Lower Clark Fork Native Salmonid

Limiting Factors Assessment

Final Report

2011-2015

Montana Tributary Habitat Acquisition and Recreational Fishery Enhancement Program

Appendix B

February 2016

Montana Fish, Wildlife & Parks

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Lower Clark Fork Native Salmonid Limiting Factors Assessment

Final Report

2011-2015

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Abstract

This report is an evaluation of the biological characteristics of selected streams where the status of Bull Trout and Westslope Cutthroat Trout populations in the lower Clark Fork River drainage (LCFR) were relatively uncertain. Accordingly, data collected from fisheries surveys, temperature monitoring and habitat assessments for the four streams selected is presented and evaluated with the goal of prioritizing native species management activities. The streams in this assessment include two tributaries to the Bull River– North Fork East Fork Bull River (NFEFBR) and Copper Creek, and two tributaries to Noxon Reservoir– Deep Creek and upper Graves Creek. Salmonid populations in Deep Creek and the NFEFBR were comprised solely of Westslope Cutthroat Trout, while portions of Copper Creek and upper Graves Creek contained native and non-native salmonids. Stream temperature in each stream was monitored for two to four years between 2011 and 2014. Yearly maximum temperature ranged from a low of 10.5°C in August of 2011 in upper Graves Creek to a high of 13.7°C in July of 2013 in the NFEFBR. Mean daily high temperatures for a given year ranged from a low 9.1°C in August of 2011 in upper Graves Creek to a high of 12.3°C in August of 2013 in the NFEFBR. Habitat surveys suggest these streams are generally comprised of high-quality habitat typical of low-order streams in northwest Montana, with the exception of lower Copper Creek.

The streams investigated for this study were occupied mainly by resident Westslope Cutthroat Trout and it is these small headwaters streams that encompass the bulk of the species distribution in the LCFR. Estimates of population abundance and density noted relatively stable population trends when compared with previous sampling data, however the location of these populations within the watershed may make them vulnerable in the future. These streams are probably at an elevated risk of Westslope Cutthroat Trout decline or extirpation because they occur low in the Clark Fork River watershed where temperature and habitat are, in many cases, more typical of those found to be dominated by non-native salmonids. The results of temperature monitoring suggest that current stream temperatures are cool enough to sustain native salmonid populations but increases in summer temperatures could facilitate the expansion of non-native salmonids into headwater strongholds. Some level of isolation was also noted in three of four populations, varying from seasonal isolation during low flow periods to complete isolation facilitated by natural or anthropogenic barriers. While resident Westslope Cutthroat Trout populations are still common in the LCFR, the results of this study outline gaps in data that may be important for managing individual populations in an uncertain future including documentation of the species lower and upper distribution in a given stream, the distribution of ephemeral stream reaches, updating hybridization information, stream temperature regime, the presence of non-native salmonids and the level of isolation. Together this baseline information on a population's current status and the threats it may face will help prioritize future management or conservation efforts. It is recommended that some of the larger and more roust Westslope Cutthroat Trout populations are monitored every 3-5 years, including the four streams in this study.

Introduction and Background

The conservation of native species depends upon an understanding of environmental variables and population level processes that influence the distribution and abundance of a given organism (Brown 1984). Habitat requirements, life-history variation, interactions with other species, metapopulation dynamics, and environmental conditions are factors that dictate where a species lives and the size of a local population. This study investigated factors that could potentially limit the success of native Bull Trout *Salvelinus confluentus* and Westslope Cutthroat Trout *Oncorhynchus clarki lewisi* populations in the lower Clark Fork River (LCFR) drainage of northwestern Montana. The streams selected for this study were chosen for detailed investigation based on limited datasets and knowledge of their potential as important native salmonid streams. The objectives for this project were to collect baseline information related to the physical and biological conditions of each stream and evaluate how different management and restoration strategies could benefit native trout in these drainages. The variables investigated for this study included temperature regime, available connected habitat, habitat quality and stability, as well as the composition of the current fish community.

Bull Trout and Westslope Cutthroat Trout (also referred to as Cutthroat Trout) are sensitive species and indicators of aquatic ecosystem health. These native salmonid species, which often occur in sympatry, both require high-quality aquatic habitats that include cold water temperatures, low levels of fine sediment, habitat complexity and connectivity between habitats and populations. Bull Trout have one of the lowest thermal tolerances of any freshwater fish species in North America (Selong et al. 2001) and are rarely found in waters where temperatures are greater than 15° C for extended periods of time (Fraley and Sheppard 1989). Likewise, Westslope Cutthroat Trout are often found in greatest abundance in cold, low-order streams and it is in these headwater systems where they may have a biological advantage over non-native salmonids such as Brook Trout *Salvelinus fontinalis* and Brown Trout *Salmo trutta* (Dunham et al. 2002; Pierce et al. 2013). Excessive levels of fine sediment have been shown to negatively impact both species by increasing egg incubation mortality (Shepard et al. 1984; Weaver and Fraley 1993) as well as acting to reduce interstitial habitat essential for juvenile trout, especially Bull Trout (McPhail and Baxter 1996). Habitat complexity in the form of large and small woody debris, roots wads, overhanging vegetation, undercut banks, substrate composition, and percentage of pool habitat allows for higher densities of fish to occupy a given patch when compared to more homogenous stream reaches (Meehan 1991). Connectivity within and between populations allows for gene flow (Rieman and Allendorf 2001), expression of varying life history forms (Nelson et al. 2002), and seasonal movement between habitats (Jakober et al. 1998). Together, the four "C's" (clean, cold, complex and connected habitat) are essential for healthy Bull Trout and Westslope Cutthroat Trout populations.

The challenges that face native trout in the LCFR are similar to issues those salmonid species encounter across their range. Issues that threaten or have negatively affected native salmonids in the LCFR include the legacy effects from mining, road construction, timber harvest, mainstem hydropower development, simplification of instream habitat for flood control, habitat fragmentation, drought, non-native species, and overharvest (Pratt and Huston 1993; GEI 2005). Land-use practices such as logging, road construction, mining, grazing and recreation have facilitated the degradation of stream ecosystems by altering streambank morphology and riparian function, increasing sediment production and stream temperatures, and reducing habitat heterogeneity (Meehan 1991). Dams, culverts, irrigation diversions, and heavily degraded habitats have created artificial barriers that limit or completely eliminate migration and gene flow (Blakney et al. 2014). Overharvest of migratory stocks has been documented in tributaries, especially in staging areas where fish tend to concentrate (Pratt and Huston 1993). The introduction of non-native salmonids has reduced or eliminated Bull Trout and Cutthroat Trout in some streams through hybridization, competition, and predation (Dunham et al. 2002; Peterson et al. 2004; Rieman et al. 2006). Drought conditions reduce summer streams flows which often equates to higher stream temperatures and less than optimal ecological conditions. Today, both species occupy a fraction of their historical range and are the subject of conservation efforts. Westslope Cutthroat Trout are considered species of special concern in Montana and Idaho and Bull Trout are listed as Threatened under the Endangered Species Act. It is essential for fisheries professionals to understand the suite of factors that have facilitated the decline of these species and what measures can be taken to sustain or enhance extant populations.

To best conserve native trout populations, an understanding of local life-history strategies and population dynamics is also imperative. The LCFR supports both migratory and resident populations of Bull Trout (Zymonas 2006) and Westslope Cutthroat Trout (Katzman and Hintz 2003). Prior to the completion of Thompson Falls Dam in 1913 and Noxon Rapids and Cabinet Gorge dams in the 1950s, many Bull Trout and Westslope Cutthroat Trout were believed to have exhibited an adfluvial or fluvial life history, where adults spent a significant portion of their lives foraging in large lentic habitats such as Lake Pend Oreille (LPO) or the mainstem Clark Fork River. These fish then migrated back to natal streams throughout the Clark Fork River basin to spawn. Since 2004, with the aid of genetic assignment tests, migratory Bull Trout captured in the Clark Fork River downstream of Cabinet Gorge Dam have been transported upstream over one or more dams, depending on their stream of origin (DeHaan et al. 2011). Many perennial tributaries in the LCFR have reaches of stream that are intermittent during a significant portion of the year and this phenomenon is caused by deep layers of unconsolidated bed sediments associated with Glacial Lake Missoula deposits, where a significant portion of surface flow is lost through the highly-permeable substrate (Sando and Blasch 2015). This type of natural isolation has probably facilitated resident life history in both species in the LCFR. Today, resident and migratory life histories are both recognized as important components of native salmonid diversity in the region.

Avista Corporation operates two LCFR hydroelectric facilities under the terms of dam relicensing between the company and the Federal Energy Regulatory Commission (FERC) license – Noxon Rapids and Cabinet Gorge dams. The Clark Fork Settlement Agreement (CFSA) was incorporated into this license and outlines 26 Protection, Mitigation and Enhancement Measures (PM&E) designed to offset the effects of Noxon Rapids and Cabinet Gorge dams (Avista Corp. 1999). Appendix B of the document represents one of the PM&E measures and sets guidelines for the Montana Tributary Habitat Acquisition and Recreational Fishery Enchantment Program. A significant portion of this PM&E focuses on habitat restoration and procurement of lands adjacent to critical tributaries. To date, numerous restoration projects on many tributaries to the LCFR have been completed with varying degrees of success (Horn 2011). The focus of current and future restoration work funded by Appendix B will be in areas that are strongholds for native species (e.g., Bull River, Vermillion River, upper Trout Creek, Graves Creek and upper Prospect Creek). An additional PM&E requires implementation of the Native Salmonid Restoration Plan (NRSP). The NSRP calls for population monitoring in important native salmonid streams with a portion this monitoring conducted under the Appendix B Native Salmonid Abundance and Tributary Habitat Restoration Monitoring program. Yearly basin-wide surveys are also conducted by Avista fisheries staff under Appendix C (i.e., the NSRP) of the CFSA. In combination with various restoration and monitoring work, individual watershed assessments have been completed for all major drainages and outline opportunities for restoration or research. Over the past 15 years in the LCFR, a wealth of demographic information has been collected for stream-dwelling fish populations and stream habitat conditions have been evaluated. Despite these efforts, knowledge gaps still exist regarding populations and habitat conditions within some streams or sections of stream.

The objective of this Assessment was to evaluate the physical and biological characteristics of selected streams where the status of Bull Trout and Westslope Cutthroat Trout was relatively uncertain. This report presents data from fisheries surveys, temperature monitoring, and habitat assessments of four tributaries originally identified as candidates for analyses (Hanson 2011). By evaluating biological data collected for this study along with local scientific literature from the selected streams, the goal of this report was to prioritize future native species management activities in the LCFR.

Methods

Study Area

The Native Salmonid Limiting Factors Assessment was conducted on four streams within the LCFR drainage downstream of Thompson Falls Dam (Figure 1). The Clark Fork River, from Thompson Falls Dam downstream 61 kilometers (km) to Noxon Rapids Dam, is considered Noxon Reservoir. The 31 km section of the river, from Noxon Rapids Dams to Cabinet Gorge Dam, is considered Cabinet Gorge Reservoir. From Cabinet Gorge Dam, which sits just inside the Idaho border, the Clark Fork River flows 16 km to its confluence with LPO. Both dams were built in the 1950s and are owned and operated by Avista Corporation.

Habitat conditions in the LCFR drainage vary greatly from cold, high-gradient mountain streams that support various trout species to large run-of-the river impoundments that support cool and warm water sportfish. Two of the four study streams, North Fork East Fork Bull River (NFEFBR) and Copper Creek, are located in the Bull River Drainage. The Bull River drains into Cabinet Gorge Reservoir northwest of the town of Noxon. Deep and Graves Creeks are both 3rd order tributaries that enter the north side of Noxon Reservoir between the towns of Thompson Falls and Trout Creek.

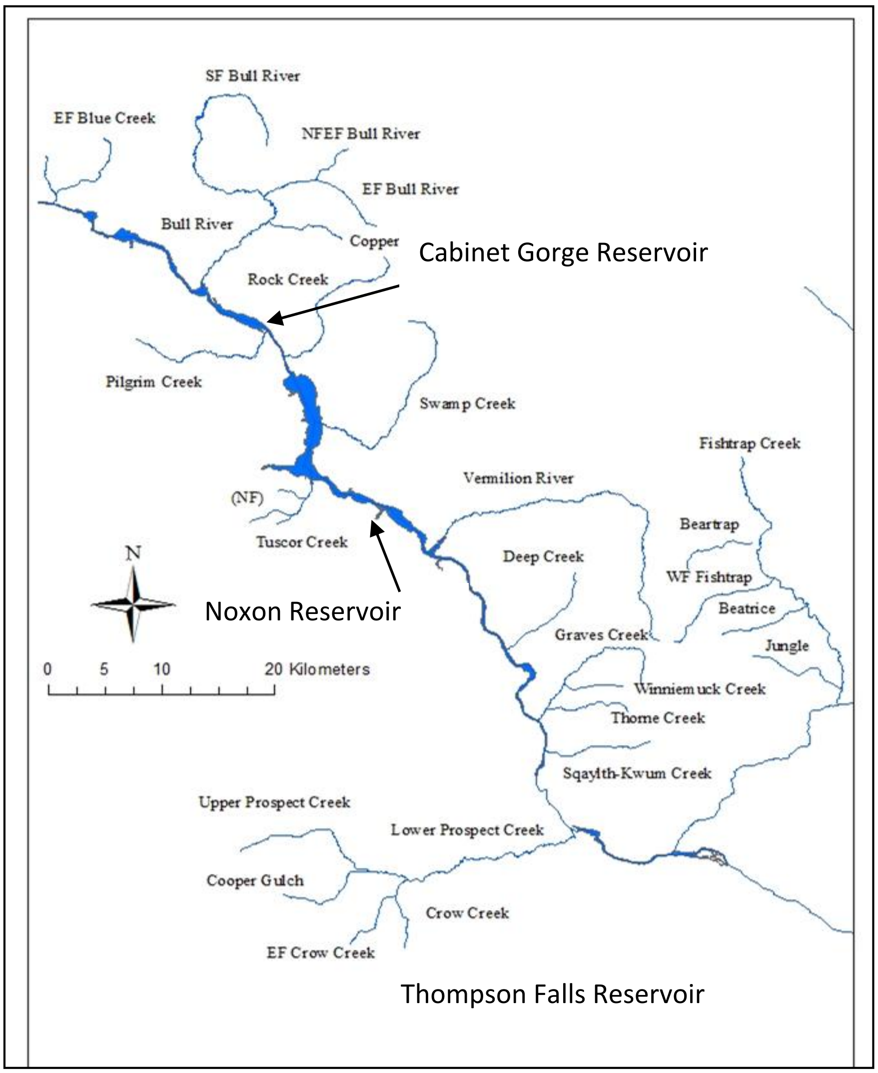

Figure 1. Lower Clark Fork River Project Area (from Thompson River downstream).

North Fork East Fork Bull River

The NFEFBR is a 3rd order tributary of the East Fork Bull River (EFBR) at river kilometer (Rkm) 5.2 (Figure 2). The entire watershed is located on Kootenai National Forest (KNF) and drains the western slopes of the Cabinet Mountain Wildness north of Copper Creek. Anthropogenic effects to stream habitat are minimal, as most of the drainage is roadless area or wilderness. Electrofishing surveys were conducted at two sites in 2013, located at Rkms 1.0 (Site 1; lower site) and 2.9 (Site 2; upper site). Prior to sampling for this study, Avista staff formally sampled three locations on the NFEFBR in 2005 at Rkms 0.8, 2.0, and 2.7 (Moran 2006).

