Fish Population Monitoring in Silver Bow Creek, Montana

2002 - 2010

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Introduction

Historically, sampling of fish in Silver Bow Creek has been very limited because of the extremely harsh environment and the perceived absence of fish. In 2002, Montana Fish, Wildlife and Parks (FWP), Montana Department of Environmental Quality (DEQ), and the Montana Natural Resource Damage Program (NRDP) believed it was important to initiate fish sampling because of the potential for improved water quality associated with remediation and restoration activities of the Streamside Tailings Operable Unit (SSTOU) in Silver Bow Creek. Presumably, improved water quality resulting from tailings removal along Silver Bow Creek will provide conditions that will allow fish to survive and complete life-history cycles to sustain a fishery. Fish Sampling began in 2002 to monitor and document fish response to ongoing remediation activities. The sampling effort was expanded by adding new electrofishing sections during 2005 and 2008 to provide better understanding of fishery trends observed during previous sampling years.

Methods

Two electrofishing study sections were sampled in Silver Bow Creek during 2002 to determine the presence or absence of fish in Silver Bow Creek near Butte, Montana. One section was located upstream of Rocker and one section was located immediately upstream of Montana Avenue in Butte. During 2003 and 2004, three electrofishing study sections were sampled in Silver Bow Creek. The sections were located near Rocker, Ramsay and below the confluence of German Gulch. The upper-most electrofishing section above Montana Street in Butte was not repeated after 2002.

Due to stream channel remediation activities in the Ramsay Area during 2005, the Ramsay Section was replaced with two sections: Reach F (above Ramsay) and Miles Crossing (below Ramsay). The Rocker Section and Below German Gulch Sections were not changed from previous years. Two additional sections were added in 2005 upstream of the sewage treatment outfall near Butte to provide an improved perspective of the longitudinal distribution of fish species in the upper Silver Bow Creek drainage. One section was located in Lower Area One (LAO) and the uppermost section was located near Father Sheehan Park.

During 2006, four of the previously established electrofishing sections were sampled. These included the LAO Section, Rocker Section, Ramsay Section, and Below German Gulch Section. These sites were also sampled in 2007, but in addition, the Father Sheehan Section was also surveyed. In 2008, all of the sections sampled in 2007 were again surveyed, and an additional section was added upstream of the Highway 1 crossing near Opportunity. In 2009 and 2010, all of the sections that were monitored in 2008 were again sampled. Figure 1 shows a map of the study area including locations of current fish sampling sections. Appendix 1 provides a description of all sites sampled in Silver Bow Creek from 2002 through 2010.

At all sections during all years, catch-per-unit-effort sampling of fish was conducted using a backpack electrofishing unit (LR-24 Electrofisher manufactured by Smith Root, Inc.). Generally, a single upstream pass was conducted by a two or three-person crew. At a few sites, multiple upstream passes were made to obtain an estimate of capture efficiency. The entire channel was sampled at all sections and one or two netters captured all observable fish. Fish were held until each pass was completed and

all fish were measured to the nearest millimeter and released. Section lengths were documented and time of electrofishing was recorded from the internal timer of the LR-24 electrofisher to provide measures of sampling effort.

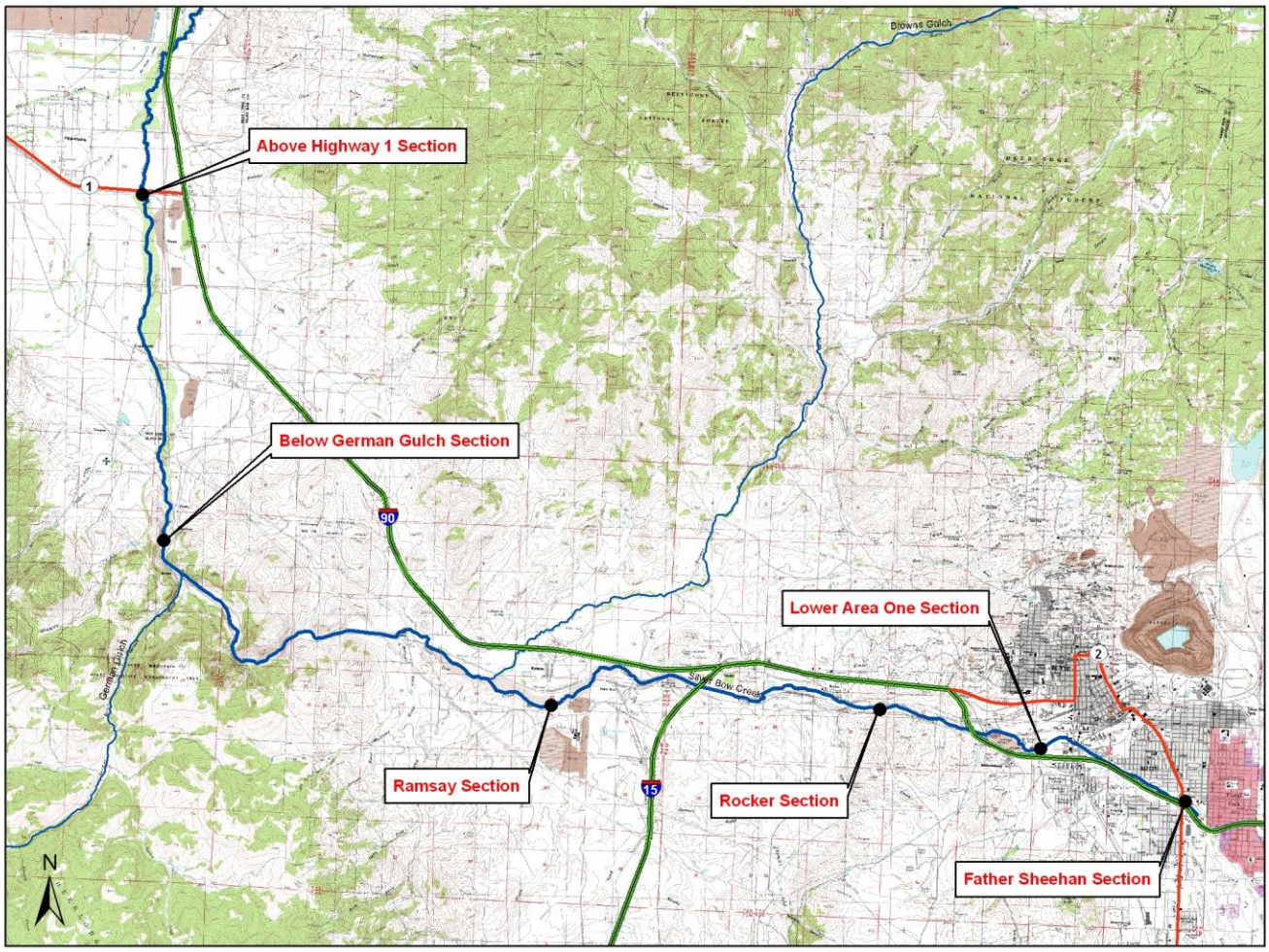

Figure 1. Map of the Silver Bow Creek study area.

Results

General:

Fish sampling results from 2002 through 2010 have primarily consisted of determining the presence or absence of a fish species, an estimate of number of fish per 100 seconds of electrofishing effort also known as Catch-Per-Unit-Effort (CPUE), and basic size structure of fish captured. This level of effort is appropriate for determining fishery trends relating water quality issues to fishery levels, and assessing fishery improvements due to ongoing remediation and restoration activities. Appendix 2 contains a table of catch-per-unit-effort values for all sample sections from 2002-2010.

Fish species composition and abundance in Silver Bow Creek varies throughout the sections sampled from 2002 through 2010. Table 1 shows species presence and general abundance in various portions of the watershed as of 2010 for westslope cutthroat trout (*Oncorhynchus clarki lewisi*), brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), longnose sucker (*Catostomus catostomus*), slimy sculpin (*Cottus cognatus*), and central mudminnow (*Umbra limi*). These represent all of the species that are known to occur in Silver Bow Creek. Westslope cutthroat trout, longnose sucker and slimy sculpin are native to the watershed while brook trout, rainbow trout, and central mudminnow are present due to introductions. Brown trout (*Salmo trutta*) (introduced species) occur downstream of Silver Bow Creek at the Warm Springs Ponds. However, to date, this species has not been captured during routine sampling efforts in the survey reaches of Silver Bow Creek.

