FISHERY RESEARCH

KOOTENAI RIVER FISHERIES RECOVERY INVESTIGATIONS: ECOSYSTEM REHABILITATION

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Photo by Charlie Holderman (KTOI)

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Kootenai River Fisheries Recovery Investigations: Ecosystem Rehabilitation

Project Progress Report

2003-2005 Annual Report

By

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ABSTRACT

A primary research objective for the 2003 and 2004 Ecosystem Rehabilitation Study was to continue the prenutrient addition baseline studies on select ecosystem response variables of the Kootenai River food web. These data will add to a database to document trends in the fish community and zooplankton composition and abundance over time. The data will also be used as "pretreatment" data for the proposed nutrient restoration of the Idaho section of the Kootenai River. Microinvertebrates (zooplankton) were sampled at three previously established biomonitoring sites from June through the end of the year. Densities of macrozooplankton *Crustacean spp*. were dominated numerically in proportion by copepods (predominantly *Nauplii*). Microzooplankton *Rotifer spp*. species were highest in June at approximately 150/L and tapered off to about 10/L in December. Rotifer species were predominately *Keratella cochlearis* and *Proales spp.* It is presumed that much of the microzooplankton densities are directly linked to entrainment from Lake Koocanusa located 76 km upstream of the Idaho/Montana border. In addition to zooplankton, five biomonitoring sites, along with a new site added in 2004 at Wardner B.C. as a reference reach, were electrofished to identify relative fish species abundance as catch per unit of effort (CPUE), abundance by weight as biomass per unit of effort (BPUE), relative weight (Wr) and condition (K), and trophic structure. Sixteen species of fish were identified from the electrofishing samples, with rkm 230 showing the most species diversity at 14 species. Sampling effort ranged from 0.63 to 1.55 hours per site. Four of the species (northern pikeminnow *Ptychocheilus oregonensis*, mountain whitefish *Prosopium williamsoni*, redside shiner *Richardsonius balteatus*, and largescale sucker *Catostomus macrocheilus*) that are relatively tolerant or intermediately tolerant to habitat disturbances were found at all of the biomonitoring locations. Diversity ranged from 7-14 species with the highest diversity located in the sample site below Bonners Ferry near Shortys Island (rkm 230). Although burbot *Lota lota* and Kootenai River white sturgeon *Acipenser transmontanus* are known to be present in small numbers, none was sampled in our index sites. Overall, there was a shift from high proportions of sensitive and intermediate species (with respect to human disturbance) in the upper river sections to more tolerant species in the lower river sections. Relative weights and condition factor generally declined in all fish species from upstream to downstream except for largescale suckers. The new reference reach of Wardner (rkm 565) exhibited three times the catch and biomass rates of all species combined than the Hemlock Bar reach (rkm 265). Length at age data for rainbow trout and mountain whitefish did not differ from that reported in 2001. Population estimates completed at Hemlock Bar (rkm 262-265) were rainbow trout 335.2 (95% CI = 186,672), mountain whitefish 7665 (95% CI = 5688, 10,591), and largescale suckers 2,206 (95% CI = 808, 5,518). Out of 25 radio tagged mountain whitefish, two (8%) made upstream migrations in late September to mid-November, indicating that our biomonitoring is being done at the correct time of year to include these as an indicator of nutrient restoration. Nutrient exposure experiments examining effects of varied concentration of nutrients on the early life stages of white sturgeon showed no direct effects of phosphorous treatments of 1.5 and 5 μg/L TDP on hatching success, yolk absorption, and yolk utilization efficiency. Recommendations are to move forward with the proposal of nutrient restoration of the Kootenai River to restore fish production to pre-Libby Dam levels.

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INTRODUCTION

Lake Koocanusa acts as a nutrient sink (Woods 1982; Snyder and Minshall 1996). According to Woods (1982), the reservoir retains approximately 63% of total phosphorus (P) and 25% of total nitrogen (N) that originates in the Kootenai River watershed. Recent evidence shows that the nutrient trapping is much higher now than previously reported (80% TP and 50% TN; Holderman and Hardy 2004). Due to low current velocities in the reservoir, these nutrients bind to sediments and precipitate out of solution (Snyder and Minshall 1996), making them unavailable to organisms in the river below the dam. Consequently, the Idaho portion of the Kootenai River is now considered "nutrient poor" (ultraoligotrophic) and P-limited (Snyder and Minshall 1996). Reduced nutrients render a reduction in food production, which may be a major contributor to poor sportfish production over the past two decades.

Primary production is thought to be the central foundation of bioenergetic development in the higher trophic levels (Vannote et al. 1980). Successful increases in primary production have been achieved with the addition of inorganic P and N (Ashley et al. 1999). It has been proposed that increases in primary production through fertilization would stimulate fish production in the Kootenai River from the bottom of the food web up (Snyder and Minshall 1996). The addition of nutrients is a commonly utilized aquaculture technique to increase fish biomass and has proven to be successful in recovering wild fish populations as well (Ashley et al. 1999; Pieters et al. 2003). For example, a large-scale nutrient enhancement program was implemented in the north arm of Kootenay Lake, British Columbia (BC) in 1992 in an attempt to recover declining kokanee *Oncorhynchus nerka* populations. The results of this implementation significantly increased all levels of the food web (Ashley et al. 1999). Significant increases in zooplankton, the main diet for kokanee, resulting from increases in algal growth, were sufficient to produce increases in kokanee numbers. Within seven years, kokanee spawners in two main tributaries to the north arm increased from 300,000 in 1992 to 2.1 million in 1998. A similar study in the Upper Arrow Reservoir, BC in 1999 showed that two years of nutrient enhancement resulted in higher escapements, increased size at maturity, increased fecundity, and a recruit:spawner ratio greater than one for kokanee (Pieters et al. 2003).

The Kootenai River Ecosystem Project was designed to take a holistic, ecosystem-based approach to rehabilitating the post-development Kootenai River fisheries. Past fisheries management programs on the Kootenai River have focused on recovering a single species. This project was designed to help support recovery of fish populations through an ecosystem-based strategy rather than simply treating the symptoms of degrading stocks. In cooperation with the Kootenai Tribe of Idaho (KTOI), the Idaho Department of Fish and Game (IDFG) proposes to add nutrients to the upper Kootenai River in a large-scale controlled experiment to boost fisheries production. The addition of nutrients to this ultraoligotrophic system (Kootenai River downstream of Libby Dam) may stimulate production in the river's depleted food web and annual downward trends in fish populations (Paragamian 2002) such as trout *Oncorhynchus spp.*, kokanee *O. nerka*, mountain whitefish, burbot, and white sturgeon.

In order to complete the biomonitoring assessment started in full in April 2002 for making a final decision and recommendation for nutrient restoration, trend data needs to be assembled for rainbow trout, mountain whitefish population, and other fish assemblages in the river. These data will be utilized in determining pre vs. post treatment differences should a treatment be set in place for the spring of 2005.

Boat electrofishing in the Kootenai River has been performed in the fall, early-mid September for multiple years since Partridge (1983). One piece of information lacking in these data are the timing of seasonal migration of many of the fish species. It is essential that we collect data from indicator species that may exhibit the benefits of nutrient additions rather than a population of transient species simply caught during one life history phase. Thus, tracking of an indicator species with a fall spawning migration (i.e. mountain whitefish) is required to help determine if our sampling of the fish community temporally in the canyon reach is representative of the community as a whole.

Many trace elements are essential to animal and plant nutrition but can be toxic in high concentrations (Maret and Skinner 2000). Trace elements occur naturally in the aquatic environment from weathering of rocks and mineral soils and from human sources such as the burning of fossil fuels, industrial discharges, auto emissions, mining, and agricultural pesticides and fertilizers (Maret and Skinner 2000). Trace elements are also found in commercial grade fertilizers at various concentrations depending on the source. Of special importance is the unknown potential direct effects of high concentrations of phosphorous treatments on endangered Kootenai River white sturgeon. Therefore, this study will address some of these possible effects in order for managers to make decisions that are more informed on nutrient restoration as a means to recover Kootenai River white sturgeon.

RESEARCH GOAL

1. Restore fish communities in the Idaho reach of the Kootenai River and improve angler fishing success.

OBJECTIVES

1. To identify baseline information for the microinvertebrate and fish community levels of the food web for comparison to post-fertilization changes in the ecosystem.

2. Determine migration timing of mountain whitefish to confirm that the timing of our fisheries biomonitoring data is representative of the fish community.

3. Determine the direct effects of proposed nutrient (phosphorous) concentrations on Kootenai River White Sturgeon hatching success and yolk-utilization.

STUDY AREA

The Kootenai River headwaters originate in Kootenay National Park in southeastern BC, Canada (Figure 1). From there, they flow southward into northwestern Montana where they are impounded by Libby Dam, forming Lake Koocanusa. From there, they turn westward and flow into the northeastern portion of the Idaho Panhandle, then flow northward back into BC to form Kootenay Lake, and finally to their confluence with the Columbia River at Castlegar, BC. The Kootenai River is the second largest of the Columbia River tributaries and the third largest in drainage (approximately 50,000 km^2; Bonde and Bush 1975). The study area consists of approximately 106 km (river kilometer [rkm] 170 to rkm 276) of the river that flows through the Idaho Panhandle, along with several reference (control) sections in Montana and BC.

The Montana and Idaho portion of the Kootenai River below Libby Dam (rkm 352) can be separated into three distinct stream habitat types. Directly below the dam, the river flows through a narrow canyon section characterized by steep canyon walls, high gradients, and boulder/cobble substrates (rkm 352 to 258.5). As the river flows through the northeast corner of the Idaho Panhandle, there is a gradient transition at Bonners Ferry. Upriver from Bonners Ferry, the channel has an average gradient of 0.6 m/km, and the velocities are often higher than 0.8m/s. There is a braided transition reach from the Moyie River (rkm 258.5) to Bonners Ferry (rkm 244.5). Downriver from Bonners Ferry, velocities slow to usually less than 0.4 m/s; average gradient is 0.02 m/km, the channel deepens, and the river meanders through the Kootenai Valley (rkm 244.5 to rkm 121).

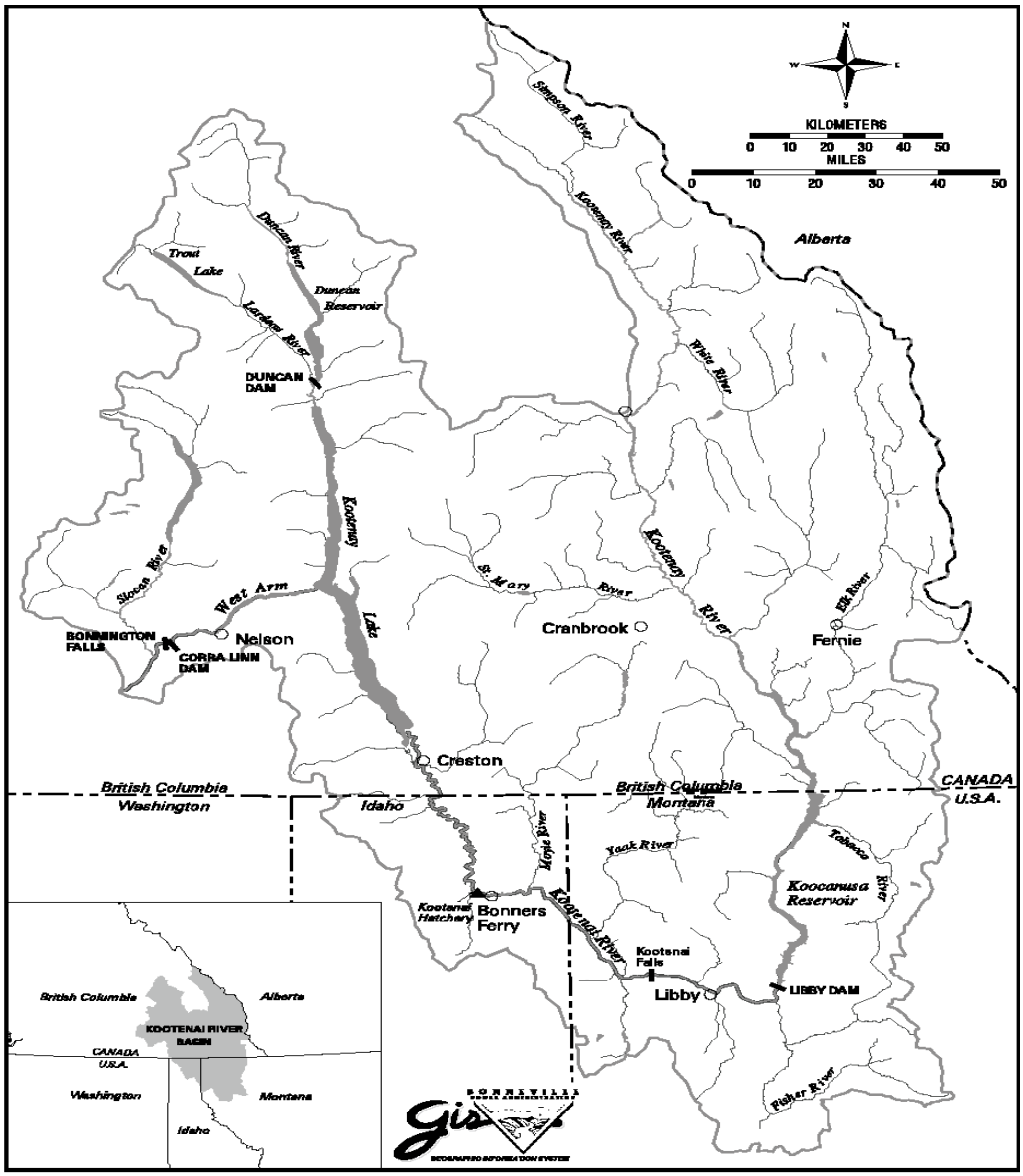

Figure 1. Location of the Kootenai River, Kootenay Lake, Lake Koocanusa, Libby Dam, Bonners Ferry, and important points.

In the Kootenai River watershed, six ecosystem biomonitoring sites have been established to gather baseline data pre- and post-nutrient restoration (Figure 2). The first site, KR14, is in the southern part of British Columbia near Wardner at rkm 565 (UTM 612607 5479569). This site serves not only as a nontreatment site, but also as a reference site without reservoir influence. The next site downstream, KR10, is below Libby Dam, which is in the Montana portion of the canyon section at rkm 283 (UTM 0574294 5381592). This location is often referred to as the Yaak River site due to its proximity to the Yaak River approximately 3 rkm upstream (Figure 2). This site serves as a nontreatment reference site below Libby Dam. The next site, KR9, in the canyon section is located at Hemlock Bar (often referred to as the Hemlock Bar site) approximately 18 km downstream at rkm 265 (UTM 0563707 5393213). A single site, KR6, is located in the braided canyon section above Bonners Ferry at rkm 250 (UTM 0554277 5394630) near the Cow Creek tributary, referred to as the Cow Creek site. The next two sites are located in the meander reach below Bonners Ferry at rkm 230 (UTM 0544834 5402535), referred to as the Shortys Island site (KR4), and at rkm 170 (UTM 0534892 5427171) near the Canadian border, referred to as the Porthill site (KR2).

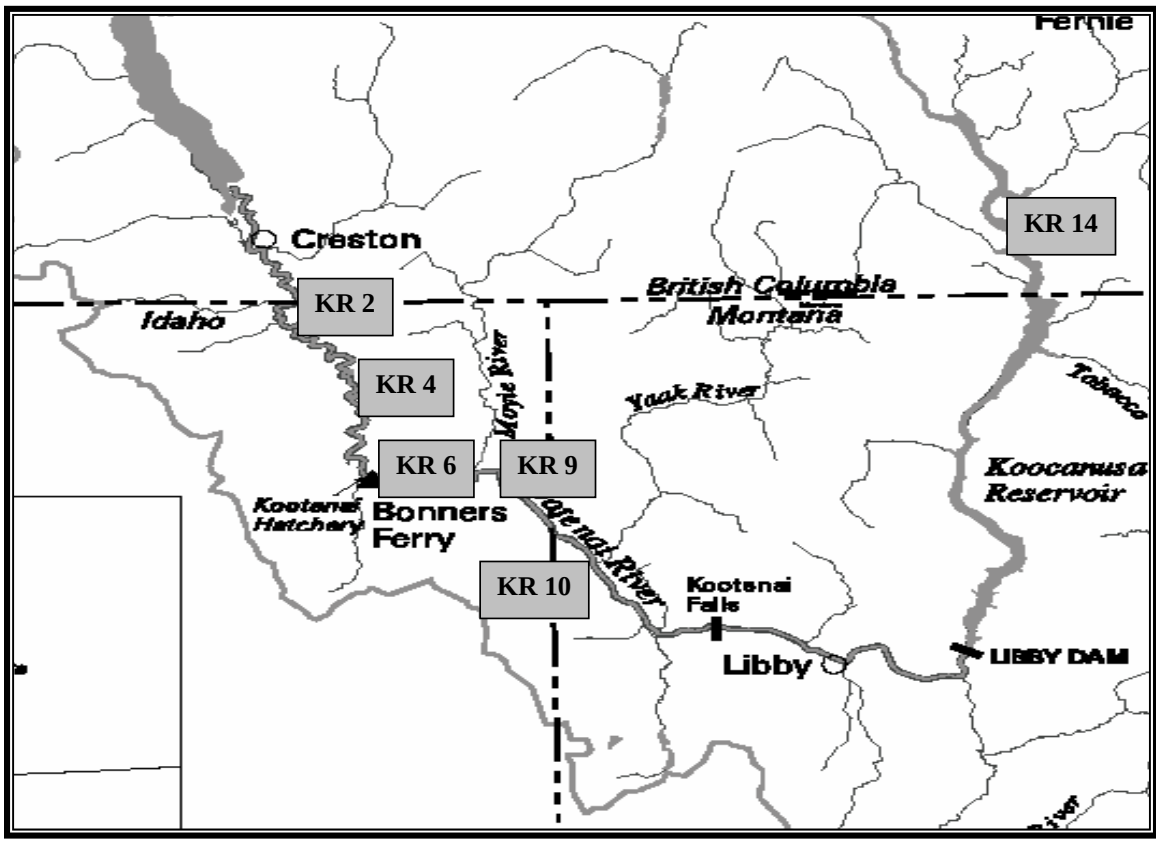

Figure 2. Kootenai River ecosystem study area and approximate locations of biomonitoring sites.

METHODS

Microinvertebrate Abundance

Zooplankton were sampled to determine a general reference to species abundance and composition and to provide a temporal baseline for determining changes following possible nutrient restoration. Zooplankton were sampled at three biomonitoring sites (rkm 283, 265, and 250) on the Kootenai River from January 2003 through May 2004, with collections made once each month from the left, center, and right channel. Zooplankton were collected by filtering 10 L of water through a 1 L straining cup lined with a 63 µm mesh filter material. Samples were taken approximately 0.3 m below the water's surface (crustacia and rotifers were assumed to be evenly mixed in a lotic system). Contents were then rinsed into 60 ml NALGENE® bottles and preserved with 0.1 ml of Lugol's iodine solution per 1 ml sample volume. Four 1 ml aliquots from each sample were analyzed to the most specific taxonomic identification of crustacia and rotifers. Resulting zooplankton and rotifer counts from subsamples were then extrapolated to number per liter.

Fish Community Assessment

Species Abundance/Catch and Biomass Rates

In September of 2003 and 2004, each of the biomonitoring sites were electrofished to identify relative species abundance as catch per unit of effort (CPUE), abundance by weight as biomass per unit of effort (BPUE), relative weight (Wr) and condition (K), and trophic structure. Effort was defined as 1 hr of shock time. These data will document trends in the fish community over time and will be used as "pretreatment" data for the proposed nutrient restoration of the Idaho section of the Kootenai River. Sites were sampled using a 5 m jet boat equipped with a Coffelt VVP-15 electroshocker powered by a 5000 watt Honda generator. Typically, electrofish settings were set to generate 6-8 amps at 175-200 volts. The sampling crew consisted of two netters and one driver, who had control of the safety microswitch. All fish species, regardless of size, were netted in order to get a representative sample of the fish community structure at each site. To increase replication, each biomonitoring section (left and right shoreline) was divided into six equal subsections of 333 m with 150 m separating each to ensure each site was independent of the next. This protocol allowed one km of electrofishing on both banks for a total of two km of sampling. Electrofishing was performed at rkm 565, 284.5, 266, 251, 231, and 172 and worked upstream at each site, respectively. A single pass was made through each subsection, starting with lower sections first to ensure no fish drifted into areas not yet sampled. After each subsection was shocked, the elapsed sampling time was recorded, and collected fish were taken back to a workup station (a convenient, safe spot on the shoreline). At the workup, fish were anesthetized, identified to species, measured (total length [TL], mm), enumerated, and weighed (g). A subsample of scales from the most abundant species at each site was taken (10 fish in each 10 mm class interval) for aging.

