Fisheries Monitoring in the Upper Clark Fork River Basin

2015 Report

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Montana Fish, Wildlife, and Parks

Table of Contents

Introduction

Decades of mining and mineral processing activities in the Butte and Anaconda areas have impacted the Upper Clark Fork River (UCFR) and altered its fishery. These alterations include changes in the fish species community and reduced trout numbers. As a result of these negative impacts, angling use of the Clark Fork River is lower than other streams in western Montana. Remediation and restoration activities, are ongoing and aim to mitigate historical mining and smelting damage to natural resources in the Upper Clark Fork River Basin (UCFRB).

The primary goal for aquatic restoration in mainstem Silver Bow Creek and the Upper Clark Fork River is to restore the fishery and angling resources to levels of similar rivers not impacted by mining contamination (Saffel et al. 2011; NRDP 2012a). To directly achieve this goal, remediation and restoration in the mainstem are being completed cooperatively by the Montana Department of Environmental Quality (DEQ) and the Natural Resource Damage Program (NRDP). Caged fish studies have been used to monitor baseline survival and metals concentrations of juvenile Brown Trout (*Salmo trutta)* prior to restoration (Cook et al. 2015). Restoration activities are underway on the UCFR, and caged fish studies are now being conducted to monitor for potential acute effects of construction activities themselves. Because these activities often involve removing vegetation and disturbing stream banks, these disturbances have the potential to temporarily increase inputs of metal laden sediments into the Clark Fork River.

Concurrent with mainstem restoration, the NRDP is directing restoration efforts on tributaries in the UCFRB. The goals of tributary restoration are to improve trout recruitment to the mainstem and offset mainstem fishery damage by improving native and recreational fisheries in tributaries. The NRDP recognized the need to monitor the effectiveness of tributary projects and the contribution of tributary restoration to the recovery of the mainstem fisheries (NRDP 2012a).

Because of the scale and scope of restoration efforts in the basin, fisheries monitoring will require building upon existing data collected through established sampling methods (i.e., fish population estimates) and new information on factors such as movement, recruitment, and population structure. Fisheries monitoring data was gathered sporadically in past decades. In 2009, Montana Fish, Wildlife and Parks (FWP) initiated a more extensive monitoring plan on the Upper Clark Fork River. This program included completing population estimates for the entire reach of the UCFR from Warm Springs Ponds to the mouth of Rock Creek. This effort replicated work completed by FWP in 1987 and provided new data to assess the current state of the Clark Fork River fishery. FWP biologists also used this data to establish long term monitoring sections that were representative of the Clark Fork River. FWP has completed population estimates in these reaches each of the subsequent years. Unlike the abundance data, data on the age structure of mainstem trout populations is just beginning to be gathered. These data can be used to determine growth and mortality rates, which are critical to understanding the population dynamics of mainstem populations.

Multiple tributaries have been identified as priorities for restoration in the UCFRB (Saffel et al., 2011). Data on species composition and distribution have been collected in multiple watersheds in the UCFRB (Lindstrom et al. 2008, Liermann et al. 2009). In addition, population estimate sections have been established in most of these priority tributaries in order to monitor changes in these fisheries as restoration efforts are implemented. However, the frequency and spatial resolution of these population surveys need to be comprehensive if restoration-induced changes are to be detected. Although information on trout abundance is valuable, this information does not account for the complexity of trout life histories. Freshwater salmonids tend to migrate between different habitats to complete requirements of different life stages. For instance, adults may move long distances to habitats that are suitable for spawning. Young fish that are produced may swim or drift to habitats that promote growth and survival during the first years of life. Successful spawning and the production and survival of juveniles (typically referred to as recruitment) will largely determine the abundance of adult trout in later years. Thus, knowing the location of important spawning and rearing habitats used by a salmonid population is critical to managing and restoring these populations.

A radio-tracking study indicated that Brown Trout in the Upper Clark Fork River make spawning related movements to both mainstem and tributary habitats (Mayfield 2013). However, just because a fish is in an area during spawning season does not guarantee that the fish will successfully spawn or that resulting offspring will survive to recruit to the fishery. Determining sources of recruitment requires that individual fish be assigned to these sources through genetics or other techniques such as hard part (bony tissue) microchemistry. Hard part microchemistry can determine the chemical signatures of a fish bony structure as those structures incorporate chemical changes in the fish's environment over a its lifetime. More specifically, this technique has been used in several studies to determine a fish's natal stream and to identify key migrations that occurred during a fish's life (Pracheil et al. 2014). One of the primary microchemistry markers used to assess freshwater fish migrations is strontium (Sr). Otolith strontium isotope (^{87}Sr:^{86}Sr) ratios and Sr/Ca ratios have been found to discriminate between habitats of interest because these chemical markers are directly related to the chemistry of the water in which fish are living (Clarke et al. 2007, Gibson-Reinemer et al. 2008).

To gather baseline fisheries data in the UCFRB, an intensive monitoring program funded by NRDP and DEQ and implemented by FWP was initiated in 2015. This program will be conducted for at least three years and has four objectives:

1) Describe baseline trout population abundances and species composition of fish communities in the Upper Clark Fork River and priority tributaries.
2) Determine growth and mortality rates of Brown Trout in the mainstem through aging of fin rays and otoliths.
3) Investigate the natal origins and sources of recruitment for Brown Trout in the mainstem Clark Fork River.
4) Monitor mortality and metals uptake of fish in cages upstream and downstream of reclamation sites in the Upper Clark Fork River as well as at the outflow of Pond 2.

Study Area

Silver Bow Creek originates from Blacktail Creek which flows from the continental divide north-east to the town of Butte. Silver Bow Creek flows through the town of Butte, downstream of which it is joined by two major tributaries, Browns Gulch and German Gulch. A fish barrier was constructed downstream of Durant Canyon to prevent non native Brown Trout and Rainbow Trout *Oncorhynchus mykiss)* from downstream of the barrier from negatively interacting with the genetically pure Westslope Cutthroat Trout *(Oncorhynchus clarkii lewisi)* upstream of the barrier. Silver Bow Creek flows into a series of set of settling ponds near Warm Springs. These ponds were constructed to trap sediments contaminated with mining waste and reduce the toxicity of metals such as copper and zinc. Restoration activities, including extensive tailings removal, have been completed on Silver Bow Creek between Butte and Warm Springs.

Warm Springs Creek joins Silver Bow Creek downstream of the Warm Springs Ponds to become the Clark Fork River. Meyers Dam, located 5.5 km upstream of Anaconda is a barrier to fish migrating upstream in Warm Springs Creek. Tributaries of the upper Warm Springs Drainage originate from the south slope of the Flint Creek Range and the north slope of the Anaconda Range. Tributaries of interest in this study were the West Fork of Warm Springs, Storm Lake, Twin Lakes, Foster, and Barker creeks.

Lost and Racetrack Creeks flow east from the Flint Creek Range and join the Clark Fork River between the towns of Warm Springs and Deer Lodge. Cottonwood Creek flows out of the Boulder Mountains where it joins the Clark Fork River on the east side of Deer Lodge. The lower reaches of Lost, Racetrack, and Cottonwood creeks are impacted by dewatering during the irrigation season.

The Little Blackfoot River flows into the Clark Fork River near Garrison. The Little Blackfoot River adds significant flow to the Clark Fork River and reduces concentrations of suspended sediment and metal contaminants through dilution (Sando et al. 2014). Downstream of the Little Blackfoot River, Warm Springs Creek (different than the Warm Springs Creek near Anaconda) and Gold Creek enter the Clark Fork.

Flint Creek starts at the outflow of Georgetown Lake. It is joined by Boulder Creek near the town of Maxville. The lower reaches of Flint Creek are heavily dewatered during the irrigation season. Harvey Creek is a small tributary that originates in the John Long Mountain Range. A barrier near the mouth of Harvey Creek isolates native Westslope Cutthroat Trout and Bull Trout (*Salvelinus confluentus)*, but also prevents nonnative species present in the Clark Fork River from moving upstream and interacting with the native species.

Rock Creek is a major tributary to the UCFR and supports a robust Brown Trout fishery in the lower reaches and populations of Westslope Cutthroat Trout and Bull Trout in headwaters and tributary streams. Rainbow Trout are also present in the Rock Creek watershed as well as mountain whitefish (*Prosopium williamsoni)*, Longnose Sucker (*Catostomus catostomus)*, Largescale Sucker (*Catostomus commersonii),* Northern Pikeminnow *(Ptychocheilus oregonensis),* and sculpins (*Cottus spp.).*

Methods

Mainstem population monitoring

In spring 2015, trout population estimates were conducted at six established sections on the Clark Fork River that are sampled annually. FWP refers to these stations as Bearmouth, Morse Ranch, Phosphate, Williams Tavenner, Below Sager Lane, and pH Shack. Fish were collected using aluminum drift boats with a mounted electrofishing unit and two front boom anodes and one netter. Estimates were made using one or two mark runs and one or two recapture runs. Recapture runs were completed roughly one week after marking runs. All captured trout were identified to species, weighed (g), measured (mm), and marked with a small fin clip. Population estimates for fish ≥ 175 mm (~7 in) were generated using the Chapman modification (Chapman 1951) of the Petersen method provided in Montana Fish, Wildlife and Park's Fisheries Information System. Estimates were calculated for trout species that had a minimum of 4 marked fish that were recaptured (B. Liermann, Montana, Fish, Wildlife, and Parks, personal communication, 2014).

Fin rays were collected from a subsample of Brown Trout during annual population estimates in 2013-1015. We attempted to collect 100 fin rays from reaches A, B, and C (as defined in Mayfield 2013) each year. These 100 samples were divided equally among four length classes (25 samples per length class): 175-249 mm, 250-324 mm, 325-399 mm, and ≥ 400 mm. Because of the lack of fish in some length classes, not all 25 fin rays could be collected in some reaches. Fin rays were sent to the fish aging lab at the University of Idaho for sectioning and aging. Resulting data were used to calculate mean length at age, von Bertalanffy growth curves, and catch curves (for mortality estimation) following standard methods (Isely and Grabowsky 2007; Miranda and Bettoli 2007). Mean length at age was compared among sampling sections and reaches A, B, and C using pairwise *t*-tests with bonferroni corrected *P*-values.

In addition to the annual population estimates, FWP conducted population estimates on the entire Upper Clark Fork River from the Warm Springs Ponds to the confluence with Rock Creek. This survey was a repeat of surveys conducted in 1987 and 2009. Methods for this continuous sampling were similar to those described above except that only one mark and one recapture run were conducted on most continuous sampling sections. Descriptions of section lengths and locations can be found in Appendix A.

Tributary population monitoring

Population estimates were conducted in 18 tributaries in the UCFRB identified as high priority in Saffel et al. 2011 (Figure 1). Population estimates were generated either by mark-recapture or depletion methods. Mark-recapture estimates consisting of one mark and one recapture run were conducted on larger waters (Flint Creek, lower Little Blackfoot River, and lower Warm Springs Creek). Two- or three- pass depletion estimates (Zippin 1958) were conducted at other sections. Fish were collected at most tributary sections using one or two backpack electrofishing units. In larger streams, a barge mounted electrofishing unit was used to collect fish. Descriptions of sampling methods, section lengths, and locations of sampling sections can be found in Appendix A.

Hard part microchemistry

In order to determine whether there is sufficient variation in ^{87}Sr:^{86}Sr and Sr/Ca ratios between tributaries and the mainstem to facilitate an otolith microchemistry study, a preliminary study of water chemistry was conducted. Water samples were collected at four sites in the mainstem Clark Fork River and 12 tributary sites (Figure 1). Mainstem sites were located near the downstream boundaries of reaches A, B, and C. An additional mainstem site was located upstream of the confluence of Racetrack Creek. Tributary water collection sites were located near tributary mouths. In Rock Creek, Flint Creek, Warm Springs Creek, and the Little Blackfoot River, additional water samples were collected approximately halfway between the mouth and the headwaters to provide additional spatial resolution of Sr ratios. Water samples were extracted by pumping 50 ml of stream water through a 0.2 µm syringe filter. Water samples were preserved by adding a nitric acid solution and refrigerated until they were shipped to the Woods Hole Oceanic Institute for analyses. Water samples were analyzed for elemental ratios (i.e., Sr:Ca) using a Thermo Scientific ELEMENT 2, rapid scanning, magnetic sector, single collector inductively-coupled plasma mass spectrometer (ICPMS). Strontium isotope ratios (^{87}Sr:^{86}Sr) were determined by a Thermo Scientific NEPTUNE, large format, magnetic sector, multicollector ICPMS. Ratios of ^{87}Sr:^{86}Sr versus Sr:Ca were plotted (isoscape plot; Muhlfield 2012) to determine if there was sufficient variation in these chemical markers to conduct a Brown Trout otolith microchemistry study.

Caged fish monitoring

Caged fish monitoring in 2015 had two objectives. The first objective was to monitor springtime discharge of Warm Springs Pond #2 (Pond 2). This discharge monitoring was centered on a potential pulse of ammonia from the pond shortly after ice out. Three fish cages were placed at three sites. One site was located at the Pond 2 outlet (lat/long NAD83: 46.17834, -

112.78194). This site served as the primary site of interest. One site was located upstream of the Warm Springs ponds to represent the water quality coming into the ponds. This site is referred to as SS-19 (46.12237, -112.79917). The third site was located in Mill-Willow Bypass (46.17754, -112.78331) near the mouth.

Twenty-five Brown Trout were placed in each cage on February 23, 2015. Fish cages were checked biweekly for mortalities between February 27 and May 7, 2015. Checks of the fish cages followed standard protocols for upper Clark Fork River fish cage studies (i.e., Cook et al 2015). Water samples were collected 5-7 times a week at fish cage sites from February 23 to April 17, 2015. A subsample of these water samples were analyzed for total ammonia nitrogen (NH_3-N).

In mid-April, 2015 additional cages were added to the Clark Fork River at Galen Road (Galen), Racetrack bridge (Racetrack), and Kohrs Bend Fishing Access Site. These fish cages were used to monitor potential impacts of construction activities between Racetrack and Galen. Three cages at each site were each stocked with 25 Brown Trout. Fish cages were checked twice a week from April 20 – Oct 13, 2015. Any fish mortalities were collected and frozen. Three live fish were collected at each site the last week of every month of the study. These live fish were submitted to the Montana Department of Health and Human Services Environmental Laboratory in Helena for determination of whole-fish metal concentrations.

Water quality

Water quality parameters were recorded in the Clark Fork River at caged fish sites with continuously recording multiparameter water quality probes (Hydrolab ® MS5). Hydrolabs Water quality parameters recorded include pH and dissolved oxygen (DO) at all sites, with the addition of total ammonia ($NH_4 + NH_3$) at Mill-Willow Bypass, SS-19, and Pond 2. were calibrated periodically during the field season. The precision with which the Hydrolab records total ammonia levels has been questionable in the past (T. Selch, Montana, Fish, Wildlife, and Parks, personal communication, 2014). As a result of the questionable reliability of the ammonia sensors, ammonia data as recorded by the Hydrolabs are not presented in this report. Daily mean values are presented for pH and DO as well as minimum daily values for DO.

