LAKE KOOCANUSA AND KOOTENAI RIVER BASIN BULL TROUT MONITORING REPORT

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EXECUTIVE SUMMARY

We conducted juvenile bull trout population estimates within reference reaches on index creeks. O'Brien Creek and West Fisher Creek have decreased dramatically since survey began. Substrate scores and substrate coring data are presented.

Bull trout redd counts in Grave Creek and the Wigwam River have significantly increased since 1995. However, bull trout redds in Grave Creek in 2004 were lower (48%) than the previous year. Bull trout redd counts in tributaries downstream of Libby Dam including Quartz, Pipe, Bear, and O'Brien creeks, and the West Fisher River have been variable over the past several years, and have not increased in proportion to bull trout redd counts upstream of Libby Dam in recent years.

MFWP conducted four adult bull trout population estimates below Libby Dam during the period April 2004 to April 2005. The four population estimates ranged from 906 – 1,068 adult fish. One estimate was made in August 2004, when mature bull trout would be expected to be in spawning tributaries. We recaptured 14 bull trout in April 2005 that were individually marked approximately one year earlier, which enabled us to calculate growth rates over the period. On average the bull trout grew 86.4 mm (total length) and gained 2,093.9 g.

We continued monitoring fish populations within the reservoir using spring and fall gill netting and present the results for bull trout and kokanee. The spring gill net catch of bull trout significantly increased since 1990. We attempted to account for differing reservoir levels during the gillnetting activities between years by multiplying the mean bull trout catch per net by reservoir volume at the time the nets were fished each year. This adjustment substantially improved the regression model's fit to the data in previous years, but did not improve the fit with the addition of the 2004 data. Bull trout redd counts in both the Wigwam River and Grave Creek are both significantly and positively correlated to the spring gill net catch rates for bull trout adjusted for reservoir elevation. The average fall catch, length and weight of kokanee was lower for the fifth straight year than the 17-year average.

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INTRODUCTION

The bull trout that inhabit Lake Koocanusa and Kootenai River represent geographically distinct and important populations within their range. Montana Fish, Wildlife & Parks list bull trout as a species of special concern and in 1996 the United States Fish and Wildlife Service (USFWS), through the Endangered Species Act, listed bull trout as threatened throughout their range

Forestry practices are the dominant land use in all bull trout core areas and represent the highest risk to bull trout in the middle Kootenai (Libby Dam to Kootenai Falls). This risk to the bull trout population in the middle Kootenai is elevated due to the low number of spawning streams (Quartz, Pipe, O'Brien, Callahan and Libby Creek drainages) available; a direct result of habitat fragmentation caused by Libby Dam. The Kootenai River is a nodal habitat containing critical over-wintering areas, migratory corridors, and habitat required for reproduction and early rearing.

Dam operations are considered a very high risk to the continued existence of the Kootenai drainage population of bull trout (Montana Bull Trout Scientific Group 1996a). Dam operations represent a direct threat to bull trout in the middle Kootenai because of the biological affects associated with unnatural flow fluctuations and real potential gas supersaturation problems arising from spilling water. The dam is a fish barrier, generally restricting a portion of this migratory population to 29 miles of river between Libby Dam and Kootenai Falls.

In the upper Kootenai (above Libby Dam), the threats to bull trout habitat include illegal fish introduction, introduced fish species, rural residential development, and forestry. Additional risks come from mining, agriculture, water diversions, and illegal harvest (Montana Bull Trout Scientific Group 1996b). Critical spawning streams include the Grave Creek drainage in the U.S. and the Wigwam drainage in British Columbia. Transboundary research is ongoing in B.C. tributaries: Elk River, St. Mary River, Skookumchuck Creek, White River, Palliser River, and the Kootenay River upstream (Baxter and Oliver 1997). Nodal habitats for this population are provided in Lake Koocanusa, Tobacco River, and the Kootenay River in Canada.

Bull trout are found below Kootenai Falls in O'Brien Creek, Callahan Creek and in Bull Lake. The latter is a disjunct population that migrates out of Bull Lake, downstream to Lake Creek then upstream in Keeler Creek. These fish inhabit areas in the lower Kootenai River and Kootenay Lake during most of the year.

It is the intention of MFWP to manage bull trout populations as sport fisheries in the future. For this to happen, relevant population information must be compiled. This report will help to provide MFWP and other decision makers with the best available information for bull trout populations in the Kootenai River system. In an effort to maintain consistent survey and analysis throughout the region, we reproduced effort initiated in the Flathead drainage. Much of the background information for this report is excerpted, with thanks, from Deleray et al. (1999).

DESCRIPTION OF STUDY AREA

Kootenai River Drainage

The Kootenai River basin is an international watershed that encompasses parts of British Columbia (B.C.), Montana, and Idaho (Figure 1). The headwaters of the Kootenai River originate in Kootenay National Park, B.C. The river flows south within the Rocky Mountain Trench to the reservoir created by Libby Dam, which is located near Libby, Montana. From the reservoir, the river turns west, passes through a gap between the Purcell and Cabinet Mountains, enters Idaho, and then loops north where it flows into Kootenay Lake, B.C. The waters leave the lake's West Arm and flows south to join the Columbia River at Castlegar, B.C. In terms of runoff volume, the Kootenai is the second largest Columbia River tributary. In terms of watershed area (36,000 km^2 or 8.96 million acres), it ranks third (Knudson 1994).

Nearly two-thirds of the 485-mile-long channel, and almost three-fourths of the Kootenai watershed is located within the province of British Columbia. Roughly twenty-one percent of the watershed lies within Montana (Figure 1), and six percent is in Idaho (Knudson 1994). The Continental Divide forms much of the eastern boundary, the Selkirk Mountains the western boundary, and the Cabinet Range the southern. The Purcell Mountains fill the center of the river's J-shaped course to Kootenay Lake. Throughout, the basin is mountainous and heavily forested.

Libby Reservoir (Lake Koocanusa) and its tributaries receive runoff from 47 percent of the Kootenai River drainage basin. The reservoir has an annual average inflow of 10,615 cfs. Three Canadian rivers, the Kootenay, Elk, and Bull, supply 87 percent of the inflow (Chisholm et al. 1989). The Tobacco River and numerous small tributaries flow into the reservoir south of the International Border.

Major tributaries to the Kootenai River below Libby Dam include the Fisher River (838 sq. mi.; 485 average cfs), Yaak River (766 sq. mi. and 888 average cfs) and Moyie River (755 sq. mi.; 698 average cfs). Kootenai River tributaries are characteristically high-gradient mountain streams with bed material consisting of various mixtures of sand, gravel, rubble, boulders, and drifting clay and silt, predominantly of glacial/lacustrine origin. Fine materials, due to their instability during periods of high stream discharge, are continually eroded and re-deposited as gravel bars, forming braided channels with alternating riffles and pools.

Streamflow in unregulated tributaries generally peaks in May and June after the onset of snow melt, then declines to low flows from November through March. Flows also peak with rain-on-snow events. Kootenai Falls, a 20-foot-high waterfall and a natural fish-migration barrier, is located eleven miles downstream of Libby, Montana.

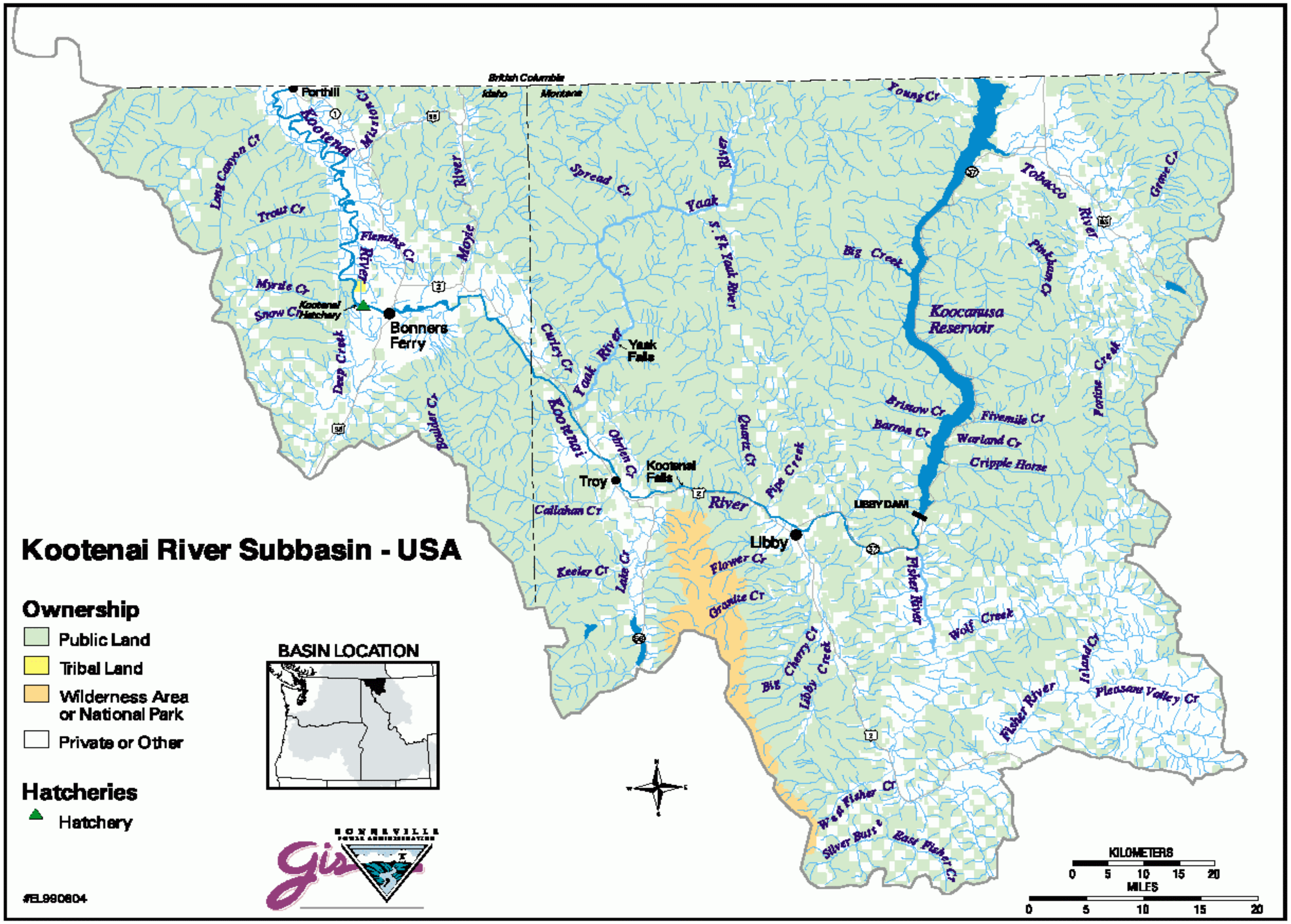

Figure 1. Kootenai River Basin (Montana, Idaho and British Columbia, Canada).

Libby Dam and Lake Koocanusa

Lake Koocanusa was created under an International Columbia River Treaty between the United States and Canada for cooperative water development of the Columbia River Basin (Columbia River Treaty 1964). Lake Koocanusa inundated 109 stream miles of the mainstem Kootenai River in the United States and Canada, and 40 miles of tributary streams in the U.S. that provided habitat for spawning, juvenile rearing, and migratory passage for salmonids.

Libby Dam is a 113-m (370-ft) high concrete gravity structure with three types of outlets: sluiceways (3), operational penstock intakes (5 operational, 8 possible), and a gated spillway. The dam crest is 931 m long (3,055 ft), and the widths at the crest and base are 16 m (54 ft) and 94 m (310 ft), respectively. A selective withdrawal system was installed at Libby Dam to allow for temperature-controlled release of water from the reservoir.

Completion of Libby Dam in 1972 created the 109-mile Lake Koocanusa. Specific morphometric data for Lake Koocanusa are presented in Table 1. Filling Lake Koocanusa inundated and eliminated 109 miles of the mainstem Kootenai River and 40 miles of critical, low-gradient tributary habitat. This conversion of a large segment of the Kootenai River from a lotic to lentic environment changed the aquatic community (Paragamian 1994). Replacement of the inundated habitat and the community of life it supported are not possible. However, mitigation efforts are underway to protect, reopen, or reconstruct the remaining tributary habitat to offset the loss. Fortunately, in the highlands of the Kootenai Basin, tributary habitat quality is high. The headwaters are relatively undeveloped and retain a high percentage of their original wild attributes and native species complexes. Protection of these remaining pristine areas and reconnection of fragmented habitats are high priorities for bull trout and other native species.

