Transboundary Flathead Water Quality and Aquatic Life: Biennial Report

2007 and 2008 Baseline Data Collection to Characterize the North Fork of the Flathead River Basin Environmental Quality

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ABSTRACT

The 2007 Montana Legislature provided funding through the Flathead Basin Commission to initiate a longer-term study of water quality and aquatic life response to potential coal mining in the Transboundary Flathead. This funding was for a two-year period from July 2007 to June 2009. The goal of the study was to focus on the Canadian portion of the Flathead where the proposed mining was to be conducted.

We found nitrate and total nitrogen concentrations were significantly elevated (1000X) at sites downstream of coal mining in the Elk Basin compared to what was observed either at Flathead Basin sites or at Elk Basin sites above coal mines. Sulfate concentrations were also significantly elevated (40-50X) in Elk Basin sites below coal mining. This is likely due to exposure of sulfide and/or sulfate bearing ores that are oxidized when exposed to the atmosphere during the mining process. Similarly to sulfate, selenium concentrations were elevated to 7-10X naturally occurring levels in Flathead and Elk Basin streams and rivers. We had a comprehensive survey design to look for metal effects in sediments transported from the coal mines. We did observe elevated concentrations of cadmium in Corbin Creek and in Michel Creek below Corbin, but we did not observe increased metal concentrations above those at sites either in the Flathead Basin or among sites in the Elk Basin above the coal mines.

Algae are an excellent indicator of nutrient pollution as well as toxicity. We observed a significant decline in algae diversity between Flathead Basin sites and Elk Basin sites below coal mining effects. Stream invertebrates are highly diverse in the Transboundary Flathead and Elk Basins. We observed significant impact to the macroinvertebrate communities in Corbin Creek and Michel Creek. These sites also showed the most pronounced effects on algae and the highest concentrations of nutrient pollution, sulfates and selenium concentrations.

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Figures 30 and 31. Diptera (true fly) larvae abundance (# per m^2) among Flathead Basin (top figure) and Elk Basin (lower figure) sites.

1.0 INTRODUCTION

1.1 Background and Overview

The Transboundary Flathead and the Crown of the Continent Ecosystem

The North Fork of the Flathead River is an international watershed that originates in southeast British Columbia and drains south across the B.C. – Montana border, where it forms the western boundary of Glacier National Park. Approximately 40% of the watershed lies in British Columbia, where it is known as the Flathead River, with the remaining 60% of the watershed in northwest Montana, where it is known as the North Fork of the Flathead River. In Montana, the North Fork of the Flathead is protected by the national "Wild and Scenic River" classification, and is included within Waterton-Glacier International Peace Park, World Heritage Site and International Biosphere

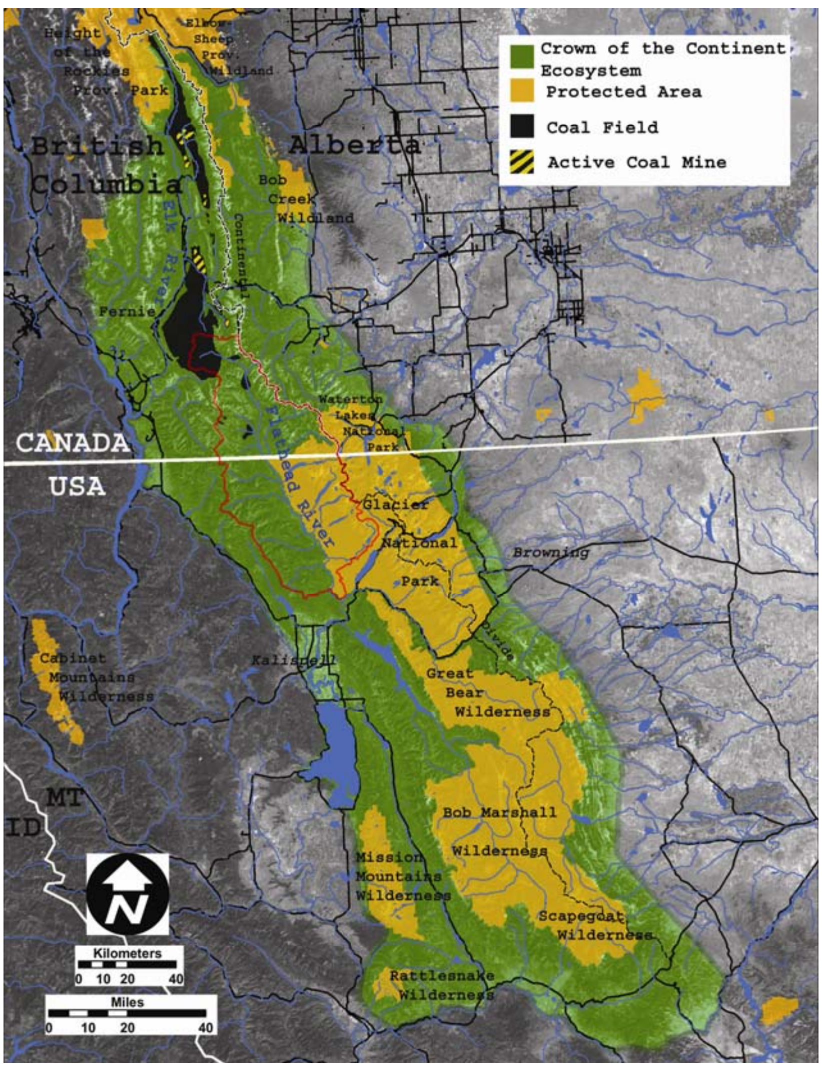


Figure 1. Map of the Crown of the Continent Ecosystem (CCE) (green). Protected areas (gold) are National, Provincial or state Parks, designated wilderness or wildlands areas. The map also shows areas of coal deposits (black) and sites of active coal mines (black and gold stripes). The Transboundary Flathead Basin (also known as the North Fork of the Flathead) is outlined in red.

Reserve. The B.C. Flathead and Montana North Fork are together known as the Transboundary Flathead. Southeast B.C. contains another transboundary watershed, the Elk River, which shares a common watershed divide with the Flathead; the Elk Basin being to the north along the continental divide and the Flathead to the south, also along the continental divide. The Elk drains into Lake Koocanusa Reservoir to the west. Lake Koocanusa is formed by Libby Dam on the Kootenai River in Montana with the northern most reaches of the reservoir extending into British Columbia. Both the Flathead and Elk Rivers are part of a larger landscape known as the Crown of the Continent Ecosystem (CCE). The CCE is an approximately 18 million-acre ecosystem defined by the Continental Divide of the Rocky Mountains between British Columbia, Alberta and Montana.

The CCE landscape is critically important because it encompasses the pristine headwaters of three great continental river systems; the Columbia, the Missouri-Mississippi and the Saskatchewan. The Crown of the Continent Ecosystem is renowned for its relative connectivity and tremendous diversity of flora and fauna, including the full array of native carnivores and ungulates. The Transboundary Flathead and Elk Rivers (Figure 2) complete the northwest corner of the CCE and together form a connectivity corridor between Waterton-Glacier International Peace Parks and the Banff-Jasper National Parks of Canada to the north. The Flathead Valley in particular is a critical transboundary linkage within the CCE, providing low-elevation riparian habitat for wide-ranging populations of transboundary carnivores, such as grizzly bear, lynx and wolves (Weaver, 2001). The Transboundary Flathead and the remainder of the Flathead River system in Montana is one the last strongholds of bull trout and west slope cutthroat trout. Of the carnivores and native trout that inhabit the Transboundary Flathead, bull trout, grizzly bears and lynx are listed species under the U.S. Federal Endangered Species Act (ESA).

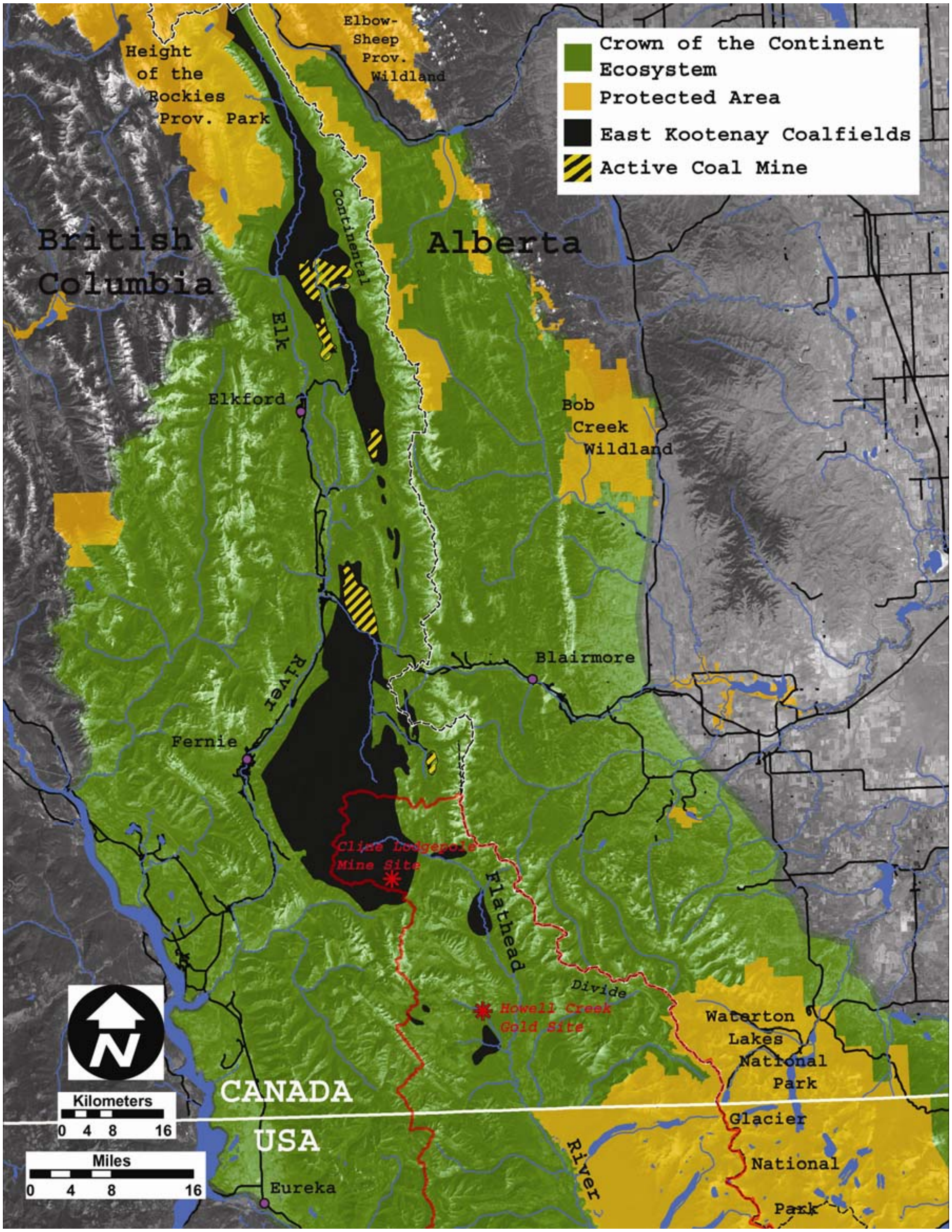


Figure 2. The northern half of the Transboundary Flathead Basin (outlined in red) and the Elk Basin to the north. Both basins are located along the Continental Divide. Areas in green are within the Crown of the Continent Ecosystem. Areas in gold are National, Provincial or State Parks or designated wilderness or wildlands. Red stars indicate locations of the Cline Lodgepole coal mine project or the site of gold exploration, respectively.

The East Kootenay Coalfields of Southeast British Columbia

The British Columbia portion of the Flathead Valley is underlain by a series of coal deposits that extend beneath the entire headwaters portion of the river, and occur intermittently throughout the B.C. portion of the drainage. The coal deposits are a part of the East Kootenay Coalfields, a larger grouping of coal that underlies both the Elk and Flathead River Valleys of southeast British Columbia. The East Kootenay Coalfields run from north to south along the Continental Divide between British Columbia and Alberta and contain low to high quality bituminous coal. The Elk Valley portion of the East Kootenay Coalfields contains five open-pit, mountain-top removal coal mines and two coalbed methane operations (see Figure 2).

Since the mid-1970's the coal deposits in the B.C. portion of the Transboundary Flathead have been targeted for resource development. The original mining proposal for the B.C. Flathead, referred to as the Cabin Creek Coal Mine, was be located in the "Flathead" coal deposits that straddle Cabin Creek, which flows west to east out of the Whitefish Range in Canada into the Flathead River within 5 km north of the international border. The proposal drew international interest and concern regarding impacts to the downstream fisheries, water quality and overall aquatic and terrestrial life. Considerable ecological work was done to evaluate existing water quality, biological integrity, and air quality in the late 1970's and early 80's, with respect to the location and potential impacts of the Cabin Creek mine site. Much of these environmental investigations were conducted under the auspices of the Flathead Basin Environmental Impact Study (1984) by researchers at Flathead Lake Biological Station and the Montana Department of Fish, Wildlife and Parks. These data were then used by the International Joint Commission (IJC) which augmented these data with additional focused study. The IJC, created by the 1909 Boundary Waters Treaty between the USA and Canada, intervened on behalf of Canada and the United States to evaluate the potential impacts of the proposed coal mine and subsequent consequences with respect to the Boundary Waters Treaty. After several years of analysis by an international team of scientists, the IJC found that the mine proposal should not be approved due to potential damage to downstream water quality and impacts to transboundary bull trout populations (IJC, 1988).

In 2003, the B.C. portion of the Flathead River was again targeted for extractive resource development, and over the last ten years, multiple projects have been proposed and several have received exploration permits. The primary proposals include the Cline Mining Corporation's Cabin Creek mine site (2003), Western Canadian Coal's Lillyburt mine site (2004), the Flathead and Elk coalbed methane tenures (2004), Cline Mining Association's Lodgpepole Mine (2004), British Petroleum's Mist Mountain Coalbed Methane Project (2008) and Max Resources Howell Creek and Crowsnest gold mine sites (2008). The most prominent of these projects has been the Cline Mining Corporation's Lodgepole Mine, which conducted extensive exploration beginning in 2004 and entered the B.C. Environmental Assessment process in 2005 (see Figure 2).

Crown of the Continent and Transboundary Flathead Research Symposiums

In response to the initiatives for coal and coalbed methane in the B.C. portion of the Flathead River, two consecutive science symposiums were held in April and November of 2005 to identify existing baseline data for the Flathead, data gaps and priority information needs. At both symposia, over thirty scientists and managers from British Columbia, Alberta and Montana attended. Proceedings from the symposia outlined critical information gaps and priority research needs for both aquatic and terrestrial science. Specifically, participants were asked to focus on four priorities; 1) Baseline data collection 2) Species and population inventories, with an emphasis on federally listed species 3) Long-term monitoring, and 4) Cumulative effects analysis.

With respect to aquatic research needs, resource managers and scientists determined that there were two primary types of data needed to accurately measure the existing or baseline condition of the watershed and also to assess the impacts of potential land uses in the B.C. portion of the Flathead Basin. These were: 1) Site-specific impacts assessment data needed to evaluate the potential impacts of current mining proposals and additional resource extraction scenarios, and 2) Comprehensive basin-wide long-term monitoring and assessment (Transboundary Flathead Research Needs Workshop, 2005). From the workshop Executive Summary:

> *"Participants concluded that overall, critical information gaps were more highly evident in the British Columbia portion of the drainage for both the terrestrial and aquatic components of the Transboundary Flathead. This is also the least impacted portion of the drainage with respect to human presence and association industry, and the area currently targeted for fossil fuel development. The scientists agreed that these information gaps must be addressed prior to major land-use changes in the basin, and that at least three years of baseline data is needed to assess the potential impacts to water quality and quantity, aquatic and terrestrial species and the overall transboundary ecosystem."*

1.2 Study Framework and Scope

Montana Legislature and this Report to the Flathead Basin Commission

The 2007 Montana Legislature provided funding through the Flathead Basin Commission to initiate a longer-term study of water quality and aquatic life response to potential coal mining in the Transboundary Flathead. This funding was for a two-year period from July 2007 to June 2009. The goal of the study was to focus on the Canadian portion of the Flathead where the proposed mining was to be conducted. This was a particularly unusual move by the State of Montana; to acquire data from sites outside of the state for the purpose of protecting resources within the state. There were some preliminary data collections prior to this study (2006) and there has been data collected through funding by the federal government after (2008 – 10) the funding for this study. Because the research is ongoing with objectives that extend beyond the scope of this segment of the suite of studies being conducted in the Transboundary Flathead, **this report is limited to the scope of the research funded by the Montana Legislature (2007-2008) and is a reporting of the data to the Flathead Basin Commission**.

2.0 Materials and Methods

2.1 Study Approach and Objectives

The purpose of this research was to assess the potential impacts of open-pit coal mining and coal-bed methane development in the Transboundary Flathead Basin. We developed a sampling design strategically directed toward a comparative analysis between the Elk River and the Flathead River. The history of coal mining and coal-bed methane extraction in the Elk River Basin provided an opportunity to conduct this comparative analysis. The focus of this report is on water quality and stream and river aquatic life (non-fish). We designed the study to directly compare surface water quality and response of aquatic life use among sites on the Elk River and its tributaries above and below the open-pit coal mines to similar sites around the proposed Cline Lodgepole Coal Mine on the Flathead River and its tributaries.

2.2 Study Area

Flathead River Basin (FRB) Sites

The upper Flathead River drainage originates in south-eastern British Columbia and northwestern Montana, encompassing approximately 18,400 km^2. The drainage includes the North, Middle and South Forks, the mainstem of the Flathead River and Flathead Lake. The basin is a major tributary headwater of the Columbia River Basin. The study area includes the B.C. portion of the North Fork of the Flathead River, which is referred to as the Flathead River in Canada. Sample sites in the Flathead River and tributaries are located within and around Foisey Creek, a headwaters tributary of the Flathead, where the Cline Mining Company's Lodgepole coal mine was proposed (Table 1, Figure 3). There are eleven on-going sample sites in the Flathead Basin, six tributary sites (McEvoy Creek, Storm Creek, Foisey Creek, Unnamed Creek across Foisey, Squaw Creek and McLatchie Creek) and five mainstem sites (Flathead River @above McEvoy Creek, Flathead River @ above Foisey Creek, Flathead River @ below Foisey Creek, Flathead River @ McLatchie Bridge and Flathead River @ Flathead B.C.).

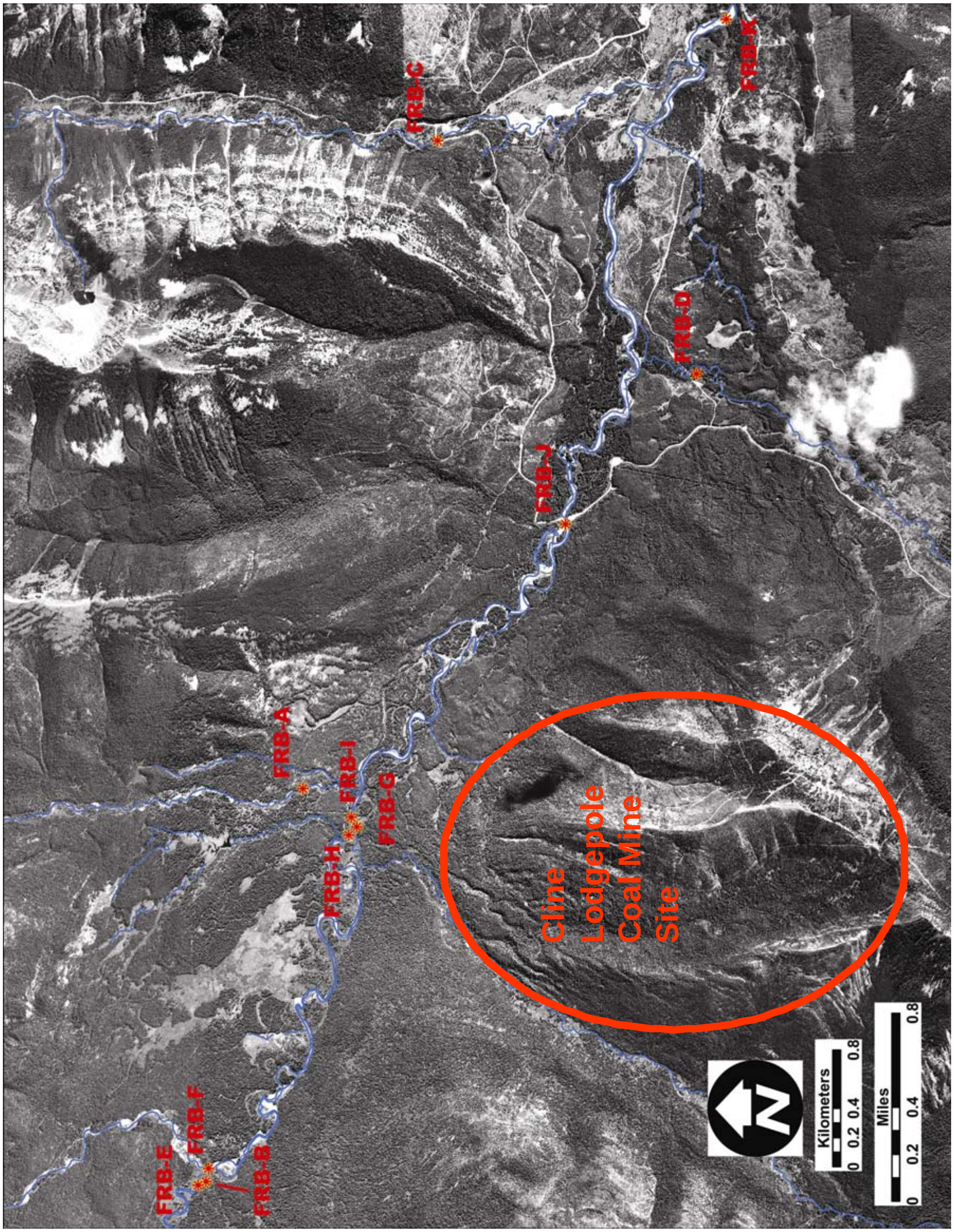


Figure 3. Satellite image of the study area in the Flathead Basin showing locations of sampling sites corresponding to Table 1 and the general location of the proposed Cline Lodgepole Coal Mine.

Table 1. Site Number, Site Description and Site Location of the Flathead River Basin Sites in this study**.**

SITE NUMBER	*SITE DESCRIPTION*	*SITE LOCATION* Latitude/Longitude	
FRB A	**Unnamed Creek Across from Foisey Cr**	49 23’ 00.2 N	114 42’ 27.0 W
FRB B	**Storm Creek @ Confluence with Flathead River**	49 23’ 23.5	114 44’ 37.1
FRB C	**Squaw Creek @ Confluence w/ Flathead River**	49 22’ 26.9	114 38’ 47.3
FRB D	**McLatchie Creek @ Bridge**	49 21’ 30.1	114 40’ 10.3
FRB E	**Flathead River @ Above McEvoy Creek**	49 23’ 23.9	114 44’ 35.7
FRB F	**McEvoy Creek @ Confluence with Flathead River**	49 23’ 23.6	114 44’ 34.9
FRB G	**Foisey Creek @ Flathead River**	49 22’ 49.4	114 42’ 45.3
FRB H	**Flathead River @ Above Foisey Creek**	49 22’ 51.8	114 42’ 45.3
FRB I	**Flathead River @ Below Foisey Creek**	49 22’ 49.3	114 42’ 37.3
FRB J	**Flathead River @ McLatchie Bridge**	49 21’ 59.2	114 40’ 59.9
FRB K	**Flathead River @ Flathead BC Town Site**	49 21’ 20.7	114 38’ 10.3

Elk River Basin (ERB) Sites

The Elk River also originates in southeast British Columbia, northeast of the Flathead River, in Elk Lakes Provincial Park, near the Continental Divide. The Elk River drains 4,450 km^2 through the Elk Valley communities of Elkford, Sparwood, Hosmer, Fernie and Elko, and drains five open-pit coal mines before it joins the Kootenay River in Lake Koocanusa, just north of the Montana border. The Elk River is also an international watershed. There are ten sample sites total in the Elk River Basin, located above and below the open-pit coal mines in the Elk Valley. Four of the sites are above the coal mines (Elk Lakes Provincial Park, Elk River above All Coal Mines, Headwaters Michel Creek and Barnes Creek above Trail Crossing), four of the sites are tributaries of the Elk River and are influenced directly by the coal mines (Corbin Creek, Michel Creek above Corbin Creek, Michel Creek below Corbin Creek, and Michel Creek near the confluence with the Elk River), and two of the sites are below the coal mines in the mainstem of the Elk River (Elk River @ Hosmer and Elk River @ Morrissey) (Table 2, Figure 4).

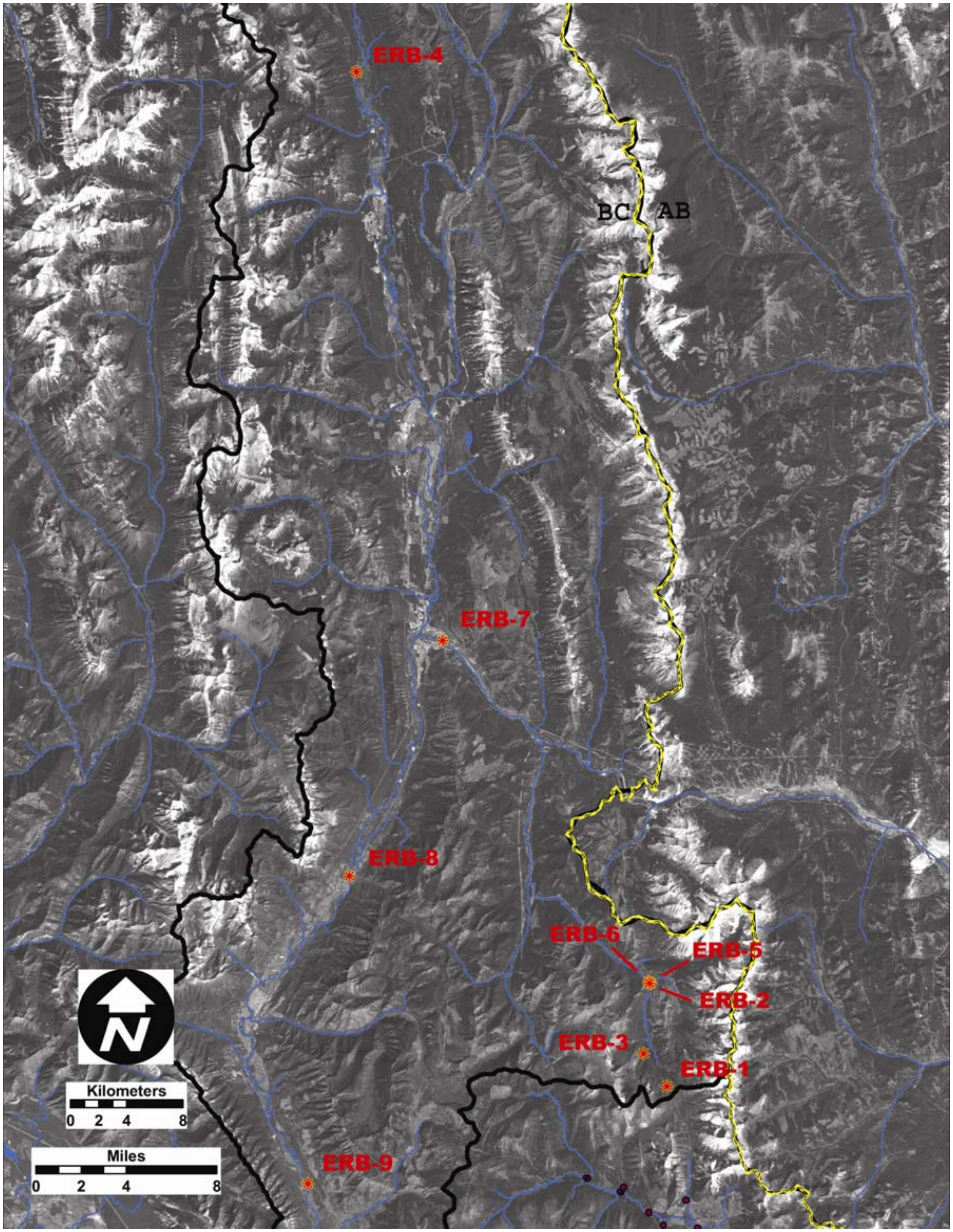


Figure 4. Satellite image of the study area in the Elk Basin showing locations of sampling sites corresponding to Table 2.