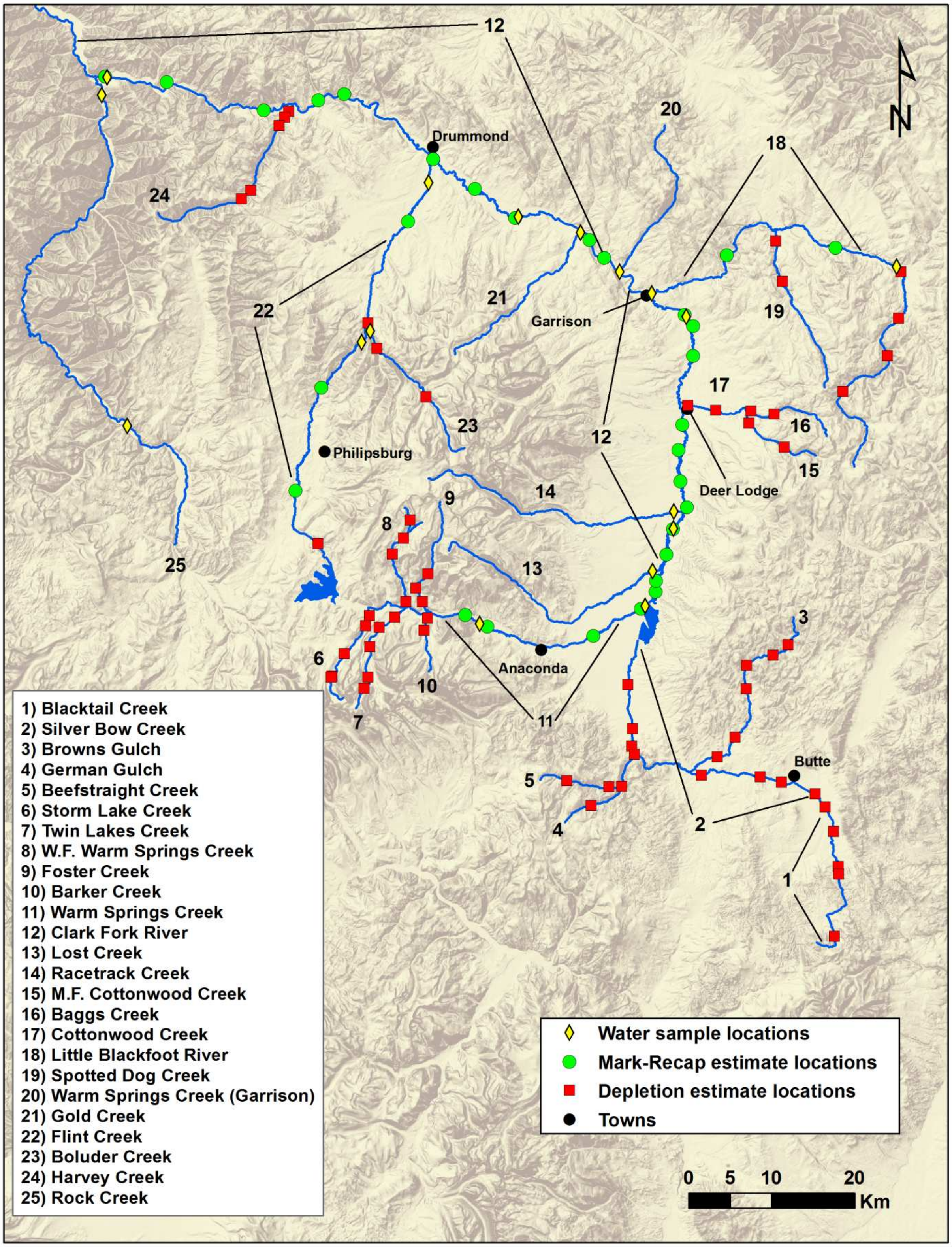

Figure 1. Map of 2015 electrofishing sections and water sampling sites in the Upper Clark Fork River Basin. Numbers refer to specific streams.

Results - *Mainstem electrofishing*

Brown Trout population estimates at the annual sampling sections ranged from 25 fish/km at Bearmouth to 267 fish/km at Williams Tavenner (Table 1). Combined estimates of Rainbow and Cutthroat Trout were 25 fish/km at Bearmouth and 3 fish/km at Morse Ranch. *Oncorhynchus* estimates could not be generated for other sections because fewer than four marked fish were recaptured. Brown Trout population estimates in 2015 were generally lower than estimates from 2013-2014 at all sections (Figure 2). The largest decrease took place at the pH Shack section. Brown Trout numbers decreased from 1,167 (991-1,383) in 2013 to 732 in 2014 to 175 in 2015 at the pH Shack Site.

Results from continuous population estimates conducted in 1987, 2009, and 2015 indicate spatial patterns in Brown Trout numbers (Figure 3). Across all sampling years, Brown Trout estimates ranged from 64-1,212 fish/km from sampling that took place in reach A. The highest estimates occurred in the most upstream reaches in 1987. Brown Trout population estimates ranged from 90-175 fish/km from sampling events in reach B. The highest estimates in reach B all occurred in 2009. Estimates ranged from 5-52 fish/km in reach C.

Table 1. Electrofishing data collected in 2015 from annual sampling sections on the Upper Clark Fork River. Population estimates (95% confidence interval) are for trout greater than 175 mm (~ 7”) in total length. Species abbreviations: LL = Brown Trout, WCT = Westslope Cutthroat Trout, BULL = Bull Trout, RB = Rainbow Trout. Asterisks indicate species were combined for the population estimate.

Section	Species	Population Estimate (fish/Km)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Bearmouth	LL	25(20-33)	157	378	151-535	55
	RB*	25(18-37)*	107	322	195-446	38
	WCT*		18	347	192-393	6
	BULL		3	516	308-674	1
Morse Ranch	LL	65(54-80)	401	360	151-484	94
	RB*	3(2-5)*	16	320	240-413	4
	WCT*		7	326	225-440	4
	BULL		1	502	502	<1
Phosphate	LL	163(107-262)	167	334	194-460	98
	WCT		4	288	200-347	2
Williams Tavenner	LL	267(208-348)	399	371	123-546	98
	WCT		8	375	340-397	2
Below Sager Lane	LL	205(97-470)	158	358	125-457	100
PH Shack	LL	175(116-274)	165	342	102-483	97
	RB		5	364	295-460	3

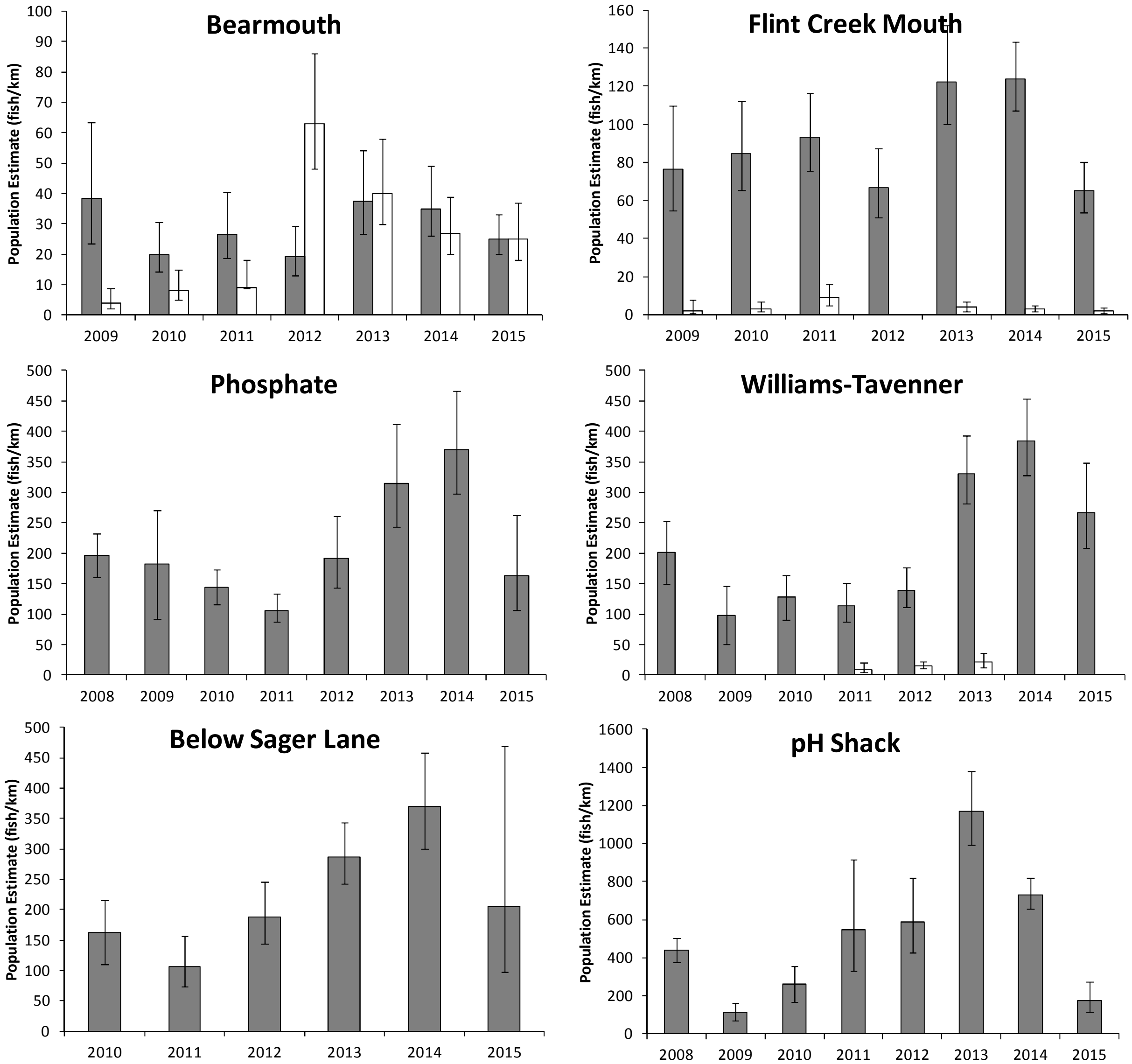

Figure 2. Clark Fork River Brown Trout (grey bars) and *Oncorhynchus sp.* (white bars) population estimates from 2008-2015 by sample reach. Sample reaches are displayed downstream to upstream, left to right then top to bottom. Please note that axis values are not the same for every sample reach.

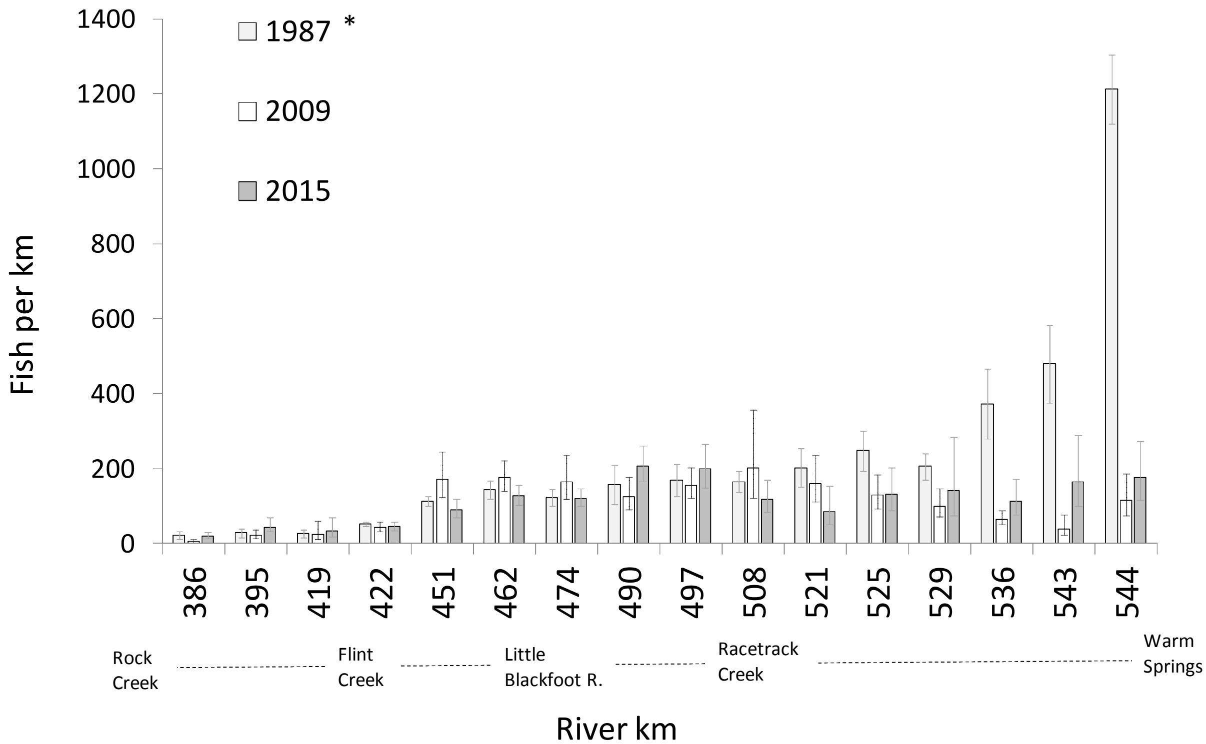

Figure 3. Brown Trout population estimates and 95% confidence intervals from continuous electrofishing surveys in the Upper Clark Fork River. *Section boundaries were at slightly different locations in 1987 than in other years.

Mainstem Brown Trout age, growth, and mortality

Mean length at age varied between sampling sections and river reaches (Table 2a). However, the variation in length at age also varied significantly between individual fish, limiting the significance of most statistical comparisons between sections or reaches. Age 3 fish sampled from the Bearmouth section were longer on average than any other section, but the difference was statistically significant only when compared to Sager, Phosphate, and Morse. Age 6 fish from the pH Shack section were on average > 30 mm longer than any other section, but the differences were not significant due to considerable variation in length at age 6 within the pH Shack section itself (Table 2a). When pooling data into reaches A, B, and C, length at age 3 was significantly greater for reach C compared to both A and B (Table 2b). No other comparisons were significantly different.

Plots of Von Bertalanffy growth curves for different sample section indicate different growth patterns in the different sampling sections (Figure 4). The ph Shack and Sager sections showed relatively slow growth at the younger age classes, but relatively high growth at ages beyond age 5. Conversely, Brown Trout from the Bearmouth section displayed rapid growth to age 3, but slower growth compared to other sections after age 5. When growth data was pooled into reaches A, B, and C the Von Bertalanffy curves indicated that Brown Trout had higher growth at age 3 in reach C (Figure 5). The growth curve for reach A exceeded the other reaches after age 5.

