Kootenai River Tributaries
Water Quality Summary
1998 / 2000

Boundary Cr. Discharge (cfs)
USGS # 12321500

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Water Quality Summary
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Abstract

The tributaries to the Kootenai River support resident and adfluvial fish populations and influence the unique fisheries (sturgeon and burbot) in the Kootenai River. Water quality samples were collected in the tributaries to the Kootenai River by the Kootenai Tribe of Idaho to determine the potential for heavy metal contamination and the nutrient inputs from these watersheds to the Kootenai River. The concentration of arsenic, cadmium, copper, mercury, selenium, and zinc in the tributaries was generally measured below detection limits; only 1-3% of the samples exceeded detection limits. The results for these elements (arsenic, cadmium, copper, mercury, selenium, and zinc) do not indicate a potential concern with toxicity given the constraints of the field and laboratory methods used. Two metals, aluminum and lead, occurred at concentrations which exceed laboratory detection limits; 34 percent of total aluminum samples and 24 percent of lead samples occurred above recommended U.S. EPA chronic toxicity criteria for protection of aquatic life. Since the data was collected as unfiltered samples and reported as total metals, the bioavailability of these metals cannot be determined without further study. The probability is that the aluminum is tied up in the particulate fraction, and is not bioavailable since the higher concentrations occur during spring runoff when sediments are being generated from the watersheds. The lead concentrations measured above detection limits appear to be an artifact of the analytical methods used rather than a signal of potential toxicity. Collecting filtered samples and using a laboratory that specializes in trace metal analysis can resolve these questions. Nutrients occur at low levels in the Kootenai River tributaries consistent with the nutrient concentrations observed in the Kootenai River. Dissolved phosphorus concentrations were, for the most part, below detection limits of 0.01 - 0.026 mg/L. Nitrates were measured above the detection limit (0.005 mg/L) 75 % of the time, but still occur at low concentrations (overall median of 0.022 mg/L) characteristic of oligotrophic systems.

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Kootenai River Tributaries Water Quality Summary, 1998/2000.

1.0   Introduction

The following water quality report is prepared under contract to the Kootenai Tribe of Idaho (KTOI) to evaluate trace metal and nutrient data collected by the Tribe in tributaries to the Kootenai River. Concern about declining fish populations in the Kootenai River and tributaries has initiated a variety of studies to evaluate potential causative factors. Water quality is one of many possible stressors that may be contributing to the decline of fisheries in the basin and has been studied for some time. The Kootenai Tribe collected water quality samples from the Idaho reach of the Kootenai River (April 1997 – November 1998) and tributaries to the river in this reach (1998 – 2000). This report evaluates the data for the tributaries to the Kootenai River. The water quality data for the Kootenai River stations was evaluated in an earlier report (Bauer 1999).

1.1   Report Objectives

The Kootenai Tribe monitors the water quality of the Kootenai River watershed in Idaho as part of an ecosystem recovery program. Data has been collected from the Kootenai River, major tributaries, and the inlet for the Kootenai Tribe Hatchery. The purpose of this report is to evaluate water quality conditions in tributaries to the Kootenai River for data collected during the period from August 1998 to February 2000.

The tributaries to the Kootenai River support resident and adfluvial fish populations and influence the unique fisheries (sturgeon and burbot) in the Kootenai River. Water quality is evaluated as a limiting factor to the aquatic communities in these tributaries and their consequent influence on the Kootenai River. There have been two primary concerns with water quality in this reach of the Kootenia River: first, the potential effect of trace contaminants (metals) from anthropogenic sources on the aquatic community, and secondly, the low nutrient status that limits productivity in the Kootenia River. The following objectives provide the direction for this data analysis.

Objective 1:   *Evaluate trace metal contaminants in water as a potential limiting factor for fish populations in the tributaries to the Idaho reach of the Kootenai River.*

Ambient conditions in the Kootenai River tributaries will be evaluated to identify potential effects of heavy metal toxicity. Stations will be compared spatially to identify any apparent association with geologic zones or land use practices.

Objective 2:   *Evaluate tributaries as a source of nutrients to the Kootenai River.*

Previous studies (Synder and Minshall 1996, Richards 1997) have suggested that retention of nutrients by Libby Dam is a limiting factor to productivity in the Kootenai River and that ferilization should be considered as a recovery tool. Tributaries will be evaluated as a source of nutrients to the Idaho reach of the Kootenai River in addition to the status of productivity in the tributaries themselves.

1.2   Background

Previous studies and reports have evaluated the status of contaminants and nutrients in the the Kootenai River system. Refer to *Kootenai River Watershed Assessment Report* (Pacific Watershed Institute 1999), Knudson 1994, LaPatra et al. 1999 for further information. Previous studies were summarized with respect to contaminants and nutrients in the *Kootenai River Water Quality Summary Report* (Bauer 1999).

1.3   Drainage Description

The Kootenai River basin covers 45,584 square kilometers in watershed area and contributes the second largest runoff volume of all tributaries to the Columbia River. The headwaters originate in Kootenay National Park, British Columbia, North of Mount Assiniboine. The majority of the watershed is in B.C. where significant mining and agricultural activity has taken place. The river flows south across the international boundary into Montana entering Lake Koocanusa, a lake created by Libby Dam. South of the dam the river turns west and flows into Idaho and then turns North just west of Bonners Ferry returning to British Columbia. North of Creston, B.C. the Kootenai River flows into Kootenay Lake. The West Arm of Kootenay Lake flows into the Columbia River at Castlegar, B.C. Major tributaries that have significance to water quality include Elk River, Bull River, and St. Mary's River in B.C. and Yaak River and Moyie River that join the Kootenai River on the U.S. side (Figure 1).
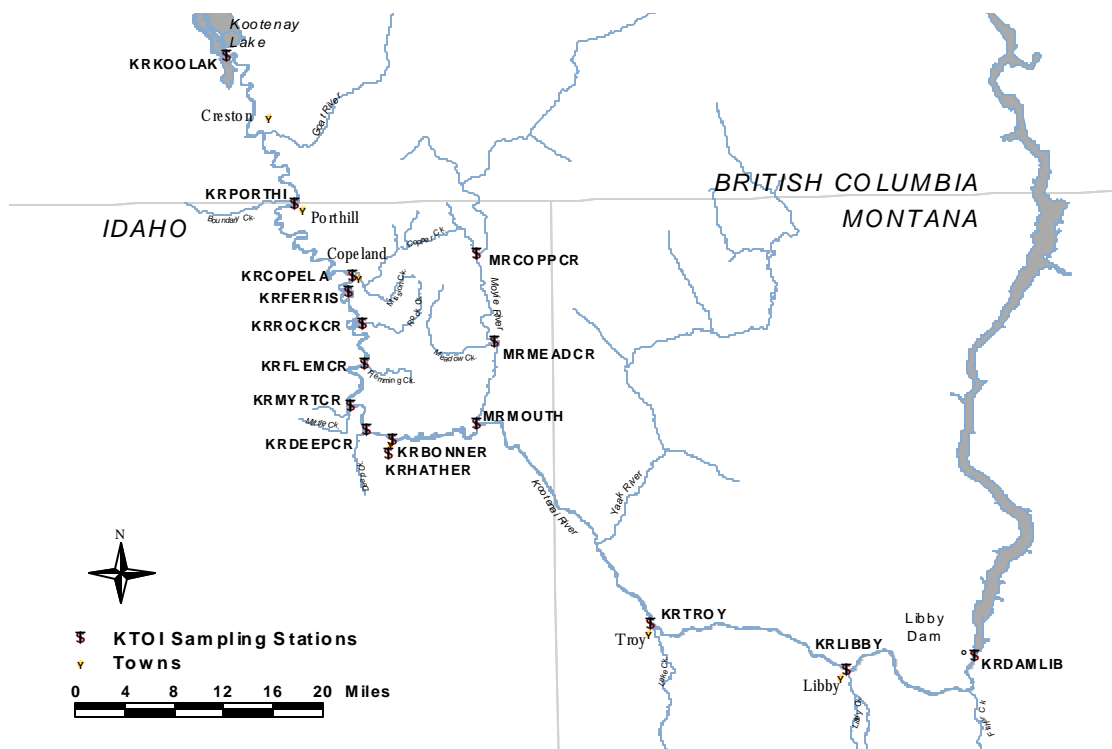

Figure 1. The Kootenai River watershed.

1.4   Basin Geology and Geomorphology

The following information on Basin geology, geomorphology, soils, and climate are taken directly from the U.S. Forest Service watershed assessment report (Deiter 2000).

The Kootenai River Basin is a product of a long, and often violent, history of natural events. It developed through periods of fires, floods, mountain building, ice, volcanic, and tectonic processes of extraordinary proportions that are difficult to imagine today. Over one billion years ago deep layers of continental sediments were being deposited in the basin that during this period was below sea level. These sediments metamorphosed over time under the extreme weight and pressure of overlying deposits. During some stages of deposition, the metasediments were intruded by molten rock that injected itself between the layers of the hardened sediment. About 70 to 80 million years ago, large masses of granite magma rose into the upper part of the earth's crust eventually leading to the formation of the Selkirk Mountains. The Purcell and Cabinet mountains to the east are thought to have detached from the Selkirk Mountains some time between 50 and 70 million years ago. The Purcell Trench is a very prominent geologic feature that is probably associated with this faulting which extends north into Canada and south towards Sandpoint (Alt and Hyndman 1989). The scarp of the Purcell Trench is exposed on the west side of the Kootenai Valley. The bottom of the trench is filled with deep deposits of glacial debris and older sediments. Mountains on the western side of the valley (i.e., the Selkirk Mountains) are typically composed of granitic rocks of the Kaniksu Batholith that formed deep in the earth's crust. Mountains on the east side of the valley (i.e. the Purcell and Cabinet mountains) typically consist of metasediments of the Belt Series that formed at shallower depths in the crust. Other major faults occur in the basin of which the Moyie River corridor and the valley between the Purcell and Cabinet mountains are examples. It took until perhaps 20 million years ago for the Selkirk, Purcell, and Cabinet Mountains to develop as they are today. Within the last 2 to 3 million years, these mountains have experienced several episodes of continental glaciation that has significantly altered their appearance. In this time period, modern river systems likely began to become established (Alt and Hyndman 1989).

Today, only the last two ice advances offer clear evidence of their occurrence on the landscape. The last major advance by the Cordilleran ice sheet reached its maximum extent roughly 15,000 years ago and ended about 10,000 years ago. The continental ice sheet covered all but the highest peaks. Alpine glaciation occurred above and flowed into the continental ice mass and is responsible for the creation of most of the high elevation lakes also known as tarns. Glacial Lake Kootenai formed as the glaciers were receding. The glacial lake was caused by an ice dam that blocked outflow of the Kootenai River from the west arm of Kootenai Lake. While the ice dam was in place, the Kootenai River spilled into the Pend Oreille Basin over the hydrologic divide near McArthur Lake, which has a current elevation of 2,150 feet. Kettle topography near the hydrologic divide suggests the presence of stagnated or buried ice that melted after recession of the glacier. At its maximum extent, glacial Lake Kootenai connected the modern Kootenai and Pend Oreille lakes. The extensive connections between waters of the Kootenai system and the large glacial lakes occupying valleys of the Columbia system to the south permitted colonization of the region by species of fish whose entrance would now be blocked by the falls on the Kootenai River, about 12 miles upstream from the junction of the Kootenai and Columbia rivers.

