FISHERY RESEARCH

KOOTENAI RIVER FISHERIES INVESTIGATIONS: SALMONID STUDIES

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Project Progress Report

2006 Annual Report

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ABSTRACT

This research report addresses bull trout *Salvelinus confluentus* redd surveys, rainbow trout *Oncorhynchus mykiss* population monitoring, and trout distribution and abundance surveys in the Kootenai River drainage of Idaho. The bull trout is one of several sport fish native to the Kootenai River, Idaho that no longer support a fishery. Bull trout are currently listed under the Endangered Species Act, and population data is useful for monitoring status relative to recovery goals. A total of 33 bull trout redds were found in North and South Callahan creeks and Boulder Creek in 2006. This is an increase from 2005 and 2004 but less than the high count in 2003. However, because redd numbers have only been monitored since 2002, the data series is too short to determine bull trout population trends based on redd counts. Rainbow trout still provide an important Kootenai River sport fishery, but densities are low, at least partly due to limited recruitment. The rainbow trout proportional stock density (PSD) remained similar to values for 2004 and 2005. Proportional stock density values for 2004-2006 represent a decrease after the highest values were recorded in 2002 and 2003. In 2006, we sampled 105 sites using electrofishing or snorkeling gear to determine trout distribution and estimate trout abundance in first- through fourth-order streams throughout the Idaho portion of the Kootenai River basin. Sample sites were selected based on the Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP) protocol using spatially distributed random sites. We estimated the number of trout 100 mm and larger to be 380,972 ± 166,169 (mean ± 95% confidence interval). Of these, we estimated that 168,014 ± 84,248 were westslope cutthroat trout *O. clarkii lewisi,* 156,353 ± 59,222 were rainbow trout, and 56,605 ± 22,699 were brook trout *S. fontinalis.* We estimated the number of bull trout to be 734 ± 750 (90% CI) in first- through fourth-order streams. Few bull trout were captured (N = 12), with density ranging from 0.023-0.067 fish/m. With regard to native fish, westslope cutthroat trout were present at 36 sites, rainbow trout were present at 43 sites, and bull trout were present at three sites. Introduced brook trout were the most widely distributed species, present at 47 sites. Additionally, brook trout were present at 21 of the 36 sites where we found westslope cutthroat trout. At sites where westslope cutthroat trout and brook trout were sympatric, westslope cutthroat trout densities were less than half compared to sites where only cutthroat were found. Management may be needed to limit further expansion of brook trout in the drainage or prevent further increases within streams where they already exist in order to minimize impact on native species.

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INTRODUCTION

The bull trout *Salvelinus confluentus* was listed as threatened under the Endangered Species Act in 1998. Bull trout are distributed throughout the Kootenai River main stem and some tributaries downstream of migration barriers (Partridge 1983; Paragamian 1994, 1995a; Downs 1999, 2000; Walters and Downs 2001; Walters 2002). Little is known about population numbers, but in 2003 juvenile bull trout densities ranged from 1.64/100 m^2 to 7.65/100 m^2 in four reaches in the Callahan Creek drainage (Walters 2004b). Bull trout redds were first documented in Boulder Creek in 2001 and in North and South Callahan creeks in 2002 (Walters 2003, 2004a). Annual bull trout redd counts have occurred on Boulder Creek since 2000 and in the Callahan Creek drainage since 2003 (Walters 2004b, Walters 2005). The bull trout draft recovery plan states that the trend criteria for recovery will be met when the bull trout population is accepted as stable or increasing based on at least 10 years of monitoring data (U.S. Fish and Wildlife Service 2002). The recovery plan calls for redd surveys to continue as a metric to document bull trout population trends (U.S. Fish and Wildlife Service 2002). Bull trout redd counts in Boulder and in North and South Callahan creeks will provide data to document population trends.

Rainbow trout *Oncorhynchus mykiss* are the most popular sport fish in the Idaho reach of the Kootenai River, but densities are low, ranging from 3 fish/ha in 1993 to 11 fish/ha in 2004 (Paragamian 1995a, 1995b; Downs 2000; Walters 2005). These low densities are at least partly due to limited juvenile recruitment (Walters et al. 2005). Decreased productivity in the Kootenai River downstream of Libby Dam may be another factor limiting fish populations (Woods 1982; Paragamian 1995a; Snyder and Minshall 1996). Woods (1982) reported that 63% of total phosphorus and 25% of total nitrogen in the Kootenai River system is captured within Lake Koocanusa. A nutrient restoration experiment is currently underway to test the nutrient limitation hypothesis (Hardy 2006). Another possible factor limiting the Kootenai River rainbow trout population may be angling exploitation (Walters and Downs 2001; Walters 2002). A 406 mm (16") minimum length limit and 2-fish bag limit was initiated in 2002 to the Kootenai River in Idaho. Annual monitoring will determine if nutrient restoration and the more restrictive fishing regulations are benefiting the rainbow trout population.

More research has been devoted to native salmonids in the Kootenai River main stem, while less is known about salmonid distribution and genetic integrity in the rest of the drainage in Idaho, including several streams with no documented surveys (Kootenai Tribe of Idaho and Montana Fish, Wildlife & Parks 2004). Redband rainbow trout *O. mykiss gairdneri* are native to the Kootenai River drainage. Genetically pure populations of redband trout have been documented in the Callahan Creek drainage and Boundary Creek, while populations with coastal (hatchery) rainbow trout have been identified in Deep Creek. Westslope cutthroat trout *O. clarkii lewisi* are also native to the Kootenai River drainage in Idaho. Recent research in the upper Kootenay River basin in Canada suggests that rainbow trout X westslope cutthroat trout hybridization is increasing and that hybrid swarms are likely to develop (Rubidge and Taylor 2005). In Idaho, westslope cutthroat trout were likely native to many Kootenai River tributaries that were inaccessible to rainbow trout due to upstream migration barriers. However, nonnative rainbow trout strains were stocked into some of those tributaries and in headwater lakes (http://fishandgame.idaho.gov/apps/stocking/year.cfm?region=1). Genetically pure westslope cutthroat trout populations were recently found in four streams in the Moyie River drainage and in Mission Creek, while eight additional populations had experienced genetic introgression (introgression levels <3%) from rainbow trout (Walters 2006). Brook trout *S. fontinalis*, an introduced salmonid, also occurs in the Kootenai River drainage in Idaho, but their distribution and numbers are not well documented. Identifying the distribution, abundance, and genetic integrity of salmonid species within the Kootenai River drainage in Idaho will aid in identifying future threats to these populations and providing management direction.

OBJECTIVES

1. To have a recovering population of bull trout, as determined by improving numbers of redd counts in index streams in the Kootenai River drainage, Idaho.

2. To improve the size structure of rainbow trout (e.g., a positive trend in quality stock density) in response to changes in trout regulations initiated in 2002.

3. To have an estimate of the distribution and abundance of trout, by species, in the Kootenai River drainage, Idaho to help formulate management decisions.