Table 2. Flathead River Basin (FRB) and Elk River Basin (ERB) by Site Number, Site Description and Site Location

SITE NUMBER	*SITE DESCRIPTION*	*SITE LOCATION* Latitude/Longitude
ERB 0	**Elk Lakes Provincial Park**	50 33’ 1.1 115 5’ 4.5
ERB 1	**Michel Creek Headwaters**	49 26’ 48.7 114 39’ 44
ERB 2	**Michel Creek above Corbin Creek**	49 30’ 47.5 114 40’ 34.9
ERB 3	**Barnes Creek above Trail Crossing**	49 28’ 6.9 114 41’ 2.6
ERB 4	**Elk River above All Coal Mines**	50 6’ 7.2” 114 56’21.5”
ERB 5	**Corbin Creek**	49 30’47.9” 114 40’29.4”
ERB 6	**Michel Creek below Corbin Creek**	49 30' 55.6" 114 40' 35.4"
ERB 7	**Michel Creek near Elk River Confluence**	49 44’10.9” 114 52’11.8”
ERB 8	**Elk River @ Hosmer**	49 35’14.5” 114 58’6.4
ERB 9	**Elk River @ Morrissey**	49 23’31.6” 115 1’2.1”

Baseline Data Collection – Water Chemistry

The two-year data collection program was conducted to provide a baseline of physiochemical data that allows for a water quality assessment of surface waters in the headwaters of the Transboundary Flathead River. The scope of work was designed to document the existing condition of the areas targeted for, or downstream of the proposed Cline Mining Corporation’s Lodgepole Mine sited in the headwaters of Foisey Creek. Parameters measured included:

- Field Physiochemistry
- Major Cations (Na, K, Ca, MG)
- Major Anions (chlorides and sulfates)
- Metals (Al, As, B, Be, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn)
- Nutrients (Phosphorous Forms [Soluble Reactive – SRP; Total Phosphorus – TP and Nitrogen Forms [nitrate - NO3; Total Persulfate Nitrogen - TPN)
- Major Metals (As, Cd, Hg, Pb, and Se) associated with sediment

Baseline Data Collection – Aquatic Biota

Simultaneous with the surface water chemistry, data collection was initiated for the major components of stream and non-fish river aquatic life. As with the surface water quality data, aquatic biota data were collected in and around the area of the proposed open-pit coal mining and potential coalbed methane development. The objective was to measure and assess the aquatic life in water associated with the proposed mining, at a subset of the water chemistry sites. Specifically, objectives included:

- Determine baseline steam/river algal community - Periphyton Biomass (AFDM) and Chlorophyll – a
- Determine baseline stream/river macroinvertebrate (food-web) community composition, distribution and abundance

2.2 Methods

Water and Sediment Samples

Water samples were collected in the field from twenty one total sites in the Elk and Flathead River Basins, once a month from June – October in 2007 and 2008. During each sample trip, one site was sampled in duplicate and one field blank was prepared, resulting in two additional quality control samples per trip. All samples were stored in field coolers with ice and returned as quickly as possible to the laboratories for analysis. Analyses in the laboratories were conducted with standard methods and laboratory quality control and assurance. Water samples for nutrient analyses were performed at the Flathead Lake Biological Station freshwater research Laboratory. Water samples and sediment samples for metal analyses were performed at the University of Montana, Department of Geosciences, Environmental Biogeochemistry Lab (EBL). In stream sections where fine sediment was present, sediment samples were collected after passing through a < 63 µm Nitex sieve/net, see Table 3 for methods and lab analysis. We also conducted a sediment core survey to examine major metals associated with sediments outside of the stream corridor that may be accumulated on the floodplains of the Flathead or Elk Rivers. Sediment cores were collected from alluvial soils along the river or stream banks in locations that are regularly flooded and experience fine sediment accumulations. Samples were collected from the following Flathead and Elk Basin sites: Flathead River at Flathead BC, Flathead River at the International Border, Elk River above all Coal Mines, Michel Creek below the confluence of Corbin Creek, Michel Creek near the confluence with Elk River, Elk River near the tunnel on Hwy 3 [below Morressey], Elk River at Elk BC in the small reservoir above the Elk Dam, and Elk River Delta to Lake Kookanusa.

Table 3. Methods table for analytes and sampling protocols.

Analytes	Sampling Protocols	Reference Method[1]	Code
	UNFILTERED SAMPLES		
Temperature	field measurement using Mettler Toledo EC meter		
pH	field measurement using Orion pH meter		pH
Electrical Conductivity	field measurement using Mettler Toledo EC meter		EC
Total Suspended Sediment	1 Liter plastic bottle depth-integrated unfiltered sample	EPA160.2	TSS
Total Alkalinity	125 mL plastic bottle (white), no head space	APHA2320	ALK
Total Phosphorous & Total Nitrogen	125 mL acid washed bottle, no headspace submit to FLBS		TNP
Total Organic Carbon, Dissolved Organic Carbon	500 mL baked quartz bottle, preserved with 1.0 mL H_3PO_4, submit to FLBS		TOC
Total Mercury	500 mL precleaned glass bottle (I-Chem certified, baked; cap: Teflon-lined, hot-acid washed + soaked in BrCl) filled to bottom of neck, cap and store on ice in separate plastic bag shipped promptly to EBL for acid preservation (0.5 mL Optima grade HCl)	EPA1631 mod	HgU
	FILTERED SAMPLES		
Nitrate, Ammonium, Soluble Reactive Phosphate	60 mL acid-washed Nalgene bottle, submit to FLBS		SNP
Metals (Al, As, Ba, Be, Ca, Cr, Cu, Fe, K, Mg, Mn, Na, Pb, Se, Zn)	250 mL ultra-cleaned Nalgene bottle (only 60 mL of sample are needed) EBL preserveD with 0.5 mL Optima grade HNO_3 (or 0.13 mL for 60 mL sample)	EPA200.8 or EPA6020	ME
Anions (F^-, Cl^-, SO_4^{2-})	60 mL non-acid washed bottle	EPA300.0 low-level	AN
Sampling Kit	<u>Individual Ziploc bag for each sample:</u> gloves bottles: TSS, ALK, AN, ME, Hg (+extra Hg bottles) 37 mm Gelman Supor syringe filter + ultraclean syringe	Training provided by EBL personnel	
Meters	Thermo Orion Model 135A portable pH meter, AccuPhast double junction pH combination electrode, Accumet gel electrode (backup), buffer solutions, storage box Mettler Toledo handheld EC meter with probe, calibration solutions, manual, storage box		
	Standard sediment sampler, sampling bottle		SED
	Sediment drying and grinding		
	Digestion		
	Analysis (EPA 6010/6020)		

[1] Published by USEPA or APHA (Standard Methods for the Examination of Water and Wastewater)

Periphyton and Macroinvertebrate Samples

Periphyton was sampled at each site at the end of the algal growing season, typically occurring in mid-September, when the amount of biomass and chlorophyll-a is maximized for the year. Five biomass samples and five chlorophyll-a samples were taken from separate rocks collected at each site. Periphyton material was collected from a $19.625 cm^2$ area and filtered onto a 0.7um glass fibre filter. Filters were enclosed in aluminum foil, labeled and frozen on dry ice or in a field freezer. At the laboratory, samples were stored in the freezer and processed within the holding time for Ash-Free-Dry-Mass (AFDM) and Chlorophyll-a analysis. AFDM samples + filters were oven dried at 105^oC for 24 hrs and weighed on a Mettler Balance to the nearest 0.00001g to obtain the filter + dry weight. The samples + filters were then combusted at 500^oC for 12 hrs, wetted then dried and weighed to obtain the ash + filter weght. The difference between the two measures was the AFDM of the sample. Similarly, chlorophyll-a samples + filters were handled individually with each sample representing the quantity of material from each site. Chlorophyll-a analyses were conducted using the acetone extraction method with a Beckman UV-vis spectrophotometer.

We collected macroinvertebrates from selected Flathead and Elk Basin sites using a standard method Stanford and Hauer net (Hauer and Resh 2006). Samples were processed at the Freshwater Research Laboratory at Flathead Lake Biological Station. Taxa were typically identified to the lowest nomenclature possible for the life history stage collected; this was typically to the genus or species level. Samples were processed in the laboratory by removing all large organisms from the entire sample. The sample was then evenly dispersed in fine-mesh sieve and subsampled for the smaller organisms. Subsamples were picked entirely clean of all macroinvertebrates. Numbers of individuals from each taxa in a sample are based on a calculation of a combined whole sample plus subsample equated to numbers per square meter.

3.0 RESULTS AND DISCUSSION

All nutrient and metals data are presented in their entirety in table-form as an Appendices at the end of this report. In the following sections we present a series of nutrient data from water samples collected at the Flathead and Elk Basin study sites. In each section we present three figures. The first figure is composed of headwater streams that are above sites affected by coal mines in the Elk Basin or the proposed Cline Lodgepole Coal Mine in the Flathead Basin. These sites are presented here as direct comparison sites to illustrate the underlying similarity or differences between the waters of the Flathead and Elk in their most native and unperturbed condition. The second figure is composed of all the Flathead Basin sites illustrating change along the longitudinal gradient from small creeks to the larger river. The third figure is composed of all the Elk Basin sites illustrating change due to coal mining effects as they occur along the stream/river corridor. The Results and Discussion section of this report focuses on analyses showing distinct differences between sites with and without coal mining effects.

3.1 Nutrient Concentrations

Nitrate Nitrogen (NO_3)

Nitrate-nitrogen is a plant growth nutrient that stimulates algal growth in freshwaters, especially when present with biologically available phosphorus. The Flathead Basin, and especially Flathead Lake has been shown to be co-limited in algal production by low levels of both nitrogen and phosphorus. The nitrate-nitrogen analysis represents one of the clearest examples of the effects of open-pit, mountain-top removal coal mining on water and water quality in the Elk Basin and by inference in the probability of similar effects on Flathead Basin surface waters. Comparing Flathead and Elk Basin headwaters (Figure 5), we observe relatively little difference between waters from the Elk or Flathead. Two headwater sites in the Elk (ERB – 3 and ERB – 4) had approximately 2X to concentration of nitrate as other headwater sites; however, these concentrations are

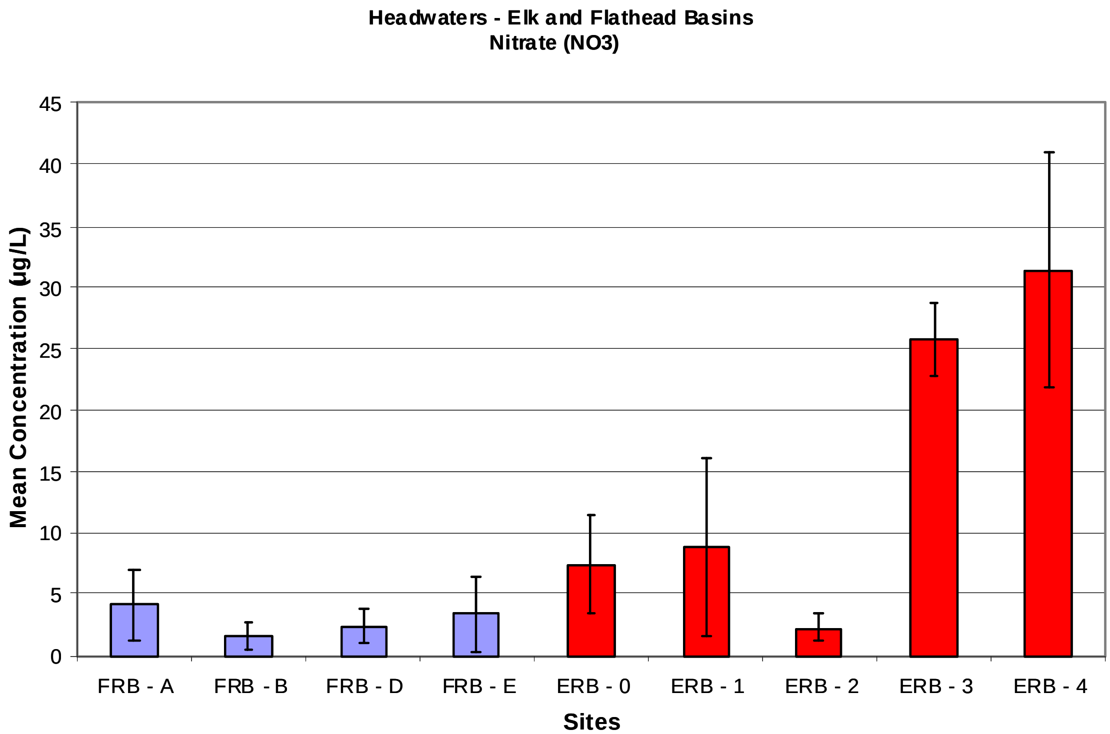


Figure 5. Mean concentration (± 1 std error) of nitrate-nitrogen (NO_3) in four Flathead Basin (blue) and five Elk Basin (red) headwater sites. Refer to Tables 1 and 2 for site descriptions.

well within levels that would be expected, especially ERB – 4 (Elk River above Coal Mines), as this site is located well below the Elk Lakes Provincial Park and is influenced by roads and other land-uses.

In our comparison of all Flathead Basin sites (Figure 6), we observed very low concentrations of nitrate at all sites, although site FRB – C (Squaw Creek) was approximately 5X higher than the other Flathead Basin sites. Note that all other sites had mean concentrations <10 ug/L and standard deviation maxima less than 20 ug/L. These concentrations are typical of other low impact, low land-use, stream sites in the Whitefish Range. We are uncertain of the reason for the elevated concentrations in Squaw Creek which drains the Flathead Pass area to the south, especially since Site ERB – 1 (Michel Creek Headwaters) had a mean concentration of < 10ug/L. However, the

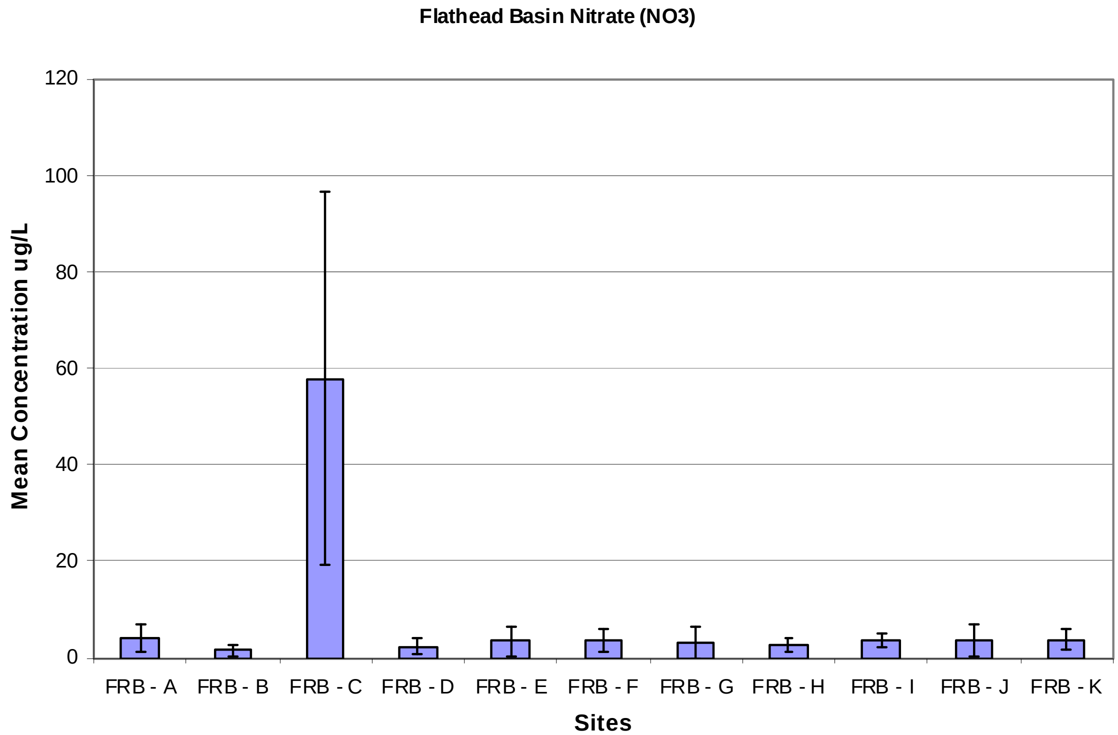


Figure 6. Mean concentration (+ 1 std error) of nitrate-nitrogen (NO_3) among the eleven Flathead Basin (blue) sites. Refer to Tables 1 and 2 for site descriptions.

road that crosses Flathead Pass and is the primary entry into the upper Flathead Basin from Fernie and Sparwood, BC, frequently crosses Squaw Creek and on several occasions runs directly down the stream bed, which may account for this difference .

The Elk Basin sites showed a dramatic difference in nitrate concentrations between sites above coal mine impacts and those sites receiving waters affected by the coal mining (Figure 7). Note that the five headwater sites given in Figure 5 (and appearing in Figure 7) were all within natural background levels of nitrate. By contrast, the five sites below mining had highly significantly ($P<0.001$) greater concentration of nitrate. Note the change in scale in the y-axis of the figure. Concentrations at sites below coal mining frequently exceeded 1000X nitrate levels in the Flathead Basin or among Elk Basin sites above coal mines. The high level of nitrate concentration among the Elk Basin streams and rivers below coal mines clearly demonstrates a major impact due to the mining activities. The consequences of the higher concentrations of nitrate are many, including increased algal production and decreased macroinvertebrate diversity, discussed in these sections below.

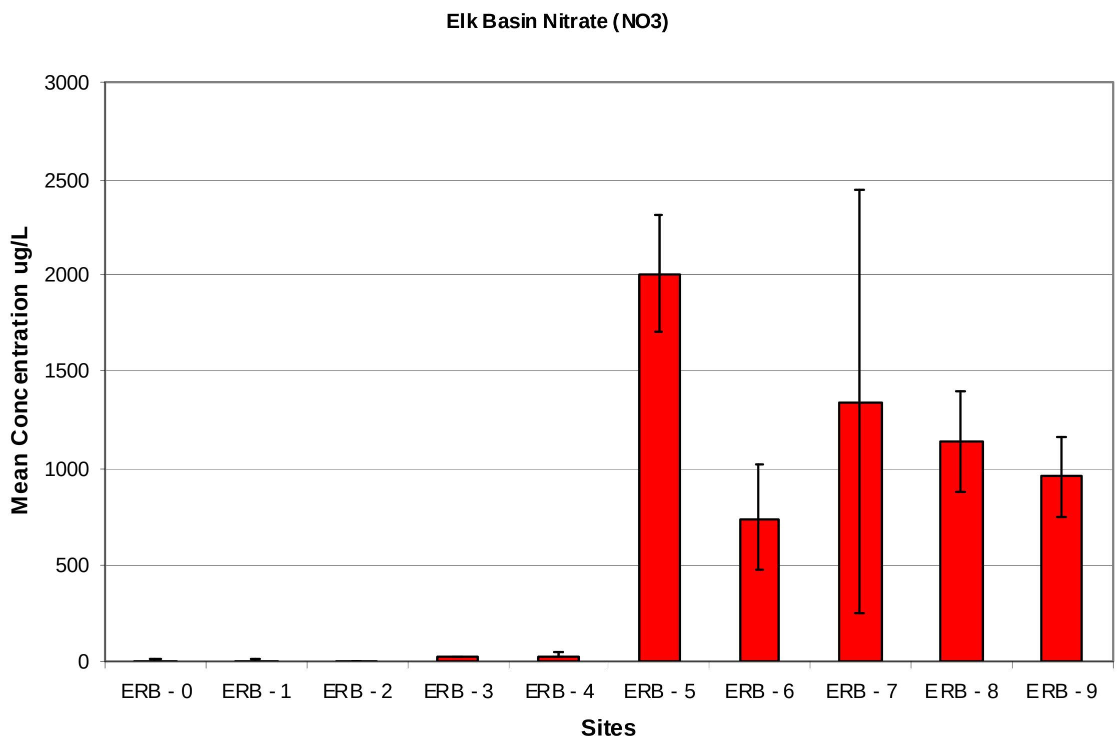


Figure 7. Mean concentration (± 1 std error) of nitrate-nitrogen (NO_3) among the ten Elk Basin (red) sites. Refer to Tables 1 and 2 for site descriptions.

Total Nitrogen (TPN)

The total nitrogen concentration is a combination of nitrate + ammonium + organic nitrogen and thus represents a combination of both inorganic forms available for plant growth and organic nitrogen, which is generally as dissolved organic plus particulate organic compounds containing nitrogen. The significance of total nitrogen analysis from nitrate is that under circumstances of nitrogen limitation, nitrate can be very low because it has been incorporated into plant growth. Thus, total nitrogen can provide insight into the nitrogen fraction, which has already stimulated algal growth.

Similar to the nitrate, total nitrogen concentration among the headwater streams of the Flathead and Elk Basins was similar and relatively low, generally < 100ug/L (Figure 8). This similarity in total nitrogen among headwater streams of the Flathead and Elk Basins underscores the similarity in climate, geology, forest type, land use, and other factors known to affect natural levels of nitrogen among these sites.

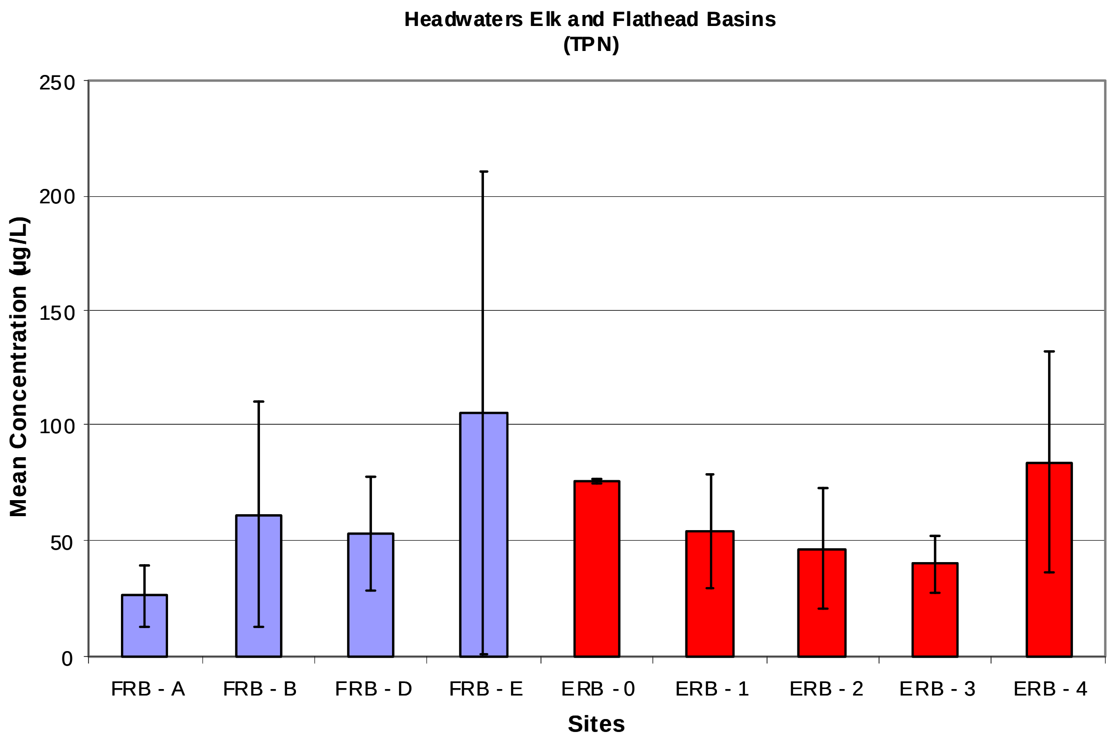


Figure 8. Mean concentration (± 1 std error) of total nitrogen (TPN) in four Flathead Basin (blue) and five Elk Basin (red) headwater sites. Refer to Tables 1 and 2 for site descriptions.

In our comparison of all Flathead Basin sites (Figure 9), we observed low concentrations of total nitrogen at all sites. In contrast Elk Basin sites affected by coal mining had significantly higher concentration of total nitrogen (Figure 10). This pattern is very similar to that observed for nitrate-nitrogen and confirms the strong influence of coal mining in the Elk Basin on nitrogen loading that extends through the food-web and affects organic as well as inorganic forms of nitrogen.

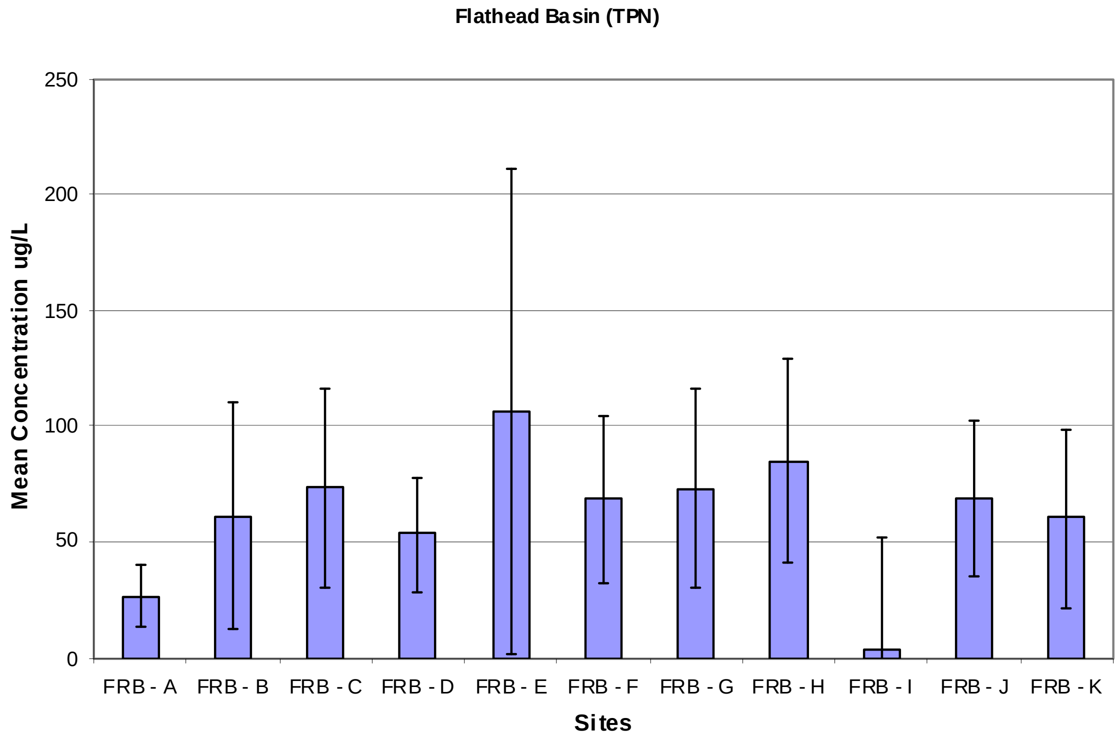


Figure 9. Mean concentration (+ 1 std error) of total nitrogen (TPN) among the eleven Flathead Basin (blue) sites. Refer to Tables 1 and 2 for site descriptions.

