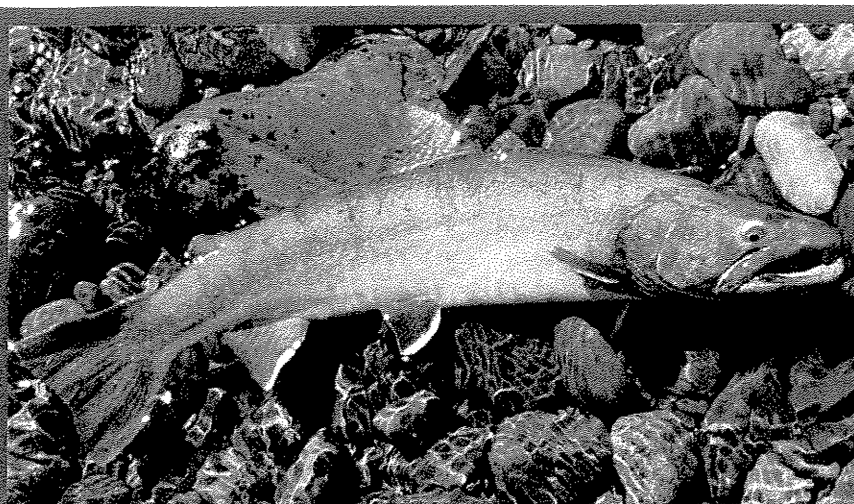
F-113-R-2
Region 2
Also F-04-19



The Blackfoot River Fisheries Inventory, Restoration and Monitoring Progress Report for 2001

A CENTURY OF CONSERVATION
1901 2001
Montana Fish, Wildlife & Parks

Blackfoot River Fisheries Inventory, Restoration and Monitoring Progress Report for 2001

by

Ron Pierce, Craig Podner and Jim McFee

A CENTURY OF CONSERVATION 1901 2001

Montana Fish, Wildlife and Parks
3201 Spurgin Road
Missoula, Montana 59804

March 2002

Abstract

In order to expand fisheries restoration in the Blackfoot Watershed beyond the current restoration focus area, we completed a three-year assessment of 49 Blackfoot River tributaries. These assessments began in 1999, continued through 2001, and focused on fish population inventories with emphasis on tributaries of the upper Blackfoot River and in the Garnet Mountains.

In 2001, we completed fish population inventories of 14 Garnet Mountain tributaries in the Upper Nevada Creek watershed. We found populations of westslope cutthroat trout (*Onchorynchus clarki lewisi*) widely distributed in headwater reaches, but also a population decline for the main stem Nevada Creek, compared with historic levels. Bull trout (*Salvelinus confluentus*) were absent from all 2001 Garnet Mountain samples, including areas where they were historically present. We found introduced species in only a few streams and the main stem of Nevada Creek upstream of Nevada Reservoir. We identified restoration potential on most inventoried streams.

In addition to these investigations, we completed restoration projects on 16 streams and fish population or habitat monitoring on 18 streams where projects were implemented. Restoration projects emphasized recovery of bull trout and westslope cutthroat trout. Salmonid densities, including native fish, continued to increase in several project tributaries, despite drought conditions in the last two years. In 2001, we continued habitat assessments in the Landers Fork and upper Blackfoot River and identified additional habitat problems in both areas.

In 2001, the FWP Commission adopted Blackfoot River regulations geared towards reducing the unintentional illegal harvest of bull trout. We also expanded special educational efforts in bull trout recovery/recreational conflict areas. Results for the 2000 whirling disease investigations showed infections expanding in the lower tributaries and over the length the main stem Blackfoot River downstream of Lincoln.

Table of Contents

Table of Contents (cont.)

Executive Summary

The Blackfoot River watershed is the site of a comprehensive wild trout restoration initiative, with emphasis on native fish recovery. Through the 1990s, we directed priority for restoration to lower Blackfoot River tributaries from the North Fork down-river. Restoration projects are now complete on many streams, and approaching final restoration phases on many others. In order to expand the restoration program, we completed the third year of a fisheries assessment for streams outside of the current restoration focus area. These assessments focused on tributaries to the upper Blackfoot River upstream of the North Fork Blackfoot River and Garnet Mountain tributaries in the southern region of the Blackfoot River watershed.

Assessments began in 1999 with fish population inventories on 13 upper Blackfoot River tributaries upstream of Nevada Creek, and continued in 2000 with fish population investigations on an additional 22 Garnet Mountain tributaries located in the southern region of the Blackfoot Watershed. In 2001, fish population investigations expanded to 18 more tributaries, of which 14 form the upper Nevada Creek watershed. Investigations included fish population surveys, westslope cutthroat trout (*Onchorynchus clarki lewisi*) genetic samples, measurements of stream discharge and temperature, and problem identification such as riparian degradation. During this three-year study, we found widespread problems influencing fish populations on agricultural bottomlands and in the foothills of the Garnet Mountain Range. We identified restoration opportunities on 52 sampled tributaries (Appendix H), and identified restoration potential on all 17 streams inventoried in 2001.

We found westslope cutthroat trout distributed throughout upper tributary reaches of Garnet Mountains streams. However, several streams supported low population densities, particularly in lower stream reaches. Of 49 sampled fish-bearing streams, 43 streams had westslope cutthroat trout. The majority (32) of streams that contained westslope cutthroat trout showed decreasing densities in the downstream direction from upstream reaches.

Streams in the Garnet Mountains support very few bull trout (*Salvelinus confluentus*) with reproduction only known to occur in two streams: Poorman Creek and Upper Nevada Creek (USFS unpublished data). We found no bull trout in upper Nevada Creek in 2001 sampling, despite their historical presence and recent USFS reports of bull trout near the mouth of Gleason Creek. We found brook trout (*Salvelinus fontinalis*) in only two of 14 sampled streams. Brown trout (*Salmo trutta*), present below Nevada Reservoir, were absent above of Nevada Reservoir. Rainbow trout (*O. mykis*) inhabit Nevada Creek and the lower reaches of several tributaries in a localized area upstream and downstream of Nevada Reservoir. Nevada Reservoir, historically stocked with hatchery rainbow trout, contributes to genetic introgression with westslope cutthroat trout populations upstream and possibly downstream of Nevada Reservoir

In addition to tributary baseline inventories, the 2001 Blackfoot River Restoration Initiative continued on several other fronts. We coordinated restoration projects on 16 tributaries and fish population monitoring on 18 project tributaries. Streams where restoration projects were completed prior to summer drought generally supported stable to increasing trout densities during the drought period. These increases demonstrate the importance of restoring riparian health and habitat features (i.e. correcting humaninduced limiting-factors) to damaged streams to be an effective method of mitigating drought, irrigation-induced low flows and other environmental extremes common to the Blackfoot watershed.

To further identify limiting-factors for the upper Blackfoot River bull trout population, we continued to evaluate habitat conditions in the lower Landers Fork and upper Blackfoot River upstream of the Landers Fork. These surveys identified elevated temperatures in the Landers Fork upstream of Copper Creek and simplified habitat in the upper Blackfoot River upstream of the Landers Fork.

During the summer of 2001, the Blackfoot watershed was subject to a second consecutive year of severe drought conditions. By early August, low flows and warming river temperatures prompted Fish, Wildlife and Parks to call for voluntary angling restrictions for the Blackfoot River and bull trout "core area" tributaries. In anticipation of the continued drought, a watershed-wide drought management plan under the guidance of the Blackfoot Challenge was implemented by mid-summer. This Plan, based on a concept of "shared sacrifice" called for phased voluntary reductions in irrigation and angling. A total of 72 drought plan participants implemented water conservation strategies. These participants, primarily irrigators, helped maintain minimal flows and fish population in several critically dewatered tributaries as well as the Blackfoot River.

Catch-and-release regulations for Blackfoot River brook trout were approved in 2001 to help protect Blackfoot River bull trout. Most anglers cannot identify bull trout and often misidentify bull trout as brook trout. Brook trout are rare in the mainstem Blackfoot River below the Landers Fork. This regulation, effective in 2002, resulted from uncontrolled angler pressure increases, the pervasive misidentification of bull trout, and the inability of other educational programs to address the problem of unintentional illegal harvest of bull trout. To further protect bull trout, FWP adopted *artificial-lure only* regulations for the Blackfoot River at the confluence of both Gold and Belmont Creeks. Bull trout are extremely vulnerable to increasing angling pressure at these confluences due to concentrated seasonal use by both bull trout and anglers.

Whirling disease studies continued in several areas. Studies include the completion of two MS graduate student research projects and continued sentinel cage studies in the Blackfoot watershed. Results from sentinel cage studies show continued increase in both the distribution and intensity of whirling disease in the mainstem Blackfoot River and some tributaries. The restoration of Kleinschmidt Creek, completed in 2001, will test if whirling disease can be reduced in degraded streams by improving stream health and reducing water temperatures.

NATIVE FISH RESTORATION SUMMARY

Five previous Blackfoot River reports detail bull trout and westslope cutthroat trout status, life history and restoration efforts in the Blackfoot drainage (Peters 1990, Pierce, Peters and Swanberg 1997, Pierce and Schmetterling 1999, Pierce and Podner 2000, Pierce, Podner and McFee 2001). The following section summarizes past findings, synthesizes new information and is presented to guide future recovery.

Bull Trout Recovery

Bull trout, listed as "Threatened" under the Endangered Species Act (ESA), has been the focus of an extensive recovery program since 1990. The primary goals of

Blackfoot bull trout recovery are to restore metapopulations, conserve genetic diversity, and restore watershed connectivity within and between all restoration areas and the seven conservation "core areas" (Montana Bull Trout Team 2000).

The Blackfoot River currently supports one of the largest populations of river-dwelling (fluvial) bull trout within the range of the species. However, fisheries investigations in the mid-to late 1980s documented declining populations with local populations extirpated in several tributary watersheds (Peters 1985, Peters 1990, Pierce et al. 1997).

Fluvial bull trout inhabit ~110 miles of the Blackfoot River main stem. Densities are very low in the upper Blackfoot River, but increase downstream of the North Fork at river-mile 54. Outside of the Clearwater drainage, bull trout occupy 23 % (22 of 94) of inventoried Blackfoot River tributaries and ~340 miles of stream. However, eleven streams support extremely low population densities. We identified no new bull trout populations in the 2001 stream inventories of 18 tributaries, and found no bull trout in two streams (McDermott Creek and upper Nevada Creek) that historically and reportedly still support bull trout.

Beginning in 1994, bull trout radio-telemetry studies identified an upper and lower component to the Blackfoot River fluvial bull trout population. For lower river bull trout (North Fork down stream), Swanberg (1997) reported the mean upstream spawning migration of ~39 river miles for 30 bull trout captured in over-wintering areas in the lower Blackfoot River. This and subsequent studies confirmed that a majority of the fluvial bull trout reproduction and rearing occurs in Monture Creek and the North Fork Blackfoot River. Most of the spawning for a smaller upper Blackfoot River population occurs in Copper Creek (Figure 1); upper river bull trout appear to occupy a much smaller home range of ~19 stream miles (Swanberg and Burns 1997). Radio-telemetry also identified bull trout movement to specific areas of thermal refugia, including cooler tributaries and the confluences of cooler tributaries, during warming periods (Swanberg, 1997). Fluvial bull trout from juvenile to adult life stages exhibit migratory behavior and include movement of young-of-the-year (YOY) to small, cold, non-spawning streams.

Our bull trout recovery program incorporates protective regulations, education on a broad scale, and an aggressive habitat restoration program. The nature of the recovery program is iterative and relies on continued habitat and population monitoring, plus expanding or modifying restoration methods based on monitoring results. Restoration has evolved from simple riparian fencing projects in spawning streams to watershed-level projects such as riparian grazing systems (including uplands), restoration of rearing streams, conservation easements and water management including the modification of irrigation methods.

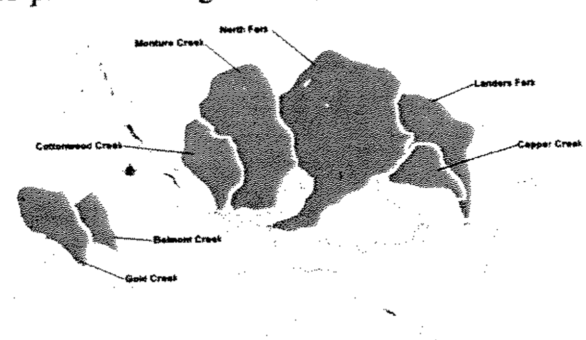


Figure 1. Bull trout core areas (excluding Clearwater River drainage) for the Blackfoot Watershed.

Bull trout recovery began in 1990 with the adoption of catch-and-release fishing regulations. Following the listing of bull trout under the ESA in 1994, FWP adopted regulations to prevent the intentional targeting of bull trout. In recent years, large increases in angling pressure, the inability of most anglers to identify bull trout, and the continued unintentional harvest has expanded concern for bull trout (FWP angler pressure estimates, Schmetterling and Long 1999). In response, the FWP Commission adopted regulations, effective in 2002, to reduce the unintentional illegal harvest of bull trout. These regulations include 1) the adoption of catch-and-release for Blackfoot River brook trout, a species rare in the Blackfoot River and commonly confused with bull trout; and 2) gear limitations (artificial-lure only) for the Blackfoot River at confluences of both Gold Creek and Belmont Creek.

In response to large angler increases and ill-advised plans to accelerate recreational developments in critical bull trout recovery areas, we identified bull trout recovery/recreational conflict areas in 2001. These are key spawning, rearing and staging areas, as well as, thermal refuge areas on reaches of Gold, Belmont, Copper and Monture Creeks, and reaches of the Landers Fork, North Fork and Blackfoot River (Pierce et al. 2001). Conflict areas identify recreational developments in areas of critical bull trout importance, those that support substantial increased angler use, and have documented illegal bull trout harvest problems. In 2001, we adopted protective regulations at two of these locations (confluence areas of Gold and Belmont Creeks) and initiated an educational campaign (regulations, bull trout identification signs) for all public access sites at all conflict areas (Figure 2). Resource planners in the Blackfoot watershed should recognize the importance of these habitats and adopt an appropriate, more conservation-based, philosophy towards recreational developments in these areas.

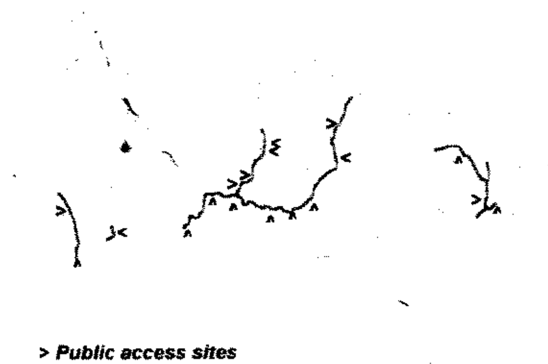


Figure 2. Bull trout recovery/recreational conflict areas.

Since 1990, bull trout restoration projects were undertaken in five of seven "core area" (spawning and rearing areas) drainages (Figure 1) and several streams historically supporting bull trout (Pierce et al. 1997, Pierce and Schmetterling, 1999, Pierce and Podner 2000). Beginning in the early 1990s, we directed the majority of bull trout restoration activities to the Monture Creek and North Fork Blackfoot River watersheds, including 8 headwater tributaries within these drainages. Restoration activities included: 1) fish screening on nine irrigation ditches; 2) riparian livestock management changes on 32-miles of riparian corridor; 3) removing seasonal migration barriers in three rearing tributaries; 4) instream habitat restoration and erosion control efforts on 17-miles of degraded stream; 5) increasing stream flows on five streams; 6) protection of spawning areas from livestock; and 7) enlisting landowners in perpetual conservation easements programs along 17-miles of riparian corridor. We completed similar but less extensive restoration directed to bull trout in the Gold, Belmont and Cottonwood Creek watersheds - all core areas. Many completed bull trout restoration projects, particularly the Monture and North Fork projects, contribute to improved bull trout status in the lower Blackfoot River.

In 2001, bull trout restoration continued in core areas of the Blackfoot River watershed including Cottonwood, Dunham, Kleinschmidt, McCabe and Rock Creeks and the North Fork. We initiated restoration projects in lower Poorman Creek and began to evaluate Dick Creek as a candidate restoration stream. Fish population monitoring on restored reaches of Rock Creek, Spring Creek, Gold Creek and Cottonwood Creek indicate initial increases in bull trout population size (Results Part III).

Bull trout densities at both lower Blackfoot River sampling locations (Johnsrud and Scotty Brown Sections) are increasing (Pierce et al. 2001). Redd surveys in index reaches of Monture Creek and the North Fork show increased bull trout reproduction (Figure 3). From 1990 to 1998, densities of juvenile bull trout also increased in Monture Creek and the North Fork (Pierce and Schmetterling 1999). Between 1998 and 2000, juvenile densities remain static in Monture Creek, but declined in both Dunham Creek and North Fork-probably due to drought. Juvenile bull trout appear to be slowly expanding into several restored smaller "non-spawning" tributaries including Bear, Chamberlain, East Twin, Rock, Kleinschmidt and Spring Creeks (Pierce et al. 1997, Pierce and Schmetterling 1999, Results Part III).

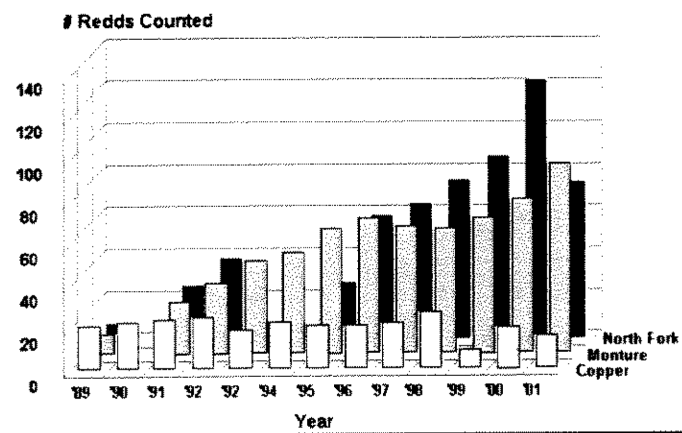


Figure 3. Fluvial bull trout redd counts in index sections of the three primary spawning streams, 1989-

Although densities of bull trout are now increasing in the lower Blackfoot River, Monture Creek and the North Fork, fluvial bull trout status remains precarious in areas of the upper Blackfoot River watershed upstream of the North Fork (Pierce and Podner 2000). This area has received very limited recovery effort. Redd surveys for the upper river population, located in a long-term index reach of Copper Creek, shows a 13-year static trend (Figure 3). Likewise, juvenile densities in Copper Creek show no signs of improvement (Pierce and Podner 2000). Bull trout densities in the upper Blackfoot River remain very low (Pierce and Podner 2000). In 2001, we continued to assess habitat in the Landers Fork and Blackfoot River upstream of the Landers Fork to help identify limiting factors for the upper Blackfoot River population. Evaluations found elevated temperatures as well as other habitat problems in a 3.7-mile section of Landers Fork between Silver King Falls and Copper Creek, and simplified habitat in the Blackfoot River upstream and downstream of the Landers Fork.

Bull trout densities (fish >6.0") for the Blackfoot River in 2000 range from 4.3 fish/1000' (2.5% of the total trout population) in the lower river (Johnsrud Section) to 7.7 fish/1000' (8% of the total trout population) in the middle Blackfoot River (Scotty Brown Bridge section). Bull trout densities in the upper Blackfoot River (upstream of Nevada Creek) are too low to estimate. However, 1999 catch statistics indicate densities (fish >6.0") range from one to two fish/1000'. We have not documented bull trout presence in the Blackfoot River between the North Fork and Nevada Creek. Poor water quality and elevated water temperatures are likely factors for bull trout absence in this 15-mile river reach.

Since 1907, Milltown Dam, located at the mouth of the Blackfoot River, has blocked upstream bull trout migrations. A recent telemetry study recorded an 8% (3 of 37) direct loss of radio-tagged Blackfoot River bull trout over Milltown Dam (Swanberg 1997). Milltown Reservoir also provides habitat for northern pike (*Exos lucius*), which have shown a seasonal dietary preference for juvenile bull trout (Schmetterling 2001). In 2000-01, ten of 14 adult bull trout that were captured below Milltown dam, implanted with transmitters and released above the reservoir, migrated upstream an average of 61.2 river miles (range 49.6–80.2) to Blackfoot River tributaries. Three of the remaining four migrated to tributaries of Rock Creek (Schmetterling 2002). These studies demonstrate some of the adverse impacts of Milltown Dam, the large spatial extent of impacts to bull trout, and the continued need to mitigate these impacts.

Westslope cutthroat trout Recovery

Westslope cutthroat trout (WSCT hereafter) is classified a "species of special concern" in Montana by the American Fisheries Society and Montana Fish, Wildlife and Parks. Within the last 100 years, WSCT have declined throughout much of their historic range, particularly east of the Continental Divide. Liknes (1984) and Shepard et al. (1997) estimated that WSCT currently inhabit only about 20% of their former range in Montana, and genetically pure populations occupy less than 10% of their current range. Reasons for the decline of WSCT include habitat loss and degradation, genetic introgression with introduced rainbow trout and Yellowstone cutthroat trout, overharvest, as well as competition with exotic species such as brook trout and brown trout (Liknes 1984, Allendorf and Leary 1988, Liknes and Graham 1988, McIntyre and Rieman 1995).

The Blackfoot watershed supports a basin-wide distribution of WSCT, with 88% (83 of 94) of surveyed fish-bearing tributaries, outside of the Clearwater drainage, containing WSCT. WSCT stocks include both migratory and non-migratory life-histories. Non-migratory or "resident" WSCT is the most abundant salmonid in the upper reaches of most tributary streams. In some cases, disjunct resident populations of WSCT occupy less than one mile of perennial stream (Pierce et al 2001). Streams without WSCT were either degraded headwater streams or degraded spring creeks and/or dominated by non-natives species.

WSCT rely on high quality tributary habitats for spawning, rearing and over-wintering. Access to tributaries from the Blackfoot River is also necessary for the migratory or "fluvial" life-history form. Fluvial WSCT spawn in small basin-fed tributaries where the young rear for up to 3-years before migrating to a river to mature (Behnke 1992). Spawning movements of Blackfoot River fluvial WSCT can be complex and extensive; up to ~70-miles. Documented movements extend from the lower river to headwater tributaries as far upstream as tributaries of the North Fork Blackfoot River (Schmetterling 2000). As with Blackfoot River bull trout, telemetry studies of WSCT in the lower Blackfoot River have documented no Blackfoot River use above the confluence of the North Fork to date (Schmetterling 2000, Schmetterling 2002).

Spawning movements of Blackfoot River fluvial WSCT begin on the rising limb of the hydrograph, with adults entering spawning tributaries near the peak of the hydrograph. This movement pattern allows WSCT the ability to navigate intermittent channels as well as other obstructions common to the Blackfoot. While in tributaries, spawners almost exclusively select for habitat units formed by instream, large woody debris, which provides holding areas, physical cover and retains spawning gravel

(Schmetterling 2001). Peak Blackfoot River flows in 2001 were the 5th lowest for a 64-year period of record (USGS 2001). These low flows during the spawning migration period along with the presence of beaver dams in the migration corridor likely restricted the upstream movement of spawners into some tributaries, including Pearson Creek (Results Part III). WSCT migration corridors, spawning and rearing areas generally occur on private land in lower-to-middle reaches and extend onto public lands in mid-to-upper reaches. Although restoration projects have improved WSCT habitat on many streams, habitat loss through riparian degradation occurs throughout the lower reaches of most streams. Of 78 streams that contain WSCT, we have identified significant habitat problems with 73 of these streams identified as impaired.

WSCT recovery began in 1990 with the adoption of catch-and-release angling regulations. Since 1990, in conjunction with fluvial bull trout recovery, the focus of WSCT restoration is reestablishing the fluvial life-history form by: 1) reducing or eliminating "controllable" sources of mortality; 2) maintaining or restoring existing spawning and rearing habitats; 3) restoring damaged habitats; and 4) reestablishing connectivity for the Blackfoot River to spawning areas. Between 1990 and 2002, we completed restoration projects targeting these features on 30 tributaries that contain WSCT.

In 2001, the Blackfoot Cooperators continued to correct habitat problems, completing projects on 9 streams that support WSCT (Chamberlain, Cottonwood, Douglas, Kleinschmidt, McCabe, Nevada Spring, Rock and Warren Creeks and North Fork Blackfoot River- *see* Results Part III); we continued to coordinate and develop projects on seven tributaries (Ashby, Belmont, Dick, Pearson, Poorman, Warren Creeks and the North Fork). Fish population monitoring on project streams show stable or improving WSCT densities in some project reaches despite the current drought (Results Part III). These results demonstrate the resiliency of some WSCT populations - an ability to respond favorably to improved habitat, even during periods of extreme low flow.

WSCT are increasing in abundance at lower elevations, including 108 miles of the mainstem Blackfoot River downstream of Poorman Creek (Pierce et al. 2001). Like bull trout, the largest density increases for Blackfoot River WSCT are occurring in the restoration focus area downstream of the North Fork Blackfoot River (Pierce and Podner 2000). Between 1989 and 2000, fluvial WSCT (fish >6.0") in the lower Blackfoot River increased in the Johnsrud Section from 1.7 to 17.4 fish/1,000' and in the Scotty Brown Bridge section from 2.3 to 23.9 fish/1,000' (Figure 3). WSCT densities increased in restored sections of the North Fork Blackfoot River, Monture, Chamberlain, McCabe, Pearson, Dunham, Spring, Shanley, Warren and Cottonwood Creeks (Pierce and Schmetterling, 1999, Pierce and Podner, 2000). Radio-telemetry and related spawning surveys confirm that several project tributaries (Gold, Chamberlain, Dry, Pearson Dunham and Monture creeks and the North Fork) support populations of fluvial WSCT (Schmetterling 2001, FWP unpublished data).

Catch-and-release regulations initiated in 1990 contribute to fluvial WSCT population increases over the length of the Blackfoot River, including reaches upstream of the North Fork. The upper Blackfoot River extends beyond the geographic scope of the current restoration focus area. The upper Blackfoot River upstream of the North Fork supports much lower WSCT densities than the lower river downstream of the North Fork. A 15-mile section of the middle Blackfoot River between the North Fork and

Nevada Creek confluences supports particularly low WSCT densities (Pierce and Podner, 2000).

In 1988, FWP initially identified habitat degradation and low fish densities in the Nevada Creek to North Fork reach of the Blackfoot River (Peters and Spoon 1989). Since then, several studies have traced low population densities to water quality problems, reduced riparian health and a lack of functional tributaries entering this reach (Ingman et al. 1990, Pierce et al. 1997, Marler 1998). In 1999, we found low densities comparable to 1988, continued weak recruitment, and the lowest WSCT densities found in the Blackfoot River monitoring sites downstream of Poorman Creek (Peters and Spoon 1989, Pierce and Podner 2000).

In 2001, we completed a three-year inventory of 53 streams, with emphasis on Garnet Mountain tributaries (Pierce and Podner 2000, Pierce et al. 2001, this report). In 2001, we completed inventories of 18 more fish-bearing Blackfoot River tributaries, of which 16 contain WSCT (Results Part II). Most of these streams have limited historical fisheries data, particularly in lower stream reaches. From this three-year study, we determined that 42 of 43 WSCT sampled streams were impaired and have potential restoration opportunities (Pierce and Podner 2000, Pierce et al. 2001, this report, Appendix H). We also continued to evaluate WSCT habitat conditions in the upper Blackfoot River and the Landers Fork. Surveys identified low habitat complexity for the Blackfoot River upstream and downstream of the Landers Fork and elevated water temperatures in the Landers Fork upstream of Copper Creek (Results Part IV).

Between 1999 and 2001, we collected WSCT genetic samples from 42 tributaries and 19 were analyzed for genetic purity (Pierce and Podner 2000, Pierce et al. 2001). In 2001, we received results of WSCT tested in six Blackfoot watershed tributaries (Appendix). Tested samples include: 1) Ashby (n=16) and Arkansas Creeks (n=20), tributaries to Union Creek; 2) Wales (n=25) and Yourname Creeks (n=25), direct tributaries to the middle Blackfoot River between Nevada Creek and the North Fork; and 3) Murray (n=25) and Cottonwood Creeks (n=24), tributaries of Douglas Creek. Genetic testing detected no introgression with hybridizing species for these six streams (Appendix I). Genetic testing is helping us outline three regions of the Blackfoot (the upper Blackfoot upstream of Nevada Creek, the Union Creek and Douglas Creek drainage) as possible candidates for WSCT conservation areas. Lack of funding is preventing analysis of the remaining samples.

Milltown Dam exerts a negative influence on fluvial Blackfoot River WSCT. In 2000-01, 15 of 26 mature WSCT captured below Milltown Dam implanted with radio transmitters and released upstream of the reservoir, made spawning migrations in the Blackfoot Watershed (Schmetterling 2001). Upstream spawning migrations averaged 37.3 river miles (range 17.7-70.7); migrations extended to tributaries of the lower Blackfoot River (i.e. Gold Creek) as far upstream as Dry Creek, a tributary of the North Fork (Schmetterling 2001). These extensive and often complex spawning movements demonstrate the large spatial extent of Milltown Dam impacts to fluvial WSCT and importance of an integrated basin-wide approach to restoration, which includes the need for continued mitigation along with fish passage at Milltown Dam.

Introduction

Fish population studies in the late 1980s and early 1990s identified that 1) mining impacts in the headwaters, 2) over-exploitation of the fishery, and 3) extensive degradation of tributary habitats contributed to declining Blackfoot River fish populations. Beginning in the mid-1990s, additional fisheries concern emerged with the introduction of several exotic organisms, along with the uncontrolled recreational increases in critical native species recovery areas.

Early studies documented low densities of native westslope cutthroat trout (*Onchorynchus clarki lewisi*) at the mid- to low elevations of the Blackfoot watershed (Peters and Spoon 1989, Peters 1990). Bull trout (*Salvelinus confluentus*) densities were low basin-wide, with local populations extirpated in several streams. Fish population investigations found that early life-stages of salmonids in the lower Blackfoot River rely on tributaries. Tributary assessments reported extensive problems, spanning multiple land ownerships that resulted in fish population declines at a watershed scale (Peters and Spoon 1989, Peters 1990, Pierce et al. 1997, Pierce and Schmetterling 1999, Pierce and Podner 2000).

Low numbers of adult rainbow (*O. mykis*) and brown trout (*Salmo trutta*) at the low-to-mid elevations of the watershed, combined with high winter mortality of young-of–the–year (YOY) trout and poor tributary habitats resulted in weak recruitment to river populations for these species (Peters and Spoon 1989, Peters 1990, Pierce et al. 1997). Reliance of native fish on upper tributary reaches at early life stages indicates an adaptation to the severe environment of the Blackfoot River. However, due to 1) poor tributary conditions, 2) long migrations, 3) high fidelity to natal streams, 4) barriers to movement, and 5) more extensive use of the tributaries at early life stages, fluvial native fish are even more subject to human impacts in the tributary system than introduced fish species. By contrast non-native rainbow and brown trout spawn in lower stream reaches, migrate shorter distances, have less fidelity to their natal streams,

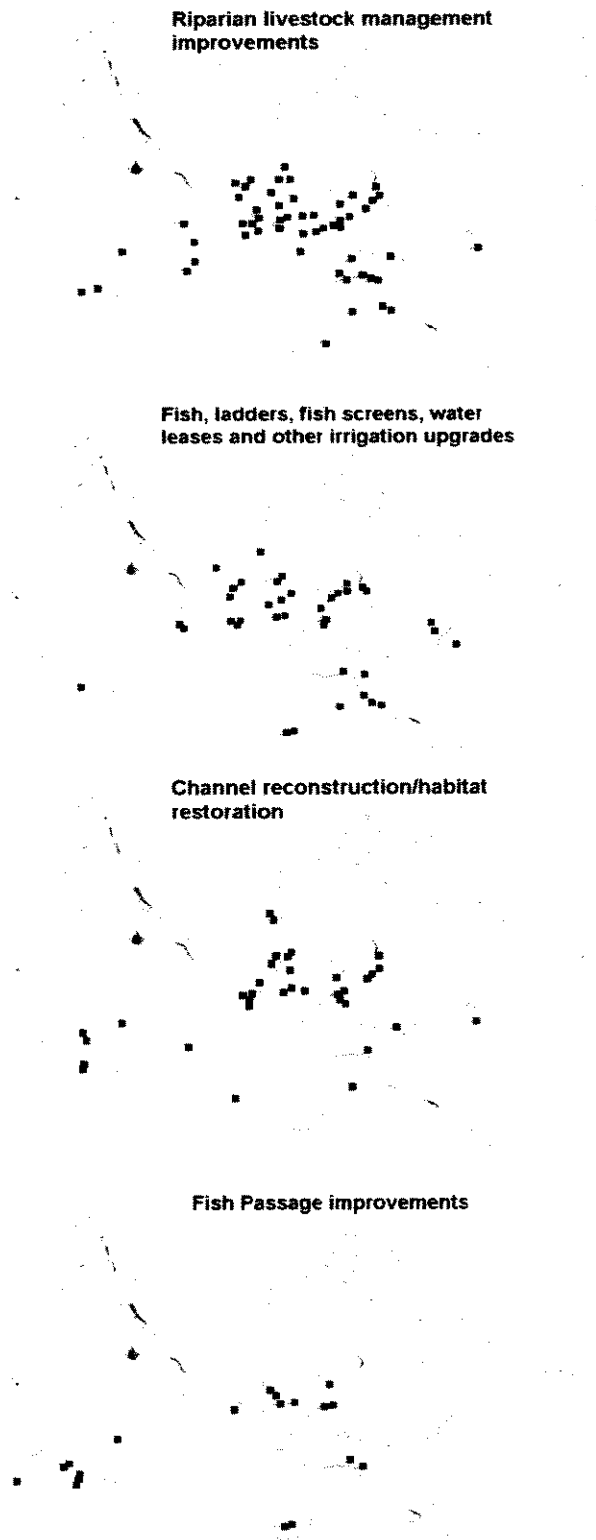


Figure 4. Location map of principal restoration activities.

and as a result are less sensitive to the same human-related impacts of the tributary system.

Throughout the 1990s, the Blackfoot River watershed was the site of cooperative private and public lands fisheries restoration initiative. During this effort, we directed special riparian and upland restoration activities, that provide for riparian-dependant species including a diversity of self-sustaining wild trout populations, to 37 tributaries of the Blackfoot River. We prioritized restoration on streams supporting populations of WSCT and bull trout, especially tributaries of the lower to middle Blackfoot River (Figure 4). Restoration tools include reconstructing stream channels and restoring habitat features to damaged streams, developing low impact grazing systems and removing streamside feedlots, planting native riparian vegetation, improving stream flows, restoring fish migration corridors and enrolling landowners in perpetual conservation easement programs. Cooperators included private landowners, private organizations, non-profit groups, and state and federal agencies.

Restoration has contributed to improved native fish populations at the low to mid elevations of the watershed. WSCT densities have increased ~900% in the lower to middle reaches of the Blackfoot River downstream of the North Fork confluence. Several tributaries support increased WSCT densities. Bull trout densities are increasing in the lower river system including both Monture Creek and the North Fork Blackfoot River, but remain at static, low densities upstream of Nevada Creek.

Although fish populations are improving in the lower watershed, correcting major habitat problems (timber, mining and agricultural impacts) is far from complete. Most of the Blackfoot watershed (upper Blackfoot River drainage upstream of Nevada Creek, Nevada Creek drainage, Clearwater River drainage and Garnet Mountains) lies beyond the scope of the current restoration focus area. In addition, several issues beyond the original scope of identified problems have emerged in the last several years. These additional challenges to the conservation of wild trout include: 1) the recent introduction of five exotic fishes (northern pike (*Exos lucius*), white sucker (*Catostomus commersoni*), yellow perch (*Perca flavescens*), fathead minnow (*Pimephales promelas*) and brook stickleback (*Culaea inconstans*)) to the Blackfoot River drainage; 2) the mitigation of Milltown Dam impacts; 3) the introduction of *Myxobolus cerebralis* and expansion of whirling disease; and 4) upward trends in recreational river use in critical bull trout recovery areas, combined with the inability of a growing number of anglers to identify bull trout. The long-term conservation of native fishes requires expanded effort with respect to these emerging issues.

In 2001, we continued to correct habitat problems in the lower watershed. We also completed a three-year investigation of fish populations outside of the current restoration focus area. The 2001 assessment included baseline fish population and riparian assessments for 14 Garnet Mountain streams plus four other streams, bringing the total number of inventoried tributaries during this three-year period to 54. The results of these inventories will help prioritize and expand tributary restoration beyond the current focus area. We also completed several other fisheries-related investigations in 2001, including restoration project monitoring, stream habitat assessments in the upper Blackfoot River, continued whirling disease studies, helped implement drought plans and adopted special regulations to protect Blackfoot River bull trout.

Primary objectives of the report are to: 1) document fish population changes in the lower Blackfoot River; 2) report fish population inventory results, for the Garnet Mountain streams upstream of Nevada Reservoir; 3) report changes in the species composition and densities of fish and changes in their habitats resulting from restoration efforts; 4) present results of other aquatic studies which relate to the health and recovery of Blackfoot River fish populations; and 5) help guide future restoration activities.

Study Area

The Blackfoot River, located in west-central Montana, begins at the junction of Beartrap and Anaconda Creeks, and flows west 132 miles from its headwaters near the Continental Divide to its confluence with the Clark Fork River in Bonner, Montana (Figure 5). Mean annual discharge is 1,607 cubic-feet-per-second (cfs).

This river system drains a 2,320 square mile watershed through a 3,700-mile stream network of which 1,900 miles are perennial streams capable of supporting fishes. The physical geography of the watershed ranges from high-elevation glaciated alpine meadows, timbered forests at the mid-elevations to prairie pothole topography on the valley floor. Glacial landforms, moraine and outwash, glacial lake sediments and erratic boulders cover the floor of the entire Blackfoot River valley and exert a controlling influence on the habitat features of the Blackfoot River and the lower reaches of most tributaries. The Blackfoot River is a free flowing river to its confluence with the Clark Fork River where Milltown dam, a run-of-the-river hydroelectric facility, has blocked upstream fish passage since 1907.

Land ownership in the Blackfoot watershed is 44% National Forest, 5% Bureau of Land Management, 7% State of Montana, 20% Plum Creek Timber Company and 24% other private ownership. In general, public lands and large tracts of Plum Creek Timber Company properties comprise large forested tracts in mountainous areas of the watershed while private lands occupy the foothills and lower valley areas (Figure 5). Traditional land-use in the basin includes mining, timber harvest, agriculture and recreation activities, all of which have contributed to habitat degradation or fish population declines. Of 94 inventoried streams, 88 have been altered, degraded or otherwise identified as fisheries-impaired since inventories began in 1989. Restoration has been directed to 37 of these streams. The majority of habitat degradation occurs on valley floor and foothills of the Blackfoot watershed and largely on private agricultural ranchlands. However, problems also extend to commercial timber areas and mining districts, state and federal public lands.

The Blackfoot River is one of twelve renowned "blue-ribbon" trout rivers in Montana an appropriated "Murphy" in-stream flow water right. The Montana Fish, Wildlife and Parks manages the Blackfoot River and tributaries for a diversity of self-sustaining "wild trout" populations. Distribution patterns of most salmonids generally conform to the physical geography of the landscape, with species richness increasing longitudinally in the downstream direction (Figure 6). Species assemblages and densities of fish can also vary greatly at the lower elevations of the watershed.

Most salmonids (WSCT, bull trout, rainbow trout and brown trout) in the river system exhibit migratory life-history characteristics. WSCT has a basin-wide distribution and is the most abundant species in the upper reaches of the tributary system. Bull trout distribution extends from the mainstem Blackfoot River to headwaters of larger tributaries north of the Blackfoot River mainstem; however, juvenile bull trout will rear in smaller "non-spawning" tributaries, some of which are located in the Garnet Mountains. Rainbow trout distribution is limited to the Blackfoot River downstream of Nevada Creek and lower reaches of the lower river tributaries, with the exception of Nevada Creek upstream and downstream of Nevada Reservoir. Rainbow trout occupy ~10% of the perennial streams in the Blackfoot watershed, with river populations reproducing primarily in the lower portions of larger south-flowing tributaries. Brown trout inhabit ~15% of the perennial stream system with a distribution that extends from the Landers Fork down the length of the Blackfoot River and into the lower foothills of the tributary system. Brook trout are widely distributed in tributaries but rare in the mainstem Blackfoot River below the Landers Fork.

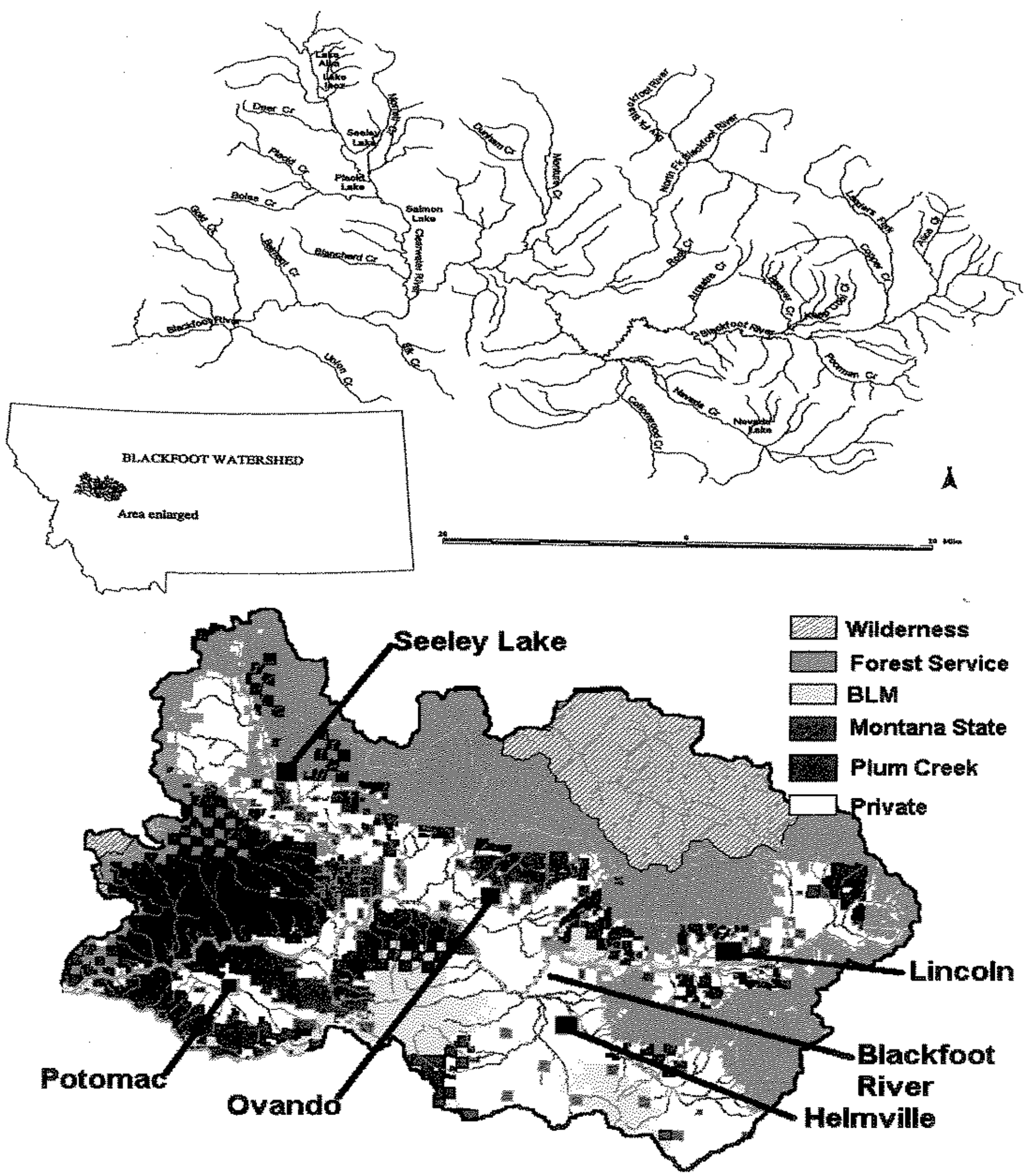
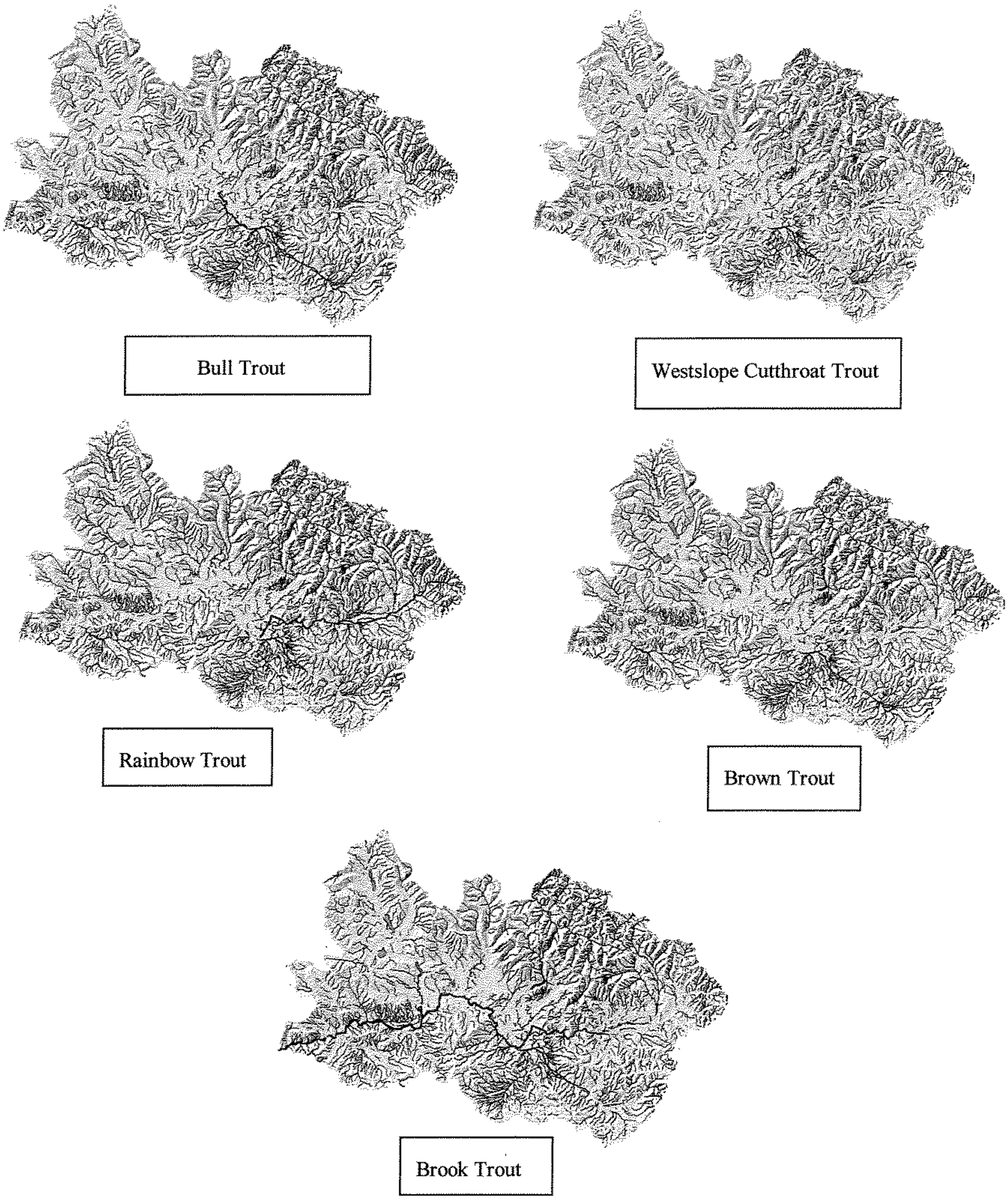


Figure 5. Study area: The Blackfoot River watershed (above) with land ownership (below).

Figure 6. Trout distribution for the Blackfoot River watershed.



Procedures

Working with Private Landowners: the Key to Successful Restoration

The emphasis of the Blackfoot River restoration initiative is to restore degraded tributaries by improving riparian health and fish habitat. Typically, each tributary project involves multiple landowners, multiple professional disciplines, more than one funding source plus the involvement of a watershed group. Restoration has focused on addressing obvious impacts to fish populations such as migration barriers, stream de-watering, fish losses to irrigation canals and degraded riparian areas. All projects are cooperative efforts between private landowners and the restoration team, and occur throughout the drainage but emphasize tributaries from the North Fork down river. All projects are voluntary, incorporate landowner needs (such as irrigation and grazing objectives), and are administered at the local level by a core group of agency resource specialists in cooperation with local watershed groups, including both the Big Blackfoot Chapter of Trout Unlimited and the Blackfoot Challenge, or local government groups such as the North Powell Conservation District. Tax incentives of the watershed groups with non-profit 501(c)3 status are key to generating private dollars for restoration.

Two full-time restoration biologists help coordinate restoration efforts (wildlife biologist from the U. S. Fish and Wildlife Service-Partners for Fish and Wildlife Program, and a fisheries biologist from the Montana Fish, Wildlife and Parks). A lead biologist generally enlists help from interagency personnel including range conservationists, hydrologists, engineers and water rights specialists as necessary. In turn, the watershed groups help prioritize projects, administer budgets, solicit bids and assist with landowner contacts, resolve conflicts and help address other social issues.

Cost-sharing of projects is arranged by project personnel and comes from many sources including landowner contributions, private donations, foundation grants, and state and federal agency programs. Project biologists and/or the watershed group undertake grant writing and fund-raising. The lead biologist usually writes environmental assessments and obtains project permits on behalf of the cooperating landowner.

Project bids (consulting and construction) conform to State and Federal procurement policies. These policies included the development of Blackfoot watershed qualified vendors lists (QVL) derived through a competitive process. A minimal project cost triggers use of the QVL. The watershed groups solicit bids from the QVL for both consulting and contractor services. Bid-contracts are signed between the watershed group and the selected vendor upon bid acceptance.

Depending on the specific project, landowners are responsible for much of the cost, construction and maintenance of projects. Addressing the source of stream degradation usually requires developing riparian/upland management options sensitive to the requirements of fish and other riparian-dependent species. Written agreements (15-30 year period) with landowners to maintain projects are arranged with cooperators on each project. These agreements vary by funding source and may include agencies, the North Powell Conservation District and/or the Fish and Habitat Committee of the Big Blackfoot Chapter of Trout Unlimited.

Landowner awareness of the habitat requirements of fish and wildlife and their full participation in projects are considered crucial to the long-term success of the restoration initiative. Landowners are encouraged to participate in all project phases from fish population data collection, to problem identification, restoration and monitoring of completed projects. Although many restoration projects have been completed in the Blackfoot River watershed, this effort is considered educational at a broad level and is far from complete.

Fish Population Investigations

Fish population densities were calculated using single-pass, mark-recapture, or multiple pass-depletion methods. We used mark-recapture in the North Fork and Monture Creek and depletion estimates in smaller streams (Appendix C). Population densities using the mark-recapture method were estimated using Chapman's modification of the Petersen formula (Ricker 1975); confidence intervals were calculated using the Seber Formula.

For small streams, fish population surveys rely on two general methods. The first is a single pass catch-per-unit effort (CPUE); this provides an index of relative abundance (Appendix A). The second is a population density estimate generated from a two-pass depletion survey (Appendix B). We developed a simple linear regression ($y = 1.717x - 0.797$) to help predict densities from CPUE; and found a close relationship between the two methods, Rsquare=0.902, $P<0.001$ (Pierce et al. 1997). Small stream size and highly efficient electrofishing conditions in our study streams contributed to this outcome. Although the regression demonstrates CPUE to be an index to population density, CPUE does not include a confidence interval like the actual population density estimate. For this report, CPUE refers to the number of fish collected in a single electrofishing pass and is adjusted per 100 feet of stream (I.e. CPUE of 8 means 8 fish captured per 100' of sampled stream). Actual population estimates are referred to as density/100'. The 95% confidence intervals for these estimates are found in Appendix B.

Fish were captured using a boat or backpack mounted electrofishing unit. In small streams, we used either a gas-powered (Coffelt Mark 10) or battery powered (Smith/Root) backpack mounted DC electrofishing unit. The anode (positive electrode) was a hand-held wand equipped with a 1-foot-diameter hoop; the cathode (negative electrode), a braided steel wire. On the North Fork and Monture Creek, we used an aluminum drift boat mounted with a Coffelt Model VVP-15 rectifier and 5,000 watt generator. The hull of the boat was used as a cathode and two fiberglass booms, each with four steel cable droppers, served as anodes. We used direct current (DC) waveform with output less than 1000 watts, which is an established method to significantly reduce spinal injuries in fish associated with electrofishing (Fredenberg 1992). Juvenile trout were sampled in the tributaries from August to November. Extra effort was used to sample stream edges and around cover to enable comparisons of densities between sampling sections. Captured fish were anesthetized with either methansulfonate (MS-222) or clove oil, weighed (g) and measured (mm) for total length (TL). For this report, we converted all weights and lengths to standard units.

Bull Trout Redd Surveys

Bull Trout redds were surveyed in Copper Creek, Dunham Creek, Gold Creek, Monture Creek and North Fork Blackfoot River. Redd counts in this report are not complete counts but rather surveys of index reaches to spawning adult abundance in selected reaches. Counts were made by walking the spawning areas in late September.

Redd areas were identified by a cleaned, oval shape (pit), and a mound of unconsolidated gravel (tailspill) left by the females digging activities. Only redds where a definite pit and tailspill were discernable were counted.

Whirling Disease Sentinel Cage Studies

Whirling disease surveys including live fish cage studies were undertaken in the Blackfoot Watershed in 2000. The live cage study is a controlled experiment used to detect levels of whirling disease. Detection of whirling disease relied on histological examination of hatchery rainbow trout placed in sentinel cages. The live cages used consisted of an 18x24" cylindrical screened container placed into a stream site allowing stream water to flow through the cage. Each cage contained 50 uninfected 35-60 mm rainbow trout or WSCT supplied by a state fish hatchery. Timing of field exposure was based on anticipated mean daily temperatures in the 50's (F), which correlates with peak triactinomyxon (TAM) production, and correspond to peak infection rates in fish. The exposure period for each live cage was standardized at 10 days. At the end of the 10-day exposure period, the trout were removed and taken to Pony, MT, where they were held for an additional 80 days at a constant 50 °F temperature to insure the WD infection would reach its maximum intensity. At the end of the 90-day period, all the surviving fish were sacrificed and sent to the Washington State University Animal Disease Diagnostic Laboratory at Pullman, WA. At the lab, the heads were histologically examined and infection intensity 0 (absent) to 5 (severe) was assigned to each fish. The results of this histological rating were presented as mean grade infection. Mean grade infections above 2.7 are likely to result in population level declines (Vincent 2001). Every live cage site also had an accompanying thermograph to establish mean daily water temperatures during the exposure period.

WSCT Genetic Investigations

In 2001, we collected WSCT genetic samples from 42 Garnet Mountain tributaries. Samples consisted of non-lethal tissue samples (fin-clip) taken from 25 individual fish when possible. Samples collected were immediately preserved in 95% ethyl alcohol and either placed in storage due to lack of funding, or were taken to the University of Montana, Salmon and Wild Trout Genetics Lab for electrophoretic analysis.

The Paired Interspersed Nuclear DNA Element-PCR (PINE-PCR) method is used to determine each fish's genetic characteristics at 21 regions of nuclear DNA. This method produces DNA fragments (PINE markers hereafter) that distinguish WSCT, from rainbow trout and Yellowstone cutthroat trout (*O. clarki. bouveri*). These species, specific PINE markers, therefore, can be used to determine whether a sample came from a genetically pure population of one of these fishes or one in which hybridization between two or all three of them has occurred. With a sample size of 25 fish, this testing method has a 95% chance of identifying as little as 1% introgression.

Stream Temperature

Warming during the summer period, in the mid-to-lower reaches of the Blackfoot River and many tributaries, periodically increases to levels considered stressful for salmonids (>70 degrees F). During the summer of 2001, we completed stream temperature monitoring for the mainstem Blackfoot River and all major direct tributaries to the Blackfoot River. The study included seven Blackfoot River sampling locations (four long-term sampling locations), plus 48 sampling sites on 37 tributaries. Of these 37 tributaries, 22 are direct tributaries to the Blackfoot River. For these 22 tributaries, temperature sensors were placed near their confluences with the Blackfoot River.

Objectives of the temperature data collections were to: 1) profile temperatures over the length of the river; 2) identify and monitor thermal properties of tributaries entering the river; 3) identify thermal regimes favorable and unfavorable for trout; 4) monitor temperature triggers used in the Drought Management Plan; 5) monitor stream restoration projects; and 5) establish additional baseline information and compile data for future studies.

In 2000, water temperatures (°F) were recorded at 48 to 72 minute intervals using Hobo temperature or tidbit data loggers. Data for each station are summarized with monthly mean, maximum, minimum and standard deviation in Appendix H.

Channel morphometrics: natural channel design and fish habitat restoration (*from* Brown, Decker, Pierce and Brandt 2001)

For channel reconstruction and habitat restoration in the Blackfoot River drainage, we rely on a natural channel design philosophy (NCDP). This philosophy requires a multidisciplinary approach to stream restoration along with an understanding of historical riparian land use. Project complexity and risk define a specific combination of design methods. The Rosgen stream classification provides the basis of this approach (Rosgen 1994; Rosgen 1996). NCDP quantifies channel shape, pattern, and gradient (Rosgen 1996). Riparian health, instream habitat, and fish population surveys, along with measurements of discharge, sediment, and bed and bank stability, permit the assessment and evaluation of existing and potential channel conditions as well as biological attributes of the project. The NCDP aims to restore natural channel stability, or dynamic equilibrium, and habitat to impaired streams. Streams in dynamic equilibrium are generally more biologically productive, providing higher quality and more complex habitat than altered or unstable streams. Geomorphic indicators (bankfull channel), prediction (reference reaches and dimensionless ratios), and method validation (regional curves) define naturally functioning channels, and provide the basis for natural channel design.

