Stream Surveys in the Big Hole River Drainage 2017-2020

Photo: McVey Creek within the grazing exclosure on state lands 2018.

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Abstract: A total of 30 streams in the Big Hole River drainage were surveyed from 2017-2020. The goal of these surveys was to update existing information or survey streams that have previously not been inventoried. The emphasis for much of the research covered in this report was the conservation of westslope cutthroat trout. Cutthroat projects that were initiated or are ongoing in the drainage include: Cherry Creek, McVey Creek, West Fork Mudd Creek, Long Branch Creek, Schultz Creek, Mule Creek, Bender Creek, French Creek, and Pintler Creek. The goal for cutthroat restoration in the Big Hole is for secured populations to occupy approximately 20% of historically occupied habitat or 400 miles of stream. The remaining nearly 2000 miles of stream in the Big Hole will to be managed for non-native sport fish, which in in the case of the Big Hole constitutes primarily brook trout. A road map to achieve this restoration goal is being developed.

Brook trout are the most common fish throughout the small streams of the Big Hole drainage. They are present in nearly every stream, apart from streams where there is an impassible fish barrier (i.e., waterfall, cascade or dam). Brook trout provide excellent fisheries for pan-sized trout and their high reproductive rate and wide distribution allow for liberal fish limits and ample opportunities to catch and harvest fish. Rainbow and brown trout fisheries in small streams of the Big Hole drainage are less common but are more likely to be found in streams that have a close association with the Big Hole River. Brown trout in particular are becoming more common in small streams of the Big Hole and in some cases, they are displacing brook trout populations.

Arctic grayling reintroduction/augmentation efforts were performed in Trail Creek, Wise River McVey Creek, Long Branch Creek and Bender Creek from 2014 to 2020. Of these introductions, only McVey Creek shows signs of being successful where grayling are reproducing on their own.

A large-scale restoration effort is underway in the French Creek drainage which including several habitat restoration projects, highway upgrades and native fish restoration. A fish barrier was completed in the fall of 2019 on French Creek and the first treatment of the stream to remove non-native fish occurred in 2020. Large-scale habitat restoration projects were completed on Oregon Creek and French Creek upstream of the Highway 569 bridge on the Mt Haggin Wildlife Management Area. Smaller habitat projects occurred on French Creek downstream of the Highway 569 bridge and on lower Moose Creek. As part of the reconstruction of Highway 569 fish passage friendly culverts were constructed on American Creek and Oregon Creek. An unused culvert crossing on American Creek was also removed. A previously unknown, non-hybridized cutthroat population was discovered in Little American Creek.

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WATERS REFERRED TO:

American Creek
Bailey Creek
Bender Creek
Blind Canyon Creek
Cherry Creek
Chub Creek
Doolittle Creek
Dry Creek
Elkhorn Creek
French Creek
Gravelle Creek
Little American Creek
Long Branch Creek
McVey Creek
Mono Creek
Oregon Creek
Pintler Creek
Sawmill Creek
Schultz Creek
Sixmile Creek
Stine Creek
Thayer Creek
Trail Creek
Twelvemile Creek
Unnamed Tributary to Governor Creek
Unnamed Tributary to Pioneer Creek
West Fork Mudd Creek
Wise River
Woody Creek
York Gulch

INTRODUCTION AND METHODS

Small streams are often important recreational fisheries. Not only do they provide crowd-free angling opportunities, but they often can also boast high densities of fish yielding high catch rates. They also can be important spawning and rearing areas for fluvial fish migrating from larger river systems. Several of the small streams of the Big Hole harbor conservation populations of westslope cutthroat trout and populations of western pearlshell mussels, both of which are species of special concern in Montana. From 2016 through 2020 several small streams in the Big Hole drainage were sampled to determine the status of their fisheries. Many of the streams were sampled because they historically harbored small populations of westslope cutthroat trout but have not been surveyed in the past 10-20 years. Additionally, several westslope cutthroat trout restoration projects were planned and executed which involved survey of these streams both pre- and post-project.

All streams were sampled using electrofishing or on rare occasions via visual survey from the stream bank. A 2- or 3-person crew used Smith-Root LR24 or an LR 20B backpack electrofishing units for all fish collections. At times, in larger streams, two electrofishing units were used side-by-side or a crawdad style boat was used with a gasoline powered generator, West style rectifying unit and mobile anode. Single pass electrofishing was used to determine presence-absence, relative abundance and/or distribution of fish. Two- or 3-pass electrofishing was done to obtain depletion population estimates. In some larger streams, Mark-Recapture population estimates were conducted using mobile anode electrofishers. In general, when electrofishing was performed in association with a population estimate, fish were captured while sampling crews moved in an upstream direction with all habitats sampled within a given reach of stream. No block nets were used during electrofishing. In some streams, sub-sampling of higher quality habitats was performed during single pass electrofishing to maximize the likelihood in encountering fish. This technique is referred to as "spot shocking" in this report and was used primarily to determine the presence/absence of fish in a stream and to collect genetic samples from cutthroat trout. Dip nets with 1/8 in mesh size were used to capture fish. Although trout were targeted, all species present were noted and a representative number of species encountered were generally captured and enumerated. Captured fish were anesthetized with MS222 or clove oil and measured (0.1 in) prior to release. Genetic samples (i.e., fin clip) were often collected from westslope cutthroat trout. The presence or absence of amphibians and reptiles in and adjacent to electrofishing reaches was also noted. In streams that contained western pearlshell mussels, population information was gathered following the methods of Stagliano (2006).

Two-pass depletion population estimates were calculated using formula's set out in Leathe (1983). Three pass removal and Mark-Recapture population estimates were calculated in FA+ (FWP 2009).

FINDINGS

Thayer Creek

Thayer Creek is a tributary to Andrus Creek which drains into Governor Creek. Historically is has been home to a non-hybridized population of westslope cutthroat trout (WCT) that is sympatric with brook trout (Olsen 2011). Until recently, conservation of cutthroat trout in Andrus Creek was not thought to be possible because there are no suitable fish barrier sites on public ground. However, an opportunity has arisen with the Hairpin Ranch which is seeking to purchase a landlocked section of DNRC trust lands within their ranch. Andrus Creek flows through a corner of this section and when the ranch tried to acquire the parcel several years ago, FWP objected to the sale because of the presence of cutthroat trout in the stream. Recently the ranch approached FWP to determine if cutthroat conservation could be

done in Andrus Creek (which would include Thayer and Bailey creeks) if FWP would no longer oppose the sale of the land. An investigation of the stream was performed, and a suitable fish barrier site was located downstream of the confluence of Bailey Creek. Other suitable fish barrier locations exist downstream of this location but there are irrigation diversions which eventually waste into Pine and Fox creeks and therefore could present avenues for non-native fish to recolonize Andrus Creek and its tributaries. Currently and agreement is being negotiated between FWP and the ranch to construct a fish barrier and restore WCT to the stream and the land sale is moving through the DNRC. Both the land sale and the fish barrier are expected to be complete in 2021.

In preparation for WCT restoration, Thayer and Bailey creeks were surveyed and genetic samples were collected. When last sampled in 2009, brook trout outnumbered cutthroat trout roughly 10:1 but there was evidence of recent reproduction as age-1 fish were present (Olsen 2011). On 9/21/20 Thayer Creek and the unnamed tributary near the headwaters were single pass electrofished. The goal of this sampling effort was to collect genetic samples. Thayer Creek was sampled from the confluence of the unnamed tributary upstream roughly 0.5 miles. A total of 10 WCT and 246 brook trout were captured (Table 1). All of the WCT captured were within the first ¼ mile upstream of the confluence with the unnamed tributary and only brook trout were found in the upper reaches. Of the cutthroat trout sampled, there were several individuals that appeared to be hybridized and one fish appeared to be a rainbow trout. In the unnamed tributary to the south of Thayer Creek the proportion of WCT was slightly higher but still brook trout greatly outnumbered westslope cutthroat (Table 1). Forest Service crews sampled Thayer Creek farther downstream near the Forest Service boundary and found only brook trout and Rocky Mountain sculpin (Table 1, Thayer 2). Genetic results of the 24 fish tested indicated that one was a non-hybridized rainbow trout and 3 others were predominantly rainbow trout (Kovach et al. 2020a). Four fish were F1 crosses between non-hybridized WCT and rainbow trout and the rest were non-hybridized WCT. Hybridization in Thayer Creek appears to be a recent event within the last 2 generation of fish. Immediate conservation actions are necessary if this population is to persist due to the low density of cutthroat and recent hybridization. It is likely that there are fewer than 50 non-hybridized cutthroat remaining in the population.

Table 1. Fisheries survey data from Thayer Creek and tributary where Length = the length of the section, L is fish length (total) and W = fish weight. The fish species sampled were: WCT = westslope cutthroat trout, EB = brook trout and RCOT = Rocky Mountain sculpin.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Thayer 1	(st)	45.17830	-113.28418	1 Pass	WCT (10)		6.2 (5.3-7.0)	
(2960)	(end)	45.17494	-113.29352		EB (246)			
Thayer 2	(st)	45.20396	-113.29258	1 Pass	EB (48)		5.6 (3.2-9.3)	
					R Cot (8)		3.1 (2.6-3.3)	
Unnamed 1	(st)	45.17799	-113.28511	1 Pass	WCT (14)		7.9 (5.2-11.4)	
(2520)	(end)	45.17157	-113.28801		EB (118)			

Bailey Creek

Bailey Creek was electrofished on 9/21/20 in the middle reaches of the stream which corresponds to Bailey 2 in the previous sampling in 2009 (Olsen 2011). In 2009, 26 WCT and 89 brook trout were captured in this general location. In 2020, 1 cutthroat trout and 281 brook trout were captured. In 2009 it was clear that Bailey Creek was being used for spawning and rearing as most of the WCT captured

were age-2 fish, but this was not the case in 2020. Additional sampling in other reaches of Bailey Creek are necessary to determine the status of WCT in the drainage.

Unnamed Tributary to Governor Creek

An unnamed tributary to Governor Creek north of Little Indian Creek has historically harbored a non-hybridized population of westslope cutthroat trout. The stream was electrofished on 7/13/17 near the Forest Service boundary (Table 2). The stream in this location was small and grass was growing in parts of the channel. Both brook and westslope cutthroat were caught in the section. Genetic samples were collected from the cutthroat trout captured. The results of the genetic samples were difficult to interpret and 2 possible explanations for the observed results were given (Whitley et al. 2018). The first is that the population is very slightly hybridized (99.2% WCT, 0.27% rainbow, 0.51% Yellowstone cutthroat). The alternative interpretation is that the population was 2.9% rainbow trout genetic contribution and 4.1% Yellowstone cutthroat trout genetic contribution. Either interpretation suggests the population is slightly hybridized but still considered a conservation population. While the second interpretation cannot be ruled out, the first interpretation is more likely (Whitley et al. 2018). The stream was spot shocked upstream from the genetic sample collection site to its origins at the base of a small meadow. Both brook and cutthroat trout were present throughout the stream, but no young of the year brook trout were encountered.

A second sampling event took place in the unnamed tributary on 8/20/20 when Forest Service crews sampled an upstream section where there were a greater proportion of brook trout. The greater proportion of brook trout may have been due to the time of year when the sampling took place when adult brook trout may have been moving upstream or congregating in preparation for spawning.