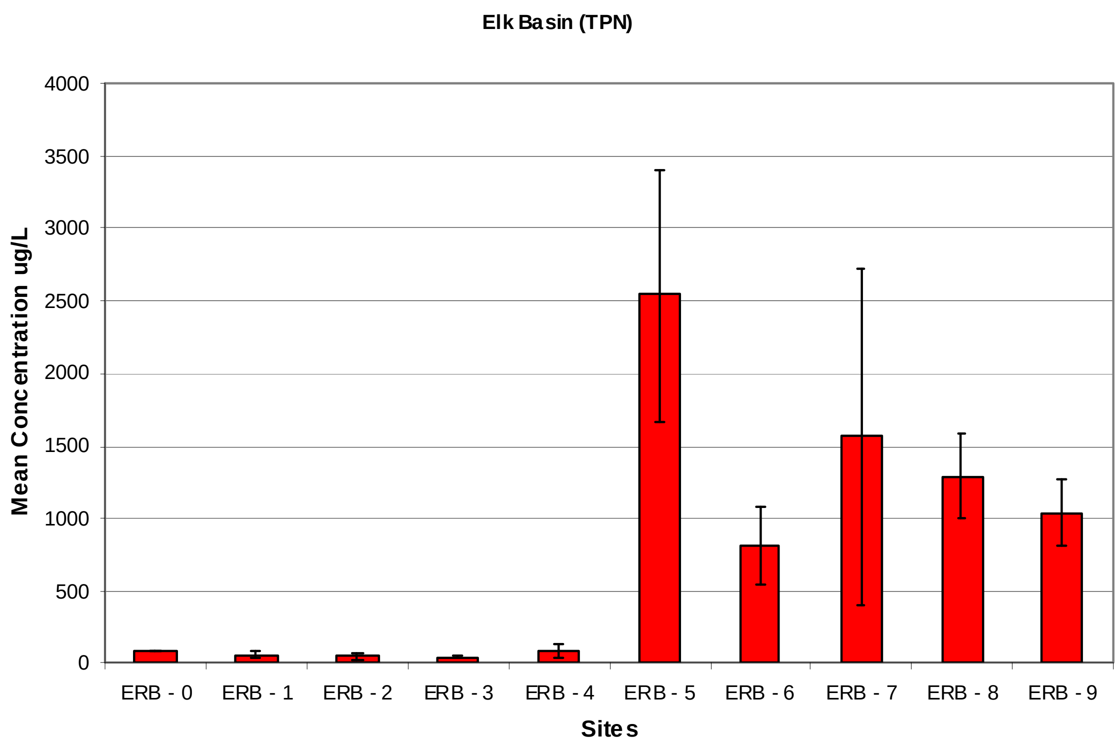


Figure 10. Mean concentration (+ 1 std error) of total nitrogen (TPN) among the ten Elk Basin (red) sites. Refer to Tables 1 and 2 for site descriptions.

Soluble Reactive Phosphorus (SRP)

Soluble reactive phosphorus (SRP), also commonly referred to as biologically available phosphorus, is measured as the concentration of PO_4, a plant growth nutrient that stimulates algal growth in freshwaters, especially when present with biologically available forms of nitrogen. The Flathead Basin freshwaters, and especially Flathead Lake, have been shown to be co-limited in algal production by low levels of both phosphorus (SRP) and nitrogen (generally as nitrate or ammonium ion).

SRP concentrations in the headwater streams of the Flathead and Elk Basins were very similar, as we observed for nitrate and total nitrogen concentrations, discussed above. Indeed, there are no significant differences between the Flathead headwater sites and the Elk headwater sites (Figure 11). However, these SRP concentrations are moderately

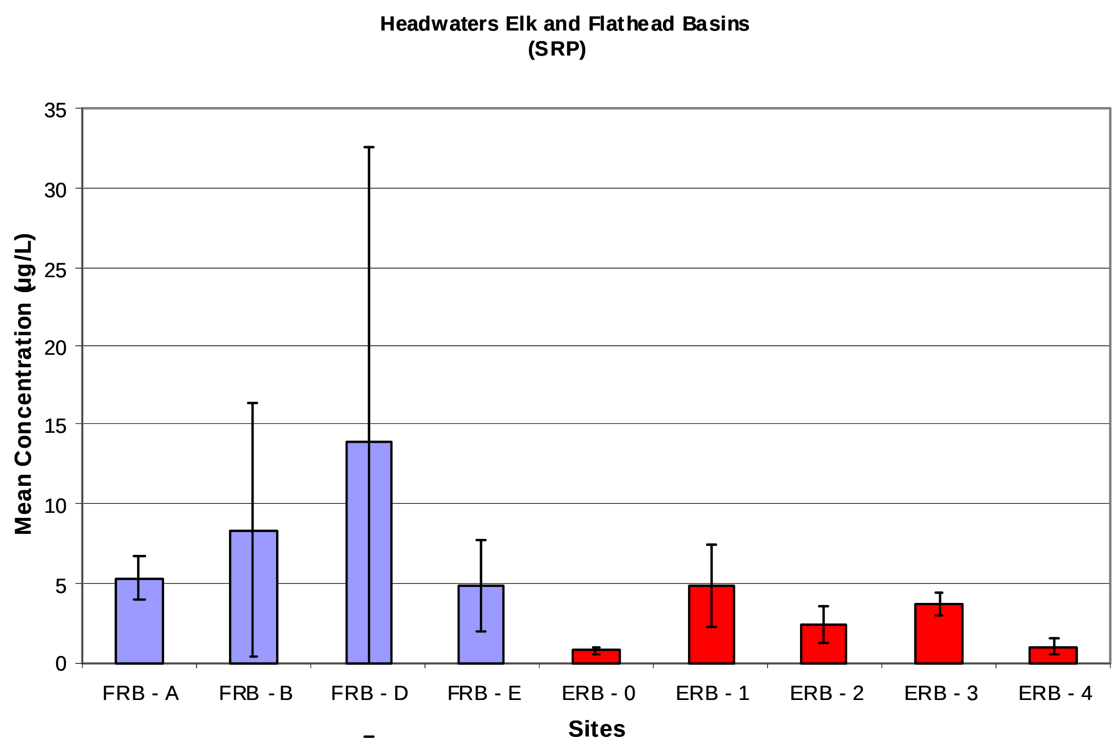


Figure 11. Mean concentration (+ 1 std error) of soluble reactive phosphorus (SRP) in four Flathead Basin (blue) and five Elk Basin (red) headwater sites. Refer to Tables 1 and 2 for site descriptions.

higher than what we often observe in the Flathead Basin in areas dominated by Argillite mudstones of Glacier and Waterton Parks. For example, in the McDonald Creek Basin in Glacier National Park, USA, the SRP concentrations between 1992 and 1998 were generally between 1 – 5ug/L (Hauer et al. 2003). In the Flathead Basin sites of this study, SRP concentrations were typically greater than 5ug/L and occasionally greater than 20ug/L (Figure 12). This is due to the exposure of more recent geological formations, hence the carboniferous formations bearing coal deposits. However, very interestingly, we observed very low concentrations of SRP in the Elk Basin sites, especially notable among the sites affected by coal mining (Figure 13). These low SRP values, especially in contrast to the very high nitrate and total nitrogen values in the five Elk Basin sites affected by coal mining, are likely due to algal uptake of the SRP in the presence of high nitrogen concentrations.

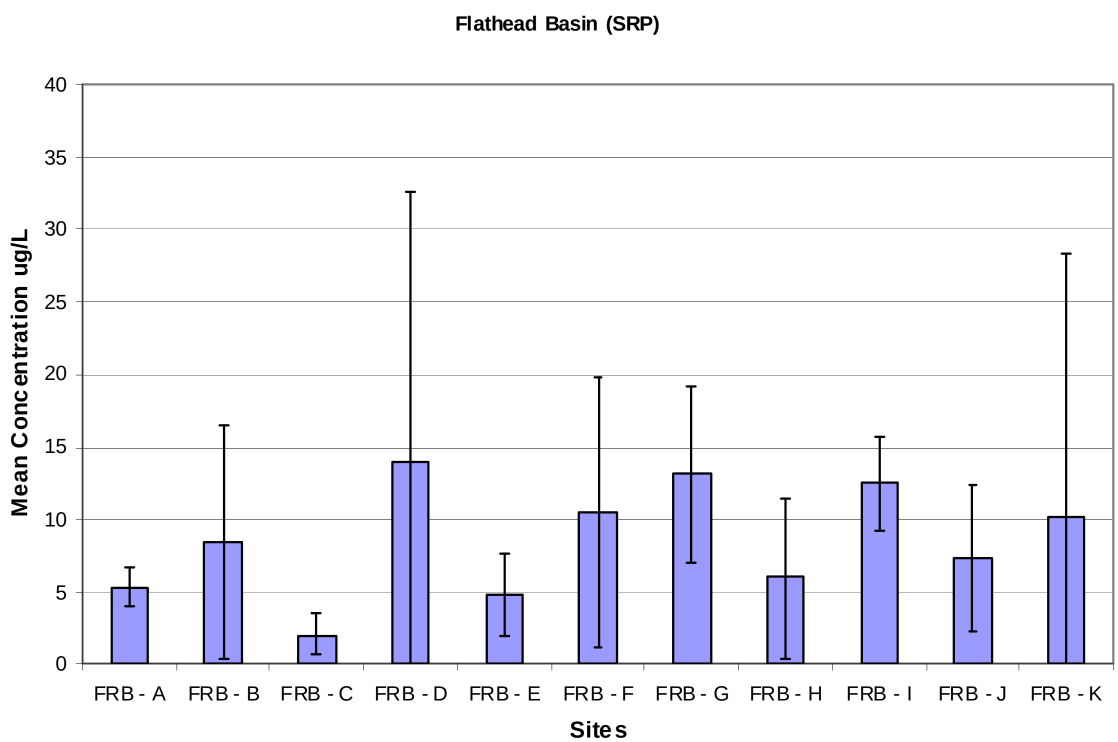


Figure 12. Mean concentration (+ 1 std error) of soluble reactive phosphorus (SRP) among the eleven Flathead Basin (blue) sites. Refer to Tables 1 and 2 for site descriptions.

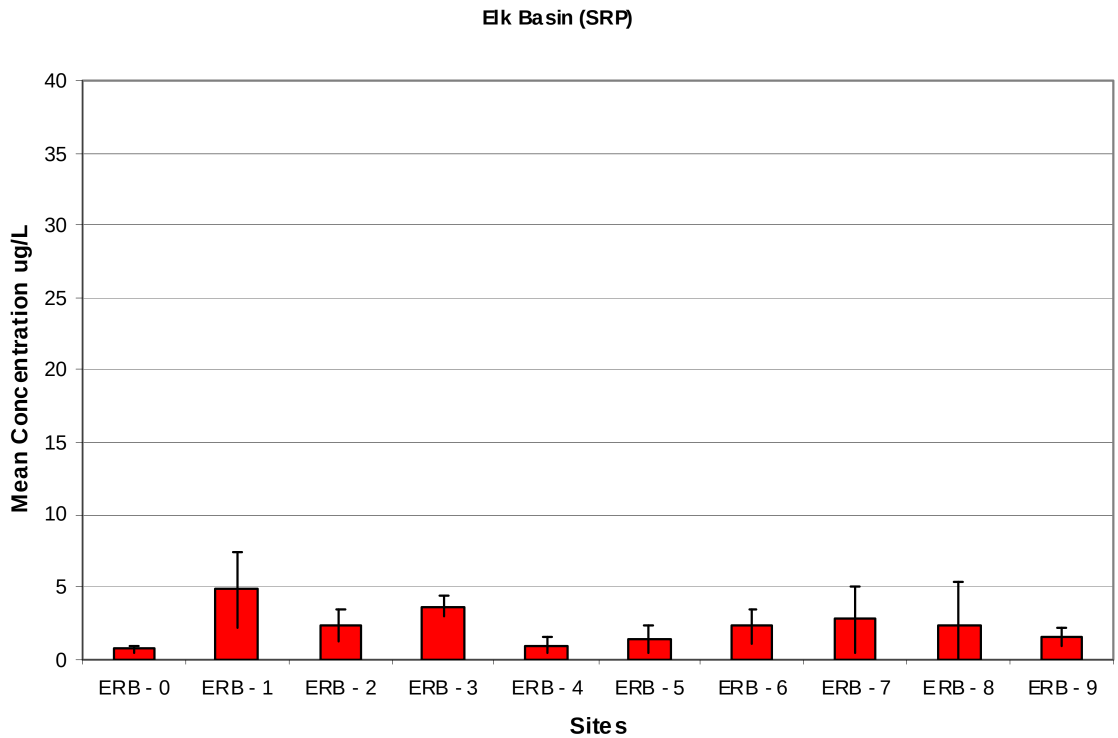


Figure 13. Mean concentration (± 1 std error) of soluble reactive phosphorus (SRP) among the ten Elk Basin (red) sites. Refer to Tables 1 and 2 for site descriptions.

While it would require specific experiments to answer why the SRP values are so comparatively low and the nitrogen values so high among the Elk Basin sites, we believe it is likely due to algal production in the Elk Basin sites stripping the SRP to concentrations lower than what would have been expected given the concentration of nitrogen among these same sites.

3.2 Dissolved Anions Concentrations

Sulfate Ion (SO_4)

Sulfate ion (SO_4) appears in freshwaters as a naturally occurring ion, generally in low concentrations. Its source is typically from minerals of calcium sulfate (gypsum) or magnesium sulfate (Epsom salts). When occurring as iron sulfide minerals, such as pyrite, which are often found associated with coal deposits (Sams and Beer 2000), oxidation of the sulfides can result in ferrous sulfate and sulfuric acid.

Sulfate ion in Flathead and Elk Basin headwaters was generally very low, with concentrations generally <10 ug/L in the Flathead and <20ug/L in the Elk (Figure 14). We also observed sulfate values across all Flathead Basin sites to be universally low among small stream sites and in the larger Flathead River (Figure 15). In contrast, the sulfate concentrations among the Elk Basin sites occurring among stream and river segments below the coal mines had distinctly elevated concentrations of sulfate ion. This was most prominent in Corbin Creek (ERB – 5) with mean concentration > 400ug/L (Figure 16). We also observed a general decline in sulfate concentration down the Michel Creek and Elk River gradient, yet at the lowest end of our sampling sites on the Elk River at Morressey (ERB – 9), we still observed sulfate concentrations approximately 5X higher than in the Elk headwaters sites or among all the Flathead Basin sites.

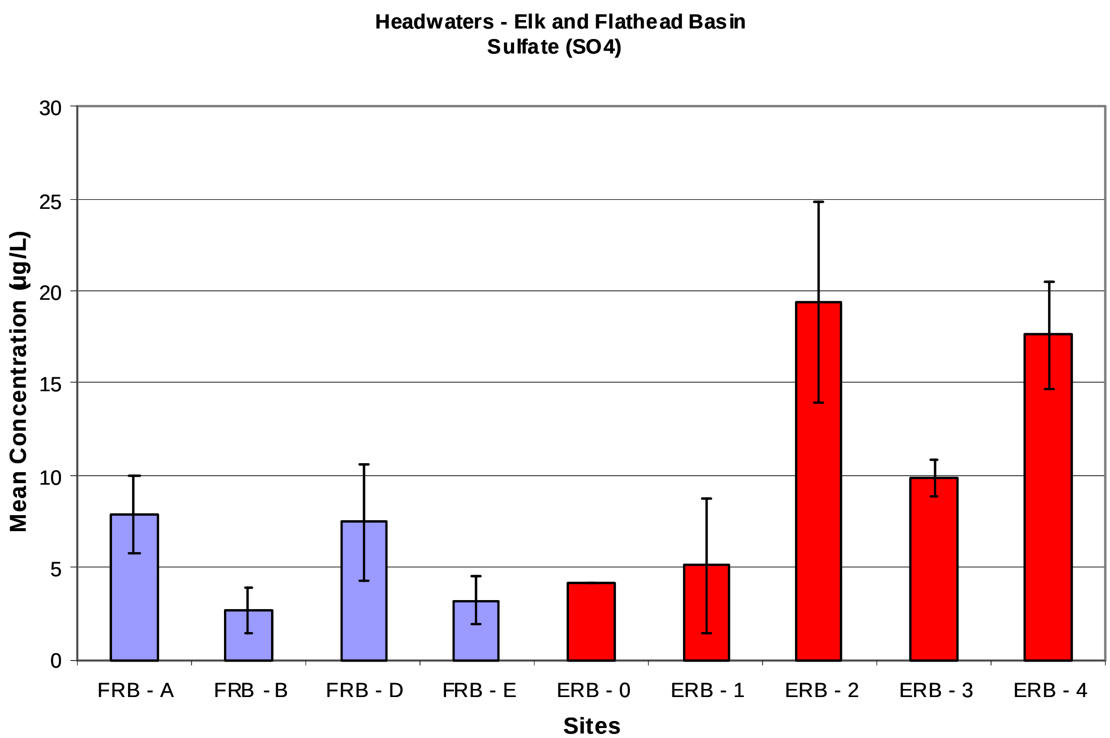


Figure 14. Mean concentration ($\pm$ 1 std error) of sulfate (SO_4) in four Flathead Basin (blue) and five Elk Basin (red) headwater sites. Refer to Tables 1 and 2 for site descriptions.

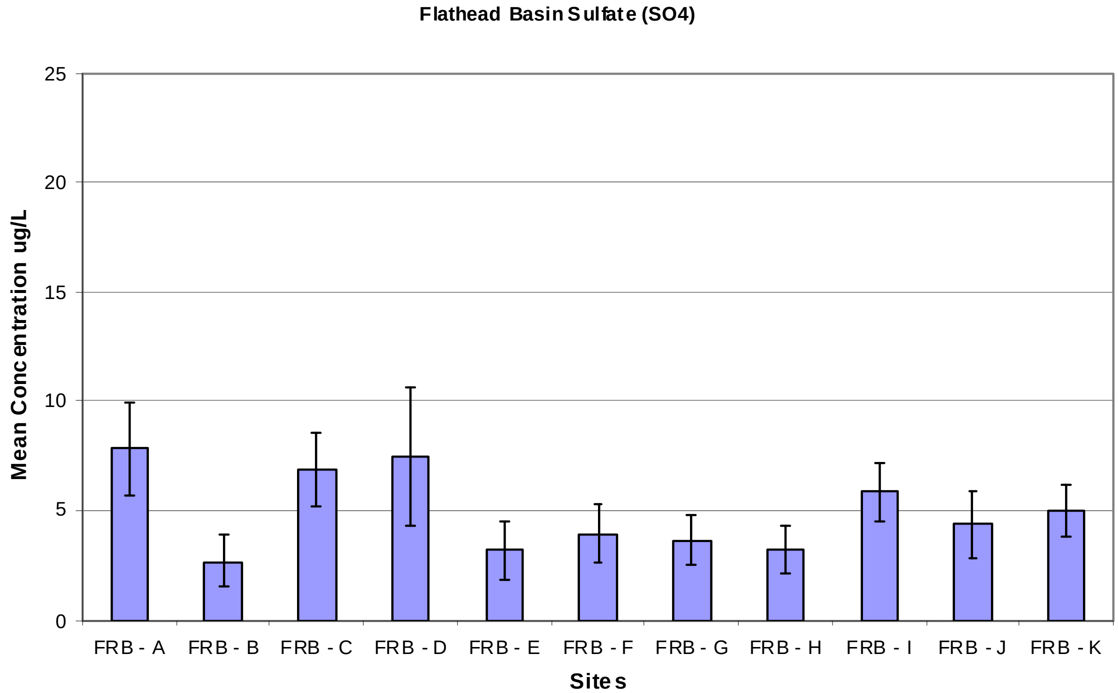


Figure 15. Mean concentration ($\pm$ 1 std error) of sulfate (SO_4) among the eleven Flathead Basin (blue) sites. Refer to Tables 1 and 2 for site descriptions.

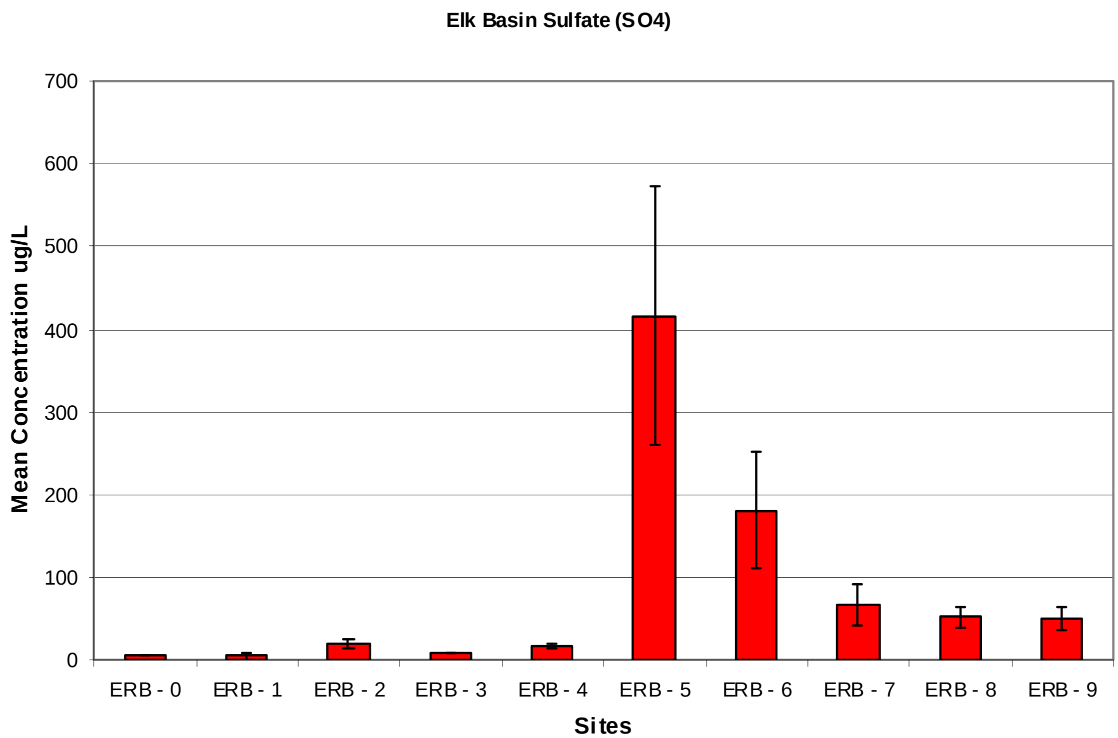


Figure 16. Mean concentration ($\pm$ 1 std error) of sulfate (SO_4) among the ten Elk Basin (red) sites. Refer to Tables 1 and 2 for site descriptions.

Selenium (Se)

Selenium occurs naturally in a number of inorganic forms, including selenide, selenate, and selenite. Selenium is found in sulfide ores, such as pyrite, and partially replaces sulfur in the ore matrix. In soils, selenium most often occurs in soluble forms such as selenate (analogous to sulfate), which are easily leached into rivers by runoff. Selenium salts are toxic in large amounts, but trace amounts of the element are necessary for cellular function in most, if not all, animals. As such, selenium is often a component in vitamins or food supplements sold for human consumption.

Selenium toxicity in the environment is known to cause health problems in domestic animals and humans and is a well documented problem in fish. For example, Lemly (2002) found that waters contaminated by selenium from a coal-fired power plant had toxic impacts to the resident fish. Symptoms of chronic selenium poisoning included; swelling of gill lamellae, elevated lymphocytes, anemia, corneal cataracts, pathological alterations (in liver, kidney, heart, and ovaries), reproductive failure (reduced production of viable eggs due to ovarian pathology, and post-hatch mortality due to bioaccumulation of selenium in eggs), and deformities (spine, head, mouth, and fins).

Selenium concentrations in streams in Flathead and Elk Basin headwaters was generally very low, consistently <1 ug/L (Figure 17). We also observed selenium values across all Flathead Basin sites to also be universally low, both among small stream sites and in the larger Flathead River (Figure 18). In contrast, the selenium concentrations among the Elk Basin sites in both stream and river segments below the coal mines had distinctly elevated concentrations of selenium (Figure 19). Similar to that observed with sulfate, selenium was most prominent in Corbin Creek (ERB – 5) with mean concentration > 10ug/L. We observed selenium concentrations in the Elk River below the coal mines approximately 10X higher than in either the Elk headwaters sites or among all the Flathead Basin sites. Implications of these high Se concentrations in streams and rivers below the coal mines of the Elk Basin are discussed below in Section 4.0 Conclusions.

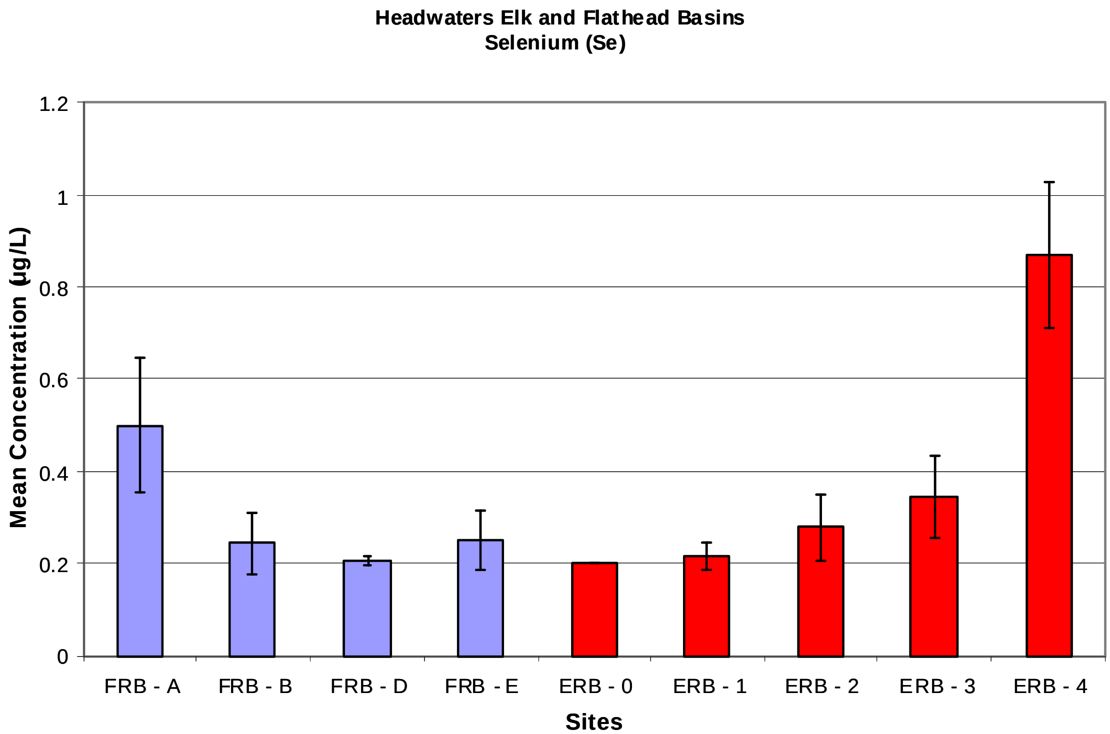


Figure 17. Mean concentration (+ 1 std error) of selenium (Se) in four Flathead Basin (blue) and five Elk Basin (red) headwater sites. Refer to Tables 1 and 2 for site descriptions.