Table 1. Fish species presence/absence and general rating of abundance in the upper Silver Bow Creek watershed as of 2010. A = abundant, C = common, P = present, R = rare, NP = not present. Species abbreviations: WCT = Westslope Cutthroat Trout, EB = Brook Trout, RB = Rainbow Trout (or phenotypic hybrid), LN SU = Longnose Sucker, SL COT = Slimy Sculpin, CM MN = Central Mudminnow.

	FISH SPECIES					
LOCATION	**WCT**	**EB**	**RB**	**LN SU**	**SL COT**	**CM MN**
Headwater Tributaries	C	C	NP	R	R	R
Silver Bow Creek – Butte Area (Father Sheehan Park)	R	C	NP	C	C	C
Silver Bow Creek- Remediated Area Above Sewage Outfall (LAO)	R	R	NP	C	A	P
Silver Bow Creek - Remediated Area Below Sewage Outfall (Rocker)	R	R	NP	A	R	R
Silver Bow Creek – Remediated Area Near (Ramsay/Miles Crossing)	R	R	NP	C	R	R
Silver Bow Creek – Below Remediated Area Downstream of German Gulch	R	P	R	C	P	NP
Silver Bow Creek – Below Remediated Area – Above Hwy. 1 Near Opportunity	R	R	R	R	P	NP

A general trend in fish species composition indicates that trout species, which are considered to be relatively sensitive to poor water quality, are mostly limited to upstream reaches of Silver Bow Creek and tributaries of Silver Bow Creek (Table 1). Based on the limited number captured during fall

sampling, trout are relatively rare in mainstem Silver Bow Creek from approximately Butte to Warm Springs Ponds. However, fall sampling from 2007 through 2010 has started to show limited numbers of trout in places where they previously had not been documented (e.g. Ramsay and Rocker Sections).

More tolerant species such as longnose sucker and slimy sculpin are present in most electrofishing sections of Silver Bow Creek at variable densities (Table 1). Suckers tend to be most abundant near the Rocker Section but are still fairly common both up and downstream from this site. Sculpin tend to be most abundant near Butte and become less abundant at downstream sites. Central mudminnow are dispersed throughout Silver Bow Creek from approximately Butte to Ramsay, but are most abundant near Butte.

2002:

Sampling conducted in Silver Bow Creek on November 6, 2002 found longnose suckers, slimy sculpin, and a central mudminnow. The fish assemblage in the Rocker Section was primarily comprised of longnose suckers. We captured 75 longnose suckers and two slimy sculpin during 1529 seconds of electrofishing. The study section length was approximately 1000 ft. A brief electrofishing run was conducted upsteam of Montana Avenue in Butte to compare species composition in the area upstream of Rocker. While longnose suckers appeared to be less abundant, slimy sculpin were found to be more plentiful near Montana Avenue, compared to the Rocker Section (Table 2).

Streamflow in Silver Bow Creek during the date of sampling in 2002 was 15 cfs at the USGS gauge station below Blacktail Creek, and was 22 cfs at the USGS gauge station at Opportunity. Additionally, mean monthly flow below Blacktail Creek was highest during June at 20.2 cfs, and lowest during July at 13.3 cfs. At Opportunity, mean monthly flow was highest during June at 67.3 cfs, and lowest during August at 19.4 cfs.

Table 2. Comparison of fish abundance in two sections of Silver Bow Creek during CPUE sampling on November 6, 2002.

SECTION	SPECIES	#PER 100 SECONDS
ROCKER	Sucker	4.9/100 seconds
	Sculpin	0.1/100 seconds
	Mudminnow	--
MONTANA AVE.	Sucker	2.6/100 seconds
	Sculpin	3.5/100 seconds
	Mudminnow	0.002/100 seconds

2003:

Fish sampling on October 10, 2003 was conducted at three electrofishing sections to include a section in the previously remediated reach of Silver Bow Creek near Rocker, and two sections downstream of remediation activities (near Ramsay and German Gulch). Sampling of the Rocker Section showed

similar results to the sampling conducted in 2002. We captured 48 longnose suckers and one slimy sculpin during 1580 seconds of electrofishing in the Rocker Section. No fish were captured in the Ramsay Section in 1622 seconds of electrofishing, and no fish were captured in the Below German Gulch Section during 1412 seconds of electrofishing. See Appendix 2 for a summary of catch-per-unit-effort for all sections sampled.

Streamflow in Silver Bow Creek during the date of sampling was 14 cfs at the USGS gauge station below Blacktail Creek, and was 19 cfs at the USGS gauge station at Opportunity. Additionally, mean monthly flow below Blacktail Creek was highest during March at 30.4 cfs, and lowest during July at 12.4 cfs. At Opportunity, mean monthly flow was highest during May at 88.5 cfs, and lowest during August at 16.0 cfs.

2004:

Fish sampling on October 1, 2004 was conducted again at the three standard electrofishing sections near Rocker, Ramsay and Below German Gulch. Once again, no fish were observed during fall sampling of the Ramsay Section and the Below German Gulch Section during 2004. As in previous years, longnose suckers and slimy sculpin were captured in the Rocker Section during the fall sampling. Sculpin continued to be rare with only one individual captured in 2004. Based on catch per effort sampling, abundance of longnose suckers declined between 2002 and 2004. See Appendix 2 for a summary of catch-per-unit-effort for all sections sampled.

Streamflow in Silver Bow Creek during fall sampling in 2004 was 16 cfs at the USGS gauge station below Blacktail Creek, and was 20 cfs at the USGS gauge station at Opportunity. Additionally, mean monthly flow below Blacktail Creek was highest during March at 18.5 cfs, and lowest during July at 14.2 cfs. At Opportunity, mean monthly flow was highest during May at 39.4 cfs, and lowest during August at 16.4 cfs.

During spring 2004, the Below German Gulch Section was sampled to determine whether fish were able to persist seasonally in a section of Silver Bow Creek downstream of German Gulch. It was suspected that fish occasionally migrated downstream from German Gulch into Silver Bow Creek. The sampling in May 2004 was to determine the potential for Silver Bow Creek to support fish during the spring when water quality may be improved by dilution due to rainfall and snowmelt. On May 19, 2004 the standard 1000 ft section below German Gulch was sampled with three electrofishing passes. Three species of fish were observed during this sampling (Table 3). Streamflow in Silver Bow Creek during the date of sampling was 22 cfs at the USGS gauge station below Blacktail Creek, and was 49 cfs at the USGS gauge station at Opportunity.

Table 3. Results of multiple pass electrofishing in the section below German Gulch in Silver Bow Creek on May 19, 2004.

PASS #	SPECIES	TOTAL LENGTH (mm)	EFFORT
1	BROOK TROUT	290 mm	1890 seconds
	CUTTHROAT TROUT	198 mm	

	LN SUCKER	51 mm	
	LN SUCKER	48 mm	
2	CUTTHROAT TROUT	76 mm	1720 seconds
3	NO FISH		1120 seconds

2005:

From 2002 through 2004, three sections were sampled to determine trends in fish abundance. In 2005, the Rocker and Below German Gulch sections were surveyed as usual, but the Ramsay Section was under construction and was replaced with two electrofishing sections (above Ramsay Section/Reach F) and below Ramsay Section/Miles Crossing). In addition, two new sections were added above the sewage treatment plant near Butte. The added sections were the Lower Area One Section and the Father Sheehan Park Section.

Fish abundance trends from 2005 indicate similar findings to previous years where sucker and sculpin abundance decline between Rocker and the unremediated section below Ramsay. Fish were observed in the Below German Gulch Section during spring sampling, which is similar to past years; however, a few fish were also observed during fall sampling at this location for the first time since this evaluation began. Fish sampling of two new sections upstream of the sewage treatment outfall in 2005 provided an improved perspective of the longitudinal distribution of fish species in the upper Silver Bow Drainage. See Appendix 2 for a summary of catch-per-unit-effort for all sections sampled.