Relative Weight (Wr) and Condition Factor (K)

Fulton's condition factor (K) was used as a measure to gauge changes in body form. K is a ratio between the observed weight and an expected weight dependent on the fish's length (Blackwell et al. 2000). Fulton's condition factor is calculated using the following formula:

$$K = (W/L^3) \times 10^5,$$

where W is the weight of the fish in g, L is the length in mm, and 10^5 is a constant used for scaling purposes. A condition of 1 represents optimal growth. Condition assumes that a fish grows isometrically (becoming more round with increasing length). Since that is rarely the case (Bolger and Connolly 1989), we additionally calculated relative weight (Wr), which compares Kootenai River fish weight to that of a standard developed for each species (Blackwell et al. 2000). Relative weight is calculated using the formula:

$$Wr = (W/Ws) \times 100,$$

where W is the actual fish weight, and Ws is a standard weight for fish of the same length. A Wr of 100 is considered optimal. Relative weight was calculated for rainbow trout, mountain whitefish, and northern pikeminnow *Ptychocheilus oregonensis*, the only fish sampled with a Ws available (Anderson and Neumann 1996). Minimum total lengths to calculate Ws were 120 mm for rainbow trout, 140 mm for mountain whitefish, and 250 mm for northern pikeminnow (Parker et al. 1995; Rogers et al. 1996; Simpkins and Hubert 1996). For purposes of comparing Wr between sites, the Wr of each species was summarized by 100 mm classes. Statistical differences in condition and relative weights will be tested in future years to detect pre- vs. post-treatment differences by using 1-way ANOVAs (GLM, general linear models; SYSTAT 7.0 1997). No statistical comparisons were performed on these data for 2003-2004.

Feeding Guilds and Tolerance

All species sampled were classified by feeding guild and relative resistance to habitat disturbances as specified in Zaroban et al. (1999). Feeding guilds utilized were omnivore, invertivore, and invert-piscivore. Omnivores primarily eat plant and animal material (min of 25% each). Invertivores are described as those species that feed primarily on invertebrate prey, primarily insects. Invert-piscivores consume considerable proportions of fish and invertebrates and typically have an enlarged mouth relative to nonpiscivorous species (Zaroban et al. 1999). Disturbance (be they natural or man-caused) or pollution tolerance was classified as follows: sensitive—those species that tend to either disappear or are greatly reduced in association with human disturbances (Karr et al. 1986); tolerant—those species that tend to increase with human disturbances (Zaroban et al. 1999); and intermediate—species that tend to be neither tolerant nor sensitive to disturbance (increased siltation, turbidity, temperature, or lowered dissolved oxygen; Zaroban et al. 1999). These fish classifications along with other trophic data are to be used in the future to determine trends following nutrient additions.

Age and Growth

Rainbow trout and mountain whitefish scales were impressed onto cellulose acetate slides and viewed on a microfiche reader at 42X. A regression of TL at capture on scale radius was used with a refined Whitney and Carlander (1956) “body proportional” method (Francis 1990) to back-calculate TL at age. The Francis (1990) method uses:

$$L_i = \left[\frac{(c + dS_i)}{c + dS_c} \right] L_c$$

where:

L_i = TL at age I,
S_i = radius measurement at time of formation of the *i*th annulus,
L_c = the TL at capture,
S_c = total scale radius,
c = the y-intercept from the regression equation, and
d = slope derived from the regression equation.

Mean length at age and annual growth increments were estimated from the back-calculation data. Due to a lag in data analysis, age and growth were only calculated on those rainbow trout and mountain whitefish collected during the fall of 2002 and 2003.

Kootenai River Fish Population Assessment

Mark-recapture population estimates for fish assemblages were conducted in the 3 rkm reach of Hemlock Bar (rkm 262-265) of the upper Kootenai River above Bonners Ferry, Idaho from August 23, 2004—August 31, 2004. Sampling was performed with boat electrofishing gear in the same method as described in the fish community assessment. Population estimates targeted rainbow trout and mountain whitefish; however, all fish received marks for potential estimates. All fish were marked the nights of August 23, 24, and 25 by clipping a small section off the lower caudal fin. The recapture samples were collected the following week on the nights of August 30 and 31 to determine the proportion of marked to unmarked fish in the sample reach. Population estimates were calculated using Chapman's modification of the Petersen Method (Ricker 1975; Krebs 1999):

$$N = ([M+1]*[C+1] / [R+1]) - 1$$

where: N = population estimate,
M = number of marked fish,
C = number of fish captured during the recapture sample, and
R = number of recapture marks in the recapture sample.

Due to the size selective nature of electrofishing (Reynolds 1996; Schill 1996; Downs 2000), estimates were calculated for 100 mm length classes where adequate number of recaptures was present (i.e. R = 3; Ricker 1975). Ninety-five percent confidence intervals based on the Poisson distribution were obtained following methods described by Ricker 1975 and Seber 1982.

Radio Telemetry

We collected mountain whitefish in July 2004 using boat electrofishing gear for radio tagging. Tagging protocols and surgery procedures were followed as described by Downs (2000). Radio telemetry surveys were conducted from 0800-1700 h by fixed-wing aircraft and by boat. The upper and lower bounds of the upper canyon section were set up with stationary receivers at rkm 252 and 275.5, which allowed us to keep track of any additional movement out of the canyon by tagged fish on hours or days when we were unable to fly or boat. We used low frequency (30 MHz) radio transmitters to maximize signal transmission in the deep, oligotrophic waters of the Kootenai River (Winter 1996; Downs 2000). Whitefish were implanted with Advanced Telemetry System (ATS) tags (F1580) with a 280 day duration, 24 hr on time, 13 x 24 mm length, 3.6 g weight, and emitted a signal at 40 pulses per minute (ppm).

Nutrient Exposure Experiments

Experiments were designed in June 2003 to test the effect of varied concentrations of phosphorus on the hatching success and yolk utilization of Kootenai River White sturgeon. The experiments were set up at the Kootenai Tribal Hatchery located in Bonners Ferry, Idaho. The first experiment addressed hatching success. Treatment tanks consisted of nine clear Plexiglas (6.5 mm thick) troughs 18 cm wide, 18 cm deep, and 2.4 m in length. Six troughs were used for nutrient manipulations, and three troughs served as controls (nontreatment groups). Each trough had a series of baffles at the influent end to facilitate even mixing and flow and was covered with a 6.5 mm Plexiglas lid. Trough groups were elevated off the floor and bolted to a wooden frame for support. Clean, even-sized (3-5 cm) river gravel, obtained from a local quarry, was added to each trough to simulate a natural streambed. The gravel was precleaned with river water to remove fine sediment. Gravel was placed to a depth of 7 cm to provide a water depth of 8 cm.

Treatment tanks (n = 9) held three round replicate tanks (n = 27) with fertilized sturgeon eggs for incubation. Replicate trays were approximately 153 mm in diameter and covered by a 250 µm mesh to keep any hatching larvae from escaping. Each replicate was labeled by its phosphorous treatment and by its relative position to the incurrent flow of the tank. Replicate position “A” was located closest to the incurrent flow, while position “C” was located furthest from the incoming flow (Figure 3). The average flow rate of the nine separate tanks was 0.55 L/s each. The flow into the mesocosm was water unfiltered and pumped directly from the Kootenai River. All nine tanks had 30 micrograms/L of N pumped to them via a peristaltic pump. Three treatment levels of phosphorous were pumped to different tanks in the mesocosm. Tanks 7, 8, and 9 were the control tanks and had 0 µg/L of P added to them. Tanks 1, 3, and 6 had 1.5 µg/L of TDP added while tanks 2, 4, and 5 had 5.0 µg/L of TDP added. Fluorescent lights were left on between the hours of 4 a.m. and 10 p.m. to simulate actual daylight due to the indoor setting of the mesocosm.

On June 8, 2003, 25 fertilized white sturgeon eggs were placed into control and treatment groups to observe hatch success. Any eggs that fungused were removed via a suction hose in an effort to reduce spread of the infection. All hatched eggs and larvae were recorded, removed, and then preserved and later measured for final yolk sac area (mm^2) and total length (mm). To obtain these morphological data, each preserved larvae was placed under a microscope, videotaped, and later analyzed with an image analysis system (Optimas v5.2 BioScan Inc., Edmonds, Washington).

Yolk sac utilization rate and efficiency, under varied concentrations of P, were also tested in 2003. For this experiment, rearing tanks from the hatching success trials were used with replicate trays removed. At the start of the experiment, 100 newly hatched larvae from the same cross of adult sturgeon as the hatching experiment were placed in each of the nine tanks. Each outflow was fitted with a mesh screen to prevent escape. The same treatment design and flow was utilized as described for the previous experiment. Every other day, two larvae were randomly sampled from each tank and preserved for analysis of yolk sac area, body area, and total length. The experiment was terminated when the presence of the dark yolk plug was extruded by the larvae, indicating full yolk-sac absorption (Hardy and Litvak 2004). Yolk-sac utilization rate (YUR) was determined by calculating slopes from a regression analysis (Proc Reg. SAS Institute Inc. 1992) of yolk-sac volume (YSV) for each treatment tank over the duration of the experiment. We determined yolk-sac utilization efficiency (YUE) by comparing the rate of body area (BA) growth (slope of BA against age regression: mBA) to the rate of yolk utilized (absolute value of slope of YSA against age regression: $|mYSA|$) until the complete

absorption of the yolk (YUE – mBA/│mYSA│). For YUE analysis, a Proc Mixed Model (SAS Ins. v9.1, 2003) was used to run a split plot mixed model with repeated measures on "Day." In this experiment, trough 9 (one of the nontreatment groups) was eliminated from the analysis because larvae escaped through the outflow.

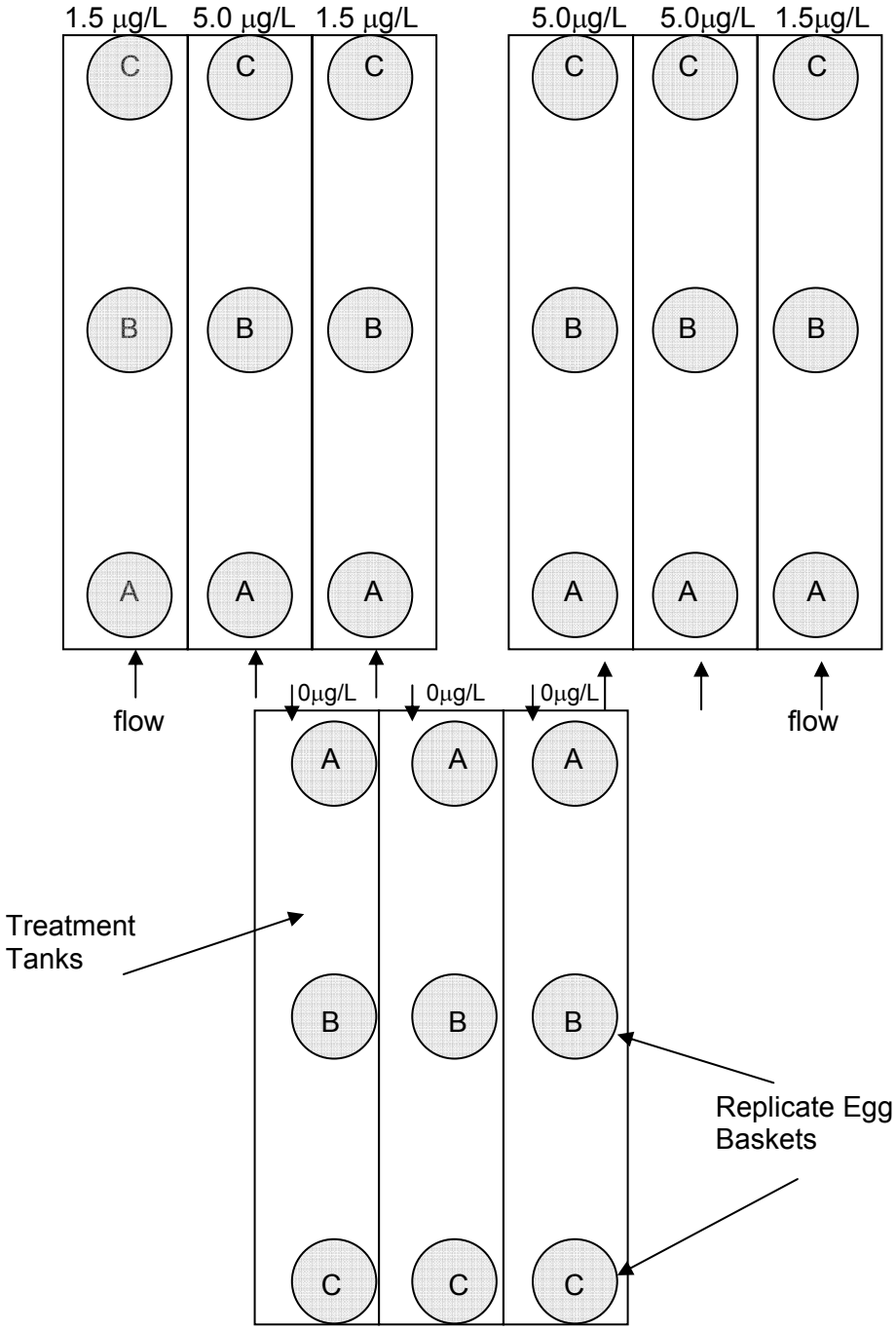

Figure 3. Experimental design setup to test the effect of varied phosphorous concentrations on the hatching success and yolk utilization of Kootenai River White Sturgeon.

RESULTS

Microinvertebrate Abundance

Fourteen species of crustaceans and 53 species of rotifers were identified in the filtered samples (n = 135) collected in 2003 and 2004. Mean crustacean densities through the sampling period ranged from 0.1 to 21.6/L (standard error [SE] ± 0.0 – 14.4, respectively; Table 1). Mean rotifer numbers were higher than crustacean ranging from 3.5–241.7/L (SE ± 0.5–21.4, respectively; Table 1). Site-specific differences within each month were minimal. Crustacean densities in collections from June of 2002 to May of 2004 closely followed mean monthly discharge of the Kootenai River (Figure 4). Mean crustacean proportions were dominated by the subclass Copepoda (*Nauplii, Cyclopoid copepodite,* and *Calanoid copepodite*) along with small proportions from the subclass Cladocera *(Bosmina longirostris, Chydorus sphaericus, Alona rustica and costata,* and *Daphnia;* Appendices A-C*). Similar proportions of the same species were represented at all three of the sites (rkm 251, 265, and 283). Mean rotifer proportions at all sites were dominated by five main species: *Keratella cochlearis, Proales spp., Bdelloid spp., Trichocerca uncinata,* and *Polyarthra remata* along with small proportions of *Kellicottia longispina, Gastropus stylifer,* and *Synchaeta spp.* (Appendices A-C*). Again, similar proportions of the same species were represented at all three of the sites.

* Appendices A-C only report zooplankton densities by species from January-May 2003. Additional tables are available for June 2003-May 2004 at the Idaho Department of Fish and Game, Panhandle Office.

Table 1. June 2003 through May 2004 zooplankton densities (crustacia and rotifers) from the upper Kootenai River at rkm 283, 265, and 251.

	RKM 251				RKM 265				RKM 283				
Sample Month	**Crustaceans (#/L)**	**SE**	**Rotifers (#/L)**	**SE**	**Crustaceans (#/L)**	**SE**	**Rotifers (#/L)**	**SE**	**Crustaceans (#/L)**	**SE**	**Rotifers (#/L)**	**SE**	**River Flow (KCFS)**
June 2003	4.28	0.59	82.00	199.00	5.43	0.78	214.67	21.43	3.57	0.18	123.47	7.90	22.7
July 2003	0.77	0.32	86.73	38.37	1.60	0.20	84.53	13.55	1.17	0.13	88.00	7.88	16.7
August 2003	0.20	0.12	10.27	5.15	0.17	0.12	11.60	1.56	0.43	0.12	11.27	0.27	16.9
September 2003	0.17	0.03	21.87	1.16	0.23	0.03	30.53	3.87	0.43	0.19	26.45	1.75	8.5
October 2003	0.27	0.07	12.47	1.29	0.17	0.12	13.40	1.63	0.07	0.03	20.43	0.65	5.0
December 2003	1.10	0.26	16.00	3.40	0.87	0.22	13.20	0.50	0.70	0.17	5.13	1.54	16.2
February 2004	0.30	0.00	11.53	6.73	0.20	0.10	3.47	0.64	0.13	0.17	5.13	1.54	4.9
March 2004	0.47	0.18	7.73	1.27	0.33	0.07	8.27	0.87	0.13	0.12	5.76	0.70	6.3
April 2004	0.73	0.07	14.30	1.87	0.43	0.38	13.23	1.20	0.30	0.06	13.37	0.90	9.8
May 2004	14.67	3.73	115.27	6.35	9.27	0.90	94.00	2.08	21.63	14.43	196.40	20.82	10.1
Minimum #/L	*0.2*	*0.0*	*7.7*	*1.2*	*0.2*	*0.0*	*3.5*	*0.5*	*0.1*	*0.0*	*5.1*	*0.3*	*4.9*
Maximum #/L	*14.7*	*3.7*	*115.3*	*199.0*	*9.3*	*0.9*	*214.7*	*21.4*	*21.6*	*14.4*	*196.4*	*20.8*	*22.7*

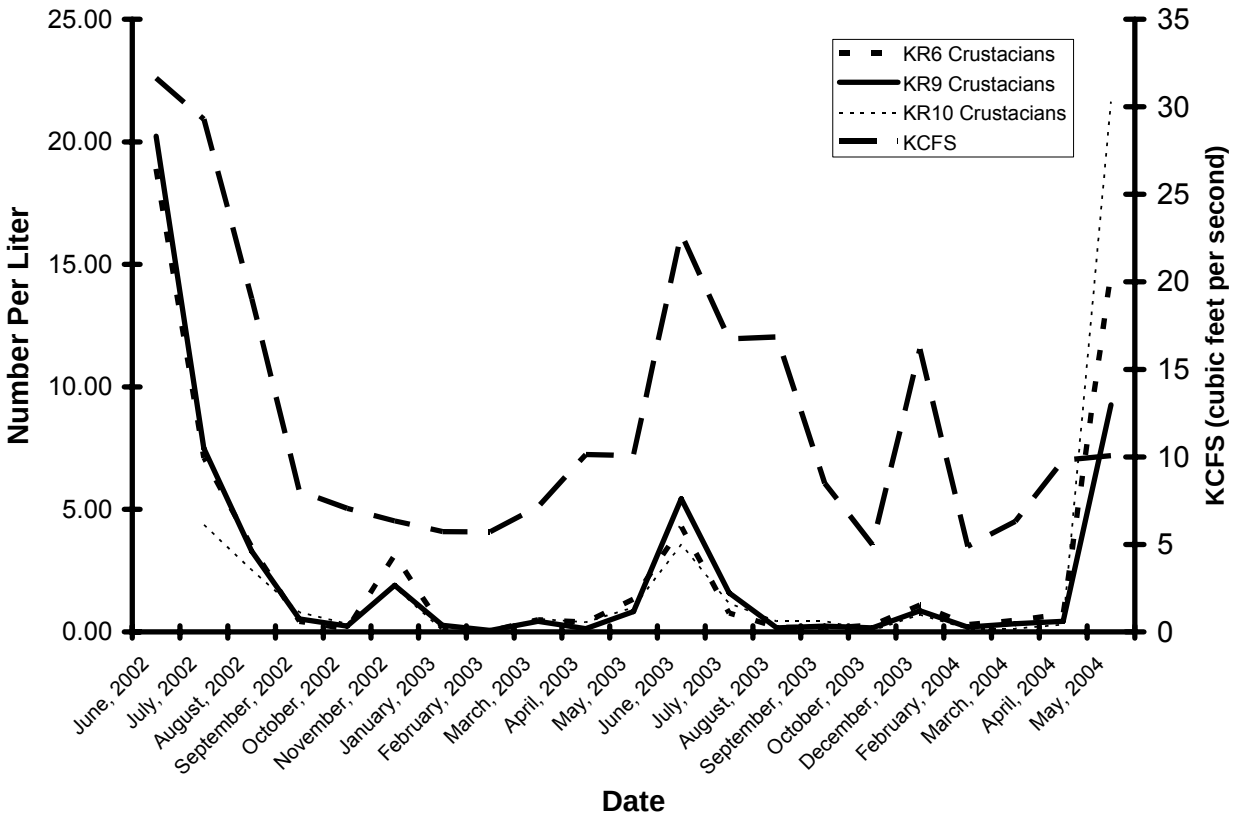

Figure 4. June 2002 through May 2004 zooplankton densities from the upper Kootenai River at rkm 283, 265, and 251 in relation to Kootenai River flow (KCFS).

