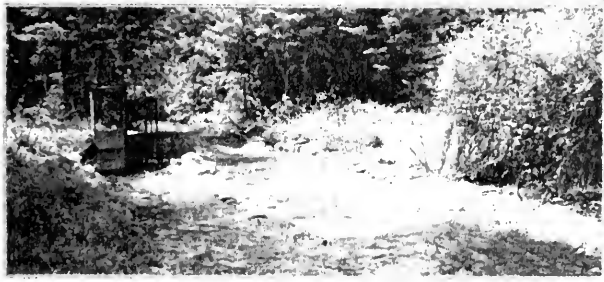
The Big Blackfoot River Restoration Progress Report for 2002 and 2003

Montana Fish, Wildlife & Parks



The Big Blackfoot River Restoration Progress Report for 2002 and 2003

by

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Executive Summary

The 2002 and 2003 reporting period was a time of continued drought in the Blackfoot Watershed. The drought began in 2000 and involved elevated summer water temperatures, below normal mid-summer and winter flow conditions, and extreme wildfires. The drought contributed to fish population declines in the Blackfoot River and many tributaries. Despite the drought, fish populations in many restored streams responded positively to riparian improvements.

Compared with 2000, total trout densities (> 6.0") declined at two long-term monitoring locations (Johnsrud and Scotty Brown Bridge) on the Blackfoot River in 2002. Declines occurred primarily with small-to-intermediate rainbow trout in the lower river (Johnsrud section), whereas densities of larger rainbow trout increased. Westslope cutthroat trout (WSCT) densities (> 6.0") remained generally stable between 2000 and 2002 after gradually increasing through the 1990s. Densities of Blackfoot River bull trout (> 6.0"), also increasing through the 1990s, were generally stable in the lower river between 2000 and 2002 (increase in the Johnsrud section and a decline in the Scotty Brown section). Densities of lower Blackfoot River brown trout (> 6.0"), also increasing through the 1990s, were similar between 2000 and 2002 (Results Part II).

In 2002, we established a new Blackfoot River population survey site - the Wales Creek section (river miles 60.0 to 66.2) downstream of Nevada Creek. This survey section supported much lower total trout densities (> 6.0") than earlier up-river (near Arrastra Creek) surveys (Pierce et al. 2000) and lower Blackfoot River survey sections (Figure 1). Because of very low densities, we were unable to generate population estimates for bull trout, WSCT and rainbow trout in the Wales Creek section. We did generate an estimate for brown trout, the dominant game fish in the section. Brown trout densities were very low compared with the lower Blackfoot River (Jonsrud and Scotty Brown Bridge) sections. Low trout densities (all species) in the Wales Creek section apparently result from weak recruitment, which likely stems from low juvenile densities, reduced water quality and fisheries-impaired (habitat) tributaries in this section of the Blackfoot River (Maguire 1991, Ingman et al. 1990, Pierce et al. 2001, Results Part IV).

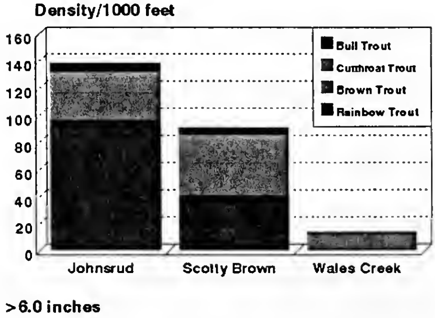


Figure 1. Estimated trout population densities for three locations of the Blackfoot River, 2002.

During the drought of 2002 and 2003, fisheries monitoring on 19 project streams (Results Part III) showed a wide range of population responses. In general, populations declined during the drought; however, we found several populations at higher densities in streams where restoration projects were implemented during drought compared with pre-project (and pre-drought) conditions. These results confirm the importance of correcting human-caused limiting factors in streams as a means of increasing the resistance of individual populations to drought. With time, cumulative habitat improvements should improve population resiliency and allow populations to recovery more quickly following drought. We also inventoried fish populations and identified fisheries impairments on Little Fish Creek, Snowbank Creek (Results Part IV) and upper Cottonwood Creek (Results Part III).

In 2002 and 2003, the Blackfoot Cooperators developed or implemented restoration projects on 12 streams (Ashby Creek, Cottonwood Creek, Elk Creek, Nevada Spring Creek, Nevada Creek, North Fork of the Blackfoot River, Pearson Creek, Poorman Creek, Rock Creek, Wales Creek, Wasson Creek and the lower Clearwater River). Projects were directed at improving habitat (8 streams) and fish passage (5 streams), minimizing fish losses to irrigation diversions (4 streams) and improving water quality (7 streams) (Results Part III).

As projects in the Blackfoot Watershed have expanded in scope and complexity, our collective need to monitor projects and review restoration methods have increased as well. To date, the Blackfoot Cooperators have modified methods to include 1) simplifying fish ladder and fish screen designs, 2) hiring personnel to assist with grazing plans and the special maintenance needs of fish screens, and 3) clarifying landowner agreements regarding stewardship and maintenance expectations. As we continue to monitor fish populations on project streams, we are observing grazing management deficiencies on many restoration projects. These deficiencies seem to involve 1) the lack of some livestock managers to implement the principles of proper streamside grazing, 2) lack of fence maintenance, 3) trespass cattle, and 4) the traditional problem of agency-developed grazing plans for uplands, with insufficient consideration of the special needs of riparian areas. Improved planning and increased monitoring of riparian grazing would help ensure projects better meet fisheries and riparian health objectives.

Pursuing recent methodologies to help minimize fish loss to irrigation diversions, we continued to evaluate the efficacy of a turbulent fountain fish screen. This fish screen, originally designed as a self-cleaning trash screen, appears to have high potential for effectively reducing fish losses to irrigation ditches. Our prototype fountain has no moving parts, operates entirely from hydraulic pressure, and offers a low maintenance, cost-effective option for screening fish (Results Part IV).

Two additional significant fisheries conservation measures advanced in 2002 and 2003: the impending sale of large tracts of industrial forest (Plum Creek Timberlands) to the Nature Conservancy (TNC); and the decision to remove Milltown Dam from the junction of the Clark Fork and Blackfoot Rivers. The TNC-Plum Creek land exchange will prevent subdivision on ~89,000 acres of land, most of which is located in bull trout *core area*s or streams supporting genetically pure WSCT. The State and EPA decision to remove Milltown Dam will restore river and riparian habitats in the area of Milltown Reservoir when implemented. Milltown Dam has eliminated upstream movements of all migratory species since its construction in 1907. Beyond fish passage and channel restoration, dam removal should eliminate northern pike spawning habitat, a species with a dietary preference for bull trout and other salmonids (Schmetterling 2001).

Identifying life history tendencies and important spawning and wintering areas are critical to the restoration and long-term conservation of Blackfoot River native fish. To better understand movement and habitat use in the upper Blackfoot River, we completed a telemetry study of fluvial bull trout and WSCT upstream of the North Fork. This study involved surgically implanting transmitters in 44 fish in wintering areas of the Blackfoot River and tracking movements over a two-year period. This study established seasonal bull trout use in a degraded section of the Blackfoot River (North Fork to Nevada Creek) and identified extensive movements between the upper Blackfoot River and spawning sites in the North Fork and Copper Creek. Bull trout that spawned in Copper Creek (n=4) migrated an average of 42.0 miles between wintering and spawning areas, then wintered in Copper Creek before migrating downstream the following spring during high flows. Only one bull trout ascended Copper Creek in 2003 and then died during the Snow-Talon wildfire. North Fork bull trout (n=5) telemetered near the mouth of Nevada Creek migrated an average of 31 miles to spawning areas. These fish exited the North Fork shortly after spawning and returned to Blackfoot River wintering areas near Nevada Creek.

Movements of fluvial WSCT exhibited a wide range of movements between winter areas of the Blackfoot River and seven spawning streams. Pre-spawning movements ranging from one to 42 miles. The great majority of habitat use by fluvial adult fish occurred on private land. Telemetered WSCT displayed very little use of degraded tributaries in the Garnet Mountains and no use of Nevada Creek (Results Part IV).

Beyond a vast scope of habitat-related restoration needs, many other challenges (continued drought, escalation of whirling disease, habitat degradation, subdivision and recreational pressures) to wild trout management and native fish recovery are emerging. From a recreational perspective, the Blackfoot River is subject to 1) expanded recreational developments in critical habitats, 2) large increases in angling pressure in vital native fish waters, and 3) pervasive misidentification and illegal harvest of native fish (Statewide angler pressure estimates 1989-2001, Schmetterling and Long 1999; Schmetterling and Bohnemann 2001). Continued drought is contributing to population declines throughout the Blackfoot watershed, including large declines in adult bull trout in some areas of the watershed. Wildfire and wildfire suppression activities in *proposed critical* bull trout habitat compound problems of low flows and elevated water temperature. Questionable wildfire suppression actions include: 1) an accidental release of cyanide-based fire retardant at the Copper Creek bull trout spawning site, and 2) extensive fire lines and road building in burn areas near the Gold Creek bull trout spawning and rearing sites. These types of activities should prompt a review of agency policies regarding appropriate methods of fire-fighting in spawning sites and other *critical habitats,* particularly in areas as remote as upper Copper Creek. Additional challenges involve recent introductions of unwanted (and illegal) exotic fish species in waters of the Blackfoot Watershed (Pierce et al. 2001) and the continued expansion of whirling disease.

Whirling disease, caused by the exotic parasite M*yxobolus cerebralis*, continues to expand at the low elevations of the watershed, with infections now confirmed from the confluence of the Blackfoot River to the mouth of Alice Creek. Whirling disease infection rates area also increasing at the low elevations of several tributaries to the lower Blackfoot River (Results Part IV).

Recovery of Imperiled Native Salmonids

Six previous Blackfoot River reports detail bull trout and westslope cutthroat trout status, life-history, restoration methods and monitoring results of restoration projects (Peters 1990; Pierce, Peters and Swanberg 1997; Pierce and Schmetterling 1999; Pierce and Podner 2000; Pierce, Podner and McFee, 2001, 2002). The following sections summarize and synthesize new information in order to help guide the recovery of both species.

Bull Trout Recovery

The Blackfoot River watershed supports populations of two *imperiled* native species, bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Onchorynchus clarki lewisi*). Of primary concern are the fluvial or migratory life forms. Migratory fish exhibit local adaptations involving specific behavior and habitat needs. This behavior involves spawning in discrete areas, tributary use by early life-stages, extensive migrations at higher flows, and seasonal use of larger, more productive river habitats in order to improve fitness and fecundity. Native salmonids also require more complex habitats, colder water, lower sediment and more tributary access than currently exists in many areas of the Blackfoot Watershed.

Bull trout, a native char capable of attaining large size (>16 pounds), inhabits ~125 miles of the Blackfoot River mainstem. Densities are very low in the upper River, but increase downstream of the North Fork at mile 54. Outside of the Clearwater River drainage, bull trout occupy ~25% of the drainage or ~355 miles of stream. Most bull trout spawning streams (Gold Creek, Dunham Creek, Monture Creek, Copper Creek, and the North Fork of the Blackfoot River) support migratory fluvial fish, although some streams (Poorman, Cottonwood and Belmont Creeks) seem to support predominately resident bull trout. Migratory bull trout basin use is generally tied to the larger, colder streams north of the Blackfoot River and larger, more productive river reaches. Fluvial bull trout reproduce in only a few discrete groundwater-fed spawning sites and seek cold-water refuge during periods of river warming. Juvenile rearing of fluvial fish can occur in the small and cold, non-spawning tributaries, in addition to the larger spawning streams and Blackfoot River.

Bull trout recovery began in the Blackfoot Watershed in 1990 when the FWP Commission adopted basin-wide catch-and-release regulations. Recovery efforts expanded in the 1990s with an emphasis on improving fish passage, restoring degraded habitat, and screening irrigation diversions in the Gold Creek, Cottonwood Creek, Monture Creek and North Fork watersheds (Pierce et al. 2001). In June 1998, the Secretary of the Interior Bruce Babbitt announced the listing of bull trout in the Columbia River drainage as *threatened* under the Endangered Species Act (ESA). During his announcement, Secretary Babbitt mentioned the bull trout recovery in the Blackfoot watershed to be the best example of bull trout restoration within the range of the species; he urged the restoration team to continue the current effort.

To help assist in bull trout recovery, the Montana Bull Trout Recovery Plan also established recovery goals for the Blackfoot watershed (MBTRT 2000). Goals are to: 1) maintain self-reproducing migratory fish in the Blackfoot River with access to tributary streams and spawning in all *core area* watersheds; 2) maintain the population genetic structure throughout the watershed; 3) maintain and increase the connectivity between the Blackfoot River and its tributaries; 4) establish a baseline of redd counts in all drainages that presently support spawning migratory bull trout; and 5) maintain a count of a least 100 redds or 2,000 individuals in the Blackfoot drainage with an increasing trend thereafter (MBTRT 2000).

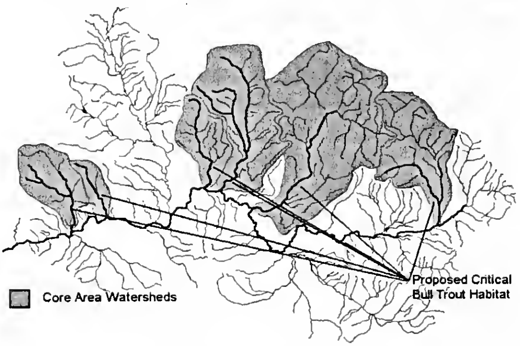


Figure 2. *Core area* watersheds and *proposed critical bull trout habitat* for the Blackfoot River Watershed (excluding the Clearwater drainage).

In 2002, the Unites States Fish and Wildlife Service (USFWS) designated *proposed critical habitat* and developed a draft recovery plan. The critical habitat designation includes the mainstem Blackfoot River and all mainstem tributaries of all core area watersheds (Figure 2). The draft recovery plan outlined measures needed to help remove bull trout from the ESA list, similar to the Montana Bull Trout Recovery Team (USFWS 2002).

During 2002 and 2003, bull trout recovery incorporated: 1) restoration on four bull trout-bearing streams (Results Part III); 2) completion of a bull trout telemetry study in the upper drainage (Results Part IV); 3) an evaluation of thermal properties of spawning sites; 4) adopted fishing gear restrictions (*artificial lure only*) at the mouth of the North Fork and Monture Creek; and 4) the decision to remove Milltown Dam. We also monitored bull trout population trends in the Blackfoot River and five spawning streams, and assessed juvenile populations on four *core area* streams (Results Part III).

Beginning in 1994, telemetry studies identified the movements and habitat use of fluvial bull trout in the lower Blackfoot River (Schmetterling 2001, 2003, Swanberg 1997; Swanberg and Burns 1997). Studies confirmed the importance of Monture Creek and North Fork to fluvial Blackfoot River bull trout, identified the Dunham Creek spawning area and revealed many restoration opportunities, including the Dunham Creek restoration project. These early studies documented extensive use of the lower river by bull trout, but no use of the upper Blackfoot River (upstream of the North Fork confluence) by lower river bull trout. Swanberg and Burns (1997) evaluated the movements and habitat use of a small number of radio-tagged bull trout in the upper Blackfoot River drainage upstream of Lincoln. This study identified a new spawning location in Copper Creek, the Landers Fork as a migration corridor, and bull trout wintering in the Landers Fork and upper Blackfoot River upstream of Lincoln.

In 2002 and 2003, we telemetered 10 adult bull trout in a 55-mile section of the upper Blackfoot River between the North Fork and Lincoln. Telemetry identified downstream movements of Blackfoot River bull trout into the North Fork, and much more extensive upstream movement of bull trout to Copper Creek than previously described (Swanberg and Burns 1997). North Fork bull trout returned to wintering areas of the Blackfoot River near Nevada Creek after spawning. Fish that spawned in Copper Creek exhibited a much larger home range than earlier studies. These fish wintered in Copper Creek before moving downstream to the middle Blackfoot River the following spring (Results Part IV).

In spring 2002, telemetry documented the presence of bull trout in the Blackfoot River between Nevada Creek and the North Fork for the first time. This reach of the Blackfoot River suffers from habitat problems including elevated summer water temperatures and nutrients levels, high sediment loads and low flow problems (Results Part I and IV). Based on a small sample of telemetered fish, habitat use near Nevada Creek appears to be limited to winter and spring use. All telemetered bull trout using this reach (n=5) exited by mid-June and returned (n=2) to wintering areas by November.

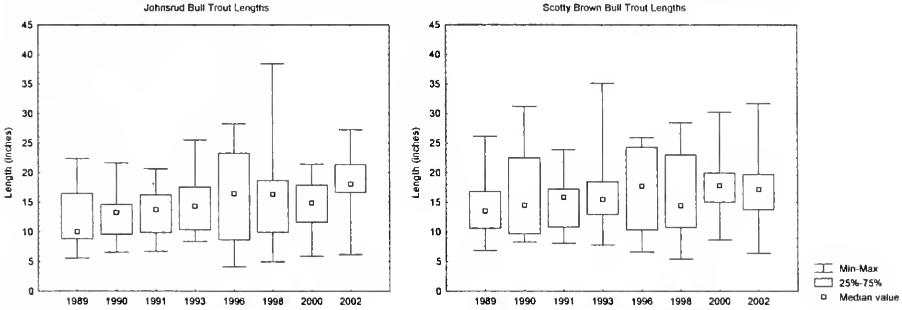


Figure 3. Length summary of sampled bull trout in the Johnsrud and Scotty Brown Bridge section 1989-2002.

We completed a winter water temperature study at bull trout spawning sites (Results Part IV). These spawning sites had significantly warmer temperatures during the winter incubation period compared with downstream non-spawning sites. This information may help identify historical spawning locations and foster recovery.

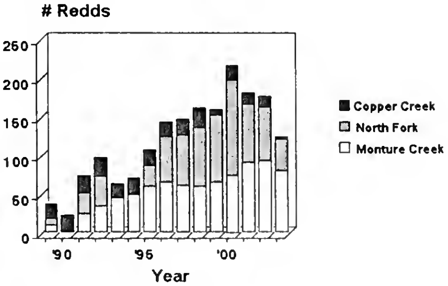


Figure 4. Bull trout redd counts in index reaches of three primary spawning streams 1989-2003.

Bull trout densities in the lower Blackfoot River have been increasing since 1990, with an inclination towards larger fish (Figure 3). These increases in length are significant in the Johnsrud section (ANOVA, 7df, P <0.001) but not in the Scotty Brown Bridge section (ANOVA, 7 df, P = 0.141). In spring 2002, bull trout densities were generally stable in the lower River with densities (> 6.0") increasing from 4.3 to 6.1 fish/1000' in the Johnsrud Section, but decreasing from 7.7 to 5.1 fish/1000' in the Scotty Brown Bridge Section (Results Part II).

By fall 2003, four years into the drought, bull trout spawning surveys (redd counts) showed a basin-wide decline in all surveyed spawning streams (Gold, Dunham, Monture and Copper Creeks and the North Fork). Compared with 2002, redd surveys in index reaches of the three primary spawning streams reveal large declines in Copper Creek and North Fork, where redd counts fell 73% and 41%, respectively. Monture Creek, a stream less prone to drought, declined 14% compared with 2002 (Figure 4, Results Part III and IV).

Juvenile bull trout surveys in 2002 at long-term monitoring sites of Monture Creek, the North Fork, and Copper Creek showed generally stable densities in Monture and Copper Creeks but a large decline in the North Fork (Results Part III). This variability seems to reflect the degree to which each stream (and local population) responds to the various influences of drought. The North Fork for example has high juvenile bull trout production in good water years (Pierce et al. 2001), but very low production under extreme low water, compared with Monture Creek where more stable flows in drought years result in more stable densities and consistent juvenile production (Results Part III). Unlike Monture Creek, the North Fork suffers flow deficiencies in critical migration corridors (intermittent flows on Kleinschmidt Flat) that inhibit the out-migration of bull trout. In the case of Copper Creek, an intense wildfire in 2003 compounded by fire-fighting activities at the bull trout-spawning site has likely exacerbated that decline.

Bull trout population surveys in upper Cottonwood Creek indicate low, but stable densities. Dunham Creek is showing early signs of recovery following the correction of a severe erosion problem immediately upstream of a small spawning site (Results Part III). We also observed adult bull trout in Grentier Spring Creek, a restored tributary to the upper Blackfoot River near Lincoln for the first time.

In 2002 and 2003, habitat restoration in bull trout streams included: 1) eliminating the last open irrigation ditch on Cottonwood Creek; 2) improving fish passage at diversions on Dunham and upper Cottonwood Creeks; 3) flow enhancement and grazing management changes on the North Fork Blackfoot River; 4) continued habitat improvements on Dunham and Rock Creeks; and 5) an instream flow and habitat restoration project on lower Poorman Creek, along with fish passage improvements in upper Poorman Creek.

We assessed potential problems for bull trout on two sites in the National Forest in 2003, which included a channel stability/erosion problem on upper Cottonwood Creek and a defunct diversion on Snowbank Creek. The Cottonwood Creek problem involved channel instability caused by flood water through a contracted opening of an undersized culvert, resulting in severe channel downcutting and a release of high volumes of fine sediment (Dave Rosgen, personal communication) into a bull trout rearing area (Pierce et al. 2002, Results Part III). Upper Cottonwood Creek runs subsurface within a short distance of entering this unstable section of channel, thereby isolating fish between the intermittent reach and the perched culvert (Results Part III). The Snowbank Creek problem, located in the Copper Creek drainage near a key bull trout-spawning site, involves severe dewatering below a defunct diversion that also entrains WSCT. This problem, if corrected, should increase flows in bull trout spawning and rearing areas and potentially improve migration corridors in the Landers Fork.

Although bull trout are particularly sensitive to many threats, whirling disease appears to be less of a concern for bull trout than for other salmonids. Compared with WSCT, rainbow trout and brook trout, bull trout exhibit a greater physiological resistance to whirling disease (Vincent 2001). In 2002 as whirling disease infection rates continued to escalate, we expanded whirling disease monitoring to the bull trout spawning or rearing areas of Cottonwood Creek, Monture Creek and the North Fork. Sentinel fish exposures indicate that whirling disease is not present at these locations, although the disease is present at moderate levels in lower reaches of these streams (Results Part IV).

Based on fisheries management-related risk factors for bull trout recovery, we recently identified *bull trout recovery - recreational conflict areas* (Pierce et al. 2001). These *conflict areas* refer to biologically critical sites (key spawning, rearing and staging areas, important migration corridors and areas of thermal refugia) and overlap with recreational developments, increased angler pressure and illegal bull trout harvest problems (Figure 5).

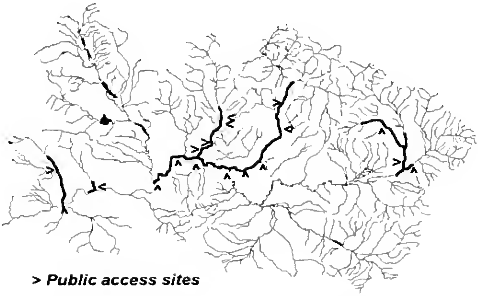


Figure 5. Bull trout recovery/recreational conflict areas.

In 2003, FWP adopted *artificial lure only* gear restrictions for the mouths of the North Fork of the Blackfoot River and Monture Creek to reduce angling pressure and angling mortality on bull tout. Both locations (junctions of major spawning streams with the Blackfoot River) receive concentrated bull trout use and very high angling pressure (Appendix K). The confluence of the North Fork is also the site of a FWP Fishing Access Site (FAS), and the Monture Creek confluence is a high use access site, currently being considered for FAS purchase. Recreational conflict concerns for bull trout further relate to: 1) large increases in angling pressure in critical recovery areas (Angler pressure estimates 1989-2001); 2) the documented inability of most anglers to identify bull trout (Schmetterling and Long 1999); 3) continued illegal harvest of bull trout (Derek Schott, FWP warden personal communication) and 4) expanded recreational developments in critical recovery areas. Recent declines in adult bull trout numbers compound these concerns. Without a more programmatic and conservation-based management philosophy, these pressures will likely either slow recovery or lead to additional angling restrictions in areas of conflict.

Westslope Cutthroat Trout Recovery

Westslope cutthroat trout, a *species of special concern* in Montana, have declined over much of their historic range within the last century. Declines are most pronounced mainly east of the Continental Divide (Shepard et al. 2003). Reasons for this decline include habitat loss and degradation, genetic introgression with introduced rainbow trout and Yellowstone cutthroat trout, overharvest and competition with introduced brook trout and brown trout (Liknes 1984; Allendorf and Leary 1988; Liknes and Graham 1988; McIntyre and Rieman 1995; Shepard et al. 2003). In the Blackfoot Watershed, WSCT occupy ~93% of historical range, compared with ~39% of occupied historical range statewide. The Blackfoot River also supports one of the larger fluvial meta-populations of genetically unaltered WSCT (upper drainage) in Montana, but at population abundance well below habitat capacity (Shepard et al. 2003).

The Blackfoot River watershed (outside of the Clearwater Drainage) supports a nearly basin-wide distribution of WSCT with 86% (84 of 98) of surveyed fish-bearing tributaries containing WSCT (Pierce et al. 1997, 2002, 2001, Pierce and Schmetterling 1999, Peters 1990, Results Part IV). Streams lacking WSCT are either impaired headwater streams or degraded spring creeks. Outside of the Clearwater River drainage, WSCT stocks include migratory (*fluvial*) and non-migratory (*resident*) fish. Fluvial fish have a sympatric resident component. Both resident and fluvial WSCT rely on high quality tributary habitats for spawning, rearing and over-wintering, and both often inhabit the same stream. Resident fish can also maintain populations in isolation, occupying less than one mile of perennial stream in some cases (Pierce et al. 2001), whereas access to the Blackfoot River is also necessary for fluvial fish (Results Part IV). Fluvial WSCT spend early life stages in smaller streams, migrate to rivers at age 2 - 3 where they mature and grow to much larger size than resident fish, before returning to natal tributaries at ~ age 5 to spawn (Behnke 1992).

In Montana, only 8 - 20% of the historical range is occupied by genetically unaltered fish (Shepard et al. 2003). By contrast, WSCT genetic tests in the Blackfoot watershed show a high degree of genetic purity over large areas of the watershed, particularly in the upper watershed upstream of the confluence of the North Fork (Figure 6). For the watershed as a whole, 52 of 72 (72%) streams tested for introgression supported unaltered WSCT stocks. Twenty five percent (n=17) of tested streams ranged from 90 - 99.9% unaltered, and 4% (n=3) of tested streams were <90% introgressed (Figure 6). Telemetry studies show WSCT utilized the entire Blackfoot River (Schmetterling 2001, Results Part IV). Introgression

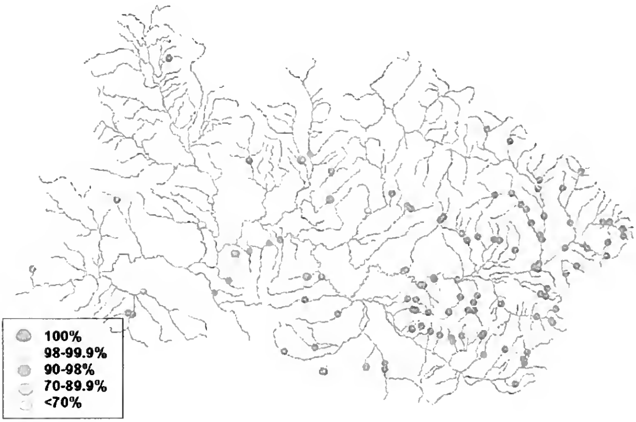


Figure 6. WSCT genetic samples sites and results for 72 tributaries of the Blackfoot Watershed (MRIS 2003, FWP files, *this report*).

of some fluvial stocks occurs the lower elevations of the watershed (downstream of the North Fork) and conform to the general distribution of fluvial rainbow trout (Figure 8). However, genetic testing has also identified outliers to the generally low-elevation distribution pattern where lake populations of hybridizing species (rainbow and Yellowstone cutthroat trout) are established (Appendix M). These include wilderness areas of the North Fork of the Blackfoot River and Landers Fork drainages and the Nevada Creek watershed near Nevada Reservoir. We have also identified a private pond in the Union Creek drainage as a source of hybridization.

During 2002 and 2003, the genetic composition of suspected WSCT populations was tested in 17 streams (Appendix M). Genetic testing exhibited no introgression in eight streams [(Chimney Creek (n=9), Cottonwood Creek (n=24), Dick Creek (n=27), Dunham Creek, (n=30), Little Fish Creek (n=27), Spring Creek in the Douglas Watershed (n=18), Wasson Creek (n=32) and Wilson Creek (n=22)]. Five streams contained mildly introgressed stocks (98 to 99.9%) [(Shanley Creek (n=27), Washoe Creek (n=28), Smith Creek (n=28), Fish Creek (n=25) and Game Creek (n=24)]. Populations in two streams were moderately introgressed (90 and 98% westslope markers) [Monture Creek (n=27) and Union Creek (n=16)], and two other populations were more heavily hybridized (<90% WSCT markers) [Spring Creek, tributary to the North Fork (n=27) and Blanchard Creek (n=27)].

We studied the movements and habitat use of 44 fluvial WSCT in the upper Blackfoot River drainage (a region of high WSCT genetic purity (Figure 6)), using radio telemetry (Results Part IV). Outside of wilderness areas of the North Fork, this study identified seven upper river tributaries supporting fluvial WSCT spawning, all of which have tested as genetically unaltered. WSCT migration corridors, spawning and rearing areas were located primarily on private lands at the lower tributary elevations, but often extend to mid-to-upper stream reaches located on public lands. Of the seven streams that supported fluvial WSCT spawning, five have been identified with some form of fisheries impairment (Results Part IV, Pierce et al. 2002). Most of the habitat use and impairments occur on private lands. Of all WSCT-bearing streams identified by FWP in the Blackfoot Watershed (outside of the Clearwater Watershed), 89% (72 of 81) contain anthropogenic fisheries impairments.

Spawning movements of Blackfoot River fluvial WSCT begin just prior to the rising limb of the hydrograph with adults entering spawning tributaries near the peak of the hydrograph. This movement allowed 62% of telemetered WSCT the ability to navigate intermittent reaches along migration corridors. As with bull trout, WSCT in the middle reaches of the Blackfoot River exhibited upstream and downstream movement before entering tributaries. Migrations of telemetered WSCT from wintering areas in the Blackfoot River to spawning sites ranged from 0.2 to 42.2 miles. Spawning tributaries ranged from 1st through 4th order streams. In a review of WSCT spawning behavior in Blackfoot tributaries, Schmetterling (2001) found spawners almost extensively select for habitat units formed of instream large woody debris, which provides holding areas, physical cover and retains spawning gravel.

Recovery of WSCT began in 1990 with the adoption of *catch-and-release* angling regulations for all Blackfoot Drainage streams and then expanded with habitat restoration. In conjunction with fluvial bull trout recovery, the focus of WSCT recovery is reestablishing the fluvial life-history form by: 1) reducing or eliminating *controllable* sources of anthropogenic mortality; 2) maintaining and restoring existing spawning and rearing habitats; 3) restoring damaged habitats; and 4) improving connectivity from the Blackfoot River to spawning areas. Most of the current WSCT work occurs in *core area* watersheds or other streams containing bull trout (Pierce et al. 1997, 2001, 2002; Results Part III)

To date, restoration projects in WSCT habitat has involved 38 streams. Projects focus on improving habitat conditions in both fluvial WSCT streams and streams supporting resident isolet populations. In 2002 and 2003, the Blackfoot Cooperators continued to develop or implement projects on 13 WSCT-bearing streams (Ashby Creek, Clearwater River, Cottonwood Creek, Elk Creek, McCabe Creek, Nevada Creek, Nevada Spring Creek, North Fork Blackfoot, Rock Creek, Pearson Creek, Poorman Creek, Wasson Creek and Wales Creeks) and monitored WSCT populations on 17 project streams (Results Part III). We identified limiting factors for WSCT on Wasson Creek, Little Fish Creek, Cottonwood Creek and an unnamed spring creek tributary to Wales Creek. We also identified several diversion ditches as being detrimental to WSCT populations by 1) bringing unwanted fish to areas of pure WSCT within the Nevada Creek watershed, 2) entraining WSCT from the lower Clearwater River to a large canal, and 3) entraining wild WSCT from Snowbank Creek to a *put-and-take* fishery at Snowbank Lake.

In response to harvest restrictions and tributary restoration, densities of WSCT have been increasing in the lower Blackfoot River (Johnsrud and Scotty Brown Bridge sections) since 1990 (Results Part II). In 2002, WSCT estimates (>6.0") ranged from a low of ~0.5 fish/1000' below Nevada Creek (Wales Creek Section) to ~15-20 fish/1000' at monitoring stations of the lower river (Johnsrud and Scotty Brown Bridge sections). Low densities in the Wales Creek section reflect impaired water quality and degraded tributaries in this section of river.

In response to WSCT introgression risk, we converted a private pond and public lake plants to a genetically compatible brood source of WSCT in WSCT habitat. Conversions involved: 1) rainbow trout to sterile rainbow in private ponds of the Union Creek drainage, and 2) rainbow trout to WSCT in Nevada Reservoir and Coopers Lake. Despite these changes, challenges to pond and lake management in WSCT habitat persist. Lifetime private pond permits for non-compatible species in WSCT habitat allow for example rainbow trout plants. In wilderness areas, established lake populations of rainbow and Yellowstone cutthroat trout coincide with the hybridization of WSCT.

Increasing levels of angler pressure is a growing concern for WSCT, particularly in the middle Blackfoot River where angling pressure has increased 611% since 1989 (Results Part IV). High angler pressure, compounded by high WSCT catchability in the Blackfoot River (Schmetterling and Bohnemann 2001) increases risk of disproportionate angling mortality for WSCT compared with other species. Hooking mortality generally ranges from 4.8% for barbed flies to 33.5% for barbed bait used as terminal gear (Taylor and White 1992). Based on estimates of angler pressure (2001) and WSCT densities (2002), we estimate ~ 6 anglers (per year) for every one WSCT (>6.0") present in the middle Blackfoot River (Angler Pressure Estimates 2001 - Results Part IV, Appendix C). Recent creel surveys showed WSCT comprised 34% of the angler catch (Schmetterling and Bohnemann 2001), while population estimates show the relative abundance of WSCT ranges from approximately 4 - 22% of the total Blackfoot River trout population (Appendix C). Telemetry studies and warden patrols have also revealed continued illegal harvest of WSCT in the Lincoln area (Results Part IV).

Whirling disease is generally found at elevations below most known WSCT spawning and rearing sites with some exceptions, including Chamberlain Creek, an important fluvial WSCT spawning stream in lower Blackfoot Watershed (Schmetterling 2001). Recent declines in WSCT in Chamberlain Creek coincide with the period of whirling disease escalation and the recent drought. It is not possible to separate the effects of these two threats.

Introduction

The Blackfoot River Watershed was settled in the 1860's when Union miners discovered gold near Lincoln, MT, followed soon thereafter by early ranchers and loggers. As extractive industries expanded during the industrial revolution, streams of the Blackfoot were subject to rapid environmental change, with little understanding of the ecological consequences. By the mid-1900s, waste from acid-bearing rock, dredges and placer mines led to extreme damage to many streams of the Garnet Mountains. At the lower elevations of the valley, increased irrigation and livestock production eventually led to dewatering, altered stream channels and excessive streamside grazing in the lower reaches of most tributaries. Meanwhile, segments of other streams were channelized with wetlands drained in order to expand hay production - often at government expense. As timber demands increased, riparian conifers were cut and shipped to downriver mills, first using splash dams, log drives, railway, and then eventually over an extensive network of roads – often constructed with little regard of fish passage problems, altered habitats or high sediment delivery to streams.

For more than a century, many native fish populations were compromised by not only toxic waste, dewatering, riparian degradation and disruption of migration corridors, but also by over-fishing, agency mismanagement and general public neglect. By the 1970's, environmental awareness let to a gradual shift in public values. By the mid-1980's, local public concern of a greatly diminished wild trout fishery prompted fisheries and habitat investigations of the Blackfoot River and primary tributaries. By 1990, fisheries investigations identified: 1) mining impacts in the headwaters, 2) over-exploitation of the fishery, and 3) excessive degradation of tributaries contributed to declining fish populations of the Blackfoot River. Early studies documented low densities of native WSCT at the middle to lower elevations of the Blackfoot watershed. Bull trout densities were precariously low basin-wide, with local populations extirpated from several streams.

Fish population surveys conducted in the Blackfoot River drainage found that early life-stages of salmonids rely on tributaries (Peters 1990, Pierce et al. 1997). Tributary assessments reported extensive problems that spanned multiple land ownerships and resulted in fish population declines at a watershed scale (Peters 1990, Pierce et al 1997). Low numbers of spawning adult rainbow trout (*O. mykiss*) and brown trout (*Salmo trutta*), combined with high winter mortality of young-of-the-year (YOY) and poor tributary habitats, resulted in weak recruitment to river populations for these species (Peters and Spoon 1989; Peters 1990; and Pierce et al. 1997). Reliance of native fish on upper tributaries 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) extensive use of tributaries at early life stages, fluvial native fish are even more subject to human impacts in the tributary system than introduced fishes. By contrast, non-native rainbow and brown trout spawn in lower stream reaches, migrate shorter distances, and as a result, are less prone to the same level of human-related impacts to the tributary system. These findings helped galvanize public support and focused restoration of tributaries as the basis of the Blackfoot River restoration initiative beginning in 1990.

Since 1990, the restoration program has expanded from simple riparian fencing projects, to the restoration of four streams in 1994, and then to the development of the *focus area* concept by 1996. As currently defined, the *focus area* directs restoration priority to streams within a broad area of the Ovando Valley, including many critical native fish streams. Since 1999, we have assessed 53 additional tributaries in order to identify restoration opportunities beyond the current focus area. To date, assessments have identified fisheries impairment on 88 of 95 tributaries (Appendix G). This information led to the adoption of restoration prioritization scheme (Pierce et al. 20002b).

Restoring populations of wild trout relies on the voluntary involvement of resource agencies, conservation groups and private landowners. The Big Blackfoot Chapter of Trout Unlimited is the primary watershed group involved in funding and coordinating of river restoration projects (*see* Procedures section). Recently, the Blackfoot Challenge has expanded restoration fundraising, TMDL development, teacher education, drought planning and coordination of conservation easements. Both the Western Water Project (Trout Unlimited National) and the DNRC Water Resources Bureau have increased their involvement with emphasis on instream flows. Above all, private landowners provide significant resources to restoration projects and are ultimately responsible for long-term stewardship.

Table 1. Anthropogenic fisheries impairment on 91 inventoried streams (not including the Clearwater River drainage) of the Blackfoot Watershed (Pierce et al. 2002; Appendix G).

Type of impact	Number Streams
Road crossings and road drainage	32
Irrigation impacts (entrainment, dewatering, fish passage)	36
Channel alterations	33
Lack of complexity	37
Riparian vegetation	46
Instream flow	40
Concentrated livestock in riparian areas (feedlots, grazing)	51
Recreational impacts (illegal harvest, high angler pressure, stream damage)	10
Whirling disease	9

The philosophy of managing *wild trout* through self-sustaining populations through natural reproduction provides the foundation of the Blackfoot River fisheries restoration initiative. This strategy emphasizes restoring tributary habitats to levels suitable to healthy wild trout populations. By correcting human-induced limiting factors, this strategy provides a framework for the recovery of imperiled native fish when integrated with appropriate harvest regulations, and site-specific recovery measures often undertaken in remote areas of the watershed. The Blackfoot fisheries restoration initiative further integrates the *core area* concept - including defined sets of recovery goals in bull trout watersheds. Guiding documents include *Restoration plan for bull trout in the Clark Fork River Basin and Kootenai River Basin Montana* (MBTRT 2000), the *Draft Recovery Plan for the Bull Trout and Proposed Critical Habitat* (USFWS 2002), *A Hierarchical Strategy for Prioritizing the Restoration of 83 Impaired Tributaries of the Big Blackfoot River* (Pierce et al 2002b). The recently developed *Westslope Cutthroat Trout Status Review* (Shepard et al. 2003) should also help shape future recovery plans as will many specific, research and restoration-related studies completed in the Blackfoot.

Restoration and conservation goals focus on correcting environmental degradation over multiple properties, including large tracts of connected public and private land. Recovery incorporates long-term protection (conservation easements) and restoration of biologically important but degraded streams. Improving habitat involves mostly passive (e.g. compatible grazing), but also active (e.g. channel reconstruction) measures depending on the degree of degradation and a stream's recovery potential. Restoration is also iterative and relies on continued habitat and population monitoring, expanding the scope of projects and modifying methods of restoration based on monitoring results. Iterative restoration leads to site-specific measures of individual tributary populations and involves restoration methods such as enhancing flows in rearing areas, preventing juvenile fish loss to irrigation in critical migration corridors, reconstructing streams, fencing livestock from critical spawning areas, and expanding these types of actions to biologically connected tributaries. Our current program does not (at this time) involve removal of non-native game fish due to lack of social acceptance, high cost, general ineffectiveness and other risks.

Since 1990, the Blackfoot Cooperators have developed or implemented fisheries improvements on 40 streams mostly on private lands. Most of the implemented projects have been successful, however project setbacks have occurred (Results Part III). Landowners are intimately involved in all aspects of fisheries restoration from baseline data collections to post-project monitoring. Attempts to address limiting factors usually involve integrating both fisheries and landowner objectives. Upon project completion, a period of rest and recovery is usually essential to meet fisheries objectives. Table 2 summarizes projects undertaken to date (*see* Appendix F and Appendix H for cooperators).

Table 2. Restoration activities in 40 tributaries of the Blackfoot Watershed (Pierce et al. 2002b, Results Part III).

Restoration Activity	Number Streams
Fish passage improvement (road crossings, irrigation diversions)	27
Prevention of fish losses to ditches	13
Spawning habitat protection	9
Fish habitat improvement	18
Instream flow enhancement	17
Improve wetlands	15
Improve range/riparian habitat	29
Improve irrigation diversions	22
Conservation easements	23
Remove streamside feedlots/corrals	13

Primary objectives of this report are to: 1) summarize the status of Blackfoot River fish populations; 2) summarize Blackfoot River restoration, inventory and monitoring results for restored streams; 3) present the results of an upper Blackfoot River telemetry and other studies, and 5) help guide future restoration actions.

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 1,596 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.

Current land ownership in the Blackfoot watershed is 42% National Forest, 25% private ownership, 19% Plum Creek Timber Company, 7% State of Montana, and 6% Bureau of Land Management. 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 7). 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 40 of these streams. The majority of habitat degradation occurs on the valley floor and foothills of the Blackfoot watershed and largely on private agricultural ranchlands. However, problems also extend to commercial timber areas, mining districts, and state and federal public lands.

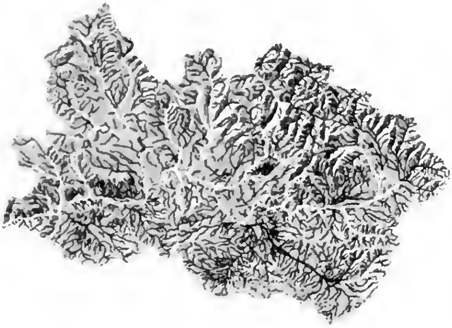
The Blackfoot River is one of twelve renowned "blue-ribbon" trout rivers in Montana with a 1972 appropriated "Murphy" in-stream flow water right of 700 cfs at the USGS Bonner gauging station. Montana Fish, Wildlife and Parks manages the Blackfoot River and tributaries for a diversity of self-sustaining "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 8). Species assemblages and densities of fish can also vary greatly at the lower elevations of the watershed. Native species of the Blackfoot Watershed are bull trout (*Salvelinus confluentus*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*), mountain whitefish (*Prosopium williamsoni*), pigmy whitefish (*Prosopium coulteri*), longnose sucker (*Catostomus catostomus*), largescale sucker (*Catasomus macrocheilus*), northern pikeminnow (*Ptychocheilus oregonensis*), peamouth (*Mylocheilus caurinus*), redside shiner (*Richardsonius balteatus*), longnose dace (*Rhinichthys cataractae*) slimy sculpin (*Cottus cognatus*) and mottled sculpin (*Cottus bairdi*). Non-native species of the Blackfoot Watershed include rainbow trout (*Onorhynchus mykiss*), kokanee (*O. nerka*), Yellowstone cutthroat trout (*O. clarki bouvieri*), brown trout (*Salmo trutta*), brook trout

(*Salvelinus fontinalis*), artic grayling (*Thymallus arcticus*), white sucker (*Catostomus commersoni*), fathead minnow (*Pimephales pomelas*), northern pike (*Esox lucius*), brook stickleback (*Culaea inconstans*), Pumpkinseed (*Lepomis gibbosus*), largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens).*

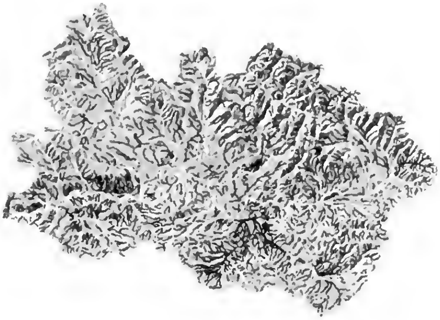
Most salmonids (WSCT, bull trout, rainbow trout and brown trout) in the river system exhibit fluvial migratory life-history characteristics, whereas tributaries support both migratory and resident populations. WSCT have a basin-wide distribution and is the most abundant species in the upper reaches of 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 7. Land ownership map of the Blackfoot River Watershed.

Figure 8. Trout distribution in the Blackfoot River watershed.

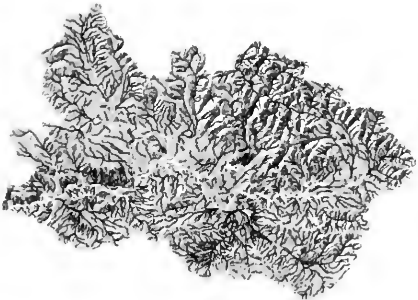


Bull Trout

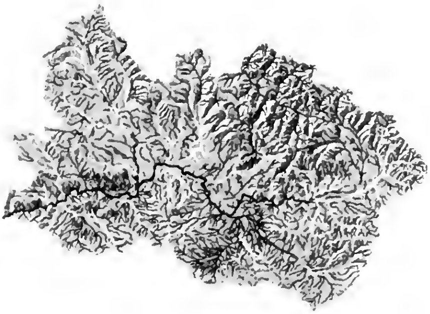


Westslope Cutthroat Trout

Rainbow Trout



Brown Trout



Brook Trout

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 dewatering, 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 and incorporate landowner needs (such as irrigation and grazing objectives). Projects 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 non-profit 501(c) three status watershed groups provide a mechanism for generating private funds.

State (FWP) and Federal (USFWS) biologists coordinate private land restoration efforts in close coordination with other agency staff, landowners and watershed groups. A lead biologist generally enlists help from interagency personnel including range conservationists, hydrologists, engineers, and water right specialists as necessary. In turn, the watershed groups help prioritize projects, help with fundraising, administer budgets, solicit bids, assist with landowner contacts, resolve conflicts and help address other social issues.

Project funding 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 watershed groups 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 (10-30 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, to development 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 Estimators

Fish population densities were calculated using single-pass, mark-recapture, or multiple pass-depletion methods. We used mark-recapture in the Blackfoot River (Appendix C) and depletion estimates (Appendix B) and single pass catch-per-unit-effort (CPUE) in smaller streams (Appendix A).

Population densities using the mark-recapture method were estimated using Chapman's modification of the Petersen formula (Ricker 1975), and standard equation for calculating variance. For this estimator:

$$N = \frac{(M+1)(C+1)}{R+1} - 1$$

$$V(N) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

Where:

N= population point estimate
M= the number of marked fish
C= the number of fish captured in the recapture sample
R= the number of marked fish captured in the recapture sample
V (N)= variance for point estimate

Confidence intervals (CI) were calculated using the equation $N \pm 1.96\ (V(N))^{-2}$ and calculated at the 95% confidence level (Appendix C).

For fish population estimates in small stream, we used a standard two-pass depletion estimator and standard equations for calculating variance (Leathe 1983). For this estimator:

$$N = \frac{(n_1)^2}{n_1 - n_2}$$

$$P = \frac{n_1 - n_2}{n_1}$$

Where:

N = point estimate,
n_1 = the number of fish collected on the first pass
n_2 = number of fish captured on the second pass
P = probability of capture (≥ 0.5 for $N \geq 50$, ≥ 0.60 for $N \leq 50$ for valid estimates)

$$\text{Standard deviation} = \frac{n_1 n_2 (n_1+n_2)}{(n_1-n_2)^2}^{-2}$$

95% confidence interval = N ± 1.96 (Standard deviation). The 95% confidence intervals for these estimates are found in Appendix B.

For small stream population assessments, we also used a single pass catch-per-unit effort (CPUE) method, which provides an index of trout abundance (Appendix A). For this CPUE, we also developed simple linear regressions (for fish < and > 4.0") to help predict densities from CPUE (Figure 9). These regressions show a significant correlation between CPUE and density (P= <0.001). Small stream size and highly efficient electrofishing conditions in study streams contributed to this outcome. Although these regressions demonstrate 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' 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'.

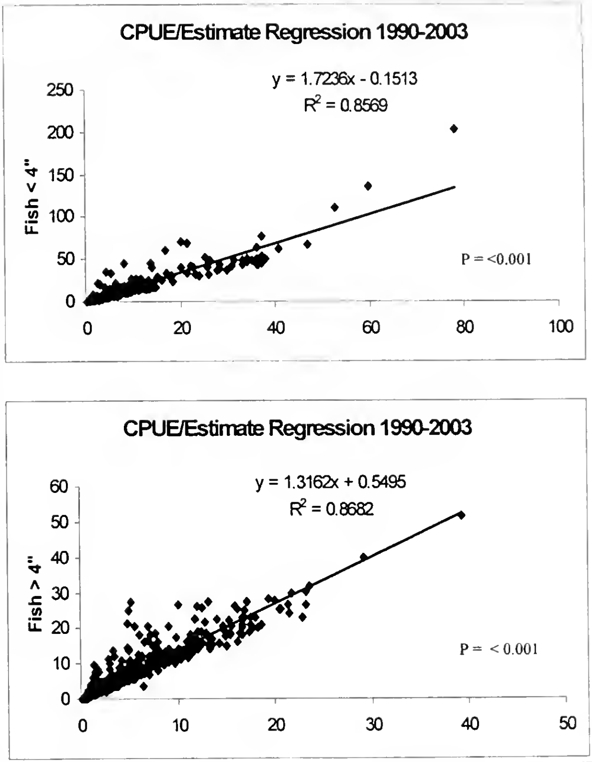


Figure 9. Regressions used to predict densities from CPUE for fish < 4.0" (top) and for fish >4.0" (bottom).

Fish were captured using a boat or backpack mounted electrofishing unit. In small streams, we used a 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 Blackfoot River 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 the 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 tricaine methanesulfonate (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.

Whirling Disease Sentinel Cage Studies

Whirling disease surveys involving sentinel fish exposures were undertaken in the Blackfoot Watershed in 2002 and 2003. Sentinel cage studies are controlled experiments used to detect levels of whirling disease. Cages consist of an 18 x 24" cylindrical screened container placed into a stream site, which allows stream water to flow through the cage. Each cage contained 50 uninfected rainbow trout or WSCT (35-60 mm) supplied by a state fish hatchery. In specific studies, brook and brown trout were also used to detect levels of whirling disease infection. Timing of field exposure was based on anticipated mean daily temperatures in the 50's (F), which correlates with peak triactinomyxon (TAM) production, and corresponds to peak infection rates in fish (Vincent 2000), except in spring creeks (Kleinschmidt and Nevada Spring Creek) where recent research indicated peak infection occurred in late winter and early Spring (Anderson 2004). The exposure period for each live cage was standardized at 10 days. At the end of the 10-day exposure period, the trout were transferred to Pony, MT, where they were held for an additional 80 days at a constant 50 °F temperature to insure the WD infection if present would reach its maximum intensity (Vincent 2000). At the end of the holding period, all 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 using the MacConnell-Baldwin histological grading scale, which ranks infection intensity from 0 (absent) to 5 (severe) (Baldwin et al. 2000). 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). Each sentinel cage also had an accompanying thermograph to establish mean daily water temperatures during the exposure period.

WSCT Genetic Investigations

In 2002 and 2003, seventeen WSCT-bearing streams were tested for genetic composition. Samples consisted of non-lethal tissue samples (fin-clip) taken from a minimum 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 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. 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. Results of WSCT genetic tests are in

Appendix J.

Stream Temperatures

During 2002 and 2003, 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. Temperature sensors were placed near the confluence with the Blackfoot River for these 22 tributaries. Water temperatures (^{o} 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 I. All water temperature data collected between 1997-2003 (92 sites with 180 individual data bases) was also complied into a GIS (ArcView) layer. We tested temperature differences using t-tests and results were considered significant at ≤ 0.05

Objectives of the temperature data collections were to: 1) continue long-term data collections at established monitoring sites; 2) 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 winter baseline data in areas of anchor ice and upwelling, and compile data for future studies.

Natural channel design and fish habitat restoration (*from* Brown et al. 2001).

Habitat restoration relies on both *passive* and *active* methods. Passive methods rely on changes to riparian areas by addressing the sources of the degradation, which generally requires incorporating grazing BMPs in degraded riparian areas, enhancing instream flows and screening irrigation ditches. Active restoration methods involve entering the channel with machinery and reconstructing severely damaged streams, or directly restoring and enhancing habitat features to areas of *simplified* habitat.

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. Methods involve a geomorphic approach that fits the proper stream to the proper stream valley. 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, and provide higher quality and more complex habitat than altered or unstable streams. Geomorphic indicators (bankfull channel), prediction analysis (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 ratios 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 ratios 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 to provide a diverse and complex channel capable of conveying flows, transporting sediment, and integrating 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 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.

Results/Discussion

Results Part I: Blackfoot River Environment

Blackfoot River Discharge: USGS Bonner gauging station #12340000

By 2002 and 2003, the Blackfoot River watershed was subject to a third and fourth year of consecutive drought. Mean discharge was 1501 cfs in 2002 and 1330 cfs in 2003, compared with a long-term mean of 1596 cfs (Figure 10).

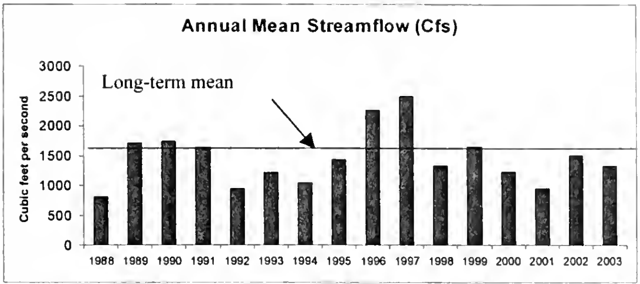


Figure 10. Annual mean discharge for calendar years 1988-3003.

The relative drought index for the Blackfoot River at Bonner showed daily river discharge at <75% of mean monthly flow on 135 days for 2002 and 196 days for 2003, with daily river discharge <50% of monthly mean on 16 and 23 days respectively (Figure 11). For the calendar year 2002, flows were particularly low during late winter and early spring with daily flows <75% of mean monthly for 77 of 121-day period between February and May. During 2003, winter flows approached normal although non-winter flows (May-October) were very low, falling to <75% of mean monthly flows on 149 of 184 days.

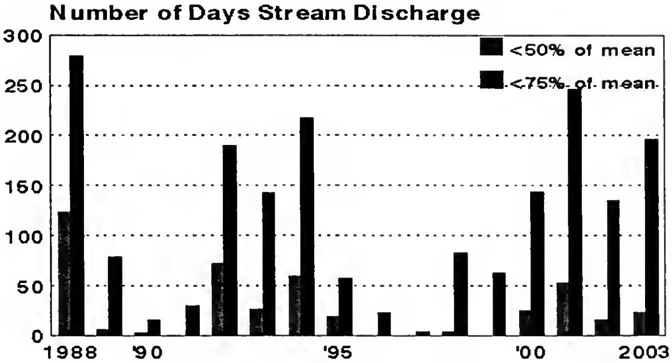


Figure 11. Relative drought index near Bonner: number of days river discharge was < 50% and < 75% of monthly mean for calendar years 1988-2003

Blackfoot River and tributary temperatures

Collecting watershed-wide water temperatures is a major element to a habitat assessment and monitoring program (Figure 12). Temperatures studies during 2002 and 2003 involved: 1) baseline and long-term data collections at established sites throughout the Blackfoot watershed; 2) assessing tributary restoration projects; 3) identifying thermal regimes (natural and anthropogenic) favorable and unfavorable for trout; 4) monitoring temperature triggers of the Drought Plan; and 5) relating other biological assessments (movements, spawning, etc.) to thermal properties of the river system. Summaries of temperature data are found throughout this report. All raw and summary data for all monitoring sites are located in Appendix I.

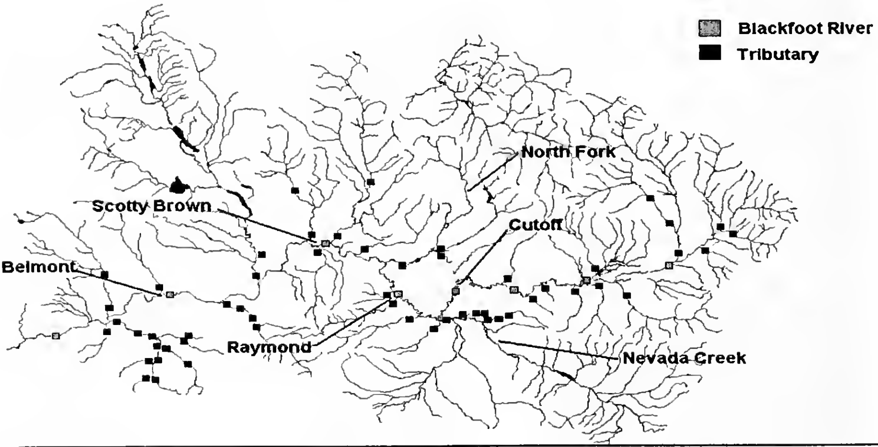


Figure 12. Water temperature monitoring sites for the Blackfoot watershed 2002 and 2003.

During 2002 and 2003, we collected 78 water temperature samples at 59 locations in 38 tributaries, along with 13 samples at seven sites in the Blackfoot River (Appendix I). Figure 13 shows a portion of the river data for critical summer periods between 1997-2003. These data outline the warming (Nevada Creek) and cooling (eg. North Fork) influences of key tributaries and the general summer-time thermal properties of the lower ~70 miles of the Blackfoot River.

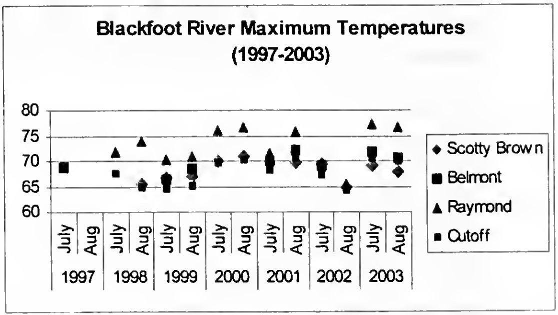


Figure 13. Maximum water temperatures for four locations of the Blackfoot River, July and August 1997-2003.

Results Part II: Blackfoot River Trout Populations

In June 2002, we completed bi-annual fish population surveys at two long-term monitoring sections (Johnsrud and Scotty Brown Bridge) of the lower Blackfoot River. We also established a new population survey site - the Wales Creek section - in the middle Blackfoot River downstream of Nevada Creek between river mile 60.0 and 67.0

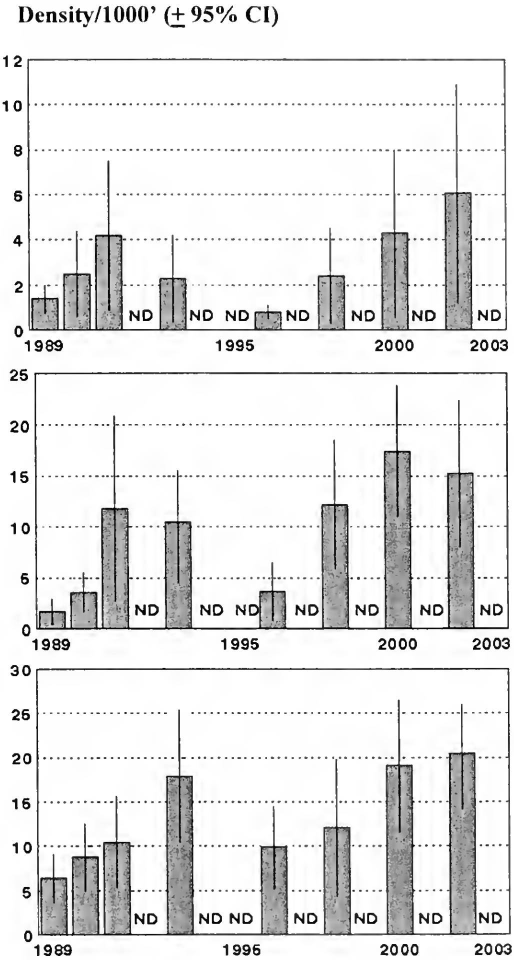


Figure 14. Estimated densities (fish>6.0") of bull trout (top), WSCT (middle) and brown trout (lower) in the Johnsrud section, 1989-2003.