Streamflow in Silver Bow Creek during 2005 fall sampling was 17 cfs (10/18/2005) and 24 cfs (11/3/2005) at the USGS gauge station below Blacktail Creek, and was 33 cfs (10/18/2005) and 44 cfs (11/3/2005) at the USGS gauge station at Opportunity. During spring sampling (6/27/2005), flow was 25 cfs at the USGS gauge station below Blacktail Creek, and was 70 cfs at the USGS gauge station at Opportunity. Additionally, mean monthly flow in Silver Bow Creek below Blacktail Creek was highest during May at 33 cfs, and lowest during July at 15.3 cfs. At Opportunity, mean monthly flow was highest during May at 97.0 cfs, and lowest during August at 20.0 cfs.

2006:

Four electrofishing sections were surveyed during early October 2006. Fish population surveys were conducted at the following sections: LAO Section (above sewage inflow), Rocker Section, Ramsay Section, and Below German Gulch Section. No spring sampling was conducted in 2006.

New sampling information collected during 2006 included pH and ammonia samples collected at the Rocker and Ramsay Sections, and tissue samples collected from suckers also at Rocker and Ramsay.

The most notable finding during fall 2006 was the capture of a single brook trout (112 mm in TL) at the Below German Gulch Section, which represents the first trout observed at this site during fall sampling. Previously, trout were only observed during spring sampling. Fish composition at the Lower Area One section changed between 2005 and 2006. Suckers dominated the catch in 2005 and sculpin were most abundant in 2006. It is not known whether changes in sampling efficiency or an actual change in species composition was responsible for the varying observations in 2005 and 2006. Sucker abundance appeared to increase at the Rocker Section between 2005 and 2006, and sucker abundance increased at the Ramsay Section between 2004 (pre-remediation, no fish) and 2006 (post-remediation, 144 suckers in 1987 seconds of sampling). Sampling of the Ramsay Section was modified in 2005 due to construction activities and results are not included in this summary. See Appendix 2 for a summary of catch-per-unit-effort for all sections sampled in 2006.

Streamflow in Silver Bow Creek during 2006 fall sampling was 16 cfs (10/3/2006) and 20 cfs (10/6/2006) at the USGS gauge station below Blacktail Creek, and was 23 cfs (10/3/2006) and 31 cfs (10/6/2006) at the USGS gauge station at Opportunity. Additionally, mean monthly flow below Blacktail Creek was highest during April at 46.9 cfs, and lowest during August at 14.1 cfs. At Opportunity, mean monthly flow was highest during April at 113.7 cfs, and lowest during August at 14.8 cfs.

2007:

Five electrofishing sections were surveyed on October 10, 2007. Sections sampled included the Father Sheehan Section, Lower Area One Section, Rocker Section, Ramsay Section, and the section below German Gulch. The section below German Gulch was also sampled in the spring on June 1, 2007. At the time of the fall sample, crews discovered that a bridge was being replaced at the site of the previously sampled section below German Gulch. Because of this, the bottom of the section was moved upstream 1000 feet (to the top of the standard section). The standard section below German Gulch was sampled during the spring.

There were several notable findings during fall 2007. At the section below German Gulch, four westslope cutthroat trout (Mean Length: 121 mm, Range: 57-184 mm) were captured in one and a half electrofishing passes (two westslope cutthroat trout were captured during 2584 seconds of sampling on the first pass, and two westslope cutthroat trout were captured during 1036 seconds of sampling on the partial, second pass). These fish represent the first westslope cutthroat trout observed at this site during fall sampling. In addition to the westslope cutthroat trout, 49 brook trout (39 on the first pass, and 10 on the partial second pass, Mean Length: 116 mm, Range: 85-148 mm), 51 longnose suckers (46 on the first pass, and 5 on the partial second pass, Mean Length: 100 mm, Range: 53-157 mm), and 23 slimy sculpin (18 on the first pass, and 5 on the partial second pass) were also captured at the below German Gulch section. This represents the highest number of brook trout ever captured at this site during fall sampling, as well as the greatest abundance of longnose suckers and slimy sculpin at the site since sampling began in 2003 (both fall or spring). On June 1, 2007, the standard 1000 ft section was sampled with two passes. On the first pass, two westslope cutthroat trout (75 and 195 mm), four brook trout (Length Range: 185 to 295 mm), 15 suckers, three sculpin, and one central mudminnow were captured during 3030 seconds of electrofishing, and one westslope cutthroat trout (67 mm) and six brook trout (Mean Length: 56 mm, Range: 30-180mm) were captured during 2552 seconds of electrofishing on the second pass.

Another notable finding during fall 2007 was the documented presence of a single brook trout (Length: 104 mm) at the Ramsay Section. This represents the first trout observed at this site since sampling was initiated in 2003 as well as the first trout in the remediated SSTOU. In addition to the one brook trout, 42 longnose suckers (Mean Length: 75 mm, Range: 43-213 mm) and three slimy sculpin were also captured during the 2092 seconds of electrofishing. While sucker abundance was down from 2006, sculpin abundance was approximately the same.

At the Rocker Section, only longnose suckers and slimy sculpin were collected during fall 2007. These are the only two species that have been collected at this site since sampling was initiated in 2002. In total, 109 longnose suckers (Mean Length: 121 mm, Range: 53-228 mm) and five slimy sculpin were captured during 2506 seconds of electrofishing. While longnose sucker abundance was down from 2006, it was approximately equal to 2005. Slimy sculpin abundance was similar to past years when sculpin were found.

Another finding of interest from fall 2007 was the presence of three brook trout (Mean Length: 206 mm, Range: 232-277 mm) in the section at Lower Area One. These fish represent the first trout collected at the site since sampling was initiated in 2005. In addition to the three brook trout, 42 longnose suckers (Mean Length: 76 mm, Range: 39-172 mm), 231 slimy sculpin, and 10 central mudminnow were captured during 2971 seconds of electrofishing. Like 2006, sculpin were much more abundant at the Lower Area One site than suckers, which for the third year in row, continued to decline in abundance. Mudminnow abundance was up from past years.

At the Father Sheehan Section, two passes were made through the section during fall 2007. During the first pass, 64 brook trout (Mean Length: 170 mm, Range: 69-308 mm), 59 longnose suckers (Mean Length: 129 mm, Range: 103-203 mm), 133 slimy sculpin, and 39 central mudminnow were captured during 2744 seconds of electrofishing. On the second pass, 11 brook trout (Mean Length: 150 mm, Range: 103-240 mm), 29 longnose suckers (Mean Length: 125 mm, Range: 102-181 mm), 58 slimy sculpin, and 15 central mudminnow were captured during 1610 seconds of electrofishing. All species sampled during fall 2007showed an increase in abundance from 2005. Table 4 contains catch-per-unit-effort values from all the sections sampled during fall 2007. See Appendix 2 for a summary of catch-per-unit-effort for all sections sampled from 2002-2007.

Streamflow in Silver Bow Creek during the 2007 fall sampling was 22 cfs at the USGS gauge station below Blacktail Creek, and was 35 cfs at the USGS gauge station at Opportunity. During spring sampling, flow was 32 cfs at the USGS gauge station below Blacktail Creek, and was 90 cfs at the USGS gauge station at Opportunity. Additionally, mean monthly flow in Silver Bow Creek below Blacktail Creek was highest during June at 36.4 cfs, and lowest during August at 15.8 cfs. At Opportunity, mean monthly flow was highest during June at 87.2 cfs, and lowest during August at 17.3 cfs.

Fish were collected from 5 sections of Silver Bow Creek in 2007 for liver metal analysis. See Appendix 3 for a summary of liver results.

Table 4. Catch-per-unit-effort for species sampled in five sections of Silver Bow Creek, October 2007. In sections where multiple electrofishing passes were made (Father Sheehan and Below German Gulch Section) only data from the first pass is summarized for comparison purposes.