Table 2. Fisheries survey data from an unnamed tributary to Governor Creek where Length = the length of the section, L is fish length (total) and W = fish weight. The fish species sampled were: WCT = westslope cutthroat trout and EB = brook trout.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Unnamed 1	=(st)	45.21720	-113.38188	1 Pass	WCT (14)		3.5 (2.0-5.4)	
(1000)	(end)	45.21524	-113.38440		EB (5)		5.3 (3.9-6.2)	
Unnamed 2		45.21642	-113.38327	1 Pass	WCT (2)		5.3 (4.7-5.9)	
					EB (11)		4.3 (3.7-5.3)	

Blind Canyon Creek

Blind Canyon Creek is a small tributary in the headwaters of the Big Hole River. It is home to an allopatric, non-hybridized population of westslope cutthroat trout (Olsen 2016). The stream at its confluence with the Big Hole is low gradient and often runs dry by late summer. Upstream of the confluence with the river it flows through a steep, bedrock canyon which currently precludes upstream fish passage. No definitive fish barriers are present in this high gradient reach. The high gradient reach in combination with the ephemeral nature of the lower reaches of Blind Canyon Creek appear to be precluding brook trout from colonizing the upper reaches of stream. The stream habitat upstream of the canyon is moderate gradient with infrequent pools and mostly large cobble and boulder substrate. In 2014 an attempt was made to collect eggs from cutthroat trout in Blind Canyon Creek to be used in the repopulation of Cherry Creek, but the attempt was unsuccessful. Cutthroat from Blind Canyon Creek were introduced to Dry Creek. On July 1, 2020, 5 ripe males were captured from Blind Canyon Creek

and transported to Cherry and Granite lakes and crossed with 5 wild females from the lakes. These eggs were incubated and hatched separately from all other eggs collected at Cherry and Granite lakes. At the time of restocking the offspring from these wild crosses were incorporated into brood lakes (Cherry, Granite, Van Houten and York Pond) at rate of 12.5%. Fin clips were taken from 25 WCT from Blind Canyon Creek (Table 3) and genetic testing indicated the population is still non-hybridized (Kovach et al. 2020b). Capture efficiency was low in Blind Canyon Creek due to relatively high flows in early July. No brook trout were encountered upstream of the cascade reach.

Table 3. Fisheries survey data from Blind Canyon Creek where Length = the length of the section, L is fish length (total) and W = fish weight. The fish species sampled were: WCT = westslope cutthroat trout.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Blind Cany 1 (2000)	(st)	45.19194	-113.52076	1 Pass	WCT (22)		4.9 (2.3-7.5)	
	(end)	45.19036	-113.52477					

Unnamed Tributary to Pioneer Creek

An unnamed tributary to Pioneer Creek has historically harbored a non-hybridized population of westslope cutthroat trout that was sympatric with brook trout. This population is isolated to less than ½ mile of stream at the headwaters of this tributary. Several mechanical suppression efforts have been made by Forest Service crews in the stream to limit the impacts of brook trout on cutthroat. Because these efforts are not sustainable and it would not be cost effective to conserve the cutthroat in their native habitat, a strategy was developed to relocate the WCT to a suitable fishless stream. On 9/23/20 a helicopter was flown into the upper meadow and 4 crews electrofished the upper mile of stream and captured as many cutthroat as possible. There are 2 meadows in the headwaters of the stream. The lower of the 2 meadows contains a boulder field at the downstream end and water flows among the rocks making fish capture difficult. At the head of the lower meadow the stream is wide (12 ft) and splits into 2 channels. The south fork leads to the upper meadow and the west fork contains high quality spawning habitat for a short distance before it becomes high gradient. A total of 61 cutthroat trout were captured (Table 4). Nearly all of these cutthroat came from the downstream meadow. Although not enumerated, brook trout were equally if not more so numerous than cutthroat and were actively spawning in the west tributary. WCT were transported via helicopter in a cooler with a battery powered aerator to Van Houten Lake. A subsample of 30 fish was genetically tested while the fish were held in live cars in the spring inlet to Van Houten Lake. Genetic results indicated the fish were slightly hybridized with Yellowstone cutthroat trout (98.7% WCT, Kovach et al. 2020a). The results from this sample are unlike a previous sample from this stream in 2008 when no Yellowstone cutthroat trout alleles were detected in a 25 fish sample. It appears that hybridization was not detected in the past sample. The power to detect hybridization is strongly influenced by the distribution of non-native alleles throughout the genome. In this case, the non-random distribution of Yellowstone alleles among markers indicates that some chromosomes have Yellowstone ancestry, while many others do not. Thus, the "true" power to detect Yellowstone ancestry was much lower in this population. The random distribution of Yellowstone alleles among individuals strongly suggests that hybridization occurred several generations ago (Kovach et al. 2020a).

The cutthroat trout from the unnamed tributary to Pioneer Creek were held for 10 days in the inlet to Van Houten Lake until these genetic results were available and then were transported to Mule Creek in the East Pioneer Mountains and released. Mule Creek is a fishless tributary to Birch Creek with roughly

2 miles of high-quality habitat. There was no mortality of the 61 fish held then subsequently released. Future monitoring of the fish introduction will be necessary to determine if the fish are able to survive the winter and naturally reproduce.

Table 4. Fisheries survey data from an unnamed tributary to Pioneer Creek and where Length = the length of the section, L is fish length (total) and W = fish weight. The fish species sampled were: WCT = westslope cutthroat trout.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Pioneer Trib	(st)	45.21248	-113.59869	1 Pass	WCT (61)		4.9 (2.3-7.5)	
(4000)	(end)	45.21017	-113.60767		EB			

Woody Creek

Woody Creek is a small tributary to Warm Spring Creek in the West Pioneer Mountains. It is home to a conservation population of slightly hybridized WCT (98.5 WCT, 1.5% RB). The population of cutthroat in Woody Creek is sympatric with brook trout but the distribution of brook trout is primarily limited to the upper reaches of the stream. The stream is entirely diverted into an irrigation ditch year-round once it reaches the floodplain of Warm Springs Creek. This diversion forms at least a seasonal barrier to upstream fish movement. The distribution of brook trout in the drainage, which is limited to upstream portions of the creek, would suggest that the potential fish passage from Warm Springs Creek occurs only rarely. A significant portion of Woody Creek flows through BLM lands. BLM fisheries crews sampled Woody Creek in 9/3/2019 in 2 locations (Table 5). Like past sampling, brook trout were only found in the upstream section near the Forest Service boundary. Cutthroat trout outnumbered brook trout in upper section 3:1. While isolated, this small population of cutthroat appears to be thriving. It may be possible to mechanically remove brook trout from the Woody Creek system; however, given the lack of a complete barrier, brook trout recolonization is likely to occur at some point.

Table 5. Fisheries survey data from Woody Creek collected by BLM crews and where Length = the length of the section, L is fish length (total) and W = fish weight. The fish species sampled were: WCT = westslope cutthroat trout and EB = brook trout.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Woody 1	(st)	45.38299	-113.32749	2 Pass	WCT (31)	545 (443-647)	5.4 (3.5-7.0)	0.05 (0.02-0.11)
(328)	(end)	45.38319	-113.32652					
Woody 2	(st)	45.38299	-113.32749	2 Pass	WCT (12)	193 (193-193)	6.0 (5.1-7.6)	0.07 (0.03-0.13)
(328)	(end)	45.38319	-113.32652		EB (4)	72 (25-120)	7.3 (5.7-8.3)	0.13 (0.01-0.19)

Gravelle Creek

Gravelle Creek is a small stream located between Miner Creek and Big Lake Creek. It was thought to be fishless and was identified in a previous Environmental Assessment as a potential site for introducing westslope cutthroat trout. Because of its small size it was feared that introduced fish may not survive so WCT from the Washoe Park Hatchery were introduced rather than Big Hole origin fish as an experiment. Forest Service crews sampled Gravelle Creek on 8/14/20 at 45.68564, -113.56978 which is in the lower reaches of the stream. One 6-inch fish was captured. It was noted that the stream in this location appeared as though it may go dry. These data suggest that fish can survive in Gravelle Creek.

Additional sampling is necessary to determine if the fish in the stream are able to reproduce and if they have a wider range than just the lower end of the stream.

Sawmill Creek

Sawmill Creek was identified as having the potential for WCT introduction in a previous Environmental Assessment. On 10/5/20 the creek was surveyed from Forest Road 945 upstream to at least the main forks of the stream at 45.39060, -113.65272 and was dry. It is very unlikely that suitable habitat is present in Sawmill Creek upstream of this location.

Dry Creek

Dry Creek is within the Rock Creek drainage west of Wisdom. Dry Creek naturally goes dry later in the summer before its confluence with Rock Creek but even at high flows the 2 streams are not connected due to irrigation diversion which direct flows across a large meadow between the two streams. Past surveys have indicated that the stream was void of trout but contained Rocky Mountain sculpin. In 2014, 36 westslope cutthroat trout from Blind Canyon Creek were introduced to Dry Creek (Olsen 2016). Subsequent surveys performed in 2015 indicated fish had survived their first winter in the stream. Dry Creek was surveyed again on 9/16/20 to determine the status of the introduced WCT. Three section of the stream were surveyed beginning at the trailhead leading up Dry Creek. At this location, all age classes of cutthroat were captured including young-of -the-year (Table 6, Dry 1) and there were over 200 cutthroat per mile. This reach of stream is braided, and the habitat is in poor condition which appears to be associated with grazing impacts. The next section sampled was Dry 2 located approximately 0.7 miles upstream from Dry 1. Dry 2 is the location where cutthroat trout from Blind Canyon Creek were stocked into Dry Creek (Table 6, Dry 2). This location is characterized by a low gradient channel with abundant, high-quality pools and a dense canopy of mature spruce trees. Cutthroat were common in this reach and multiple age classes of fish were present. Dry 3 was roughly 0.8 miles upstream from Dry 2. The habitat at Dry 3 was markedly different from Dry 2 with a higher gradient channel, predominantly large cobble and boulder substrate and infrequent pools. Young of the year trout were noted in one pool but not captured. All other fish encountered were adult fish. It appears that fish are just starting to colonize this reach of stream from below. There still appeared to be adequate water to support a fishery in this reach but the USGS map shows perennial flow extending only another ¼ mile upstream. These data suggest that the 36 WCT introduced from Dry Creek are thriving. They have expanded to fill most of the available habitat and, at least in the middle reaches, are likely at carrying capacity.

Table 6. Fisheries survey data from Dry Creek and tributary where Length = the length of the section, L is fish length (total) and W = fish weight. The fish species sampled were: WCT = westslope cutthroat trout and RCOT = Rocky Mountain sculpin.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Dry 1	(st)	45.44805	-113.63529	2 Pass	WCT (27)	241 (227-256)	5.4 (1.3-7.8)	
(600)	(end)	45.44719	-113.63730		RCOT			
Dry 2	(st)	45.44277	-113.64782	2 Pass	WCT (26)	529 (367-692)	3.7 (2.4-8.3)	
(300)	(end)	45.44231	-113.64852		RCOT			
Dry 3	(st)	45.43805	-113.66318	2 Pass	WCT (12)	82 (77-88)	7.4 (6.1-8.5)	
(775)	(end)	45.43708	-113.66574		RCOT			

Trail Creek

Trail Creek when it converges with Ruby Creek near the Big Hole National Battlefield forms the North Fork Big Hole River. Trail Creek consists mainly of a low gradient stream channel that meanders through a heavily willowed floodplain adjacent to Highway 43. Beaver activity is common, particularly farther upstream in the watershed. In this reach of stream there is preponderance of coarse granitic sand and most slow water habitats have sandy substrate. There are also common log jams in the stream. Arctic grayling were introduced to Trail Creek from 2014-2019. Grayling eggs were incubated in remote streamside incubators (RSI) in Placer Creek, Cascade Creek and in Joseph Creek near the confluence with Trail Creek. Nearly 400,000 eyed grayling eggs from Axolotl and Green Hollow lakes were hatched and released to Trail Creek. Subsequent sampling in 2015 in 2 sections of the stream did not find any grayling near the incubation sites (Olsen 2016). A single electrofishing pass was made through the lower section of the 2 sections sampled in 2015 on 9/5/19 (Table 7, referred to as Trail 2 in Olsen 2016). No grayling were captured. Except for burbot, both the number and size of brook trout, dace, suckers and brown trout were similar to the past survey (Table 7). More than double the number of burbot were capture in the 2019 survey but the size range was similar to previous surveys.