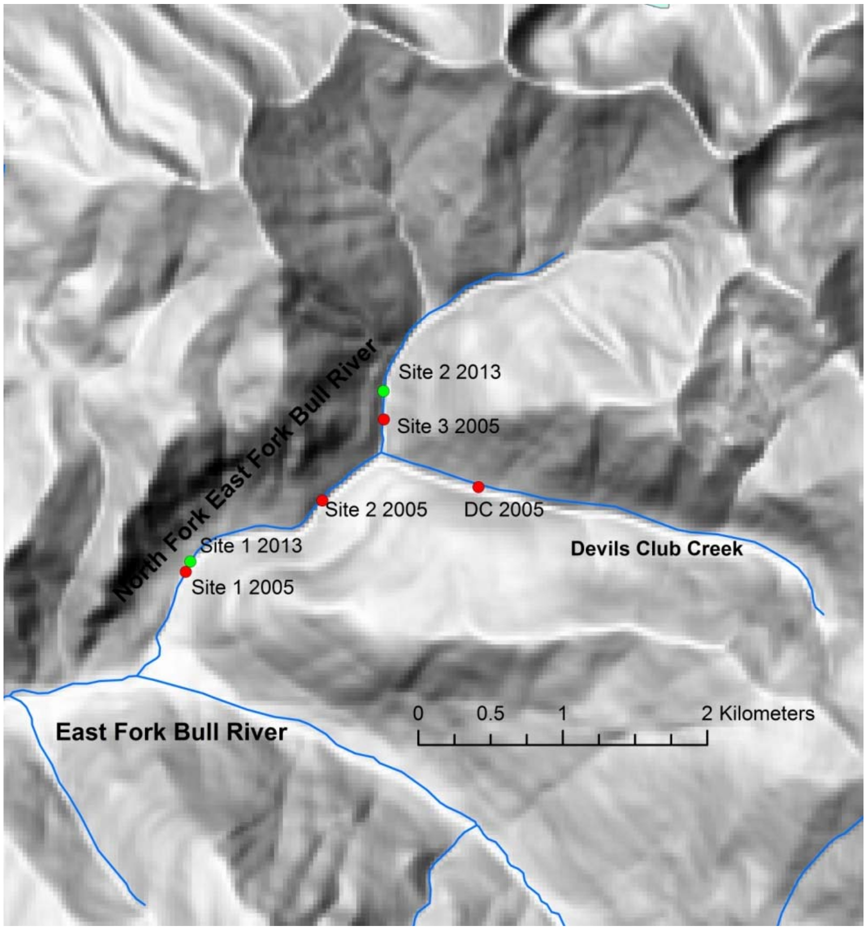

Figure 2. North Fork East Fork Bull River drainage electrofishing sites from 2005 (red, Moran 2006) and 2013 (green).

Copper Creek

Copper Creek is a 2nd order tributary that drains from the west side of St. Paul Peak in the southern portion of the Cabinet Mountain Wilderness and enters the Bull River at Rkm 11.1 (Figure 3). The majority of this stream flows through the KNF; however, public access is difficult due to private land in the lower portion of the drainage. Although much of this watershed is roadless, the stream channel and riparian area have been impacted in the lower reaches by channelization and timber harvest (Land and Water Consulting 2001). A seasonal and naturally dry stream reach was observed during the summer of 2014, between Rkms 2.0 and

2.6. Backpack electrofishing surveys were conducted in two sections of Copper Creek in 2012 and 2013. Site 1 (lower site) was located on KNF land downstream of the ephemeral segment, about 0.3 Rkms upstream of the Copper Creek—Bull River confluence. Site 2 (upper site) was located on private property upstream of the dry reach at Rkm 2.7. Prior to sampling associated with this study, Copper Creek was last surveyed in 2005 by Avista personnel at assumed RKM 0.6 and 2.4; however, the precise location of the 2005 sample sites is uncertain and was not exactly replicated (Moran 2006). A site near the confluence with the Bull River was sampled by the KNF in 2002 (KNF, unpublished data).

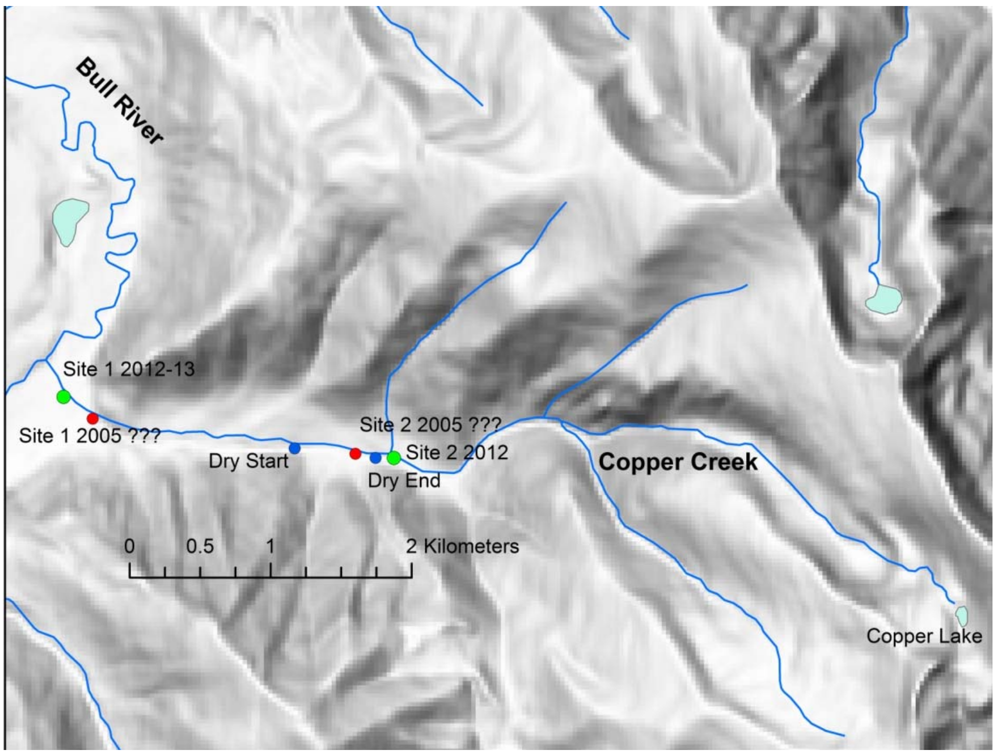

Figure 3. Copper Creek drainage electrofishing sites from 2005 (red circles; may be inaccurate; Moran 2006) and 2012–2013 (green circles) and dry stream reach (blue circles).

Deep Creek

Deep Creek is a 3rd order tributary to Noxon Reservoir that drains lands to the south and east of Slide Rock Mountain in the southern portion of the Cabinet Mountains (Figure 4). Nearly all of the drainage is located on federal land, administered by Lolo National Forest (LNF). The stream crosses Blue Slide Road at Rkm 0.9, where a perched culvert has created a complete barrier to upstream fish passage. About 75% of the lower portion of the stream, between Blue Slide Road and Noxon Reservoir was noted to be dry in 2002 (Moran 2003), however this reach did have perennial flow in the summers of 2014 and 2015. An illegal water diversion downstream of Blue Slide Road may have caused the stream reach to go dry during some years. Deep Creek is perennial upstream of Blue Slide Road where a road follows the creek upstream for approximately 3.4 km. Anthropogenic impacts to the stream upstream of the culvert are minimal and mainly consist of issues related to road encroachment in the riparian area. Above this section the drainage is roadless. Site 1 (lower site) was located at Rkm 2.0 and Site 2 (upper site) was located at Rkm 3.2. Both electrofishing sites were sampled in 2012 and 2013. Additional spot electrofishing was conducted in the summer of 2015 where a 0.15 km dry stream reach was noted near Rkm 6.9. Westslope cutthroat trout were captured above this dry area that may have been dry due to the historically low streamflow of 2015. The last formal survey in Deep Creek occurred in 2002 upstream of the barrier culvert at Rkm 1.9 (Moran 2003).

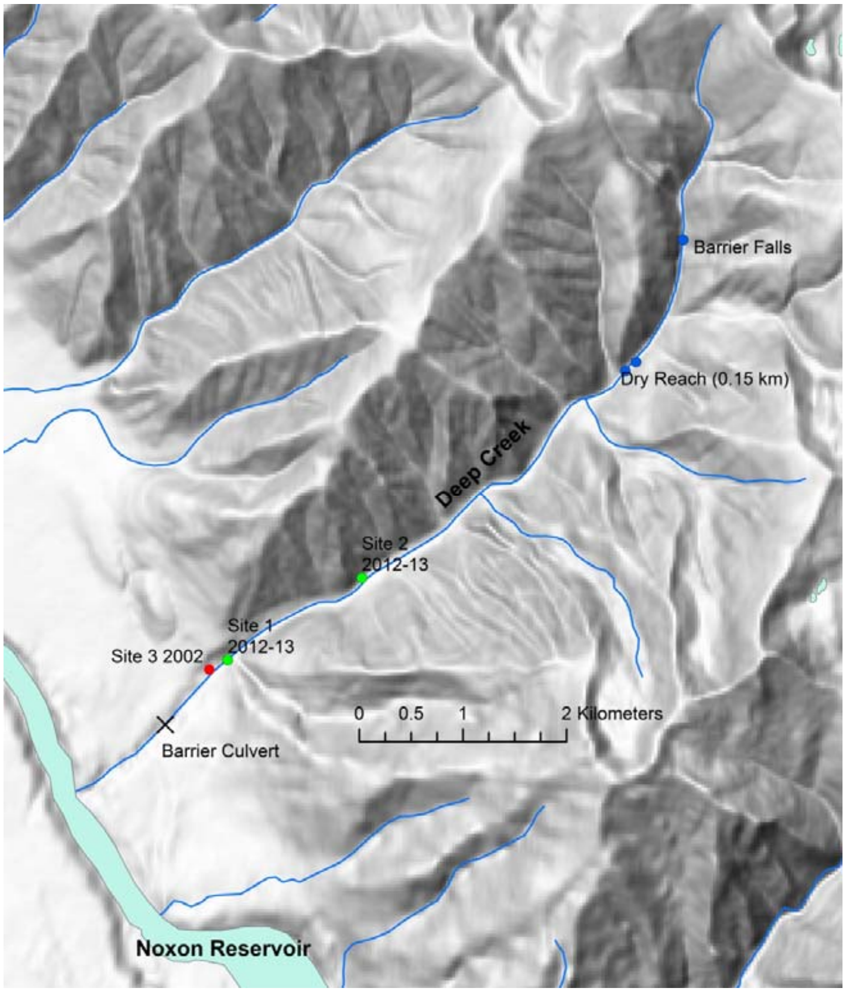

Figure 4. Deep Creek drainage including electrofishing sites from 2002 (red, Moran 2003) and 2012-2013 (green), barrier culvert (X), dry stream reaches (blue) and upper fish distribution - barrier falls (blue).

Upper Graves Creek

Sampling efforts were focused on the portion of the drainage above Graves Creek Falls, a natural barrier to upstream fish migration. Upper Graves Creek is a 3rd order tributary to Noxon Reservoir which also drains the southern edge of the Cabinet Mountains, just east of the Deep

Creek watershed (Figure 5). All of the land in the upper drainage is managed by LNF. A forest road follows the creek for several kilometers. In general, good quality stream habitat typifies much of the upper system. However, localized impacts to habitat include sedimentation associated with roads in riparian areas, stream interaction with geologically unstable hillslopes, riparian timber harvest, as well as upslope timber harvest in some areas (particularly in the Irvs Creek drainage; RDG 2005). Electrofishing surveys were conducted in 2012, 2013, and 2015. Site 1 (lower site) was located just upstream of Graves Creek Falls at Rkm 5.6 and was sampled in 2012 and 2013. Site 2 (middle site) was located at Rkm 10.5, just upstream of a bridge on Forest Road 367, and was sampled in 2015. Site 3 was located at Rkm 14.1 near the Lawn Lake Trailhead and was sampled in 2012. The three sampling locations investigated for this report are proximal to sites surveyed by Avista in 2002 (Moran 2003). Additionally, gillnet surveys were conducted at five headwater lakes: Carbine Lake, Graves Lake, Lawn Lake, Winnemuck Lake, and an unnamed lake at the head of Irvs Creek.

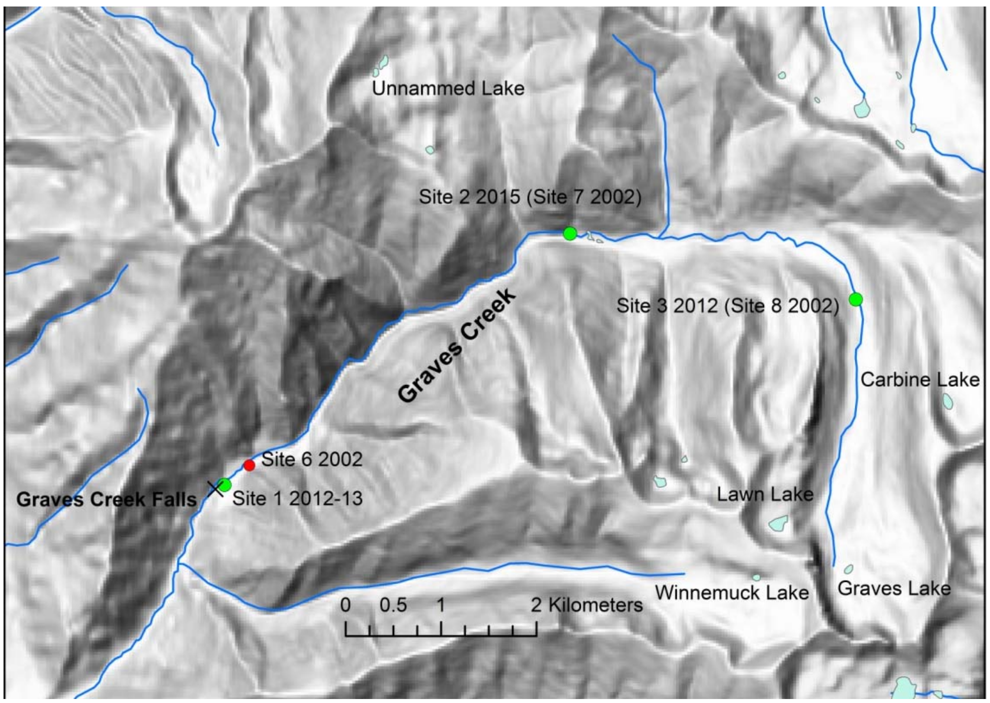

Figure 5. Graves Creek electrofishing sites from 2002 (red, Moran 2003) and for this study (green, 2012-13& 2015), along with Graves Creek Falls (X, fish passage barrier).

