Transboundary Flathead Fisheries Baseline Data Collection

Final Report for the Cooperative Agreement between the US National Park Service Glacier National Park and Montana Fish, Wildlife and Parks (Agreement No. h1434080017)

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ABSTRACT

In May 2008, the National Park Service, Glacier National Park (GNP), and Montana Fish Wildlife and Parks (FWP) entered into a cooperative agreement for the purpose of supporting fisheries investigations in the Transboundary Flathead River drainage prior to implementation of proposed mining and other development activities in British Columbia, Canada (BC). The work plan consisted of three separate projects. The first investigated baseline contaminant levels in fish tissues in the Transboundary Flathead River and Elk River drainages. The second determined baseline fish species distribution and genetic status of westslope cutthroat trout in the Transboundary Flathead River and GNP. The third implemented a monitoring strategy for fisheries resources in BC and GNP. The agreement received one year of proposed three year funding resulting in partial completion of the proposal. The monitoring strategy was not developed.

Results from the contaminant level investigation showed differences in selenium (Se) concentrations in fish tissues from different water bodies. Westslope cutthroat trout from Flathead Lake had the lowest mean Se concentrations in both muscle and liver tissues while those from the Elk River showed the highest concentrations. Sites near the proposed Cline Mine in the upper Flathead River and Wigwam River drainages (Flathead River, Lodgepole Creek, and Foisey Creek) showed intermediate concentrations, all lower than the Elk River sample.

The Elk Valley Selenium Task Force largely comprised of representatives from private coal mining companies and the BC government found elevated selenium levels in water, sediment and biota downstream of coal mines that were directly attributed to coal mining activities. This included elevated selenium concentrations in fish tissues. Coal mining in the Flathead River Drainage would likely result in elevated selenium concentrations in downstream fish populations, including migratory fish species.

We found bull trout in all Flathead River tributaries sampled to date as part of the tissue analysis survey. Migratory fish species are widely distributed throughout the Flathead River drainage in BC.

The headwaters of the Transboundary Flathead River and its tributaries as well as tributaries within GNP were surveyed for fish species distribution, habitat characteristics, and genetic structure during 2008. Westslope cutthroat trout and sculpin were found throughout much of the upper system, including near proposed mining locations. Bull trout were also found in close proximity to potential mining sites. Genetic analyses of westslope cutthroat trout indicated no introgression with rainbow trout in the headwaters of the drainage. Length frequency histograms of westslope cutthroat trout indicate a likely resident component with a potential migratory form present. Too few bull trout were detected in a given patch to construct very informative length frequencies, though fish present likely represent rearing fluvial and/or adfluvial juveniles. Habitat parameters characterized include gradient, reach length, average stream width, presence of large woody debris, temperature, elevation, and substrate dominance.

The third part of the proposal implemented a fisheries monitoring strategy for the BC portion of the Flathead River Drainage. This was not implemented due to funding limitations; however, FWP completed bull trout redd counts as part of basin-wide surveys intermittently conducted since 1980, every three to five years. FWP also annually surveyed the river near the proposed mine site since 2006.

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1.0 INTRODUCTION

1.1 GNP and FWP Cooperative Agreement

In May 2008, the National Park Service, Glacier National Park (GNP), and Montana Fish, Wildlife and Parks (FWP) entered into a cooperative agreement for the purpose of supporting fisheries investigations in the Transboundary Flathead River drainage prior to implementation of proposed mining and other development activities in British Columbia, Canada (BC). Agencies entered into this agreement with the expectation of funding for a three year project. Agencies received funding for only the first year. The proposed work plan was modified in accordance to available funding. FWP provided all personnel costs and was able to continue surveys beyond one year.

The work plan consisted of three separate projects. The first investigated baseline contaminant levels in fish tissues in the Transboundary Flathead River and Elk River drainages. The second determined baseline fish species distribution, habitat information, and genetic sampling in the Transboundary Flathead River and GNP. The third implemented a monitoring strategy for fisheries resources in BC and GNP. The monitoring strategy was not developed due to funding limitations.

Baseline Contaminant Investigation

Pollution from proposed mining activities in the British Columbian portion of the Flathead River drainage has potential to contaminate fisheries of the Flathead Lake and River system. High concentrations of selenium have been observed in the Elk River due to upstream coal mines (McDonald and Strosher 1998; Golder Associates Ltd. 2008). Selenium (Se) can be toxic to fish and other vertebrates, leading to low reproductive success (Lemly 1993; McDonald and Strosher 1998; Rudolph et al. 2008). High concentrations of Se have been observed in westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) in the Elk River Drainage (McDonald and Strosher 1998; Kennedy et al. 2000; Golder Associates Ltd. 2008). Selenium and other contaminant concentrations in fish tissues in the Flathead Lake and River drainage are currently unknown and once determined would provide baseline conditions to assess potential impacts and allow comparisons to conditions in the Elk River drainage.

Mercury in the environment comes from both natural and anthropogenic sources including mining operations and the combustion of fossil fuels. Fish can accumulate Hg from the water, but the majority of Hg comes from dietary methyl-mercury (MeHg) which accounts for 95-99% of the total Hg found in fish muscle tissue (Grieb et al. 1990). Fish species that are long-lived, feed on high trophic-level prey, and grow slowly, can rapidly accumulate MeHg (Wiener and Spry 1996).

The project goal was to determine baseline contaminant levels in fish tissues in the Flathead drainage prior to proposed mining activities and to compare with previous sampling in the adjacent Elk River system. Tissue samples were collected from fish populations in both the Flathead Lake and River system and in the Elk River and Lake Koocanusa system. Sampling in Lake Koocanusa determined existing contaminant levels in a lentic reservoir system downstream of coal mining activities and allowed comparison to upstream sampling and baseline conditions in the Flathead drainage. We measured Se levels in individual fish collected in each water body. We also ran a 17-metal scan on a composite sample to assess tissue levels of other potential contaminants. The 17-metal test had a less sensitive detection limit and was not as accurate as the individual testing, but highlighted the need for future testing if specific contaminants were detected.

Baseline Fish Species Distribution

Little information on fish species distribution, habitat characteristics, and genetic composition in most of the perennial streams in the BC portion of the Transboundary Flathead drainage existed prior to the initiation of this work. Baseline fisheries information was also lacking for some streams on the west side of GNP (tributaries to the Transboundary Flathead). Genetic surveys conducted lower in the drainage (within Montana) indicated that hybridization between westslope cutthroat trout and nonnative rainbow trout was progressing upstream over time. However, hybridization within BC portion of the system was unknown. Sculpin species distribution was unknown and previous work suggests the existence of least one undescribed sculpin taxon in the drainage.

These critical data gaps required attention to accurately evaluate potential impacts of various mining and other development activities in the Transboundary Flathead drainage. In 2008, fish species distribution, associated habitat characteristics, and genetic composition was evaluated across the upper drainage, providing baseline data needed to develop a long-term monitoring strategy for the entire Transboundary Flathead River drainage. The ground survey work received funding for 2008 only and those data are reported in this report. The funded genetic analyses correspond to data collected during 2008-2009 and are reported accordingly.

Monitoring Strategy

Bull trout and westslope cutthroat trout from Flathead Lake migrate into the North Fork of the Flathead River and tributaries to spawn and complete their life histories. Similarly, in the Koocanusa System, both trout migrate into the Elk and Wigwam rivers in BC from Montana. Montana Fish, Wildlife and Parks monitored migratory fish populations in portions of these drainages for over 27 years. This monitoring has included intermittent bull trout redd count surveys in the BC portions of these drainages. In order to fully assess status of migratory species, a monitoring program should encompass entire drainages including Montana, GNP, and BC. It is particularly important to develop a monitoring program that can assess impacts to fishery resources prior to potential mining or other further development of the drainage.

After baseline data collections determine species distribution and life histories, monitoring surveys would provide quantitative data on the status of early life stages and spawning and juvenile habitat quality for these trout species in tributary streams in the Flathead and Wigwam drainages. Although agencies were not able to complete this project because of limited funding, the tissue contaminant and species distribution projects laid the foundation for development of a long-term monitoring program should funding become available. Additionally, FWP continues monitoring activities in the Montana portion of the Flathead River system as it has in the past.

1.2 Background

The Flathead Lake and River System located in northwest Montana consists of Flathead Lake, the main stem Flathead River above Kerr Dam, and major tributaries including the Swan River, Whitefish River, and Stillwater River drainages, and the North, Middle, and South forks of the Flathead River and their major tributaries. The Flathead Basin drains an area of roughly 18,400 km^2, which is underlain by nutrient-poor Precambrian sedimentary rock. The drainage is known for its high water quality (Zackheim 1983). The system is managed as one ecosystem due to the migratory nature and complex life histories of many species in the system. Adfluvial fish interact with lake and river stocks, emphasizing the interdependency and connectivity of the lake and river fisheries.

Flathead Lake is oligomesotrophic with a surface area of roughly 510 km^2 (125,250 acres), a mean depth of 50.2 m, and a maximum depth of 113.0 m (Zackheim 1983). The southern half of the lake lies within the Flathead Indian Reservation. Kerr Dam was built in 1938 and is located on the southern end of Flathead Lake, seven km downstream of the natural lake outlet. Kerr Dam regulates the top three meters of water and is operated to provide flood control and power production. Presently, flood control and recreation require the lake level to be dropped to the low pool elevation 879.3 m above sea level (2,883 feet) by April 15, refilled to 881.5 m (2,890 feet) by May 30, raised to full pool elevation of 882.4 m (2,893 feet) by June 15, and held at full pool through Labor Day.

Two major tributaries to Flathead Lake are the Swan and Flathead rivers. The Swan River drains the Swan Valley and Swan Lake. Fish movement upstream from Flathead Lake into the Swan River is blocked by Bigfork Dam, located less than two kilometers above Flathead Lake. The dam was built in 1902 for electrical power production. The three forks of the Flathead River supply roughly 80 percent of the annual discharge (9 million acre-feet) in the Flathead system (Zackheim 1983). The North Fork flows out of BC, defines the western border of Glacier National Park (GNP), and primarily drains forested lands of GNP, the Flathead National Forest, and other managed forestlands. The Middle Fork flows out of the Great Bear Wilderness Area, defines the southern boundary of GNP, and drains forested lands of GNP and the Flathead National Forest. The South Fork flows for over 95 km in the Bob Marshall Wilderness Area before impoundment in Hungry Horse Reservoir (56 km in length) located in the Flathead National Forest.

The major sport fish species in Flathead Lake include westslope cutthroat trout, bull trout (*Salvelinus confluentus*), lake trout (*S. namaycush*), lake whitefish (*Coregonus clupeaformis*), and yellow perch (*Perca flavenscens*). The major sportfish in the river are westslope cutthroat trout, bull trout, rainbow trout (*O. mykiss*), and mountain whitefish (*Prosopium williamsoni*). Scattered populations of largemouth bass (*Micropterus salmoides*), yellow perch, and northern pike (*Esox lucius*) occur in old oxbows of and the main stem river. Other native fish in the Flathead system include longnose sucker (*Catostomus catostomus*), largescale sucker (*C. macrocheilus*), northern pikeminnow (*Ptychocheilus oregonensis*), peamouth (*Mylocheilus caurinus*), pygmy whitefish (*P. coulteri*), and redside shiner (*Richardsonius balteatus*).

The native trout and char, westslope cutthroat trout and bull trout, have evolved varied life histories to be successful in the Flathead drainage. There are three life history forms: (1) adfluvial stocks which spawn and rear in river tributaries and move downstream to mature and reside in Flathead Lake; (2) fluvial stocks which spawn and rear in river tributaries then move downstream to mature and reside in the Flathead River, and; (3) tributary or "resident" stocks which spawn, rear, and reside for their entire life cycle in a tributary stream (Shepard et al. 1984; Liknes and Graham 1988; Fraley and Shepard 1989). Westslope cutthroat trout employ all three of these strategies in the Flathead system, although it appears that bull trout are primarily adfluvial. Individual fish may combine the first two strategies. Juveniles reside in tributaries for 1-3 years before migrating downstream into river or lake habitats (Shepard et al. 1984). Adfluvial fish take advantage of improved forage and growth rates during lake residence and thus reach larger sizes than either fluvial or tributary residents. Tributary fish mature at relatively smaller sizes ($\approx$200 mm) and don't grow as large (> 400 mm) as fish using the other strategies (Shepard et al. 1984; Liknes and Graham 1988).

These three life history forms inhabit three general types of habitat: tributary streams, main stem river and forks, and lake. In order for fish populations in the basin to be successful, all habitats must present adequate conditions for fish survival at related life history stages. Degraded conditions in one of these habitat types may limit the population, stressing the importance of habitat quality and connectivity within the lake-river-tributary system.

The North Fork of the Flathead River is called the Flathead River in BC. The Flathead River originates on the far southeastern edge of BC and flows south about 50 km (30 miles) to the Montana/BC boarder. Roughly 30% of the North Fork drainage lies in Canada. From the border, the North Fork flows about 90 km (55 miles) to the confluence with the Middle Fork of the Flathead River. The upper portion of the river flows through a broad glaciated valley about 12.9 km wide and was classified in 1976 as a Scenic River under the National Wild and Scenic Rivers Act. The middle of the river defines the western boundary of GNP, part of the Waterton-Glacier International Peace Park. This area is also designated a World Heritage Site and International Biosphere Reserve.

There is limited human development in the drainage beyond timber harvest and small residences. Coal fields exist in the British Columbian portion of the Flathead and, for decades, there has been proposed extraction. However, only exploratory surveys and no large scale extraction have been conducted. In 2004, Cline Mining Corporation proposed a coal mine at Foisey Creek, a headwater tributary to the Flathead River.

Immediately west of the Flathead River drainage is the Elk River drainage in BC. The Elk River flows south for 220 km (140 miles) into Lake Koocanusa, a reservoir on the Kootenay River that straddles the BC/Montana border. Within the Elk River Valley there are five active coal mines.

2.0 METHODS

2.1 Baseline Contaminant Investigation

We collected fish from lakes, rivers, and small streams using a variety of capture methods (Table 1). We sampled fish using overnight gill-net surveys in Flathead Lake and Lake Koocanusa. We minimized agency costs and fish mortality by taking samples from fish captured in ongoing monitoring surveys conducted by FWP. In Howell Creek (Flathead drainage) and Michel Creek (Elk drainage) we combined hook and line angling and electrofishing to capture fish. We only used angling in the Elk River and the Flathead River in BC. Electrofishing surveys consisted of a two person crew and a Smith-Root backpack electrofishing unit. We sampled 10 to 20 of the largest fish caught, when possible. Sampling conformed to collection permits issued by the BC Ministry of Environment. Total length (mm), weight (g), and scales were collected from all fish that were sampled for contaminants. Muscle, liver or gonad tissues were collected from individual fish. We collected only whole fish samples from sculpin, *Cottus spp*. We also ran a 17-metal scan on liver tissue from a composite sample for each water body to assess levels of other potential contaminants.

For muscle samples, we filleted fish (trying not to puncture organs) by making an incision behind the head and working back toward the dorsal fin. The 25 to 50 mm piece of muscle was taken from above the rib-cage and the skin was removed. We then rinsed tissues with deionized water from squirt bottle before placing in labeled jar. Livers were removed whole from the body cavity and rinsed with deionized water before placing in a jar or tube. For composite liver samples, we cut the liver in half longitudinally, so that there were two “mirror image” pieces. We collected one composite of five to seven liver samples per species, per water body from the largest sized fish of each species. Between fish we rinsed off the cutting board with tap water. In the field, between fish we replaced a piece of tin foil covering the cutting board. We wore latex gloves, which we washed off with water between fish. Likewise, we washed our knife with water and then rinsed the knife with hexane. We collected gonad samples in the same manner. All tissue samples were immediately placed in an ice chest or freezer. When in the field, samples were stored on ice until a freezer was available.

Within three weeks of sampling, we shipped samples using UPS overnight shipping in ice chests packed with ice packs. We sent samples to Energy Laboratories Inc. in Billings, Montana. The lab digested samples and performed Inductively Coupled Plasma Mass Spectrometry (ICPMS) analysis for Se and total Hg concentration and determined the percentage of moisture in tissue samples. Se concentrations were reported in mg/kg dry weight. Similarly, composite samples were stored in tubes and frozen. Composite samples were sent to and analyzed by the Montana Department of Public Health and Human Services Environmental Laboratory.

Table 1. Sampling locations and capture methods for surveys in 2008 and 2009.

Water Name	Abbreviation	Latitude	Longitude	Method of Capture	Date
Cabin Creek	CAB	49.09442	-114.55365	Electrofish	9/1/2009
Elk River	ELK	49.26198184	-115.0933797	Angling	9/9/2008 8/26/2009
Flathead Lake	FHL	48.07738	-114.23657	Gill Netting	5/2/2008 5/1/2009
Flathead River (BC)	FR	49.36656117	-114.6827389	Angling	7/29/2008
Foisey Creek	FOI	49.37515497	-114.7181869	Electrofish	7/28/2008
Harvey Creek	HV	49.26078	-114.65944	Electrofish	7/22/2009
Howell Creek	HOW	49.14	-114.56	Electrofish & Angling	9/2/2009
Lake Koocanusa	KOO KOK	48.9037	-115.1632	Gill Netting	5/14/2008 9/17/2008
Lodgepole Creek	LPO	49.29828286	-114.8486442	Electrofish	8/6/2008
McEvoy Creek	MCE	49.39895	-114.74157	Electrofish	9/8/2009
McLatchie Creek	MCL	49.3353	-114.69435	Electrofish	7/21/2009
Michel Creek	MIC	49.52740252	-114.7023351	Electrofish & Angling	9/3/2008
Middlepass Creek	MIP	49.21351	-114.48536	Electrofish	9/9/2009
North Fork Flathead River	NFR	48.87489	-114.37395	Electrofish & Angling	7/16/2009 8/18/2009
Pollock Creek	POL	49.3197	-114.56116	Electrofish	7/21/2009
Shepp Creek	SHP	49.28001	-114.58102	Electrofish	7/22/2009

As requested, Energy Labs reported Se concentrations in dry weight and percent moisture for each sample. The following equations transform results from dry to wet weight values (mg/kg) or from wet to dry weight values (mg/kg).

wet wt. = (dry wt.)(100-%moisture)(0.01) and dry wt. = (wet wt.)(100) / (100-%moisture)

2.2 Baseline Fish Species Distribution

Patch and sample site delineation

In 2008, FWP conducted baseline fish species distribution, genetic surveys, and habitat characteristics in B.C. whereas the USGS conducted identical surveys in GNP. Potential bull trout (BULL) and westslope cutthroat trout (WCT) habitat patches were delineated (Figure 2) using available GIS layers and adaptations of the methods outlined in the Bull Trout Recovery Monitoring and Evaluation Guidance document (RMEG) (USFWS 2008). It was impossible to develop potential habitat patches based on species distributions given the minimal habitat, water temperature, and species distribution data available for the upper Transboundary Flathead drainage in B.C. Therefore, patches were delineated based on hydrologic and geographic boundaries at the sub-watershed level.

In similar work (USFWS 2008), the number of reaches sampled per patch has related to the probability of detection based on previous BULL or WCT density data for a given area. Without sufficient data to locally inform sample site numbers in Transboundary Flathead patches, an uninformed probability of detection of 0.50 was assumed (i.e., if a random reach in a patch is sampled, the probability of detecting WCT or BULL is 0.5). The 0.5 value was chosen based on previous sampling in B.C. and the North Fork Flathead in Montana (Boyer and Muhlfeld 2006; FWP unpublished data, Kalispell). According to RMEG, at least 5 reaches must be sampled per patch to maintain 95% power at a 0.50 probability of detection (USFWS 2008). Therefore, a minimum of 5 reaches were sampled per patch. If BULL and WCT were not detected, a maximum of 12 reaches were sampled.

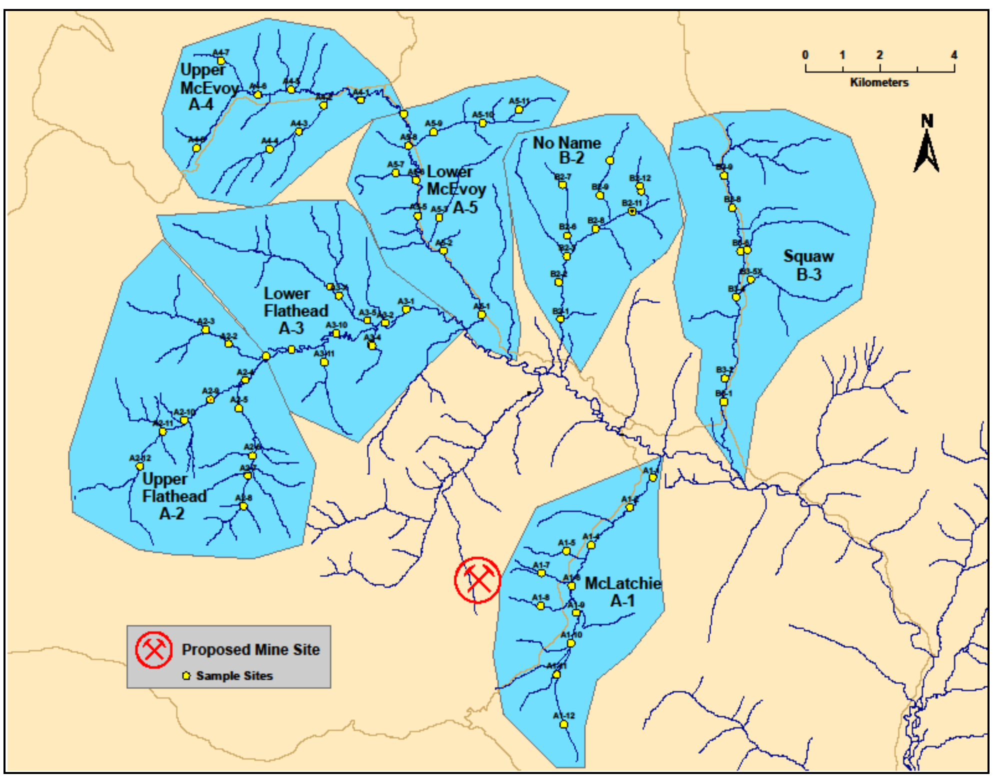

Figure 1. Sample patches and sample sites in the Transboundary Flathead River headwaters, British Columbia, 2008. Patches were delineated by hydrologic and geographic characteristics whereas sample sites were selected using a longitudinal, systematic approach.

Sample reaches were distributed longitudinally throughout each patch *a priori*, though locations were periodically and minimally augmented dependent upon logistics and ease of access. The upper limits of each patch were delineated as channel gradients equal to or greater than 15% because this exceeds the upper gradient limit of many salmonids in the Rocky Mountains (Post and Paul 2001). Previous investigations of BULL distribution sampled a minimum reach length of 12 m (mean = 36 m) and a minimum of two pools per reach (Rieman et al. 2006). We adopted a more conservative minimum length of 50 m per reach with a minimum of two pools. Pools were defined as low velocity areas spanning at least half the channel width. A maximum of 150 m were sampled per reach if two pools were not detected.

Fish and habitat sampling

Single-pass, backpack electrofishing was conducted at each sample reach with a Smith-Root LR-24 backpack electrofisher. Electrofishing was conducted moving upstream during daylight hours (between 10:00 and 17:00). Total shock time (sec) was recorded to determine catch per unit effort (CPUE). Block nets were not used. Generally, crews consisted of one person carrying the electrofishing unit with one or two people netting fish.

All fish encountered were netted and placed in buckets. After the entire reach was sampled, captured fish were anesthetized using MS-222. All fish were counted, identified to species (WCT, BULL, mountain whitefish, and sculpin), and measured (total length (mm), weight (g)). Fin clips were collected from the first ten fish of a species per reach for genetic analyses (excluding sculpin). Scales were collected from the same fish for age and growth determination. Fin clips were placed in a vile containing 95% ethanol in preparation for laboratory analysis.

For each sampling reach, the following habitat parameters were collected:

- **Elevation** was determined by a handheld GPS unit.
- **Temperature** (^{o}C)
- **Large woody debris** (LWD) pieces and aggregates (≥ 3 LWD pieces combined) were counted throughout the length of each reach. LWD = wood > 30.5 cm in diameter and > 3 m in length. Only LWD in the channel or within 1 m of the water surface was counted.
- **Wetted width** (m) was measured at a minimum of five, evenly-spaced (relatively) locations per reach. A mean value with associated variance was subsequently produced.
- **Reach area** (m^2) was estimated using the average wetted width (m) x length (m).
- **Dominant and subdominant substrate** was determined in a representative riffle using a modified Wentworth scale (sand and silt (≤ 0.2 cm; rank 1), small gravel (0.3–0.6 cm; rank 2), large gravel (0.7–7.5 cm; rank 3), cobble (7.6–29.9 cm; rank 4), small boulders (30.0–60.0 cm; rank 5), large boulders (> 60.0 cm; rank 6), and bedrock (rank 7), and expressed as the percent composition of each (i.e., 75% cobble, 25% large gravel).
- **Gradien**t was measured using a clinometer. Up and downstream measurements were taken with an average produced from the two as a percent change over the reach length.

Genetic samples collected in distribution and contaminant levels sampling (N=480 from the Flathead River drainage and N=50 from the Elk River drainage) were analyzed at the University of Montana Conservation Genetics Laboratory to test for hybridization with introduced Yellowstone cutthroat and rainbow trout and to describe the westslope cutthroat trout population genetic structure.

Genetic analysis of sculpin collected from Foisey Creek, BC in 2006 suggested that a previously undescribed taxon might exist in this drainage. Sculpin were detected throughout much of the upper Transboundary Flathead in 2008, although no meristic or genetic data were collected at these locations. In 2009, FWP contracted Dr. David Neely to conduct a meristic analysis of sculpin samples from several stream tributaries to the Transboundary Flathead River. Depending on his assessment, he may compare his samples to museum specimens collected from the Fraser, Columbia, and upper Missouri River drainages in future contracts. His results will help guide future field sampling and genetic analyses to further elucidate the taxonomic relationships among *Cottus* species. Dr. Neely produced a preliminary report of his findings in 2010 (Appendix A).

<u>Additional data collection</u>

In 2008, FWP contracted with the Canadian Columbia River Inter-Tribal Fisheries Commission, Fisheries Renewal Partnership to survey and complete fish population estimates in tributaries of the Elk River. As specified in the Cooperative Agreement, we are sending a copy of the Elk River Native Fish Distribution Assessment 2008 to the NPS Contracting Officer.

3.0 RESULTS AND DISCUSSION

3.1 Baseline Contaminant Investigation

This project investigated baseline contaminant levels in fish tissues in the Transboundary Flathead River and Elk River drainages. Work included completing permitting requirements with BC, collecting tissue samples, lab analysis of tissues, and reporting. FWP sampled 15 water bodies, 13 streams and two lakes, and conducting selenium (Se) analyses on 555 fish, consisting of 989 tissue samples, from 11 species. We conducted a 17-metal scan on 27 composite samples from 13 waters. We primarily sampled westslope cutthroat trout, followed by sculpin and mountain whitefish, but also sampled peamouth, kokanee, bull trout, northern pike minnow, longnose sucker, lake trout, rainbow trout and lake whitefish. Tissue samples came from muscle (435), liver (363), gonads (98) and whole fish (93). Muscle tissue was sampled for all fish, liver tissue for most samples, and ovaries when available from gravid females. Whole fish samples were only taken for sculpin.

We sampled four waters in the Elk River drainage and eleven in the Flathead River drainage (Table 1 and Figure 2). In 2008, we sampled Lake Koocanusa, Michel Creek, Lodgepole Creek and the Elk River in the Elk River Drainage and in the Flathead River Drainage, Flathead Lake, Foisey Creek, and the Flathead River in BC. In 2009, we sampled the Elk River site a second time and the Flathead River at a site just downstream of the Canada/United States border in Montana. We also sampled McEvoy, Middlepass, Cabin, Howell, Shepp, Pollock, McLatchie, and Harvey creeks, all tributaries to the Flathead River in BC.

<u>Characteristics of Fish Sampled</u>

Over the two year period, we sampled 200 westslope cutthroat trout. From each water we took tissues from the largest fish captured and targeted fish over 150 mm in total length if available. Cutthroat trout total lengths ranged from 121 to 517 mm (Table 2, Appendix B). Fish lengths were dependent on habitat type and migratory life stages sampled. The largest cutthroat trout captured and greatest mean lengths 332, 334, and 305 mm were observed in the larger water bodies, Flathead Lake, Elk River and Michel Creek, respectively (Figure 3). Adult migratory cutthroat trout reside in these waters. Two locations on the Flathead River had intermediate mean lengths, 243 and 238 mm, indicative of presence of migratory subadults and fluvial adults. Mean lengths in samples from smaller tributaries (nine streams) ranged from 148 to 190 mm (Figure 3), indicating the presence of primarily young migratory fish and possibly small resident adults. Fish in tributary samples likely resided in the smaller stream for their entire life prior to capture. However, the stream residence histories for the larger trout are not known, since these fish may have moved between spawning habitat and larger waters downstream. Migratory westslope cutthroat trout in the Flathead System remain in their spawning/rearing stream for 1 to 3 years prior to downstream migrations to the Flathead River or Flathead Lake. Once mature these fish return to spawning streams and then return to larger waters.

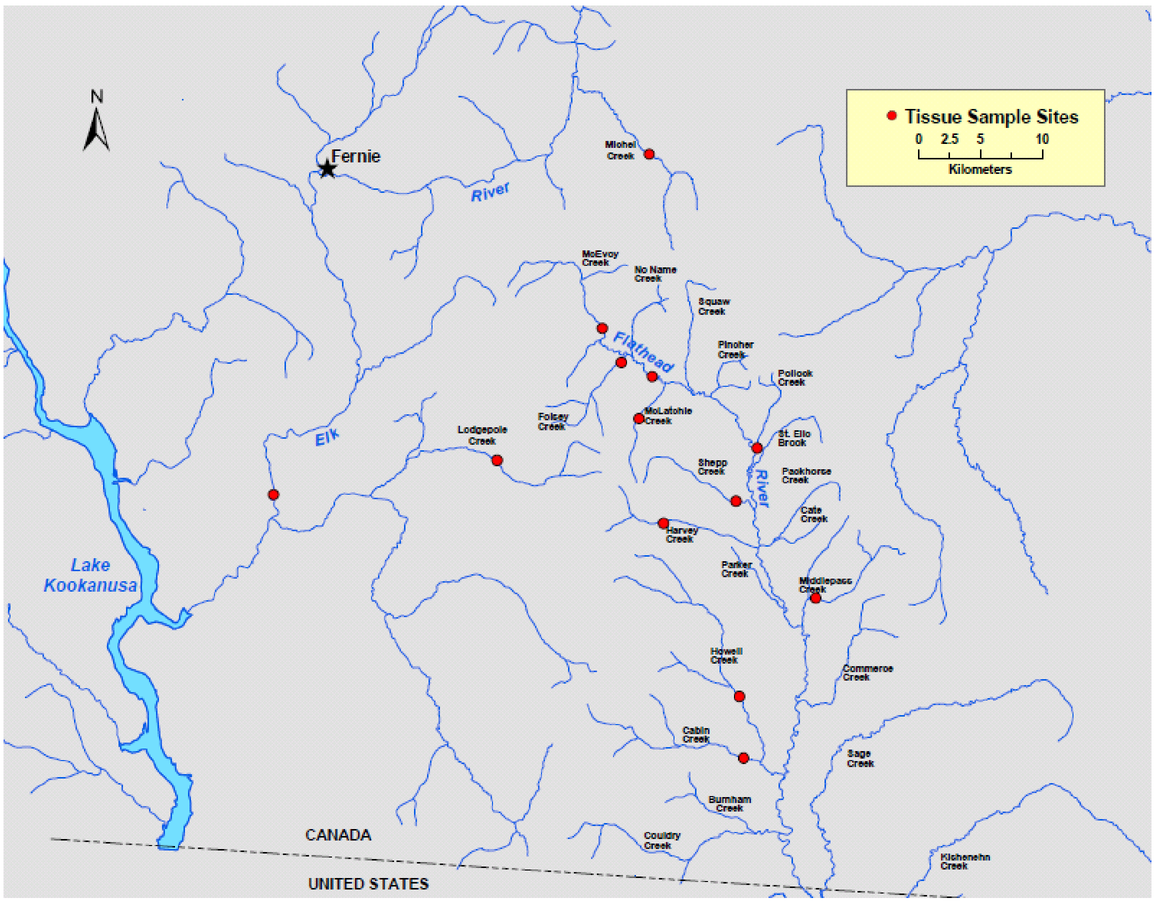

Figure 2. Sample locations for fish tissue collections in the Flathead River, British Columbia, 2008 and 2009.

Table 2. Summary statistics for total lengths (mm) of westslope cutthroat trout samples.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	331.9	15.4	331.0	67.2	214	517	19	32.4
NFR	243.1	6.7	231.0	25.8	212	288	15	14.3
CAB	190.2	10.9	189.5	34.4	148	234	10	10.0
HOW	147.8	12.1	139.0	24.2	130	183	4	8.0
MIP	189.2	14.4	177.5	45.5	150	301	10	32.6
HV muscle *	162.8	9.3	161.5	29.3	121	231	10	21.0
HV liver *	167.4	9.0	163.0	26.9	136	231	9	20.7
POL	157.1	4.4	156.5	14.0	136	181	10	10.0
MCL	177.3	8.9	171.0	28.2	146	234	10	20.1
FR	238.2	12.0	225.5	50.9	177	373	18	25.3
FOI	168.0	6.8	166.5	30.4	124	262	20	14.2
MCE	174.7	7.4	174.0	23.3	143	218	10	16.7
ELK	333.6	7.9	331.0	35.3	272	412	20	16.5
LPO	184.0	8.6	180.0	38.5	126	262	20	18.0
MIC	305.1	14.1	283.0	56.2	249	423	16	30.0

* HV liver tissue sample had one less fish length than the muscle tissue sample

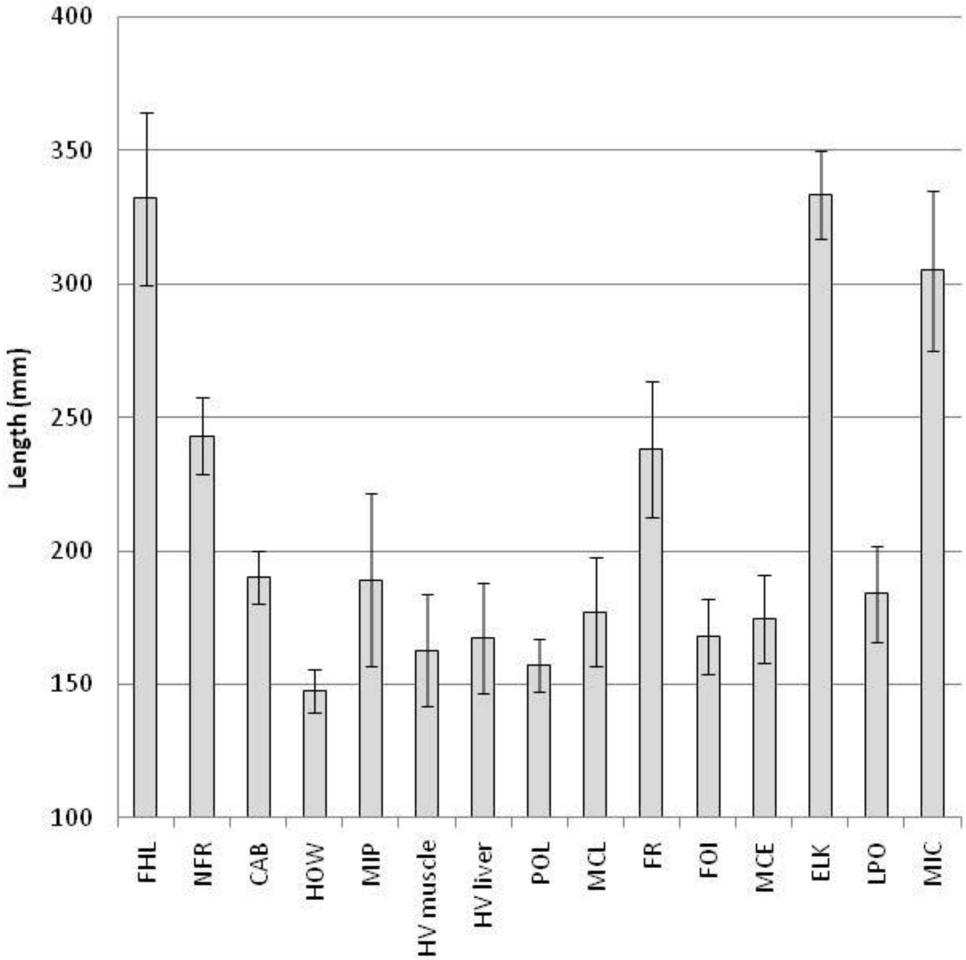

Figure 3. Mean total lengths of westslope cutthroat trout samples. Error bars represent 95% confidence intervals.

We did not capture cutthroat trout at our sampling location in Shepp Creek. Appendix B contains weights for sampled westslope cutthroat trout.

We sampled sculpin from sites in the Flathead River and tributaries (Table 3). Sculpin samples were likely comprised of one or two species. As part of this study, we contracted with Dr. David Neely to investigate the systematic of sculpin in the Flathead River System. Dr. Neely's report (Appendix A) described two species in the Flathead System, the Rocky Mountain sculpin (*Cottus* (*Uranidea*) sp. cf *bairdii*) and the Columbia slimy sculpin (*Cottus* (*Uranidea*) sp. cf *cognatus*). We did not try to distinguish species of sculpin in our sampling and likely both species are represented. Sculpin lengths ranged from 68 to 133 mm and mean sample lengths ranged from 86 to 103 mm (Table 3 and Figure 4). Sculpin reside in these streams for their entire life history.

Table 3. Summary statistics for total lengths (mm) of *Cottus spp*. samples from the Flathead River and tributaries.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
NFR	86.4	1.4	85.0	6.3	78	101	20	2.9
CAB	103.1	4.4	100.0	14.0	89	133	10	10.0
HOW	99.1	3.5	96.5	11.2	88	127	10	8.0
MIP	85.6	2.6	85.0	8.2	76	98	10	5.8
FOI	85.6	3.0	84.5	13.5	68	121	20	6.3
MCE	94.0	2.7	94.5	8.5	83	111	10	6.1

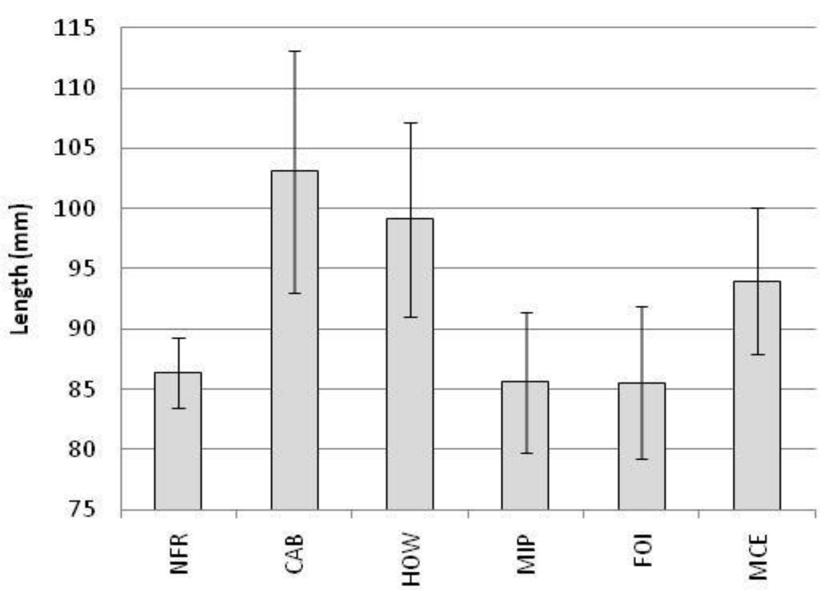

Figure 4. Mean total lengths of *Cottus spp*. samples. Error bars represent 95% confidence intervals.