STUDY AREA

The Kootenai River (spelled Kootenay in Canada) flows south out of British Columbia into Montana, northwest into Idaho, then north back into British Columbia and Kootenay Lake (Figure 1). It flows out of the west arm of Kootenay Lake and enters the Columbia River at Castlegar, British Columbia. In the U.S., the Kootenai River is regulated by Libby Dam, impounding Lake Koocanusa in Montana (Figure 1). In Idaho, the Kootenai River has the following three reaches: 1) the canyon reach (22 km) from the Montana border to the Moyie River, 2) the braided reach (10 km) from the Moyie River to Bonners Ferry, and 3) the meandering reach (73 km) from Bonners Ferry to the Canadian border (Fredericks and Hendricks 1997). The meandering reach has a relatively slow velocity and substrates consisting mainly of sand, silt, and clays (Partridge 1983). Dikes on either side of this reach reduce flooding into the adjacent agricultural lands. The braided and canyon reaches upstream of Bonners Ferry appear more suitable for fluvial rainbow trout with riffles, runs and pools, and gravel and cobble substrates. Sampling in 2006 was conducted in the Kootenai River and several tributary drainages including Boulder, Callahan, and Mission creeks and the Moyie River drainage (Figure 1). Waterfalls preventing the upstream migration of fish occur 1.9 km upstream from the mouth of Boulder Creek, 4.2 km upstream from the mouth of Mission Creek, and 2.4 km upstream from the mouth of the Moyie River (Partridge 1983).

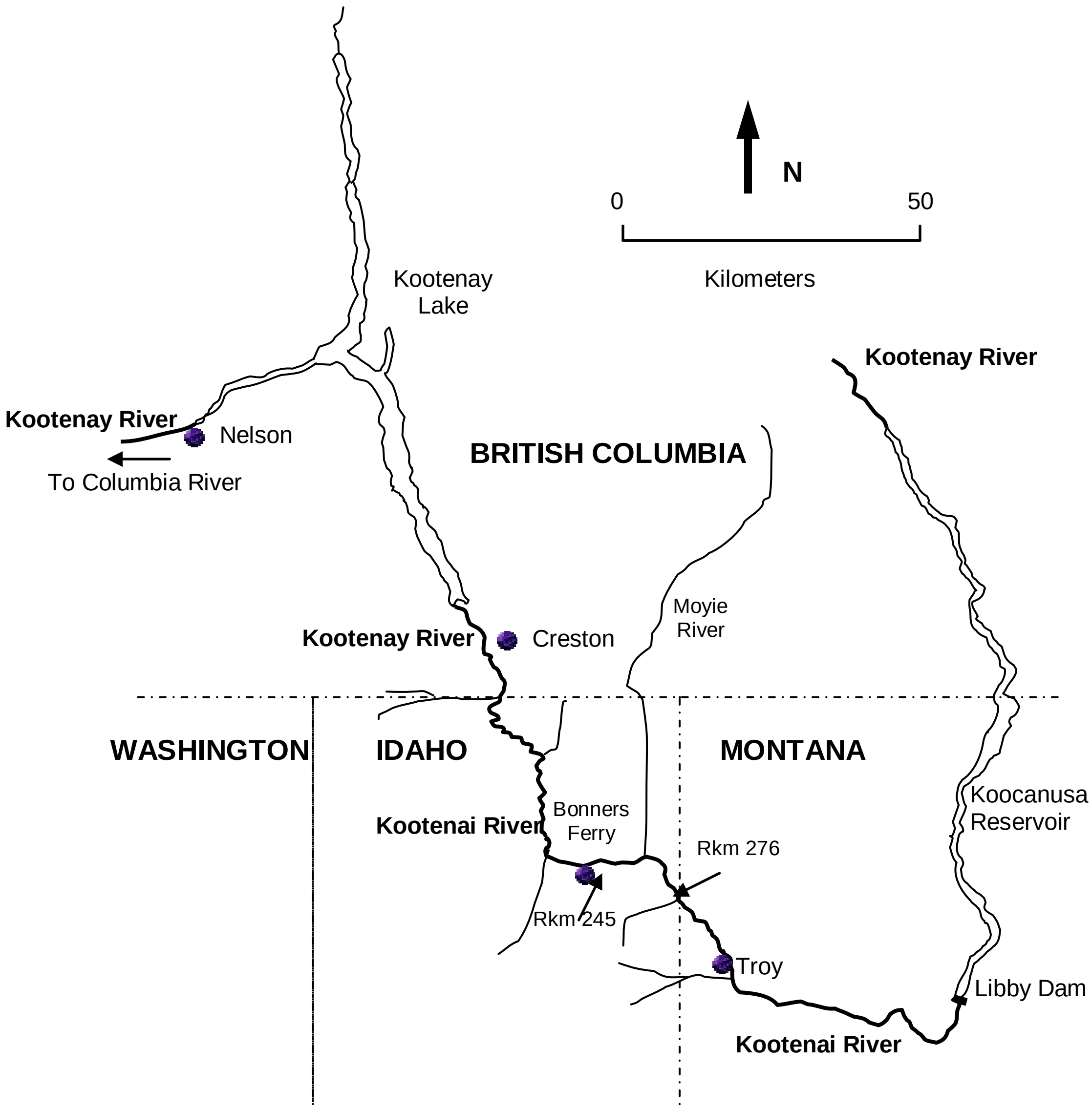

Figure 1. The Kootenai River drainage and major tributaries in Idaho.

METHODS

Bull Trout Redd Surveys

Bull trout redd surveys were conducted along index transects (Walters 2004b) on October 5 on Boulder Creek and October 10, 2006 on North and South Callahan creeks. Each index transect was surveyed once during midday. Disturbed and cleaned gravel or cobble areas showing a pit and tailspill were identified as bull trout redds (Shepard and Graham 1983; Dunham et al. 2001).

Rainbow Trout Population Monitoring

In fall 2006, rainbow trout were sampled while electrofishing the Kootenai River from rkm 250 (Cow Creek) to rkm 275.5 (near Boulder Creek) until a minimum sample size of 50 was reached. In addition, we used data collected during a companion study (Hardy 2006). Rainbow trout were measured for total length (mm), weighed (g), and released. Rainbow trout catch-per-unit-effort, relative weights (W_r), proportional stock density (PSD), and quality stock density (QSD) were calculated (Anderson 1976; Wege and Anderson 1978; Anderson and Neumann 1996). These variables have been measured annually to monitor the rainbow trout population size structure. Proportional and quality stock densities were calculated for rainbow trout >305 mm and >406 mm, respectively, using 200 mm as stock length (Schill 1991). Confidence intervals (95%) were estimated for the PSD and QSD using the table provided by Gustafson (1988). Relative weights were calculated for rainbow trout length groups of 201-305 mm , 306-406 mm, and >406 mm using the standard weight (W_s) equation for lotic rainbow trout populations proposed by Simpkins and Hubert (1996).

Trout Distribution and Abundance Surveys

Sampling Design and Site Selection

Selection of study sites was based on the Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP) protocol which uses a spatially balanced sampling design (Stevens and Olsen 2003; Stevens and Olsen 2004). The EPA provided a list of 2,082 possible sample site UTM coordinates within the Kootenai River drainage of Idaho. These sites were stratified by stream order (first through fourth order). Sampling initially occurred on the first 30 sites for first-order streams. After initial sampling, it is believed a representative sample of first-order streams was obtained and therefore, sampling continued down the list with only stream orders two and higher. Sites that were sampleable were considered to be target sites. However, some target sites could not be sampled as a result of denied access, low conductivity and water temperature, dry channels, and a frozen channel at one site. Additionally, some sites were identified as nontarget as a result of being high order (greater than 5), zero order (irrigation canals and ditches, intermittent streams), impounded streams, or as a result of map error (no stream located at GPS coordinates). These sites were not included in abundance or distribution analysis. Sample sites were located using handheld Global Positioning System (GPS) units.