Section	Species	# Per 100 Seconds of Effort
Father Sheehan	Brook Trout	2.33
	Longnose Sucker	2.15
	Sculpin	4.85
	Central Mudminnow	1.42
Lower Area One	Brook Trout	0.10
	Longnose Sucker	1.41
	Sculpin	7.78
	Central Mudminnow	0.34
Rocker	Longnose Sucker	4.35
	Sculpin	0.20
Ramsay	Brook Trout	0.05
	Longnose Sucker	2.01
	Sculpin	0.14
Below German Gulch	Westslope Cutthroat Trout	0.08
	Brook Trout	1.51
	Longnose Sucker	1.78
	Sculpin	0.70

2008:

Six electrofishing sections were surveyed on October 6 and 7, 2008. Sections sampled included the Father Sheehan Section, Lower Area One Section, Rocker Section, Ramsay Section, Below German Gulch Section, and a newly added section above the Highway 1 crossing near Opportunity.

At the Father Sheehan Section, two passes were made through the 500-foot section. During the first pass, 84 brook trout (Mean Length: 150 mm, Range: 69-358 mm), 12 longnose suckers (Mean Length: 137 mm, Range: 69-262 mm), 84 slimy sculpin, and 16 central mudminnow were captured during 2339 seconds of electrofishing. On the second pass, 26 brook trout (Mean Length: 121 mm, Range: 73-253 mm), 4 longnose suckers (Mean Length: 163 mm, Range: 132-190 mm), 69 slimy sculpin, and 9 central mudminnow were captured during 1839 seconds of electrofishing. Brook trout showed an increase in density in the section compared to 2007, while the remaining three species all showed declines in relative abundance with longnose sucker showing the most notable drop. Table 5 contains catch-per-unit-effort values from all the sections sampled during fall 2008. See Appendix 2 for a summary of catch-per-unit-effort for all sections sampled from 2002-2008.

At Lower Area One, one 2467 second electrofishing pass was made through the sample section. This sampling effort yielded 41 longnose suckers, 114 slimy sculpin, and six central mudminnow. Longnose

sucker and central mudminnow appeared to be at similar densities to 2007, while slimy sculpin appeared to drop in relative abundance (Table 5; Appendix 2). No trout were observed at the Lower Area One Section in 2008 despite the presence of three brook trout in 2007.

At the Rocker Section, one 2108 second electrofishing pass turned up 188 longnose suckers but no other species. During past sampling efforts low numbers of slimy sculpin had been found in the section. Trout have remained absent from the Rocker Section since sampling was initiated in 2002.

Perhaps one of the most notable findings during 2008 sampling was the discovery of two westslope cutthroat trout at the Ramsay Section. These fish were captured during one 1584 second electrofishing pass through the survey site. These two trout were relatively large ranging in size from 300 to 450 mm in total length, and represent the fist native trout documented in this now remediated reach of stream. In addition, 2008 sampling also turned up one brook trout (137 mm total length), 32 longnose suckers (Mean Length: 52 mm, Range: 37-227 mm), and five slimy sculpin. All but one of the longnose suckers captured appeared to be young-of-the-year. Densities of species captured in the Ramsay Section in 2008 (excluding westslope cutthroat trout) were similar to 2007.

Other findings of interest in 2008 were the documentation of rainbow trout at the sections below German Gulch and above the Highway 1 crossing near Opportunity. At the section below German Gulch, one large (455 mm total length) rainbow trout and one phenotypic rainbow trout-westslope cutthroat trout hybrid (250 mm total length) were captured during 1865 seconds of electrofishing. Additionally, two brook trout (Mean Length: 83 mm, Range: 51-115 mm), 35 longnose suckers, and four slimy sculpin were also noted in the section. At the section above the Highway 1 crossing near Opportunity, four rainbow trout, 23 longnose suckers, and 29 slimy sculpin were captured during 3269 seconds of electrofishing. The documentation of rainbow trout in these two sections is the first record of the species in Silver Bow Creek since sampling was initiated in 2002.

Streamflow in Silver Bow Creek during the 2008 fall sampling was 18 cfs at the USGS gauge station below Blacktail Creek, and was 30 cfs at the USGS gauge station at Opportunity. Mean monthly flow in Silver Bow Creek below Blacktail Creek was highest in 2008 during June at 75.1 cfs, which was over 40 cfs higher than the period-of-record (POR) average for the same month (POR = 31.1 CFS). Mean monthly flow was lowest at the USGS gauge station below Blacktail Creek during January at 14.3 cfs, with August similarly low at 15.2 cfs. At Opportunity, mean monthly flow was highest in Silver Bow Creek also during June, at 194.3 cfs (POR = 96.8 cfs), and lowest during August at 20.2 cfs (POR = 27.1 cfs).

Table 5. Catch-per-unit-effort for species sampled in six sections of Silver Bow Creek, October 2008. In sections where multiple electrofishing passes were made (Father Sheehan) only data from the first pass is summarized for comparison purposes

Section	Species	# Per 100 Seconds of Effort
Father Sheehan	Brook Trout	3.59
	Longnose Sucker	0.51
	Sculpin	3.59
	Central Mudminnow	0.68

Lower Area One	Longnose Sucker	1.66
	Sculpin	4.62
	Central Mudminnow	0.24
Rocker	Longnose Sucker	8.92
Ramsay	Westslope Cutthroat Trout	0.13
	Brook Trout	0.06
	Longnose Sucker	2.02
	Sculpin	0.32
Below German Gulch	Rainbow /W. Cutthroat Trout	0.11
	Brook Trout	0.11
	Longnose Sucker	1.88
	Sculpin	0.21
Above Highway 1 Bridge	Rainbow Trout	0.12
	Longnose Sucker	0.70
	Sculpin	0.89

2009:

Six electrofishing sections were surveyed on October 8, 2009. Sections sampled included Father Sheehan, Lower Area One, Rocker, Ramsay, Below German Gulch, and Above Highway 1 Bridge. Table 6 contains catch-per-unit-effort values from all the sections sampled during fall 2009. See Appendix 2 for a summary of catch-per-unit-effort for all sections sampled from 2002-2009.

At the Father Sheehan Section, two passes were made through the 500-foot section. During the first pass, 82 brook trout (Mean Length: 144 mm, Range: 76-341 mm), one longnose sucker (Length: 200 mm), 36 slimy sculpin, and six central mudminnow were captured during 1394 seconds of electrofishing. On the second pass, 32 brook trout (Mean Length: 130 mm, Range: 78-332 mm), two longnose suckers (Mean Length: 155 mm, Range: 117-192 mm), 26 slimy sculpin, and two central mudminnow were captured during 1453 seconds of electrofishing. Brook trout appeared to show an increase in density in the section compared to previous years based on calculated CPUE, but the actual number of fish captured was similar to 2008. Other species present in the reach appeared to show a continued decline in relative abundance, although the reason for this pattern is not well understood at this time.

At Lower Area One, one 1837-second electrofishing pass was made through the sample section. This sampling effort yielded one westslope cutthroat trout, two brook trout, 19 longnose suckers, 69 slimy sculpin, and seven central mudminnow. The presence of a westslope cutthroat trout in Lower Area One was notable as it was the first documented presence of the species during fall sampling in the reach. Densities of other species captured in the section in 2009 were roughly similar to 2008, although sucker and sculpin density did appear to show some decline.

At the Rocker Section, one 1760-second electrofishing pass turned up 40 longnose suckers and one slimy sculpin. The calculated CPUE for suckers was noticeably lower than the previous four years. Trout have remained absent from the Rocker Section during fall sampling since it was initiated in 2002.

At the Ramsay Section, one 1387-second electrofishing pass was made through the 1000-foot sample reach. The most notable finding was the presence of four westslope cutthroat trout (Mean Length: 246 mm, Range: 169-298 mm). This species was first documented in the reach in 2008 when two relatively large individuals were captured. Electrofishing in 2009 also turned up seven young-of-the-year longnose suckers (Mean Length: 54 mm), and one slimy sculpin. Both sucker and sculpin density appeared down from recent years.

