

**FISH MONITORING STUDIES  
IN BUCK, FOXY AND CROW CREEKS  
AND GOOSLY LAKE 2012**

Prepared by

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for

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**EQUITY MINE**

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## **EXECUTIVE SUMMARY**

This report presents the results of the 2012 fish monitoring program conducted in the vicinity of Equity Mine near Houston BC. Treated water from the mine is seasonally released into upper Buck Creek via Bessemer Creek as well as into upper Foxy Creek. The program includes monitoring fish abundance in upper Buck Creek above and below Bessemer Creek confluence. It also monitors metal levels in rainbow trout fish tissue in samples from Goosly Lake and Foxy Creek. Metal sampling from a site in Crow Creek was added to the 2012 program to provide a reference site for Foxy Creek.

Rainbow trout fry densities at the potential effects site downstream from Bessemer Creek and in the reference site immediately upstream from Bessemer were similar to each other and above the average of past years. A second long-term reference location had higher fry densities than the two lower sites, and near average densities compared to past years. Rainbow parr densities at the two reference sites and the potential effects site below Bessemer were all similar to each other in 2012, and well above the average for past years.

Rainbow fry and parr were smaller than average at all locations in 2012, presumably reflecting rearing conditions common to all sites. Condition factors of parr were normal to high at the three index sites. Observations suggest a low level of external fish health abnormalities in rainbow trout from Goosly Lake, upper Buck, Foxy and Crow creeks.

Levels of cadmium and zinc in fish muscle tissue from Goosly Lake rainbow were comparable to the average levels measured since 1982, with zinc levels continuing to demonstrate a long-term increasing trend. Copper levels were slightly above the highest past levels ever recorded and were strongly influenced by a small number of individual fish. There was no significant trend in cadmium or copper levels in Goosly Lake fish.

Copper levels in Foxy Creek rainbow trout exceeded all past sample results in this system, but were not statistically different from the Crow Creek results that also demonstrated high copper levels. Zinc levels in Foxy Creek rainbow, although high, were within the range of past sampling and were strongly influenced by a single fish. The Crow Creek reference site had lower zinc levels than in Foxy Creek, but the samples were not statistically different reflecting high variance in the Foxy sample.

Trend analyses for metals in Foxy Creek rainbow trout continue to indicate an upward trend over time for zinc and copper and no trend for cadmium. The 2012 results demonstrate the importance of including the Crow Creek reference site in the program.

The metal analyses were confounded by some difficulties with the lab preparation of the muscle tissue, and analyses had to be re-done in 2012. The lab has improved its handling of fish tissue sample preparation to avoid future problems.



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## **1.0 INTRODUCTION**

### **1.1 BACKGROUND**

Fisheries studies were conducted in the vicinity of the Equity Mine site during late July through to the end of August 2012 as part of an Environmental Effects Monitoring (EEM) program conducted by Goldcorp Canada Ltd. (Equity Division). The 2012 fisheries program included monitoring fish abundance in upper Buck Creek and fish tissue metal levels in Foxy and Crow creeks and Goosly Lake. Crow Creek was added to the 2012 program to serve as a reference location for Foxy Creek, where fish tissue metal levels were elevated in 2011 compared to past years (Bustard 2012). Other than the addition of Crow Creek, the 2012 program was a standard monitoring year. Expanded monitoring programs have been undertaken every four years, with the last extended program conducted in 2010 (Bustard 2011).

The upper Buck Creek fish sampling compares fish abundance and external fish health characteristics at a reference location upstream from Bessemer Creek (BB2 old) and at a potential effects site (BB1) located downstream (Figure 1). This sampling has been conducted during 17 previous years since 1987. In 2003 a second reference location (BB2 new) was added closer to Bessemer Creek to allow for a better assessment of potential effects from Bessemer Creek inflows.

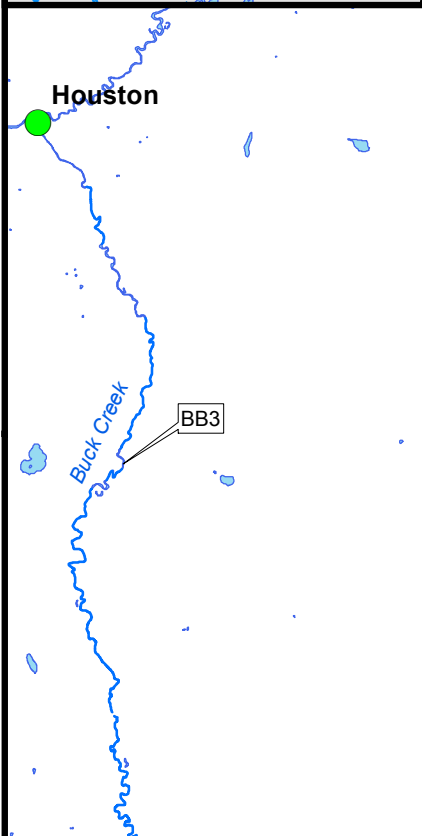
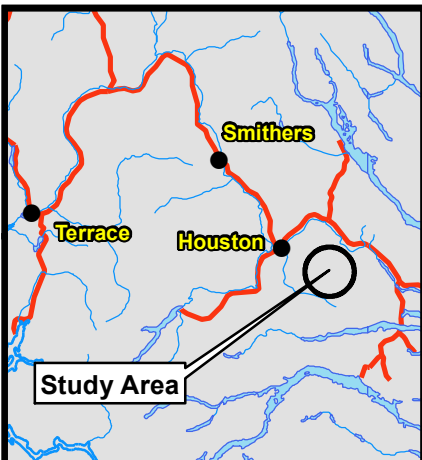
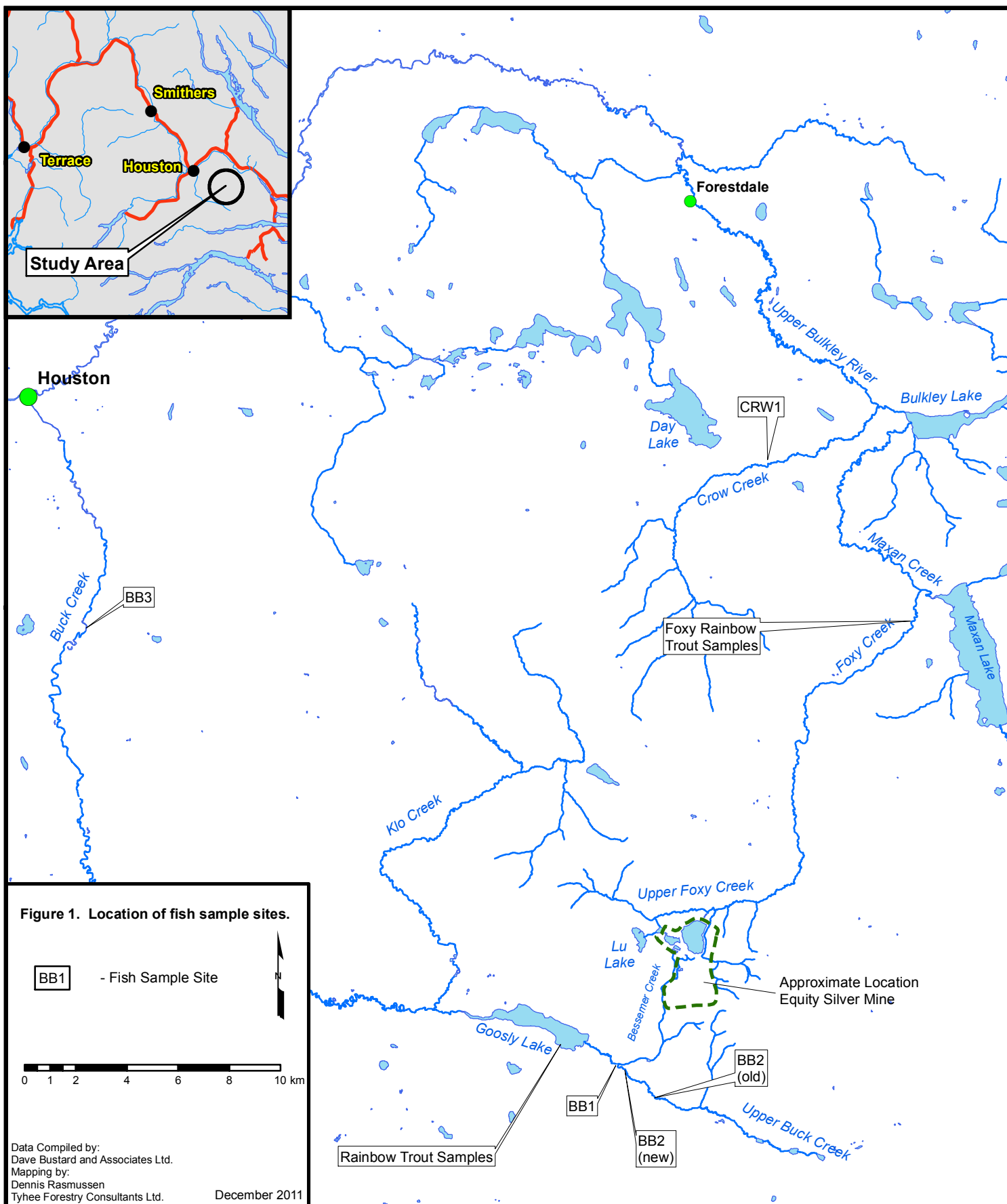
The annual fish sample program also includes collecting fish samples from Goosly Lake and Foxy and Crow creeks to measure levels of metals in fish muscle tissue. At least 17 years of background metals information is available at the Goosly and Foxy Creek locations. Three years of background metals information is available for the Crow Creek site at a locations that has normally only been sampled during the years of an extended program that occurs every four years.

### **1.2 OBJECTIVES**

The 2012 objectives were as follows:

- To compare fish density, size, and external fish health information at the Buck Creek index sites located above and below Bessemer Creek.
- To collect rainbow trout muscle tissue for metal analyses and compare results to historical results in Goosly Lake and Foxy and Crow creeks.
- To examine external fish health of rainbow trout from Goosly Lake and Foxy and Crow creeks.

This work was authorized under fish collection permit #SM12-77813 (Ministry of Environment).



## **2.0 METHODS**

### **2.1 LAKE SAMPLING**

Fish sampling was undertaken at Goosly Lake on July 26th, 2012 targeting rainbow trout using three floating gillnets (1.5" mesh) at the southwest end of the lake (Figure 1). Nets were monitored continuously and fish were carefully removed from the nets and transferred to a holding pen established on the south side of Goosly Lake for processing.

The three nets were effective in collecting the target 20 fish for the metal analyses. All fish were weighed, fork lengths measured and scales removed for ageing. External fish health assessments were conducted on the lake sample of fish using the same field keys and characteristics as those used since 2002 (Hatfield Consultants Ltd. 2003). Body cavities were opened to confirm the sex of fish samples. Scales from rainbow trout were aged by Birkenhead Scale Analyses (Lone Butte).

The fish samples were bagged separately and placed on ice in the field, frozen within the day and sent to ALS Labs for dissection of muscle tissue (no skin attached) and subsequent lab analysis for metals.

### **2.2 STREAM SAMPLING**

#### **2.2.1 Buck Creek**

The three main fish index sites in upper Buck Creek were sampled in 2012. Sampling was also conducted at a fourth location in lower Bessemer Creek since it was still wetted during the late August sample period. The fish population studies in upper Buck Creek were conducted between August 27<sup>th</sup> and August 29<sup>th</sup>, corresponding closely to the timing of past surveys undertaken in Buck Creek since 1987.

Prior to 2002 the potential effects index site was located approximately 300 m upstream from Goosly Lake. This site was moved to a location approximately 1.5 km upstream from the lake with the top of the site approximately 25 m downstream from the Bessemer Creek confluence. The original reference Site BB2 (old) is located a further 2 kms upstream from Bessemer Creek or 3.5 kms from Goosly Lake. The second reference site (BB2 new) is located approximately 50 m upstream from Bessemer Creek confluence with Buck Creek.

The juvenile sampling methods have remained similar for all years of sampling in Buck Creek. The sites were blocked with stopnets at their upstream and downstream ends and sampled using a Smith-Root backpack electrofisher. Small adjustments were made to site length to accommodate debris shifting. One thorough sweep up and back down through the sites including a net check constituted a single pass. Two passes were conducted at the two reference sites, typical of most sampling conducted during past years. Three-pass removal was undertaken at Site BB1 in 2012 due to a poor decline in both fry and parr numbers in passes 1 and 2. Effort was recorded as number of seconds of electrofishing per pass. Pulse and frequency adjustments were made compared to

standard settings to accommodate higher conductivity downstream from the Bessemer Creek confluence, similar to 2011.

Rainbow parr and any other species captured at the sites were measured and weighed. At each site a sample of up to 50 rainbow trout fry was measured to the nearest mm fork length and weighed, with all other rainbow fry simply counted.

Population estimates were derived using the two-pass removal method outlined in Seber and LeCren (1967). Standard error estimates have been derived from methods outlined in Chapman (1951) and used to calculate confidence intervals for the population estimates. The three-pass removal estimates were calculated using Schnute's (1983) removal approach to determine the maximum likelihood population estimate. All parr age 1+ and older were combined to calculate the confidence intervals.

A sample of 30 rainbow trout parr per site was examined for external fish health characteristics using the same field keys and characteristics as in 2002 (Hatfield Consultants Ltd. 2003). These fish were weighed and scales were removed from representative length classes for ageing (three scales for each 5 mm length class per site between 90 and 105 mm). The age separation for fish smaller than this size was clear from length-frequency distributions.

Condition factor (K) was calculated from the length and weight measurements as follows:

$$\text{Condition Factor (K)} = 100(\text{body weight}/\text{length}^3)$$

Sample site areas were calculated by measuring the site length and a series of width measurements at 5 m intervals along the site. Habitat characteristics including a description of bed material, cover, habitat type, pool and riffle depths, and slope were recorded similar to past observations at these sites. Upstream and downstream photos were taken at each site. Discharge was measured at a single cross section within each of the three main sample locations using a Swiffer velocity meter.

A small beaver dam located at the bridge site (BB2 new) was lowered approximately 50 cm to enable effective sampling. This was undertaken after the lower stopnet was in place to ensure fish did not leave the site.

### **2.2.2 Foxy and Crow Creeks**

Length and weight measurements and an external fish health assessment were conducted on 30 rainbow parr collected by electrofishing in Foxy and Crow creeks on August 30<sup>th</sup>, 2012<sup>1</sup>. Scales were removed from representative length classes for ageing. The muscle tissue metal analyses were conducted on 10 samples each consisting of a single fish from this same group of fish. The total tissue needed to conduct the metal analyses was reduced from 20 g in 2012 due to ALS Lab's capability to conduct the digestions and

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<sup>1</sup> All Foxy Creek fish were sampled in the riprap at the bridge crossing. No other fish species were present in 2012. Crow Creek fish were captured at the Crow Creek bridge crossing on the main access road.

analyses on a smaller total amount of fish tissue requiring a single fish sample. The fish samples were bagged separately, placed on ice in the field and frozen within the day. The samples were then submitted to ALS Labs as whole fish with the muscle dissections undertaken in the lab to minimize field contamination – similar to past years.

### **2.3 FISH SAMPLE LAB RE-ANALYSES**

Comparison of the first results from the lab analyses to historical sampling results indicated unusually high metal levels, particularly for cadmium for all systems including the Crow Creek control site. The lab was contacted by Goldcorp Canada to re-examine the submitted fish samples. ALS re-checked the dissection procedures and tissue analyses by using the second half of the fish filets, paying particular attention to removing skin and bones from the samples as in past years. The results of the re-check have been used for the metal summaries presented in this year's report unless noted otherwise due to lack of tissue for the second analyses.

The detailed explanation for the differences and the improved handling and filleting procedures for future analyses are documented in a letter from ALS Labs to Goldcorp Canada Equity Division (Appendix 6). The results for the initial reported results and the re-checked results are also presented in this appendix.

### **2.4 TREND ANALYSIS**

Trend analysis was used to determine the significance of apparent trends over time for metal analyses in fish tissues, and to estimate the magnitude of such trends<sup>2</sup>. The Mann-Kendall test for temporal trend (Hollander and Wolfe 1973) and Sen's slope estimate (Gilbert 1987) were used to evaluate the correlation of tissue metal concentrations with time. No trend analysis of metal levels in Crow Creek fish was undertaken due to an insufficient time series of data for this system.

When cadmium levels were below the 0.03 mg/kg detection limits, trend analyses were conducted substituting one-half the detection limits (Trial 1) and the minimum detection limit (Trial 2).

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<sup>2</sup> This work was undertaken with the assistance of Hatfield Consultants Ltd.

## **3.0 RESULTS**

Streamflows in late August 2012 were generally low following a dry summer period. The discharge estimates of 43-55 l/sec at upper Buck Creek fish index sites were the third lowest in the past nine years during the late summer sample period (Appendix 1 Table 1). A summary of maximum daily discharge in lower Buck Creek indicates the flood peak occurred in late May 2012 and was below the average since 1973 (Appendix 1 Figure 1).