Electrofishing Surveys

Electrofishing surveys were conducted at two to three sites per stream in 2012 and/or 2013 (and one in 2015) using a Smith-Root model LR-24 backpack unit. Most stream reaches were sampled at or near (i.e., 0–500 m) locations that had been previously sampled as part of Avista's Fish Abundance Studies (Moran 2003; Moran 2006) in order to evaluate changes in species composition and abundance over time. Sampling sites were generally located in single channel reaches devoid of obstructions deemed deleterious to electrofishing efficiency (e.g., large log jams). Electrofishing began at an upstream riffle break and continued downstream to a temporary block net anchored to rocks or trees. Two to three passes were made during backpack electrofishing based on depletion adequacy. A sample was considered adequate when the number of fish (≥ 75 mm TL) captured on a given run was < 20% of the number captured on the first run. Each personnel conducted the same task for each pass on a stream reach to keep shocking and netting proficiency consistent. Fish less than 75 mm are generally considered less susceptible to capture using electrofishing gear and were not included in population estimates (Reynolds 1996). The commonality of methods: downstream, backpack multiple-pass depletion electrofishing into a blocknet, common training, as well as estimators and indices equations used, (see below, and Moran 2006) enabled direct comparison to earlier sampling. Specific coordinates for sampling locations on study streams are presented in Appendix A (Table A-1).

Captured fish were housed in net pens downstream of the electrofishing reach before and after handling. All fish were anesthetized with MS-222, and then species, total length (TL; mm) and weight (g) were measured and recorded. Section length and up to eight representative widths (m) of the wetted channel in the section were also measured. Location of the downstream end of the section was determined with a GPS unit. Other data gathered included a detailed site description, date, personnel, electrofishing settings, and electrofishing time for each depletion pass. The river kilometer where sampling events took place was estimated using a Montana Fish, Wildlife and Parks GIS layer that places points on each $1/10^{th}$ of a mile section of stream and miles were subsequently converted into kilometers.

Fisheries Analyses

Population abundance estimates were carried out at all sampling locations using electrofishing and removal, or depletion methods (Zippin 1958, Carle and Strub 1978). Two pass depletion estimates were calculated according to Armour et al. (1983). For three pass depletion estimates, the M (bh) model in the program CAPTURE (White et al. 1982) was used to calculate population estimates and confidence intervals. Linear abundance and density estimates (fish/100 m and fish/100 m^2) were standardized using stream length and width measurements taken during sampling. Salmonid biomass (g/100m^2) was calculated using the abundance estimates, mean fish weight, and total area sampled at each location.

Habitat Surveys

Stream habitat surveys were conducted using the Montana Natural Resources Conservation Service Riparian Assessment Method (Pick et al. 2004; Pick et al. 2012). This survey provides an assessment of the suitability and function of a riparian area by facilitating a mainly qualitative understanding of riparian health and is designed as a starting point for identifying stream reaches requiring further study. Ten physical and ecological attributes are given a score based on their current condition and the results of these ratings can be used to prioritize protection or restoration measures, and serves as a way to evaluate the success of such management activities. The attributes scored include the level of incisement, bank erosion, width to depth ratio, riparian plant community and floodplain stability. Supplemental questions that allow for additional characterization of current stream and riparian conditions include channel type, substrate composition, quality of fish habitat, current land-use activities, the presence of barriers or diversions; and indicators present that may influence temperature, flow, or nutrient regime. Based on the initial findings from this survey methodology, more in-depth habitat assessments could undertaken if issues are found that need to be quantified. This method has recently been use to prioritize streams for restoration activates of in the upper Clark Fork River basin (Saffel et al. 2011).

Habitat surveys were conducted in reaches where electrofishing surveys were performed. On three of the four streams, only one habitat survey was performed because habitat conditions were very similar between electrofishing reaches. As a general rule, surveys should encompass 12 meanders lengths or about 0.4 km of stream in areas that are representative of stream habitat at broader spatial scales. Two surveys were completed on Copper Creek as habitat quality and species composition varied greatly between the lower and upper sampling locations. Individual stream habitat data sheets are located in Appendix B of this document.

Stream Temperature Monitoring

Stream temperatures were monitored for two to four years, between 2011 and 2014, using Onset Tidbit v2 and Onset StowAway Tidbit thermograph recorders. One thermograph was deployed in each stream, typically near the lower end of the study area. Temperature monitoring began on the descending limb of the hydrograph, in late June or early July, and ran through late fall, recording data at half hour intervals. For the NFEFBR, temperature was chronicled at the Forest Road 407 crossing at Rkm 0.3, approximately 0.9 km downstream of electrofishing Site 1. In Copper Creek, temperature was monitored at electrofishing Site 1 (Rkm 0.3). Stream temperatures in Deep Creek were recorded at the Blue Slide Road culvert crossing, approximately 0.9 km downstream of electrofishing Site 1 at Rkm 1.1. Temperature data in upper Graves Creek was collected at electrofishing Site 1 (Rkm 5.6; just upstream of Graves Creek Falls). A table with mean daily August temperatures for streams is reported in Appendix C of this document.

Mountain Lakes Gillnetting

Mountain lake sampling consisted of overnight sets using sinking, experimental monofilament gillnets. These nets were 38 m long by 1.2 m high with 5 panels of differing mesh sizes; 19 mm, 25 mm, 32mm, 38mm and 51 mm. One gillnet was set per lake with the smallest diameter mesh being set closest to shore. Nets were set by tying a rope to the end of a dog *Canis familiaris*. While one of the biologists stayed with the dog, the other would walk the shoreline to a point directly across the lake. Using a combination of positive tones and encouraging language, the other biologist would coax the dog across the lake. After the dog emerged on the adjacent shoreline, the rope would be disconnected from the dog, attached to a net, and the net was pulled out into the lake and tied off to rocks or a tree. The dog would then be rewarded with a treat.

Results

Electrofishing Surveys

North Fork East Fork Bull River

The NFEFBR was sampled at two locations in July of 2013. Westslope Cutthroat Trout were the only species captured at both the lower (Site 1; Rkm 1.0) and upper (Site 2; Rkm 2.9) sites (Table 1). Individual fish lengths ranged from 55 to 202 mm and were similar between sites. Estimates of abundance per 100 meters of stream for fish ≥ 75m was 42.7 fish/100m at Site 1 and 47.4 fish/100m at Site 2. Density was similar between sites, with 9.11 fish/100m² at Site 2 and 8.05 fish/100m² at Site 1 (Table 2). Biomass estimates for Site 2, was over 100 grams higher than what was estimated at Site 1. Prior to sampling for this study, the NFEFBR was formally last sampled in 2005 at Rkms 0.8, 2.0, and 2.7. Abundance and biomass estimates were markedly higher at all three sites in 2005 when compared to the two sites sampled in 2013, and although sampling locations were not exactly replicated, habitat among these locations was analogous. Species abbreviations are located in Appendix A (Table A-2).

Table 1. Date, site number, river kilometer, section length, species (spp.), number captured, length range for fish captured in the North Fork East Fork Bull River.

Date	Site #	River KM #	Section Length (m)	Spp.	Total Captured	Length Range (mm)
7/19/2005	1 [1]	0.8	90	WCT	47	75-215
8/7/2013	1	1.0	75	WCT	40	58-190
7/20/2005	2 [1]	2.0	78	WCT	65	76-217
7/20/2005	3 [1]	2.7	79	WCT	52	84-217
8/8/2013	2	2.9	76	WCT	38	63-202

[1]Moran 2006

Table 2. Date, site number, species (spp.), standardized linear abundance (fish/100m), density (fish/100m²) and biomass (g/100m²) for fish captured in the North Fork East Fork Bull River. Abundance, density and biomass estimates represent fish ≥ 75 mm (with 95% confidence intervals).

Date	Site #	Spp.	Estimate per 100 m	95% C.I.	Estimate per 100 m^2	95% C.I.	g/100 m^2
7/19/2005	1 [1]	WCT	53.5	50.8-56.2	10.7	10.5-11.2	223.7
8/7/2013	1	WCT	42.7	42.7-42.7	8.05	8.05-8.05	168.25
7/20/2005	2 [1]	WCT	86.1	81.3-91.0	20.0	19.4-21.1	472.7
7/20/2005	3 [1]	WCT	67.3	64.2-70.5	17.9	17.6-18.8	453.1
8/8/2013	2	WCT	47.4	43.7-51.1	9.11	8.86-9.81	270.55

[1]Moran 2006

Copper Creek

Copper Creek was sampled at two sites in August of 2012 and 2013. The lower section (Site 1; Rkm 0.3), downstream of a seasonally dry reach (Rkms 2.0-2.6), contained Brown Trout, Brook Trout and suspected Westslope Cutthroat Trout x Rainbow Trout *Oncorhynchus mykiss* hybrids (WCT x RBT; only in 2012). At the upper site (Site 2; Rkm 2.7), above the intermittent stretch, Cutthroat Trout were the only species observed in 2012 and 2013.

At Site 1, a total of 42 fish were captured in 2012 and 57 fish in 2013 (Table 3). Species composition was quite different between 2012 and 2013, with Brook Trout making up 62% of fish captured in 2012 and 30% in 2013, while Brown Trout comprised 29% of the community in 2012 and 70% in 2013. The length range for these two species across the two year period was similar, suggesting the same age classes were sampled in both years. In 2012, overall abundance of fish ≥ 75 mm was higher when compared to 2013, even though more total fish were captured in 2013. This was due to a greater number of age-0 fish captured in 2013. Likewise, overall fish density was greater in 2012 when compared to 2013. Total biomass between the two years was similar (100 g/100 m^2 in 2012 vs. 105.7 g/100 m^2 in 2013).

At Site 2, a total of 57 Westslope Cutthroat Trout were captured in 2012 and 70 in 2013 (Table 3). The total number of cutthroat captured at Site 2 in 2012 and 2013 was much higher than the 22 cutthroat (and 1 brook trout) captured at Rkm 2.4, 0.3. km downstream of Site 2 in 2005, although fish under 75 mm were not counted (Moran 2006). Abundance, density and biomass of Westslope Cutthroat Trout increased at the upper site since 2005 (Table 4), although the location of the upper site is uncertain so a direct comparison was not possible. No Brook Trout were observed above the dry reach in 2012 or 2013.

Table 3. Date, site number, river kilometer, section length, species (spp.), number captured, length range for fish captured in Copper Creek.

Date	Site #	River KM #	Section Length (m)	Spp.	Total Captured	Length Range (mm)
8/29/2012	1	0.3	88	RBxWCT	4	95-161
				EB	26	50-147
				LL	12	65-169
8/19/2013	1	0.3	79	EB	17	56-156
				LL	40	46-175
7/18/2005	1 [1]	0.5	85	WCT	36	75-193
				EB	1	150
7/18/2005	2 [1]	2.4	76	WCT	22	75-170
				EB	1	150
8/28/2012	2	2.7	95	WCT	57	56-215
8/19/2013	2	2.7	92	WCT	70	70-198

[1] Moran 2006

Table 4. Date, site number, species (spp.), standardized linear abundance (fish/100m), density (fish/100m²) and biomass (g/100m²) for fish captured in Copper Creek. Abundance, density and biomass estimates represent fish ≥ 75 mm (with 95% confidence intervals).

Date	Site #	Spp.	Estimate per 100 m	95 % C.I.	Estimate per 100 m²	95 % C.I.	g/100 m²
8/29/2012	1 [2]	RBxWCT	4.5	4.5-4.5	1.11	1.1-1.1	26.61
		EB	17	14.2-19.8	4.16	3.9-4.8	32.84
		LL	12.5	10.0-15.6	3.05	2.8-3.8	40.55
8/19/2013	1 [2]	EB	10.1	8.8-11.4	2.6	2.6-2.9	41.8
		LL	15.2	13.9-16.5	3.89	3.9-4.3	63.88
7/18/2005	1 [1]	WCT	43.3	40.1-46.6	9.5	9.2-10.2	152.3
		EB	1.2	N/A	0.3	N/A	11.8
7/18/2005	2 [1]	WCT	29.1	29.1-29.1	7.6	7.6-7.6	131.3
		EB	1.3	1.3-1.3	0.3	0.3-0.3	14.8
8/28/2012	2 [2]	WCT	45.3	43.7-46.9	12.93	12.9-13.4	227.61
8/19/2013	2 [2]	WCT	69.9	67.1-72.1	25.76	25.4-26.7	378.74

[1] Moran 2006

Deep Creek

Two sites were sampled in Deep Creek in July of 2012 and 2013, upstream of the barrier culvert on Blue Slide Road. Westslope Cutthroat Trout were the only species caught at both the lower (Site 1; Rkm 2.0) and upper (Site 2; Rkm 3.6) sites. In late June of 2015, a spot electrofishing survey was conducted to determine the upper distribution of Cutthroat Trout. Westslope

Cutthroat Trout were found inhabiting Deep Creek up to Rkm 8.4, meaning this isolated population occupies about 7 km of stream, taking into account a seasonally dry stretch of stream that was documented in late June of 2015.

At Site 1, a total of 73 fish were captured in 2012 and 90 fish in 2013 (Table 5). Less fish were collected at Site 2 in both years when compared with Site 1, with 64 cutthroat trout captured in 2012 and 79 in 2013. The length range of individuals captured was similar between years and sites (52-239 mm). Abundance estimates show higher numbers of fish per 100 m at Site1 in both years (Table 6). Density ranged from 10.1 to 15.0 fish/100m². Density was higher at Site 2 in 2012; however no significant difference in density occurred between the two sites in 2013, based on overlap of confidence intervals. Likewise, biomass in 2012 was significantly higher at Site 2, but no difference was observed in 2013. In 2002, a site was surveyed at Rkm 1.9 and the estimates were in the range of what was observed in this study (Moran 2003), suggesting no drastic changes in size structure, abundance or density.

Table 5. Date, site number, river kilometer, section length, species (spp.), number captured, length range for fish captured in Deep Creek.

Date	Site #	River KM #	Section Length (m)	Spp.	Total Captured	Length Range (mm)
8/2002	3 [1]	1.9	77	WCT	74	60-219
7/30/2012	1	2.0	77	WCT	73	52-236
7/16/2013	1	2.0	77	WCT	90	49-225
7/31/2012	2	3.6	96	WCT	64	55-239
7/17/2013	2	3.6	96	WCT	79	55-221

[1]Moran 2003

Table 6. Date, site number, species (spp.), standardized linear abundance (fish/100m), density (fish/100m²) and biomass (g/100m²) for fish captured in Deep Creek. Abundance, density and biomass estimates represent fish ≥ 75 mm (with 95 % confidence intervals).

Date	Site #	Spp.	Estimate per 100 m	95 %C.I.	Estimate per 100 m²	95 %C.I.	g/100 m²
8/2002	3 [1]	WCT	84.4	81.1-87.7	15.4		268.9
7/30/2012	1	WCT	74.0	70.9-77.1	10.1	10.0-10.6	190.6
7/16/2013	1	WCT	70.1	66.9-73.3	12.3	12.1-12.9	239.9
7/31/2012	2	WCT	58.3	56.1-60.5	15.0	14.7-15.6	332.1
7/17/2013	2	WCT	50.0	46.0-54.3	13.2	12.7-14.3	250.0

[1]Moran 2003

Upper Graves Creek

Upper Graves Creek was sampled in 2012, 2013 and 2015 (Table 7). The lowest reach (Site 1; Rkm 5.6) was sampled in 2012 and 2013. Westslope Cutthroat Trout and Brook Trout were sampled on each occasion, with Cutthroat comprising over 90% of the fish community both years. At Site 1, estimates of Cutthroat Trout abundance and density were similar between 2012 and 2013, while a slight decline in Brook Trout was detected for these two metrics in 2013. The stream appears to support fairly large resident Cutthroat, as fish in the 280 mm class were captured both years. Prior to sampling efforts for this study, a site in close proximity was sampled by an Avista Crew in 2002. Cutthroat abundance and density in 2002, was similar to what was documented in 2012-2013. Brook Trout comprised 15% of the catch in 2002 and estimates of abundance and density were analogous to what was observed in 2012.