Johnsrud Section

The 2002 trout species composition (% of total catch) in the Johnsrud section was 64.3% rainbow trout (n=617), 20.5% brown trout (n=197), 11.4% WSCT (n=109) and 3.8% bull trout (n=37). Compared with 2000, this represents a relative increase in brown trout and bull trout, a decline in rainbow trout and no change in WSCT. Based on the total trout point estimate, the overall trout (> 6.0") density decreased 23% from 171 to 132 fish/1000' between 2000 and 2002. This decline occurred primarily within the small-to-intermediate rainbow trout size classes (Figure 16). The 2002 point estimate for small rainbow trout (5.0-9.9") decreased from 99 to 67.4 fish/1000'. Rainbow trout in the intermediate (10.0-11.9") size class also decreased from 27.0 to 19.5 fish/1000' between 2000 and 2002. Larger rainbow trout (> 12.0") increased from 17.9 to 32.2 fish /1000' (Figure 16).

From 2000 to 2002, the combined densities of WSCT, bull trout and brown trout (> 6.0") remained generally stable. For native WSCT (> 6.0"), densities decreased slightly from 17.4 to

15.2 fish/1000' (Figure 14). Densities of native bull trout (> 6.0") increased from 4.3 to 6.1 fish/1000' (Figure 14). The 2002 point estimate for brown trout (> 6.0") remained static at 20.1 compared with 19.1 fish/1000' in 2000 (Figure14).

In 2002, we observed two northern pike in the Johnsrud section, compared with six in 2000, two in 1998, one in 1996, and none prior to 1996.

Scotty Brown Bridge Section

The 2002 percent trout composition for the total catch in the Scotty Brown Bridge section was 38.7% rainbow trout (n=276), 31.5% brown trout (n=225), 23.0% WSCT (n=164), 6.7 % bull trout (n=48) and 0.1% brook trout (n=1). Total trout (fish >6.0") densities decreased ~8% from 98 to 90 fish/1000' between 2000 and 2002.

Densities of smaller rainbow trout (4.0 - 10.9") decreased from 25.1 to 12.7 fish/1000' between 2000 and 2002. Rainbow trout in the intermediate (11.0 - 13.9") class also decreased from 8.2 to 6.2 fish/1000'. Densities of large rainbow trout however (fish >14.0") increased from 9.2 to 24.5 fish/1000' (Figure 16).

The point estimate for brown trout (>6.0") was static with 24.1 fish/1000' in 2000 compared with 23.8/1000' in 2003 (Figure 15).

Estimated bull trout densities (fish >6.0") decreased from 7.7 to 5.1 fish/1000' between 2000 and 2002. WSCT densities (fish >6.0") also decreased from 23.0 to 20.3 fish/1000' between 2000 and 2002 (Figure 15).

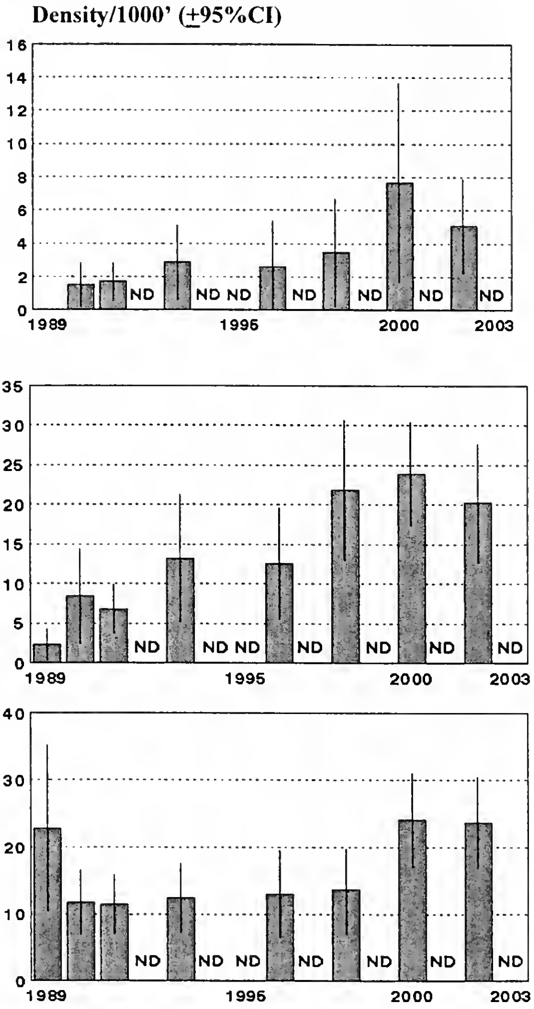


Figure 15. Estimated densities (fish>6.0") of bull trout (top), WSCT (middle) and brown trout (bottom) for the Scotty Brown Bridge section, 1989-2003

Unlike the Johnsrud section, we have not observed northern pike in the Scotty Brown Bridge section in samples to date.

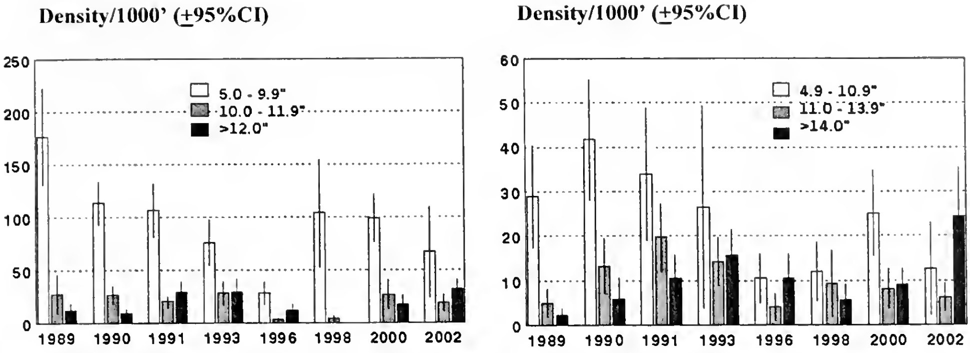


Figure 16. Estimated Rainbow trout densities for the Johnsrud (left) and Scotty Brown Bridge (right) sections, 1989-2002.

<u>Wales Creek Section</u>

In 2002, we established a new fish population survey site (the Wales Creek section) in a middle reach of Blackfoot River between the North Fork Blackfoot River and Nevada Creek (rm 60.0-66.2). This section of the Blackfoot River suffers from impaired water quality (elevated levels of fine sediment, summer water temperatures, and nutrient levels) and degraded tributaries (Pierce et al. 2001).

In May 2002, trout species composition (% of total catch) in the Wales Creek section was 82.9% brown trout (n=136), 9.1% rainbow trout (n=15), 6.1% WSCT (n=10) and 1.8% bull trout (n=3). We estimated total trout density (> 6.0") for the Wales Creek section at 12.7 fish /1000'. Of this, the brown trout (> 6.0") point estimate was 10.1 fish/1000'. We did not attain density estimates for the other species due to low densities and small sample size. Estimated total trout densities (>6.0") in the Wales Creek Section are 86% lower than the nearest downstream survey section (Scotty Brown Bridge Section). A comparison of estimated densities of salmonids in the three 2002 Blackfoot River survey sections are displayed in Figure 3.

Results Part III: Restoration-Related Tributary Assessments

Seven previous Blackfoot River reports detail Blackfoot River restoration projects, beginning in 1990 (Peters 1990; Pierce 1990; Pierce, Peters and Swanberg 1997; Pierce and Schmetterling 1999; Pierce and Podner 2000; Pierce, Podner and McFee, 2001-2002). The following section summaries the 2002 and 2003 tributary findings and synthesizes new monitoring and restoration updates for 20 project 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 to the lower Blackfoot River, flows six miles north to its mouth where it enters the Blackfoot River at river mile 12.2 with a base flow of 3-5 cfs. Bear Creek is one of the colder tributaries to the lower Blackfoot River. For August 2002 and 2003, mean daily temperatures (mile 1.0) were in the low 50's with maximum summer temperatures ~6^{0} F cooler than the Blackfoot River at the USGS gauging station at river mile 7.9 (Appendix I).

Bear Creek has a long history of adverse habitat changes. These include placement of undersized culverts, road drainage and siltation, irrigation, channelization of the stream, excessive riparian grazing and streamside timber harvest (Pierce et al. 1997; Pierce and Schmetterling 1999). These activities, implemented without fisheries considerations, contributed to the loss of migration corridors, and the simplification and degradation of salmonid habitat.

Restoration of Bear Creek began in 1995, continued through 2000 and involved: 1) upgrading culverts and addressing road drainage problems; 2) improving water control structures at irrigation diversions; 3) reconstructing 2,000' of channel; 4) enhancing habitat complexity on an additional 2,000' of stream; 5) shrub plantings and the development of compatible riparian grazing systems for one mile of stream; and 6) off-stream water development.

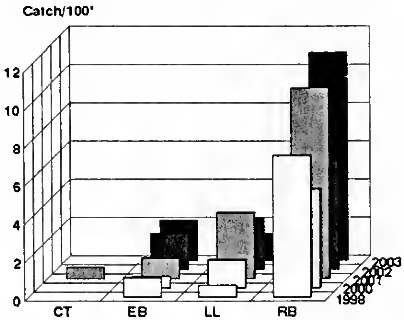


Figure 17. CPUE for salmonids (fish >4.0") in lower Bear Creek (mile 1.1), 1998-2003.

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 recruitment to the lower Blackfoot River sport fishery.

In 2002 and 2003, we continued fish population monitoring in a reconstructed section of Bear Creek. Total CPUE for all salmonids (> 4.0") is showing an overall positive trend increasing from 7.7 in 2000, to 14.7 fish/100' in 2003 (Figure 17). Increased densities (> 4.0") were noted for all species in the sample. Total CPUE for fish <4.0" decreased from 18.6 fish/100' in 2000 to 14.1 fish/100' in 2003.

Blanchard Creek

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

Project Summary

Blanchard Creek, a small 2nd order tributary to the lower Clearwater River entering at mile 2.9, has a long history of adverse land management activities, and riparian and fish habitat degradation. 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 by Missoula County road maintenance crews, excessive livestock access to riparian areas, and dewatering through irrigation.

Chronic dewatering in the lower one mile of the stream from irrigation resulted in large fish population declines. In 1991, the irrigator began increasing flows, and then entered into a water lease between 1993 and 2000 for three-cfs instream flow during the irrigation season. In 2001 with the onset of the drought, irrigation needs increased. During this time, the water right holder began to exercise a lease option to increase irrigation, thereby dewatering the stream during low flow periods of 2001-03. In spring 2004, continued drought, competing water use and declining population trends led to a decision to terminate the water lease. In 2002, the DNRC completed a needed riparian grazing project for a 2.7 mile reach (mile 1.1 to 3.8) to manage grazing on State land.

Fish Populations

Blanchard Creek is a spawning tributary for rainbow and WSCT, and supports low densities of brown trout and brook trout. During the early years of the water lease, Blanchard Creek supported high rainbow trout densities. However, since the early 1990's population monitoring recorded a downward trend in rainbow trout (> 4.0") densities (Figure 18). The trend coincides with a period of more intensive riparian grazing in lower Blanchard Creek. With increased

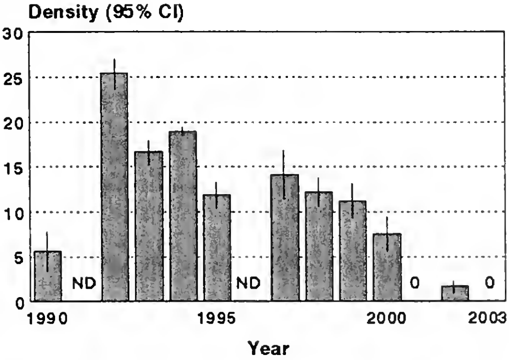


Figure 18. Estimated rainbow trout (fish >4.0") for Blanchard Creek at mile 0.1. 1990-2003.

irrigation (between 2001-03), the monitoring site (mile 0.1) was dry in 2001 and 2003. Improved grazing practice on public land upstream of the dewatered reach should help offset habitat loss in lower Blanchard Creek.

Clearwater River irrigation ditch assessment

In order to assess entrainment of fish >4.0" in total length, between May 23 and July 24 2003, we sampled an irrigation canal located at rm 3.5 on the lower Clearwater River using an Idaho picket weir trap set 0.8 miles below the diversion. Trapped game fish included gravid and spent WSCT, rainbow trout, brown trout, mountain whitefish and northern pike. Non-game fish included longnose dace, northern pikeminnow, longnose sucker and largescale sucker. The highest densities of fish were observed in June.

Following trap removal in September, we electrofished the upper 0.8 mile of irrigation ditch and netted 68 rainbow trout and 11 brown along with lower numbers of largescale suckers, northern pikeminnow and mountain whitefish (Appendix A). We also observed abundant densities of redside shiners, YOY mountain whitefish and crayfish in the ditch during trapping and electro-fishing.

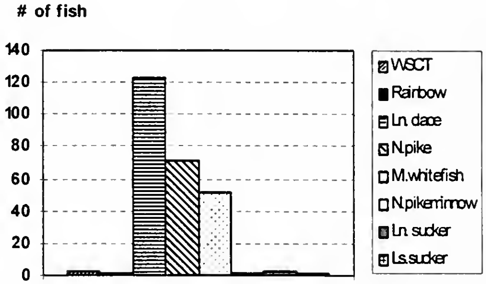


Figure 19. Relative abundance of fish collected in the Clearwater ditch weir trap, summer 2003.

Copper Creek

Copper Creek, the largest tributary to the lower Landers Fork entering at rm 3.6, is a critical spawning and rearing stream for genetically pure fluvial WSCT and fluvial bull trout in the upper Blackfoot River drainage. Copper Creek supports an entirely native fish community basin-wide, and provides the only major spawning migration of fluvial bull trout in the upper Blackfoot River basin. Copper Creek's consistent cold stream temperatures help moderate temperatures in the lower Landers Fork.

During August 2003, the Snow/Talon fire on the Helena National Forest ran through the Copper Creek drainage. This high intensity, stand replacement wildfire burned significant portions of the basin including a fluvial bull trout spawning site approximately three weeks prior to spawning. This spawning area contained adult staging bull trout, including one radioed adult bull trout as part of a 2002 and 2003 upper Blackfoot River telemetry study. During fire fighting operations, a section of the Copper Creek bull trout spawning area was subject to an accidental drop of fire retardant (Fire-trol LCG-R), considered toxic to aquatic life. Following the fire and accidental retardant drop, a fish kill was reported by the USFS. An investigation by FWP reported the telemetered bull trout was also a casualty. Water temperature monitoring approximately two miles downstream of the fire recorded no temperature increase during the fire period (Appendix I).

Fish Populations

In 2002, we duplicated fish population sampling at four long-term monitoring sites established in 1989. The combined CPUE for both bull trout and WSCT show continued static densities in Copper Creek (Figure 20). Following the fire in 2000, bull trout redd counts declined 73 % in the index reach of Copper Creek compared with 2002 and declined 80% compared with the long term mean of 20 redds (1989-2002). Future monitoring will attempt to assess the fire and post-fire related impacts to Copper Creek native fish.

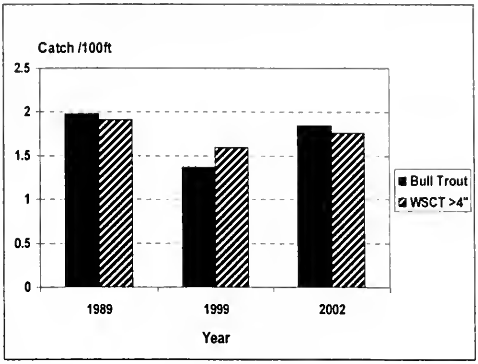


Figure 20. CPUE for bull trout and WSCT > 4" for Copper Creek (1989, 1999 and 2002).

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 tributary to the middle Blackfoot River originating near Cottonwood Lakes, flows 16-miles to its junction with the Blackfoot River at river mile 43. Cottonwood Creek supports bull trout, WSCT, rainbow trout, brown trout and brook trout. WSCT and bull trout dominate the headwaters. Genetic testing of WSCT in Cottonwood Creek in 2003 showed no introgression (Appendix J). Rainbow trout inhabit the lower mile of stream while brook trout and brown trout dominate middle stream reaches.

Impacts to fish populations and their habitats were present throughout the Cottonwood Creek drainage, although most of the identified private land problems were corrected during the 1990s. Completed restoration measures involve water conservation and water leasing, upgrading irrigation diversions with fish ladders, fish screens at large diversions, and implementation of riparian grazing changes. In 2002, the last open irrigation ditch was closed during a flood-to-sprinkler irrigation conversion. In 2003, diversion deficiencies were corrected at the Dreyer Diversion by replacing the existing diversion with a cross-vane diversion.

We also assessed a road-crossing problem related to an undersized culvert at stream mile 15.9. This undersized and perched culvert causes severe channel downcutting and high erosion immediately below the culvert, along with aggradation below the incised reach (Dave Rosgen, personal communication). This instability appears to contribute to the loss of surface flows during base flow periods and isolation of fish between the dewatered section and the perched culvert. We measured a decrease in flows from 0.4 cfs to the complete loss of surface flow over a distance of 765' in

September 2003. Cottonwood Creek also supports a high-grade whirling disease infection in the lower stream reaches. The upper stream reaches have remained negative for the presence of WD. Both reaches have been monitored between 1998 and 2003 (Results Part IV).

Project Monitoring

In 2002 and 2003, we continued to monitor fish populations in upper Cottonwood Creek in the area of a water lease, downstream of the Dreyer Diversion. The water lease was initiated in 1997, prior to which time a major diversion (Dreyer Diversion) completely dewatered a portion of Cottonwood Creek during the late irrigation season.

Fish population monitoring in the water lease area (stream mile 12.1) show increasing densities of WSCT following increased flows. The 2003 fish population data show densities of WSCT (> 4.0") have declined since the 2001, likely the result of extended drought (Figure 21).

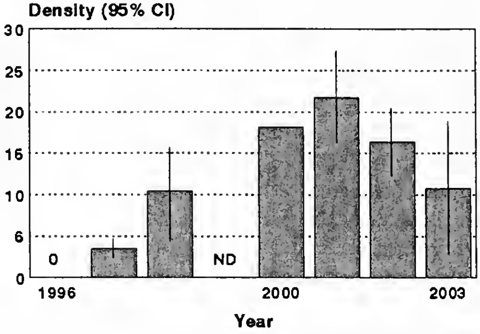


Figure 21. Estimated densities of WSCT (fish > 4.0") in Cottonwood Creek at mile 12.1, 1996-2003.

At stream mile 16, near the upper culvert problem, we recorded a CPUE for WSCT of 2.4 fish/100' above the culvert compared with 4.6 below the culvert. All fish captured below the culvert were concentrated near the culvert. We found very low numbers of bull trout below the culvert (CPUE = 0.2) and no bull trout upstream of the culvert.

Chamberlain Creek

Restoration objectives: improve access to spawning areas; improve rearing conditions for WSCT; improve recruitment of WSCT to the river; provide thermal refuge and rearing opportunities for fluvial bull trout.

Project Summary

Chamberlain Creek is a small Garnet Mountain tributary to the middle Blackfoot River, entering at river mile 43.9 with a base flow of ~2-3 cfs. Sections of lower Chamberlain Creek were severely altered, leading to historic declines in WSCT densities. Adverse changes to stream habitat included channelization, loss of instream wood, dewatering, excessive riparian livestock access, road encroachment, and elevated instream sediment from road drainage. Other problems included fish losses to irrigation ditches, impaired fish passage, and more recently the escalation of whirling disease in lower reaches.

Since 1990, Chamberlain Creek has been the focus of a comprehensive fisheries restoration effort. Projects include: road drainage repairs, riparian livestock management changes, fish habitat restoration, irrigation upgrades (consolidate ditches, water conservation, eliminate fish entrainment, fish ladder installation on a diversion), and improved stream flows through water leasing. Restoration occurred throughout the drainage but focused mostly in the lower mile of stream.

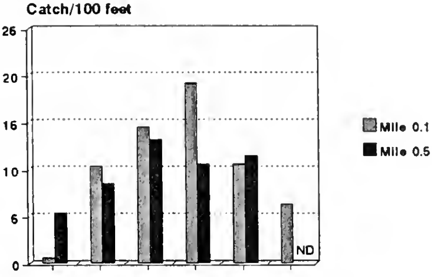


Figure 22. CPUE for WSCT (fish>4.0") in two sections of lower Chamberlain Creek, 1989-2003.

Fish Populations

Chamberlain Creek is a WSCT dominated stream over its entire length, with low densities of rainbow and brown trout in lower reaches. Chamberlain Creek supports a migration of fluvial WSCT from the Blackfoot River. Fluvial spawning occurs throughout the mainstem and extends into Pearson Creek and the East Fork of Chamberlain Creek. Beginning in 1997, we found low numbers of bull trout using the stream in areas affected by restoration. In 2002 and 2003, we continued to monitor fish populations at mile 0.1 and 0.5. These surveys show recent declines in WSCT densities in the lower-most portion of Chamberlain (Figure 22). A time-series whirling disease (Results Part IV) assessment indicates high infection levels during the WSCT emergence period. Prolonged drought and whirling disease escalation are likely contributors to recent WSCT declines.

Dunham Creek

Restoration objectives: Eliminate the loss of native fish to irrigation canals; restore habitat conditions and migration corridors; improve recruitment of bull trout and WSCT 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 channelized. This channelized stream has since become both vertically and laterally unstable, resulting in significant increases in bank and bed erosion, as well as a channel braiding in downstream reaches.

Two fisheries restoration projects were recently completed on Dunham Creek: 1) the screening of the Dunham ditch 1996 and diversion upgrades in 2002, and 2) the reconstruction of 1.3 miles of channelized stream in 2000.

Before the reconstruction project, mean bankfull width in the degraded project reach was 62.2', compared with mean stable reference bankfull width of 37.1'. The width/depth ratio of the reference reach was 22.4 compared with 59.1 in the project reach. Sediment deliveries in the project area were ~25-times 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 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. Our review of the project indicates that surface water is now reestablished to the lower portion of the reconstruction project where the channel was braided and intermittent prior to reconstruction.

Fish Populations

Dunham Creek supports populations of genetically pure fluvial WSCT, fluvial bull trout and brook trout. In 2002 and 2003, we completed bull trout redd counts and continued to monitor fish populations at mile 2.3. The 2.3-mile survey is located 0.6 miles downstream of the project,

Sixteen bull trout redds were counted during the 2002 redd surveys in Dunham Creek, of which six were located in the newly constructed channel. The 2003 surveys counted 6 redds in Dunham Creek, with none in the project areas. Early fish population monitoring at mile 2.3 shows an initial positive bull trout response to the project (Figure 23).

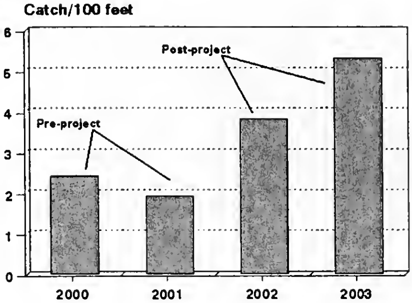


Figure 23. CPUE for bull trout in Dunham Creek (mile 2.3), 2000-2003.

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 originates in the Garnet Mountains and enters the Blackfoot River at river mile 28.0 with a base flow of ~2-3 cfs. Elk Creek, an "impaired" stream on the DEQ 303(d) list, has a long history of adverse land management activities (placer mining, channelization, road construction and improper maintenance practices, undersized culverts, road drainage problems and concentrated riparian livestock grazing) with well-documented negative influences to fish populations (Pierce et al. 1997, this report).

To begin improving water quality in lower Elk Creek, a major 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. Although this necessary project addressed a major sediment problem, subsequent monitoring of water temperature, fish populations, and suspended sediment all confirm Elk Creek failed to meet intended project benefits. Objectives were not met, as grazing prescriptions were not adhered to. Other grazing plans on adjacent riparian pastures were not implemented.

In 2003, landowners approached FWP requesting an evaluation of Elk Creek, and the development of a restoration plan. In order to begin the process of developing a restoration project, we resurveyed long-term fish population survey sections, and collected water temperatures at three sites. We also enlisted the assistance of: 1) a range conservationist to evaluate current and alternative riparian grazing strategies, and 2) David Rosgen (hydrologist) to help assess channel stability and methods of correcting channel incision.

Although lower Elk Creek tested negative for whirling disease between 1999 and 2002, samples that are more recent indicate a rapid escalation as infection levels were detected at a mean grade of 2.86 in 2003. (Results Part IV).

Elk Creek Monitoring

To assess the current condition of habitat and its fish population, we collected water temperature data at three long-term monitoring sites and conducted fish population surveys at four long-term monitoring locations. Dave Rosgen performed geomorphic assessments at two locations on lower Elk Creek.

Elevated water temperatures on lower Elk Creek are also considered a primary limiting factor adversely affecting fish populations. Our assessments show a large (~14.0 °F) temperature increase between stream mile 5.6 and 1.0 where maximum summer water temperatures approached 80° F in 2003. Water temperatures at mile 5.6 are well within the thermal tolerances for trout. Conversely, water temperatures near 1.0 are above the stress (> 73° F) levels for salmonids (Appendix 1). The incremental loss of shrubs and shade, over-widened stream banks, and the exposure of the channel to direct sunlight are likely contributors to elevated water temperatures.

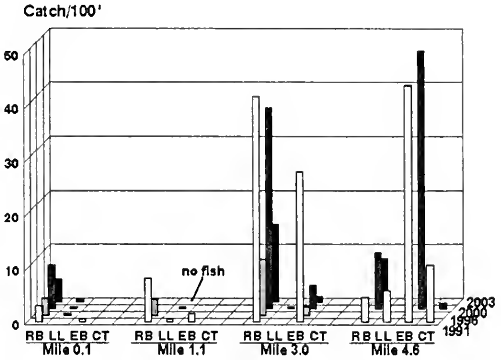


Figure 24. CPUE for salmonids captured at four locations of lower Elk Creek, 1991, 1996, 2000 and 2003

Fish populations

Fish population data collected in 2003 show similar trends to early surveys at long-term monitoring locations on lower Elk Creek, including significant reduction in trout densities in the lower Elk Creek, compared with upstream monitoring sites. Fish populations are also showing a declining trend in densities over the last decade on portions of lower Elk Creek (Figure 24). Our 2003 surveys marked the first time trout were not collected from a long-term fish population monitoring section at mile 1.1. Photo monitoring shows the incremental loss of riparian shrubs at this site. Dave Rosgen's evaluations also indicated channel incision currently occurring in the immediate area of our fisheries sample location. An initial review with Dave Rosgen indicates active incision in some areas due to grazing practices, and in others due to poor floodplain drainage through undersized culverts. Dave Rosgen recommended: 1) correcting the grazing problems; 2) widening floodplains where entrenched and actively sloughing; and 3) restoring riffle elevations up so the stream can access its floodplain at normal bankfull (i.e. 1.5 years) flows.

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-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 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 three-mile section (Schmetterling and Pierce 1999).

Gold creek has consistently tested positive for whirling disease in recent years, but at very low infection levels. Whirling disease was not detected in Gold Creek in 2003.

Fish Populations

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

In 2002 and 2003, we continued to monitor fish populations in the project area, counted bull trout redds, and monitored water temperatures. Fish population surveys, undertaken on an annual basis since 1996, indicate positive increases for rainbow and brown trout in the section (Figure 25), but no clear trend for native fish. Bull trout redd counts show a small run of bull trout reproducing in Gold Creek, with four redds counted in 2003, down from six a year earlier.

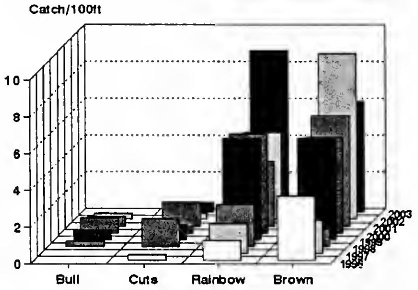


Figure 25. CPUE for salmonids (> 4.0") in lower Gold Creek (mile 1.9), 1996-2003.

Gold Creek exerts a cooling influence on the lower Blackfoot River, and appears to offer the highest quality thermal refugia (based on stream size and channel complexity) for bull trout in the lower Blackfoot River downstream of Monture Creek. In 2002 and 2003, stream temperature monitoring near the mouth recorded maximum temperatures of

67 ° F, approximately 4 ° F cooler than the Blackfoot River near Belmont Creek at mile 21.9. (Appendix I).

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 Blackfoot River bull trout.

Project Summary

Kleinschmidt Creek, located on the southern margin of Kleinschmidt Flat, is a spring creek tributary to the North Fork of the Blackfoot River, entering at mile 6.1 with a base flow of 11.4 cfs in September 2001. Kleinschmidt Creek currently supports low numbers of brown trout and brook trout, along with very low densities of bull trout, rainbow trout and WSCT. Kleinschmidt has a long history of intensive riparian grazing, with very little regard for riparian health and channel stability. In addition to livestock over-use, placement of rock dams, undersized culverts and highway channelization further degraded, and over-widened Kleinschmidt Creek (Pierce 1991). In 2000-01, the Blackfoot Cooperators reconstructed 6,250' of degraded and over-widened stream to C and E-type channels. A summary of pre-and post-project channel parameters is described by Pierce et al. 2002.

Fish Populations

In 2002 and 2003, we monitored fish populations, water temperatures and whirling disease infection levels. Fish population surveys were completed at two locations of lower Kleinschmidt Creek (mile 0.5 and 0.8) at sections established in 1998. To assess the influence of LWD in newly constructed E4-type channels, we placed no LWD in the mile 0.5 survey section during reconstruction, whereas the rest of the stream included LWD placement, including the mile 0.8 survey section.

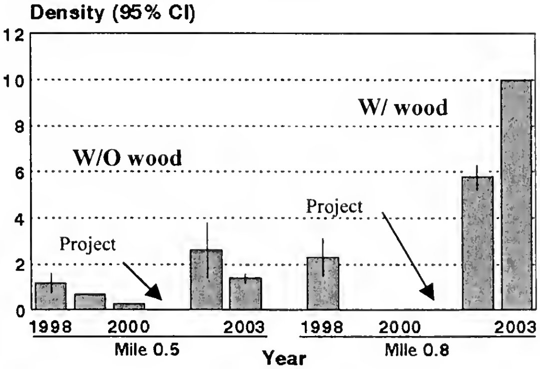


Figure 26. Estimated densities of age 1+ brown trout in two locations of Kleinschmidt creek, 1998-2003.

The 2002 estimate for age 1+ brown trout showed substantial increases at the 0.5-mile section one year post-project, compared with pre-project densities (Figure 26). Our surveys also showed significantly higher densities of age 1+ brown trout where LWD was incorporated in the channel (mile 0.8) compared with where it was not (Appendix B).

In 2003, population densities continued to increase in the section with wood but declined in the section without wood. We attribute this decline in the woodless section to excessive livestock access into the project area during the very sensitive early recovery period, and damage (hoof-shear) to stream banks. Livestock have since been fenced from the riparian area. The survey site at mile 0.8 was not subject to streamside livestock damage.

Water temperature monitoring shows moderately significant declines (Paired t-test; $P = 0.08$) following reconstruction, with maximum water temperatures ~15° F cooler post-project compared with pre-project. Whirling disease sampling shows continued high infection (results Part IV).

McCabe Creek

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

Project Summary

McCabe Creek, a cold basin-fed tributary to lower Dick Creek entering at stream mile 3.8, is located in the Monture Creek bull trout recovery area. 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 passes through a beaver-influenced wetland bog before entering Dick Creek, a lower tributary to Monture Creek, entering at stream mile 3.8.

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

A comprehensive restoration project for McCabe Creek began in 1999 and was completed in 2002. 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) replaced a county road culvert with an open-bottom box culvert. In 2001-02, the project completed the irrigation conversion, developed off-stream livestock watering, and reconstructed ~1/2 mile of stream channel. Post-project monitoring has identified excessive livestock access, damaging portions of the newly constructed stream.

Fish Populations

Benefits to fish population relate to increasing stream flows, reducing water temperatures in Dick Creek, eliminating WSCT losses to ditches, and restoring habitat complexity to a damaged stream channel.

McCabe Creek is a WSCT dominated stream, with decreased densities of brook trout in lower stream reaches. Due to cool summer

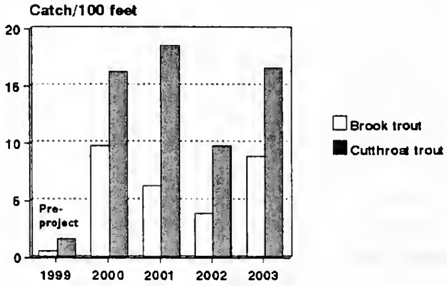


Figure 27. CPUE for all salmonids sampled in McCabe Creek at mile 2.3. 1999-2003

temperatures, McCabe Creek likely supported bull trout historically. In 1999, prior to habitat restoration, we established a fish population survey section in a degraded section of stream (mile 2.2), an area of low habitat complexity and chronic low flows. Following the initial surveys, we screened the upper diversion, enhanced stream flows by 3-5 cfs and improved habitat in the survey reach by adding LWD to the channel. We also implemented grazing changes and developed off-stream livestock water.

In 2003, WSCT (> 4.0") continued to show a positive response three years post-project (Figure 27). Less encouraging, our monitoring is also showing a proportional increase in brook trout at the monitoring site.

Monture Creek

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

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 Blackfoot River warming. Reproduction of WSCT and bull trout occurs primarily in the mid-to-upper basin. Fluvial rainbow trout and brown trout inhabit the lower portions of the drainage. Brook trout are found throughout the drainage.

Riparian areas in the mid-to-lower reaches of Monture Creek have a long history of riparian timber harvest and improper 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), which contributed to improving the health of Monture Creek.

Fish Populations and other monitoring

Monitoring for 2002 and 2003 period included: 1) bull trout redd counts; 2) assessments of juvenile abundance at long-term monitoring stations; 3) water temperature monitoring; and 4) continued whirling disease studies.

Bull trout redd counts have been upward trending since restrictive angling regulations were enacted in 1990. In 2002 and 2003 bull

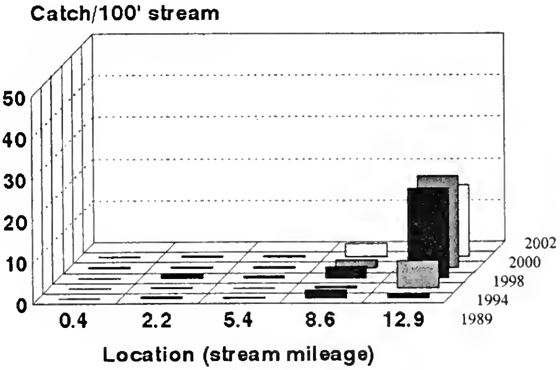


Figure 28. CPUE for bull trout captured at five locations on Monture Creek, 1989, 1994, 1998, 2000 and 2002.

trout redd counts began to level out and in 2003 declined 14% from 101 redds in 2002 to 83 in 2003. The 2003 declines are consistent with other spawning site in the Blackfoot during the fourth year of the drought. Assessments of juvenile bull trout abundance at long-term monitoring stations showed an upward trend through the 1990s and generally stable between 2000 and 2002 (Figure 28).

In 1998, lower Monture Creek tested negative for whirling disease, but tested positive in July 2000 with a 1.7 mean grade infection, which increased to a 3.2 mean grade infection in 2002. Upstream bull trout spawning sites of Monture Creek tested negative for WD in 2003.

Nevada Spring Creek

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

Project Summary

Nevada Spring Creek, a tributary of lower Nevada Creek, originates from an artesian spring and flows 3.2 miles to its junction with Nevada Creek at stream mile 6.2. The spring produces between six and nine cfs. Wasson Creek, a small, basin-fed tributary (*see* Wasson Creek section) to Nevada Spring Creek enters near the spring source with a base flow of ~2 cfs during the non-irrigation season. Water temperatures at the spring source are a constant year-around 44-47 °F (Appendix I). However, summer water temperatures increase to >70 °F within 1.6 miles of the source due to the over-widened condition of the channel (Pierce et al. 2002). In addition to warm water, Nevada Spring Creek contributes elevated levels of nitrate and phosphate to lower Nevada Creek (Pierce and Peters 1990).

A comprehensive habitat restoration project for the upper 1.6 miles of Nevada Spring Creek was completed in 2001-02. The project entailed the complete reconstruction of Nevada Spring Creek and riparian grazing changes. In fall 2003, the lower 1.6 miles of Nevada Spring Creek was also reconstructed to a deep, narrow E-type channel.

Table 3. Pre-and-post project channel measurements for Nevada Spring Creek from stream mile 1.6 to 3.2.

Measurement	Pre-project*	Post-project	%change
Stream length (ft)	8,700	11,050	+27%
Sinuosity	1.4	1.8	+27%
Wetted surface area (acres)	9.8	3.0	-69%
Wetted width (ft)	49 (14-98)	11.8(6.7-16.6)	-76%
W/D ratio	22	3.2	-85%
Pool Frequency (#/1000 ft)	5.6	17.7	+127%
Mean pool depth (ft)	2.4	3.7	+54%

* *from* Pierce 1990.

Fish populations and other project monitoring

Nevada Spring Creek supports brown trout dominated community in upper reaches and non-game species (redside shiners, northern pikeminnow, and largescale sucker) in lower reaches (Pierce et al 2002). WSCT thought to originate in Wasson Creek, also inhabit Nevada Spring Creek in low densities, although according to historical accounts were once abundant (Frank Potts, personal communication).

In 2002 and 2003, we monitored channel changes (Table 3), water temperature (Figure 29), substrate composition (Figure 30), fish populations, and whirling disease levels in Nevada Spring Creek.

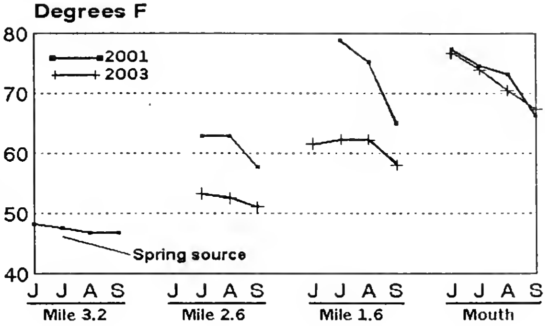


Figure 29. Maximum monthly summer water temperatures before (2001) and after (2003) 1.6 miles of channel reconstruction

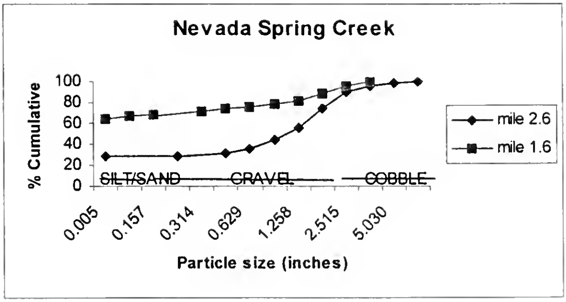


Figure 30. Summary of pebble count surveys at two locations of Nevada Spring Creek, summer 2003

The habitat survey on Nevada Spring Creek focused on measuring pools, riffles, and substrate composition on the restored sections of the spring creek. The survey began at the spring source (mile 3.2) and proceeded downstream to mile 2.0, randomly selecting a pool (1-4) and measuring every fourth pool and preceding downstream riffle. Pool measurements include: total pool length, maximum pool depth, riffle crest depth, and wetted widths at the pools maximum depth and the riffle crest. The difference between maximum pool depth and riffle crest depth was used to calculate residual pool depth. Sinuosity, valley slope and channel slope were measured with GIS using USGS digital orthophotos. Two modified Wolman pebble counts were implemented (miles 3.0 and 2.0) to determine substrate composition. Pool parameter data was summarized based on mean dimensions.

Objective for Nevada Spring Creek habitat survey were to provide an assessment of quality of post-restoration pools and substrate composition, and to provide a baseline for future monitoring efforts.

Water temperature monitoring in the upper 1.6 miles of reconstructed channel recorded large temperature declines at two monitoring locations (mile 2.6 and 1.6) below the spring source (Figure 29). Maximum summer temperatures (June through September) declined 9.6 ° F (62.8 - 53.2) at mile 2.5 and 16.5 ° F (78.7 - 62.2) at mile 1.6 (Appendix I). Water temperatures near the mouth of Nevada Spring Creek continued to record elevated temperatures in 2003 similar to 2001, but should begin to cool in 2004 following the reconstruction of lower Nevada Spring Creek.

Fish population surveys at upper Nevada Spring Creek (mile 3.0) in 2003, one-year post channel reconstruction, recorded a increase in brown trout densities compared with previous samples (Figure 31). The survey revealed higher densities of all year classes, particularly YOY indicating successful reproduction in the new channel. We also captured one WSCT YOY in the sample. Whirling disease monitoring (2002 and 2003) has not yet detected the parasite *Myxobolus cerebralis* in Nevada Spring Creek.

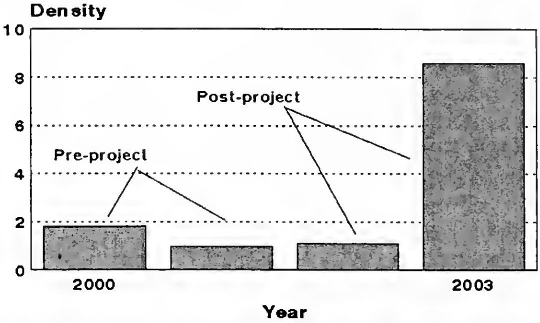


Figure 31. Estimated total brown trout densities for Nevada Spring Creek at mile 3.0. 2000-2003.

North Fork Blackfoot River

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

Project Summary

The North Fork of the Blackfoot, named the *Salmontrout Fork of the Blackfoot River* by early settlers, is the largest tributary to the Blackfoot River, with headwaters draining the Scapegoat Wilderness. Upon exiting the mountains near rm 12, the North Fork enters Kleinschmidt Flat, a large glacial outwash plain before entering the middle Blackfoot River at rm 54. Five irrigation canals, located on the Flat between mile 8.8 and 15.3, divert an estimated 40-60 cfs from the North Fork. In addition, this reach of the North Fork loses water to natural seepage.

The North Fork is a primary fluvial bull trout-spawning stream for the Blackfoot River. Bull trout recovery and related *core area* fisheries conservation projects involve developing compatible riparian grazing systems and eliminating fish entrainment on five canals. More recently, the North Fork restoration project evolved into a more holistic approach, enrolling landowners in conservation easement programs, incorporating water conservation measures in leaky ditches, and restoring habitat conditions to five impaired tributaries (Spring, Rock, Kleinschmidt, Dry and Salmon Creeks). In 2002 and 2003, the

Blackfoot Cooperators continued to work closely with landowners on a wide range of conservation measures involving instream flow enhancement, riparian grazing changes, and channel re-naturalization on North Fork tributaries.

Fish Populations and other monitoring

The North Fork of the Blackfoot River is a primary spawning tributary for fluvial bull trout and fluvial WSCT to headwater areas, and supports rainbow trout, brown trout and brook trout in the lower basin. Fisheries-related monitoring for 2002 and 2003 included: 1) bull trout redd surveys; 2) assessments of juvenile fish abundance; 3) whirling disease sentinel cage studies; and 4) water temperature monitoring.

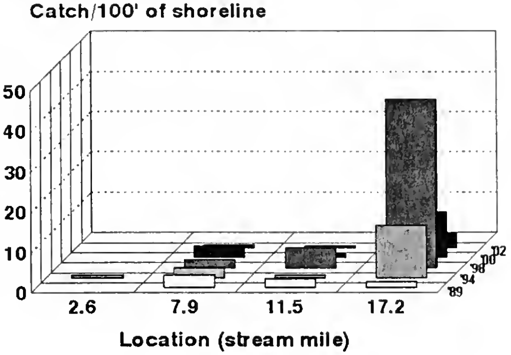


Figure 31. CPUE for juvenile bull trout in four long-term sampling sites on the North Fork 1989-2002.

Bull trout redd counts in 2002 and 2003, show declining numbers of adult spawners for the third consecutive year, declining from a high of 123 in 2000, to 41 in 2003 in the long-term monitoring reach. Monitoring of juvenile bull trout abundance in four long-term monitoring sections of the North Fork, also show a sharp decline during the drought (Figure 31). For the first time in 2002, we recorded no YOY bull trout at the uppermost survey section at mile 17.2.

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 detected in the Blackfoot River at Raymond Bridge (mile 60.2).

Whirling disease is present the lower North Fork, and its two primary lower tributaries, Kleinschmidt Creek and Rock Creek. The disease is currently absent from upstream bull trout spawning sites in the North Fork (Results Part IV).

Pearson Creek

Restoration objectives: restore the stream to its original channel; improve stream flows, access to, and the condition of a historical fluvial WSCT spawning site.

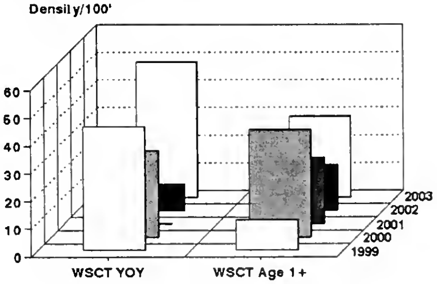


Figure 32. Estimated densities of WSCT in Pearson Creek at mile 1.1, 1999-2003.

Project Summary

Pearson Creek is a small tributary to Chamberlain Creek with a base-flow of approximately one cfs. Pearson Creek has a history of channel alterations, and adverse irrigation and riparian land management practices in its lower two-miles of channel. The Pearson Creek restoration effort included conservation easements, water leasing, channel reconstruction, riparian habitat restoration and improved riparian grazing management.

Fish Populations

In September 2002 and 2003, we re-sampled WSCT in lower Pearson Creek (mile 1.1) in a stream reach influenced by a water lease and related riparian improvements (riparian fencing and habitat restoration). Between these sampling periods, we found a large increase in WSCT densities following changes to a more sensitive riparian grazing methods (Figure 32).

Poorman Creek

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

Project Summary

Poorman Creek is one of the larger tributaries entering the Blackfoot River from the Garnet Mountains, entering at river mile 108.0. In 1999, we assessed fish populations and habitat conditions on lower Poorman Creek. These surveys identified fish loss to ditches, and extensive habitat problems in the lower two miles of stream. These initial surveys help set the stage for a comprehensive restoration project. This project involves the conversion of flood to pivot irrigation (consolidation of two ditches to a single pipe), screening of the intake, instream flow enhancement and riparian grazing changes. Grazing changes involve corridor fencing (FSA *continuous conservation reserve* program), off-stream water developments, shrub planting, the removal of two culverts, and the construction of three bridges. This combined project should be completed in 2004.

Fish Populations

Poorman Creek supports populations of WSCT, brown trout, and brook trout, and is one of only two known Garnet Mountains stream to support bull trout reproduction. In 2001, we established fish population monitoring sites immediately upstream and downstream of the irrigation project. In 2003, we repeated the surveys in order to develop a better pre-project baseline for the irrigation project. Findings in 2003 were similar to 2001, with large declines in trout

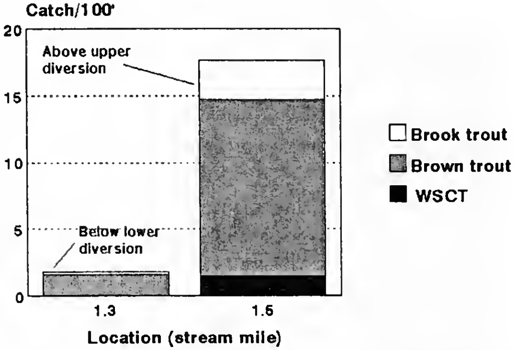


Figure 33. CPUE for salmonids above and below two diversions on Poorman Creek, August 2003.

densities below the lower diversion compared with above the upper diversion (Figure 33).

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 of the Blackfoot River, has been the focus of restoration since 1990.

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 to a wide range of past channel alterations and riparian management activities (Pierce 1990; Pierce et al. 1997).

In 2002, the Blackfoot cooperators reconstructed ~3,000' of floodplain in an over-widened section of stream between mile 3.0 and 3.8. This project focused on importing sod-mats and included shrub plantings, along with fencing and off-stream water developments. To date, this brings the total amount of restored stream to ~7.2 miles.

Fish Populations

Rock Creek supports spawning migrations of brown trout and rainbow trout in lower reaches, and brook trout throughout the length of the stream. Middle reaches provide bull trout rearing and fluvial migration corridors to small headwater populations. In 2002, we continued to survey fish populations in a section (mile 1.6) of stream reconstructed in 1999. Our surveys show an increase in densities (Figure 34) and a shift from a brook trout to a more brown trout dominated community (Appendix A). Bull trout and rainbow trout also periodically utilize this portion of Rock Creek in lower abundance.

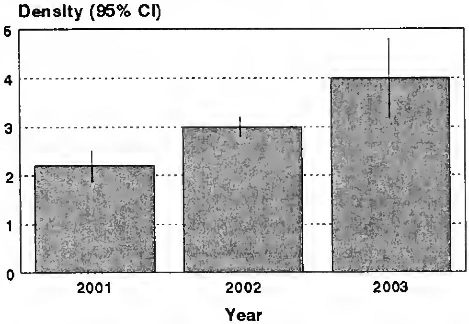


Figure 34. Total trout densities (fish > 4.0") for Rock Creek at mile 1.6, 2001-03.

Wales Creek

Restoration objective: improve habitat conditions for resident WSCT above Wales Creek Reservoir; improve instream flows and overall habitat conditions below Wales Creek reservoir; increase recruitment of WSCT to the Blackfoot River.

Project Summary

Wales Creek is a small tributary to the Blackfoot River entering at river mile 60.2 with a base flow of ~1-2 cfs. A reservoir at mile 2.4 provides irrigation storage and forms a total barrier to upstream movements of WSCT. Wales Creek is one of the few streams in the Blackfoot Watershed where a significant amount of the watershed consists of weathered granite. Streams with this geologic composition are particularly vulnerable to sediment related impacts. In 2003, we began to assess Wales Creek from a restoration perspective. The assessment will carry into 2004 and focus on irrigation and instream flow needs, and determine if sufficient water is available for both.

Fish Populations

Wales Creek above the reservoir supports a native fish community of genetically pure WSCT and sculpins. Below the reservoir, Wales Creek supports WSCT, brown trout and very low rainbow trout densities near the mouth. In 2003, we measured flows and completed fish population surveys above and below the reservoir, as well as in a small spring creek tributary to lower Wales Creek. Our flow measurements recorded 0.9 cfs above the reservoir (mile 2.6), no flow immediately below the reservoir (mile 1.9), 1.1 cfs at mile 0.3, and 1.0 cfs (mile 0.1) below a small spring creek near the mouth.

Surveys showed higher densities of WSCT upstream of the reservoir (mile 2.6) than below the reservoir (mile 0.1), and the relative abundance of brown trout increased near the mouth (Figure 35). We captured brown trout and low densities of WSCT in the unnamed spring creek, with a combined CPUE of 6.6 fish/100'.

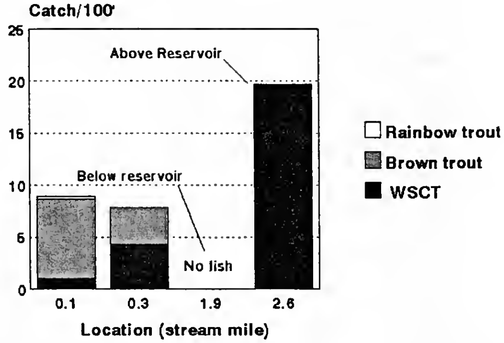


Figure 35. CPUE for salmonids at four sampling locations on Wales Creek, October 2003.

Warren Creek

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

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 rm 50, with a base flow of ~3-4 cfs. Warren Creek water is used for irrigated hay production and livestock watering. Irrigation causes the middle section of Warren Creek to dewater, although the lower section gains inflow from springs and maintains perennial base-flows 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, all contributing to the dedregation of salmonid habitat over most of the length of Warren Creek. Whirling disease had escalated in Warren Creek from mean grade of 0.21 in 1998 to a high of 2.1 in 1999. 2003 monitoring recorded a decline in infection levels (mean grade 0.06).

In 2001, we completed the restoration of lower Warren Creek on 3.4 miles (mile 0.6 and 4.0) of stream, with emphasis on channel reconstruction in areas of historic channel dredging. Grazing management changes, riparian shrub plantings and restoration of two drained wetlands were also incorporated. This project increased stream length by 46% (6,080' to 8,870') in a straightened section. The Blackfoot cooperators are currently in the developmental phases of a similar upstream restoration project.

Fish Populations

In 2002 and 2003, we continued fish population and temperature monitoring in the project reach. In 2003, we observed a decline in brown trout densities in lower Warren Creek. Lower Warren appears to be prone to elevated sediment levels and drought stressors, including low flows and elevated water temperatures. We also observed the clinical signs of whirling disease (cranial deformities) in a high percentage of sampled brook trout. We established a new fish population survey section in 2003 (mile 6.7) in order to collect baseline fisheries information in an upcoming project area. Fish collected in this survey section, located in an area with extensive habitat problems (channelization, excessive grazing and dewatering), were limited to very low densities of brook trout (Figure 36).

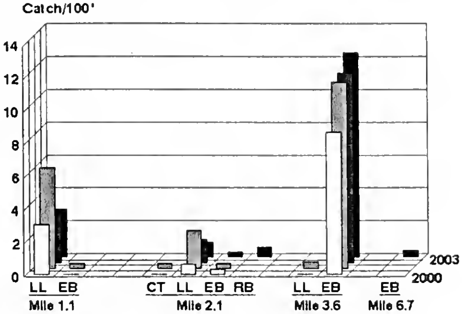


Figure 36. CPUE for salmonids (fish >4.0") in four sections of Warren Creek.

Wasson Creek

Restoration Objectives: Restore flows and habitat conditions suitable to WSCT; improve spawning and rearing conditions for WSCT, and increase downstream recruitment to Nevada Spring Creek.

Project Summary

Wasson Creek is a small basin-fed tributary to Nevada Spring Creek. Wasson Creek begins on the Helena National Forest, then enters private ranchland, before entering Nevada Spring Creek immediately below the spring source with a base flow of ~2 cfs during the non-irrigation season. In 2003 we began to evaluate Wasson Creek from a fisheries restoration perspective. This involved fish population sampling upstream and downstream of major diversions, as well as near the mouth. In addition, a consultant to

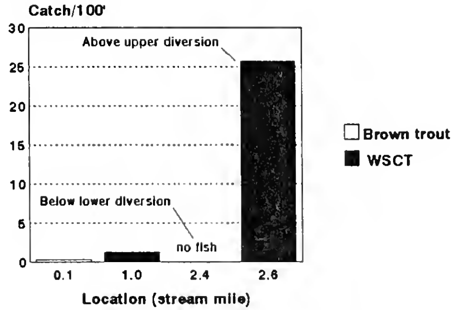


Figure 37. CPUE for salmonids at four locations in Wasson Creek, August 2003.

the landowners monitored water temperatures, assessed stream channel conditions, measured stream discharge and evaluated riparian grazing practices. These studies all indicate high potential for fisheries improvement if corrective measures are implemented.

Fish Populations

We sampled fish populations at four locations (miles 0.1, 1.0, 2.4 and 2.6) of Wasson Creek. The upper surveys show a large decline in WSCT densities below the diversions with a CPUE declining from 25.7 fish/100' above the diversions to zero fish /100' (Figure 37). In lower Wasson Creek, we also found WSCT in very low densities (1.3/100' at mile 1.0) and extremely low densities of brown trout near the mouth of Wasson Creek, in addition to longnose and largescale suckers and redside shiners.

Interestingly, we also found one yellow perch and one largescale sucker in the upper-most sample. The two species likely entered Wasson Creek from the North Helmville Canal, which periodically delivers water (and apparently unwanted fish species) to Wasson Creek and perhaps to other adjacent drainages. Introductions of unwanted fish from Nevada Creek near the reservoir have the potential to compromise the WSCT population of Wasson Creek depending on the species introduced. Preventing the movement of unwanted fish to from the canal to Wasson Creek should be a necessary component to restoration planning.

Results Part IV: Additional Investigations

Results part IV includes a series of primarily restoration-related studies, which include: 1) tributary inventories: Little Fish Creek and Snowbank Creek; 2) habitat assessments for the upper Blackfoot River; 3) movements and habitat use of fluvial native fish in the upper Blackfoot Watershed; 4) bull trout redd surveys and winter water temperatures assessments in spawning sites; 5) whirling disease status; 6) Coopers Lake and Nevada Reservoir fisheries assessments; and 6) modifications of a turbulent fountain fish screen for use in small high gradient streams.

Fisheries inventories on Little Fish Creek and Snowbank Creek

Little Fish Creek

Little Fish Creek is a 1st order tributary stream to the lower Blackfoot River. Draining the southern slopes of Lost Horse Mountain, it flows northwest through a checkerboard of State, BLM, Plum Creek, and private land before entering the Blackfoot River at river mile 32.8 with an estimated base flow of ~1 cfs. Stream gradients range from 760'/mile at the headwaters to 190'/mile near the mouth (Figure 38). In 2003, we established three survey sections on Little Fish Creek (miles 0.3, 0.9 and 3.8).

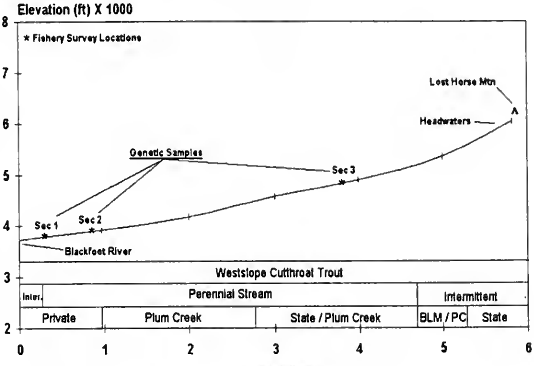


Figure 38. Longitudinal profile for Little Fish Creek.

The upper most survey section (mile 3.8) is a moderately entrenched, cobble dominated, high gradient A3-type channel, beneath a mixed over-story of Douglas fir, ponderosa pine, larch and aspen. The riparian under-story supports a diverse community of rocky mountain maple, red osier dogwood, alder, forbs and grasses cumulatively providing shade and wood for fish habitat. Both lower survey sections are moderately entrenched gravel-dominated B4-type channels supporting an over story of ponderosa pine, larch, and aspen, an under-story of alder and red osier dogwood above a ground layer of forbs and grasses. Based on visual observations, instream sediment levels appear to be elevated in downstream reaches.

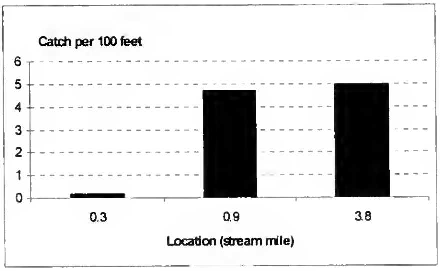


Figure 39. CPUE for WSCT at three locations on Little Fish Creek in 2003.

Problems influencing fish

populations on lower Little Fish Creek include grazing impacts upon streamside vegetation creating slumping banks and elevated sediment levels. Proximity to roads from timber harvest also appears to contribute moderate levels of sediment to the channel.

Fish Populations

Population surveys (mile 0.3, 0.9 and 3.8) found only WSCT in Little Fish Creek. CPUE for WSCT decreased 96% from 5.0 fish/100' in the upper section to 0.2 fish/100' at the lower section (Figure 39). YOY densities were highest at the middle section and absent from the lower sample site (Appendix A). We collected 27 WSCT genetic samples from the three survey sections, the results of which are pending.

Snowbank Creek

Snowbank Creek is a 1st order tributary to Copper Creek, which is an important spawning and rearing stream for fluvial WSCT and fluvial bull trout of the upper Blackfoot River. Snowbank Creek begins on the eastern slope of Stonewall Mountain and flows northeast 4.4 miles through the Helena National Forest before entering Copper Creek at mile 5.9. Stream gradients range from 910'/mile in upper reaches to 220'/mile near the mouth (Figure 40).

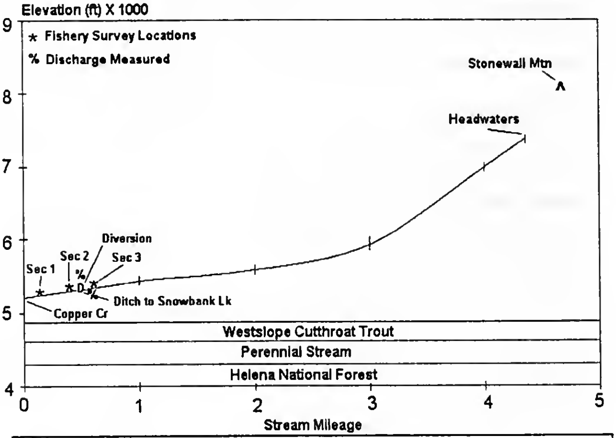


Figure 40. Longitudinal profile for Snowbank Creek.

Our assessments focused on identifying restoration opportunities at a defunct diversion on lower Snowbank Creek. The diversion (mile 0.4) was constructed in 1962 to divert water to create a *put-and-take* fishery at Snowbank Lake.

In August 2003, we conducted fish population surveys immediately above and below the diversion (mile 0.4) and near the mouth (mile 0.1). Stream flow measurements were also taken in Snowbank Creek below the diversion and in the ditch. Of the total 5.3 cfs, 4.1 cfs was diverted to Snowbank Lake, leaving only 1.2 cfs instream.