At the reach level, stream geomorphology is quantified in both project and reference reaches. The reference reach should be naturally functioning, provide optimal fish habitat, and serve as a model for the design channel. "Bankfull" indicators and other geomorphic variables are measured in both reaches. Bankfull elevation, a geomorphic indicator signifying the point of incipient flooding, coincides with the stage above which the stream accesses its floodplain or flood-prone area (Rosgen 1996). By doing the work that creates the average morphologic channel characteristics, bankfull discharge forms and maintains the channel over time (Dunne and Leopold 1978). Channel pattern (plan view characteristics), dimension (channel size and shape), and profile (longitudinal elevations and gradients) are measured. Appropriate designs may include creating aquatic habitat, prescribing a revegetation plan, and constructing an appropriate floodplain.

Synthesizing reference reach field data and incorporating regional stream information helps identify design channel parameters. Regional data and dimensionless coefficients help predict channel attributes relative to the watershed area and bankfull characteristics. Watershed discharge, sediment entrainment, and bankfull channel cross sections are then hydraulically modeled to validate bankfull discharge. Design dimensions are developed relative to bankfull discharge. Comparing design dimensions to dimensionless coefficients and a reference reach database further validates the design.

The final restoration design seeks to mimic a stream in dynamic equilibrium with its watershed, and provide a diverse and complex channel capable of conveying flows, transporting sediment, and integrates essential habitat features related to fish population recovery goals. Vegetation colonization through mature shrub and sod mat transplanting, as well as other revegetation efforts, along with woody materials and rock provide immediate fish habitat and temporary bank stability. These structures allow for shrub colonization which, when established, provides for long-term channel stability and habitat complexity. Proper land management is essential to the success of these methodologies. Most restoration projects necessarily incorporate compatible grazing strategies and other land management changes.

Habitat Surveys in the Upper Blackfoot River and Kleinschmidt Creek

Our habitat survey methods focused on assessing geomorphic features of the channel and instream habitat. We used modified Rosgen level II channel surveys, and Rosgen-modified Wolman pebble counts (Wolman 1954, Rosgen 1996) for the geomorphic assessments. These measurements included bankfull width (pools), sinuosity, valley slope, channel slope, substrate composition and channel type. Sinuosity was determined using a hip-chain to measure total stream length and USGS topographic maps to measure total valley length.

Habitat assessments focused on channel and pool complexity, survey precision and repeatability. We measured distance between pools, and adjusted pool frequency to number/1000'. We also measured every pool and preceding downstream riffle. The pool measurements included total pool length, wetted width, max depth, and bankfull width at every forth pool. We measured riffles depth at the riffle crest. The difference between pool maximum depth and riffle crest depth was used to determine residual pool depth.

We counted and measured all the wood within the bankfull width of the channel along the longitudinal profile of the 5-mile survey section and adjusted the wood count to stem density/1000'. We also counted all functional instream wood for pools and recorded function. Methods for measuring the woody debris associated with the entire section involved, counting the number of pieces ($\geq$ 4" x 5') within the bankfull width of the channel, and measuring the length and diameter of randomly selected wood pieces to determine a range and average size of channel wood. We also recorded the function of the wood (e.g. vertical scour).

Survey objectives were to identify morphologic features of the channel including areas of channel instability, identify areas of simplified habitat with restoration potential and provide a repeatable baseline for future monitoring efforts.

RESULTS /DISCUSSION

PART I: BLACKFOOT RIVER ENVIRONMENT

Blackfoot River Discharge: USGS Bonner gauging station #12340000

In 2001, the Blackfoot River Watershed was subject to a second consecutive year of drought conditions. The 2001 water year produced the ninth lowest annual water yield (698,863 ac) for a 64-year period of record. A peak flow of 4,140 cfs was 49 % of mean peak flow (8,474 cfs), and the fifth lowest for the 64-year period of record. Mean discharge for the water year was 966 cfs, 60.1% of the long-term average (1,607 cfs.) (Figure 7). These values show the year 2001 was the 2nd lowest low-flow year since 1988, with 1992 producing less flow than 2001. In late August 2001, flow fell to a low of 442 cfs or 52 % of mean August flow of 846 cfs, 23 cfs above the one-in-twenty year low-flow event of 419 cfs (USGS 2001).

The relative drought index for the calendar year 2001 show daily river discharge at <75% of mean monthly flows on 208 days and 54 days for flows at <50% (Figure 8). Except for November and December, flows were well below normal for the 2001 calendar year.

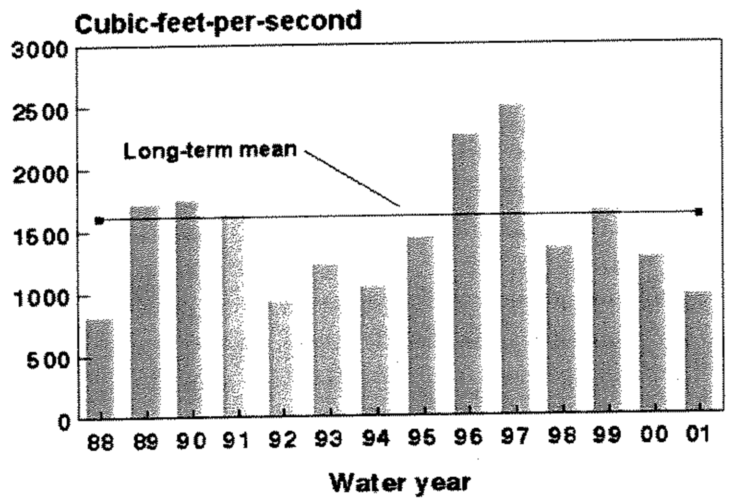


Figure 7. Annual mean discharge for water years 1988-2001.

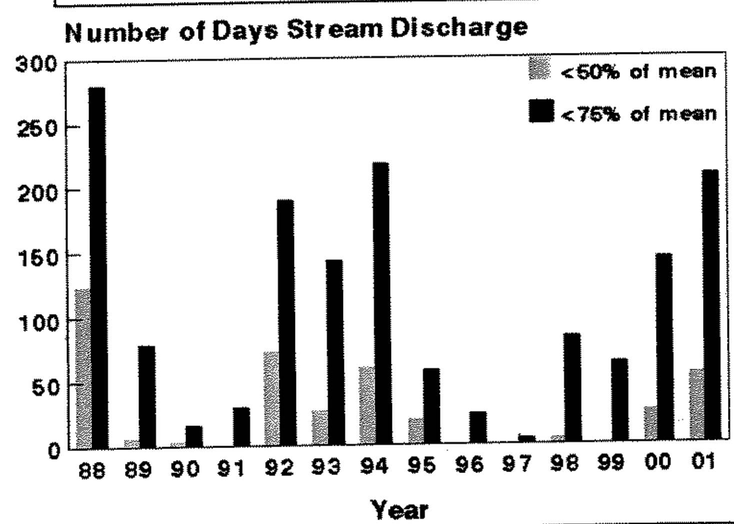


Figure 8. Relative drought index near Bonner: number of days river discharge was <50% and <75% of monthly mean, calendar years 1988-2001.

Blackfoot River Temperatures for August 2001

The 2001 temperature study included 55 monitoring sites in the Blackfoot River watershed. We collected summer water temperatures at seven Blackfoot River monitoring sites (mile 7.9-USGS gauging station, 21.9-above Belmont Creek, 45.7-Scotty Brown Bridge, 60.0-Raymond Bridge, 71.8-Cutoff Bridge, 104.4-Dalton Mountain Rd Bridge, 118.5-Aspen Campground), including four long-term monitoring locations (Belmont Creek, Scotty Brown Bridge, Raymond Bridge, and Cutoff Bridge).

For August 2001, Blackfoot River temperatures show an upward trend in the downstream direction (Figure 10) with mean temperatures increasing 7.1 °F between the upper (mile 118.5) and lower monitoring sites (mile 7.9). Between mile 118.5 and 104.4 maximum August temperatures decreased from 68.5 °F to 64.0 °F. Maximum water temperatures then increased 11.8 °F in the downstream direction from 64.0 °F at Dalton Mountain Rd Bridge (mile 104.4) to 75.8 °F at Raymond Bridge (mile 60.0), a distance of 44.4 river miles. The largest increase in this reach occurred over ~11-miles between the Cutoff Bridge (mile 71.8) and Raymond Bridge (mile 60.9), where maximum water temperatures increased from 70.3 °F to 75.8 °F. Nevada Creek enters this reach with maximum August temperature of 76. 4 °F.

From Raymond Bridge to Scotty Brown Bridge (mile 45.7), maximum river temperatures then decreased 6.0 °F from 75.8 °F to 69.8 °F, due to the cooling influence of the North Fork, before increasing again in the lower Blackfoot River. At both lower Blackfoot River monitoring stations, water temperature exceeded 70 °F, with the Belmont Creek site recording a maximum of 71.9 °F and 71.1 °F at the USGS gauging station.

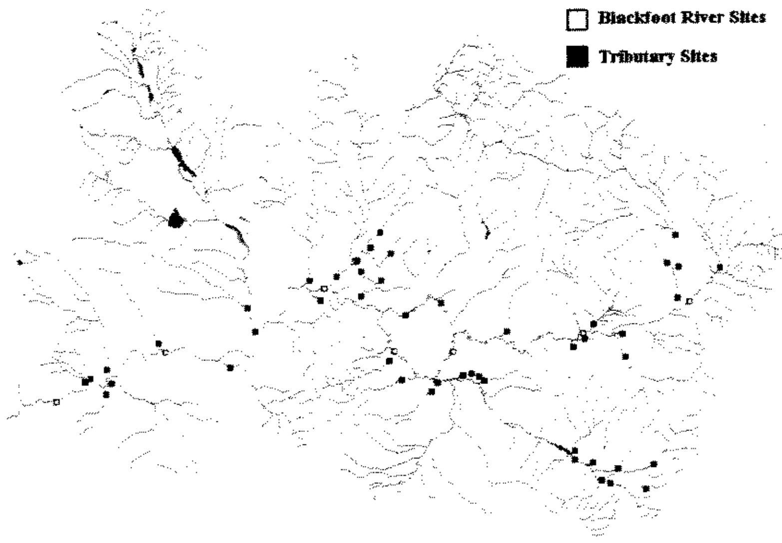


Figure 9. Stream temperature recording stations in the Blackfoot Watershed 2001.

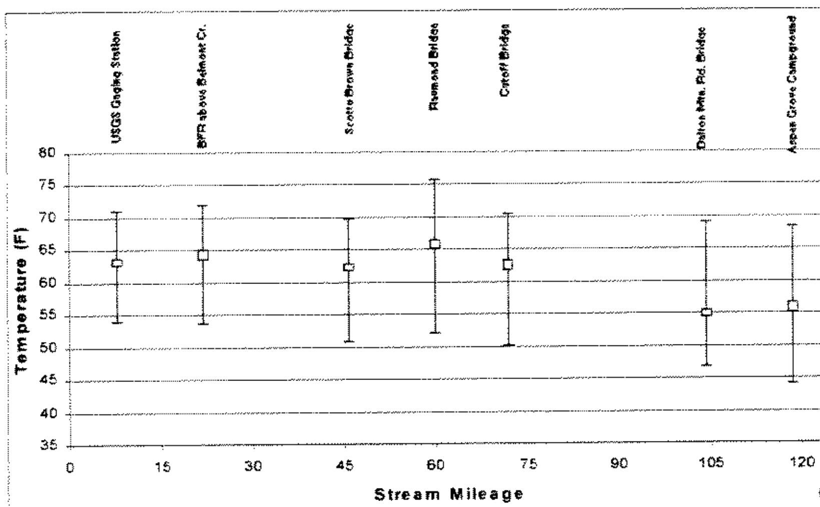


Figure 10. Minimum, maximum and mean temperatures for Blackfoot River at seven monitoring sites, August 2001.

Tributary Temperatures for August 2001

Between river mile 10.6 and 122.8, we monitored water temperatures on 22 direct tributaries to the Blackfoot River. Tributary temperatures for August 2001 show an increasing trend in the downstream direction from Alice Creek (mile 122.8) to the Clearwater River (mile 34.7). Conversely, tributaries to the lower Blackfoot River show a reverse trend of decreasing temperatures in the downstream direction (Figure 11). Sixteen of 22 streams had a cooling influence on the Blackfoot River.

The upper most tributary, Alice Creek, recorded a monthly maximum temperature of 66.7^{0}F, 1.8 ^{0}F cooler than the Blackfoot River at mile 118.5. The Landers Fork entered 7.2 ^{0}F cooler than the Blackfoot River at mile 118.5.

Between Lincoln and the Cutoff Bridge (mile 71.8), we recorded water temperatures for Grentier Spring (mile 108), Willow (mile 102.5), Sauerkraut (mile 102.1) and Arrastra Creeks (mile 88.8). Grentier Spring Creek recorded the lowest water temperature with a August maximum of 60.4 ^{0}F, ~3.5 ^{0}F cooler than the Blackfoot River at mile 104.4. Willow and Sauerkraut Creek recorded monthly maximum temperatures of 69.6 ^{0}F and 69.7 ^{0}F, ~5 degrees warmer than the Blackfoot River mile 104.4 site. Arrastra Creek recorded a maximum of 61.2 ^{0}F or 9.3 ^{0}F lower than the Blackfoot River at the Cutoff Bridge.

The Blackfoot River between the Cutoff Bridge (mile 71.8) and Raymond Bridge (mile 60.0) contained three tributaries with temperature sensors. Nevada Creek (mile 67.8) was the warmest with peak temperatures ~6 ^{0}F warmer than the Blackfoot River at the Cutoff Bridge (mile 71.8). Both Yourname and Wales Creeks, recorded maximum August temperature ~6 and ~10 cooler than the Blackfoot River at Raymond Bridge.

The section between Raymond Bridge (mile 60.0) and Scotty Brown Bridge (mile 45.7) contained three tributaries with temperature sensors. The North Fork (mile 54.1) was one of the coolest tributaries to the Blackfoot River producing an August mean temperature of 53.5 ^{o}F, ~12 ^{0}F cooler than the Blackfoot River at Raymond Bridge and ~9 ^{0}F cooler than the downstream sensor at Scotty Brown Bridge. Warren Creek recorded a monthly maximum of 73.9 ^{0}F, ~4 degrees warmer than the Blackfoot River at Scotty Brown Bridge. Monture Creek (mile 45.9) enters the Blackfoot River immediately upstream of the Scotty Brown Bridge monitoring station with maximum temperatures of 68.7, ^{0}F, or ~1^0 F lower than the Blackfoot River at Scotty Brown Bridge.

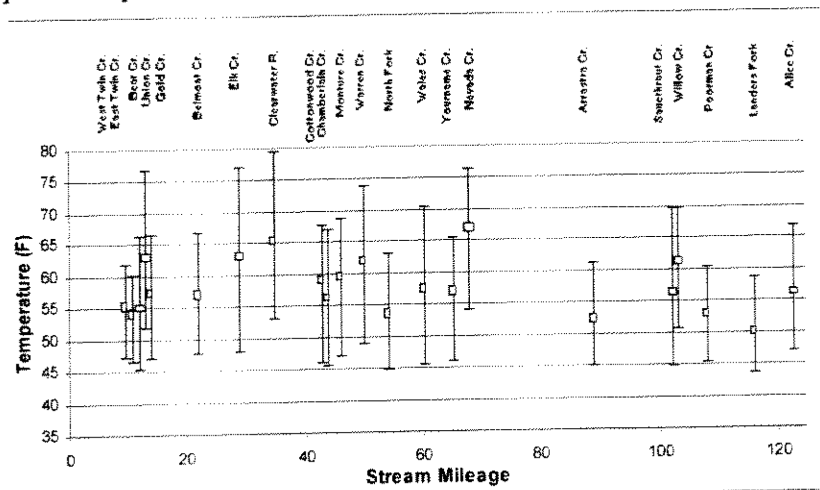


Figure 11. Blackfoot tributary mean, max and min temperatures for August 2001.

Between Scotty Brown Bridge (mile 45.7) and Belmont Creek (mile 21.9), we placed temperature sensors in four tributaries. Both Chamberlain Creek (mile 43.9), and Cottonwood Creek (mile 42.9) recorded a cooling effect on the river with maximum temperatures ~2-3 ^{0}F cooler than the Blackfoot River at Scotty Brown Bridge. Conversely, the Clearwater River (mile 34.7) and Elk Creek (mile 28.7) have a warming influence on lower Blackfoot River. The Clearwater River, influenced by a series of lakes through which it flows, recorded a monthly maximum of 79.4 ^{o}F and Elk Creek, a degraded stream, produced a monthly maximum of 77 ^{o}F, ~5-7 ^{0}F higher than the

Blackfoot River at Belmont Creek; both supported among the highest water temperatures in the Blackfoot watershed.

For the Blackfoot River between Belmont Creek (mile 21.9) and the USGS monitoring station (mile 7.9), five tributaries (Belmont (mile 21.9), Gold (mile 13.5) and Bear (mile 12.3), East Twin (mile 10.8) and West Twin (mile 10.6) Creeks) provide a cooling influence on the Blackfoot River. Conversely, Union Creek (mile 12.9), a degraded tributary, has a warming influence on the lower Blackfoot River and a maximum temperatures of ~6 °F warmer than the lower Blackfoot River (Appendix H).

PART II: FISH POPULATION INVENTORIES WITH EMPHASIS ON UPPER NEVADA CREEK TRIBUTARIES

Part II outlines fish population inventory results for 14 Garnet Mountain streams from Nevada Reservoir upstream (Figure 12). These tributaries are organized beginning with the lower-most tributary and proceeding upstream. Four additional inventoried waterbodies outside of the Nevada Creek watershed section (Coopers Lake at tributaries, Dick Creek, Fish Creek and Ward Creek) are then summarized at the end of this section. All restoration project streams are summarized in Results Part III.

In Part II, population summaries generally rely on a catch-per-unit-effort (CPUE) statistic, which provides an index of relative abundance. CPUE refers to the number of fish collected in a single (or first) electrofishing pass and is adjusted per 100' of stream (i.e. CPUE of 8 means 8 fish captured per 100'). Additional catch statistics are in Appendix A. Amphibian observations are also located in Appendix A.

For some charts in Results Part II and III, abbreviations delineate fish species; they are CT for westslope cutthroat trout (WSCT), DV for bull trout, LL for brown trout, EB for brook trout and RB for rainbow trout.

Introduction

In 2001, with support from the North Powell Conservation District (NPCD), we inventoried fish populations, and collected related information on 14 upper Nevada Creek streams from Nevada Reservoir upstream. Two of these tributaries flow directly into Nevada Creek Reservoir: Indian Creek (mile 33.3) including its east and west forks, and Buffalo Gulch (mile 33.5) including tributaries California Gulch and Clear Creek. Eight tributaries flow directly into upper Nevada Creek: Gallagher Creek (mile 36.1), Jefferson Creek (mile 36.5), Washington Creek (mile 37.8), Finn Creek (mile 39.5) Halfway Creek including tributary Strickland Creek (mile 40.3), Mitchell Creek (mile 43.2), Shingle Mill Creek (mile 45.1) and Gleason Creek (mile 47.6)(Figure 12).

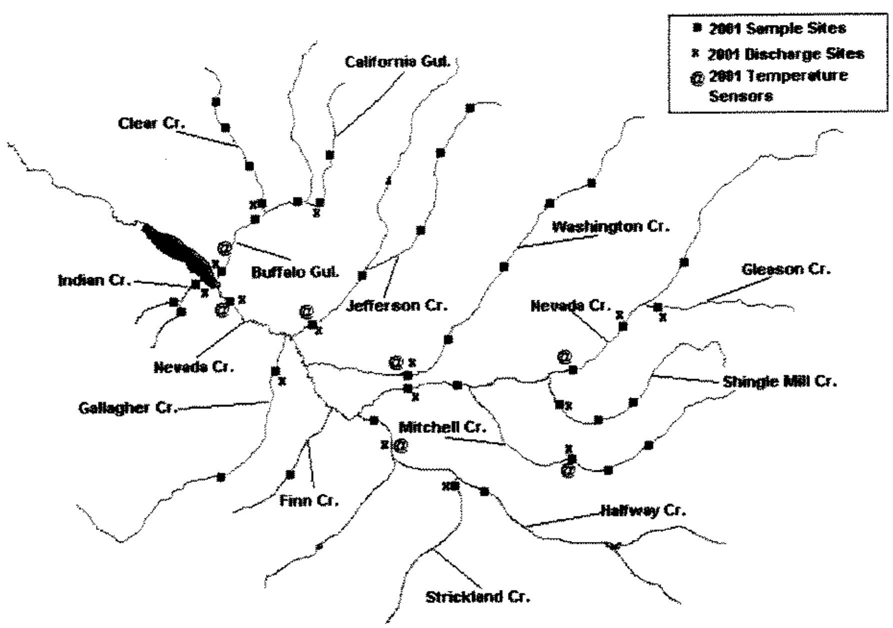


Figure 12. Sampling locations in the upper Nevada Creek watershed.

Inventoried tributaries focused on obtaining longitudinal samples extending from public lands in headwater, forested areas to downstream agricultural bottomlands. Surveys included fish population surveys, measurements of stream discharge and water temperature, WSCT genetic sampling and fisheries problem identification. Objectives were to collect baseline fish population information, monitor historical survey sections, identify possible restoration opportunities, and provide a basis for monitoring future NPCD-sponsored projects.

Nevada Creek from Nevada Reservoir upstream

Upper Nevada Creek originates on the western slopes of the Continental Divide north of Nevada Mountain and flow in a westerly direction for approximately 22.6 miles before entering Nevada Creek Reservoir at stream mile 33.7. The Nevada Creek channel is predominately a slightly entrenched, meandering, riffle/pool, cobble-dominated (C-type) channel, with a stream gradient ranging from 320'/mile at the headwaters to 53'/mile upstream of the Nevada Reservoir inlet (Figure 13).

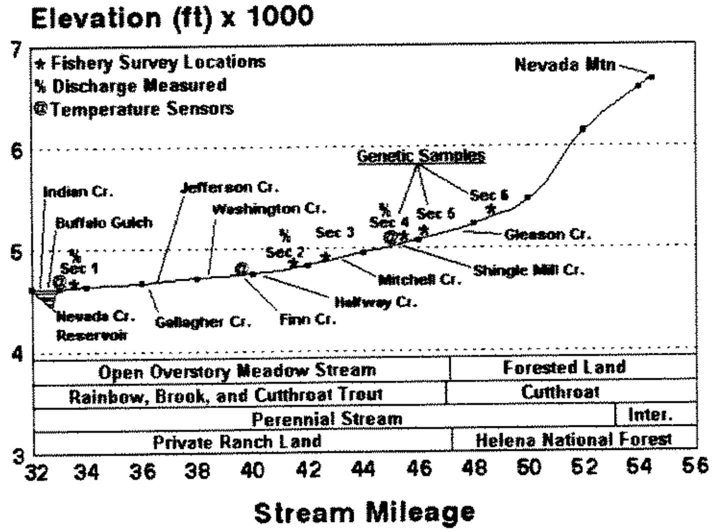


Figure 13. Longitudinal profile for Nevada Creek above the reservoir.

Based on our flow measurements, Washington, Gleason, Jefferson and Gallagher Creeks are the four largest contributors of flow to upper Nevada Creek, contributing 2.9, 2.2, 2.2 and 1.5 cfs in July 2001 (Appendix D). Measured discharge at three sites on Nevada Creek (miles 33.8, 41.5, and 45.9, recorded 14.6, 8.6, and 11.2 cfs) found that, once off Helena National Forest land, flows decreased 2.6 cfs between mile 45.9 and 41.5 due to irrigation. However, an influx of water from downstream tributaries (Washington, Jefferson, and Gallagher Creeks) increased Nevada Creek flow upstream of the reservoir by 6.0 cfs.

We measured water temperature in four tributaries of the upper Nevada Creek watershed and three sites (miles 33.8, 39.5, and 45.5) on the mainstem Nevada Creek (Figure 14). Temperature sensors consistently recorded higher temperatures (>70 ^{0}F) at the two downstream monitoring sites on Nevada Creek, compared to the upper-most monitoring site, and recorded a surprisingly large

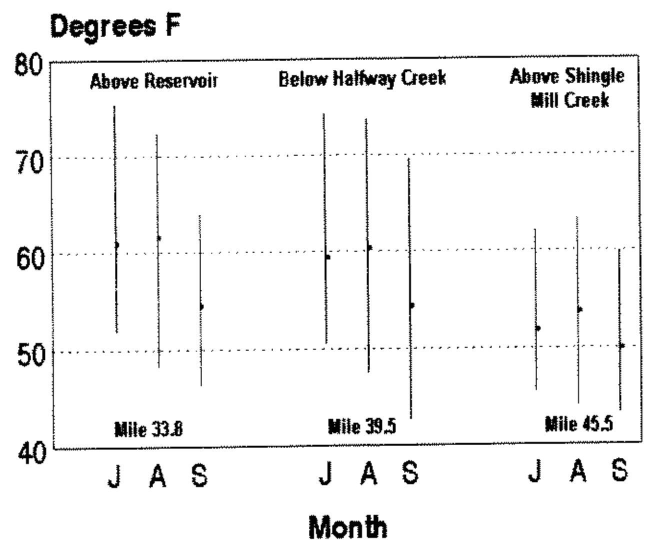


Figure 14. Mean, Maximum, Minimum monthly water temperatures at 3 Nevada Creek sites, summer 2001.

temperature increase (~10-12 ^{0}F) in a 6-mile section of Nevada Creek between mile 39.5 and 45.5. Halfway Creek, a low-elevation basin, entering at mile 40.3, contributes to elevated water temperatures, recording a maximum summer temperature of 76.6 ^{0}F for the month of July. Both Halfway Creek and Nevada Creek (mile 39.5) recorded a maximum temperature for August of 73.8 ^{0}F, compared to 63.5 ^{0}F at mile 45.5 on Nevada Creek (Appendix H).

In 2001, we re-surveyed fish populations at four historic survey sections (miles 33.8, 41.5, 42.8, and 48.6) established in 1957. We also established two new survey sections at mile 45.5 and 46.1.

At the two upper survey locations (mile 46.1 and 48.6), located on the Helena National Forest, the riparian zone consists of ponderosa pine and Douglas fir overstory above an understory of dense alder, red-osier dogwood and rocky mountain maple, along with grasses and sedges mixed with horsetail, clover and thistle. The riparian area appeared healthy and stream banks were stable. Overhanging vegetation, undercut banks and deep runs provide the majority of fish habitat. In spite of the abundant streamside vegetation and stable banks, the channel lacks sufficient woody debris. We found no evidence of excessive livestock access to the riparian area.

Riparian health at the four survey locations on private ranch land (miles 33.8, 41.5, 42.8, and 45.5) appeared marginal. Bank under-story vegetation is predominately timothy mixed with various grasses, sedges, horsetail, clover and bulrush. Alder and willow are scarce at mile 33.8, resulting in poor wood recruitment and weakened stream banks. Alder and willow densities begin to increase upstream of mile 41.5. Consequently, fish habitat conditions improve. Livestock impacts, including degraded and slumping banks, areas of over-widened and braided stream channel, were common habitat problems observed. Portions of the channel are undergoing channel incision (Dave Rosgen, personal communication).

Fish Populations

We re-sampled Nevada Creek at four fish population sections (miles 33.8, 41.5, 42.8, and 48.6) originally established in 1957, and established two new survey sections (miles 45.5 and 46.1). The survey results show a significant shift in the salmonid community for a ~10-mile reach of upper Nevada Creek over the last 45 years (Figure 15). These changes include the loss of bull trout and mountain whitefish; both species were present in 1957, but absent in 2001. In 1957 WSCT, the dominant species (excluding mountain whitefish) of the three downstream samples (mile 33.8, 41.5 and 42.8), were either rare (N=1 at mile 33.8) or absent in 2001. In place of these native species, non-native rainbow trout and brook trout now dominate this ~10-mile reach of Nevada Creek.

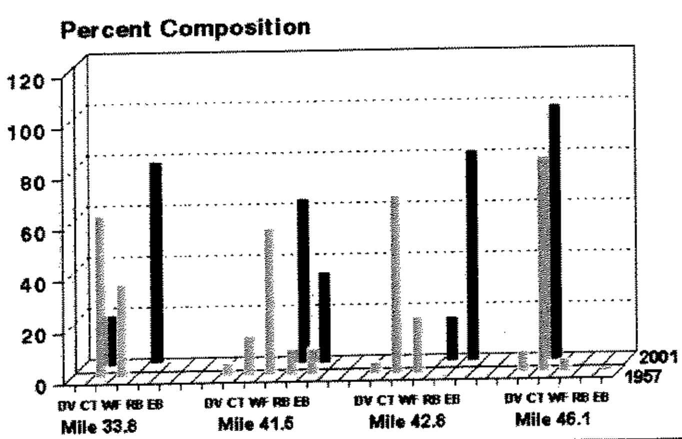


Figure 15. Percent species composition for salmonids in upper Nevada Creek at four locations, 1957 and 2001.

We found generally low salmonid densities in Nevada Creek upstream of the reservoir at all sampled locations (Figure 16). We found the distribution of rainbow trout, the dominant fish in lower samples, to extend ~11-12 miles upstream of Nevada Reservoir. For rainbow trout, CPUE (fish >4.0") ranged from 0.8 - 1.9 fish/100'. Brook trout (fish > 4.0") dominate a localized area of upper Nevada Creek near mile 42.8. Brook trout samples recorded CPUE ranging from 1.1 - 2.9 fish/100'. We found WSCT, the only salmonid recorded in the upper three samples, at decreasing densities over a three-mile reach of stream between mile 48.6 and 45.5, with CPUE (fish >4.0") decreasing from 1.7 (mile 48.6) to 0.1 fish/100' (mile 45.5). Sculpins were common at all the survey sites. Redside shiner, longnose sucker and longnose dace were present at the lower-most sample site (mile 33.8).

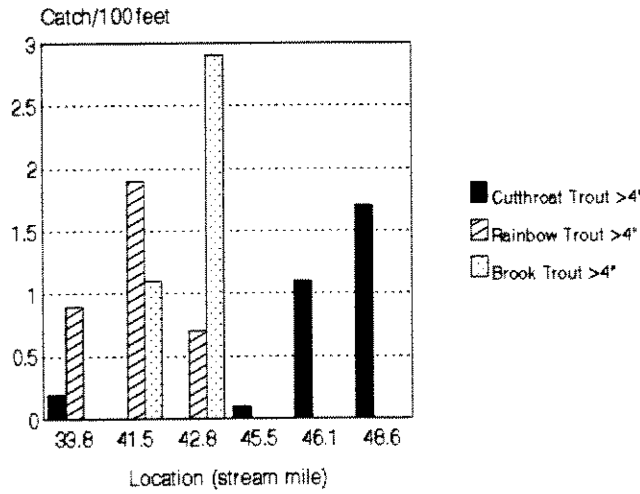


Figure 16. CPUE for salmonids (fish > 4.0") at 6 sites on Nevada Creek.

We collected 19 WSCT genetic samples from the three upper Nevada Creek sites (Appendix I). Previous WSCT genetic analysis (N= 10) collected by USFS on 8-1-88 showed a hybrid population (90.8% WSCT and 9.2% rainbow trout) above stream mile 48.0.

Indian Creek (including East and West Forks)

Indian Creek, a 2nd order tributary to Nevada Creek Reservoir, drains forested BLM land before entering a small section of private land near the mouth. We measured discharge near the mouth at 1.5 cfs on 8-1-01 (Appendix D). We established three fish population survey sections in the Indian Creek drainage: one near the mouth (mile 0.1), and one in the East Fork (mile 0.1) and West Fork (miles 0.1) (Figure 17).

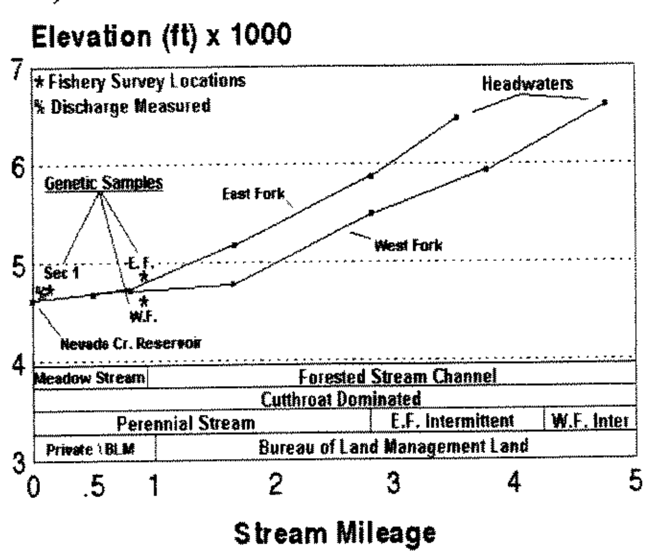


Figure17. Longitudinal profile for Indian Creek (including East and West Fork).

The headwaters of Indian Creek include steep, deeply entrenched and confined (A3-type) channel that attenuate into moderately entrenched (B4-type) channel with a lower 2-4% gradient near the junction of the forks. We found similar riparian plant communities and channels at both East and West Forks sampling sites: a moderate overstory of Englemann spruce above a very dense alder understory along with grass and forb groundcover. We found stable banks, adequate instream woody debris and cool water temperatures at both upper survey sites. Overall, we found a well-managed riparian area and identified no problems at either site except for low habitat complexity at the lower site.

Near the mouth of Indian Creek, the channel is a gentle gradient, riffle/pool stream with a low to moderate sinuosity and deep, narrow (E4-type) channel. The lower end of the survey section, near the mouth, is developing a slightly entrenched, meandering, gravel-dominated, riffle/pool sequence (C4-type) channel. We found stable stream banks, moderate willow density along with a groundcover of grasses, sedges and forbs, undercut banks and overhanging vegetation. Some beaver activity is present directly upstream of the lower survey section.

Fish Populations

Our surveys recorded WSCT, sculpins and no other species. WSCT densities were generally low with the exception of the East Fork (Figure 18). We found WSCT (fish <4,0") in the West Fork and low densities of larger (fish >4.0"). The CPUE for WSCT (fish >4.0") ranged from a high of 4.8 on the East Fork to 1.0 fish/100' on the West Fork. Near the mouth of Indian Creek, CPUE (fish >4.0") was 2.6 fish/100'. Sculpins were common on both the East and West Forks of Indian Creek and abundant at the lower site. We collected 17 WSCT genetic samples from the three survey sections (Appendix I).

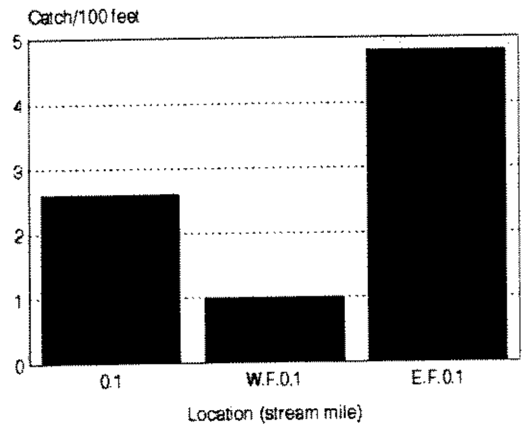


Figure 18. CPUE for WSCT (fish >4.0") at 3 sites in the Indian Creek drainage.

Buffalo Gulch

Buffalo Gulch, a 2nd order tributary to Nevada Reservoir, flows a total of 6.4 miles, first through Helena National Forest before entering private ranchland near mile 4.0 (Figure 19). Stream gradients range from 380'/mile at its headwaters to 105'/mile near the mouth. We measured discharge near the mouth of Buffalo Gulch at 2.7 cfs on 7-24-01 (Appendix D). Summer water temperature monitoring (mile 0.1) recorded a maximum temperature of 69 ^{0}F, during the months of July and August (Appendix H). Because of limited access to the headwaters, we established three fish population survey sites (mile 0.1, 1.3, and 2.5) in the lower-to-middle reaches of Buffalo Gulch.

At the upper survey location (mile 2.5), we found a gravel-bottom, gentle gradient, moderate sinuosity (E4-type) meadow stream with riffle/pool sequence. The riparian overstory contains sparse cottonwood stands above an understory of alder and willow with a grass/forb groundcover. Because of excessive cattle access to the stream banks, the channel width is increasing, sinuosity is decreasing, and the channel morphology is beginning to shift to a C4-type channel. Fish habitat is poor, limited to a few woody pools and undercut banks.

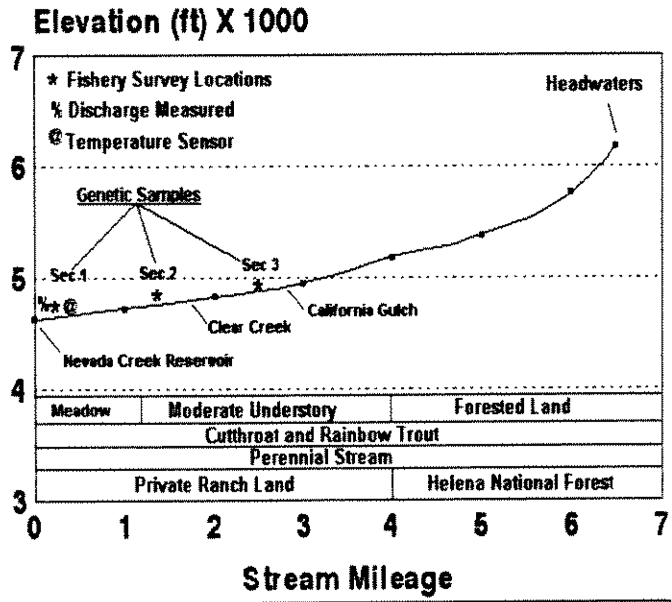


Figure 19. Longitudinal profile for Buffalo Gulch.

Downstream at mile 1.3, Buffalo Gulch is a stable, moderately entrenched, cobble-bottom (B3-type) stream with a gradient of 2-4%. Wood-formed plunge pools are the dominant habitat features. The riparian overstory consists of ponderosa pine and Douglas fir, above a dense understory of willow and alder and a grass/forb groundcover. The dense understory gives rise to complex fish habitat with ample instream wood. Riparian grazing resulted in only minor impacts to the stream channel. Overall, the survey section is in good condition. Below the survey section, Bufflalo Gulch was channelized, the apparent result of past mining practices

At the lower survey section (mile 0.1), we found a slightly entrenched, meandering, gravel dominated, riffle/pool (C4-type) channel, with a dense riparian shrub community of alder and willow along with bulrush, horsetail, clover and grasses. Dense riparian vegetation form stable undercut banks and woody pools. We found no excessive cattle access in this section of the stream and sediment levels were low.

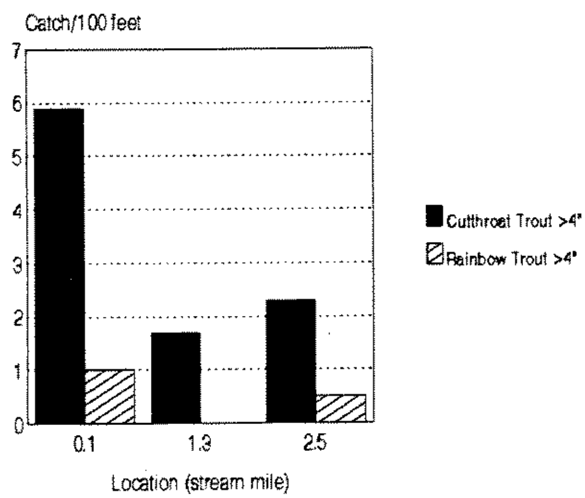


Figure 20. CPUE for fish > 4.0" at 3 sites on Buffalo Gulch.

Fish Populations

Fish population sampling found WSCT, rainbow trout and sculpins. CPUE for WSCT (fish > 4.0") range from 1.7 - 5.9 fish/100", with higher densities near the mouth (Figure 20). We sampled rainbow trout at low densities at two sites, with CPUE ranging from 0.5 to 1.0 fish/100'. We found YOY, likely rainbow trout, only in the lower (mile 0.1) sample. Sculpins were present at all three survey sites. We collected 25 genetic samples from the three survey sections (Appendix I). Genetic data collected by USFS in 1992 shows 100% pure WSCT (N=10) above mile 2.8.

Clear Creek

Clear Creek is a 2nd order tributary entering Buffalo Gulch at mile 1.8. Clear Creek flows in a southeastern direction, first through the Helena National Forest before entering Plum Creek Timber Company and private ranch land downstream of mile 1.5 (Figure 21). Stream gradients range from 340'/mile at its headwaters to 160'/mile at the mouth. On 7-24-01, we recorded discharge at 0.7 cfs near the mouth. We established four fish population survey sections (mile 0.1, 1.2, 1.9, and 2.5) on Clear Creek.

Clear Creek maintained similar channel features at all four survey sections: moderately entrenched (B3 to B4-type) channels with moderate gradient of 2-4%. The riparian communities at the upper two survey sections also support a Douglas fir and Englemann spruce forest above a red-osier dogwood shrub layer with a fern /moss undergrowth. All four-survey sections support dense shrub communities of willow, hawthorn, and alder, with a bulrush, grass and forb undergrowth. All riparian communities appeared healthy, providing bank stability and high quality habitat for fish. Each survey sites contain high amounts of woody debris and light to moderate

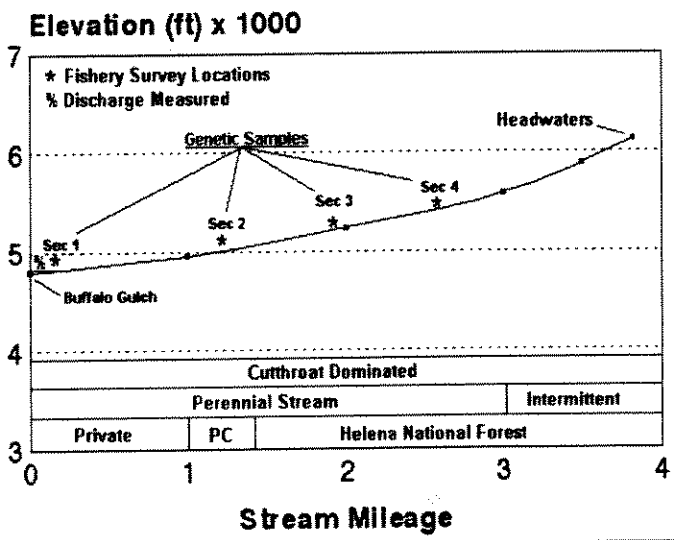


Figure 21. Longitudinal profile for Clear Creek.

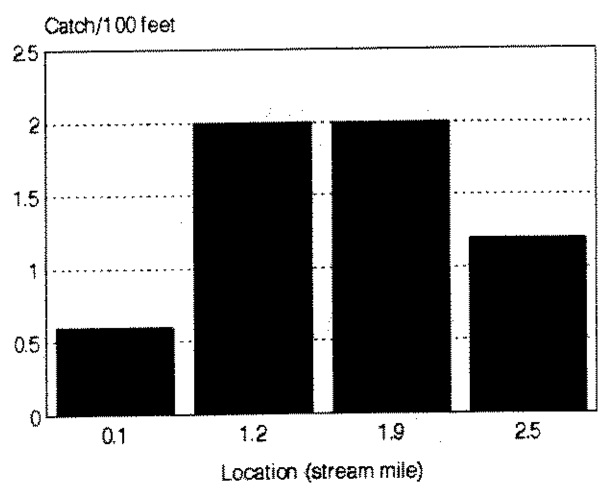


Figure 22. CPUE (fish > 4.0") for WSCT at 4 sites on Clear Creek

sediment levels. Fish habitat includes plunge pools, over-hanging vegetation and woody debris. A culvert at mile 0.1-survey section appeared suitable for fish passage.

Fish Populations

We found only WSCT in Clear Creek and sculpins at the lower sample. Densities appeared low at all survey sections, partly due to dense riparian vegetation and low sampling efficiencies. Densities appear higher in the middle survey sections compared to the upper and lower survey sites (Figure 22). We collected 25 WSCT genetic samples from the four survey sections (Appendix I). Previous genetic samples collected by the USFS in 1990 (miles 1.4 (N=10) and 2.0 (N=8) found WSCT slightly hybridized (~97 % pure) with rainbow trout.

California Gulch

California Gulch, a small 2nd order stream, drains the southern slope of Dalton Mountain, first through Helena National Forest land and then private ranch land, before entering Buffalo Gulch at mile 2.8. California gulch is 3.5 miles in length, with a stream gradient ranging from 370'/mile at the headwaters to 90'/mile near its mouth. We measured discharge near the mouth at 0.3 cfs on 7-23-01. In 2001, we established two fish populations survey sections (miles 0.4 and 1.8) on California Gulch (Figure 23).

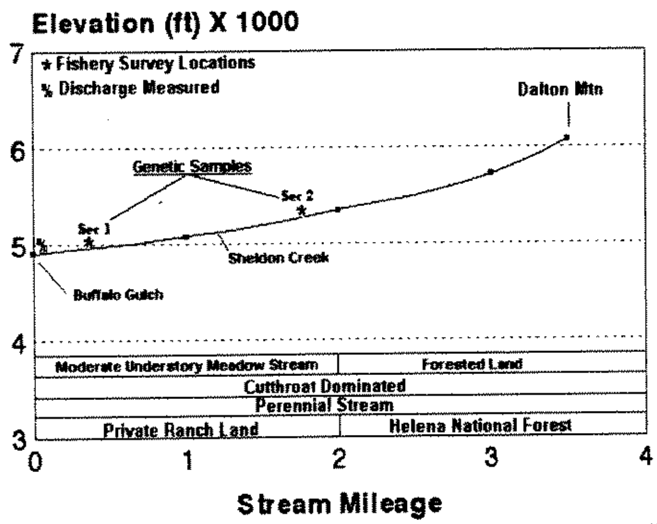


Figure 23. Longitudinal profile for California Gulch.

At mile 1.8, we found a moderately entrenched channel with a 2-4% gradient and gravel dominated (B4-type) channel. At this site, we noted excessive cattle impacts in the form of unstable banks and over-widened channel. The riparian community consists a sparse overstory of aspen, a shrub understory of alder and hawthorn along with grasses and sedges along the shoreline. A culvert located at the upper end of the survey section is in good condition for fish passage.

At mile 0.4, California Gulch is a low gradient, meandering (E4-type) channel with a gravel substrate. We observed heavy livestock impacts to both the channel and riparian area. The riparian vegetation consists of alder, willow and grasses. Heavy bank degradation is creating an over-widened channel and contributing to elevated sediment input to the stream. The culvert at the lower end of the section is in good shape but has a board placed across the upstream end, possibly hindering fish passage at low flows.

Fish Populations

In our two surveys, we found only WSCT at low densities with a CPUE (fish > 4.0") ranging from 0.3 to 0.9 fish/100' (Figure 24). We collected 9 WSCT genetic samples from the two survey sections (Appendix I). Previous genetic data (N=10) collected by the USFS on Sheldon Creek a tributary to California Gulch in 1992 found a WSCT population slightly hybridized (98.3 %) with rainbow trout.

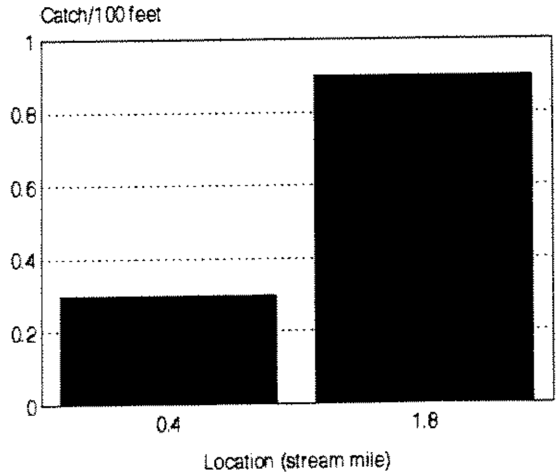


Figure 24. CPUE for WSCT (fish > 4.0") at 2 sites on California Gulch.

Gallagher Creek

Gallagher Creek, a 2nd order tributary to Nevada Creek, drains the slopes of Windy Rock Mountain and flows northeast 7 miles, first through BLM land before entering private ranch land. Gallagher Creek enters Nevada Creek at mile 36.1 (Figure 25). Stream gradients range from 240'/mile at the headwaters to 100'/mile near the mouth. We measured a discharge at 1.5 cfs on 8-1-01 at mile 0.3 (Appendix D). In 2001, we established two fish populations surveying sections (mile 0.3 and 2.8) on lower Gallagher Creek. We were unable to sample upper Gallagher Creek due to limited access.

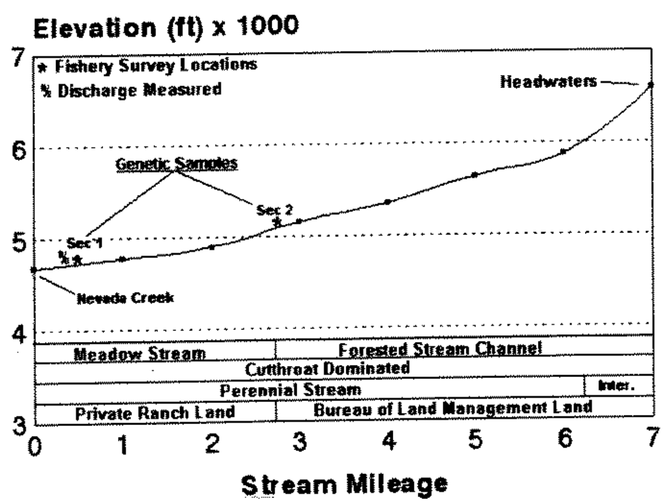


Figure 25. Longitudinal profile for Gallagher Creek.

At the upper survey section (mile 2.8), we found a cobble-dominated, moderately entrenched (B3-type) stream with a 2-4% gradient. The riparian zone supports healthy community of Douglas fir, Englemann spruce, alder, red-osier dogwood and willow, grasses and a diversity of forbs. Stream banks were generally stable despite localized areas of high cattle use. We found high amounts of woody debris recruitment to the stream channel. Sediment levels were low.

At mile 0.3, we surveyed a meandering meadow stream with a deep, narrow (E4-type) channel and a moderate sinuosity. We found livestock management compatible with riparian health. The riparian area appeared healthy with shrub-dominated community of alder and willow above an undergrowth of bulrush, sedge and grasses. Banks were stable, sediment levels low and habitat quality high. The culvert in this section is not a fish barrier.

Fish Populations

We found only WSCT and sculpins. WSCT densities were low with CPUE (fish > 4.0") ranging from 1.5 - 2.2 fish/100' with densities decreasing slightly in the downstream direction (Figure 26). We also found moderate densities of fish < 4.0" at mile 2.8. We collected 25 WSCT genetic samples from the two survey sections (Appendix I).

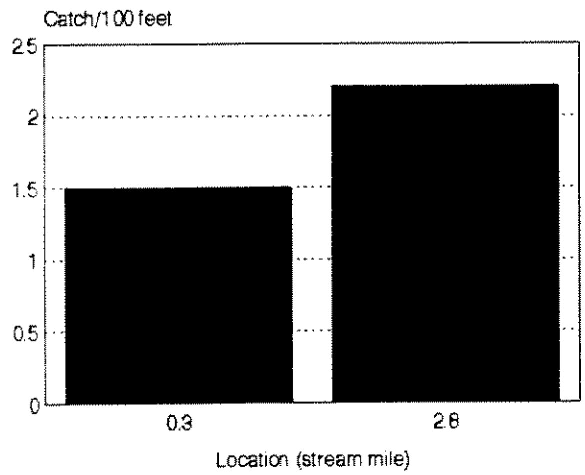


Figure 26. CPUE for WSCT (fish > 4.0") at 2 sites on Gallagher Creek.

Jefferson Creek

Jefferson Creek, a 2nd order tributary, drains the eastern slope of Dalton Mountain and flows southwest 7.4 miles through mostly private ranch land before entering to Nevada Creek at mile 36.5. (Figure 27). Stream gradients range from 440'/mile at the headwaters to 40'/mile near the mouth. We measured discharge at 2.2 cfs at mile 0.3 on 7-23-01 (Appendix D). A water temperature sensor (mile 0.3) recorded a maximum summer temperature of 69° F during both July and August, ~5.5 °F cooler than Nevada Creek at mile 33.8 (Appendix H). In 2001, we established fish five population survey sites (mile 0.5, 2.3, 4.7, 5.5, and 7.2) on Jefferson Creek.

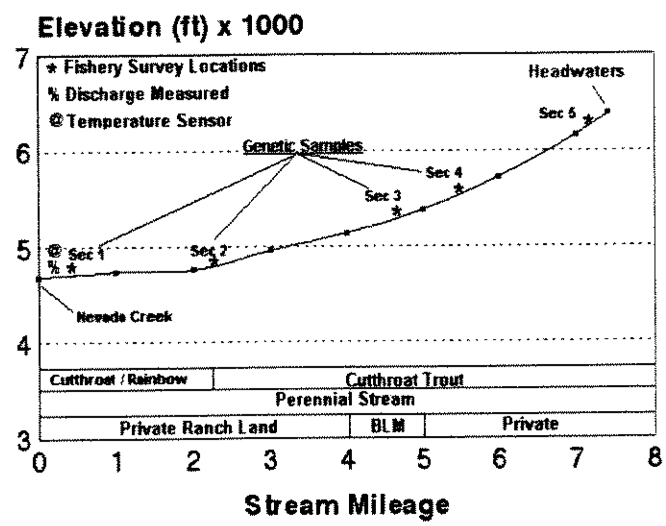


Figure 27. Longitudinal profile for Jefferson Creek.

We established our upper survey site (mile 7.2) in a steep, entrenched, and confined (A4-type) channel with a mixed, gravel to boulders substrate and low sediment levels. Because of past mining disturbances, the riparian vegetation lacks any type of large timber over-story, and consists of a dense grass/sedge ground cover. This section lacks complex fish habitat.

At mile 5.5, we sampled a moderately entrenched gravel-dominated (B4-type) channel with a 2-4% gradient, where mining practices have severely altered the channel. Riparian shrubs, willows and alders along with a grass/forb undergrowth have taken hold, stabilizing the banks. A crushed and plugged 12" culvert at the lower end of the survey section is diverting ~¾ of the stream flow to an off-stream settling pond, containing fish. Because of low flows, fish passage out of the pond is difficult.

Mining practices further altered the stream channel at mile 4.7. Berms of mining rock spoil, 8-10' high on both sides of channel, result in a straightened and entrenched channel. The (G4-type) channel is becoming incised within the heterogeneous substrate of cobble, gravel and sand. We noted poor riparian health with a very sparse community of aspen and alder, above a groundcover of thistle, grasses, sedges and forbs. Because of the poor condition of the riparian vegetation, no woody debris recruitment occurs the channel lacks complexity and fish habitat is limited. We observed elevated levels of instream sediment.

At mile 2.3, we sampled a gravel dominated, riffle/pool meadow (E4-type) stream with a gentle gradient. The riparian community consists of sparse of cottonwood, alder and willow, above a ground cover of timothy, bulrush, sedges and forbs. Woody debris recruitment to the stream channel is low. The majority of wood present in the channel consists mainly of diversion boards. The survey section contains three small irrigation diversions that create 1-2' plunge pools. We observed a culvert at the downstream end of the survey section. Boards placed across the upstream end of the culvert to back-up water for irrigation, creates a 3' drop into to the culvert. We also noted high accumulations of sediment in low velocity areas, along with additional mining disturbance downstream of the survey section.

The lower most survey section (mile 0.5) was also a meandering meadow (E4-type) channel. We found dense, healthy riparian willow shrub community with grasses and sedges forming stable stream banks. Woody debris recruitment to the stream channel is poor in this section.. We found proper streamside grazing practices and observed no livestock impacts to the riparian zone.

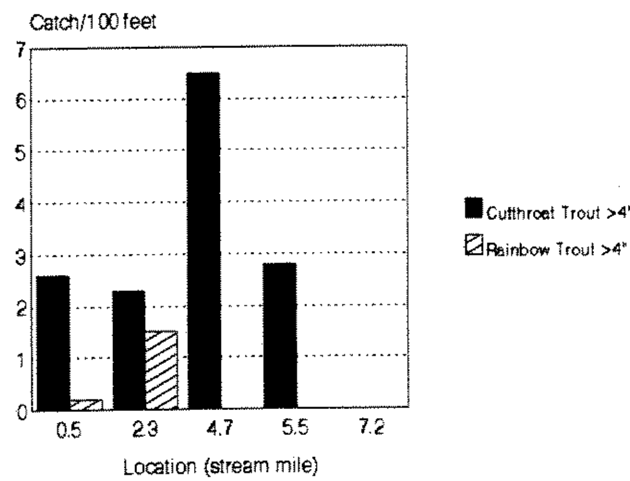


Figure 28. CPUE for fish > 4.0" at 5 sites on Jefferson Creek.

Fish Populations

In 2001, we sampled Jefferson Creek at five locations (mile 0.5, 2.3, 4.7, 5.5 and 7.2). We found a WSCT dominated stream, except for the fishless upper-most survey section, with low densities of rainbow trout in lower Jefferson Creek (Figure 28).

At mile 5.5, we found low densities of WSCT with a CPUE (fish > 4.0") of 2.8 fish/100'. Densities of WSCT at mile 4.7 were higher densities (CPUE = 6.5 fish/100') despite habitat problems. At both lower sampling sites, we found low densities of WSCT with CPUE ranging from 2 to 3 fish/100', along with lower densities of rainbow trout. Sculpins were abundant at the mile 0.5.

We collected 25 westslope cutthroat genetic samples from the four survey sections on Jefferson Creek (Appendix I). A previous genetic sample (N=22) collected by FWP on 7-14-86, found a rainbow trout hybridized the WSCT (93% purity) population above mile 2.3.