During this period, heavy silt loads from streams and glacial melt water were deposited into the lake. The Kootenai River eroded and removed much of the lake deposits as the ice dam cleared. As a result, river breaklands step up from the Kootenai River floodplain to the top of the remaining lake sediments that form benches on both sides of the Purcell Trench. These benches have a nearly uniform upper elevation between 2,200 to 2,300 feet. In addition to lake deposits, the bench lands surrounding the Kootenai and Moyie Rivers also contain moraines and valley train deposits which tend to be well drained. As a result surface runoff is converted to ground water flow and the streams become influent causing them to go dry or become intermittent when draining over these deposits.

Another result of faulting and repeated glaciation is that the base elevation of the Kootenai River was significantly lowered. As a result, tributaries to the Kootenai have had to vigorously down cut to try to match grade with the Kootenai valley. Of the major tributaries, only Deep and Boundary Creek have matched grade with the Kootenai River. The remaining tributaries have waterfalls which are barriers to fish migration. The rapid tributary down cutting has resulted in oversteepened mountain slopes, which tend to be less stable than slopes that have not yet been similarly rejuvenated. Natural and management induced landslides are most common on these rejuvenated landforms.

For larger Kootenai River tributaries, the elevation of oversteepened stream gradients and valley side slopes range from 3,000 to 4,200 feet in elevation in the Selkirks (3,500 feet is most common). Similar patterns of streams and slopes range about 2,400 to 2,600 feet in the Moyie River and Boulder Creek, which flow out of the Purcell and Cabinet Mountains.

The legacy and interactions of glacial advances and recessions, tectonic forces, volcanic eruptions, and fluvial processes have left a very complex and varied landscape which has fundamental implications to the stability and productivity of physical and biological features in the basin. About 6,700 years ago - immediately following the end of the Glacial Epoch - the basin settled into the very dynamic, but far more moderate, conditions under which the present streams, riparian areas, and aquatic biota evolved to tolerate and flourish. Before that time, it is likely that the slopes were very unstable and extremely responsive to rainfall and snowmelt. Such slope conditions were not good sites for vegetation establishment, and the lack of good cover contributed to the maintenance of the unstable and hydrologically responsive slopes. Stream flows probably fluctuated rapidly between extreme floods (relative to today) in the spring and during intense rainfall events, to very low summer flows. Sediment loading and movement through the channels was exceptional, resulting in rapidly adjusting channel conditions with intense aggradation and degradation. Many streams and floodplains in the basin have morphologies that are remnant of a wetter periglacial climate and hydrologically responsive slopes. Therefore, these streams are somewhat "oversized" given current climate and hydrologic conditions.

Aquatic species adapted to these conditions; but the stresses they were subject to may have lead to "boom and bust" populations that were frequent periods of major adjustment. Then, 6,700 years ago, volcanic activity from Mount Mazama (Crater Lake) in the Oregon Cascade Mountains caused several significant ash falls up to 18 to 24 inches over north central Idaho and the north Idaho panhandle. The ash provided a tremendous media for dense plant development and slope stabilization. The landscapes, and the ecosystems as we know them today have evolved and been refined to their present status under circumstances by ecologic and climatic processes that have been in place in the last 6,000 years. The present climate and hydrologic conditions are still very dynamic; but they are orders of magnitude more stable than most of the basin's prior history.

1.5   Soils

The basin is underlain by granite rocks associated with the Kaniksu Batholith and metasediments associated with the Belt Series. The quartzite-based Belt rocks weather into a broad range of size classes. These are significantly more stable and resilient on hill slopes and in stream channels than the uniform coarse weathered granitic sands of the intrusive batholiths. The bedrock is typically covered with glacial till which consists of unsorted and unstratified materials from glacial ice movement. The till is composed of material derived from rocks that were transported and deposited by the continental ice sheet. The till derived from Belt rocks is usually medium textured with a moderate amount of rock fragments. The granitic till is usually sandier and has a more variable amount of rock fragments. The top portion of the glacial till is loose and permeable while the lower part can be dense and impermeable. The dense layer can restrict water movement and root penetration. Deposits of outwash and alluvium are found in valley bottoms and were deposited by streams. Glaciofluvial deposits are located on slopes and valley bottoms where ice lobes caused water to pond. Lacustrine sediments from glacial lakes are usually found at elevations below 2,600 feet, but they are found at higher elevations. These deposits typically have a silt to sandy texture with few rock fragments. The lacustrine soil is contains more sandy near the Pend Oreille/Kootenai divide.

A layer of volcanic ash ½ to 1¼ feet thick has covered most of the glacial material. The ash is silt and has few rock fragments. This material came from several of the Cascade volcanoes with most ash coming from Mt. Mazama. The ash is usually a silt loam texture with little gravel or cobble. It normally has a high infiltration rate and high permeability. The ash has a high water and nutrient holding capacity. It is excellent for tree growth but can be easily compacted and displaced by heavy equipment.

1.6   Climate and Hydrology

The climate of the area is more moderate than most of the land to the east at the same latitude. Over half of the precipitation comes as winter snow, with November and December usually being the wettest months. Winter temperatures are cool and summers are warm and relatively dry. The precipitation amounts and patterns, as well as the temperature regimes are strongly influenced by air masses and storms from the Pacific Ocean that have migrated in from the west coast. The north-south trending mountains ranges and deep valleys are the dominant influence on local climate. "Prevailing weather is from the west, bringing air masses from the Pacific with high moisture content and moderate temperatures. Since the mountain ranges are more or less perpendicular to the prevailing weather, the air masses are forced to rise and cool, dumping their moisture as rain or snow on the mountains and rendering the adjacent valleys relatively drier.

Most of the winter precipitation accumulates in the basin as snow, over half of that becomes available as runoff as temperatures increase in the spring. This annual cycle of snow in winter and rain and melt in spring results in a strong spring peak in the annual hydrograph.

A stream gage on Boundary Creek has a long-term record which provides an example of the typical annual hydrograph. Peak flows occur annually in late May to June associated with the spring rain and snow melt as shown for water years 1990-99 (Figure 2).
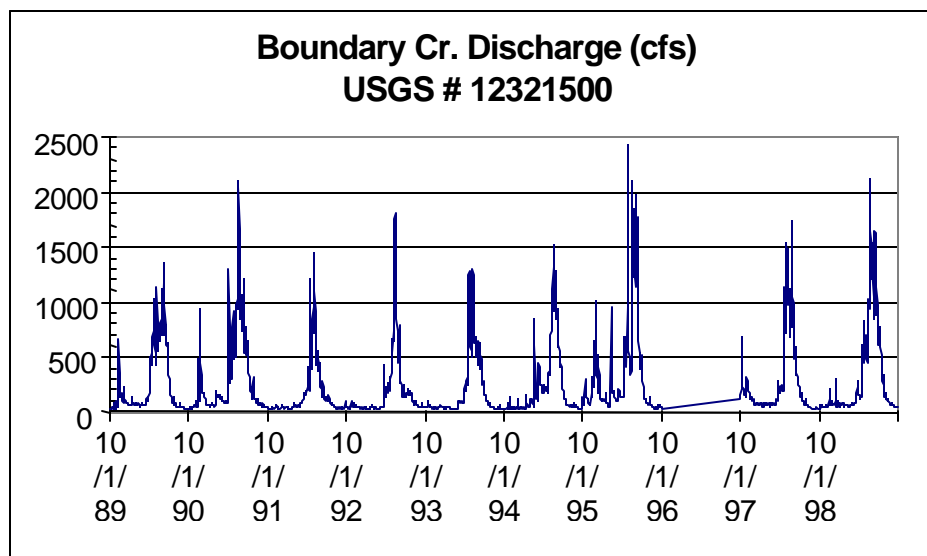

Figure 2: Daily mean discharge at Boundary Creek, water year 1990-1999.

Flows during the sample collection period followed the typical pattern (Figure 3). The annual mean discharge for WY 1999 was 282 cfs compared to 220 cfs for WY 1988-1999. Highest daily mean flow for WY 1999 occurred on May 25 (2120 cfs) and the seven-day minimum flow occurred October 21 (31 cfs).
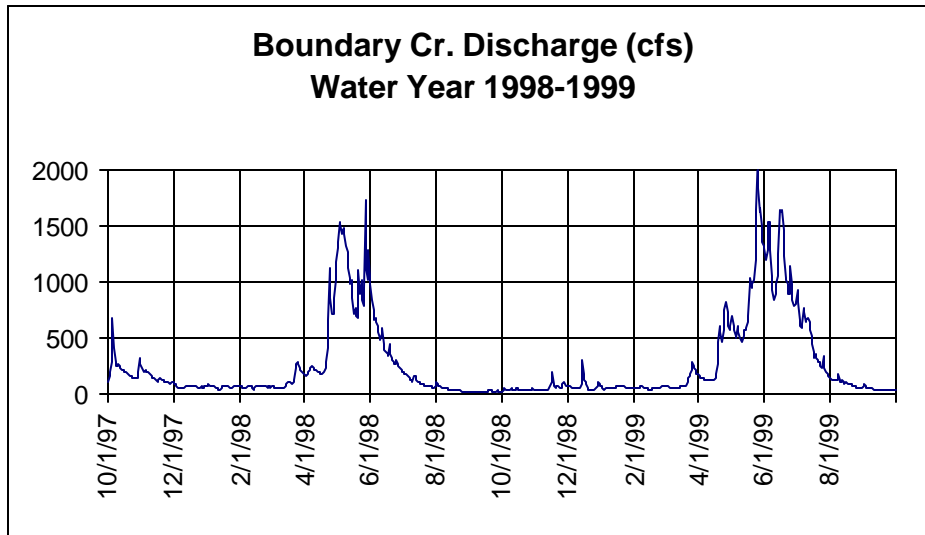
Figure 3: Daily mean discharge at Boundary Creek, water year 1998-1999.

1.7 Fisheries Resources

The Kootenai River basin has a diverse fishery resource important to native Americans and early settlers (Paragamian 1994). The Kootenai River has two unique fish species, an endemic population of burbot (*Lota lota*) and a genetically distinct population of white sturgeon (*Acipenser transmontanus*). Native salmonids in the basin include westslope cutthroat trout (*Oncoryhynchus clarki lewisi*), interior redband trout (*Oncoryhynchus mykiss gairdneri*), and kokanee (*Oncoryhynchus nerka*) and below Kootenai Falls, bull trout *(Salvelinus confluentus)* and mountain whitefish (*Prosopium williamsoni*) (summarized in Pacific Watershed Institute 1999). In general, native fish populations in the Kootenai River have been in decline for the past several decades. White sturgeon are currently listed as an endangered species and bull trout are listed as threatened (USFWS 1998). Burbot are a species of special concern in Idaho.

EcoAnalysts (1998) sampled three of the Kootenai River tributaries, Trout Creek, Long Canyon Creek, and Parker Creek. Fish sampling sites on Trout Creek illustrate the difference in fish communities that occur in high gradient stream reaches above the gradient break compared to the reach below the stream gradient and land use break. Upstream of the west side road the fish community was composed entirely of three species of Salmonidae: cutthroat trout, rainbow trout, and bull trout. On the low gradient reach of the stream near the Kootenai River the fish community shows evidence of anthropogenic disturbance. The fish community in this reach was dominated by sculpin (*Cottus sp*.), speckled dace (*Rhinichthys osculus*), and redside shiner (*Richardsonius balteatus*). Two introduced species, the black bullhead (*Ictalurus melas*) and brook trout (*Salvelinus fontinalis*) were also collected in this reach. The downstream reaches of Long Canyon Creek and Parker Creek were likewise dominated by sculpin, speckled dace, and redside shiners.