Fish Community Assessment

Species Abundance

Sixteen species of fish were identified from the electrofishing samples during 2003-2004. Species diversity ranged from 7-14 with the highest diversity located in the sample site below Bonners Ferry near Shortys Island (rkm 230; Table 2). Four of the species (northern pikeminnow, mountain whitefish, redside shiner, and largescale sucker) that are relatively tolerant or intermediately tolerant to habitat disturbances were found at all of the biomonitoring locations. With the exception of a very low number of rainbow trout, none of the species that are considered sensitive to such perturbations or natural habitat variation in a large river system (e.g., bull trout, westslope cutthroat trout *O. clarkii lewisi*, and kokanee) were located at the Porthill site (rkm 170; Table 2). Although burbot and Kootenai River white sturgeon are known to be present in small numbers, none was sampled in our index sites.

Catch and Biomass Rates

Total catch and biomass per hour (CPUE and BPUE across species) varied from upriver to downriver locations. Total effort ranged from 0.63 h to 1.55 h per site. The highest total CPUE across species was recorded for the section below Bonners Ferry near Shortys Island (rkm 230) at 306 fish/h in 2003, while in 2004, the highest CPUE was recorded at the section near Wardner B.C. (rkm 565) at 459 f/h). 2004 was the first year of sampling this location. The location with the lowest catch rate in both 2003 and 2004 was in the upper canyon reach near the confluence of Yaak River, Montana (rkm 283) at 188 and 158 fish/h, respectively (Figure 5). The highest BPUE in 2003 (56 kg/h) was sampled in the upper canyon at the Hemlock Bar reach (rkm 265); while in 2004 the sample location near Wardner, B.C. had the highest at 144 kg/h (Figure 6). In 2003 the lowest BPUE (24 kg/h) occurred in the meander reach at Shortys (rkm 230) and in 2004 (19 kg/h) at Porthill (rkm 170; Figure 6).

In 2003, largescale suckers, mountain whitefish, and rainbow trout were consistently higher than other species in catch and biomass rates in the upper sites (rkm 283, 265, and 251; Appendices D-F). Of the upper sample sites, the Cow Creek reach (rkm 251) was highest in mean catch and biomass rates of largescale sucker (29 fish/h; 23 kg/h, respectively), as well as catch and biomass rates of mountain whitefish (225 fish/h; 25 kg/h, respectively). In the meander reach sites (rkm 230 and 170), rainbow trout and mountain whitefish were negligible in numbers and biomass. In these sites, largescale sucker, northern pikeminnow, peamouth chub *Mylocheilus caurinus*, and redside shiner represented the majority of catch and biomass (Appendices G and H). Mean CPUE at rkm 230 and 170 was highest in northern pikeminnow (141 and 130 fish/h, respectively), yet BPUE was highest in these two sites in largescale suckers (11 and 15 kg/h, respectively). Across all sample sites, largescale suckers were more abundant in the lower sites yet made up less of the biomass than in the upper canyon reaches.

In 2004, largescale suckers, mountain whitefish, and rainbow trout were also greater in abundance than that of other species in catch and biomass rates in the upper sites (rkm 283, 265, and 251; Appendices I-K). Of the upper sample sites, the Wardner reach (rkm 565) was highest in mean catch and biomass rates of largescale sucker (101 fish/h: 80 kg/h, respectively) as well as catch and biomass rates of mountain whitefish (322 fish/h; 44 kg/h, respectively). In contrast, in the meander reach sites (rkm 230 and 170), rainbow trout and mountain whitefish were negligible in numbers and biomass. In these sites, largescale sucker, northern pikeminnow, peamouth chub, and redside shiner represented the majority of catch and biomass (Appendices L and M). Mean CPUE at rkm 230 and 170 was highest in peamouth chub (120 and 156 fish/h, respectively). BPUE was highest in these two sites in peamouth as well as largescale suckers (10 kg/h for largescale at rkm 230 and 8 kg/h for peamouth at rkm 170). The new reference reach of Wardner (rkm 565) added in 2004 exhibited three times the catch and biomass rates of the Hemlock Bar reach (rkm 265).

Relative Weight (Wr) and Condition Factor (K)

In general, relative weights in 2003 and 2004 for rainbow trout and mountain whitefish (all size classes) declined from upper to lower sites (rkm 565, 283, 265, 251 to rkm 230 and 170, respectively; Appendices O-Z). Relative weight for rainbow trout in the 101-200 mm class interval were greatest in the upper canyon, while those in the 301-400 mm class interval had the poorest Wr downstream in the braided and lower river sections (Appendices O-Q and U-W). Relative weight for mountain whitefish tended to be higher in the 201-300 and 301-400 mm size

classes in the upper canyon and braided sections and lowest for those in the 101-200 mm size class sampled at downstream sites (Appendices P and V). Relative weights of northern pikeminnow (all size classes) were poor relative to the standard, ranging from 57 to 89 at all river sections (Appendices Q and W).

Condition factor (K) was calculated for largescale sucker, peamouth chub, and redside shiners (Appendices R-T and X-Z). In 2004, few largescale suckers were collected under 301 mm across all sample sites (n = 14; Appendix X). In general, largescale suckers in 2003 exhibited higher condition in the meander reaches (rkm 230 and 170) than the upper canyon reach. This difference was not as evident in 2004.

Feeding Guild and Tolerance

Feeding guilds changed considerably in percent of total catch and biomass as we sampled from the upper river to lower river sections. In the upper river sections, the braided canyon reach (rkm 251) exhibited the highest percent of total catch and percent of total biomass in both 2003 and 2004 (85 and 49% to 82 and 58%, respectively; Appendices AA-AC and AF-AI). All of the upper canyon sections (rkm 565-251) were dominated in percentage of catch and biomass by invertivore species. However, in the lower river sections the top guilds represented are split between invert-piscivores and to a lesser extent invertivores (Appendices AD-AE and AJ-AK). The percent of total biomass, however, was primarily made up of omnivore species in these two sample sections (range of 31–59%; Appendices AD-AE and AJ-AK). For a full list of species classified by feeding guild and tolerance, see Table 2.

Tolerance classifications also showed considerable changes in proportion of catch and biomass as we moved from upper to lower river sections in our 2003 and 2004 sampling. Overall, there was a shift from high proportions of sensitive and intermediate species in the upper river sections to more tolerant species in the lower river sections (Appendices AA-AK). As in 2002, the 2003 and 2004 sampling showed that river kilometer 251 in the braided reach exhibited the highest percent of total catch and biomass of intermediate species of all the sample sites (82 and 47-58%, respectively; Appendices AC and AI). In general, the two lower river sections in the meander reach (rkm 230 and 170) were negligible in percent of total catch and biomass of sensitive species and highest in those parameters in tolerant species (Appendices AD-AE and AJ-AK).

Age and Growth

Rainbow trout age and growth data from fish sampled in the September 2002 and 2003 electrofish biomonitoring are shown in Tables 3 and 4. The total length vs. scale radius regression equation for rainbow trout sampled in 2002 was $Y = 4.8 (X) + 44.8$ (R^2=0.72, P = 0.080). The 2003 regression equation for rainbow trout was $Y = 4.3 (X) + 48.9$ (R^2=0.80, P = 0.008).

Mountain whitefish age and growth data from fish sampled in the September 2002 and 2003 electrofish biomonitoring are shown in Tables 5 and 6. The total length vs. scale radius regression equation for mountain whitefish sampled in 2002 was $Y = 2.3 (X) + 48.1$ (R^2 = 0.93, P <0.001). The 2003 regression equation for rainbow trout was $Y = 2.4 (X) + 38.6$ (R^2 = 0.94, P = 0.001).

Population Assessment

Ten species of fish were caught during the August 2004 electrofishing of the Hemlock Bar reach (Table 7). Due to the small number of recaptures collected of other species, population estimates were only calculated for mountain whitefish, rainbow trout, and largescale suckers. Mountain whitefish were the most abundant species at 7,665 (95% CI = 5,688, 10,591), followed by largescale suckers at 2,206 (95% CI = 808-5,518; Table 6).

Radio Telemetry

Six mountain whitefish were initially fitted with radio tags on July 22, 2004, kept in holding pens for 12 hrs, and checked the following day to assess status for release. All fish in the net pen (including two fish not implanted with radio tags) were mortalities. The second attempt at tagging was made on July 26-28, 2004 when we collected and radio-tagged 25 mountain whitefish. During these dates, in order to ensure a successful release, a more rigid Nitex mesh net box was used to keep the netting from folding in on the fish (assumed to be the cause of mortality in the first tagging effort). This method proved to be successful in holding and the fish were released on July 28. Three of the 25 marked fish were not included in the analysis, as contact was lost within a week of tagging. Of the fish tagged, only two fish (frequency 30.641 and 30.532) made notable migrations (Figures 7-10; Appendix AL). Tag 30.641 made the furthest upstream migration of 28.6 rkm from its original tagging location and remained in the mainstem of the Kootenai River (Figures 7 and 9). Tag 30.532 made a 9.6 rkm migration upstream from its original tagging location and entered the Moyie River, which was the furthest upstream location it was detected. Dates of general spawning looked to be between September 13 and November 8, 2004.

Nutrient Exposure Experiments

We tested the hatching success of white sturgeon embryos in varying concentrations of phosphorus in May of 2003. The first white sturgeon eggs hatched on day 10 of the experiment (6/16/03). Of the 675 eggs added to the experiment, 58 (8.6%) successfully hatched over a three day period (Table 8). Although those tanks that received 1.5 µg/L TDP exhibited the highest mean percent of total hatch (47%), there was no statistically significant difference detected between the treatments ($F = 0.532$; $P = 0.46$; GLM, ANOVA; SYSTAT Inc. 2004). The hatching success between replicates, however, was significantly different. Replicate A in each of the treatment tanks (the replicate closest to the inflow) showed a significantly higher ($F = 5.621$; $P = 0.004$; GLM, ANOVA; SYSTAT Inc. 2004) hatching success (62%) between treatments than did replicates C (24%) and D (14%; Table 8).

White sturgeon egg mortality was high in all of the treatment tanks. Of this mortality, ninety-two percent of the sturgeon egg mortality was caused by fungus (Table 9). There was no significant difference of percentage fungus mortality detected between treatment and replicates ($F = 0.0.014$; 0.116; $P = 0.90$; $P = 0.89$ respectively; GLM, ANOVA; SYSTAT Inc. 2004). Final yolk sac area and total length of larvae at hatch are shown in Table 10. No significant difference was detected for total length ($F = 0.341$; $P = 0.56$; GLM, ANOVA; SYSTAT Inc. 2004) or yolk sac area ($F = 0.83$; $P = 0.37$; GLM, ANOVA; SYSTAT Inc. 2004).

Phosphorus concentrations did not significantly influence white sturgeon yolk sac utilization rate or efficiency. A total 123 larvae were sampled and analyzed over a 14-day

period. On day 15, the presence of extruded yolk plugs was recorded in the tanks, confirming full yolk-sac absorption, and the experiment was terminated. All treatment data on total length, absorption rate, and utilization efficiency was found to be normal (Proc Univariate; SAS Institute 1992) and variances homogeneous (F_{max}-test; Sokal and Rohlf 1981). We found no detectable difference in the rate of yolk sac absorption between treatment groups (F = 0.15; P 0.87; Proc GLM ANOVA; Figure 12). Mean total length of larvae tested between treatment groups over the duration of the experiment showed a significant difference between days, yet no significant difference between treatment groups (see Table 11 for level of significance). Mean maximum total length achieved by larva in each treatment also showed no significant difference (P >0.05; GLM ANOVA) between treatment groups (Table 11). Although the mean yolk-sac utilization efficiency between treatments was highest in the control group at 3.36 (SE ± 0.18), when statistically tested all groups showed not to be different (F 2.53; P = 0.17). A Proc Mixed Model (SAS Ins. v9.1, 2003) was used to run a split plot mixed model with repeated measures on "Day" (Figure 12). To strengthen the level of confidence in our estimate, a power analysis was run following Zar (4th edition 1999) where a minimum detectible difference was specified as three separate percentages of the mean YUE for the three treatment groups. The results of this analysis shown in Table 12 indicate that we are 86% confident that we can detect a 25% difference.

Table 2. Species sampled at Kootenai River biomonitoring sites in September 2003 and 2004 with boat electrofishing gear. I = Intolerant; T = Tolerant; S = Sensitive (describes response to habitat perturbations; Zaroban et al. 1999).

2003-2004	**Sample location**							
Species	**rkm 565**	**rkm 283**	**rkm 265**	**rkm 250**	**rkm 230**	**rkm 170**	**Feeding guild**	**Tolerance**
Brown Bullhead *Ameiurus nebulosus*						X	Invert-Piscivore	T
Brown trout *Salmo trutta*							Invert-Piscivore	I
Bull trout *Salvelinus confluentus*	X	X			X		Invert-Piscivore	S
Kokanee *Oncorhynchus nerka*	X	X	X	X	X		Invertivore	S
Largescale sucker *Catostomus macrocheilus*	X	X	X	X	X	X	Omnivore	T
Longnose dace *Rhinichthys cataractae*	X						Invertivore	I
Longnose sucker *Catostomus catostomus*	X	X			X	X	Invertivore	I
Mountain whitefish *Prosopium williamsoni*	X	X	X	X	X	X	Invertivore	I
Northern pikeminnow *Ptychocheilus oregonensis*	X	X	X	X	X	X	Invert-Piscivore	T
Peamouth chub *Mylocheilus caurinus*		X	X		X	X	Invertivore	I
Pumpkinseed *Lepomis gibbosus*					X		Invert-Piscivore	T
Rainbow trout *O. mykiss*	X	X	X	X	X	X	Invert-Piscivore	S
Redside shiner *Richardsonius balteatus*	X	X	X	X	X	X	Invertivore	I
Torrent sculpin *Cottus rhotheus*	X				X	X	Invert-Piscivore	I
Westslope cutthroat trout *O. clarkii lewisi*	X	X	X	X	X		Invert-Piscivore	S
Yellow perch *Perca flavescens*					X	X	Invert-Piscivore	I
Total number of species	11	10	8	7	14	10		

Table 3. Back-calculated total length (TL, mm) and standard error (SE) at age for rainbow trout caught while electrofishing the Kootenai River, Idaho, September 2002.

				TL range at capture		Mean back calculated total length (mm) at:							
Age at capture	**n**	**Mean TL at capture (mm)**	**SE**	**Min**	**Max**	**Age-1**	**Age-1 SE**	**Age-2**	**Age-2 SE**	**Age-3**	**Age-3 SE**	**Age-4**	**Age-4 SE**
1	21	175	5	129	216	89	3						
2	12	214	10	163	289	93	2	139	9				
3	10	291	13	227	340	91	5	146	13	232	19		
4	5	349	23	280	393	104	7	146	8	208	10	314	19
					Weighted Mean	92	1	143	0.68	224	3	314	-
					Increment	92		51		81		90	
					n	48		27		15		5	

Table 4. Back-calculated total length (TL, mm) and standard error (SE) at age for rainbow trout caught while electrofishing the Kootenai River, Idaho, September 2003.

				TL range at capture		Mean back calculated total length (mm) at:									
Age at capture	**n**	**Mean TL at capture (mm)**	**SE**	**Min**	**Max**	**Age-1**	**Age-1 SE**	**Age-2**	**Age-2 SE**	**Age-3**	**Age-3 SE**	**Age-4**	**Age-4 SE**	**Age-5**	**Age-5 SE**
1	11	180	6	144	212	101	4								
2	17	256	11	192	326	99	4	170	9						
3	10	308	15	243	384	105	7	177	17	260	18				
4	4	391	17	351	432	108	6	168	20	256	28	350	24		
5	1	364	-	364	364	105	-	130	-	235	-	339	-	356	-
					Weighted Mean	102	2.4	171	7.32	257	13.7	348	18.4	356	-
					Increment	102		69		87		90		8	
					n	43		32		15		5		1	

Table 5. Back-calculated total length (TL, mm) and standard error (SE) at age for mountain whitefish caught while electrofishing the Kootenai River, Idaho, September 2002.

				TL range at capture		Mean back calculated total length (mm) at:													
Age at capture	n	Mean TL at capture (mm)	SE	Min	Max	Age 1	Age-1 SE	Age 2	Age-2 SE	Age 3	Age-3 SE	Age 4	Age-4 SE	Age 5	Age-5 SE	Age 6	Age-6 SE	Age 7	Age-7 SE
1	50	182	2	153	213	121	2												
2	51	226	3	163	280	120	2	188	3										
3	74	262	2	157	301	121	2	190	2	237	3								
4	17	294	4	263	325	128	3	199	4	247	5	277	4						
5	3	395	47	321	481	138	11	215	18	257	15	304	22	345	33				
6	3	453	14	426	469	126	7	216	2	281	5	351	11	395	16	428	16		
7	1	490	-	490	490	131	-	229	-	291	-	363	-	410	-	431	-	454	-
				Weighted Mean		122	0	191	0.55	241	1	293	6	376	11	429	0.64	454	-
					Increment	122		70		50		52		82		53		25	
					n	199		149		98		24		7		4		1	

Table 6. Back-calculated total length (TL, mm) and standard error (SE) at age for mountain whitefish caught while electrofishing the Kootenai River, Idaho, September 2003.

				TL range at capture		Mean back calculated total length (mm) at:															
Age at capture	n	Mean TL at capture (mm)	SE	Min	Max	Age 1	Age-1 SE	Age 2	Age-2 SE	Age 3	Age-3 SE	Age 4	Age-4 SE	Age 5	Age-5 SE	Age 6	Age-6 SE	Age 7	Age-7 SE	Age 8	Age-8 SE
1	63	195	2	164	170	115	1														
2	30	240	3	190	267	114	3	182	3												
3	28	267	4	211	312	122	3	182	6	234	4										
4	41	289	4	251	366	120	2	194	3	236	3	266	4								
5	27	304	5	265	370	115	2	186	4	233	4	261	5	286	4						
6	3	313	32	261	372	113	6	194	16	235	23	262	22	282	22	297	24				
7	3	374	39	316	448	116	10	195	13	236	19	278	25	312	28	334	35	358	11		
8	1	393	-	393	393	114	-	201	-	263	-	291	-	324	-	343	-	360	-	374	-
				Weighted Mean		117	0.2	187	0.48	235	0.3	265	0.6	289	1.7	319	8.0	359	0.5	374	-
					Increment	117		70		48		30		24		30		39		16	
					n	196		133		103		75		34		7		4		1	

Table 7. Summary of fish sampled during the population estimate (Modified Peterson Method) at the 3 rkm section of Hemlock Bar (rkm 262-265) August 23-31, 2004. Length range is recorded as total length.