Table 1. Morphometric data presented for Lake Koocanusa Morphometric data.

Surface elevation	
maximum pool	749.5 m (2,459 ft)
minimum operational pool	697.1 m (2,287 ft)
minimum pool (dead storage)	671.2 m (2,222 ft)
Area	
maximum pool	188 sq. km (46,500 acres)
minimum operational pool	58.6 sq. km (14,487 acres)
Volume	
maximum pool	7.24 km^3 (5,869,400 acre-ft)
minimum operational pool	1.10 km^3 (890,000 acre-ft)
Maximum length	145 km (90 mi)
Maximum depth	107 m (350 ft)
Mean depth	38 m (126 ft)
Shoreline length	360 km (224 mi)
Shoreline development	7.4 km (4.6 mi)
Drainage area	23,271 sq. km (8,985 sq. mi)

Fish Species

Eighteen species of fish are present in Koocanusa Reservoir and the Kootenai River drainage (Table 2). The reservoir currently supports an important fishery for kokanee *Oncorhynchus nerka* and rainbow trout *Oncorhynchus mykiss* (Kamloops strain), with annual fishing pressure from 30,000 to over 100,000 angler days. The Kootenai River below Libby Dam is a "blue ribbon" rainbow trout fishery, and the state record fish was harvested there in 1997 (over 33 pounds). Bull trout *Salvelinus confluentus* are captured "incidentally".

Table 2. Current relative abundance (A=abundant, C=common, R=rare, N = Not Found) and abundance trend from1975 to 2002 (I=increasing, S = stable, D = decreasing, U = unknown) of fish species present in Lake Koocanusa and the Kootenai River drainage.

Common Name	Scientific name	Relative Abundance Reservoir	Trend	Relative Abundance drainage	Trend	Native
Game fish species						
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	R	D	C	S	Y
Rainbow trout	*Oncorhynchus mykiss*	R	D	C	S	Y
Bull trout	*Salvelinus confluentus*	C	I	C	I	Y
Brook trout	*Salvelinus fontinalis*	R	U	A	S	N
Lake trout	*Salvelinus namaycush*	N	U	R	D	N
Kokanee salmon	*Oncorhynchus nerka*	A	U	R	U	N
Mountain whitefish	*Prosopium williamsoni*	R	D	A	S	Y
Burbot	*Lota lota*	C	D	R	D	Y
Largemouth bass	*Micropterus salmoides*	R	U	R	U	N
White sturgeon	*Acipenser transmontanus*	R	D[∈]	R	D	Y[∉]
Northern pike	*Esox lucius*	R	U	R	U	N
Yellow perch	*Perca flavescens*	C	I	R	U	N
Non-game fish species						
Pumpkinseed	*Lepomis gibbosus*	R	U	R	U	N
Redside shiner	*Richardsonius balteatus*	R	D	R	U	Y
Peamouth	*Mylocheilus caurinus*	A	I	R	U	Y
Northern pikeminnow	*Ptychocheilus oregonensis*	A	I	R	U	Y
Largescale sucker	*Catostomus macrocheilus*	A	S	C	U	Y
Longnose sucker	*Catostomus catostomus*	C	D	R	U	Y

[∈] Five white sturgeon were relocated from below Libby Dam to the reservoir. At least one of these fish moved upriver out of the reservoir while two have been accounted for from angler reports and one verified mortality.

[∉] An abundance of anecdotal reports exist of white sturgeon above Kootenai Falls although research to date has failed to validate any reports.

STREAM ELECTROFISHING/
JUVENILE BULL TROUT ABUNDANCE ESTIMATES

Introduction

Estimation of fish population abundance is necessary for understanding basic changes in numbers, species composition and year class strength. Direct enumeration is the most accurate technique, but in most situations indirect methods must be employed. We generally use a combination of techniques in order to minimize errors. Fish populations are dynamic and may fluctuate considerably, even over relatively short periods of time, regardless of human influence. Consequently, managers seeking to assess the effects of various activities on fish populations must understand the nature and causes of such fluctuations as fully as possible.

We used the protocols similar to those developed to assess fish abundance in the Flathead Basin using electrofishing techniques (Shepard and Graham 1983). Monitoring focuses on quantifying yearly variation of fish abundance in stream sections sampled consistently year after year. We recommend using electrofishing techniques to assess fish abundance in accessible streams because:

1. The precision of electrofishing can be estimated and reported, providing a measure of reliability;

2. There is less bias associated with changes in field personnel; and

3. Estimates derived using electrofishing techniques are presently more accepted by fisheries professionals.

Two-pass Assumptions (Seber and LeCren 1967):

1. Probability of capture (p) is large enough to have a significant effect upon population total (N).

We can test this assumption by computing (p) after two passes are complete. If p is less than 0.5, assumption 1 probably has been violated (Junge and Libovarsky 1965) and more effort is required. We recommend (p) should be 0.6 or larger.

2. Probability of capture is constant. Fishing effort is the same for both catches and fish remaining after the first pass are as vulnerable to capture as were those that were caught in the first pass.

Assumption 2 has frequently been found to be faulty when electrofishing (Lelek 1965, Gooch 1967, Cross and Stott 1975, Mahon 1980). White et al. (1982) found if p was 0.8 or larger, two-catch estimates were reliable because failure of constant probability of capture (assumption 2) did not matter. We found that as long as p was 0. 6 or larger and stream discharge was less than 20 cfs, estimates computed using two-catch estimators were similar to mark-recapture estimates. Zippin (1958) determined that if the probability of capture (p) decreases with subsequent collections, the estimate was an underestimate of the true population size. These estimates may still be reported, but should be used cautiously. They can be used to compare trends in population abundance, provided the same techniques are used throughout the monitoring program.

3. There is no recruitment, mortality, immigration or emigration between the times of the two collections.

Assumption 3 can be easily met, since both electrofishing collections take place within a single day and the section is isolated using block nets.

4. The first catch is removed from the population or, if returned alive, the individuals are marked so they can be ignored when counting the second catch.

This assumption can be met by removing the first catch from the population.

Bull trout fry are exceedingly difficult to capture by electrofishing. There are several reasons for this:

1: Their small surface area makes effective, efficient, repeatable shocking difficult
2: Their small size (usually 35 to 50 mm at time of estimates) makes seeing them difficult
3: Because of their small size there is a high likelihood they will slip through nets during the estimate
4: Because of their small size there is a high likelihood that they will slip through the block nets.

We felt that these reasons led to too much probability to violate our capture assumptions, especially 1,2,and 3. We therefore chose not to include fry in the yearly estimates. We captured a representative sample of bull trout fry and included measurements on the field sheets.

Methods

We incorporated the following fish abundance monitoring guidelines for Kootenai drainage estimates:

1. In streams less than 10 cfs, we used two-pass electrofishing technique. In these small streams adequate numbers of fish were captured using a backpack mounted generator-Variable Voltage Pulsator combination. Probability of capture (p) should be higher than 0.6 to obtain reliable results.

2. In streams 10 to 20 cfs, we used two-pass electrofishing estimation. We used two backpack mounted shocking units. If the p-value falls below 0.6 for a sample site, more effort (third pass) should be made instead of simply reporting the two-catch estimate.

3. In streams larger than 20 cfs, two-pass electrofishing technique was used; however p value must be higher than 0.6. We used both boat mounted shocking equipment and backpack mounted equipment simultaneously for these sample sections.

Two-pass Procedure:

We placed a braided nylon block net (1/4 inch mesh) at the lower boundary of the shocking section. When using a block net, we placed the net in the stream with the bottom edge facing upstream and place rocks on the weighted (bottom) edge of the net to hold it in position. We tied the ropes along the top edge of the net to a tree (or any available stable item) on each bank to stretch the net tight and hold it perpendicular to the flow. Rocks placed along the entire bottom edge of the net ensure no fish move under the net. Rebar cut into 1.0 m lengths supported the net upright.

We chose sample sections based on accessibility and proximity to redds that were found in previous years. Though we kept sample sites consistent, section length was not consistent between sites or between years due to considerable shifting of streambeds during some years. Section lengths were based on riffle breaks at the top of sections and pools at the bottom.

We sampled each section from the upstream boundary to the lower block net. We found that downstream electrofishing was more efficient than upstream electrofishing, and if two passes were needed for each catch (to provide a reliable estimate), both passes should be downstream. It is important to extend equal efforts during each pass, so that if two passes were used for the first catch; two passes must also be completed for the second catch. Mahon (1980) believed longer time periods between catches improved the accuracy of catch per unit effort estimators. For this reason, we recommend some time between collections. During this time, we worked all fish captured on the first pass.

Two-Pass Estimators:

We used the following formula to estimate population number (Seber and LeCren 1967):

$$N = \frac{C_1^2}{C_1 - C_2}$$

Where N = population size at the time of first pass

C_1 = number of fish > 1+ captured during first pass (by species)
C_2 = number of fish > 1+ captured during second pass (by species)

Variance of the estimate:

$$V(N) = \frac{C_1^2 C_2^2 (C_1 + C_2)}{(C_1 - C_2)^4}$$

Probability of capture (p):

$$p = \frac{C_1 - C_2}{C_1}$$

As stated previously, p should be ≥ 0.6 for a reliable, two-pass estimate to be made. Though there were times when time constraints made a third pass problematic, if p ≤ 0.6, the estimate was reported, but must be viewed with caution. If p ≥ 0.6 we completed the estimate; otherwise, generally more fishing effort was expended. This effort can be expended for computing a multiple estimate (by completing additional electrofishing and computing a multi-catch estimate using formulas presented in Zippin 1958). Population estimates and associated 95% confidence intervals were estimated using *Microfish 2.2* (Van Deventer and Platts 1983).

When reporting the estimates of fish numbers computed by electrofishing, we reported the estimate, the 95 percent confidence interval, the area of the section surveyed, the date, and the density and number of mortalities. When reporting two-pass estimates, we reported the probability of capture (p) with the estimate.

Findings

Grave Creek

The Grave Creek fish abundance section is the only section in the U.S. portion of Lake Koocanusa. It is located just upstream of Clarence Creek and has varied from 190 m to 220 m in length. It is a relatively stable section but has been affected periodically by high flows and beaver activity. We have electrofished this section annually since 1997 results are presented in Table 3. Redd counts have increased dramatically in this tributary since 1997, but densities of juveniles are not showing similar results. At the same time we saw an increase in Young-of-year bull trout caught in a screw trap (located approximately 7 miles upstream from the mouth) that was installed to assess migration into an irrigation ditch. In 1998, we trapped 32 bull trout, all of which were 1+ and older; in 2001, we found 204 bull trout in the trap of which ten were 1+ and older; and in 2002, only one of 178 trapped was 1+. These results lead us to believe that under current habitat conditions, Grave Creek may be near or at carrying capacity for juvenile bull trout.

Table 3. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of Grave Creek, 1997 - 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
Grave Creek	1997	158	+/- 12	0.72	9.7
	1998	186	+/- 9	0.77	11.4
	1999	139	+/- 27	0.57	8.5
	2000	160	+/- 17	0.51	9.8
	2001	165	+/- 18	0.67	11.6
	2002	116	+/- 15	0.66	8.5
	2003	156	+/- 19	0.75	15.6
	2004	153	+/- 10	0.83	13.3
	2005	153	+/- 17.6	0.76	14.5

West Fork Quartz Creek

The West Fork Quartz Creek fish abundance section is located at the FS 399 bridge. The section has varied in length from 165 m to 248 meters due to spring flows and downfall from wind events. We chose West Fork Quartz rather than mainstem Quartz Creek because we found the majority of redds from year to year are in that tributary. Densities of juvenile bull trout have generally increased since 1997 (Table 4). This is likely due to a number of factors that include reduced land management in the drainage and increased numbers of spawning adults from the Kootenai River. This section has remained relatively stable for juvenile bull trout in spite of highly variable redd counts.

Table 4. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of West Fork Quartz Creek, 1997 - 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
West Fork Quartz Creek	1997	76	+/- 1	0.94	5.4
	1998	82	+/- 5	0.74	6.6
	1999	Not Sampled			
	2000	87	+/- 14	0.60	9.2
	2001	89	+/- 9	0.67	7.4
	2002	89	+/- 4	0.77	10.6
	2003	70	+/- 6	0.67	7.6
	2004	72	+/- 6	0.81	7.9
	2005	64	+/- 10	0.76	7.3

Pipe Creek

The Pipe Creek fish abundance section is located approximately 3 miles below the confluence with East Fork Pipe Creek. We have found redds above and below the section.. The section has varied in length from 147 to 206 meters due to changes caused by spring flows and downfall from wind events. This is a relatively stable stretch but, there have been some pool changes. Densities of juvenile bull trout remained relatively stable to slightly decreasing between 1999 and 2005 (Table 5). This occurred as redd counts decreased substantially in 1999 and 2005 likely from low water conditions and periodic manmade dams below the spawning sites.

