Fish Population Monitoring in Silver Bow Creek, Montana

2002 - 2009

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February 2010

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, all of the sections that were sampled 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 2009.

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.

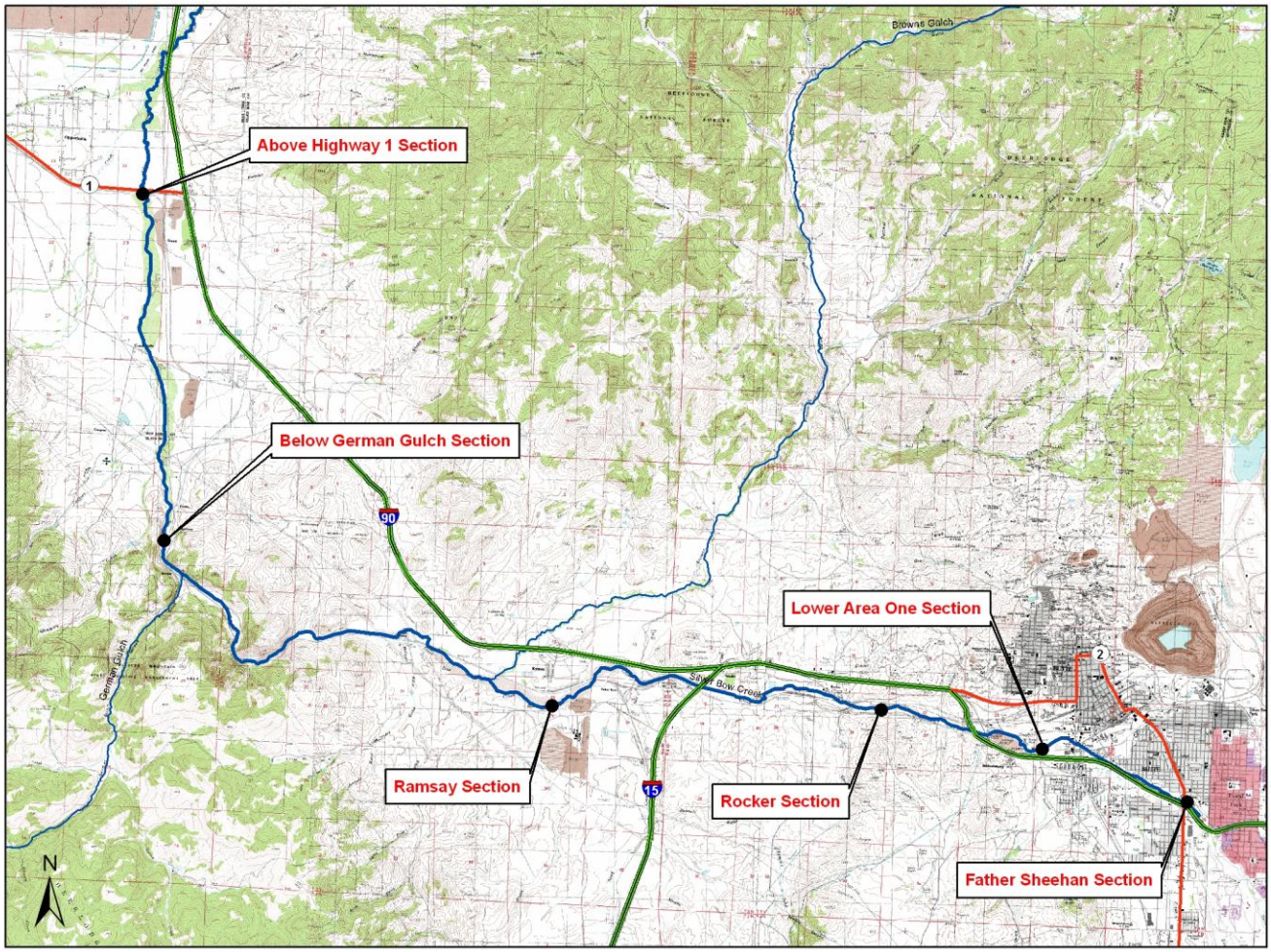

Figure 1. Map of the Silver Bow Creek study area.

Results

General:

Fish sampling results from 2002 through 2009 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 2002-2009.

Fish species composition and abundance in Silver Bow Creek varies throughout the sections sampled from 2002 through 2009. Table 1 shows species presence and general abundance in various portions of the watershed as of 2009 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 2009. 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	NP	R	R	P	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 2009 has started to show limited numbers of trout in places where they previously had not been documented (e.g. Ramsay Section).

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.

Fish Sampling Results in 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

Fish Sampling Results in 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.

Fish Sampling Results in 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

Fish Sampling Results in 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.

Fish Sampling Results in 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.