Above the diversion, the stream channel has been moved and straightened with berms for approximately 250' to accommodate the diversion. This was evident by the observation of an old relic channel directly south of the existing channel. The exiting channel shows signs of channel instability above and below the diversion. The riparian zone is stable, supporting a moderate canopy of Douglas fir and lodgepole pine above a dense under-story of rocky mountain maple and alder. Fish habitat is primarily woody debris-formed scour pools.

Fisheries related problems identified include: fish entrainment, fish passage problems, and dewatering below the diversion. Entrainment of WSCT to Snowbank Lake leads to mixing of wild and hatchery fish (FWP files) and the harvest of both. The diversion and likely hinders upstream movement of juvenile fish. A culvert near the mouth of Snowbank also appear to be a high flow fish passage barrier.

In its existing condition, the diversion cannot be controlled, which contributes to dewatering during base flow periods. During August 2003, a severe, stand-replacement wildfire burned the Snowbank Creek drainage.

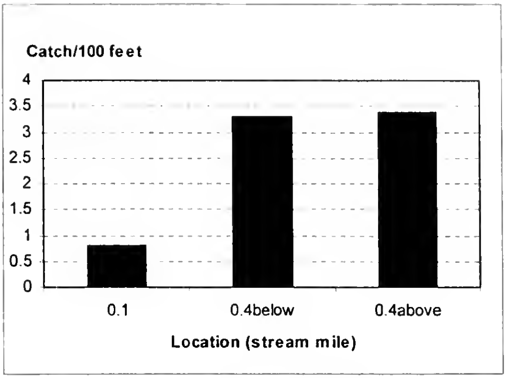


Figure 41. CPUE for WSCT at three locations on Snowbank Creek, August 2003

Fish Populations

Fish population inventories at three locations on Snowbank Creek recorded low densities of WSCT (Figure 41). We found no other species present. Sampling found comparable densities above and below the diversion, but substantially lower densities at the sample site near the mouth (Figure 41).

Habitat Assessments for the Upper Blackfoot River

Introduction

In 2001, we began geomorphic and habitat assessments of the upper mainstem Blackfoot River upstream of the Landers Fork at rm 121.6, continuing downstream to Stemple Pass Bridge (rm 108.9) in 2001 (Pierce et al. 2001, 2002). In 2002 and 2003, we continued these surveys in the downstream direction with the inventory of a 54.9-mile section of the upper Blackfoot River between the Stemple Pass Bridge and the confluence of the North Fork at rm 54.0 (Figure 42). Our objectives were to: 1) assess mainstem morphologic and habitat features including river temperature and riffle sediment regimes; 2) augment TMDL and related studies; 3) identify areas of simplified habitat with restoration potential; 4) provide a repeatable baseline for future monitoring; and 5) help assess habitat use by telemetered fish. The purpose is to help identify limiting factors and direct restoration activities.

Study Area

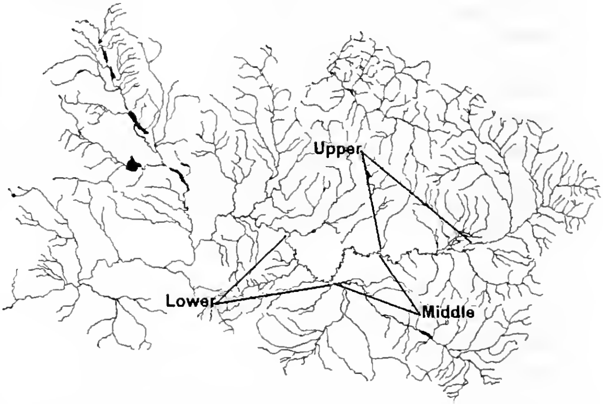


Figure 42. Three habitat inventory reaches of the upper Blackfoot River.

We stratified the upper river into three reaches (upper, middle, lower). The upper reach extends from Lincoln to Arrastra Creek (rm 108.9 - 88.8). The section begins at the lower portion of an intermittent reach – an area where the river begins to gain significant inflows from spring creeks and groundwater during base-flow periods. This gaining reach provides a concentrated spawning area for mainstem brown trout (FWP files) and very limited bull trout reproduction (FWP files). Several basin-fed tributaries, all supporting WSCT populations enter the upper reach (Pierce et al. 2000), most of which have been identified at various levels of fisheries impairment (Pierce et al. 2002). The upper reach supports significantly higher salmonid densities than the lower reach below Nevada Creek (Pierce et al. 2000, Results Part II).

The middle reach extends from Arrastra Creek (rm 88.8) to Nevada Creek (rm 67.7). At this junction, the river loses slope and becomes highly sinuous and prone to the deposition of fine sediment. No tributaries enter this 21-mile reach. Stream bank erosion and active channel migrations increase in the downstream portion of this reach.

The lower reach begins at Nevada Creek (rm 67.7), a large degraded tributary to the middle Blackfoot River, and extends to the mouth of the North Fork (rm 54.0). At this point, the river becomes confined by moraine against the Garnet Mountain where a major increase in channel slope and substrate size also occurs. Several small degraded tributaries enter this reach, the lower reaches of which are non-functional from a fisheries perspective (Pierce et al. 2001). Water quality is impaired (Ingman et al. 1990, Pierce et al. 1997)) and riparian health declines (Marler 1997). This reach supports the lowest salmonid densities for the entire Blackfoot River, with tributary spawning fish (rainbow trout, WSCT and bull trout) in very low abundance (Results Part II). Mainstem spawning brown trout are in higher abundance, compared with tributary spawning fish.

Methods

Geomorphic assessments were completed using modified Rosgen level II channel surveys (Rosgen 1996), and modified Wolman pebble counts (Wolman 1954). We measured sinuosity, valley slope, channel slope, radius of curvature, meander length and belt width using GIS with ADAR high resolution (one meter) imagery and USGS 7.5 minute quads. To calculate belt width, meander length and radius of curvature, we selected a reference reach (of two full meanders) from the mid-portion of each reach and calculated these variables with ADAR imagery using GIS.

Modified Wolman pebble counts involved a single pebble count cross-section, within wetted and bankfull widths at a morphologically stable riffle near the mid-portion of each reach, as a simple index to spawning substrate quality. This method measures only the particle size on the substrate surface and likely underestimates the amount of fines within the substrate and within redds. Based on sample particle size-classes, we define "fine" sediment as < 0.31''. This small particle closely corresponds to the particle sizes that negatively influence successful reproduction of native salmonids (Weaver and Fraley 1991, 1993; Magee 1996). We defined the suitable spawning size substrate between 0.31" - 2.5" as measured at the intermediate axis, a method consistent with recent bull trout spawning studies (Dunham and Reiman 2001)

Habitat survey methods began at the upper limit of the upper reach and proceeded down river through all three reaches. We measured stream channel distance using a Garmin 3+ global positioning satellite receiver (GPS) unit. Measured pools were randomly selected using a starting pool (pool 1-4), and then every fourth pool and the preceding downstream riffle were systematically measured using a survey rod and 300' tape. Measurements included: total pool length, maximum pool depth, riffle crest depth, and wetted widths at the pools maximum width and the riffle crest. The difference between maximum pool depth and riffle crest depth was used to calculate residual pool depth. We also calculated distance between pools, and adjusted pool frequency to number/1000'. During intensive pool surveys, we estimated pool cover based on a visual estimate of percent of the pool surface area covered by large woody debris (LWD).

Water temperatures (48-minute intervals) were monitored using Tidbit data loggers in each of the three reaches (Dalton Mountain Bridge (rm 101.1), Cutoff Bridge (rm 70.2), Raymond Bridge (rm 58.4)) from January 2002 through October of 2003 (Appendix I). We used a Mann-Whitney rank sum t-tests to test the relationship between core winter (January and February) and core summer temperatures (July and August) between the rm 101.1 site and the rm 58.4-mile site. Differences were considered significant at < 0.05.

In order to determine large woody debris (LWD) stem densities in the three stratified river reaches, we counted and visually measured all large woody debris within the bankfull width of the channel. The wood count was adjusted to stem density/1000'. We also counted all functional instream wood associated with the pools and recorded their function (e.g. vertical scour). Methods for measuring woody debris included counting and recording the number of woody stems in one of four diameter categories (4 - 12"; 1'- 2'; 2' - 2.5' and > 2.5'), and one of three length sub-categories (5' - 16'; 16' - <50'; and > 50'). Diameters were measured at breast height (DBH). Root wads with stem lengths of < 5' were recorded under the respective diameter category based on the diameter of the root mass. Diameters and lengths of partially covered wood in logjams were estimated. To simplify analysis, LWD was summarized by the overall total number of stems/reach, mean number of stems/1000' per reach and by the four major diameter categories, regardless of length. To test the relationship of LWD density among reaches, we used a Kruskal-Wallis One Way Analysis of Variance (ANOVA), with differences considered significant at < 0.05.

Results

Summary geomorphic measurements show a wide range of variability between reaches (Table 4). LWD stem densities were significantly different among the three reaches (ANOVA, 2df, $P < 0.001$), with a 89 % decrease from a mean of 122.6 stems/1000' in the upper reaches to 12.9 stems/1000' in the lower reach. The highest concentrations of LWD were found in logjams between river mile 91 and 102 in the upper reach (Figure 43, Table 6).

Table 4. Summary of geomorphic features of three reaches of the upper Blackfoot River

Geomorphic variable	Upper	middle	lower
Stream length (miles)	20.1	21.1	13.7
Valley length (miles)	11.1	8.3	8.1
Sinuosity	1.8	2.5	1.7
Mean belt width (range ft)	323 (259-479)	777(564-967)	792(400-1285)
Meander length (range ft)	469-633	1,010-1508	951-2,630
Radius of curvature (range ft)	295-318	298-430	154-351
Valley Slope	0.0036	0.0019	0.0050
Stream slope	0.0021	0.0007	0.0029
Channel type	C4	C4	variable
Substrate (D35, 50, 85 mm)	9, 18, 40	<1, 11, 40	1.7, 12, 125

Table 5. Summary of habitat measurements for three reaches of the upper Blackfoot River.

Measurement	Upper	Middle	Lower
Total # pools (% wetted area)	293 (62%)	145 (31%)	35 (7.4%)
Total # pools measured	73	49	12
Pools measured with LWD	50 (68.4%)	34 (69.4%)	5 (41.7%)
Mean pool length (ft)	147 ± 90 (22 - 456)	171 ± 77 (55 - 465)	237 ± 126 (87 - 450)
Mean max pool depth (ft)	6 ± 1.6 (2.1 - 9)	6.0 ± 1.3 (4 - 9.2)	4.9 ± 1.5 (3.1 - 7.4)
Mean riffle crest depth(ft)	1.5 ± 0.8 (0.2 - 3.8)	2.8 ± 0.8 (1.1 - 5.9)	2.8 ± 0.9 (2 - 4.9)
Mean residual depth (ft)	4.2 ± 1.5 (0.8 - 7.7)	3.3 ± 1.4 (0.5 - 6.2)	2.0 ± 1.6 (0.3 - 5.0)
Mean wetted width at max pool depth (ft)	47 ± 19.3 (17 - 117)	95 ± 34 (29 - 270)	126 ± 24.2 (87 - 172)
Mean wetted width at riffle crest (ft)	58 ± 26.5 (12 - 131)	86 ± 22 (31 - 160)	109 ± 22 (58 - 140)
Mean pool area (acres)	0.20 ± 0.16 (0.12 - 0.83)	0 .36 ± 0.21 (0.07 - 1.33)	0.66 ± 0.41 (0.24 - 1.54)

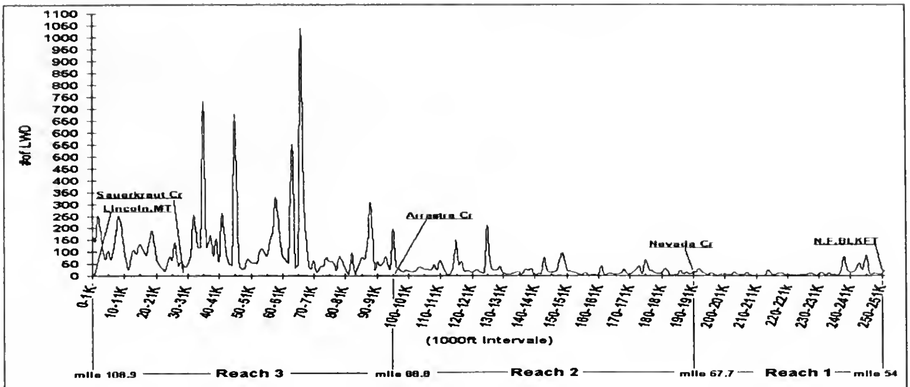


Figure 43. Total LWD (stems/1000') count for the upper Blackfoot river between the North Fork and Stemple Pass Road..

	Upper	Middle	Lower
Length of reach	95,000	96,000	60,000
Total # of LWD stems	11,651 (77.6%)	2,578 (17.2%)	790 (5.2%)
Mean # stems /1,000'	122.6 (75.5%)	26.8 (16.5%)	12.9 (8%)
Range	10 - 1035	1 - 210	0 - 88
Total # stems (4" to 12" dia)	6,022 (77.5%)	1,311 (16.9%)	439 (5.6%)
Mean # stems /1,000'	63.4 (75.3%)	13.6 (16.1%)	7.2 (8.6%)
Range	3 - 462	1 - 83	0 - 42
Total # stems (1' to 2' dia)	4,332 (79%)	914 (16.7%)	238 (4.3%)
Mean # stems /1,000'	45.6 (77.3%)	9.5 (16.1%)	3.9 (6.6%)
Range	2 - 333	0 - 91	0 - 45
Total # stems (2' to 2.5' dia)	853 (74.6%)	238 (21%)	53 (4.6%)
Mean # stems /1,000'	9 (72.8%)	2.5 (20.2%)	0.87 (7%)
Range	0 - 180	0 - 36	0 - 7
Total # stems (> 2.5' dia)	444 (71.7%)	115 (18.6%)	60 (9.7%)
Mean # stems /1,000'	4.7 (68.3%)	1.2 (17 4%)	0.98 (14.2%)
Range	0 - 60	0 - 26	0 - 8

Table 6. Summary of LWD count for three reaches of the upper Blackfoot River.

Of 473 total pools, we measured 134 pools over the entire survey reach (Table 5). Pool frequency decreased in the downstream direction from 2.7/1000' (upper reach), to 1.3/1000' (middle reach), to 0.5/1000' in the lower reach. In the upper reach, 73 of 293 pools were measured, of which 68% (N= 50) contained LWD. For the middle reach, 69% (34 of 49) of measured pools contained LWD compared with 42% (5 of 12) pools in the lower reach. For measured pools with LWD, the percent of pool cover formed from wood decreased on the downstream direction from 12% (range 0.5-80) in the upper reach to 10.2% (range1.0-60) in the middle reach to 3.7% (range 0.5-10) in the lower reach.

Mean wetted widths (pools and riffles) and pool length all increased in the downstream direction. Mean residual pool depth decreased from 4.2' in the upper reach to 3.3' (middle reach) to 2.0' in the lower reach.

We completed pebble counts for both the bankfull (Figure 44) and wetted-width (riffle-crest) cross-sections. For the wetted-width surveys, we recorded a large decrease in suitable spawning-size (0.3-2.5') gravels in the downstream direction. In the upper reach cross-section, we found well-sorted substrate ranging from a 0.04" to 5.0" diameter with 89% of the surface substrate falling into the 0.3-2.5" diameter size range. In the middle reach cross-section, we found alluvial gravel with a smaller range of particle sizes (compared with the upper reach) ranging from very fine sand to small cobble, a bimodal distribution with 19% of the sample comprised of sand (modal class), 28% <0.3" diameter and 70 % of the sample within the medium to coarse gravel (0.3-2.5") substrate range. For the lower reach cross-section, we found a poorly sorted, more heterogeneous mixture of substrate in riffles, with a much wider range of substrate sizes ranging from clay/silt to boulder (<0.02" to 20"). A veneer of silt and clay covered the surface and interstitial spaces of the substrate and only 28% of the sample gravels fell within the suitable spawning-size range. For bankfull measurements, we found a bimodal distribution at all three samples, with very fine sand and smaller particles being a dominant size-class.

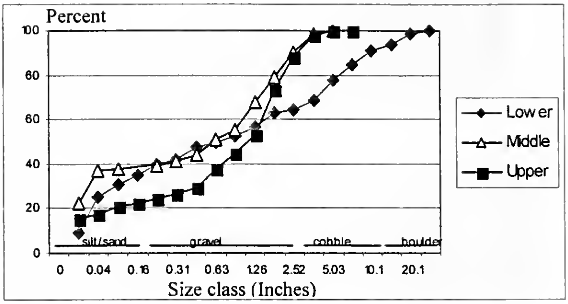


Figure 44. Pebble count particle distribution at bankfull riffle cross-sections in three reaches of the upper Blackfoot River.

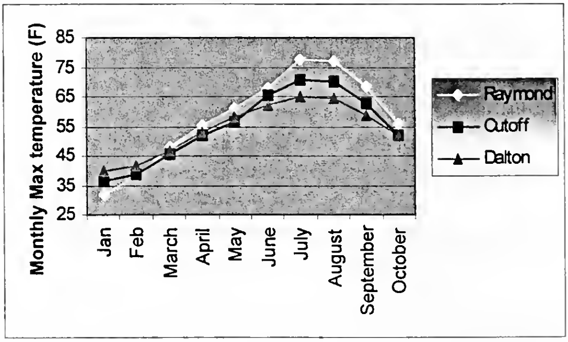


Figure 45. Monthly maximum water temperatures at three locations of the upper Blackfoot River January-October 2003.

Water temperatures show a wide range of variability within and between reaches (Figure 45, Appendix I). Winter water temperatures were significantly lower in the lower reach compared with the upper reach ($P < 0.001$) during core winter months (January and February) with mean water temperatures ~4 ^{0} F above freezing in the upper reach, but at or near freezing in the middle and lower reaches. Summer water temperatures were significantly warmer in the lower reach compared with the upper reach ($P < 0.001$) during core summer months (July and August) with maximum water temperatures of 65 ° F in the upper reach compared with a high of 77 ° F in the lower reach (Appendix I).

Discussion

Compared with the laterally contained, boulder and bedrock (B and F2-3-type) channels of the lower Blackfoot River, the upper Blackfoot River (upstream of Nevada Creek) is a predominately a laterally extended, gravel-bed alluvial (C4-type) river channel. This channel type is vegetative controlled, and much more subject to higher natural sediment input and anthropogenic disturbance than the lower river (Rosgen 1996).

The Blackfoot River from Lincoln to Nevada Creek supports a brown trout-dominated salmonid community with low densities of brook trout, fluvial bull trout and WSCT, and very low numbers of rainbow trout in the area of Nevada Creek. Beginning below Lincoln, total trout densities (all salmonids) in this section of river decrease progressively in the downstream direction from a total estimated density of 55 fish/1000' at rm mid-point 95.3 (in 1999) to 12.7 fish/1000' at rm mid-point 63.1 in 2003 for fish >6.0" (Pierce et al. 2000, Results Part II). Early juvenile fisheries studies found a similar trend with higher abundances of Blackfoot River YOY brown trout below Lincoln (~30 fish/100') and progressively lower densities in the downstream direction (~5 fish/100' between Nevada Creek and the North Fork) (Peters and Spoon 1989). These downriver trends towards lower densities appear to be a function of many interacting natural and human-related factors occurring in the mainstem and tributaries.

Consistent with higher juvenile trout densities, we found higher quality spawning substrates in the upper portion of the river downstream of Lincoln. Consistent with downward trends in juvenile abundance, we also found a progression towards smaller particle sizes and less suitable spawning substrate in the downstream direction. Excessive levels of "fines" limit not only embryo and emergence success (Weaver and Fraley 1993), but also recruitment (Cederholm and Reid 1987), and instream production of food organisms that salmonids in this portion of the study area rely on (Ingman et al 1990; McGuire 1991). We also recorded a bimodal distribution of particle sizes, with a large amount of fine sediment in all bankfull samples, indicating non-point, upstream erosion sources. Sources of sediment production, both natural and anthropogenic, have been largely identified between Lincoln and Nevada Creek and calculated at 34,492 tons/year generated from eroding banks, of which 5,400 tons/year (16%) results from anthropogenic sources such as grazing and road encroachment (Confluence 2003). Further contributing to this impairment, involves reduced riparian health up and downstream of Nevada Creek (Marler 1997, Marler and Schmetterling 1999).

Alluvial rivers in forested areas are heavily dependant of on the input of organic matter. Woody riparian communities not only help stabilized stream banks, they also provide input of nutrients and cycling of LWD to the channel. LWD influences channel morphology by creating channel features and habitat for salmonids. The occurrence of LWD in the study decreases significantly among reaches in the downstream direction. The downstream reduction in LWD abundance seems to relate to differences in recruitment, containment (log jams), export rates and channel type, all of which vary longitudinally and by reach. LWD recruitment is often higher in (middle and upper reaches) alluvial channels than (lower reach) contained channels (Martin 2001). The decline in LWD in the downstream direction also seems to vary with increasing channel size and a greater capacity of for larger stream to move material downstream. Local land clearing (middle and upper reaches) has reduced stand density and LWD recruitment to some degree (Marler 1997, Confluence 2003).

Temperature monitoring found a suitable range of summer water temperatures (<65 °F) for salmonids (including bull trout) downstream of Lincoln, produced by large volumes of groundwater entering the river. Groundwater upwelling and spring creeks not only moderate downstream summer water temperatures, but also appear to inhibit severe winter ice formation for ~25 river miles below Lincoln. Below this area of groundwater influence, water temperatures progressively become extreme, with large significant increases in the summer and corresponding decreases in the winter. Mid-summer temperatures below Nevada Creek progressively warm in excess of >75 ° F, consistently higher than all other reaches of the Blackfoot River. Temperatures >65 ° F threaten growth and survival of bull trout, and when >73 ° F likewise effect rainbow trout and brown trout (FWP files). Degraded water quality originating in the Nevada Creek watershed and impaired riparian conditions contribute to elevated temperatures and other related impairments (Ingman and McGuire 1990; Pierce and Peters 1990; Marler and Schmetterling 1999). Fish population surveys report extremely low salmonid densities in the lower Nevada Creek (Pierce et al. 1997). Between Arrastra and the North Fork, channel ice formation also progressively increases in the downstream direction in core winter months (Appendix I). Severe winter conditions, including extensive areas of anchor ice, induce stress and reduce juvenile trout survival of in this area of the river (Peters and Spoon 1989).

In summary, factors limiting fisheries production for the mainstem Blackfoot River (Lincoln and the North Fork) appear to involve: 1) naturally low flows near Lincoln, and human-induced low flows near Nevada Creek; 2) high sediment loads and low insect productivity (food supply) in portions of the middle and lower reaches; 3) severe winter conditions in middle and lower reaches, and elevated summer water temperatures in the lower reach; and 4) inadequate juvenile recruitment in both middle and lower reaches. Correcting anthropogenic impairments to the mainstem (creating buffer zones and managing for vegetative heath) would improve river conditions for salmonids. However based on recruitment limitations, restoring tributaries (water quality and juvenile production) will also likely prove necessary to substantially improve populations in the mid-to-lower reaches of the study area.

Spawning migrations and habitat use by fluvial westslope cutthroat and bull trout in the upper Blackfoot Watershed

Introduction

Recently the seasonal movements and habitat use by fluvial westslope cutthroat trout and bull trout have been studied in the lower Blackfoot River and its tributaries (Swanberg 1997, Schmetterling 2001, 2003). These studies provide insight to fluvial life history strategies, seasonal movements and habitat use by fluvial bull trout and westslope cutthroat trout (WSCT)). Often, extensive migrations (>70 miles) to spawn in natal tributaries are a component to fluvial life histories (Schmetterling 2001; Swanberg 1997). Spawning often occurs at discrete locations in tributaries (Swanberg 1997, *this report*). After spawning, the young rear in these tributaries for up to four years before migrating to mainstem rivers to mature (Shepard et al 1984, Northcote 1992). Thus, tributaries that are connected to the mainstem river, with habitats suitable for spawning and rearing are critical for maintaining population of WSCT and bull trout (Swanberg 1997, Schmetterling 2001, *this report*).

Tributary inventories in the Blackfoot watershed have identified pervasive alterations to tributaries at the low-to mid elevations of the watershed with 85 of 90 inventoried streams identified as *fisheries-impaired* (Pierce et al. 2002b). This level of tributary alteration contributes not only to population declines at a broad level; it also necessitates expansive tributary restoration as a primary method of native species conservation and recovery.

To begin a transition of expanding restoration to the upper Blackfoot Watershed, in 1999 the Montana Fish, Wildlife and Parks began a 3-year fisheries inventory and problem identification study on 49 tributaries in the upper watershed upstream of the North Fork confluence (Pierce et al. 2002, 2001 and 2000). These studies identified: 1) the widespread distribution of non-introgressed WSCT in tributaries; 2) precariously low bull trout densities; and 3) impairment on 46 of 49 inventoried tributaries, with significantly lower densities of native fish in the lower reaches of most tributaries compared with upstream reaches. Reduced population densities result from environmental variables such as natural stream dewatering, as well as anthropogenic sources such as habitat alterations and degradation, entrainment in irrigation ditches, irrigation dewatering, and barriers to movement and non-native species interactions (Pierce et al. 2002, 2001 and 2000).

Expanding on these upper basin studies and in order to determine 1) patterns of movement and behavior of bull trout and westslope cutthroat trout; 2) identify tributaries where fluvial bull and WSCT spawn; 3) 4) identify restoration opportunities in tributaries supporting fluvial native fish; and 5) provide information necessary for future funding of identified restoration opportunities, we conducted a radio telemetry study of fluvial bull trout and WSCT captured in a 54.9 miles reach of the upper Blackfoot River between the North Fork and Lincoln. The habitat features of this upper Blackfoot River differ substantially from the lower river, and this upper reach has received no use of radioed fish in previous lower river studies. The goal of this study is foster restoration and the recovery of dwindling stocks of fluvial bull trout and WSCT in the upper Blackfoot Watershed.

Study Area

The Blackfoot River watershed supports distinct regional difference between the upper and lower basin. The general features of the upper Blackfoot River include 1) a primarily alluvial valley, 2) large sections of river lacking natural tributaries, 3) areas of low instream productivity (Ingman et al.1990), 4) extensive intermittent channels in headwater areas, and 5) a reach of "impaired" river between the confluences of Nevada Creek and the North Fork. In contrast, the lower Blackfoot River (below the North Fork) receives a large influx of colder water from the North Fork, which reduces environmental stress and approximately doubles the base flow of the Blackfoot River. Beyond increased flows and improved water quality, the lower river supports higher secondary productivity (Ingman et al. 1990), and higher native salmonid densities than the upper river (Results Part II).

The upper Blackfoot Watershed (including the North Fork Watershed) covers ~1,150 square miles of largely glaciated belt sedimentary rock. Bioclimatic zones range from alpine mountains to semi-arid bunch grass/fescue prairies at low elevations of the watershed. Landownership consists of 65% public land and 35% private ownership. Private lands consist primarily of agricultural bottomlands and private timberland in the foothills.

We stratified 54.9-miles of the upper Blackfoot River into three reaches (upper, middle and lower) (Figure 46). The upper reach extends 20.1 river miles (rm) from Lincoln (rm 108.9) to Arrastra Creek (rm 88.). The upper boundary of this reach starts where an intermittent section begins to gain significant groundwater and spring creek inflows (Keep Cool Creek, Spring Creek and Grentier Spring Creek). Several basin-fed tributaries entering this reach (Little Moose, Moose, Sauerkraut, Willow Creek (Lower), Keep Cool, Lincoln Gulch, and Poorman Creek), all support WSCT populations and most have been identified at various levels of fisheries impairment (Pierce et al. 2002b; Confluence 2003). This section of river is more densely

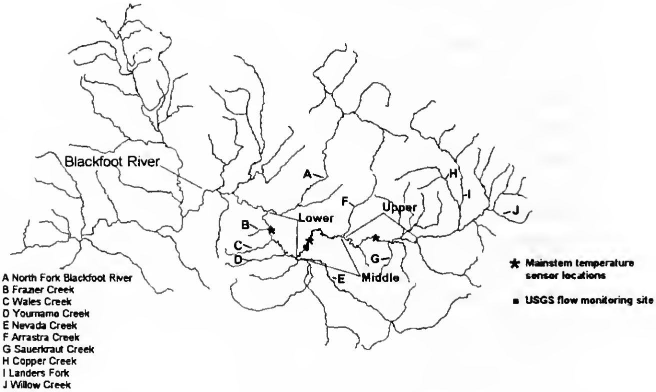


Figure 46. Three study reaches, primary tributary as well as mainstem temperature and flow monitoring sites.

wooded than the lower two reaches, with larger volumes of instream LWD and water temperatures moderated by groundwater on a continuous basis (Results Part IV).

The middle reach extends 21.1 rm from Arrastra Creek downstream to Nevada Creek (rm 67.7). At this junction, the river is less wooded; the channel loses slope and becomes highly sinuous and prone to the accumulation of fine sediment. Stream bank erosion and active channel migrations increase in the downstream direction. No tributaries enter this reach. Water temperatures in the middle reach increase during the summer and decrease during the winter more extremely as compared with the upper reach (Appendix I). Channel icing (including increased anchor ice formation) also progressively increases downstream.

The lower reach extends 13.7 rm from Nevada Creek (a large water quality impaired tributary), downstream to the mouth of the North Fork (rm 54). Below Nevada Creek, the river becomes confined by moraine against the Garnet Mountain where a major increase in channel slope and substrate size occurs. Once confined, the river acquires a more linear longitudinal profile, sinuosity decreases and channel gradient increases abruptly from 4' to 15'/mile. Within this reach boulders increase, volumes of instream LWD decrease and channel bedforms and velocities become more variable. Riparian health also declines in this section (Marler 1997), water quality is diminished by the influence of non-point runoff originating in the Nevada Creek watershed (Ingman et al. 1990). Compared with the two upper reaches, summer and winter water temperatures are extreme in the lower reach (Appendix I). Several small and degraded tributaries (Frazier, Wales and Yourname Creeks) enter this reach, all of which are fisheries-impaired (Pierce et al. 2001). This reach supports the lowest salmonid densities for the Blackfoot River downstream of Lincoln (Pierce et al. 2000; *this report*, Results Part II).

Methods

Forty-five WSCT and 10 bull trout were captured and implanted with radio transmitters between March 13-April 18, 2002 and March 18-April 13, 2003. Transmitters were evenly distributed within the three study reaches. Fish captures were made in early spring, prior to migrations, with either hook and line or by electro-fishing with a Coffelt model VVP-15 DC electroshocker mounted on an 14 ' aluminum drift boat.

We followed surgery methods described by Swanberg (1997) and Schmetterling (2001). Captured fish were anesthetized with tricaine methanesulfonate (MS-222), measured (total length, mm) and weighed (g). For this report, all metrics were converted to standard units. Surgical tools were sterilized in betadine and rinsed with 0.9% saline solution prior to each surgery. New surgical scalpels, latex gloves, and steel surgical staples were used for each surgery. Surgeries consisted of bathing the gills with diluted MS-222, while radio transmitters (Lotek Wireless) were inserted internally through a 2-cm incision made along the linea alba anterior to the pelvic girdle. The transmitter antenna was then passed through the body wall posterior to the pelvic girdle (Ross and Kleiner 1982). Transmitters weighed 7.7 grams and did not exceed 2% of fish weight as previously suggested (Winter 1996). Transmitter life was estimated at ~454 days. Incisions were closed with Reflex-One 35W surgical staples (Swanberg et al. 1999). Surgeries lasted 1-15 minutes (mean 4.2 min). Following surgery, the fish were held in a live car in the river until fully recovered and then released at capture locations. Each transmitter emitted an individual coded signal.

Fish locations were determined using an aircraft or from the ground (truck and by foot). For ground tracking, we used either an omni-directional whip antenna (truck) or a hand held three-element Yagi antenna (foot). When ground tracking failed to locate a fish, we relied on fixed wing aircraft flying approximately 100-200 meters above the river, equipped with a three-element Yagi antenna attached to the wing strut. We assigned a code (range 1-8) to all relocations based on the accuracy. When we located a fish within a habitat type (code 6 or higher), we recorded the channel bedform (ie. pool (and pool-type), riffle, run, glide) as well as the fish's association with cover when concealed by 1) maximum pool depth, 2) overhanging banks, 3) boulders or 4) LWD. This habitat use was then compared to the availability of primary bedforms and a census of LWD from concurrent habitat inventory completed for the three reaches (Kramer et al. 1997, Results Part IV). We stratified Blackfoot River habitat use by summering and wintering periods. We arbitrarily assigned time-periods for wintering use to be November through April, and summering use from July 15 through October.

Fish were located at least three times per week immediately prior to and during migrations, once per week while holding in tributaries and once per month during the winter due to a lack of winter movement (Schmetterling 2001). Fish were categorized as migratory (entered a tributary) or non-migratory (did not enter tributary). Migratory fish were further divided into spawning or non-spawning categories. Fish were assumed to have spawned if they ascended an area of tributary conducive to spawning, during a spawning period appropriate to the species. A mean date between two contacts surrounding an event, such as a migration start, was used to describe the date of an event (Schmetterling 2001).

Temperature sensors were placed within each of the three reaches of the Blackfoot River and at the mouth of tributaries to evaluate the effect of temperature on the onset of migration and spawning. The data loggers recorded temperature every 48-minute the mainstem and 72-minute intervals in tributaries. Blackfoot River daily discharge data were obtained from a U.S. Geological Survey gauging station at river mile 72.2 (USGS 12335100) to determine the relationship between discharge and fish movement.

To determine the genetic composition of individual WSCT and identify addition tributary genetic inventory needs, we collected anal fin clips prior to surgery and preserved them in 95% ethanol. All samples were analyzed by the University of Montana, Trout and Wild Salmon Genetics Laboratory, Missoula, Montana. Genetic samples were also collected from populations of WSCT in tributaries throughout the study area between 1999-2001 prior to this study.

Relocation data was analyzed within the context of land ownership, general habitat use and availability, home range size and life history traits, and within the context of other telemetry studies undertaken in the Blackfoot drainage (Swanberg 1997, Schmetterling 2001). Relocations were converted to (via degree decimals) to an ArcView GIS point coverage with all relational data attached using EXCEL databases. Within tributaries, movements were expressed as the distance upstream from the mouth. Land ownership (Private, State, USFWS, USFS, BLM, and PC) was categorized for over-wintering, migration, and spawning locations in the Blackfoot River for bull trout and WSCT within the three river reaches, based on the total mileage of use.

WSCT and bull trout from 2002 and 2003 were grouped by species to analyze data in all cases excluding inter-annual differences. We compared the dates migrations began for each species using a Kruskal-Wallis One Way Analysis of Variance on Ranks. This test was also used to test for differences in the mean date WSCT entered tributaries, and also to test if WSCT spent a significantly longer amount of time in the seven tributaries used for spawning. Because of small sample size and failure to meet parametric assumptions, we used Mann-Whitney Rank Sum test to determine if the mean date bull trout entered tributaries to spawn were different, and if they stayed in a tributary significantly longer than another. Mann-Whitney Rank Sum test was also used to compare the mean dates migrations began for WSCT between years and if they entered the tributaries at different times between the two study years. We used t-tests to determine if migratory WSCT body lengths were different from non-migratory WSCT. We used a simple linear regression to determine if there was a relationship between body length and distance migrated and timing of migration. We also tested if the date migration began was related to pre-spawning distance moved for WSCT and bull trout. Simple linear regression was also used to test the relationship between spawning tributary size (drainage area) and number of days WSCT spent in each of these tributaries. All tests were performed at the alpha 0.05 level of significance.

Results

Of the 55 original radioed fish, we successfully tracked 44 fish (34 WSCT and 10 bull trout). The remaining 11 WSCT either 1) fell prey to avian predators (six heron and one osprey), 2) were poached (n=2), or 3) died due to survery-induced mortality. Tracking began in March 2002 and continued into March 2004. We made 1882 contacts with an average of thirty-seven contacts (range: 16-83) for each fish. Of 44 telemetered WSCT, 42-two were subspecifically pure based on DNA analysis; two contained rainbow trout genetic markers (Appendix M).

Twenty-eight WSCT (Figure 48) trout and ten bull trout (Figure 49) migrated during the two-year study period. We found no significant size differences between migrating and non-migrating WSCT, and the mean lengths for each group were within 0.2 inches (t-test, $P = 0.5$). The mean starting date of migration for each

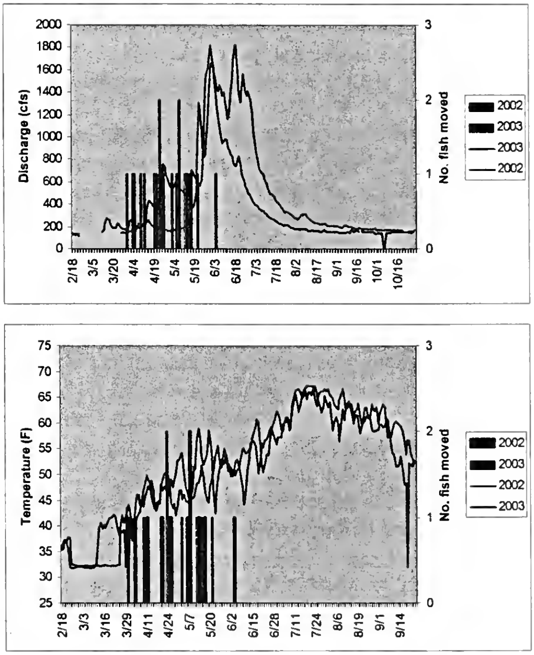


Figure 47. Relationship of discharge (top) and temperatures (bottom) to dates WSCT began migrations in 2002 and 2003.

species was similar between three study reaches where fish were captured (ANOVA, WSCT P = 0.79; bull trout P = 0.81). Inter-annual differences on the mean start date of migration were not different for WSCT (Mann-Whitney Rank Sum, P = 0.056). Size of fish did not appear to effect distance of migration (Simple linear regression: WSCT: R^2 = 0.01, P = 0.64; bull trout: R^2 = 0.14, P = 0.29), or timing of the initial starting date of migration (Simple linear regression, WSCT: R^2 = 0.02, P = 0.50; Bull trout: R^2 = 0.05, P = 0.52). However, a relationship was found between the date WSCT migration began and the distance moved (pre-spawning movement) (Simple linear regression; R^2 = 0.21, P = 0.01). The same relationship was not found with bull trout (Simple linear regression; R^2 = 0.35, P = 0.07). Although river temperatures were similar between 2002 and 2003 peak flows occurred approximately three weeks earlier in 2002 (Figure 47). WSCT migrations began on the rising limb of the hydrograph, as temperatures approached 40°F. Before ascending spawning streams, nineteen WSCT and five bull trout migrated upstream, while nine WSCT and five bull trout moved downstream. The river migration period for WSCT trout averaged 16.1 days (range 1-68); while bull trout averaged 44 days (range 8-109). The average number of river miles moved before ascending tributaries varied from 13 miles (range 0.2-37.7) for WSCT trout, to 28 miles (range 3.3-82.4) for bull trout. WSCT entered tributaries a mean (tributary) temperature of 44 °F (range 33-53); whereas bull trout entered spawning streams at mean temperatures of 50.5 °F (range 43-62). Total river movement of non-migratory WSCT (n = 15) averaged 16.6 miles (range 0.1-34.4).

WSCT spawning streams varied in size from 1st to 4th order, while bull trout used only 3rd to 4th order tributaries. WSCT spawning occurred in seven tributaries (North Fork of the Blackfoot River, Wales, Arrastra, Sauerkraut, Hogum, Copper, and upper Willow Creeks with Arrastra Creek and upper Willow Creek supporting the highest percentages of total spawning use nine spawners (34%) and five spawners (22%), respectively (Figure 48). Each had at least one spawner from 2002 return in 2003. Bull trout spawning was limited exclusively to North Fork of the Blackfoot River and Copper Creek (Figure 49). WSCT entered tributaries between mid-April through mid-June (median date: May 19), while bull trout entered tributaries between late May and late July (median date: June 15). No significant differences were found when comparing the mean date WSCT and bull trout entered individual tributaries (WSCT = ANOVA, P = 0.18; Bull trout = Mann Whitney, P = 0.19). Average tributary movement was 5.7 miles for WSCT trout (range 0.4-48.0) and 12.7 miles for bull trout (range 0.6-18.5). WSCT trout averaged 51.5 days in tributaries (range 4-153); while bull trout stayed longer with an average of 160 days (range 60-358). WSCT spent significantly different amounts of time in the seven different spawning tributaries, staying in the largest tributary, the North Fork, the longest (ANOVA, P = 0.002). We found a significant relationship between the drainage area of individual spawning tributaries and the number of days WSCT remained in these tributaries (Simple linear regression; R^2 = 0.67, P = 0.04). When comparing the number of days bull trout spent in the North Fork compared with Copper Creek, significant differences were not detected (Mann-Whitney, P = 0.11). However, the mean number of days bull trout spent in Copper Creek was 258, compared with 83.2 days in the North Fork, a 310 % decrease.

Lower reach WSCT spawned primarily in the North Fork of the Blackfoot River and two tributaries to the North Fork (Dry Fork and Cabin Creek) (n = 6), but also utilized Wales Creek (n = 3) and Arrastra Creek (n = 2). Arrastra Creek, the only tributary between rm 67.8 and 88.8, captured 64% of middle reach WSCT (n = 7) tributary use. WSCT telemetered in the middle reach also utilized upper Willow Creek (n = 2), the North Fork (n = 1) and Sauerkraut Creek (n = 1). WSCT captured in the upper reach migrated to Arrastra Creek (n = 1), Copper Creek (n = 1), the Landers Fork (n = 1) and Hogum Creek (n = 1), but he majority (n = 3) spawned in upper Willow Creek, of which two were repeat spawners (5 spawning events total).

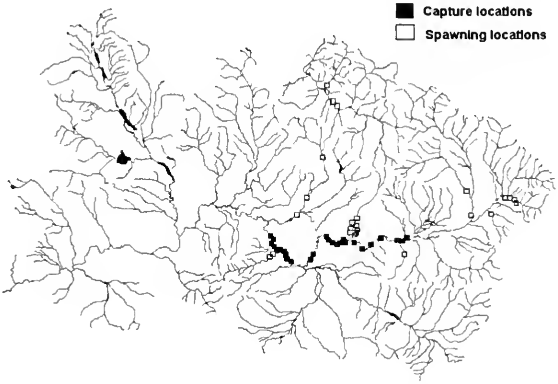


Figure 48. Capture locations and furthest upstream or spawning stream locations of WSCT.

All telemetered bull trout migrated, with nine of 10 ascending spawning streams and one non-spawning fish ascending a spring creek tributary near Lincoln. Total pre-spawning movements for bull trout spawning in Copper Creek averaged 42 rm (range 27.9-66.8) between capture and spawning sites, compared with 43.9 rm (range 25.5-100.9) for bull trout spawning in the North Fork. One bull trout swam up-river from Nevada Creek to Lincoln before returning down-river to ascend the North Fork, a total distance of 101 miles. Bull trout from all three reaches spawned in Copper Creek, while North Fork bull trout migrated from the lower and middle reaches of the Blackfoot River. The only non-spawning bull trout moved from its capture location near Lincoln Gulch into Keep Cool Creek on April 26, 2003, presumably for refuge from high

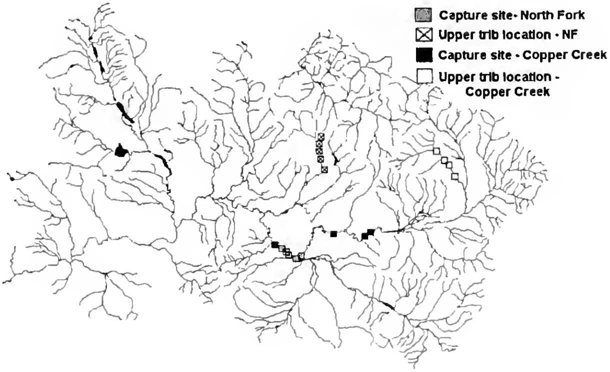


Figure 49. Capture locations and furthest upstream or spawning stream locations of nine fluvial bull trout.

flows. This fish remained in Keep Cool Creek for 50 days before returning to its former location in a pool on June 15. This fish did not spawn and fell prey to a suspected mammal attack in October 2003.

Both the Copper Creek and North Fork bull trout spawned during September in known discrete locations in reaches dominated by alluvial channels. The Copper Creek bull trout spawned in a confirmed groundwater upwelling area where winter surface water temperatures were significantly higher than downstream non-spawning downstream sites ($P < 0.05$, *this report*, Results Part IV). Bull trout that spawned in the North Fork and Copper Creek behaved differently after spawning and into the winter. All post-spawning bull trout ($n = 3$) in Copper Creek remained throughout the winter, while all surviving ($n=3$) North Fork post-spawning bull trout returned to the mainstem Blackfoot River to within one-mile of, or to their previous mainstem Blackfoot River over-wintering locations.

Of the 28 WSCT that spawned in 2002 and 2003, eight (29%) died after spawning (all before July 15th). Nine of the surviving twenty WSCT (45%) returned to their capture locations within 1-217 days (mean: 72.3) of exiting tributaries. Four WSCT summered in the Blackfoot River within an average of 6.7 miles (range 0.8-17.8) of their capture location and seven summered in their spawning tributaries.

Of the original 20 surviving migratory WSCT, eleven wintered (November 1 – April 30) in the Blackfoot River. Eight of these (73%) returned to original capture locations and the remaining three over-wintered an average of 8.4 miles (range 0.8 – 17.1) from capture sites. One WSCT radioed in a pool in the Blackfoot River near rm 64.7 in 2002 over-wintered in the North Fork (rm 20.2) the following year, a distance of 30.6 river miles between wintering sites. We observed wintering fish in larger complex pools and exhibited very little movement between September and March. The remaining nine WSCT either died or their transmitters expired prior to winter.

Ten WSCT (40 %) and three bull trout (60 %) captured in 2002 were alive with working transmitters in 2003. Of the ten WSCT, four (40%) were repeat spawners with three of four returning to the same stream used in 2002, and within 0.6 miles of the previous year's spawning location. The fourth fish returned to the mouth of the previous years spawning tributary, within 0.7 miles of the previous spawning site, at which point contact was lost. Two WSCT that did not spawn in 2002 did in 2003. The remaining four made either no spawning attempt or their transmitter expired prior to the spawning period.

Land ownership (Private, State, USFWS, USFS, BLM, and PC) use for bull trout and WSCT trout was variable; although, private land was shown to be important (Table 7). For bull trout, private land comprised the majority of over-wintering sites (94%) and migration corridors (67%); however, spawning was limited exclusively to USFS land. Private land was critical for WSCT for over-wintering and migration corridors in all three reaches. Likewise, WSCT spawning occurred primarily on private land in all three reaches.

WSCT use of pools varied by reach. For the two upper (C-type) reaches, WSCT occupied pools 89% of the time (89% for summering and 88% for wintering), although pools comprised only 46% (grand mean) of the wetted channel area. Most occupied pools (73%) were associated with large woody debris (LWD) and 27% with other forms of cover (undercut banks and depth). WSCT use of pool/LWD association occurred at levels slightly higher than the 69% availability of the sampled pool/LWD habitat-type. This use of pools and LWD as cover varied by channel-type with associations with wood higher in alluvial (C-type) channels, compared with moraine and bedrock controlled (B and F-type) channels of the lower reach (Rosgen 1996). WSCT in the lower reach occupied pools 56% of the time (29% for summering and 59% for wintering) although pools comprise only 7% of the wetted channel area. These WSCT were associated with geologic cover (primarily boulder and bedrock) during all contacts. While in tributaries, of the 158 WSCT habitat unit contacts, 113 (72%) were located in pools, with cover associations primarily of wood (65%) and to a lesser degree, other forms of cover (undercut banks and overhanging vegetation 9%, boulders and bedrock 15% and depth at 11%).

	Private	State	USFS	USFWS	BLM	Plum Creek
WSCT						
Migration Corridors	69	7	9	1	7	7
Spawning Areas	64	3	17	0	13	3
Wintering Areas	80	5	0	0	4	11
Bull trout						
Migration Corridors	67	9	9	2	5	8
Spawning Areas	0	0	100	0	0	0
Wintering Areas	94	0	6	0	0	0

Based on total mileage by ownership

Table 7. Native fish use by percent land ownership.

Bull trout in upper and middle reaches used pools with LWD 79% of the time (76% for wintering and 90% for wintering), compared with 67% of contacts in the lower reach. All bull trout pool contacts (all reaches) were associated with cover, the form of which varied by reach (Table 8). Of the 81 individual habitat unit contacts made in tributaries, 56 (69%) were in pools. Of these pools, bull trout cover associations included 48% LWD, 38% boulders and bedrock, 11% depth only and 4% undercut banks and overhanging vegetation.

	reach totals					Summering				Wintering			
Reach	# fish	# loc.	# in pools	pools w/LWD	pools/ other	# loc.	# in pools	pools w/LWD	pools/ other	# loc.	# in pools	pools w/LWD	pools/ other
WSCT													
lower	16	52	29(56)	2(7)	27(93)	15	7(29)	2(29)	5(71)	37	22(59)	0	22(100)
middle	20	85	70(82)	50(71)	19(27)	45	37(82)	25(68)	12(32)	40	33(82)	25(76)	7(21)
upper	21	89	84(94)	63(75)	21(25)	52	49(94)	42(86)	7(14)	37	35(95)	21(60)	14(40)
total		226	183(81	115(63)	67(37)	112	93(83)	69(74)	24(26)	114	90(75)	46(51)	43(48)
Bull trout													
lower	6	43	29(67)	1(2)	28(97)	22	15(68)	0(0)	15(100	21	14(67)	1(7)	13(93)
middle	4	9	4(44)	1(11)	3(75)	5	1(20)	0(0)	1(100)	4	3(75)	1(33)	2(67)
upper	6	30	27(90)	21(88)	6(22)	24	21(88)	18(86)	3(14)	6	6(100)	3(50)	3(50)
Total		82	60(73)	23(28)	37(62)	51	37(73)	18(49)	19(57)	31	23(74)	3(13)	18(78)

( ) percent of use

Table 8. Summary of pool use and cover association for WSCT and bull trout in three reaches of the upper Blackfoot River. 2002 and 2003.

Discussion

We found general movement patterns of westslope cutthroat trout and bull trout were similar to fish captured in the Blackfoot river in downstream reaches (Swanberg 1997, Schmetterling 2001, 2003), but also noteworthy differences.

Bull trout: movements and habitat use

While the bull trout in the Blackfoot River downstream of the North Fork have been studied (Swanberg 1997; Schmetterling 2003), upper river fluvial bull trout (above the North Fork) have not been adequately evaluated, with the exception of a limited telemetry study upstream of Lincoln (Swanberg and Burns 1997). Early telemetry studies reported an *upper* and *lower* component to Blackfoot River fluvial bull trout population (Swanberg 1997; Swanberg and Burns 1997).

Nine of 10 telemetered adult bull trout in the upper Blackfoot River migrated and presumably spawned. Spawners utilized localized areas in only two spawning streams, the North Fork and Copper Creek. This and early studies (Swanberg 1997, Swanberg and Burns 1997) showed that these fish behave differently. In this study, bull trout spawners entered in the North Fork between late May and mid-July and exited between late September and mid-November, consistent with movements in lower river (Swanberg 1997). By contrast, bull trout spawners in Copper Creek entered later (mid-June through late July) and remained in Copper Creek longer than the North Fork bull trout, and than Copper Creek bull trout described in earlier studies (Swanberg 1997; Swanberg and Burns 1997).

This study identified upper river use (upstream of the North Fork Blackfoot) by bull trout that spawn and presumably rear in the North Fork Blackfoot. This use involved the down-river movement of bull trout captured near Nevada Creek before ascending the North Fork, and the up-river return to wintering areas of the Blackfoot River (near Nevada Creek) shortly after spawning. For these fish, the high fidelity to spawning and wintering sites observed in our study conforms to movement patterns in the lower basin (Swanberg 1997).

This mainstem over-wintering use provides the first FWP documented presence of bull trout in the Blackfoot River between Nevada Creek and the North Fork. This reach of the Blackfoot River suffers water quality problems including elevated summer water temperatures (Peters and Spoon 1988; Ingman et al 1990; Results Part IV). Densities of bull trout are extremely low based on population surveys conducted during spring 2002. Based on the thermal tolerances of bull trout (and small sample size), use near Nevada Creek appears to be seasonal and likely limited to over-wintering. All telemetered bull trout using this reach exited by mid-June, and returned to previous wintering areas by November.

In contrast to a 1996 bull trout telemetry study (n=5) upstream of Lincoln (Swanberg and Burns 1997), bull trout that spawned in Copper Creek attained larger mean size (23.7" compared with 20.9"; t-test, $P = 0.11$), occupied a much larger mean home range size (42.2 river miles compared with 11.0), exhibited tributary wintering and displayed more diverse migratory traits. Unlike this early study that found post-spawning tributary out-movement, three post-spawning Copper Creek bull trout made no attempt to leave and instead wintered in Copper Creek. These inter-annual differences in movement patterns can be explained by small sample size, variations in the hydrograph, and the subsequent condition of migration corridors during the spawning out-migrations. For example in October 2002, Blackfoot River flows near Bonner ranged from ~560 to 410 cfs. Under these below normal conditions, bull trout remained in Copper Creek presumably to avoid isolation in intermittent reaches or marginal wintering areas. In contrast, October flows in 1996 ranged from ~700 to 650 cfs during which time four radioed bull trout exited Copper Creek. Isolated and marginal wintering areas near the mouth of the Landers Fork may also influence this wintering behavior (Swanberg and Burns 1997; Pierce et al. 2002).

Spawning occurs in discrete areas, where groundwater inflows provide a significant warming influence during winter compared to downstream non-spawning sites where mid winter anchor ice formation common (*this report*, Results Part IV). These upwelling areas have been shown to be important to embryo survival and the timing of emergence (Weaver and Fraley 1991).

Two of three Copper Creek fish survived the winter, and moved downstream during spring runoff, to the middle Blackfoot River near original capture locations. The forth bull trout that migrated into Copper Creek in 2003 did not survive the Snow-Talon wildfire. The acute affects of wildfire (and possibly fire fighting activities) appear to result in high mortality of bull trout in Copper Creek, based on sharp declines in redd counts (USFS data - *this report* Executive Summary). These losses (and potential post fire impacts) underscore the risks posed by catastrophic events on what is essentially the only fluvial spawning population for the entire upper Blackfoot watershed (Swanberg and Burns 1997, *this report*). This population appears to possess distinct life history traits necessary for population resiliency and long-term population viability. Isolation of a portion of the population caused by natural dewatering makes this population even more vulnerable to catastrophic events such as severe wildfire (Swanberg and Burns 1997; *this report*) and other disturbance. Fortunately, this study identified Copper Creek fluvial bull trout between Lincoln and Nevada Creek – far below the area of anticipated post-fire impacts. These fluvial fish should provide a higher level of resiliency than previously reported (*see* Swanberg and Burns 1997).

We tracked only one non-spawning migratory bull trout. This sub-adult fish captured near Lincoln Gulch, entered a spring creek tributary in April, presumably to avoid high flows, a common movement pattern in the Rock Creek watershed (Eric Reiland, FWP personal communication). It returned to its capture location in the Blackfoot River in June where in remained until killed by a predator in October. This fish remained in the river during summer in a reach where maximum summer temperatures were < 65 °F, or ~ 5 to 12 ° F lower than Blackfoot River below Nevada Creek (Appendix I). By contrast, a majority of migratory non-spawning fish in the lower river ascend cooler tributaries in mid-summer presumably to avoid unfavorable summer-time temperatures of the lower Blackfoot River (Swanberg 1997).

Our study documented the mortality of five bull trout (50 %). Sources included one mammal, one suspected poaching, one to the Snow-Talon wildfire, and two unknowns. Increases in visible avian inflected scars (talon and beak scars) on bull trout were observed by FWP biologists during field sampling during the drought period. Bull trout have also been observed holding in "vulnerable" habitats, including shallow waters lacking cover while in tributaries, increasing their vulnerability to predation during the current drought.

Restoration and management implications

This study underscores the importance of two spawning streams in the upper Blackfoot basin, while expanding the known geographic scale of both North Fork and Copper Creek bull trout stocks regarding the mainstem Blackfoot River. Based on this and previous telemetry studies (Swanberg 1997, Schmetterling 2003), bull trout that spawning in the North Fork occupy the Blackfoot River from its mouth to Lincoln and downstream in the Clark Fork >30 miles. The known range of Copper Creek spawning stock has greatly expanded, extending from spawning sites, downriver ~65 rm, to near the confluence of the North Fork. These broad areas of use underscore a need to manage and recovery bull trout on a regional scale.

Although many human-related factors cumulatively influence the strength of both local populations over broad areas, many habitat problems are being corrected in the lower Blackfoot Watershed, and have been identified in the upper Blackfoot Watershed. Within the North Fork, irrigation ditch screening, tributary restoration and instream flow enhancement in critical migration corridors are at various stages of implementation. Improvements like these contribute to increases in bull trout redd counts and increased use of juvenile bull trout in restored streams (Pierce et al. 2002, *this report* Results Part IV). However, loss of flows (irrigation and natural) during the North Fork bull trout out-migration time-period continue to periodically isolate adult bull trout in intermittent reaches during low flow years (Pierce et al. 2002). Instream flow enhancement through improved irrigation efficiency has potential to correct this "bottleneck" to out-migrant North Fork bull trout. At this point, there are no significant recovery efforts directed towards anthropogenic problems influencing the Copper Creek bull trout population. However, potential restoration opportunities have been identified throughout tributary and mainstem reaches (Pierce et al. 2002, 2001; *this report,* Results Part IV), and extend from spawning sites (Snowbank Creek and the Talon-Snowbank burn area) down river to the area of Nevada Creek.

WSCT movements and habitat use

Compared with fluvial WSCT telemetry study in the lower Blackfoot Watershed, our study was undertaken higher in the drainage (above the North Fork), above the range of rainbow trout reproduction and the general distribution of rainbow trout. This area is identified as a region of high genetic WSCT integrity with most sampled streams supporting genetically unaltered populations of WSCT (Pierce et al. 2000; Shepard et al. 2003, *this report*). Densities of fluvial WSCT are low and range from ~9 fish/1000 (>6.0") in the upper reach (above Arrastra Creek) to ~0.5 fish/1000' in the lower reach below Nevada Creek (Pierce et al. 2000; *this report* Results Part II).

As expected, our study confirmed many aspects of WSCT movement and spawning behavior similar to the lower Blackfoot drainage including migration timing and tributary use (Schmetterling 2001). However, we also found considerable differences in the movements and behavior of WSCT in the upper river (above the North Fork) compared with the lower river (below the North Fork). Similar to bull trout, these differences indicate more variability of fluvial life histories in the Blackfoot watershed as a whole based on quantified differences between WSCT of the upper and lower drainages. In addition, we also identified several fluvial spawning streams, along with many problems influencing WSCT populations in spawning streams. Problems are pervasive and involve culvert crossing, irrigation dewatering, entrainment to irrigation ditches and habitat degradation (Pierce et al. 2002, 2001, 2000).

Similar to previous studies, spawning movements of Blackfoot River fluvial WSCT began just prior to the rising limb of the hydrograph, at which point adult fluvial spawners moved up- and down river before entering spawning tributaries near the peak of the hydrograph (Schmetterling 2001). Similar to the lower river study, WSCT spawning in larger tributaries began movements earlier, migrated longer distances and remained in larger tributaries significantly longer compared with WSCT spawning in smaller tributaries. Repeat and alternate year spawning occurred and post-spawning mortality was also high. Similar to this previous study, we failed to confirm mainstem spawning, with one possible exception in an upper 3rd-order section of the Blackfoot River, from a fish that moved to the mouth of the previous years spawning tributary.

Unlike other studies that showed more discrete use of lower-order streams (Magee 1996), our results were similar to the lower Blackfoot River study, as we identified spawning sites in a wide range of sites that did not necessarily conform to any two-dimensional geographical pattern.

WSCT migration patterns appeared to be influenced by a degree of reach-related variability in our study area. Mean starting date of the spawning migration incrementally increased in the upstream direction from April 27th in the lower reach, to April 30th (middle reach) to May 3rd in the upper reach, despite lower water temperatures (average of 2° F, both years on April 27) in the lower reach compared with the upper reach. WSCT migration distances also increased in the lower reach. Consistent with earlier migrations and larger total pre-spawning movements, WSCT of the lower reach exhibited longer duration (8 days) of pre-spawning movements (compared with the combined upper reaches) and sustained substantially higher post-spawning mortality (64%) compared with middle and upper reaches (combined total = 36%). Differences between the distance, duration and mortality between the lower and upper reaches seem to relate to the degraded conditions of tributaries and general lack of spawning site availability in the lower reach. We identified extensive river movements (mean = 16.6 miles) of non-spawning WSCT, compared with 3.6 miles in the lower drainage (Schmetterling 2001). Comparing these movements with fish length between studies, we found no significant differences (Mann-Whitney t-test, $P=0.084$). These movements further outline that resource exploitation not only extends over broad areas of the river, but also varies regionally within the watershed. Furthermore, unlike the previous study, we failed to confirm relationships that smaller fish moved longer distances or moved earlier. Schmetterling (2001) speculated this alternative finding was competition driven. If this is the case, our finding would be consistent with this hypothesis given low salmonid densities. Our study area would result in less competition, compared with the lower river study where densities are much higher (Results Part II).

