LAKE PEND OREILLE/CLARK FORK RIVER FISHERY RESEARCH AND MONITORING

2007 PROGRESS REPORT

2007 LAKE PEND OREILLE BULL TROUT REDD COUNTS

2007 CLARK FORK RIVER FISHERY ASSESSMENT PROGRESS REPORT

2007 TRESTLE AND TWIN CREEKS BULL TROUT OUTMIGRATION AND LAKE PEND OREILLE SURVIVAL STUDY PROGRESS REPORT

2007 GRANITE CREEK FISH POPULATION MONITORING PROGRESS REPORT

Idaho Tributary Habitat Acquisition and Enhancement Program

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Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring

Progress Report 2007

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2007 Lake Pend Oreille Bull Trout Redd Counts Progress Report

ABSTRACT

Bull trout *Salvelinus confluentus* redd counts were conducted in 18 tributaries to Lake Pend Oreille and the Clark Fork River, as well as the Clark Fork River spawning channel in 2007. Two tributaries to the lower Priest River, the Middle Fk. East River, and Uleda Creek, were also surveyed. The total number of redds counted in these areas in 2007 was 654. Six of these tributaries (six index streams; Johnson, East Fk. Lightning, Trestle, Grouse, North Gold, and Gold creeks) have been surveyed consistently on an annual basis since 1983. The 2007 redd count for these six streams combined was 456 - considerably lower than the long-term average of 518 redds. A much lower count observed in Trestle Creek in 2007, as well as a decline in Gold Creek, were partially responsible for the overall lower redd count totals. We identified no statistically significant correlations in the long term redd count data from 1983 to 2007. While some populations such as Granite and Gold creeks appear to be healthy and may be at or approaching restoration objectives, others, particularly those in the Lightning Creek drainage, appear to be persisting at very low levels. Most notably, Porcupine and Savage creeks, where redd counts as high as 36 and 52, respectively, were documented in the early 1980's, but have averaged less than six since 1992.

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INTRODUCTION

Redd counts are used across the range of bull trout *Salvelinus confluentus* to monitor population trends. They are typically used as an index of abundance to gauge the relative strength of adult escapement from year to year. They can also be used to estimate actual adult escapement by expanding the redd counts to fish numbers using various "spawner" to redd ratios. Redd counts require far less effort to conduct than other traditional monitoring methods such as trapping, yet provide information on adult bull trout abundance at the watershed and/or population level. However, redd counts are not without their limitations, as the technique has been shown to be prone to observer variability (Dunham et al. 2001), yet they remain an important monitoring tool for bull trout populations.

Redd counts have been conducted annually since 1983 on six tributaries to Lake Pend Oreille (LPO), and intermittently since 1983 on an additional 10 tributaries based on the work of Pratt (1984, 1985). The Idaho Department of Fish and Game (IDFG) added the Clark Fork River spawning channel to the list of sites monitored annually in 1992, as well as Strong and Morris creeks more recently. A redd count was also conducted in West Gold Creek, a tributary to Gold Creek located at the southern end of the lake, starting in 2006. Additionally, the Middle Fk. of the East River and Uleda Creek (Priest River drainage) were found to support migratory bull trout from LPO (J. DuPont, IDFG, personal communication). Monitoring of bull trout redds began in these two streams in 2001. The North Fk. of the East River, another tributary in the Priest River drainage, was added in 2004, but was not done in 2007, after two consecutive years of zero redds observed.

METHODS

IDFG hosted a one day redd count training course on Trestle Creek, a tributary to LPO with high densities of bull trout redds, immediately prior to conducting annual redd counts in September, 2007. The objective of the training course was to improve the consistency of counts among experienced observers, and train new observers. The training session involved breaking into several teams to conduct replicate counts of redds in a section on Trestle Creek. After all individual groups had finished their counts and made their maps of the redd locations, the group reconvened and together walked the section again to discuss discrepancies in the redd counts.

Following the training session, IDFG with assistance from Avista fishery staff conducted redd counts on 18 tributaries to LPO, as well as the Clark Fork River, between October 8th and October 19th, 2007 (Figure 1; Table 1). Redds were located visually by walking along annual monitoring sections within each tributary. Redds were defined as areas of clean gravels at least 0.3 x 0.6 m in size with gravels of at least 76.2 mm in diameter having been moved by the fish, and with a mound of loose gravel downstream from a depression (Pratt 1984). In areas where redds were superimposed over another redd, each distinct depression was counted as one redd.

In addition to monitoring direct tributaries to LPO and the lower Clark Fork River, IDFG staff counted redds in the Middle Fk. East River and Uleda Creek, which are tributaries to the lower Priest River. Recent telemetry studies have shown bull trout using these systems are from

LPO. They migrate downstream out of LPO in the Pend Oreille River to the Priest River, and then migrate upstream to the Middle Fk. East River to spawn (J. DuPont, IDFG, personal communication).

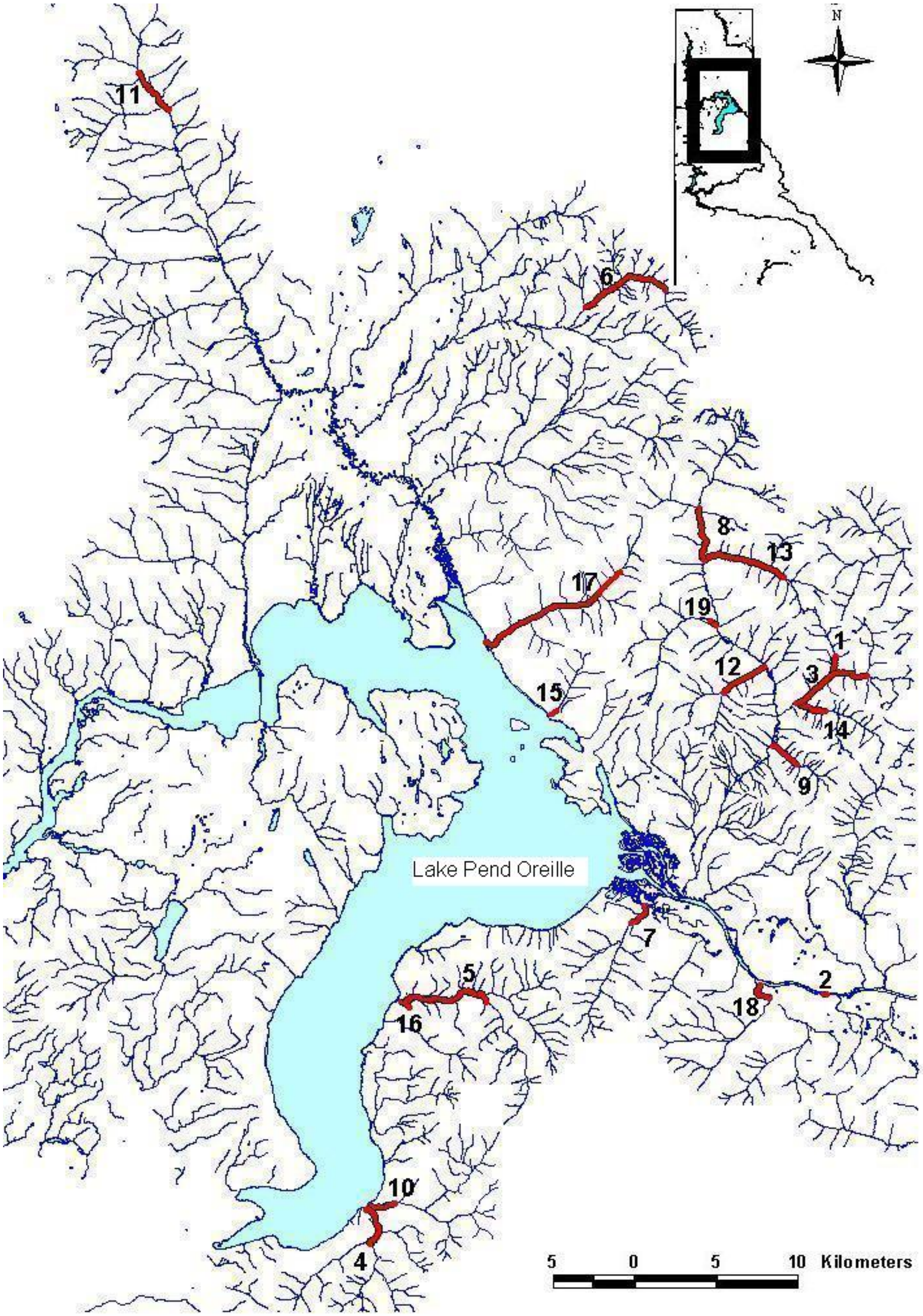

Figure 1. Bull trout redd count sections (with shading) in tributaries of Lake Pend Oreille, Idaho. Numbers denote stream name in Table 1.

Table 1. Survey streams for annual bull trout redd counts in tributaries to Lake Pend Oreille, Idaho.

Stream name	**Stream number**	**Section description (approximate length (km))**	**Years monitored**
Char Cr.	1	Mouth to falls (1.2)	1983-1987, 1992-2007
Clark Fork River	2	Spawning channel (N/A)	1992-2007
E. Fk. Lightning Cr.[a]	3	Savage to Thunder Creek (5.0)	1983-2007
Gold Cr.[a]	4	Mouth to 0.2 km upstream of W. Gold confluence (2.4)	1983-2007
Granite Cr.	5	Mouth to road 278 crossing (6.4)	1983-1987, 1992-2007
Grouse Cr.[a]	6	Flume Creek to end of road 280 (2.4 km beyond gate) (6.5)	1983-2007
Johnson Cr.[a]	7	Mouth to falls (1.5)	1983-2007
Lightning Cr.	8	Rattle to Quartz (3.2)	1983-1987, 1992-2007
Morris Cr.	9	Mouth to trail 132 crossing (N/A)	1999-2007
N. Gold Cr.[a]	10	Mouth to falls (1.2)	1983-2007
Pack R.	11	Road 231 bridge near McCormick Cr. to Falls located 0.4 km downstream of W. Branch (2.8)	1983-1987, 1992-2007
Porcupine Cr.	12	Mouth to S.Fk. (3.2)	1983-1987, 1992-2007
Rattle Cr.	13	Mouth to falls by upper bridge (5.7)	1983-1987, 1992-2007
Savage Cr.	14	Mouth to trail 61 crossing (2.0)	1983-1985, 1987, 1992-2007
Strong Cr.	15	Mouth to diversion barrier (N/A)	1996, 2002, 2004
Sullivan Springs	16	Mouth upstream 0.4 km (0.4)	1983-1985, 1987, 1992-2007
Trestle Cr.[a]	17	1.6 km upstream of mouth to 0.5 km upstream of the road 275 switchback (10.4 km); 0.5 km upstream of road 275 switchback upstream to confluence with first southeast bank un-named tributary (0.5 km)	1983-2007
Twin Cr.	18	Mouth to River Road (1.5)	1983-1987, 1992-2007
Wellington Cr.	19	Mouth to falls (0.5)	1983-1987, 1992-2007

[a] Denotes "index" stream

The LPO Bull Trout Conservation Plan (PBTAT 1998) proposed two restoration targets for bull trout: 1) ensure the LPO basin bull trout population is not vulnerable to extinction; and 2) provide for an overall bull trout population sufficient to produce an annual harvestable surplus. Evaluating probability of persistence coupled with trend analysis has been recommended as an approach to assessing extinction risk (PBTAT 1998). The two primary metrics for determining if criteria have been met are that LPO supports at least six "healthy" bull trout populations, and efforts are underway to improve conditions in all high and medium priority tributaries. It is assumed that once target 1 has been met, a harvestable surplus will exist (target 2).

The U.S. Fish and Wildlife Service (USFWS) Bull Trout Draft Recovery Plan criteria (Plan) for LPO (USFWS 2002) has some similarities to the LPO Bull Trout Conservation Plan. The Plan calls for six populations consisting of greater than 100 individuals, a total abundance of 2,500 adults, and an increasing trend in abundance.

We used a nonparametric rank-correlation procedure, Kendall's tau (Daniel 1990), to test for trends in the long-term LPO redd count data set (Rieman and Myers 1997), as recommended in the LPO Bull Trout Conservation Plan. We used tau-b to compensate for any bias caused by ties in the data, and noted statistical significance at the $\alpha = 0.05$ level (Rieman and Myers 1997). Data for the year 1995 were not used for any streams except the mainstem Clark Fork River, Sullivan Springs, North Gold and Gold creeks in this analysis because poor water visibility due to high water conditions likely affected the accuracy of the counts. In addition, we did not use the 1983 data point for Grouse Creek or the 1986 data points for Rattle and East Fk. Lightning creeks because some segments of these streams that may have contained relatively substantial numbers of redds were not counted. To test for long-term trends, we ran correlations between year and redd count using the full data set (1983-present). In addition, we tested for short-term trends using data collected since 1998. We used 1998 as the cutoff date for short-term analysis as the draft USFWS Bull Trout Recovery Plan (USFWS 2002) requires at least 10 years of redd count data for trend analysis. The sign of the correlation was used to infer trend.

RESULTS

We successfully completed bull trout redd counts in 18 tributaries to LPO, as well as the Clark Fork River spawning channel in 2007. Bull trout redds were also counted in the Middle Fk. East River and Uleda Creek, in the Priest River drainage. Redd counts ranged from a low of zero redds in Savage, Twin, Morris and W. Gold Creeks, to a high of 179 redds in Gold Creek (Appendix A). The 2007 bull trout redd count was the lowest since 1997, and nearly half the record total count of 1,256 redds in 2006.

No statistically significant correlation between year and redd count was detected from 1983 to 2007 (Table 2). Half (50%) of correlation coefficients for the long-term analysis were positive, suggesting improved spawning escapement in a proportion of the tributaries monitored. Trend direction remained consistent within most tributaries sampled. However, trends in the Pack River and Johnson Creek shifted slightly from stable (tau-b = 0.00) or nearly stable (tau-b = <0.01) to negative. Twin Creek correlation coefficients also shifted in a negative direction due to surveying no detectable redds for the first time in over ten years.

Table 2. Correlations between year and redd count (trends) for bull trout populations monitored from 1983 through 2007 in tributaries to Lake Pend Oreille, Idaho.

Stream	Number of Years	Tau-b	P-value
Char Cr.	20	0.04	0.23
East Fk. Lightning Cr.	21	-0.03	-0.18
Gold Cr.	25	0.44	3.09
Granite Cr.	20	0.48	2.94
Grouse Cr.	23	-0.01	-0.08
Johnson Cr.	24	0.14	0.95
Lightning Cr.	20	-0.09	-0.53
North Gold Cr.	25	-0.13	-0.92
Pack River	20	-0.05	-0.29
Porcupine Cr.	20	-0.13	-0.78
Rattle Cr.	19	0.02	0.11
Savage Cr.	19	0.02	0.11
Sullivan Cr.	20	0.26	1.58
Trestle Cr.	24	0.13	0.92
Twin Cr.	20	-0.08	-0.50
Wellington Cr.	20	-0.07	-0.43

[a] Denotes statistical significance at the 0.05 level

Examining only the data from 1998 to present to obtain a view of the short-term trends in populations (10 years), we find that all but five tributary populations evaluated exhibited positive correlation values (Table 3). Of positive values, two were statistically significant while three others bordered on statistical significance.

Table 3. Correlations between year and redd count (trends) for bull trout populations monitored from 1998 to 2007 in tributaries to Lake Pend Oreille, Idaho.

Stream	Number of Years	Tau-b	P-value
Char Cr.	10	-0.11	0.65
East Fk. Lightning Cr.	10	-0.20	0.42
Gold Cr.	10	0.47	0.06
Granite Cr.	10	0.56	0.03[a]
Grouse Cr.	10	0.00	1.00
Johnson Cr.	10	0.25	0.31
Lightning Cr.	10	0.28	0.27
North Gold Cr.	10	0.45	0.07
Pack River	10	0.47	0.06
Porcupine Cr.	10	0.57	0.02[a]
Rattle Cr.	10	-0.04	0.86
Savage Cr.	10	0.40	0.11
Sullivan Cr.	10	0.22	0.37
Trestle Cr.	10	-0.02	0.93
Twin Cr.	10	-0.31	0.21
Wellington Cr.	10	0.16	0.51

[a] Denotes statistical significance

DISCUSSION

Six tributaries (index streams; Johnson, East Fk. Lightning, Trestle, Grouse, North Gold, and Gold creeks) have been surveyed consistently on an annual basis since 1983. The 2007 redd count for these six streams combined (456) was lower than the long-term average of 518 redds. Instability in the redd count index continued to be driven primarily by changes in counts from Trestle Creek, which due to its large spawning run, has a large influence over this pooled count. For example, only 145 redds were observed in Trestle Creek in 2007, compared to 395 observed in 2006. The total redd count in 2007 of 654 redds was comparable to the long-term average of 678 redds. However, the 2007 redd count included 36 redds from streams not sampled prior to 2006.

We identified no statistically significant correlations (trends) at the $\alpha = 0.05$ level among the 16 streams analyzed in the full data set (1983 to 2007) due to the large variability in redd numbers within the data set. Significant correlation between year and redds has generally been limited, but has been identified in Granite and Gold Creeks in previous years (Downs and Jakubowski 2007, Downs and Jakubowski 2006, Downs and Jakubowski 2005). This is not unexpected as previous authors using similar data sets predicted it may take over 100 years of continuous redd count data collection before a statistically significant trend can be detected (Rieman and Myers 1997).

Trestle and Gold creeks have a large influence on the total number of redds counted in the entire LPO system. From 1983 to 2007, Trestle and Gold creeks together accounted on average for the majority (73%) of the total number of redds counted in the six index streams annually. Any trend analysis that lumps all of the populations together is likely to be heavily influenced by the trends in these two streams. There appears to be a high degree of population structuring among local bull trout populations (Spruell et al. 1999; Neraas and Spruell 2001) and for this reason it is important to maintain as many local populations as possible to reduce the likelihood of extinction, as well as to preserve genetic diversity. Spruell et al. (1999) estimated straying rates between LPO bull trout populations at one individual/year based on genetic analysis. Evaluating trends at the local population level is more appropriate to understand the population dynamics of bull trout in LPO. Although it is clear that many populations had undergone fairly dramatic reductions in abundance, it appears that many have recovered and are now on a positive trajectory. It is likely that if lake trout *Salvelinus namaycush* abundance is successfully suppressed, bull trout should benefit through reduced competition and predation in the lake environment.

LPO bull trout continued to meet or nearly meet recovery objectives of the USFWS Plan (USFWS 2002). LPO met the criteria of having six local populations with greater than 100 individuals in each (seven in 2004; ten in 2005; six in 2006 and 2007). However, the threshold population size established in the Plan of 2,500 adults (estimated at 2,092 in 2007) was not met. This estimate of the total number of adults is based on expanding redd counts by the average ratio of 3.2 fish/redd observed across multiple streams and years of this program (Downs and Jakubowski 2006). A third criterion in the Plan is an increasing trend in abundance. Both the long and the short-term abundance trend evaluations suggested increasing adult escapement in at least half of the tributaries. The shorter-term evaluation (10 year) showed this more dramatically than the longer-term analysis.

Changes in fishing regulations may be partially responsible for the continued increases in adult escapement. A trophy regulation was enacted in 1994 that allowed for harvest of only one fish greater than 500 mm (IDFG 1994), and the fishery was closed to harvest in 1996 (IDFG 1996). This likely allowed more fish to reach maturity, and increased the number of fish that survive to repeat spawn. Bull trout harvest opportunities may exist currently in some populations where adult escapement is adequate to fully seed the available rearing habitat. The apparent high degree of fidelity of local bull trout populations (Spruell et al. 1999; Neraas and Spruell 2001) may afford some opportunity to selectively harvest from healthy populations.

Rieman and McIntyre (1996) suggested that year-class variation within adfluvial bull trout populations is more likely related to tributary spawning and rearing conditions than the lake environment. Differing trends observed in redd counts between individual tributaries to LPO lend support to this idea. If the majority of population regulation is currently occurring within tributaries, it will be difficult to detect positive trends once populations reach juvenile carrying capacity, which may be the case in tributaries such as Trestle and Gold creeks. Tributary habitat protection in these spawning streams (and all others) should remain the highest priority conservation action for bull trout in the LPO system at this time. In addition, watershed restoration aimed at restoring the physical template that produced healthy bull trout populations in the past should be a high priority in other drainages, such as Lightning Creek and the Pack River.

It is possible that predation/competition from the rapidly increasing introduced lake trout population will overcome the ability of individual tributaries to produce enough juveniles to support current adult escapement levels, even in Trestle and Gold creeks. Lake trout have been identified as the biggest existing threat to bull trout persistence in the LPO system (PBTAT 1998). Donald and Alger (1993), and Fredenberg (2002), have documented the incompatibility of sympatric bull and lake trout populations in numerous lake systems. Efforts to remove lake trout in LPO are currently underway.