Fish Sampling Results in 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

Fish Sampling Results in 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

Fish Sampling Results in 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

Trends in fish abundance:

In addition to presence/absence data, it is often useful to monitor trends in abundance of selected species that span most or all of the sampling sections. Since sampling was initiated, longnose suckers have been present in all of the sampling sections where fish have been observed, and this species is probably a good choice for monitoring trends in abundance between various sections.

In 2005, suckers were most abundant at Lower Area One (Figure 2), which is located above the municipal sewage outfall near Butte. However, in 2006 and 2007, sucker abundance decreased noticeably at this site (Figure 2). In 2008 sucker density was slightly up from 2007, and this was the first year since sampling was initiated (2005) that the species did not witness a precipitous decline in relative abundance in the section (Figure 2). Although CPUE in 2009 was the lowest on record, it was relatively similar to the previous two years. The cause of the decline of sucker density between 2005 and 2007 is not well understood, and occurred during the same period when sculpin density was increasing (Appendix 2).

The Father Sheehan Section, similar to Lower Area One, is situated above the Butte municipal sewage outfall. Water quality in this section is presumed to be relatively good, as it seems to support a rather healthy brook trout fishery. Nevertheless, sucker density has been somewhat variable in this reach since sampling was initiated in 2005. Between 2005 and 2007 (sampling was not conducted in 2006), sucker numbers appeared to increase (Figure 2; Appendix 2). However, in 2008 and 2009, sucker density declined. In fact in 2009, only three suckers were captured in the reach during two electrofishing passes.

Since 2006, sucker density during fall sampling has been highest at the Rocker Section (Figure 2), which is located just downstream of the Butte municipal sewage discharge. While no trout have been documented in this section since sampling was initiated (2002), sucker numbers have generally been relatively high despite frequent annual variation in CPUE (Figure 2; Appendix 2). Nevertheless in 2009, sucker density showed a noticeable decline from 2008, and was the second lowest that has been recorded for the reach since 2002 (Appendix 2).

The site of the Ramsay Section underwent remediation in 2005. Prior to this no fish had been documented in the reach during fall sampling. In 2006, suckers were shown to be present in the reach, and their density was similar to that found upstream in the Rocker Section. More recently however, sucker density has declined in this reach (Figure 2; Appendix 2), and in 2009 only a few young-of-the-year were captured during fall sampling. The reasons for this decline are not fully understood.

Suckers were first observed in the section below German Gulch (currently unremediated) during fall sampling in 2005 (Appendix 2). The species continued to show an increased presence in the reach through 2008. However in 2009, and similar to other sampled sections, suckers appeared to show a decline in relative density. One interesting note is that from 2007 to 2009, sucker density in the unremediated section below German Gulch was similar to that found at the Ramsay Section which was remediated in 2005. At the Above Highway 1 Section (added in 2008), suckers were present at this unremediated site in both 2008 and 2009, but they occurred at relatively low densities in both years (especially 2009).