2.0   Summary of Applicable Reports

Studies in the Kootenai River basin were previously evaluated with respect to trace contaminants and nutrients in the *Kootenai River Water Quality Summary* (Bauer 1999). The majority of the reports address upstream sources of pollution in the Kootenai River (above Libby Dam) so the application to tributary watersheds in the Idaho reach is limited. The information is useful, however, in identifying the key contaminants (metals) that should be considered for evaluation in the Idaho tributary watersheds.

Metals

The previous studies (Table 1document the occurrence of metal sources in the Kootenai River watershed and their occurrence in water and sediment samples. Cadmium, copper, lead, zinc, and selenium were associated with specific sources in the watershed. Major source areas occur upstream of the Idaho reach and are associated with mining and milling operations in the Montana and British Columbia portion of the watershed. In some reports, statements were made regarding exceedence of water quality criteria in the Idaho reach of the Kootenai River, however, the potential for random contamination, analytical errors with trace contaminants, and misinterpretation of censored data (below lab detection limits) should lead one to be cautious in accepting these conclusions. The reports generally agree that the concentration of contaminants in the river has decreased over time due to pollution control measures at the source and construction of the Libby Dam, which acts as a settling basin for upstream pollutants. However, the continued contamination of water/sediments associated with current and historic mining areas and the potential bio-geological cycling of these contaminants through the ecosystem provide reasonable concern regarding their impact on aquatic resources.

Based on the review of the previous studies and the data evaluation completed on the Idaho reach (Bauer 1999), this report focuses on the following set of trace contaminants: arsenic, cadmium, copper, lead, mercury, selenium, and zinc.

Nutrients

Previous studies generally are in agreement that low nutrient concentrations are a major limiting factor for fisheries in the Kootenai River. There is less agreement on the causitive factors and thus the potential solutions that are needed to improve the fisheries. Synder and Minshall (1996) suggest that Lake Koocanusa acts as a nutrient sink on the Kootenai River, thus creating a food limitation for river fish communities. Pacific Watershed Institute (1999) suggest that the Kootenai River is naturally nutrient poor so the effect of Libby Dam and Lake Koocanusa as a nutrient sink may not be as important as other anthropogenic modifications to the river and flood plain (such as diking, flow regulation, etc.) below Libby Dam. This question of nutrients limiting fish productivity is the subject of continued evaluation in the Kootenai River system. For this report, we will evaluate the tributaries as nutrient sources to the Kootenai River and look for any spatial distributions that may provide some information on nutrient processing on the Idaho reach of the Kootenai River.

Table 1: Water quality and fisheries studies in the Kootenai River basin.

Kootenai River Studies	
1. Gruenenfelder, C.R. 1987.	Hydrogeology, hydrochemistry and reclamation alternatives for an inactive lead-silver mine in Northern

	Idaho. University of Idaho. Moscow, Idaho.
2. Apperson, K.A. and P.J. Anders. 1990.	Kootenai River white sturgeon investigations and experimental culture. US Dept. of Energy. Bonneville Power Administration, Division of Fish and Wildlife. Portland, Oregon.
3. Apperson, K.A. 1992.	Kootenai River white sturgeon investigations and experimental culture. Annual progress report FY 1991. US Dept. of Energy. Bonneville Power Administration, Division of Fish and Wildlife. Portland, Oregon.
4. Knudsen, K. 1994.	Water Quality Status Report, Kootenay River Basin British Columbia, Montana and Idaho. Ecological Resource Consulting. Helena, Montana.
5. Kinne, P., P. Anders, and S.V.L. Laboratories. 1995.	Interim report of Kootenai River water quality. Kootenai Tribe of Idaho. Bonners Ferry, Idaho.
6. **US Fish and Wildlife Service. 1998.**	White sturgeon: Kootenai River population *Acipenser transmontanus.* DRAFT Recovery plan. US Fish and Wildlife Service, Region 1. Portland, Oregon.
7. British Columbia State of Water Quality Reports	Kootenai River at Fenwick (Webber, T.N. 1996) Elk River at Highway 93 (Webber, T.N. 1996b) Kootenai River at Creston (Wipperman, B. 1997)
8. McDonald, L.E. and M.M. Strosher. 1998.	Selenium mobilization from surface coal mining in the Elk River basin, British Columbia: a survey of water, sediment and biota. Ministry of Environment, Lands and Parks, Kootenay Region. Cranbrook, British Columbia.
9. Snyder, E.B. and G.W. Minshall. 1996.	Ecosystem metabolism and nutrient dynamics in the Kootenai River in relation to impoundment and flow enhancement for fisheries management. Stream Ecology Center Dept. of Biological Sciences. Idaho State University. Pocatello, Idaho.
10. Richards, D. 1997.	Kootenai River Biological Baseline Status Report. U.S. Dept. of Energy. Bonneville Power Administration, Portland, Oregon.
11. Pacific Watershed Institute and Resources. 1999.	Kootenai River Watershed Assessment Report. Prepared for: The Kootenai Tribe of Idaho. Olympia and Spokane, WA.

3.0   Methods

4.0   Station Locations

Water quality stations were located on the major tributaries to the Idaho reach of the Kootenai River. Listed in upstream order this includes Deep, Myrtle, Ball, Fleming, Rock, Trout, Fisher, Mission, Parker, Long Canyon, Smith and Boundary Creek (Table 2, Figure 4 & Figure 5). *(River miles were calculated by measuring distance from the Canadian border with the GIS tool, so these river miles may not match up with other sources.)* Generally two stations were located on each tributary, one station at the approximate break from steep gradient to a shallow gradient. This location also generally separates the forested land use from the agricultural land use. Stream reaches below the slope break have generally been altered for agricultural uses via straightening and construction of levees, so the character of the stream changes abruptly. The second station is located as close to the mouth of the tributary as feasible in each situation. Since Trout Creek has two branches, a total of four stations were sampled, one upstream of the West Side road and one at the mouth of each branch.

Table 2. KTOI sampling stations on the Kootenai River Tributaries.

Station	Location	Description	Township	Range	River Mile
DC1	Deep Creek	Mouth of Deep Cr. at Kootenai R.	48*42'26.6"N	116*22'50.5"W	148.3
DC2	Deep Creek	3.25 miles upstream from the mouth.	48*38'42.3"N	116*23'28.6"W	
M1	Myrtle Creek	Mouth of Myrtle Cr. at Kootenai R.	48*44'18.8"N	116*24'43.6"W	144.8
M2	Myrtle Creek	Myrtle Cr. immediately upstream of the West Side road bridge.	48*42'26.6"N	116*24'56.6"W	
B1	Ball Creek	Mouth of Ball Cr. at Kootenai R.	48*47'17.2"N	116*24'31.8"W	140.1
B1	Ball Creek	Ball Cr. immediately upstream of the West Side road bridge.	48*47'35.1"N	116*24'43.6"W	
F1	Fleming Creek	Mouth of Fleming Cr. at Kootenai R.	48*47'28.3"N	116*22'59.3"W	138.9
R1	Rock Creek	Mouth of Rock Cr. at Kootenai R.	48*50'37.4"N	116*23'0.5"W	133.1
T1	Trout Creek (North Br.)	Mouth of Trout Cr. at Kootenai R.	48*50'20.4"N	116*24'39"W	131.7
T2	Trout Creek (North Br.)	Trout Cr. (North Branch) immediately upstream of the West Side road bridge.	48*50'5.1"N	116*25'9.4"W	
T3	Trout Creek (South Br.	Mouth of Trout Cr. (South Branch) at Kootenai R.	48*50'18.7"N	116*24'41.3"W	
T4	Trout Creek (South Br.	Trout Cr. (South Branch) immediately upstream of the West Side road bridge.	48*49'55.8"N	116*25'11.7"W	131.7
FS1	Fisher Creek	Mouth of Fisher Cr. at Kootenai R.	48*52'47"N	116*25'21.2"W	127.3
FS2	Fisher Creek	Fisher Cr. immediately upstream of the West Side road bridge.	48*52'50.4"N	116*26'3.3"W	

Station	Location	Description	Township	Range	River Mile
MS1	Mission Creek	Mouth of Mission Cr. at Kootenai R.	48*54'20.5"N	116*24'6.1"W	124.1
MS2	Mission Creek	Mission Cr. immediately downstream of County Road 45 – approx. 1 mile from Highway 95.	48*54'19.7"N	116*23'26.3"W	
P1	Parker Creek	Mouth of Parker Cr. at Kootenai R.	48*55'35.7"N	116*28'35.6"W	118
P2	Parker Creek	Parker Cr. immediately upstream of the West Side road bridge.	48*55'6"N	116*29'29.6"W	
LC1	Long Canyon Creek	Mouth of Long Canyon Cr. at Kootenai R.	48*57'38.5"N	116*32'6.1"W	110.7
LC2	Long Canyon Creek	Long Canyon Cr. immediately upstream of the West Side road bridge.	48*57'2"N	116*32'3.9"W	
S1	Smith Creek	Mouth of Smith Cr. at Kootenai R.	48*57'50"N	116*31'44.4"W	110.4
S2	Smith Creek	Smith Cr. immediately upstream of the West Side road bridge.	48*57'38.5"N	116*33'11"W	
BD1	Boundary Creek	Mouth of Boundary Cr. at Kootenai R.	48*59'59.2"N	116*30'16.4"W	105.7
BD2	Boundary Creek	Boundary Cr. approximately 1.3 miles from the West Side road on Boundary Cr. road.	48*59'48.4"N	116*34'8.4"W	

4.1 Field and Laboratory Methods

Samples are collected by the Kootenai Tribe of Idaho in plastic bottles provided by the Spokane Tribal Laboratories, Spokane, Washington. The bottles and caps are rinsed with the sample water before the sample is collected. Water samples are collected by immersing the bottles into the top six inches of surface water. No preservatives are used for these water samples. The samples are then packaged into a cooler with ice and sent to the lab via a Federal Express priority overnight delivery.

Water quality samples were collected on an approximately monthly frequency from August 1998 to February 2000.