The Lightning Creek drainage offers the greatest opportunity to increase bull trout numbers in the LPO system due to its relatively large drainage area, the opportunity for numerous habitat restoration projects, and the presence of at least five genetically distinct bull trout populations (Spruell et al. 1999). Several tributaries in Lightning Creek continue to have low numbers of bull trout spawners returning annually (Char, Porcupine, mainstem Lightning, Savage, and Wellington creeks). This, coupled with a high degree of reproductive isolation, places bull trout at an increased risk of local extinction (Spruell et al. 1999). Assessing and addressing the cause for the bull trout decline in the Porcupine and Savage creek drainages, as well as in other Lightning Creek tributaries, should be among the highest bull trout restoration priorities in the LPO system.

Efforts to improve bull trout habitat in Lightning Creek offer the greatest potential to increase bull trout numbers in the LPO system. A watershed assessment funded by Avista was recently completed in the Lightning Creek drainage to identify impairments to stream channel function, as unstable channels are believed to be one of the most significant habitat problems in the drainage (PBTAT 1998). Channel intermittency due to excess bedload is an obvious problem in Rattle, East Fk. Lightning, Savage, and mainstem Lightning creeks in many years. This channel intermittency causes direct loss of juvenile bull trout through stranding and predation in drying pools in late summer, and reduces the amount of physical rearing habitat available. This situation is most obvious in Rattle Creek where a section of stream channel in the middle of the bull trout spawning and rearing area, approximately 1 km in length, currently goes dry in late summer. Adult bull trout become stranded either within the intermittent reaches, or upstream of them, and are unable to reach spawning areas or outmigrate following spawning until fall rains occur. This may not occur until late October and stranded fish likely experience higher mortality as a result. In some years, mainstem Lightning Creek flows subsurface in the vicinity of the town of Clark Fork and all spawning bull trout remain stranded in Lightning Creek until flows increase in response to fall precipitation.

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APPENDICES

Appendix A. Annual bull trout redd counts (1983-2007) for tributaries to Lake Pend Oreille, Idaho.

Table A.1. Bull trout redd counts for Lake Pend Oreille, Idaho, basin tributaries, 1983-2007.

Stream	**1983[g,k]**	**1984[g]**	**1985[i]**	**1986[h]**	**1987[h,k]**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Clark Fork R.	--	--	--	--	--	--	--	--	--	2	8	17	18
Lightning Cr.	28	9	46	14	4	--	--	--	--	11	2	5	0 [b]
E. F. Lightning Cr.	110	24	132	8 [j]	59	79	100	29	--	32	27	28	3 [b]
Savage Cr.	36	12	29	--	0	--	--	--	--	1	6	6	0 [b]
Char Cr.	18	9	11	0	2	--	--	--	--	9	37	13	2 [b]
Porcupine Cr.	37 [j]	52	32	1 [j]	9	--	--	--	--	4	6	1	2 [b]
Wellington Cr.	21	18	15	7	2	--	--	--	--	9	4	9	1 [b]
Rattle Cr.	51	32	21	10[j]	35	--	--	--	--	10	8	0	1 [b]
Johnson Cr.	13	33	23	36	10	4	17	33	25	16	23	3	4 [b]
Twin Cr.	7	25	5	28	0	--	--	--	--	3	4	0	5 [b]
Morris Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--
North Shore													
Trestle Cr.	298	272	298	147	230	236	217	274	220	134	304	276	140 [b]
Pack River	34	37	49	25	14	--	--	--	--	65	21	22	0 [b]
Grouse Cr.	2[j]	108	55	13 [j]	56	24	50	48	33	17	23	18	0 [b]
Strong Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--
East Shore													
Granite Cr.	3	81	37	37	30 [j]	--	--	--	--	0	7	11	9 [b]
Sullivan Springs	9	8	14	--	6	--	--	--	--	0	24	31	9
North Gold Cr.	16	37	52	8	36	24	37	35	41	41	32	27	31
Gold Cr.	131	124	111	78	62	111	122	84	104	93	120	164	95
W. Gold Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--
Lower Priest R.													
M.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--
N.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--
Uleda Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--
Total 6 index streams[d]	570	598	671	290	453	478	543	503	423[a]	333	529	516	273 [b]
Total of all streams	814	881	930	412	555	478	543	503	423[a]	447	656	631	320[b]

Table A.1. Continued.

Stream	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007[n]
Clark Fork R.	3	7	8	5	5	6	7	8	1	0	3	2
Lightning Cr.	6	0	3	16	4	7	8	8	9	22	9	3
E. Fk. Light. Cr.	49	22	64	44	54	36	58	38	77	50	51	34
Savage Cr.	0	0	0	4	2	4	15	7	15	7	25	0[m]
Char Cr.	14	1	16	17	11	2	8	7	14	15	20	1
Porcupine Cr.	0	0	0	4	4	0	0	5	10	14	8	8
Wellington Cr.	5	2	1	22	8	7	7	8	7	6	29	9
Rattle Cr.	10	2	15	13	12	67	33	37	34	34	21	2
Johnson Cr.	5	27	17	31	4[c]	34	31	0	32	45	28	32
Twin Cr.	16	6	10	19	10	1	8	3	6	7	11	0
Morris Cr.	--	--	--	1	1	0	7	1	1	3	16	0
North Shore												
Trestle Cr.	243	221	330	253	301	335[e]	333[e]	361	102[b]	174	395	145
Pack River	6	4	17	0	8	28	22	24	31	53	44	16
Grouse Cr.	50	8	44	50	77	18	42	45	28	77	55	38
Strong Cr.	2	--	--	--	--	--	0	--	0	--	--	--
East Shore												
Granite Cr.	47	90[f]	49	41	25	7	57	101	149	132	166	104
Sullivan Springs	15	42	10	22	19	8	15	12	14	15	28[l]	17
North Gold Cr.	39	19	22	16	19	16	24	21	56	34	30	28
Gold Cr.	100	76	120	147	168	127	203	126	167	200	235	179
W. Gold Cr.	--	--	--	--	--	--	--	--	--	--	4	0
Lower Priest R.												
M.F. East River	--	--	--	--	--	4[k]	8[k]	21	20	48	71	34
N.F. East River	--	--	--	--	--	--	--	--	1	0	0	--
Uleda Cr.	--	--	--	--	--	3[k]	4[k]	3	7	4	7	2[m]
6 index streams[d]	486	373	597	541	623	566	691	591	462	580	794	456
Total of all streams	610	527	726	705	732	710	890	836	781	940	1256	654

Table A.1. Continued.

[a] Represents a partial count due to early snow fall because E. Fk. Lightning was not counted.
[b] Observation conditions impaired by high runoff.
[c] Head-cut barrier prevented access to most of the spawning area.
[d] Index streams include Gold, N. Gold, Trestle, Johnson, Grouse, and E. Fk. Lightning creeks.
[e] Approximately 0.5 km of stream was added to the upstream end of the historic Trestle Creek redd count section in 2001 because the debris jam barrier collapsed. Accounted for four redds in both 2001 and 2002, and two in 2003.
[f] Three additional redds observed in Dry Gulch.
[g] Data from Pratt (1985).
[h] Data from Hoelscher and Bjornn (1989).
[i] Data from Irving (1986).
[j] Partial survey and count of varying amounts. See Pratt (1985) and Holescher and Bjornn (1989) for details.
[k] Partial counts.
l Large early spawning kokanee made it difficult to distinguish bull trout redds from kokanee redds in Sullivan Springs.
m Flows were up and counting conditions were difficult in Savage and Uleda creeks.
n Severe flooding in the Lightning Creek drainage in November 2006 had significant adverse impacts on some stream channels.

2007 Clark Fork River Fishery Assessment Progress Report

ABSTRACT

The objective of this project is to measure the intended benefits of increasing the minimum flow from Cabinet Gorge Dam from 84.9 cubic-meters-per-second (cms) (3,000 cubic-feet-per-second) to 141.5 cms (5,000 cfs) in the Clark Fork River, Idaho. Mark-recapture population estimates were conducted in the fall of 2007 to estimate the abundance of rainbow *Oncorhynchus mykiss* and westslope cutthroat trout *O. clarkii lewisi*. We estimated 152 rainbow and 142 westslope cutthroat trout greater than 200 mm total length in the study reach during the fall sampling period in 2007. In general, based on population estimates and catch-per-unit-effort (CPUE), mountain whitefish *Prosopium williamsoni* are the most abundant salmonid species in the Clark Fork River, with the exception of periodic seasonally strong runs of kokanee *Oncorhynchus nerka*. Although population estimates suggest low abundance of trout in the Clark Fork River, proportional stock density (PSD) values continue to remain high, with an estimated PSD for rainbow and westslope cutthroat trout in the fall of 2007 of 74 and 63, respectively. This indicates a large majority of the electrofishing catch was greater than 305 mm. The short-term nature of the data set, a lack of an obvious trend in the abundance estimates, and the lack of population estimate data prior to increasing the minimum flow in the Clark Fork River, limits our ability to draw conclusions regarding the benefits of the increased minimum flow at this time.

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INTRODUCTION

Avista Corporation (Avista; formerly Washington Water Power (WWP)) relicensed two of its hydroelectric facilities on the Clark Fork River in Idaho and Montana in 1999. Cabinet Gorge Dam is located just inside the Idaho border and Noxon Rapids Dam is located approximately 32 km upstream in Montana (Figure 1).

Minimum flows in the Clark Fork River were one issue of particular concern to the local stakeholders involved in a collaborative relicensing process conducted by Avista. Photo documentation was used to estimate the minimum flow needed to provide a meaningful increase in permanently wetted perimeter of the Clark Fork River (Beak 1997). A new minimum flow was negotiated for Cabinet Gorge Dam as part of the relicensing agreement, which increased the base flow from 84.9 cms (3,000 cfs) to 141.5 cms (5,000 cfs) (Avista 1999). Cabinet Gorge Dam is operated as a "peaking" facility, and daily flow fluctuations ranged from 84.9 cms (3,000 cfs) to 1,010.3 cms (35,700 cfs) prior to the increased minimum discharge. The objective of the increased minimum flow was to increase the amount of permanently wetted river habitat to benefit the aquatic resources of the Clark Fork River.

In addition, Avista modified the Foster Bar side-channel inlet to provide perennial flow into the approximately 2 km-long side-channel at the new minimum discharge elevation from Cabinet Gorge Dam. It was anticipated this would provide valuable off-channel rearing habitat for salmonids, which is in limited supply in the Idaho reach of the Clark Fork River. The project also was intended to improve recreational fishing opportunities for adult salmonids in the side-channel.

Limited quantitative information exists relative to the fishery resources of the Clark Fork River in Idaho. Several studies have investigated river use by adfluvial fish from Lake Pend Oreille (LPO), as well as the fish community composition over the course of an entire year (Heimer 1965, Anderson 1978, WWP 1995 and 1996). Avista, in preparation for their hydropower license renewal, conducted investigations into relative abundance of fish species present in the Clark Fork River in Idaho (WWP 1995 and 1996). The information contained in these Avista reports adds to our baseline knowledge of fish populations in the Clark Fork River. In combination, the earlier Avista work and the first several years of this investigation will form the baseline from which we will gauge the effects of the increased minimum flow.

Previous work (Downs et al. 2003) suggested sampling in alternating years, in the spring for fall spawning salmonids and the fall for spring spawning salmonids, would help isolate the effect the new minimum flow was having on river fish, by avoiding spawning migration periods of fish from the lake. The target salmonid species in the overall assessment are brown trout *Salmo trutta*, mountain whitefish *Prosopium williamsoni*, rainbow trout *Oncorhynchus mykiss*, and westslope cutthroat trout *O. clarkii lewisi*. In addition, catch-per-unit-effort (CPUE) information would be collected during fall sampling periods to examine changes in the relative proportions of salmonids and non-salmonids, as well as monitor changes in abundance of non-salmonid species resulting from the increase in minimum flow.

In addition to enhancing minimum flows in the Clark Fork River, Avista and the Idaho Department of Fish and Game (IDFG) completed a project to provide perennial flow through Foster Bar side-channel to enhance fish habitat. This involved lowering several hydraulic control points within the side-channel so that water would flow through the side-channel over the range of discharges from Cabinet Gorge Dam. Prior to relicensing, when discharge from Cabinet Gorge Dam dropped below approximately 311.3 cms (11,000 cfs), the side-channel would become a series of un-connected pools until flows increased beyond 311.3 cms (11,000 cfs) again.

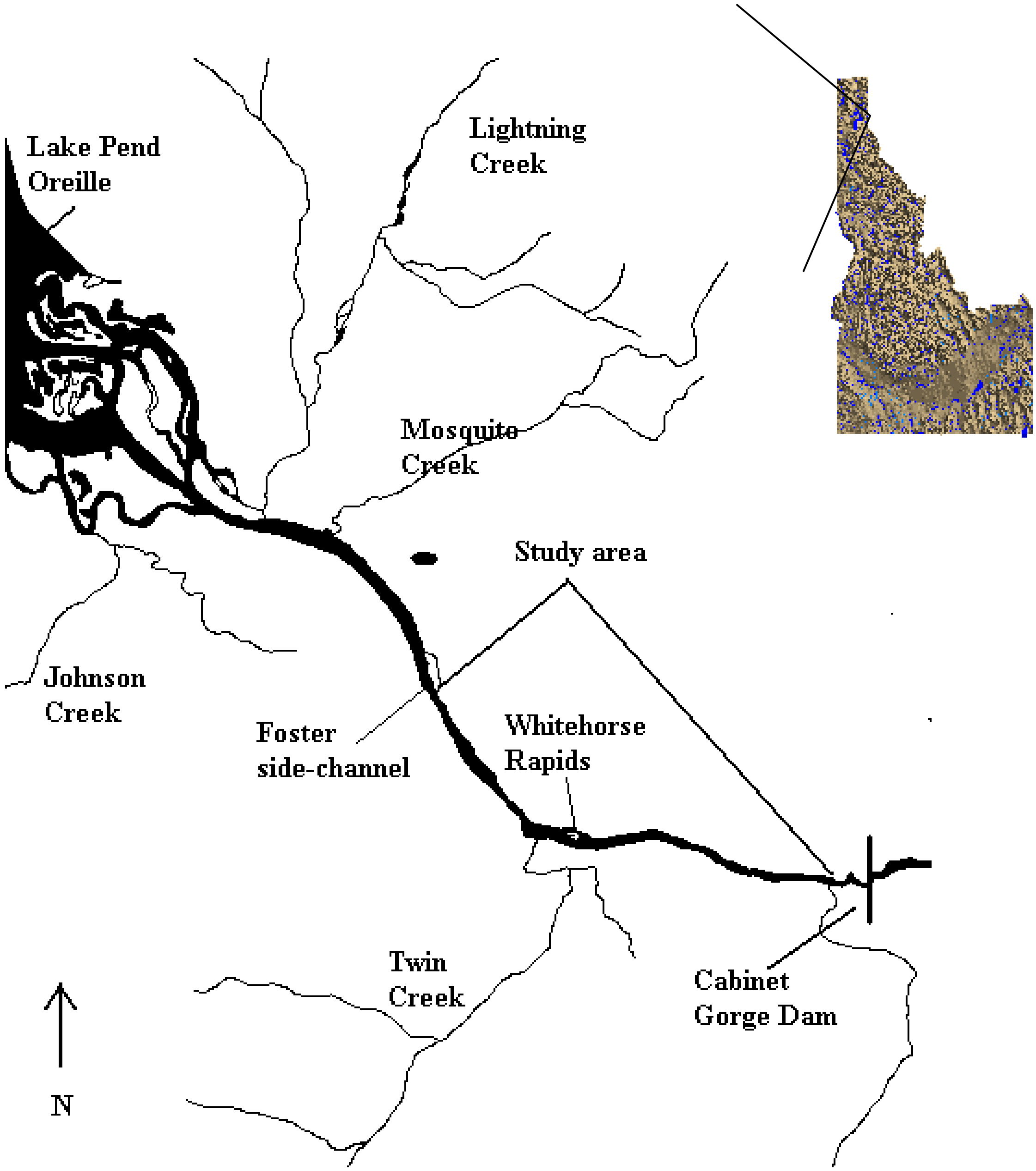

Figure 1. Fishery evaluation study area on the Clark Fork River, a tributary to Lake Pend Oreille, Idaho.

STUDY AREA

The Clark Fork River is the largest tributary to LPO, contributing an estimated 92% of the annual inflow (Frenzel 1991) and draining approximately 59,324 km^2 of western Montana (Lee and Lunetta 1990). Four tributaries enter the Clark Fork River downstream of Cabinet Gorge Dam: Twin, Mosquito, Lightning, and Johnson creeks (Figure 1). Peak flows in the Clark Fork River typically occur as a result of snow melt in May or June (PBTAT 1998).

The study area encompasses approximately 6.6 km of river habitat from the USGS gauging station below Cabinet Gorge Dam downstream to the inlet of Foster Bar side-channel (approximately river km 234 – 241) (Figure 1). There is approximately 17 km of river habitat between Cabinet Gorge Dam and LPO. Physical habitat in the Clark Fork River below Cabinet Gorge Dam can be characterized as primarily low gradient laminar flow, with three major riffles and several deep pools (to 23 m in depth) (WWP 1995). Riffles are located near the mouths of Twin and Lightning creeks, as well as at Foster Bar side-channel. Substrate composition in the river has been described as gravel (26.3%), fines (22.2%), boulder (17.9%) and cobble (16.2%), (WWP 1995).

Foster Bar side-channel is located approximately 1.9 km downstream of the confluence of Twin Creek with the Clark Fork River (Figure 1). The side-channel is approximately 2.45 km in length. During periods of winter drawdown of LPO, the side-channel functions as a lotic system. During periods of high summer lake levels, about half of the side-channel is influenced by a backwater effect from LPO, and stream flow through the side-channel is greatly slowed.

METHODS

Population Estimates and Catch-Per-Unit-Effort

Mark-recapture population estimates were conducted in the fall of 2007 for rainbow and westslope cutthroat trout (target species) greater than 200 mm total length (TL) in the approximately 6.6 km long study reach of the Clark Fork River. Distances and river kilometers were initially estimated from previous Avista GIS work (Parametrix 2000a). We previously estimated a total surface area of the study reach at 120.7 ha (Downs and Jakubowski 2003) using the earlier Avista GIS work. We validated this estimated area by measuring twenty-five wetted widths along the estimate section, as well as the total length of the section (25 sub-section lengths for a total estimated length of 6.61 km), using a laser range-finder. Using this method, we estimated the surface area at 114.8 ha at approximately 906 cms (32,000 cfs) discharge from Cabinet Gorge Dam. We estimated the surface area at this discharge because it is close to the upper operating limit of the project (approximately 990.5 cms (35,000 cfs)), and flows often fluctuate widely during the actual population estimates. By using the higher flow to calculate surface area, we would end up with a more conservative estimate of density for comparison with other populations**.** In 2007, we conducted our marking runs from October 22 through October 24, and our recapture runs from October 29 through November 1.

Boom-type electrofishing was conducted at night, typically using two crews in 6 m-long jet boats. However, due to equipment problems with one of the boats in 2007, the first two nights of the recapture run was conducted with one boat shocking both banks. On the third night, with only one boat available to estimate CPUE for all species encountered, only one bank was shocked. A fourth night was required to shock the other bank and conduct CPUE for all species. The electrofishing setup in each boat consisted of a Coffelt VVP-15 electroshocker powered by a 5000 watt Honda generator. Smooth DC current was employed to minimize risk of injury to trout (Dalbey et al. 1996). Typically, electrofishing settings were set to generate 5 to 8 amps at 200-220 volts.

Electrofishing boats floated in fast flow areas, or motored slowly in areas of very slow flow downstream, parallel with the shoreline. While electrofishing, we attempted to keep the anode closest to shore in approximately 0.6 m of water depth. Each boat typically made a single pass down each shoreline, and multiple passes along the shorelines in the Whitehorse Rapids area (to increase sample size in productive areas) each night. The "marking" period was conducted over a three-night period in the first week of sampling, and the "recapture" period was conducted over a four-night period the following week. We continued with recapture runs until we captured at least three previously marked fish of each target species to reduce probability of statistical bias in our estimates (Ricker 1975). We dip netted all fish encountered on one complete pass down each bank of the river during the recapture run to estimate CPUE for all species encountered.

Stunned fish were netted out of the electrofishing field and placed into a livewell for recovery. We attempted to net all salmonids stunned by electrofishing during the fall sampling. We used these data to conduct the mark-recapture population estimates for rainbow and westslope cutthroat trout, and also to estimate CPUE for all salmonids encountered along both banks on the first night of fall sampling, over the entire study reach. Captured fish were anesthetized and checked for fin clips. All fish were measured ((TL), mm). Larger fish were weighed to the nearest 10 g on a top loading spring scale and smaller fish to the nearest 1 g on a digital scale, marked with a fin clip, and released.