As part of the water management program, Equity Mines released treated water into upper Buck Creek from April 23 to July 27 and into upper Foxy Creek from May 8 to July 27<sup>3</sup>. Treated water was not being released into any of the fish sample locations during the late August 2012 sample period. No releases occurred during the fall due to low creek flows.

### **3.1 FISH ABUNDANCE AND GROWTH**

#### **3.1.1 Buck Creek**

##### **3.1.1.1 Buck Creek Fish Composition**

The upper Buck Creek catch for all sample sites continues to be dominated by rainbow trout (Table 1). Age 1+ rainbow comprised 97% of the total parr catch for the three sites combined, 3% were age 2+ and a single parr was age 3+ or older. Four of the 718 fish estimated in the three sites in 2012 were prickly sculpins. A total of 18 longnose suckers were present in the upper Buck Creek index sites in 2012.

The species composition of the catch at the lower Buck Creek index site (BB1) prior to re-locating it upstream in 2002 indicates that longnose suckers, mountain whitefish, and prickly sculpins were more common in the slow-flowing lowermost section of Buck Creek just upstream from Goosly Lake that was sampled prior to 2002 (Appendix 3 Table 1). Beaver dams in Buck Creek downstream from the present sample sites may restrict these other fish species to the lowermost creek section below the index sites during most years.

The four prickly sculpins sampled in 2012 were all captured at the reference site (BB2 new). More detailed prickly sculpin catch information in upper Buck Creek is summarized in Appendix 3 Table 2. The 18 longnose suckers sampled in 2012 is the highest combined catch for this species to date (Appendix 3 Table 1). Eight suckers were present at the lowermost site (BB1) while the other 10 were captured just upstream in the reference site (BB2 new).

No fish were captured at the Bessemer Creek reference site in 2012 (Appendix 2 Table 4).

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<sup>3</sup> Information provided by Mike Aziz, Equity Mine.



**Table 1. Summary of fish composition by species combined for all sites in upper Buck Creek 2003 to 2012<sup>4</sup>.**

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Mean
Rainbow fry	283	413	385	107	153	103	298	215	316	320	259
Rainbow parr	281	194	365	295	181	109	493	217	176	376	269
Longnose suckers	0	0	2	1	8	4	4	1	4	18	4
Prickly sculpins	0	0	0	0	4	0	0	0	0	4	1
Longnose dace	0	0	0	0	0	0	0	3	0	0	0
<b>Total</b>	<b>564</b>	<b>607</b>	<b>752</b>	<b>403</b>	<b>346</b>	<b>216</b>	<b>795</b>	<b>436</b>	<b>496</b>	<b>718</b>	<b>533</b>

### 3.1.1.2 Buck Creek Fish Abundance

Fry densities at the potential impact site below Bessemer Creek (BB1) were high (32 fry/100 m<sup>2</sup>) compared to most sampling results since this site was first established at the present location in 2002 (Table 2 and Figure 3)<sup>5</sup>.

Rainbow fry densities of 33 fry/100 m<sup>2</sup> immediately upstream at the reference site (BB2 new) were also well above the average of 22 fry/100 m<sup>2</sup> since the site was first established, and were comparable to the potential impact site (BB1) in 2012 (Table 2 and Figure 2).

Similar to most years, 2012 rainbow fry densities were highest at the uppermost long-term reference site in Buck Creek (BB2 old in Figure 2 and Table 2). Fry densities at this location (39 fry/100 m<sup>2</sup>) were just below the mean of 42 fry/100 m<sup>2</sup> for the comparable period (Table 2) and for the period of record at this site (Appendix 2 Table 5). Confidence intervals around the 2012 fry data at the lowermost index site were wide (Figure 2), reflecting a poor decline in fry and parr captures between passes 1 and 2 leading to the need for a third pass at this site.

The pattern of highest rainbow trout fry densities at the uppermost Buck Creek site (BB2 old) has been prevalent for most of the past 11 years of sampling at these three locations (Figure 3)<sup>6</sup>. This may reflect a higher suitability for fry rearing at this location including more riffle habitat, a coarser bed material component and a location close to good potential spawning sites as outlined in Bustard (2003).

Rainbow parr densities at the Site BB1 below Bessemer Creek (41 parr/100 m<sup>2</sup>) were close to those measured at the two reference locations in 2012 (Table 2), and above the mean parr densities at this site since 2003. Combined parr densities at the potential impact site (BB1) have been higher than the new reference site just upstream (BB2 new)

<sup>4</sup> Note - totals are based on estimated catch from the multiple passes.

<sup>5</sup> Note- these comparisons focus on the period from 2003 onward, corresponding to the period that both reference sites have been sampled.

<sup>6</sup> The exception was in 2006, when densities were highest in BB1. Confidence in the data at this site in that year was poor despite a three-pass removal.

**Table 2. Rainbow trout fry and parr<sup>7</sup> densities (fish/100 m<sup>2</sup>) at the Buck Creek index sites from 2003 to 2012.**

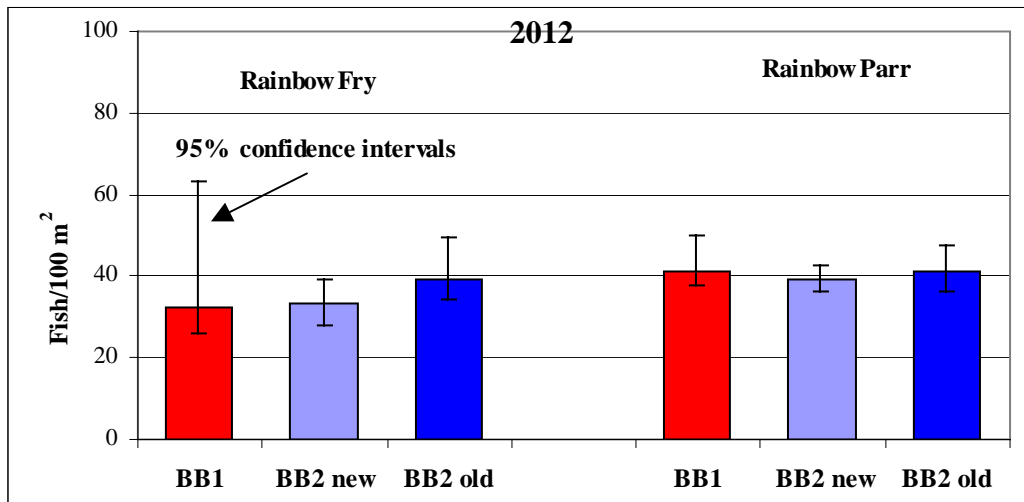
SAMPLE SITE	YEAR	DENSITY (fish/100 m <sup>2</sup> )	
		0+	Parr
<b>BB1</b>	2003	25	32
Downstream from	2004	12	13
Bessemer Creek	2005	29	37
	2006	31	34
	2007	9	16
	2008	2	4
	2009	31	77
	2010	16	12
	2011	29	11
	2012	32	41
	<b>Mean (2003-12)</b>	<b>21.7</b>	<b>27.5</b>
<b>BB2 old</b>	2003	42	40
Reference site	2004	80	41
1.3 km upstream	2005	51	45
	2006	19	41
	2007	18	23
	2008	18	13
	2009	45	43
	2010	48	43
	2011	61	25
	2012	39	41
	<b>Mean (2003-12)</b>	<b>42.1</b>	<b>35.5</b>
<b>BB2 new</b>	2003	23	20
Reference site	2004	61	20
just upstream from	2005	32	24
Bessemer Creek	2006	2	21
	2007	15	12
	2008	10	14
	2009	24	37
	2010	6	14
	2011	11	20
	2012	33	39
	<b>Mean (2003-12)</b>	<b>21.9</b>	<b>22.1</b>

in six of the past nine years (Table 2), but have been lower than or equal to the old reference location (BB2 old) in all years but 2009.

Rainbow trout parr densities at the upper Buck reference site (BB2 old) were high compared to the long-term average since 1987 (Appendix 2 Table 5). The overall higher parr densities at the three index sites in 2012 may partially reflect the lower flow conditions during the 2012 late August sample period (Appendix 1 Table 1) leading to more crowding than during wetter years.

<sup>7</sup> Combined age 1+ and older parr.

**Figure 2. Rainbow trout fry and parr densities (fish/100 m<sup>2</sup>) at the Buck Creek index sites in 2012<sup>8</sup>.**



### 3.1.1.3 Buck Creek Fish Size and Condition

Rainbow trout fry mean fork lengths ranged from 33 to 37 mm in 2012 (Table 3) and were not significantly different at the old reference site (BB2 old) and the site downstream from Bessemer (BB1)<sup>9</sup>. The smallest fry were located at the upper reference site (BB2 old) closest to spawning locations. Fry at the new reference site were significantly larger than at the other two locations in 2012 (Table 3).

Fry lengths in 2012 were on average 3 mm smaller than the long-term mean for all past years at all of the sample locations (Appendix 4 Table 1). Fry at all of the sites were more than 3 mm larger than the 2011 fry sample that were the smallest fry for all years sampled (Appendix 4 Table 1). The fact that small fry were sampled at both the reference site and the potential impact site suggests that environmental factors common throughout the system were affecting fry size.

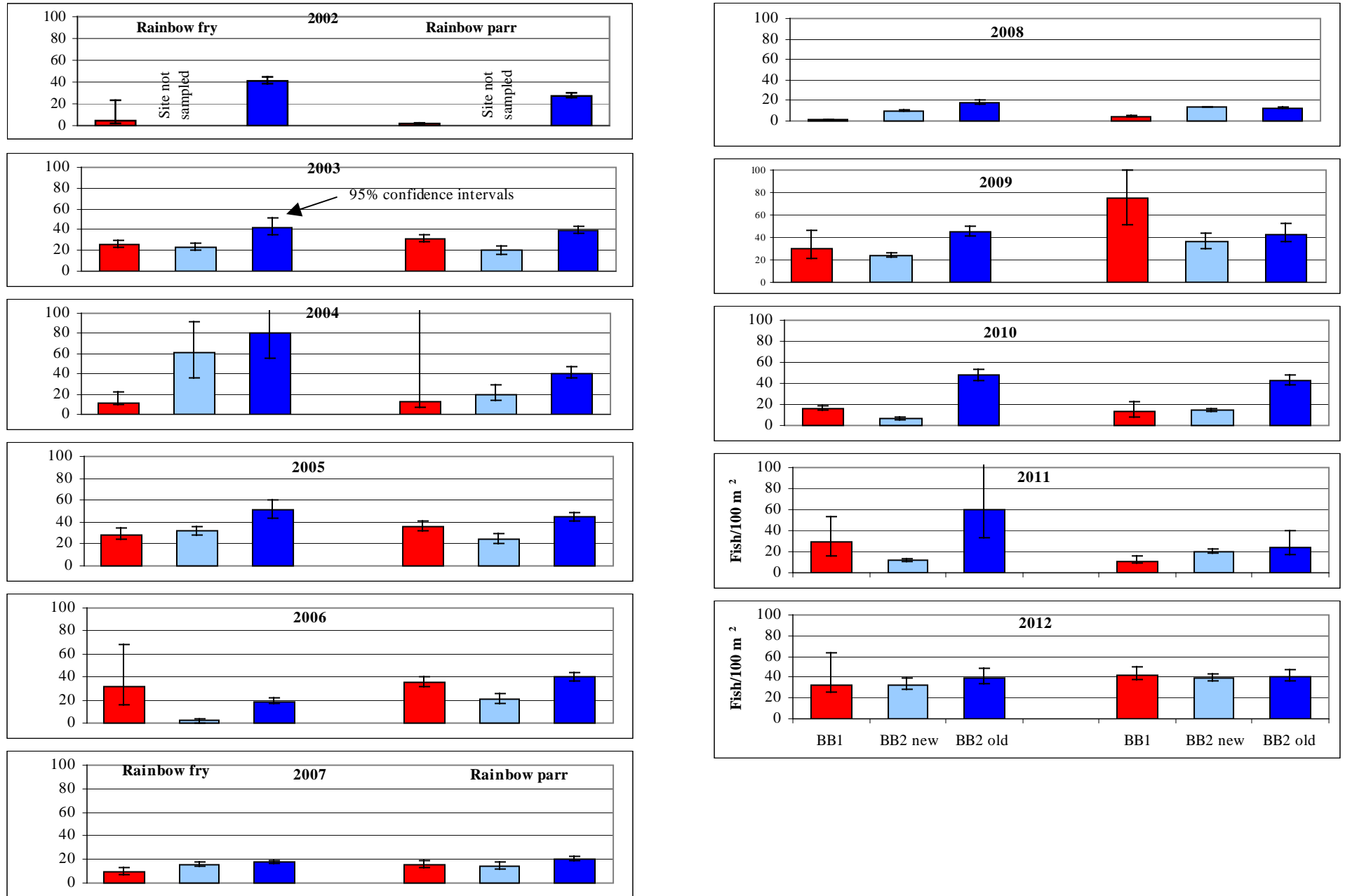
**Table 3. Fork length and condition factors for age 0+ and age 1+ rainbow trout at four locations in upper Buck Creek in 2012.**

	AGE 0+			AGE 1+		
	Mean fl (mm ± std)	Condition (k ± std)	Sample Size	Mean fl (mm ± std)	Condition (k ± std)	Sample Size
<b>BB2 (old)</b>	33.2 ± 5.3	1.07 ± 0.24	51	72.0 ± 11.8	1.17 ± 0.16	85
<b>BB2 (new)</b>	36.9 ± 4.0	1.12 ± 0.21	50	73.5 ± 7.3	1.09 ± 0.12	124
<b>BB1</b>	34.4 ± 3.2	1.07 ± 0.17	50	73.0 ± 11.3	1.05 ± 0.10	83

<sup>8</sup> Parr age 1+ and greater.

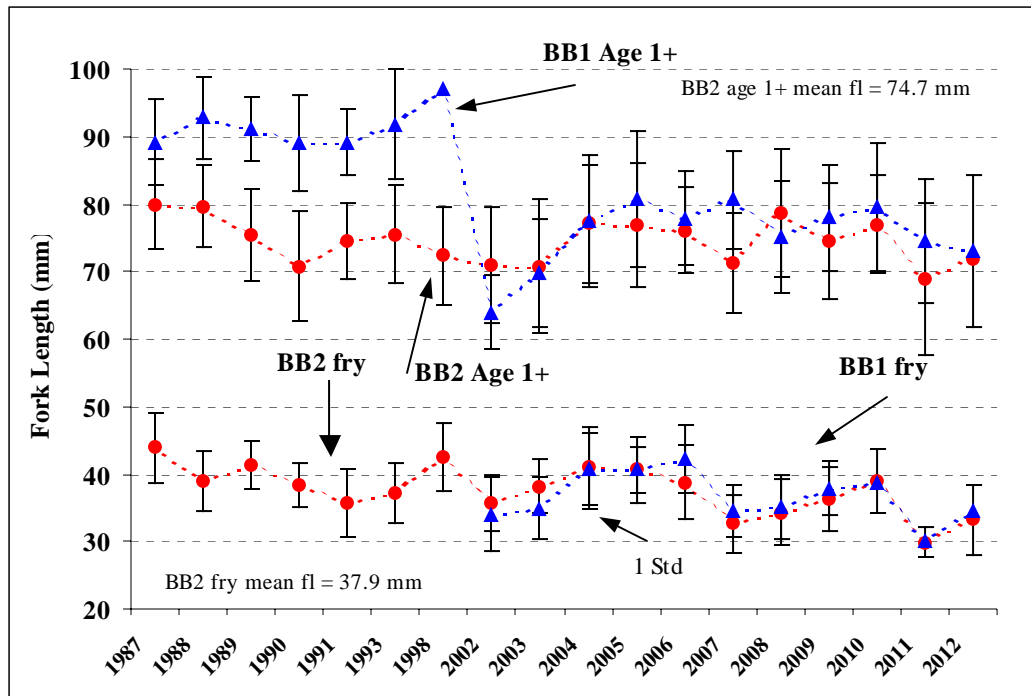
<sup>9</sup> T-tests p=0.05.

Figure 3. Rainbow trout fry and parr densities 2002 to 2012.



Rainbow age 1+ parr were not significantly different in length at the uppermost reference site compared to the potential impact location below Bessemer Creek (Figure 4) or at the second reference site (BB2 new) in 2012<sup>10</sup>. Larger parr have been present at this downstream location for seven of the past nine years.