Table 7. Fisheries survey data from Trail Creek and tributaries where Length = the length of the section, L is fish length and W = fish weight. The fish species sampled were: EB = brook trout, BUR = burbot, LND = longnose dace, LSU = longnose sucker, MWF = mountain whitefish, R Cot = Rocky Mountain sculpin, LL = brown trout.

Section (Length)	Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Trail 2 (2019) (st)	45.65652	113.71636	1-Pass	EB (174)		7.3 (2.3-14.3)	
(8448) (end)	45.64527	113.69735		BUR (165)		7.6 (4.7-14.8)	
				LL (1)		7.6	
				LND (4)		3.8 (2.5-5.3)	
				LSU (26)		7.3 (5.0-9.5)	

McVey Creek

McVey Creek originates in the West Pioneer Mountains northeast of Wisdom. It is a small stream that originates on the Beaverhead Deerlodge National Forest and flows northwest through lands managed by the DNRC. There are two tracts of private land that intersect McVey Creek, but the majority of the stream is in public ownership. McVey Creek has historically harbored a non-hybridized population of westslope cutthroat trout residing primarily on the Forest. Habitat conditions in McVey Creek on the forest are good with abundant willows in the riparian area and stable banks. The stream is low gradient near the forest service boundary but becomes moderate gradient and heavily forested farther upstream near the forks. Downstream on private and DNRC ground there are fewer willows and the stream banks are impacted by livestock grazing. The stream substrate in this area consists of primarily coarse granitic sand and some areas of gravel. There are two irrigation diversions on McVey Creek: one near the forest boundary and another approximately ¾ mi upstream of Highway 43. The lower of the two diversions captures the entire stream at base flows and the natural channel is dry for approximately ¼ mile. However, springs, which likely stem from the ditch, eventually returns flow to the stream and fish and amphibians are present. A grazing exclosure and bridge over McVey Creek was constructed on DNRC ground on McVey Creek immediately downstream of the Giem property (Olsen 2016).

In 2011 a fish barrier was constructed on McVey Creek at the crossing of Highway 43 and brook trout were removed upstream. Prior to removal, roughly 160 cutthroat trout were salvaged and held in live car cages then released back to the stream. Subsequent electrofishing in 2012 and 2014 did not catch any brook trout and WCT were found to be thriving and filling the available habitat. Genetic samples collected in 2015 indicated that, unlike previous samples, the cutthroat trout in McVey Creek are slightly hybridized with Yellowstone cutthroat trout (99.3% westslope, Leary 2016).

Four hundred age-1 Arctic grayling were introduced into the pond upstream of the fish barrier in McVey Creek in June of 2018. Two subsequent plants occurred in 2019 and 2020. A short duration (30 min) gill net was set in McVey Pond on 4/26/19 to determine if the grayling survived their first winter and to check on their growth. A total of 3 grayling and 2 WCT were captured in the net and subsequently released alive. The average length of grayling was 10.7 inches. The mean length of grayling stocked in 2018 was 6.6 inches suggesting growth in the pond was excellent. In July of 2019 multiple juvenile fish were observed McVey Creek upstream of the pond. The stream was electrofished to confirm the species composition and all fish encountered were young-of-the-year Arctic grayling. Over 100 young-of-the-year Arctic grayling were visually counted up to the first irrigation diversion. Additional sampling later in the fall indicated young of the year grayling were present at low density up to the private land boundary nearly 1.5 miles upstream of the fish barrier pond. These data indicate that there is adequate spawning habitat for grayling upstream of the pond in McVey Creek and that age-2 grayling successfully spawned in the creek.

Brook trout were discovered in McVey Creek in the fall of 2019. In the roughly 1-mile section of stream from the lowest irrigation diversion on the creek to intersection with private property 12 brook trout and 63 WCT were captured. In 2020, McVey Creek was extensively electrofished to determine the distribution of brook trout and hopefully discover the origins of the fish in the drainage. There were four possible explanations for brook trout in McVey Creek: 1. Brook trout jumped over the fish barrier; 2. Brook trout came up from the Big Hole River through an irrigation ditch; 3. Brook trout were missed with the initial treatment or; 4. Brook trout were illegally introduced. From August 31- September 3rd, 2020 McVey Creek was surveyed beginning immediately upstream of the fish barrier pond (Table 8). The entire length of the stream was electrofished upstream and into the upper forks on the National Forest. Brook trout were found throughout the stream except immediately upstream of the fish barrier and in the upper north fork (Table 8). The data showed an increasing trend in brook trout numbers and a decrease in size up, indicating evidence of reproduction, to the Forest Boundary then a sharp decline thereafter. The Giem Fork, which enters McVey Creek at the Forest Boundary appeared to be the source of brook trout (Table 8) as more brook trout were captured in that fork than the rest of the stream combined. It is very likely that a small number of brook trout were missed in the initial treatment of the Giem Fork in 2011 and were the source of brook trout recolonization in McVey Creek. The upper reaches of McVey Creek and the Giem Fork were only treated 1 time with rotenone (Olsen 2016) and it has subsequently been found that single treatments are rarely effective at removing 100% of fish. The presence of brook trout in the South Fork was interesting because very few brook trout were found in the mainstem below the forks and no brook trout were found in the North Fork so it is not clear if they were missed in the initial treatment or if they emigrated into that fork. There was no evidence of reproduction in the North Fork, so it is possible that brook trout in that fork were recent emigrants. A plan is being developed to salvage and retreat McVey Creek to eliminate brook trout upstream of the fish barrier. This plan would also include the restocking of Arctic grayling in the lower reaches of the stream.

Table 8. Fisheries survey data from McVey Creek going from downstream to upstream during 2020 where Length = the length of the section, L is fish length and W = fish weight. The fish species sampled

were: WCT = westslope cutthroat trout, AG = Arctic grayling, WSU = white sucker and EB = brook trout.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Pond-1st Divers.	(st)	45.69867	-113.423373	2 Pass	WCT (2)		7.5 (7.2-7.8)	0.17 (0.13-0.21)
(4500)	(end)	45.69432	-113.40968		AG (87)	113 (99-128)	3.3 (2.6-3.9)	
1st Divers-Harr	(st)	45.69432	-113.40968	2 Pass	WCT (12)	20 (17-23)	7.5 (2.4-11.4)	
(3300)	(end)	45.68722	-113.40719		AG (2)		7.7 (7.2-8.1)	
					WSU (1)		6.0	
Harrington	(st)	45.68723	-113.40719	2 Pass	WCT (212)	208 (199-217)	5.9 (1.7-10.3)	
(5640)	(end)	45.68334	-113.39125		AG (2)		4.5	
					EB (21)	22 (16-27)	6.2 (4.7-8.5)	
Harr-Graz Excl	(st)	45.68334	-113.39125	2 Pass	WCT (206)	674 (602-746)	5.1 (2.8-11.2)	
(1860)	(end)	45.67958	-113.38953		EB (24)	70 (64-75)	6.2 (4.5-9.0)	
Gr Excl-Bridge	(st)	45.67958	-113.38953	2 Pass	WCT (217)	911 (868-955)	5.1 (2.9-10.7)	
(1325)		45.67734	-113.38800		EB (18)	73 (67-78)	5.8 (2.3-8.0)	
Bridge-Camp	(st)	45.67734	-113.38800	1 Pass	WCT (234)		5.3 (2.4-12.6)	
(1815)	(end)	45.67200	-113.38557		EB (28)		5.3 (1.8-8.0)	
Canp-2nd Div	(st)	45.67200	-113.38557	1 Pass	WCT (290)		5.0 (2.5-14.6)	
(1960)		45.66919	-113.38011		EB (139)		4.5 (1.8-10.0)	
Div-FS Bdry	(st)	45.66919	-113.38011	1 Pass	WCT (180)		5.7 (2.0-10.2)	
(1100)	(end)	45.66779	-113.37615		EB (43)		4.6 (2.0-7.1)	
Giem Fork	(st)	45.66792	-113.37673	1 Pass	WCT (80)			
(3655)	(end)	45.66791	-113.36717		EB (394)			
FS Bdry-Forks	(st)	45.66779	-113.37615	1 Pass	WCT (464)		4.4 (2.0-9.7)	
(6190)	(ends)	45.65786	-113.36040		EB (3)		5.4 (5.0-5.7)	
N Fork	(st)	45.65786	-113.36040	1 Pass	WCT (69)		4.7 (2.6-9.1)	
(2000)	(end)	45.65706	-113.35123					
S Fork	(st)	45.65786	-113.36040	1 Pass	WCT (241)		3.5 (1.8-7.0)	
(2150)	(end)	45.65167	-113.35395		EB (8)		4.7 (4.0-5.3)	

Doolittle Creek

Doolittle Creek drains from the West Pioneer Mountains to the Big Hole River northwest of Wisdom. It has been an important stream because its forks all contained non-hybridized westslope cutthroat trout populations; however recent surveys indicated that only the South Fork Doolittle Creek has an extant population (Olsen 2016). A fish barrier was constructed on the North Fork Doolittle Creek and brook trout were removed upstream of the barrier (Olsen 2016). WCT from the South Fork Doolittle Creek were released into the North Fork to repopulate the stream. Over a 2-year period, approximately 30 WCT were moved over to the North Fork. Brook trout were discovered again in the North Fork in 2018 and mechanical removals using electrofishing began in 2019. The origin of brook trout in the North Fork is unknown. The distribution of fish (highest density near the fish barrier) suggests either brook trout ascended the fish barrier or were illegally moved upstream. Mechanical suppression of brook trout

in the South Fork of Doolittle Creek has also occurred annually upstream of the Forest Road 2421 since 2017. The purpose of suppression is to ensure that WCT in the South Fork persist until a barrier could be constructed in Doolittle Creek and brook trout could be chemically removed. In 2020, there were approximately 125 cutthroat trout in the South Fork and 75 in the North Fork. WCT from Doolittle Creek will be infused into the brood at Cherry and Granite lakes in 2021 by crossing 5 Doolittle males with 5 brood females. In preparation for this effort genetic samples were collected from 25 fish and were found to be non-hybridized (Kovach et al. 2020a). Disease samples were also collected and the fish were found to be pathogen free.

A permanent fish barrier was constructed on Doolittle Creek downstream of the confluence of the North Fork in the fall of 2020 (Figure 1) and isolates over 11 miles of stream. Removal of brook trout is scheduled to begin in 2021. Prior to removal, WCT will be salvaged and held in non-treated water while the stream is treated with rotenone. Once the rotenone is neutralized, the WCT will be released back to Doolittle Creek. Unlike the previous treatment in the North Fork when EDNA technology did not exist, Doolittle Creek will be EDNA tested to determine if brook trout have been completely removed.

Figure 1. Fish barrier on Doolittle Creek below the confluence of the North Fork constructed in the fall of 2020.

Schultz Creek

Schultz Creek is a small tributary to Johnson Creek on the western edge of the Pintler Range. Most of the drainage was burned in a forest fire in the early 2000's and with the exception of the headwaters of the stream, there is very little canopy cover. The burned trees have resulted in an abundance of woody debris in the stream channel creating high quality stream habitat. A natural fish barrier is present in a high gradient reach of Shultz Creek as it drops into the Johnson Creek drainage (Olsen 2016). The hybridized Yellowstone cutthroat trout in the stream were chemically removed in 2015 and 2016 in an effort to restore WCT. Thirty WCT from Plimpton Creek and 30 WCT from Hellroaring Creek were collected, transported via backpack and introduced into Schultz Creek in 2017.