Laboratory methods follow EPA analysis procedures as indicated by Method Number in the table (Table 3).
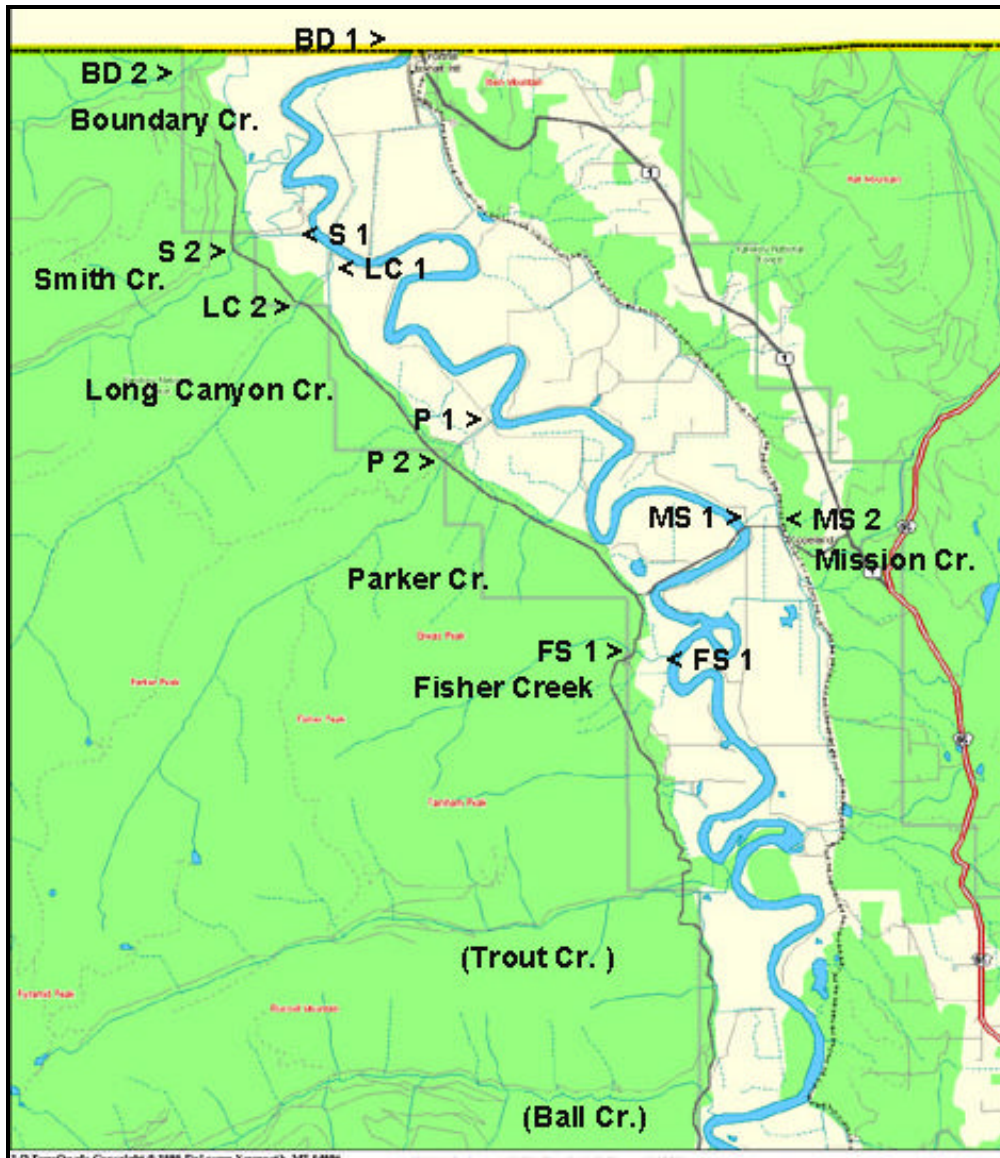
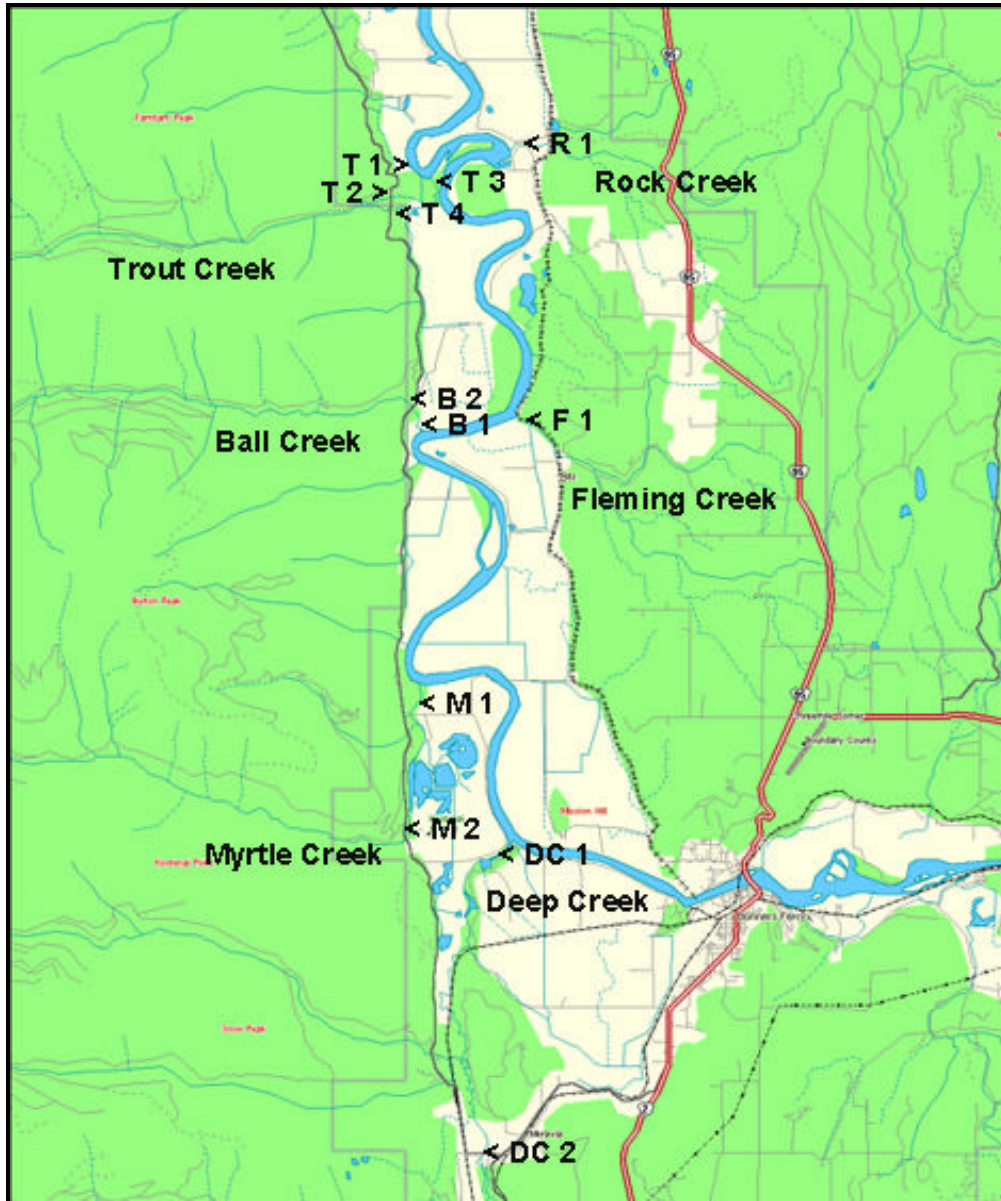**Figure 4: Kootenai River tributary stations (downstream segment).**

Figure 5: Kootenai River tributary stations (upstream segment).

Table 3. Laboratory analytical methods and reporting limits.

Element	Parameter	Reporting limit (mg/L)	Method
Inorganic non-metals			
	Hardness as $CaCO_3$		EPA 160.1
	Chloride, Cl		EPA 300
	Fluoride, F		EPA 300
	Nitrate as N		EPA 300
	Nitrite as N		EPA 300
	Total Phosphorous		EPA 200.7
	Ortho-Phosphate as P		EPA 300
	Total alkalinity as $CaCO_3$		EPA 310
	Bicarbonate as $CaCO_3$		EPA 310
	Carbonate as $CaCO_3$		EPA 310
Metals			
	Aluminum. Al	0.01-0.06	EPA 200.7
	Antimony, Sb		EPA 200.7
	Arsenic, As	0.04-0.05	EPA 200.7
	Barium, Ba		EPA 200.7
	Beryllium, Be		EPA 200.7
	Cadmium, Cd	0.004-0.005	EPA 200.7
	Calcium, Ca		EPA 200.7
	Chromium, Cr	0.004-0.007	EPA 200.7
	Cobalt, Co		EPA 200.7
	Copper, Cu	0.004-0.007	EPA 200.7
	Iron, Fe		EPA 200.7
	Lead, Pb	0.001-0.005	EPA 200.9
	Magnesium, Mg		EPA 200.7
	Manganese, Mn		EPA 200.7
	Mercury, Hg	0.0002	EPA 245.1
	Nickel, Ni		EPA 200.7
	Potassium, K		EPA 200.7
	Selenium, Se	0.05-0.08	EPA 200.7
	Silver, Ag		EPA 200.7
	Sodium, Na		EPA 200.7
	Zinc, Zn		EPA 200.7

4.2   Data Interpretation Issues

There are several issues that need to be considered when interpreting the toxicity of metals from water samples. The outcome of data interpretation depends on how these issues were addressed in sampling and analysis. These issues include: the method used for filtration and digestion; the quality control provided in sample collection; quality control/quality analysis in the laboratory; comparability between laboratory procedures and detection limits; and use and applicability of state and national water quality criteria.

4.2.1 Dissolved vs. Total Metals

Dissolved metal is operationally defined as the metals in a solution that passed through a 0.40 to 0.45 micron filter. A part of what is measured as dissolved metal is actually soluble hydrated or complexed metal ions combined with particulate metal that is small enough to pass through the filter openings, or metals that are adsorbed to or complexed with organic colloids and ligands. Some or all of the small particulate-bound metal in the soluble complexed metal may not be toxic to aquatic organisms. Total recoverable metal is defined as the measurement of metals after acid digestion, according to U.S. EPA promulgated analytical methods. Particulate metal is operationally defined as the difference between total recoverable metal and dissolved metal in sample (Bergman and Dorward-King 1997). Historically, water quality criteria for metals have been expressed exclusively in terms of total recoverable metal. EPA has changed that policy and now recommends dissolved metal concentrations for water quality standards (U.S. EPA 1999a). The reason for the change in policy is that dissolved metal more closely approximates the toxicity of a metal in the water column than does total recoverable metal.

4.2.2 Method Detection Limits

Method Detection Limit (MDL) refers to the concentration that, when processed through the complete method, produces a signal with a 99 % probability that it is different from the blank (Standard Methods, APHA 1998). Laboratories provide the "reporting limit" with each analysis that is completed, the reporting limit is usually considered 2-3 times the noise in the analytical system. Where ambient metal concentrations are much higher than the detection limits the data may be considered to be comparable for purposes of interpretation. However, when detected concentrations are close to the method detection limits then there are legitimate concerns about comparability. The decision to delete suspected values from the data set due to perceived detection limit problems is discussed in the results section for each metal evaluated.

4.2.3 Application of Water Quality Criteria to Data Interpretation

EPA national recommended criteria are intended to provide guidance to states and tribes with authority to develop water quality standards. Ideally, water quality criteria would be developed on a site-specific basis to reflect the individual characteristics of the basin geochemistry and the aquatic species. However, developing specific water and sediment criteria is technically challenging and is rarely been completed at a local scale.

U.S. EPA criteria are used as a screening tool for evaluation of metals toxicity. Our experience is that developing localized criteria from the literature for a report (assuming that there is sufficient information available) leads to considerable confusion. The conclusions from such an independent analysis can lead to a proliferation of various interpretations -- each of which have no basis in environmental law or regulation. Each analyst can interpret the literature in a different manner which leads to different judgment of toxicity. The national criteria are based upon several decades of experience and have been subjected to a rigorous review process.