**Figure 4. Mean fork lengths of upper Buck Creek age 0+ and age 1+ rainbow trout from 1987 to 2012 at the long-term reference site (BB2 old) compared to the potential impact site just downstream from Bessemer Creek (BB1).**

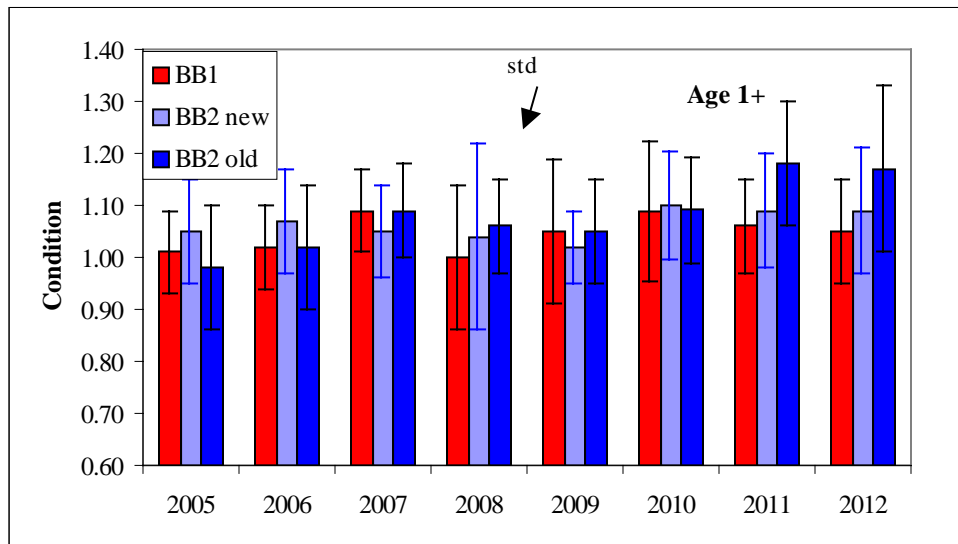


Similar to the fry fork length comparisons, upper Buck Creek parr at the long-term reference site and the site below Bessemer Creek were approximately 3 mm smaller than the means at these locations since 2003. The results suggest that environmental factors affecting fry development and growth in 2012 also influenced the age 1+ parr.

The condition factors for juvenile rainbow parr provide a relative measure of well-being, with higher condition factors reflecting a heavier or plumper fish. Condition factors of age 1+ rainbow trout are probably a more meaningful measurement than fry condition, as these fish have been rearing for a full year in Buck Creek. The summaries for the three Buck Creek sites (Figure 5) indicate that rainbow parr condition factors over the past year were in the mid-range of past measurements at the two index sites located above and below Bessemer Creek in 2012. Parr condition was high at the uppermost reference site (BB2 old), similar to 2011, and comparable to the mean condition factor for Foxy Creek parr in 2012 (Appendix 7 Table 4).

<sup>10</sup> T-test  $p=0.05$

**Figure 5. Condition factors for rainbow trout age 1+ parr for the past eight years in upper Buck Creek.**



### 3.1.2 Goosly Lake Rainbow Trout Life History Characteristics

The Goosly Lake rainbow trout that were captured in the standard mesh size nets and used in the metal analyses and for external fish health assessment were all age 2+ to 4+ with a mean fork length of 18 cm (Table 4 and Appendix 7 Table 6). This is within the range of past samples at the lake using the same net mesh size. The mean condition factor of 0.97 is near the average condition of rainbow trout measured in Goosly Lake since 2002 (Table 4).

### 3.1.3 Foxy and Crow Creeks Rainbow Trout Life History Characteristics

Foxy Creek rainbow trout were a mix of age 1+ and age 2+ fish (Appendix 7 Table 4). The 2012 sample averaged near 10 cm in fork length, and were on average 1 cm larger than similar samples from the past decade (Table 4). There was no significant difference between Foxy and Crow creek fish lengths, but fish from Foxy Creek had a higher condition factor than Crow Creek fish<sup>11</sup>. The Crow Creek fish sample in 2012 had more older and larger fish compared to past samples, while Foxy Creek fish lengths were within the range of past sample parameters.

<sup>11</sup> T-tests  $p=0.01$ .

**Table 4. Summary of biological parameters of rainbow trout sampled in Goosly Lake and Foxy and Crow creeks, 2002 to 2012<sup>12</sup>.**

Location	Species	Year	N	Length (cm ± SD)	Weight (g ± SD)	Condition (K ± SD)	Age (mean ± SD)
Goosly Lake	Rainbow	2002	53	18.3 ± 2.1	57.0 ± 16.9	0.92 ± 0.09	4.4 ± 1.06
		2003	16	20.4 ± 3.7	95.9 ± 45.9	1.04 ± 0.15	3.5 ± 0.63
		2004	20	18.8 ± 2.7	67.6 ± 26.8	1.00 ± 0.09	3.8 ± 0.85
		2005	20	16.3 ± 2.5	45.1 ± 17.8	0.99 ± 0.05	2.8 ± 1.02
		2006	30	17.4 ± 1.0	50.9 ± 7.0	0.96 ± 0.07	2.7 ± 0.60
		2007	20	18.5 ± 1.3	64.3 ± 15.1	1.00 ± 0.06	3.1 ± 0.31
		2008	20	17.8 ± 1.3	55.9 ± 10.9	0.98 ± 0.08	3.3 ± 0.44
		2009	20	18.3 ± 1.1	57.3 ± 9.0	0.94 ± 0.07	3.2 ± 0.41
		2010	20	17.2 ± 1.3	53.2 ± 11.2	1.03 ± 0.06	3.3 ± 0.55
		2011	17	18.1 ± 1.4	54.4 ± 10.1	0.92 ± 0.10	3.2 ± 0.56
		2012	20	18.2 ± 9.0	59.3 ± 9.1	0.97 ± 0.07	2.8 ± 0.64
			<b>Mean</b>			<b>18.1 ± 1.0</b>	<b>60.1 ± 12.7</b>
Foxy Creek	Rainbow	2002	194	5.70 ± 2.2	2.9 ± 2.7	1.0 ± 0.14	na
		2003	38	8.95 ± 2.1	10.1 ± 7.5	1.21 ± 0.07	1.5 ± 0.63
		2004	58	7.89 ± 1.6	6.0 ± 4.2	1.08 ± 0.09	1.1 ± 0.29
		2005	30	10.5 ± 1.8	14.0 ± 7.7	1.11 ± 0.10	1.6 ± 0.56
		2006	30	10.4 ± 2.8	16.5 ± 19.0	1.12 ± 0.13	1.3 ± 0.60
		2007	30	9.19 ± 1.7	9.3 ± 6.5	1.05 ± 0.12	1.4 ± 0.61
		2008	30	8.75 ± 1.8	9.0 ± 5.9	1.17 ± 0.09	1.4 ± 0.50
		2009	30	10.2 ± 1.6	12.4 ± 6.9	1.05 ± 0.08	1.3 ± 0.61
		2010	30	9.30 ± 1.4	8.8 ± 5.2	1.01 ± 0.08	1.1 ± 0.39
		2011	25	8.39 ± 1.2	7.3 ± 3.2	1.17 ± 0.10	1.1 ± 0.28
		2012	30	9.87 ± 11.1	11.4 ± 4.0	1.14 ± 0.14	1.3 ± 0.50
			<b>Mean</b>			<b>9.01 ± 1.4</b>	<b>9.8 ± 3.8</b>
Crow Creek	Rainbow	2002	30	8.67 ± 1.28	7.75 ± 4.05	1.10 ± 0.16	1.3 ± 0.45
		2006	30	9.83 ± 2.02	11.0 ± 7.0	1.03 ± 0.08	1.3 ± 0.60
		2010	30	9.07 ± 1.86	9.50 ± 7.8	1.09 ± 0.09	1.5 ± 0.59
		2012	30	10.1 ± 1.41	11.8 ± 4.9	1.06 ± 0.07	1.8 ± 0.43
			<b>Mean</b>			<b>9.42 ± 0.6</b>	<b>10.0 ± 1.5</b>

<sup>12</sup> 2002 data from Hatfield Consultants (2003); 2003 data from Bustard (2003). A subsample of 2002 rainbow trout were used in the Goosly Lake metal analyses, while all of the fish from 2003 to 2012 have been used. A subsample of the Foxy and Crow Creek fish has been used in the metal analyses. The 2002 Crow Creek sample used the 30 largest fish captured at the sample location to summarize parameters.

## 3.2 METALS IN FISH

### 3.2.1 Goosly Lake

The results of metal analyses of the 20 rainbow trout muscle tissue samples from Goosly Lake indicate that levels of cadmium and zinc are comparable to the mean levels measured since 1982 (Table 5). There was higher variability in the zinc levels compared to results from the past decade, largely reflecting high zinc levels in one fish (RBT7 in Appendix 5 Table 1).

Similar to most years, the zinc levels in the Goosly Lake rainbow were higher than a sample of BC lakes summarized in Rieberger (1992) and past results for the reference Maxan Lake (Table 5). Cadmium levels are considerably lower than the summary of provincial lakes (Table 5). Only five of 20 fish in the sample exceeded the lower detection limits of 0.03 mg/kg (Appendix 5 Table 1).

Copper levels in Goosly fish were high compared to past sample results (Table 5), and were slightly above the highest levels recorded in 2002 (Figure 6). There was considerable variability in copper levels within the samples compared to past years. In particular, the results from the 20 fish sampled in 2012 were influenced by high copper levels measured in two fish (RBT2 and RBT15 in Appendix 5 Table 1). There were large differences in the results from the initial and re-check results for these two fish (Appendix 6). Copper levels of near 2 mg/kg are comparable to the average of the BC lakes reported in Table 5.

Trend analyses conducted on Goosly Lake rainbow indicate there was no significant difference in cadmium and copper concentrations with time at an alpha level of 0.10 or lower. The trend analysis continues to show an increasing trend in zinc in fish muscle tissue since 1982 at alpha=0.05 and higher (Table 6). The trend was not as strong as in 2009 when it was significant at alpha=0.01 (Bustard 2010), reflecting the lower zinc concentration in the sample results for the past three years (Figure 6).

**Table 5. Summary of 2012 metal concentrations (mean  $\pm$  std) in rainbow trout in Goosly Lake compared to historical means<sup>13</sup>.**

Location	Year	Muscle Tissue Metal Concentration (mg/kg dry weight)		
		Cd <sup>14</sup>	Cu	Zn
Goosly	2012	0.04 $\pm$ 0.01	2.25 $\pm$ 1.11	40.4 $\pm$ 18.0
<b>Goosly mean for all years</b>	1982 to 2012	0.04 $\pm$ 0.02	1.58 $\pm$ 0.36	36.7 $\pm$ 9.8
<b>Maxan (reference) - mean</b>	2002 and 2010	<0.03	1.47 $\pm$ 0.36	23.2 $\pm$ 6.05
<b>BC lakes - Rieberger (1992)<sup>15</sup></b>		1.15 $\pm$ 0.15	1.95 $\pm$ 1.45	21.4 $\pm$ 6.5

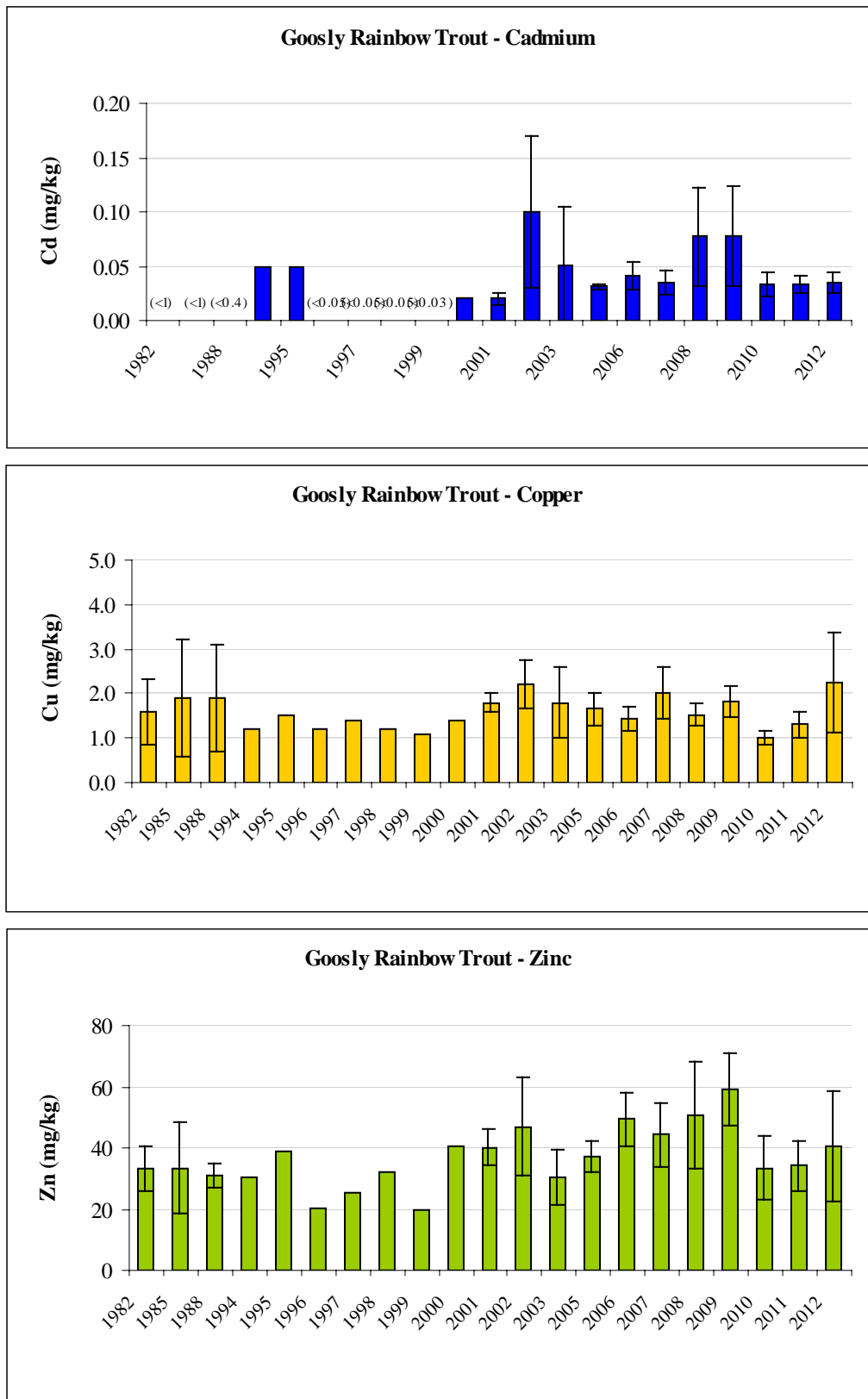
<sup>13</sup> The 2004 metal results are not included in summaries due to different sample treatment that yielded results that are not comparable to other years.

<sup>14</sup> When cadmium levels in individual fish were below detection levels (0.03 mg/kg), we have assumed levels of 0.03 mg/kg to calculate mean cadmium levels. This is the same method as used in past years.

<sup>15</sup> Muscle tissue information. We have assumed 80% moisture content to convert the wet weight information reported in Rieberger (1992) to dry weights presented in this report.



**Figure 6. Summary of rainbow trout muscle tissue total metal concentration (mean  $\pm$  std) sampled in Goosly Lake 1982 to 2012.**



**Table 6. Results of trend analyses on Goosly Lake cadmium, copper, and zinc in rainbow trout muscle tissue, 1982 to 2012.**

	Variable Measured	Number of Observations	Slope (units/year)	Mann Kendall Statistic	Alpha	Critical	Significant?
	Sen's Slope Estimator	Cd Trial 1 <sup>16</sup>	21	0	47	0.01	87
0.05						66	No
0.1						56	No
0.2						44	Up
Cd Trial 2 <sup>17</sup>		21	0	38	0.01	87	No
					0.05	66	No
					0.1	56	No
					0.2	44	No
Cu		21	0.004	15	0.01	87	No
					0.05	66	No
					0.1	56	No
					0.2	44	No
Zn		21	0.603	79	0.01	87	No
					0.05	66	Up
					0.1	56	Up
					0.2	44	Up

### 3.2.2 Foxy and Crow Creeks

Copper and zinc levels in rainbow trout muscle tissue sampled in Foxy Creek in 2012 were above the mean levels obtained since 1994 (Table 7). Cadmium levels were comparable to the long- term mean. Detailed information for each fish sampled in Foxy and Crow creeks in 2012 is presented in Appendix 5 Tables 2 and 3.

Mean copper levels of 3.5 mg/kg in Foxy rainbow exceeded all of the past measurements over an 18-year period at this location (Figure 7). These higher copper levels were consistent across all of the 10 fish sampled. Past sampling at this location has averaged 2.2 mg/kg at this location.

The mean copper level at the reference site in Crow Creek was also high in 2012 averaging 3.0 mg/kg (Table 7). These levels are distinctly higher than past measurements at this location. The 2012 copper levels in Foxy and Crow creeks were not significantly different from each other<sup>18</sup>. Five of the 10 fish sampled in Crow Creek in 2012 exceeded 3 mg/kg copper in the muscle tissue (Appendix 5 Table 3).

Zinc levels in fish muscle tissue of 40 mg/kg were above the average of 33 mg/kg for the period of record but were within the range of past levels measured at this site (Figure 7).

<sup>16</sup> If less than detection level (0.03 mg/kg), then one-half detection level used in analysis.

<sup>17</sup> If less than detection level (0.03 mg/kg), then actual detection level used in the analysis.

<sup>18</sup> T-test at p=0.01

These results were strongly influenced by unusually high zinc levels in a single fish<sup>19</sup>. This fish added a high variance to the 2012 sample results (Figure 7).

Rainbow trout from the Crow Creek reference site averaged 31 mg/kg zinc in their muscle tissue, within the range of past measurements at this site. The Foxy and Crow creek sample results were not statistically different from each other ( $p=0.1$ )<sup>20</sup> reflecting the high variance in the Foxy sample.

