Technical Report No. 12-11

Aquatic Biomonitoring at Greens Creek Mine, 2012

by

Katrina M. Kanouse and

Benjamin P. Brewster

April 2013

Alaska Department of Fish and Game **Division of Habitat**

Cover: A mayfly (Ephemeroptera: Ephemerellidae) collected at Greens Creek Site 48 in 2012. Copyright Alaska Department of Fish and Game. Photo by Greg Albrecht.

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AQUATIC BIOMONITORING AT GREENS CREEK MINE, 2012

by
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and
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Alaska Department of Fish and Game
Division of Habitat, Region I
802 3rd Street, Douglas, Alaska, 99824

April 2013

This project was fully financed by Hecla Greens Creek Mining Company.

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in reports by the Divisions of Habitat, Sport Fish and of Commercial Fisheries. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per billion	ppb
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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Several biologists with the Alaska Department of Fish and Game Division of Habitat participated with this year's effort: Rick Hoffman, Nicole Legere, and Jackie Timothy conducted the field sampling, and Greg Albrecht and Tally Teal assisted with data entry and conducted the laboratory analyses for the periphyton samples. Greg Albrecht performed quality assurance/quality control of the macroinvertebrate samples. Sport Fish Division Biometrician Dan Reed provided biometric review. Dr. Al Ott and Jackie Timothy of Habitat Division, Amy Carroll of Commercial Fisheries Division, and Jennifer Saran of Hecla Greens Creek Mining Company provided technical review. Nora Foster of NRF Taxonomic Services identified the benthic macroinvertebrates.

EXECUTIVE SUMMARY

In 2001, the Alaska Department of Fish and Game (ADF&G) Division of Habitat and the USDA Forest Service (USFS) initiated the aquatic biomonitoring program at Greens Creek Mine near Juneau. The purpose of the program is to annually document stream health in Greens Creek and Tributary Creek, two streams near mine development and operations.

The aquatic biomonitoring program includes sampling three levels of aquatic productivity for comparison over time: periphyton (attached algae), benthic macroinvertebrates (aquatic insects), and juvenile fish. Estimates of periphyton biomass, benthic macroinvertebrate density and community composition, juvenile fish populations, and concentrations of five heavy metals and selenium in whole body juvenile fish together provide information we use to assess stream health.

In 2012, we sampled Greens Creek sites 48 and 54, and Tributary Creek Site 9. Samples from all three sites continued to suggest productive aquatic communities were present in amounts similar to those observed since sampling began in 2001. Of note, whole body copper concentrations in several fish samples collected at all three sites in 2012 were the greatest observed, some by more than one magnitude. The unusual results for all three sites suggest contamination.

We added two studies to the program in 2012: we weighed captured juvenile fish to the nearest 0.1 g to calculate fish condition, and tested juvenile fish for whole body total mercury. Per recommendations listed in the 2011 report (Kanouse 2012), we also investigated relationships of cadmium, copper, lead, and zinc concentrations in whole body fish and water samples, and present our findings for each site. In 2013, we will measure cadmium, copper, mercury, lead, selenium, silver, and zinc concentrations in fine (< 2 mm) sediment at Greens Creek sites 48 and 54 and Tributary Creek Site 9 to investigate relationships among concentrations in whole body juvenile fish, water and sediment at each site.

INTRODUCTION

Greens Creek Mine is located near Hawk Inlet on the west side of Admiralty Island in Southeast Alaska, about 29 km west of Juneau. The mine began operations in 1989, and produces export concentrates of lead, zinc, silver and gold. Tailings are disposed at the dry-stack facility near the headwaters of Tributary Creek, and mine facilities and production rock storage areas are adjacent to Greens Creek. The mine did not operate between 1993 and 1996 and has otherwise operated year-round by a few different companies. Hecla Greens Creek Mining Company (Hecla) has owned and operated the Greens Creek Mine since April 2008.

The aquatic biomonitoring program is included in the mine's Fresh Water Monitoring Program (FWMP) in the Plan of Operations required by the USFS, and the mine's current Waste Management Permit required by the Alaska Department of Environmental Conservation. Reports from previous years' biomonitoring work are available in Weber Scannell and Paustian (2002), Jacobs et al. (2003), Durst and Townsend (2004), Durst et al. (2005), and Durst and Jacobs (2006–2010), and Kanouse (2011–2012).

PURPOSE

The purpose of the Greens Creek Mine biomonitoring program is to document the conditions of the aquatic biological communities in select reaches of Greens Creek and Tributary Creek near mine development and operations. This report summarizes results from sampling in 2012, the twelfth consecutive year.

AQUATIC STUDIES

In 2012, we completed the following studies:

1. Periphyton biomass and chlorophyll-type;
2. Benthic macroinvertebrate density and community composition;
3. Juvenile fish populations and fish condition; and
4. Juvenile fish whole body concentrations of Ag, Cd, Cu, Hg, Pb, Se, and Zn.

STUDY AREA

In 2012, we completed aquatic studies at three sample sites (Figure 1):

1. Greens Creek Sites 48 (upstream of mine activities);
2. Greens Creek Site 54 (downstream of mine activities); and
3. Tributary Creek Site 9 (downstream of the tailing disposal facility).

Sites 48, 54 and 9 have been sampled annually since 2001, while Site 6 (located between sites 48 and 54) is sampled once every five years (2001, 2006 and 2011). Hecla personnel sample ambient water quality monthly at the each sample site and report results to the Alaska Department of Environmental Conservation in their FWMP annual report.

Greens Creek

Greens Creek begins in the alpine, drains an area of 22.33 km^2 (USGS 2013), and is about 16 km long from headwater to tidewater. At each sample site, gradients range from 2% to 4%, cobble is the dominant substrate, and large woody debris, important for habitat creation, stability, and diversity, is present. The creek is largely fed by snowmelt and other drainages, and the magnitude of annual discharge depends on snowpack depth. During the 2012 water year, USGS Gage 15101490 (USGS 2013) recorded peak discharges mid-May through early June, up to 187 ft^3/s. Rainfall events during the fall also cause periods of high discharge.

Greens Creek Site 48

Site 48 is located upstream of all mine and mill facilities, except for exploratory drilling, and serves as the reference site for comparing data collected downstream at Site 54. Site 48 is at approximately 265 m elevation, and about 0.8 km upstream from the infiltration gallery and concrete weir in Greens Creek, which blocks upstream fish passage. Resident Dolly Varden char *Salvelinus malma* is the only fish species documented at Site 48.

During field sampling in 2012, mean channel wetted width was 10.6 m within the 50 m fish sample reach. Accumulations of large wood and overhanging trees are common in this reach, contributing to deep pool habitat, cover, and split channel formations. Periphyton and benthic macroinvertebrate sampling occurs downstream of the fish sample reach.

Greens Creek Site 6

Site 6 is located downstream of mine and mill facilities and monitored to detect potential changes from mine, mill, or shop activities. Data collected at Site 6 are compared to data collected at Site 54, which is located downstream of Bruin Creek's confluence and production rock storage areas 23 and D. At about 235 m elevation, Site 6 is 0.8 km downstream of the concrete weir. Large woody debris is less abundant at Site 6 than at sites 48 and 54. Anadromous fish access this site via the fish pass.[a] Dolly Varden char and juvenile coho salmon *Oncorhynchus kisutch* have been documented at this site. Periphyton and benthic macroinvertebrate sampling occurs downstream of the fish sample reach, and upstream of the confluence of Bruin Creek with Greens Creek. We did not sample Site 6 in 2012; sampling is scheduled again in 2016.

Greens Creek Site 54

Site 54 is located at about 225 m elevation, downstream of production rock storage areas 23 and D and Bruin Creek's confluence. Data collected at Site 54 are compared to data collected at reference Site 48, located upstream mine influence, and monitored to detect potential changes from the rock storage areas and treatment ponds, as well as from the mine, mill and shop facilities upstream. Anadromous fish access this site via the fish pass near river km 5.6. Coho salmon, Dolly Varden char, and cutthroat trout *O. clarki* have been documented at this site.

From 2001 to 2010, we sampled juvenile fish populations in a 28 m reach, nearly half the length of the fish sample reaches at Greens Creek Site 48 and Tributary Creek Site 9. In 2011 we extended the 28 m reach to 50 m. While sampling in 2012, mean channel wetted width was 12.6 m within the 50 m fish sample reach. Accumulations of large wood and overhanging and fallen trees also are common in this reach, contributing to deep pool habitat, cover, and split channel formations. Gallagher Creek enters Greens Creek within the fish sample reach. Periphyton and benthic macroinvertebrate sampling occurs upstream of the fish sample reach.

Tributary Creek

Tributary Creek is about 1.6 km long, and is a low-energy, lowland stream fed by groundwater, precipitation, and a few hillside drainages. The tailing storage facility is located in the headwaters of the creek. The gradient varies slightly from 1% to 2% along the entire creek, and discharge estimates based on field measurements during sampling and limited gage data indicate annual stream flows range 1–5 ft^3/s (USDA Forest Service 2003).

Tributary Creek Site 9

Site 9 is located 1.2 km downstream of the tailing disposal facility at about 25 m elevation, and is monitored to detect potential changes from the tailing disposal facility. Tributary Creek provides habitat for pink salmon *O. gorbuscha*, chum salmon *O. keta*, coho salmon, cutthroat trout, rainbow trout *O. mykiss*, Dolly Varden char, and sculpin *Cottus* sp.

During field sampling in 2012, mean channel wetted width was 2.6 m within the 50 m fish sample reach. Leaning and fallen trees contribute to pool formation and substrate retention, which consists of organics, sand, and gravel. Periphyton and benthic macroinvertebrate sampling occurs within the fish sample reach, though not while trapping fish.

---

[a] In 1989, Greens Creek Mining Company installed an engineered fish pass at Greens Creek river km 5.6 as mitigation for impacts to Tributary Creek from the approved tailing dry-stack facility. The timber and concrete weirs are designed to provide adult coho salmon passage though a natural bedrock chute that prevents fish migration. The fish pass was damaged during flood flows in November 2005, limiting upstream adult coho salmon passage.

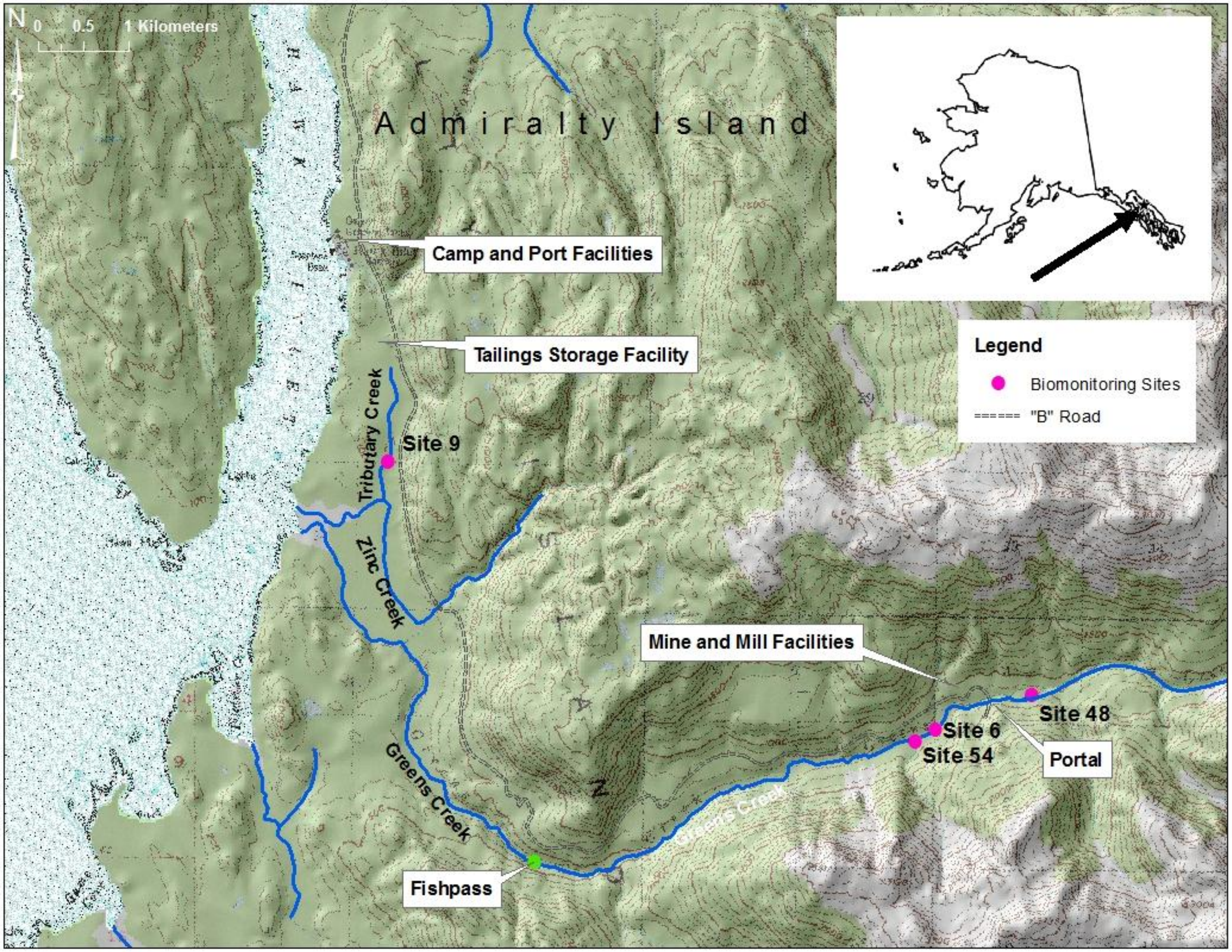

Figure 1.–Location of Greens Creek Mine project facilities and biomonitoring sample sites.

METHODS

We followed methods used previously at Greens Creek Mine (Weber Scannell and Paustian 2002; Jacobs et al. 2003; Durst and Townsend 2004; Durst et al. 2005; Durst and Jacobs 2006–2010; Kanouse 2011–2012).[b] In addition to the sample parameters described in this section, at each site we also measured five wetted widths to estimate fish density, water depth and velocities at benthic macroinvertebrate sample locations, and flow across each site to estimate discharge.

DATA ANALYSES

We performed data analyses using Statistix® 9 (Analytical Software. 2008. Statistix 9 User's Manual. Analytical Software, Tallahassee, Florida, http://www.statistix.com/features.html).

We used the Kruskal-Wallis One-Way Analysis of Variance by ranks test, a nonparametric alternative to a one-way analysis of variance, to test for equality of population medians between years and sites (Neter et al. 1990). We used all-pairwise comparisons on the mean ranks for each group to test for homogeneity between years and sites. We used the Spearman's Rank Correlation Coefficient to detect correlations between water samples and fish samples (Zar 1984). We used nonparametric tests because these tests are robust when the distributions of parameters being estimated differ greatly from a Normal probability distribution. For data comparisons of whole body silver concentrations, we used the minimum reporting limit (0.02 mg Ag/Kg) for results reported as not detected. Significant differences are reported when $p \leq 0.05$.

The long-term dataset is occasionally reviewed to ensure accuracy. We report and correct errors in the document and appendices. The most recent technical report presents the current dataset and should be used to analyze the data from previous years. In this report, we adjusted fish population estimates for all sample sites and all years based on recommendations by Dan Reed (Sport Fish Biometrician, ADF&G, Nome, personal communication).

WATER QUALITY

Hecla personnel use field meters to characterize basic water quality at each site during sampling, including temperature, pH, and conductivity. 2012 results are included in this report for each site.

PERIPHYTON BIOMASS AND COMMUNITY COMPOSITION

Rationale

Periphyton (attached algae) are primary producers, have short life cycles, and are sensitive to changes in water quality (Barbour et al. 1999). We measure periphyton biomass to assess local primary productivity and detect short-term changes, and monitor biomass and proportions of chlorophylls *a*, *b*, and *c* to detect change over time. Chlorophyll *a* pigment is produced by plants, and density provides an estimate of active algal biomass. Chlorophyll *b* and *c* pigments provide information on the types of organisms present. We use periphyton data with data from other local studies (e.g., benthic macroinvertebrate data) to assess overall stream health at each site.

Sample Collection and Analysis

We attempt to sample periphyton at low flow and not within three weeks after a high flow event, which can scour the substrate and reduce biomass. We collected 10 smooth, flat, undisturbed,

[b] Deviations from previously used methods are described in the *Results* section.

perennially wetted rocks in riffle habitats in < 0.45 m water depth using the collection methods described in Ott et al. (2010). We placed a 5×5 cm square of high-density foam on each rock and scrubbed the area around the foam with a toothbrush to remove attached algae outside the covered area. We rinsed the rock by dipping it with foam intact in the stream.

We removed the foam square and scrubbed the sample area with a rinsed toothbrush over a 1 µm, 0.47 mm glass fiber filter attached to a vacuum pump. We used stream water in a wash bottle to rinse the loosened periphyton, the toothbrush, and the inside of the vacuum pump onto the filter. After extracting as much water as possible from the filter, we added a few drops[c] of saturated magnesium carbonate ($MgCO_3$) to the filter before we pumped the sample dry to prevent acidification and conversion of chlorophyll to phaeophyton. We removed the glass fiber filter, folded it in half with the sample on the inside, and wrapped it in a large paper coffee filter to absorb additional water. We placed the samples in a sealed, labeled plastic bag with desiccant and stored the samples in a light-proof cooler containing frozen gel packs in the field, and in a camp freezer while onsite. When we returned to the office, we locked the samples in a –20°C freezer until we processed them in our laboratory.

We followed U.S. Environmental Protection Agency (1997) protocol for chlorophyll extraction and measurement, and instrument detection limit and error.[d] We removed the samples from the freezer, cut each filter into small pieces, and transferred the filter pieces for each sample into individual centrifuge tubes containing 10 ml of 90% buffered acetone. We capped the centrifuge tubes, placed them in a metal rack, covered them with aluminum foil, and stored them in a refrigerator for not more than 24 h to extract the chlorophyll. Then we centrifuged the samples for 20 min at 1,600 rpm and read them on a Shimadzu UV-1800 Spectrophotometer at optical densities (OD) 664 nm, OD 647 nm, and OD 630 nm.[e] We also read the samples at OD 750 nm to correct for turbidity and used an acetone blank to correct for the solvent. Then we treated the samples with 80 µl of 0.1 N hydrochloric acid to convert the chlorophyll to phaeophytin, and read each sample again at OD 665 nm and OD 750 nm.

Data Presentation

We include a figure of mean daily discharge in Greens Creek three weeks prior to field sampling in the *Results* section. Periphyton biomass, estimated by mean chlorophyll *a* concentration ± one standard deviation, excluding potential outliers, is presented in a figure for each sample site. A star (✳) in the figure represents a possible outlier, where chlorophyll *a* density in the sample exceeded the mean for the typical range of data that year by more than three times. Though we exclude possible outlier values from the typical range of data in figures for illustration, we include possible outlier data in calculation of the annual mean, statistical analyses, and in the raw data set presented in Appendix A. We also present a figure of annual mean proportions of chlorophylls *a*, *b* and *c* for each sample site.

---

[c] This measurement is not exact as the amount of water used to dilute the magnesium carbonate is not exact and fixes the sample regardless of the concentration without affecting data integrity.

[d] Except, we stored our samples longer than 3.5 weeks and we cut our filters rather than homogenized them due to risk of acetone exposure (Ott et al. 2010).

[e] In 2012, our error detection limit for the spectrophotometer was greater than in 2011, potentially due to scratches on the cuvettes. We disposed and replaced the cuvettes in late 2012, and will regularly replace the cuvettes to prevent elevated detection limits on future readings.

BENTHIC MACROINVERTEBRATE DENSITY AND COMMUNITY COMPOSITION

Rationale

Benthic macroinvertebrates classified in the Orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), collectively known as EPT taxa, are sensitive to changes in water quality and an important food source for fish. Most benthic macroinvertebrates have a complex one-year (or more) life cycle and therefore provide an ideal indicator to detect short-term and long-term changes in local aquatic communities (Barbour et al. 1999). We use benthic macroinvertebrate density and community composition data to detect change over time and to assess overall stream health.

Sample Collection and Analysis

We collected five benthic macroinvertebrate samples from each site using a Hess sampler in riffles where we observe the greatest amount of taxonomic density and richness (Barbour et al. 1999). This sample design reduces the variability that arises from sampling other habitat types.

We pushed the Hess sampler into the stream bottom, encompassing a 0.086 m^2 sample area, in riffle areas with varying flow sufficient to transport insects to the cod end of the sampler. Within the sample area, we brushed and discarded rocks and disturbed substrate to about 10 cm depth to dislodge macroinvertebrates, which drifted into a 363 μm mesh net and cod end. We transfered samples to prelabeled 500 mL bottles, preserved them in 80% denatured ethanol (3 parts ethanol, 1 part sample), and shipped them to a private laboratory for sorting and taxonomic identification to the lowest practical level (genus in most cases). For quality assurance and control, we identified, counted, and compared numbers of insects in two random samples (>10% of samples collected in 2012).

We calculated the density of aquatic macroinvertebrates per square meter by dividing the number of aquatic insects per sample by 0.086 m^2, the Hess sample area, then calculated the mean of the five samples. Richness is the total number of taxa observed in all five samples.

Data Presentation

We include a figure of mean daily discharge in Greens Creek three weeks prior to field sampling in the results section. We present a figure of mean aquatic macroinvertebrate densities ± one standard deviation with taxa richness, and a figure illustrating percent community composition, for each site. Current and historical results are included in Appendix B.

JUVENILE FISH POPULATIONS

Rationale

Salmonids are migratory, predators, an indicator of aquatic conditions and long-term condition (Barbour et al. 1999), and afford another biological level to detect change within the aquatic community and assess overall stream health. We compare current year population estimates to estimates from previous years sampling to detect change over time.

Sample Collection and Analysis

We sampled fish populations using a modification[f] of a depletion method developed by the USFS (Bryant 2000). We sampled reaches isolated by natural features, such as shallow riffles, and set baited minnow traps opportunistically along the upper and lower reach boundaries to capture potential migrants (fish captured in these block traps were not included in the population estimate). We saturated the sample reaches with 6.35 mm (0.25 in) minnow traps baited with whirl packs containing disinfected salmon eggs (Magnus et al. 2006), setting traps opportunistically in all habitat types where water depth and flow allowed. We placed rocks in the traps to increase trap weight, maintain trap position, and provide cover for fish.

We soaked the traps for 1.5 h, then retrieved each trap, transferred captured fish into plastic buckets, removed the spent bait, rebaited the trap, and reset each trap in the same location for another 1.5 h soak. In between trapping events, we processed captured fish. Biologists anesthetized[g] fish in an aerated bucket, measured and recorded FL to the nearest 1 mm, weight to the nearest 0.1 g, and species (Pollard et a. 1997). We retained captured fish in perforated plastic buckets secured in the stream during the sample period, and returned captured fish[h] to the sample reach after all three passes were complete.

We collected data to meet the assumptions of closure and equal probability of capture (Lockwood and Schneider 2000) during all three sampling events by ensuring the following.

- Fish emigration and immigration during the sampling period was negligible.
    - Sample reaches were isolated by natural stream features and using block traps, which are strategically set to capture potential migrants.
    - Total sample period was short, about 4.5 hours.
- All fish were equally vulnerable to capture during a pass.
    - Baited minnow traps were set in all habitat types where water depth and flow allowed.
- Fish do not become more wary of capture with each pass.
    - Trap numbers and placement remained constant during all three capture events.
    - Field crew completed all three capture events as quickly possible.
    - Field crews moved away from minnow traps so fish were not disturbed while the traps soaked each 1.5 h capture event.

[f] We sampled shorter reaches, used more minnow traps, and completed three passes instead of four.
[g] Clove oil (0.5 mL/gl) in 2012. We will dilute the clove oil with ethanol for solubility in 2013, per Anderson et al. (1997).
[h] Except, we retained six fish for whole body metals concentrations at each sample site.

- Collection effort and conditions which affect collection efficiency remained constant.
    - Field crew sets, retrieves, and replaces traps as quickly as possible between events.
    - For the second and third capture events, the field crew replaced the spent bait with fresh bait and reset each trap in the exact same location.

We estimated resident fish populations using the multiple-pass depletion method developed by Lockwood and Schneider (2000), based on methods developed by Carle and Strub (1978). The repetitive method produces a maximum likelihood estimate (MLE) of fish with a 95% confidence interval.

Let *X* represent an intermediate sum statistic where the total number of passes, *k*, is reduced by the pass number, *i*, and multiplied by the number of fish caught in the pass, C_i, for each pass,

$$X = \sum_{i=1}^{k} (k-i)C_i$$

Let *T* represent the total number of fish captured in the minnow traps for all passes. Let *n* represent the predicted population of fish, using *T* as the initial value tested. Using *X*, the MLE, *N*, is calculated by repeated estimations of *n*. The MLE is the smallest integer value of *n* greater than or equal to *T* which satisfies[i]:

$$\left[\frac{n+1}{n-T+1}\right] \prod_{i=1}^{k} \left[\frac{kn-X-T+1+(k-i)}{kn-X+2+(k-i)}\right]_i \leq 1.000$$

The probability of capture, *p*, is given by the total number of fish captured, divided by an equation where the number of passes is multiplied by the MLE and subtracted by the intermediate statistic, *X*,

$$p = \frac{T}{kN-X}$$

The variance of *N*, a measure of variability from the mean, is given by,

$$\text{Variance of } N = \frac{N(N-T)T}{T^2 - N(N-T)\left[\frac{(kp)^2}{(1-p)}\right]}$$

The standard error (SE) of *N* was calculated by the square root of the Variance of *N*, and the 95% confidence interval for the MLE is given by: MLE $\pm$ 2(SE). A MLE cannot be generated from samples from small populations if few fish are captured during the three sample events; in these cases, we present the number of fish captured as the result and do not include a MLE or 95% confidence interval.

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[i] Lockwood and Schneider (2000) suggest the result should be rounded to one decimal place (1.0). We use three decimal places (1.000) as described in Carle and Strub (1978).

Calculating a MLE using three-pass depletion data relies heavily on equal capture probability among passes (Bryant 2000, Carle and Strub 1968, Lockwood and Schneider 2000). To evaluate equal capture probability, we use the goodness of fit test in White et al. (1982), recommended by Lockwood and Schneider (2000), which follows the χ^2 test form. We first calculate expected numbers of fish captured for each pass ($C_1, C_{2.}, C_3$) using variables previously described,

$$E(C_1) = N(1-p)^{i-1}p$$

Then we calculate χ^2,

$$\chi^2 = \frac{[C_1 - E(C_1)]^2}{E(C_1)} + \frac{[C_2 - E(C_2)]^2}{E(C_2)} + \frac{[C_3 - E(C_3)]^2}{E(C_3)}$$

If the goodness of fit test indicates we did not achieve equal capture probability, the MLE will be biased low.

Data Presentation

We present a figure illustrating annual Dolly Varden char and coho salmon population estimates for each sample site. We calculated and report fish densities using the population estimate and the mean of five wetted width measurements within the fish sample reaches. Capture data and length frequencies of captured fish from each reach and each year are included in Appendix C.

JUVENILE FISH CONDITION

Rationale (APDES 1.5.3.3.1)

We used captured fish length and weight data to calculate Fulton's condition factor (K), an index of fish health. Age, sex, season, maturation, diet, gut fullness, fat reserve, and muscular development affect fish condition. 2012 was the first year we recorded fish weight.

Sample Collection and Analysis

We weighed fish captured in our juvenile fish population surveys to the nearest 0.1 g and measured FL to the nearest 1 mm. We used this data to calculate Fulton's condition factor (K) using the equation given in Anderson and Neumann (1996) where the weight of each fish measured in grams (W) is divided by the cubed length of fish (L) measured in millimeters, and the product multiplied by 100,000,

$$K = \frac{W}{L^3} \times 100{,}000$$

Data Presentation

We include mean fish condition of captured fish by species in the *Juvenile Fish Populations* section for each site.

METALS CONCENTRATIONS IN JUVENILE FISH

Rationale

We sample six juvenile Dolly Varden char measuring 85–125 mm FL for whole body concentrations of silver (Ag), cadmium (Cd), copper (Cu), mercury (Hg)[j], lead (Pb), selenium (Se), and zinc (Zn). The sample size of six fish is used for long term monitoring near other mines in Alaska. The specific size class improves the likelihood of sampling two or three size classes of resident fish at sample sites where anadromous fish are present as well. We compare current year data to previous years' data to detect change over time.

In this report, we compared annual median whole body Dolly Varden char Cd, Cu, Pb, and Zn concentrations to mean concentrations in water sampled within two months prior to fish collection to investigate relationships.

Sample Collection and Analysis

We collected six juvenile Dolly Varden char measuring within the size class 85–125 mm FL at each sample site. We captured the fish in minnow traps baited with disinfected salmon eggs during the juvenile fish population survey, measured each to FL, and individually packed the samples in clean, prelabeled plastic bags. We immediately placed samples in a cooler containing gel ice packs, then stored the samples in a camp freezer until we returned to Juneau where we weighed the fish in the sealed bags, corrected for bag weight, and stored the samples in a locked –20°C freezer until we shipped them to a private analytical laboratory, where they were individually freeze dried, digested, and analyzed on a dry-weight basis.

We maintained written chain of custody documentation for the samples. The analytical laboratory provided Tier II quality assurance/quality control validation information for each analyte including matrix spikes, standard reference materials, laboratory calibration data, sample blanks, and sample duplicates.

Data Presentation

We present a figure showing maximum, median, and minimum whole body metals and Se concentrations for each analyte, each site. In the figures, the dashed line represents the laboratory's minimum reporting limit. Current and historical data, and the current year laboratory report are included in Appendix D.

[j] We added mercury to the data set in 2012.

RESULTS AND DISCUSSION

During and three weeks prior to sampling Greens Creek in 2012, mean daily discharges were greater than we typically observe in July (Figure 2). Rainfall increased flow mid-month when we usually see a decreasing flow trend (Figure 3). The USDA Natural Resources Conservation Service (2012) Alaska snow pack map suggests the remaining snowpack near Greens Creek mine on May 1, 2012 was greater than 150% of the 30-year average (1971–2000). Heavy snowpack, below normal air temperatures, and above normal precipitation during the months prior to sampling contributed to steady high discharge in Greens Creek in July.

Figure 2.–Greens Creek Site 54 during sampling on July 23, 2012. Gallagher Creek confluence on left. Copyright Alaska Department of Fish and Game.

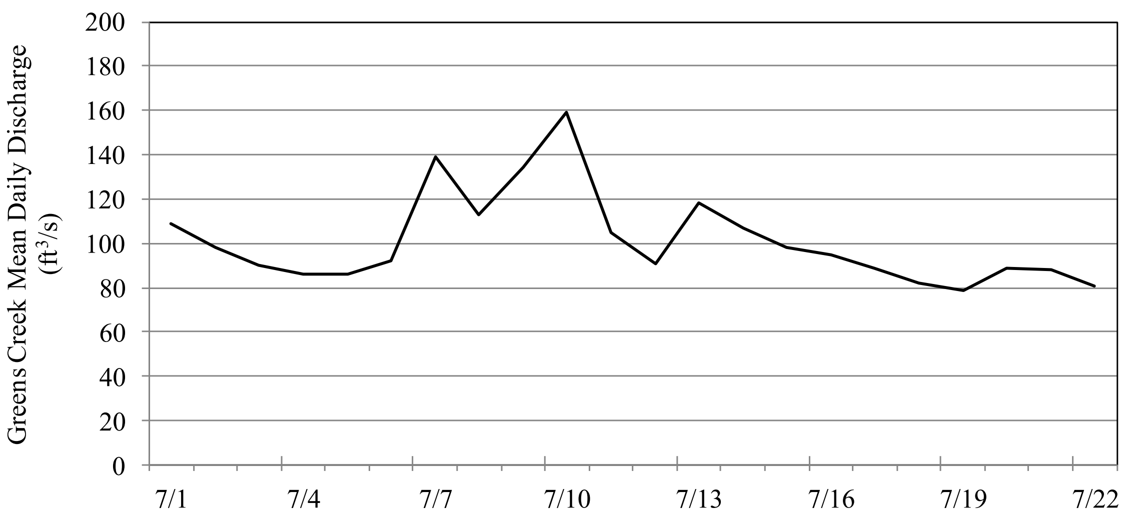

Figure 3.–Greens Creek (USGS Gage 15101490) mean daily discharges (ft^3/s) three weeks prior to sampling in July 2012.

Sampling for the aquatic biomonitoring program has occurred after varying flows in Greens Creek (Figure 4). Flows prior to sampling in 2012 were similar to those observed in 2007 and 2008, and the third greatest observed since sampling began in 2001 (Appendix A).

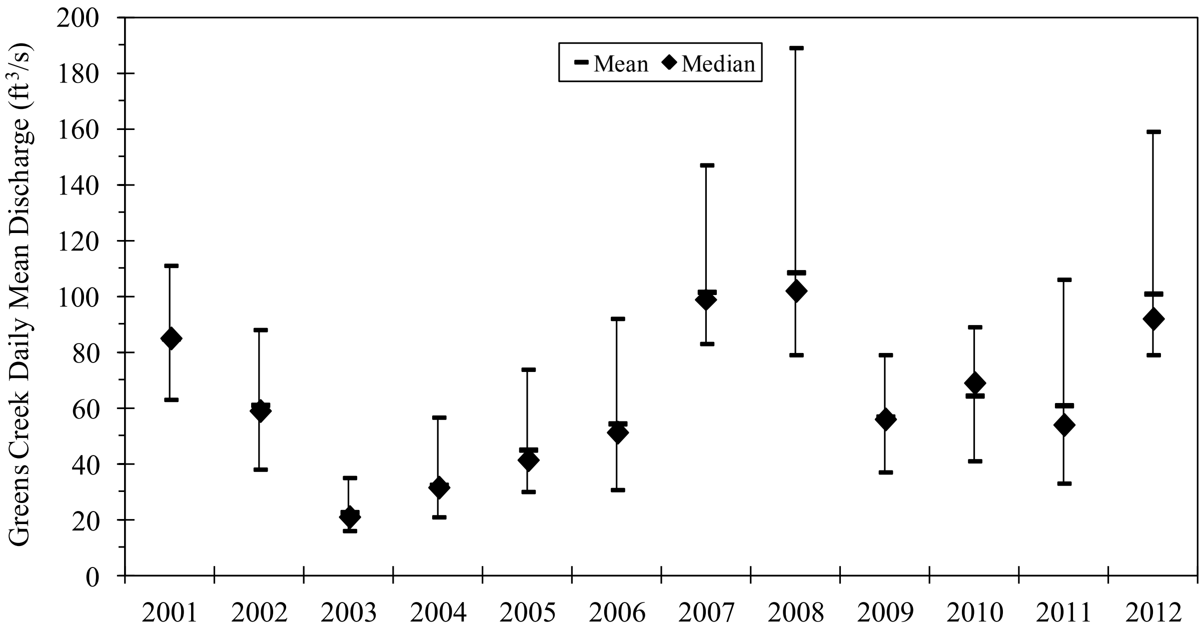

Figure 4.–Greens Creek (USGS Gage 15101490) range of mean daily discharges (ft^3/s) three weeks prior to sampling, 2001–2012.

High discharge can affect periphyton and benthic macroinvertebrate densities and fish abundance and distribution. Discharge capable of transporting gravel and cobble can reduce periphyton and benthic macroinvertebrate densities by physical scour and increased drift. Fish move to lower-velocity side channels and tributaries seeking refuge from swift current, altering fish abundance and distribution in the mainstem. High discharge in Greens Creek during and immediately prior to sampling in July 2012 may have affected these biological communities and our sample results.

Continuous flow data is not available for Tributary Creek.

GREENS CREEK SITE 48

We sampled Greens Creek Site 48 during the morning of July 24, 2012. Hecla personnel recorded the following water quality measurements in Greens Creek at 1:55 p.m. during sampling: water temperature 6.59°C, conductivity 92 μS/cm, pH 7.80 units, and turbidity 6.5 nephelometric turbidity units (NTU).

Periphyton Biomass and Community Composition

Periphyton biomass, estimated by mean chlorophyll *a* density among samples, was the lowest documented (1.27 mg/m^2) at Site 48 since sampling began in 2001 (Figure 5). When we compared the 2012 data to previous years' data, the mean rank of the 2012 sample densities was significantly different ($p \leq 0.05$) than the mean ranks of the 2003, 2004, 2006, and 2007 densities, years when we observed the greatest amount of chlorophyll *a* in samples.

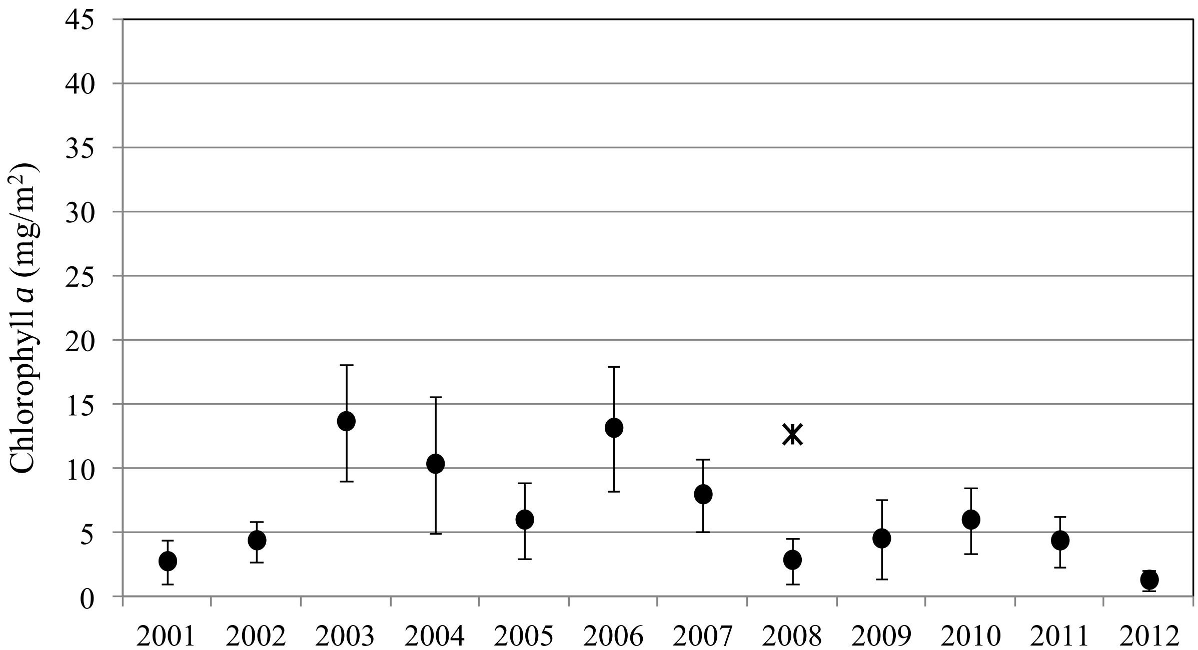

Figure 5.–Periphyton biomass, estimated by mean chlorophyll *a* density (mg/m^2) ± one standard deviation, excluding potential outliers (∗), in Greens Creek Site 48 samples, 2001-2012.