We identified higher fidelity of adult WSCT to spawning and wintering sites, compared with the lower study. High site fidelity for WSCT has previously been documented (Magee et al. 1996), but not in the lower Blackfoot where repeat migrants did not spawn within 3.1 miles of their previous year's spawning location (Schmetterling 2001). This range of fidelity within the Blackfoot River watershed (low in the lower basin and high in the upper basin) indicates that spawning sites may be more limiting in the upper drainage than in the lower drainage. Lower densities of WSCT in the upper drainage compared with the lower drainage seem to support this premise. We also found higher fidelity to wintering sites with 40% of post-spawning fish returning to their original capture locations, compared with 11% in the lower river study. These differences may relate to the quality of wintering pools in the upper drainage compared with the lower drainage where pools are larger. In our study, we observed wintering in larger pools.

Although we did not analyze the extent of intermittent reaches between the upper and lower drainages, a majority of WSCT (62%) ascended intermittent reaches to access upstream spawning sites in our study, compared with 4% of WSCT utilizing spawning streams identified in an earlier study (Schmetterling 2001). All telemetered WSCT migrating downstream through intermittent reaches returned during non-base flow periods. Mortality did not appear to be directly related to intermittent reaches, a problem affecting out-migrant bull trout during base flow migration periods (Swanberg and Burns 1997; Pierce et al. 2001), indicating a highly selective adaptations to intermittent channels for WSCT.

This study outlines the importance of pools and LWD as an important habitat features. WSCT not only occupied for pools a majority of the time (despite low availability in some areas), they were also "cover-oriented" at all locations regardless of the channel type or location within a habitat unit. Implications with pool and cover associations relate to certain land management (unregulated riparian grazing and timber harvest), which potentially influence the integrity of stream banks, overhanging vegetation, and recruitment of LWD, more so in alluvial (C-type) channels, which are more subject to stream bank damage, channel widening and subsequent loss of cover than geologically controlled (B and F-type) channels (Rosgen 1996). Adverse alterations of WSCT habitat in (C-type channels) occurs in the middle and upper reaches of the study area (Marler 1997; Confluence 2003) and is extensive in tributaries with comparable alluvial valley bottoms (Pierce et al. 2002b).

The high post-spawning mortality and predation by avians observed in this study suggests WSCT are vulnerable in tributaries, especially during low-water years, which has been confirmed in other studies (Brown and Mackay 1995; Schmetterling 2001). In our study, we found nine of 11 (82%) WSCT known mortality sources occurred by predators and the remaining two were illegally harvested. Of avian predation, 50% (4 of 8) of the WSCT mortality was traced to a single heron rookery near the mouth of Nevada Creek. The distance from kill sites to the rookery extended from 0.5 to 19.5 air miles. Vulnerability to heron predation may be elevated in part due to extensive riparian and channel alterations that have widened channels and reduced cover in many streams in the alluvial bottomlands near Nevada Creek.

Restoration and management implications

This and other assessment demonstrate that genetically pure fluvial WSCT utilize significant portions of the upper Blackfoot watershed in the absence of hybridizing species (Pierce et al. 2002, 2001, 2000, Shepard et al 2003, *this report*). Within this setting, a primary conservation strategy identified in the upper Blackfoot Watershed involves managing for metapopulation function and multiple life-history strategies (Shepard et al. 2003). This conservation strategy involves protecting existing high quality habitat, improving altered habitat, and maintaining or improving the connection between occupied habitats. This strategy further involves 1) correcting road crossings to allow passage, 2) sustaining recruitment of LWD to tributaries and the river, and 3) managing lakes and private fishponds with appropriate species. We also identified poaching problems in the Lincoln area and a need for additional enforcement (and education) at public fishing access sites.

Fluvial WSCT of the Blackfoot River rarely used tributaries between the North Fork and Arrastra Creek. None used Nevada Creek, Yourname Creek and Frazier Creek, despite WSCT in the headwaters of these streams. Tributary assessments report degradation and fragmented habitats (and populations) in lower stream reaches of these streams (Pierce et al. 2001). Only Wales Creek received limited spawning use by three WSCT and of these, two did not survive due to speculated irrigation-induced low flows during the spawning period. Wales Creek is the lowest-most spawning site identified in this study. This spawning site overlaps with the upper range of the rainbow trout and may be influenced by private fish-ponds containing rainbow trout, which drain in to lower Wales Creek. A critical example of this influence is of the two WSCT showing hybridization, both entered Wales Creek. For the lower reach as a whole, managing for either resident or fluvial WSCT will require correcting extensive anthropogenic problems resulting primarily from agricultural practices.

Arrastra Creek, the next upstream (identified) spawning stream (28.4 miles upstream of Wales Creek) received the highest amount of spawning use of all streams; however, all fish spawned downstream from a set of improperly placed culverts. During the WSCT migration period, we measured velocities at these culverts at >7 ft/sec, well above recommended velocities for fish passage through culverts (Evans 1974).

FWP studies identify restoration potential on many Blackfoot tributaries in the upper reach between Arrastra Creek and Lincoln (Pierce et al 2000). Tributaries in this area are less impaired, and problems in the upper reach are more localized and restoration can be completed with less effort and at less expense than tributaries entering the lower reach. Interestingly, tributaries to the Blackfoot River upstream of Lincoln provide a substantial amount of the spawning for fluvial westslope cutthroat and bull trout that summer and winter in the Blackfoot River between Lincoln and the North Fork, despite intermittent channels and long distances between tributary spawning sites and nodal habitats. Protection of these areas should be considered within the context of downriver recruitment and migration corridors maintained.

Conclusions

Diversity of life history traits is common in native inland salmonids (Behnke 1992). In the Blackfoot Watershed, local diversity partially results from selective pressures in a post-glacial landscape of regional geoclimatic variability. Dispersal and the full expression of life histories in salmonid populations requires free movement of migratory fish (Reiman and Allendorf 2001), a condition critical to long-term persistence of populations (Reiman and McIntyre 1993). Maintenance of life history variation means not only recognizing the importance (and recovery implications) to locally-adapted fish (like the Copper Creek bull trout), but by necessity further involves social considerations of a basin under mixed ownership where management of streams often conflict with the fundamentals of long-term conservation, particularly for wide-ranging species such as fluvial WSCT and bull trout.

Fisheries impairment throughout the upper Blackfoot River watershed is documented, with the majority of impairment occurring at lower elevations and primarily on private land (Pierce et al. 2000; 2001; 2002; 2002b; Confluence 2003; *this report*). Although public lands comprise a significant portion of the upper drainage, they also comprise a limited amount of fluvial WSCT spawning sites, migration corridors and wintering areas. Bull trout spawned exclusively on public land yet less than 25% of the migration corridors and winter areas were on public lands. This disproportionate (and variable) use of private land emphasizes the continued need to work with individual private landowners at a broad scale in order to conserve and restore fluvial native fish in the upper Blackfoot Watershed.

Bull Trout Redd Surveys

Bull trout redds counts are a common tool to monitor escapement of adult fluvial bull trout (Dunham et al. 2001). Redds of fluvial bull trout are generally large (> 3 ft long) and can be easily identified by a cleaned, oval shape (pit), and a mound of unconsolidated gravel (tailspill) left by a females digging activities (Kondolf and Wolman 1993). Redd counts in selected spawning reaches have been conducted consistently in the "big three" spawning streams (Copper Creek (by USFS), Monture Creek, and the North Fork of the Blackfoot River) beginning in 1989 and continuing through 2003, and less intensively in Gold and Dunham Creeks beginning in 1994 or 1995 (Table 9). Bull trout spawning reaches were surveyed in late September, which corresponds with the immediate post-spawning period. Only redds where a definite pit and tailspill were discernable were counted. Redd counts in this report are both complete counts (for 2003) and surveys of index reaches to spawning adult abundance in selected reaches.

The spawning index reach of Monture Creek has displayed an upward, more stable trend than either the North Fork or Copper Creek, increasing from 10 redds in 1989 to 80 in 2003, averaging 58 redds over a 14-year period of record. Likewise, the index section of the North Fork averages 58 redds (with 12-years of record) and was upward trending, with numbers of redds increasing from 8 in 1989 to 123 in 2000. Redds in the North Fork began to decline in 2001, and were down sharply to 41 by 2003. The index section of Copper Creek average 19 redds (range 4-27) with 15-years of record. Redd numbers dramatically declined in 2003.

Table 9. Bull trout redd counts for five tributaries of the Big Blackfoot River, 1989-2003.

	Gold	Dunham	Monture	North Fork	Copper
1989			10	8	21
1990					23
1991			25	26	24
1992			34	39	25
1993			45		19
1994			49		23
1995			60	27	21
1996			65(79)	59	21(35)
1997			61(71)	65	22(41)
1998			60(67)	76	27(44)
1999			65(75)	87	9(38)
2000			74(80)	123	20(44)
2001			94(93)	75	16(37)
2002	6	11	93(101)	70	15(38)
2003	4	6	80(83)	41(50)	4(18)
average			58(81)	58	19(37)

counts based on index reaches, ( ) total counts

Gold Creek and Dunham Creek each have smaller runs of bull trout and have averaged 6 to 8 redds. Compared with 2002, redd number have declined in both streams.

Dunham Creek declined from 11 redds in 2002 to 6 in 2003. We counted four redds in Gold Creek in 2003, down from six a year earlier.

Bull trout spawning area temperature study

Bull trout spawning occurs at discrete locations, which coincide with water temperature regimes typically influenced by groundwater inputs, a source that moderates temperatures throughout the entire year. The influence of groundwater upwelling on bull trout incubation temperatures has not been well quantified (MBTSG 1998), although is important because it influences embryo survival, development and timing of emergence (Weaver and Fraley 1991). To determine water temperatures in critical bull trout spawning areas during the winter months, temperature data was collected in Gold Creek, Monture Creek, Copper Creek and Cottonwood Creek in 2001-02 at current or presumed historic spawning locations (Table 10). In order to compare temperatures in upstream (spawning) with downstream (non-spawning) reaches, temperature data was also collected in each of these streams close to the mouth, downstream of spawning locations. Kleinschmidt and Nevada Spring Creeks were also monitored during the winter months of 2001. These two streams were historical bull trout spawning sites based on local accounts. Temperatures were collected at these suspected historical sites to see how winter thermal regimes compare to current bull trout spawning sites.

Table 10. Winter water temperature summaries for six streams influenced by groundwater

Location	Mean	Min	Max
Gold Creek			
Upstream	34.4	31.86	39.58
Downstream	32.4	31.25	37.17
Monture Creek			
Upstream	38.4	35.24	40.65
Downstream	30.8	29.61	37.69
Copper Creek			
Upstream	33.7	31.2	37.1
Downstream	32.3	31.6	35.1
Cottonwood Creek			
Upstream	36.9	31.9	42.5
Downstream	34.4	31.7	41.44
Kleinschmidt	43.1	34.4	46.9
Nevada Spring Creek	45.3	45.2	46.3

Temperature results from Gold, Monture, Copper, and Cottonwood Creeks in 2002 revealed that upstream spawning locations were significantly warmer during mid-winter months as compared with downstream, non-spawning locations (Paired t-test, $P < 0.05$). Temperatures in upstream spawning reaches are very important to bull trout populations wintering in these areas as the formation of anchor ice (which induces stress) is inhibited, while conditions in downstream locations were shown to be less ideal. For example, Monture Creek, the most stable of all bull trout streams in terms of successful reproduction, maintained the highest winter temperature and lowest range of water temperature fluctuations of the current spawning sites. Downstream locations on all non-spawning locations had temperatures significantly lower during winter months, and conditions more favorable to anchor ice formation (Figure 51).

Kleinschmidt and Nevada Spring Creeks had winter temperatures that averaged near 43° and 45°F during winter months, and were warmer than other current bull trout spawning sites. When comparing these two sites, Nevada Spring Creek temperatures were more consistent and fluctuated 1° F or less during winter months.

Although we assessed only one aspect (winter surface water temperatures) of spawning habitat, results provide some insight in to a discrete and critical component of bull trout spawning sites. In the future, we hope to expand these types of winter temperature studies to the intra-gravel environment of current and suspect historical spawning sites. Incorporating more specific geomorphic assessments to further define areas where expansion of bull trout to historical spawning sites may also be possible.

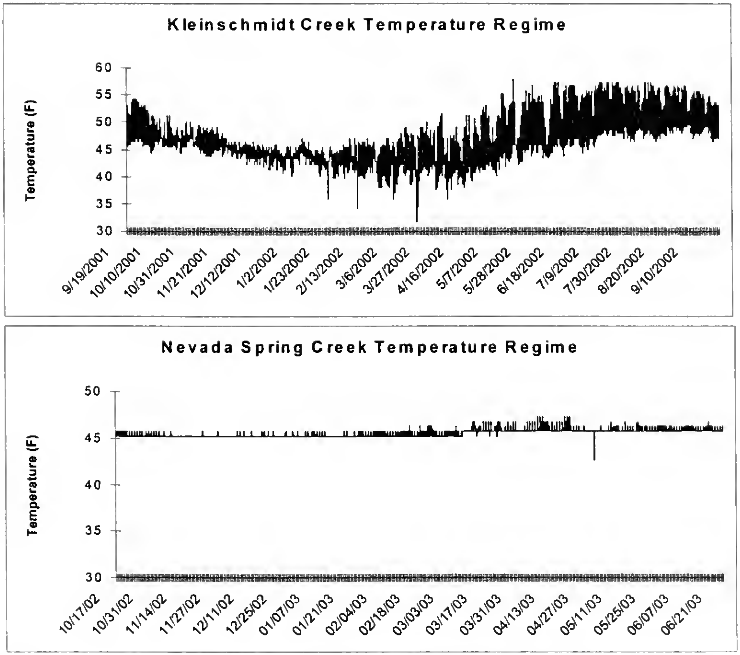


Figure 50. Winter water temperatures at two suspected historical bull trout spawning sites, winter 2002 and 2003.

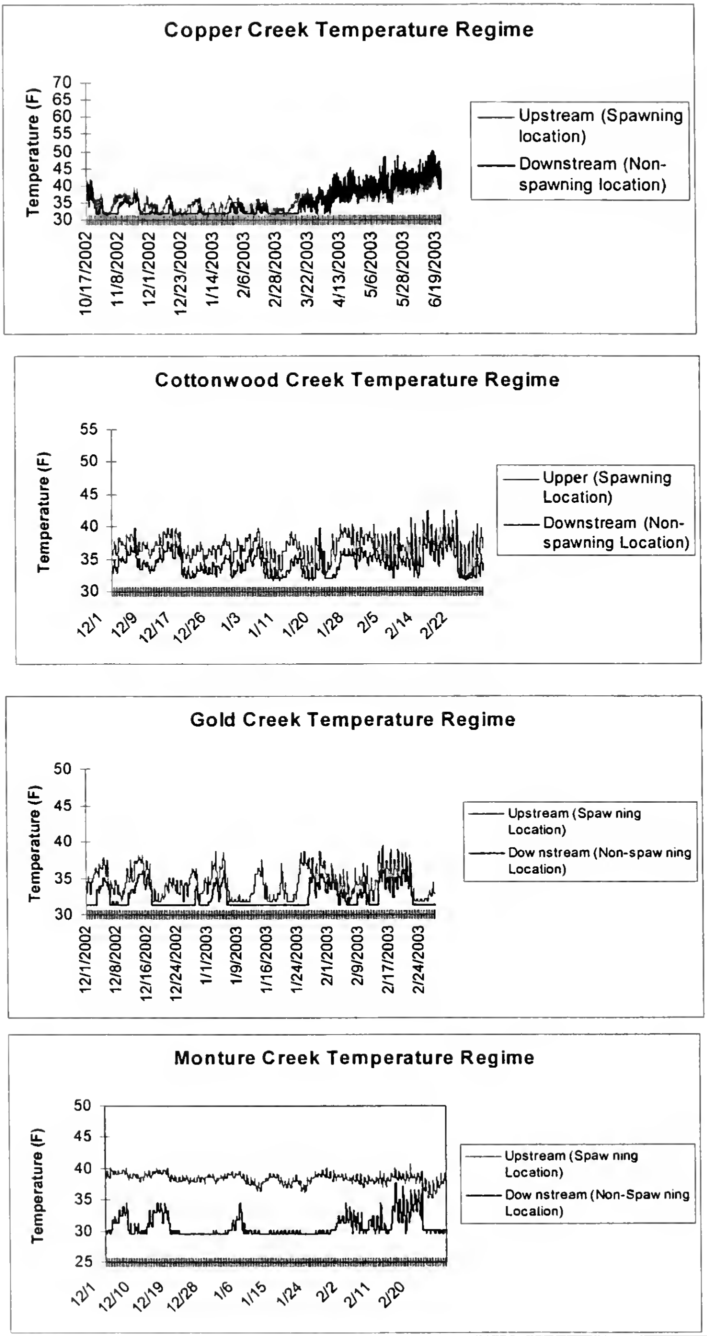


Figure 51. Winter water temperatures in known and historical bull trout spawning sites compared to downstream non-spawning sites, winter 2002 and 2003.

Coopers Lake and Nevada Reservoir Fisheries Assessments (*from* Berg 2003)

Nevada and Coopers Lakes are located near the middle portions of the Blackfoot River watershed. Nevada Lake, formed by an earthen dam in 1941, is located in the middle reaches of the Nevada Creek. At an elevation of 4,615', the lake has a surface area of approximately 337 acres. Coopers Lake is a natural glacial trough lake with a surface area of ~196 acres at an elevation of 4,490'. McDermott Creek flows out of the Scapegoat wilderness into the north end Coopers Lake. Salmon Creek is the outlet stream.

Methods

Fish sampling surveys were conducted June 21-24, 2003 on Nevada Lake and July 12-16, 2003 on Coopers Lake. We used standard "Montana" experimental floating and sinking nylon or monofilament gill nets, measuring 6' x 125' with graduated mesh ranging from 0.75 to 2.0" square measure. Overnight stationary gill net sets were equally distributed around the entire perimeter of each lake to produce a representative catch. The size and complexity of each lake dictated the number of gill nets set used. During the surveys, 16 floating and 4 sinking gill net sets were placed on the Nevada Lake and 19 floating and 6 sinking gill net sets on Coopers Lake. Locations coordinates for each gill net set were recorded using GPS. Locations were also marked on USGS topographic maps. Sampling recorded sex, total length to the nearest millimeter and weighed to the nearest 10 grams for all species.

Results

Our overnight stationary gill net survey on Nevada Lake handled 1,871 fish (Table 11). Yellow perch, illegally introduced into Nevada Reservoir, accounted for 55% of the total catch, followed by longnose suckers (13%), and red-side shiners (9%), largescale suckers (9 %), rainbow trout (8%) and westslope cutthroat trout (8%).

Coopers Lake survey produced 632 fish. Northern pikeminnow comprised 71% of the total catch, followed by longnose suckers (28%) and low densities of WSCT (0.6%) and brook trout (0.6%).

Discussion

Sampling and stocking of Coopers Lake has been inconsistent. Coopers Lake supported bull trout in the 1970s; however, in 2003, we detected no bull trout and very low densities of other game fish (WSCT and brook trout). Recent tributary sampling indicates weak recruitment of wild fish to the reservoir (Pierce et al. 2002). Based on recent angler interviews, satisfaction with the fishery also appears low. In addition, Coopers Lake has also had a long history of perceived over-population problems with non-game species. The sum of these variables makes Coopers Lake a likely location for an illegal fish introduction.

Beginning in 2003, we initiated increased plants of WSCT into Coopers Lake. Sampling in 2003 did not detect the recently introduced hatchery fish. This may be the result of an ineffective net mesh size (too large) for these fish, planting location or other variables. Future surveys will assess the success of these plants and identify alternative management if needed.

Recently, FWP converted lake plants of rainbow trout to WSCT in Nevada Reservoir. Our surveys show Nevada Reservoir supports high densities of yellow perch and much higher densities of salmonid game fish compared with Coopers Lake. Based on these surveys, densities appear high given a history of dewatering in the reservoir.

Table 11. Catch and size statistics for fish sampled in Coopers Lake and Nevada Reservoir in 2003.

Nevada Lake

Fish Species	Number Sampled	Mean Length (inches)	Length Range (inches)	Mean Weight (oz)	Weight Range (oz)	Fish / net	
						Floating	Sinking
Rainbow trout	160	12.9	6.1 - 16.6	12.70	1.4 - 25.4	8.7	5.2
Westslope cutthroat	110	11.2	6.3 - 15.1	8.60	1.4 - 14.8	6.4	1.8
Yellow perch	1027	7.2	4.2	2.80	0.35 - 9.5	41	92.8
Large scale sucker	167	12.9	6.2 - 18.7	15.1	1.4 - 38		
Longnose sucker	237	10.9	6 - 18.3	9.8	1.4 - 33.5		
Red-side shinner	170	5.9	5.3 - 10.4	1.4	0.71 - 2.1		
Total	1871						

Coopers Lake

Fish Species	Number Sampled	Mean Length (inches)	Length Range (inches)	Mean Weight (oz)	Weight Range (oz)	Fish / net	
						Floating	Sinking
Northern pikeminnow	449	10.4	6.5 - 21.2	5.90	0.71 - 43.4		
Westslope cutthroat	4	12.2	6.7 - 17.3	17.00	1.4 - 31	0.2	0.2
Brook trout	4	9.4	6.7 - 12.2	6.30	1.8 - 12	0.05	0.5
Longnose sucker	175	14.6	8.3 - 17.3	17.70	4.2 - 27.5		
Total	632						

MODIFICATIONS OF A TURBULENT FOUNTAIN FOR USE AS A FISH SCREEN IN SMALL HIGH GRADIENT STREAMS

Abstract

We tested the efficacy of a modified turbulent fountain for its ability to screen fish from an irrigation diversion in McCabe Creek, Montana. We released westslope cutthroat trout (*Onchorynchus clarki lewisi*) into the intake of a prototype fountain in order to field-test screening capability and impingement rates. We then corrected observed flaws in the screen and repeated the test to compare efficacy of the prototype to the modified, more "fish-friendly" design. Fish lengths were similar between the two tests. Following modification of the prototype screen, the number of impinged fish declined from 37% to six percent. The duration of impingement declined by 93%, from a median of 30 seconds to two seconds. This evaluation indicates that turbulent fountain screens, when designed and constructed with proper fisheries considerations, can be effective at screening fish, and provide a low-maintenance, more practical alternative to traditional fish irrigation screening devices on small streams.

Key Words: turbulent fountain, irrigation diversion, impingement, fish screen, native fish recovery.

From: Pierce, R, W., R. J. Krogstad and G. A. Neudecker. 2003. Modifications of a turbulent fountain for use as a fish screen in small high gradient streams. *Intermountain Journal of Sciences*, Volume 9(4).

Introduction

Populations of many native fishes in the western United States have declined in part because of entrainment in irrigation ditches (Schill 1984; Fleming et al. 1987; Der Hovanisian and Megargle 1998). In the Blackfoot drainage of Montana, unscreened irrigation ditches are common within the range of bull trout (*Salvelinus confluentus*), which is *threatened* (63 FR 31647) under the ESA (USFWS 2002), and westslope cutthroat trout (*Onchorynchus clarki lewisi)* a *species of special concern* in Montana (Pierce et al. 2002). Blackfoot tributary assessments have identified irrigation ditches on 47 of 89 inventoried streams (Montana Fish, Wildlife and Parks files). As a tool to assist recovery of native fish populations, resource agencies, conservation groups and irrigators are screening irrigation diversions in order to minimize population losses due to ditch entrainment. Screening irrigation ditches in the Blackfoot River drainage had contributed to increased fish densities in tributary populations as well as the overall densities of imperiled native fish in the Blackfoot River (Pierce et al. 2002b).

Although some states require irrigators to screen ditches, Montana relies on voluntary compliance. In order for voluntary screening programs to be effective, fish screening devices must first meet fish screening objectives and provide adequate water supply for agricultural needs, operate effectively with little or no maintenance and must be cost effective (Black 1998; personal observation). Although there are many options for screening irrigation ditches (Odeh 1999; Nordlum 1996), barrier screens are often expensive and require higher maintenance than many irrigators are willing to accept (Mefford and Kubitschek 1997; Fleming et al. 1987; Black 1998; personal observation).

Herein, we discuss the potential for a turbulent fountain, originally designed as a self-cleaning trash remover (Bondurant 1983), and then modified as an effective fish screen. A turbulent fountain screen consists of a circular, horizontal screen with a vertical riser pipe in the center. The water flows up through the center pipe and spreads laterally over the screen pushing fish and any entrained debris outward towards the edge of the screen surface (Kemper and Bondurant 1985). Turbulent fountain screens operate entirely with hydraulic pressure as a single integrated diversion structure and contain no moving parts, require no external power and only minimal maintenance (*See* Bondurant and Kemper (1985) and Kincaid (2002) for original descriptions and diagrams of turbulent fountain screens).

As with other types of barrier screens used for fish protection, the suitability of a turbulent fountain screen varies with site conditions. A turbulent fountain is most appropriate for small irrigation diversions with flows ranging from 0.03 - 0.15 m^3s, and a moderate level of hydraulic differential between the intake and the fountain riser (e.g. higher gradient streams; Kincaid 2002). Although turbulent fountain screens offer an effective, low-maintenance option for screening debris from small stream irrigation diversions (Bondurant and Kemper 1985), the efficacy of turbulent fountains is untested for screening fish.

In order to assess efficacy for screening fish, we designed and installed a prototype turbulent fountain fish screen on McCabe Creek, Montana. Our objectives for evaluating the turbulent fountain fish screen were to: 1) determine the potential of a turbulent fountain system for screening fish; 2) assess impingement (fish contact with the face of the screen); and 3) provide guidance to irrigators regarding efficacy and design criteria of this alternative fish screen.

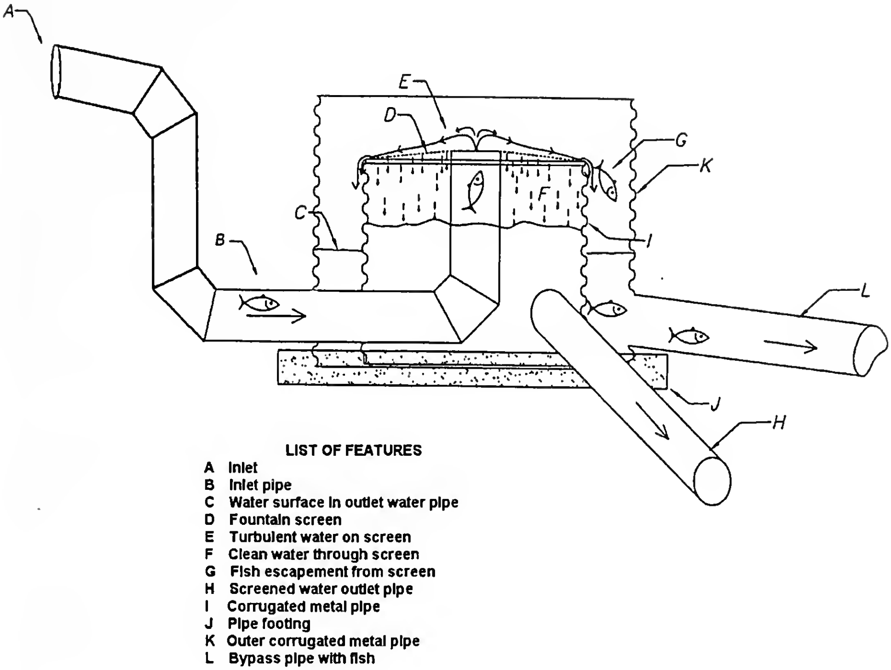


Figure 54. Conceptual design of a turbulent fountain fish screen with bypass to stream.

Methods

In addition to hydraulic design criteria defined by Bondurant and Kemper (1985), our prototype "fish screen" design incorporated a circular outer wall with an attached fish bypass pipe (Figure 54), along with inflow and outflow capacity designed to maintain constant flow through the bypass pipe. The screen was designed for a maximum inflow of 0.14 m^3s, of which a maximum 0.085 m^3s was available for outflow, with the remainder available for the bypass. The screen incorporated a 1.25 mm mesh over a 1.68 m^2 circular stainless screen set at a one percent slope, with a maximum mean approach velocity of 0.122 meters-per-second over the surface of the screen. We also reduced the screen diameter from the recommended original criteria of 213 cm to 152 cm in order to more effectively wash fish and debris off the screen. Following construction, we evaluated the fish screening capability in 2000, and then again in 2002 following correction of observed construction flaws.

In 2000, we captured 48 westslope cutthroat trout using a backpack mounted, battery-powered DC electrofishing unit (Smith-Root). Fish were anesthetized with tricaine methanesulfonate, counted and measured for total length. After fish recovered from the anesthetic, we released individual fish through the fountain intake. As fish exited the intake riser, we counted and visually estimated total length to the nearest 25 mm and timed the duration of all fish impinged on the screen for $\geq$ 2 seconds. After all fish passed, we walked up-and downstream of the bypass exit to visibly detect signs of related mortality or signs of injury.

During this impingement evaluation of our initial fish screen design, we identified two construction flaws that appeared to contribute to unnecessary impingement: 1) the close proximity of inner chamber to a portion of outer wall of the structure, and 2) a lower screen angle than specified in our prototype design (photo 1). Due to the first construction flaw, the fountain was unable to completely wash debris from the edge of the screen. At this location, fish were unable to wash free of the screen and were impinged on the screen against the debris. Based on this observation, we modified our original screen by adding a flow deflector shield to the fountain riser in order to direct water, debris and fish away from this area of screen. We also modified the shape of the screen from a low-angle flat screen to a rounded cone-shaped screen with a mean 1% slope (Figure 54).

Following these screen modifications, in 2002 we repeated the impingement trial with 66 westslope cutthroat trout entrained through the fountain intake. The capture, handling and observation of these fish were similar to the previous trial. During both experiments, the fountain intake was operating at full (0.14 m^3s) capacity.

We used a Mann-Whitney nonparametric tests to compare fish lengths in the initial trial to fish lengths in the second trial. We also used Mann-Whitney to compare the duration of impingement between the prototype and modified design. A chi-square analysis was used to test whether the number of impinged fish varied by size class (50-110mm, 111-150mm, and >151mm) between trials, where the number of impinged fish from the original design trial was used as the expected values of impingement in the modified design trial. In all cases, differences were considered significant at *P*-values $\leq$ 0.05.

Results

Prior to screen modification, 31 westslope cutthroat trout (65%) passed through the fountain with no impingement (<2 seconds) on the screen. Seventeen fish (35%) were impinged for $\geq$2 seconds, of which 14 managed to work free of the screen (median impingement time, 30 (range, 2-1560 seconds)). Three (6%) of the sampled fish remained on the fish screen after 26 minutes when we ended the experiment (Table 15).

Following screen modifications, all but four (6%) of the 66 fish immediately passed through the fountain and screen with no impingement (<2 seconds). Of the four impinged fish, all washed over the screen within four seconds (median, 2 (range = 2-3 seconds)). For these four fish, all impingement occurred in a localized boundary area between the main flow and the shielded portion of the screen.

There was no difference between the total length of fish in the first test and the second test (Mann-Whitney, P=0.081, Table 1), nor did the proportion of impinged fish vary significantly among the three size classes between the first and second trial (x^2 =3.0, df =2, P=0.223). The number of impinged fish declined from 37% in the first test to six percent in the second test (Table 12). The duration of impingement between the first and second test also declined significantly (Mann-Whitney, P=0.006).

Upon completion of both experiments, we walked up-and downstream of the bypass and found no evidence of injury or mortality resulting from impingement from either test.

Table 12. Numbers and sizes of impinged fish before (2000) and after (2002) modification of the original screen.

		Total lengths (mm)	Number fish	Size class of impinged fish (mm)		
Year	N	mean (SD), range	impinged	(50-110)	(111-150)	(>151)
2000	48	134(45), 61-241	17	9	3	5
2002	66	121(38), 61-216	4	2	1	1

Discussion

Our modifications and evaluations of turbulent fountain screens suggest that this device can provide an effective, low-cost, low-maintenance fish screening system. Our field trials further outline the importance of constructing screens to exact design specifications.

Based on our design – evaluate – modify approach, the following observations will help ensure effective application of this screen in the future. Fabricators and installers should ensure there is sufficient distance between the inner and outer chamber to facilitate the movement of fish and entrained debris off the screen, plus include a sloped (or crowned) screen with a minimum 1% slope. Not only do lower angle screens increase impingement, but also several fish, once on the original more horizontal screen, attempted to swim towards the main flow (center) of the fountain. These fish remained on the screen for an extended time before escaping. A smaller diameter inner chamber with minimal screen surface would also clean the screen more efficiently and reduce fish contact with the screen on the outer portion of the screen. A larger intake with excessive volume would serve a similar purpose by washing fish more quickly from the screen. Similarly, a smaller diameter out-flow pipe relative to intake pipe diameter forces upwelling on the outer portion of a sloped screen and assists in washing fish from the screen with less screen contact. Another possibility that was not tested might be to elevate the bypass pipe or otherwise submerge the screen in order to minimize fish contact with the screen and enhance fish passage over the screen.

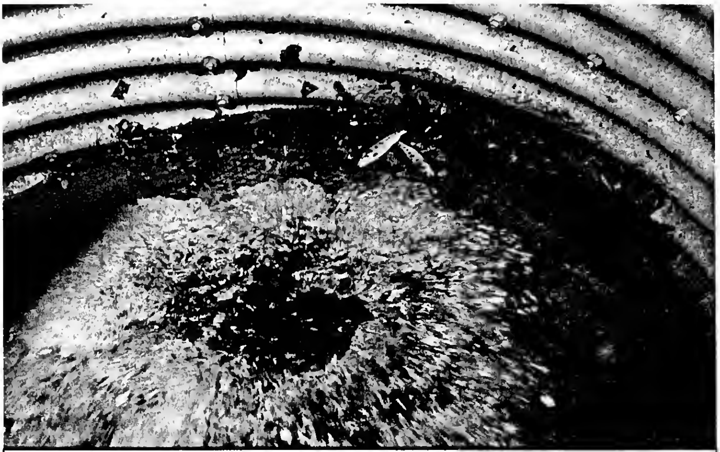


Photo 1. Fish impinged on the outer portion of the screen against the screen in area

Proper operation and maintenance of a fish screen is equally important to quality screen design (Nordlum 1996) in order to assure long-term effectiveness and function. In the Blackfoot River drainage, inadequate maintenance has reduced the effectiveness of many mechanical fish screens (paddlewheel and rotating drum). Because it has no mechanical parts, the turbulent fountain screen requires less maintenance than conventional fish screens and is cheaper to install and use. The total cost of the entire modified turbulent fountain system including the head gate was $9,900, approximately 75% of the cost of self-powered paddlewheel driven fish screen and head gate of comparable flow capacity (Montana Fish, Wildlife and Parks data). While comparable in cost to electrically powered rotating drums of similar capacity, a turbulent fountain required lower maintenance at less expense. Throughout the three summers of use, the turbulent fountain required less manual cleaning than either traditional paddlewheel driven flat-plate screens or electrically powered rotating drums.

With proper design and construction, a turbulent fountain fish screen, as an integrated diversion structure, can meet multiple objectives. These include: 1) volume control to an irrigation system and automatic removal of debris from a pipeline, 2) the elimination of entrainment into diversion ditches and the return of fish directly back to the stream immediately below the diversion point, 3) reduced impingement, 4) minimal screen maintenance, and 5) a cost-effective screening device. Unfortunately turbulent fountains have not been designed for volumes >0.15 m^3s although Bondurant and Kemper (1985) suggest designs for higher flows are possible. Required hydraulic differential for larger diversions should also be evaluated in order to identify specific site requirements. Although turbulent fountain screens appear to minimize entrainment and impingement on small diversions, we did not fully measure all aspects of screen velocities (approach or sweeping), nor all aspects of physical contact of fish with the screen. Future studies should also evaluate screen injury potential such as scale loss, as well as other design improvements in order to expand this technology to areas where formal fish screening criteria currently preclude use of turbulent fountain fish screens.

Whirling Disease Status

Whirling disease, caused by the myxosporean parasite *Myxobolus cerebralis,* was first detected in the Blackfoot River in 1995 near Ovando, MT. Since then, the disease has increased in distribution and intensity. It now infects the lower 122 miles of the mainstem Blackfoot River and continues to expand in the lower reaches of some tributaries of Blackfoot River (Figure 55, Tables 13 and 14).

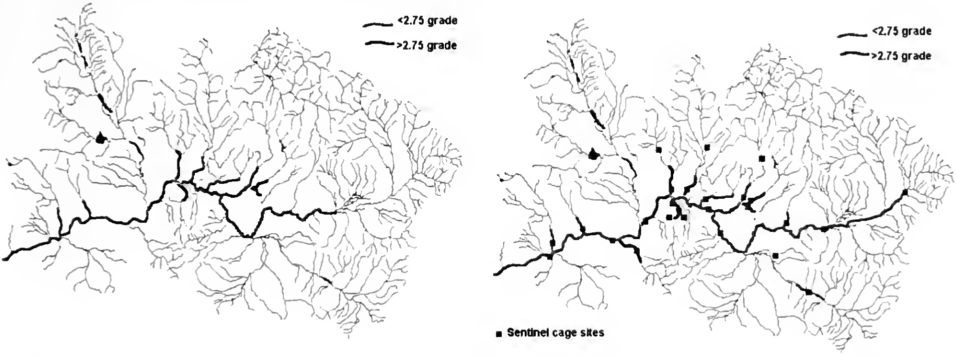


Figure 55. Generalized distribution and grade infections of whirling disease for 2000-01 (left) and 2002 and 2003 (right) in the Blackfoot watershed.

Table 13. Sentinel cage sampling results for six sections of the Blackfoot River in 2002 and 2003.

River Location	River Mile	Date	# Fish	% Infected	Mean Grade Infection	Mean water temperature	Comments
Below Gold Creek	13	Jul-02	34	29	0.59	67.1	
		Jun-03	50	90	2.62		
Below Elk Creek	27	Jul-02	29	75	1.59	66.3	
		Jul-03					
Above Clearwater	38	Jul-02	19	89	2.79	64.1	Time series
	38	Jul-02	50	68	1.48		Time series
Below Nevada Creek	67	Jul-02	31	54	0.9	66.6	
		Jul-03	50	88	2.12		
Below Lincoln	90	Jul-02	32	93	2.44	59.6	
Headwaters	122	Jul-02	36	0	0		
		Jun-03	50	2	0.02		

Table 14. Sentinel cage sampling results for 12 tributaries of the Big Blackfoot River, 2002 and 2003.

Tributary	Stream Mile	Date	# Fish	% Infected	Mean Grade Infection	Mean water temperature	Comments
Arrastra Creek	0.1	Jun-03	50	22	0.34		
Belmont Creek	0.1	Jul-02	36	13	0.19	58.4	
	0.1	Jun-03	50	0	0		
Chamberlain Creek	0.1	Jul-02	36	83	2.53	64.2	Time series
Chamberlain Creek	0.1	Jul-02	48	95	2.63	63.5	Time series
Chamberlain Creek above East Fork		Jul-02	33	0	0	60.6	
Chamberlain Creek above West Fork		Jul-02	36	0	0	58.2	
Cottonwood Creek Dwnstrm HWY 200	1	Jul-02	26	100	4.5	60.6	
	1	Jun-03	45	100	4.47		
Cottonwood Creek dwnstrm Woodworth Rd		Jul-02	47	0	0	53.3	
		Jun-03	50	0	0		
Elk Creek	0.1	Jul-02	33	0	0	64.5	
		Jun-03	50	96	2.86		
Gold Creek	2	Jul-02	40	0	0	58.5	
	2	Jun-03	50	0	0		
Monture Creek @ FAS		Jul-02	37	100	3.22	59	
Monture Creek near Dunham Creek		Jul-02	47	0	0	51.6	
		Jun-03	50	0	0		
Nevada Creek		Jun-03	50	8	0.1		
Nevada Spring Creek	3	Mar-02	21	0	0	41.7	Brook trout
Nevada Spring Creek	3	Mar-02	43	0	0	41.7	Rainbow trout
Nevada Spring Creek	3	Mar-02	19	0	0	41.7	Brown trout
Nevada Spring Creek	3	Apr-03	50	0	0		Rainbow trout
North Fork Blackfoot above Kleinschmidt Creek		Jul-02	32	46	0.78	55.7	
		Jun-03	50	64	1.32		
North Fork Blackfoot near USFS boundary		Jul-02	27	0	0	52.4	
		Jun-03	50	0	0		
Kleinschmidt Spring Creek	0.1	Mar-02	50	96	4.02	42.3	Brook trout
Kleinschmidt Spring Creek	0.1	Mar-02	48	100	4.52	42.3	Rainbow trout
Kleinschmidt Spring Creek	0.1	Mar-02	43	2	0.02	42.3	Brown trout
Kleinschmidt Spring Creek	0.1	Apr-03	50	98	4.7		Rainbow trout
Rock Creek	0.1						
Warren Creek		Jun-03	50	6	0.06		

Myxobolus cerebralis has a complex, two-host life cycle involving a salmonid and the aquatic oligochaete worm, *Tubifex tubifex*. There are also two spore forms of the parasite; a fragile triactinomyxon (TAM) that is released by the worm and infects young trout and a hardy myxospore later released by infected fish and ingested by the worm host, where the myxospore is then converted back to the TAM stage. The development and severity of whirling disease in exposed salmonids is dependent on many factors involving: 1) the fish host (species, strain, age, size) (Thompson et al. 1999;Vincent 2002; Ryce 2003); 2) the worm host (Granath et al. 2002); 3) the environment (water quality parameters, water temperature, flow rates) (MacConnell and Vincent 2002; Smith 2002); and 4) the overlap of contact with both spore types (overlap of TAM with susceptible fry species and myxospore being encountered by the worm) (Kerans and Zale

2002). With regard to whirling disease status in the Blackfoot Watershed, many of these factors are discussed below.

Sentinel cages provide an indirect measure of TAM abundance in tested waters, and were first deployed in the Blackfoot Watershed in 1998 (*see* methods). Sentinel cage monitoring has continued through 2003 at established Blackfoot River sites and throughout tributaries in order to assess disease expansion. A mean grade is determined from histology results from sentinel fish exposed in each cage to determine infection severity at individual locations (Table 15). An important criterion for determining cage deployment dates is based on water temperatures. Previous studies have shown the highest infection levels coincide with a specific water temperature range of 50 to 61 °F (Baldwin et al. 2000; Downing et al. 2002; Vincent 2002). In the Blackfoot River, these temperatures coincide with an early summer (mid-June through early July) sampling period. Results of recent Blackfoot cages show progressive increases in the disease in the up-and downriver directions, and a corresponding expansion in the lower reaches of many tributaries (Figure 55). During the last two years, whirling disease in the mainstem Blackfoot River has 1) expanded (~20 river miles) to the upper mainstem above Lincoln, 2) increased infection levels in the lower Blackfoot River (below the mouth of the Clearwater River), and 3) appears to have stabilized in the middle Blackfoot River at moderate to high levels.

Mean grade category	Infection Level Description
0.0-2.0	Low
2.01-2.74	Medium
2.75-3.7	High
3.71-5.0	Very High

Table 15. Mean grade category descriptions

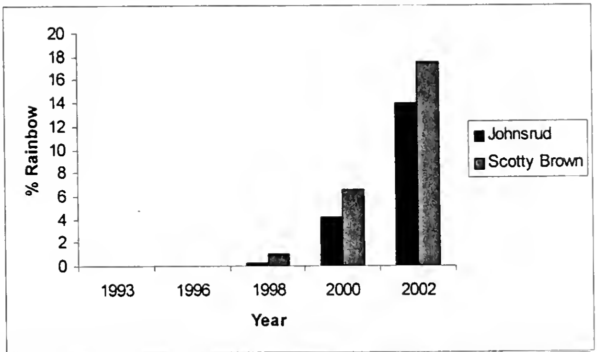


Figure 56. Rainbow trout showing clinical signs of WD in two population monitoring sections in the Blackfoot River..

The recent escalation of the disease is also expressing itself at two long-term Blackfoot River (Johnsrud and Scotty Brown Bridge) population monitoring sites, where clinical signs of whirling disease (cranial and skeletal deformities), first noticed in 1998, have dramatically increased in 2000 and 2002 (Figure 56).

Previous studies have classified salmonid based on susceptibility to the disease, which varies considerably by species (MacConnell and Vincent 2002). All salmonids in the Blackfoot Watershed (WSCT, bull trout, rainbow trout, brown trout, brook trout, and whitefish) can be infected by the parasite, but rainbow trout are reported to be the most susceptible, and brown trout and bull trout more resistant (Table 16). This species susceptibility description coincides with population (species) changes in Blackfoot tributaries at several sites. For example lower Cottonwood Creek, highly infected since 1998, shows a large decline in rainbow trout (mile 0.1) compared with the 1989 pre-whirling disease period, whereas brown trout densities have dramatically increased (Figure 57). A similar pattern was also observed with YOY in this same section in Cottonwood Creek. Likewise, brook trout, a species susceptible to the disease, have declined in one section of Kleinschmidt in the presence of high infection (Figure 58).

Common Name	Susceptibility
Rainbow Trout	3
Westslope Cutthroat	2
Brook Trout	2
Bull Trout	1
Brown Trout	1
Mountain Whitefish	2S

Table 16. Susceptibility to whirling disease among species of salmonids in the Blackfoot River. Scale of 0 to 3 or S: 0 = resistant; 1= partial resistance; 2 = susceptible; 3 = highly susceptible; S = susceptibility is unclear (conflicting reports). (adapted from MacConnell and Vincent 2002).

Blackfoot River native WSCT and bull trout appear to have a diminished risk of contracting whirling disease due in part to habitat use and life history strategies that entail spawning and rearing in tributaries, above the general elevation of the disease. Whirling disease severity typically increases in the downstream direction in Blackfoot River tributaries. This inverse relationship between elevation and infection has been detected in previous studies (Hiner and Moffitt 2001; Sandell 2001; Smith 2001; Hubert 2002; Anderson 2004), and may be a result of the parasite's lack of time in the area, low numbers of myxospores in the environment, or a lack of suitable habitat supporting *T. tubifex*.

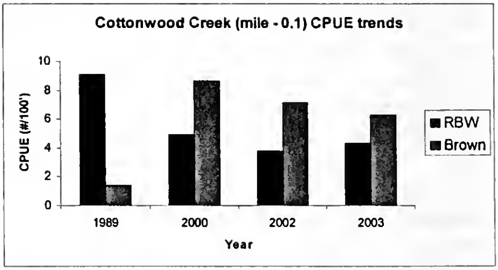


Figure 57. CPUE in Cottonwood Creek for rainbow and brown trout.

In Cottonwood Creek, Smith (1998) reported higher gradient, higher elevation habitats typically support lower *T. tubifex* densities and thus fewer TAMs. Sentinel cage studies confirm this relationship in Cottonwood Creek where periodic sampling reports high infections near the mouth, but negative results in the upper drainage (Pierce et al 2002; Table 14). Environmental conditions (water temperature, substrate and channel type) similar to upper Cottonwood Creek occur in

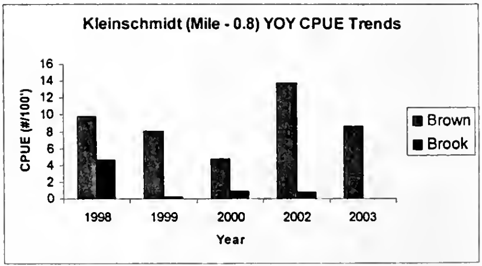


Figure 58. CPUE for YOY on Kleinschmidt Spring Creek, 1998-2003.

tributaries of the lower drainage (Gold, Belmont and Bear Creeks), and many other tributaries to the Blackfoot River. Many of these streams show mild infection levels and no signs of rainbow trout declines at this time, despite higher infections in receiving waters. Water temperatures are also typically much lower in forested and upper stream reaches (Pierce et al. 2002) and out of the reported critical temperature range of high-risk waters (Vincent 2002). As a result, the risk of exposure is variable, but in general should increase in the downstream direction. These downstream-infected areas often overlap with rainbow and brown trout spawning areas (Pierce et al. 2002, *this report* Study area maps, Figure 8).

One exception to habitats where native fish appear somewhat isolated from the disease is lower Chamberlain Creek. Lower Chamberlain Creek supports concentrated WSCT spawning and high juvenile densities (Pierce et al. 1997; Schmetterling 2001) in lower stream reaches in an overlapping area of high whirling disease infection (Table 17). Infection levels in July have reached mean grades of 3.9, a grade considered to cause population declines in exposed fish (Vincent 2002). WSCT numbers have been declining beginning in 2000; however, the confounding drought conditions limit interpretation of the disease's true effects. Fortunately, the disease currently appears localized at the lower-most portion of Chamberlain Creek, largely downstream of WSCT spawning areas.

WSCT telemetry studies conducted in the Blackfoot River have identified several important spawning tributaries (Arrastra, Belmont, Chamberlain, Copper, Gold, Monture, Sauerkraut, upper Willow and Wales Creeks, and the North Fork Blackfoot River). Four of these (Copper Creek, Sauerkraut Creek, upper Willow and Wales Creeks) have not been tested for the presence of whirling disease. The remaining six streams all tested positive with mean grade infections ranging from 0.12 to 4.5 (Table 17). Although whirling disease is present in the lower segments of these streams, known WSCT spawning typically occurs at elevations above the disease. In many cases, this upstream spawning appears to segregate critical early life stages from parasite exposure. In addition, telemetry investigations and monitoring of primary bull trout spawning sites show these areas to be currently free of the parasite, despite infected downstream waters.

The effect of habitat restoration on whirling disease severity is being investigated in the Blackfoot watershed. Our objective is to determine if restoring an infected system (i.e. reducing favorable worm habitat by regaining flushing flows and reducing sediment input through stabilizing banks) will moderate the disease. The premise behind this idea is a result of several ecological risk factors being hypothesized to influence whirling disease severity. These factors include: high productivity, lack of flushing flows, low gradient, human altered or enriched habitats that amplify the density of *T. tubifex*, and the presence of brown trout that can act as a reservoir for the disease (Modin 1998; McWilliams 1999; Zendt and Bergersen 2000). All of these factors, including high levels of whirling disease were present in Kleinschmidt Creek, a stream that was restored in 2001. Through this restoration work width to depth ratios decreased, velocities increased, stream banks were stabilized and water temperatures were moderated. Whirling disease has been monitored in this stream prior to, during, and after restoration and a decrease in infection has not yet been detected. Initially, whirling disease was detected at a mean grade of 2.8 in July of 1998. Results from cage studies in 2003, two years post project, detected infection levels at a mean grade of 4.9. It may take several years for a turnover of aquatic insect communities to occur, or perhaps *T. tubifex* numbers have been reduced, but numbers are significant enough to support the continuation of the disease life cycle.

Recent studies provide evidence to support the idea that elevated densities *of T. tubifex* are not necessary to cause high infection levels in whirling disease positive streams. For example, a study on the Madison River found low densities of *T. tubifex* can still produce sufficient TAMs to be highly infective to trout (Krueger 2002). In the upper Colorado River basin, *T. tubifex* was found to be widespread, but fluctuated in abundance throughout sites, suggesting there are point sources of *M. cerebralis* infection (Zendt and Bergersen 2000). As suggested, individual sources may not be significant, but the collective effect of these "hot spots" could lead to high levels of infection in a stream. The presence and density of *T. tubifex* was not the most important indicator of infection severity in a study on Montana spring creeks (Anderson 2004), indicating a combination of tubificid maturity, suitable habitat to support *T. tubifex*, and an input of viable *M. cerebralis* spores (Markiw 1986) may be a better predictor of infection severity. There appears to be consensus that sediment and nutrient enrichment foster the development of abundant *T. tubifex* populations, but due to the variety of conditions that *T. tubifex* inhabit, habitat does not appear to be the limiting factor. Restoration work may in fact be decreasing *T. tubifex* habitat, but perhaps there are limited areas within a stream capable of supporting the worm in significant abundance to support the whirling disease life cycle. The true effects (if any) of habitat restoration on whirling disease severity may take several years of monitoring to be detected.

Recent research into the ecology of whirling disease has provided new information pertinent to the monitoring and management of whirling disease in the Blackfoot Watershed. Recent studies show infections to occur at much lower temperatures ranges than previously identified (Anderson 2004; Hally Lukins, Montana State University, personal communication). Infections in spring creeks were highest at temperatures ranging from 43 to 53.6 °F and in sampled rivers at 45.5 – 53.6 °F, also as low as 33.8 °F (Anderson 2004). Although temperatures found in spring creeks were favorable for prolonged TAM release and high infections almost year round, this occurrence was not detected. This study indicated seasonal cycles of infection in spring creeks may occur independent of a specific "optimal range" of temperatures as previously described in basin-fed environments. Rather than infection timing being strictly dependent on a limited range of temperatures, seasonal changes in infections may result from an accumulation of temperature units (Anderson 2004).

A recent study also detected a pattern of infection timing unique to spring creeks, compared with river and basin-fed streams (Anderson 2004). The seasonal cycle of *M. cerebralis* detected in sentinel fish exposed in spring creeks followed a pattern where infection was highest in winter and early spring, decreased to low levels during summer, and then increased again in late fall. This contrasts with late May and late June peaks observed in a recent study in the Madison River (Downing et al. 2002) and with a study in the Colorado River where triactinomyxons were shown to be at their highest density during June through September (Thompson and Nehring 2000). The lack of overlap between infection timing and emergence and early rearing of rainbow trout fry suggested spring-spawning trout would be at low risk of infection, even in spring creeks with high infection severity. This contrasts with other studies from surface-fed streams where there was a high overlap between the "vulnerable period" and high infection levels in the spring (Baldwin et al. 2000; Downing et al. 2002).

In contrast to the lack of overlap between emergence and infection risk for spring spawners, fall spawning trout were shown to face a much higher risk of infection during hatching, emergence and early rearing in spring creek systems. Brown trout fry emergence occurred from December through early April, which coincided with very high infection levels in my two intensively sampled spring creeks. Although brown trout have been reported to be much more resistant to *M. cerebralis* infection as compared with rainbow and cutthroat trout (Hedrick et al. 1999; Baldwin et al. 2000), brown trout can still be infected and could be a source of infective spores, thus perpetuating the life cycle of *M. cerebralis*. Other fall spawning species such as brook trout have been shown to be susceptible to *M. cerebralis* (Vincent 2002) and emerging fry are likely to be infected in spring creeks. Utilizing this winter/early springtime period to try to capture peak infections, we sampled Kleinschmidt Creek and Nevada Spring Creek during March of 2002 and April of 2003. Infection was very high in Kleinschmidt but was not detected in Nevada Spring Creek (Table 1).

Many factors will influence future distributions of whirling disease and impacts to salmonids in the Blackfoot River. Monitoring through the disease establishment period is necessary to determine the extent and degree to which whirling disease will be influenced by the physical features of the Blackfoot Watershed. At this time, the disease continues to expand, but is contained at the low elevations of the watershed. The current distribution of whirling disease overlaps with the distribution of rainbow and brown trout reproduction and occurs at levels harmful to rainbow trout populations in many streams. Adopted strategies to help moderate impacts of the disease include: 1) improving migration corridors and rearing areas between headwater spawning streams and the Blackfoot River, 2) restoring native populations of WSCT and bull trout, whose life history could help reduce risk of infection by allowing the juvenile recruitment of these species to downstream river reaches and 3) through efforts in the early developing stages of habitat restoration, lowering sediment and nutrient input to streams by developing compatible streamside grazing practices will continue to be a focus.

Recommendations

- Continue to expand *on the ground restoration* with support provided through watershed groups including the Big Blackfoot Chapter of Trout Unlimited, the North Powell Conservation District, Northwestern Energy, the Blackfoot Challenge as well as other supporting agencies and organizations.

- Complete restoration projects in all core areas and current restoration streams. Expand restoration to the upper Blackfoot watershed.

- Focus restoration and protection on migration corridors, spawning and rearing areas, and tributaries that have a high proportion of their stream length in higher elevations and basin-fed stream with steeper gradients. These habitat types have been found to be less susceptible to *T. tubifex* and whirling disease infection.

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

- Assemble an interdisciplinary team to evaluate grazing methods on all restoration project streams. Implement necessary modifications to grazing systems.

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

- Continue fish populations monitoring at the Jonsrud and Scotty Brown Bridge section of the Blackfoot River, and major tributary restoration projects.

- Expand fisheries inventories to wilderness areas.

- Increase FWP enforcement efforts in bull trout spawning and staging areas, and assess angler behavior in critical bull trout recovery areas.

- 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.

- Complete the cleanup of contaminated sediments at the Mike Horse mine and on Helena National Forest.

- Adopt a conservative approach to recreational planning in native fish recovery areas.

- Develop an effective fish identification program directed toward non-resident anglers.

Acknowledgements

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APPENDIX

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2002 and 2003.

Exhibit B: Summary of two pass estimates for tributaries, 2002 and 2003.

Exhibit C: Mark and recapture estimates in the Blackfoot River drainage, 2002 and 2003.

Exhibit D: Length-frequency histograms for 2000 and 2002.

Exhibit E: Summary of stream discharge measurements for 2002 and 2003.

Exhibit F: Restoration streams and table of activities through 2003.

Exhibit G: Table of potential restoration projects in the Blackfoot drainage through 2003.

Exhibit H: Table of restoration streams and cooperators through 2003.

Exhibit I: Summary of water temperature monitoring in the Blackfoot drainage, 2002 and 2003.

Exhibit J: Westslope cutthroat trout genetic sampling sites and results.

Exhibit K: Angler pressure estimates for the Blackfoot River, 1989-2001.

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2002-2003.