The middle reach (Site 2; Rkm 10.5) of upper Graves Creek was sampled in 2015. A total of 97 Westslope Cutthroat Trout and one Brook Trout were captured. Cutthroat abundance and density of fish ≥ 75 mm were the highest estimates ever recorded for the species above Graves Creek Falls (Table 8). In fact, the estimates of 97.8 fish/100 m and 15.8 fish/100 m^2 more than doubled past estimates of abundance and density. Westslope Cutthroat Trout biomass was also the highest biomass recorded for either species in upper Graves Creek. Interestingly, the last time this site was surveyed in 2002, equal numbers of Cutthroat and Brook Trout were captured (37 individuals of each species). During Avista's drainage-wide survey in 2002, the highest biomasses for any species across the eight mainstem sections sampled was for Brook Trout at this site (Site 7 in 2002; Moran 2003).

The upper most electrofishing site (Site 3; Rkm 14.1) was sampled in 2012. Two Westslope Cutthroat Trout were captured; both from the same year class (117-119 mm). Not surprisingly, the estimates of abundance and density for this reach, were lowest ever recorded for Cutthroat in upper Graves Creek. A proximal site was sampled during Avista's drainage-wide survey in 2002, where 13 Cutthroat were captured (Moran 2002). There was some speculation that these fish resembled Yellowstone Cutthroat Trout, but subsequent genetic analyses determined that it was very likely the specimens were genetically pure Westslope Cutthroat Trout (MFWP, unpublished data).

Table 7. Date, site number, river kilometer, section length, species (spp.), number captured, length range for fish captured in upper Graves Creek.

Date	Site #	River KM #	Section Length (m)	Spp.	Total Captured	Length Range (mm)
9/5/2012	1	5.6	76	WCT	28	69-281
				EB	3	99-182
7/30/2013	1	5.6	76	WCT	36	58-285
				EB	2	101-186

9/5/2002	6 [1]	5.9	70	WCT	23	65-234
				EB	4	105-232
9/3/2002	7 [1]	10.5	94	WCT	37	60-246
				EB	37	94-279
6/30/2015	2	10.5	95	WCT	97	63-223
				EB	1	185
9/4/2002	8 [1]	14.1	70	WCT	13	93-170
8/4/2012	3	14.1	70	WCT	2	117-119

[1]Moran 2003

Table 8. Date, site number, species (spp.), standardized linear abundance (fish/100m), density (fish/100m²) and biomass (g/100m^2) for fish captured in upper Graves Creek. Abundance, density and biomass estimates represent fish ≥ 75 mm (with 95 % confidence intervals).

Date	Site #	Spp.	Estimate per 100 m	95 %C.I.	Estimate per 100 m^2	95 %C.I.	g/100 m^2
9/5/2012	1	WCT	36.8	33.0-40.6	6.6	6.3-7.3	365.8
		EB	5.3	3.0-14.2	0.9	0.7-2.5	31.7
7/30/2013	1	WCT	34.2	31.3-37.1	5.7	5.5-6.2	259.4
		EB	2.6	2.6-2.6	0.4	0.4-0.4	14.9
9/5/2002	6 [1]	WCT	31.4	27.8-35.0	5.2	4.6-5.7	194.8
		EB	5.7	n/a	0.9	n/a	44.0
9/3/2002	7 [1]	WCT	37.2	35.0-40.0	6.3	5.8-6.8	372.3
		EB	40.4	38.0-43.1	6.9	6.4-7.3	301.5
6/30/2015	2	WCT	97.8	92.7-102.9	15.8	15.2-16.6	460.8
		EB	1.1	n/a	0.2	n/a	12.7
9/4/2002	8 [1]	WCT	20	16.5-23.5	3.8	3.1-4.4	99.3
8/4/2012	3	WCT	2.9	2.9-2.9	0.5	0.5-0.5	6.45

[1]Moran 2003

Mountain Lakes Gillnetting

To investigate the possible source of Brook Trout in upper Graves Creek, five mountain lakes were sampled using gillnets in 2013. Carbine, Graves and Winnemuck Lakes, along with an unnamed lake in the headwaters of Irvs Creek were all found to be fishless. Westslope Cutthroat Trout were found in Lawn Lake in the headwaters of the mainstem of Graves Creek and this was not surprising, given the lake is stocked with fingerlings every few years. Thirteen fish were captured, ranging from 219-237 mm, and likely represent fish stocked in August of 2009 (MFWP, unpublished data).

Habitat Surveys

North Fork East Fork Bull River

Stream habitat was surveyed at one location on the NFEFBR, at the lower 2013 electrofishing site (Site 1; Rkm 1.0). The reach scored 56 of a possible 56 points (100%). This high-gradient mountain stream has nearly pristine habitat conditions with an abundance of pools and large woody debris (LWD) (Figure 6). The riparian area is comprised mostly of old growth, western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*), providing greater than 85 % canopy cover to the stream. An additional habitat survey was not conducted at the upper electrofishing site (Site 2; Rkm 2.9), as habitat conditions were similar between sites.

Figure 6. Woody debris and cobble dominated substrate, typical habitat on the North Fork East Fork Bull River.

Copper Creek

The two habitat surveys conducted on Copper Creek documented considerable differences between the sample sites. At the 2012–2013 lower electrofishing site (Site 1; Rkm 0.3), stream habitat has been greatly impaired (Figure 7). This reach scored a relatively low rating of 46 of a possible 60 points (77%). A portion of lower Copper Creek was channelized and large wood was removed from the stream for flood control purposes in 1972 (Land and Water Consulting 2001). These flood control berms are still functional and visible, and act to straighten the stream and simplify habitat. As a result, the stream is over-widened and shallow (with a high width to depth ratio, 20.6), with very little pool habitat. This channelization has also led to loss of connectivity between the stream and it natural floodplain, alteration of sediment transport regime, and lack of riparian vegetation in some areas. The riparian area is comprised of some large cottonwoods (*Populus* spp.), but is devoid of large diameter conifers typically found along lower-order streams in northwest Montana. Revegetation is occurring in the riparian area and is comprised of mainly younger age classes of alder (*Alnus* spp.), cottonwood, lodgepole pine (*Pinus contorta*) and white pine (*Pinus strobus*).

The survey at the 2012–2013 upper electrofishing site (Site 2; Rkm 2.7) noted good quality habitat, with a score of 56 out of a possible 60 points (93%) (Figure 8). This stretch of stream is located on a largely pristine piece of private property with lands upstream being either National Forest roadless area or wilderness. While evidence of some historic riparian timber harvest is present, the riparian area is currently comprised of large diameter trees and woody debris is present in the stream, suggesting overall stream habitat is stable. No issues with bank stability or erosion were noted and the width to depth ratio (6.5) is three times less than what was observed in the lower section of Copper Creek.

Figure 7. Typical riffle habitat that dominates much of lower Copper Creek, with flood control berms evident.

Figure 8. An example of pool habitat and the dense riparian forest that characterizes much of upper Copper Creek

Deep Creek

One habitat survey was conducted at the lower 2012–2013 electrofishing survey site (Site 1; Rkm 2.0). Habitat conditions were typical of a low-order, unaltered mountain stream in the LCFR: cobble/boulder dominated substrate, healthy riparian community comprised of alder and mature coniferous trees, abundant pool/pocket water habitat and an appropriate width to depth ratio of 9.12 (Figure 9). This reach scored 58 of a possible 60 points (97%). An additional habitat survey was not conducted at the upper electrofishing site (Site 2; Rkm 3.6), because habitat conditions were very similar to those observed at the lower site.

Figure 9. Typical habitat in Deep Creek above Blue Slide road; cobble/boulder dominated substrate, abundant pool/pocket water habitat, mature riparian forest and ample large and small woody debris.

Upper Graves Creek

A stream habitat survey was conducted at the lower most 2012–2013 electrofishing reach (Site 1; Rkm 5.6). The reach scored 60 of out of a possible 60 points (100%). Habitat conditions in the reach were similar to those observed in Deep Creek and typical of an unaltered, low-order mountain stream (Figure 10). The substrate was comprised of mostly cobble and boulder, different successional stages of riparian trees and shrubs were present and woody debris and pool/pocket water habitat was abundant. A forest road follows much of upper Graves Creek and in total; about 32 km of roads exists in the headwaters. In one of the headwater tributaries, Irvs Creek, about 78% (5% of total Graves Creek watershed) of this basin was logged in the 1950's and 60's, mostly on mid and upper slopes (RDG 2005). While issues related to altered hydrology and road failure have been noted, it is believed that sediment delivery from natural mass slope failure has probably also impacted the stream (GEI 2005). Overall, excessive levels of fine sediments were not observed at any of the three electrofishing sites and habitat degradation in the upper watershed should be considered minimal. Habitat surveys were not conducted at the other electrofishing sites, as habitat conditions were similar among the three sites.

Figure 10. Higher gradient pocket pool habitat typical of upper Graves Creek.

Stream Temperature Monitoring

North Fork East Fork Bull River

In the NFEFBR, stream temperatures were monitored over a four year period, from 2011-2014 (Figures 11 and 12). Maximum temperatures were recorded in late August of 2011, and from early July to early August in 2012, 2013 and 2014 (Figure 11). Maximum yearly temperature of 12.3°C in 2011 occurred on August 27 (data from July 8 to November 16). A maximum temperature of 13.5°C in 2012 was documented on July 18 (data from July 5 to December 4). In 2013, a high temperature of 13.7°C was recorded on July 7 (data from June 27 to November 24). For 2014, a high temperature of 13.0°C was observed on July 16 and August 16 (data from July 11 to November 18). Mean daily high temperature and their respective dates for each year were as follows; 11. 7°C on August 29 2011, 12.1°C on July 14, 2012, 12.3°C on August 10 and 11 2013 and 12.2°C on August 2, 2014 (Figure 12).

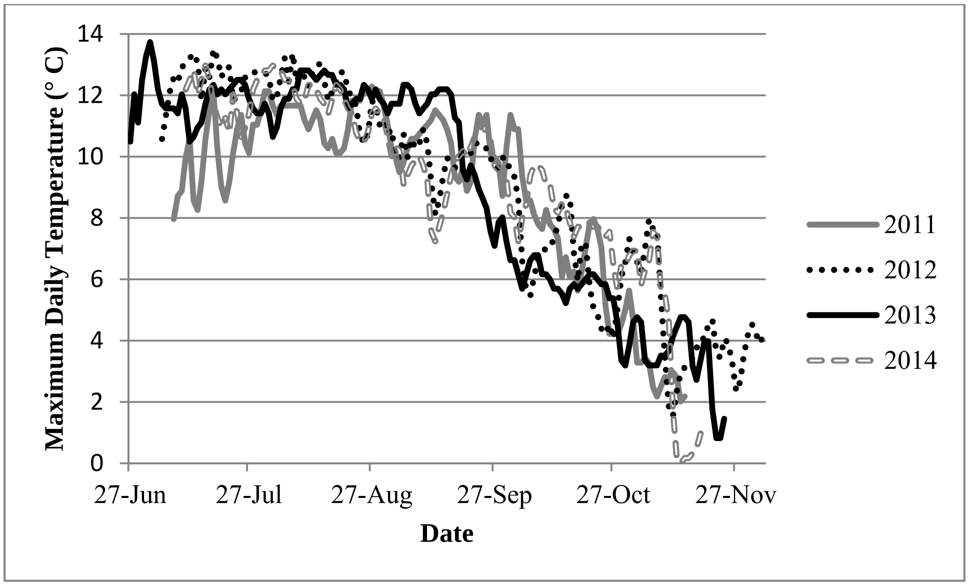

Figure 11. Maximum daily temperature recorded in the North Fork East Fork Bull River from early summer to late fall, from 2011 to 2014.

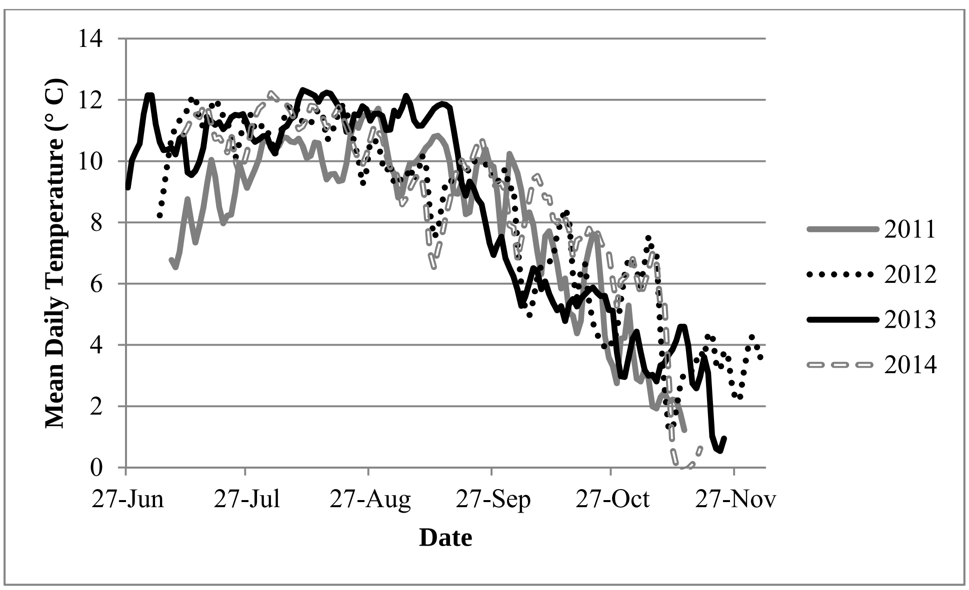

Figure 12. Mean daily temperature recorded in the North Fork East Fork Bull River from early summer to late fall, from 2011 and 2014.

Copper Creek

Stream temperature was monitored in lower Copper Creek, downstream of a naturally intermittent reach, in 2013 and 2014 (Figures 13 and 14). In 2013, temperature was recorded from June 27 to November 24. A maximum temperature for the year of 11.4°C was documented on July 2 (Figure 13). Temperature in 2014 was recorded from July 11 to November 18. The maximum temperature for the year of 11.7°C was chronicled on August 28. The mean daily temperature maximum of 10.0°C in 2013 occurred on August 25 and September 5, while an mean daily high of 9.6°C in 2014 occurred on August18, 19 and 26 (Figure 14).

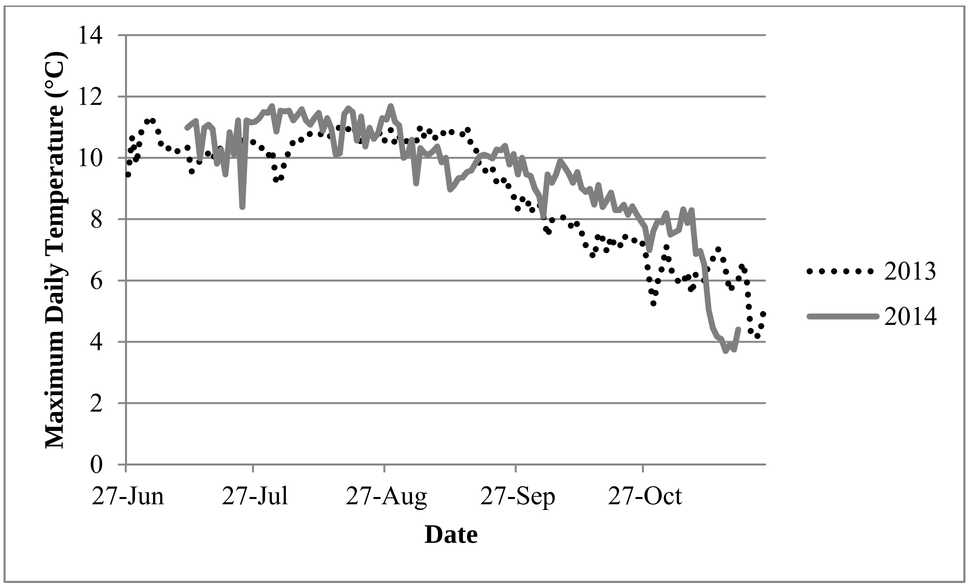

Figure 13. Maximum daily temperature recorded in lower Copper Creek from early summer to late fall of 2013 and 2014.