Population estimates were calculated using the modified Petersen method for sampling without replacement (any individual can only be counted once) (Krebs 1989) as:

$$N = ((M+1)(C+1)/(R+1)) - 1 \qquad (1)$$

Where: N = Estimated population

M = Number of individuals marked in the first sample

C = Total number of individuals captured in the second sample

R = Number of individuals in second sample that are previously marked

Confidence intervals were estimated using a Poisson distribution to account for small recapture sample size (Chapman 1948, Seber 1982). Confidence intervals (95%) were calculated using tabled values provided in Hayes et al. (2007). Confidence intervals (95%) around population estimates were examined between years to determine significant differences.

CPUE was estimated as fish captured per minute of electrofishing. We compared CPUE for all species captured the last two nights of the recapture run for trend analysis of relative abundance. We used linear regression to evaluate trends in CPUE data.

Population Size Structure and Condition

Relative weight (*Wr*) (Anderson and Neumann 1996) was calculated to assess salmonid condition. Proportional stock density (PSD) (Anderson and Neumann 1996) was calculated to examine population size structure. PSD for salmonids was separated into two classes; proportion > 305 mm and the proportion > 406 mm (Quality Stock Density, QSD) using 200 mm (TL) as stock length (Schill 1991).

RESULTS

Population Estimates and Catch-Per-Unit-Effort

We estimated 152 rainbow and 142 westslope cutthroat trout greater than 200 mm total length occupied the study reach during the fall sampling period in 2007 (Table 1). We captured a total of six westslope cutthroat X rainbow trout hybrids greater than 200 mm total length and included them in with the rainbow trout population estimate (mean TL; mm = 333.0; range = 281-408; S.D. = 47.8). Population estimates for westslope cutthroat trout and rainbow trout, including rainbow trout X cutthroat trout hybrids, in 2007 were lower than 2005 estimates. However, overlap of 95% confidence intervals across all years suggested there was no statistically significant change or trend in abundance (Figures 2 and 3).

Table 1. Population estimate statistics for westslope cutthroat (Wct), and rainbow trout (Rbt) and rainbow trout X westslope cutthroat trout hybrids >200 mm captured in the 6.6 km study reach of the Clark Fork River, Idaho, below Cabinet Gorge Dam, during the third and fourth weeks of October and first week of November, 2007.

Species	M	C	R	Population estimate	Lower 95% CI	Upper 95% CI
Wct	29	18	3	142	38	642
Rbt/hybrids	33	26	5	152	55	440

M = Number of individuals marked in the first sample
C = Total number of individuals captured in the second sample
R = Number of individuals in second sample that are previously marked

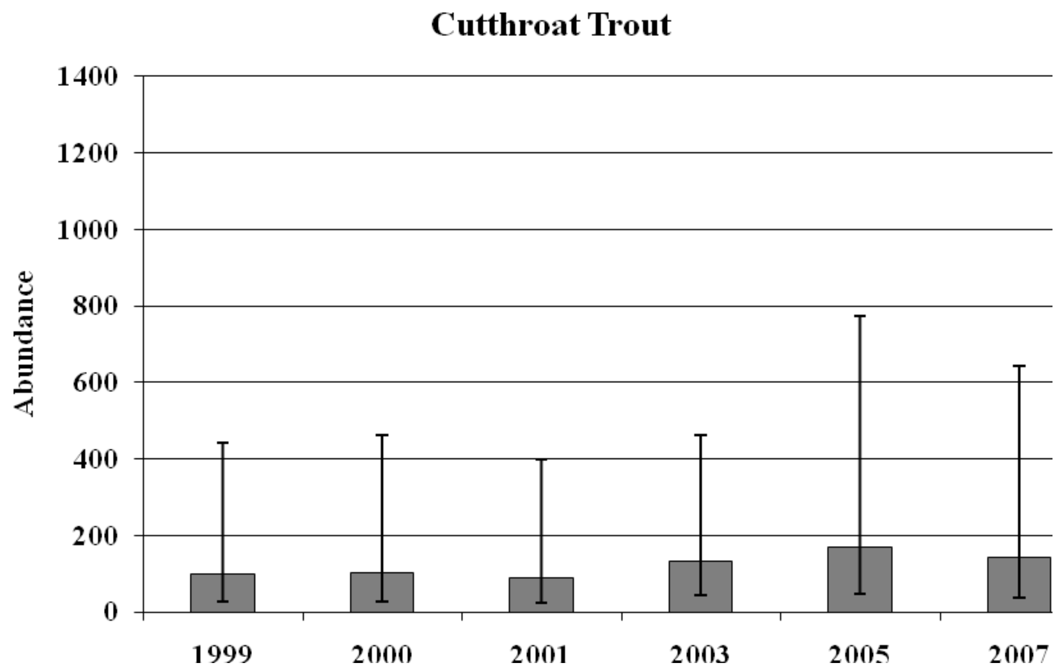

Figure 2. Comparison of population estimates and associated 95% confidence intervals, for westslope cutthroat trout in the 6.6 km long study reach of the Clark Fork River, Idaho, 1999 through 2007.

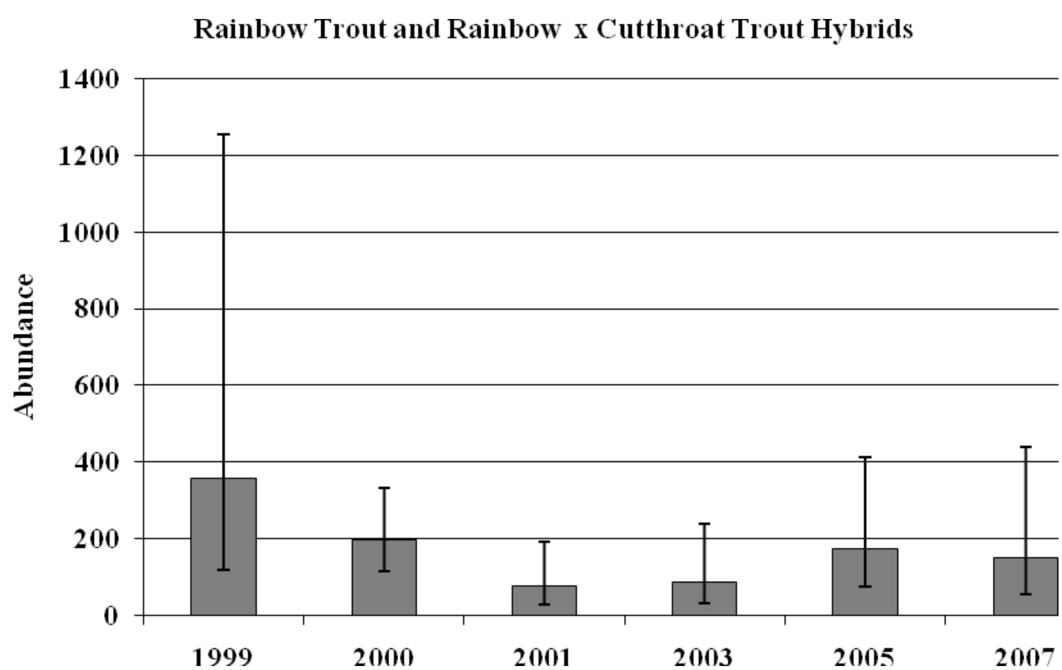

Figure 3. Comparison of population estimates and associated 95% confidence intervals, for rainbow trout in the 6.6 km long study reach of the Clark Fork River, Idaho, 1999 through 2007.

We captured a total of 15 fish species during the fall 2007 marking and recapture runs combined (Table 2). CPUE for all fish species, sampled during the recapture run, was highest for northern pikeminnow *Ptychocheilus oregonensis* (0.32 fish/min.). Largemouth bass *Micropterus salmoides* were the rarest fish in our catch (<0.01 fish /min). No bull trout *Salvelinus confluentus*, brown bull head *Ictalurus nebulosus*, pumpkinseed *Lepomis gibbosus*, smallmouth bass *Micropterus dolomieui*, or walleye *Sander vitreus* were captured in the sample despite being present in previous fall sampling collections.

Table 2. Catch Per Unit Effort (CPUE) for all species captured over 340.2 minutes of electrofishing along both banks of the 6.6 km study reach in the Clark Fork River, Idaho, during the fall, 2007 recapture run.

Species	Scientific name	Number captured	CPUE (fish/minute)
Brook trout[a]	*Salvelinus fontinalis*	0	0.00
Brown trout	*Salmo trutta*	43	0.13
Kokanee	*Oncorhynchus nerka*	9	0.03
Lake trout[a]	*Salvelinus namaycush*	0	0.00
Lake whitefish	*Coregonus clupeaformis*	14	0.04
Largemouth bass	*Micropterus salmoides*	1	<0.01
Largescale sucker	*Catostomus macrocheilus*	63	0.19
Longnose sucker	*Catostomus catostomus*	2	<0.01
Mountain whitefish	*Prosopium williamsoni*	53	0.16
Northern pikeminnow	*Ptychocheilus oregonensis*	108	0.32
Peamouth	*Mylocheilus caurinus*	93	0.27
Rainbow trout	*Oncorhynchus mykiss*	11	0.03
Redside shiner	*Richardsonius balteatus*	5	0.01
Westslope cutthroat trout	*Oncorhynchus clarkii lewisi*	11	0.03
Yellow perch	*Perca flavescens*	4	0.01

[a]No brook or lake trout were captured during the recapture run. A single fish of each species was captured during the marking run.

No significant correlation was identified between year and CPUE at the $\alpha = 0.05$ level for any species sampled in the Clark Fork River Fishery Investigation since 1999 or by WWP in 1994 (Table 3; WWP 1996, Downs and Jakubowski 2006, Downs and Jakubowski 2005, Downs et al. 2003). Trends in CPUE by year were weakly present ($P \leq 0.10$) in bull trout, longnose sucker, northern pikeminnow, and pumpkinseed, suggesting some changes in population density in these species may have occurred since 1994. Between 53% and 61% of the variation in CPUE was attributable to sampling year in species with p-values less than or equal to 0.10. However, annual variation explained less than 30% of the variation in CPUE in the majority of species sampled. Of those species indicating weak trends in relative abundance, all were positive trends with the exception of northern pikeminnow.

Table 3. Results of regression analysis between year (1994, 1999, 2001, 2003, 2005, and 2007) and CPUE including; the square of Pearsons correlation coefficient (r^2), slope of regression line through the data, and the *P-value* indicating significance of the relationship.

Species	r^2	Slope	*P-value*
Bull trout	0.53	<0.01	0.10
Longnose sucker	0.61	<0.01	0.07
Northern pikeminnow	0.60	-0.06	0.07
Pumpkinseed	0.61	<0.01	0.07
Brown bullhead	0.03	<0.01	0.76
Brown trout	0.45	0.01	0.15
Kokanee	0.32	-0.11	0.24
Lake whitefish	0.31	0.01	0.26
Largemouth bass	0.13	<0.01	0.48
Largescale sucker	0.09	-0.02	0.57
Mountain whitefish	0.04	0.01	0.72
Peamouth	0.00	<0.01	0.94
Rainbow trout	0.14	<0.01	0.47
Redside shiner	0.42	-0.10	0.16
Smallmouth bass	0.16	<0.01	0.44
Tench	0.03	<0.01	0.76
Walleye	0.03	<0.01	0.76
Westslope cutthroat trout	0.09	<0.01	0.57
Yellow perch	0.39	<0.01	0.18

Population Size Structure and Condition

During the report period, average length-at-capture across all salmonid species ranged from 290.2 mm for kokanee to 877.0 mm for lake trout (Table 4; Figures 4 through 9). PSD (proportion of catch > 305 mm) was above 60 for all target salmonid species and was measured at 71, 88, 74, and 63 for brown trout, mountain whitefish, rainbow trout, and westslope cutthroat trout, respectively. QSD's (proportion of the catch > 406 mm) were 16, 0.7, 32, and 2 for brown trout, mountain whitefish, rainbow trout, and westslope cutthroat trout, respectively (Table 5). Estimated *Wr* for westslope cutthroat and rainbow trout was 91 and 87, respectively (Figures 10 and 11). Metrics collected on non-salmonid species are listed in Table 6.

Table 4. Mean lengths (TL; mm), mean weights (g), standard deviation (SD), sample size (n), and length range (mm) for salmonid species inhabiting the 6.6 km long study reach on the Clark Fork River, Idaho, during the marking and recapture runs, combined, in fall, 2007.

Species	Mean length (SD) (n)	Length range	Mean weight (SD) (n)
Brook trout	305.0 (N/A) (1)	N/A	240.0 (N/A) (1)
Brown trout	354.4 (80.0) (213)	212-736	472.2 (487.3) (213)
Kokanee	290.2 (56.6) (10)	215-391	318.2 (162.4) (5)
Lake trout	877.0 (N/A) (1)	N/A	7,485 (N/A) (1)
Lake whitefish	431.2 (35.2) (29)	375-535	737.2 (210.9) (27)
Mountain whitefish	344.0 (34.1) (138)	195-444	479.2 (142.4) (138)
Rainbow trout	373.1 (80.9) (53)	224-590	560.8 (327.0) (52)
Westslope cutthroat trout	326.9 (41.7) (48)	266-427	364.6 (150.2) (48)

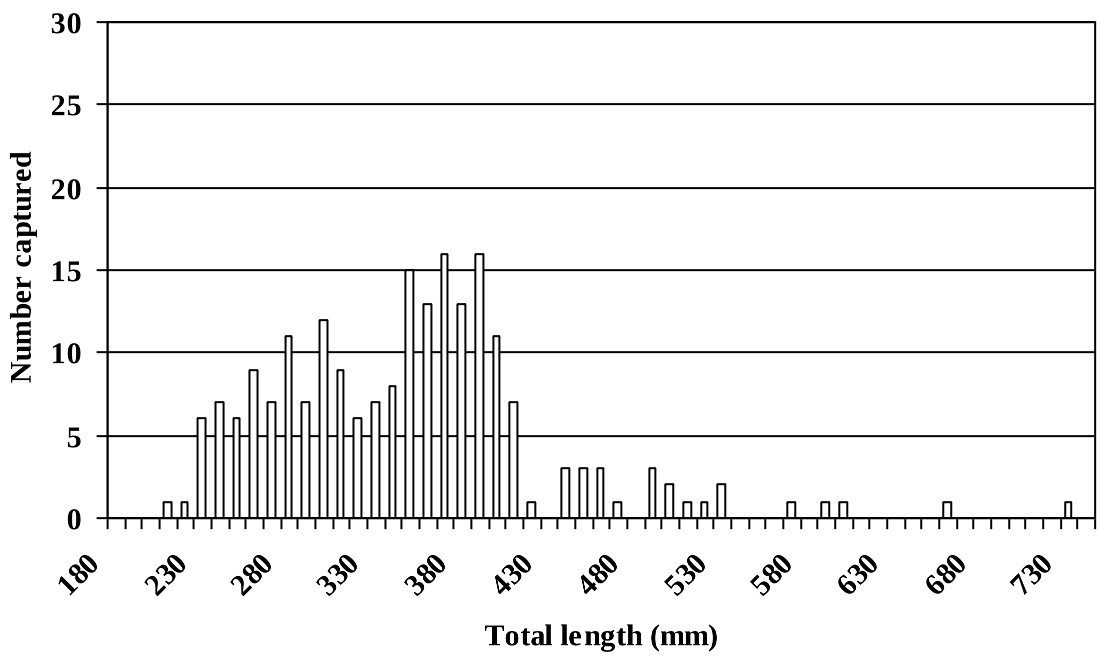

Figure 4. Length frequency histogram for brown trout (n = 213) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, during the marking and recapture runs, combined, in fall, 2007.

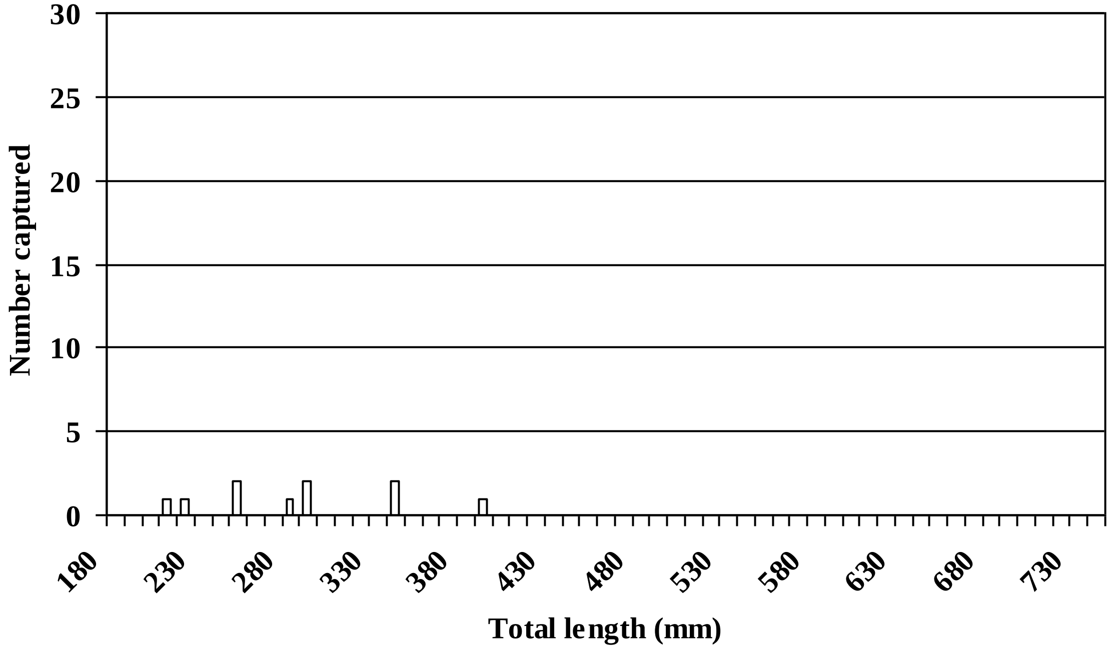

Figure 5. Length frequency histogram for kokanee (n = 10) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, during the marking and recapture runs, combined, in fall, 2007.

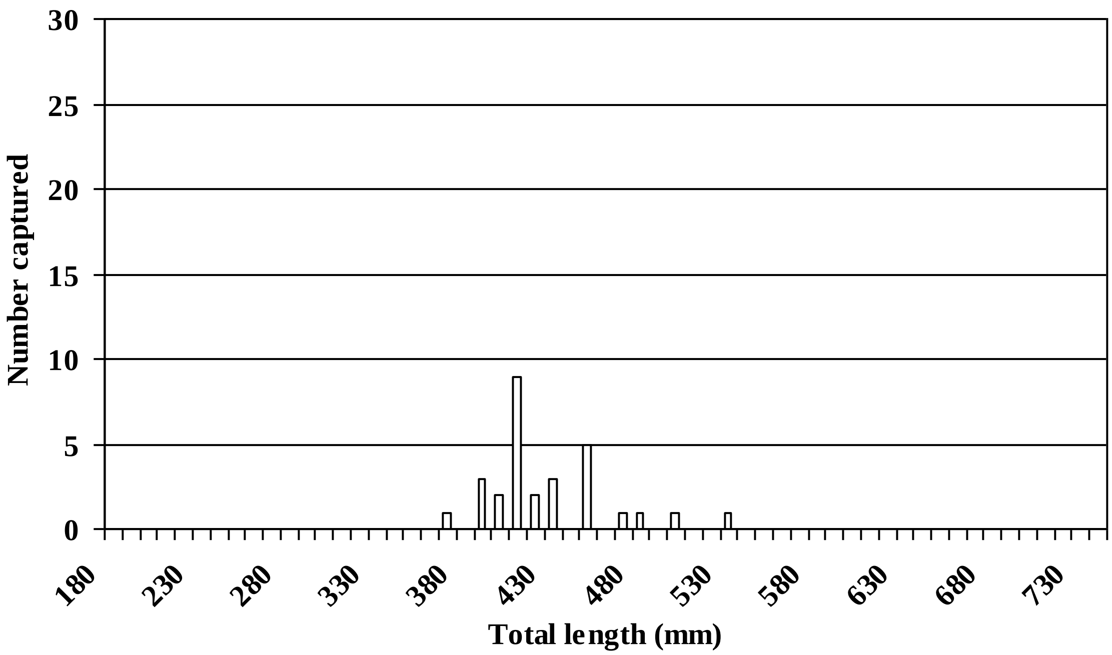

Figure 6. Length frequency histogram for lake whitefish (n = 29) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, during the marking and recapture runs, combined, in fall, 2007.