Fish Sampling

Fish sampling to quantify densities and distribution of trout was conducted from mid-May through early October 2006. We initially used electrofishing to conduct removal estimates of trout abundance but learned that water conductivity was often <25 µS/cm. We then used snorkel sampling when water conductivity was <25 µS/cm and electrofishing when conductivity was ≥25 µS/cm (personal communication Smith-Root technician). Conductivity was measured using a Hanna Instruments handheld digital conductivity meter. In streams less than about 5 m wetted width, electrofishing removals were conducted using a single backpack electrofisher (Smith-Root, Inc. Vancouver, Washington; Model 11A or Halltech Aquatic Research Inc. Guelph, Ontario, Canada; Model HT 2000 B) with pulsed DC. Sites greater than 5 m wide were electrofished with two backpack electrofishers. Voltage and frequency settings ranged from 200-700 V and 15-60 Hz, respectively, depending on conductivity and efficiency. Efficiency was observed visually by the electrofisher operator based on fish attraction to the anode probe; electrofisher settings were adjusted accordingly in order to maximize fish attraction. Sites that were too wide or deep to effectively electrofish were snorkeled.

Sample sites were usually 100 m in length, but a natural barrier or obstruction within 95 to 105 meters upstream of the bottom of the site may have varied from the 100 m standard site length. We used 5 mm mesh block nets at the upstream and downstream end of each electrofishing reach in order to meet the assumption that the fish population was closed (Ricker 1975; Peterson et al. 2005). A block net was not used at the upstream end of a site if a barrier existed that would prevent upstream fish passage.

Electrofishing was performed while walking upstream with one or two netters. Fish were held in buckets until each pass was completed. If 10 or less fish were captured in the initial electrofishing pass, another pass was not completed. If 25% or less fish were captured in the second electrofishing pass, relative to the initial pass, a third pass was not completed (K. Meyer, Idaho Department of Fish and Game, personal communication). At two sites, we used Peterson mark recapture electrofishing (Ricker 1975). Fish were captured with a backpack electrofisher, marked with an upper caudal fin clip, and released between block nets. We returned the following day and recaptured fish with a backpack electrofisher; block nets were left in place overnight.

After each pass, the fish were anesthetized, identified, measured for total length to the nearest millimeter, and weighed to the nearest gram. A tissue sample was taken from rainbow trout, westslope cutthroat trout, and bull trout for genetic analysis.

Snorkel sites were sampled by one to four snorkelers depending on water visibility, habitat type, and stream width, as described by Thurow (1994). Snorkeling generally followed the direct enumeration sampling procedures of Thurow (1994). When two or more snorkelers were required, the stream width was divided into equal corridors with each snorkeler counting all fish in one direction between themselves and the adjacent snorkeler or shoreline (Schill and Griffith 1984; Northcote and Wilkie 1963).

Snorkelers recorded fish species and length group on a PVC sleeve, on their arm, or with a grease pencil or called out the data to a recorder on the bank. Fish lengths were estimated as either < or≥ 100 mm. Prior to beginning the summer snorkel surveys, snorkelers were trained and practiced estimating the lengths of objects placed in the stream.

Habitat Assessment

Habitat categories were characterized at each site including average wetted width, average depth, water temperature (using a handheld thermometer), conductivity, dominant riparian habitat, land use, Rosgen stream type (Rosgen 1994), streamflow conditions, sinuosity, valley bottom type, substrate composition, percent shade rating, and percent bank stability.

Ten habitat transects were usually measured at each site, but five transects were measured at some sites due to time constraints. The first transect was randomly chosen within the first 10 m upstream of the furthest downstream extent of the site, with subsequent transects continuing upstream every ten meters (Overton et al. 1997).

Average wetted width was measured to the nearest 0.1 m with a 30 m measuring tape. If the transect fell in a split channel, the width of the exposed channel was subtracted from the overall width. Depths were taken at 25%, 50%, and 75% of the wetted width and divided by four to compensate for bank depth of zero (Overton et al. 1997). Depths were measured with a staff to the nearest 0.01 m.

Substrate composition, bank stability, and percent shade were visually estimated along a 1 m wide band centered on the transect. Substrate classes ranged from fines to bedrock based on the Wentworth Scale (Harrelson et al. 1994). Bank stability was measured as described by Overton et al. (1997, and shade ratings were expressed as a percentage. Dominant riparian type, land use, streamflow conditions, valley bottom type, sinuosity, and Rosgen stream type were visual observations that were representative of the entire reach. Gradient was measured using a handheld clinometer. Gradients were recorded over the longest straight reaches within the survey reach. Three gradients were taken for each site and averaged. Habitat data was entered into the Idaho Department of Fish and Game Standard Stream Survey database, but further analysis is beyond the scope of this report.

Historic Ranges of Native Trout

We hypothesize that the historic range of the westslope cutthroat trout in the Kootenai River drainage in Idaho is limited to portions of tributaries upstream of fish migration barriers (Behnke 1992). We considered the main Kootenai River below Kootenai Falls and upstream to migration barriers in tributaries to the Kootenai River to be historic Columbia River redband trout range (Behnke 1992).

Trout Abundance Estimates

Population estimates were calculated only for trout ≥100 mm. *Fisheries Analysis+* (*FA+*) software was used to calculate maximum likelihood abundance estimates for sites where three or more electrofishing passes were conducted (Montana Fish, Wildlife, and Parks 2004; Zippen 1958). We established a linear regression relationship between the number of fish captured on the first pass and the population estimates from three pass electrofishing sites. This relationship was used to estimate the trout population at one and two pass electrofishing sites (K. Meyer, Idaho Department of Fish and Game, personal communication). Sites with a capture probability (CP) lower than 0.5 were not included in the linear regression relationship, because low CP underestimates population size (Riley and Faush 1992; Peterson et al. 2004).

We estimated snorkeling efficiency at eight sites by marking trout prior to snorkeling the site and recording the number of marked fish observed while snorkeling (Thurow et al. 2006). Fish were captured using angling or electrofishing gear, measured for total length (mm,), weighed (g), marked with an upper caudal fin clip, and released within the site between block nets. Sites were snorkeled between 1 h and 1 d after fish were released. Block nets were left in place for this duration to ensure that fish did not enter or exit the site. Separate efficiency estimates were calculated for each species at each site. Snorkel efficiency was estimated as the proportion of marked fish observed in a reach to the total number of fish marked in that reach. In order to obtain a population estimate, the total number of fish captured in a reach was divided by the snorkel efficiency. Hybrid cutthroat x rainbow trout were considered rainbow trout because these hybrids look more like rainbow trout than cutthroat trout and were difficult to distinguish while snorkeling. Trout population estimates were converted to linear density estimates (trout/m). Thurow and Schill (1996) estimated an efficiency of 75% while day snorkeling for bull trout; because we did not calculate bull trout snorkeling efficiency, we applied the 75% efficiency estimate to our bull trout density estimate.