Species	Total number caught[a]	Length range at capture (mm)	Number marked (M)	Number recaptures (R)	Number in capture sample (C)	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit
Bull trout	1	262	—	—	—	—	—	—
Kokanee	45	93-265	—	—	—	—	—	—
Longnose sucker	1	296	—	—	—	—	—	—
Largescale sucker	175	all length classes (70-687)	85	2	76	2206	808	5,518
Mountain whitefish	1223	75-219	106	10	241	2352	1,335	4,543
		>220	451	31	335	4744	3,375	6,903
		all length classes	557	41	576	7665	5,688	10,591
Northern pikeminnow	74	123-577	—	—	—	—	—	—
Peamouth chub	18	187-305	—	—	—	—	—	—
Rainbow trout[b]	135	125-179	3	2	8	11	4	30
		180-249	20	3	31	167	69	420
		250-349	12	4	26	69.2	31	176
		350-449	4	0	13	—	70	70
		≥450	1	0	3	—	8	8
		all length classes	40	9	81	335.2	186	672
Redside shiner	39	77-198	—	—	—	—	—	—
Westslope cutthroat	7	208-377	—	—	—	—	—	—

[a] Number caught includes total number of fish caught during the sampling period including recaptures.
[b] Rainbow trout population estimates taken from Walters (in preparation).

Table 8. Summary of white sturgeon egg hatching success in varied phosphorous concentrations. For tank and replicate layout, see Table 1.

Total eggs hatched by treatment	Number hatched	% of total hatched	% of total eggs from start
0 μg/L TDP	14	24	2.1
1.5 μg/L TDP	27	47	4.0
5 μg/L TDP	17	29	2.5
Total eggs hatched by replicate			
A	36	62	5.3
B	14	24	2.1
C	8	14	1.2
Totals	**58**	**100**	**8.6**

Table 9. Summary of white sturgeon egg fungus rate varied phosphorous concentrations. For tank and replicate layout, see Table 1. SE = ± 1 standard error.

Total eggs fungused by treatment	Number hatched	% of total hatched	% of total eggs from start
0 μg/L TDP	287	46	42.5
1.5 μg/L TDP	150	24	22.2
5 μg/L TDP	183	30	27.1
Total Eggs Fungused By Replicate			
A	189	30	28.0
B	213	34	31.6
C	218	35	32.3
Totals	**620**	**100**	**91.9**

Table 10. Final mean total length and yolk sac area of white sturgeon larvae incubated in varying phosphorous concentrations. For tank and replicate layout, see Table 1.

Treatment	N	Mean total length (mm)	SE	Mean yolk sac area (mm^2)	SE
0 μg/L TDP	6	11.8	0.1	7.6	0.1
1.5 μg/L TDP	20	12.3	0.0	7.3	0.0
5 μg/L TDP	16	12.1	0.0	7.5	0.0

Table 11. Summary of final mean total length of white sturgeon yolk-sac larvae reared to yolk-sac absorption in varying phosphorous concentrations. SE = ± 1 standard error.

Treatment	Mean total length (mm)	SE	n	
0 μg/L TDP	13.5	0.38	34	
1.5 μg/L TDP	14.0	0.31	47	
5 μg/L TDP	13.9	0.34	43	
Tested effect	DF	DF	F Value	Pr > F
Treatment	2	34.6	0.57	0.5686
Day	6	51.2	802.23	<0.0001
treatment*day	12	50.8	1.6	0.123

Table 12. Power analysis (SAS Inc. 2002) performed on white sturgeon yolk-utilization efficiency data.

Minimum detectable difference Proportion of the maximum mean	Value	Phi	Power
0.10	0.336	0.406	0
0.20	0.672	1.624	48
0.25	0.840	2.538	86

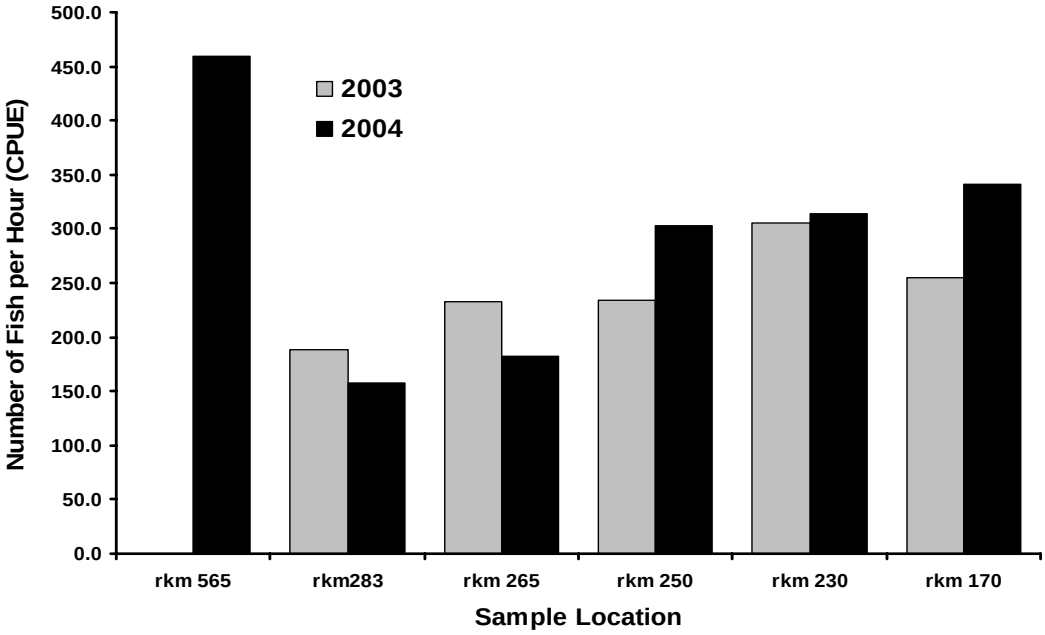

Figure 5. Total catch per unit of effort (CPUE) for all combined species sampled at Kootenai River biomonitoring sites in September 2003 and 2004 with boat electrofishing gear.

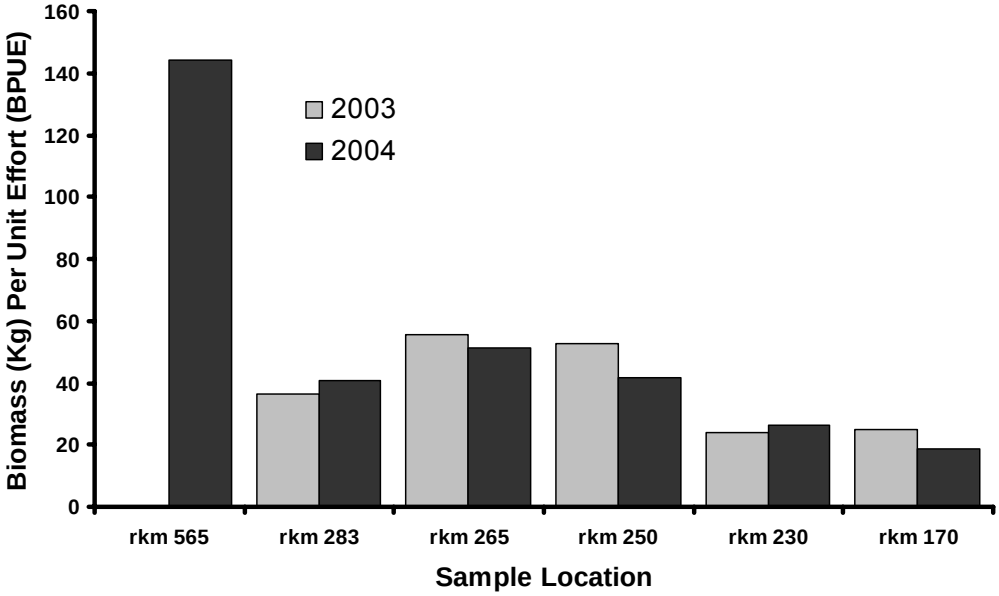

Figure 6. Total biomass per unit of effort (BPUE) for all combined species sampled at Kootenai River biomonitoring sites in September 2003 and 2004 with boat electrofishing gear.

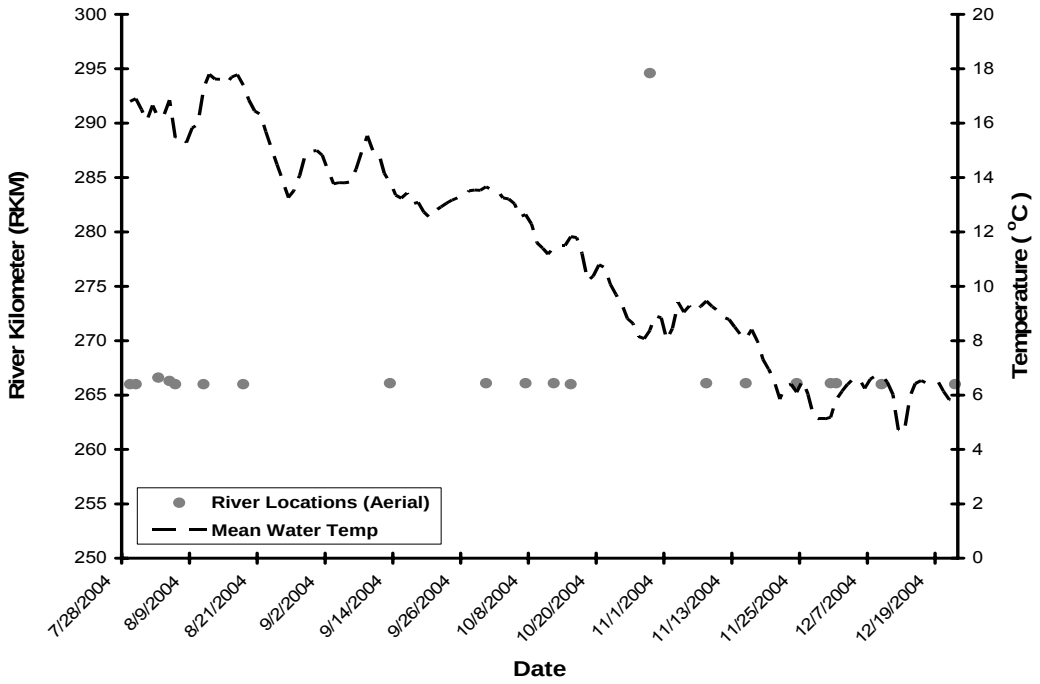

Figure 7. Location data of radio tagged fish (freq. 30.641) in the Kootenai River with relation to average daily water temperatures in 2004.

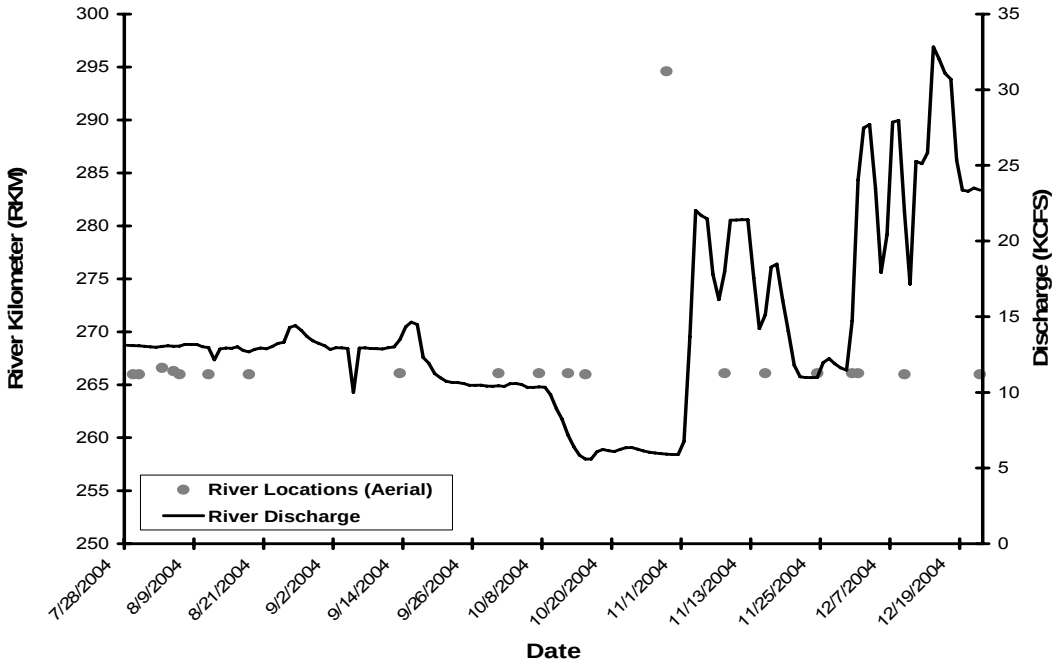

Figure 8. Location data of radio tagged fish (freq. 30.641) in the Kootenai River with relation to average daily discharge in 2004.

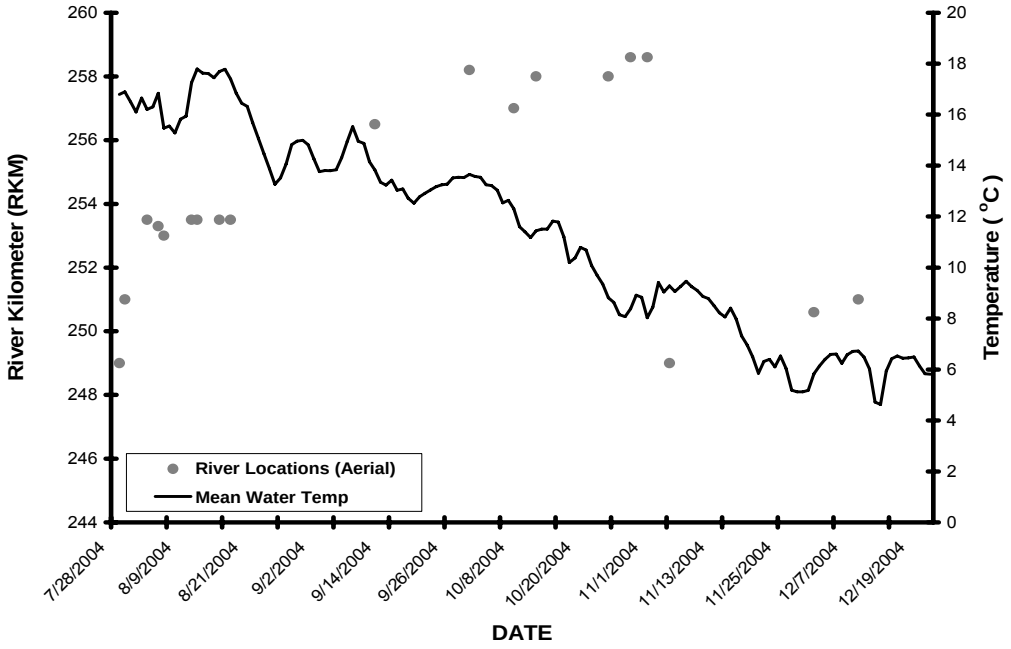

Figure 9. Location data of radio tagged fish (freq. 30.532) in the Kootenai River with relation to average daily temperature in 2004.

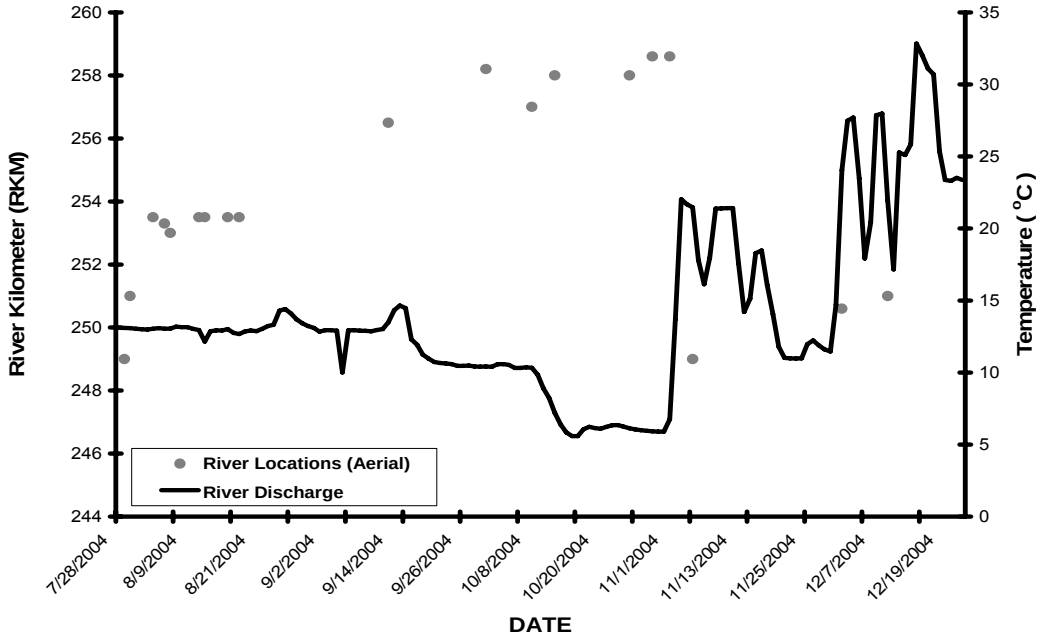

Figure 10. Location data of radio tagged fish (freq. 30.532) in the Kootenai River with relation to average daily discharge in 2004.

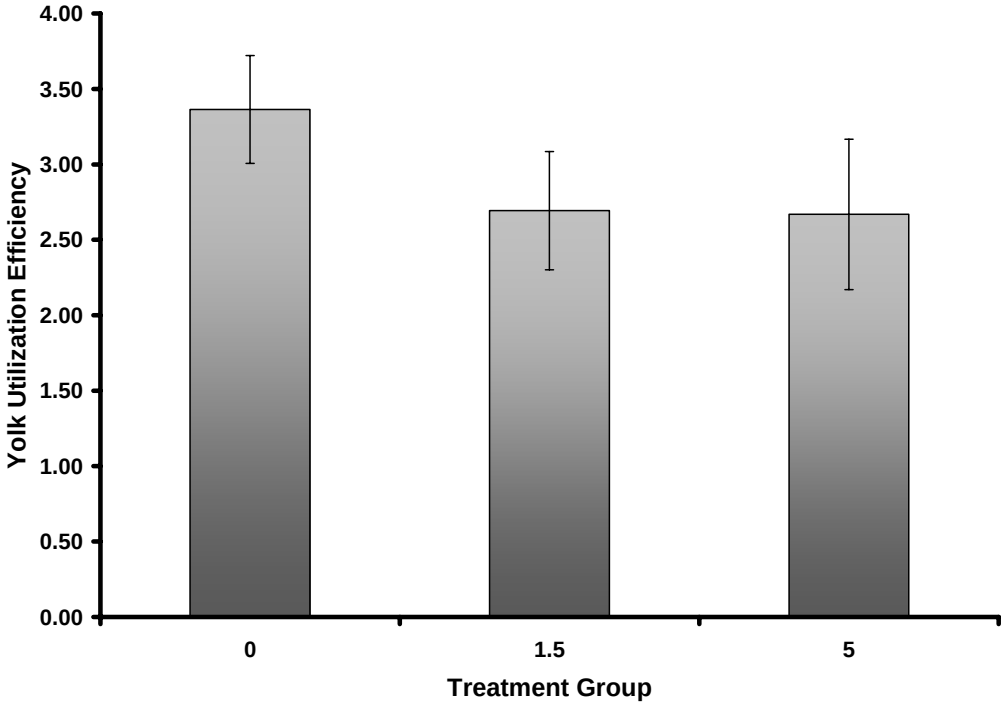

Figure 11. Yolk-sac utilization efficiency (YUE) of larval Kootenai River White Sturgeon three phosphorous concentrations. Error bars represent ± 95% CI. June 2003.

