genetic samples from the North Fork Teton River. On July 30th, 2024, a 400 m reach of North Fork Teton River was backpack electrofished near the West Fork Forest Service Cabin. Only one brook trout and one Rocky Mountain sculpin were collected in this effort. Additional attempts at angling on the North Fork were attempted on August 6th and 8th in the box canyon upstream of the Waldron Creek confluence. No fish were collected. Further attempts will be made in 2025 to collect updated genetic samples from the North Fork Teton River.

Waldron Creek

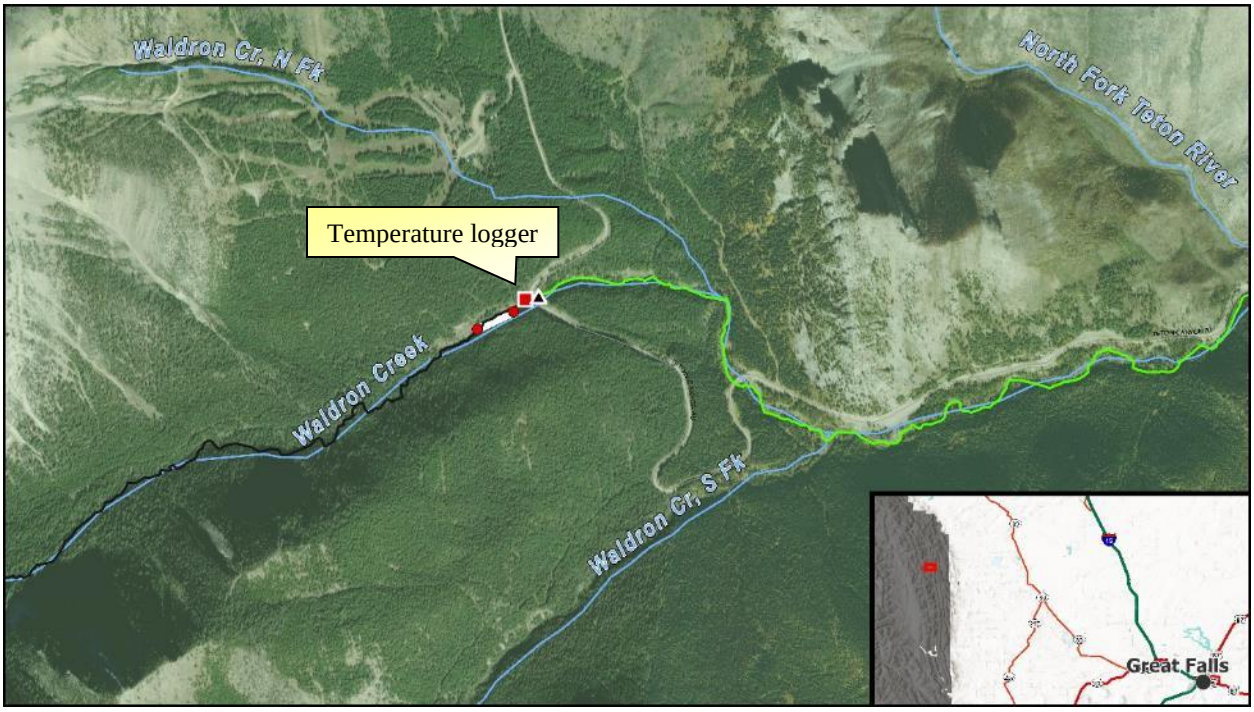

Figure 30. Waldron Creek in the Teton River subbasin. The stream segments delineated in green indicate the area occupied by hybridized WCT and the area in black represents fishless habitat. The stream segment highlighted in white indicates the area sampled in 2024.

Background

Waldron Creek is a tributary of the North Fork Teton River located approximately 28 miles west of Choteau, MT. Genetic monitoring of the WCT population has occurred sporadically from 1990-2000. Genetic results have ranged from 96.8% WCT (South Fork Waldron Creek) to 99% WCT genetic ancestry (Waldron Creek above FS RD 144). Forest Service monitoring of Waldron Creek above the upper FS RD 144 crossing (47.92446, -112.80225) in 1998 found the upper 2.1 miles of habitat above this culvert to be fishless.

2024 Monitoring

Waldron Creek was sampled on June 18th, 2024, to determine fish presence/absence above the upper FS RD 144 culvert and evaluate habitat for future WCT translocation. A 200 m reach of Waldron Creek was backpack electrofished starting immediately above the culvert. No fish were detected, and aquatic macroinvertebrates were noted as being abundant. It is unclear why WCT are absent from this reach of Waldron Creek as the culvert did not appear to be a complete barrier to fish movement.

Stream temperature monitoring of Waldron Creek was performed in 2024 to assess suitability for WCT. A temperature logger was deployed at 47.92445, -112.80281 just upstream of the upper FS RD 144 crossing on June 18th and recovered on September 18th. The mean July stream temperature was 7.98°C and the mean August stream temperature was 7.92°C (Figure 31). Summer stream temperatures in Waldron Creek are at the minimum required for successful cutthroat trout reproduction and recruitment (Harig and Fausch 2002). Waldron Creek should be considered as a marginal candidate for translocation of at-risk WCT populations.

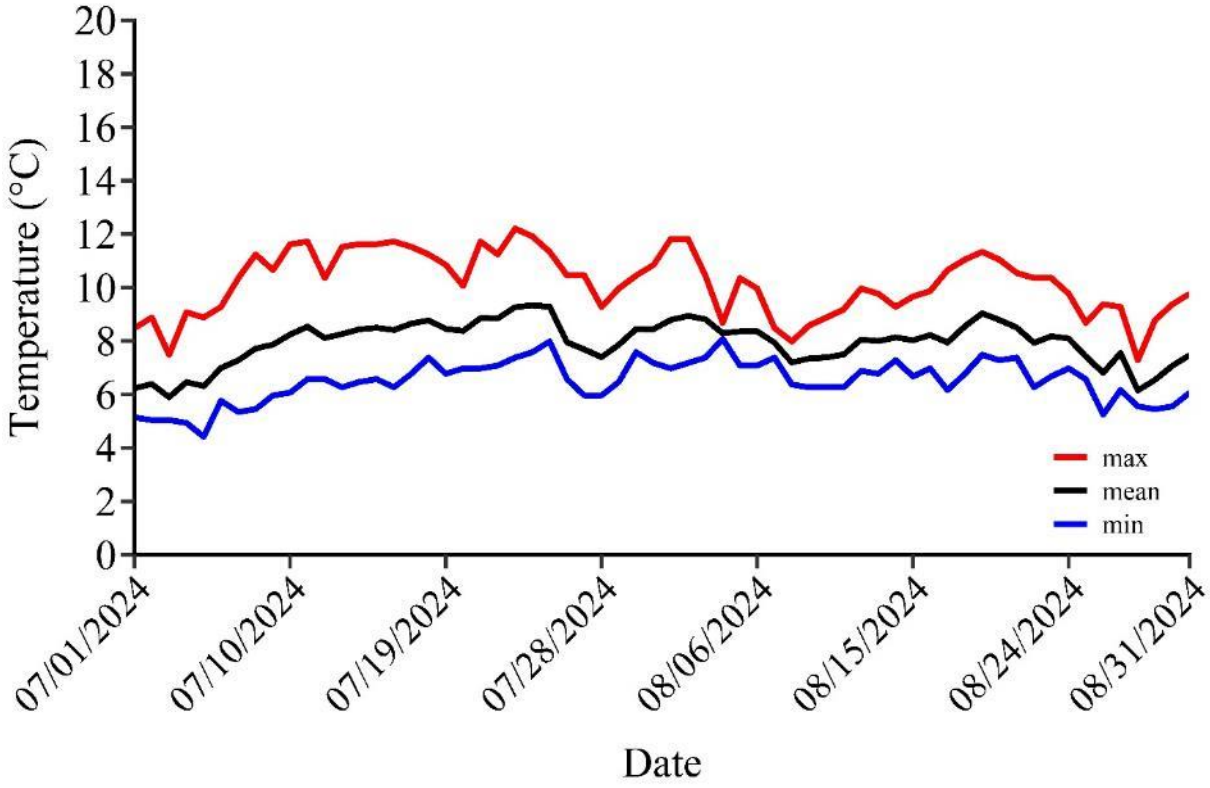

Figure 31. Daily maximum (red line), mean (black line), and minimum (blue line) stream temperatures from Waldron Creek. Temperature logger was deployed on June 18, 2024, and collected September 18, 2024. The mean July stream temperature was 7.98°C and the mean August stream temperature was 7.92°C.

West Fork North Fork Teton River

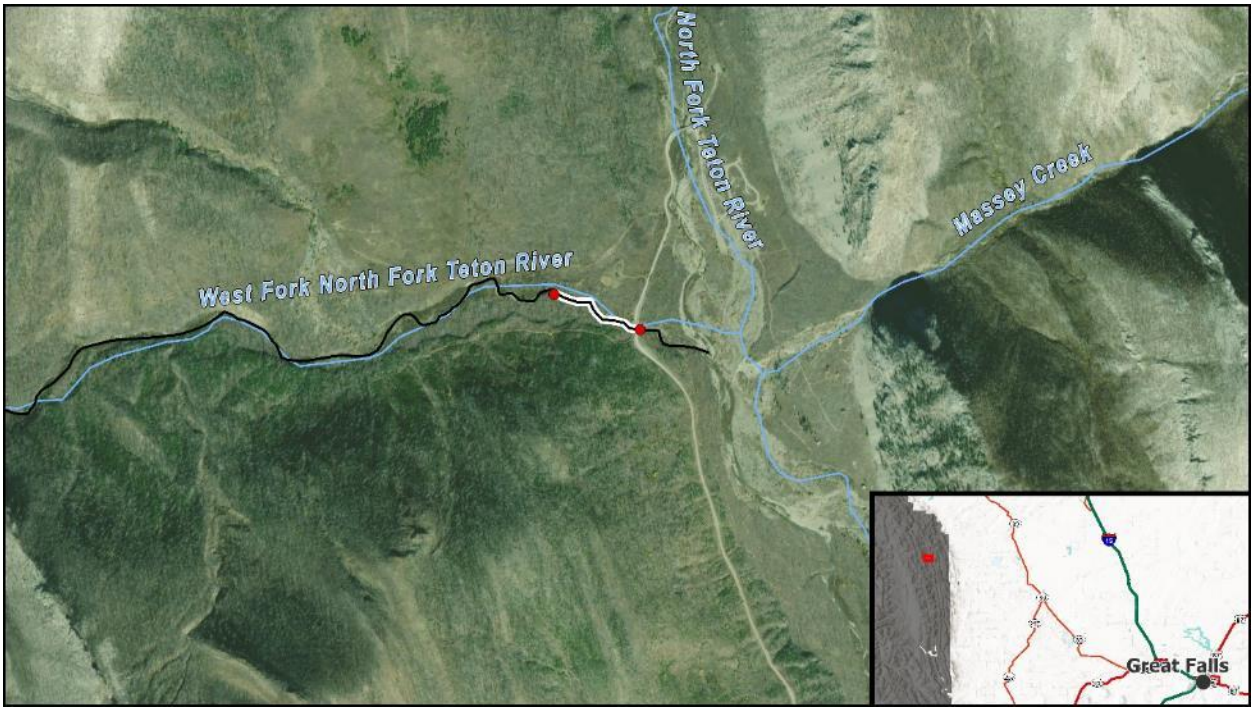

Figure 32. West Fork North Fork Teton River in the Teton River subbasin. The stream segment highlighted in white indicates the area sampled in 2024.

Background

The West Fork North Fork Teton River is a 5-mile-long tributary of the North Fork Teton River located approximately 30 miles west of Choteau, MT. Previous sampling performed by the Forest Service in 1996 documented WCT presence in the lower reaches of the stream above the Teton Canyon Road bridge. The West Fork North Fork Teton River is one of two waterbodies in the North Fork Teton River drainage with a historical WCT collection record but no genetic sampling.

2024 Monitoring

The West Fork North Fork Teton River was sampled on July 30th, 2024, to collect genetic samples. A 400-m reach was backpack electrofished starting at the Teton Canyon Road bridge. A total of 7 brook trout were collected ranging in size from 113-186 mm in total length. No WCT were detected, and overall fish density appeared to be low. Further evaluation of the West Fork North Fork Teton River is needed to determine if WCT persist in this drainage.

VII. Two Medicine River Subbasin

Pike Creek

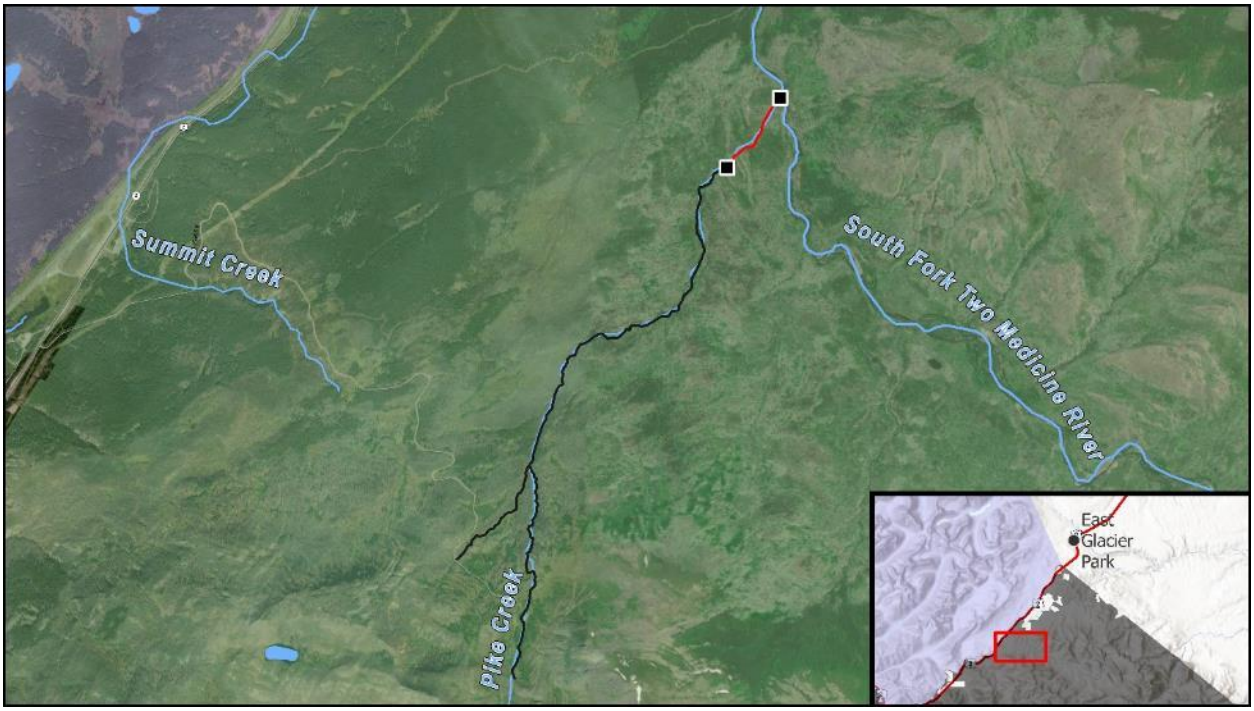

Figure 33. Pike Creek in the Two Medicine River subbasin. The stream segment delineated in red indicates the area occupied by Rocky Mountain sculpin and the area in black indicates fishless habitat. The black squares represent the presence of bedrock barriers.