The most recent EPA national criteria have been compiled in the document, *National Recommended Water Quality Criteria -- Correction* (U.S. 1999a). Water quality criteria for freshwater are reported for two exposure periods, Criteria Maximum Concentration (CMC) and Criteria Continuous Concentration (CCC), based on lab toxicity test for 24 and 96 hour periods. The CCC is defined as ***"the highest in-stream concentration of the toxicant to which organisms can be exposed indefinitely without causing unacceptable effect"***. The CCC is operationally equivalent to chronic toxicity and CMC to acute toxicity. For all data comparisons we have used the chronic criteria, or CCC, since this is more applicable to the goal of protection of fisheries in the river.

The recommendations for water quality criteria vary slightly between the latest EPA guidance and the current Idaho water quality standards. These differences are important from a regulatory standpoint, but have little practical significance. We have chosen to use the *National Recommended Water Quality Criteria (*U.S. EPA 1999a) to be consistent with the latest national recommendations. EPA recently completed a biological assessment of the Idaho Water Quality Standards for toxic pollutants (U.S. EPA 1999b) for listed species in Idaho including the Kootenai

River sturgeon and several species of salmon. The document is a comprehensive review, which provides an update of toxicity information for application to the listed species and summarizes issues relevant to data interpretation. Please refer to the summary of metal toxicity from this document (U.S. EPA 1999b) included in Appendix C.

4.3   Hardness Values used to calculate criteria

The freshwater criteria for several metals are expressed as a function of calcium carbonate hardness (mg/L) in the water column. These metals include cadmium, chromium, copper, lead, nickel, silver, and zinc. As hardness decreases, the calculated criteria also decrease, reflecting the higher toxicity of metals in waters with low mineral concentrations (low hardness).

The first step in calculating criteria for these metals is to determine the hardness value to use.   Hardness varies in the Kootenai River tributaries based on geographic location (geologic parent material), season and discharge (Figure 6, Appendix A). The overall median hardness value for the Kootenai River tributaries is 15 mg/L. Using a lower hardness value results in a lower criteria value; this is more conservative (protective) of the aquatic resource; therefore we used 15 mg/L to calculate the metals criteria for all tributaries. Note that Deep Creek, Fleming Creek, Rock Creek, and Mission Creek exhibit considerably higher hardness values than the overall median.
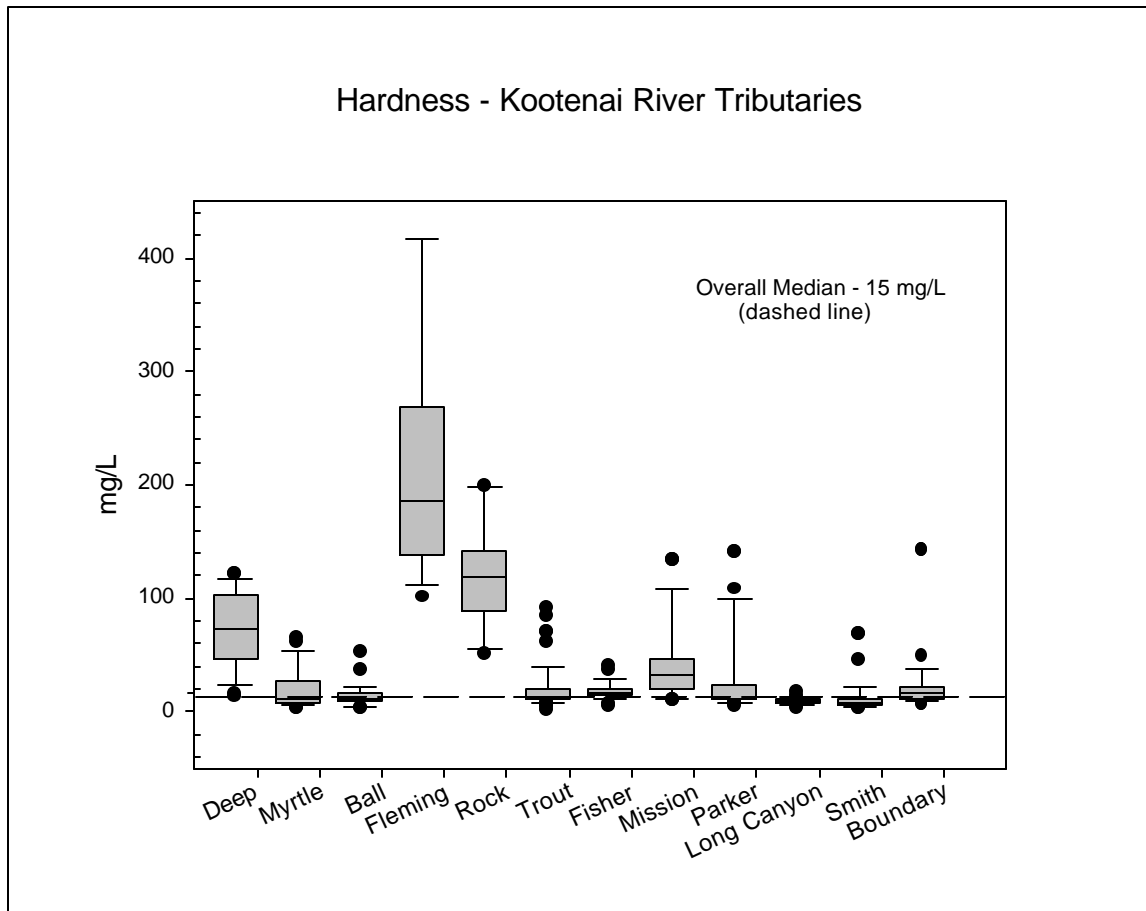
Figure 6: Hardness values for Kootenai River tributaries.

The water quality criteria resulting from application of the 15 mg/L hardness value as well as criteria for other elements are listed in Table 3. The units, ì g/L (parts per billion) are the units of scale used in the EPA guidance document. In the Results Section, we use mg/L (parts per million) since these are the units reported by the laboratory. Although somewhat cumbersome for comparison to criteria, using the same units reported by the lab retains continuity with the underlying databases.

Table 4. Water quality criteria applicable to the Kootenai River.

US EPA Water Quality Criteria (EPA 1999) Freshwater Aquatic Life for 15 mg/L hardness

	Chronic Criteria		
Element	**(ug/L)**	**(mg/L)**	**Footnotes**
Arsenic	50.00	0.0500	2,3,6
Cadmium	0.55	0.00055	1,3
Chromium III	15.67	0.01567	1,3
Chromium VI	11.00	0.0110	3
Copper	1.77	0.00177	1,3
Lead	0.30	0.0003	1,3
Nickel	10.45	0.0105	1,3
T. Mercury	0.77	0.0008	3,5
Selenium	4.61	0.0046	4
Silver	0.13	0.00013	7
Zinc	23.68	0.02368	1, 3
Aluminum	87.00	0.0870	8
Iron	1000.00	1.0000	

Notes to Criteria:

1) Cadmium, chromium, copper, lead, nickel, silver, and zinc criteria are hardness dependent.

2) The recommended criteria was derived from data for As III, but is applied to total As.

3) Criteria are expressed in terms of dissolved metals.

4) The criteria for selenium is converted to be expressed as dissolved metals.

5) Criteria derived from inorganic mercury (II), but applied to total mercury.
   If a substantial portion of the mercury is methlymercury, the criterion will be underprotective.

6) Arsenic criteria of 50 ug/L is derived from the Idaho Water Quality Standards (IDEQ 2000)

7) Silver criteria listed is for acute toxicity. No chronic criteria for silver has been promulagated.

8) Aluminum criteria for Total Recoverable Metals.

5.0   Results

Metals data were first sorted by element; obvious outliers were then evaluated against laboratory reports and data entry error corrections were made. Data were sorted by station and then by date to complete the tables included in Appendix B. The units reported by the lab, mg/L (parts per million) are retained in this report, although contaminants and their criteria are routinely reported in ì g/L (parts per million). Converting these results to ì g/L would inaccurately convey a sense of accuracy and precis ion that was not achieved by the methods used. The summary statistics address both the values less than the detection limits and values greater than the detection limits as explained below.

Summary statistics were computed on the entire data set, including the less-than values. Less-than-values were treated as a real number for the purpose of this data summary including the ***Number in the data set, Mean, Standard Deviation, Minimum, Maximum, Median, 1st Quartile, 2nd Quartile and 3rd Quartile***. Summary statistics tables are presented for all elements in Appendix B.

The second section of the Summary Statistics Tables list the ***Number less than the detection limits, the Number greater than the detection limits, and the Mean and Median for results greater than the detection limits***. Lastly, the table lists the ***Number greater than the water quality criteria*** and the percent of all samples that exceed the criteria.

Generally the median and interquartile range (non-parametric statistics) are more meaningful for water quality data than the mean and standard deviation (Helsel and Hirsh 1995). The ***median***, or 50th percentile, is a measure of central tendency that is resistent to the effects of extreme observations. The ***interquartile range*** is a resistent measure of the spread of the data around the median, and is calculated as the difference between the 3rd and 1st quartile. Because most values are reported at the detection limit, there is little spread to the data and so the interquartile range is not presented as a separate statistic.

5.1   Aluminum

The EPA criterion for aluminum is expressed in terms of the dissolved metal (footnote D, U.S. EPA 1999a). The criteria for freshwater life is 87 µg/L (0.00087 mg/L) for chronic toxicity. The Spokane Tribal Lab reported aluminum as Total Aluminum, in mg/L with a detection limit of 0.01 – 0.06 mg/L.

Of the 301 results reported for aluminum, 198 were measured above the detection limit. The overall median value for all samples is 0.061 mg/L; for samples over detection limits the median value is 0.094 mg/L. Thirty-four percent (103) of the samples exceeded the EPA criterion. Higher values for aluminum occurred in March and April, with extreme values occurring during the March 15, 1999 sample period.

As can be noted in Table 5, the highest values occur in Rock Creek, Fleming Creek and Deep Creek. These high values may be associated with natural chemical composition of the geologic parent material in these basins and/or associated with human disturbance activities (roads, mining etc.) that mobilize minerals. Since extreme values were detected in March, these higher values are likely associated with suspended particles entrained in the water column due to snowmelt/spring runoff as illustrated for Deep Creek (Figure 7).

Are these higher aluminum concentrations a source of toxicity to aquatic organisms? Since data was collected as grab samples and analyzed as total metals, it is not feasible to answer this question with certainty. Bioavailability of metals (and toxicity) to organisms is generally acknowledged to be associated with the dissolved fraction of the metal (Bergman and Doward-King 1997). To get a better assessment, field-filtered samples for analysis as dissolved metals should be collected at the same time as total samples. If the

metals reported are primarily in the paticulate fraction (non-bioavailable), the assumption is that the metal is in an essentially non-toxic form. If the metals were in a dissolved fraction (bioavailable), there would be a greater cause for concern. This question can be answered with a follow-up study that targets aluminum in selected parts of the drainage (Rock, Fleming, and Deep Creek) and by using appropriate methods of data collection and analysis, such as field filtration and analysis for dissolved metals.

Table 5: Aluminum summary statistics.