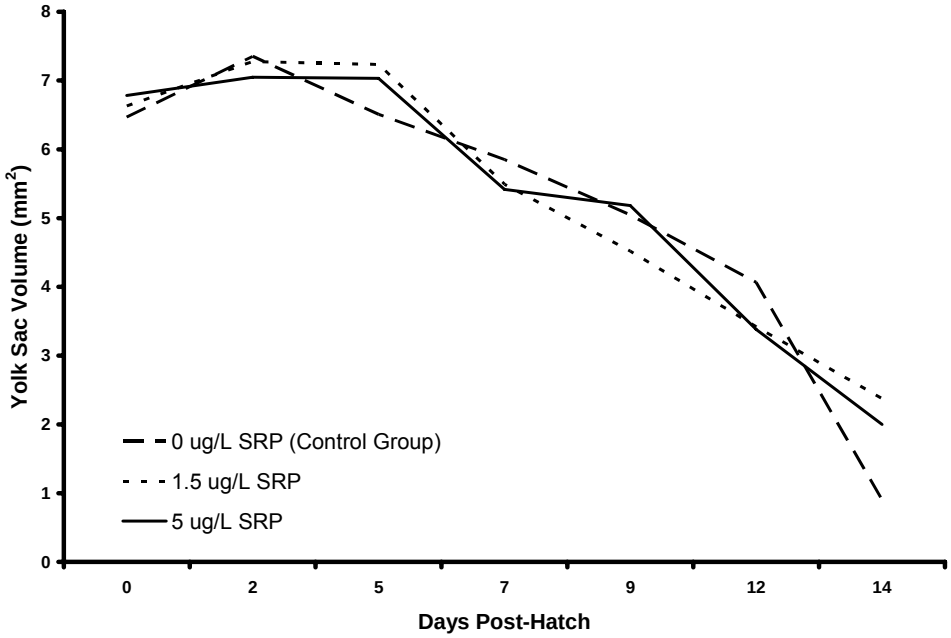

Figure 12. Yolk-sac volume of larval Kootenai River White Sturgeon reared at three phosphorous concentrations over the duration of the experiment, June 2003.

DISCUSSION

Microinvertebrate Abundance

Prior to this large-scale nutrient biomonitoring project, limited research on zooplankton and no research on the rotifer communities of the Kootenai River had been done. Although numbers of zooplankton recently collected are higher than Paragamian (1995) and Richards (1998) reported (0.1 to 3 plankters/L seasonally), the total number per liter we report is still relatively low during the growing season of July-September (0.07 to 1.60 plankters/L). In a more natural river state, zooplankton numbers would be expected to increase (at least immature stages) during the most productive months of June through August. Saunders and Lewis (1988) reported zooplankton densities fell to very low levels in the Caura River, Venezuela during peak discharges, yet densities increased sharply at the tail end of the flow in late June and early July. Much of the "true" plankton in large river systems originates in backwater sloughs, side channels, or other gently flowing areas (Hynes 1970). If the retention time of a stream or lake is short, then little plankton may develop (Hynes 1970). Seasonal fluctuations in river level regulate the development of source areas suitable for zooplankton growth and control the export of plankton from the source areas (Saunders and Lewis 1988). Since the Kootenai River is impounded above Libby Dam, much of what is sampled in the water column below is presumed to be largely due to drift from the reservoir above. More information is needed on seasonal timing of dam operations (selective withdrawal systems) to further understand the proportion of zooplankton the reservoir contributes vs. local inflow, or mainstem production in the upper canyon of the Kootenai River below the dam. Density of zooplankton numbers in large river systems has been significantly positively correlated with temperature, turbidity, conductivity, total phosphorus, and chlorophyll a (Kobayashi et al. 1998). Guelda et al. (2005) reported that algal concentrations were significant predictors of species such as *Bosmina* but not *cyclopoids*. If plans to enhance the river are carried out, it may allow us to determine microinvertebrate production in the river as opposed to what is an artifact of drift and/or entrainment.

Fish Community Assessment

Substantial changes in fish assemblages have occurred in the Kootenai River since the construction of Libby Dam (Paragamian 2002). As previously noted, it is likely that the reduction in river productivity has indirectly reduced fish numbers through lower food abundance (i.e. insect densities; for examples see Hardy 2003). It is obvious from the results that more of the biomass and catch is tied up in sucker and mountain whitefish populations over much of the river than more sensitive trout species. Dissimilarity in stream flow has been seen to elicit changes in insect abundance, productivity, and species composition (Cushman 1985). Although not directly comparable spatially, our results of the Hemlock Bar area (rkm 283 and 265) were relatively equal in biomass of mountain whitefish and largescale sucker. Largescale sucker catch per unit of effort as well as biomass per unit of effort were highest where the river turns into the meander reach (slower and deeper depositional zone). However, without any information on densities of sucker populations prior to Libby Dam's construction, it is difficult to determine if this was always the case. Below the dam, the exclusion of peak flows in the spring prevents the flushing of sediments from cobble-gravel substrates, essentially armoring interstitial spaces and reducing habitat heterogeneity (Paragamian 2002). Recently, habitat analysis of sections in this meander reach show cobble and gravel substrates under several layers of sand deposits (Gary Barton, personal communication, USGS, Tacoma, Washington, 2003). It is likely that prior to the dam's construction, this area supported higher numbers of invertivores and invert-piscivores whose life history stages depend on such substrate types.

Examination of the 2004 data of the fish catch and biomass in the Wardner sample reach clearly showed that largescale sucker and mountain whitefish dominate in both response variables as well. This being our reference reach, one may conclude that it should be this way in the lower river. However, turbidity levels (measured by KTOI) show that they are orders of magnitude higher in this reach than in the lower river. Since trout are sight predators, they may find this habitat less hospitable and are not representative of what a true density could be in the lower river. The high CPUE in the Wardner reach shows us that we are currently not reaching the peak amount of catch that a two-man boat electrofishing crew can obtain. We also presume that the Wardner CPUE is significantly lower than the maximum CPUE obtainable simply because the water is so turbid (>20NTU in late August) that the netters have a significant visual disadvantage from their netting in the lower river sections. One additional caveat in comparing the Wardner reach with the lower river is that Wardner is much higher in the watershed and may present differences due to physical habitat limitations. For this reason, we also have the Yaak River reference site that is 10 rkm above the proposed treatment location, yet still below Libby dam and thereby influenced from it. Unfortunately, no exact representative reference site for comparison exists in the Kootenai River drainage.

According to Walters (2002), rainbow trout recruitment in these sections of the upper canyon reach may not be limited only by habitat but additionally by low river productivity. It was evident that the Wr of large rainbow trout (>300 mm) in the upper river sections was lower than optimal (100) and continued to decline as we moved downstream. Similar low relative weights for rainbow trout were identified by Walters (2002) and Downs (2000). Relative weights of mountain whitefish were also at suboptimal levels in the upper sites and continued to deteriorate as we sampled downstream. Low relative weights may be indicative of a paucity of suitable prey items (Blackwell et al. 2000). In contrast, fish in relatively good condition should be able to utilize more energy for gamete production than fish that are in poor condition. Significant positive correlations between the percentage of mature eggs and fish biomass and Wr have been reported in numerous studies (Wege and Anderson 1978; Neumann and Murphy 1992; Neumann and Willis 1995). The low numbers of northern pikeminnow in samples may not allow us to draw any conclusions about their condition; however, we speculate that the same factors driving K for the other fishes are influencing northern pikeminnow. It is also evident that the omnivorous largescale suckers are well adapted for most areas of the river with little spatial effects on their condition.

As previously mentioned, disturbances in a river can significantly alter fish community assemblages. Because fish communities reflect such aspects as hydrology, water quality, biological interactions, habitat structure, and energy resources, they are useful for assessing the effects of anthropogenic activities across regions (Zaroban et al. 1999). For example, changes in trophic structure from increased pollution tend to favor omnivorous species that are more tolerant of human disturbance (Karr et al. 1986). In the Kootenai River, we saw a shift to a higher proportion in catch and biomass of tolerant species (such as northern pikeminnow and largescale suckers) as we moved to lower river sections. In the Kootenai River's upper river sections, we sampled a greater proportion of intermediate and sensitive species (such as mountain whitefish and trout); however, these proportions are thought to have been much higher prior to Libby Dam's construction (V. Paragamian, personal communication). Sampling the Wardner location higher in the watershed provided valuable information on the CPUE and BPUE of fish assemblages (such as largescale sucker and mountain whitefish) that have not been influenced by the reservoir. However, it did not provide as good of information about mainstem trout populations, which are presumably affected by the low visibility.

The comparison of age and growth data for mountain whitefish was similar to that reported by Walters (2002). Mean whitefish ages reported in 1980, 1981, and 1982 by Partridge (1983) were higher on average, giving some indication of the reduction in productivity of the lower river over the last two decades. Length at age data on rainbow trout from the past decade seems to be consistent between years. However, with no data available on years before or near the construction of Libby Dam, we are left speculating on what adequate length at age should be for the Kootenai River. Bennett and Underwood (1988) reported substantially higher growth of rainbow trout in the Spokane River. Mean age-1 fish ranged from 134-153 mm, whereas mean age-1 fish in the Kootenai ranged from 89-101 mm. These differences were also reported by Paragamian (1995). This information coincides with system productivity where the Spokane River has exhibited macroinvertebrate densities as high as 60,000 insects/ m^2 (Kadlec 2000) as compared to the Kootenai River's 900 insects/m^2 most recently reported by Holderman and Hardy (2004).

The population estimates performed showed that the mountain whitefish and largescale sucker population numbers have remained relatively stable since the last estimate done by Downs in 1999. Rainbow trout have increased slightly from this estimate (see Walters in progress for complete description). As with Downs' estimate, our estimate is much lower than the 14,000-16,000 MWF reported in 1982 by Partridge (1983). This reduction is presumably linked to the reduction in macroinvertebrate densities through a loss of habitat and food abundance. As an example of a similar, large Pacific Northwest River, the forage base for rainbow trout in the Spokane River, mentioned previously, supports trout populations of 1,900 fish/rkm (Bennett and Underwood 1988).

Radio tracking of mountain whitefish in the fall of 2004 provided valuable information on timing of spawning in relation to temperature and river discharge. Although one migration began approximately mid-late September, the most obvious spawning migrations occurred when the river dropped in temperature approximately 4°C from 12 to 8°C in mid-October. Although the Kootenai River is slightly warmer than most British Columbia streams, our reported spawn timing coincides with that found in most streams in British Columbia (mid-October through November at temperatures ranging from 3 to 5°C; Northcote and Ennis 1994). This information allows us to feel somewhat secure that if our fish biomonitoring is performed in early September, the majority of the whitefish will be resident populations. From the data, it is important to note that one fish exhibited a possible mainstem spawning type movement and the other fish entered the Moyie River approximately 10 rkm from its tagged location and presumably spawned in late October. This has also been seen in the Fraser River, BC and its tributaries, suggesting that spawning occurs in both the main river and throughout the length of some major tributaries (McPhail 1999). It is very possible that the Kootenai River whitefish populations exhibit similar life history stages, a mixture of mainstem and tributary spawners that share common summer feeding and overwintering locations. This can conceivably have implications on length at age since those fry reared in tributaries may have a much lower length at age 1-2 than those in the mainstem. It is possible, however, that the whitefish that exhibited the furthest upstream migration did not in fact spawn in the mainstem; rather the migration may have been interrupted by the increase in flow (an increase of 453 m^3/s) during both migrations. With only 25 fish tagged and 8% (2 fish) exhibiting spawning type migrations, more information is needed to determine the extent of tributary vs. mainstem spawning, effect of increased flows on migrations, approximate timing of migrations, and validation of actual spawning events.

Much of the data and discussion on fish assemblage biomonitoring is supporting evidence that increases in primary production (through nutrient additions) may add to the recovery of rapidly diminishing trout populations in the upper Kootenai River. Ideally, should

nutrients be added, most of the benefits would be transferred into sensitive species (trout spp.) in the upper canyon reach. However, due to the complexity of ecosystem functioning, it is difficult to specifically speculate which feeding guilds will exhibit a significant increase from nutrient additions. It has been speculated that if nutrients are added correctly (in the proper N:P ratios in relation to ambient river nutrients and flow) and the optimum amount of energy transfer takes place at each trophic level, a change may not be detectible in water quality or algal production. For example, nutrient supplementation may cause a rapid increase in algal production (decreasing the measurable levels of TDP), which is then subsequently grazed off by an increased insect density.

In addition to the complexity of the bioenergetics of this experiment, other factors must be considered when evaluating the success of the experiment. The largest river that has been intentionally fertilized was the Mesilinka River in British Columbia, which typically had flows of 30-60 m^3/s when nutrients were added. The Kootenai River has a 4-6 fold greater weekly discharge than the Mesilinka River ranging from 200-400 m^3/s during the growing season. This would make the Kootenai River the largest river in the world to have nutrients intentionally added for restoring fish populations, and the only river in the lower U.S. to be involved in such a program. Restoring nutrients to a river of this magnitude requires special considerations. One concern is that SRP will be utilized within a very short distance of the river (<5 rkm), and positive effects may be limited. In this case, weekly water quality testing will allow managers to determine potential cost:benefit factors to determine if the objectives laid out in this document are achievable. The KTOI and IDFG are working directly with nutrient restoration experts (e.g., Ken Ashley, BCMWLAP) and other ecologists on the International Kootenai River Ecosystem Recovery Team (IKERT) to determine the exact formulation of nutrients needed to achieve the set objectives.

The 2003 and 2004 data in addition to data provided by Hardy (2003) support that this river has the potential to benefit from nutrient additions. Based on other nutrient addition studies (Pieters et al. 1998; Ashley et al. 1999; Wilson et al. 1999) fish populations should indirectly benefit from an increased prey base relatively shortly after additions begin (3-5 years). The exposure experiments performed on egg hatching success and development of Kootenai River White Sturgeon yolk-sac larva showed that phosphorous additions to the Kootenai (in the range of adequate aquatic growth (Ashley and Stockner 2003) should essentially have no negative direct effect to those reared in the canyon reach. Careful evaluation of the trophic interactions within a proposed 5-year experimental period should reveal to what extent additions were successful. Management criteria of the nutrient additions must be set up to try to safeguard against any long-term deleterious effects of the treatments. In other words, if managers see nutrient additions resulting in potentially negative effects, the experiment will be discontinued and re-evaluated by the IKERT. These criteria will allow managers to make the proper decisions should we see nutrient additions resulting in anything other than an increase in sensitive Kootenai River fish species.

RECOMMENDATIONS

1. Add nutrients in the form of liquid N and P fertilizer to restore river productivity.

2. Develop evaluation criteria report to determine success of nutrient additions.

3. Continue mountain whitefish tracking to support it as an adequate indicator of a treatment effect.

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APPENDICES

Appendix A. Mean seasonal crustacea and rotifer densities in the Kootenai River at the Yaak River sample site (rkm 283) spring (January–May) 2003. SE = ± 1 standard error.

	January			February			March			April			May		
Crustacea Species	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**
Alona costata	—	—	—	—	—	—	—	—	—	—	—	—	0.10	—	0.08
Alona rustica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bosmina longirostris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Calenoid copepodite	—	—	—	—	—	—	—	—	—	—	—	—	0.20	—	0.17
Chydorus sphaericus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyclopoid copepodite	—	—	—	—	—	—	0.10	-	0.17	—	—	—	—	—	—
Cyclops bicuspidatus thomasii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daphnia	—	—	—	—	—	—	—	—	—	0.10	—	0.20	—	—	—
Daphnia galeata mendotae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Harpacticoidea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leptodiaptmus tyrrell	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nauplii	0.10	—	1.00	—	—	—	0.50	0.12	0.83	0.40	0.09	0.80	0.90	0.25	0.75
Ostracoda	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rotifer species	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ascomorpha ovalis	—	—	—	0.30	0.09	0.09	1.70	0.47	0.12	—	—	—	—	—	—
Asplanchna priodonta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bdelloid rotifer	0.20	—	0.05	0.40	0.12	0.12	1.00	0.29	0.07	2.50	1.02	0.18	0.40	0.19	0.03
Brachionus angularis	—	—	—	—	—	—	0.50	—	0.04	—	—	—	—	—	—
Brachionus calyciflorus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brachionus caudatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cephalodella spp.	—	—	—	—	—	—	0.30	0.04	0.02	0.40	0.12	0.03	0.20	—	0.01
Collotheca mutabilis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Collotheca obtusa	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Colurella obtusa	0.20	—	0.05	—	—	—	0.20	—	0.01	0.50	—	0.04	0.60	0.43	0.04
Euchlanis parva	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Euchlanis spp.	0.70	0.37	0.17	0.70	0.36	0.21	0.70	0.15	0.05	2.80	0.55	0.20	0.70	0.34	0.05
Kellicottia longispina	0.20	-	0.05	0.20	—	0.06	0.80	0.23	0.06	0.60	0.21	0.04	1.60	0.12	0.12
Keratella cochlearis	0.80	0.37	0.20	0.20	—	0.06	0.90	0.21	0.07	0.60	0.07	0.04	3.40	0.53	0.25
Keratella longispina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Keratella quadrata	—	—	—	—	—	—	0.50	0.20	0.04	0.40	0.12	0.03	0.20	—	0.01
Lecane elasma	0.20	—	0.05	—	—	—	—	—	—	0.20	—	0.01	—	—	—
Lecane spp.	0.20	—	0.05	—	—	—	—	—	—	—	—	—	—	—	—
Lepadella patella	—	—	—	—	—	—	—	—	—	0.30	—	0.02	0.20	—	0.01
Monostyla closterocerca	0.20	—	0.05	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla lunaris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla quadridentata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Notholca	—	—	—	—	—	—	—	—	—	0.50	—	0.04	—	—	—

Appendix A. Continued.

	January			February			March			April			May		
Crustacea Species	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**
Notholca acuminata	—	—	—	—	—	—	0.90	—	0.07	—	—	—	—	—	—
Notholca laurentiae	0.20	—	0.05	0.20	—	0.06	1.50	0.20	0.11	0.90	—	0.07	0.50	—	0.04
Philodina sp.	—	—	—	—	—	—	—	—	—	0.20	—	0.01	—	—	—
Philodinidae	0.20	—	0.05	—	—	—	—	—	—	—	—	—	—	—	—
Polyarthra major	—	—	—	—	—	—	0.30	—	0.02	—	—	—	—	—	—
Polyarthra remata	0.30	0.10	0.07	—	—	—	1.00	0.44	0.07	0.20	—	0.01	4.30	0.41	0.32
Proales spp.	—	—	—	0.70	0.10	0.21	1.70	0.51	0.12	1.40	0.12	0.10	0.40	0.12	0.03
Rotifera unidentified	0.50	—	0.12	0.40	0.15	0.12	0.20	0.03	0.01	0.30	0.10	0.02	0.90	0.06	0.07
Synchaeta spp.	—	—	—	0.30	0.04	0.09	1.20	0.36	0.09	1.90	1.37	0.14	—	—	—
Trichocerca porcellus	0.20	—	0.05	—	—	—	0.20	—	0.01	—	—	—	—	—	—
Trichocerca pusilla	—	—	—	—	—	—	0.20	—	0.01	—	—	—	—	—	—
Trichocerca rousseleti	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trichotria tetractis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trichocerca unicinata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Appendix B. Mean seasonal crustacea and rotifer densities in the Kootenai River at the Hemlock Bar sample site (rkm 266) spring (January–May) 2003. SE = ± 1 standard error.

	January			February			March			April			May		
Crustacea Species	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**
Alona costata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Alona rustica	—	—	—	—	—	—	—	—	—	—	—	—	0.10	—	0.10
Bosmina longirostris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Calenoid copepodite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chydorus sphaericus	—	—	—	—	—	—	—	—	—	0.10	—	0.33	—	—	—
Cyclopoid copepodite	0.10	—	0.33	0.10	—	0.50	0.10	—	0.20	—	—	—	0.20	0.06	0.20
Cyclops bicuspidatus thomasii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daphnia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daphnia galeata mendotae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Harpacticoidea	—	—	—	—	—	—	—	—	—	—	—	—	0.10	—	0.10
Leptodiaptmus tyrrell	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nauplii	0.20	0.07	0.67	0.10	—	0.50	0.40	0.10	0.80	0.20	0.04	0.67	0.50	0.07	0.50
Ostracoda	—	—	—	—	—	—	—	—	—	—	—	—	0.10	—	0.10

Appendix B. Continued.