We sampled 55 mountain whitefish from five locations; Lake Koocanusa and the Elk River in the Kootenai River System and Flathead Lake and two sites in the Flathead River in the Flathead River System. Sampled mountain whitefish ranged in total length from 226 to 375 mm (Table 4) and sample mean lengths were similar between waters (Figure 5). The two fish Lake Koocanusa sample was comprised of two larger fish (Table 4). The sixteen gonad samples came from fish that also provided muscle tissue samples. The mean values for the gonad samples are different than those for the muscle tissue samples since the sample size is smaller for the gonad tissue.

Table 4. Summary statistics for total lengths (mm) of mountain whitefish samples.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	281.6	11.1	286.5	31.4	243	345	8	26.2
NFR	309.2	7.9	307.0	35.5	226	372	20	16.6
NFR gonad *	288.1	10.7	284.5	30.2	226	323	8	25.3
FR	284.9	7.8	282.0	30.3	244	363	15	16.8
KOO	358.5	16.5		23.3	342	375	2	209.7
ELK	286.8	9.8	279.5	31.0	241	342	10	22.2
ELK gonad *	284.0	11.0	279.5	31.1	241	342	8	26.0
* gonad tissue samples contained fewer fish than the liver or muscle samples.								

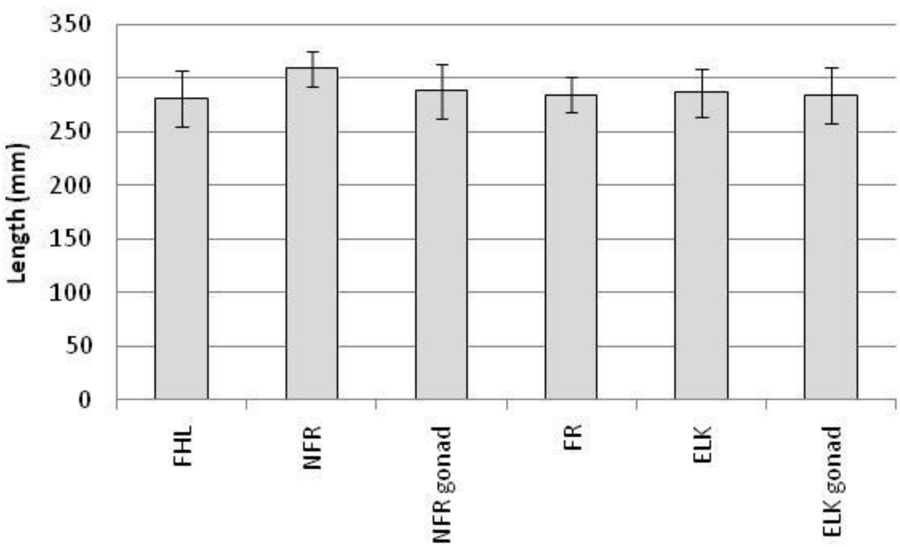

Figure 5. Mean total lengths of mountain whitefish samples. Error bars represent 95% confidence intervals.

In Lake Koocanusa and Flathead Lake, FWP conducts annual monitoring gill-netting surveys. We collected tissue samples from these catches for a number of species, including bull trout, northern pikeminnow, longnose sucker, peamouth, kokanee, lake whitefish, rainbow trout and lake trout (Table 5). When possible we chose fish in similar lengths between these two waters. The mean lengths for bull trout, northern pikeminnow, peamouth, and longnose sucker were similar between waters (Figure 6).

Table 5. Summary statistics for total lengths (mm) of fish species collected from Flathead Lake (FHL) and Lake Koocanusa (KOO). Species abbreviations are bull trout (Bull), northern pikeminnow (Npm), peamouth (Pm), lake trout (Lt), kokanee (Kok), longnose sucker (LnSu), lake whitefish (Lwf), and rainbow trout (Rb).

Location	Species	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	Bull	520.2	57.1	560.5	180.5	231	715	10	129.1
KOO	Bull	631.2	19.8	626.5	88.4	480	737	20	41.4
FHL	Npm	486.9	9.9	486.0	32.8	436	543	11	22.0
KOO	Npm	517.7	7.2	511.0	32.0	470	603	20	15.0
KOO gonad *	Npm	519.6	7.8	515.5	33.3	470	603	18	16.5
FHL	Pm	261.7	4.3	260.0	19.8	227	311	21	9.0
FHL gonad *	Pm	277.0	6.0	271.0	17.9	251	311	9	13.8
KOO	Pm	291.2	3.2	288.0	14.5	265	314	20	6.8
FHL	Lt	697.4	32.5	723.0	134.0	487	921	17	68.9
KOO	Kok	269.4	1.9	269.5	8.6	255	292	20	4.0
FHL	LnSu	360.4	14.7	372.0	53.0	241	433	13	32.0
KOO	LnSu	353.6	10.2	344.5	38.2	286	421	14	22.0
KOO gonad *	LnSu	403.3	11.0	409.5	22.0	373	421	4	35.0
FHL	Lwf	459.5	6.5	461.5	29.1	405	532	20	13.6
KOO	Rb	353.0	16.0	353.0	22.6	337	369	2	203.3

*Sample sizes are smaller for KOO and FHL gonad samples than for other tissue samples.

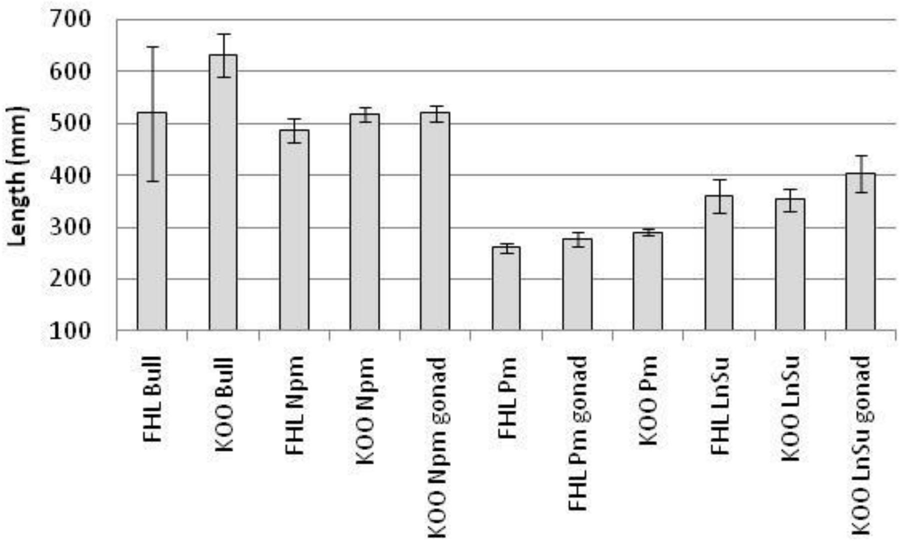

Figure 6. Mean total lengths of fish species collected from Flathead Lake (FHL) and Lake Koocanusa (KOO). Error bars represent 95% confidence intervals. Species abbreviations are bull trout (Bull), northern pikeminnow (Npm), peamouth (Pm), lake trout (Lt), kokanee (Kok), longnose sucker (LnSu), lake whitefish (Lwf), and rainbow trout (Rb).

Selenium Concentrations in Tissues

Westslope Cutthroat Trout

The assessment of the selenium concentrations in tissues showed expected results. Se concentrations in liver tissues were greater than those in muscle tissues and samples with higher liver concentrations also had higher muscle concentrations. Results show statistically significant differences in Se concentrations in fish from different water bodies. All Se concentrations are reported in mg/kg dry weight (dw).

Se concentrations in westslope cutthroat trout tissues were assessed in 14 waters (Tables 6 and 7, Figures 7 and 8). Westslope cutthroat trout from Flathead Lake had the lowest mean Se concentrations in both muscle and liver tissues while those from the Elk River showed the highest concentrations. Values from tributary streams to the Elk and Flathead rivers were intermediate to these extremes. For individual waters, the mean concentrations for muscle and liver tissues were closely related, that is if a water body had a relatively high or low Se concentration in muscle tissue then it also had a correspondingly relatively high or low concentration in liver tissue.

Flathead Lake had the lowest mean concentration of Se in muscle tissue and Elk River had the highest, 1.5 and 6.9 mg/kg, respectively (Table 6). The Elk River sample ranged from 4.5 to 8.4 mg/kg, the later was the highest Se muscle concentration observed for all samples from westslope cutthroat trout. The other streams showed intermediate levels (Figure 7). Lemly (1993) established biological effects thresholds for Se, which are used to assess the Se status and health of fish populations. For muscle tissue, the threshold value for Se concentration was 8 mg/kg. All means values were below this value. Three of the 20 westslope cutthroat trout sampled in Elk Creek had Se muscle concentrations higher than the threshold (Appendix B).

Mean Se concentrations in liver tissue ranged from 9.7 (Flathead Lake) to 25.7 mg/kg (Elk River) (Table 7). For liver tissues the biological effects threshold was 12 mg/kg, dry weight (Lemly 1993). All of the fish populations in this study contained individual fish with liver concentrations higher than the threshold value. The Flathead Lake mean value was the only one we observed lower than the threshold. The mean value for the Elk River was over two times higher than the threshold.

In the Foisey Creek sample we observed the highest individual liver Se concentration in westslope cutthroat trout, 36.7 mg/kg in a 173 mm (TL) long fish, although this same fish did not have a correspondingly high muscle tissue concentration (Appendix B). The second highest westslope cutthroat trout value (35.3 mg/kg) came from the Elk River and this fish also had one of the highest muscle Se concentrations.

The Elk River sample also had the highest minimum liver Se concentration (20.3 mg/kg, dw) across all waters (Table 7). Elk River westslope cutthroat trout liver samples ranged from 20.3 to 35.3 mg/kg (Table 7). These results are not surprising since Canadian researchers have found similar results in the Elk River, BC (McDonald and Strosher 1998). In 2007, the Elk River Selenium Task Force reported in their annual Se status report that Se was elevated in water, sediment and biota downstream of coal mines and was attributed directly to mining activities (Golder Associates Ltd. 2008). They also concluded that Se water concentrations continually increase and double every 10 years and that Se concentrations in fish tissues are elevated downstream of coal mines.

Table 6. Summary statistics for selenium concentrations (mg/kg, dry weight) in muscle tissue samples from westslope cutthroat trout.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	1.5	0.07	1.5	0.32	1.0	2.5	19	0.15
NFR	3.6	0.17	3.6	0.66	2.6	5.2	15	0.36
CAB	4.0	0.12	4.2	0.39	3.2	4.4	10	0.28
HOW	3.5	0.09	3.5	0.17	3.3	3.7	4	0.27
MIP	2.9	0.11	2.9	0.34	2.5	3.5	10	0.24
HV	3.8	0.14	3.7	0.45	3.3	4.6	10	0.32
POL	3.2	0.14	3.2	0.43	2.5	3.8	10	0.31
MCL	3.8	0.24	3.6	0.76	2.8	5.5	10	0.54
FR	4.1	0.21	4.0	0.88	2.7	6.7	18	0.44
FOI	4.7	0.14	4.9	0.63	3.1	6.0	20	0.29
MCE	3.3	0.11	3.3	0.35	2.8	3.8	10	0.25
ELK	6.9	0.24	7.2	1.08	4.5	8.4	20	0.51
LPO	4.9	0.17	5.0	0.77	3.5	6.4	20	0.36
MIC	3.6	0.30	3.2	1.21	2.1	5.8	16	0.65

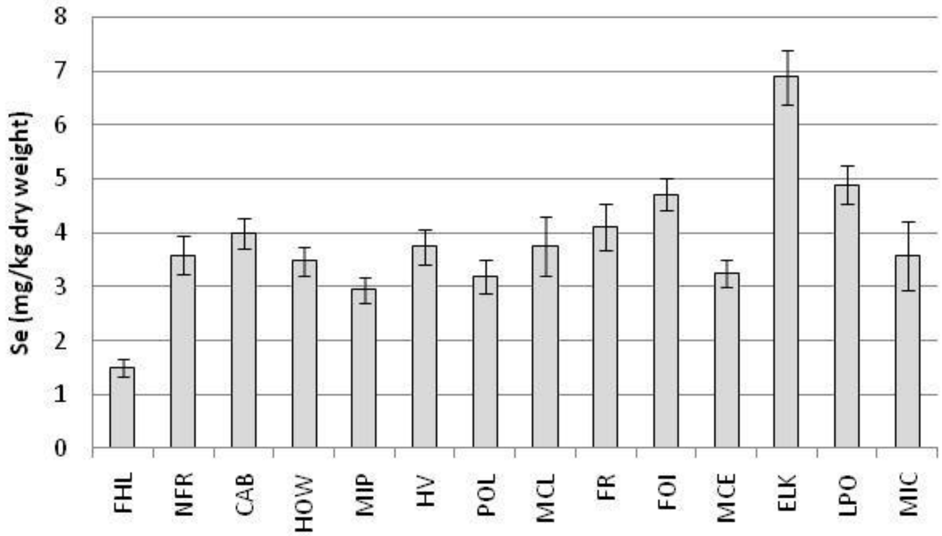

Figure 7. Mean selenium concentrations in muscle tissue from westslope cutthroat trout. Error bars represent 95% confidence intervals.

Table 7. Summary statistics for selenium concentrations (mg/kg, dry weight) in liver tissue samples from westslope cutthroat trout.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	9.7	0.70	9.3	3.06	5.3	18.6	19	1.47
NFR	16.2	0.79	16.4	3.05	11.3	25.1	15	1.69
CAB	20.0	1.64	18.6	5.19	12.5	29.5	10	3.71
HOW	17.6	2.39	17.8	4.78	12.4	22.3	4	7.60
MIP	15.0	1.71	12.9	5.40	8.9	26.4	10	3.86
HV	13.9	0.73	13.4	2.05	11.8	18.0	8	1.72
POL	12.9	0.97	13.2	3.06	9.4	18.9	10	2.19
MCL	14.0	0.89	13.3	2.83	10.6	20.3	10	2.02
FR	17.5	0.91	17.0	3.86	12.0	26.8	18	1.92
FOI	20.2	1.37	18.2	6.14	11.9	36.7	20	2.88
MCE	13.9	1.49	13.5	4.46	6.9	21.2	9	3.43
ELK	25.7	0.80	25.5	3.59	20.3	35.3	20	1.68
LPO	17.6	0.73	16.9	3.28	14.0	28.1	20	1.54
MIC	13.3	0.96	11.9	3.85	7.6	21.8	16	2.05

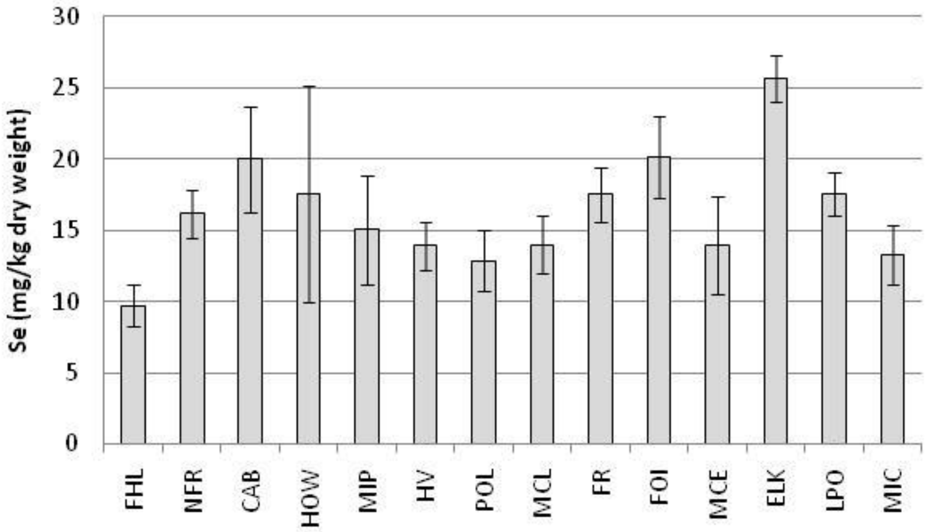

Figure 8. Mean selenium concentrations in liver tissue from westslope cutthroat trout. Error bars represent 95% confidence intervals.

The Michel Creek sample showed unexpected results. Se concentrations in liver tissue ranged from 7.6 to 21.8 with a mean of 13.3 mg/kg (Table 7). This intermediate level was lower than what was expected from a drainage with an active coal mine. The mean was similar to the means from tributaries without coal mines (Figure 8). We observed similar results for the muscle tissue concentrations. The westslope cutthroat trout sample from Michel Creek was comprised of fish with a wide size range and included large migratory adults. The Michel Creek westslope cutthroat trout sample showed a significant positive relationship between fish length and Se tissue concentration for both liver and muscle tissues (R^2=0.3145 p-value<0.05, R^2=0.6348 p-value=<0.05, respectively). The relationship between fish length and muscle concentration of Se in Michel Creek was the strongest observed (Figure 9). We did not observe a similar relationship in samples from other waters, including Flathead Lake and the Elk River both of which also included samples from adult migratory fish.

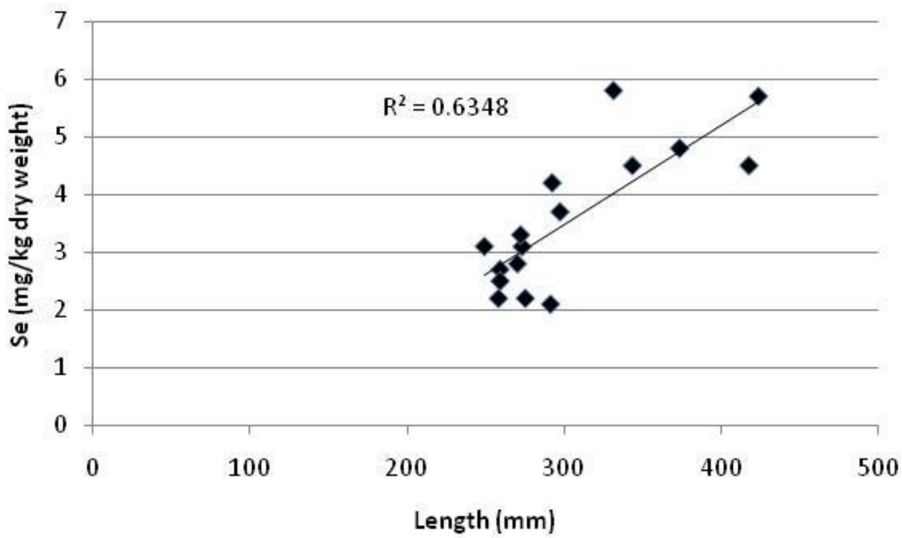

Figure 9. Selenium concentration in muscle tissue of westslope cutthroat trout collected in Michel Creek.

In the Michel Creek sample, westslope cutthroat trout greater than 300 mm (TL) had a significantly ($P<0.05$) greater mean concentration of Se in muscle and liver tissue than westslope cutthroat trout less than 300 mm (TL). The larger westslope cutthroat trout had mean concentrations of 16.0 and 5.1 mg/kg in liver and muscle, respectively. The smaller westslope cutthroat trout had mean concentrations of 12.1 and 2.9 mg/kg in liver and muscle, respectively. We did not observe similar relationships in samples from other waters. The wide size distribution of fish sampled could explain the differences in Se concentrations between groups. The larger fish may inhabit different habitat than the smaller size group. For example, the larger fish may use the Elk River and lower reaches of Michel Creek, below the outflow of a coal mine on Corbin Creek, whereas the younger fish could be moving downstream from the upper drainage, above the coal mine outflow. We do not have migratory history of individual fish, but it appears from the differences in Se concentrations that larger and smaller fish did not share the same habitat prior to capture. Since we did not see a difference in Se concentrations related to fish length in other waters, we assume that the fish comprising other samples used the same habitat.

Sculpin

We sampled sculpin from six waters, five tributaries to the Flathead River in BC and the Flathead River in Montana near the Canadian/United States border. Three streams, Cabin, Howell and Foisey creeks, were in drainages with underlying coalfields. Two streams, Middlepass and McEvoy creeks, were not associated with coalfields. Cabin Creek sculpin had the highest whole fish mean Se concentration of 8.1 mg/kg. Howell Creek, Foisey Creek and the Flathead River sample had moderate mean concentrations and Middlepass and McEvoy creeks had the lowest concentrations, 2.9 and 3.1 mg/kg respectively (Table 8 and Figure 10). Lemly (1993) established a whole fish Se threshold of 4 mg/kg. Only Middlepass and McEvoy creeks had lower mean Se concentrations and these were significantly lower than the other means. The Flathead River sample had a moderately high mean Se concentration similar to the samples from Howell and Foisey creeks. There was potentially a relationship between Se concentrations and underlying coalfields. Further investigation is required to determine a relationship.

Table 8. Summary statistics for selenium concentrations (mg/kg, dry weight) in whole fish samples from sculpin.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
NFR	5.4	0.22	5.4	1.00	3.8	7.2	20	0.47
CAB	8.1	0.48	8.6	1.51	5.6	10.0	10	1.08
HOW	6.1	0.25	6.2	0.77	5.0	7.6	10	0.55
MIP	2.9	0.24	2.8	0.77	1.9	4.3	10	0.55
FOI	5.4	0.42	5.0	1.89	2.8	11.5	20	0.88
MCE	3.1	0.29	3.0	0.92	1.8	4.7	10	0.66

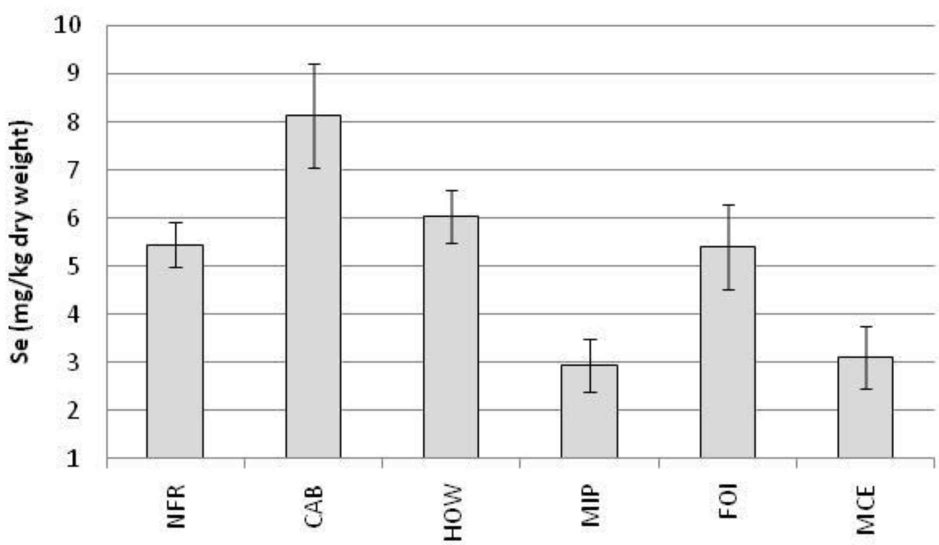

Figure 10. Mean selenium concentrations in whole fish samples from sculpin. Error bars represent 95% confidence intervals.

Mountain Whitefish

We sampled mountain whitefish muscle and liver tissue from five sites, Flathead Lake, Lake Koocanusa, two locations on the Flathead River, and the Elk River (Tables 9 and 10, Figures 11 and 12). We also sampled ovaries from mountain whitefish in the Flathead and Elk rivers (Table 11 and Figure 13). The Koocanusa sample contained only two fish, leading to wide confidence intervals. The Koocanusa mean Se concentration values were moderate to low when compared to the other samples, but the small sample size limits comparisons. Flathead Lake consistently had the lowest concentrations and similarly to other species, the Elk River samples consistently had the highest values. Mean Se concentration values for muscle tissue showed the Flathead River samples to be intermediate to the high Elk River value and the low Flathead Lake value (Figure 11).

One liver sample from the Flathead River in Montana (NFR) showed an exceptionally high value of 111 mg/kg (dw) that we were unable to rule out as an outlier. The muscle tissue sample from this fish did not show a correspondingly high concentration (4.2 mg/kg dw).

We sampled mature gonads from female whitefish in the Elk River and at one site in the Flathead River (Table 11). Mean gonad Se concentrations were higher in the Elk River sample although the relationship was not significantly different at a 95% confidence level (Figure 13).

The liver sample from Flathead Lake was the only mean concentration below the Lemly (1993) Se threshold of 12 mg/kg. The remaining three samples were all much greater than this level. Conversely, all mean muscle Se concentrations were below the 8 mg/kg threshold. The mountain whitefish muscle values for these water bodies were very similar to the westslope cutthroat trout muscle values for these same waters (Table 6). Similar to the liver results, the mean Se concentrations in ovaries from the Flathead and Elk rivers samples, 28.9 and 36.1 mg/kg, were much higher than the Lemly threshold value of 10 mg/kg.

Table 9. Summary statistics for selenium concentrations (mg/kg, dry weight) in muscle tissue samples from mountain whitefish.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	1.5	0.09	1.5	0.26	1.3	2.1	8	0.21
NFR	3.7	0.20	4.0	0.87	2.5	5.0	20	0.41
FR	3.9	0.18	3.9	0.69	3.0	5.2	15	0.38
ELK	5.8	0.28	5.4	0.88	4.8	7.8	10	0.63
KOO	2.5	0.45	2.5	0.64	2.0	2.9	2	5.72

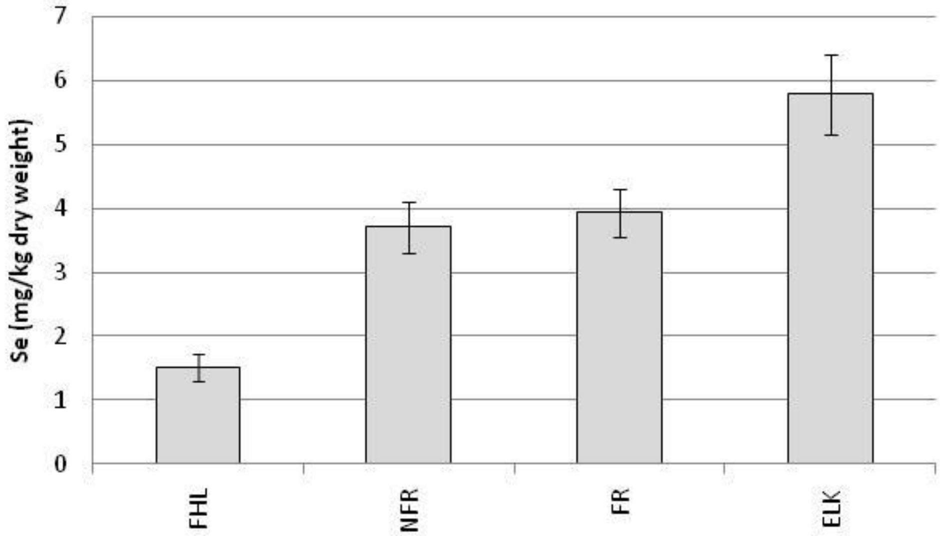

Figure 11. Mean selenium concentrations in muscle tissue from mountain whitefish. Error bars represent 95% confidence intervals.

Table 10. Summary statistics for selenium concentrations (mg/kg, dry weight) in liver tissue samples from mountain whitefish.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	10.7	0.73	11.5	2.08	7.5	13.2	8	1.74
NFR	42.5	4.90	35.4	21.9	17.7	111.0	20	10.3
FR	30.1	2.52	29.0	9.77	16.0	47.4	15	5.41
ELK	44.6	4.48	39.3	14.2	33.2	74.9	10	10.1
KOO	27.8	15.4	27.8	21.7	12.4	43.1	2	195.0

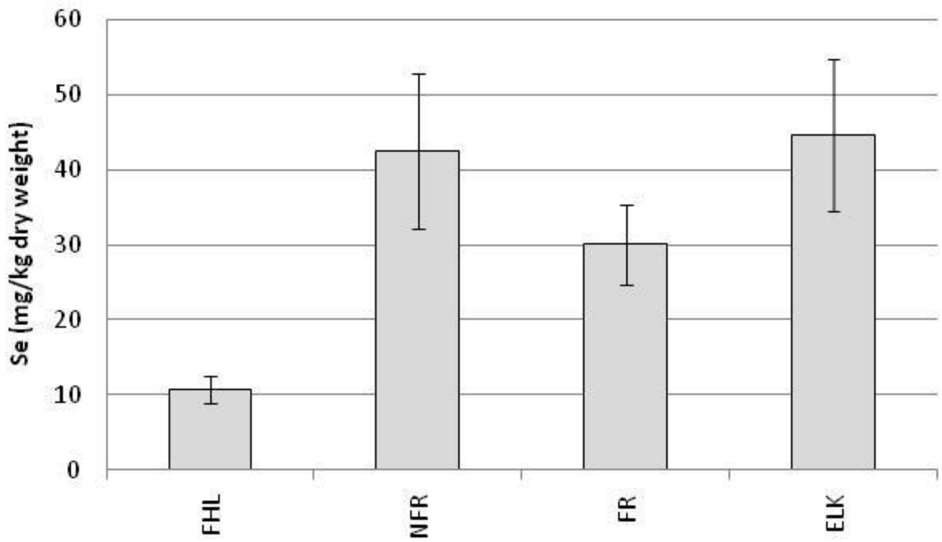

Figure 12. Mean selenium concentrations in liver tissue from mountain whitefish. Error bars represent 95% confidence intervals.

Table 11. Summary statistics for selenium concentrations (mg/kg, dry weight) in gonad tissue samples from female mountain whitefish.

Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
NFR	28.9	2.06	29.0	5.82	20.8	36.3	8	4.86
ELK	36.1	2.14	34.4	6.05	29.6	45.5	8	5.06

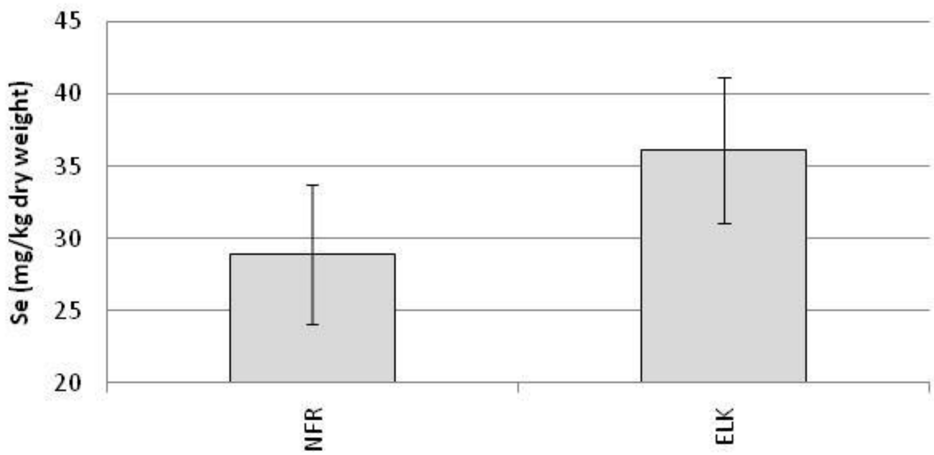

Figure 13. Mean selenium concentrations in ovarian tissue from mountain whitefish. Error bars represent 95% confidence intervals.

Other Fish Species

In Flathead Lake and Lake Koocanusa we sampled bull trout, longnose sucker, lake whitefish, lake trout, kokanee, rainbow trout, northern pikeminnow, and peamouth. The rainbow sample from Koocanusa consisted of only two fish, limiting opportunities for comparisons.

We collected muscle tissue samples from all of these species (Table 12 and Figure 14). Bull trout from Flathead Lake and Lake Koocanusa had similar levels of selenium in muscle tissue. Likewise, the concentrations in northern pikeminnow were similar between the two waters. Selenium concentrations in muscle tissue were higher in Lake Koocanusa longnose suckers than in those from Flathead Lake (Figure 14). Likewise, the samples from peamouth were higher in selenium concentrations in Lake Koocanusa than concentrations in muscle tissue from Flathead Lake (Figure 14). None of the muscle samples for these additional species had mean concentrations greater than the 8 mg/kg threshold level (Table 12).

For liver samples, Se concentrations in Flathead Lake bull trout and longnose suckers samples were lower than those in Lake Koocanusa (Table 13 and Figure 15). Kokanee livers from Lake Koocanusa had the highest mean Se concentration (10.5 mg/kg dw) and bull trout in Flathead Lake had the lowest value (4.6 mg/kg dw), which differed from the muscle tissues where bull trout from the two waters contained similar concentrations. All mean concentrations in liver samples were lower than the threshold level of 12 mg/kg (Lemly 1993), with the exception of the two fish rainbow trout sample from Koocanusa (Table 13).

We did not observe differences in selenium concentrations in ovary samples from peamouth in the two waters (Table 14 and Figure 16). The mean concentrations in gonad tissues were below the 10 mg/kg biological effects threshold level.

Table 12. Summary statistics for selenium concentrations (mg/kg, dry weight) in muscle tissue samples from fish species collected in Flathead Lake (FHL) and Lake Koocanusa (KOO). Species abbreviations are bull trout (Bull), northern pikeminnow (Npm), peamouth (Pm), lake trout (Lt), kokanee (Kok), longnose sucker (LnSu), lake whitefish (Lwf), and rainbow trout (Rb).

Location	Species	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	Bull	1.3	0.09	1.4	0.29	0.9	1.7	10	0.21
KOO	Bull	1.6	0.10	1.7	0.45	0	2	20	0.21
FHL	LnSu	1.4	0.08	1.4	0.28	0.9	1.9	13	0.17
KOO	LnSu	3.5	0.21	3.2	0.77	2.5	5.1	14	0.44
FHL	Npm	1.2	0.25	1.0	0.84	0.8	3.7	11	0.57
KOO	Npm	1.3	0.06	1.3	0.27	1	1.9	20	0.13
FHL	Pm	1.5	0.06	1.5	0.27	1	2	21	0.12
KOO	Pm	2.9	0.18	2.9	0.82	1.7	4.6	20	0.38
FHL	Lwf	1.5	0.05	1.4	0.21	1	1.8	20	0.10
FHL	Lt	1.5	0.06	1.5	0.23	1.2	2	17	0.12
KOO	Kok	1.7	0.05	1.7	0.23	1.3	2.1	20	0.11
KOO	Rb	1.6	0.05	1.6	0.07	1.5	1.6	2	0.64

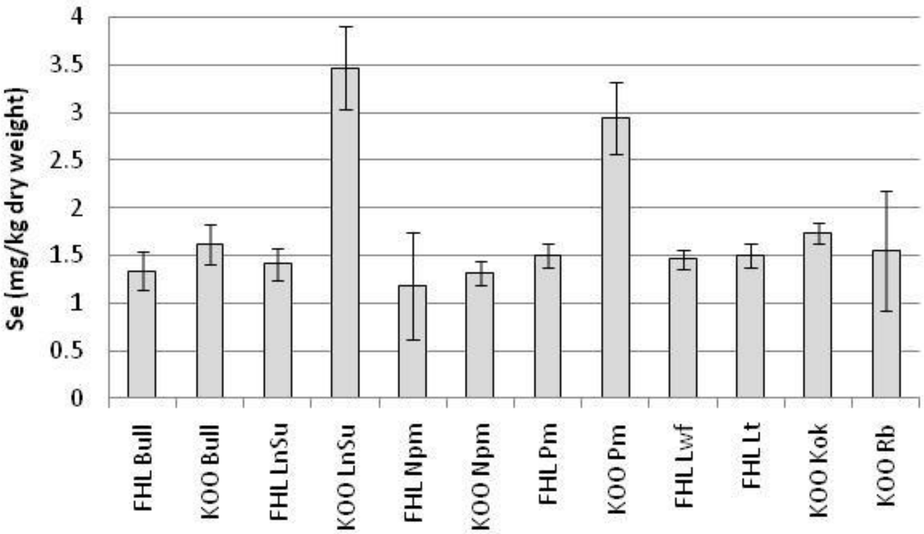

Figure 14. Mean selenium concentrations in muscle tissue from fish species collected in Flathead Lake (FHL) and Lake Koocanusa (KOO). Error bars represent 95% confidence intervals. Species abbreviations are bull trout (Bull), northern pikeminnow (Npm), peamouth (Pm), lake trout (Lt), kokanee (Kok), longnose sucker (LnSu), lake whitefish (Lwf), and rainbow trout (Rb).

Table 13. Summary statistics for selenium concentrations (mg/kg, dry weight) in liver tissue samples from fish species collected in Flathead Lake (FHL) and Lake Koocanusa (KOO). Species abbreviations are bull trout (Bull), northern pikeminnow (Npm), peamouth (Pm), lake trout (Lt), kokanee (Kok), longnose sucker (LnSu), lake whitefish (Lwf), and rainbow trout (Rb).

Location	Species	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	Bull	4.6	0.51	4.8	1.61	2.2	7.9	10	1.15
KOO	Bull	7.6	0.44	7.3	1.99	3.9	12.0	20	0.93
FHL	LnSu	5.2	0.36	5.3	1.30	3.2	7.2	13	0.78
KOO	LnSu	8.8	0.50	7.9	1.86	5.7	11.7	14	1.07
FHL	Lwf	7.8	0.39	8.1	1.73	4.6	11.2	20	0.81
FHL	Lt	7.5	0.60	7.1	2.46	4.1	11.6	17	1.26
KOO	Kok	10.5	0.84	10.2	3.77	5.0	17.3	20	1.76
KOO	Rb	13.9	6.50	13.9	9.19	7.4	20.4	2	82.6

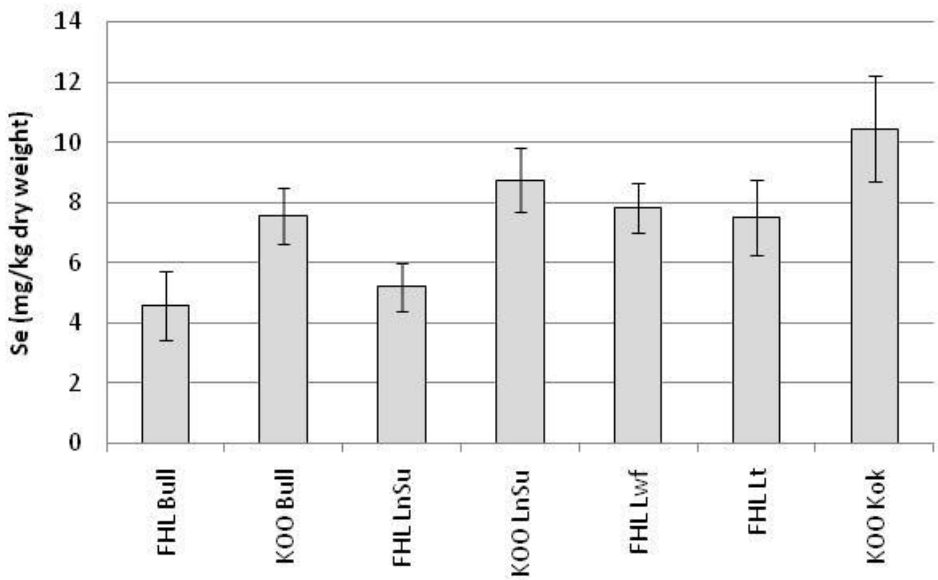

Figure 15. Mean selenium concentrations in liver tissue from fish species collected in Flathead Lake (FHL) and Lake Koocanusa (KOO). Error bars represent 95% confidence intervals. Species abbreviations are bull trout (Bull), lake trout (Lt), kokanee (Kok), longnose sucker (LnSu), and lake whitefish (Lwf).