Historically, high zinc levels were also recorded in Foxy rainbow trout in 2002 (54 mg/kg) (Table 7). Those sample results had a high standard deviation suggesting considerable variability amongst individual samples for that year with individual samples up to 86 mg/kg (Hatfield Consultants Ltd. 2003). Tissue samples were also collected from Crow Creek rainbow trout in 2002 to serve as a reference (Table 7). The Crow Creek rainbow trout samples had similarly high zinc levels (49 mg/kg) and displayed a high level of variability in 2002 with the highest zinc level of 68 mg/kg in an individual fish.

The only past sample results with Zn levels exceeding 100 mg/kg such as FOX1 in 2012 (Appendix 5 Table 2) was in 2004 when whole fish samples were homogenized with skin and bone included. The results from the 2004 analyses have not been included in the data set due to the different sample preparation methods used in that year. The issues with sample preparation in 2012 are discussed in detail in Appendix 6.

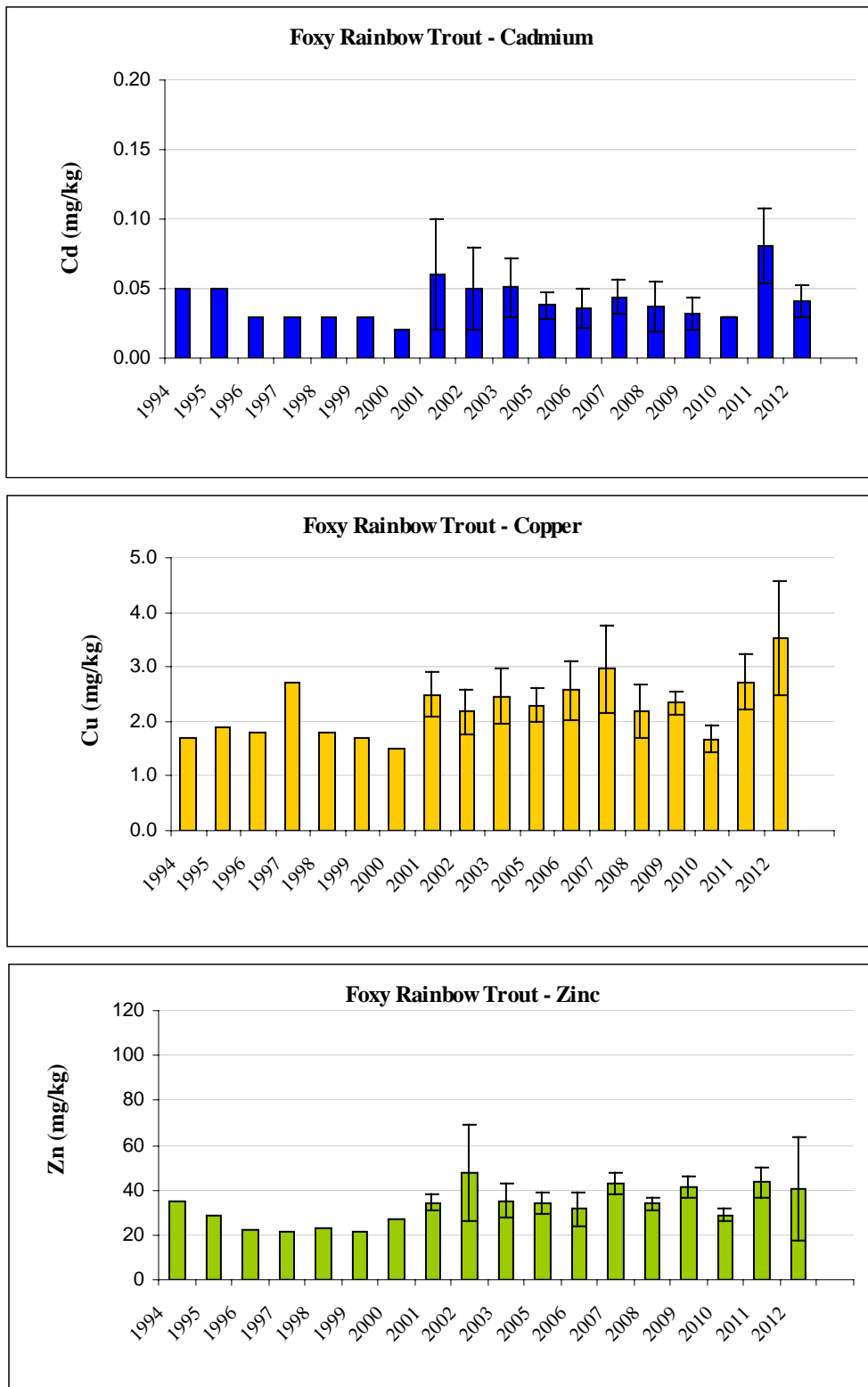
**Table 7. Summary of 2012 metal concentrations (mean  $\pm$  std) in rainbow trout in Foxy Creek compared to historical means and to the Crow Creek reference site.**

Location	Year	Muscle Tissue Metal Concentration (mg/kg dry weight)			
		N	Cd	Cu	Zn
Foxy Creek	2012	10	<b>0.04 <math>\pm</math> 0.01</b>	<b>3.52 <math>\pm</math> 1.05</b>	<b>40.4 <math>\pm</math> 23</b>
	2011	10	0.08 $\pm$ 0.03	2.72 $\pm$ 0.50	43.6 $\pm$ 6.8
	2010	10	<0.03	1.68 $\pm$ 0.24	28.8 $\pm$ 3.0
	2006	10	0.04 $\pm$ 0.01	2.57 $\pm$ 0.55	31.5 $\pm$ 7.7
	2002	10	0.04 $\pm$ 0.01	2.03 $\pm$ 0.29	54.5 $\pm$ 24
<b>Foxy</b>	<b>1994 to '2012</b>	5-20	0.04 $\pm$ 0.01	2.21 $\pm$ 0.45	32.6 $\pm$ 8.0
Crow Creek	2012	10	<b>0.04 <math>\pm</math> 0.03</b>	<b>2.98 <math>\pm</math> 1.01</b>	<b>30.9 <math>\pm</math> 3.98</b>
	2011		not sampled		
	2010	10	0.04 $\pm$ 0.01	1.47 $\pm$ 0.20	26.6 $\pm$ 5.0
	2006	10	0.04 $\pm$ 0.01	2.15 $\pm$ 0.21	32.8 $\pm$ 5.4
	2002	10	0.06 $\pm$ 0.01	2.42 $\pm$ 0.60	48.9 $\pm$ 14.0

<sup>19</sup> The re-check analysis confirmed the high levels of Zn in FOX1 (Appendix 6).

<sup>20</sup> The difference was significant at  $p=0.2$ .

**Figure 7. Summary of rainbow trout muscle tissue total metal concentration (mean ± std) sampled in Foxy Creek 1994 to 2012.**



Trend analyses conducted on metal concentrations in Foxy Creek trout from 1994 to 2012 (Table 8) indicate an upward trend in zinc and copper levels ( $\alpha = 0.05$ ). There was no significant trend in cadmium levels with time in Foxy Creek fish.

### **3.3 EXTERNAL FISH HEALTH ASSESSMENTS**

External observations of abnormalities used in this study were mainly designed for adult fish populations (Hatfield Consultants Ltd. 2003). The degree of exposure over time to stressors in the aquatic environment is less for juvenile fish and some abnormalities related to pathological stress may not be evident.

#### **3.3.1 Goosly Lake Fish Health Assessment**

External fish health examinations of rainbow trout from Goosly Lake resulted in a 20% incidence of abnormalities observed in rainbow trout in 2012 (Table 9) with a single incidence of mild hemorrhage in the thymus and three observations of external parasites on fish samples. More details are provided in Appendix 7 Table 6. These observations are within the range of past reported external abnormalities for Goosly Lake fish.

#### **3.3.2 Buck Creek Fish Health Assessment**

None of the 30 fish sampled at the lower effects site downstream from Bessemer had evidence of abnormalities (Table 10). Within the sample of 30 fish at reference site (BB2 old), a single individual had a thickened spine (Appendix 7 Table 3 and Photos 1 and 2)). We suspect this spinal condition may be the result of an electrofishing injury from previous sampling based on similar observations during fish monitoring studies conducted at Kemess Mine<sup>21</sup>.

#### **3.3.3 Foxy and Crow Creek Fish Health Assessment**

External abnormalities noted in a sample of rainbow trout from Foxy Creek in 2012 included one incidence of an eroded caudal fin and two observations of parasites on fish gills (Table 11 and Appendix 7 Table 4). The incidence of external abnormalities in 2012 was comparable to most past years. No external abnormalities were noted in any of the Crow Creek fish sampled in 2012.

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<sup>21</sup> Studies of vertebral column deformities in juvenile Dolly Varden were undertaken by Trent Bollinger at University of Saskatchewan and are reported in Hatfield Consultants (2011)

**Table 8. Results of trend analyses on Foxy Creek cadmium, copper, and zinc in rainbow trout muscle tissue, 1994 to 2012.**

	Variable Measured (mg/kg)	Number of Observations	Slope (units/year)	Mann Kendall Statistic	Alpha	Critical	Significant?
	Sen's Slope Estimator	Cd	18	0.001	22	0.01	68
0.05						53	No
0.1						45	No
0.2						36	No
Cu		18	0.055	55	0.01	68	No
					0.05	53	Up
					0.1	45	Up
					0.2	36	Up
Zn		18	0.919	56	0.01	68	No
					0.05	53	Up
					0.1	45	Up
					0.2	36	Up

**Table 9. Summary of external abnormalities in adult rainbow trout from Goosly Lake, 2002 to 2012.**

Feature	Abnormality	Survey year										
		2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
<b>External</b>												
<b>Eyes</b>	Opaque	0	0	0	0	0	0	0	0	0	0	0
<b>Gills</b>	Frayed	0	0	0	0	0	0	0	0	0	3	1
	Marginate	0	0	0	0	0	0	0	0	2	4	8
<b>Skin</b>	Abberation	0	0	0	1	0	0	0	0	0	0	0
<b>Fins</b>	Erosion	0	0	0	0	0	0	1	0	0	0	2
<b>Opercula</b>	Shortening	0	0	1	0	0	0	0	0	0	0	0
<b>Thymus</b>	Hemorrhage	1	0	2	1	1	1	1	4	9	0	0
<b>Pseudobranchs</b>	Swollen	0	0	0	0	0	0	1	0	0	1	nr
	Lithic	0	0	0	0	0	0	0	0	0	0	nr
<b>Spinal/cranial</b>		0	0	0	nr	nr	nr	nr	nr	nr	nr	nr
<b>Parasites</b>	Presence	3	1	0	1	1	2	3	1	2	4	12
<b>Total External</b>		4	1	3	3	1	3	6	5	13	12	23
<b>Number of Fish Evaluated</b>		20	19	20	20	20	20	30	20	20	20	55
<b>% Affected</b>		20	5	15	15	5	15	20	25	65	60	42

**Table 10. Summary of external abnormalities in juvenile rainbow trout from upper Buck Creek, 2002 to 2012.**

Feature	Abnormality	BB1 - Below Bessemer										
		2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
Eyes	Opaque	0	0	0	0	0	0	0	0	0	0	0
Gills	Frayed	0	0	0	0	0	0	0	0	0	0	1
	Marginate	0	0	0	0	0	0	0	0	0	0	0
Skin	Abberation	0	0	0	0	0	0	0	0	1	0	0
Fins	Erosion	0	0	0	0	1	0	0	0	0	0	1
Opercula	Shortening	0	0	0	0	0	0	0	0	3	4	1
Thymus	Hemorrhage	0	0	0	0	0	0	0	0	0	0	nr
Pseudobranchs	Swollen	0	0	0	0	0	0	0	0	0	0	nr
	Lithic	0	0	0	0	0	0	1	0	0	0	nr
Spinal/cranial		0	0	1	nr	nr	nr	nr	nr	nr	nr	nr
Parasites	Presence	0	0	0	0	0	0	1	0	0	0	0
<b>Total</b>		0	0	1	0	1	0	2	0	4	4	3
<b>Number of Fish</b>		30	30	30	30	15	30	30	30	28	30	7
<b>% Affected</b>		0	0	3.3	0	6.7	0.0	6.7	0.0	14.3	13.3	42.9

Feature	Abnormality	BB2 (old) - Reference										
		2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
Eyes	Opaque	0	0	0	0	0	0	0	0	0	0	0
Gills	Frayed	0	0	0	0	0	0	0	0	0	0	0
	Marginate	0	0	0	0	0	0	0	0	0	0	0
Skin	Abberation	0	0	1	0	0	0	0	0	0	0	0
Fins	Erosion	0	0	1	0	1	0	0	0	0	0	0
Opercula	Shortening	0	0	0	0	1	0	0	0	0	2	3
Thymus	Hemorrhage	0	0	0	0	0	0	0	0	0	0	0
Pseudobranchs	Swollen	0	0	0	0	0	0	0	0	0	0	0
	Lithic	0	0	0	0	0	0	0	0	0	0	0
Spinal/cranial		1	0	0	nr	nr	nr	nr	nr	nr	nr	nr
Parasites	Presence	0	0	0	0	0	0	0	1	0	0	0
<b>Total</b>		1	0	2	0	2	0	0	1	0	2	3
<b>Number of Fish</b>		30	30	30	30	30	30	30	30	30	30	30
<b>% Affected</b>		3.3	0	6.7	0.0	6.7	0.0	0.0	3.3	0.0	6.7	10.0

**Table 11. Summary of external abnormalities in juvenile rainbow trout from Foxy and Crow creeks, 2002 to 2012.**

Feature	Abnormality	Foxy										
		2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
Eyes	Opaque	0	0	0	0	0	0	0	0	0	0	0
Gills	Frayed	0	0	0	0	0	0	0	0	0	1	0
	Marginate	0	0	1	0	0	0	0	0	1	0	0
Skin	Abberation	0	0	0	1	0	0	0	0	0	0	0
Fins	Erosion	1	0	1	0	0	1	1	1	0	3	2
Opercula	Shortening	0	0	0	0	2	0	0	0	3	3	0
Thymus	Hemorrhage	0	0	0	0	3	10	3	5	4	0	nr
Pseudobranchs	Swollen	0	0	0	0	0	1	1	0	0	0	nr
	Lithic	0	0	0	0	0	0	0	0	0	0	nr
Spinal/cranial		0	0	0	nr	nr	nr	nr	nr	nr	nr	nr
Parasites	Presence	2	0	1	0	0	0	0	0	0	0	
<b>Total</b>		3	0	3	1	5	12	5	6	8	7	2
<b>Number of Fish</b>		30	25	30	30	30	30	30	30	58	30	30
<b>% Affected</b>		10	0	10.0	3.3	16.7	40.0	16.7	20.0	13.8	23.3	6.7

Feature	Abnormality	Crow			
		2012	2010	2006	2002
Eyes	Opaque	0	0	0	0
Gills	Frayed	0	0	0	0
	Marginate	0	0	0	0
Skin	Abberation	0	0	0	0
Fins	Erosion	0	0	0	0
Opercula	Shortening	0	0	0	0
Thymus	Hemorrhage	0	0	1	nr
Pseudobranchs	Swollen	0	0	0	nr
	Lithic	0	0	0	nr
Spinal/cranial		0	0	nr	nr
Parasites	Presence	0	0	0	0
<b>Total</b>		0	0	1	0
<b>Number of Fish</b>		30	30	30	30
<b>% Affected</b>		0	0.0	3.3	0



## 4.0 CONCLUSIONS

- Four upper Buck Creek fish index sites were sampled in 2012, including two sites upstream from Bessemer Creek and one located immediately downstream. Fish were not present at a fourth site located in lower Bessemer Creek in 2012.
- Equity Mines discharged treated water from late April until late July 2012 in Buck Creek and early May until late July in Foxy Creek. The stream fish sampling was conducted during August at the end of a dry late summer period and approximately one month after treated water releases finished.
- Rainbow trout fry densities at the potential effects site downstream from Bessemer Creek were high compared to most past sampling at this location. Densities at the reference site just upstream from Bessemer Creek were also above average, while fry densities at the old reference location one km upstream from Bessemer were close to the long-term average. The uppermost reference site continues to have the highest fry densities of the three locations, but the difference amongst sites was low in 2012.
- Rainbow parr densities at the two reference index sites and the potential effects site below Bessemer Creek were all close in 2012, well above the average for past years. The uppermost reference site typically has higher parr densities than the downstream locations.
- Rainbow trout fry lengths were on average 3 mm smaller than the long-term mean at all of the sample locations. Similarly, yearling rainbow parr at all of the index sites were smaller than average.
- The small fry and parr captured in 2012 at both the reference and potential impact site suggest that environmental factors common throughout the system were affecting size. It is not clear if these environmental conditions common to all of the sites (e.g. low late summer flows) reflect increased rearing competition between high densities of fry and parr, leading to smaller overall fish lengths.
- Overall condition factor of rainbow parr at the index sites were in the mid-range of past measurements at all sites except the upstream reference location, where parr condition was high. A similar pattern was noted in 2011.
- Long-term monitoring suggests that typically Buck Creek is adequately seeded with fry, and that parr densities in the range of 20 to 40 parr/100m<sup>2</sup> reflect the habitat capabilities of a relatively stable stream environment in this section of Buck Creek. The overall parr densities measured at all of the reference sites in 2012 were at the upper end or just exceeded this historical range. Parr densities in the potential impact site have been more variable than the two reference locations.