Trout abundance estimates for the entire drainage within Idaho were calculated. An R function was used to extrapolate abundance by species using the above density estimates and the total kilometers of stream within the Idaho portion of the drainage (Phil Larsen, U.S. Environmental Protection Agency, personal communication). Abundance estimates included 95% confidence intervals. Bull trout abundance basinwide was calculated using stratified random sampling formulas from Scheaffer et al. (1996). We calculated the total number of sampling units in each stratum (N_i) by dividing the total stream length by the typical sampling reach length (100 m). Abundance estimates were standardized to density per 100 linear meters of stream and a mean abundance ($_i$) within each stratum was calculated and an associated variance. For total population size (N_{census}), we used the formula

$$(N_{census}) = \sum_{i=1}^{L} N_i \bar{y}_i ,$$

and for variance of N_{census} we used the formula

$$V(N_{census}) = \sum_{i=1}^{L} N_i^2 \left(\frac{N_i - n_i}{N_i}\right)\left(\frac{s_i^2}{n_i}\right) ,$$

where s_i^2 is the variance of the observations in stratum i, and n_i is the sample size within stratum i. From this we calculated 90% confidence intervals around the abundance estimates.

We used a two-sample t-test to compare the means of sites where only westslope cutthroat trout were present versus sites where they were sympatric with brook trout. Raw data and fish population estimates for each site were entered into the Idaho Department of Fish and Game Standard Stream Survey database.

RESULTS

Bull Trout Redd Surveys

Twenty-nine bull trout redds were observed in North Callahan Creek, four in South Callahan Creek, and none in Boulder Creek. A summary of bull trout redd counts for the Kootenai River drainage in Idaho since 2000 is shown in Table 1.

Rainbow Trout Population Monitoring

In fall 2006, 130 rainbow trout were collected during 16,140 s (4.48 h) of electrofishing effort on the Kootenai River, for a catch per unit effort of 29 fish/h. A summary of electrofishing catch per unit effort data collected for rainbow trout since 2000 is shown in Table 2. The rainbow trout proportional stock density (PSD) was 32, while the quality stock density (QSD) was 1. Relative weight values were 90 for the 201-305 mm length group, 84 for the 306-406 mm length group, and 76 for fish >406 mm. A summary of rainbow trout population metrics data collected since 1993 are shown in Table 3.

Table 1. Numbers of bull trout redds in the Kootenai River drainage of Idaho, 2000-2006.

Stream	Year	Transect start point description	Start point UTM coordinates[a] Eastings	Start point UTM coordinates[a] Northings	Transect end point description	End point UTM coordinates[a] Eastings	End point UTM coordinates[a] Northings	Number of bull trout redds
Boulder Cr.	2000	mouth	569849	5386164	waterfalls 1.9 km upstr.	568641	5385028	0
Boulder Cr.	2001	mouth	569849	5386164	waterfalls 1.9 km upstr.	568641	5385028	2
Boulder Cr.	2002	mouth	569849	5386164	waterfalls 1.9 km upstr.	568641	5385028	2
Boulder Cr.	2003	mouth	569849	5386164	waterfalls 1.9 km upstr.	568641	5385028	0
Boulder Cr.	2004	mouth	569849	5386164	waterfalls 1.9 km upstr.	568641	5385028	0
Boulder Cr.	2005	mouth	569849	5386164	waterfalls 1.9 km upstr.	568641	5385028	1
Boulder Cr.	2006	mouth	569849	5386164	waterfalls 1.9 km upstr.	568641	5385028	0
N. Callahan Cr.	2002	100 m downstr. of Smith Cr.	569501	5365990	Waterfalls barrier	568218	5366538	13
N. Callahan Cr.	2003	Jill Cr., Montana[b]	570786[c]	5365340[c]	Waterfalls barrier	568218	5366538	32
N. Callahan Cr.	2004	Jill Cr., Montana	570786[c]	5365340[c]	Waterfalls barrier	568218	5366538	17
N. Callahan Cr.	2005	Jill Cr., Montana	570786[c]	5365340[c]	Waterfalls barrier	568218	5366538	10
N. Callahan Cr.	2006	Jill Cr., Montana	570786[c]	5365340[c]	Waterfalls barrier	568218	5366538	29
S. Callahan Cr.	2002	bridge on forest rd. 4554	570596	5362719	Forest Rd. 414 bridge (trailhead #154)	566519	5361191	3[e]
S. Callahan Cr.	2003	bridge on forest rd. 4554	570596	5362719	Forest Rd. 414 bridge (trailhead #154)	567347	5360822	10
S. Callahan Cr.	2004	bridge on forest rd. 4554	570596	5362719	Forest Rd. 414 bridge (trailhead #154)[d]	567347	5360822	8
S. Callahan Cr.	2005	bridge on forest rd. 4554	570596	5362719	Forest Rd. 414 bridge (trailhead #154)	567347	5360822	5
S. Callahan Cr.	2006	bridge on forest rd. 4554	570596	5362719	Forest Rd. 414 bridge (trailhead #154)	567347	5360822	4

[a] UTM Zone 11; WGS84 datum.
[b] On 9/24/2003 the section from approximately 500 m downstream of Jill Creek upstream to Jill Creek was also surveyed, but no redds were seen.
[c] Estimated from electronic version of topographic map.
[d] S. Callahan was also surveyed from the Forest Road 414 bridge upstream approximately 500 m, but no redds were seen.
[e] One additional redd was found within 0.9 km upstream of Forest Road 414 bridge.

Table 2. Rainbow trout catch per unit effort (CPUE) by electrofishing in the fall, Kootenai River, Idaho.

Length group (mm)	2000 CPUE (n/h)	2001 CPUE (n/h)	2002 CPUE (n/h)	2003 CPUE (n/h)	2004 CPUE (n/h)	2005 CPUE (n/h)	2006 CPUE (n/h)
≤199	7.9	3.8	7.0	3.8	4.3	4.1	4.2
200-305	12.7	10.5	6.5	7.0	18.1	19.8	16.7
306-406	7.9	3.4	7.8	7.6	7.2	7.0	7.8
>406	0.4	0.0	0.3	1.0	0.0	1.0	0.2
all	28.8[a]	17.7	21.5	19.3	29.6	31.9	29.0

Table 3. Summary of population statistics for rainbow trout sampled by electrofishing during fall in the Kootenai River (rkm 250 to rkm 275), including proportional (PSD) and quality (QSD) stock densities ("—" = no data).

Year	Population estimate	Lower 95% C. L.	Upper 95% C. L.	n/ha	n/km	PSD	PSD ± 95% CI	QSD	QSD ± 95% CI[a]	Relative weights 201-305 mm	Relative weights 306-406 mm	Relative weights >406 mm
1993	98	78	118	3.3	33	—	—	—	—	—	—	—
1994	135	114	160	4.6	45	—	—	—	—	—	—	—
1998	217	168	294	7.4	72	42	12	5	—	85	83	83
1999	217	160	332	7.4	72	47	13	3	—	95	86	81
2000	—	—	—	—	—	39	15	2	—	86	79	82
2001	—	—	—	—	—	24	22	0	—	83	80	—
2002	—	—	—	—	—	55	15	2	—	83	80	96
2003	—	—	—	—	—	55	16	6	—	84	85	83
2004	335	190	800	11.4	112	35	9	7	5	86	85	—
2005	—	—	—	—	—	29	10	4	5	89	83	84
2006	-	-	-	-	-	32	10	1	-[b]	90	84	76

[a] Sample sizes were too small prior to 2004 to calculate confidence intervals for QSD.