At the German Gulch Section, 2849 seconds of electrofishing turned up two westslope cutthroat trout (Mean Length: 340 mm, Range: 327-353 mm), six brook trout (Mean Length: 152 mm, Range: 78-267 mm), and nine longnose suckers. While trout densities were relatively similar to what was found in 2008, sucker density appeared lower compared to the last couple of years.

At the section above the Highway 1 crossing near Opportunity, three rainbow trout, one brook trout, one longnose sucker, and six slimy sculpin were captured during 1644 seconds of electrofishing. The presence of a brook trout was the first documented occurrence of the species in this reach since sampling was initiated in 2008. Rainbow trout density appeared similar to the previous year, while sucker and sculpin density appeared to be down.

Streamflow in Silver Bow Creek during the 2009 fall sampling was 22 cfs at the USGS gauge station below Blacktail Creek, and was 39 cfs at the USGS gauge station at Opportunity. Mean monthly flow in Silver Bow Creek below Blacktail Creek was highest in 2009 during May at 40.3 cfs, which was about 9 cfs higher than the period-of-record (POR) average for the same month (POR = 31CFS). Mean monthly flow was lowest at the USGS gauge station below Blacktail Creek during January at 16.2 cfs. At Opportunity, mean monthly flow was highest in Silver Bow Creek during May, at 176 cfs (POR = 98 cfs), and lowest during September at 29.9 cfs (POR = 30 cfs).

Table 6. Catch-per-unit-effort for species sampled in six sections of Silver Bow Creek, October 2009. In sections where multiple electrofishing passes were made (Father Sheehan) only data from the first pass is summarized for comparison purposes

Section	Species	# Per 100 Seconds of Effort
Father Sheehan	Brook Trout	5.88
	Longnose Sucker	0.07
	Sculpin	2.58
	Central Mudminnow	0.43
Lower Area One	Westslope Cutthroat Trout	0.05
	Brook Trout	0.11
	Longnose Sucker	1.03
	Sculpin	3.76
	Central Mudminnow	0.38

Rocker	Longnose Sucker	2.27
	Sculpin	0.06
Ramsay	Westslope Cutthroat Trout	0.29
	Longnose Sucker	0.50
	Sculpin	0.07
Below German Gulch	Westslope Cutthroat Trout	0.07
	Brook Trout	0.21
	Longnose Sucker	0.32
Above Highway 1 Bridge	Rainbow Trout	0.18
	Brook Trout	0.06
	Longnose Sucker	0.06
	Sculpin	0.36

2010:

Six electrofishing sections were surveyed on October 14, 2010. Sections sampled included Father Sheehan, Lower Area One, Rocker, Ramsay, Below German Gulch, and Above Highway 1 Bridge. Table 7 contains catch-per-unit-effort values from all the sections sampled. See Appendix 2 for a summary of catch-per-unit-effort for all sections sampled from 2002-2010.

At the Father Sheehan Section, one electrofishing pass was made through the 500-foot section. In this pass, 114 brook trout (Mean Length: 171 mm, Range: 74-377 mm), 12 longnose sucker (Mean Length: 124 mm, Range: 57-237 mm), 33 slimy sculpin, and five central mudminnow were captured during 1764 seconds of electrofishing. Brook trout appeared to show an increase in density in the section compared to the previous year, and CPUE was the highest on record. Longnose sucker density appeared up from the previous year, but was still relatively low overall. Other species present in the reach (sculpin and mudminnow) appeared to show a continued decline in relative abundance, although the reason for this pattern is not well understood at this time.

At Lower Area One, one 2103-second electrofishing pass was made through the sample section. This sampling effort yielded 20 brook trout (Mean Length: 172 mm, Range: 129-276 mm), nine longnose suckers (Mean Length: 147 mm, Range: 110-168 mm), and 30 slimy sculpin. Brook trout density was by far the highest on record. Sucker and sculpin density however, appeared to show a decline from 2009. One thing to note about the Lower Area One Section is that at the time of sampling, beavers had impounded much of the section and physical habitat was different from previous years. The stream was deeper and slower and that may have affected species composition and/or electrofishing capture efficiency. Given the physical changes to the habitat in the section, changes in fish density should be evaluated with caution.

At the Rocker Section, one 1952-second electrofishing pass collected four westslope cutthroat trout (Mean Length: 192 mm, Range: 129-303 mm), 268 longnose suckers (Mean Length: 152 mm, Range: 75-265 mm), and two slimy sculpin. Perhaps the most notable finding of 2010 was the appearance of

trout in the Rocker Section. The presence of four westslope cutthroat trout represents the first documented presence of trout in this section during fall sampling. Sucker density was also noticeably higher than previous years, and was actually the highest on record based on CPUE. Additionally, most of the suckers were from larger, older age classes (i.e. numbers were not heavily comprised of young-of-the-year fish). It is unclear where many of these fish were located during previous sampling years, or why they were so abundant in the Rocker Section in 2010.

At the Ramsay Section, one 1545-second electrofishing pass was made through the 1000-foot sample reach. The most notable finding was the presence of eight westslope cutthroat trout (Mean Length: 353 mm, Range: 316-385 mm). This species was first documented in the reach in 2008 when two relatively large individuals were captured. Electrofishing in 2010 also turned up four young-of-the-year longnose suckers (Mean Length: 41 mm), and one relatively large brook trout (Length: 416 mm). Overall fish density remains low in the Ramsay Section despite this stream reach having already been remediated/restored in 2005.

At the German Gulch Section, 1688 seconds of electrofishing turned up two westslope cutthroat trout (Mean Length: 188 mm, Range: 150-225 mm), 16 brook trout (Mean Length: 118 mm, Range: 85-230 mm), 36 longnose suckers (Mean Length: 89 mm, Range: 48-168 mm), and five slimy sculpin. Trout density was up from the previous two years, although the species composition was primarily made up of non-native brook trout. Sucker density also appeared up from the previous year, and was similar to densities observed in 2007 and 2008.

At the section above the Highway 1 crossing near Opportunity, one westslope cutthroat trout (Length: 317 mm), four rainbow trout (Mean Length: 392 mm, Range: 325-488 mm), and 41 slimy sculpin were captured during 1233 seconds of electrofishing. The presence of a westslope cutthroat trout was the first documented occurrence of the species in this reach since sampling was initiated in 2008. Rainbow trout density was similar to previous years. Sculpin density however, appeared to be up considerably based on CPUE.

Table 7. Catch-per-unit-effort for species sampled in six sections of Silver Bow Creek, October 2010.

Section	Species	# Per 100 Seconds of Effort
Father Sheehan	Brook Trout	6.46
	Longnose Sucker	0.68
	Sculpin	1.87
	Central Mudminnow	0.28
Lower Area One	Brook Trout	0.95
	Longnose Sucker	0.43
	Sculpin	1.43
Rocker	Westslope Cutthroat Trout	0.20
	Longnose Sucker	13.73
	Sculpin	0.10

Ramsay	Westslope Cutthroat Trout	0.52
	Brook Trout	0.06
	Longnose Sucker	0.26
Below German Gulch	Westslope Cutthroat Trout	0.12
	Brook Trout	0.95
	Longnose Sucker	2.13
	Sculpin	0.30
Above Highway 1 Bridge	Westslope Cutthroat Trout	0.08
	Rainbow Trout	0.32
	Sculpin	3.33

Daily streamflow in Silver Bow Creek during the 2010 fall sampling was 19 cfs at the USGS gauge station below Blacktail Creek, and was 48 cfs at the USGS gauge station at Opportunity. Mean monthly flow in Silver Bow Creek below Blacktail Creek was highest in 2010 during June at 75.8 cfs, which was about 43 cfs higher than the period-of-record (POR) average for the same month (POR = 33 cfs). Mean monthly flow was lowest at the USGS gauge station below Blacktail Creek during January at 16.9 cfs. No 2010 mean monthly flow data was available for the USGS gauge station at Opportunity at the time this report was written. However, from an examination of daily flow data, the mean monthly flow at this site was highest in June at approximately 263 cfs, which was about 156 cfs higher than the period-of-record (POR ~ 107 cfs).