Washington Creek

Washington Creek, a 2^{nd} order tributary, begins on the Helena National Forest and flows southwest 10.7 miles through mixed ownership, primarily private ranchlands, before entering Nevada Creek at mile 37.8. Stream gradient ranges from 340'/mile at the headwaters to 60'/mile near the mouth. A water temperature sensor at mile 1.9 recorded a summer maximum temperature of 70.4 ^{0}F during July, ~4 ^{0}F cooler than Nevada Creek at mile 39.5 (Appendix H). We measured a discharge of 2.9 cfs at mile 1.9 on 7/18/01. Our 2001 flow measurements found Washington Creek to be the largest contributor of flow to upper Nevada Creek (Appendix D). In 2001, we established five fish population survey sites on Washington Creek (mile 2.0, 3.0, 4.8, 6.1, and 7.2) (Figure 29).

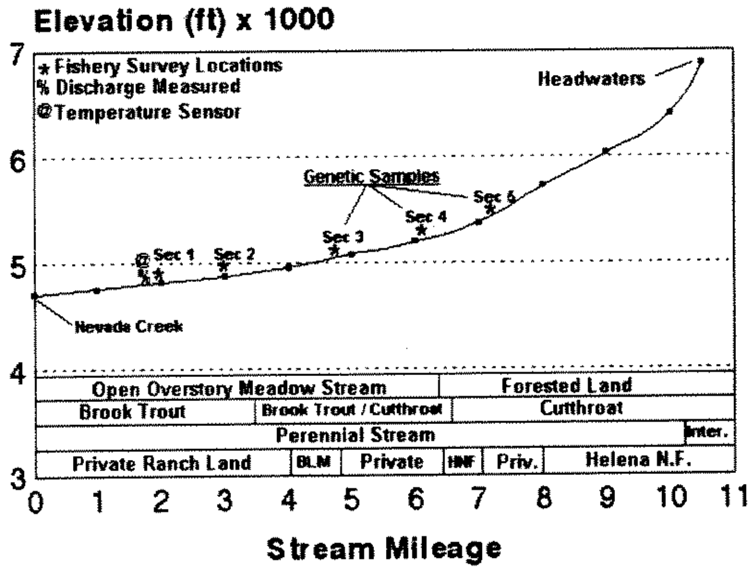


Figure 29. Longitudinal profile for Washington Creek.

The upper most survey section (mile 7.2) contains a high gradient, deeply entrenched (A3-type) channel with stable banks of bedrock and boulder. Riparian vegetation consists of a full Douglas fir canopy above an understory of alder and rocky mountain maple along with an undergrowth of horsetail, forbs and grasses. Woody debris recruitment to the stream channel was low. Plunge pools form the majority of fish habitat. High gradient flows maintain low sediment levels. It was apparent that the land around the stream was disturbed by past mining practices. We also identified a fish passage barrier, created by a defunct diversion with a 3' drop, at the downstream end of our survey section. To assess whether the diversion is a fish barrier, we sampled a 100' section downstream of the diversion and found a mixed WSCT and brook trout assemblage below, as opposed to, only WSCT upstream in the survey section. We determined that the diversion is impassable and likely, the upper limit for brook trout in the system.

At mile 6.1, Washington Creek's channel is deeply entrenched and highly altered from past mining disturbances. Mining disturbances include a straightened channel with berms ~ 8-10' in height that have stabilized over time. Sparse communities of willow, alder, horsetail, forbs and grasses constitute the riparian vegetation. Fish habitat is limited to small plunge pools and low amounts of woody debris.

The survey section at mile 4.8 appears to be an old channelized reach with remnants of an old historic channel 25' to the east. The current (B3, B4-type) channel is straight and slightly entrenched with a cobble/gravel substrate. Banks are stable from the riparian vegetation of immature cottonwoods and alder above a groundcover of horsetail, sedges and grasses. The stream channel is void of woody debris. Over-hanging vegetation and undercut banks provide limited fish habitat.

The survey section at mile 3.0 is a deep and narrow, low gradient, gravel-dominated, meandering (E4-type) channel, slightly entrenched on one side by a hill. A dense canopy of willow and alder above a timothy, horsetail, sedge and bulrush community constitute the riparian vegetation. Stream banks are generally stable except where localized cattle crossings and watering areas have over-widened the channel

Washington Creek channel at mile 2.0 is a meandering (E5-type) channel with a sand/silt substrate. The riparian community consists of a cottonwood canopy, a dense shrub understory of willow and alder, along with an undergrowth of timothy, sedge and bulrush, mixed with horsetail. Stream banks are stable despite heavily browsed shrubs.

Fish Populations

Sampling recorded densities of WSCT and brook trout in Washington Creek decreasing in the downstream direction. Sampling at the upper survey section (mile 7.2) found only WSCT with a CPUE (fish > 4.0") of 5.4 fish/100' (Figure 30). A fish barrier at the lower end of this survey site appears to inhibit the upstream expansion of brook trout. We found brook trout at all locations downstream of mile 7.2 along with decreasing densities of WSCT.

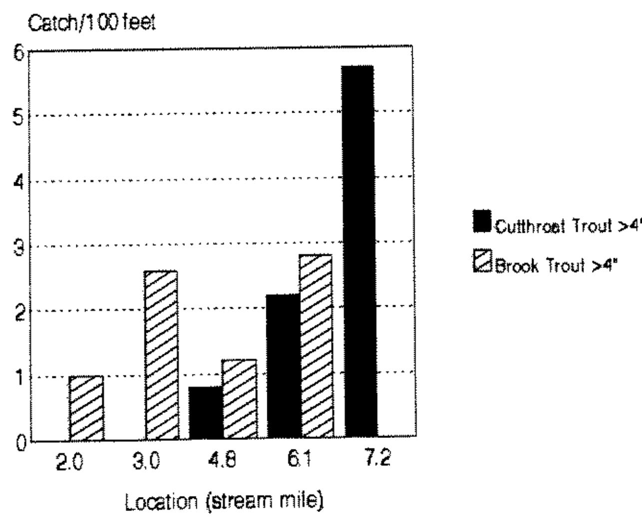


Figure 30. CPUE for fish > 4.0" at 5 sites on Washington Creek.

At mile 6.1, the CPUE (fish > 4.0") for WSCT was 2.2 and 2.8 fish/100' for brook trout. Low numbers of sculpins were present in this sample.

The survey at mile 4.8 recorded lower densities for both species. We recorded CPUE (fish > 4.0") of 0.8 for WSCT and 1.2 fish/100' for brook trout. Sculpins were abundant in this sample.

At the two lower survey sections (miles 2.0 and 3.0), we found only brook in low abundance, with CPUE (fish > 4.0") ranging from 1.0 to 2.6 fish/100'.

We collected 19 westslope cutthroat trout genetic samples from the three upper Washington Creek survey sections (Appendix I). Genetic samples (N=27) collected in 1989 (near mile 7.4), reported no introgression.

Finn Creek

Finn Creek, a small 2nd order stream flows northeast from its headwaters in the Garnet Mountains 3.3 miles through private ranchland to its confluence with Nevada Creek at mile 39.5. Stream gradient ranges from 760'/mile to 140'/mile near the mouth (Figure 31). We were unable to take a discharge measurement on lower Finn Creek because of low instream flow. Because of low flows in lower Finn Creek and limited access to upper Finn Creek, we established only one fish population survey site (mile 1.4).

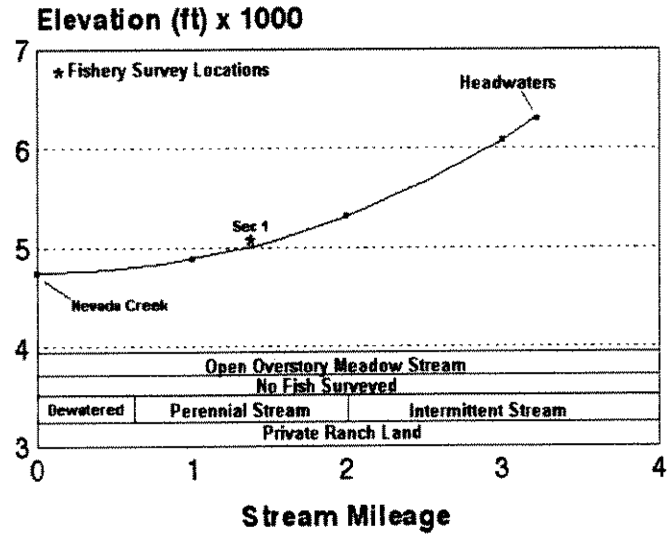


Figure 31. Longitudinal profile for Finn Creek.

At mile 1.4, Finn Creek has a slightly entrenched, straight (B4-type) channel with elevated levels of fine sediment. Heavy cattle use and old logging in the riparian area have caused unstable and degraded banks. Vegetation consists of an alder over-story with an under-story of grazed grasses and forbs.

Fish Populations

No fish were sampled in the 400' survey section at mile 1.4 on Finn Creek.

Halfway Creek

Halfway Creek, a 3rd order stream, is a tributary to Nevada Creek at mile 40.3. Draining beaver ponds fed by McKay Creek in the southwestern foothills of Nevada Mountain, Halfway Creek flows northwest 8.5 miles through private ranchland (Figure 32). Stream gradients range from 250'/mile at the headwaters to 20'/mile near the mouth. We measured discharge at 0.9 cfs at mile 0.9 on 8-1-01. Strickland Creek, a tributary to Halfway Creek, contributes 0.3 cfs of this flow (Appendix D). Temperature monitoring at mile 0.9 showed a maximum summer temperature of 76.6° F in July, 2.1°F warmer than the Nevada Creek 0.8 miles downstream

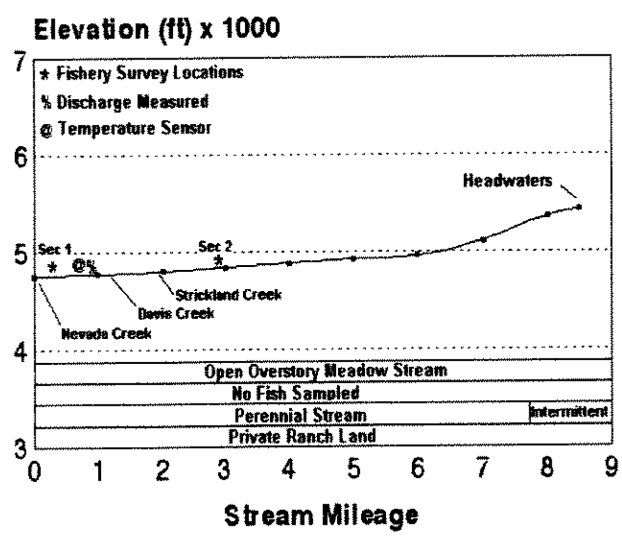


Figure 32. Longitudinal profile for Halfway Creek.

of the mouth of Halfway Creek (mile 39.5) (Appendix H).

We established two fish population survey sites (mile 0.3 and 2.9) on Halfway Creek. At stream mile 2.9, the channel is a low gradient, low sinuosity meadow (E6-type) stream, lined with a dense ground cover of grasses and sedges. An abundance of aquatic vegetation, deep pools and undercut banks with overhanging vegetation characterize the habitat. A culvert located in this section is in good condition. Livestock grazing impacts include unstable banks and high sediment levels ranging 12"-24"in depth.

On lower Halfway Creek (mile 0.3), the channel is an unstable entrenched low-gradient (G6-type) gully, deeply incised in cohesive silt and clay. Riparian vegetation consists of a heavily grazed grass/sedge community. Aquatic plant species inhabit the stream channel. Fish habitat is comprised of pools with aquatic vegetation. Degraded banks caused by grazing cattle are present. Sediment levels are high, ranging 6"-12" in depth with a noticeable methane odor.

Fish Populations

No salmonids were sampled at the two survey locations. We observed redside shiners and longnose suckers at both sections and sculpins at mile 0.3.

Strickland Creek

Strickland Creek, a small 2nd order tributary, originate near Deer Park on the northern slopes of Gravely Mountain and flows northeast 6.5 miles through private ranchland before entering Halfway Creek at mile 2.0. Stream gradients range from 370'/mile in the headwaters to 70'/mile near the mouth (Figure 33). We measured discharge at 0.3 cfs at mile 0.1 on 8-1-01, or ~36% of Halfway Creek discharge (Appendix D). On 8-1-01, we established one fish population survey section on lower Strickland Creek (mile 0.1). Because of access restrictions, we did not sample the middle and upper reaches of Strickland Creek.

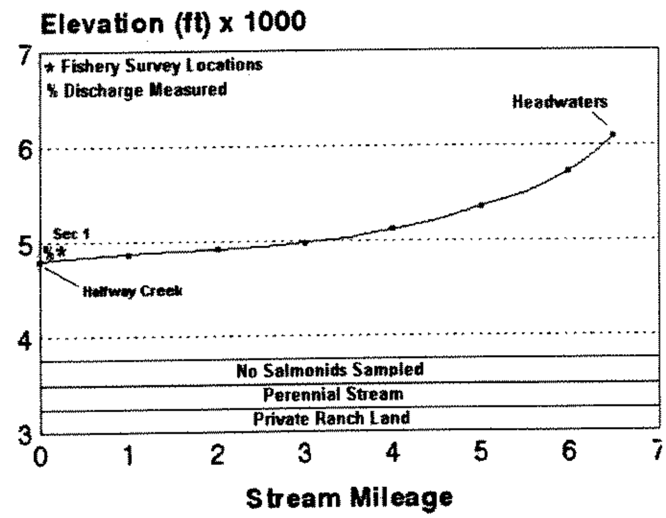


Figure 33. Longitudinal profile for Strickland Creek

Lower Strickland Creek is primarily a meandering meadow stream (E6-type) channel, with a low to moderate sinuosity, gentle gradient and a low width/depth ratio. At mile 0.1, we observed areas of slumping streambanks and channel over-widening, the apparent result of past livestock impacts. The riparian vegetation lacks diversity, supporting a grass/sedge community with browsed willow.

Fish Populations

The Strickland Creek survey recorded no salmonids. Species present were redside shiner and longnose sucker.

Mitchell Creek

Mitchell Creek, a 1st order tributary, originates on the Helena National Forest land, flows through private ranch land below mile 4.0 and enters Nevada Creek at mile 43.2. Mitchell Creek flows 7.1 miles and drains the southwestern slope of Nevada Mountain (Figure 34). Stream gradients range from 1,000'/mile near the headwaters to 130'/mile near the mouth. We measured a discharge of 0.7 cfs at mile 3.0 on 7-16-01 (Appendix D). Temperature monitoring at mile 3.0 recorded a summer maximum of 63.5 °F in August (Appendix H). In 2001, we established three fish population survey sites (mile 3.0, 3.5, and 4.7) in mid- to upper reaches of Mitchell Creek.

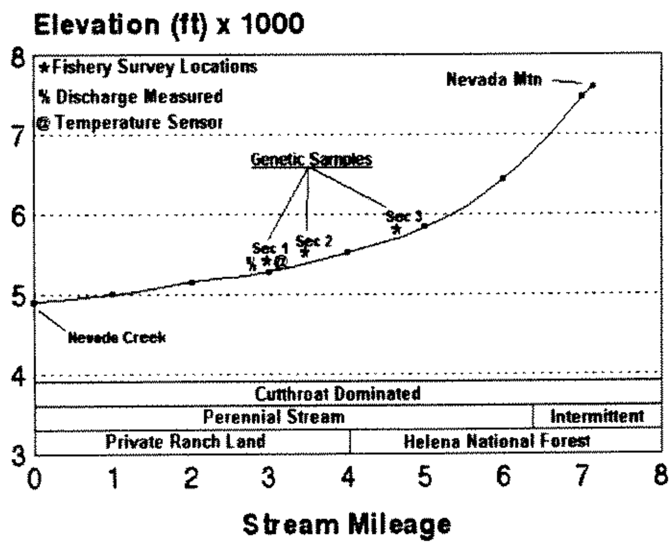


Figure 34. Longitudinal profile for Mitchell Creek.

At the upper survey section (mile 4.7), the channel is moderately entrenched (B3-type) channel with a moderate width/depth ratio on a gradient of 2-4% and cobble-dominated substrate. Overall, the riparian vegetation appears healthy with a dense canopy of Douglas fir and Englemann spruce above an understory of alders, and mixed ground cover of grasses, sedges and forbs. The channel contained long riffles, lacks instream wood and pools. Livestock presence resulted in minimal impacts to the riparian area.

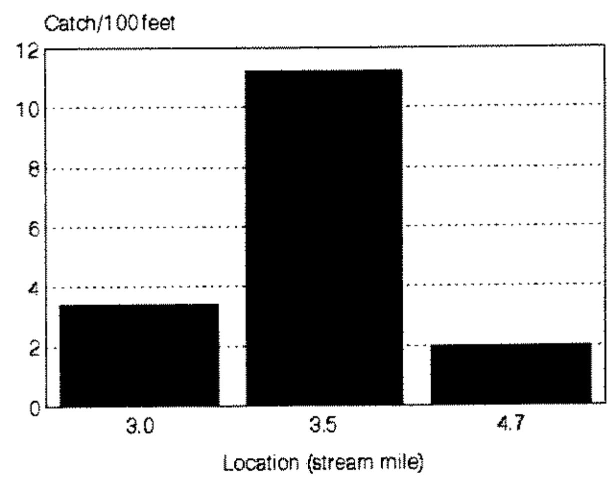


Figure 35. CPUE for WSCT (fish > 4.0") at 3 sites on Mitchell Creek.

The middle survey section (mile 3.5) has similar (B4-type) channel features as the upper site, but with a finer more gravel-dominated substrate. The riparian vegetation consists of a Douglas fir and cottonwood canopy above an under-story of alder and willows. Riparian undergrowth consists of woods rose, grasses and forbs. Moderate amounts of woody debris enhancing the plunge pools along with undercut banks provide improved habitat for fish. Although generally stable, we noted minor livestock impacts in the survey section. Below the fence-line at the downstream end of this section, the stream channel is highly degraded from excessive cattle use.

Because of access restrictions and several large beaver complexes in the lower reaches of the stream, we were unable to sample downstream of mile 3.0. The stream channel is in the process of incision, adjusting vertically from a meandering gentle gradient (E4-type) channel to an incised, higher gradient (G4-type) channel. The riparian community consists of a sparse overstory of aspen, above a shrub understory of alder, willow, currant and woods rose along with clover, yarrow, sticky geranium and sedge in the undergrowth. Woody debris recruitment is high in this section, but excessive cattle use has degraded and over-widened the channel. A culvert at the lower end of the section is perched, and may be a partial fish barrier.

Fish Populations

We found only WSCT at the three Mitchell Creek survey sites, with the middle section supporting the highest densities. The upper most section (mile 4.7) recorded a CPUE (fish >4") of 2.0, compared to 11.2 at mile 3.5 and 3.4 fish/100' at mile 3.0 (Figure 35). We collected 25 WSCT genetic samples from the three survey sections on Mitchell Creek (Appendix I).

Shingle Mill Creek

Shingle Mill Creek, a 1st order tributary, drains the western slopes of Nevada Mountain before entering Nevada Creek at mile 45.1. Shingle Mill Creek courses 5.5-miles in length, mostly through Helena National Forest, before entering private ranchland at mile 1.6 (Figure 36). Stream gradient ranges from 570'/mile at the headwaters to 160'/mile near the mouth. We measured discharge at 0.7 cfs at mile 0.8 on 7-17-01 (Appendix D). In 2001, we established three new fish population survey sites (mile 0.8, 1.6, and 2.2) on Shingle Mill Creek.

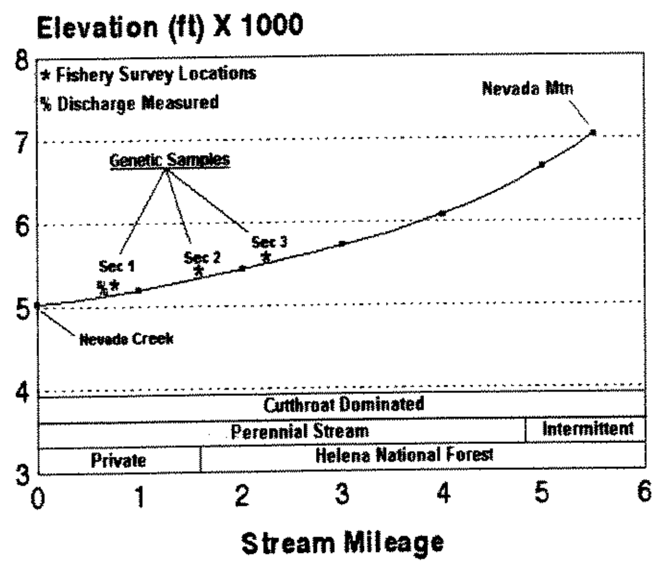


Figure 36. Longitudinal profile for Shingle Mill Creek.

Streambank stability and general habitat conditions were similar at both upper survey sections (miles 1.6 and 2.2): moderately entrenched (B3-type) channels with moderate gradient and cobble-dominated substrate. We observed generally stable banks with only limited livestock impacts. The riparian vegetation at both upper survey sections consists of Douglas fir and Englemann spruce above a dense shrub understory of alder and dogwood along with an undergrowth of horsetail, grasses, sedges and forbs.

The lower survey section, at mile 0.8, is a low gradient, highly sinuous, gravel-bottom stream (E-4-type) channel, located on private ranchland. The riparian community contains a sparse canopy of Douglas fir and Englemann spruce above a shrub layer of alder and willow and a mixed groundcover of grasses, sedges and forbs. Heavy cattle use in the adjacent riparian area has left the banks degraded and unstable. Fish habitat is limited due to unstable banks. A large beaver complex extends downstream to the mouth below this section.

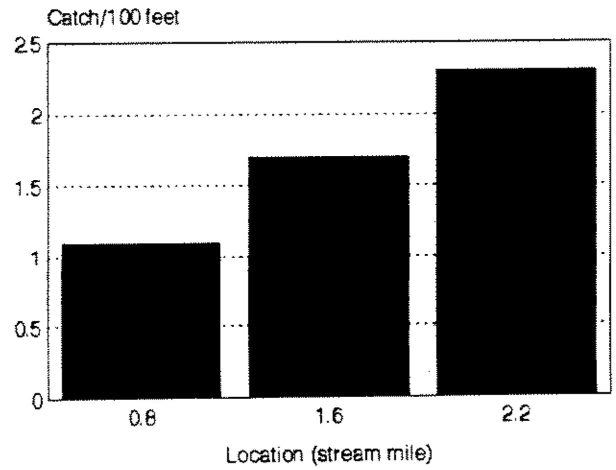


Figure 37. CPUE for WSCT (fish > 4.0") at 3 sites on Shingle Mill Creek.

Fish Populations

We found only WSCT in Shingle Mill Creek in low densities, which decreased in the downstream direction (Figure 37). The upper section produced a CPUE (fish > 4.0") of 2.3 compared to 1.1 fish/100' at the lower sample. We collected 25 WSCT genetic samples from the three survey sections on Shingle Mill Creek (Appendix I). Genetic sampling (N=10) by the USFS in 1992 (mile 2.0) reported no introgression.

Gleason Creek

Gleason Creek, a 1st order tributary, drains the northern slope of Nevada Mountain, flows west 4.4 miles through the Helena National Forest before entering Nevada Creek at mile 47.6. Stream gradients range from 720'/mile in the headwaters to 190'/mile near the mouth. Because of the lack of access to the middle and upper reaches of Gleason Creek, we were only able to survey one location near the mouth (mile 0.1) (Figure 38). We measured a discharge of 2.2 cfs at mile 0.1 on 7-25-01.

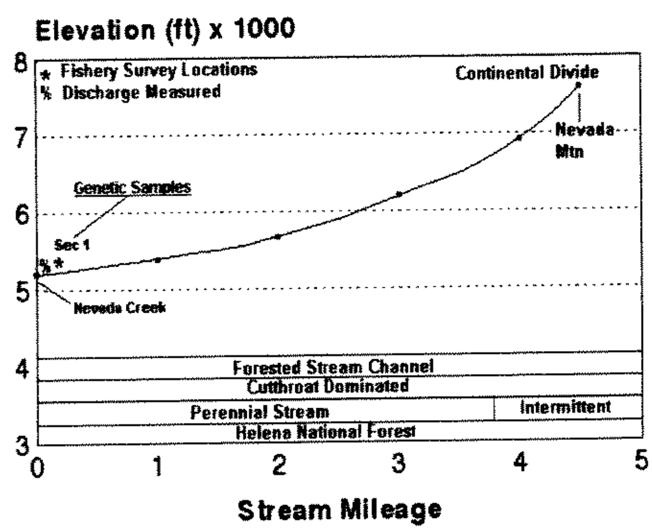


Figure 38. Longitudinal profile for Gleason Creek.

Upstream of the Nevada Creek road crossing (mile 0.1), Gleason Creek is a steep, incised and confined (A3-type) channel with a cobble-dominated streambed. Downstream of the road to the mouth, Gleason Creek becomes moderately entrenched with a moderate gradient (B3-type) channel. We found a healthy riparian zone with an over-story of Douglas fir and lodgepole pine above a dense under-story of willow, alder and rocky mountain maple, along with horsetail, grasses and a diversity of forbs in the undergrowth. Dense woody vegetation and wood-formed plunge pools characterize the habitat. The only problem observed was a slightly perched, sloped, 45' long culvert under the Nevada Creek road, which likely acts as a selective fish barrier.

Fish Populations

Lower Gleason Creek supports low densities of WSCT and sculpins. The CPUE for WSCT (fish > 4.0") was 1.4 fish/100'. We collected genetic samples from all WSCT (N=9) sampled. Genetic samples collected in 1988 by USFS from a Nevada Creek, slightly upstream of Gleason Creek, found a hybridized population of WSCT.

Additional Blackfoot River tributary Inventories

Cooper's Lake and Tributaries

Ten miles north of Ovando, Montana, Cooper's Lake is situated in a secluded, conifer filled glacial valley blocked by walls of bedrock on the southern end. This oligotrophic lake is surrounded by Lolo National Forest, Plum Creek, and mainly private land. Located at an elevation of 4,490', lake surface area covers 180 acres and contains 7,364 acre-feet of water. Maximum depth in Cooper's Lake is ~56 feet. In the summer of 2001, we gillnetted Cooper's Lake at three locations and electro-fished McDermott Creek and a small unnamed stream entering the east shore of Coopers Lake (Figure 39).

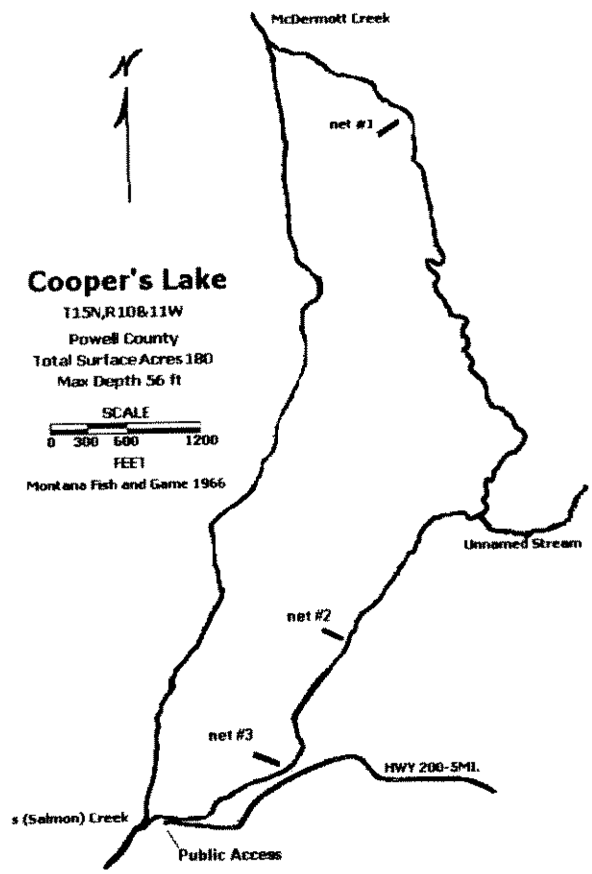


Figure 39. Map of Cooper's Lake gillnet and tributary locations.

McDermott Creek is a 2nd order tributary to Cooper's Lake. It drains the southwest slopes of Mineral Hill and the western side of Windy Pass. Stream gradients range from 1,500'/mile in the headwaters to 70'/mile near the mouth. Near the mouth of McDermott Creek we recorded a moderately entrenched B and C-type channel with stable streambanks and large amount of instream wood and the heavy movement of bedload. This bedload influx likely results from of the Canyon Creek fire, which burned the headwaters of McDermott Creek in 1988. The 2nd unnamed tributary to Cooper's Lake is a glacially formed 1st order stream two-miles in length. It drains the western slopes of Daly Peak, Echo, and Iron Mountain, entering the east shore of

Coopers Lake. Stream gradients average 930'/mile. Near the mouth of this stream, we sampled an E-type meadow stream with a gentle gradient that becomes a much steeper channel at mile 0.8. Both of these streams were sampled from the mouth upstream.

Coopers Lake Fish Populations

The 1957 and 1963 gillnet data revealed a lake over-populated with longnose suckers and northern pikeminnow. Montana Fish and Game took action to eradicate these undesirable species and restore the WSCT sport fishery, in the fall of 1967. The lake and two tributaries were treated with rotenone to make way for WSCT hatchery fry in 1968.

Gillnetting records from the summer of 1969 showed improved numbers of WSCT. However, longnose suckers and northern squawfish were still present in the lake following the treatment. Gillnetting data from 1976 showed an increase in the longnose sucker population and a mixed assemblage of trout species including bull, brook, rainbow and cutthroat (Yellowstone and westslope) trout, in low numbers (Figure 40).

The 2001 gillnet data shows yet another change in the species composition of Coopers Lake. The lake is now dominated by northern pikeminnon, longnose suckers in lower densities and low brook trout densities of brook trout. We found no native salmonids in the 2001 samples.

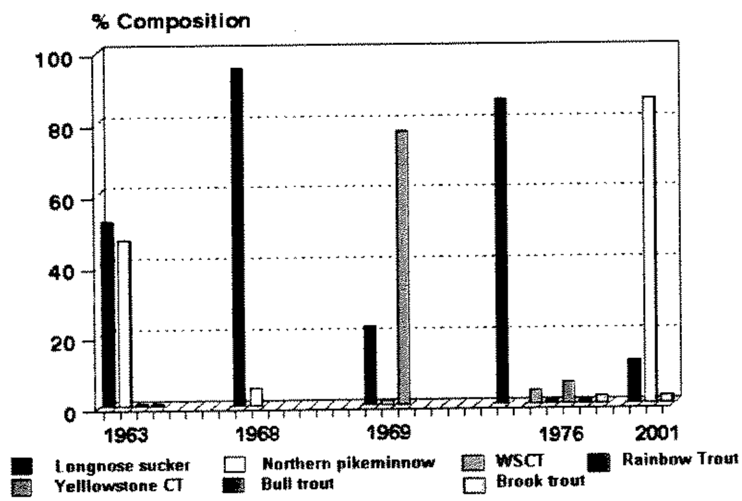


Figure 40. Percent species composition for fishes of Coopers Lake.

Tributaries to Coopers Lake

The electro-fishing of McDermott Creek produced brook trout, longnose dace, sculpins and one WSCT in a 500' section. Brook trout produced a CPUE of 6 fish/100' for all size classes. The unnamed tributary to Cooper's Lake contained one WSCT and very low densities of brook trout (N=4).

Dick Creek

Dick Creek, a 3rd order tributary, drains the western slopes of Ovando Mountain then flows in a southwest direction through a checkerboard of landowners including: Lolo National Forest, State, Plum Creek Timberland and private ranch lands before entering Monture Creek at mile 4.1 (Figure 41). With a total length of 13.6 miles, the upper portion of Dick Creek is a relatively steep mountain stream before entering a large alluvial fan in middle reaches and knob-and-kettle topography in the lower basin. Lower Dick Creek flows through a series of wetland bogs, which contribute to elevated water temperatures. Stream gradients range from 720'/mile, at the headwaters, to 15'/mile near the mouth.

Summer water temperature monitoring occurred at two locations on Dick Creek (mile 0.8 and 5.3). Recording summer maximum temperatures of 73.9 °F (mile 0.8) and 51.1 °F (mile 5.3) during August, a 22.8 °F increase over 4.5 mile length of channel (Appendix H). Dick Creek at mile 5.3 was among the coldest summer stream temperatures recorded of any tributary in the middle Blackfoot Watershed, with monthly mean temperatures ranging between 45.8 and 46.3 °F.

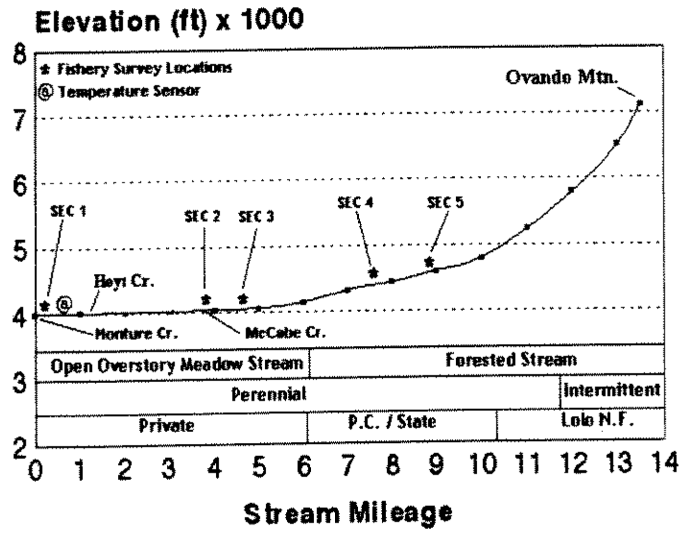


Figure 41. Longitudinal profile for Dick Creek.

Water temperature monitoring on Hoyt Creek, a lower Dick Creek tributary entering at mile 1.1, recorded a summer maximum temperature of 75.9 °F for July, 4.1°F warmer than the lower Dick Creek. However, Hoyt Creek was 4.9 °F cooler during August, recording a maximum temperature of 69.0 °F. McCabe Creek, a cold basin-fed tributary, entering at mile 3.8, recorded a maximum temperature of 66.3°F during August, 7.6 °F cooler than lower Dick Creek, but 15.2 °F warmer than the upper Dick Creek site (mile 5.3).

In 2001, we re-surveyed two 1992 fish population survey sections on Dick Creek (miles 0.1 and 8.8) and established three new section (miles 3.9, 4.8, and 7.8).

The three lower fish population surveys were undertaken in stream reaches influenced by wetlands and groundwater inflows. The two upper survey locations were located near diversion points located in the basin-fed portion of Dick Creek.

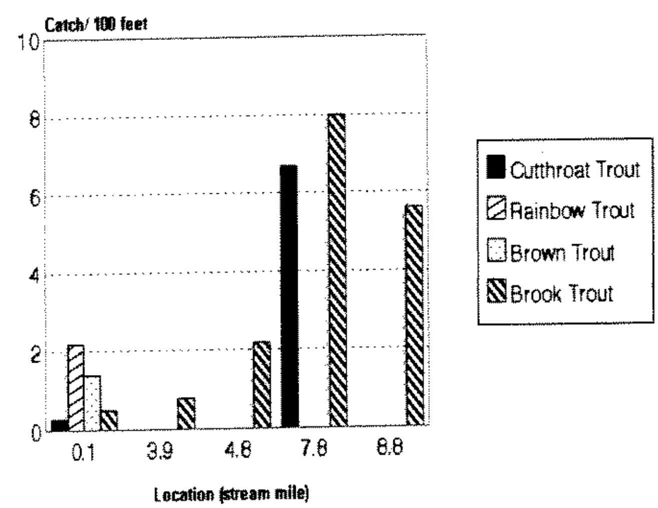


Figure 42. CPUE for fish > 4.0" at 5 sites on Dick Creek.

Fish Populations

In 2001, we sampled Dick Creek at five locations. Surveys recorded the presence of only brook trout at the upper most section, WSCT and brook trout at the mid-to upper sites, and a mixed WSCT, rainbow, brown, and brook trout at the lower survey site, with densities decreasing in the downstream direction (Figure 42). Only brook trout were found at the upper most survey section (mile 8.8), for a CPUE (fish > 4.0") of 5.6 fish/100'. Our sampling at mile 7.8 found relatively good densities of WSCT and brook trout producing CPUE (fish > 4.0") of 6.7 and 8.0 fish/100', respectively. Unlike mile 7.8, WSCT were absent from the middle reaches, producing only low numbers of brook trout, with CPUE (fish > 4.0") of 2.2 fish/100'(mile 4.8) and 0.8 fish/100'(mile 3.9). At the lower most section (mile 0.8), we sampled a diverse fish species composition, but in very low densities with CPUE (fish >4.0") of 0.3 for WSCT, 2.2 for rainbow trout, 1.4 for brown trout, and 0.5 fish/100' for brook trout. Our sampling also found sculpins were abundant at only the two lower sites (miles 0.1 and 3.9) (Appendix A). Mountain whitefish, longnose dace and longnose suckers were present only at mile 0.1. Redside shiners, longnose suckers and largescale suckers were abundant at mile 4.8.

Fish Creek

Fish Creek is a 1st order tributary stream to the lower Blackfoot River, entering at river mile 33.1 from the Garnet Mountains. Fish Creek drains Bata and Lost Horse Mountains, and flows 5.1 miles northwest through a checkerboard of State, Plum Creek, and private land. Gradient ranges from 640'/mile in the headwaters to 200'/mile near the mouth (Figure 43). In 2001, we established three survey sections on Fish Creek (miles 0.7, 1.8, and 2.8).

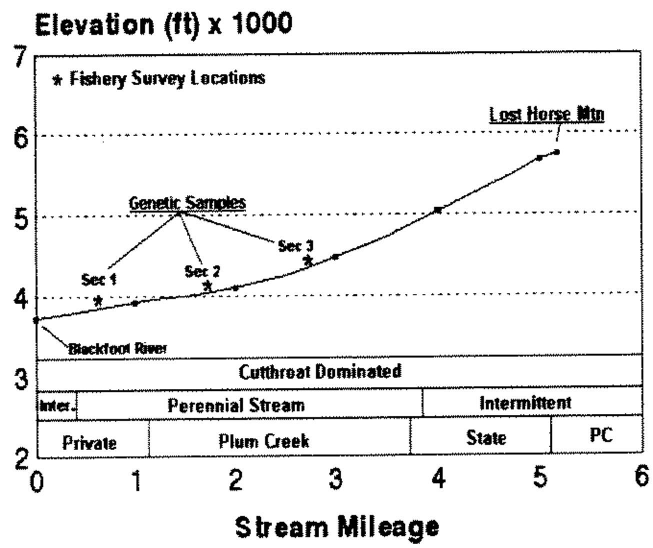


Figure 43. Longitudinal profile for Fish Creek.

Channel features range from a deeply entrenched, high gradient (A3-type) channel (mile 2.8) to a moderately entrenched gravel-dominated (B4-type) channel with a 2-4% slope at both lower sites (miles 0.7 and 1.8). Riparian habitats at all three survey sections are in good health. The riparian community at the upper site is comprised of a Douglas fir overstory along with a diverse understory of rocky mountain maple, alder, red osier dogwood, ferns, various forbs and grasses. The dense understory provides shade, wood, and generally high quality fish habitat. Both lower sections support a riparian overstory of ponderosa pine-aspen and Douglas fir-larch above dense understory of alder, red osier dogwood with a groundcover of grasses, forbs and ferns. Instream sediment levels ranged from light to moderate.

Problems we observed influencing fish populations, was the dewatering of the lower 0.3 miles, a dam acting as a fish barrier at mile 1.0, and an undersize culvert at mile 1.8.

Fish Populations

The 2001 Fish Creek fish population surveys found only WSCT, with densities decreasing in the downstream direction (Figure 44). Total CPUE for WSCT decreased 98% from 14.6 fish/100' at mile 2.8 to 0.3 fish/100' at mile 0.7. YOY WSCT densities were highest at the upper survey site and absent from the lower site (Appendix A). The dense under-story at the three survey sites reduced fish sampling efficiencies. We collected a genetic sample from 25 WSCT at the three survey sections (Appendix I).

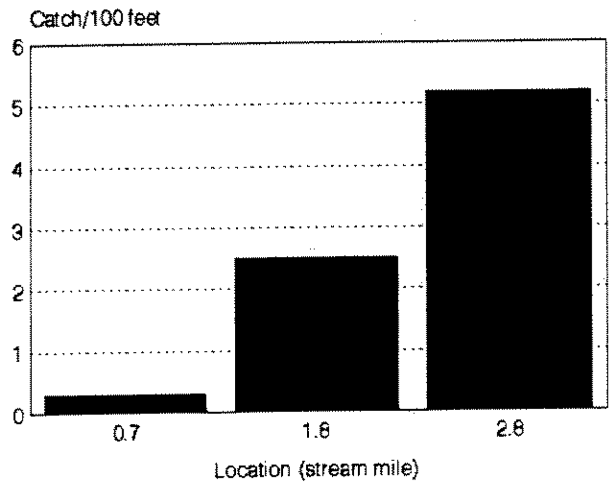


Figure 44. CPUE for WSCT (fish > 4.0") at 3 sites on Fish Creek.

Ward Creek

Ward Creek, a 2nd order tributary to the North Fork of the Blackfoot River, originates on Helena National Forest land near Arrastra Mountain and flows southwest 10.8 miles through checkerboard ownership before entering Browns Lake (Figure 45). As the outlet stream from Browns Lake, Ward Creek then continues through private ranchland for 2.8 miles before entering Kleinschmidt Lake. Below Kleinschmidt Lake, Ward Creek flows another mile to its confluence with the North Fork of the Blackfoot River at mile 5.0. Total stream length is 17.4 miles. Gradient ranges from 780'/mile at its headwaters to 100'/mile at its confluence with the NF Blackfoot River. Lower Ward Creek from Kleinschmidt Lake downstream its confluence with the North Fork was dry during our sampling period..

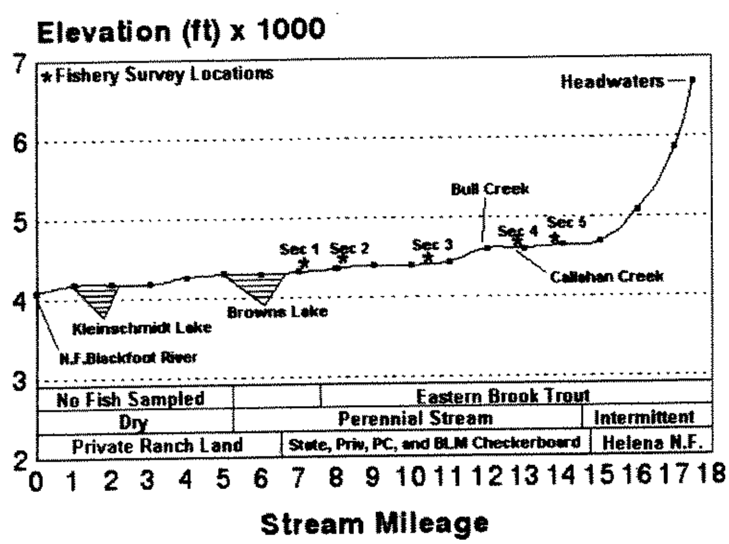


Figure 45. Longitudinal profile for Ward Creek.

Ward Creek is a degraded channel with a long history of riparian impacts, including intensive grazing and irrigation. Except for the extreme headwaters, Ward Creek is predominately a meadow stream (E-type) with a low to moderate sinuosity, gentle to moderate gradient and low channel width/depth ratio and sand substrate.

In 2001, we established five fish population survey sections on Ward Creek above Browns Lake (miles 7.2, 8.2, 10.5, 12.9, and 13.8). Dewatering prevented us from sampling lower Ward Creek. We found a livestock degraded (E6-type) meadow stream at mile 13.8 with unstable banks, over-widened and shallow channel. The channel appears to be in the process of incision. Instream sediment levels range from 6-24" in depth. Highly over-grazed sedges and grasses compose the riparian plant community.

The riparian plant communities at mile 12.9 consist of a dense groundcover of horsetail, sedge and grasses beneath sparse willows. Banks are stable with no evidence of excessive cattle use. Over-hanging vegetation and undercut banks provide limited habitat for fish. Heavy stream sediment from upstream sources ranges from 12 - 30" in depth.

At mile 10.5, we found a moderate overstory of Douglas fir above a shrub understory dominated by dense hawthorn mixed with chokecherry above a groundcover of timothy and other grasses. At this site, banks are stable, however we also observed adjacent highly degraded areas from cattle use.

At mile 8.2, the stream channel has a dense shrub community of alder and willow, grasses and forbs. Problems observed were areas of grazing-induced bank degradation, creating an over-widened channel and contributing high concentrations of sediment. Spot water temperatures indicate excessive warming in the reach, in part due to a small reservoir upstream at mile 8.3.

At the lower-most section (mile 7.2), the riparian area is dominated by a sedge community mixed with timothy and grasses, giving rise to stable streambanks. No livestock use is evident.

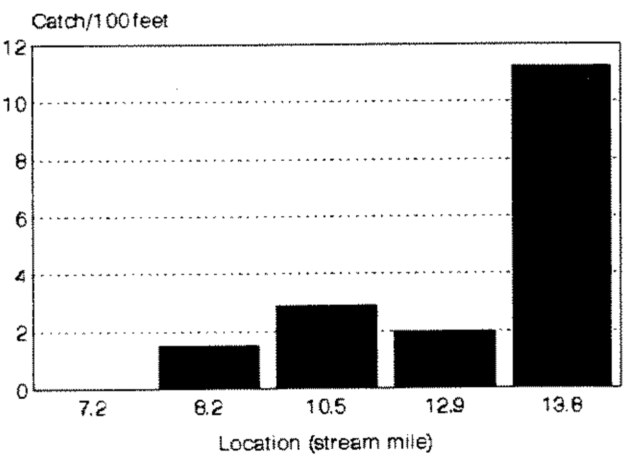


Figure 46. CPUE for Brook Trout (fish > 4.0") at 5 sites on Ward Creek.

Fish Populations

We found no native salmonids in Ward Creek, although WSCT were likely present historically. Fish population surveys found a brook trout dominated stream, along with sculpins, redside shiners, and longnose suckers (Appendix A). No salmonids were present at the lower survey section (mile 7.2). Densities showed a downward trend with CPUE (fish > 4.0") decreasing from 11.2 fish/100' at mile 13.8 to 1.5 fish/100' at mile 8.2 (Figure 46).

PART III: FISH POPULATION AND OTHER ASSESSMENTS FOR RESTORATION STREAMS

Part III summarizes 2001 restoration project results, including fish population or habitat monitoring on project streams or streams considered for restoration (Figure 47). Streams are organized alphabetically. For most of these streams, more detailed project and fisheries information can be found in five previous reports (Peters 1990, Pierce et al. 1997, Pierce and Schmetterling 1999, Pierce and Podner 2000, Pierce et al. 2001). In Results Part III, both CPUE and density estimates are used. All density estimates plus the 95% confidence intervals for density estimates are found in Appendix C.

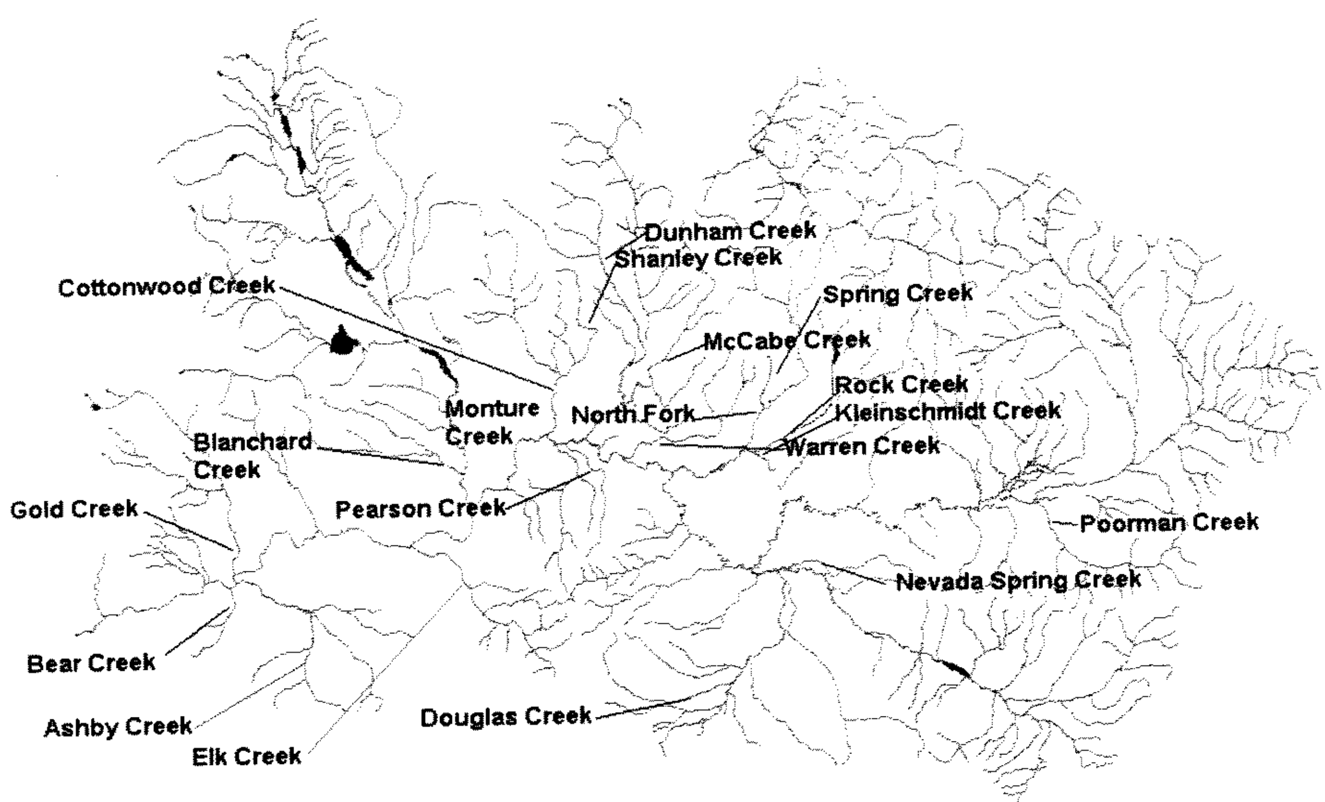


Figure 47. 2001 Restoration streams or streams being considered for restoration.

Bear Creek

Restoration Objectives: restore habitat degraded by historical activities in the channel, restore fish passage and thermal refugia, and improve recruitment of trout to the Blackfoot River.

Project Summary

Bear Creek, a small 2nd order tributary of the lower Blackfoot River, flows six miles north to its mouth; bear creek enters the Blackfoot River at river mile 12.2 with a base flow of 3-5 cfs. Bear Creek is one of the colder streams entering the lower Blackfoot River. For Summer 2001, mean daily temperatures (mile 1.0) were in the low 50's with maximum summer temperature of 66.4 °F, or ~4.5 °F degrees cooler than the Blackfoot River at the USGS gauging station at river mile 7.9 (Appendix H).

Bear Creek has a long history of intensive riparian management activities, many of which resulted in adverse habitat changes and other impacts to salmonids; these include placement of undersized culverts, road drainage problems, irrigation impacts, channelization of the stream, riparian grazing and streamside timber harvest activities (Pierce et al. 1997, Pierce and Schmetterling 1999). These activities, implemented without fisheries considerations, contributed to the loss of migration corridors, dewatering and simplification and degradation of salmonid habitat.

Restoration of Bear Creek began in 1995 and continued through 2000. Projects included: 1) upgrading culverts and addressing road drainage problems; 2) improving water control structures at irrigation diversions; 3) reconstructing 2,000' of channel and enhancing habitat complexity on an additional 2,000' of stream; 4) shrub plantings and the development of compatible riparian grazing systems for one mile of stream, which includes offstream water.

Fish Populations

Bear Creek supports populations of rainbow trout, brown trout and brook trout along with low densities of WSCT in the upper basin and very low densities of juvenile bull trout. Bear Creek provides salmonid recruitment to the lower Blackfoot River sport fishery.

In 2001, we continued fish population monitoring in a reconstructed section of Bear Creek. Total CPUE for all salmonids (fish >4.0") increased from 7.7 in 2000 to 15.2 fish/100' in 2001 (Figure 48). Increased densities (fish > 4.0") were noted for all species in the sample. Conversely, total CPUE for fish <4.0" decreased from 18.6 fish/100' in 2000 to 8.2 fish/100' in 2001.

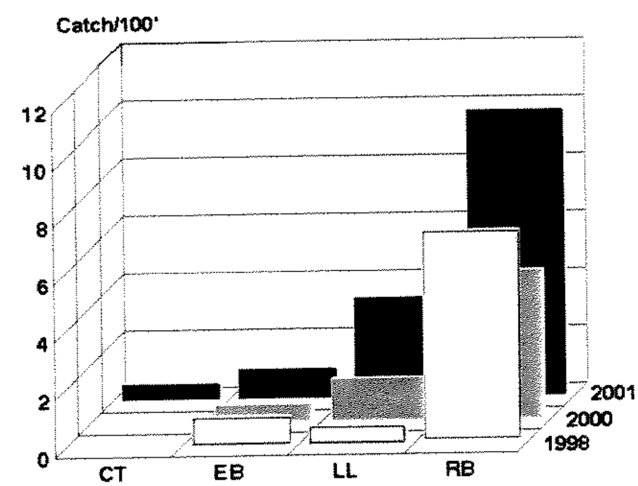


Figure 48. CPUE for salmonids (fish> 4.0") for Bear Creek at mile 1.1, 1998-2001.

Blanchard Creek

Restoration objectives: improve access, spawning and rearing conditions for trout and increase recruitment of trout to the Blackfoot River.

Project Summary

Blanchard Creek has a long history of intensive and adverse land management activities, which have resulted in riparian degradation and loss of fish habitat. These include changes to the hydrograph (12% above natural) related to timber harvest (DNRC unpublished data), side casting of road grade material to the channel for road maintenance purposes, excessive livestock access to riparian areas and dewatering through irrigation. Two past projects were implemented on Blanchard Creek to improve riparian health and fish populations: 1) riparian livestock management changes on State Land; and 2) irrigation upgrades near the mouth.

Blanchard Creek was historically dewatered in its lower one mile from irrigation, resulting in large fish population declines (Pierce et al. 1997). In 1991, the irrigator began increasing flows, and then entered into a water lease in 1993 in order to maintain a 3 cfs minimum instream flow during the irrigation season. In 2001, the water-rights holder terminated the water lease for the 2001 irrigation season, which resulted in the complete dewatering of the lower 1.1 miles of Blanchard Creek.

Fish Populations

Blanchard Creek, a tributary to the lower Clearwater River, is a spawning tributary for rainbow and cutthroat trout, and supports low densities of brown trout and brook trout. During the early years of the water lease, Blanchard Creek supported some of the highest rainbow trout densities found in tributaries of the Blackfoot River. However, since the early 1990s sampling of trout has recorded a downward trend in densities for fish >4.0" (Figure 49).

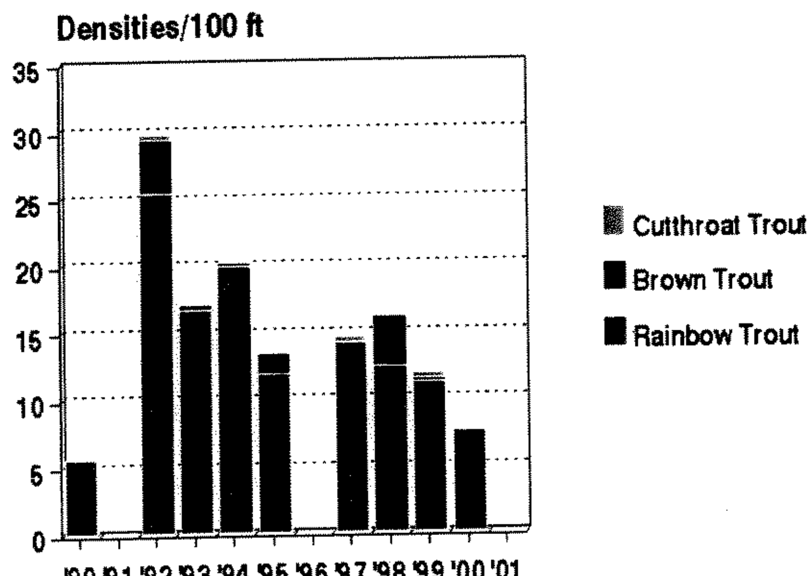


Figure 49. Estimated densities of salmonids (fish>4.0") in lower Blanchard Creek (mile 0.1), 1990-2001.

In 2001, there were no fish in the dewatered section of Blanchard Creek, compared to a total trout density estimated at 59 fish/100' in 2000.

Cottonwood Creek

Restoration objectives: improve degraded habitat; eliminate fish losses to irrigation ditches and restore migration corridors for native fish.

Project Summary

Cottonwood Creek, a large 3rd order tributary to the middle Blackfoot River, begins near Cottonwood Lakes and flows 16 miles south from a glacial valley through prairie pothole country to its mouth at river mile 43. Cottonwood Creek supports populations of bull trout, WSCT, rainbow trout, brown trout and brook trout. Rainbow trout inhabit the lower mile of stream while brook trout and brown trout dominate middle stream reaches. WSCT and bull trout dominate the headwaters.

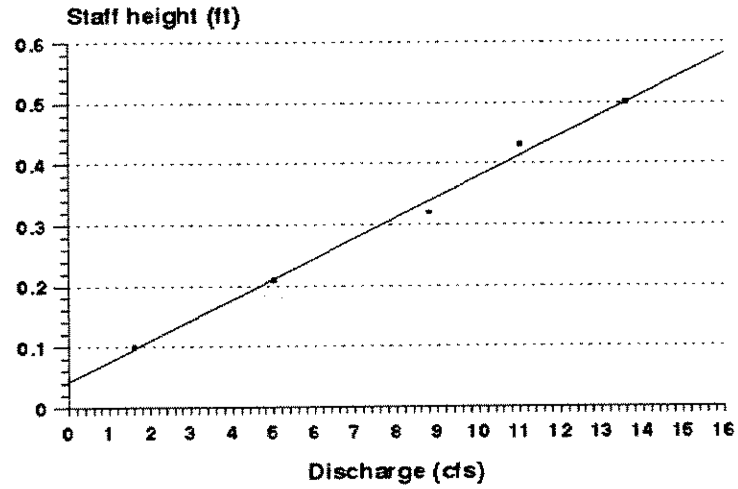


Figure 50. Stage Discharge relationship for the staff gage at the flume in the Dryer Diversion, Cottonwood Creek.