Trout Distribution and Abundance Surveys

We estimated that there were 1,749 km (1:100,000 scale) of first- through fourth-order stream in the Kootenai River drainage in Idaho (Table 4). We sampled, or attempted to sample, 131 sites. Of these sites, three were designated as nontarget, 23 sites as target not sampled, and 105 as target sampled. Nontarget site designations were a result of map error (1) and impoundment (2). Target sites not sampled were a result of access being denied (4 sites), low conductivity and temperature (3 sites), dry streams (15), and a frozen stream (1 site). We considered 1,702 km of stream target water and 47 km of stream nontarget (P. Larsen, U.S. Environmental Protection Agency, personal communication; Table 4).

Table 4. Total length (km) of stream by order and target code in the Kootenai River drainage, Idaho.

Stream Order	Code: Target Stream (km)	Code: Nontarget Stream (km)	Total (km)
1	1112	0	1112
2	316	42	358
3	211	0	211
4	63	5	68
Total	**1702**	**47**	**1749**

We sampled 105 sites with either electrofishing or snorkeling gear; 20 (19%) sites occurred in first-order stream reaches, 37 (35%) were second-order, 35 (33%) were third-order, and 13 (12%) were fourth-order.

Distribution of Trout

Brook trout were the most widely distributed species of trout in the Kootenai River drainage in Idaho, present at 47 (45%) sites (Table 5). Rainbow trout and hybrids were present at 43 (41%) sites, westslope cutthroat trout were present at 36 (34%) sites, and bull trout were present at three (3%) sites. Westslope cutthroat trout were the primary trout species found at sample sites in first-order streams; however, they were not as widely distributed at third- and fourth-order streams as were rainbow trout and brook trout (Table 5).

Table 5. Distribution of rainbow trout (RBT), westslope cutthroat trout (WCT), bull trout (BLT), and brook trout (BKT) by stream order.

Stream and sample site characteristics	Stream Order				
	1	**2**	**3**	**4**	**Total**
Total km of stream	1112	358	211	68	1749
km of Target stream	1112	316	211	63	1702
Total number of sites sampled	20	37	35	13	105
Sites containing trout	5	33	31	10	79
Sites containing RBT	0	14	19	10	43
Sites containing WCT	5	16	12	3	36
Sites containing BLT	0	1	2	0	3
Sites containing BKT	1	19	21	6	47
WCT sites containing RBT	0	2	3	3	8
WCT sites containing BKT	1	8	9	3	21
RBT sites containing BKT	0	7	12	6	25

Current Distribution within Historic Ranges

We sampled 26 streams containing trout thought to be within historic westslope cutthroat trout range (Table 6; Figure 1). Westslope cutthroat trout were present at 17 (65%) of these sites (Figure 2). Brook trout were present at 16 (62%) streams within the native historic range of westslope cutthroat trout. Additionally, brook trout were observed at seven of the nine streams where westslope cutthroat were no longer present (Figure 3). Rainbow trout were present at 11 (42%) streams within the historic westslope cutthroat trout range, and were present at six of the nine sites that no longer contained westslope cutthroat trout (Figure 4). We observed eight streams (31%) with only cutthroat trout within the historic range.

Table 6. Historic and current study locations of westslope cutthroat trout (WCT) and redband trout and study locations of rainbow trout (RBT), brook trout (BRK), and bull trout (BLT).

Stream	Historic WCT	Study WCT	Historic Redband	Study Redband	RBT	BRK	BLT
Ball Creek	✓	✓			✓		
Beaver Creek	✓	✓				✓	
Boulder Creek	✓	✓			✓	✓	
Boundary Creek		✓	✓		✓		
Brush Creek	✓	✓					
Canuck Creek	✓	✓					
Caribou Creek	✓	✓			✓	✓	
Cone Creek			✓			✓	
Cow Creek			✓		✓	✓	
Curley Creek	✓					✓	
Cutoff Creek	✓	✓					
Deep Creek			✓		✓	✓	
Deer Creek	✓	✓			✓	✓	
Fall Creek	✓	✓	✓		✓	✓	
Fisher Creek			✓		✓		
Grass Creek	✓		✓			✓	
Hall Creek	✓					✓	
Long Canyon			✓		✓	✓	✓
Mission Creek	✓	✓				✓	
Moyie River	✓				✓	✓	
Myrtle Creek	✓				✓	✓	
North Callahan			✓	✓	✓		✓
Ruby Creek	✓				✓	✓	
Sand Creek	✓				✓	✓	
Skin Creek	✓	✓				✓	
Smith Creek	✓	✓			✓		
Snow Creek	✓	✓				✓	
South Callahan			✓	✓	✓		✓
Trout Creek	✓	✓					
Wall Creek	✓	✓					

Figure 2. Streams where westslope cutthroat trout were observed in the study (bold lines). Light lines represent streams within the hypothesized range of westslope cutthroat trout that were sampled but westslope cutthroat trout were not present.

Figure 3. Bold lines represent streams within historic westslope cutthroat trout range in which we observed brook trout; light lines represent the historic westslope cutthroat trout range.

Figure 4. Bold lines represent streams within historic westslope cutthroat trout range in which we observed rainbow trout; light lines represent the historic westslope cutthroat trout range.

We sampled 12 streams containing trout thought to be within historic Columbia River redband trout range (Table 6; Figure 5). We observed rainbow trout at 10 (83%) of these streams (Figure 6). Brook trout were observed at six (50%) streams within the native redband range and were observed at both streams where rainbow trout were absent (Figure 7). Westslope cutthroat trout were observed at two (17%) streams within historic redband range (Figure 8).

Figure 5. Hypothesized historic range of redband trout, bold lines represent those streams within historic redband trout range that were sampled in this study where trout were found.

Figure 6. Streams within the hypothesized historic range of redband trout where rainbow trout were observed in the present study (bold lines), and those streams where rainbow trout were not present (light lines)

Figure 7. Bold lines represent streams within historic RBT range in which we observed BKT; light lines represent the historic RBT range.

Figure 8. Bold lines represent streams within historic RBT range in which we observed WCT; light lines represent the historic RBT range.

Snorkel Efficiency

We had the greatest snorkel efficiency for brook trout, followed by rainbow trout and westslope cutthroat (Table 7).

Table 7. Mean estimates of snorkeling efficiency for all trout species combined, brook trout (BKT), rainbow trout (RBT), and westslope cutthroat trout (WCT).

Species	**Mean Snorkeling Efficiency**
All trout	0.64
BKT	0.92
RBT	0.63
WCT	0.58

Population Estimates

We found a significant relationship between first pass fish capture and corresponding maximum-likelihood depletion estimate ($p < 0.001$, $r^2 = .866$, N = 24; Figure 9).