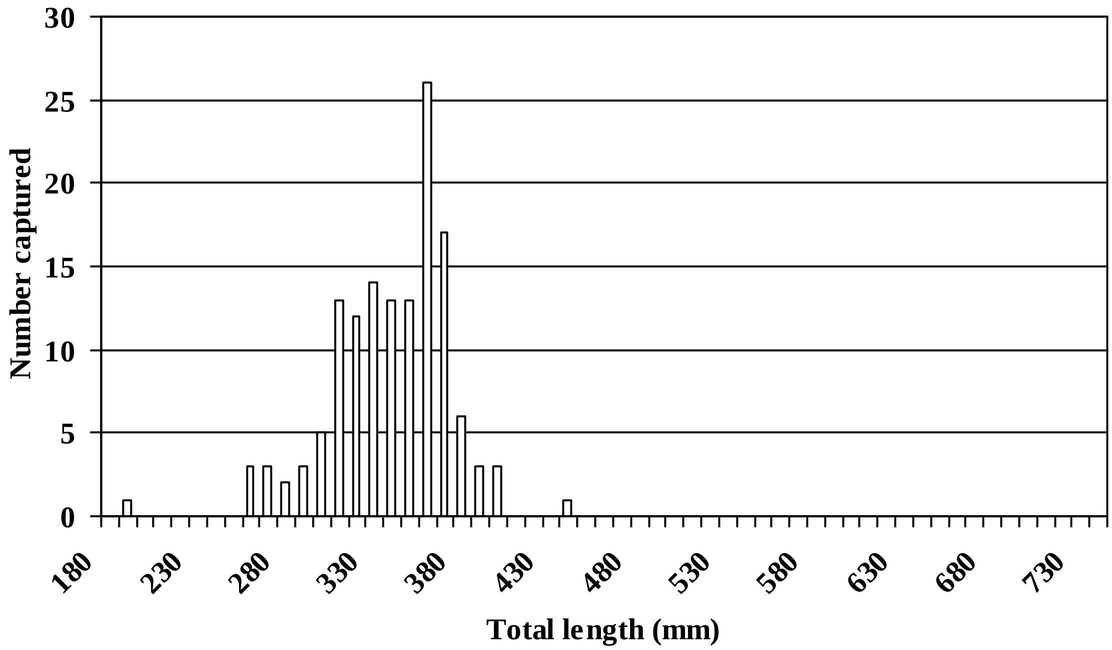

Figure 7. Length frequency histogram for mountain whitefish (n = 138) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, during the marking and recapture runs, combined, in fall, 2007.

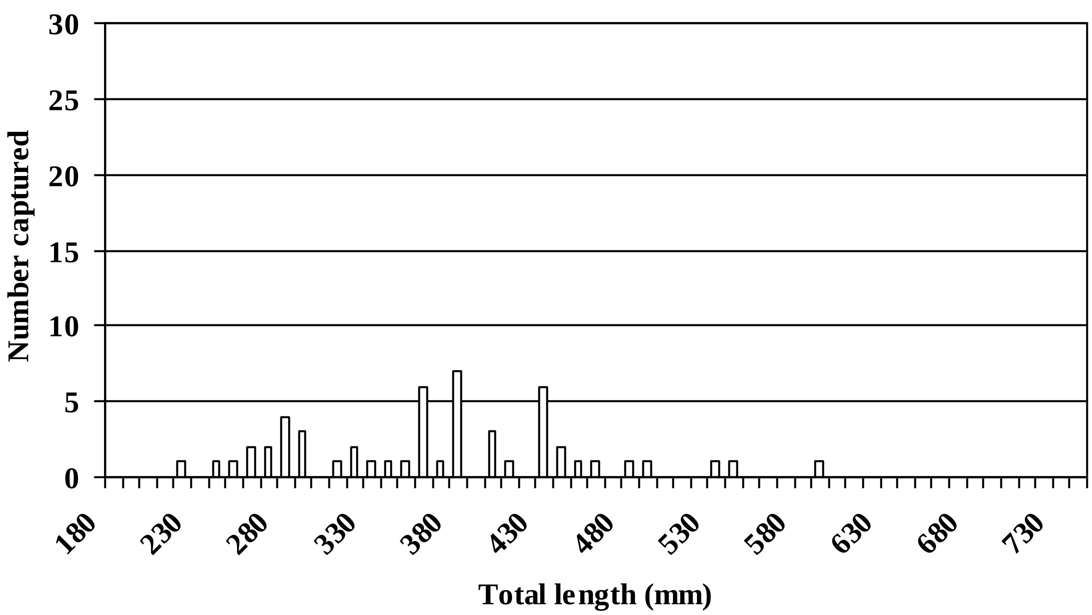

Figure 8. Length frequency histogram for rainbow trout (n = 53) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, during the marking and recapture runs, combined, in fall, 2007.

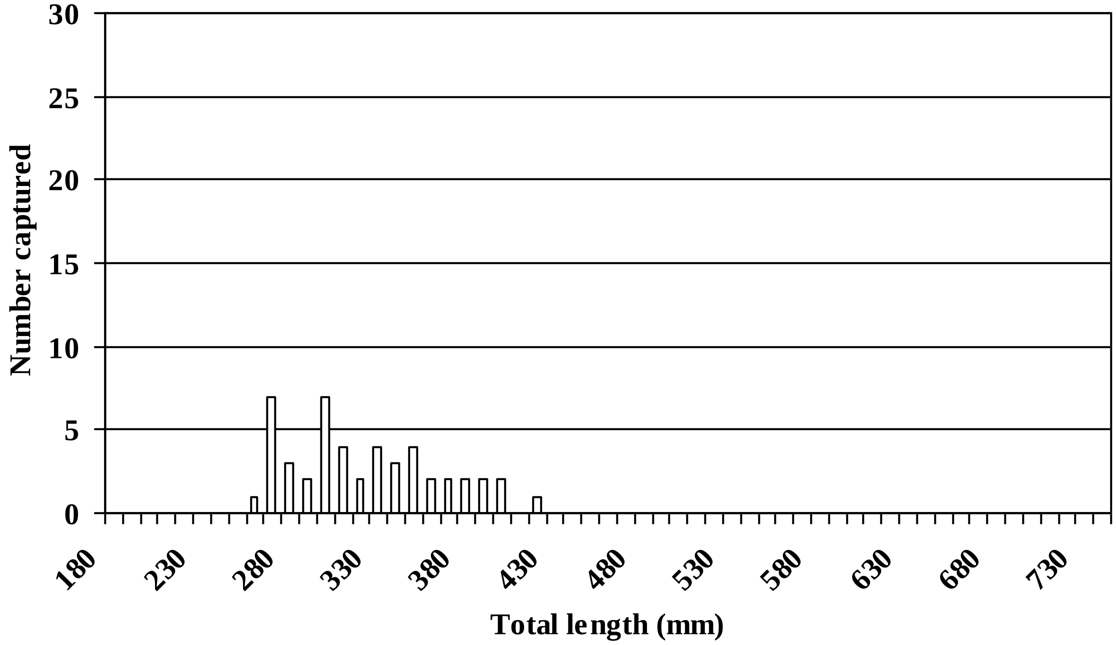

Figure 9. Length frequency histogram for westslope cutthroat trout (n = 48) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, during the marking and recapture runs, combined, in fall, 2007.

Table 5. Proportional stock density (>305 mm) and quality stock density (>406 mm) estimated for westslope cutthroat and rainbow trout captured in the Clark Fork River, Idaho, during fall sampling from 1999 through 2007. Stock length was 200 mm.

	Westslope cutthroat trout		Rainbow trout	
Year	**PSD**	**QSD**	**PSD**	**QSD**
1999	69	0	72	10
2000	29	4	77	11
2001	62	0	89	19
2003	61	4	86	9
2005	65	2	64	25
2007	63	2	74	32

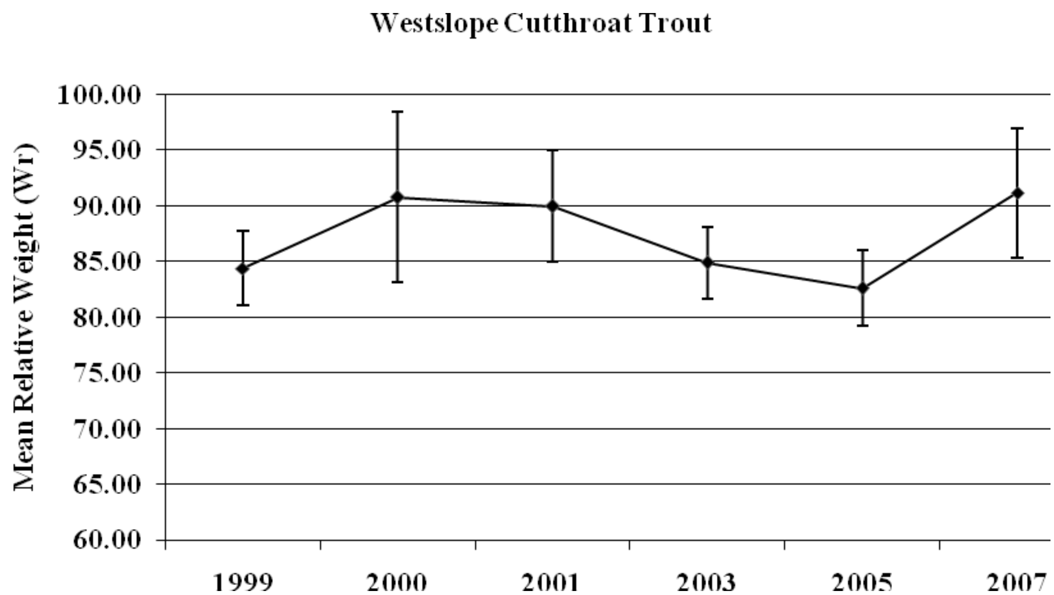

Figure 10. Mean relative weight (*Wr*) and 95% confidence intervals estimated for westslope cutthroat trout captured in the Clark Fork River, Idaho, during fall sampling from 2001 through 2007.

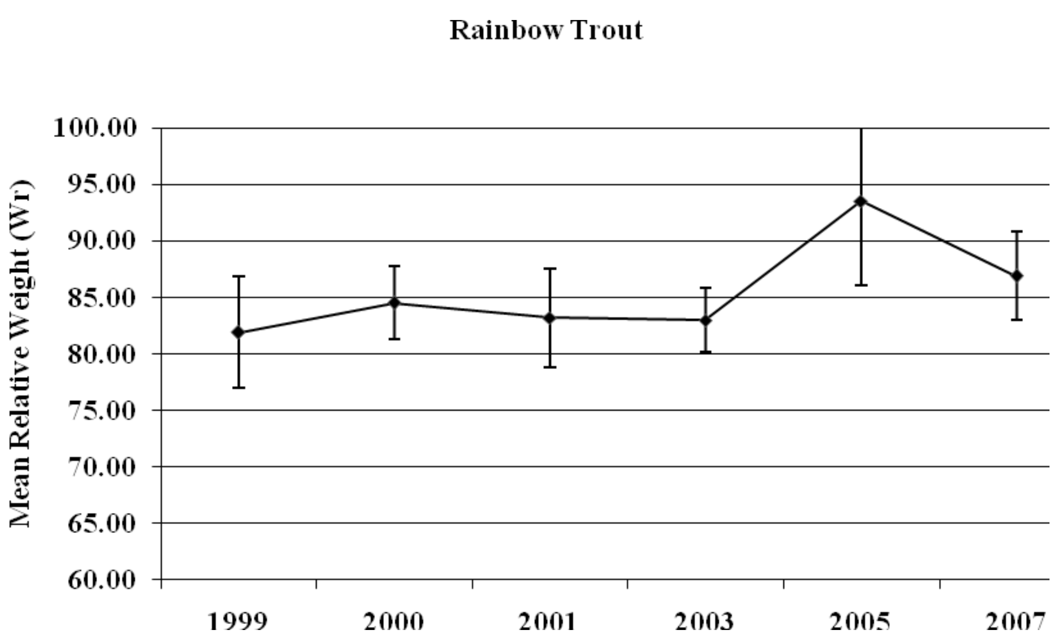

Figure 11. Mean relative weight (*Wr*) and 95% confidence intervals estimated for rainbow trout captured in the Clark Fork River, Idaho, during fall sampling from 2001 through 2007.

Table 6. Mean lengths (TL; mm), mean weights (g), standard deviation (SD), sample size (n), and length range (mm) for non-salmonid species inhabiting the 6.6 km long study reach on the Clark Fork River, Idaho, during the recapture run, in fall, 2007.

Species	**Mean length (SD) (n)**	**Length range**	**Mean weight (SD) (n)**
Largemouth bass	121.0 (N/A) (1)	N/A	19.0 (N/A) (1)
Largescale sucker	389.3 (120.9) (63)	115-550	688.0 (490.6) (29)
Longnose sucker	351.0 (86.3) (2)	290-412	N/A
Northern pikeminnow	253.0 (70.5) (108)	103-496	130.3 (89.4) (51)
Peamouth	224.3 (50.9) (93)	138-335	92.3 (60.2) (83)
Redside shiner	89.6 (6.4) (5)	80-98	6.8 (1.5) (5)
Yellow perch	157.0 (15.9) (4)	146-180	43.5 (16.0) (4)

DISCUSSION

Population Estimates and Catch-Per-Unit-Effort

Evaluation of population estimates from 1999 to 2007 suggested no change has occurred in westslope cutthroat trout and rainbow trout densities over the sampled time period. Evaluation of CPUE also suggested changes in target species density has not fluctuated significantly. Marginally significant changes in CPUE for bull trout, longnose sucker, northern pikeminnow, and pumpkinseed were detected. However, the magnitude of possible change was limited as identified by the slopes of less than 0.01 to -0.06 observed in regression analysis (Table 3).

Annual variance has remained high within population estimates as demonstrated by consistently wide confidence bounds. Consequently, detecting a statistically significant change was difficult without dramatic shifts in abundance. Low sample sizes and resulting recapture rates are the likely cause of high variability and suggest population densities are in fact low, but also sampling techniques may be low in efficiency.

High variability in estimates of population size, relatively short-term data sets, and the lack of pre-treatment population estimates continue to make meaningful conclusions regarding the effectiveness of the increased minimum flow to benefit salmonids difficult. It may take a number of years for any benefits resulting from improved rearing conditions to be expressed in terms of adult abundance. Data from 1999 (post minimum flow change) may be useful in evaluating changes in the absence of pre-treatment population estimates. However, the use of this early post treatment data from 1999 has not suggested any change has occurred at this time, as described in the comparison of abundance estimates in this year. Appendix T of the Clark Fork Settlement Agreement (Avista 1999) calls for evaluation of the increased minimum flow over the first 10 years of the agreement (1999-2008). We will continue the 10 year monitoring period with spring sampling in 2008 to monitor brown trout and mountain whitefish. Population monitoring in the fall and spring will likely continue beyond 2008 in a less intensive form in order to track future fish community abundances.

Population Size Structure and Condition

Population structures of sampled target salmonid species in 2007 surveys indicated those populations were made up of a relatively significant portion of larger individuals. PSD values above 60 for all four target species and length frequency histograms supported this observation (Table 5; Figures 4-9). Sampled size classes suggested primarily adult fish were present. Population structures skewed to larger fish were observed in all fall samples from 1999 to 2007 with the exception of the 2000 collection of westslope cutthroat trout (PSD, 29). Low westslope cutthroat trout PSD in 2000 was believed to represent a potential sampling bias, as the PSD values were relatively consistent both before and after the 2000 sampling season. Rainbow trout PSD's showed greater variability than the westslope cutthroat trout PSD's, but do not reveal any consistent trends (Table 5). There were also no apparent trends across years in estimated mean total length for either westslope cutthroat or rainbow trout (Table 7).

Table 7. Mean total length (TL; mm) estimated for westslope cutthroat and rainbow trout captured in the Clark Fork River, Idaho, during fall sampling from 2001 through 2007.

	Westslope cutthroat trout		**Rainbow trout**	
Year	**Mean TL (SD)**	**Sample size**	**Mean TL (SD)**	**Sample size**
1999	319.0 (30.3)	36	341.1 (66.5)	78
2000	307.8 (41.2)	31	349.8 (52.4)	107
2001	325.9 (39.8)	32	364.1 (57.6)	37
2003	319.3 (39.6)	46	350.1 (44.9)	44
2005	327.0 (37.4)	49	342.9 (82.6)	64
2007	326.9 (41.7)	48	373.1 (80.9)	53

The resulting descriptions of population size structure in salmonids suggested present fish communities likely represented life history types exhibiting spawning and rearing in alternate locations or sampling protocols are not suited for capturing all size classes. Population estimates and measures of relative abundance (CPUE) suggested no changes have occurred within this monitoring project which indicates recruitment limitations were not the cause of the absent juvenile component of these populations. Regardless of the cause it is evident that the juvenile component of the population is not represented in these electrofishing surveys. In the absence of evidence that suggests recruitment is a limiting factor, adult abundance and associated survival becomes essential in monitoring change in lower Clark Fork River fish populations. Observable changes in adult abundance due to water level manipulations may potentially take several generations to be detected due to the time lag between new recruits occurring in alternate locations and changes in adult survival rates within the main river.

Conditional indices also demonstrated stability in rainbow trout and westslope cutthroat populations. A basic premise of *Wr* is that the value of 100 represents the shape of a fish of that species in good condition. When *Wr's* are consistently well below 100, problems may exist in food or feeding (Anderson and Neumann 1996). Our observed values for both westslope cutthroat and rainbow trout were consistently less than 100, suggesting less than optimum foraging conditions may have existed in the Clark Fork River. We have not observed any significant trends or changes in *Wr* across years for either westslope cutthroat trout or rainbow trout except in 2005 rainbow trout *Wr* was significantly different than 2003, but no difference was detected from any other year which suggested the change did not represent a critical shift in condition (Figures 10 and 11).

A number of factors acting in combination likely continue to regulate salmonid abundance and condition in the Clark Fork River. These include low habitat diversity (only one section of riffle habitat in the study area), limited tributary spawning and rearing habitat (Twin Creek), relatively warm summer water temperatures (21^0C recorded on July 24, 2002) (C. Downs, IDFG, personal communication), elevated total dissolved gas levels in most years (Parametrix 2000b), and continued power-peaking.

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2007 Trestle and Twin Creeks Bull Trout Outmigration and Lake Pend Oreille Survival Study Progress Report

ABSTRACT

Idaho Department of Fish and Game (IDFG) and Avista staff utilized a rotary screw trap and weirs to capture juvenile bull trout *Salvelinus confluentus* from Trestle Creek in 2000 through 2002 and Twin Creek from 2000 through 2003, in order to estimate abundance and evaluate survival rates in tributary and lake environments. A total of 921 age-1 and older out-migrating juvenile bull trout in Trestle Creek were injected with Passive Integrated Transponder (PIT) tags from 2000 through 2002 to directly estimate survival from juvenile to adults in Lake Pend Oreille (LPO). A remote PIT tag detection weir was operated seasonally on Trestle Creek from 2001 through 2007 to identify marked bull trout upon their return as adults. We detected the first returning PIT tagged adults in 2003 that were originally marked as juveniles in Trestle Creek. Survival of juvenile bull trout from out-migration to returning adult ranged from 8.9% to 15.5%. We also marked adult bull trout captured moving downstream out of Trestle Creek with PIT tags in 2000 and again in 2005 to compare return rates. Observed minimum survival of tagged adults returning to spawn in subsequent years was between 53.3% and 61.6%. The overall return rate for marked adults was lower in 2005 than in 2000, but it was not significantly different. Ninety-three juvenile bull trout were marked with PIT tags in Twin Creek for lake survival estimation from 2000 through 2003. Only one of these individuals has been detected as an adult anywhere in the LPO system.

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INTRODUCTION

Long-term data sets are available for bull trout *Salvelinus confluentus* redd counts in many Lake Pend Oreille (LPO) tributaries. Relationships have also been developed to estimate the size of adult spawning populations using observed adult bull trout to redd count ratios. An aspect of interest in the LPO system is how the number of redds observed in a tributary relates to the actual number of juvenile out-migrants and their survival back to adult escapement.

Development of juvenile bull trout migration estimation techniques may provide a mechanism by which we can more accurately identify trends in local bull trout populations, and identify survival problems earlier, with more specificity than simply using redd counts. In addition, quantification of juvenile return rates through recapture as spawning adults will provide an estimate of in-lake survival and insight into the role the lake environment plays in regulating local bull trout abundance, as well as its' role in recovering upstream bull trout stocks. This topic is particularly timely given the expansion of the lake trout *S. namaycush* in LPO.

This study also provides a mechanism to estimate juvenile bull trout production from two Idaho tributaries heavily involved in either restoration and/or habitat protection. We will be able to measure the success of our restoration/habitat protection efforts by periodically comparing trapping results to establish trends.

Two streams are being used in the study, Trestle and Twin creeks. Trestle Creek, a tributary entering the northeast portion of LPO, Idaho, has consistently remained the greatest producer of bull trout in the LPO system (Figure 1). Trestle Creek drains approximately 60 square-kilometers (km^2) of the Cabinet Mountains and generally supports the largest annual run of any of the LPO tributaries. Trestle Creek represents a large proportion of the bull trout spawning escapement from LPO on an annual basis. The LPO Key Watershed Bull Trout Problem Assessment (PBTAT 1998) recognized Trestle Creek as the highest priority tributary stream and as having the highest probability of persistence of any stream in the LPO watershed. The assessment also noted that bull trout have highly specific habitat requirements and high sensitivity to human-induced disturbance.