We did not observe chlorophyll *b* pigment in the 2012 samples, similar to previous years. Mean chlorophyll *c* density (0.19 mg/m^2) was the lowest documented at Site 48 since sampling began in 2001. Mean proportions of chlorophylls *a*, *b*, and *c* densities were similar to previous years (Figure 6).

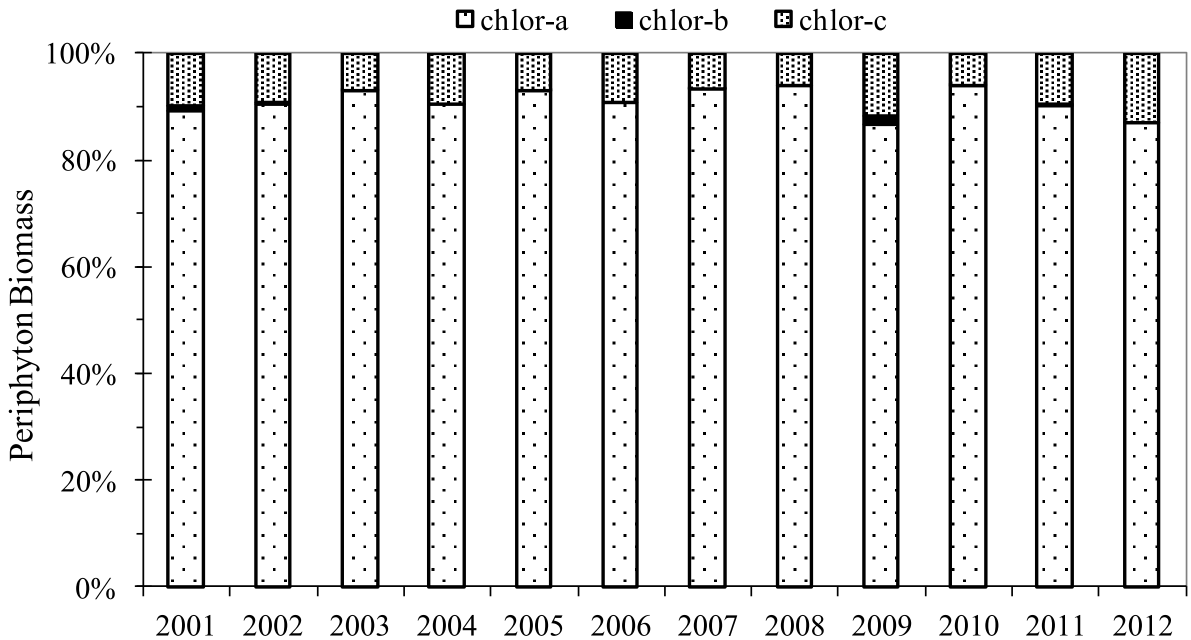

Figure 6.–Proportions of mean chlorophylls *a*, *b* and *c* densities in Greens Creek Site 48 samples, 2001–2012.

Benthic Macroinvertebrate Density and Community Composition

Mean benthic macroinvertebrate density among the 2012 Site 48 samples was 1,612 insects/m^2, similar to mean densities observed in previous years except in 2003 when density was greatest (Figures 7–8). We identified 22 taxa among the 2012 samples, similar to richness previously observed. The mean rank of 2012 sample densities was significantly different ($p \leq 0.05$) than the mean rank of 2003 densities.

Figure 7.–Rick Hoffman collecting benthic macroinvertebrates at Greens Creek Site 48 in 2012.

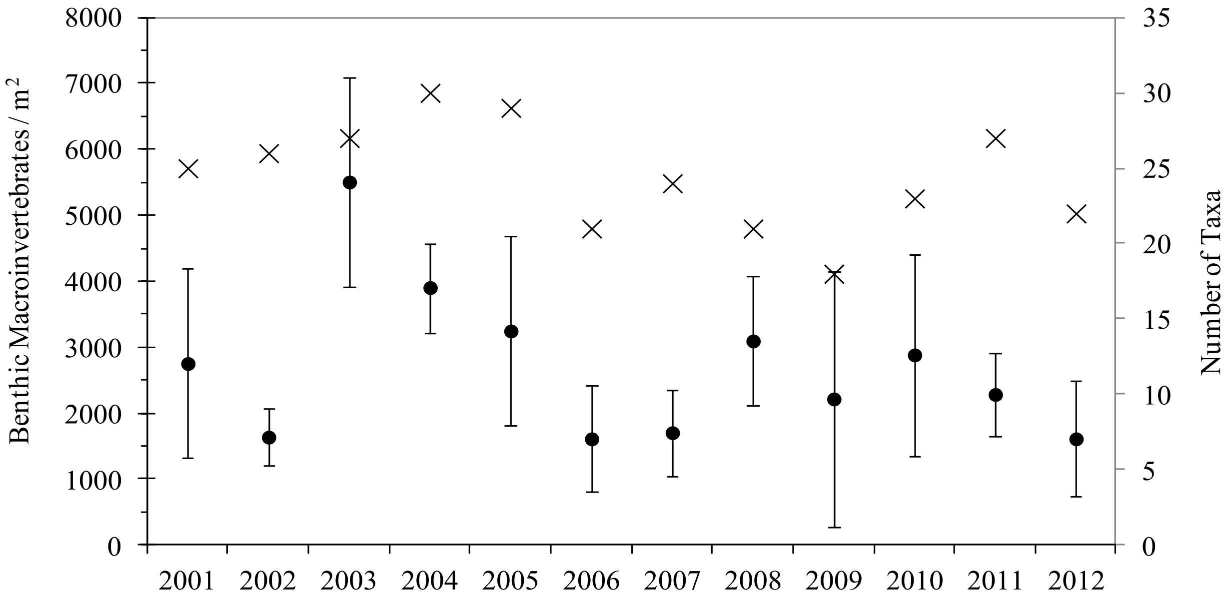

Figure 8.–Mean benthic macroinvertebrate density ± one standard deviation and taxa richness (×) among samples collected at Greens Creek Site 48, 2001–2012.

About 89% of the benthic macroinvertebrates collected at Site 48 in 2012 were EPT taxa, greater than observed in the 2011 samples and similar to percentages observed since sampling began in 2001 (Figure 9). Dominant taxa among samples were Baetidae Baetis, rated moderately sensitive to impaired water quality, and Heptageniidae Rhithrogena, rated highly sensitive to impaired water quality (Barbour et al. 1999). Aquatic Diptera and other non-EPT taxa were less common in 2012 than in 2011 when both groups represented a greater percentage.

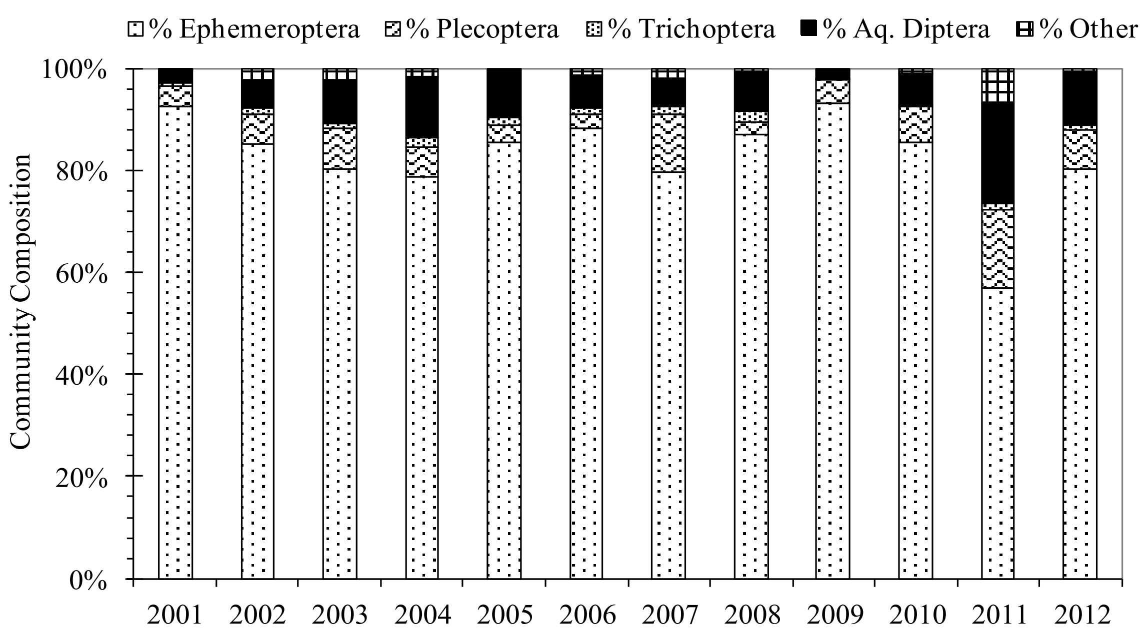

Figure 9.–Benthic macroinvertebrate community composition among Greens Creek Site 48 samples, 2001–2012.

Juvenile Fish Populations and Fish Condition

The 2012 Site 48 Dolly Varden char population estimate was 153±17 fish, was not significantly different compared to the previous three years and within the range of estimates observed since 2001 (Figure 10). We estimated Dolly Varden char density at 0.41 fish/m^2, also similar to previous years. The large 95% confidence intervals for the 2001 and 2011 estimates were due to poor depletion, particularly because we captured a greater number of fish during the third minnow trap event relative to the previous two passes.

Length frequency plots (Appendix C) of Dolly Varden char captured at Site 48 suggest multiple age classes were present most years, except in 2008 and 2012 and when young-of-year fry appeared to be absent. In 2012, we observed young-of-year Dolly Varden char downstream of Site 48 in a small drainage to Greens Creek. It is possible young-of-year Dolly Varden char escaped our 6.35 mm mesh minnow traps both years. Mean fish condition among the 135 Dolly Varden char we captured in 2012 was 1.03 g/mm^3.

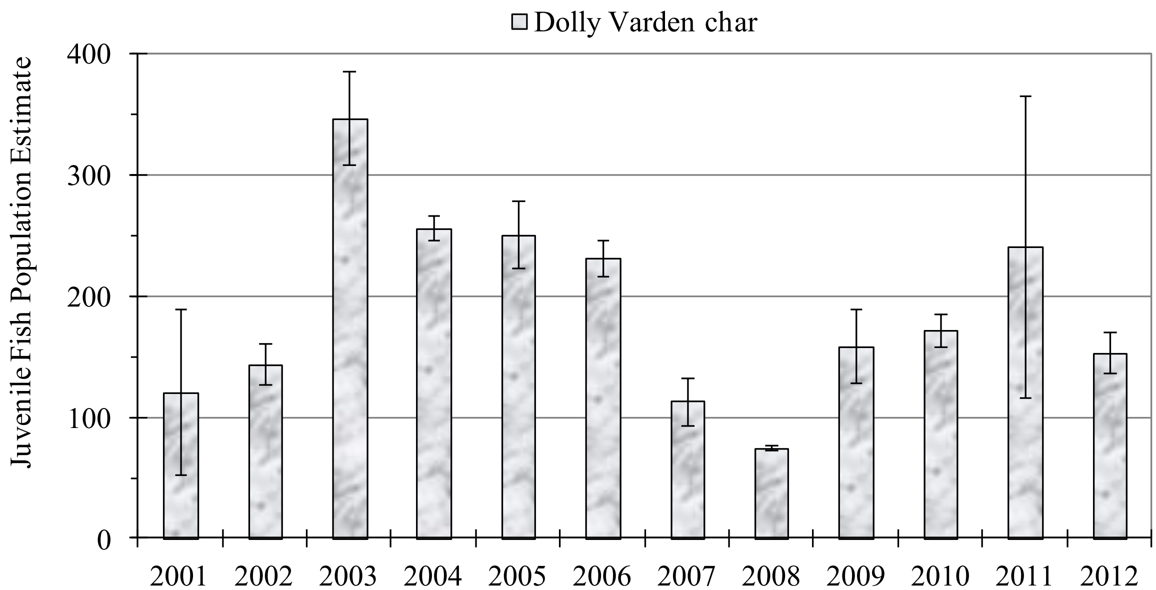

Figure 10.–Juvenile fish population estimates at Greens Creek Site 48, 2001–2012.

Metals Concentrations in Juvenile Fish

Median concentrations of Cd, Cu, and Pb in the 2012 whole body juvenile Dolly Varden char samples were the greatest observed since sampling began in 2001 (Figure 11). When we compared data from all years, the mean rank of Cu concentrations for the 2012 samples was significantly different ($p \leq 0.05$) than the mean ranks for the 2009 and 2010 samples. Mean concentrations of Ag, Se and Zn were similar to previous years. We tested for whole body Hg in fish samples for the first time in 2012. Median Hg concentration (0.141 mg/kg) among samples was similar to the median observed in 2010 (0.135 mg/kg), when the lab accidentally tested and reported Hg concentrations.

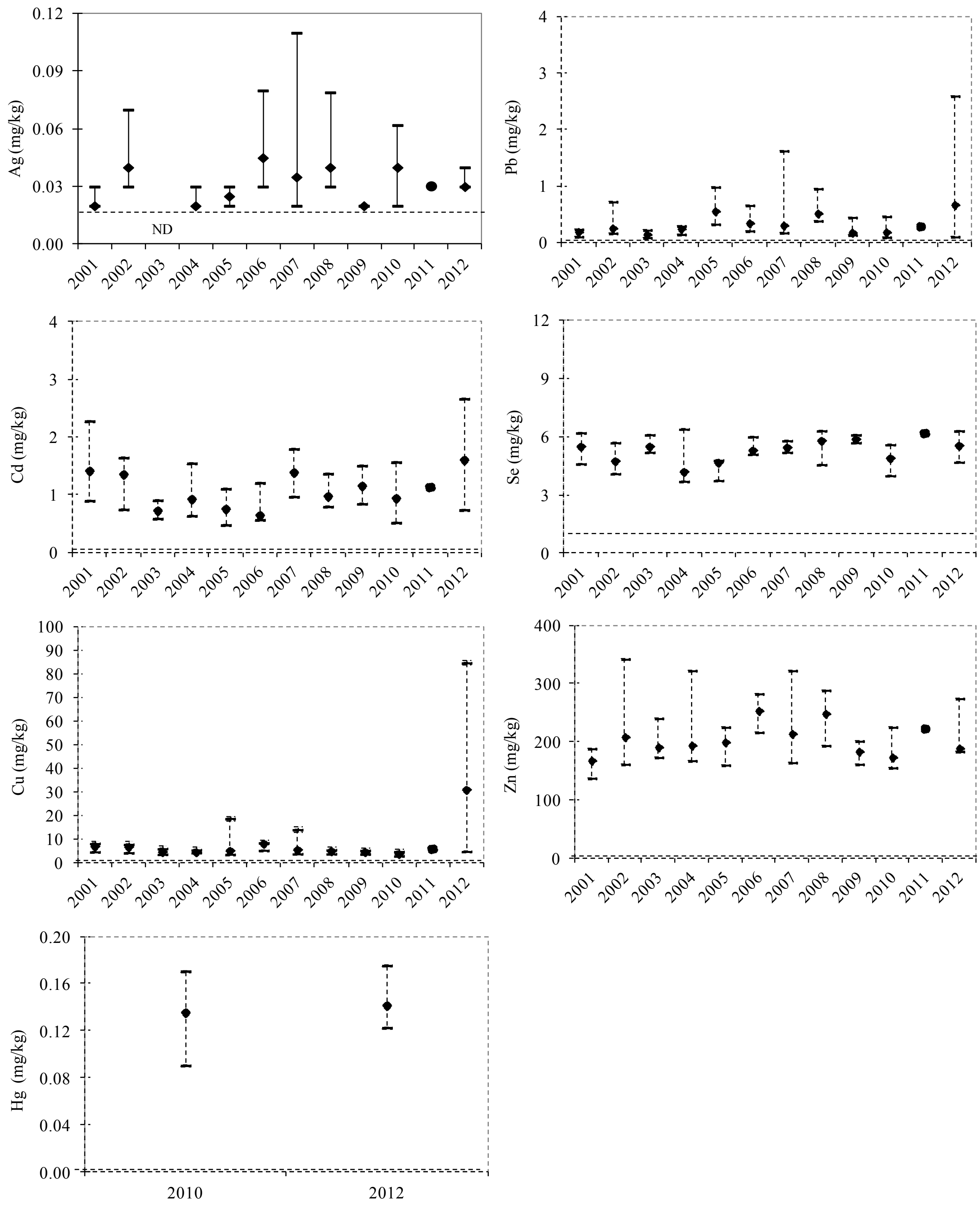

Figure 11.–Maximum, median, and minimum whole body fish concentrations (mg/kg) of Ag, Cd, Cu, Hg, Pb, Se, and Zn in Dolly Varden char captured at Greens Creek Site 48, 2001–2012.

Comparison of Metals Concentrations in Juvenile Fish and Water Samples

When we compared Site 48 median whole body fish Cd, Cu, Pb, and Zn concentrations to mean water quality concentrations among samples collected the same month and two months prior, 2001–2011, we found a significant ($p \leq 0.05$) correlation for Cd (Figure 12–15).

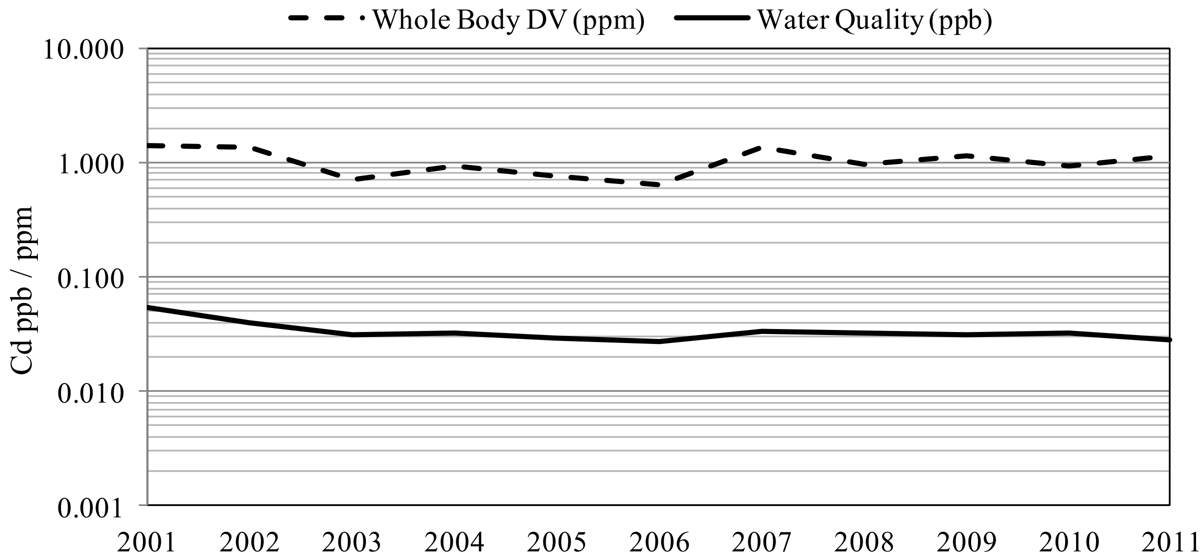

Figure 12.–Median whole body fish and mean water Cd concentrations for samples collected at Site 48 in May (water) and July (fish and water), 2001–2011.

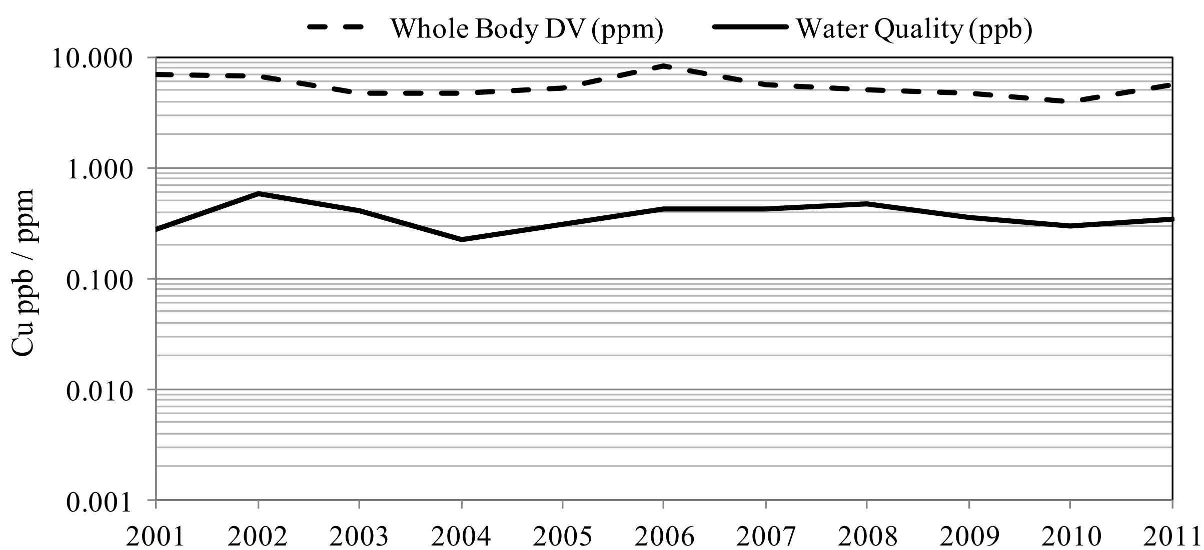

Figure 13.–Median whole body fish and mean water Cu concentrations for samples collected at Site 48 in May (water) and July (fish and water), 2001–2011.

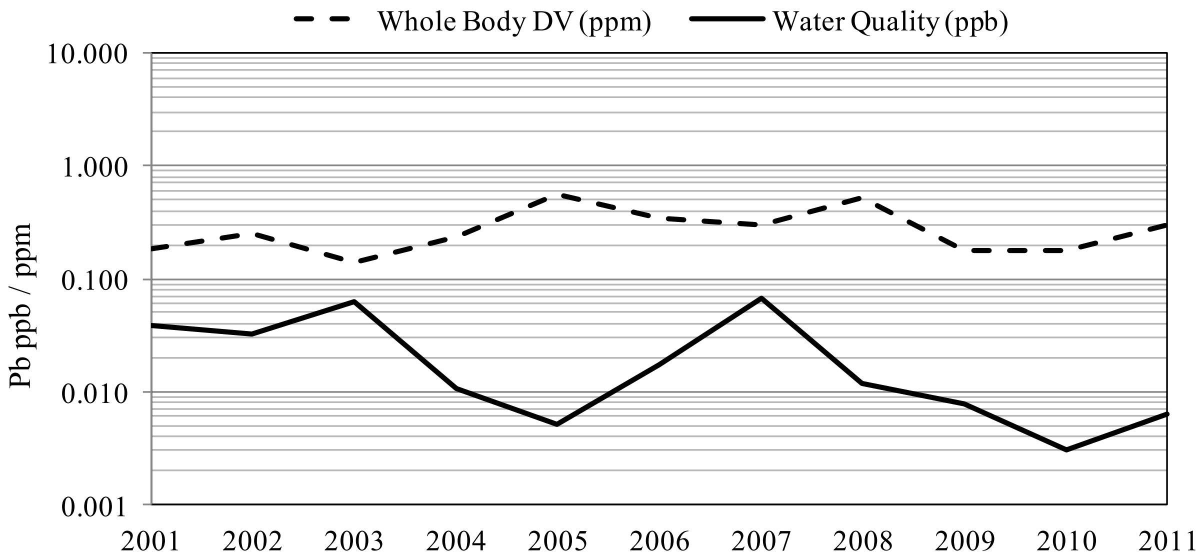

Figure 14.–Median whole body fish and mean water Pb concentrations for samples collected at Site 48 in May (water) and July (fish and water), 2001–2011.

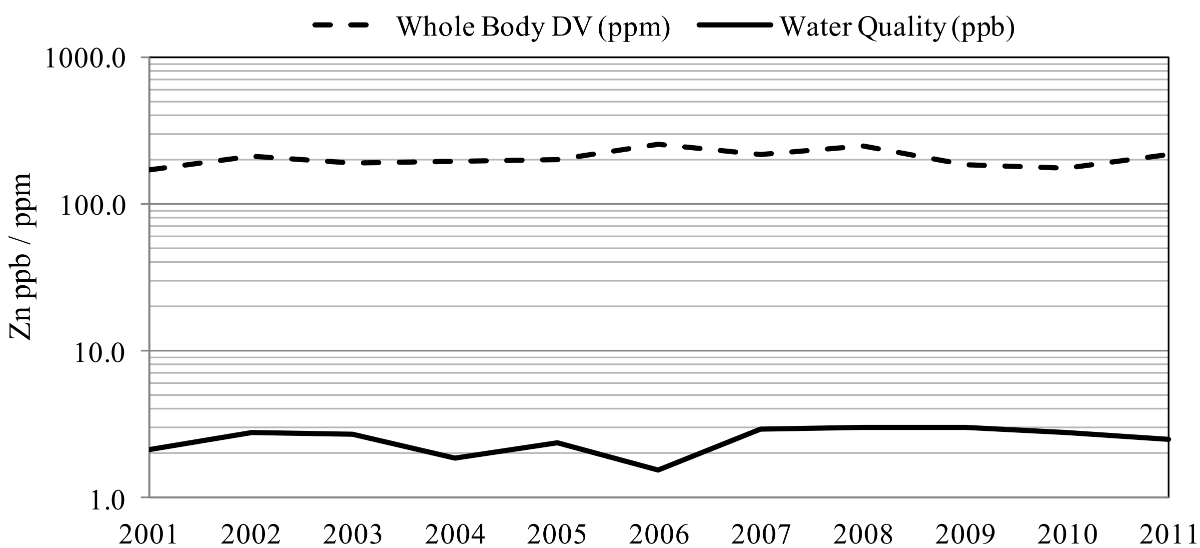

Figure 15.– Median whole body fish and mean water Zn concentrations for samples collected at site 48 in May (water) and July (fish and water), 2001–2011.

Greens Creek Site 48 Summary

Site 48 is located upstream of all mine development and operations, and serves as a reference reach to provide data on aquatic conditions in Greens Creek upstream of mine influence. Periphyton biomass among the 2012 samples was the lowest observed at Site 48 since sampling began in 2001, and may be due to scouring stream flows two weeks prior to sampling. Low discharge prior to and during sampling 2003–2006 may explain the greater densities of periphyton and benthic macroinvertebrates those years. The aquatic insects at Site 48 continue to be dominated by sensitive EPT species, particularly those classified under Ephemeroptera, and the 2012 Dolly Varden char population was within the range of estimates observed in previous years.

Juvenile Dolly Varden char whole body concentrations of Cd, Cu, and Pb among the 2012 samples were the greatest observed in samples from Site 48. When we compared the 2012 data to previous years for each element, we found two significant differences for Cu. Finally, when we compared median metals fish data to mean water quality data for samples collected two months prior to fish sample collection, we found a significant correlation for Cd between the sample types. All together, the suite of data suggests a productive aquatic community was present at Greens Creek Site 48 in amounts observed since 2001.

GREENS CREEK SITE 54

We sampled Greens Creek Site 54 during the morning of July 23, 2012. Hecla personnel recorded the following water quality measurements in Greens Creek at 11:52 a.m. during sampling: water temperature 6.65°C, conductivity 95 μS/cm, pH 7.99 units, and turbidity 2.6 NTU.

Periphyton Biomass and Community Composition

Periphyton biomass among the 2012 Site 54 samples (3.71 mg/m^2) was similar to densities observed in previous years (Figure 16). The mean rank of the 2012 sample densities was significantly different ($p \leq 0.05$) than the mean ranks of the 2003 and 2006 sample densities.

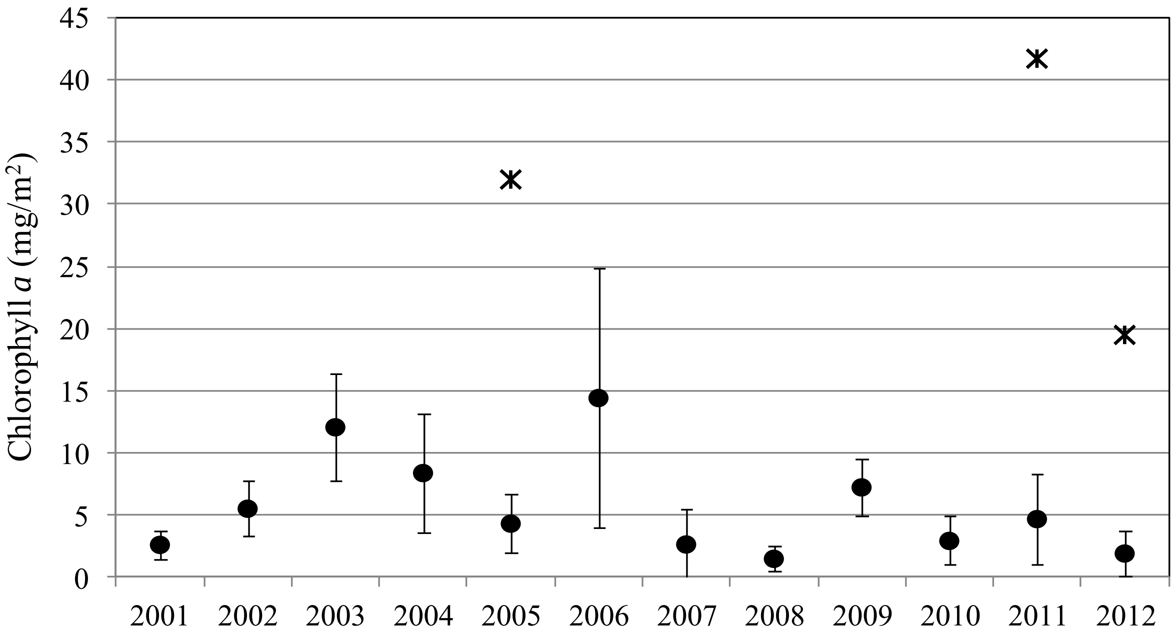

Figure 16.–Periphyton biomass, estimated by mean chlorophyll *a* density (mg/m^2) ± one standard deviation, excluding potential outliers (∗), in Greens Creek Site 54 samples, 2001–2012.

Mean chlorophylls *b* and *c* densities were similar to previous years: 0.001 mg/m^2 (*b*), and 0.22 mg/m^2 (*c*). Organisms producing chlorophyll *c* pigment continue to be more common than those producing chlorophyll *b* pigment, which is often absent in samples. Proportions of mean chlorophylls *a*, *b*, and *c* densities were similar to previous years (Figure 17).

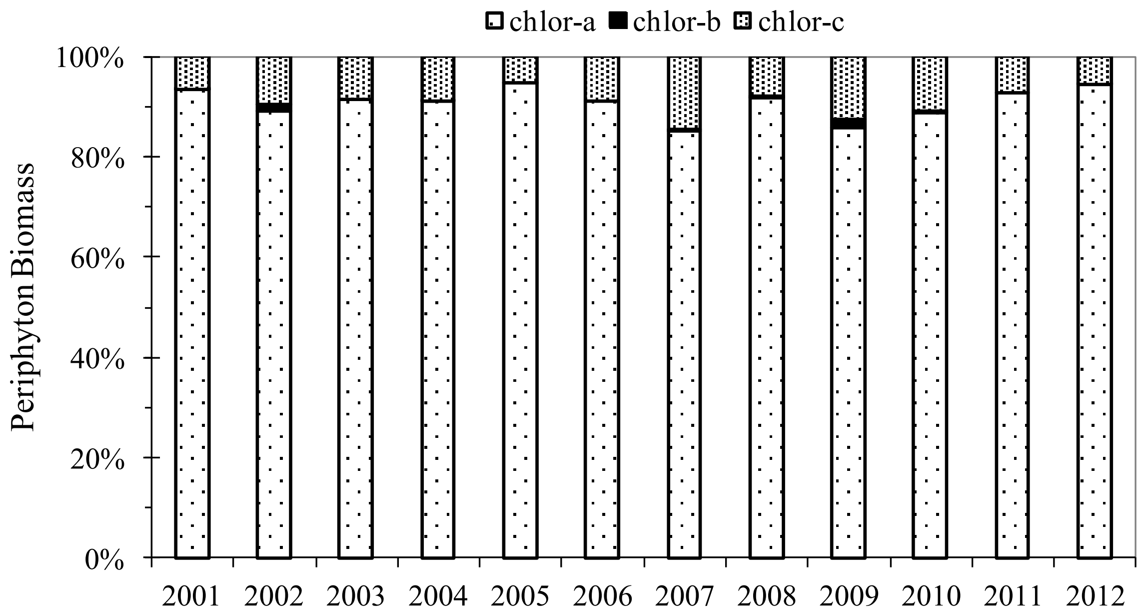

Figure 17.–Proportions of mean chlorophylls *a*, *b* and *c* densities in Greens Creek Site 54 samples, 2001–2012.

Benthic Macroinvertebrate Density and Community Composition

Mean benthic macroinvertebrate density among the 2012 Site 54 samples was 1,753 insects/m^2, the third lowest density observed since sampling began in 2001 (Figure 18). We observed 30 taxa among samples, greater than observed in samples from most previous years. We did not find any statistical differences when we compared 2012 macroinvertebrate density and richness sample data to data from previous years.

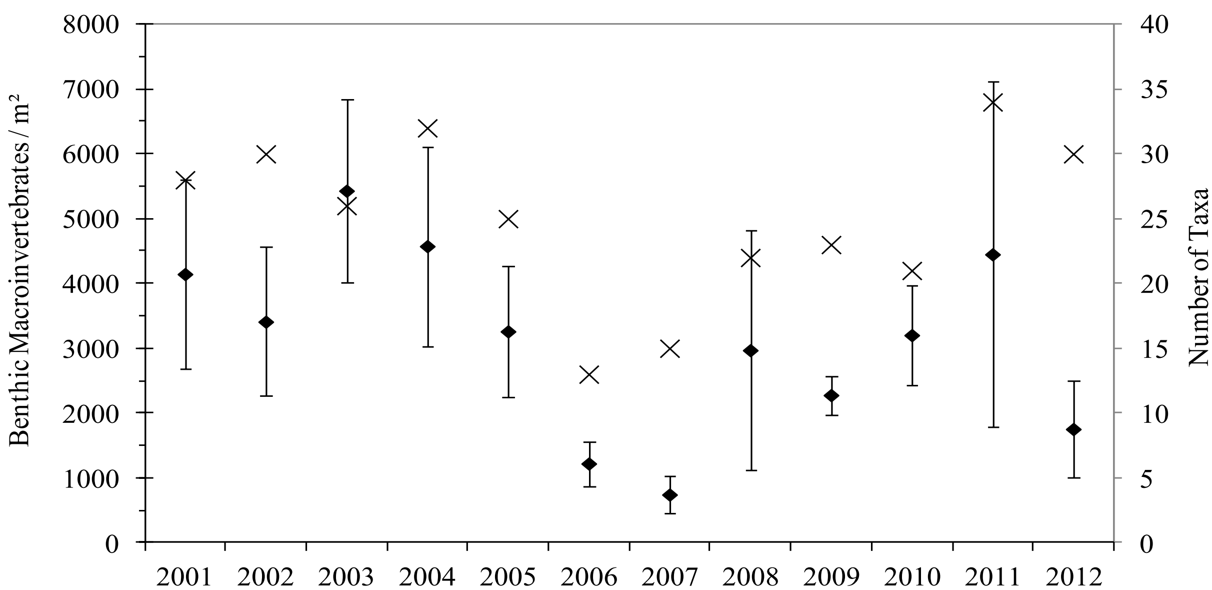

Figure 18.–Mean benthic macroinvertebrate density ± one standard deviation and taxa richness (×) among samples collected at Greens Creek Site 54, 2001–2012.

About 86% of the benthic macroinvertebrates collected at Site 54 in 2012 were EPT taxa, similar to the percentage observed in the 2011 and the lowest observed at this site, yet still a healthy portion of the aquatic insect community (Figure 19). Three dominant taxa classified under Ephemeroptera made up the majority of EPT insects: Baetidae Baetis, rated moderately sensitive to impaired water quality, and Ephemerellidae Drunella and Heptageniidae Epeorus, both rated extremely sensitive (Barbour et al. 1999). Diptera taxa represented about 11% of samples, similar to samples from 2011, the greatest percentages observed at Greens Creek Site 54 since sampling began in 2001.

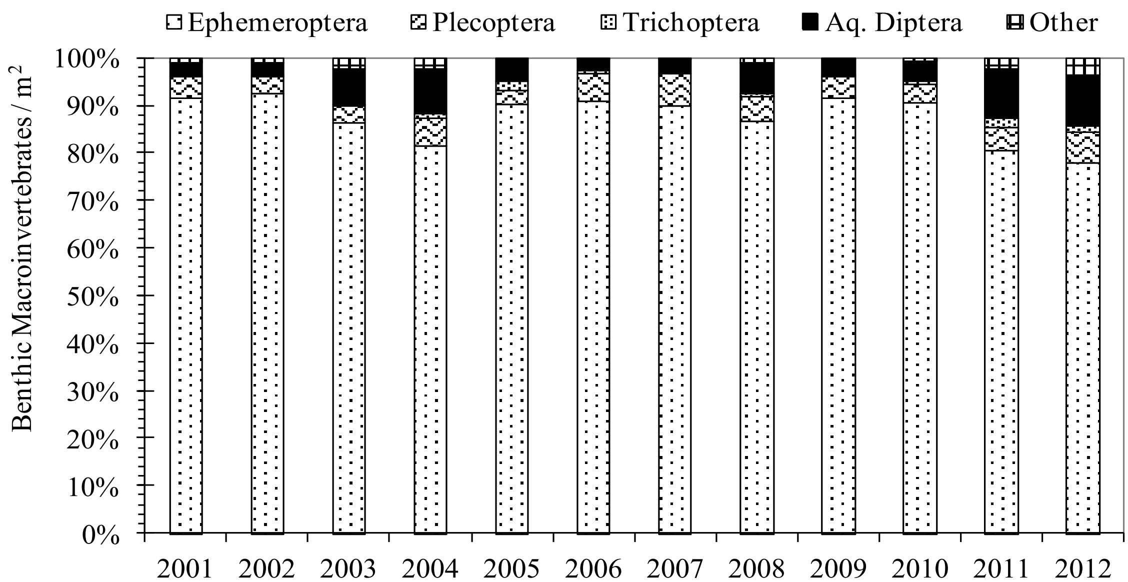

Figure 19.–Benthic macroinvertebrate community composition among Greens Creek Site 54 samples, 2001–2012.

Juvenile Fish Populations and Fish Condition

The 2012 Site 54 Dolly Varden char population estimate was 313±105 fish, similar to the 2011 estimate (Figure 20[k]). Dolly Varden char density was about 0.26 fish per m^2. Length frequency plots (Appendix C) of Dolly Varden char captured at Site 54 2001–2012 suggest multiple age classes were present each year. Mean condition of the 189 Dolly Varden char captured in 2012 was 0.99 g/mm^3.We captured five juvenile coho salmon at Site 54 in 2012 (<0.01 fish/m^2), similar to captures since 2006 following the failure of the fish pass. Mean condition of the five coho salmon we captured in 2012 was 1.08 g/mm^3.