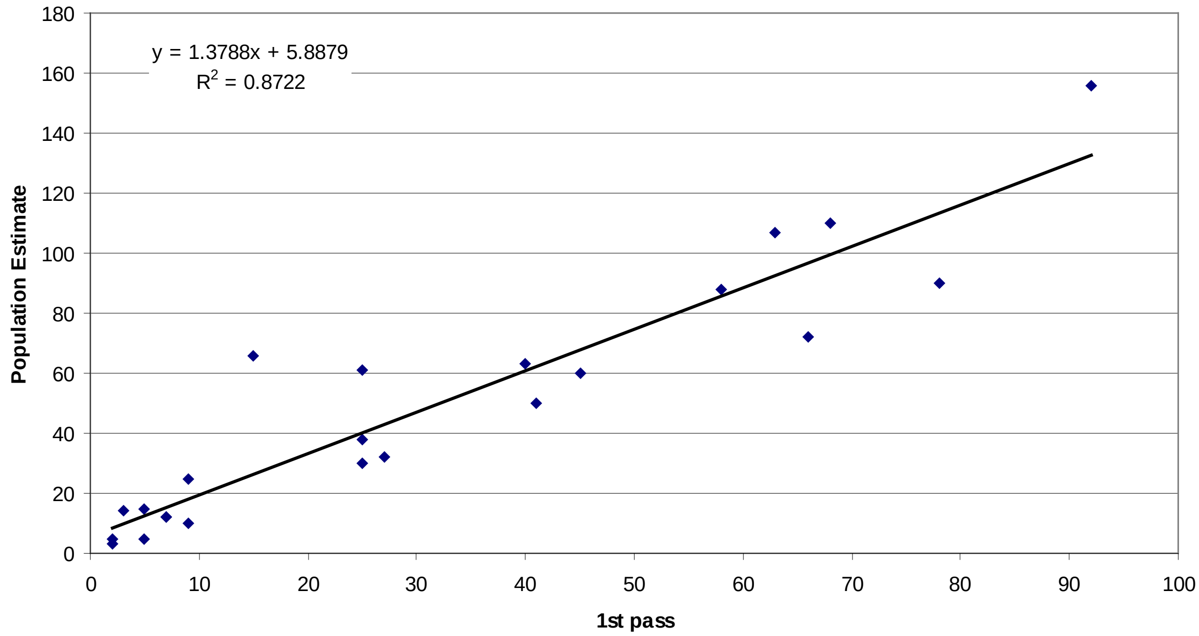

Figure 9. Relationship between 1st pass electrofishing fish captured and population estimates.

The mean density for trout 100 mm TL and larger (excluding bull trout) at all sites was 0.0819 trout/m ± .0315 (mean ± 95% confidence interval) for first- through fourth-order streams, combined, within the Kootenai River drainage in Idaho. Brook trout were the most widely distributed species but had the lowest densities (Table 8). Westslope cutthroat trout had the smallest distribution and the highest densities. Highest overall trout density at one site occurred on Ball Creek (2.066 trout/m); this site occurred in a second-order stream that was inhabited by only westslope cutthroat trout. We captured a total of 12 bull trout in three streams. Highest bull trout density was observed in North Callahan Creek (0.067 trout/m); we also observed bull trout in South Callahan Creek (0.027 trout/m) and Long Canyon Creek (0.027 trout/m). One bull trout was observed outside of our sample site in Ball Creek.

Table 8. Average linear density (trout/m) of rainbow trout (RBT), westslope cutthroat trout (WCT), and brook trout (BKT) and 95% confidence intervals for all sites combined.

Species	Estimate (Trout/m)	Lower 95% CI	Upper 95% CI
RBT	0.09	0.06	0.13
WCT	0.12	0.07	0.17
BKT	0.03	0.02	0.05

No rainbow trout were captured in first-order streams; however, their densities were highest among trout species in second- through fourth-order streams. Westslope cutthroat trout density was highest in first-order streams, followed by brook trout (Figure 10).

We estimated that there were 380,972 ± 166,169 (mean ± 95% confidence interval) trout present in the Kootenai River drainage in Idaho in first- through fourth-order streams (excluding bull trout) (Figure 11). We also estimated that 168,014 ± 84,248 were westslope cutthroat trout, 156,353 ± 59,222 were rainbow trout, and 56,605 ± 22,699 were brook trout. We estimated a basinwide abundance of 734±750 (90% confidence interval) bull trout in first- through fourth-order tributaries.

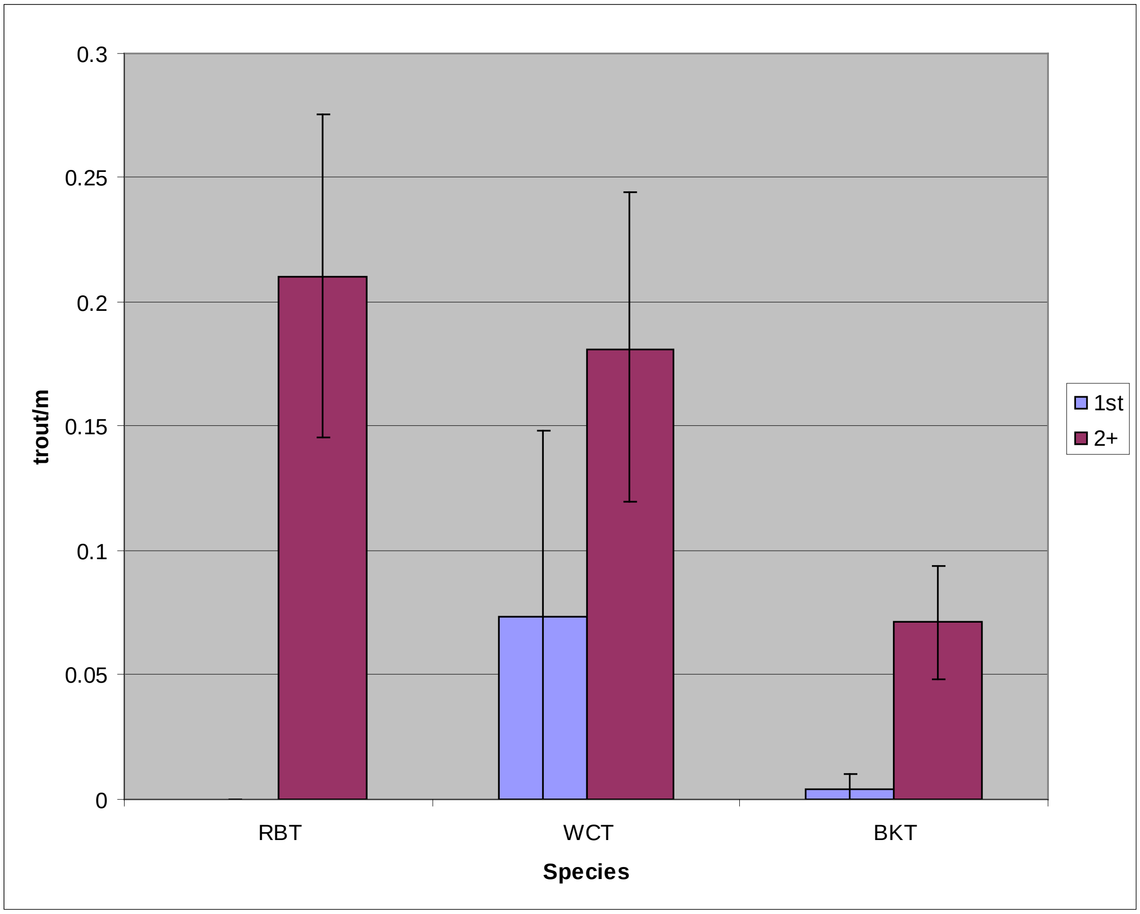

Figure 10. Average density (trout/m) of rainbow trout (RBT), westslope cutthroat trout (WCT), and brook trout (BKT) in the Idaho Kootenai River drainage in first-order streams and second- through fourth-order streams (2+).