Physical habitat conditions were generally considered to be good in Trestle Creek. Legacy effects from past logging and road construction, and potential impacts from future timber harvest and road construction, have been largely addressed in the watershed (PBTAT 1998). The Trestle Creek Local Working Committee developed and adopted site-specific forestry best management practices (BMP's) under the Idaho Forest Practices Act. In 1995, the U.S. Forest Service completed a comprehensive Trestle Creek watershed restoration project that was designed to mitigate adverse watershed impacts from decades of road construction and logging (USDA Forest Service 1993). That project was considered to have significantly reduced the threats to bull trout habitat in the upper watershed (PBTAT 1998). In addition, the Idaho Tributary Habitat Acquisition and Enhancement Program funded by Avista Corporation, under the Clark Fork Settlement Agreement, funded the purchase of four riparian properties on Trestle Creek totaling 46.1 ha. The acquisition protects riparian habitat and reduces the risk of residential development.

Twin Creek is a spring-fed tributary to the lower Clark Fork River in Bonner County, Idaho, and drains approximately 28.5 km^2 of the Bitterroot Mountains. Twin Creek is used for spawning by bull trout and westslope cutthroat trout *Oncorhynchus clarkii lewisi*, as well as brown trout *Salmo trutta*, mountain whitefish *Prosopium williamsoni*, rainbow trout *O. mykiss*, and kokanee *O. nerka* migrating from the Clark Fork River and LPO (Figure 1). Brook trout *Salvelinus fontinalis* are also present. Construction of Cabinet Gorge Dam in 1952, located several kilometers upstream of Twin Creek, blocked upstream migrations of fish from LPO to tributaries in Montana. During the mid-1950's, biologists documented between 50 and 80 bull trout redds each fall in the lower 1.6 km of Twin Creek. Recent estimates of bull trout spawner to redd ratios for LPO tributaries suggest an average of 3.2 bull trout spawn for every redd constructed (Downs and Jakubowski 2006), or that approximately 160 to 256 adults were entering Twin Creek annually to spawn. In the early 1950's, much of lower Twin Creek was channelized for agricultural purposes, resulting in a significant reduction in actual stream length and a loss of habitat diversity. The stream channel was relatively straight, wide, and shallow, with depths rarely exceeding 15 cm during the summer/fall low flow period. Livestock grazing occurred throughout most of the summer, and streamside vegetation was limited to grasses and a few alders along approximately 30 percent of the channel length. Since 1992, the average number of bull trout redds counted in this reach has been seven.

A project was initiated in 1999 to move much of Twin Creek back into its original channel, restore the natural meander pattern, and increase habitat diversity. The primary goal of the restoration project was to increase bull trout use for spawning and rearing.

Our work on Trestle and Twin creeks in 2007 marks the eighth year of what is anticipated to be a nine-year study into the life-history and survival of bull trout inhabiting LPO tributaries. The first three years of the study (2000-2002), involved the capture and marking of bull trout, and the subsequent six years will involve recapture of marked individuals to estimate the desired survival rates and life-history parameters.

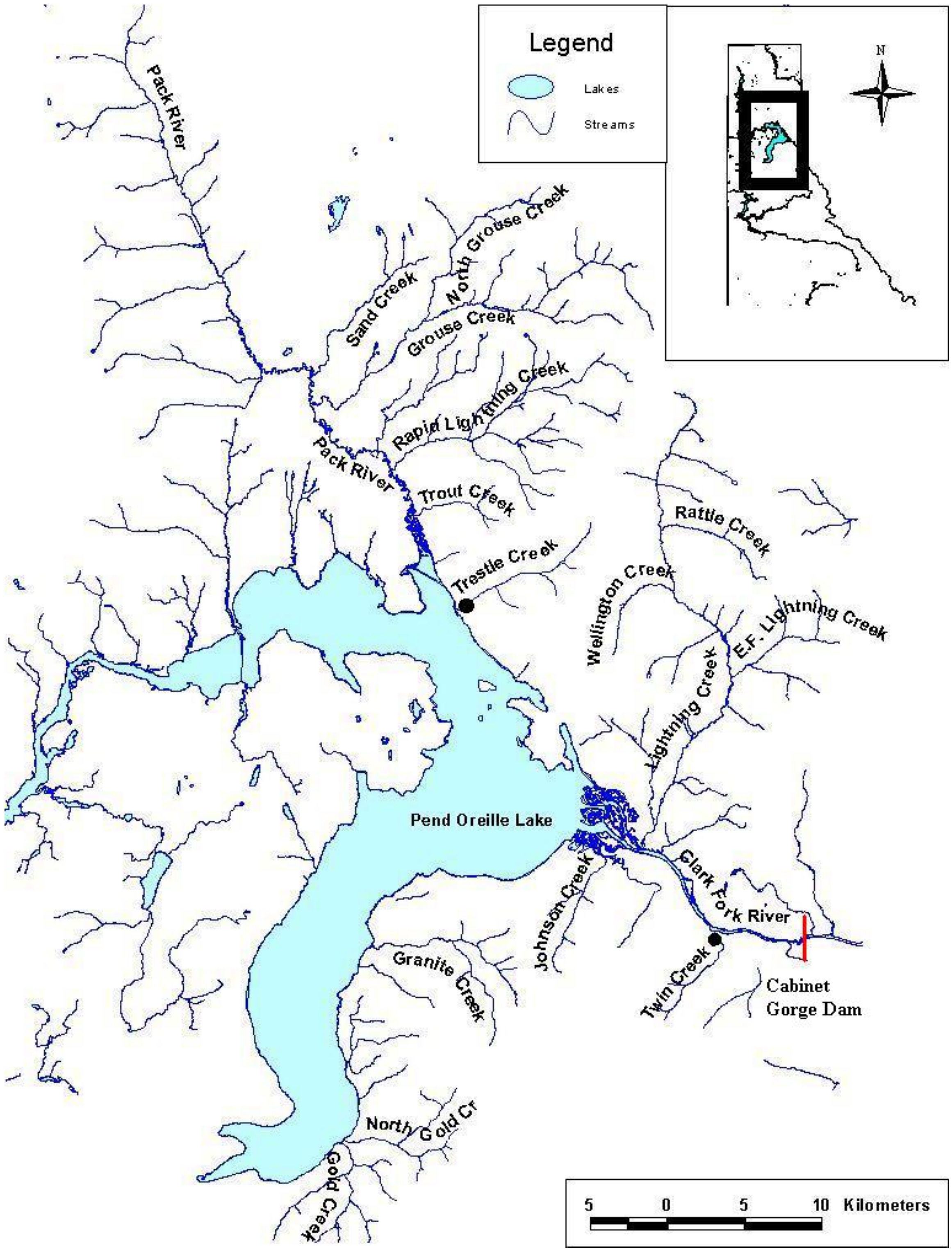

Figure 1. Trap locations on Trestle and Twin creeks, Idaho, tributaries to Pend Oreille Lake and the Clark Fork River, Idaho, below Cabinet Gorge Dam.

METHODS

Survival Estimation Trestle Creek

From 2000 through 2002, 921 juvenile bull trout were captured migrating out of Trestle Creek in a rotary-screw trap and/or downstream weir, and marked for lake survival estimation using PIT tags (Downs and Jakubowski 2003). Juveniles were double marked in 2001 and 2002 with an adipose clip to estimate tag retention. In addition, 428, 245, and 144 adult bull trout were also tagged with PIT tags in Trestle Creek in 2000, 2002, and 2005, respectively.

In 2001, we developed and installed a remote PIT tag detection weir near the mouth of Trestle Creek to reduce the labor needed to handle hundreds of adult bull trout moving in Trestle Creek and reduce fish stress (Downs and Jakubowski 2003). The setup consisted of a picket weir and modified trap box. Fish were guided by the weir panels, into a conical shaped entrance in a metal frame trap box covered with 6 mm black plastic mesh. The cone funneled down to an opening approximately 175 mm in diameter, surrounded by a waterproof PIT tag reading antennae. As PIT tagged fish passed through the antennae, the frequencies were recorded on a FS-2001 PIT tag reader (full-duplex tag reading system) enclosed in a protective ammo can mounted on top of the trap box. We utilized a 12-volt deep cycle battery or 120-volt AC to power the system. Data was downloaded from the PIT tag reader to a laptop computer for storage and analysis. In previous years we tested the efficiency of the PIT tag detection system for cheek tagged adult bull trout by comparing the number of PIT tagged adults captured in the screw trap moving downstream, with the number of these fish subsequently detected at the remote PIT tag receiver station (Downs and Jakubowski 2003).

In 2007, the remote PIT tag detection weir was installed in Trestle Creek on August 13 and removed on October 24, having operated for all but three nights. In 2007, we also utilized a weir on Trestle Creek with both upstream and downstream trap boxes, to increase detection of returning adult bull trout, and to test the efficiency of the remote PIT tag receiving station. We also used the weir to check long-term tag retention by noting the presence of an adipose clip, and the presence/absence of a PIT tag in the abdomen of captured fish. The weir consisted of steel pickets with 25.4 mm spacing in a metal frame, with 1.22 m x 0.91 m x 0.91 m steel frame trap boxes wrapped in 6 mm black plastic mesh used to capture the fish (Downs and Jakubowski 2003). The weir was located upstream of the remote PIT tag receiving station at the Bear Paw campground, where the screw trap had previously been located. It was installed on August 29, and removed on October 24, 2007. During the time the weir was in operation, a weir panel was also placed at the inlet of a side-channel to Trestle Creek, located downstream of the weir trapping site, to prevent out-migrating bull trout from entering and becoming stranded. This side-channel diverts approximately 10% of the total flow from Trestle Creek during low-flow periods, and had previously been identified as an area of concern.

Captured bull trout were anesthetized, examined for marks, scanned for the presence of a PIT tag, and measured (total length (TL); mm). If a PIT tag was not already present in a captured adult bull trout, a 11.5 X 2.1 mm 134.2 khtz PIT tag was inserted into the soft tissue of the cheek, oriented approximately parallel with the dorsal-ventral plane of the fish. With the exception of two individuals, juvenile bull trout (< 300 mm) were not PIT tagged in the abdomen in Trestle

Creek in 2007. All fish were allowed to recover their equilibrium in fresh water for several minutes. All other fish were anesthetized, identified to species, measured (TL; mm) and weighed (g).

A minimum estimate of lake survival from juvenile migrants to mature adult was estimated as the proportion of individual juvenile bull trout marked in Trestle Creek in 2000, 2001, and 2002, and subsequently detected returning to spawn as an adult in Trestle Creek. We tested for differences in the survival proportions for each marking year using the chi-square test of homogeneity (Zar 1996), comparison of the 95% confidence intervals of the survival proportions, and by developing a 95% confidence interval for the difference between the two survival proportions (Fleiss 1981). Confidence intervals for the survival proportions were estimated using the binomial distribution. We used a t-test for independent samples to evaluate differences in return rates for juvenile marking groups based on size. We did not make statistical comparisons for returns for the 2002 marking group with other years, as the returns for this group may be incomplete at this point. We anticipate completing this analysis next year.

A similar analysis approach was used for estimating minimum annual survival rates of adult bull trout from both the 2000 and 2005 adult marking groups. Survival was estimated as the cumulative proportion of individual migrating PIT tagged adult bull trout marked in either 2000 or 2005 that were detected as a return to Trestle Creek in any subsequent year. Confidence intervals for the survival proportions were estimated using the binomial distribution. We used a cumulative total of returns because a small proportion may not return on an annual basis (alternate year spawners), and our detection system is less than 100% efficient in any given year. We did not use the 2002 adult marking data for adult survival estimation because these fish were captured in a screw trap and we could not be certain they had survived to leave Trestle Creek. We filtered the 2000 and 2005 adult marking groups such that we only included marked individuals in our analysis that were last detected moving downstream at our weir near the mouth of Trestle Creek. We assumed all of these fish survived and continued downstream to the lake, located approximately 1.4 km downstream of our trap. Few bull trout spawn downstream of our trap location.

Bull trout lake residency was described in years as the length of time between juvenile migration and adult return to the stream of origin. Initiation of lake residency was determined by the timing of out-migration. Juvenile bull trout migrating in the spring (March-June) or summer (July-August) were included in the current year as a year spent residing and maturing in the lake. Juveniles that migrated in the fall (Sept-Nov.) of the year were counted in the following migration year, as they were not present in the lake during the primary growing season. We did not include the year the juvenile bull trout returned to Trestle Creek as an adult as a year spent maturing in the lake.

We utilized a mark-recapture approach to estimate the abundance of adult spawners in Trestle Creek using the 2005 and 2006 Trestle Creek weir data. We used the number of adult bull trout we captured and marked with PIT tags moving upstream in our weir as the number of marks (M), the total number of adult bull trout we captured moving back downstream after spawning as the number of captures (C), and the number of marked bull trout from the upstream marking group (M) that we recaptured moving back downstream as the number of recaptures (R). Abundance estimates were compared to previous estimates conducted in 1998 and 2000.

Survival Estimation Twin Creek

On August 7, 2007, we installed a weir on Twin Creek with both upstream and downstream trap boxes to capture migrating adult bull trout. The weir consisted of steel pickets with 25.4 mm spacing in a metal frame, with 1.22 m x 0.91 m x 0.91 m steel frame trap boxes wrapped in 6.35 mm black plastic mesh used to capture the fish (Downs and Jakubowski 2003). The weir was removed on October 29, 2007.

Captured bull trout were anesthetized, examined for marks, scanned for the presence of a PIT tag, and measured (total length (TL); mm). If a PIT tag was not already present in a captured adult bull trout, a 11.5 X 2.1 mm 134.2 khtz PIT tag was inserted into the soft tissue of the cheek, oriented approximately parallel with the dorsal-ventral plane of the fish. If a PIT tag was not already present in a juvenile bull trout (< 300 mm), a PIT tag was inserted into the abdomen of individuals greater than 75 mm. All fish were allowed to recover their equilibrium in fresh water for several minutes. All other fish were anesthetized, identified to species, measured (TL; mm) and weighed (g).

RESULTS and DISCUSSION

Trestle Creek

To date, a total of 29 unique bull trout originally marked as juveniles in 2000, were detected in Trestle Creek as returning adults (10.7%). Of the 349 juveniles originally marked migrating from Trestle Creek in 2001, 54 unique individuals (15.5%) returned to date. Twenty-seven unique individuals (8.9%) from the 2002 marking group returned to date (Table 1). One additional adult/sub-adult bull trout from the 2002 juvenile marking group (PIT tag number 985120011471814) was killed in gill nets in LPO on August 29, 2006. This fish was 429 mm, and would likely not have returned to spawn until 2007. This fish was not used in any of the summary data or analysis in this report because it did not survive and return to its natal stream. No previously undetected adult bull trout from the 2000 juvenile marking group returned to Trestle Creek during 2007, although three new fish from the 2001 marking group and four from the 2002 marking group returned in 2007.

Estimates of lake survival rested on a critical assumption that Trestle Creek juvenile bull trout have a high degree of fidelity to their natal stream. This assumption is supported by genetic evidence that suggests straying occurs, but at very low levels in the LPO system (Spruell et al. 1999).

Pit tag retention in returning adult bull trout was variable among years. In 2007, 14 returning adult bull trout with a missing adipose fin were captured, and five also contained a PIT tag in their abdomen (36% retention rate). In 2001 and 2002, all juvenile bull trout captured and PIT tagged in the abdomen on Trestle Creek (n = 349 and n = 302) also had their adipose fin removed. In 2006, we captured 41 returning adult bull trout with a missing adipose fin, and 25 also contained a PIT tag in their abdomen (61% retention rate). For comparison, in 2005 we also ran the Trestle Creek weir to estimate PIT tag loss, and 13 of 20 adult bull trout with an adipose clip also had a PIT tag in their abdomen (65% retention rate).

It was apparent that tag loss continued as the fish matured in the lake environment or during spawning in the tributary environment. Previous estimates of short-term (24-hour) PIT tag retention in juvenile bull trout were high, ranging from 94% to 98% (Downs and Jakubowski 2003). Average retention is likely between 36% and 65%.

Table 1. Returning adult bull trout to Trestle Creek, a tributary to Lake Pend Oreille, Idaho, originally PIT tagged as juveniles in 2000, 2001 and 2002. New returns refer to bull trout that were tagged but had not been detected in a previous return year.

Return year	2000 tagged fish (n = 270)		2001 tagged fish (n = 349)		2002 tagged fish (n = 302)	
	Total returns	New returns	Total returns	New returns	Total returns	New returns
2001	0	0	N/A	N/A	N/A	N/A
2002	0	0	0	0	N/A	N/A
2003	4	4	1	1	0	0
2004	19	19	9	8	0	0
2005	7	6	32	29	3	3
2006	2	0	18	13	21	20
2007	1	0	5	3	4	4
Totals		29		54		27

We evaluated the differences in the raw juvenile to adult survival rates (unadjusted for tag loss) between the 2000 and 2001 marking groups using the chi-square test of homogeneity, comparison of 95% confidence intervals, and by developing a 95% confidence interval for the difference between the two survival rates. Return rates for the 2000 and 2001 juvenile bull trout marking groups did not differ significantly when evaluated using the chi-square test of homogeneity (χ^2=3.0, df=1, P>0.05). We also constructed a 95% confidence interval for the difference between the two proportions. The confidence interval included zero ($-0.009 \leq P_2 - P_1 \leq 0.103$), which is consistent with the results of the χ^2 test. The 95% confidence intervals also overlap for the 2000 and 2001 return groups, providing further support for the conclusion that the proportions are not significantly different (Figure 2). Although the 2002 return estimate is lower than both the 2000 and 2001 estimates, we will collect an additional years' data before drawing conclusions regarding the return rate from the 2002 marking group.

Of the 370 marked adult bull trout last captured moving downstream (out of Trestle Creek) with PIT tags in 2000, 228 (61.6%) of these fish were detected in at least one subsequent year (2001-2007) in Trestle Creek. Two of these fish (both female) were detected in Trestle Creek annually from 2000 through 2007. A third female was present in all years except 2006. Of the 105 adult bull trout marked moving downstream with PIT tags in 2005, 56 (53.3%) of these were detected in subsequent years (2006 and/or 2007) in Trestle Creek. The overall return rate for marked adults was lower in 2005 than in 2000, but the return rates for the two groups did not differ significantly when evaluated using the chi-square test of homogeneity (χ^2=2.3, df=1, P>0.05). We also constructed a 95% confidence interval for the difference between the two proportions. The confidence interval included zero ($-0.031 \leq P_2 - P_1 \leq 0.197$), which is consistent with the results of the χ^2 test. The 95% confidence intervals also overlap for the 2000 and 2005 return groups, providing further support for the conclusion that the proportions are not significantly different (Figure 3). However, females from the 2000 adult marking group returned at a significantly higher rate (67.7%) than males (40.2%) ($\chi^2=20.51$, df=1, $P<0.05$) (Figure 4).

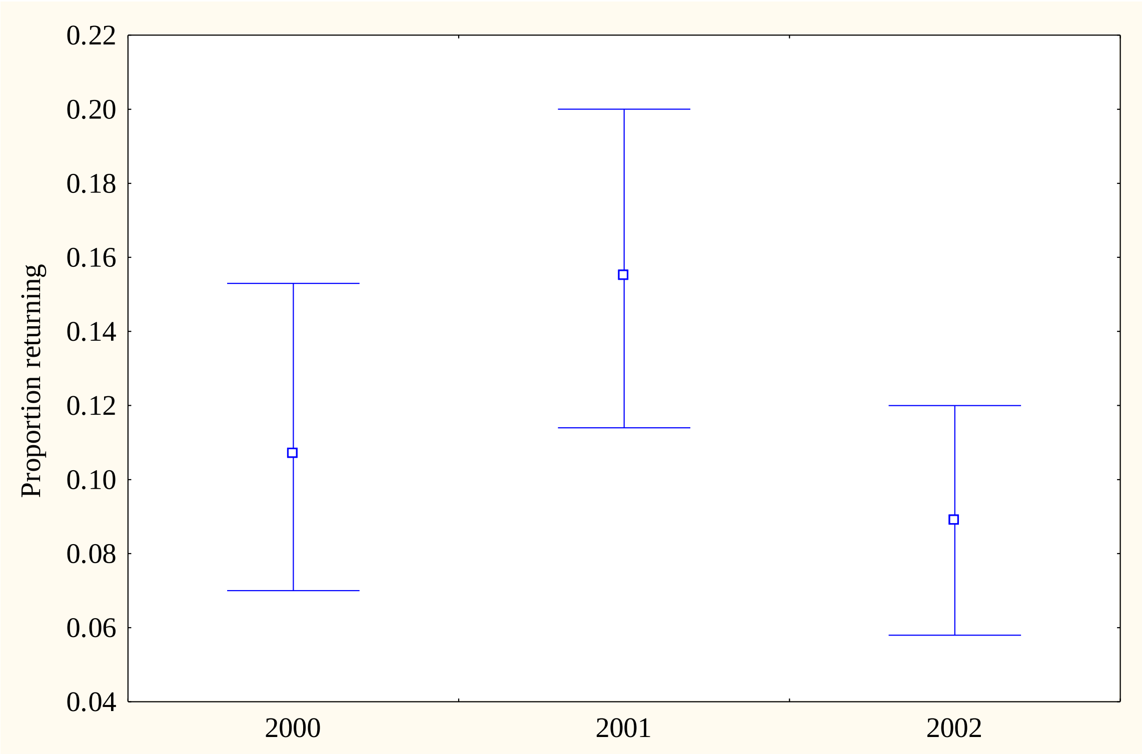

Figure 2. Estimated return rates and associated 95% confidence intervals for juvenile bull trout, marked in Trestle Creek, Idaho, from 2000 through 2002.