Water temperature was monitored at four locations along Silver Bow Creek, as well at one location in Blacktail Creek, through the summer of 2010. In Silver Bow Creek, the monitoring sites were located above Rocker (operated June 9 – October 20), at Miles Crossing (operated June 9 – October 20), below German Gulch (operated June 10 – October 20), and near Opportunity (operated July 27 – October 20). In Blacktail Creek, the site was situated within Father Sheehan Park above the confluence with Basin Creek (operated June 9 – October 20). At this site, daily high temperature exceeded 15°C on 65 days, but on only one day did temperature rise above 20°C. The maximum daily temperature at this site was 20.6°C recorded on June 28. In Silver Bow Creek, at the site above Rocker, maximum daily water temperature exceeded 15°C on 77 days, but on only 2 days did it exceed 20°C. The maximum-recorded temperature at this site was 21.3°C on August 5. At Miles Crossing, maximum daily temperatures exceeded 15°C on 93 days including 33 days in which it exceeded 20°C. The maximum-recorded temperature was 23.0°C on July 25. At the site below German Gulch, maximum daily temperature exceeded 15°C on 65 days, and exceeded 20°C on 15 days. Maximum-recorded temperature at this site was 21.7°C on July 25. Near Opportunity, daily high temperatures exceeded 15°C on 55 days, and 20°C on 24 days. The maximum daily temperature at this site was 24.1°C recorded on August 5.

Discussion

Prior to 2002, fish sampling in the upper Silver Bow Creek watershed was primarily confined to tributaries such as Blacktail Creek and German Gulch. Silver Bow Creek was generally considered to be void of fish except for occasional observations of suckers during the late 1990's when remediation of the stream channel began. Sampling described in this report represents the first formal sampling of fish presence and abundance in Silver Bow Creek. Fish sampling was conducted to provide a general perspective of fish response to ongoing remediation activities in Silver Bow Creek. Since sections were sampled using relatively low effort sampling techniques, interpretation of results should be limited to observations of major trends in fish species composition and abundance. Sampling conducted in this effort is sufficient to determine if a sampling reach was fishless for one or more years, followed by colonization by tolerant species such as suckers and sculpin, and then followed by colonization by sensitive species such as trout. Fluctuations in fish abundance or species composition at specific sampling locations should not be considered overly significant unless a large change or multi-year trend is observed.

The presence or absence of various fish species among the sample sections in Silver Bow Creek provides insight into changes in water quality along the longitudinal gradient of the stream. Because of their sensitivity to poor water quality, trout are good to examine for distributional changes over time. Brook trout are common in upper Silver Bow Creek at Father Sheehan Park as well as in German Gulch and Browns Gulch. Fish in each of these areas have access to downstream reaches of Silver Bow Creek that provide relatively similar physical habitat types. However, prior to 2007, no brook trout were captured during fall sampling in sections downstream of Father Sheehan Park (e.g. Lower Area One, Rocker, and Ramsay), except for one individual captured below the confluence of German Gulch in 2006. It can be reasonably assumed that water quality deterioration downstream of Father Sheehan Park was the primary reason for the absence or rarity of trout in downstream reaches of Silver Bow Creek. In fall 2007, brook trout were found in two reaches where they had previously not been documented. Three brook trout were captured at the Lower Area One Section, and one brook trout was captured at the Ramsay section. Since 2007, brook trout have been documented in at least one or more sampling years at all of the current sampling sections except Rocker. While this is an improvement over the past, fish density downstream of Butte still continues to be low.

In addition to brook trout, westslope cutthroat trout are also beginning to be detected with relative frequency in Silver Bow Creek. Westslope cutthroat trout are most common in German Gulch, but also occur in relatively low densities in upper Browns Gulch as well as upper Blacktail Creek. Prior to 2008, westslope cutthroat trout had only been observed in Silver Bow Creek just downstream of German Gulch. And, the first fall presence of the species in this area was not described until 2007. In 2008, one of the most interesting findings of the fall monitoring was the appearance of westslope cutthroat trout in the Ramsay Section. While it was only two individuals, both were relatively large in size. In 2009, westslope cutthroat trout continued to be present in the Ramsay section (4 individuals were collected), and a single individual was also captured in the Lower Area One Section. In 2010, westslope cutthroat trout were present in all but the two upper-most sample sites (Father Sheehan, where westslope cutthroat trout have never been documented, and Lower Area One, where a single individual was captured in 2009). The most surprising finding of the fall sampling in 2010 was the presence of westslope cutthroat trout in the Rocker Section. While trout density was still extremely low at this site, the presence of any trout at all was a first in this section since sampling was initiated in 2002.

While the continued presence or appearance of trout in all of the current monitoring sections in Silver Bow Creek is an improvement over past years when no fish could be detected, the rarity of these species still suggests water quality remains a concern downstream of Butte. At the Rocker Section, water quality is impaired by several factors including elevated ammonia levels directly related to the Butte wastewater treatment plant discharge located just upstream. Wastewater discharged directly into Silver Bow Creek from this facility has very high ammonia concentrations and as this ammonia reaches the stream, microbial oxidation creates a reach of stream with limited available oxygen, especially during the summer months. The longitudinal and temporal extent of this condition and its effects on fish species composition and abundance is unclear. However, within the Rocker Section itself, it is quite apparent that wastewater discharge is affecting the fish community at this site. Although fall sampling in 2010 detected four westslope cutthroat trout in the Rocker Section (the first trout documented in the section since sampling was initiated in 2002), it should not lessen the significance of the impacts the Butte wastewater treatment plant has on the fish community of upper Silver Bow Creek. Longnose suckers continue to dominate the fish assemblage at this site. Sucker species tend to be more tolerant of a variety of pollutants such as metals, nutrients, low dissolved oxygen, high sediment loading, and elevated water temperatures. It is unlikely we will witness a significant improvement in the health of the fishery of upper Silver Bow Creek until the discharge of the Butte wastewater treatment plant is addressed.

Perhaps one of the most interesting sections that we currently monitor in Silver Bow Creek is the Ramsay Section. This section was remediated in 2005 and has now been cleaned up for approximately 5 years. Prior to being remediated, fish sampling in 2003 and 2004 found no fish present. However, in 2006 (post remediation), longnose suckers were found to have colonized the reach and were in fact, relatively common. Since then, sucker density has continued to decline to the point that in 2010, only a few young-of-the-year were collected during fall sampling. In contrast, westslope cutthroat trout have begun to colonize the reach, and have been found in the section every year since 2008, with a few more fish being found each year. Despite this, fish densities in this reach are still extremely low. The reason for this is not completely clear. While it is likely that downstream impacts of the wastewater discharge in Butte continue to impact this segment of Silver Bow Creek, it is unknown why longnose suckers continue to be so rare when they are very common in the Rocker Section, which is closer to the discharge point. Another factor that may help to describe fish distribution patterns at the Ramsay section is summer stream temperature. In 2010, temperature monitoring in Silver Bow Creek above Rocker and at Miles Crossing (just below the Ramsay Section) showed a noticeable difference in the two reaches in terms of the number of days stream temperature rose above 20º C, a value often considered to be near the upper limit tolerated by many trout species. Typically, stream temperatures in excess of 20º C are stressful and potentially deadly to trout and other coldwater fish species. During the summer of 2010, maximum daily stream temperatures only rose above 20º C for two days at the Rocker section. However, farther downstream at Miles Crossing (near the Ramsay Section), stream temperature rose above 20º C on 33 days. Prolonged exposure to high stream temperatures in conjunction with low oxygen levels created by the nitrification of ammonia, may be leading to increased fish mortality or avoidance in this reach during the summer months.

In short, it is clear that there are multiple factors affecting fish use and survival in Silver Bow Creek. Only continued monitoring and more in-depth research will begin to answer some of these questions.