Impacts to fish and their habitats have occurred throughout the Cottonwood Creek drainage, although many of the major problems were addressed in the last several years. Completed restoration measures include water conservation and water leasing, upgrading irrigation diversions with fish ladders and fish screens and implementation of riparian grazing systems along Cottonwood and Shanley Creeks. Problems still limiting fish populations include reduced riparian health and simplified habitat in middle reaches, along with and the loss of migration corridors and tributary habitats in Spring Creek. Cottonwood Creek also supports a high-grade whirling disease infection in the lower stream reaches (Pierce and Podner 2000).

Project Monitoring

In 2001, we monitored Cottonwood Creek in the area of a water lease using two methods. We developed 1) a stage/discharge rating curve for a staff gage in the Dreyer Ditch (Figure 50); and 2) resurveyed fish populations in Cottonwood Creek downstream of the Dreyer Diversion. Before 1997 when the water lease took effect, Cottonwood Creek below the Dreyer diversion was dewatered completely during the irrigation season.

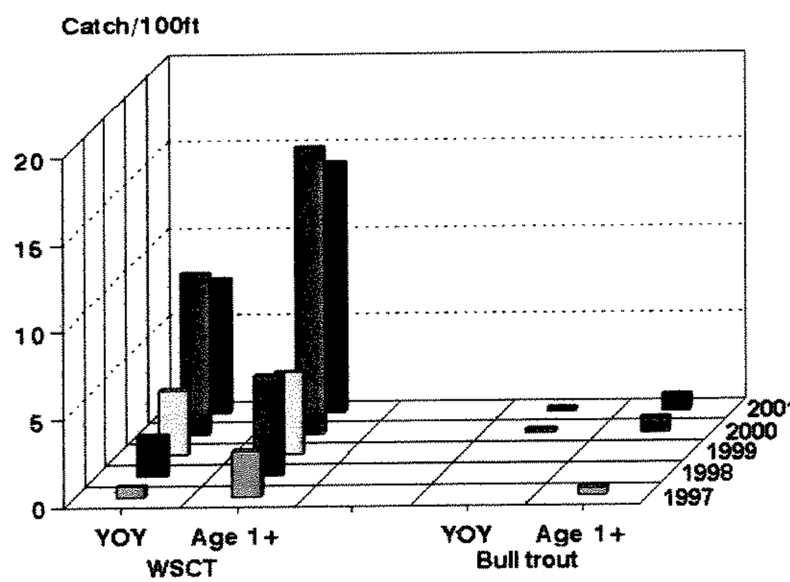


Figure 51. Electrofishing catch for Cottonwood Creek at mile 12.0, 1997-2001.

The Dreyer ditch diverts water from Cottonwood Creek at stream mile 12.1. On June 27, 2001, we measured discharge at various flow rates in order to calibrate the stage/discharge relationship at a partial flume staff gage located ~200' downstream of the point of diversion, with the purpose monitoring the Cottonwood Creek water lease.

Fish Populations

In September 2001, we re-sampled fish populations at mile 12.0, downstream of the Dreyer Diversion. We recorded very little change in westslope cutthroat and bull trout densities compared to 2000 (Figure 51). In 2001, the CPUE for age 1+ WSCT was 14.3 fish/100' and 7.7 fish/100' YOY WSCT. The CPUE for age 1+ bull trout showed was 0.9 fish/100' in 2001. The 2001 surveys indicate for both native species continue to respond to increased flows and ditch screening.

Dunham Creek

Restoration objectives: Eliminate the loss of native fish to irrigation canals, restore habitat conditions and migration corridors, and improve recruitment of bull trout and cutthroat trout to the Blackfoot River.

Project Summary

Dunham Creek, the largest tributary to Monture Creek, is an impaired spawning stream for fluvial WSCT and bull trout. In the early 1970's, ~ 1.3 miles of the Dunham riparian area was clear-cut and burned and the stream then channelized. This channelized section of stream has since become both vertically and laterally unstable, the result of which is significant increases in bank and bed erosion rates, as well as, channel braiding in downstream reaches.

In 2001, the Blackfoot cooperators completed the reconstruction of ~1.3 miles of Dunham Creek to natural channel dimensions consistent with a stable alluviated (C4-type) channel.

Before the project, mean bankfull width in the degraded project reach was 62.2' compared to mean stable reference reach bankfull width of 37.1'. The width/depth ratio of the reference reach was 22.4 compare to 59.1 in the project reach. Sediment deliveries in the project area were ~25-times the natural levels and increased significantly following high flow events of the late 1990s (USFS 2001). This influx of unnaturally high levels of sediment entered the channel immediately upstream of the Dunham Creek bull trout spawning area.

The re-naturalization project focused on channel reconstruction with emphasis on natural channel

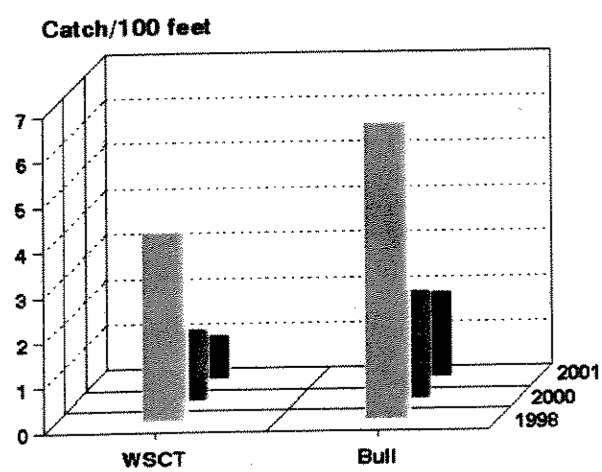


Figure 52. CPUE for Dunham Creek native fish (fish >4.0") at mile 2.3, 1998, 2000 and 2001.

morphology, habitat complexity and included an aggressive revegetation of disturbed banks. The primary objective of the project was to stabilize the stream to allow riparian vegetation to encompass the stream over a 10-15 year period and thus provide long-term stability.

Fish Populations

We resurveyed fish populations at two monitoring sites (mile 2.3 and 4.2) in Dunham Creek before channel reconstruction. The 2.3-mile survey is located 0.6 miles downstream of the project, while the upper site (mile 4.2) is located in the project site.

Both sample sites show lower native fish densities in 2001 compared to earlier surveys. The surveys at mile 2.3 show declines for both WSCT and bull trout (fish >4.0") between 1998 and 2001 (Figure 52). In the project area (mile 4.2), estimated densities were also very low compared to 1998 samples (Appendix B).

Recent population declines likely result from low flows, related to drought, and a large influx of fine sediment, primarily sand, in spawning riffles downstream of the channelized reach.

Elk Creek

Restoration objectives: eliminate significant sources of sediment; improve management of livestock; improve reproduction, rearing and recruitment of all species to the Blackfoot River.

Project Summary

Elk Creek, a degraded tributary to the lower Blackfoot River, originates in the Garnet Mountains and enters the Blackfoot River at river mile 28.0. Elk Creek is considered an "impaired" stream based on the Department of Environmental Quality 303(d) list. Elk Creek has a long history of adverse land management activities that result in well-documented negative influences to fish populations. These include placer mining, channelization, road construction and maintenance practices, road drainage problems and concentrated riparian livestock grazing.

To begin improving water quality in lower Elk Creek, an erosion control project was undertaken in a channelized section of lower Elk Creek (mile 1.3-2.9) in 1994. This project included the reconstruction of 8,600' of new channel, as well as, some livestock management changes (Pierce et al. 1997). Although this necessary project addressed channel incision and severe erosion, subsequent monitoring of water temperature, fish populations and suspended sediment all confirm Elk Creek requires additional measures to improve riparian heath. Additional measures must include compatible riparian grazing strategies, if riparian

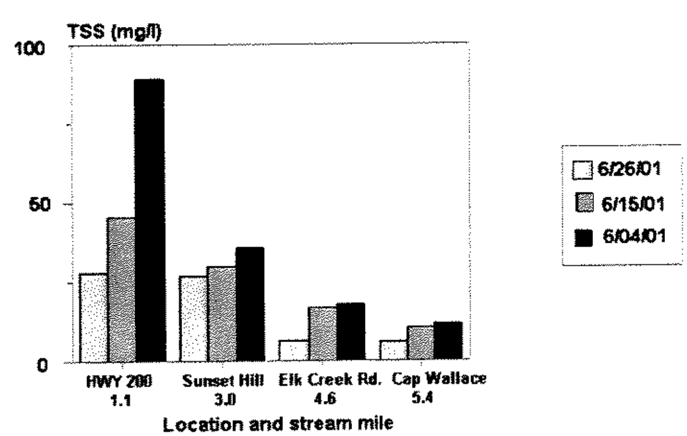


Figure 53. Total suspended sediment for Elk Creek at four locations, June 2001.

health, water quality and fish populations are to improve.

Elk Creek Monitoring

In 2001, we collected water temperatures at Highway 200, along with suspended sediment data at four locations in lower Elk Creek.

Past studies have shown an ~6.0 ° F temperature increase in the lower three miles of stream (Pierce and Schmetterling 1999). In August 2001, temperature sensors recorded a maximum of temperature of 77 ° F at Highway 200, or ~5.0 ° F warmer than the Blackfoot River above Belmont Creek. Elk Creek water temperatures are consistently among the highest in the Blackfoot River Watershed.

We collected total suspended sediment (TSS) samples on Elk Creek at four locations at 11-day intervals in June (Figure 53). These surveys found the highest TSS at the lower-most sampling site (mile 1.1). During the June 26, 2001 sample, TSS increasing from 11.4 mg/liter at Cap Wallace (mile 5.4) to 89.4 mg/liter at Highway 200 (mile 1.1), an increase of 684%. The majority of sediment production is generated between the lower two sampling locations. An inspection of the Elk Creek riparian area confirmed trampling and hoof-shear of stream banks and channel instability, contribute to this turbidity.

An evaluation of fish populations in 2001 confirmed a significant fish population decrease for lower Elk Creek, with total trout densities of 26.4 ± 1.7 fish/100' at mile 4.6 decreasing to 0.2 ± 0.0 fish/100' at mile 1.1 (Pierce et al 2001), a decrease in total estimated densities of 99.2%.

Gold Creek

Restoration Objectives: restore pool habitat and morphological complexity; restore thermal refugia for Blackfoot River native fish.

Project Summary

Gold Creek is the largest tributary to the lower Blackfoot River, entering at river mile 13.5. Discharge at the mouth of Gold Creek was 19.4 cfs in August 2000 (Pierce et al 2001). Over 90% of the Gold Creek watershed is industrial forest. Past harvest of riparian conifers combined with the actual removal of large woody debris from the channel has reduced habitat complexity in the lower three miles of Gold Creek. Before 1996, pools accounted for less than 1% of the wetted surface area in this section of stream (Pierce 1990). Low densities of age 1+ fish, including native fish, resulted from this habitat simplification. In 1996, we installed 66 habitat structures made of native material (rock and wood) that resulted in 61 new pools in the 3-mile section.

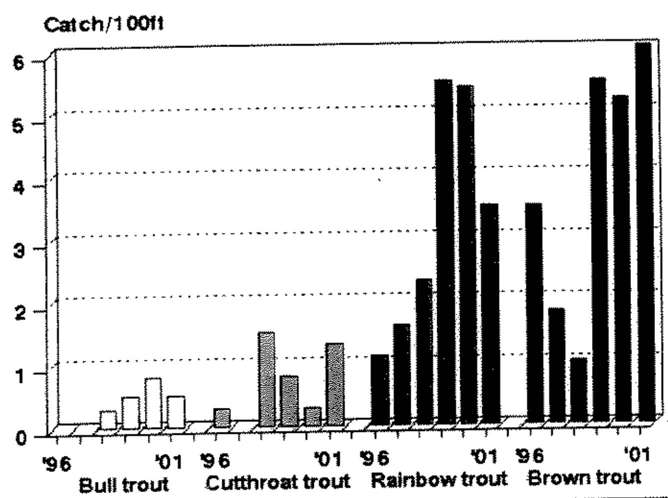


Figure 54. CPUE for salmonids in lower Gold Creek at mile 1.9, 1996-2001.

Fish Populations

Gold Creek is a spawning tributary to the lower Blackfoot River for bull trout, WSCT, rainbow trout and brown trout. Resident populations of brook trout also inhabit the drainage. The Gold Creek mainstem and confluence area also provides thermal refugia for Blackfoot River bull trout.

Before restoration in 1996, we established a fish population survey section in the treated area (mile 1.9). Fish population surveys, undertaken on an annual basis since 1996, indicate positive increases for salmonids in the section (Figure 54).

Gold Creek exerts a cooling influence on the lower Blackfoot River. In 2001, stream temperature monitoring near the mouth recorded maximum temperatures of 67 °F, or ~ 4 °F lower than the Blackfoot River near Belmont Creek at mile 21.9. (Appendix H).

Kleinschmidt Creek

Restoration objectives: reduce whirling disease infection levels, restore stream channel morphology for all life stages of trout, increase recruitment of trout to the Blackfoot River, and restore thermal refugia and rearing areas for North Fork bull trout.

Project Summary

Kleinschmidt Creek, located on the southern margin of Kleinschmidt Flat, is spring-fed tributary entering the North Fork of the Blackfoot River at mile 6.1. In Sept. 2001, we measured Kleinschmidt Creek discharge at three locations (mile 0.5, 0.8 and 1.1). These measurements show a gaining reach, generating 2.7 cfs over this 0.6-mile reach, with flows increasing from 8.7 cfs (mile 1.1) to 11.4 cfs (mile 0.5)

Kleinschmidt has a long history of intensive riparian grazing with very little regard for riparian health and channel stability. In addition to grazing, placement of rock dams and undersized culverts along with channelization further degraded and over-widened Kleinschmidt Creek (Pierce 1991). In 2000-01, the Blackfoot Cooperators reconstructed 6,250' of degraded stream to C and E-type channels.

Kleinschmidt Creek currently supports low numbers of brown trout and brook trout, along with very low densities of bull trout (Pierce and Podner 2001).

	Stream Length	Habitat Type	# of units sampled total/ measured	# units/ 1000'	Mean Length	Mean Wetted Width	Mean Max Depth	Mean bkf Depth	Area (Ft2)	% Area
		Pool	12/6	2.4	171.9	33.1	2.2	2.9	5,696	28.4
pre-project	6250'	Non-pool	32/16	6.4	236.7	29.2	1.1	1.6	14,365	71.6
1990		Total	44/22	9.0	204.3	31.2	1.7	2.3	195,000	100
		Pool	126/63	14.8	37.5	10.7	3.5	3.6	401	53.2
Post-project	8494'	Non-pool	128/64	15.1	36.4	9.7	1.7	1.8	353	46.8
2001		Total	254/127	29.9	37	10.2	2.6	2.7	86,639	100

Table 1. Summary of the Kleinschmidt Creek Habitat Survey.

Project Monitoring

In 2001, we assessed post-project geomorphic and habitat features of Kleinschmidt Creek from mile 0.4 upstream; monitored water temperatures and continued whirling disease sentinel cage studies (Table 3).

Following reconstruction, channel sinuosity increased from 1.06 pre-project to 1.44 post-project, an increase of 36 %. Pool frequency increased 517 % from 2.4/1,000' pre-project to 14.8/1,000' post-project. Mean wetted-width decreased from 31.2' before to 10.2' after. Mean maximum pool depth increased from 2.9' to 3.6' (Table 1). A mean residual pool depth of 2.2' was calculated from the habitat survey. Wetted channel area decreased 56% from 195,000 square feet before the project to 86,600 square feet after project completion. The frequency of instream woody stems increased 1,089 % from 1.9 to 22.6 stems/1,000'. Woody debris is evenly distributed along the restored section of Kleinschmidt Creek (Figure 55). The lack of woody debris between the seventh and twenty second pool is to monitor the fish populations in a section of reconstructed E-type channel, minus the wood.

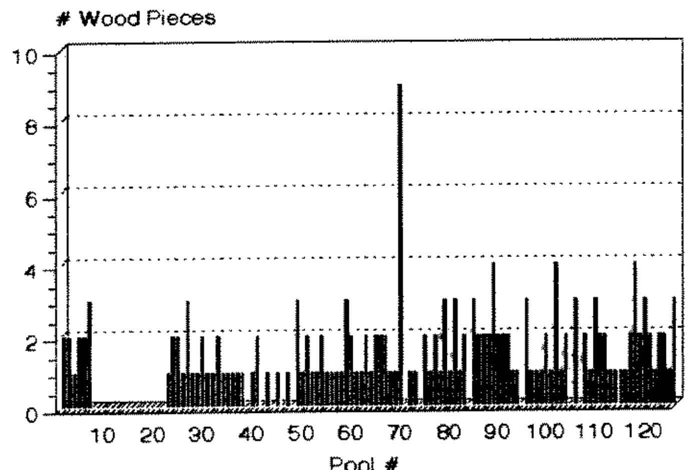


Figure 55. Woody Debris Distribution for the Kleinschmidt Restoration Section.

Water temperature for lower Kleinschmidt Creek recorded mean temperatures ranging from 52.8 to 53.7 °F. Maximum water temperatures range from 70.2 °F in late May to 61.6 °F in August.

Whirling disease sentinel cage studies consistently record high-level infections (> 2.7 grade) in Kleinschmidt Creek (Results Part IV). Future monitoring will test whether habitat and riparian health changes will moderate infection levels.

McCabe Creek

Restoration objective: restore instream flows and habitat conditions for bull trout and WSCT.

Project Summary

McCabe creek is located in the Monture Creek bull trout recovery area. McCabe Creek a cold basin-fed tributary to lower Dick Creek entering at stream mile 3.8. McCabe Creek begins as a steep mountain stream in its headwaters before entering knob-and-kettle topography in the lower basin. In lower reaches, McCabe Creek enters a series of beaver-influenced wetland bogs before entering Dick Creek.

McCabe Creek has a long history of adverse fisheries impacts related to channel alterations and agricultural activities. These include chronic dewatering, loss of fish to irrigation ditches, intensive riparian grazing, physical alterations to the channel and poorly designed road crossings.

A comprehensive restoration project for McCabe Creek began in 1999 and was completed in 2001. This project 1) consolidated four irrigation ditches into one pipeline and screened the intake; 2) converted flood to sprinkler irrigation; 3) restored habitat conditions including the placement of instream wood and shrub plantings along 1/2 mile of stream; 4) incorporated necessary riparian livestock management changes; and 5) improved a county road crossing. In 2001, the project completed the irrigation conversion, developed offstream livestock watering and reconstructed ~1/2 mile of stream channel.

In 2001, water temperatures sensors placed at two locations (mile 1.3 and 0.1), recorded maximum August temperatures of 54.6 °F at mile 1.3 and 66.3 °F at mile 0.1 - an increase of 11.3 °F. Despite this increase during August, McCabe Creek discharged water 6.6 °F degrees cooler than lower Dick Creek. These data suggest that enhanced McCabe Creek flows should help moderate temperatures in lower Dick Creek (Appendix H).

Fish Populations

Fish population benefits relate to increasing stream flows, eliminating WSCT losses to ditches and restoring habitat complexity to a damaged stream channel.

McCabe Creek is a WSCT dominated stream with low densities of brook trout in lower stream reaches. Due to cool summer temperatures, McCabe Creek likely supported bull trout historically. In 1999 prior to project implementation, fish population surveys sites were established in two restoration project locations: one upstream of an irrigation diversion (mile 3.2); and a second downstream site in an area of low habitat complexity and reduced stream flows. Following these initial surveys, we screened the upper diversion and completed habitat restoration in the downstream reach.

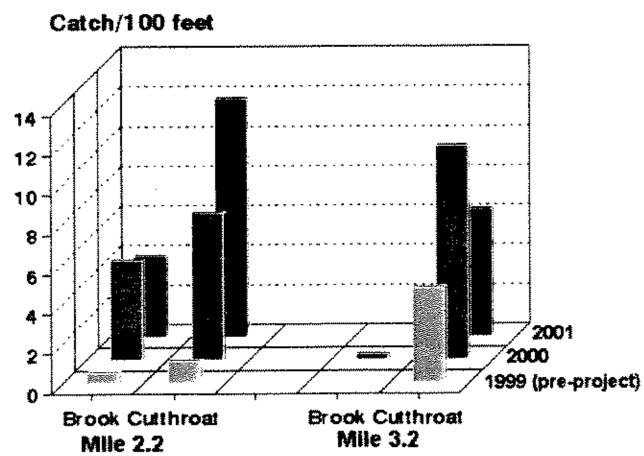


Figure 56. CPUE for WSCT and brook trout (fish >4.0") at two locations on McCabe Creek, 1999-2001.

In 2001, WSCT (fish >4.0") increased at both sections compared to pre-project densities (Figure 56). The habitat restoration project, in particular shows an encouraging early response.

Monture Creek

Restoration objectives: restore habitat for spawning and rearing bull trout and WSCT; improve staging areas and thermal refugia for fluvial bull trout; improve recruitment of bull trout and WSCT to the Blackfoot River.

Project Summary

Monture Creek, a large tributary to the middle Blackfoot River, is a primary spawning and rearing tributary for fluvial bull trout and fluvial WSCT. Monture Creek also serves as thermal refugia for fluvial bull trout during periods of river warming. Reproduction of WSCT and bull trout occurs primarily in the mid- to upper basin. Rainbow trout and brown trout inhabit the lower portions of the drainage. Brook trout are found throughout the drainage.

The riparian area of the mid-to-lower reaches of Monture Creek has a long history of riparian timber harvest and grazing practices with resulting adverse impacts to native fish habitat. Furthermore, all lower tributaries, from Dunham Creek downstream, were likewise identified as fisheries-impaired. Many identified problems were corrected through a decade of cooperative restoration activities (Pierce et al. 1997, Pierce et al. 2001).

Fish Populations and other monitoring

Monitoring results for 2001 included 1) bull trout redd counts, 2) fish population survey in lower Monture Creek 3) and temperature monitoring at one location (mile 1.5).

Annual bull trout redd counts, beginning in 1989, continued an upward trend with 93 redds recorded in 2001 compared to 80 redds in 2000 (Figure 1).

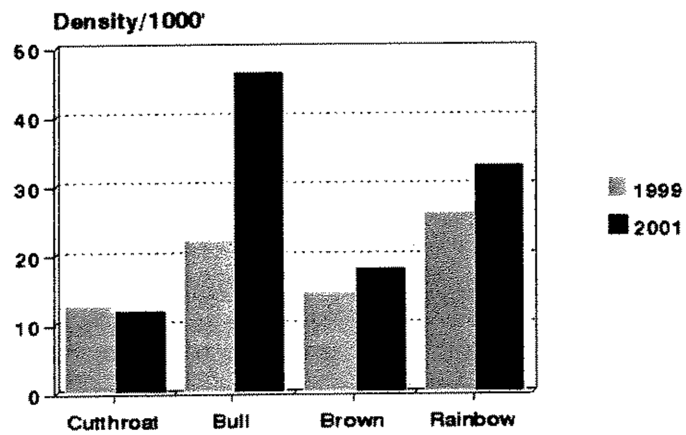


Figure 57. Estimated salmonid densities (fish >6.0") in lower Monture Creek, 1999 and 2001.

We completed a mark-and-recapture estimate of trout densities in a restoration project area of lower Monture Creek. This survey section, established in 1999, includes two adjacent survey sections (upstream unrestored and downstream restored), the purpose of which was to evaluate fish population response to habitat restoration (Pierce and Podner 2000). In fall 1999, following the initial survey, we completed the restoration of the upstream section; this project included riparian fencing and instream woody debris placement project. Before this project, the frequency of instream large woody debris in the untreated reach was 6.1 large woody stems/1,000' compared to 18.1 stems/1,000' in the lower treated reach (Koopal 1998).

The population survey, for both sections combined, estimated a total trout (fish > 6.0") density of 95.7 $\pm$ 27.6 fish/1,000' for 2001 compared to 73.9 $\pm$ 24 fish/1,000' in 1999. The point estimates were higher for all species except WSCT (Figure 57). For the newly restored upper section, total trout densities (fish >6.0") increased from 60 $\pm$ 29 fish/1,000' in 1999 to 119 $\pm$ 49 fish/1,000' in 2001. For the lower section, total trout densities (fish >6.0") decreased from 107 $\pm$ 48 in 1999 to 80 $\pm$ 33 fish/1,000' in 2000. Sampling results for individual species for both sites are in Appendix C.

We also received whirling disease testing results from a sentinel cage placed in Monture Creek in 2000. Results show lower Monture Creek now supports a low – level (grade 1.72) infection of whirling disease. In 1998, Monture Creek tested negative for whirling disease.

Nevada Spring Creek

Restoration objectives: restore habitat suitable for a cold water trout; improve downstream water quality and reduce thermal stress in Nevada Creek and the Blackfoot River.

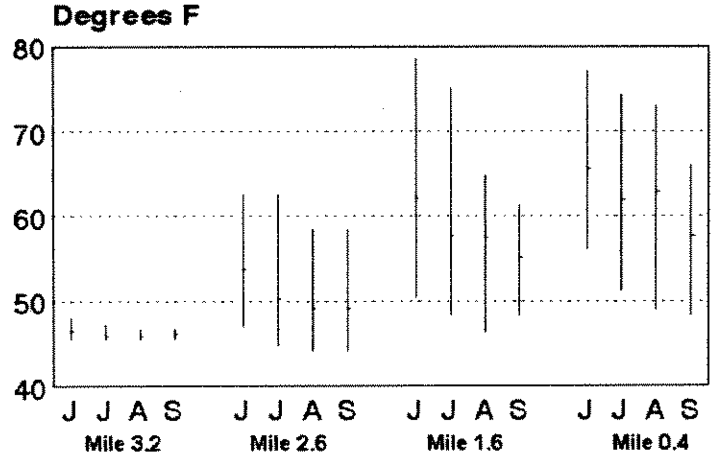


Figure 58. Max., Min. and mean stream temperatures of Nevada Spring Creek at four locations, Summer 2001.

Project Summary

Nevada Spring Creek, located in the lower Nevada Creek valley, originates from an artesian aquifer and flows 3.2 miles to its junction with Nevada Creek, located at mile 6.2. Stream discharge measured in November 2000 ranged from 9.7 cfs below the spring source, (includes 2.2 cfs from Wasson Creek) to 10.0 cfs near the mouth. Nevada Spring Creek receives flow from irrigation return flow and small spring seeps in the mid-to lower reaches.

Nevada Spring Creek is a degraded spring creek and contributes warm water plus elevated levels of nitrate and phosphate to lower Nevada Creek (Pierce and Peters 1990, Pierce et al. 1997). Through restoration, Nevada Spring Creek has potential for downstream cooling in lower Nevada Creek and possibly the Blackfoot River. From a water quality and fisheries perspective, restoration of Nevada Spring Creek may be the most cost-effective and beneficial project in the lower Nevada Creek watershed.

Limited past restoration efforts (fencing, shrub plantings and placement of instream wood) were completed on upper Nevada Spring Creek (mile 2.6-3.2) in 1990. A habitat restoration project for the middle reach of Nevada Spring Creek (mile 1.6-2.6) was implemented in 2001. The project entails reconstruction of an over-widened and degraded channel along with necessary livestock management changes.

Fish Populations

Nevada Spring Creek is a brown trout dominated stream found in low abundance. WSCT also inhabit Nevada Spring Creek in very low densities. Wasson Creek, a WSCT dominated stream enters, enters Nevada Spring Creek immediately below the spring source.

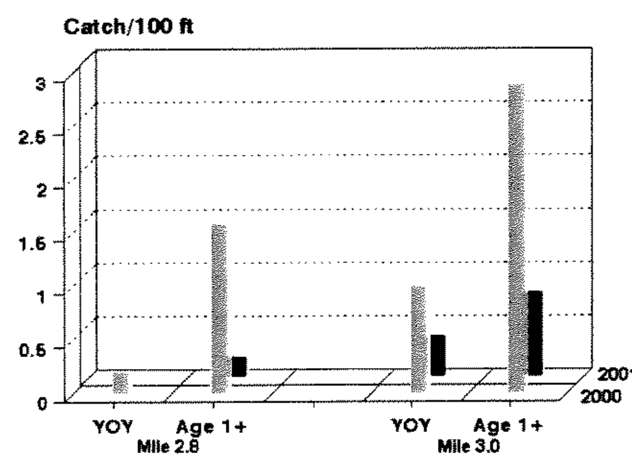


Figure 59. CPUE for brown trout sampled in Nevada Spring Creek at two locations, 2000 and 2001.

In 2001 we re-surveyed fish populations at two locations (mile 2.8 and 3.0). These surveys were established as a pre-project baseline before stream reconstruction and restoration. Results of the 2001 surveys show very low and declining densities compared to 2000 (Figure 59).

Temperature studies for Nevada Spring Creek recorded a constant summer-time temperature of 45-48 °F at the spring source (mile 3.2) for 2001. Between the source and mile 1.6, water temperature increased 30.5 °F to a maximum of 78.7 °F (Figure 58). Maximum stream temperatures increased 14 °F between mile 0.7 and mile 3.2.

North Fork Blackfoot River

Restoration objectives: eliminate the loss of bull trout and westslope cutthroat trout to irrigation canals; manage riparian areas to protect habitat for native fish; improve recruitment of native fish to the Blackfoot River.

Project Summary

The restoration of the North Fork involves working throughout the lower watershed including North Fork mainstem, tributaries and uplands.

Restoration of the North Fork bull trout initially involved implementing compatible riparian grazing systems, eliminating fish entrainment on five canals on the North Fork. More recently, the North Fork restoration evolved a more holistic approach, enrolling landowners in conservation easement programs, incorporating water conservation measures in leaky ditches and restoring impaired tributaries (Spring, Rock, Kleinschmidt, Dry and Salmon Creeks).

Fish Populations

North Fork fish population monitoring program in 2001 included 1) bull trout redd surveys; 2) mark-and-recapture fish population estimates in the lower North Fork; 3) whirling disease sentinel cage studies; and 4) water temperature monitoring.

The North Fork of the Blackfoot River is the primary Blackfoot River spawning tributary for fluvial bull trout. The North Fork also supports populations of WSCT throughout the mainstem, along with rainbow trout, brown trout and brook trout in the lower reaches.

In 2001, we counted 75 bull trout redds in the index section of the North Fork compared to 123 in 2000, a decline of 47 redds (Figure1). Poor access to the spawning site - low flows and beaver activity in an intermittent reach, near mile 7, contribute to this decline. In the downstream gaining area of this intermittent reach and below a beaver dam, we found a concentration of bull trout redds, for fish unable to access the known upper spawning sites. Past spawning surveys in this reach found no spawning in this location. This downstream spawning site is located in an area of groundwater upwelling, a habitat feature necessary for successful reproduction. Future YOY monitoring should determine the success of bull trout reproduction in the lower North Fork.

Following the spawning period, beaver dams and very low flows also restricted the downstream movement of out-migrant bull trout. Low flows contained ~80 adult bull trout within two in pools of the intermittent reach. Flow in the intermittent reached was measured at 6 cfs on September 6th (DNRC, unpublished data), and reached an estimated low flow of ~3-4 cfs during the bull trout out-migration period in late September.

Adjacent to a beaver dam, we also found two dead bull trout that expired on gravel bars while apparently attempting to navigate a shallow riffle. After three weeks of continued low flows and no movement from these pools, we captured and moved 67 bull trout (length range =17.5-33.9", mean=27.3") to the lower North Fork.

Population estimates, using mark-and-recapture surveys in August 2001, found a continued upward trend in the densities of larger bull trout for the lower North Fork monitoring section (mile2.3-5.9). Bull trout densities (fish >12") increasing from 3.8 fish/1,000' in 1998 to 8.0 fish/1,000' in 2001. Poor upstream passage from the lower North Fork probably contributes to this increase. Conversely, catch statistics indicate fewer juvenile bull trout (6.0-12.0") compared to 1998. Densities of larger WSCT (fish >8.0') showed almost no change compared to 1998, and indicate a continued upward trend that began in the early 1990s. Brown trout (fish >12.0") continue to show slight declines. Rainbow trout (fish >12.0") densities declined from 3.3 in 1998 to 1.0 fish/1,000' in 2001 (Figure 60).

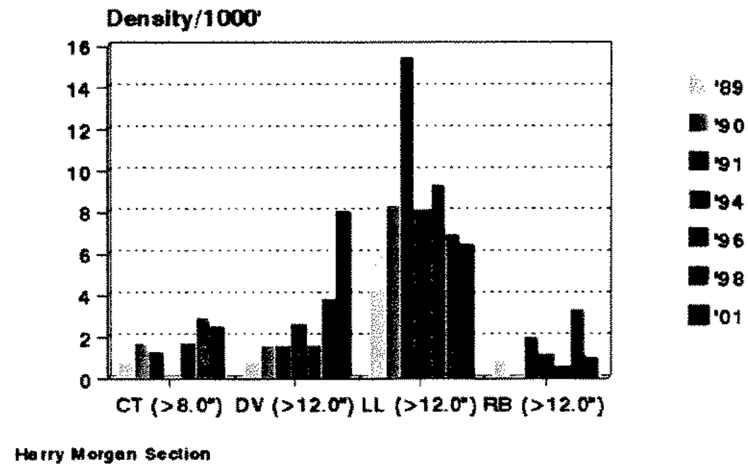


Figure 60. Estimate trout densities in the Harry Morgan Section of the North Fork Blackfoot River, 1989-2001

Temperature monitoring in the lower North Fork Blackfoot River (mile 2.3) recorded a maximum summer temperature of 63.1 °F in August, 12.7 °F cooler than the 75.8 °F Blackfoot River at Raymond Bridge (mile 60.2). Maximum August temperatures at Scotty Brown Bridge (mile 45.8) were 69.8 °F or 6.0 °F cooler than Raymond Bridge.

Whirling disease sentinel cage study results from 2000 show continued increase in infection (grade 2.06) for the lower North Fork, and its two primary lower tributaries, Kleinschmidt Creek and Rock Creek (Results Part IV).

Pearson Creek

Restoration objectives: restore the stream to its original channel; improve stream flows and access to historical spawning sites for fluvial WSCT.

Project Summary

Pearson Creek is a small 2nd order Garnet Mountain tributary to Chamberlain Creek with a base-flow of approximately one cfs. Pearson Creek has a history of channel alterations along with irrigation and riparian land management impacts in its lower 2 miles of channel. The Pearson Creek restoration effort includes conservation easements, water leasing, channel reconstruction, riparian habitat restoration and improved riparian grazing management (Pierce et al 1997). In 2000, continued restoration involved 1) placing instream woody debris, 2) riparian livestock management measures, and 3) shrub plantings in WSCT spawning and rearing areas.

Fish Populations

In September 2001, we re-sampled fish populations in a Pearson Creek section (mile 1.1) established prior to a restoration project, completed in spring 2000. This sampling site is located in a stream reach influenced by a water lease and related riparian improvements (riparian fencing and habitat restoration). In 2001, we found no YOY in the survey section, compared to a YOY density of 31.1± 2.5/100' in 2000. Age I+ WSCT densities were lower in the survey reach, declining from 38.9 ± 2.5 fish/100' in 2000 to 23.7 +2.2 fish/100' in 2001 (Figure 61).

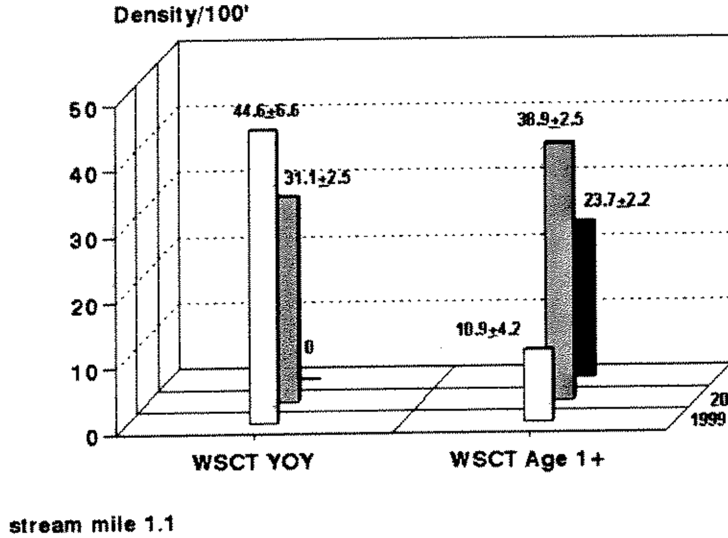


Figure 61. Estimated densities of WSCT for Pearson Creek at mile 1.1. 1999-2001.

The loss of the 2001 year-class probably relate to drought, including low flows and the inability of WSCT access the spawning site through a series of beaver dams. The decline in age 1+ WSCT likely resulted from low-flow and excessive livestock access to the project due to the failure of an electric fence.

Poorman Creek

Restoration objectives: improve riparian habitat conditions and enhance instream flows; eliminate fish losses to irrigation ditches and restore migration corridors; improve recruitment of native fish to the Blackfoot River.

Project Summary

In 1999, we assessed fish populations and habitat conditions in lower Poorman Creek. These surveys identified fish loss to ditches and extensive habitat problems in the lower 2 miles of stream (Pierce and Podner 2000). These initial surveys helped set the stage for a comprehensive restoration project. Currently in the development phase, the project will likely involve conversion of flood to sprinkler irrigation, eliminate fish loss to ditches, enhance instream flows with salvage water and develop compatible riparian livestock grazing methods.

Fish Populations

Poorman Creek supports populations of WSCT, brown trout and brook trout and is one of two Garnet Mountain streams to support bull trout reproduction. In 2001, we established fish population monitoring sites immediately up and downstream of the irrigation project: plus one in each of two the irrigation ditches. Estimated total trout densities declined significantly from 11.1± 1.6 fish/100' above the upper diversion (mile

1.5) to 2.9 ± 2.0 fish/100' below the lower diversion (mile 1.3) (Appendix B). The CPUE surveys indicate a portion of the decline can be attributed to fish losses in the upper ditch (mile 1.4) (Figure 62).

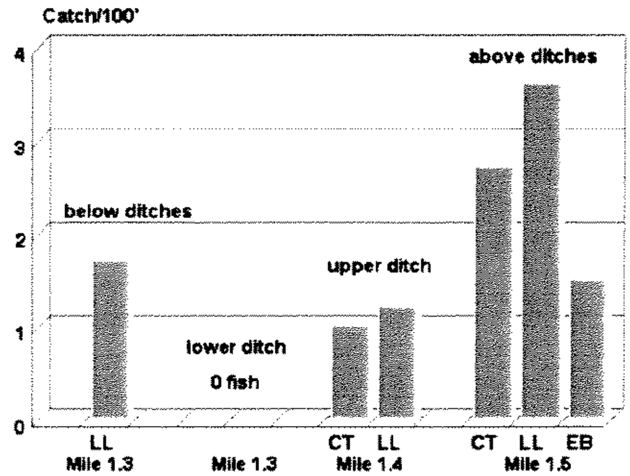


Figure 62. CPUE for Poorman Creek fish sampled up and downstream of two diversion and in the ditches, August 2001.

Rock Creek

Restoration Objectives: restore migration corridors for native fish; restore natural stream morphology to improve spawning and rearing conditions for all fish using the system.

Project Summary

Rock Creek, the largest tributary to the lower North Fork Blackfoot River, has been the focus of restoration activities throughout the 1990s.

Rock Creek, a basin-fed stream over most of its length, receives significant groundwater inflows between mile 1.2 and 1.6. Rock Creek was degraded over most of its 8.2-mile length due a wide range of historical channel alterations and riparian management activities (Pierce 1990, Pierce et al. 1997).

In 2001, we reconstructed 5,800' of degraded and over-widened stream (mile 3.8-5.0 pre-project length) to an E4 channel type. This project reduced mean bankfull width from 23.0' to 7.9', increased mean bankfull depth from 0.4' to 1.3' and increased total stream length from 5,800' to 8,130'. The restoration project also incorporated instream woody debris and shrub plantings, along with fencing, offstream water and the removal of a streamside corral, which brings the total amount of restored stream to ~6.8 miles.

A sentinel cage, placed near the mouth of Rock Creek in 2000, identified a grade 2.1 whirling disease infection.

Fish Populations

Rock Creek supports spawning migrations of brown trout and rainbow trout in lower reaches. Middle reaches provide WSCT and bull trout migration corridors to headwater areas. In 2001, we surveyed fish populations in a reach of channel reconstructed in 1999. These surveys indicate shift in the fish community from a brook trout to a more brown trout dominated reach, with low densities of bull trout (CPUE =3 fish/100') now present in the newly constructed channel (Appendix A).

Shanley Creek

Restoration objectives: restore habitat for all fish species; restore migration corridors for native fish; reduce loss of fish to irrigation ditches; maintain minimal instream flows.

Project Summary

Shanley Creek, the primary tributary to Cottonwood Creek, has been the focus of several riparian improvement projects. Since 1994, most of the restoration work focused on improving riparian grazing practices and upgrading irrigation systems to reduce fish losses and conserve water. Currently the lower 1.8 miles of Shanley Creek are under riparian grazing management strategies.

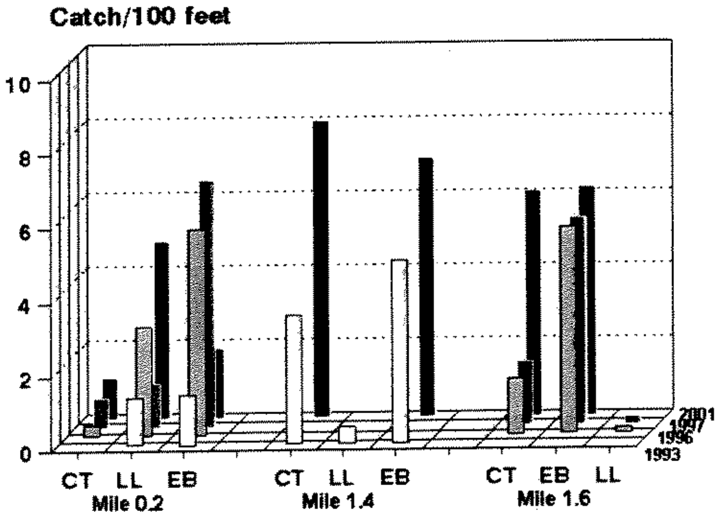


Figure 63. CPUE for salmonids (fish >4.0") sampled at three locations in Shanley Creek.

Fish Populations

We resurveyed fish populations at three locations influenced by restoration projects (0.2. 1.4, and 1.6). In 1993, we established the downstream monitoring station (mile 0.2) in a degraded section of Shanley Creek prior to livestock exclusion. The middle survey section was sampled two year following the implementation of a rotational grazing system. The upper sample site was established immediately downstream of the Bandy Reservoir diversion before ditch screening. The survey results indicate improved WSCT densities throughout these project reaches (Figure 63).

Spring Creek (trib. to North Fork)

Restoration Objectives: restore migrations of juvenile bull trout; reduce losses of fish to irrigation ditches and maintain minimal instream flows.

Project Summary

Spring Creek, a small WSCT dominated tributary, originates on the north side of Ovando Mountain and flows 6 miles south where it enters the lower North Fork at mile 9.9 with a base flow of less than one cfs. Spring Creek has a history of irrigation impacts (dewatering and entrainment) to WSCT and fish passage problems (undersized culvert) affecting the upstream movement of juvenile bull trout. The restoration of Spring Creek fish populations began in 1998 with the

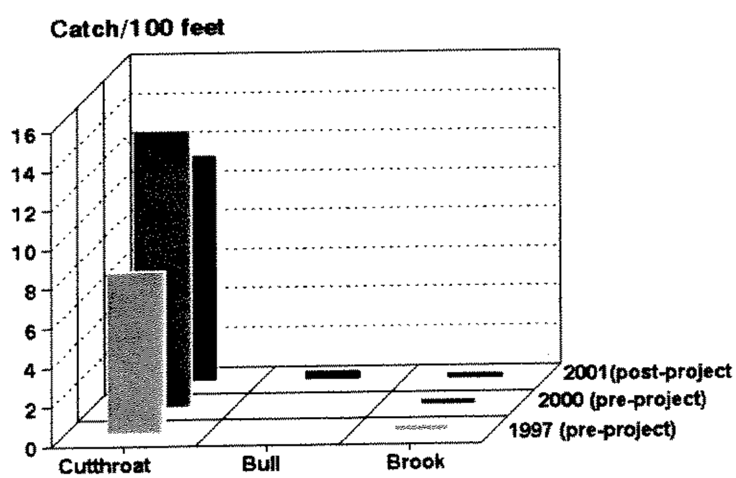


Figure 64. CPUE for fish captured upstream of the Spring Creek culvert crossing (mile 0.6), 1997, 2000 and 2001.

installation of a new irrigation diversion retrofitted with a denil fish ladder at mile 1.8. In 2000, we replaced an undersized culvert (mile 0.5) with a baffled squash-pipe. The culvert and installation were designed to pass all fish including YOY bull trout.

Fish Populations

In 2001, we re-sampled fish populations at above the new culvert to lower Spring Creek. The survey found the culvert was passing juvenile bull trout including YOY (Figure 64) (Appendix A).

Warren Creek

Restoration Objectives: Restore riparian vegetation and stream habitat for all life cycle stages of fish; improve spawning and rearing conditions; increase recruitment of trout to the middle Blackfoot River; moderate whirling disease.

Project Summary

Warren Creek, a small tributary to the middle Blackfoot River, originates on Ovando Mountain, flows 12 miles southwest through knob-and-kettle topography until its junction with the Blackfoot River at river mile 50. Warren Creek water is used for irrigated hay production and livestock watering. Irrigation withdrawal causes the middle section of Warren Creek to dewater, although the lower section gains inflow from springs and maintains perennial base-flow of 3-5 cfs. Some of the riparian areas in the mid-to-lower portion of the stream were cleared, heavily grazed, dredged and straightened, degrading salmonid habitat over most of the length of Warren Creek. Whirling disease has escalated in Warren Creek from mean grade infection increasing from 0.2 in 1998 to 1.72 in 2000.

In 2001, we completed the restoration of lower Warren Creek with a comprehensive restoration project on 3.4 miles (mile 0.6 and 4.0) of stream. The project focused on channel reconstruction (Rosgen B, C and E-type channels) in areas of historic channel dredging. This project increased stream length 46% from 6,080' to 8,870' in a straightened section. Related projects included 1) building floodplain within incised channels, 2) livestock management changes (fences, well, offstream water) over the length of the project, 3) replacement of an irrigation diversion, 4) instream woody debris placement, 5) riparian shrub plantings, and 6) restoration of two drained wetlands.

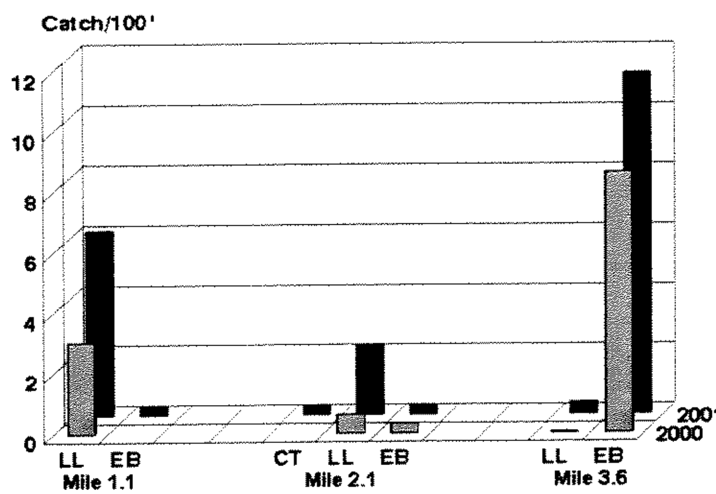


Figure 65. CPUE for fish >4.0" at three sampling locations in lower Warren Creek, 2000 (pre-project) and 2001 (Post project).

Fish Populations

In 2001, we continued both fish population and temperature monitoring in the project reach. A stream temperature study in the summer of 2001 found maximum summertime stream temperatures approaching 74 °F (Appendix I). .

We resurveyed fish populations at three locations within the project area (mile 1.1, 2.1 and 3.6). The surveys indicate general improvement in densities for fish >4.0 inches (Figure 65). Brown trout (fish >4.0") densities increased at all sample locations.

PART IV: ADDITIONAL AQUATIC INVESTIGATIONS

Fish Habitat Survey for the Upper Blackfoot River upstream of the Landers Fork

In 2000-01, we assessed habitat conditions in the upper Blackfoot River upstream of Lincoln. The initial 2000 surveys extended 6.3-miles from the Stemple Pass road (mile 109.8) to the mouth of the Landers Fork (mile 116.1) and for the Landers Fork between the mouth (mile 0.0) and Silver King falls (mile 7.25) (*see* Pierce et al 2001). In fall 2001, we continued these assessments with: 1) a geomorphic and habitat surveys for an additional 5.5 mile section of the upper Blackfoot River (mile 116.1-121.6) upstream of the Landers Fork; and 2) a water temperature evaluation for an over-widened reach of Landers Fork, between Copper Creek (mile 4.1) and Silver King Falls (mile7.1) (Figure 66). Our survey objectives were to identify morphologic features of the channel including areas of channel instability, identify areas of simplified habitat with restoration potential and provide a repeatable baseline for future monitoring efforts. Surveys focused on measuring and classifying channel type (Rosgen 1996), measuring pools and functional instream wood, and collecting measurements of water temperature.

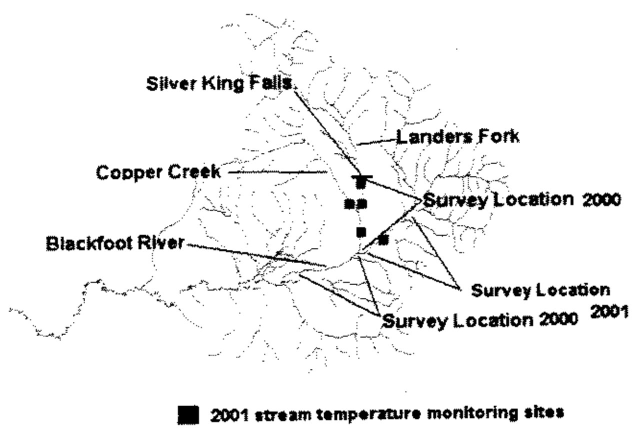


Figure 66. Location map of upper Blackfoot habitat surveys, 2000-01.

<u>Upper Blackfoot River: Landers Fork upstream 5.5 miles</u>

We conducted the habitat survey for a 5.5-mile section of the Blackfoot River between the Landers Fork (mile 116.1) and mile 121.6 of the Blackfoot River. We timed our habitat survey (October) to correspond with the known out-migration of bull trout from Copper Creek to wintering areas in the upper Blackfoot River (Swanberg and Burns 1997). No adult bull trout were observed in this section of stream during the survey.

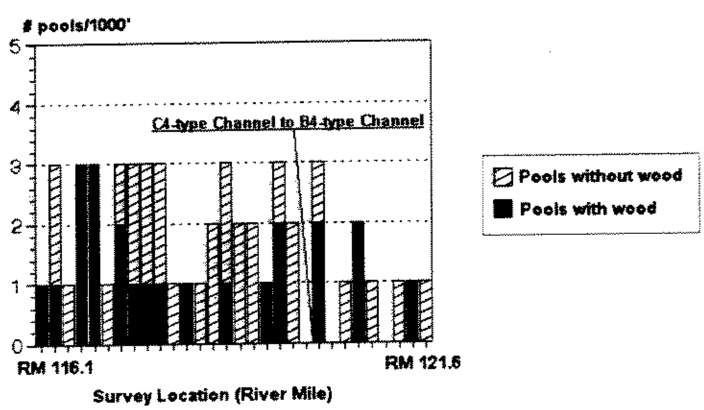


Figure 67. Pool Frequency for a five-mile section of the Blackfoot River, upstream of the Landers Fork.

Based on geomorphic features of the channel, we divided our habitat survey into two reaches: a 4.1-mile "lower" reach with C4-type channel (mile 116.1-120.2); and a 1.4-mile "upper" reach, B4-type channel (mile 120.2-121.6).

For the entire section, mean bankfull pool width was 44.7' but varied between sections. Mean bankfull width decreased from 47' (range = 26.2'-87.6') in the lower reach to 31.3' (range 26.2'-38.0') in the upper reach. Bankfull pool width-to-depth ratio (W/D) likewise decreased from 9.2 in the lower reach to 7.9 in the upper reach. We recorded sinuosity of 1.2 at both reaches.

We counted, measured and classified all 49 pools in the 5.5-mile survey section (n=42 in lower reach, n=7 in the upper reach) for a total frequency of 1.7 pools/1000'. For the entire 2001 survey section, we measured pool frequency at 1.7/1000', compared to 0.74/1000' in the upper perennial Landers Fork to Lincoln section (Pierce et al. 2000). We classified pool types upstream of the Landers Fork as scour (81.6%), dammed (10.2%), lateral scour (4.1%) and bedrock (4.1).

Pool frequency decreased from 1.8/1000' (range = 0.0-3.0') in the lower reach and 0.8 pools/1000' (range 0.0-2.0) in the upper reach. Mean residual pool depth increased from 2.4' (range = 1.1-4.9') in the lower reach to 2.9' (range = 1.8-5.6') in the upper reach. Mean pool length decreased from 111.5' (range = 17.1-988') in the lower reach to 92.6 (range= 50-157'). Mean wetted pool width increased slightly from 27.7' in the lower reach to 28.3' in the upper reach. The percent pool area decreased by 50% from 20% wetted channel area in the lower reach to 10% in the upper reach.

We counted all 229 pieces of LWD (> 4" x 6') within bankfull channel width and by pool for the entire survey section. The total amount of in-channel LWD averaged 7.7 stems/1000' and showed, overall, little change between upper (8.0 stems/1000') and lower (7.0 stems/1000'). We found the highest concentrations of in-channel wood (38 stems/1000') 0.57 to 0.76 miles above the Landers Fork. Despite similar in-channel distribution of wood, the density of LWD per pool decreased 65% from 2.45 stems/pool (range 0 to 14) in the lower reach to 0.86 stems/pool (range 0.0 to 3.0) in the upper reach. For the total survey section, less than half (46.9%) of the pools contain functional, instream wood. Fifty-two percent of pools (n=22) in the lower reach had no function wood compared to 57% (n=4) in the upper reaches (Figure 67).

Density of in-channel woody stems, upstream of the Landers Fork, decrease ~92% compared to the 2000 survey reach below the Landers Fork; even though we calculated 2.24 stems/pool in this survey, compared to 1.7 stems/pool in the perennial reach below the Landers Fork (Figure 68).

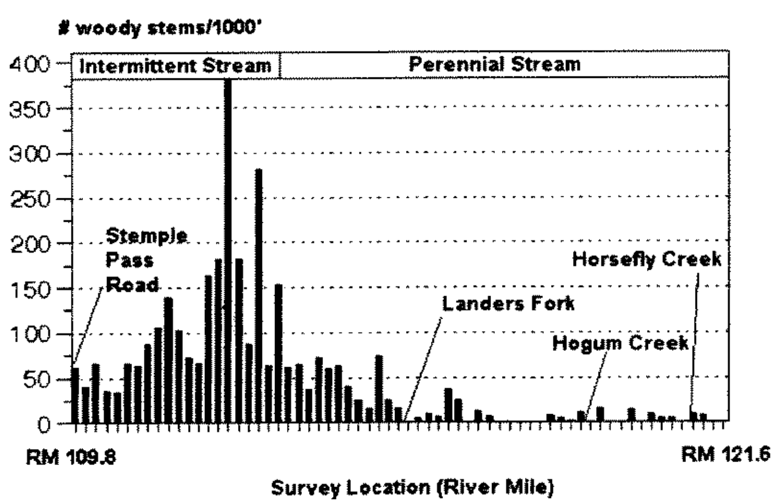


Figure 68. Woody Debris Distribution for an 11.8-mile section of the Upper Blackfoot River.

In summary, we found the upper Blackfoot River, in surveyed perennial reaches up and downstream of the Landers Fork, lacks large woody debris and complex pools habitat. Additional information relating potential to recruit large wood from riparian woodlands to the channel should also be assessed. Future recruitment of LWD, based on existing in-channel wood, appear limited; however, our surveys also indicate the reach above the Landers Fork is in better condition than perennial section below the Landers Forks. The upper Blackfoot River may contain less woody debris above the Landers Fork, but pool densities, percent pool area, and stems/pool densities increase.

LWD must be within the wetted edge of the river to aid in forming complex fish habitat. Large amounts of LWD remain within the bankfull width of the Blackfoot River channel in the intermittent section three miles below the Landers Fork (Figure 68). However, LWD within bankfull channel width is lacking in the perennial sections up and downstream of the Landers Fork. These perennial reaches provide staging, rearing, wintering areas for fluvial bull trout and WSCT. Restoration of simplified habitat in similiar (B and C-type) channel types have improved population size for both bull trout and WSCT in several project reaches of lower Blackfoot River tributaries. A restoration pilot project could easily test the potential fish population benefits of a habitat restoration in these reaches of the upper Blackfoot River.

Lander Fork water temperature monitoring

We conducted stream temperature monitoring at 3 sites on the Landers Fork between Highway 200 and Silver King Falls (mile 1.1, 4.5 and 7.1), plus one site on Copper Creek (mile 1.2). Copper Creek is the largest tributary to the Landers Fork, entering at mile 4.1. The upstream Landers Fork sensor (mile 7.1) at Silver King Falls recorded a maximum August temperature of 68 °F compared a maximum temperature of 77 °F at mile 4.5, a ~ 9 °F temperature increase over a distance of only 2.6 miles (Figure 69). We attribute this warming primarily to the over-widened condition of the channel identified in the 2000 survey (Pierce et al 2001). These over widened channels may also contribute to loss of surface water in the Landers Fork (Dave Rosgen, personal communication, 2001).