Table 5. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of Pipe Creek, 1999 - 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
Pipe Creek	1999	31	+/- 1	0.76	2.2
	2000	54	+/- 9	0.68	3.8
	2001	23	+/- 4	0.76	2.1
	2002	18	+/- 1	0.71	1.8
	2003	24	+/- 4	0.77	2.2
	2004	22	+/- 2	0.85	1.6
	2005	12	No Recaptures		1.0

West Fisher Creek

West Fisher Creek was sampled for the first time in 2002. The section is centered on the FS 231 road bridge and was 207 meters long and averaged 7.6 meters in width. Though densities were low, the 2002 estimate of 37 juvenile bull trout was unexpected because of extremely low redd counts and low water during 2001 and 2002 (Table 6). About one-half of the juveniles counted were from the adults that spawned in 2000. Unfortunately, the trend continues downward. This may be due to drought over the last several years has caused low flows and elevated temperatures in the downstream tributaries. The increase in spawning in 2004 may reverse this trend.

Table 6. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of West Fisher Creek, 2002 - 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
West Fisher Creek	2002	37	+/- 2	0.75	2.0
	2003	9	+/- 2	0.81	0.6
	2004	5	+/- 1	0.83	0.3
	2005	2	No Recaptures		0.1

Bear Creek

The Bear Creek fish abundance section is centered on the FS 278 bridge. The section has varied in length from 132 to 213 meters due to changes caused by spring flows and downfall from wind events. This is a relatively stable stretch of stream although there have been some pool changes. Densities of juvenile bull trout increased substantially between 1999 and 2002 (Table 7). We believe the dramatic decrease in 2002, 2004 and 2005 were caused by low water. Several sections of Libby Creek, to which Bear Creek is a tributary, dried by late July in 2001. The same occurred in 2002 so we expect similar, if not lower densities. Montana Fish, Wildlife & Parks special projects is working with private, corporate and public landholders to reconstruct portions of Libby Creek in hopes that the complete loss of stream flow during low water years can be minimized. This is a slow and laborious process that will likely take 10's of years.

Table 7. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of Bear Creek, 1999 - 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
Bear Creek	1999	101	+/- 9	0.73	8.5
	2000	103	+/- 3	0.87	12.1
	2001	80	+/- 9	0.72	14.0
	2002	67	+/- 3	0.85	6.2
	2003	108	+/- 10	0.79	8.4
	2004	46	+/- 7	0.77	2.6
	2005	79	+/- 17.6	0.69	3.8

O'Brien Creek

O'Brien Creek is the only tributary below Kootenai Falls confirmed to support bull trout spawning from the Kootenai River (there are bull trout in Callahan Creek, although we have not been successful in trapping upstream migrating adults). The O'Brien Creek fish abundance section currently is centered on the FS 331 bridge above Rabbit Creek. The section has remained stable at 140 meters since the initial survey in 1998. This is a relatively stable stretch of stream with little change in pools from year to year. Densities of juvenile bull trout decreased dramatically between 1998 and 2002 and have remained extremely low since then (Table 8). We could not do estimate in 2002 or 2005 because we got no recaptures.

We believe that the decrease in juvenile densities was caused by a combination of an encroaching beaver population and low water. Redd counts remained relatively stable over this time but the distribution of redds shifted downstream because beaver dams have caused very high sedimentation in some traditional spawning areas. Additionally, estimates of resident brook trout and westslope cutthroat trout and rainbow trout were similar throughout the survey years.

Table 8. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of O'Brien Creek, 1998 - 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
O'Brien Creek	1998	91	+/- 4	0.84	13.2
	1999	29	+/- 1	0.88	4.2
	2000	21	+/- 7	0.66	3.0
	2001	11	+/- 2	0.61	1.6
	2002	2	No Recaptures		0.3
	2003	5	+/- 1	0.83	0.5
	2004	16	+/- 1	0.89	2.1
	2005	2	No Recaptures		0.3

Keeler Creek

Bull trout that spawn in Keeler Creek (including the North, South and West Forks) are adfluvial and migrate downstream out of Bull Lake into Lake Creek, then up Keeler Creek. This downstream spawning migration is somewhat unique when compared to other bull trout populations (Montana Bull Trout Restoration Team 1996a). Lake Creek, a tributary of the Kootenai River, has an upstream waterfall barrier isolating this population from the mainstem Kootenai River population. A micro-hydropower dam constructed in 1916 covered the upper portion of the waterfall. A series of high gradient waterfalls are still present below the dam, and are barriers to all upstream fish passage. Keeler Creek may supply some recruitment to the Kootenai River through downstream migration.

The Keeler Creek fish abundance section located approximately 1 mile below North Fork Keeler Creek. The section lengths remained fairly constant between 203 and 214 meters since the initial survey in 1998. This is a relatively stable stretch of stream with little change in pools from year to year. The top of the section is controlled by a rock out crop and the bottom is a very stable pool. Densities of juvenile bull trout remained very stable between 1999 and 2002 (Table 9). The estimate in 1998 was an exception. We captured more than twice as many bull trout that year as others. One explanation might be that the flows were very high that year and more juveniles passed into this stable section that includes two fairly large pools. Continued low estimates since 2002 may be reflecting low water and beaver activity.

Table 9. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of Keeler Creek, 1998 - 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
Keeler Creek	1998*	159	+/- 50	0.33	7.7
	1999	65	+/- 16	0.69	3.3
	2000	61	+/- 41	0.42	3.1
	2001*	66	+/- 12	0.50	3.0
	2002	74	+/- 13	0.73	3.9
	2003	63	+/- 11	0.74	3.4
	2004	27	+/- 2	0.84	1.4
	2005	18	+/- 1	0.95	1.1

* Three pass estimates.

Callahan Creek

The Callahan Creek fish abundance section is actually on North Callahan Creek just above the confluence with South Callahan Creek and is located above the FS 414 bridge. The section has varied in length from 154 m to 183 meters due to spring flows and downfall from wind events. We chose North Callahan Creek rather than mainstem Quartz Creek because we found the majority of redds from year to year are above that tributary and logistics of access to mainstem was difficult at best. Densities of juvenile bull trout have generally increased since 2003 (Table 10). Idaho Fish and Game monitors the redds for this stream and we will continue to track juvenile estimates.

Table 10. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of Callahan Creek, 2003 - 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
Callahan Creek	2003	10	+/- 1	0.83	0.7
	2004	43	+/- 4	0.82	2.4
	2005	35	+/- 4	0.79	2.2

Libby Creek Above Falls

The Libby Creek fish abundance section is located above Libby Falls below the Montenore mine site. We have two years of electrofishing at this site and the section has remained at 150 meters. This particular population is an isolated resident population separated from upstream movement by Libby Falls (approximately 60 ft). The estimate has likely included resident adults. Densities of bull trout increased from 2003 to 2005 (Table 11). We will continue to monitor this unique population as it is also below a proposed adit mine.

Table 11. Population estimates (N), 95 percent confidence intervals (95% C.I.), probability of first pass capture (p) and densities for Age 1 and older bull trout calculated from electrofishing in the permanent section of Libby Creek, 2003 and 2005.

Stream	Year	N	95 % C.I.	p	Density (#100m^2)
Libby Creek	2003	27	+/- 2	0.90	3.0
Above Libby Falls	2004	No estimate			
	2005	55	+/- 8	0.72	5.2

STREAMBED CORING

Introduction

Successful egg incubation and fry emergence are dependent on gravel composition, gravel permeability, water temperature, and surface flow conditions. The female trout begins redd construction by digging an initial pit or depression in the streambed gravel with her tail. After the spawning pair deposits eggs and sperm into this area, the female moves upstream a short distance and continues the excavation, covering the deposited eggs. The process is then repeated several more times, resulting in a series of egg pockets formed by the upstream progression of excavations. The displaced gravel mounds up, covering egg pockets already in place. After egg deposition is complete the female creates a large depression at the upstream edge of the redd. This enhances intra-gravel flow and displaces more gravel back over the entire spawning area. Excavation of the redd causes fine sediments and organic particles to be washed downstream, leaving the redd environment with less fine material than the surrounding substrate. Weather, streamflow, and transport of fine sediment and organic material in the stream can change conditions in redds during the incubation period. Redds can be disturbed by other spawning fish, animals, human activities, or by high flows which displace streambed materials (Chapman 1988).

Redd construction by migratory bull trout in the Flathead drainage disturbs the streambed to a depth of at least 18.0 to 25.0 cm (Weaver and Fraley 1991). Egg pockets of smaller fish (brook trout) tend to be shallower. The maximum depth of gravel displacement is indicative of egg deposition depth (Everest et al. 1987). Freeze coring documented larger substrate particles (up to 15.2 cm) at the base of egg pockets than in overlying substrates (Weaver and Fraley 1991). These particles are likely too large for the female to dislodge during redd construction. Eggs are deposited and settle around these larger particles (Chapman 1988). Continued displacement of streambed materials by the female then covers the eggs.

Redds become less suitable for incubating embryos if fine sediments and organic materials are deposited in interstitial spaces of the gravel during the incubation period. Fine particles impede movement of water through the gravel, thereby reducing delivery of dissolved oxygen to, and flushing of metabolic wastes away from incubating embryos. This results in lower survival (Wickett 1958; McNeil and Ahnell 1964; Reiser and Wesche 1979). For successful emergence to occur fry need to be able to move within the redd, but high levels of fine sediment can restrict their movements (Koski 1966; Bjornn 1969; Phillips et al. 1975). In some instances, embryos that incubate and develop successfully can become entombed (trapped by fine sediments). Sediment levels can alter timing of emergence (Alderdice et al. 1958; Shumway et al. 1964) and affect fry condition at emergence (Silver et al. 1963; Koski 1975).

Measurements of the size range of materials in the streambed are indicative of spawning and incubation habitat quality. In general, research has shown negative relationships between fine sediment and incubation success for salmonids that construct redds (Chapman 1988). A significant inverse relationship exists between the percentage of fine sediment in substrates and survival to emergence of westslope cutthroat trout and bull trout embryos in incubation tests

(Weaver and White 1985; Weaver and Fraley 1991, 1993). Mean adjusted emergence success ranged from about 80 percent when no fine material was present, to less than 5 percent when half of the incubation gravel was smaller than 6.35 mm; about 30 percent survival occurs at 35 percent fines. Entombment was the major mortality factor.

Median percentages of streambed materials smaller than 6.35 mm at fry emergence ranged from 24.8 to 50.3 percent in 29 separate bull trout spawning areas sampled during the Flathead Basin Forest Practice Water Quality and Fisheries Study (Weaver and Fraley 1991). Linear regression of results against output from models assessing ground disturbing activity and water yield increases in these 29 Flathead Basin tributary drainages showed significant positive relationships (Weaver and Fraley 1991). These results demonstrate a linkage between on-the-ground activity and spawning habitat quality. This testing allowed development of models that predict embryo survival to emergence, given the percentage of material smaller than 6.35 mm in the incubation environment. We monitor bull trout spawning and incubation habitat quality by determining the percent fines in a given spawning area through hollow core sampling across years.

Methods

Field crews used a standard 15.2 cm hollow core sampler (McNeil and Ahnell 1964) to collect four samples across each of three transects at each study area. We located actual coring sites at the transects using a stratified random selection process. The total width of stream having suitable depth, velocity, and substrate for spawning was visually divided into four equal cells. We randomly took one core sample in each cell. In some study areas we deviated from this procedure due to limited or discontinuous areas of suitable spawning habitat. We selected study areas based on observations of natural spawning. We only sampled in spawning areas used by adfluvial and fluvial bull trout. During the period of study, these fish spawned in the same general areas, so sampling locations remained similar.

Sampling involved working the corer into the streambed to a depth of 15.2 cm. We removed all material inside the sampler and placed it in heavy duty plastic bags. We labeled the bags and transported them to the Kootenai National Forest Soils Laboratory in Libby, Montana, for gravimetric analysis. We sampled the material suspended in water inside the corer using an Imhoff settling cone (Shepard and Graham 1982). We allowed the cone to settle for 20 minutes before recording the amount of sediment per liter of water. After taking the Imhoff cone sample, we determined total volume of the turbid water inside the corer by measuring the depth and referring to a depth to volume conversion table (Shepard and Graham 1982).