Background

Pike Creek is a tributary of the South Fork Two Medicine River located approximately 9 miles southeast of the community of East Glacier Park, MT. Previous survey work in 2022 confirmed the presence of a bedrock barrier that isolates this drainage from the South Fork Two Medicine River. Rocky Mountain Sculpin was the only fish species collected above this barrier in 2022 presence/absence sampling. The Pike Creek watershed was highly impacted by the 2007 Skyland Fire resulting in a channel filled with large woody debris.

2024 Monitoring

A comprehensive survey of Pike Creek was performed on August 13th, 2024, to evaluate fish habitat and perform presence/absence surveys of the entire 3.05 miles of habitat above the bedrock barrier. Personnel from FWP, Glacier National Park, and USGS divided Pike Creek into four reaches to evaluate physical habitat and backpack electrofish to determine fish presence. Flow measurements were also recorded at multiple points within the survey area. Similar to the 2022 survey, Rocky Mountain Sculpin was the only fish species detected in the lower most reach surveyed. An additional bedrock barrier was discovered in this reach at 48.32131, -113.30806, above which no fish were detected (Figure 34). Summertime base flows conditions were observed with a discharge of 0.44 cfs recorded below the Elk Calf Mountain Trail #137 lower crossing (48.3174, -113.30977). Rocky Mountain Tailed Frog adults and juveniles were noted as common. The stream channel throughout Pike Creek is dominated by large woody debris input from the 2007 Skyland Fire and green alder. Habitat appears sufficient to support WCT.

Figure 34. Additional bedrock barrier located in Pike Creek at 48.32131, -113.30806. No Rocky Mountain Sculpin were collected above this point.

Unnamed Tributary to Hall Creek

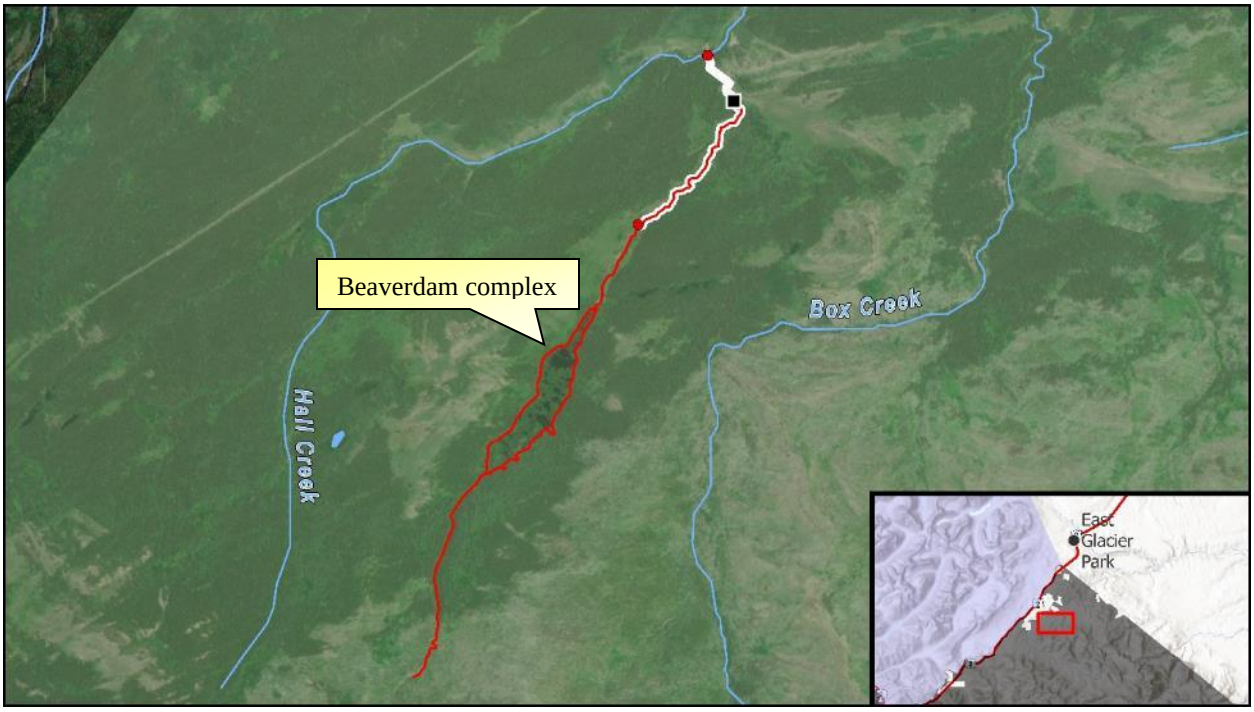

Figure 35. Hall Creek in the Two Medicine River subbasin. The stream segment delineated in red indicates the area occupied by WCT. The stream segment highlighted in white indicates the area sampled in 2024. The black square represents the presence of a bedrock barrier.

Background

Hall Creek is a tributary of the South Fork Two Medicine River located approximately 6 miles southeast of the community of East Glacier Park, MT. Previous sampling performed in 2003 by the Forest Service near the FS Trail #159 (Hyde Connector Trail) crossing found Hall Creek to contain rainbow trout, WCTxRB hybrid trout, brook trout, and Rocky Mountain sculpin. Genetic analysis of ten WCTxRB hybrids collected in 2003 determined the population to be a hybrid swarm containing individuals from at least two different spawning populations.

2024 Exploration

On August 12th, 2024, a barrier investigation and presence/absence survey of an unnamed tributary to Hall Creek was performed. This location was selected based on channel morphology determined through satellite imagery and the presence of several bedrock barriers present on nearby streams with similar traits (Box Creek, Hyde Creek, and Mettler Coulee). A 1400 m reach of the unnamed tributary was backpack electrofished beginning at the confluence with Hall Creek. The unnamed tributary supplied 100% of the flow to Hall Creek as the mainstem was dry above this point. Four rainbow trout and five WCTxRB hybrids were collected in the lower 225 m of the unnamed tributary of Hall Creek. At 48.34989, -113.24547, a previously undocumented bedrock barrier was discovered (Figure 36). This barrier is estimated to be 6ft tall with an additional 4ft bedrock control feature located directly upstream. Approximately 100 m above this barrier, a single large pool was found to contain 4 WCT. Genetic samples were collected, and an additional 1000 m were spot shocked above this pool in an attempt to collect more WCT. However, habitat was noted to be marginal with very low streamflow and only Rocky Mountain Tailed Frog adults were detected.

Figure 36. Previously unknown bedrock barrier on the unnamed tributary to Hall Creek located at 48.34989, -113.24547.

The unnamed tributary to Hall Creek was revisited on September 24th, 2024, to collect additional genetic samples of WCT located above the bedrock barrier. A 15-acre beaver dam complex located upstream of the previous survey location was selected as a likely location to encounter additional WCT. The largest pond within the complex, located at 48.34162, -113.2544, was hook-and-line sampled by packraft for 5.25 hours by a single angler. An additional 9 WCT were collected ranging in size from 304-372 mm in length (Figure 37). A total of 13 samples were submitted to the University of Montana Conservation Genetics Laboratory for analysis in 2024. Future work for the unnamed tributary of Hall Creek should include collection of additional genetic samples, locate upstream distribution of WCT, and complete 100 m depletion estimate if suitable stream habitat is present above the beaver dam complex.

Figure 37. Beaverdam complex located upstream of the bedrock barrier on unnamed tributary to Hall Creek with inset of WCT collected by angling.

VIII. Upper Missouri River Subbasin

Beartrap Gulch

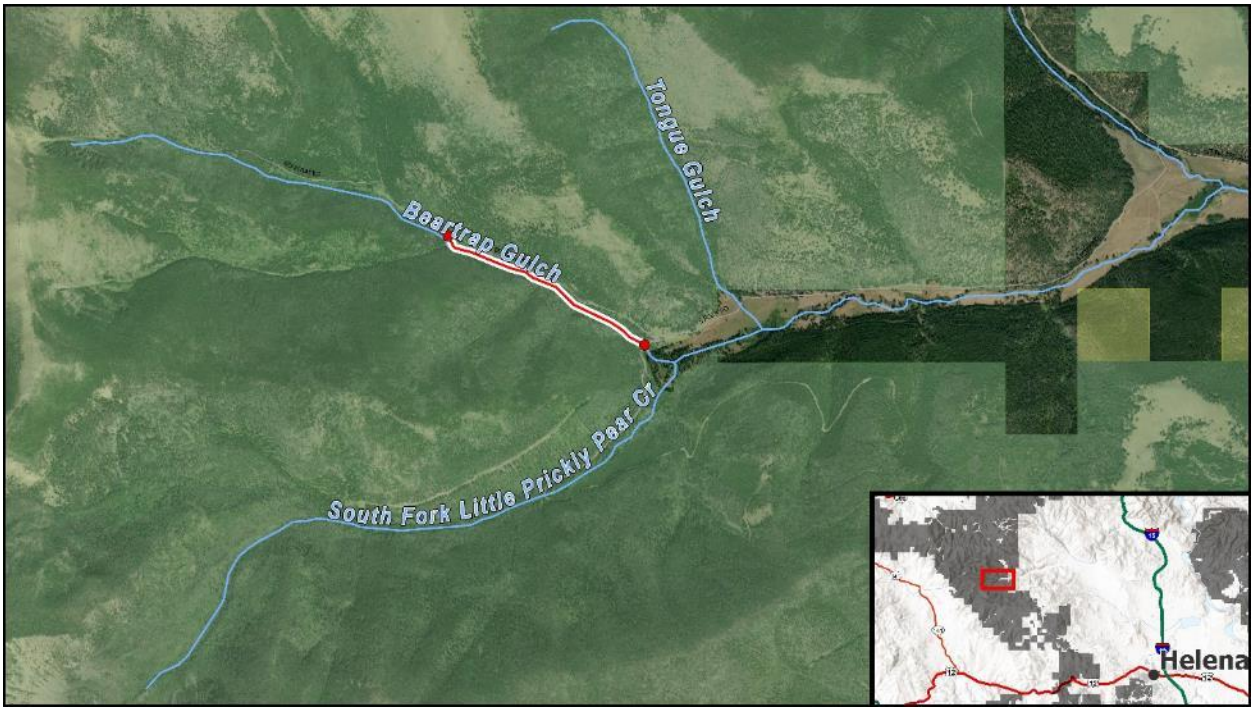

Figure 38. Beartrap Gulch in the Upper Missouri River subbasin. The stream segment highlighted in white indicates the area sampled in 2024.

Background

Beartrap Gulch is a tributary of South Fork Prickly Pear Creek in the Upper Missouri River subbasin located approximately 24 miles northwest of Helena, MT. A presence/absence survey performed in 2023 found 12 WCT and 2 brook trout present in the 0.8-mile reach of Beartrap Gulch above the FS RD 4038 culvert. This was the first documentation of WCT presence in this waterbody. Genetic samples collected from South Fork Prickly Pear Creek near the Beartrap Creek confluence in 1990 indicated the presence of a WCTxRB hybrid swarm with a significant rainbow trout genetic contribution (65% WCT 35% RB).

2024 Monitoring

Beartrap Gulch was surveyed on July 10th, 2024, to collect WCT genetic samples. The 0.8-mile reach of Beartrap Gulch was backpack electrofished starting at the South Fork Little Prickly Pear Road (FS RD 4038) culvert. Only 2 WCT were collected in this effort. Genetic samples were collected but not submitted in 2024. It appears Beartrap Gulch likely only provides occasional spawning/rearing habitat when adult WCT and brook trout can negotiate the perched FS RD 4038 culvert during periods of high discharge.

Granite Creek

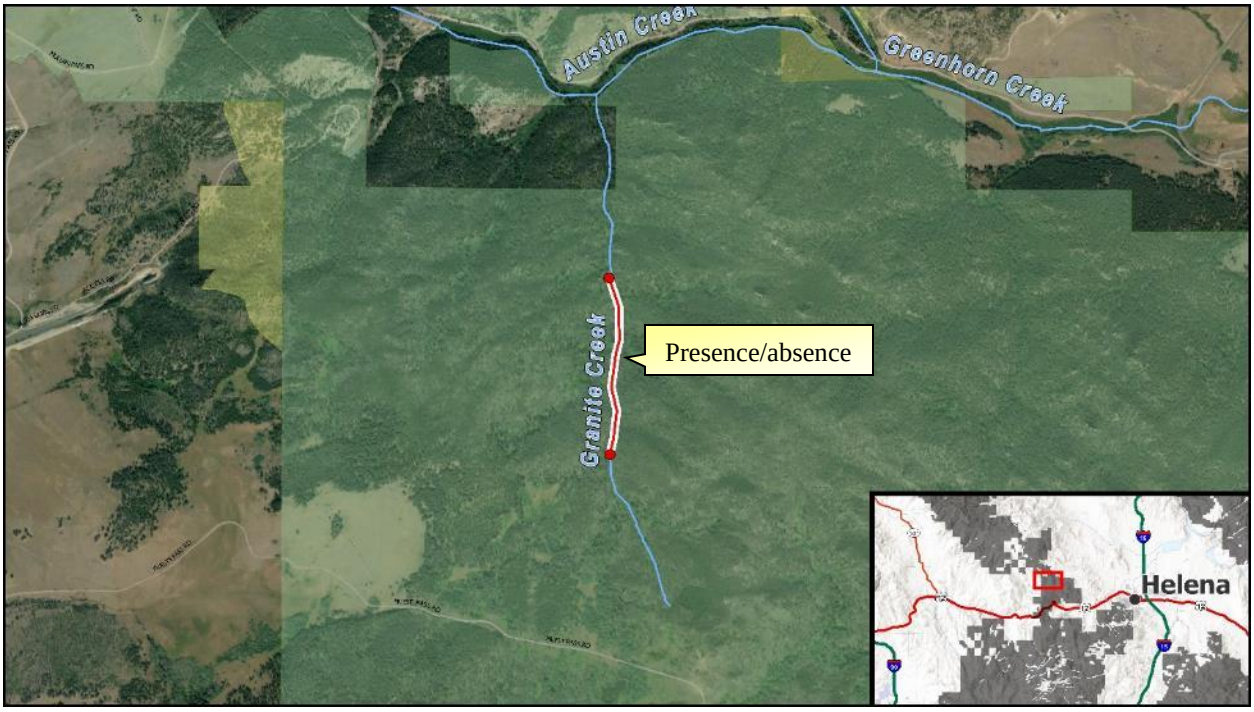

Figure 39. Granite Creek in the Upper Missouri River subbasin. The stream segment highlighted in white indicates the area sampled in 2024.