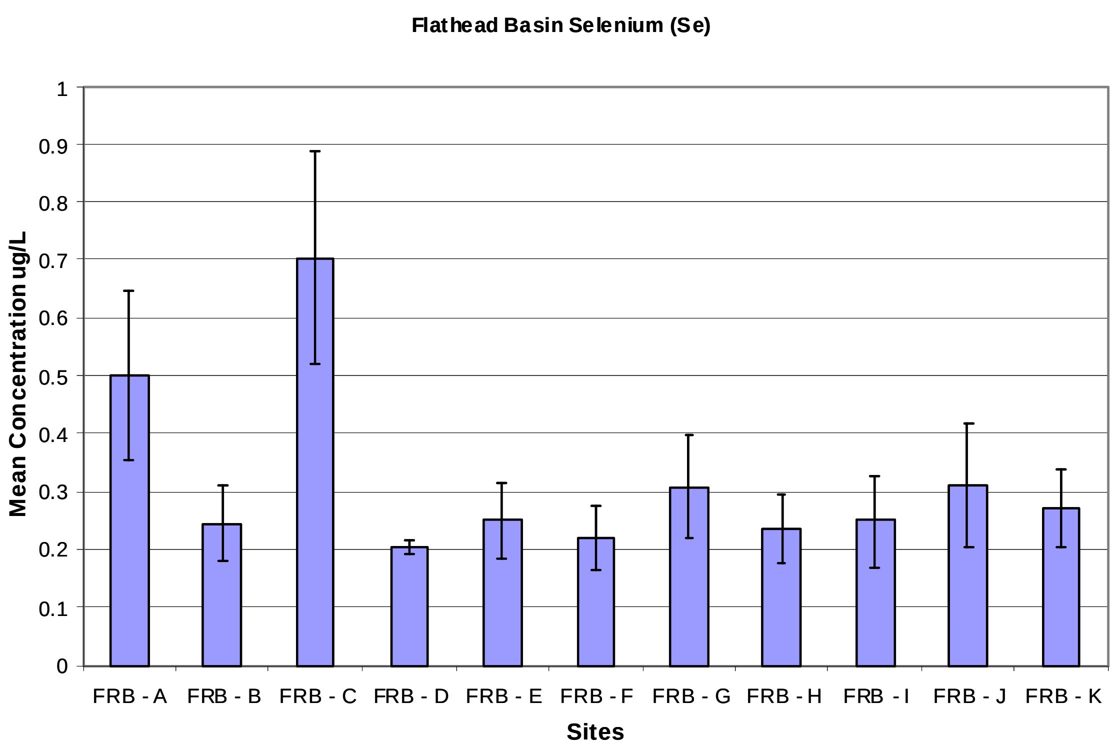


Figure 18. Mean concentration (+ 1 std error) of selenium (Se) among the eleven Flathead Basin (blue) sites. Refer to Tables 1 and 2 for site descriptions.

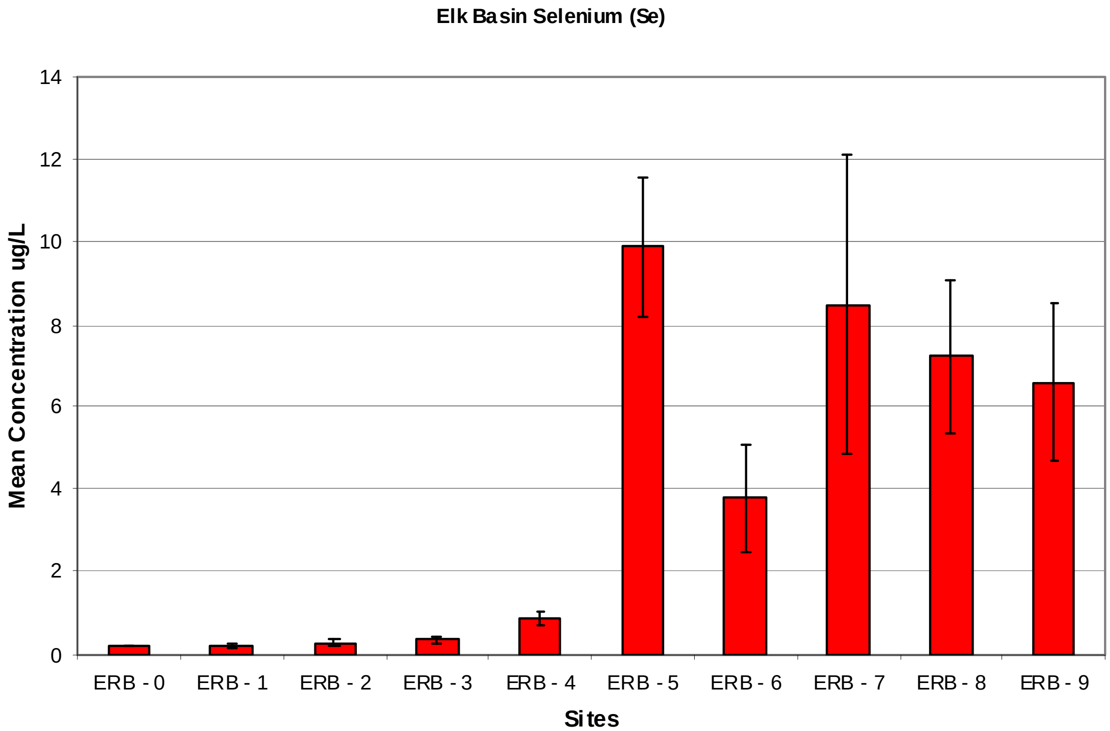


Figure 19. Mean concentration (+ 1 std error) of selenium (Se) among the ten Elk Basin (red) sites. Refer to Tables 1 and 2 for site descriptions.

3.3 Stream and River Sediments

We collected fine sediment and core sediment samples in an experimental design to examine the possibility of various metals and anions being associated with the transport and deposition of sediment. We were particularly concerned about both Selenium and Mercury as elements that have been shown to be associated with coal. Furthermore, as shown above, we observed increased selenium concentrations in waters of the Elk Basin below the coal mines.

Stream and River Fine Sediment

We collected fine sediments along the stream or rivers edge in areas of deposition. See the methods section above for collecting protocols. The purpose of this sampling was to examine the sediment metals being transported by the stream/river systems of the Flathead and Elk Rivers and their association with existing coal mines. These sediments were analyzed for a broad suite of metals (As, Be, Ca, Cd, Co, Cr, Cu, Fe, Li, Mg, Mn, Mo, Ni, P, Pb, S, Se, Sr, Ti, V, Zn). Concentrations (mg/kg) are presented in the Appendix for all results. We observed no significant differences in sediment metals between Flathead Basin Site and those in the Elk Basin. Further, we observed no differences in these sediment metals, cations, and anions between Elk Basin sites above the Coal Mines versus sites below the coal mines, including those of selenium and mercury, two elements of particular concern.

Sediment Metals from Floodplain Core Samples

We collected sediment core samples from eight floodplain sites; two in the Flathead Basin [Flathead River at Flathead BC (FRB - K) and the Flathead River at the International Border], and six sites in the Elk Basin [Elk River Above all Coal Mines (ERB – 4), Michel Creek below Corbin Creek (ERB – 6) Michel Creek (ERB – 7), Elk River at the Hwy 3 tunnel near Elko, Elk River at Elko Dam Reservoir, Elk River at the delta to Lake Kookanusa. The purpose of this sampling was to examine long-term transport and accumulation of metals associated with sediment and their long-term storage in floodplain sediments. These data provide a long term perspective separately from those of the fine sediments that were samples in channel along stream and river edges at each of the sample sites.

Similar to the fine sediment metals, we found great similarity between Flathead and Elk Basin sites (see Appendix tables). We present herein the results of the cadmium (Cd) analysis, as this was the only metal that showed a significant response with higher concentrations of Cd metal in Michel Creek below Corbin (ERB – 6) and in Michel Creek near the Elk River (ERB – 7)(Figure 20) than among other sites. The higher cadmium concentrations in both Michel Creek sites can be attributed to sources from Corbin Creek with the lower concentrations in the Elk river sites likely due to dilution.

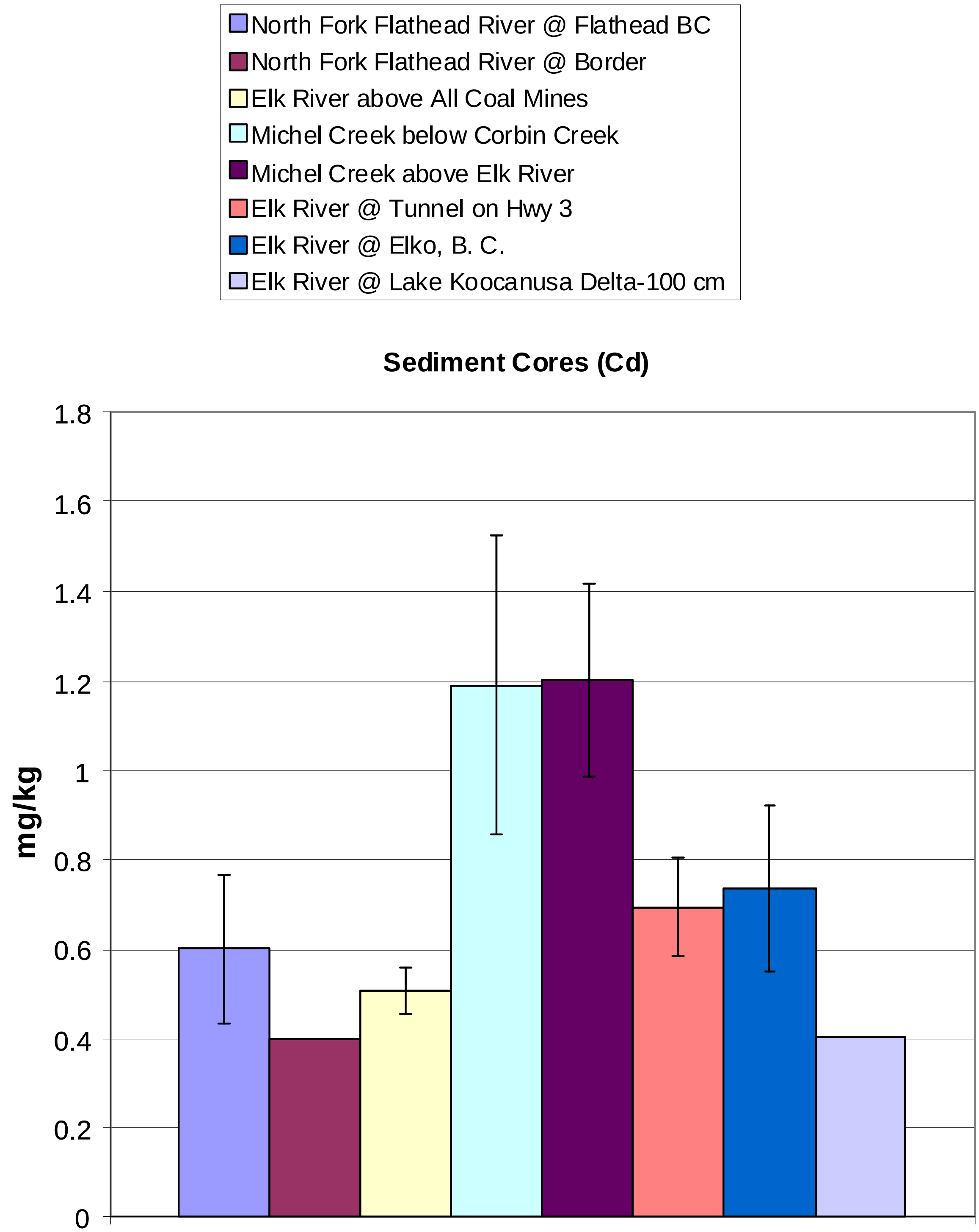


Figure 20. Mean concentration (+ 1 std error) of cadmium (Cd) among two Flathead Basin and six Elk Basin sites. Note that the Michel Creek sites were significantly greater than either the Flathead Basin sites and the Elk River above all coal mines site.

3.4 *Algal Periphyton*

Many organisms are useful as indicators of overall biological condition because they integrate a wide variety of stressors over time (Stevenson and Hauer 2002). Each species has a specific response curve to environmental conditions. Many diatom-based indices have been used to estimate water quality based on these responses. Most of these indices assume this response curve is unimodal and symmetrical and assign each species an indicator value based on the "optima" or peak of the response curve. The weighted averages of indicator values can be used to infer environmental parameters based on the species assemblage. While Potapova et al. 2004 showed that diatom response curves are not always symmetrical and unimodal, they found that an index which accounted for irregular response curves had no better predictive power than the traditional method.

We collected periphyton samples in the summer of 2006, 2007 and 2008. The results here reflect the overall sampling effort and the trends associated with the examination of periphyton algal diatom diversity as an indicator of ecological health and the distribution and abundance of chlorophyll-a as an indicator of nutrient enrichment.

We found algal species diversity to be significantly affected by coal mining discharge of surface and/or groundwaters into Michel Creek. In comparison of Flathead Basin sites to Elk Basin sites, we found a significantly higher diversity of algae in Flathead Basin sites where there is no mining compared with Elk Basin sites below the effects of coal mining (Figure 21). We found less difference in the density of chlorophyll-a (ug/cm^2) on the stream and river bottoms, but when take as a whole, there was generally more algae and thus the stream bottom appears more green than among the Flathead Basin sites, where chlorophyll-a density was very low at all sample locations (Figures 22 and 23).

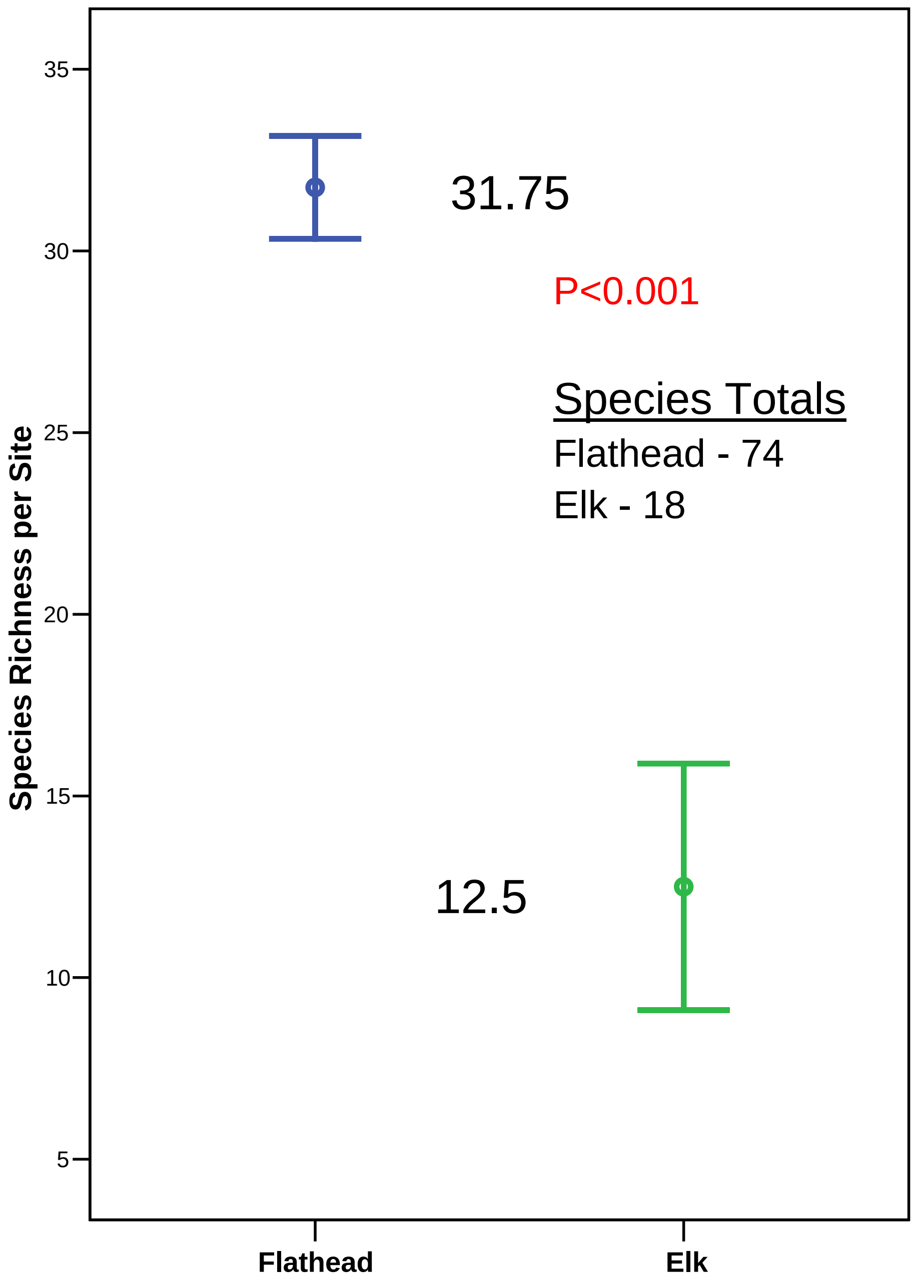
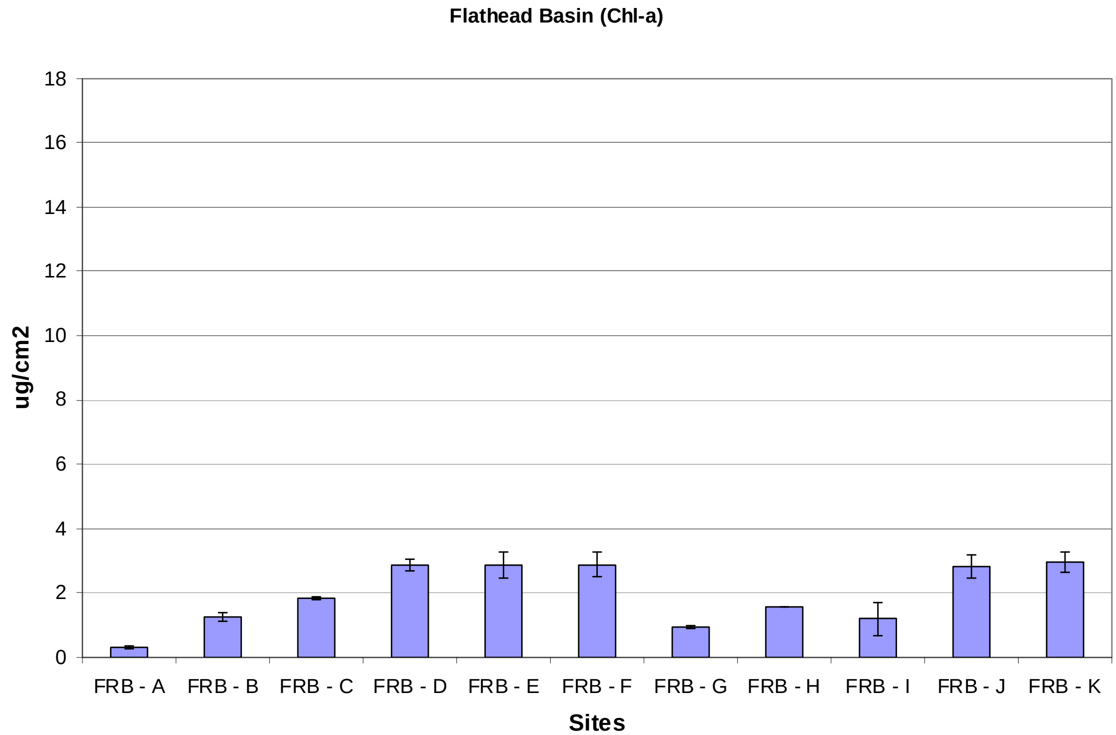
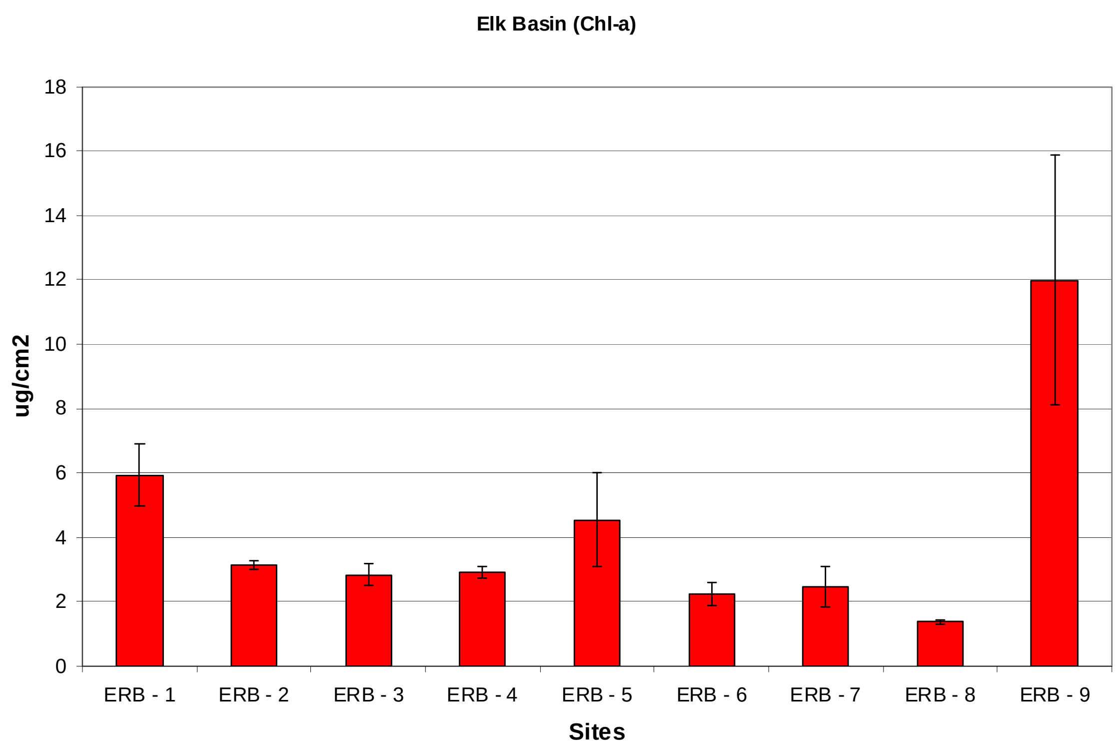


Figure 21. Mean algal species richness in the Flathead Basin sites compared with the Elk Basin.





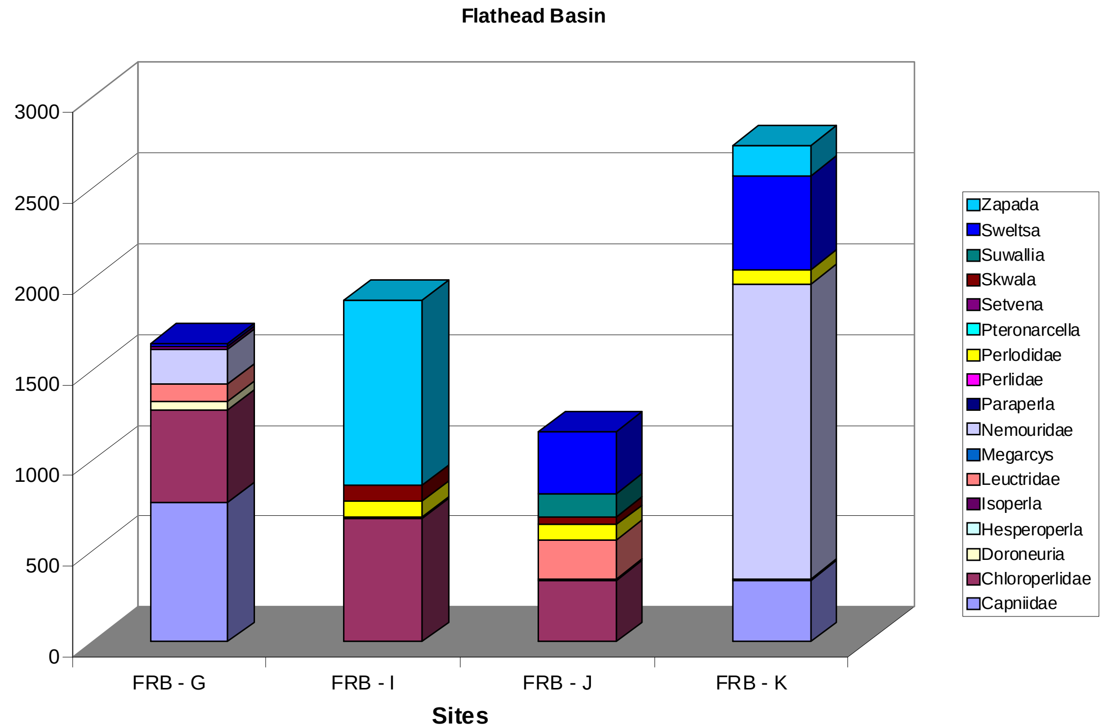
Figures 22 and 23. Chlorophyll-a density among Flathead Basin (upper figure) and Elk Basin (lower figure) sites.

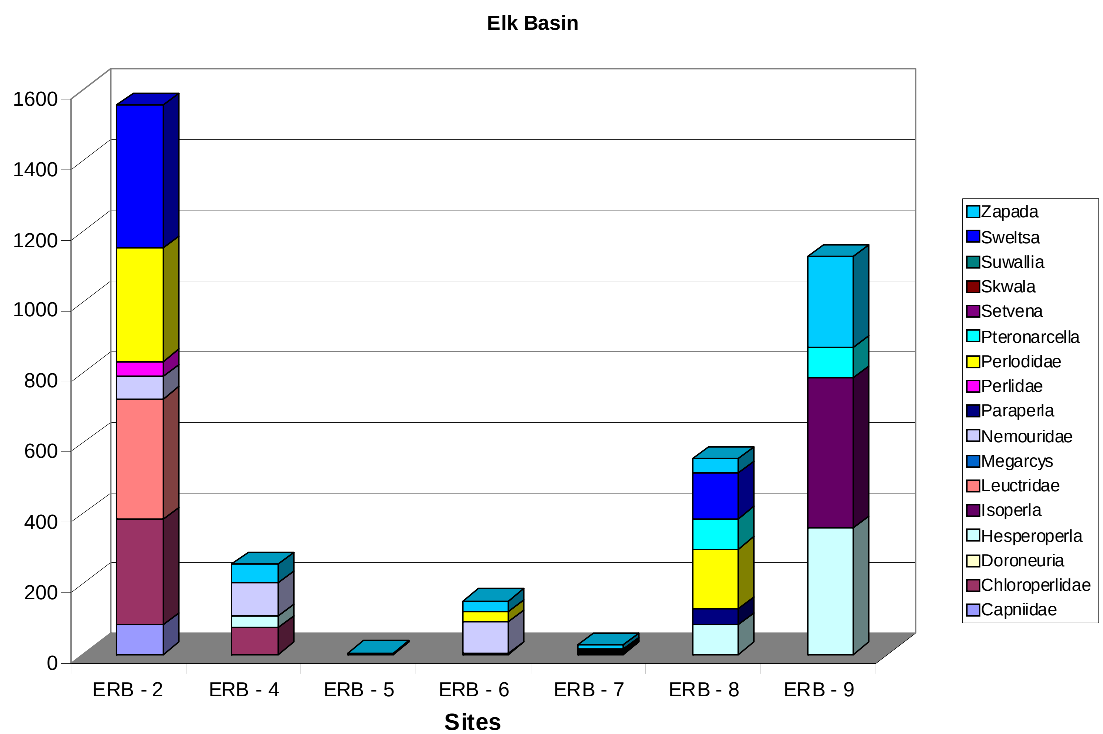
3.5 *Benthic Macroinvertebrates*

Benthic macroinvertebrates, also referred to as zoobenthos, are a reliable indicator of trends within riverine systems. A large proportion of zoobenthos are thus highly responsive to changes in the algal structure of a given habitat. Such photosynthetic developments are dependent on factors such as substrata, thermal consistency, nutrient content and flux, and toxic materials dissolved in the water. These physico-chemical factors are reflected in the distributions and abundances of benthic macroinvertebrates. It is of particular importance to understand the specific community structure of an ecosystem, both for the purpose of enhancing understanding of taxa response to the environment, but also with goal of establishing an identifiable relationship with the functional factors of that system. The relationship between structure and function, once established in an ecosystem of a particular type, can be utilized to make predictions of structure based on observations of function, or vice versa.