The product of the cone reading (ml of sediment per liter) and the total volume of turbid water inside the corer (liters) yields an approximation of the amount of fine sediment suspended inside the corer after sample removal. We than applied a wet to dry conversion factor developed for Flathead tributaries by Shepard and Graham (1982), yielding an estimated dry weight (g) for the suspended material.

We oven dried the bagged samples and sieve separated them into 13 size classes ranging from

>76.1 mm to <0.063 mm in diameter (Table 12). We weighed the material retained on each sieve and calculated the percent dry weight in each size class. The estimated dry weight of the suspended fine material (Imhoff cone results) was added to the weight observed in the pan, to determine the percentage of material <0.063 mm.

Table 12. Mesh size of sieves used to gravimetrically analyze hollow core streambed substrate samples collected from Kootenai River basin tributaries.

76.1 mm	(3.00 inch)
50.8 mm	(2.00 inch)
25.4 mm	(1.00 inch)
18.8 mm	(0.74 inch)
12.7 mm	(0.50 inch)
9.52 mm	(0.38 inch)
6.35 mm	(0.25 inch)
4.76 mm	(0.19 inch)
2.00 mm	(0.08 inch)
0.85 mm	(0.03 inch)
0.42 mm	(0.016 inch)
0.063 mm	(0.002 inch)
Pan	(<0.002 inch)

We refer to each set of samples by using the median percentage <6.35 mm in diameter. This size class is commonly used to describe spawning gravel quality, and it includes the size range typically generated during land management activities. We examined the range of median values for this size class observed throughout the survey area.

Findings

Core sampling in indicator streams has been sporadic since 1994 (Table 13). The current standard for assessing impairment of streams due to increase in sediments is based on fine sediment (<6.35 mm). Weaver and Fraley (1991) found that survival is reduced to one-third when fine sediments reach 35 percent and at 40 percent the survival drops to one-quarter.

Though there is not enough long-term data presented to fully assess trends in the monitored streams, most appear show stable if not decreasing fine sediment levels. Two exceptions are O'Brien Creek and the British Columbia portion of the Wigwam River. Both have been impacted by extra activities in the past several years.

As was mentioned previously, beavers have become well established in the upper end of O'Brien Creek and are migrating downstream. O'Brien Creek appears to be a fairly high sediment system at the upper end with a large amount of low gradient tortuous stream immediately above the historic spawning areas. Fine sediments may be held back from flushing during high water events and the additional daily activity of the beavers throughout the lower water may release more fine sediments into the stream.

The sediment characteristic in the Wigwam River drainage like most of the bull trout drainages in the Kootenai River basin is a product of natural and anthropogenic disturbances through history. Heavy logging activities in both Montana and British Columbia drainages and 100 year and 200-year flood events have shaped the system in the last 50 years. Oliver and Cope (1999) suggested that "…Frequent lateral channel migrations over time have resulted in erosion of adjacent terraces, coarse sediment delivery to the mainstem river, and have created numerous section of braided channel comprised of sorted gravels and cobbles that provide prime spawning habitat for bull trout". Tepper (2002) found that between 1998 and 2002 the average median of fine sediments (<6.35 mm) increased from 25.2 to 31.7 from the upstream (Montana portion) to downstream (Bighorn Creek) survey sites. It would be advisable to continue monitoring this important tributary as land management activities including considerable new road building occur in the next 10 years.

Table 13. Median percentage of streambed material smaller than 6.35 mm in McNeil core samples collected from bull trout spawning areas in tributary streams to the Kootenai River basin, 1998 – 2004.

Stream	1998	1999	2000	2001	2002	2003	2004
Grave Creek	22.0		25.3	20.4	29.6	28.9	28.7
West Fork Quartz Creek	27.5			29.3	27.0	26.4	32.8
Pipe Creek	38.5	31.5	31.4	29.1	32.4	37.0	31.0
Bear Creek			19.0		28.7	36.7	25.3
O'Brien Creek	36.5			35.5	31.5	36.1	35.4
North Fork Keeler Creek	29.0		18.7	22.4	27.3	33.7	30.8
Wigwam River (Ram Cr)	24.0	30.0	37.0	34.0	35.0		
Wigwam River U.S.	26.5	21.0	24.9				

SUBSTRATE SCORING

Introduction

Environmental factors influence distribution and abundance of juvenile bull trout within drainages throughout the range of the species, as well as within specific stream segments (Oliver 1979, Allan 1980, Leathe and Enk 1985, Pratt 1985, Fraley and Shepard 1989, Ziller 1992). Temperature, cover, and water quality regulate general distributions and abundances of juvenile salmonids within drainages. Depth, velocity, substrate, cover, predators, and competitors affect juvenile presence at specific locations in a stream. Although spawning occurs in limited portions of the drainage, juvenile salmonids disperse to occupy most of the areas within the drainage that are suitable and accessible (Everest 1973; Leider et al. 1986).

Juvenile bull trout rear for up to four years in Kootenai Basin tributaries. Snorkel and electrofishing observations during past studies indicate juvenile bull trout are extremely substrate-oriented and can be territorial (Fraley and Shepard 1989). This combination of traits results in partitioning of suitable rearing habitat and a carrying capacity for each stream. We monitor substrate-related habitat potential by calculating substrate scores (Leathe and Enk 1985).

Substrate composition influences distribution of juvenile bull trout and rearing capacities of nursery streams. Sediment accumulations reduce pool depth, cause channel braiding or dewatering, and reduce interstitial spaces among larger streambed particles (Megahan et al. 1980, Shepard et al. 1984, Everest et al. 1987). Juvenile bull trout are almost always found in close association with the substrate (McPhail and Murray 1979, Shepard et al. 1984, Weaver and Fraley 1991). A significant positive relationship existed between substrate score and juvenile bull trout densities in Swan River tributaries (Leathe and Enk 1985) and Flathead River tributaries (Weaver and Fraley 1991), where a high substrate score was indicative of large particle sizes and low score of embeddedness (Crouse et al. 1981). This relationship is thought to reflect substrate types favoring over winter survival (Pratt 1984, Weaver and Fraley 1991).

A substrate score is an overall assessment of streambed particle size and embeddedness. Large particles that are not embedded in finer materials provide more interstitial space that juvenile bull trout favor. This situation generates a higher substrate score. Low substrate scores occur when smaller streambed particles and greater embeddedness limit the interstices within the streambed.

Linear regression of substrate scores against output from a model assessing ground disturbing activity in 28 Flathead Basin tributary drainages showed a significant negative relationship. Researchers also obtained a significant negative relationship between substrate scores and output from a model predicting increases in water yields (Weaver and Fraley 1991). These results demonstrate a linkage between ground disturbance and increased water yield and streambed conditions. Linear regression of juvenile bull trout density against substrate scores in 15 Flathead Basin streams showed a significant positive relationship (Weaver and Fraley 1991). This showed a strong linkage between streambed condition as measured by substrate scoring and actual juvenile bull trout abundance.

Methods

Substrate scoring involves visually assessing the dominant and subdominant streambed substrate particles, along with embeddedness across transects. Surveyors assign a rank to both the dominant and subdominant particle size classes in each cell (Table 14). They also rank the degree to which the dominant particle size is embedded (Table 14). The three ranks are summed, obtaining a single variable for each cell. A mean of all transects in a section results in the substrate score.

Table 14. Characteristics and ranks for computing substrate scores (modified by Leathe and Enk 1985 from Crouse et al. 1981).

Rank	Characteristic
	Particle Size Class[1]
1	Silt and/or detritus
2	Sand (<2.0 mm)
3	Small gravel (2.0-6.4 mm)
4	Large gravel (6.5-64.0 mm)
5	Cobble (64.1-256.0 mm)
6	Boulder and/or bedrock (>256.0 mm)
	Embeddedness
1	Completely embedded or nearly so (75% - 100%)
2	50% - 75% embedded
3	25% – 50% embedded
4	5% – 25% embedded
5	Unembedded

[1]Used for both dominant and subdominant particle ranking

We obtained the substrate scores using ten equally spaced transects in the juvenile bull trout abundance sections. Again, lower scores indicate poorer quality rearing habitat; higher values indicate good conditions.

Findings

We began collecting substrate scores in 1998 and collected them only sporadically until 2002 (Table 15). Because of limited sampling a quality assessment is not possible. For the most part, the scores from most of the streams compare favorably with Flathead River basin streams where Flathead Basin Cooperative Forest Practice Study determined that scores of 10.0 or less threatened juvenile bull trout rearing capacity and scores 9.0 or less impaired rearing capacities (Deleray et al. 1999). The exception in this assessment is O'Brien Creek. As was mentioned previously, the section used for juvenile estimates has likely been impacted by beaver activity. We intend to continue gathering substrate scores yearly to assess trends.

Table 15. Summary of Kootenai Drainage substrate scores the stream sections monitored at juvenile population estimate sites in Kootenai River basin stream, 1998 - 2005.

Stream	1998	1999	2000	2001	2002	2003	2004	2005
Grave Creek	13.4				13.2	14.3	13.8	12.8
West Fork Quartz Creek	13.2				13.2	13.3	14.5	14.1
Pipe Creek	13.0	14.0			13.7	12.3	12.1	12.9
Bear Creek		13.0			13.6	14.6	13.8	13.7
West Fisher Creek					13.1	13.8	12.9	14.1
O'Brien Creek	11.5	12.2			10.6	11.9	10.9	11.8
Keeler Creek	12.8	14.4			12.4	13.2	15.5	13.4
Callahan Creek						14.5	15.5	13.9
Libby Creek above falls						14.3		13.6

BULL TROUT REDD COUNTS

Introduction

A reliable survey of annual spawner escapement is a valuable element of any fisheries monitoring program. These data are frequently used as measures of anticipated production in succeeding generations. They also provide an index of success in regulating the fishery. Observations during past studies indicate that migratory fish populations in the Kootenai System consistently use the same stream sections for spawning. Similar findings resulted from spawning site surveys in the Flathead and Clark Fork River drainages (Montana Fish, Wildlife & Parks, Kalispell, unpublished file data; MBTSG 1996b, 1996c). As a result of specific spawning habitat requirements, the majority of bull trout spawning is clustered in a small portion of the available habitat, making these areas critical to bull trout production.

Field crews annually monitor the number of spawning sites (redds). These counts provided information on trends in escapement into upper basin tributaries and allowed us to choose sampling locations for other monitoring activities. Timing of salmonid spawning has likely evolved in response to seasonal changes in water temperature (Bjornn and Reiser 1991). Initiation of spawning by bull trout appears to be strongly related to water temperature, although photoperiod and streamflow may also be factors (Shepard et al. 1984). Most bull trout spawn between late August and early November (McPhail and Murray 1979; Oliver 1979; Shepard et al. 1984; Pratt 1985; Brown 1992; Ratliff 1992). Spawning in the Flathead drainage (Fraley and Shepard 1989) and in Mackenzie Creek, British Columbia (McPhail and Murray 1979), began when daily maximum water temperatures declined to 9-10^{o} C. Spawning takes place primarily at night (Heimer 1965; Weaver and White 1985), but has been observed during daylight hours (Needham and Vaughan 1952; personal observations).

Bull trout spawning typically occurs in areas influenced by groundwater (Allan 1980; Shepard et al. 1984; Ratliff 1992; Fraley and Shepard 1989). Such areas tend to remain open in the Kootenai drainage during harsh winter conditions, while adjacent stream sections ice over or contain extensive accumulations of anchor ice. Recent investigations in the Swan River drainage found that bull trout spawning site selection occurred primarily in stream reaches that were gaining water from the subsurface, or in reaches immediately downstream of upwelling reaches (Baxter 1997).

Reaches used by spawning adults typically have gradients less than 2 percent (Fraley and Shepard 1989). Water depths at the upstream edges of 80 redds of migratory bull trout in the Flathead drainage ranged from 0.1 to 0.6 m and averaged 0.3 m; water velocities (at 0.6 of the depth below the surface) ranged from 0.09 to 0.61 m/s and averaged 0.29 m/s (Fraley et al. 1981). Similar mean depths (0.3 m) and water velocities (0.31 m/s) at migratory bull trout redds were documented in the Swan River drainage (Kitano et al. 1994).

Migratory bull trout redds ranged from 1.0 to 3.1 m in length (mean 2.1 m) in tributaries of the North and Middle forks of the Flathead River (n=465); width of these redds ranged from 0.8 to 1.5 m and averaged 1.1 m (Fraley et al. 1981). These dimensions are comparable to redds created by fluvial and adfluvial bull trout in the Kootenai drainage.