Table 14. Summary statistics for selenium concentrations (mg/kg, dry weight) in ovary tissue samples from fish species collected in Flathead Lake (FHL) and Lake Koocanusa (KOO). Species abbreviations are northern pikeminnow (Npm), peamouth (Pm), kokanee (Kok), and longnose sucker (LnSu).

Location	Species	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL	Npm	2.6	0.30	2.5	0.98	0.8	5	11	0.66
KOO	Npm	3.6	0.23	3.5	0.98	2.5	5.9	18	0.49
FHL	Pm	7.3	0.89	7.4	2.68	2.9	10.9	9	2.06
KOO	Pm	7.3	0.47	7.2	2.08	4	11.6	20	0.97
KOO	Kok	3.7	0.13	3.6	0.59	2.9	4.9	20	0.27
KOO	LnSu	4.8	0.45	4.9	0.90	4	5.6	4	1.43

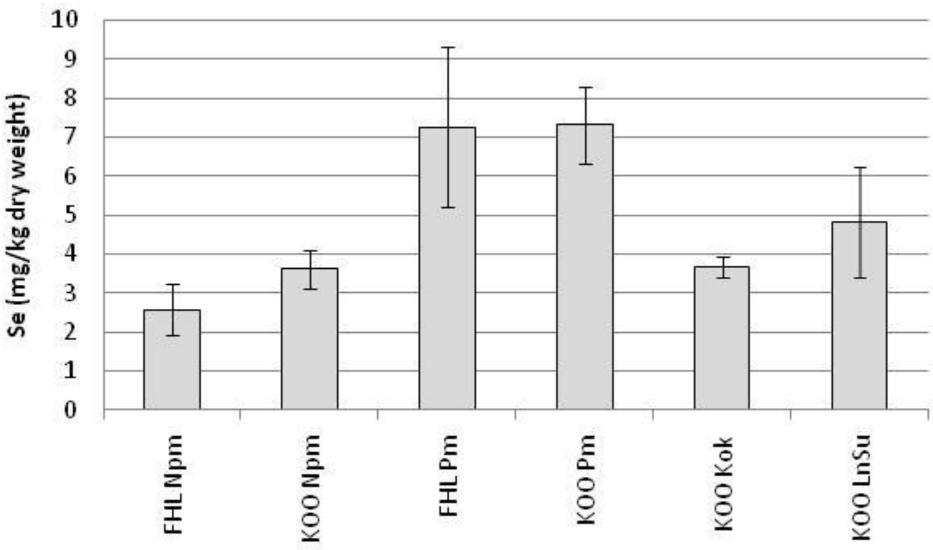

Figure 16. Mean selenium concentrations in ovarian tissue from fish species collected in Flathead Lake (FHL) and Lake Koocanusa (KOO). Error bars represent 95% confidence intervals. Species abbreviations are northern pikeminnow (Npm), peamouth (Pm), kokanee (Kok), and longnose sucker (LnSu).

<u>17-Metal Concentrations in Tissues from Composite Samples</u>

Composite fish livers were analyzed for 17 metals at the Montana Department of Health and Human Service Environmental Lab according to method EPA 200.7. All composite samples were comprised of liver tissues, except the sculpin samples which were comprised of whole fish. Table 15 describes the lengths of fish comprising the composite samples. Some composites contained small sample sizes largely due to permitting limits for fish mortality.

The majority of metals examined were below or slightly above minimum detection limits (Table 16). The exceptions were Lake Koocanusa kokanee which contained elevated liver Cu levels (489 mg/kg dw) that were an order of magnitude higher than all other samples, except lake trout from Flathead lake (123 mg/kg dw) which were also elevated (Table 16). Se concentrations in all composite samples were elevated and above detection levels (Table 16).

Based on results from composite scans, the highest Se were found in mountain whitefish livers from the Elk River (35.6 mg/kg dw), while the lowest liver Se concentrations were found in bull trout from Flathead Lake (3.3 mg/kg dw). Sculpin whole fish sample (N=1) from McEvoy Creek had the lowest concentration (3.0 mg/kg dw). Whole fish samples generally have lower Se concentrations than liver tissues.

Table 15. Summary statistics for total lengths (mm) of fish samples from the Flathead River and tributaries, Elk River and tributaries, Flathead Lake (FHL) and Lake Koocanusa (KOO). Species abbreviations are bull trout (Bull), northern pikeminnow (Npm), peamouth (Pm), lake trout (Lt), kokanee (Kok), longnose sucker (LnSu), and lake whitefish (Lwf).

Westslope Cutthroat Trout								
Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
MIC	353.7	20.0	343.0	53.0	292	423	7	49.0
LPO	167.3	19.6	132.0	52.0	124	252	7	48.0
ELK	374.5	10.4	367.0	25.5	351	412	6	26.7
FOI	135.6	2.2	136.0	5.0	130	141	5	6.2
FR	295.5	16.5	283.5	40.4	257	373	6	42.4
MIP	221.2	20.4	203.0	45.5	191	301	5	56.5
MCE	193.0	7.1	191.0	15.9	176	218	5	19.7
CAB	222.0	4.0	221.0	9.0	213	234	5	11.2
NFR	270.5	6.2	270.0	15.2	251	288	6	15.9
FHL	364.5	19.7	342.5	48.3	324	442	6	50.6
Sculpin								
Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
NFR	76.5	0.5	76.5	0.7	76	77	2	6.4
CAB	81.3	1.8	82.0	3.1	78	84	3	7.6
HOW	77.3	2.7	77.5	5.3	71	83	4	8.5
MIP	75.3	0.9	75.0	1.5	74	77	3	3.8
FOI	63.1	1.1	63.0	2.9	60	68	7	2.7
MCE	81.0						1	
Mountain Whitefish								
Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
NFR	339.0	10.0	341.0	22.3	311	372	5	27.7
FR	301.0	9.5	293.0	28.4	274	363	9	21.8
ELK	303.8	11.1	300.0	27.3	270	342	6	28.6
Other Fish Species								
Location	Mean	SE	Median	SD	Min	Max	Count	CI 95%
FHL Bull	662.7	1.8	662.0	3.1	660	666	3	7.6
KOO Bull	679.0	19.8	685.0	44.3	621	734	5	54.9
FHL Lt	754.7	32.2	723.0	55.7	722	819	3	138.4
FHL Lwf	480.4	9.1	475.0	24.0	465	532	7	22.2
KOO LnSu	367.7	10.6	351.0	33.5	336	421	10	24.0
KOO Kok	277.8	5.9	274.0	13.2	262	298	5	16.4
KOO Pm	290.7	4.2	288.0	13.3	272	314	10	9.5
KOO Npm	528.6	11.5	531.0	38.2	476	603	11	25.6

Table 16. Results from composite liver metal scan conducted the Montana Department of Health and Human Service Environmental Laboratory according to method EPA 200.7. Shaded metals represent metals of most interest and include As, Cd, Cu, Pb, Se, and Zn.

Spp	N	Water	L (mm)	W (g)	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Se	Sr	Ti	V	Zn
Cot	3	Cabin Creek	81.3		17.0	<1.00	7.73	<2.00	<0.50	<4.00	<2.00	3.37	67.7	17.6	<4.00	<0.50	8.11	23.6	<4.00	<4.00	69.2
Wct	5	Cabin Creek	222.0	111.2	<10.0	<1.00	<2.00	<2.00	0.84	<4.00	<2.00	13.5	375	4.92	<4.00	<0.50	17.1	<4.00	<4.00	<4.00	98.5
Wct	6	Elk River	364.5	522.0	<5.00	<0.50	<1.25	<0.50	0.49	<1.25	<0.50	12.6	1010	5.33	<1.25	<0.30	30.9	<2.50	<1.25	<1.25	91.3
Mwf	6	Elk River	303.8	263.8	<10.0	<1.00	<2.00	<2.00	<0.50	<4.00	<2.00	8.93	328	6.41	<4.00	<0.50	35.6	<4.00	<4.00	<4.00	90.4
Lt	3	Flathead Lake	754.7	4182.3	<10.0	<0.40	<1.00	<0.50	<0.40	<2.00	<2.00	123	693	3.99	<1.00	<0.40	6.66	<2.00	<2.00	<2.00	130
Bull	3	Flathead Lake	662.7	2763.3	<10.0	<0.40	<1.00	<0.50	<0.40	<2.00	<2.00	41.7	338	3.40	<1.00	<0.40	3.27	<2.00	<2.00	<2.00	83.5
Lwf	7	Flathead Lake	480.4	955.0	<10.0	0.60	<1.00	<0.50	0.58	<2.00	<2.00	52.0	704	9.78	<1.00	<0.40	7.34	<2.00	<2.00	<2.00	119
Wct	6	Flathead Lake	364.5	530.0	<10.0	0.57	<1.00	<0.50	<0.40	<2.00	<2.00	25.7	935	4.68	<1.00	<0.40	9.64	<2.00	<2.00	<2.00	97.5
Wct	6	Flathead River	295.5	260.3	17.8	0.50	<1.25	<0.50	2.72	<1.25	<0.50	23.3	592	5.47	<1.25	<0.30	18.1	<2.50	<1.25	<1.25	91.1
Mwf	9	Flathead River	301.0	250.6	9.35	<0.50	<1.25	<0.50	0.97	<1.25	0.55	10.8	263	7.12	<1.25	<0.30	26.9	<2.50	<1.25	<1.25	104
Wct	5	Foisey Creek	135.6		<5.00	<0.50	<1.25	<0.50	1.63	<1.25	<0.50	9.17	381	5.58	<1.25	<0.30	24.1	<2.50	<1.25	<1.25	98.3
Cot	7	Foisey Creek	63.1		30.4	<0.50	14.6	<0.50	1.18	<1.25	<0.50	2.97	107	19.0	<1.25	<0.30	7.03	35.5	<1.25	<1.25	85.4
Cot	4	Howell Creek	77.3		23.5	<1.00	5.60	<2.00	<0.50	<4.00	<2.00	3.30	85.8	11.1	<4.00	<0.50	5.66	15.8	<4.00	<4.00	67.5
Bull	5	Lake Kookanusa	734.0	4018.0	<10.0	<0.40	<1.00	<0.50	<0.40	<2.00	<2.00	30.3	601	2.89	<1.00	<0.40	7.45	<2.00	<2.00	<2.00	104
Npm	10	Lake Kookanusa	528.6		<10.0	0.43	<1.00	<0.50	<0.40	<2.00	<2.00	22.4	73.6	2.59	1.36	<0.40	3.18	<2.00	<2.00	<2.00	92.7
LnSu	10	Lake Kookanusa	367.7	545.6	<10.0	<0.40	<1.00	<0.50	0.81	<2.00	<2.00	34.6	237	8.77	<1.00	<0.40	7.35	<2.00	<2.00	<2.00	73.3
Pm	10	Lake Kookanusa	290.7		<10.0	<0.40	1.25	<0.50	0.69	<2.00	<2.00	14.3	645	7.51	1.95	<0.40	7.25	<2.00	<2.00	<2.00	88.0
Kok	5	Lake Kookanusa	277.8	195.2	5.89	0.52	<1.25	<0.50	0.30	<1.25	<0.50	489	829	4.12	<1.25	<0.30	33.2	<2.50	<1.25	<1.25	203
Wct	7	Lodgepole Creek	234.0	132.0	7.84	0.63	<1.25	<0.50	1.95	<1.25	0.50	13.2	355	5.74	<1.25	<0.30	20.2	<2.50	<1.25	<1.25	98.2
Cot	1	McEvoy Creek	81.0	6.0	17.5	<1.00	16.3	<2.00	0.65	<4.00	<2.00	3.59	59.9	10.8	<4.00	<0.50	2.95	43.9	<4.00	<4.00	64.5
Wct	5	McEvoy Creek	193.0	76.0	<10.0	<1.00	<2.00	<2.00	1.65	<4.00	<2.00	29.2	237	6.91	<4.00	<0.50	14.3	<4.00	<4.00	<4.00	96.8
Wct	7	Michel Creek	353.7	538.0	6.68	0.59	<1.25	<0.50	2.94	<1.25	<0.50	13.0	1320	6.85	<1.25	<0.30	21.8	<2.50	<1.25	<1.25	97.8
Cot	3	Middle Pass Creek	75.3	4.7	28.0	<1.00	4.86	<2.00	<0.50	<4.00	<2.00	2.86	76.0	8.10	<4.00	<0.50	3.35	8.55	<4.00	<4.00	73.8
Wct	5	Middle Pass Creek	221.2	134.8	<10.0	1.25	<2.00	<2.00	1.59	<4.00	<2.00	9.15	290	4.32	<4.00	<0.50	12.1	<4.00	<4.00	<4.00	89.9
Cot	2	North Fork Flathead R	76.5	5.0	29.4	<1.00	24.4	<2.00	<0.50	<4.00	<2.00	3.98	88.4	15.6	<4.00	<0.50	4.77	34.8	<4.00	<4.00	95.7
Mwf	9	North Fork Flathead R	339.0	368.8	<10.0	<1.00	<2.00	<2.00	<0.50	<4.00	<2.00	9.09	635	7.07	<4.00	<0.50	29.1	<4.00	<4.00	<4.00	101
Wct	6	North Fork Flathead R	270.5	212.0	26.5	<1.00	<2.00	<2.00	<0.50	<4.00	<2.00	11.2	601	8.52	<4.00	<0.50	11.0	<4.00	<4.00	<4.00	96.0

Liver tissues typically contain the highest levels of Se compared to muscle, whole fish or gonads. The toxic effects threshold for liver Se levels is 12 mg/kg dw (Lemly 1993). Composite liver scans revealed 12 of the 21 Se concentrations in excess of the threshold value. For westslope cutthroat trout, eight of ten samples were greater than the threshold value (Figure 17). Similar to the results for individual fish samples, the Elk River composite samples had the highest Se concentration and the Flathead Lake sample had the lowest, with all other intermediate. All mountain whitefish samples contained greater concentrations than the threshold value (Figure 18). Conversely, all Flathead Lake samples were below the threshold value. In Lake Koocanusa, only the kokanee sample was greater than the threshold value (Figure 19).

The toxic effects threshold for whole fish Se levels is 4 mg/kg dw (Lemly 1993). Four of the six composite samples of whole sculpin had higher concentrations of Se than the threshold value (Figure 20). Three of these four, Cabin, Howell, and Foisey creeks are in drainages underlain with coal seams, while Middlepass and McEvoy creeks were not. The Flathead River sample (NFR) was collected in Montana, just downstream of the confluence with Trail Creek. Further study is required to determine if a relationship exists between Se concentrations in sculpin and their proximity to coal seams.

Compared to mean Se values from individual liver analyses, composite scans consistently tracked the individual analyses (Figure 17). There was a highly significant correlation (R^2=0.69, p-value<0.005) between the Se scan results and those from individual analyses. Se concentrations in Lake Koocanusa Kokanee were the only results not clearly consistent with the results from individual fish livers; composite scan was 217.7 % higher than mean from individuals fish livers (Figure 19). Kokanee from Lake Koocanusa also contained elevated Cu concentrations noted above.

Results from tissue scans on 27 samples, from 11 water bodies and 10 species, provide reference baseline data for current background levels of metals. Consistent results for scans and individual Se analysis showed that the scans could be used as a metric initially to evaluate Se in fish tissues. It is difficult to determine the reason behind the inconsistent result from the Lake Koocanusa kokanee sample. The elevated Se and Cu concentrations in this liver scan may suggest the scan analysis was inaccurate, however the Se concentration measured in the scan (33.20 mg/kg dw) was very similar to concentrations (34.4 ± 11.2 mg/kg dw) found by McDonald (2005). Twenty Se analyses were conducted on individual fish and were very consistent (SE=0.84). Since only five fish livers were used in the composite scan, it is possible some or all of the fish contained elevated the Cu and Se concentrations.

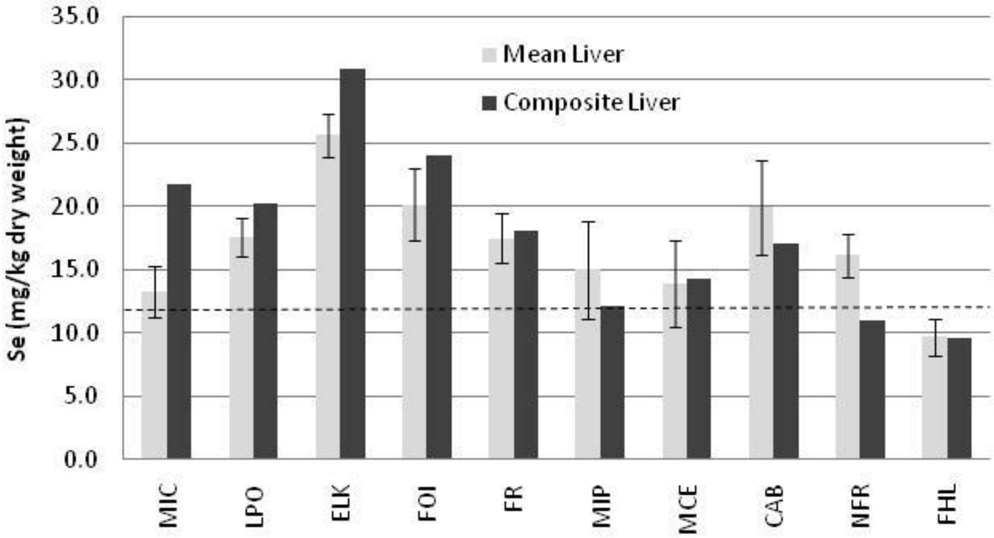

Figure 17. Mean liver Se concentrations for westslope cutthroat trout from individual analyses (grey bars; ± 95% CI) and composite metal scans (black bars). Horizontal line represents Lemly's (1993) toxic effects threshold for liver Se concentrations (12 mg/kg dw).

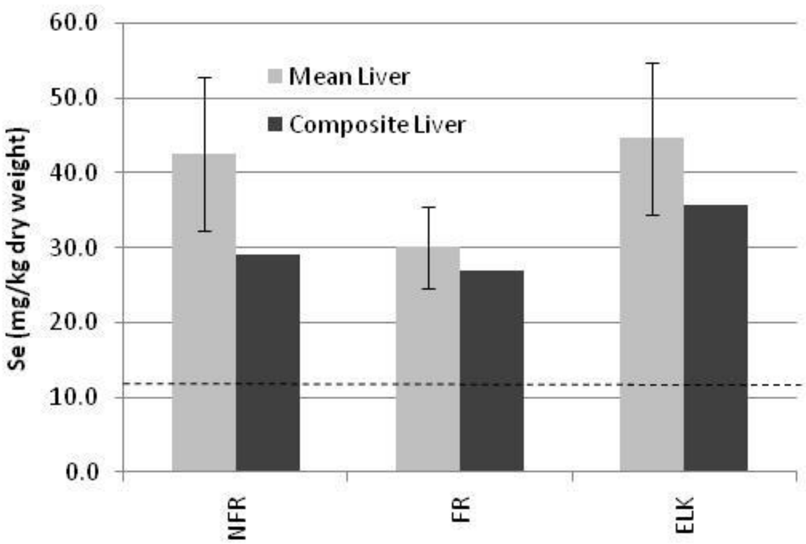

Figure 18. Mean liver Se concentrations for mountain whitefish from individual analyses (grey bars; ± 95% CI) and composite metal scans (black bars). Horizontal line represents Lemly's (1993) toxic effects threshold for liver Se concentrations (12 mg/kg dw).

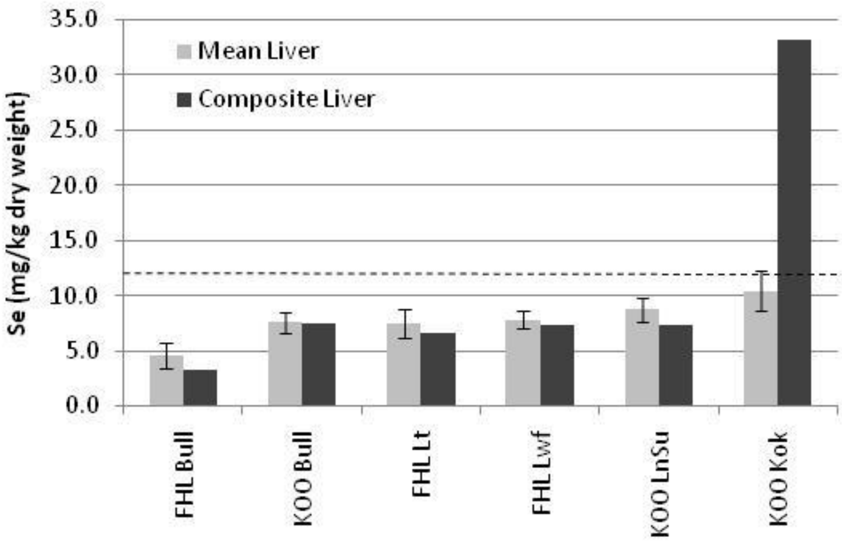

Figure 19. Mean liver Se concentrations for other fish species from Flathead Lake (FHL) and Lake Koocanusa (KOO) from individual analyses (grey bars; ± 95% CI) and composite metal scans (black bars). Horizontal line represents Lemly's (1993) toxic effects threshold for liver Se concentrations (12 mg/kg dw). Species abbreviations are bull trout (Bull), lake trout (Lt), kokanee (Kok), longnose sucker (LnSu), and lake whitefish (Lwf).

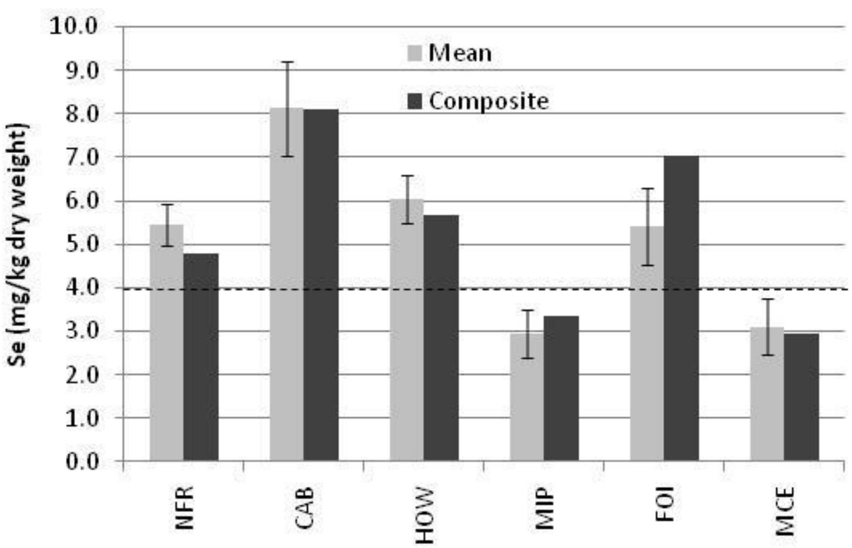

Figure 20. Mean whole fish Se concentrations for sculpin from individual analyses (grey bars; ± 95% CI) and composite metal scans (black bars). Horizontal line represents Lemly's (1993) toxic effects threshold for whole fish Se concentrations (4 mg/kg dw).

Mercury Concentrations in Tissues

Mercury (Hg) is a naturally occurring element found in the environment and with mining activities and other industries. Fish absorb Hg from water and prey and it accumulates in tissues. Fish species higher in the food chain accumulate higher levels of Hg then fish lower in the food chain.

This study originally included an assessment of mercury (Hg) contamination in fish tissues in addition to the Se and composite 17 metal scan surveys. Due to funding limitations, we were unable to complete Hg assessments. However, for three waters, Michel Creek, Elk River, and Lake Koocanusa, we collected muscle tissue from westslope cutthroat trout or bull trout and tested for Hg concentrations (Table 17).

The westslope cutthroat trout samples from Michel Creek and Elk River contained low levels of Hg (Table 17). The bull trout sample from Lake Koocanusa contained a moderate mean concentration with some individuals containing relatively high levels (Table 17).

Table 17. Mercury (Hg) concentration (mg/kg dry weight) in muscle tissue and total lengths (L) of westslope cutthroat trout (Wct) from Michel Creek and the Elk River and bull trout (Bull) from Lake Koocanusa, 2008. ND refers to Hg concentrations below detection level.

Location	Species	Count	Mean Hg	SE	Min Hg	Max Hg	Mean % Moisture	Mean L	SE	Min L	Max L
MIC	Wct	5	0.1	0.03	ND	0.2	80.5	377.4	18.71	331	423
ELK	Wct	5	0.1	0.04	ND	0.2	78.7	379.2	11.35	353	412
KOO	Bull	20	0.8	0.07	0.5	1.8	76.0	631.2	19.76	480	737

Conclusion

Results show differences in selenium (Se) concentrations in fish tissues from different water bodies. Westslope cutthroat trout from Flathead Lake had the lowest mean Se concentrations in both muscle and liver tissues while those from the Elk River showed the highest concentrations. Sites near the proposed Cline Mine in the upper Flathead and Wigwam drainages (Flathead River, Lodgepole Creek, and Foisey Creek) showed intermediate concentrations, all lower than the Elk River sample.

The Elk Valley Selenium Task Force largely comprised of representatives from private coal mining companies and the BC government found elevated selenium levels in water, sediment and biota downstream of coal mines that were directly attributed to coal mining activities (Golder Associates Ltd., 2008). This included elevated selenium concentrations in fish tissues. Coal mining in the Flathead River Drainage would likely result in elevated selenium concentrations in downstream fish populations, including migratory fish species.

We found bull trout in all Flathead River tributaries sampled to date as part of the tissue analysis survey. Migratory fish species are widely distributed throughout the Flathead River Drainage in BC.

3.2 Baseline Fish Distribution

FWP sampled seven patches in 2008, including 71 sites in 30 streams, investigating species distribution, genetic structure, and habitat characteristics in the Transboundary Flathead River and its tributaries. Westslope cutthroat trout were found throughout much of the system, including near proposed mining locations (Figure 21). Bull trout and sculpin were also detected near mining sites (Figures 22 and 23).

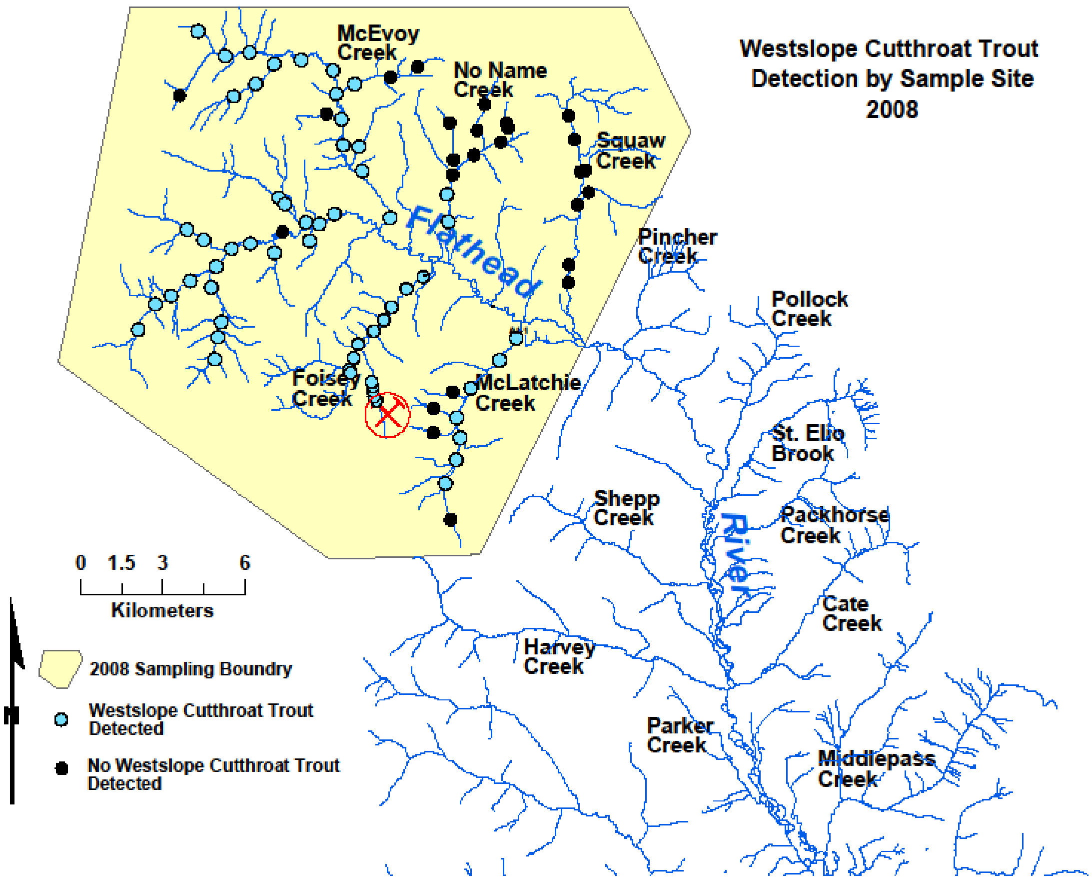

Figure 21. Westslope cutthroat trout detection locations based on sampling performed in the Transboundary Flathead River, British Columbia, in 2006 (Foisey Creek) and 2008 (remaining sample area).

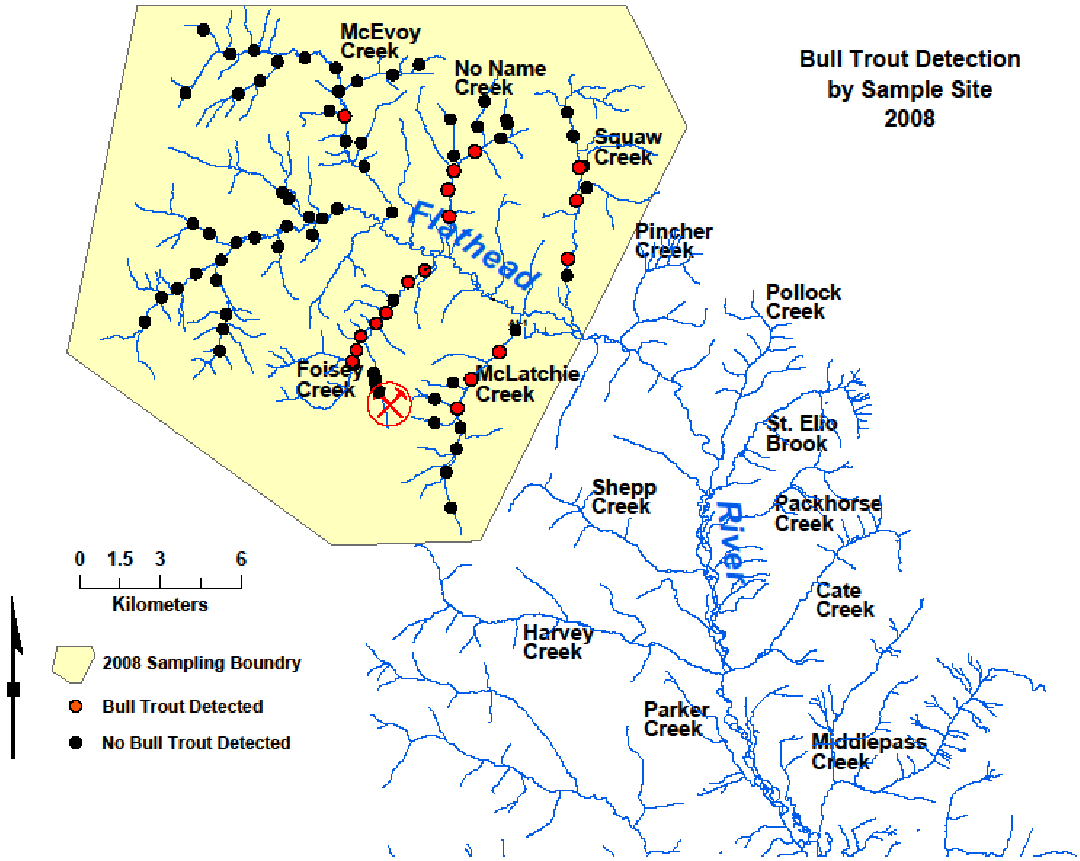

Figure 22. Bull trout detection locations based on sampling performed in the Transboundary Flathead River, British Columbia, in 2006 (Foisey Creek) and 2008 (remaining sample area).

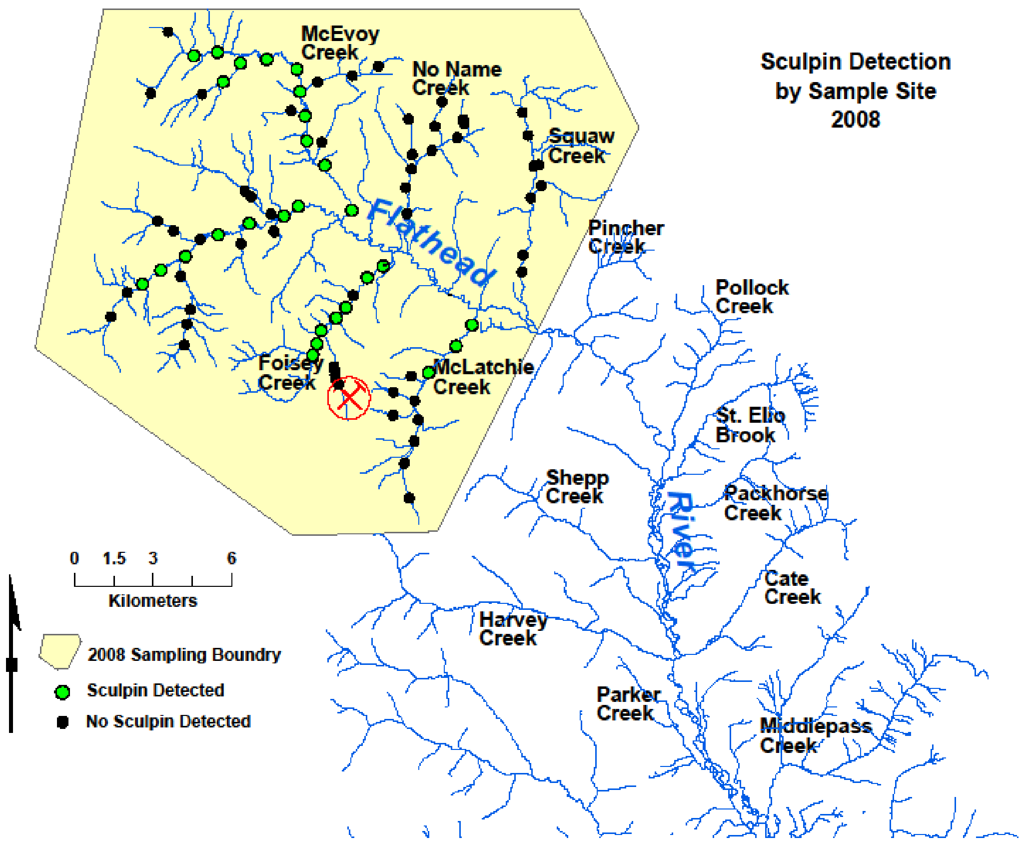

Figure 23. *Cottus* species detection locations based on sampling performed in the Transboundary Flathead River, British Columbia, in 2006 (Foisey Creek) and 2008 (remaining sample area).

Cobble was the dominant substrate throughout all patches sampled in B.C. as well as GNP during 2008, followed by gravel and boulder, respectively (Figure 24). Westslope cutthroat trout were more frequently associated with cobble whereas bull trout were equally distributed between cobble and gravel-dominated patches. Both species were equally represented in boulder-dominated patches, with neither detected in silt/sand nor bedrock-dominated patches.

Length frequency histograms of westslope cutthroat trout by patch indicate a likely resident component with a potential migratory form present (Figures 25-29). Too few bull trout were detected in a given patch to construct very informative length frequencies, though fish from an unnamed tributary represent fluvial and/or adfluvial juveniles rearing in that boulder-dominated patch (Figure 30).

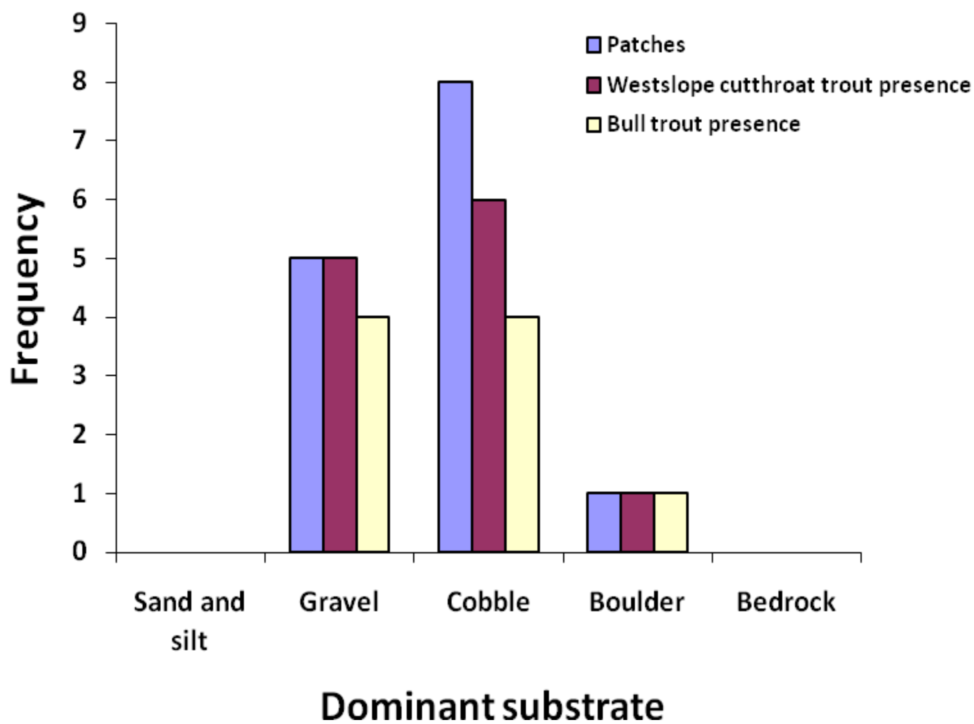

Figure 24. Frequency of substrate type dominance throughout all upper Transboundary Flathead River and Glacier National Park patches sampled in 2008. The frequencies of species represent the number of patches that a given species was detected in with associated dominant substrate.

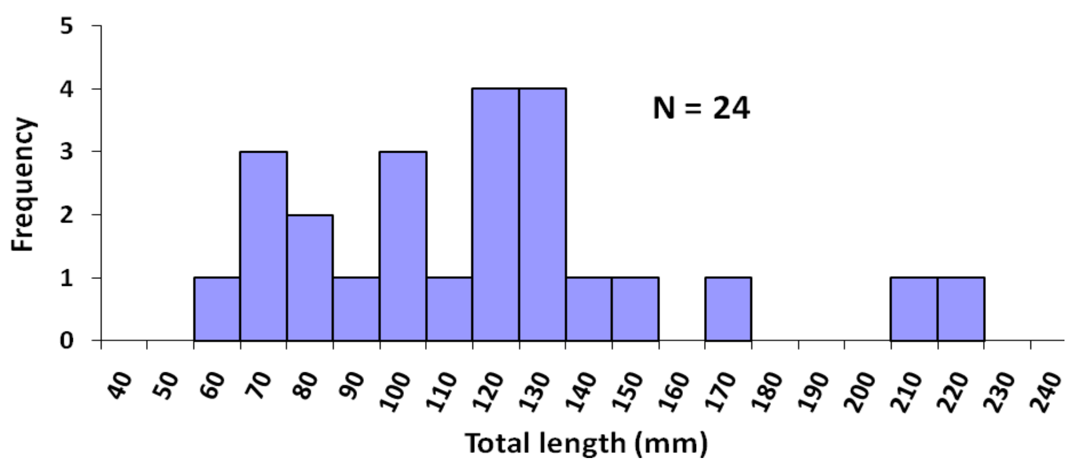

Figure 25. Length frequency of westslope cutthroat trout sampled in McLatchie Creek, a tributary to the Transboundary Flathead River, 2008.