Stream	River Mile	Location (T,R,S)	Date Sampled	Section Length (ft)	Species	Total Number Captured	Number Captured 1st Pass	YOY(<4.0") Captured 1st Pass	Range of Lengths (in)	Mean Length (in)	CPUE (#/100' in 1st Pass)	YOY CPUE (#/100' in 1st Pass)
Bear Creek	1.1	13N,16W,18B,	22-Jul-02	372	RB	54	42	21	2.7-8.2	4.3	11.3	5.6
lower river trib		13N,16W,7C			LL	10	10	0	4.6-8.8	6.2	2.7	0.0
					EB	8	7	0	3.0-6.4	4.8	1.9	0.0
old channel					SCUL	abundant						
			6-Aug-03	375	RB	108	89	48	1.2-7.9	3.7	23.7	12.8
					LL	11	10	5	2.2-14.6	5.3	2.7	1.3
new channel					EB	11	8	0	3.2-8.4	5.7	2.1	0.0
					WCT	2	1	0	4.0-6.1	5.1	0.3	0.0
					SCUL	present						
Blanchard Creek	0.1	14N,14W,5A	19-Sep-02	310	CT*	4	4	2	2.7-4.6	3.8	1.3	0.6
					RB*	54	45	31	2.0-4.8	2.9	14.5	10.0
					LL	1	1	1	3.8	3.8	0.3	0.3
					SCUL	common	MWF	uncommon				
	1.1	14N,14N,5B	9-Oct-03	225	CT*	10	10	1	3.2-5.6	4.5	4.4	0.4
					RB	75	75	60	1.08-5.8	3.0	33.3	28.7
	3.3	15N,15W,36AB	9-Oct-03	366	CT*	51	51	15	3.0-7.4	4.5	13.9	4.1
					RB*	16	16	0	4.6-7.4	5.7	4.4	0.0
Smith Cr (trib to Camas Creek)	0.1	12N,15W,8C	26-Aug-02	537	CT	65	65	33	1.1-7.8	4.2	12.1	6.1
Chamberlain Creek	0.1	15N,13W,32A	18-Sep-02	440	CT*	120	105	59	1.8-8.5	1.8	23.9	13.4
					RB*	4	4	2	2.9-4.9	3.9	0.9	0.5
					LL	11	8	4	3.3-11.5	5.3	1.8	0.9
					SCUL & RSS	abundant,	LND & LNS	present				
			1-Oct-03	440	CT	118	80	53	1.98-7.95	3.5	18.2	12.0
					LL	9	7	3	3.2-5.5	4.1	1.6	0.7
					RB	2	2	2	2.4-3.0	2.7	0.5	0.5
	0.5	15N,13W,3D	18-Sep-02	366	CT*	200	174	132	1.7-6.8	3.1	47.5	36.1
					LL	2	1	1	3.4-5.2	4.3	0.3	0.3
					SCUL	abundant	LNS	common				
	1.9	14N,13W,4D	19-Sep-02	438	CT*	250	204	159	1.6-9.2	3.0	46.6	36.3
					RB	1	1	0	4.2	4.2	0.2	0.0
					LL	2	2	0	9.9-12.4	11.2	0.5	0.0
					SCUL	abundant						
	3.8	14N,13W,8D,17	19-Sep-02	350	CT*	186	159	84	1.6-8.8	1.6	45.4	24.0
					EB	14	13	7	2.0-6.6	3.5	3.7	2.0
					SCUL	abundant						
Clearwater Ditch	1	14N,14W,4B,4C	2-Sep-03	4224	LL	11	11	2	3.2-8.3	6.4	0.3	0.0
					RB	68	68	0	5.8-9.4	7.6	1.6	0.0
					RSS, NPM,	MWF,&LSS	present					
Copper Creek	1.1	15N,8W,25C &26A	4-Sep-02	555	CT	2	2	1	3.5-4.1	3.8	0.4	0.2
					SCUL common,							
	6.2	15N,8W,9A	4-Sep-02	512	DV	16	16	7	1.9-8.7	4.1	3.1	1.4
					CT	23	23	8	2.6-7.2	4.4	4.5	1.6
					SCUL abundant							
	8.9	15N,8W,5B	4-Sep-02	454	DV	6	6	0	5.1-5.9	5.4	1.3	0.0
					CT	2	2	0	4.2-7.5	5.9	0.4	0.0
	10.8	15N,9W,1B	4-Sep-02	390	DV	3	3	0	6.4-10.2	7.6	0.8	0.0
					CT	17	17	1	3.7-8.7	6.2	4.4	0.3
					SCUL present							
Cottonwood Creek	0.1	15N,13W,29C	16-Sep-02	450	CT	5	5	0	4.9-8.0	6.2	1.1	0.0
					DV	3	1	0	8.1-14.0	10.8	0.2	0.0
					RB	20	17	8	2.0-8.8	4.1	3.8	1.8
					LL	37	32	13	2.9-11.6	6.0	7.1	2.9
					SCUL & MWF	abundant,	LND common,	Spotted frogs	present			
			1-Oct-03	465	CT	1	1	0	7.4	7.4	0.2	0.0
					RB	28	20	15	1.6-7.4	3.2	4.3	3.2
					LL	34	23	8	3.0-18.4	6.3	4.9	1.7
					SCUL	common	MWF	present				
	12.0	16N,14W,24D	18-Sep-02	500	CT*	76	61	30	1.4-12.6	4.5	12.2	6.0
					DV	5	3	0	2.9-10.1	6.2	0.6	0.0
					EB	14	10	5	2.0-6.6	4.3	2.0	1.0
					SCUL common	Tailed frogs	present					
			30-Sep-03	500	DV*	6	4	0	4.3-11.1	6.2	0.8	0.0
					CT	41	28	10	1.2-8.6	4.5	5.6	2.0
					EB	2	2	0	5.0-5.7	5.4	0.4	0.0
					SCUL	abundant						
	15.9	16N,14W,10A	30-Sep-03	500	DV	1	1	0	8.2	8.2	0.2	0.0
					CT	23	23	0	3.9-6.3	5.3	4.6	0.0
	16	16N,14W,10A &11B	30-Sep-03	540	CT	13	13	3	3.0-7.4	5.2	2.4	0.6
Dunham Creek	2.3	16N,12W,19B	14-Aug-03	525	DV	28	28	20	2.4-	4.5	5.3	3.8
					CT	14	14	0	6.1-	11.8	2.7	0.0
					EB	4	4	2	2.3-5.7	4.1	0.8	0.4
					SCUL	abundant						
	2.3	16N,12W,19B	12-Aug-02	426	DV	22	16	0	4.4-8.1	6.1	3.8	0.0
					CT	20	6	2	2.9-8.7	4.8	1.4	0.5
					EB	2	1	0	4.7-6.8	5.8	0.2	0.0
					SCUL abundant							
	4.2	16N,13W,12D	12-Aug-02	790	DV	23	15	1	2.4-7.7	5.6	1.9	0.1
					CT	14	13	2	3.2-8.7	5.6	1.6	0.3
					EB	25	23	0	4.0-6.9	4.9	2.9	0.0
					SCUL present							
Elk Creek	0.1	14N,15W,26D	22-Sep-03	430	RB	23	18	2	2.4-7.9	5.3	4.2	0.5
					LL	2	2	0	8.0-10.1	9.1	0.5	0.0
					WF	72	42	24	3.1-4.8	3.9	9.8	5.6
					LSS present							
	1.1	14N,15W,36A	22-Sep-03	345	No Salmonids sampled,		LSS abundant,	MWF present				
	2.3	14N,14W,31B	22-Sep-03	420	RB	18	13	2	2.5-7.3	5.1	3.1	0.5
					LNS present							
	3.0	14N,14W,32C	22-Sep-03	450	RB	78	65	57	1.7-7.7	2.9	14.4	12.7
					EB	4	4	1	3.3-8.5	8.7	0.9	0.2
					suckers abundant							
	4.6	13N,14W,5D	23-Sep-03	300	RB	35	24	8	1.8-8.3	4.2	8.0	2.7
					EB	77	65	35	3.3-9.4	4.2	21.7	11.7

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2002-2003.

Stream	River Mile	Location (T,R,S)	Date Sampled	Section Length (ft)	Species	Total Number Captured	Number Captured 1st Pass	YOY(<4.0") Captured 1st Pass	Range of Lengths (in)	Mean Length (in)	CPUE (#/100' in 1st Pass)	YOY CPUE (#/100' in 1st Pass)
Frazier Creek,N.F.	0.1	14N,12W,32A	5-Seo-02	360	CT	39	39	21	1.6-6.5	3.9	10.8	5.8
					Missed appro	0.8	of YOYs	observed				
Gold Creek	1.9	14N,16W,30D	3-Sep-02	400	DV	1	1	0	8.1	8.1	0.3	0.0
					CT	1	1	0	7.2	7.2	0.3	0.0
					RB*	54	45	27	1.6-11.7	4.2	11.3	6.8
					LL	85	48	12	2.3-18.8	5.4	12.0	3.0
					SCUL	abundant						
			15-Sep-03	400	RB	93	93	58	1.8-11.1	3.5	23.3	14.5
					LL	51	51	27	2.1-14.6	5.1	12.8	6.8
					CT	2	2	0	7.5-12.5	10	0.5	0.0
Kleinschmidt Creek	0.5	14N,11W,5C	28-Aug-02	500	LL	178	116	111	2.1-16.7	3.6	23.2	22.2
			3-Sep-02	500	LL	12	9	1	4.0-15.5	8.1	1.8	0.2
CPUE based on year class					SCUL	common						
			21-Aug-03	500	LL	51	43	37	2.1-16.8	3.6	8.8	7.4
					EB	1	1	1	3.7	3.7	0.2	0.2
	0.8	14N,11W,5C	28-Aug-02	500	LL	160	93	69	2.1-18.1	4.0	18.6	13.8
CPUE based on year class					EB	5	5	4	2.2-8.3	3.9	1.0	0.8
					SCUL	abundant						
			21-Aug-03	500	LL	79	79	43	1.9-16.6	5.1	15.8	8.6
					LNS	1	1	0	11	11.0	0.2	0.0
	1.1	14N,11W,5C	25-Aug-03	510	LL	51	44	18	2.0-23.6	6.5	8.6	3.5
					RB	2	2	0	9.0-9.4	9.2	0.4	0.0
Little Fish Creek	0.3	14N,14W,28C	26-Aug-03	480	CT	1	1	0	5.2	5.2	0.2	0.0
	0.9	14N,14W,28D	26-Aug-03	300	CT	14	14	11	2.9-4.3	3.5	4.7	3.7
				Spotted	frog	observed						
	3.8	13N,14W,2C	26-Aug-03	300	CT	15	15	5	2.5-5.1	4.2	5.0	1.7
				Spotted	frog	observed						
McCabe Creek	2.2	15N,12W,5C	15-Aug-02	340	CT	44	33	5	2.6-9.4	5.1	9.7	1.5
					EB	22	13	7	1.6-5.8	4.2	3.8	2.1
					SCUL	common						
Post restoration			14-Aug-03	340	CT	72	56	30	2.6-11,1	5.0	16.5	8.8
					EB	38	30	4	2.2-9.5	5.4	8.8	1.2
					SCUL	common						
Monture Creek	0.4	15N,13W,27C	21-Aug-02	446	RB	64	64	63	1.1-4.6	1.8	14.3	14.1
					LL	20	20	18	1.3-10.7	3.0	4.5	4.0
					MWF	present,	SCUL	common				
	2.2	15N,13W,22D	21-Aug-02	355	DV	1	1	0	8.8	8.8	0.3	0.0
					RB*	89	89	87	1.1-4.6	1.8	25.1	24.5
					LL	15	15	11	2.0-10.3	3.8	4.2	3.1
					SCUL	common						
	5.4	15N,13W,13A	14-Aug-02	465	DV	1	1	1	2.4	2.4	0.2	0.2
					CT	4	4	0	4.4-15.9	7.4	0.9	0.0
					RB*	6	6	6	1.1-1.4	1.2	1.3	1.3
					LL	16	18	10	2.2-9.5	3.8	3.4	2.2
					SCUL	common						
	8.6	15N,12W,6C	14-Aug-02	680	DV	22	22	21	2.2-5.3	2.8	3.2	3.1
					CT*	6	6	3	1.1-8.3	3.7	0.9	0.4
					LL	15	15	10	1.8-6.6	3.3	2.2	1.5
					EB	37	37	35	1.7-6.2	2.6	5.4	5.1
					SCUL	common,	LND & Tailed	frogs present				
	12.9	16N,12W,29B	14-Aug-02	375	DV	65	65	59	2.4-8.6	2.8	17.3	15.7
					CT	11	11	10	3.1-4.3	3.4	2.9	2.7
					EB	61	61	21	2.5-7.9	4.4	16.3	5.6
					SCUL	abundant						
Nevada Spring Cr.	2.8	13N,11W,11D	10-Sep-02	450	No fish	sampled	RSS abundant,	Spotted frogs	present			
	3.0	13N,11W,11D	10-Sep-02	500	LL	5	4	0	7.2-10.3	8.3	0.8	0.0
					EB	1	1	0	6.4	6.4	0.2	0.0
					Spotted Frogs	present						
			23-Sep-03	470	LL	31	24	16	3.3-15.1	6.0	5.1	3.4
					CT	1	1	1	1.7	1.7	0.2	0.2
North Fork	2.6	14N,12W,11C	22-Aug-02	660	RB	20	18	18	1.3-2.0	1.7	2.7	2.7
Blackfoot River					LL	9	7	2	2.5-6.6	4.1	1.1	0.3
					SCUL abundan	MWF & LND	present					
	7.6	15N,11W,32B	29-Aug-02	1010	DV	3	3	2	2.4-6.8	3.9	0.3	0.2
					RB	6	6	8	1.1-1.6	1.3	0.6	0.6
	7.6	15N,11W,32C	29-Aug-02	850	DV	6	6	5	2.3-7.5	3.3	0.7	0.6
					RB	18	18	17	1.4-4.9	1.6	2.1	2.0
					LL	1	1	0	9.3	9.3	0.1	0.0
					EB	1	1	0	8.5	6.5	0.1	0.0
					MWF	present						
	7.9	15N,11W,29C	21-Aug-02	885	DV	6	8	6	2.2-3.1	2.5	0.7	0.7
					CT	2	2	0	4.0-6.8	5.4	0.2	0.0
					RB*	1	1	0	5.9	5.9	0.1	0.0
					LL	1	1	0	4.7	4.7	0.1	0.0
					EB	1	1	1	3.5	3.5	0.1	0.1
					Scul	common						
	11.5	15N,11W,15C	22-Aug-02	500	DV	2	2	2	2.0-2.4	2.2	0.4	0.4
Lund Ditch	15.5	15N,11W,2C	29-Aug-02	65	DV	11	11	10	2.2-5.9	2.8	16.9	15.4
			13-Aug-02	500	DV	1	1	0	10.4	10.4	0.2	0.0
					EB	10	4	0	4.3-5.5	5	0.8	0.0
					CT	1	0	0	7.5	7.5	0.0	0.0
	17.2	16N,11W,35B	22-Aug-02	250	DV	9	9	0	4.8-5.6	5.0	3.6	0.0

Exhibit A: Summary of catch and size statistics for Blackfoot River tributaries, 2002-2003.

Stream	River Mile	Location (T,R,S)	Date Sampled	Section Length (ft)	Species	Total Number Captured	Number Captured 1st Pass	YOY(<4.0") Captured 1st Pass	Range of Lengths (in)	Mean Length (in)	CPUE (#/100' In 1st Pass)	YOY CPUE (#/100' in 1st Pass)
Pearson Creek	1.1	14N,13W,3B	17-Sep-02	450	CT	101	89	28	1.8-7.4	4.0	19.8	6.2
					EB	2	1	0	4.1-6.1	5.1	0.2	0.0
CPUE based on year class					LNS	2	1	0	5.8-6.0	5.9	0.2	0.0
			23-Sep-03	300	CT	226	194	113	1.6-7.3	3.1	64.7	37.7
					EB	4	4	2	3.3-4.0	3.8	1.3	0.7
Poorman Creek	1.3	14N,9W,36A	13-Aug-03	450	LL	7	7	7	2.5-3.2	2.8	1.6	1.8
Below Lower Ditch					EB	1	1	0	4	4.0	0.2	0.0
					SCUL	present						
Above Upper Ditch	1.5	14N,9W,36A	13-Aug-03	270	CT	7	4	0	4.5-10.4	7.8	1.5	0.0
					LL	44	38	2	2.4-10	8.4	13.3	0.7
					EB	11	8	4	2.4-8.7	4.5	3.0	1.5
					LNS	1	1	0	5.2	5.2	0.4	0.0
					SCUL	present						
Rock Creek	1.6	14N,11W,5A	26-Aug-02	606	RB	12	9	8	1.4-4.6	2.1	1.5	1.3
Below Forks					LL	33	27	14	2.4-7.9	4.3	4.5	2.3
					EB	8	8	6	2.2-7.5	4.0	1.3	1.0
					SCUL abundant,							
			11-Aug-03	510	LL	35	28	13	2.1-15.3	5.1	5.5	2.5
					RB	1	1	1	1.8	1.8	0.2	0.2
					EB	15	11	11	2.4-3.7	3.0	2.2	2.2
Above Forks	1.7	14N,11W,5A	26-Aug-02	453	RB*	1	0	0	4.4	4.7	0.0	0.0
					LL	7	6	1	3.1-6.2	5.1	1.3	0.2
					EB	20	16	10	2.7-8.5	4.2	3.5	2.2
					SCUL abundant							
Shanley Creek	1.4	15N,13W,3B	9-Oct-03	375	CT	33	33	4	3.7-7.2	5.3	8.8	1.1
					EB	19	19	7	2.3-7.3	4.9	5.1	1.9
Snowbank Creek	0.1	15N,8W,9A	23-Jul-03	500	CT	4	4	0	4.4-10.3	6.6	0.8	0.0
below diversion	0.4	15N,8W,9A	22-Jul-03	460	CT	15	15	3	2.0-11.4	6.2	3.3	0.7
above diversion				465	CT	16	16	4	2.0-7.2	4.9	3.4	0.9
Spring Creek,	0.5	15N,11W,21B	26-Aug-02	446	CT	29	29	17	2.3-5.1	3.8	6.5	3.8
Trib. to N.F.					EB	7	7	6	2.0-5.3	3.2	1.6	1.3
above & below culvert					CT YOY	abundant,	SCUL common					
Murphy Ditch	1.8	15N,11W,16A	16-Oct-03	375	CT	29	29	26	1.3-4.1	2.6	7.7	6.9
Ditch above road xing		15N,11W,20B	16-Oct-03	255	CT	3	3	0	6.1-9.6	8.1	1.2	0.0
					EB	1	1	0	5.1	5.1	0.4	0.0
Ditch below road xing				237	CT	2	2	0	4.0-6.6	5.2	0.8	0.0
Wales Creek	0.1	14N,12W,34B	6-Oct-03	391	CT	4	4	1	3.2-7.1	5.3	1.0	0.3
					LL	37	30	20	2.4-8.9	4.0	7.7	5.1
					RB	1	1	0	5.9	5.9	0.3	0.0
					MWF	3	2	2	3.0-3.7	3.2	0.5	0.5
	0.3	14N,12W,33A	6-Oct-03	231	CT	10	10	8	2.6-6.1	3.8	4.3	2.6
					LL	8	8	5	3.2-6.1	3.9	3.5	2.2
	1.9	13N,12W,5B	6-Oct-03		No Fish	sampled	stream channel dewatered					
Above reservoir	2.6	13N,12W,5B	6-Oct-03	330	CT	118	116	89	1.6-6.0	3.5	35.2	27.0
Unnamed Spring Cr	0.1	14N,12W,34B	6-Oct-03	405	CT	1	1	0	6.5	6.5	0.2	0.0
to Wales Cr @ mile 0.2					LL	26	25	7	3.4-9.5	5.0	6.4	1.7
Warren Creek	1.1	15N,12W,31C	11-Sep-02	576	LL	44	24	7	3.1-10.7	4.9	4.2	1.2
					RB	1	0	0	4.6	4.6	0.0	0.0
					SCUL & LND	abundant,	RSS & Spotted	frogs common	MWF present			
			4-Sep-03	345	LL	14	10	2	3.5-8.4	5.8	2.9	0.6
					RSS	21	21	21	1.9-3.5	2.5	6.1	6.1
					LSS	30	30	5	3.1-7.4	5.0	8.7	1.4
					LND	3	3	3	1.7-2.8	2.3	0.9	0.9
	2.1	15N,12W,31A	11-Sep-02	360	LL	6	5	0	4.5-8.4	7.2	1.4	0.0
					SCUL	abundant,	LNS	present				
			4-Sep-03	345	EB	2	2	1	3.4-8.7	6.0	0.6	0.3
					LL	3	3	0	4.1-8.8	7.2	0.9	0.0
					RB	2	2	0	4.8-5.1	5.0	0.6	0.0
					LNS	5	5	0	5.1-5.5	5.3	1.4	0.0
	3.6	15N,12W,32C	11-Sep-02	468	LL	4	2	0	6.4-9.0	7.5	0.4	0.0
					EB	79	61	7	3.3-9.8	5.4	13.0	1.5
					SCUL	abundant						
			4-Sep-03	468	EB	87	66	8	3.0-9.6	5.0	14.1	1.7
					LNS	16	7	4	3.0-5.5	4.2	1.5	0.9
	6.7	15N,12W,35B	4-Sep-03	272	EB	2	2	1	2.8-5.4	4.1	0.7	0.4
Doney Lake Outlet	1.1	15N,12W,24B	11-Sep-02	330	CT	1	1	0	8.4	8.4	0.3	0.0
stream					EB	9	9	0	4.2-8.0	5.0	2.7	0.0
	10.2	15N,12W,23D	11-Sep-02	260	CT	1	1	0	4.6	4.6	0.4	0.0
					EB	35	35	27	1.8-7.9	3.2	13.5	10.4
					LNS & Spotted	frogs present						
Washoe Creek	0.1	13N,15W,28A	26-Aug-02	390	CT	43	43	15	2.2-9.0	4.8	11.0	3.8
Wasson Creek	0.1	13N,11W,11D	18-Aug-03	366	LNS	7	7	4	1.9-6.5	4.3	1.9	1.1
					LSS	7	7	6	3.1-4.3	3.5	1.9	1.8
					LL	1	1	1	3.9	3.9	0.3	0.3
					RSS	1	1	1	3.2	3.2	0.3	0.3
	1	13N,11W,13B	18-Aug-03	303	CT	4	4	0	4.3-8.0	6.3	1.3	0.0
below Irrigation ditch	2.4	13N,10W,7C	18-Aug-03	300	No Fish	sampled or	observed					
	2.8	13N,10W,7C	18-Aug-03	249	CT	64	64	27	1.5-7.7	3.8	25.7	10.8
					LSS	1	1	0	6.9	6.9	0.4	0.0
					Y Perch	1	1	1	4.1	4.1	0.4	0.4

* Sample may include rainbow trout / cutthroat trout hybrids

** Sample may include bull trout / brook trout hybrids

Exhibit B: Summary of two-pass estimates for Blackfoot River tributaries, 2002-2003

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 ± CI	Estim/100' ± CI	Total Estimate	95% CI	Estm/100'	95% CI
Bear Creek	1.1	13N, 16W, 18B, 7C	22-Jul-02	372	CT	<4.0	0	0								
						>4.0	0	0								
					RB	<4.0	21	6		0.71	29.4 ± 5.7	7.9 ± 1.5	29.40	5.7	7.9	1.5
						>4.0	20	7		0.65	30.8 ± 8.4	8.3 ± 2.3	30.77	8.4	8.3	2.3
					LL	<4.0	0	0								
						>4.0	10	0		1.00			10.00	0.0	2.7	0.0
					EB	<4.0	0	1			0.0 ± 0.0	0.0 ± 0.0	0.00	0.0	0.0	0.0
						>4.0	7	0		1.00	7.0 ± 0.0	1.9 ± 0.0	7.00	0.0	1.9	0.0
					All	<4.0	21	7		0.67	31.5 ± 7.8	8.5 ± 2.1	31.50	7.8	8.5	2.1
						>4.0	37	7		0.81	45.6 ± 3.7	12.3 ± 1.0	45.63	3.7	12.3	1.0
			8-Aug-03	375	CT	<4.0	0	0								
						>4.0	1	1		0.00						
					RB	<4.0	48	8		0.88	54.86 ± 2.4	14.6 ± 0.6	54.86	2.4	14.6	0.6
						>4.0	41	13		0.68	60.04 ± 9.8	16 ± 2.6	60.04	9.8	16.0	2.6
					LL	<4.0	5	1		0.80	6.25 ± 1.5	1.7 ± 0.4	6.25	1.5	1.7	0.4
						>4.0	5	0		1.00	5.0 ± 0.0	1.3 ± 0.0	5.00	0.0	1.3	0.0
					EB	<4.0	0	1					0.00	0.0	0.0	0.0
						>4.0	8	2		0.75	10.67 ± 2.8	2.8 ± 0.7	10.67	2.8	2.8	0.7
					All	<4.0	53	8		0.85	62.42 ± 3.2	16.6 ± 0.9	62.42	3.2	16.6	0.9
						>4.0	55	18		0.71	77.56 ± 9.6	20.7 ± 2.5	77.56	9.6	20.7	2.5
Blanchard Creek	0.1	14N, 14W, 5A	19-Sep-02	310	CT*	<4.0	2	0		1.00	4.0 ± 0.0	1.3 ± 0.0	2.00	0.0	0.6	0.0
						>4.0	2	0		1.00	2.0 ± 0.0	0.6 ± 0.0	2.00	0.0	0.6	0.0
					RB*	<4.0	31	8		0.74	41.78 ± 5.7	13.5 ± 1.9	41.78	5.7	13.5	1.9
						>4.0	4	1		0.75	5.3 ± 1.9	1.7 ± 0.6	5.33	1.9	1.7	0.6
					LL	<4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
						>4.0	0	0								
					MWF	<4.0	0	0								
						>4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
					All	<4.0	36	8		0.78	46.3 ± 4.8	14.9 ± 1.5	46.29	4.8	14.9	1.5
						>4.0	7	1		0.86	8.2 ± 1.1	2.6 ± 0.3	8.17	1.1	2.6	0.3
Chamberlain Creek	0.1	15N,13W,32A	18-Sep-02	440	CT	<4.0	59	5		0.92	64.5 ± 1.6	14.7 ± 0.4	64.46	1.6	14.7	0.4
						>4.0	46	10		0.78	58.9 ± 5.2	13.4 ± 1.2	58.78	5.2	13.4	1.2
					RB	<4.0	2	0		1.00	2.0 ± 0.0	0.5 ± 0.0	2.00	0.0	0.5	0.0
						>4.0	2	0		1.00	2.0 ± 0.0	0.5 ± 0.0	2.00	0.0	0.5	0.0
					LL	<4.0	4	1		0.75	5.3 ± 1.9	1.2 ± 0.4	5.33	1.9	1.2	0.4
						>4.0	4	2		0.50	8.0 ± 9.6	1.8 ± 2.2	8.00	9.6	1.8	2.2
					All	<4.0	65	6		0.91	71.6 ± 1.9	16.3 ± 0.4	71.61	1.9	16.3	0.4
						>4.0	52	12		0.77	67.6 ± 6.1	15.4 ± 1.4	67.60	6.1	15.4	1.4
			1-Oct-03	440	CT	<4.0	53	25		0.53	100.3 ± 29.3	22.8 ± 6.6	100.32	29.3	22.8	6.6
						>4.0	27	13		0.52	52.07 ± 22.2	11.8 ± 5.0	52.07	22.2	11.8	5.0
					RB	<4.0	2	0		1.00	2.0 ± 0.0	0.5 ± 0.0	2.00	0.0	0.5	0.0
						>4.0	0	0								
					LL	<4.0	3	2		0.33	9.0 ± 26.3	2.0 ± 6.0	9.00	26.3	2.0	6.0
						>4.0	4	0		1.00	4.0 ± 0.0	0.9 ± 0.0	4.00	0.0	0.9	0.0
					All	<4.0	58	27		0.53	108.52 ± 29.4	24.7 ± 8.7	108.52	29.4	24.7	6.7
						>4.0	31	13		0.58	53.3 ± 16.2	12.1 ± 3.7	53.39	16.2	12.1	3.7
	0.5	15N,13W,32D	18-Sep-02	366	CT*	<4.0	132	21		0.84	156.9 ± 5.5	42.9 ± 1.5	156.97	5.5	42.9	1.5
						>4.0	42	5		0.88	47.7 ± 2.1	13.0 ± 0.6	47.68	2.1	13.0	0.6
					LL	<4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
						>4.0	0	1			0.0 ± 0.0	0.0 ± 0.0	0.00	0.0	0.0	0.0
					All	<4.0	133	21		0.84	157.9 ± 5.4	43.2 ± 1.5	157.94	5.4	43.2	1.5
						>4.0	42	6		0.86	49.0 ± 2.6	13.4 ± 0.7	49.00	2.6	13.4	0.7
	1.9	14N,13W,4D	19-Sep-02	438	CT*	<4.0	159	35		0.78	203.9 ± 9.9	46.5 ± 2.3	203.88	9.9	46.5	2.3
						>4.0	45	11		0.76	59.6 ± 6.3	13.6 ± 1.4	59.56	6.3	13.6	1.4
					RB*	<4.0	0	0								
						>4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
					LL	<4.0	0	0								
						>4.0	2	0		1.00	2.0 ± 0.0	0.5 ± 0.0	2.00	0.0	0.5	0.0
					All	<4.0	159	35		0.78	203.8 ± 9.9	46.5 ± 2.3	203.88	9.9	46.5	2.3
						>4.0	48	11		0.77	62.3 ± 5.8	14.2 ± 1.3	62.27	5.8	14.2	1.3
	3.8	14N,13W,17A	19-Sep-02	350	CT*	<4.0	84	18		0.79	106.9 ± 6.9	30.5 ± 2.0	106.91	6.9	30.5	2.0
						>4.0	75	9		0.88	85.2 ± 2.8	24.4 ± 0.8	85.23	2.8	24.4	0.8
					EB	<4.0	7	0		1.00	7.0 ± 0.0	2.0 ± 0.0	7.00	0.0	2.0	0.0
						>4.0	6	1		0.83	7.2 ± 1.2	2.1 ± 0.4	7.20	1.2	2.1	0.4
					All	<4.0	91	18		0.80	113.4 ± 6.3	32.4 ± 1.8	113.44	6.3	32.4	1.8
						>4.0	81	10		0.88	92.4 ± 3.0	26.4 ± 0.9	92.41	3.0	26.4	0.9
Cottonwood Creek	0.1	15N,13W,29C	16-Sep-02	450	CT*	<4.0	0	0								
						>4.0	5	0		1.00	5.0 ± 0.0	1.1 ± 0.0	5.00	0.0	1.1	0.0
					DV	<4.0	0	0								
						>4.0	1	2		-1.00			-1.00	6.8	-0.2	1.5
					RB	<4.0	8	2		0.75	10.7 ± 2.8	2.4 ± 0.6	10.67	2.8	2.4	0.6
						>4.0	9	1		0.89	10.1 ± 0.9	2.3 ± 0.2	10.13	0.9	2.3	0.2
					LL	<4.0	13	1		0.92	14.1 ± 0.7	3.1 ± 0.1	14.08	0.7	3.1	0.1
						>4.0	19	4		0.79	24.1 ± 3.2	5.3 ± 0.7	24.07	3.2	5.3	0.7
					All	<4.0	21	3		0.86	24.5 ± 1.9	5.4 ± 0.4	24.50	1.9	5.4	0.4
						>4.0	34	7		0.79	42.8 ± 4.1	9.5 ± 0.9	42.81	4.1	9.5	0.9
			1-Oct-03	465	CT	<4.0	0	0								
						>4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
					LL	<4.0	8	4		0.50	16.0 ± 13.6	3.4 ± 2.9	16.00	13.6	3.4	2.9
						>4.0	15	7		0.53	28.13 ± 15.1	6.0 ± 3.2	28.13	15.1	6.0	3.2
					RB	<4.0	15	6		0.60	25.0 ± 10.0	5.4 ± 2.1	25.00	10.0	5.4	2.1
						>4.0	5	2		0.60	8.33 ± 5.8	1.8 ± 1.2	8.33	5.8	1.8	1.2
					All	<4.0	23	10		0.57	40.69 ± 15.3	8.8 ± 3.3	40.69	15.3	8.8	3.3
						>4.0	20	9		0.55	36.36 ± 15.7	7.8 ± 3.4	36.36	15.7	7.8	3.4
	12.0	16N,14W,24D	18-Sep-02	500	CT*	<4.0	30	5		0.83	36.0 ± 2.8	7.2 ± 0.6	36.00	2.8	7.2	0.6
						>4.0	31	10		0.68	45.8 ± 8.8	9.2 ± 1.8	45.76	8.8	9.2	1.8
					DV	<4.0	0	1			0.0 ± 0.0	0.0 ± 0.0	0.00	0.0	0.0	0.0
						>4.0	3	1		0.67	4.5 ± 2.9	0.9 ± 0.6	4.50	2.9	0.9	0.6
					EB	<4.0	5	1		0.80	6.25 ± 1.5	1.3 ± 0.3	6.25	1.5	1.3	0.3
						>4.0	5	3		0.40	12.5 ± 20.8	2.5 ± 4.2	12.50	20.8	2.5	4.2
					All	<4.0	35	7		0.80	43.7 ± 4.0	8.8 ± 0.8	43.75	4.0	8.8	0.8
						>4.0	39	14		0.64	12.2 ± 2.5	12.2 ± 2.5	60.84	12.5	12.2	2.5
			30-Sep-03	500	CT	<4.0	10	6		0.40	25.0 ± 29.4	5.0 ± 5.9	25.00	29.4	5.0	5.9
						>4.0	18	7		0.61	29.45 ± 10.2	5.9 ± 2.0	29.45	10.2	5.9	2.0
					DV	<4.0	0	0								
						>4.0	4	2		0.50	8.0 ± 9.6	1.6 ± 1.9	8.00	9.6	1.6	1.9
					EB	<4.0	0	0								
						>4.0	2	0		1.00	2.0 ± 0.0	0.4 ± 0.0	2.00	0.0	0.4	0.0
					DVXEB	<4.0	0	0								
						>4.0	3	1		0.67	4.5 ± 2.9	0.9 ± 0.6	4.50	2.9	0.9	0.6
					All	<4.0	10	6		0.40	25.0 ± 29.4	5.0 ± 5.9	25.00	29.4	5.0	5.9
						>4.0	24	10		0.58	41.14 ± 14.0	8.2 ± 2.8	41.14	14.0	8.2	2.8

Exhibit B: Summary of two-pass estimates for Blackfoot River tributaries, 2002-2003

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 ± CI	Estim/100' ± CI	Total Estimate	95% CI	Estm/100'	95% CI
Dunham Creek	2.3	16N, 12W, 19B	12-Aug-02	426	CT	<4.0	2	6	2	-2.00			-1.00	4.2	-0.2	1.0
						>4.0	4	4	2	0.00						
					DV	<4.0	0	0	0							
						>4.0	16	5	1	0.69	23.2 ± 5.9	5.5 ± 1.4	23.27	5.9	5.5	1.4
					EB	<4.0	0	0	0							
						>4.0	1	1	0	0.00						
					All	<4.0	2	6	2	-2.00			-1.00	4.2	-0.2	1.0
						>4.0	21	10	3	0.52	40.1 ± 18.9	9.4 ± 4.4	40.09	18.9	9.4	4.4
	4.2	16N, 13W, 12D	12-Aug-02	790	DV	<4.0	1	1		0.00					0.0	
						>4.0	14	7		0.50	28.0 ± 18.0	3.5 ± 2.3	28.00	18.0	3.5	2.3
					CT	<4.0	2	0		1.00	2.0 ± 0.0	0.3 ± 0.0	2.00	0.0	0.3	0.0
						>4.0	11	1		0.91	12.1 ± 0.7	1.5 ± 0.1	12.10	0.7	1.5	0.1
					EB	<4.0	0	0								
						>4.0	23	2		0.91	25.2 ± 1.0	3.2 ± 0.1	25.19	1.0	3.2	0.1
					All	<4.0	3	1		0.67	4.5 ± 2.9	0.6 ± 0.4	4.50	2.9	0.8	0.4
						>4.0	48	10		0.79	60.6 ± 5.0	7.7 ± 0.6	60.63	5.0	7.7	0.6
Elk Creek	0.1	14N,15W,26D	22-Sep-03	430	RB	<4.0	2	0		1.00	2.0 ± 0.0	0.5 ± 0.0	2.00	0.0	0.5	0.0
						>4.0	16	5		0.69	23.27 ± 5.9	5.4 ± 1.4	23.27	5.9	5.4	1.4
					LL	<4.0	0	0								
						>4.0	2	0		1.00	2.0 ± 0.0	0.5 ± 0.0	2.00	0.0	0.5	0.0
					All	<4.0	2	0		1.00	2.0 ± 0.0	0.5 ± 0.0	2.00	0.0	0.5	0.0
						>4.0	18	5		0.72	24.92 ± 5.0	5.8 ± 1.2	24.92	5.0	5.8	1.2
					MWF	<4.0	24	12		0.50	48.0 ± 23.5	11.2 ± 5.5	48.00	23.5	11.2	5.5
						>4.0	18	18		0.00						
	2.3	14N,14W,31D	22-Sep-03	420	RB	<4.0	2	4								
						>4.0	11	1		0.91	12.1 ± 0.7	2.9 ± 0.2	12.10	0.7	2.9	0.2
	3.0	14N, 14W, 32C	22-Sep-03	450	RB	<4.0	57	10		0.82	69.13 ± 4.1	15.4 ± 0.9	69.13	4.1	15.4	0.9
						>4.0	8	3		0.63	12.8 ± 6.2	2.8 ± 1.4	12.80	6.2	2.8	1.4
					EB	<4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
						>4.0	3	0		1.00	3.0 ± 0.0	0.7 ± 0.0	3.00	0.0	0.7	0.0
					All	<4.0	58	10		0.83	70.08 ± 4.1	15.6 ± 0.9	70.08	4.1	15.6	0.9
						>4.0	11	3		0.73	15.13 ± 3.8	3.4 ± 0.8	15.13	3.8	3.4	0.8
	4.6	13N,14W,5D	23-Sep-03	300	RB	<4.0	8	7		0.13	64.0 ± 425.1	21.3 ± 141.7	64.00	425.1	21.3	141.7
						>4.0	16	4		0.75	21.33 ± 3.9	7.1 ± 1.3	21.33	3.9	7.1	1.3
					EB	<4.0	35	8		0.77	45.37 ± 4.9	15.1 ± 1.6	45.37	4.9	15.1	1.6
						>4.0	30	4		0.87	34.62 ± 2.0	11.5 ± 0.7	34.62	2.0	11.5	0.7
					All	<4.0	43	15		0.65	66.04 ± 12.3	22.0 ± 4.1	66.04	12.3	22.0	4.1
						>4.0	46	8		0.83	55.68 ± 3.7	18.6 ± 1.2	55.68	3.7	18.6	1.2
Gold Creek	1.9	14N,16W,30D	3-Sep-02	400	DV	>4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
					CT*	>4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
					RB	<4.0	27	1		0.96	28.0 ± 0.4	7.0 ± 0.1	28.04	0.4	7.0	0.1
						>4.0	18	8		0.56	32.4 ± 14.4	8.1 ± 3.6	32.40	14.4	8.1	3.6
					LL	<4.0	12	4		0.67	18.0 ± 5.9	4.5 ± 1.5	18.00	5.9	4.5	1.5
						>4.0	36	13		0.64	56.4 ± 12.1	14.1 ± 3.0	56.35	12.1	14.1	3.0
					All	<4.0	39	5		0.87	44.7 ± 2.2	11.2 ± 0.5	44.74	2.2	11.2	0.5
						>4.0	56	21		0.63	89.6 ± 16.5	22.4 ± 4.1	89.60	16.5	22.4	4.1
					All	4.0-7.9	45	17		0.62	72.3 ± 15.1	18.1 ± 3.8	72.32	15.1	18.1	3.8
					All	>8.0	11	4		0.64	17.3 ± 6.8	4.3 ± 1.7	17.29	6.8	4.3	1.7
Kleinschmidt Creek	0.5	14N,11W,6D,5C	28-Aug-02	500	LL	YOY(<4.3")	111	53		0.52	212 ± 43.9	42.5 ± 8.8	212.43	43.9	42.5	8.8
			3-Sep-02	500		Age 1+(>4.3)	8	3		0.63	12.8 ± 6.2	2.6 ± 1.2	12.80	6.2	2.6	1.2
			21-Aug-03	500	LL	YOY [<4.3]	37	7		0.81	45.6 ± 3.7	9.1 ± 0.7	45.63	3.7	9.1	0.7
E channel "woodless" section						Age 1+ [>4.3]	6	1		0.83	7.2 ± 1.2	1.4 ± 0.2	7.20	1.2	1.4	0.2
					EB	YOY [<4.3]	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
						Age [>4.3]	0	0								
					All	YOY [<4.3]	38	7		0.82	46.58 ± 3.6	9.3 ± 0.7	46.58	3.6	9.3	0.7
						Age [>4.3]	6	1		0.83	7.2 ± 1.2	1.4 ± 0.2	7.20	1.2	1.4	0.2
	0.8	14N 11W,5C	28-Aug-02	500	LL	YOY(<4.3")	69	48	15				151.00		3.3	
						age 1+(>4.3)	24	4		0.83	28.0 ± 2.5	5.8 ± 0.5	28.80	2.5	5.8	0.5
E channel "woody" section					all EB	[2.2"-8.3"]	5	0		1.00	5.0 ± 0.0	1.0 ± 0.0	5.00	0.0	1.0	0.0
			25-Aug-03	500	LL	YOY [<4.3]	29	13	8	0.55	52.6 ± 18.7	10.5 ± 3.7	52.56	18,7	10.5	3.7
						Age 1+ [>4.3]	22	17	5				50.00		10.0	
	1.1	14N,11W,5C	25-Aug-03	510	LL	YOY[<4.3]	18	4		0.78	23.1 ± 3.4	4.5 ± 0.7	23.14	3.4	4.5	0.7
						Age1+[>4.3]	26	3		0.88	29.4 ± 1.6	5.8 ± 0.3	29.39	1.6	5.8	0.3
					RB	YOY[<4.3]	0	0								
						Age 1+[>4.3]	2	0		1.00	2.0 ± 0.0	0.4 ± 0.0	2.00	0.0	0.4	0.0
					All	YOY[<4.3]	18	4		0.78	23.1 ± 3.4	4.5 ± 0.7	23.14	3.4	4.5	0.7
						Age 1+[>4.3]	28	3		0.89	31.4 ± 1.5	6.1 ± 0.3	31.36	1.5	6.1	0.3
McCabe Creek	2.2	15N, 12W, 5C	15-Aug-02	340	CT	<4.0	5	4		0.20			25.00	117.6	7.4	34.6
						>4.0	28	7		0.75	37.3 ± 5.2	11.0 ± 0.5	37.33	5.2	11.0	1.5
					EB	<4.0	7	6		0.14						
						>4.0	6	3		0.50	12.0 ± 11.8	3.5 ± 3.5	12.00	11.8	3.5	3.5
					All	>4.0	34	10		0.71	48.2 ± 7.8	15.2 ± 2.3	48.17	7.7	14.2	2.3
			14-Aug-03	340	CT	<4.0	30	5		0.83	36.0 ± 2.8	10.6 ± 0.8	36.00	2.8	10.6	0.8
						>4.0	26	11		0.58	45.07 ± 15.2	13.3 ± 4.5	45.07	15.2	13.3	4.5
					EB	<4.0	4	3		0.25	16.0 ± 62.2	4.7 ± 8.3	16.00	62.2	4.7	8.3
						>4.0	26	5		0.81	32.19 ± 3.2	9.5 ± 0.9	32.19	3.2	9.5	0.9
					All	<4.0	34	8		0.76	44.46 ± 5.1	13.1 ± 1.5	44.46	5.1	13.1	1.5
						>4.0	52	16		0.69	75.11 ± 10.4	22.1 ± 3.1	75.11	10.4	22.1	3.1
Nevada Spring Creek	3.0	13N, 11W, 11D	10-Sep-02	500	LL	>4.0	4	1		0.75	5.3 ± 1.9	1.1 ± 0.4	5.33	1.9	1.1	0.4
					EB	>4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
					All	>4.0	5	1		0.80	6.2 ± 1.5	1.3 ± 0.3	6.25	1.5	1.3	0.3
			23-Sep-03	470	LL	<4.0	16	2		0.88	18.3 ± 1.4	3.9 ± 0.3	18.29	1.4	3.9	0.3
						>4.0	8	5		0.38	21.3 ± 31.4	4.5 ± 6.7	21.33	31.4	4.5	6.7
					CT	<4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
						>4.0	0	0								
					All	<4.0	17	2		0.88	19.3 ± 1.3	4.1 ± 0.3	19.27	1.3	4.1	0.3
						>4.0	8	5			21.3 ± 31.4	4.5 ± 6.7	21.33	31.4	4.5	6.7
Pearson Creek	1.1	14N,13W,3B	17-Sep-02	450	CT YOY	<3.2	28	7		0.75	37.3 ± 5.2	8.3 ± 1.1	37.33	5.2	8.3	1.1
					age 1+	>3.2	61	5		0.92	66.5 ± 1.5	14.8 ± 0.3	66.45	1.5	14.8	0.3
					All EB	(4.1-6.1)	1	1		0.00						
			23-Sep-03	300	CT	<3.2	113	26		0.77	146.8 ± 9.0	48.9 ± 3.0	146.77	9.0	48.9	3.0
						>3.2	81	6		0.93	87.48 ± 1.6	29.2 ± 0.5	87.48	1.6	29.2	0.5
					EB	<4.0	2	0		1.00	2.0 ± 0.0	0.7 ± 0.0	2.00	0.0	0.7	0.0
						>4.0	2	0		1.00	2.0 ± 0.0	0.7 ± 0.0	2.00	0.0	0.7	0.0
					LNS	>4.0	3	0		1.00	3.0 ± 0.0	1.0 ± 0.0	3.00	0.0	1.0	0.0

Exhibit B: Summary of two-pass estimates for Blackfoot River tributaries, 2002-2003

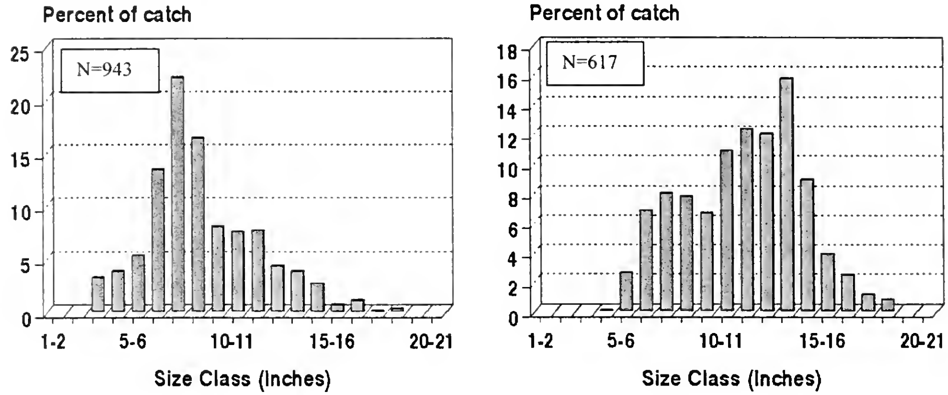
Stream	River Mile	Location (T,R,S)	Date Sampled	Section Length (ft)	Species	Size Class (in)	1st Pass	2nd Pass	3rd Pass	Prob. of Capture	Total Estimate ± CI	Estim/100' ± CI	Total Estimate	95% CI	Estm/100'	95% CI
Poorman Creek	1.3	14N,9W 36A	13-Aug-03	450	LL	<4.0	7	0		1.00	7.0 ± 0.0	1.6 ± 0.0	7.00	0.0	1.6	0.0
						>4.0	0	0								
					EB	>4.0	1	0		1.00			1.00	0.0	0.2	0.0
					All	<4.0	7	0		1.00	7.0 ± 0.0	1.6 ± 0.0	7.00	0.0	1.6	0.0
						>4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
	1.5	14N,9W,36A	13-Aug-03	270	CT	<4.0	0	0								
						>4.0	4	3		0.25	16.0 ± 62.23	5.9 ± 23.0	16.00	62.23	5.9	23.0
					LL	<4.0	2	1		0.50	4.0 ± 6.79	1.5 ± 2.5	4.00	6.79	1.5	2.5
						>4.0	34	7		0.79	42.81 ± 4.1	15.9 ± 1.5	42.81	4.10	15.9	1.5
					EB	<4.0	4	3		0.25	16.0 ± 62.23	5.9 ± 23.0	16.00	62.23	5.9	23.0
						>4.0	4	0		1.00	4.0 ± 0.0	1.5 ± 0.0	4.00	0.00	1.5	0.0
					All	<4.0	6	4		0.33	18.0 ± 37.19	6.7 ± 13.8	18.00	37.19	6.7	13.8
						>4.0	42	10		0.76	55.13 ± 5.8	20.4 ± 2.1	55.13	5.80	20.4	2.1
Rock Creek	1.6	14N,11W,5A	26-Aug-02	606	RB	<4.0	8	3		0.63	12.8 ± 6.2	2.1 ± 1.0	12.80	6.2	2.1	1.0
						>4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
					LL	<4.0	14	4		0.71	19.6 ± 4.7	3.2 ± 0.8	19.60	4.7	3.2	0.8
						>4.0	13	2		0.85	15.4 ± 1.6	2.5 ± 0.3	15.36	1.6	2.5	0.3
					EB	<4.0	6	0		1.00	6.0 ± 0.0	1.0 ± 0.0	6.00	0.0	1.0	0.0
						>4.0	2	0		1.00	2.0 ± 0.0	0.3 ± 0.0	2.00	0.0	0.3	0.0
					All	<4.0	28	7		0.75	37.3 ± 5.2	6.2 ± 0.9	37.33	5.2	6.2	0.9
						>4.0	16	2		0.88	18.3 ± 1.4	3.0 ± 0.2	18.29	1.4	3.0	0.2
			11-Aug-03	510	LL	<4.0	13	3		0.77	16.9 ± 3.1	3.3 ± 0.6	16.90	3.1	3.3	0.6
						>4.0	15	4		0.73	20.45 ± 4.2	4.0 ± 0.8	20.45	4.2	4.0	0.8
					EB	<4.0	11	4		0.64	17.29 ± 6.8	3.4 ± 1.3	17.29	6.8	3.4	1.3
						>4.0	0	0								
					RB	<4.0	0	1								
						>4.0	0	0								
					All	<4.0	24	8		0.67	36.0 ± 8.3	7.1 ± 1.6	36.00	8.3	7.1	1.6
						>4.0	15	4		0.73	20.45 ± 4.2	4.0 ± 0.8	20.45	4.2	4.0	0.8
Above the forks	1.7	14N, 11W, 5A	26-Aug-02	453	RB	>4.0	0	1								
					LL	<4.0	1	0		1.00	1.0 ± 0.0	0.2 ± 0.0	1.00	0.0	0.2	0.0
						>4.0	5	1		0.80	6.25 ± 1.5	1.4 ± 0.3	6.25	1.5	1.4	0.3
					EB	<4.0	10	4		0.60	16.7 ± 8.1	3.7 ± 1.8	16.67	8.1	3.7	1.8
						>4.0	6	0		1.00	6.0 ± 0.0	1.3 ± 0.0	6.00	0.0	1.3	0.0
					All	<4.0	11	4		0.64	17.3 ± 6.8	3.8 ± 1.5	17.29	6.8	3.8	1.5
						>4.0	11	2		0.82	13.4 ± 1.9	3.0 ± 0.4	13.44	1.9	3.0	0.4
Wales Creek	0.1	14N,12W,34B	6-Oct-03	391	LL	<4.0	20	3		0.85	23.53 ± 2.0	6.0 ± 0.5	23.53	2.0	6.0	0.5
						>4.0	10	4		0.60	16.67 ± 8.1	4.3 ± 2.1	16.67	8.1	4.3	2.1
					CT	<4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
						>4.0	3	0		1.00	3.0 ± 0.0	0.8 ± 0.0	3.00	0.0	0.8	0.0
					RB	<4.0	0	0								
						>4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
					All	<4.0	21	3		0.86	24.5 ± 1.9	6.3 ± .05	24.50	1.9	6.3	0.5
						>4.0	14	4		0.71	19.6 ± 4.7	5.0 ± 1.2	19.60	4.7	5.0	1.2
Warren Creek	1.1	15N,12W, 31C	11-Sep-02	576	RB*	>4.0	0	1					0.00	0.0	0.0	0.0
					LL	<4.0	7	2	3	0.71	9.8 ± 3.3	1.7 ± 0.6	9.80	3.3	1.7	0.6
						>4.0	17	11	3	0.35	48.2 ± 53.9	8.4 ± 9.4	48.17	53.9	8.4	9.4
					all LL	(3.0-8.6)	24	14	6	0.42	57.6 ± 40.6	1.0 ± 7.0	57.60	40.6		
					All	< 4.0	7	2		0.71	9.8 ± 3.3	1.7 ± 0.6	9.80	3.3	1.7	0.6
						>4.0	17	12		0.29	57.8 ± 86.1	10.0 ± 15.0	57.80	86.1	10.0	15.0
			4-Sep-03	345	LL	<4.0	2	0		1.00	2.0 ± 0.0	0.6 ± 0.0	2.00	0.0	0.6	0.0
						>4.0	8	4		0.50	16.0 ± 13.6	4.6 ± 3.9	16.00	13.6	4.6	3.9
	2.1	15N,12W,31A	11-Sep-02	360	LL	>4.0	5	1		0.80	6.25 ± 1.5	1.7 ± 0.4	6.25	1.5	1.7	0.4
			4-Sep-03	345	LL	<4.0	0	0								
						>4.0	3	0		1.00	3.0 ± 0.0	0.9 ± 0.0	3.00	0.0	0.9	0.0
					EB	<4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
						>4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
					RB	<4.0	0	0								
						>4.0	2	0		1.00	2.0 ± 0.0	0.6 ± 0.0	2.00	0.0	0.6	0.0
					All	<4.0	1	0		1.00	1.0 ± 0.0	0.3 ± 0.0	1.00	0.0	0.3	0.0
						>4.0	6	0		1.00	6.0 ± 0.0	1.7 ± 0.0	6.00	0.0	1.7	0.0
	3.6	15N,12W,32C	11-Sep-02	468	LL	<4.0	0	0								
						>4.0	2	2		0.00						
					EB	<4.0	7	5		0.29	24.5 ± 59.4	5.2 ± 12.7	24.50	59.4	5.2	12.7
						>4.0	54	13		0.76	71.1 ± 6.7	15.2 ± 1.4	71.12	6.7	15.2	1.4
					All	<4.0	7	5		0.29	24.5 ± 59.4	5.2 ± 12.7	24.50	59.4	5.2	12.7
						>4.0	56	15		0.73	76.5 ± 8.3	16.3 ± 4.8	76.49	8.3	16.3	1.8
			4-Sep-03	468	EB	<4.0	8	1		0.88	9.14 ± 1.0	2.0 ± 0.2	9.14	1.0	2.0	0.2
						>4.0	58	20		0.66	88.53 ± 13.9	18.9 ± 3.0	88.53	13.9	18.9	3.0

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

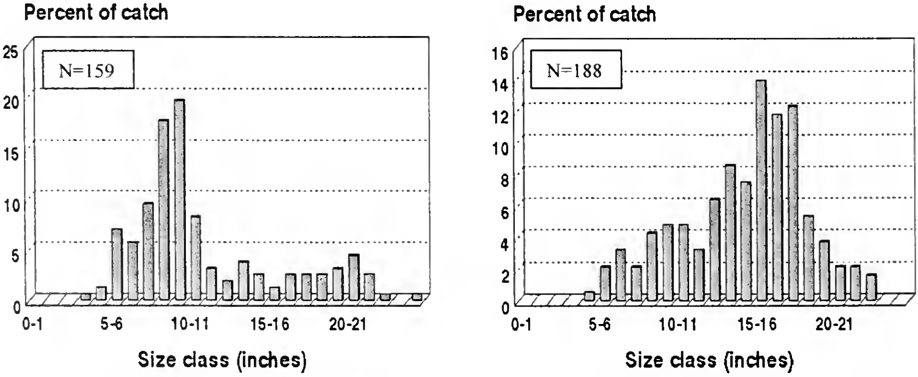
Exhibit C: Mark and recapture estimates for the Blackfoot River, 2002-2003.

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
Blackfoot River, (Johnsrud Section)	13 5	14N,16W,29D, 32ADC & 13N,16W, 6ABC & 13N,17W, 1DCB	30-May-02	18700	CT	>6 0	58	62	12	0 19	288 ± 133	15 2 ± 7 1
					DV	>6 0	21	20	3	0 15	115 ± 90	6 1 ± 4 8
					LL	>6 0	106	108	30	0 28	375 ± 110	20 1 ± 5 9
					RB	5 0-9 9	81	122	7	0 06	1260 ± 796	67 4 ± 42 6
						10 0-11 9	93	69	17	0 25	365 ± 141	19 5 ± 7 6
						>12 0	182	131	39	0 30	603 ±154	32 2 ± 8 2
						>6 0	351	311	63	0 20	1799 ± 402	91 7 ± 19 9
					All	>6 0	536	501	108	0 22	2472 ± 409	132 2 ± 21 9
Blackfoot River (Scotty Brown Bridge Section)	43 9	5N,13W,32AB, 29C 30DC, 25D	29-May-02	20064	CT	>6 0	90	88	19	0 22	407 ± 153	20 3 ± 7 6
					DV	>6 0	35	19	6	0 32	102 ± 57	5 1 ± 2 8
					LL	>6 0	146	103	31	0 30	477 ± 135	23 8 ± 6 7
					RB	4 0-10 9	40	24	3	0 13	255 ± 205	12 7 ± 10 2
						11 0-13 9	37	32	9	0 28	124 ± 61	6 2 ± 3 1
						>14 0	85	85	14	0 16	492 ± 219	24 5 ± 10 9
						>6 0	155	140	26	0 19	814 ± 271	40 8 ± 13 5
					All	>6 0	426	350	82	0 23	1805 ± 337	89 9 ± 16 8
Blackfoot River (Wales Cr. Section)	63 0	3N,12W,12B,2DAE & 14N,12W,35C, 34DAB,33A	20-May-02	31635	CT	>6 0	8	3	1	0 33	17 ± 14	0 5 ± 0 4
					DV	>6 0	0	3	0	0 00		
					LL	>6 0	108	64	21	0 33	321 ± 107	10 1 ± 3 4
					RB	>6 0	10	5	1	0 20	32 ± 30	1 0 ± 0 9
					ALL	>6 0	126	75	23	0 31	401 ± 130	12 7 ± 4 1

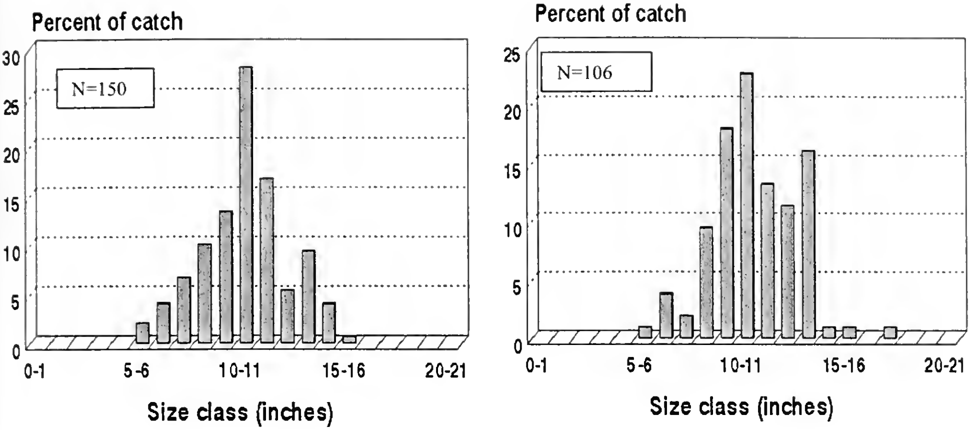
Exhibit D: Length-frequency histograms for the Blackfoot River, 2000 and 2002.



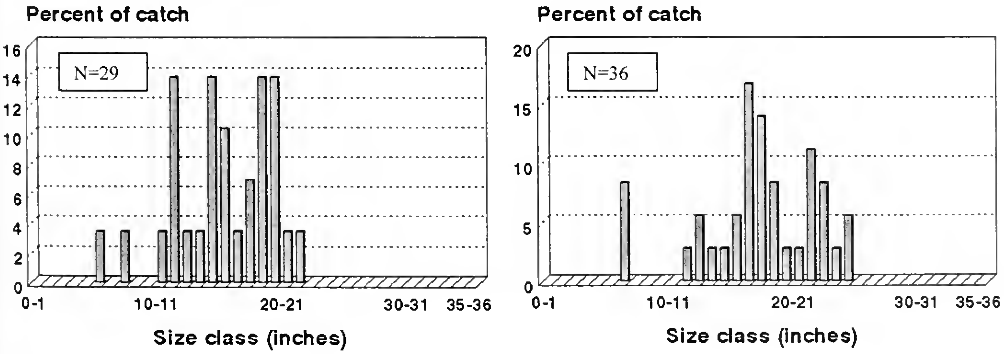
Length-frequency of rainbow trout in the Johnsrud section of the Blackfoot River, 2000 (left) and 2002 (right).



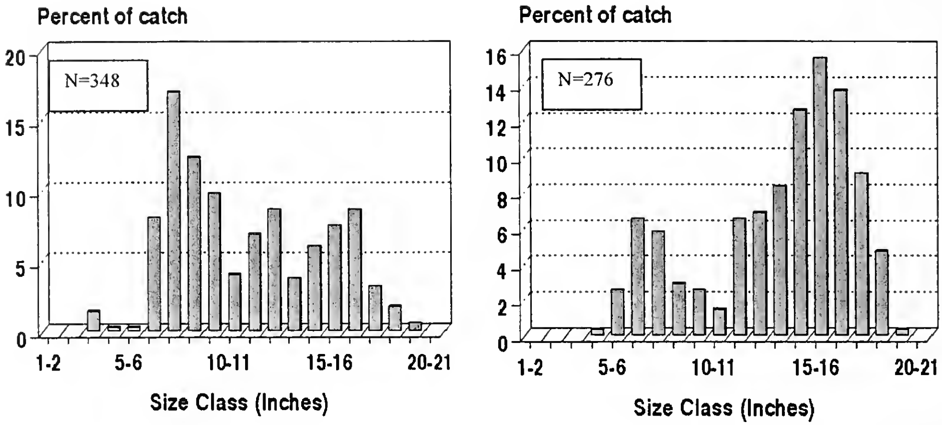
Length-frequency of brown trout in the Johnsrud section of the Blackfoot River, 2000 (left) and 2002 (right).



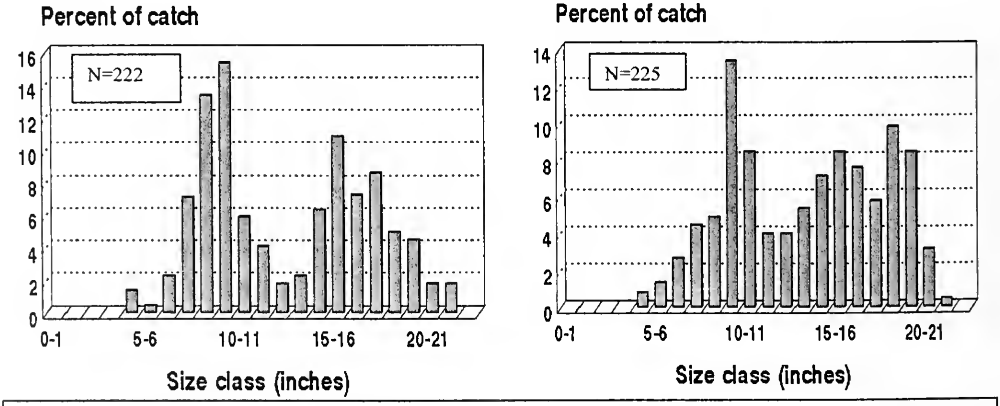
Length Frequency for westslope cutthroat trout in the Johnsrud Section of the Blackfoot River, 2000 (left) and 2002 (right).