Background

Granite Creek is a tributary of Austin Creek in the Upper Missouri subbasin located 12 miles northwest of Helena, MT. No previous collection records for this waterbody could be found.

2024 Exploration

Granite Creek was surveyed on July 1st, 2024, to determine WCT presence/absence. A 1300 m reach of Granite Creek was backpack electrofished downstream the Priest Pass Road (FS RD 335). No fish were detected in this effort. Macrophytes and EPT taxa were noted as being abundant in the reach sampled, indicating perennial flow. Spawning gravels were common but large overwintering pools were rare. Granite Creek is likely not a candidate for WCT translocation due to lack of habitat.

Left Hand Fork Deadman Creek

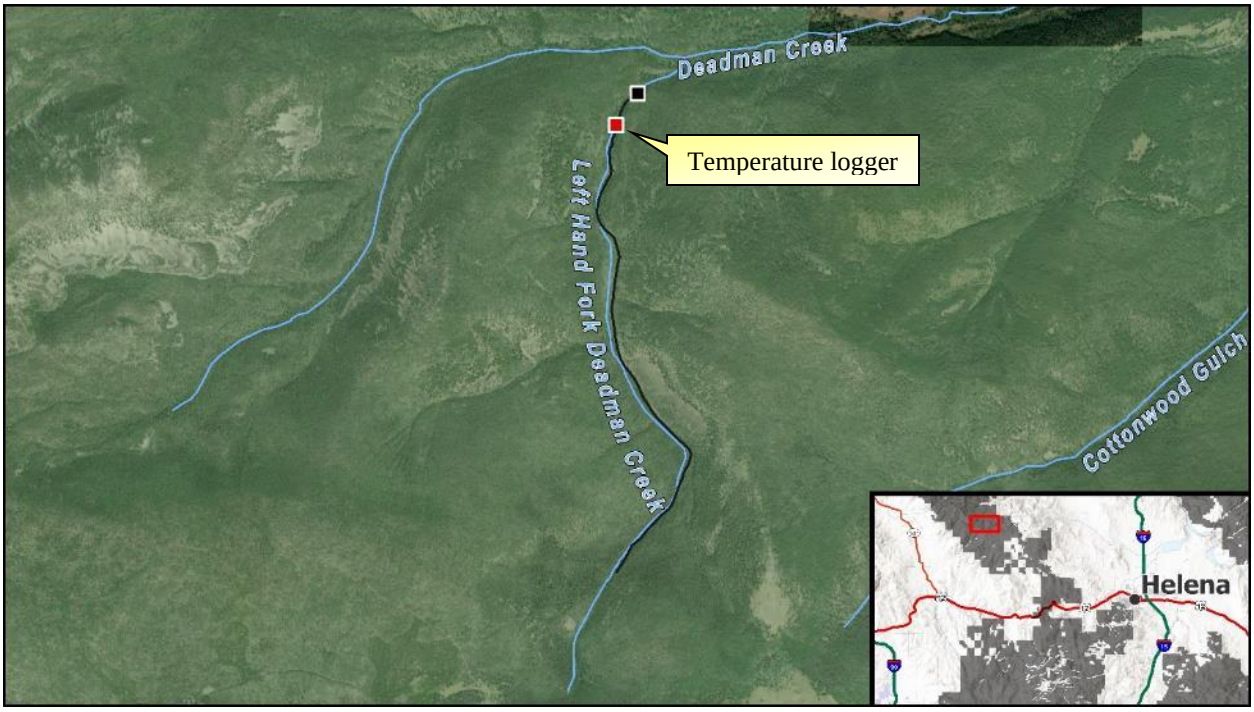

Figure 40. Left Hand Fork Deadman Creek in the Upper Missouri River subbasin. The stream segment delineated in black indicates the fishless habitat locate above Paradise Falls. The black square represents presence of waterfall barrier.

Background

Left Hand Fork Deadman Creek is a tributary of Deadman Creek in the Upper Missouri River subbasin located approximately 22 miles northwest of Helena, MT. Presence/absence sampling above Paradise Falls in 2023 determined the upper 1.64 miles of Left Hand Fork Deadman Creek to be fishless. An attempt was made to monitor summer stream temperatures in 2023, however, temperature logger battery failure prevented data collection.

2024 Monitoring

Stream temperature monitoring of Left Hand Fork Deadman Creek was performed in 2024 to assess suitability for WCT. A temperature logger was deployed at 46.75029, -112.46526 above Paradise Falls on May 16th and recovered on September 12th. The mean July stream temperature was 9.03°C and the mean August stream temperature was 9.21°C which is above the minimum 7.8°C required for successful cutthroat trout reproduction and recruitment (Figure 41, Harig and Fausch 2002). Left Hand Fork Deadman Creek appears to be thermally suitable for WCT.

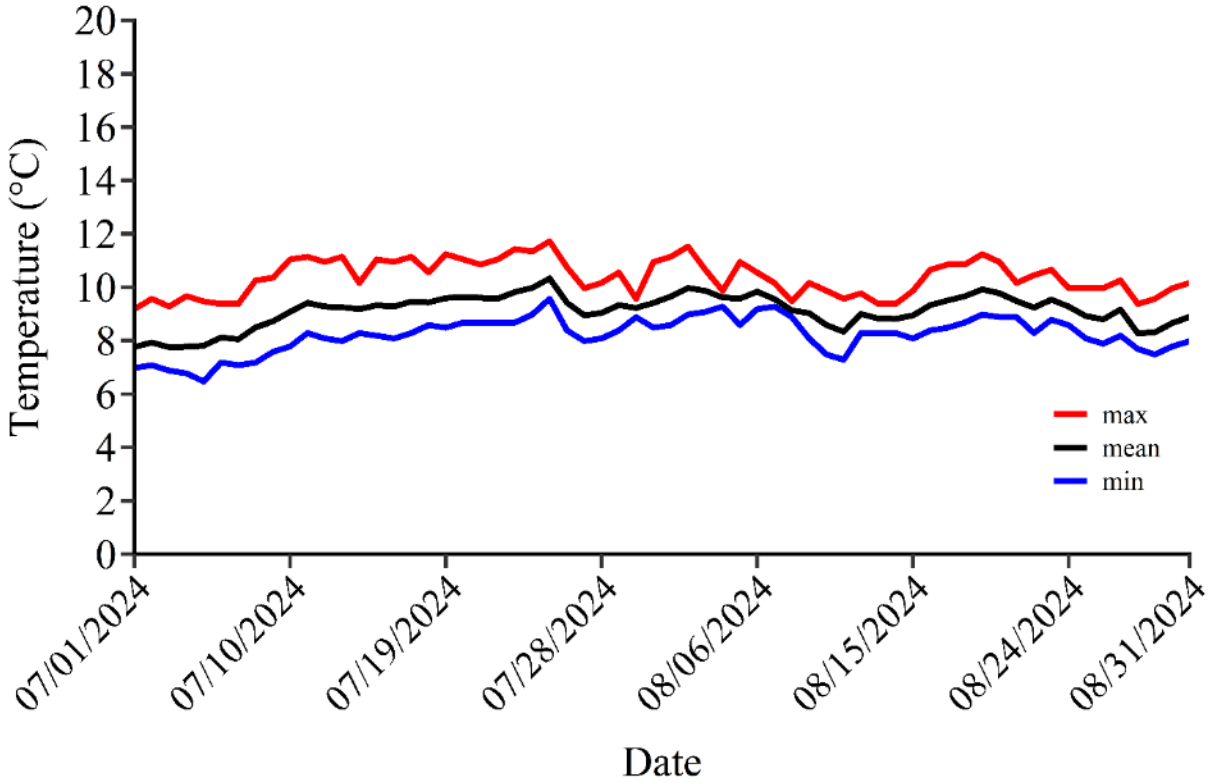

Figure 41. Daily maximum (red line), mean (black line), and minimum (blue line) stream temperatures from Left Hand Fork Deadman Creek. Temperature logger was deployed on May 16, 2024, and collected September 12, 2024. The mean July stream temperature was 9.03°C and the mean August stream temperature was 9.21°C.

Tar Head Creek

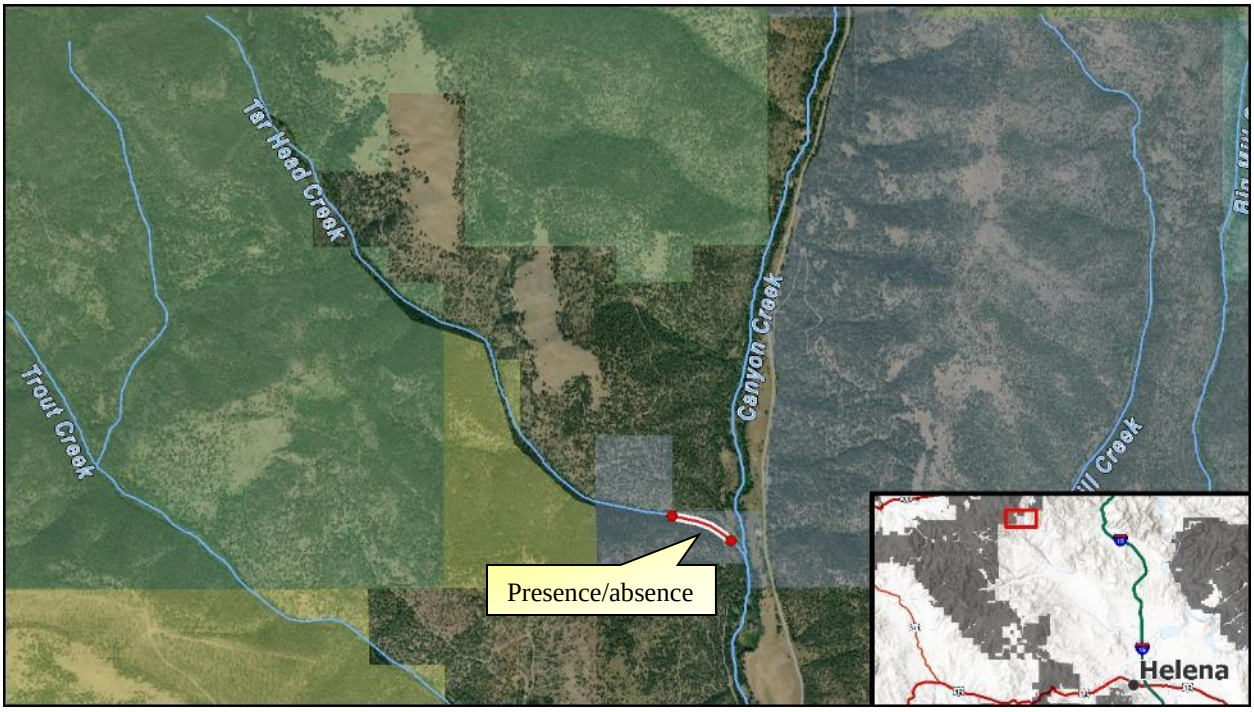

Figure 42. Tar Head Creek in the Upper Missouri River subbasin. The stream segment highlighted in white indicates the area sampled in 2024.

Background

Tar Head Creek is a tributary of Canyon Creek in the Upper Missouri River subbasin located approximately 26 miles northwest of Helena, MT. No previous surveys for this waterbody could be found. However, WCT collection records exist in nearby tributaries of Canyon Creek (Specimen and Weino Creeks).

2024 Exploration

Tar Head Creek was surveyed on August 14th, 2024, to determine WCT presence/absence. A 500 m reach of Tar Head Creek was backpack electrofished upstream of the Canyon Creek confluence on the Canyon Creek Wildlife Management Area (Figure 42). No fish were collected in this effort. Fish habitat was minimal with very low discharge observed.

Unnamed Tributary to Trout Creek

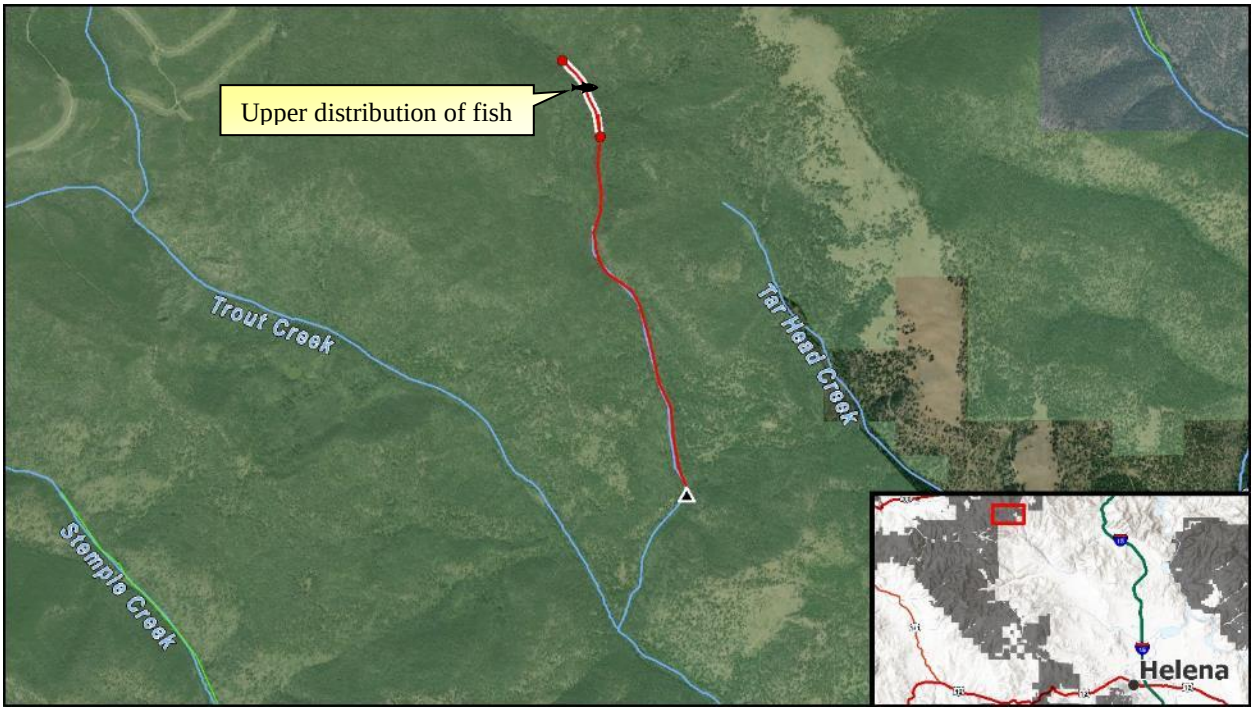

Figure 43. Trout Creek in the Upper Missouri River subbasin. The stream segment delineated in red indicates the unnamed tributary occupied by WCT. The stream segment highlighted in white indicates the area sampled in 2024.