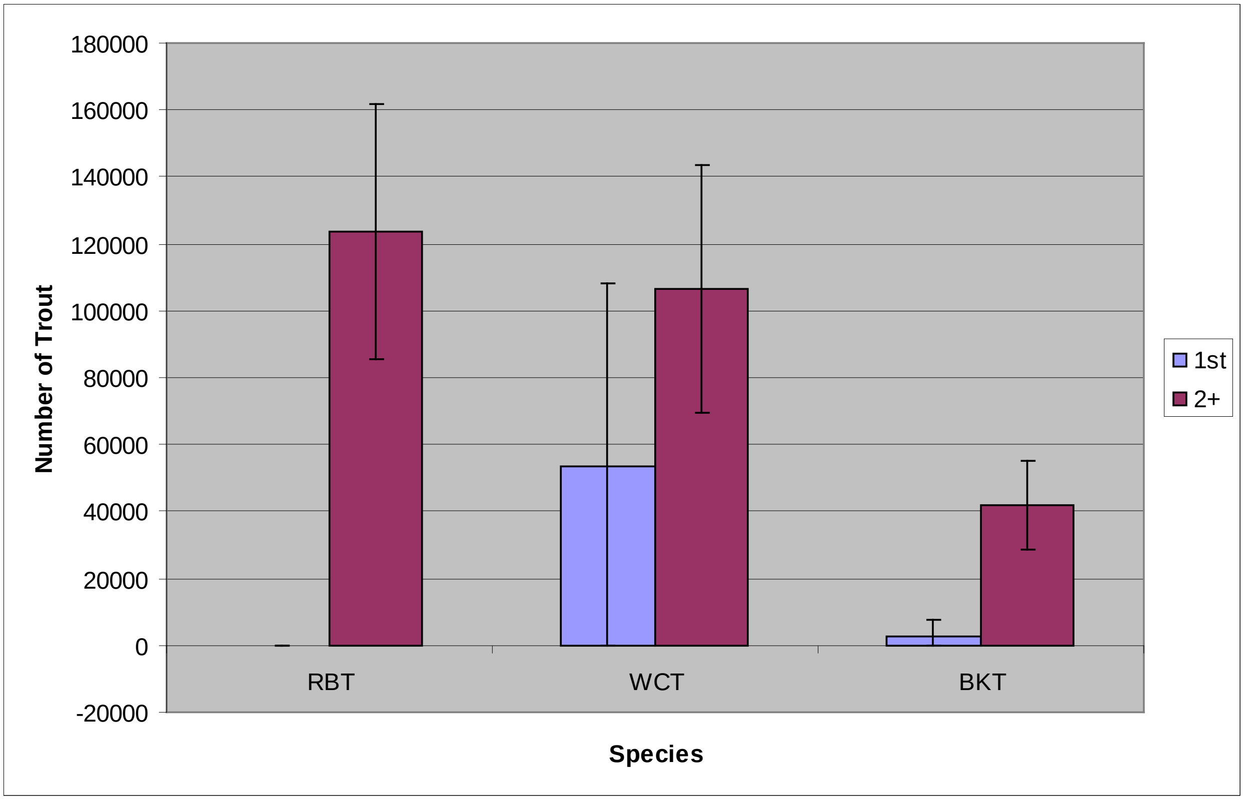

Figure 11. Total basinwide abundance estimates for rainbow trout (RBT), westslope cutthroat trout (WCT), and brook trout (BKT) in first- and second- through fourth-order streams.

Native vs. Nonnative Species

We estimated that westslope cutthroat trout densities were significantly lower at sites when sympatric with brook trout than when cutthroat trout was the only species present ($p < 0.02$, df = 15). The mean linear density for westslope cutthroat trout was 0.267 WCT/m (n = 20) at sites where they were sympatric with brook trout and 0.735 WCT/m (n = 14) at sites where brook trout were not present. At most sites where brook trout densities were relatively high, westslope cutthroat trout densities were relatively low, and vice versa (Figures 12 and 13). We sampled five sites that were inhabited by only westslope cutthroat trout and had higher densities than any single site that had both brook trout and westslope cutthroat trout present. The trend did not follow for rainbow trout. We found no significant difference between rainbow trout densities at sites where they were the only trout species compared to sites where they were sympatric with brook trout ($p > 0.05$, df = 34).

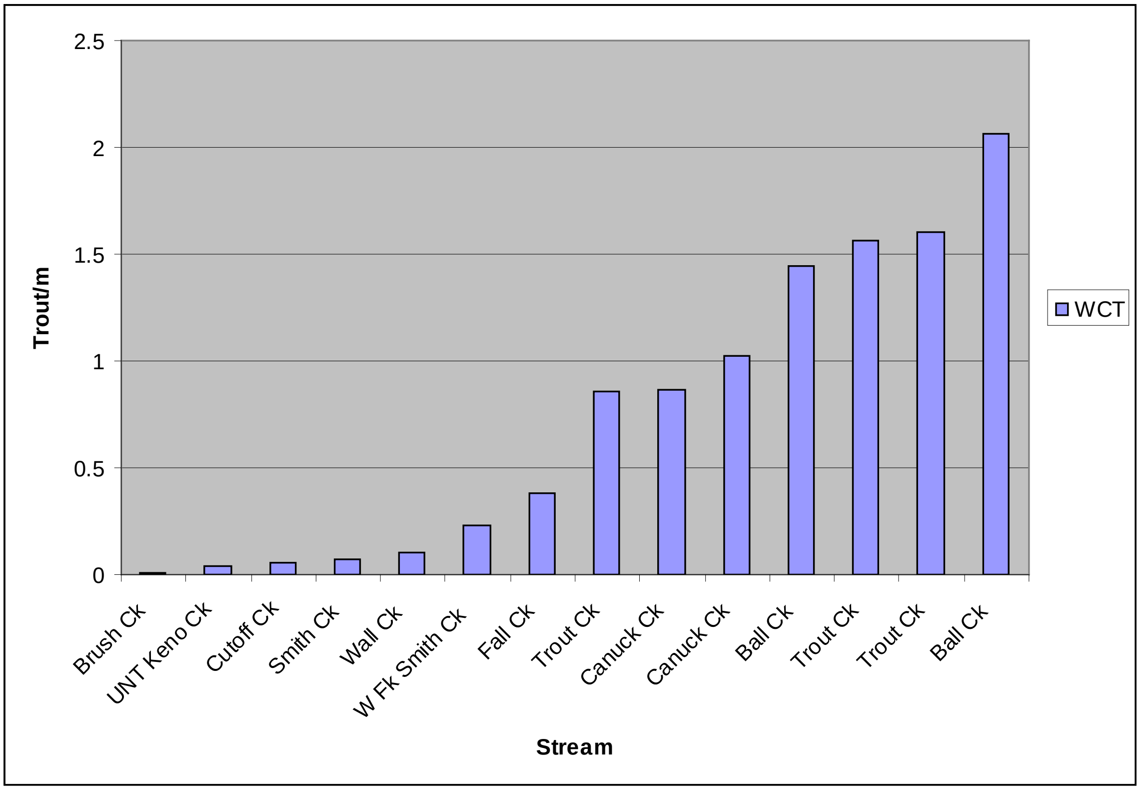

Figure 12. Mean densities of westslope cutthroat trout at sample sites without other trout species.