- Levels of cadmium and zinc in Goosly Lake rainbow trout muscle tissue in 2012 were comparable to the mean levels measured since 1982. Copper levels in Goosly fish were high compared to past samples, and were slightly above the highest levels recorded in 2002. The 2012 Goosly Lake zinc and copper levels were strongly influenced by high metal levels reported for a small number of individual fish leading to a high variance in the sample results.
- The data continue to demonstrate a long-term trend of increasing zinc levels in Goosly Lake fish, but at a reduced significance level compared to some past years. There was no significant trend for cadmium or copper.
- The 2012 Foxy Creek copper results exceeded all of the past measurements at this location, but were not significantly different from the reference site in Crow Creek that also demonstrated high copper levels. Both sites had consistently high copper levels across most fish sampled.
- Zinc levels in Foxy Creek fish muscle tissue were also high in 2012, but within the range of past levels measured at this site. The results were strongly influenced by results in a single fish from Foxy Creek. The Crow Creek reference site had lower zinc levels than in Foxy, but the samples were not statistically different due to high variance in the Foxy sample.
- Trend analyses of metal levels in Foxy Creek rainbow trout continue to suggest an upward trend over time for zinc and copper and no trend for cadmium. This upward trend in zinc and copper levels was strengthened by the 2012 results.
- The metal analyses were confounded by some difficulties with the lab preparation of the muscle tissue, and analyses had to be re-done in 2012. The lab has improved its handling of fish tissue sample preparation to avoid future problems.
- External fish health assessments were continued in 2012. The observations suggest a low incidence of external abnormalities in rainbow trout from Goosly Lake, upper Buck, Foxy, and Crow creeks. Most abnormalities were associated with external parasites. There was also indication of past electrofishing injury to a single fish in the sample of 30 fish assessed in upper Buck Creek.
- The 2012 results demonstrate the importance of conducting sampling in the Crow Creek reference site, and we recommend that this should be continued in the upcoming field season.

It is our opinion that it is highly improbable that juvenile rainbow trout from Foxy Creek have any regular connection to fish captured at the Crow Creek reference site. Foxy Creek enters Maxan Creek approximately one km downstream from Maxan Lake (Figure 1). Studies conducted on rainbow trout spawning suggest Maxan rainbow spawn in lower Foxy Creek and in Maxan Creek for a short distance downstream from the Foxy confluence (Bustard 1993). Cool water temperatures and

suitable bed material in Foxy Creek are probably key factors for spawning site selection.

Crow Creek enters the upper Bulkley River approximately 2 kms downstream from the Bulkley Lake outlet (Figure 1). The sample collection site is located a further 4 kms upstream on Crow Creek at the road crossing. We suspect these Crow Creek juveniles are associated with rainbow spawners from Bulkley Lake that drop downstream below the lake and into the cooler inlet tributary (Crow Creek) to spawn in the lower accessible sections similar to the Maxan rainbow using Foxy Creek.

The pattern of rainbow spawners moving into a lake outlet and then up a tributary to the outlet stream is similar to that studied by Northcote (1969) for Hihium Creek, tributary to the Loon Lake outlet stream. We would not expect Foxy Creek juveniles to move 10 km downstream through Maxan Creek to Bulkley Lake, and then move through the lake and into the outlet, and then up the outlet creek to rear, before moving back up into a lake as older juveniles.

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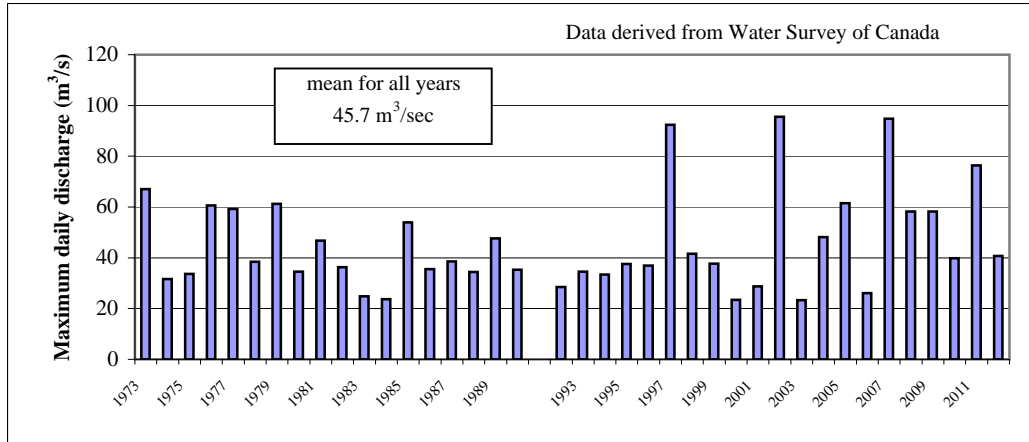


**Photo 1. Spinal anomaly noted in this fish at reference Site BB2 old may be the result of a past electrofishing injury.**



**Photo 2. Looking down on thickened spine on rainbow trout sample at Site BB2 old.**

**Appendix 1 Figure 1. Maximum daily discharge during the snowmelt freshet (Apr-June) in lower Buck Creek from 1973 to 2012.**



Year	Date	Max daily flow (m³/s)	Year	Date	Max daily flow (m³/s)
1973	16-May	67.1	1993	22-May	34.6
1974	27-May	31.7	1994	1-May	33.4
1975	12-May	33.7	1995	10-May	37.6
1976	6-May	60.6	1996	25-May	36.9
1977	27-Apr	59.2	1997	15-May	92.4
1978	15-Jun	38.5	1998	4-May	41.6
1979	3-May	61.2	1999	25-May	37.7
1980	12-May	34.6	2000	11-Jun	23.5
1981	15-May	46.8	2001	29-May	28.8
1982	5-Jun	36.3	2002	22-May	95.6
1983	30-Apr	24.8	2003	27-Apr	23.3
1984	20-May	23.7	2004	5-May	48.1
1985	21-May	54	2005	27-Apr	61.5
1986	31-May	35.6	2006	4-Jun	26.1
1987	9-May	38.6	2007	7-Jun	94.8
1988	14-May	34.4	2008	19-May	58.2
1989	5-May	47.6	2009	21-Apr	58.2
1990	30-May	35.3	2010	21-May	39.8
1991	10-May	28.8	2011	30-May	76.4
1992	20-Apr	28.5	2012	28-May	40.7

**Appendix 1 Table 1. Summary of discharge estimates at juvenile fish sample sites during sample period since 2004.**

Year	Discharge estimate (l/s)						
	BB1	BB2 old	BB2 new	Bessemer	FF1	FF2	CRW1
2012	49	55	43	1-2***			
2011*	264	112	138	72			
2010	nm	61	70	dry	nm	45	6
2009	nm	nm	27	dry			
2008	474	485	294	87			
2007	181	188	256	13			
2006	28	23	21	dry	54	83	11
2005	nm	108	108				
2004**	390	59	76				

\*Bessemer discharge provided by Equity Mines Ltd.

nm= no measure

\*\*Heavy rain between sampling dates

\*\*\* visual estimate

**Appendix 2 Table 1. Electrofishing site BB1 2012.**

SITE:	BB1	PHOTOS:	1 u/s	DATE:	Aug 28, 2012
SITE LOCATION:	Top of site approximately 25 m below Bessemer Creek confluence.				
ACCESS:	Veh	EFFORT:	PASS 1	2347 secs	
			PASS 2	2049 secs	
			PASS 3	2068 secs	
SLOPE (%):	<0.5	TEMP (C):	12	TIME 16:00	COND. pH:
SAMPLING COMMENTS:	Sample problem on first pass so did 3 pass removal. Used Setting J6 - 300 v.				

POPULATION ESTIMATES:

SPECIES	AGE	FL RANGE	FL MEAN	PASS			NUMBER	CI	N/M*M	N/100M	MEAN WT	BIOMASS g/m*m
				1	2	3						
Rbt	0+	30-42	34.4	37	27	16	109.1	88-212	0.324	168.6	0.45	0.144
Rbt	1+	60-98	73.0	57	49	10	133.1	121-161	0.396	205.7	4.19	1.657
Rbt	2+	108-136	119.2	2	3	0	5.0	na	0.015	7.7	17.89	0.266
Rbt	3+			0	0	0	0.0		0.000	0.0		0.000
Rbt	4+			0	0	0	0.0		0.000	0.0		0.000
LN Dace	0+			0	0	0	0.0		0.000	0.0		0.000
LN Dace	>1+			0	0	0	0.0		0.000	0.0		0.000
Ln Sucker	0+			0	0	0	0.0		0.000	0.0		0.000
LN Sucker	>1+	64-92	82.0	3	2	2	7.8	na	0.023	12.1	6.34	0.147
Prickly Sculpin	>1+			0	0	0	0.0		0.000	0.0		0.000
M. Whitefish	>1+			0	0	0	0.0		0.000	0.0		0.000
Lamprey	all			0	0	0	0.0		0.000	0.0		0.000
TOTAL							255.0		0.758	394.1		2.214

LOCATION	WIDTH (m)		SITE COVER (%)		SITE WATER TYPE (%)	MEAN DEPTH (cm)
0	5.3	LOD	60		POOL	80
3	4.4	COBBLE			RIFFLE	20
6	6.0	IN VEG			RUN	
9	7.5	OVER VEG	20		OTHER	
12	3.1	CUTBANK	20			
15	3.6	DEEP POOL				
18	3.9				D90/50:	10/1
20	7.8	TOTAL	80		(cm)	
24						
	5.2					
AREA (M*M)	336.4	MARGIN (M)	65			

HABITAT COMMENTS:

Not impounded at the lower end of the site- shallower and easier to sample  
Discharge calculated - 49 l/s



**Appendix 2 Table 2. Electrofishing site BB2(old) 2012.**

SITE:	BB2 OLD	PHOTOS:	1 & 2	DATE:	Aug 27/12
SITE LOCATION:	2 km upstream from bridge - same location as past years.				
ACCESS:	Veh	EFFORT:	PASS 1	2819 secs	
			PASS 2	2339 secs	
SLOPE (%):	1	TEMP (C):	12.0	TIME	9:00 COND.
					pH:
SAMPLING COMMENTS:	Good sample. Low flows after long dry hot period				

POPULATION ESTIMATES:

SPECIES	AGE	FL		PASS			NUMBER	S.E.	N/M*M	N/100M	MEAN WT	BIOMASS g/m*m
		RANGE	MEAN	1	2	U1+U2						
Rbt	0+	23-42	33.2	54	23	77	94.1	11.3	0.394	156.8	0.42	0.165
Rbt	1+	52-103	72.0	64	22	86	97.5	7.4	0.409	162.5	4.63	1.890
Rbt	2+	113	113.0	1	0	1	1.0	0.0	0.004	1.7	13.29	0.056
Rbt	3+			0	0	0	0.0	0.0	0.000	0.0		0.000
Rbt	4+			0	0	0	0.0	0.0	0.000	0.0		0.000
LN Dace	0+			0	0	0	0.0	0.0	0.000	0.0		0.000
LN Dace	>1+			0	0	0	0.0	0.0	0.000	0.0		0.000
Ln Sucker	0+			0	0	0	0.0	0.0	0.000	0.0		0.000
LN Sucker	>1+			0	0	0	0.0	0.0	0.000	0.0		0.000
Prickly Sculpin	>1+			0	0	0	0.0	0.0	0.000	0.0		0.000
M. Whitefish	>1+			0	0	0	0.0	0.0	0.000	0.0		0.000
Lamprey	all			0	0	0	0.0	0.0	0.000	0.0		0.000
TOTAL							192.6		0.807	321.0		2.111

LOCATION	WIDTH (m)	SITE COVER (%)	SITE WATER TYPE (%)	MEAN DEPTH (cm)
0	3.5	LOD	POOL	80
3	3.1	COBBLE	RIFFLE	20
6	5.5	IN VEG	RUN	
9	6.0	OVER VEG	OTHER	
12	3.5	CUTBANK		
15	3.9	DEEP POOL		
18	3.0		D90/50:	15/3
20	5.1	TOTAL	(cm)	
24	2.2			
	4.0			
AREA (M*M)	238.7	MARGIN (M)	60	

HABITAT COMMENTS:

Continued bank erosion at lower pool made this part of site more complex.  
Discharge = 55 l/s

**Appendix 2 Table 3. Electrofishing site BB2(new) 2012.**

SITE:	BB2 NEW	PHOTOS:	1 to 4	DATE:	Aug 29, 2012
SITE LOCATION:	Downstream net just below bridge as in past years.				
ACCESS:	Veh	EFFORT:	PASS 1	2464	secs
			PASS 2	NA	secs
SLOPE (%):	<0.5	TEMP (C):	10.5	TIME:	COND.
					pH:
SAMPLING COMMENTS:	Removed 50 cm high dam after lower net in place. Sampled effectively - good nets.				

POPULATION ESTIMATES:

SPECIES	AGE	FL		PASS			NUMBER	S.E.	N/M*M	N/100M	MEAN WT	BIOMASS g/m*m
		RANGE	MEAN	1	2	U1+U2						
Rbt	0+	28-46	36.9	71	28	99	117.2	10.7	0.331	244.2	0.58	0.192
Rbt	1+	58-100	72	97	28	125	136.4	6.4	0.385	284.1	4.44	1.711
Rbt	2+	106-134	119.0	2	0	2	2.0	0.0	0.006	4.2	20.10	0.114
Rbt	3+	179.0	179	1	0	1	1.0	0.0	0.003	2.1	57.40	0.162
Rbt	4+					0	0.0	0.0	0.000	0.0		0.000
LN Dace	0+					0	0.0	0.0	0.000	0.0		0.000
LN Dace	>1+					0	0.0	0.0	0.000	0.0		0.000
Ln Sucker	0+	57-102	86.6	4	6	10	10.0	na	0.028	20.8	7.44	0.210
Ln Sucker	>1+					0	0.0	0.0	0.000	0.0		0.000
Prickly Sculpin	>1+	67-83	75.75	2	2	4	4.0	na	0.011	8.3	5.74	0.065
M. Whitefish	>1+			0	0	0	0.0	0.0	0.000	0.0		0.000
Lamprey	all			0	0	0	0.0	0.0	0.000	0.0		0.000
TOTAL							270.6		0.764	563.7		2.454

LOCATION	WIDTH (m)		SITE COVER (%)	SITE WATER TYPE (%)	MEAN DEPTH (cm)
0	6.0	LOD	60	POOL	90
3	4.0	COBBLE	30	RIFFLE	5
6	3.1	IN VEG	5	RUN	5
9	4.5	OVER VEG	5	OTHER	
12	10.9	CUTBANK			
15	14.4	DEEP POOL			
18	8.5			D90/50:	40/1
20	7.6	TOTAL	100	(cm)	
24					
	7.4				
AREA (M*M)	354.0	MARGIN (M)	48		

HABITAT COMMENTS:

Staff gauge = 0.282 Bessemer Creek was flowing throughout summer.  
Settings J6- 500 volts

Discharge = 43 l/s

**Appendix 2 Table 4. Electrofishing site BES1 2012.**

SITE:	BES1	PHOTOS:	3 & 4	DATE:	Aug 27/12
SITE LOCATION:	Road culvert near bottom end downstream for 42 m.				
ACCESS:	veh	EFFORT:	PASS 1 PASS 2	312 secs	
SLOPE (%):	1	TEMP (C):	13	TIME	1700 COND. pH:
SAMPLING COMMENTS:	Low flows. Brushy and only one pass due to low catch.				

POPULATION ESTIMATES:

SPECIES	AGE	FL		PASS		U1+U2	NUMBER	S.E.	N/M*M	N/100M	MEAN WT	BIOMASS g/m*m
		RANGE	MEAN	1	2							
Rbt	0+	No fish				0	0.0	0.0	0.000	0.0		0.000
Rbt	1+					0	0.0	0.0	0.000	0.0		0.000
Rbt	2+					0	0.0	0.0	0.000	0.0		0.000
Rbt	3+					0	0.0	0.0	0.000	0.0		0.000
Rbt	4+					0	0.0	0.0	0.000	0.0		0.000
LN Dace	0+					0	0.0	0.0	0.000	0.0		0.000
LN Dace	>1+					0	0.0	0.0	0.000	0.0		0.000
Ln Sucker	0+					0	0.0	0.0	0.000	0.0		0.000
LN Sucker	>1+					0	0.0	0.0	0.000	0.0		0.000
Prickly Sculpin	>1+					0	0.0	0.0	0.000	0.0		0.000
M. Whitefish	>1+					0	0.0	0.0	0.000	0.0		0.000
Lamprey	all					0	0.0	0.0	0.000	0.0		0.000
TOTAL							0.0		0.000	0.0		0.000

LOCATION	WIDTH (m)		SITE COVER (%)	SITE WATER TYPE (%)	MEAN DEPTH (cm)
0	1.9	LOD	10	POOL	8
3	2.0	COBBLE		RIFFLE	24
6	1.6	IN VEG		RUN	
9	2.0	OVER VEG	60	OTHER	
12	0.8	CUTBANK	30		
15	2.2	DEEP POOL			
18				D90/50:	4/2
20		TOTAL	30	(cm)	
24					
AREA (M*M)	1.8 73.5	MARGIN (M)	42		

<b>HABITAT COMMENTS:</b>	
Discharge 1-2 l/s based visual estimate.	
Channel more open than in past due to high flows in past year. Re-marked ribbon up to culvert.	