Background

Trout Creek is a tributary of Virginia Creek in the Upper Missouri River subbasin located approximately 25 miles northwest of Helena, MT. Previous survey work in the Trout Creek drainage found the stream to contain hybrid trout, brook trout, and Rocky Mountain sculpin. Genetic monitoring of hybrid trout collected in the mainstem of Trout Creek by the Forest Service in 1990 found the fish to be a hybrid swarm with an average 45% WCT, 44% RB, and 2% YCT genetic contribution (n=4). In 2009, a survey of the unnamed tributary to Trout Creek was performed above the closed FS RD 1828 crossing and both brook trout and WCT were collected. A 50 fish genetic sample was analyzed from the WCT in this reach and found to contain a population with 99.4% WCT and 0.6% YCT genetic ancestry.

2024 Monitoring

The unnamed tributary of Trout Creek was surveyed on July 9th, 2024, to perform updated genetic monitoring of the WCT population. A 720 m headwater reach of the unnamed tributary was backpack electrofished until 20 WCT were collected. WCT ranged from 74-153 mm in length. Genetic samples were collected from all fish sampled and submitted to the University of Montana Conservation Genetics Laboratory for analysis. No brook trout were detected in this reach of the unnamed tributary. The upper distribution of fish was found to be 46.9392, -112.39634.

Weino Creek

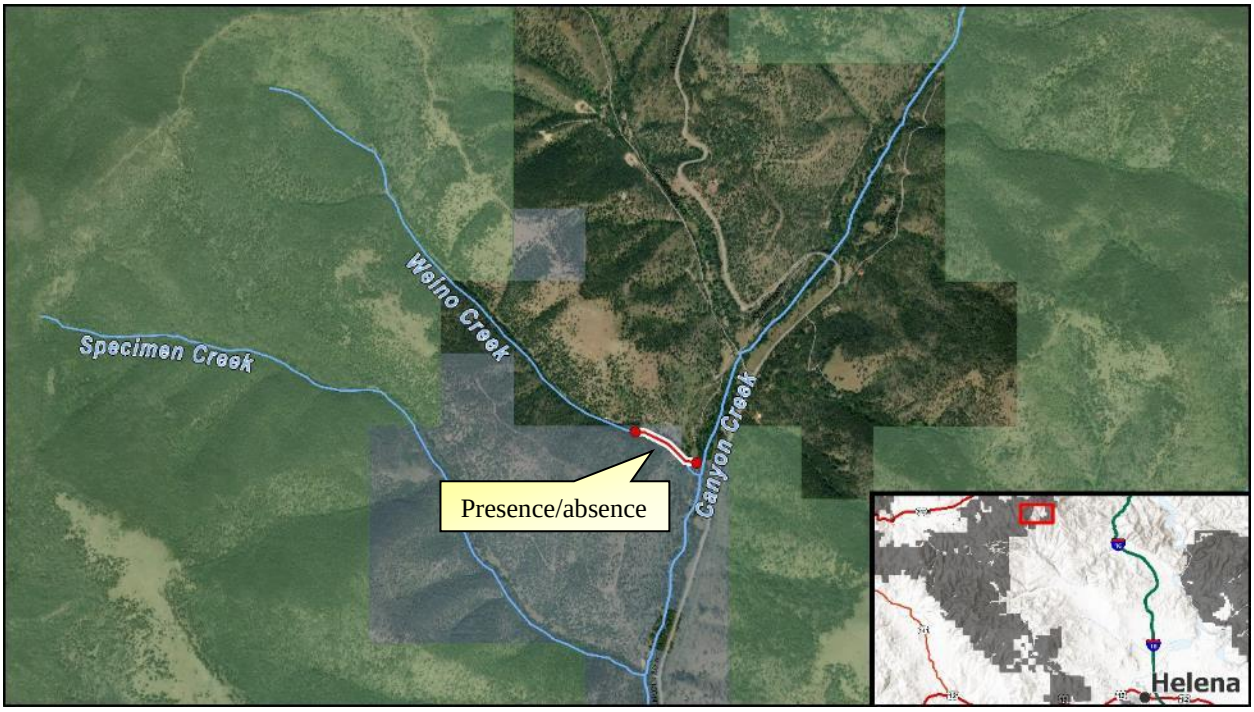

Figure 44. Weino Creek in the Upper Missouri River subbasin. The stream segment highlighted in white indicates the area sampled in 2024.

Background

Weino Creek is a tributary of Canyon Creek in the Upper Missouri River subbasin located approximately 28 miles northwest of Helena, MT. Previous survey work performed by the Forest Service in 2008 recorded a single WCT and 8 brook trout present in the reach located above the Forest Service boundary.

2024 Monitoring

Weino Creek was surveyed on August 14th, 2024, to determine WCT presence/absence. A 600 m reach of Weino Creek was backpack electrofished upstream of the Canyon Creek confluence on the Canyon Creek Wildlife Management Area (Figure 44). Twelve brook trout and two Rocky Mountain sculpin were collected and no WCT were detected. Similar to Tar Head Creek, fish habitat was limited, and very low flows were observed.

IX. Upper Missouri-Dearborn River Subbasin

Big Coulee

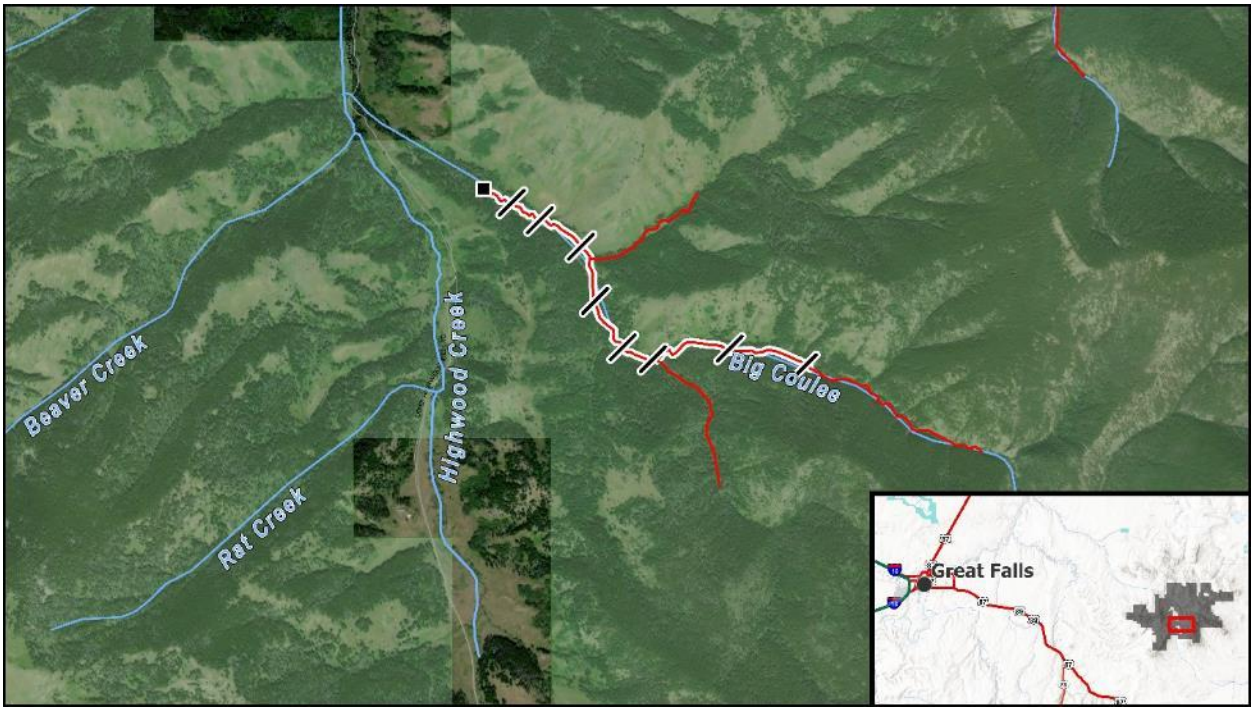

Figure 45. Big Coulee in the Upper Missouri-Dearborn River subbasin. The stream segments delineated in red indicate the areas occupied by nonhybridized WCT. The stream segment highlighted in white indicates the area sampled in 2024. Horizontal bars represent depletion reach breaks.

Background

Big Coulee, a tributary of Highwood Creek, contains a nonhybridized WCT population that has been intensively managed since the late 1990s. A bedrock feature was enhanced on Big Coulee by blasting in 2002 and 2004 to create a barrier to fish movement. From 1997-2008, brook trout were removed to reduce negative impacts on the remaining WCT found above the barrier. The reach upstream of the barrier was thought to be devoid of brook trout by 2008 and the WCT population was monitored annually from 2009-2015.

In 2015, brook trout were discovered above the barrier during annual monitoring efforts. Additionally, a 10-inch fish with rainbow trout phenotypic characteristics was found and removed in 2016. Unfortunately, a genetic sample was not collected from this fish to confirm its identity. Genetic samples collected from 32 WCT in 2016 were classified as nonhybridized.

Nonnative removals were again initiated in 2015 above the barrier. From 2015 to 2021, approximately 674 brook trout were removed including ~200 in 2015, ~330 in 2016, ~110 in 2017, 15 in 2018, 8 in both 2019 and 2020, and 3 in 2021. No brook trout were detected in 2022 and 2023.

2024 Monitoring

WCT population monitoring was performed on 1.76 miles of Big Coulee from August 19th - August 22nd, 2024. Eight sections of Big Coulee were two-pass backpack electrofished. A total of 1,650 WCT were collected in the initial 2024 monitoring effort (Table 2). One brook trout was collected in Section 1 and

one brown trout was collected in Section 3. This is the first detection of nonnatives above the bedrock barrier since 2021 and the first ever detection of brown trout in this reach.

Table 2. Big Coulee electrofishing catch by section during initial monitoring 2024.

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9[2]
Pass 1	223 WCT[1] 1 EB		138 WCT 1 LL	120 WCT	215 WCT	156 WCT	259 WCT	200 WCT	NA
Pass 2	34 WCT[1]		59 WCT	77 WCT	37 WCT	43 WCT	49 WCT	40 WCT	NA

[1] – Sections 1 and 2 were combined in 2024.
[2] – Section 9 was not electrofished in 2024 to perform additional passes on sections 1, 2, and 3.

Following the completion of two-pass backpack electrofishing of Sections 1-8, additional electrofishing passes of Sections 1-3 were performed to increase detection probability of nonnative trout in those sections. Four additional passes were performed over a two-day period with all collected WCT being moved upstream out of the lower reaches to increase capture efficiency. No additional nonnative trout were detected in this effort.

Based on the results of the 2024 Big Coulee WCT monitoring efforts, it appears that nonnative trout were able to bypass the bedrock barrier at some point prior to August. This bypass event most likely occurred during spring runoff. A large snowstorm occurred May 7-8, 2024, and heavily impacted portions of the Little Belt and Highwood Mountains with localized areas recording over 3 feet of snow. The Big Coulee drainage experienced this heavy snowfall based on the large number of downed lodgepole pines observed in the stream reach and upslope areas upstream of the barrier location.

FWP contracted Pioneer Technical Services, Inc. for survey and design of enhancements to the Big Coulee bedrock barrier in 2024 (Figure 46). Construction will be pursued in the summer/fall of 2025.

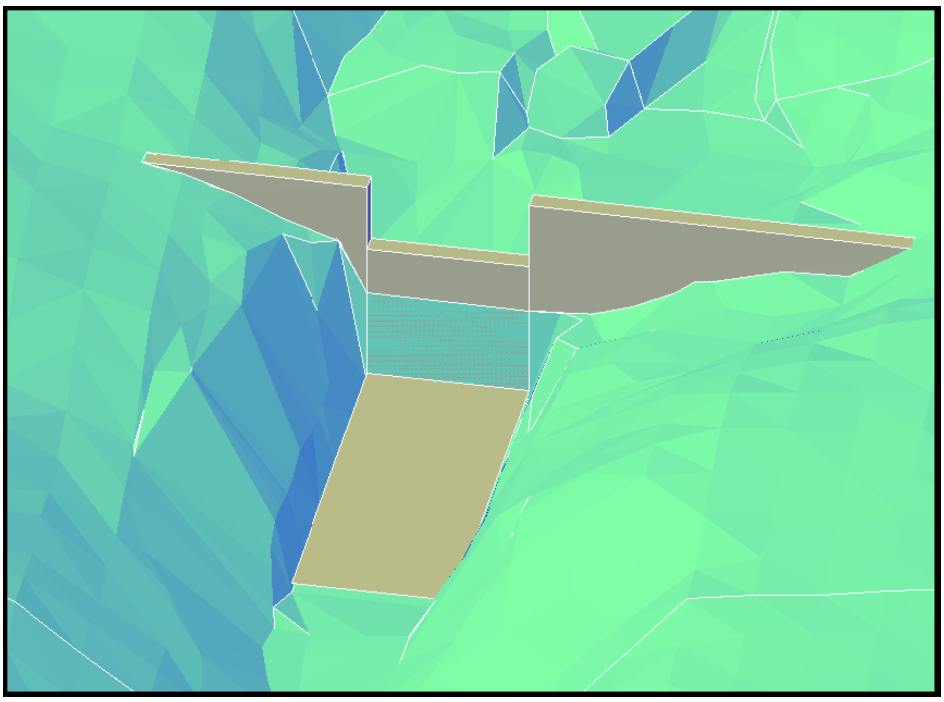

Figure 46. Preliminary Big Coulee barrier enhancement conceptual design.