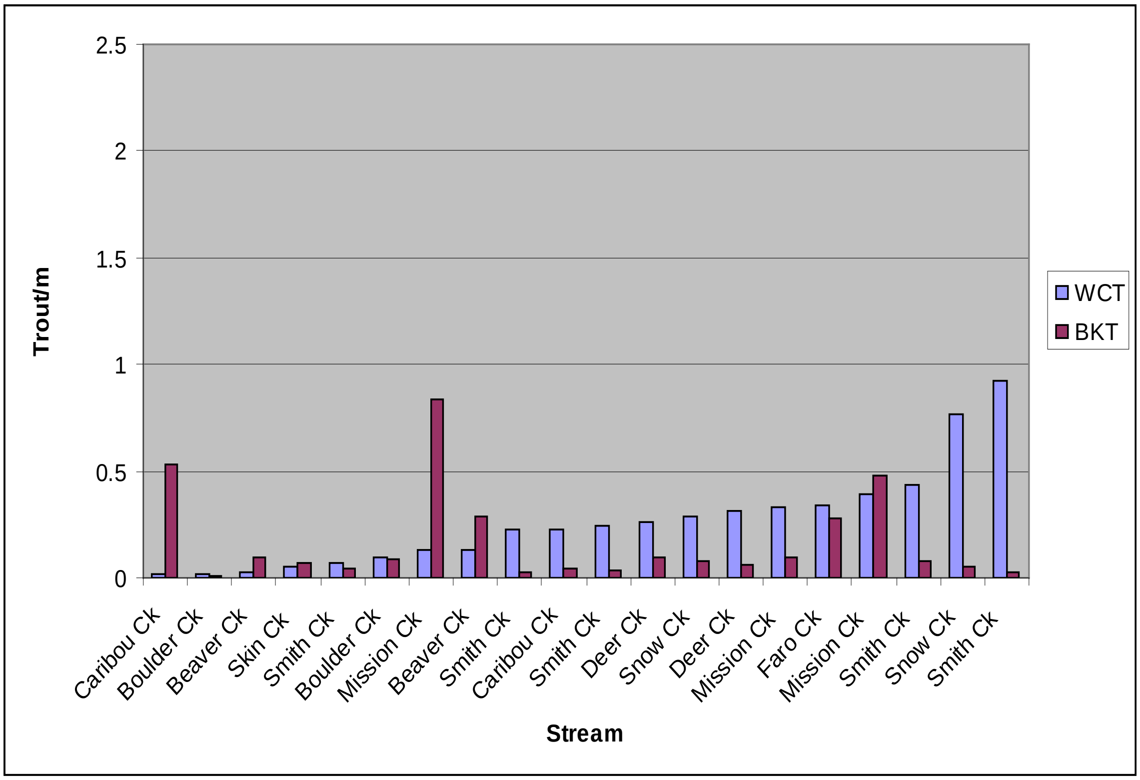

Figure 13. Mean densities of westslope cutthroat trout (WCT) and brook trout (BKT) where they were observed in the same stream.

DISCUSSION

The 2006 bull trout redd count for the Callahan drainage was the second highest recorded since counts began in 2002. However, the count for South Callahan Creek decreased for the third year in a row following the high count of 10 in 2003 (Table 1). Because redd numbers in the Callahan Creek drainage have only been monitored since 2002, the data series is too short to determine bull trout population trends based on redd counts. Index redd counts should continue annually on North and South Callahan creeks and Boulder Creek.

The distribution and abundance surveys allowed us to pinpoint tributaries in which bull trout were present as well as provided a basinwide population estimate of 734±750 (90% confidence interval) or 0.0819 bull trout/m in first- through fourth-order tributaries. Variability was high as a result of low sample size and that they were only found in three streams. In comparison to most other recovery units in Idaho bull trout densities in the Kootenai River unit were low (High et al. 2008), but researchers also noted data from this unit was low but our estimate will provide a good baseline with which to compare future estimates.

Rainbow trout PSD and catch per unit effort (CPUE) values remained comparable to those measured in 2004 and 2005, indicating that size structure and abundance have stabilized under the 406 mm length limit initiated in 2002 (Walters 2005). Monitoring of the rainbow trout population structure should continue to further evaluate the current regulations.

The Kootenai River nutrient restoration project was initiated in 2005. Nutrient restoration of the Kootenai River may promote an increase in rainbow trout survival and densities. An average of 5,300 age-0 rainbow trout out-migrate to the canyon reach of the Kootenai River each year from tributary streams in Idaho (Walters et al. 2005). Little is known about the ecology of these juvenile fish, but if nutrient restoration increases available food, juvenile survival would likely increase due to higher growth rates and body condition. Improved growth rates and condition of rainbow trout may also result in a younger age at maturity and higher fecundity rates. Monitoring of the rainbow population should continue to assess the success of the nutrient restoration program.

Sampling that we completed to assess trout distribution and abundance will serve as baseline data to monitor trout population trends in the Kootenai River drainage in Idaho. Even though native westslope cutthroat trout are the most abundant trout species in the Kootenai River drainage, they are still facing threats from nonnative brook trout and hybridization with nonnative rainbow trout. Brook trout have been shown to displace cutthroat populations, particularly where gradients are lower and sediments are finer, temperatures are higher, and the frequency of pools and woody debris is increased (Shepard 2004, Dunham et al. 2002). Rainbow trout were absent from first-order stream sample sites in this study. Rainbow trout are typically concentrated in the lower reaches of streams whereas cutthroat trout are more typically located in the upstream reaches (Behnke 1992, Bear et al. 2007). Because westslope cutthroat trout exist primarily above barriers from the Kootenai River, (and in some cases above many fish passage barriers), some subpopulations may be secure against invasion from nonnative species. It is important to identify these isolated genetically unaltered subpopulations and ensure that precautions are taken to avoid nonnative species invasion.

We could not differentiate between native Columbia River redband trout and introduced rainbow trout based on phenotypic traits; future genetic analysis may provide us with a better understanding of the current redband abundance and distribution within the drainage. Past decline in distribution within range of native trout can be attributed to the invasion of nonnative species as well as poor land use practices. Trout densities were highest in streams of the Selkirk Range, an area that has been less affected by anthropogenic activity than the Purcell and Cabinet mountains, as well as the Kootenai and Deep Creek valleys. Because habitat varies greatly within the Kootenai River drainage in Idaho, some streams within historic range that we hypothesized were lacking native trout may be inhabited by them in sections of stream that we did not sample.

There may be some bias associated with mark-recapture population estimates. Snorkeling was conducted within 1 hour to 1 day of marking fish, which was likely too short a duration to allow for the redistribution of fish. These population estimates may therefore be somewhat elevated. Future estimates should allow a period of two or more days between the marking and recapture sampling events.

In addition, we may have some bias in our basinwide analysis because our estimates were based on the 1:100,000 scale stream hydrography GIS layer. Estimates are likely low because actual stream length differed from mapped stream length. We had a relatively large number of sites (15) that were dry at the time of sampling. Many of these streams may be perennial streams that do not contain water or trout year round.

RECOMMENDATIONS

1. Continue annual bull trout redd surveys on index reaches of North and South Callahan creeks and Boulder Creek. This will allow construction of a time series to determine the bull trout population trend.

2. Maintain the current harvest regulations for rainbow trout (406 mm [16”] minimum size and 2 fish creel limit) in the Kootenai River and continue monitoring rainbow trout population statistics. Continued monitoring of rainbow trout population will provide information necessary to determine changes due to nutrient restoration or regulation changes.

3. Formulate a management approach for streams inhabited by salmonids in the Kootenai River drainage in Idaho that includes a relative ranking of remaining pure populations in terms of abundance and genetics. Develop a plan to control the distribution and density of brook trout, or to prevent further introgression of rainbow trout into westslope cutthroat trout populations for the highest priority systems.

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