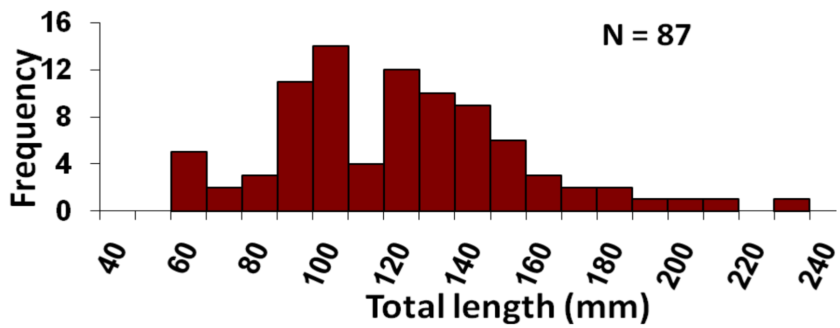

Figure 26. Length frequency of westslope cutthroat trout sampled in the upper headwaters of the Transboundary Flathead River, 2008.

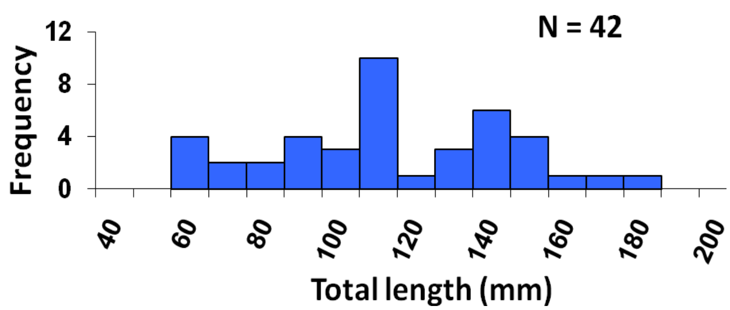

Figure 27. Length frequency of westslope cutthroat trout sampled in the upper mainstem (downstream of upper headwaters) of the Transboundary Flathead River, 2008.

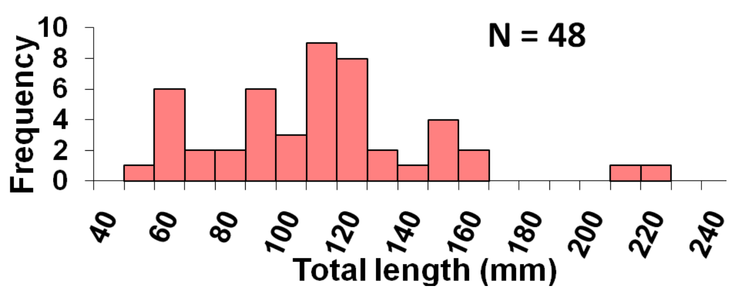

Figure 28. Length frequency of westslope cutthroat trout sampled in upper McEvoy Creek, a tributary of the Transboundary Flathead River, 2008.

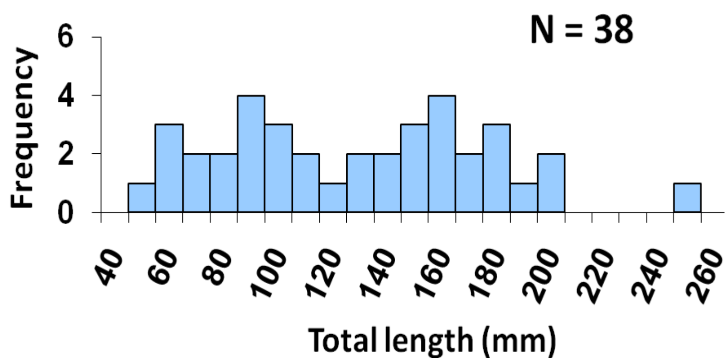

Figure 29. Length frequency of westslope cutthroat trout sampled in lower McEvoy Creek, a tributary of the Transboundary Flathead River, 2008.

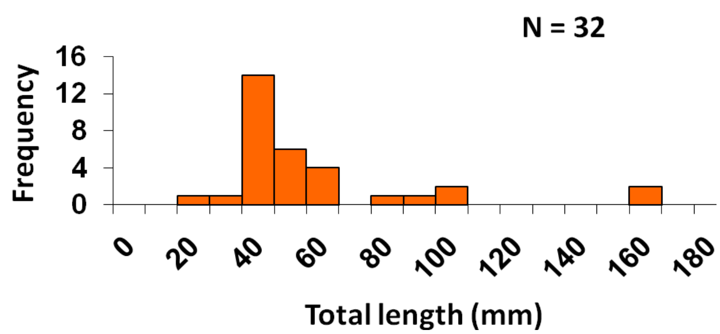

Figure 30. Length frequency of bull trout sampled in an unnamed tributary of the Transboundary Flathead River, 2008.

During both the contaminant and fish distribution surveys, we collected genetic tissues samples from westslope cutthroat trout. No rainbow trout introgression was detected in WCT sampled from the Transboundary Flathead (BC) in 2008-2009. However, low levels of introgression were found in samples from the Elk River downstream from Elko, and in Michel Creek near Sparwood, BC. Detailed results of genetic analyses are reported in Appendix G.

3.3 Monitoring Strategy

The objective of this project was to begin implementation of a monitoring strategy for fish populations in BC and GNP similar to the program conducted by FWP in the Montana portion of the Transboundary Flathead River. FWP has researched and monitored bull trout and westslope cutthroat trout throughout the US-portion of the system since the early 1980's; however, fisheries information collected north of the border had been limited to autumn bull trout spawning surveys initiated by FWP in 1980.

In 2008, FWP completed a basin-wide (North and Middle Forks of the Flathead River) redd count survey of all known bull trout spawning habitat, including tributaries of the Flathead River in BC. Results indicated that 42% of all bull trout redds in the North Fork were in BC, representing 21% of all bull trout originating from Flathead Lake. Further, the majority (68%) of all bull trout redds in BC were in the Flathead River between the mouths of Foisey Creek and Pollock Creek, near and downstream of Cline Mining Company's proposed Lodgepole Mine.

Since no additional funding was appropriated in 2009, no funding from this agreement was spent by FWP to assess species distribution in the Flathead River, BC. FWP continued survey work in 2009 under projects funded through the Bonneville Power Administration and results will be reported under those contracts.

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5.0 APPENDICES

Appendix A.

Systematics of Montana Sculpins, Final Report on Activities Conducted During 2009-2010.

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Introduction:

Perhaps no group of North American freshwater fishes remains as taxonomically problematic as sculpins; particularly for the biologist in the field. Freshwater sculpins are morphologically conservative, and many of the morphological characters that covary with genetic differentiation are subtle and require a keen eye.

Hendricks (1997) provided an excellent overview of many of the problems associated with this enigmatic group, as well as a detailed bibliography on ecological studies on sculpins in Montana and the northern Rockies. Ongoing research on the systematics of North American sculpins has led to several notable discoveries in the thirteen years since this publication, and particularly during the Montana FWP-funded grant period of 2009-2010. I will discuss each of these changes to our perception of sculpin diversity, along with advances in the period following Hendricks (1997) summary of Montana sculpins, as well as directions in which future research would be likely to make significant contributions.

Most notably, research into the relationships of the genus *Cottus* suggest that the genus as currently recognized is broadly paraphyletic, rendering the use of the genus *Cottus* for most of our North American species problematic. Kinziger et al (2005) recommended recognition of several clade names in lieu of changes to taxonomy, at least until the relationships between several taxa could be resolved. Addition of nuclear sequence data (unpublished) has helped meet this goal; the relevant clade names are likely to be elevated to genera in the very near future, and are given in parentheses herein.

Five species are positively known from the State of Montana (i.e., records supported by vouchered museum specimens); a sixth likely occurs in the State and is included in the Key, below. The three most widely-distributed taxa in the State are members of diverse species-complexes and are represented in Montana by undescribed species; the distribution of each of these differs rather dramatically from what Hendricks (1997) suggested. I treat each of these on a species-by-species basis, below.

Research activities during 2009 focused primarily on fieldwork in the Flathead and Kootenay, as well as completing a description of the RMS for publication; this has contributed materially to this effort and I hope to submit the manuscript by 1 July 2010.

SPECIES ACCOUNTS *Cottus* (*Uranidea*) sp. cf *bairdii*, Rocky Mountain Sculpin (RMS).

Anaconda Creek, Flathead Co., MT

Systematic notes: Treated as Mottled Sculpin (in part) and as Shorthead Sculpin (in part) by Hendricks (1997). Populations of "Mottled Sculpin" in the upper Missouri River drainage, and "Shorthead Sculpin" in the Flathead and portions of the Clark Fork drainage in Montana represent an undescribed species that is genetically very divergent from both "real" Mottled Sculpin from eastern North America, and "Mottled Sculpin" from the Bonneville, Snake, Colorado, and Columbia drainages. One of the largest members of the "mottled sculpin species complex," reaching a maximum length of at least 116 mm SL (141 mm TL; MSU 3248). Differs from other species of the Western *bairdii* complex in having a higher number of second dorsal and anal fin rays, a lower number of pectoral fin rays, a lower number of lateral line pores, and a generally more slender body shape and shorter head. The short head likely contributed to historical confusion between this species and Shorthead Sculpin, *Cottus confusus*. Bailey and Bond's (1964:17) comment on the fact that populations of C. confusus from the upper Columbia drainage in Montana and endorheic drainages of the Snake River plain in east-central Idaho are unprickled is based on misidentifications of *Cottus* sp. cf. *bairdii* from the Flathead system, as verified by their observation of higher pectoral and anal-fin ray counts (consistent w/ *C*. sp. cf. *bairdii*) and a reduced frequency of a postmaxillary pore in their Flathead material. Unprickled "Shorthead Sculpin" from the Lost River system of central Idaho appear to represent a separate, undescribed species (pers. obs.; also suggested by Don Zaroban, pers. comm. 2010).

Meristics (of Montana specimens): Dorsal fin spines 7-9 (usually 8); dorsal fin rays 15-19 (usually 16-17); anal fin rays 11-14 (usually 12-13); pectoral fin rays 13-15 (usually 14); pelvic fin rays usually 4. Infraorbital pores 10-11 (usually 10); preoperculomandibular pores 10-11 (usually 11); lateral line usually incomplete, with 21-28 pores (mean among 110 individuals is 24.1).

Distribution: Broadly distributed throughout the upper Missouri River drainage, including the upper Milk (downstream to Blaine County), Missouri (downstream to Fergus County), Musselshell (Wheatland County), and Yellowstone (downstream to Stillwater County) rivers. Anecdotally reported from the Bighorn River in Wyoming (W. Hubert, pers. comm. 2002); specimens not examined to date. Broadly distributed through the North and Middle Fork Flathead drainages, present but scattered in the South Fork Flathead, and patchy in the Clark Fork drainage (downstream to near Thompson Falls). When co-occurring with other sculpin species (eg., in the Flathead and Clark Fork drainage), often occurs downstream of both *Cottus* sp. cf *confusus* and *Cottus* sp. cf *cognatus*. (S. Adams, pers. comm. 2009, 2010)

Abundance and Status in Montana: Abundant across its range, reasonably secure. Currently given protected status by COSEWIC in Canada, where it is nearly extralimital, occurring only in the Flathead, Milk, and St. Marys rivers.

***Cottus* (*Uranidea*) sp. cf *cognatus*, "Columbia Slimy" Sculpin**.

Trumbull Creek, Flathead Co., MT

McLatchie Creek, BC **Systematic notes:** Specimens from the Columbia Basin are genetically very divergent from populations of *C. cognatus* outside of the Columbia Basin, including specimens from Alaska, Russia, and eastern North America. However, analyses to date have not included material from the Pacific Slope north of the Columbia in Canada (eg., Fraser River).

Meristics (of Montana specimens): Dorsal fin spines 7-9 (usually 8); dorsal fin rays 15-19 (usually 16-17); anal fin rays 11-12 (usually 12); pectoral fin rays 13-14 (usually 14); pelvic fin rays 3-4 (usually 4). Infraorbital pores 9-10 (usually 9); preoperculomandibular pores 10-11 (usually 11); lateral line usually incomplete, with 13-26 pores (mean among 30 individuals is 19.9). Hendricks (1997) suggested that this species usually lacked prickles; while this may be the case in the eastern U.S., Montana specimens usually have an axillary prickle patch.

Distribution: Broadly distributed in the Kootenay, Flathead, and Clark Fork drainages. This form is restricted to the Columbia basin; it is patchy and locally restricted in much of the south and western portion of the drainage, but is widely distributed across much of the Canadian portion.

Abundance and Status in Montana: Abundant across its range, reasonably secure, although generally restricted to headwater reaches of streams and/or spring-influenced systems.

***Cottus* (*Uranidea*) sp. cf *confusus*, "Clark Fork" Shorthead Scupin**

Systematic notes: The systematic status of this enigmatic sculpin was first discussed by Gregg et al.

(unpublished). It has been the subject of multiple ongoing ecological projects (S. Adams and D. Schmetterling, unpubl.). While it is genetically very distinct from geographically adjacent populations of Shorthead Sculpin in Idaho, it is morphologically similar (only meristic difference noted in a preliminary analysis is a slightly higher number of LL pores in the Montana specimens, although there were differences in body shape -see below). Hendricks (1997) suggested that these specimens could be *Cottus beldingii*; none of the morphological or molecular characters examined to date support this hypothesis. A description of this species is currently underway.

Meristics (of Montana specimens): Dorsal fin spines 7-9 (usually 8); dorsal fin rays 17-19 (usually 18); anal fin rays 13-14; pectoral fin rays 13-14 (usually 14); pelvic fin rays usually 4.

Infraorbital pores 9-11 (usually 10); preoperculomandibular pores 10-12 (usually 11); lateral line usually incomplete, with 21-28 pores (mean among 25 individuals is 24.9).

This population exhibits a tendency towards the anteriormost dorsal fin pterygiophore bearing two rays (~80-90% of specimens); both sexes appear to have genital papilla (very unusual in cottids); a tendency for interrupted LL posteriorly, occasional specimens with canal collapsed; and weak nubbles on head.

When contrasted with Montana C. sp. cf bairdii, the "Clark Fork" Shorthead Sculpin does have a shorter head (as percent of SL; 0.27-0.31, mean 0.29 for 19 Clark Fork *C.* sp. cf *confusus*, 0.280.34, mean 0.32 for 15 *C*. sp. cf *bairdii*).

Morphometric comparison with Idaho *C. confusus*:

	St. Regis (n=19)		*C. confusus* (n=10)	
	Mean	SD	Mean	SD
SNL/HL	0.322	0.018	0.316	0.022
HL/SL	0.294	0.012	0.291	0.013
BD/SL	0.193	0.012	0.200	0.013
CPD/SL	0.093	0.005	0.086	0.006
CPL/SL	0.159	0.012	0.161	0.011
P1L/SL	0.267	0.011	0.259	0.030
P2L/SL	0.199	0.013	0.193	0.013
EYE/HL	0.212	0.009	0.236	0.013
IOW/HL	0.132	0.010	0.113	0.010

Distribution: Known from the east slope of the Bitterroots in Saunders, Mineral, and Ravalli Counties, Montana, where it occurs in mid-to high elevation reaches of tributaries to the Clark Fork drainage. The Saunders County record was discovered during a March 2010 museum trip (MSU 7018, n=5, not measured -alizarin stained, MT: Sanders, Prospect Creek T21N R29W S18, J. Gangemi & D. Perkinson, 3-Oct-1991); the Ravalli Country record, though unvouchered, was documented through a USFS genetic project (M. Young, pers. comm. 2010).

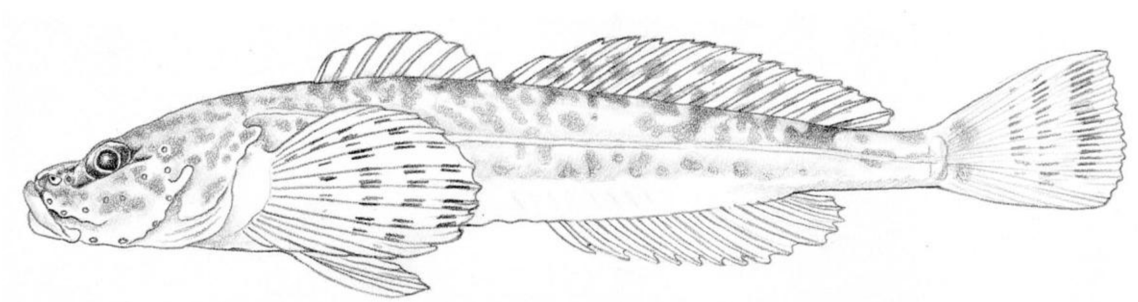
Abundance and Status in Montana: Possibly endemic to Montana, so comments refer to entire range. Common in upstream reaches of tributaries to the Clark Fork, although there is evidence for recent extirpation of downstream populations (S. Adams, pers. comm. 2009 and 2010). Due to its habitat specificity, this species is likely very susceptible to the local effects of global climate change.

***Cottus* (*Uranidea*) *rhotheus*, Torrent Sculpin**

Libby Cr., Lincoln Co., MT **Systematic notes:** No thorough rangewide survey of variation has been conducted; although

regional studies have documented differences in prickling and meristic counts in different subdrainages. **Meristics (of Montana specimens):** Not compiled for this species. **Distribution:** Widespread and abundant in the Kootenay drainage of NW Montana; occurring

from the state line upstream in both the mainstem and tributaries; only known congener in the drainage is *C*. sp. cf *cognatus*. **Abundance and Status in Montana:** see above regarding abundance;



reasonably secure. ***Cottus* (*Cottus*) *ricei*, Spoonhead Sculpin**
~65mm SL, Lake Nipigon, Ontario

Systematic notes: not compiled for this species. **Meristics (of Montana specimens):** not compiled for this species. **Distribution:** Restricted to the St. Marys drainage in Montana, including portions of the Belly River and Waterton Lake. **Abundance and Status in Montana:** As no thorough survey has been conducted for this species in the State, current status remains unknown.

Quick and Dirty Key for Montana Sculpins.

1a. Branchiostegal membranes not attached to isthmus; free all the way to the ventral midline (Fig. 1a); dorsal fins separated by a gap at least as long as the space between the first two dorsal rays (Fig. 2)...*Myoxocephalus thompsonii*, Deepwater Sculpin

1b. Branchiostegal membranes connect to isthmus, not to each other (Fig 1b; *Cottus ricei* depicted); dorsal fins joined or slightly separated, gap between them is less than the space between the first two dorsal rays...2.

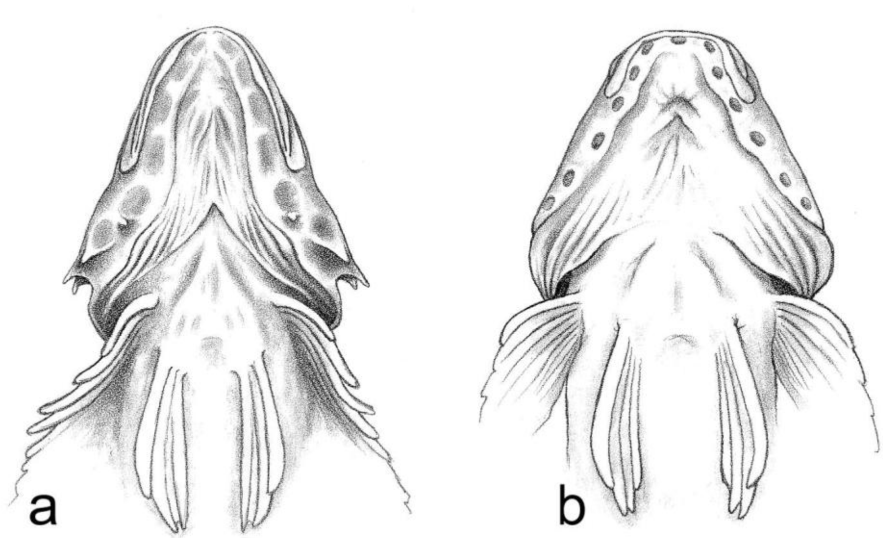


Fig. 1. Ventral view of head of a) *Myoxocephalus thompsonii* (Lake Michigan, WI; DAN uncatalogued specimen) and b) *Cottus ricei* (Lake Nipigon, Ontario; DAN uncat.)

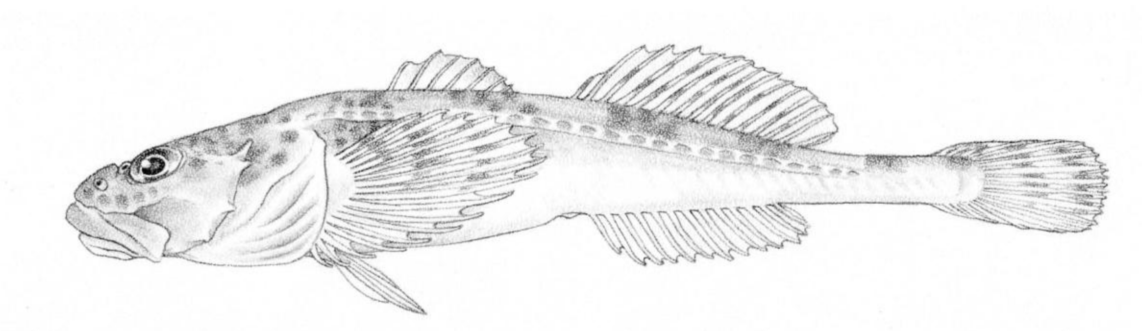


Fig. 2. *Myoxocephalus thompsonii*, ~80 mm SL, Lake Michigan, WI.

2a. Dorsal preopercular spine long and curved strongly inward (Fig. 2a, Fig. 3); head strongly flattened; anterior infraorbitals expended, giving front of head a tri-lobed appearance in dorsal view (Fig. 3); one pore at tip of chin (canals on each side of chin united by pore) ....*Cottus ricei*, Spoonhead Sculpin

2b. Dorsal preopercular spine variable in length but not strongly curved medially; head not as strongly flattened as above; head not as strongly tri-lobed, usually two pores at extreme tip of chin (canals on each side separate)...3.

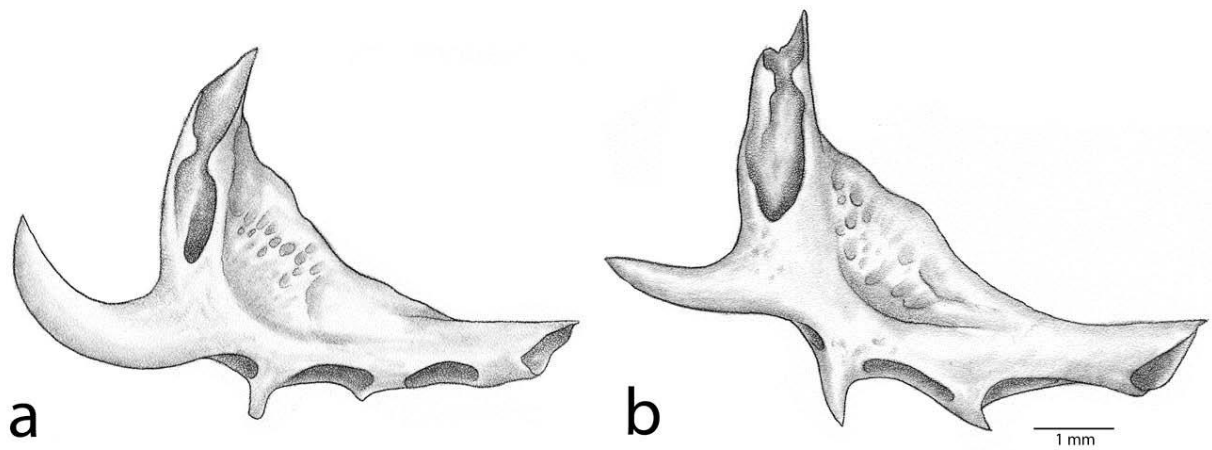


Fig. 3. Lateral view of preopercle of a) *Cottus ricei* (Lake Nipigon, Ontario; DAN uncat.) and b) *Cottus asper* (Stilliguamish River, Skyhomish Co., WA)

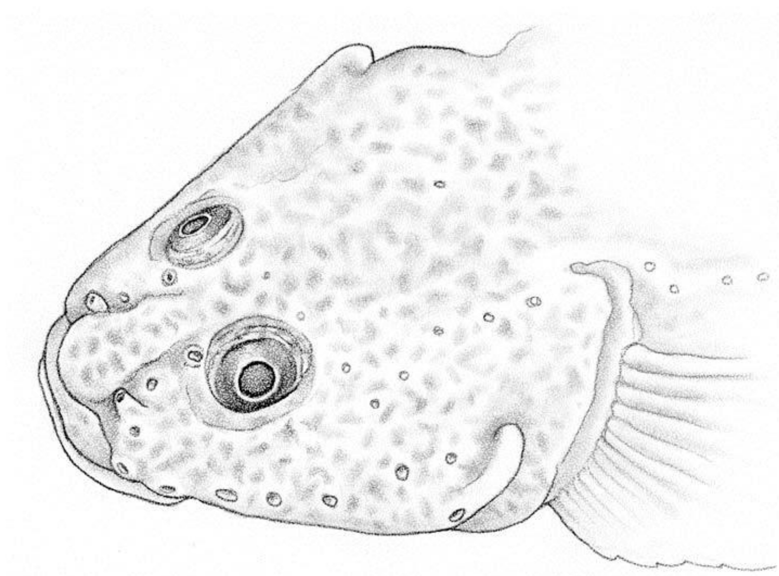


Fig. 4. Dorsolateral view of head of *Cottus ricei*, ~65mm SL, Lake Nipigon, Ontario (DAN uncat.). Note medial curvature of dorsalmost preopercular spine, and very deep indentations between anteriormost infraorbital and the ethmoid cartilage.

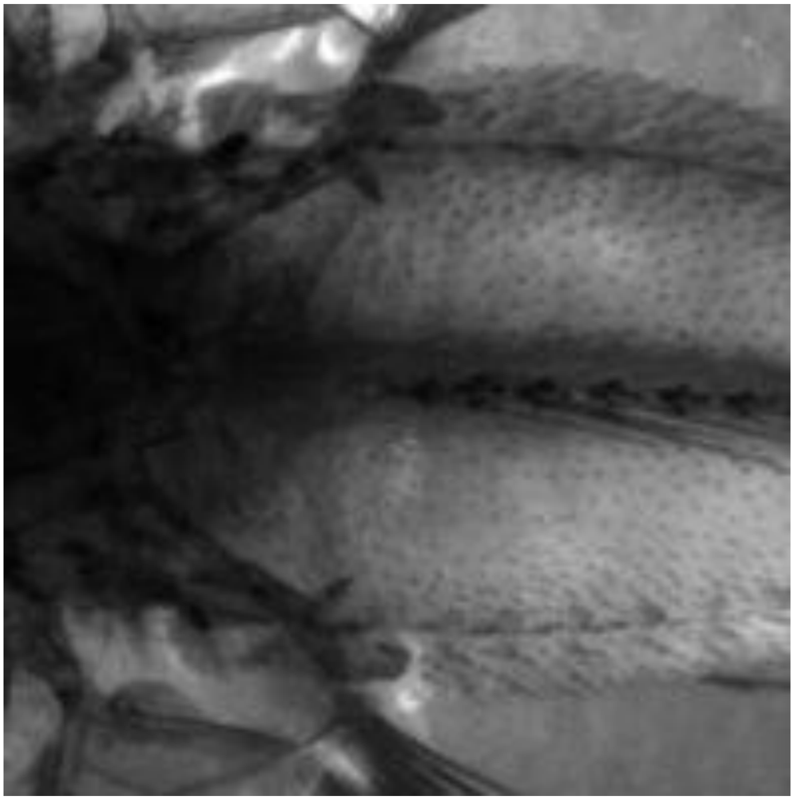
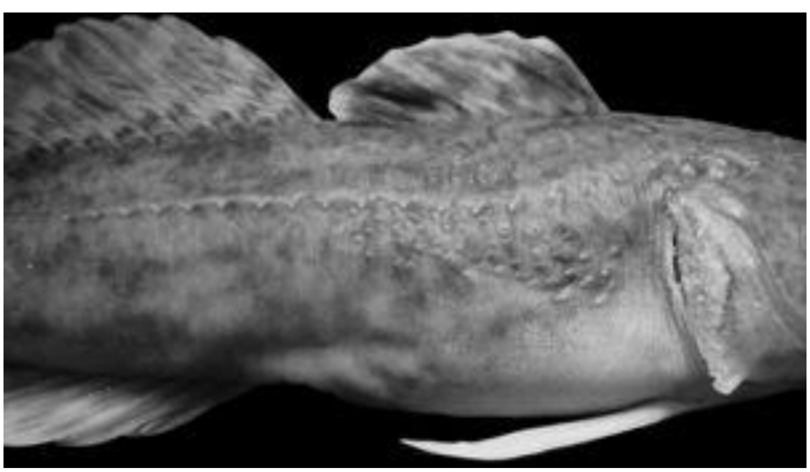


Fig. 5. Cleared and stained specimen of *Cottus rhotheus*, UAIC 11670; dermal prickles are broadly distributed across dorsum.

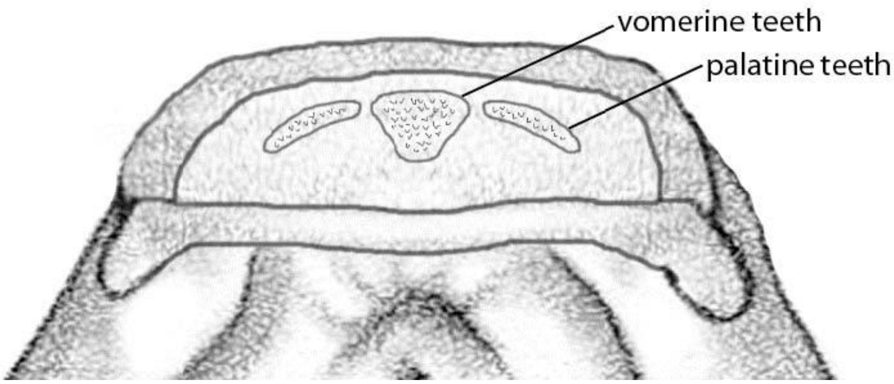
3a. Dorsum with extensive prickling (feels like sandpaper, Fig. 5); head and mouth broad; caudal peduncle usually very narrow, palatine teeth very robust, usually two broad saddles under 2nd dorsal fin.. .*Cottus rhotheus*, Torrent Sculpin

3b. Prickling absent or restricted to an axillary patch (behind base of pectoral fins; Fig. 6; often best observed by lightly blowing on side of fish to dry prickle tips) ....4.

Fig. 6. Lateral view of right side of *Cottus* sp. cf *cognatus*, DAN09-97; right pectoral fin has been excised for DNA and to show axillary prickle patch.



4a. Palatine teeth (Fig. 7) absent or reduced to one or a few scattered teeth on one side; occasional specimens with palatine teeth can be separated by low anal fin ray count (usually 1112 vs. usually 12-13 or more*) and infraorbital pore count (modally 9 in *C*. sp. cf *cognatus* vs. 10)..*Cottus* sp. cf *cognatus*, Columbia "Slimy" Sculpin



4b. Palatine teeth present in patch consisting of at least one row of teeth on each side................5.

Fig. 7. Ventral view of head of sculpin, with mouth open and lower jaw reflexed, showing tooth patches on roof of mouth.

5a. Palatine teeth robust; usually lacking or with few prickles broadly scattered in axillary region or above lateral line...*Cottus* sp. cf *bairdii*, Rocky Mountain Sculpin

5b. Palatine teeth weak to moderately-developed; prickles in dense, obliquely-oriented patch; long-bodied, usually with three well-developed saddles under the 2nd dorsal fin .... *Cottus* sp. cf *confusus*, "Clark Fork Shorthead" Sculpin

*Note: if the last two rays are attached to the same pterygiophore (they are attached at base) they are counted as one.

Suggested Procedures for Vouchering Sculpins.

Some species of sculpins can be easily identified in the field (*Cottus rhotheus*, *Cottus ricei*), but most are more problematic --a series should be retained whenever possible to allow a check of the ID. Even well-trained ichthyologists occasionally make mistakes; a significant range extension for *Myoxocephalus thompsonii* in Alberta was discovered on a museum shelf; it had been misidentified as *Cottus ricei* (Steinhilber and Neely 2008).

If dropped into a jar of fixative, sculpins have a tendency to die with mouth agape, head strongly reflexed, pectoral fins spread perpendicular to the body axis and fins depressed along the body. The resulting body shape is difficult to compare against well-fixed materials. The following protocol results in well-prepared voucher specimens that can be readily used for both morphological and molecular analyses.

Sculpins are killed with overdose of anesthesia (MS222) in small batches; allowing sufficient time to work fish up before starting a new batch. An individually numbered tag is affixed to the fish (I attach a small cardstock tag, as usually used for herps, double half-hitched to 100% cotton surgical thread, through the ramus of the lower jaws or in mouth and out right gill opening, and tied with a square knot). The right pectoral fin is cut with scissors (cleaned with EtOH after each fish) and placed in 95% non-denatured ethanol. The fin clip can be air-dried, if EtOH is not available. Either way, the tissue sample needs to be kept cool for the first 24h, and if EtOH is used, the EtOH should be changed at least once. The carcass is placed on its side in a shallow tray of 10% formalin, and the fins held erect with fine-point forceps while they fix (30-45 sec/specimen). Care should be taken not to tear the fins at this stage; if the mouth opens, it should be held shut, gently pushing in on the cheeks and bottom of head to keep the branchiostegal membranes closed.

If photos are desired, they should be taken at this point, before the eyes cloud up and tissues become fully opaque. Specimens are transferred to a Nalgene jar of 10% formalin and allowed to fix for between 1-2 weeks. They are removed from the formalin, rinsed for ~24h, and stored in 70% ethanol. Small specimens can be preserved in strong ethanol (>70%), although the ethanol should be changed several times within the first couple days after sampling (until it stops discoloring). Specimens preserved in this manner are less useful for morphometric analysis (higher rate of shrinkage from the ethanol), but clear and stain very well and are useful for DNA analyses.

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2008. A new record of Deepwater Sculpin, *Myoxocephalus thompsonii*, in northeastern Alberta. Canadian Field-Naturalist 120(4): 480-482.

Appendix B. Selenium concentrations and size measurements of westslope cutthroat trout collected in the Baseline Contaminant Investigation.