**Appendix 2 Table 5. Summary of rainbow trout densities in upper Buck Creek sites for all years by age classes.**

SAMPLE SITE	YEAR	DENSITY (fish/100 m <sup>2</sup> )		
		0+	1+	>=2+
<b>BB1</b>	1987	0	7	2
Downstream from	1988	0	6	1
Bessemer Creek	1989	5	4	2
	1990	1	16	2
	1991	0.4	9	4
	1993	0	2	1
	1998	0	0	0.2
	2002	5	2	0.3
	2003	25	29	3
	2004	12	12	0.2
	2005	29	36	0.3
	2006	31	30	4
	2007	9	10	6
	2008	2	3	0.4
	2009	31	64	13
	2010	16	12	0.5
	2011	29	10	1.0
	2012	32	40	1.5
	<b>Mean (87-12)</b>	<b>12.6</b>	<b>16.1</b>	<b>2.4</b>
<b>BB2 - old</b>	1987	59	27	3
Reference site	1988	36	23	0
1.3 km upstream	1989	62	27	1
	1990	55	34	1
	1991	175	32	1
	1993	18	12	0.2
	1998	37	39	2
	2002	41	24	4
	2003	42	37	3
	2004	80	40	1
	2005	51	43	1
	2006	19	35	7
	2007	18	19	4
	2008	18	12	0.3
	2009	45	38	5
	2010	48	39	4
	2011	61	21	4
	2012	39	41	0.4
	<b>Mean (87-12)</b>	<b>50.2</b>	<b>30.2</b>	<b>2.3</b>
<b>BB2 - new</b>	2003	23	19	1
Reference site	2004	61	20	0.0
just upstream from	2005	32	24	1
Bessemer Creek	2006	2	20	1
	2007	15	9	3
	2008	10	13	0.3
	2009	24	34	3
	2010	6	14	0.8
	2011	12	18	2.1
	2012	33	39	0.9
	<b>Mean (03-12)</b>	<b>21.9</b>	<b>20.8</b>	<b>1.3</b>
<b>BES1*</b>	2002	1	0	3
Bessemer Creek	2005	12	0	2
at lower road	2007	0	9	6
	2008	0	0	0
	2011	1	0	0
	2012	0	0	0

\* Sampled in years when creek not dewatered.

**Appendix 3 Table 1. Catch composition at Upper Buck Creek fish sample sites 1987 to 2012.**

<b>SPECIES</b>	<b>1987</b>	<b>1988</b>	<b>1989</b>	<b>1990</b>	<b>1991</b>	<b>1993</b>	<b>1998</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>Mean</b>
<b>SITE BB1</b>																			
<b>Rainbow Fry</b>	1	0	21	5	2	0	0	16	72	45	112	107	27	6	97	68	126	109	45.2
(%)	1.3	0.0	26.6	4.2	2.4	0.0	0.0	76.2	43.9	60.8	43.9	48.0	35.1	27.3	28.3	57.1	72.0	42.7	31.7
<b>Rainbow Parr</b>	37	29	24	86	57	15	1	5	92	29	142	115	47	15	245	51	45	138	65.2
(%)	48.7	56.9	30.4	72.3	67.9	50.0	5.9	23.8	56.1	39.2	55.7	51.6	61.0	68.2	71.4	42.9	25.7	54.1	49.0
<b>Mountain Whitefish</b>	13	0	8	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1.7
(%)	17.1	0.0	10.1	6.7	0.0	3.3	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
<b>Prickly Sculpins</b>	25	22	25	20	24	12	2	0	0	0	1	0	0	0	0	0	0	0	7.3
(%)	32.9	43.1	31.6	16.8	28.6	40.0	11.8	0.0	0.0	0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.4
<b>Longnose Suckers</b>	0	0	1	0	1	1	14	0	0	0	0	1	3	1	1	0	4	8	1.9
(%)	0.0	0.0	1.3	0.0	1.2	3.3	82.4	0.0	0.0	0	0.0	0.4	3.9	4.5	0.3	0.0	2.3	3.1	5.7
<b>Peamouth Chub*</b>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.1
(%)	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
<b>TOTAL</b>	<b>76</b>	<b>51</b>	<b>79</b>	<b>119</b>	<b>84</b>	<b>30</b>	<b>17</b>	<b>21</b>	<b>164</b>	<b>74</b>	<b>255</b>	<b>223</b>	<b>77</b>	<b>22</b>	<b>343</b>	<b>119</b>	<b>175</b>	<b>255</b>	<b>121</b>
<b>Area Sampled (m<sup>2</sup>)</b>	409	394	406	476	445	502	402	354	287	403	389	341	356	427	319	423	430	336	394
<b>SITE BB2 (OLD)</b>																			
<b>Rainbow Fry</b>	190	130	213	188	599	77	130	106	111	214	148	47	58	53	105	123	150	94	152.0
(%)	66.2	61.0	69.2	61.4	84.5	57.9	47.1	58.8	51.6	66.5	53.6	31.6	46.0	57.6	51.0	52.3	70.4	48.8	57.5
<b>Rainbow Parr</b>	97	83	95	118	110	55	146	73	104	108	128	102	67	39	101	112	63	99	94.4
(%)	33.8	39.0	30.8	38.6	15.5	41.4	52.9	40.7	48.4	33.5	46.4	68.4	53.2	42.4	49.0	47.7	29.6	51.2	42.3
<b>Longnose Suckers</b>	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0.2
(%)	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.6	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.1
<b>TOTAL</b>	<b>287</b>	<b>213</b>	<b>308</b>	<b>306</b>	<b>709</b>	<b>133</b>	<b>276</b>	<b>180</b>	<b>215</b>	<b>322</b>	<b>276</b>	<b>149</b>	<b>126</b>	<b>92</b>	<b>206</b>	<b>234</b>	<b>213</b>	<b>193</b>	<b>247</b>
<b>Area (m<sup>2</sup>)</b>	319	359	343	340	342	426	355	257	257	268	288	252	341	320	233	257	248	239	302

**Appendix 3 Table 1. Catch composition at Upper Buck Creek fish sample sites 1987 to 2012.**

<b>SPECIES</b>	<b>1987</b>	<b>1988</b>	<b>1989</b>	<b>1990</b>	<b>1991</b>	<b>1993</b>	<b>1998</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>Mean</b>
<b>SITE BB2 (NEW)</b>																			
<b>Rainbow Fry</b>								100	149	125	7	59	37	96	24	40	117	75.4	
(%)								54.1	72.0	56.8	8.2	53.6	40.7	39.0	29.1	38.8	43.3	43.6	
<b>Rainbow Parr</b>								85	58	94	78	47	51	147	55	68	139	82.1	
(%)								45.9	28.0	42.7	91.8	42.7	56.0	59.7	66.0	61.2	51.5	54.6	
<b>Prickly Sculpins</b>									0	1	0	4	0	0	0	0	4	1.0	
(%)									0.0	0.5	0.0	3.6	0.0	0.0	0.0	0.0	1.5	0.6	
<b>Longnose Suckers</b>									0	0.0	0.0	4	3	3	1	0	10	2.3	
(%)									0.0	0.0	0.0	3.6	3.3	1.2	1.2	0.0	3.7	1.5	
<b>Longnose Dace</b>									0	0	0	0	0	0	3	0	0	0.3	
									0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.4	
<b>TOTAL</b>								<b>185</b>	<b>207</b>	<b>220</b>	<b>85</b>	<b>110</b>	<b>91</b>	<b>246</b>	<b>83</b>	<b>108</b>	<b>270</b>	<b>160</b>	
<b>Area (m<sup>2</sup>)</b>								432	408	389	370	380	390	397	382	338	354	384	

**NOTES:**

Site BB1 was moved upstream to ~50 m below Bessemer Ck mouth in 2002.

Site BB2 old was moved ~300 m upstream in 2002 due to beaver impounding at the old site.

\* 1993 specimen was re-examined in 2007 - former identification as brassy minnow was incorrect.

**Appendix 3 Table 2. Prickly sculpin summary for sites in upper Buck Creek to 2012.**

<b>Site BB1</b>						
<b>Date</b>	<b>Area (m<sup>2</sup>)</b>	<b>Number</b>	<b>Mean Fork Length (mm)</b>	<b>Range (mm)</b>		<b>Mean Wt (g)</b>
				<b>Min</b>	<b>Max</b>	
1987	409	20	74.0	54	103	4.9
1988	394	19	77.4	55	103	6.3
1989	406	25	65.6	40	101	3.1
1990	476	15	85.5	71	108	7.8
1991	445	17	90.5	59	111	10.5
1993	502	12	85.6	62	102	8.8
1998	402	2	80.0	69	82	7.2
Site moved to upstream location in 2002						
2002	354	0				
2003	287	0				
2004	403	0				
2005	389	1	93	93	93	10.6
2006-2012	336-430	0				
<b>Site BB2(new)</b>						
2003-2004	389-432	0				
2005	389	1	105	105	105	16.3
2006	370	0				
2007	380	4	95.5	78	130	7.5
2008-2011	338-397	0				
2012	354	4	75.8	67	83	5.7
<b>Site BB2(old)</b>						
No sculpins have ever been sampled at this location since 1987						

**Appendix 4 Table 1. Mean fork length of upper Buck Creek rainbow trout for all years.**

	<b>BB2 (Old) AGE 0+</b>			<b>BB1 AGE 0+</b>			<b>BB2 (New) AGE 0+</b>		
	Mean fl (mm)	Std.	Sample Size	Mean fl (mm)	Std.	Sample Size	Mean fl (mm)	Std.	Sample Size
<b>1987</b>	43.9	5.26	30						
<b>1988</b>	39.0	4.35	30						
<b>1989</b>	41.3	3.56	32						
<b>1990</b>	38.3	3.22	30						
<b>1991</b>	35.7	5.05	49						
<b>1993</b>	37.1	4.44	50						
<b>1998</b>	42.5	5.08	45						
<b>2002</b>	35.6	4.18	50	34.0	6.68	7			
<b>2003</b>	38.2	4.01	30	34.9	4.74	30	36.6	3.46	30
<b>2004</b>	40.9	6.01	48	40.8	5.51	42	43.4	5.00	51
<b>2005</b>	40.6	4.97	52	40.6	4.51	50	42.0	5.52	50
<b>2006</b>	38.8	5.37	44	42.2	5.31	54	46.7	6.50	7
<b>2007</b>	32.6	4.30	48	34.5	3.30	50	36.0	4.6	50
<b>2008</b>	34.3	4.88	52	35.2	5.0	6	38.4	5.4	37
<b>2009</b>	36.3	4.85	50	37.9	4.0	50	38.9	4.6	50
<b>2010</b>	39.0	4.75	50	38.6	4.7	49	45.3	4.7	21
<b>2011</b>	29.9	2.28	50	30.2	3.89	51	32.4	2.58	37
<b>Mean (87-11)</b>	<b>37.9</b>	<b>4.5</b>	<b>43.5</b>	<b>36.9</b>	<b>4.8</b>	<b>38.9</b>	<b>40.0</b>	<b>4.7</b>	<b>37.0</b>
<b>2012</b>	33.2	5.30	51	34.4	3.20	50	36.9	4.00	50

	<b>BB2 (Old) AGE 1+</b>			<b>BB1 AGE 1+</b>			<b>BB2 (New) AGE 1+</b>		
	Mean fl (mm)	Std.	Sample Size	Mean fl (mm)	Std.	Sample Size	Mean fl (mm)	Std.	Sample Size
<b>1987</b>	80.0	6.81	82	89.1	6.33	23			
<b>1988</b>	79.7	6.05	36	92.8	6.00	18			
<b>1989</b>	75.4	6.86	87	91.1	4.85	16			
<b>1990</b>	70.8	8.06	107	89.0	7.19	63			
<b>1991</b>	74.6	5.65	101	89.1	4.90	38			
<b>1993</b>	75.5	7.29	36	91.8	8.10	8			
<b>1998</b>	72.3	7.19	134	97.0	na	1			
<b>2002</b>	70.9	8.53	58	64.0	5.40	5			
<b>2003</b>	70.8	9.93	90	69.8	7.99	76	65.0	8.47	70
<b>2004</b>	77.1	8.80	97	77.5	9.87	25	76.6	7.90	58
<b>2005</b>	76.8	9.13	113	80.7	10.16	126	79.6	6.93	77
<b>2006</b>	76.1	6.40	81	77.9	6.90	95	77.1	6.90	64
<b>2007</b>	71.3	7.50	62	80.6	7.30	31	80.4	6.90	32
<b>2008</b>	78.6	9.50	37	75.0	8.33	13	72.7	8.40	50
<b>2009</b>	74.5	8.48	76	78.0	7.82	129	78.6	6.71	98
<b>2010</b>	77.0	7.22	88	79.6	9.47	33	80.6	9.02	49
<b>2011</b>	68.9	11.20	37	74.6	9.23	34	80.5	7.70	56
<b>Mean (87-11)</b>	<b>74.7</b>	<b>7.9</b>	<b>77.8</b>	<b>77.1</b>	<b>8.6</b>	<b>43.2</b>	<b>76.8</b>	<b>7.7</b>	<b>61.6</b>
<b>2012</b>	72.0	11.80	85	73.0	11.30	83	73.5	7.30	124

Note: BB1 age 1+ mean lengths are from 2003 onward due to site re-location and small sample size prior to 2003.



<b>Appendix 5 Table 1. Metal concentration in rainbow trout muscle tissue</b>					
<b>from Goosly Lake, 2012.</b>					
<b>Metal concentrations in muscle tissue</b>					
<b>(mg/kg dry weight)</b>					
	<b>Cadmium</b>	<b>Cd Trial 1</b>	<b>Cd Trial 2</b>	<b>Copper</b>	<b>Zinc</b>
RBT1*	<0.03	0.030	0.015	2.93	36.2
RBT2*	<0.03	0.030	0.015	4.12	35.9
RBT3*	<0.03	0.030	0.015	2.04	31.3
RBT4*	<0.03	0.030	0.015	2.19	28.2
RBT5	0.062	0.062	0.062	1.95	59.7
RBT6*	<0.03	0.030	0.015	2.42	38.9
RBT7	0.057	0.057	0.057	2.70	104.0
RBT8*	<0.03	0.030	0.015	1.99	30.8
RBT9*	<0.03	0.030	0.015	1.85	40.6
RBT10	0.047	0.047	0.047	1.65	45.5
RBT11*	<0.03	0.030	0.015	1.30	23.0
RBT12*	<0.03	0.030	0.015	1.37	33.7
RBT13*	<0.03	0.030	0.015	2.20	31.0
RBT14	0.053	0.053	0.053	2.19	46.3
RBT15*	<0.03	0.030	0.015	6.03	30.5
RBT16*	<0.03	0.030	0.015	1.50	25.2
RBT17*	<0.03	0.030	0.015	1.32	28.2
RBT18*	<0.03	0.030	0.015	2.14	32.4
RBT19	0.035	0.035	0.035	1.86	56.0
RBT20*	<0.03	0.030	0.015	1.33	49.8
Mean		0.035	0.024	2.25	40.4
Std		0.010	0.017	1.11	18.0
* Cadmium levels were below detection of 0.03.					
Trial 1 we have assumed 0.03 for <0.30					
Trial 2 we have assumed 0.015 when less than detection					
Based on Feb 13, 2013 re-check data					
Used values from Dec reported trials - data for Feb not available due to tissue volume limits					

<b>Appendix 5 Table 2. Metal concentration in rainbow trout muscle tissue</b>					
<b>from Foxy Creek, 2012.</b>					
<b>Metal concentrations in muscle tissue</b>					
<b>(mg/kg dry weight)</b>					
	<b>Cadmium</b>	<b>Cd Trial 1</b>	<b>Cd Trial 2</b>	<b>Copper</b>	<b>Zinc</b>
FOX1	0.058	0.058	0.058	5.88	105.0
FOX2*	<0.03	0.03	0.015	2.83	31.5
FOX3	0.039	0.039	0.047	3.06	30.2
FOX4*	<0.03	0.03	0.015	3.31	42.8
FOX5	0.045	0.045	0.045	2.70	40.9
FOX6	0.044	0.044	0.044	4.83	30.6
FOX7	0.046	0.046	0.080	3.24	33.0
FOXY8*	<0.06	0.060	0.030	3.60	27.2
FOX9*	<0.03	0.03	0.015	2.51	32.7
FOX10*	<0.03	0.03	0.015	3.19	30.1
Mean		0.041	0.036	3.52	40.4
Std		0.011	0.022	1.05	23.22
* Cadmium levels were below detection of 0.03 or 0.06.					
We have assumed levels of 0.03 or 0.06 to determine mean.					
FOXY8 used value of 0.06 due to tissue volume limits for re-sample					
Based on Feb 13, 2013 re-check data					
Used values from Dec reported trials - data for Feb not available due to tissue limits					