North Fork Highwood Creek

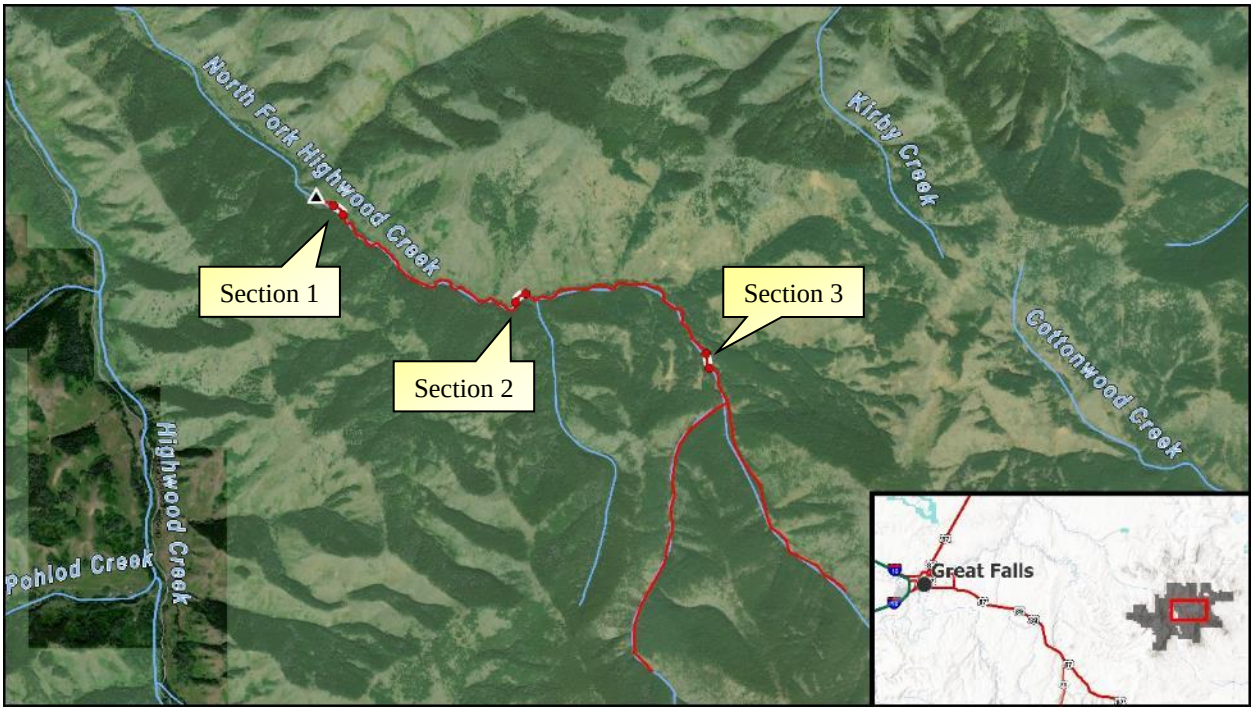

Figure 47. North Fork Highwood Creek in the Upper Missouri-Dearborn River subbasin. The stream segments delineated in red indicate the areas occupied by nonhybridized WCT. The stream segments highlighted in white indicates the area sampled in 2024.

Background

North Fork Highwood Creek is a headwater tributary of Highwood Creek which drains the northwestern aspect of the Highwood Mountains approximately 34 miles east of Great Falls, MT (Figure 47). The upper 4.21 miles of habitat contains a restored nonhybridized population of WCT above a constructed fish barrier located at 47.45916, -110.56873. WCT restoration efforts began in 2011 with the construction the barrier followed by three years of chemical treatment from 2012-2014 to remove nonnative brook trout and hybrid trout. Prior to the initiation of the project, nonhybridized WCT were restricted to 1.16 miles of habitat in an isolated tributary above a bedrock barrier. Following removal of nonnative trout, WCT from the isolated tributary slowly began expanding into the newly vacant habitat in the mainstem North Fork Highwood Creek. Monitoring performed in 2020 found that post-treatment WCT densities were still low, particularly in the lower 1.5 miles of habitat above the barrier.

2024 Monitoring

North Fork Highwood Creek was surveyed on October 15th, 16th, and 24th, 2024, to perform demographic monitoring. Three 100-m long-term monitoring sites were established upstream of the constructed fish barrier to obtain a population estimate of the restored WCT population. Multiple pass depletion methods were used to estimate population abundance. High densities of WCT were observed at all three sites with an average estimated density of 1,167 fish/km based on the results of the population estimates (Figure 48). When extrapolated to the entire length of the occupied habitat (6.77 km), a total of 7,898 WCT are estimated to be present. WCT have fully expanded into the available habitat upstream of the constructed fish barrier and the population is now considered secured.

North Fork Highwood Creek —NATIVE TROUT POPULATION SURVEY

1. General Information— Date: **October 15, 16, 24, 2024** Biologist: **A. Poole**
2. Stream Information—
   Name, section, county: **North Fork Highwood Creek, 34 & 35, Chouteau**
3. Survey Site Information (see attached map)—
   Upstream range of native trout (general description and GPS): **Section 1 (47.43764, -110.52611; estimate, based on satellite imagery)**
   Downstream range of native trout (general description and GPS): **Constructed fish barrier (47.45917, -110.56872)**
   Location (GPS) and description of barriers: **Constructed fish barrier (47.45917, -110.56872) Cutty trib bedrock barrier (47.44747, -110.53715)**
   Stream Length—Occupied habitat: **6.77 km (4.21 mi)** Available habitat: **11.59 km (7.20 mi)[1]**
   Survey method & equipment: **backpack battery electrofisher; two-pass depletion**
   Survey sites (general description and UTM)—
   Section 1: **Above fish barrier; 47.45858, -110.56733**
   Section 2: **Above 2nd tributary; 47.45334, -110.55269**
   Section 2: **Above FS Trail 415 crossing; 47.45055, -110.53737**

Parameter	**Section 1**	**Section 2**	**Section 3**
Section length (m)	100 m	100 m	100 m
Mean stream width (m) (n)	3.75 m (10)	2.83 m (10)	2.44 m (10)
Section area (hectares)	0.038 ha	0.028 ha	0.024 ha
WCT			
Removal Pattern	33 13 6	103 32 17	88 32
Population estimate	55 (±6)	159 (±8)	136 (±18)
Capture probability	0.605	0.636	0.652
Mean length (mm) (n)	174 (52)	151 (152)	115 (120)
Mean weight (g) (n)	54 (52)	35 (152)	17 (120)
Mean KTL (n)	0.85 (52)	0.81 (152)	0.82 (120)
Number fish per km (95 % CI)	550 (±60)	1,590 (±80)	1,360 (±180)
Number fish per ha (95 % CI)	1,447 (±158)	5,678 (±286)	5,667 (±750)
Biomass (kg per ha) (95 % CI)	78 (±9)	199 (±10)	96 (±13)

4. Comments: YOY WCT observed at all three sites. Rocky Mountain Sculpin were abundant in Section 1 and absent from Sections 2 and 3.

[1] – Includes 4.35 km (2.70 mi) of habitat below the constructed fish barrier

Figure 48. North Fork Highwood Creek fish population estimate results.

Wegner Creek

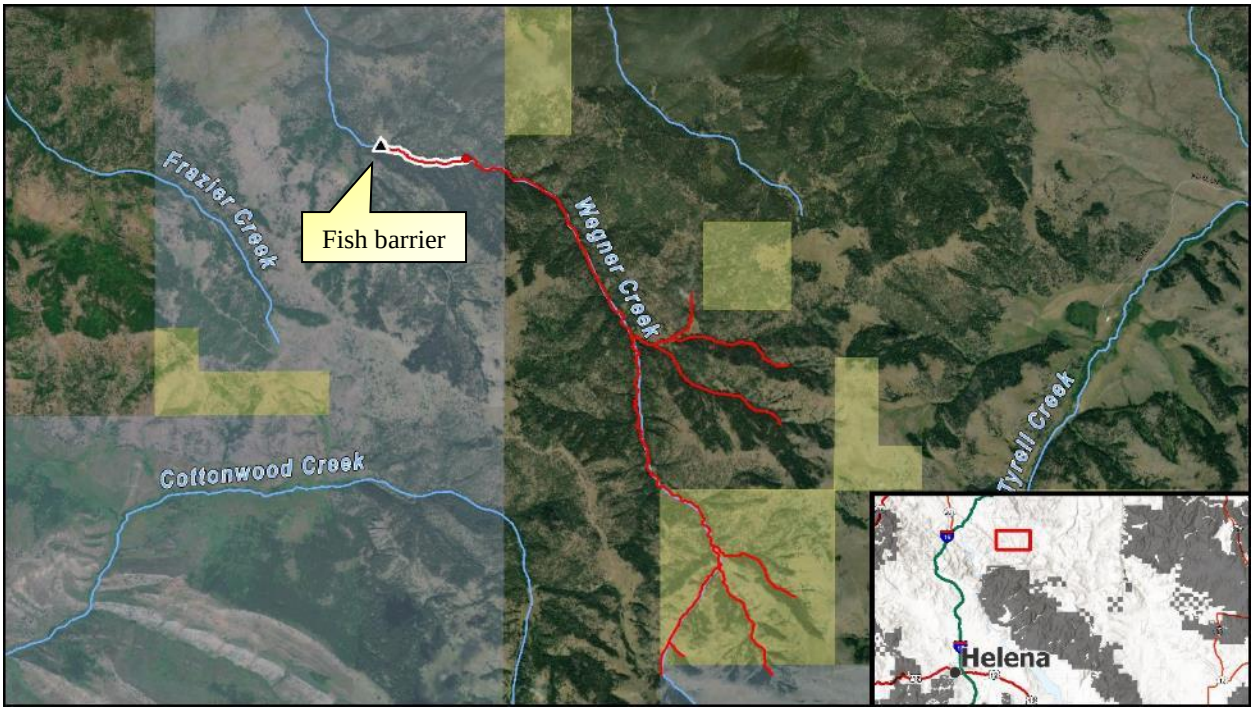

Figure 49. Wegner Creek in the Upper Missouri-Dearborn River subbasin. The stream segments delineated in red indicate potential WCT restoration area. The stream segment highlighted in white indicates the area sampled in 2024.

Background

In 2014, the Beartooth Wildlife Management Area expanded by 2,840-acres and that addition included portions of Wegner Creek. Wegner Creek, a tributary of the Missouri River, was surveyed in 2015 and found to contain brook trout, rainbow trout, and Rocky Mountain sculpin. Based on the high density of trout and sculpin observed, the stream was considered as a potential conservation area for WCT. In 2017, a small concrete barrier was built on a natural bedrock slide to isolate the Wegner Creek headwaters. A piscicide treatment was performed upstream of the barrier on July 10th, 2018. A cursory electrofishing survey of the lower 1.5 miles of stream above the barrier was performed in the fall of 2018 to assess the success of the piscicide treatment and only Rocky Mountain sculpin was observed.

In 2019, the stream was sampled upstream of the barrier to further assess the success of the previous year's piscicide treatment. Several large rainbow trout were collected in the first 400 m above the barrier. After this discovery, the barrier was modified to increase the height by approximately 7 inches and extend the barrier laterally by approximately 6 feet. Additional electrofishing above the barrier in 2019 detected brook trout still present in the vicinity of the unnamed tributary, suggesting an incomplete chemical treatment. To test the efficacy of the barrier addition, annual marking of brook and rainbow trout has occurred below the barrier since 2019. Additionally, presence/absence monitoring has been performed above the barrier annually to detect bypass events.

2024 Monitoring

Wegner Creek was surveyed on June 20th, 2024, to perform presence/absence monitoring above the fish barrier. A 1300 m reach of Wegner Creek was backpack electrofished above the barrier to detect the

presence of marked fish or large, migratory Missouri River rainbow trout. A single 134 mm unmarked rainbow trout was collected in this effort.

FWP contracted Pioneer Technical Services, Inc. for survey and design of enhancements to the Wegner Creek fish barrier in 2024 (Figure 50). Construction may be pursued in the summer/fall of 2026, dependent upon progress made in other higher priority watersheds.

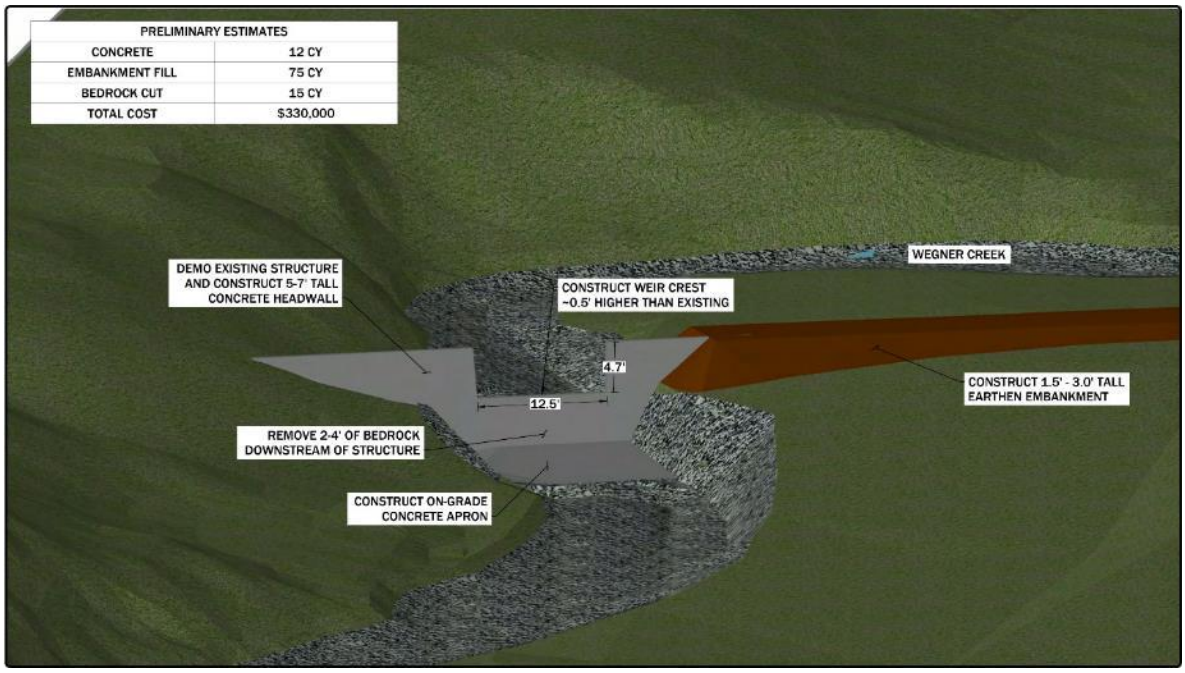

Figure 50. Preliminary Wegner Creek barrier enhancement conceptual design.