Table B1. Selenium concentration in muscle samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Pollock Creek	Muscle	173	53	3	77.6	21-Jul-09
Wct	Pollock Creek	Muscle	150	38	2.6	80.5	21-Jul-09
Wct	Pollock Creek	Muscle	163	46	3.8	79.4	21-Jul-09
Wct	Pollock Creek	Muscle	146	32	3.7	84.8	21-Jul-09
Wct	Pollock Creek	Muscle	144	31	3.2	81.6	21-Jul-09
Wct	Pollock Creek	Muscle	151	30	3.3	80.4	21-Jul-09
Wct	Pollock Creek	Muscle	136	26	2.5	83	21-Jul-09
Wct	Pollock Creek	Muscle	181	55	3.6	78.6	21-Jul-09
Wct	Pollock Creek	Muscle	165	44	3.1	80.6	21-Jul-09
Wct	Pollock Creek	Muscle	162	46	3.2	81.9	21-Jul-09
Wct	North Fork Flathead River	Muscle	231	123	3.1	78.6	18-Aug-09
Wct	North Fork Flathead River	Muscle	240	148	3.5	78.8	16-Jul-09
Wct	North Fork Flathead River	Muscle	212	99	4.3	79.4	16-Jul-09
Wct	North Fork Flathead River	Muscle	220	110	3	79.5	16-Jul-09
Wct	North Fork Flathead River	Muscle	230	129	3.9	79.6	16-Jul-09
Wct	North Fork Flathead River	Muscle	216	115	5.2	80.6	16-Jul-09
Wct	North Fork Flathead River	Muscle	216	105	3.8	79.9	16-Jul-09
Wct	North Fork Flathead River	Muscle	231	139	3.6	77.3	16-Jul-09
Wct	North Fork Flathead River	Muscle	251	170	2.9	78.5	16-Jul-09
Wct	North Fork Flathead River	Muscle	288	253	3.1	77.9	16-Jul-09
Wct	North Fork Flathead River	Muscle	257	184	3.9	78.6	16-Jul-09
Wct	North Fork Flathead River	Muscle	268	202	3.1	78.1	16-Jul-09
Wct	North Fork Flathead River	Muscle	272	211	2.6	79.3	16-Jul-09
Wct	North Fork Flathead River	Muscle	287	252	3.8	78.5	16-Jul-09
Wct	North Fork Flathead River	Muscle	228	124	4	78	16-Jul-09

Table B1. Cont. Selenium concentration in muscle samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Middle Pass Creek	Muscle	161	37	3.4	80.7	09-Sep-09
Wct	Middle Pass Creek	Muscle	154	32	2.6	80.6	09-Sep-09
Wct	Middle Pass Creek	Muscle	215	104	2.9	80.3	09-Sep-09
Wct	Middle Pass Creek	Muscle	301	335	3	77.6	09-Sep-09
Wct	Middle Pass Creek	Muscle	191	63	2.7	83	09-Sep-09
Wct	Middle Pass Creek	Muscle	150	31	3.2	81.8	09-Sep-09
Wct	Middle Pass Creek	Muscle	164	38	3.5	81.1	09-Sep-09
Wct	Middle Pass Creek	Muscle	203	91	2.7	82.6	09-Sep-09
Wct	Middle Pass Creek	Muscle	196	81	2.9	81	09-Sep-09
Wct	Middle Pass Creek	Muscle	157	33	2.5	81.9	09-Sep-09
Wct	Michel Creek	Muscle	258	206	2.2	77	03-Sep-08
Wct	Michel Creek	Muscle	373	519	4.8	82.2	03-Sep-08
Wct	Michel Creek	Muscle	292	284	4.2	80.2	03-Sep-08
Wct	Michel Creek	Muscle	331	428	5.8	78.3	03-Sep-08
Wct	Michel Creek	Muscle	343	458	4.5	78.5	03-Sep-08
Wct	Michel Creek	Muscle	297	305	3.7	79.8	03-Sep-08
Wct	Michel Creek	Muscle	272	237	3.3	79.6	03-Sep-08
Wct	Michel Creek	Muscle	273	235	3.1	82.7	03-Sep-08
Wct	Michel Creek	Muscle	270	230	2.8	80.8	03-Sep-08
Wct	Michel Creek	Muscle	291	314	2.1	77.2	03-Sep-08
Wct	Michel Creek	Muscle	249	176	3.1	83	03-Sep-08
Wct	Michel Creek	Muscle	259	180	2.7	79	03-Sep-08
Wct	Michel Creek	Muscle	423	850	5.7	81.1	03-Sep-08
Wct	Michel Creek	Muscle	417	922	4.5	82.3	03-Sep-08
Wct	Michel Creek	Muscle	259	196	2.5	78	03-Sep-08
Wct	Michel Creek	Muscle	275	243	2.2	73.6	03-Sep-08
Wct	McLatchie Creek	Muscle	155	42	3.5	80.9	21-Jul-09
Wct	McLatchie Creek	Muscle	146	35	4.4	81.2	21-Jul-09

Table B1. Cont. Selenium concentration in muscle samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	McLatchie Creek	Muscle	156	44	3.1	80.6	21-Jul-09
Wct	McLatchie Creek	Muscle	171	52	3.5	81.6	21-Jul-09
Wct	McLatchie Creek	Muscle	171	59	3.4	79.2	21-Jul-09
Wct	McLatchie Creek	Muscle	188	86	2.8	80.1	21-Jul-09
Wct	McLatchie Creek	Muscle	234	129	5.5	82	21-Jul-09
Wct	McLatchie Creek	Muscle	204	97	3.7	80.1	21-Jul-09
Wct	McLatchie Creek	Muscle	197	98	4.1	81.8	21-Jul-09
Wct	McLatchie Creek	Muscle	151	33	3.6	77.8	21-Jul-09
Wct	McEvoy Creek	Muscle	191	72	3.8	81	08-Sep-09
Wct	McEvoy Creek	Muscle	143	27	3.2	84.1	08-Sep-09
Wct	McEvoy Creek	Muscle	196	77	2.8	79.1	08-Sep-09
Wct	McEvoy Creek	Muscle	184	68	3.5	82.5	08-Sep-09
Wct	McEvoy Creek	Muscle	176	55	3	80.8	08-Sep-09
Wct	McEvoy Creek	Muscle	172	51	3	78.9	08-Sep-09
Wct	McEvoy Creek	Muscle	160	38	3.3	80.8	08-Sep-09
Wct	McEvoy Creek	Muscle	147	30	2.8	82.3	08-Sep-09
Wct	McEvoy Creek	Muscle	160	35	3.6	82.5	08-Sep-09
Wct	McEvoy Creek	Muscle	218	108	3.5	78.8	08-Sep-09
Wct	Lodgepole Creek	Muscle	216	97	4.1	81.2	06-Aug-08
Wct	Lodgepole Creek	Muscle	219	114	5.9	81.2	06-Aug-08
Wct	Lodgepole Creek	Muscle	252	167	5.6	78.8	06-Aug-08
Wct	Lodgepole Creek	Muscle	262	169	5.4	79.7	06-Aug-08
Wct	Lodgepole Creek	Muscle	202	82	3.8	79.3	06-Aug-08
Wct	Lodgepole Creek	Muscle	126	21	4.6	80.6	06-Aug-08
Wct	Lodgepole Creek	Muscle	158	34	3.7	79.4	06-Aug-08
Wct	Lodgepole Creek	Muscle	133	22	5.2	74.5	06-Aug-08
Wct	Lodgepole Creek	Muscle	189	74	5.5	80.5	06-Aug-08
Wct	Lodgepole Creek	Muscle	148	29	5.3	82.7	06-Aug-08

Table B1. Cont. Selenium concentration in muscle samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Lodgepole Creek	Muscle	190	74	5	80.9	06-Aug-08
Wct	Lodgepole Creek	Muscle	212	93	4.8	80.7	06-Aug-08
Wct	Lodgepole Creek	Muscle	143	28	5.3	80.8	06-Aug-08
Wct	Lodgepole Creek	Muscle	201	95	4.9	78.7	06-Aug-08
Wct	Lodgepole Creek	Muscle	151	34	3.5	75.5	06-Aug-08
Wct	Lodgepole Creek	Muscle	171	48	4.6	81.5	06-Aug-08
Wct	Lodgepole Creek	Muscle	160	40	4	79.2	06-Aug-08
Wct	Lodgepole Creek	Muscle	221	127	5.5	81	06-Aug-08
Wct	Lodgepole Creek	Muscle	169	46	4.8	76.5	06-Aug-08
Wct	Lodgepole Creek	Muscle	157	36	6.4	80.4	06-Aug-08
Wct	Howell Creek	Muscle	144	22	3.4	84.1	02-Sep-09
Wct	Howell Creek	Muscle	130	18	3.7	85.4	02-Sep-09
Wct	Howell Creek	Muscle	134	19	3.3	82.3	02-Sep-09
Wct	Howell Creek	Muscle	183	56	3.5	82.2	02-Sep-09
Wct	Harvey Creek	Muscle	151	32	3.8	83.7	22-Jul-09
Wct	Harvey Creek	Muscle	136	26	3.4	80.9	22-Jul-09
Wct	Harvey Creek	Muscle	163	43	3.7	80.6	22-Jul-09
Wct	Harvey Creek	Muscle	121	15	3.4	82.8	22-Jul-09
Wct	Harvey Creek	Muscle	182	62	3.3	81.2	22-Jul-09
Wct	Harvey Creek	Muscle	231	128	4.6	81	22-Jul-09
Wct	Harvey Creek	Muscle	153	35	3.6	84	22-Jul-09
Wct	Harvey Creek	Muscle	164	48	3.7	82.1	22-Jul-09
Wct	Harvey Creek	Muscle	167	48	4.5	83.2	22-Jul-09
Wct	Harvey Creek	Muscle	160	45	3.5	82.1	22-Jul-09
Wct	Foisey Creek	Muscle	144	26	5	81.6	28-Jul-08
Wct	Foisey Creek	Muscle	150	33	5	81.6	28-Jul-08
Wct	Foisey Creek	Muscle	177	57	5.4	80.2	28-Jul-08
Wct	Foisey Creek	Muscle	158	37	4.6	80.3	28-Jul-08

Table B1. Cont. Selenium concentration in muscle samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Foisey Creek	Muscle	173	52	5.1	81.2	28-Jul-08
Wct	Foisey Creek	Muscle	174	49	4.1	81.2	28-Jul-08
Wct	Foisey Creek	Muscle	165	44	4.8	83.1	28-Jul-08
Wct	Foisey Creek	Muscle	151	32	5.2	83.4	28-Jul-08
Wct	Foisey Creek	Muscle	168	46	5.1	79.6	28-Jul-08
Wct	Foisey Creek	Muscle	142	29	5	82.2	28-Jul-08
Wct	Foisey Creek	Muscle	147	31	4.9	82.7	28-Jul-08
Wct	Foisey Creek	Muscle	150	30	6	81.3	28-Jul-08
Wct	Foisey Creek	Muscle	137	27	5.2	83.5	28-Jul-08
Wct	Foisey Creek	Muscle	172	48	4.1	81.5	28-Jul-08
Wct	Foisey Creek	Muscle	262	151	3.1	79.1	28-Jul-08
Wct	Foisey Creek	Muscle	189	70	4.3	79.2	28-Jul-08
Wct	Foisey Creek	Muscle	186	61	4.6	78.3	28-Jul-08
Wct	Foisey Creek	Muscle	214	96	4.1	79.4	28-Jul-08
Wct	Foisey Creek	Muscle	176	54	4.2	80	28-Jul-08
Wct	Foisey Creek	Muscle	124	16	4.5	82.3	28-Jul-08
Wct	Flathead River	Muscle	220	102	4.1	80.9	29-Jul-08
Wct	Flathead River	Muscle	201	76	4.1	81.4	29-Jul-08
Wct	Flathead River	Muscle	257	160	5	81.8	29-Jul-08
Wct	Flathead River	Muscle	257	173	4	78.2	29-Jul-08
Wct	Flathead River	Muscle	204	77	6.7	80.6	29-Jul-08
Wct	Flathead River	Muscle	373	502	4.3	78.4	29-Jul-08
Wct	Flathead River	Muscle	201	79	3.7	82.5	29-Jul-08
Wct	Flathead River	Muscle	212	92	3.8	80.3	29-Jul-08
Wct	Flathead River	Muscle	276	170	2.9	81.8	29-Jul-08
Wct	Flathead River	Muscle	183	57	3.9	79.5	29-Jul-08
Wct	Flathead River	Muscle	196	78	3.8	78.9	29-Jul-08
Wct	Flathead River	Muscle	191	59	2.7	83.9	29-Jul-08

Table B1. Cont. Selenium concentration in muscle samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Flathead River	Muscle	241	123	4.4	78.5	29-Jul-08
Wct	Flathead River	Muscle	177	55	3.4	80	29-Jul-08
Wct	Flathead River	Muscle	284	232	3.9	74.9	29-Jul-08
Wct	Flathead River	Muscle	283	250	3.8	78.2	29-Jul-08
Wct	Flathead River	Muscle	300	235	4.5	80.4	29-Jul-08
Wct	Flathead River	Muscle	231	115	5.1	78.6	29-Jul-08
Wct	Flathead Lake	Muscle	354	426	1.3	78.6	07-May-09
Wct	Flathead Lake	Muscle	332	323	1.3	79.2	07-May-09
Wct	Flathead Lake	Muscle	277	189	1.6	79.8	01-May-09
Wct	Flathead Lake	Muscle	274	180	1.5	78.6	01-May-09
Wct	Flathead Lake	Muscle	301	256	1.1	79.2	01-May-09
Wct	Flathead Lake	Muscle	517	1407	1.3	76.9	01-May-09
Wct	Flathead Lake	Muscle	331	369	1.6	77.1	02-May-08
Wct	Flathead Lake	Muscle	341	397	1.7	80.9	02-May-08
Wct	Flathead Lake	Muscle	307	251	1.6	79.3	02-May-08
Wct	Flathead Lake	Muscle	214	81	2.5	82.4	02-May-08
Wct	Flathead Lake	Muscle	354	413	1.3	76.5	02-May-08
Wct	Flathead Lake	Muscle	442	980	1.5	75	02-May-08
Wct	Flathead Lake	Muscle	319	317	1.3	80.8	02-May-08
Wct	Flathead Lake	Muscle	270	170	1.7	82.4	02-May-08
Wct	Flathead Lake	Muscle	332	377	1	79.2	02-May-08
Wct	Flathead Lake	Muscle	405	704	1.3	71.6	02-May-08
Wct	Flathead Lake	Muscle	282	189	1.5	78.1	02-May-08
Wct	Flathead Lake	Muscle	324	314	1.7	78.6	02-May-08
Wct	Flathead Lake	Muscle	331	400	1.7	77.2	02-May-08
Wct	Elk River	Muscle	321	351	7.8	78	09-Sep-08
Wct	Elk River	Muscle	346	462	8.1	82.5	09-Sep-08
Wct	Elk River	Muscle	412	803	5.8	75.4	09-Sep-08

Table B1. Cont. Selenium concentration in muscle samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Elk River	Muscle	377	631	7.7	79	09-Sep-08
Wct	Elk River	Muscle	272	248	8.2	79.8	09-Sep-08
Wct	Elk River	Muscle	293	254	4.6	79.8	09-Sep-08
Wct	Elk River	Muscle	326	374	7.6	80.2	09-Sep-08
Wct	Elk River	Muscle	341	431	7.3	80.9	09-Sep-08
Wct	Elk River	Muscle	337	417	6.2	80.4	09-Sep-08
Wct	Elk River	Muscle	323	371	7.3	80.1	09-Sep-08
Wct	Elk River	Muscle	351	454	6.9	83.7	09-Sep-08
Wct	Elk River	Muscle	353	430	4.5	80.2	09-Sep-08
Wct	Elk River	Muscle	287	285	7.6	82.3	09-Sep-08
Wct	Elk River	Muscle	302	308	6.6	76.4	09-Sep-08
Wct	Elk River	Muscle	316	339	8.4	81.9	09-Sep-08
Wct	Elk River	Muscle	336	391	7	83.1	09-Sep-08
Wct	Elk River	Muscle	397	744	6.4	78.2	09-Sep-08
Wct	Elk River	Muscle	310	322	7.3	83.2	09-Sep-08
Wct	Elk River	Muscle	357	460	6	80.8	09-Sep-08
Wct	Elk River	Muscle	315	346	6.6	79	09-Sep-08
Wct	Cabin Creek	Muscle	156	30	4.2	82.2	01-Sep-09
Wct	Cabin Creek	Muscle	148	27	3.6	84	01-Sep-09
Wct	Cabin Creek	Muscle	165	41	3.6	86.6	01-Sep-09
Wct	Cabin Creek	Muscle	166	41	4.2	80.8	01-Sep-09
Wct	Cabin Creek	Muscle	157	35	4.3	82.1	01-Sep-09
Wct	Cabin Creek	Muscle	213	102	4.2	82.2	01-Sep-09
Wct	Cabin Creek	Muscle	214	103	4.2	80.6	01-Sep-09
Wct	Cabin Creek	Muscle	221	110	4.4	80.5	01-Sep-09
Wct	Cabin Creek	Muscle	228	113	3.2	79	01-Sep-09
Wct	Cabin Creek	Muscle	234	128	4.1	79.9	01-Sep-09

Table B2. Selenium concentration in liver samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Pollock Creek	Liver	173	53	10.3	74.3	21-Jul-09
Wct	Pollock Creek	Liver	150	38	9.8	78.4	21-Jul-09
Wct	Pollock Creek	Liver	163	46	10	84.1	21-Jul-09
Wct	Pollock Creek	Liver	146	32	15	81	21-Jul-09
Wct	Pollock Creek	Liver	144	31	13.9	76.9	21-Jul-09
Wct	Pollock Creek	Liver	151	30	18.9	75.4	21-Jul-09
Wct	Pollock Creek	Liver	181	55	12.6	80.7	21-Jul-09
Wct	Pollock Creek	Liver	165	44	13.7	82.4	21-Jul-09
Wct	Pollock Creek	Liver	136	26	9.4	79.5	21-Jul-09
Wct	Pollock Creek	Liver	162	46	15.2	75.8	21-Jul-09
Wct	North Fork Flathead River	Liver	231	123	16.6	79.6	18-Aug-09
Wct	North Fork Flathead River	Liver	240	148	17.1	75.6	16-Jul-09
Wct	North Fork Flathead River	Liver	212	99	14.1	74.4	16-Jul-09
Wct	North Fork Flathead River	Liver	220	110	16.6	77.6	16-Jul-09
Wct	North Fork Flathead River	Liver	230	129	17.3	76.2	16-Jul-09
Wct	North Fork Flathead River	Liver	216	115	25.1	79.5	16-Jul-09
Wct	North Fork Flathead River	Liver	216	105	14.4	82.1	16-Jul-09
Wct	North Fork Flathead River	Liver	231	139	14.8	75.1	16-Jul-09
Wct	North Fork Flathead River	Liver	251	170	14.9	75.3	16-Jul-09
Wct	North Fork Flathead River	Liver	288	253	14.8	74.3	16-Jul-09
Wct	North Fork Flathead River	Liver	257	184	16.4	76.3	16-Jul-09
Wct	North Fork Flathead River	Liver	268	202	16.5	76.8	16-Jul-09
Wct	North Fork Flathead River	Liver	272	211	11.3	76	16-Jul-09
Wct	North Fork Flathead River	Liver	287	252	13.9	75.5	16-Jul-09
Wct	North Fork Flathead River	Liver	228	124	18.6	73.1	16-Jul-09
Wct	Middle Pass Creek	Liver	161	37	26.4	84.2	09-Sep-09
Wct	Middle Pass Creek	Liver	154	32	8.9	81.1	09-Sep-09

Table B2. Cont. Selenium concentration in liver samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Middle Pass Creek	Liver	215	104	17.5	78.6	09-Sep-09
Wct	Middle Pass Creek	Liver	150	31	11.1	81.9	09-Sep-09
Wct	Middle Pass Creek	Liver	191	63	11.4	80.4	09-Sep-09
Wct	Middle Pass Creek	Liver	157	33	20.5	82.5	09-Sep-09
Wct	Middle Pass Creek	Liver	301	335	11.5	76.6	09-Sep-09
Wct	Middle Pass Creek	Liver	164	38	17.2	82.6	09-Sep-09
Wct	Middle Pass Creek	Liver	203	91	14.3	77.6	09-Sep-09
Wct	Middle Pass Creek	Liver	196	81	11.4	83.7	09-Sep-09
Wct	Michel Creek	Liver	259	196	7.6	78.8	03-Sep-08
Wct	Michel Creek	Liver	343	458	14.7	77.8	03-Sep-08
Wct	Michel Creek	Liver	373	519	16.2	79.9	03-Sep-08
Wct	Michel Creek	Liver	331	428	14.9	73.6	03-Sep-08
Wct	Michel Creek	Liver	297	305	11.2	77.7	03-Sep-08
Wct	Michel Creek	Liver	272	237	10.2	80	03-Sep-08
Wct	Michel Creek	Liver	273	235	10.7	81.4	03-Sep-08
Wct	Michel Creek	Liver	270	230	17.4	79.2	03-Sep-08
Wct	Michel Creek	Liver	291	314	9.9	82.8	03-Sep-08
Wct	Michel Creek	Liver	249	176	11.1	81.4	03-Sep-08
Wct	Michel Creek	Liver	259	180	9.1	79.7	03-Sep-08
Wct	Michel Creek	Liver	292	284	21.8	80.7	03-Sep-08
Wct	Michel Creek	Liver	275	243	11.2	79.5	03-Sep-08
Wct	Michel Creek	Liver	423	850	17.2	78	03-Sep-08
Wct	Michel Creek	Liver	417	922	16.8	83.1	03-Sep-08
Wct	Michel Creek	Liver	258	206	12.5	77.7	03-Sep-08
Wct	McLatchie Creek	Liver	155	42	20.3	82.8	21-Jul-09
Wct	McLatchie Creek	Liver	146	35	15.6	80.6	21-Jul-09
Wct	McLatchie Creek	Liver	156	44	15.6	81	21-Jul-09
Wct	McLatchie Creek	Liver	171	52	11.2	80.3	21-Jul-09

Table B2. Cont. Selenium concentration in liver samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	McLatchie Creek	Liver	171	59	12.3	82.9	21-Jul-09
Wct	McLatchie Creek	Liver	197	98	13.7	81.3	21-Jul-09
Wct	McLatchie Creek	Liver	234	129	12.5	78.6	21-Jul-09
Wct	McLatchie Creek	Liver	151	33	10.6	78.5	21-Jul-09
Wct	McLatchie Creek	Liver	188	86	12.9	79.4	21-Jul-09
Wct	McLatchie Creek	Liver	204	97	15.2	80.4	21-Jul-09
Wct	McEvoy Creek	Liver	191	72	11.4	79.9	08-Sep-09
Wct	McEvoy Creek	Liver	143	27	13.4	79	08-Sep-09
Wct	McEvoy Creek	Liver	196	77	21.2	82.2	08-Sep-09
Wct	McEvoy Creek	Liver	184	68	108	97.2	08-Sep-09
Wct	McEvoy Creek	Liver	176	55	13.5	82.1	08-Sep-09
Wct	McEvoy Creek	Liver	172	51	9.4	79.9	08-Sep-09
Wct	McEvoy Creek	Liver	160	38	18.3	81.3	08-Sep-09
Wct	McEvoy Creek	Liver	147	30	6.9	81.2	08-Sep-09
Wct	McEvoy Creek	Liver	160	35	13.8	79.8	08-Sep-09
Wct	McEvoy Creek	Liver	218	108	17.2	80.6	08-Sep-09
Wct	Lodgepole Creek	Liver	216	97	15.6	74.3	06-Aug-08
Wct	Lodgepole Creek	Liver	252	167	18.2	76.9	06-Aug-08
Wct	Lodgepole Creek	Liver	171	48	17.6	81.2	06-Aug-08
Wct	Lodgepole Creek	Liver	151	34	14	74.9	06-Aug-08
Wct	Lodgepole Creek	Liver	219	114	22.2	81.3	06-Aug-08
Wct	Lodgepole Creek	Liver	262	169	18.4	77.7	06-Aug-08
Wct	Lodgepole Creek	Liver	202	82	16.2	81.4	06-Aug-08
Wct	Lodgepole Creek	Liver	201	95	17.2	79	06-Aug-08
Wct	Lodgepole Creek	Liver	169	46	15.1	76.4	06-Aug-08
Wct	Lodgepole Creek	Liver	190	74	20.4	73.2	06-Aug-08
Wct	Lodgepole Creek	Liver	221	127	28.1	80.3	06-Aug-08
Wct	Lodgepole Creek	Liver	126	21	14.1	71.4	06-Aug-08

Table B2. Cont. Selenium concentration in liver samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Lodgepole Creek	Liver	143	28	15.4	71.3	06-Aug-08
Wct	Lodgepole Creek	Liver	157	36	19.6	78.4	06-Aug-08
Wct	Lodgepole Creek	Liver	148	29	15.7	74.4	06-Aug-08
Wct	Lodgepole Creek	Liver	189	74	18.8	76.5	06-Aug-08
Wct	Lodgepole Creek	Liver	133	22	16.1	82.3	06-Aug-08
Wct	Lodgepole Creek	Liver	158	34	14.5	81.6	06-Aug-08
Wct	Lodgepole Creek	Liver	160	40	16.5	76.5	06-Aug-08
Wct	Lodgepole Creek	Liver	212	93	17.9	77.3	06-Aug-08
Wct	Howell Creek	Liver	130	18	12.4	84.9	02-Sep-09
Wct	Howell Creek	Liver	144	22	20.9	91.2	02-Sep-09
Wct	Howell Creek	Liver	134	19	14.7	77.6	02-Sep-09
Wct	Howell Creek	Liver	183	56	22.3	83.6	02-Sep-09
Wct	Harvey Creek	Liver	160	45	13.6	79.9	22-Jul-09
Wct	Harvey Creek	Liver	164	48	12.8	80.7	22-Jul-09
Wct	Harvey Creek	Liver	153	35	13.2	78.9	22-Jul-09
Wct	Harvey Creek	Liver	151	32	65.3	94.8	22-Jul-09
Wct	Harvey Creek	Liver	136	26	13.8	78.5	22-Jul-09
Wct	Harvey Creek	Liver	182	62	18	75	22-Jul-09
Wct	Harvey Creek	Liver	167	48	15.8	78	22-Jul-09
Wct	Harvey Creek	Liver	231	128	11.8	78.7	22-Jul-09
Wct	Harvey Creek	Liver	163	43	12.2	80.1	22-Jul-09
Wct	Foisey Creek	Liver	177	57	26.4	78.6	28-Jul-08
Wct	Foisey Creek	Liver	173	52	36.7	84.8	28-Jul-08
Wct	Foisey Creek	Liver	174	49	18.1	78.9	28-Jul-08
Wct	Foisey Creek	Liver	142	29	23.7	80.9	28-Jul-08
Wct	Foisey Creek	Liver	150	33	15.8	72.7	28-Jul-08
Wct	Foisey Creek	Liver	168	46	21.4	75.6	28-Jul-08
Wct	Foisey Creek	Liver	158	37	21.2	82.6	28-Jul-08

Table B2. Cont. Selenium concentration in liver samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Foisey Creek	Liver	165	44	11.9	82	28-Jul-08
Wct	Foisey Creek	Liver	176	54	21.1	78.4	28-Jul-08
Wct	Foisey Creek	Liver	151	32	20.2	79.3	28-Jul-08
Wct	Foisey Creek	Liver	147	31	17.9	79.2	28-Jul-08
Wct	Foisey Creek	Liver	150	30	33.8	82.1	28-Jul-08
Wct	Foisey Creek	Liver	137	27	13.1	80.5	28-Jul-08
Wct	Foisey Creek	Liver	172	48	16.4	78.5	28-Jul-08
Wct	Foisey Creek	Liver	144	26	18.2	81.9	28-Jul-08
Wct	Foisey Creek	Liver	262	151	17	75.2	28-Jul-08
Wct	Foisey Creek	Liver	189	70	17.2	79	28-Jul-08
Wct	Foisey Creek	Liver	186	61	16.9	74.6	28-Jul-08
Wct	Foisey Creek	Liver	214	96	18.4	76.9	28-Jul-08
Wct	Foisey Creek	Liver	124	16	17.8	83.7	28-Jul-08
Wct	Flathead River	Liver	220	102	13.9	77.2	29-Jul-08
Wct	Flathead River	Liver	257	160	19.4	77.6	29-Jul-08
Wct	Flathead River	Liver	201	76	13.8	75.2	29-Jul-08
Wct	Flathead River	Liver	257	173	19.3	78.6	29-Jul-08
Wct	Flathead River	Liver	204	77	26.8	81.5	29-Jul-08
Wct	Flathead River	Liver	373	502	20.9	80.6	29-Jul-08
Wct	Flathead River	Liver	201	79	14.8	78.2	29-Jul-08
Wct	Flathead River	Liver	212	92	16.4	71.9	29-Jul-08
Wct	Flathead River	Liver	276	170	13.5	76.4	29-Jul-08
Wct	Flathead River	Liver	183	57	15.8	79.1	29-Jul-08
Wct	Flathead River	Liver	300	235	17.4	78.8	29-Jul-08
Wct	Flathead River	Liver	283	250	19.1	76.7	29-Jul-08
Wct	Flathead River	Liver	177	55	12	78	29-Jul-08
Wct	Flathead River	Liver	284	232	18	78.2	29-Jul-08
Wct	Flathead River	Liver	231	115	23.6	86.9	29-Jul-08

Table B2. Cont. Selenium concentration in liver samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Flathead River	Liver	241	123	20.5	78	29-Jul-08
Wct	Flathead River	Liver	191	59	13.7	95.2	29-Jul-08
Wct	Flathead River	Liver	196	78	16.5	77.8	29-Jul-08
Wct	Flathead Lake	Liver	354	426	5.5	80.4	07-May-09
Wct	Flathead Lake	Liver	332	323	8.2	79.3	07-May-09
Wct	Flathead Lake	Liver	274	180	8	81.4	01-May-09
Wct	Flathead Lake	Liver	301	256	5.3	78.8	01-May-09
Wct	Flathead Lake	Liver	517	1407	7.4	78.6	01-May-09
Wct	Flathead Lake	Liver	277	189	9	81	01-May-09
Wct	Flathead Lake	Liver	270	170	8.5	75.3	02-May-08
Wct	Flathead Lake	Liver	332	377	9.3	76.1	02-May-08
Wct	Flathead Lake	Liver	214	81	18.6	73.4	02-May-08
Wct	Flathead Lake	Liver	341	397	10.8	74.8	02-May-08
Wct	Flathead Lake	Liver	307	251	13	71.3	02-May-08
Wct	Flathead Lake	Liver	331	400	10.4	78.5	02-May-08
Wct	Flathead Lake	Liver	354	413	10.7	76.8	02-May-08
Wct	Flathead Lake	Liver	324	314	9.5	76.4	02-May-08
Wct	Flathead Lake	Liver	331	369	7.3	79.3	02-May-08
Wct	Flathead Lake	Liver	405	704	13.5	78.1	02-May-08
Wct	Flathead Lake	Liver	282	189	11.7	78.3	02-May-08
Wct	Flathead Lake	Liver	442	980	8.4	77	02-May-08
Wct	Flathead Lake	Liver	319	317	9.4	77.2	02-May-08
Wct	Elk River	Liver	287	285	23.1	77.9	09-Sep-08
Wct	Elk River	Liver	310	322	22.7	80.3	09-Sep-08
Wct	Elk River	Liver	323	371	24.4	84.2	09-Sep-08
Wct	Elk River	Liver	293	254	20.8	81.3	09-Sep-08
Wct	Elk River	Liver	316	339	23.1	79.6	09-Sep-08
Wct	Elk River	Liver	353	430	20.3	76.9	09-Sep-08

Table B2. Cont. Selenium concentration in liver samples from westslope cutthroat trout.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Wct	Elk River	Liver	302	308	25.6	79.7	09-Sep-08
Wct	Elk River	Liver	346	462	35.3	85.6	09-Sep-08
Wct	Elk River	Liver	412	803	25.4	78.4	09-Sep-08
Wct	Elk River	Liver	351	454	29	74.6	09-Sep-08
Wct	Elk River	Liver	315	346	23.2	79	09-Sep-08
Wct	Elk River	Liver	272	248	26.9	80.3	09-Sep-08
Wct	Elk River	Liver	321	351	21.2	79.2	09-Sep-08
Wct	Elk River	Liver	326	374	28.7	77	09-Sep-08
Wct	Elk River	Liver	341	431	27.9	78.1	09-Sep-08
Wct	Elk River	Liver	337	417	28.3	78.7	09-Sep-08
Wct	Elk River	Liver	397	744	28.4	77.3	09-Sep-08
Wct	Elk River	Liver	357	460	26	80.6	09-Sep-08
Wct	Elk River	Liver	377	631	24.4	77.9	09-Sep-08
Wct	Elk River	Liver	336	391	28.3	78.8	09-Sep-08
Wct	Cabin Creek	Liver	156	30	29.5	92.4	01-Sep-09
Wct	Cabin Creek	Liver	148	27	25.9	92.2	01-Sep-09
Wct	Cabin Creek	Liver	165	41	16.3	84.6	01-Sep-09
Wct	Cabin Creek	Liver	166	41	16.6	85.3	01-Sep-09
Wct	Cabin Creek	Liver	157	35	17.9	85.7	01-Sep-09
Wct	Cabin Creek	Liver	213	102	16.4	78.6	01-Sep-09
Wct	Cabin Creek	Liver	214	103	24.1	80.6	01-Sep-09
Wct	Cabin Creek	Liver	221	110	19.3	78.6	01-Sep-09
Wct	Cabin Creek	Liver	228	113	12.5	79.4	01-Sep-09
Wct	Cabin Creek	Liver	234	128	21.2	80.8	01-Sep-09

Appendix C. Selenium concentrations and size measurements of sculpin collected in the Baseline Contaminant Investigation.

Table C1. Selenium concentration in sculpin whole fish samples.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Cot	North Fork Flathead River	Whole	81	7	5.6	79.7	18-Aug-09
Cot	North Fork Flathead River	Whole	81	6	6.7	78.8	18-Aug-09
Cot	North Fork Flathead River	Whole	81	5	4	81.2	18-Aug-09
Cot	North Fork Flathead River	Whole	78	5	5.5	81	18-Aug-09
Cot	North Fork Flathead River	Whole	82	6	4.9	79	18-Aug-09
Cot	North Fork Flathead River	Whole	82	6	4.7	78.2	18-Aug-09
Cot	North Fork Flathead River	Whole	85	7	5.3	78.6	18-Aug-09
Cot	North Fork Flathead River	Whole	84	6	6.9	80	18-Aug-09
Cot	North Fork Flathead River	Whole	78	5	5.4	76.9	18-Aug-09
Cot	North Fork Flathead River	Whole	90	7	5.7	79	18-Aug-09
Cot	North Fork Flathead River	Whole	91	7	5	79	18-Aug-09
Cot	North Fork Flathead River	Whole	88	7	3.9	76.4	18-Aug-09
Cot	North Fork Flathead River	Whole	83	8	7.2	80.3	18-Aug-09
Cot	North Fork Flathead River	Whole	91	9	6.9	81.9	18-Aug-09
Cot	North Fork Flathead River	Whole	99	10	3.8	80.6	18-Aug-09
Cot	North Fork Flathead River	Whole	90	8	4.7	77.4	18-Aug-09
Cot	North Fork Flathead River	Whole	91	9	5.7	81.2	18-Aug-09
Cot	North Fork Flathead River	Whole	101	11	5.1	77.3	18-Aug-09
Cot	North Fork Flathead River	Whole	87	7	5.4	81	18-Aug-09
Cot	North Fork Flathead River	Whole	85	7	6.5	78.1	18-Aug-09
Cot	Middle Pass Creek	Whole	91	8	4.3	78.3	09-Sep-09
Cot	Middle Pass Creek	Whole	92	8	2.7	77.1	09-Sep-09
Cot	Middle Pass Creek	Whole	98	9	2.1	74.4	09-Sep-09
Cot	Middle Pass Creek	Whole	87	8	2.8	74.4	09-Sep-09
Cot	Middle Pass Creek	Whole	83	6	1.9	76.1	09-Sep-09

Table C1. Cont. Selenium concentration in sculpin whole fish samples.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Cot	Middle Pass Creek	Whole	81	6	3.7	76.2	09-Sep-09
Cot	Middle Pass Creek	Whole	77	5	2.5	76.1	09-Sep-09
Cot	Middle Pass Creek	Whole	76	5	3.8	79	09-Sep-09
Cot	Middle Pass Creek	Whole	76	5	2.9	74.8	09-Sep-09
Cot	Middle Pass Creek	Whole	95	8	2.7	76.7	09-Sep-09
Cot	McEvoy Creek	Whole	93	9	2.9	77.1	08-Sep-09
Cot	McEvoy Creek	Whole	111	18	4.7	75.6	08-Sep-09
Cot	McEvoy Creek	Whole	83	6	2.7	75.5	08-Sep-09
Cot	McEvoy Creek	Whole	87	7	1.8	73.4	08-Sep-09
Cot	McEvoy Creek	Whole	94	8	3	73.2	08-Sep-09
Cot	McEvoy Creek	Whole	95	10	3.3	76.5	08-Sep-09
Cot	McEvoy Creek	Whole	95	9	2.2	76	08-Sep-09
Cot	McEvoy Creek	Whole	101	12	2.8	75.9	08-Sep-09
Cot	McEvoy Creek	Whole	98	11	4.6	76	08-Sep-09
Cot	McEvoy Creek	Whole	83	6	3.1	74.5	08-Sep-09
Cot	Howell Creek	Whole	106	15	6.3	77	02-Sep-09
Cot	Howell Creek	Whole	88	8	5	76.3	02-Sep-09
Cot	Howell Creek	Whole	127	23	5.4	79.3	02-Sep-09
Cot	Howell Creek	Whole	96	11	6	75.3	02-Sep-09
Cot	Howell Creek	Whole	93	10	6.3	78.9	02-Sep-09
Cot	Howell Creek	Whole	90	10	5	77.8	02-Sep-09
Cot	Howell Creek	Whole	99	10	6.5	75.6	02-Sep-09
Cot	Howell Creek	Whole	97	10	7.6	76	02-Sep-09
Cot	Howell Creek	Whole	102	11	6.2	78.9	02-Sep-09
Cot	Howell Creek	Whole	93	10	6.2	78.3	02-Sep-09
Cot	Foisey Creek	Whole	76	5	5.4	77.9	28-Jul-08
Cot	Foisey Creek	Whole	101	9	3.9	82.5	28-Jul-08
Cot	Foisey Creek	Whole	102	11	4.6	84	28-Jul-08

Table C1. Cont. Selenium concentration in sculpin whole fish samples.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Cot	Foisey Creek	Whole	104	13	11.5	93.3	28-Jul-08
Cot	Foisey Creek	Whole	91	8	6	85.8	28-Jul-08
Cot	Foisey Creek	Whole	88	8	4.9	78.4	28-Jul-08
Cot	Foisey Creek	Whole	93	8	3.6	82.5	28-Jul-08
Cot	Foisey Creek	Whole	84	6	4.8	85	28-Jul-08
Cot	Foisey Creek	Whole	85	5	5.1	88.2	28-Jul-08
Cot	Foisey Creek	Whole	85	7	7	83	28-Jul-08
Cot	Foisey Creek	Whole	85	6	3.8	77.6	28-Jul-08
Cot	Foisey Creek	Whole	79	6	5.9	84.1	28-Jul-08
Cot	Foisey Creek	Whole	82	6	5.3	76.9	28-Jul-08
Cot	Foisey Creek	Whole	70	4	6.9	81	28-Jul-08
Cot	Foisey Creek	Whole	76	5	4.9	80	28-Jul-08
Cot	Foisey Creek	Whole	71	3	4.4	88.6	28-Jul-08
Cot	Foisey Creek	Whole	71	3	3.9	81.2	28-Jul-08
Cot	Foisey Creek	Whole	68	3	7.6	85.2	28-Jul-08
Cot	Foisey Creek	Whole	121	21	6.1	74.6	28-Jul-08
Cot	Foisey Creek	Whole	79	5	2.8	83	28-Jul-08
Cot	Cabin Creek	Whole	116	21	6.1	77	01-Sep-09
Cot	Cabin Creek	Whole	89	8	9.6	77.4	01-Sep-09
Cot	Cabin Creek	Whole	92	9	10	76.4	01-Sep-09
Cot	Cabin Creek	Whole	91	8	8.5	78.3	01-Sep-09
Cot	Cabin Creek	Whole	92	9	6.9	76.2	01-Sep-09
Cot	Cabin Creek	Whole	100	11	8.6	76.1	01-Sep-09
Cot	Cabin Creek	Whole	113	16	7.6	75.7	01-Sep-09
Cot	Cabin Creek	Whole	105	12	9.3	77.6	01-Sep-09
Cot	Cabin Creek	Whole	133	23	5.6	77.1	01-Sep-09
Cot	Cabin Creek	Whole	100	12	9.1	77	01-Sep-09

Appendix D. Selenium concentrations and size measurements of mountain whitefish collected in the Baseline Contaminant Investigation.