Mean length of marked juvenile bull trout ranged from 165 mm (n=270; S.D.=21.5) in 2000 to 172 mm (n=302; S.D.=25.0) in 2002. Examination of the 95% confidence intervals indicates that the 2000 marking group was significantly smaller than the 2002 marking group. However, overlapping 95% confidence intervals for means between the 2001 (mean=168 mm; n=349; S.D.=21.6) marking group and both the 2000 and 2002 marking groups indicates the 2001 marking group mean length is not significantly different from either the 2000 or the 2002 marking groups.

There did appear to be some size-selection in the survival of juvenile migrants. The t-test (t-value=-2.33; d.f.=1,029; $p<0.05$) indicated a significant difference between the mean length of the original marking group, and the mean length-at-marking for the return group. In general, larger out-migrants survived better than smaller ones. This is evident when we plot the frequency distributions of the length-at-marking for the marked versus the recaptured groups (Figure 5). The variability in return rates across the marking length groups obscured a clear trend (Figure 6), however it appeared that in general, survival was better for those fish leaving the stream greater than, versus less than, 165 mm (TL). This is particularly evident when we examine the data for those length groups with the largest sample sizes (140 to 190 mm).

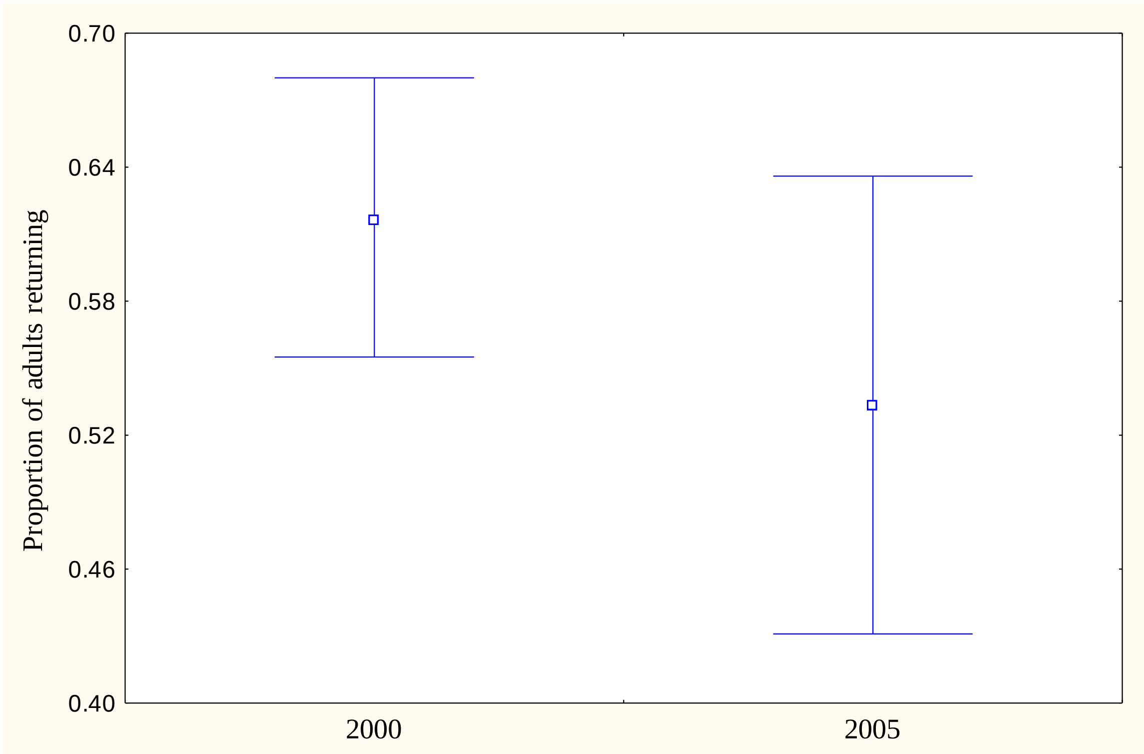

Figure 3. Estimated return rates and associated 95% confidence intervals for adult bull trout, marked in Trestle Creek, Idaho, in 2000 and 2005.

Most fish spent four years (growing seasons) in the lake before returning as adults (Figure 7). We defined the number of growing seasons as the number of years (including the outmigration year if the individual migrated in the spring or summer of that year) that an individual spent in the lake environment before returning to spawn. We did not have precise return dates (only the year) for returning adults, so we did not include the year an adult returned as a year maturing in the lake. In all likelihood, the maturation process was completed the year before the fish returned in order to allow gametes (particularly eggs) to develop for the fall spawning season.

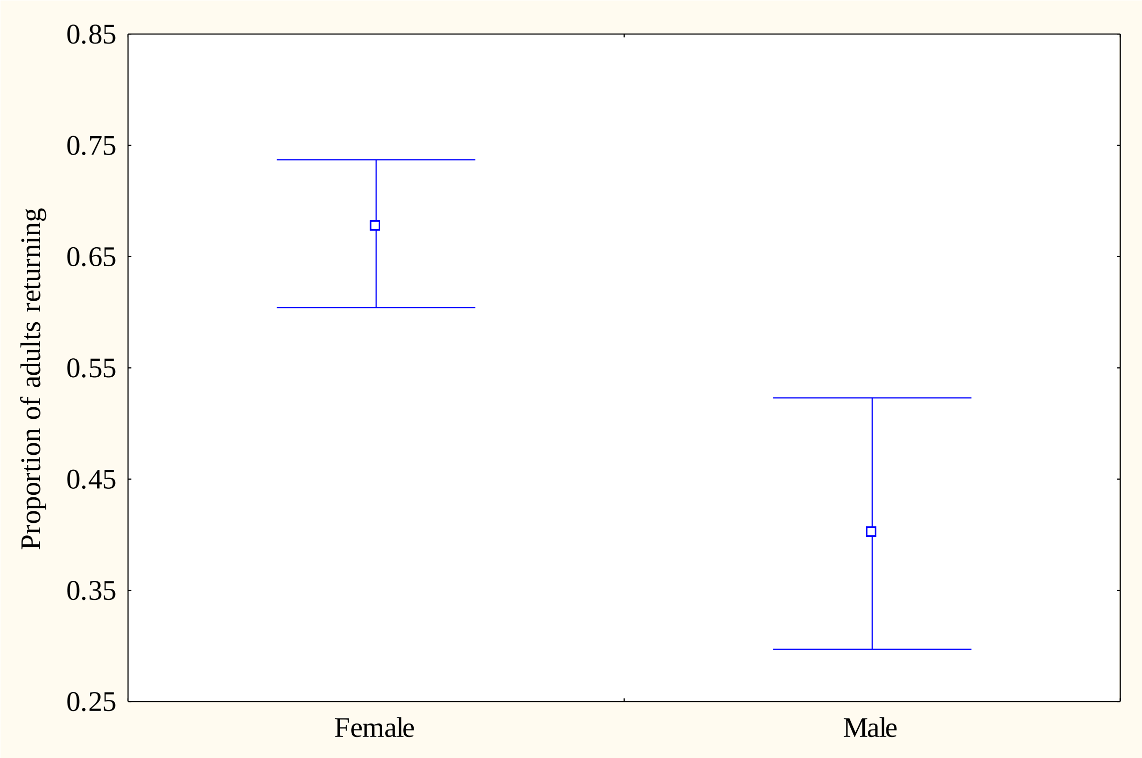

Figure 4. Estimated return rates and associated 95% confidence intervals for male and female adult bull trout, marked in Trestle Creek, Idaho, in 2000.

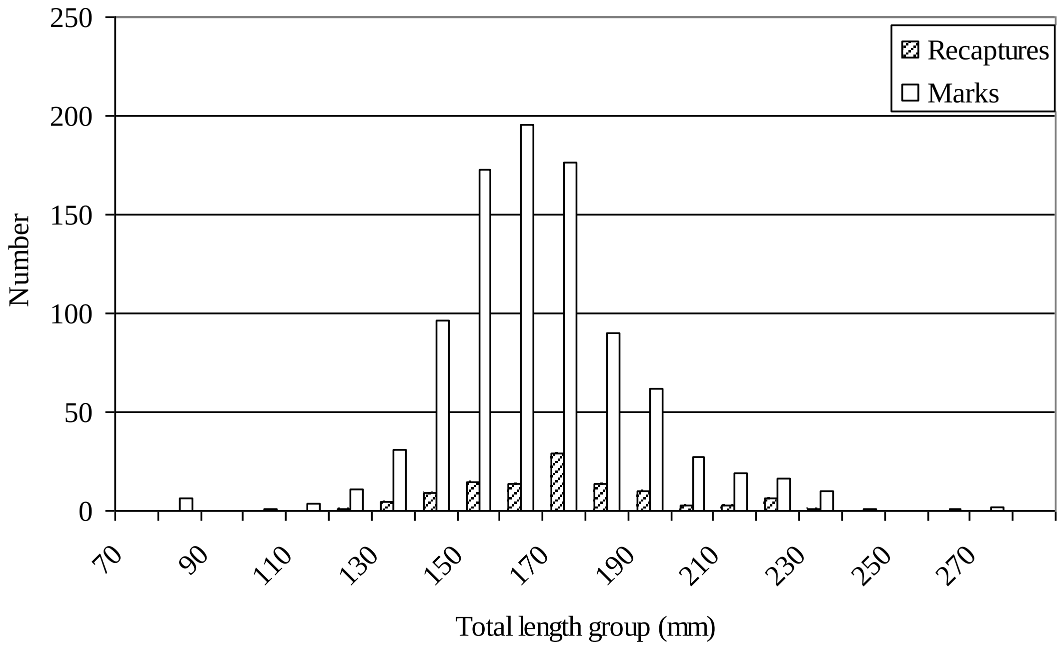

Figure 5. Comparison of the distributions of length-at-marking for both the entire juvenile marking group and the group that survived to return to Trestle Creek, Idaho.

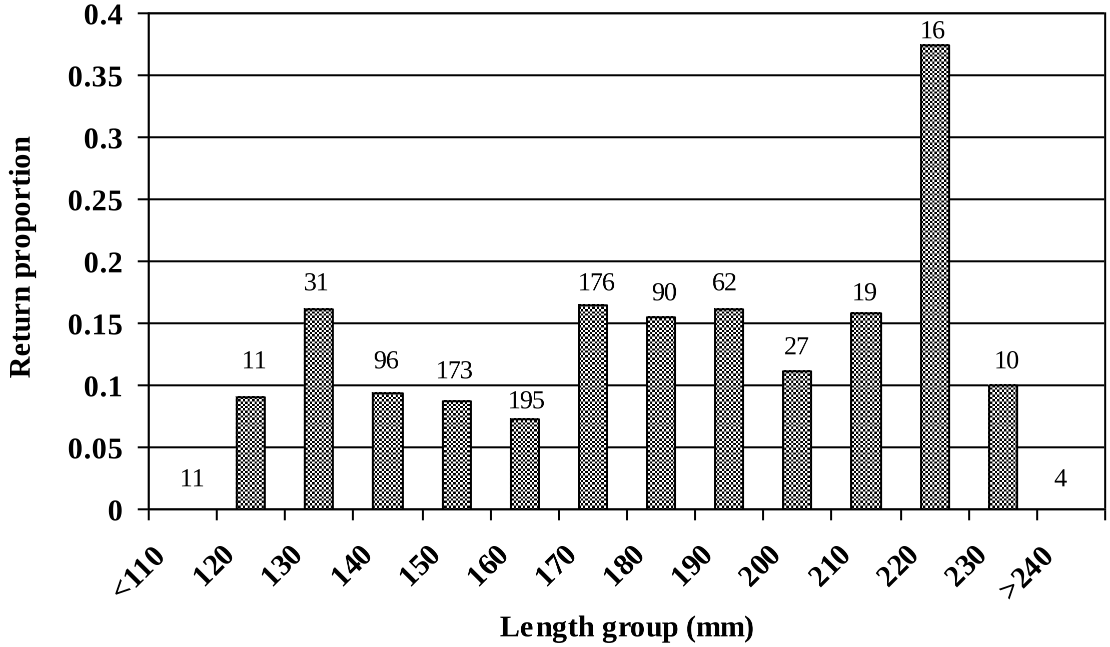

Figure 6. Return proportions for juvenile bull trout marked in Trestle Creek, Idaho in 2000-2002. Marking group sample sizes are denoted above each length category.

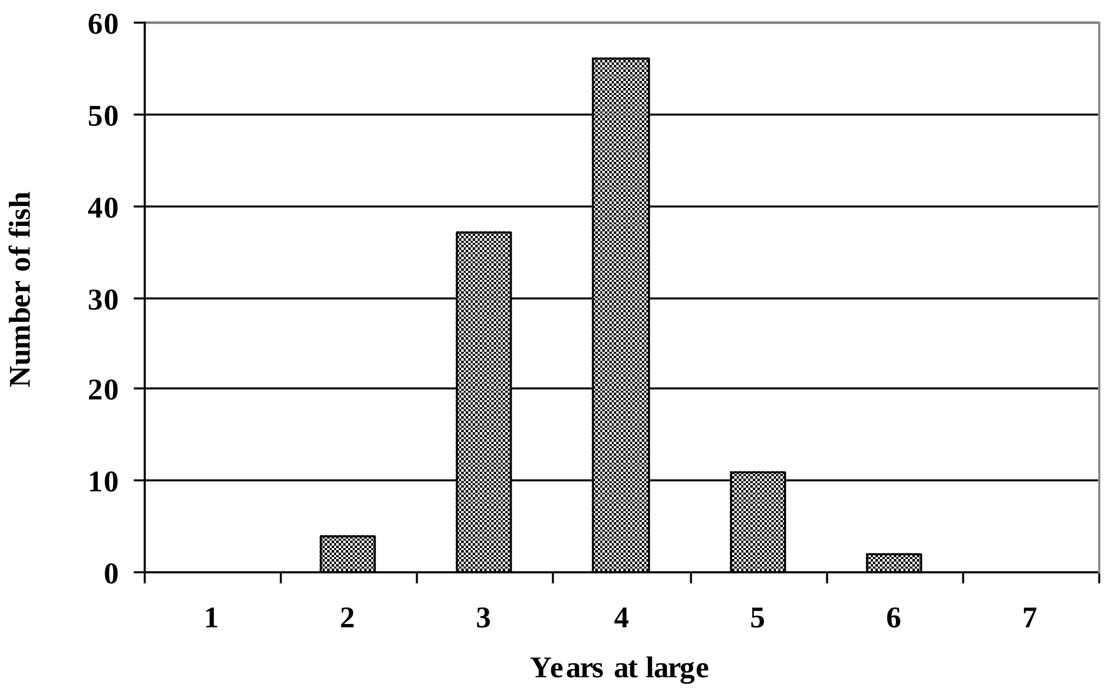

Figure 7. Number of years juvenile bull trout spent maturing in Lake Pend Oreille, Idaho, before returning to Trestle Creek to spawn.

In Trestle Creek in 2007, a total of 92 adult bull trout were captured moving upstream at the weir; 38 of which were previously PIT tagged. Of the 38 captured with a previous tag, six had the PIT tag located in the abdomen. Five of the six also had an adipose clip, signifying that they were originally tagged as juveniles in 2001 or 2002, while the single fish without the adipose clip had been tagged as a juvenile in 2000. Of the remaining 32 previously tagged fish, which were tagged as adults, two were tagged in 2000, four were tagged in 2002, 14 were tagged in 2005, and 12 were tagged in 2006 (Table 2). Adult bull trout moving upstream ranged in size from 405 to 705 mm (Table 3; Figure 8). We also captured four juvenile bull trout at the weir site in 2007, two of which were subsequently PIT tagged in the abdomen.

In the 2007 Trestle Creek downstream weir, a total of 51 adult (including four natural spawning mortalities) and 71 juvenile bull trout were captured. Only one of the juvenile bull trout was PIT tagged in 2007. Twenty-eight adults were captured with a previous PIT tag, 15 of which had been tagged in a previous year, while 13 were tagged moving upstream in 2007 (Table 2). Of the 15 bull trout that had been tagged in a previous year, all were cheek tagged, indicating that they had all been tagged as adults. Fourteen of those were tagged in Trestle Creek, while an additional fish (Tag # 985120029752138) that we are presently unable to determine a tagging history for, was also captured. Adult bull trout, including spawning mortalities, moving downstream, ranged in size from 389 to 754 mm (Table 3; Figure 9). Juvenile bull trout migrants ranged from 58 to 235 mm (Figure 10).

We derived an abundance estimate of 517 adult bull trout (95% CI=367-779) and 549 adult bull trout (95% CI=353-764) in 2005 and 2006, respectively. These numbers are significantly lower than estimates of 1,534 (95% CI=1,366-1703) and 1,114 (95% CI=894-1,334) generated in both 1998 and 2000, respectively (Dunham et al. 2001, Downs et al. 2003). The former estimate of Dunham et al. (2001) is more appropriate for comparison as it was also conducted using a weir for recapture of fish as they left the stream following spawning, similar to our methodology. Therefore, it appears as though the spawning population in Trestle Creek has been reduced to roughly 1/2 to 1/3 of the abundance in 1998 and 2000.

There are several potential contributing factors to consider when evaluating the cause of the decline. Continued residential development pressure in the lower Trestle Creek drainage has resulted in riparian disturbance due to home site and access road construction. Combined with erosion from the gravel county road located immediately adjacent to the stream, sediment from these sources is likely reducing habitat quality and quantity for juvenile bull trout rearing in the middle and lower reaches of Trestle Creek. Juvenile bull trout abundance estimates in these reaches reveal relatively low densities of juvenile bull trout, despite favorable temperature conditions (Downs and Jakubowski 2003). Qualitatively, the substrate appears fairly well armored and embedded, and is likely not providing the needed amount of large interstitial spaces within large cobble size substrate juvenile bull trout favor as overwinter and concealment habitat (Thurow 1997, Bonneau and Scarnecchia 1998). Barring relocation of the lower reaches of the Trestle Creek Road away from the riparian zone, evaluating the environmental costs and benefits of paving the lower and middle reaches of the Trestle Creek Road is appropriate. This action would hold some potential to reduce fine sediment input to these reaches of stream. Encouraging the recruitment, retention, and tolerance of large woody debris in these lower reaches would also be beneficial. Large wood in stream channels enhances pool development, enhances sediment sorting and storing, and increases localized mobilization and scour of the substrate.

The increasing abundance of lake trout is also likely playing a role in population decline through predation on and competition with, juvenile bull trout. However, we have not seen a similar decline in other LPO bull trout populations. Through our tagging work on Trestle Creek, we have demonstrated that repeat spawning by bull trout is important in maintaining adult escapement levels. With estimated annual survival rates at or exceeding 50%, repeat spawners make up a significant component of the spawning population. The importance of this annual, repeat spawning behavior is further evidenced by several females documented to have spawned in seven consecutive years or more. It is likely that changes in adult survival may be impacting adult escapement. Estimated adult survival was lower in 2005-2006 than it was in 2000-2001, however this difference was not statistically significant. If declining adult post-spawn survival indeed becomes a trend, it will impact observed escapement in Trestle Creek. A potential mechanism for the reductions in survival rates of adult bull trout would be competition for a declining kokanee forage base. Kokanee are a primary food source for the three top-level predator species (i.e. bull, lake, and rainbow trout) in LPO (Vidergar 2000), and recent declines in age-2 and older kokanee abundance has the potential to impact post-spawn adult bull trout in LPO. Adult bull trout migrate into Trestle Creek as early as May (Downs and Jakubowski 2003), and remain through the spawning season, in September and October. There is likely a significant energetic cost to this migration and spawning behavior, and returning back to the lake to a severely depleted food supply (i.e. kokanee) may impact spawning recovery and survival. Lake trout do not exhibit this type of reproductive behavior because they spawn in lakes, and the energetic cost of reproduction is likely much lower. If continued lake trout suppression activities currently being implemented on LPO continue to show favorable population suppression results, they will undoubtedly benefit bull trout at multiple life-history stages.

Table 2. Returning adult bull trout to Trestle Creek, a tributary to Lake Pend Oreille, Idaho, originally PIT tagged as adults in 2000 and 2002. New returns refer to bull trout that were tagged but had not been detected in a previous return year.