In 2011 and 2012 we sampled fish in a 50 m reach at Site 54, unlike previous years when we sampled a 28 m reach, which explains the larger fish population estimates those years. The large 95% confidence intervals for the 2011 and 2012 estimates were due to poor depletion, particularly because we captured a greater number of fish during the third passes.

[k] During our third minnow trap event at Site 54 in 2010, a brown bear *Ursus arctos* destroyed 8 of the 29 minnow traps and 7 of the 8 block traps on the downstream end of the fish sample reach. The first pass captured 47 fish, the second pass captured 18 fish, and the undisturbed traps in the third set captured 14 fish. The number of fish captured during the third pass may have been greater had the bear not intervened, therefore the 2010 abundance may be underestimated.

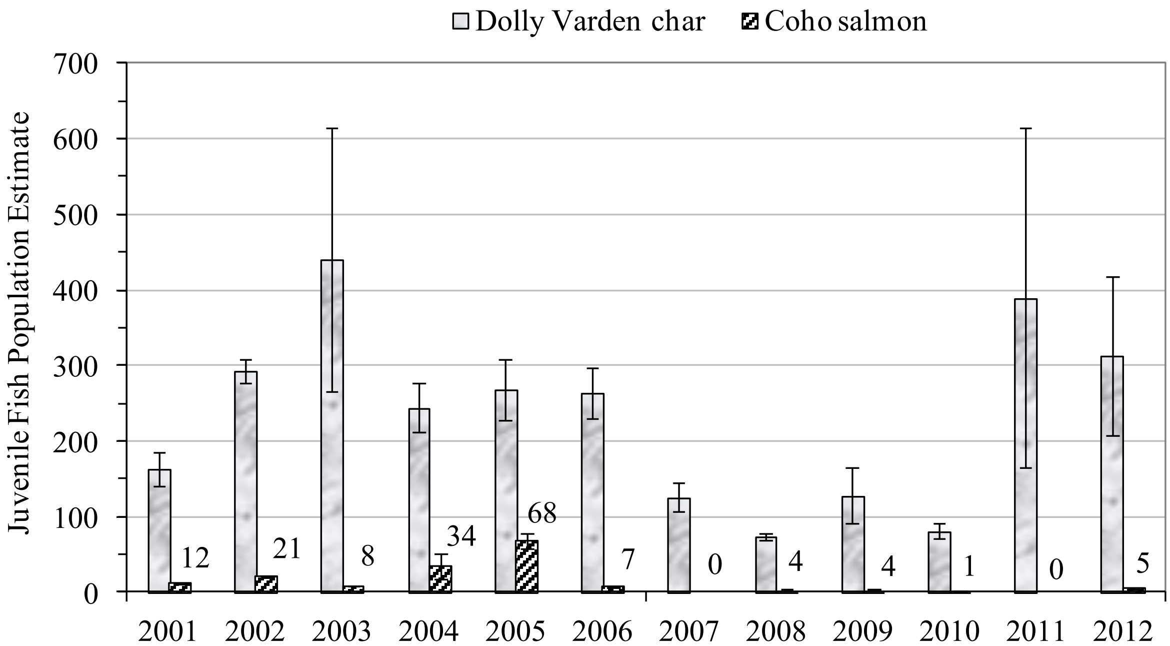

Figure 20.–Juvenile fish population estimates at Greens Creek Site 54, 2001–2012.

Metals Concentrations in Juvenile Fish

Median concentrations of Cd and Cu in the 2012 Site 54 whole body juvenile Dolly Varden char samples were the greatest observed since sampling began in 2001 (Figure 21). When we compared data from all years, we found significant differences ($p \leq 0.05$) between the 2012 and 2001 mean ranks for Cd, the 2012 and 2010 mean ranks for Cu, and the 2012, 2005, and 2002 mean ranks for Se.

Median concentrations of Ag, Pb and Zn were similar to previous years. We tested for whole body Hg in fish samples for the first time in 2012. Median Hg concentration (0.111 mg/kg) among samples was similar to the median observed among samples collected in 2010 (0.110 mg/kg), when the lab accidentally tested and reported Hg concentrations.

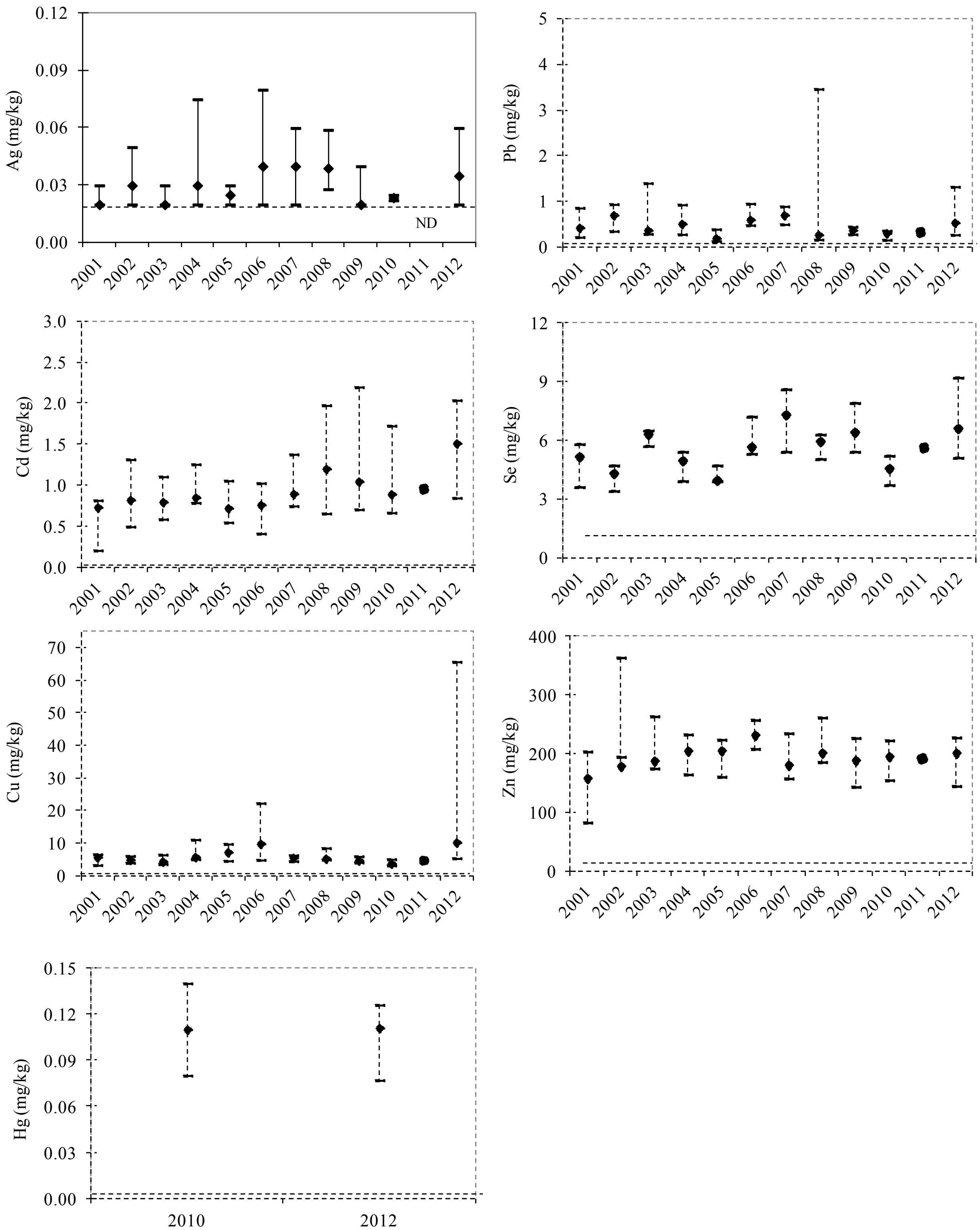

Figure 21.–Maximum, median, and minimum whole body fish concentrations (mg/kg) of Ag, Cd, Cu, Hg, Pb, Se, and Zn in Dolly Varden char captured at Greens Creek Site 54, 2001–2012.

Comparison of Metals Concentrations in Juvenile Fish and Water Samples

When we compared the Site 54 annual median whole body fish Cd, Cu, Pb, and Zn concentrations to mean water quality concentrations among samples collected the same month and two months prior, 2001–2011, we did not find any significant ($p \leq 0.05$) correlations (Figures 22–25).

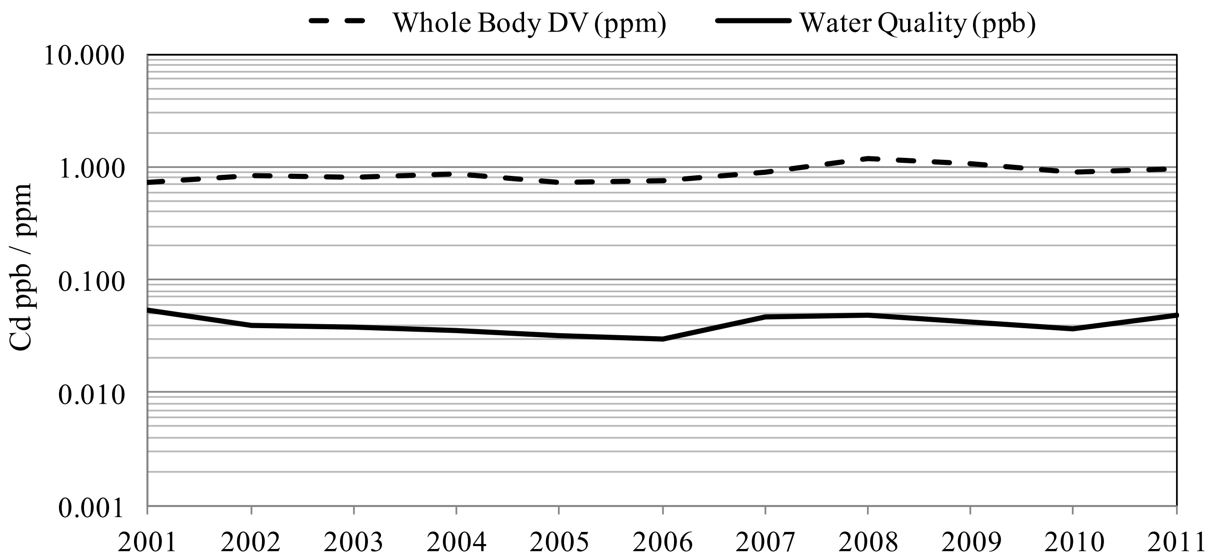

Figure 22.–Median whole body fish and mean water Cd concentrations for samples collected at Site 54 in May (water) and July (fish and water), 2001–2011.

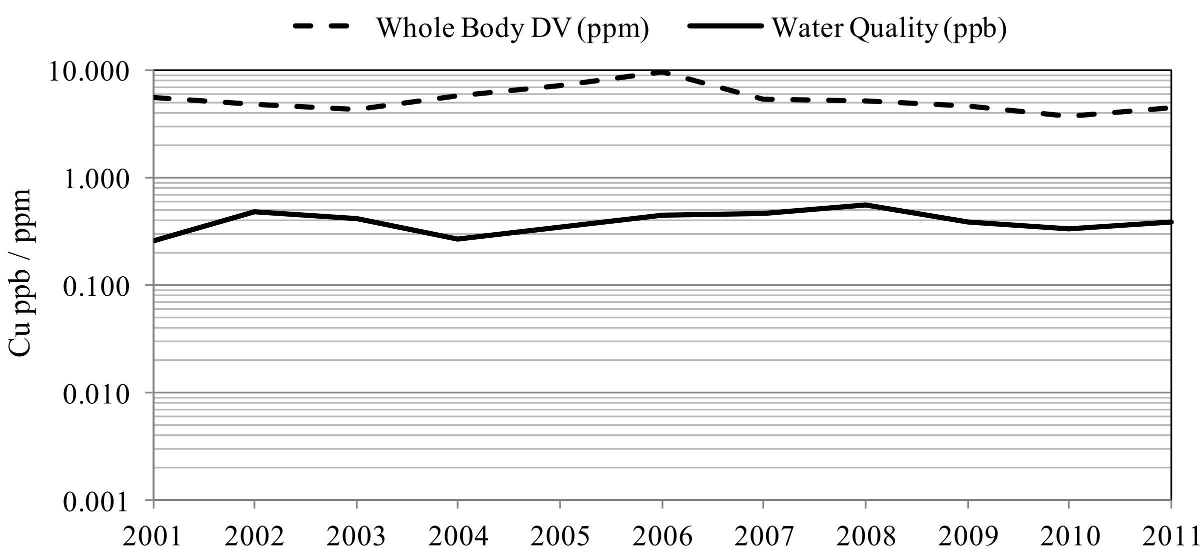

Figure 23.–Median whole body fish and mean water Cu concentrations for samples collected at Site 54 in May (water) and July (fish and water), 2001–2011.

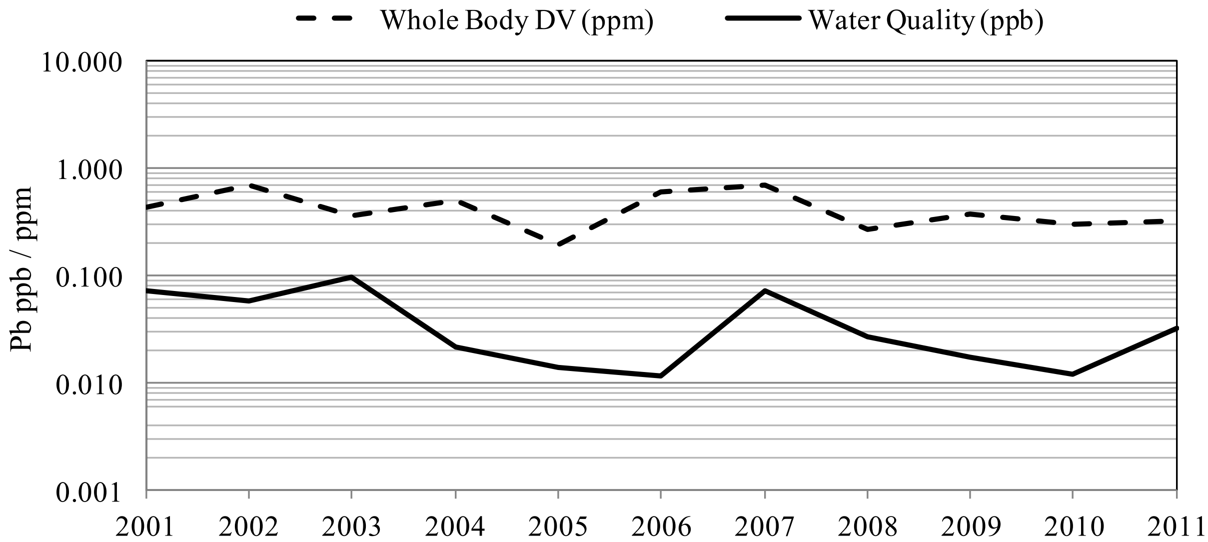

Figure 24.–Median whole body fish and mean water Pb concentrations for samples collected at Site 54 in May (water) and July (fish and water), 2001–2011.

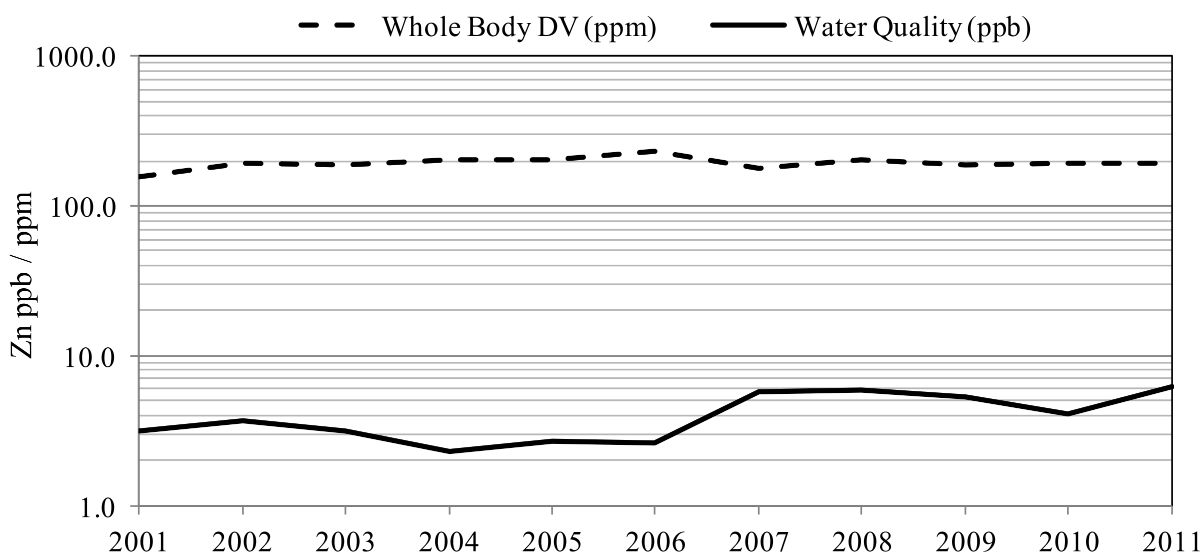

Figure 25.–Median whole body fish and mean water Zn concentrations for samples collected at Site 54 in May (water) and July (fish and water), 2001–2011.

Greens Creek Site 54 Summary

Site 54 is located downstream of the mine portal, mill facilities, and production rock storage areas 23 and D, and monitored to detect potential changes from these sites and mining activities. Periphyton biomass has been lower in recent years; scouring high flows before sampling in 2007, 2008, and 2012 appeared to affect results by reducing biomass. The aquatic insects at Site 54 continue to be dominated by EPT species, particularly those classified under Ephemeroptera.

The 2012 juvenile fish population estimate was less than the 2011 estimate and not significantly different. In both years we sampled a larger reach than previous years, and found a larger population of Dolly Varden char. We captured five juvenile coho salmon in 2012, the greatest number since 2006. A heavy rainstorm in late 2005 damaged the fish pass, limiting adult fish passage and reproduction upstream of the natural barrier bedrock chute. Concentrations of Cd, Cu, and Se in whole body fish were the greatest observed since sampling began, and significantly different compared to a few previous years. Finally, when we compared median metals fish data to mean water quality data for samples collected two months prior to fish sample collection, 2001–2012, we did not find a significant correlation for any metal between the sample types. All together, the suite of data suggests a productive aquatic community is present at Site 54 in amounts similar to those observed since 2001.

TRIBUTARY CREEK SITE 9

We sampled Tributary Creek Site 9 during the morning of July 26, 2012. Hecla personnel recorded the following water quality measurements in Greens Creek at 8:50 a.m. during sampling: water temperature 11.93°C, and conductivity 106 μS/cm, pH 7.40 units, and turbidity 10.3 NTU.

Periphyton Biomass and Community Composition

Periphyton biomass among the 2012 Site 9 samples (5.13 mg/m^2) was similar to densities observed in previous years (Figures 26 and 27). The mean rank of the 2012 sample densities was significantly different ($p \leq 0.05$) than the mean rank of the 2003 sample densities.

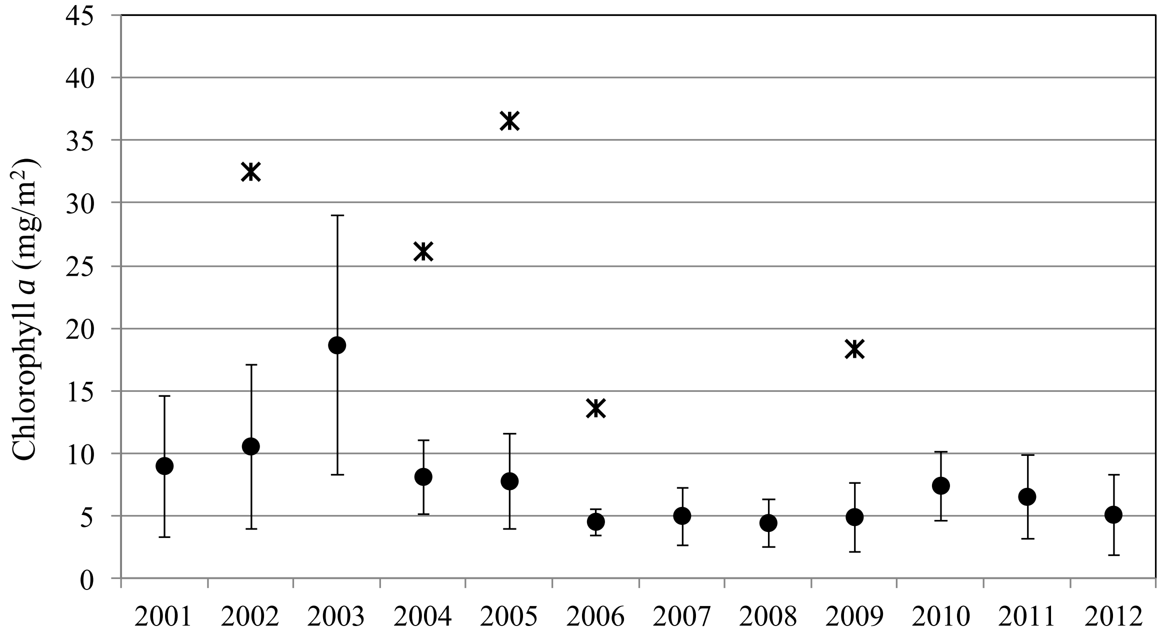

Figure 26.–Periphyton biomass, estimated by mean chlorophyll *a* density (mg/m^2) ± one standard deviation, excluding potential outliers (∗), in Tributary Creek Site 9 samples, 2001–2012.

We did not observe chlorophyll *b* pigment in the 2012 samples, similar to samples collected in 2003. Mean chlorophyll *c* density (0.26 mg/m^2) was the second lowest obsercved at Site 9 since sampling began in 2001. Proportions of mean of chlorophylls *a, b*, and *c* densities were similar to previous years (Figure 28).

Figure 27.–Jackie Timothy (right) processing periphyton samples with Jennifer Nelson (left), at Tributary Creek Site 9, 2012.

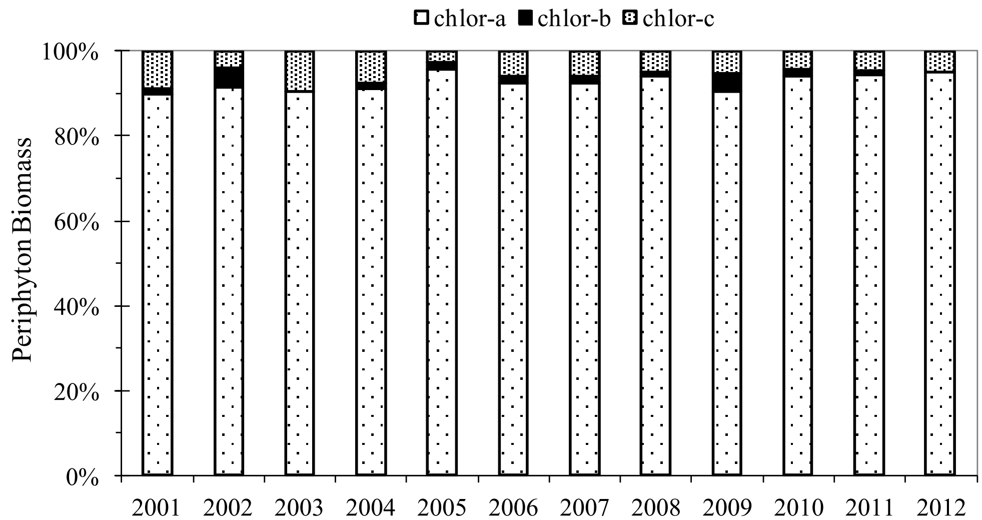

Figure 28.–Proportions of mean chlorophylls *a, b* and *c* densities in Tributary Creek Site 9 samples, 2001–2012.

Benthic Macroinvertebrate Density and Community Composition

Mean benthic macroinvertebrate density among the 2012 Site 9 samples was 1,416 insects/m^2, similar to mean densities previously observed (Figure 29). We identified 27 taxa among the samples, the third greatest amount observed since sampling began in 2001. We did not find any statistical differences when we compared the 2012 macroinvertebrate density and richness sample data to data from previous years.

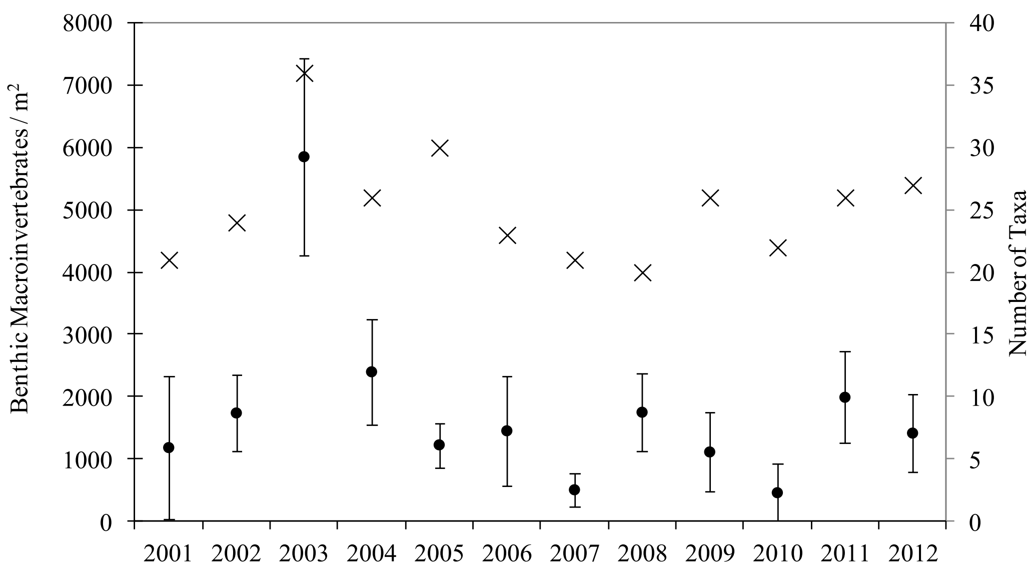

Figure 29.–Mean benthic macroinvertebrate density ± one standard deviation and taxa richness (×) among samples collected at Tributary Creek Site 9, 2001–2012.

About 53% of the benthic macroinvertebrates collected at Site 9 in 2012 were EPT taxa, similar to the 2001, 2010, and 2011 data (Figure 30). Many of the EPT taxa present were rated extremely sensitive to impaired water quality (Barbour et al. 1999). Chironomidae was the dominant taxon (26%) for the fourth year in a row. Ostracods (crustaceans) and Oligocheates (worms) were the majority of other organisms (11%) observed in the 2012 samples, a similar percentage observed in previous years.

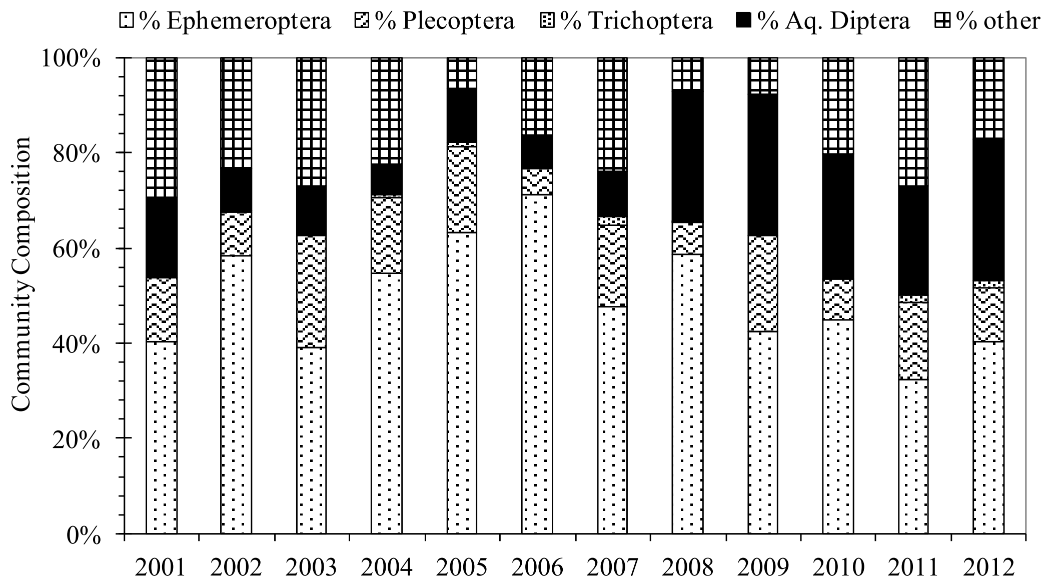

Figure 30.–Benthic macroinvertebrate community composition in Tributary Creek Site 9 samples, 2001–2012.

Figure 30 suggests the percentage of EPT taxa at Site 9 has varied between 50% and 80% since 2001, with a decreasing trend beginning in 2006. Though the percentage of EPT taxa has varied since 2001, EPT density and taxa richness was similar previous years, except in 2003 when EPT density and taxa richness was greatest (Figure 31).

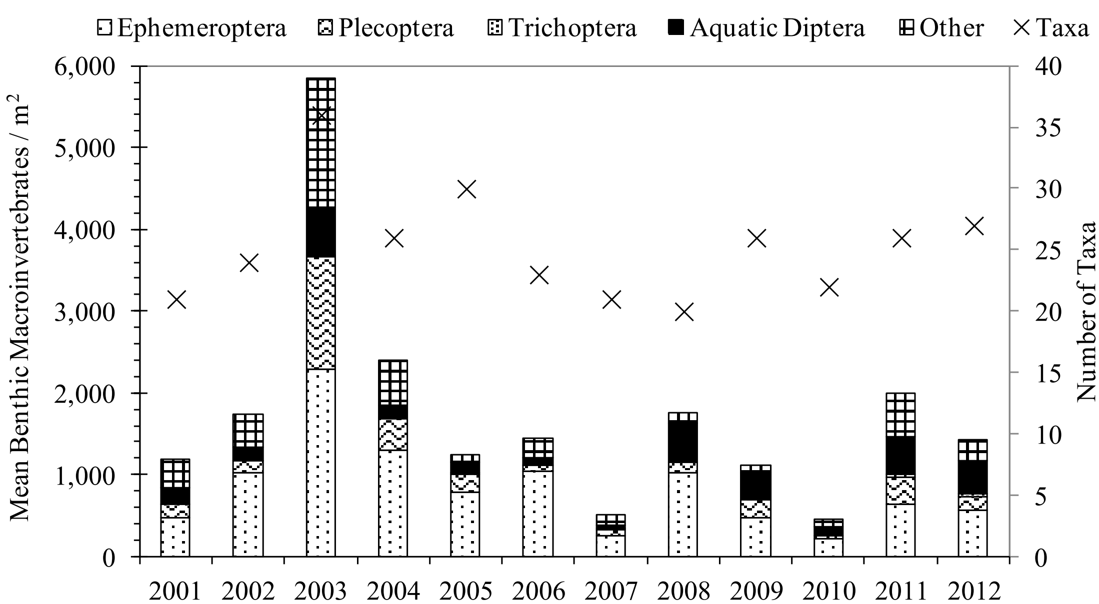

Figure 31.–Mean benthic macroinvertebrate density, community composition, and taxa richness (×) in Tributary Creek Site 9 samples, 2001–2012.

Juvenile Fish Populations and Fish Condition

Stream flow during sampling at Tributary Creek Site 9 in 2012 (Figure 32) was the lowest observed since sampling began in 2001. In 2012, we were only able to use 16 minnow traps for the juvenile fish population survey due to low water and limited trap sites. A few of the 16 trap sites required manually excavating the streambed to provide sufficient water depth. In previous years, we used at least 20 minnow traps at Site 9.

Figure 32.–Looking upstream within the Tributary Creek Site 9 fish sample reach during sampling, 2012. Copyright Alaska Department of Fish and Game.

The 2012 Site 9 Dolly Varden char total catch was 40 fish with an approximate density of 0.31 fish/m^2, and 55 coho salmon with an approximate density of 0.43 fish per m^2 (Figure 33).[1] We did not achieve equal capture probability among the three passes and are unable to provide population estimates with 95% confidence intervals. Captures of both Dolly Varden char and coho salmon in 2012 were similar to population estimates for previous years.

Length frequency plots of Dolly Varden char and coho salmon captured at Site 9 (Appendix C) suggest two age classes were present in 2012, except Dolly Varden char young-of-year which also appeared to be absent among the 2006 and 2007 captures. Young-of-year coho salmon appeared to be absent in the 2006 captures. It is possible young-of-year escaped our 6.35 mm mesh minnow traps. Mean condition of Dolly Varden char captured at Site 9 in 2012 was 1.00 g/mm^3, and mean condition of coho salmon was 1.14 g/mm^3.

[1] During the second minnow trap pass at Tributary Creek Site 9 in 2012, a black bear *Ursus americanus* sow and cub destroyed a block trap set on the downstream end of the fish sample reach. We do not believe this activity affected the capture results for the study.

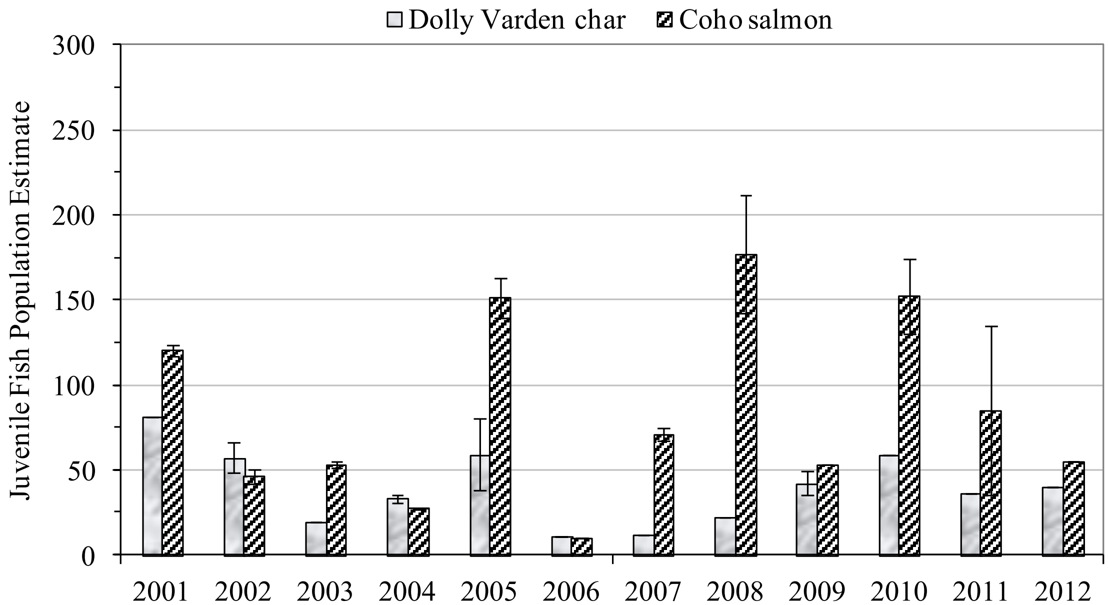

Figure 33.–Juvenile fish populations at Tributary Creek Site 9, 2001–2012.

Metals Concentrations in Juvenile Fish

Median concentrations of Ag, Cd, Pb, Se, and Zn in juvenile Dolly Varden char collected at Site 9 in 2012 were generally similar to those observed in previous years (Figure 34). Median Cu concentration was the greatest observed since sampling began in 2001, and the 2012 mean rank was significantly different ($p \leq 0.05$) than the 2008–2010 mean ranks of samples. The mean rank for Cd was significantly different than 2007 mean rank. Median Hg concentration (0.249 mg/kg) among samples was lower than the median observed among samples collected in 2010 (0.390 mg/kg), when the lab accidentally tested and reported Hg concentrations.

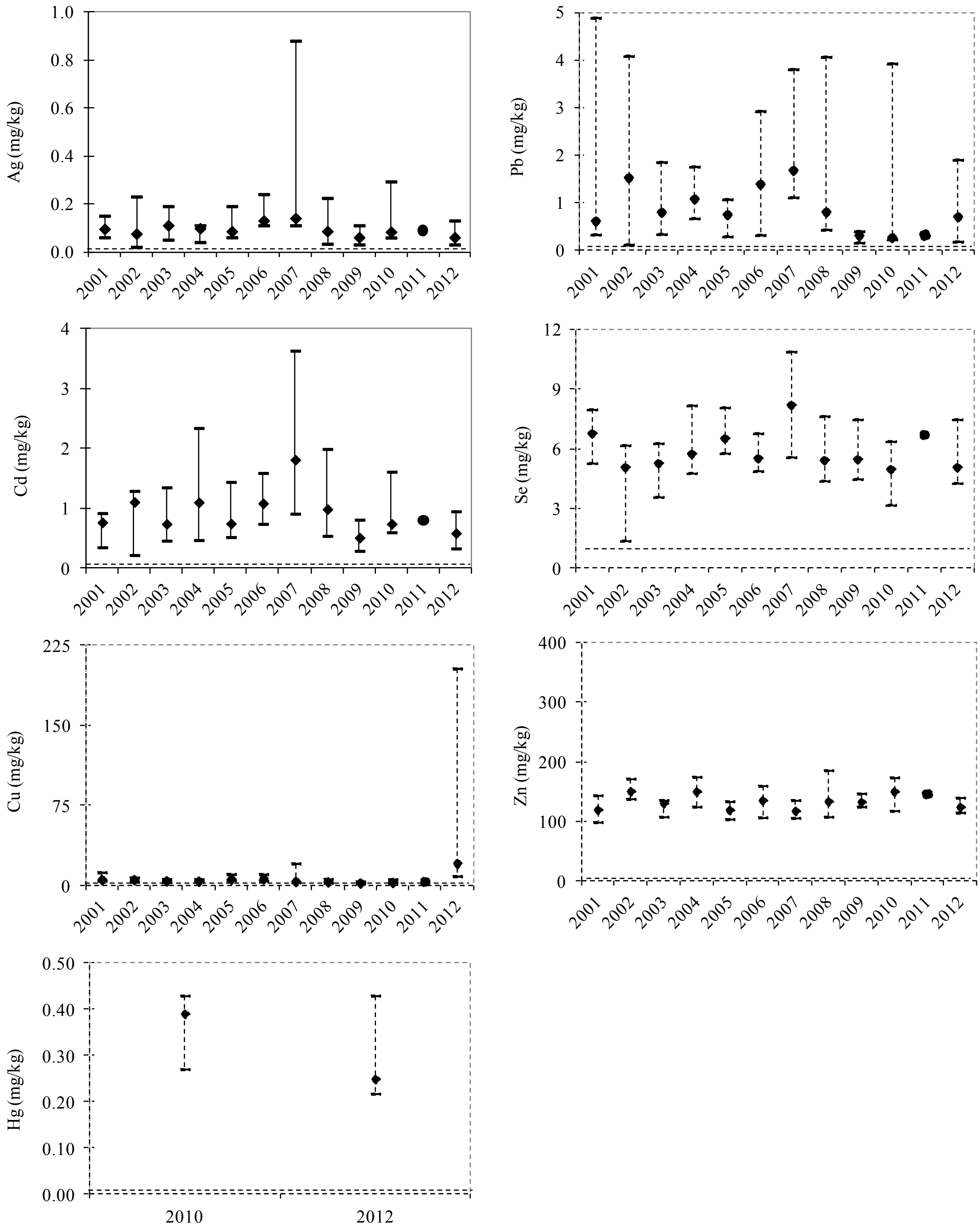

Figure 34.– Maximum, median, and minimum whole body fish concentrations (mg/kg) of Ag, Cd, Cu, Hg, Pb, Se, and Zn in Dolly Varden char captured at Tributary Creek Site 9, 2001–2012.