Schultz Creek was electrofished in 4 section to monitor the introduction of WCT to the stream and were called Lower, Middle, White Rocks and Upper (Table 9). WCT from Hellroaring Creek were introduced immediately upstream of the Middle Section and WCT from Plimpton Creek were released in the Upper Section. No fish were captured in the Lower section, 12 WCT were captured in the Middle section, 3 were captured in the White Rocks Section and multiple WCT were captured in the Upper Section at the culvert crossing (Table 9). Fish were not enumerated or measured in the upper section because of fading daylight but field notes indicate fish were common, particularly age-1 fish. Genetic samples were collected from all fish captured in the Middle Reach and from one fish in the White Rocks Section that appeared to be a hybrid. Genetic results indicated that the fish from middle section were non-hybridized but the one individual from the White Rocks section was indeed a hybridized cutthroat trout (Kovach et al. 2020b).

The presence of a hybridized fish in Schultz Creek prompted additional sampling in 2020. Beginning roughly ¼ mile downstream from the Middle Section, most of Schultz Creek upstream to the culvert crossing was electrofished. The goal of this effort was to collect genetic samples from a wide geographic distribution to determine the extent and focal areas of hybridization. A total of 176 genetic samples were collected and 100 were processed from the locations identified in Table 9. Samples process were not selected at random. All fish over 6 inches (33) were tested then the remaining samples were selected at random but equally distributed among sections. Genetic samples were quickly processed within a week at the lab and results (Kovach et al. 2020a) indicated that most fish in Upper 1 and Upper 2 were hybridized cutthroat trout (32 of 38 fish tested). Ten of the 13 age-1 fish tested in Upper 1 and Upper 2 were age-1, F1 crosses between non-hybridized WCT and Yellowstone hybrids indicating that cross breeding between introduced, non-hybridized cutthroat and hybrid cutthroat has already occurred. No hybrids were detected upstream of Upper 2 (14 fish tested). Only one hybrid was detected downstream of Upper 1 and that was in Middle 3 (1 of 39 fish tested). This single hybridized fish was readily distinguishable from the other cutthroat and was euthanized immediately after capture.

These data make it clear that the first 2 treatments of Schultz Creek were not successful at removing the hybridized Yellowstone cutthroat. The data also suggest that hybridized cutthroat survived in one distinct area (Upper 1 and Upper 2). Multiple Yellowstone hybrids trout survived the initial 2 treatments which suggests that an unidentified spring or tributary stream is likely the source of these fish. Although hybrid Yellowstone cutthroat trout adults could readily be distinguished from WCT, the indistinguishable F1 hybrids between Yellowstone and the introduced WCT will require the future treatment of Schultz Creek if a non-hybridized population of WCT is desired in Schultz Creek. Future treatments will require that the area between Upper 1 and Upper 2 where Yellowstone cutthroat trout have survived be identified. After treatment, EDNA testing should be done to verify that all fish have been removed before restocking occurs. One thing is clear from these most recent surveys and that is the WCT in the future will thrive in Schultz Creek. In only 3 years since the introduction of 60 fish, WCT have expanded and reached densities over 1,000 fish/mile (Table 9).

Table 9. Fisheries survey data from Schultz Creek where Length = the length of the section, L is fish length and the fish species sampled was WCT = westslope cutthroat trout.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
2019								
Lower	(st)	45.76427	-113.74014	1-Pass	No Fish			
(611)	(end)	45.76548	-113.74122					

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Middle (340)	(st)	45.77314	-113.75389	1-Pass	WCT (12)		4.1 (2.7-7.2)	
	(end)	45.77454	-113.75670					
White Rocks (430)	(st)	45.77553	-113.76190	1-Pass	WCT (3)		8.0 (7.7-8.5)	
	(end)	45.77588	-113.76303					
2020								
Middle 1 (480)	(st)	45.77314	-113.75389	1-Pass	WCT (95)		3.5 (1.5-7.5)	
	(end)	45.77408	-113.75508					
Middle (340)	(st)	45.77423	-113.75558	2-Pass	WCT (60)	938 (780-1096)	3.3 (1.6-5.9)	
	(end)	45.77454	-113.75672					
Middle 2 (350)	(st)	45.77454	-113.75672	1-Pass	WCT (53)		3.3 (1.5-5.7)	
	(end)	45.77496	-113.75768					
Middle 3 (575)	(st)	45.77523	-113.76020	1 Pass	WCT (39)		4.2 (1.7-8.8)	
	(end)	45.77518	-113.76072					
White Rocks (430)	(st)	45.77551	-113.76189	1 Pass	WCT (14)		5.5 (3.3-8.0)	
	(end)	45.77588	113.76304					
Upper 1 (620)	(st)	45.77674	113.76615	1-Pass	WCT (53)		4.5 (2.9-8.0)	
	(end)	45.77779	-113.76727					
Upper 2 (560)	(st)	45.77779	-113.76727	1-Pass	WCT (40)		3.6 (1.3-7.3)	
	(end)	45.77867	-113.76884					
Upper 3 (750)	(st)	45.77867	-113.76884	1-Pass	WCT (48)		5.0 (3.3-8.2)	
	(end)	45.77995	-113.77097					
Upper 4 (690)	(st)	45.77995	-113.77097	1-Pass	WCT (73)		3.7 (2.6-7.5)	
	(end)	45.78126	-113.77278					
Culvert (500)	(st)	45.78126	-113.7728	2-Pass	WCT (109)	1169 (1134-1202)	3.3 (1.0-8.4)	
	(end)	45.78219	-113.7740					

Bender Creek

Bender Creek, similar to Schultz Creek, is a tributary to Johnson Creek draining out of the Pintler Mountain Range. The headwaters of Bender Creek contain a non-hybridized population of westslope cutthroat trout. When the headwaters of the stream were last sampled in 1995, cutthroat trout were isolated in the upper ½ mile of stream. WCT from Bender Creek were used in the founding of the Big Hole WCT brood in the Cherry Creek drainage. A fish barrier was constructed on Bender Creek in 2017 at the crossing of Forest Road 1203 (Figure 2). Barrier construction on Bender Creek also required a barrier be placed on a separate culvert approximately ¼ mile from the bridge crossing. During high water, a secondary channel in Bender Creek from the meadows above becomes active and flows overland and down a separate channel and under Road 1203. The culver was fitted with a screened drop structure on the inlet to prevent fish passage for the few weeks in June when the channel is active. Bender Creek was treated with rotenone to remove brook trout in 2018. Prior to brook trout removal the WCT in the headwaters were salvaged using electrofishing and kept in Bender Creek upstream of the

treatment area. Roughly 60 WCT were held during the treatment. EDNA testing occurred the following year in early summer in the upper 1.5 miles of the stream to determine if a second salvage of WCT would be necessary prior to retreatment of the stream. EDNA indicated that brook trout remained in the headwaters of the stream in 2 locations so WCT were once again salvaged and held and the stream was treated a second time. Only 32 WCT were captured during the 2nd salvage event in 2018. In 2019, the entire stream upstream of the fish barrier was EDNA tested and there were positive hits for brook trout near the fish barrier and approximately 3 miles upstream near an unnamed tributary. The stream was treated a 3rd time focusing on the areas where EDNA indicated brook trout presence. Two brook trout were found immediately upstream of the fish barrier but no brook trout were observed farther upstream during the treatment. No additional EDNA testing has been performed to date and the WCT in the headwaters will be allowed to reproduce and begin to fill the habitat downstream. Additional EDNA testing is warranted to determine if fish removals produced complete brook trout removal.

Figure 2. Bender Creek fish barrier in June 2020. Barrier was constructed in 2017.

Westslope cutthroat were discovered in an unnamed tributary to Bender Creek downstream of the fish barrier in 2017. This tributary enters Bender Creek from the north. It is characterized by a large wide valley bottom with historic and current beaver activity. The lower reaches of the meadow were burned in by wildfire and the stream channel is deeply incised and downcutting. The upper meadow has active beavers and several large dams are present. Upstream of the beaver dams the stream is small and has dense willow growth making access to the stream difficult to survey. The tributary including a tributary to the west were electrofished in an effort to capture WCT. Only 3 age-1 WCT were encountered. Genetic testing indicated there was no evidence of hybridization (Kovach et al 2019). Because of the few fish that remained in the headwaters of Bender Creek, addition of fish from within the drainage to augment this population was highly desirable. However, the following year only one WCT from the stream could be captured and it was one of the 3 fish sampled the previous year. This single fish was moved upstream of the fish barrier on Bender Creek and released

Arctic grayling were introduced to Bender Creek immediately upstream of the fish barrier. This reach of stream appears to be ideal grayling habitat with a low gradient channel and numerous beaver dams. Five-hundred age-1 grayling (6.0 inches) from the Axolotl Lake brood were distributed in the first 1 mile of stream upstream of the fish barrier. A minimum of 2 additional plants of grayling are planned for Bender Creek with the hope of establishing a self-sustaining population of Arctic grayling in the stream.

Pintler Creek

Pintler Creek drains from the Pintler Mountain Range north of Wisdom. The upper portion of the drainage is located in the Anaconda-Pintler Wilderness Area. Pintler Falls is an apparent barrier to fish migration located near the Anaconda Pintler Wilderness boundary. In 2014 Pintler Creek and its tributaries upstream of Pintler Falls including Oreamnos Lake were treated with rotenone to remove rainbow trout and restore westslope cutthroat. EDNA testing was done in 2017 on the lower 4 miles of Pintler and the lower 2 miles of Beaver Creek to determine if rainbow trout had been completely removed. No rainbow trout were detected in Beaver Creek, but rainbow trout DNA was detected in the 3 locations in Pintler Creek ranging the upper portions of Pintler Meadows to roughly 1.5 miles upstream of the confluence with Beaver Creek. In 2018, Pintler Creek was electrofished by 3 crews working in tandem with 2 shockers each beginning in the middle of Pintler Meadows and extending upstream for 1.5 miles above the last EDNA detection. Four rainbow trout were captured. The first was captured immediately downstream of the confluence of Beaver Creek and the last was captured approximately 1 mile upstream of Beaver Creek. In 2019 the electrofishing effort was repeated. No rainbow trout were captured in the area where fish were captured the previous year, but 3 additional rainbow trout were collected immediately upstream of the reach of stream where the fish were captured the previous year. No rainbow trout were found in the stream upstream of where EDNA indicated there were fish remaining in the stream. It is likely that the fish found in 2019 were not observed in 2018 because efficiency can be low in Pintler Creek due to the low conductivity of the stream. Even though 5 years had elapsed since rainbow trout were chemically removed from Pintler Creek, there was no evidence of rainbow trout reproduction in the stream. All 7 rainbows caught between the 2 years of sampling were adult fish.

Restocking or cutthroat trout into Pintler Creek began in 2018. Eyed eggs were introduced to the stream using containerized incubators consisting of rectangular plastic containers with removable lids (Figure 3). These containers were used because of the remote nature of Pintler Creek and they did not require frequent maintenance unlike traditional remote streamside incubators. The incubators were constructed by drilling holes in the lower ¾ of the container that were too small for a cutthroat trout egg to fit through but would allow stream water to move through. The upper ¼ of the container was perforated with larger holes (1/2 inch) which would allow emerging to swim out of the container into the stream. Local stream gravel was sieved (1/2 inch mesh) to removed fine sediment and used to fill the container to ¾ full (Figure 3). The container was placed in quiet water, allowed to fill with water and the eggs were added and allowed to infiltrate into the gravels. The lid was placed on the container and it was placed under water in the stream in an area with moderate flows (generally near the tailout of a pool). Large rocks were placed on the lid of the container and it was left for 2 months. In the fall when containers were removed, fry were observed in the stream margins near the incubator sites.