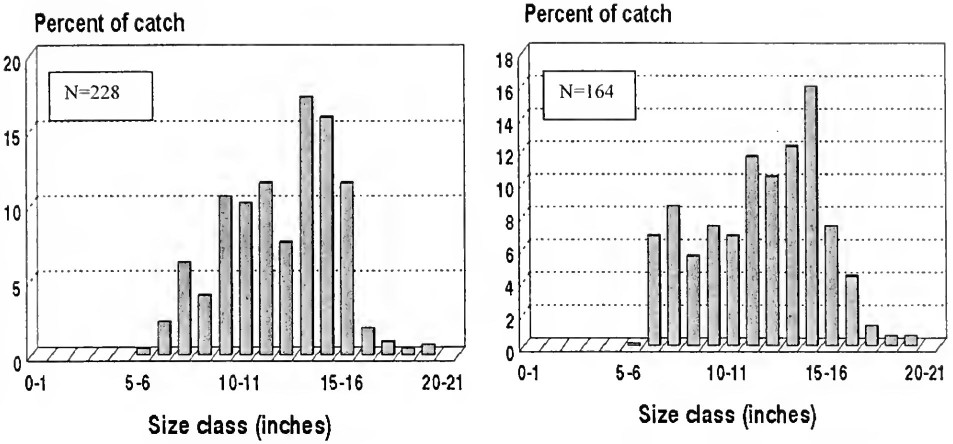
Length Frequency for bull trout in the Johnsrud Section of the Blackfoot River, 2000 (left) and 2002 (right).



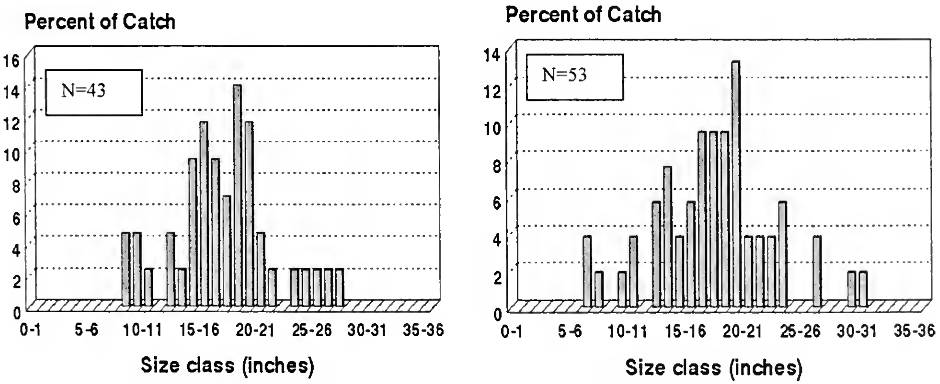
Length-frequency of rainbow trout in the Scotty Brown Bridge section of the Blackfoot River, 2000 (left) and 2002 (right).



Length-frequency of brown trout in the Scotty Brown Bridge section of the Blackfoot River, 2000 (left) and 2002 (right).



Length Frequency for westslope cutthroat trout in the Scotty Brown Bridge Section of the Blackfoot River, 2000 (left) and 2002 (right).



Length Frequency for bull trout in the Scotty Brown Bridge Section of the Blackfoot River, 2000 (left) and 2002 (right).

Exhibit E: Summary of stream discharge measurements for 2002-03.

Stream	Legal Description	Stream Mile	Date	Discharge ft³/s	Location
Cottonwood Creek	16N,14W,10A	15.9	30-Sep-03	0.4	Below Morrel Cr Rd xing
Elk Creek	14N,15W,26D	0.1	14-Oct-03	2.7	Near mouth
Kleinschmidt Creek	14N,11W,6A	0.1	13-Aug-02	15.3	Near mouth
Nevada Spring Creek	13N,11W,11B	3	10-Sep-02	9.3	Near upper fenceline
Nevada Spring Creek	13N,11W,10A	2	8-Oct-03	5.7	Near lower fenceline
Nevada Spring Creek	13N,11W,11B	3	2-Oct-03	6.9	Near upper fenceline
Poorman Creek	14N,9W,36A	1.5	13-Aug-03	1.8	Below of lower diversion
Poorman Creek	14N,9W,36A	1.6	13-Aug-03	2.4	Above of upper diversion
Rock Creek	14N,11W,6A	0.1	13-Aug-02	29	Near mouth
Snowbank Creek	15N,8W,9B	0.4	21-Jul-03	1.4	Below diversion
Snowbank Creek Ditch	15N,8W,9B	0.4	21-Jul-03	4.1	In irrigation ditch to Snowbank Lake
Wales Creek	14N,12W,34B	0.1	6-Oct-03	1	Near mouth
Spring Cr to Wales Creek	14N,12W,34B	0.1	6-Oct-03	1.3	Near mouth of spring creek
Wales Creek	14N,12w,33a	0.4	6-Oct-03	0.1	Below lower bridge
Wales Creek	13N,12W,5C	2.5	6-Oct-03	0.9	Above reservoir

Exhibit F: Restoration Streams and Table of 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		X	
Blackfoot River(NF to Lincoln)								X	X		X	X
Blackfoot River(Lincoln to Headwaters)												
Blanchard Creek	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												
Clearwater River		X										
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

Exhibit F: Restoration Streams and Table of 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
Douglas Creek	X					X						
Dry Creek						X			X		X	
Dunham Creek	X	X		X	X	X				X	X	
Elk Creek				X	X			X				
East Twin Creek	X											
Finn Creek												
Fish Creek												
Frazier Creek											X	
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	X											
Keep Cool Creek												
Kleinschmidt Creek	X		X	X	X	X		X	X		X	
Landers Fork												
Lincoln Spring Creek				X	X	X			X			
Little Fish Creek												
Lodgepole Creek												
McElwain Creek												X
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												

Exhibit F: Restoration Streams and Table of 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
Nevada Creek	X					X			X	X		
Nevada Spring Creek	X		X	X	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	X	X	X	X	X	X
Poorman Creek	X	X				X	X		X	X		
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												
Snowbank Creek												
Spring Creek (upper Cottonwood)												
Spring Creek (North Fork)	X									X		
Strickland Creek												
Sturgeon Creek												
Union Creek												
Wales Creek												
Wales Spring Creek												
Ward Creek									X		X	
Warm Springs Creek												
Warren Creek	X		X	X	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											
Willow Creek (above Lincoln)												
Willow Creek (below Lincoln)												
Yourname Creek												

Exhibit G: 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	X		
Ashby Creek		X	X				X	X				
Basin Spring Creek												
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		
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	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		X			X				X
Clearwater River		X				X						
Copper Creek									X			
Cottonwood Creek (lower trib.)	X		X	X	X	X	X	X		X		
Cottonwood Creek (Nevada drain.)	X	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				X				X				

Exhibit G: 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
Dunham Creek					X	X						
East Twin Creek												
Elk Creek	X	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		
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		
Landers Fork			X	X	X	X			X			
Lincoln Spring Creek	X			X	X							X
Little Fish Creek	X							X				
Lodgepole Creek												
McElwain Creek	X	X			X	X	X	X				
McCabe Creek	X				X							
Mitchell Creek	X			X				X				
Monture Creek	X		X	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												
North Fork Blackfoot River			X	X	X	X			X	X		
Pearson Creek					X		X					
Poorman Creek	X		X	X	X	X	X				X	

Exhibit G: 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
Rock Creek	X	X	X	X	X	X		X		X		X
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				
Snowbank Creek		X	X			X			X			
Spring Creek (upper Cottonwood)		X	X		X	X						
Spring Creek (North Fork)		X				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		X				
Wales Spring Creek			X		X			X				
Ward Creek	X	X	X	X	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		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				

Exhibit H. Table of Restoration Streams and Cooperators

Stream Name	FWP	USFWS	BLM	NRCS	USFS	MDT	DNRC	NPCD	BBCTU	Private Landown.	Chutney Found.	Blackfoot Challenge	Nat. F & W Found.	Northwestern Energy	Plum Creek
Alice Creek															
Arkanas Creek															
Arrastra Creek															
Ashby Creek	X	X				X			X	X	X	X		X	
Bartlett Creek															
Basin Spring Creek	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					
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															
Clearwater River	X								X	X					
Copper Creek															
Cottonwood Creek (lower trib.)	X	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															
Dunham Creek	X	X			X				X	X	X	X		X	
Elk Creek	X	X	X						X	X			X		

Exhibit H: Table of Restoration Streams and Cooperators

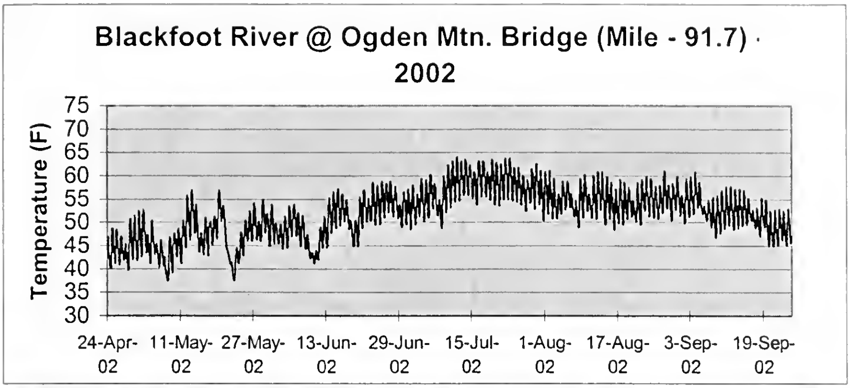
Stream Name	FWP	USFWS	BLM	NRCS	USFS	MDT	DNRC	NPCD	BBCTU	Private Landown.	Chutney Found.	Blackfoot Challenge	Nat. F & W Found.	Northwestern	Plum Creek
East Twin Creek	X					X									X
Finn Creek															
Fish Creek															
Frazier Creek															
Frazier Creek, north fork															
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					
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															
Little Fish 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	X	X		X	X		X		X	X	X	X		X	
Rock Creek	X	X				X	X	X	X	X	X	X	X	X	
Salmon Creek	X	X							X	X	X		X		
Seven up Pete Creek															
Saurekraut Creek															
Shanley Creek	X	X							X	X					

Exhibit H. Table of Restoration Streams and Cooperators

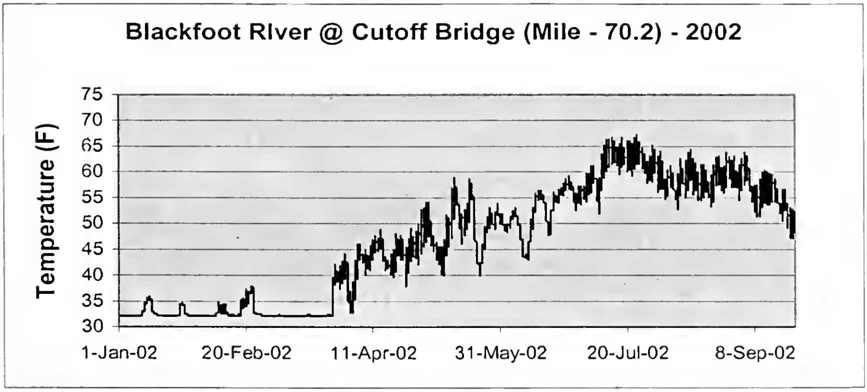
Stream Name	FWP	USFWS	BLM	NRCS	USFS	MDT	DNRC	NPCD	BBCTU	Private Landowners	Chutney Found.	Blackfoot Challenge	Nat. F & W Found.	Northwestern	Plum Creek
Sheep Creek															
Snowbank Creek															
Shingle Mill Creek															
Spring Creek (upper Cottonwood)															
Spring Creek (North Fork)	X	X		X			X		X	X					X
Strickland Creek															
Sturgeon Creek															
Union Creek															
Wales Creek															
Wales Spring 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 I. 2002 Temperature sensor locations

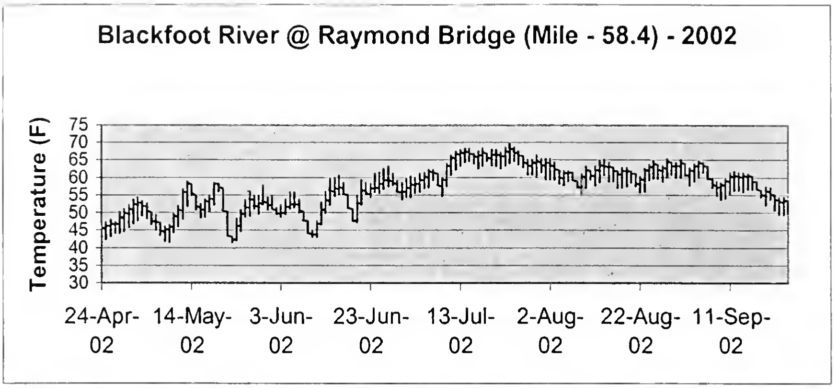
Stream Name	Location (stream mile)	Legal Description	Duration	Sensor Type	Recording Rate
Arkansas Creek	1.4	13N,16W,27D	7/1-9/29	HOBO	72min.
Arrastra Creek	0.4	14N,10W,30A	4/22-7/21	HOBO	72min.
Ashby Creek	0.1	13N,16W,14C	7/13-9/30	HOBO	72min.
Ashby Creek	3.1	13N,16W,35B	7/3/02-9/30	HOBO	72min.
Bear Creek	1	13N,16W,7B	7/1-9/29	HOBO	72min.
Beaver Creek	0.2	14N,9W,22B	4/22-7/21	HOBO	72min.
Belmont Creek	0.1	14N,16W,24C	7/3-9/30	HOBO	72min.
Blackfoot River	7.9	13N,17W,9B	1/1-9/23	Tidbit	50min.
Blackfoot River	21.8	14N,16W,24C	7/3/-7/21	Tidbit	50min.
Blackfoot River	46.1	15N,13W,33A	1/1-9/24	Tidbit	50min.
Blackfoot River	60	14N,12W,28D	4/24-9/24	Tidbit	50min.
Blackfoot River	72.2	14N,11W,32D	1/1-9/24	Tidbit	50min.
Blackfoot River	94.7	14N,10W,34B	4/24-9/26	Tidbit	50min.
Camas Creek	0.9	13N,16W,14D	7/1-9/29	HOBO	72min.
Camas Creek	7.1	12N,15W,5C	7/1-9/30	HOBO	72min.
Chamberlain Creek	1.8	14N,13W,4A	4/23-7/21	HOBO	72min.
Clearwater River	0.1	14N,14W,16C	7/1-9/29	HOBO	72min.
Copper Creek	6.3	15N,8W,9A	1/1-9/26	Tidbit	50min.
Cottonwood Creek	1	15N,13W,29B	7/1-9/30	HOBO	72min.
E.Fork Ashby Creek	0.1	12N,16W,3C	7/1-9/29	HOBO	72min.
Elk Creek	1	14N,15W,36A	7/1-9/29	HOBO	72min.
Elk Creek	3	14N,14W,32C	7/1-9/29	HOBO	72min.
Elk Creek	5.5	13N,14W,9C	7/1-9/29	HOBO	72min.
Frazier Creek	0.1	14N,12W,28D	4/24-7/21	HOBO	72min.
Gold Creek	1.6	14N,16W,30C	1/1-9/25	Tidbit	50min.
Kleinschmidt Creek	0.4	14N,11W,6A	1/1-9/25	Tidbit	50min.
Lander's Fork	1.1	14N,8W,12C	1/1-9/26	Tidbit	50min.
Little Moose Creek	0.1	14N,10W,26C	4/23-7/21	HOBO	72min.
Lower Willow Creek	1.7	14N,9W,28A	4/22-8/28	HOBO	72min.
McElwain Creek	1.3	13N,11W,18C	4/23-8/29	HOBO	72min.
Monture Creek	1.8	15N,13W,22D	1/1-9/24	Tidbit	50min.
Moose Creek	0.2	14N,10W,34C	4/22-8/29	HOBO	72min.
Nevada Creek	0.1	13N,11W,7C	4/23-8/28	HOBO	72min.
Nevada Spring Creek	3.5	13N,11W,11D	7/2-9/29	Tidbit	50min.
North Fork	2.6	14N,12W,10D	1/1-9/24	Tidbit	50min.
Poorman Creek	2.2	14N,9W,36D	4/22-8/28	HOBO	72min.
Rock Creek	0.15	14N,11W,6A	7/1-9/29	HOBO	72min.
Sauerkraut Creek	0.1	14N,9W,29B	4/22-7/21	HOBO	72min.
Union Creek	0.1	13N,16W,6D	7/1-9/29	HOBO	72min.
Union Creek	6.3	13N,16W,14B	7/1-9/29	HOBO	72min.
Union Creek	7.5	13N,16W,13B	7/3-9/30	HOBO	72min.
Union Creek	14.4	13N,15W,27C	7/1-9/29	HOBO	72min.
W. Fork Ashby Creek	4.7	12N,16W,3C	7/3-9/30	HOBO	72min.
Warren Creek	1.1	15N,12W,31C	7/1-9/30	HOBO	72min.
Washoe Creek	0.1	13N,15W,28A	7/1-9/30	HOBO	72min.
Yourname Creek	1.9	13N,12W,10B	4/23-8/28	HOBO	72min.


Blackfoot River @ Ogden Mtn. Bridge (Mile - 91.7) - 2002

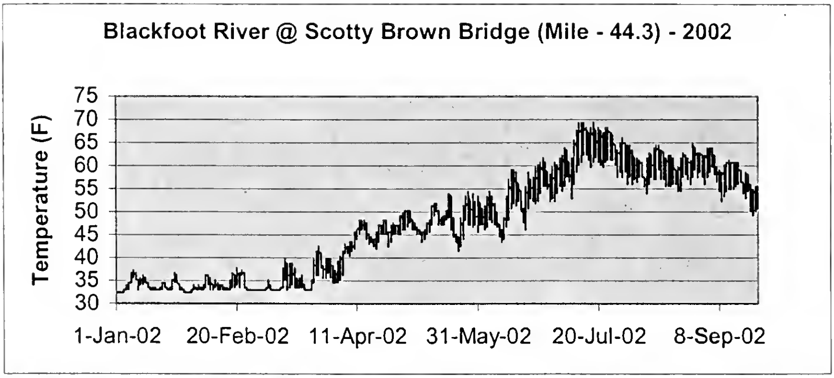
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	51.54	39.75	44.63	2.92	8.51
May	56.86	37.48	46.86	4.15	17.22
June	58.84	41.16	50.43	4.22	17.82
July	64.01	48.45	57.33	3.52	12.38
August	61.13	48.45	54.81	2.80	7.82
September	60.84	44.82	51.87	3.28	10.74


Blackfoot River @ Cutoff Bridge (Mile - 70.2) - 2002

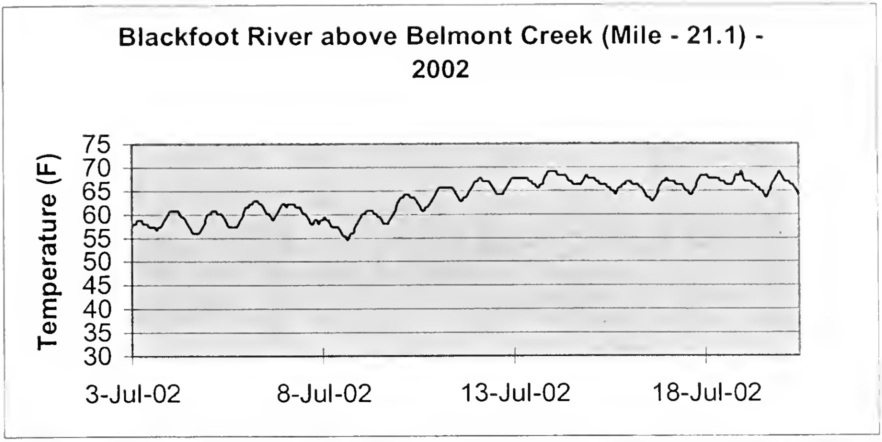
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	35.89	32.15	32.62	0.93	0.87
February	37.89	32.15	33.06	1.44	2.07
March	44.08	32.15	33.56	3.08	9.48
April	52.73	32.73	43.29	3.54	12.55
May	58.89	39.87	49.11	4.25	18.03
June	59.18	42.96	52.14	3.94	15.50
July	67.25	51.90	60.89	3.48	12.12
August	64.34	52.73	58.58	2.44	5.94
September	63.76	47.15	55.65	3.49	12.17


Blackfoot River @ Raymond Bridge (Mile - 58.4) - 2002

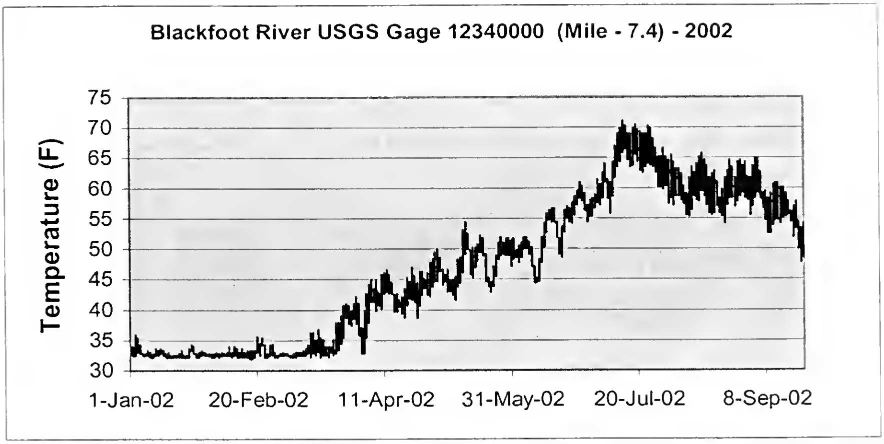
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	52.11	40.37	46.37	2.44	5.96
May	58.80	41.49	50.27	4.22	17.78
June	63.08	42.90	53.57	4.58	20.99
July	69.49	54.33	63.01	3.66	13.43
August	65.40	55.17	60.70	2.21	4.88
September	64.53	49.31	57.66	3.52	12.37


Blackfoot River @ Scotty Brown Bridge (Mile - 44.3) - 2002

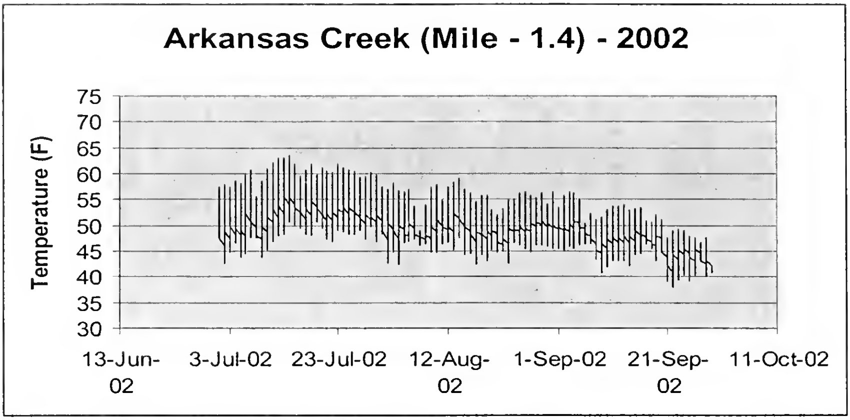
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	37.22	32.41	33.67	1.20	1.43
February	37.75	32.41	33.87	1.21	1.46
March	42.46	32.95	35.06	2.44	5.96
April	49.73	34.56	43.53	3.61	13.02
May	54.39	41.43	47.78	2.59	6.69
June	61.72	43.50	52.27	4.28	18.29
July	69.26	52.32	62.03	3.93	15.44
August	64.93	53.87	59.61	2.43	5.92
September	63.86	49.21	57.48	3.12	9.74


Blackfoot River above Belmont Creek (Mile - 21.1) - 2002

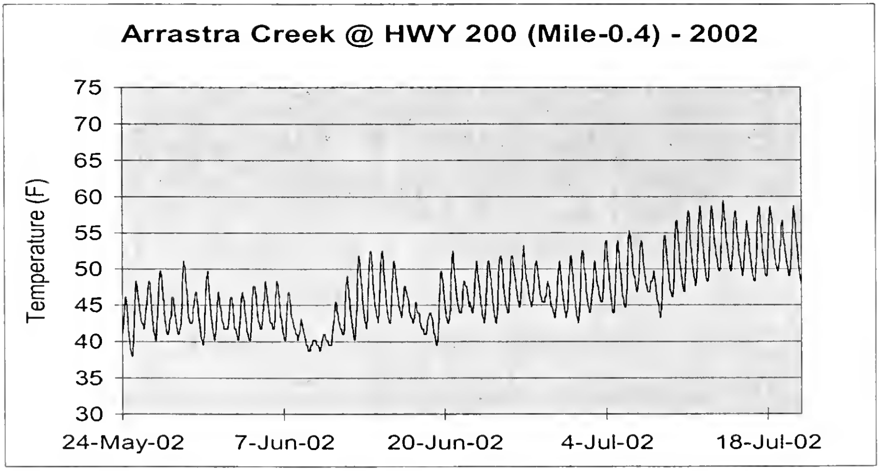
Month	Max Temp	Min Temp	Avg Temp	StDevTemp	VarTemp
July	69.02	54.58	62.96	3.83	14.65


Blackfoot River USGS Gage 12340000 (Mile - 7.4) - 2002

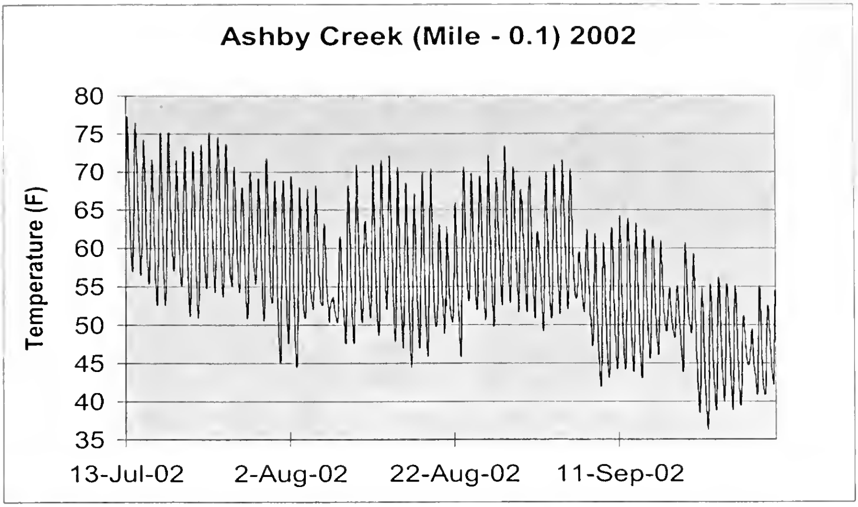
Month	MaxTemp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	35.92	32.18	32.81	0.54	0.30
February	35.64	31.88	32.78	0.65	0.42
March	42.13	32.18	34.61	2.65	7.03
April	48.26	32.76	42.12	2.83	7.99
May	54.41	41.57	47.44	2.75	7.55
June	60.87	44.37	52.65	4.18	17.45
July	71.07	55.25	63.57	3.90	15.20
August	65.77	54.13	60.25	2.46	6.03


Arkansas Creek (Mile - 1.4) - 2002

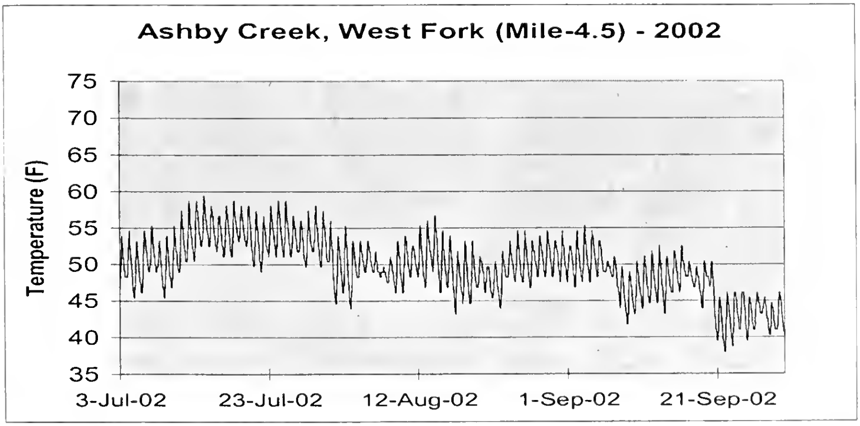
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	63.54	42.76	52.91	4.65	21.59
August	59.01	42.52	49.77	3.82	14.57
September	56.45	37.97	46.85	3.76	14.14


Arrastra Creek @ HWY 200 (Mile-0.4) - 2002

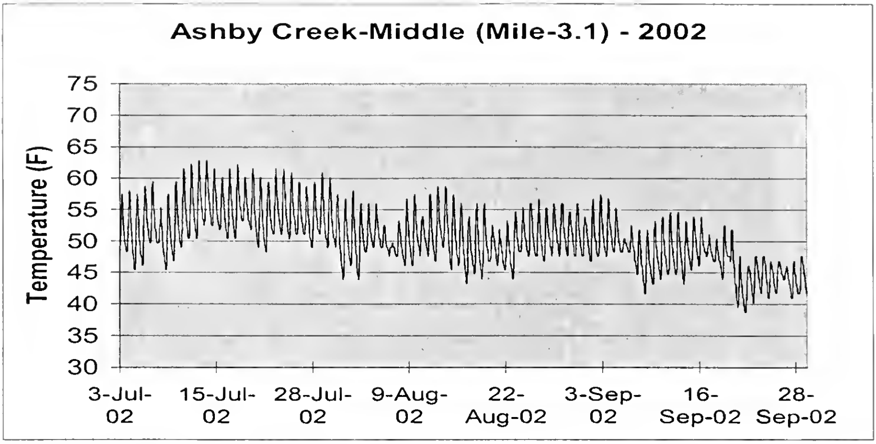
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	57.40	33.30	41.96	5.47	29.87
May	65.60	33.30	44.22	5.79	33.54
June	53.20	38.70	44.80	3.34	11.14
July	59.40	42.50	50.69	3.92	15.34



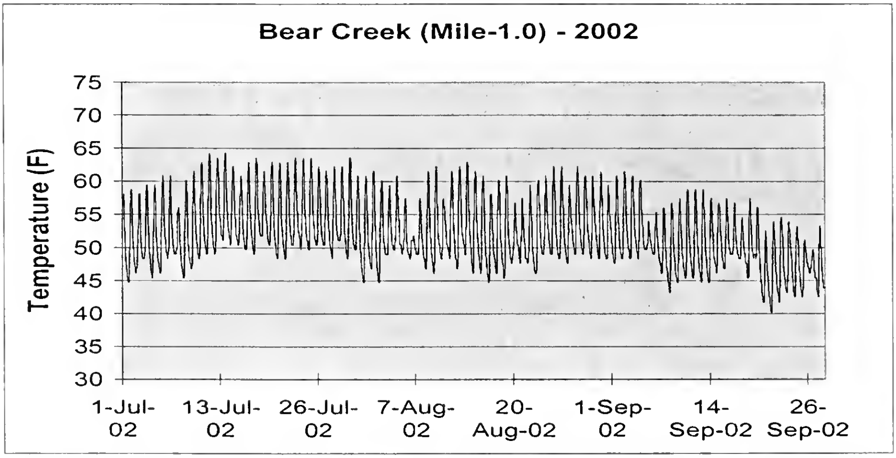
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	77.28	50.57	62.37	6.71	45.07
August	73.29	44.45	57.61	6.76	45.74
September	71.49	36.27	51.70	7.07	49.95



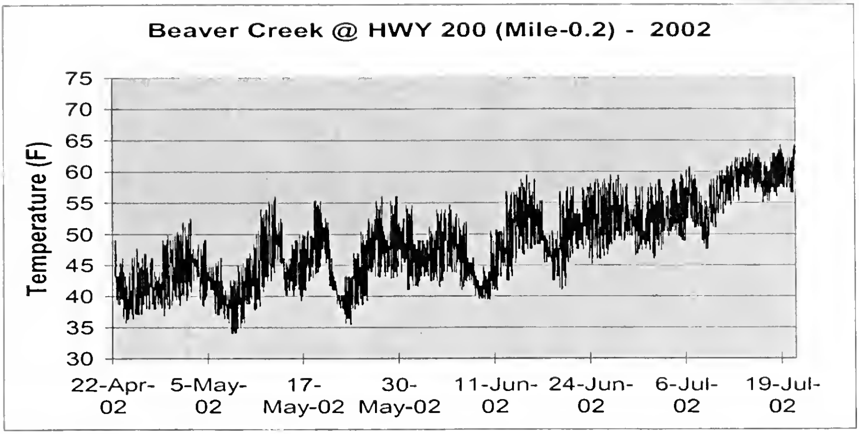
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	59.42	45.38	52.85	2.91	8.48
August	56.66	43.19	49.67	2.47	6.10
September	55.28	37.97	46.66	3.56	12.66



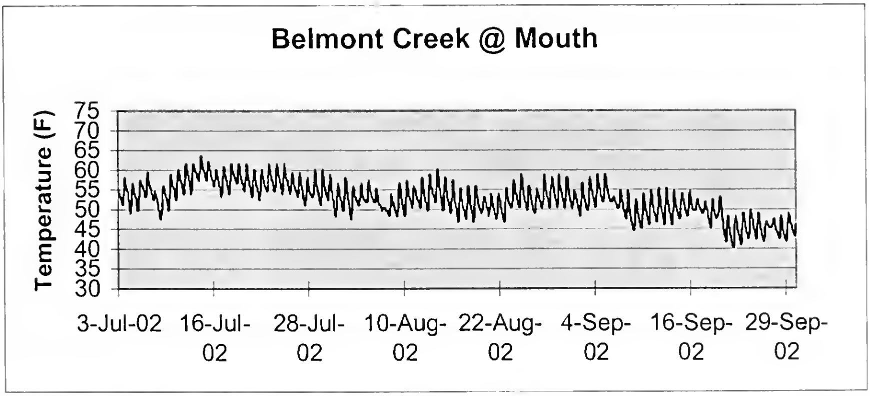
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	62.80	45.40	53.82	3.86	14.90
August	58.70	43.20	50.31	3.28	10.73
September	57.40	38.70	47.30	3.66	13.40



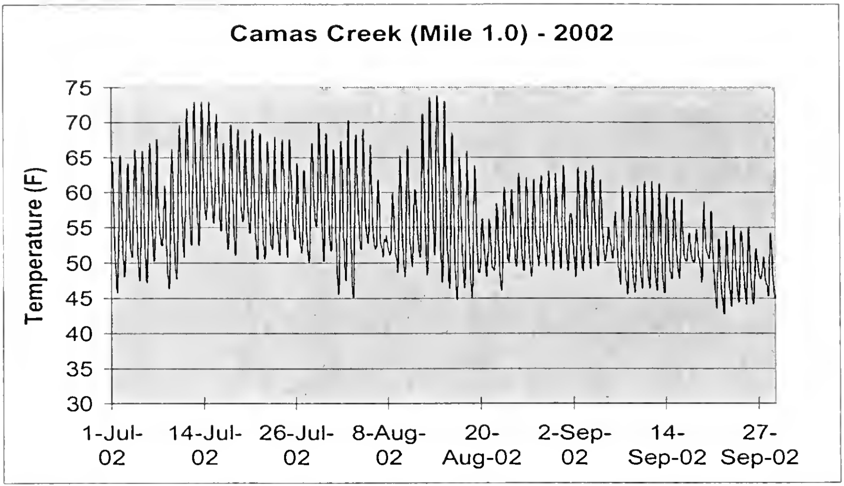
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	64.20	44.70	53.71	4.77	22.71
August	62.80	44.70	52.44	4.54	20.59
September	61.50	40.20	49.79	4.37	19.11


Beaver Creek @ HWY 200 (Mile-0.2) - 2002

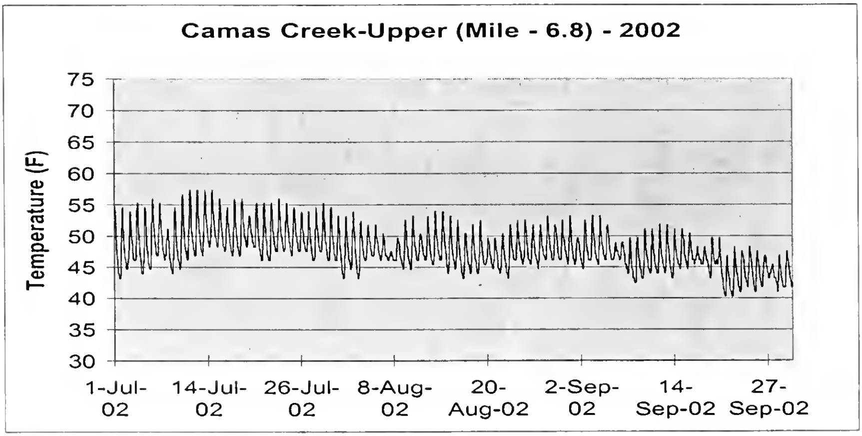
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	49.70	35.70	41.70	3.50	12.22
May	56.00	34.10	44.71	4.79	22.99
June	59.40	39.50	49.11	4.90	23.99
July	64.20	46.10	56.38	4.15	17.21


Belmont Creek @ Mouth

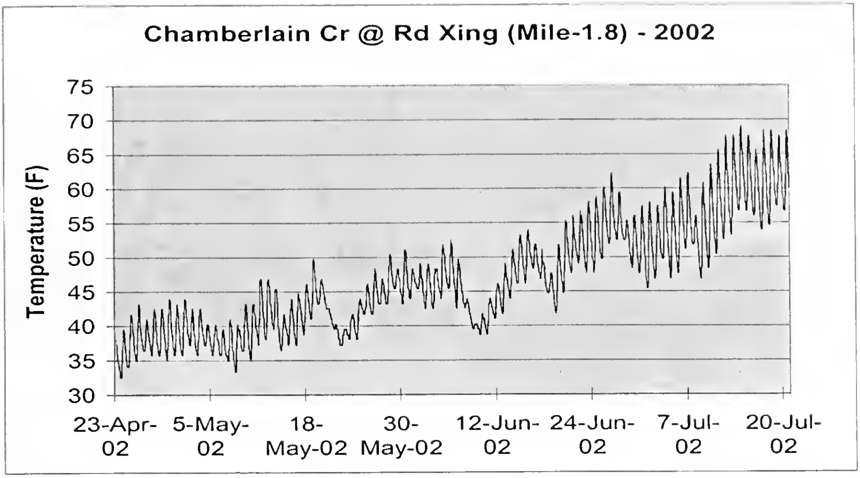
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	63.54	47.53	56.11	2.96	8.77
August	60.11	46.82	52.47	2.74	7.50
September	58.73	40.23	48.94	3.91	15.31



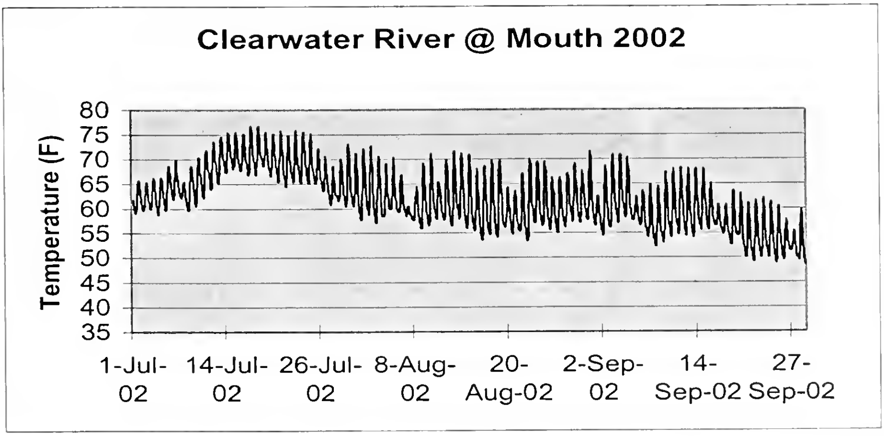
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	72.92	45.82	58.35	6.18	38.23
August	73.83	44.71	55.35	6.11	37.33
September	63.80	42.75	51.57	4.43	19.64



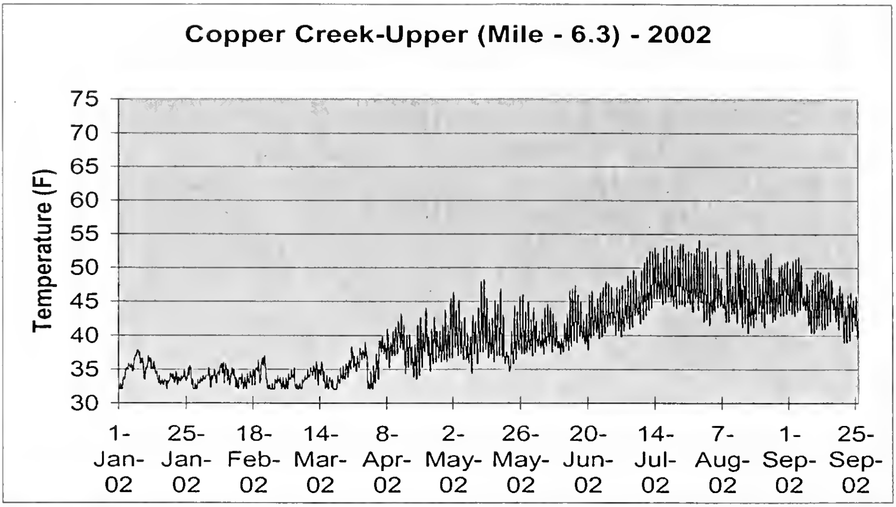
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	57.35	43.19	49.65	3.10	9.60
August	53.89	43.19	47.67	2.42	5.84
September	53.19	40.23	45.86	2.61	6.79


Chamberlain Cr @ Rd Xing (Mile-1.8) - 2002

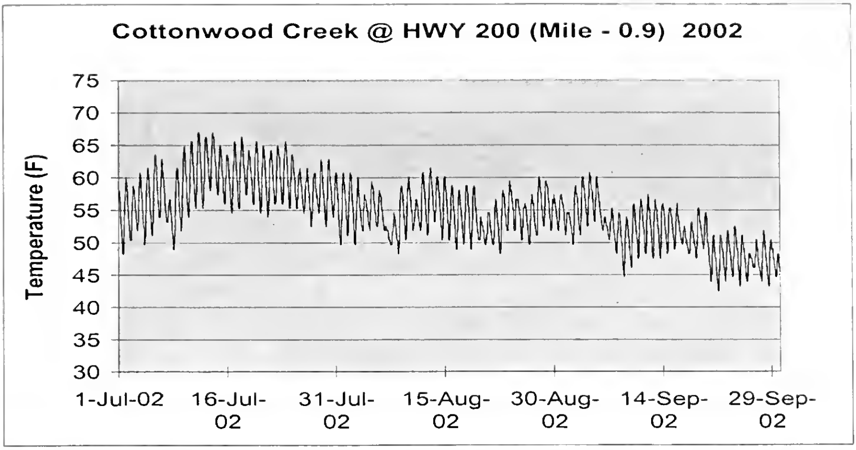
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	43.90	32.50	37.98	2.71	7.36
May	51.10	33.30	41.16	3.63	13.18
June	62.20	38.70	48.22	4.86	23.63
July	69.00	45.40	56.78	5.67	32.14


Clearwater River @ Mouth 2002

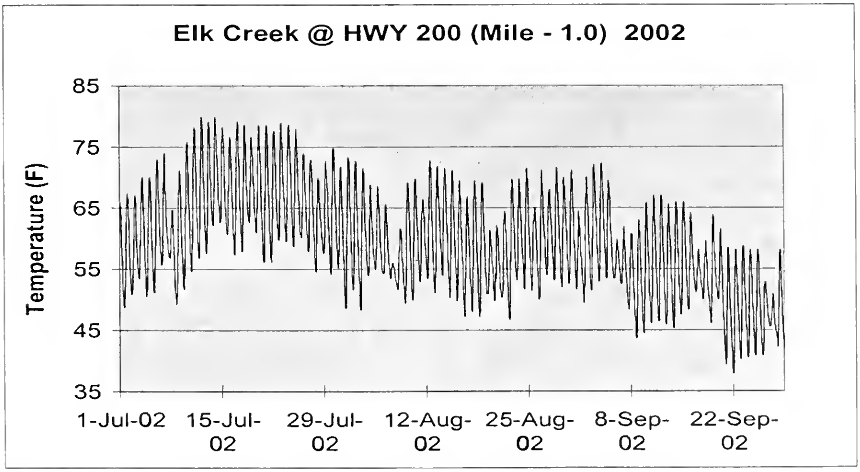
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	76.65	58.70	66.97	4.32	18.65
August	72.67	53.41	61.30	4.48	20.03
September	70.88	48.64	57.69	4.88	23.81



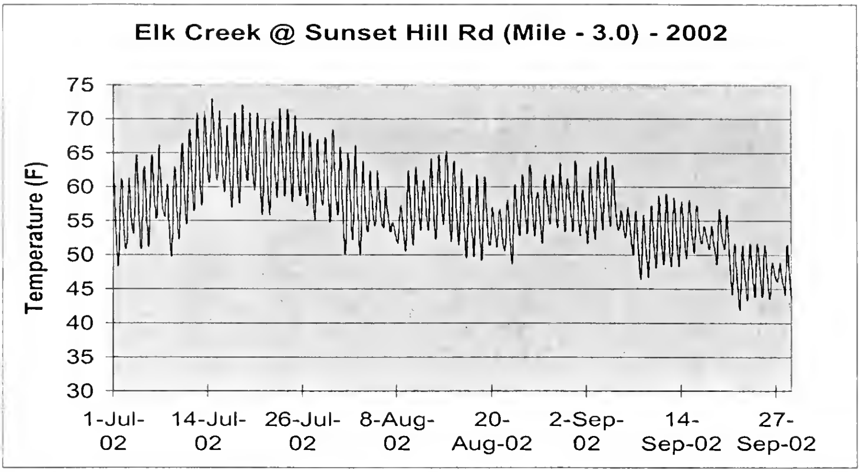
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	37.83	32.07	34.25	1.41	2.00
February	36.97	32.07	33.91	1.16	1.33
March	38.96	32.07	34.19	1.64	2.70
April	44.03	32.07	37.79	2.64	6.95
May	48.21	34.38	39.72	2.94	8.63
June	47.93	37.26	41.32	2.55	6.50
July	54.09	39.81	46.74	3.19	10.17
August	52.97	40.37	45.99	3.00	9.01
September	51.58	38.96	44.71	2.75	7.56
October	41.26	31.16	35.58	2.80	7.86
November	39.69	31.16	35.35	2.13	4.55
December	37.05	31.16	33.51	1.51	2.28



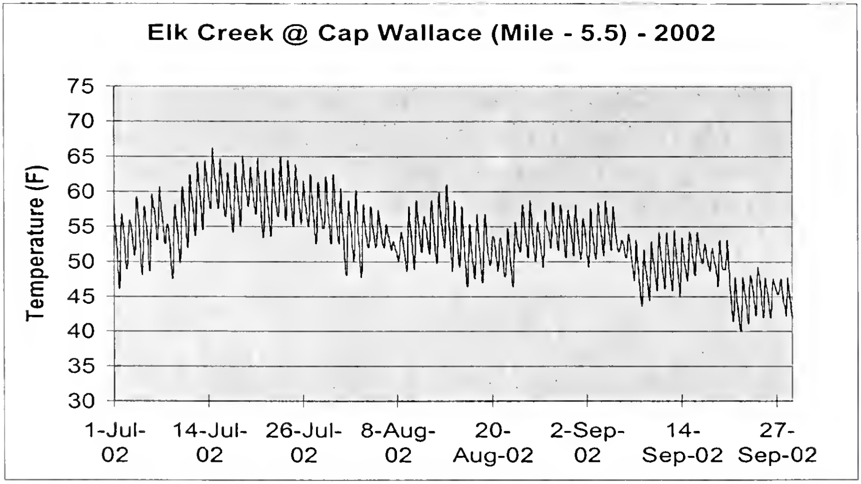
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	66.96	48.25	58.65	4.01	16.12
August	61.48	48.25	54.56	3.03	9.15
September	60.80	42.46	50.99	3.81	14.51



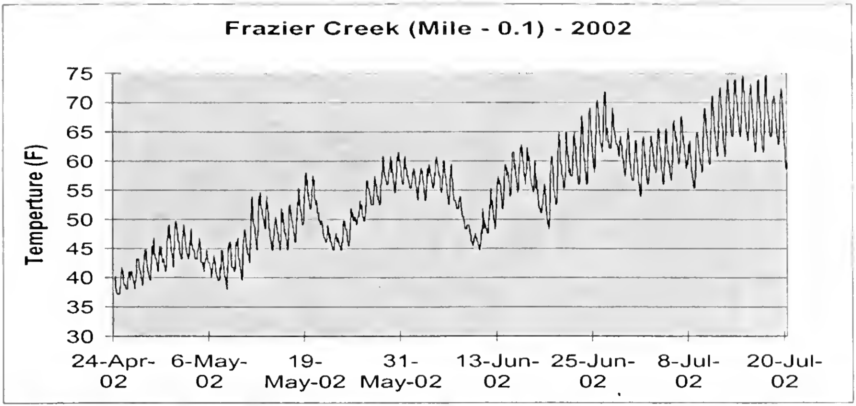
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	79.87	48.64	64.91	7.39	54.67
August	73.29	46.68	59.45	6.42	41.21
September	72.35	37.97	54.08	7.08	50.16



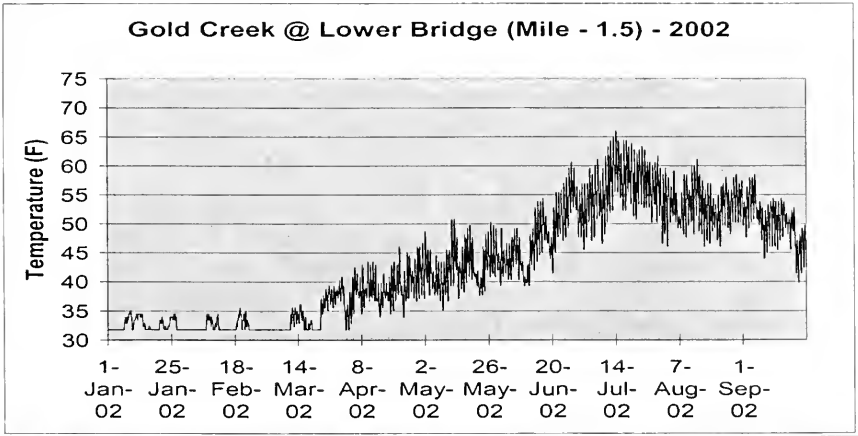
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	72.92	48.32	61.32	5.22	27.24
August	66.12	48.60	56.52	3.73	13.88
September	64.38	41.90	52.14	4.59	21.03



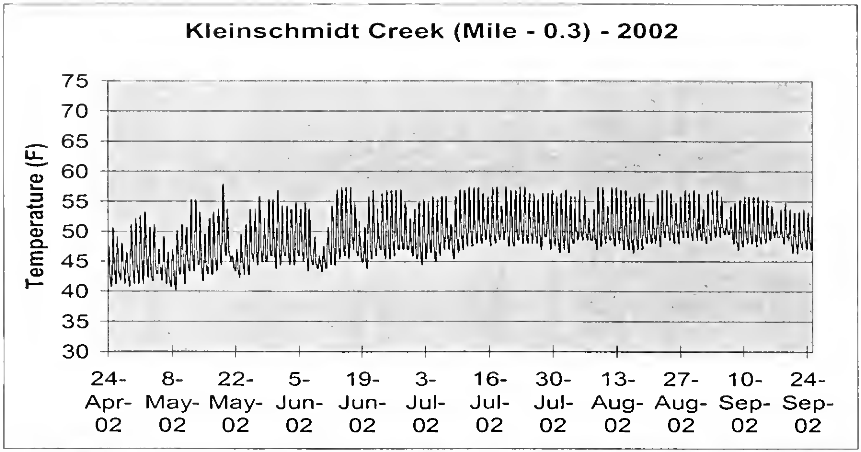
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	66.20	46.12	57.26	3.87	15.00
August	60.96	46.42	53.23	2.88	8.32
September	58.70	39.97	49.22	3.91	15.26


Frazier Creek (Mile - 0.1) - 2002

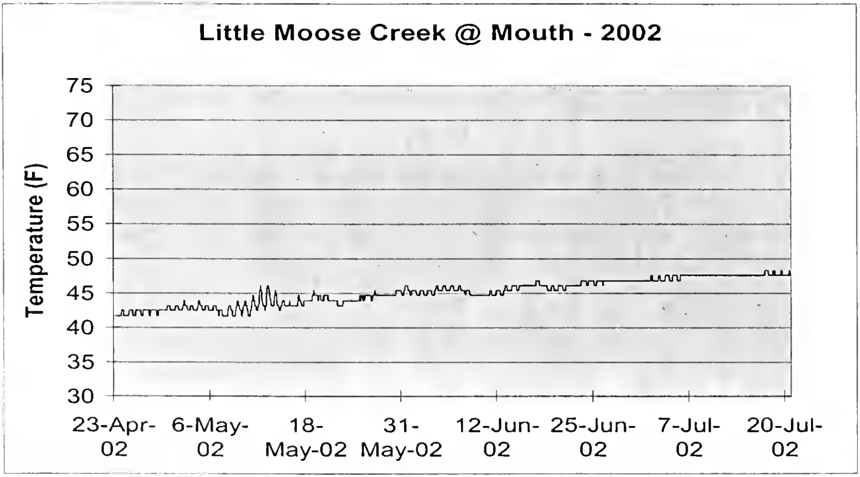
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	46.80	37.20	41.00	2.36	5.56
May	61.50	38.00	48.38	5.06	25.61
June	71.80	44.70	57.00	5.37	28.86
July	74.60	53.90	64.04	4.83	23.29


Gold Creek @ Lower Bridge (Mile - 1.5) - 2002

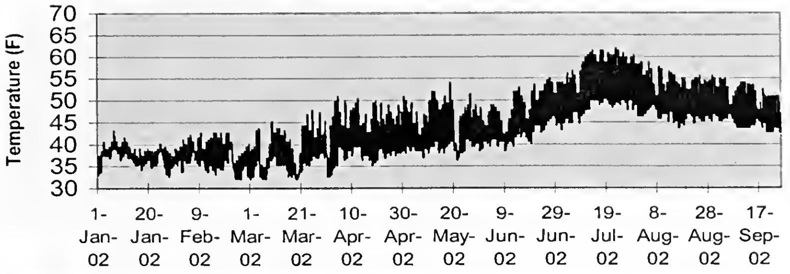
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	35.04	31.79	32.56	1.02	1.04
February	35.57	31.79	32.34	0.92	0.84
March	40.84	31.79	33.86	2.60	6.76
April	46.04	31.79	38.75	2.91	8.47
May	50.72	35.04	42.45	3.30	10.87
June	60.61	39.28	47.87	5.10	26.05
July	65.96	45.52	56.33	4.42	19.52
August	61.14	46.04	53.12	3.31	10.94
September	58.51	39.80	50.22	3.64	13.28


Kleinschmidt Creek (Mile - 0.3) - 2002

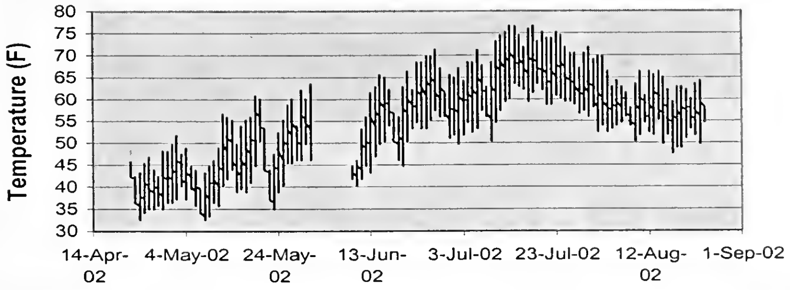
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	52.15	40.74	44.89	2.93	8.60
May	57.87	40.21	46.64	3.71	13.79
June	57.35	43.33	48.77	3.59	12.86
July	57.35	44.37	50.77	3.27	10.70
August	57.35	46.46	50.93	2.87	8.25
September	56.83	46.46	50.52	2.39	5.73


Little Moose Creek @ Mouth - 2002

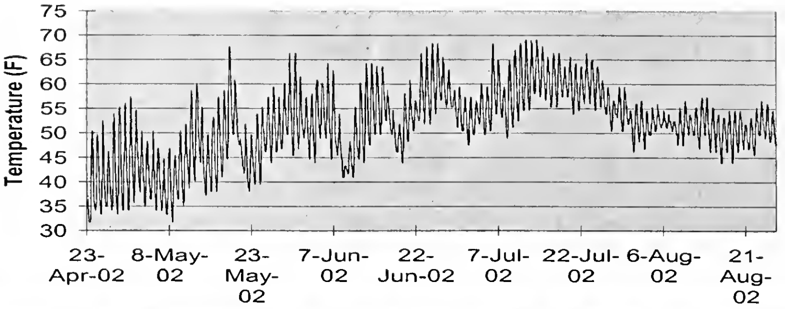
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	43.20	41.70	42.24	0.44	0.19
May	46.10	41.70	43.64	1.00	0.99
June	46.80	44.70	45.83	0.72	0.52
July	48.30	46.80	47.47	0.36	0.13


Landers Fork @ HWY 200 2002

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	43.14	32.59	37.19	1.73	2.99
February	42.62	32.05	36.85	2.31	5.33
March	47.82	32.05	37.07	3.35	11.20
April	50.92	32.59	40.59	3.83	14.69
May	54.03	36.32	42.59	3.68	13.55
June	55.07	38.45	45.31	3.71	13.73
July	61.88	43.14	52.41	4.16	17.32
August	58.72	43.66	49.71	3.27	10.71
September	55.07	42.62	47.22	3.05	9.33

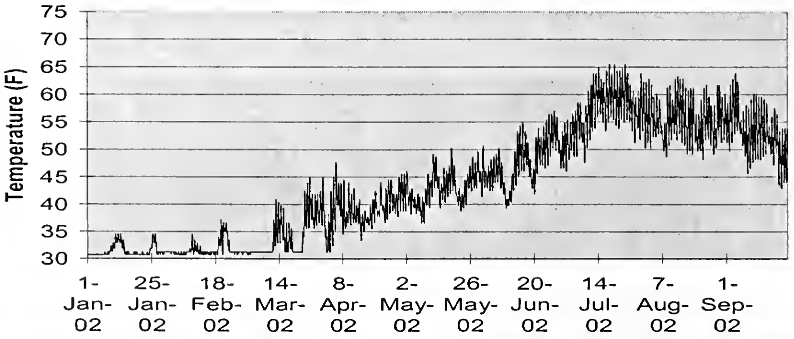

Lower Willow Creek near mouth 2002

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	48.25	32.52	40.11	3.99	15.91
May	63.54	32.52	46.19	6.84	46.81
June	71.08	40.23	55.78	7.23	52.32
July	76.62	49.67	64.26	5.90	34.85
August	80.12	36.43	57.91	5.26	27.67



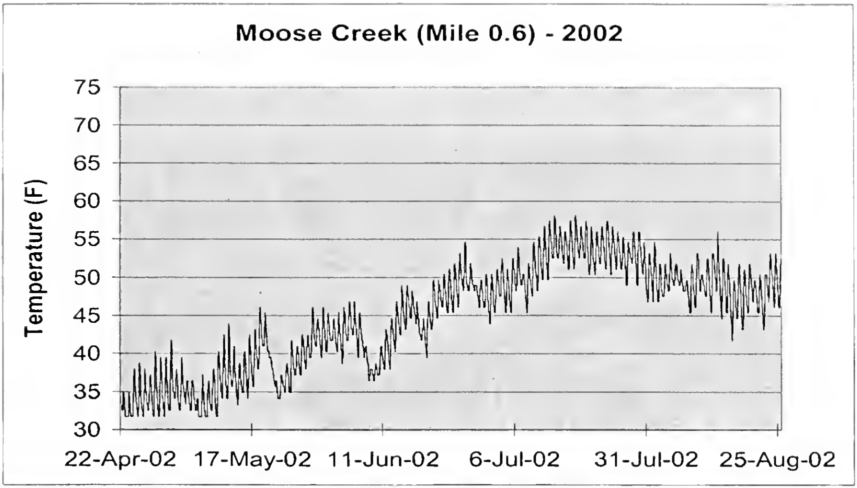
McElwain Creek @ Ovando-Helmville Rd (Mile - 1.2) - 2002

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	55.97	31.72	41.34	6.69	44.71
May	67.65	31.72	46.61	7.27	52.87
June	68.33	40.97	53.57	6.08	37.00
July	69.02	47.53	58.00	4.80	23.06
August	57.35	43.92	51.25	2.76	7.59