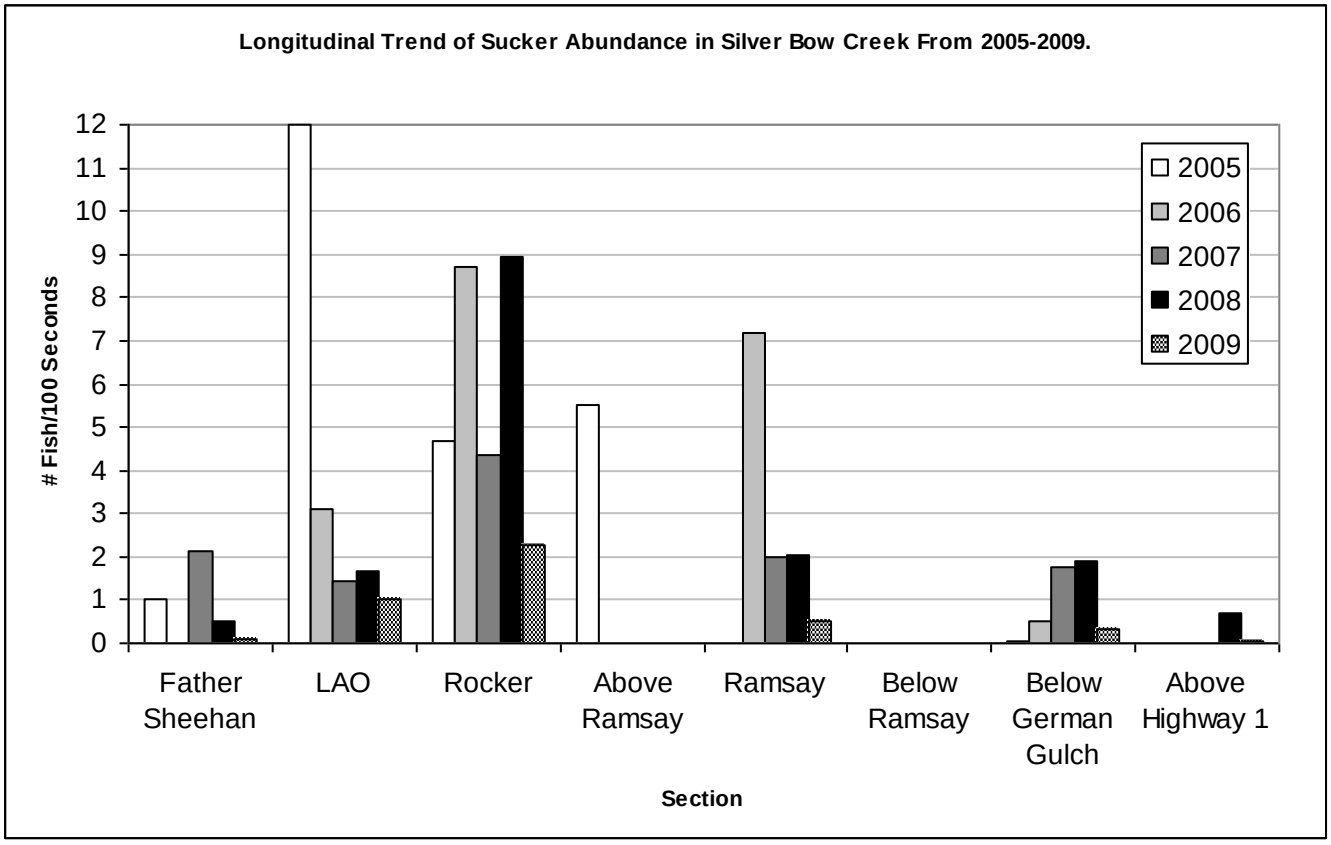

Figure 2. Longitudinal trend of longnose sucker relative abundance in eight sections of upper Silver Bow Creek from 2005-2009. (Above and below Ramsay sections only sampled in 2005 because of construction activities at the Ramsay section. The Ramsay section was remediated by 2006. The Above Highway 1 Section was added and first sampled in 2008. The below German Gulch and Above Highway 1 Sections are still unremediated).

Results by Long Term Section:

Rocker Section

The Rocker Section has been sampled every year since sampling was initiated in 2002. Longnose sucker and slimy sculpin are the only two species that have been documented in this reach during fall sampling. Longnose suckers are fairly common in the reach, and have been present at variable densities since 2002. Slimy sculpin, while present in the reach in all years except 2005 and 2008, tend to be much less abundant. See Appendix 2 for a summary of catch-per-unit-effort for the Rocker Section from 2002-2009.

Based on observed trends in abundance of longnose suckers at the Rocker Section, it appears that 2006 and 2008 provided better conditions for sucker survival compared to other years of sampling. The highest numbers of suckers were captured during these years (Table 7). Three sculpin were also captured during sampling in 2006. In addition to fish sampling, a Hach Colorimeter was used to measure Total Ammonia at the Rocker Section on October 3, 2006. Total Ammonia was measured at 4.02 ppm, and pH was 7.71 on this date. During 2007, sucker abundance was similar to that of 2005 and 2002 (Table 7). In 2008, sucker density was the highest on record but was similar to 2006 in terms of CPUE (Table 7). In 2009,sucker density showed a decline from the previous high in 2008, and was the second lowest density ever recorded as measured by CPUE (Table 7).

Table 7. Catch-per-unit effort electrofishing trend for longnose suckers in the Rocker Section of Silver Bow Creek (2002-2009).

Year	# LONGNOSE SUCKERS	EFFORT	# FISH/100 SEC. (CPUE)
2002	75	1529 seconds	4.9
2003	48	1580 seconds	3.0
2004	20	1672 seconds	1.2
2005	122	2602 seconds	4.7
2006	167	1912 seconds	8.7
2007	109	2506 seconds	4.4
2008	188	2108 seconds	8.9
2009	40	1760 seconds	2.3

Ramsay Section

Sampling in the Ramsay Section was initiated fall 2003 (pre-remediation), when no fish were found during 1622 seconds of electrofishing. Sampling conditions were favorable for capturing fish if any were present, and the area of Silver Bow Creek was assumed to be void of fish as of October 2003. Again in 2004, no fish were observed during fall sampling. Construction activities in 2005 prevented sampling of the section. Due to floodplain reclamation activities, two new sections were established near Ramsay. One was in the newly reconstructed reach (Reach F) and one was below the remediation at Miles Crossing. Reach F contained 145 longnose suckers, 2 sculpin, and 1 central mudminnow in

2648 seconds of electrofishing. The Miles Crossing section contained no fish during fall 2005 based on 1473 seconds of electrofishing.