Areas in which redds are counted on a routine basis are called "index" areas. In some cases these index surveys continue to an upstream barrier. It is important to establish upper and lower limits of index areas. Through repeated annual index surveys we obtain valuable trend information to use in monitoring bull trout populations. Detection of trends will often require at least 10 years of monitoring index areas (Rieman and Meyers 1997).

Methods

We conducted preliminary surveys to determine appropriate timing for final counts. During a basin-wide count we surveyed all habitat that appeared suitable for bull trout spawning (as described above). From this basin-wide survey, index areas were identified for annual surveys. We began final inventories after we observed completed redds, few adult fish, and little evidence of active spawning during the preliminary surveys. Timing of final counts is critical, because as redds age, they lose the characteristic cleaned or bright appearance becoming more difficult to identify. Also, as winter approaches, fall freshets are fairly common in the Kootenai drainage and can wipe out traces of redds if flows get high enough.

We surveyed the Wigwam River and West Fisher, Grave, Quartz, Bear (tributary to Libby Creek), Keeler, Pipe, and O'Brien Creeks. MFWP and U.S. Forest Service (USFS) personnel walked streams in the United States and personnel from the British Columbia Ministry of Water, Land, and Air Protection walked the Wigwam River and associated tributaries. They visually identified redds by the presence of a pit or depression and associated tail area of disturbed gravel. If timing is correct, identification of redds presents little problem. We classified redds differently than in the Flathead. We counted redds only if they were positively identified. We did not include "probable redds" in our counts. We felt that our crews were well trained and confident enough to assess redds as existing or not. We used linear regression to assess population trends.

Findings

Grave Creek

MFWP counted redds in the Grave Creek Basin (including Blue Sky, Clarence, Williams and Lewis Creeks) for the first time in 1983, as well as in 1984, 1985, and 1993 through 2004. Grave Creek was surveyed from its confluence with the Tobacco River upstream to near the mouth of Lewis Creek (approximately13 miles), where it becomes intermittent. Most redds in Grave Creek were located upstream from the mouth of Clarence Creek to the confluence with Lewis Creek. MFWP found 10 redds between the confluence with the Tobacco River and one mile below Clarence Creek in 1983. However, we did not find redds in this reach during surveys conducted in 1993 and 2000. The distribution of bull trout redds in Blue Sky, Clarence, Williams and Lewis creeks was similar to observations in previous years (Hoffman et al. 2002).

We observed 141 bull trout redds in Grave Creek in 2004, which represented a 48% reduction from the previous year (Table 16). Nevertheless, bull trout have exhibited a significant positive trend in spawning abundance in Grave Creek since 1993 (Figure 2; $r^2 = 0.717$; $p = 0.0005$).

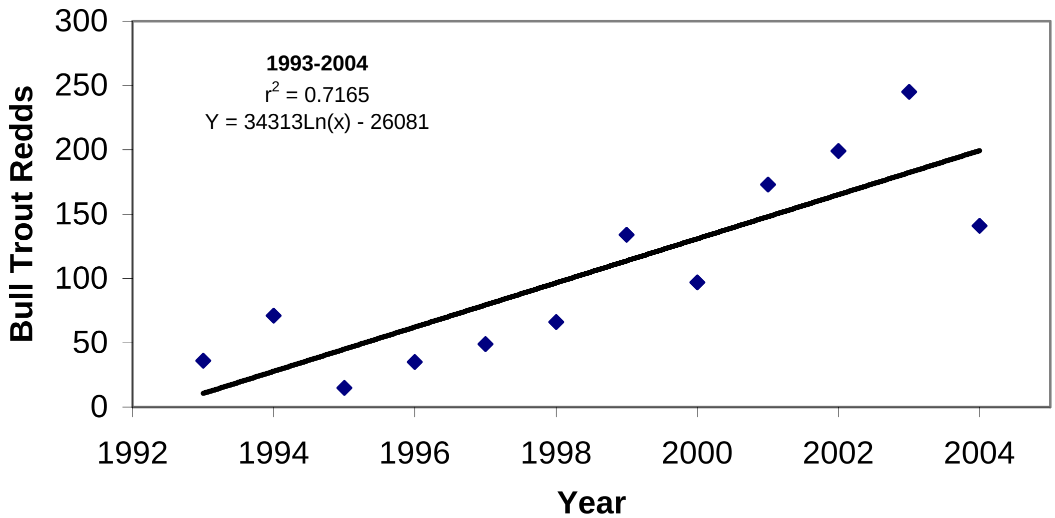

Figure 2. Bull trout redd counts, and trend analysis for Grave Creek, 1993 through 2004.

Table 16. Summary of Kootenai Drainage bull trout spawning site inventories from 1993 - 2004 in the stream sections monitored annually.

Stream	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Grave Creek [a]	36	71	15	35	49	66	134	97	173	199	245	141
Quartz Creek [c]	89	64	66	47	69	105	102	91	154	62	55	49
Pipe Creek	6	7	5	17	26	34	36	30	6	11	10	8
Bear Creek			6	10	13	22	36	23	4	17	14	6
West Fisher Creek	2	0	3	4	0	8	18	23	1	1	1	13
O'Brien Creek	6	7	22	12	36	47	37	34	47	45	46	51
Keeler Creek [d]				74	59	92	99	90	13	102	87	126
Wigwam River (U.S. &B.C.) [b]		104	247	512	598	679	868	1204	1496	1916	2053	2133
Skookumchuk River (B.C.)					66	105	161	189	132	143	134	140
White River (B.C.)									166	153	143	93
Callahan Creek (IDFG)[e]											40	25
Total				711	916	1158	1491	1781	2192	2649	2828	2785

[a] Includes mainstem Grave Creek, Clarence Creek, Blue Sky Creek
[b] Includes mainstem Wigwam River, Ram Creek, Lodgepole Creek, Desolation Creek.
[c] Includes mainstem Quartz Creek and West Fork Quartz Creek
[d] Includes mainstem Keeler Creek, North Fork Keeler Creek, South Fork Keeler Creek.
[e] Includes North and South Callahan Creeks

Wigwam Drainage

Bull trout redd counts for the Wigwam River includes the tributary streams of Bighorn, Desolation, and Lodgepole creeks, and the portion of the Wigwam River within Montana. A total of 2133 bull trout redds were observed in the Wigwam Drainage in 2004, which was a record high since counts began (Table 16). Bull trout redds in the Wigwam River have consistently increased each year since 1995 (Figure 3; $r^2 = 0.968$; $p = 2.83*10^{-7}$).

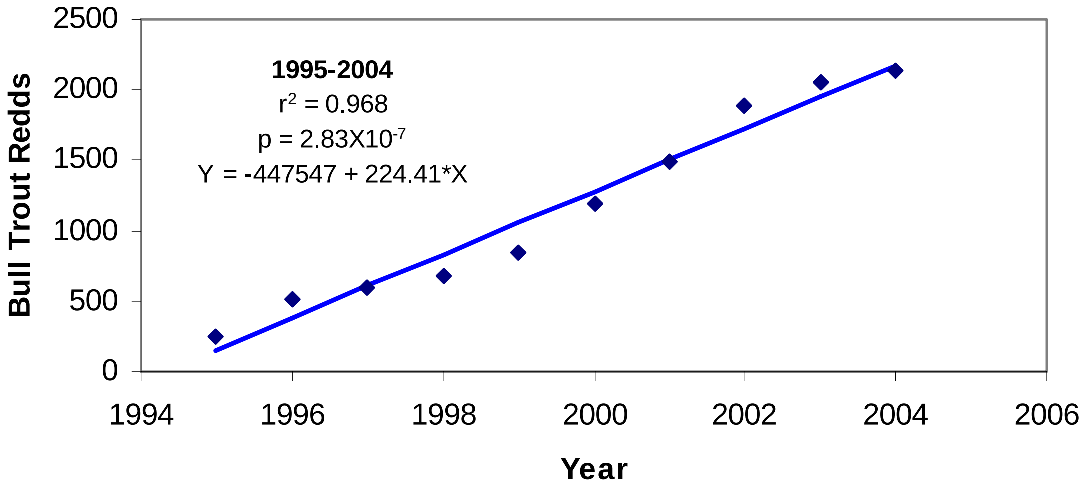

Figure 3. Bull trout redd counts and trend analysis for the Wigwam River (including Bighorn, Desolation, and Lodgepole creeks) 1995-2004.

Quartz Creek

Bull trout redd counts in Quartz Creek since 1995 have been variable (Figure 4; $r^2 = 0.035$). Although overall trend is positive, annual variation limits our ability to statistically distinguish this relationship from a stable (zero slope) population (Figure 4; $p = 0.498$). We observed a total of 49 redds in Quartz and West Fork Quartz creeks in 2004 (Table 1). The average number of redds of the period of record was 74.9 redds. The 2004 observation of 49 redds was 34.5% lower than the average over the period of record. A log jam located approximately 0.25 miles upstream of the confluence of West Fork Quartz Creek in 2002 and 2003 may have limited bull trout spawner escapement during these years. This log jam was removed prior to adult bull trout upstream migration in 2004.

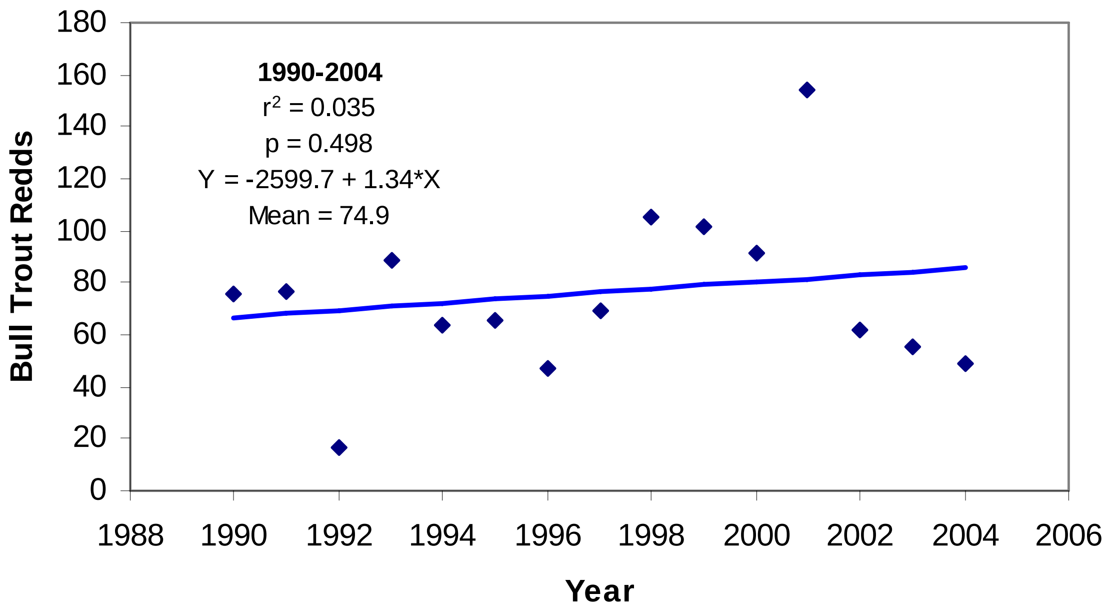

Figure 4. Bull trout redd counts and trend analysis for Quartz Creek (including West Fork Quartz) 1990-2004.

Pipe Creek

Bull trout redd counts in Pipe Creek peaked in 1999 with 36 redds, with redd numbers and have decreased since that peak. Despite the decreasing trend of bull trout redds during the last five years, the overall general trend during the time period 1995-2004 has been variable, with a slope that is not significantly different than a stable population (Figure 5; r^2 = 0.075; p = 0.324). The mean number of bull trout redds since 1990 has been 14.5 redds. The 8 redds we observed in Pipe Creek in 2004 was 45% lower than the 14 year average. Low water conditions during the fall spawning season during the past four years may partially explain the low spawner escapement into Pipe Creek.