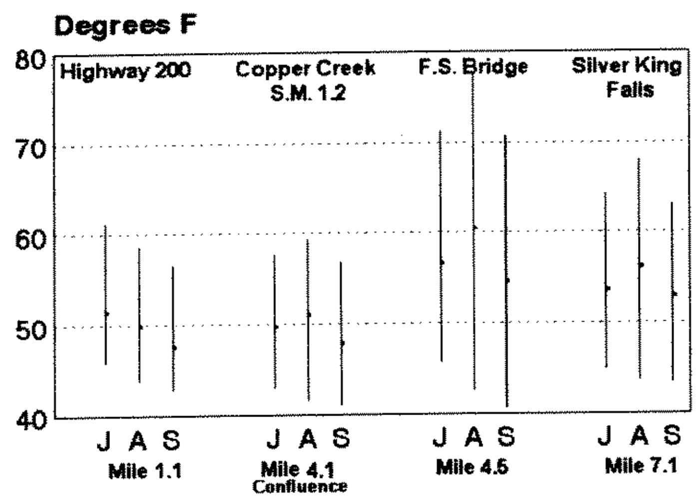


Figure 69. Minimum, maximum and mean water temperatures at 4 sites in the Landers Fork drainage.

Copper Creek, entering the Landers Fork at mile 4.1 has a cooling effect on the stream. The Copper Creek sensor (mile 1.2) recorded an August maximum temperature of 59°F, ~ 18° cooler than the Landers Fork upstream of its confluence. The Landers Fork remains cool over the next three miles, with August maximum temperature of 58 °F at Highway 200. Local groundwater upwelling contributes to lower temperature recorded near the mouth.

Whirling Disease Status

Over the last several years, the parasite *Myxobolus cerebralis*, which causes whirling disease in salmonid species has been discovered throughout the low elevations of the Blackfoot Watershed. Since first detected near Ovando in 1995, whirling disease infection levels and distribution continue to expand. Based on sentinel cage studies undertaken in July 2000, whirling disease has now increased from a low-to-moderate infection in the lower Blackfoot River (Figure 71). Whirling disease has also expanded from the confluence of the North Fork up the Blackfoot River 55 miles to Lincoln. The upper Blackfoot River from the North Fork to Lincoln tested negative for the disease in 1998, but now supports a low-grade infection (Figure 70, Table 2). Whirling disease has further infected the lower reaches of several tributaries including Gold Creek, Cottonwood Creek, Chamberlain Creek, Monture Creek, Warren Creek, Rock Creek, Kleinschmidt Creek and the North Fork (Table 2), and likely many others. Segments of the lower Blackfoot River and some lower tributary reaches now support infection levels high enough (>2.7 grade) to result in population level losses for vulnerable species (Table 1 and 2) (Vincent 2001).

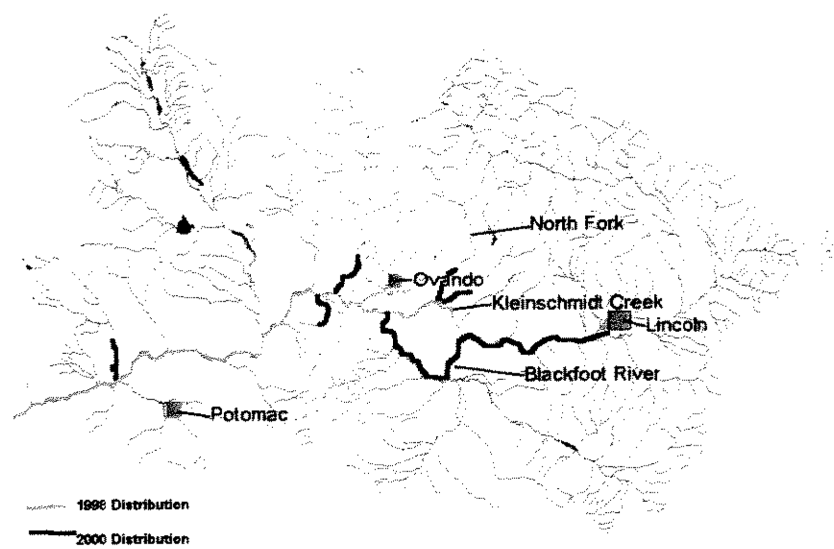


Figure 70. Current known distribution of whirling disease.

Recent research into the epidemiology and ecology of whirling disease provide insight into the importance of aquatic ecosystem function, restoration of fish migration corridors to headwater tributaries and maintaining and managing for native fish life history variation.

In order to complete its life-cycle, the parasite *Myxobolus cerebralis* requires not only a salmonid host, but also an alternate host - the aquatic oligocheate worm *Tubifex tubifex*. Recent *T. tubifex* studies in a tributary to the Blackfoot river found an inverse relationship between worm densities and elevation (Smith 1998). Other studies indicate not only spatial variation in risk related to worm densities, but also

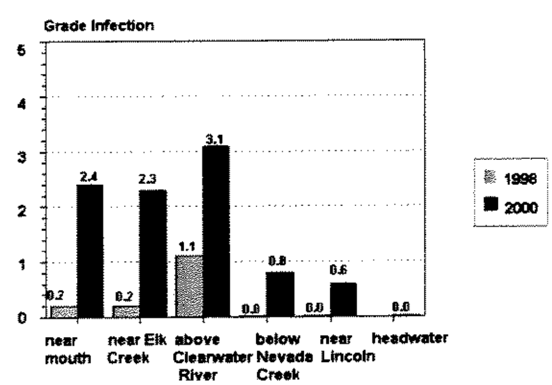


Figure 71. Mean grade whirling disease infections for the Blackfoot River at six sites.

temporal variation in risk to infection even in highly infected streams (McMahan et al. 1999, Smith 1998). Temporal variation of infection risk varies with 1) water temperature, which is highly variable in the Blackfoot watershed (Appendix H), and the 2) age at which fish are infected (Ryce et al. 1999). Field exposures of rainbow trout showed the highest infection intensities at water temperatures between 54 and 61°F, with infection intensities declining rapidly as mean daily water temperatures decrease or increased from these optimum water temperatures (Vincent 2001). The effect of this disease is also substantially higher if fish exposure occurs within the first nine weeks of age (Ryce et al. 1999). According to Vincent (2001), susceptibility to whirling disease also varies by fish species, with rainbow trout and brook trout more vulnerable to the disease than westslope cutthroat trout, bull trout or brown trout. Thus, where and when fish spawn and rear in relation to water temperature, and species susceptibly, could have a significant effect on infection risk (McMahan et al. 1999, Vincent 2001).

Many factors will influence future distribution of whirling disease and impacts to salmonids in the Blackfoot River drainage including: worm distribution and densities, water temperatures, triactinomyxon (TAM) concentrations and flow rates (dilution of TAMSs), matching location and production periods along with densities of TAMS with with ages and sizes of young salmonids, vulnerablity of specific species to the parasites, location of primary fry habitat in relation to TAM production areas, and movement of fry at very early life stages in relation to high infection sites.

The sum of these relationships seems to suggest that risk of contracting whirling disease diminishes for native trout, due in part to habitat use and life-histories strategies that entail spawning and rearing in headwater tributaries. Studies indicate basin-fed headwater tributaries support lower worm densities (Smith 1998), support lower water temperature (Appendix I), produce fewer TAMS when mean daily temperatures occur <54 °F (Vincent 2001), and support more native fish reproduction and rearing than lower elevation streams (Appendix A, FWP many studies). Although several studies suggests a longitudinal relationship of decreasing infection risk in the downstream direction, future monitoring through the disease escalation period is necessary to determine the extent to which whirling disease will be contained by the physical geography of the Blackfoot Watershed.

The Blackfoot River Restoration Initiative has adopted two related strategies to help moderate the impacts of the disease. The first strategy involves protecting headwater streams and continuing restoration of low-elevation stream reaches. Stream habitat restoration reduces the habitat favorable for the worm-host. Stream restoration involves restoring riparian systems, reducing stream temperatures and fine sediments, and restoring healthy insect communities. Stream rehabilitation involves mechanically rebuilding degraded streams, shrub plantings and initiating grazing systems and other land management changes. The second strategy involves restoring populations of native westslope cutthroat trout and bull trout. These species reproduce in headwater streams, which appears to limit exposure of young fish at an age when they are vulnerable to the disease. The two strategies may work in concert as well. Restoring habitat conditions in spawning and rearing streams and improving migration corridors to headwater areas should help restore native fish and reduce the impacts of whirling disease.

Table 2. Whirling Disease (Sentinel Cage) Sampling Results for the Blackfoot River 1998-2000.

Location	**River mile**	**Date**	**# Fish**	**Percent infected**	**Mean daily water temp.**	**Mean Grade Infection**
Near Mouth	1.0	7/98	36	14	64.7	0.22
Below Gold Creek	13	7/00	36	94	63.2.	2.44
Below Elk Creek	27	7/98	41	15		0.21
		7/99		42	61.2	0.52
		7/00	50	90	62.6	2.30
Above Clearwater	38	7/98	20	52		1.10
		7/99		17	58.2	0.22
		7/00	45	95	61.1	3.11
Below North Fork	53	7/98	41	15		0.25
Nevada Creek	67	7/98	27	0		0.00
		7/00	50	54	63.8	0.84
Below Lincoln	90	7/98	50	0		0.00
		7/00	37	27	57.0	0.60
Headwaters	122	7/00	50	0	59.1	0.00

Table 3. Whirling Disease (Sentinel Cage) Sampling Results for the Blackfoot River tributaries 1998-2000.

Location	**River mile**	**Date**	**# Fish**	**Percent infected**	**Mean daily water temp.**	**Mean Grade Infection**
Belmont Creek	0.1	7/00	50			0.00
Chamberlain Creek	0.1	8/99		55	62.3	0.90
		7/00				3.88
	1.0	7/98	50	8		0.16
		7/99		93	56.9	2.71
E. F. Chamberlain	0.1	8/99		0	55.0	0.00
		7/00				0.00
W. F. Chamberlain	0.1	8/99		0	51.2	0.00
		7/00				0.00
Cottonwood Creek	1.0	7/98	50	94		3.66
		7/99	50	98	54.6	4.52
Elk Creek	1.0	7/00	50			0.00
Gold Creek	2.0	9/99	50	8	48.5	0.12
		7/00	43			0.00
Kleinschmidt Creek	0.1	7/98	48	90		2.83
		7/99	46	90	52.5	3.56
		4/00	50	94		3.06
		4/00	50	100		3.62
		5/00	50	96		3.52
		5/00	50	96		3.56
North Fork Blackfoot	6.0	7/98	50	12	52.2	0.14
	7.0	7/98	43	0	57.3	0.00
		7/00				0.06
		7/01				2.06*
Monture Creek	2.0	7/98				0.00
		7/00	50	78		1.76
Rock Creek	0.1	4/00	50	86		2.12
Warren Creek	1.0	7/98	47	19		0.21
		7/99		84	61.1	2.10
		7/00				1.72

* placed in spring source area and may not be representative of the reach.

Program Recommendations

- Continue the effort by the Montana Fish, Wildlife and Parks and UFWS Partners of Fish and Wildlife Program on the Blackfoot Restoration Project. This effort relies on personnel with primary responsibilities of coordinating restoration and land management changes that are sensitive to fish and wildlife. This program requires continued funding, personnel and technical support in order to meet current restoration program demands. This Program relies on continued support of the Big Blackfoot Chapter of Trout Unlimited, the North Powell Conservation District, the Blackfoot Challenge supporting agencies and conservation groups.

-Prioritize inventoried streams for inclusion into the restoration program. Begin to shift program direction from inventory and problem identification to more restoration, monitoring and project maintenance. Complete bull trout restoration projects in all core area and current restoration streams. Expand restoration to the Landers Fork upstream of Copper Creek and Upper Blackfoot River as staff and funds become available.

-Continue fish population monitoring at the Johnsrud and Scotty Brown Bridge section of the Blackfoot River, and tributary restoration projects.

-Expand telemetry investigations to fluvial WSCT and bull trout in the Upper Blackfoot River upstream of the North Fork confluence.

-Address fish passage and northern pike issues at Milltown Dam and continue to mitigate for Milltown Dam within the geographic range of fish population impacts.

-Focus restoration and protection on migration corridors, spawning and rearing areas, and tributaries that have high proportion of their stream length in higher elevation and basin-fed stream with steeper gradients, which appear to be less susceptible to *T. tubifex* and whirling disease.

-Continue to monitor the spread and impacts of whirling disease and the results of restoration on infection rates and incorporate pertinent results into the restoration program.

-Increase landscape protection efforts through conservation easements on critical fish and wildlife habitats in cooperation with the Montana Land Reliance, Nature Conservancy, US Fish and Wildlife Service and Montana Fish, Wildlife and Parks.

-The downward trend in the upper Blackfoot River westslope WSCT population underscores the need for a thorough and timely cleanup of the Mike Horse mine and associated public lands.

-Promote a more conservative approach to recreational planning in critical bull trout and WSCT recovery areas. Develop an effective fish identification program directed toward non-resident anglers.

Acknowledgements

The Big Blackfoot Chapter of Trout Unlimited (BBCTU), Blackfoot Challenge, U.S. Fish and Wildlife Service, Chutney Foundation, North Powell Conservation District, Montana Power Company made the 2001 fisheries program possible by funding two seasonal fisheries technicians. These technicians complete the Garnet Mountain data collections, assisted in project monitoring and made much of the restoration work possible. The Fish and Habitat Committee of the BBCTU reviewed and administered projects, resolved social conflicts, assisted in project maintenance and helped sponsor the Rosgen training sessions. The USFWS Partners for Fish and Wildlife Program continued to support of the native fish initiative on several fronts. Dave Rosgen provided insight, training and helped develop our restoration methods. Regional FWP fisheries staff included contributions of David Schmetterling, Ladd Knotek, and Brad Liermann. Glen Phillips and Mark Lere and the Future Fisheries Committee supported the effort though funding, administration and environmental permitting. Other key agency cooperators included: 1) the Natural Resources Conservation Service for their contributions in the Nevada Creek watershed; 2) the Bureau of Land Management for funding whirling disease studies, and for expanding their program to restoration-level work in Chamberlain and Belmont Creeks; 3) the U.S. Forest Service for their efforts on Dunham Creek; 4) the Montana Department of Transportation for helping fund the Kleinschmidt Creek project; 5) the Department of Natural Resources and Conservation for assisting in drought mitigation and for evaluating ditch efficiencies on the North Fork and Poorman Creeks; and 6) the Bureau of Reclamation for providing engineering assistance on several projects. Montana Power Company, Stone Container and Plum Creek Timber Company also supported several restoration projects. We also thank the interns, high school teachers and students, consultants, contractors and above all the landowners who cooperated on restoration projects and allowed us access to streams during the 2001 field season. Finally, the comments of Ladd Knotek improved the quality of this report.

Literature Cited

Allendorf, F. W., and R. F. Leary. 1988. Conservation and distribution of genetic variation in polytypic species, the cutthroat trout. Conservation Biology 2:170-184.

Behnke, R. 1992. Native trout of western North America. American Fisheries Society monograph 6. American Fisheries Society. Bethesda, MD.

Brown, C, G. Decker, R. Pierce and T. Brant. 2001. Applying natural channel design philosophy to the restoration of inland native fish habitat. Practical Approaches for Conserving Native Inland Fishes of the West. American Fisheries Society Symposium Proceedings.

DNRC. 2001. Mike Roberts, hydrologist, provided flow information through personal communication.

Dunne, T. and L. Leopold. 1998. Water in environmental planning. W. H. Freeman and Co. San Fransisco, CA. 818 pp.

Fredenberg, F. 1992. Evaluation of electrofishing-induced spinal injuries resulting from field electrofishing surveys in Montana. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana.

Koopal, M. 1998. Stream habita analysis of selected tributaries of the Blackfoot River. Report prepared for the Montana, Fish, Wildlife and Parks, Missoula.

Ingman, G, L., M.A. Kerr and D.L. McGuire. 1990. Water quality investigations in the Blackfoot River drainage, Montana. Department of Health and Environmental Services, Helena, Montana.

Liknes, G. A. 1984. The present status and distribution of the westslope cutthroat trout (Salmon Clarki lewisi) east and west of the continental divide in Montana. Report to the Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Liknes, G. A. and P. J. Graham. 1998. Westslope cutthroat trout in Montana: life history, status and management. Pages 53-60 in R.E. Gresswell, editor. Status and management of westslope cutthroat trout: American Fisheries Society, Symposium 4, Bethesda, Maryland.

Marler, M. 1997. Riparian health and inventory of the Blackfoot River between Nevada Creek and the North Fork Confluence: A GIS mapping project. Report to Montana Fish, Wildlife and Parks, Missoula, MT.

MBTSG (Montana Bull trout Scientific Group). 1995. Blackfoot River drainage bull trout status report. Unpubl. Report prepared for the Montana Bull Trout Restoration Team. Montana Fish, Wildlife and Parks.

McIntyre, J. D., and B. E. Reiman, 1995. Westslope WSCT. Pages 1-15 in M. K. Young, editor. Conservation assessment for inland WSCT. U. S. Forest Service General Technical Report. RM-256.

McMahon, T. E. and 9 co-authors. 1999. Life history variation in rainbow trout in relation to whirling disease infection risk. Proceeding of the Fifth Annual Whirling Disease Symposium,. Research and Management Perspective, Missoula, MT. Whirling Disease Foundation, Bozeman, MT.

Montana Bull Trout Restoration Team. 2000. Restoration plan for bull trout in the Clark Fork River Basin and Kootenai River Basin Montana. A report to Governor Marc Racicot c/o Montana Fish, Wildlife and Parks, Helena, Montana.

Peters, D. 1985. Current status of bull trout in the headwaters of the Clark Fork River, Montana. Page 37 in D. D. MacDonald, editor, Proceedings of the Flathead River basin bull trout biology and population dynamics modeling Information exchange Fisheries Branch, Brithish Columbia Ministry of Environmental. Cranbrook, British Columbia.

Peters, D. and R. Spoon. 1989. Preliminary fisheries inventory of the Big Blackfoot River. Montana Department of Fish, Wildlife and Parks, Missoula, Montana.

Peters, D. 1990. Inventory of fishery resources in the Blackfoot River and major tributaries to the Blackfoot River. Montana Department of Fish, Wildlife and Parks, Missoula, Montana.

Pierce R. and D. Peters, 1990. Aquatic investigations in the middle Blackfoot River, Nevada Creek and Nevada Spring Creek corridors. Montana Department of Fish, Wildlife and Parks, Missoula.

Pierce, R. 1991. A stream habitat and fisheries analysis for six tributaries to the Blackfoot River. Montana Department of Fish, Wildlife and Parks, Missoula, Montana.

Pierce, R., D. Peters and T. Swanberg. 1997. Blackfoot River restoration progress report. Montana Fish Wildlife and Parks, Missoula, Montana.

Pierce, R., and D. Schmetterling. 1999. Blackfoot River restoration project monitoring and progress report 1997-1998. Montana Fish, Wildlife and Parks, Missoula, Montana.

Montana.

Pierce, R. and C. Podner. 2000. Blackfoot River fisheries inventory, monitoring and restoration report. Montana Fish, Wildlife and Parks, Missoula, Montana.

Pierce, R. and C. Podner and J. McFee. 2001. Blackfoot River fisheries inventory, monitoring and restoration report. Montana Fish, Wildlife and Parks, Missoula, Montana.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada, Bulletin 191. Ottawa, Canada.

Rosgen, D. 1994. A classification of natural rivers. Catena 22:169-199.

Rosgen, D. 1996. Applied Fluvial Geomorphology. Wildland Hydrology, Pagosa Springs Colorado.

Rosgen, D. 2001. Provided geomorphic information through personal communication.

Ryce, E. K., and E. L. MacConnell and A. V. Zale. 1999. Effects of age and dose on the development of whirling disease in rainbow trout. Proceedings of the Fifth Annual Whirling Disease Symposium, Research and Mangement Perspectives, Missoula, MT. Whirling Disease Foundation. Bozeman. MT.

Schmetterling D. and M. Long. 1999. Montana anglers inability to identify bull trout and other salmonids. Fisheries Vol. 24 No. 7, pp. 24-27.

Schmetterling, D. A. 2001. Seasonal movement of westslope cutthroat trout in the Blackfoot drainage, Montana. North American Journal of Fisheries Management, 21:507-520.

Schmetterling, D. A. 2002. Reestablishing connectivity to a fragmented river system: movements of westslope cutthroat trout and bull trout after transport upstream of Milltown Dam, Montana Fish, Wildlife and Parks, Missoula, Montana.

Shepard, B. B., B. Sanborn, L. Ulmer, and D.C. Lee. 1997. Status and risk of extinction for westslope cutthroat trout in the upper Missouri River basin, Montana. North American Journal of Fisheries Management 17:1158-1172.

Smith. L. 1998. Study on the distribution and abundance of *Tubifex tubifex* within Cottonwood Creek in the Blackfoot Drainage. MS Thesis, University of Missoula, Missoula, Montana.

Swanberg, T. R. 1997. Movements of and habitat use by fluvial bull trout in Blackfoot River. Transactions of the American Fisheries Society 126:735-746.

in the upper Blackfoot River drainage, Special report Region 2 Fisheries. Montana Fish, Wildlife and Parks, Missoula, Montana.

Vincent. R. 2001. Relative susceptibility of various salmonids to whirling disease with emphasis on rainbow and cutthroat trout. American Fisheries Society Symposium 26:1-11.

USFS. 2001. Dunham Creek Rehabilitation Design. Water Resources, Lolo National Forest. Missoula, MT.

USGS. 2002. Gaging station 1234000 provisional unpublished data.

Wolman, M. 1954. A method of sampling coarse river-bed material. Transations of American Geophysical Union 35: 951-956.

Appendix

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2001.

Exhibit B: Summary of two-pass population estimates for tributaries, 2001.

Exhibit C: Mark and recapture estimates in the Blackfoot River drainage, 2001.

Exhibit D: Summary of stream discharge measurements for 2001.

Exhibit E: Restoration stream and table of activities through 2001.

Exhibit F: Table of potential restoration projects in the Blackfoot Drainage through 2001

Exhibit G: Table of restoration streams and cooperators through 2001.

Exhibit H: Summary of water temperature monitoring in the Blackfoot Drainage, 2001.

Exhibit I: Westslope WSCT genetic sampling sites and results.

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2001

Stream	River Mile	Location (T, R, S)	Date Sampled	Section Length (ft)	Species	Total Number Captured	Number Captured 1st Pass	Fish<4.0" Captured 1st Pass	Range of Lengths (in)	Mean Length (in)	CPUE (#/100' in 1st Pass	Fish<4.0" CPUE (#/100' in 1st Pass)
Bear Creek	1.1	13N,16W,18B;	7-Aug-01	372	CT	4	4	2	3.6-6.1	4.7	1.1	0.5
lower river trib.		13N,16W,7C			RB	75	62	25	1.3-7.6	4.0	16.7	6.7
					LL	14	13	0	5.0-10.9	7.0	3.5	0.0
					EB	11	8	4	2.4-8.6	4.1	2.2	1.1
					SCUL	abundant						
Belmont Creek	0	14N,16W,24C	9-Aug-01	576	DV	8	8	0	6.6-12.2	10.4	1.4	0.0
					CT	1	1	0	8.8	8.8	0.2	0.0
					RB	28	28	6	2.0-7.2	4.7	4.9	1.0
					LL	13	13	6	2.7-6.4	4.3	2.3	1.0
					MWF	2	2	2	3.3-3.6	3.5	0.3	0.3
					RB YOY	common,	SCUL	abundant				
	0.6	14N,16W,24B	9-Aug-01	267	DV	3	2	0	6.6-10.1	8.3	0.7	0.0
					RB	52	38	4	2.0-8.7	5.2	14.2	1.5
					LL	58	49	8	2.2-9.9	4.9	18.4	3.0
					EB	1	1	0	4.4	4.4	0.4	0.0
					YOY's	abuundant						
	1.5	14N,16W,14A	9-Aug-01	357	DV	1	1	0	7.9	7.9	0.3	0.0
					RB	27	27	6	1.6-7.9	4.7	7.6	1.7
					LL	31	31	1	2.7-10.5	7.0	8.7	0.3
					SCUL	uncommon						
	4.3	14N,16W,11B	13-Aug-01	330	DV	1	1	0	4.6	4.6	0.3	0.0
					CT	24	24	1	2.4-10.8	6.1	7.3	0.3
					RB	2	2	0	4.5-5.5	5.0	0.6	0.0
					LL	6	6	0	4.9-9.4	6.9	1.8	0.0
	7.4	15N,16W,20A	13-Aug-01	405	DV	4	4	0	6.7-7.2	6.9	1.0	0.0
					CT	11	11	0	4.4-8.3	5.9	2.7	0.0
Blackfoot River	114	14N, 8W, 22A	8-Aug-01	1340	CT	1	1	0	7.9	7.9	0.1	0.0
Mary Faith Hefner Ditch					LL	1	1	1	2.7	2.7	0.1	0.1
					MWF	4	4	4	2.6-2.8	2.7	0.3	0.3
					Western Toa	present						
Buffalo Gulch	0.1	12N,9W,18D	23-Jul-01	390	CT+	29	29	6	1.9-5.2	4.4	7.4	1.5
					RB	5	5	1	3.6-4.9	4.2	1.3	0.3
					SCUL	common						
	1.3	12N,9W,7D	23-Jul-01	426	CT	14	14	7	3.5-7.4	4.4	3.3	1.6
					SCUL	present						
	2.5	12N,9W,8A&9B	23-Jul-01	402	CT	10	10	1	3.8-8.2	5.5	2.5	0.2
					RB	2	2	0	4.4-4.7	4.5	0.5	0.0
					SCUL	common	Spotted frog,	present				
California Gulch	0.4	12N,9W,9A	23-Jul-01	330	CT+	4	4	1	3.6-4.6	4.1	1.2	0.3
					Spotted fro	present						
	1.8	12N,9W,3B	23-Jul-01	400	CT	5	5	4	2.8-4.3	3.4	1.3	1.0
Clear Creek	0.1	12N,9W,8C	24-Jul-01	291	CT+	8	8	6	2.5-5.5	3.7	2.7	2.1
					SCUL	present						
	1.2	12N,9W,5C	24-Jul-01	200	CT	4	4	0	3.9-5.5	4.6	2.0	0.0
	1.9	12N,9W,6A	24-Jul-01	399	CT	24	24	16	1.8-6.4	3.6	6.0	4.0
	2.5	13N,9W,31D	24-Jul-01	250	CT	7	7	4	1.9-4.8	3.7	2.8	1.6

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2001

Stream	River Mile	Location (T, R, S)	Date Sampled	Section Length (ft)	Species	Total Number Captured	Number Captured 1st Pass	Fish<4.0" Captured 1st Pass	Range of Lengths (in)	Mean Length (in)	CPUE (#/100' in 1st Pass	Fish<4.0" CPUE (#/100' in 1st Pass
Clearwater Ditch	0	14N,14,W,4B	30-Aug-01	567	NP	4	4	0	8.1-9.1	8.7	0.7	0.0
					YOY	NSQ&LNS	present					
	1	14N,14W,4C	30-Aug-01	480	NP	4	4	0	7.7-9.4	8.6	0.8	0.0
					NSQ	18	18	0	5.1-9.0	7.0	3.8	0.0
					LNS	4	4	0	6.4-9.2	7.6	0.8	0.0
					PUMP	4	4	4	0.9-2.7	1.4	0.8	0.8
	1.3	14N,14W,9A	30-Aug-01	1100	NSQ	3	3	0	7.4-8.3	7.7	0.3	0.0
Coopers Lake tril	0	15N,10W,7B	24-Jul-01	300	CT	1	1	0	4	4.0	0.3	0.0
					EB	4	4	4	2.3-3.0	2.7	1.3	1.3
Cottonwood Creek	12.0	16N,14W,24D	20-Sep-01	470	DV	4	4	1	2.4-7.3	5.1	0.9	0.2
					CT*	92	67	36	1.8-10.2	4.1	14.3	7.7
					EB	9	9	6	2.4-6.7	3.9	1.9	1.3
					SCUL	abundant						
Dick Creek	0.1	15N,13W,24AB	6-Sep-01	360	CT*	1	1	0	7.1	7.1	0.3	0.0
					RB	25	25	17	2.0-8.2	3.7	6.9	4.7
					LL	21	21	16	2.1-10.5	4.4	5.8	4.4
					EB	4	4	2	2.9-11.7	6.4	1.1	0.6
					SCUL&MWF	abundant						
					LND&LNS	present						
	3.9	15N,12W,17B	6-Sep-01	260	EB	2	2	0	4.0-7.0	5.5	0.8	0.0
					SCUL	abundant						
					Tailed&Sp	present						
	4.8	15N,12W,17D	6-Sep-01	368	EB	17	17	9	2.8-11.2	5.7	4.6	2.4
					RSS,LNS,LS	abundant						
	7.8	15N,12W,15B	6-Sep-01	225	CT	17	17	2	2.9-9.1	6.1	7.6	0.9
					EB	23	23	5	2.3-9.3	5.3	10.2	2.2
Stone's Ditch			6-Sep-01		CT	6	6	6	1.4-1.6	1.5		
					EB	10	10	6	2.1-7.5	4.1		
Shocker problems	8.8	15N,12W,3A	6-Sep-01	90	EB	6	6	1	2.4-9.2	6.1	6.7	1.1
Colburn Ditch			6-Sep-01	312	EB	23	23	16	2.0-6.7	7.1	7.4	
Dunham Creek	2.3	16N,12W,19B	25-Jul-01	426	DV*	15	11	3	2.3-19.1	5.2	2.6	0.7
					CT	16	11	7	2.2-10.9	4.5	2.6	1.6
					EB	6	5	0	4.0-7.6	4.7	1.2	0.0
					SCUL	common						
Fish Rescue for Restoration	4	16N,13W,12D	26-Jul-01	1000	DV	36	36	0	4.0-7.1	6.2	3.6	0.0
					CT	22	22	4	1.1-11.0	6.3	2.2	0.4
					EB	28	28	0	4.0-9.0	5.4	2.8	0.0
					SCUL	present						
	4.2	16N,13W,12D	26-Jul-01	655	CT	9	6	0	4.6-7.4	5.8	0.9	0.0
					DV	19	16	1	1.9-8.6	5.3	2.4	0.2
					EB	5	5	0	4.2-5.6	4.9	0.8	0.0
Fish Creek	0.7	14N,14W,28A	10-Sep-01	290	CT	1	1	0	5.4	5.4	0.3	0.0
					Spotted fro	present						
	1.8	14N,14W,27D	10-Sep-01	405	CT	30	30	20	1.7-7.5	3.9	7.4	4.9
	2.8	14N,14W,35C	10-Sep-01	309	CT	45	45	29	1.6-6.0	3.6	14.6	9.4
Finn Creek	1.4	11N,9W,5D	30-Jul-01	400	No	Fish						
					Spotted fro	western tc	present					

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2001

Stream	River Mile	Location (T, R, S)	Date Sampled	Section Length (ft)	Species	Total Number Captured	Number Captured 1st Pass	Fish<4.0" Captured 1st Pass	Range of Lengths (in)	Mean Length (in)	CPUE (#/100' in 1st Pass	Fish<4.0" CPUE (#/100' in 1st Pass)
Gallagher Creek	0.3	12N,9W,29A	1-Aug-01	393	CT	6	6	0	4.1-5.5	4.9	1.5	0.0
					SCUL	present	Spotted Frog:	present				
	2.8	11N,9W,5C&6D	30-Jul-01	398	CT	26	26	17	2.4-5.9	3.8	6.5	4.3
					SCUL	common						
Gleason Creek	0.1	12N,8W,22B	25-Jul-01	363	CT	9	9	4	2.7-7.9	4.2	2.5	1.1
					SCUL	nt below culvert						
Gold Creek	0.2	14N,16W,31B	16-Aug-01	510	CT[4]	11	10	0	4.8-12.0	8.4	2.0	0.0
					DV	1	1	0	12.4	12.4	0.2	0.0
					LL	35	26	17	2.0-11.0	4.0	5.1	3.3
					RB	61	39	9	1.7-9.0	4.5	7.6	1.8
					Scul,	common,	Mwf present					
treatment	1.9	14N,16W,30D	16-Aug-01	400	DV	2	2	0	6.3-6.4	6.3	0.5	0.0
					CT	6	5	0	5.7-7.9	7.1	1.3	0.0
					RB[4]	38	27	13	1.6-9.0	4.6	6.8	3.3
					LL	64	51	27	1.7-15.5	4.4	12.8	6.8
					SCUL,	common,						
Halfway Creek	0.3	12N,9W,34C	30-Jul-01	441	CUL,RSS,LN	common,	Spotted frog:	present				
	2.9	11N,9W,1B	30-Jul-01	350	RSS,LNS	common	Western toad:	present				
Indian Creek	0.1	12N,9W,19B	1-Aug-01	351	CT[4]	9	9	5	1.0-5.6	3.2	2.6	1.4
					SCUL	abundant						
West Fork	0.1	12N,9W,24A	1-Aug-01	315	CT	3	3	0	4.3-5.0	4.6	1.0	0.0
					SCUL	common						
East Fork	0.1	12N,9W,24A	1-Aug-01	293	CT	14	14	14	1.2-3.8	2.7	4.8	4.8
					SCUL	common						
Jefferson Creek	0.5	12N,9W,21C	19-Jul-01	456	CT[4]	12	12	0	4.2-6.4	5.1	2.6	0.0
					RB	1	1	0	7.5	7.5	0.2	0.0
					SCUL	abundant						
	2.3	12N,9W,15C	19-Jul-01	552	CT[4]	20	20	7	3.3-6.8	4.7	3.6	1.3
					RB	13	13	5	3.5-4.9	4.1	2.4	0.9
	4.7	12N,9W,11A	19-Jul-01	399	CT	85	85	59	2.4-5.7	3.6	21.3	14.8
					Spotted froc	Western toa	present					
	5.5	12N,9W,2A	19-Jul-01	402	CT	18	18	7	2.7-5.8	4.3	4.5	1.7
	7.2	13N,8W,31C	19-Jul-01	195	NO FISH							
McCabe Creek	0	15N,12W,17B	6-Sep-01	125	LL	1	1	0	13.4	13.4	0.8	0.0
					EB	14	14	0	4.8-12.0	7.7	11.2	0.0
					SCUL	present						
	2.2	15N,12W,5C	22-Aug-01	340	CT	82	63	22	2.9-10.1	4.7	18.5	6.5
					EB	26	21	7	2.0-11.0	4.7	6.2	2.1
					SCUL	common						
post fountain pr	3.2	15N,12W,4C	22-Aug-01	360	CT	43	30	7	2.5-8.7	5	8.3	1.9
					SCUL	abundant	Tailed frogs	present				
McDermott Creek	0	15N,10W,1A	24-Jul-01	500	CT	1	1	0	4.1	**4.1**	0.2	0.0
					EB	30	30	24	2.4-6.1	**3.4**	6.0	4.8
					LND	1	1	0	4.5	**4.5**	0.2	0.0
					SCUL	abundant						
Mitchell Creek	3	11N,8W,5A	16-Jul-01	435	CT	18	18	3	3.0-7.0	4.7	4.1	0.7
					Spotted fro	present						
	3.5	11N,8W,4BC	16-Jul-01	400	CT	58	58	13	2.5-7.5	4.6	14.5	3.3
					Spotted fro	present						
	4.7	11N,8W,3B	16-Jul-01	390	CT	15	15	7	3.0-5.0	3.9	3.8	1.8

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2001

Stream	River Mile	Location (T, R, S)	Date Sampled	Section Length (ft)	Species	Total Number Captured	Number Captured 1st Pass	Fish<4.0" Captured 1st Pass	Range of Lengths (in)	Mean Length (in)	CPUE (#/100' in 1st Pass	Fish<4.0" CPUE (#/100' in 1st Pass
Nevada Creek	33.8	12N,9W,19A	3-Jul-01	456	CT	1	1	0	9	9.0	0.2	0.0
					RB	4	4	0	11.4-12.1	11.8	0.9	0.0
					RSS	20	20	2	3.6-6.5	4.5	4.4	0.4
					LND	4	4	3	2.7-4.1	3.3	0.9	0.7
					LSS	4	4	0	12.4-14.6	13.4	0.9	0.0
	41.5	12N,9W,35B	3-Jul-01	476	RB	9	9	0	4.9-16.8	9.0	1.9	0.0
					EB	5	5	0	8.1-11.0	9.7	1.1	0.0
					SCUL	present						
	42.8	12N,9W,25	5-Jul-01	486	RB	4	4	1	3.7-4.9	4.5	0.8	0.2
					EB	19	19	5	1.6-10.4	5.7	3.9	1.0
					SCUL	common						
	45.5	12N,8W,29C	3-Jul-01	531	CT	5	5	4	1.5-5.1	3.2	0.9	0.8
					SCUL	common						
	46.1	12N,8W,29A&28B	5-Jul-01	630	CT	11	11	4	2.3-8.5	4.6	1.7	0.6
					EB	1	1	1	3.9	3.9	0.2	0.2
					SCUL	common						
	48.6	12N,8W,15	3-Jul-01	474	CT	12	12	4	2.3-10.6	5.0	2.5	0.8
					SCUL	abundant						
Nevada Spring Cr	2.8	13N,11W,11D	18-Sep-01	450	LL	4	3	0	7.7-11.7	9.1	0.7	0.0
					MWF	1	1	0	4.4	4.4	0.2	0.0
	3.0	13N,11W,11D	18-Sep-01	510	LL	6	6	2	3.8-7.7	6.1	1.2	0.4
					Spotted Fro	present						
Pearson Creek	1.3	14N,13W,3B	20-Sep-01	300	CT	67	54	11	3.2-6.3	4.6	18.0	3.7
					LL	1	1	0	7.3	7.3	0.3	0.0
					EB	5	4	2	1.9-6.8	4.5	1.3	0.7
					LNS	5	3	0	4.3-5.8	5.2	1.0	0.0
Poorman Creek												
below lower ditc	1.3	14N,9W,36A	6-Aug-01	291	LL	7	5	5	1.9-3.1	2.3	1.7	1.7
Lower Ditch	1.3	14N,9W,36A	6-Aug-01	550	NO FISH							
Upper ditch	1.4		6-Aug-01	591	CT	6	6	0	6.8-7.7	7.0	1.0	0.0
					LL	7	7	4	2.2-5.1	3.5	1.2	0.7
Above Upper Ditc	1.5		6-Aug-01	522	CT	20	14	0	4.0-11.6	6.5	2.7	0.0
					LL	23	19	3	2.2-8.8	5.7	3.6	0.6
					EB	10	8	0	5.0-9.2	7.2	1.5	0.0
					SCUL	present						
Rock Creek Below Forks	1.6	14N,11W,5A	15-Aug-01	606	DV	3	2	0	4.4-7.8	5.6	0.3	0.0
					LL	72	50	44	1.2-6.0	2.7	8.3	7.3
					EB	16	9	6	2.4-5.6	3.4	1.5	1.0
					SCUL	abundant						
Above Forks	1.7	14N,11W,5A	23-Aug-01	370	RB	1	1	1	1.7	1.7	0.3	0.3
					LL	17	13	6	2.3-12.5	5	3.5	1.6
					EB	53	45	41	2.4-4.9	3.1	12.2	11.1
Shanley Creek	0.2	15N,13W,9B	4-Aug-01	360	CT	4	4	0	4.2-7.6	5.6	1.1	0.0
					LL	25	20	3	1.6-11.0	5.5	5.6	0.8
					EB	7	7	0	4.3-7.4	5.8	1.9	0.0
					SCUL	abundant						
	1.4	15N,13W,3B	14-Aug-01	213	CT	27	27	10	2.5-6.6	4.4	12.7	4.7
					EB	19	19	4	2.2-7.2	4.8	8.9	1.9
					Spotted fro	present						
	1.6	15N,13W,3B	14-Aug-01	466	CT	62	45	17	2.9-6.9	4.3	9.7	3.6

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2001

Stream	River Mile	Location (T, R, S)	Date Sampled	Section Length (ft)	Species	Total Number Captured	Number Captured 1st Pass	Fish<4.0" Captured 1st Pass	Range of Lengths (in)	Mean Length (in)	CPUE (#/100' in 1st Pass	Fish<4.0"CPUE (#/100' in 1st Pass
Shanley Creek (cont.)					SCUL	abundant,	Spotted frog:	present				
Shingle Mill Cre	0.8	12N,8W,32B	5-Jul-01	355	CT	9	9	5	3.2-4.7	3.9	2.5	1.4
	1.6	12N,8W,32D	5-Jul-01	420	CT	13	13	6	3.1-5.1	4.1	3.1	1.4
	2.2	12N,8W,33A	5-Jul-01	339	CT	15	15	7	2.2-5.5	3.9	4.4	2.1
Spring Creek, Trib. to N.F.	0.6	15N,11W,21B	8-Aug-01	375	DV	2	2	1	1.6-4.8	3.2	0.5	0.3
					CT	43	43	30	1.2-6.3	3.3	11.5	8.0
					EB	1	1	1	3.6	3.6	0.3	0.3
					SCUL	common						
Strickland Creek	0.1	11N,9W,2A	1-Aug-01	315	otted froc	RSS&LSS	present					
Ward Creek	7.2	14N,11W,16D	27-Aug-01	525	SCUL	present	YOY RSS&LNS	abundant				
	8.2	14N,11W,15B	27-Aug-01	417	EB	29	29	23	2.5-7.8	3.9	7.0	5.5
					LNS&RSS	common						
	10.5	14N,11W,2C	27-Aug-01	309	EB	48	48	39	2.2-6.4	3.4	15.5	12.6
					YOY EB	observed	Spotted frog:	present				
	12.9	15N,11W,36D	29-Aug-01	348	EB	18	18	11	2.4-6.1	3.6	5.2	3.2
	13.8	15N,10W,31D	29-Aug-01	303	EB	74	74	40	2.3-9.0	4.1	24.4	13.2
					Spotted fro	present						
Warren Creek	1.1	15N,12W,31C	11-Sep-01	345	LL	26	21	0	3.9-9.1	5.2	6.1	0.0
					EB	1	1	0	8.9	8.9	0.3	0.0
					RSS&LND	present						
	2.1	15N,12W,31A	11-Sep-01	345	CT	1	1	0	7.6	7.6	0.3	0.0
					LL	12	8	0	4.0-8.6	6.4	2.3	0.0
					EB	1	1	0	7.9	7.9	0.3	0.0
					SCUL	abundant,	Spotted frog	common,	LNS	present		
	3.6	15N,12W,32C	11-Sep-01	468	LL	2	2	0	7.1-8.5	7.5	0.4	0.0
					EB	77	60	7	3.3-9.8	5.6	12.8	1.5
					SCUL	abundant						
Washington Creek	2	12N,9W,26C	17-Jul-01	315	EB	3	3	0	6.3-6.6	6.4	1.0	0.0
					SCUL	present						
	3	12N,9W,26A	17-Jul-01	423	EB	19	19	8	1.2-10.9	4.4	4.5	1.9
	4.8	12N,9W,24A	17-Jul-01	610	CT	10	10	5	3.1-5.4	3.9	1.6	0.8
					EB	15	15	8	1.8-6.0	3.4	2.5	1.3
					SCUL	abundant						
	6.1	12N,8W,18BA	18-Jul-01	462	CT	19	19	9	3.0-7.8	4.8	4.1	1.9
					EB	13	13	0	4.2-8.3	5.2	2.8	0.0
					SCUL	present						
	7.2	12N,8W,7A&8B	18-Jul-01	411	CT	46	46	24	2.0-7.5	4	11.2	5.8
					EB	observed	3low diversion					

* Sample may include rainbow trout / cutthroat trout hybrids
** Sample may include bull trout / brook trout hybrids

Exhibit 8: Summary of two-pass population estimates for tributaries, 2001

Stream	River Mile	Location (T,R,S)	Date Sampled	Section Length (ft)	Species	Size Class (in)	1st Pass	2nd Pass	3rd Pass	Prob. of Capture	Total Estimate ± 95%CI	Estim/100' ± 95%CI
Bear Creek	1.1	13N, 16W, 18B, 7C	7-Aug-01	372	CT	<4.0	2	0		1.00	2.00+0.0	0.5+0.0
					CT	>4.0	2	0		1.00	2.00+0.0	0.5+0.0
					RB	<4.0	25	6		0.76	32.89+4.5	8.8+1.2
					RB	>4.0	37	7		0.81	45.63+3.7	12.3+1.0
					LL	<4.0	0	0				
					LL	>4.0	13	1		0.92	14.8+0.7	3.8+0.2
					EB	<4.0	4	1		0.75	5.33+1.9	1.4+0.5
					EB	>4.0	4	2		0.50	8.00+9.8	2.2+2.8
					All	<4.0	31	7		0.77	40.04+4.6	10.8+1.2
					All	>4.0	56	10		0.82	68.17+4.2	18.3+1.1
Belmont Creek	0.6	14N,16W,24B	9-Aug-01	267	DV	<4.0	0	0				
					DV	>4.0	2	1		0.50	4.00+6.8	1.5+2.5
					RB	<4.0	4	0		1.00	4.00+0.0	1.5+0.0
					RB	>4.0	34	14		0.59	57.80+16.2	21.6+6.1
					LL	<4.0	8	3		0.63	12.80+6.2	4.8+2.3
					LL	>4.0	41	6		0.85	48.03+2.7	18.0+1.0
					EB	<4.0	0	0				
					EB	>4.0	1	0		1.00	1.00+0.0	0.4+0.0
					All	<4.0	12	3		0.75	16.00+3.4	6.0+1.3
					All	>4.0	78	21		0.73	106.74+9.8	40.0+3.7
Cottonwood Creek	12.0	16N,14W,24D	20-Sep-01	500	DV	<4.0	1	0		1.00	1.00+0.0	0.2+0.0
					DV	>4.0	3	0		1.00	3.00+0.0	0.6+0.0
					CT	<4.0	36	11		0.69	51.84+8.5	10.4+1.7
					CT	>4.0	31	14		0.55	56.53+19.7	11.3+3.9
					EB	<4.0	6	0		1.00	6.00+0.0	1.2+0.0
					EB	>4.0	3	0		1.00	3.00+0.0	0.6+0.0
					All	<4.0	43	11		0.74	57.78+6.7	11.6+1.3
					All	>4.0	37	14		0.62	59.52+13.7	11.9+2.7
Dunham Creek	2.3	16N, 12W, 19B	25-Jul-01	426	CT	>4.0	4	2		0.50	8.0 ± 9.6	1.9 ± 2.3
					DV	>4.0	8	4		0.50	16.0 ± 13.6	3.8 ± 3.2
					EB	>4.0	5	1		0.80	6.2 ± 1.5	1.5 ± 0.4
					ALL	>4.0	17	7		0.59	28.9 ± 11.4	6.8 ± 2.7
	4.2	16N, 13W, 12D	26-Jul-01	655	DV	>4.0	15	3		0.80	18.8 ± 2.6	2.9 ± 0.4
					CT	>4.0	6	3		0.50	12.0 ± 11.8	1.8 ± 1.8
					EB	>4.0	5	0		1.00	5.0 ± 0.0	0.8 ± 0.0
					ALL	>4.0	26	6		0.77	33.8 ± 4.3	5.2 ± 0.7
Gold Creek	0.2	14N, 16W, 31B	16-Aug-01	510	DV	>4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0
					CT*	>4.0	10	1		0.90	11.1 ± 0.8	2.2 ± 0.2
					RB	>4.0	30	14		0.53	56.2 ± 21.3	11.0 ± 4.2
					LL	>4.0	9	7		0.22	40.5 ± 123.5	7.9 ± 24.2
					ALL	>4.0	50	22		0.56	89.3 ± 23.3	17.5 ± 4.6
	1.9	14N,16W,30D	16-Aug-01	400	DV	>4.0	2	0		1.00	2.0 ± 0.0	0.5 ± 0.0
					CT*	>4.0	5	1		0.80	6.2 ± 1.5	1.6 ± 0.4
					RB	>4.0	14	5		0.64	21.8 ± 7.4	5.4 ± 1.8
					LL	>4.0	23	7		0.70	33.1 ± 6.8	8.3 ± 1.7
					All	>4.0	44	13		0.70	62.5 ± 8.8	15.6 ± 2.2
McCabe Creek	2.2	15N, 12W, 5D	22-Aug-01	340	CT	>4.0	41	15		0.63	64.6±13.3	19.0 ± 3.9
					EB	>4.0	14	5		0.64	21.8 ± 7.4	6.4 ± 2.2
					All	>4.0	55	20		0.64	86.4 ± 15.2	25.4 ± 4.5
	3.2	15N, 12W, 4C	22-Aug-01	360	CT	>4.0	22	8		0.64	34.6 ± 9.6	9.6 ± 2.7
Nevada Spring Creek	2.8	13N, 11W, 11D	18-Sep-01	450	LL	<4.0	0	0				
					LL	>4.0	3	1		0.67	4.50+2.9	1.0+0.7
					MWF	>4.0	1	0		1.00	1.00+0.0	0.2+0.0
	3	13N,11W,11D	18-Sep-01	510	LL	<4.0	2	0		1.00	2.00+0.0	0.4+0.0
					LL	>4.0	4	0		1.00	4.00+0.0	0.8+0.0
Pearson Creek	1.1	14N,13W,3B	20-Sep-01	300	CT YOY	<3.2	0	0				
					1+	>3.2	54	13		0.76	71.1 + 6.7	23.7 + 2.2
					EB	<4.0	2	0		1.00	2.0+0.0	0.7+0.0
					EB	>4.0	2	1		0.50	4.0+6.8	1.3+2.3
					LL	<4.0	0	0				
					LL	>4.0	1	0		1.00	1.00+0.0	0.3+0.0
					LNS	>4.0	3	2		0.33	9.00+26.3	3.0+8.8
Poorman Creek (below lower diversion)	1.3	14N,9W,36A	6-Aug-01	291	LL	<4.0	5	2		0.60	8.33+5.8	2.9+2.0
(above upper diversion)	1.5		6-Aug-01	522	CT	<4.0	0	0				
					CT	>4.0	14	6		0.57	24.50+11.5	4.7+2.2
					LL	<4.0	3	0		1.00	3.00+0.0	0.6+0.0
					LL	>4.0	16	4		0.75	21.33+3.9	4.1+0.7
					EB	<4.0	0	0				
					EB	>4.0	8	2		0.75	10.67+2.8	2.0+0.5
					All		41	12		0.71	57.9 ± 8.3	11.1 ± 1.6
					All	>4.0	38	12		0.68	55.54+9.3	10.6+1.8

Exhibit B: Summary of two-pass population estimates for tributaries, 2001

Stream	River Mile	Location (T,R,S)	Date Sampled	Section Length (ft)	Species	Size Class (in)	1st Pass	2nd Pass	3rd Pass	Prob. of Capture	Total Estimate ± 95%CI	Estim/100' ± 95%CI
Rock Creek	1.6	14N,11W,5A	15-Aug-01	606	DV	<4.0	0	0				
Below the forks					DV	>4.0	2	1		0.50	4.00+8.8	0.7+1.1
					LL	<4.0	44	22		0.50	88.00+31.8	14.5+5.3
					LL	>4.0	6	0		1.00	6.00+0.0	1.0+0.0
					EB	>4.0	3	1		0.67	4.50+2.9	0.7+0.5
					All	<4.0	50	28		0.44	113.64+50.1	18.8+8.3
					All	>4.0	11	2		0.82	13.44+1.9	2.2+0.3
Above the forks	1.7	14N, 11W, 5A	23-Aug-01	370	RB	<4.0	1	0		1.00	1.00+0.0	0.3+0.0
					RB	>4.0	0	0				
					LL	<4.0	6	4		0.33		
					LL	>4.0	7	0		1.00	7.00+0.0	1.9+0.0
					EB	<4.0	41	8		0.80	50.94+4.1	13.8+1.1
					EB	>4.0	4	0		1.00	4.00+0.0	1.1+0.0
					All	<4.0	48	12		0.75	64.00+6.7	17.3+1.8
					All	>4.0	11	0		1.00	11.00+0.0	3.0+0.0
Shanley Creek	0.2	15N, 13W, 9B	14-Aug-01	360	CT	<4.0	0	0				
					CT	>4.0	4	0		1.00	4.00+0.0	1.1+0.0
					LL	<4.0	3	2		0.33	9.00+26.3	2.5+7.3
					LL	>4.0	17	3		0.82	20.64+2.3	5.7+0.8
					EB	<4.0	0	0				
					EB	>4.0	7	0		1.00	7.00+0.0	1.9+0.0
					All	<4.0	3	0		1.00	3.00+0.0	0.8+0.0
					All	>4.0	28	3		0.89	31.36+1.5	8.7+0.4
	1.4	15N, 13W, 3B	14-Aug-01	213	CT	<4.0	10	0		1.00	10.00+0.0	4.7+0.0
					CT	>4.0	17	0		1.00	17.00+0.0	8.0+0.0
					EB	<4.0	4	0		1.00	4.00+0.0	1.9+0.0
					EB	>4.0	15	0		1.00	15.00+0.0	7.0+0.0
					All	<4.0	14	0		1.00	14.00+0.0	6.6+0.0
					All	>4.0	32	0		1.00	32.00+0.0	15.0+0.0
	1.6	15N, 13W, 3B	14-Aug-01	466	CT	<4.0	17	9		0.47	36.13+23.9	7.8+5.1
					CT	>4.0	28	8		0.71	39.20+6.6	8.4+1.4
					EB	<4.0	8	4		0.50	16.00+13.6	3.4+2.9
					EB	>4.0	29	3		0.90	32.35+1.4	6.9+0.3
					All	<4.0	25	13		0.48	52.08+27.3	11.2+5.9
					All	>4.0	57	11		0.81	70.63+4.8	15.2+1.0
Warren Creek	1.1	15N,12W, 31C	11-Sep-01	345	LL	<4.0	0	0				
					LL	>4.0	21	5		0.76	27.56+4.1	8.0+1.2
					EB	<4.0	0	0				
					EB	>4.0	1	0		1.00	1.00+0.0	0.3+0.0
					All	>4.0	22	5		0.77	28.47+3.9	8.3+1.1
	2.1	15N,12W,31A	11-Sep-01	345	CT	>4.0	1	0		1.00	1.00+0.0	0.3+0.0
					LL	>4.0	8	4		0.50	16.00+13.6	4.6+3.9
					EB	>4.0	1	0		1.00	1.00+0.0	0.3+0.0
					All	>4.0	10	4		0.60	16.67+8.1	4.8+2.4
	3.6	15N,12W,32C	11-Sep-01	468	LL	<4.0	0	0				
					LL	>4.0	2	0		1.00	2.00+0.0	0.4+0.0
					EB	<4.0	7	3		0.57	12.25+8.1	2.6+1.7
					EB	>4.0	53	14		0.74	72.03+7.8	15.4+1.7
					All	>4.0	55	14		0.75	73.78+7.5	15.8+1.6

* Sample may include rainbow trout / cutthroat trout hybrids

Exhibit C: Mark and recapture estimates in the Blackfoot River drainage, 2001

Stream	River Mile Mid-point	Location (T,R,S)	Date Sampled	Section Length (ft)	Species	Size Class (in)	Marked	Captured	Recaptured	Efficiency (R/C)	Total Estim ± CI	Estim/1000' ± CI
North Fork	4.0	12W,14N,10D	21-Aug-01	18,829	CT	>8.0	17	18	6	0.33	48 ± 27	2.5 ± 1.4
Blackfoot River						>12.0	13	12	4	0.33	35 ± 23	1.9 ± 1.2
						ct>6.0	18	18	6	0.33	51 ± 28	2.7± 1.5
					DV	6.0-12.0	10	4	2	0.50	17 ± 11	0.9 ± 0.6
						>12.0	66	24	10	0.42	151 ± 65	8.0 ± 3.4
						>6.0	76	28	12	0.43	171 ± 68	9.1 ± 3.5
					LL	6.0-12.0	54	43	12	0.28	185 ± 83	9.8 ± 4.3
						>12.0	69	58	33	0.57	120 ± 27	6.4± 1.4
						>6.0	123	101	45	0.45	274 ± 59	14.5 ± 3.1
					RB	6.0-12.0	17	13	3	0.23	62 ± 47	3.3 ± 2.4
						>12.0	15	10	8	0.80	19 ± 5	1.0 ± 0.3
						>6.0	32	23	11	0.48	65 ± 25	3.5 ± 1.3
					All	>6.0	249	170	74	0.44	569 ± 98	30.2 ± 5.1
Monture Creek	1.5	15N,13W,S27	19-Jul-01	5437	CT	>6.0	27	18	7	0.39	66 ± 33	12.0 ± 6.0
total						>12.0	11	4	2	0.50	19 ± 12	3.5 ± 2.2
both sections					DV	>6.0	46	26	4	0.15	253 ± 186	46.5 ± 33.6
					LL	>6.0	47	30	14	0.47	98 ± 35	18.1 ± 6.4
						>14.0	19	9	8	0.89	21 ± 4	3.9 ± 0.8
					RB	>6.0	39	26	5	0.19	179 ± 119	32.9 ± 21.5
						>10.0	14	2	1	0.50	22 ± 14	14 ± 0.4
					All	>6.0	159	100	30	0.30	520 ± 153	95.7 ± 27.6
Monture Creek		15N,13W,S27	19-Jul-01	3378	CT	>6.0	9	9	3	0.33	24 ± 17	7.1 ± 4.8
upper section					DV	>6.0	35	19	2	0.11	239 ± 220	70.8 ± 63.9
					natives	>6.0	44	28	5	0.18	217 ± 146	64.1 ± 42.3
Post restoration					LL	>6.0	30	17	7	0.41	69 ± 34	20.4 ± 9.9
					RB	>6.0	27	16	3	0.19	118 ± 92	34.9 ± 26.8
					RBandLL	>6.0	57	34	10	0.29	184 ± 88	54.3 ± 25.5
					All	>6.0	101	62	15	0.24	401 ± 168	118.6 ± 48.7
Monture Creek		15N,13W,S27	19-Jul-01	2059	CT	>6.0	18	9	4	0.44	37 ± 21	18 ± 10.2
lower section					DV	>6.0	11	7	1	0.14	47 ± 47	22.8 ± 22.4
					natives	>6.0	29	16	5	0.31	84 ± 51	40.8 ± 24.3
Restored reference					LL	>6.0	17	13	6	0.46	35 ± 18	17.0 ± 8.3
					RB	>6.0	11	10	2	0.20	43 ± 37	20.9 ± 17.5
					RBandLL	>6.0	28	23	8	0.35	76 ± 38	37.1 ± 18.2
					All	>6.0	57	39	13	0.33	165 ± 69	80 ± 32.6

Exhibit D: Summary of Stream Discharge Measurements for 2001.