In 2006, 144 suckers and 2 sculpin were captured in the Ramsay Section during 1987 seconds of sampling. This section is similar to the location sampled during 2003, when no fish were observed prior to channel remediation. The 2006 results at the Ramsay Section were similar to findings during 2005 sampling at Reach F (when channel remediation activities prevented sampling the traditional Ramsay Section of 2002-2004). In addition to fish sampling, a Hach Colorimeter was used to measure Total Ammonia on 3 October 2006. Total Ammonia was measured at 0.59 ppm, which is considerably lower than the measurement on the same day at the Rocker Section. Measured pH was 8.3 in the Ramsay Section.

In 2007, the presence of a single brook trout was documented at the Ramsay Section. This represented the first trout observed within the remediated portion of the SSTOU since sampling was initiated in 2003. In addition to the one brook trout, 42 longnose suckers and three slimy sculpin were also captured. While sucker abundance was down from 2006, sculpin abundance was approximately the same.

In 2008, sampling discovered two westslope cutthroat trout in the Ramsay Section. This finding was rather significant as it was the first documentation of native trout in the remediated portion of the SSTOU. Additionally sampling in 2008 also turned up a brook trout, 32 longnose suckers, and five slimy sculpin. An interesting note regarding suckers captured in the reach was that all but one appeared to be young-of-the-year. The density of older age classes was down despite overall CPUE being similar to 2007.

In 2009, westslope cutthroat trout were again captured in the Ramsay Section during fall electrofishing. Four individuals were observed in the sample reach along with seven longnose suckers and one slimy sculpin. Both sucker and sculpin density appeared down from recent years, and all of the suckers appeared to be young-of-the-year.

Below German Gulch Section

The section below German Gulch was added in the fall of 2003. At this sampling event, no fish were captured during 1412 seconds of electrofishing. The section was sampled again in both the spring and fall of 2004. 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 totaling 4730 seconds of effort. Three species of fish were observed during this sampling including one brook trout, two cutthroat trout, and two longnose suckers.

During spring 2005, no cutthroat trout or longnose sucker were observed during 1958 seconds of electrofishing in the 1000-foot section. Brook trout, however, were relatively common with 31 individuals captured during the sampling effort. One sculpin was also captured during the spring sampling on 27 June 2005. Streamflow was relatively high during this sampling effort and capture efficiency was presumed to be very low.

During fall 2005, three sculpin, one longnose sucker and no trout were captured in 1956 seconds of sampling the standard section. Although it is common to capture fish in this section during spring sampling, 2005 is the first year that fish have been found during the fall sampling effort.

During 2006, sampling of the standard electrofishing section was conducted on 6 October 2006, and no sampling was done during the spring. Sampling effort was 2218 seconds in the standard 1000 ft section, and one brook trout, three sculpin, and 11 suckers were captured. The fall 2006 sampling observed the most fish captured since the first fall sampling was conducted in 2003. In addition, the capture of a brook trout (112 mm TL) represents the first trout observed during fall sampling of this section.

During 2007, the Below German Gulch section was again sampled in both the spring and the fall. On June 1, 2007, the standard 1000 ft section was sampled with two passes. On the first pass, two westslope cutthroat trout, four brook trout, 15 suckers, three sculpin, and one central mudminnow were captured during 3030 seconds of electrofishing. On the second pass, one westslope cutthroat trout (67 mm) and six brook trout (Mean Length: 56 mm, Range: 30-180mm) were captured during 2552 seconds of electrofishing.

During fall 2007, four westslope cutthroat trout were captured in one and a half electrofishing passes through the section. 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, 51 longnose suckers, and 23 slimy sculpin were also captured at the section during the fall survey. This represents the highest number of brook trout ever captured at this site during fall sampling, as well as the greatest number of longnose suckers and slimy sculpin at the site since sampling began in 2003 (both fall or spring). Streamflow was relatively high during this sampling effort

During fall 2008, one large rainbow trout and one phenotypic rainbow trout-westslope cutthroat trout hybrid were captured in the section below German Gulch. Additionally, two brook trout, 35 longnose suckers, and four slimy sculpin were also noted in the section. The documentation of rainbow trout in this section is the first record of the species in Silver Bow Creek since sampling was initiated in 2002. Overall, fish density appeared down from 2007 although CPUE was somewhat similar for all species except brook trout, which were notably less abundant.

In 2009, fall sampling at the section below German Gulch yielded two westslope cutthroat trout, six brook trout, 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.