Kootenia River Tributaries Aug 1998 - Feb 2000

Total Aluminum (mg/L)
Summary Statistics

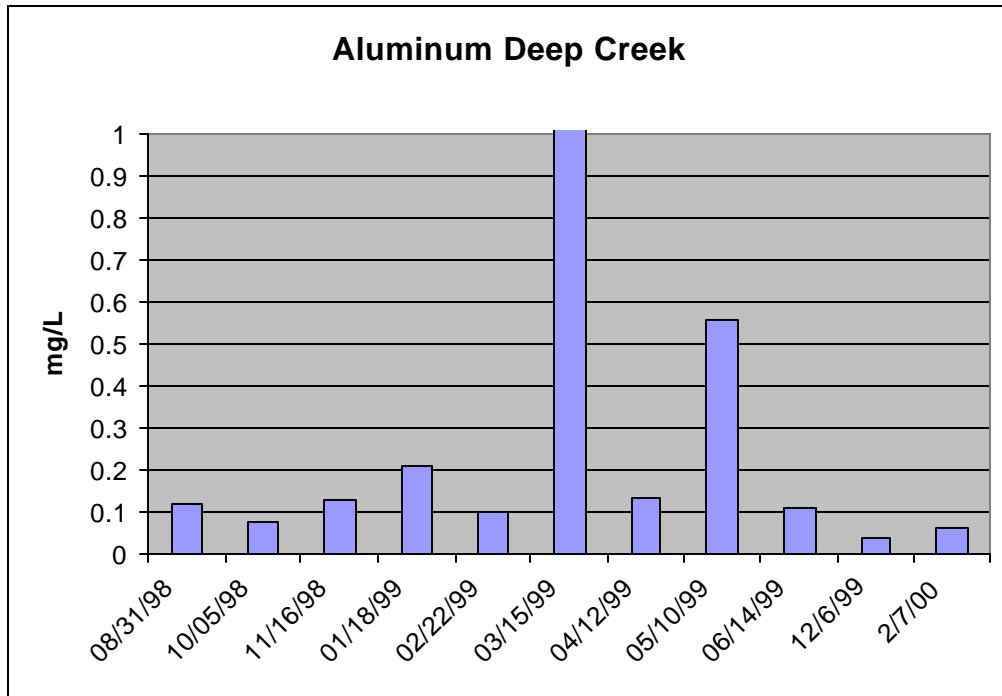|	
Number	301
Mean	0.174
Standard Deviation	0.618
Min	0.01
Max	8
Median	0.061
1st Quartile	0.053
2nd Quartile	0.061
3rd Quartile	0.125
N < detection limit	103
N > detection limit	198
Mean > detection limit	0.240
Number > criteria	103
% exceedence of criteria	34.22%
Notes:	
Al Criteria	0.087
Detection Limit	0.01 - 0.06

Figure 7: Seasonal distribution of aluminum in a representative tributary.

5.2   Arsenic

The EPA criteria for arsenic is derived from data for arsenic (III) but applied to Total Arsenic, i.e., the sum of As (III) plus As (V), µg/L (footnote A, U.S. EPA 1999a) and should correctly be identified as ***Dissolved Inorganic Arsenic***. The EPA criteria document also indicates that the criteria in the table are expressed in terms of the dissolved metal in the water column (footnote D, U.S. EPA 1999a). The EPA criteria for freshwater life is 150 µg/L for chronic toxicity. The State water quality standard of 50 µg/L is lower than the EPA criteria and is therefore used as a screening tool in this assessment.

Spokane Tribal Laboratories reported arsenic as Total Arsenic, mg/L. Of the 230 results reported for arsenic, 8 were measured above the detection limit of 0.04-0.05 mg/L, and 6 exceeded the criteria (Table 6). The median value for arsenic for the 8 positive detected samples is 0.053 mg/L with a range of 0.042 – 0.062 mg/L. There is no obvious temporal or spatial pattern to the arsenic data.

The concentration of arsenic that is toxic to aquatic organisms has not been resolved among toxicologists, resulting in different criteria recommended for arsenic (0.05 mg/L, Idaho DEQ water quality standards and 0.15 mg/L, EPA recommended criteria). The current State criteria is procedurally derived from an earlier EPA recommendation (the National Toxics Rule, EPA 1992), which was revised by EPA (U.S. EPA 1999a). Given this state of the science, and the low measured concentrations, it does not appear that arsenic is a concern in these tributaries.

Table 6: Arsenic summary statistics.

Kootenia River Tributaries Aug 1998 - Feb 2000

Total Arsenic (mg/L)
Summary Statistics

Number	230
Mean	0.047
Standard Deviation	0.005
Min	0.04
Max	0.065
Median	0.05
1st Quartile	0.04
2nd Quartile	0.05
3rd Quartile	0.05
N < detection limit	222
N > detection limit	8
Mean > detection limit	0.055
Number > criteria	6
% exceedence of criteria	2.61%

Notes:

As Criteria	0.05
Detection Limit	0.04 - 0.05

5.3   *Cadmium*

The EPA criterion for cadmium is expressed in terms of the dissolved metal (footnote D, U.S. EPA 1999a) as a function of hardness (footnote E, U.S. EPA 1999a) in the water column. A hardness value of 15 mg/L is used to calculate criteria, resulting in a criteria of 0.55 µg/L or 0.00055 mg/L.

Spokane Tribal Laboratories reported cadmium as Total Cadmium, µg/L. Of the 301 results reported for cadmium, 2 were measured above the detection limit. The one high value, 3.5 mg/L, appears to be an outlier when compared to the rest of the data on the Kootenai River.

5.4   *Copper*

The EPA criteria for copper are expressed in terms of the dissolved metal as a function of hardness (footnote E, U.S. EPA 1999a). Using a hardness value of 15 mg/L , the chronic criteria is 1.77 µg/L or 0.00177mg/L.

The Spokane Tribal Laboratories reported copper as Total Copper, mg/L. Of the 301 results reported for copper, 9 were measured above the detection limit. The median for the samples detected is 0.006 mg/L.

5.5 Lead

The EPA criteria for lead is expressed in terms of the dissolved metal (footnote D, U.S. EPA 1999a) as a function of hardness (footnote E, U.S. EPA 1999a). A hardness value of 15 mg/L results in a chronic criteria of 0.30 µg/L (0.0003 mg/L).

Spokane Tribal Laboratories reports lead as Total Lead, mg/L with detection limits of 0.001 – 0.005 mg/L. This detection limit is higher than the criteria by a factor of 3 or more; e.g, placed on a comparable scale (multiply by 10,000) the criteria of 3 is much lower than the detection limits of 10-50. Non-detections would therefore exceed the criteria if the less than sign were ignoired, leading to possible false data interpretations if this fact were not taken into account.

Of the 266 results reported for lead, 65 (24 %) were measured above the detection limit. The median value for samples above detection limits is 0.003 mg/L (Table 7). An inspection of the data (Appendix B) shows that the majority of the positive detections occurred at or slightly above the detection limits.

Do these results represent ambient lead concentrations that are a concern for aquatic toxicity or are they an artifact of the analytical procedures? To answer this question, the results reported for the tributaries can be compared to the results for lead in the mainstem of the Kootenai River as reported in Bauer (1999). Lead analyzed in the Kootenai River samples were analyzed by several laboratories including Frontier Geosciences, a lab that specializes in low-level metals analysis. The median value for lead in the Kootenai River (only samples greater than detection limits) reported from the Frontier Geosciences lab was 0.035 ì g/L. Using comparable units, this is equivalent to 0.000035 mg/L. The median value for the tributaries of 0.003 mg/L is approximately 100 times greater than the value reported in the Kootenai River. Our inspection of the two data sets and the laboratory detection limits leads us to conclude that the positive detections reported for the tributaries are an artifact of the analytical methods used rather than a cause for concern with lead contamination. The only way to positively resolve this question would be to resample for lead (and other metals of concern) using clean sampling procedures and low-level analytical methods as used by Frontier Geosciences laboratory.

Kootenia River Tributaries Aug 1998 - Feb 2000

Total Lead (mg/L)
Summary Statistics

Number	266
Mean	0.002
Standard Deviation	0.003
Min	0.001
Max	0.02
Median	0.001
1st Quartile	0.001
2nd Quartile	0.001
3rd Quartile	0.001
N < detection limit	201
N > detection limit	65
Mean > detection limit	0.005
Median > detection limit	0.003
Number > criteria	65
% exceedence of criteria	24.44%

Notes:

Pb Criteria	0.0003
Detection Limit	0.001-0.005

5.6   Mercury

The EPA criteria for mercury is derived from inorganic mercury (II), but, applied to Total Mercury (Total implying all the species of mercury in the sample). Th EPA criteria document notes that if a substantial portion of the mercury is methylmercury, the criteria will be underprotective (footnote hh, U.S. EPA 1999a). The criteria apply to the dissolved metal (footnote D, U.S. EPA 1999a) which implies that EPA criteria should be expressed in terms such as Total Dissolved Mercury. The mercury criteria for freshwater life is 0.77 µg/L for chronic toxicity.

Spokane Tribal Laboratories reported mercury as Total Mercury in mg/L with a detection limit of 0.0002 mg/L. Of the 293 results reported for mercury, no samples were measured above the detection limit.

5.7   Selenium

The EPA acute toxicity criteria for selenium is based on the fraction of total selenium that is in the form of selenite (IV) and selenate (VI) (footnote L, U.S. EPA 1999a). The fractions for this calculation were based on the values reported for the Kootenai River (Bauer 1999) since these fractions were not analyzed in the tributaries. The EPA document notes that the recommended water quality criterion is expressed in terms of total recoverable metals, but, can be expressed in terms of dissolved metal by multiplying by a factor of 0.922 (footnote T, U.S. EPA 1999a). The chronic criteria, expressed as Dissolved Selenium is 4.61 µg/L or 0.00461 mg/L.

Spokane Tribal Laboratories reported selenium as Total Selenium at a detection limit of 0.05 – 0.08 mg/L.

Of the 230 results reported for selenium, 4 were measured above the detection limit.

5.8   Zinc

The EPA criteria for zinc are expressed in terms of the dissolved metal (footnote D, U.S. EPA 1999a) as a function of hardness (footnote E, U.S. EPA 1999a) in the water column. A hardness value of 15 mg/L was used to calculate a criterion of 23.7 ì g/L (0.0237 mg/L).

Spokane Tribal Laboratories reported selenium as Total Zinc at a detection limit of 0.005 – 0.01 mg/L.

Of the 299 results reported for zinc, 4 were measured above the detection limit.

5.9   Nutrient Data

Nutrient data for the Kootenai River tributaries is compared to water quality in the Kootenia River for three previous studies: 1994 data (Synder and Minshall 1996); 1980-1995 data (USGS data as reported in Synder and Minshall 1996); and KTOI data for 1997-1998 (Bauer 1999). Comparability between nutrient data reported in different studies is an important consideration in data interpretation so the forms of nutrients will be discussed first. Only ortho-phosphate as P was analyzed in the tributaries so the discussion will be limited to dissolved phosphorus forms.

The reported phosphorus species depends on the sampling and preservation technique used in the field and steps used in the lab to filter, digest, and analyze the water sample. Phosphorus reported by the KTOI for the Kootenai River samples (1997-98 study) was ortho-Phosphorus as P (USBR laboratories, U.S. EPA Method 365.3, 0.003 mg/L detection limit) and ortho-Phosphate as P (Spokane Tribal Laboratories, U.S. EPA Method 300.0, 0.01 mg/L detection limit). The samples are filtered (0.45 ì m filter) in the laboratory, are not digested before colorimetry, and are therefore equivalent to Dissolved Reactive Phosphorus as described in Standard Methods (APHA 1998). Spokane Tribal Laboratories used the same method for the tributary study as for the river study so these results are directly comparable. We therefore have combined the samples in data analysis and will refer to them as *Dissolved Phosphorus*. Generally the dissolved fraction is considered readily bio-available.