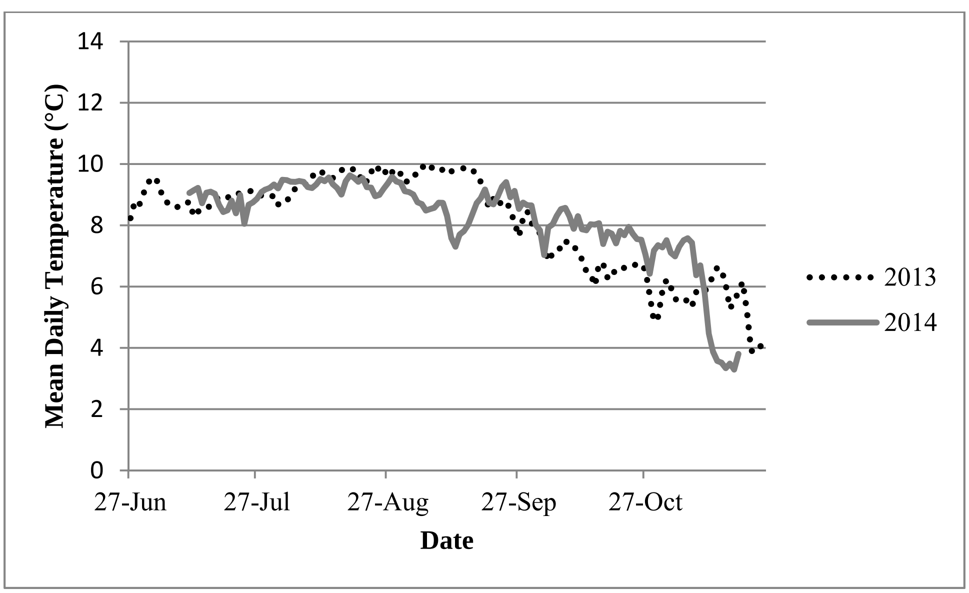

Figure 14. Mean daily temperature recorded in lower Copper Creek, from early summer to late fall of 2013 and 2014.

Deep Creek

Temperature in Deep Creek was monitored from early summer through late fall, from 2011 to 2013 (Figures 15 and 16). Maximum temperatures were recorded in mid to late August each year (Figure 15). In 2011, a maximum temperature for the year of 11.9°C occurred on two different days, August 27 and 29 (data from July 7 to November 16). A maximum temperature of 13.0° C in 2012 was documented on August 20 (data from July 3 to November 5). For 2013, a maximum temperature of 13.5°C was noted on August 18 (data from June 26 to November 20). Mean daily temperatures peaked on August 29, 2011 at 10.5°C (Figure 16). In 2012, a mean daily temperature record of 11.0°C occurred on August 20, while the 2013 record of 11.5°C occurred on August 17.

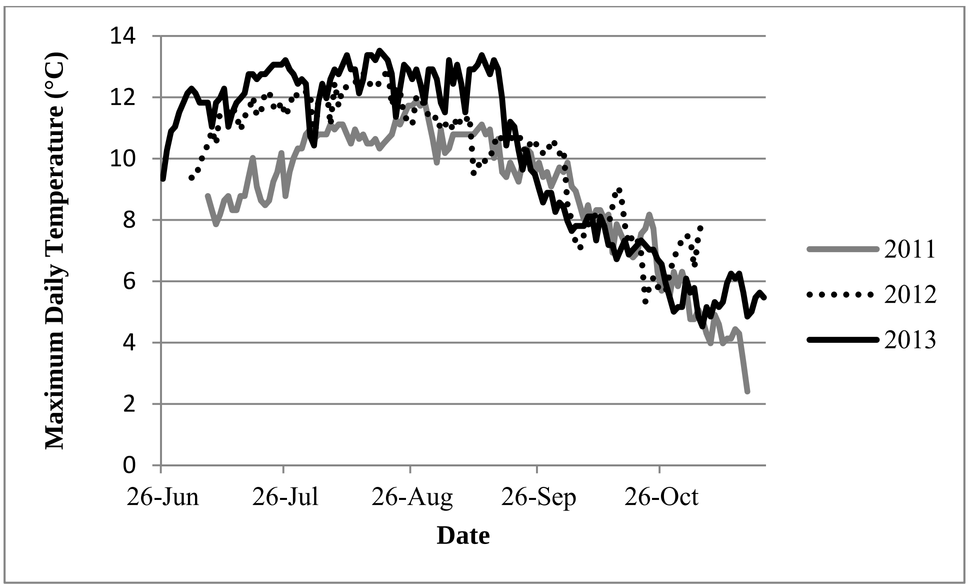

Figure 15. Maximum daily temperature recorded in Deep Creek from early summer to late fall of 2011, 2012 and 2013.

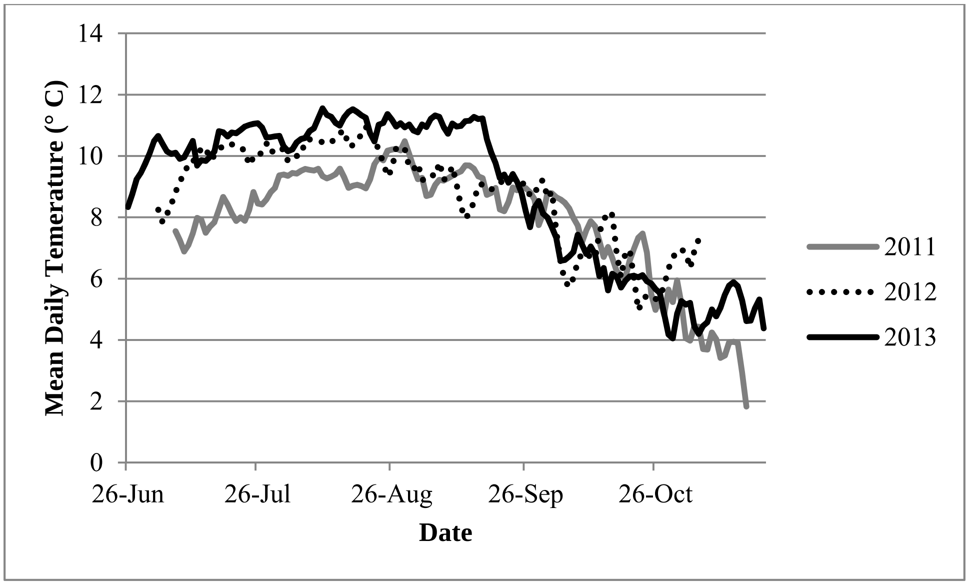

Figure 16. Mean daily temperature recorded in Deep Creek from early summer to late fall of 2011, 2012 and 2013.

Upper Graves Creek

Stream temperature in upper Graves Creek was monitored from early summer through late fall, from 2011 to 2013 (Figures 17 and 18). Maximum temperatures were recorded in mid to late August of 2011 and 2012 and in early July of 2013 (Figure 17). In 2011, a maximum temperature for the year of 10.5°C occurred on August 27 (data from July 7 to November 16). For 2012, a maximum temperature of 11.5°C was recorded on July 13 and July 20 (data from July 3 to November 5). A maximum temperature of 12.2°C was noted on July 2 of 2013 (data from June 26 to November 20). A mean daily temperature maximum in 2011 of 9.1°C took place on August 29 (Figure 18). In 2012 mean daily temperature record high of 9.5°C occurred on August 20, while the 2013 record of 10.4°C occurred on August 10. Yearly maximum and mean daily temperatures in Deep Creek and Graves Creek occurred on the same days in 2011 and 2012.

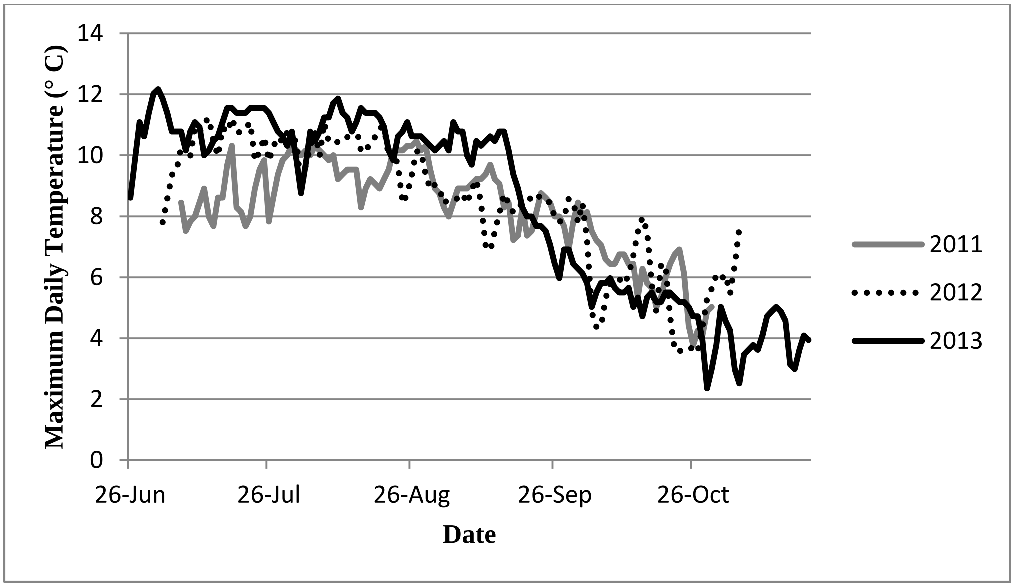

Figure 17. Maximum daily temperature recorded in upper Graves Creek from early summer to late fall of 2011, 2012 and 2013

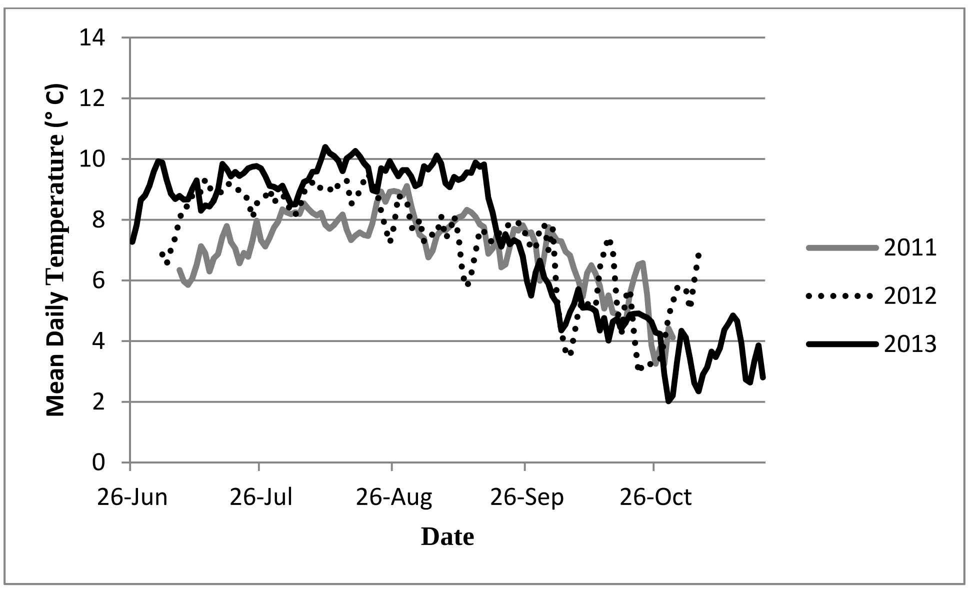

Figure 18. Mean daily temperature recorded in upper Graves Creek from early summer to late fall of 2011, 2012 and 2013.

Discussion

North Fork East Fork Bull River

The NFEFBR is a tributary to the EFBR, which is an important spawning and rearing tributary for migratory Bull Trout from LPO, Cabinet Gorge Reservoir, and the Bull River (Katzman and Hintz 2003). Resident Bull Trout also are believed to occur in the EFBR as well (WWP 1996).

The EFBR has averaged nearly 14 redds a year between 2001 and 2014 – the second highest mean redd count in the LCFR over this time period (Storaasli 2015). The NFEFBR enters the EFBR in an area known to be used extensively by Bull Trout for spawning and juvenile rearing. Pratt and Huston (1993) noted Bull Trout as being present but fail to cite any observations of the species being found in the stream. Similarly, MFWP's M-FISH database reports Bull Trout are present in the stream based on professional judgment. Sampling investigation for this study failed to find Bull Trout, as did the four sites (three in the NFEFBR and one in Devils Club Creek) sampled by Avista's Bull River Fish Abundance Study in 2005 (Moran 2006).

However, Bull Trout have been encountered in the NFEFBR on multiple occasions. In August of 1999, Chadwick Ecological Consultants (2000) noted capturing and PIT tagging six Bull Trout in the NFEFBR, from the confluence upstream 2.8 km to Devils Club Creek (specific locations not know) with individual lengths ranging from 101–250 mm. As part of a Bull Trout and Westslope Cutthroat Trout study of the Bull River, Katzman (2003) noted, "In September of 2000, " two large bull trout (at least 500 mm) and another bull trout about 300 mm in length were observed near a redd about 0.8 km upstream of the mouth of the NFEFBR. On September 28th, four redds were observed between this location and the mouth of the NFERBR" (Katzman and Hintz 2003). The authors noted that no redds were found in the NFEFBR in 2001 or 2002. In fact, it appears that until 2015, 2000 was the only other year that Bull Trout redds were observed in the stream. In the fall of 2015, two redds and one migratory adult Bull Trout were encountered in the stream at approximately Rkm 1.0. The NFEBR was surveyed for Bull Trout redds from its confluence with the EFBR upstream to Devils Club Creek from 2001 through 2005. Additionally the lower approximately 300 m of the NFEFBR has been occasionally surveyed during the EFBR Bull Trout redd survey (Storaasli 2015). Avista personnel conducted periodic electrofishing trainings on the NFEFBR above and below the bridge from 2006 to 2010. In total, three Bull Trout were captured below the bridge just upstream of the confluence with the East Fork (one fish in 2006 [287 mm] and two fish in 2008 [110 and 173 mm]; J. Storaasli, Avista, Personal Communication). Thus, Bull Trout use of the NFEFBR appears to be sporadic and limited to lower reaches.