Lower Area One Section

The section at Lower Area one was added in fall 2005 to provide an improved perspective of the longitudinal distribution of fish species in the upper Silver Bow Creek drainage. During fall sampling in 2005 (November 3rd), 310 longnose suckers, 19 slimy sculpin, and four central mudminnow were captured during 2578 seconds of electrofishing. The water was very turbid during the time of the survey and it is likely that efficiency was low, especially on hard to see species such as sculpin. No trout were captured at the site during the 2005 sampling event.

Sampling at the section was repeated in fall 2006. One 4320 second electrofishing pass on October 6th found 299 slimy sculpin, 133 longnose suckers, and six central mudminnow. Sucker abundance appeared to decline noticeably from 2005, while sculpin density appeared to increase. Similar to 2005, no trout were observed in the section in 2006.

During fall 2007, three adult brook trout were captured in the Lower Area One section. 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, 231 slimy sculpin, and 10 central mudminnow were captured in the section in 2007. 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 also up from past years.

During 2008, 41 longnose suckers, 114 slimy sculpin, and six central mudminnow were captured in the Lower Area One Section. Longnose sucker and central mudminnow appeared to be at similar densities to 2007, while slimy sculpin appeared to drop in relative abundance. No trout were observed at the Lower Area One Section in 2008.

In 2009, fall sampling in the Lower Area One Section netted one westslope cutthroat trout, two brook trout, 19 longnose suckers, 69 slimy sculpin, and seven central mudminnow. The presence of a westslope cutthroat trout was notable as it was the first native trout documented in the reach during fall sampling. 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.

Father Sheehan Section

The Father Sheehan Section was initially sampled in fall 2005, and like the section at Lower Area One, was added to provide and improved perspective of longitudinal fish distribution in upper Silver Bow Creek. On November 3, 2005, two electrofishing passes were made through the 500-foot section. On the first pass, 36 brook trout, 19 longnose suckers, and 71 slimy sculpin were captured during 1866 seconds of electrofishing. Brook trout from the first pass ranged between 95 and 260 mm in length. On the second pass (1351 seconds), only brook trout were targeted, of which 15 were captured ranging in length from 110 to 214 mm. No population estimate was run for brook trout due to fairly low capture efficiency.

The Father Sheehan Section was not sampled during 2006, but was surveyed again in October 2007. At this sampling event, two electrofishing passes were made through the established 500-foot section. During the first pass, 64 brook trout, 59 longnose suckers, 133 slimy sculpin, and 39 central mudminnow were captured during 2744 seconds of electrofishing. On the second pass, 11 brook trout, 29 longnose suckers, 58 slimy sculpin, and 15 central mudminnow were captured during 1610 seconds of electrofishing. All species sampled during fall 2007 showed an increase in abundance from 2005. Brook trout capture efficiency during 2007 was also high enough to produce population estimates for two size classes. For brook trout 75 to 149 mm in length, the population estimate was 33 (95% confidence interval: 33-37) fish per 500 feet of channel, and for brook trout greater than 150 mm in length, the estimate was 42 (95% confidence interval: 42-44) fish per 500 feet of channel.

During 2008, the Father Sheehan section was again sampled. Two electrofishing passes were made through the 500-foot section yielding 84 brook trout, 12 longnose suckers, 84 slimy sculpin, and 16 central mudminnow on the first pass, and 26 brook trout, 4 longnose suckers, 69 slimy sculpin, and 9 central mudminnow on the second pass. 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.

In 2009, fall sampling in the Father Sheehan Section was again conducted with two electrofishing passes. On the first pass, 82 brook trout, one longnose sucker, 36 slimy sculpin, and six central mudminnow were captured. On the second pass, 32 brook trout, two longnose suckers, 26 slimy sculpin, and two central mudminnow were collected. 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.

Above Highway 1 Crossing

The section above the Highway 1 bridge crossing near Opportunity was added in 2008 to gain perspective of fish presence in lower, unremediated reaches of Silver Bow Creek, and to determine if rainbow and brown trout, which are stocked annually in the connected Warms Springs Ponds, may be moving upstream out of the ponds. During 2008, four rainbow trout, 23 longnose suckers, and 29 slimy sculpin were captured in the 250 m (820 foot) reach.

In 2009, the section above the Highway 1 bridge crossing near Opportunity was again sampled. The single electrofishing pass made through the sample reach turned up three rainbow trout, one brook trout, one longnose sucker, and six slimy sculpin. 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 down.

Discussion

Prior to 2002 fishery 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 of Silver Bow Creek from 2002 to 2009 was conducted to provide a general perspective of fish response to ongoing remediation activities in Silver Bow Creek. Since numerous sections were sampled using relatively low effort sampling techniques, interpretation of results should be limited to observations of major trends in fish species composition. 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. Relatively small fluctuations in fish abundance or species composition at specific sampling locations should not be considered significant unless a multi-year trend is observed.