ISU reported P as Soluble Reactive Phosphorus (described as filtered, followed by colorimetric analysis), which is equivalent to *Dissolved Phosphorus* sampled by KTOI. USGS samples, summarized in Synder and Minshall (1996), are reported as *Total Dissolved Phosphorus as P*, TPO_4. According to Standard Methods (APHA 1998) these samples have been filtered, then digested, and therefore are ***not*** directly comparable to Dissolved Phosphorus reported by ISU or KTOI. The digestion step would reduce any complex forms of P to its elemental form for analysis as ortho-phosphate, and, therefore could be expected generally to result in a higher concentration of P in comparison to non-digested samples. For the purpose of this report, we

compare the USGS data for *Total Dissolved Phosphorus* to the Dissolved Phosphorus reported by ISU and KTOI.

Dissolved inorganic nitrogen in surface waters is measured as nitrates (NO_3), nitrites (NO_2), and ammonia (NH_4). In waters not contaminated by anthropogenic sources, the majority of the inorganic nitrogen occurs as nitrate. Typically, surface samples are analyzed as nitrate plus nitrite, since these forms are readily interconvertable and bioavailable to autotrophic organisms. The two laboratories used by KTOI for the river study reported data as **Nitrate as N** (mg/L); USBR (U.S. EPA method 353.2) and Spokane Tribal Laboratory (U.S. EPA method 353.2). ISU and USGS data was reported as Nitrate + Nitrite ($NO_3 + NO_2$), mg/L as N. These forms are considered comparable for this report since nitrites are expected to be very low in the Kootenai River. For the current tributary study Spokane Tribal Laboratories used EPA Method 300.0 to analyze for nitrites and nitrates (**Nitrate as N** (mg/L) separately.

5.9.1   Treatment of Less-Than Values

For nutrient data the less-than values are meaningful since one of the issues in the Kootenai River is the low level nutrient status. The less than-values are retained at the level reported, and were not otherwise converted or manipulated in the data base. ***Ortho-phosphate concentrations reported in the tributaries were all less than the laboratory detection limits of 0.01 - 0.026 mg/L***.

5.10   Dissolved Phosphorus

Dissolved phosphorus was reported for 301 samples in the Kootenai River tributaries for the period August 1998 - February 2000. All samples were reported below the detection limits: 142 less than 0.01 mg/L, 114 less than 0.026 mg/L, and 45 less than 0.026 mg/L (Appendix F). Given the lack of data above detection limits, it is not feasible to evaluate spatial or temporal distribution, but, it does give some information on phosphorus concentrations in comparison to the mainstem Kootenai River.

The data distribution for the tributaries are compared to the values in the Kootenai River reported in previous studies: KTOI data for 1997-1998, ISU for 1994 and USGS for 1980 – 1995 (Figure 8). Although the USGS record spans a long time period, the data represents a small sample frequency per year (2-5 samples per season). Both the ISU and USGS data for dissolved phosphorus was reported close to or below the detection limit of 0.01 mg/L. The median and interquartile range for the two data sets are comparable - ISU (0.010 ± 0.005 mg/L) and USGS (0.010 ± 0.011 mg/L). The median value of 0.02 mg/L for the tributaries reflects the higher detection limits, not environmental differences.

Dissolved phosphorus levels are as low in the tributaries as they are in the mainstem Kootenai River. Although tributaries have been influenced by human activities there is no signal from this data that the tributaries have been enriched with phosphorus. It appears that these watersheds have a naturally low level of phosphorus and therefore even land-disturbing activities that may increase sediments (and associated phosphorus) have not had an effect on increasing phosphorus to the Kootenai River system.

5.11   Nitrates

No samples collected in the tributaries contained any nitrite above detection limits, so the results will only address the concentration of nitrates. The detection limit of 0.005 mg/L for Nitrate as N was exceeded for 226 out of 301 observations.

Streams are arrayed from downstream (Deep Cr.) to upstream (Boundary Cr.) along the X axis in Figure 9. Nitrate concentrations are variable in the stations depending on location in the watershed and placement along the stream. Many of the westside tributaries (Myrtle, Ball, Trout, Fisher, Long Canyon Creek) exhibit very low nitrate concentrations, many below the detection limit. The eastside tributaries (Fleming, Mission, Rock) and Deep Creek (on the south) show higher nitrate concentrations: median of 0.015 for westside tributaries versus 0.071 for the eastside tributaries.

At some streams (Deep, Parker, and Boundary), nitrates are higher at the lower station near the mouth than at the upstream station. Several of the data distributions are skewed by a few extreme values measured in February/March of 1999: For example, Fleming 3.9 & 11.1 mg/L, upper Mission 9.0 mg/L, Mission 7.5 mg/L, Boundary 2.4 mg/L, Parker 1.7 mg/L, Rock 0.84 mg/L. The assumption is that agricultural and drainage activities near the river are increasing nutrient concentrations, however, the source of these high values is not known.

The effect of location in the watershed can be noted by comparison of nitrate concentrations in the tributaries, grouped as eastside or westside, to the concentation in the Kootenai River (Table 8, Figure 10). The median in the three river studies are similar: KTOI (0.055 mg/L), ISU (0.070 mg/L) and USGS (0.059 mg/L). In comparison, the eastside tributaries exhibit a much lower nitrate concentration, median of 0.015 mg/L. Westside tributaries (median 0.071 mg/L) exhibit a similar to higher concentration than the river stations.

Dissolved Phosphorus: Tributaries versus Kootenai River
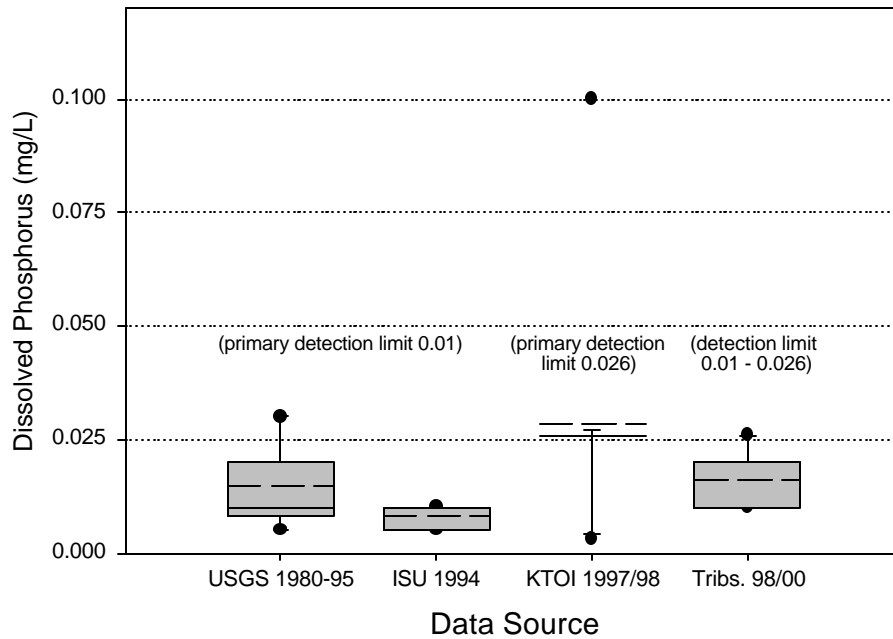
[Box Plot: Plots the median, 5th, 25th, 75th, and 95th percentiles. Arithmetic mean - dashed line.]

(Note: All 301 tributary samples were less than detection limits.)

(Note: See text regarding the phosphorus fraction reported in the study.)

Figure 8: Dissolved Phosphorus: Comparison of Tributaries to River.

Table 8: Nitrate as N (mg/L): Summary Statistics.

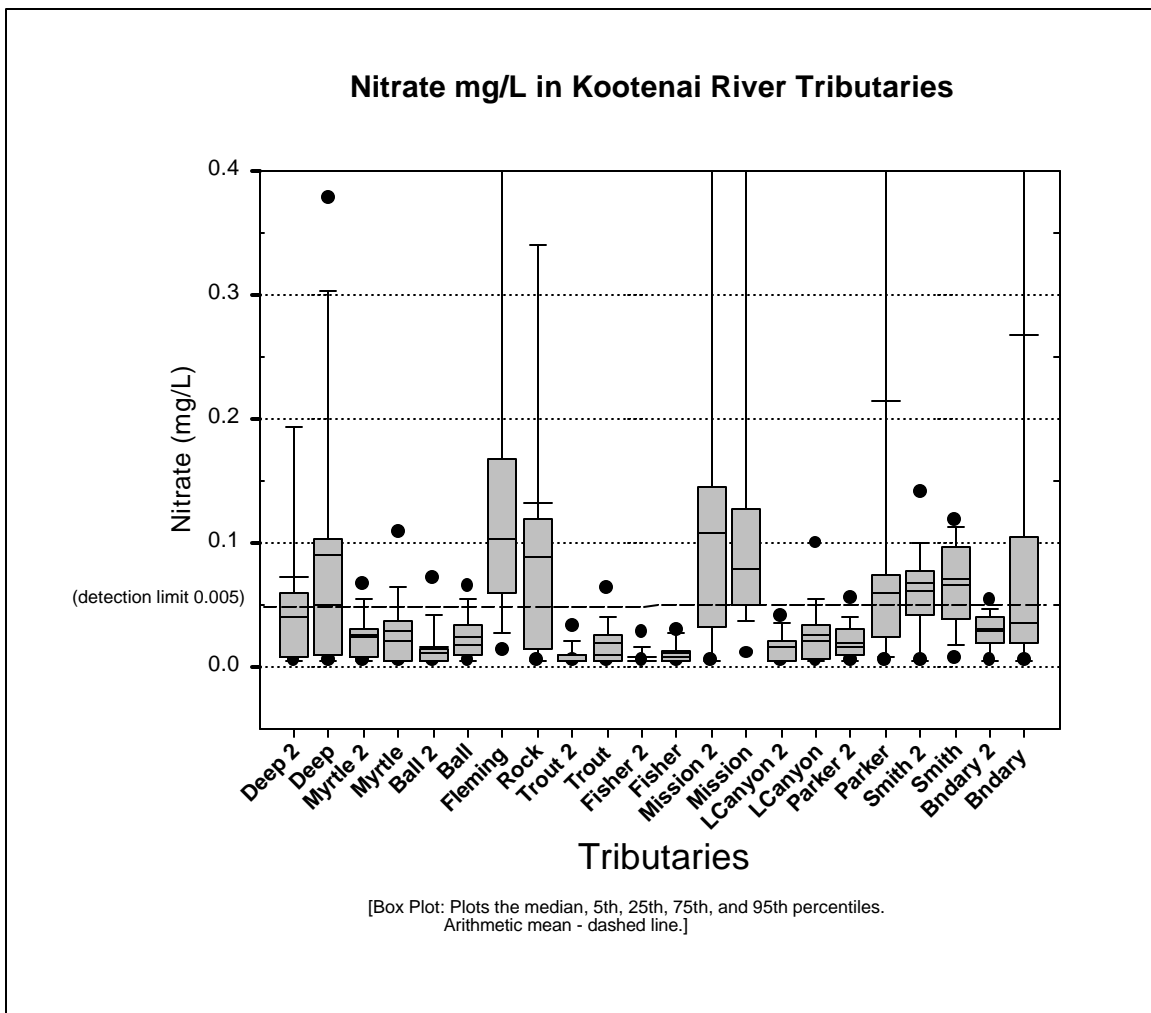|	Kootenai River			Tributaries	
				Eastside	Westside
	KTOI	**ISU**	**USGS**	**KTOI**	**KTOI**
Number	122	29	34	226	75
N > detection limits	11	29	33	65	161
Median	0.055	0.07	0.059	0.015	0.071
Interquartile range	0.057	0.04	0.057	0.033	0.092
Average	0.108	0.08	0.06	0.0495	0.5073
Minimum	0.005	0.015	0	0.005	0.005
Maximum	2.05	0.141	0.14	2.41	11.1
1st Quartile	0.033	0.06	0.033	0.005	0.031
3rd Quartile	0.09	0.1	0.09	0.038	0.123