The Brown Trout population in reach A is primarily composed of age 3 and age 4 fish (Figure 6). Fish in these two age classes comprise 74% of the fish captured. For comparison, age 3 and -4 fish were 63% and 58% of fish captured in reaches B and C, respectively. Total annual mortality estimates from catch curves (Figure 7) were 0.65, 0.46, and 0.32 for reaches A, B, and C, respectively (Table 3).

Table 2a. Mean length (mm) at age for Brown Trout captured in 2013-2015 at six electrofishing sections in the Upper Clark Fork River. Standard deviations are in parentheses. Different lowercase letters within each age class indicate statistically significant differences in pairwise *t*-tests.

Section	2	3	4	5	6	7	8	10	11
PH Shack	212 (23)	287 (44)^{ab}	353 (51)	396 (43)	450 (80)		457 (40)		482 (2)
Sager	185 (34)	265 (57)^{b}	350 (41)	402 (49)	410 (39)	458 (65)			
W-T	250 (101)	273 (47)^{ab}	346 (46)	394 (59)	417 (48)				
Phosphate	230 (54)	276 (53)^{b}	335 (58)	399 (37)	402 (27)	418 (29)			
Morse	224 (31)	273 (49)^{b}	345 (67)	380 (49)	410 (28)	419 (31)			
Bearmouth	227 (40)	306 (58)^{a}	348 (56)	384 (50)	401 (42)	402 (46)	424 (36)	393 (n/a)	

Table 2b. Mean length (mm) at age for Brown Trout captured in 2013 and 2014 by reach in the Upper Clark Fork River. Standard deviations are in parentheses. Different lowercase letters within each age class indicate statistically significant differences in pairwise *t*-tests.

Section	2	3	4	5	6	7	8	10	11
A	232 (83)	276 (49)^{b}	350 (46)	396 (51)	421 (52)	458 (65)	457 (40)		482 (2)
B	227 (44)	275 (51)^{b}	339 (61)	389 (44)	407 (27)	418 (29)			
C	227 (40)	306 (58)^{a}	348 (56)	384 (50)	401 (42)	402 (46)	424 (36)	393 (n/a)	

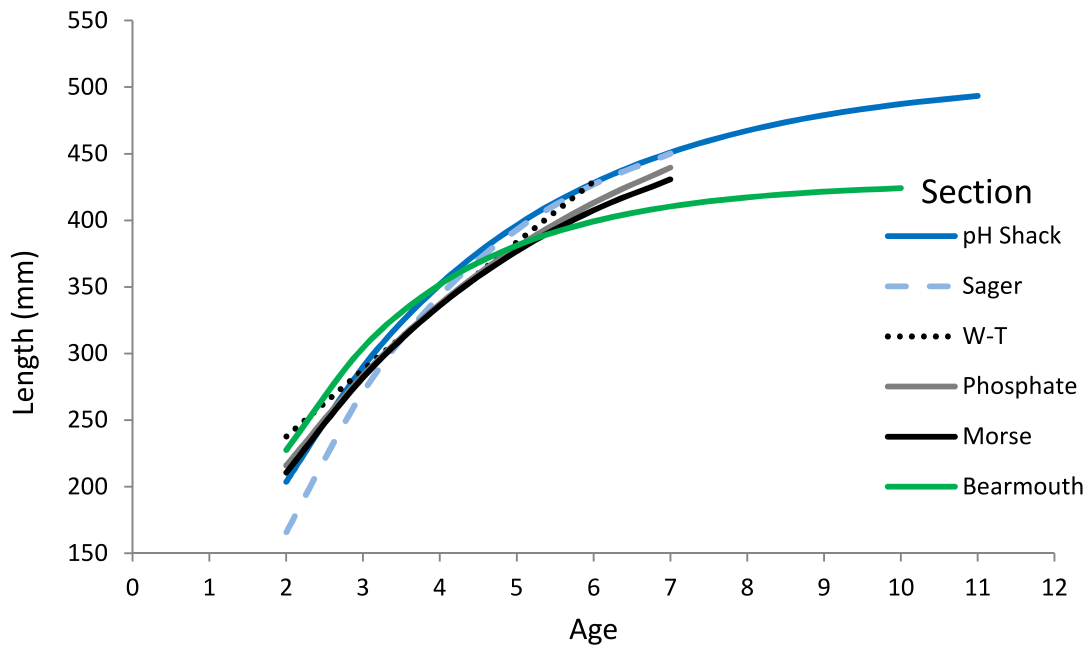

Figure 4. Brown Trout von Bertalanffy growth curves for six sampling sections in the upper Clark Fork River. Curves were plotted up to the oldest age observed at each section.

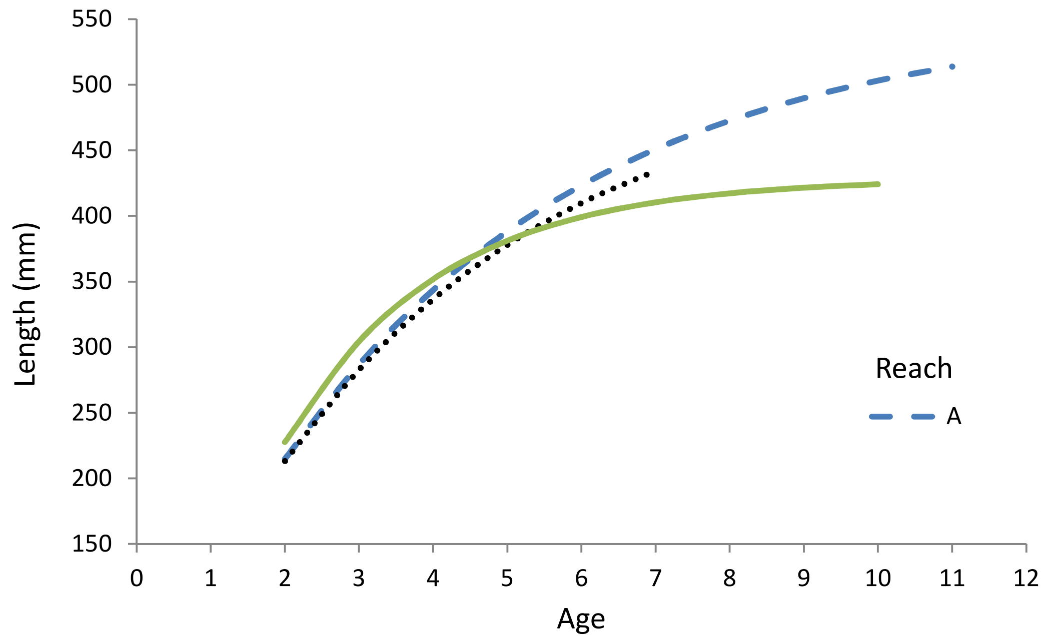

Figure 5. Brown Trout von Bertalanffy growth curves for reaches A, B, and C in the upper Clark Fork River. Curves were plotted up to the oldest age observed at each reach.

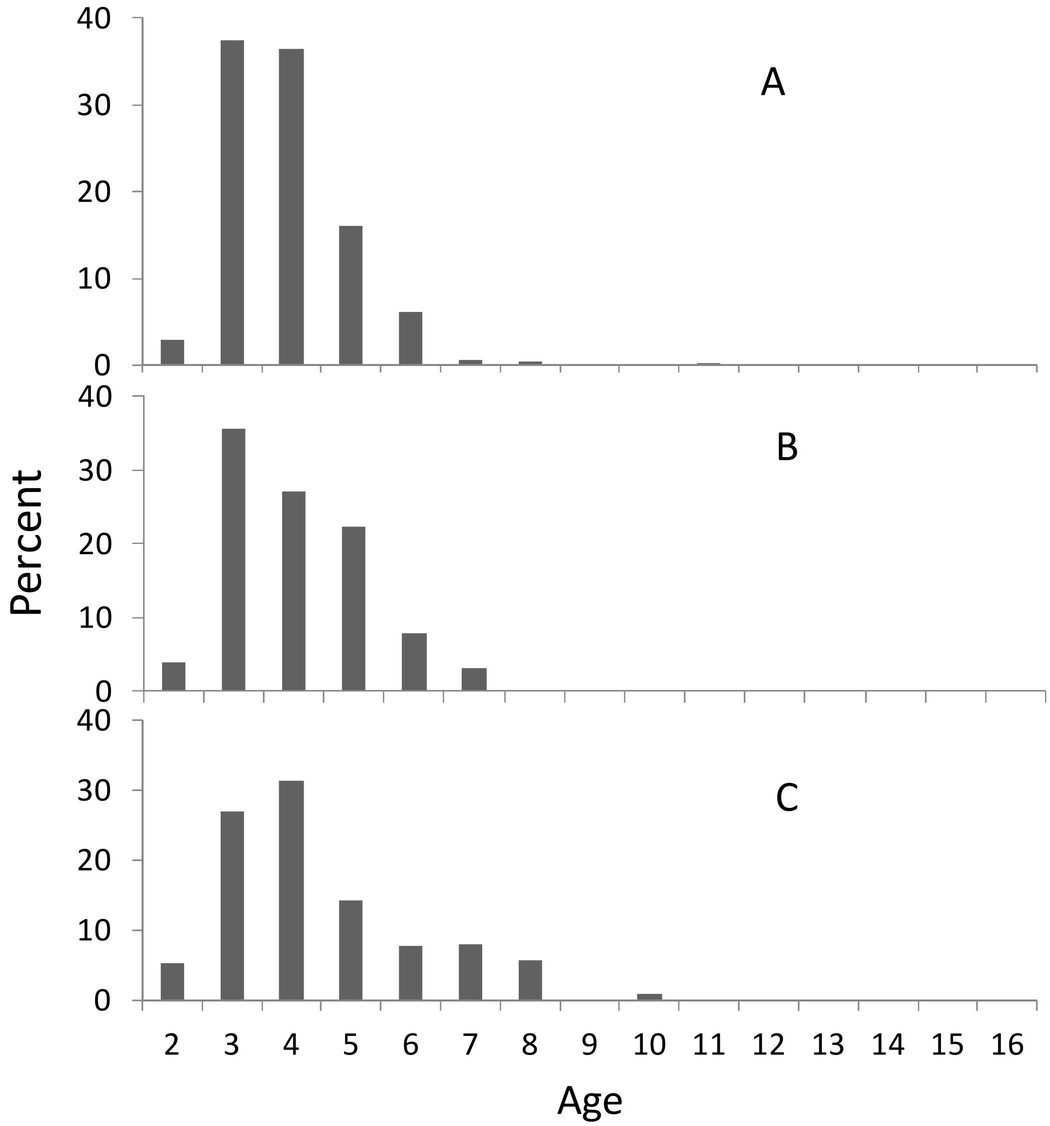

Figure 6. Percent of different age classes of Brown Trout collected during 2013-2015 population estimates in three reaches of the Upper Clark Fork River.

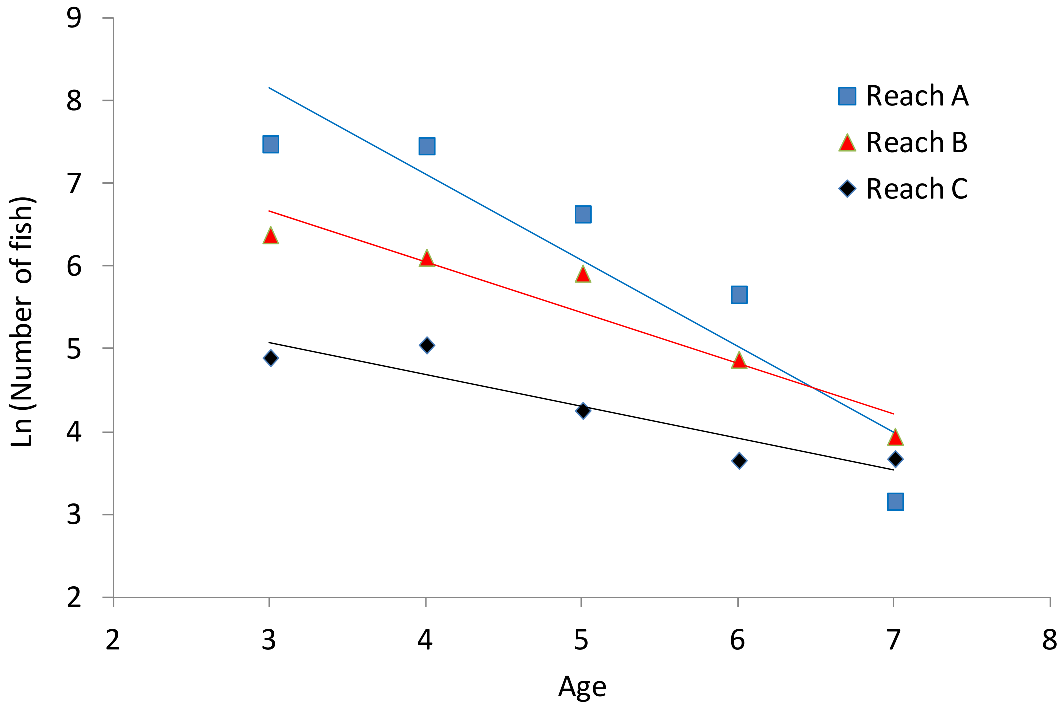

Figure 7. Catch curves for the three reaches of the Upper Clark Fork River.

Table 3. Catch curve derived mortality and survival estimates for three reaches of the Clark Fork River.

Reach	Total Annual Mortality	Annual Survival
A	0.65	0.35
B	0.46	0.54
C	0.32	0.68

Tributary Electrofishing Surveys

Between 7/6/2015 and 10/14/15, a total of 76 sections comprising 18.6 km of stream were sampled in tributaries of the Upper Clark Fork River and Silver Bow Creek. Sixty-four depletion and nine mark-recapture population estimates were conducted on these waters. Electrofishing data are presented for each watershed below.

Silver Bow Creek and Tributaries

Twenty-four depletion estimates were done on Silver Bow Creek and four of its tributaries (Tables 4-8). In Blacktail Creek Eastern Brook Trout (EB) were the most abundant trout species in the lower four sections and Westslope Cutthroat Trout (WCT) were most abundant in the upper two sections. In the sections where EB were most abundant, they accounted for 56-90% of the fish captured in the section. WCT made up 63-64% percent of the catch in the sections where they were dominant. EB were present in all six sections while WCT were only present in the upper four. Non trout species Longnose Sucker (LNSU), unspecified sculpins (COT), and Central Mudminnow (*Umbra limi,* CM MN) were observed in the lower three reaches.

Six estimate sections were conducted in Browns Gulch with EB being the dominant species throughout. In the lower three sections EB accounted for 59-65% of the species present. COT and LNSU were the next most abundant fish species in the lower three sections. In the upper three sections EB accounted for 83-96% percent of fish present. COT and LNSU were absent in the upper three sections. WCT were present five of six sections but in very low numbers compared to EB.