The presence or absence of various fish species among the sample sections in Silver Bow Creek provides insight into the tolerance of each species to changes in water quality along the longitudinal gradient of the stream. Because of their sensitivity to poor water quality, trout are a good species 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 clearly have access to downstream reaches of Silver Bow Creek that provide similar physical habitat types. However, prior to 2007, no brook trout were ever 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 is the primary reason for the absence or rarity of brook 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. However in 2008 and 2009, brook trout remained absent or rare in the Lower Area One Section, and numbers continued to be very low at Ramsay and below German Gulch. One point of interest however, is the appearance of westslope cutthroat trout in the Ramsay Section in 2008. 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 however, 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 2009, westslope cutthroat trout continued to be present in the Ramsay section, and a single individual was also captured in the Lower Area One Section. While the presence of trout at several of these sections during recent sampling is an improvement over past years, the rarity of these sensitive species, and their continued absence from the Rocker Section, still suggests water quality remains a concern downstream of Butte. Continued monitoring of these sections will help provide needed clarification.

At the Rocker Section, water quality is impaired by several factors including elevated ammonia levels directly related to the Butte sewage treatment plant discharge located just upstream. Only longnose suckers and slimy sculpin have been documented at the Rocker Section since sampling was initiated in 2002. Sucker and sculpin 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. However, low summer streamflows, perhaps associated with drought conditions, tend to exacerbate water quality problems in Silver Bow Creek. An examination of annual differences in longnose sucker density at the Rocker Section appears to provide some support for this. Between 2002 and 2004, sucker density appeared to decline in the Rocker Section. During this period, average monthly spring and summer flows were relatively low. Longnose suckers spawn in the spring (April-May) and higher flows during this period likely benefit recruitment. Subsequently, low spring flows and further reduced summer flows may limit fish survival in areas of Silver Bow Creek. An assessment of USGS streamflow data collected for Silver Bow Creek below Blacktail Creek showed several patterns that seemed to correlate with fall sucker density in the Rocker Section. From 2002 through 2004, mean July flows were relatively low in Silver Bow Creek ranging from 12.4 to 14.2 cfs during this period. Mean July flow over the period of record (1983-2007) was 20.7 cfs. In addition to low summer flows, mean monthly flows in May from 2002 through 2004 averaged just 20.5 cfs (range: 16.2 - 24.0 cfs). The mean May flow over the period of record was 29.9 cfs. While summer flows in 2005 were similar to previous years, improved spring stream flow during this year may be a possible explanation for a recovery of sucker density observed at

the Rocker Section during this year. In 2005, there was an abundance of young-of-the-year suckers present at the Rocker Section. During this year, mean flow during the month of May was 33 cfs, and the increased flows may have contributed to improved sucker recruitment during 2005. In 2006, mean May flows were similar to that of 2005, and sucker density at Rocker was the highest since sampling was initiated in 2002. In 2007, sucker density in the Rocker section appeared to decline to a level similar to that of 2005. The majority of fish captured during this year were larger than those from 2005 however, and likely represented individuals from the strong 2005 year-class. Oddly, mean monthly spring and summer flows were relatively similar to those of 2005 and 2006. In 2008, we observed the highest density of suckers in the Rocker Section ever recorded. During this year, mean flow during the month of May was 42 cfs, one of the highest mean May flows on record. The mean May flow for the period of record (1984-2008) was only 31 cfs. These increased spring flows may have contributed to improved sucker recruitment in 2008. However, confounding this is that in 2009, fall sampling showed the lowest sucker density in the Rocker Section since 2004. Spring and summer stream flows appeared good, and no relationship between flow and sucker density was apparent.