Comparison of Metals Concentrations in Juvenile Fish and Water Samples

When we compared 2006–2011 Site 9 annual median whole body fish Cd, Cu, Pb, and Zn concentrations to mean water quality concentrations among samples collected the same month and two months prior, we did not find any significant ($p \leq 0.05$) correlations (Figures 35–38).

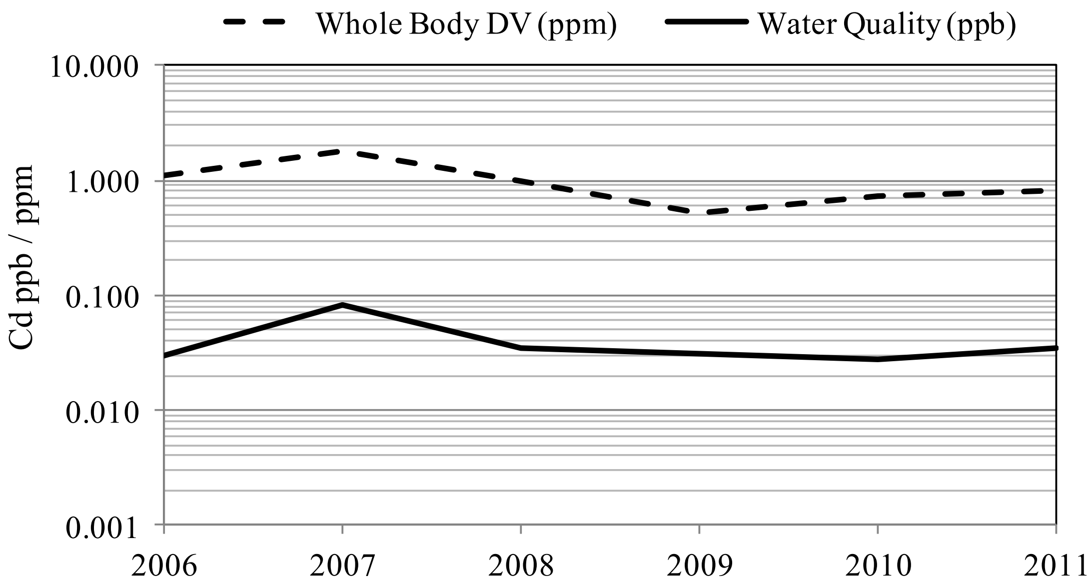

Figure 35.–Median whole body fish and mean water Cd concentrations for samples collected at Site 9 in May (water) and July (fish and water), 2006–2011.

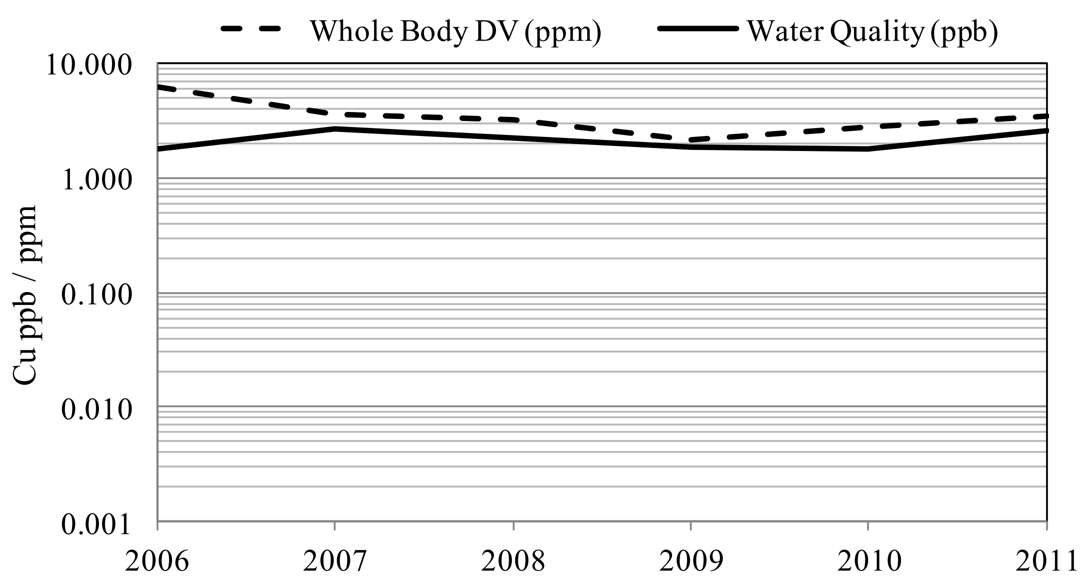

Figure 36.–Median whole body fish and mean water Cu concentrations for samples collected at Site 9 in May (water) and July (fish and water), 2006–2011.

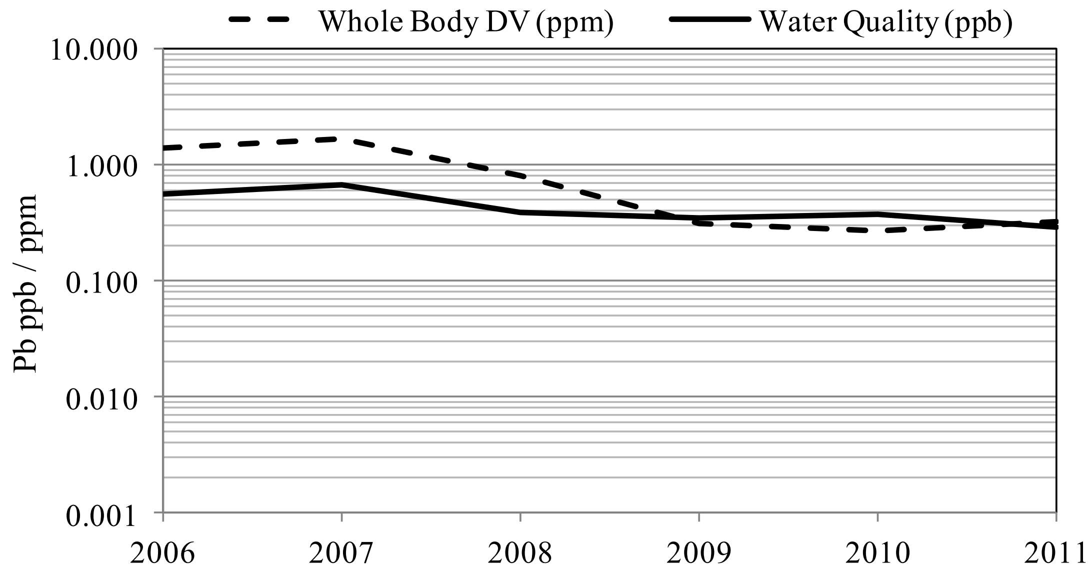

Figure 37.–Median whole body fish and mean water Pb concentrations for samples collected at Site 9 in May (water) and July (fish and water), 2006–2011.

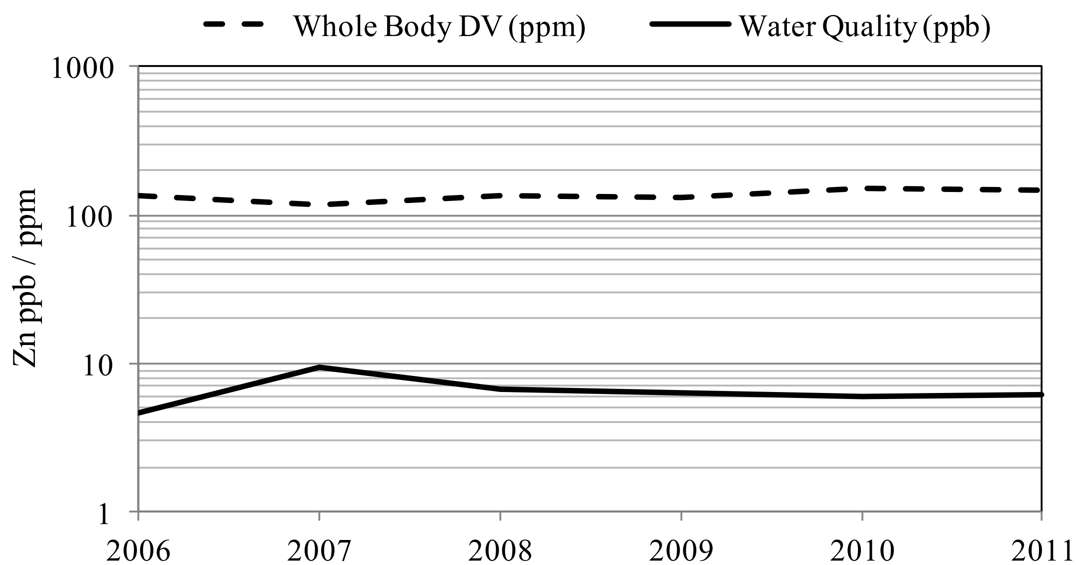

Figure 38.–Median whole body fish and mean water Zn concentrations for samples collected at Site 9 in May (water) and July (fish and water), 2006–2011.

Tributary Creek Site 9 Summary

Site 9 is located downstream of the tailing disposal facility and monitored to detect potential changes from the facility and road runoff. Periphyton biomass and mean benthic macroinvertebrate density in 2012 were similar to those observed since 2004, and not significantly different compared to data from previous years. The aquatic insect community continues to be dominated by EPT taxa, and more recently Chironomids (nonbiting midges).

Juvenile fish populations were variable in the 12 years of monitoring at this site, and whole body metals concentrations in juvenile Dolly Varden char collected in 2012 were similar to concentrations observed in previous years, except median Cu concentration which was the greatest observed since sampling began. Finally, when we compared metals and Se concentrations among annual median whole body fish metals data to mean water data for samples collected two months prior to fish sample collection, 2006–2011, we did not find a significant correlation for any metal between sample types. All together, the suite of data suggests a productive aquatic community continues to be present at Site 9 in similar amounts observed since 2001.

COMPARISON AMONG GREENS CREEK SITES

We do not compare periphyton, benthic macroinvertebrate or fish population data between the Greens Creek and Tributary Creek sample sites because those systems provide different habitats for aquatic life, which have a direct effect on productivity of these organisms. We provide a comparison of the whole body fish metals and Se data and water sample metals and Se data between creeks in *Comparison Among Sites.*

Periphyton Biomass and Community Composition

Periphyton biomass in the 2012 samples from sites 48 and 54 were not significantly different, and biomass in the Site 48 samples was the lowest documented at this site since 2001. High discharge, below normal air temperatures, and above normal precipitation three weeks prior to sampling may have decreased periphyton biomass in the 2012 Greens Creek samples for both sites.

Biomass at sites 48 and 54 generally followed a similar trend 2001–2012, with peak densities observed in 2003, 2004 and 2006 (Figure 39). Discharge in Greens Creek during and prior to sampling 2003–2006 were the lowest observed during the sample period 2001–2012, which may explain the greater periphyton densities during those years. Greatest discharges observed during and prior to sampling Greens Creek occurred in 2007, 2008 and 2012, which may explain the lower biomass observed those years.

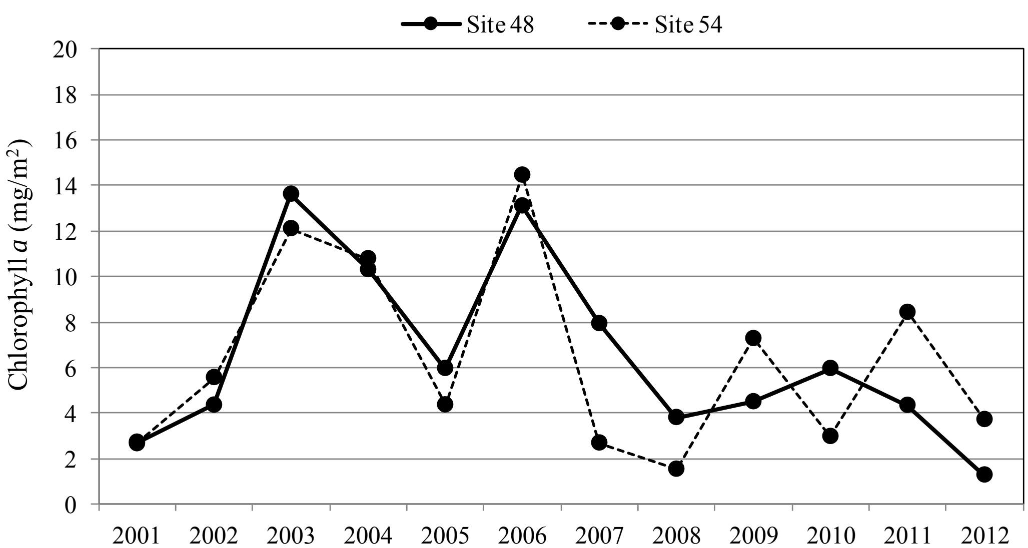

Figure 39.–Comparison of periphyton biomass, estimated by mean chlorophyll *a* density (mg/m^2) among Greens Creek sample sites 48 and 54, 2001–2012.

Periphyton samples collected at Greens Creek sites 48 and 54 since 2001 generally contained more than 90% chlorophyll *a*, zero or nearly no chlorophyll *b*, and less than 10% chlorophyll *c*, except in 2009 when chlorophylls *b* and *c* were both elevated. Little presence of chlorophyll *b* at these sites suggest organisms such as green algae or euglenophytes are occasionally present in the periphyton community, while presence of chlorophyll *c* in all years indicates organisms such as diatoms and dinoflagellates are a regular component of the periphyton community at each site.

Benthic Macroinvertebrate Density and Community Composition

Mean benthic macroinvertebrate density (Figure 40) and taxonomic richness (Figure 41) among samples collected at Greens Creek sites 48 and 54 each year generally followed a similar pattern during the period 2001–2012. Samples generally contained more than 90% EPT taxa and included pollution-sensitive species, which suggest complex and healthy benthic macroinvertebrate communities were present. Variable discharge in Greens Creek within a few weeks prior to sampling in 2012 may have scoured the streambed and caused increased insect drift, contributing to lower densities of benthic macroinvertebrates in samples collected at sites 48 and 54 that year. We did not find any statistical differences when we compared the 2012 macroinvertebrate density and richness sample data among Greens Creek sample sites.

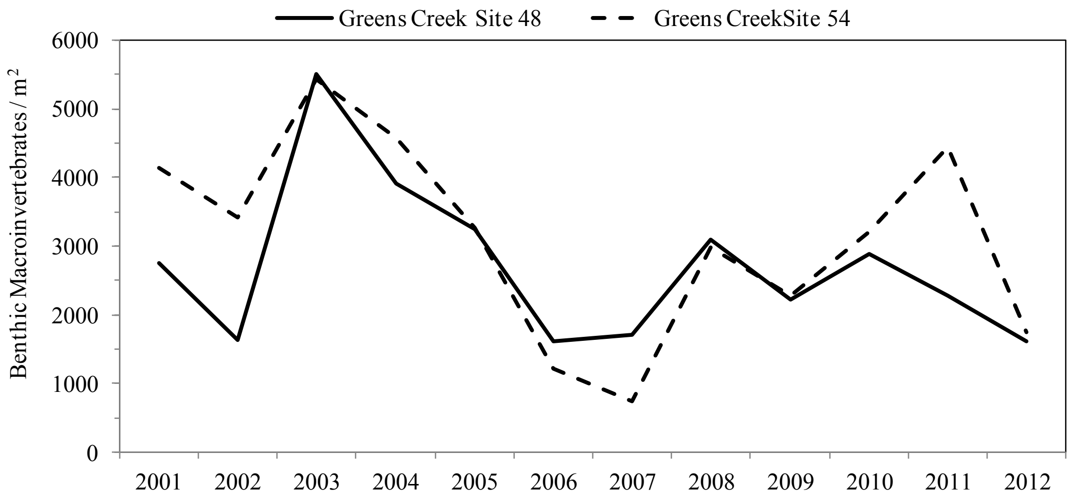

Figure 40.–Comparison of mean benthic macroinvertebrate densities among Greens Creek site 48 and 54 samples, 2001–2012.

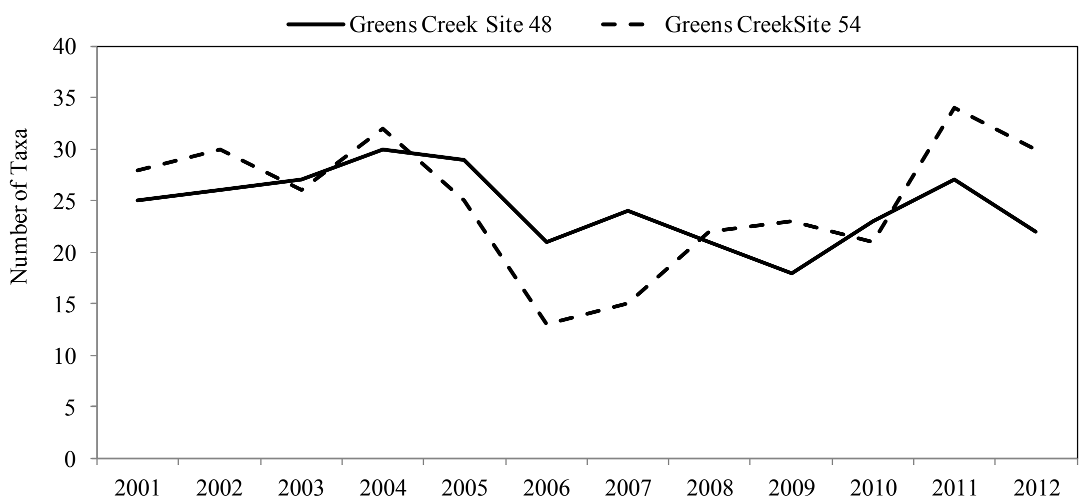

Figure 41.–Comparison of taxa richness among Greens Creek site 48 and 54 benthic macroinvertebrate samples, 2001–2012.

Juvenile Fish Populations and Fish Condition

Dolly Varden char population estimates for Greens Creek sites 48 and 54 followed a similar trend 2001–2012 (Figure 42), with both populations largest in 2003 and smallest in 2008. We sampled a 28 m reach at Site 54 2001–2010, and a 50 m reach in 2011 and 2012, which explains the recent significantly greater populations. We captured several age classes of Dolly Varden char at both sites most years. Some years we do not catch young-of-year fry, though we often observe them in side channels and tributaries. It is possible young-of-year fry escape the 6.35 mm mesh minnow traps we use. Fish condition of captured Dolly Varden char was similar at sites 48 and 54 in 2012, both about 1.0 g/mm^3.

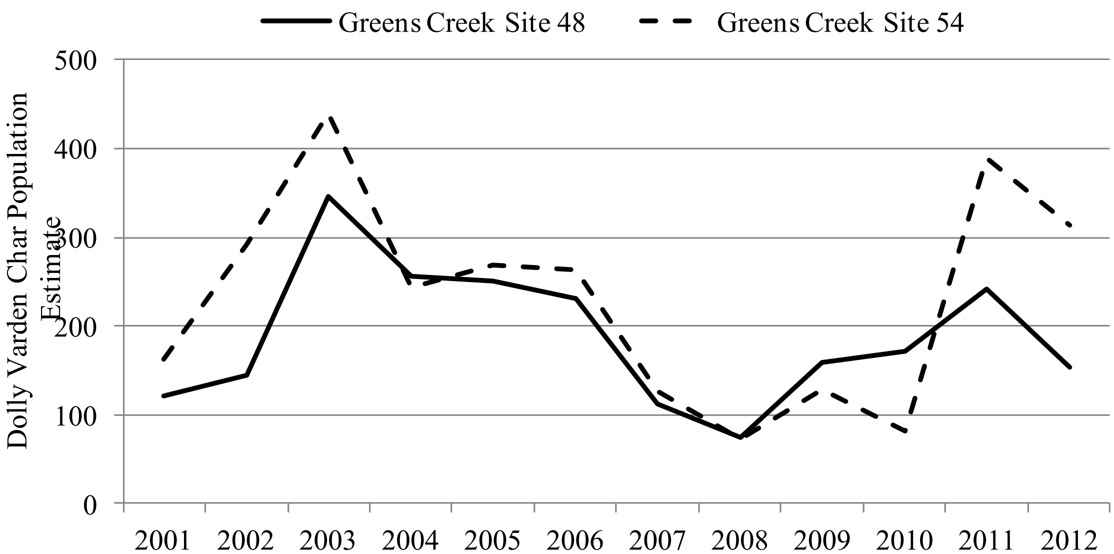

Figure 42.–Comparison of Dolly Varden char population estimates among Greens Creek sites 48 and 54, 2001–2012.

We captured five juvenile coho salmon at Site 54 in 2012, the greatest number since 2006. We have not captured many juvenile coho salmon at Site 54 since 2005, when the downstream fish pass was damaged by flood flows during a heavy rainstorm mid-November when discharges measured up to 272 ft^3/s (USGS 2007). Discharge during the month of November generally ranges 20–60 ft^3/s. Annual peak snowmelt discharge is usually < 200 ft^3/s.

Metals Concentrations in Juvenile Fish

We investigated and did not find relationships between fish length and metals and Se concentrations among whole body fish samples collected 2001–2012.

Comparing only the 2012 Greens Creek data (Figure 43), mean concentrations of metals were greater at reference Site 48 than at Site 54, except Ag and Se. Comparing the 2012 Greens Creek and Tributary Creek Site 9 data, Ag, Cu and Hg were greatest at Tributary Creek Site 9 and we found the following significant differences between:

- mean rank of Cd for Site 9 and the mean ranks for sites 48 and 54,
- mean rank of Hg for Site 9 and the mean rank for Site 54, and
- mean rank of Zn for Site 9 and the mean ranks for sites 48 and 54.

Figure 43 includes reference data (KGM) for comparing whole body juvenile Dolly Varden char metals and Se concentrations collected in Upper Slate Creek, near Kensington Gold Mine, 2011–2012 (Timothy and Kanouse 2013). Whole body fish samples from Upper Slate Creek generally contained lower concentrations of metals and Se in 2011 and 2012 than Greens Creek and Tributary Creek samples in 2012.

Samples from Tributary Creek Site 9 tend to have greater variability and concentrations of metals and Se than the Greens Creek samples, except Cu and Zn, 2001–2012 (Figure 44). When we compared the 2001–2012 data set among sites, we found several significant differences as follows:

- mean rank of Ag for Site 9 and the mean ranks for sites 48 and 54,
- mean rank of Cu for Site 9 and the mean ranks for sites 48 and 54,
- mean rank of Pb for Site 9 and the mean ranks for sites 48 and 54,
- mean rank of Pb for Site 48 and the mean rank for Site 54,
- mean rank of Se for Site 9 and the mean rank for Site 48, and
- mean rank of Zn for Site 9 and the mean ranks for sites 48 and 54.

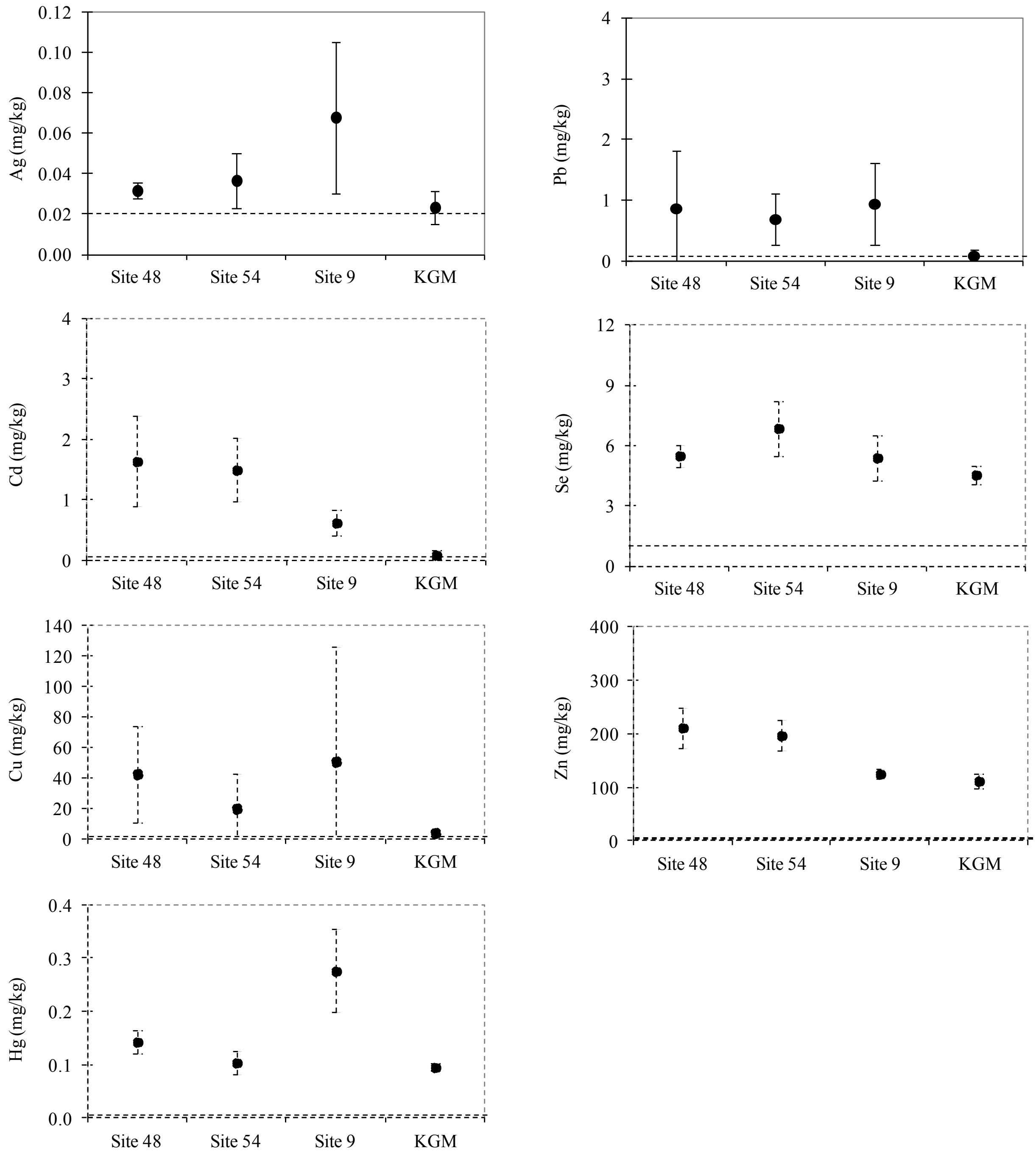

Figure 43.–Whole body fish mean concentrations (mg/kg) ± one standard deviation for Ag, Cd, Cu, Hg, Pb, Se, and Zn in samples collected at Greens Creek sites 48 and 54 and Tributary Creek Site 9 in 2012.

Note: Reference data titled KGM represents whole body Dolly Varden char data for samples collected in Upper Slate Creek, near Kensington Gold Mine, 2011–2012 (Timothy and Kanouse 2013).

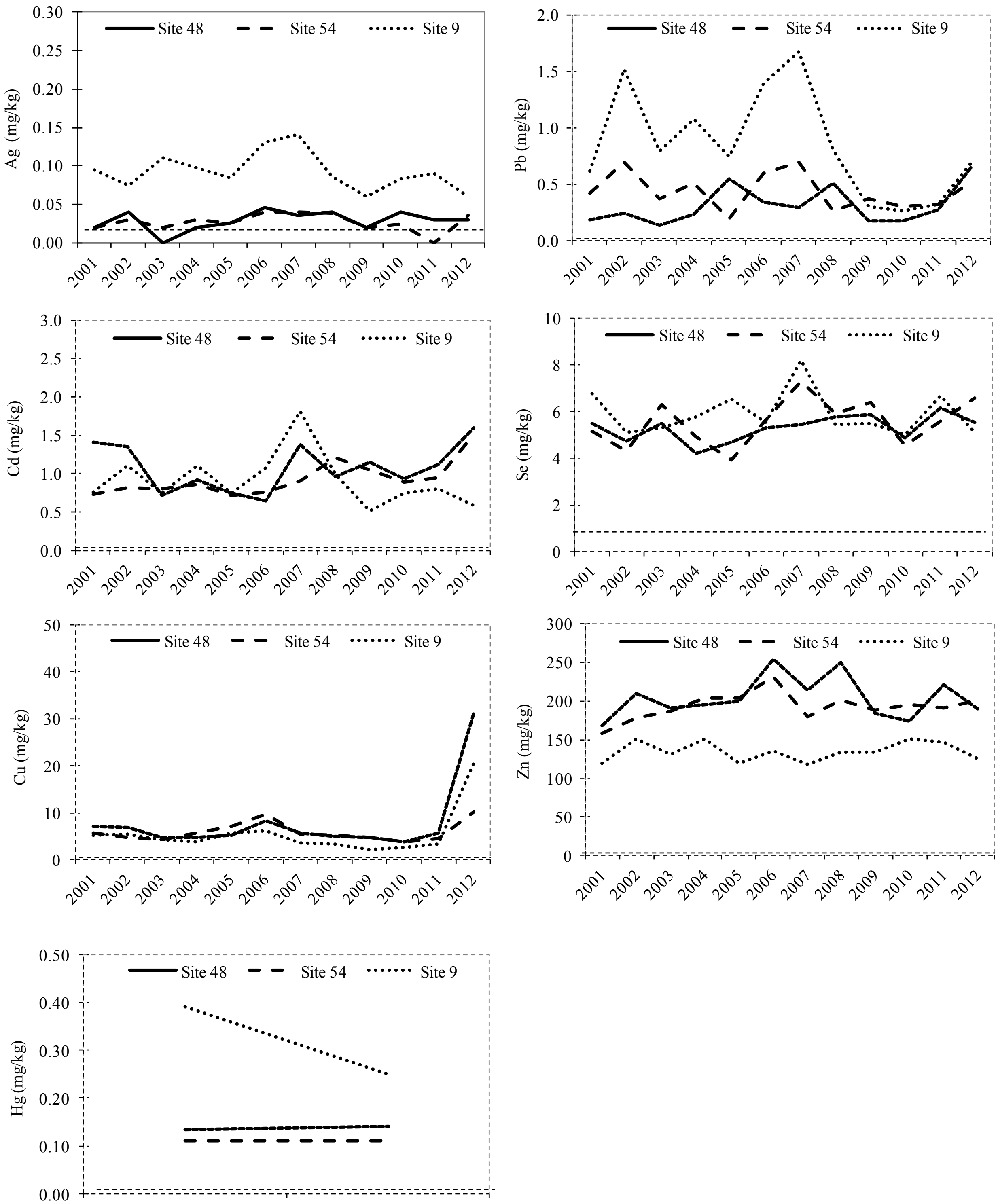

Figure 44.–Median whole body fish concentrations (mg/kg) of Ag, Cd, Cu, Hg, Pb, Se, and Zn among samples collected at Greens Creek sites 48 and 54 and Tributary Creek Site 9, 2001–2012.

RECOMMENDATIONS

Based on our review of the 2001–2012 biomonitoring data set, we recommend the following:

1. Sample sediment metals concentrations at Greens Creek sites 48 and 54 and Tributary Creek Site 9 to examine possible relationships of Cd, Cu, Pb, and Zn with whole body fish and water sample concentrations.
2. Compare biological abundance and composition data with available water metals and Se data, and to results of the sediment metals sampling we recommend above.

We considered recommending to replace the 6.35 mm mesh minnow traps with smaller mesh (3.2 mm) traps to improve young-of-year captures, and decided to continue using the same methods implemented since 2001 as the benefit to introducing a new age class to the long-term data set 12 years into the monitoring program would not provide additional information necessary to assess long-term population trends at each site.

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APPENDIX A: PERIPHYTON BIOMASS DATA

Appendix A.–Chlorophylls *a*, *b*, and *c* densities in periphyton samples collected near Greens Creek Mine, 2001–2012.

	2001			2002			2003			2004		
mg/m²	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*
Greens Creek Site 48												
	1.914	0.012	0.139	5.165	0.000	0.295	14.410	0.000	1.264	18.049	0.000	2.033
	1.826	0.000	0.183	4.031	0.000	0.215	17.825	0.026	1.566	6.728	0.000	0.690
	5.612	0.000	0.695	6.210	0.000	0.713	8.432	0.089	0.390	8.971	0.000	0.898
	0.313	0.079	0.058	2.830	0.000	0.246	9.531	0.009	0.635	12.816	0.000	1.454
	2.959	0.038	0.361	5.157	0.000	0.755	11.357	0.000	0.720	5.447	0.000	0.623
	5.442	0.000	0.617	6.393	0.000	0.754	11.764	0.016	0.863	20.399	0.000	2.150
	3.379	0.000	0.467	5.843	0.000	0.729	24.095	0.000	2.137	6.301	0.000	0.449
	1.867	0.034	0.146	2.091	0.072	0.248	13.305	0.128	0.988	11.641	0.000	1.384
	2.635	0.137	0.144	3.203	0.000	0.358	11.540	0.000	0.565	7.476	0.000	0.651
	1.229	0.023	0.165	2.559	0.000	0.151	13.969	0.000	0.895	5.233	0.000	0.545
mean	2.718	0.032	0.298	4.348	0.007	0.446	13.623	0.027	1.002	10.306	0.000	1.088
median	2.275	0.017	0.174	4.594	0.000	0.327	12.535	0.004	0.879	8.224	0.000	0.794
max	5.612	0.137	0.695	6.393	0.072	0.755	24.095	0.128	2.137	20.399	0.000	2.150
min	0.313	0.000	0.058	2.091	0.000	0.151	8.432	0.000	0.390	5.233	0.000	0.449
Greens Creek Site 6												
	5.069	0.000	0.700	-	-	-	-	-	-	-	-	-
	7.154	0.035	0.722	-	-	-	-	-	-	-	-	-
	4.472	0.000	0.780	-	-	-	-	-	-	-	-	-
	1.270	0.074	0.226	-	-	-	-	-	-	-	-	-
	3.196	0.000	0.426	-	-	-	-	-	-	-	-	-
	1.643	0.000	0.142	-	-	-	-	-	-	-	-	-
	0.903	0.101	0.144	-	-	-	-	-	-	-	-	-
	2.511	0.000	0.157	-	-	-	-	-	-	-	-	-
	6.882	0.000	1.019	-	-	-	-	-	-	-	-	-
	7.024	0.000	0.999	-	-	-	-	-	-	-	-	-
mean	4.012	0.021	0.532	-	-	-	-	-	-	-	-	-
median	3.834	0.000	0.563	-	-	-	-	-	-	-	-	-
max	7.154	0.101	1.019	-	-	-	-	-	-	-	-	-
min	0.903	0.000	0.142	-	-	-	-	-	-	-	-	-
Greens Creek Site 54												
	1.595	0.007	0.149	2.647	0.000	0.303	13.289	0.000	1.049	17.195	0.000	2.018
	3.095	0.046	0.409	9.324	0.000	1.017	8.355	0.000	0.788	9.719	0.000	0.927
	3.611	0.000	0.207	7.519	0.000	0.239	14.896	0.000	1.455	8.758	0.000	0.674
	2.966	0.000	0.294	4.296	0.000	0.378	5.938	0.000	0.618	32.040	0.000	3.662
	1.880	0.000	0.011	5.152	0.000	0.528	15.515	0.000	1.737	5.233	0.000	0.423
	1.778	0.000	0.190	2.976	0.865	1.258	10.499	0.000	1.060	3.738	0.000	0.305
	4.947	0.000	0.223	6.263	0.000	0.639	5.708	0.000	0.387	12.816	0.000	1.349
	1.459	0.000	0.101	4.621	0.000	0.398	16.425	0.000	1.715	1.922	0.031	0.089
	1.690	0.000	0.135	4.709	0.000	0.453	12.603	0.000	1.075	10.466	0.000	1.087
	3.475	0.000	0.159	8.083	0.000	0.791	17.862	0.000	1.748	5.981	0.000	0.533
mean	2.650	0.005	0.188	5.559	0.087	0.600	12.109	0.000	1.163	10.787	0.003	1.107
median	2.423	0.000	0.175	4.931	0.000	0.490	12.946	0.000	1.067	9.238	0.000	0.800
max	4.947	0.046	0.409	9.324	0.865	1.258	17.862	0.000	1.748	32.040	0.031	3.662
min	1.459	0.000	0.011	2.647	0.000	0.239	5.708	0.000	0.387	1.922	0.000	0.089
Tributary Creek Site 9												
	6.623	0.000	0.788	8.905	0.000	0.519	12.893	0.000	1.261	9.398	0.224	0.803
	11.150	0.000	1.200	16.433	0.950	1.276	8.550	0.000	0.792	5.767	0.000	0.423
	15.054	0.000	1.472	12.647	0.174	0.000	3.977	0.000	0.289	5.447	0.000	0.484
	16.577	0.234	1.506	5.441	0.451	0.072	12.290	0.000	1.114	6.088	0.031	0.383
	3.149	0.000	0.335	23.721	1.205	0.838	17.087	0.000	1.916	14.525	0.021	1.395
	2.593	0.064	0.279	12.746	0.400	0.216	17.400	0.000	1.876	6.515	0.173	0.404
	1.608	0.000	0.013	32.532	0.000	1.894	33.871	0.000	3.977	10.360	0.135	0.799
	6.659	0.000	0.426	4.403	1.496	0.000	24.561	0.000	2.432	6.835	0.042	0.364
	15.210	0.812	1.436	2.941	0.301	0.172	20.020	0.000	1.688	26.166	0.511	2.608
	11.550	0.000	1.509	8.007	1.471	0.275	36.017	0.000	3.856	8.437	0.218	0.531
mean	9.017	0.111	0.896	12.778	0.645	0.526	18.667	0.000	1.920	9.954	0.136	0.819
median	8.904	0.000	0.994	10.776	0.426	0.245	17.244	0.000	1.782	7.636	0.089	0.507
max	16.577	0.812	1.509	32.532	1.496	1.894	36.017	0.000	3.977	26.166	0.511	2.608
min	1.608	0.000	0.013	2.941	0.000	0.000	3.977	0.000	0.289	5.447	0.000	0.364