<b>Appendix 5 Table 3. Metal concentration in rainbow trout muscle tissue</b>					
<b>from Crow Creek, 2012.</b>					
<b>Metal concentrations in muscle tissue</b>					
<b>(mg/kg dry weight)</b>					
	<b>Cadmium</b>	<b>Cd Trial 1</b>	<b>Cd Trial 2</b>	<b>Copper</b>	<b>Zinc</b>
CRW1*	<0.03	0.03	0.015	1.86	32.0
CRW2	0.051	0.051	0.051	3.32	26.9
CRW3	0.039	0.039	0.039	3.44	31.5
CRW4*	<0.03	0.03	0.015	3.53	29.8
CRW5*	<0.03	0.03	0.015	3.61	24.9
CRW6*	<0.120	0.12	0.120	4.99	30.5
CRW7*	<0.03	0.03	0.015	2.16	38.1
CRW8	0.058	0.058	0.058	2.61	26.9
CRW9*	<0.03	0.03	0.015	2.70	33.9
CRW10*	<0.03	0.03	0.015	1.60	34.2
Mean		0.045	0.036	2.98	30.9
Std		0.028	0.034	1.01	3.98
* Cadmium levels were below detection of 0.03 or 0.12.					
We have assumed levels of 0.03 or 0.12 to determine mean.					
CROW6 used value of 0.12 due to tissue volume for re-sample.					
Based on Feb 13 2013 re-check data					
Used values from Dec trials - data for Feb not available due to tissue volume limits					

## **Appendix 6**

**Details Describing Metal Re-Analysis of Rainbow Trout Muscle Tissue Including:**

- 1.) Letter from ALS Labs to Goldcorp Canada Equity Division**
- 2.) Results of Original Reported Results and Re-checks**



February 14, 2013

GOLDCORP CANADA EQUITY DIVISION  
PO Box 1450  
Houston, BC,  
V0J 1Z0

Attention: Mike Aziz

Dear Mr. Aziz,

**RE: ALS Corrective Action Report (CAR) #9310 - Issues Encountered for Samples Submitted by GOLDCORP CANADA EQUITY DIVISION under ALS File L1204836**

On September 5, 2012 Goldcorp Canada Equity Division submitted forty fish tissue samples for trace metals analysis. Specific details on this submission are outlined below:

ALS File	Type of Samples	# Samples	Submission Date
L1204836	Rainbow Trout	40	September 5, 2012

Comparison of this data with past years sampling events highlighted that many samples had results higher in concentration than in past years, particularly for Cadmium (Cd). Upon investigation it was determined that some small bones (pin bones) may have been included with the original sample filleting and homogenization. We also understand that Goldcorp clearly requested no skin and bones were to be included in the analysis of the samples submitted, only muscle tissue was to be removed and analysed.

Each of the forty samples has since been re-filleted, using the remaining side of the whole fish originally submitted, with careful attention paid to remove all pin bones. These new analyses yielded much lower results for Cadmium (Cd) in many samples, many lower results for Zinc (Zn), and for the most part Copper (Cu) remained the same (some higher and some lower results). Analysis of the pin bones themselves, as a whole, clearly confirmed the presence of Cadmium, Copper and Zinc, and at concentrations greater than that seen in the muscle tissue alone, for Cadmium and Zinc. This analysis of the pin bones, along with the re-analysis of the remaining sample fillet (muscle tissue only - pin bones confidently removed), clearly indicates that the original analysis results would have been biased high for concentrations of Cadmium and Zinc where the pin bones had not been completely removed.

In order to ensure that this issue does not occur again in the future, corrective actions have been implemented. Overviews of the corrective actions implemented or in progress are outlined below:

ADDRESS 8081 Lougheed Highway, Burnaby British Columbia V5A 1W9 Canada | PHONE +1 604 253 4188 | FAX +1 604 253 6700  
ALS CANADA LIMITED Part of the ALS Group A Campbell Brothers Limited Company



- Revised Training for Tissue Sample Preparation Staff: Expanded training on a variety of aspects of the tissue sample preparation process have been implemented. In addition, all written laboratory methods and procedures will be updated with the new practices.
- Tissue Processing Changes: Our current procedure for documenting client instructions with regards to tissue sample processing involves the use of a form that must be completed by the ALS Account Manager based on information supplied by the client. The tissue processing procedure requires that this form be consulted prior to initiating any sample preparation, homogenization or digestion. For the affected samples, the information on this form was incorrectly interpreted by the laboratory analyst resulting in samples being filleted with the skin removed, but without ensuring the removal of all pin bones. This tissue processing form has since been revised to include additional information that will ensure clarity and eliminate confusion and errors like that experienced here.

ALS recognizes and understands the implications of the issue we have outlined in this letter and take this issue very seriously. We would like to sincerely apologize for the inconvenience that we have caused Goldcorp and assure you that we are committed to resolving this issue to Goldcorp's satisfaction.

We hope this letter provides an explanation of the issue that occurred and addresses how we plan to ensure that it does not occur again in the future.

Please feel free to contact myself or Katherine Thomas if you require any additional information.

Sincerely,

Blair Easton, B.Sc.  
Inorganics Laboratory Manager – Vancouver

Katherine B. Thomas, B.Sc.  
General Manager – BC & Yukon Region

<b>Project</b>													
<b>Report To</b>	Mike Aziz, GOLDCORP CANADA EQUITY DIVISION ~HOUSTON												
<b>ALS File No.</b>	L1204836												
<b>Date Received</b>	05-Sep-12 12:30												
<b>Date</b>	13-Feb-13												
<b>RESULTS OF ANALYSIS</b>													
Sample ID	GOOSLY LAKE RAINBOW TROUT 1	GOOSLY LAKE RAINBOW TROUT 2	GOOSLY LAKE RAINBOW TROUT 3	GOOSLY LAKE RAINBOW TROUT 4	GOOSLY LAKE RAINBOW TROUT 5	GOOSLY LAKE RAINBOW TROUT 6	GOOSLY LAKE RAINBOW TROUT 7	GOOSLY LAKE RAINBOW TROUT 8	GOOSLY LAKE RAINBOW TROUT 9	GOOSLY LAKE RAINBOW TROUT 10	GOOSLY LAKE RAINBOW TROUT 11	GOOSLY LAKE RAINBOW TROUT 12	GOOSLY LAKE RAINBOW TROUT 13
Date Sampled													
Time Sampled													
ALS Sample ID	L1204836-1	L1204836-2	L1204836-3	L1204836-4	L1204836-5	L1204836-6	L1204836-7	L1204836-8	L1204836-9	L1204836-10	L1204836-11	L1204836-12	L1204836-13
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
<b>Field Tests</b>													
Length, Client Supplied	18.7	17.3	18.5	18.2	17.5	19.3	17.2	17.3	19.6	16.9	19.8	18	18
Total Weight, Client Supplied	60.6	45.3	66.3	55.3	50.5	71.1	49.4	48	65	51	75.2	60.2	56.2
<b>Physical Tests</b>													
% Moisture	76.9	78.1	75.6	77.2	76.1	76.1	78.4	76.7	80.1	76.6	77.7	75.8	76.5
<b>Metals</b>													
Cadmium (Cd)-Total - reported	<0.030	<0.030	<0.030	<0.030	0.062	0.089	0.057	<0.030	<0.030	0.047	<0.030	<0.030	<0.030
Cadmium (Cd)-Total - original	0.054	<0.030	0.109	0.073	0.131	0.089	0.284	0.069	0.036	0.121	<0.030	0.070	0.096
Cadmium (Cd)-Total - recheck	<0.030	<0.030	<0.030	<0.030	0.062	<0.030	0.057	<0.030	<0.030	0.047	<0.030	<0.030	<0.030
Copper (Cu)-Total - reported	2.93	1.65	2.04	2.19	1.95	2.42	2.70	1.99	1.85	1.65	1.30	1.37	2.20
Copper (Cu)-Total - original	3.13	1.65	1.71	3.28	1.63	2.42	2.70	2.85	2.11	2.14	2.54	4.94	2.14
Copper (Cu)-Total - recheck	2.93	4.12	2.04	2.19	1.95	N/A	N/A	1.99	1.85	1.65	1.30	1.37	2.20
Zinc (Zn)-Total - reported	36.2	43.4	31.3	28.2	59.7	36.6	108	30.8	40.6	45.5	23.0	33.7	31.0
Zinc (Zn)-Total - original	40.5	43.4	51.8	56.9	60.5	36.6	108	36.9	57.3	53.5	42.7	52	64.2
Zinc (Zn)-Total - recheck	36.2	35.9	31.3	28.2	59.7	38.9	104	30.8	40.6	45.5	23.0	33.7	31.0

Sample ID	GOOSLY LAKE RAINBOW TROUT 14	GOOSLY LAKE RAINBOW TROUT 15	GOOSLY LAKE RAINBOW TROUT 16	GOOSLY LAKE RAINBOW TROUT 17	GOOSLY LAKE RAINBOW TROUT 18	GOOSLY LAKE RAINBOW TROUT 19	GOOSLY LAKE RAINBOW TROUT 20	FOXY CREEK RAINBOW TROUT 1	FOXY CREEK RAINBOW TROUT 2	FOXY CREEK RAINBOW TROUT 3	FOXY CREEK RAINBOW TROUT 4	FOXY CREEK RAINBOW TROUT 5	FOXY CREEK RAINBOW TROUT 6
Date Sampled													
Time Sampled													
ALS Sample ID	L1204836- 14	L1204836- 15	L1204836- 16	L1204836- 17	L1204836- 18	L1204836- 19	L1204836- 20	L1204836- 21	L1204836- 22	L1204836- 23	L1204836- 24	L1204836- 25	L1204836- 26
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
<b>Field Tests</b>													
Length, Client Supplied	17.5	18.9	17.4	18.9	17.1	19.9	18.9	10.6	12.7	11.2	12.9	10.9	10.9
Total Weight, Client Supplied	56.5	71.4	56.5	69.5	52.5	67.9	57.9	19.75	22.52	15.36	20.63	11.83	15.24
<b>Physical Tests</b>													
% Moisture	76.9	77.2	78.1	73.5	78.0	81.1	78.8	93.9	74.7	77.0	79.3	72.6	75.5
<b>Metals</b>													
Cadmium (Cd)-Total - reported	0.053	0.039	<0.030	<0.030	<0.030	0.035	<0.030	0.058	<0.030	0.047	<0.030	0.045	0.044
Cadmium (Cd)-Total - original	0.138	0.039	0.203	0.060	0.099	0.064	0.213	0.058	<0.030	0.047	<0.030	0.045	0.044
Cadmium (Cd)-Total - recheck	0.053	<0.030	<0.030	<0.030	<0.030	0.035	<0.030	<0.15	<0.030	0.039	<0.030	<0.060	<0.060
Copper (Cu)-Total - reported	2.19	4.95	1.50	1.32	2.14	1.86	1.33	6.46	1.96	2.89	2.60	2.57	3.13
Copper (Cu)-Total - original	2.45	4.95	2.09	1.39	3.66	2.26	4.81	6.46	1.96	2.89	2.60	2.57	3.13
Copper (Cu)-Total - recheck	2.19	6.03	1.50	1.32	2.14	1.86	1.33	5.88	2.83	3.06	3.31	2.70	4.83
Zinc (Zn)-Total - reported	46.3	48.9	25.2	28.2	32.4	56.0	49.8	101	23.1	27.7	43.0	33.7	30.3
Zinc (Zn)-Total - original	44.8	48.9	41.8	35.1	52.2	51.9	81.4	101	23.1	27.7	43.0	33.7	30.3
Zinc (Zn)-Total - recheck	46.3	30.5	25.2	28.2	32.4	56.0	49.8	105	31.5	30.2	42.8	40.9	30.6



Sample ID	FOXY CREEK RAINBOW TROUT 7	FOXY CREEK RAINBOW TROUT 8	FOXY CREEK RAINBOW TROUT 9	FOXY CREEK RAINBOW TROUT 10	CROW CREEK RAINBOW TROUT 1	CROW CREEK RAINBOW TROUT 2	CROW CREEK RAINBOW TROUT 3	CROW CREEK RAINBOW TROUT 4	CROW CREEK RAINBOW TROUT 5	CROW CREEK RAINBOW TROUT 6	CROW CREEK RAINBOW TROUT 7	CROW CREEK RAINBOW TROUT 8	CROW CREEK RAINBOW TROUT 9	CROW CREEK RAINBOW TROUT 10
Date Sampled														
Time Sampled														
ALS Sample ID	L1204836-27	L1204836-28	L1204836-29	L1204836-30	L1204836-31	L1204836-32	L1204836-33	L1204836-34	L1204836-35	L1204836-36	L1204836-37	L1204836-38	L1204836-39	L1204836-40
Matrix	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
<b>Field Tests</b>														
Length, Client Supplied	10	10.4	10.5	10.4	13	9.8	13.4	12.1	10.2	9.1	11.3	11.3	8.9	11.4
Total Weight, Client Supplied	11.05	11.63	13.9	12.3	22.85	10.46	25.69	17.7	11.43	7.85	14.99	13.76	7.9	16.76
<b>Physical Tests</b>														
% Moisture	76.4	74.6	75.4	73.7	74.5	75.7	74.3	71.3	74.7	70.2	77.4	74.7	73.1	75.5
<b>Metals</b>														
Cadmium (Cd)-Total - reported	0.080	<0.060	<0.030	<0.030	<0.030	0.051	0.045	<0.030	0.037	<0.120	0.046	0.053	0.053	<0.030
Cadmium (Cd)-Total - original	0.080	<0.030	<0.030	<0.030	<0.030	0.051	0.045	0.112	0.037	0.303	0.046	0.053	0.053	<0.030
Cadmium (Cd)-Total - recheck	0.046	<0.060	<0.030	<0.030	<0.030	<0.06	0.039	<0.030	<0.030	<0.120	<0.030	0.058	<0.030	<0.030
Copper (Cu)-Total - reported	1.79	3.60	1.95	3.06	2.06	3.78	1.92	3.53	3.20	2.03	2.59	3.33	2.73	3.41
Copper (Cu)-Total - original	1.79	1.05	1.95	3.06	2.06	3.78	1.92	4.22	3.20	2.03	2.59	3.33	2.73	3.41
Copper (Cu)-Total - recheck	3.24	3.60	2.51	3.19	1.86	3.32	3.44	3.53	3.61	4.99	2.16	2.61	2.700	1.60
Zinc (Zn)-Total - reported	35.7	27.2	29.4	26.6	24.9	24.9	37.0	29.8	27.4	27.1	33.1	28.0	29.2	34.4
Zinc (Zn)-Total - original	35.7	9.26	29.4	26.6	24.9	24.9	37.0	47.3	27.4	27.1	33.1	28.0	29.2	34.4
Zinc (Zn)-Total - recheck	33.0	27.2	32.7	30.1	32.0	26.9	31.5	29.8	24.9	30.5	38.1	26.9	33.9	34.2

Appendix 7 Table 1. External fish health assessment for Buck Creek Site BB1, 2012.

Date: Aug 28

2012

Fish #	Metal #	Scale	Age	Length (mm)	Weight (g)	K	Fins	Pseudo-branches	Skin	Thymus	Eye	Gills	Opercles	Spinal Anomal	Total # Anomalies
1	na		1	76	4.17	0.9499	N	N	N	N	N	N	N	N	0
2	na		1	71	3.57	0.9975	N	N	N	N	N	N	N	N	0
3	na		1	72	3.66	0.9806	N	N	N	N	N	N	N	N	0
4	na		1	74	4.05	0.9994	N	N	N	N	N	N	N	N	0
5	na	3-1	2	94	8.28	0.9969	N	N	N	N	N	N	N	N	0
6	na		1	71	4.06	1.1344	N	N	N	N	N	N	N	N	0
7	na		1	76	4.35	0.9909	N	N	N	N	N	N	N	N	0
8	na		1	70	3.72	1.0845	N	N	N	N	N	N	N	N	0
9	na		1	73	3.73	0.9588	N	N	N	N	N	N	N	N	0
10	na		1	74	4.09	1.0093	N	N	N	N	N	N	N	N	0
11	na		1	77	3.56	0.7798	N	N	N	N	N	N	N	N	0
12	na		1	77	4.93	1.0799	N	N	N	N	N	N	N	N	0
13	na	3-2	2	98	9.50	1.0094	N	N	N	N	N	N	N	N	0
14	na	3-3	2	94	8.37	1.0077	N	N	N	N	N	N	N	N	0
15	na		1	81	5.10	0.9597	N	N	N	N	N	N	N	N	0
16	na		1	75	4.40	1.0430	N	N	N	N	N	N	N	N	0
17	na		1	71	3.50	0.9779	N	N	N	N	N	N	N	N	0
18	na	4-1	2	98	9.06	0.9626	N	N	N	N	N	N	N	N	0
19	na		1	76	5.30	1.2074	N	N	N	N	N	N	N	N	0
20	na		1	72	4.25	1.1387	N	N	N	N	N	N	N	N	0
21	na		1	90	5.57	0.7641	N	N	N	N	N	N	N	N	0
22	na		1	76	4.03	0.9180	N	N	N	N	N	N	N	N	0
23	na		1	73	4.61	1.1850	N	N	N	N	N	N	N	N	0
24	na		2	112	12.98	0.9239	N	N	N	N	N	N	N	N	0
25	na		1	73	3.79	0.9743	N	N	N	N	N	N	N	N	0
26	na		1	73	2.85	0.7326	N	N	N	N	N	N	N	N	0
27	na		1	81	5.48	1.0312	N	N	N	N	N	N	N	N	0
28	na		1	78	4.64	0.9778	N	N	N	N	N	N	N	N	0
29	na		1	73	3.88	0.9974	N	N	N	N	N	N	N	N	0
30	na		1	82	5.74	1.0410	N	N	N	N	N	N	N	N	0
	na														
Mean	na		1.2	79.4	5.17	0.9938									
Std	na		0.40	10.27	2.25	0.11									
<b>TOTALS</b>	na						<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**NOTES:**

**K=condition factor**

**N = normal**

**P = parasites**

\*shortened lower jaw

Thymus - Mild hemorrhage = 3 or less red spots

Moderate = more than 3 spots - both sides

Assumed age based on scales examined

Appendix 7 Table 2. External fish health assessment for Buck Creek Site BB2 old, 2012.