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Appendix A – University of Montana Conservation Genetics Laboratory Report

Date: August 14, 2024

Biologist(s): Alex Poole

Location(s) and sampling date:

1. Boyd Creek (47.4535, -110.46677; 0729/21)
2. Haystack Creek (46.96956, -110.71613; 08/30/23)
3. Spruce Creek (47.03255, -110.65963; 09/27/22)
4. Tillinghast Creek (46.96139, -110.84242; 07/25/23)
5. Big Hill Creek (46.73139, -110.47236; 07/24/23)
6. Unnamed Trib to Deadhorse (46.69968, -110.46039; 07/24/23)
7. Weatherwax Creek (46.83677, -110.63018; 08/30/22)
8. Big Camas Creek (46.55599, -111.30073; 06/19/23)
9. Cottonwood Creek (46.44881, -110.81171; 08/16/23)
10. South Fork Willow Creek (46.50163, -110.81437; 08/15/23)
11. South Fork Teton River (47.84582, -112.7820; 07/20/23)
12. South Fork South Fork Teton River (47.85067, -112.77639; 10/19/21)
13. Skelly Gulch (46.69842, -112.28932; 08/12/21)

Agency: Montana Fish, Wildlife & Parks

Target species: Westslope cutthroat trout

Authors: Ryan Kovach, Steve Amish, Sally Painter, Angela Lodmell

PROJECT SUMMARY: Genetic samples from the various locations in Montana FWP R4 were analyzed for purposes of describing the presence and extent of non-native genetic admixture from rainbow trout or Yellowstone cutthroat trout. Where appropriate, we also quantified genetic variation and/or genetic differentiation.

All Results, Discussion, and Recommendations are described below. Summary statistics for the population samples are in Table 1 (below). Lab and data analysis methods are described in Appendix 1.

RESULTS, DISCUSSION, AND RECOMMENDATIONS

Table 1. The presence and extent of rainbow trout and Yellowstone cutthroat trout hybridization from waterbodies within the native range of westslope cutthroat trout. ID refers to the FWP sample ID number and N is the sample size. The Taxa column denotes whether a sample include non-hybridized individuals (WCT), rainbow/westslope hybrids (WCT x RBT), Yellowstone/westslope hybrids (WCT x YCT) or hybrids between all three taxa (WCT x RBT x YCT). The mean estimate for the percent ancestry of each taxon is presented in the last three columns. The WCT value was calculated by subtracting the RBT and YCT values.

Sample	ID	N	Method	Taxa	WCT	RBT	YCT
Boyd Creek	5781	30	GTseq	WCTxRBT	99.4	0.6	

Haystack Creek	5782	20	GTseq	WCT			
Spruce Creek	5783	20	GTseq	WCTxRBTxYCT	99.7	0.1	0.2
Tillinghast Creek	5784	20	GTseq	WCTxRBTxYCT	99.2	0.7	0.1
Big Hill Creek	5785	20	GTseq	WCTxRBTxYCT	96.9	1.8	1.3
Unnamed trib to Deadhorse	5786	19	GTseq	WCTxRBTxYCT	97.0	2.9	0.1
Weatherwax Creek	5787	94	RADcap	WCTxRBTxYCT	96.5	2.5	1.0
Big Camas Creek	5788	8 11	GTseq	WCT WCTxYCT			
Cottonwood Creek	5789	20	GTseq	WCT			
South Fork Willow Creek	5790	20	GTseq	WCT			
South Fork Teton River	5791	20	GTseq	WCTxRBT	98.9	1.1	
SF SF Teton River	5792	24	GTseq	WCTxRBT	99.0	1.0	
Skelly Gulch	5793	25	GTseq	WCTxRBTxYCT	99.1	0.2	0.7

Boyd Creek

In the sample from Boyd Creek we clearly detected rainbow trout ancestry. We did not detect any Yellowstone cutthroat trout ancestry. Rainbow trout alleles were detected in 18 of the fish in the sample (60%), but given that rainbow trout ancestry was limited on an individual level (max = 4%; Supplementary Table 1), this is almost certainly an underestimate. Overall, it appears that Boyd Creek likely harbors a hybrid swarm between westslope cutthroat trout and rainbow trout. We combined the westslope and rainbow diagnostic markers to estimate overall population ancestry and found that there is approximately 0.6% rainbow trout ancestry in this sample from Boyd Creek. Nevertheless, Boyd Creek clearly contains a population of conservation value, with relatively high genetic variation compared to other westslope populations found in the Missouri River drainage (Table 2).

Haystack Creek

In the sample from Haystack Creek we did not detect any rainbow or Yellowstone alleles. This is consistent with past sampling, suggesting that Haystack Creek harbors a non-hybridized population of westslope cutthroat trout. Estimates of genetic variation from the fish in this sample were very low compared to other westslope cutthroat trout populations in the Missouri River drainage (Table 2).

Typically, we would suggest that this population is a clear candidate for genetic rescue. However, given that gene flow from Carpenter Creek may be likely to occur in the very near future as water quality improves in the watershed, immediate translocations are likely unnecessary unless there is concern about the current demographic status of the population (i.e., if population sizes are concerningly small). If there are concerns about population viability, a translocation from Carpenter Creek itself is likely to benefit at least some population vital rates (survival, reproductive success, or abundance), or at worse, have limited (i.e., neutral) effect. Thus, it is a low-risk strategy in this situation if needed.

Spruce Creek

We detected a small number of rainbow trout and Yellowstone cutthroat trout alleles in the sample from Spruce Creek (Supplementary Table 1). When non-native alleles are at very low frequency, it is difficult to say anything definitive about the distribution of non-native ancestry within and among individuals in the sample. At present, all we can say with any confidence is the mean rainbow trout ancestry across individuals was 0.1%, and the mean Yellowstone cutthroat trout ancestry across individuals was 0.2%. Nevertheless, Spruce Creek clearly contains a population of conservation value, with relatively high genetic variation compared to other westslope populations found in the Missouri River drainage (Table 2).

Tillinghast Creek

In the sample from Tillinghast Creek we detected both rainbow trout and Yellowstone cutthroat trout ancestry. A majority (55%) of fish in the sample were hybrids, but this is almost certainly an underestimate given that non-native ancestry was limited on an individual basis (Supplementary Table 1). Overall, it seems very likely that Tillinghast Creek harbors a hybrid swarm with a relatively small amount of rainbow trout ancestry (0.7%) and Yellowstone cutthroat trout ancestry (0.1%). Nevertheless, Tillinghast Creek still contains a core westslope cutthroat trout population, with relatively high genetic variation compared to other westslope populations found in the Missouri River drainage (Table 2).

Big Hill Creek

In the sample from Big Hill Creek we clearly detected both rainbow trout and Yellowstone cutthroat trout ancestry (Fig. 1). Non-native alleles were detected in all individuals in the sample (Supplementary Table 1). The overall mean rainbow trout ancestry across individuals was 1.8%, and the mean Yellowstone cutthroat trout ancestry across individuals was 1.3%. Non-native alleles were detected across 48% of the westslope diagnostic loci. Although genomic data would be preferable for documenting genomic extinction, the data available here are sufficient to suggest that the westslope population in Big Hill Creek – though technically a "conservation population" – should receive lower priority than other westslope populations in the region.

Unnamed tributary to Deadhorse Creek

In the sample from Tillinghast Creek we detected both rainbow trout and Yellowstone cutthroat trout ancestry (Fig. 2). A majority (73.7%) of fish in the sample were hybrids, but this is likely an underestimate given that non-native ancestry was limited on an individual basis (Supplementary Table 1). At present it seems reasonable to assume that up to 20% of the fish may be non-hybridized. Depending on overall population size, that number may be too few to justify a tag- and transfer action at this stage of hybridization. That being said, non-hybridized cutthroat trout are rare in the Judith basin, which does make this management approach more viable than in other basins where non-hybridized westslope cutthroat trout are more widespread. Overall, the mean rainbow trout ancestry across individuals was 2.9% and the mean Yellowstone cutthroat trout ancestry was 0.1%.

Weatherwax Creek

We obtained quality genomic data from 94 of the 98 fish in the sample. We definitively detected non-native ancestry in runs of hybridity in all but ten of those fish, but, it is likely that many or all of the remaining fish had some very trivial, amount of rainbow or Yellowstone cutthroat trout ancestry (Supplementary Table 1). Although non-native ancestry was widespread among individuals, many fish had very low amounts of rainbow or Yellowstone ancestry. For example, 29 of the fish in the sample had greater than 99% westslope cutthroat trout ancestry across all three types of diagnostic loci. Given the rarity of westslope cutthroat trout in the Judith River basin, these fish still have very high conservation value and as such, are worthy candidates of genetic salvage efforts. The mean rainbow ancestry among all individuals in the sample was 2.5%, and the mean Yellowstone cutthroat trout ancestry was 1.0%.

Big Camas Creek

The 19-fish sample from Big Camas Creek above Big Camas Lake was composed of 8 non-hybridized westslope cutthroat trout, and 11 F1 hybrids between westslope cutthroat trout and Yellowstone cutthroat trout. The data provide very clear evidence that hybridization is occurring between westslope and Yellowstone cutthroat trout in this watershed; in fact, hybrids now appear to be the majority of fish, at least in this reach, of Big Camas Creek.

Cottonwood Creek

In the sample from Cottonwood Creek we did not detect any rainbow or Yellowstone alleles. This is consistent with past sampling, suggesting that Haystack Creek harbors a non-hybridized population of westslope cutthroat trout. Estimates of genetic variation from the fish in this sample were low compared to other westslope cutthroat trout populations in the Missouri River drainage (Table 2).

South Fork Willow Creek

In the sample from South Fork Lower Willow Creek we did not detect any rainbow or Yellowstone alleles. This is consistent with past sampling, suggesting that South Fork Lower Willow Creek harbors a non-hybridized population of westslope cutthroat trout. Estimates of genetic variation from the fish in this sample were very low compared to other westslope cutthroat trout populations in the Missouri River drainage (Table 2). This population is a clear candidate for an assisted translocation focused on providing gene flow (i.e., genetic rescue). Based on results from other efforts across the state, it's possible that genetic rescue would enable fish from South Fork Willow Creek to more rapidly expand and populate the upstream fishless part of the watershed if moved above the current bedrock barrier.

South Fork Teton River

We clearly detected rainbow trout ancestry in the sample from the South Fork Teton River (Fig. 3). Rainbow trout alleles were detected in all but 4 individuals (Supplementary Table 1), but this may be an underestimate given that rainbow trout ancestry was relatively limited on an individual basis (maximum individual rainbow trout ancestry was less than 4%). Given that we did not detect any Yellowstone

ancestry, we combined the rainbow trout and westslope cutthroat trout diagnostic markers and found that the mean rainbow trout ancestry across individuals was 1.1%.

South Fork South Fork Teton River

We clearly detected rainbow trout ancestry in the sample from the South Fork South Fork Teton River (Fig. 4). Rainbow trout alleles were detected in all but 4 individuals (Supplementary Table 1), but this may be an underestimate given that rainbow trout ancestry was relatively limited on an individual basis (maximum individual rainbow trout ancestry was less than 4%). Given that we did not detect any Yellowstone ancestry, we combined the rainbow trout and westslope cutthroat trout diagnostic markers and found that the mean rainbow trout ancestry across individuals was 1.0%.

Skelly Gulch

We clearly detected rainbow trout and Yellowstone cutthroat trout ancestry in the sample from Skelly Gulch (Fig. 5). We detected non-native alleles in a slight majority (54%) of fish in the sample, but this is likely an underestimate given that non-native ancestry was limited on an individual basis (Supplementary Table 1). The mean rainbow ancestry among all individuals in the sample was 0.2%, and the mean Yellowstone cutthroat trout ancestry was 0.7%. As such, Skelly Gulch still harbors a core population of westslope cutthroat trout, albeit one with relatively low genetic variation compared to other westslope cutthroat trout population in the Missouri River drainage (Table 2).

Table 2. Estimates of genetic variation for westslope cutthroat trout populations in the Columbia River basin. P is the proportion of polymorphic SNP loci in the sample, and He is the expected heterozygosity.

Population	Watershed	P	He
Boyd Creek	Arrow	0.64	0.199
Cottonwood Creek	Arrow	0.64	0.185
Brays Canyon	Beaverhead	0.15	0.05
Buffalo Creek	Beaverhead	0.35	0.074
Cottonwood Creek	Beaverhead	0.05	0.015
Dyce Creek	Beaverhead	0.26	0.071
Jake Canyon	Beaverhead	0.27	0.073
Left Fork Stone Creek	Beaverhead	0.55	0.182
Reservoir Creek	Beaverhead	0.19	0.064
Carpenter Creek	Belt	0.55	0.18
Charcoal Creek	Belt	0.76	0.242
Crawford Creek	Belt	0.52	0.174
Dry Fork Belt Creek	Belt	0.79	0.251
Gold Run	Belt	0.31	0.101
Graveyard Gulch	Belt	0.41	0.144
Harley Creek Tributary	Belt	0.89	0.278
Haystack Creek	Belt	0.12	0.042
Henn Gulch	Belt	0.68	0.224
NF Little Belt	Belt	0.44	0.141
Oti Park Creek	Belt	0.76	0.238
Pilgrim Creek	Belt	0.59	0.211
Sawmill Creek	Belt	0.62	0.199
Shorty Creek	Belt	0.65	0.204

Smoke-in-hole Creek	Belt	0.75	0.242
Spruce Creek	Belt	0.68	0.226
Tillinghast Creek	Belt	0.81	0.259
Villars Creek	Belt	0.78	0.243
American Creek	Big Hole	0.64	0.205
Bailey Creek	Big Hole	0.65	0.105
Bender Creek	Big Hole	0.55	0.065
Blind Canyon Creek	Big Hole	0.12	0.04
Bryant Creek	Big Hole	0.05	0.013
Hell Roaring Creek	Big Hole	0.13	0.047
Jerry Creek	Big Hole	0.93	0.305
Lacy Creek	Big Hole	0.52	0.17
Little American Creek	Big Hole	0.35	0.114
McVey Creek	Big Hole	0.23	0.073
Mono Creek	Big Hole	0.47	0.102
North Fork Fox Creek	Big Hole	0.26	0.089
Plimpton Creek	Big Hole	0.35	0.124
Rabbia Creek	Big Hole	0.35	0.106
Rock Creek	Big Hole	0.58	0.146
Sappington Creek	Big Hole	0.92	0.291
SF Doolittle Creek	Big Hole	0.26	0.066
SF NF Divide Creek	Big Hole	0.22	0.044
South Fork Andrus Creek	Big Hole	0.32	0.091
Christiansen Creek	Big Hole	0.55	0.162
Christiansen Lake	Big Hole	0.19	0.057
Twelvemile Creek	Big Hole	0.19	0.067

High Ore Creek	Boulder	0.84	0.27
Jack Creek	Boulder	0.67	0.206
Little Boulder	Boulder	0.77	0.251
Muskrat Creek	Boulder	0.78	0.265
Red Rock Creek	Boulder	0.84	0.239
Collar Gulch Creek	Box Elder	0.28	0.085
Half Moon Creek	Flatwillow	0.32	0.106
Beehive Basin Creek	Gallatin	0.19	0.053
Bostwick Creek	Gallatin	0.14	0.045
West Fork Wilson Creek	Gallatin	0.72	0.124
Wild Horse	Gallatin	0.07	0.024
East Fork Big Spring Creek	Judith	0.42	0.133
West Fork Cottonwood Creek	Judith	0.49	0.138
Weatherwax Creek	Judith	0.59	0.191
Last Chance	Madison	0.18	0.048
McClure Creek	Madison	0.07	0.03
Garrott Creek	Madison	0.15	0.048
Horse Creek	Madison	0.29	0.019
Lox Creek	Madison	0.14	0.038
Bean Creek	Red Rock	0.20	0.067
Bear Creek Red	Red Rock	0.11	0.04
Browns	Red Rock	0.92	0.322
Craver Creek	Red Rock	0.16	0.049
Mcninch Creek	Red Rock	0.39	0.105
Meadow	Red Rock	0.59	0.145
NF Everson	Red Rock	0.26	0.085