Given the proximity and connectivity between the NFEFBR and the spawning and rearing habitat in EFBR, it is unclear why Bull Trout do not use the NFEFBR on a more predictable basis. Cabinet Mountain streams are dynamic and inherently unstable due to bedload movement and high flows associated with run-off (Land and Water Consulting 2001). In Rieman and McIntyre (1993), the authors describe the five most important habitat characteristics for Bull Trout which include channel stability and substrate composition. Bedload movement and substrate comprised mainly of large particles was cited as a possible reason for Bull Trout being absent or at low densities in other portions of the Bull River drainage including the North Fork, Middle Fork and possibly the NFEFBR (Chadwick Ecological Consultants 2000). It is possible that high bedload movement results in high egg mortality and that the large size of substrate limits the streams spawning potential, which together might limit the success of Bull Trout in the

NFEFBR. However, it would be expected that such factors should also limit the species successes in the EFBR as the streams are very similar in relation to these variables. A bedload movement study is currently being conducted on the EFBR by KNF staff and the results of this study will help us better understand how this variable could impact Bull Trout redds and spawning habitat. Early runoff from rain-on-snow events, such as the events that occurred in the late winter of 2015, could be responsible for increased mortality of eggs and embryos in the gravel and post-emergence age-0 fish. It is recommended that winter stream temperature in the EFBR is monitored to estimate Bull Trout emergence dates and then evaluate how early freshets could influence egg and fry survival.

Habitat observations indicated that the distribution of spawning gravel in the NFEFBR is limited to pocket water habitat (e.g., downstream side of boulders) and is similar to that of other higher gradient mountain streams in the area (e.g., upper Rock Creek, and the West Fork Thompson River). It may be that Bull Trout find more suitable spawning habitat in the EFBR or that they only use the NFEFBR for spawning on an infrequent basis due to the fidelity to the reach of stream where they were born (presumably in the East Fork Bull River). At this time, Bull Trout use of the NFEFBR appears to be limited to transient juvenile exploration or possibly thermal refuge based on fairly limited spatial sampling. It has been suggested that Bull Trout use of the NFEFBR would increase if saturation of rearing habitat occurred in the East Fork Bull River (S. Moran, Avista, Personal Communication).

The EFBR drainage including the NFEFBR is a stronghold Westslope Cutthroat Trout, especially the resident life history form (Katzman and Hintz 2003; Moran et al. 2012). A recent decline in Westslope Cutthroat Trout abundance has been noted in the lower EFBR despite ongoing suppression efforts that have reduced non-native salmonids by 70 % (Moran and Storaasli 2015). The decline in Cutthroat between the 2005 and 2013 sampling periods was also especially evident at the upper electrofishing site in the NFEFBR. This downward trend could be related to natural variation within a population, changes or differences in habitat between sites and years, disease, some other environmental variable or from putative excessive disturbance during the EFBR suppression efforts. Habitat conditions in the NFEFBR are ideal, with high habitat complexity, and therefore no habitat restoration projects are recommended at this time. Temperature monitoring data shows that of the four streams in this study, the NFEFBR consistently had the highest yearly maximum, mean daily maximum, and mean August temperatures recorded. This stream's riparian area provides ample shade to the stream as it is comprised of old growth cedar and hemlock stands and the drainage is almost entirely roadless land and wilderness, and as a result, improving stream temperature conditions are not feasible. Mean August temperatures ranged from 10.6°C to 11.5°C from 2011 and 2014 (Appendix A, Table A-2), and these temperatures are close to the 12°C benchmark where a recent study in western Montana found Brown Trout population growth was maximized (Al-Chokhachy et al., in press). It is possible that non-native salmonid species that occupy the EFBR could pioneer into the NFEFBR, as has been observed in the lower EFBR tributary of Snake Creek (Moran 2006).

Proposed mining operations in and around the southern portion of the Cabinet Mountain Wilderness will likely reduce streamflow conditions in the EFBR (U.S. Forest Service 2015). This could potentially increase the importance of the NFEFBR as spawning and rearing habitat for both Bull Trout and Westslope Cutthroat Trout. Monitoring of native salmonids in the upper EFBR and NFEFBR should help document shifts in species-use and density associated with the negative influences of reduced stream discharge. Regular monitoring should be implemented on this stream to also evaluate the Westslope Cutthroat Trout population (which declined substantially at the upper site since 2005), Bull Trout use and to determine if non-native salmonid species present in the EFBR have colonized the stream.

Copper Creek

Two years of temperature monitoring in Copper Creek, indicated the stream provides a source of cool water to the Bull River. Between 2013 and 2014, the maximum temperature recorded was 11.7°C on August 28, 2014. The mean daily temperature high for the monitoring period was 10.0°C and occurred on August 25 and September 5 2013.

Fish community composition and habitat conditions varied dramatically over a few kilometers of stream in Copper Creek. In the lower, anthropogenically altered portion of Copper Creek, the fish community was comprised almost entirely of non-native trout species, with 90% and 88% of fish collected being less than 115 mm, in 2012 and 2013, respectively. The KNF sampled a site on lower Copper Creek in 2002 near the confluence with the Bull River, and noted a fish community comprised of Brown Trout, Brook Trout and Sculpin, with 98% of the salmonids less than 115 mm (Doug Grupenhoff, KNF, unpublished data). The preponderance of young-of-the-year (YOY) and age-1 Brown and Brook Trout in 2002, 2012, and 2013 (i.e., fish $\leq$ 115 mm; Moran et al. 2012) suggests the lower sections of this stream provides spawning and rearing habitat for adult trout that reside in the mainstem Bull River and/or Cabinet Gorge Reservoir. Sculpin were noted in this section in 2002, but were not encountered in 2012 or 2013. An Avista crew also sampled a site on lower Copper Creek in 2005, 0.2 km upstream from the lower site sampled in 2012 and 2013. At that time, the fish community was dominated by Westslope Cutthroat Trout with a lone Brook Trout also being captured. A change in community composition from native to non-native trout has been a common occurrence across the range of cutthroat trout subspecies in the western U.S., but it is unlikely that the fish community in a small stream would have such a dramatic swing in species composition over a few year period from non-native trout (2002) to native trout (2005) back to non-native trout (2012-2013). Coordinates for the 2005 sampling event were noted to be inaccurate in the subsequent report (Moran 2006), and while new coordinates were provided, it seems plausible that the sampling location would have to have been upstream of the intermittent reach where only Cutthroat Trout were observed in 2012 and 2013 (above Rkm 2.6). It is therefore probable that the lower, perennial two kilometers of Copper Creek is and has been dominated by juvenile Brook and Brown Trout that use this reach as rearing habitat.

In the upper section, above the intermittent reach, Westslope Cutthroat Trout were the only species captured and occurred at relatively high abundance in 2012 and 2013. While it has been reported that this population is slightly hybridized (Land and Water Consulting 2001), Montana Fish, Wildlife and Parks MFISH database confirms that the population was genetically pure when it was analyzed in 1992 (MFWP, unpublished data). In 2002, KNF staff sampled an unknown distance of stream in the vicinity (T. 27 N, R. 32 W, S. 20) and only found Cutthroat Trout (Doug Grupenhoff, KNF, unpublished data). Similarly in 2005, Avista personnel sampled an upper site at Rkm 2.4 and collected Westslope Cutthroat Trout and a lone Brook Trout. Brook Trout were not encountered during 2012 and 2013 sampling efforts, but because they were observed in the area in 2005, a more thorough investigation of their distribution above the dry stream reach might be warranted, as the species is known to outcompete and displace native Cutthroat Trout (Dunham et al. 2002). Spot electrofishing long distances of stream where only the most appropriate habitat is surveyed is recommend for species that are rare or occur at low abundance (Blakney 2012) and is probably the best method to determine Brook Trout distribution and abundance in upper Copper Creek, if the species does still occur above the dry reach. Such an instance of limited and apparently unsuccessful colonization by Brook Trout was noted in the upper West Fork Trout Creek where extensive electrofishing surveys in 2010 captured just two Brook Trout, while none were captured in 2013 or 2015 (Horn and Tholl 2011; Moran and Storaasli 2014; J. Blakney, Personal observation, 2015).

It has been suggested that Bull Trout historically occupied Copper Creek. Pratt and Huston (1993) present a table depicting Bull Trout distribution in the LCFR, including the Bull River drainage. The table description notes Bull Trout presence in streams is based on oral histories of locals living in the area (1920s to 1950s), prior to fragmentation of the LCFR by Cabinet Gorge and Noxon Dams. These interviews are found in Appendix D of the document and upon review of these oral accounts, no account mentioned specifically seeing or catching Bull Trout in Copper Creek. Montana Fisheries Information System (MFISH) states that Bull Trout presence in Copper Creek is based on professional judgment, with no documentation of the species being found in the creek during sampling events. Thus without physical proof or even anecdotal evidence, it is conceivable that a resident or migratory population may have never existed in this Bull River tributary.

Due to the small size and limited amount of habitat in Copper Creek, this stream may be unsuitable for Bull Trout. A study conducted in the Boise River basin of southwestern Idaho, sampled 67 streams to determine Bull Trout presence, and never found the species occupying a stream less than 2 m wide, based on a detection probability of about 80 % (Rieman and McIntyre 1995). While the authors acknowledge that individual Bull Trout may use small streams, they speculate that this habitat may be unsuitable to sustain a population. The results of their research suggest population persistence in small habitat patches (i.e., small streams) is dependent upon demographic support and displacement of individuals from adjacent larger or more stable populations.

The mouth of Copper Creek is 4.6 km downstream from the mouth of the EFBR, a stronghold for the species in the Bull River Drainage. The EFBR population would be the most proximate to Copper Creek, with the primary Bull Trout spawning and rearing area occurring upstream of Snake Creek, about 2.5 km up from the confluence with the mainstem Bull River (Moran and Storaasli 2015). This distance between the principal spawning and rearing area in the EFBR and lower Copper Creek is about 7 km, which is not far given the ability of migratory bull trout to move long distances. While the 2012 and 2013 average stream widths for both the lower (4.0 ± 0.3 m [mean ± 95% CI]) and upper (3.1 ± 0.5 m) electrofishing sites was greater the lower limit for stream width (2 m) where Bull Trout were encountered in the Boise River drainage (Rieman and McIntyre 1995), habitat conditions in lower Copper Creek are poor. The habitat has been altered through channelization and removal of large woody debris (LWD), and consequently, little pool habitat currently exists. In fact, it was estimated that 96% of a reach sampled in lower Copper Creek was comprised of riffle habitat (Land and Water Consulting 2001). Based on the current state of habitat in lower Copper Creek, it seems very unlikely that meaningful numbers of transient or introduced Bull Trout would find suitable habitat in the stream for more than a short period of time.

In 2014, an ephemeral stream reach was documented between Rkm 2.0 and 2.6. Above the dry reach only Westslope Cutthroat Trout were captured, both in 2012 and 2013. Habitat conditions in the upper reach represent an unaltered, low-order, mountain stream habitat typical of northwest Montana. It has been suggested that channel reconstruction on the lower channelized portion of Copper Creek might re-establish perennial flows and improve fish passage, while also increasing channel stability and floodplain connectivity (Land and Water Consulting 2001). Recent research has shown that the ephemeral nature of streams in the LCFR is natural and related to the underlying geology of the area. This phenomenon is associated with deep layers of unconsolidated bed sediments linked with Glacial Lake Missoula Deposits, where a significant portion of surface flow is lost through the substrate (Sando and Blasch 2015). Although the Bull River was not specifically investigated in the intermittency study, stream flow patterns of a neighboring drainage (i.e., Rock Creek) were found to be highly influenced by the region's past geologic history. Therefore, it is very unlikely that channel reconstruction would alleviate the issue of intermittency on Copper Creek. Furthermore, habitat restoration in lower Copper Creek as well as improved connectivity might put the genetically pure population of Westslope Cutthroat Trout at higher risk of invasion by Brook Trout and Brown Trout, which comprise the vast majority of the fish community below the seasonally dry stream reach and in the mainstem Bull River.

A recent Environmental Impact Statement for the Montanore Mine, drafted by the KNF, suggested mitigation efforts in Copper Creek could offset "both projected losses of Bull Trout numbers and critical habitat in the East Fork Bull River and the lower Clark Fork Core Area" (U.S. Forest Service 2015). The report goes on to propose that habitat restoration in the lower drainage could alleviate seasonal drying and that this enhanced connectivity would provide migratory Bull Trout access to perennial habitat upstream, thereby allowing for the establishment and maintenance of a self-sustaining population. Based on the presence of two species of non-native trout and poor quality habitat in the lower drainage, the naturally ephemeral nature of streams in the LCFR, the presence of a genetically pure Westslope Cutthroat Trout population upstream, the lack of direct or anecdotal evidence of Bull Trout presence in Copper Creek and the small size of the stream; mitigation measures that seek to improve habitat and make Copper Creek a Bull Trout stream are impractical and should be not be taken seriously in discussions of future mitigation efforts.

Deep Creek

Less is known about Deep Creek than the other streams surveyed for this assessment. Research for this project was focused above the culvert at the Blue Slide road crossing, which is a complete barrier to upstream fish passage. The section of Deep Creek above the culvert (Rkm 1.1), was sampled in 2002 (Moran 2003) and in 2012-2013 (this study), and the fish community remains solely comprised of Westslope Cutthroat Trout. Genetic analyses of Cutthroat collected above the culvert in 1984 (~ Rkm 2.1), confirm the population is genetically pure (MFWP, unpublished data). Mountain Whitefish *Prosopium williamsoni*, Bull Trout, Brook Trout and Brown Trout have been found below the culvert in lower Deep Creek (Moran 2003).

Recent research in western Montana has sought to evaluate how climate change and stream temperatures influence native and non-native trout population growth and abundance (Al-Chokhachy et. al., In Press). The study found that Bull Trout populations tended to be stable when mean August temperatures were below 10°C and that the species has apparently been extirpated from nearly 60% of sample sites where mean August temperatures exceed 10°C, with Brown Trout population growth being greatest at sites where mean temperatures above 12°C. They conclude that as streams warm, Brown Trout will potentially replace Bull Trout. Three years of temperature monitoring in Deep Creek (2011 through 2013) showed that mean daily August temperatures ranged from 9.6°C in 2011 to 11.0°C in 2013. While the mean daily August temperatures were within the thermal optimum for Westslope Cutthroat Trout (Bear et al. 2007), these temperatures might also facilitate the expansion of Brown Trout into native species strongholds within the LCFR, including Deep Creek. Therefore, because non-native trout are found below the culvert and the genetically pure Cutthroat population appears to be quite robust, based on abundance/density and the amount of habitat occupied, it is recommended that the culvert be left in place and remain a barrier to upstream fish passage.

Deep Creek should be considered important native fish refugia in the LCFR and should be regularly monitored. Westslope Cutthroat Trout in Deep Creek occupy about 7.3 km of habitat upstream of the culvert. From the culvert upstream 5.8 km to just below a 0.15 km dry stream reach, Cutthroat Trout occur at relatively high densities when compared with other populations in Montana and Idaho (IDFG 2013; Moran and Storaasli 2014). Above this dry reach to the barrier falls at RKM 8.4, densities appeared to be much lower in the upper 1.3 km of the drainage occupied by fish, based on visual observation during spot shocking investigations in 2015. As with many other streams in the LCFR, current genetic data is lacking and could be updated. Overall, stream habitat is in very good condition and other than a forest road that follows the lower 3.4 km of the stream, anthropogenic impacts to the watershed are minimal and thus no restoration based activities are recommended at the current time. In order to sustain the robust Cutthroat population in Deep Creek, the barrier culvert at the Blue slide Road crossing should be formally evaluated to determine its stability, permanency and whether it is appropriately sized. If the structure is determined to be in need of repair or replacement Appendix B dollars should be spent on such upgrades to ensure the continued security of this population.