German Gulch had three estimate sections with WCT being the dominant species in all sections making up 63-100% of the species present. COT were the only non trout fish captured and only one was captured in the lowest section. One Rainbow Trout (RB) and one rainbow-cutthroat trout hybrid (RBxWCT) were also captured. EB were present in the two lower sections but absent in the upper section.

Beefstraight Creek had two estimate sections with WCT being the dominant species in both accounting for 75-89% of fish captured. Fewer EB were present in the upper section. No non trout species were observed.

Population estimates were attempted at seven sections on Silver Bow Creek. Trout population estimates could be computed for four sections (Fairmont, Below German Gulch, Ramsay, and Father Sheehan). Population estimates for LNSU were generated for the Ramsay and Rocker sections and for Central Mudminnow (CM MN) at the Rocker Section. At the other sites, insufficient fish numbers or poor capture efficiency prevented the calculation of estimates.

At the two sections downstream of the fish barrier at Durant Canyon (HWY 1 Bridge and Fairmont), EB were the most common tout species. Rocky Mountain Sculpin (RMCOT) were the most abundant fish making up 67-77% percent of fish captured in these two sections. LNSU were also present in the sections, but in low numbers. In four sections located above the barrier to the downstream end of Butte (Below German Gulch, Ramsay, Rocker, and LAO) there were low numbers of EB and WCT in each section. Non trout species accounted for the majority of the fish in these four sections. Of these four sections, RMCOT were the most abundant fish species in the lower and upper sections and LNSU were the most abundant in the middle two sections. The lower six sections on Silver Bow Creek had relatively small populations of trout. The upstream most section near Father Sheehan Park had the most trout of any of the seven Silver Bow Creek sections with EB being the only trout species captured. LNSU and COT were also captured in this section.

Table 4. Electrofishing data collected on Blacktail Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, EB = Eastern Brook Trout, LNSU = Longnose Sucker, COT = unidentified sculpin, CM MN = Central Mudminnow, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (fish/100m)	# Fish handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Golf Course Butte C.C.	EB	128 (127-131)	154	165	56-420	89
	LNSU	13 (13-13)	13	215	173-250	7
	COT		6	83	60-113	3
	CM MN		1	90	90	<1
Above Blacktail Loop	EB	75 (72-81)	119	106	52-240	90
	LNSU	12 (11-17)	12	116	72-170	9
	CM MN		1	84	84	<1
Below 9 Mile	EB	42 (41-45)	58	120	51-262	60
	WCT	26 (26-28)	26	168	88-235	27
	LNSU	12 (12-14)	12	164	131-205	13
Above 9 Mile	EB	43 (42-45)	58	114	38-210	56
	WCT	33 (33-34)	45	109	62-216	43
	RBxWCT		1	125	125	1
Upper Thompson	WCT	52 (46-62)	53	107	68-286	64
	EB	28 (28-30)	30	126	46-194	36
Upper Forest Service	WCT	15 (15-17)	17	91	53-145	63
	EB	12 (10-21)	10	118	75-157	37

Table 5. Electrofishing data collected on Brown's Gulch in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, EB = Eastern Brook Trout, LNSU = Longnose Sucker, COT = unidentified sculpin, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Lower Ueland RM 2.6	EB	21 (21-22)	25	188	85-290	42
	RMCOT		21		39-124	35
	LNSU	11 (11-12)	13	138	78-177	22
	WCT		1	240	240	1
Upper Ueland RM 5.3	EB		15	130	70-249	65
	COT		5	84	71-103	22
	LNSU		3	97	87-108	13
Brothers Ranch RM 9.7	EB	34 (34-35)	41	132	50-211	59
	LNSU	21 (19-28)	19	142	115-167	28
	COT		6	94	77-125	9
	WCT		3	137	35-226	4
Balentine RM 11.5	EB	103 (100-109)	109	119	50-215	83
	WCT	22 (22-23)	20	113	77-245	15
	RBxWCT		2	156	154-158	2
Lower Forest Service RM 13.8	EB	42 (42-44)	53	119	44-203	87
	WCT	8 (8-10)	8	126	76-204	13
Upper Forest Service RM 15.3	EB	104 (102-108)	140	110	41-183	96
	WCT		6	137	69-170	4

Table 6. Electrofishing data collected on German Gulch in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, EB = Eastern Brook Trout, RB = Rainbow Trout, RMCOT = Rocky Mountain Sculpin, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
RM 0.2	WCT	52 (51-55)	96	193	70-400	63
	EB	22 (22-23)	53	174	56-207	35
	RB		1	207	207	<1
	RBxWCT		1	322	322	<1
	RMCOT		1	74	74	<1
RM 3.0	WCT	28 (28-29)	33	133	45-236	67
	EB	6 (6-7)	16	96	51-264	33
RM 6.0	WCT		11	157	65-188	100

Table 7. Electrofishing data collected on Beefstraight Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, EB = Eastern Brook Trout.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Above lower bridge RM 1.3	WCT	54 (51-58)	114	133	57-309	75
	EB	22 (22-23)	39	103	46-163	25
Below Spring Creek Trail Crossing RM 4.5	WCT	56 (55-59)	55	122	79-176	89
	EB		7	115	75-226	11

Table 8. Electrofishing data collected on Silver Bow Creek in 2015. Population estimates (95% CI) are for fish greater than 75 mm (~ 3”) in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, EB = Eastern Brook Trout, RB = Rainbow Trout, LNSU = Longnose Sucker, RMCOT = Rocky Mountain Sculpin, COT = unidentified scuplin, CM MN = Central Mudminnow, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Above Hwy 1 Bridge	RMCOT		47	74	29-115	77
	LNSU		9	116	54-224	15
	EB		4	168	136-245	7
	RB		1	89	89	1
Fairmont	RMCOT		88	73	36-142	67
	EB	7 (6-10)	22	156	86-401	17
	LNSU		13	189	103-260	10
	WCT	3 (3-4)	9	264	103-398	6
Below German Gulch	RMCOT		68	70	40-123	70
	LNSU		11	89	50-117	11
	WCT	3 (3-4)	11	209	70-420	11
	EB		7	114	95-144	7
	RBxWCT		1	175	175	1
Ramsay	LNSU	24 (21-27)	80	152	62-266	58
	EB	7 (7-8)	26	174	110-258	19
	WCT	6 (5-7)	20	264	119-393	15
	RMCOT		10	104	85-118	7
	CM MN		1	109	109	<1
Rocker	LNSU	90 (85-95)	246	119	48-236	88
	CM MN	10 (9-11)	25	105	93-130	9
	RMCOT		4	103	98-106	1
	WCT		2	268	152-383	<1
	EB		2	165	146-184	<1
LAO	RMCOT		82	90	43-129	84
	LNSU		10	60	48-105	10
	EB		5	350	300-405	5
	WCT		1	200	200	1
Father Sheehan	EB	148 (139-157)	325	148	58-380	94
	LNSU		18	134	55-257	5
	COT		4	84	65-115	1

Warm Springs Creek and Tributaries

Nineteen depletion estimates and four mark/recapture estimates were conducted in the Warm Springs Creek watershed (Tables 9-13). Five electrofishing sections were sampled on Storm Lake Creek with WCT being the most abundant species in all sections ranging from 56% in the lower section to 94% in the upper section. EB, Bull Trout (BULL) and RB were also present. There were no non trout species captured in any section of Storm Lake Creek.

Five sections were sampled on Twin Lakes Creek with WCT being the most common trout species throughout making up 52-73% of all fish species. EB and BULL were present in all but one section. Sculpin were observed in all sections and both RMCOT and SLCOT were found in Twin Lakes Creek. SLCOT were found in all but the most upstream section and RMCOT were found in all but the most downstream section.

Foster Creek had three estimate sections with WCT being the most abundant species in all sections accounting for 68-98% of fish present. EB were present in all sections. BULL were present in two sections, but in low numbers. There were bull-brook trout hybrids present in the lowest section. Sculpin were also captured in the lowest section but were not identified to species.

Barker Creek had two estimate sections with BULL accounting for 63-66% percent of fish. WCT were present in both section and one EB was captured in the lower section. No sculpin were captured.

Warms springs Creek (including the West Fork) had eight estimate sections with LL comprising 73-92% of fish in the lower three sections below Myers dam and WCT accounting for 32-100% of fish in the five sections above Myers dam. EB were present in five sections. BULL were present in all but the lower two sections and second most upstream section. In all sections where both BULL and EB were found, hybrids between these two species were also found. RMCOT were present in the lowest section. Sculpin were also observed in the two sections just upstream of Meyers Dam, but were only identified to species (SLCOT) in the Veronica Trail section.

Table 9. Electrofishing data collected on Storm Lake Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, RB = Rainbow Trout, EB = Eastern Brook Trout, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Lower	WCT	18 (18-19)	18	148	110-230	56
RM 0.6	EB	13 (12-18)	12	147	110-210	38
	BULL		2	163	160-165	6
Above First	WCT	19 (19-21)	22	128	62-192	57
Crossing	EB	15 (13-23)	13	152	107-235	33
RM 1.4	BULL		4	163	150-582	10
Lower	WCT	38 (38-39)	40	137	62-214	85
Meadow	RB	6 (6-7)	6	181	154-220	13
RM 4.2	EB		1	238	238	2
Below upper	WCT	44 (44-46)	57	98	37-195	77
Storm Lake	RBxWCT		7	114	69-198	10
road crossing	EB		6	132	114-182	8
RM 6.3	BULL	4 (4-5)	4	204	192-216	5
Above upper	WCT	69 (56-88)	60	127	65-215	94
Storm Lake	EB		3	119	97-131	5
road crossing	BULL		1	214	214	1
RM 6.3						

Table 10. Electrofishing data collected on Twin Lakes Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, EB = Eastern Brook Trout, SLCOT = Slimy Sculpin, RMCOT = Rocky Mountain Sculpin, COT = unidentified sculpin.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Lower RM 1.3	WCT	28 (27-33)	27	153	63-245	73
	BULL		5	123	84-168	14
	EB		4	148	137-158	11
	SLCOT		1	104	104	2
Meadow RM 2.8	WCT	54 (46-68)	46	147	75-239	53
	EB	32 (30-37)	30	157	106-244	34
	SLCOT		7	83	70-117	8
	COT		2	48	40-55	3
	BULL		1	196	196	1
	RMCOT		1	90	90	1
Upstream of old bridge RM 4.6	WCT	30 (28-36)	29	128	115-193	56
	EB	8 (8-9)	8	152	68-237	15
	RMCOT		8		82-110	15
	SLCOT		7		71-113	14
Downstream of lower lake RM 7.2	RMCOT		24		57-109	70
	WCT		7	112	46-177	21
	SLCOT		2		67-82	6
	BULL		1	166	166	3
Upstream of upper lake RM 8.5	WCT	38 (34-47)	36	107	69-155	52
	BULL	13 (13-15)	17	123	60-207	24
	RMCOT		15		60-115	21
	EB		2	280	150-410	3

Table 11. Electrofishing data collected on Foster Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, EB = Eastern Brook Trout, COT = unidentified sculpin, EBxBULL = phenotypic hybrid between Eastern Brook Trout and Bull Trout, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (fish/100m)	# Fish handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Lower	WCT	79 (78-82)	79	144	60-294	89
RM 1.0	COT		5	69	45-91	6
	EBxBULL		2	223	220-225	2
	BULL		1	66	66	1
	EB		1	166	166	1
	RBxWCT		1	164	164	1
Middle	WCT	41 (39-46)	42	102	66-194	68
RM 2.3	EB	6 (6-8)	19	82	45-140	31
	BULL		1	186	186	1
Upper	WCT	105 (102-110)	138	122	62-223	98
RM 3.8	EB		3	169	128-193	2

Table 12. Electrofishing data collected on Barker Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, EB = Eastern Brook Trout.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Lower	BULL	38 (21-98)	21	155	109-212	66
RM 0.5	WCT	9 (9-12)	10	169	74-206	31
	EB		1	265	265	3
RM 1.5	BULL	21 (19-25)	27	138	95-428	63
	WCT	11 (11-12)	16	169	81-292	37

Table 13. Electrofishing data collected on Warm Springs Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, LL = Brown Trout, RB = Rainbow Trout, EB = Eastern Brook Trout, MWF = mountain whitefish, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout, EBxBULL= phenotypic hybrid between Eastern Brook Trout and Bull Trout.

Section	Species	Population Estimate (Fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Wildlife Management Area RM 3.3	LL	60 (50-74)	331	193	55-462	73
	MWF	24 (17-34)	116	310	94-484	26
	RBxWCT		2	326	293-358	<1
	RB		1	264		<1
	EB		1	277		<1
	RMCOT		2	75	60-90	<1
	RSSH		1	87		<1
Below Airport Road RM 9.0	LL	86 (73-104)	344	174	60-427	92
	MWF		29	206	87-376	8
	RBxWCT		2	277	238-298	<1
Below Meyers Dam	LL	118 (107-131)	789	210	58-415	85
	RBxWCT	10 (8-15)	67	188	80-396	7
	RB	3 (2-6)	23	190	98-451	2
	EB	2 (1-3)	14	183	129-250	2
	BULL		14	384	180-605	2
	WCT		13	218	94-374	1
	EBxBULL		4	436	180-522	<1
Garrity WMA (Above Meyers Dam)	WCT	48 (40-59)	286	169	68-395	48
	RBxWCT	23 (20-28)	200	153	81-428	33
	LL	5 (4-9)	40	210	56-385	7
	BULL	5 (3-8)	33	216	55-384	6
	RB	3 (2-5)	23	244	125-376	4
	EB	2 (1-4)	14	132	102-177	2
	EBxBULL		2	324	274-373	<1
	COT		?	?	52-90	?

Table 13 - Continued. Electrofishing data collected on Warm Springs Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3”) in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, LL = Brown Trout, RB = Rainbow Trout, EB = Eastern Brook Trout, MWF = mountain whitefish, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout, EBxBULL= phenotypic hybrid between Eastern Brook Trout and Bull Trout.

Section	Species	Population Estimate (Fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Above Veronica Trail RM 26.0	WCT	28 (27-34)	27	145	71-293	57
	EB	8 (8-10)	8	179	101-341	17
	BULL		5	131	109-157	11
	RB		3	92	72-125	6
	RBxWCT		3	129	86-173	6
	SLCOT		3	89	78-95	
	EBxBULL		1	180	180	3
Below Upper Bridge RM 27.4	EB	12 (12-13)	12	194	136-311	39
	WCT	10 (10-10)	10	174	127-213	32
	BULL	8 (8-9)	8	246	202-291	26
	EBxBULL		1	249	249	3
Below Confluence of Upper Forks	WCT	52 (52-54)	52	163	89-236	100
West Fork	WCT	50 (47-57)	50	133	58-201	94
	BULL		3	236	128-314	6

Cottonwood Creek and Tributaries

Six depletion estimates were conducted on Cottonwood Creek and one of its tributaries, Baggs Creek (Tables 14-15). In Cottonwood Creek, LL were the most abundant species in the lower two sections making up 75-83% of all fish captured. In the lower section, several young of year LL were captured. The section at river mile 3.0 was generally depauperate of fish, probably due to dewatering. WCT and EB were captured in similar numbers in the upper section accounting for 41 and 39 percent of fish, respectively. Sculpin were captured in the three mainstem sections but were only identified to species in the lower section. No sculpin were captured in the Middle Fork of Cottonwood Creek.