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mg/m²	2005			2006			2007			2008		
	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*
Greens Creek Site 48												
	0.972	0.000	0.009	8.503	0.000	0.799	6.638	0.000	0.162	1.500	0.000	0.090
	4.699	0.000	0.510	11.590	0.000	0.710	5.639	0.000	0.228	4.700	0.000	0.160
	6.622	0.000	0.274	10.742	0.000	1.253	7.595	0.000	0.330	2.670	0.000	0.240
	6.194	0.000	0.506	20.604	0.000	2.038	11.692	0.000	1.391	2.140	0.000	0.170
	11.107	0.000	0.915	10.600	0.000	0.979	7.038	0.000	0.471	0.850	0.000	0.020
	5.660	0.000	0.512	14.345	0.000	1.724	11.401	0.000	0.541	12.600	0.000	0.330
	7.690	0.000	0.533	17.271	0.000	1.761	11.995	0.012	0.603	2.780	0.000	0.190
	5.126	0.000	0.291	15.808	0.000	1.742	4.941	0.000	0.291	6.300	0.000	0.740
	2.456	0.015	0.276	17.265	0.000	1.730	8.259	0.000	1.096	1.280	0.000	0.140
	9.078	0.000	0.630	4.336	0.000	0.537	4.112	0.000	0.435	3.200	0.000	0.370
mean	5.961	0.002	0.446	13.106	0.000	1.327	7.931	0.001	0.555	3.802	0.000	0.245
median	5.927	0.000	0.508	12.968	0.000	1.489	7.316	0.000	0.453	2.725	0.000	0.180
max	11.107	0.015	0.915	20.604	0.000	2.038	11.995	0.012	1.391	12.600	0.000	0.740
min	0.972	0.000	0.009	4.336	0.000	0.537	4.112	0.000	0.162	0.850	0.000	0.020
Greens Creek Site 6												
	-	-	-	27.315	0.000	2.782	-	-	-	-	-	-
	-	-	-	19.321	0.000	2.046	-	-	-	-	-	-
	-	-	-	17.578	0.000	1.788	-	-	-	-	-	-
	-	-	-	33.946	0.000	3.307	-	-	-	-	-	-
	-	-	-	47.552	0.000	4.935	-	-	-	-	-	-
	-	-	-	16.118	0.000	1.589	-	-	-	-	-	-
	-	-	-	8.957	0.000	1.033	-	-	-	-	-	-
	-	-	-	11.842	0.000	1.107	-	-	-	-	-	-
	-	-	-	8.645	0.000	0.975	-	-	-	-	-	-
	-	-	-	29.194	0.000	3.087	-	-	-	-	-	-
mean	-	-	-	22.047	0.000	2.265	-	-	-	-	-	-
median	-	-	-	18.449	0.000	1.917	-	-	-	-	-	-
max	-	-	-	47.552	0.000	4.935	-	-	-	-	-	-
min	-	-	-	8.645	0.000	0.975	-	-	-	-	-	-
Greens Creek Site 54												
	10.360	0.000	0.535	19.859	0.000	1.617	0.407	0.036	0.045	2.990	0.000	0.290
	2.563	0.000	0.255	5.625	0.000	0.756	**0.060**	---	---	1.170	0.020	0.000
	3.311	0.000	0.169	12.742	0.000	1.186	1.365	0.042	0.114	1.500	0.000	0.190
	2.884	0.000	0.117	23.569	0.000	2.626	4.248	0.000	0.482	1.710	0.000	0.130
	5.660	0.000	0.383	4.615	0.000	0.466	**0.060**	---	---	2.240	0.000	0.090
	2.990	0.000	0.135	27.671	0.000	2.215	3.285	0.000	0.382	2.140	0.000	0.110
	4.272	0.000	0.177	4.248	0.000	0.384	7.934	0.000	0.977	2.460	0.000	0.250
	4.379	0.000	0.310	8.958	0.000	0.935	**0.060**	---	---	0.960	0.000	0.010
	4.058	0.000	0.160	31.845	0.000	3.171	2.966	0.000	0.392	**0.060**	---	---
	3.097	0.000	0.158	5.483	0.000	0.678	6.434	0.000	0.815	**0.060**	---	---
mean	4.357	0.000	0.240	14.461	0.000	1.403	2.682	0.011	0.458	1.529	0.003	0.134
median	3.685	0.000	0.173	10.850	0.000	1.061	2.165	0.000	0.392	1.605	0.000	0.120
max	10.360	0.000	0.535	31.845	0.000	3.171	7.934	0.042	0.977	2.990	0.020	0.290
min	2.563	0.000	0.117	4.248	0.000	0.384	0.060	0.000	0.045	0.060	0.000	0.000
Tributary Creek Site 9												
	6.429	0.000	0.250	3.538	0.249	0.190	---	---	---	2.350	0.000	0.120
	8.010	1.283	0.183	4.211	0.396	0.202	5.447	0.079	0.228	6.940	0.000	0.270
	1.816	0.131	0.075	7.073	0.000	0.404	7.262	0.005	0.544	6.300	0.240	0.340
	9.826	0.060	0.291	4.012	0.011	0.320	---	---	---	6.410	0.000	0.250
	5.682	0.000	0.102	4.201	0.000	0.391	---	---	---	2.460	0.120	0.190
	5.383	0.000	0.123	4.745	0.000	0.287	0.854	0.164	0.107	6.190	0.050	0.390
	8.181	0.000	0.203	13.635	0.000	0.573	6.408	0.055	0.244	4.060	0.000	0.130
	15.433	0.000	0.455	4.379	0.005	0.205	7.049	0.236	0.649	4.590	0.000	0.370
	36.600	0.099	1.120	5.158	0.000	0.559	5.020	0.000	0.258	1.600	0.000	0.000
	9.452	0.000	0.263	3.756	0.372	0.262	3.204	0.000	0.234	3.740	0.000	0.280
mean	10.681	0.157	0.306	5.471	0.103	0.339	5.035	0.077	0.323	4.464	0.041	0.234
median	8.095	0.000	0.226	4.295	0.003	0.303	5.447	0.055	0.244	4.325	0.000	0.260
max	36.600	1.283	1.120	13.635	0.396	0.573	7.262	0.236	0.649	6.940	0.240	0.390
min	1.816	0.000	0.075	3.538	0.000	0.190	0.854	0.000	0.107	1.600	0.000	0.000

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	2009			2010			2011			2012		
mg/m²	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*	chlor-*a*	chlor-*b*	chlor-*c*
Greens Creek Site 48												
	3.20	0.00	0.49	8.54	0.00	0.44	4.49	0.00	0.50	**0.09**	---	---
	1.50	0.00	0.25	4.59	0.00	0.61	6.51	0.00	0.59	0.69	0.00	0.10
	4.17	0.11	0.59	5.13	0.00	0.27	2.88	0.00	0.30	1.29	0.00	0.12
	5.66	0.07	0.73	3.10	0.00	0.26	2.59	0.17	0.05	2.56	0.00	0.39
	3.42	0.06	0.50	7.58	0.00	0.29	3.31	0.00	0.36	0.85	0.00	0.00
	8.22	0.13	0.95	5.55	0.00	0.55	5.13	0.00	0.55	1.60	0.00	0.26
	0.43	0.11	0.11	10.68	0.00	0.64	7.16	0.00	1.06	1.82	0.00	0.29
	1.39	0.18	0.29	7.69	0.00	0.41	5.66	0.00	0.49	1.92	0.00	0.28
	7.80	0.00	0.89	3.63	0.00	0.25	0.85	0.00	0.11	0.32	0.00	0.08
	9.18	0.17	1.19	3.10	0.02	0.15	4.81	0.00	0.49	1.60	0.00	0.16
mean	4.50	0.08	0.60	5.96	0.00	0.39	4.34	0.02	0.45	1.27	0.00	0.19
median	3.79	0.09	0.55	5.34	0.00	0.35	4.65	0.00	0.49	1.45	0.00	0.16
max	9.18	0.18	1.19	10.68	0.02	0.64	7.16	0.17	1.06	2.56	0.00	0.39
min	0.43	0.00	0.11	3.10	0.00	0.15	0.85	0.00	0.05	0.09	0.00	0.00
Greens Creek Site 6												
	-	-	-	-	-	-	3.42	0.00	0.24	-	-	-
	-	-	-	-	-	-	2.24	0.00	0.18	-	-	-
	-	-	-	-	-	-	1.11	0.00	0.08	-	-	-
	-	-	-	-	-	-	5.34	0.00	0.62	-	-	-
	-	-	-	-	-	-	4.17	0.00	0.49	-	-	-
	-	-	-	-	-	-	1.71	0.00	0.22	-	-	-
	-	-	-	-	-	-	4.40	0.00	0.39	-	-	-
	-	-	-	-	-	-	5.98	0.00	0.56	-	-	-
	-	-	-	-	-	-	2.67	0.00	0.31	-	-	-
	-	-	-	-	-	-	6.94	0.00	0.92	-	-	-
mean	-	-	-	-	-	-	3.80	0.00	0.40	-	-	-
median	-	-	-	-	-	-	3.79	0.00	0.35	-	-	-
max	-	-	-	-	-	-	6.94	0.00	0.92	-	-	-
min	-	-	-	-	-	-	1.11	0.00	0.08	-	-	-
Greens Creek Site 54												
	8.01	0.11	1.06	2.67	0.00	0.29	9.61	0.00	0.64	5.54	0.00	0.24
	7.58	0.11	1.13	6.73	0.00	0.69	0.43	0.00	0.06	0.11	0.00	0.04
	6.84	0.07	0.89	4.38	0.00	0.74	3.42	0.00	0.32	2.65	0.00	0.11
	9.18	0.09	0.96	2.14	0.00	0.25	3.42	0.00	0.33	1.82	0.00	0.10
	---	0.47	2.21	5.23	0.00	0.67	41.76	0.00	3.02	1.07	0.00	0.04
	8.33	0.15	1.11	1.71	0.04	0.25	5.23	0.00	0.64	1.17	0.00	0.13
	11.32	0.20	1.57	1.39	0.02	0.11	10.36	0.00	0.45	0.75	0.00	0.06
	5.34	0.17	0.66	3.20	0.00	0.46	7.16	0.00	0.53	19.54	0.00	1.10
	4.49	0.10	0.63	2.03	0.00	0.21	0.64	0.00	0.07	4.06	0.00	0.30
	4.38	0.10	0.43	0.21	0.01	0.05	2.24	0.00	0.29	0.43	0.01	0.04
mean	7.27	0.16	1.06	2.97	0.01	0.37	8.43	0.00	0.64	3.71	0.00	0.22
median	7.58	0.11	1.01	2.41	0.00	0.27	4.33	0.00	0.39	1.50	0.00	0.10
max	11.32	0.47	2.21	6.73	0.04	0.74	41.76	0.00	3.02	19.54	0.01	1.10
min	4.38	0.07	0.43	0.21	0.00	0.05	0.43	0.00	0.06	0.11	0.00	0.04
Tributary Creek Site 9												
	2.03	0.10	0.16	12.82	0.00	0.39	4.81	0.47	0.08	3.63	0.00	0.25
	5.45	0.17	0.38	6.62	0.00	0.39	3.84	0.00	0.12	8.97	0.00	0.33
	4.38	0.24	0.30	7.69	0.00	0.43	4.91	0.00	0.34	10.68	0.00	0.48
	7.05	0.58	0.33	5.66	0.12	0.32	10.47	0.03	0.50	3.74	0.00	0.25
	9.08	0.36	0.49	9.72	0.88	0.40	5.13	0.00	0.37	1.28	0.00	0.04
	8.76	0.41	0.62	5.98	0.00	0.20	1.71	0.00	0.01	1.71	0.00	0.12
	2.14	0.08	0.09	5.55	0.00	0.40	6.30	0.00	0.44	5.66	0.00	0.29
	18.37	0.66	0.78	10.57	0.28	0.34	9.61	0.00	0.35	6.09	0.00	0.26
	2.35	0.18	0.16	4.06	0.05	0.16	12.50	0.00	0.87	2.14	0.00	0.21
	3.20	0.20	0.33	5.77	0.00	0.32	6.30	0.00	0.17	7.37	0.00	0.40
mean	6.28	0.30	0.36	7.44	0.13	0.34	6.56	0.05	0.33	5.13	0.00	0.26
median	4.91	0.22	0.33	6.30	0.00	0.37	5.71	0.00	0.35	4.70	0.00	0.26
max	18.37	0.66	0.78	12.82	0.88	0.43	12.50	0.47	0.87	10.68	0.00	0.48
min	2.03	0.08	0.09	4.06	0.00	0.16	1.71	0.00	0.01	1.28	0.00	0.04

Note: Bolded values are the spectrophotometer error detection limit, chlorophyll a was not detected in the sample.

APPENDIX B: BENTHIC MACROINVERTEBRATE DATA

Appendix B1.–Benthic macroinvertebrate data for samples collected at Greens Creek Site 48, near Greens Creek Mine, 2001–2012.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total Number of Aquatic Taxa	25	26	27	30	29	21	24	21	18	23	27	22
Mean No. Ephemeroptera/sample	219	120	379	265	239	122	117	232	177	212	112	111
Mean No. Plecoptera/sample	10	8	38	19	9	4	16	7	9	17	30	11
Mean No. Trichoptera/sample	1	2	4	6	4	2	2	5	0	1	2	1
Mean No. Aquatic Diptera/sample	6	8	41	40	25	9	8	20	3	16	39	15
Mean No. Other/sample	1	3	11	6	1	2	3	2	1	2	14	1
% Ephemeroptera	92%	85%	80%	79%	86%	88%	80%	87%	93%	86%	57%	80%
% Plecoptera	4%	6%	8%	6%	3%	3%	11%	2%	5%	7%	15%	8%
% Trichoptera	1%	1%	1%	2%	2%	1%	2%	2%	0%	0%	1%	1%
% Aquatic Diptera	3%	6%	9%	12%	9%	6%	6%	8%	2%	6%	20%	11%
% Other	0%	2%	2%	2%	1%	1%	2%	1%	0%	1%	7%	1%
% EPT	97%	92%	89%	86%	90%	92%	92%	92%	98%	93%	73%	89%
% Chironomidae	1%	4%	7%	11%	8%	3%	4%	6%	1%	5%	17%	9%
% Dominant Taxon	41%	35%	30%	28%	30%	37%	36%	58%	46%	31%	21%	37%
Total Terrestrial Invertebrates Counted	0	4	5	1	24	5	2	8	2	11	4	0
Total Aquatic Invertebrates Counted	1,184	704	2,367	1,679	1,396	693	733	1,331	953	1,240	982	693
Total Invertebrates Counted	1,184	708	2,372	1,680	1,420	698	735	1,339	955	1,251	986	693
% Aquatic	100%	99%	100%	100%	98%	99%	100%	99%	100%	99%	100%	100%
% Terrestrial	0%	1%	0%	0%	2%	1%	0%	1%	0%	1%	0%	0%
Sample Area (m^2)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Mean Number of Total Inverts/m^2	2,753	1,647	5,516	3,907	3,302	1,623	1,709	3,114	2,221	2,909	2,293	1,612
Mean Number of Aquatic Inverts/m^2	2,753	1,637	5,505	3,905	3,247	1,612	1,705	3,095	2,216	2,884	2,284	1,612
± 1 Standard Deviation	1,435	434	1,579	677	1,441	807	648	980	1,939	1,530	630	872

Appendix B2.–Benthic macroinvertebrate data for samples collected at Greens Creek Site 6, near Greens Creek Mine, 2001–2012.

	2001	2006	2011
Total Number of Aquatic Taxa	19	12	27
Mean No. Ephemeroptera/sample	183	53	123
Mean No. Plecoptera/sample	6	2	26
Mean No. Trichoptera/sample	0	0	2
Mean No. Aquatic Diptera/sample	5	6	21
Mean No. Other/sample	5	0	3
% Ephemeroptera	92%	87%	70%
% Plecoptera	3%	3%	15%
% Trichoptera	0%	0%	1%
% Aquatic Diptera	3%	9%	12%
% Other	2%	0%	2%
% EPT	95%	90%	86%
% Chironomidae	2%	9%	8%
% Dominant Taxon	53%	36%	30%
Total Terrestrial Invertebrates Counted	0	2	9
Total Aquatic Invertebrates Counted	998	307	877
Total Invertebrates Counted	998	309	886
% Aquatic	0%	99.4%	1.0%
% Terrestrial	0%	0.6%	99.0%
Sample Area (m^2)	0.43	0.43	0.43
Mean Number of Total Inverts/m^2	2,319	719	2,060
Mean Number of Aquatic Inverts/m^2	2,319	714	2,040
± 1 Standard Deviation	1,776	466	845

Appendix B3.–Benthic macroinvertebrate data for samples collected at Greens Creek Site 54, near Greens Creek Mine, 2001–2012.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total Number of Aquatic Taxa	28	30	26	32	25	13	15	22	23	21	34	30
Mean No. Ephemeroptera/sample	325	270	402	320	253	95	57	221	179	249	307	119
Mean No. Plecoptera/sample	16	11	16	23	7	6	4	13	9	11	19	10
Mean No. Trichoptera/sample	1	1	2	4	6	1	0	2	1	2	6	2
Mean No. Aquatic Diptera/sample	11	8	35	37	13	3	2	17	6	12	41	16
Mean No. Other/sample	3	3	11	9	1	0	0	3	1	2	9	5
% Ephemeroptera	91%	92%	86%	81%	90%	91%	90%	87%	91%	91%	80%	78%
% Plecoptera	4%	4%	4%	6%	3%	6%	7%	5%	4%	4%	5%	6%
% Trichoptera	0%	0%	1%	1%	2%	1%	0%	1%	0%	1%	2%	1%
% Aq. Diptera	3%	3%	7%	9%	5%	2%	3%	7%	3%	4%	11%	11%
% other	1%	1%	2%	2%	0%	0%	0%	1%	1%	1%	2%	4%
% EPT	96%	96%	90%	88%	95%	97%	97%	92%	96%	95%	87%	86%
% Chironomidae	2%	2%	6%	8%	4%	2%	2%	5%	2%	3%	9%	9%
% Dominant Taxon	52%	43%	40%	38%	40%	31%	34%	53%	40%	35%	43%	30%
Total Terrestrial Invertebrates Counted	0	4	7	1	3	1	6	1	8	9	14	3
Total Aquatic Invertebrates Counted	1,782	1,466	2,335	1,967	1,402	525	319	1,277	979	1,377	1,913	764
Total Invertebrates Counted	1,782	1,470	2,342	1,968	1,405	526	325	1,278	987	1,386	1,927	797
% Aquatic	100%	100%	100%	100%	100%	100%	98%	100%	99%	99%	99%	100%
% Terrestrial	0%	0%	0%	0%	0%	0%	2%	0%	1%	1%	1%	0%
Sample Area (m^2)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Mean Number of Total Inverts/m^2	4,144	3,419	5,447	4,577	3,267	1,223	756	2,972	2,295	3,223	4,481	1,765
Mean Number of Aquatic Inverts/m^2	4,144	3,409	5,430	4,575	3,260	1,221	742	2,970	2,277	3,202	4,449	1,753
± 1 Standard Deviation	1,464	1,148	1,422	1,540	1,016	345	293	1,855	297	772	2,668	738

Appendix B4.–Benthic macroinvertebrate data for samples collected at Tributary Creek Site 9, near Greens Creek Mine, 2001–2012.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total Number of Aquatic Taxa	21	24	36	26	30	23	21	20	26	22	26	27
Mean No. Ephemeroptera/sample	41	87	196	112	67	89	21	88	41	18	55	49
Mean No. Plecoptera/sample	14	14	119	33	19	7	7	10	19	3	28	14
Mean No. Trichoptera/sample	0	0	1	1	1	0	1	0	0	0	3	2
Mean No. Aquatic Diptera/sample	17	13	51	13	12	8	4	41	28	10	39	36
Mean No. Other/sample	30	35	136	47	7	20	10	11	8	8	46	21
% Ephemeroptera	40%	58%	39%	54%	63%	71%	48%	59%	42%	45%	32%	40%
% Plecoptera	13%	9%	24%	16%	18%	6%	17%	7%	20%	9%	16%	11%
% Trichoptera	0%	0%	0%	0%	1%	0%	2%	0%	0%	0%	2%	2%
% Aquatic Diptera	17%	9%	10%	6%	11%	7%	10%	27%	29%	26%	23%	29%
% Other	30%	23%	27%	23%	7%	16%	24%	7%	8%	20%	27%	17%
% EPT	54%	68%	63%	71%	82%	77%	67%	65%	63%	54%	50%	53%
% Chironomidae	7%	5%	5%	5%	8%	4%	1%	1%	22%	23%	21%	26%
% Dominant Taxon	26%	29%	26%	44%	37%	40%	26%	33%	32%	32%	24%	30%
Total Terrestrial Invertebrates Counted	0	5	15	3	12	33	1	5	50	22	2	9
Total Aquatic Invertebrates Counted	509	748	2516	1032	528	625	218	753	479	198	856	609
Total Invertebrates Counted	509	753	2531	1035	540	658	219	758	529	220	858	618
% Aquatic	100%	99%	99%	100%	98%	95%	100%	99%	91%	90%	100%	99%
% Terrestrial	0%	1%	1%	0%	2%	5%	0%	1%	10%	11%	0%	1%
Sample Area (m^2)	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086
Mean Number of Total Inverts/m^2	1,184	1,751	5,886	2,407	1,256	1,530	509	1,763	1,230	512	1,995	1,437
Mean Number of Aquatic Inverts/m^2	1,184	1,740	5,851	2,400	1,228	1,453	507	1,751	1,114	460	1,991	1,416
± 1 Standard Deviation	1,148	620	1,579	851	357	878	268	631	636	463	447	615

.

APPENDIX C: JUVENILE FISH CAPTURE DATA

Appendix C1.–Juvenile fish capture data at Greens Creek Mine biomonitoring sites, 2001–2012.

Year and Sample Site	Species[a]	FL (mm)	Number of Fish Captured Set 1	Set 2	Set 3	Total	Population Estimate	Density (fish/m^2)
2001								
Greens Creek Site 48	DV	48-139	30	16	22	68	121±68	0.25
Greens Creek Site 6	DV	52-168	80	8	43	131	172±37	0.33
	CO	81-90	1	0	2	3	3	<0.01
Greens Creek Site 54	DV	27-162	70	49	19	138	163±21	0.60
	CO	32-95	2	6	4	12	17	0.04
Tributary Creek Site 9	DV	58-110	70	4	7	81	81	0.92
	CO	39-101	89	18	11	118	120±3	1.36
	CT	124	1	0	0	1	1	<0.01
	Sc	75-98	3	1	0	4	4	<0.01
2002								
Greens Creek Site 48	DV	45-160	74	29	23	126	144±17	0.22
Greens Creek Site 54	DV	33-160	168	72	31	271	293±16	1.01
	CO	59-85	14	6	1	21	21	0.07
Tributary Creek Site 9	DV	38-147	29	14	8	51	57±9	0.47
	CO	27-85	29	9	6	44	46±4	0.38
	CT	124	0	0	1	1	1	<0.01
	Sc	90-100	0	1	1	2	2	<0.01
2003								
Greens Creek Site 48	DV	54-180	157	72	56	285	347±39	0.94
Greens Creek Site 54	DV	51-184	92	81	59	232	440±175	1.26
	CO	44-52	5	3	0	8	8	0.04
Tributary Creek Site 9	DV	54-114	13	4	2	19	19	0.28
	CO	46-88	37	11	4	52	53±2	0.79
	CT	122	1	0	0	1	1	<0.01
	Sc	80	0	0	1	1	1	<0.01
2004								
Greens Creek Site 48	DV	54-158	168	48	28	244	256±10	0.88
Greens Creek Site 54	DV	52-161	118	36	47	201	244±32	1.63
	CO	70-95	9	9	6	24	34±17	0.23
Tributary Creek Site 9	DV	64-109	21	6	5	32	33±2	0.56
	CO	40-94	23	2	2	27	27	0.45
	CT	122	1	0	0	1	1	<0.01
	RT	86-106	3	1	0	4	4	<0.01
	Sc	67-85	1	1	0	2	2	<0.01

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Appendix C1. Page 2 of 3.

Year and Sample Site	Species[a]	FL (mm)	Number of Fish Captured Set 1	Set 2	Set 3	Total	Population Estimate	Density (fish/m^2)
2005								
Greens Creek Site 48	DV	50-149	118	56	38	212	251±28	0.67
Greens Creek Site 54	DV	52-146	111	59	43	213	269±40	1.26
	CO	66-93	33	20	8	61	68±9	0.32
Tributary Creek Site 9	DV	59-131	21	12	11	44	59±21	0.47
	CO	39-103	82	42	15	139	151±12	1.21
	CT	91-103	1	1	0	2	2	0.02
	Sc	78-99	2	0	0	2	2	0.02
2006								
Greens Creek Site 48	DV	49-150	138	40	34	212	231±15	0.60
Greens Creek Site 6	DV	53-150	44	41	12	97	119±23	0.26
	CO	89	1	0	0	1	1	<0.01
Greens Creek Site 54	DV	49-158	116	61	40	217	264±33	1.27
	CO	62-88	6	0	1	7	7	0.03
Tributary Creek Site 9	DV	85-117	7	3	1	11	11	0.08
	CO	69-108	5	4	1	10	10	0.08
	CT	---	0	0	0	0	0	0.00
	Sc	---	0	0	0	0	0	0.00
2007								
Greens Creek Site 48	DV	53-154	50	29	16	95	113±19	0.18
Greens Creek Site 54	DV	50-145	64	19	24	107	126±19	0.38
	CO	---	0	0	0	0	0	0.00
Tributary Creek Site 9	DV	81-158	7	5	0	12	12	0.08
	CO	38-104	50	10	9	69	71±4	0.45
	CT	138	0	0	1	1	1	<0.01
	Sc	---	0	0	0	0	0	0.00
2008								
Greens Creek Site 48	DV	77-137	54	10	9	73	75±4	0.14
Greens Creek Site 54	DV	45-131	50	15	6	71	73	0.21
	CO	53-69	4	0	0	4	4	0.01
Tributary Creek Site 9	DV	60-108	15	4	3	22	22	0.16
	CO	41-100	72	44	26	142	177±30	1.33
	CT	82-112	1	0	2	3	3	0.02
	Sc	---	0	0	0	0	0	0.00

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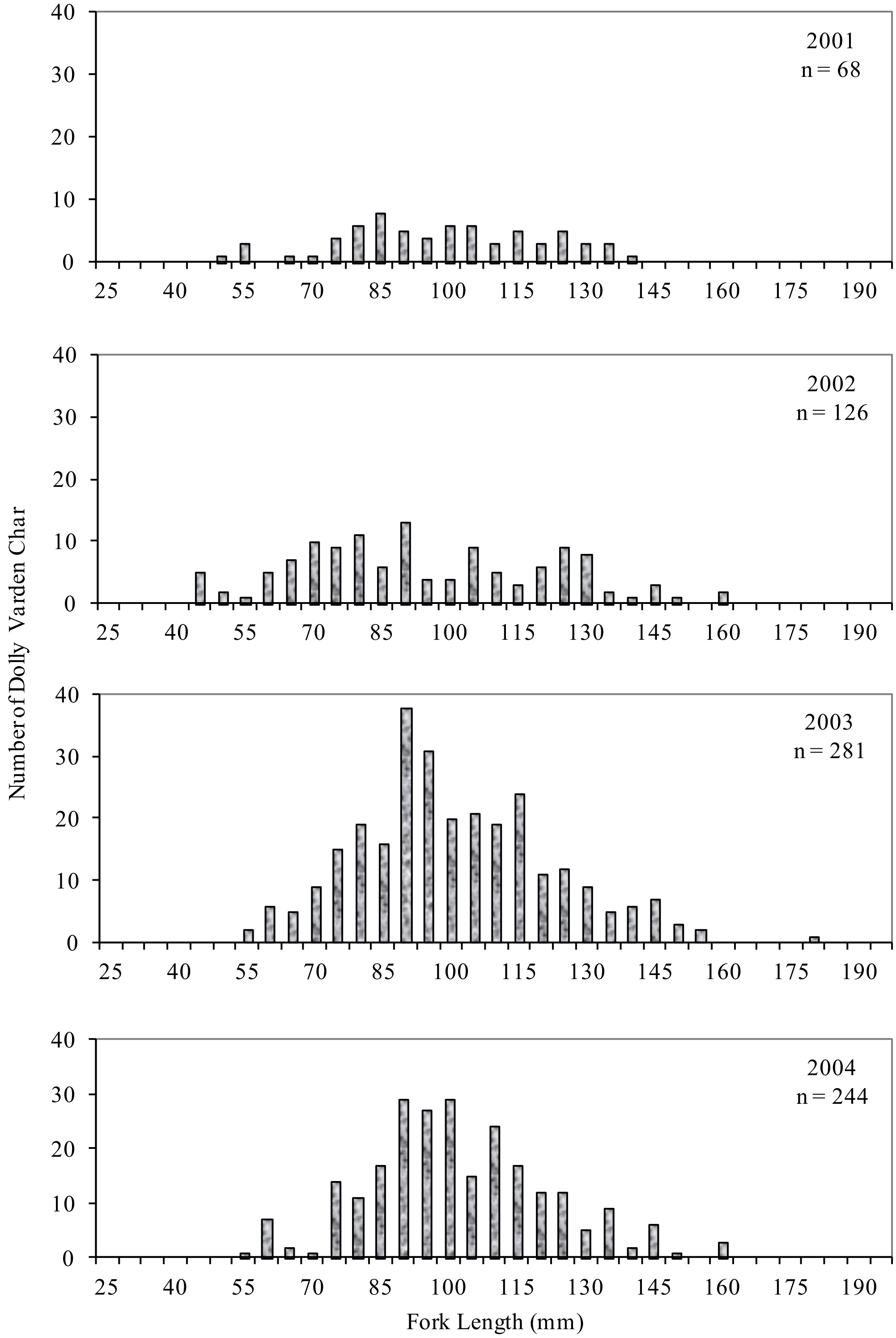
Appendix C1. Page 3 of 3.

Year and Sample Site	Species[a]	FL (mm)	Number of Fish Captured Set 1	Set 2	Set 3	Total	Population Estimate	Density (fish/m^2)
2009								
Greens Creek Site 48	DV	47-142	67	31	28	126	159±30	0.45
Greens Creek Site 54	DV	47-101	42	32	19	93	128±37	0.40
	CO	67-73	2	2	0	4	4	0.01
Tributary Creek Site 9	DV	48-98	24	5	9	38	42±7	0.35
	CO	38-116	42	9	2	53	53	0.44
	CT	97	1	0	0	1	1	<0.01
	Sc	75-94	4	0	1	5	5	0.04
2010								
Greens Creek Site 48	DV	47-170	97	41	20	158	172±13	0.31
Greens Creek Site 54	DV	52-151	46	13	14	73	81±10	0.24
	CO	77	1	0	0	1	1	<0.01
Tributary Creek Site 9	DV	58-108	21	7	31	59	59	0.52
	CO	39-90	77	21	30	128	152±22	1.35
	CT	64-89	4	1	0	5	5	0.04
	Sc	60-100	4	1	0	5	5	0.04
2011								
Greens Creek Site 48	DV	54-155	56	28	41	125	241±125	0.24
Greens Creek Site 6	DV	31-151	98	42	23	163	180±15	0.35
	CO	---	0	0	0	0	0	0.00
Greens Creek Site 54	DV	43-150	73	43	57	173	390±224	0.60
	CO	---	0	0	0	0	0	0.00
Tributary Creek Site 9	DV	50-125	15	7	14	36	36	0.31
	CO	38-100	18	18	13	49	85±50	0.74
	CT	115	1	0	0	1	1	<0.01
	Sc	66-85	0	1	1	2	2	0.02
2012								
Greens Creek Site 48	DV	64-148	85	22	28	135	153±17	0.41
Greens Creek Site 54	DV	47-143	92	39	58	189	313±105	0.43
	CO	67-71	0	3	2	5	5	0.01
Tributary Creek Site 9	DV	66-112	17	11	12	40	40	0.31
	CO	46-105	39	9	7	55	55	0.43
	CT	63-93	4	0	1	5	5	0.04
	Sc	60	1	0	0	1	1	<0.01

[a] Species: DV = Dolly Varden char, CO = coho salmon, CT = cutthroat trout, RT = rainbow trout, Sc = *Cottus* spp.

Appendix C2.–Length frequency diagrams for Dolly Varden char captured at Greens Creek Site 48, near Greens Creek Mine, 2001–2012.



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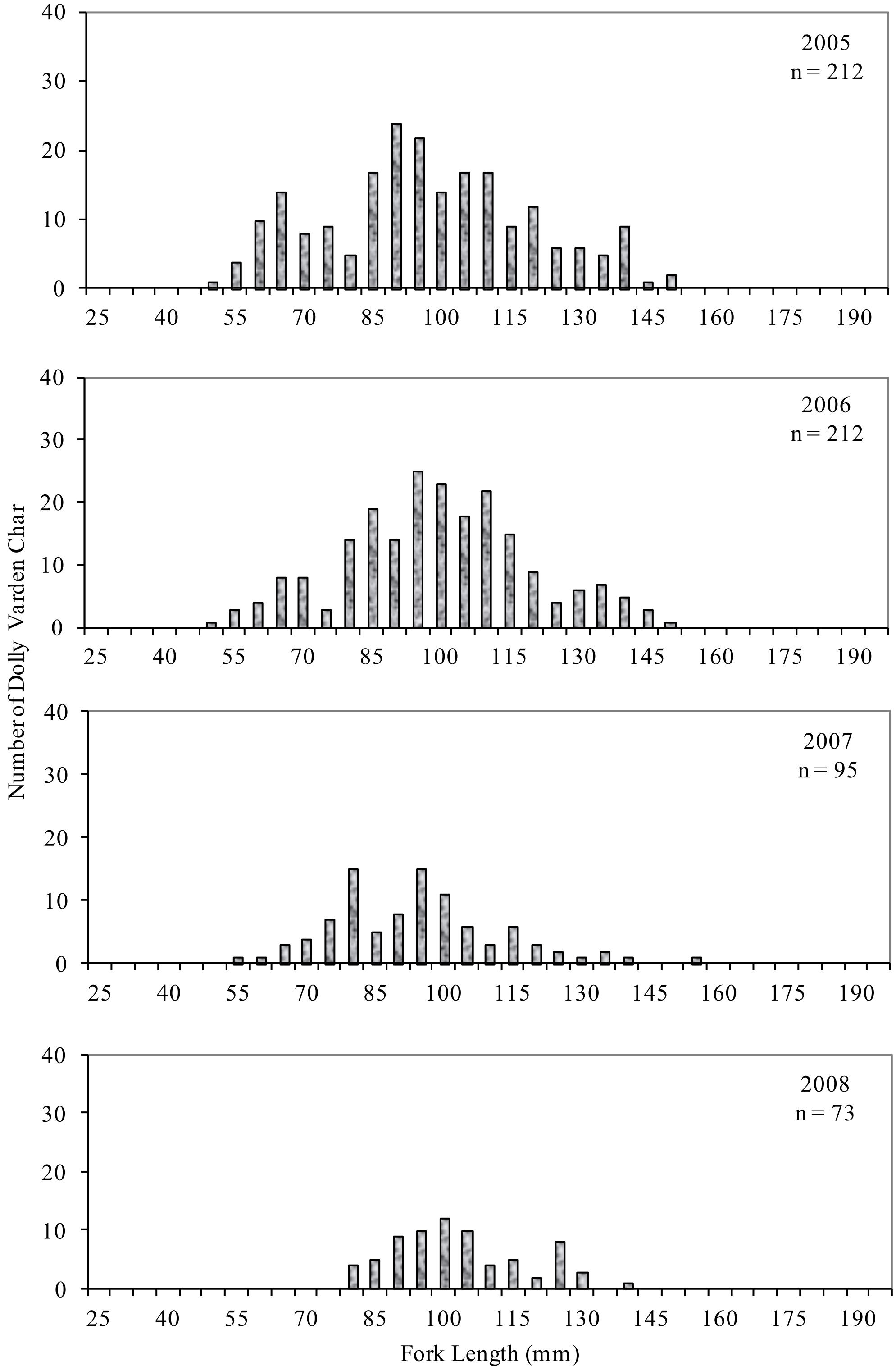
2005
n = 212
2006
n = 212
2007
n = 95
2008
n = 73
Number of Dolly Varden Char
Fork Length (mm)
0
10
20
30
40
25
40
55
70
85
100
115
130
145
160
175
190