Upper Graves Creek

Graves Creek downstream from Graves Creek Falls is one of the most important migratory Bull Trout spawning and rearing tributaries in the LCFR. A permanent weir was recently built on the lower end of the stream with the primary goals of increasing capture rates for outmigrating juvenile Bull Trout for downstream transport to LPO and for capturing adults on spawning migrations. Passive Integrated Transponder antennas stationed upstream and downstream of the weir help collect important information on juvenile and adult Bull Trout movements. Along with Bull Trout, other species found in lower Graves Creek include Westslope Cutthroat, Brook, Brown and Rainbow Trout along with Mountain Whitefish (Moran 2003). Above Graves Creek Falls, the fish community is comprised of genetically pure Westslope Cutthroat Trout and Brook Trout, with high quality habitat found throughout the upper drainage.

In upper Graves Creek, Cutthroat Trout were found at a range of densities among sampling sites while Brook Trout currently appear to occur at low densities throughout the survey area and were found to be absent in five headwater lakes. Results from fish monitoring surveys completed for this project found Cutthroat at moderate densities directly upstream of the Falls (2012-2013), at high density in the middle reach (2015), and at very low density at the upper most sample reach (2012). These three sites were originally sampled by Avista personnel in 2002. Cutthroat Trout densities at the lower site were similar to 2002 estimates; however, cutthroat densities at the middle site increased sharply, but declined at the upper site. Brook Trout densities have remained stable and low at the lower site and declined drastically at the middle site, with no Brook Trout encountered at the upper site in 2002 or 2012. It is unclear why Cutthroat Trout abundance and density at the middle sampling reach has increased dramatically over a ten year period while Brook Trout have declined precipitously. No noticeable changes in habitat are known to have occurred over this time and no suppression projects have taken place in the drainage.

Some Cutthroat Trout populations appear to be productive and stable despite Brook Trout being present for decades (Dunham et al. 2002). Graves Creek is one of the colder tributary streams in the LCFR with yearly maximum temperatures reaching 10.5°C in 2011, 9.5°C in 2012 and

12.2°C in 2013. Mean maximum daily temperatures ranged from 9.1°C in 2011 to 10.4°C in 2013. In the St. Regis River drainage (Middle Clark Fork River) of western Montana, Adams (1999) found a decline in Brook Trout growth in the upstream direction associated with stream temperature and such conditions may have created the upstream distributional limit for the species. Environmental conditions in these headwater streams may favor Cutthroat Trout that mature at a larger size with a higher fecundity (Dunham et al. 2002). The decline in growth and associated decline in fecundity as well as increased age at sexual maturation for Brook Trout in the upstream direction should theoretically lead to reduced population growth without an increase in survival, which is unlikely in the harsh environments of headwater mountain streams (Adams 1999). In these sink habitats, lack of immigration from a source population and environmental conditions limit recruitment and the stability of the population (Peterson et al. 2004). Evidence also suggests that Cutthroat may be better competitors at cooler water temperatures. In a laboratory setting, Brook Trout and Colorado River Cutthroat Trout *Oncorhynchus clarki pleuriticus* were found to be equal competitors at 10°C; whereas at 20°C Brook Trout showed a competitive dominance by being more aggressive, consuming more food, and holding the superior feeding position (De Staso and Rahel 1994). Beaver ponds, side channels and backwater habitats have been shown to support the vast majority of age-0 Brook Trout in stream reaches in the western U.S. (Thompson and Rahel 1996, Hilderbrand 1998, Adams 1999). The patchy nature or absence of such habitats on a given stream may therefore influence the distribution, abundance and survival of YOY Brook Trout, and ultimately recruitment and population growth. These juvenile nursery habitats were limited in our sampling reaches but their prevalence in upper Graves Creek beyond electrofishing sites is unknown. It could be that the undocumented loss of beaver ponds or changes in side channel habitat have led to the reduced success of Brook Trout since the stream was last sampled in 2002. Cold water temperatures and their putative influence on population stability and interaction between the two species, the absence of connectivity to a source population, and the observed lack of Brook Trout nursery habitat may provide evidence as to why Brook Trout have had limited success in upper Graves Creek.

Fish population monitoring should be conducted at the three established electrofishing sites above Graves Creek Falls on a more frequent basis than the past ten year (i.e., 2002 to 2012) interval to assess the dynamics between native Westslope Cutthroat Trout and non-native Brook Trout, approximately every three to five years. If during these surveys, the Brook Trout population appears to be more abundant or expanding, further electrofishing investigations should focus on better describing the species distribution, abundance and habitat use; and the feasibility of some type of suppression effort should be discussed. Recent fisheries suppression work in Montana has shown that Brook Trout can be mechanical removed from small streams (base flow wetted width < 3 m) at fairly small spatial scales (2.4-3.0 km) with considerable effort (6-14 treatments with 2-4 passes per treatment) (Shepard et at. 2014). The mean wetted stream width for sampling locations on upper Graves Creek ranged from 5.6 to 6.2 m and while it is unclear how much habitat Brook Trout occupy in the upper drainage, the species at a minimum occurs in at least 5 km of stream above the Falls (between Sites 1 and 2) and likely extend further up the drainage. Given the size of the stream and the amount of habitat occupied, it seems that even very intensive electrofishing efforts might be unsuccessful at completely removing Brook Trout from upper Graves Creek, especially if key rearing habitat does exist in this portion of the drainage. A more thorough discussion of the importance of removing Brook Trout from upper Graves Creek is certainly warranted, but it is clear that complete removal of the species could only be accomplished through the use of piscicides. Under this scenario, intensive efforts to salvage what is believed to be a relic Westslope Cutthroat Trout population above a natural waterfall would need to be initiated.

Evidence suggests Westslope Cutthroat Trout are native above Graves Creek Falls. An interview with a local resident recounts Cutthroat Trout being caught at a hunting camp upstream of Graves Creek Falls near Irvs Creek in 1939 (Pratt and Huston 1993). Montana Fish, Wildlife and Parks stocking records indicate Graves Creek was stocked with an unidentified subspecies of "Cutthroat Trout" in early October and late November of 1934, unfortunately the locations these stocking events are unknown. No stocking was noted prior to 1934 and then next stocking event took place in 1942 (MFWP, unpublished data). It is believed that between the mid to late 1930s through the 1960s most stockings of Cutthroat Trout west of the Continental Divide were of Yellowstone Cutthroat Trout (L. Nelson, MFWP, Personal communication). In 2002, 30 Cutthroat Trout from Rkm 14.6 were analyzed for hybridization, and results indicated all of individuals tested were genetically pure Westslope Cutthroat Trout. Therefore, if Yellowstone Cutthroat Trout were stocked above the falls in 1934, some levels of hybridization should have been detected. There has also been speculation as to whether, Westslope Cutthroat are native above a natural waterfall in the Vermilion River drainage (WWP 1996), located just west of Graves Creek in the southern portion of the Cabinet Mountains. Genetic testing in 1993 also confirmed all specimens to be pure Westslope Cutthroat Trout. The Vermilion drainage was stocked with "Cutthroat Trout" several times from the 1930s through the 1960's. Evidence of hybridization between Yellowstone Cutthroat Trout and Westslope Cutthroat Trout was noted in a tributary of the Vermilion River below the falls, Cataract Creek. Stocking records indicated Cataract Creek was stocked with "Cutthroat Trout" in 1941 and this population showed relatively high levels of hybridization between the two Cutthroat Trout subspecies in 1983 (51 % Yellowstone, 49 % Westslope) (MFWP, unpublished data). Given that "Cutthroat Trout" were only stocked in the Vermilion River from 1933 to 1953, it is likely that if Yellowstone Cutthroat Trout were stocked above Vermilion Falls there should be some genetic signature of hybridization. Thus based on best available evidence, Westslope Cutthroat Trout populations above natural waterfalls in the Graves Creek and Vermilion River drainages should consider relictual populations of high conservation value.

The results of this study indicate efforts should be made to sustain water temperatures and habitat quality in upper Graves Creek as it is currently a stronghold for genetically pure Westslope Cutthroat Trout that occupy at least 8.7 km of stream. This project did not identify any specific areas where restoration could improve habitat conditions and thus no such projects are recommended at the current time. Upper Graves Creek appears to provide appropriate habitat and a thermal regime that could support a resident Bull Trout population and future efforts to introduce Bull Trout into suitable unoccupied habitats in upper Graves Creek and other LCFR streams should be evaluated. Regular monitoring in upper Graves Creek will help determine the dynamics between Westslope Cutthroat Trout and Brook Trout, which in turn will help focus discussions on how to deal with a non-native species that has the ability to negatively impact both native salmonid species in the Graves Creek drainage.

Conclusions and Recommendations

The streams investigated for this study were occupied mainly by resident Westslope Cutthroat Trout and it is these small headwaters streams that encompass the bulk of the species distribution in the LCFR. The results of this project outline to the author the importance of 1) Determining how much stream a given native fish population occupies; 2) How natural stream intermittency influences these populations; 3) Genetic purity of a given population; 4) Temperature regime; 5) If non-native species are present; 6) The level of isolation (Table 9). A complete understanding of the six aforementioned variables is needed to help prioritize future sampling and conservations efforts. Collecting baseline distributional information on headwater Westslope Cutthroat Trout populations would be a difficult task, but the knowledge gained from this work is an important step for future management of native trout in an uncertain future that includes climate-change, expansion of non-native species, and land management activities that could adversely impact streams.

Table 9. Key information on four resident Westslope Cutthroat Trout populations in the lower Clark Fork River drainage including minimum amount of habitat occupied (km), occurrence of stream intermittency, genetic purity, year tested, maximum mean August temperature, year recorded, the presence of non-native salmonid species and the level of isolation.

Stream	Minimum KM Occupied	Intermittency?	Genetic Purity	Year Tested	Max Mean August Temp (°C)	Year Recorded*	Non-natives species?	Level of isolation
NFEFBR	3.6	No	-	-	11.5	2013	No	Connected
Copper Creek	?	Yes	100%	1992	9.5	2013	Yes	Seasonal
Deep Creek	7.3	Yes	100%	1984	11.0	2013	No	Complete
Upper Graves Creek	8.7	No	100%	2002	9.6	2013	Yes	Complete

*Based on 2-4 years of temperature monitoring, 2011-2014.

In the summer of 2015, all-time record low flows were recorded for many streams in the northern Rocky Mountains, including in LCFR tributaries (e.g., Prospect Creek). Evaluating natural stream intermittency in relation to snowpack and run-off timing would allow for a better perspective on how these factors influence stream flow conditions and connectivity at low flow periods. Stream intermittency occurs in most streams in the LCFR and acts to isolate Cutthroat Trout populations in Prospect, Trout, Marten, Swamp, Rock, Beaver, Elk and Blue Creek drainages and in the Bull River basin. Given the prevalence of natural stream intermittency throughout the LCFR (Sando and Blasch 2015), distributional surveys should precisely document dry stream reaches. Such distributional surveys should also be completed in junction with efforts to update hybridization information. Three of the four streams in this study have been tested for *Oncorhynchus* hybridization including Cooper Creek (1992), Deep Creek (1984) and upper Graves Creek (2002). It is recommended that hybridization data be updated maybe every 10 to 15 years, or sooner under specific circumstances. These aforementioned baseline surveys (in many cases) could be conducted by CFSA Appendix B and C crews, and realistically might take five or more years to complete as they would need to be fit in to already packed summer-fall sampling schedules and September sampling could occur in streams not occupied by Bull Trout. Previous drainage-wide surveys conducted by Appendix C will be very helpful in streamlining these proposed sampling efforts.

The monitoring of stream temperatures, stream habitat and fish population trends overall portrays relatively stable conditions in the study streams. Temperature data suggest current temperatures are within the thermal niche of native salmonids (Selong et. al 2001; Bear et al. 2007); however current temperatures are also within the range where Brown Trout replacement of native salmonids in western Montana has been observed (Al-Chokhachy et al., in press). Habitat conditions in most of the stream reaches represent fairly undisturbed low-order stream habitat with the exception of the anthropogenically altered, lower reaches of Copper Creek. Estimates of density and abundance for the populations investigated for this report varied between sample sites and drainages but were within the range of what has been observed for resident Westslope Cutthroat populations in western Montana and northern Idaho (IDFG 2013; Moran and Storaasli 2014). At most sites, Cutthroat Trout were observed to be stable or increasing with the exception of the NFEFBR and the upper most sampling location in upper Graves Creek (Rkm 14.1) where declines in estimates of abundance and density of Westslope Cutthroat Trout were observed when compared to past sampling events.

While many resident Westslope Cutthroat Trout populations currently appear to be stable, a suite of factors makes them vulnerable in the future. Streams in the LCFR are lower in elevation than many other Westslope Cutthroat populations and drainages are relatively small. Populations often only inhabit a few kilometers of stream and many are probably isolated from neighboring populations. Furthermore, non-native salmonids are often present in lower portions of tributaries and/or mainstem reservoirs.

Elevation and its association with stream temperature has been shown to dictate the distribution of both native and non-native salmonids in the northern Rocky Mountains (Paul and Post 2001). Typically, non-natives dominate in the lower portions of watersheds, while native trout abundance peaks in headwater reaches in the middle and upper portions of watersheds (Pierce et al. 2013). Streams in the LCFR are probably at an elevated risk of Cutthroat Trout decline or extirpation because they occur low in the watershed where temperature and habitat are, in many cases, are more typical of those found to be dominated by non-native salmonids. In the LCFR, non-natives salmonids occur in both Noxon and Cabinet Gorge Reservoirs and in many of the larger streams including the mainstem Bull River. Thus given the right ecological conditions, they could expand it areas that are currently strongholds for Westslope Cutthroat Trout.

A good portion of these small-stream Cutthroat Trout populations are isolated, including three of the four populations examined in this study. The level of isolation varies among streams and drainages, from seasonal isolation during low flow periods to complete isolation facilitated by anthropogenic (i.e., perched culvert) or natural barriers (i.e., waterfalls or intermittent stream reaches) to upstream movement. The deleterious influences of isolation include reduced genetic diversity associated with the lack of gene flow and the inability to recolonize novel habitats following extirpation (Meffe 1986). The major positive benefit to isolation (complete) is that it limits the colonization of non-native salmonids into headwater refugia. Non-native salmonids have been observed upstream of intermittent stream reaches in the West Fork of Trout Creek and in upper Cooper Creek, which suggest these species can and do have the ability to move though such habitats. Although no recent evidence of a non-native salmonid establishing a population above an intermittent stream reach has been documented, the presence of non-natives downstream of seasonally dry stream reaches should certainly be consider a threat to the long-term persistence of headwater Cutthroat Trout populations. If an understanding of the conditions that facilitate such range expansion of non-native fish species could be achieved, management actions could be taken with the on-set of such conditions to reduce the threat of expansion.

It is recommended that several of the larger Cutthroat populations in the LCFR, including the four streams studied for this report, are monitored on a somewhat frequent basis, every 3-5 years. Their location in the watershed, often isolated nature, and widespread presence of non-native salmonids makes them vulnerable to population contraction, replacement and/or extirpation. Our current lack of critical information on small stream headwater Cutthroat Trout limits the ability to prioritize populations for management activities including monitoring, non-native species removal, habitat restoration, and supplementation. By collecting updated information for the six variables listed in Table 9 (km of stream occupied, level of intermittency, level of genetic purity, stream temperature regime, presence of non-natives, level of isolation) priorities for the previously mentioned management activities can be properly assessed. The Clark Fork River Native Salmonid Restoration Program, Five Year Plan (2016-2020) outlines five area/drainages in Montana that are most important for native trout; Bull River, Vermilion River, upper Trout Creek, Graves Creek, and upper Prospect Creek (AIT 2016). These areas would be ideal places to start filling in suggested gaps in resident Cutthroat Trout data. Lower Prospect should also be included in this prioritized list because several populations occupy tributaries in this part of the watershed including in Daisy Creek, Therriualt Gulch, Brush Gulch, Wilkes Creek, upper Clear Creek and upper Dry Creek. Eventually efforts should be made to collect the recommended data for all LCFR Westslope Cutthroat Trout populations. With the completion of this work, the most important information for all Cutthroat Trout populations will be available and streamlined which will give stakeholders the best shot at managing and conserving these populations in an uncertain future.