Date: Aug 27

2012

Fish #	Metal #	Scale	Age	Length (mm)	Weight (g)	K	Fins	Pseudo-branches	Skin	Thymus	Eye	Gills	Opercles	Spinal Anomal	Total # Anomalies
1	na		1	67	3.89	1.2934	N	N	N	N	N	N	N	N	0
2	na		1	84	6.79	1.1456	N	N	N	N	N	N	N	N	0
3	na	1-1	2	103	10.94	1.0012	N	N	N	N	N	N	N	N	0
4	na		1	82	2.24	0.4063	N	N	N	N	N	N	N	N	0
5	na		1	68	3.32	1.0559	N	N	N	N	N	N	N	N	0
6	na		1	74	4.46	1.1006	N	N	N	N	N	N	N	N	0
7	na		1	84	5.97	1.0072	N	N	N	N	N	N	N	N	0
8	na		1	70	3.12	0.9096	N	N	N	N	N	N	N	N	0
9	na		1	87	7.14	1.0843	N	N	N	N	N	N	N	N	0
10	na	1-2	1	95	8.53	0.9949	N	N	N	N	N	N	N	N	0
11	na		1	73	4.18	1.0745	N	N	N	N	N	N	N	N	0
12	na		1	73	3.90	1.0025	N	N	N	N	N	N	N	N	0
13	na		1	79	5.93	1.2027	N	N	N	N	N	N	N	N	0
14	na		1	71	3.78	1.0561	N	N	N	N	N	N	N	N	0
15	na		1	91	7.09	0.9409	N	N	N	N	N	N	N	N	0
16	na		1	73	3.76	0.9665	N	N	N	N	N	N	N	N	0
17	na		1	71	3.76	1.0505	N	N	N	N	N	N	N	N	0
18	na		1	70	3.95	1.1516	N	N	N	N	N	N	N	N	0
19	na		1	70	3.50	1.0204	N	N	N	N	N	N	N	N	0
20	na		1	100	13.79	1.3790	N	N	N	N	N	N	N	thickened	Photo 1&2
21	na		1	77	4.68	1.0251	N	N	N	N	N	N	N	N	0
22	na		1	71	3.90	1.0897	N	N	N	N	N	N	N	N	0
23	na		1	93	9.48	1.1786	N	N	N	N	N	N	N	N	0
24	na		1	89	8.14	1.1547	N	N	N	N	N	N	N	N	0
25	na		1	74	4.93	1.2166	N	N	N	N	N	N	N	N	0
26	na		1	93	8.16	1.0145	N	N	N	N	N	N	N	N	0
27	na		2	113	13.29	0.9211	N	N	N	N	N	N	N	N	0
28	na	1-3	2	96	8.48	0.9585	N	N	N	N	N	N	N	N	0
29	na		1	78	4.95	1.0431	N	N	N	N	N	N	N	N	0
30	na		1	71	3.52	0.9835	N	N	N	N	N	N	N	N	0
31*	na	2-1	2	103	15.91	1.4560	N	N	N	N	N	N	N	thickened	Photo 3&4
Mean			1.1	82.0	6.31	1.0476									
Std			0.20	10.70	2.76	0.17									
<b>TOTALS</b>							<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>

NOTES:

K=condition factor

N = normal

31\* Not included in averages - selected from remaining fish during sampling due to anomaly.

P = parasites

Thymus - Mild hemorrhage = 3 or less red spots

Moderate = more than 3 spots - both sides

Assumed age based on scales examined

Appendix 7 Table 3. External fish health assessment for Buck Creek Site BB2 new, 2012.

Date: Aug 29

2012

Fish #	Metal #	Scale	Age	Length (mm)	Weight (g)	K	Fins	Pseudo-branches	Skin	Thymus	Eye	Gills	Opercles	Spinal Anomal	Total # Anomalies
1	na	5-1	2	106	15.62	1.3115	N	N	N	N	N	N	N	N	0
2	na		1	72	3.71	0.9940	N	N	N	N	N	N	N	N	0
3	na		1	71	3.75	1.0477	N	N	N	N	N	N	N	N	0
4	na		1	77	4.31	0.9441	N	N	N	N	N	N	N	N	0
5	na		1	76	4.96	1.1299	N	N	N	N	N	N	N	N	0
6	na	5-2	2	98	10.46	1.1114	N	N	N	N	N	N	short	N	1
7	na		1	75	4.93	1.1686	caudal torn	N	N	N	N	N	N	N	1
8	na		1	73	3.81	0.9794	N	N	N	N	N	N	N	N	0
9	na		1	86	7.41	1.1650	N	N	N	N	N	N	N	N	0
10	na		1	87	7.71	1.1708	N	N	N	N	N	N	N	N	0
11	na		1	83	5.74	1.0039	N	N	N	N	N	N	N	N	0
12	na		2	117	16.92	1.0564	N	N	N	N	N	N	N	N	0
13	na		1	179	57.40	1.0008	N	N	N	N	N	N	N	N	0
14	na		1	77	4.20	0.9200	N	N	N	N	N	N	N	N	0
15	na		1	75	4.49	1.0643	N	N	N	N	N	N	N	N	0
16	na		1	72	4.55	1.2190	N	N	N	N	N	N	N	N	0
17	na		1	71	3.34	0.9332	N	N	N	N	N	N	N	N	0
18	na		1	78	4.48	0.9440	N	N	N	N	N	N	N	N	0
19	na		1	74	4.10	1.0118	N	N	N	N	N	N	N	N	0
20	na		1	79	5.17	1.0486	N	N	N	N	N	N	N	N	0
21	na		1	83	5.98	1.0458	N	N	N	N	N	N	N	N	0
22	na		1	70	3.30	0.9621	N	N	N	N	N	N	N	N	0
23	na		1	80	4.74	0.9258	N	N	N	N	N	N	N	N	0
24	na		1	82	4.68	0.8488	N	N	N	N	N	N	N	N	0
25	na		1	82	5.88	1.0664	N	N	N	N	N	N	N	N	0
26	na		1	81	5.20	0.9785	N	N	N	N	N	N	N	N	0
27	na		1	76	4.37	0.9955	N	N	N	N	N	N	N	N	0
28	na		1	72	3.70	0.9913	N	N	N	N	N	N	N	N	0
29	na		1	76	3.88	0.8839	N	N	N	N	N	N	N	N	0
30	na		1	75	4.26	1.0098	N	N	N	N	N	N	N	N	0
Mean			1.1	83.4	7.44	1.0311									
Std			0.33	22.14	10.64	0.11									
<b>TOTALS</b>							<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>2</b>

NOTES:

**K=condition factor**

**N = normal**

**P = parasites**

\*Thick and curved spine - 3 photos

Thymus - Mild hemorrhage = 3 or less red spots

Moderate = more than 3 spots - both sides

Assumed age based on scales examined

Appendix 7 Table 4. External fish health assessment for Foxy Creek rainbow trout, 2012.

Date: Aug 30

2012

Fish #	Metal #	Scale	Age	Length (mm)	Weight (g)	K	Fins	Pseudo-branches	Skin	Thymus	Eye	Gills	Opercles	Spinal Anomal	Total # Anomalies
1	1	1	2	106	19.75	1.6582	N	N	N	N	N	N	N	N	0
2	2	1	2	127	22.52	1.0994	N	N	N	N	N	N	N	N	0
3	3	1	2	112	15.36	1.0933	N	N	N	N	N	N	N	N	0
4	4	2	2	129	20.63	0.9610	N	N	N	N	N	N	N	N	0
5	5	2	1	109	11.83	0.9135	N	N	N	N	N	N	N	N	0
6	6	2	2	109	15.24	1.1768	N	N	N	N	N	N	N	N	0
7	7	3	1	100	11.05	1.1050	N	N	N	N	N	N	N	N	0
8	8	3	1	104	11.63	1.0339	N	N	N	N	N	N	N	N	0
9	9	3	1	105	13.90	1.2007	N	N	N	N	N	N	N	N	0
10	10	4	2	104	12.30	1.0935	N	N	N	N	N	N	N	N	0
11		4	1	95	10.46	1.2200	N	N	N	N	N	N	N	N	0
12		4	1	99	10.51	1.0832	N	N	N	N	N	N	N	N	0
13		5	1	92	9.81	1.2598	N	N	N	N	N	N	N	N	0
14		5	1	97	9.07	0.9938	N	N	N	N	N	N	N	N	0
15			1	82	6.02	1.0918	N	N	N	N	N	N	N	N	0
16			1	84	7.72	1.3025	N	N	N	N	N	N	N	N	0
17		5	2	103	12.05	1.1027	caudal	N	N	N	N	N	N	N	1
18			2	109	14.50	1.1197	N	N	N	N	N	N	N	N	0
19		6	1	92	9.51	1.2213	N	N	N	N	N	N	N	N	0
20			2	108	11.92	0.9462	N	N	N	N	N	N	N	N	0
21		6	1	95	10.08	1.1757	N	N	N	N	N	N	N	N	0
22		6	1	95	10.04	1.1710	N	N	N	N	N	N	N	N	0
23			1	101	10.85	1.0531	N	N	N	N	N	N	N	N	0
24			1	102	11.70	1.1025	N	N	N	N	N	N	N	N	0
25			2	107	13.82	1.1281	N	N	N	N	N	N	N	N	parasites on gills
26			1	84	6.63	1.1186	N	N	N	N	N	N	N	N	0
27			1	81	6.69	1.2588	N	N	N	N	N	N	N	N	0
28			1	76	5.41	1.2324	N	N	N	N	N	N	N	N	0
29			1	77	5.93	1.2989	N	N	N	N	N	N	N	N	parasites on gills
30			1	77	5.82	1.2748	N	N	N	N	N	N	N	N	0
Mean			1.3	98.7	11.43	1.1497									
Std			0.50	11.19	3.98	0.14									
<b>TOTALS</b>							<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>

K=condition factor

Thymus - Mild hemorrhage = 3 or less red spots

Age based on break-out from scale results

N = normal

Moderate = more than 3 spots - both sides

P = parasites

Evidence that two spring salmon spawners had been poached under the bridge- parts of carcasses left in creek.

No fry observed while sampling site- 11 extra yearlings not measured.

Appendix 7 Table 5. External fish health assessment for Crow Creek rainbow trout, 2012.

Date: Aug 30

2012

Fish #	Metal #	Scale	Age	Length (mm)	Weight (g)	K	Fins	Pseudo-branches	Skin	Thymus	Eye	Gills	Opercles	Spinal Anomal	Total # Anomalies
1	1	1	2	130	22.85	1.0401	N	N	N	N	N	N	N	N	0
2	2	1	2	98	10.46	1.1114	N	N	N	N	N	N	N	N	0
3	3	1	3	134	25.69	1.0677	N	N	N	N	N	N	N	N	0
4	4	2	2	121	17.70	0.9991	N	N	N	N	N	N	N	N	0
5	5	2	2	102	11.43	1.0771	N	N	N	N	N	N	N	N	0
6	6	2	1	91	7.85	1.0417	N	N	N	N	N	N	N	N	0
7	7	3	2	113	14.99	1.0389	N	N	N	N	N	N	N	N	0
8	8	3	2	113	13.76	0.9536	N	N	N	N	N	N	N	N	0
9	9	3	2	89	7.90	1.1206	N	N	N	N	N	N	N	N	0
10	10	4	2	114	16.76	1.1313	N	N	N	N	N	N	N	N	0
11		4	2	91	7.20	0.9555	N	N	N	N	N	N	N	N	0
12			2	110	14.08	1.0579	N	N	N	N	N	N	N	N	0
13		4	2	92	9.20	1.1815	N	N	N	N	N	N	N	N	0
14			2	106	12.36	1.0378	N	N	N	N	N	N	N	N	0
15			1	88	7.60	1.1152	N	N	N	N	N	N	N	N	0
16		5	2	98	10.07	1.0699	N	N	N	N	N	N	N	N	0
17			2	129	19.92	0.9279	N	N	N	N	N	N	N	N	0
18			2	109	13.07	1.0092	N	N	N	N	N	N	N	N	0
19			2	108	13.22	1.0494	N	N	N	N	N	N	N	N	0
20			2	112	14.26	1.0150	N	N	N	N	N	N	N	N	0
21			2	115	16.52	1.0862	N	N	N	N	N	N	N	N	0
22		5	2	97	9.89	1.0836	N	N	N	N	N	N	N	N	0
23		5	2	101	11.24	1.0909	N	N	N	N	N	N	N	N	0
24		6	2	103	11.92	1.0908	N	N	N	N	N	N	N	N	0
25			1	89	8.78	1.2454	N	N	N	N	N	N	N	N	0
26			1	78	5.09	1.0726	N	N	N	N	N	N	N	N	0
27			1	82	5.66	1.0265	N	N	N	N	N	N	N	N	0
28			1	74	4.83	1.1919	N	N	N	N	N	N	N	N	0
29			1	80	4.91	0.9590	N	N	N	N	N	N	N	N	0
30			1	77	4.58	1.0032	N	N	N	N	N	N	N	N	0
Mean			1.8	101.5	11.79	1.0617									
Std			0.43	14.13	4.91	0.07									
<b>TOTALS</b>							<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

NOTES:

**K=condition factor**


**N = normal**

**P = parasites**

Lots of fry observed while sampling site - parr captured under bridge (~40 mm fl)

Thymus - Mild hemorrhage = 3 or less red spots

Moderate = more than 3 spots - both sides

 Age based on break-out from scale results

Appendix 7 Table 6. External fish health assessment for Goosly Lake rainbow trout, 2012.

Fish #	Metal #	Scale	Age	Sex	Length (mm)	Weight (g)	K	Fins	Pseudo-branches	Skin	Thymus	Eye	Gills	Opercles	Spinal Anomal	External Parasites	Total # Anomalies
1	1	1	3	F	187	60.6	0.9267	N	N	N	N	N	N	N	N	N	0
2	2	2	2	M	173	45.3	0.8749	N	N	N	N	N	N	N	N	N	0
3	3	3	3	M	185	66.3	1.0471	N	N	N	N	N	N	N	N	N	0
4	4	4	2	M	182	55.3	0.9173	N	N	N	N	N	N	N	N	N	0
5	5	5	3	F	175	50.5	0.9423	N	N	N	N	N	N	N	N	Y	P- opercles
6	6	6	3	F	193	71.1	0.9890	N	N	N	Y-mild	N	N	N	N	N	1
7	7	7	3	F	172	49.4	0.9708	N	N	N	N	N	N	N	N	N	0
8	8	8	2	M	173	48.0	0.9270	N	N	N	N	N	N	N	N	N	0
9	9	9	3	M-kelt	196	65.0	0.8630	N	N	N	N	N	N	N	N	N	0
10	10	10	3	F	169	51.0	1.0558	N	N	N	N	N	N	N	N	N	0
11	11	11	3	F	198	75.2	0.9683	N	N	N	N	N	N	N	N	N	0
12	12	12	2	M	180	60.2	1.0322	N	N	N	N	N	N	N	N	N	0
13	13	13	2	M	180	56.2	0.9636	N	N	N	N	N	N	N	N	N	0
14	14	14	3	F	175	56.5	1.0542	N	N	N	N	N	N	N	N	N	0
15	15	15	4	F	189	71.4	1.0576	N	N	N	N	N	N	N	N	N	0
16	16	16	4	F	174	56.5	1.0725	N	N	N	N	N	N	N	N	N	0
17	17	17	3	M	189	69.5	1.0294	N	N	N	N	N	N	N	N	N	0
18	18	18	2	M	171	52.5	1.0500	N	N	N	N	N	N	N	N	N	0
19	19	19	3	M	199	67.9	0.8616	N	N	N	N	N	N	N	N	Y	P- base anal
20	20	20	3	M	189	57.9	0.8576	N	N	N	N	N	N	N	N	Y	P-black spot
Mean			2.8		182.5	59.3	0.9731										
Std			0.64		9.0	9.1	0.0670										
<b>TOTALS</b>											<b>1</b>						<b>4</b>

**NOTES:**

**K=condition factor**

**N = normal**

Thymus - Mild hemorrhage = 3 or less red spots

Moderate = more than 3 spots - both sides

**P- mostly copepods**

some fish had internal parasites including small white roundworms in body cavity