Eggs were introduced into Pintler Creek from Cherry and Granite lakes, York Pond and Van Houten Lake. WCT in Van Houten Lake were transferred from Cherry Creek. Genetic analysis of these fish indicated that there was a high proportion of genes from the M012 westslope cutthroat trout from the Washoe Park hatchery in Anaconda, rather than Big Hole fish (see Cherry Creek below). It was determined that with the potential for hybridization with any remaining rainbow trout in Pintler Creek,

eggs from Van Houten with M012 genes would only be stocked into Pintler Creek. In 2018, 25,000 eggs were stocked into Pintler Creek and Beaver Creek using containerized incubators as described above. Incubators were installed in July and August and stocked with eyed eggs. Roughly 2,000-5,000 eggs were stocked in each container. In 2019, construction of an isolation facility at the Washoe Park hatchery was completed and eggs from the same sources listed above were incubated and hatched in this facility. In 2019 and 2020 9,872 and 27,136 juvenile cutthroat trout were stocked into Pintler Creek respectively. Because of its wilderness designation fish were transported to the stream either via backpack or a 20-gal cooler fitted with and oxygen tank and loaded onto a game cart. In 2019, livestock were also used to distribute fish up to within 1 mile of Oreamnos Lake. In 2018 Oreamnos Lake was stocked with 1,000 fertile fish from York Pond via helicopter.

Figure 3. Egg containers used to restock Pintler Creek in 2018. Blue arrows indicate the incubator and yellow arrow is the sieve used to filter fines from gravels added to egg containers. All equipment and eggs could be carried in one backpack.

York Gulch

York Gulch is a small tributary to the Big Hole River south of Wisdom which drains from the foothills of the Pinter Mountain Range. It is home to a small population of native westslope cutthroat trout which is sympatric with brook trout. Cutthroat trout are limited in distribution in the stream to the headwaters on the National Forest. The flows in York Gulch are augmented from flows diverted from the West Fork of Mudd Creek through an irrigation ditch and pipe. A cutthroat restoration project was performed in York Gulch and the West Fork of Mudd Creek in 2012. All remaining cutthroat in York Gulch were captured using electrofishing and transported to York Pond then York Gulch was treated with rotenone. A small, low water fish barrier was installed in the stream but at higher flows it does not function as a fish barrier. Eggs collected from York Pond were used to repopulate York Gulch after treatment and the stream was stocked 3 consecutive years beginning in 2015 using remote stream-side incubators.

In 2019 York Gulch was surveyed from the Forest Boundary upstream to the point where water from West Fork Mudd Creek enters the stream. Brook trout and WCT were present in the stream at roughly equal proportions. Young of the year WCT were observed indicating successful reproduction of introduced fish from York Pond. The presence of brook trout was not unexpected given the lack of a

functional fish barrier downstream. To maintain a cutthroat population in York Gulch will require a fish barrier that functions at all flows. Such a barrier would not likely be cost effective given the wide nature of the floodplain, small size of the stream and the limited amount of habitat it would secure. To maintain the WCT population in York Gulch will likely require periodic removal of brook trout or relocation to suitable fishless habitat elsewhere.

West Fork Mudd Creek

In 2010 the York diversion on the West Fork Mudd Creek was modified to function as a fish barrier. During subsequent years the barrier height was increased and a screen was added to completely preclude upstream fish passage. These modifications proved successful and no brook trout have passed over the fish barrier. The West Fork of Mudd Creek was treated with rotenone in August of 2013 and 2014 upstream of the fish barrier. No fish were observed during the second treatment of the stream in 2014 so it was assumed that a complete removal of brook trout had taken place. Thirty non-hybridized westslope cutthroat trout were transported from Rabbia Creek in the Wise River drainage in 2016 and introduced to the West Fork Mudd Creek. Because conditions were less than ideal during the 2016 electrofishing effort in Rabbia Creek, a second trip to was made in 2018 and an additional 7 fish were captured and transported to the West Fork Mudd Creek. No other WCT were found in Rabbia Creek in but brook trout were common. It is likely that few if any WCT remain in Rabbia Creek.

Additional modifications were made to the W Fk Mudd Creek fish barrier in 2019 following a disagreement about how water was allocated between the West Fork of Mudd Creek and York Gulch. The initial conflict resulted in the boards in the fish barrier/diversion structure being removed by a downstream rancher. These board provided the extra height necessary to preclude upstream fish passage in the stream. After meeting with the owners of the 2 ranches it was determined that the solution to the problem would be to raise the inlet elevation to the headgate to match the elevation of the fish barrier to deliver a roughly 2/3 to 1/3 delivery of water to West Fork Mudd Creek and York Ditch respectively (Figure 4). Flows into the ditch are not closely monitored so this alteration to the configuration of the structure will apportion water with little maintenance.

Figure 4. York diversion on the West Fork of Mudd Creek after modifications in 2019. Inset photo is of the barrier drop and screen.

In 2020 the West Fork of Mudd Creek was electrofished to monitor the 37 introduced westslope cutthroat from Rabbia Creek upstream of the fish barrier. Four sections were sampled beginning at the fish barrier and extending upstream to the 2nd meadow (Table 10). In all sited only WCT were captured suggesting the fish barrier is continuing to preclude upstream fish passage. The 37 cutthroat trout initially introduced in the 1st Meadow have successfully reproduced and have expanded upstream and downstream to occupy most of the available habitat in the West Fork of Mudd Creek. The density of fish was lower in the upstream most reaches surveyed but the average size was greater suggesting that adult and subadult fish are likely just beginning to colonize these reaches of the stream. The meadow reaches of the stream contain high quality habitat with large deep pools and abundant spawning gravels. All age classes of fish were present in the lower reaches of stream including young-of-the-year. Population estimates indicate there were over 1,000 fish per mile in the lower meadow and near the fish barrier. In 2008 brook trout density immediately upstream of the fish barrier was 310 fish/mile (Olsen 2011). In 2010 brook trout density between 1st Meadow and 1st Trail Crossing Sections sampled in this report was 1,220 fish/mile (Olsen 2011, Table 12 W Fk Mudd 2). In only 4 years, 37 introduced WCT have expanded and nearly equaled the density of brook trout prior to their removal. There are currently well over 2,000 WCT in the West Fork Mudd Creek with the potential for the population to still expand upstream. Genetic samples were collected from 25 individuals and were verified as being non-hybridized (Kovach et al. 2020a). Five male WCT from the West Fork of Mudd Creek are slated to be crossed with females from Cherry and Granite lakes in 2021 to genetically augment the Big Hole Brood. In preparation for this effort, 60 brook trout were collected in 2020 downstream of the fish barrier and tested for disease and pathogens were detected.

Table 10. Fisheries survey data from West Fork Mudd Creek where Length = the length of the section, L is fish length and the fish species sampled was WCT = westslope cutthroat trout.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Barrier	(st)	45.87446	-113.40165	2-Pass	WCT (91)	1102 (931-1274)	4.2 (2.4-6.3)	
(500)	(end)	45.87501	-113.40335					
1st Meadow	(st)	45.88061	-113.40958	2-Pass	WCT (84)	1133 (1051-1215)	3.4 (0.9-8.3)	
(410)	(end)	45.88132	-113.41027					
1st Trail Xing	(st)	45.88735	-113.41581	2-Pass	WCT (33)	663 (189-1138)	5.1 (3.6-9.1)	
(390)	(end)	45.88769	-113.41668					
Upper Trail	(st)	45.88966	-113.41955	1-Pass	WCT (7)		6.5 (4.4-9.2)	
(300)	(end)	45.89032	-113.41977					

Chub Creek

Chub Creek is a small tributary to Seymour Creek and is home to a conservation population of WCT. Past genetic samples from the stream indicate that the fish are slightly hybridized with Yellowstone cutthroat (94% WCT). These samples were collected in Chub Creek near the confluence of Seymour Creek. Immediately upstream of the confluence with Seymour Creek, Chub Creek ascends a very high gradient reach to a small meadow. Given the high gradient nature of this reach of stream it is likely that fish passage is limited, and it is possible that non-hybridized WCT could be present in the headwaters. Forest Service crews sampled Chub Creek in 2020 in the meadow reach above the cascades in the fall of 2020 and found it to contain only WCT (4 fish, 3.9-7.1 in). Unfortunately, no genetic samples were collected. Genetic samples should be collected from Chub Creek to determine if non-hybridized WCT are present in the upper reaches of the creek.

Twelvemile Creek

Twelve Mile Creek was surveyed previously in 2010 and found to still contain a non-hybridized population of WCT near the headwaters. WCT were moved into a fishless reach of stream upstream of a cascade fish barrier near the headwaters of the stream in 2012 (Olsen 2016). Two years later the fish introduced to the first meadow were thriving. In 2015, 54 cutthroat were captured downstream of the cascade and transported to a 2nd fishless meadow upstream of the first meadow and released. A steep reach of stream separates the two meadow reaches but it is unknown if there are barriers that would prelude upstream fish passage in this reach.

The upper meadow reach was sampled in 2020, and it was found that while not as successful as the lower meadow, the introduced WCT were surviving and reproducing (Table 11). It should be noted that not all fish encountered in the upper meadow were captured and measured because the primary reason for electrofishing was to determine if natural reproduction was occurring. The habitat quality in the upper reach is less than the lower meadow, primarily because of limited spawning gravels. However, juvenile fish were captured in the upstream meadow and it appears as though this segment of the population will also be self-sustaining. To secure the long-term persistence, the Twelvemile Creek population of cutthroat would need to be expanded downstream of its current distribution. Even with the expansion into the upstream meadow, WCT in Twelvemile Creek only occupy roughly 2 miles of

habitat. A potential barrier site was identified in 2020 downstream of the confluence of the West Fork Twelvemile Creek (45.98326, -113.10490). A barrier at this location would isolate roughly 9 miles for cutthroat trout in Twelvemile Creek but additional information is needed prior to moving forward with a restoration proposal.

Because of the presence of non-hybridized WCT, Twelvemile Creek was selected as one of the streams to contribute genetically to the Big Hole WCT brood. Other studies had suggested that it is possible to collect milt from trout and store it for several days, with the aid of a preservative, and successfully fertilize eggs (Rodgers 2010). Following these methods milt was collected from 5 males in Twelvemile Creek to be transported to Cherry and Granite lakes and crossed with females from the lake. Prior to adding preserved milt to wild eggs, a small subsample of preserved milt was checked for viability 1 day after collection. No sperm were viable from any of the 5 males. The preservative was checked for efficacy using WCT milt from the M012 brood stock. Milt was collected, preserved and checked for viability after 1, 2, 3 and 4 days. Preserved sperm from the M012 brood fish showed no signs of decreased motility until day 4. Because of the inability to preserve sperm from wild fish, it was determined that 5 males would be live transported to Cherry and Granite lakes to cross with females from the lake. Transporting males and crossing them with females from lakes proved successful and the eggs were reared in the Washoe Park isolation facility. It is still unclear why the preservation of milt from wild WCT was unsuccessful unlike the hatchery brood.

Fish captured from Twelvemile Creek during the collection of males were enumerated and the data are shown in Table 11. Twenty-five fish were genetically tested and were confirmed to be 100% WCT (Kovach et al. 2020b). In connection with the wild infusion into the Big Hole brood, Twelvemile Creek was tested for disease in 2019. Sixty brook trout from near the Dry Creek Road crossing were tested and found to pathogen free.

Table 11. Fisheries survey data from Twelvemile Creek during June 2020 where Length = the length of the section, L is fish length and W = fish weight. The fish species sampled were: WCT = westslope cutthroat trout.