Painter	Red Rock	0.76	0.171
Rape Creek	Red Rock	0.15	0.023
SF Everson	Red Rock	0.24	0.071
Simpson Creek	Red Rock	0.24	0.092
Dark Hollow Creek	Ruby	0.18	0.047
Harris Creek	Ruby	0.30	0.078
Idaho Creek	Ruby	0.25	0.067
Jack Creek Ruby	Ruby	0.14	0.049
Meadow Fork Greenhorn	Ruby	0.20	0.058
Mill Gulch	Ruby	0.72	0.067
North Fork Greenhorn Creek	Ruby	0.32	0.098
Ramshorn	Ruby	0.04	0.011
SF Greenhorn Cr	Ruby	0.24	0.075
Cottonwood Smith	Smith	0.24	0.078
Lone Willow Creek	Smith	0.09	0.035
SF Willow Creek	Smith	0.16	0.029
North Fork Willow Creek	Teton	0.66	0.193
Midvale	Two Medicine	0.86	0.277
Sydney	Two Medicine	0.69	0.243
Whiterock Creek	Two Medicine	0.61	0.196
White Creek MO	Upper Missouri	0.35	0.043
Duck Creek	Upper Missouri	0.15	0.033
Elkhorn Creek (Upper)	Upper Missouri	0.69	0.228
Hall Creek	Upper Missouri	0.11	0.031
Kady Gulch	Upper Missouri	0.70	0.248
McClellan Cr	Upper Missouri	0.19	0.049

Page Gulch	Upper Missouri	0.83	0.294
Prickly Pear Creek	Upper Missouri	0.02	0.006
Ray Creek	Upper Missouri	0.21	0.066
SF Quartz	Upper Missouri	0.45	0.119
SF Warm Springs Creek	Upper Missouri	0.32	0.102
Skelly Gulch	Upper Missouri	0.19	0.053
Staubach	Upper Missouri	0.05	0.018
Threemile	Upper Missouri	0.24	0.079
Dutchman Creek	Upper Missouri	0.64	0.197
Cottonwood Creek	Upper Missouri	0.26	0.087

FIGURES

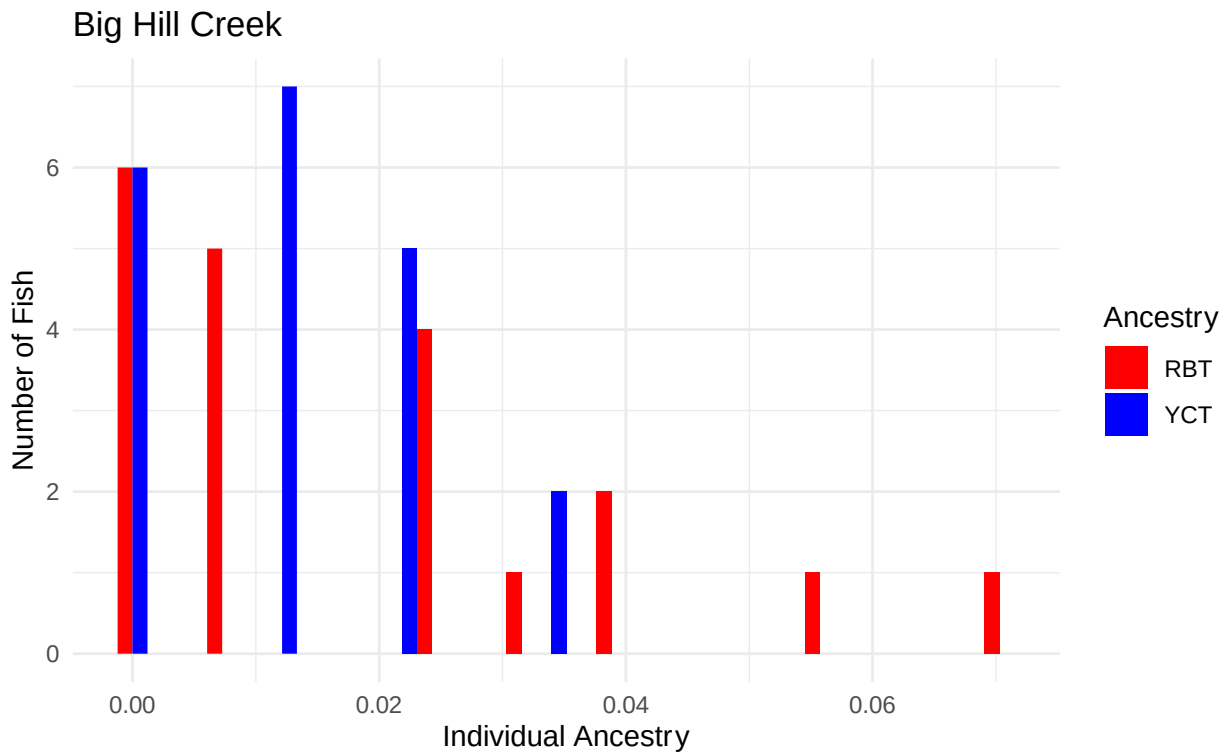

Figure 1. Observed distribution of individual rainbow and Yellowstone cutthroat trout ancestry in a sample of fish from Big Hill Creek.

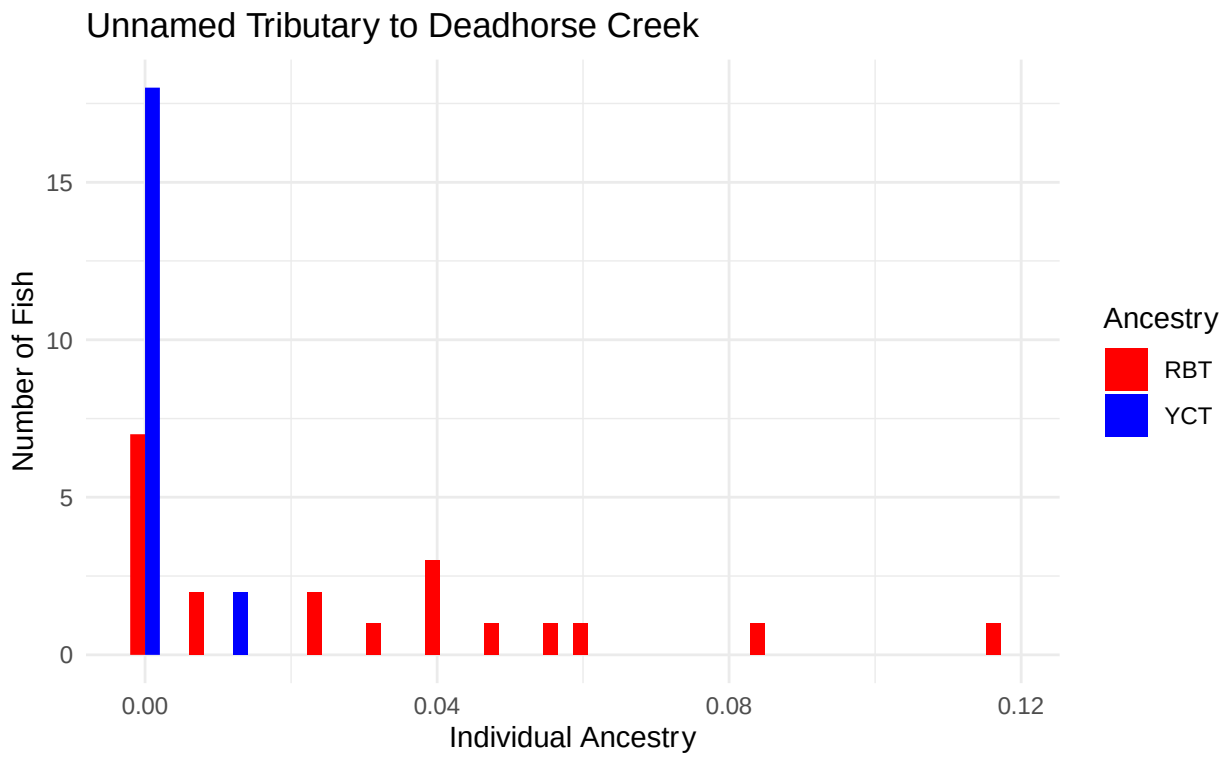

Figure 2. Observed distribution of individual rainbow and Yellowstone cutthroat trout ancestry in a sample of fish from an unnamed tributary to Deadhorse Creek.

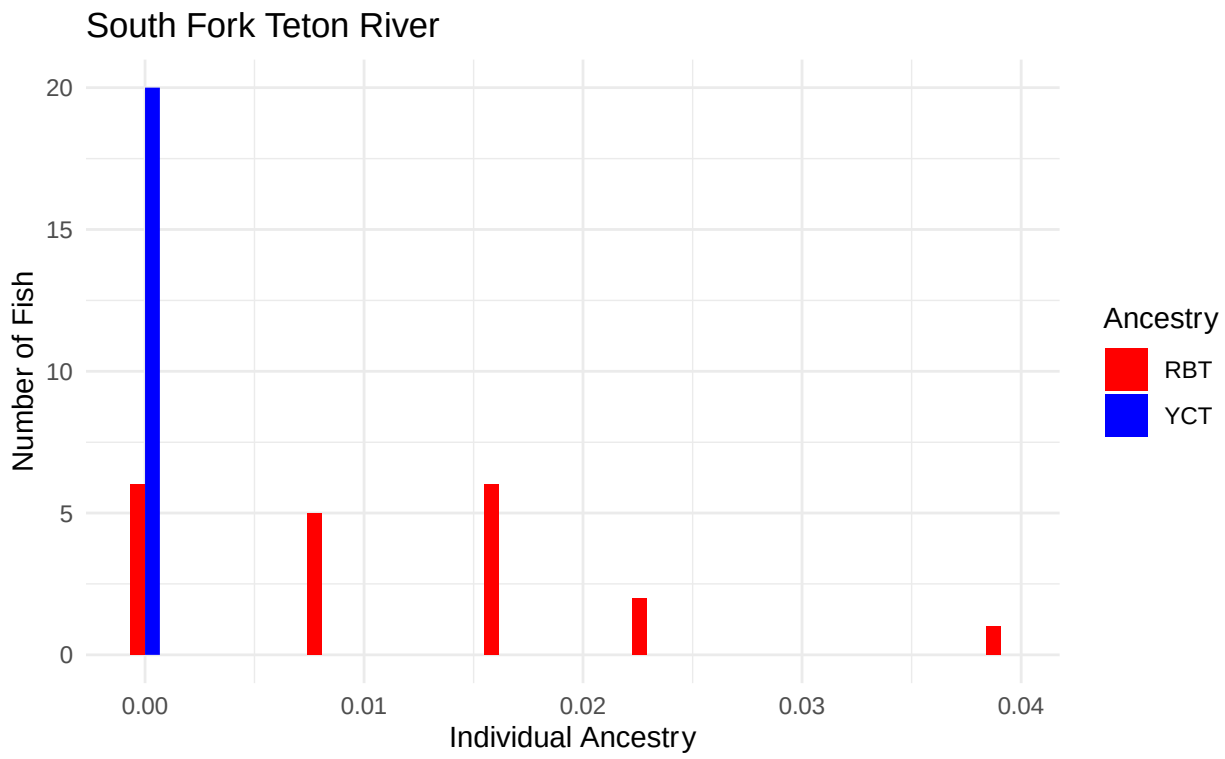

Figure 3. Observed distribution of individual rainbow and Yellowstone cutthroat trout ancestry in a sample of fish from the South Fork Teton River.

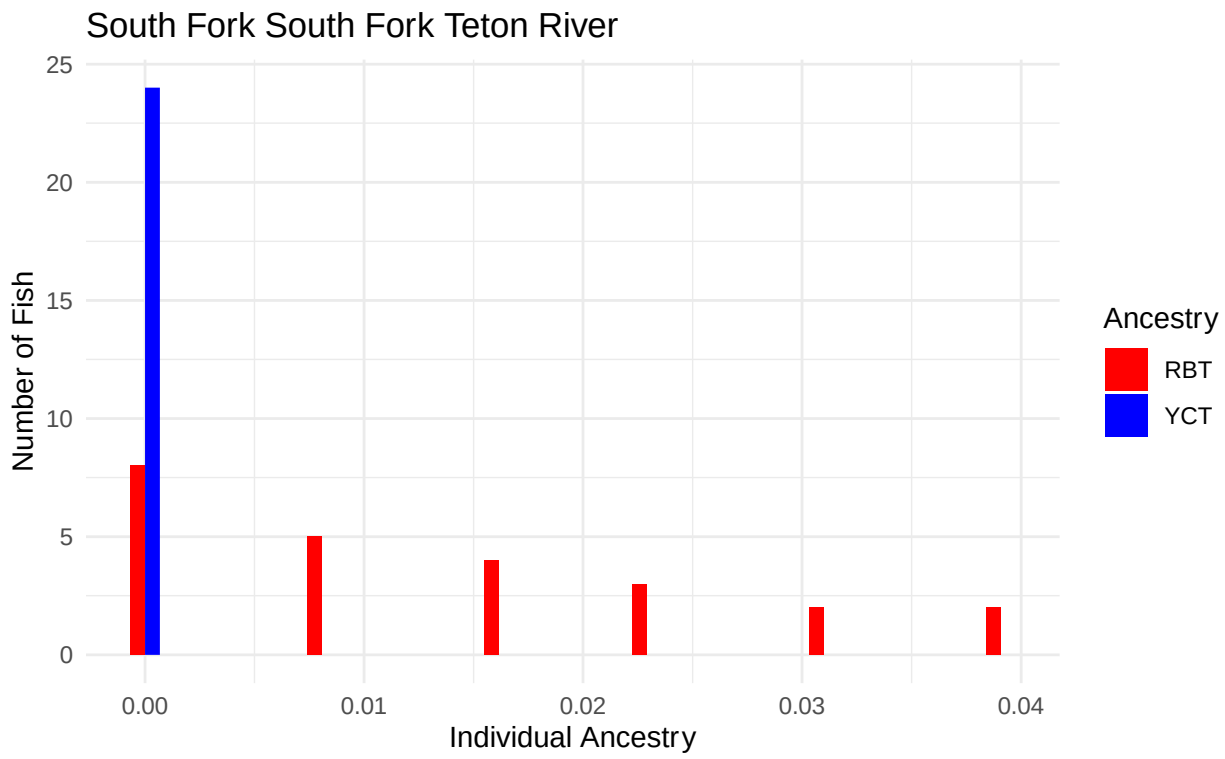

Figure 4. Observed distribution of individual rainbow and Yellowstone cutthroat trout ancestry in a sample of fish from the South Fork of the South Fork Teton River.