Sampling Considerations- "Hindsight is 20-20, I'm nearly going blind" (Randy Travis, *1982*).

The Lower Clark Fork Native Salmonid Limiting Factors Assessment was first proposed in 2011 and since then at least 4 biologists and 6 technicians have contributed to the collection of biological data from the streams outlined in this report. Considerable time and financial resources were used to collect field data, enter and organize data, and to produce this final report. It is safe to say that the blood, sweat and tears of several dedicated folks went into this project. That being said, the author after careful consideration, has determined some areas where this project should have collected additional data to provide the clearest possible picture of the status of the resident Westslope Cutthroat Trout that occupy these four streams. Most areas of interest have been outlined in the report as being key factors to better understanding, assessing and prioritizing management activities that benefit native salmonids in headwater streams.

- Definitive understanding of the species lower and upper distribution in each stream.
- Updated Westslope Cutthroat Trout hybridization data for each stream.
- Outlined level of stream intermittency over multiple years to evaluate if/how varying levels of snowpack and timing of run-off influences baseflow conditions timing and extent of intermittency.
- Flow measurements at base flow conditions to give a more quantitative view of how much habitat is available to fish
- Additional electrofishing reaches per stream or duplication of all electrofishing surveys over multiple years to get a more informed perspective on how these small stream populations abundance/density may varying across time and space.

A few aspects of the initial proposal for this project were not conducted or were not specifically outlined in this final report such as quantification of fine sediment, tributary trapping and landowner interviews (Hanson 2011). Fine sediment levels in these streams were not quantified because all reaches contained high-quality habitat (except lower Copper Creek) and excessive levels of fine sediment were not observed. Tributary trapping was not conducted because of the laborious nature of this effort and because the streams were occupied by mainly resident Cutthroat Trout. Trapping may have determined if some fish in study stream outmigrate and the use of these drainages by migratory fish, but it was decided that this level of investigation would need to be addressed in a separate study. Most of the land within the highlighted drainages is federally owned. Upper Graves Creek and the NFEFBR lie entirely on public land, as does the Deep Creek drainage above Blue slide Road crossing. Most of the Cooper Creek watershed resides on public land as well, and the one major landowner was contacted and access was granted to this property. However, this landowner was not formally interviewed.

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Dedication

This report is dedicated to my dear friend and the brother I never had, Sven Gustav Haaland (4-17-80 to 5-21-15). If it were not for you, I would not be here finishing this report today. Thanks for all years of being my boy, all the bad times and the good, and for your irreplaceable enthusiasm for life. Your sprit will be with me high on a mountain, deep in thought and those places in between. Until we meet again, rest easy kiiiiid.

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Appendix A

Table A-1. Coordinates for electrofishing sites, ephemeral streams reaches and barriers for study streams; Creek, Deep Creek, upper Graves Creek and the North Fork East Fork Bull River (NFEFBR).

Stream	Sample Site	Lat	Long	Notes
NFEFBR	Site 1 2013	48.13328	115.71936	Lower, ~550m above Rd 407 crossing (RKM # 1.0)
	Site 2 2013	48.14482	115.7027	Upper, 450m above Devils Club Cr Confl. (RKM # 2.9)
	Site 1 2005	48.13262	115.7197	Lower, ~500 m up from USFS rd 407 (RKM # 0.8)
	Site 2 2005	48.13772	115.70756	Middle , ~500 m down from Devils Club (RKM # 2.0)
	Site 3 2005	48.14306	115.70245	Upper,~300 m up from Devils Club (RKM # 2.7)
	Devils Club Creek 2005	48.13933	115.69318	~500 m up trail (RKM # 0.7)
Copper Creek	Site 1 2012-13	48.08607	115.77195	Lower (RKM # 0.3)
	Site 2 2012	48.08387	115.74014	Upper (RKM # 2.7)
	Site 1 2005 ?	48.08483	115.76903	Lower (RKM # 0.6 ?)
	Site 2 2005 ?	48.08394	115.74382	Upper (RKM # 2.6 ?)
	Dry Start 2014	48.08397	115.74964	Start of dry section (downstream) (RKM # 2.0)
	Dry End 2014	48.08378	115.74188	End of dry section (upstream) (RKM # 2.6)
Deep Creek	Site 1 2012-13	47.752	115.43465	Lower (RKM # 2.0)
	Site 2 2012-13	47.75999	115.41821	Upper (RKM # 3.6)
	Site 3 2002	47.75105	115.43689	Upper (RKM # 1.9)
	Barrier Culvert	47.746	115.442	Culvert at Blue Slide Road
	Falls	47.79145	115.3802	Upper fish distribution
	Dry Start 2015	47.78054	115.38507	Start of dry section (downstream)
	Dry End 2015	47.7797	115.38638	End of Dry section (upstream)
Graves Creek	Site 1 2012-13	47.72145	115.37679	Lower (RKM # 5.6)
	Site 2 2015 (Site 7 2002)	47.7475	115.33124	Middle (RKM #10.5)
	Site 3 2012 (Site 8 2002)	47.74331	115.29071	Upper (RKM # 14.1)
	Site 6 2002	47.72346	115.37356	~50 m up from lip of Falls (RKM # 5.8)
	Graves Creek Falls	47.721	115.378	Barrier Falls

Table A-2. Species Abbreviations.

Species	Abbreviation
Westslope Cutthroat Trout	WCT
Rainbow Trout-Westslope Cutthroat Trout hybrid	RBxWCT
Brook Trout	EB
Brown Trout	LL

Appendix B

Stream Name: Copper Creek **Reach:** Electrofishing Site 1 (2012-13), RKM 0.3

Date: 10/29/2014 **Coordinates:** Lat. 48.08586 Long. 115.77163

Bankfull Depth (m): 0.50 **Bankfull Width (m):** 10.3 Width**/Depth Ratio:** 20.6 **Channel Type:** B/F?

Substrate: Cobble **Primary Land Use:** Channel was straightened historically. Also harvest of mature riparian trees.

Habitat Component	Score	Possible	Comments
Stream Incisement	4	8	Channel Was very stable
Bank Erosion	8	8	No active lateral cutting or erosion
W/D ratio and Sediment	4	6	W'D ratio was appropriate and sediment was in balance
Vegetation	6	6	Large woody species/plant community comprised of alder, ponderosa pine, douglas-fir, cedar and more
Canopy Cover	2	6	Canopy Cover is <85%
Noxious Weeds	3	3	No noxious weeds observed
Disturbance Plants	3	3	No disturbance induced plants observed
Woody Species Regeneration	6	8	Mostly older mature trees, but regen is occurring
Browsing	4	4	Very little browse observed
Floodplain, Energy	6	8	Channel is choked with large rock and woody debris
Total	46	60	
Score	0.77		

Supplemental Questions	
Substrate	Stony substrate of several sizes packed together. Interstices obvious. Substrate is easily moved.
Fish Habitat	Majority of pools are small and shallow or pools are absent; Habitats created by woody debris, overhanging vegetation, boulders, root wads, or undercut banks and/or aquatic vegetations are rare or nonexistent
Temperature Indicators	The stream has adequate shading, stable geomorphology, and sufficient flow
Flow	There is no noticeable alteration to flow
Nutrient Indicators	A thin layer of algae is barely visible or rocks are slippery, patches of filamentous algae are short and occur occasionally

Additional comments: Very little pool habitat, mostly shallow riffle. Seasonally dry reach occurs upstream.

Stream Name: Copper Creek **Reach:** Electrofishing Site 2 (2012-13), RKM 2.7

Date: 10/29/2014 **Coordinates:** Lat. 48.08586 Long. 115.77163

Bankfull Depth (m): 1 **Bankfull Width (m):** 6.5 Width**/Depth Ratio:** 6.5

Channel Type: B Substrate**:** Boulder/Cobble **Primary Land Use:** Wilderness draining, but some historic riparian cedar harvest

Habitat Component	Score	Possible	Comments
Stream Incisement	8	8	Channel Was very stable
Bank Erosion	8	8	No active lateral cutting or erosion
W/D ratio and Sediment	6	6	W'D ratio was appropriate and sediment was in balance
Vegetation	6	6	Large woody species/plant community comprised of larch, alder, hemlock, cottonwood, cedar, spruce, grand fir
Canopy Cover	4	6	Canopy Cover is <85%
Noxious Weeds	3	3	No noxious weeds observed
Disturbance Plants	3	3	No disturbance induced plants observed
Woody Species Regeneration	6	8	Mostly older mature trees, but regen is occurring
Browsing	4	4	Very little browse observed
Floodplain, Energy	8	8	Channel is choked with large rock and woody debris
Total	56	60	
Score	0.93		

Supplemental Questions	
Substrate	Stony substrate of several sizes packed together. Interstices obvious. Substrate is easily moved.
Fish Habitat	Even mix of all-size pools. Habitat created by large boulders, woody debris, overhanging vegetation, root wads, undercut banks
Temperature Indicators	The stream has adequate shading, stable geomorphology, and sufficient flow
Flow	There is no noticeable alteration to flow
Nutrient Indicators	A thin layer of algae is barely visible

Additional comments: Streambed is dry between **48.08397** 115.74964 (lower) & 48.08378 115.74188 (upper). Intermittent section is approximately 0.58 km in length.

Stream Name: Deep Creek **Reach:** Electrofishing Site 1 (2012-13), RKM 2.0

Date: 9/25/2014 **Coordinates:** Lat. 47.75241 Long. 115.43436

Bankfull Depth (m): 0.56 Bankfull **Width (m):** 5.11 Width**/Depth Ratio:** 9.12

Channel Type: B **Substrate:** Cobble/Boulder **Primary Land Use:** National Forest, roaded & roadless

Habitat Component	Score	Possible	Comments
Stream Incisement	8	8	Channel Was very stable
Bank Erosion	8	8	No active lateral cutting or erosion
W/D ratio and Sediment	6	6	W'D ratio was appropriate and sediment was in balance
Vegetation	6	6	Large woody species/plant community comprised of alder, ponderosa pine, douglas-fir, cedar and more
Canopy Cover	4	6	Canopy Cover is <85%
Noxious Weeds	3	3	No noxious weeds observed
Disturbance Plants	3	3	No disturbance induced plants observed
Woody Species Regeneration	8	8	Mostly older mature trees, but regeneration is occurring
Browsing	4	4	Very little browse observed
Floodplain, Energy	8	8	Channel is choked with large rock and woody debris
Total	58	60	
Score	0.97		

Supplemental Questions	
Substrate	Stony substrate of several sizes packed together. Interstices obvious. Substrate is easily moved
Fish Habitat	Even mix of all-size pools. Habitat created by large boulders, woody debris, overhanging vegetation, root wads, undercut banks
Temperature Indicators	The stream has adequate shading, stable geomorphology, and sufficient flow
Flow	There is no noticeable alteration to flow
Nutrient Indicators	Filamentous algae may be present, but filaments are short and patchy and occurrences are not widespread

Additional comments: Culvert at Blue Slide Road is a complete barrier to upstream fish passage.

Stream Name: Graves Creek **Reach:** Electrofishing Site 1 (2012-13), RKM 5.6

Date: 3/25/2015 **Coordinates:** Lat. 47.72167 Long. 115.37651

Bankfull Depth (m): 0.8 **Bankfull Width (m):** 7.8 **Width/Depth Ratio:** 9.8

Channel Type: B **Substrate:** Boulder/Cobble **Primary Land Use:** National Forest, Roaded

Habitat Component	Score	Possible	Comments
Stream Incisement	8	8	Channel Was very stable
Bank Erosion	8	8	No active lateral cutting or erosion
W/D ratio and Sediment	6	6	W'D ratio was appropriate and sediment was in balance
Vegetation	6	6	Large woody species/plant community comprised of Grand fir, Douglas Fir, Cottonwood, Alder
Canopy Cover	6	6	Not actually a full canopy cover over stream, but existing plants are stable & channel is boulder dominated. Solar heating is not an issue
Noxious Weeds	3	3	No noxious weeds observed
Disturbance Plants	3	3	No disturbance induced plants observed
Woody Species Regeneration	8	8	Many sizes classes of alders & conifers present. Regeneration is occurring for all species.
Browsing	4	4	Very little browse observed
Floodplain, Energy	8	8	Channel is choked with large rock and woody debris
Total	60	60	
Score	1.00		

Supplemental Questions	
Substrate	Stony substrate of several sizes packed together. Interstices obvious. Substrate is easily moved.
Fish Habitat	Even mix of all-size pools. Habitat created by large boulders, woody debris, overhanging vegetation, root wads, undercut banks
Temperature Indicators	The stream has adequate shading, stable geomorphology, and sufficient flow
Flow	There is no noticeable alteration to flow
Nutrient Indicators	A thin layer of algae is barely visible

Additional comments:

Stream Name: North Fork East Fork Bull River **Reach:** Above East Fork Bull River Rd., RKM 0.3

Date: 9/25/2014 **Coordinates:** Lat. 48.12888 Long. 115.72163

Bankfull Depth (m): 0.86 **Bankfull Width (m):** 9.14 **Width/Depth Ratio:** 10.63

Channel Type: B **Substrate:** Cobble/Boulder **Primary Land Use:** National Forest Land, primarily roadless

Habitat Component	Score	Possible	Comments
Stream Incisement	8	8	Channel Was very stable
Bank Erosion	8	8	No active lateral cutting or erosion
W/D ratio and Sediment	6	6	W'D ratio was appropriate and sediment was in balance
Vegetation	2	2	Large woody species/plant community comprised almost entirely of cedar and hemlock
Canopy Cover	6	6	Canopy Cover is >85%
Noxious Weeds	3	3	No noxious weeds observed
Disturbance Plants	3	3	No disturbance induced plants observed
Woody Species Regeneration	8	8	Mostly older mature trees, but regeneration is occurring
Browsing	4	4	Very little browse observed
Floodplain, Energy	8	8	Channel is choked with large rock and woody debris
Total	56	56	
Score	1		

Supplemental Questions	
Substrate	Stony substrate of several sizes packed together. Interstices obvious. Substrate is easily moved
Fish Habitat	Even mix of all-size pools. Habitat created by large boulders, woody debris, overhanging vegetation, root wads, undercut banks
Temperature Indicators	The stream has adequate shading, stable geomorphology, and sufficient flow
Flow	There is no noticeable alteration to flow
Nutrient Indicators	A thin layer of algae is barely visible

Additional comments:

Appendix C

Table C-1. Mean August temperature (°C) with 95 % C.I. for study streams between 2011 and 2014.

	2011	2012	2013	2014
Copper Creek			9.5 (± 0.1)	9.4 (± 0.1)
Deep Creek	9.6 (± 0.1)	10.3 (± 0.1)	11.0 (± 0.1)	
Graves Creek	8.2 (± 0.2)	8.7 (± 0.2)	9.6 (± 0.2)	
NFEFBR	10.6 (± 0.2)	10.9 (± 0.3)	11.5 (± 0.2)	11.2 (± 0.2)