Section (Length)	Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Lower Meadow (500)	45.03747	-113.15051	1 Pass	WCT (45)		5.8 (3.6-8.3)	
Upper Meadow (500)	45.04350	-113.15900	1 Pass	WCT (11)		4.9 (2.9-7.3)	

French Creek

French Creek is the largest tributary to Deep Creek which flows to the Big Hole River near East Bank Fishing Access Site. The French Creek watershed lies mostly on the Mount Haggin Wildlife Management Area (WMA). The watershed has had a colorful history with multiple uses including intensive logging, mining (both placer and hardrock) and grazing. It has also been significantly impacted by atmospheric fallout from smelting operations in Anaconda. FWP acquired the WMA from the Nature Conservancy in 1976 who purchased the property from the Mt. Haggin Livestock Company. French Creek has been a focus area for restoration work over the past decade. Several large projects have been completed to restore the past impacts of mining, grazing and smelter operations (Olsen 2016).

Additional restoration work as described below has been completed during the time period covered in this report.

Upstream of the Highway 569 crossing on Mount Haggin, French Creek flows against high, chalky banks which are actively eroding (Figure 5). These chalky banks are frequently calving into the stream causing annual deposition of an estimated 400+ tons of sediment per year. The cause of this erosion appears to be, at least in part, related to past mining activity in the area. French Creek has a very wide and well vegetated floodplain through this reach; however, it appears that the stream has been forced against the bluff so the floodplain could be mined. There is also a historic dredge channel that may have been used to convey water to the mining site. To restore this reach and reduce the chronic erosion problem, a design was developed to construct a new stream channel in the wide floodplain located to the southeast of the existing stream and also restore the mined reach and create a functioning floodplain and riparian area. Approximately 2,700 ft of lineal feet of new stream channel were constructed in the floodplain away from the eroding hillslope (Figure 6). The upstream portion of the new stream channel was located in an area of healthy riparian vegetation. Native sods and existing willows and willow transplants were used to construct the banks of the new stream channel. Because of the intact floodplain and vegetation in this reach, less floodplain work was necessary. The lower reaches of the new channel flow through the formerly mined area. Bioengineered meander bends with added log jams and root wads were constructed in the in this area. Excess fill generated from construction was disposed of against the eroding terrace. The steep slopes of the terrace and bench on top contain potential important prehistoric artifacts and by stabilizing the toe of the eroding slope, losses of these resources will be greatly diminished. Construction of the project took place in the late fall of 2019 and was completed in roughly 2 months. The cost of the project was just under $400,000. Great thanks are owed to the Big Hole Watershed Committee served as the lead on this project from planning to fundraising to implementation and monitoring.

Figure 5. Eroding bands of French Creek upstream of Highway 569 crossing in 2016

Figure 6. New stream channel on the left and the historic stream channel on the right (frozen) of French Creek in November of 2019 immediately after construction.

Downstream of Highway 569 an assessment was performed to determine the cause and potential remedy of significant bank erosion occurring on nearly every outside meander bend on the west side of the stream channel. This assessment indicated that the pasture on the west side of the stream contains introduced pasture grasses which are shallow rooted and easily undermined causing the banks to calve off into the stream (Figure 7). Most of the eastern banks are stable with healthy sedge and willow riparian vegetation. The assessment also revealed that stream channels were present through the pasture suggesting that water at one time was actively flowing across the floodplain. It is likely that before manipulation for grass production in the early 1900's, this meadow was a riparian area. A project was developed in 2019 and implemented in 2020 to stabilize many of the outside meander bends that were actively eroding and to reactivate one of the historic side channels. The goal of the stream bank stabilization was to use local material and re-slope the outside banks and transplant sods and mature willows from the inside of the stream to the outside. The goal of the side channel activation is to provide for juvenile fish habitat and also begin to expand riparian vegetation into the former floodplain of French Creek. A total of 21 stream banks totaling over 3,000 linear ft were reconstructed (Figure 7). The side channel activated was designed to carry roughly 1 cfs at low flows. This channel parallels

French Creek for over 1,200 ft before rejoining the channel as it enters the canyon reach downstream. This project cost just over $60,000 and was completed in 2 weeks in the fall of 2020.

Figure 7. French Creek stream banks in lower pasture before reconstruction (above) and after construction (lower). Note: these are not before and after photos of the same bank, only examples of conditions before and after construction.

A fish barrier was constructed on French Creek near the downstream end of the MT Haggin WMA property in 2019. Construction access was made via a private logging road on Phil Ralston's property which extended to the WMA boundary. Roughly 2,000 ft of new road was cut in the spring of 2019 from the WMA boundary to the fish barrier site. Barrier construction began in mid-July. The stream was diverted through a 4 ft culvert during construction to reduce turbidity. Major construction was completed by the end of September. The barrier consists of a concrete spill way and an earthen dam which spans the width of the valley bottom (Figure 8). The earthen portion of the fish barrier was constructed of fill generated from the placer mining restoration on French Gulch. The barrier was designed to pass the 100-year flood event with 6 inches of freeboard and to function as a barrier up to the 50-year flood event. A flood and breech analysis of the dam was performed by an independent engineering firm at the request of downstream landowners and it was found that the fish barrier, even in the event of a breech during a 100-year flood even, would not significantly increase the flood surface elevation or threaten the homes located downstream. The total cost of the fish barrier including design and additional analysis was just over $450,000. Because of the height of the fish barrier, a significant pool of water upstream was created. Using DEQ sediment estimates for French Creek and assuming all sediment being transported into the pool above the barrier settles, the pool should take 7-10 years to fill.

Figure 8. Fish barrier on French Creek completed in the fall of 2019. Access road can be seen in the upper right of the photo.

With the fish barrier completed, French Creek and all its tributaries upstream of the fish barrier were treated with rotenone for the first time in 2020. Treatments began in the tributary streams on July 20. As tributaries were individually treated, small, temporary fish barriers were erected near the confluence with French Creek to prevent upstream fish passage until the mainstem stream could be treated in mid-August. These barriers generally consisted of placing a canvas dam across the stream and placing rocks on the downstream side of the dam to prevent a scour pool from forming (Figure 9). Once the tributaries were treated, the mainstem creek was treated beginning at the headwaters of California Creek on August 17. In each tributary stream encountered as the treatment progressed downstream, a rotenone drip station was placed 2 hours travel time upstream of the temporary fish barrier to ensure that if any fish ascended the fish barrier they would be killed. No fish were observed above these fish barriers in any of the tributary streams, so it was assumed that they were successful at keeping fish from moving upstream. The progress of the treatment was monitored daily using sentinel fish placed in cages in the stream at predetermined locations. Fish 4 hours upstream of the fish barrier (near the Highway 569 crossing) were checked at least twice daily for signs of rotenone. If these fish showed signs of being affected by rotenone, detoxification with potassium permanganate at the fish barrier was initiated. Detoxification was initiated on August 13 when fish at the 4-hour mark showed signs of rotenone sickness. This was due to the treatment that occurred in American Creek the previous day. Detoxification was run for 24 hours after which time it was discontinued because the fish at the 4-hour mark recovered. No fish at the fish barrier shows signs of rotenone sickness. The mainstem creek was treated to the fish barrier from August 17-August 20. Detoxification was imitated again on August 19 as treated waters from above caused sickness in fish at the 4-hour mark.

Figure 9. Temporary fish barrier on French Gulch which was similar to the temporary barriers placed on all tributary streams with the exception of American Creek.

The treatment of French Creek was completed on August 20. Detoxification ran continuous until August 22 when fish immediately downstream of the fish barrier held in treated waters survived for 4 hours. The effectiveness of the detoxification station is monitored in 2 ways. First sentinel fish are placed in cages at the fish barrier (before neutralization) and at 30 minutes of travel (how far the water travels in 30 minutes) downstream, which was at the WMA boundary. Fish at the fish barrier are expected to die, indicating the rotenone is at a fish killing concentration upstream of the fish barrier and the fish at the 30-minute mark should live indicating that the rotenone has been successfully neutralized. The second monitoring method is direct measurement of the concentration of potassium permanganate in the water. To effectively neutralize rotenone, the potassium permanganate has to be administered to the stream at a rate such that at the 30-minute mark there is a residual concentration of of 0.5-1.0 parts per million. Water samples are collected at the 30-minute mark and analyzed using a hand-held meter. Measurements are taken at a minimum of every 4 hours. Potassium permanganate was kept within the guidelines for successful neutralization during the entire treatment and the fish in the cage held at the 30-minute mark survived the entire week.

Treating French Creek was difficult due to the large size and complexity of the watershed. The stream and its tributaries have multiple areas of active beavers. Beaver dams, particularly those that are larger than the immediate channel of the creek and spread the water across the floodplain, are particularly problematic. In the French Creek watershed these dams would often force water into a separate stream channel that would parallel the main channel for a long distance before reconnecting. This creates areas that can provide refuge for fish from the main treatment of the stream. To facilitate treatment, beaver dams were often notched the week and/or the day before treatment. Notching consisted of hand pulling a notch in the dam to lower the surface elevation of the stream and drain the inundated areas that are not well connected to the stream channel. In active beaver areas, these dams were rebuilt overnight and required pulling the day of treatment. Streams with active beaver included: Panama Creek (Lincoln Gulch), Moose Creek, American Creek, California Creek and several unnamed tributaries. In addition, there were multiple springs and tributaries that were spring fed that required additional treatments with drip stations and/or backpack sprayers. In total, 51 gallons of rotenone were applied to French Creek and its tributaries, nearly ½ of which was applied using backpack sprayers to spring seeps, beaver areas

and backwaters. Each week a crew of 6-12 people were employed to treat the streams. The final week of treatment on August 17, a crew of 18 were present to treat the mainstem down to the fish barrier. Crews from the BLM, Forest Service and DNRC all assisted in the implementation of this project. The 2nd treatment of French Creek is slated for 2021.

Oregon Creek

The lower ½ mile Oregon Creek was placer mined from roughly the Highway 569 crossing to the confluence with California Creek. The post mining stream was very incised and straight and isolated from its former floodplain. Large gravel piles flanked the eastern side of the stream and there was no access of the stream to its former floodplain. The aquatic habitat in Oregon Creek was limited due to the straight nature of the stream channel and limited riparian vegetation. A project was initiated to restore the impacts of past placer mining in this area and potentially increase late season flows and construction occurred in 2019. The goal of the stream restoration was to create a sinuous stream channel with a functioning riparian area and floodplain. An area west of the stream had an intact willow community and appeared to contain relic stream channels. It was likely that this was the former floodplain elevation before mining. The new Oregon Creek stream channel was constructed in this area to take advantage of an intact floodplain and robust riparian vegetation (Figure 10). The adjacent willows had to be trimmed to allow for machine access, but the roots were not disturbed. These trimmed willows are expected to survive sprout new shoots. The new channel has increased sinuosity which should facilitate the deposition of spawning gravels and increase available spawning habitat. The former stream channel and adjacent placer mined area to the east were leveled and converted into a series of water retention areas. The purpose of these retention areas is to capture over bank flows from Oregon Creek during spring runoff and saturate the floodplain. Then, as flows recede later in the summer, these saturated soils should slowly drain and add late season flow to the stream. Willow trenches were made with willow whips to accelerate riparian vegetation establishment within and adjacent to these retention areas. The stream channel was excavated into the existing willow riparian area.

Figure 10. Restored reach of Oregon Creek downstream of Highway 569 constructed in 2019 with the new stream channel on the right side (west) and the retention areas on the left (east) in spring of 2020.

In the summer of 2019 highway reconstruction was performed on Highway 569 from the French Gulch Road turn off to the Sugar Loaf Lodge. This construction included the replacement of the crossing over Oregon Creek. The crossing over Oregon Creek was greatly improved to provide for sediment transport and fish passage. The previous crossing consisted of twin, 30-inch, cement culverts (Figure 11). The culverts were replaced by a single 10-ft metal culvert with a constructed stream channel inside (Figure 11). Because of aggradation of sediment upstream of the undersized twin-culvert crossing, 2 small rock weirs had to be placed to prevent downcutting.

Figure 11. Highway 569 crossing over Oregon Creek before reconstruction (left) and after reconstruction (right) in 2019.