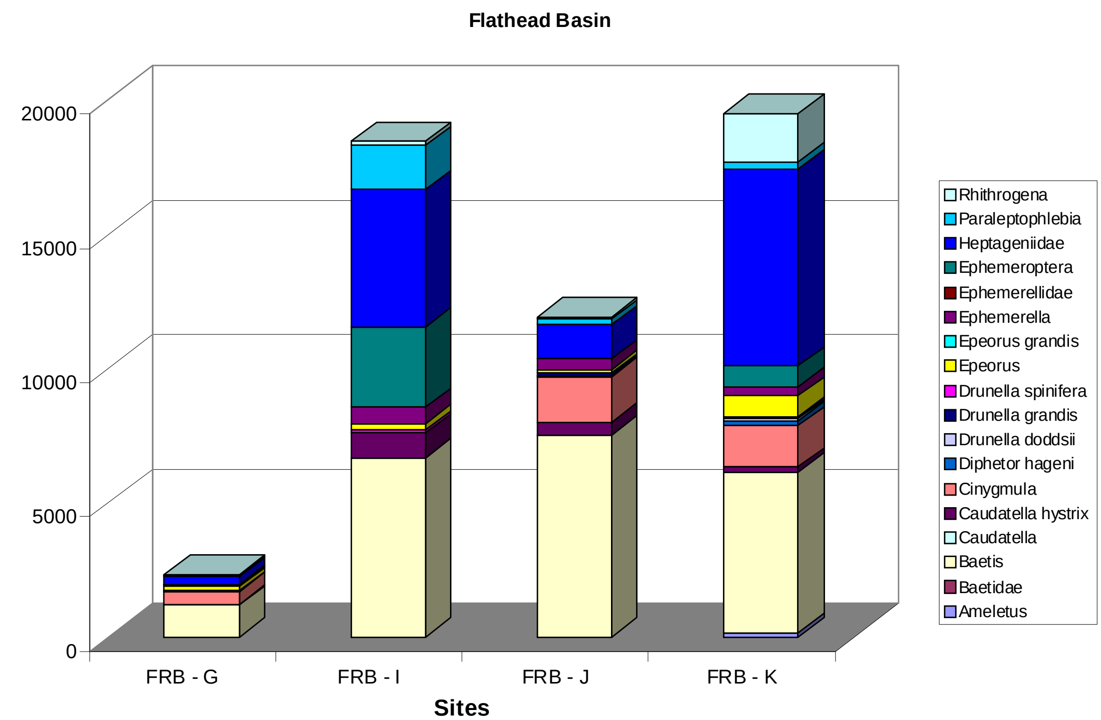
Biotic factors also determine the distribution and abundance of benthic macroinvertebrates. Both intra- and inter-specific competition may affect stream macroinvertebrates, yet may be compensated for and alleviated by habitat heterogeneity. The benthic macroinvertebrate communities that exist along stream and river corridors in the Transboundary Flathead are extremely diverse (Hauer et al 2000). The orders Plecoptera, Ephemeroptera, and Trichoptera on the Flathead River typically are diverse and compose over 90% of the benthic invertebrate biomass. These species have been used extensively throughout the US and Canada as indicator taxa of stream and river ecosystem environmental condition.

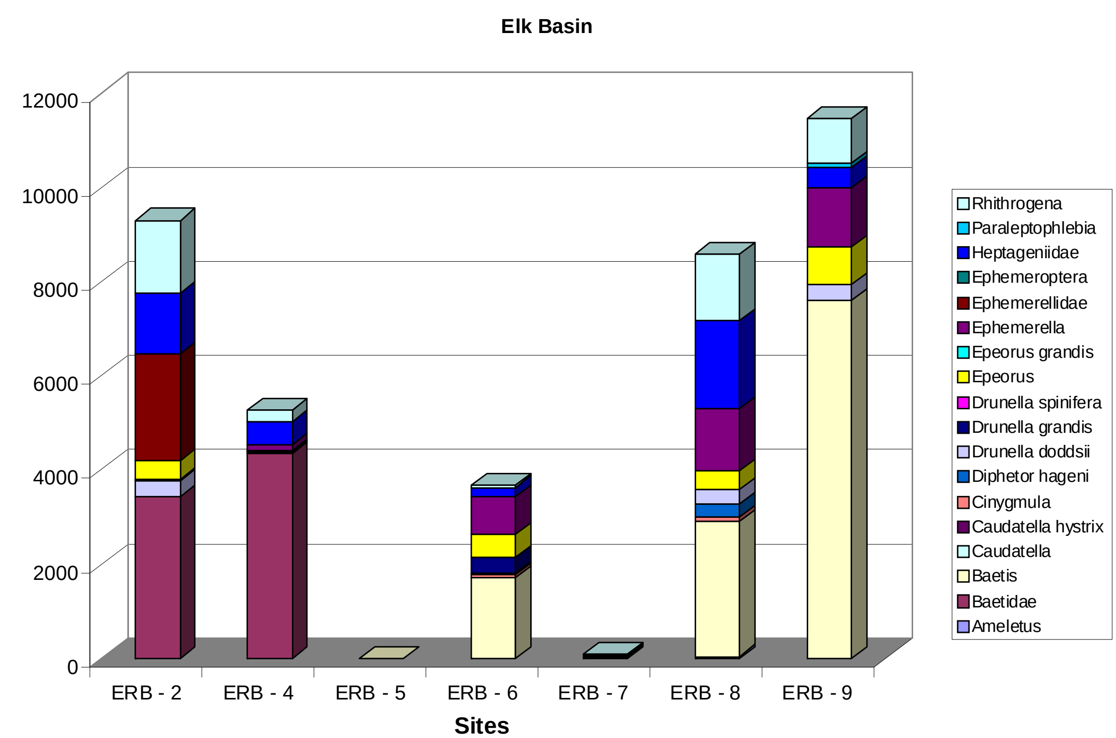
We found the Plecoptera (Figures 24 and 25) , Ephemeroptera (26 and 27), and Trichoptera (Figures 28 and 29), as well as the Diptera (Figures 30 and 31), to be diverse and responsive to environmental effects of coal mining in the Elk Basin.



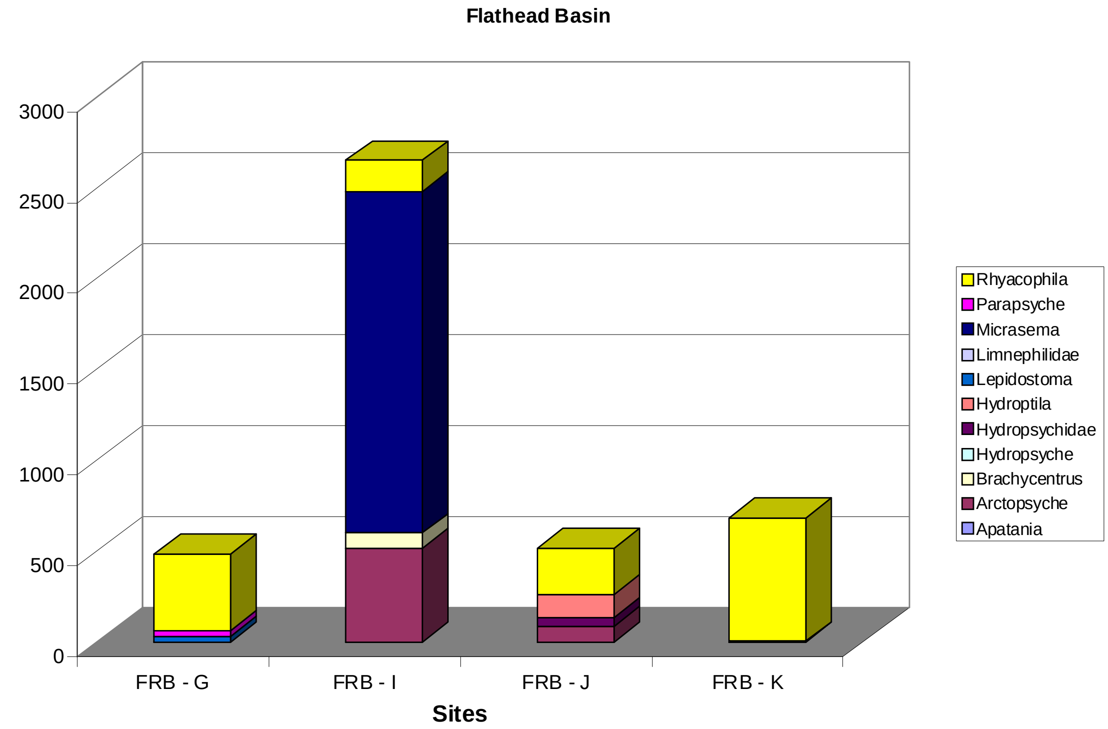


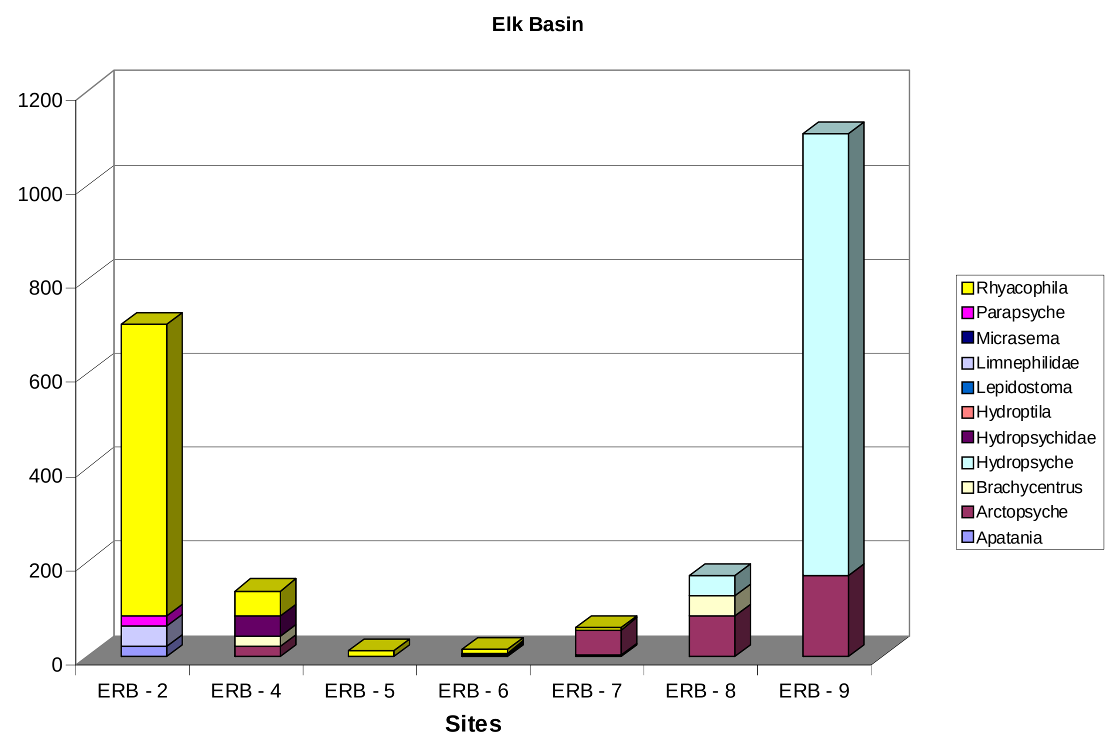
Figures 24 and 25. Plecoptera (stonefly) nymph abundance (# per m^2) among Flathead Basin (top figure) and Elk Basin (lower figure) sites.



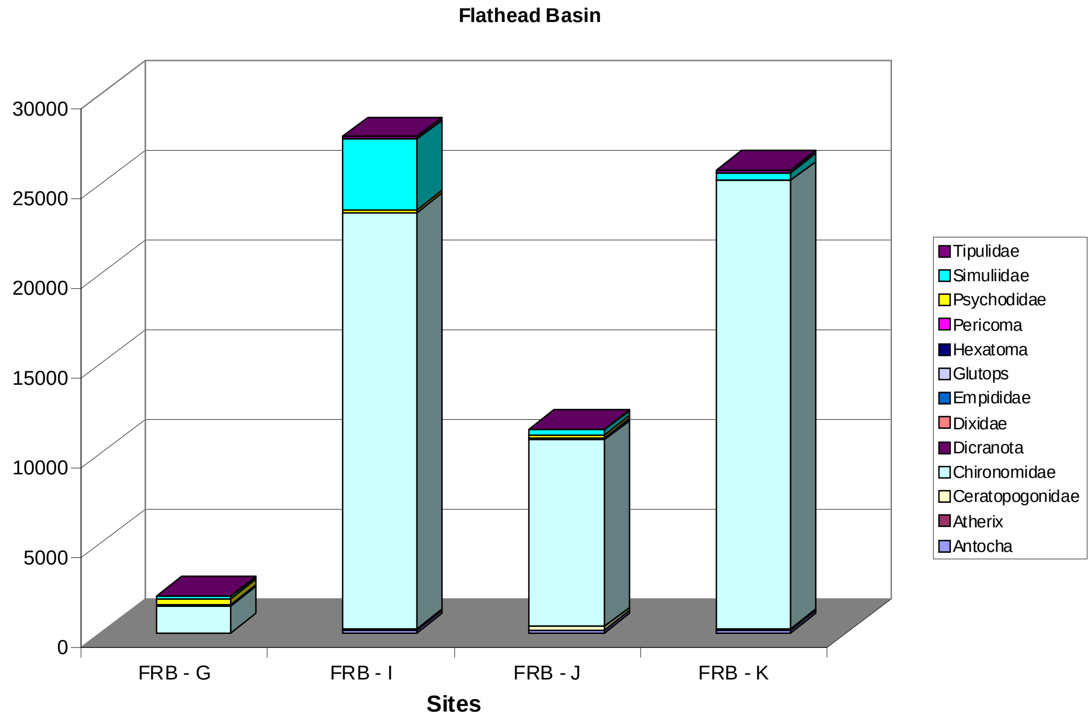


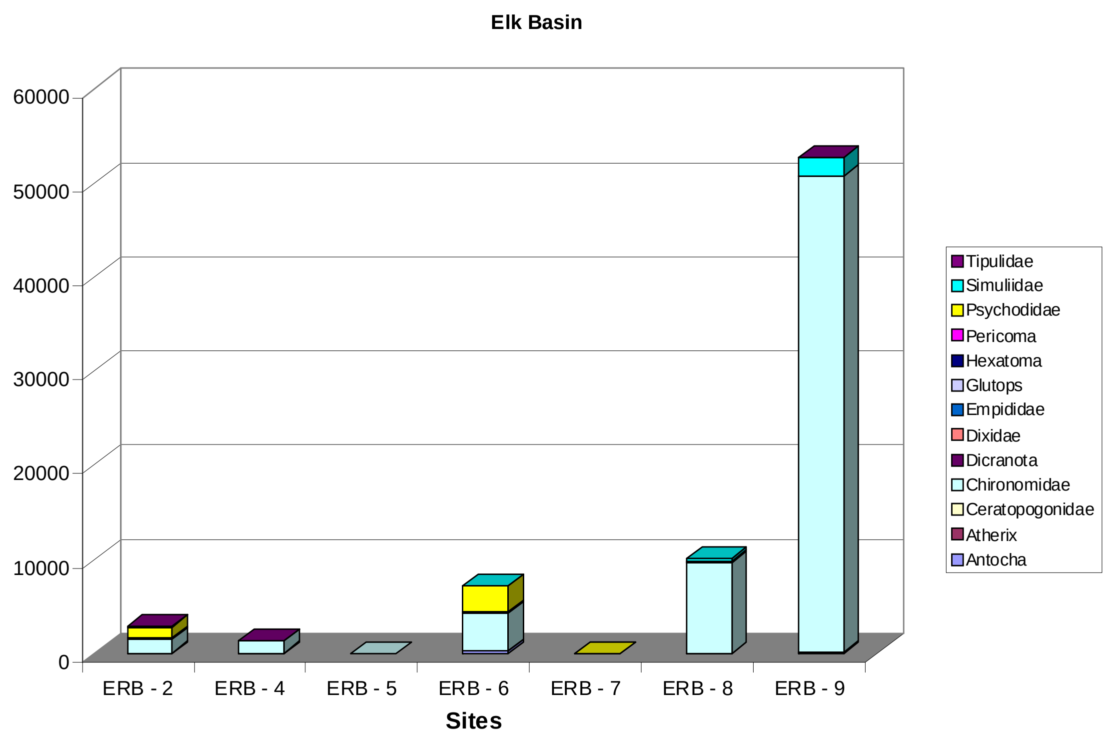
Figures 26 and 27. Ephemeroptera (mayfly) nymph abundance (# per m^2) among Flathead Basin (top figure) and Elk Basin (lower figure) sites.





Figures 28 and 29. Trichoptera (caddis fly) larvae abundance (# per m^2) among Flathead Basin (top figure) and Elk Basin (lower figure) sites.





Figures 30 and 31. Diptera (true fly) larvae abundance (# per m^2) among Flathead Basin (top figure) and Elk Basin (lower figure) sites.

Among the Plecoptera and Trichoptera in particular, we found the frequency of nymphs and larvae to be markedly depressed in Corbin Creek and Michel Creek below Corbin and Michel Creek near the confluence with the Elk River. In contrast, populations were very robust among all the Flathead Basin sites and in Elk Basin sites above the effects of coal mining. We also found that populations of these taxa had "recovered' in the down river areas of the Elk River represented by our sites at Hosmer and at Morressey where we found relatively robust invertebrate populations.

We observed a similar pattern among the Ephemeroptera nymphs, but much of the density in the downstream reaches was related to high abundance of Baetis sp. Both Baetis and the Hydropsychid caddisflies that were very abundant at ERB – 9 are known to be tolerant of pollution and become very abundant as algal biomass is stimulated by increases in nutrients. Diptera larvae were also abundant in the Flathead Basin Sites, but showed strong negative effects of pollution in Corbin Creek (ERB - 5) some recovery at the Michel Creek below Corbin (ERB – 6), but with marked decline again at Michel Creek near Elk river confluence (ERB – 7).

4.0 CONCLUSIONS

Nutrients - Nitrate and total nitrogen concentrations were significantly elevated at sites downstream of coal mining in the Elk Basin compared to what was observed either at Flathead Basin sites or at Elk Basin sites above coal mines. Without particular speculation as to the cause of this observed condition, nitrate and TPN concentrations were around 1000X greater associated with coal mines than when waters are not affected by mines. Phosphorus was not similarly affected by mining. Furthermore, the natural concentrations of SRP in the Transboundary Flathead and Elk are such that it is probable that these waters are normally N-limited; thus, making these waters particularly vulnerable to increased Nitrogen loading.

Sulfate and Selenium – Sulfate concentrations were also significantly elevated in Elk Basin sites below coal mining. This is likely due to exposure of sulfide and/or sulfate bearing ores that are oxidized when exposed to the atmosphere during the mining process. Sulfate is very soluble in water and readily mobilized. Sulfate can be a stressor of algae, macroinvertebrates and fish at high levels and under some conditions can lead to acidic stream condition known as acid mine waste. While we did not observe acidic conditions, sulfate concentrations being 40-50X higher than what occurs naturally in Flathead Basin and Elk Basin streams cause for concern. Similarly to sulfate, selenium concentrations were elevated to 7-10X naturally occurring levels in Flathead and Elk Basin streams and rivers. Selenium is of particular concern because of its toxicity to plants and animals and that the concentrations in the sites below the coal mining frequently exceed the values known to cause toxicity and abnormal development in fish. The high concentrations of sulfates and selenium in waters downstream of Elk Basin coal mines represent a significant threat to the ecological integrity of these streams and rivers. This should be of great concern to both Environment Canada and the US EPA as the Elk is a tributary to the Kootenai River, which flows into the USA in western Montana.

Sediment Metals – We had a comprehensive survey design to look for metal effects in sediments transported from the coal mines. We were particularly concerned about selenium, mercury, cadmium, zinc and other elements associated with runoff from mining sites. We did observe elevated concentrations of cadmium in Corbin Creek and in Michel Creek below Corbin, but we did not observe increased metal concentrations above those at sites either in the Flathead Basin or among sites in the Elk Basin above the coal mines.

Stream Periphyton – Algae is an excellent indicator of nutrient pollution as well as toxicity. We observed a significant decline in algae diversity between Flathead Basin sites and Elk Basin sites below coal mining effects. Effects on algal abundance were less distinct than what we observed with algal diversity. Chlorophyll-a density was only slightly higher in Elk Basin sites, although we did observe the highest density of algae in the Elk River at Morressey.

Benthic Macroinvertebrates – Stream invertebrates are highly diverse in the Transboundary Flathead and Elk Basins. And, these organisms have been used extensively throughout the US and Canada as indicator taxa of environmental degradation. We observed significant impact to the macroinvertebrate communities in Corbin Creek and Michel Creek. These sites also showed the most pronounced effects on algae and the highest concentrations of nutrient pollution, sulfates and selenium concentrations.

Summary – We observed significant ecological and environmental effects of coal mining on freshwaters of the Elk Basin when compared to both the Flathead Basin and the Elk Basin at sites above coal mines. These effects are highly distinctive and prevalent throughout the study period and across all seasons. All coal mining affected sites had increased nitrogen loading, increased sulfate loading, increased selenium loading, decreased algal diversity, and decrease benthic diversity and abundance. These factors point to a degraded freshwater ecosystem in the Elk River Basin below coal mines. Indeed, we observed both a decrease in ecosystem structure and ecosystem function, with an overall loss of ecosystem integrity.

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Appendix A. Tables of Nutrient Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collected	ALK	Ca	Cl	F	K	Mg	Na	NH3-N	NO2/3	SO4	SRP	TP	TPN	TSS
		mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L
FRB - A	6/23/07	75	26962	0.067	0.11	154	7177	314	7.3	3.0	4.2	5.9	12.3	26.5	< 3
FRB - A	7/24/07	98	34335	0.075	0.13	222	10823	340	5.8	4.0	8.2	5.9	11.1	19.4	< 3
FRB - A	8/22/07	96	41536	0.078	0.14	235	13461	714	12.9	3.1	9.0	5.1	9.2	32.2	< 3
FRB - A	9/26/07	127	42053	0.093	0.13	168	14240	1064	5.2	1.7	9.5	3.9	10.9	15.4	< 3
FRB - A	11/19/07	119	38087	0.17	0.18	181	11272	230	4.6	11.2	8.7	4.8	10.3	41.7	< 3
FRB - A	6/25/08	87	26611	0.071	0.098	106	7578.8	401	< 5.0	< 0.6	3.4	6.6	10.9	37.6	< 3
FRB - A	7/23/08	106	32487	0.062	0.13	120	10368	340	< 5.0	7.0	7.3	6.1	8.5	53.2	< 3
FRB - A	8/20/08	126	41609	0.061	0.13	200	13357.2	837	4.4	3.8	8.9	7.9	10.8	13.2	< 3
FRB - A	9/9/08	125	24179	0.062	0.13	205	7686.5	1148	3.6	4.1	9.3	2.9	9.2	12.2	< 3
FRB - A	10/13/08	129	37872	0.082	0.12	207	12255.5	420	10.6	1.9	9.7	4.0	8.5	13.0	< 3
FRB - B	6/23/07	23	7280	0.037	0.05	286	1728	1576	7.1	1.9	1.0	6.7	12.4	27.7	< 3
FRB - B	7/24/07	43	15397	0.074	0.076	591	3413	2226	7.0	1.7	2.6	5.6	12.1	70.2	< 3
FRB - B	8/22/07	45	19989	0.074	0.076	577	5607	3585	14.2	< 0.3	3.3	5.9	9.3	41.3	< 3
FRB - B	9/26/07	62	20785	0.22	0.077	438	4196	3333	4.8	< 0.3	4.2	4.8	7.2	19.4	< 3
FRB - B	10/25/07	27	7913	0.3	0.084	279	1635	3112	9.5	1.4	1.4	7.1	22.2	199.2	< 3
FRB - B	6/24/08	18	5079	0.044	0.04	232	1114.4	735	6.4	1.2	0.7	5.1	13.0	77.7	8.2
FRB - B	7/22/08	42	14956	0.055	0.068	465	3123.4	1826	7.1	1.9	2.3	32.2	9.8	51.5	< 3
FRB - B	8/19/08	49	17316	0.06	0.045	424	4410.1	1243	5.9	4.1	3.8	7.8	11.2	51.2	< 3
FRB - B	9/9/08	60	18930	0.061	0.069	519	4305.8	2843	12.4	2.2	3.6	4.6	7.9	28.7	< 3
FRB - B	10/15/08	60	17632	0.31	0.069	425	3756.5	3342	9.5	< 0.3	3.9	4.0	7.5	45.9	< 3
FRB - C	6/22/07	90	35038	0.084	0.17	164	7113	332	< 2.5	33.0	4.9	2.0	3.8	16.4	< 3
FRB - C	7/25/07	96	38875	0.1	0.18	165	7771	336	5.7	42.4	6.3	0.7	3.8	55.4	< 3
FRB - C	8/21/07	93	45316	0.16	0.19	178	8620	630	< 2.5	54.1	7.4	0.6	4.2	58.9	< 3
FRB - C	9/25/07	124	46435	0.13	0.17	135	9139	1116	5.7	75.2	7.1	2.2	2.8	76.4	< 3
FRB - C	10/24/07	129	43558	0.18	0.21	179	7760	247	6.3	151.0	9.2	0.7	7.0	189.0	< 3
FRB - C	6/25/08	99	34990	0.099	0.16	< 100	6381.1	296	< 6.3	8.2	3.9	0.9	2.6	53.8	< 3
FRB - C	7/22/08	107	40447	0.076	0.18	156	7240.9	209	7.6	13.6	5.6	3.3	4.0	43.6	< 3
FRB - C	8/18/08	117	44200	0.093	0.18	147	6995.6	197	6.2	58.4	6.7	3.9	2.9	77.3	< 3
FRB - C	9/8/08	120	43729	0.11	0.17	178	8624	557	6.8	61.6	7.7	4.7	2.0	70.2	< 3
FRB - C	10/15/08	125	42705	0.12	0.17	182	8060.7	385	12.0	81.3	9.7	< 1.3	1.0	92.5	< 3