Return year	2000 tagged fish		2002 tagged fish	
	Total returns	New returns	Total returns	New returns
2001	237	237	N/A	N/A
2002	161	18	N/A	N/A
2003	89	4	76	76
2004	30	2	28	16
2005	16	0	21	1
2006	7	0	18	0
2007	2	0	6	0

Table 3. Mean lengths (TL; mm), mean weights (g), standard deviation (SD), sample size (n), and length range (mm) for adult and juvenile bull trout captured moving downstream and upstream in the weir on Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

	Mean length (SD) (n)	**Length range**	**Mean weight (SD) (n)**
Adult bull trout (down)	533.9 (86.2) (51)	389-754	1,228.9 (658.4) (51)
Juvenile bull trout (down)	170.3 (31.3) (71)	58-235	43.5 (19.7) (69)
Adult bull trout (up)	547.9 (78.5) (92)	405-705	1,486.0 (686.4) (92)
Juvenile bull trout (up)	169.8 (59.4) (4)	84-217	36.3 (28.0) (3)

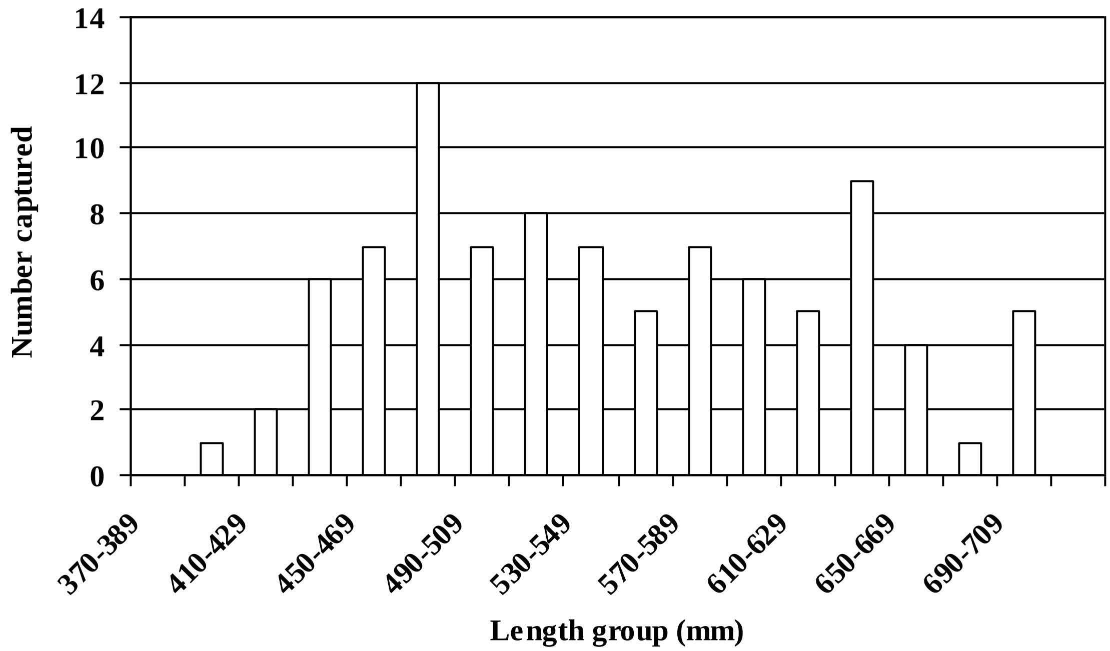

Figure 8. Length frequency histogram for adult bull trout (n = 92) captured in the upstream weir in Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

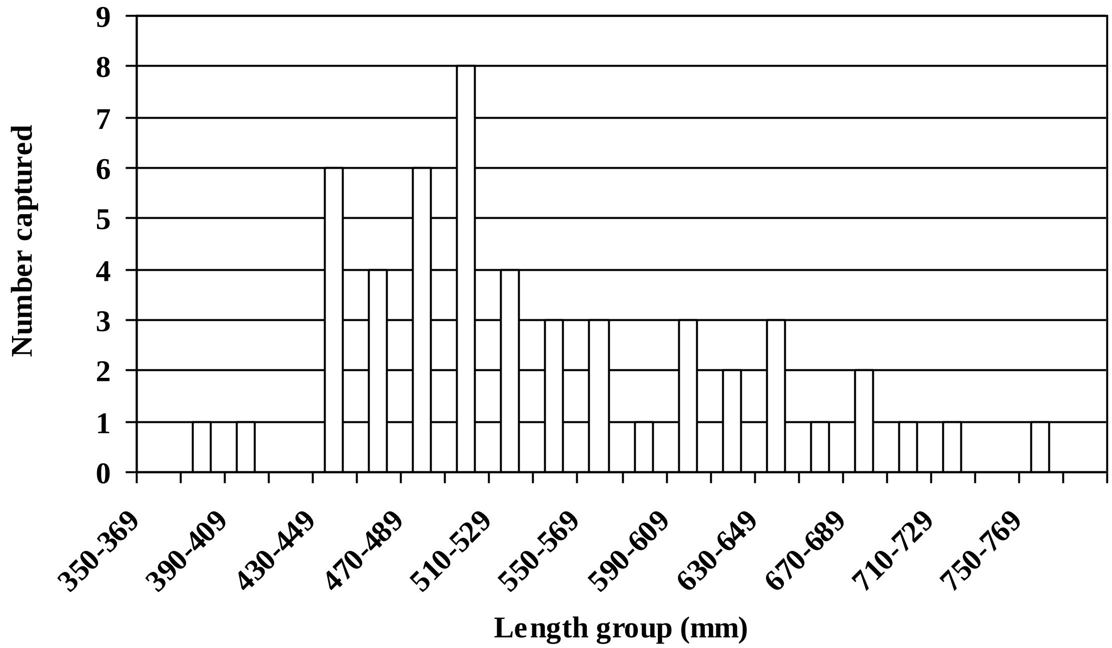

Figure 9. Length frequency histogram for adult bull trout (n = 51) captured in the downstream weir in Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

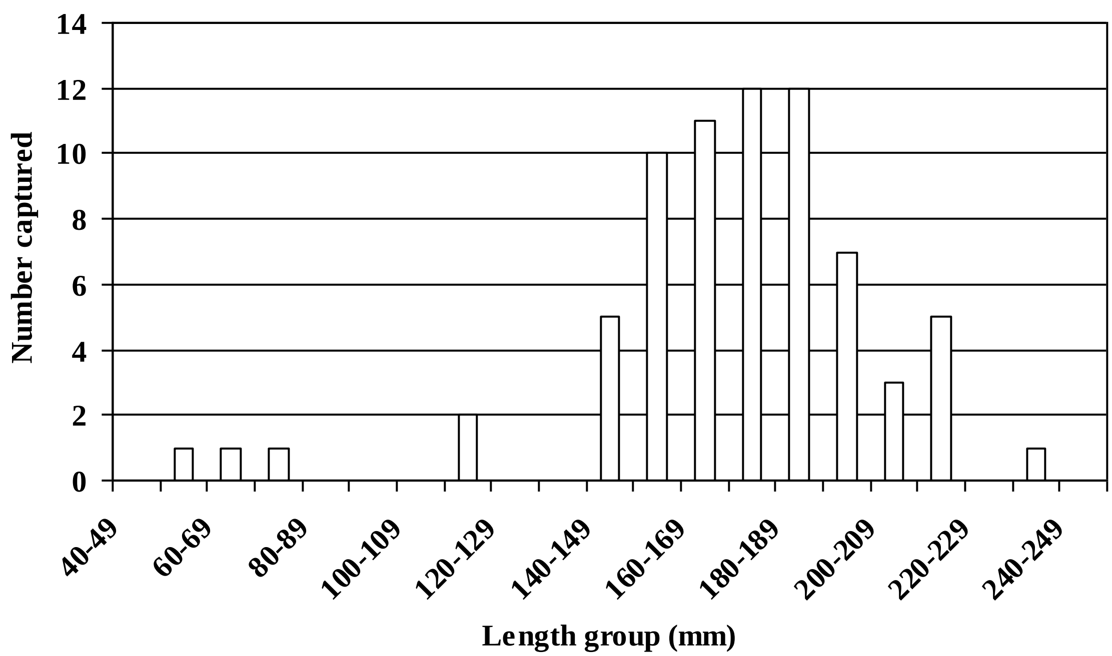

Figure 10. Length frequency histogram for juvenile bull trout (n = 71) captured in the downstream weir in Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

We also captured four species of salmonids plus unidentified juvenile *Oncorhynchus sp*. in addition to bull trout in Trestle Creek in 2007. In the upstream weir we captured unidentified juvenile *Oncorhynchus sp*., adult kokanee, rainbow and westslope cutthroat trout. (Table 4; Figures 11 and 12). In the downstream weir we captured juvenile *Oncorhynchus sp*., adult kokanee, rainbow and westslope cutthroat trout, and mountain whitefish (Table 5; Figure 13 and 14). We also captured two westslope X rainbow trout hybrids, based on visual classification, 185 and 231 mm total length, moving downstream in 2007.

Table 4. Mean lengths (TL; mm), mean weights (g), standard deviation (SD), sample size (n), and length range (mm) for salmonid species captured in the upstream weir on Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

Species	**Mean length (SD) (n)**	**Length range**	**Mean weight (SD) (n)**
Kokanee	371.0 (27.3) (104)	235-424	500.6 (118.8) (102)
Oncorhynchus sp.	63.0 (5.7) (2)	59-67	2.0 (0.0) (2)
Rainbow trout	178.5 (43.7) (14)	72-242	59.1 (29.0) (14)
Westslope cutthroat trout	245.0 (54.0) (3)	198-304	142.7 (88.2) (3)

Table 5. Mean lengths (TL; mm), mean weights (g), standard deviation (SD), sample size (n), and length range (mm) for salmonid species captured in the downstream weir on Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

Species	**Mean length (SD) (n)**	**Length range**	**Mean weight (SD) (n)**
Kokanee	355.5 (34.9) (127)	226-415	430.9 (130.8) (127)
Mountain whitefish	192.0 (6.0) (3)	186-198	56.0 (7.9) (3)
Oncorhynchus sp.	57.3 (4.7) (3)	52-61	1.7 (0.6) (3)
Rainbow trout	182.4 (31.9) (13)	133-239	55.7 (25.7) (13)
Westslope cutthroat trout	225.0 (54.2) (4)	192-306	109.3 (90.9) (4)

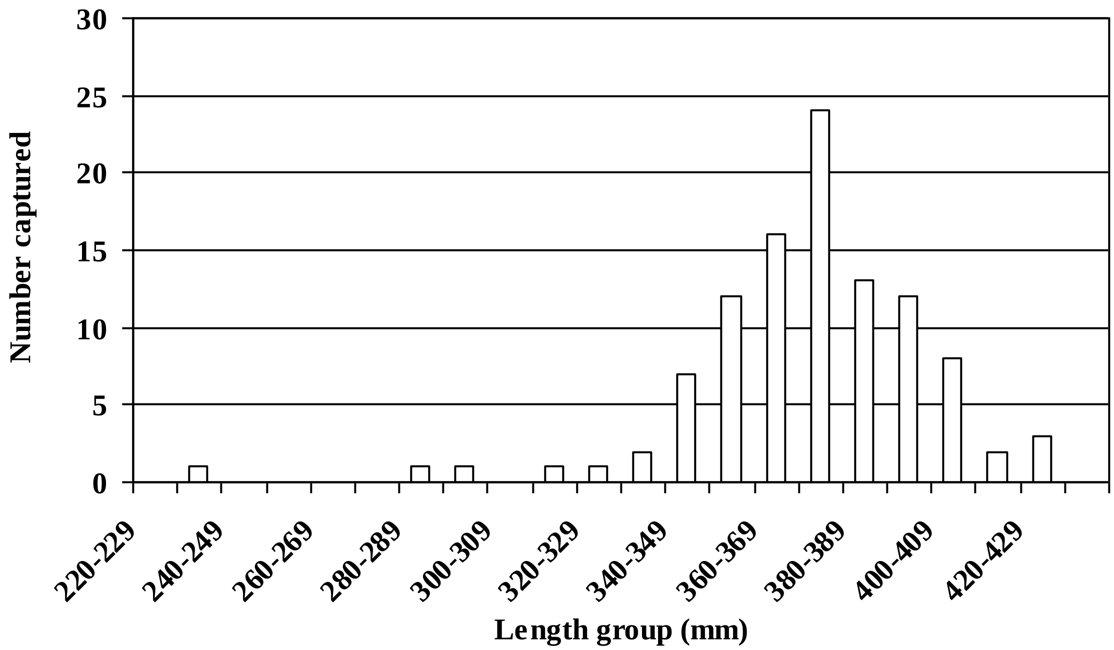

Figure 11. Length frequency histogram for kokanee (n = 104) captured in the upstream weir in Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

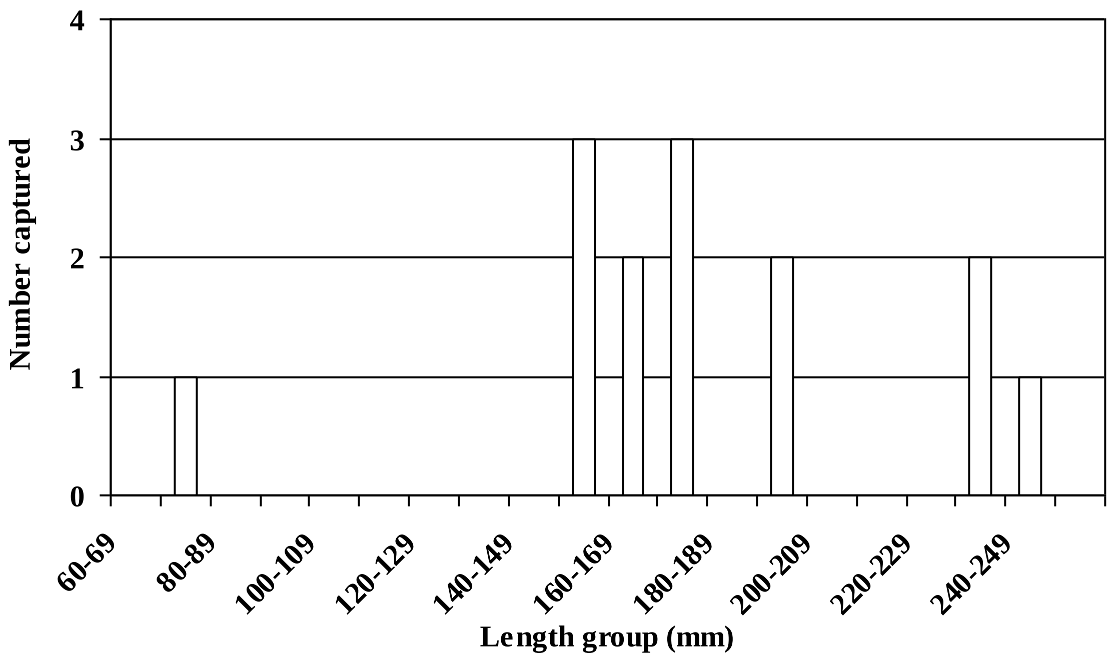

Figure 12. Length frequency histogram for rainbow trout (n = 14) captured in the upstream weir in Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

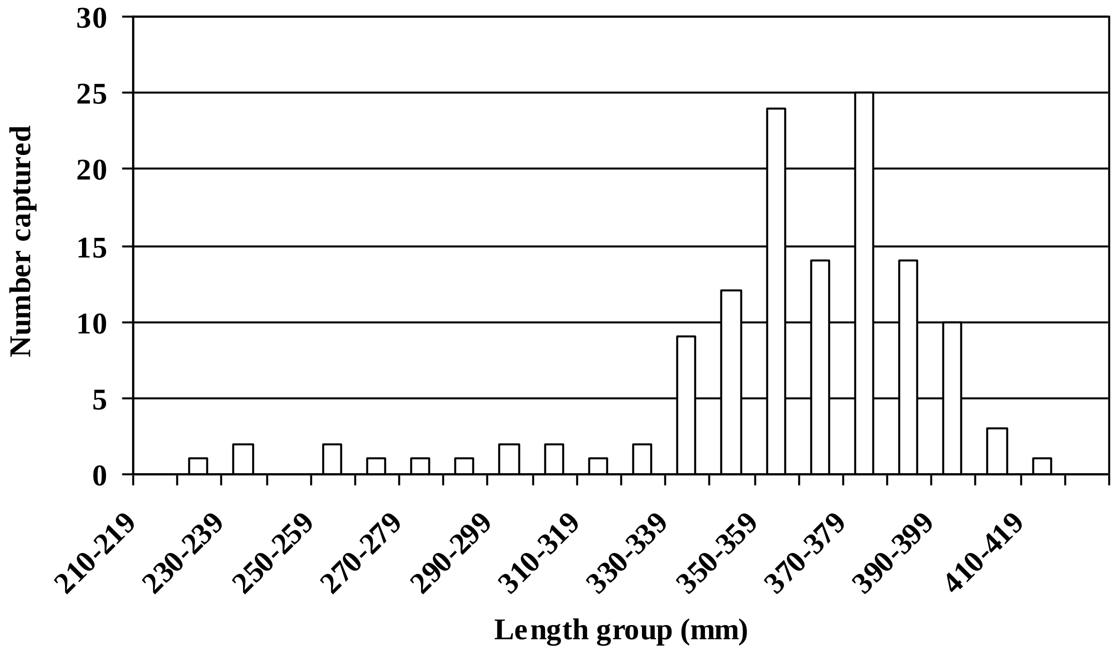

Figure 13. Length frequency histogram for kokanee (n = 127) captured in the downstream weir in Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

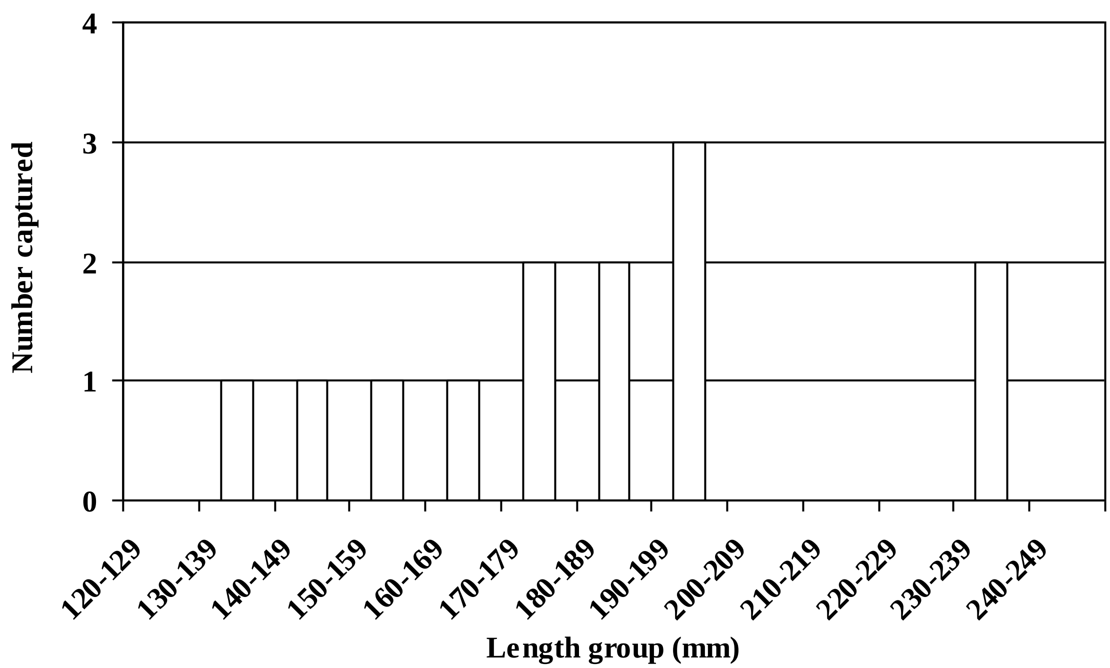

Figure 14. Length frequency histogram for rainbow trout (n = 13) captured in the downstream weir in Trestle Creek, a tributary to Lake Pend Oreille, Idaho, during 2007.

Twin Creek

We marked 93 juvenile bull trout with PIT tags moving downstream in Twin Creek for lake survival estimation from 2000 through 2003. Only one of these individuals has been detected as an adult anywhere in the LPO system. This fish was marked in 2002 as a juvenile in Twin Creek at 181 mm, and subsequently recaptured as an adult at 554 mm by electrofishing in the Clark Fork River in 2007. Average size of tagged juvenile bull trout was 118 mm (S.D.=42.2), with a large proportion (86%) being less than 165 mm (Figure 15). Fifty percent of the marked migrants were also less than 110 mm. The Trestle Creek survival data suggests considerably lower survival rates for juvenile bull trout migrating at sizes less than 165 mm versus greater than 165 mm, and we did not observe any survival for migrants less than 110 mm. The small average size of out-migrants is likely playing a significant role in the low apparent survival of juvenile bull trout from Twin Creek. The Twin Creek project restored a more natural pattern and added large wood to the system, however the fine-grained bed substrate is likely limiting juvenile bull trout habitat. Underlying geology and stream gradient are factors controlling the substrate size in the restored spawning and rearing reach.