	January			February			March			April			May		
Crustacea Species	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**
Rotifer species															
Ascomorpha ovalis	0.40	0.12	0.08	0.50	0.20	0.07	1.30	0.55	0.13	0.30	—	0.02	—	—	—
Asplanchna priodonta	—	—	—	0.20	—	0.03	—	—	—	—	—	—	—	—	—
Bdelloid rotifer	0.20	—	0.04	0.70	—	0.10	1.70	0.40	0.17	6.90	1.38	0.39	4.00	2.76	0.11
Brachionus angularis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brachionus calyciflorus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brachionus caudatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cephalodella spp.	—	—	—	—	—	—	0.20	—	0.02	0.50	0.15	0.03	0.20	—	0.01
Collotheca mutabilis	—	—	—	—	—	—	0.20	—	0.02	—	—	—	0.20	—	0.01
Collotheca obtusa	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Colurella obtusa	0.20	—	0.04	0.30	—	0.04	0.20	—	0.02	—	—	—	1.90	1.27	0.05
Euchlanis parva	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Euchlanis spp.	0.80	0.29	0.16	1.10	0.35	0.16	—	—	—	4.40	—	0.25	2.10	1.06	0.06
Kellicottia longispina	0.20	—	0.04	0.20	—	0.03	0.30	0.09	0.03	0.40	0.07	0.02	5.00	3.97	0.14
Keratella cochlearis	0.60	0.21	0.12	0.70	—	0.10	0.40	0.07	0.04	0.40	0.19	0.02	5.80	4.01	0.16
Keratella longispina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Keratella quadrata	—	—	—	—	—	—	0.20	—	0.02	—	—	—	1.70	—	0.05
Lecane elasma	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lecane spp.	—	—	—	0.20	—	0.03	—	—	—	—	—	—	0.20	—	0.01
Lepadella patella	—	—	—	—	—	—	—	—	—	0.20	—	0.01	1.70	—	0.05
Monostyla closterocerca	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla lunaris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla quadridentata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla spp.	0.20	—	0.04	—	—	—	0.20	—	0.02	—	—	—	0.90	—	0.03
Notholca	0.20	—	0.04	—	—	—	—	—	—	—	—	—	0.60	0.25	0.02
Notholca acuminata	—	—	—	—	—	—	—	—	—	—	—	—	0.90	—	0.03
Notholca laurentiae	0.20	0.03	0.04	0.20	—	0.03	0.80	0.46	0.08	0.80	0.16	0.04	0.20	—	0.01
Philodina sp.	0.90	0.29	0.18	—	—	—	—	—	—	—	—	—	—	—	—
Philodinidae	0.20	—	0.04	—	—	—	—	—	—	—	—	—	—	—	—
Polyarthra major	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Polyarthra remata	0.30	—	0.06	0.20	—	0.03	0.70	0.25	0.07	0.40	0.09	0.02	7.70	5.62	0.21
Proales spp.	—	—	—	1.30	0.07	0.19	2.10	0.44	0.20	1.80	—	0.10	1.20	0.45	0.03
Rotifera unidentified	0.30	0.10	0.06	0.30	0.09	0.04	0.20	—	0.02	1.20	0.36	0.07	1.60	0.93	0.04
Synchaeta spp	—	—	—	0.30	0.10	0.04	1.80	0.17	0.17	0.50	0.00	0.03	—	—	—
Trichocerca porcellus	0.20	—	0.04	0.50	—	0.07	—	—	—	—	—	—	—	—	—
Trichocerca pusilla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trichocerca rousseleti	0.20	—	0.04	—	—	—	—	—	—	—	—	—	—	—	—
Trichotria tetractis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trichocerca unicinata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Appendix C. Mean seasonal crustacea and rotifer densities in the Kootenai River at the Cow Creek sample site (rkm 251) spring (January–May) 2003. SE = ± 1 standard error.

	January			February			March			April			May		
Crustacea Species	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**
Alona costata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Alona rustica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bosmina longirostris	—	—	—	—	—	—	—	—	—	—	—	—	0.10	—	0.07
Calenoid copepodite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chydorus sphaericus	0.10	—	0.33	—	—	—	—	—	—	—	—	—	—	—	—
Cyclopoid copepodite	0.10	—	0.33	0.10	—	1.00	—	—	—	—	—	—	0.40	0.06	0.29
Cyclops bicuspidatus thomasii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daphnia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daphnia galeata mendotae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Harpacticoidea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leptodiaptmus tyrrell	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nauplii	0.10	—	0.33	—	—	—	0.50	0.58	1.00	0.40	0.17	0.80	0.80	0.39	0.57
Ostracoda	—	—	—	—	—	—	—	—	—	0.10	—	0.20	0.10	—	0.07
Rotifer species															
Ascomorpha ovalis	0.20	—	0.04	—	—	—	0.20	—	0.02	0.20	—	0.02	—	—	—
Asplanchna priodonta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bdelloid rotifer	0.20	—	0.04	0.40	0.05	0.10	3.50	0.49	0.27	2.60	0.35	0.23	0.90	—	0.04
Brachionus angularis	—	—	—	—	—	—	0.50	—	0.04	—	—	—	—	—	—
Brachionus calyciflorus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brachionus caudatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cephalodella spp.	—	—	—	—	—	—	0.20	—	0.02	0.30	—	0.03	0.30	—	0.01
Collotheca mutabilis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Collotheca obtusa	—	—	—	0.20	—	0.05	0.20	—	0.02	—	—	—	—	—	—
Colurella obtusa	—	—	—	0.20	—	0.05	0.30	—	0.02	0.20	—	0.02	0.30	—	0.01
Euchlanis parva	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Euchlanis spp.	1.70	0.84	0.33	0.70	0.40	0.18	1.00	—	0.08	2.30	0.12	0.21	0.50	0.12	0.02
Kellicottia longispina	0.40	0.06	0.08	—	—	—	0.30	0.10	0.02	0.20	—	0.02	1.90	0.44	0.08
Keratella cochlearis	0.50	0.09	0.10	0.20	—	0.05	1.00	—	0.08	0.80	0.49	0.07	5.70	0.98	0.24
Keratella longispina	—	—	—	—	—	—	—	—	—	—	—	—	5.70	—	0.24
Keratella quadrata	—	—	—	—	—	—	0.20	—	0.02	1.00	—	0.09	0.30	—	0.01
Lecane elasma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lecane spp.	—	—	—	—	—	—	—	—	—	—	—	—	0.30	—	0.01
Lepadella patella	—	—	—	—	—	—	—	—	—	0.20	—	0.02	0.30	—	0.01
Monostyla closterocerca	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla lunaris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla quadridentata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Monostyla spp.	0.20	—	0.04	0.20	—	0.05	—	—	—	—	—	—	—	—	—
Notholca	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Appendix C. Continued.

	January			February			March			April			May		
Crustacea Species	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**	**Mean**	**SE**	**% of Total**
Notholca acuminata	0.20	—	0.04	—	—	—	—	—	—	—	—	—	—	—	—
Notholca laurentiae	—	—	—	—	—	—	2.10	0.13	0.16	0.70	0.39	0.06	0.30	—	0.01
Philodina sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Philodinidae	—	—	—	—	—	—	—	—	—	—	—	—	0.30	—	0.01
Polyarthra major	0.60	—	0.12	—	—	—	—	—	—	—	—	—	—	—	—
Polyarthra remata	0.30	—	0.06	—	—	—	0.90	0.15	0.07	0.20	—	0.02	4.90	0.36	0.21
Proales spp.	—	—	—	1.00	0.29	0.25	1.30	0.80	0.10	1.20	0.20	0.11	1.00	0.36	0.04
Rotifera unidentified	0.50	0.22	0.10	0.50	0.18	0.13	0.50	0.08	0.04	0.80	0.22	0.07	0.80	0.10	0.03
Synchaeta spp	0.20	—	0.04	0.20	—	0.05	0.90	0.08	0.07	0.50	0.20	0.04	—	—	—
Trichocerca porcellus	0.20	—	0.04	0.20	—	0.05	—	—	—	—	—	—	—	—	—
Trichocerca pusilla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trichocerca rousseleti	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trichotria tetractis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trichocerca unicinata	—	—	—	0.20	—	0.05	—	—	—	—	—	—	0.30	—	0.01

Appendix D. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2003 during boat electrofishing at rkm 283 (Yaak River, Montana reach). Total shocking effort was 1.52 hrs.

Species	Number caught	% of total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Bull trout	1	0	1	5	9	3	4750
Kokanee	4	2	3	0	1	0	89
Longnose sucker	6	2	4	1	1	0	110
Largescale sucker	35	14	23	16	29	10	469
Mountain whitefish	128	52	84	24	44	16	192
Northern pikeminnow	14	6	9	2	3	1	110
Rainbow trout	31	13	20	6	12	4	209
Redside shiner	25	10	16	0	1	0	13
Westslope cutthroat	2	1	1	1	2	1	523

Appendix E. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2003 during boat electrofishing at rkm 265 (Hemlock Bar reach). Total shocking effort was 0.79 hrs.

Species	Number caught	% of Total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Kokanee	1	1	1	0	0	0	80
Longnose sucker	22	13	28	18	42	23	826
Mountain whitefish	107	64	136	16	37	21	152
Northern pikeminnow	8	5	10	3	7	4	358
Peamouth chub	2	1	3	0	1	0	112
Rainbow trout	20	12	25	6	14	8	301
Redside shiner	8	5	10	0	0	0	10

Appendix F. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2003 during boat electrofishing at rkm 251 (Cow Creek reach). Total shocking effort was 0.62 hrs.

Species	Number caught	% of Total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Kokanee	6	4	10	1	2	1	103
Largescale sucker	18	11	29	14	43	23	779
Mountain whitefish	139	81	225	15	47	25	114
Northern pikeminnow	6	4	10	3	8	4	432
Rainbow trout	1	1	2	0	0	0	50
Redside shiner	1	1	2	0	0	0	8

Appendix G. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2003 during boat electrofishing at rkm 230 (Shortys Island reach). Total shocking effort was 1.39 hrs.

Species	Number caught	% of total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Bull trout	1	0	1	0	0	0	67
Kokanee	1	0	1	0	0	0	3
Longnose sucker	13	3	9	2	7	2	183
Largescale sucker	74	14	53	16	48	11	212
Mountain whitefish	28	5	20	0	1	0	13
Northern pikeminnow	196	38	141	7	21	5	35
Peamouth chub	97	19	70	5	16	4	56
Pumpkinseed	2	0	1	0	0	0	11
Rainbow trout	2	0	1	0	1	0	98
Redside shiner	92	18	66	1	2	1	9
Torrent sculpin	1	0	1	0	0	0	4
Westslope cutthroat	3	1	2	1	4	1	390
Yellow perch	1	0	1	0	0	0	17

Appendix H. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2003 during boat electrofishing at rkm 170 (Porthill reach). Total shocking effort was 1.55 hrs.

Species	Number caught	% of Total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Longnose sucker	6	2	4	1	2	0	123
Largescale sucker	37	10	24	23	59	15	633
Northern pikeminnow	202	52	130	9	22	6	43
Peamouth chub	82	21	53	6	16	4	75
Redside shiner	59	15	38	1	2	0	10
Torrent sculpin	1	0	1	0	0	0	7
Yellow perch	2	1	1	0	0	0	40

Appendix I. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2004 during boat electrofishing at rkm 565 (Wardner, B.C. reach). Total shocking effort was 0.80 hrs.

Species	Number caught	% of total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Bull trout	5	1	6	9	8	11	1837
Longnose dace	1	0	1	0	0	0	1
Longnose sucker	4	1	5	2	2	3	514
Largescale sucker	81	22	101	64	57	80	790
Mountain whitefish	257	71	322	36	31	44	140
Northern pikeminnow	4	1	5	1	1	1	227
Rainbow trout	1	0	1	0	0	0	126
Redside shiner	3	1	4	0	0	0	10
Torrent sculpin	1	0	1	0	0	0	11
Westslope cutthroat	4	1	5	1	1	1	271

Appendix J. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2004 during boat electrofishing at rkm 283 (Yaak River, Montana reach). Total shocking effort was 1.18 hrs.

Species	Number caught	% of total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Largescale sucker	18	10	15	15	31	13	827
Mountain whitefish	115	62	98	23	47	19	197
Northern pikeminnow	11	6	9	2	3	1	146
Peamouth chub	10	5	9	1	3	1	123
Rainbow trout	29	16	25	7	15	6	250
Redside shiner	2	1	2	0	0	0	23
Westslope cutthroat	1	1	1	0	0	0	173

Appendix K. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2004 during boat electrofishing at rkm 265 (Hemlock Bar reach). Total shocking effort was 0.71 hrs.

Species	Number caught	% of Total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Largescale sucker	29	23	41	22	59	31	758
Mountain whitefish	70	55	98	9	25	13	134
Northern pikeminnow	4	3	6	1	2	1	186
Rainbow trout	22	17	31	5	12	6	209
Redside shiner	1	1	1	0	0	0	3
Westslope cutthroat	1	1	1	1	2	1	608

Appendix L. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2004 during boat electrofishing at rkm 251 (Cow Creek reach). Total shocking effort was 0.67 hrs.

Species	Number caught	% of Total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Largescale sucker	11	5	16	7	22	11	673
Mountain whitefish	159	78	237	19	58	28	120
Northern pikeminnow	6	3	9	4	11	6	624
Rainbow trout	18	9	27	3	8	4	147
Redside shiner	8	4	12	0	0	0	10
Westslope cutthroat	1	0	1	0	1	0	186

Appendix M. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2004 during boat electrofishing at rkm 230 (Shortys Island reach). Total shocking effort was 1.15 hrs.

Species	Number caught	% of total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Longnose sucker	1	0	1	0	2	0	464
Largescale sucker	25	7	22	12	38	10	468
Mountain whitefish	39	11	34	1	4	1	28
Northern pikeminnow	123	34	107	5	17	5	43
Peamouth chub	138	38	120	10	32	9	72
Rainbow trout	6	2	5	1	3	1	152
Redside shiner	28	8	24	0	1	0	9
Westslope cutthroat	2	1	2	1	3	1	467
Yellow perch	1	0	1	0	0	0	13

Appendix N. Mean catch and biomass per unit of effort (CPUE and BPUE), total number and biomass, and mean weight of fish sampled in 2004 during boat electrofishing at rkm 170 (Porthill reach). Total shocking effort was 1.35 hrs.

Species	Number caught	% of Total catch	Mean CPUE (n/h)	Total biomass (kg)	% of total biomass	Mean BPUE (kg/h)	Mean weight (g)
Longnose sucker	2	0	1	0	1	0	139
Largescale sucker	19	4	14	8	31	6	424
Mountain whitefish	18	4	13	1	2	0	34
Northern pikeminnow	113	25	83	4	18	3	39
Peamouth chub	212	46	156	11	43	8	50
Rainbow trout	1	0	1	0	1	0	362
Redside shiner	91	20	67	1	4	1	10
Torrent sculpin	1	0	1	0	0	0	5

Appendix O. Relative weights (Wr) of rainbow trout (RBT) sampled at Kootenai River biomonitoring sites in September 2003 with boat electrofishing gear. SE = ± 1 standard error.

	RBT TL classes (mm)														
	101-200			201-300			301-400			>401			All lengths		
Rkm	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n
283	99	3	6	93	2	17	90	4	8	—	—	—	93	2	31
265	98	1	5	88	2	4	91	2	10	62	—	1	91	2	20
251	90	—	1	—	—	—	—	—	—	—	—	—	90	—	1
230	—	—	—	82	5	2	—	—	—	—	—	—	82	5	2
170	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Appendix P. Relative weights (Wr) of mountain whitefish (MWF) sampled at Kootenai River biomonitoring sites in September 2003 with boat electrofishing gear. SE = ± 1 standard error.

	MWF TL classes (mm)														
	101-200			201-300			301-400			>401			All lengths		
Rkm	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n
283	89	3	9	95	1	91	99	2	22	—	—	—	95	1	122
265	88	2	21	91	1	68	89	3	9	103	6	2	90	1	100
251	82	2	47	82	1	75	77	3	9	—	—	—	82	1	131
230	83	1	2	—	—	—	—	—	—	—	—	—	83	1	2
170	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Appendix Q. Relative weights (Wr) of northern pikeminnow (NPM) sampled at Kootenai River biomonitoring sites in September 2003 with boat electrofishing gear. SE = ± 1 standard error.

	NPM TL classes (mm)											
	201-300			301-400			>401			All lengths		
Rkm	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n
283	73	2	2	61	—	1	—	—	—	69	4	3
265	65	3	3	73	1	2	64	—	1	67	2	6
251	61	4	3	64	5	2	66	—	1	63	2	6
230	59	4	4	60	5	2	—	—	—	59	3	6
170	57	1	11	—	—	—	—	—	—	57	1	11

Appendix R. Fulton's condition factor (K) of largescale suckers (LSS) sampled at Kootenai River biomonitoring sites in September 2003 with boat electrofishing gear. SE = ± 1 standard error.

	LSS TL classes (mm)														
	101-200			201-300			301-400			>401			All lengths		
Rkm	K	SE	n	K	SE	n	K	SE	n	K	SE	n	K	SE	n
283	1.1	0.06	7	0.98	0.05	5	0.87	0.03	4	0.85	0.05	18	0.91	0.03	34
265	—	—	—	0.91		1	0.81	0.04	6	0.87	0.02	15	0.86	0.02	22
251	—	—	—	0.87	0.00	2	0.70	0.14	5	0.81	0.02	11	0.78	0.04	18
230	1.0	0.03	35	0.92	0.02	16	0.87	0.03	9	0.87	0.02	12	0.94	0.02	72
170	0.9	0.03	2	—	—	—	0.89	0.07	14	0.92	0.04	21	0.91	0.03	37

Appendix S. Fulton's condition factor (K) of peamouth chub (PMC) sampled at Kootenai River biomonitoring sites in September 2003 with boat electrofishing gear. SE = ± 1 standard error.

	PMC TL classes (mm)											
	101-200			201-300			301-400			All lengths		
Rkm	K	SE	n	K	SE	n	K	SE	n	K	SE	n
283	—	—	—	—	—	—	—	—	—	—	—	—
265	—	—	—	0.72	0	2	—	—	—	0.72	0	2
251	—	—	—	—	—	—	—	—	—	—	—	—
230	0.79	0.02	58	0.74	0.01	39	—	—	—	0.77	0.02	97
170	0.70	0.01	25	0.71	0.01	56	—	—	—	0.70	0.01	81

Appendix T. Fulton's condition factor (K) of redside shiners (RSS) sampled at Kootenai River biomonitoring sites in September 2003 with boat electrofishing gear. SE = ± 1 standard error.

	RSS TL classes (mm)								
	0-100			101-200			All lengths		
Rkm	K	SE	n	K	SE	n	K	SE	n
283	1.08	0.05	6	1.01	0.02	19	1.02	0.02	25
265	0.93	0.04	4	0.82	0.08	4	0.88	0.04	8
251	—	—	—	0.71	—	1	0.71	—	1
230	0.86	0.02	50	0.85	0.02	42	0.86	0.01	92
170	0.83	0.01	24	0.83	0.01	35	0.83	0.01	59

Appendix U. Relative weights (Wr) of rainbow trout (RBT) sampled at Kootenai River biomonitoring sites in September 2004 with boat electrofishing gear. SE = ± 1 standard error.

	RBT TL classes (mm)														
	101-200			201-300			301-400			>401			All lengths		
Rkm	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n
565	—	—	—	81	—	1	—	—	—	—	—	—	81	—	1
283	84	—	1	87	1.4	16	85	2.3	11	71	—	1	86	1.3	29
265	107	—	1	86	1.7	14	88	3.1	7	—	—	—	88	1.7	22
251	86	3	4	93	7.1	10	78	2.3	3	—	—	—	89	4.4	17
230	77	3	2	84	0.9	3	82	—	1	—	—	—	81	1.6	6
170	—	—	—	—	—	—	72.2	—	1	—	—	—	72	—	1

Appendix V. Relative weights (Wr) of mountain whitefish (MWF) sampled at Kootenai River biomonitoring sites in September 2004 with boat electrofishing gear. SE = ± 1 standard error.

	MWF TL classes (mm)														
	101-200			201-300			301-400			>401			All lengths		
Rkm	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n
565	81	1.8	67	86	1.1	147	87	1.6	31	84	—	1	85	0.9	246
283	78	—	1	91	0.9	89	98	1.2	24	85	—	1	92	0.8	115
265	94	3.9	21	88	1.5	42	99	2.0	3	76	2	2	90	1.6	68
251	72	2.4	41	83	0.9	82	84	2.1	20	93	—	1	80	1.0	144
230	71	1.2	32	81	2.4	5	—	—	—	—	—	—	72	1.3	37
170	71	2.6	14	70	6.7	3	74	—	1	—	—	—	71	2.2	18

Appendix W. Relative weights (Wr) of northern pikeminnow (NPM) sampled at Kootenai River biomonitoring sites in September 2004 with boat electrofishing gear. SE = ± 1 standard error.