Appendix A cont. Tables of Nutrient Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collected	ALK	Ca	Cl	F	K	Mg	Na	NH3-N	NO2/3	SO4	SRP	TP	TPN	TSS
		mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L
FRB - D	6/24/07	78	27568	0.076	0.066	281	7255	692		2.2	6.6	15.7	25.9	42.3	3.3
FRB - D	7/23/07	105	37300	0.095	0.055	403	11318	1301	8.7	3.3	8.0	9.7	25.1	95.6	9.8
FRB - D	8/21/07	102	42259	0.11	0.054	423	13105	1366	14.1	3.1	8.1	2.8	8.4	29.7	< 3
FRB - D	9/25/07	130	47536	0.16	0.055	324	15243	1186	3.4	1.0	9.1	1.3	7.7	29.6	< 3
FRB - D	10/25/07	106	32572	0.26	0.062	291	8449	2080	4.8	1.9	11.6	5.8	18.7	72.7	4.7
FRB - D	6/23/08	72	22237	0.063	0.065	142	6452.1	883	15.8	2.5	5.2	25.9	46.1	82.6	23.6
FRB - D	7/21/08								5.9	< 0.6		65.5	38.5	76.8	
FRB - D	8/18/08	129	47027	0	0	358	14927.9	612	3.7	5.6	0.0	6.8	12.1	36.9	< 3
FRB - D	9/8/08	125	40251	0.1	0.048	375	12326	998	8.0	3.1	9.0	3.1	10.4	42.3	< 3
FRB - D	10/13/08	129	38211	0.16	0.045	344	11533.7	891	10.6	0.6	9.6	3.2	7.6	24.2	< 3
FRB - E	6/23/07	16	5629	0.038	0.037	212	1479	994	13.9	1.7	1.2	5.5	10.1	50.9	< 3
FRB - E	7/24/07	39	14074	0.069	0.057	479	3295	1906	3.4	4.3	3.5	4.5	13.6	126.3	< 3
FRB - E	8/22/07	40	17560	0.059	0.062	495	5681	3462	26.8	3.0	4.3	1.9	6.5	55.7	< 3
FRB - E	9/26/07	50	17159	0.13	0.058	378	3928	2635	< 2.5	2.6	4.9	1.7	6.1	41.8	< 3
FRB - E	10/25/07	21	6103	0.35	0.041	194	1423	2722	16.4	11.7	2.2	5.5	73.1	411.5	5.3
FRB - E	6/24/08	15	4023	0.041	0.027	122	989.3	603	7.2	< 0.6	0.8	5.5	10.1	90.5	3.7
FRB - E	7/22/08	40	13049	0.062	0.049	371	3334.2	1668	6.0	0.9	2.9	11.9	13.8	70.4	< 3
FRB - E	8/19/08	54	19283	0.047	0.055	451	3304.7	1887	6.4	4.5	4.2	6.1	10.0	93.0	< 3
FRB - E	9/9/08	51	15520	0.047	0.053	436	4077.6	2535	12.2	3.8	4.3	2.7	7.2	60.3	< 3
FRB - E	10/15/08	43	12922	0.2	0.044	305	3049.1	2207	8.2	0.6	4.0	2.5	7.3	56.7	< 3
FRB - F	6/23/07	25	7873	0.052	0.046	255	1956	1100	7.0	1.6	1.8	8.8	14.8	64.3	< 3
FRB - F	7/24/07	50	19783	0.093	0.053	495	4350	1351	11.2	8.3	4.1	37.2	12.3	78.2	< 3
FRB - F	8/22/07	52	23208	0.075	0.048	503	7711	2703	5.0	1.7	4.4	7.3	10.6	41.0	< 3
FRB - F	9/26/07	67	23667	0.15	0.048	302	5353	1814	4.5	3.3	5.6	3.9	7.0	29.5	3.7
FRB - F	10/25/07	25	10280	0.45	0.059	229	2087	3310	8.9	8.1	3.6	7.8	24.5	166.6	4.8
FRB - F	6/24/08	23	6039	0.068	0.034	165	1378.3	690	6.7	< 0.6	1.3	8.3	13.8	88.7	3.5
FRB - F	7/22/08	49	17316	0.06	0.045	424	4410.1	1243	< 5.0	1.5	3.8	13.9	11.6	55.8	< 3
FRB - F	8/19/08	69	24555	0.045	0.045	428	4790.2	1192	7.2	3.0	4.6	9.0	9.7	54.7	< 3
FRB - F	9/9/08	67	23585	0.07	0.045	394	5652.9	1635	11.4	4.3	5.0	3.8	7.4	60.4	< 3
FRB - F	10/15/08	66	19593	0.28	0.041	291	4403	1764	19.7	3.4	5.2	4.6	7.4	43.1	< 3

Appendix A cont. Tables of Nutrient Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collected	ALK	Ca	Cl	F	K	Mg	Na	NH3-N	NO2/3	SO4	SRP	TP	TPN	TSS
		mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L
FRB - G	6/23/07	28	8146	0.049	0.051	227	2543	1180	5.9	0.3	1.8	19.0	25.5	61.8	< 3
FRB - G	7/24/07	48	16874	0.061	0.062	425	5057	1250	13.2	6.1	3.7	21.3	35.4	136.2	< 3
FRB - G	8/22/07	117	51288	0.11	0.048	367	12649	695	6.4	4.8	4.1	12.1	17.7	45.3	< 3
FRB - G	9/26/07	62	20108	0.17	0.063	233	5654	1930	7.0	0.6	5.1	7.3	15.6	42.9	< 3
FRB - G	10/25/07	30	8921	0.35	0.096	260	2497	1066	4.6	1.6	3.3	6.6	24.3	174.0	< 3
FRB - G	6/25/08	25	6390	0.061	0.041	145	1993	650	7.2	< 0.6	1.3	22.8	27.0	77.2	3.3
FRB - G	7/23/08	49	16535	0.059	0.055	226	4198.6	984	5.7	< 0.6	3.5	4.3	22.1	54.2	< 3
FRB - G	8/20/08	61	23874	0.042	0.059	334	5267.4	1572	6.4	10.1	4.3	16.5	20.6	52.8	< 3
FRB - G	9/9/08	60	18451	0.057	0.054	357	5790	1586	8.0	5.4	4.4	10.5	16.5	44.1	< 3
FRB - G	10/13/08	61	17472	0.2	0.05	268	4994.1	1487	13.1	1.2	4.8	11.1	17.3	41.1	< 3
FRB - H	6/23/07	20	6561	0.041	0.04	218	1619	1332	13.1	1.2	1.4	7.0	13.0	52.1	< 3
FRB - H	7/24/07	41	14547	0.081	0.058	519	3519	1821	7.3	2.9	3.4	5.8	19.3	138.3	< 3
FRB - H	8/22/07	41	18088	0.051	0.058	446	4381	2367	2.9	1.6	3.8	0.5	6.5	52.8	< 3
FRB - H	9/26/07	52	17900	0.11	0.057	316	4038	2987	58.8	0.4	4.5	2.2	5.8	52.3	< 3
FRB - H	10/25/07	22	6148	0.42	0.082	322	1580	857	8.2	4.6	3.5	6.5	22.4	187.8	6.9
FRB - H	6/25/08	18	5219	0.044	0.03	156	1253.6	666	8.0	3.9	1.0	6.6	13.0	107.4	4.8
FRB - H	7/23/08	44	13616	0.076	0.05	389	3490.5	1597	5.3	1.4	3.0	21.3	8.7	72.2	< 3
FRB - H	8/20/08	52	17609	0.046	0.054	423	3745.2	1728	5.9	3.7	3.7	3.2	10.2	80.6	< 3
FRB - H	9/9/08	51	16498	0.051	0.051	422	3934.4	1996	8.5	3.5	4.0	2.3	6.3	51.3	< 3
FRB - H	10/13/08	47	14825	0.21	0.045	319	3321	1871	12.7	3.0	4.0	3.9	6.1	52.9	< 3
FRB - I	6/23/07	20	7203	0.045	0.041	260	1788	954	9.4	0.9	1.5	8.1	10.8	64.3	< 3
FRB - I	7/24/07	47	17193	0.093	0.079	481	4844	1493	< 2.5	4.4	3.7	13.8	17.4	123.6	< 3
FRB - I	8/22/07	44	20350	0.056	0.06	361	4556	1946	15.7	2.3	4.0	3.0	8.2	57.0	< 3
FRB - I	9/26/07	63	21298	0.16	0.074	326	5658	2519	8.0	0.9	5.6	3.3	7.6	50.4	< 3
FRB - I	10/25/07	25	8312	0.4	0.055	354	2338	835	5.6	4.3	3.5	6.1	25.3	209.3	< 3
FRB - I	6/25/08	19	5297	0.049	0.03	152	1302.3	700	11.7	< 0.6	1.0	6.3	16.1	120.6	5.2
FRB - I	7/23/08	48	14037	0.058	0.054	362	4035.6	1374	7.7	1.4	3.1	6.7	11.6	103.7	< 3
FRB - I	8/20/08	62	17769	0.049	0.062	444	5021	2617	6.4	4.4	3.9	5.5	10.9	68.7	< 3
FRB - I	9/9/08	56	19031	0.054	0.061	377	5349.2	1642	7.3	3.5	4.4	3.5	10.1	61.2	< 3
FRB - I	10/13/08	58	17346	0.2	0.051	325	4385.5	1661	13.4	1.6	4.5	2.2	7.1	37.5	< 3

Appendix A cont. Tables of Nutrient Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collected	ALK	Ca	Cl	F	K	Mg	Na	NH3-N	NO2/3	SO4	SRP	TP	TPN	TSS
		mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L
FRB - J	6/24/07	36	12630	0.048	0.058	205	3091	669	10.4	3.0	2.3	8.1			< 3
FRB - J	7/23/07	68	22576	0.078	0.086	364	6259	1015	10.5	4.6	5.0	6.8	14.7	109.0	< 3
FRB - J	9/25/07	85	28381	0.12	0.083	279	7972	1644	5.2	1.9	6.1	2.0	5.7	29.7	< 3
FRB - J	10/25/07	41	10950	0.32	0.062	186	3510	2941	4.0	< 0.3	3.4	5.0	19.4	133.8	< 3
FRB - J	6/23/08	27	8227	0.047	0.045	127	2384.5	688	9.1	5.9	1.5	10.5	17.2	79.2	4
FRB - J	7/22/08	69	21597	0.051	0.08	346	6303.8	864	< 5.0	< 0.6	4.5	6.2	15.8	45.2	< 3
FRB - J	8/18/08	99	32068	0.067	0.087	363	7083.9	925	7.6	4.0	5.7	19.8	10.4	63.1	< 3
FRB - J	9/8/08	82	27319	0.11	0.077	349	8043.2	1426	7.3	11.3	5.5	4.6	9.0	54.4	< 3
FRB - J	10/15/08	75	22787	0.17	0.065	302	6207.3	1336	12.4	1.4	5.5	2.4	6.2	35.6	< 3
FRB - K	7/25/07	86	30736	0.079	0.092	338	8344	848	4.8	5.8	5.2	1.8	12.5	46.1	< 3
FRB - K	8/21/07	81	34080	0.089	0.086	372	9982	1714	21.7	2.7	5.7	2.0	6.4	41.8	< 3
FRB - K	9/25/07	98	33626	0.12	0.08	271	9521	2658	16.7	< 0.3	6.2	1.1	5.7	40.0	< 3
FRB - K	10/25/07	39	11557	0.39	0.062	277	3094	850	6.9	5.7	3.8	6.4	20.5	164.0	5.9
FRB - K	6/25/08	53	16126	0.055	0.072	157	4017.2	546	5.3	1.6	2.3	8.9	14.5	68.9	4.8
FRB - K	7/22/08	89	30231	0.074	0.092	310	7454.9	663	8.8	6.7	4.8	61.0	23.9	43.2	< 3
FRB - K	8/18/08	112	36166	0.078	0.083	342	8038.1	756	5.1	4.3	5.7	7.1	12.0	51.5	< 3
FRB - K	9/8/08	98	33040	0.069	0.075	317	9175.3	1225	8.8	4.0	5.8	1.4	6.8	57.2	< 3
FRB - K	10/15/08	87	27454	0.18	0.067	268	7191.6	1229	12.0	1.9	5.9	1.5	4.8	28.9	< 3

Appendix A cont. Tables of Nutrient Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collec	ALK	Ca	Cl	F	K	Mg	Na	NH3-N	NO2/3	SO4	SRP	TP	TPN	TSS
		mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L
ERB - 0	7/25/07	121	41783	0.10	0.046	318	10845	450	5.8	4.6	4.1	0.9	4.9	75.8	< 3
ERB - 0	8/23/07	117	51288	0.11	0.048	367	12649	695	12.0	10.2	4.1	0.6	3.6	76.7	< 3
ERB - 1	6/22/07	83	27455	0.06	0.039	203	8808	610	5.9	4.4	2.3	4.4	14.2	69.1	< 3
ERB - 1	7/25/07	106	34749	0.07	0.041	166	11507	370	6.9	18.9	2.7	7.0	12.7	59.4	< 3
ERB - 1	8/23/07								3.2	17.3		3.6	9.7	42.5	
ERB - 1	9/27/07	130	39685	0.11	0.043	187	14925	964	5.7	2.4	3.5	3.2	8.7	25.2	< 3
ERB - 1	10/24/07	83	23483	0.36	0.053	262	7194	1259	14.7	4.0	7.0	5.0	11.4	111.6	< 3
ERB - 1	6/26/08	92	26684	0.14	0.054	231	7609	1101	6.9	1.9	6.7	3.2	6.9	42.9	< 3
ERB - 1	7/24/08	112	38617	0.25	0.074	467	10310	2277	5.5	1.9	12.8	3.1	7.4	40.0	< 3
ERB - 1	8/20/08	114	36472.5	0.07	0.039	217	12529	891	4.4	15.6	2.6	11.1	14.3	54.5	< 3
ERB - 1	9/10/08	122	33220	0.08	0.037	181	11450	507	6.3	13.4	3.0	3.1	9.7	45.0	< 3
ERB - 2	6/22/07	74	26276	0.11	0.077	279	8222	1212	7.3	1.7	10.0	3.9	16.2	21.6	8.2
ERB - 2	7/25/07	102	36869	0.22	0.11	396	11371	2078	7.1	3.1	18.3	1.4	9.8	67.4	< 3
ERB - 2	8/23/07	108	48848	0.31	0.1	465	14023	3884	12.9	3.0	18.8	0.9	5.7	27.2	< 3
ERB - 2	9/27/07	145	51423	0.42	0.088	387	15309	4019	11.5	1.7	23.0	0.8	8.4	39.3	< 3
ERB - 2	10/26/07	128	44824	0.42	0.089	346	12362	3303	13.8	3.4	20.0	3.4	7.6	39.4	< 3
ERB - 2	6/26/08	84	24243	1.00	0.066	230	8351	1091	10.3	< 0.6	10.1	3.4	11.1	54.1	8.8
ERB - 2	7/24/08	109	39920	0.20	0.041	439	12327	1959	5.0	1.3	20.4	2.7	11.5	105.2	< 3
ERB - 2	8/20/08	126	42103.8	0.27	0.086	532	12833	3193	12.1	3.2	22.9	3.5	8.5	55.3	< 3
ERB - 2	9/10/08	135	26790.6	0.33	0.079	454	7779	2993	6.3	3.7	24.3	1.2	5.7	43.9	< 3
ERB - 2	10/16/08	141	46155.8	0.44	0.071	408	13384	2974	12.1	0.9	25.9	2.1	3.9	13.5	< 3
ERB - 3	9/10/08	108	27632.8	0.08	0.073	247	10239	589	4.5	27.9	9.2	3.2	10.4	48.6	< 3
ERB - 3	10/16/08	110	31476.3	0.13	0.07	226	11618	657	11.7	23.7	10.5	4.1	7.7	31.8	< 3

Appendix A cont. Tables of Nutrient Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Colle	ALK	Ca	Cl	F	K	Mg	Na	NH3-N	NO2/3	SO4	SRP	TP	TPN	TSS
		mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L
ERB - 4	9/27/07	140	51485	0.34	0.17	287	12437	2576	4.7	22.7	18.9	< 0.5	4.9	44.3	< 3
ERB - 4	10/26/07	138	51166	0.37	0.18	224	11802	2815	< 3.6	46.4	21.5	< 0.5	8.5	89.8	7.6
ERB - 4	6/26/08	113	35990	0.25	0.15	219	8766	594	10.4	39.8	14.1	1.8	15.2	185.8	11.2
ERB - 4	7/25/08	108	43429	0.23	0.16	292	9032	501	< 5.0	23.3	14.7	0.9	6.0	87.9	4.6
ERB - 4	8/21/08	116	38987.5	0.31	0.15	304	9853	1076	6.3	24.0	15.2	1.4	5.5	65.9	< 3
ERB - 4	9/12/08	133	46924.7	0.32	0.16	307	11761	901	6.9	36.8	19.0	0.7	5.0	62.5	< 3
ERB - 4	10/14/08	132	47456.4	0.40	0.15	324	11270	1065	11.9	26.5	20.2	< 1.3	2.1	53.5	< 3
ERB - 5	6/22/07	177	122537	3.00	0.14	1686	52814	9776	12.1	1884.5	282.9	1.0	9.4	2141.6	3.9
ERB - 5	7/25/07	177	152174	4.40	0.17	1937	68547	13930	64.5	1893.0	450.5	0.8	11.8	2148.1	3.8
ERB - 5	8/23/07	167	179000	2.90	0.16	2244	74604	15731	5.7	1640.5	479.8	< 0.5	5.3	2314.3	< 3
ERB - 5	9/27/07	230	195000	6.40	0.18	2137	82308	19689	8.2	1681.0	498.6	< 0.5	10.7	1739.5	27.6
ERB - 5	10/26/07	246	105650	6.50	0.19	2476	86102	19108	23.8	2227.8	537.9	2.5	4.8	3397.3	< 3
ERB - 5	6/26/08	165	124722	2.00	0.17	1801	56447	9119	13.2	1681.0	333.0	0.9	6.0	1754.8	< 3
ERB - 5	7/24/08	212	149704	4.00	0.13	2155	76191	14773	25.8	2135.9	448.8	0.9	5.9	2343.3	< 3
ERB - 5	8/20/08	217	172000	4.10	0.13	2749	81826	15518	15.8	2440.4	52.7	2.1	25.2	4625.7	< 3
ERB - 5	9/10/08	231	172000	6.70	0.11	2489	82457	15548	18.0	2412.8	556.8	0.9	7.3	2633.3	< 3
ERB - 5	10/16/08	248	159000	7.50	0.11	2145	81543	18728	13.3	2122.7	529.0	3.4	3.5	2272.4	< 3
ERB - 6	6/22/07	95	51865	0.63	0.092	625	20030	3286	16.7	393.2	60.8	4.8	17.1	499.3	6.2
ERB - 6	7/25/07	128	74984	1.60	0.13	969	30553	6120	25.9	594.7	164.7	2.3	20.0	689.5	< 3
ERB - 6	8/23/07	139	110000	1.60	0.12	1260	44379	9467	5.8	725.2	216.9	< 0.5	5.6	784.1	< 3
ERB - 6	9/27/07	181	111000	2.80	0.12	1124	43300	10972	8.8	706.0	227.0	0.8	6.9	731.0	< 3
ERB - 6	10/26/07	174	198050	3.30	0.12	1126	42677	10104	10.8	933.7	243.0	2.1	4.4	1072.7	< 3
ERB - 6	6/26/08	108	42544	0.49	0.08	527	16428	2578	8.1	313.6	65.6	2.4	10.2	367.8	6.6
ERB - 6	7/24/08	131	68421	1.20	0.12	943	28081	5330	11.7	689.1	144.6	2.4	7.2	748.6	< 3
ERB - 6	8/20/08	171	91256.8	2.00	0.11	1500	41764	9189	10.6	1135.6	238.3	2.5	11.2	1172.2	< 3
ERB - 6	9/10/08	177	83964	3.30	0.098	1384	36825	8768	17.0	1106.3	255.0	1.4	8.0	1160.6	< 3
ERB - 6	10/16/08	184	93661.1	3.10	0.089	1056	38490	7796	10.4	825.3	205.9	3.3	4.2	826.4	< 3

Appendix A cont. Tables of Nutrient Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Colle(	ALK	Ca	Cl	F	K	Mg	Na	NH3-N	NO2/3	SO4	SRP	TP	TPN	TSS
		mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L
ERB - 7	6/22/07	76	34949	0.86	0.12	456	9441	1429	15.2	484.0	28.6	8.7	18.1	490.8	6.6
ERB - 7	7/25/07	130	60650	2.70	0.18	881	21419	2849	19.1	2697.8	79.8	1.3	46.8	2826.5	< 3
ERB - 7	8/23/07	131	81576	3.50	0.17	1066	28448	4439	18.1	3336.2	94.5	2.1	7.8	4174.9	< 3
ERB - 7	9/27/07	170	82619	3.40	0.17	862	28623	4220	10.6	2306.9	96.6	1.0	19.2	1824.4	< 3
ERB - 7	10/26/07	139	58515	1.70	0.17	493	17237	4078	5.5	726.6	59.8	1.2	4.8	768.6	< 3
ERB - 7	6/26/08	92	30446	0.78	0.12	368	9418	1238	11.2	215.4	24.8	3.2	14.8	307.5	3.5
ERB - 7	7/25/08	136	59997	1.80	0.15	703	19592	2202	25.3	881.7	63.1	2.4	7.8	1098.1	< 3
ERB - 7	8/21/08	149	61887.4	2.30	0.14	936	21631	3652	33.0	1215.4	73.0	3.5	51.5	1385.9	28.5
ERB - 7	9/11/08	156	47432.8	2.40	0.15	782	15397	3091	16.8	98.4	74.8	1.8	7.0	1067.3	< 3
ERB - 7	10/14/08	159	64334.4	2.80	0.14	760	21652	3153	19.0	1501.3	80.2	2.3	4.2	1700.4	< 3
ERB - 8	9/27/07	158	69535	2.50	0.21	604	22428	2925	8.2	1317.5	60.8	1.0	8.7	1520.5	3
ERB - 8	10/26/07	153	62528	2.50	0.21	483	18462	4935	3.4	1470.2	61.6	1.1	4.4	1476.5	< 3
ERB - 8	6/26/08	128	40885	0.93	0.16	418	11590	1245	11.7	707.2	29.1	1.0	10.5	792.1	13.4
ERB - 8	7/25/08	128	55960	1.40	0.18	546	16304	1684	10.5	1040.5	42.5	1.0	5.7	1138.4	3.5
ERB - 8	8/21/08	141	58080.8	1.90	0.18	633	17891	2971	11.7	954.8	47.7	9.1	8.5	1081.2	9.3
ERB - 8	9/12/08	151	59332.1	2.20	0.19	539	18553	2854	8.4	1280.5	57.4	0.7	7.8	1625.2	< 3
ERB - 8	10/16/08	159	60318.4	2.60	0.18	557	18750	2668	11.9	1225.3	61.1	1.8	2.7	1369.7	< 3
ERB - 9	9/27/07	157	68324	2.60	0.2	624	21780	3054	13.3	1138.6	61.2	0.8	8.9	1375.3	< 3
ERB - 9	10/26/07	148	58408	2.50	0.19	498	16436	4448	15.0	993.8	56.0	1.7	5.2	1123.6	< 3
ERB - 9	6/26/08	107	40990	0.96	0.15	396	11148	1255	10.8	576.6	25.5	1.6	20.7	649.3	34.6
ERB - 9	7/25/08	124	52700	1.50	0.17	534	14961	1707	15.9	909.2	42.4	1.5	6.8	1028.3	4
ERB - 9	8/21/08	138	47928.2	1.90	0.16	659	13883	3435	14.3	818.0	44.5	1.5	17.3	922.8	15.1
ERB - 9	9/12/08	219	81523.1	2.36	0.245	663	24741	3500	17.1	1158.1	62.5	1.2	4.4	1054.8	< 26.6
ERB - 9	10/16/08	158	61490.2	2.70	0.17	586	18500	3025	30.2	1079.2	59.7	2.8	4.8	1120.9	< 3

Appendix B. Tables of Metals Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collected	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Se	Sr	U	Zn
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
FRB - A	6/23/07	< 50	0.264	13.2	< 1	< 0.1	< 0.1	< 5	0.14	< 5	< 0.002	0.13	< 0.5	< 0.1	0.266	31.5	< 1	< 0.5
FRB - A	7/24/07	< 50	0.278	20.2	< 1	< 0.1	< 0.1	< 5	0.16	< 5	< 0.002	0.194	< 0.5	< 0.1	0.481	50.5	< 1	< 0.5
FRB - A	8/22/07	< 50	0.206	19.3	< 1	< 0.1	< 0.1	< 5	< 0.10	< 5	< 0.002	0.264	< 0.5	< 0.1	0.491	58.2	< 1	< 0.5
FRB - A	9/26/07	< 50	0.214	17.4	< 1	< 0.1	< 0.1	< 5	0.20	< 5	< 0.002	0.197	< 0.5	< 0.1	0.506	57.4	< 1	< 0.5
FRB - A	11/19/07	< 50	0.236	17.3	< 1	< 0.1	< 0.1	< 5	0.19	5.15	< 0.002	0.449	< 0.5	< 0.1	0.577	52.6	< 1	0.581
FRB - A	6/25/08	< 50	0.155	54.2	< 1	< 0.1	< 0.1	< 5	0.22	< 5	0.680	0.162	< 0.5	< 0.1	< 0.2	32.3	< 1	11.19
FRB - A	7/23/08	< 50	0.192	54.2	< 1	< 0.1	< 0.1	< 5	< 0.10	9.42	< 0.500	< 0.1	< 0.5	< 0.1	0.595	41.2	< 1	9.54
FRB - A	8/20/08	< 50	0.196	16.6	< 1	< 0.1	< 0.1	< 5	< 0.10	< 5	0.650	< 0.1	< 0.5	< 0.1	0.588	46	< 1	< 0.5
FRB - A	9/9/08	< 50	0.204	18.7	< 1	< 0.1	< 0.1	< 5	0.25	< 5	< 0.500	< 0.1	< 0.5	< 0.1	0.658	49.7	< 1	< 0.5
FRB - A	10/13/08	< 50	0.181	17.8	< 1	< 0.1	< 0.1	< 5	0.12	7.74	< 0.500	< 0.1	< 0.5	< 0.1	0.653	51.7	< 1	0.231
FRB - B	6/23/07	< 50	0.115	31.6	< 1	< 0.1	< 0.1	< 5	0.48	< 5	< 0.002	0.575	< 0.5	< 0.1	0.227	37.5	< 1	< 0.5
FRB - B	7/24/07	< 50	0.311	67.1	< 1	< 0.1	< 0.1	< 5	0.47	< 5	< 0.002	0.716	< 0.5	< 0.1	< 0.2	80.8	< 1	1.47
FRB - B	8/22/07	< 50	0.208	72	< 1	< 0.1	< 0.1	< 5	0.36	< 5	< 0.002	0.697	< 0.5	< 0.1	< 0.2	103	< 1	< 0.5
FRB - B	9/26/07	< 50	0.194	66.6	< 1	< 0.1	< 0.1	< 5	0.55	< 5	< 0.002	0.585	< 0.5	< 0.1	0.253	104	< 1	0.479
FRB - B	10/25/07	< 50	0.187	23.9	< 1	< 0.1	< 0.1	< 5	0.88	27.1	0.006	0.972	< 0.5	0.108	< 0.2	37.2	< 1	0.702
FRB - B	6/24/08	30.9	0.108	47.2	< 1	< 0.1	< 0.1	< 5	0.38	11.2	3.900	0.638	< 0.5	< 0.1	< 0.2	25.6	< 1	11.66
FRB - B	7/22/08	< 50	0.189	89.8	< 1	< 0.1	< 0.1	< 5	0.33	5.21	1.100	0.426	< 0.5	< 0.1	0.362	62.4	< 1	15.06
FRB - B	8/19/08	< 50	0.187	90.7	< 1	< 0.1	< 0.1	< 5	0.29	< 5	0.990	0.125	< 0.5	< 0.1	0.382	66.3	< 1	11.65
FRB - B	9/9/08	< 50	0.177	67.6	< 1	< 0.1	< 0.1	< 5	0.32	< 5	0.860	0.126	< 0.5	< 0.1	< 0.2	92.4	< 1	< 0.5
FRB - B	10/15/08	< 50	0.162	60.8	< 1	< 0.1	< 0.1	< 5	0.56	< 5	0.920	0.444	< 0.5	< 0.1	0.225	93.8	< 1	< 0.5
FRB - C	6/22/07	< 50	0.248	11	< 1	< 0.1	< 0.1	< 5	0.20	< 5	< 0.002	< 0.1	< 0.5	< 0.1	0.541	46.2	< 1	< 0.5
FRB - C	7/25/07	< 50	0.326	12.2	< 1	< 0.1	< 0.1	< 5	0.16	< 5	< 0.002	< 0.1	< 0.5	< 0.1	0.638	52.2	< 1	< 0.5
FRB - C	8/21/07	< 50	0.329	11.3	< 1	< 0.1	< 0.1	< 5	3.93	< 5	< 0.002	< 0.1	0.539	< 0.1	0.551	54.8	< 1	2.54
FRB - C	9/25/07	< 50	0.352	11	< 1	< 0.1	< 0.1	< 5	0.26	< 5	< 0.002	< 0.1	< 0.5	< 0.1	0.73	55.2	< 1	< 0.5
FRB - C	10/24/07	< 50	0.311	11.7	< 1	< 0.1	< 0.1	< 5	0.20	6.68	< 0.002	< 0.1	< 0.5	< 0.1	0.872	53	< 1	1.73
FRB - C	6/25/08	< 50	0.235	39.2	< 1	< 0.1	< 0.1	< 5	0.37	6.46	0.670	0.123	< 0.5	< 0.1	0.394	41.9	< 1	9.68
FRB - C	7/22/08	< 50	0.275	11.2	< 1	< 0.1	< 0.1	< 5	0.10	8.73	< 0.500	< 0.1	< 0.5	< 0.1	0.76	41.2	< 1	0.64
FRB - C	8/18/08	< 50	0.255	10.7	< 1	< 0.1	< 0.1	< 5	< 0.10	5.43	< 0.500	< 0.1	< 0.5	< 0.1	0.707	45.5	< 1	0.98
FRB - C	9/8/08	< 50	0.289	11.6	< 1	< 0.1	< 0.1	< 5	0.13	< 5	< 0.500	0.161	< 0.5	< 0.1	0.746	51.8	< 1	0.149
FRB - C	10/15/08	< 50	0.312	11.8	< 1	< 0.1	< 0.1	< 5	0.13	8.8	< 0.500	< 0.1	< 0.5	< 0.1	1.1	53.1	< 1	0.182