Table D1. Selenium concentration in muscle samples from mountain whitefish.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Mwf	North Fork Flathead River	Muscle	289	219	2.5	80	18-Aug-09
Mwf	North Fork Flathead River	Muscle	282	209	2.5	78.6	18-Aug-09
Mwf	North Fork Flathead River	Muscle	281	206	2.9	78.3	18-Aug-09
Mwf	North Fork Flathead River	Muscle	276	189	2.7	79.3	18-Aug-09
Mwf	North Fork Flathead River	Muscle	287	224	3.1	79.7	18-Aug-09
Mwf	North Fork Flathead River	Muscle	292	236	3.4	80.2	18-Aug-09
Mwf	North Fork Flathead River	Muscle	286	216	2.9	79.5	18-Aug-09
Mwf	North Fork Flathead River	Muscle	307	275	4.2	79.5	18-Aug-09
Mwf	North Fork Flathead River	Muscle	307	286	4.1	79.6	18-Aug-09
Mwf	North Fork Flathead River	Muscle	371	444	4.7	80.2	18-Aug-09
Mwf	North Fork Flathead River	Muscle	302	265	3.8	78.4	18-Aug-09
Mwf	North Fork Flathead River	Muscle	323	322	2.7	78.7	18-Aug-09
Mwf	North Fork Flathead River	Muscle	350	393	4.3	80.2	18-Aug-09
Mwf	North Fork Flathead River	Muscle	317	339	2.8	79.8	18-Aug-09
Mwf	North Fork Flathead River	Muscle	275	192	4.9	78.2	16-Jul-09
Mwf	North Fork Flathead River	Muscle	372	445	4.2	78	16-Jul-09
Mwf	North Fork Flathead River	Muscle	341	354	4.2	77.2	16-Jul-09
Mwf	North Fork Flathead River	Muscle	311	303	4.4	77	16-Jul-09
Mwf	North Fork Flathead River	Muscle	342	422	4.8	75.5	16-Jul-09
Mwf	North Fork Flathead River	Muscle	329	320	5	79.5	16-Jul-09
Mwf	Lake Koocanusa	Muscle	375	428	2	81.5	14-May-08
Mwf	Lake Koocanusa	Muscle	342	363	2.9	79.5	14-May-08
Mwf	Flathead River	Muscle	291	205	3.3	79.3	29-Jul-08
Mwf	Flathead River	Muscle	293	222	4.9	78.7	29-Jul-08
Mwf	Flathead River	Muscle	271	159	4.8	79.3	29-Jul-08

Table D1. Cont. Selenium concentration in muscle samples from mountain whitefish.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Mwf	Flathead River	Muscle	273	177	3.1	78.5	29-Jul-08
Mwf	Flathead River	Muscle	296	242	4	78.6	29-Jul-08
Mwf	Flathead River	Muscle	282	215	3.3	78.1	29-Jul-08
Mwf	Flathead River	Muscle	332	335	4.5	77.8	29-Jul-08
Mwf	Flathead River	Muscle	262	149	5.2	80.1	29-Jul-08
Mwf	Flathead River	Muscle	274	169	3.5	78.4	29-Jul-08
Mwf	Flathead River	Muscle	257	138	3.8	77.3	29-Jul-08
Mwf	Flathead River	Muscle	244	128	3.9	78.6	29-Jul-08
Mwf	Flathead River	Muscle	363	430	4.4	78.5	29-Jul-08
Mwf	Flathead River	Muscle	283	211	3	78.4	29-Jul-08
Mwf	Flathead River	Muscle	257	146	3.9	78	29-Jul-08
Mwf	Flathead River	Muscle	295	226	3.4	78.5	29-Jul-08
Mwf	Flathead Lake	Muscle	345	310	1.5	79.4	07-May-09
Mwf	Flathead Lake	Muscle	288	178	1.3	77.9	01-May-09
Mwf	Flathead Lake	Muscle	287	176	1.4	79.6	01-May-09
Mwf	Flathead Lake	Muscle	286	187	1.4	77.6	02-May-08
Mwf	Flathead Lake	Muscle	260	138	1.3	77.8	02-May-08
Mwf	Flathead Lake	Muscle	290	189	1.5	79.1	02-May-08
Mwf	Flathead Lake	Muscle	243	106	1.5	80.7	02-May-08
Mwf	Flathead Lake	Muscle	254	130	2.1	80.2	02-May-08
Mwf	Elk River	Muscle	266	171	5.9	75.7	26-Aug-09
Mwf	Elk River	Muscle	241	129	6.5	79	26-Aug-09
Mwf	Elk River	Muscle	264	162	5.3	78.6	26-Aug-09
Mwf	Elk River	Muscle	274	196	5.4	77.6	26-Aug-09
Mwf	Elk River	Muscle	270	195	7.8	79.4	26-Aug-09
Mwf	Elk River	Muscle	289	233	5.2	77.1	26-Aug-09
Mwf	Elk River	Muscle	311	302	5.3	78.9	26-Aug-09
Mwf	Elk River	Muscle	342	322	6.3	80.5	26-Aug-09

Table D1. Cont. Selenium concentration in muscle samples from mountain whitefish.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Mwf	Elk River	Muscle	326	351	4.8	76.5	26-Aug-09
Mwf	Elk River	Muscle	285	180	5.4	79.6	26-Aug-09

Table D2. Selenium concentration in liver samples from mountain whitefish.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Mwf	North Fork Flathead River	Liver	289	219	26.7	77.5	18-Aug-09
Mwf	North Fork Flathead River	Liver	282	209	25.6	79.3	18-Aug-09
Mwf	North Fork Flathead River	Liver	281	206	37.9	77	18-Aug-09
Mwf	North Fork Flathead River	Liver	276	189	36.3	78.9	18-Aug-09
Mwf	North Fork Flathead River	Liver	287	224	35.6	80.4	18-Aug-09
Mwf	North Fork Flathead River	Liver	292	236	63.9	76.7	18-Aug-09
Mwf	North Fork Flathead River	Liver	286	216	32.1	85.1	18-Aug-09
Mwf	North Fork Flathead River	Liver	307	275	111	86.7	18-Aug-09
Mwf	North Fork Flathead River	Liver	307	286	35.2	78.8	18-Aug-09
Mwf	North Fork Flathead River	Liver	371	444	57.2	79.2	18-Aug-09
Mwf	North Fork Flathead River	Liver	302	265	76.2	79.2	18-Aug-09
Mwf	North Fork Flathead River	Liver	323	322	29.2	80.2	18-Aug-09
Mwf	North Fork Flathead River	Liver	350	393	54	82.6	18-Aug-09
Mwf	North Fork Flathead River	Liver	317	339	17.7	77.4	18-Aug-09
Mwf	North Fork Flathead River	Liver	275	192	44.4	78.5	16-Jul-09
Mwf	North Fork Flathead River	Liver	372	445	27.9	77.5	16-Jul-09
Mwf	North Fork Flathead River	Liver	341	354	29.3	79.2	16-Jul-09
Mwf	North Fork Flathead River	Liver	311	303	33.4	75.3	16-Jul-09
Mwf	North Fork Flathead River	Liver	342	422	24.3	76.2	16-Jul-09
Mwf	North Fork Flathead River	Liver	329	320	52	79.2	16-Jul-09
Mwf	Lake Koocanusa	Liver	375	428	12.4	80.3	14-May-08

Table D2. Cont. Selenium concentration in liver samples from mountain whitefish.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Mwf	Lake Koocanusa	Liver	342	363	43.1	78.6	14-May-08
Mwf	Flathead River	Liver	291	205	21.9	76.8	29-Jul-08
Mwf	Flathead River	Liver	293	222	47.4	78	29-Jul-08
Mwf	Flathead River	Liver	271	159	30.5	77.9	29-Jul-08
Mwf	Flathead River	Liver	273	177	25.9	80.2	29-Jul-08
Mwf	Flathead River	Liver	296	242	27.2	71.2	29-Jul-08
Mwf	Flathead River	Liver	282	215	26.2	77.6	29-Jul-08
Mwf	Flathead River	Liver	332	335	35	84.5	29-Jul-08
Mwf	Flathead River	Liver	262	149	36.4	78.6	29-Jul-08
Mwf	Flathead River	Liver	274	169	17	78.7	29-Jul-08
Mwf	Flathead River	Liver	257	138	44.5	78.7	29-Jul-08
Mwf	Flathead River	Liver	244	128	29	78.5	29-Jul-08
Mwf	Flathead River	Liver	363	430	43.1	85.6	29-Jul-08
Mwf	Flathead River	Liver	283	211	16	76.4	29-Jul-08
Mwf	Flathead River	Liver	257	146	31.3	80.1	29-Jul-08
Mwf	Flathead River	Liver	295	226	19.4	75.6	29-Jul-08
Mwf	Flathead Lake	Liver	345	310	7.5	81.5	07-May-09
Mwf	Flathead Lake	Liver	288	178	8.3	81.7	01-May-09
Mwf	Flathead Lake	Liver	287	176	11.7	80.5	01-May-09
Mwf	Flathead Lake	Liver	286	187	11.7	72.7	02-May-08
Mwf	Flathead Lake	Liver	260	138	11.2	76	02-May-08
Mwf	Flathead Lake	Liver	290	189	9.4	75.3	02-May-08
Mwf	Flathead Lake	Liver	243	106	13.2	74.8	02-May-08
Mwf	Flathead Lake	Liver	254	130	12.7	74	02-May-08
Mwf	Elk River	Liver	266	171	43.1	81.7	26-Aug-09
Mwf	Elk River	Liver	241	129	74.9	83.1	26-Aug-09
Mwf	Elk River	Liver	264	162	44.6	85.7	26-Aug-09
Mwf	Elk River	Liver	274	196	34.5	78.2	26-Aug-09

Table D2. Cont. Selenium concentration in liver samples from mountain whitefish.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Mwf	Elk River	Liver	270	195	65.4	85.8	26-Aug-09
Mwf	Elk River	Liver	289	233	35.8	78	26-Aug-09
Mwf	Elk River	Liver	311	302	42.2	78.9	26-Aug-09
Mwf	Elk River	Liver	342	322	33.2	79.8	26-Aug-09
Mwf	Elk River	Liver	326	351	36.1	79.5	26-Aug-09
Mwf	Elk River	Liver	285	180	36.3	83.6	26-Aug-09

Table D3. Selenium concentration in ovary samples from mountain whitefish.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Mwf	North Fork Flathead River	Gonad	282	209	30.6	67.4	18-Aug-09
Mwf	North Fork Flathead River	Gonad	281	206	36.3	63.6	18-Aug-09
Mwf	North Fork Flathead River	Gonad	276	189	34.2	67.1	18-Aug-09
Mwf	North Fork Flathead River	Gonad	287	224	34.1	66.7	18-Aug-09
Mwf	North Fork Flathead River	Gonad	317	339	22.1	62.5	18-Aug-09
Mwf	North Fork Flathead River	Gonad	323	322	27.3	66.2	18-Aug-09
Mwf	North Fork Flathead River	Gonad	289	219	20.8	67.8	18-Aug-09
Mwf	North Fork Flathead River	Gonad	307	286	25.8	67.2	18-Aug-09
Mwf	Elk River	Gonad	285	180	40.4	68.9	26-Aug-09
Mwf	Elk River	Gonad	241	129	31.8	63.9	26-Aug-09
Mwf	Elk River	Gonad	342	322	45.5	64.6	26-Aug-09
Mwf	Elk River	Gonad	266	171	29.6	65.5	26-Aug-09
Mwf	Elk River	Gonad	289	233	30.5	61.2	26-Aug-09
Mwf	Elk River	Gonad	274	196	31.7	61.7	26-Aug-09
Mwf	Elk River	Gonad	264	162	36.9	67.3	26-Aug-09
Mwf	Elk River	Gonad	311	302	42.2	64.8	26-Aug-09

Appendix E. Selenium concentrations and size measurements of other fish species collected in the Baseline Contaminant Investigation.

Table E1. Selenium concentration in muscle samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Pm	Lake Koocanusa	Muscle	265		2.9	82.7	14-May-08
Pm	Lake Koocanusa	Muscle	314		3.2	81.2	14-May-08
Pm	Lake Koocanusa	Muscle	294		2.7	81.6	14-May-08
Pm	Lake Koocanusa	Muscle	289		3.3	83.1	14-May-08
Pm	Lake Koocanusa	Muscle	283		2.7	82.3	14-May-08
Pm	Lake Koocanusa	Muscle	304		3.1	82.3	14-May-08
Pm	Lake Koocanusa	Muscle	274		2.9	80.9	14-May-08
Pm	Lake Koocanusa	Muscle	303		3.5	81.1	14-May-08
Pm	Lake Koocanusa	Muscle	272		2.9	80.7	14-May-08
Pm	Lake Koocanusa	Muscle	274		4.2	81.2	14-May-08
Pm	Lake Koocanusa	Muscle	287		3.7	83.2	14-May-08
Pm	Lake Koocanusa	Muscle	287		1.9	82.7	14-May-08
Pm	Lake Koocanusa	Muscle	284		2.8	82.4	14-May-08
Pm	Lake Koocanusa	Muscle	306		2.6	81.4	14-May-08
Pm	Lake Koocanusa	Muscle	281		4.6	82.6	14-May-08
Pm	Lake Koocanusa	Muscle	314		1.8	82.2	14-May-08
Pm	Lake Koocanusa	Muscle	307		2.3	82.2	14-May-08
Pm	Lake Koocanusa	Muscle	298		4.2	83.3	14-May-08
Pm	Lake Koocanusa	Muscle	283		1.7	81.9	14-May-08
Pm	Lake Koocanusa	Muscle	304		1.9	83	14-May-08
Pm	Flathead Lake	Muscle	271	187	1.7	81.7	02-May-08
Pm	Flathead Lake	Muscle	283	218	1.4	79.9	02-May-08
Pm	Flathead Lake	Muscle	267	174	1.2	77.2	02-May-08
Pm	Flathead Lake	Muscle	266	177	1.5	81.3	02-May-08
Pm	Flathead Lake	Muscle	271	155	1.6	82.8	02-May-08

Table E1. Cont. Selenium concentration in muscle samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Pm	Flathead Lake	Muscle	277	184	1.6	81.3	02-May-08
Pm	Flathead Lake	Muscle	260	156	2	80.7	02-May-08
Pm	Flathead Lake	Muscle	256	146	1.6	83.4	02-May-08
Pm	Flathead Lake	Muscle	297	206	1.9	79.5	02-May-08
Pm	Flathead Lake	Muscle	251	130	1.3	82.2	02-May-08
Pm	Flathead Lake	Muscle	263	145	1	81.3	02-May-08
Pm	Flathead Lake	Muscle	311	255	1.8	83.2	02-May-08
Pm	Flathead Lake	Muscle	270	174	1.3	79.3	02-May-08
Pm	Flathead Lake	Muscle	247	137	1.5	77.6	02-May-08
Pm	Flathead Lake	Muscle	250	125	1.7	84.4	02-May-08
Pm	Flathead Lake	Muscle	256	150	1.7	78.8	02-May-08
Pm	Flathead Lake	Muscle	243	122	1.4	79.3	02-May-08
Pm	Flathead Lake	Muscle	227	98	1	78	02-May-08
Pm	Flathead Lake	Muscle	238	113	1.6	80.4	02-May-08
Pm	Flathead Lake	Muscle	244	117	1.5	78.9	02-May-08
Pm	Flathead Lake	Muscle	247	131	1.2	77.3	02-May-08
Rbt	Lake Koocanusa	Muscle	337		1.6	78.8	14-May-08
Rbt	Lake Koocanusa	Muscle	369		1.5	79.1	14-May-08
Npm	Lake Koocanusa	Muscle	548	1973	1	73.4	14-May-08
Npm	Lake Koocanusa	Muscle	603	2259	1.9	79.4	14-May-08
Npm	Lake Koocanusa	Muscle	537	1708	1.2	78.8	14-May-08
Npm	Lake Koocanusa	Muscle	531	1720	1.3	80.6	14-May-08
Npm	Lake Koocanusa	Muscle	558	1789	1.3	80.7	14-May-08
Npm	Lake Koocanusa	Muscle	509	1557	1.4	79.7	14-May-08
Npm	Lake Koocanusa	Muscle	562	1705	1.2	78.5	14-May-08
Npm	Lake Koocanusa	Muscle	495	1303	1.3	76.9	14-May-08
Npm	Lake Koocanusa	Muscle	476	1183	1.3	79	14-May-08
Npm	Lake Koocanusa	Muscle	483	1340	1	78.5	14-May-08

Table E1. Cont. Selenium concentration in muscle samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Npm	Lake Koocanusa	Muscle	513	1347	1.1	79.4	14-May-08
Npm	Lake Koocanusa	Muscle	502	1592	1.2	78.3	14-May-08
Npm	Lake Koocanusa	Muscle	500	1226	1.2	79.6	14-May-08
Npm	Lake Koocanusa	Muscle	518	1740	1.1	79.9	14-May-08
Npm	Lake Koocanusa	Muscle	495	1434	1.5	81.3	14-May-08
Npm	Lake Koocanusa	Muscle	523	1586	1.6	82	14-May-08
Npm	Lake Koocanusa	Muscle	518	1728	1.7	80.5	14-May-08
Npm	Lake Koocanusa	Muscle	507	1306	1.2	80.8	14-May-08
Npm	Lake Koocanusa	Muscle	506	1521	1	79.2	14-May-08
Npm	Lake Koocanusa	Muscle	470	1140	1.9	80.4	14-May-08
Npm	Flathead Lake	Muscle	493	1191	1	78	05-May-09
Npm	Flathead Lake	Muscle	536	1743	0.8	74.3	05-May-09
Npm	Flathead Lake	Muscle	484	1145	1.1	79.6	05-May-09
Npm	Flathead Lake	Muscle	543	1692	0.9	78.3	05-May-09
Npm	Flathead Lake	Muscle	506	1256	1	80.9	05-May-09
Npm	Flathead Lake	Muscle	452	887	0.9	80.3	05-May-09
Npm	Flathead Lake	Muscle	466	986	0.8	81.2	05-May-09
Npm	Flathead Lake	Muscle	464	921	1	81.3	05-May-09
Npm	Flathead Lake	Muscle	436	824	0.8	80.6	05-May-09
Npm	Flathead Lake	Muscle	490	1324	3.7	78	05-May-09
Npm	Flathead Lake	Muscle	486	1348	1	80.1	05-May-09
Bull	Lake Koocanusa	Muscle	734	4018	1.7	73.2	14-May-08
Bull	Lake Koocanusa	Muscle	621		1.8	75.8	14-May-08
Bull	Lake Koocanusa	Muscle	651		1.7	72.7	14-May-08
Bull	Lake Koocanusa	Muscle	685		1.8	74.6	14-May-08
Bull	Lake Koocanusa	Muscle	704		1.8	79.8	14-May-08
Bull	Lake Koocanusa	Muscle	626		2	76.5	14-May-08
Bull	Lake Koocanusa	Muscle	724		1.8	77	14-May-08

Table E1. Cont. Selenium concentration in muscle samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Bull	Lake Koocanusa	Muscle	627		1.6	77.2	14-May-08
Bull	Lake Koocanusa	Muscle	711		1.5	73.6	14-May-08
Bull	Lake Koocanusa	Muscle	602		1.7	76.6	14-May-08
Bull	Lake Koocanusa	Muscle	619		0	77.1	14-May-08
Bull	Lake Koocanusa	Muscle	727		1.4	73.2	14-May-08
Bull	Lake Koocanusa	Muscle	586		1.9	78.4	14-May-08
Bull	Lake Koocanusa	Muscle	737		1.1	67.8	14-May-08
Bull	Lake Koocanusa	Muscle	735		2	76.5	14-May-08
Bull	Lake Koocanusa	Muscle	493		2	78.2	14-May-08
Bull	Lake Koocanusa	Muscle	525		1.6	77.8	14-May-08
Bull	Lake Koocanusa	Muscle	480		1.7	78.7	14-May-08
Bull	Lake Koocanusa	Muscle	495		1.4	76.6	14-May-08
Bull	Lake Koocanusa	Muscle	541		2	78.2	14-May-08
Bull	Flathead Lake	Muscle	272	161	0.9	86.4	07-May-09
Bull	Flathead Lake	Muscle	715	2842	1.1	79.3	07-May-09
Bull	Flathead Lake	Muscle	683	2837	1.1	76.4	05-May-09
Bull	Flathead Lake	Muscle	452	940	1.1	80.2	05-May-09
Bull	Flathead Lake	Muscle	461	990	1.2	75.2	02-May-08
Bull	Flathead Lake	Muscle	400	596	1.6	74.4	02-May-08
Bull	Flathead Lake	Muscle	666	2708	1.6	78.8	02-May-08
Bull	Flathead Lake	Muscle	662	2658	1.7	77.5	02-May-08
Bull	Flathead Lake	Muscle	660	2924	1.5	74	02-May-08
Bull	Flathead Lake	Muscle	231	99	1.6	80.9	02-May-08
LnSu	Lake Koocanusa	Muscle	421	815	2.5	82.2	14-May-08
LnSu	Lake Koocanusa	Muscle	418	826	2.8	81.8	14-May-08
LnSu	Lake Koocanusa	Muscle	401	615	3.2	81.4	14-May-08
LnSu	Lake Koocanusa	Muscle	350	460	3.6	79.8	14-May-08
LnSu	Lake Koocanusa	Muscle	373	571	3	82.2	14-May-08

Table E1. Cont. Selenium concentration in muscle samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
LnSu	Lake Koocanusa	Muscle	341	414	3.2	79.9	14-May-08
LnSu	Lake Koocanusa	Muscle	352	499	2.5	79.8	14-May-08
LnSu	Lake Koocanusa	Muscle	337	435	5.1	80.7	14-May-08
LnSu	Lake Koocanusa	Muscle	336	384	3.5	82.1	14-May-08
LnSu	Lake Koocanusa	Muscle	348	437	4.3	81.5	14-May-08
LnSu	Lake Koocanusa	Muscle	340	425	4.2	81	14-May-08
LnSu	Lake Koocanusa	Muscle	337	388	3.2	81.1	14-May-08
LnSu	Lake Koocanusa	Muscle	311	287	3.1	80.9	14-May-08
LnSu	Lake Koocanusa	Muscle	286	232	4.4	81.9	14-May-08
LnSu	Flathead Lake	Muscle	433	888	1.4	82.1	01-May-09
LnSu	Flathead Lake	Muscle	372	508	1.9	79.9	02-May-08
LnSu	Flathead Lake	Muscle	432	948	1.8	81.3	02-May-08
LnSu	Flathead Lake	Muscle	364	500	1.3	81.6	02-May-08
LnSu	Flathead Lake	Muscle	344	379	1.4	81.8	02-May-08
LnSu	Flathead Lake	Muscle	387	674	1.7	82.8	02-May-08
LnSu	Flathead Lake	Muscle	285	247	1.1	80.8	02-May-08
LnSu	Flathead Lake	Muscle	241	120	1.4	83.6	02-May-08
LnSu	Flathead Lake	Muscle	362	444	1.3	80.9	05-May-09
LnSu	Flathead Lake	Muscle	382	547	1.4	81.8	05-May-09
LnSu	Flathead Lake	Muscle	380	592	1.5	80.2	07-May-09
LnSu	Flathead Lake	Muscle	327	353	0.9	79.1	07-May-09
LnSu	Flathead Lake	Muscle	376	525	1.2	81.3	07-May-09
Kok	Lake Koocanusa	Muscle	265	172	1.7	81.1	17-Sep-08
Kok	Lake Koocanusa	Muscle	276	179	2	79.3	17-Sep-08
Kok	Lake Koocanusa	Muscle	270	174	1.5	79.7	17-Sep-08
Kok	Lake Koocanusa	Muscle	269	161	1.8	80.1	17-Sep-08
Kok	Lake Koocanusa	Muscle	282	211	1.5	81.6	17-Sep-08
Kok	Lake Koocanusa	Muscle	275	178	1.6	81.2	17-Sep-08

Table E1. Cont. Selenium concentration in muscle samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Kok	Lake Koocanusa	Muscle	265	172	1.3	80.8	17-Sep-08
Kok	Lake Koocanusa	Muscle	269	150	2.1	79.5	17-Sep-08
Kok	Lake Koocanusa	Muscle	271	186	1.7	80	17-Sep-08
Kok	Lake Koocanusa	Muscle	273	193	1.6	81.2	17-Sep-08
Kok	Lake Koocanusa	Muscle	271	187	1.5	83.1	17-Sep-08
Kok	Lake Koocanusa	Muscle	258	133	1.5	81.4	17-Sep-08
Kok	Lake Koocanusa	Muscle	292	219	1.5	81.9	17-Sep-08
Kok	Lake Koocanusa	Muscle	271	184	1.7	79.6	17-Sep-08
Kok	Lake Koocanusa	Muscle	259	157	1.9	80.5	17-Sep-08
Kok	Lake Koocanusa	Muscle	268	171	2	79.8	17-Sep-08
Kok	Lake Koocanusa	Muscle	255	165	2	76.7	17-Sep-08
Kok	Lake Koocanusa	Muscle	262	164	1.8	80.5	17-Sep-08
Kok	Lake Koocanusa	Muscle	261	154	1.9	80.4	17-Sep-08
Kok	Lake Koocanusa	Muscle	275	184	2.1	79.7	17-Sep-08
Lwf	Flathead Lake	Muscle	451	798	1.4	80.4	02-May-08
Lwf	Flathead Lake	Muscle	485	911	1.7	80.9	02-May-08
Lwf	Flathead Lake	Muscle	484	868	1	79.7	02-May-08
Lwf	Flathead Lake	Muscle	468	795	1.8	80.5	02-May-08
Lwf	Flathead Lake	Muscle	476	925	1.2	79.6	02-May-08
Lwf	Flathead Lake	Muscle	465	897	1.5	81	02-May-08
Lwf	Flathead Lake	Muscle	458	779	1.6	80.7	02-May-08
Lwf	Flathead Lake	Muscle	489	935	1.7	82.4	02-May-08
Lwf	Flathead Lake	Muscle	477	850	1.2	79.2	02-May-08
Lwf	Flathead Lake	Muscle	465	879	1.8	81.4	02-May-08
Lwf	Flathead Lake	Muscle	405	562	1.4	79	02-May-08
Lwf	Flathead Lake	Muscle	476	951	1.4	80.1	02-May-08
Lwf	Flathead Lake	Muscle	532	1349	1.4	78.7	02-May-08
Lwf	Flathead Lake	Muscle	415	516	1.7	80.3	02-May-08

Table E1. Cont. Selenium concentration in muscle samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Lwf	Flathead Lake	Muscle	442	754	1.4	80.3	02-May-08
Lwf	Flathead Lake	Muscle	420	681	1.4	78.9	02-May-08
Lwf	Flathead Lake	Muscle	447	745	1.4	80.5	02-May-08
Lwf	Flathead Lake	Muscle	445	735	1.3	80.6	02-May-08
Lwf	Flathead Lake	Muscle	450	723	1.3	79.8	02-May-08
Lwf	Flathead Lake	Muscle	440	754	1.6	80.4	02-May-08
Lt	Flathead Lake	Muscle	805	4389	1.5	77.5	02-May-08
Lt	Flathead Lake	Muscle	741	3940	1.2	76.3	02-May-08
Lt	Flathead Lake	Muscle	487	955	1.6	77.6	02-May-08
Lt	Flathead Lake	Muscle	915	5905	1.5	78.9	02-May-08
Lt	Flathead Lake	Muscle	921	7491	1.5	74.8	02-May-08
Lt	Flathead Lake	Muscle	606	1758	1.9	77.4	02-May-08
Lt	Flathead Lake	Muscle	731	3544	1.3	75.9	02-May-08
Lt	Flathead Lake	Muscle	540	1261	1.3	76.8	02-May-08
Lt	Flathead Lake	Muscle	722	3524	1.2	74.6	02-May-08
Lt	Flathead Lake	Muscle	819	4739	1.3	76.2	02-May-08
Lt	Flathead Lake	Muscle	751	3177	1.7	78	02-May-08
Lt	Flathead Lake	Muscle	723	4284	1.5	75.8	02-May-08
Lt	Flathead Lake	Muscle	555	1279	2	81.8	02-May-08
Lt	Flathead Lake	Muscle	548	1273	1.3	78.9	02-May-08
Lt	Flathead Lake	Muscle	644	2015	1.7	76	02-May-08
Lt	Flathead Lake	Muscle	546	1236	1.6	77.4	02-May-08
Lt	Flathead Lake	Muscle	801		1.4	77	02-May-08

Table E2. Selenium concentration in liver samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Rbt	Lake Koocanusa	Liver	369		7.4	77.8	14-May-08
Rbt	Lake Koocanusa	Liver	337		20.4	76.6	14-May-08
Lwf	Flathead Lake	Liver	484	868	8.3	74.3	02-May-08
Lwf	Flathead Lake	Liver	405	562	6.6	76.1	02-May-08
Lwf	Flathead Lake	Liver	445	735	10	74.4	02-May-08
Lwf	Flathead Lake	Liver	420	681	6.6	75.9	02-May-08
Lwf	Flathead Lake	Liver	440	754	6.4	75.2	02-May-08
Lwf	Flathead Lake	Liver	465	879	7.4	74.8	02-May-08
Lwf	Flathead Lake	Liver	465	897	8.3	75.4	02-May-08
Lwf	Flathead Lake	Liver	450	723	6.1	74.4	02-May-08
Lwf	Flathead Lake	Liver	489	935	9.9	76.2	02-May-08
Lwf	Flathead Lake	Liver	458	779	11.2	73.5	02-May-08
Lwf	Flathead Lake	Liver	476	951	7.9	75.3	02-May-08
Lwf	Flathead Lake	Liver	532	1349	4.6	77	02-May-08
Lwf	Flathead Lake	Liver	485	911	9.6	73.6	02-May-08
Lwf	Flathead Lake	Liver	415	516	7.4	75	02-May-08
Lwf	Flathead Lake	Liver	442	754	8.4	79.8	02-May-08
Lwf	Flathead Lake	Liver	468	795	9.7	76	02-May-08
Lwf	Flathead Lake	Liver	447	745	8.2	79.1	02-May-08
Lwf	Flathead Lake	Liver	477	850	5.7	78.1	02-May-08
Lwf	Flathead Lake	Liver	476	925	8.7	75.8	02-May-08
Lwf	Flathead Lake	Liver	451	798	5.6	76.1	02-May-08
Lt	Flathead Lake	Liver	722	3524	8.3	72.9	02-May-08
Lt	Flathead Lake	Liver	731	3544	7.1	63.3	02-May-08
Lt	Flathead Lake	Liver	801		10.7	73.7	02-May-08
Lt	Flathead Lake	Liver	805	4389	11.6	77.6	02-May-08
Lt	Flathead Lake	Liver	606	1758	6.3	73.1	02-May-08

Table E2. Cont. Selenium concentration in liver samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Lt	Flathead Lake	Liver	546	1236	4.1	72.9	02-May-08
Lt	Flathead Lake	Liver	915	5905	10	72.8	02-May-08
Lt	Flathead Lake	Liver	819	4739	9.9	75.7	02-May-08
Lt	Flathead Lake	Liver	751	3177	7.5	81.2	02-May-08
Lt	Flathead Lake	Liver	548	1273	6.1	78.1	02-May-08
Lt	Flathead Lake	Liver	555	1279	11.5	74.5	02-May-08
Lt	Flathead Lake	Liver	741	3940	4.7	75.7	02-May-08
Lt	Flathead Lake	Liver	921	7491	6.4	72.6	02-May-08
Lt	Flathead Lake	Liver	723	4284	6.6	77.5	02-May-08
Lt	Flathead Lake	Liver	540	1261	4.4	66.2	02-May-08
Lt	Flathead Lake	Liver	487	955	5	74.8	02-May-08
Lt	Flathead Lake	Liver	644	2015	7.2	76	02-May-08
LnSu	Lake Koocanusa	Liver	418	826	9.8	75.3	14-May-08
LnSu	Lake Koocanusa	Liver	421	815	11.3	80.7	14-May-08
LnSu	Lake Koocanusa	Liver	350	460	7.7	74.2	14-May-08
LnSu	Lake Koocanusa	Liver	373	571	11.7	80.3	14-May-08
LnSu	Lake Koocanusa	Liver	341	414	5.7	69.6	14-May-08
LnSu	Lake Koocanusa	Liver	352	499	7.8	75.6	14-May-08
LnSu	Lake Koocanusa	Liver	401	615	11.3	76.9	14-May-08
LnSu	Lake Koocanusa	Liver	336	384	9.4	75.8	14-May-08
LnSu	Lake Koocanusa	Liver	348	437	7.7	74.9	14-May-08
LnSu	Lake Koocanusa	Liver	340	425	7.3	72.6	14-May-08
LnSu	Lake Koocanusa	Liver	337	388	10.3	78.1	14-May-08
LnSu	Lake Koocanusa	Liver	286	232	7.6	78.7	14-May-08
LnSu	Lake Koocanusa	Liver	311	287	7.9	74.8	14-May-08
LnSu	Lake Koocanusa	Liver	337	435	7.1	70.8	14-May-08
LnSu	Flathead Lake	Liver	376	525	4	75.4	07-May-09
LnSu	Flathead Lake	Liver	285	247	3.2	72.5	02-May-08

Table E2. Cont. Selenium concentration in liver samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
LnSu	Flathead Lake	Liver	387	674	6.1	78.2	02-May-08
LnSu	Flathead Lake	Liver	344	379	5.6	77.3	02-May-08
LnSu	Flathead Lake	Liver	364	500	3.4	76.5	02-May-08
LnSu	Flathead Lake	Liver	327	353	4.8	79.2	07-May-09
LnSu	Flathead Lake	Liver	380	592	4.2	75.8	07-May-09
LnSu	Flathead Lake	Liver	382	547	5.3	76.9	05-May-09
LnSu	Flathead Lake	Liver	372	508	5.3	72.1	02-May-08
LnSu	Flathead Lake	Liver	362	444	6.7	79.4	05-May-09
LnSu	Flathead Lake	Liver	432	948	7.2	75.1	02-May-08
LnSu	Flathead Lake	Liver	433	888	4.8	79.7	01-May-09
LnSu	Flathead Lake	Liver	241	120	6.9	81.2	02-May-08
Kok	Lake Koocanusa	Liver	269	150	12.7	78.6	17-Sep-08
Kok	Lake Koocanusa	Liver	259	157	12	82.2	17-Sep-08
Kok	Lake Koocanusa	Liver	275	178	7.3	81	17-Sep-08
Kok	Lake Koocanusa	Liver	265	172	13.6	80.3	17-Sep-08
Kok	Lake Koocanusa	Liver	255	165	16.8	78.8	17-Sep-08
Kok	Lake Koocanusa	Liver	262	164	8.2	81.8	17-Sep-08
Kok	Lake Koocanusa	Liver	261	154	16.4	80.5	17-Sep-08
Kok	Lake Koocanusa	Liver	268	171	7.5	77.2	17-Sep-08
Kok	Lake Koocanusa	Liver	271	184	6.3	80.3	17-Sep-08
Kok	Lake Koocanusa	Liver	292	219	13.3	83.1	17-Sep-08
Kok	Lake Koocanusa	Liver	269	161	10.4	78.5	17-Sep-08
Kok	Lake Koocanusa	Liver	271	187	17.3	82.5	17-Sep-08
Kok	Lake Koocanusa	Liver	273	193	8.5	79	17-Sep-08
Kok	Lake Koocanusa	Liver	276	179	11	77.9	17-Sep-08
Kok	Lake Koocanusa	Liver	271	186	5	77.3	17-Sep-08
Kok	Lake Koocanusa	Liver	265	172	6.3	82.3	17-Sep-08
Kok	Lake Koocanusa	Liver	282	211	6.9	81.6	17-Sep-08

Table E2. Cont. Selenium concentration in liver samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Kok	Lake Koocanusa	Liver	258	133	10	79.7	17-Sep-08
Kok	Lake Koocanusa	Liver	270	174	6.9	78.1	17-Sep-08
Kok	Lake Koocanusa	Liver	275	184	12.6	79.5	17-Sep-08
Bull	Lake Koocanusa	Liver	626		9.3	75.3	14-May-08
Bull	Lake Koocanusa	Liver	704		7.9	77.6	14-May-08
Bull	Lake Koocanusa	Liver	685		3.9	63.5	14-May-08
Bull	Lake Koocanusa	Liver	651		7.2	74	14-May-08
Bull	Lake Koocanusa	Liver	734	4018	8.3	74.6	14-May-08
Bull	Lake Koocanusa	Liver	724		10.9	76.1	14-May-08
Bull	Lake Koocanusa	Liver	619		6.9	75.9	14-May-08
Bull	Lake Koocanusa	Liver	621		8.5	76.5	14-May-08
Bull	Lake Koocanusa	Liver	495		5.9	73	14-May-08
Bull	Lake Koocanusa	Liver	711		6.9	74	14-May-08
Bull	Lake Koocanusa	Liver	541		6	78.4	14-May-08
Bull	Lake Koocanusa	Liver	627		8.3	75	14-May-08
Bull	Lake Koocanusa	Liver	480		9.5	75.6	14-May-08
Bull	Lake Koocanusa	Liver	525		12	78.2	14-May-08
Bull	Lake Koocanusa	Liver	735		7	73.6	14-May-08
Bull	Lake Koocanusa	Liver	737		4.2	70	14-May-08
Bull	Lake Koocanusa	Liver	586		7.4	72.3	14-May-08
Bull	Lake Koocanusa	Liver	727		6.9	76.8	14-May-08
Bull	Lake Koocanusa	Liver	602		8.6	71.3	14-May-08
Bull	Lake Koocanusa	Liver	493		6	67.6	14-May-08
Bull	Flathead Lake	Liver	400	596	4.2	73.3	02-May-08
Bull	Flathead Lake	Liver	272	161	4.7	77.6	07-May-09
Bull	Flathead Lake	Liver	715	2842	5.1	80.7	07-May-09
Bull	Flathead Lake	Liver	231	99	7.9	79.1	02-May-08
Bull	Flathead Lake	Liver	660	2924	2.4	64.3	02-May-08

Table E2. Cont. Selenium concentration in liver samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Bull	Flathead Lake	Liver	452	940	4.8	81.2	05-May-09
Bull	Flathead Lake	Liver	666	2708	5.6	79.5	02-May-08
Bull	Flathead Lake	Liver	683	2837	4	78.5	05-May-09
Bull	Flathead Lake	Liver	461	990	2.2	67.8	02-May-08
Bull	Flathead Lake	Liver	662	2658	4.9	79.3	02-May-08

Table E3. Selenium concentration in ovary samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Pm	Lake Koocanusa	Gonad	307		5.8	70.2	14-May-08
Pm	Lake Koocanusa	Gonad	265		7.7	69.6	14-May-08
Pm	Lake Koocanusa	Gonad	298		7.3	69.3	14-May-08
Pm	Lake Koocanusa	Gonad	304		4.7	70.2	14-May-08
Pm	Lake Koocanusa	Gonad	314		5	66.4	14-May-08
Pm	Lake Koocanusa	Gonad	281		11.6	71.4	14-May-08
Pm	Lake Koocanusa	Gonad	306		5.7	68.5	14-May-08
Pm	Lake Koocanusa	Gonad	284		6.1	68.8	14-May-08
Pm	Lake Koocanusa	Gonad	287		7.1	69.7	14-May-08
Pm	Lake Koocanusa	Gonad	287		7.3	68.4	14-May-08
Pm	Lake Koocanusa	Gonad	314		5.8	66.1	14-May-08
Pm	Lake Koocanusa	Gonad	283		6.7	68.3	14-May-08
Pm	Lake Koocanusa	Gonad	274		11.1	65.3	14-May-08
Pm	Lake Koocanusa	Gonad	294		7.3	73.1	14-May-08
Pm	Lake Koocanusa	Gonad	289		9	69.7	14-May-08
Pm	Lake Koocanusa	Gonad	283		8.2	71.5	14-May-08
Pm	Lake Koocanusa	Gonad	304		4	69.5	14-May-08
Pm	Lake Koocanusa	Gonad	274		10.8	72.4	14-May-08

Table E3. Cont. Selenium concentration in ovary samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Pm	Lake Koocanusa	Gonad	303		8.3	69.9	14-May-08
Pm	Lake Koocanusa	Gonad	272		6.7	70.6	14-May-08
Pm	Flathead Lake	Gonad	270	174	2.9	64.3	02-May-08
Pm	Flathead Lake	Gonad	271	187	7.9	66.9	02-May-08
Pm	Flathead Lake	Gonad	311	255	10.9	73.4	02-May-08
Pm	Flathead Lake	Gonad	283	218	5.2	71.7	02-May-08
Pm	Flathead Lake	Gonad	267	174	4.5	65.2	02-May-08
Pm	Flathead Lake	Gonad	266	177	7.4	65.3	02-May-08
Pm	Flathead Lake	Gonad	277	184	7.3	70.8	02-May-08
Pm	Flathead Lake	Gonad	297	206	8.8	70	02-May-08
Pm	Flathead Lake	Gonad	251	130	10.5	75.3	02-May-08
Npm	Lake Koocanusa	Gonad	476	1183	3.5	78.6	14-May-08
Npm	Lake Koocanusa	Gonad	495	1303	3.6	74.2	14-May-08
Npm	Lake Koocanusa	Gonad	483	1340	2.5	72.9	14-May-08
Npm	Lake Koocanusa	Gonad	509	1557	3.6	77.9	14-May-08
Npm	Lake Koocanusa	Gonad	562	1705	3.2	77.2	14-May-08
Npm	Lake Koocanusa	Gonad	558	1789	4.9	71.4	14-May-08
Npm	Lake Koocanusa	Gonad	531	1720	2.9	75.5	14-May-08
Npm	Lake Koocanusa	Gonad	537	1708	3.7	75.2	14-May-08
Npm	Lake Koocanusa	Gonad	502	1592	2.8	74.7	14-May-08
Npm	Lake Koocanusa	Gonad	548	1973	2.8	69.8	14-May-08
Npm	Lake Koocanusa	Gonad	500	1226	2.7	75.7	14-May-08
Npm	Lake Koocanusa	Gonad	603	2259	3	71.4	14-May-08
Npm	Lake Koocanusa	Gonad	518	1740	2.7	76.8	14-May-08
Npm	Lake Koocanusa	Gonad	523	1586	4.2	77.2	14-May-08
Npm	Lake Koocanusa	Gonad	518	1728	4.2	73	14-May-08
Npm	Lake Koocanusa	Gonad	507	1306	5.9	77.2	14-May-08
Npm	Lake Koocanusa	Gonad	470	1140	5.5	78.1	14-May-08

Table E3. Cont. Selenium concentration in ovary samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Npm	Lake Koocanusa	Gonad	513	1347	3.5	72.1	14-May-08
Npm	Flathead Lake	Gonad	452	887	2.4	77.8	05-May-09
Npm	Flathead Lake	Gonad	490	1324	2.5	67.9	05-May-09
Npm	Flathead Lake	Gonad	436	824	3.1	78.3	05-May-09
Npm	Flathead Lake	Gonad	486	1348	0.8	66.3	05-May-09
Npm	Flathead Lake	Gonad	493	1191	5	72.8	05-May-09
Npm	Flathead Lake	Gonad	536	1743	2.3	64.9	05-May-09
Npm	Flathead Lake	Gonad	484	1145	2.5	71.2	05-May-09
Npm	Flathead Lake	Gonad	506	1256	2.5	72.4	05-May-09
Npm	Flathead Lake	Gonad	466	986	2.3	70.1	05-May-09
Npm	Flathead Lake	Gonad	464	921	2.3	71.3	05-May-09
Npm	Flathead Lake	Gonad	543	1692	2.7	67.1	05-May-09
LnSu	Lake Koocanusa	Gonad	373	571	4.1	66.2	14-May-08
LnSu	Lake Koocanusa	Gonad	401	615	5.6	67.1	14-May-08
LnSu	Lake Koocanusa	Gonad	418	826	5.6	67.4	14-May-08
LnSu	Lake Koocanusa	Gonad	421	815	4	68.4	14-May-08
Kok	Lake Koocanusa	Gonad	255	165	4.9	59.4	17-Sep-08
Kok	Lake Koocanusa	Gonad	273	193	3.4	61.3	17-Sep-08
Kok	Lake Koocanusa	Gonad	275	184	4.3	59.9	17-Sep-08
Kok	Lake Koocanusa	Gonad	261	154	3.4	59.4	17-Sep-08
Kok	Lake Koocanusa	Gonad	262	164	4.3	58.1	17-Sep-08
Kok	Lake Koocanusa	Gonad	268	171	4.7	59.4	17-Sep-08
Kok	Lake Koocanusa	Gonad	259	157	3.1	61.6	17-Sep-08
Kok	Lake Koocanusa	Gonad	271	184	3.7	59.9	17-Sep-08
Kok	Lake Koocanusa	Gonad	292	219	3.1	63.4	17-Sep-08
Kok	Lake Koocanusa	Gonad	271	187	3.3	62.7	17-Sep-08
Kok	Lake Koocanusa	Gonad	271	186	4	59.4	17-Sep-08
Kok	Lake Koocanusa	Gonad	269	150	3	59.2	17-Sep-08

Table E3. Cont. Selenium concentration in ovary samples from other fish species.