	NPM TL classes (mm)											
	201-300			301-400			>401			All lengths		
Rkm	Wr	SE	n	Wr	SE	n	Wr	SE	n	Wr	SE	n
565	89	—	1	77	6.0	2	—	—	—	84	5.1	3
283	78	2.2	6	88	5.6	3	—	—	—	81	2.2	9
265	—	—	—	72	2.9	2	—	—	—	75	2.1	2
251	76	1.2	2	78	—	1	73	11	3	75	4.9	6
230	73	1.4	20	77	2.1	2	—	—	—	75	0.9	22
170	67	1.3	16	66	—	1	—	—	—	69	0.6	97

Appendix X. Fulton's condition factor (K) of largescale suckers (LSS) sampled at Kootenai River biomonitoring sites in September 2004 with boat electrofishing gear. SE = ± 1 standard error.

	LSS TL classes (mm)														
	101-200			201-300			301-400			>401			All lengths		
Rkm	K	SE	n	K	SE	n	K	SE	n	K	SE	n	K	SE	n
565	0.91	—	1	0.93	0.02	2	1.08	0.04	12	0.97	0.02	66	0.99	0.01	81
283	—	—	—	1.06	—	1	0.92	0.01	2	0.92	0.01	15	0.93	0.01	18
265	1.00	—	1		—		0.87	0.1	4	0.81	0.02	24	0.82	0.02	29
251	1.02	—	1	1.07	—	1	1.02	—	1	0.85	0.05	8	0.90	0.05	11
230	0.88	0.0	3		—		0.89	0.02	11	0.87	0.03	10	0.88	0.02	24
170	0.86	0.1	3	0.92	—	1	0.96	0.04	6	0.94	0.03	6	0.93	0.02	16

Appendix Y. Fulton's condition factor (K) of peamouth chub (PMC) sampled at Kootenai River biomonitoring sites in September 2004 with boat electrofishing gear. SE = ± 1 standard error.

	PMC TL classes (mm)											
	101-200			201-300			301-400			All lengths		
Rkm	K	SE	n	K	SE	n	K	SE	n	K	SE	n
565	—	—	—	—	—	—	—	—	—	—	—	—
283	0.8	—	1	0.79	0.02	8	0.93	—	1	0.80	0.02	10
265	—	—	—	—	—	—	—	—	—	—	—	—
251	—	—	—	—	—	—	—	—	—	—	—	—
230	0.7	0.01	62	0.77	0.01	71	—	—	—	0.75	0.01	133
170	0.7	0.00	143	0.71	0.01	64	—	—	—	0.69	0.00	207

Appendix Z. Fulton's condition factor (K) of redside shiners (RSS) sampled at Kootenai River biomonitoring sites in September 2004 with boat electrofishing gear. SE = ± 1 standard error.

	RSS TL classes (mm)								
	0-100			101-200			All lengths		
Rkm	K	SE	n	K	SE	n	K	SE	n
565	0.91	—	1	—	—	—	0.91	—	1
283	1.00	0.03	2	—	—	—	1.00	0.03	2
265	—	—	—	—	—	—	—	—	—
251	0.8	0.08	6	—	—	—	0.84	0.08	6
230	0.9	0.03	13	—	—	—	0.86	0.03	13
170	0.8	0.01	57	—	—	—	0.82	0.01	57

Appendix AA. Feeding guilds and tolerance of all fish species sampled at rkm 283 (Yaak River, Montana site) in September 2003 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	66	46
Invert-Piscivore	20	25
Omnivore	14	29
Sensitive species	15	23
Intermediate species	65	45
Tolerant species	20	32

Appendix AB Feeding guilds and tolerance of all fish species sampled at rkm 265 (Hemlock Bar site) in September 2003 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	70	38
Invert-Piscivore	17	20
Omnivore	13	42
Sensitive species	13	14
Intermediate species	70	38
Tolerant species	18	48

Appendix AC. Feeding guilds and tolerance of all fish species sampled at rkm 251 (Cow Creek site) in September 2003 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	85	49
Invert-Piscivore	4	8
Omnivore	11	43
Sensitive species	4	2
Intermediate species	82	47
Tolerant species	14	51

Appendix AD. Feeding guilds and tolerance of all fish species sampled at rkm 230 (Shortys Island site) in September 2003 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	45	27
Invert-Piscivore	40	25
Omnivore	14	48
Sensitive species	1	4
Intermediate species	45	27
Tolerant species	53	68

Appendix AE. Feeding guilds and tolerance of all fish species sampled at rkm 170 (Porthill site) in September 2003 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	38	19
Invert-Piscivore	53	22
Omnivore	10	59
Sensitive species	0	0
Intermediate species	39	19
Tolerant species	61	81

Appendix AF. Feeding guilds and tolerance of all fish species sampled at rkm 565 (Wardner, B.C. site) in September 2004 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	73	33
Invert-Piscivore	4	10
Omnivore	23	57
Sensitive species	1	1
Intermediate species	75	41
Tolerant species	24	57

Appendix AG. Feeding guilds and tolerance of all fish species sampled at rkm 283 (Yaak River, Montana site) in September 2004 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	68	50
Invert-Piscivore	22	19
Omnivore	10	31
Sensitive species	16	16
Intermediate species	68	50
Tolerant species	16	34

Appendix AH Feeding guilds and tolerance of all fish species sampled at rkm 265 (Hemlock Bar site) in September 2004 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	56	25
Invert-Piscivore	21	16
Omnivore	23	59
Sensitive species	18	14
Intermediate species	56	25
Tolerant species	26	61

Appendix AI. Feeding guilds and tolerance of all fish species sampled at rkm 251 (Cow Creek site) in September 2004 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	82	58
Invert-Piscivore	12	20
Omnivore	5	22
Sensitive species	9	9
Intermediate species	82	58
Tolerant species	8	34

Appendix AJ. Feeding guilds and tolerance of all fish species sampled at rkm 230 (Shortys Island site) in September 2004 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	57	38
Invert-Piscivore	36	23
Omnivore	7	38
Sensitive species	2	6
Intermediate species	57	38
Tolerant species	41	56

Appendix AK. Feeding guilds and tolerance of all fish species sampled at rkm 170 (Porthill site) in September 2004 with boat electrofishing gear.

Feeding guild and tolerance level	Percent of total catch	Percent of total biomass
Invertivore	71	50
Invert-Piscivore	25	19
Omnivore	4	31
Sensitive species	0	1
Intermediate species	71	50
Tolerant species	29	49

Appendix AL. Telemetry locations for radio-tagged mountain whitefish tagged with active transmitters in 2004.

Freq	Total Length (mm)	Sex	Tag Date	Location Date	Location (rkm)	Comments
30.080	310	male	7/26/04	7/29/04	249.5	shallow river left
30.080				7/29/04	249	river left 6 ft deep
30.080				7/29/04	249	river left 6 ft deep across from thermo
30.080				7/29/04	249	just below tagging site
30.080				7/29/04	249	beaver lodge 5 ft
30.080				7/29/04	249	gravel bar river left 6 ft
30.080				7/29/04	248	back eddy below gravel bar
30.080				7/29/04	248	back eddy below gravel bar near 30572
30.080				7/29/04	249	across from cabin 5 ft
30.080				7/29/04	262	corner below hemlock river left gravel shallows
30.080				7/29/04	263.5	near big rock river left above corner
30.080				7/29/04	265	same location
30.080				7/29/04	266	main channel river left above tag site
30.080				7/29/04	266	same location
30.080				7/29/04	266	same location
30.080				7/29/04	266	same location
30.080				7/29/04	265	across from Katka
30.080				7/29/04	263	not very good signal below Katka
30.080				7/29/04	262	corner pool weak signal under power line
30.080				7/29/04		NOT FOUND has not been located since tagging
30.322	310	unk	7/27/04	7/29/04		NOT FOUND last tracked below Katka Ck
30.322				7/29/04		NOT FOUND
30.322				7/30/04	250	Bend above Gravel pit
30.322				7/30/04	249.6	Just above gravel pit
30.322				7/30/04	251	Just below cabin
30.322				7/30/04	251.1	Across from cabin
30.322				7/30/04	251	Just below cabin
30.322				7/30/04	250	Bend above Gravel pit
30.322				7/30/04	249.6	Just above gravel pit

Appendix AL. Continued.

Freq	Total Length (mm)	Sex	Tag Date	Location Date	Location (rkm)	Comments
30.322				7/30/04		missing
30.322				7/30/04	252.5	Just below bend above cow creek
30.322				7/30/04	253.5	First bend above cow creek
30.322				7/30/04	258.3	Mouth of Moyie River
30.322				7/30/04		missing
30.322				7/30/04	259.5	Bend just up from Moyie…Deep hole
30.322				7/30/04	265	By Katka ck
30.322				7/30/04	264.5	Just below Katka
30.322				7/30/04	266	Left channel above tag site
30.322				7/30/04	261.5	Below Hemlock bend
30.322				7/30/04	266	Right Channel above release site
30.432	321	female	7/28/04	7/30/04	265	Below release site…right bend
30.432				7/30/04	258.3	Mouth of Moyie River
30.432				7/30/04		missing
30.432				7/30/04		missing
30.432				8/3/04	245.9	near pwrline, weak signal
30.432				8/3/04	246.0	above bridge, top of island
30.432				8/3/04	246.4	above pumping station
30.432				8/3/04	246.5	above pumping station
30.432				8/3/04	247.4	
30.432				7/30/04	249.6	just above gravel pit
30.432				8/3/04	251.0	
30.432				8/3/04	251.1	across from cabin; NF 8/3
30.432				8/3/04	251.5	NF 8/3
30.432				8/3/04	251.5	NF 8/3
30.432				8/2/04	251.6	@ fixed receiver
30.432				7/31/04	251.6	@ fixed receiver
30.432				7/31/04	251.6	@ fixed receiver
30.432				8/3/04	251.9	above pwrline
30.432				8/3/04	253.5	at bend
30.432				8/3/04	253.7	
30.472	313.000	unk	7/27/04	8/3/04	255.5	weak signal (4 pulse)
30.472				8/3/04	255.9	bend below Moyie
30.472				8/3/04	263.0	by Katka Creek
30.472				8/3/04	265.5	NF 8/3
30.472				8/3/04	265.5	NF 8/3
30.472				8/3/04	266.6	upsrtm end island
30.472				8/5/04	244.0	below Ambush Rock
30.472				8/5/04	245.7	below railroad bridge
30.472				8/5/04	245.9	near pwrline, weak signal
30.472				8/5/04	246.4	above pumping station
30.472				8/5/04	246.6	above pumping station
30.472				8/5/04	247.3	
30.472				8/5/04	248.0	
30.472				8/5/04	251.0	
30.472				8/5/04	251.1	across from cabin; NF 8/5
30.472				8/5/04	251.5	NF 8/5
30.472				8/5/04	251.5	NF 8/5
30.472				8/5/04	251.6	@ fixed receiver, NF 8/5
30.472				8/5/04	251.6	@ fixed receiver, NF 8/5
30.472				8/5/04	251.6	@ fixed receiver, NF 8/5
30.482	325	female	7/28/04	8/5/04	251.9	above pwrline, NF 8/5
30.482				8/5/04	253.3	at bend
30.482				8/5/04	255.5	weak signal (4 pulse), NF 8/5
30.482				8/5/04	255.9	bend below Moyie
30.482				8/5/04	263.0	by Katka Creek, NF 8/5
30.482				8/5/04	264.5	very weak signal (full vol. needed)
30.482				8/5/04	265.5	NF 8/5
30.482				8/5/04	266.3	
30.482				8/6/04	244.5	same location just below Ambush Rock
30.482				8/6/04	246	just above Kootenai River Inn
30.482				8/6/04	246.3	just below railroad bridge very faint
30.482				8/6/04	246.3	just below railroad bridge
30.482				8/6/04	246.5	pumping station
30.482				8/6/04	247.5	just below car corner by big dome
30.482				8/6/04	247.5	just above car corner
30.482				8/6/04	252	just above cabin

Appendix AL. Continued.

Freq	Total Length (mm)	Sex	Tag Date	Location Date	Location (rkm)	Comments
30.482				8/6/04	253	corner above Cow Creek stretch
30.482				8/6/04	256	bend above crossport
30.482				8/6/04	256.5	way down between bends below Moyie above crossport weak
30.482				8/6/04	264	same location river left
30.482				8/6/04	266	same location side channel
30.492	340	male	7/27/04	8/6/04		MISSING
30.492				8/6/04		MISSING
30.492				8/6/04		MISSING
30.492				8/6/04		MISSING
30.492				8/6/04		MISSING
30.492				8/6/04		MISSING
30.492				8/6/04		MISSING
30.492				8/6/04		MISSING
30.492				8/6/04		DID NOT LOCATE
30.492				8/11/04	244.3	below Ambush Rock
30.492				8/11/04	245.6	below railroad bridge
30.492				8/6/04	245.7	below RR bridge; faint signal
30.492				8/6/04	246.0	above KRI
30.492				8/11/04	246.5	pumping station
30.492				8/11/04	247.0	just above power line
30.492				8/11/04	247.3	just above power line
30.492				8/11/04	247.5	just above car corner
30.492				8/6/04	251.1	across from cabin; NF 8/6
30.492				8/6/04	251.5	NF 8/6
30.492				8/11/04	251.0	across from cabin;
30.501	380	unk	7/26/04	8/6/04	251.6	@ fixed receiver, NF 8/6
30.501				8/6/04	251.6	@ fixed receiver, NF 8/6
30.501				8/6/04	251.6	@ fixed receiver, NF 8/6
30.501				8/6/04	251.9	above pwrline, NF 8/6
30.501				8/11/04	253.5	@ bend
30.501				8/9/04	255.5	weak; where side ch. enters
30.501				8/11/04	256.0	bend below Moyie
30.501				8/6/04	256.5	twn bends below Moyie
30.501				8/11/04	264.0	very weak signal (full vol. needed)
30.501				8/9/04	265.5	heard in reach 269-275 8/9
30.501				8/11/04	266.0	side channel
30.501				8/12/04	223.0	below Flemming, above pump site
30.501				8/12/04	227.0	Ball Creek!
30.501				8/12/04	244.3	below Ambush Rock
30.501				8/12/04	245.6	below railroad bridge
30.501				8/12/04	246.0	above KRI; NF 8/12
30.501				8/12/04	246.7	power line
30.501				8/12/04	246.8	just above power line
30.501				8/12/04	247.6	below cabin
30.501				8/12/04	247.7	@ cabin
30.512	321	female	7/26/04	8/12/04	251.0	
30.512				8/12/04	251.1	across from cabin; NF 8/12
30.512				8/12/04	251.5	NF 8/12
30.512				8/12/04	251.6	@ fixed receiver, NF 8/12
30.512				8/12/04	251.6	@ fixed receiver, NF 8/12
30.512				8/12/04	251.9	above pwrline, NF 8/12
30.512				8/12/04	253.5	@ bend
30.512				8/12/04	255.5	in side channel ~ 25 yds from top
30.512				8/12/04	256.0	bend below Moyie
30.512				8/12/04	256.5	twn bends below Moyie; NF 8/12
30.512				8/11/04	264.0	very weak signal (full vol. needed)
30.512				8/9/04	265.5	heard in reach 269-275 8/9
30.512				8/11/04	266.0	side channel
30.512				8/16/04	223.0	below Flemming, above pump site
30.512				8/16/04	227.5	just above Ball Ck.
30.512				8/16/04	244.3	below Ambush Rock
30.512				8/16/04	245.6	below railroad bridge
30.512				8/16/04	246.0	above KRI; NF 8/16
30.512				8/16/04	246.7	just above pwr line
30.512				8/16/04	246.8	just above pwr line
30.512				8/16/04	247.5	below cabin
30.512				8/16/04	247.7	@ cabin

Appendix AL. Continued.

Freq	Total Length (mm)	Sex	Tag Date	Location Date	Location (rkm)	Comments
30.512				8/16/04	248.3	outer channel, upstream of cabin
30.512				8/16/04	251.0	
30.512				8/16/04	251.5	NF 8/16
30.512				8/16/04	251.6	@ fixed receiver, NF 8/16
30.512				8/16/04	251.6	@ fixed receiver, NF 8/16
30.512				8/16/04	251.9	above pwrline, NF 8/16
30.512				8/16/04	253.5	@ bend
30.512				8/16/04	255.5	in side channel ~ 25 yds from top
30.532	305	male	7/28/04	8/16/04	256.0	bend below Moyie; deep hole
30.532				8/16/04	256.5	twn bends below Moyie; NF 8/16
30.532				8/16/04	264.0	very weak signal (full vol. needed)
30.532				8/16/04	265.5	heard in area 269-275 8/9; NF 8/16
30.532				8/11/04	266.0	side channel
30.532				8/18/04	264	same location signal seems better
30.532				8/18/04	266	same location side channel hemlok
30.532				8/18/04	256.5	weak signal just above house below moyie
30.532				8/18/04	255	bend below house
30.532				8/18/04	255.5	side channel river right crossport couldn't spook
30.532				8/18/04	253.5	same location bend above cow receiver
30.532				8/18/04	252.5	same location cabin
30.532				8/18/04	248	above powerline and just above car corner
30.532				8/18/04	248.5	above powerline
30.532				8/18/04	246.7	same location gauging station
30.532				8/18/04	246.5	Kootenai river inn
30.532				8/18/04	245.5	same location below RR bridge
30.532				8/18/04	244	same location below ambush
30.532				8/18/04		missing
30.532				8/18/04		missing
30.532				8/18/04		missing
30.532				8/18/04		missing
30.532				8/18/04		missing
30.541	325	unk	7/27/04	8/18/04		missing
30.541				8/18/04		missing
30.541				8/18/04		NOT TRACKED
30.541				8/18/04		NOT TRACKED
30.541				9/13/04	223.0	above pump site; NS 9/13
30.541				9/13/04	227.5	just above Ball Ck.; NS 9/13
30.541				9/13/04	244.0	below Ambush Rock
30.541				9/13/04	245.5	below railroad bridge
30.541				9/13/04	246.0	above KRI
30.541				9/13/04	246.0	above pwerline
30.541				9/13/04	246.7	@ pwrline-faint
30.541				9/13/04	247.5	rt side looking upstream-faint
30.541				9/13/04	248.2	car corner-faint
30.541				9/13/04	248.3	outer channel, upstream of cabin
30.541				9/13/04	250.5	Koot. river left; Webber Sl. area
30.541				9/13/04	251.5	NS 9/13
30.541				9/13/04	251.6	NS 9/13
30.541				9/13/04	251.6	NS 9/13
30.541				9/13/04	251.9	NS 9/13
30.541				9/13/04	255.0	bend below Moyie; NF 9/13
30.541				9/13/04	255.5	in side channel; very faint
30.552	305	unk	7/27/04	9/13/04	256.5	below Moyie
30.552				9/13/04	256.5	between bends below Moyie; NF 9/13
30.552				9/13/04	264.0	very weak signal (full vol.); NF 9/13
30.552				9/13/04	265.5	heard area 269-275 8/9; NF 9/13
30.552				9/13/04	266.1	side channel; up .1 rkm
30.552				9/30/04	223.0	above pump site
30.552				9/30/04	227.8	Burton Ck.-up slightly
30.552				9/30/04	244.0	below Ambush Rock
30.552				9/30/04	245.5	below railroad bridge
30.552				9/30/04	246.0	above KRI
30.552				9/30/04	246.1	above pwerline
30.552				9/30/04	246.7	@ pwrline-faint
30.552				9/30/04	247.5	rt side looking upstream-faint
30.552				9/30/04	248.2	car corner-faint
30.552				9/30/04	248.3	outer channel, upstream of cabin

Appendix AL. Continued.