Two sections were sampled on Baggs Creek with WCT and EB making up similar percentages of fish in both sections. WCT were slightly more abundant accounting for 57 and 55 percent of the fish while EB made up 43 and 45 percent. The lowest section had very few fish which is probably due to low stream flows resulting from water diversion for irrigation. No non-trout species were captured in either section.

Table 14. Electrofishing data collected on Cottonwood Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3”) in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, LL = Brown Trout, EB = Eastern Brook Trout, COT = unidentified sculpin.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
School RM 0.8	LL	48 (46-52)	54	134	68-305	83
	RMCOT		10		95-112	15
	EB		1	137	137	2
Middle RM 3.0	LL		3	66	65-68	75
	COT		1	65	65	25
Upper RM 6.9	WCT	52 (51-55)	55	128	68-258	41
	EB	31 (31-32)	52	102	45-220	39
	COT		27	47	34-85	20
Middle Fork	WCT	160 (155-167)	169	125	62-212	89
	EB	22 (21-26)	21	130	85-165	11

Table 15. Electrofishing data collected on Baggs Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3”) in total length. Species abbreviations: EB = Eastern Brook Trout, WCT = Westslope Cutthroat Trout.

Section	Species	Population Estimate (fish/100m)	# Fish handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
RM 0.4	WCT		4	102	31-136	57
	EB		3	115	78-188	43
RM 2.4	WCT	81 (76-87)	86	135	77-252	55
	EB	40 (38-44)	70	112	52-228	45

Little Blackfoot River and Tributaries

Two mark recapture estimates and six depletion estimates were conducted on the Little Blackfoot River and one of its tributaries (Tables 16-17). In the lower two sections of the Little Blackfoot River, LL were the most abundant trout species, accounting for 91-100% of fish captured. Many mountain whitefish (MWF) were observed in the lower two sections, but were not netted due to time constraints. Sculpin were also present in the lower section. Brown Trout numbers were lower in the upper four sections than the lower two. WCT were the most abundant trout species in the upper three sections making up 44-61% of fish present. EB were present in all but the lowest section. MWF were present in all sections but there were fewer present in the upper sections.

Two depletion estimates were done on Spotted Dog Creek. Brown Trout were the most abundant species in the lower section making up 94% of fish. Similar numbers of LL and WCT were captured at the upper section, but an estimate was not done for LL because the majority of the fish were less than 75 mm in length. Sculpin were present in both sections. EB, LNSU, and MWF were captured in the upper section, but not the lower section.

Table 16. Electrofishing data collected on the Little Blackfoot River in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3”) in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, LL = Brown Trout, EB = Eastern Brook Trout, MWF = mountain whitefish, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (Fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Rest Area - FWP FAS	LL	57 (46-72)	340	286	68-471	100
	MWF	-	-	-	-	-
	RMCOT	-	-	-	-	-
Above North Trout Creek Confluence	LL	36 (31-44)	255	232	72-395	91
	EB		13	180	99-211	5
	WCT		12	268	170-340	4
	MWF	-	-	-	-	-
Above Hwy 12 Bridge near Elliston RM 26.7	MWF	42 (37-48)	112	306	160-385	60
	LL	14 (14-16)	41	198	100-353	22
	WCT	10 (9-14)	26	219	80-351	14
	EB		7	123	45-204	4
	COT	-	-	-	-	-
Above Sunshine Camp	WCT	9 (8-12)	27	148	68-290	44
	LL	8 (8-9)	24	185	93-356	40
	MWF	3 (3-3)	8	293	234-333	13
	EB		2	66	63-69	3
Below Ontario Creek RM 34.9	WCT	43 (34-59)	44	139	74-241	61
	LL	10 (10-11)	14	163	87-296	19
	MWF		12	225	114-315	17
	EB		1	112	112	<1
	RBxWCT		1	148	148	<1
	COT	-	-	-	75-150	-
Above Kading Campground RM 40.1	WCT	24 (23-25)	48	157	62-273	50
	EB	10 (10-11)	21	138	44-205	22
	LL	8 (8-9)	16	132	74-235	17
	MWF	6 (6-7)	11	195	130-285	11
	COT	-	-	-	-	-

Table 17. Electrofishing data collected on Spotted Dog Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3”) in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, LL = Brown Trout, EB = Eastern Brook Trout, LNSU = Longnose Sucker, COT = unidentified sculpin, MWF = mountain whitefish, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
RM 1.1	LL	23 (23-24)	34	257	128-375	94
	WCT		2	120	118-121	6
	COT		2		49-80	
RM 4.6	WCT	18 (17-23)	29	99	73-129	40
	LL		29	74	45-391	40
	EB		5	84	51-163	7
	LNSU		4	138	86-177	6
	COT		3	75	56-107	5
	RBxWCT		1	130	130	1
	MWF		1	66	66	1

Flint Creek and Tributaries

Three mark recapture and four depletion estimates were conducted on Flint Creek and Boulder Creek (Tables 18-19). Flint Creek had four estimate sections with LL comprising 80-99% of captured fish. Abundant MWF were observed in the three lowest sections, but were not netted. WCT were captured in the lower two sections, EB in the middle two sections and RB in the upper three sections. Sculpin (RMCOT) were observed in only the lowest section.

Boulder Creek had three estimate sections with LL being the most abundant fish in the lower two sections accounting for 68% and 60% of fish. BULL was the most abundant species in the upper section making up 71% of fish captured. One adult BULL was captured in the lowest section. WCT were present in all three sections. Phenotypic rainbow-cutthroat trout hybrids and sculpin were observed in the lower two sections.

Table 18. Electrofishing data collected on Flint Creek in 2015. Population estimates (95% CI) are for trout greater than 175 mm (~ 7") in total length for the Hall, Johnson Tuning Fork and Chor sections. Estimate is for trout greater than 75 mm (~3") for the Dam section. Species abbreviations: WCT = Westslope Cutthroat Trout, LL = Brown Trout, EB = Eastern Brook Trout, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (Fish/Km)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
Hall	LL	175 (151-208)	214	278	152-45	99
	WCT		1	334	334	<1
	RBxWCT		1	353	353	<1
	RMCOT	-	-	-	-	-
Johnson Tuning Fork	LL	416 (376-470)	419	281	159-452	97
	RB		9	264	198-400	2
	EB		2	236	230-241	<1
	WCT		1	268	268	<1
Chor	LL	277 (251-310)	327	296	160-470	98
	EB		6	241	193-272	<2
	RB		1	225	225	<1
		(Fish/100m)				
Dam (Above Campground)	LL	51 (46-56)	49	290	186-460	80
	RB	12 (11-13)	12	195	124-238	20

Table 19. Electrofishing data collected on Boulder Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviations: WCT = Westslope Cutthroat Trout, BULL = Bull Trout, RBxWCT = phenotypic hybrid between Rainbow Trout and Westslope Cutthroat Trout.

Section	Species	Population Estimate (Fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
USGS Gauge	LL	15 (14-16)	28	124	60-370	68
RM 0.4	WCT	16 (12-31)*	7	188	78-352	17
	RBxWCT		5	189	108-336	12
	BULL		1	225	225	3
	SLCOT	-	-	-	-	-
RM 2.0	LL	26 (25-30)	41	127	62-395	60
	RBxWCT	30 (26-44)*	16	149	46-305	24
	WCT		11	129	91-225	16
	SLCOT	-	-	-	35-91	-
Copper Lakes	BULL	20 (20-21)	24	159	55-355	71
Trailhead	WCT	10 (10-12)	10	176	83-271	29

*WCT and RBxWCT are combined in estimate.

Harvey Creek

There were six estimate sections on Harvey Creek (Table 20). WCT were the most abundant trout species in all six sections. WCT made up 100 percent of trout in the lower three sections. WCT abundance was highest at the RM 2.3 section and generally declined at sections the farther upstream and downstream from RM 2.3. BULL were present in the upper three sections and accounted for 3%, 26% and 48% of trout in those sections. Sculpin were present in the lower four sections.

Table 20. Electrofishing data collected on Harvey Creek in 2015. Population estimates (95% CI) are for trout greater than 75 mm (~ 3") in total length. Species abbreviation: WCT = Westslope Cutthroat Trout, BULL = Bull Trout.

Section	Species	Population Estimate (Fish/100m)	# Fish Handled	Mean Length (mm)	Length Range (mm)	Species Composition (%)
RM 0.6	WCT	26 (25-30)	34	109	55-216	81
	RMCOT	-	8	-	75-98	19
RM 1.2	WCT	46 (45-47)	56	145	90-305	72
	SLCOT	-	22	-	60-97	28
RM 1.6	WCT	121 (114-130)	114	123	75-339	86
	SLCOT	-	18	-	66-101	14
RM 2.3	WCT	65(61-72)	61	144	80-311	97
	BULL		2	285	144-426	3
	COT	-	-	-	-	-
Below 8 Mile	WCT	63 (55-74)	78	145	42-470	74
	BULL	13 (14-23)	28	94	42-326	26
Above FS Road	WCT	33 (32-36)	36	113	60-220	52
	BULL	27 (27-29)	33	113	49-266	48

Microchemistry

Strontium isotope ratios ($^{87}Sr:^{86}Sr$) from water samples collected in the UCFRB ranged from 0.707446 to 0.727524 (Table 21). Water samples from Rock Creek had the highest isotope ratios, whereas samples from the Little Blackfoot River had the lowest ratios. Isoscape plots indicate clear separation of the mainstem and most tributary waters (Figure 8). Exceptions were water samples taken from Lower Flint Creek and Lost Creek, which clustered close together. The sample from Racetrack Creek was within the cluster of mainstem samples taken upstream of the Little Blackfoot River and just upstream of Racetrack Creek. With the possible exception of

Racetrack Creek, there appears to be sufficient variation in Sr signatures between waters of the UCFRB for movements between the mainstem Clark Fork River and tributaries to be apparent in the future otolith microchemistry study.

Table 21. Strontium isotope ratios (^{87}Sr:^{86}Sr) for water samples collected in the Upper Clark Fork River Basin. Samples are listed from highest to lowest values.

Site	87Sr/86Sr
Rock Creek #1 (Near Mouth)	0.727524
Rock Creek #2 (Above Stony Creek)	0.724798
Warm Springs Creek #2 (Above Myers Dam)	0.715863
Flint Creek #2 (Above Boulder Creek)	0.714373
Warm Springs Creek #1 (Near Mouth)	0.712644
Flint Creek #1 (Near Mouth)	0.711860
Lost Creek (Near Mouth)	0.711203
Clark Fork River #4 (Above Racetrack Creek)	0.710381
Warm Springs Creek-Garrison (Near Mouth)	0.710240
Racetrack Creek (Near Mouth)	0.710203
Clark Fork River #3 (Above Little Blackfoot)	0.709699
Clark Fork River #1 (Above Rock Creek)	0.709664
Clark Fork River #2 (Above Flint Creek)	0.709529
Gold Creek (Near Mouth)	0.708735
Little Blackfoot #1 (Near Mouth)	0.708529
Little Blackfoot #2 (Above Dog Creek)	0.707446

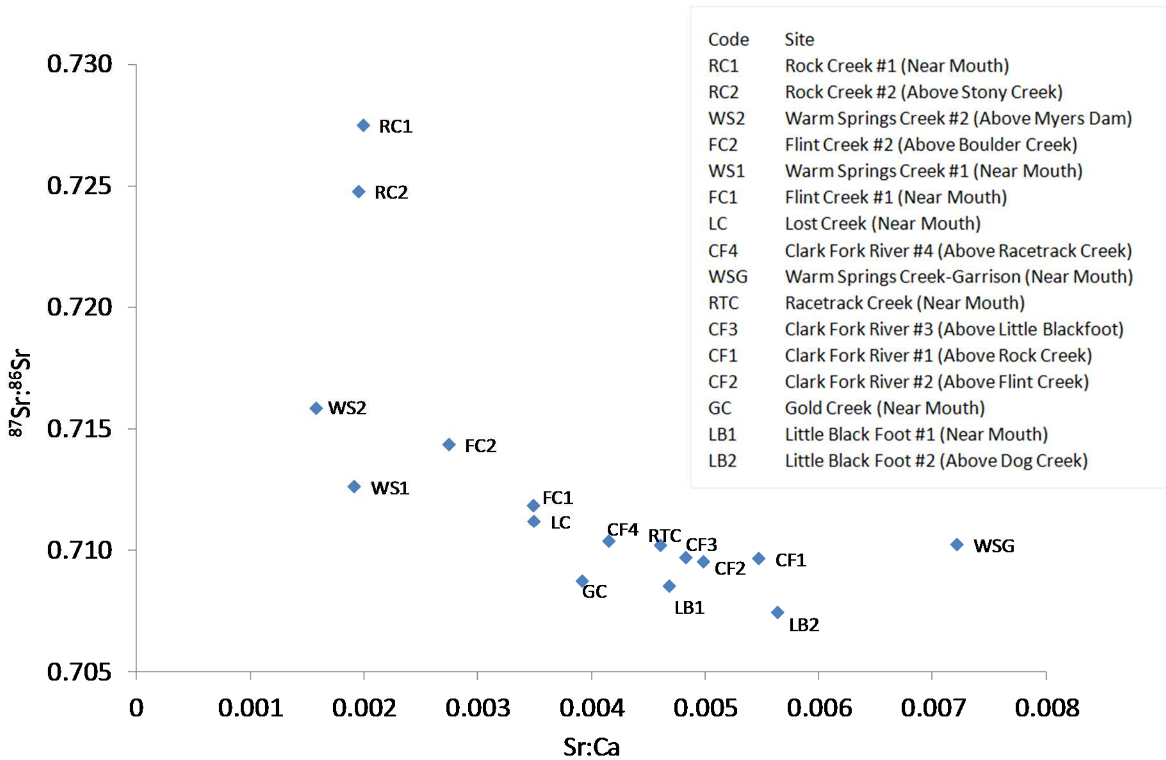

Figure 8. Water ^{87}Sr:^{86}Sr and Sr:Ca values for streams in the Upper Clark Fork River Basin.