Appendix B cont. Tables of Metals Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collected	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Se	Sr	U	Zn
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
FRB - D	6/24/07	< 50	0.576	38.5	< 1	< 0.1	< 0.1	< 5	0.22	5.66	< 0.002	3.4	< 0.5	< 0.1	< 0.2	53.9	< 1	< 0.5
FRB - D	7/23/07	< 50	0.851	59.3	< 1	< 0.1	< 0.1	< 5	0.43	7.06	0.002	3.6	< 0.5	< 0.1	< 0.2	69.4	< 1	< 0.5
FRB - D	8/21/07	< 50	0.727	49.5	< 1	< 0.1	< 0.1	< 5	0.20	19.7	< 0.002	3.75	0.555	0.225	< 0.2	74.7	< 1	< 0.5
FRB - D	9/25/07	< 50	0.616	46.1	< 1	< 0.1	< 0.1	< 5	0.25	11.6	< 0.002	2.61	< 0.5	0.174	< 0.2	80.7	< 1	< 0.5
FRB - D	10/25/07	< 50	0.452	43.8	< 1	< 0.1	< 0.1	< 5	0.45	17.7	< 0.002	2.95	< 0.5	< 0.1	0.239	71.6	< 1	0.794
FRB - D	6/23/08	< 50	0.399	118.5	< 1	< 0.1	< 0.1	< 5	0.48	9.57	2.800	2.3	< 0.5	< 0.1	< 0.2	46.5	< 1	23.24
FRB - D	8/18/08	< 50	0.648	49.9	< 1	< 0.1	< 0.1	< 5	< 0.10	10.3	0.570	0.967	< 0.5	< 0.1	< 0.2	64.9	< 1	1.07
FRB - D	9/8/08	< 50	0.592	50.8	< 1	< 0.1	< 0.1	< 5	0.13	7.78	0.620	3.73	< 0.5	< 0.1	< 0.2	68	< 1	0.117
FRB - D	10/13/08	< 50	0.436	56.4	< 1	< 0.1	< 0.1	< 5	0.23	11.7	< 0.500	3.38	< 0.5	< 0.1	< 0.2	70.9	< 1	0.111
FRB - E	6/23/07	< 50	0.103	28.1	< 1	< 0.1	< 0.1	< 5	0.49	21.5	< 0.002	3.95	< 0.5	< 0.1	< 0.2	40.4	< 1	< 0.5
FRB - E	7/24/07	< 50	0.341	65.8	< 1	< 0.1	< 0.1	< 5	0.45	34.7	< 0.002	5.37	< 0.5	< 0.1	< 0.2	111	< 1	< 0.5
FRB - E	8/22/07	< 50	0.245	69.5	< 1	< 0.1	< 0.1	< 5	0.43	74.3	< 0.002	10.2	< 0.5	< 0.1	< 0.2	129	< 1	< 0.5
FRB - E	9/26/07	< 50	0.2	61	< 1	< 0.1	< 0.1	< 5	0.44	81.9	< 0.002	9.53	< 0.5	< 0.1	0.209	127	< 1	< 0.5
FRB - E	10/25/07	< 50	0.142	19	< 1	< 0.1	< 0.1	< 5	0.91	38.6	0.005	2.83	< 0.5	< 0.1	0.29	40.3	< 1	0.437
FRB - E	6/24/08	32.3	0.103	58.1	< 1	< 0.1	< 0.1	< 5	0.46	20.4	3.200	2.26	< 0.5	< 0.1	< 0.2	28.4	< 1	15.71
FRB - E	7/22/08	< 50	0.213	129.5	< 1	< 0.1	< 0.1	< 5	0.34	34.4	0.990	4.14	< 0.5	< 0.1	0.404	80.5	< 1	17.67
FRB - E	8/19/08	< 50	0.253	60.5	< 1	< 0.1	< 0.1	< 5	0.27	32.2	1.200	0.324	< 0.5	< 0.1	0.211	147.4	< 1	0.111
FRB - E	9/9/08	< 50	0.197	64	< 1	< 0.1	< 0.1	< 5	0.35	60.8	0.720	5.89	< 0.5	< 0.1	0.264	143.2	< 1	< 0.5
FRB - E	10/15/08	< 50	0.15	50.8	< 1	< 0.1	< 0.1	< 5	0.45	49	0.790	3.41	< 0.5	< 0.1	0.307	107.5	< 1	< 0.5
FRB - F	6/23/07	< 50	0.124	32.9	< 1	< 0.1	< 0.1	< 5	0.54	11.1	< 0.002	1.82	< 0.5	< 0.1	< 0.2	42	< 1	< 0.5
FRB - F	7/24/07	< 50	0.273	72	< 1	< 0.1	< 0.1	< 5	0.39	< 5	< 0.002	1.53	< 0.5	< 0.1	< 0.2	86.1	< 1	< 0.5
FRB - F	8/22/07	< 50	0.183	81.4	< 1	< 0.1	< 0.1	< 5	0.43	< 5	< 0.002	1.56	< 0.5	< 0.1	< 0.2	103	< 1	< 0.5
FRB - F	9/26/07	< 50	0.16	67	< 1	< 0.1	< 0.1	< 5	0.39	< 5	< 0.002	0.3	< 0.5	< 0.1	< 0.2	101	< 1	0.549
FRB - F	10/25/07	< 50	0.175	26.2	< 1	< 0.1	< 0.1	< 5	1.06	23.1	0.005	1.56	< 0.5	< 0.1	< 0.2	50	< 1	0.507
FRB - F	6/24/08	35.4	0.111	51	< 1	< 0.1	< 0.1	< 5	0.60	15.9	3.700	1.41	< 0.5	< 0.1	< 0.2	33.7	< 1	20.62
FRB - F	7/22/08	< 50	0.187	90.7	< 1	< 0.1	< 0.1	< 5	0.29	< 5	0.990	0.125	< 0.5	< 0.1	0.382	66.3	< 1	11.65
FRB - F	8/19/08	< 50	0.172	71.1	< 1	< 0.1	< 0.1	< 5	0.16	< 5	0.780	< 0.1	< 0.5	< 0.1	< 0.2	88.1	< 1	0.389
FRB - F	9/9/08	< 50	0.169	72.4	< 1	< 0.1	< 0.1	< 5	0.24	< 5	0.550	0.387	< 0.5	< 0.1	< 0.2	93.3	< 1	< 0.5
FRB - F	10/15/08	< 50	0.131	61.4	< 1	< 0.1	< 0.1	< 5	0.40	< 5	0.630	0.197	< 0.5	< 0.1	< 0.2	91.6	< 1	< 0.5

Appendix B cont. Tables of Metals Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collected	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Se	Sr	U	Zn
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
FRB - G	6/23/07	< 50	0.222	29.6	< 1	< 0.1	< 0.1	< 5	0.44	7.76	0.002	1.37	< 0.5	< 0.1	0.212	36.2	< 1	< 0.5
FRB - G	7/24/07	< 50	0.442	55.3	< 1	< 0.1	< 0.1	< 5	0.34	6.45	0.002	1.64	< 0.5	< 0.1	0.293	68.3	< 1	< 0.5
FRB - G	8/22/07	< 50	0.172	39.7	< 1	< 0.1	< 0.1	< 5	0.26	16	< 0.002	2.45	0.724	< 0.1	< 0.2	42.2	< 1	< 0.5
FRB - G	9/26/07	< 50	0.222	40.4	< 1	< 0.1	< 0.1	< 5	0.42	5	0.002	0.675	< 0.5	0.314	0.337	77.9	< 1	< 0.5
FRB - G	10/25/07	86.6	0.186	26.6	< 1	< 0.1	< 0.1	< 5	0.66	67.8	0.004	3.86	< 0.5	0.547	0.265	42.7	< 1	1.76
FRB - G	6/25/08	25.7	0.156	45.6	< 1	< 0.1	< 0.1	< 5	0.40	11.7	3.400	0.953	< 0.5	< 0.1	0.213	26.6	< 1	13.97
FRB - G	7/23/08	< 50	0.261	75.8	< 1	< 0.1	< 0.1	< 5	0.28	6.08	0.840	0.902	< 0.5	< 0.1	0.389	58.5	< 1	12.81
FRB - G	8/20/08	< 50	0.252	42.9	< 1	< 0.1	< 0.1	< 5	0.31	5.9	1.300	0.951	< 0.5	< 0.1	0.318	64.1	< 1	< 0.5
FRB - G	9/9/08	< 50	0.223	49.2	< 1	< 0.1	< 0.1	< 5	0.28	5.53	0.890	< 0.1	< 0.5	< 0.1	0.337	72.5	< 1	< 0.5
FRB - G	10/13/08	< 50	0.214	44	< 1	< 0.1	< 0.1	< 5	0.25	6.72	0.810	0.701	< 0.5	< 0.1	0.506	69.7	< 1	< 0.5
FRB - H	6/23/07	< 50	0.21	31.2	< 1	< 0.1	< 0.1	< 5	0.64	19.4	< 0.002	2.95	< 0.5	< 0.1	< 0.2	42.8	< 1	< 0.5
FRB - H	7/24/07	< 50	0.464	65.6	< 1	< 0.1	< 0.1	< 5	0.49	39.6	< 0.002	6.68	< 0.5	< 0.1	< 0.2	92.8	< 1	0.183
FRB - H	8/22/07	< 50	0.222	66.4	< 1	< 0.1	< 0.1	< 5	0.38	26.2	< 0.002	6.14	< 0.5	< 0.1	0.22	107	< 1	< 0.5
FRB - H	9/26/07	< 50	0.202	51.6	< 1	< 0.1	< 0.1	< 5	0.52	39.2	< 0.002	6.06	< 0.5	< 0.1	< 0.2	107	< 1	< 0.5
FRB - H	10/25/07	392.2	0.247	32.8	< 1	< 0.1	< 0.1	< 5	0.83	175	0.005	1.73	< 0.5	0.143	0.203	40.6	< 1	0.583
FRB - H	6/25/08	30.6	0.109	50.6	< 1	< 0.1	< 0.1	< 5	0.46	22.1	3.700	3.28	< 0.5	< 0.1	< 0.2	32.8	< 1	14.65
FRB - H	7/23/08	< 50	0.184	110.9	< 1	< 0.1	< 0.1	< 5	0.43	20.9	0.850	4.39	< 0.5	< 0.1	0.297	78.6	< 1	18.64
FRB - H	8/20/08	< 50	0.24	60.4	< 1	< 0.1	< 0.1	< 5	0.24	18.6	1.100	3.17	< 0.5	< 0.1	0.259	86.1	< 1	0.406
FRB - H	9/9/08	< 50	0.208	62.4	< 1	< 0.1	< 0.1	< 5	0.17	28	0.670	6.85	< 0.5	< 0.1	0.391	95.4	< 1	< 0.5
FRB - H	10/13/08	< 50	0.164	54.6	< 1	< 0.1	< 0.1	< 5	0.45	39.7	0.710	1.06	< 0.5	< 0.1	< 0.2	89.9	< 1	0.104
FRB - I	6/23/07	< 50	0.203	35.8	< 1	< 0.1	< 0.1	< 5	0.52	20.1	< 0.002	3.52	< 0.5	< 0.1	< 0.2	46.4	< 1	< 0.5
FRB - I	7/24/07	< 50	0.441	60.8	< 1	< 0.1	< 0.1	< 5	0.45	48.7	< 0.002	4.85	< 0.5	< 0.1	0.219	87.8	< 1	1.39
FRB - I	8/22/07	< 50	0.221	55.4	< 1	< 0.1	< 0.1	< 5	0.34	29.1	< 0.002	4.61	< 0.5	< 0.1	< 0.2	108	< 1	< 0.5
FRB - I	9/26/07	< 50	0.217	48.2	< 1	< 0.1	< 0.1	< 5	0.47	45	0.002	5.43	< 0.5	< 0.1	0.213	100	< 1	< 0.5
FRB - I	10/25/07	596.4	0.188	32.2	< 1	< 0.1	0.111	< 5	0.80	197	0.005	11.1	< 0.5	0.184	< 0.2	42.9	< 1	1.27
FRB - I	6/25/08	32.6	0.108	58.4	< 1	< 0.1	< 0.1	< 5	0.70	22.2	3.700	3.08	< 0.5	< 0.1	< 0.2	32.3	< 1	16.43
FRB - I	7/23/08	< 50	0.235	92.3	< 1	< 0.1	< 0.1	< 5	0.31	18.6	0.980	3.18	< 0.5	< 0.1	0.45	71.3	< 1	15.26
FRB - I	8/20/08	< 50	0.335	54.7	< 1	< 0.1	< 0.1	< 5	0.48	15.8	1.100	3.42	< 0.5	< 0.1	0.333	82.1	< 1	< 0.5
FRB - I	9/9/08	< 50	0.208	53.4	< 1	< 0.1	< 0.1	< 5	0.28	20.6	0.720	4.6	< 0.5	< 0.1	0.266	82.4	< 1	< 0.5
FRB - I	10/13/08	< 50	0.187	51.2	< 1	< 0.1	< 0.1	< 5	0.30	35.6	0.750	4.74	< 0.5	< 0.1	< 0.2	83.9	< 1	0.264

Appendix B cont. Tables of Metals Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collected	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Se	Sr	U	Zn
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
FRB - J	6/24/07	< 50	0.245	28.5	< 1	< 0.1	< 0.1	< 5	0.35	11.8	< 0.002	1.91	< 0.5	< 0.1	< 0.2	39.7	< 1	< 0.5
FRB - J	7/23/07	< 50	0.287	46.8	< 1	< 0.1	< 0.1	< 5	0.30	7.67	< 0.002	1.47	< 0.5	< 0.1	0.23	68.6	< 1	< 0.5
FRB - J	9/25/07	< 50	0.184	43.5	< 1	< 0.1	< 0.1	< 5	0.32	10.1	< 0.002	0.831	< 0.5	< 0.1	0.336	85.6	< 1	< 0.5
FRB - J	10/25/07	< 50	0.184	22.7	< 1	< 0.1	< 0.1	< 5	0.90	24.7	0.004	1.75	< 0.5	< 0.1	0.297	40.5	< 1	1.27
FRB - J	6/23/08	22.2	0.133	73.9	< 1	< 0.1	< 0.1	< 5	0.53	13.9	3.100	1.51	< 0.5	< 0.1	< 0.2	31.2	< 1	20.68
FRB - J	7/22/08	< 50	0.209	42.8	< 1	< 0.1	< 0.1	< 5	0.21	9.87	0.740	0.304	< 0.5	< 0.1	0.541	57.7	< 1	< 0.5
FRB - J	8/18/08	< 50	0.204	44.7	< 1	< 0.1	< 0.1	< 5	< 0.10	5.45	0.770	< 0.1	< 0.5	< 0.1	0.217	73.4	< 1	0.453
FRB - J	9/8/08	< 50	0.206	46.8	< 1	< 0.1	< 0.1	< 5	0.18	10.4	0.540	0.909	< 0.5	< 0.1	0.385	79.2	< 1	< 0.5
FRB - J	10/15/08	< 50	0.168	45.8	< 1	< 0.1	< 0.1	< 5	0.37	16.6	0.550	1.04	< 0.5	< 0.1	0.394	79.8	< 1	0.228
FRB - K	7/25/07	< 50	0.428	50.1	< 1	< 0.1	< 0.1	< 5	0.27	< 5	< 0.002	1.34	< 0.5	< 0.1	0.248	71.2	< 1	< 0.5
FRB - K	8/21/07	< 50	0.315	47.7	< 1	< 0.1	< 0.1	< 5	0.26	8.15	< 0.002	1.53	< 0.5	< 0.1	< 0.2	77.4	< 1	< 0.5
FRB - K	9/25/07	< 50	0.264	42.7	< 1	< 0.1	< 0.1	< 5	0.42	5.91	< 0.002	0.522	< 0.5	< 0.1	0.263	80.5	< 1	< 0.5
FRB - K	10/25/07	97.8	0.192	31	< 1	< 0.1	< 0.1	< 5	0.64	95.6	0.004	7.92	< 0.5	0.144	0.25	45.6	< 1	0.827
FRB - K	6/25/08	16.1	0.197	46.1	< 1	< 0.1	< 0.1	< 5	0.36	12.5	2.100	1.8	< 0.5	< 0.1	< 0.2	36.6	< 1	10.61
FRB - K	7/22/08	< 50	0.271	40.6	< 1	< 0.1	< 0.1	< 5	0.19	8.63	0.570	0.965	< 0.5	< 0.1	0.419	55.2	< 1	< 0.5
FRB - K	8/18/08	< 50	0.251	46.8	< 1	< 0.1	< 0.1	< 5	0.10	5.71	0.660	0.141	< 0.5	< 0.1	0.207	69.4	< 1	0.282
FRB - K	9/8/08	< 50	0.237	48.2	< 1	< 0.1	< 0.1	< 5	0.18	6.73	0.680	0.688	< 0.5	< 0.1	0.339	75.3	< 1	< 0.5
FRB - K	10/15/08	< 50	0.192	44.6	< 1	< 0.1	< 0.1	< 5	0.41	10.4	0.580	0.535	< 0.5	< 0.1	0.299	72.2	< 1	0.333

Appendix B cont. Tables of Metals Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Colle	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Se	Sr	U	Zn
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
ERB - 0	7/25/07	< 50	0.151	36.8	< 1	< 0.1	< 0.1	< 5	0.31	< 5.00	< 0.002	1.41	< 0.5	< 0.1	< 0.2	36.2	< 1	< 0.5
ERB - 0	8/23/07	< 50	0.172	39.7	< 1	< 0.1	< 0.1	< 5	0.26	16.00	< 0.002	2.45	0.724	< 0.1	< 0.2	42.2	< 1	< 0.5
ERB - 1	6/22/07	< 50	0.211	11.5	< 1	< 0.1	< 0.1	< 5	0.27	5.74	< 0.002	1.16	< 0.5	< 0.1	< 0.2	25.8	< 1	< 0.5
ERB - 1	7/25/07	< 50	0.348	11.3	< 1	< 0.1	< 0.1	< 5	0.14	11.70	< 0.002	1.49	< 0.5	< 0.1	< 0.2	26.1	< 1	0.744
ERB - 1	9/27/07	< 50	0.362	9.74	< 1	< 0.1	< 0.1	< 5	0.22	6.05	< 0.002	2.05	< 0.5	< 0.1	< 0.2	30.5	< 1	< 0.5
ERB - 1	10/24/07	< 50	0.266	10.7	< 1	< 0.1	< 0.1	< 5	0.42	18.70	< 0.002	1.61	< 0.5	< 0.1	< 0.2	29	< 1	2.66
ERB - 1	6/26/08	< 50	0.217	57.2	< 1	< 0.1	< 0.1	< 5	1.70	8.92	0.820	0.239	< 0.5	< 0.1	0.28	64.4	< 1	10.19
ERB - 1	7/24/08	< 50	0.212	42.4	< 1	< 0.1	< 0.1	< 5	0.21	5.32	0.810	0.101	< 0.5	< 0.1	0.248	123	< 1	0.45
ERB - 1	8/20/08	< 50	0.468	10.1	< 1	< 0.1	< 0.1	< 5	0.18	5.29	0.880	1.55	< 0.5	< 0.1	< 0.2	25.4	< 1	< 0.5
ERB - 1	9/10/08	< 50	0.366	10.1	< 1	< 0.1	< 0.1	< 5	< 0.10	10.30	< 0.500	2.25	< 0.5	< 0.1	< 0.2	25.8	< 1	< 0.5
ERB - 2	6/22/07	< 50	0.119	32.8	< 1	< 0.1	< 0.1	< 5	0.22	< 5.00	< 0.002	1.85	< 0.5	< 0.1	0.261	70.2	< 1	1.32
ERB - 2	7/25/07	< 50	0.206	56.9	< 1	< 0.1	< 0.1	< 5	0.23	< 5.00	< 0.002	3.36	< 0.5	< 0.1	0.253	120	< 1	0.138
ERB - 2	8/23/07	< 50	0.186	77.9	< 1	< 0.1	< 0.1	< 5	0.24	< 5.00	< 0.002	3.14	0.517	< 0.1	< 0.2	155	< 1	< 0.5
ERB - 2	9/27/07	< 50	0.18	76.5	< 1	< 0.1	< 0.1	< 5	0.41	< 5.00	< 0.002	2.88	< 0.5	0.678	0.212	164	< 1	0.105
ERB - 2	10/26/07	< 50	0.184	58.5	< 1	< 0.1	< 0.1	< 5	0.42	6.79	< 0.002	3.12	< 0.5	0.272	0.352	135	< 1	0.361
ERB - 2	6/26/08	< 50	0.142	56.3	< 1	< 0.1	< 0.1	< 5	0.35	7.24	1.000	1.91	< 0.5	< 0.1	0.235	66	< 1	11.35
ERB - 2	7/24/08	< 50	0.173	53.8	< 1	< 0.1	< 0.1	< 5	0.20	5.56	0.630	1.53	< 0.5	< 0.1	0.213	118	< 1	0.53
ERB - 2	8/20/08	< 50	0.255	65.7	< 1	< 0.1	< 0.1	< 5	0.27	5.54	0.670	4.79	< 0.5	< 0.1	0.291	136.8	< 1	< 0.5
ERB - 2	9/10/08	< 50	0.172	70	< 1	< 0.1	< 0.1	< 5	0.28	7.16	< 0.500	1.55	< 0.5	< 0.1	0.414	95.2	< 1	
ERB - 2	10/16/08	< 50	0.13	73.4	< 1	< 0.1	< 0.1	< 5	0.13	6.74	< 0.500	3.79	< 0.5	< 0.1	0.355	158.3	< 1	
ERB - 3	9/10/08	< 50	0.173	26.5	< 1	< 0.1	< 0.1	< 5	< 0.10	< 5.00	0.600	0.23	< 0.5	< 0.1	0.408	46.9	< 1	< 0.5
ERB - 3	10/16/08	< 50	0.157	26.7	< 1	< 0.1	< 0.1	< 5	< 0.10	< 5.00	< 0.500	< 0.1	< 0.5	< 0.1	0.28	55.5	< 1	< 0.5

Appendix B cont. Tables of Metals Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collec	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Se	Sr	U	Zn
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
ERB - 4	9/27/07	< 50	0.126	42.7	< 1	< 0.1	< 0.1	< 5	0.53	< 5.00	< 0.002	0.798	< 0.5	< 0.1	0.816	218	< 1	< 0.5
ERB - 4	10/26/07	< 50	0.13	40.7	< 1	< 0.1	< 0.1	< 5	0.46	5.25	< 0.002	0.477	< 0.5	0.207	0.921	200	< 1	0.495
ERB - 4	6/26/08	< 50	< 0.1	56	< 1	< 0.1	< 0.1	< 5	0.40	7.56	1.200	1.99	< 0.5	< 0.1	0.62	198	< 1	9.32
ERB - 4	7/25/08	< 50	0.102	36.2	< 1	< 0.1	< 0.1	< 5	0.20	< 5.00	0.650	0.377	< 0.5	< 0.1	0.848	186	< 1	0.19
ERB - 4	8/21/08	< 50	0.163	37.3	< 1	< 0.1	< 0.1	< 5	0.27	< 5.00	0.570	0.565	< 0.5	< 0.1	0.888	175.2	< 1	< 0.5
ERB - 4	9/12/08	< 50	0.111	47.5	< 1	< 0.1	< 0.1	< 5	< 0.10	4.57	0.671	0.588	< 0.5	< 0.1	0.84	191.9	< 1	0.311
ERB - 4	10/14/08	< 50	< 0.1	43.1	< 1	< 0.1	< 0.1	< 5	0.23	9.67	< 0.500	0.592	< 0.5	< 0.1	1.16	219.8	< 1	0.119
ERB - 5	6/22/07	< 50	0.192	51.2	< 1	< 0.1	0.451	< 5	1.21	5.49	< 0.002	4.08	15.5	< 0.1	8.16	306	2.36	0.595
ERB - 5	7/25/07	< 50	0.319	66.4	< 1	< 0.1	0.49	< 5	1.27	8.07	< 0.002	3.65	11.2	< 0.1	8.86	429	2.5	1.38
ERB - 5	8/23/07	< 50	0.269	77.6	< 1	< 0.1	0.262	< 5	0.66	8.11	< 0.002	0.858	11.8	< 0.1	8.63	471	3.4	1.04
ERB - 5	9/27/07	< 50	0.272	82.3	< 1	< 0.1	0.265	< 5	0.78	7.46	< 0.002	0.738	11.2	0.186	8.04	497	2.95	1.3
ERB - 5	10/26/07	< 50	0.492	73.6	< 1	< 0.1	0.444	< 5	1.47	19.60	< 0.002	1.49	16	< 0.1	8.74	454	4.95	2.38
ERB - 5	6/26/08	< 50	0.214	60.4	< 1	< 0.1	0.45	< 5	0.96	26.20	0.670	1.9	16.2	< 0.1	9.4	343	2.6	14.55
ERB - 5	7/24/08	< 50	0.278	62.5	< 1	< 0.1	0.267	< 5	1.00	17.30	0.700	0.246	13.6	0.316	11.2	386	3.53	0.57
ERB - 5	8/20/08	< 50	0.376	63.8	< 1	< 0.1	0.262	< 5	0.58	16.00	0.930	0.556	16.7	< 0.1	11.9	425.8	4.55	0.875
ERB - 5	9/10/08	< 50	0.339	69.2	< 1	< 0.1	0.309	< 5	0.33	28.10	0.650	1.13	16.3	< 0.1	12.6	508.2	4.71	0.309
ERB - 5	10/16/08	< 50	0.291	75.9	< 1	< 0.1	0.302	< 5	0.31	20.50	0.800	1.14	10.7	< 0.1	11.4	490.4	3.98	0.422
ERB - 6	6/22/07	< 50	0.15	36.9	< 1	< 0.1	0.14	< 5	0.46	< 5.00	< 0.002	2.41	4.1	< 0.1	2.18	135	< 1	< 0.5
ERB - 6	7/25/07	< 50	0.276	63.1	< 1	< 0.1	0.215	< 5	0.58	< 5.00	< 0.002	3.59	4.34	< 0.1	3.3	224	1.14	0.525
ERB - 6	8/23/07	< 50	0.211	76.8	< 1	< 0.1	0.152	< 5	0.42	6.84	< 0.002	1.99	5.87	< 0.1	4.2	307	1.7	0.297
ERB - 6	9/27/07	< 50	0.212	80.2	< 1	< 0.1	0.14	< 5	0.57	5.36	< 0.002	1.83	5.13	0.12	3.59	300	1.56	0.803
ERB - 6	10/26/07	< 50	0.296	61.8	< 1	< 0.1	0.22	< 5	0.82	11.30	< 0.002	2.31	6.23	< 0.1	3.98	271	1.82	1.24
ERB - 6	6/26/08	< 50	0.15	57.9	< 1	< 0.1	0.117	< 5	0.43	9.70	0.990	1.97	3.04	< 0.1	1.83	134	< 1	10.12
ERB - 6	7/24/08	< 50	0.206	56.9	< 1	< 0.1	0.135	< 5	0.45	9.11	0.600	2.18	3.84	< 0.1	3.1	184	1.23	1.05
ERB - 6	8/20/08	< 50	0.297	68.8	< 1	< 0.1	0.149	< 5	0.38	10.40	0.820	3.08	7.86	< 0.1	5.6	253.7	2.09	0.624
ERB - 6	9/10/08	< 50	0.238	73.1	< 1	< 0.1	0.154	< 5	0.17	16.60	0.680	1.86	6.9	< 0.1	5.92	238.5	2.02	< 0.5
ERB - 6	10/16/08	< 50	0.189	76.2	< 1	< 0.1	0.157	< 5	0.19	12.80	< 0.500	2.69	4.21	< 0.1	4.24	290.5	1.71	