Recommendations and Additional Studies

Continued monitoring of the established electrofishing sections in Silver Bow Creek still remains one of the best ways to assess fish response to ongoing remediation and restoration efforts as well as other factors such as drought and nutrient loading. Fish sampling in the Rocker, Ramsay and Below German Gulch Sections should be repeated annually, and sampling at the sections added in 2005 at Father Sheehan Park and at Lower Area One should also be continued. Additionally, adding and repeating new sample sections downstream of German Gulch such as the one above the Highway 1 crossing near Opportunity (added in 2008) will be necessary as remediation activities continue to move downstream.

Seasonal fish movements throughout the Silver Bow Creek watershed may result in problems interpreting trends with fish populations. Electrofishing surveys during the fall provide a snapshot of the fishery status during a specific point in time, but fish mortality during one season may be masked by fish migration during another. A fish tagging and movement study would provide beneficial information on how fish are utilizing and moving in the Silver Bow Creek watershed. A study of this sort began in the summer of 2009. A graduate student from Montana State University is conducting the study with assistance from Montana Fish, Wildlife and Parks. So far in this study, well over 2000 fish (including brook trout, westslope cutthroat trout, and longnose suckers) have been tagged with passive integrated transponder (PIT) tags, and multiple antenna stations have been set up to record fish movement. Fish were tagged in the mainstem of Silver Bow Creek from below German Gulch all the way upstream to the confluence with Blacktail Creek. Additionally, a number of fish were tagged in the lower reaches of the more significant tributaries such as German Gulch and Browns Gulch. It is still too early to report on findings of this study, but preliminary results have documented that fish are in fact moving into and out of Silver Bow Creek from the tributaries at different times of the year. The study is also starting to better describe patterns of fish distribution throughout more extensive reaches of Silver Bow Creek, as well as get a better grasp on potential limiting factors driving observed patterns of fish distribution and abundance. This multi-year project should yield some very interesting and important results related to fish behavior in the Silver Bow Creek watershed.

Appendices

Appendix 1. Description of fish sampling sections in Silver Bow Creek from 2002 through 2010.

Section 1. Father Sheehan Section – Above the SSTOU
- Section Length: 500 ft
- Years Sampled: Fall 2005, 2007, 2008, 2009, 2010
- GPS: N45.98524 W112.50719 (Bottom of 500 ft section)

Section 2. Montana Street Section – Above the SSTOU
- Section Length: Approx. 500 ft
- Years Sampled: Fall 2002
- GPS: N/A (Montana Avenue to confluence with metro storm drain)

Section 3. Lower Area One Section – Above the SSTOU
- Section Length: 1000 ft
- Years Sampled: Fall 2005, 2006, 2007, 2008, 2009, 2010
- GPS: N45.99489 W112.54819 (Bottom); N45.99550 W112.54564 (Top)

Section 4. Rocker Section – Remediated in 2001
- Section Length: 1000 ft
- Years Sampled: Fall 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010
- GPS: N46.00.070 W112.35.601 (Top of section; bottom near concrete block on north bank)

Section 5. Above Ramsay Section (Reach F) – Remediated in 2004
- Section Length: Approx. 1000 ft
- Years Sampled: Fall 2005
- GPS: N46.00311 W112.39756 (Bottom); N46.00388 W112.39907 (Top)

Section 6. Ramsay Section – Remediated in 2005
- Section Length: Approx. 1000 ft
- Years Sampled: Fall 2002, 2003, 2004, 2006, 2007, 2008, 2009, 2010
- GPS: N46º 00.000’ W112º 41.109’ (bottom) N46º 00.057’ W112º 40.902’ (top)

Section 7. Below Ramsay Section (Miles Crossing) - Unremediated
- Section Length: Approx. 1000 ft
- Year Sampled: Fall 2005
- GPS: N46.00756 W112.43591 (Bottom/RR crossing); N46.00678 W112.43719 (Top/road)

Section 8. Below German Gulch - Unremediated
- Section Length: 1000 ft
- Years Sampled: Fall 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010
  Spring 2004, 2005, 2007
- GPS: N/A Start 700 ft below bridge; End 300 ft above bridge crossing

Section 9. Above Highway 1 Crossing – Unremediated
- Section Length: 250 m (820 ft)
- Years Sampled: 2008, 2009, 2010
- GPS: Latitude (DD) N46.09396 Longitude (DD) W112.80338 (Top of section)

Appendix 2. Catch-Per-Unit-Effort values in number of fish per 100 seconds of electrofishing time for all species and sections sampled in Silver Bow Creek from 2002 through 2010. WCT = Westslope Cutthroat Trout, RB = Rainbow Trout, EB = Brook Trout, LN SU = Longnose Sucker, SL COT = Slimy Sculpin, CM MN = Central Mudminnow.

Section	Species	2002	2003	2004	2005	2006	2007	2008	2009	2010
Father Sheehan	WCT	n/a	n/a	n/a	0	n/a	0	0	0	0
	EB	n/a	n/a	n/a	1.9	n/a	2.33	3.59	5.88	6.46
	LN SU	n/a	n/a	n/a	1	n/a	2.15	0.51	0.07	0.68
	SL COT	n/a	n/a	n/a	3.8	n/a	4.85	3.59	2.58	1.87
	CM MN	n/a	n/a	n/a	0	n/a	1.42	0.68	0.43	0.28
Lower Area One	WCT	n/a	n/a	n/a	0	0	0	0	0.05	0
	EB	n/a	n/a	n/a	0	0	0.1	0	0.11	0.95
	LN SU	n/a	n/a	n/a	12	3.1	1.41	1.66	1.03	0.43
	SL COT	n/a	n/a	n/a	0.74	6.9	7.78	4.62	3.76	1.43
	CM MN	n/a	n/a	n/a	0.16	0.14	0.34	0.24	0.38	0
MT Avenue	WCT	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	EB	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	LN SU	2.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	SL COT	3.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	CM MN	0.002	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rocker	WCT	0	0	0	0	0	0	0	0	0.20
	EB	0	0	0	0	0	0	0	0	0
	LN SU	4.9	3	1.2	4.7	8.7	4.35	8.92	2.27	13.73
	SL COT	0.1	0.06	0.06	0	0.16	0.2	0	0.06	0.10
	CM MN	0	0	0	0	0	0	0	0	0
Above Ramsay	WCT	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a	n/a
	EB	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a	n/a
	LN SU	n/a	n/a	n/a	5.5	n/a	n/a	n/a	n/a	n/a
	SL COT	n/a	n/a	n/a	0.08	n/a	n/a	n/a	n/a	n/a
	CM MN	n/a	n/a	n/a	0.04	n/a	n/a	n/a	n/a	n/a
Ramsay	WCT	n/a	0	0	n/a	0	0	0.13	0.29	0.52
	EB	n/a	0	0	n/a	0	0.05	0.06	0	0.06
	LN SU	n/a	0	0	n/a	7.2	2.01	2.02	0.50	0.26
	SL COT	n/a	0	0	n/a	0.1	0.14	0.32	0.07	0
	CM MN	n/a	0	0	n/a	0	0	0	0	0
Below Ramsay	WCT	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a	n/a
	EB	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a	n/a
	LN SU	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a	n/a
	SL COT	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a	n/a
	CM MN	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a	n/a
German G. - Fall	WCT(w/RB)	n/a	0	0	0	0	0.08	0.11	0.07	0.12
	EB	n/a	0	0	0	0.05	1.51	0.11	0.21	0.95
	LN SU	n/a	0	0	0.05	0.5	1.78	1.88	0.32	2.13
	SL COT	n/a	0	0	0.15	0.14	0.7	0.21	0	0.30
	CM MN	n/a	0	0	0	0	0	0	0	0
German G. - Spr.	WCT	n/a	n/a	0.11	0	n/a	0.07	n/a	n/a	n/a
	EB	n/a	n/a	0.05	1.58	n/a	0.13	n/a	n/a	n/a
	LN SU	n/a	n/a	0.11	0	n/a	0.5	n/a	n/a	n/a
	SL COT	n/a	n/a	0	0.05	n/a	0.1	n/a	n/a	n/a
	CM MN	n/a	n/a	0	0	n/a	0.03	n/a	n/a	n/a
Above Hwy 1	RB	n/a	n/a	n/a	n/a	n/a	n/a	0.12	0.18	0.32
	WCT	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0.08
	EB	n/a	n/a	n/a	n/a	n/a	n/a	0	0.06	0
	LN SU	n/a	n/a	n/a	n/a	n/a	n/a	0.70	0.06	0
	SL COT	n/a	n/a	n/a	n/a	n/a	n/a	0.89	0.36	3.33
	CM MN	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0

Appendix 3.