Caged fish monitoring

No pulse of ammonia was detected in daily water sampling at the Pond 2 outflow. There were three caged fish mortalities at the outflow of Pond 2 compared to 14 at SS-19, and 36 at Mill-Willow. Most of the mortalities at Mill-Willow were in the first week of the study and were probably related to acclimation to new environmental conditions (Figure 9). Given the low mortality and no detection of an acute mortality event at Pond 2, there was no evidence of a lethal ammonia pulse in the Pond 2 discharge.

In the fish cages used for construction monitoring, there were 20 mortalities at the Galen site, 13 mortalities at the Pond 2 site, 11 mortalities at Kohrs Bend, and five mortalities at Racetrack. Mortalities tended to occur shortly after fish were placed in cages and on the descending limb of the hydrograph (Figures 10-13). Water temperatures exceeded the upper critical temperature of 19°C for 74 days at Pond 2, 63 days at Galen, 53 days at Racetrack, and 83 days at Kohrs Bend. Water temperatures exceeded the upper incipient lethal temperature of 24.7°C for 4 days at Pond 2, 0 days at Galen, 0 days at Racetrack, and 10 days at Kohrs Bend.

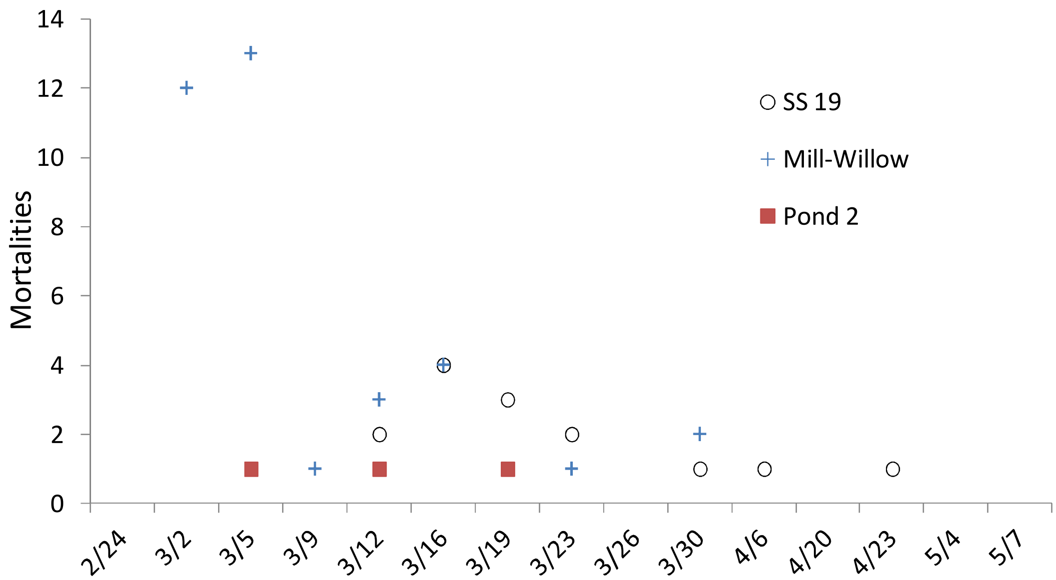

Figure 9. Brown Trout mortalities over time at three caged fish sites used to monitor potential ammonia discharge from Pond 2 in spring, 2015.

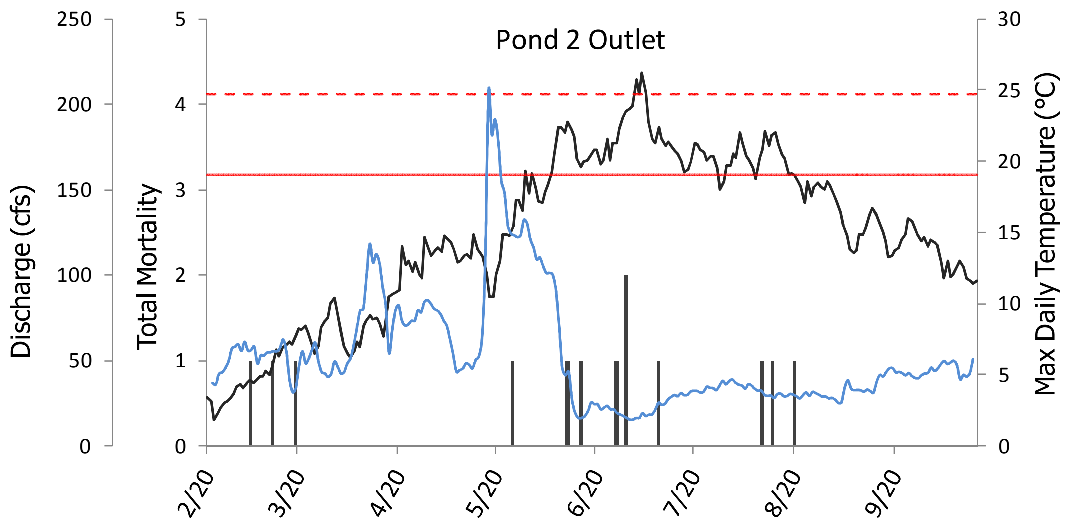

Figure 10. Total fish mortalities, maximum daily water temperature, and mean daily discharge for Silver Bow Creek at the outlet of Pond 2. The solid red line indicates the upper critical temperature threshold and the dashed red line represents the upper incipient lethal temperature for Brown Trout.

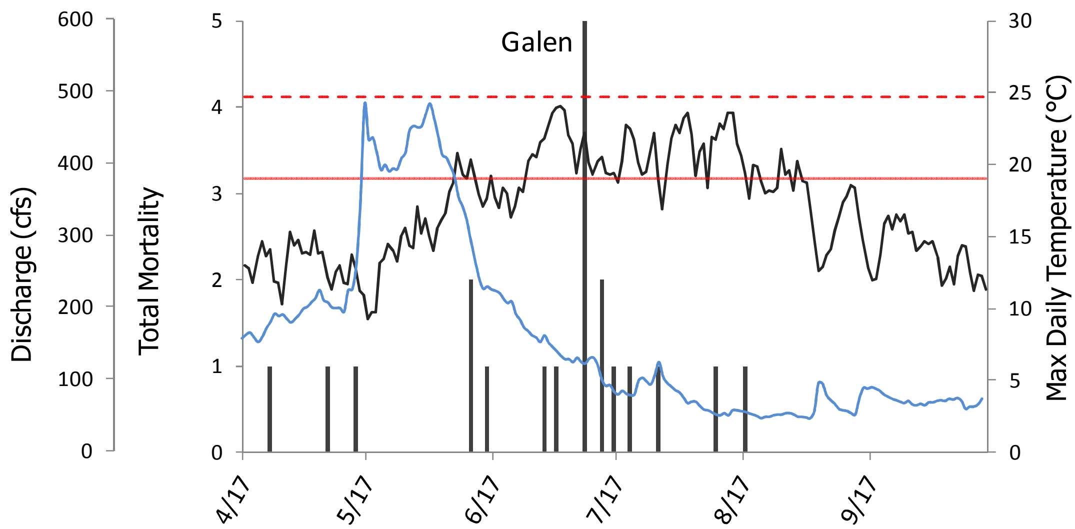

Figure 11. Total fish mortalities, maximum daily water temperature, and mean daily discharge for the Galen Site. The solid red line indicates the upper critical temperature threshold and the dashed red line represents the upper incipient lethal temperature for Brown Trout.

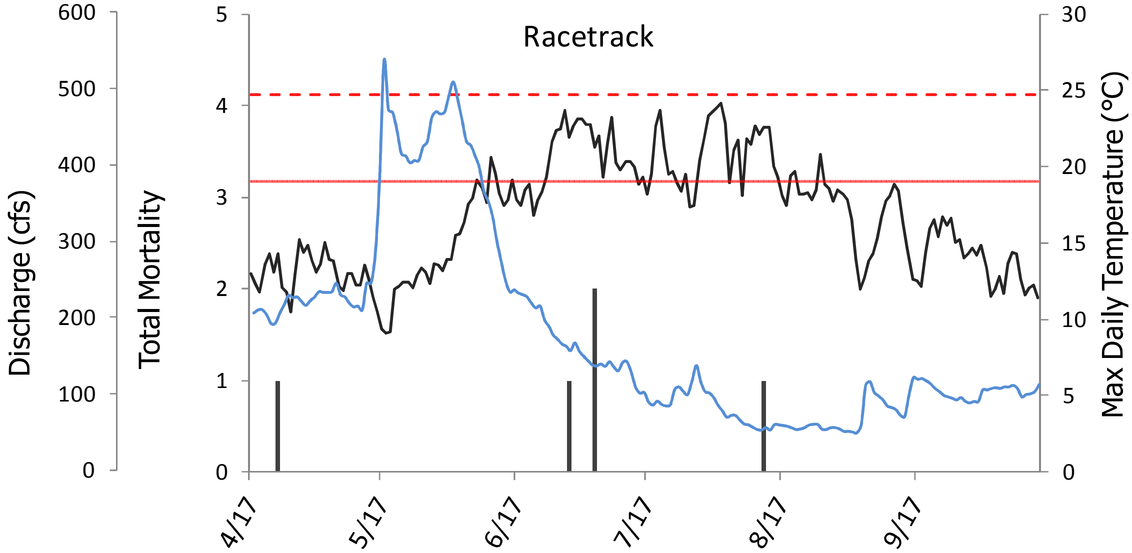

Figure 12. Total fish mortalities, maximum daily water temperature, and mean daily discharge for the Racetrack site. The solid red line indicates the upper critical temperature threshold and the dashed red line represents the upper incipient lethal temperature for Brown Trout.

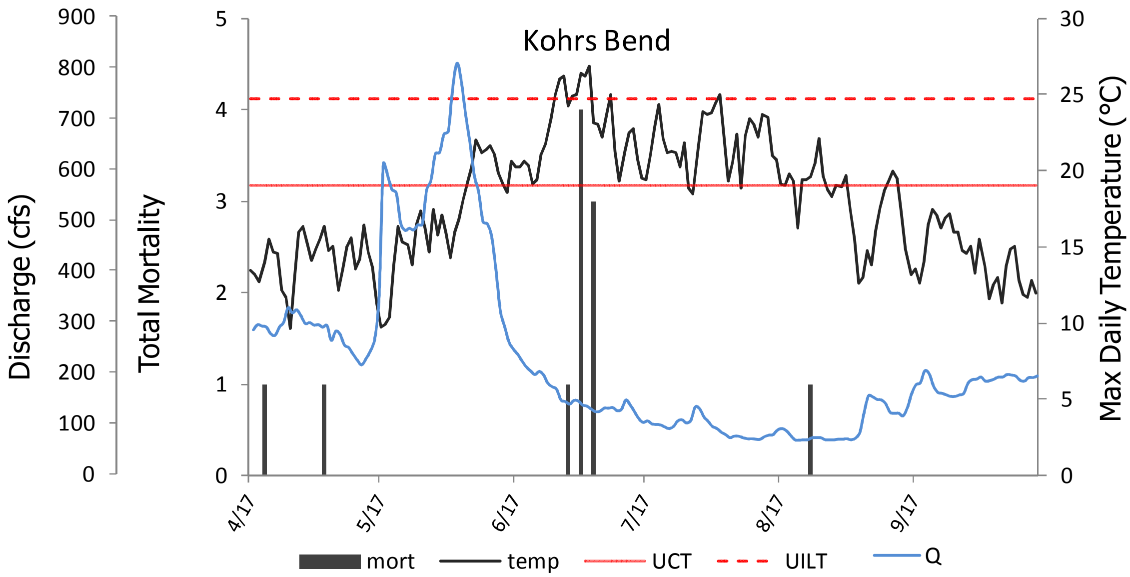

Figure 13. Total fish mortalities, maximum daily water temperature, and mean daily discharge for the Kohrs Bend site. The solid red line indicates the upper critical temperature threshold and the dashed red line represents the upper incipient lethal temperature for Brown Trout.

Water quality

At the Pond 2 outlet, pH rapidly increased from early June to August and exceeded 10 for at least 53 days (Figure 14). The Hydrolab probe at Pond 2 was removed for maintenance for five days in early September. Based on pH readings > 10 both before and after the maintenance, the pH would likely have been over 10 during this time period as well. Daily mean pH measurements were between 7.8 and 9.2 at other sites. Dissolved oxygen ranged from 6.5 to 10.9 mg/L at the four sites, with the lowest DO occurring during the summer months (Figure 15). Although minimum DO concentrations approached 4 mg/L at Pond 2, Galen, and Racetrack, only the Racetrack site actually reached DO concentrations below 4 mg/L during a night in August (Figure 16).

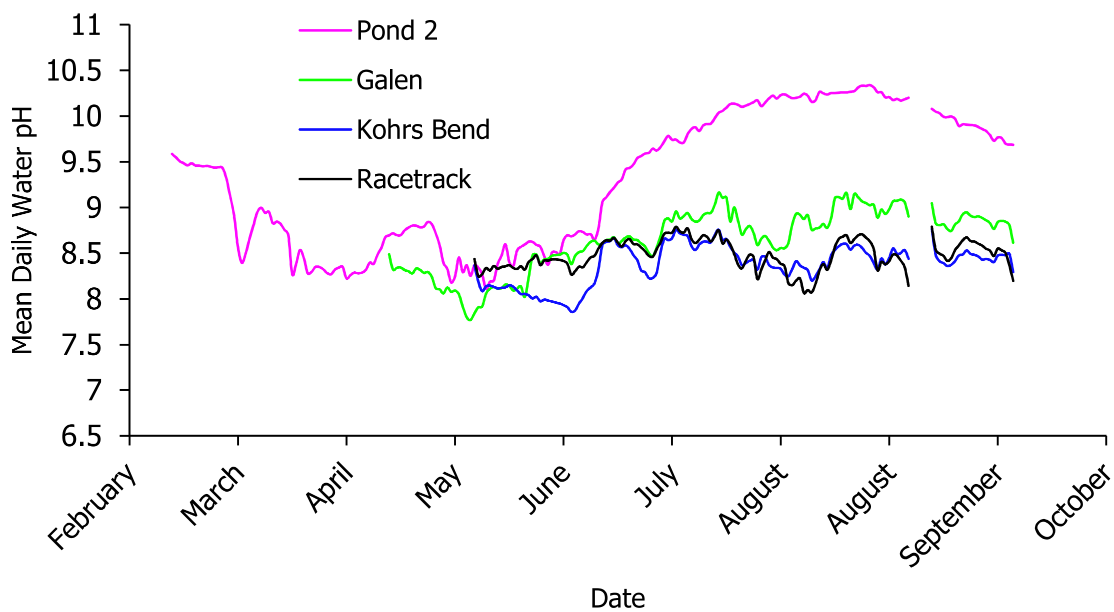

Figure 14. Mean daily water pH at 2015 caged fish sites.