Sixmile Creek

A barrier was blasted on Sixmile Creek and brook trout upstream of that barrier were removed in 2013 (Olsen 2016). The stream was restocked beginning in 2014 with a 25 adult WCT from Jerry Creek and again from 2016-2018 with eggs from Cherry and Granite lakes. In 2019 fry from Cherry and Granite lakes were stocked rather than eggs. To monitor the reintroduction of cutthroat, Sixmile Creek was surveyed in 2018. The sample location was downstream end of the beaver meadows and corresponds to Sixmile 2 from previous reports prior to brook trout removal (Olsen 2011). All age classes of westslope cutthroat were present including young of the year indicating that the cutthroat are successfully reproducing (Table 12). The population estimate was over 750 fish per mile which is roughly 1/3 of the previous estimate for brook trout. However, the average and maximum size of cutthroat was substantially larger than that of brook trout. Brook trout prior to their removal were over-populated in this reach of Sixmile Creek which resulted in smaller fish. The cutthroat, on the other hand, appear to be reproducing at a rate which is producing a fine fishery for the size of stream but is not resulting in over population. Genetic samples were collected from 27 of the cutthroat captured and results indicated a mix of non-hybridized cutthroat trout and hybridized fish (Kovach et al. 2019). Eight of the fish tested were hybridized with rainbow trout. Interestingly, this sample was quite similar to a previous sample from Sixmile Creek that was collected prior to treatment. In that 10-fish sample collected in 2012, some fish in Sixmile Creek appeared to be nonhybridized westslope cutthroat trout (70%), while others were clearly rainbow trout hybrids (30%). Hybrid index scores among hybrids were fairly similar to those observed in the 2018 sample (hybrid index scores ranged from 3-7 in the 2012 sample and 4-11 in 2018 sample). In other words, the current population is remarkably similar to the pre-piscicide population, in terms of rainbow trout admixture (Kovach et al 2020b). The most likely explanation for the observed genetic characteristic of cutthroat trout in this location is that the barrier blasted in the canyon downstream is not a complete barrier. The barrier does seem to preclude upstream brook trout passage, but it may preclude hybridized cutthroat passage. This theory is further substantiated with additional genetic samples collected in 2020 approximately 1 mile upstream of the population estimate section where WCT were introduced from Cherry and Granite lakes and no hybridization was detected (Kovach et al. 2020b).

Moose Creek

Moose Creek is a tributary to French Creek in the middle part of the drainage. A placer mining restoration project was completed on the stream and reported previously (Olsen 2016). In addition, Highway 569 which ran through the floodplain of French Creek and affected the connectivity between Moose and French Creek, was removed and relocated to a dry bluff to the south in 2015. When the highway was removed the 4 culvert crossings that connected Moose to French Creek were also removed. Unfortunately, however, no stream channels or floodplain were restored after the culverts were removed leaving a linear and incised stream channel leading to French Creek. The area has active beaver and the narrow channels left from culvert removal were ideal locations for beaver dams. These dams forced flows from Moose Creek to the southeast away from French Creek. At the final culvert crossing, flows from Moose Creek entered crossed the decommissioned highway into the former borrow ditch (Figure 12). Although Moose Creek and French Creek were less than 20 ft from each other at this point, Moose Creek continued to flow for over a mile down the borrow ditch where eventually additional beaver activity forced flows to split with part of the water entering Panama Creek and part flowing into a large wet meadow. To fix this problem and reconnect Moose Creek with French Creek, 200 ft of new stream channel was constructed at downstream most culvert crossing of Moose Creek across the decommissioned highway (Figure 12). The channel was constructed using only native materials. Sods and mature willows were salvaged from the highway borrow ditch and used to form the banks of the stream. The stream followed the natural contours of the landscape and joined French Creek in an area that has willow cover and stable stream banks. The new channel was constructed with a wide (30-50 ft) floodplain. The purpose of this floodplain is to facilitate natural stream function through time and to discourage easy beaver dam construction that would completely plug the channel. If the channel is eventually plugged by a beaver dam, the wide floodplain should allow flows to go around the dam and still allow for fish passage. The waste material generated through channel construction was placed in the borrow ditch of the highway. Moose Creek is an important spawning and rearing stream to French Creek. There is high quality spawning habitat less than 1 mile from French Creek that fish from French Creek will be able to use thanks to this project. George Grant Trout Unlimited and The Salmon and Trout Foundation funded this project and the total cost was $9,500.

American Creek

American Creek is the largest tributary to French Creek. It is also home to the only known aboriginal population of WCT in the drainage located in the headwaters of the stream. A dam was constructed on American Creek and was an important location for the shipping of logs via a flume network to Anaconda. The remnants of this dam are still present today and the dam was thought to be the fish barrier that has resulted in the absence of brook trout and the persistence of the WCT in the headwaters of the stream. Because it is the last known population of WCT in the drainage and the total number of fish is low, a salvage effort was made downstream of the dam structure prior to treatment with rotenone. A two-pass electrofishing effort was conducted beginning roughly 1 mile downstream of the dam. A total of 23 cutthroat were captured (Table 12). Although not enumerated, brook trout outnumbered cutthroat roughly 5:1. Interestingly, no juvenile fish, except for 1, 4-inch cutthroat, were captured. The stream was moderate gradient with infrequent pools but the density of trout seemed lower than what the habitat could support. While the historic dam was thought to be the fish barrier precluding brook trout from upstream habitat occupied by only cutthroat, a small cascade roughly ½ mile downstream of the dam (45.958868, -112.971985) appears to end of brook trout in the stream. All captured WCT were held in a live car 1 week while American Creek was treated downstream of the dam and then released.

Figure 12. Figure above shows historic flow path of Moose Creek prior to restoration (note the stream flowed down the borrow ditch of the old highway. Photo below shows restored flow path between Moose and French creeks

Figure 13. American Creek culvert before removal in 2019.

As part of the reconstruction of Highway 569 in 2019, the twin, concrete culverts on American Creek were replaced with a single 15-ft wide rectangular box culvert that was filled partway with stream sediments. In exchange for using the remaining waste rock from the placer mining restoration on French Gulch, the construction company for the highway project also agreed to remove a 4-ft culvert and associated road fill on American Creek downstream of the highway crossing (Figure 13). This culvert crossing in not used for access and while not a fish barrier, it served no purpose. Because there was a drop at both the inlet and outlet of the culvert, a single pine tree was imbedded into both banks of the stream at the location of the culvert inlet to serve as a grade control. Two pine tree root wads were placed at the culvert outlet extending into the stream from each bank. These roots wads constrict the flows of American Creek at the center of the channel and creates the necessary velocity to maintain the pool created by the culvert outlet. Sods and willows were salvaged from the nearby floodplain and used to reform the stream banks. The excess road fill in the floodplain was removed and used in the reconstruction of the highway. The removed culvert should facilitate fish passage and improve floodplain function and riparian habitat through this reach of stream.

Little American Creek

Little American Creek is a tributary to American Creek that was previously unsurveyed (Oswald 1981). Much of the lower stream is a series of valley wide beaver dams, some of which were very old as evidence by heavy sedge sods covering the dams. In August of 2020 prior to treatment, the stream was electrofished upstream of the major beaver complexes (Table 12). Only WCT were encountered upstream of the beaver complex but brook trout were present downstream of the beaver dams. Genetic testing indicated the fish were non-hybridized westslope cutthroat (Kovach et al 2020b). The captured WCT were held during the treatment of Little American Creek and the beaver ponds and released the following week. Although numbers and distribution of WCT in Little American is limited, it represents only the 2nd aboriginal cutthroat trout population left in the French Creek drainage.

Table 12. Fisheries survey data from tributaries to French Creek where Length = the length of the section, L is fish length and W = fish weight. The fish species sampled were: WCT = westslope cutthroat trout. Length is the section length in feet.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Sixmile 2 (400)		46.00264	-113.03753	3-Pass	WCT (52)	752 (740-860)	5.9 (4.0-9.0)	
American (3432)	(st)	45.96079	-112.97639	2-Pass	WCT (23)	38 (31-46)	7.2 (4.0-10.2)	
	(end)	45.95546	-112.96662					
Little Amer.1 (5800)	(st)	45.97024	-112.99490	,1-Pass -	WCT (38)		3.6 (1.8-6.9)	
	(end)	45.96713	-112.97462					
Little Amer. 2 (1500)	(st)	45.96731	-112.9783	1-Pass	WCT (9)		3.3 (1.9-4.2)	
	(end)	45.96502	-112.9745					

Wise River

The Wise River is one of the largest tributaries to the Big Hole River. Because of its large size and the volume of cold water it delivers to the Big Hole River, it is one of the most important tributary streams. Beginning in 2014, Arctic grayling were introduced into the Wise River and in Wyman Creek using remote stream-side incubators (RSI). One of the objectives of increased monitoring in the Wise River was to monitor the grayling introduced to the system. RSIs were set up on Little Joe Creek at the confluence with Wise River and in Wyman Creek at the confluence of Stringher Creek. Over 350,000 grayling eggs were incubated in these streams from 2014-2018. Egg incubation was successful and thousands of fry swam from the RSI's into the Wise River and Wyman Creek. Two section of Wise River were monitored to determine if the egg incubations and fry releases were producing a grayling fishery. The Little Joe Section was located at the confluence of Little Joe Creek and extended downstream 1.2 miles. This section was surveyed in 2015 and no juvenile grayling were captured but 1 adult was captured. The size of the fish would have precluded it from being a fish from an RSI which could have been only an age-0 or age-1 fish at the time. The section was surveyed again in 2019 (Table 13) and the fishery was very similar to the previous sampling; however, no grayling were found. It appears that if the grayling introduced via RSI survived, they did not stay in this section to rear or return as adults to occupy this high meadow habitat. In 2019 brook trout numbers were nearly double those observed in 2015 while whitefish numbers were lower (Olsen 2016).

Stine Creek

Stine Creek is one of the first tributaries to Wise River on the west upstream of the confluence with the Big Hole River. An irrigation diversion at the highway crossing may be a partial fish barrier. Past sampling by Forest Service crews has been very limited in Stine Creek but it is considered home to a conservation population of WCT. Forest Service crews sampled the stream just upstream of the Highway 73 crossing and found a mix of what were called hybridized cutthroat, westslope cutthroat and brook trout in roughly equal proportions. No genetic samples were collected from the fish. Additional survey information is needed from Stine Creek to determine the status of WCT in the stream.

Mono Creek

Mono Creek and Jacobsen Creek form the Wise River at the headwaters of the drainage. Mono Creek is also home to a conservation population of WCT. A high gradient reach in the lower ½ mile of the stream appears to preclude upstream fish passage at least for brook trout. Upstream of this high gradient reach the stream meanders through a long meadow with high quality pools. Hybridized WCT have been detected in lower reaches of the stream but non-hybridized fish have been sampled in the upper reaches with the most recent genetic samples coming from 2001. There are no known fish barriers in the system except near the confluence with Jacobsen Creek. A short reach of Mono Creek was sampled in the summer of 2018 at the headwaters near the confluence with Sheldon Creek to collect genetic samples (Table 13). Only WCT were captured in the section and the genetic results from fin clips taken suggest the fish were non-hybridized westslopes (Leary et al. 2018). It was unexpected to find non-hybridized fish in Mono Creek given the elapsed time since the last genetic sampling and the lack of fish barriers in the system. Additional genetic sampling is warranted in the drainage so the genetic characteristics of the entire population can be better understood. Cutthroat trout occupy roughly 4 miles of habitat in Mono Creek.