Fish species that are more tolerant of pollution and water quality problems such as longnose suckers and slimy sculpin reside in more areas of Silver Bow Creek. However, even these species have had trouble persisting in Silver Bow Creek downstream of Ramsay where metal loading remains high in areas not yet remediated. Prior to 2005, it appeared that that Silver Bow Creek was not suitable for supporting fish in the two study sections located downstream of remediation activities (Ramsay or German Gulch). No fish were observed in these two sections during fall sampling in 2003 and 2004. However, three species of fish were found in the section below German Gulch during May 2004. Brook trout, westslope cutthroat trout, and longnose suckers were observed in low numbers during spring 2004, indicating that dilution water from German Gulch allows at least a temporary fishery to establish in the study section located about 0.5 miles downstream of the mouth. In addition, this observation confirmed the idea that German Gulch will likely provide an important source of fish recruitment to Silver Bow Creek in the future. Until 2005, it did not appear that any species of fish was able to persist throughout the year below German Gulch because no fish were observed during fall sampling. In October of 2005, three sculpin and one longnose sucker were observed in this section, and this sampling confirmed the first observation of fish in this section during the fall. In 2006, one brook trout was observed in the Below German Gulch Section during October, representing the first observation of trout in this area outside of the spring time period. In fall 2007, a rather remarkable number of fish were captured at the below German Gulch Section. A total of four westslope cutthroat trout, 49 brook trout, 51 longnose suckers, and 23 slimy sculpin were captured during the October electrofishing. This represents the first record of westslope cutthroat at this site during the fall. Higher fall streamflows in Silver Bow Creek below the confluence of German Gulch from 2005 through 2007, is one possible reason for the increased density of fish present in the reach during fall sampling. Based on examination of USGS streamflow data collected for Silver Bow Creek near Opportunity, mean October streamflow during the period of record (1988-2007) is 35.4 cfs. From 2002 through 2004, mean October flow was rather low in Silver Bow Creek, ranging from 21.5 to 23.7 cfs, and no fish were captured during fall sampling in the section below German Gulch during these years. However, between 2005 and 2007, mean October streamflow was noticeably higher in Silver Bow Creek, ranging from 32.5 to 35.6 cfs. This increase in average flow during October likely improved water quality and allowed fish to persist into the fall in the Below German Gulch Section. The reason for such a notable increase in fish density at the below German Gulch section during fall 2007 is not completely understood. It should be noted that the section below German Gulch that was sampled during fall 2007, was moved slightly upstream from the historic site

due to bridge construction activity in the area of the historic section. It is unlikely however, that this small amount of movement could justify the differences in fish numbers from past surveys. Another potentially significant factor that is difficult to quantify, is that by the fall of 2007, most of the area known as Ramsay Flats, and farther downstream almost to Miles Crossing, had the majority of the contaminants removed from the floodplain. This area was a large source of metal contaminants and the removal of these contaminants may have benefited the fishery. Sampling during fall 2008 and 2009 did little to clarify any of this however. During these years, trout densities were again relatively low at the section below German Gulch, although the continued presence of westslope cutthroat trout appears to be a positive sign. Mean monthly flows in May and June (measured near Opportunity) during 2008 and 2009 were much higher on average than in 2007, yet these increased flows did not appear to benefit trout at this location. One possibility is that the higher than average May and June flows mobilized metals from bed sediments that led to increased fish mortality. It is obvious that there are multiple factors affecting fish use and survival in Silver Bow Creek, and it is going to take continued monitoring and more in-depth research to start answering 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. During this first year, over 1400 fish (including brook trout, westslope cutthroat trout, and longnose suckers) were tagged with passive integrated transponder (PIT) tags, and multiple antenna stations were 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 the results of this multi-year project should yield some interesting and important results related to fish movement and behavior in the Silver Bow Creek watershed.

Appendices

Appendix 1. Description of fish sampling sections in Silver Bow Creek from 2002 through 2009.

Section 1. Father Sheehan Section – Above the SSTOU
- Section Length: 500 ft
- Years Sampled: Fall 2005, 2007, 2008, 2009
- 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
- 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
- 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
- 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
  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
- 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 2009. 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
Father Sheehan	WCT	n/a	n/a	n/a	0	n/a	0	0	0
	EB	n/a	n/a	n/a	1.9	n/a	2.33	3.59	5.88
	LN SU	n/a	n/a	n/a	1	n/a	2.15	0.51	0.07
	SL COT	n/a	n/a	n/a	3.8	n/a	4.85	3.59	2.58
	CM MN	n/a	n/a	n/a	0	n/a	1.42	0.68	0.43
Lower Area One	WCT	n/a	n/a	n/a	0	0	0	0	0.05
	EB	n/a	n/a	n/a	0	0	0.1	0	0.11
	LN SU	n/a	n/a	n/a	12	3.1	1.41	1.66	1.03
	SL COT	n/a	n/a	n/a	0.74	6.9	7.78	4.62	3.76
	CM MN	n/a	n/a	n/a	0.16	0.14	0.34	0.24	0.38
MT Avenue	WCT	0	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
	LN SU	2.6	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
	CM MN	0.002	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rocker	WCT	0	0	0	0	0	0	0	0
	EB	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
	SL COT	0.1	0.06	0.06	0	0.16	0.2	0	0.06
	CM MN	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
	EB	n/a	n/a	n/a	0	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
	SL COT	n/a	n/a	n/a	0.08	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
Ramsay	WCT	n/a	0	0	n/a	0	0	0.13	0.29
	EB	n/a	0	0	n/a	0	0.05	0.06	0
	LN SU	n/a	0	0	n/a	7.2	2.01	2.02	0.50
	SL COT	n/a	0	0	n/a	0.1	0.14	0.32	0.07
	CM MN	n/a	0	0	n/a	0	0	0	0
Below Ramsay	WCT	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a
	EB	n/a	n/a	n/a	0	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
	SL COT	n/a	n/a	n/a	0	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