Appendix B cont. Tables of Metals Concentrations (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Date Collec	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Se	Sr	U	Zn
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
ERB - 7	6/22/07	< 50	0.196	57.5	< 1	< 0.1	< 0.1	< 5	0.38	< 5.00	< 0.002	1.39	1.16	< 0.1	3.51	80.6	< 1	0.379
ERB - 7	7/25/07	< 50	0.206	100	< 1	< 0.1	0.137	< 5	0.51	5.45	< 0.002	2.41	3.32	< 0.1	10.5	154	1.09	0.616
ERB - 7	8/23/07	< 50	0.211	122	< 1	< 0.1	0.134	< 5	0.31	8.34	< 0.002	2.12	4.77	< 0.1	13.3	198	1.48	0.11
ERB - 7	9/27/07	< 50	0.223	128	< 1	< 0.1	0.114	< 5	0.36	7.18	< 0.002	1.7	2.54	< 0.1	12.3	194	1.28	0.204
ERB - 7	10/26/07	< 50	0.274	93.5	< 1	< 0.1	0.107	< 5	0.65	8.69	< 0.002	1.4	0.554	0.654	5.78	133	< 1	1.02
ERB - 7	6/26/08	< 50	0.178	72.3	< 1	< 0.1	< 0.1	< 5	0.44	8.61	1.300	1.14	0.638	0.184	2.73	75.6	< 1	5.01
ERB - 7	7/25/08	< 50	0.182	90.4	< 1	< 0.1	< 0.1	< 5	0.37	7.31	0.630	0.417	0.574	0.101	6.8	136	< 1	0.74
ERB - 7	8/21/08	< 50	0.264	105.7	< 1	< 0.1	< 0.1	< 5	0.39	6.51	3.200	0.83	1.09	< 0.1	9.26	154	1.01	0.16
ERB - 7	9/11/08	< 50	0.2	112.3	< 1	< 0.1	< 0.1	< 5	< 0.10	12.60	< 0.500	0.716	0.589	< 0.1	9.19	134.6	1.05	< 0.5
ERB - 7	10/14/08	< 50	0.188	108	< 1	< 0.1	0.108	< 5	0.27	11.40	1.700	1.34	1.1	< 0.1	11.3	174.8	1.09	< 0.5
ERB - 8	9/27/07	50	0.238	87.1	1	0.1	0.1	5	0.17	5.00	0.002	0.585	0.793	0.375	7.77	236	1.04	0.5
ERB - 8	10/26/07	< 50	0.283	71.6	< 1	< 0.1	0.111	< 5	0.71	7.07	< 0.002	0.914	< 0.5	< 0.1	7.59	210	1.04	0.458
ERB - 8	6/26/08	< 50	0.145	69.2	< 1	< 0.1	< 0.1	< 5	0.34	8.26	1.300	1.32	0.505	< 0.1	4.05	161	< 1	6.92
ERB - 8	7/25/08	< 50	0.177	61.7	< 1	< 0.1	< 0.1	< 5	0.25	6.70	0.560	0.778	< 0.5	< 0.1	6.22	182	< 1	0.33
ERB - 8	8/21/08	< 50	0.247	65.9	< 1	< 0.1	< 0.1	< 5	0.33	5.98	0.680	0.794	0.514	< 0.1	6.38	208.6	< 1	< 0.5
ERB - 8	9/12/08	< 50	0.23	77.1	< 1	< 0.1	< 0.1	< 5	0.23	7.61	< 0.500	0.484	< 0.5	< 0.1	9.25	208.9	1.19	< 0.5
ERB - 8	10/16/08	< 50	0.202	74.4	< 1	< 0.1	< 0.1	< 5	0.11	8.19	< 0.500	0.3	< 0.5	< 0.1	9.27	231	1.08	< 0.5
ERB - 9	9/27/07	< 50	0.233	86.3	< 1	< 0.1	< 0.1	< 5	0.18	< 5.00	< 0.002	0.612	0.709	0.144	7.15	254	1.01	< 0.5
ERB - 9	10/26/07	< 50	0.273	79.3	< 1	< 0.1	0.115	< 5	0.64	9.57	< 0.002	1.97	< 0.5	< 0.1	6.26	209	< 1	0.34
ERB - 9	6/26/08	< 50	0.146	67.9	< 1	< 0.1	< 0.1	< 5	1.40	9.21	1.900	1.93	< 0.5	< 0.1	3.5	162	< 1	7.2
ERB - 9	7/25/08	< 50	0.215	65.9	< 1	< 0.1	< 0.1	< 5	0.27	9.72	0.540	1.44	< 0.5	< 0.1	5.8	180	< 1	0.64
ERB - 9	8/21/08	< 50	0.255	72.7	< 1	< 0.1	< 0.1	< 5	0.59	6.21	1.300	0.88	0.547	< 0.1	5.62	187.4	1.08	2.34
ERB - 9	9/12/08	< 100	0.631	193.9	< 2	< 0.2	< 0.2	< 10	0.67	16.30	< 3.300	3.64	< 1	< 0.2	< 9.1	270.5	< 2	< 23.74
ERB - 9	10/16/08	< 50	0.213	77	< 1	< 0.1	< 0.1	< 5	0.38	14.30	< 0.500	0.663	< 0.5	< 0.1	8.81	249.6	1.06	0.54

Appendix C. Tables of Sediment Metals Concentration (see Tables 1 and 2 in text above for Site Descriptions and Locations).

MEAN	As mg/kg	Be mg/kg	Ca mg/kg	Cd mg/kg	Co mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Hg mg/kg	Li mg/kg	Mg mg/kg
ERB - 0	3.59	0.66	29883.0	0.810	4.39	20.30	10.85	11928.5	0.061	16.1	10528.0
ERB - 1	11.06	1.22	10518.1	0.427	7.44	22.24	18.64	23050.3	0.066	25.4	4821.2
ERB - 2	6.81	0.95	17033.8	0.400	7.15	13.83	17.22	20371.4	0.035	21.6	6968.7
ERB - 3	7.95	0.75	11455.0	0.400	10.70	15.30	22.10	21560.0	0.048	9.5	4588.5
ERB - 4	5.58	0.54	43495.0	0.400	5.03	14.71	11.89	13009.3	0.040	12.7	12741.3
ERB - 5	6.58	0.71	96902.1	2.201	23.77	8.40	13.73	8932.0	0.065	6.1	7345.0
ERB - 6	6.86	0.86	41875.9	0.631	12.36	12.95	16.89	17835.4	0.041	19.1	6912.8
ERB - 7	4.72	0.55	47338.5	0.907	4.61	10.58	11.91	12213.5	0.045	9.4	7832.8
ERB - 8	5.35	0.51	67882.9	0.520	4.29	12.39	11.47	11789.4	0.037	11.4	13784.6
ERB - 9	5.07	0.50	66470.0	0.527	4.47	11.97	10.66	12121.4	0.035	11.7	14150.0
1 - Standard Deviation											
ERB - 0	0.28	0.04	1381.7	0.042	0.25	2.55	0.49	719.1	0.007	1.3	837.2
ERB - 1	1.93	0.40	4133.0	0.055	0.92	3.95	7.72	2510.4	0.018	4.5	1287.9
ERB - 2	0.88	0.25	2139.4	0.000	1.02	1.65	3.06	1570.6	0.005	3.0	595.0
ERB - 3	0.46	0.04	1774.8	0.000	0.28	1.41	0.28	226.3	0.004	1.4	869.0
ERB - 4	1.21	0.08	14875.2	0.000	1.15	2.27	3.87	1829.3	0.008	2.3	3038.1
ERB - 5	1.28	0.13	31813.1	0.800	7.01	1.48	3.43	2202.7	0.010	1.5	2060.3
ERB - 6	1.05	0.16	21523.0	0.359	5.45	1.25	2.57	2477.1	0.008	3.6	453.2
ERB - 7	0.70	0.07	19112.2	0.448	0.48	1.31	1.42	916.6	0.005	1.7	975.1
ERB - 8	0.85	0.04	11145.0	0.113	0.83	2.36	3.43	1803.4	0.010	2.8	2271.4
ERB - 9	1.08	0.15	7487.6	0.163	0.40	1.93	1.70	1061.7	0.007	1.7	1669.6

Appendix C cont. Tables of Sediment Metals Concentration (see Tables 1 and 2 in text above for Site Descriptions and Locations).

MEAN	Mn mg/kg	Mo mg/kg	Ni mg/kg	P mg/kg	Pb mg/kg	S mg/kg	Se mg/kg	Sr mg/kg	Ti mg/kg	V mg/kg	Zn mg/kg
ERB - 0	279.0	0.50	24.30	1071.0	14.6	681.0	8.000	55.1	127.5	59.8	114.5
ERB - 1	1227.7	1.30	28.96	1457.2	18.7	753.9	6.667	27.1	54.2	30.6	134.4
ERB - 2	627.2	0.88	24.12	1440.7	15.3	757.8	6.667	41.4	39.0	24.8	94.0
ERB - 3	1685.5	1.88	39.70	1770.5	12.3	1024.0	5.000	27.9	35.7	22.7	113.0
ERB - 4	586.0	0.93	19.28	1370.4	7.6	472.1	5.857	57.6	35.9	25.1	80.4
ERB - 5	395.9	0.82	70.57	667.8	12.4	2630.9	6.572	120.5	35.8	17.2	300.2
ERB - 6	626.8	0.91	48.64	1255.9	13.7	1291.1	6.500	63.2	36.8	23.6	140.3
ERB - 7	242.2	0.73	27.13	1193.4	10.8	1164.2	6.531	66.0	48.8	29.3	105.3
ERB - 8	445.6	0.61	20.37	1195.9	7.5	841.7	5.857	82.8	31.5	24.9	87.4
ERB - 9	354.6	0.62	18.60	1214.4	8.5	1069.0	5.857	77.0	44.6	23.8	76.4
1 - Standard Deviation											
ERB - 0	21.2	0.00	1.70	7.1	2.3	4.2	0.000	1.9	6.4	4.5	9.2
ERB - 1	498.9	1.38	4.74	76.2	8.8	129.3	1.581	15.1	11.3	3.7	13.8
ERB - 2	180.3	0.42	2.58	95.6	6.2	150.0	1.581	2.8	8.8	2.4	9.6
ERB - 3	23.3	0.07	0.99	23.3	0.0	152.7	0.000	2.5	6.7	1.2	5.7
ERB - 4	199.8	0.44	2.85	141.9	3.8	55.6	1.464	20.5	10.1	2.8	8.2
ERB - 5	128.6	0.45	6.64	100.4	8.4	1017.1	1.503	28.2	28.2	3.9	81.5
ERB - 6	205.8	0.47	19.56	143.6	5.7	523.8	1.581	19.3	5.6	1.4	36.3
ERB - 7	80.9	0.28	7.73	48.6	3.0	435.8	1.551	21.2	5.8	3.1	13.5
ERB - 8	27.6	0.19	2.01	77.6	1.9	322.1	1.464	12.1	2.7	4.3	9.9
ERB - 9	78.1	0.22	4.72	51.1	4.3	510.0	1.464	11.0	9.0	4.1	18.5

Appendix C cont. Tables of Sediment Metals Concentration (see Tables 1 and 2 in text above for Site Descriptions and Locations).

MEAN	As mg/kg	Be mg/kg	Ca mg/kg	Cd mg/kg	Co mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Hg mg/kg	Li mg/kg	Mg mg/kg
FRB - A	6.38	0.76	20341.4	0.400	6.06	19.73	10.57	16213.0	0.034	15.0	9200.9
FRB - B	5.02	0.93	4416.6	0.400	6.75	10.99	13.21	16582.4	0.037	16.5	3331.4
FRB - C	9.68	0.67	106059.6	0.400	2.66	15.95	7.53	8265.9	0.049	8.9	25730.1
FRB - D	8.10	0.99	20827.1	0.400	8.86	12.87	16.23	19441.4	0.057	19.2	6509.7
FRB - E	6.23	0.99	4930.2	0.400	8.83	18.40	17.81	21505.6	0.046	20.8	4487.7
FRB - F	6.23	0.97	5139.6	0.409	8.32	17.44	17.78	21285.6	0.050	20.6	4577.1
FRB - G	5.67	0.87	5111.9	0.531	8.99	19.11	20.22	21096.0	0.060	20.9	4543.6
FRB - H	5.76	0.87	5065.9	0.473	7.98	17.52	16.96	20190.2	0.046	19.6	4419.9
FRB - I	5.67	0.81	4894.5	0.437	8.08	17.47	16.52	19767.1	0.044	19.2	4430.4
FRB - J	5.83	0.93	6095.5	0.431	8.01	17.43	16.49	20321.0	0.047	18.7	4790.7
FRB - K	6.78	0.87	14674.9	0.416	7.73	16.85	16.79	19250.1	0.050	19.1	7241.9
1 - Standard Deviation											
FRB - A	1.12	0.17	7260.0	0.000	0.96	4.54	2.76	2018.8	0.008	3.6	2871.2
FRB - B	0.88	0.12	337.0	0.000	0.91	1.45	1.86	1794.3	0.010	3.1	298.7
FRB - C	1.89	0.18	10708.1	0.000	0.67	3.58	2.23	1878.8	0.011	2.5	4179.0
FRB - D	1.29	0.22	5505.9	0.000	1.93	1.67	3.25	1244.1	0.012	2.8	668.9
FRB - E	1.70	0.38	2042.8	0.000	1.42	3.02	3.72	2475.3	0.005	3.3	511.7
FRB - F	0.92	0.28	493.8	0.031	1.11	1.70	3.07	1904.1	0.015	3.2	154.7
FRB - G	0.93	0.19	775.7	0.296	1.77	2.68	4.55	1290.8	0.010	4.4	479.3
FRB - H	2.17	0.38	1282.3	0.146	1.72	3.23	6.06	3392.1	0.012	5.3	683.3
FRB - I	1.52	0.18	967.7	0.078	1.42	2.93	3.78	1569.9	0.011	3.8	454.0
FRB - J	1.16	0.31	639.8	0.104	0.85	1.15	2.35	1705.5	0.007	2.4	264.9
FRB - K	0.90	0.34	5304.2	0.046	1.02	2.22	3.65	2394.5	0.014	2.8	1659.9

Appendix C cont. Tables of Sediment Metals Concentration (see Tables 1 and 2 in text above for Site Descriptions and Locations).

MEAN	Mn mg/kg	Mo mg/kg	Ni mg/kg	P mg/kg	Pb mg/kg	S mg/kg	Se mg/kg	Sr mg/kg	Ti mg/kg	V mg/kg	Zn mg/kg
FRB - A	676.4	0.51	19.91	1393.9	10.1	346.9	6.125	27.9	102.0	24.9	94.6
FRB - B	338.4	0.50	17.74	622.5	16.0	104.4	6.125	34.1	75.8	26.7	74.4
FRB - C	186.0	0.66	21.14	1011.2	10.5	623.4	5.857	81.3	46.5	20.4	175.4
FRB - D	546.2	0.60	22.81	1232.8	17.5	1014.4	6.800	61.0	34.9	25.2	87.9
FRB - E	419.9	0.50	25.94	893.8	16.7	258.8	6.636	47.0	181.4	44.0	100.0
FRB - F	501.4	0.50	25.40	1077.2	16.7	262.4	6.636	42.2	162.6	42.0	96.9
FRB - G	455.7	0.50	27.40	998.0	14.4	251.0	6.500	58.5	245.0	46.8	101.8
FRB - H	659.9	0.50	24.06	964.3	12.6	305.0	6.333	45.6	187.8	40.7	93.1
FRB - I	614.8	0.50	24.11	970.3	14.0	312.2	6.500	41.4	179.5	40.9	92.0
FRB - J	535.7	0.50	24.51	1004.1	15.2	308.7	6.636	42.4	184.4	41.2	96.0
FRB - K	479.1	0.50	23.91	1076.0	12.9	386.3	6.125	42.7	149.5	36.4	98.6
1 - Standard Deviation											
FRB - A	113.9	0.02	3.24	113.5	5.2	111.6	1.553	6.6	32.0	3.7	19.0
FRB - B	64.0	0.00	2.06	55.7	7.5	22.6	1.553	6.2	21.2	2.8	7.2
FRB - C	62.5	0.27	4.30	115.8	3.7	131.4	1.464	10.0	16.4	4.4	40.6
FRB - D	148.1	0.21	3.43	184.3	6.0	218.9	1.549	16.4	6.1	2.1	7.6
FRB - E	74.7	0.00	3.59	179.8	9.0	119.2	1.567	6.2	60.4	8.6	11.8
FRB - F	93.5	0.00	2.20	79.9	8.3	81.7	1.567	1.9	27.9	4.2	7.3
FRB - G	108.1	0.00	3.66	112.1	8.2	83.9	1.581	11.8	75.2	4.5	12.7
FRB - H	671.5	0.00	4.64	180.9	6.3	317.1	1.581	9.8	33.1	4.9	16.3
FRB - I	406.2	0.00	2.69	148.9	7.2	188.7	1.581	7.0	29.8	4.4	12.3
FRB - J	151.9	0.00	1.61	101.0	8.0	147.5	1.567	3.6	27.1	2.9	7.0
FRB - K	115.5	0.00	2.72	105.5	7.2	148.3	1.553	8.3	27.9	4.0	11.2

Appendix D. Tables of Sediment Core Metals Concentration (see Tables 1 and 2 in text above for Site Descriptions and Locations).

			As	Cd	Pb	Se	Hg
Site	**Location (Bench)**	**Location (Bank)**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
		PQL	**1.5**	**0.4**	**5**	**5**	**0.0003**
North Fork Flathead River @ Flathead BC	High	LB	7.43	b.d.	7.65	b.d.	0.053
North Fork Flathead River @ Flathead BC	High	RB	6.65	b.d.	6.94	b.d.	0.053
North Fork Flathead River @ Flathead BC	High	LB	6.57	b.d.	7.16	b.d.	0.046
North Fork Flathead River @ Flathead BC	Low	LB	6.82	b.d.	7.20	b.d.	0.053
North Fork Flathead River @ Flathead BC	Low	RB	7.78	0.72	8.32	b.d.	0.061
North Fork Flathead River @ Flathead BC	Low	LB	5.30	0.48	7.39	b.d.	0.051
North Fork Flathead River @ Flathead BC	Mid	RB	5.70	b.d.	7.12	b.d.	0.050
North Fork Flathead River @ Flathead BC	Mid	RB	6.54	b.d.	6.97	b.d.	0.065
North Fork Flathead River @ Flathead BC	Mid	LB	6.87	b.d.	7.17	b.d.	0.052
North Fork Flathead River @ Border	High	LB	7.99	b.d.	6.18	b.d.	0.046
North Fork Flathead River @ Border	High	RB	7.37	b.d.	5.33	b.d.	0.047
North Fork Flathead River @ Border	High	LB	8.46	b.d.	b.d.	b.d.	0.039
North Fork Flathead River @ Border	High	LB	9.21	b.d.	b.d.	b.d.	0.040
North Fork Flathead River @ Border	Low	RB	6.64	b.d.	6.03	b.d.	0.040
North Fork Flathead River @ Border	Low	LB	5.93	b.d.	5.22	b.d.	0.034
North Fork Flathead River @ Border	Low	RB	6.30	b.d.	b.d.	b.d.	0.040
North Fork Flathead River @ Border	Mid	RB	7.38	b.d.	b.d.	b.d.	0.043
North Fork Flathead River @ Border	Mid	LB	6.05	b.d.	b.d.	b.d.	0.031

Appendix D cont. Tables of Sediment Core Metals Concentration (see Tables 1 and 2 in text above for Site Descriptions and Locations).

Site	Location (Bench)	Location (Bank)	As mg/kg	Cd mg/kg	Pb mg/kg	Se mg/kg	Hg mg/kg
		PQL	**1.5**	**0.4**	**5**	**5**	**0.0003**
Michel Creek above Elk River	Mid	LB	6.83	1.10	9.16	b.d.	0.049
Michel Creek above Elk River	High	LB	6.29	1.45	9.49	b.d.	0.059
Michel Creek above Elk River	Low	RB	4.42	1.13	8.11	b.d.	0.050
Michel Creek above Elk River	High	LB	6.92	1.23	12.8	b.d.	0.069
Michel Creek above Elk River	Low	RB	4.20	1.17	7.23	b.d.	0.050
Michel Creek above Elk River	High	RB	6.59	1.18	9.66	b.d.	0.049
Michel Creek above Elk River	Low	LB	5.07	1.63	8.52	b.d.	0.065
Michel Creek above Elk River	Mid	LB	5.99	0.98	7.20	b.d.	0.045
Michel Creek above Elk River	Mid	RB	5.08	0.96	6.76	b.d.	0.044
Michel Creek below Corbin Creek	High	LB	8.73	0.78	6.96	b.d.	0.049
Michel Creek below Corbin Creek	Low	LB	6.73	1.13	6.32	b.d.	0.049
Michel Creek below Corbin Creek	Mid	LB	6.85	1.49	6.51	b.d.	0.049
Michel Creek below Corbin Creek	High	RB	7.96	0.87	6.86	b.d.	0.044
Michel Creek below Corbin Creek	Low	RB	6.99	1.07	6.50	b.d.	0.043
Michel Creek below Corbin Creek	Mid	RB	9.18	1.17	9.09	b.d.	0.033
Michel Creek below Corbin Creek	High	LB	8.63	0.92	7.78	b.d.	0.056
Michel Creek below Corbin Creek	Low	RB	6.96	1.50	6.85	b.d.	0.048
Michel Creek below Corbin Creek	Mid	RB	8.45	1.79	8.67	b.d.	0.059

Appendix D cont. Tables of Sediment Core Metals Concentration (see Tables 1 and 2 in text above for Site Descriptions and Locations).

			As	Cd	Pb	Se	Hg
Site	**Location (Bench)**	**Location (Bank)**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
		PQL	**1.5**	**0.4**	**5**	**5**	**0.0003**
Elk River above All Coal Mines	High	LB	5.31	0.51	b.d.	b.d.	0.040
Elk River above All Coal Mines	High	RB	5.18	0.47	b.d.	b.d.	0.031
Elk River above All Coal Mines	High	LB	5.12	0.52	b.d.	b.d.	0.039
Elk River above All Coal Mines	Low	LB	4.26	0.50	b.d.	b.d.	0.029
Elk River above All Coal Mines	Low	RB	4.09	0.55	b.d.	b.d.	0.044
Elk River above All Coal Mines	Low	LB	4.42	0.62	b.d.	b.d.	0.046
Elk River above All Coal Mines	Mid	RB	5.59	0.47	b.d.	b.d.	0.045
Elk River above All Coal Mines	Mid	LB	5.10	0.49	b.d.	b.d.	0.047
Elk River above All Coal Mines	Mid	RB	5.06	0.45	b.d.	b.d.	0.039
Elk River @ Tunnel on Hwy 3	High	LB	5.02	0.61	b.d.	b.d.	0.037
Elk River @ Tunnel on Hwy 3	High	LB	6.06	0.61	5.69	b.d.	0.039
Elk River @ Tunnel on Hwy 3	High	LB	5.22	0.60	5.39	b.d.	0.036
Elk River @ Tunnel on Hwy 3	Low	LB	4.84	0.89	b.d.	b.d.	0.038
Elk River @ Tunnel on Hwy 3	Low	LB	5.67	0.77	5.83	b.d.	0.048
Elk River @ Tunnel on Hwy 3	Low	LB	4.51	0.76	b.d.	b.d.	0.049
Elk River @ Tunnel on Hwy 3	Mid	RB	4.36	0.57	b.d.	b.d.	0.036
Elk River @ Tunnel on Hwy 3	Mid	LB	5.69	0.67	b.d.	b.d.	0.042
Elk River @ Tunnel on Hwy 3	Mid	LB	6.06	0.78	6.18	b.d.	0.043

Appendix D cont. Tables of Sediment Core Metals Concentration (see Tables 1 and 2 in text above for Site Descriptions and Locations).

			As	Cd	Pb	Se	Hg
Site	Delta Location		**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
		PQL	**1.5**	**0.4**	**5**	**5**	**0.0003**
Elk River @ Elko, B. C.	Upper		3.73	0.93	b.d.	b.d.	0.037
Elk River @ Elko, B. C.	Lower		4.18	0.58	b.d.	b.d.	0.036
Elk River @ Elko, B. C.	Lower		4.60	0.54	b.d.	b.d.	0.037
Elk River @ Elko, B. C.	Lower		5.52	0.65	5.36	b.d.	0.040
Elk River @ Elko, B. C.	Middle		4.12	0.80	b.d.	b.d.	0.044
Elk River @ Elko, B. C.	Middle		4.52	0.54	b.d.	b.d.	0.032
Elk River @ Elko, B. C.	Middle		4.01	0.72	b.d.	b.d.	0.043
Elk River @ Elko, B. C.	Upper		5.26	1.08	b.d.	b.d.	0.035
Elk River @ Elko, B. C.	Upper		4.40	0.78	b.d.	b.d.	0.035

			As	Cd	Pb	Se	Hg
Site	Sample Depth (cm)		**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
		PQL	**1.5**	**0.4**	**5**	**5**	**0.0003**
Elk River @ Lake Koocanusa Delta-Surface	0		1.75	b.d.	b.d.	b.d.	0.036
Elk River @ Lake Koocanusa Delta-20 cm	20		3.87	b.d.	b.d.	b.d.	0.030
Elk River @ Lake Koocanusa Delta-40 cm	40		6.30	b.d.	5.50	b.d.	0.040
Elk River @ Lake Koocanusa Delta-60 cm	60		4.73	0.40	b.d.	b.d.	0.043
Elk River @ Lake Koocanusa Delta-80 cm	80		6.84	b.d.	6.06	b.d.	0.039
Elk River @ Lake Koocanusa Delta-Surface	0		2.38	b.d.	b.d.	b.d.	0.037
Elk River @ Lake Koocanusa Delta-20 cm	20		2.68	b.d.	b.d.	b.d.	0.034
Elk River @ Lake Koocanusa Delta-40 cm	40		6.05	b.d.	5.52	b.d.	0.027
Elk River @ Lake Koocanusa Delta-60 cm	60		2.12	b.d.	b.d.	b.d.	0.033
Elk River @ Lake Koocanusa Delta-80 cm	80		4.19	b.d.	b.d.	b.d.	0.031
Elk River @ Lake Koocanusa Delta-100 cm	100		3.92	b.d.	b.d.	b.d.	0.033
Elk River @ Lake Koocanusa Delta-120 cm	120		4.31	b.d.	b.d.	b.d.	0.033