Stream	Legal Description	Stream Mile	Date	Discharge ft^3/s	Location
Buffalo Gulch	T12N,R9W,S18D	0.1	24-Jul-01	2.71	Mouth
California Gulch	T12N,R9W,S9B	0.1	23-Jul-01	.338	Mouth
Clear Creek	T12N,R9W,S8C	0.1	24-Jul-01	.656	Mouth
Gallagher Creek	T12N,R9W,S29A	0.3	1-Aug-01	1.51	Mannix Ranch
Gleason Creek	T12N,R8W,S22B	0.1	25-Jul-01	2.22	Mouth
Halfway Creek	T12N,R9W,S34D	0.9	1-Aug-01	.876	Quigley Ranch
Indian Creek	T12N,R9W,S19B	0.1	1-Aug-01	1.46	Mouth
Jefferson Creek	T12N,R9W,S21C	0.3	23-Jul-01	2.21	Hwy 141 xing
Kleinschmidt Cr.	T14N,R11W,S5C	1.1	6-Sept-01	8.68	Upper end, near pond
Kleinschmidt Cr.	T14N,R11W,S5C	0.8	6-Sept-01	9.38	Below Rue's bridge
Kleinschmidt Cr.	T14N,R11W,S5C	0.5	6-Sept-01	11.4	Below Freide's bridge
Hoeffner Ditch	T14N,R8W,S22B	0.1	8-Aug-01	2.42	Below headgate
Mitchell Creek	T11N,R8W,S5A	3.0	16-Jul-01	.705	Quigley Ranch
Nevada Creek	T12N,R8W,S28B	45.9	25-Jul-01	11.2	Nevada Cr. Rd. xing
Nevada Creek	T12N,R9W,34A	41.5	25-Jul-01	8.56	Hwy 141 xing
Nevada Creek	T12N,R9W,19A	33.8	25-Jul-01	14.6	Bridge above reservoir
Poorman Creek	T14N,R9W,S36A	1.5	6-Aug-01	3.53	Above upper Grantier ditch
Poorman \ Upper Ditch	T14N,R9W,S36A	1.5	6-Aug-01	1.37	Below headgate
Poorman \ Lower Ditch	T14N,R9W,S36A	1.2	6-Aug-01	2.25	Below headgate
Poorman Creek	T14N,R9W,S36A	1.2	6-Aug-01	< .1	Below lower Grantier ditch
Shingle Mill Cr.	T12N,R8W,32A	0.8	17-Jul-01	.670	Quigley Ranch
Strickland Creek	T11N,R9W,S2A	0.1	1-Aug-01	.311	Mouth
Washington Cr.	T12N,R9W,S26C	1.9	18-Jul-01	2.93	Hwy 141 xing

Appendix E. Table of Restoration Streams and Activities

Stream Name	Fish passage improvement	Prevent Irrigation ditch losses	Spawning habitat protection	Channel restoration	Fish habitat improvement	Riparian vegetation improve.	Improve instream flows	Improve wetlands	Improve range/ riparian habitat	Improve irrigation	Conserv. easements	Remove streamside feedlots
Alice Creek												
Arkansas Creek												
Arrastra Creek												
Ashby Creek												
Bartlett Creek												
Basin Spring Creek				X	X	X	X	X	X	X	X	X
Bear Creek (lower River)	X			X	X	X	X		X	X		X
Bear Creek (middle River)												
Bear Creek (North Fork)												
Beaver Creek	X	X						X		X	X	
Belmont Creek	X		X						X			
Black Bear Creek												
Blackfoot River(mouth to Clearwater)							X				X	
Blackfoot River(Clearwater to N.F)							X		X		X	
Blackfoot River(NF to Lincoln)								X	X		X	X
Blackfoot River(Lincoln to Headwaters)												
Blanchard Creek	X	X				X	X		X	X		
Buffalo Gulch												
Burnt Bridge Creek												
California Gulch												
Camas Creek												
Chamberlain Creek	X	X	X	X	X	X	X	X	X	X	X	X
Chamberlain Creek, east fork												
Chamberlain Creek, west fork									X			
Chicken Creek												
Chimney Creek (trib to Douglas)												
Chimney Creek (Nevada drain.)												
Clear Creek												
Copper Creek												
Cottonwood Creek (lower trib.)	X	X				X	X	X	X	X	X	X
Cottonwood Creek (Nevada drain.)	X			X		X			X	X		X
Dick Creek	X	X		X	X	X	X	X	X	X	X	X
Douglas Creek	X					X						

Appendix E. Table of Restoration Streams and Activities

Stream Name	Fish passage improvement	Prevent Irrigation ditch losses	Spawning habitat protection	Channel restoration	Fish habitat improvement	Riparian vegetation improve.	Improve Instream flows	Improve wetlands	Improve range/ riparian habitat	Improve irrigation	Conserv. easements	Remove streamside feedlots
North Fork Blackfoot River		X		X	X	X	X		X	X	X	
Pearson Creek	X	X	X	X	X	X	X	X	X	X	X	X
Poorman Creek												
Rock Creek	X	X		X	X	X	X	X	X	X	X	X
Salmon Creek	X	X	X	X	X	X	X	X	X	X	X	X
Seven up Pete Creek												
Sauerkraut Creek												
Shanley Creek		X				X	X		X	X	X	
Sheep Creek												
Shingle Mill Creek												
Spring Creek (upper Cottonwood)												
Spring Creek (North Fork)	X									X		
Strickland Creek												
Sturgeon Creek												
Union Creek												
Wales Creek												
Ward Creek												
Warm Springs Creek												
Warren Creek	X		X	X	X	X	X	X	X	X		X
Washington Creek												
Washoe Creek												
Wasson Creek	X					X	X		X	X	X	X
Wilson Creek												
West Twin Creek	X											
Willow Creek (above Lincoln)												
Willow Creek (below Lincoln)												
Yourname Creek												

Appendix E. Table of Restoration Streams and Activities

Stream Name	Fish passage improvement	Prevent Irrigation ditch losses	Spawning habitat protection	Channel restoration	Fish habitat improvement	Riparian vegetation improve.	Improve Instream flows	Improve wetlands	Improve range/ riparian habitat	Improve irrigation	Conserv. easements	Remove streamside feedlots
Dry Creek						X			X			
Dunham Creek		X		X	X	X				X	X	
Elk Creek	X			X	X	X		X	X			
East Twin Creek	X											
Finn Creek												
Fish Creek												
Frazier Creek												
Frazier Creek, north fork												
Gallagher Creek												
Game Creek												
Gleason Creek												
Gold creek					X							
Grantier Spring Creek	X		X	X	X	X		X	X			
Hogum Creek												
Hoyt Creek	X					X			X	X	X	
Humbug Creek												
Indian Creek												
Jefferson Creek												
Johnson Creek												
Keep Cool Creek												
Kleinschmidt Creek	X		X	X	X	X		X	X		X	
Landers Fork												
Lincoln Spring Creek				X	X	X			X			
Lodgepole Creek												
McElwain Creek												
McCabe Creek	X	X		X	X	X	X		X	X		
Mitchell Creek												
Monture Creek			X	X	X	X	X	X	X	X	X	
Moose Creek												
Murray Creek												
Nevada Creek	X					X			X	X		
Nevada Spring Creek			X	X	X	X	X	X	X		X	

Appendix F. Table of Potential Restoration Projects

Stream Name	Road Crossings	Irrigation Impacts	Channel alterations	Lacks Complexity	Riparian vegetation	Instream flow	Road drainage	Feedlots, Grazing	Recreation Impacts	Whirling Disease	Mining	Residential
Alice Creek				X	X				X			
Arkansas Creek							X	X				
Arrastra Creek	X						X		X			
Ashby Creek		X	X				X	X				
Bartlett Creek					X				X			
Bear Creek (lower River)					X		X					
Bear Creek (middle River)	X											
Bear Creek (North Fork)		X				X						
Beaver Creek		X			X	X		X				
Belmont Creek				X			X	X	X			
Black Bear Creek	X					X		X				
Blackfoot River(mouth to Clearwater)			X	X			X	X	X	X		
Blackfoot River(Clearwater to N.F)			X		X			X	X	X		
Blackfoot River(NF to Lincoln)		X	X	X	X	X		X	X	X		
Blackfoot River(Lincoln to Headwaters)		X	X	X		X			X		X	
Blanchard Creek		X	X	X	X	X	X	X				
Buffalo Gulch	X			X	X			X			X	
Burnt Bridge Creek	X	X	X		X	X	X					
California Gulch	X			X	X			X				
Camas Creek			X	X				X				
Chamberlain Creek				X	X		X			X		
Chamberlain Creek, east fork							X					
Chamberlain Creek, west fork							X					
Chicken Creek			X	X	X			X				
Chimney Creek (trib to Douglas)		X	X	X	X			X				
Chimney Creek (Nevada drain.)	X	X	X			X		X				
Clear Creek								X				
Copper Creek									X			
Cottonwood Creek (lower trib.)				X	X	X		X		X		
Cottonwood Creek (Nevada drain.)	X	X	X	X	X	X		X				
Dick Creek	X	X		X	X	X		X				
Douglas Creek		X	X	X	X	X	X	X				
Dry Creek												
Dunham Creek					X							

Appendix F. Table of Potential Restoration Projects

Stream Name	Road Crossings	Irrigation Impacts	Channel alterations	Lacks Complexity	Riparian vegetation	Instream flow	Road drainage	Feedlots, Grazing	Recreation Impacts	Whirling Disease	Mining	Residential
East Twin Creek												
Elk Creek	X	X	X	X	X	X	X	X			X	
Finn Creek		X		X		X		X				
Fish Creek		X	X									
Frazier Creek		X	X			X		X				
Frazier Creek, north fork			X			X		X				
Gallagher Creek	X							X				
Game Creek	X							X				
Gleason Creek	X										X	
Gold creek							X		X	X		
Grantier Spring Creek												
Hogum Creek	X				X			X				
Hoyt Creek				X	X							
Humbug Creek		X	X		X	X		X				
Indian Creek				X								
Jefferson Creek	X		X	X		X					X	
Johnson Creek												
Keep Cool Creek								X				
Kleinschmidt Creek	X		X	X	X			X		X		
Landers Fork			X	X	X	X			X			
Lincoln Spring Creek	X			X	X							X
Lodgepole Creek												
McElwain Creek	X	X			X	X	X	X				
McCabe Creek					X							
Mitchell Creek	X			X				X				
Monture Creek			X	X	X			X	X	X		
Moose Creek	X											
Murray Creek	X	X		X	X	X	X	X				
Nevada Creek		X	X	X	X	X		X				
Nevada Spring Creek		X	X	X	X			X				
North Fork Blackfoot River			X	X	X	X			X	X		
Pearson Creek				X	X		X					
Poorman Creek	X	X	X	X	X	X	X	X			X	
Rock Creek	X	X	X	X	X	X		X		X		

Appendix F. Table of Potential Restoration Projects

Stream Name	Road Crossings	Irrigation Impacts	Channel alterations	Lacks Complexity	Riparian vegetation	Instream flow	Road drainage	Feedlots, Grazing	Recreation Impacts	Whirling Disease	Mining	Residential
Salmon Creek		X		X		X						
Seven up Pete Creek											X	
Sauerkraut Creek	X		X	X	X			X			X	
Shanley Creek		X			X			X				
Sheep Creek						X		X				
Shingle Mill Creek		X						X				
Spring Creek (upper Cottonwood)		X	X		X	X						
Spring Creek (North Fork)						X						
Strickland Creek				X	X			X				
Sturgeon Creek			X		X	X		X				
Union Creek	X	X		X	X	X		X				
Wales Creek		X	X			X		X				
Ward Creek				X	X			X				
Warm Springs Creek	X	X				X	X					
Warren Creek	X	X	X	X	X	X		X		X		
Washington Creek		X	X	X				X			X	
Washoe Creek				X				X				
Wasson Creek			X	X	X	X		X				
Wilson Creek	X	X				X						
West Twin Creek												
Willow Creek (above Lincoln)					X			X				
Willow Creek (below Lincoln)		X			X	X		X				
Yourname Creek		X	X	X	X	X		X				

Appendix G. Table of Restoration Streams and Cooperators through 2001

Stream Name	FWP	USFWS	BLM	NRCS	USFS	MDT	DNRC	NPCD	BBCTU	Private Landowners	Chutney Foundation	National F & W Found.	MPC	Plum Creek
Alice Creek														
Arkanas Creek														
Arrastra Creek														
Ashby Creek														
Bartlett Creek														
Bear Creek (lower River)	X	X		X			X		X	X			X	X
Bear Creek (middle River)														
Bear Creek (North Fork)														
Beaver Creek		X							X	X				
Belmont Creek	X								X					X
Black Bear Creek														
Blackfoot River(mouth to Clearwater)														X
Blackfoot River(Clearwater to N.F)	X	X							X	X				
Blackfoot River(NF to Lincoln)	X	X							X	X				
Blackfoot River(Lincoln to Headwaters)														
Blanchard Creek	X	X	X				X		X	X				
Buffalo Gulch														
Burnt Bridge Creek														
California Gulch														
Camas Creek														
Chamberlain Creek	X	X	X						X	X		X		X
Chamberlain Creek, east fork	X	X	X											X
Chamberlain Creek, west fork			X											X
Chicken Creek														
Chimney Creek (trib to Douglas)														
Chimney Creek (Nevada drain.)														
Clear Creek														
Copper Creek														
Cottonwood Creek (lower trib.)	X	X	X				X		X	X				
Cottonwood Creek (Nevada drain.)		X												
Dick Creek	X	X		X					X	X				X
Douglas Creek	X	X		X				X	X	X				
Dry Creek														

Appendix G. Table of Restoration Streams and Cooperators through 2001

Stream Name	FWP	USFWS	BLM	NRCS	USFS	MDT	DNRC	NPCD	BBCTU	Private Landowners	Chutney Foundation	National F & W Found.	MPC	Plum Creek
Dunham Creek	X	X			X				X	X				
Elk Creek	X	X	X						X	X		X		
East Twin Creek	X					X								X
Finn Creek														
Fish Creek														
Frazier Creek														
Frazier Creek, north fork														
Gallagher Creek														
Game Creek														
Gleason Creek														
Gold creek	X	X	X				X		X	X			X	X
Grantier Spring Creek	X	X							X	X				
Hoyt Creek	X	X							X	X				
Humbug Creek														
Indian Creek														
Jefferson Creek														
Johnson Creek	X	X							X	X			X	
Keep Cool Creek														
Kleinschmidt Creek	X	X				X			X	X	X	X		
Lincoln Spring Creek														
Lodgepole Creek														
Mitchell Creek														
McElwain Creek	X	X							X	X				
McCabe Creek	X	X		X	X	X			X	X			X	
Monture Creek	X	X		X	X				X	X		X		
Moose Creek														
Murray Creek														
Nevada Creek	X	X	X	X				X	X	X		X		
Nevada Spring Creek	X	X		X				X	X	X				
North Fork Blackfoot River	X	X					X		X	X	X	X		X
Pearson Creek	X	X	X						X	X				X
Poorman Creek														
Rock Creek	X	X				X	X	X	X	X	X	X	X	

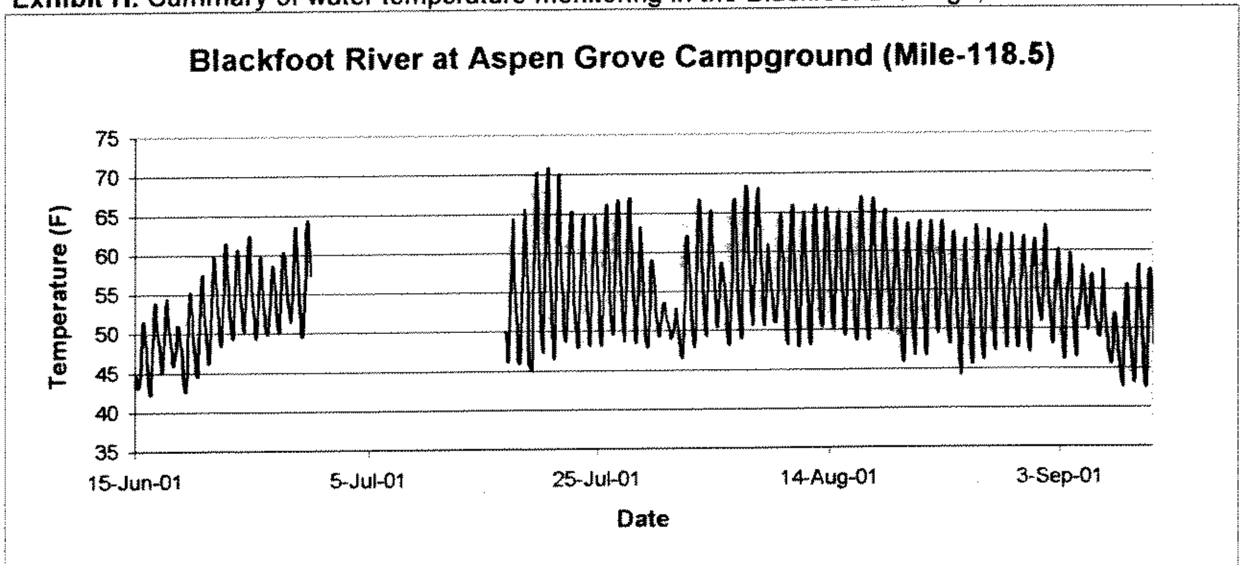
Appendix G. Table of Restoration Streams and Cooperators through 2001

Stream Name	FWP	USFWS	BLM	NRCS	USFS	MDT	DNRC	NPCD	BBCTU	Private Landowners	Chutney Foundation	National F & W Found.	MPC	Plum Creek
Salmon Creek	X	X							X	X	X	X		
Seven up Pete Creek														
Saurekraut Creek Spelling?														
Shanley Creek	X	X							X	X				
Sheep Creek														
Shingle Mill Creek														
Spring Creek (upper Cottonwood)														
Spring Creek (North Fork)	X	X		X			X		X	X				X
Strickland Creek														
Sturgeon Creek														
Union Creek														
Wales Creek														
Ward Creek														
Warm Springs Creek														
Warren Creek	X	X		X				X	X	X	X			X
Washington Creek														
Washoe Creek														
Wasson Creek	X	X		X				X	X	X				
Wilson Creek														
West Twin Creek	X					X								
Willow Creek (above Lincoln)														
Willow Creek (below Lincoln)														
Yourname Creek														

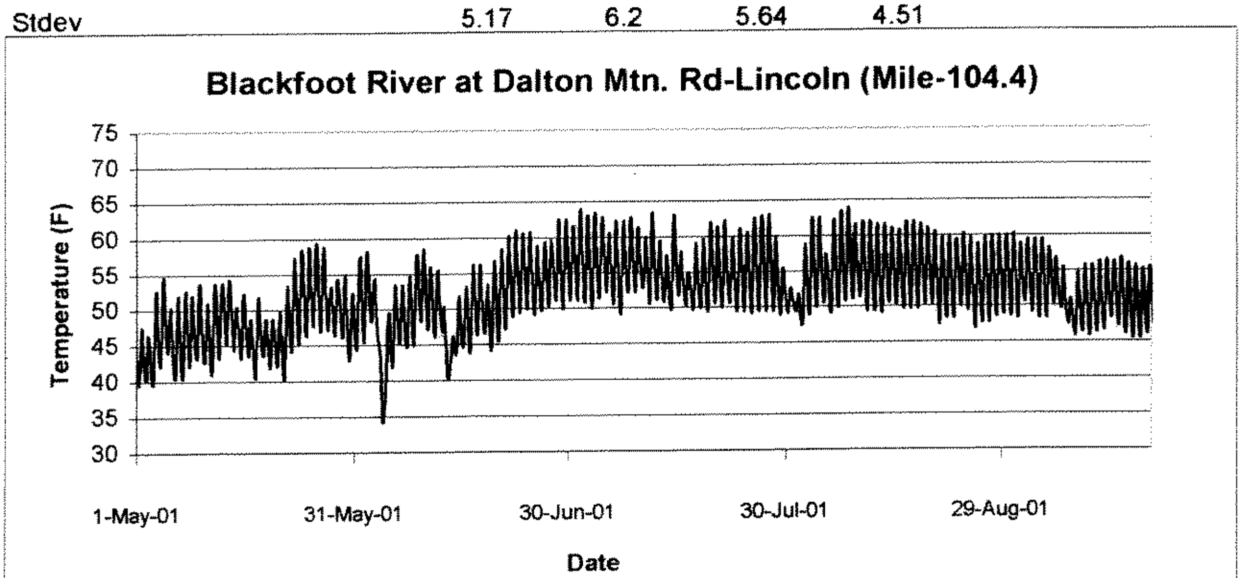
Exhibit H: Summary of water temperature monitroring in the Blackfoot Drainage, 2001

Stream Name	Location (stream mile)	Legal Description	Duration	Sensor Type	Recording Rate
Alice Creek	0.2	15N,7W,27AD	6/15/01-9/11/01	HOBO	72min.
Arrastra Creek	0.1	14N,10W,30A	6/19/01-9/11/01	HOBO	72min.
Bear Creek	1	13N,17W,12A	6/19/01-9/15/01	HOBO	72min.
Beaver Creek	0.2	14N,9W,22A	6/15/01-9/11/01	HOBO	72min.
Belmont Creek	0.1	14N,16W,24C	5/2/01-9/18/01	Tidbit	50min.
Blackfoot River	118.5	14N,7W,7D	6/15/01-9/11/01	HOBO	72min.
Blackfoot River	104.4	14N,9W,28A	5/1/01-9/19/01	Tidbit	50min.
Blackfoot River	71.8	14N,11W,32D	5/1/01-9/19/02	Tidbit	50min.
Blackfoot River	60	14N,12W,28D	5/1/01-9/19/03	Tidbit	50min.
Blackfoot River	45.7	15N,13W,34B	8/1/01-9/19/01	Tidbit	50min.
Blackfoot River	21.9	14N,16W,24C	5/1/01-9/19/01	Tidbit	50min.
Blackfoot River	7.9	13N,17W,9A	5/1/01-9/19/02	Tidbit	50min.
Blanchard Creek	0.1	14N,14W,5D	6/19/01-8/13/01	HOBO	72min.
Buffalo Gulch	0.1	12N,10W18C	7/3/01-9/29/01	HOBO	72min.
Chamberlain Creek	1.8	14N,13W,4A	6/20/01-9/15/01	HOBO	72min.
Clearwater River	0.1	14N,14W,16C	7/21/01-9/14/01	HOBO	72min.
Copper Creek	1.2	15N,8W,25C	5/2/01-9/18/01	Tidbit	50min.
Cottonwood Creek	0.5	15N,13W,29B	6/1/01-9/17/01	HOBO	72min.
Dick Creek	5.3	15N,12W,16A	6/26/01-9/15/01	HOBO	72min.
Dick Creek	0.8	15N,13W,13D	6/21/01-9/15/01	HOBO	72min.
East Twin Creek	0.1	13N,17W,2A	6/20/01-9/16/01	HOBO	72min.
Elk Creek	1	14N,15W,36A	6/20/01-9/15/01	HOBO	72min.
Grentier Spring Creek	0.1	14N,9W,25B	6/15/01-9/10/01	HOBO	72min.
Gold Creek	1.6	14N,16W,31B	5/2/01-9/18/01	Tidbit	72min.
Halfway Creek	0.9	12N,9W,34D	7/3/01-9/30/01	HOBO	72min.
Hoyt Creek	4	15N,12W,28C	8/16/01-9/11/01	HOBO	72min.
Hoyt Creek	1	15N,12W,19C	6/21/01-9/11/01	HOBO	72min.
Jefferson Creek	0.3	12N,9W,21C	7/3/01-9/29/01	HOBO	72min.
Kleinschmidt Creek	1	14N,11W,5C	5/2/01-9/18/01	Tidbit	50min.
Landers Fork	7.1	15N,8W,13A	6/15/01-9/10/01	HOBO	72min.
Landers Fork	4	15N,8W,36B	6/15/01-9/10/01	HOBO	72min.
Landers Fork	1.1	14N,8W,12C	5/2/01-9/18/01	Tidbit	50min.
McCabe Creek	1.3	15N,12W,5C	6/20/01-9/14/01	HOBO	72min.
McCabe Creek	0.1	15N,12W,8C	6/20/01-9/14/01	HOBO	72min.
McElwain Creek	1.3	13N,11W,18C	6/19/01-9/12/01	HOBO	72min.
Mitchell Creek	3	11N,8W,5A	7/3/01-9/29/01	HOBO	72min.
Monture Creek	1.5	15N,13W,22D	5/2/01-9/18/01	Tidbit	50min.
Nevada Creek	45.5	12N,8W,29D	7/3/01-9/29/01	HOBO	72min.
Nevada Creek	39.5	12N,9W,34C	7/4/01-9/29/01	HOBO	72min.
Nevada Creek	33.8	12N,9W,19A	7/3/01-9/29/01	HOBO	72min.
Nevada Creek	0.2	13N,11W,7C	6/20/01-9/12/01	HOBO	72min.
Nevada Spring Creek	3.1	13N,11W,11D	6/22/01-9/17/01	HOBO	72min.
Nevada Spring Creek	3	13N,11W,11D	6/23/01-9/17/01	HOBO	72min.
Nevada Spring Creek	2.7	13N,11W,11B	6/23/01-9/17/01	HOBO	72min.
Nevada Spring Creek	0.8	13N,11W,10B	6/23/01-9/17/01	HOBO	72min.
North Fork	2.5	14N,12W,10D	5/2/01-9/18/01	Tidbit	50min.
Poorman Creek	2	14N,9W,36D	6/15/01-9/10/01	HOBO	72min.
Sauerkraut Creek	0.2	14N,9W,29C	6/19/01-9/11/01	HOBO	72min.
Union Creek	0.1	13N,16W,6C	6/20/01-9/16/01	HOBO	72min.
Wales Creek	0.2	14N,12W,33A	6/19/01-9/11/01	HOBO	72min.
Warren Creek	1.1	15N,12W,31D	6/19/01-9/11/01	HOBO	72min.
Washington Creek	1.9	12N,9W,26C	7/3/01-9/29/01	HOBO	72min.
West Twin Creek	0.1	13N,17W,2B	6/20/01-9/15/01	HOBO	72min.
Willow Creek	1	14N,9W,28A	6/15/01-9/11/01	HOBO	72min.
Yourname Creek	1.8	13N,12W,10B	6/19/01-9/11/01	HOBO	72min.

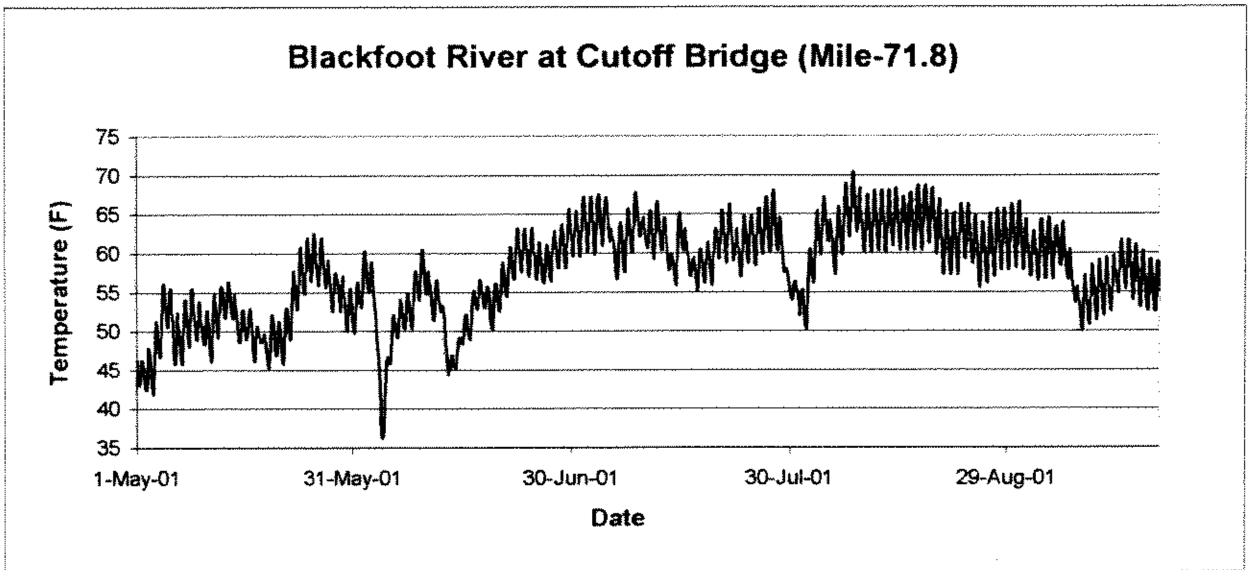
Exhibit H: Summary of water temperature monitoring in the Blackfoot Drainage, 2001



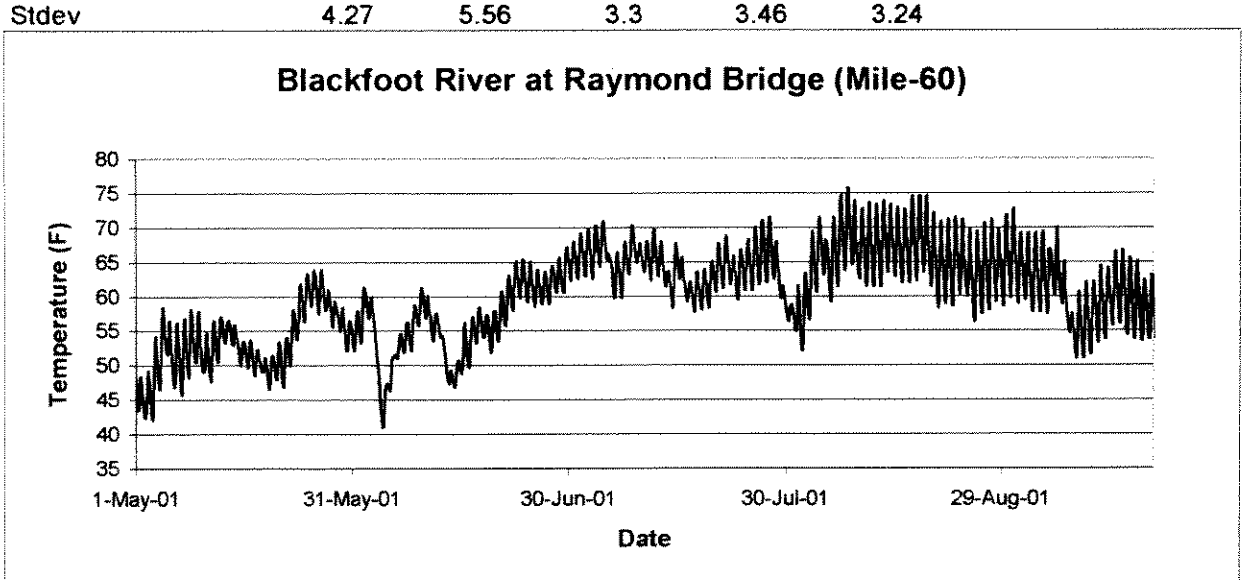
Month	May	June	July	August	September
Monthly Mean	N.A.	52.32	55.16	55.92	51.53
Monthly Max		64.4	70.88	68.51	63.23
Monthly Min		42.21	45	44.18	42.52
Stdev		5.17	6.2	5.64	4.51



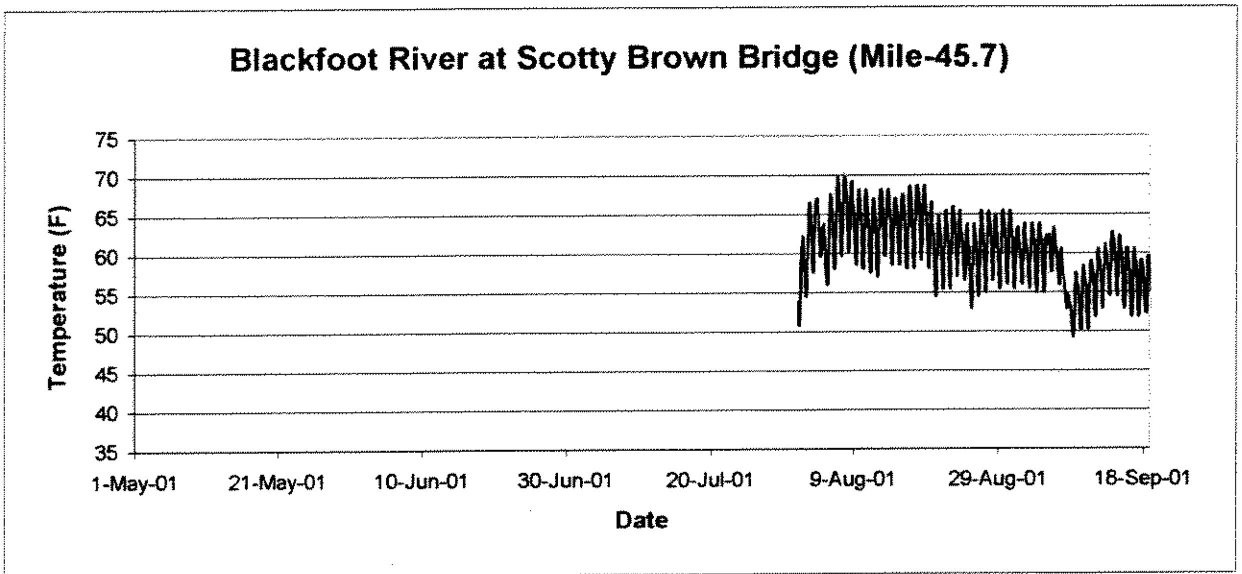
Month	May	June	July	August	September
Monthly Mean	47.98	51.04	55.09	54.85	51.58
Monthly Max	59.43	62.57	64.01	64.01	59.43
Monthly Min	39.52	34.1	48.77	46.83	45.43
Stdev	4.45	5.4	4.02	4.2	3.51



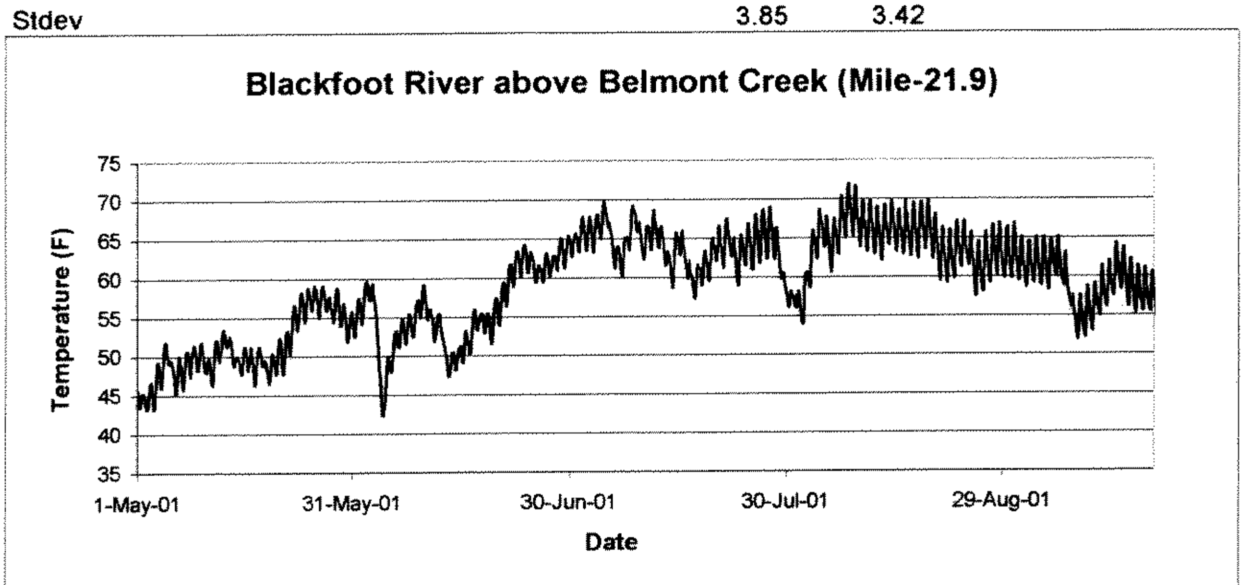
Month	May	June	July	August	September
Monthly Mean	51.83	54.7	61.22	62.68	57.27
Monthly Max	62.61	65.8	68.12	70.49	64.63
Monthly Min	41.83	36.18	51.9	50.22	49.94
Stdev	4.27	5.56	3.3	3.46	3.24



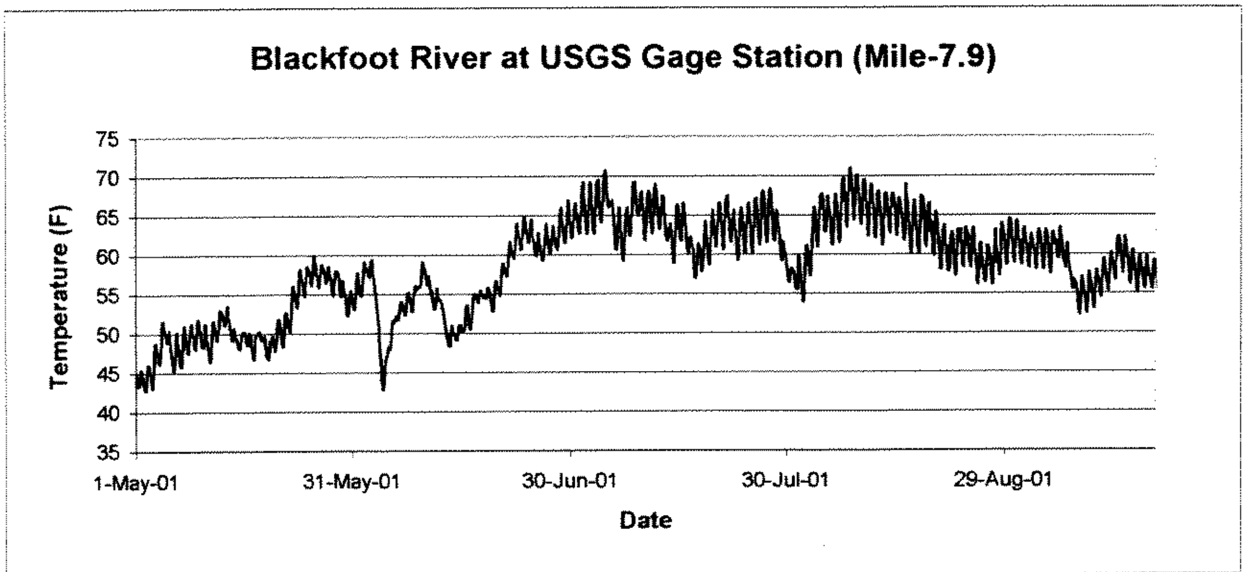
Month	May	June	July	August	September
Monthly Mean	53.28	56.58	63.98	65.83	59.69
Monthly Max	63.95	68.03	71.58	75.85	70.08
Monthly Min	42.05	40.93	54.98	52.11	50.99
Stdev	4.6	5.51	3.42	4.56	4.29



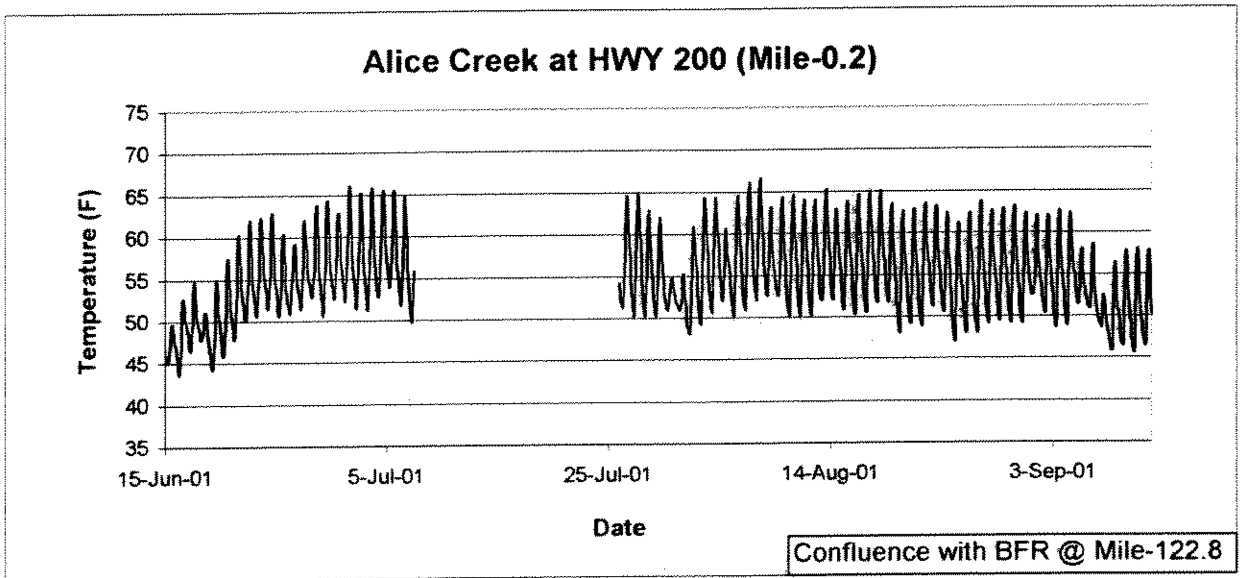
Month	May	June	July	August	September
Monthly Mean	N.A.	N.A.	N.A.	62.2	57.33
Monthly Max				69.81	63.86
Monthly Min				50.76	49.21
Stdev				3.85	3.42



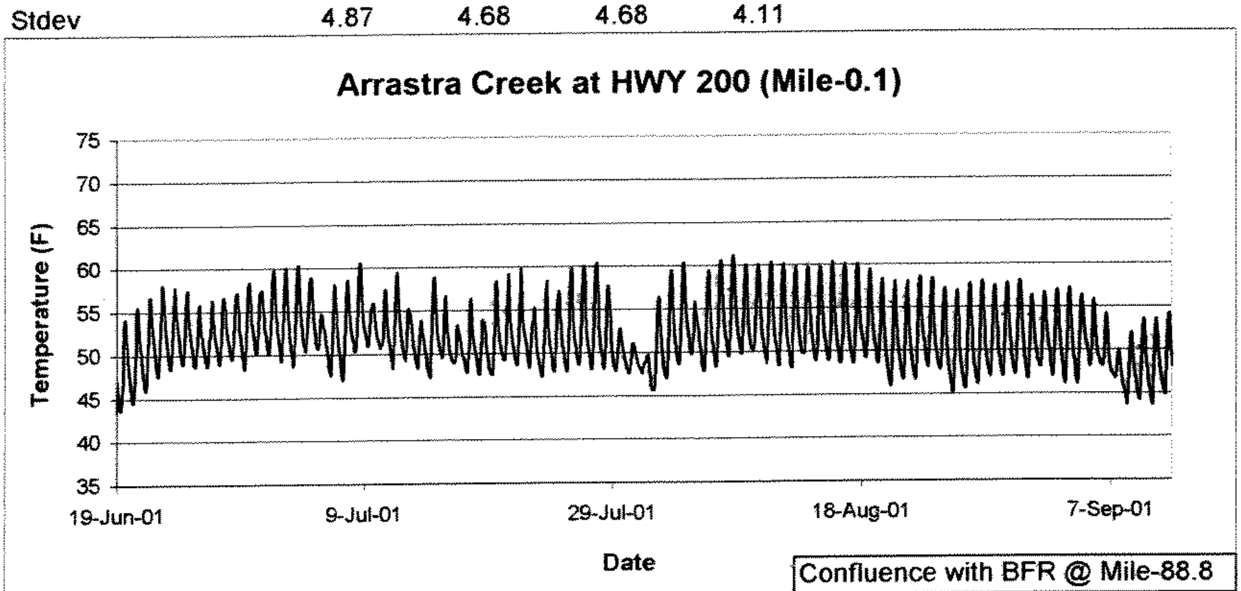
Month	May	June	July	August	September
Monthly Mean	51.14	56.13	63.58	64.42	58.86
Monthly Max	59.12	65.76	69.89	71.98	65.18
Monthly Min	43.13	42.29	56.02	53.78	51.82
Stdev	3.92	5.17	3.06	3.23	3.07



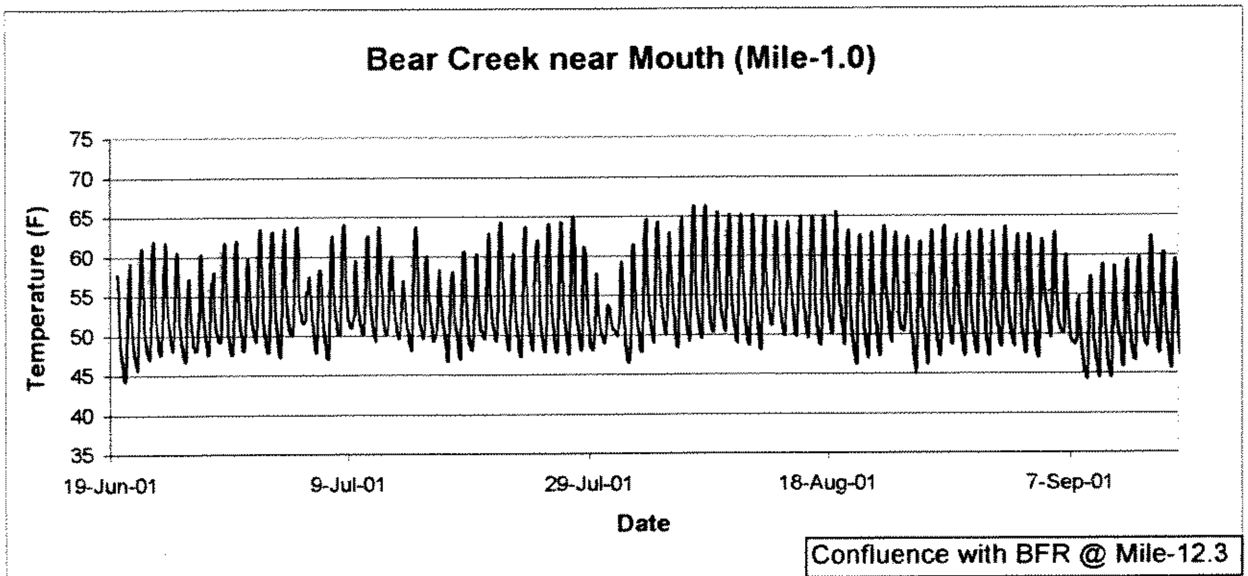
Month	May	June	July	August	September
Monthly Mean	51.07	56.34	63.54	63.03	58.33
Monthly Max	60.02	66.94	70.77	71.07	63.45
Monthly Min	42.69	42.69	55.53	53.85	52.18
Stdev	4.06	5.08	3.18	3.4	2.52



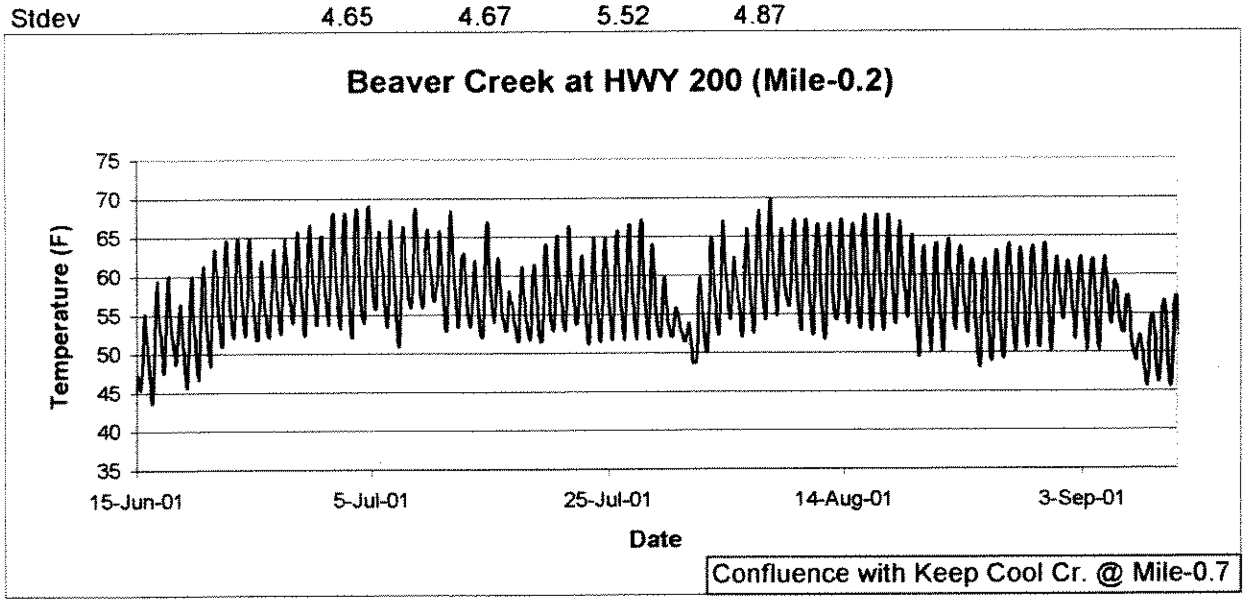
Month	June	July	August	September
Monthly Mean	53.1	56.25	56.03	52.75
Monthly Max	64.38	66.12	66.7	62.65
Monthly Min	43.59	49.72	46.93	45.54
Stdev	4.87	4.68	4.68	4.11



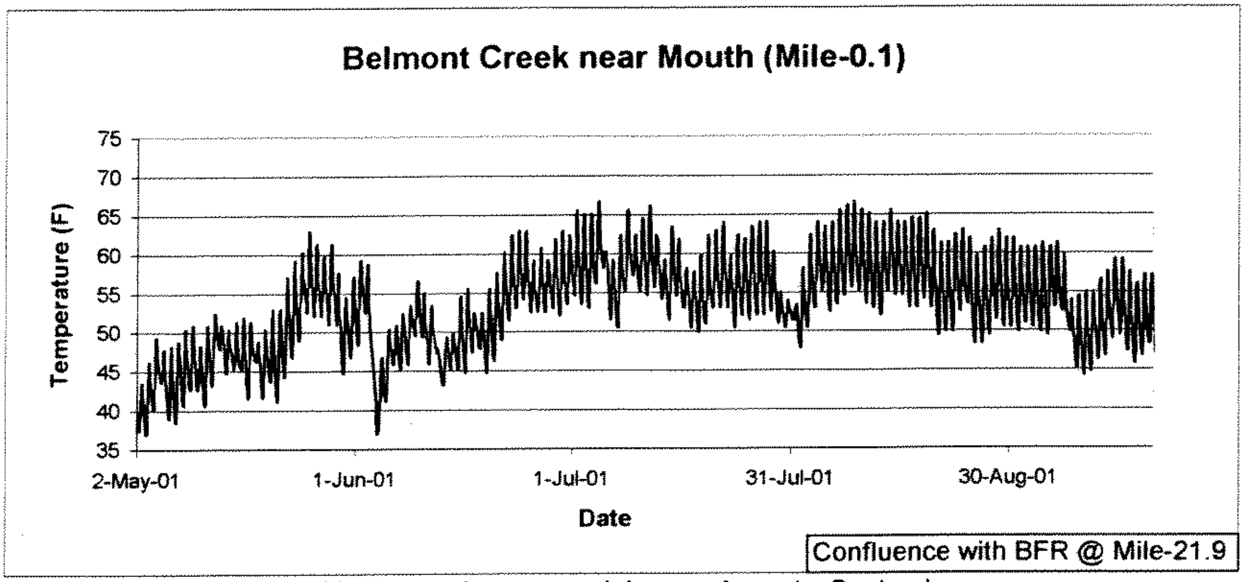
Month	June	July	August	September
Monthly Mean	51.8	52.09	52.33	49.5
Monthly Max	58.37	60.64	61.21	57.52
Monthly Min	43.59	46.93	44.99	43.59
Stdev	3.46	3.31	3.96	3.33



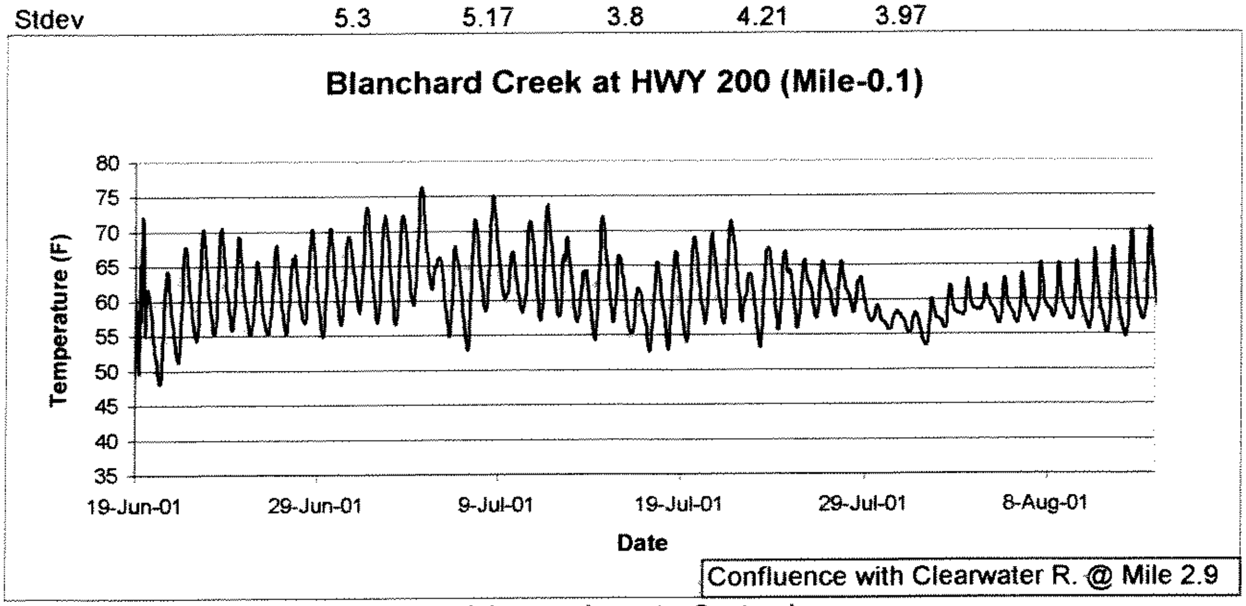
Month	June	July	August	September
Monthly Mean	52.28	53.64	54.74	52.21
Monthly Max	62.07	64.96	66.41	63.51
Monthly Min	44.15	46.65	45.27	44.15
Stdev	4.65	4.67	5.52	4.87



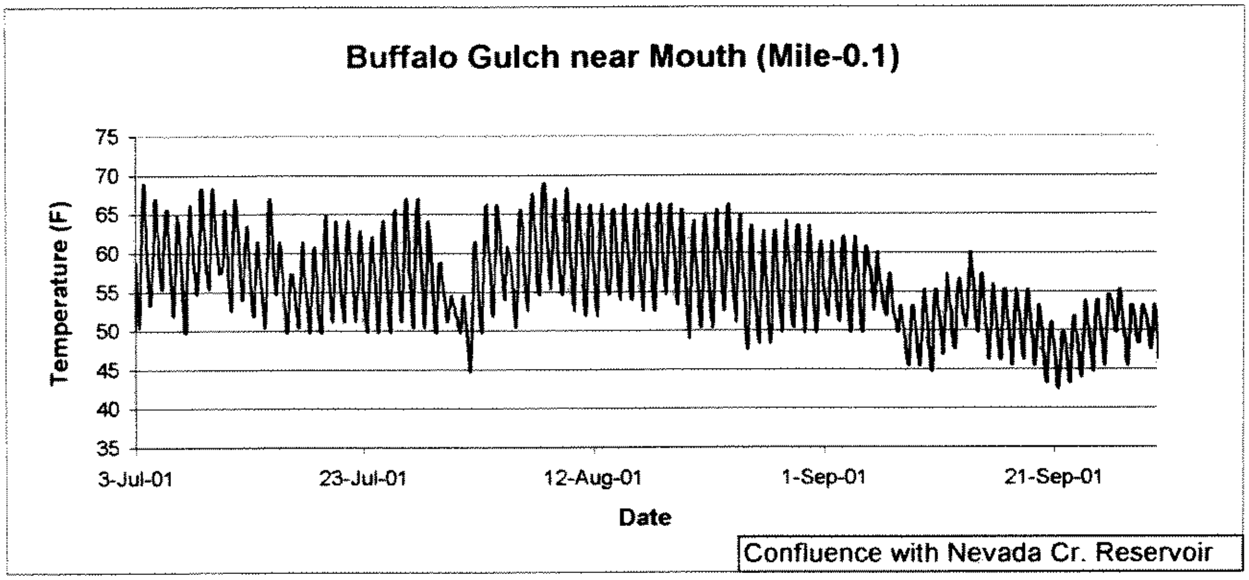
Month	June	July	August	September
Monthly Mean	55.63	58.05	58.27	54.18
Monthly Max	66.7	69.07	69.92	62.36
Monthly Min	43.59	50.84	48.04	45.54
Stdev	5.39	4.79	5.17	4.43