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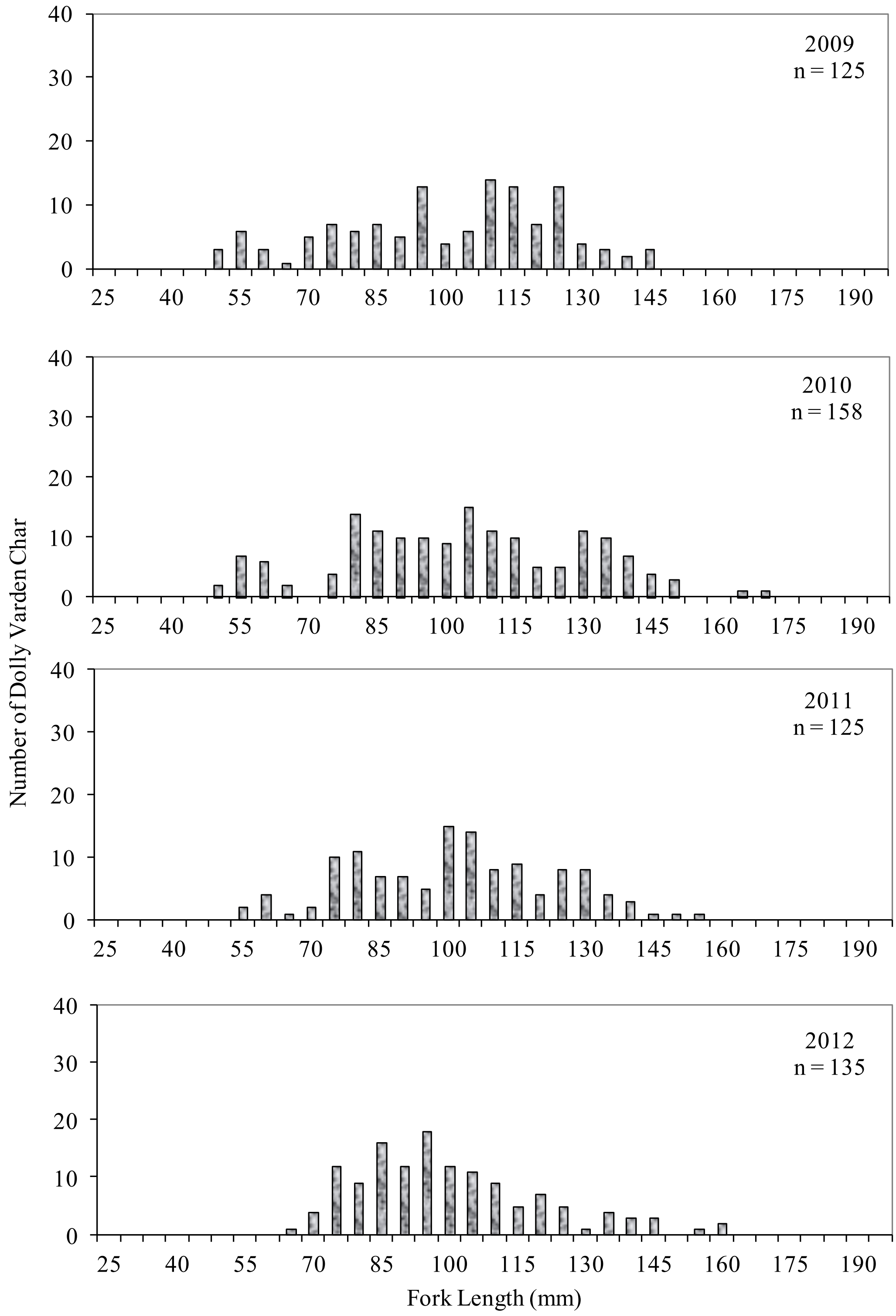
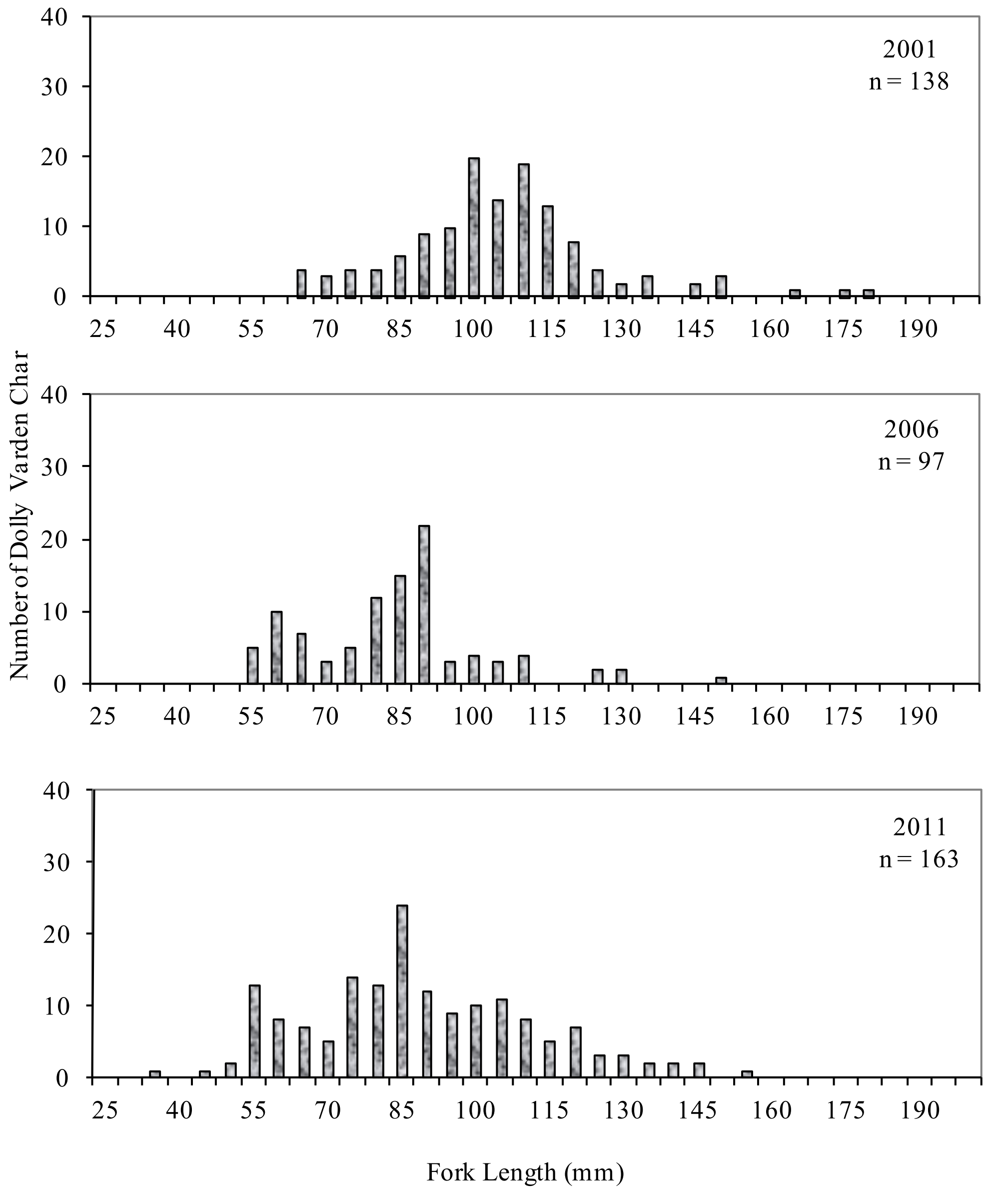
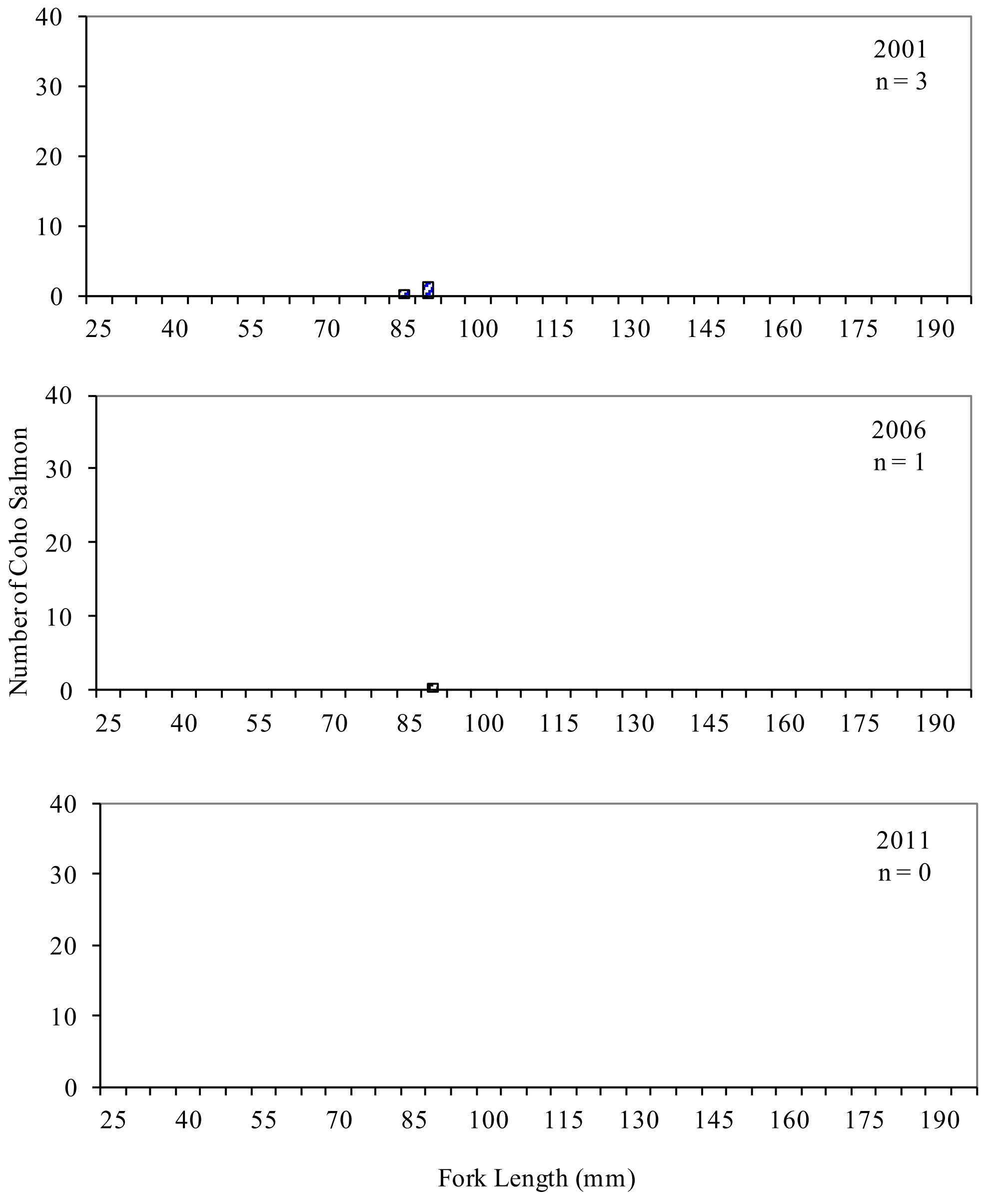
Appendix C2. Page 3 of 3.



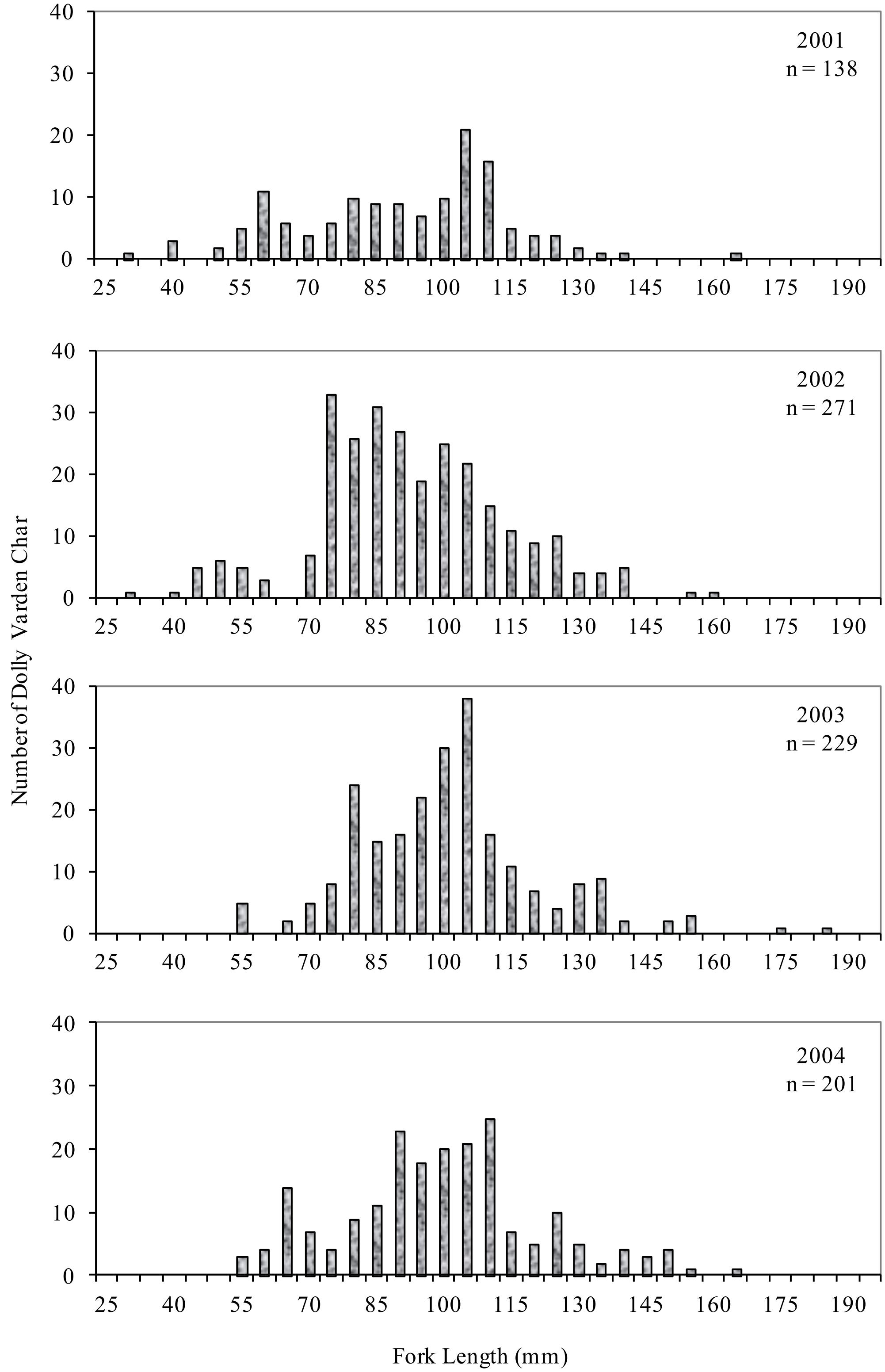
Appendix C3.–Length frequency diagrams for Dolly Varden char captured at Greens Creek Site 6, near Greens Creek Mine, in 2001, 2006, and 2011.



Appendix C4.–Length frequency diagrams for coho salmon captured at Greens Creek Site 6, near Greens Creek Mine, in 2001, 2006, and 2011.



Appendix C5.–Length frequency diagrams for Dolly Varden char captured at Greens Creek Site 54, near Greens Creek Mine, 2001–2012.



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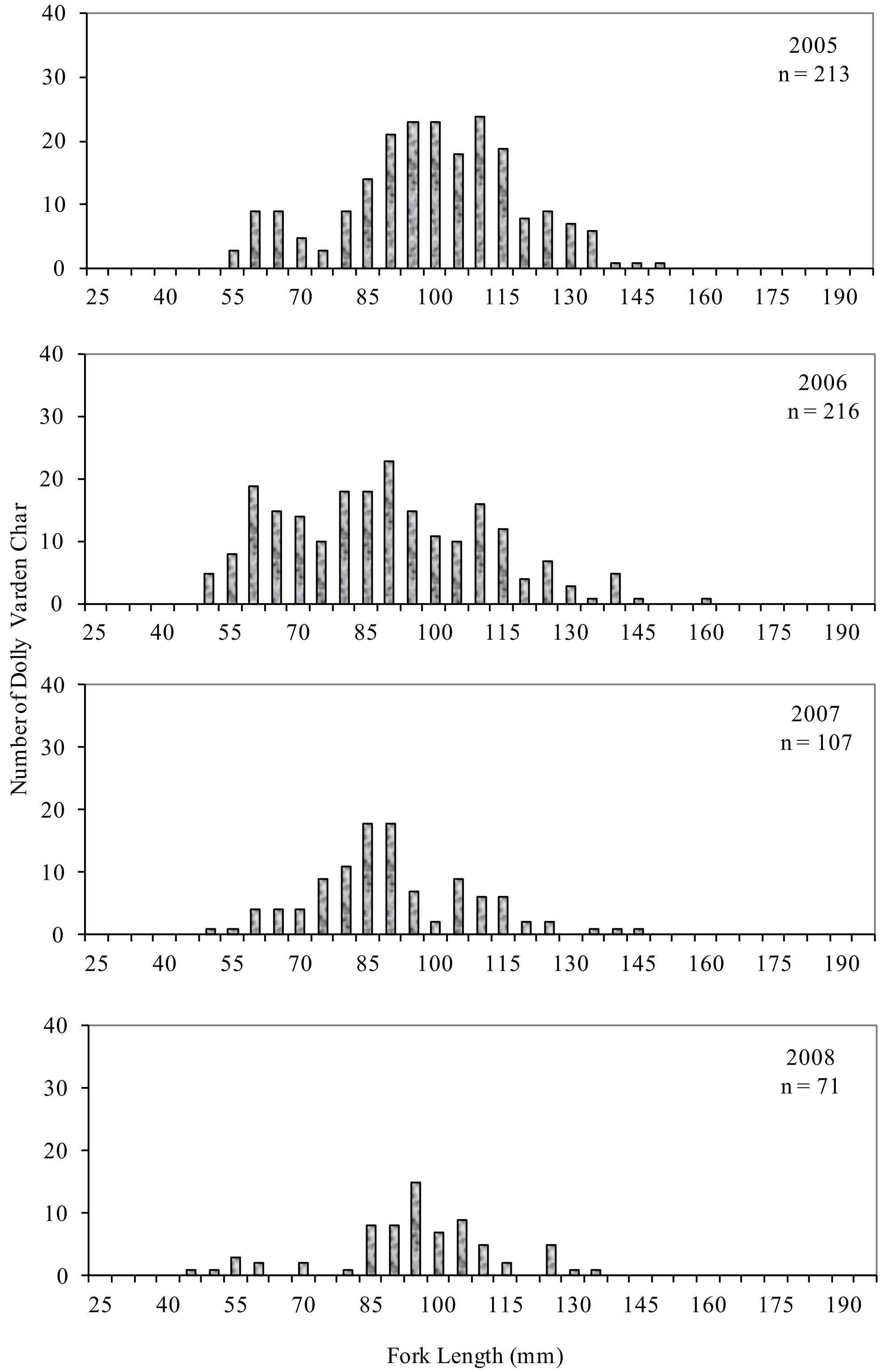
Appendix C5. Page 2 of 3.



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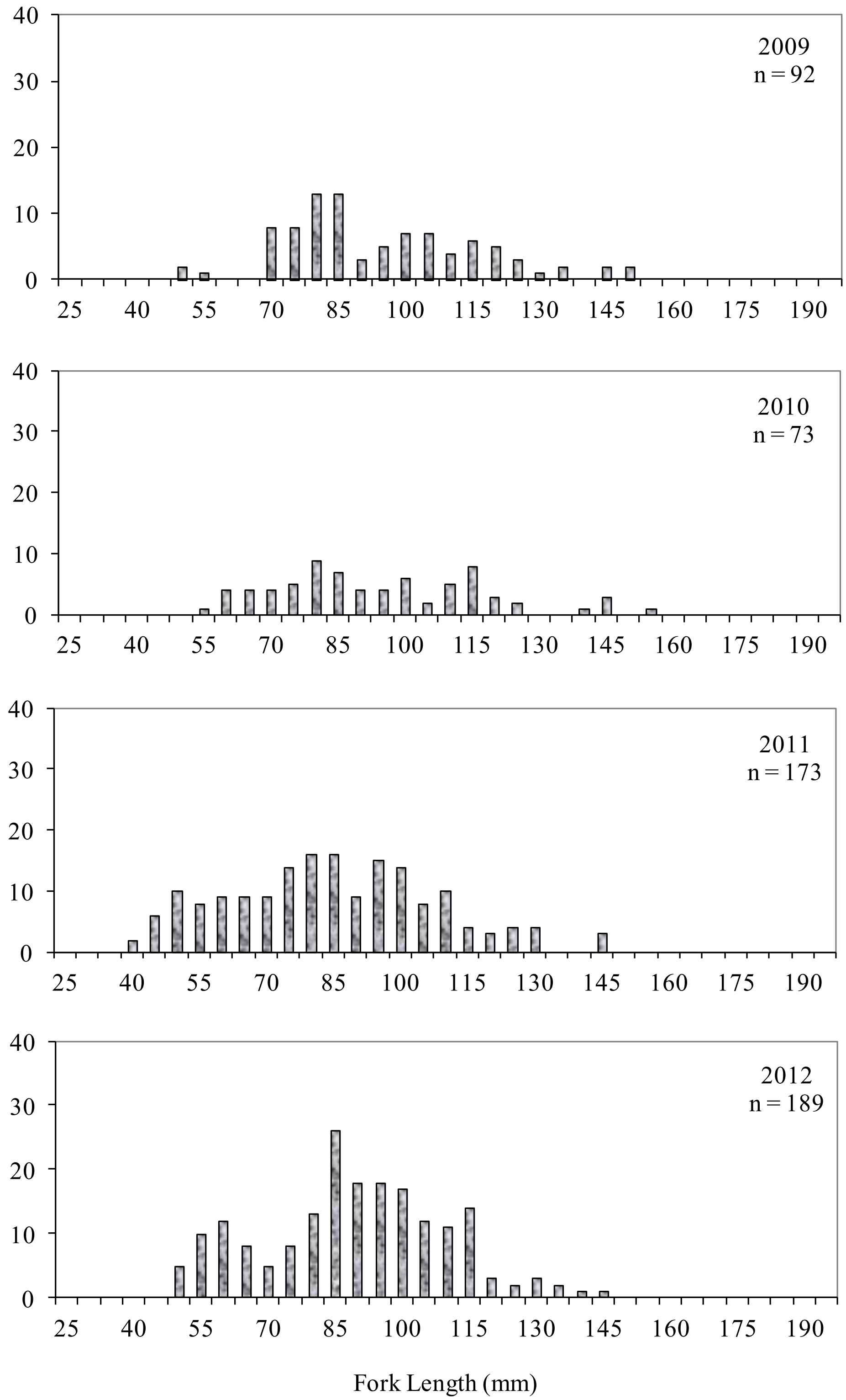
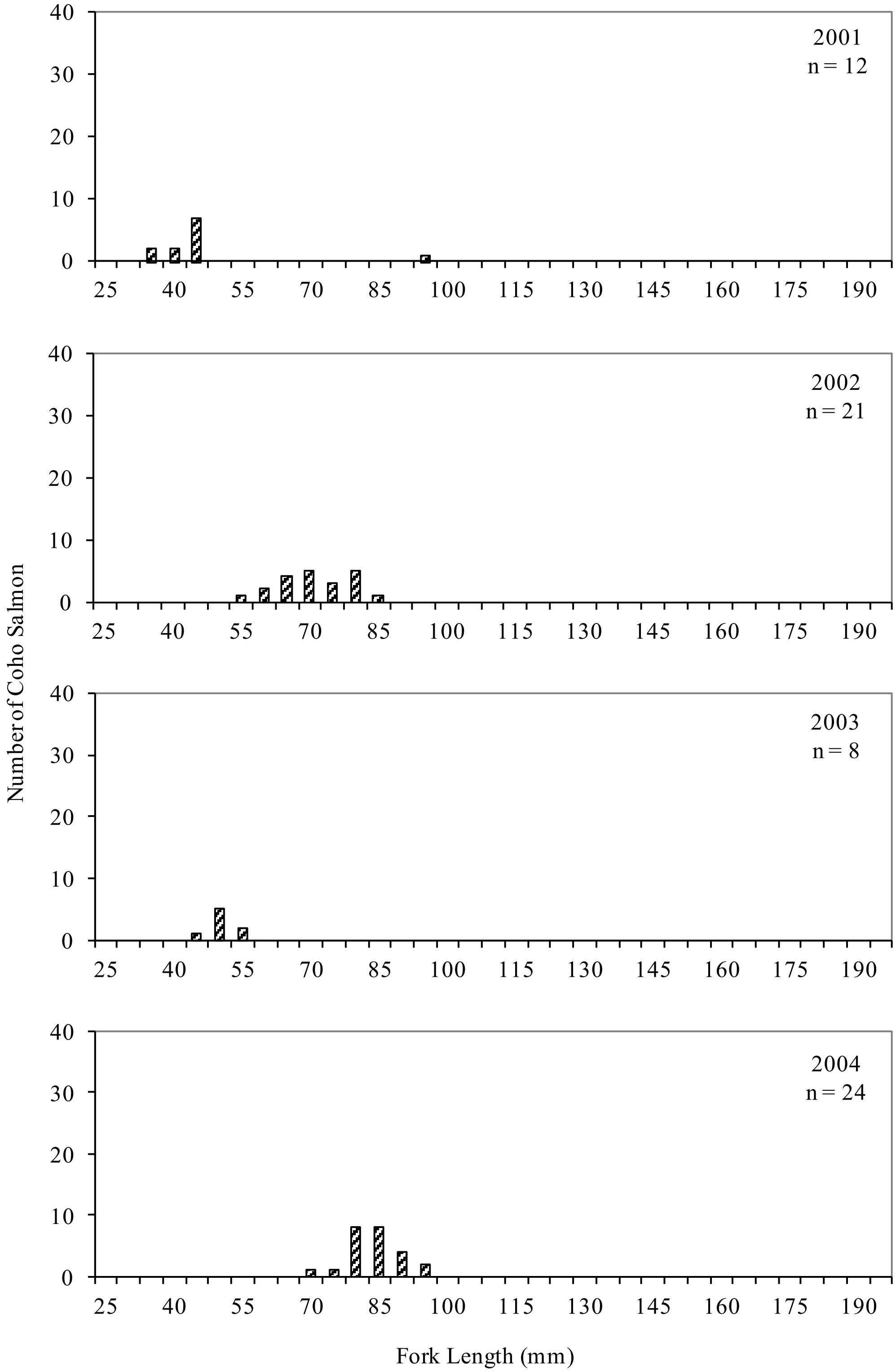

0
10
20
30
40
2009
n = 92
2010
n = 73
2011
n = 173
2012
n = 189
25 40 55 70 85 100 115 130 145 160 175 190
Fork Length (mm)

Appendix C6.–Length frequency diagrams for coho salmon captured at Greens Creek Site 54, near Greens Creek Mine, 2001–2012.



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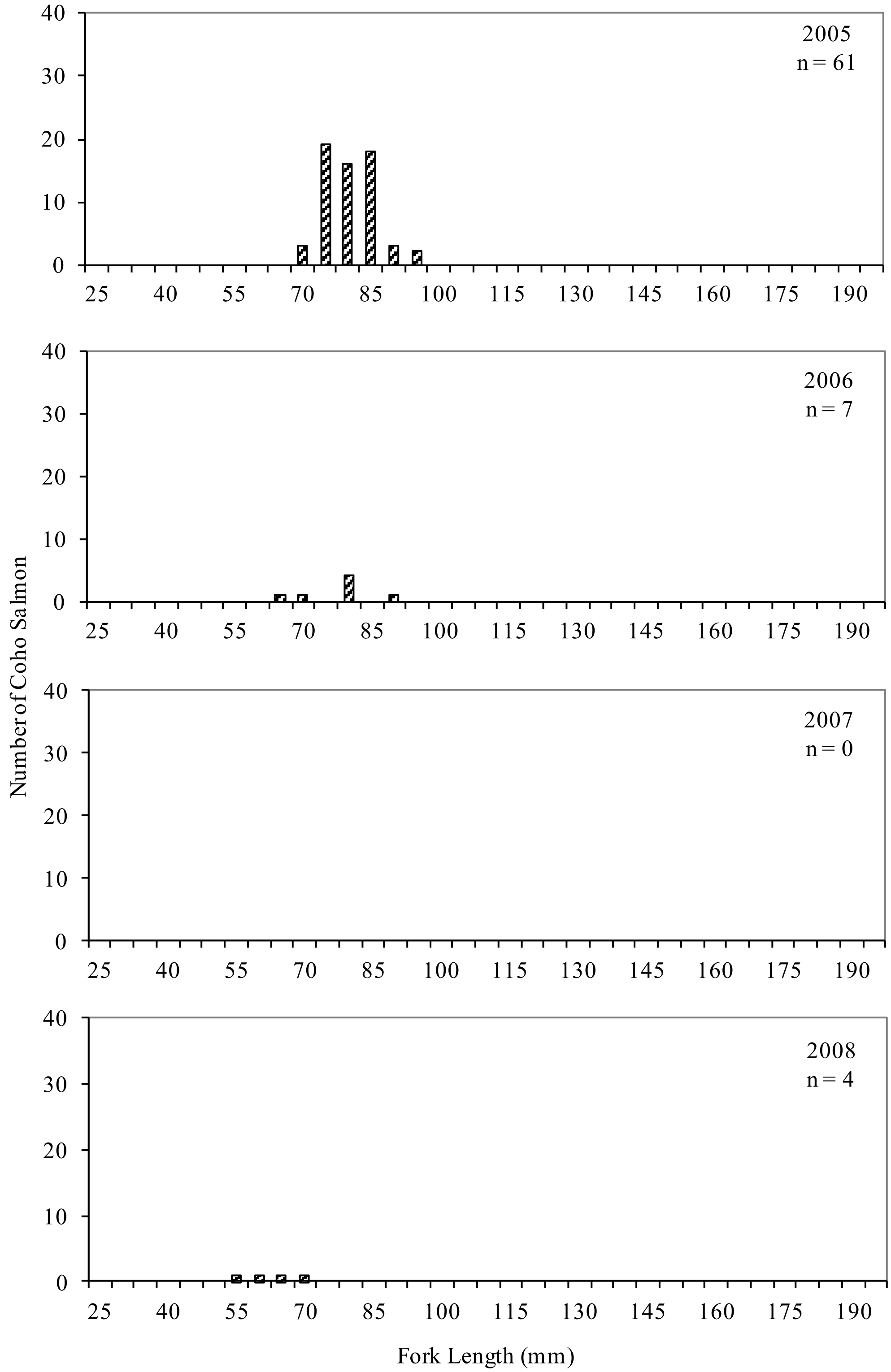
2005
n = 61
2006
n = 7
2007
n = 0
2008
n = 4
Number of Coho Salmon
0
10
20
30
40
25
40
55
70
85
100
115
130
145
160
175
190
Fork Length (mm)

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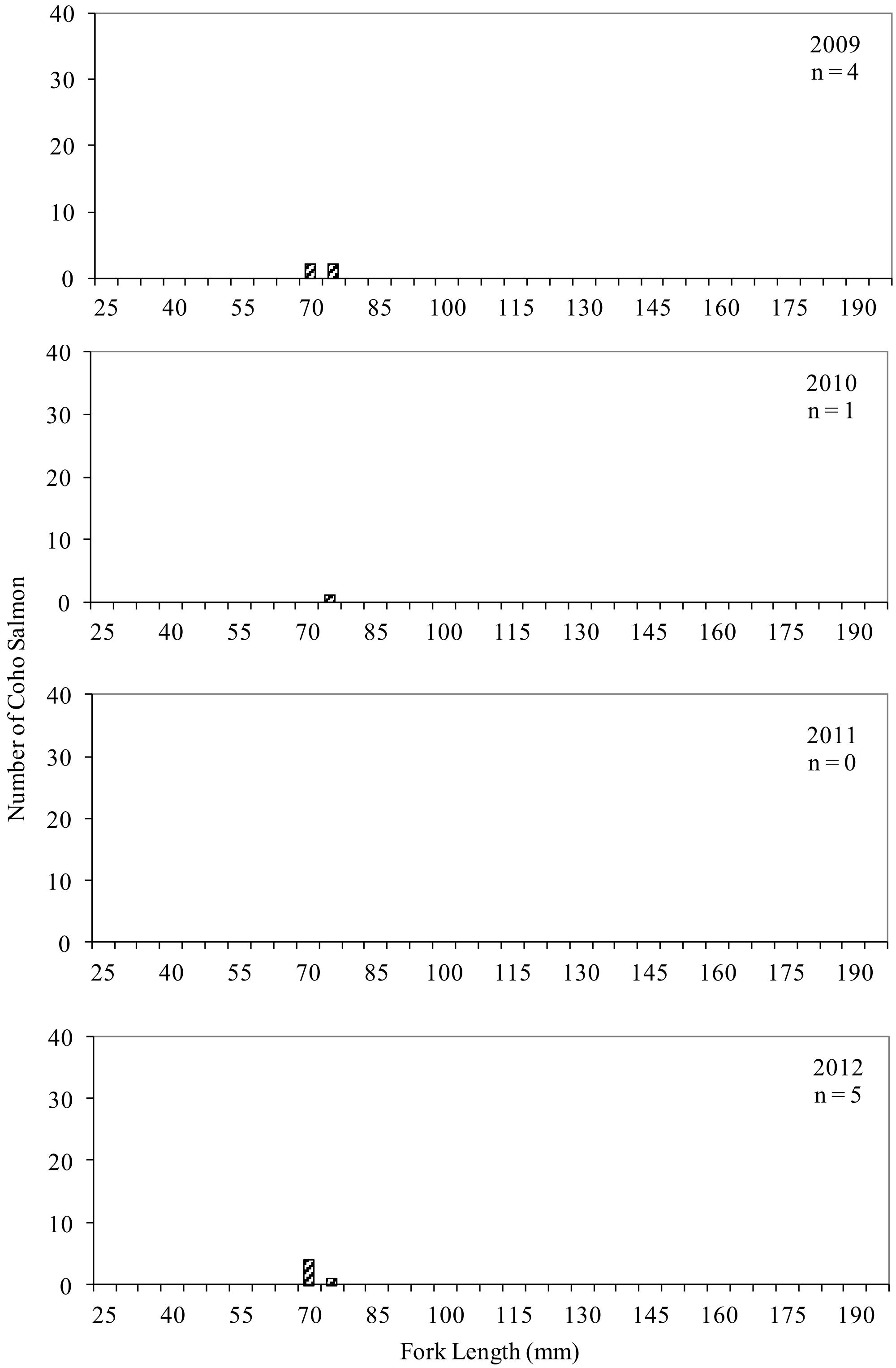
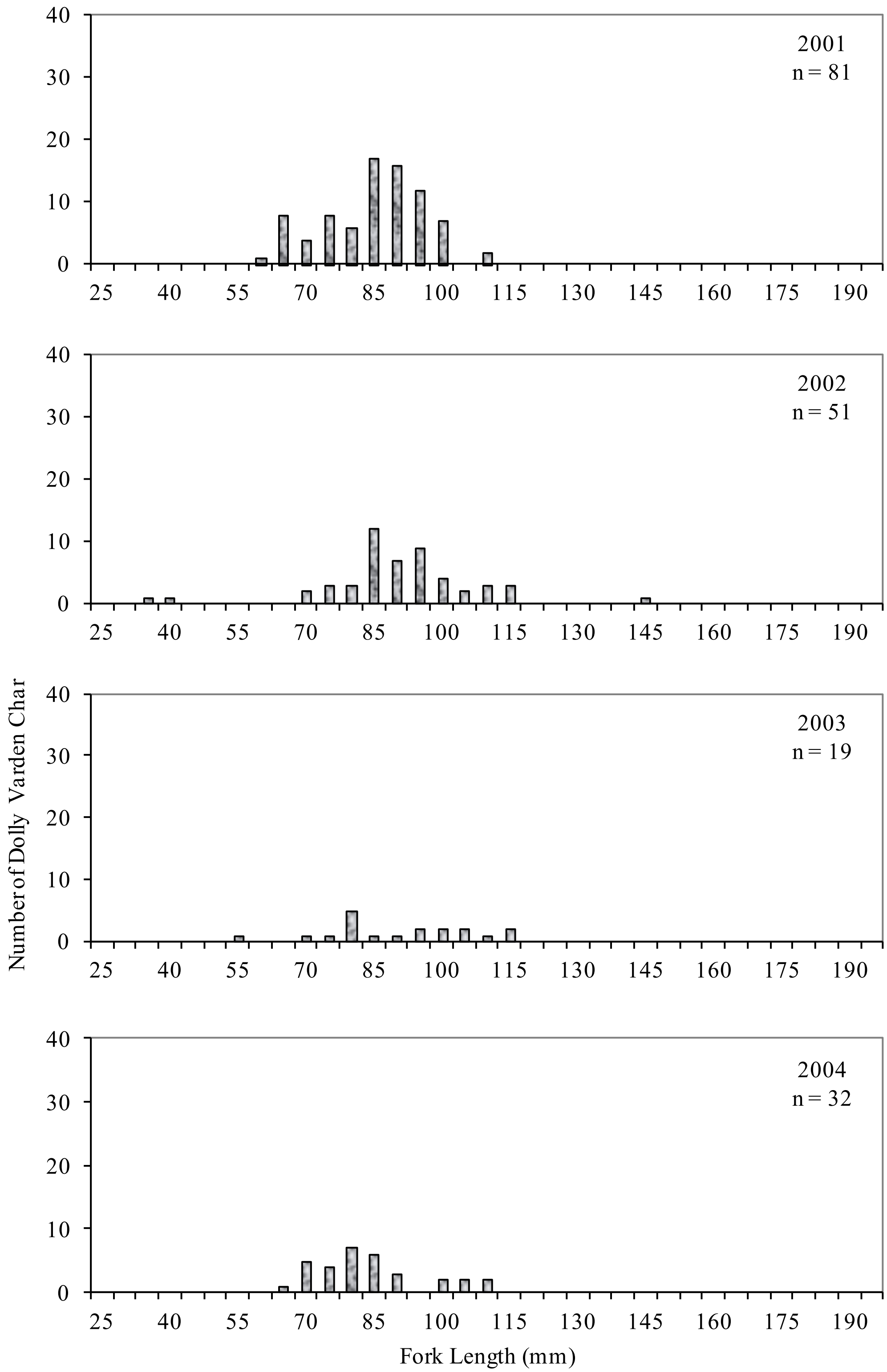
Appendix C6. Page 3 of 3.



Appendix C7.–Length frequency diagrams for Dolly Varden char captured at Tributary Creek Site 9, near Greens Creek Mine, 2001–2012.