Freq	Total Length (mm)	Sex	Tag Date	Location Date	Location (rkm)	Comments
30.552				9/30/04	250.5	Koot. river left; Webber Sl. area
30.552				9/30/04	251.5	NS 9/30
30.552				9/30/04	251.6	NS 9/30
30.552				9/30/04	251.6	NS 9/30
30.552				9/30/04	251.9	NS 9/30
30.562	311	unk	7/27/04	9/30/04	255.0	bend below Moyie; NF 9/30
30.562				9/30/04	255.5	side channel; faint; NF 9/30
30.562				9/30/04	256.5	between bends below Moyie; NF 9/30
30.562				9/30/04	258.2	
30.562				9/30/04	264.0	very weak signal (full vol.); NF 9/30
30.562				9/30/04	265.5	heard area 269-275 8/9; NS 9/30
30.562				9/30/04	266.1	side channel; up .1 rkm
30.562				10/7/04	264	Same location river left
30.562				10/7/04	266.1	Same location in side channel POSSIBLE DROPPED TAG
30.562				10/8/04		NOT SEARCHED
30.562				10/8/04		NOT SEARCHED
30.562				10/8/04		NOT SEARCHED
30.562				10/8/04	245.5	Same location; no visible low gain river left
30.562				10/8/04	246	Same location at KRI; no visible
30.562				10/8/04	246.5	Same location; tree in center of channel just above guage
30.562				10/8/04	247	River left at siloh; possible dropped tag?
30.562				10/8/04	247.5	Gravel bar area above car corner
30.562				10/8/04	247.5	Back eddy above car corner river right
30.562				10/8/04	247.5	Side channel river right above car corner
30.562				10/8/04	246	Highway bridge
30.572	337	unk	7/27/04	10/8/04		NOT FOUND
30.572				10/8/04		NOT FOUND
30.572				10/8/04		NOT FOUND
30.572				10/8/04		NOT FOUND
30.572				10/8/04		NOT FOUND
30.572				10/8/04	256.5	Not sure; may have heard just above crossport
30.572				10/8/04	256.5	Bend below Moyie above house; can't pinpoint; weak
30.572				10/8/04	257	Just below Moyie bend
30.572				10/7/04	264	Same location
30.572				10/7/04		NOT FOUND
30.572				10/7/04	266	Same location; may be dropped tag?
30.572				10/15/04		NOT SEARCHED
30.572				10/15/04		NOT SEARCHED
30.572				10/15/04	244.5	Just behind Ambush Rock river left; BAD habitat
30.572				10/15/04	245.5	visual on a dead fish ~7 ft deep; possibly BB
30.572				10/15/04	246	Same location at KRI; no visual
30.572				10/15/04	246.5	Same location; tree in center of channel just above gauge; possible visual
30.572				10/15/04	247	River left at siloh
30.572				10/15/04	247.5	Side channel river left at siloh; deep hole
30.572				10/15/04	247.5	Weedy side channel/backeddy above car corner; not good habitat
30.582	467.000	female	7/27/04	10/15/04	247.5	Back eddy river right above car corner
30.582				10/15/04	246	Highway bridge river left riprap
30.582				10/15/04		NOT FOUND
30.582				10/15/04		NOT FOUND
30.582				10/15/04		NOT FOUND
30.582				10/15/04		NOT FOUND
30.582				10/15/04		NOT FOUND
30.582				10/15/04		NOT FOUND
30.582				10/15/04	256.5	Bend below Moyie above house; can't pinpoint; weak
30.582				10/15/04		NOT FOUND
30.582				10/15/04	264	NOT SEARCHED
30.582				10/15/04		NOT SEARCHED
30.582				10/15/04	266	NOT SEARCHED
30.582				10/21/04		NOT FOUND
30.582				10/21/04		NOT FOUND
30.582				10/21/04		NOT FOUND
30.582				10/21/04		NOT FOUND
30.582				10/21/04		NOT FOUND
30.582				10/21/04		NOT FOUND
30.591	not recorded	unk	7/27/04	10/21/04		NOT FOUND
30.591				10/21/04	264	Same location river left below Katka Ck

Appendix AL. Continued.

Freq	Total Length (mm)	Sex	Tag Date	Location Date	Location (rkm)	Comments
30.591				10/21/04		NOT FOUND
30.591				10/21/04		NOT FOUND
30.591				10/25/04		NOT FOUND
30.591				10/25/04		NOT FOUND
30.591				10/25/04		NOT FOUND
30.591				10/25/04		NOT FOUND
30.591				10/25/04		NOT FOUND
30.591				10/25/04		NOT FOUND
30.591				10/25/04		NOT FOUND
30.591				10/25/04	264	Same location river left below Katka Ck
30.591				10/25/04		NOT FOUND
30.591				10/25/04		NOT FOUND
30.591				10/12/04	223.0	above pump site
30.591				10/12/04	227.8	Burton Ck.-up slightly
30.591				10/12/04	244.0	below Ambush Rock
30.591				10/12/04	245.4	below railroad bridge
30.591				10/12/04	246.0	just above H'way bridge
30.591				10/12/04	246.1	above KRI; faint
30.591				10/12/04	246.5	tree ctr channel, above gauge
30.612	347	unk	7/26/04	10/12/04	247.0	river left, @ siloh
30.612				10/12/04	247.1	river left, @ siloh
30.612				10/12/04	248.2	side channel, riv rt, above car corner
30.612				10/12/04	248.3	side channel, riv rt, above car corner
30.612				10/12/04	251.5	NF 10/12
30.612				10/12/04	251.6	NF 10/12
30.612				10/12/04	251.6	NF 10/12
30.612				10/12/04	251.9	NF 10/12
30.612				10/12/04	255.0	bend below Moyie; NF 10/12
30.612				10/12/04	256.5?	poss. above Crossport; NF 10/12
30.612				10/12/04	256.5	between bends below Moyie, NF 10/12
30.612				10/12/04	258.0	between bends below Moyie
30.612				10/12/04	264.0	weak signal (full vol.),NF 10/12
30.612				10/8/04	265.5	heard area 269-275 8/9; NF 10/8
30.612				10/12/04	266.1	side channel
30.612				10/12/04	223.0	above pump site
30.612				10/12/04	227.8	Burton Ck.-up slightly
30.612				10/25/04	244.5	below Ambush Rock
30.612				10/15/04	245.5	dead fish?
30.612				10/25/04	245.5	just above H'way bridge; river left
30.622	353.000	male	7/26/04	10/25/04	245.6	above KRI; faint
30.622				10/25/04	246.5	tree ctr channel, above gauge
30.622				10/25/04	247.0	river left, @ siloh
30.622				10/25/04	247.5	river left, @ siloh
30.622				10/25/04	248.3	side channel, riv rt, above car corner
30.622				10/25/04	248.3	side channel, riv rt, above car corner
30.622				10/25/04	251.5	NF 10/25
30.622				10/25/04	251.6	NF 10/25
30.622				10/25/04	251.6	NF 10/25
30.622				10/25/04	251.9	NF 10/25
30.622				10/25/04	255.0	bend below Moyie; NF 10/25
30.622				10/25/04	256.5	between bends below Moyie; NF 10/25
30.622				10/25/04	256.5?	poss. above Crossport; NF 10/25
30.622				10/25/04	258.0	between bends below Moyie, NF 10/25
30.622				10/25/04	264.0	weak signal (full vol.),NF 10/25
30.622				10/8/04	265.5	heard area 269-275 8/9; NF 10/8
30.622				10/25/04	285.6	just above Yaak
30.622				10/26/04	227.8	Just above Burton Ck. Tracked to near road?
30.622				10/26/04		Not found
30.622				10/28/04	244	Just behind Ambush Rock
30.632	315	unk	7/28/04	10/28/04		NOT FOUND
30.632				10/28/04	247	Same area; tracked from road
30.632				10/28/04	246.5	Same area; tracked from road
30.632				10/28/04	246	Same area; tracked from road
30.632				10/28/04		Couldn't pick up from road
30.632				10/28/04		Couldn't pick up from road
30.632				10/28/04		Couldn't pick up from road
30.632				10/28/04		Couldn't pick up from road

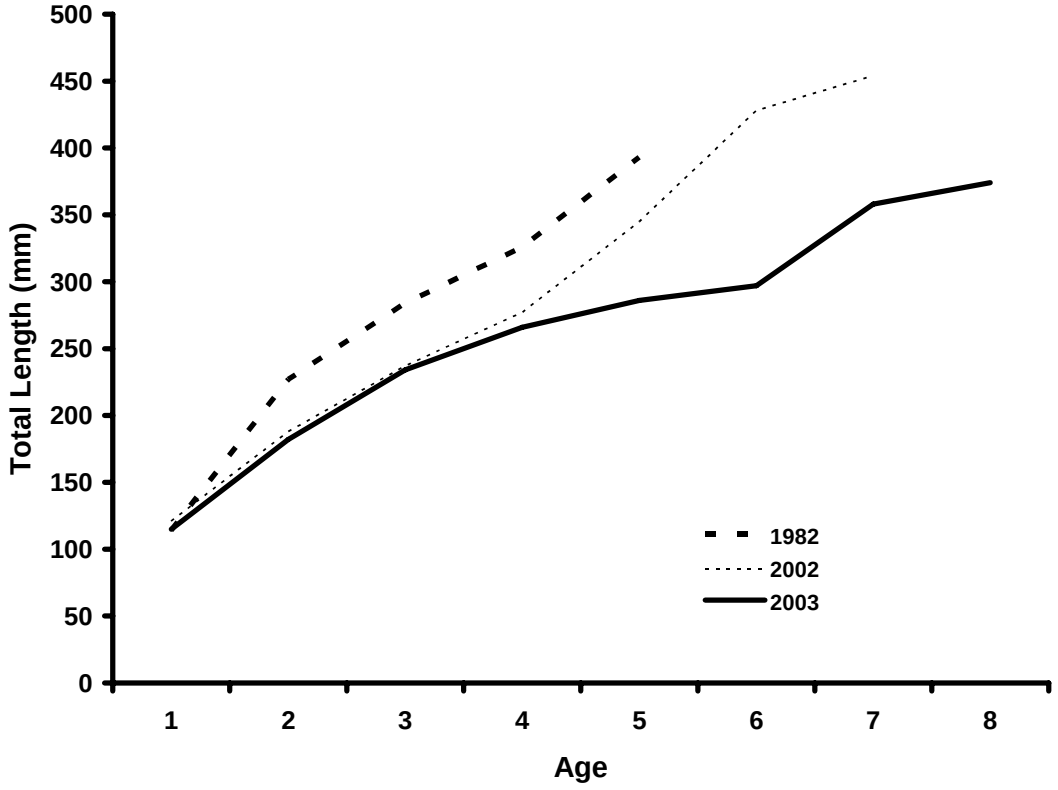
Appendix AL. Continued.

Freq	Total Length (mm)	Sex	Tag Date	Location Date	Location (rkm)	Comments
30.632				10/29/04	264	Same location; river left
30.632				10/26/04	223.0	above pump site; NF 10/26
30.632				10/26/04	227.8	Burton Ck.-up slightly
30.632				10/29/04	244.5	below Ambush Rock
30.632				10/28/04	245.5	NF 10/28
30.632				10/29/04	245.5	just above H'way bridge; river left
30.632				10/29/04	245.6	above KRI; faint
30.632				10/29/04	246.5	tree ctr channel, above gauge
30.632				10/29/04	247.0	mid-channel, @ siloh
30.632				10/29/04	247.5	river left, @ siloh
30.632				10/29/04	248.0	mid-channel, above car corner
30.632				10/29/04	248.3	side channel, riv rt, above car corner
30.641	321	male	7/27/04	10/29/04	251.6	NF 10/29
30.641				10/29/04	251.6	NF 10/29
30.641				10/29/04	251.9	NF 10/29
30.641				10/29/04	255.0	bend below Moyie; NF 10/29
30.641				10/29/04	256.5	between bends below Moyie; NF 10/29
30.641				10/29/04	256.5?	poss. above Crossport; NF 10/29
30.641				10/29/04	258.0	in Moyie, across from Mill
30.641				10/29/04	264.0	weak signal (full vol.),NF 10/29
30.641				10/29/04	275.0	poss above Leonia (fixed), NF 10/29
30.641				10/29/04	275.0	poss above Leonia (fixed), NF 10/29
30.641				10/29/04	294.6	off runway, above Hwy bridge
30.641				11/1/04	258.6	Picked up at the mouth of the Moyie
30.641				11/1/04	264	Same location
30.641				11/5/04	264	same horrible interference
30.641				11/5/04	256.5	same river right above house
30.641				11/5/04	249	down out of moyie below cabin
30.641				11/5/04	247.5	same above car corner
30.641				11/5/04	247.5	above car corner
30.641				11/5/04	248	back eddy above car corner river right
30.641				11/5/04	248.3	same above car corner
30.641				11/5/04	246.5	same at pumping station
30.641				11/5/04	245.6	same KRI
30.641				11/5/04	245.5	same highway riprap river left
30.641				11/5/04	244.5	same ambush
30.641				11/8/04	264	same location river left below Katka
30.641				11/8/04	266.1	back to same location in side channel above Hemlock
30.641				11/15/04	264	same location river left below Katka
30.652	300	unk	7/27/04	11/15/04	266.1	back to same location in side channel above Hemlock
30.652				10/26/04	223.0	above pump site; NF 10/26
30.652				11/24/04	264	same location river left below Katka
30.652				11/24/04	266.1	same location in side channel above Hemlock
30.652				11/24/04	256.5	same location river right upstream of house below Moyie
30.652				11/30/04	264	same location river left below Katka
30.652				11/30/04	266.1	same location side channel at Hemlock
30.652				11/17/04	223.0	above pump site; NS 11/17
30.652				11/17/04	227.8	Burton Ck.-up slightly; NS 11/17
30.652				12/1/04	244.5	below Ambush Rock
30.652				11/17/04	245.5	NF 11/17
30.652				11/17/04	245.5	just above H'way bridge; NF 11/17
30.652				12/1/04	245.6	above KRI
30.652				12/1/04	246.6	at pumping station
30.652				12/1/04	247.3	river left, @ siloh
30.652				12/1/04	247.5	above car corner
30.652				12/1/04	248.0	river rt, above car corner
30.652				12/1/04	248.3	side channel, riv rt, above car corner
30.652				12/1/04	250.6	below cabin below fixed rec
30.652				11/17/04	251.6	NF 11/17
30.662	339	unk	7/27/04	11/17/04	251.6	NF 11/17
30.662				11/17/04	251.9	NF 11/17
30.662				11/17/04	255.0	bend below Moyie; NF 11/17
30.662				11/17/04	256.5?	poss. above Crossport; NF 11/17
30.662				11/17/04	256.5	river rt, above house; NF 11/17
30.662				11/17/04	264.0	river lt, below Katka; NF 11/17
30.662				12/1/04	266.1	side channel, above Hemlock
30.662				11/17/04	275.0	poss above Leonia (fixed), NF 11/17

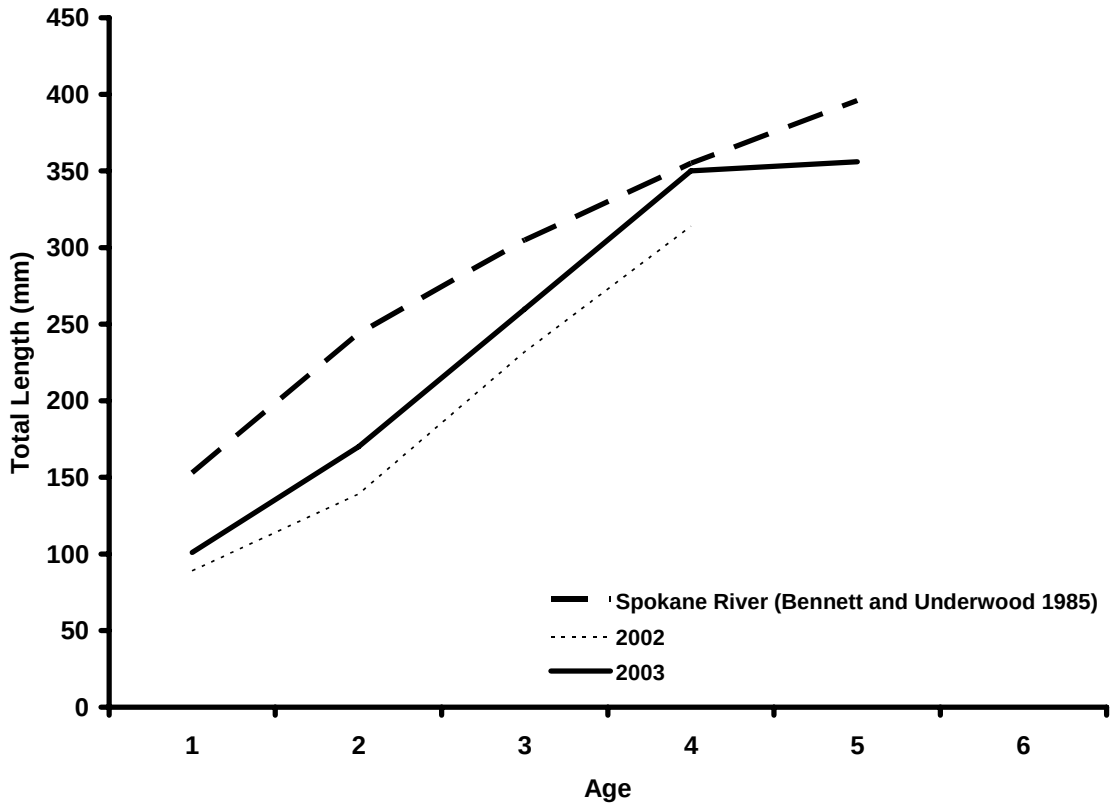
Appendix AL. Continued.

Freq	Total Length (mm)	Sex	Tag Date	Location Date	Location (rkm)	Comments
30.662				11/17/04	275.0	poss above Leonia (fixed), NF 11/17
30.662				12/1/04	223.0	above pump site; NS 12/1
30.662				12/1/04	227.8	Burton Ck.-up slightly; NS 12/1
30.662				12/1/04	244.5	below Ambush Rock
30.662				12/1/04	245.5	NF 12/1
30.662				12/1/04	245.5	just above H'way bridge; NF 12/1
30.662				12/1/04	245.6	above KRI
30.662				12/1/04	246.6	at pumping station
30.662				12/1/04	247.3	river left, @ siloh
30.662				12/1/04	247.5	above car corner
30.662				12/1/04	248.0	river rt, above car corner
30.662				12/1/04	248.3	side channel, riv rt, above car corner
30.662				12/1/04	250.6	below cabin below fixed rec
30.672	310	unk	7/26/04	12/1/04	251.6	NF 12/1
30.672				12/1/04	251.6	NF 12/1
30.672				12/1/04	251.9	NF 12/1
30.672				12/1/04	255.0	bend below Moyie; NF 12/1
30.672				12/1/04	256.5?	poss. above Crossport; NF 12/1
30.672				12/1/04	256.5	river rt, above house; NF 12/1
30.672				12/1/04	264.0	river lt, below Katka; NF 12/1
30.672				12/1/04	266.1	side channel, above Hemlock
30.672				12/1/04	275.0	poss above Leonia (fixed), NF 12/1
30.672				12/1/04	275.0	poss above Leonia (fixed), NF 12/1
30.672				12/9/2004	264	same location; river left below Katka Ck
30.672				12/9/2004	266	same location; river right of side channel above Hemlock
30.672				12/9/2004	256.5	same location; river right just upstream of house
30.672				12/9/2004	251	same location; river right downstream of cabin
30.672				12/13/2004	244.5	Same location; behind Ambush rock in back eddy
30.672				12/13/2004	227.5	Same location; just downstream of Burton Ck. Near overhanging cedar river left
30.672				12/13/2004		NOT FOUND
30.672				12/14/2004	247	same general area; tracked from road
30.672				12/14/2004	245.9	same location; highway bridge tracked from road
30.672				12/22/2004	264	Same location below Katka river left
30.672				12/22/2004	266	Same location side channel above Hemlock

Appendix AM. 2002 and 2003 Kootenai River back-calculated mountain whitefish ages in comparison with those taken in 1982 by Partridge (1983).



Appendix AN. 2002 and 2003 Kootenai River back-calculated rainbow trout ages in comparison with those taken in the Spokane River in 1985 by Bennett and Underwood (1988).



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