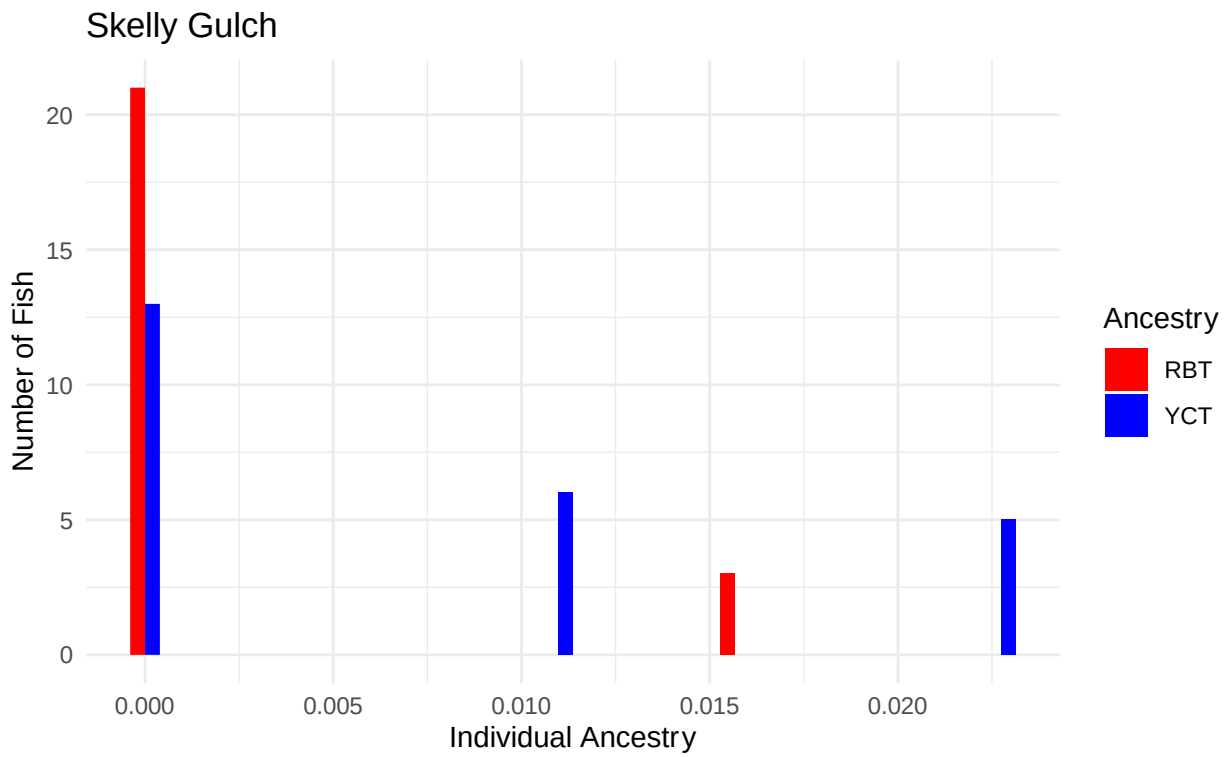

Figure 5. Observed distribution of individual rainbow and Yellowstone cutthroat trout ancestry in a sample of fish from Skelly Gulch.

Appendix B - Statistics of Fish Captured During Stream Surveys in 2024. N, CPUE (100 m) and CPUE (hr.) calculated from 1st pass samples. Minimum, maximum, and averages calculated from total catch (all fish).

Sampling Site	Drainage	Legal	Species	Date	Length (m)	Seconds Sampled	Total Length (mm) N	Min	Max	Avg	CPUE (100m)	CPUE (hr)
Beartrap Gulch, Above culvert, Genetics	(Upper Missouri)	*T12N R7W Sec21*	WCT	7/10/2024	1900	3145	2	136	147	141.5	0.1	2
Big Camas Creek, Upper, Suppression	(Smith)	*T9N R3E Sec12*	WCT	6/13/2024	1500	4912	2	282	321	301	0.1	1.5
			YCT	6/13/2024	1500	4912	4	345	442	385	0.3	3
			WCTxYCT	6/13/2024	1500	4912	6	137	212	168	0.4	4
			CT	6/13/2024	1500	4912	12	47	138	89	0.8	9
Big Camas Creek, Upper, Suppression	(Smith)	*T9N R3E Sec12*	WCT	6/19/2024	1500	5227	4	120	235	157	0.3	3
			WCTxYCT	6/19/2024	1500	5227	6	145	158	150	0.4	4
			CT	6/19/2024	1500	5227	11	41	119	68	0.7	8
Big Camas Creek, Upper, Suppression	(Smith)	*T9N R3E Sec12*	WCT	7/8/2024	1500	4784	8	128	285	217	0.5	6
			WCTxYCT	7/8/2024	1500	4784	11	103	177	133	0.7	8
			CT	7/8/2024	1500	4784	17	46	107	75	1.1	13
Big Coulee, Section 1 & 2, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/19/2024	450	4575	257				50	175
			EB	8/19/2024	450	4575	1	211	211	211	0.2	0.8
Big Coulee, Section 1 & 2, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/26/2024	450	3370	270				46	222
Big Coulee, Section 1 & 2, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/27/2024	450	2437	28				3	21

Sampling Site	Drainage	Legal	Species	Date	Length (m)	Seconds Sampled	Total Length (mm) N	Min	Max	Avg	CPUE (100m)	CPUE (hr)
Big Coulee, Section 3, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/19/2024	300	3846	197				46	129
			LL	8/19/2024	300	3846	1	250	250	250	0.3	0.94
Big Coulee, Section 4, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/20/2024	350	5113	197				34	84
Big Coulee, Section 5, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/20/2024	370	4492	252				58	172
Big Coulee, Section 6, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/21/2024	200	4512	199				78	124
Big Coulee, Section 7, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/21/2024	550	5196	308				47	180
Big Coulee, Section 8A, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/22/2024	240	4254	142				50	102
Big Coulee, Section 8B, Presence/Absence	(Upper Missouri-Dearborn)	*T19N R9E Sec10*	WCT	8/22/2024	240	2227	98				33	128
Big Timber Gulch, Upper, Genetics	(Belt)	*T15N R5E Sec36*	WCT	7/24/2024	1780	613	27	55	209	149	1.5	158

Sampling Site	Drainage	Legal	Species	Date	Length (m)	Seconds Sampled	Total Length (mm) N	Min	Max	Avg	CPUE (100m)	CPUE (hr)
Carpenter Creek, Between Barriers, Presence/Absence (Belt)		*T14N R8E Sec20*	NO FISH	8/02/2024	250	1678						
Chamberlain Creek, Above Barrier, Presence/Absence (Belt)		*T13N R8 Sec2*	WCT	8/28/2024	425	2639	50	72	251	162	12	68
Cottonwood Creek, Between Barriers, Lower, Presence/Absence (Arrow)		*T19N R10 Sec5*	WCT	9/11/2024	750	5442	221				29	146
Cottonwood Creek, Between Barriers, Upper, Presence/Absence (Arrow)		*T19N R10 Sec5*	WCT	9/11/2024	750	6879	311				41	163
Cottonwood Creek, Unnamed Tributary, Presence/Absence (Arrow)		*T19N R10E Sec5*	WCT	9/11/2024	1200	2105	284				24	486
Dry Fork Belt Creek, Above Gray Creek, Fish Health (Fish Health)		*T15N R9E Sec29*	WCT	9/04/2024	760	3568	15	144	270	198	2	15
			EB	9/04/2024	760	3568	45	121	230	160	6	45
Fourmile Creek, Between Barriers, Transfer (Smith)		*T9N R8E Sec33*	WCT	9/16/2024	180	927	50	74	238	149	28	194
Granite Creek, near Priest Pass, Presence/Absence (Upper Missouri)		*T10N R5W Sec18*	NO FISH	7/01/2024	1300	89						

Sampling Site / Drainage	Legal	Species	Date	Length (m)	Seconds Sampled	Total Length (mm) N	Min	Max	Avg	CPUE (100m)	CPUE (hr)
Graveyard Gulch, Above Barrier, Presence/Absence	*T14N R7E Sec36*										
(Belt)		WCT	8/28/2024	350	2513	54	67	203	145	15	77
Lost Creek, FS Boundary to Barrier, Genetics	*T16N R9E Sec29*										
(Belt)		WCT	7/31/2024	1100	430	15	86	267	147	1.4	126
Lost Creek, Above FS Boundary, Population Estimate	*T16N R9E Sec29*										
(Belt)		WCT	7/31/2024	100	1041	18	94	235	144	16	55
Middle Fork Little Belt Creek, Above Culvert, Presence/Absence	*T19N R8E Sec13*										
(Belt)		WCT	9/10/2024	360	1255	76	73	266	141	21	218
North Fork Highwood Creek, Lower, Population Estimate	*T20N R9E Sec34*										
(Upper Missouri-Dearborn)		WCT	10/15/2024	100	1364	52	55	270	170	33	87
		RM COT	10/15/2024	100	1364	74				30	79
North Fork Highwood Creek, Middle, Population Estimate	*T20N R9E Sec35*										
(Upper Missouri-Dearborn)		WCT	10/16/2024	100	1711	152	45	250	146	103	217
North Fork Highwood Creek, Upper, Population Estimte	*T20N R9E Sec35*										
(Upper Missouri-Dearborn)		WCT	10/24/2024	100	1864	120	73	226	119	88	170
North Fork Teton River, near West Fork Cabin, Genetics Attempt	*T26N R9W Sec31*										
(Teton)		EB	7/30/2024	400	546	1				0.25	7
		RM COT	7/30/2024	400	546	1				0.25	7

Sampling Site	Drainage	Legal	Species	Date	Length (m)	Seconds Sampled	Total Length (mm) N	Min	Max	Avg	CPUE (100m)	CPUE (hr)
Pike Creek, Middle, Presence/Absence		*T30N R13W Sec33*										
	(Two Medicine)		NO FISH	8/14/2024	1600	1094						
Pilgrim Creek, Mouth to Barrier, Fish Health		*T16N R6E Sec26*										
	(Belt)		WCT	9/03/2024	1000	1498	1	264	264	264	0.1	2
			RB	9/03/2024	1000	1498	17	129	320	199	1.7	41
			RBxWCT	9/03/2024	1000	1498	10	130	230	179	1	24
			EB	9/03/2024	1000	1498	4	194	209	204	0.4	10
Pilgrim Creek, Above Barrier, Fish Health		*T16N R6E Sec26*										
	(Belt)		WCT	9/03/2024	750	1131	24	145	233	187	3	76
			RBxWCT	9/03/2024	750	1131	8	147	255	184	1	13
Running Wolf Creek, Above FS Boundary, Fish Health		*T14N R11E Sec6*										
	(Judith)		EB	7/29/2024	175	689	62				35	324
South Fork Willow Creek, Above Diversion, Fish Health		*T9N R7E Sec26*										
	(Smith)		WCT	8/5/2024	275	1477	10	106	231	170	3.6	24
			EB	8/5/2024	275	1477	60	125	245	167	22	146
Tar Head Creek, State Section, Presence/Absence		*T13N R6W Sec3*										
	(Upper Missouri)		NO FISH	8/14/2024	500	102						

Sampling Site	Drainage	Legal	Species	Date	Length (m)	Seconds Sampled	Total Length (mm) N	Min	Max	Avg	CPUE (100m)	CPUE (hr)
Tyrell Creek, WMA, Population Estimate		*T14N R1W Sec16*										
(Smith)			WCT	8/15/2024	100	1096	32	45	250	150	26	85
			RM COT	8/15/2024	100	1096	58				30	99
Unnamed Trib. To Hall Creek, Mouth to Barrier, Presence/Absence		*T30N R13W Sec24*										
(Two Medicine)			RBxWCT	8/12/2024	365	79	5	90	120	110	1	228
			RB	8/12/2024	365	79	4	37	180	97	1	182
Unnamed Trib. To Hall Creek, Above Barrier, Presence/Absence		*T30N R13W Sec24*										
(Two Medicine)			WCT	8/12/2024	1035	223	4	148	270	218	0.39	65
Unnamed Trib to Trout Creek, Upper, Genetics		*T14N R6W Sec29*										
(Upper Missouri)			WCT	7/9/2024	720	940	20	74	161	120	2.77	77
Urvi Creek, Road to Barrier, Presence/Absence		*T14N R5E Sec36*										
(Smith)			WCT	6/24/2024	2700	212	2	198	223			
Villars Creek, Mouth to End of Fish, Genetics		*T15N R9E Sec29*										
(Belt)			WCT	8/1/2024	600	2614	64	63	210	93	11	88
			EB	8/1/2024	600	2614	34	45	235	130	6	47
Waldron Creek, Above FS Rd 144, Presence/Absence		*T25N R9W Sec17*										
(Teton)			NO FISH	6/18/2024	200	507						

Sampling Site	Drainage	Legal	Species	Date	Length (m)	Seconds Sampled	Total Length (mm) N	Min	Max	Avg	CPUE (100m)	CPUE (hr)
Weatherwax Creek, Lower, Fish Transfer		*T13N R9E Sec31*										
	(Judith)		WCT	9/30/2024	1100	6499	51	131	265	195	4.6	28
			RBxWCT	9/30/2024	1100	6499	8	158	220	197	0.7	4
Weatherwax Creek, Middle, Fish Transfer		*T12N R9E Sec6*										
	(Judith)		WCT	10/1/2024	575	5341	32	90	246	152	5.6	22
Weatherwax Creek, Upper, Fish Transfer		*T12N R8E Sec1*										
	(Judith)		WCT	10/1/2024	1500	5093	27	129	270	202	2	19
Wegner Creek, Above Barrier, Presence/Absence		*T15N R2W Sec36*										
	(Upper Missouri-Dearborn)		RB	6/20/2024	1300	3624	1	134	134	134	0.07	1
Weino Creek, State Section, Presence/Absence		*T14N R6W Sec27*										
	(Upper Missouri)		EB	8/14/2024	600	166	12	54	82	70	2	260
			RM COT	8/14/2024	600	166	2				0.33	43
West Fork North Fork Teton River, Above Bridge, Genetics Attempt		*T26N R9W Sec31*										
	(Teton)		EB	7/30/2024	400	752	7	113	186	155	1.8	34