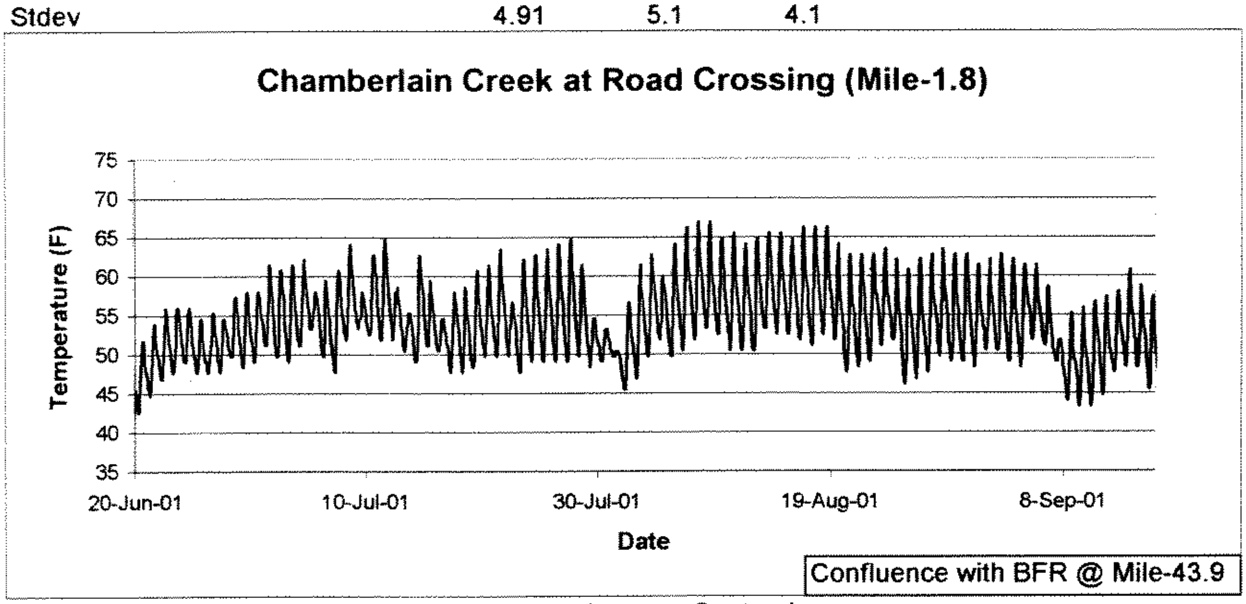
Month	May	June	July	August	September
Monthly Mean	48.21	51.52	56.77	56.99	52.37
Monthly Max	62.97	62.97	66.74	66.74	61.36
Monthly Min	36.86	36.86	49.89	47.82	44.18
Stdev	5.3	5.17	3.8	4.21	3.97



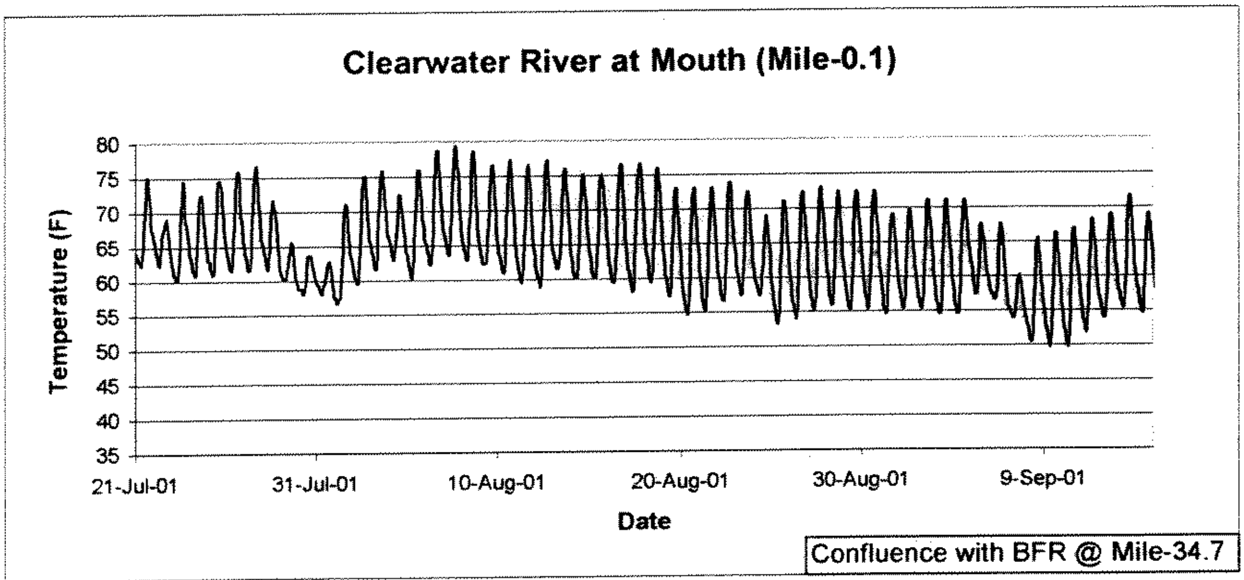
Month	June	July	August	September
Monthly Mean	60.73	61.96	59.59	Dry Channel
Monthly Max	72.08	76.39	71.14	
Monthly Min	48.08	52.55	53.41	
Stdev	5.42	4.97	3.54	



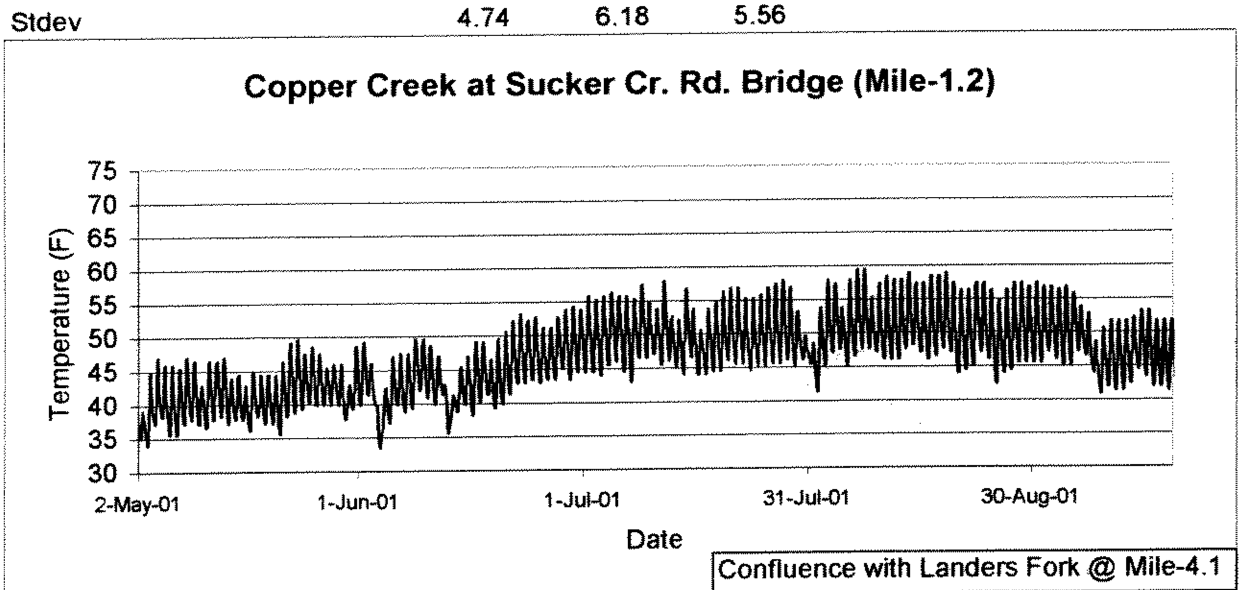
Month	June	July	August	September
Monthly Mean	N.A.	57.53	58.3	51.38
Monthly Max		69.02	69.02	62.17
Monthly Min		49.67	44.65	42.46
Stdev		4.91	5.1	4.1



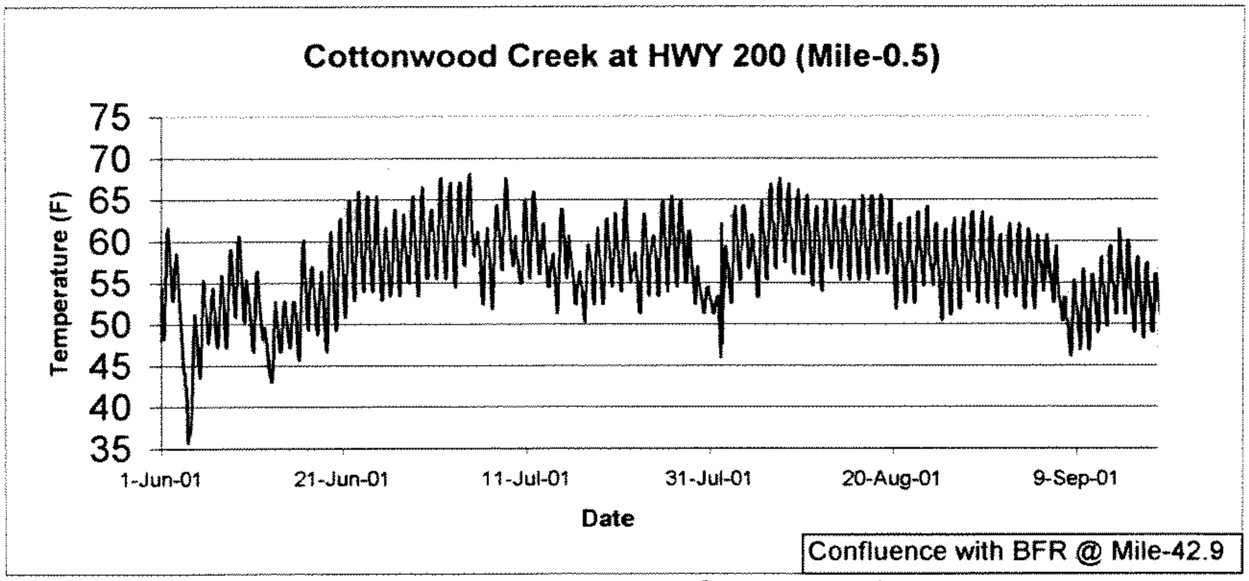
Month	June	July	August	September
Monthly Mean	51.14	54.45	55.98	52.36
Monthly Max	58	64.9	67	62.8
Monthly Min	42.5	47.6	45.4	43.2
Stdev	3.41	3.98	4.84	4.41



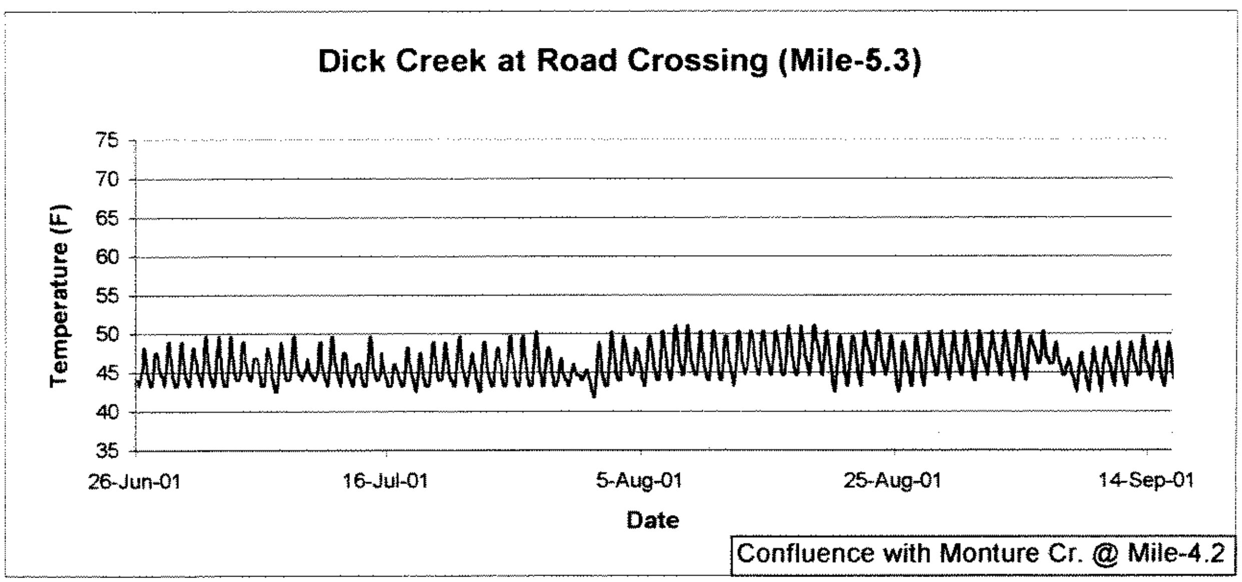
Month	June	July	August	September
Monthly Mean	N.A.	65.01	65.38	60.17
Monthly Max		76.62	79.41	71.77
Monthly Min		58.04	53.19	49.67
Stdev		4.74	6.18	5.56



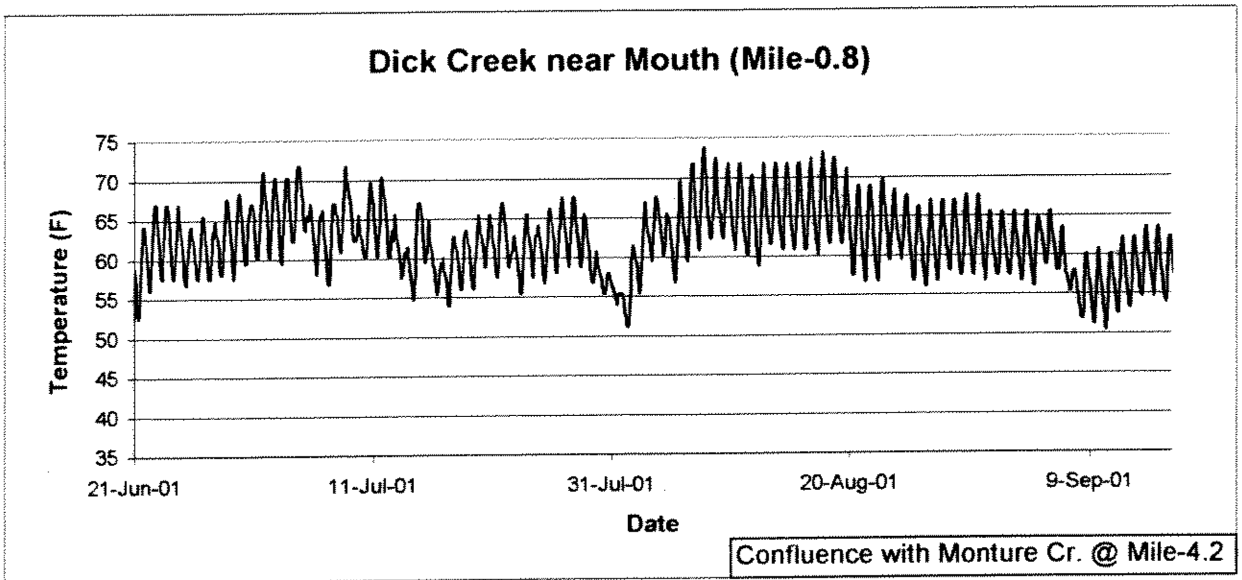
Month	May	June	July	August	September
Monthly Mean	41.29	44.39	49.73	50.95	47.82
Monthly Max	49.46	54.31	57.96	59.53	56.91
Monthly Min	33.92	33.38	42.89	41.33	40.81
Stdev	3.29	4.18	3.54	4.11	3.73



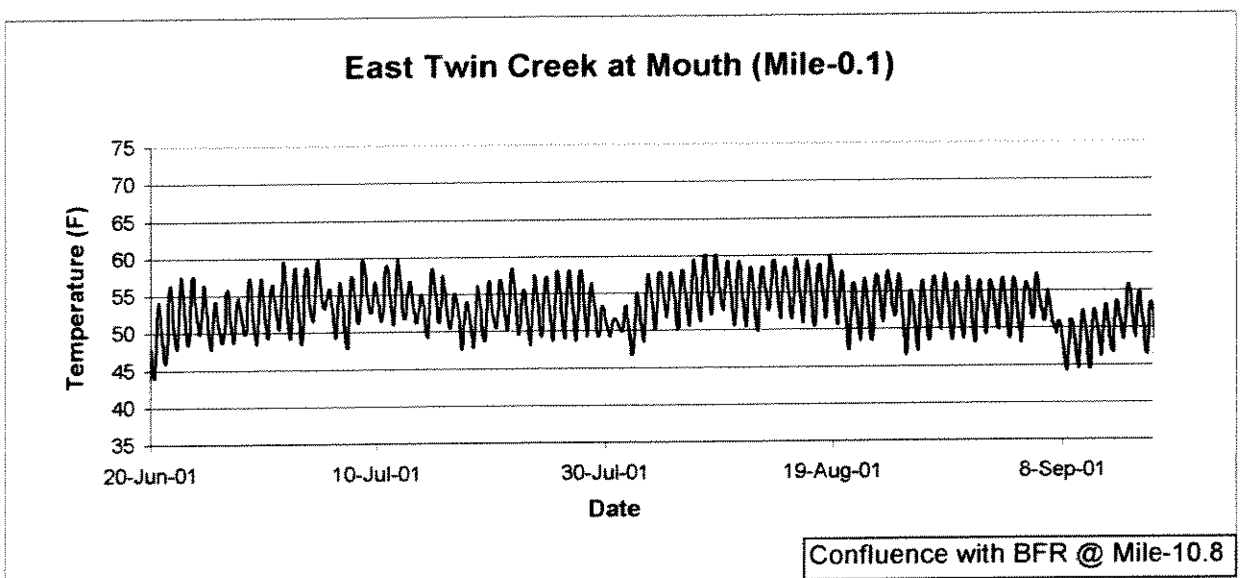
Month	June	July	August	September
Monthly Mean	53.98	58.27	59	54.26
Monthly Max	66.55	68.17	67.65	62.17
Monthly Min	35.63	50.25	46.1	46.1
Stdev	5.85	3.99	3.85	3.49



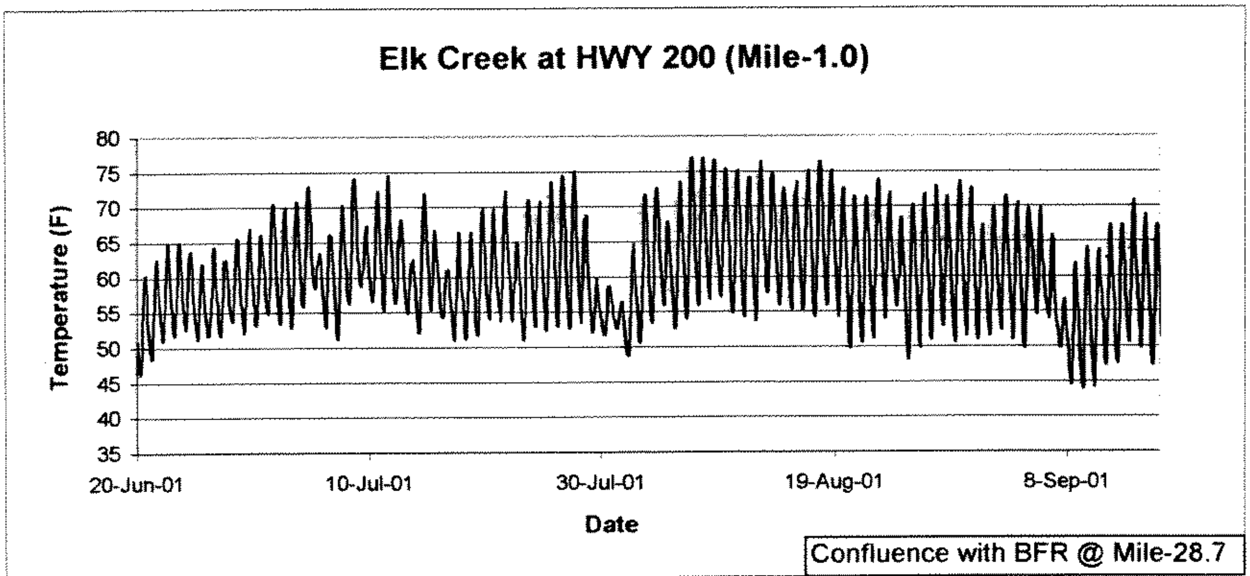
Month	June	July	August	September
Monthly Mean	45.48	45.4	46.78	46.33
Monthly Max	48.96	50.38	51.06	50.38
Monthly Min	43.19	42.46	41.72	42.46
Stdev	1.81	1.89	2.23	1.89



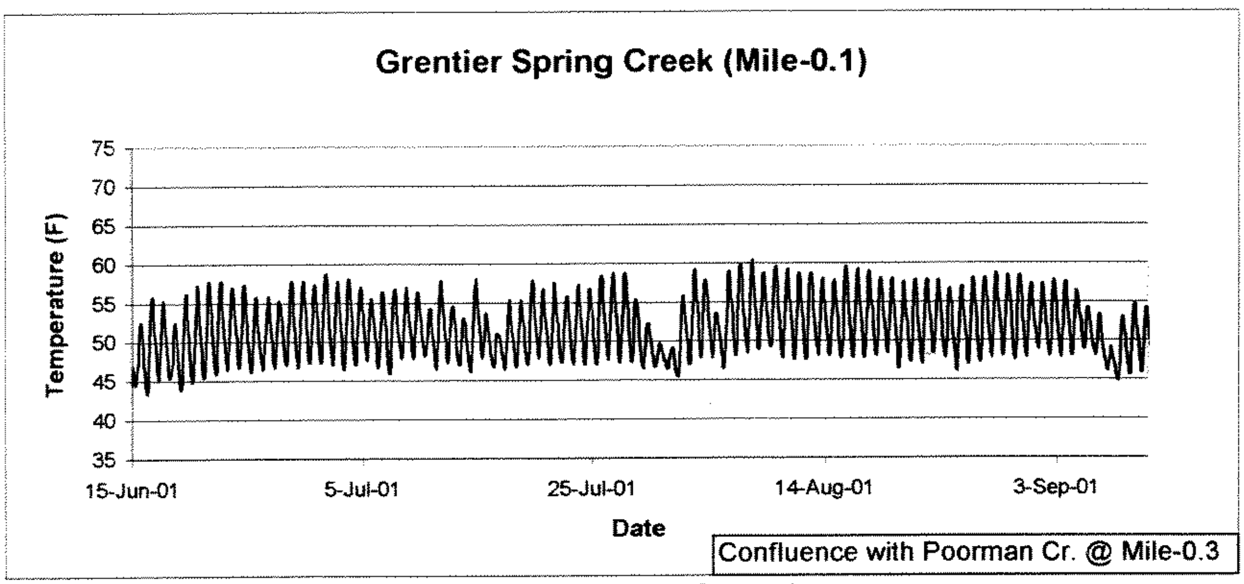
Month	June	July	August	September
Monthly Mean	61.75	62.07	63.82	58.52
Monthly Max	68.4	71.8	73.9	65.6
Monthly Min	52.5	53.9	51.1	50.4
Stdev	3.59	3.99	4.35	3.55



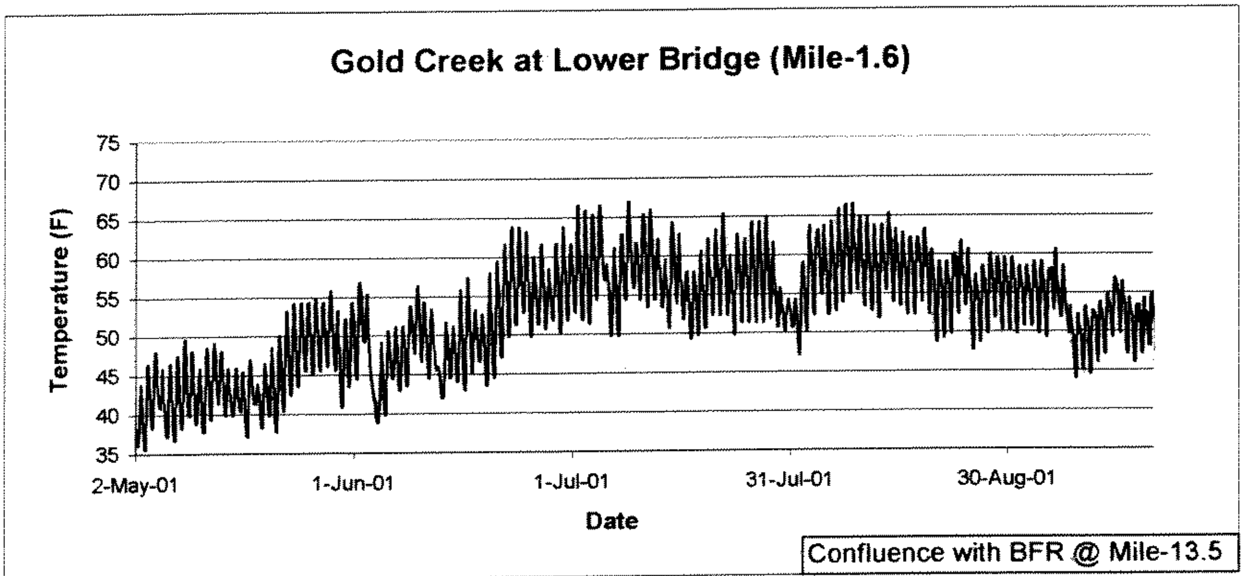
Month	June	July	August	September
Monthly Mean	51.9	53.4	54.06	51.17
Monthly Max	57.56	59.83	60.14	57.31
Monthly Min	43.89	47.54	46.42	44.18
Stdev	3.24	2.96	3.19	3.07



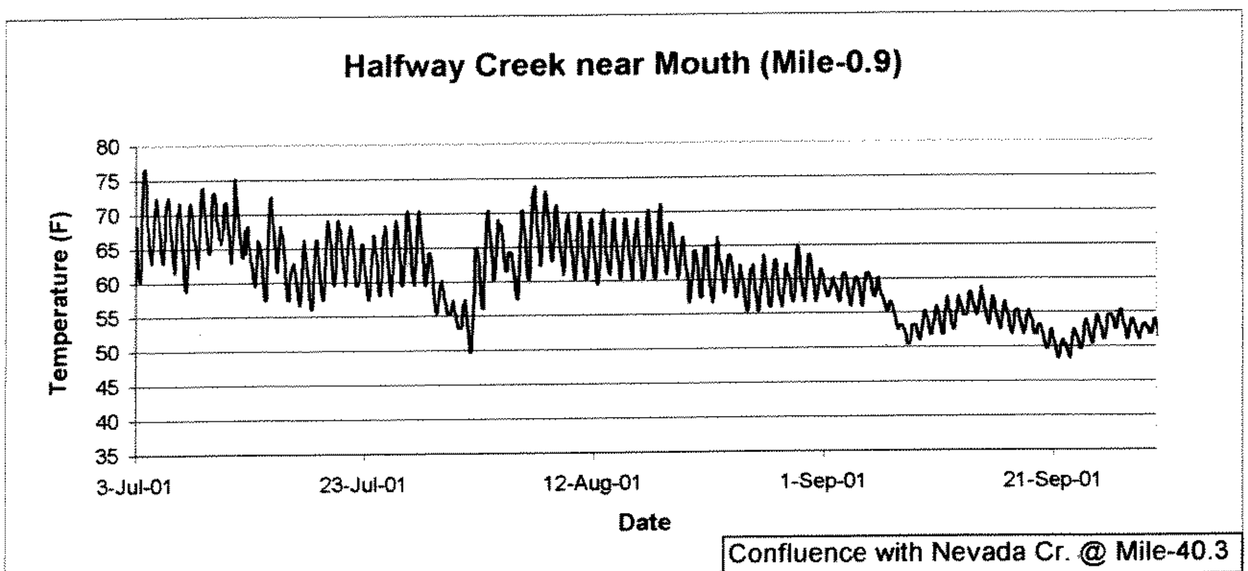
Month	June	July	August	September
Monthly Mean	57.18	60.7	62.83	57.53
Monthly Max	67.04	75.12	77	71.49
Monthly Min	46.12	50.88	48.08	43.89
Stdev	4.91	5.96	7.2	6.86



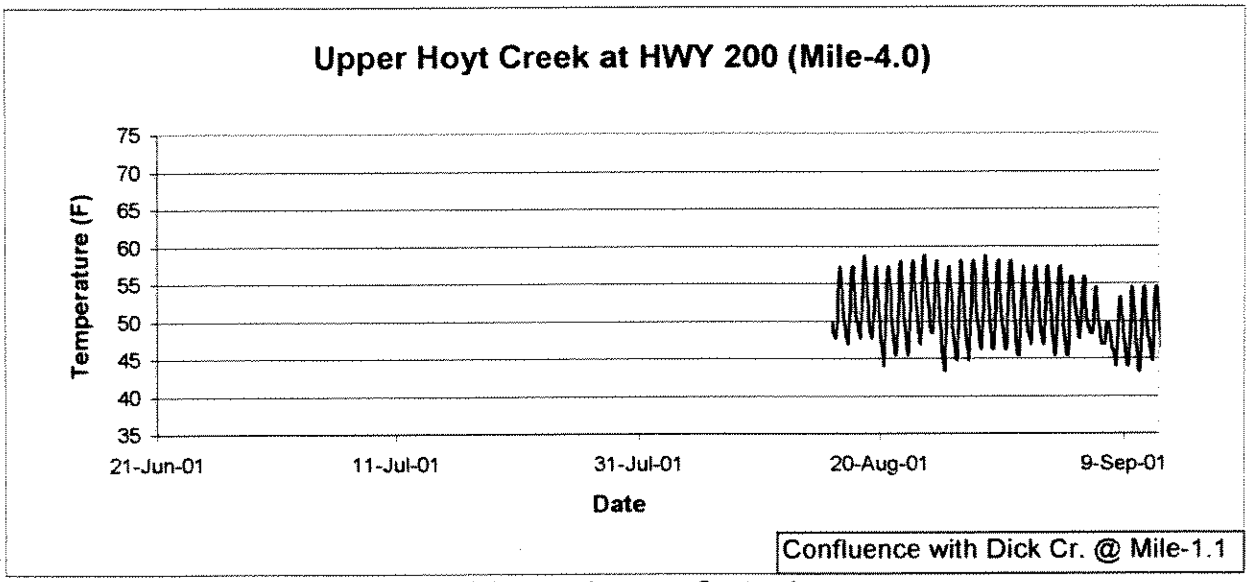
Month	June	July	August	September
Monthly Mean	50.7	51.33	52.77	50.8
Monthly Max	57.87	58.7	60.4	57.87
Monthly Min	43.32	45.87	45.31	44.75
Stdev	3.91	3.4	3.77	3.23



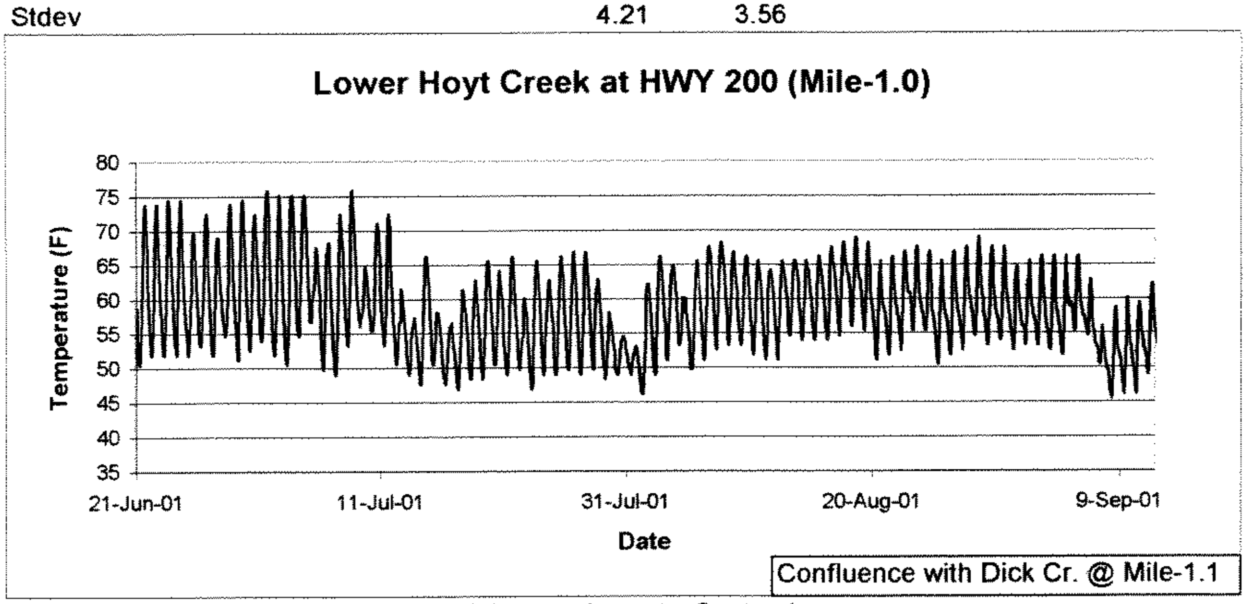
Month	May	June	July	August	September
Monthly Mean	44.66	50.9	56.93	57.17	52.28
Monthly Max	55.9	63.81	67.04	66.5	60.61
Monthly Min	35.57	38.75	49.17	47.09	43.96
Stdev	4.63	5.49	4.12	3.98	3.41



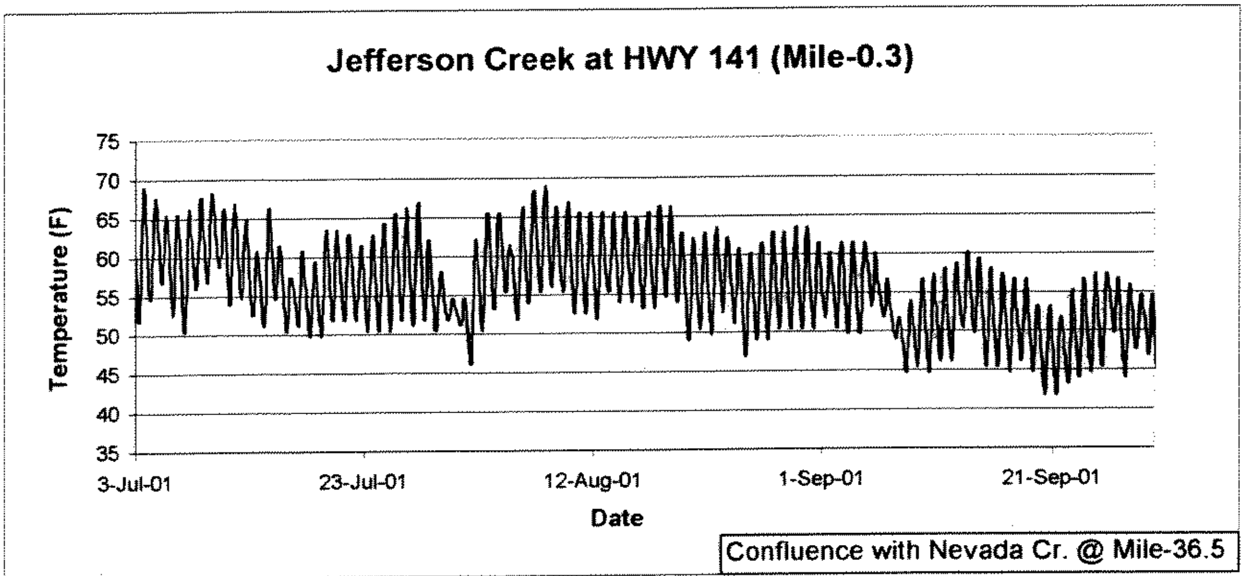
Month	June	July	August	September
Monthly Mean	N.A.	63.92	62.7	54.14
Monthly Max		76.62	73.84	60.8
Monthly Min		53.19	49.67	48.25
Stdev		4.92	4.24	2.87



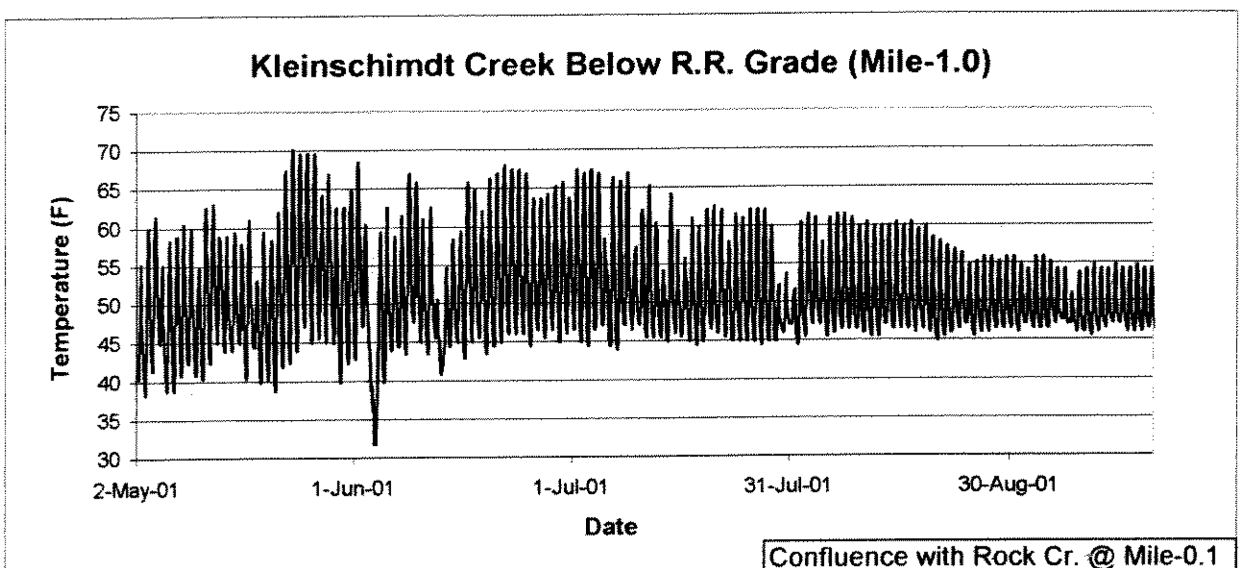
Month	June	July	August	September
Monthly Mean	N.A.	N.A.	51.52	49.9
Monthly Max			58.73	57.35
Monthly Min			43.19	43.19
Stdev			4.21	3.56



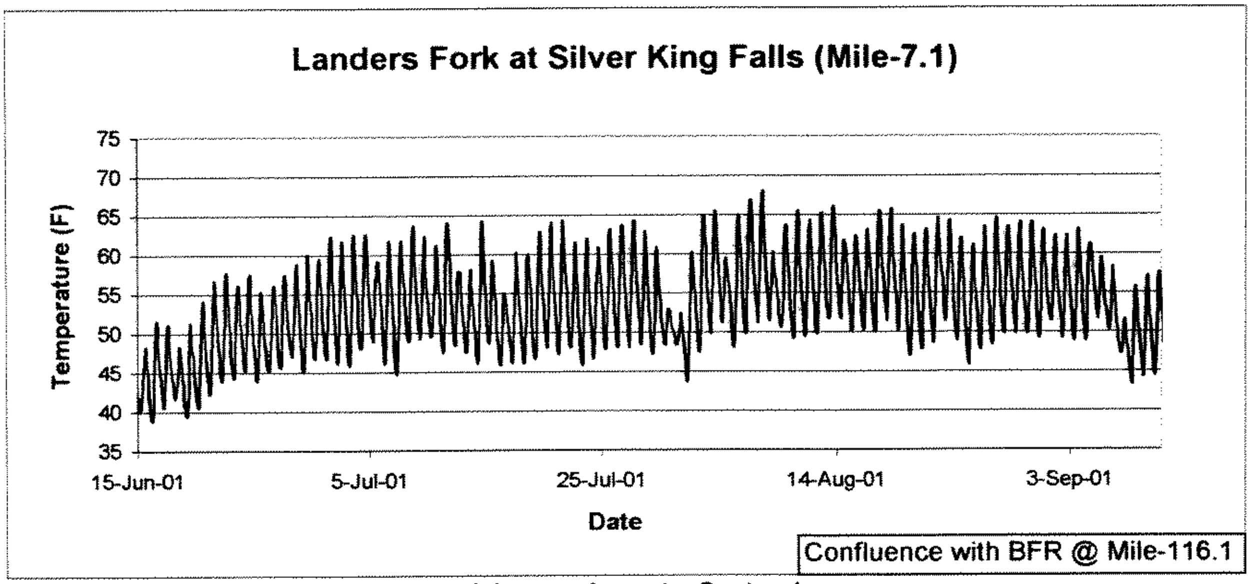
Month	June	July	August	September
Monthly Mean	61.67	57.79	59.42	55.28
Monthly Max	74.53	75.92	69.02	66.28
Monthly Min	50.38	46.82	59.42	45.38
Stdev	7.35	6.8	4.93	4.75



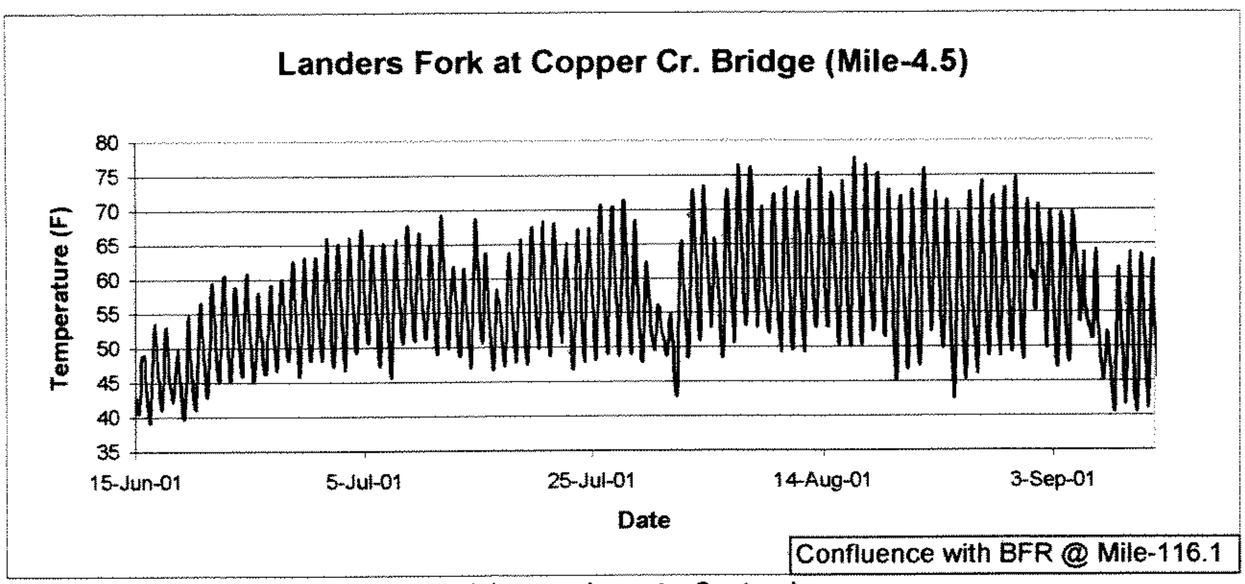
Month	June	July	August	September
Monthly Mean	N.A.	57.81	58	51.58
Monthly Max		69.02	69.02	61.48
Monthly Min		49.67	46.1	40.97
Stdev		4.78	4.86	4.48



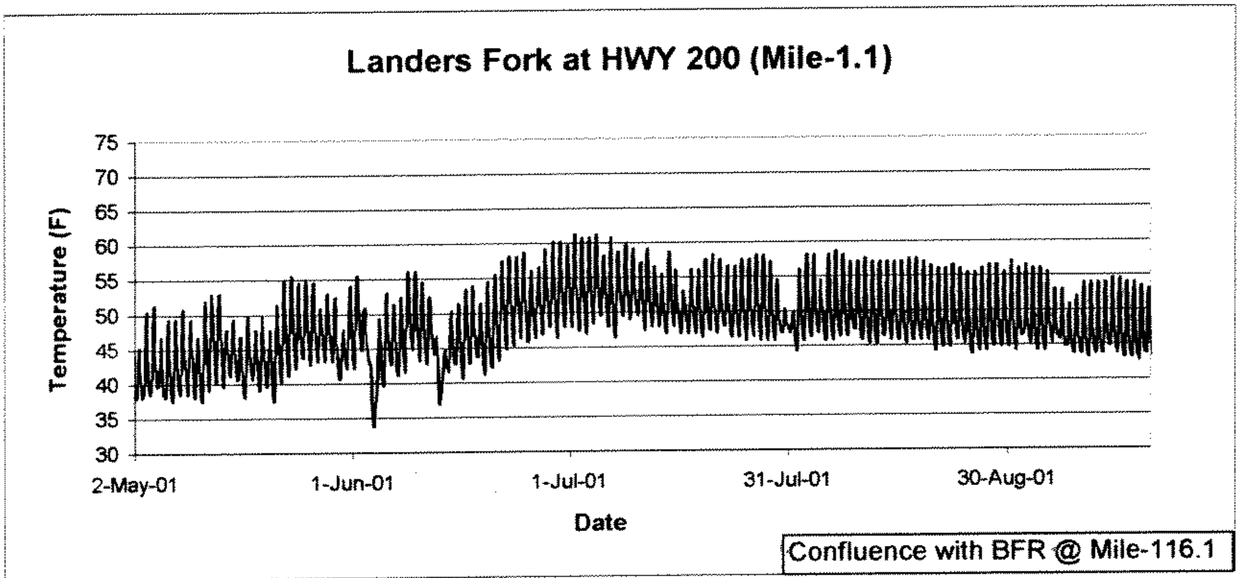
Month	May	June	July	August	September
Monthly Mean	50.99	52.01	51.81	50.99	49.27
Monthly Max	70.2	68.55	67.46	61.55	55.79
Monthly Min	38.11	31.7	43.85	44.37	45.41
Stdev	7.41	7.61	6.06	4.61	2.8



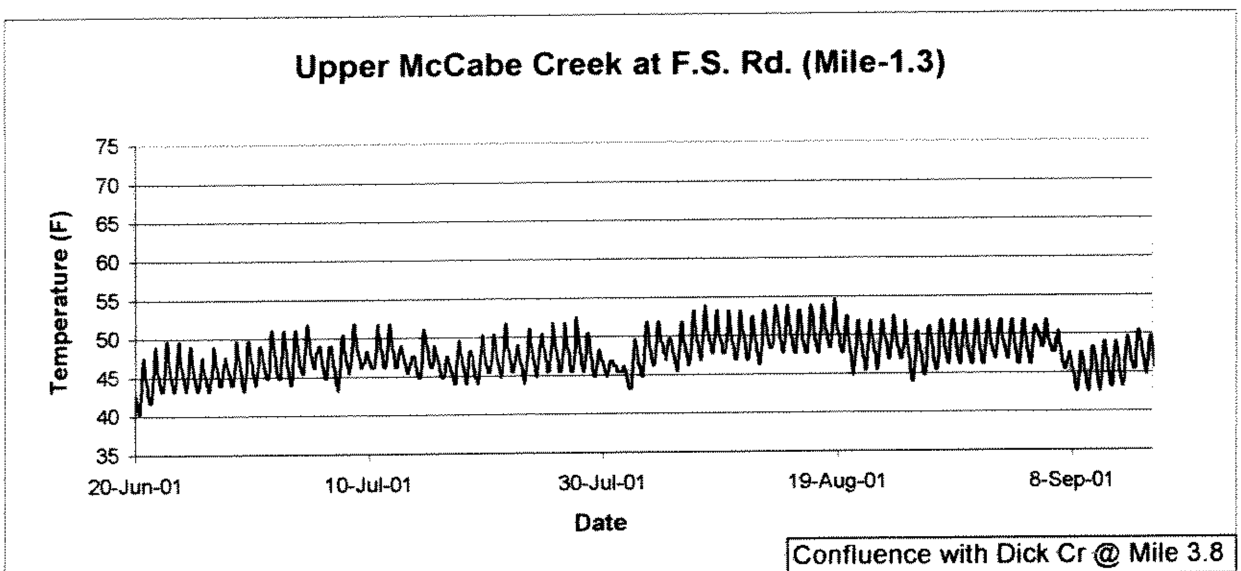
Month	June	July	August	September
Monthly Mean	48.44	53.64	56.11	52.75
Monthly Max	60.07	64.38	68.15	63.22
Monthly Min	38.81	44.71	43.59	43.31
Stdev	5.13	4.99	5.18	4.68



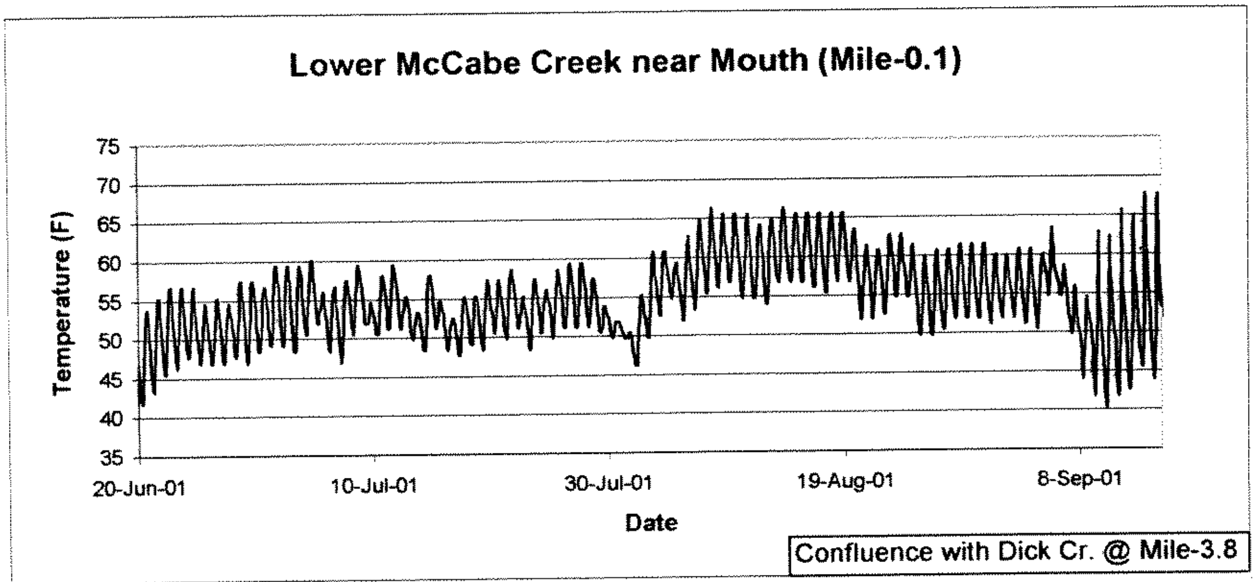
Month	June	July	August	September
Monthly Mean	50.21	56.57	60.34	54.59
Monthly Max	63.22	71.42	77.55	70.82
Monthly Min	39.09	45.54	42.46	40.5
Stdev	5.92	6.22	8.42	7.68



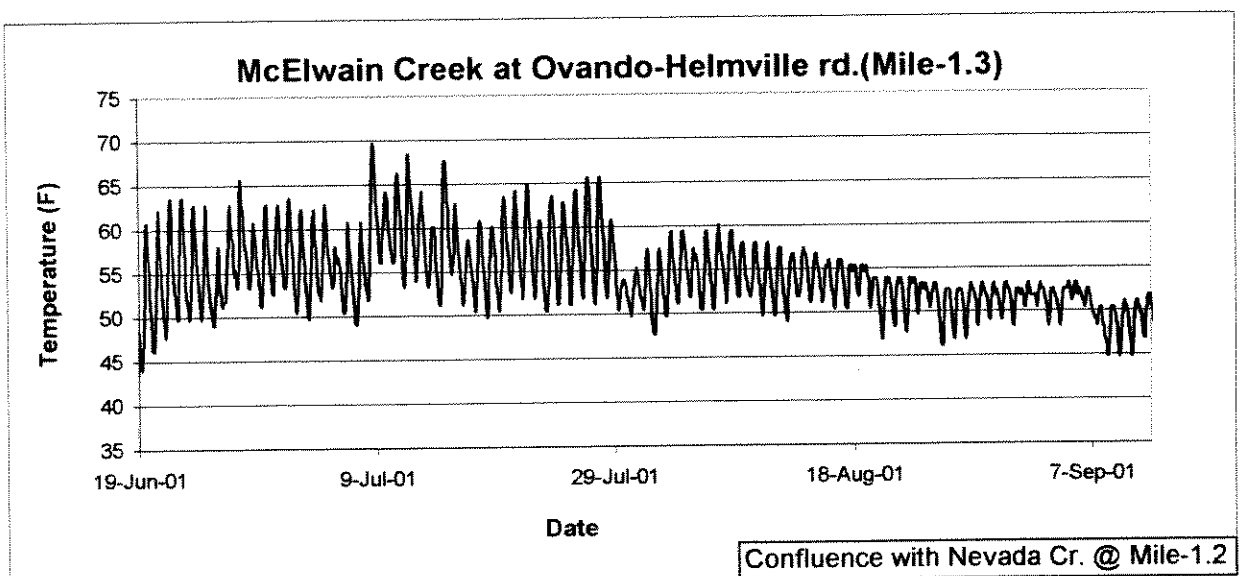
Month	May	June	July	August	September
Monthly Mean	44.58	48.03	51.5	49.85	47.55
Monthly Max	55.59	60.29	61.35	58.72	56.63
Monthly Min	37.39	33.66	45.74	43.66	42.62
Stdev	4.28	5.16	3.84	4.05	3.49



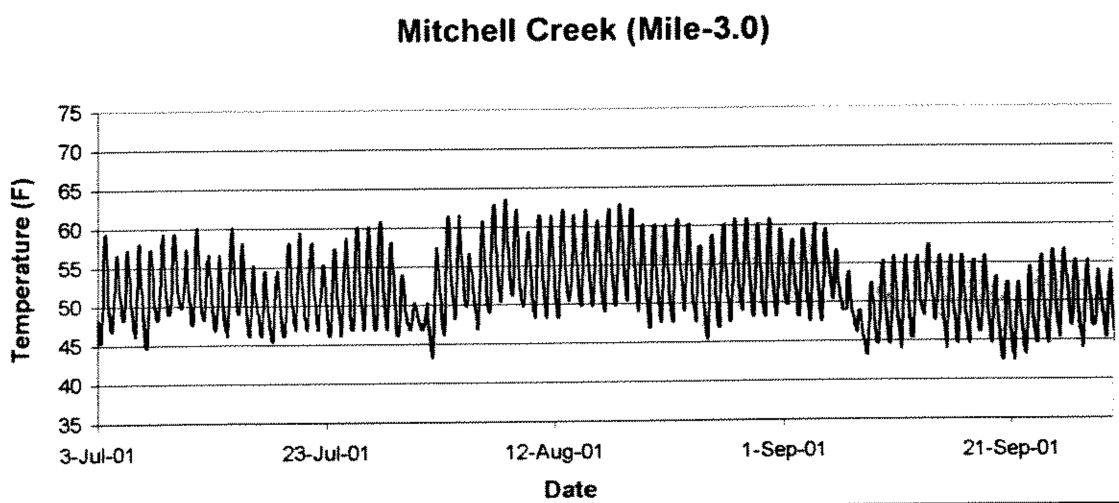
Month	June	July	August	September
Monthly Mean	45.49	47.23	48.99	47.29
Monthly Max	49.7	52.5	54.6	51.8
Monthly Min	40.2	43.2	43.2	42.5
Stdev	2.18	1.92	2.31	2.3



Month	June	July	August	September
Monthly Mean	50.97	53.41	58.09	53.24
Monthly Max	57.4	60.1	66.3	67.7
Monthly Min	41.7	46.8	46.1	40.2
Stdev	3.78	2.97	4.26	5.35

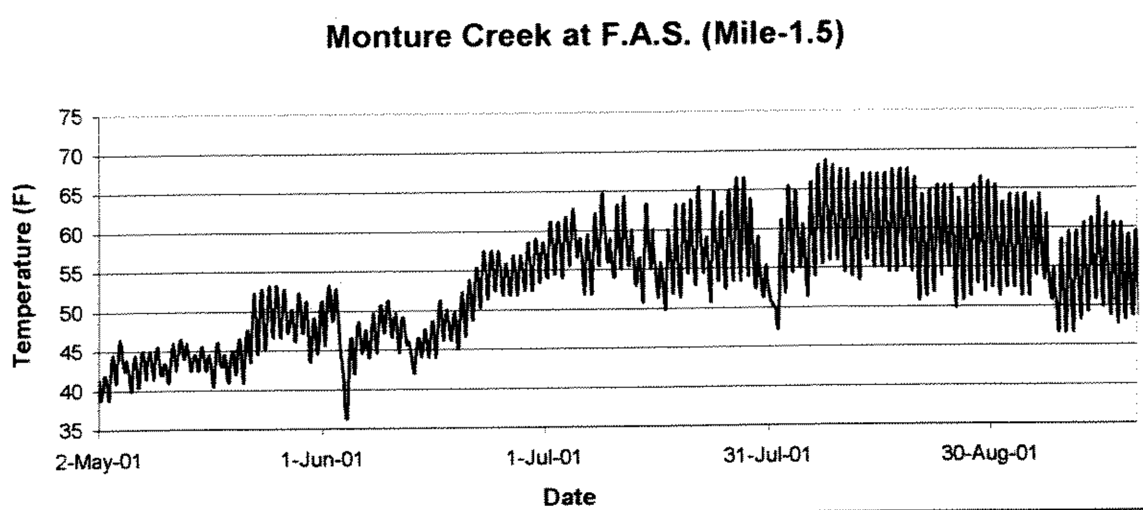


Month	June	July	August	September
Monthly Mean	55.18	56.8	53.04	50.32
Monthly Max	65.6	69.7	60.1	53.2
Monthly Min	43.9	49	46.1	44.7
Stdev	4.72	4.4	2.74	2.09