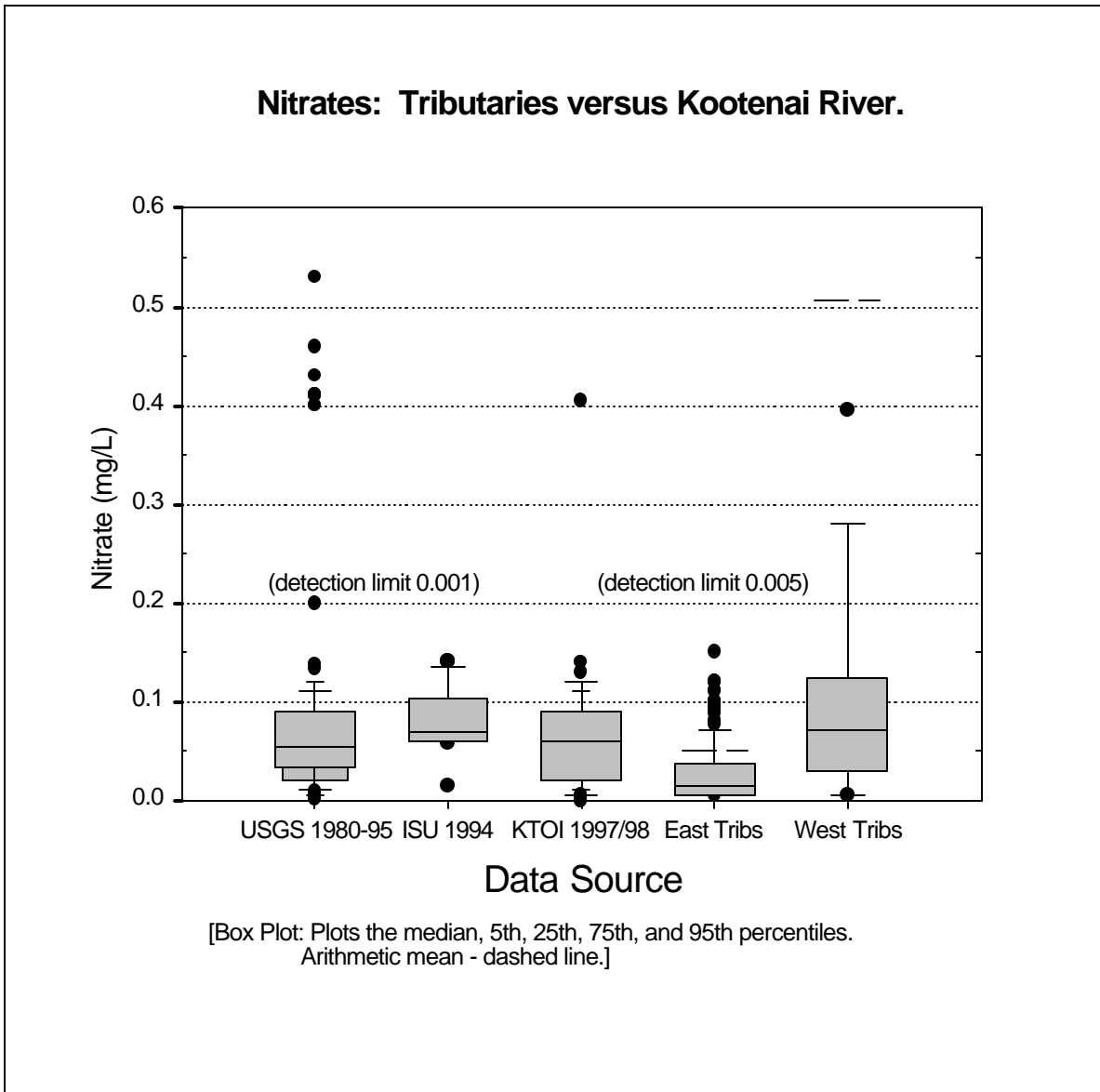**Figure 9: Nitrate distribution in Kootenai River tributaries.**

Figure 10: Nitrates: Comparison of Tributaries to Kootenai River stations.

6.0   Summary and Conclusions

The tributaries to the Kootenai River support resident and adfluvial fish populations and influence the unique fisheries (sturgeon and burbot) in the Kootenai River. There are two primary concerns with water quality in the Kootenai River drainage. First, there is the potential for heavy metal toxicity, primarily derived from historical activities in the basin. The second is the effect of the trophic status of the Kootenai River on biological communities. The low nutrient concentrations are considered to be a limiting factor to productivity of the aquatic community, which controls in part the recovery of the fish populations.

6.1   Metals

Interpretation of metals toxicity is limited by the field and laboratory procedures used for these samples. Since samples were not filtered in the field, the results from this study are reported as *total metals*. Data reported as total metals limits the possible data interpretation of biological effects since total metals includes both the dissolved (considered bio-available) and the particulate fraction (less likely to be bio-available). If total metals are greater than the recommended criteria, which are based on dis solved metals, it is not possible to conclude that the metals occur at harmful levels. Conversely, it is infeasible to conclude no effect since the bioavailability of the toxicant has not been established. A second factor limiting data interpretation is the detection level achieved by the analytical laboratory. Routine laboratory analysis for metals is often not sufficient to achieve the low level detection limits required for comparison to toxicity criteria.

U.S. EPA chronic toxicity criteria were used as a screening tool for evaluation of potential metals toxicity. The relevance of these criteria to fish populations, including the Kootenai River sturgeon, was recently reviewed in a biological assessment (U.S. EPA 1999b) for ESA listed species. The biological assessment, abstracted in *Appendix C* of this report, concludes that these criteria are reasonably protective for the species of interest in the Kootenai River system.

The concentration of arsenic, cadmium, copper, mercury, selenium, and zinc in the tributaries was generally measured below detection limits; only 1-3% of the samples exceeded detection limits. The few, positive detections occurred at concentrations close to the detection limits: this limits the utility of the data in toxicity evaluations since samples reported near detection limits exhibit poor precision and accuracy. The concentrations of these elements (arsenic, cadmium, copper, mercury, selenium, and zinc) do not indicate any potential concern with toxicity given the constraints of the field and laboratory methods used.

Sixty-five percent of the aluminum samples were reported above detection limits, and 34 percent of the samples exceeded the EPA criterion. Higher values for aluminum occurred in March and April, with extreme values occurring during the March 15, 1999 sample period. *Are the higher aluminum concentrations a source of toxicity to aquatic organisms?* Since the metals were analyzed as total metals, it is not feasible to answer this question with the current data set. Bioavailability of metals to organisms is associated with the dissolved fraction of the metal. To obtain a data set more comparable to the water quality criteria, field-filtered samples should be collected and anaylzed for dissolved metals. If the metals concentrations were in a dissolved fraction (bioavailable), there would be a greater cause for concern. This question can be answered with a follow-up study that targets aluminum in selected parts of the drainage where higher concentrations were found (Rock, Fleming, and Deep Creek) and by using appropriate methods of data collection and analysis, such as field filtration and analysis for dissolved metals.

Twenty-four percent of the lead samples were measured above the detection limit. An inspection of the data shows that the majority of the positive detections occurred at or slightly above the detection limits. *Do*

these results represent ambient lead concentrations that are a concern for aquatic toxicity or are they an artifact of the analytical procedures? To answer this question, the results reported for the tributaries were compared to the results for lead in the mainstem of the Kootenai River summarized in an earlier study (Bauer 1999) from a lab that specializes in trace metal analysis. The median value for the tributaries of 0.003 mg/L is approximately 100 times greater than the value reported in the Kootenai River. Based on an inspection of the two data sets and a comparison of the laboratory detection limits used in the two studies, it appears that the positive detections reported for the tributaries in this study are an artifact of the analytical methods. The only way to positively resolve this question would be to resample for lead using clean sampling procedures and low-level analytical methods.

6.2   Nutrients

Nutrients occur at low levels in the Kootenai River tributaries consistent with the nutrient concentrations observed in the Kootenai River. Dissolved phosphorus concentrations were for the most part below detection limits of 0.01 - 0.026 mg/L. Although tributaries have been influenced by human activities there is no signal from this data set that the tributaries have been enriched with phosphorus. It appears that these watersheds have a naturally low level of phosphorus and therefore even land-disturbing activities that may increase sediments (and associated phosphorus) have not had an effect on increasing phosphorus to the Kootenai River tributaries.

Nitrates were measured above the detection limit (0.005 mg/L) 75 % of the time, but still occur at low concentrations characteristic of oligotrophic systems. Nitrate concentrations in the tributaries were comparable to nitrate concentrations measured in the Kootenai River (median of 0.022 mg/L vs 0.055 mg/L in the river). Tributaries on the east and southside (Fleming, Mission, Rock and Deep Creek) were noticeably higher with a median concentration of 0.071 mg/L possibly reflecting some anthropogenic sources.

7.0   Recommendations

Recommendations regarding changes to the monitoring program were made in the companion report, *Kootenai River Water Quality Summary* (Bauer 1999). The same suggestions apply to a monitoring program for the tributaries and do not need repetition here. An overarching consideration is to increase the responsiveness of the monitoring effort to program objectives by developing a rigorous experimental design.

The monitoring design should address the following elements at a minimum:

- Monitoring design keyed to answer specific questions (objectives).
- Rationale for selection of monitoring stations.
- Selection of specific parameters based on previously documented sources or ambient concentrations.
- Specification of monitoring season, project duration, and sample frequency to assure that a sufficient number of results are obtained to address the objective reliably.
- Consideration of trade-offs in sampling protocols, e.g., clean sampling versus cross composite-depth integrated sampling.
- Specification of minimum laboratory detection limits to achieve meaningful results.
- Development of a comprensive QA/QC Plan for both field and laboratory analysis to include blank, replicate, and spike samples.

- Procedures for data reduction, storage, and reporting.

Future metals monitoring should address several issues that influence the usability of the data in interpreting toxicity. First, metals data should always include field filtration so that dissolved metals can be analyzed. Secondly, because of the low concentrations encountered in the Kootenai River, "clean sampling" methods should be adopted to reduce the possibility of random contamination. Lastly, detection limits suitable for measuring low concentrations specified in toxicity criteria need to be identified when contracting with a laboratory. Higher costs associated with these low trace analysis can be offset by decreasing the parameter set and the number of stations sampled.

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