Species	Water Name	Tissue	Length (mm)	Weight (g)	Selenium (mg/kg dry wt)	Moisture %	Collection Date
Kok	Lake Koocanusa	Gonad	265	172	3.8	64	17-Sep-08
Kok	Lake Koocanusa	Gonad	275	178	3.5	60.6	17-Sep-08
Kok	Lake Koocanusa	Gonad	282	211	2.9	61.9	17-Sep-08
Kok	Lake Koocanusa	Gonad	269	161	3	58.8	17-Sep-08
Kok	Lake Koocanusa	Gonad	270	174	3.6	57.6	17-Sep-08
Kok	Lake Koocanusa	Gonad	276	179	4.4	60	17-Sep-08
Kok	Lake Koocanusa	Gonad	265	172	3.5	59.7	17-Sep-08
Kok	Lake Koocanusa	Gonad	258	133	3.6	61.5	17-Sep-08

Appendix F. Mercury concentrations and size measurements of westslope cutthroat trout and bull trout collected in the Baseline Contaminant Investigation.

Table F1. Mercury concentration in muscle tissue samples from westslope cutthroat trout and bull trout.

Species	Water Name	Length (mm)	Weight (g)	Mercury (mg/kg dry wt)	Moisture %	Collection Date
Wct	Michel Creek	423	850	0.1	81.1	03-Sep-08
Wct	Michel Creek	373	519	0.1	82.2	03-Sep-08
Wct	Michel Creek	331	428	ND	78.3	03-Sep-08
Wct	Michel Creek	343	458	0.1	78.5	03-Sep-08
Wct	Michel Creek	417	922	0.2	82.3	03-Sep-08
Bull	Lake Koocanusa	685		1	74.6	14-May-08
Bull	Lake Koocanusa	619		1	77.1	14-May-08
Bull	Lake Koocanusa	602		0.7	76.6	14-May-08
Bull	Lake Koocanusa	711		0.6	73.6	14-May-08
Bull	Lake Koocanusa	627		0.8	77.2	14-May-08
Bull	Lake Koocanusa	724		0.8	77	14-May-08
Bull	Lake Koocanusa	727		1	73.2	14-May-08
Bull	Lake Koocanusa	704		1.8	79.8	14-May-08
Bull	Lake Koocanusa	493		0.6	78.2	14-May-08
Bull	Lake Koocanusa	651		0.6	72.7	14-May-08
Bull	Lake Koocanusa	621		0.8	75.8	14-May-08
Bull	Lake Koocanusa	626		0.7	76.5	14-May-08
Bull	Lake Koocanusa	586		0.7	78.4	14-May-08
Bull	Lake Koocanusa	734	4018	1.2	73.2	14-May-08
Bull	Lake Koocanusa	735		0.6	76.5	14-May-08
Bull	Lake Koocanusa	525		1.2	77.8	14-May-08
Bull	Lake Koocanusa	480		0.5	78.7	14-May-08
Bull	Lake Koocanusa	495		0.6	76.6	14-May-08
Bull	Lake Koocanusa	541		0.6	78.2	14-May-08

Table F1. Cont. Mercury concentration in muscle tissue samples from westslope cutthroat trout

Species	Water Name	Length (mm)	Weight (g)	Mercury (mg/kg dry wt)	Moisture %	Collection Date
Bull	Lake Koocanusa	737		0.7	67.8	14-May-08
Wct	Elk River	397	744	0.2	78.2	09-Sep-08
Wct	Elk River	353	430	0.2	80.2	09-Sep-08
Wct	Elk River	357	460	0.1	80.8	09-Sep-08
Wct	Elk River	377	631	ND	79	09-Sep-08
Wct	Elk River	412	803	ND	75.4	09-Sep-08

Appendix G. Genetic analysis of sample collected in the Flathead River and Elk River drainages. Letter from the University of Montana Conservation Genetics Laboratory.

University of Montana Conservation Genetics Laboratory

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September 24, 2009

Matt Boyer

Montana Fish, Wildlife & Parks

490 North Meridian Road

Kalispell, Montana 59901

Matt;

In order to determine if there is evidence of hybridization, we used microsatellite loci to analyze DNA extracted from fin clips taken from trout sampled from the following waters:

Sample #	Water Name/Location/ Collection Date/ Collector	a N	b #Markers	c Taxa ID	d Power	e %	f Individuals
3884	Cyclone Creek 48.66576 114.24541 Summer 2008 Amber Steed	15	R10Y7	WCT X RBT			
3885	McLatchie Creek (British Columbia) 49.35677 114.67026 July/August 2008 Amber Steed	24	R10Y7	WCT	R99Y97		
3886	Flathead River (Columbia Falls) 48.36572 114.16927 3/3 & 6/08 Amber Steed	10	R10Y7	WCT WCT X RBT WCT X RBT		 W52.5 X R47.5 W1.4 X R98.6	1 2 7

Sample #	Water Name/Location/ Collection Date/ Collector	a N	b #Markers	c Taxa ID	d Power	e %	f Individuals
3887	**Upper North Fork Flathead River-site 1 (British Columbia) 49.38197 114.83022 July/August 2008 Amber Steed**	**19**	**R10Y7**	**WCT**	**R98Y93**		
3888	**Upper North Fork Flathead River-site 2 (British Columbia) 49.36601 114.82430 July/August 2008 Amber Steed**	**25**	**R10Y7**	**WCT**	**R99Y97**		
3889	**Upper North Fork Flathead River-site 3 (British Columbia) 49.35979 114.85222 July/August 2008 Amber Steed**	**25**	**R10Y7**	**WCT**	**R99Y97**		
3890	**Lincoln Lake y=295708 x=5385670 8/6/2004 Mike Meeuwig**	**31**	**R10Y7**	**WCT**	**R99Y99**		
3891	**Michel Creek (British Columbia) 49.52740 114.70233 9/3/2008 Mark Deleray**	**24**	**R10Y7**	**WCT X RBT**		**W99.8 X R0.2**	
3892	**Cerulean Lake y=275818 x=5417739 7/27/2004 Mike Meeuwig**	**25**	**R10Y7**	**WCT WCT X RBT**	**R99Y97**	** W90.0 X R10.0**	**24 1**
3893	**Lower Quartz Lake y=267108 x=5410826 8/2/2005 Mike Meeuwig**	**25**	**R10Y7**	**WCT X RBT**		**W99.8 X R0.2**	

Sample #	Water Name/Location/ Collection Date/ Collector	a N	b #Markers	c Taxa ID	d Power	e %	f Individuals
3894	Middle Quartz Lake y=269378 x=5412475 8/6/2005 Mike Meeuwig	16	R10Y7	WCT	R96Y89		
3895	Quartz Lake y=272341 x=5413080 9/22/2005 Mike Meeuwig	21	R10Y7	WCT	R99Y95		
3896	McGee Creek-lower site 1 y=276108 x=5387543 7/10/2008 Clint Muhlfeld	13	R10Y7	WCT X RBT		W98.3 X R1.7	
3897	McGee Creek-lower site 2 y=276108 x=5387543 7/10/2008 Clint Muhlfeld	10	R10Y7	WCT X RBT WCT X RBT		W97.1 X R2.9	7 3
3898	McGee Creek-Tributary A y=276108 x=5387543 7/10/2008 Clint Muhlfeld	2	R10Y7	WCT??	R33Y24		
3899	Harrison Lake y=295408 x=5377446 8/28/2005 Mike Meeuwig	21	R10Y7	WCT X RBT			
3900	Starvation Creek y=252150 x=5427857 7/19/2008 Clint Muhlfeld	14	R10Y7	WCT	R94Y86		
3901	McEvoy Creek-lower (British Columbia) 49.41543 114.76319 July/August 2008 Amber Steed	25	R10Y7	WCT	R99Y97		

Sample #	Water Name/Location/ Collection Date/ Collector	a N	b #Markers	c Taxa ID	d Power	e %	f Individuals
3902	McEvoy Creek-upper site 1 (British Columbia) 49.44234 114.82567 July/August 2008 Amber Steed	22	R10Y7	WCT	R99Y95		
3903	McEvoy Creek-upper site 2 (British Columbia) 49.44213 114.79984 July/August 2008 Amber Steed	25	R10Y7	WCT	R99Y97		
3904	Kintla Lake y=258085 x=5428187 8/20/2005 Mike Meeuwig	25	R10Y7	WCT	R99Y97		
3905	Langford Creek 48.60323 114.18824 July/August 2008 Amber Steed	15	R10Y7	WCT X RBT X YCT WCT X RBT		W98.1 X R1.4 X Y0.5	7 7
3906	Bowman Lake y=268172 x=5417196 8/11/2005 Mike Meeuwig	21	R10Y7	WCT	R99Y95		
3907	Logging Lake y=274047 x=5405135 8/16/2005 Mike Meeuwig	32	R10Y7	WCT WCT X RBT	R99Y99	 W85.0 X R15.0	31 1
3908	Elk River (British Columbia) 49.26198 115.09338 9/9/2008 Mark Deleray	24	R10Y7	WCT X RBT WCT X RBT		W99.0 X R1.0	20 4
3909	Akokala Creek y=260473 x=5417383 8/15/2008 Clint Muhlfeld	17 (42)	R10Y7	WCT	R99Y99		

Sample #	Water Name/Location/ Collection Date/ Collector	a N	b #Markers	c Taxa ID	d Power	e %	f Individuals
3910	Longbow Creek-upper y=260473 x=5417383 8/15/2008 Clint Muhlfeld	3	R10Y7	WCT??	R45Y34		
3911	Lower North Fork Flathead River (British Columbia) 49.39362 114.76386 July/August 2008 Amber Steed	25	R10Y7	WCT	R99Y97		

[a]Number of fish successfully analyzed. If combined with a previous sample, the number in parentheses indicates the combined sample size.

[b]Number of diagnostic loci analyzed for the non-native taxa (R=rainbow trout *Oncorhynchus mykiss,* W=westslope cutthroat trout

O. clarkii lewisii, Y=Yellowstone cutthroat trout *O. c. bouvieri*).

[c]Codes: WCT = westslope cutthroat trout; RBT = rainbow trout; YCT = Yellowstone cutthroat trout . Only one taxon code is listed when the entire sample possessed alleles from that taxon only. It must be noted, however, that we cannot definitely rule out the possibility that some or all of the individuals are hybrids. We may not have detected any non-native alleles at the loci examined because of sampling error (see Power %). Taxa codes separated by "x" indicate hybridization between those taxa.

[d]Number corresponds to the percent chance we have to detect 1% hybridization given the number of individuals successfully analyzed and the number of diagnostic markers used. For example, with 25 individuals we have better than a 99 % chance to detect as little as 1% hybridization with rainbow trout or a 97% chance to detect as little as 1% hybridization with Yellowstone cutthroat trout in a hybrid swarm (a random mating population in which taxa markers are randomly distributed among individuals such that essentially all of them in the population are of hybrid origin) that once was a westslope cutthroat trout population. Not reported when hybridization is detected. Taxa as in b.

[e]Indicates the genetic contribution of the hybridizing taxa denoted as in b. This number is usually reported only if the sample appears to have come from a hybrid swarm.

[f]Indicates number of individuals with genetic characteristics corresponding to the taxa ID code column when the sample can be analyzed at the individual level. This occurs when marker alleles are not randomly distributed among individuals and hybrids and non-hybrids can be reliably distinguished.

Methods and Data Analysis

Microsatellite analysis uses short synthetically made segments of DNA called primers, in pairs, to detect areas of DNA in which small nucleotide sequences (usually two to five nucleotides) are consecutively repeated numerous times. During the polymerase chain reaction (PCR), the primers bind to specific areas of the organismal DNA flanking a microsatellite region (locus) and many copies of the locus between the primers are made using dye labeled nucleotides. A particular microsatellite locus can have different forms, termed alleles. The alleles differ among themselves based on length differences due to the variable number of repeat units they possess. After PCR, the alleles are separated from each other using capillary electrophoresis and visualized using an applied Biosystems 3130x1 genetic analyzer. The alleles are labeled by the particular microsatellite locus and the number of nucleotides in the sequence (i.e. length). After electrophoresis, the alleles detected in an individual are determined by comparison to synthetic fragments of DNA of known length and alleles from previously analyzed individuals.

We obtained data from 11 microsatellite loci. At ten of these loci, westslope cutthroat trout, *Oncorhynchus clarki lewisii*, and rainbow trout, *O. mykiss*, rarely, if ever, share alleles in common (Table 1). This situation also pertains to a comparison of westslope and Yellowstone cutthroat trout, *O. c. bouvieri*, at seven loci (Table 1).

Loci at which taxa rarely, if ever, share alleles in common are often termed diagnostic or marker loci because the alleles detected at them can be used to help determine if a sample came from a non-hybridized population or a population in which hybridization between two or more taxa has or is occurring. Individuals from a non-hybridized population will possess alleles at all diagnostic loci analyzed characteristic of only that taxon. In contrast, since half the DNA from first generation hybrids (F_1) comes from each of the parental taxa F_1 individuals will possess alleles characteristic of both the hybridizing taxa at all diagnostic loci analyzed. In later generation hybrids (post F_1), the amount and particular regions of DNA acquired from the parental taxa will vary among individuals. Thus, the particular alleles detected in post F_1 hybrids will be highly variable at the diagnostic loci analyzed within and among individuals.

An important aspect of microsatellite alleles is that they demonstrate a codominant mode of inheritance. That is, all genotypes are readily distinguishable from each other. Thus, at diagnostic loci the genotype of individuals in a sample can directly be determined. From these data, the proportion of alleles from different taxa in the population sampled can be directly estimated at each diagnostic locus analyzed. These values averaged over all diagnostic loci yields an estimate of the proportion of alleles in the population that can be attributed to one or more taxa (proportion of admixture).

When evidence of hybridization is detected, the main issue to address is whether or not the sample appears to have come from a hybrid swarm. That is, a random mating population in which the alleles of the hybridizing taxa are randomly distributed among individuals such that essentially all of them are of hybrid origin.

A common attribute of hybrid swarms is that the overall frequency of the alleles from the hybridizing taxa are usually similar among the diagnostic loci because their presence can all be traced to a common origin or origins. Thus, one criterion we used for the assessment of whether or not a sample appeared to have come from a hybrid swarm was whether or not the allele frequencies among diagnostic loci reasonably conformed to homogeneity using contingency table chi-square.

In order to determine whether or not alleles at the diagnostic loci were randomly distributed among the fish in a sample showing evidence of hybridization, we calculated a hybrid index for each fish in the sample. The hybrid index for an individual was calculated as follows. At each diagnostic locus, an allele characteristic of the native taxon was given a value of zero and an allele characteristic of the non-native taxon a value of one. Thus, at a single diagnostic locus the hybrid index for an individual could have a value of zero (only native alleles present), one (both native and non-native alleles present), or two (only non-native alleles present). These values summed over all diagnostic loci analyzed yields an individual's hybrid index. Considering westslope cutthroat and rainbow trout, therefore, non-hybridized westslope cutthroat trout would have a hybrid index of zero, non-hybridized rainbow trout a hybrid index of 20, F_1 hybrids a hybrid index of ten, and post F_1 hybrids could have values ranging from zero to 20. The distribution of hybrid indices among fish in a sample was statistically compared to the expected random binomial distribution based on the proportion of admixture detected. If the allele frequencies appeared to be statistically homogeneous among diagnostic loci and the observed distribution of hybrid indices reasonably conformed to the expected random distribution, then the sample was considered to have come from a hybrid swarm.

In some hybrid swarms, allele frequencies among diagnostic loci can randomly diverge from homogeneity over time because of genetic drift. In this case, however, the observed distribution of hybrid indices is still expected to reasonably conform to the expected random distribution. Thus, if the allele frequencies were statistically heterogeneous among the diagnostic loci in a sample, but the observed distribution of hybrid indices reasonably conformed to the expected random distribution the sample was also considered to have come from a hybrid swarm.

The strongest evidence that a sample showing evidence of hybridization did not come from a hybrid swarm is failure of the observed distribution of hybrid indices to reasonably conform to the expected random distribution. The most likely reasons for this are that the population has only recently become hybridized or the sample contains individuals from two or more populations with different proportions of admixture. At times, the distribution of genotypes at diagnostic loci and the observed distribution of hybrid indices can provide insight into which of these two factors appears mainly responsible for the sample not appearing to have come from a hybrid swarm. At other times, the distribution of genotypes at diagnostic loci and the observed distribution of hybrid indices may provide little or no insight into the cause of the non-random distribution of alleles among individuals. The latter situation is expected to be fairly common as the two factors usually responsible for the non-random distribution of alleles are not necessarily mutually exclusive. Regardless of the cause, when the sample does not appear to have come from a hybrid swarm estimating the proportion of admixture has little if any biological meaning and, therefore, is generally not estimated and reported.

Failure to detect evidence of hybridization in a sample does not necessarily mean the population is non-hybridized because there is always the possibility that we would not detect evidence of hybridization because of sampling error. When no evidence of hybridization was detected in a sample, we assessed the likelihood the population is non-hybridized by determining the chances of not detecting as little as a one percent genetic contribution of a non-native taxon to a hybrid swarm. This is simply 0.99^{2NX} where N is the number of fish in the sample and X is the number of diagnostic loci analyzed.

Results and Discussion:

Cyclone Creek 3884

Alleles characteristic of both westslope cutthroat and rainbow trout were detected at nine of the ten diagnostic loci between these fishes that were analyzed in the sample from Cyclone Creek (Table 2). Although the rainbow trout allele frequencies were statistically homogeneous (X^2_9=5.052, P>0.50) among the diagnostic loci, the rainbow trout alleles were not randomly distributed (X^2_4=26.192, P<0.001) among the fish in the sample. In contrast, significantly more fish had a hybrid index of zero or greater than two and significantly fewer had a hybrid index of one than expected by chance (Figure 1). Thus, this sample contained definite hybrids between westslope cutthroat and rainbow trout with varying amounts of admixture and possibly some non-hybridized westslope cutthroat trout.

When Cyclone Creek was first sampled (#106, col. 8/15/84, T34N R21W S36, N=23), allozyme analysis suggested the fish were non-hybridized westslope cutthroat trout. Subsequently, PINE analysis (#1915, col. 8/10/98, T34N R21W S35, N=25) indicated that at least some of the fish had become hybridized with rainbow trout. Microsatellite analysis of trout sampled from Cyclone Creek in 2001 (#2760, col. 8/6/01, N=24), however, suggested the stream still contained some non-hybridized westslope cutthroat trout. The most recent sample also suggests the stream contains a mixture of non-hybridized westslope cutthroat trout and hybrids. Since the potential non-hybridized westslope cutthroat trout are not clearly separable from the hybrids on an individual basis, however, from a management perspective Cyclone Creek should now simply be considered to contain hybrids between westslope cutthroat and rainbow trout.

McLatchie Creek (British Columbia) 3885

In the sample from McLatchie Creek, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of 24, we have better than a 99 percent chance of detecting as little as a one percent rainbow and about a 97 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, McLatchie Creek very likely contains a non-hybridized westslope cutthroat trout population.

Note one fish (McLCA1-6-02) in this sample was not an *Oncorhynchus*.

Flathead River (Columbia Falls) 3886

Alleles characteristic of both westslope cutthroat and rainbow trout were detected at all ten of the diagnostic loci between these fishes that were analyzed in the sample from the Flathead River near Columbia Falls. Although the rainbow trout allele frequencies were statistically homogeneous (X^2_9=2.992, P>0.90) among the diagnostic loci, the rainbow trout alleles were not randomly distributed (X^2_6=105.227, P<0.001) among the fish in the sample. Rather, the hybrid indices clearly divided the fish into three distinct groups (Figure 2). Most of the fish appeared to have come from a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.986) rainbow trout genetic component, two others (CFalls 18 and 46) were hybrids between westslope cutthroat and rainbow trout with a substantial amount of admixture, and one (CFalls 43) may have been a non-hybridized westslope cutthroat trout.

Upper North Fork Flathead River (British Columbia)

Samples were collected from three reaches in the upper North Fork Flathead River in British Columbia. Among the samples evidence of genetic variation was detected at seven loci. The allele frequencies were statistically heterogeneous (contingency table chi-square analysis; P<0.05) among the samples at four of these loci. This could indicate that genetic differences exist among the samples or these apparent differences could simply be chance departures from homogeneity because of the number of comparisons performed. In order to distinguish between these possibilities, we compared the chi-square statistics at the heterogeneous loci to those associated with the modified level of significance proposed by Rice (1989). The differences remain significant at the modified level indicating that genetic differences exist among the samples. Thus, each sample was treated separately for further analysis.

Upper North Fork Flathead River (British Columbia)-Site 1 3887

In the sample from the upper North Fork Flathead River in British Columbia collected from site 1, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of 19, we have about a 98 percent chance of detecting as little as a one percent rainbow but only about a 93 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, we cannot reasonably exclude the possibility that the trout in this reach of the North Fork Flathead River may be slightly hybridized with Yellowstone cutthroat trout but evidence of this was not detected because of sampling error. With this uncertainty, the conservative approach would be to consider this reach to contain non-hybridized westslope cutthroat trout unless future data indicate otherwise.

Upper North Fork Flathead River (British Columbia)-Site 2 3888

Alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci that were analyzed in the sample from the upper North Fork Flathead River in British Columbia collected from site 2 (Table 3). With the sample size of 25, we have better than a 99 percent chance of detecting as little as a one percent rainbow and about a 97 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. This reach of the North Fork Flathead River, therefore, very likely contains a non-hybridized westslope cutthroat trout population.

Upper North Fork Flathead River (British Columbia)-Site 3 3889

In the sample from the upper North Fork Flathead River in British Columbia collected from site 3, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of 25, we have better than a 99 percent chance of detecting as little as a one percent rainbow and about a 97 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, this reach of the North Fork Flathead River very likely contains a non-hybridized westslope cutthroat trout population.

Lincoln Lake 3890

Alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci that were analyzed in the sample from Lincoln Lake (Table 3). With the sample size of 31, we have better than a 99 percent chance of detecting as little as a one percent rainbow or Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Lincoln Lake, therefore, very likely contains a non-hybridized westslope cutthroat trout population.

Michel Creek (British Columbia) 3891

Alleles characteristic of both westslope cutthroat and rainbow trout were detected at one of the ten diagnostic loci between these fishes that were analyzed in the sample from Michel Creek (Table 2). Normally we would be uncertain whether this indicated evidence of hybridization or if it was simply westslope cutthroat trout genetic variation that was indistinguishable with the technique used from that usually characteristic of rainbow trout. In this case, however, we favor the former interpretation because a study of Rubidge and Taylor (2004) clearly detected evidence of hybridization between westslope cutthroat and rainbow trout in the Michel Creek drainage. Thus, this reach of Michel Creek that was sampled appears to contain a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.998) westslope cutthroat trout genetic component.

The present results are somewhat different from those obtained from a previous indel/microsatellite analysis of trout collected from Michel Creek (#3722, col. 9/4/07, N=25). This analysis detected no evidence of hybridization but with the number of diagnostic loci and fish we had only about a 73 percent chance of detecting as little as a 0.2 percent genetic contribution of rainbow trout to a hybrid swarm. Thus, this sample may also have come from a hybrid swarm with a very small rainbow trout genetic contribution but evidence of this was not detected because of sampling error.

Cerulean Lake 3892

In the sample from Cerulean Lake, alleles characteristic of both westslope cutthroat and rainbow trout were detected at two of the ten diagnostic loci between these fishes that were analyzed (Table 2). Although the rainbow trout allele frequencies were statistically homogeneous (X^2_9=8.032, P>0.50) among the diagnostic loci, the rainbow trout alleles were not randomly distributed (X^2_1=12.467, P<0.001) among the fish in the sample. Rather, they were all detected in only one fish. Thus, this sample appears to have been a mixture of mainly non-hybridized westslope cutthroat trout and a small proportion of hybrids between westslope cutthroat and rainbow trout with a moderate amount of admixture.

Lower Quartz Lake 3893

Alleles characteristic of both westslope cutthroat and rainbow trout were detected at one of the ten diagnostic loci between these fishes that were analyzed in the sample from Lower Quartz Lake (Table 2). Normally we would be uncertain whether this indicated evidence of hybridization or if it was simply westslope cutthroat trout genetic variation that was indistinguishable with the technique used from that usually characteristic of rainbow trout. In this case, however, we favor the former interpretation because Cerulean Lake (# 3892) in the headwaters of the Quartz Creek drainage clearly contains hybrids between westslope cutthroat and rainbow trout. Thus, Lower Quartz Lake appears to contain a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.998) westslope cutthroat trout genetic component.

Middle Quartz Lake 3894

In the sample from Middle Quartz Lake, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of 16, we have about a 96 percent chance of detecting as little as a one percent rainbow but only about an 89 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, we cannot reasonably exclude the possibility that the trout in Middle Quartz Lake may be slightly hybridized with Yellowstone cutthroat trout but evidence of this was not detected because of sampling error. With this uncertainty, however, the conservative approach would be to consider Middle Quartz Lake to contain non-hybridized westslope cutthroat trout unless subsequent data indicate otherwise.

Note one fish (MQL2352) in this sample was not an *Oncorhynchus*.

Quartz Lake 3895

Alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci that were analyzed in the sample from Quartz Lake (Table 3). With the sample size of 21, we have about a 99 percent chance of detecting as little as a one percent rainbow and about a 95 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Quartz Lake, therefore, very likely contains a non-hybridized westslope cutthroat trout population.

McGee Creek drainage (lower)

Samples were collected from two reaches of lower McGee Creek and tributary A to lower McGee Creek. Evidence of hybridization with rainbow trout was detected in both samples from lower McGee Creek. Because of the small sample sizes, we increased statistical power to detect evidence of genetic differences among the samples by comparing the average frequency of westslope cutthroat and rainbow trout alleles over all the diagnostic loci among the samples. Contingency table chi-square analysis indicates that the average frequency of westslope cutthroat and rainbow trout alleles was statistically heterogeneous (X^2_2=11.756, P<0.01) among the samples. Thus, we treated each sample separately for further analysis.

McGee Creek (lower)-Site 1 3896

In the sample from lower McGee Creek collected from site 1, alleles characteristic of both westslope cutthroat and rainbow trout were detected at five of the ten diagnostic loci between these fishes that were analyzed (Table 2). The rainbow trout allele frequencies were statistically homogeneous (X^2_9=8.957, P>0.50) among the diagnostic loci and the rainbow trout alleles appeared to be randomly distributed (X^2_2=4.110, P>0.10) among the fish in the sample. This sample, therefore, appears to have come from a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.983) westslope cutthroat trout genetic component.

McGee Creek (lower)-Site 2 3897

Alleles characteristic of both westslope cutthroat and rainbow trout were detected at eight of the ten diagnostic loci between these fishes that were analyzed in the sample from lower McGee Creek site 2 (Table 2). Although the rainbow trout allele frequencies were statistically homogeneous (X^2_9=9.523, P>0.10) among the diagnostic loci, the rainbow trout alleles were not randomly distributed (X^2_4=11.376, P<0.05) among the fish in the sample. In contrast, this sample appeared to contain a mixture of individuals from a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.971) westslope cutthroat trout genetic component and hybrids with a higher amount of admixture (Figure 3).

McGee Creek (lower)-Tributary A 3898

In the sample from tributary A to lower McGee Creek, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of only 2, however, we have only about a 33 percent chance of detecting as little as a one percent rainbow and only about a 24 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, we cannot reasonably exclude the possibility that the trout in tributary A to lower McGee Creek may be hybridized with rainbow trout, Yellowstone cutthroat trout, or both fishes but evidence of this was not detected because of sampling error. The genetic status of the trout in this stream, therefore, is presently uncertain.

Harrison Lake 3899

In the sample from Harrison Lake, alleles characteristic of both westslope cutthroat and rainbow trout were detected at three of the ten diagnostic loci between these fishes that were analyzed (Table 2). Although the rainbow trout allele frequencies were statistically homogeneous (X^2_9=7.050, P>0.50) among the diagnostic loci, the rainbow trout alleles were not randomly distributed (X^2_1=4.726, P<0.05) among the fish in the sample. In contrast, one fish had a higher proportion of admixture than expected by chance (Figure 4). This sample, therefore, appears to have contained a mixture of individuals from a hybrid swarm between westslope cutthroat and rainbow trout with a predominant westslope cutthroat trout genetic contribution and a small proportion of fish with a slightly higher amount of admixture.

The present results are fairly similar to those obtained from a previous PINE analysis (#2775, col. 8/30/00, N=15) of trout sampled from Harrison Lake. These results also indicated the fish to be slightly hybridized with rainbow trout.

Starvation Creek 3900

Samples were collected from three reaches of Starvation Creek. Among the samples evidence of genetic variation was detected at eight loci. The allele frequencies were statistically heterogeneous (contingency table chi-square analysis; $P<0.05$) among the samples at one of these loci. This could indicate that genetic differences exist among the samples or this apparent difference could simply be a chance departure from homogeneity because of the number of comparisons performed. In order to distinguish between these possibilities, we compared the chi-square statistic at the heterogeneous locus to that associated with the modified level of significance proposed by Rice (1989). The difference is not significant at the modified level indicating it most likely represents a chance departure from homogeneity. Since there was no compelling evidence of genetic differences among the samples, they were combined for further analysis.

Alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed in the sample from Starvation Creek (Table 3). With the sample size of 14, we have only about a 94 percent chance of detecting as little as a one percent rainbow and only about an 86 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, we cannot reasonably exclude the possibility that the trout in Starvation Creek may be slightly hybridized with rainbow trout, Yellowstone cutthroat trout, or both fishes but evidence of this was not detected because of sampling error. With this uncertainty, the conservative approach would be to consider Starvation Creek to contain non-hybridized westslope cutthroat trout unless subsequent data indicate otherwise.

McEvoy Creek (lower, British Columbia) 3901

In the sample from lower McEvoy Creek, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of 25, we have better than a 99 percent chance of detecting as little as a one percent rainbow and about a 97 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Lower McEvoy Creek, therefore, very likely contains a non-hybridized westslope cutthroat trout population.

McEvoy Creek (upper, British Columbia)

Samples were collected from two reaches of upper McEvoy Creek. Between the samples evidence of genetic variation was detected at seven loci. The allele frequencies were statistically heterogeneous (contingency table chi-square analysis; $P<0.05$) between the samples at two of these loci. This could indicate that genetic differences exist between the samples or these apparent differences could simply be chance departures from homogeneity because of the number of comparisons performed. In order to distinguish between these possibilities, we compared the chi-square statistics at the heterogeneous loci to those associated with the modified level of significance proposed by Rice (1989). The differences remain significant at the modified level indicating genetic differences exist between the samples. Thus, each sample was treated separately for subsequent analysis.

McEvoy Creek (upper, British Columbia)-Site 1 3902

Alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci that were analyzed in the sample from site 1 of upper McEvoy Creek (Table 3). With the sample size of 22, we have about a 99 percent chance of detecting as little as a one percent rainbow but and about a 95 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. This section of upper McEvoy Creek, therefore, very likely contains a non-hybridized westslope cutthroat trout population.

McEvoy Creek (upper, British Columbia)-Site 2 3903

In the sample from site 2 of upper McEvoy Creek, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of 25, we have better than a 99 percent chance of detecting as little as a one percent rainbow and about a 95 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, this reach of upper McEvoy Creek very likely contains a non-hybridized westslope cutthroat trout population.

Kintla Lake 3904

Alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci that were analyzed in the sample from Kintla Lake (Table 3). With the sample size of 25, we have better than a 99 percent chance of detecting as little as a one percent rainbow and about a 97 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Kintla Lake, therefore, very likely contains a non-hybridized westslope cutthroat trout population.

Langford Creek 3905

In the sample from Langford Creek, alleles characteristic of both westslope cutthroat and rainbow trout were detected at all ten diagnostic loci between these fishes that were analyzed (Table 2). Although the rainbow trout allele frequencies were statistically homogeneous (X^2_9=14.312, P>0.05) among the diagnostic loci, the rainbow trout alleles were not randomly distributed (X^2_7=172.576, P<0.001) among the fish in the sample. In contrast, the hybrid indices divided the fish into two groups one of which appeared to have come from a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.981) westslope cutthroat trout genetic contribution (Figure 5). The other group was composed of hybrids with a higher and more variable amount of admixture.

In the hybrid swarm, one individual possessed an allele usually characteristic of Yellowstone cutthroat trout at one diagnostic locus. Normally we would be uncertain whether this indicated evidence of hybridization or if it was simply westslope cutthroat trout genetic variation that was indistinguishable with the technique used from that usually characteristic of Yellowstone cutthroat trout. In this case, however, we favor the former interpretation because analysis of trout sampled from the upper portion of the drainage clearly indicated they contained a Yellowstone cutthroat trout genetic component (#3336, col. 9/15/04, N=25). Thus, the hybrid swarm in Langford Creek also appears to contain a small (0.005) Yellowstone cutthroat trout genetic contribution.

When Langford Creek was first sampled (#101, col. 8/14/84, N=15), allozyme analysis indicated the stream contained a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.980) westslope cutthroat trout genetic component. Subsequently (#1924, col. 8/1/98, N=20), PINE analysis indicated of the 20 fish sampled from the stream five showed no evidence of hybridization, one appeared to be an F_1 hybrid, and the others to be post F_1 hybrids with a substantial amount of admixture. The former fish probably were not non-hybridized westslope cutthroat trout. In contrast, they more likely were slightly hybridized with rainbow trout and evidence of this was not detected because of sampling error. Microsatellite analysis of trout collected from Langford Creek in 2004 (#3912, col. 2004, N=30) produced results very similar to those obtained from the PINE analysis except no F_1 hybrids were detected. Results from the most recent sample suggest that this situation still existed 2008. Thus, since at least 1998 Langford Creek appears to have contained a mixture of individuals from a hybrid swarm with a predominant westslope cutthroat trout genetic component and hybrids with a higher amount of admixture.

Bowman Lake 3906

In the sample from Bowman Lake, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of 21, we have about a 99 percent chance of detecting as little as a one percent rainbow and about a 95 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, Bowman Lake very likely contains a non-hybridized westslope cutthroat trout population.

Note one fish (BOW3199) in this sample was not an *Oncorhynchus*.

Logging Lake 3907

In the sample from Logging Lake, alleles characteristic of both westslope cutthroat and rainbow trout were detected at three of the ten diagnostic loci between these fishes that were analyzed (Table 2). Although the rainbow trout allele frequencies were statistically homogeneous (X^2_9=7.033, P>0.50) among the diagnostic loci, the rainbow trout alleles were not randomly distributed (X^2_1=8.338, P<0.01) among the fish in the sample. Rather, they were all detected in only one fish. Thus, this sample appears to have been a mixture of mainly non-hybridized westslope cutthroat trout and a small proportion of hybrids between westslope cutthroat and rainbow trout with a moderate amount of admixture.

Elk River (British Columbia) 3908

Alleles characteristic of both westslope cutthroat and rainbow trout were detected at all ten diagnostic loci between these fishes that were analyzed in the Elk River sample (Table 2). Although the rainbow trout allele frequencies were statistically homogeneous (X^2_9=5.747, P>0.50) among the diagnostic loci, the rainbow trout alleles were not randomly distributed (X^2_5=124.108, P<0.001) among the fish in the sample. In contrast, the hybrid indices clearly divided the fish into a group that appeared to have come from a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.990) westslope cutthroat trout genetic contribution and a group of hybrids with a higher and quite variable amount of admixture (Figure 6).

With the exception of the second group of fish, the above results are very similar to those obtained from a previous indel/microsatellite analysis (#3721, col. 7/11/07, N=20) of trout sampled from the Elk River. These fish appeared to have come from a hybrid swarm between westslope cutthroat and rainbow trout with a predominant (0.992) westslope cutthroat trout genetic contribution.

Akokala Creek 3909

Samples were collected from two reaches of Akokala Creek. Between the samples, evidence of genetic variation was detected at eight loci. The allele frequencies were statistically homogeneous (contingency table chi-square analysis; P>0.05) among the samples at all of these loci. Since there was no compelling evidence of genetic differences between the samples, they were combined for further analysis.

Alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci that were analyzed in the sample from Akokala Creek (Table 3). A previous PINE analysis (#2750, col. 8/8/00, N=25) of fish collected from Akokala Creek also detected no evidence of hybridization. With the combined sample size of 42, we have better than a 99 percent chance of detecting as little as a one percent rainbow or Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Akokala Creek, therefore, very likely contains a non-hybridized westslope cutthroat trout population.

Note 12 fish (1LKT2; 3LKT1 and 2; 2COT1, 15, 16, and 17; 2MFW5, 6, 9, 12, and 13) in this sample were not *Oncorhynchus*.

Longbow Creek (upper) 3910

In the sample from upper Longbow Creek, alleles characteristic of only westslope cutthroat trout were detected at all the diagnostic loci analyzed (Table 3). With the sample size of only 3, however, we have only about a 45 percent chance of detecting as little as a one percent rainbow and only about a 34 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, we cannot reasonably exclude the possibility that the trout in upper Longbow Creek may be hybridized with rainbow trout, Yellowstone cutthroat trout, or both fishes but evidence of this was not detected because of sampling error. The genetic status of the trout in upper Longbow Creek, therefore, is presently uncertain.