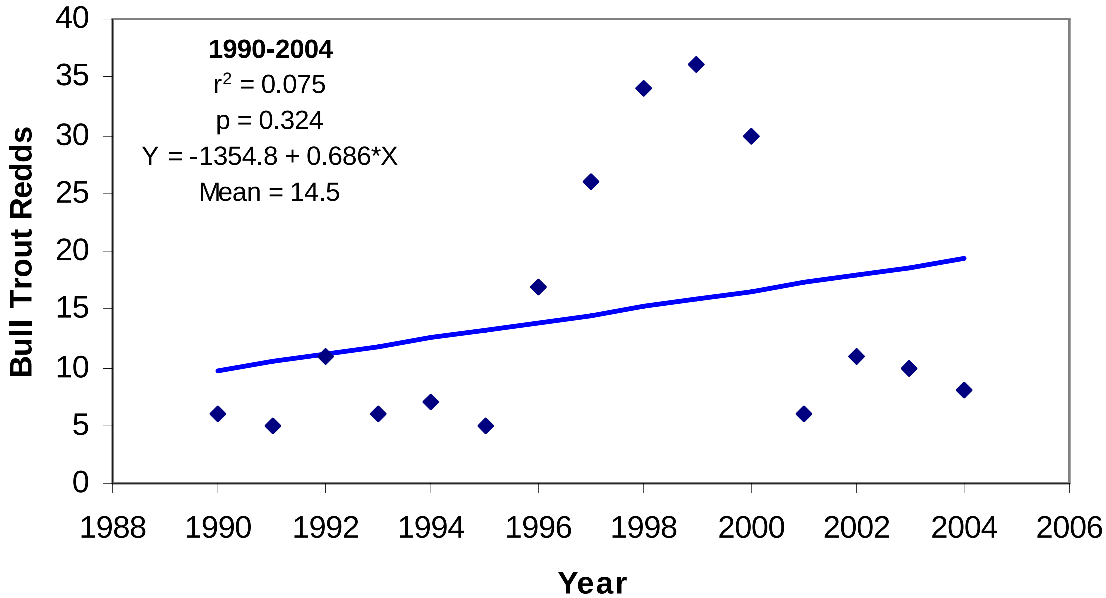

Figure 5. Bull trout redd counts and trend analysis for Pipe Creek 1990-2004.

Bear Creek

Bear Creek bull trout redd counts have been variable during the period 1995-2004 (Figure 6; r^2 = 0.001). Although the overall general trend has increased since 1995, the relationship is not statistically different than a stable population (Figure 6; p = 0.923). Low water conditions in Bear Creek during the past four years also partially explain the low spawner escapement in Bear Creek. The average number of bull trout redds since 1995 in Bear Creek has been 15.1 redds. The 6 redds we observed in Bear Creek in 2004 was 60.3% less than the 9 year average.

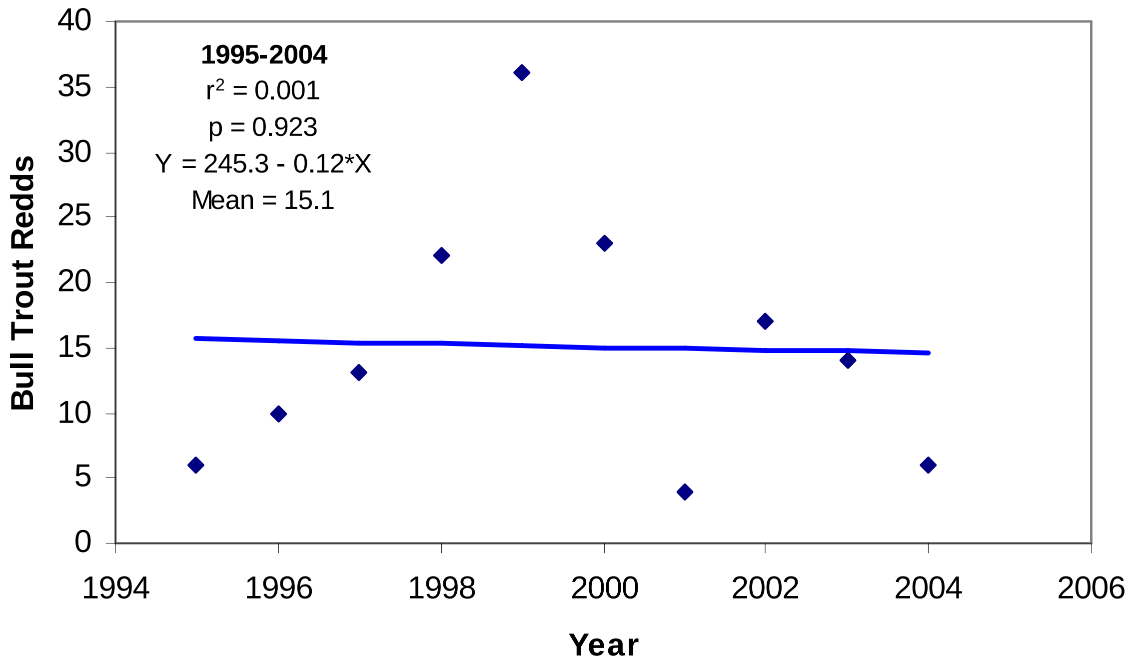

Figure 6. Bull trout redd counts and trend analysis for Bear Creek, a tributary to Libby Creek, 1995-2004. The mean number of bull trout redds was 15.1.

O'Brien Creek

The general trend of bull trout redds in O'Brien Creek is generally increasing since 1995 (Figure 7; $r^2 = 0.647$; $p = 0.0005$). We observed a total of 51 bull trout redds in O'Brien Creek in 2004 (Table 14).

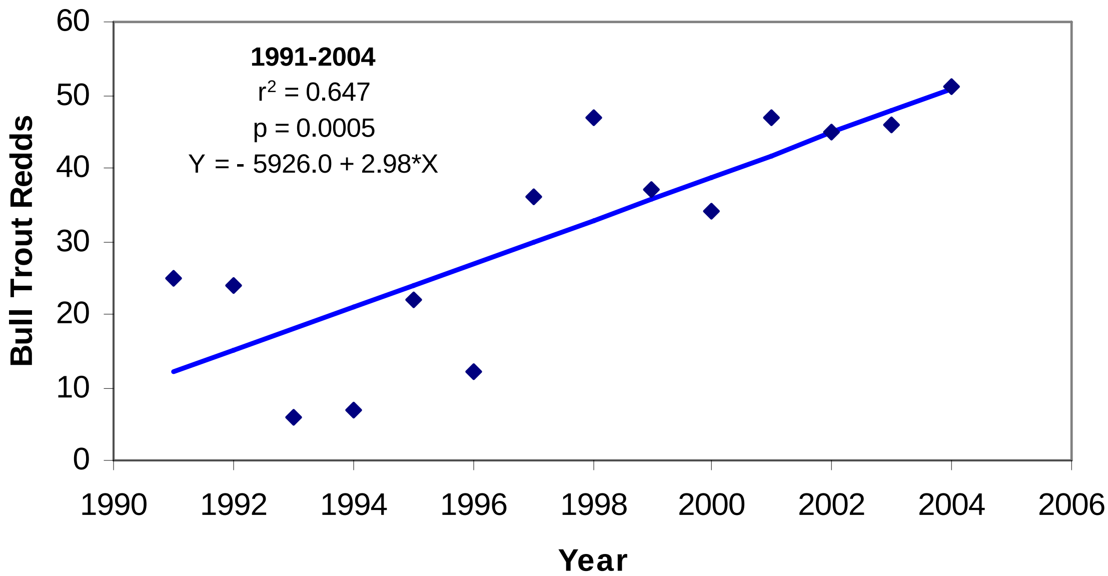

Figure 7. Bull trout redd counts and trend line for O'Brien Creek 1991-2004.

West Fisher Creek

We were unable to determine a significant trend in bull trout redds in West Fisher Creek over the period of record for this stream (1993-2004). From the period 1993-2000, the general trend was one of increasing abundance. However, during the period of 2001-2003, we observed only 1 bull trout redd each year (Table 16). However, we observed 21 bull trout redds in West Fisher Creek in 2004, which represented the second highest observation during the past 10 years. The overall trend was not significantly different than a stable (zero slope) population ($r^2 = 0.151$; $p = 0.211$). Given the amount of variation present within this dataset, the overall mean number of redds in West Fisher Creek (mean = 6.83 redds) does an equally good job at predicting redd numbers. Drought conditions during the recent summers/late fall periods may have contributed to the lower bull trout spawner escapement into West Fisher Creek.

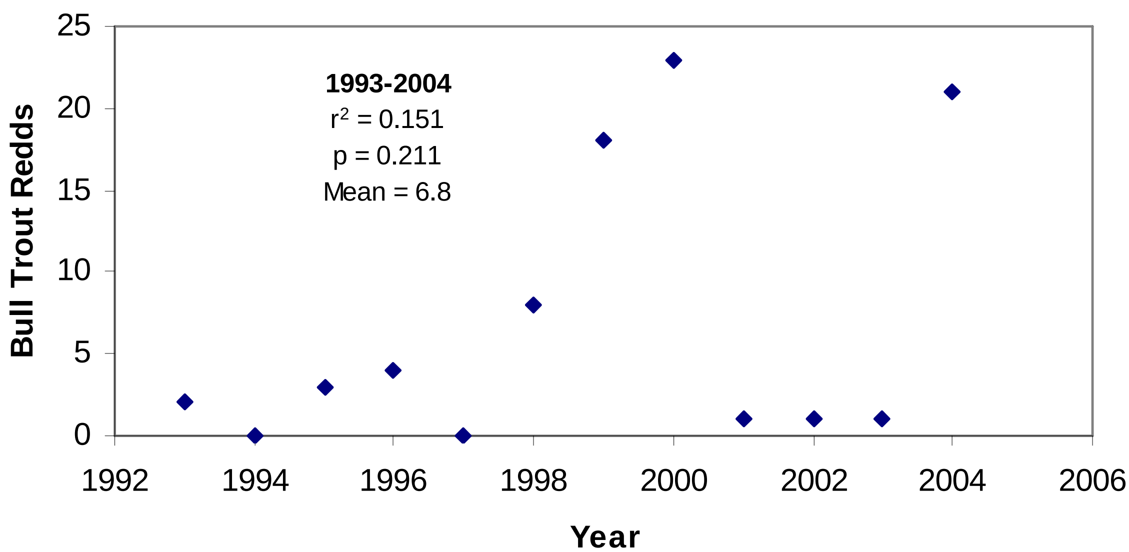

Figure 8. Bull trout redd counts for the West Fisher Creek, 1993-2004.

Keeler Creek

Bull trout that spawn in Keeler Creek (including the North, South and West Forks) are an adfluvial stock that migrates downstream out of Bull Lake into Lake Creek, then up Keeler Creek. This downstream spawning migration is somewhat unique when compared to other bull trout populations (Montana Bull Trout Scientific Group 1996).

We observed a total of 13 and 102 bull trout redds in Keeler Creek and associated tributaries in 2001 and 2002, respectively (Table 116). A beaver dam built in lower Keeler Creek during late summer/early fall 2001 impeded upstream bull trout migration. The dam was removed, but a fall freshet increased stream flow substantially and prevented accurate counts. Therefore, the 13 redds observed in 2001 is undoubtedly an underestimate of the true number of redds in Keeler Creek in 2001.

We observed a total of 126 bull trout redds in Keeler Creek and associated tributaries in 2003 (Table 1), which represented a record high during our period of record. Bull trout redd counts in Keeler Creek have exhibited a positive trend since 1996, although the trend is not significantly different from a stable population (Figure 9; p = 0.397). Given this relationship, the annual mean (82.4 redds) does an equally good job of prediction. The 2004 observation represents a 52% increase relative to the annual mean.

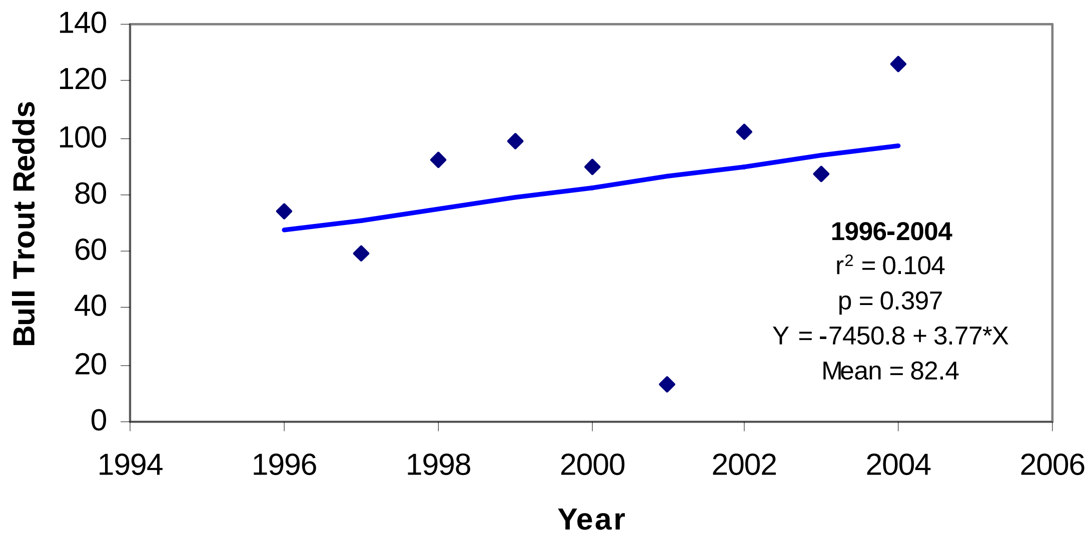

Figure 9. Bull trout redd counts and trend line for Keeler Creek, a tributary to Lake Creek, 1996-2004.