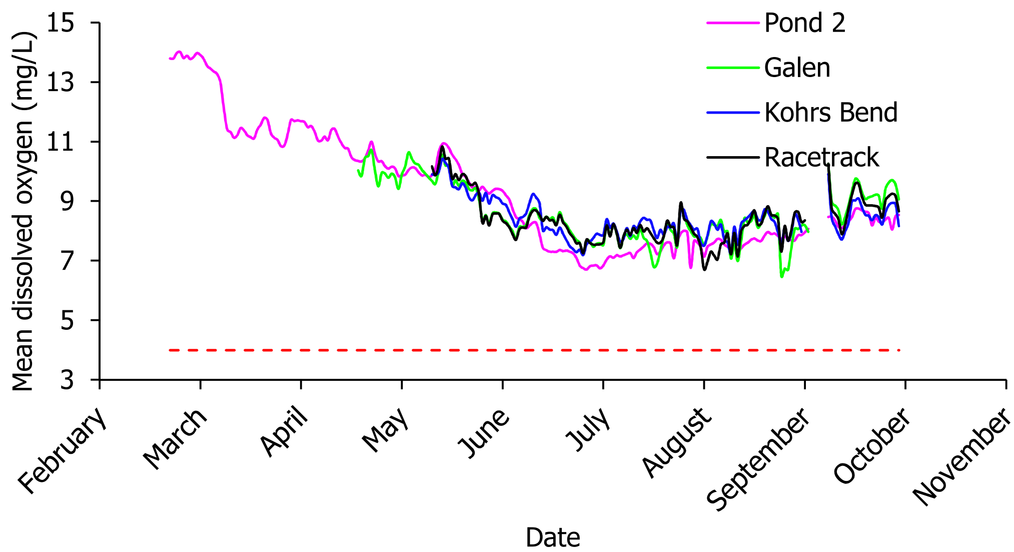

Figure 15. Mean daily dissolved oxygen concentrations at 2015 caged fish sites. The red dashed horizontal line denotes the freshwater ALS one day minimum.

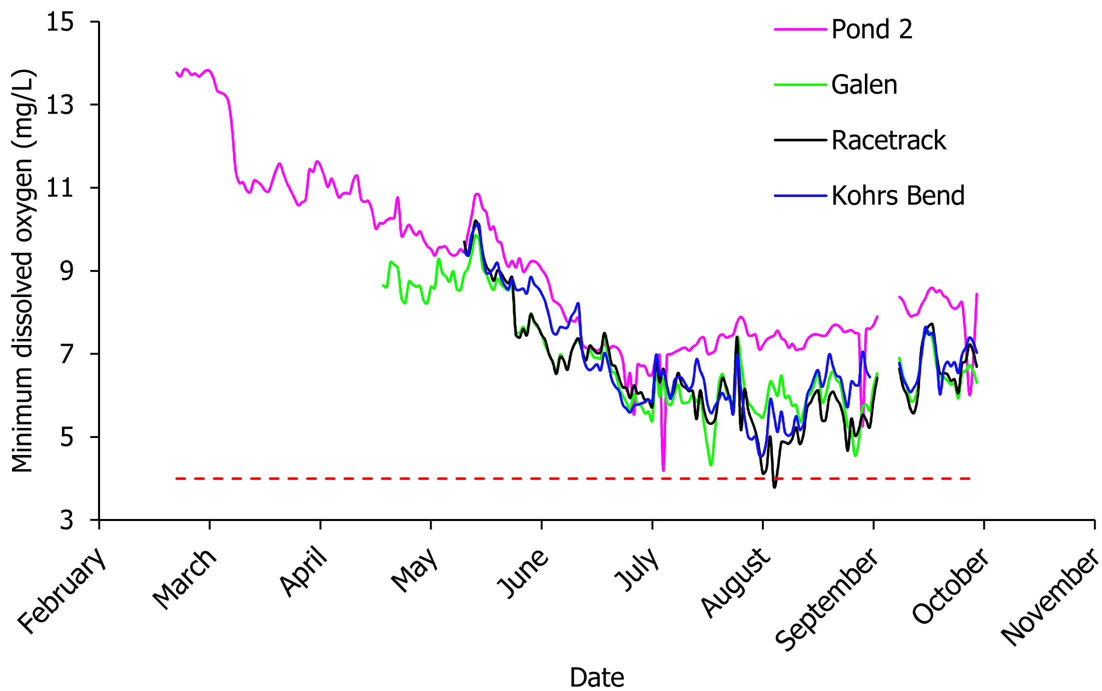

Figure 16. Minimum daily dissolved oxygen concentrations at 2015 caged fish sites. The red dashed horizontal line denotes the freshwater ALS one day minimum.

Discussion

At sections of the Clark Fork River sampled annually, Brown Trout population estimates were lower in 2015 than they had been since at least 2012 at all sites. Brown Trout in the UCFR are not fully vulnerable to electrofishing until age 3 (Figure 6). The increase in Brown Trout numbers in 2013 and 2014 is largely due to increases in numbers of three and four year old fish. These strong year classes are from 2010 and 2011, which were good water years (Figure 17). The higher flows during these years may have provided additional spawning and/or rearing habitats that are not are not available at lower flows. Conversely, 2012 was more of a drought year and these lower flows likely contributed to reduced recruitment, and lower population estimates in 2015.

Like the mainstem Brown Trout populations, Brown Trout estimates were relatively low in some tributary populations in 2015. Brown Trout population estimates have been conducted on two sections of the Little Blackfoot River and one section of Warm Spring Creek since 2007. Data collected from all these sections indicate that Brown Trout populations were lower in 2015 than in any other year that these sections were surveyed (Figure 18). Synchronous declines in mainstem and tributary Brown Trout suggest that similar environmental conditions may affect these populations. Many Brown Trout that reside most of the year in the mainstem Clark Fork River move into tributaries such as the Little Blackfoot and Warm Springs Creek to spawn (Mayfield 2013), so it makes sense that populations trends in the tributaries and mainstem would be linked. The otolith microchemistry project that is currently underway will provide data on fish movement between tributaries and the mainstem and shed light on the primary sources of Brown Trout recruitment in the UCFRB. Information from the microchemistry project will provide more insight into the prevalence of fluvial life histories and the exchange of individual Brown Trout between populations or metapopulations in the UCFRB.

Continuous (entire river) population estimates were conducted on the Clark Fork River in 1987, 2009, and 2015. Population estimates from annual sections indicate Brown Trout numbers were relatively low throughout the Clark Fork River in both 2009 and 2015. Population estimates from the upper reaches of the Clark Fork River were relatively high in 1987. For example, there were 1,212 Brown Trout/km at the most upstream section in 1987. The Brown Trout population in the most upstream sections of the Clark Fork River is more variable from year to year compared to other sections of the Clark Fork River. The coefficient of variation (standard deviation/mean) of Brown Trout population estimates conducted 2008 through 2015 is 0.68 at pH Shack compared to 0.27-0.52 at other reaches during the same time period. The reason for this variability is not well understood, but could be related to metals contamination from banks, sediment, and groundwater inputs, water quality of the discharge of Pond 2, warm summer water temperatures, or low summer flows in either the mainstem or important spawning tributaries. More than likely, the Brown Trout population in the upper sections of the Clark Fork River is impacted by a complex interaction of these factors.

Age 3 fish from Bearmouth (the only annual sampling section in reach C) were significantly longer on average than age 3 fish from other sections or reaches. There was considerable variation in length at age of individual fish, even within the same sampling sections. This variation limited the power of statistical comparisons. However, von Bertalanffy growth curves indicated some differences between reaches and sampling sections that are likely biologically relevant even though the differences are not statistically significant. Generally, fish in reach C (Bearmouth sampling section) grew faster to age 3, but growth appeared to slow down compared to other parts of the Clark Fork River from age 5 on. Brown Trout from the most upstream sampling sections (pH Shack and Sager Lane) were generally longer than fish from other sections from age 5 on. Interestingly age 2 fish from these sections were shorter on average compared to downstream sections. It is possible that older Brown Trout in the upper sections of the Clark Fork River are able to use different resources than younger fish, allowing for an increase in growth once they reach a certain size. Larger Brown Trout do not have the gape limitations of smaller fish, which allows larger fish to eat larger prey items.

Mortality estimates indicate that Brown Trout in reach A of the Clark Fork River have higher mortality rates compared to reaches B and C. This result was consistent to a telemetry study that directly measured mortality of individual fish in the upper Clark Fork River (Mayfield 2013). Mayfield (2013) attributed the increased mortality in reach A primarily to elevated copper concentrations. Estimates of annual mortality from the telemetry study were 0.75 for reach A, 0.68 for reach B, and 0.50 for reach C. These estimates were higher than those generated by catch curves in this study. However, the pattern of high mortality in reach A, intermediate mortality in reach B, and low mortality in reach C was consistent between the catch curves and telemetry studies. The mortality estimate for reach A is among the highest reported in studies of lotic Brown Trout populations (Table 21).

One of the assumptions of catch curves is that mortality is constant between age classes (Miranda and Bettoli 2007). If this assumption is met, a catch curve will be perfectly linear with the log-transformed numbers of fish captured fitting perfectly on the regression line. It is clear that the number of age 7 fish in reach A is well below the value predicted by the catch curve for this reach (Figure 7). Simple annual mortality calculations (N_{t+1}/N_t) indicate that older age classes in reaches A and B experience higher mortality than younger age classes (Table 22). This pattern of increasing mortality with age does not appear to be the case in reach C. One possible explanation for this pattern is the emigration of older trout from reaches A and B into reach C. Catch curve analysis does not account for immigration or emigration when calculating mortality. However, the telemetry study conducted 2009-2011 indicated that movement between reaches of the UCFR was rare for Brown Trout (Mayfield 2013).

Some of the tributary monitoring sections sampled in 2015 have been sampled repeatedly in the past, some have only been sampled for species composition, and some had never been sampled before. The same tributary monitoring sections will be repeated for at least the next two years. These data will be critical in revealing any population trends or changes in fish communities following restoration activities.

In previous surveys of streams in the UCFRB, sculpin either were not identified to species or were thought to be SLCOT. In 2015 surveys, we identified sculpin to species in most sampling sections where they were found and detected a number of RMCOT populations.

RMCOT are generally found in the lower reaches of tributaries to large rivers or streams. SLCOT are generally found upstream of RMCOT and can tolerate colder water temperatures (Adams, Schmetterling and Neeley 2015). Interestingly, Twin Lakes Creek shows the opposite pattern with RMCOT residing higher up in the steam than SLCOT. It is possible that the species was introduced into the upper Twin Lakes Creek system, perhaps through a bait bucket transfer into one or both of the Twin Lakes.

Metals cleanup activities on Silver Bow Creek are nearing completion. FWP has been monitoring the fishery response to cleanup for several years. This monitoring has been done through single pass electrofishing. While single pass electrofishing allows for examinations of species composition and relative abundance, population estimates were not available (except for the Father Sheehan section). In 2015, we were able to generate population estimates for four fish species at four additional sections. These population estimates will be crucial for monitoring future colonization and establishment of various fish species in Silver Bow Creek. Based on the 2015 trout population estimates and overall low number of trout captured, it appears that the trout populations in Silver Bow Creek downstream of Butte are currently small. In contrast to trout, RMCOT and/or LNSU are present in relatively high numbers in most Silver Bow Creek sections. In streams that are rehabilitated for mining impacts, sculpin typically colonize habitats after trout, either because sculpin are less mobile than trout (Mebane et al. 2015) or because sculpin are more sensitive to metals contaminants such as copper (Besser et al. 2007). However, RMCOT far outnumber either EB or WCT at the Above Hwy 1 Bridge and LAO sampling sections. The reason for the high abundance of sculpin in sections with low trout numbers is unclear, but future fish community monitoring may shed light on the factors limiting different fish taxa in Silver Bow Creek.

Sr isotope ratios were highest in Rock Creek and lowest in the Little Blackfoot River. Variation in strontium isotope ratios from water samples collected the UCFRB indicate this chemical marker holds promise for evaluating natal origins and movement of fish in the basin. The range of ^{87}Sr:^{86}Sr ratios in the 16 samples collected in the UCFRB was 0.707446-0.727524. This range is smaller than the range of 0.71131-0.74679 in ^{87}Sr:^{86}Sr ratios of 41 water samples collected in streams of the Flathead River basin in Montana (Mulfield et al 2012). The range of ^{87}Sr:^{86}Sr values in the UCFRB may have been larger if more sites in more tributaries been sampled. When ^{87}Sr:^{86}Sr data is combined with Sr:Ca ratios, most waters sampled in the UCFRB were clearly separated in isoscape plots. The separation of waters and sampling sites by Sr values suggest that otolith strontium profiles will be good markers for examining fish movements and recruitment sources in the UCFRB.

The temporal pattern of caged fish mortality in 2015 was similar to patterns in previous Clark Fork River caged fish studies (e.g., Cook et al. 2015). Most mortalities occurred during low summer flows and high water temperatures. There were no spikes in mortality at Racetrack that would indicate impacts of excessive runoff or other input of contaminated sediments from phase 5 and 6 construction activities.

The pH at the outflow of Pond 2 was elevated for nearly two months, probably because of liming activities. The discharge of high pH water from the Warm Springs Ponds appears to elevate pH at least as far downstream as the Galen Site, which is ~ 13 stream km from the outlet of Pond 2. Racetrack (19 ~ km from Pond 2) and Kohrs Bend (~ 58 km from Pond 2) had similar pHs, suggesting that influence of the high pH water discharged from Pond 2 is minimal at these sites.

Mean daily DO concentrations were well above the ALS standard (4.0 mg/L) at all sites. However, DO did approach or dip below 4 mg/L several times at night at all sites. The dips in DO took place on summer nights when, presumably, biologic demand was high and no photosynthesis was taking place. There were not specific mortality events that took place during these dips in DO, but mortality was generally elevated during periods of high water temperatures.

Restoration of the UCFRB has the potential to permanently benefit the fish and aquatic ecosystem of the Clark Fork River and its tributaries. Restoration activities will take years to complete and fish communities of the UCFRB may take decades to fully respond to aquatic habitat enhancements. Monitoring fisheries changes due to restoration in the UCFRB requires an intensive sampling effort and a wide array of techniques. Population estimates, research on vital rates and water quality, and microchemistry data on fish movement and recruitment will be invaluable for understanding changes in fish populations over time. However, there still may gaps in our understanding of some aspects of the UCFRB aquatic community. For example, more understanding is needed of non trout species, amphibians, invertebrates and the complex interactions of these organisms their environments. Monitoring changes in the UCFRB ecosystem will require an adaptive approach and need to take place at multiple spatial scales including the basin as whole, within individual watersheds and streams, and at specific restoration projects.