Longnose suckers were collected for liver metal analysis from five sections of upper Silver Bow Creek, October 10, 2007. Livers were removed from five suckers at each site, and composite samples were analyzed for metals using ICP (EPA methods 3051 and 200.8). The mean length of fish collected at each of the five sections was plotted using 95% confidence intervals (CI; Figure 1). Confidence intervals that overlap would not be considered significantly different (p<0.05). Overall, fish collected from Lower Area One (LAO) had the smallest mean size (mean length=131.6 (10.7) mm TL); fish collected from the Rocker section (ROK) had the largest mean size (mean length=199.6 (7.5) mm TL; Figure 1).

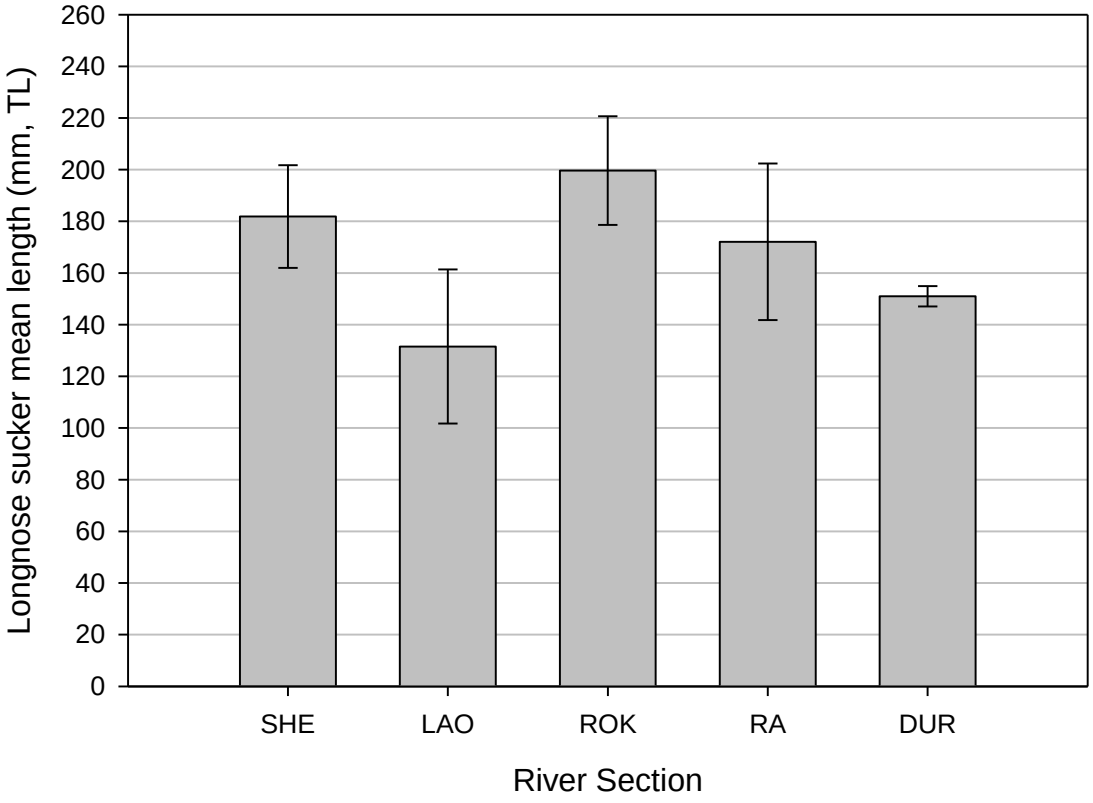

Figure 1. Longitudinal trend in mean length (mm, TL) of longnose suckers (*Catostomus catostomus*) collected in the fall, 2007 from five sections of upper Silver Bow Creek for liver metal analysis. Sites listed include: Father Shehan (SHE), Lower Area One (LAO), Rocker (ROK), Ramsey (RA), and Durant Canyon – below German Gulch (DUR). Error bars represent 95% confidence intervals (CI).

Results from ICP metal analysis on longnose sucker livers are shown in Table 2. Of the 17 metals analyzed, only eight were found to be above the minimum detection limit based on sample quantity. Fish livers from the Father Sheehan section (SHE) contained the highest concentrations of chromium, iron, selenium, strontium, and zinc. The Ramsey section (RA) contained the highest cadmium and copper concentrations, and the Rocker section (ROK) contained the highest concentration of manganese (Table 2). Concentrations of key trace elements in longnose sucker livers collected at the Rocker

section (ROK) in 2007 were compared with fish collected in 2004 (Table 2). Copper and zinc concentrations in fish livers from 2007 were lower than concentrations found in 2004 fish. All other metals analyzed in 2007 (arsenic, cadmium, and lead) were below minimum detection limits (Table 2). Mean length of fish collected in 2007 were larger than those captured in 2004 (Table 2), suggesting lower metal concentrations found in 2007 fish livers were not the result of analyzing smaller fish.

Continued monitoring of the bio-concentration of metals in fish is important in documenting the restoration and recovery of Silver Bow Creek. More specifically, the continuation of spatial and temporal sampling of longnose suckers conducted at standardized sites along the Creek will allow for interpretable comparisons in future years. However, as higher trophic-level species (i.e., westslope cutthroat trout and brook trout) re-establish viable populations within the main-stem of Silver Bow Creek, documenting site specific macro-invertebrate recovery and metal concentrations, and corresponding fish abundance and liver metal concentrations may provide further insight into the toxicological dynamics of the system.

Appendix 3 (continued).

Table 1. Concentrations of metals (μg/g dry weight) in longnose suckers (*Catostomus catostomus*) collected in the fall, 2007 from five sections of upper Silver Bow Creek. Sites are listed on a longitudinal gradient from the upper most section: Father Shehan (SHE), Lower Area One (LAO), Rocker (ROK), Ramsey (RA), and Durant Canyon – below German Gulch (DUR). Liver concentrations represent mean composite values from 5 fish captured in each river section. (*) Only 4 fish were analyzed from the Ramsey section. Results listed with a < represent samples with concentrations below minimum detection limits based on sample quantity.

Section	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Se	Sr	Ti	V	Zn
SHE	<10.0	<0.80	<0.80	<0.80	<0.80	<0.80	1.54	27.4	238.0	7.64	<2.00	<0.80	4.8	2.0	<2.0	<0.80	89.8
LAO	<10.0	<0.80	<0.80	<0.80	<0.80	<0.80	1.10	24.4	80.2	8.21	<2.00	<0.80	3.0	2.0	<2.0	<0.80	67.1
ROK	<10.0	<0.80	<0.80	<0.80	<0.80	<0.80	1.02	15.0	76.0	8.86	<2.00	<0.80	3.2	2.0	<2.0	<0.80	71.0
RA*	<10.0	<0.80	<0.80	<0.80	0.82	<0.80	0.92	67.7	78.8	5.98	<2.00	<0.80	4.0	2.0	<2.0	<0.80	87.1
DUR	<10.0	<0.80	<0.80	<0.80	<0.80	<0.80	1.06	46.4	90.0	8.74	2.07	<0.80	<2.0	2.0	<2.0	<0.80	68.9

Table 2. Concentrations of key trace elements (μg/g dry weight) in Longnose sucker (*Catostomus catostomus*) livers collected at the Rocker site (ROK), Silver Bow Creek, in the fall of 2004 and 2007. Results listed with a < represent samples with concentrations below minimum detection limits based on sample quantity.

Date of collection	Mean length (mm, TL)	Arsenic	Cadmium	Copper	Lead	Zinc
2004	188.0	<0.20	0.98	20.9	0.38	74.3
2007	199.6	<0.80	<0.80	15.0	<0.80	71.0