Lower North Fork Flathead River (British Columbia) 3911

Alleles characteristic of only westslope cutthroat trout were detected at all of the diagnostic loci that were analyzed in the sample collected from the lower North Fork Flathead River in British Columbia (Table 3). With the sample size of 25, we have better than a 99 percent chance of detecting as little as a one percent rainbow and about a 97 percent chance of detecting as little as a one percent Yellowstone cutthroat trout genetic contribution to a hybrid swarm that once was non-hybridized westslope cutthroat trout. Thus, this reach of the North Fork Flathead River very likely contains a non-hybridized westslope cutthroat trout population.

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Table 1

Alleles at the diagnostic loci that usually differentiate westslope cutthroat from rainbow trout and westslope from Yellowstone cutthroat trout. ND= locus not diagnostic between westslope cutthroat trout and the indicated taxon.

	Taxa and characteristic alleles		
Locus	Westslope	Rainbow	Yellowstone
*Ogo8**	82	98	ND
	88	100	
	90	102	
	92		
	94		
	96		
	98		
*Omm1019**	150	172	ND
	154	182	
	156	184	
	162	186	
	166	188	
		190	
		192	
		194	
		198	
		199	
		200	
*Omm1037-1**	121	159	127
	139	167	
	143	171	
	147	179	
	151	183	
	155	187	
		191	
		195	
		203	
*Omm1037-2**	104	98	106
		100	
		102	

Table 1- continued

Locus	Westslope	Rainbow	Yellowstone
		Taxa and characteristic alleles	
*Omm1050**	228	240	235
	230	244	
	234	254	
	236	259	
		260	
		267	
		270	
		280	
		284	
		292	
		296	
		304	
		306	
		308	
		312	
		328	
		329	
		358	
*Omm1060**	106	97	ND
	109	100	
	112	103	
*Omy0004**	77	131	189
		137	191
		139	195
		141	197
		143	
		145	
		153	
		157	
		159	
		165	

Table 1- continued

Locus	Westslope	Rainbow	Yellowstone
		Taxa and characteristic alleles	
*Omy1001**	223	182	220
	228	186	266
	232	188	270
	236	190	
	240	194	
	244	196	
	248	198	
	252	200	
	256	202	
	260	206	
	264	210	
	268	226	
	272		
	276		
*Sfo8**	194	220	ND
	196	224	
	202	230	
	204	232	
	208	240	
	212	250	
	214	260	
		262	
		264	
		274	
		288	
		290	
		292	
		296	
		298	
*Oki10**	101	ND	141
	103		145
	105		149
	109		153
	113		157
	117		161
	121		163
	125		165
	129		169
	133		173
	137		177
			181

Table 1- continued

Locus	Taxa and characteristic alleles Westslope	 Rainbow	 Yellowstone
*Ssa408**	195	170	199
		174	
		178	
		182	
		183	
		186	
		190	
		191	
		194	
		198	
		202	
		206	
		210	
		214	
		218	
		221	
		222	
		226	
		230	
		234	
		238	
		239	
		246	
		247	
		250	
		254	
		262	
		266	
		267	
		282	
		286	

Table 2

Allele frequencies at the diagnostic loci between westslope cutthroat and rainbow trout in samples showing evidence of hybridization between these fishes collected from Cerulean Lake, Cyclone Creek, Elk River, Harrison Lake, Langford Creek, Logging Lake, Lower Quartz Lake, lower McGee Creek sites 1 and 2, and Michel Creek. Averages are reported only if the sample appeared to have come from a hybrid swarm. Alleles and allele frequencies in bold are characteristic of rainbow trout. *Ssa408*199* detected in the Langford Creek sample is characteristic of Yellowstone cutthroat trout. Thus, this sample also showed evidence of a slight amount of hybridization with Yellowstone cutthroat trout.

		Sample and allele frequencies				
Locus	Alleles	Cerulean	Cyclone	Elk	Harrison	Langford
*Ogo8**	*90*	0.980	0.900	0.770	1.000	0.567
	92	0.020		0.083		
	96					0.067
	98		0.033	0.104		0.333
	100		**0.067**			**0.033**
	102			**0.042**		
*Omm1019**	*154*	0.100	0.033	0.543	0.405	0.071
	156				0.024	
	162	0.760	0.800	0.130	0.500	0.464
	166	0.140	0.067	0.196	0.071	0.179
	172			**0.022**		**0.071**
	182					**0.071**
	184		**0.033**			
	186		**0.033**			**0.036**
	188					**0.036**
	190			**0.022**		**0.036**
	192			**0.022**		
	194		**0.033**			**0.036**
	200			**0.065**		
*Omm1037-1**	*121*					
	139	0.540	0.367	0.375	0.190	0.200
	143					0.067
	147	0.160	0.033			0.033
	151	0.300	0.567	0.521	0.810	0.600
	159			**0.021**		**0.033**
	167					**0.033**
	171		**0.033**			**0.033**
	183			**0.063**		
	187			**0.021**		
	195					

Table 2-continued

Locus	Alleles	Sample and allele frequencies				
		Cerulean	Cyclone	Elk	Harrison	Langford
*Omm1037-2**	***98***					
	100		**0.033**	**0.163**		**0.167**
	104	1.000	0.967	0.833	1.000	0.833
*Omm1050**	*228*			0.022		
	230		0.067	0.217	0.190	
	234	1.000	0.867	0.543	0.786	0.700
	236			0.130		
	240					**0.033**
	254			**0.043**		
	260		**0.033**			
	267			**0.022**		
	270			**0.022**		**0.033**
	284					**0.033**
	292					**0.033**
	296					**0.033**
	306		**0.033**			**0.067**
	308					
	312				**0.024**	
	328					**0.067**
*Omm1060**	***97***	**0.020**		**0.021**		
	100			**0.042**	**0.024**	**0.167**
	103			**0.083**		
	106	0.880	0.867	0.854	0.905	0.833
	109	0.080	0.133		0.071	
	112	0.020				
*Omy0004**	*77*	0.980	0.900	0.854	1.000	0.900
	137		**0.100**			
	139			**0.021**		**0.033**
	141			**0.021**		
	143			**0.021**		
	145	**0.020**				**0.067**
	153			**0.063**		
	157			**0.021**		

Table 2-continued

		Sample and allele frequencies				
Locus	Alleles	Cerulean	Cyclone	Elk	Harrison	Langford
*Omy1001**	***182***					**0.067**
	186					**0.033**
	188			**0.023**		
	194		**0.033**	**0.023**		
	196		**0.033**			
	198				**0.024**	
	200					
	202					**0.033**
	206					**0.067**
	223			0.023		
	226			**0.045**		
	228			0.023		
	232	0.160	0.033	0.068	0.048	0.267
	236	0.120	0.300	0.159	0.381	0.067
	240	0.320	0.200	0.136	0.190	0.033
	244	0.020	0.067	0.045		0.133
	248	0.040		0.068		
	252	0.020				0.033
	256			0.023		0.100
	260	0.080	0.167	0.091	0.214	
	264	0.100		0.023	0.048	0.133
	268	0.060	0.033	0.182	0.071	
	272	0.060	0.133	0.068	0.024	0.033
	276	0.020				
*Sfo8**	*194*	0.760	0.800	0.229	0.500	0.600
	204	0.240	0.133	0.458	0.500	0.100
	208					0.033
	212			0.083		
	214			0.104		
	220		**0.033**			
	224					**0.033**
	230			**0.021**		
	240					**0.033**
	250		**0.033**			
	260			**0.083**		
	262			**0.021**		
	264					**0.067**
	288					**0.033**
	290					**0.067**
	296					**0.033**

Table 2-continued

Locus	Alleles	Sample and allele frequencies				
		Cerulean	Cyclone	Elk	Harrison	Langford
*Ssa408**	***174***			**0.021**		
	178			**0.063**		
	182					**0.100**
	186					**0.033**
	190			**0.042**		
	195	1.000	0.967	0.854	1.000	0.700
	198					**0.067**
	199					**0.033**
	210					
	214		**0.033**			
	234			**0.021**		**0.033**
	250					**0.033**
Average Westslope						
Average Rainbow						

Table 2-continued

		Sample and allele frequencies				
			Lower	lower McGee		
Locus	Alleles	Logging	Quartz	Site 1	Site 2	Michel
*Ogo8**	*90*	1.000	1.000	0.961	0.800	0.958
	92					0.042
	96					
	98			0.039	0.200	
	100					
	102					
*Omm1019**	*154*	0.032	0.040	0.077	0.050	0.917
	156					
	162	0.758	0.620	0.731	0.550	0.042
	166	0.210	0.340	0.154	0.350	0.042
	172					
	182					
	184					
	186			**0.039**		
	188				**0.050**	
	190					
	192					
	194					
	200					
*Omm1037-1**	*121*	0.031				
	139	0.313	0.520	0.269	0.100	0.271
	143			0.077		
	147	0.641	0.140	0.077		
	151	0.016	0.340	0.577	0.700	0.729
	159					
	167					
	171					
	183				**0.050**	
	187					
	195				**0.150**	
*Omm1037-2**	***98***	**0.016**				
	100			**0.077**	**0.050**	
	104	0.984	1.000	0.923	0.950	1.000

Table 2-continued

		Sample and allele frequencies				
			Lower	lower McGee		
Locus	Alleles	Logging	Quartz	Site 1	Site 2	Michel
*Omm1050**	*228*					
	230			0.192	0.100	0.458
	234	1.000	1.000	0.731	0.800	0.521
	236			0.039		
	240					
	254					**0.021**
	260					
	267					
	270					
	284					
	292					
	296			**0.039**		
	306					
	308				**0.100**	
	312					
	328					
*Omm1060**	***97***					
	100				**0.150**	
	103					
	106	0.969	0.820	0.961	0.800	1.000
	109	0.031	0.180	0.039	0.050	
	112					
*Omy0004**	*77*	1.000	0.980	1.000	0.850	1.000
	137				**0.050**	
	139					
	141		**0.020**		**0.100**	
	143					
	145					
	153					
	157					

Table 2-continued

		Sample and allele frequencies				
			Lower	lower McGee		
Locus	Alleles	Logging	Quartz	Site 1	Site 2	Michel
*Omy1001**	***182***					
	186				**0.100**	
	188					
	194			**0.039**		
	196					
	198					
	200			**0.039**		
	202					
	206					
	223					
	226					
	228					
	232	0.109	0.100	0.039	0.100	0.333
	236	0.375	0.240	0.308	0.100	0.292
	240	0.188	0.380	0.192	0.500	0.083
	244	0.141	0.040		0.100	
	248	0.016	0.040	0.039		
	252	0.109	0.020			
	256	0.016		0.154		
	260	0.047	0.060			0.042
	264		0.060			0.083
	268		0.020	0.115	0.050	0.167
	272			0.077	0.050	
	276		0.040			
*Sfo8**	*194*	0.781	0.140	0.769	0.650	0.188
	204	0.203	0.860	0.231	0.350	0.771
	208					0.042
	212					
	214					
	220					
	224					
	230					
	240					
	250					
	260	**0.016**				
	262					
	264					
	288					
	290					
	296					

Table 2-continued

		Sample and allele frequencies				
			Lower	lower McGee		
Locus	Alleles	Logging	Quartz	Site 1	Site 2	Michel
*Ssa408**	***174***					
	178					
	182					
	186					
	190					
	195	0.984	1.000	0.962	0.900	1.000
	198					
	199					
	210			**0.038**		
	214	**0.016**				
	234				**0.100**	
	250					
Average Westslope			0.998	0.983		0.998
Average Rainbow			0.002	0.017		0.002

Table 3

Allele frequencies at the loci showing evidence of genetic vatiation in samples from what appear to be non-hybridized westslope cutthroat trout collected from Akokala Creek, Bowman Lake, Kintla Lake, Lincoln Lake, upper Longbow Creek, lower McEvoy Creek, upper McEvoy Creek sites 1 and 2, lower McGee Creek tributary A, McLatchie Creek, Middle Quartz Lake, lower North Fork Flathead River, upper North Fork Flathead River sites 1, 2, and 3, Quartz Lake, and Starvation Creek.

		Sample and allele frequencies					
Locus	Alleles	Akokala	Bowman	Kintla	Lincoln	upper Longbow	lower McEvoy
*Ogo8**	*88*	0.032					
	90	0.967	1.000	1.000	1.000	1.000	1.000
	92						
	98						
*Omm1019**	*154*	0.147	0.143	0.040	0.161		0.180
	162	0.618	0.833	0.700	0.710	0.500	0.740
	166	0.235	0.024	0.260	0.129	0.500	0.080
*Omm1037-1**	*139*	0.294	0.357	0.240	0.226	0.167	0.400
	143						
	147	0.032		0.100	0.097		0.020
	151	0.559	0.643	0.620	0.677	0.833	0.580
	155	0.118		0.040			
*Omm1050**	*230*	0.059	0.024	0.100	0.145	0.167	0.020
	234	0.941	0.976	0.900	0.855	0.833	0.980
*Omm1060**	*106*	0.941	0.833	0.960	0.984	1.000	1.000
	109	0.059	0.167	0.040	0.016		
*Omy1001**	*232*	0.032	0.048	0.100	0.113		0.180
	236	0.147	0.405	0.360	0.161	0.333	0.120
	240	0.206	0.190	0.220	0.258	0.167	0.160
	244	0.118	0.024	0.060	0.113		
	248				0.016		0.020
	252	0.032	0.095	0.020	0.016		0.080
	256	0.118		0.020	0.048	0.167	0.100
	260	0.206	0.143		0.032	0.167	0.100
	264		0.024	0.040	0.145		
	268	0.059	0.071	0.160	0.016		0.140
	272	0.088		0.020	0.081	0.167	0.100
	276						

Table 3-continued

		Sample and allele frequencies					
Locus	Alleles	Akokala	Bowman	Kintla	Lincoln	upper Longbow	lower McEvoy
*Sfo8**	*194*	0.912	0.714	0.860	0.758	1.000	0.660
	196						
	204	0.088	0.286	0.140	0.242		0.340
*Oki10**	*101*				0.048		0.020
	105	0.147	0.333	0.060	0.129	0.167	0.240
	109	0.118	0.095	0.260	0.242	0.167	0.140
	113	0.500	0.286	0.440	0.355	0.333	0.200
	117	0.032	0.095	0.020			
	121			0.020	0.032		
	125						
	129	0.118	0.167	0.140	0.129	0.333	0.240
	133	0.088	0.024	0.040	0.065		0.140
	137			0.020			0.020

Table 3-continued

Locus	Alleles	Sample and allele frequencies					
		upper McEvoy		McGee		Middle	N. F. Flathead
		Site 1	Site 2	Trib. A	McLatchie	Quartz	lower
*Ogo8**	*88*						
	90	1.000	1.000	1.000	1.000	0.875	1.000
	92					0.094	
	98					0.031	
*Omm1019**	*154*	0.205	0.420	0.750	0.125	0.094	0.140
	162	0.614	0.420	0.250	0.604	0.750	0.640
	166	0.182	0.160		0.271	0.156	0.220
*Omm1037-1**	*139*	0.455	0.380	0.500	0.333	0.594	0.380
	143			0.250			
	147	0.205	0.020			0.094	
	151	0.341	0.600	0.250	0.646	0.313	0.620
	155				0.021		
*Omm1050**	*230*	0.023				0.063	0.040
	234	0.977	1.000	1.000	1.000	0.938	0.960
*Omm1060**	*106*	0.977	0.980	1.000	0.979	0.875	1.000
	109	0.023	0.020		0.021	0.125	
*Omy1001**	*232*	0.068	0.020		0.043	0.125	0.040
	236	0.159	0.120		0.152	0.219	0.120
	240	0.182	0.340	0.750	0.326	0.375	0.160
	244	0.023					0.080
	248					0.094	
	252				0.022	0.031	0.020
	256	0.023	0.180		0.065		0.060
	260	0.068	0.020		0.239	0.031	0.060
	264	0.295	0.080			0.094	0.220
	268	0.182	0.140		0.043		0.240
	272		0.100	0.250	0.022	0.031	
	276				0.095		
*Sfo8**	*194*	0.636	0.640	1.000	0.761	0.813	0.600
	196						
	204	0.364	0.360		0.239	0.188	0.400

Table 3-continued

Locus	Alleles	upper McEvoy Site 1	upper McEvoy Site 2	McGee Trib. A	McLatchie	Middle Quartz	N. F. Flathead lower
*Oki10**	*101*					0.031	
	105	0.159	0.200		0.188	0.219	0.180
	109	0.114	0.040		0.021	0.094	0.080
	113	0.318	0.400	0.500	0.563	0.344	0.560
	117	0.023					0.020
	121	0.023					
	125	0.045	0.020		0.021		
	129	0.227	0.120	0.250	0.146	0.094	0.160
	133	0.068	0.220	0.250	0.063	0.219	
	137	0.023					

Table 3-continued

Locus	Alleles	N. F. Flathead-upper Site 1	N. F. Flathead-upper Site 2	N. F. Flathead-upper Site 3	Quartz	Starvation
*Ogo8**	*88*					
	90	1.000	1.000	1.000	1.000	0.964
	92					0.036
	98					
*Omm1019**	*154*	0.316	0.420	0.140	0.048	0.071
	162	0.447	0.440	0.560	0.714	0.786
	166	0.237	0.140	0.300	0.238	0.143

*Omm1037-1**	*139*	0.395	0.400	0.400	0.524	0.500
	143					
	147		0.020		0.095	0.071
	151	0.579	0.580	0.540	0.381	0.286
	155	0.026		0.060		0.143
*Omm1050**	*230*		0.040		0.024	0.143
	234	1.000	0.960	1.000	0.976	0.857
*Omm1060**	*106*	1.000	1.000	0.980	0.833	0.893
	109			0.020	0.167	0.107
*Omy1001**	*232*	0.026	0.080	0.200	0.119	0.071
	236	0.079	0.160	0.260	0.381	0.286
	240	0.368	0.300	0.320	0.310	0.179
	244		0.040			0.179
	248		0.040		0.024	
	252	0.026	0.020			0.036
	256	0.158	0.060	0.160		0.071
	260	0.026	0.100		0.095	0.071
	264	0.316	0.120		0.048	0.036
	268		0.040	0.020		0.036
	272		0.040	0.040	0.024	0.036
	276					
*Sfo8**	*194*	0.868	0.540	0.420	0.857	0.750
	196					0.071
	204	0.132	0.460	0.580	0.143	0.179

Table 3-continued

		Sample and allele frequencies				
		N. F. Flathead-upper				
Locus	Alleles	Site 1	Site 2	Site 3	Quartz	Starvation
*Oki10**	*101*				0.024	0.107
	105	0.132	0.120	0.340	0.333	0.143
	109	0.342	0.080	0.120	0.095	0.179
	113	0.316	0.560	0.220	0.381	0.357
	117					
	121					0.036
	125					
	129	0.184	0.200	0.200	0.071	
	133	0.026	0.040	0.100	0.095	0.107
	137			0.020		0.071

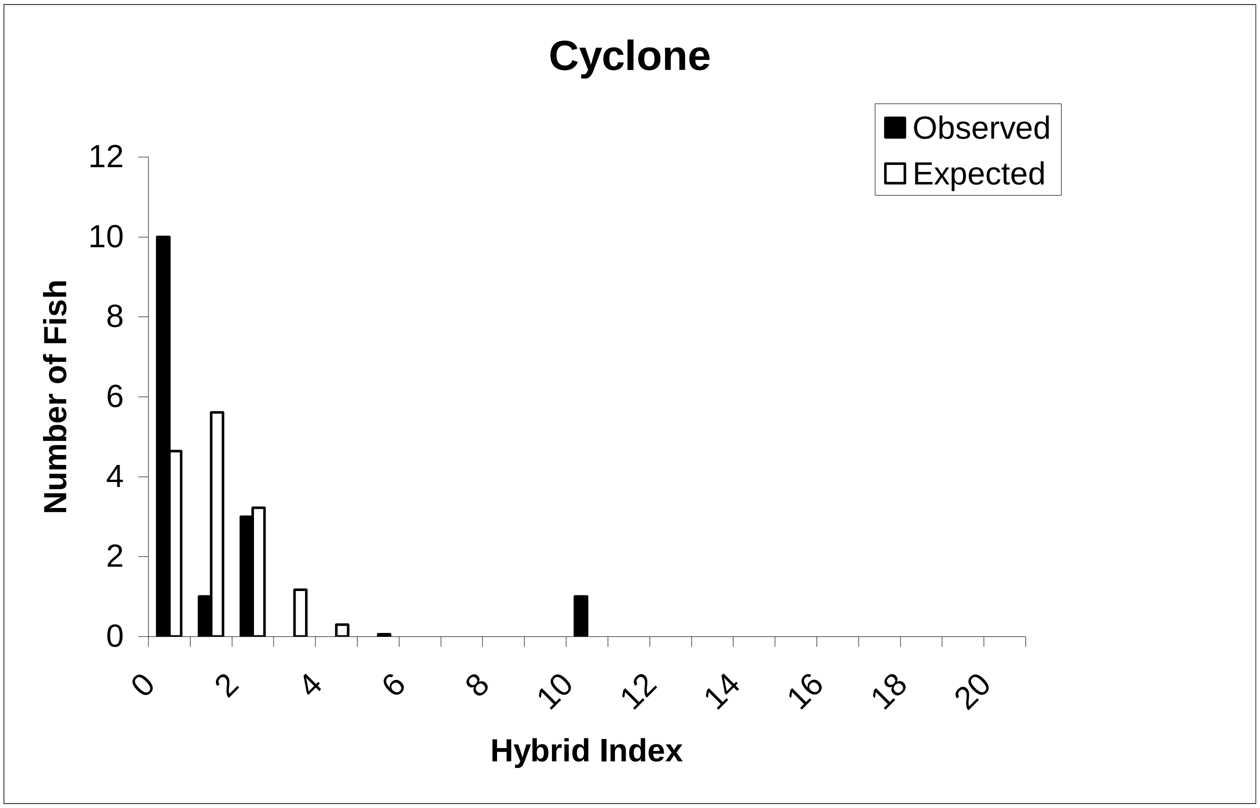

Figure 1. Observed and expected random distribution of hybrid indices in a sample showing evidence of hybridization between westslope cutthroat and rainbow trout collected from Cyclone Creek. Note the observed distribution significantly ($P<0.05$) differs from the expected random distribution indicating the sample did not come from a hybrid swarm.

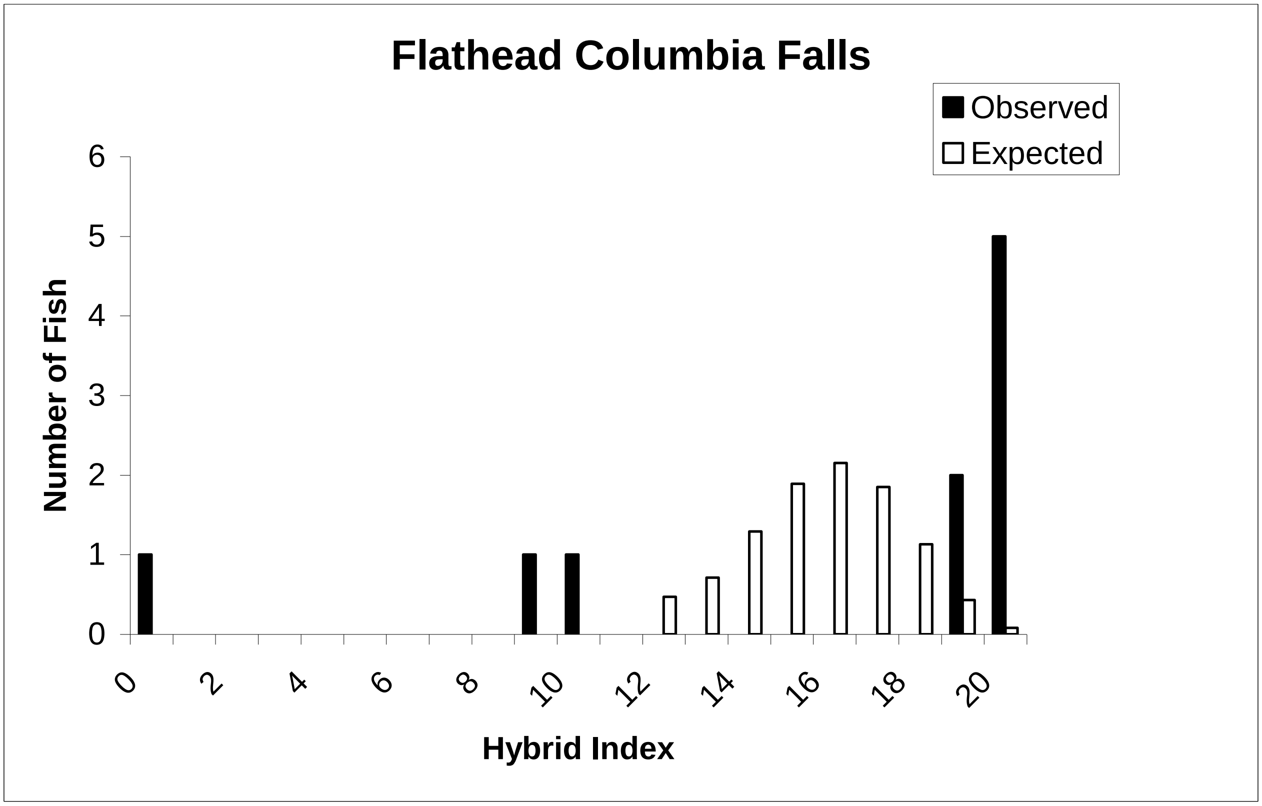

Figure 2. Observed and expected random distribution of hybrid indices in a sample showing evidence of hybridization between westslope cutthroat and rainbow trout collected from the Flathead River near Columbia Falls. Note the observed distribution significantly ($P<0.05$) differs from the expected random distribution indicating the sample did not come from a hybrid swarm.

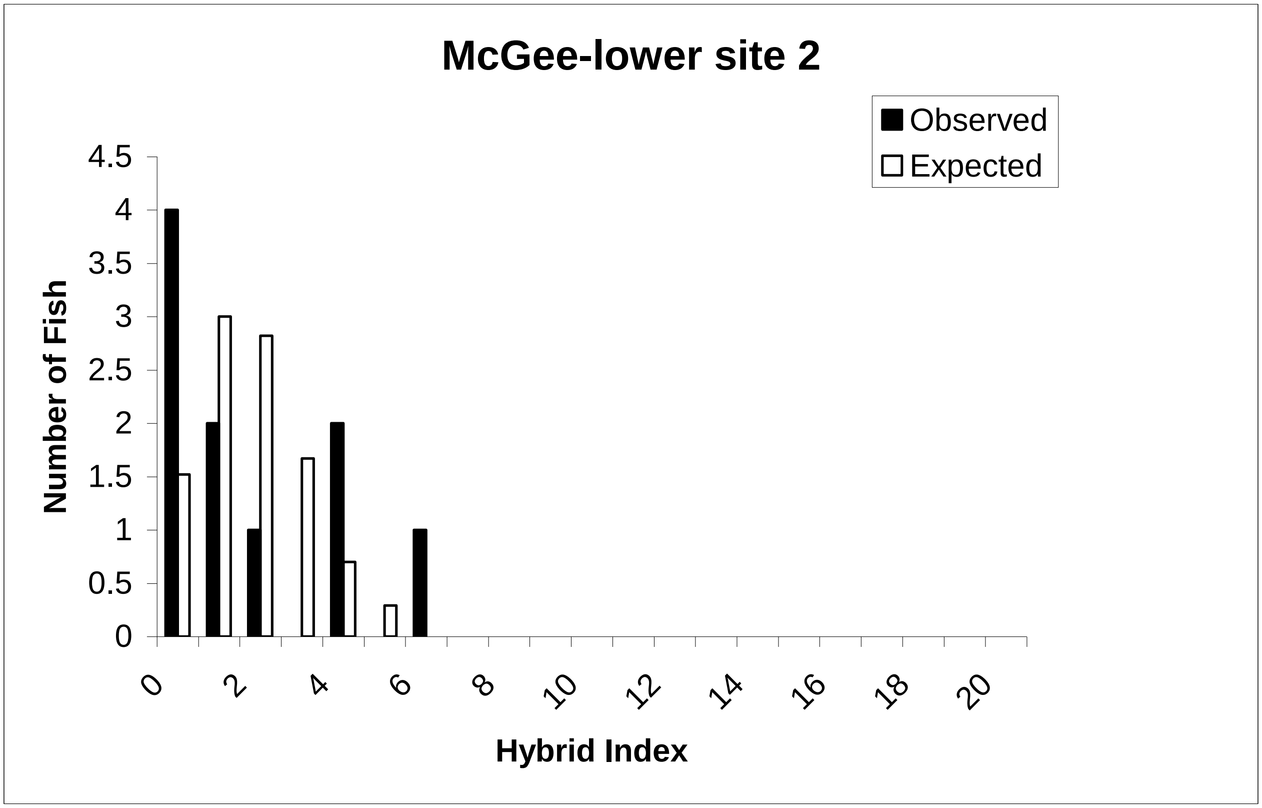

Figure 3. Observed and expected random distribution of hybrid indices in a sample showing evidence of hybridization between westslope cutthroat and rainbow trout collected from site 2 of lower McGee Creek. Note the observed distribution significantly ($P<0.05$) differs from the expected random distribution indicating the sample did not come from a hybrid swarm.

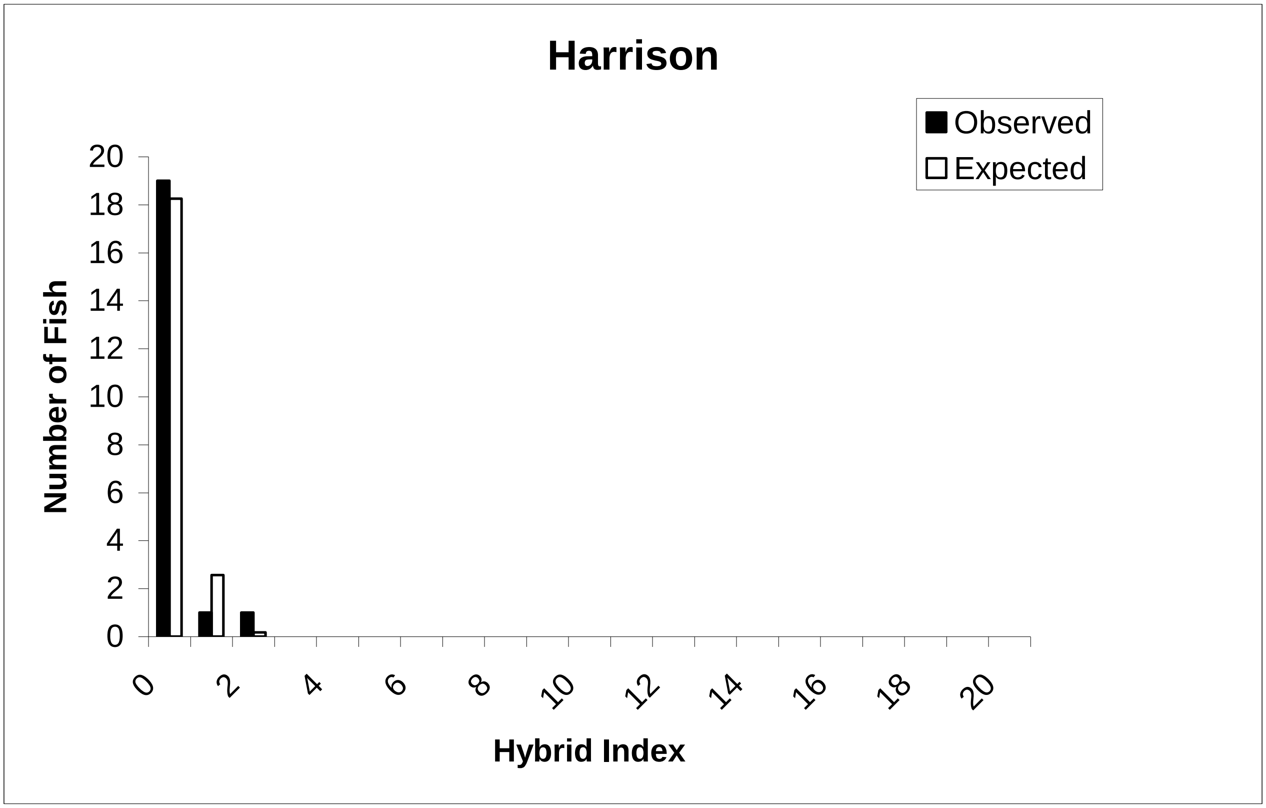

Figure 4. Observed and expected random distribution of hybrid indices in a sample showing evidence of hybridization between westslope cutthroat and rainbow trout collected from Harrison Lake. Note the observed distribution significantly (P<0.05) differs from the expected random distribution indicating the sample did not come from a hybrid swarm.

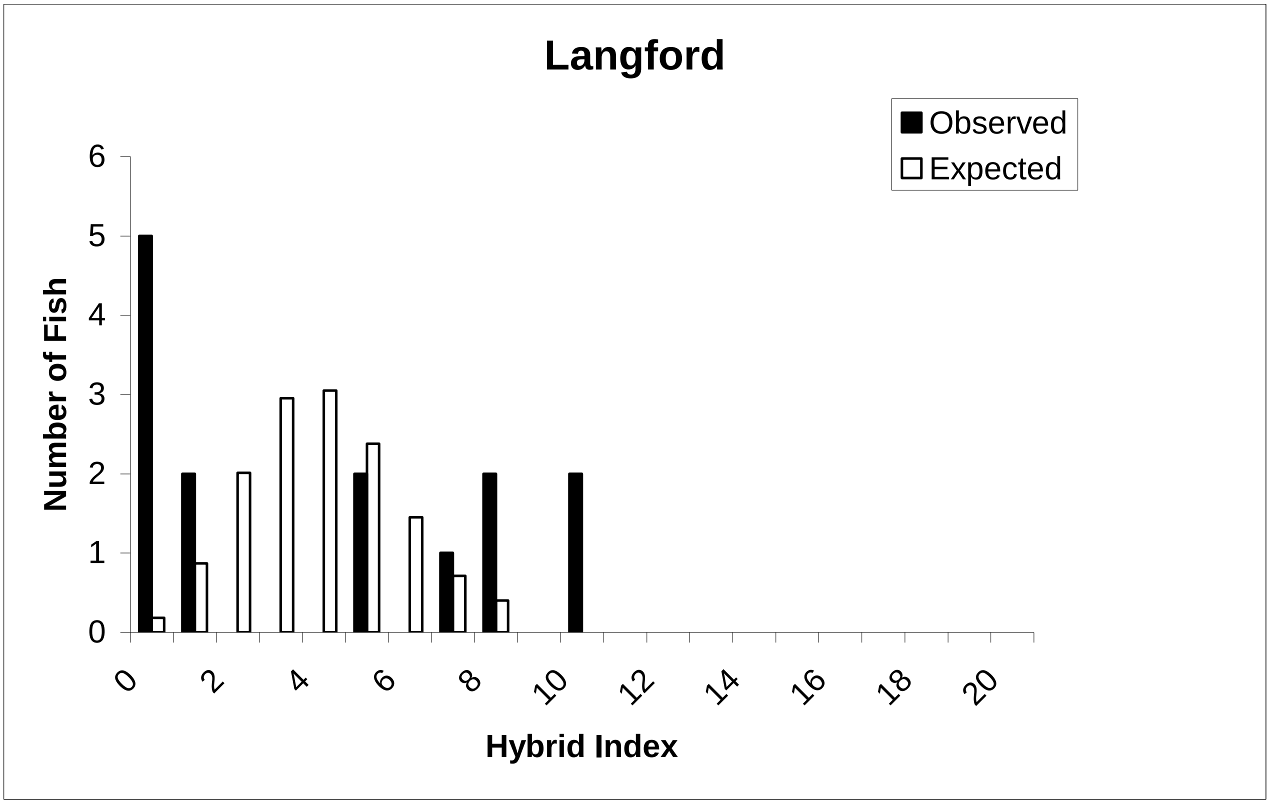

Figure 5. Observed and expected random distribution of hybrid indices in a sample showing evidence of hybridization between westslope cutthroat and rainbow trout collected from Langford Creek. Note the observed distribution significantly (P<0.05) differs from the expected random distribution indicating the sample did not come from a hybrid swarm.

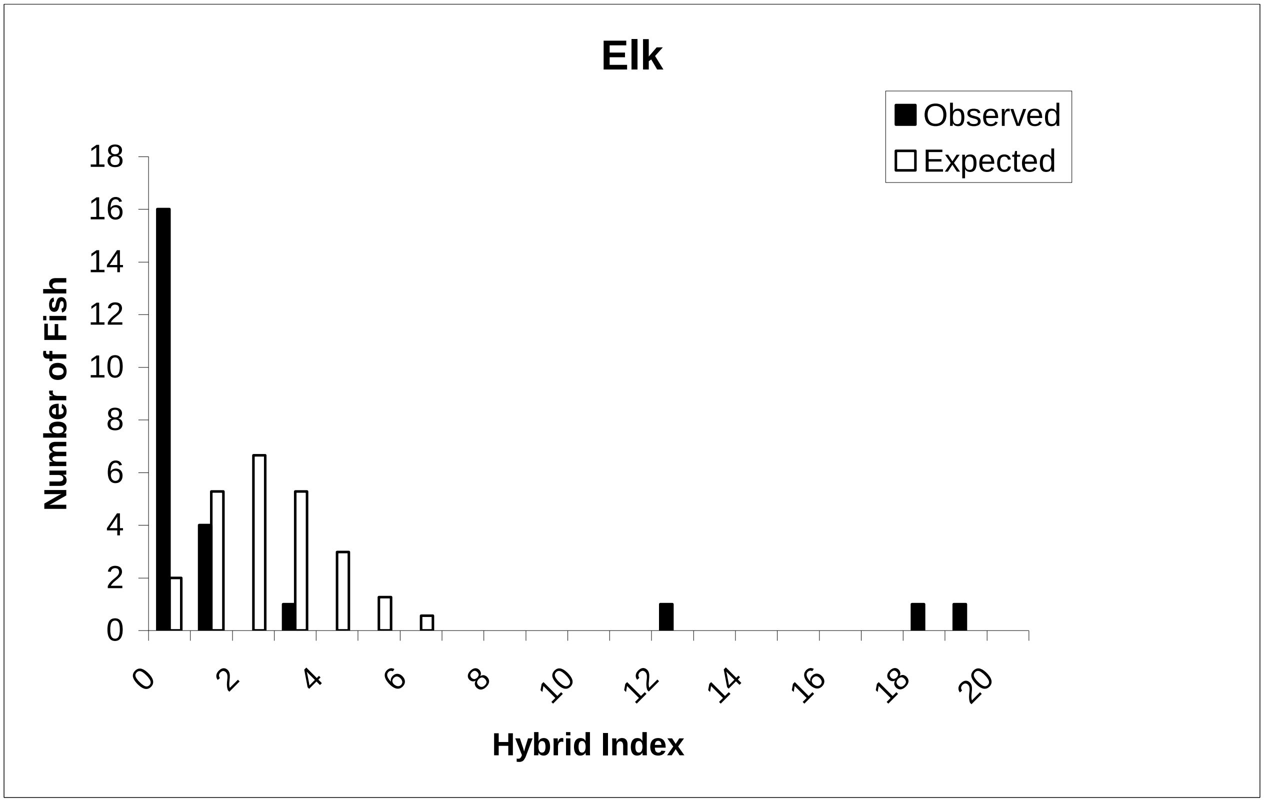

Figure 6. Observed and expected random distribution of hybrid indices in a sample showing evidence of hybridization between westslope cutthroat and rainbow trout collected from the Elk River. Note the observed distribution significantly (P<0.05) differs from the expected random distribution indicating the sample did not come from a hybrid swarm.