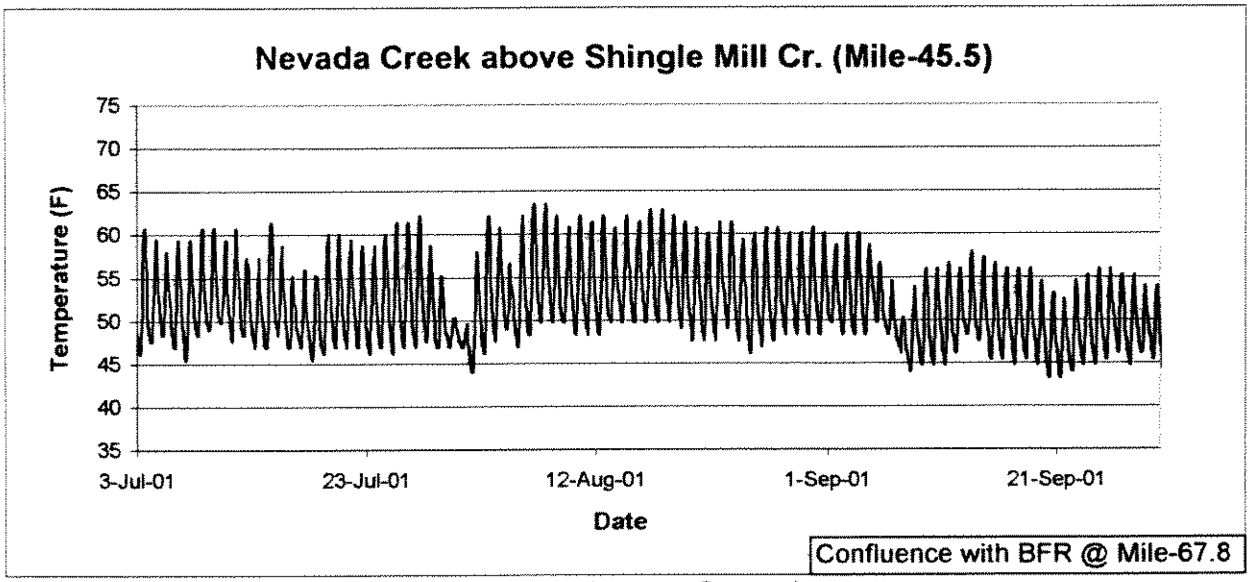
Confluence with Nevada Cr. @ Mile-43.2

Month	June	July	August	September
Monthly Mean	N.A.	51.4	54.04	50.04
Monthly Max		60.8	63.54	60.11
Monthly Min		44.65	43.19	42.46
Stdev		3.94	4.48	3.9

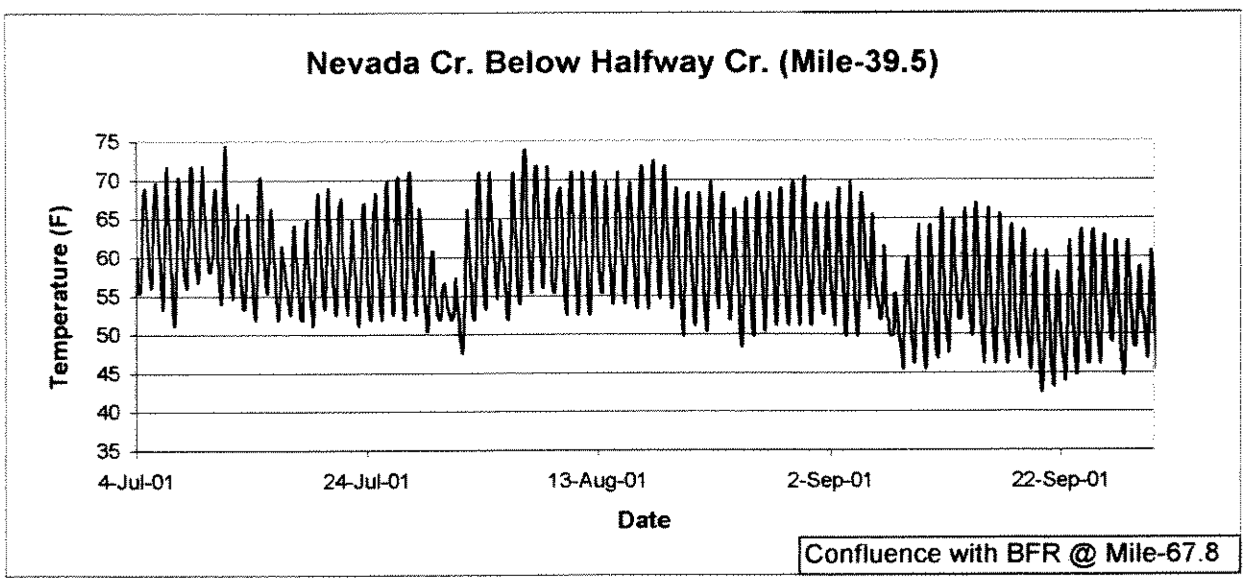


Confluence with BFR @ Mile-45.9

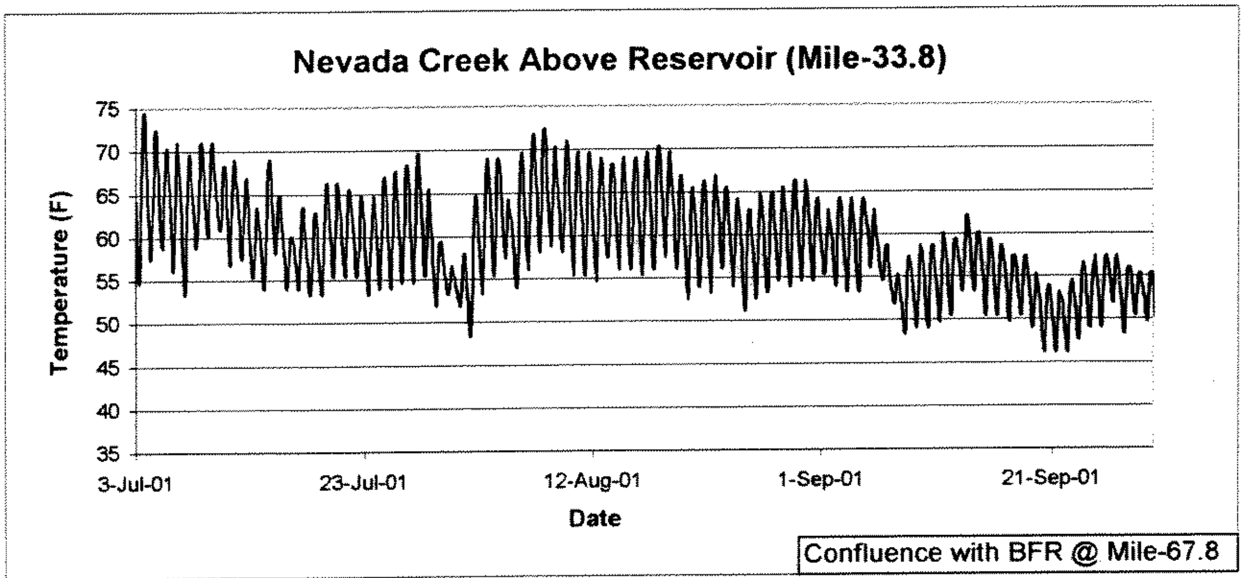
Month	May	June	July	August	September
Monthly Mean	45.15	49.64	57.38	59.49	55.2
Monthly Max	53.31	59.06	66.53	68.71	64.38
Monthly Min	38.75	36.1	49.69	47.1	46.58
Stdev	3.28	4.59	3.64	4.73	4.44



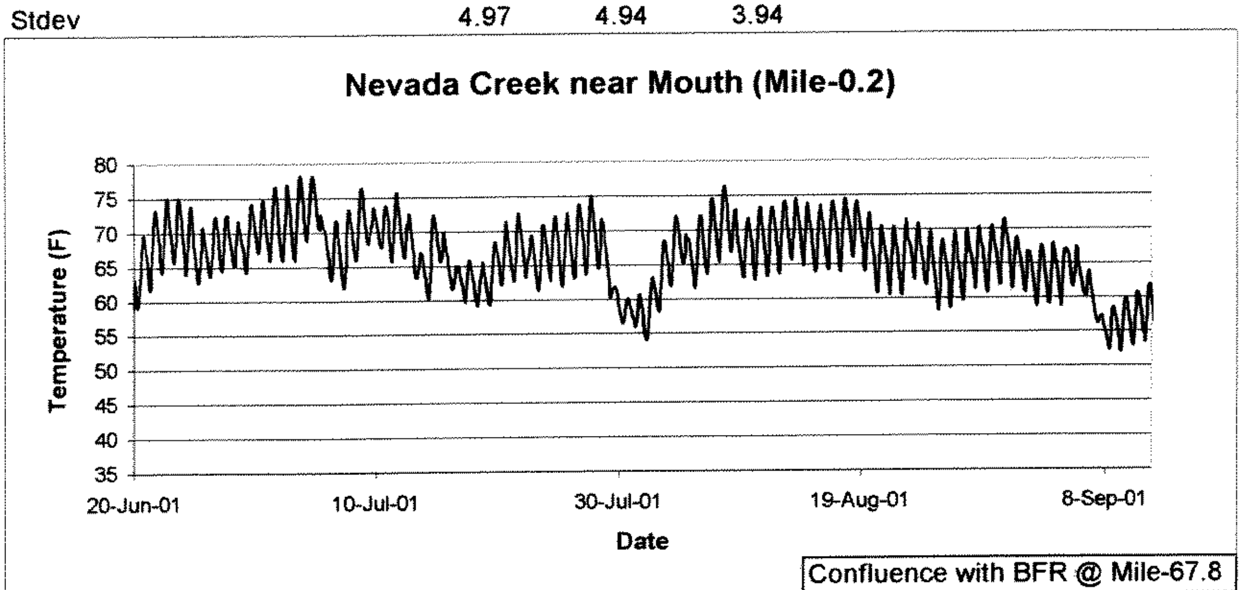
Month	June	July	August	September
Monthly Mean	N.A.	51.75	53.77	50.02
Monthly Max		62.17	63.54	60.11
Monthly Min		45.38	43.92	43.17
Stdev		4.27	4.55	3.78



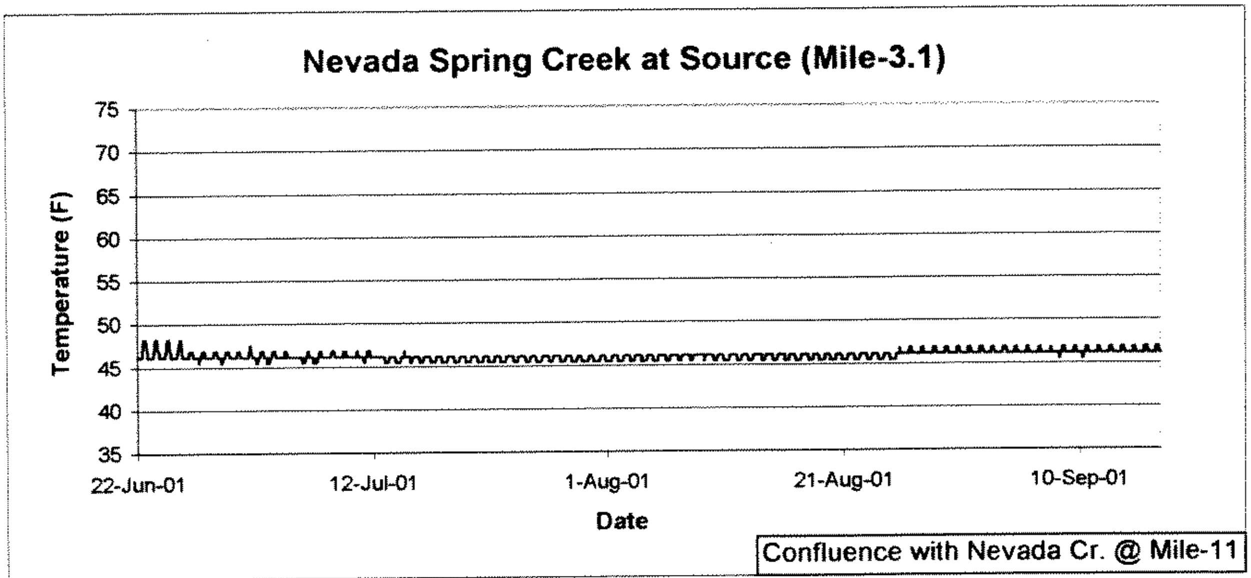
Month	June	July	August	September
Monthly Mean	N.A.	59.54	60.4	54.43
Monthly Max		74.53	73.84	69.71
Monthly Min		50.38	47.53	42.46
Stdev		5.56	6.25	6.07



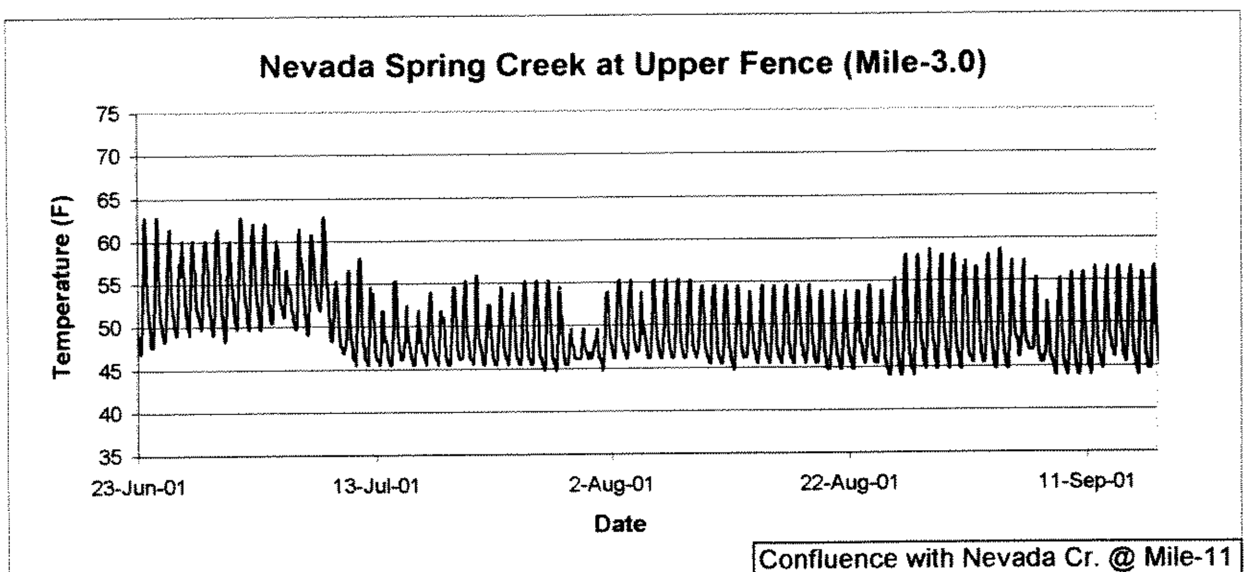
Month	June	July	August	September
Monthly Mean	N.A.	61.05	61.62	54.64
Monthly Max		74.53	72.46	64.22
Monthly Min		51.79	48.25	46.1
Stdev		4.97	4.94	3.94



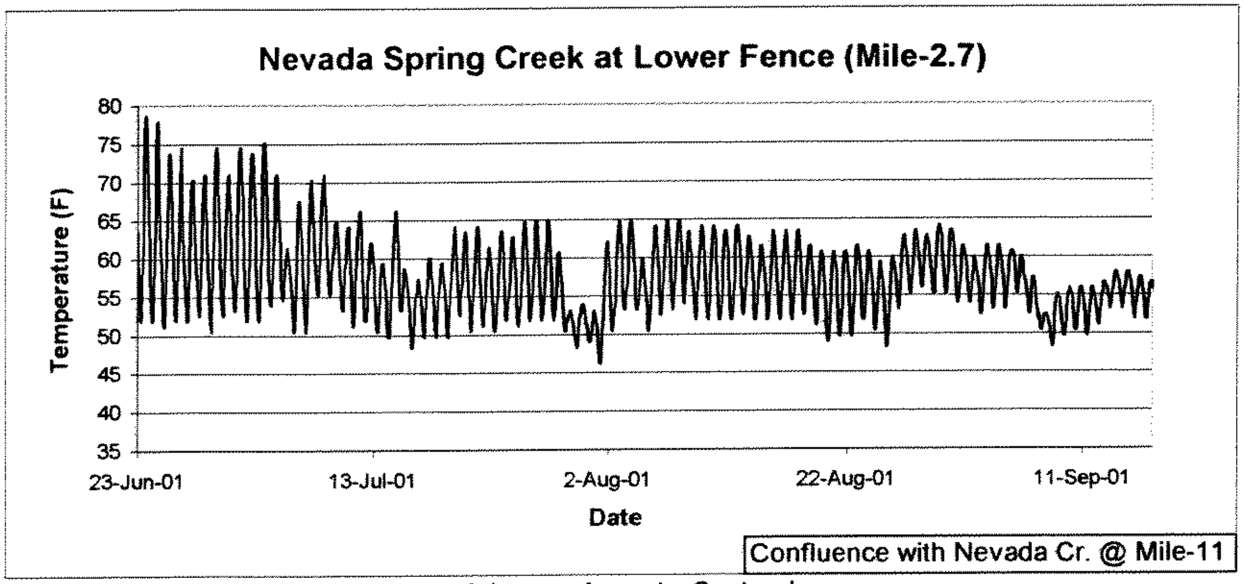
Month	June	July	August	September
Monthly Mean	68.35	67.22	67.1	60.19
Monthly Max	75.12	78.23	76.39	67.93
Monthly Min	59.01	55.89	53.96	51.99
Stdev	3.66	4.8	4.12	4.18



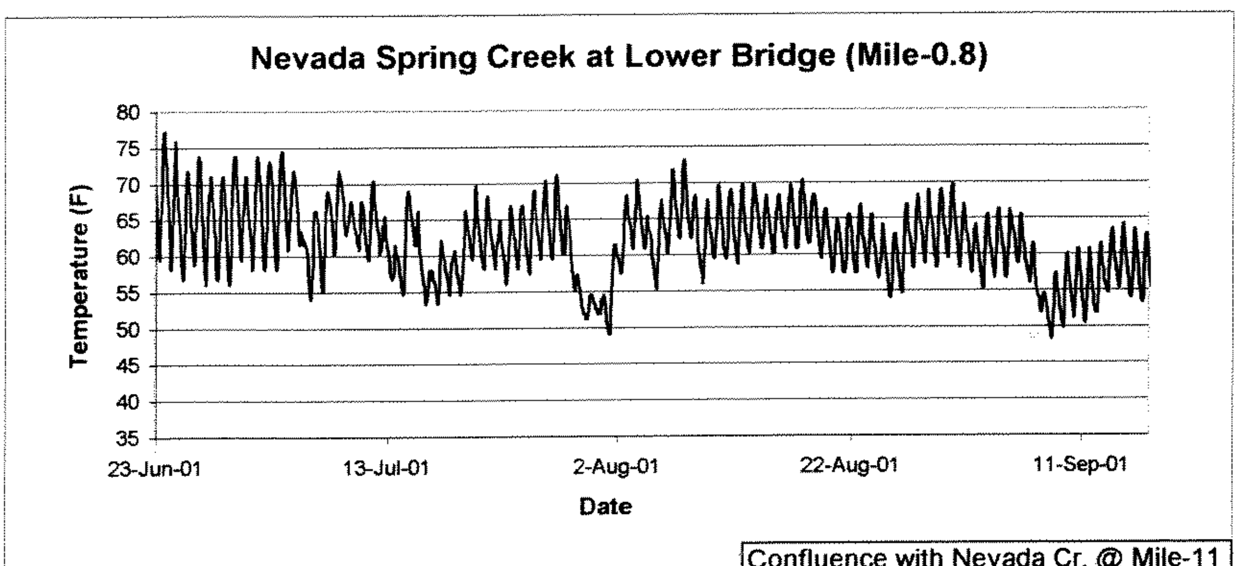
Month	June	July	August	September
Monthly Mean	46.49	45.93	45.91	46.27
Monthly Max	48.25	47.53	46.82	46.82
Monthly Min	45.38	45.38	45.38	45.38
Stdev	0.64	0.41	0.4	0.32



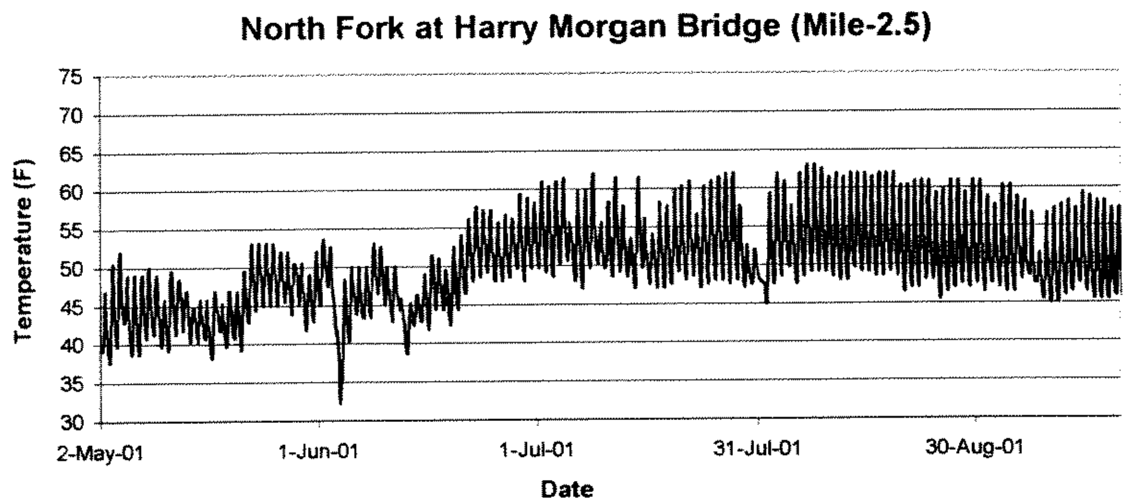
Month	June	July	August	September
Monthly Mean	53.85	50.25	49.11	49.14
Monthly Max	62.85	62.85	58.73	58.73
Monthly Min	46.82	44.65	43.92	43.92
Stdev	4.39	4.22	3.6	4.06



Month	June	July	August	September
Monthly Mean	62.16	57.71	57.58	55.14
Monthly Max	78.71	75.22	64.91	61.48
Monthly Min	50.38	48.25	46.1	48.25
Stdev	7.85	5.7	4.19	2.94

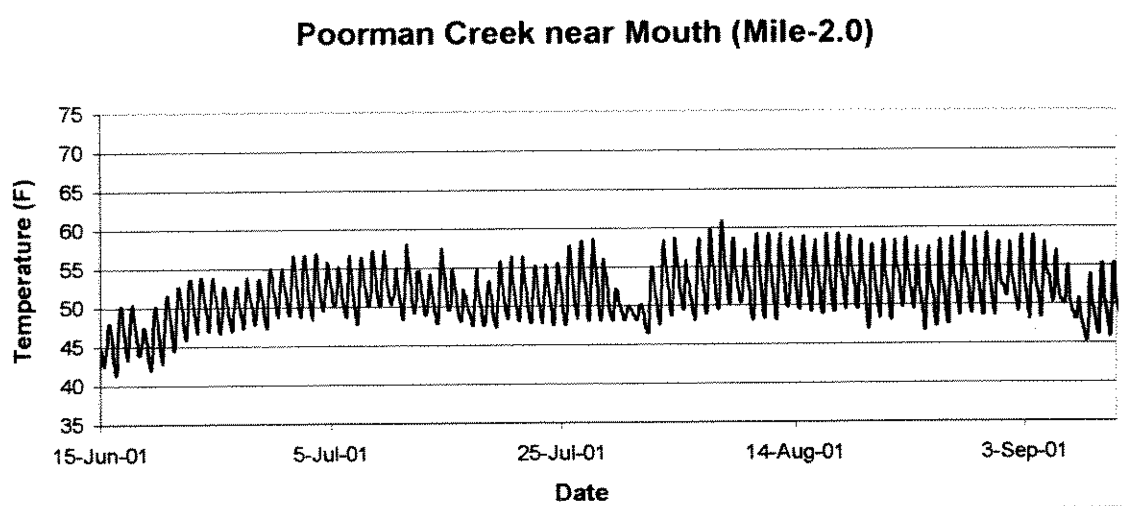


Month	June	July	August	September
Monthly Mean	65.68	61.9	62.93	57.74
Monthly Max	77.31	74.53	73.15	66.28
Monthly Min	55.97	51.08	48.96	48.25
Stdev	5.53	5.11	4.06	4.1



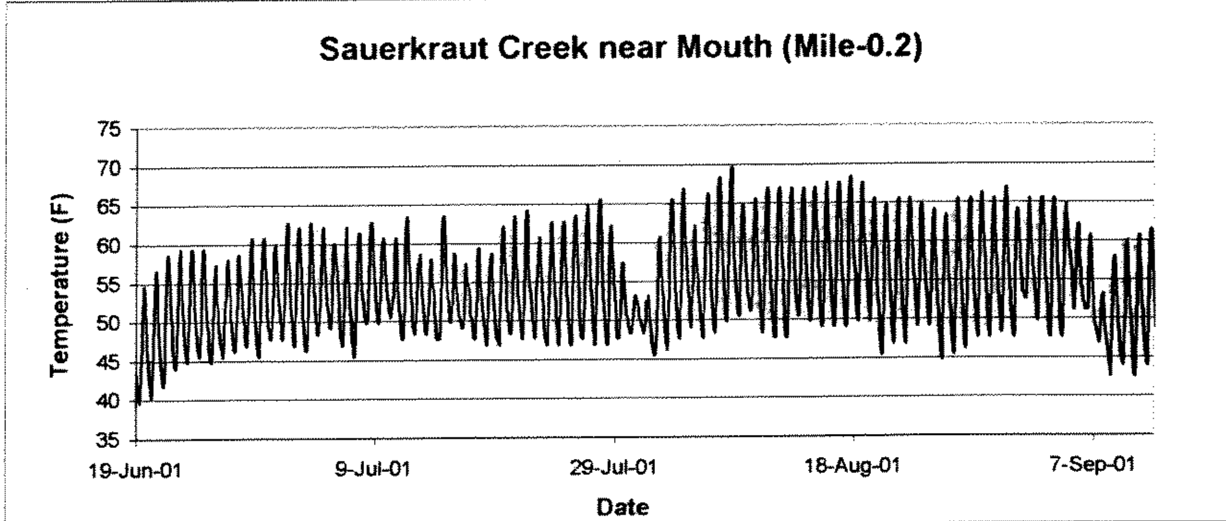
Confluence with BFR @ Mile-54.1

Month	May	June	July	August	September
Monthly Mean	45.09	48.28	52.95	53.54	50.84
Monthly Max	53.16	59.42	62.07	63.13	60.47
Monthly Min	37.55	32.21	46.95	44.86	44.86
Stdev	3.56	4.69	4.01	4.71	4.12



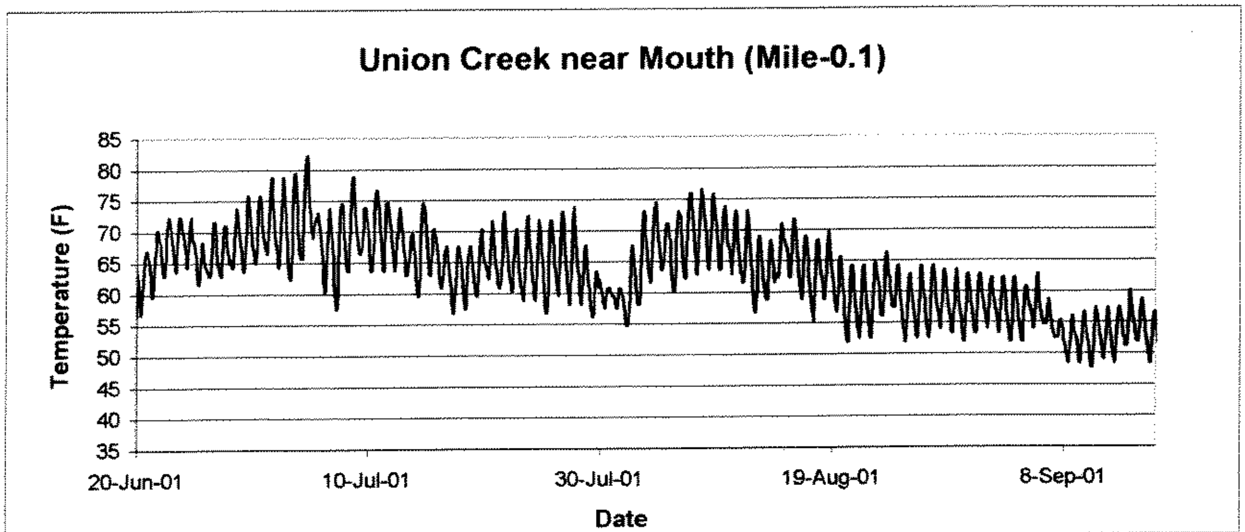
Confluence with BFR @ Mile-108

Month	June	July	August	September
Monthly Mean	48.79	51.62	52.98	51.29
Monthly Max	55.02	58.65	60.93	58.94
Monthly Min	41.34	47.21	46.38	45.27
Stdev	3.24	2.71	3.35	3.22



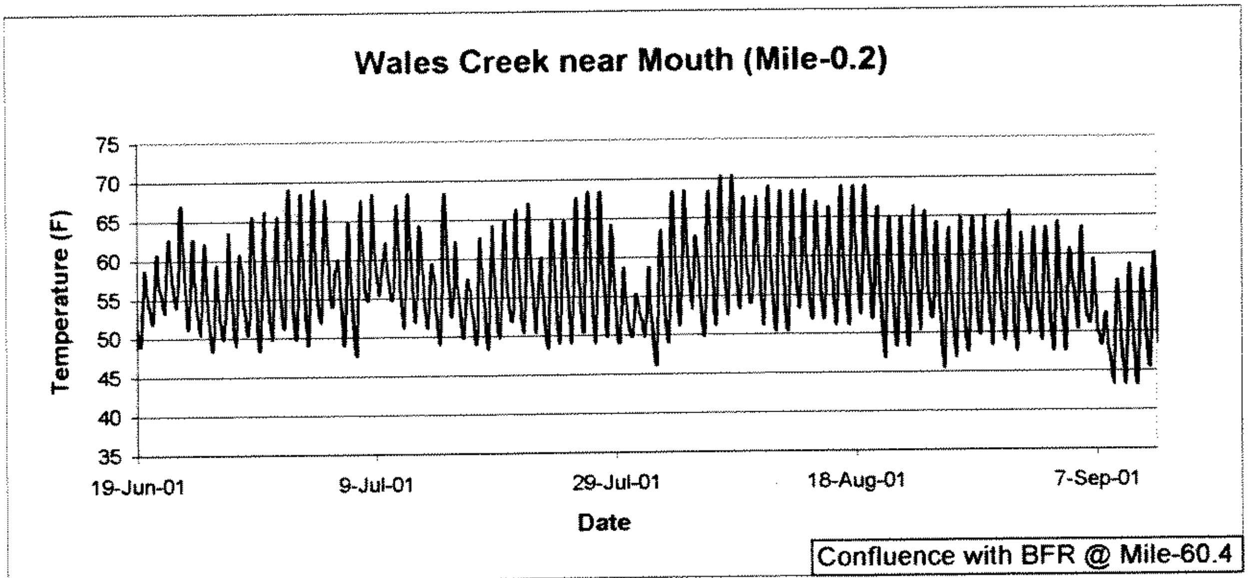
Confluence with BFR @ Mile-102.1

Month	June	July	August	September
Monthly Mean	50.72	53.52	56.29	53.68
Monthly Max	60.8	65.6	69.7	65.6
Monthly Min	39.5	45.4	44.7	42.5
Stdev	5.34	4.85	6.38	5.97

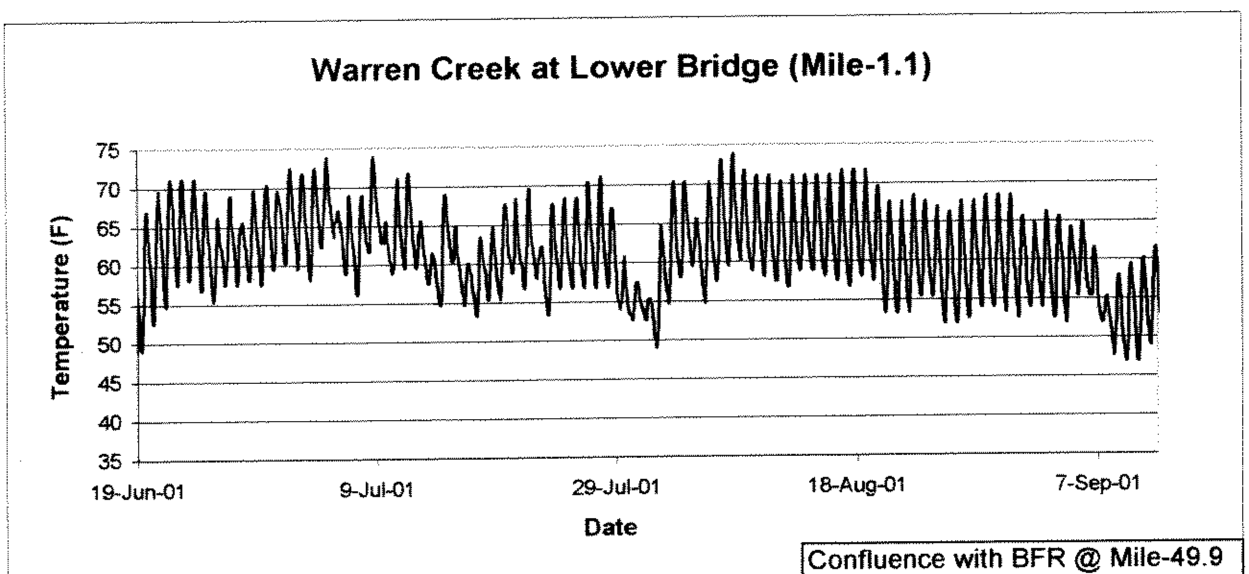


Confluence with BFR @ Mile-12.9

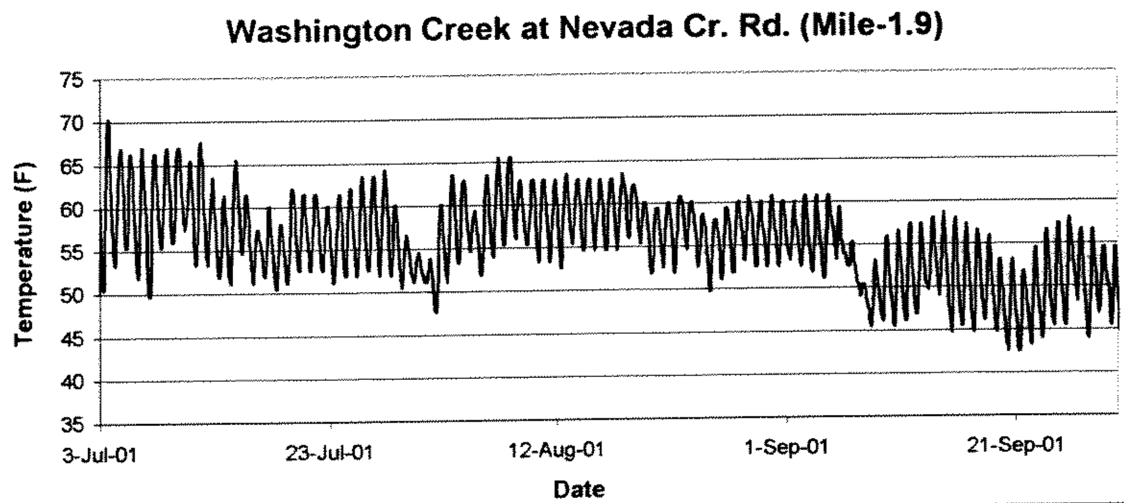
Month	June	July	August	September
Monthly Mean	67.11	66.38	62.88	54.55
Monthly Max	76	82.3	76.7	62.8
Monthly Min	56.7	56	51.8	47.6
Stdev	3.88	5.48	5.82	3.54



Month	June	July	August	September
Monthly Mean	55.74	56.61	57.46	52.83
Monthly Max	67	69	70.4	64.2
Monthly Min	48.3	47.6	45.4	43.2
Stdev	4.65	5.31	5.9	5.13

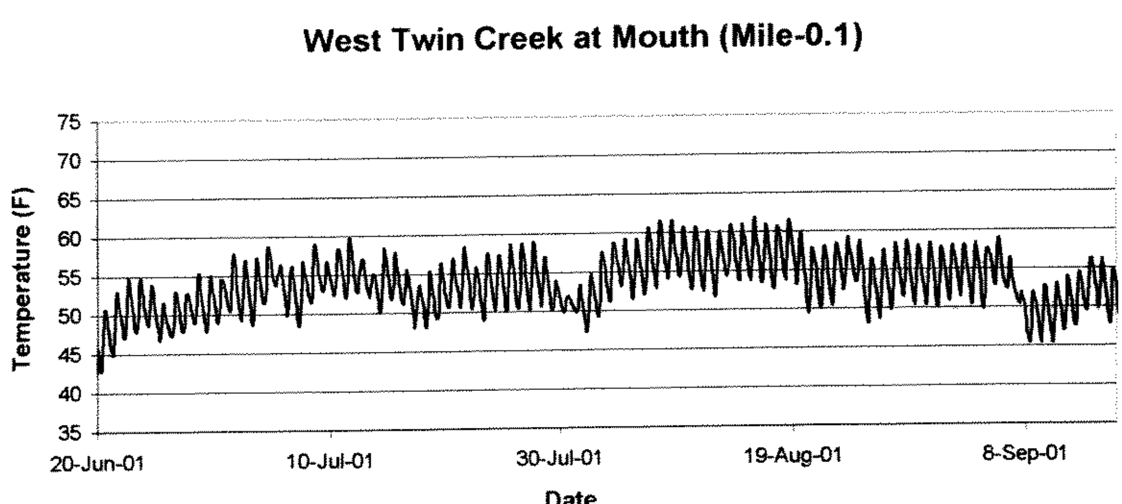


Month	June	July	August	September
Monthly Mean	62.64	61.95	61.97	56.31
Monthly Max	71.1	73.9	73.9	66.3
Monthly Min	49	52.5	49	46.8
Stdev	4.99	4.89	5.32	4.74



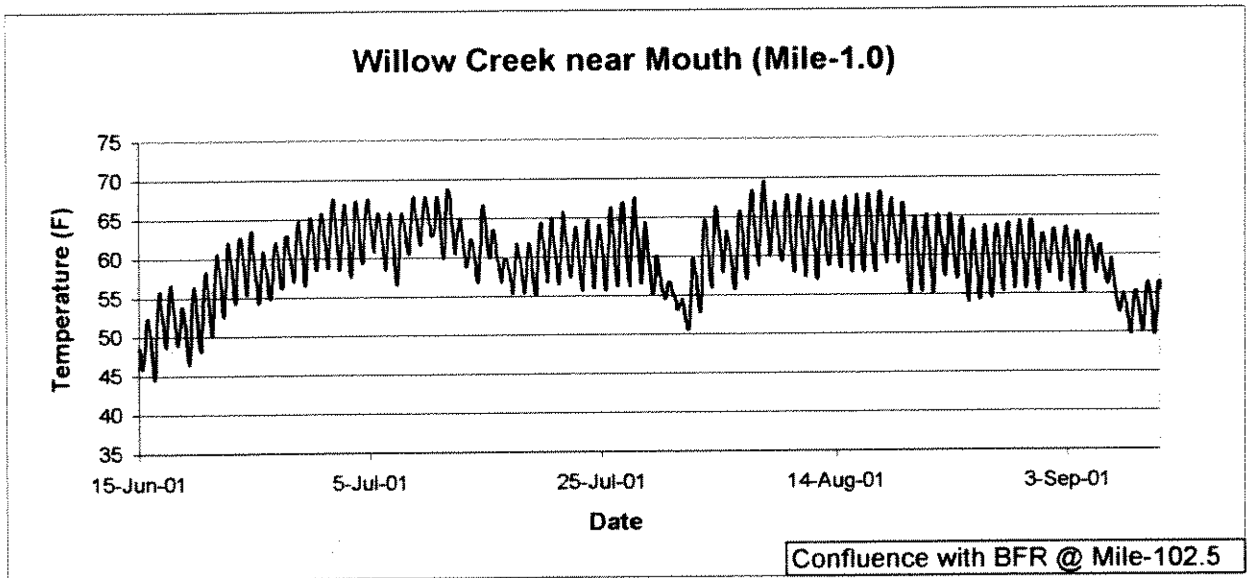
Confluence with Nevada Cr. @ Mile-37.8

Month	June	July	August	September
Monthly Mean	N.A.	57.49	57.7	51.37
Monthly Max		70.39	65.59	60.8
Monthly Min		49.67	47.53	41.72
Stdev		4.61	3.5	4.3

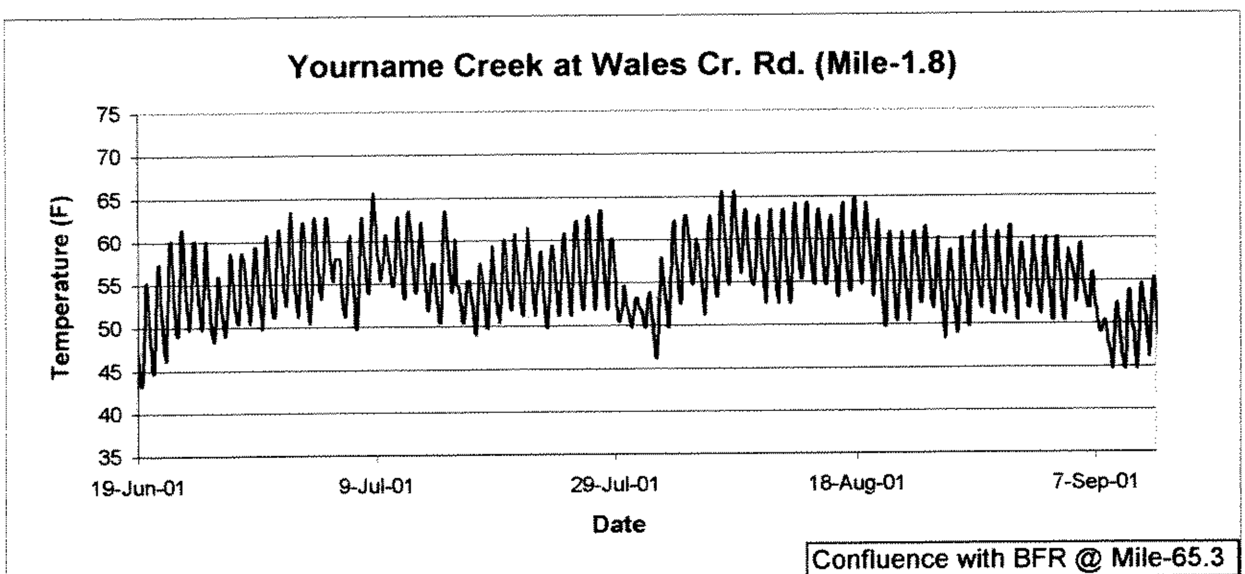


Confluence with BFR @ Mile-10.6

Month	June	July	August	September
Monthly Mean	50.19	53.51	55.38	52.17
Monthly Max	55.33	59.83	61.85	59.01
Monthly Min	42.76	48.08	47.23	45.31
Stdev	2.77	2.6	3.13	3.19



Month	June	July	August	September
Monthly Mean	56.17	61.17	61.25	56.76
Monthly Max	65.83	68.73	69.62	63.51
Monthly Min	44.43	53.06	50.56	49.72
Stdev	5.1	3.63	3.84	3.76



Month	June	July	August	September
Monthly Mean	53.52	55.86	57.02	52.42
Monthly Max	61.5	65.6	65.6	60.1
Monthly Min	43.2	49	46.1	44.7
Stdev	4.37	3.74	3.99	3.92

Exhibit I: Westslope genetic trout sampling results

Stream Name	Date	Location (stream mile)	Township,Range, Section	# of Samples analyzed	% Purity	Introgression
Buffalo Gulch	7/23/2001	0.1	12N,9W,18D	12		
Buffalo Gulch	7/23/2001	1.3	12N,9W,7D	8		
Buffalo Gulch	7/23/2001	2.5	12N,9W,8A&9B	5		
California Gulch	7/23/2001	0.4	12N,9W,9A	5		
California Gulch	7/23/2001	1.8	12N,9W,3B	4		
Clear Creek	7/24/2001	0.1	12N,9W,8C	6		
Clear Creek	7/24/2001	1.2	12N,9W,5C	4		
Clear Creek	7/24/2001	1.9	12N,9W,6A	10		
Clear Creek	7/24/2001	2.5	13N,9W,31D	5		
Fish Creek	9/10/2001	0.7	14N,14W,28A	1		
Fish Creek	9/10/2001	1.8	14N,14W,27D	16		
Fish Creek	9/10/2001	2.8	14N,14W,35C	8		
Gallagher Creek	8/1/2001	0.3	12N,9W,29A	6		
Gallagher Creek	7/30/2001	2.8	11N,9W,5C&6D	19		
Gleason Creek	7/25/2001	0.1	12N,8W,22B	9		
Indian Creek	8/1/2001	0.1	12N,9W,19B	5		
Indian Creek W.F.	8/1/2001	W.F. 0.1	12N,10W,24A	3		
Indian Creek E.F.	8/1/2001	E.F. 0.1	12N,10W,24A	9		
Jefferson Creek	7/19/2001	0.5	12N,9W,21C	10		
Jefferson Creek	7/19/2001	2.3	12N,9W,15C	5		
Jefferson Creek	7/19/2001	4.7	12N,9W,11A	5		
Jefferson Creek	7/19/2001	5.5	12N,9W,2A	5		
Mitchell Creek	7/16/2001	3	11N,8W,5A	12		
Mitchell Creek	7/16/2001	3.5	11N,8W,4BC	8		
Mitchell Creek	7/16/2001	4.7	11N,8W,3B	5		
Nevada Creek	7/3/2001	33.8	12N,9W,19A	1		
Nevada Creek	7/3/2001	45.5	12N,8W,29C	2		
Nevada Creek	7/5/2001	46.1	12N,8W,29A&28B	7		
Nevada Creek	7/3/2001	48.6	12N,8W,15D	10		
Shingle Mill Creek	7/5/2001	0.8	12N,8W,32B	8		
Shingle Mill Creek	7/5/2001	1.6	12N,8W,33B&C	10		
Shingle Mill Creek	7/5/2001	2.2	12N,8W,33A	7		
Washington Creek	7/17/2001	4.8	12N,9W,24A	10		
Washington Creek	7/18/2001	6.1	12N,8W,18BA	8		
Washington Creek	7/18/2001	7.2	12N,8W,7A&8B	7		

The University of Montana

Division of Biological Sciences
The University of Montana
Missoula, Montana 59812-4824
Phone: (406) 243-5122
FAX: (406) 243-4184

December 6, 2001

Ladd Knotek
Genetics Contact, Region 2
Montana Fish, Wildlife & Parks
3201 Spurgin Road
Missoula, MT 59801

Ladd:

We have completed analysis of the following samples:

Table 1. Summary of results

Sample #	Site Name, Collection Date, Location	N[a]	markers[b]	Population ID[c]	Power (%)[d]	% Westslope[e]	Individuals[f]
2035	**Ashby Creek** (6/16/00) Union Creek - Blackfoot T13N R16W Secs 35,3,36	25 (20)	5	WSCT	87	100	-
2036	**Cottonwood Creek** (8/2/00) Nevada Creek T12N R11W Sec 26A	25 (24)	6	WSCT	94	100	-
2031	**Surveyors Creek** (7/7/00) Middle Clark Fork T12N R25W Secs 35,36	32	6	WSCTxRBT	-	96	-
2034	**Arkansas Creek** (6/21/00) Union Creek - Blackfoot T13N R16W Secs 23,27,33	24 (16)	5	WSCT	80	100	-

[a]Number of fish analyzed; if combined with previous sample (indicated in "Location" column), number indicates the combined sample size; if present, the number in () is the average number successfully analyzed per locus (some individuals do not amplify for all marker loci).
[b]Number of markers analyzed that are diagnostic for the non-native species.
[c]Codes: WSCT = westslope cutthroat trout (*Oncorhynchus clarki lewisi*); RBT= rainbow trout (*O. mykiss*); YSCT= Yellowstone cutthroat trout (*O. clarki bouvieri*). Only one taxon code is listed when the entire sample possessed alleles from only that taxon. However, it should be noted that in such cases we cannot completely rule out the possibility that some or all of the individuals are hybrids; we merely have not detected any non-native alleles at the limited number of loci examined (see Power % column). Codes separated by "x" indicate hybridization between the taxa.
[d]Number corresponds to the percent chance we have to detect 1% hybridization given the number of individuals successfully analyzed and the number of diagnostic markers used (e.g., 25 individuals are required to yield a 95% chance to detect 1% hybridization of rainbow or Yellowstone cutthroat trout into a westslope trout population using 6 markers). Not reported when hybridization is detected.
[e]Indicates the genetic contribution of westslope cutthroat trout to the sample assuming Hardy-Weinberg proportions. This number is reported only if the sample appears to come from a random mating population.
[f]Indicates number of individuals with genotypes corresponding to the taxon in the code column when the sample does not appear to have come from a random mating hybrid swarm.
*See the "**Sample Details**" section below.

Brief Description of Methods:

Polymerase chain reaction (PCR) amplification of paired interspersed nuclear DNA elements (PINEs) was used to determine each fish's genetic characteristics at multiple regions of the nuclear DNA. This method produces DNA fragments that can be used to distinguish between various cutthroat trout subspecies (*Oncorhynchus clarki spp.*), rainbow trout (*O. mykiss*) and their hybrids, and between bull trout (*Salvelinus confluentus*), brook trout (*S. fontinalis*), and their hybrids. The presence of a PINE marker is dominant to absence. First-generation (F_1) hybrids will have all the diagnostic markers characteristic of the two hybridizing taxa. Most backcrossed individuals will possess some, but not all, markers characteristic of both parental taxa. The appearance of a marker indicates the individual is either heterozygous or homozygous for that marker, which precludes us from directly calculating allele frequencies.

Unless the distribution of markers indicates otherwise, we assume genotypes in the sample conform to random mating expectations and we can estimate the average genetic contribution of each taxon to such hybrid swarms. Regardless of the percent contribution from the non-native taxon, in hybrid swarms all individuals are of hybrid origin, even those that appear "pure" at our diagnostic loci. It is not possible to rescue pure individuals from these populations, as they likely do not exist. Due to the random reshuffling of alleles during sexual reproduction, some individuals will appear pure for one or the other parental taxa due to the limited number of marker loci used. It has been shown that 6 markers are adequate to provide adequate power for detection of hybridization at the population level, but upwards of 70 markers are required to discriminate between pure individuals, if they exist, and backcrossed individuals in hybrid swarms (Boecklen and Howard 1997).

The distribution of non-native markers may not be randomly distributed among the fish in a sample primarily because hybridization has only recently begun in the population, the sample contains individuals from two or more genetically divergent populations, or both. Such collections can be analyzed at the individual level only. Since such samples do not come from hybrid swarms, the proportion of native and non-native markers cannot reliably be estimated. In these cases, the sample may contain some non-hybridized individuals. Rather than reporting percent genetic contributions we report the number of individuals in the sample, based on the fragments they possessed that may be non-hybridized.

Literature Cited:

Boecklen WJ, and Howard DJ (1997) Genetic analysis of hybrid zones: numbers of markers and power of resolution. *Ecology* 78 (8) pp. 2611-2616.

Sample Details:

Ashby Creek: All individuals in this sample that were successfully analyzed exhibited fragments diagnostic of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) only. With a sample size of 20, we have only an 87% chance of detecting 1% hybridization with rainbow trout (*O. mykiss*) using 5 markers. This sample appears to have come from a pure westslope population, but we cannot reasonably exclude the possibility that it might be slightly hybridized with rainbow trout. Unless further data indicate otherwise, it should be managed as a westslope cutthroat trout population.

Cottonwood Creek: All successfully analyzed individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout only. With a sample size of 24, we have a 94% chance of detecting 1% hybridization with rainbow trout using 6 markers. This sample appears to have come from a pure westslope population, but we cannot reasonably exclude that it might be slightly hybridized with rainbow trout.

Surveyor's Creek: All individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout. However, some samples also displayed diagnostic rainbow trout markers. The individuals that appeared hybrid were all post-F1 hybrids, indicating that low-level hybridization has been occurring for generations. Assuming random mating proportions, the genetic contribution of westslope cutthroat trout and rainbow trout is 96% and 4%, respectively.

Arkansas Creek: All successfully analyzed individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout only. With a sample size of 16, we have only an 80% chance of detecting 1% hybridization with rainbow trout using 5 markers. This sample may come from a pure westslope population, but we cannot reasonably exclude the possibility that it might be hybridized with rainbow trout. Unless further data indicate otherwise, it should be managed as a westslope cutthroat trout population.

Sincerely,

Marirose Spade

Cc: Steve Carson, Jenny Corbin (email)

March 20, 2001

Ladd Knotek
Genetics Contact, Region 2
Montana Fish, Wildlife & Parks
3201 Spurgin Road
Missoula, MT 59801

Ladd:

We have completed analysis of the following samples:

All Pure

Table 1. Summary of results.

Location (description and date collected)	N[a]	# markers[b]	Species ID[c]	Power (%)[d]	% Westslope[e]	Individuals[f]
Murray Creek (7/12/00) T12N R12W S9C	25	6	WSCT	95	100	-
Wales Creek (3/18/00) T14N R12W S34B	25	6	WSCT*	95	100*	-
Yourname Creek (08/03/00) T14N R12W S34B	25	6	WSCT	95	100	-

[a]Number of samples analyzed; if combined with previous sample (indicated in "Location" column), number indicates the combined sample size; if present, the number in () is the average number successfully analyzed per locus (some individuals do not amplify for all marker loci).
[b]Number of markers analyzed that are diagnostic for the non-native species.
[c]Codes: WSCT = westslope cutthroat trout (*Oncorhynchus clarki lewisi*); RBT= rainbow trout (*O. mykiss*); YSCT= Yellowstone cutthroat trout (*O. clarki bouvieri*). Only one species code is listed when the entire sample possessed alleles from that species only. However, it must be noted that in such cases we cannot definitively rule out the possibility that some or all of the individuals are hybrids; we merely have not detected any non-native alleles at the limited number of loci examined (see Power % column). Species codes separated by "x" indicate hybridization between those species.
[d]Number corresponds to the percent chance we have to detect 1% hybridization given the number of individuals successfully analyzed and the number of diagnostic markers used (e.g., 25 individuals are required to yield a 95% chance to detect 1% hybridization of rainbow or Yellowstone cutthroat trout into a westslope trout population using the 6 available markers). Not reported when hybridization is detected.
[e]Indicates the genetic contribution of westslope cutthroat trout to the sample assuming Hardy-Weinberg proportions. This number is reported only if samples appear to come from a randomly mating population and can be analyzed at the population level.
[f]Indicates number of individuals with genotypes corresponding to the species code column when the sample can be analyzed on the individual level only; this occurs when alleles are not randomly distributed and hybridization appears to be recent and/or if the sample appears to consist of an admixture of populations.
*See the "**Sample Details**" section below.

Brief Description of Methods:

Polymerase chain reaction (PCR) amplification of paired interspersed nuclear DNA elements (PINEs) was used to determine each fish's genetic characteristics at multiple regions of the nuclear DNA. This method produces DNA fragments that can be used to distinguish between various cutthroat trout subspecies (*Oncorhynchus clarki spp.*), rainbow trout (*O. mykiss*) and their hybrids, and between bull trout (*Salvelinus confluentus*), brook trout (*S. fontinalis*), and their hybrids. The presence of a PINE marker is dominant to absence. First-generation (F_1) hybrids will have all the diagnostic markers characteristic of the two hybridizing species. Backcrossed individuals will possess some, but not all, markers characteristic of both parental species. The appearance of a marker indicates the individual is either heterozygous or homozygous for that marker, which precludes us from directly calculating allele frequencies.

Unless the distribution of markers dictates otherwise, we assume the samples conform to random mating expectations in order to estimate the average genetic contribution from each species. In these cases, we report the percent genetic contribution from each species present in the population. When hybridization is present in these situations, the population is considered a hybrid swarm. Regardless of the percent contribution from the non-native species, in hybrid swarms, all individuals are of hybrid origin, even those that appear "pure" at our diagnostic loci. It is not possible to rescue pure individuals from these populations, as they likely do not exist. Due to the random reshuffling of alleles during sexual reproduction, many individuals will appear pure for one or the other parental species due to the limited number of marker loci used. It has been shown that 6 markers are adequate to provide coarse classification of hybridization, but upwards of 70 markers are required to discriminate between pure individuals, if they exist, and backcrossed individuals in hybrid swarms (Boecklen and Howard 1997).

However, when the distribution of non-native markers appears to be non-random, it is not valid to report genetic contributions of the component species at the population level, as they do not come from a randomly mating population. It is likely that the individuals in these samples either come from populations where hybridization is recent or are from admixtures of populations. Samples can be analyzed at the individual level only. These samples are not considered to come from hybrid swarms and some pure individuals may exist. In these cases, we report the number of individuals with genotypes corresponding to each species and/or the types of hybrids detected and do not report genetic contribution percentages.

Literature Cited:
Boecklen WJ, and Howard DJ (1997) Genetic analysis of hybrid zones: numbers of markers and power of resolution. *Ecology* 78 (8) pp. 2611-2616.

Sample Details:

Murray Creek: The 25 individuals in this collection exhibited PINE markers indicative of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) only. With a sample size of 25, we had a 95% chance to detect as little as 1% hybridization. This collection appeared to come from a pure westslope cutthroat trout population.

Wales Creek: Twenty-four of the 25 individuals in this collection exhibited PINE markers indicative of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) only. One individual exhibited one marker indicative of rainbow trout (*O. mykiss*). However, regional variation at this marker within pure westslope cutthroat trout populations is sometimes indistinguishable electrophoretically from that exhibited by rainbow trout. Furthermore, given that this was the only potential rainbow marker exhibited in this entire sample, we cautiously conclude that this collection was from a pure westslope cutthroat trout population. With a sample size of 25, we had a 95% chance to detect as little as 1% hybridization.

Yourname Creek: The 25 individuals in this collection exhibited PINE markers indicative of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) only. With a sample size of 25, we had a 95% chance to detect as little as 1% hybridization. This collection appeared to come from a pure westslope cutthroat trout population.

Sincerely,

John K. Wenburg

Cc: Steve Carson (electronic version)