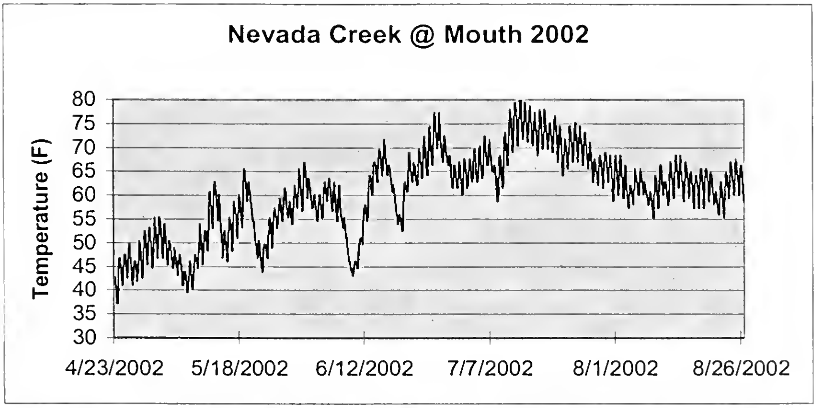


Monture Creek @ FAS (Mile - 1.8) - 2002

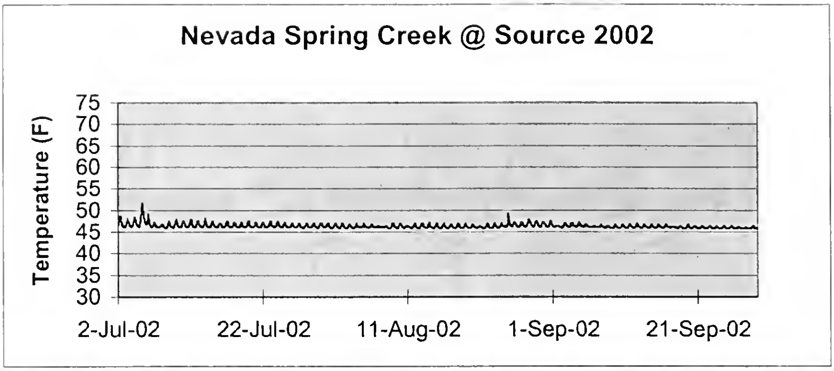
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	34.49	30.70	31.37	1.01	1.02
February	37.16	30.70	31.64	1.32	1.75
March	45.01	30.70	34.08	3.69	13.58
April	47.62	31.24	38.93	3.10	9.59
May	50.72	36.63	42.99	2.86	8.19
June	56.97	39.28	47.71	4.09	16.71
July	65.45	46.05	57.00	4.28	18.29
August	63.30	48.14	55.33	3.55	12.64
September	63.84	42.93	53.05	4.25	18.08


Moose Creek (Mile 0.6) - 2002

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	40.23	31.72	34.21	2.29	5.25
May	46.10	31.72	37.43	3.50	12.23
June	54.58	36.43	44.45	3.89	15.10
July	58.04	43.92	52.03	3.06	9.39
August	55.97	41.72	49.00	2.39	5.71

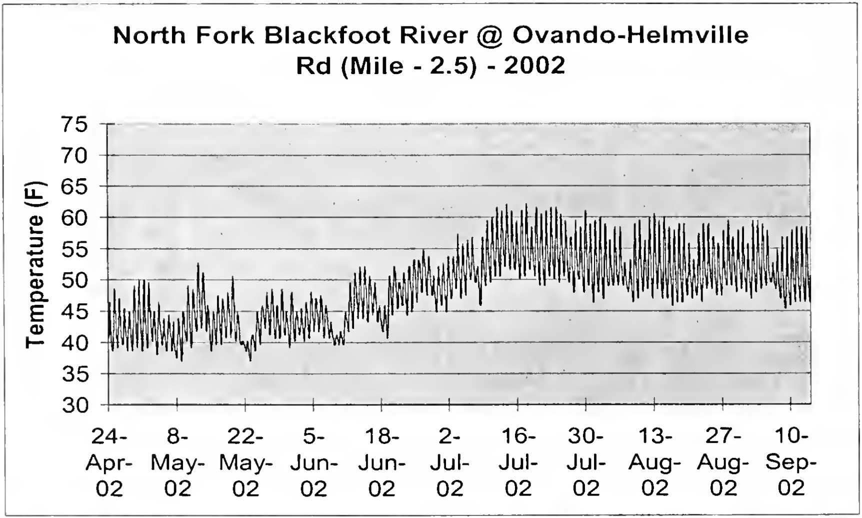

Nevada Creek @ Mouth 2002

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	53.19	37.20	45.51	3.64	13.25
May	66.96	39.48	52.56	6.10	37.21
June	77.31	43.19	61.28	7.38	54.44
July	80.12	58.73	69.35	4.71	22.20
August	68.33	55.28	62.12	2.92	8.52



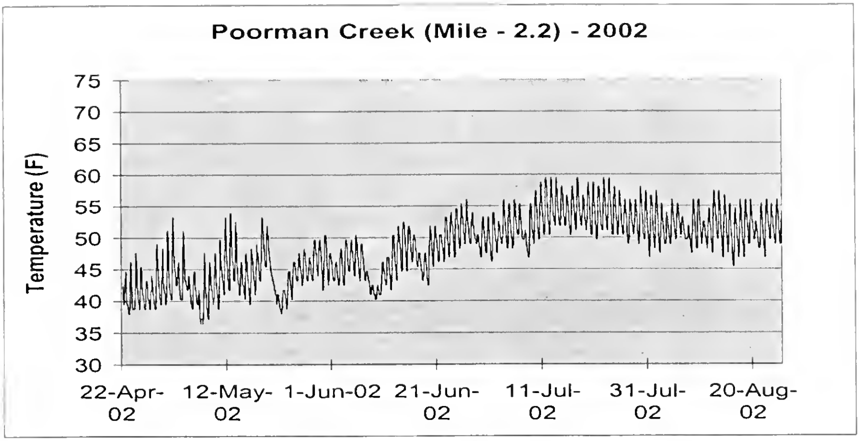
Nevada Spring Creek @ Source 2002

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	53.10	45.87	46.65	0.85	0.73
August	56.19	45.87	46.39	0.90	0.81
September	47.23	45.87	46.14	0.28	0.08

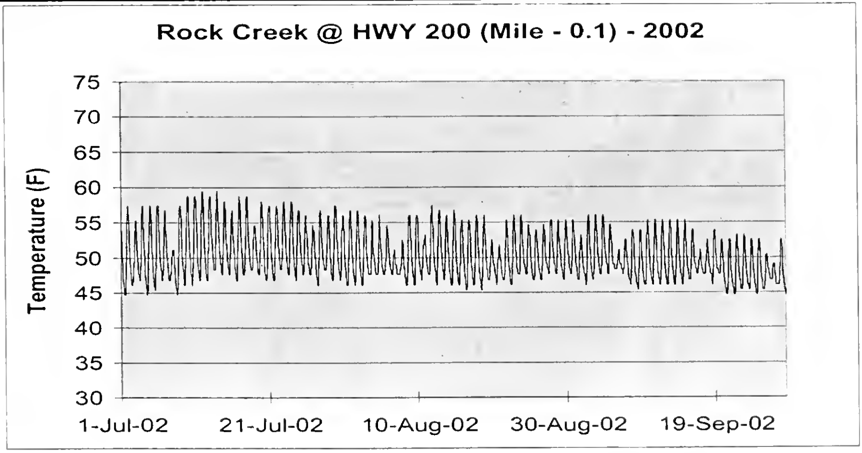


North Fork Blackfoot River @ Ovando-Helmville Rd (Mile - 2.5) - 2002

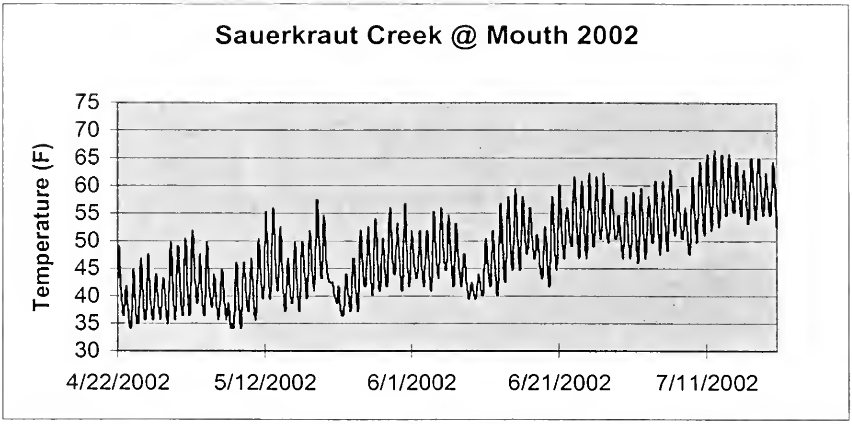
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	50.06	37.55	42.71	3.04	9.25
May	52.64	37.02	42.87	3.08	9.49
June	54.72	39.66	45.94	3.64	13.25
July	62.07	44.86	53.49	3.85	14.86
August	60.47	45.90	51.95	3.61	13.03
September	59.42	45.38	51.32	3.58	12.84



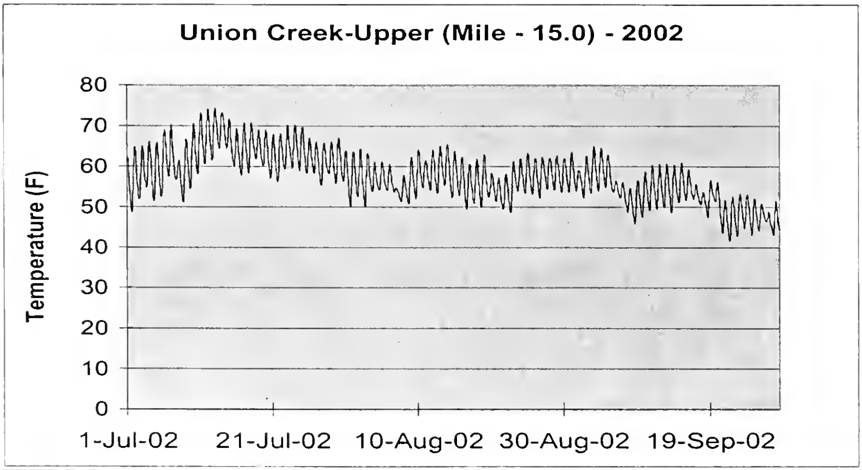
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	48.96	37.97	41.63	2.55	6.52
May	53.89	36.43	43.94	3.52	12.40
June	55.97	40.23	47.32	3.50	12.24
July	59.42	46.10	53.05	2.99	8.95
August	57.35	45.38	51.61	2.62	6.84



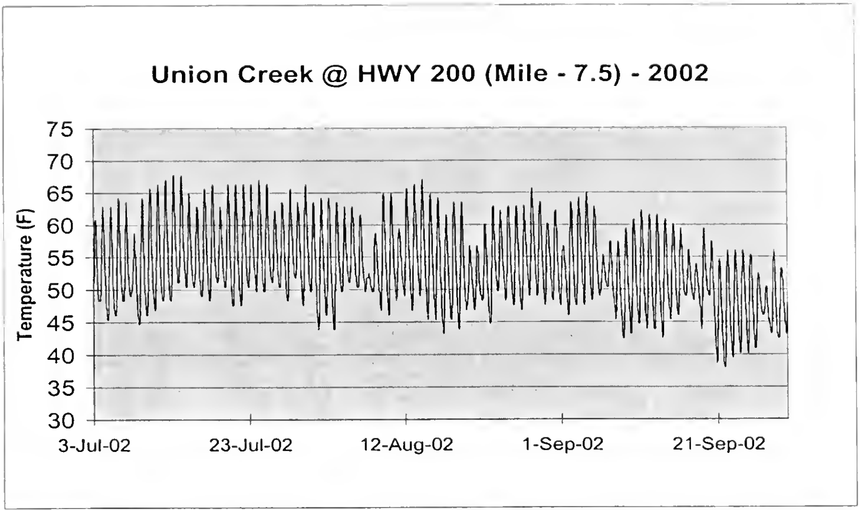
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	59.40	44.70	51.36	3.79	14.38
August	57.40	45.40	50.23	3.07	9.43
September	56.00	44.70	49.23	2.78	7.72



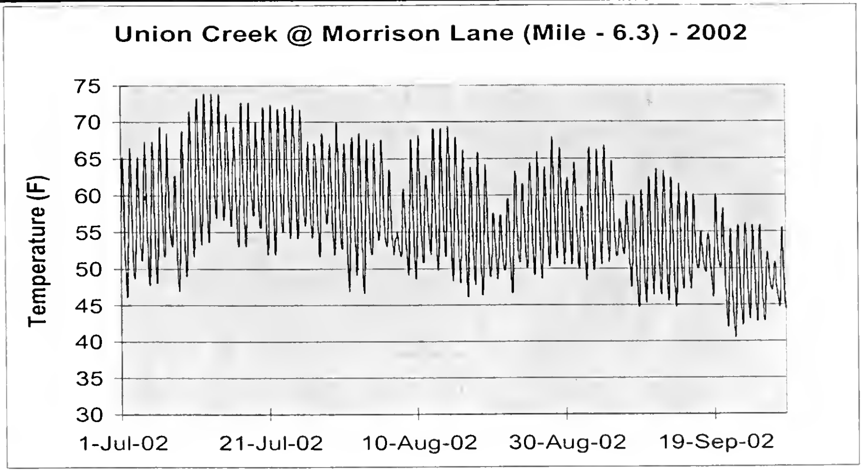
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	49.70	34.10	40.23	4.15	17.22
May	57.40	34.10	43.50	5.23	27.34
June	62.20	39.50	49.26	5.42	29.43
July	66.30	46.10	56.24	4.88	23.80



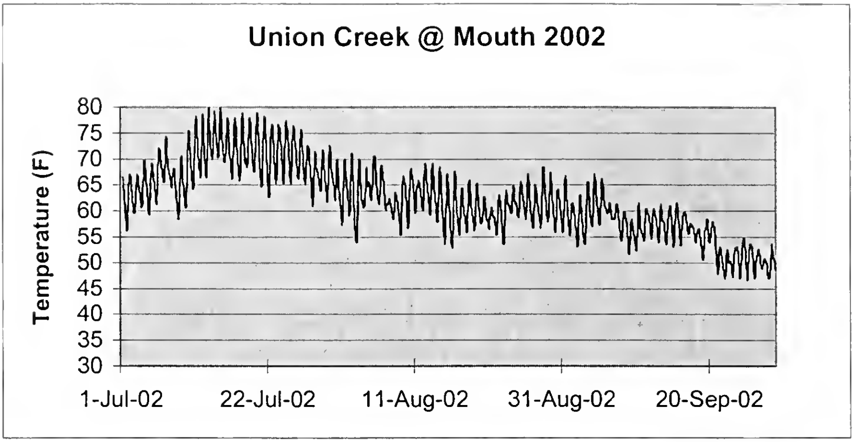
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	74.44	48.60	62.66	5.12	26.22
August	65.54	48.60	56.99	3.77	14.19
September	64.96	41.62	52.72	4.90	23.99


Union Creek @ HWY 200 (Mile - 7.5) - 2002

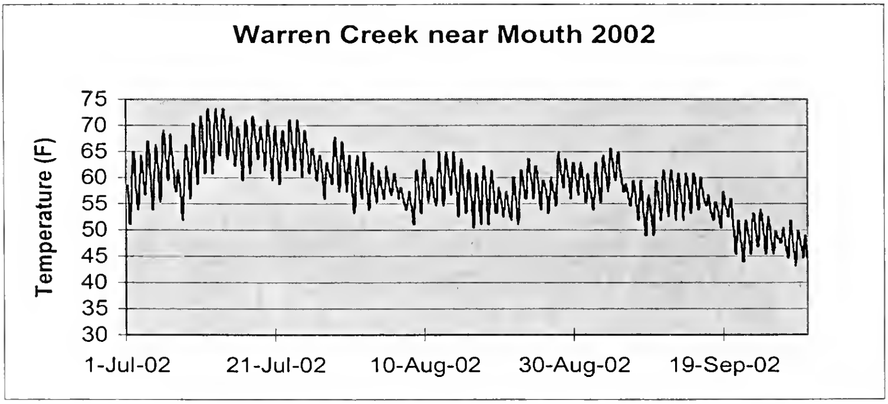
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	67.70	44.70	55.29	5.79	33.48
August	67.00	43.20	54.06	5.54	30.65
September	64.90	38.00	50.67	5.62	31.54


Union Creek @ Morrison Lane (Mile - 6.3) - 2002

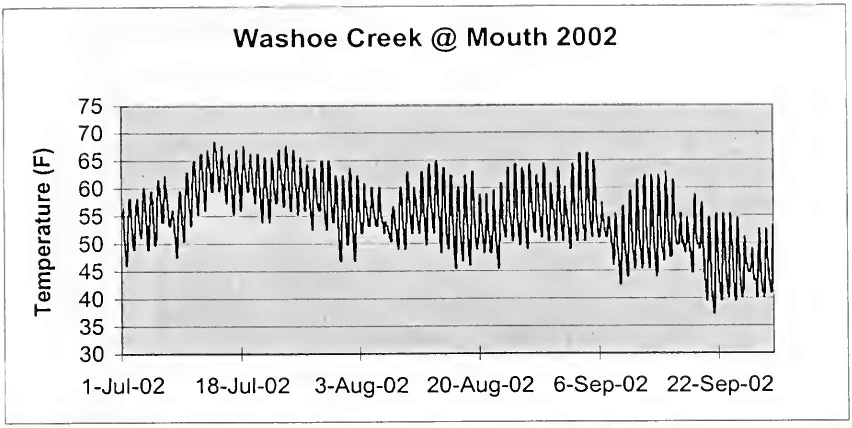
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	73.83	46.10	60.40	6.50	42.25
August	69.32	46.10	56.51	5.65	31.90
September	66.70	40.50	52.40	5.43	29.52



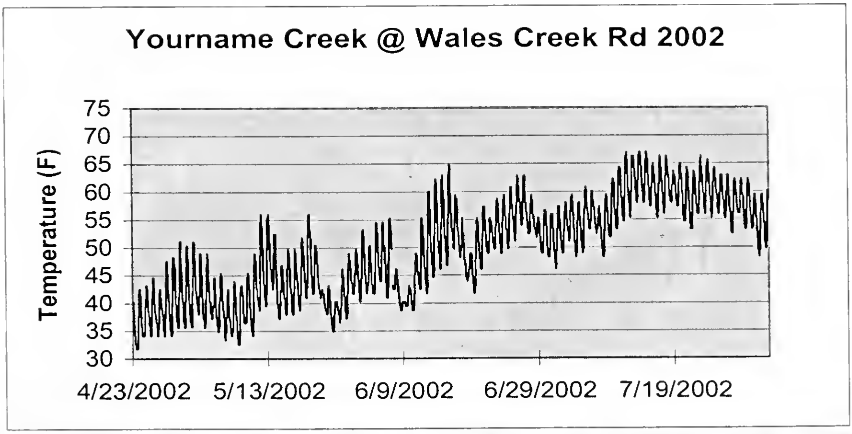
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	79.87	56.19	68.96	4.95	24.47
August	71.14	52.86	61.78	3.71	13.80
September	67.04	46.68	55.71	4.34	18.86



Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	73.15	51.08	63.82	4.59	21.09
August	64.91	50.38	58.09	3.26	10.64
September	65.59	43.19	54.00	5.06	25.59



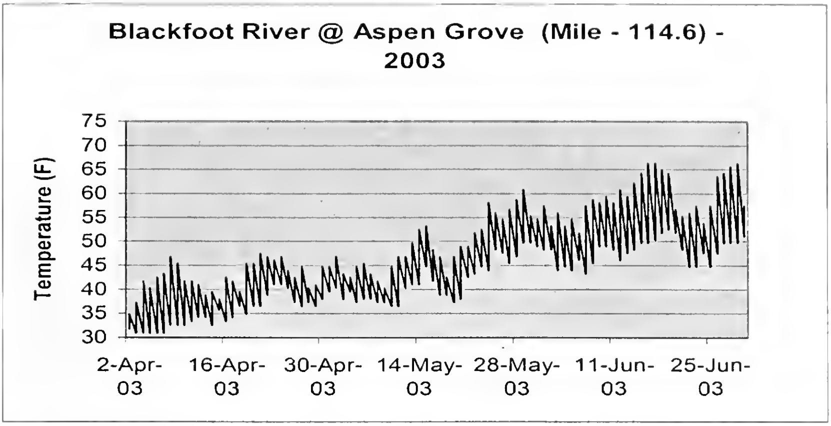
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	68.33	46.10	58.82	4.67	21.82
August	64.91	45.38	54.94	4.41	19.46
September	66.28	37.20	50.42	5.92	35.02



Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	51.08	31.72	39.05	4.50	20.21
May	55.97	32.52	43.02	5.20	27.01
June	64.91	38.72	50.89	6.19	38.33
July	66.96	46.10	57.95	4.49	20.18
August	60.80	46.82	53.27	3.08	9.47

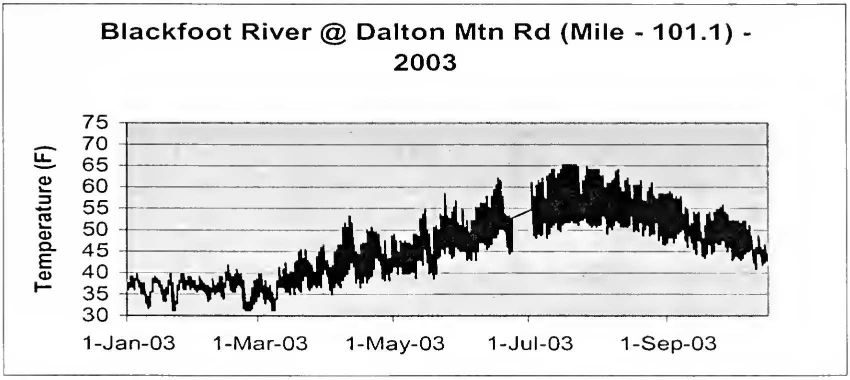
2003 Temperature sensor locations

Stream Name	Location (stream mile)	Legal Description	Duration	Sensor Type	Recording Rate
Alice Creek	0.9	15N,7W,27C	4/2/03-6/30/03	HOBO	72min.
Arrastra Creek	0.4	14N,10W,30A	4/1/03-6/30/03	HOBO	72min.
Beaver Creek	0.2	14N,9W,22B	4/2/03-6/30/03	HOBO	72min.
Belmont Creek	0.1	14N,16W,24C	6/2/03-10/14/03	Tidbit	50min.
Blackfoot River	7.9	13N,17W,9B	7/2/03-10/14/03	Tidbit	50min.
Blackfoot River	21.8	14N,16W,24C	7/2/03-10/14/03	Tidbit	50min.
Blackfoot River	46.1	15N,13W,33A	7/2/03-10/29/03	Tidbit	50min.
Blackfoot River	60	14N,12W,28D	1/1/03-10/14/03	Tidbit	50min.
Blackfoot River	72.2	14N,11W,32D	1/1/03-10/21/03	Tidbit	50min.
Blackfoot River	104.5	14N,9W,28B	1/1/03-10/16/03	Tidbit	50min.
Blackfoot River	114.6	14N,7W,7D	4/2/03-6/30/03	HOBO	72min.
Chamberlain Creek	1.8	14N,13W,4A	4/1/03-7/1/03	HOBO	72min.
Clearwater River	0.1	14N,14W,16C	7/1/03-10/14/03	HOBO	72min.
Clearwater River Ditch	0.1	14N,14W,4B	7/1/03-10/14/03	HOBO	72min.
Copper Creek	1.2	15N,8W,25C	1/1/03-10/16/03	Tidbit	50min.
Copper Creek	6.3	15N,8W,9A	1/1/03-6/23/03	Tidbit	50min.
Cottonwood Creek	1	15N,13W,29B	1/1/03-10/14/03	Tidbit	50min.
Cottonwood Creek	7.3	15N,13W,5B	1/1/03-6/23/03	Tidbit	50min.
Elk Creek	0.1	14N,15W,26D	7/1/03-10/14/03	HOBO	72min.
Elk Creek	1	14N,15W,36A	7/1/03-10/14/03	HOBO	72min.
Elk Creek	3	14N,14W,32C	7/1/03-10/14/03	HOBO	72min.
Elk Creek	5.5	13N,14W,9C	7/1/03-10/14/03	HOBO	72min.
Frazier Creek	0.1	14N,12W,28D	4/1/03-7/1/03	HOBO	72min.
Gold Creek	1.6	14N,16W,30C	1/1/03-10/16/03	Tidbit	72min.
Gold Creek	6.3	14N,17W,12A	1/1/03-10/23/03	Tidbit	72min.
Hogum Creek	0.4	14N,7W,8A	4/2/03-6/30/03	HOBO	72min.
Kleinschmidt Creek	0.4	14N,11W,6A	7/2/03-10/14/03	Tidbit	50min.
Little Moose Creek	0.1	14N,10W,26C	4/2/03-6/30/03	HOBO	72min.
Lower Willow Creek	1.7	14N,9W,28A	4/2/03-6/30/03	HOBO	72min.
Monture Creek	1.8	15N,13W,22D	1/1/03-10/14/03	Tidbit	50min.
Monture Creek	13.1	16N,12W,29C	1/1/03-6/23/03	Tidbit	50min.
Moose Creek	0.6	14N,10W,34C	4/2/03-6/30/03	HOBO	72min.
Nevada Creek	0.1	13N,11W,7C	4/1/03-7/1/03	HOBO	72min.
Nevada Spring Creek	3.5	13N,11W,11D	1/1/03-6/23/03	Tidbit	50min.
Nevada Spring Creek	2.5	13N,11W,11B	5/13/03-10/30/03	HOBO	72min.
Nevada Spring Creek	1.6	13N,11W,10A	5/13/03-10/30/03	HOBO	72min.
Nevada Spring Creek	0.1	13N,11W,9D	5/13/03-10/30/03	HOBO	72min.
North Fork	2.6	14N,12W,10D	7/2/03-10/14/03	Tidbit	50min.
Poorman Creek	2.2	14N,9W,36D	4/2/03-6/30/03	HOBO	72min.
Sauerkraut Creek	0.1	14N,9W,29B	4/2/03-6/30/03	HOBO	72min.
Upper Willow Creek	0.7	15N,7W,35C	4/2/03-6/30/03	HOBO	72min.
Wales Creek	0.1	14N,12W,33A	4/1/03-7/1/03	HOBO	72min.
Warren Creek	1.1	15N,12W,31C	7/1/03-10/8/03	HOBO	72min.
Wasson Creek	1.3	13N,11W,13B	7/2/03-8/1/03	HOBO	72min.
Wasson Creek	2.4	13N,10W,7D	8/6/03-11/14/03	HOBO	72min.
Wasson Creek	0.1	13N,11W,11D	5/13/03-10/30/03	HOBO	72min.
Yourname Creek	1.9	13N,12W,10B	4/1/03-7/3/03	HOBO	72min.



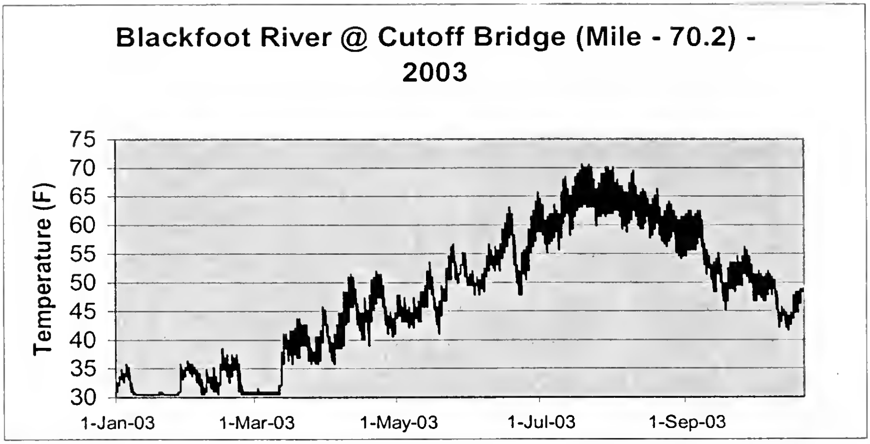
Blackfoot River @ Aspen Grove (Mile - 114.6) - 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	47.53	30.91	38.10	4.02	16.15
May	60.80	36.43	45.14	5.46	29.86
June	66.28	43.19	53.00	5.09	25.94

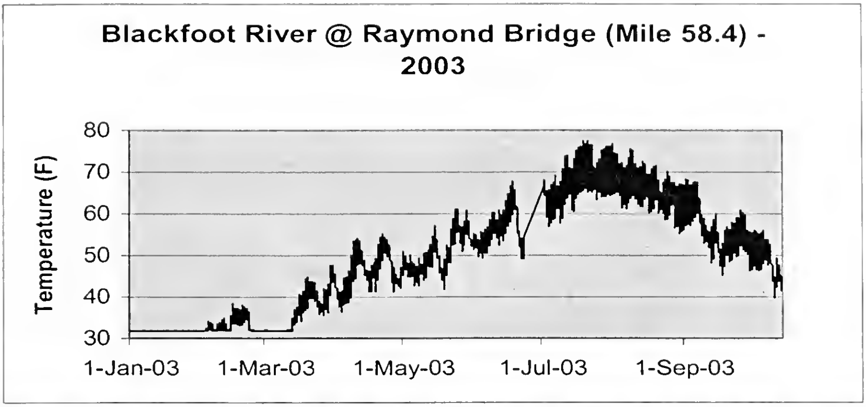


Blackfoot River @ Dalton Mtn Rd (Mile - 101.1) - 2003

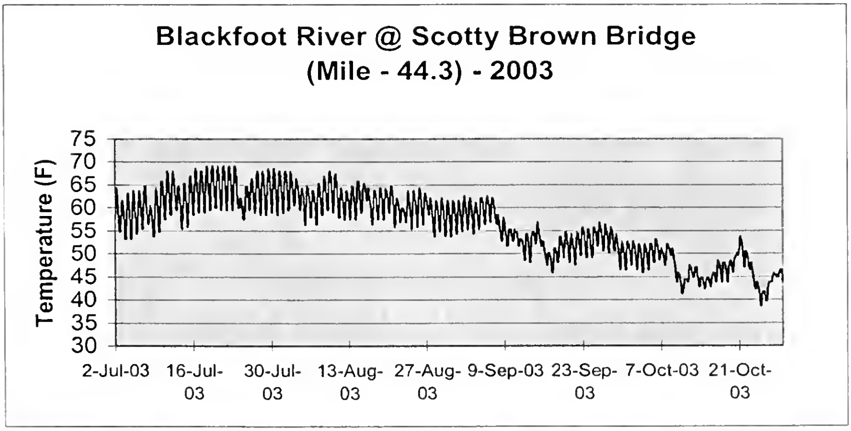
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	39.66	31.13	36.47	1.94	3.76
February	41.75	31.13	36.10	2.17	4.72
March	46.43	31.13	38.13	3.06	9.37
April	53.16	34.89	42.77	3.74	13.99
May	58.37	38.61	46.04	4.11	16.89
June	62.07	42.78	50.57	4.19	17.55
July	65.28	47.99	56.64	4.64	21.53
August	64.21	46.43	55.05	3.86	14.91
September	58.90	42.78	50.17	3.43	11.77
October	52.12	40.71	46.26	2.80	7.84


Blackfoot River @ Cutoff Bridge (Mile - 70.2) - 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	36.33	30.43	31.56	1.70	2.88
February	38.45	30.43	33.24	2.11	4.47
March	45.74	30.43	36.17	4.58	20.99
April	51.97	35.80	44.21	3.75	14.07
May	56.64	41.07	47.90	3.73	13.91
June	65.66	47.82	54.33	4.11	16.90
July	70.57	55.08	63.48	3.57	12.73
August	70.02	54.04	62.00	3.14	9.85
September	62.43	45.22	53.57	3.95	15.59
October	51.97	41.59	47.12	2.77	7.69

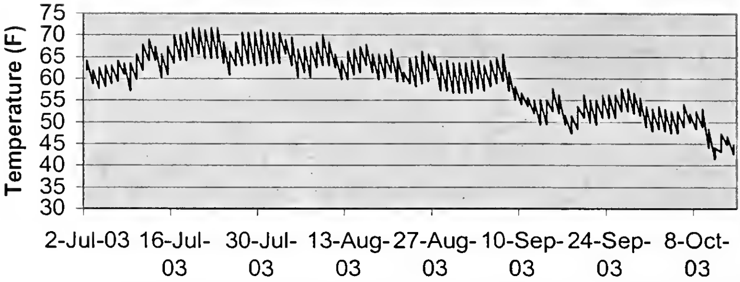

Blackfoot River @ Raymond Bridge (Mile 58.4) - 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	31.80	31.80	31.80	0.00	0.00
February	38.40	31.80	33.09	1.71	2.91
March	47.64	31.80	36.26	4.40	19.38
April	55.17	36.41	45.99	4.33	18.72
May	61.09	41.77	50.32	4.46	19.86
June	67.74	49.03	56.12	4.18	17.50
July	77.41	56.83	67.46	4.74	22.46
August	76.79	55.17	65.83	4.13	17.08
September	68.32	45.14	55.91	5.12	26.19
October	56.00	39.80	48.84	3.97	15.73


Blackfoot River @ Scotty Brown Bridge (Mile - 44.3) - 2003

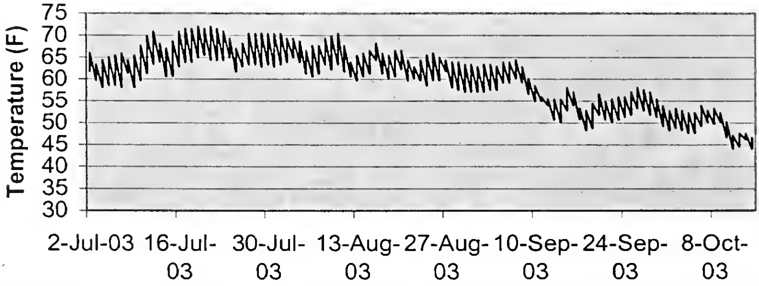
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	69.09	53.19	62.20	3.95	15.63
August	68.00	53.71	61.21	3.07	9.44
September	62.62	45.93	54.13	3.74	14.02
October	53.71	38.64	46.89	3.27	10.69

**Blackfoot River above Belmont
(Mile - 21.1) - 2003**

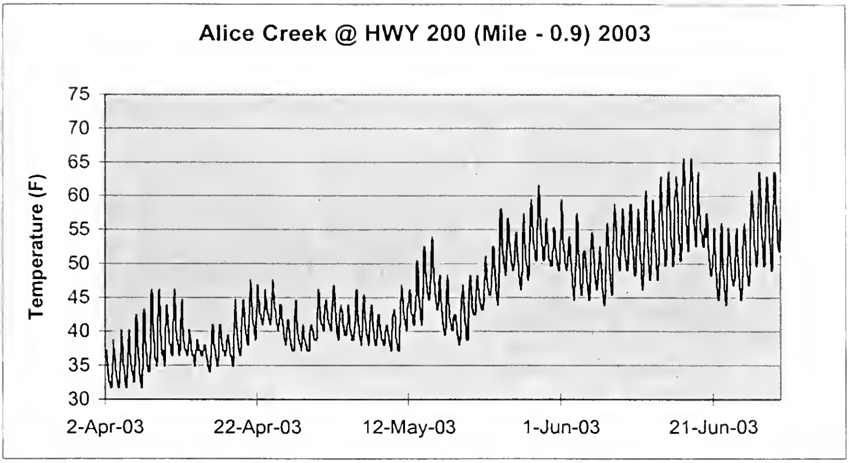


Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	71.67	57.15	64.95	3.34	11.15
August	70.55	56.63	63.27	2.83	8.04
September	65.64	47.30	55.05	4.01	16.11
October	54.03	41.59	48.36	3.05	9.31

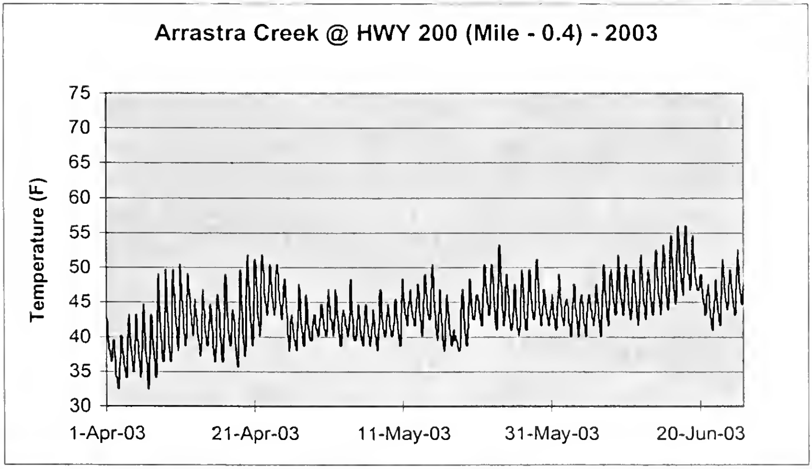
**Blackfoot River @ USGS Gage 12340000
(Mile - 7.4) - 2003**



Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	72.04	58.04	65.48	3.48	12.08
August	70.37	56.99	63.84	2.78	7.74
September	64.40	48.18	56.02	3.74	14.02
October	53.87	44.02	49.50	2.61	6.81

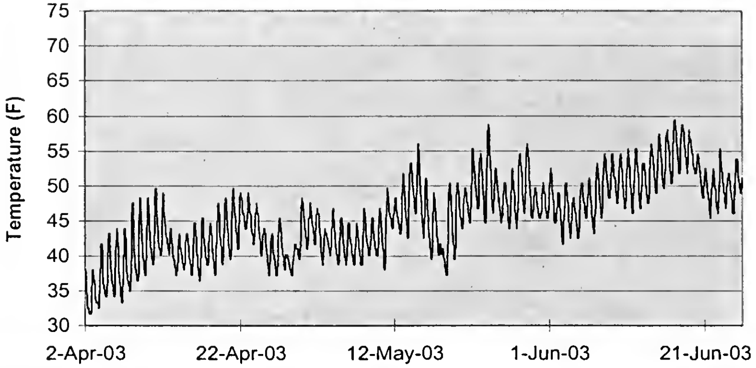

Alice Creek @ HWY 200 (Mile - 0.9) 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	47.53	31.72	38.82	3.47	12.01
May	61.48	37.20	45.26	5.36	28.72
June	65.59	43.92	52.69	4.83	23.37


Arrastra Creek @ HWY 200 (Mile - 0.4) - 2003

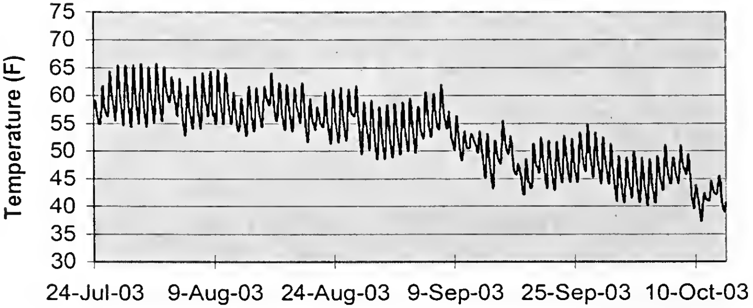
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	51.80	32.50	41.67	4.23	17.93
May	53.20	38.00	43.39	3.05	9.28
June	56.00	40.20	46.19	3.37	11.34

Beaver Creek @ HWY 200 (Mile - 0.2) - 2003

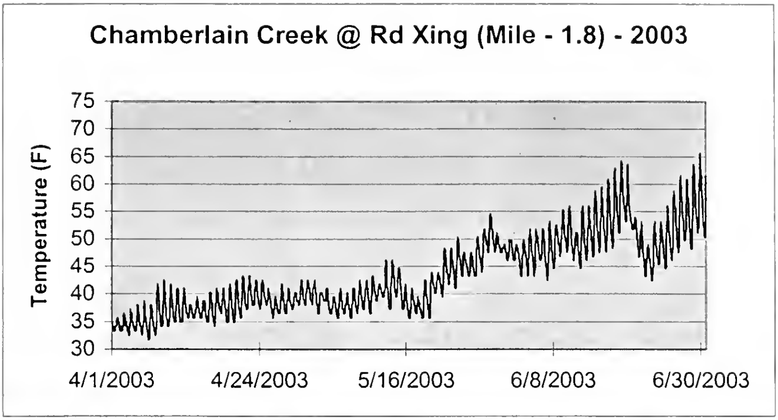


Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	49.70	31.70	41.01	3.97	15.72
May	58.70	37.20	45.79	4.30	18.52
June	59.40	41.70	50.40	3.66	13.42

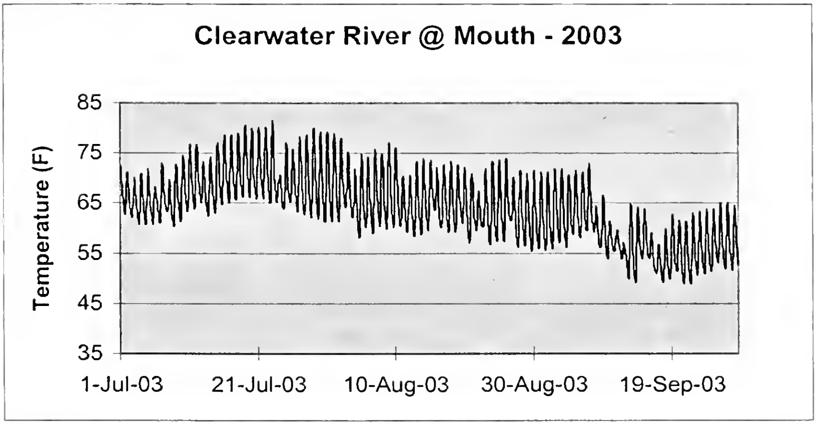
Belmont Creek @ Mouth - 2003



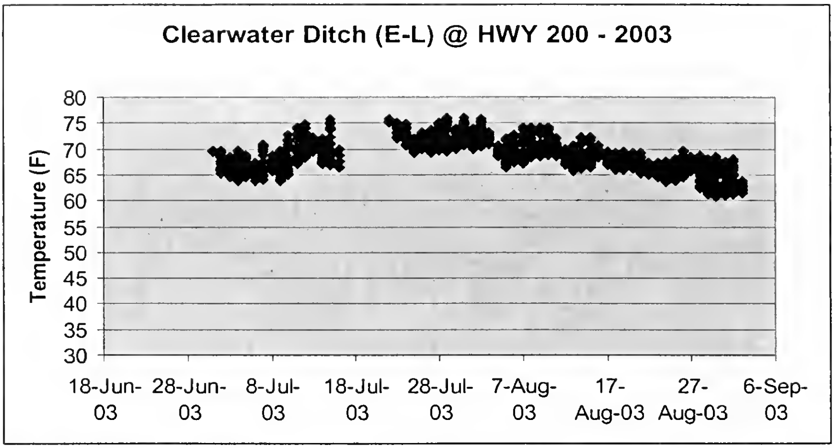
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	66.35	50.18	58.09	3.76	14.15
August	65.76	48.49	57.22	3.41	11.61
September	62.00	40.93	50.16	4.26	18.13
October	51.02	37.26	44.13	3.08	9.49


Chamberlain Creek @ Rd Xing (Mile - 1.8) - 2003

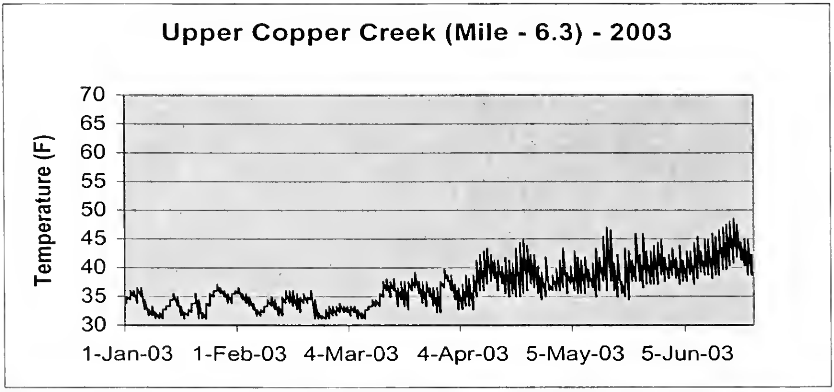
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	43.19	31.72	37.35	2.55	6.50
May	54.58	35.66	41.80	4.26	18.18
June	65.59	42.46	50.85	4.71	22.19
July	61.48	50.38	53.81	3.29	10.83


Clearwater River @ Mouth - 2003

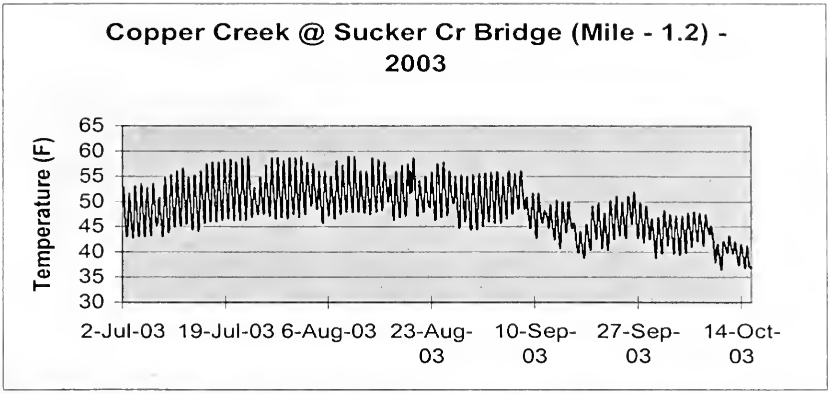
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	81.44	60.40	68.87	5.09	25.94
August	78.87	55.33	65.24	5.23	27.30
September	72.96	48.89	58.17	5.41	29.31


Clearwater Ditch (E-L) @ HWY 200 - 2003

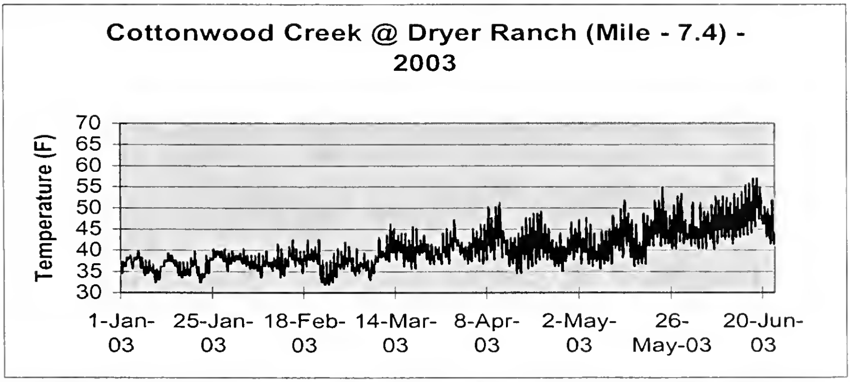
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	76.03	63.8	69.9	3.02	9.1
August	75.8	60.7	68.2	2.8	7.9
September	67.9	61.3	63.8	2	4.2


Upper Copper Creek (Mile - 6.3) - 2003

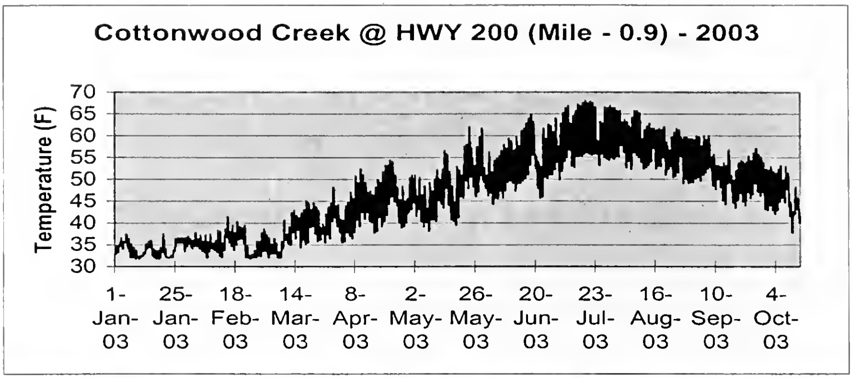
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	37.05	31.16	33.90	1.55	2.41
February	36.52	31.16	33.55	1.40	1.95
March	39.69	31.16	34.83	2.09	4.38
April	44.89	32.78	37.93	2.53	6.41
May	46.98	34.39	39.05	2.60	6.74
June	48.54	37.05	41.47	2.55	6.50


Copper Creek @ Sucker Cr Bridge (Mile - 1.2) - 2003

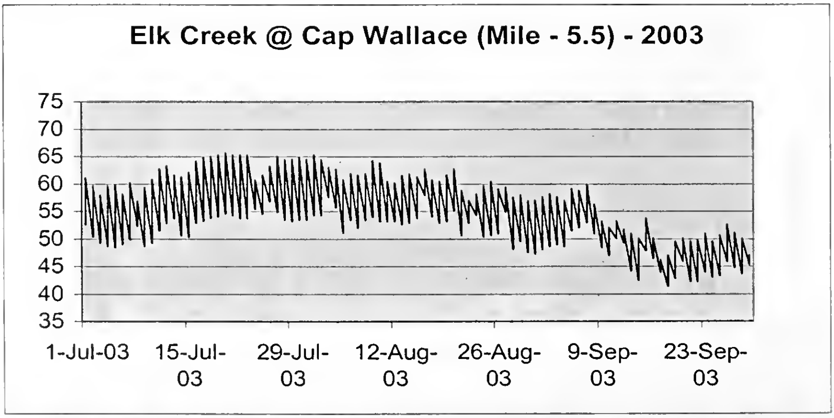
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	35.07	31.88	32.32	0.80	0.65
February	35.07	31.88	32.57	0.85	0.72
March	38.76	31.88	33.44	1.80	3.25
April	45.20	31.88	37.92	2.58	6.64
May	48.54	35.35	40.47	2.71	7.36
June	50.22	38.19	43.01	2.70	7.30
July	58.88	42.69	50.42	4.03	16.28
August	58.88	44.37	51.67	3.38	11.43
September	56.08	38.76	47.02	3.81	14.48
October	48.26	36.49	42.36	3.04	9.26


Cottonwood Creek @ Dryer Ranch (Mile - 7.4) - 2003

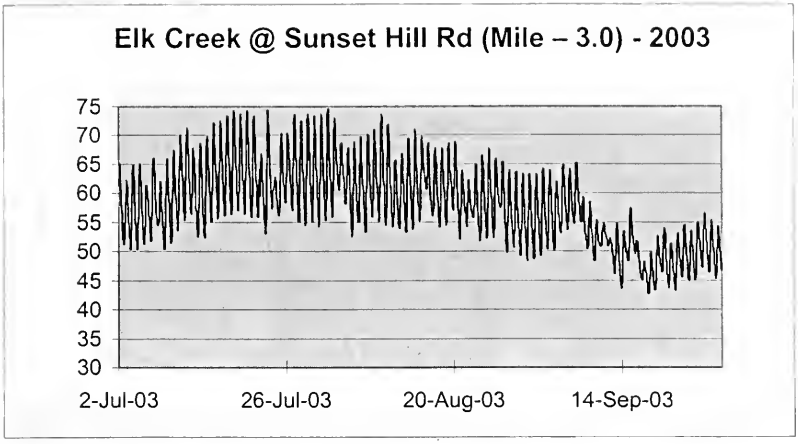
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	40.38	32.41	36.65	1.84	3.38
February	42.46	31.87	37.02	2.14	4.58
March	47.14	32.95	39.15	2.70	7.28
April	51.28	34.56	41.16	3.41	11.66
May	54.91	35.63	43.00	3.99	15.95
June	56.99	40.38	47.04	3.95	15.61



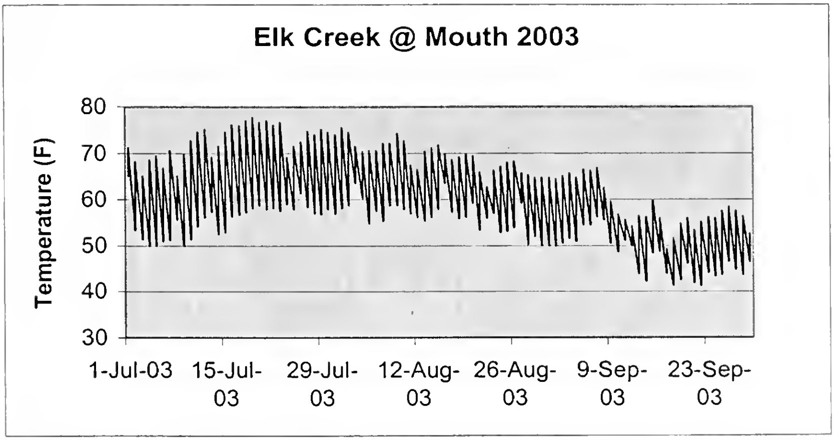
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	37.48	31.70	33.96	1.56	2.44
February	41.44	31.70	35.00	2.03	4.11
March	48.17	32.00	37.91	3.52	12.37
April	54.34	35.47	44.16	4.14	17.11
May	61.99	38.05	48.18	4.96	24.55
June	64.88	44.26	53.19	4.46	19.87
July	68.11	49.85	59.45	4.35	18.94
August	65.76	49.01	57.70	3.63	13.16
September	59.98	43.13	51.55	3.70	13.66
October	53.22	37.77	46.28	3.54	12.53



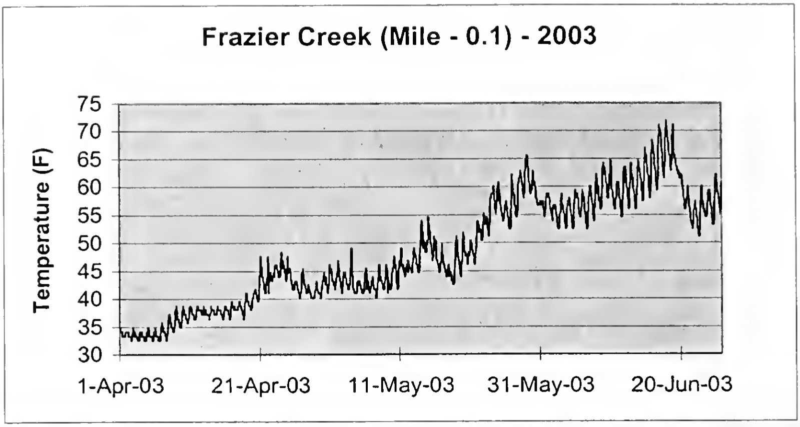
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	65.62	48.35	57.16	3.95	15.63
August	65.29	47.23	56.54	3.42	11.68
September	59.83	41.39	49.38	3.94	15.51


Elk Creek @ Sunset Hill Rd (Mile – 3.0) - 2003

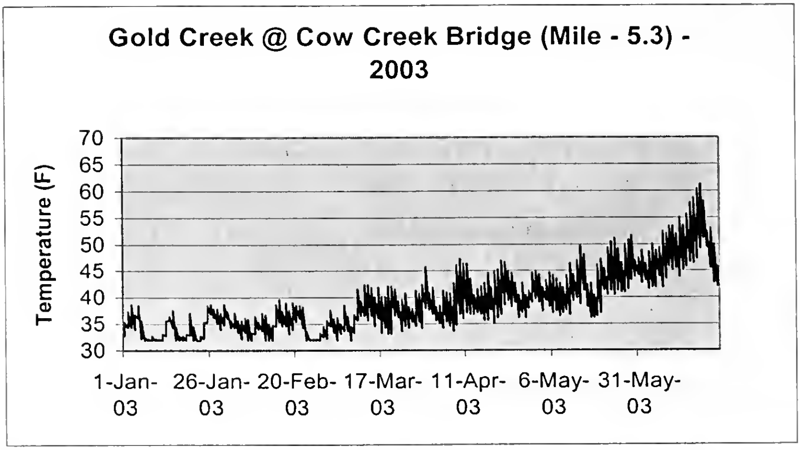
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	74.44	50.28	61.50	6.00	36.02
August	74.75	48.32	60.49	5.29	27.99
September	65.25	42.75	51.92	4.97	24.70


Elk Creek @ Mouth 2003

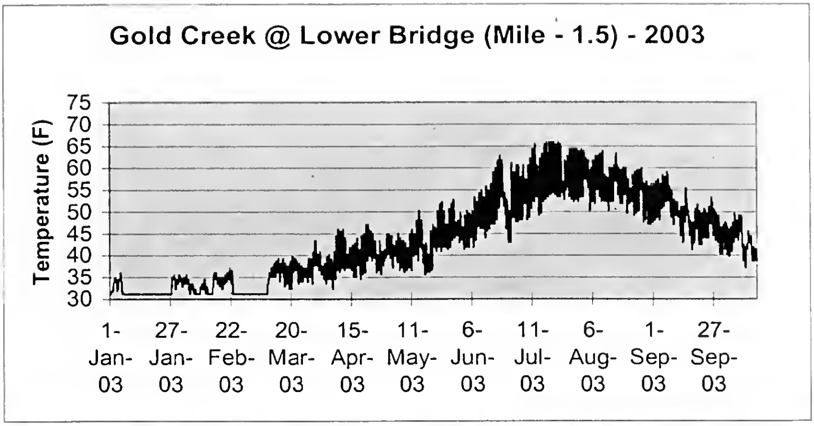
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	77.64	50.02	64.48	6.92	47.94
August	75.42	50.02	62.87	5.39	29.04
September	66.77	41.39	52.95	5.77	33.28



Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	48.30	32.50	38.53	3.91	15.29
May	65.60	40.20	48.90	6.30	39.74
June	71.80	51.10	59.01	4.22	17.80

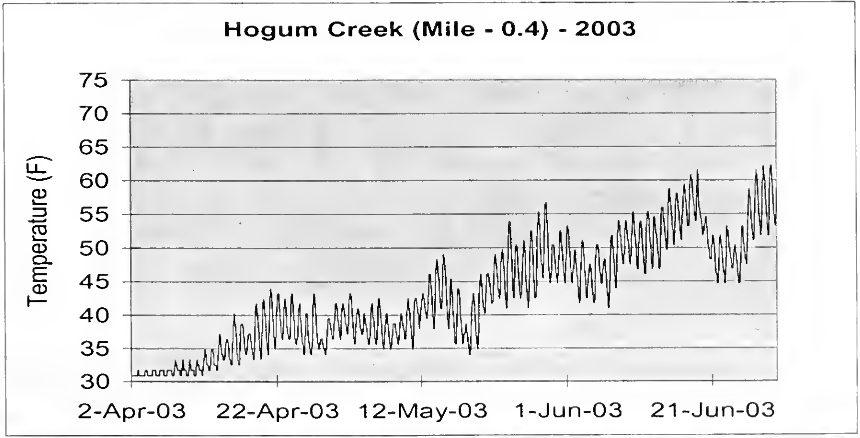


Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	38.74	31.86	34.19	2.10	4.41
February	39.58	31.86	34.38	1.87	3.48
March	45.76	31.86	36.67	2.47	6.10
April	47.15	33.60	39.37	2.81	7.89
May	51.62	36.18	42.36	3.37	11.35
June	61.17	41.55	48.71	4.17	17.38



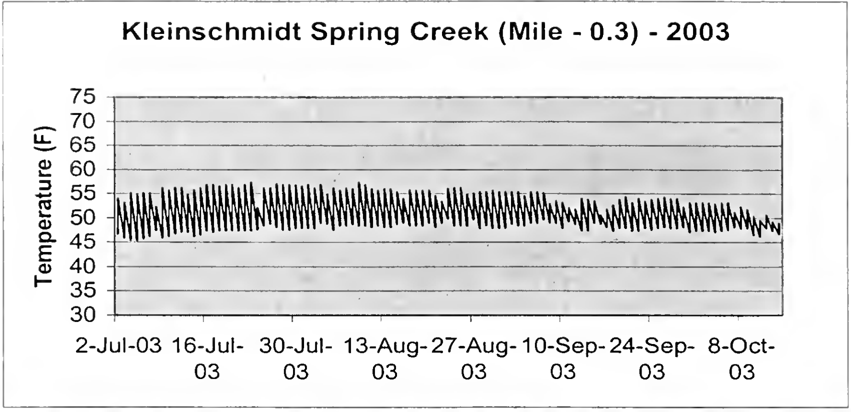
Gold Creek @ Lower Bridge (Mile - 1.5) - 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	36.10	31.25	32.07	1.40	1.95
February	37.17	31.25	32.93	1.65	2.73
March	43.44	31.25	35.14	2.99	8.97
April	47.09	32.33	39.41	3.04	9.22
May	52.78	35.57	42.85	3.76	14.12
June	62.74	41.36	49.82	4.74	22.46
July	65.96	47.61	57.37	4.55	20.67
August	64.35	47.09	56.36	3.61	13.05
September	59.04	40.32	49.81	3.89	15.12
October	49.68	37.17	43.79	2.96	8.76

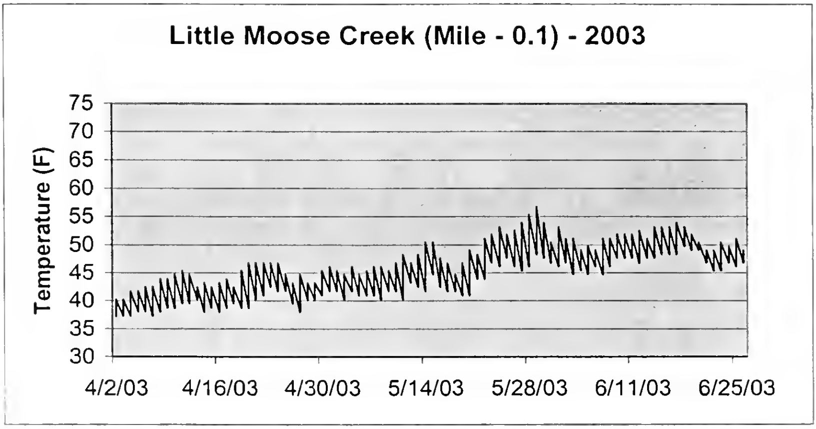


Hogum Creek (Mile - 0.4) - 2003

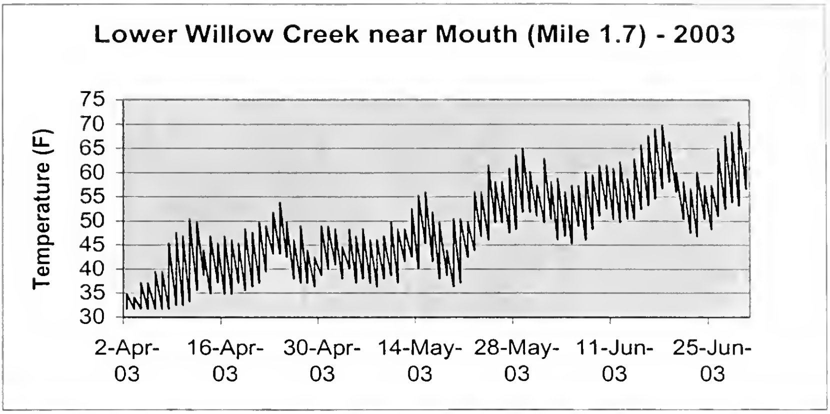
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	43.92	30.91	35.05	3.60	12.93
May	56.66	34.10	42.37	4.91	24.07
June	62.17	40.97	51.15	4.56	20.84