German G. - Fall	WCT/RB	n/a	0	0	0	0	0.08	0.11	0.07
	EB	n/a	0	0	0	0.05	1.51	0.11	0.21
	LN SU	n/a	0	0	0.05	0.5	1.78	1.88	0.32
	SL COT	n/a	0	0	0.15	0.14	0.7	0.21	0
	CM MN	n/a	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
	EB	n/a	n/a	0.05	1.58	n/a	0.13	n/a	n/a
	LN SU	n/a	n/a	0.11	0	n/a	0.5	n/a	n/a
	SL COT	n/a	n/a	0	0.05	n/a	0.1	n/a	n/a
	CM MN	n/a	n/a	0	0	n/a	0.03	n/a	n/a
Above Hwy 1	RB	n/a	n/a	n/a	n/a	n/a	n/a	0.12	0.18
	EB	n/a	n/a	n/a	n/a	n/a	n/a	0	0.06
	LN SU	n/a	n/a	n/a	n/a	n/a	n/a	0.70	0.06
	SL COT	n/a	n/a	n/a	n/a	n/a	n/a	0.89	0.36
	CM MN	n/a	n/a	n/a	n/a	n/a	n/a	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).

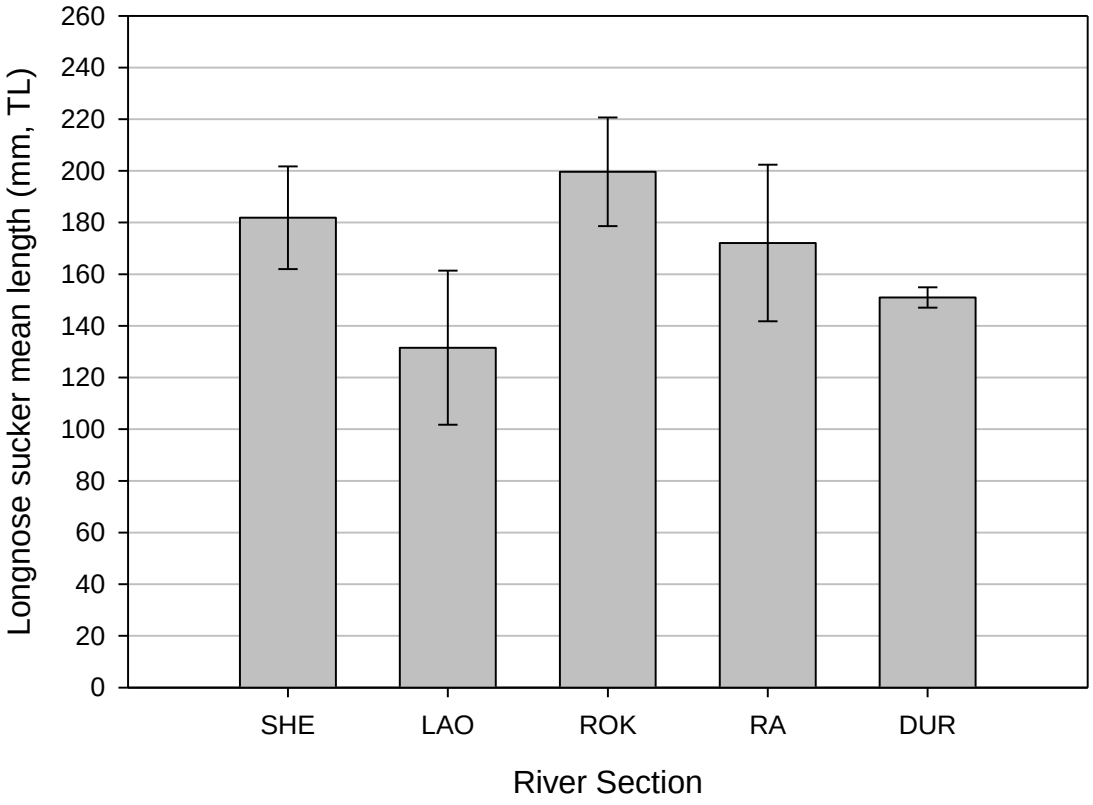

Figure 1. Longitudinal trend in mean length (mm, TL) of longnose suckers (*Catostomus catostomus*) collected in the fall, 2007 from five sections of upper Silver Bow Creek for liver metal analysis. Sites listed include: Father Shehan (SHE), Lower Area One (LAO), Rocker (ROK), Ramsey (RA), and Durant 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