KOOTENAI RIVER ADULT BULL TROUT POPULATION ESTIMATE

Methods

We collected adult bull trout using nighttime electrofishing by jet boat to perform a mark-recapture population estimate of bull trout in the Kootenai River from Libby Dam (River mile [RM] 221.7) downstream to the confluence of the Fisher River (RM 218.2). We operated two boat crews during each sampling event. Each boat contained a driver and two netters. Our electrofishing unit on each boat consisted of a Coffelt model Mark 22 electrofishing unit operating with an electrical output ranging from 200-350 volts at 5-8 amps powered by a 5,000 watt gasoline powered generator.

In order to thoroughly electrofish the entire 3.5 miles of Kootenai River, we divided the sample area into 2 sections, and conducted electrofishing on each section on a single evening. Section 1 was from Libby Dam downstream to the Alexander Creek confluence (RM 220.5), and was 1.2 miles long. Section 2 was from the Alexander Creek confluence downstream to the Fisher River Confluence, and was 2.3 miles long. We marked bull trout on the evenings of 4/8/04, 4/15/04, 4/21/04, 4/22/04, 5/5/04, 5/6/04, 8/18/04, 8/19/04, 4/20/05 and 4/21/05.

We recorded the total time (minutes) electrical current was generated in the water as a measure of effort. We measured total length (mm), weighed (g), examined all fish for marks, collected scale samples, and released all bull trout captured near their capture location. All bull trout were marked with individually numbered 134 (ISO) KHz passive integrated transponder (PIT) tags and an adipose fin clip was removed to evaluate PIT tag retention. PIT tags were inserted with an 8-gauge hypodermic needle into the musculature behind the dorsal fin.

We estimated bull trout abundance using a mark-recapture population estimation technique which assumes the population of bull trout is “closed”, suggesting no births, deaths or migrations occurred during sampling periods (Ricker 1975). Additional assumptions were that marked and unmarked fish have equal mortality rates, marked fish were randomly distributed throughout the study area, marks were not lost, and all marked fish captured were recognized and counted (Lagler 1956). We used a computer software program called Mark/Recapture (version 7.0) that uses a log-likelihood estimator to estimate the absolute abundance of adult bull trout within the study reach. We estimated the total population present within the study area after each marking episode, beginning with the second episode.

Findings

We conducted a total of five individual fish marking episodes on the Kootenai River below Libby Dam. Each marking episode consisted of two nights of capturing fish that ranged between 1 to 7 days between nights (Table 17). We calculated population estimates and associated 95% confidence intervals after each episode, excluding the first episode. The mean population estimate for all samples periods over the one-year period was 976 adult bull trout, ranging from 906 to 1,068. The population estimate for each sampling episode varied by less then 10% compared to the mean (Table 17).

We estimated that recapture rates ranged between 4% and 12% for each sampling episode. The average bull trout total length was 647 mm (range = 343 – 861 mm; Figure 10). We standardized each population estimate and 95% confidence interval into fish per mile, with a mean of 279 bull trout per mile (95% confidence interval = 158-400).

We recaptured 14 bull trout during our sampling period April 20 and 21, 2005. All the recaptured fish during this sampling episode were originally captured and marked approximately one year prior (+/- 1 to 12 days). The recaptured bull trout grew an average of 86.4 mm (range 42 – 179 mm; total length; Table 18), and gained an average of 2094 g (range 1,421 – 3,550 g; Table 18).

Table 17. The sampling dates for adult bull trout marked, recaptured, and the estimated total population and fish per mile in the Kootenai River from Libby Dam downstream to the Fisher River confluence. The 95 percent confidence intervals are in parentheses.

Dates	Number Marked	Number Recaptured	Total Population Estimate (95 % CI)	Fish per Mile (95 % CI)
April 8 & 15 2004	109	N/A		
April 21 & 22, 2004	103	13	918 (511 – 1,326)	262 (146 – 379)
May 5 & 6, 2004	61	14	1,068 (600 – 1,537)	305 (176 – 434)
August 18 & 19, 2004	28	11	906 (494 – 1,318)	259 (144 – 374)
April 20 & 21, 2005	38	13	1,012 (608 – 1,415)	289 (177 – 401)
Total	339	51		
Mean	68	13	976 (553 – 1,399)	279 (158 – 400)

Table 18. Recapture summary information for bull trout recaptured below Libby Dam on April 20 and 21, 2005. Information includes the date each fish was originally captured, recaptured, and length and weight for each encounter.

Original Tag Date	Recapture Date	PIT tag Number	Length at Capture (mm)	Weight at Capture (g)	Length at Recapture (mm)	Weight at Recapture (g)	Length Increase (mm)	Weight Increase (g)
4/8/2004	4/20/2005	3D9.1BF1C59ED4	689	3878	765	5979	76	2101
4/8/2004	4/20/2005	3D9.1BF1C4F0B6	672	3209	740	4630	68	1421
4/8/2004	4/21/2005	3D9.1BF1C725D0	558	1591	668	3444	110	1853
4/8/2004	4/21/2005	3D9.1BF1C63390	551	1582	730	3262	179	1680
4/15/2004	4/20/2005	3D9.1BF1C68E63	700	3336	778	5364	78	2028
4/15/2004	4/20/2005	3D9.1BF1C679AA	697	2780	739	4303	42	1523
4/15/2004	4/21/2005	3D9.1BF1C6798C	593	1903	705	3915	112	2012
4/15/2004	4/21/2005	3D9.1BF1C6816B	735	4366	763	6244	28	1878
4/21/2004	4/20/2005	3D9.1BF1C70756	744	3975	803	5818	59	1843
4/22/2004	4/20/2005	3D9.1BF1C68F1E	745	5056	828	8606	83	3550
4/22/2004	4/21/2005	3D9.1BF1C479C2	820	6631	875	9305	55	2674
4/22/2004	4/21/2005	3D9.1BF1C5A309	446	755	604	2660	158	1905
4/22/2004	4/21/2005	3D9.1BF1C633C6	644	2715	733	5310	89	2595
4/22/2004	4/21/2005	3D9.1BF1C5A804	657	2814	730	5065	73	2251
Mean			**660.8**	**3185.1**	**747.2**	**5278.9**	**86.4**	**2093.9**

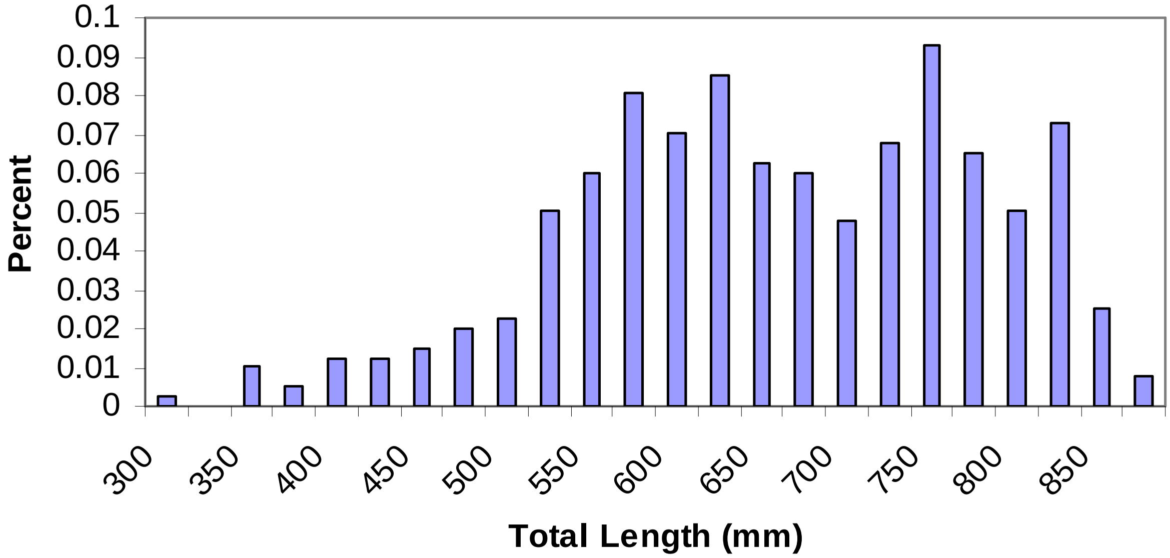

Figure 10. Length frequency distribution of bull trout captured from April 8, 2004 through April 21, 2005 below Libby Dam.

LAKE KOOCANUSA GILLNET MONITORING

Methods

Gillnets have been used by MFWP since 1975 to assess annual trends in fish populations and species composition. These yearly sampling series were accomplished using criteria established by Huston et al. (1984).

Netting methods remained similar to those reported in Chisholm et al. (1989). Netting effort was reduced from 128 ganged (coupled) nets in 1975, to 56 in 1988, and 14 ganged floating and 28 single sinking nets in 1991. Netting effort occurred in the spring and fall, rather than the year round effort prior to 1988. Because of their importance to bull trout either as prey or competitors, kokanee salmon (*Oncorhynchus nerka*) and Kamloops rainbow trout (*Oncorhynchus mykiss gairdneri*) were included in this assessment. Kamloops rainbow trout were distinguished from wild rainbow trout by eroded fins (pectoral, dorsal and caudal); these fish are held in the hatchery until release into the reservoir at age 1+.

The year was stratified into two gillnetting seasons based on reservoir operation and surface water temperature criteria:

1) Spring (April - June): The reservoir was being refilled, surface water temperatures increased to 9 - 13^{o}C.

2) Fall (September - October): Drafting of the reservoir began, surface water temperature decreased to 13 - 17^{o}C.

Seasonal and annual changes in fish abundance within the near-shore zone were assessed using floating and sinking horizontal gillnets. These nets were 38.1 m long and 1.8 m deep and consisted of five equal panels of 19-, 25-, 32-, 38-, and 51-mm mesh.

Fourteen to twenty-eight floating (ganged) and one or two single, sinking nets were set in the fall in the Tenmile, Rexford and Canada portions of the reservoir. Spring netting series consisted of 20 to 111 (standardized to 28 in 1991) sinking nets and an occasional floating net set only in the Rexford area. Spring floating and fall sinking net data are not included in this report due to a lack of standardization in net placement. Nets were set perpendicular from the shoreline in the afternoon and were retrieved before noon the following day. All fish were removed from the nets and identified, followed by collection of length, weight, sex and maturity data. When large gamefish (Kamloops rainbow, cutthroat, bull trout or burbot) were captured alive, only a length was recorded and the fish were released.

Findings

Bull trout

From 1988 until present, one monitoring area (Koocanusa bridge to Montana/B.C. border) was netted. Over time, seasonal netting was reduced to spring and fall series (Chisholm, et al 1989, Dalbey et al 1997). However, our fall gill netting series typically captures few bull trout. The primary reasons are that sampling dates purposely coincided with the period in which adults were in spawning tributaries, and that bull trout are not traditionally captured in floating gillnets. Table 19 summarizes long-term bull trout mean catch per net in Koocanusa from spring sinking nets.

Table 19. Spring sinking gill net summary of bull trout catch per net in Lake Koocanusa 1975 - 2002.