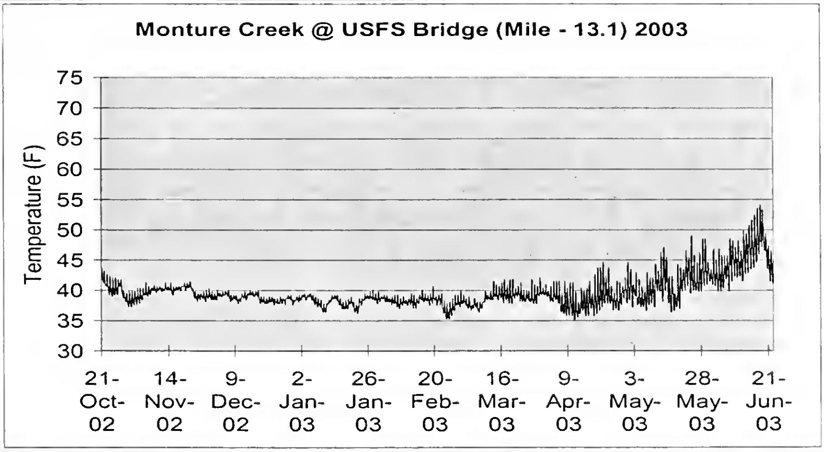
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	57.34	45.35	50.60	3.24	10.53
August	57.34	47.58	51.19	2.48	6.15
September	55.39	47.03	50.23	2.01	4.04
October	53.16	46.19	48.93	1.71	2.91



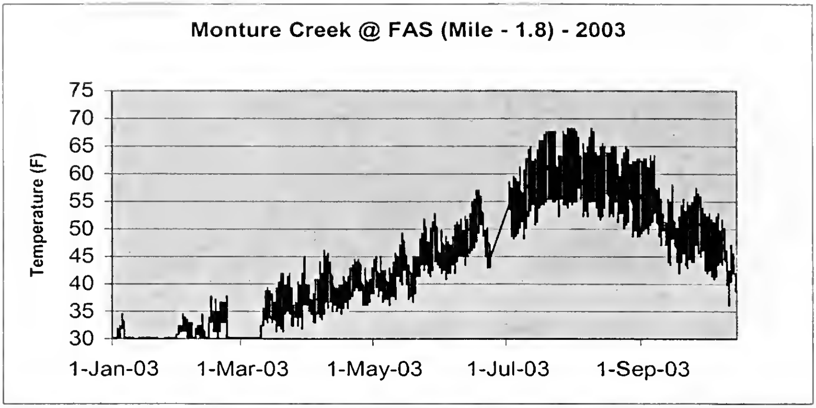
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	46.80	37.20	41.30	2.21	4.89
May	56.70	40.20	45.74	3.53	12.44
June	53.90	44.70	48.95	1.97	3.88


Lower Willow Creek near Mouth (Mile 1.7) - 2003

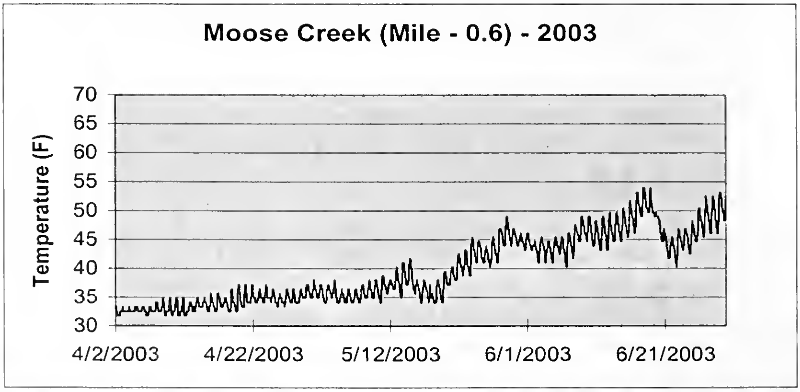
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	53.89	31.72	40.39	5.40	29.18
May	64.91	36.43	47.20	6.45	41.62
June	70.39	45.38	56.46	5.33	28.40


Monture Creek @ USFS Bridge (Mile - 13.1) 2003

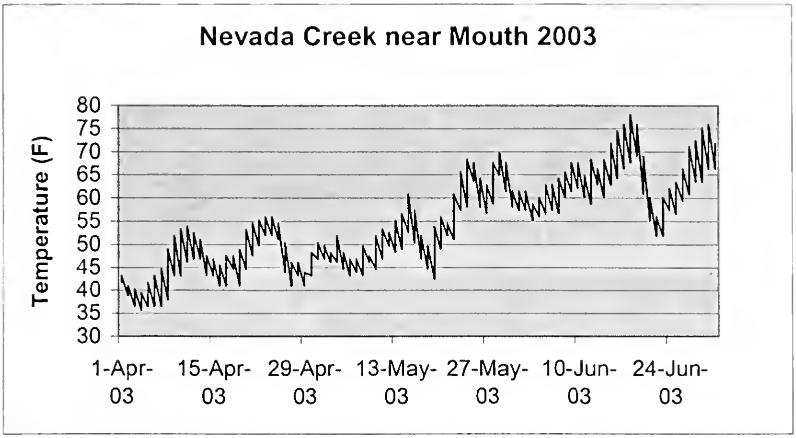
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	40.09	36.11	38.23	0.77	0.60
February	40.65	35.24	38.06	0.86	0.74
March	42.06	36.39	38.82	1.10	1.21
April	44.59	34.96	38.62	1.82	3.32
May	49.05	36.39	41.00	2.56	6.57
June	54.09	39.81	45.24	3.11	9.67
October	43.75	37.26	40.23	1.41	1.98
November	41.50	37.26	39.71	0.87	0.75
December	40.09	37.54	38.75	0.57	0.32


Monture Creek @ FAS (Mile - 1.8) - 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	34.49	29.61	30.03	0.78	0.61
February	37.69	29.61	31.69	1.89	3.57
March	45.01	29.61	34.09	3.49	12.17
April	46.05	32.87	38.84	2.75	7.58
May	52.79	36.10	42.84	3.48	12.12
June	56.97	40.85	47.98	3.62	13.10
July	68.16	48.14	58.31	4.76	22.66
August	68.16	48.66	58.33	4.34	18.82
September	63.30	41.89	51.39	4.64	21.51
October	52.79	36.10	45.34	3.83	14.66

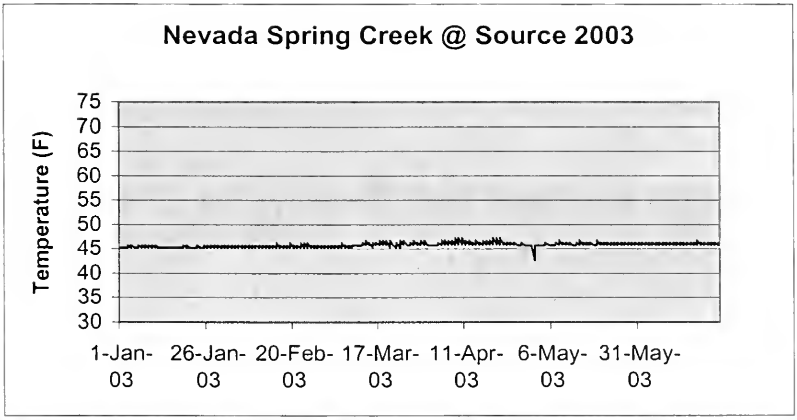

Moose Creek (Mile - 0.6) - 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	37.20	31.72	33.86	1.37	1.87
May	48.96	34.10	38.54	3.75	14.09
June	53.89	40.23	46.39	2.97	8.79



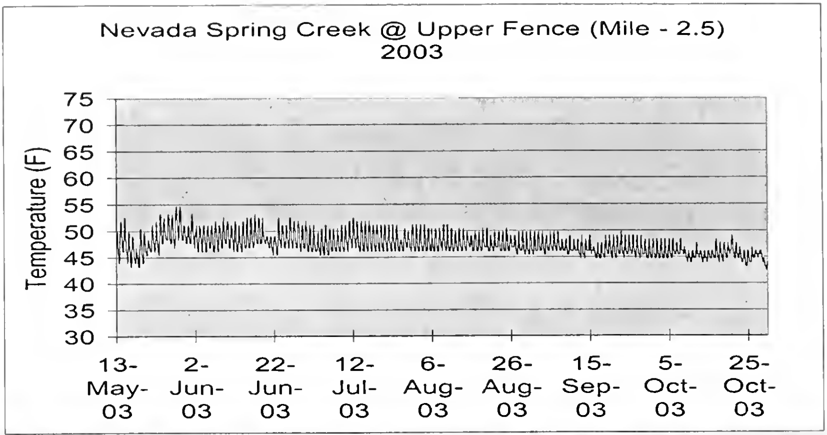
Nevada Creek near Mouth 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	55.97	35.66	45.80	5.05	25.53
May	69.71	42.46	53.43	7.05	49.73
June	78.01	51.79	63.40	5.56	30.90
July	71.77	66.28	68.68	1.97	3.90

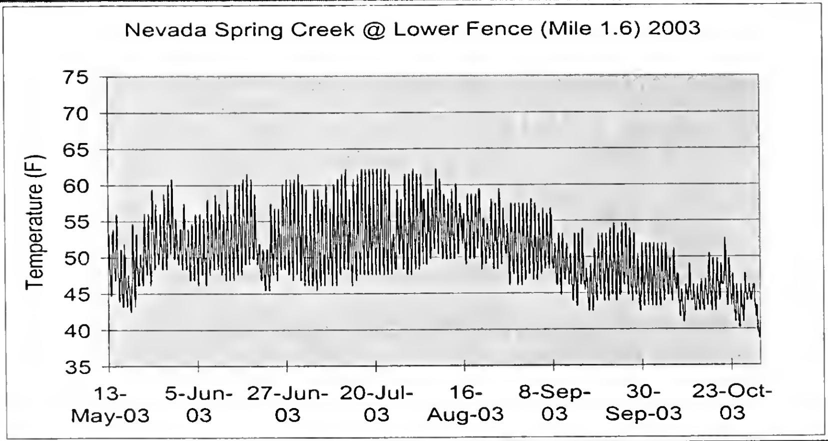


Nevada Spring Creek @ Source 2003

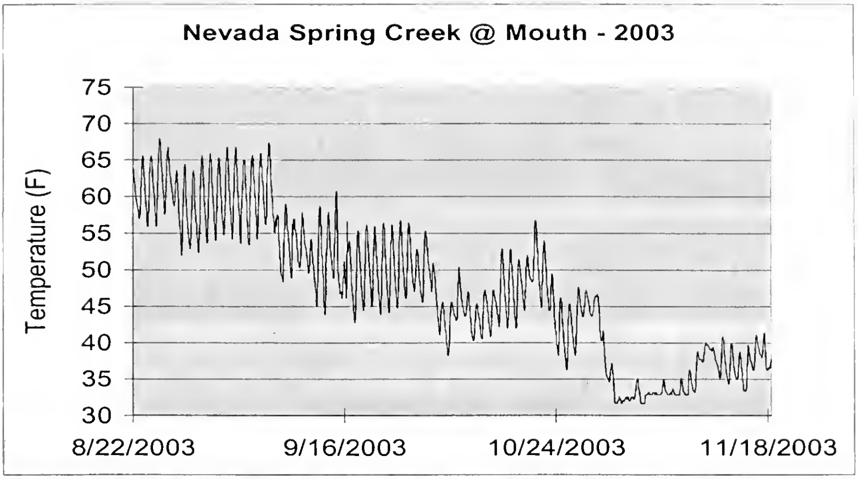
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
January	45.74	45.22	45.25	0.13	0.02
February	46.26	45.22	45.39	0.26	0.07
March	46.78	45.22	45.70	0.30	0.09
April	47.30	45.74	45.84	0.29	0.08
May	46.78	42.62	45.80	0.21	0.05
June	46.78	45.74	45.84	0.21	0.04


Nevada Spring Creek @ Upper Fence (Mile - 2.5) 2003

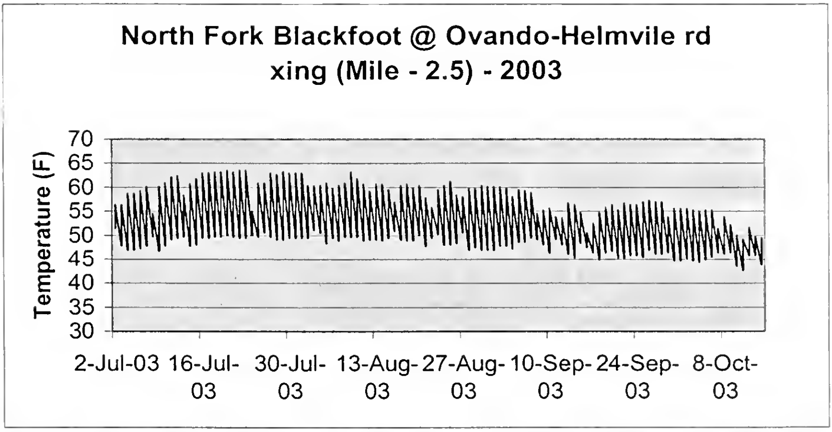
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
May	54.60	43.20	48.37	2.59	6.71
June	53.20	45.40	48.82	1.77	3.14
July	52.50	45.40	48.09	1.78	3.16
August	51.10	45.40	47.54	1.39	1.93
September	49.70	44.70	46.62	1.26	1.60
October	49.00	42.50	45.45	1.13	1.29


Nevada Spring Creek @ Lower Fence (Mile 1.6) 2003

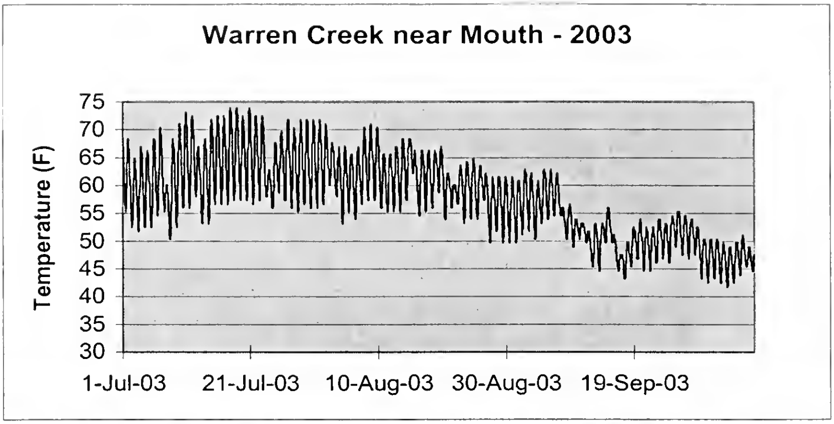
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
May	60.80	42.50	50.40	4.05	16.43
June	61.50	45.40	52.03	3.94	15.50
July	62.20	45.40	53.16	4.80	23.07
August	62.20	46.10	53.59	3.44	11.80
September	58.00	42.50	49.10	3.50	12.27
October	52.50	38.70	45.39	2.70	7.27


Nevada Spring Creek @ Mouth - 2003

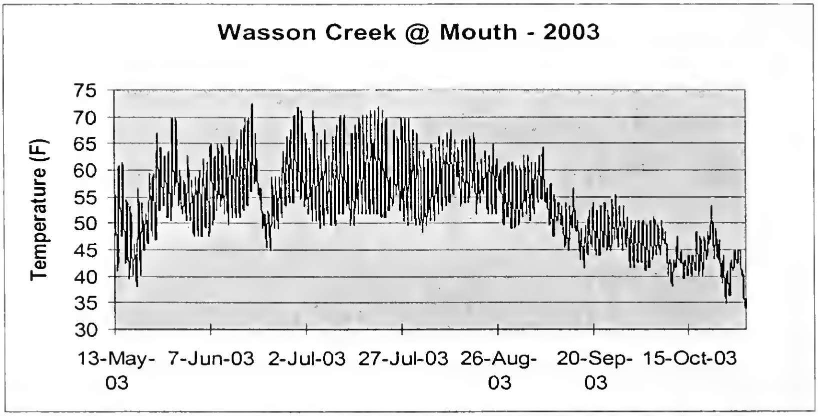
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
August	67.93	51.99	60.23	3.84	14.72
September	67.35	42.76	55.48	5.71	32.64
October	56.76	31.66	45.83	5.35	28.65
November	41.39	31.66	35.41	2.70	7.28


North Fork Blackfoot @ Ovando-Helmvile rd xing (Mile - 2.5) - 2003

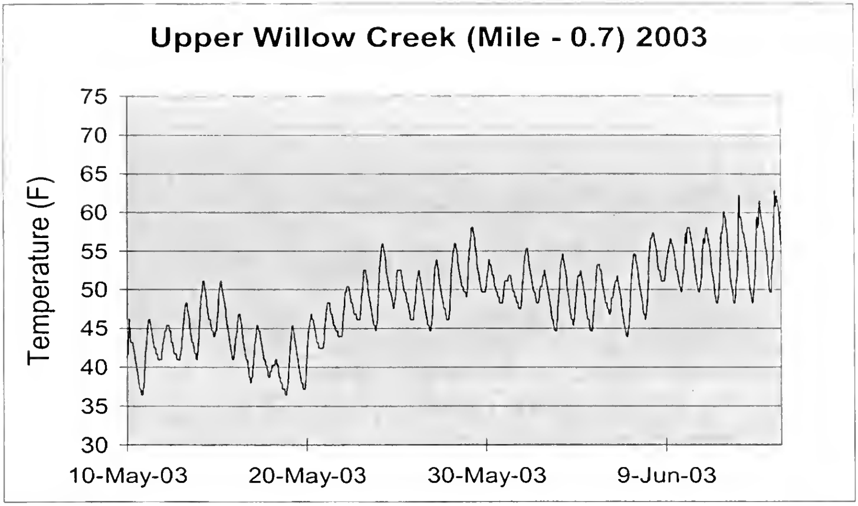
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	63.47	46.60	54.30	4.45	19.81
August	63.18	46.87	53.50	3.91	15.28
September	60.03	44.64	50.56	3.57	12.77
October	55.53	42.67	48.08	3.10	9.60



Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	73.84	50.38	63.03	5.70	32.51
August	71.77	49.67	61.14	4.58	20.96
September	62.85	43.19	52.24	4.39	19.24
October	51.08	41.72	46.84	2.41	5.83

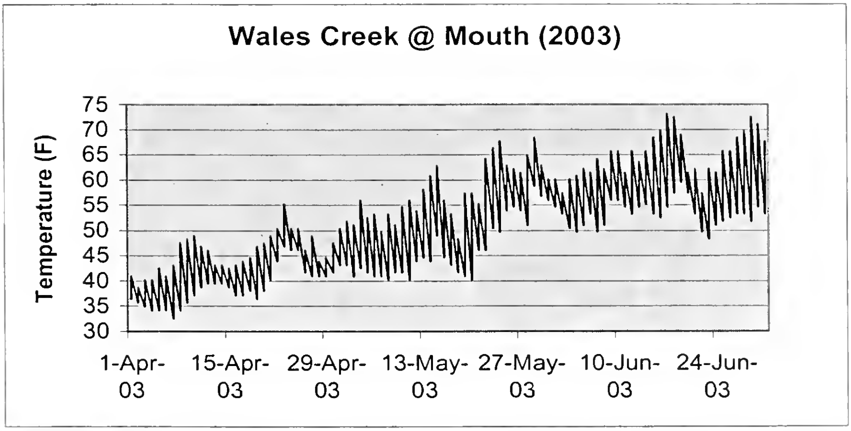


Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
May	69.7	38	52.8	7	49.1
June	72.5	44.7	56.8	5.5	30.4
July	71.8	49	58.8	6.1	36.7
August	67.7	48.3	57.5	4.5	20.3
September	64.2	41.7	50.9	4.7	21.7
October	53.2	34.1	43.8	3.5	12.1



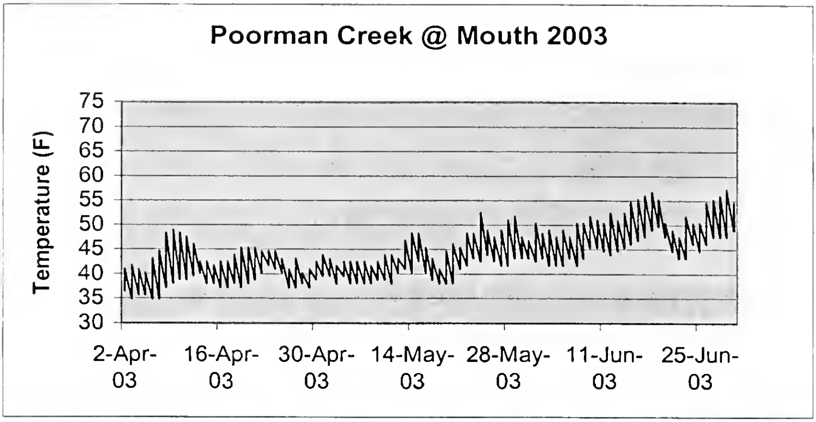
Upper Willow Creek (Mile - 0.7) 2003

Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
May	58.04	36.43	46.25	4.71	22.15
June	62.85	43.92	51.95	4.08	16.61

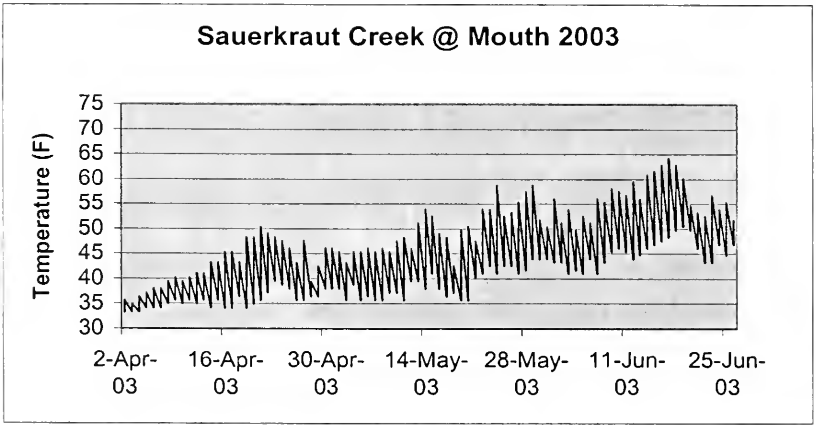


Wales Creek @ Mouth (2003)

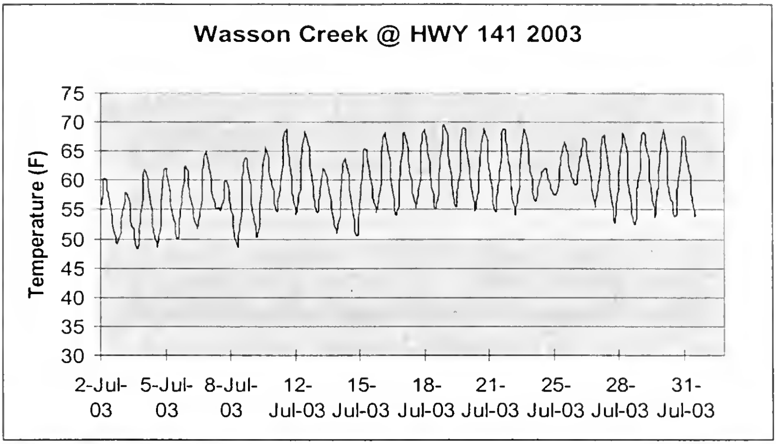
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	55.28	32.52	41.35	4.29	18.37
May	68.33	40.23	50.93	6.60	43.53
June	73.15	48.25	58.32	5.07	25.70
July	67.65	53.19	57.87	4.39	19.30



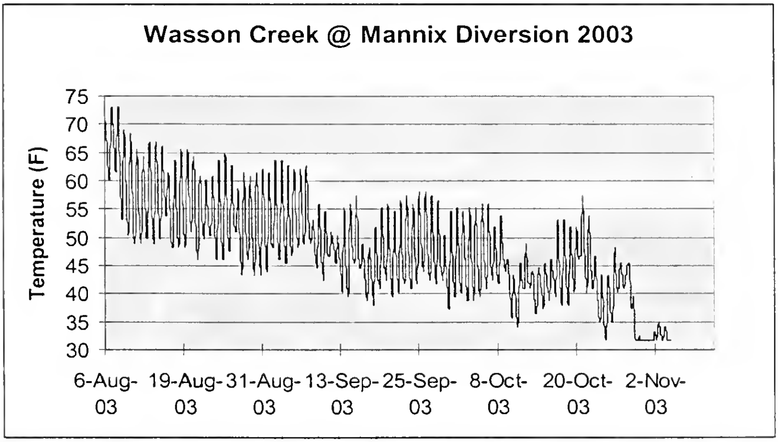
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	48.96	34.88	40.61	2.68	7.17
May	52.49	37.97	42.89	3.13	9.77
June	57.35	41.72	48.36	3.40	11.54



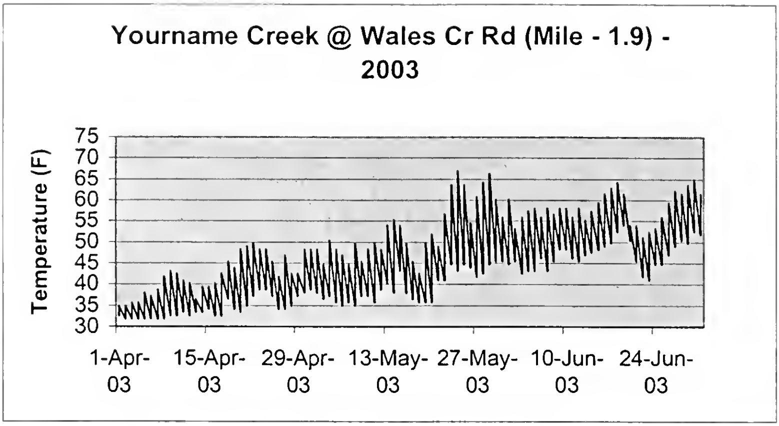
Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	50.40	33.30	38.62	3.79	14.37
May	58.70	35.70	43.73	5.12	26.21
June	64.20	41.00	50.27	4.97	24.67



Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
July	69.6	48.3	59.6	5.12	26.3

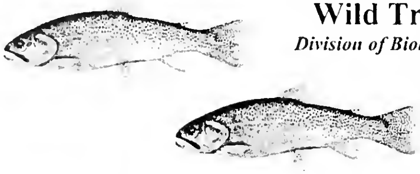


Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
August	73.2	43.2	56.4	6.8	46.4
September	63.5	37.2	48.9	5.8	33.2
October	57.4	31.7	42.9	5.7	32.8
November	34.9	31.7	32.5	1	0.99



Month	Max Temp	Min Temp	Avg Temp	StDev Temp	Var Temp
April	49.67	31.72	37.31	4.18	17.50
May	66.96	34.88	45.10	6.68	44.61
June	64.91	40.97	52.06	5.08	25.84
July	61.48	51.79	55.64	3.01	9.08

Exhibit J. Westslope cutthroat trout genetic sampling sites and results



Wild Trout and Salmon Genetics Laboratory
*Division of Biological Sciences * University of Montana * Missoula, MT 59812*
(406) 243-5503/6749   Fax (406) 243-4184

February 10, 2004

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 submitted by yourself and Ron Pierce, under the Montana Fish, Wildlife and Parks budget for Region 2:

Table 1. Summary of results

Sample #	Site Name, Collection Date, Biologist Location	N[a]	markers[b]		Population ID[c]	Power (%)[d]		% Westslope[e]	Individuals[f]
			YSCT	RBT		YSCT	RBT		
	Blackfoot Telemetry Samples November 2002 Pierce	15	-	-	--	-	-	--	12
	Deep Creek (Missoula) Sept. 2000 Knotek	24	4	7	WSCT X RBT	85	97	95.2	6
	Dunham Creek August 2002 Pierce	30	4	7	WSCT	91	99	100.0	0
	Rock Creek (Missoula) Sept. 2000 Knotek	25	4	7	WSCT	87	97	100.0	0
	Second Creek June 2000 Knotek	27	4	7	WSCT	89	98	100.0	0
	Smith Creek August 2002 Pierce	28	4	7	WSCT X RBT	89	98	99.0	1
	Spring Creek (N. Fork) August 2002 Pierce	27	4	7	WSCT X RBT	89	98	86.8	11
	Twelvemile Creek July 2000 Knotek	15	4	7	WSCT X RBT	70	88	97.3	1
	Washoe Creek August 2002 Knotek	28	4	7	WSCT X RBT	89	98	98.8	4
	Blanchard Creek September 2003 Pierce	27	4	7	WSCT X RBT	89	98	79.7	17

Dick Creek September 2003 Pierce	27	4	7	WSCT	89	98	100.0	0
Little Fish Creek September 2003 Pierce	27	4	7	WSCT	89	98	100.0	0
Monture Creek September 2003 Pierce	27	4	7	WSCT X RBT	89	98	94.0	4
Shanley Creek September 2003 Pierce	27	4	7	WSCT X RBT	89	98	99.0	1

[a] Number of samples successfully 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:

Blackfoot River Telemetry 2002: The original letter that we received regarding these samples indicated that there were going to be twenty-five sent to us, but we only received fifteen. All fifteen successfully amplified individuals in this sample displayed PINE fragments diagnostic of westslope cutthroat trout.

- Three of these individuals only displayed PINE fragments diagnostic of westslope cutthroat trout.
    - Individual #: 8, 9, 11
- Twelve individuals also displayed PINE fragments diagnostic of rainbow trout.
    - Eleven of these individuals appear to be post first generation hybrids. Individual #: 1, 2, 3, 4, 5, 6, 7, 10, 12, 13, 15
    - Individual 14 appears to be a first generation hybrid.

Due to the random reshuffling of alleles during sexual reproduction and the limited number of diagnostic markers we use, we cannot be sure that the individuals displaying only westslope cutthroat PINE fragments did not come from a hybrid population or that they are truly "pure." As a main stem sample, this analysis does not represent a single population, and further analysis is not possible.

The original letter also asked us to provide hybridization information for each individual fish, labeled with a four-digit code that corresponded to a transmitter number. The samples we received were only labeled with a two-digit code that we kept through out the analysis.

Deep Creek: All twenty-four successfully amplified individuals in this sample displayed PINE fragments diagnostic of Westslope cutthroat trout. Six individuals also displayed PINE fragments diagnostic of rainbow trout. With a sample size of twenty-four, we have a 97 % chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-four, we have an 85% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Dunham Creek: All thirty successfully amplified individuals in this sample displayed only PINE fragments diagnostic of Westslope cutthroat trout. With a sample size of thirty, we have a 99 % chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of thirty, we have a 91% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Rock Creek: All twenty-five successfully amplified individuals in this sample displayed only PINE fragments diagnostic of Westslope cutthroat trout. With a sample size of twenty-five, we have a 97 % chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-five, we have an 87% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Second Creek: All twenty-seven successfully amplified individuals in this sample displayed only PINE fragments diagnostic of Westslope cutthroat trout. With a sample size of twenty-seven, we have a 98 % chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-seven, we have an 89% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Smith Creek: All twenty-eight successfully amplified individuals in this sample displayed PINE fragments diagnostic of Westslope cutthroat trout. One individual also displayed PINE fragments diagnostic of rainbow trout. With a sample size of twenty-eight, we have a 98 % chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-eight, we have an 87% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Spring Creek: All twenty-seven successfully amplified individuals in this sample displayed PINE fragments diagnostic of Westslope cutthroat trout. Eleven individuals also displayed PINE fragments diagnostic of rainbow trout. With a sample size of twenty-seven, we have a 98% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-seven, we have an 89% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Twelvemile Creek: All fifteen successfully amplified individuals in this sample displayed PINE fragments diagnostic of Westslope cutthroat trout. One individual also displayed PINE fragments diagnostic of rainbow trout. With a sample size of fifteen, we have an 88% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of fifteen, we have a 70% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Washoe Creek: All twenty-eight successfully amplified individuals in this sample displayed PINE fragments diagnostic of Westslope cutthroat trout. Four individuals also displayed PINE fragments diagnostic of rainbow trout. With a sample size of twenty-eight, we have a 98% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-eight, we have an 89% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Blanchard Creek: All twenty-seven successfully amplified individuals in this sample displayed PINE fragments diagnostic of Westslope cutthroat trout. Seventeen individuals also displayed PINE fragments diagnostic of rainbow trout. With a sample size of twenty-seven, we have a 98% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-seven, we have an 89% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Dick Creek: All twenty-seven successfully amplified individuals in this sample displayed only PINE fragments diagnostic of Westslope cutthroat trout. With a sample size of twenty-seven, we have a 98% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-seven, we have an 89% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Little Fish Creek: All twenty-seven successfully amplified individuals in this sample displayed only PINE fragments diagnostic of Westslope cutthroat trout. With a sample size of twenty-seven, we have a 98% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-seven, we have an 89% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Monture Creek: All twenty-seven successfully amplified individuals in this sample displayed PINE fragments diagnostic of Westslope cutthroat trout. Four individuals also displayed PINE fragments diagnostic of rainbow trout. With a sample size of twenty-seven, we have a 98% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-seven, we have an 89% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Shanley Creek: All twenty-seven successfully amplified individuals in this sample displayed PINE fragments diagnostic of Westslope cutthroat trout. One individual also displayed PINE fragments diagnostic of rainbow trout. With a sample size of twenty-seven, we have a 98% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-seven, we have an 89% chance of detecting as little as 1% hybridization between Yellowstone cutthroat trout and westslope cutthroat trout.

Sincerely,

Aaron E. Martin

Cc: Ron Pierce (electronic copy)

Wild Trout and Salmon Genetics Laboratory
*Division of Biological Sciences * University of Montana * Missoula, MT 59812*
(406)243-5503/6749 Fax (406)243-4184

March 17, 2003

LADD KNOTEK
Genetics Contact, Region 2
MT Fish, Wildlife, and Parks
3201 Spurgin Rd
Missoula, MT 59801

Dear LADD:

We have completed analysis of the following samples:

Table 1. Summary of results.

Sample	Water Name/Location/Collection Date/ Collector	N[a]	# markers[b]	Species ID[c]	Power (%)[d]	% WCT[e]	Individuals[f]
2273	**Chimney Creek** 12N12W24 7/11/00 LADD KNOTEK	9	6	WCT	66	100	
2279	**Twelvemile Creek** 19N28W23 7/21/00 LADD KNOTEK	17	6	WCT X RBT	87	95.3	
2312	**Skalkaho Cr, Ward Ditch** 05N20W16 9/10/02 CHRIS CLANCY	25	6	WCT X RBT	95	98.7	2

[a] Number of samples successfully analyzed (average, as 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 sample size and 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).
[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 random 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.
Note: For further details on each sample, 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 (F_2+) 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. However, in order to provide comparative values, we have assumed the samples conform to Hardy-Weinberg expectations in order to estimate the average genetic contribution from each species.

It is critical to note that in all hybrid swarms, regardless of the percent contribution from the non-native species, 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).

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:

Chimney Creek: A total of nine of eleven samples amplified from this sample. All nine individuals displayed only PINE fragments diagnostic of westslope cutthroat trout. With a sample size of nine individuals, we have a 66% chance of detecting as little as 1% hybridization between westslope cutthroat and rainbow trout. A larger sample size is necessary for a more accurate analysis.

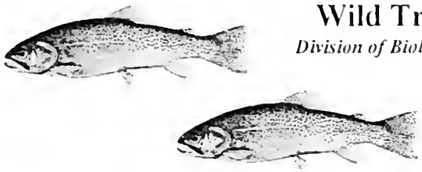
Twelvemile Creek: A total of seventeen of thirty samples amplified at all three primer pairs. All individuals displayed PINE fragments diagnostic of westslope cutthroat trout. Five individuals also displayed PINE fragments diagnostic of rainbow trout. The majority of individuals were re-extracted without success. With a sample size of seventeen individuals, we have an 87% chance of detecting as little as 1% hybridization between westslope and rainbow trout. The successfully amplified individuals that displayed PINE fragments diagnostic of rainbow trout and their corresponding site number follows: Sample#(Site#) 2(4), 3(4), 4(4), 9(5), 23(7)

Skalkaho Creek: All twenty-five successfully amplified individuals in this sample displayed PINE fragments diagnostic of westslope cutthroat trout. Two individuals also displayed PINE fragments diagnostic of rainbow trout. With a sample size of twenty-five individuals, we have a 95% chance of detecting as little as 1% hybridization between westslope cutthroat and rainbow trout.

Main Stem Clark Fork: The results of the telemetry analysis are attached to this report.

Sincerely,

Margaret K. Cook



Wild Trout and Salmon Genetics Laboratory
*Division of Biological Sciences * University of Montana * Missoula, MT 59812*
(406)243-5503/6749 Fax (406)243-4184

March 14, 2003

Ron Pierce
R-2 Headquarters
3201 Spurgin Road
Missoula, MT 59804

Ron:

We have completed analysis of the following samples:

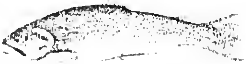
	Code
Reach 1 (n=7): North Fork to Nevada Creek	17-21 through 17-30
Reach 2 (n=9): Nevada Creek to Arrastra Creek	18-11 through 18-20
Reach 3 (n=9): Arrastra Creek to Lincoln	19-01 through 19-09

Each individual from the above samples showed only PINE fragments diagnostic of westslope cutthroat trout. None of the twenty-five individuals exhibited markers characteristic of rainbow trout. We cannot be sure, however that these individuals did not come from a hybrid population. Due to random reshuffling of alleles during sexual reproduction, many hybrid individuals could appear "pure" because of the limited number of marker loci used.

Sincerely,

Margaret K Cook

Margaret K. Cook



Wild Trout and Salmon Genetics Laboratory
*Division of Biological Sciences * University of Montana * Missoula, MT 59812*
(406)243-5503/6749 Fax (406)243-4184

June 18, 2003

LADD KNOTEK
Genetics Contact, Region 2
MT Fish, Wildlife, and Parks
3201 Spurgin Rd
Missoula, MT 59801

Dear LADD:

We have completed analysis of the following samples:

Table 1. Summary of results.

Sample	Water Name/Location/Collection Date/ Collector	N[a]	# markers[b]	Species ID[c]	Power (%)[d]	% WCT[e]	Individuals[f]
2272	**Slowey Gulch** 18N26W30 7/16/02 LADD KNOTEK	23	6	WCT	94	100	
2274	**Spring Creek** —Douglas 12N12W27 7/25/00 LADD KNOTEK	18	6	WCT	89	100	
2275	**Wilson Creek** 13N10W16 7/8/00 LADD KNOTEK	22	6	WCT	93	100	
2278	**Second Creek** 16N24W14 6/1/00 LADD KNOTEK	25	6	N/A	N/A	N/A	
2281	**Pattee Creek** 13N19W02 4/18/02 LADD KNOTEK	13	6	WCT	79	100	
2284	**Deep Creek** 16N25W25 5/22/00 LADD KNOTEK	25	6	WCT	95	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 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* characteristics at multiple regions of the nuclear DNA. This method produces DNA fragments that can be used to distinguish), 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 (Table 2), 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 these 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:

Slowey Gulch (2272): All twenty-three successfully amplified individuals in this sample displayed PINE fragments diagnostic of westslope cutthroat trout. No evidence of introgression with rainbow trout was detected. With a sample size of twenty-three, we have a 94% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-three, we have an 84% chance of detecting as little as 1% hybridization between Yellowstone and westslope cutthroat trout.

Spring Creek to Sturgeon Creek (2274): All eighteen successfully amplified individuals in this sample displayed only PINE fragments diagnostic of westslope cutthroat trout. With a sample size of eighteen, we have an 89% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of eighteen, we have a 76% chance of detecting as little as 1% hybridization between Yellowstone and westslope cutthroat trout. A larger sample size is necessary for a more accurate analysis.

Wilson Creek (2275): All twenty-two successfully amplified individuals in this sample displayed only PINE fragments diagnostic of westslope cutthroat trout. Three individuals failed to amplify at one primer pair. With a sample size of twenty-two, we have a 93% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-two, we have an 83% chance of detecting as little as 1% hybridization between Yellowstone and westslope cutthroat trout.

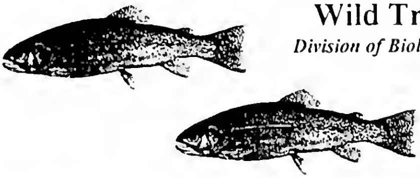
Second Creek (2278): This sample failed to amplify at two of the three primer pairs. The samples were rerun as motherlodes and still failed to amplify. This may be due to storage in bad ethanol (collected 6/2000).

Pattee Creek (2281): All thirteen successfully amplified individuals in this sample displayed PINE fragments diagnostic of westslope cutthroat trout. No evidence of introgression with rainbow trout was detected. With a sample size of thirteen, we have a 79% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of thirteen, we have a 65% chance of detecting as little as 1% hybridization between Yellowstone and westslope cutthroat trout. A larger sample size is necessary for a more accurate analysis.

Deep Creek near Superior (2284): All twenty-five successfully amplified individuals in this sample displayed only PINE fragments diagnostic of westslope cutthroat trout. With a sample size of twenty-five, we have a 95% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This sample was also tested for introgression with Yellowstone cutthroat trout. No evidence of introgression was detected. With a sample size of twenty-five, we have an 87% chance of detecting as little as 1% hybridization between Yellowstone and westslope cutthroat trout.



Wild Trout and Salmon Genetics Laboratory
*Division of Biological Sciences * University of Montana * Missoula, MT 59812*
(406)243-5503/6749 Fax (406)243-4184

August 14,2002

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]		% WSCT[e]	Individuals[f]
			YSCT	RBT		YSCT	RBT		
	West Fork Bitterroot								
	Bitterroot River								
2259	T1S R22W Sec 23	14	3	4	WSCTxRBT	78	73	97.3	1
					WSCT				13
	Main Stem Bitterroot								
	Bitterroot River								
2254	T2N R21W Sec11	10	4	6	WSCTxRBT	55	70	-	1
	Butte Cabin Creek (9/25/01)								
2256	Rock Creek	9	4	6	WSCTxRBTxYSCT	52	66	53.3	9
	T9N R17E Sec20				BROWN				16
	Game Creek (6/22/00)								
2261	Union Creek	24	3	4	WSCTxRBT	76	85	98.7	
2263	T13N R16W Sec20 &30				WSCT				
	First Creek (7/7/01)								
2258	Middle Clark Fork	17	3	4	WSCT	64	75	100	
	T16N R25W Sec9/10								

2257	**Douglas Creek** (8/20/01) Flint Creek T9N R13W Sec23	24	4	6	WSCT	85	94	100	
2255	**Hogback Creek** (8/17/99) Rock Creek T8N R17W Sec25	19	4	6	WSCTxRBT WSCT	78	90	75	9 10
			Bull	**Brook**					
2030	**Grant Creek** (7/11/01) Middle Clark Fork T14N R19W Sec3,10,?	15	7	4	Bull/Brook Bull	88	70		4 11

[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*); Bull Trout (*Salvelinus confluentus*). 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 bull 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:

West Fork Bitterroot: All individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout. However, a single first generation (F_1) westslope cutthroat/rainbow trout hybrid was detected indicating that an extremely low level of hybridization has recently occurred. Assuming random mating proportions, the genetic contribution of westslope cutthroat trout and rainbow trout is 97.3% and 2.7%, respectively.

Main Stem Bitterroot: All individuals in this sample displayed all PINE fragments diagnostic of westslope cutthroat trout. One fish in this sample also exhibited a single diagnostic rainbow trout marker at 1 locus (telemetry code 40.442). The individual that appeared hybrid in this sample was a post-F1 hybrid, indicating that an extremely low level of hybridization has been occurring for generations.

Since this sample was collected from the main stem of the Bitterroot River, it is not valid to report genetic contributions of the component species at the population level, as it is likely that the individuals come from several different populations.

It is important to note that with the small sample size of this population, the accuracy of this estimate is limited until further data is available. Also, collection of samples from spawning tributaries can provide a better picture of the extent of hybridization within those streams, rather than individuals from a main stem stream.

Butte Cabin Creek: Only nine individuals in this sample displayed PINE fragments diagnostic of westslope cutthroat trout. These individuals also displayed characteristic Yellowstone cutthroat trout markers and rainbow markers. The remaining 16 displayed Brown trout PINE fragments.

Game Creek: All individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout. However, individuals 1-2 and 1-8 displayed a single Rainbow trout diagnostic marker at one locus. The presence of this marker in the sample could indicate hybridization with rainbow trout or alternatively it could be a rare westslope cutthroat trout variation. In this situation, we favor the latter since if the presence of this fragment was due to hybridization, then we usually expect to observe fragments at other diagnostic loci characteristic of rainbow trout in frequencies similar to the former. This, however, was not the case. With 24 individuals, we have an 85% chance of detecting 1% hybridization with rainbow trout. It is possible that this population may be hybridized with Rainbow trout. However, unless further data indicate otherwise, the conservative approach would be to treat the population as westslope cutthroat trout.

First Creek: All successfully analyzed individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout only. With a sample size of 18, we have a 76% chance of detecting 1% hybridization with rainbow trout using 4 markers. This sample appears to have come from a pure westslope population, but with the small sample size, we cannot reasonably conclude 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.

Douglas Creek: All 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. Unless further data indicate otherwise, it should be managed as a westslope cutthroat trout population.

Hogback Creek: All successfully analyzed individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout. However, nine of the 19 samples also displayed diagnostic rainbow markers. The individuals that appeared hybrid were all post-F_1 hybrids, indicating that hybridization has been occurring for generations. Assuming random mating proportions, the genetic contribution of westslope cutthroat trout and rainbow trout is 75% and 25%, respectively.

Grant Creek: Eleven out of the 15 samples in this collection exhibited alleles indicative of bull trout. Four of the 15 samples appeared to be bull/brook F_1 hybrids (samples 1,2,5, and 7). These four samples were all in site 6.

Sincerely,

Sara Somerville

Cc: Chris Clancy, Eric Reiland

Wild Trout and Salmon Genetics Laboratory
*Division of Biological Sciences * University of Montana * Missoula, MT 59812*
(406)243-5503/6749 Fax (406)243-4184

May 14, 2002

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 submitted under the Montana Fish, Wildlife and Parks budget for Region 2:

Table 1. Summary of results

Sample #	Site Name, Collection Date, Location	N[a]	markers[b]		Population ID[c]	Power (%)[d]		% Westslope[e]	Individuals[f]
			YSCT	RBT		YSCT	RBT		
2032	**Silver Creek** (7/14/01) St. Regis R. / Mid Clark Fk R. T18N R31W Sec14&22	**38**	4	6	WSCTxRBT	95	99	98*	
2037	**Deer Creek** (5/20/99) Fish Ck / Middle Clark Fk R. T13N R24 Sec7,9,10&8	**12**	3	4	WSCT	52	62	100*	
2033	**Siegel Creek** (6/20/00) Middle Clark Fk R R18N R25W Sec36	**18**	4	6	WSCT	76	89	100	
2046	**Wasson Creek** (7/18/00) Nevada Creek T13N R10W Sec8&9	**32**	3	4	WSCT	85	92	100*	
2047	**Union Creek** (6/5/00) Union Creek T12N R15W Sec3, T13N R16W Sec13&14	**16**	3	4	WSCTxRBT	62	72	92*	
2151	**Pattee Creek** (10/28/01) Middle Clark Fk R	10	4	6	WSCT	55	70	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.

[*]Longitudinal sample, 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:

Silver Creek: (longitudinal sample) All individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout *(Oncorhynchus clarki lewisi)*. However, three individuals from Section 1 also displayed diagnostic rainbow trout markers *(O. mykiss)*. The individuals that appeared hybrid were all post-F1 hybrids, indicating that hybridization has been occurring for generations. Assuming random mating proportions, the genetic contribution of westslope cutthroat trout and rainbow trout *at Site 1* is 93% and 7%, respectively. Samples taken from Sites 2 and 3 showed no evidence of hybridization. Assuming random mating proportions, genetic contributions of westslope cutthroat trout and rainbow trout averaged over all three sampling sites is 98% and 2%, respectively.

Deer Creek: (longitudinal sample)·All 12 successfully amplified individuals in this sample exhibited only fragments diagnostic of westslope cutthroat trout. With a sample size of 12, we have only a 62% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout using four PINE markers. Although we found no evidence of introgression, our confidence in our ability to detect introgression with rainbow trout is lower than if we had a full sample to analyze. Until further data indicate otherwise, the conservative approach would be to manage this as a pure westslope cutthroat trout population.

Siegel Creek: All 18 successfully amplified individuals in this sample exhibited only fragments diagnostic of westslope cutthroat trout. With a sample size of 18, we have an 89% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout using six PINE markers. Although we found no evidence of introgression, our confidence in our ability to detect introgression with rainbow trout is lower than if we had a full sample to analyze. Until further data indicate otherwise, the conservative approach would be to manage this as a pure westslope cutthroat trout population.

Wasson Creek: (longitudinal sample) All 32 successfully amplified individuals in this sample exhibited only fragments diagnostic of westslope cutthroat trout. With a sample size of 32, we have a 92% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout using four PINE markers. Although we found no evidence of introgression. our confidence in our ability to detect hybridization between westslope cutthroat trout and rainbow trout is lower than if we had been able to analyze the sample at all six rainbow marker loci. Until further data indicate otherwise, the conservative approach would be to manage this as a pure westslope cutthroat trout population.

Union Creek: (longitudinal sample) All 16 successfully amplified individuals in this sample exhibited fragments diagnostic of westslope cutthroat trout. Individuals from two of the three sampling sites (S2 and S4) contained hybrid individuals. The single individual from S3 failed to amplify. Assuming random mating proportions, the genetic contribution of westslope cutthroat trout and rainbow trout is 92% and 8%, respectively.

Pattee Creek: All 10 individuals in this sample exhibited only fragments diagnostic of westslope cutthroat trout. With a sample size of 10, we have only a 70% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout using six PINE markers. Although we found no evidence of introgression. our confidence in our ability to detect introgression with rainbow trout is lower than if we had a full sample to analyze. Until further data indicate otherwise, the conservative approach would be to manage this as a pure westslope cutthroat trout population.

Sincerely,

Marirose Spade

Cc: Steve Carson (email)

Wild Trout and Salmon Genetics Laboratory
*Division of Biological Sciences * University of Montana * Missoula, MT 59812*
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Ladd Knotek
Genetics Contact, Region 2
Montana Fish, Wildlife & Parks
3201 Spurgin Road
Missoula, MT 59801

Ladd:

We have completed the 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]	Individual
			YSCT	RBT		YSCT	RBT		
	Bitterroot River								
2307	T8N R20W S17	10				-	N/A	N/A	-
	Rattlesnake Creek								
2271		23	4	6	WSCTx RBT	-	94	60.8	-
	Fish Creek Blackfoot River								
2277	T14N R14W S35C,27D,28A	25	4	6	WSCTx RBT	-	95	98	-
	Cottonwood Creek Blackfoot River								
2276	T16N R14W S24A	24	4	6	WSCT	-	94	100	-
	Sevenmile Creek Middle Clark Fork								
2285	T19N 27W S34, S27	26	4	6	WSCT	-	96	100	

[a] Number of samples analyzed; 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).

[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 random 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 (F_2+) 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. However, in order to provide comparative values, we have assumed the samples conform to random mating expectations in order to estimate the average genetic contribution from each species.

It is critical to note that in all hybrid swarms, regardless of the percent contribution from the non-native species, 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).

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:

Bitterroot River: Four individuals in this sample exhibit PINE fragments diagnostic of only westslope cutthroat trout. One individual displays PINE fragments characteristic of an F1 hybrid of westslope cutthroat trout and rainbow trout. Five individuals were post-F1 hybrids of westslope cutthroat trout and rainbow trout. As a main stem sample, this does not represent a single population, and further analysis is not possible.

Rattlesnake Creek: All 23 successfully amplified individuals in this population displayed PINE fragments diagnostic of westslope cutthroat trout and rainbow trout. Assuming random mating proportions, the genetic contributions of westslope cutthroat and rainbow trout are 60.8% and 39.2%, respectively. With a sample size of 23, we have a 94% chance of detecting as little as 1% hybridization between westslope cutthroat and rainbow trout.

This population was also tested for introgression with Yellowstone cutthroat trout. No evidence of Yellowstone cutthroat trout introgression was found. With a sample size of 23, we have an 84% chance of detecting as little as 1% hybridization.

Fish Creek: All 25 successfully amplified individuals in this population displayed PINE fragments diagnostic of westslope cutthroat trout. However, three fish also exhibited characteristic rainbow trout markers. Assuming random mating proportions, the genetic contributions of westslope cutthroat and rainbow trout are 98% and 2%, respectively. With a sample size of 25 individuals, we have a 95% chance of detecting as little as 1% hybridization between westslope cutthroat trout and rainbow trout.

This population was also tested for introgression with Yellowstone cutthroat trout. No evidence of Yellowstone cutthroat trout introgression was found. With a sample size of 25, we have an 87% chance of detecting as little as 1% hybridization. Without a larger sample size, we cannot exclude the possibility that this population may also be slightly hybridized with Yellowstone cutthroat trout.

Cottonwood Creek: All 24 successfully amplified individuals in this population displayed only PINE fragments diagnostic of westslope cutthroat trout. With a sample size of 24 individuals, we have a 94% chance of detecting as little as 1% hybridization with rainbow trout and an 85% chance of detecting as little as 1% hybridization with Yellowstone cutthroat trout. This sample appears to have come from a pure westslope population, but we cannot reasonably exclude that it might be hybridized with either rainbow or Yellowstone cutthroat trout. With a larger sample size, a more accurate analysis is possible.

Sevenmile Creek: All 26 successfully amplified individuals in this population displayed only PINE fragments diagnostic of westslope cutthroat trout. With a sample size of 24 individuals, we have a 96% chance of detecting as little as 1% hybridization with rainbow trout and an 88% chance of detecting as little as 1% hybridization with Yellowstone cutthroat trout.

Sincerely,

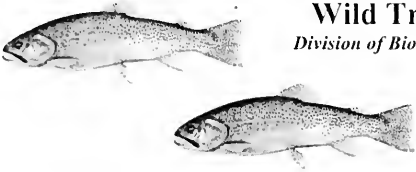
Margaret K Cook

Margaret K. Cook

Cc: Steve Carson (electronic version)

Table 2. Samples and allele frequencies

Locus		2271 Rattlesnake Cr.	2277 Fish Cr.	2276 Cottonwood Cr.	2285 Sevenmile Cr.
HpaI 5'/HpaI 3' 70 (RB)	*a*	0.551	0.960	1.000	1.000
	p	0.449	0.040	0.000	0.000
HpaI 5'/HpaI 3' 66 (RB)	*a*	0.551	1.000	1.000	1.000
	p	0.449	0.000	0.000	0.000
HpaI 5'/HpaI 3' 252 (YS)	*a*	1.000	1.000	1.000	1.000
	p	0.000	0.000	0.000	0.000
FokI 5'/TcI 369 (RB)	*a*	0.540	0.980	1.000	1.000
	p	0.460	0.020	0.000	0.000
FokI 5'/TcI 230 (RB)	*a*	0.890	0.980	1.000	1.000
	p	0.110	0.020	0.000	0.000
FokI 5'/TcI 159 (YS)	*a*	1.000	1.000	1.000	1.000
	p	0.000	0.000	0.000	0.000
FokI 5'/TcI 138 (YS)	*a*	1.000	1.000	1.000	1.000
	p	0.000	0.000	0.000	0.000
HpaI 5'/33.6+2 395 (RB)	*a*	0.540	0.980	1.000	1.000
	p	0.460	0.020	0.000	0.000
HpaI 5'/33.6+2 266 (RB)	*a*	0.577	1.000	1.000	1.000
	p	0.423	0.000	0.000	0.000
HpaI 5'/33.6+2 248 (YS)	*a*	1.000	1.000	1.000	1.000
	p	0.000	0.000	0.000	0.000
Average rainbow		**0.392**	**0.020**	**0.000**	**0.000**
Average Yellowstone		**0**	**0**	**0.000**	**0**
Average westslope		**0.608**	**0.980**	**1.000**	**1.000**



Wild Trout and Salmon Genetics Laboratory

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(406) 243-5503/6749   Fax (406) 243-4184

March 23, 2004

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

Ron:

We have completed analysis of the following samples submitted by yourself and Ron Pierce, under the Montana Fish, Wildlife and Parks budget for Region 2:

Table 1. Summary of results

Sample #	Site Name, Collection Date, Biologist Location	N[a]	markers[b] YSCT	markers[b] RBT	Population ID[c]	Power (%)[d] YSCT	Power (%)[d] RBT	% Westslope[e]	Individuals[f]
2003	Blackfoot Telemetry Samples 06/16/03 Pierce	20	4	7	WSCTxRBT	-	-	99.3% (Pooled)	2 } Confirme Hybrids

[a] Number of samples successfully 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.

<u>Sample Details</u>:

Blackfoot River Telemetry 2003: All twenty successfully amplified individuals in this sample displayed PINE fragments diagnostic of westslope cutthroat trout.

- Eighteen of these individuals displayed only PINE fragments diagnostic of westslope cutthroat trout.
    - Sample #: 17-21, 17-28, 17-43, 17-44, 17-45, 18-16, 18-50, 18-51, 18-52, 18-53, 18-55, 18-56, 19-06, 19-07, 19-61, 19-62,19-64 and 19-65.
- Two individuals also displayed PINE fragments diagnostic of rainbow trout.
    - Sample # 17-22 and 17-41 each showed that they are post-first generation hybridized fish. Both of these fish came from designated *Reach 1 (North Fork to Nevada Creek, n=7).*

Due to the random reshuffling of alleles during sexual reproduction and the limited number of diagnostic markers we use, we cannot be sure that the individuals displaying only westslope cutthroat PINE fragments did not come from a hybrid population or that they are truly "pure." As a main stem sample, this analysis does not represent a single population, and further analysis is not possible.

The original letter also asked us to provide hybridization information for each individual fish, labeled with a four-digit code that corresponded to a transmitter number. This numbers was kept throughout the analysis. I have attached a hybridization matrix of your samples along with this summary report.

Please call the lab if you have any questions.

Sincerely,

Aaron E. Martin

Cc: Ladd Knotek (electronic copy)

R2 Blackfoot River Telemetry 2003					N = 20															
					INDIVIDUAL															
	17-21	17-22	17-28	17-41	17-43	17-44	17-45	18-16	18-50	18-51	18-52	18-53	18-55	18-56	19-06	19-07	19-61	19-62	19-64	19-65
232 YCT																				
153 WCT	1	1	1	1	1	1	*	1	1	1	1	1	1	1	1	1	1	1	1	1
110.5 RBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72 WCT, YCT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
70 RBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69 WCT, YCT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
66 RBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17-21	17-22	17-28	17-41	17-43	17-44	17-45	18-16	18-50	18-51	18-52	18-53	18-55	18-56	19-06	19-07	19-61	19-62	19-64	19-65
369 RBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
366 WCT, YCT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
230 RBT	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
159 YCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
138 YCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110 WCT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	17-21	17-22	17-28	17-41	17-43	17-44	17-45	18-16	18-50	18-51	18-52	18-53	18-55	18-56	19-06	19-07	19-61	19-62	19-64	19-65
395 RBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
388 WCT, YCT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
266 RBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
248 YCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
148 WCT, YCT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RBT?																				
WSCT?	yes		yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
F1?		no		no																

Hybrids

Hybrid

Exhibit K. Angler Pressure Estimates for the Blackfoot River 1989-2001

Angler pressure estimates for resident anglers (1989-2001)

Year	Reach1	Reach 2	Reach 3	Total
‘89	8689	2054	2732	13475
’91	9789		4186	17695
’93	14006	7951	4744	21131
’95	10964	10020	3972	26774
’97	11555	8939	5128	25621
’99	16791	10399	5213	32375
‘01	10405	11626	3080	24916

Angler pressure estimates for non-resident anglers (1989-2001)

Year	Reach1	Reach 2	Reach 3	Total
‘89	1672	460	622	2754
’91	1239	655	454	2348
’93	3394	3258	826	7478
’95	5555	3897	1818	9452
’97	3554	2980	3190	9724
’99	5974	5682	2356	14012
‘01	2925	6253	1859	11343

Reach 1-Mouth to the Clearwater (34.7 river miles)
Reach 2-Clearwater to Arrastra (54.1 river miles)
Reach 3-Arrastra Creek to headwaters (43.2 river miles)
Note: 1997 was a high water year
2001 was a drought year with angler restrictions