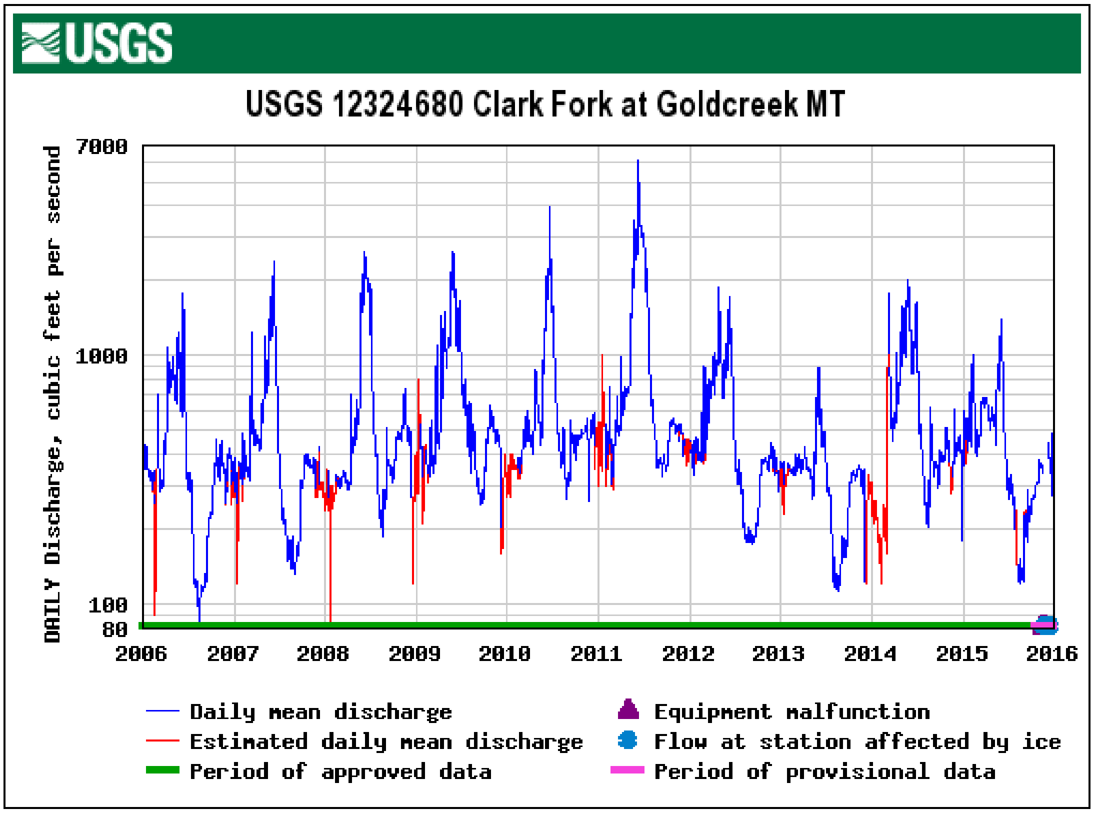

Figure 17. USGS hydrograph from the Clark Fork River gauge near Goldcreek.

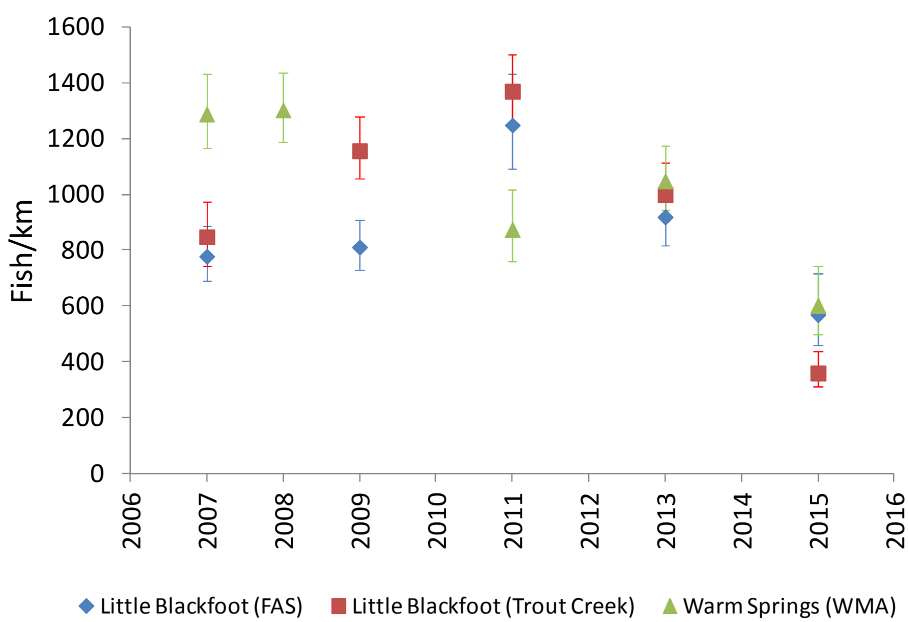

Figure 18. Brown Trout population estimates and 95% CI from two sampling sections on the Little Blackfoot River and one section of Warm Springs Creek. Section names are in parentheses.

Table 21. Catch curve derived Brown Trout total annual mortality estimates from various studies.

Location	Max Age	Total Annual Mortality	Reference
Viau River, France	8	0.55	Pauly and Abad 1994
Vébre River, France	7	0.74	
Green River, WY	6	0.56	Wiley and Dufek 1980
Cedar Run Creek, PA	4	0.31	McFadden and Cooper 1962
Spring Creek, PA	4	0.54	
Spruce Creek, PA	7	0.39	
Young Woman Creek, PA	4	0.23	
Kettle Creek, PA	4	0.54	
Shaver Creek, PA	8	0.31	
Madison River, MT	> 4	0.56	Vincent 1987
Clark Fork River			This study
Reach A	11	0.65	
Reach B	7	0.46	
Reach C	10	0.32	

Table 22. Age specific mortality estimates for Brown Trout in three reaches of the upper Clark Fork River.

	Age			
Reach	**3**	**4**	**5**	**6**
A	2.3	56.1	62.1	91.8
B	24.0	17.4	64.7	60.6
C	-16.4	54.7	45.3	-2.0

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Appendix

Table A1. Locations for monitoring sections on Harvey Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
RM 0.6	100 m	Depletion	46.69828	-113.37712
RM 1.2	120 m	Depletion	46.69159	-113.38245
RM 1.6	100 m	Depletion	46.6822	-113.39116
RM 2.3	100 m	Depletion	46.6768	-113.39555
Below 8 Mile	137 m	Depletion	46.61099	-113.43065
Above FS Road	100 m	Depletion	46.60113	-113.44439

Table A2. Locations for monitoring sections on Boulder Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
USGS Gauge RM 0.4	100 m	Depletion	46.47399	-113.23616
RM 2.0	100 m	Depletion	46.44669	-113.22075
Copper Lakes Trailhead	100 m	Depletion	46.39672	-113.14002

Table A3. Locations for monitoring sections on Flint Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream lat	Downstream Long
Hall	1.54 Km	Mark/Recapture	46.58556	-113.18108
Johnson Tuning Fork	1.32 Km	Mark/Recapture	46.40133	-113.30400
Chor	1.42 Km	Mark/Recapture	46.28823	-113.33698
Above Campground	100 m	Depletion	46.23226	-113.29792

Table A4. Locations for monitoring sections on Warm Springs Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Wildlife Management Area RM 3.3	900 m	Mark/Recapture	46.17756	-112.78963
Below Airport Road RM 3.3	609 m	Mark/Recapture	46.14632	-112.86194
Below Myers Dam	1000 m	Mark/Recapture	46.15136	-113.0276
Garrity WMA	970 m	Mark/Recapture	46.1627	-113.06291
Above Veronica Trail RM 26.0	100 m	Depletion	46.17413	-113.15636
Below Upper Bridge RM 27.4	100 m	Depletion	46.22478	-113.18143
Below Confluence of Upper Forks	100 m	Depletion	46.24232	-113.16467

Table A5. Location for monitoring section on West Fork Warm Springs Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
RM 1.0	100 m	Depletion	46.26241	-113.15594

Table A6. Locations for monitoring sections on the Little Blackfoot River in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Rest Area-FWP FAS	1200 m	Mark/Recapture	46.56424	-112.67784
Above North Trout Creek confluence	1000 m	Mark/Recapture	46.57673	-112.50767
Above Hwy 12 Bridge near Elliston RM 26.7	300 m	Depletion	46.55356	-112.40379
Above Sunshine Camp	200 m	Depletion	46.50319	-112.40455
Below Ontario Creek RM 34.9	120 m	Depletion	46.46229	-112.42051
Above Kading Campground RM 40.1	200 m	Depletion	46.42166	-112.48753

Table A7. Locations for monitoring sections on Silver Bow Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Above Hwy 1 Bridge	325 m	Depletion	46.09515	-112.80497
Fairmont	338 m	Depletion	46.04733	-112.79514
Below German Gulch	388 m	Depletion	46.02852	-112.79500
Ramsay	365 m	Depletion	46.00009	-112.68518
Rocker	250 m	Depletion	46.00108	-112.59348
LAO	237 m	Depletion	46.99606	-112.56037
Father Sheehan	204 m	Depletion	46.98526	-112.50751

Table A8. Locations for monitoring sections on Blacktail Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Golf Course Butte C.C	100 m	Depletion	45.97131	-112.49102
Above Blacktail Loop	100 m	Depletion	45.94505	-112.47636
Below 9 Mile	100 m	Depletion	45.90676	-112.46682
Above 9 Mile	122 m	Depletion	45.89902	-112.46577
Upper Forest Service	100 m	Depletion	45.83146	-112.46887

Table A9. Locations for monitoring sections on Foster Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Lower RM 1.0	100 m	Depletion	46.17497	-113.13055
Middle RM 2.3	100 m	Depletion	46.18919	-113.14171
Upper RM 3.8	130 m	Depletion	46.20537	-113.12403

Table A10. Locations for monitoring sections on Spotted Dog Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
RM 1.1	150 m	Depletion	46.58143	-112.60246
RM 4.6	170 m	Depletion	46.53831	-112.58932

Table A11. Locations for monitoring sections on Twin Lakes Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Lower RM 1.3	96 m	Depletion	46.15655	-113.17270
Meadow RM 2.8	100 m	Depletion	46.14503	-113.19615
Upstream of old bridge RM 4.6	100 m	Depletion	46.12344	-113.20932
Downstream of lower lake RM 7.2	100 m	Depletion	46.09039	-113.21017
Upstream of upper lake RM 8.5	100 m	Depletion	46.07794	-113.21556

Table A12. Locations for monitoring sections on Storm Lake Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Lower RM 0.6	100 m	Depletion	46.15704	-113.21209
Above first road crossing RM 1.4	100 m	Depletion	46.14611	-113.21759
Lower end of meadow RM 4.2	100 m	Depletion	46.11486	-113.24855
Below upper road crossing RM 6.3	100 m	Depletion	46.08979	-113.26583
Above upper road crossing RM 6.3	100 m	Depletion	46.08854	-113.26732

Table A13. Locations for monitoring sections on Barker Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Lower RM 0.5	100 m	Depletion	46.15737	-113.12189
RM 1.5	140 m	Depletion	46.14403	-113.12628

Table A14. Locations for monitoring sections on Cottonwood Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
School RM 0.8	113 m	Depletion	46.40001	-112.72959
Middle RM 3.0	200 m	Single Pass	46.39602	-112.68595
Upper RM 6.9	100 m	Depletion	46.38310	-112.63288

Table A15. Location for monitoring section on Middle Fork Cottonwood Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
RM 0.7	100 m	Depletion	46.35883	-112.57642

Table A16. Locations for monitoring sections on Brown's Gulch in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Lower Ueland RM 2.6	117 m	Depletion	46.02115	-112.66180
Upper Ueland RM 5.3	100 m	Depletion	46.04280	-112.63497
Brothers Ranch RM 9.7	100 m	Depletion	46.09545	-112.62047
Balentine RM 11.5	90 m	Depletion	46.12129	-112.62178
Lower Forest Service RM 13.8	100 m	Depletion	46.13335	-112.58119
Upper Forest Service RM 15.3	100 m	Depletion	46.14518	-112.55856

Table A17. Locations for monitoring sections on Baggs Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
RM 0.4	120 m	Single Pass	46.39659	-112.63052
RM 2.4	113 m	Depletion	46.39407	-112.59422

Table A18. Locations for monitoring sections on Beefstraight Creek in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Above Lower bridge RM 1.3	180 m	Depletion	45.98366	-112.82762
Below Spring Creek trail crossing RM 4.5	100 m	Depletion	45.98829	-112.89375

Table A19. Locations for monitoring sections on German Gulch in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
RM 0.2	188 m	Depletion	46.02005	-112.79037
RM 3.0	100 m	Depletion	45.98455	-112.80830
RM 6.0	100 m	Depletion	45.96258	-112.85433

Table A20. Locations for long term monitoring sections on the Upper Clark Fork River.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
PH Shack	2.57 Km	Mark/Recapture	46.19658	-112.76772
Below Sager Lane	5.15 Km	Mark/Recapture	46.35108	-112.74109
Williams Tavenner	4.02 Km	Mark/Recapture	46.48631	-112.72647
Phosphate	3.38 Km	Mark/Recapture	46.57443	-112.89466
Morse Ranch	12.3 Km	Mark/Recapture	46.65427	-113.14620
Bearmouth	10.6 Km	Mark/Recapture	46.69818	-113.41624

Table A21. Locations for continuous monitoring sections on the Upper Clark Fork River in 2015.

Section Name	Section Length	Estimate Type	Downstream Lat	Downstream Long
Bottom of PH Shack to Perkins Lane	2.41 Km	Mark/Recapture	46.20856	-112.76762
Perkins Lane to Galen Bridge	7.1 Km	Mark/Recapture	46.23732	-112.75307
Galen Bridge to Racetrack Bridge	7.1 Km	Mark/Recapture	46.26529	-112.74454
Racetrack Bridge to Huey Long’s	5.47 Km	Mark/Recapture	46.28933	-112.72417
Huey Long’s to Sager Lane Bridge	6.12 Km	Mark/Recapture	46.31737	-112.73621
Sager Lane Bridge to Arrowstone Park	13.5 Km	Mark/Recapture	46.37852	-112.73710
Arrowstone Park to State Land	13.4 Km	Mark/Recapture	46.45383	-112.72440
State Land to Korh’s Bend	7.08 Km	Mark/Recapture	46.49806	-112.74048
Korh’s Bend to Phosphate	17.86 Km	Mark/Recapture	46.55581	-112.87045
Phosphate to Jens	15.29 Km	Mark/Recapture	46.59489	-113.01276
Jens to Morse Ranch	8.53 Km	Mark/Recapture	46.62399	-113.07820
Drummond to BLM Access	17.54 Km	Mark/Recapture	46.71999	-113.29063
BLM Access to Bear Gulch	3.7 Km	Mark/Recapture	46.71202	-113.33117
Bearmouth to Beavertail	13.5 Km	Mark/Recapture	46.72345	-113.57130
Beavertail to Rock Creek	9.0 Km	Mark/Recapture	46.72556	-113.66805