Year	Date	Reservoir Elevation	Mean Catch Per Net
1975	6/9		1.4
1976	5/1	2373	1.9
1978	5/15	2367	2.2
1980	5/5	2389	0.8
1981	5/5	2378	1.3
1982	5/25	2363	1.5
1984	6/12	2412	1.8
1985	6/6	2415	1.3
1986	5/8	2379	1.9
1987	5/5	2390	1.2
1988	5/12	2344	2.0
1989	5/1	2355	1.2
1990	5/10	2358	1.2
1991	5/16	2330	0.5
1992	5/5	2333	2.3
1993	5/17	2352	1.2
1994	5/16	2405	3.0
1995	5/8	2386	2.3
1996	5/12	2365	3.5
1997	5/12	2350	3.1
1998	5/11	2418	2.5
1999	5/17	2352	3.6
2000	5/14	2371	6.7
2001	5/15	2393	5.4
2002	5/13	2384	4.9
2003	5/13	2417	5.4
2004	5/11	2419	6.4

Spring gill net catch of bull trout during the period 1975-1989 appeared to exist at an equilibrium with a slope (0.0091) that was not significantly different than zero ($r^2 = 0.011$; $p = 0.751$). However, beginning in approximately 1990, bull trout catch per net in Libby Reservoir began significantly increasing through 2004 (Figure 11; $r^2 = 0.808$; $p = 5.14*10^{-6}$). We attempted to account for differing reservoir levels during the gillnetting activities between years by multiplying the mean bull trout catch per net by reservoir volume at the time the nets were fished each year.

This adjustment substantially improved the regression model's fit to the data in previous years (Dunnigan et al. 2004), but did not improve the fit with the addition of the 2004 data (Figure 12; $r^2 = 0.806$; $p = 5.51*10^{-6}$). Bull trout redd counts (see above) in both the Wigwam River and Grave Creek are both significantly and positively correlated to the spring gill net catch rates for bull trout adjusted for reservoir elevation (Figure 13; $r^2 = 0.738$; $p = 0.0007$).

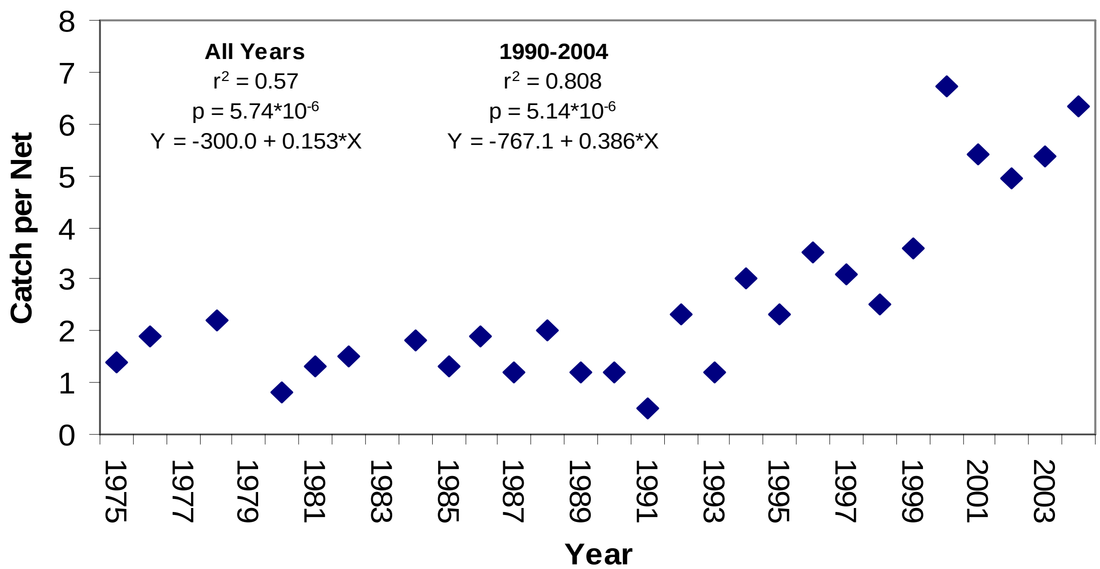

Figure 11. Average catch per net of bull trout in spring gill nets at the Rexford site on Libby Reservoir 1975-2004.

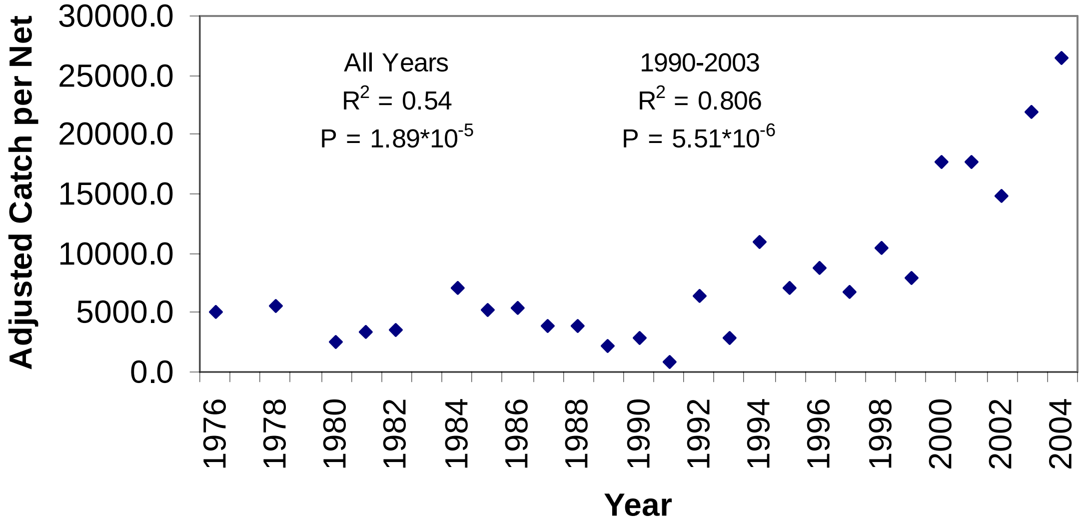

Figure 12. Average adjusted catch per net of bull trout in spring gill nets at the Rexford site on Libby Reservoir. Average annual bull trout catch per net was adjusted by multiplying catch by reservoir volume at the time of gillnetting.

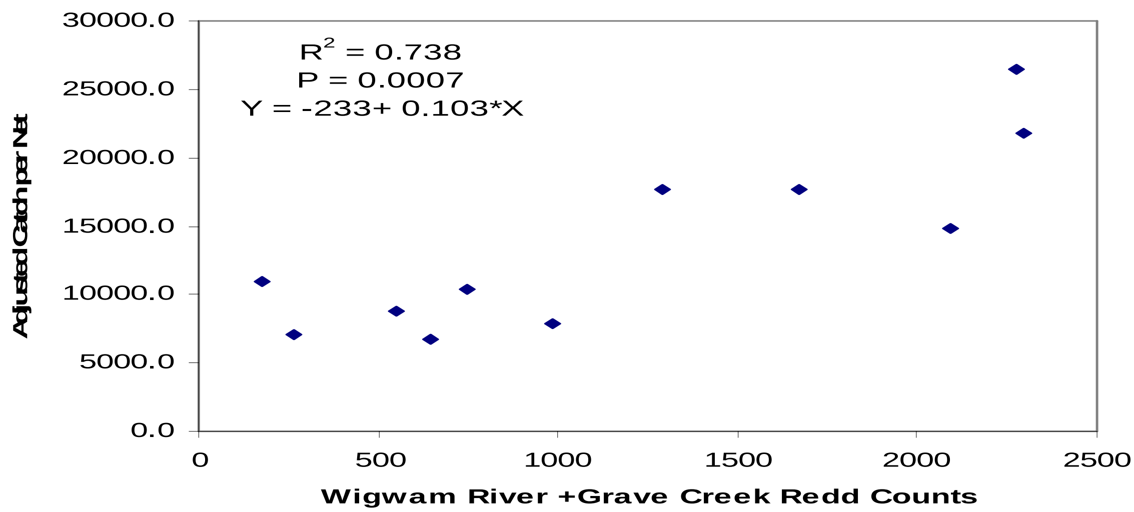

Figure 13. Average adjusted catch per net of bull trout in spring gill nets at the Rexford site on Libby Reservoir related to total annual bull trout redd counts for the Wigwam River and Grave Creek during the period 1994-2004. Average annual bull trout catch per net was adjusted by multiplying catch by reservoir volume at the time of gillnetting.

Kokanee

Chisholm et al. (1989) found that kokanee were the most important prey species in stomachs of bull trout between October and April. Trout were next but as the number of trout has decreased in the reservoir, the importance of kokanee has certainly increased. For that reason, the gill netting surveys for kokanee are included in this report.

Since the accidental introduction of at least 250,000 fry from the Kootenay Trout Hatchery in British Columbia into Lake Koocanusa in 1980 and quite likely other inadvertent introductions of presumed moribund fish, kokanee have become the second most abundant fish captured during fall gillnetting (Peamouth chub [*Mylocheilus caurinus*]). Fluctuations in catch have corresponded to the strength of various year classes and have varied by year, with no apparent trend in abundance (Figure 14).

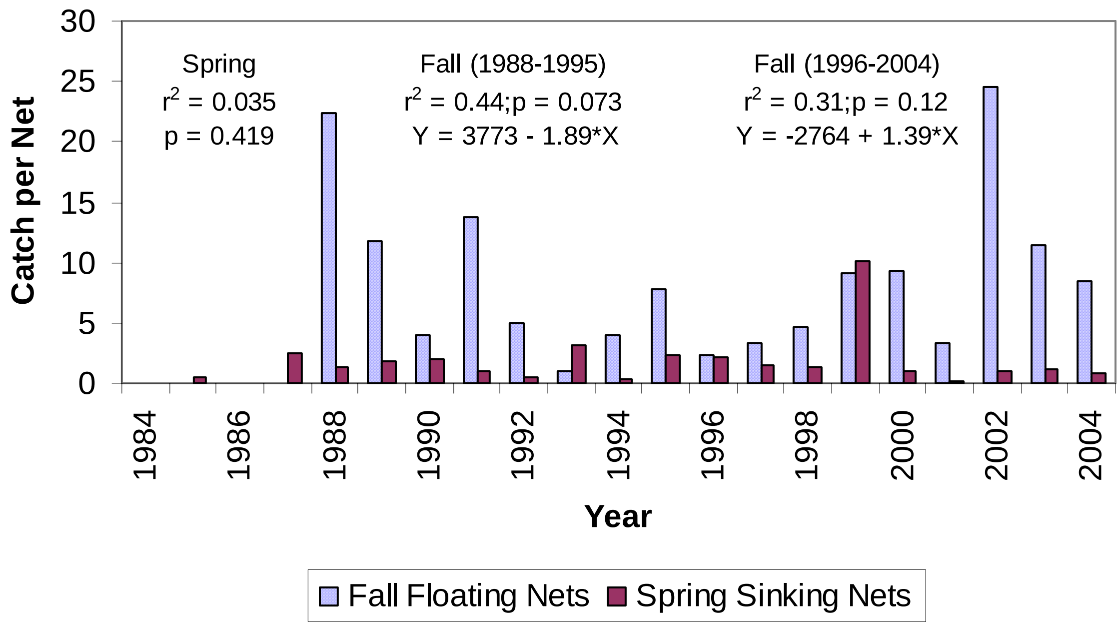

Figure 14. Average catch per net of kokanee for fall floating (1988-2004) and spring sinking (1984-2004) gill nets in Koocanusa Reservoir.

Average length of kokanee varied among years. Average length and weight between 1988 and 2004 was 288.6 mm and 230.7 g respectively (Table 20), while maximum average size occurred in 1992 (350 mm, 411 g). However, the minimum mean length (251.3) was observed in 2002 (Table 20). Adult escapement to surveyed tributaries increased substantially from 1997 through 2002. In the last two years, escapement numbers have decreased dramatically. Tepper (BCMOE, 2005, personal communication) felt that the count from 2004 was suspect because of unusually high flows. It is uncertain if increasing bull trout; kamloops trout and other predators have negatively impacted kokanee population numbers during this time.

Table 20. Average length and weight of kokanee salmon captured in fall floating gillnets (Tenmile and Rexford) in Lake Koocanusa, 1988 through 2004.

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	AVG.
Sample size (n)	2150	1259	517	624	250	111	291	380	132	88	76	200	342	120	357	263	194	432
Length (mm)	315.5	275	257.3	315.8	350	262.7	270.2	300.2	293.7	329.6	333.9	291.6	271.3	261.6	251.3	264.9	288.6	288.6
Weight (gm)	289.1	137.2	158.4	327.3	411.3	162.3	191.7	261.6	234.5	363.2	322.0	229.6	185.6	161.6	152.2	175.5	159.2	230.7
Adult Escapement[1]									397,697	116,317	147,026	258,817	328,747	351,653	452,740	148,330	40,595	

[1]Escapement count from Westover (2002) and Tepper (BCE personal communication, 2005). Count from 2004 was affected by unusually high stream flows

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