Elkhorn Creek

Elkhorn Creek is moderate sized tributary to Jacobsen Creek. The area has an extensive and fascinating history of mining. The following excerpt was taken from Wintergerst (2019): "Ore was first discovered at the site in 1872… a total of 1,013 ounces of gold, 180,843 ounces of silver, 370,799 pounds of copper, 4,100 pounds of zinc, and 851,725 pounds of lead were produced from the claims that made up the site over the course of its operations. No activity at the site was reported from 1893 to 1906. In 1913 the Boston-Montana Mining Company was formed and began operations at the site. The Company made several major improvements to the site including the construction of a large mill (Figure 14). A narrow gage railroad was constructed in the early 1900's from the town of Divide up the Big Hole and Wise rivers to Coolidge to supply equipment and supplies to the mine site and transport ore to Divide where it could be shipped to smelters in other states (DEQ 2020). It was thought to be the last narrow gage railroad constructed in the United States. A major economic blow to the Company occurred in 1927 when a flood destroyed a major portion of the company's thirty-five miles of railroad line. The Company did not recover from this disaster and operations were ended at the site by 1930."

Figure 14. Mill site at Coolidge with the tailings pile visible on the left-center of the photo and Elkhorn Creek in the foreground.

The mining activity in the drainage has lead to the contamination of the site with elevated levels of arsnic, lead, copper and zinc. Several cleanup operations have taken place at the Coolidge site and much of the mill structure itself has been removed. In the late 1990's and early 2000's the tailings at the mill were removed including tailing in the floodplain of Elkhorn Creek and the waste was hauled to a repository 2 miles away. At the same time the mine waste dump at the adit was capped and measures taken to reduce infiltration of water (Wintergerst 2019). Water flowing out of the main mine adit was diverted around the tailings. In Elkhorn Creek a sinuous stream channel and floodplain were reconstructed and a diversion was created to maintain some flow through the historic ditches adjacent to the town of Coolidge while directing the main flows of the creek to the new stream channel.

FWP and the Big Hole Watershed Committee have expressed interest in better understanding the impacts of past mining practices on the water quality of Elk Horn Creek. Despite the cleanup efforts mentioned above there is a significant quantity of water discharges from the main adit which then flows into Elkhorn Creek. Additionally, there are seeps discharging from the tailings material that appear to be introducing metals into Elkhorn Creek. The Big Hole Watershed Committee contracted Watershed Consulting Inc. to characterize the Coolidge site as it relates to potential metals loading to Elkhorn Creek (DNRC 2020). The study found that significant metals loading is still occurring through both surface and groundwater means to Elkhorn Creek. To understand the impacts of the mine area on the fishery of Elkhorn Creek 4 sections of the stream were electrofished below, through and above the mining site (Table 13). Two sections were surveyed downstream of the mine site (Elkhorn 1 and 2). The habitat in the lower site (Elkhorn 1) at the Forest Service road crossing consisted of a moderate grade stream channel with mostly cobble substrate. The largest pool in this section was formed by abutments of the old railroad bridge across Elkhorn Creek. Cutthroat trout, some of

which appeared to be significantly hybridized, Rocky Mountain sculpin and a single brook trout and were captured in this section (Table 13). At Elkhorn 2 the valley grade was less and the stream was more sinuous with more gravels and high-quality, deep (> 3 ft) pools. The fishery in this section was very similar to that below in both species composition and density. Only 2 brook trout were captured, and both were young-of-the-year. The 3rd section sampled was immediately downstream of the mill site in the restored reach of channel mentioned above. This is a low gradient reach of stream with a sedge floodplain. The outside meander bends are armored with native granite boulders. The infrequent pools lacked in overhead cover and pool depth was minimal. There are few willows or other woody species in the floodplain, but the stream banks were quite stable due to thick sedge mats. The substrate consists of primarily coarse granitic sand which was covered in a veneer of orange duff. A marked drop in fish density was present at the site as only a handful of cutthroat were present (Table 13). There was no evidence of reproduction as only older age classes of fish were present. The 4th section samples was upstream of the mine site and the habitat was a mix of low gradient and moderate gradient areas with many large boulders forming the pool habitats. Pools were relatively frequent and high quality with depth > 3 ft. The fishery in this reach was very similar to Elkhorn 1 and 2 but with no brook trout. The cutthroat phenotypically appeared to be westslope cutthroat trout (Figure 15), but no genetic samples were collected. Past genetic samples suggest the cutthroat trout in this reach are hybridized with rainbow trout and may not constitute a conservation population. Past surveys done by the Forest Service through the early 1990's failed to detect any brook trout anywhere in Elkhorn Creek. It is likely that as water quality improves brook trout will continue to colonize Elkhorn Creek. Current genetic samples are needed, particularly upstream of the mine, to determine if a conservation population of WCT remains in Elkhorn Creek. If a conservation population of cutthroat remain, actions to prevent colonization and expansion of the brook trout population may be warranted.

Figure 15. Westslope cutthroat trout from Elkhorn Creek upstream of the Coolidge/Elkhorn mine site 2020.

These data indicate a significant drop in fish density at the mine site but fish density within one mile downstream is similar to upstream of the mine. It is possible that the mine has an acute impact on the fish near discharges to the stream but that these impacts quickly attenuate downstream. The poorer quality habitat in the restored reach of stream adjacent to the mill may also affect fish density. Sandy substrates like those found downstream of the mill generally produces fewer and less diverse aquatic invertebrate communities which may limit food availability for fish. In addition, there was very limited spawning habitat observed in the restored reach. Fish samples should be collected from the stream to determine potential contamination from metals.

Table 13. Fisheries data collected from Wise River and tributaries where Length = the length of the section, L is fish length and W = fish weight. The fish species sampled were: EB = brook trout, WCT = westslope cutthroat trout, RBxWCT = rainbow trout-westslope cutthroat trout hybrids, LL = brown trout, BUR = burbot, MWF = mountain whitefish and LSU = longnose sucker.

Section (Length)		Latitude	Longitude	Survey Type	Species (# sampled)	Pop Est/mi (95% CI)	Avg L (in) (range)	Avg W (lbs) (range)
Little Joe	(st)	45.55573	-113.09241	1-Pass	EB (242)		6.5 (2.2-12.2)	
(1.2 miles)	(end)	45.56630	-113.10447		RBxWCT (26)		7.6 (4.4-12.6)	
					BUR (16)		8.4 (5.8-13.9)	
					MWF (21)		8.2 (2.9-13.6)	
					LL (9)		11.4 (4.2-8.5)	
					LSU (1)		6.9	
Mono Creek (300)	(st)	45.50594	-113.10724		WCT (15)		5.8 (4.6-8.2)	
Elkhorn 1	(st)	45.51876	-113.05613	3-Pass	WCT* (62)	739 (615-853)	4.7 (2.2-8.5)	
(500)	(end)	45.51468	-113.05509		EB (1)		9.3	
Elkhorn 2	(st)	45.50966	-113.05009	2- Pass	WCT (64)	667 (585-748)	4.8 (1.4-8.7)	
(550)	(end)	45.50887	-113.04922		EB (2)		2.5 (2.4-2.6)	
Elkhorn 3	(st)	45.49654	-113.04178	3-Pass	WCT (9)	75 (68-83)	6.6 (3.4-8.1)	
(627)	(end)	45.49531	-113.04072					
Elkhorn 4	(st)	45.48499	-113.03496	2-Pass	WCT (73)	628 (573-684)	5.2 (2.5-9.0)	
(650)	(end)	45.48373	-113.03411					

* WCT in this section appeared to be heavily hybridized with rainbow trout

Cherry Creek

Cherry Creek drains from the East Pioneer Mountains and converges with the Big Hole River near Melrose. Cherry Creek was selected for westslope cutthroat trout restoration and a fish barrier and removals of non-native fish commenced in 2011. The stream was treated in August and again in October of the same year. A third treatment was performed on the lower 3 miles of stream in 2012 after brown and brook trout were found near the fish barrier. No trout were observed in subsequent electrofishing surveys in Cherry Creek. Because no other trout were found in Cherry Creek, efforts began to repopulate the stream and lakes with non-hybridized westslope cutthroat trout. From

2012-2014 eggs were collected from 7 streams in the Big Hole. In 2015 brook trout were discovered in Cherry Creek upstream of the Cherry Creek Ranch. A single brown trout was also found farther downstream on BLM lands. The presence of reproducing non-native trout prompted the need to retreat the lower 6 miles of Cherry Creek in 2016 and again in 2017. EDNA testing of Cherry Creek in 2018 suggested that both brown and brook trout remained in the stream in the lower 3 miles. This area was intensively electrofished and only 1 cutthroat was captured. However, electrofishing efficiency in Cherry Creek is low owing to fast flows in the stream and extremely dense woody vegetation that precludes access to some sections of the creek. Cherry Creek was treated again in 2018 and no fish were observed in the treated area. EDNA testing in 2019 did not detect brook trout anywhere in the drainage, but there were still positive hits for brown trout in the lower creek. Once again electrofishing efforts failed to find any brown trout in the lower creek. It was determined that the brown trout detections were likely false positives and efforts were started to repopulate the stream with westslope cutthroat.

The first egg collection at Cherry and Granite lakes occurred in 2016. A summary of egg collection efforts can be found in Olsen (2020). The first successful egg collection occurred in 2018. Because it was unclear if non-native fish had been removed from the lower reaches of Cherry Creek, eyed eggs were only restocked into the upper 5 miles of stream using RSI's. Approximately 15,000-20,000 eggs were incubated in the upper stream. Beginning in the fall of 2019 the entire stream was stocked with fry that were collected as eggs at Cherry and Granite lakes and reared in the isolation facility at the Washoe Park Hatchery. Stocking was done in October from eggs collected in June and July. The fish were roughly 2 inches and 11,995 were distributed throughout Cherry Creek from the confluence of the outlet streams from Cherry and Granite lakes to the fish barrier. Similarly, a second age class of fish was stocked into the creek in 2020 and 8,466 fish were distributed in similar fashion. Fish from the 2019 stocking were observed in the creek during the 2020 stocking event. Stocking the stream will occur for one more year in 2021 and the fish are anticipated to become self-sustaining after that point.

Long Branch Creek

Long Branch Creek is a tributary to Rock Creek near Glen. It originates at the base of Mount Alverson in the East Pioneer Mountains and flows east to its confluence with Rock Creek. A natural cascade fish barrier is present on Long Branch Creek immediately upstream of its confluence with Rock Creek (Olsen 2016). Because of the presence of a natural fish barrier and the high quality of habitat, Long Branch Creek became a prime candidate for the restoration of native species. In 2015 the stream and lake were treated with rotenone to remove non-native trout. During the treatment it was discovered that water and fish from Tendoy Lake in the Willow Creek drainage was entering Long Branch Creek via a failed irrigation ditch. Working cooperatively with the water right holder and the Forest Service, the failing dam on Tendoy Lake was removed in 2017 which halted the flow of water from the lake into Long Branch Creek (Olsen 2020). Long Branch Creek was treated again in 2018 with rotenone to remove the hybridized cutthroat trout. No fish were found in the lower half of the drainage during the treatment, but the upper reaches of the stream had been repopulated presumable by Yellowstone cutthroat originating from Tendoy Lake before the dam was breached. Subsequent

electrofishing in 2020 found cutthroat trout in the uppermost meadow of the stream in the cascades at the downstream end of the meadow. Only a small handful of age-1 and age-2 fish were present in a roughly 200-yard section of stream. No fish were encountered in the next 1.5 miles downstream through next meadow and cascade below. Additional extensive removals of fish occurred in the reach of stream where fish were detected until no fish could be captured. EDNA testing should be done in 2021 to determine if all fish have been removed from the system before westslope cutthroat trout are restocked.

Beginning in 2018, Arctic grayling were stocked into the lower reaches of Long Branch Creek including Long Branch Lake. The lake was stocked again in 2019 and 2020. The success of the stocking has not yet been evaluated but it is expected that grayling will become self-sustaining the lake and adjacent creek both upstream and downstream.

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