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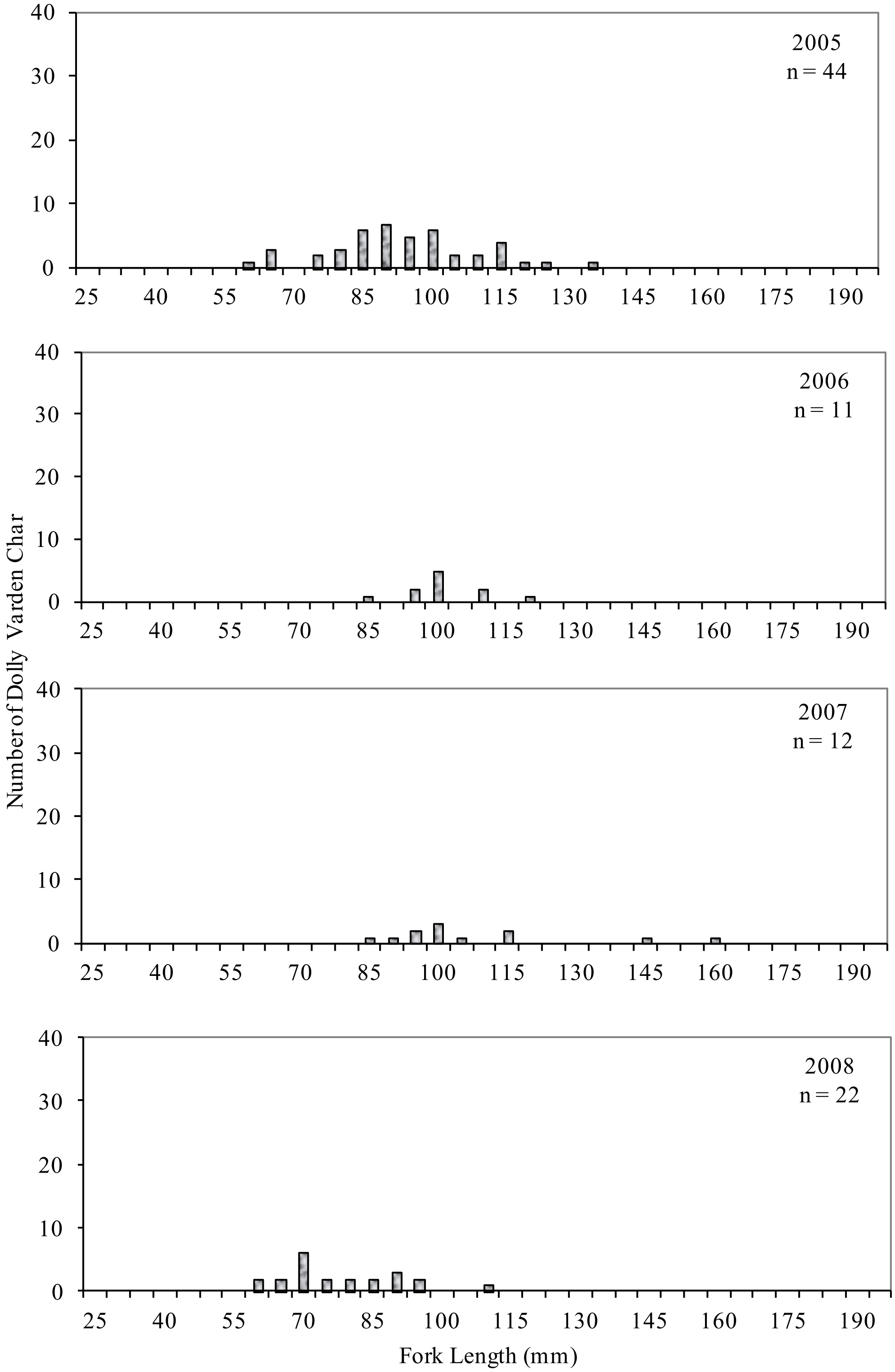
2005
n = 44
2006
n = 11
2007
n = 12
2008
n = 22
Number of Dolly Varden Char
Fork Length (mm)
0
10
20
30
40
25 40 55 70 85 100 115 130 145 160 175 190

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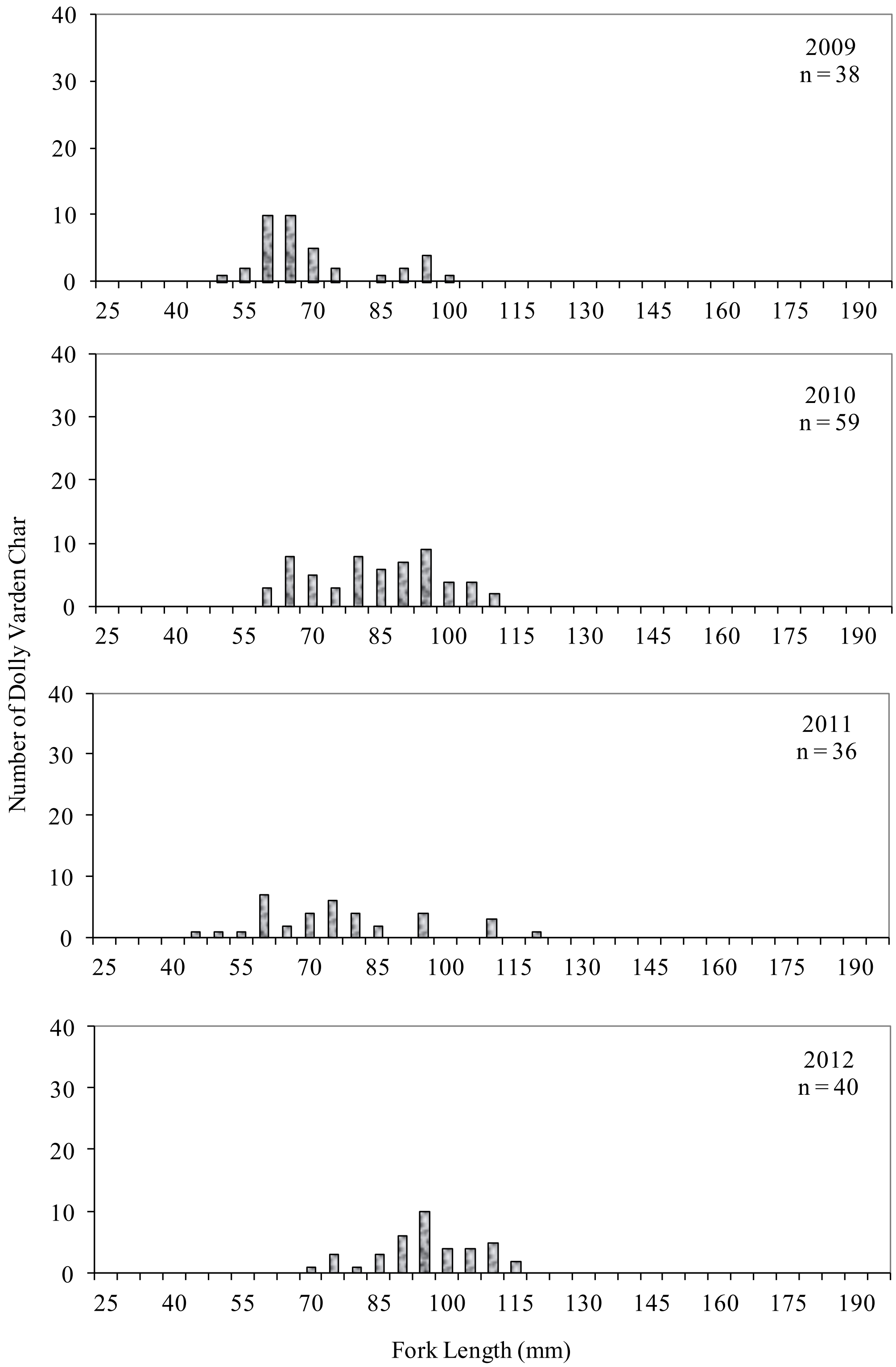
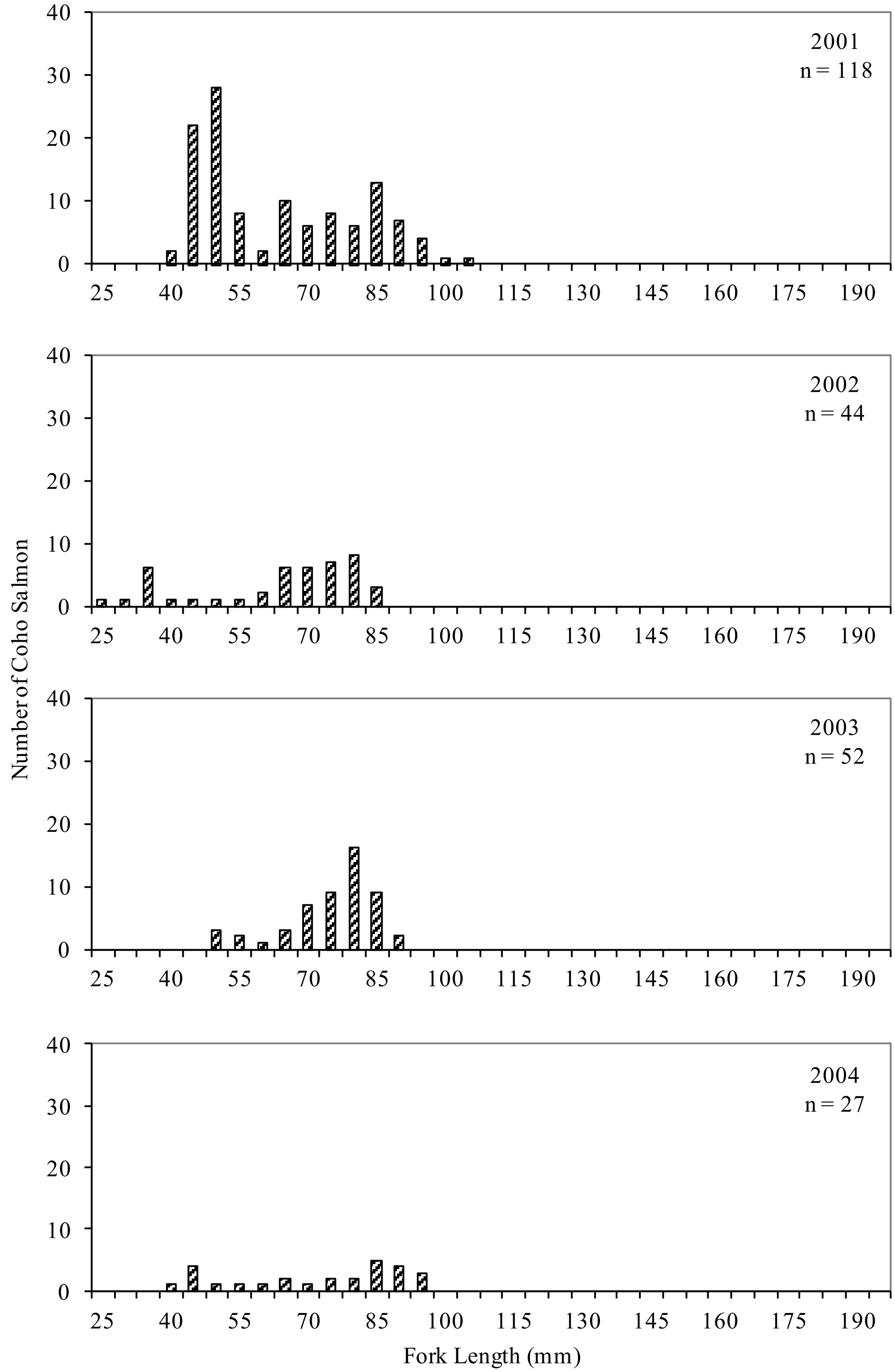
Appendix C7. Page 3 of 3.



Appendix C8.–Length frequency diagrams for coho salmon captured at Tributary Creek Site 9, near Greens Creek Mine, 2001–2012.



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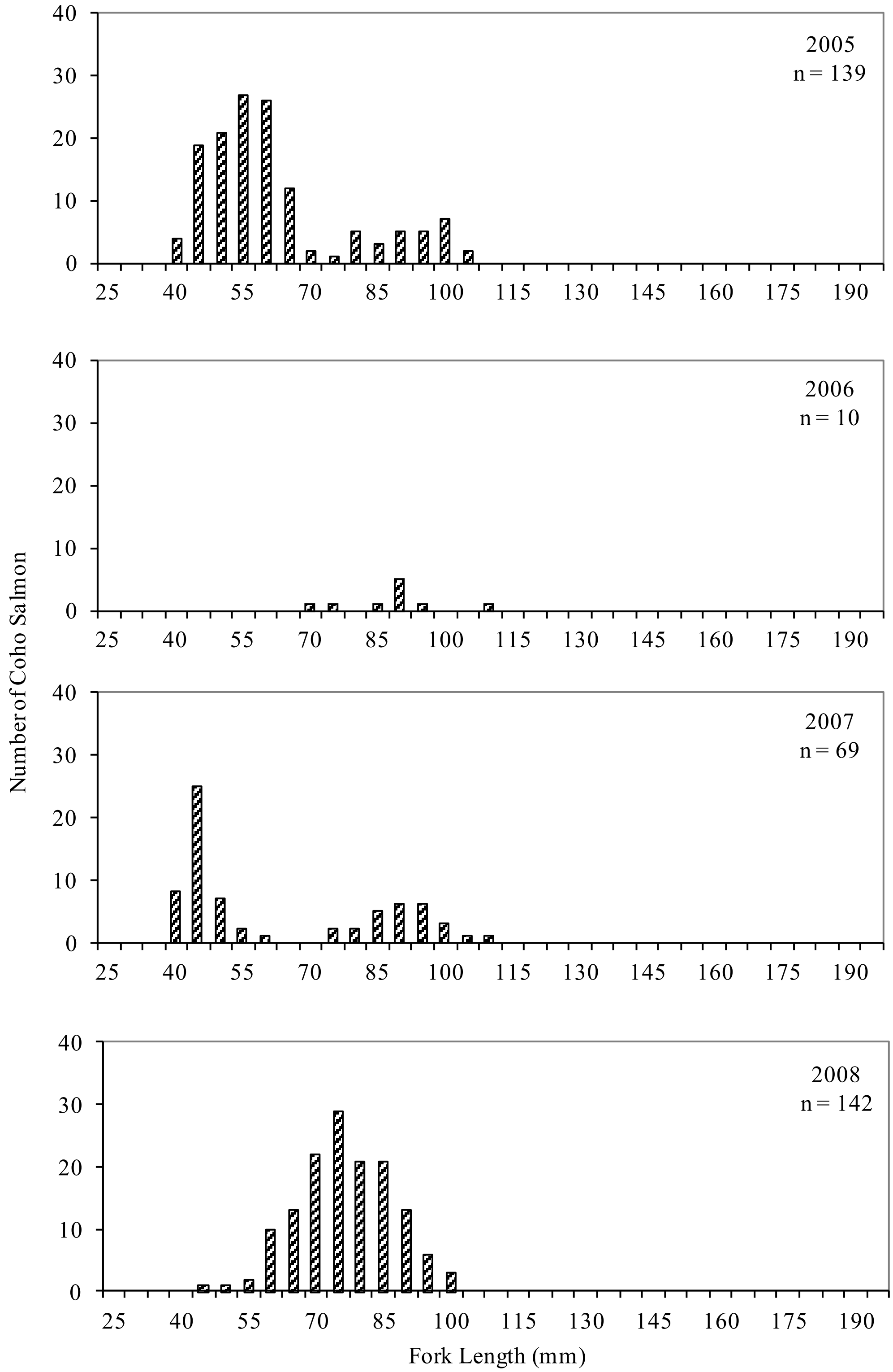
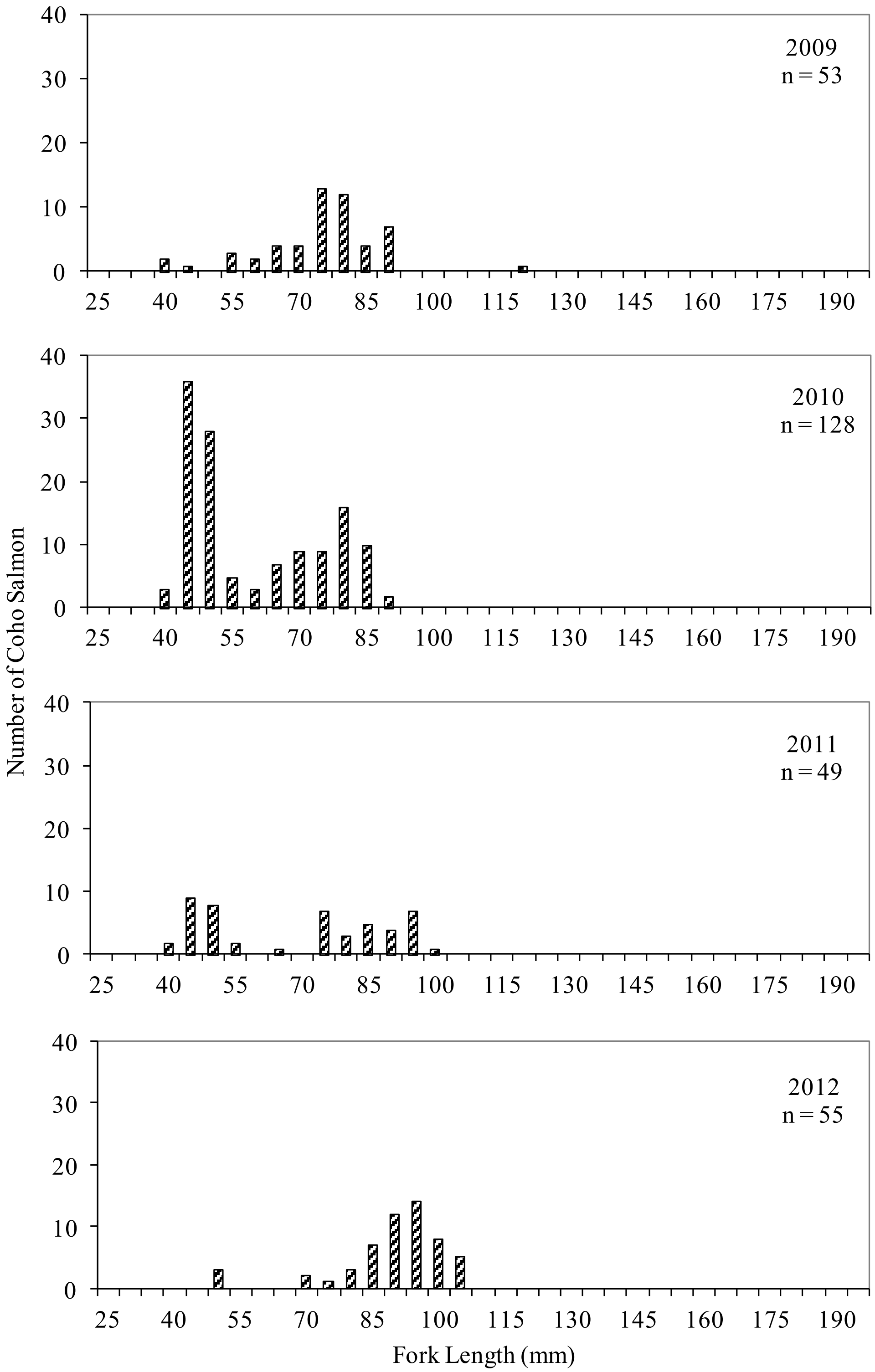

2005
n = 139
2006
n = 10
2007
n = 69
2008
n = 142
Number of Coho Salmon
Fork Length (mm)
0
10
20
30
40
25
40
55
70
85
100
115
130
145
160
175
190

-continued-


2009
n = 53
2010
n = 128
2011
n = 49
2012
n = 55
Number of Coho Salmon
Fork Length (mm)
0
10
20
30
40
25
40
55
70
85
100
115
130
145
160
175
190

APPENDIX D: JUVENILE FISH METALS CONCENTRATIONS DATA AND LABORATORY REPORT

Appendix D1.–Whole body metals and Se concentrations data for juvenile Dolly Varden char collected at Greens Creek Site 48, near Greens Creek Mine, 2001–2012.

Date Collected	Sample Site	FL (mm)	Mass (g)	Ag (mg/Kg)	Cd (mg/Kg)	Cu (mg/Kg)	Hg (mg/kg)	Pb (mg/Kg)	Se (mg/Kg)	Zn (mg/Kg)
		Minimum Detection Limit		0.02	0.02	0.10	0.02	0.02	1.00	0.50
7/23/01	Greens Creek Site 48	131	26.0	0.02	1.76	8.3	n/a	0.20	6.1	180
7/23/01	Greens Creek Site 48	137	28.8	0.03	0.89	7.2	n/a	0.17	4.6	146
7/23/01	Greens Creek Site 48	119	18.8	0.02	2.27	5.7	n/a	0.20	6.2	189
7/23/01	Greens Creek Site 48	121	21.1	0.02	1.56	6.9	n/a	0.17	5.2	182
7/23/01	Greens Creek Site 48	111	13.7	0.03	0.89	4.7	n/a	0.23	5.4	138
7/23/01	Greens Creek Site 48	121	21.1	<0.02	1.26	7.4	n/a	0.10	5.6	157
7/24/02	Greens Creek Site 48	133	23.2	0.03	1.64	6.8	n/a	0.72	4.8	239
7/24/02	Greens Creek Site 48	120	15.0	0.07	0.85	7.0	n/a	0.28	4.1	210
7/24/02	Greens Creek Site 48	122	17.5	0.03	0.74	4.3	n/a	0.17	4.9	162
7/24/02	Greens Creek Site 48	127	20.8	0.04	1.40	6.1	n/a	0.16	4.7	185
7/24/02	Greens Creek Site 48	134	24.8	0.05	1.30	7.9	n/a	0.46	4.3	208
7/24/02	Greens Creek Site 48	128	21.7	0.04	1.56	6.8	n/a	0.22	5.7	343
7/22/03	Greens Creek Site 48	90	8.9	<0.02	0.65	4.2	n/a	0.14	5.6	191
7/22/03	Greens Creek Site 48	98	9.9	<0.02	0.90	5.1	n/a	0.22	5.5	180
7/22/03	Greens Creek Site 48	103	12.1	<0.02	0.82	5.6	n/a	0.16	5.4	241
7/22/03	Greens Creek Site 48	112	12.5	<0.02	0.78	6.1	n/a	0.11	6.1	192
7/22/03	Greens Creek Site 48	108	11.9	<0.02	0.63	3.9	n/a	0.14	5.2	174
7/22/03	Greens Creek Site 48	100	10.5	<0.02	0.58	3.7	n/a	0.08	5.5	218
7/22/04	Greens Creek Site 48	96	8.6	<0.02	0.63	4.7	n/a	0.15	4.3	206
7/22/04	Greens Creek Site 48	88	6.8	<0.02	0.83	5.6	n/a	0.26	4.0	175
7/22/04	Greens Creek Site 48	101	11.5	<0.02	1.54	4.6	n/a	0.21	4.1	183
7/22/04	Greens Creek Site 48	98	9.3	<0.02	0.80	5.2	n/a	0.28	3.7	168
7/22/04	Greens Creek Site 48	93	7.6	<0.02	1.25	4.4	n/a	0.14	6.4	220
7/22/04	Greens Creek Site 48	91	7.5	0.03	1.01	4.5	n/a	0.29	5.6	323
7/22/05	Greens Creek Site 48	103	19.7	0.02	0.66	4.4	n/a	0.44	4.2	183
7/22/05	Greens Creek Site 48	96	13.1	<0.02	0.84	14.5	n/a	0.98	4.8	220
7/22/05	Greens Creek Site 48	119	15.6	0.02	0.89	4.3	n/a	0.66	4.8	226
7/22/05	Greens Creek Site 48	114	17.1	0.02	0.59	6.0	n/a	0.32	4.8	178
7/22/05	Greens Creek Site 48	111	15.3	0.03	1.10	18.8	n/a	0.79	4.6	217
7/22/05	Greens Creek Site 48	125	16.9	0.03	0.47	3.6	n/a	0.36	3.8	160
7/20/06	Greens Creek Site 48	110	15.8	0.04	0.56	8.5	n/a	0.37	5.4	244
7/20/06	Greens Creek Site 48	110	15.4	0.05	1.20	8.3	n/a	0.31	6.0	217
7/20/06	Greens Creek Site 48	113	16.1	0.04	0.65	6.3	n/a	0.24	5.4	264
7/20/06	Greens Creek Site 48	132	25.0	0.06	0.63	8.1	n/a	0.66	5.2	232
7/20/06	Greens Creek Site 48	104	12.8	0.08	0.96	8.5	n/a	0.37	5.1	283
7/20/06	Greens Creek Site 48	114	16.7	0.03	0.63	5.3	n/a	0.20	5.1	270
7/21/07	Greens Creek Site 48	122	17.9	0.03	1.16	5.5	n/a	0.17	5.5	221
7/21/07	Greens Creek Site 48	95	10.4	0.02	1.42	3.9	n/a	0.29	5.8	165
7/21/07	Greens Creek Site 48	135	22.8	0.08	1.34	14.1	n/a	1.37	5.3	166
7/21/07	Greens Creek Site 48	98	9.9	0.03	0.96	5.7	n/a	0.27	5.2	269
7/21/07	Greens Creek Site 48	105	13.2	0.11	1.79	11.4	n/a	1.62	5.4	323
7/21/07	Greens Creek Site 48	99	10.0	0.04	1.43	5.2	n/a	0.31	5.7	208
7/22/08	Greens Creek Site 48	112	16.4	0.07	1.23	5.2	n/a	0.95	5.7	289
7/22/08	Greens Creek Site 48	123	21.3	0.04	0.79	3.9	n/a	0.57	4.6	194
7/22/08	Greens Creek Site 48	105	14.0	0.08	0.81	4.6	n/a	0.52	5.9	200
7/22/08	Greens Creek Site 48	124	20.6	0.04	0.87	4.9	n/a	0.42	6.3	244
7/22/08	Greens Creek Site 48	115	16.9	0.03	1.36	5.3	n/a	0.51	5.4	254
7/22/08	Greens Creek Site 48	122	19.8	0.04	1.07	5.6	n/a	0.38	6.1	260
7/21/09	Greens Creek Site 48	120	20.1	<0.02	1.05	5.2	n/a	0.22	5.9	186
7/21/09	Greens Creek Site 48	121	20.7	<0.02	1.40	5.3	n/a	0.44	5.7	173
7/21/09	Greens Creek Site 48	119	17.9	0.02	1.10	4.5	n/a	0.13	5.9	182
7/21/09	Greens Creek Site 48	108	13.6	<0.02	1.20	4.1	n/a	0.15	5.7	162
7/21/09	Greens Creek Site 48	109	14.6	<0.02	1.50	4.9	n/a	0.17	5.9	186
7/21/09	Greens Creek Site 48	110	15.2	<0.02	0.84	3.8	n/a	0.18	6.1	202
7/21/10	Greens Creek Site 48	103	11.9	0.02	1.56	4.8	n/a	0.16	5.0	226
7/21/10	Greens Creek Site 48	109	16.1	<0.02	0.51	3.0	n/a	0.20	5.6	168
7/21/10	Greens Creek Site 48	108	13.9	0.04	0.91	4.2	n/a	0.30	5.0	180
7/21/10	Greens Creek Site 48	105	13.8	<0.02	0.98	3.4	n/a	0.09	4.6	163
7/21/10	Greens Creek Site 48	98	10.8	0.06	0.90	4.8	n/a	0.46	4.8	213
7/21/10	Greens Creek Site 48	93	9.1	<0.02	0.96	3.6	n/a	0.09	4.0	156
7/22/11	Greens Creek Site 48	88-112	n/a	0.03	1.14	5.7	n/a	0.30	6.1	218
7/24/12	Greens Creek Site 48	109	11.3	0.03	2.26	27.0	0.122	0.16	5.5	186
7/24/12	Greens Creek Site 48	123	18.3	0.03	1.37	4.9	0.159	0.10	5.7	184
7/24/12	Greens Creek Site 48	110	9.8	0.03	1.83	25.6	0.175	2.59	5.6	275
7/24/12	Greens Creek Site 48	103	10.6	0.03	0.99	76.8	0.122	0.30	5.1	189
7/24/12	Greens Creek Site 48	104	10.7	0.03	2.66	84.8	0.148	1.05	6.3	242
7/24/12	Greens Creek Site 48	116	15.8	0.04	0.73	35.1	0.429	1.03	4.7	190

Appendix D2.–Whole body metals and Se concentrations data for juvenile Dolly Varden char collected at Greens Creek Site 6, near Greens Creek Mine, in 2001, 2006, and 2011.

Date Collected	Sample Site	FL (mm)	Mass (g)	Ag (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
		Minimum Detection Limit		0.02	0.02	0.10	0.02	0.02	1.00	0.50
7/23/01	Greens Creek Site 6	139	28.4	0.04	1.94	16.7	n/a	1.24	5.0	173
7/23/01	Greens Creek Site 6	140	30.5	0.03	0.84	4.6	n/a	1.00	4.5	167
7/23/01	Greens Creek Site 6	167	43.9	0.03	0.82	5.3	n/a	1.94	4.3	171
7/23/01	Greens Creek Site 6	155	34.8	0.03	1.52	5.4	n/a	1.78	4.5	215
7/23/01	Greens Creek Site 6	109	15.7	0.02	0.89	11.1	n/a	0.33	5.3	126
7/23/01	Greens Creek Site 6	168	49.1	0.04	0.73	8.0	n/a	1.96	4.6	169
7/21/06	Greens Creek Site 6	103	12.6	0.03	0.71	8.0	n/a	0.70	5.2	183
7/21/06	Greens Creek Site 6	106	13.5	0.04	0.81	12.0	n/a	0.62	5.6	271
7/21/06	Greens Creek Site 6	96	11.8	0.03	0.56	12.7	n/a	0.97	4.5	215
7/21/06	Greens Creek Site 6	110	12.0	0.03	0.56	7.7	n/a	0.92	5.9	223
7/21/06	Greens Creek Site 6	128	23.2	0.03	0.95	5.4	n/a	1.31	4.4	221
7/21/06	Greens Creek Site 6	102	11.5	0.02	0.63	6.5	n/a	0.86	4.5	302
7/21/11	Greens Creek Site 6	85-120	n/a	0.03	0.92	6.6	n/a	0.82	5.7	209

Appendix D3.–Whole body metals and Se concentrations data for juvenile Dolly Varden char collected at Greens Creek Site 54, near Greens Creek Mine, 2001–2012.

Date Collected	Sample Site	FL (mm)	Mass (g)	Ag (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
		Minimum Detection	Limit	0.02	0.02	0.10	0.02	0.02	1.00	0.50
7/23/01	Greens Creek Site 54	121	21.5	0.03	0.46	4.3	n/a	0.33	5.7	126
7/23/01	Greens Creek Site 54	119	19.3	0.02	0.21	3.2	n/a	0.22	3.6	82
7/23/01	Greens Creek Site 54	107	15.7	0.03	0.73	6.3	n/a	0.59	4.7	144
7/23/01	Greens Creek Site 54	109	13.6	0.02	0.82	5.4	n/a	0.86	4.9	172
7/23/01	Greens Creek Site 54	105	13.5	<0.02	0.79	6.5	n/a	0.45	5.8	203
7/23/01	Greens Creek Site 54	138	27.5	<0.02	0.74	5.8	n/a	0.40	5.4	171
7/24/02	Greens Creek Site 54	118	18.0	0.03	0.50	4.4	n/a	0.94	3.4	363
7/24/02	Greens Creek Site 54	128	22.3	0.03	0.52	4.5	n/a	0.35	4.7	150
7/24/02	Greens Creek Site 54	115	17.7	0.05	0.95	6.0	n/a	0.66	4.4	161
7/24/02	Greens Creek Site 54	115	18.9	0.03	1.03	5.2	n/a	0.66	4.2	216
7/24/02	Greens Creek Site 54	124	21.1	0.05	1.32	5.2	n/a	0.74	3.9	194
7/24/02	Greens Creek Site 54	123	20.9	0.02	0.70	3.9	n/a	0.78	4.4	195
7/22/03	Greens Creek Site 54	123	21.1	0.03	0.85	6.4	n/a	1.40	6.1	188
7/22/03	Greens Creek Site 54	101	10.6	<0.02	0.67	4.2	n/a	0.32	6.4	174
7/22/03	Greens Creek Site 54	88	9.2	<0.02	0.75	4.3	n/a	0.35	6.5	186
7/22/03	Greens Creek Site 54	109	14.8	<0.02	1.11	5.8	n/a	0.38	5.7	188
7/22/03	Greens Creek Site 54	95	10.6	<0.02	0.59	3.5	n/a	0.29	5.7	174
7/22/03	Greens Creek Site 54	92	9.7	<0.02	0.91	4.1	n/a	0.43	6.5	263
7/21/04	Greens Creek Site 54	103	9.9	0.02	0.79	11.0	n/a	0.57	4.6	232
7/21/04	Greens Creek Site 54	104	10.0	<0.02	0.88	5.5	n/a	0.54	5.0	206
7/21/04	Greens Creek Site 54	86	6.6	<0.02	1.26	5.1	n/a	0.36	5.3	164
7/21/04	Greens Creek Site 54	96	9.3	0.03	0.79	5.9	n/a	0.28	5.4	191
7/21/04	Greens Creek Site 54	93	9.9	<0.02	0.83	5.0	n/a	0.48	3.9	202
7/21/04	Greens Creek Site 54	104	12.9	0.07	1.12	7.0	n/a	0.93	4.9	216
7/22/05	Greens Creek Site 54	120	12.3	0.03	0.72	5.0	n/a	0.27	4.0	160
7/22/05	Greens Creek Site 54	106	12.1	0.02	0.63	4.5	n/a	0.13	3.9	200
7/22/05	Greens Creek Site 54	113	20.8	<0.02	0.73	8.8	n/a	0.17	4.7	223
7/22/05	Greens Creek Site 54	114	17.9	<0.02	0.82	9.7	n/a	0.17	3.9	222
7/22/05	Greens Creek Site 54	112	16.1	0.03	1.06	8.8	n/a	0.22	4.4	209
7/22/05	Greens Creek Site 54	118	22.3	0.02	0.55	5.5	n/a	0.39	3.9	185
7/20/06	Greens Creek Site 54	137	27.3	0.06	0.42	4.8	n/a	0.50	5.7	208
7/20/06	Greens Creek Site 54	112	14.9	0.04	0.75	16.0	n/a	0.95	7.2	223
7/20/06	Greens Creek Site 54	102	12.0	0.02	0.93	22.2	n/a	0.52	6.3	239
7/20/06	Greens Creek Site 54	114	19.6	0.04	1.03	7.6	n/a	0.85	5.3	252
7/20/06	Greens Creek Site 54	98	12.3	0.08	0.54	10.9	n/a	0.48	5.4	223
7/20/06	Greens Creek Site 54	115	16.9	0.04	0.78	8.6	n/a	0.68	5.6	257
7/20/07	Greens Creek Site 54	102	11.8	0.04	0.88	5.3	n/a	0.54	5.6	157
7/20/07	Greens Creek Site 54	125	21.1	0.03	0.97	5.2	n/a	0.83	7.5	234
7/20/07	Greens Creek Site 54	97	10.7	0.06	0.81	5.7	n/a	0.89	8.6	185
7/20/07	Greens Creek Site 54	123	19.7	0.02	0.75	4.4	n/a	0.50	7.1	175
7/20/07	Greens Creek Site 54	104	12.5	0.03	0.92	5.6	n/a	0.57	7.8	174
7/20/07	Greens Creek Site 54	110	15.1	0.04	1.38	6.2	n/a	0.82	5.4	191
7/22/08	Greens Creek Site 54	123	21.9	0.04	0.66	5.3	n/a	0.26	5.5	185
7/22/08	Greens Creek Site 54	94	10.8	0.04	1.04	5.1	n/a	0.28	6.1	203
7/22/08	Greens Creek Site 54	123	21.5	0.03	1.53	4.9	n/a	3.46	6.3	261
7/22/08	Greens Creek Site 54	97	11.2	0.03	1.34	5.0	n/a	0.17	5.9	199
7/22/08	Greens Creek Site 54	108	16.0	0.05	1.98	6.3	n/a	0.23	6.0	220
7/22/08	Greens Creek Site 54	108	14.2	0.06	1.07	8.4	n/a	1.31	5.0	195
7/21/09	Greens Creek Site 54	132	26.9	0.04	1.10	4.8	n/a	0.33	5.4	213
7/21/09	Greens Creek Site 54	141	32.3	0.02	0.71	4.5	n/a	0.45	7.9	143
7/21/09	Greens Creek Site 54	116	17.9	<0.02	0.99	4.2	n/a	0.40	6.3	153
7/21/09	Greens Creek Site 54	117	17.7	0.03	1.00	5.9	n/a	0.39	6.8	200
7/21/09	Greens Creek Site 54	119	22.1	<0.02	1.20	4.0	n/a	0.28	6.5	176
7/21/09	Greens Creek Site 54	103	13.0	0.02	2.20	5.3	n/a	0.35	5.9	226
7/20/10	Greens Creek Site 54	115	16.0	<0.02	0.81	3.4	n/a	0.30	4.7	161
7/20/10	Greens Creek Site 54	112	12.8	0.02	0.67	3.1	n/a	0.34	3.7	154
7/20/10	Greens Creek Site 54	118	12.6	<0.02	0.98	3.6	n/a	0.25	5.2	190
7/20/10	Greens Creek Site 54	108	10.6	<0.02	1.31	3.8	n/a	0.16	4.1	212
7/20/10	Greens Creek Site 54	115	12.3	<0.02	1.73	5.0	n/a	0.36	4.4	222
7/20/10	Greens Creek Site 54	94	9.0	0.03	0.77	4.0	n/a	0.31	4.8	199
7/21/11	Greens Creek Site 54	95-117	n/a	<0.02	0.95	4.5	n/a	0.32	5.6	191
7/23/12	Greens Creek Site 54	132	24.2	0.04	1.03	7.7	0.109	0.57	6.3	199
7/23/12	Greens Creek Site 54	118	17.3	0.02	0.83	7.7	0.112	0.41	9.2	142
7/23/12	Greens Creek Site 54	109	13.1	0.06	2.04	19.2	0.126	1.32	7.4	215
7/23/12	Greens Creek Site 54	97	9.1	0.03	2.04	65.6	0.123	0.50	6.2	227
7/23/12	Greens Creek Site 54	115	15.4	0.04	1.22	12.6	0.080	1.10	6.9	202
7/23/12	Greens Creek Site 54	119	18.3	0.03	1.81	5.3	0.134	0.27	5.1	191

Appendix D4.–Whole body metals and Se concentrations data for juvenile Dolly Varden char collected at Tributary Creek Site 9, near Greens Creek Mine, 2001–2012.

Date Collected	Sample Site	FL (mm)	Mass (g)	Ag (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
		Minimum Detection Limit		0.02	0.02	0.10	0.02	0.02	1.00	0.50
7/21/01	Tributary Creek Site 9	97	9.1	0.09	0.35	4.3	n/a	0.56	6.8	127
7/21/01	Tributary Creek Site 9	97	9.7	0.10	0.77	5.2	n/a	0.67	8.0	118
7/21/01	Tributary Creek Site 9	97	9.5	0.15	0.92	5.4	n/a	4.88	5.3	144
7/21/01	Tributary Creek Site 9	98	10.4	0.15	0.86	6.7	n/a	2.19	-	99
7/21/01	Tributary Creek Site 9	86	6.4	0.08	0.76	4.9	n/a	0.33	6.2	106
7/21/01	Tributary Creek Site 9	93	7.8	0.06	0.37	12.0	n/a	0.38	6.8	122
7/24/02	Tributary Creek Site 9	103	10.8	0.02	0.22	3.7	n/a	0.12	1.4	144
7/24/02	Tributary Creek Site 9	97	10.4	0.07	1.20	5.5	n/a	1.66	3.3	172
7/24/02	Tributary Creek Site 9	100	11.2	0.13	1.06	6.1	n/a	3.40	5.0	138
7/24/02	Tributary Creek Site 9	90	7.9	0.23	1.29	7.1	n/a	4.08	5.2	168
7/24/02	Tributary Creek Site 9	90	9.2	0.08	1.15	5.2	n/a	1.39	6.2	150
7/24/02	Tributary Creek Site 9	100	9.3	0.04	0.84	3.2	n/a	0.33	5.4	152
7/23/03	Tributary Creek Site 9	106	10.7	0.06	0.46	2.8	n/a	0.34	6.3	134
7/23/03	Tributary Creek Site 9	89	6.8	0.10	1.01	4.0	n/a	0.82	6.0	131
7/23/03	Tributary Creek Site 9	112	17.4	0.16	1.35	4.4	n/a	1.85	5.7	108
7/23/03	Tributary Creek Site 9	95	11.6	0.19	0.69	5.6	n/a	1.30	3.6	136
7/23/03	Tributary Creek Site 9	91	9.5	0.05	0.72	4.4	n/a	0.56	4.9	131
7/23/03	Tributary Creek Site 9	84	8.4	0.12	0.76	3.9	n/a	0.78	4.7	125
7/21/04	Tributary Creek Site 9	84	5.5	0.10	0.96	3.2	n/a	1.19	5.4	169
7/21/04	Tributary Creek Site 9	96	8.5	0.10	1.24	3.8	n/a	0.67	5.9	138
7/21/04	Tributary Creek Site 9	105	14.1	0.10	2.02	4.0	n/a	1.75	5.7	125
7/21/04	Tributary Creek Site 9	85	5.8	0.04	0.47	3.7	n/a	0.93	4.8	175
7/21/04	Tributary Creek Site 9	81	6.4	0.09	2.34	4.3	n/a	1.44	8.2	140
7/21/04	Tributary Creek Site 9	86	10.4	0.11	0.83	5.5	n/a	0.97	5.8	161
7/23/05	Tributary Creek Site 9	97	11.1	0.06	0.70	10.4	n/a	0.29	6.4	104
7/23/05	Tributary Creek Site 9	113	16.8	0.10	0.63	4.7	n/a	0.97	6.1	122
7/23/05	Tributary Creek Site 9	115	18.8	0.07	0.52	6.3	n/a	0.53	5.8	109
7/23/05	Tributary Creek Site 9	117	20.5	0.19	0.79	9.9	n/a	1.07	6.7	117
7/23/05	Tributary Creek Site 9	101	11.7	0.07	1.44	5.2	n/a	1.00	8.1	130
7/23/05	Tributary Creek Site 9	107	13.7	0.10	1.29	4.6	n/a	0.46	8.0	134
7/21/06	Tributary Creek Site 9	99	12.9	0.12	0.74	4.0	n/a	0.32	6.3	120
7/21/06	Tributary Creek Site 9	96	11.6	0.12	0.76	7.7	n/a	1.32	6.8	157
7/21/06	Tributary Creek Site 9	94	10.9	0.18	1.59	10.3	n/a	2.48	4.9	160
7/21/06	Tributary Creek Site 9	100	10.9	0.11	1.34	8.5	n/a	1.46	5.2	142
7/21/06	Tributary Creek Site 9	97	11.7	0.14	0.88	4.6	n/a	0.96	5.2	107
7/21/06	Tributary Creek Site 9	117	20.8	0.24	1.29	4.3	n/a	2.92	5.9	129
7/20/07	Tributary Creek Site 9	98	12.4	0.11	0.91	2.7	n/a	1.10	7.7	106
7/20/07	Tributary Creek Site 9	89	8.9	0.12	1.72	3.3	n/a	1.80	5.6	136
7/20/07	Tributary Creek Site 9	114	14.1	0.15	2.76	3.4	n/a	1.28	8.7	122
7/20/07	Tributary Creek Site 9	81	7.1	0.14	1.90	4.2	n/a	2.03	7.0	114
7/20/07	Tributary Creek Site 9	114	14.6	0.88	3.63	3.9	n/a	1.56	10.9	131
7/20/07	Tributary Creek Site 9	93	10.6	0.14	1.50	20.3	n/a	3.80	9.4	107
7/23/08	Tributary Creek Site 9	103	12.9	0.22	1.99	4.2	n/a	3.47	7.7	169
7/23/08	Tributary Creek Site 9	108	14.8	0.10	0.96	3.2	n/a	0.86	5.8	143
7/23/08	Tributary Creek Site 9	88	8.9	0.08	0.93	3.3	n/a	0.75	4.4	186
7/23/08	Tributary Creek Site 9	86	9.3	0.22	1.91	5.7	n/a	4.06	5.7	119
7/23/08	Tributary Creek Site 9	92	9.6	0.07	1.01	2.7	n/a	0.61	5.2	125
7/23/08	Tributary Creek Site 9	90	8.7	0.03	0.54	2.2	n/a	0.43	4.8	108
7/22/09	Tributary Creek Site 9	83	6.9	0.04	0.29	1.7	n/a	0.24	5.4	127
7/22/09	Tributary Creek Site 9	91	8.6	0.06	0.55	2.1	n/a	0.16	5.1	137
7/22/09	Tributary Creek Site 9	91	8.5	0.11	0.36	2.0	n/a	0.23	7.5	138
7/22/09	Tributary Creek Site 9	98	10.3	0.09	0.81	3.4	n/a	0.38	5.8	147
7/22/09	Tributary Creek Site 9	91	8.6	0.03	0.47	2.2	n/a	0.40	4.5	125
7/22/09	Tributary Creek Site 9	90	7.8	0.06	0.60	2.2	n/a	0.38	5.6	129
7/20/10	Tributary Creek Site 9	87	7.4	0.29	1.61	5.4	n/a	3.92	6.4	151
7/20/10	Tributary Creek Site 9	94	10.9	0.12	0.82	2.5	n/a	0.24	5.7	174
7/20/10	Tributary Creek Site 9	90	8.5	0.08	0.73	2.9	n/a	0.29	5.3	125
7/20/10	Tributary Creek Site 9	90	8.2	0.06	0.60	2.3	n/a	0.33	4.7	151
7/20/10	Tributary Creek Site 9	108	13.5	0.08	0.66	2.6	n/a	0.25	3.2	118
7/20/10	Tributary Creek Site 9	105	11.6	0.08	0.75	3.1	n/a	0.23	3.9	150
7/21/11	Tributary Creek Site 9	85-115	n/a	0.09	0.80	3.4	n/a	0.32	6.7	146
7/26/12	Tributary Creek Site 9	89	7.3	<0.02	0.33	18.4	0.4	0.18	4.3	123
7/26/12	Tributary Creek Site 9	122	16.5	0.03	0.60	8.4	0.3	0.54	4.8	126
7/26/12	Tributary Creek Site 9	74,75	8.1	0.05	0.76	42.4	0.2	1.65	4.9	140
7/26/12	Tributary Creek Site 9	105	11.7	0.13	0.57	22.6	0.2	0.74	7.5	128
7/26/12	Tributary Creek Site 9	98	9.9	0.07	0.95	203.0	0.2	1.90	5.5	115
7/26/12	Tributary Creek Site 9	86,112	20.2	0.06	0.53	8.5	0.3	0.67	5.3	116

November 9, 2012 Analytical Report for Service Request No: K1209737

Ben Brewster
Alaska Department of Fish and Game
Division of Habitat
P.O. Box 110024
Juneau, AK 99811

RE: Hecla Greens Creek Biomonitoring

Dear Ben:

Enclosed are the results of the samples submitted to our laboratory on September 28, 2012. For your reference, these analyses have been assigned our service request number K1209737.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current NELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP-accredited analytes, refer to the certifications section at www.caslab.com. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. dba ALS Environmental (ALS) is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please call if you have any questions. My extension is 3363. You may also contact me via Email at Lisa.Domenighini@alsglobal.com.

Respectfully submitted,

Columbia Analytical Services, Inc. dba ALS Environmental

Lisa Domenighini
Project Manager

LD/jw

ADDRESS 1317 S. 13th Avenue, Kelso, WA 98626
PHONE +1 360 577 7222 | FAX +1 360 636 1068
Columbia Analytical Services, Inc.
Part of the ALS Group A Campbell Brothers Limited Company

Acronyms

ASTM	American Society for Testing and Materials
A2LA	American Association for Laboratory Accreditation
CARB	California Air Resources Board
CAS Number	Chemical Abstract Service registry Number
CFC	Chlorofluorocarbon
CFU	Colony-Forming Unit
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DOE	Department of Ecology
DOH	Department of Health
EPA	U. S. Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
LUFT	Leaking Underground Fuel Tank
M	Modified
MCL	Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL	Method Detection Limit
MPN	Most Probable Number
MRL	Method Reporting Limit
NA	Not Applicable
NC	Not Calculated
NCASI	National Council of the Paper Industry for Air and Stream Improvement
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SIM	Selected Ion Monitoring
TPH	Total Petroleum Hydrocarbons
tr	Trace level is the concentration of an analyte that is less than the PQL but greater than or equal to the MDL.

Inorganic Data Qualifiers

* The result is an outlier. See case narrative.
# The control limit criteria is not applicable. See case narrative.
B The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
E The result is an estimate amount because the value exceeded the instrument calibration range.
J The result is an estimated value.
U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
DOD-QSM 4.2 definition : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X See case narrative.
Q See case narrative. One or more quality control criteria was outside the limits.
H The holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

Metals Data Qualifiers

The control limit criteria is not applicable. See case narrative.
J The result is an estimated value.
E The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M The duplicate injection precision was not met.
N The Matrix Spike sample recovery is not within control limits. See case narrative.
S The reported value was determined by the Method of Standard Additions (MSA).
U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
DOD-QSM 4.2 definition : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
W The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X See case narrative.
+ The correlation coefficient for the MSA is less than 0.995.
Q See case narrative. One or more quality control criteria was outside the limits.

Organic Data Qualifiers

* The result is an outlier. See case narrative.
# The control limit criteria is not applicable. See case narrative.
A A tentatively identified compound, a suspected aldol-condensation product.
B The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
C The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D The reported result is from a dilution.
E The result is an estimated value.
J The result is an estimated value.
N The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
U The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
DOD-QSM 4.2 definition : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
X See case narrative.
Q See case narrative. One or more quality control criteria was outside the limits.

Additional Petroleum Hydrocarbon Specific Qualifiers

F The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z The chromatographic fingerprint does not resemble a petroleum product.

Columbia Analytical Services, Inc. dba ALS Environmental (ALS) - Kelso
State Certifications, Accreditations, and Licenses

Agency	Web Site	Number
Alaska DEC UST	http://dec.alaska.gov/applications/eh/ehllabreports/USTLabs.aspx	UST-040
Arizona DHS	http://www.azdhs.gov/lab/license/env.htm	AZ0339
Arkansas - DEQ	http://www.adeq.state.ar.us/techsvs/labcert.htm	88-0637
California DHS (ELAP)	http://www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx	2286
DOD ELAP	http://www.denix.osd.mil/edqw/Accreditation/AccreditedLabs.cfm	L12-28
Florida DOH	http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm	E87412
Georgia DNR	http://www.gaepd.org/Documents/techguide_pcb.html#cel	881
Hawaii DOH	Not available	-
Idaho DHW	http://www.healthandwelfare.idaho.gov/Health/Labs/CertificationDrinkingWaterLabs/tabid/1833/Default.aspx	-
Indiana DOH	http://www.in.gov/isdh/24859.htm	C-WA-01
ISO 17025	http://www.pjlabs.com/	L12-27
Louisiana DEQ	http://www.deq.louisiana.gov/portal/DIVISIONS/PublicParticipationandPermitSupport/LouisianaLaboratoryAccreditationProgram.aspx	3016
Louisiana DHH	Not available	LA110003
Maine DHS	Not available	WA0035
Michigan DEQ	http://www.michigan.gov/deq/0,1607,7-135-3307_4131_4156---,00.html	9949
Minnesota DOH	http://www.health.state.mn.us/accreditation	053-999-368
Montana DPHHS	http://www.dphhs.mt.gov/publichealth/	CERT0047
Nevada DEP	http://ndep.nv.gov/bsdw/labservice.htm	WA35
New Jersey DEP	http://www.nj.gov/dep/oqa/	WA005
New Mexico ED	http://www.nmenv.state.nm.us/dwb/Index.htm	-
North Carolina DWQ	http://www.dwqlab.org/	605
Oklahoma DEQ	http://www.deq.state.ok.us/CSDnew/labcert.htm	9801
Oregon – DEQ (NELAP)	http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	WA200001
South Carolina DHEC	http://www.scdhec.gov/environment/envserv/	61002
Texas CEQ	http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html	T104704427-08-TX
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C1203
Wisconsin DNR	http://dnr.wi.gov/	998386840
Wyoming (EPA Region 8)	http://www.epa.gov/region8/water/dwhome/wyomingdi.html	-
Kelso Laboratory Website	www.caslab.com	NA

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. A complete listing of specific NELAP-certified analytes, can be found in the certification section at www.caslab.com or at the accreditation bodies web site

Please refer to the certification and/or accreditation body's web site if samples are submitted for compliance purposes. The states highlighted above, require the analysis be listed on the state certification if used for compliance purposes and if the method/anlayte is offered by that state.

ALS ENVIRONMENTAL

Client:	Alaska Department of Fish and Game	**Service Request No.:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Received:**	9/28/12-10/3/12
Sample Matrix:	Tissue		

CASE NARRATIVE

All analyses were performed consistent with the quality assurance program of ALS Environmental. This report contains analytical results for samples designated for Tier II data deliverables. When appropriate to the method, method blank results have been reported with each analytical test. Additional quality control analyses reported herein include: Matrix/Duplicate Matrix Spike (MS/DMS), and Laboratory/Duplicate Laboratory Control Sample (LCS/DLCS).

Sample Receipt

Eighteen tissue samples were received for analysis at ALS Environmental on 9/28/12-10/3/12. The samples were received in good condition and consistent with the accompanying chain of custody form. The samples were stored in a refrigerator at 4ºC and frozen at –20ºC upon receipt at the laboratory.

Total Metals

No anomalies associated with the analysis of these samples were observed.

Approved by____________________________________

Greens Creek Biomonitoring - 2012							
Juvenile Fish for Whole Body Metals				COOLER #1/1			
Basis, all samples: Dry Weight, Report %Moisture							
No preservative added; all fish frozen							
Requested Analyses: Ag, Cd, Cu, Pb, Se, Zn							
Matrix	**Collector**	**Date Collected**	**Sample Number**	**Sample Location**	**Analysis Requested**	**Fk Length (mm)**	**Weight (g)**
Whole Body	ADF&G	7/21/2010	Greens Creek Site 54 sample #1	Greens Creek Site 54	Ag, Cd, Cu, Pb, Se, Zn	132	24.2
Whole Body	ADF&G	7/21/2010	Greens Creek Site 54 sample #2	Greens Creek Site 54	Ag, Cd, Cu, Pb, Se, Zn	118	17.3
Whole Body	ADF&G	7/21/2010	Greens Creek Site 54 sample #3	Greens Creek Site 54	Ag, Cd, Cu, Pb, Se, Zn	109	13.1
Whole Body	ADF&G	7/21/2010	Greens Creek Site 54 sample #4	Greens Creek Site 54	Ag, Cd, Cu, Pb, Se, Zn	97	9.1
Whole Body	ADF&G	7/21/2010	Greens Creek Site 54 sample #5	Greens Creek Site 54	Ag, Cd, Cu, Pb, Se, Zn	115	15.4
Whole Body	ADF&G	7/21/2010	Greens Creek Site 54 sample #6	Greens Creek Site 54	Ag, Cd, Cu, Pb, Se, Zn	119	18.3
Whole Body	ADF&G	7/24/2012	Greens Creek Site 48 sample #1	Greens Creek Site 48	Ag, Cd, Cu, Pb, Se, Zn	109	11.3
Whole Body	ADF&G	7/24/2012	Greens Creek Site 48 sample #2	Greens Creek Site 48	Ag, Cd, Cu, Pb, Se, Zn	123	18.3
Whole Body	ADF&G	7/24/2012	Greens Creek Site 48 sample #3	Greens Creek Site 48	Ag, Cd, Cu, Pb, Se, Zn	110	9.8
Whole Body	ADF&G	7/24/2012	Greens Creek Site 48 sample #4	Greens Creek Site 48	Ag, Cd, Cu, Pb, Se, Zn	103	10.6
Whole Body	ADF&G	7/24/2012	Greens Creek Site 48 sample #5	Greens Creek Site 48	Ag, Cd, Cu, Pb, Se, Zn	104	10.7
Whole Body	ADF&G	7/24/2012	Greens Creek Site 48 sample #6	Greens Creek Site 48	Ag, Cd, Cu, Pb, Se, Zn	116	15.8
Whole Body	ADF&G	7/22/2010	Tributary Creek Site 9 sample #1	Tributary Creek Site 9	Ag, Cd, Cu, Pb, Se, Zn	89	7.3
Whole Body	ADF&G	7/22/2010	Tributary Creek Site 9 sample #2	Tributary Creek Site 9	Ag, Cd, Cu, Pb, Se, Zn	122	16.5
Whole Body	ADF&G	7/22/2010	Tributary Creek Site 9 sample #3	Tributary Creek Site 9	Ag, Cd, Cu, Pb, Se, Zn	74	
Whole Body	ADF&G	7/23/2010	Tributary Creek Site 9 sample #3	Tributary Creek Site 10	Ag, Cd, Cu, Pb, Se, Zn	75	8.1
Whole Body	ADF&G	7/22/2010	Tributary Creek Site 9 sample #4	Tributary Creek Site 9	Ag, Cd, Cu, Pb, Se, Zn	105	11.7
Whole Body	ADF&G	7/22/2010	Tributary Creek Site 9 sample #5	Tributary Creek Site 9	Ag, Cd, Cu, Pb, Se, Zn	98	9.9
Whole Body	ADF&G	7/22/2010	Tributary Creek Site 9 sample #6	Tributary Creek Site 9	Ag, Cd, Cu, Pb, Se, Zn	86	
Whole Body	ADF&G	7/23/2010	Tributary Creek Site 9 sample #6	Tributary Creek Site 10	Ag, Cd, Cu, Pb, Se, Zn	112	20.2

CHAIN OF CUSTODY

Columbia Analytical Services INC.
An Employee - Owned Company
1317 South 13th Ave. • Kelso, WA 98626 • (360) 577-7222 • (800) 695-7222x07 • FAX (360) 636-1068

SR#: K1209737

PAGE ______ OF ______ COC # ______

PROJECT NAME: Greens Creek Biomonitoring
PROJECT NUMBER: Hecla Greens Creek Mining Co
PROJECT MANAGER: Kate Kanouse ADFG Habitat
COMPANY/ADDRESS: Alaska Dept. Fish and Game Hab. 802 West 3rd St.
CITY/STATE/ZIP: Juneau, AK, 99801
E-MAIL ADDRESS: benjamin.brewster@alaska.gov
PHONE #: 907-465-6160 FAX#: 907-465-4759
SAMPLER'S SIGNATURE: Benjamin Brewster

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐ 8270LL☐	Volatile Organics 624☐ 8260☐	Hydrocarbons (*see below) Gas☐ 8021☐ BTEX☐	☐ Fuel Fingerprint (FIQ) Diesel☐ Oil☐	☐ NW-HCID Screen	Oil & Grease/TRPH 1664 HEM☐ 1664 SGT☐	PCB's Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081A☐ 8141A☐ 8151A☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	PAHS 8310☐ SIM☐	Metals, Total or Dissolved (See list below)	Cyanide☐ Hex-Chrom☐	pH, Cond., Cl, SO4, PO4, F, NO2, NO3, BOD, TSS, TDS (circle)	NH3-N, COD, Total-P, TKN, TOC, DOC (circle) NO2+NO3	TOX 9020☐ AOX 1650☐ 506☐				REMARKS
See attached list of juvenile fish, whole body samples					18											X								

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required

X II. Report Dup., MS, MSD as required

___ III. Data Validation Report (includes all raw data)

___ IV. CLP Deliverable Report

___ V. EDD

INVOICE INFORMATION

P.O. # HGMC, c/o Jennifer
Bill To: Saran, P.O. Box 32199 Juneau, AK 99803

TURNAROUND REQUIREMENTS

___ 24 hr. ___ 48 hr.

___ 5 Day

X Standard (10-15 working days)

___ Provide FAX Results

______ Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al As Sb Ba Be B Ca (Cd) Co Cr (Cu) Fe (Pb) Mg Mn Mo Ni K (Ag) Na (Se) Sr Tl Sn V (Zn) Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORTHWEST OTHER: ______ (CIRCLE ONE)

SPECIAL INSTRUCTIONS/COMMENTS:

Dry wgt Basis - Report % moisture
Send ecopy and hardcopy to Benjamin Brewster
ADFG Habitat
802 West 3rd St. Juneau AK, 99801

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: Benjamin Brewster Date/Time:	Signature: Karla Smith Date/Time: 9/28/12 0940	Signature: Date/Time:	Signature: Date/Time:
Printed Name: Benjamin Brewster Firm: ADFG	Printed Name: Karla Smith Firm: ALS	Printed Name: Firm:	Printed Name: Firm:

ALS

PC Lisa

Cooler Receipt and Preservation Form

Client / Project: Hecla Green Mine Service Request K12 09737

Received: 9/28/12 Opened: 9/28/12 By: KB Unloaded: 9/28/12 By: KB

1. Samples were received via? Mail **(Fed Ex)** UPS DHL PDX Courier Hand Delivered
2. Samples were received in: (circle) **(Cooler)** Box Envelope Other ______ NA
3. Were custody seals on coolers? NA **(Y)** N If yes, how many and where? 1, Front

   If present, were custody seals intact? **(Y)** N If present, were they signed and dated? **(Y)** N

Cooler Temp °C	Temp Blank °C	Thermometer ID	Cooler/COC ID (NA)	Tracking Number	NA	Filed
2.5	—	316		8015 3750 0698		

7. Packing material: Inserts **(Baggies)** Bubble Wrap **(Gel Packs)** Wet Ice Dry Ice Sleeves
8. Were custody papers properly filled out (ink, signed, etc.)? NA **(Y)** N
9. Did all bottles arrive in good condition (unbroken)? *Indicate in the table below.* NA **(Y)** N
10. Were all sample labels complete (i.e analysis, preservation, etc.)? NA **(Y)** N
11. Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* NA **(Y)** N
12. Were appropriate bottles/containers and volumes received for the tests indicated? NA **(Y)** N
13. Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* **(NA)** Y N
14. Were VOA vials received without headspace? *Indicate in the table below.* **(NA)** Y N
15. Was C12/Res negative? **(NA)** Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

Notes, Discrepancies, & Resolutions: Did not Rec. Tributary Creek Site ID Sample

Page ____ *of* ____

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Collected:**	07/21-24/12
Sample Matrix:	Tissue	**Date Received:**	09/28/12

Moisture

Prep Method:	NONE	Units:	PERCENT
Analysis Method:	Freeze Dry	Basis:	Wet
Test Notes:			

Sample Name	**Lab Code**	**Date Analyzed**	**Result**	**Result Notes**
Greens Creek Site 54 Sample #1	K1209737-001	10/15/12	75.8	
Greens Creek Site 54 Sample #2	K1209737-002	10/15/12	76.4	
Greens Creek Site 54 Sample #3	K1209737-003	10/15/12	77.6	
Greens Creek Site 54 Sample #4	K1209737-004	10/15/12	76.8	
Greens Creek Site 54 Sample 5	K1209737-005	10/15/12	77.0	
Greens Creek Site 54 Sample #6	K1209737-006	10/15/12	75.6	
Greens Creek Site 48 Sample #1	K1209737-007	10/15/12	77.4	
Greens Creek Site 48 Sample #2	K1209737-008	10/15/12	75.8	
Greens Creek Site 48 Sample #3	K1209737-009	10/15/12	80.3	
Greens Creek Site 48 Sample #4	K1209737-010	10/15/12	77.8	
Greens Creek Site 48 Sample #5	K1209737-011	10/15/12	78.1	
Greens Creek Site 48 Sample #6	K1209737-012	10/15/12	76.7	
Tributary Creek Site 9 Sample #1	K1209737-013	10/15/12	76.7	
Tributary Creek Site 9 Sample #2	K1209737-014	10/15/12	76.2	
Tributary Creek Site 9 Sample #3	K1209737-015	10/15/12	78.7	
Tributary Creek Site 9 Sample #4	K1209737-016	10/15/12	75.9	
Tributary Creek Site 9 Sample #5	K1209737-017	10/15/12	74.9	
Tributary Creek Site 9 Sample #6	K1209737-018	10/15/12	76.5	

COLUMBIA ANALYTICAL SERVICES, INC.
Now part of the ALS Group
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Collected:**	07/21/12
Sample Matrix:	Tissue	**Date Received:**	09/28/12
		Date Extracted:	NA
		Date Analyzed:	10/15/12

Duplicate Summary

Sample Name:	Greens Creek Site 54 Sample #1	Units:	PERCENT
Lab Code:	K1209737-001D	Basis:	Wet
Test Notes:			

Analyte	Prep Method	Analysis Method	Sample Result	Duplicate Sample Result	Average	Relative Percent Difference	Result Notes
Moisture	NA	Freeze Dry	75.8	75.3	75.6	<1	

COLUMBIA ANALYTICAL SERVICES, INC.
Now part of the ALS Group

- Cover Page -
INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Game
Project Name: Hecla Greens Creek Biomonitoring
Project No.:

Service Request: K1209737

Sample Name:	Lab Code:
Greens Creek Site 54 Sample #1	K1209737-001
Greens Creek Site 54 Sample #1D	K1209737-001D
Greens Creek Site 54 Sample #1S	K1209737-001S
Greens Creek Site 54 Sample #2	K1209737-002
Greens Creek Site 54 Sample #3	K1209737-003
Greens Creek Site 54 Sample #4	K1209737-004
Greens Creek Site 54 Sample 5	K1209737-005
Greens Creek Site 54 Sample #6	K1209737-006
Greens Creek Site 48 Sample #1	K1209737-007
Greens Creek Site 48 Sample #2	K1209737-008
Greens Creek Site 48 Sample #3	K1209737-009
Greens Creek Site 48 Sample #4	K1209737-010
Greens Creek Site 48 Sample #5	K1209737-011
Greens Creek Site 48 Sample #6	K1209737-012
Tributary Creek Site 9 Sample #1	K1209737-013
Tributary Creek Site 9 Sample #2	K1209737-014
Tributary Creek Site 9 Sample #3	K1209737-015
Tributary Creek Site 9 Sample #4	K1209737-016
Tributary Creek Site 9 Sample #5	K1209737-017
Tributary Creek Site 9 Sample #6	K1209737-018
Method Blank	K1209737-MB

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/21/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Greens Creek Site 54 Sample #1** **Lab Code:** **K1209737-001**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.83		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	7.7		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.41		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	9.2		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.02		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	142		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client:	Alaska Department of Fish and Ga	**Service Request:**	K1209737
Project No.:	NA	**Date Collected:**	07/21/12
Project Name:	Hecla Greens Creek Biomonitoring	**Date Received:**	09/28/12
Matrix:	TISSUE	**Units:**	mg/Kg
		Basis:	DRY

Sample Name: **Greens Creek Site 54 Sample #2** **Lab Code:** **K1209737-002**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	1.03		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	7.7		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.57		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	6.3		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.04		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	199		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/21/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Greens Creek Site 54 Sample #3** **Lab Code:** **K1209737-003**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	2.04		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	19.2		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	1.32		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	7.4		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.06		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	215		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/21/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Greens Creek Site 54 Sample #4** **Lab Code:** **K1209737-004**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	2.04		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	65.6		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.50		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	6.2		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.03		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	227		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client:	Alaska Department of Fish and Ga	**Service Request:**	K1209737
Project No.:	NA	**Date Collected:**	07/21/12
Project Name:	Hecla Greens Creek Biomonitoring	**Date Received:**	09/28/12
Matrix:	TISSUE	**Units:**	mg/Kg
		Basis:	DRY

Sample Name: **Greens Creek Site 54 Sample 5** **Lab Code:** **K1209737-005**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	1.22		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	12.6		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	1.10		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	6.9		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.04		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	202		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client:	Alaska Department of Fish and Ga	**Service Request:**	K1209737
Project No.:	NA	**Date Collected:**	07/21/12
Project Name:	Hecla Greens Creek Biomonitoring	**Date Received:**	09/28/12
Matrix:	TISSUE	**Units:**	mg/Kg
		Basis:	DRY

Sample Name: **Greens Creek Site 54 Sample #6** **Lab Code:** **K1209737-006**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	1.81		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	5.3		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.27		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	5.1		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.03		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	191		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client:	Alaska Department of Fish and Ga	**Service Request:**	K1209737
Project No.:	NA	**Date Collected:**	07/24/12
Project Name:	Hecla Greens Creek Biomonitoring	**Date Received:**	09/28/12
Matrix:	TISSUE	**Units:**	mg/Kg
		Basis:	DRY

Sample Name: **Greens Creek Site 48 Sample #1** **Lab Code:** **K1209737-007**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	2.26		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	27.0		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.16		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	5.5		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.03		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	186		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/24/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Greens Creek Site 48 Sample #2** **Lab Code:** **K1209737-008**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	1.37		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	4.9		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.10		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	5.7		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.03		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	184		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client:	Alaska Department of Fish and Ga	**Service Request:**	K1209737
Project No.:	NA	**Date Collected:**	07/24/12
Project Name:	Hecla Greens Creek Biomonitoring	**Date Received:**	09/28/12
Matrix:	TISSUE	**Units:**	mg/Kg
		Basis:	DRY

Sample Name: **Greens Creek Site 48 Sample #3** **Lab Code:** **K1209737-009**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	1.83		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	25.6		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	2.59		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	5.6		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.03		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	275		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/24/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Greens Creek Site 48 Sample #4** **Lab Code:** **K1209737-010**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.99		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	76.8		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.30		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	5.1		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.03		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	189		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/24/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Greens Creek Site 48 Sample #5** **Lab Code:** **K1209737-011**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	2.66		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	84.8		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	1.05		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	6.3		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.03		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	242		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/24/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Greens Creek Site 48 Sample #6** **Lab Code:** **K1209737-012**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.73		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	35.1		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	1.03		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	4.7		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.04		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	190		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client:	Alaska Department of Fish and Ga	**Service Request:**	K1209737
Project No.:	NA	**Date Collected:**	07/22/12
Project Name:	Hecla Greens Creek Biomonitoring	**Date Received:**	09/28/12
Matrix:	TISSUE	**Units:**	mg/Kg
		Basis:	DRY

Sample Name: **Tributary Creek Site 9 Sample #** **Lab Code:** **K1209737-013**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.33		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	18.4		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.18		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	4.3		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.02	U	
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	123		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/22/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Tributary Creek Site 9 Sample #** **Lab Code:** **K1209737-014**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.60		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	8.4		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.54		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	4.8		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.03		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	126		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/22/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Tributary Creek Site 9 Sample #** **Lab Code:** **K1209737-015**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.76		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	42.4		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	1.65		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	4.9		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.05		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	140		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/22/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Tributary Creek Site 9 Sample #** **Lab Code:** **K1209737-016**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.57		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	22.6		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.74		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	7.5		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.13		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	128		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga

Service Request: K1209737

Project No.: NA

Date Collected: 07/22/12

Project Name: Hecla Greens Creek Biomonitoring

Date Received: 09/28/12

Matrix: TISSUE

Units: mg/Kg

Basis: DRY

Sample Name: **Tributary Creek Site 9 Sample #** **Lab Code:** **K1209737-017**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.95		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	203		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	1.90		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	5.5		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.07		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	115		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected: 07/22/12
Project Name: Hecla Greens Creek Biomonitoring
Date Received: 09/28/12
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Tributary Creek Site 9 Sample #** **Lab Code:** **K1209737-018**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.53		
Copper	200.8	0.1	5.0	10/23/12	11/05/12	8.5		
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.67		
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	5.3		
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.06		
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	116		

Comments:

Metals

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: Alaska Department of Fish and Ga
Service Request: K1209737
Project No.: NA
Date Collected:
Project Name: Hecla Greens Creek Biomonitoring
Date Received:
Matrix: TISSUE
Units: mg/Kg
Basis: DRY

Sample Name: **Method Blank**
Lab Code: **K1209737-MB**

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Cadmium	200.8	0.02	5.0	10/23/12	11/05/12	0.02	U	
Copper	200.8	0.1	5.0	10/23/12	11/05/12	0.1	U	
Lead	200.8	0.02	5.0	10/23/12	11/05/12	0.02	U	
Selenium	200.8	1.0	5.0	10/23/12	11/05/12	1.0	U	
Silver	200.8	0.02	5.0	10/23/12	11/05/12	0.02	U	
Zinc	200.8	0.5	5.0	10/23/12	11/05/12	0.5	U	

Comments:

Metals
- 5A -
SPIKE SAMPLE RECOVERY

Client: Alaska Department of Fish and Ga **Service Request:** K1209737

Project No.: NA **Units:** MG/KG

Project Name: Hecla Greens Creek Biomonitoring **Basis:** DRY

Matrix: TISSUE

Sample Name: Greens Creek Site 54 Sampl **Lab Code:** K1209737-001S

Analyte	Control Limit %R	Spike Result	C	Sample Result	C	Spike Added	%R	Q	Method
Cadmium	70 - 130	5.97		0.83		4.98	103		200.8
Copper	70 - 130	31.0		7.7		24.9	94		200.8
Lead	70 - 130	45.17		0.41		49.83	90		200.8
Selenium	70 - 130	29.3		9.2		16.6	121		200.8
Silver	70 - 130	5.08		0.02		4.98	102		200.8
Zinc	70 - 130	191.8		141.6		49.8	101		200.8

An empty field in the Control Limit column indicates the control limit is not applicable

Metals

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DUPLICATES

Client: Alaska Department of Fish and Ga **Service Request:** K1209737

Project No.: NA **Units:** MG/KG

Project Name: Hecla Greens Creek Biomonitoring **Basis:** DRY

Matrix: TISSUE

Sample Name: Greens Creek Site 54 Samp **Lab Code:** K1209737-001D

Analyte	Control Limit	Sample (S)	C	Duplicate (D)	C	RPD	Q	Method
Cadmium	20	0.83		0.87		4.7		200.8
Copper	20	7.7		7.7		0.0		200.8
Lead	20	0.41		0.40		2.5		200.8
Selenium	20	9.2		9.2		0.0		200.8
Silver		0.02		0.02		0.0		200.8
Zinc	20	141.6		146.8		3.6		200.8

An empty field in the Control Limit column indicates the control limit is not applicable.

Metals
-7-
LABORATORY CONTROL SAMPLE

Client: Alaska Department of Fish and Ga **Service Request:** K1209737

Project No.: NA

Project Name: Hecla Greens Creek Biomonitoring

Aqueous LCS Source: CAS MIXED **Solid LCS Source:**

Analyte	Aqueous (ug/L)			Solid (mg/kg)				
	True	Found	%R	True	Found	C	Limits	%R
Cadmium	50.0	49.1	98					
Copper	250.0	243.0	97					
Lead	500.0	476.2	95					
Selenium	167.0	181.9	109					
Silver	50.0	50.4	101					
Zinc	500.0	463.9	93					

Client:	Alaska Department of Fish and Game	**Service Request:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Tissue	**Date Received:**	NA
		Date Extracted:	10/23/12
		Date Analyzed:	11/05/12

Standard Reference Material Summary
Total Metals

Sample Name:	Standard Reference Material	Units:	mg/Kg (ppm)
Lab Code:	K1209737-SRM	Basis:	Dry
Test Notes:			

Source: N.R.C.C. Dorm-3

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	Control Limits	Result Notes
Cadmium	PSEP Tissue	200.8	0.29	0.31	107	0.216 - 0.372	
Copper	PSEP Tissue	200.8	15.5	14.8	95	11.9 - 19.4	
Lead	PSEP Tissue	200.8	0.395	0.29	73	0.276 - 0.534	
Zinc	PSEP Tissue	200.8	51.3	50.7	99	38.6 - 65.3	

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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Tissue	**Date Received:**	NA
		Date Extracted:	10/23/12
		Date Analyzed:	11/05/12

Standard Reference Material Summary
Total Metals

Sample Name:	Standard Reference Material	Units:	mg/Kg (ppm)
Lab Code:	K1209737-SRM	Basis:	Dry
Test Notes:			

Source: N.R.C.C. Tort-2

Analyte	**Prep Method**	**Analysis Method**	**True Value**	**Result**	**Percent Recovery**	**Control Limits**	**Result Notes**
Cadmium	PSEP Tissue	200.8	26.7	29.3	110	20.9-32.8	
Copper	PSEP Tissue	200.8	106	97.9	92	77-139	
Lead	PSEP Tissue	200.8	0.35	0.323	92	0.18-0.58	
Selenium	PSEP Tissue	200.8	5.63	7.17	127	3.97-7.56	
Zinc	PSEP Tissue	200.8	180	183	102	139-223	

Analytical Report

Client: Alaska Department of Fish and Game
Project: Hecla Greens Creek Biomonitoring
Sample Matrix: Animal tissue

Service Request: K1209737
Date Collected: 07/21-22/2012
Date Received: 09/28/12

Mercury, Total

Prep Method: METHOD
Analysis Method: 1631E
Test Notes:

Units: ng/g
Basis: Dry

Sample Name	Lab Code	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	Result Notes
Greens Creek Site 54 Sample #1	K1209737-001	5.0	100	10/22/12	10/23/12	76.8	
Greens Creek Site 54 Sample #2	K1209737-002	5.0	100	10/22/12	10/23/12	109	
Greens Creek Site 54 Sample #3	K1209737-003	5.0	100	10/22/12	10/23/12	112	
Greens Creek Site 54 Sample #4	K1209737-004	5.0	100	10/22/12	10/23/12	126	
Greens Creek Site 54 Sample 5	K1209737-005	5.0	100	10/22/12	10/23/12	123	
Greens Creek Site 54 Sample #6	K1209737-006	5.0	100	10/22/12	10/23/12	79.8	
Greens Creek Site 48 Sample #1	K1209737-007	5.0	100	10/22/12	10/23/12	134	
Greens Creek Site 48 Sample #2	K1209737-008	5.0	100	10/22/12	10/23/12	122	
Greens Creek Site 48 Sample #3	K1209737-009	5.0	100	10/22/12	10/23/12	159	
Greens Creek Site 48 Sample #4	K1209737-010	5.0	100	10/22/12	10/23/12	175	
Greens Creek Site 48 Sample #5	K1209737-011	5.0	100	10/22/12	10/23/12	122	
Greens Creek Site 48 Sample #6	K1209737-012	5.0	100	10/22/12	10/23/12	148	
Tributary Creek Site 9 Sample #1	K1209737-013	5.0	100	10/22/12	10/23/12	429	
Tributary Creek Site 9 Sample #2	K1209737-014	5.0	100	10/22/12	10/23/12	257	
Tributary Creek Site 9 Sample #3	K1209737-015	4.9	100	10/22/12	10/23/12	217	
Tributary Creek Site 9 Sample #4	K1209737-016	5.0	100	10/22/12	10/23/12	241	
Tributary Creek Site 9 Sample #5	K1209737-017	4.9	100	10/22/12	10/23/12	235	
Tributary Creek Site 9 Sample #6	K1209737-018	5.0	100	10/22/12	10/23/12	278	
Method Blank 1	K1209737-MB1	1.0	100	10/22/12	10/23/12	ND	
Method Blank 2	K1209737-MB2	1.0	100	10/22/12	10/23/12	ND	
Method Blank 3	K1209737-MB3	1.0	100	10/22/12	10/23/12	ND	

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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Collected:**	07/21/12
Sample Matrix:	Animal tissue	**Date Received:**	09/28/12
		Date Extracted:	10/22/12
		Date Analyzed:	10/23/12

Matrix Spike/Duplicate Matrix Spike Summary
Total Metals

Sample Name:	Greens Creek Site 54 Sample #1	Units:	ng/g
Lab Code:	K1209737-001MS, K1209737-001DMS	Basis:	Dry
Test Notes:			

Analyte	Prep Method	Analysis Method	MRL	Spike Level MS	Spike Level DMS	Sample Result	Spike Result MS	Spike Result DMS	Percent Recovery MS	Percent Recovery DMS	Percent Recovery CAS Acceptance Limits	Relative Percent Difference	Result Notes
Mercury	METHOD	1631E	5.0	250	250	76.8	311	325	94	99	70-130	6	

QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Water	**Date Received:**	NA
		Date Extracted:	NA
		Date Analyzed:	10/23/12

Ongoing Precision and Recovery (OPR) Sample Summary
Total Metals

Sample Name: Ongoing Precision and Recovery (Initial)

Units: ng/g
Basis: NA

Test Notes:

Analyte	**Prep Method**	**Analysis Method**	**True Value**	**Result**	**Percent Recovery**	**CAS Percent Recovery Acceptance Limits**	**Result Notes**
Mercury	METHOD	1631E	5.00	5.33	107	70-130	

Client:	Alaska Department of Fish and Game	**Service Request:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Water	**Date Received:**	NA
		Date Extracted:	NA
		Date Analyzed:	10/23/12

Ongoing Precision and Recovery (OPR) Sample Summary
Total Metals

Sample Name: Ongoing Precision and Recovery (Final)

Units: ng/g
Basis: NA

Test Notes:

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	CAS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	5.00	4.81	96	70-130	

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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1209737
Project:	Hecla Greens Creek Biomonitoring	**Date Collected:**	NA
LCS Matrix:	Animal tissue	**Date Received:**	NA
		Date Extracted:	10/22/12
		Date Analyzed:	10/23/12

Quality Control Sample (QCS) Summary
Total Metals

Sample Name:	Quality Control Sample	Units:	ng/g
Lab Code:		Basis:	Dry
Test Notes:			

Source: TORT

Analyte	**Prep Method**	**Analysis Method**	**True Value**	**Result**	**Percent Recovery**	**CAS Percent Recovery Acceptance Limits**	**Result Notes**
Mercury	METHOD	1631E	270	278	103	70-130	