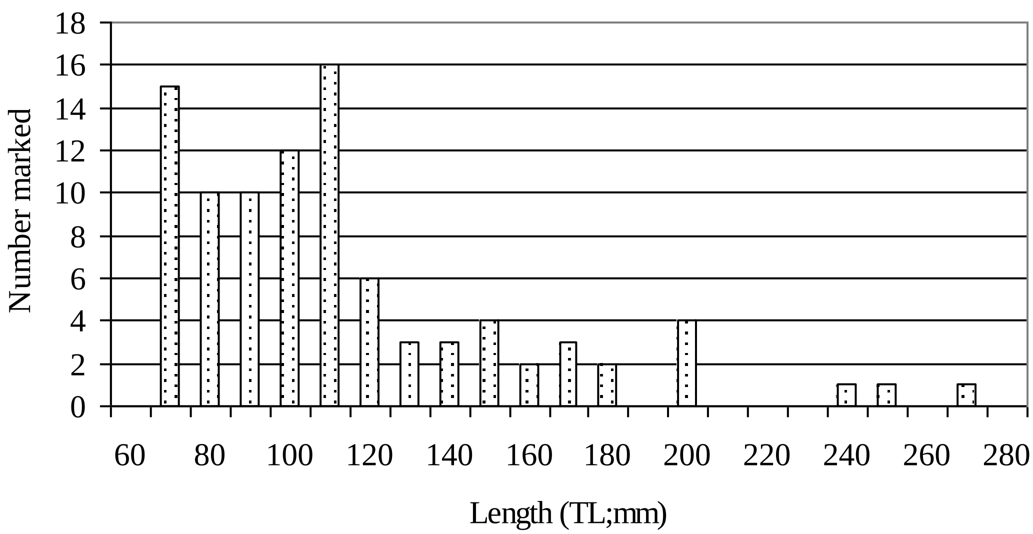

Figure 15. Length distribution of PIT tagged juvenile bull trout from Twin Creek, Idaho, marked between 2000 and 2003.

The migration corridor is considerably different for Twin Creek bull trout juveniles than it is for Trestle Creek migrants. Trestle Creek migrants move directly to the lake from their natal stream, while Twin Creek migrants must journey down the Clark Fork River several miles, and enter the lake through the relatively shallow Clark Fork River delta. Predation by non-native salmonids may also be a potential issue impacting Twin Creek bull trout migrants. The river corridor may bring predators and juvenile bull trout into contact by concentrating them in the migratory corridor, which would not be an issue for Trestle Creek bull trout. Additional research may help resolve questions regarding migration corridor impacts of non-native fish on native salmonids.

We captured 11 species of juvenile fish, plus unidentified juvenile sucker *Catostomus sp*. and unidentified juvenile *Oncorhynchus sp*. in the weir moving upstream and/or downstream in Twin Creek from August 7 to October 29 in 2007 (Table 6). Brook trout and sculpin *Cottus sp*. are included with the juvenile data due to uncertainty about their age and level of sexual maturity. Twenty-three juvenile visually identified bull X brook trout hybrids were also captured, but are not included in the species total (Tables 7 and 8). Brown trout were the most abundant fish in the downstream trap box, while sculpin were the most abundant in the upstream trap box (Tables 7 and 8). Average lengths of juvenile salmonids ranged from 57.5 mm for unidentified *Oncorhynchus sp*. to 174.9 mm for brook trout. (Tables 7 and 8).

In Twin Creek in 2007, we captured 11 juvenile bull trout moving downstream, nine of which were PIT tagged (Table 8). In the upstream weir box, there were no juvenile bull trout captured.

Table 6. Species captured in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2007.

Species	**Abbreviation**
Bull trout *Salvelinus confluentus*	BLT
Brook trout *Salvelinus fontinalis*	BRK
Brown trout *Salmo trutta*	BRN
Catostomus species (unidentified)	UNS
Kokanee *Oncorhynchus nerka*	KOK
Largescale sucker *Catostomus macrocheilus*	LSS
Longnose sucker *Catostomus catostomus*	LNS
Mountain whitefish *Prosopium williamsoni*	MWF
Oncorhynchus species (unidentified)	ONC
Rainbow trout *Oncorhynchus mykiss*	RBT
Redside shiner *Richardsonius balteatus*	RSS
Sculpin *Cottus Spp*.	SCL
Westslope cutthroat trout *Oncorhynchus clarkii lewisi*	WCT

We captured three species of adult fish moving upstream and/or downstream in Twin Creek during 2007; bull trout, brown trout, and kokanee (Table 9). A total of two individual adult bull trout were captured in Twin Creek in 2007. Neither fish had been previously PIT tagged, and were subsequently tagged. The first was captured moving upstream on September 10, then recaptured moving downstream on September 13. The other was captured moving upstream on October 22, then was recaptured as a trapping mortality (it had gilled itself in a hole chewed in the weir trap box by a muskrat) on October 24. It is not believed that either fish spawned. A single brown trout, 330 mm total length was also captured moving downstream in Twin Creek. In addition to adult bull trout, brown trout and kokanee salmon, we also captured two visually identified westslope X rainbow trout (WRHY) hybrids (305 mm and 307 mm) in Twin Creek in 2007.

Table 7. Mean lengths (TL; mm), mean weights (g), standard deviation (SD), sample size (n), and length range (mm) for juvenile species captured in the upstream weir on Twin Creek, a tributary to the Clark Fork River, Idaho, during 2007.

Species	Mean length (SD) (n)	Length range	Mean weight (SD) (n)
BRN	88.5 (10.9) (4)	75-100	6.3 (1.7) (4)
ONC	60.8 (5.1) (6)	54-68	2.3 (0.8) (6)
SCL	24.7 (1.5) (7)	23-27	1.0 (0.0) (7)
UNS	55.0 (17.7) (3)	39-74	2.0 (1.0) (3)

Table 8. Mean lengths (TL; mm), mean weights (g), standard deviation (SD), sample size (n), length range (mm), and catch-per-unit-effort (CPUE) for juvenile species, and bull X brook trout hybrids (BBHY) captured in the downstream weir on Twin Creek, a tributary to the Clark Fork River, Idaho, during 2007.

Species	Mean length (SD) (n)	Length range	Mean weight (SD) (n)	CPUE (fish/trap night)
BBHY	125.7 (34.4) (23)	85-273	21.8 (33.7) (23)	0.28
BLT	99.8 (26.6) (11)	60-145	11.0 (8.9) (11)	0.13
BRK	174.9 (71.0) (15)	57-289	72.4 (66.1) (13)	0.18
BRN	81.7 (24.0) (548)	53-224	6.7 (10.9) (545)	6.60
KOK	59.0 (N/A) (1)	N/A	1.0 (N/A) (1)	0.01
LNS	195.0 (N/A) (1)	N/A	71.0 (N/A) (1)	0.01
LSS	108.7 (33.9) (3)	70-133	14.0 (9.2) (3)	0.04
MWF	109.2 (8.2) (45)	97-128	9.3 (2.2) (44)	0.54
ONC	57.5 (5.9) (410)	40-69	1.8 (0.8) (398)	4.94
RBT	90.2 (39.3) (105)	70-295	12.2 (29.2) (101)	1.27
RSS	98.0 (N/A) (1)	N/A	8.0 (N/A) (1)	0.01
SCL	48.4 (25.3) (16)	23-107	2.6 (2.8) (16)	0.19
UNS	118.2 (46.3) (10)	56-171	21.9 (18.4) (10)	0.12
WCT	112 (N/A) (1)	N/A	12.0 (N/A) (1)	0.01

Table 9. Mean lengths (TL; mm), mean weights (g), standard deviation (SD), sample size (n), and length range (mm) for adult bull trout captured in the upstream weir and adult kokanee captured in the upstream and downstream weir combined, on Twin Creek, a tributary to the Clark Fork River, Idaho, during 2007.

Species	Mean length (SD) (n)	Length range	Mean weight (SD) (n)
BLT	518.0 (24.0) (2)	501-535	1,190.0 (254.6) (2)
KOK	253.5 (40.2) (11)	211-362	127.9 (87.9) (11)

Timing of upstream migration of bull trout in Twin Creek is later than that observed in other LPO tributaries, with most upstream movement occurring in September and October (Downs et al. 2003, Downs and Jakubowski 2003). In 2007, we observed a continuation of this trend. This lends support to the idea that some of the spawners in Twin Creek may be individuals who are unable to return to their natal streams due to Cabinet Gorge Dam. Previous data from trapping and PIT tagging work in Twin Creek and the Clark Fork River (Downs and Jakubowski 2003) also supported this theory. Genetic testing showed the most likely population of origin for one of the two adult bull trout captured in Twin Creek in 2007 to be Lightning Creek, and the other Twin Creek. Previous genetic evaluations (Neraas and Spruell 2001) did not identify Twin Creek as a unique population of bull trout. Genetic assignment, calculated back to the tributary of origin, were only 39% higher for Twin Creek than for the other 17 tributaries to LPO and the lower Clark Fork River. An alternative explanation for late entry into Twin Creek could be water temperature, which may be warmer than that desired by bull trout, until early September.

Redd counts in recent years have been low in Twin Creek (averaging five annually from 2001-2007). Efforts should be made to use caution when electrofishing to collect bull trout from the Clark Fork River for upstream passage to avoid "mining" individuals from this population, and other remnant populations downstream of Cabinet Gorge Dam. This is currently being accomplished through a "rapid-response" genetic assignment test prior to upstream transport of captured adult bull trout. Use of this technique will facilitate the selective passage of upstream bull trout stocks until trapping facilities are completed at Cabinet Gorge Dam.

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2007 Granite Creek Fish Population Monitoring Progress Report

ABSTRACT

The Avista mitigation program has been acquiring stream habitat, restoring stream habitat, and conducting habitat assessments in tributaries to Lake Pend Oreille (LPO) since the Clark Fork Settlement Agreement was signed in 1999. Fish population monitoring in these tributaries is critical to establish baseline information on fish populations from which we can gauge the success/failure of our efforts, and better understand population dynamics of fish species of interest. In 2007 we conducted depletion-removal population estimates on Granite Creek, a tributary to LPO, Idaho. Estimates were conducted in a total of three sections in Granite Creek. Bull trout *Salvelinus confluentus* were present in all sections sampled, with the highest densities estimated in the sections located highest in the tributary. Westslope cutthroat trout *Oncorhynchus clarkii lewisi* were also found in all sections sampled, with the highest density estimated in the lower most section. No brook trout *S. fontinalis* were captured in Granite Creek in 2007, although genetically confirmed bull trout X brook trout hybrids have been previously detected.

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INTRODUCTION

As part of a relicensing agreement for Cabinet Gorge and Noxon Rapids dams, Avista Corporation provides annual funding to acquire and/or enhance habitat in tributaries to Lake Pend Oreille (LPO) and the Clark Fork River in Idaho. The initial focus of these efforts is on enhancing native fish populations including bull trout *Salvelinus confluentus* and westslope cutthroat trout *Oncorhynchus clarkii lewisi*, as well as mountain whitefish *Prosopium williamsoni*. Significant investments have been made in habitat acquisitions in the Gold, Granite, and Trestle creek drainages since implementation began in 1999. In 2002, a large-scale watershed assessment was undertaken in the Lightning Creek drainage to identify potential restoration opportunities in the drainages. In 2003, we undertook a feasibility assessment and developed a restoration design for approximately 945 m of Granite Creek. Construction began in 2005, and by fall, the restoration project was completed. The objective of the Granite Creek restoration project is to provide fish passage and improved habitat conditions for bull trout.

Each of these actions will require monitoring to determine project effectiveness. In addition, tributary monitoring provides a way to measure the health of fish populations. By only monitoring adult bull trout populations through redd counts, we may potentially miss important trends in species composition or numbers at the juvenile life stage until they reach a point where they adversely affect the adult stock. For habitat acquisition projects, data will be used to establish baseline population estimates that can be compared with future estimates to see if populations decline, remain stable, or increase in response to conservation measures or other influencing events. Habitat enhancement projects will be monitored to determine if project objectives have been met by comparing pre and post-restoration population estimates of target fish in the same sections of stream over time. By evaluating project effectiveness, we gain understanding of fish population response to our activities, and enhance the likelihood of success in the future.

STUDY SITE

Granite Creek is an east shoreline tributary to LPO and drains approximately 68 km^2 of the northern end of the Bitterroot Mountains (PBTAT 1998) (Figure 1). Bankfull discharge for Granite Creek is approximately 6.2 cms (River Design Group 2004). Maximum water temperature reached 14.8 ^{0}C at the USFS Road 2711 bridge crossing, lower in the watershed, on August 7, 2001. Farther upstream at the USFS Road 278 crossing, water temperatures were cooler, with a high of 13.3 ^{0}C on the same date (USFS, unpublished data).

The LPO Key Watershed Bull Trout Problem Assessment (PBTAT 1998) recognized Granite Creek as high priority for bull trout restoration/conservation actions. Bull trout redd counts have averaged 56 annually from 1983 through 2007. Recent trends in redd counts suggest a stable or increasing population (Downs and Jakubowski 2006). During flood events in the winter of 1995-96, the reach of Granite Creek between Kilroy Bay Bridge and the mouth of Sullivan Springs, immediately downstream of Section 1 (Figure 1), underwent significant changes, and had a diffuse and largely sub-surface flow pattern during low flow conditions. Fish passage was impaired during summer/fall months in this location on Granite Creek. Continued channel instability in this reach threatened to degrade fish habitat further in Granite Creek. A restoration project was completed in Granite Creek in 2005, constructing/restoring approximately 946 m of stream channel in the impaired reach.

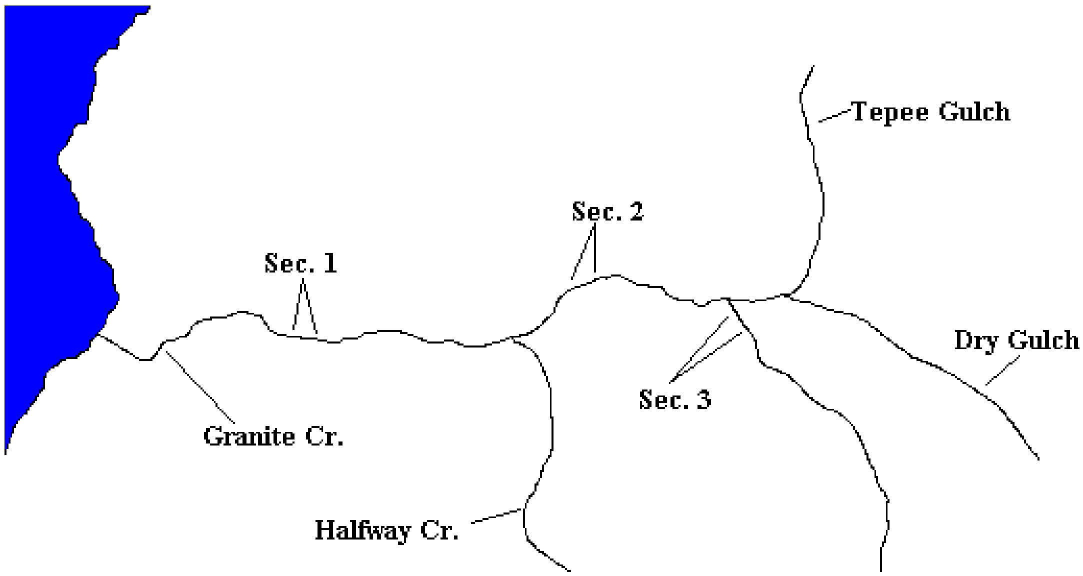

Figure 1. Electrofishing sections on Granite Creek, a tributary to Lake Pend Oreille, Idaho, sampled in 2007.

METHODS

We used the removal (depletion) method (Zippin 1958) to estimate abundance and size structure of fish populations in Granite Creek. The software program Capture (White et al. 1982) was used to derive estimates from the depletion data when three or more passes were conducted, while Microfish (Van Deventer and Platts 1986) was used to derive estimates from the depletion data when a two-pass estimator was needed. Population and density estimates were conducted for fish $\geq$ 75 mm only (total length; TL), due to sampling efficiency considerations. When all the individuals of a particular species were captured on the first pass and a depletion estimate was not possible, we report the total catch on the first pass as the population estimate. We also estimated catch-per-unit-effort (CPUE) as fish captured per minute of electrofishing on the first pass only. We standardized the results of the population estimates by converting the number estimated per linear 100 m, to the number captured per 100 m^2. To establish a baseline for bull trout and westslope cutthroat trout densities in Granite Creek, density estimates were reported individually by year (2005-2007) and cumulatively as the average of the estimates from 2005 to 2007.

Depletion-removal estimates involved measuring a 100 m reach of stream and blocking both ends with a seine to prevent fish movement in or out of the section. GPS coordinates were recorded and flagging/stakes were used to mark the sections to ensure repeatability. Reaches were numbered sequentially, moving from the downstream-most section (Section one) to the upstream-most section (Section three) (Figure 1). Wetted-widths were measured every 20 m along the transect to estimate the total area of the section. A crew of two or three individuals slowly progressed downstream within the section carefully shocking the stream. A Smith-Root model 12-B battery powered backpack shocker, using pulsed DC current, was used to stun fish. Fish were netted and placed in a bucket carried with the crew while shocking. Typical settings for the electrofishing unit were H-3 at 600 to 800 volts. Small holes (approximately 3 mm) were drilled in the top half of the side of the bucket to allow a crew member to provide fresh water to the fish without risking escape. Repeated passes were made through the section until the catch on a pass was reduced to 20% or less of the catch on the first pass.

Fish were anesthetized, identified, measured (total length; mm) and weighed (g). In addition, genetic samples were collected from westslope cutthroat trout for future analysis. Fish were allowed to recover their equilibrium and were released back into the stream below the section.

RESULTS

We captured bull and westslope cutthroat trout, as well as a single unidentified *Oncorhynchus* species (41 mm, total length) and single sculpin *Cottus* species (66 mm, total length) in Granite Creek on July 26 and 27, 2007. In section 1, westslope cutthroat trout density was (12.41/100 m^2), and bull trout density was 2.39/100 m^2 (Table 1). In Section 2, the bull trout density was 5.12/100 m^2, while it was 2.22/100 m^2 for westslope cutthroat trout (Table 1). In Section 3, the density for bull trout was the highest of all three sections, (8.01/100 m^2), while the density for westslope cutthroat trout was (11.86/100 m^2) (Table 1).

Average size of salmonids $\geq$ 75 mm in Section 1 ranged from 124.3 mm for westslope cutthroat trout to 134.5 mm for bull trout (Table 2). Length-frequency histograms from Section 1 indicate multiple age-classes present for both bull trout and westslope cutthroat trout (Figure 2). In Section 2, average size of salmonids $\geq$ 75 mm ranged from 117.1 mm for westslope cutthroat trout to 141.3 mm for bull trout (Table 2). Length-frequency histograms from Section 2 indicate the presence of multiple age-classes for bull and westslope cutthroat trout (Figure 3). Average size of salmonids $\geq$ 75 mm in Section 3 ranged from 119.6 mm for westslope cutthroat trout to 124.9 mm for bull trout (Table 2). The length-frequency histograms from Section 3 indicate multiple age-classes present for bull trout and westslope cutthroat trout (Figure 4).

Table 1. Total number captured (all lengths) and population estimates for bull trout (BLT) and westslope cutthroat trout (WCT) ($\geq$ 75 mm; TL) captured in the three sections in Granite Creek, a tributary to Lake Pend Oreille, Idaho, in 2007.

Location	Species	Total captured	Estimate (95% CI)	N/100m^2 2007	Average N/100m^2 2005-2007	CPUE (fish/minute)
Section 1	BLT	55	11 (8-14)	2.39	3.83	0.38
	WCT	56	57 (53-61)	12.41	7.17	2.20
Section 2	BLT	30	30 (24-36)	5.12	4.83	1.00
	WCT	17	13 (12-14)	2.22	3.13	0.53
Section 3	BLT	48	25 (24-36)	8.01	9.19	0.82
	WCT	41	37 (37-37)	11.86	5.85	1.91

Table 2. Mean lengths (TL; mm), mean weights (g), standard deviation (SD) and sample size (n) for individual bull trout (BLT) and westslope cutthroat trout (WCT) $\geq$ 75 mm, and length range (mm) for all individuals captured in the three sections in Granite Creek, a tributary to Lake Pend Oreille, Idaho, in 2007.

Location	Species	Mean length (mm) (S.D.) (n)	Length range	Mean weight (g) (S.D.) (n)
Section 1	BLT	134.5 (60.7) (11)	54-222	33.2 (33.6) (11)
	WCT	124.3 (21.3) (56)	77-168	21.6 (11.1) (56)
Section 2	BLT	141.3 (28.8) (28)	58-245	27.0 (21.1) (28)
	WCT	117.1 (49.3) (13)	66-227	25.5 (35.5) (13)
Section 3	BLT	124.9 (22.6) (23)	48-164	18.1 (8.9) (23)
	WCT	119.6 (44.1) (37)	65-245	24.5 (30.3) (37)

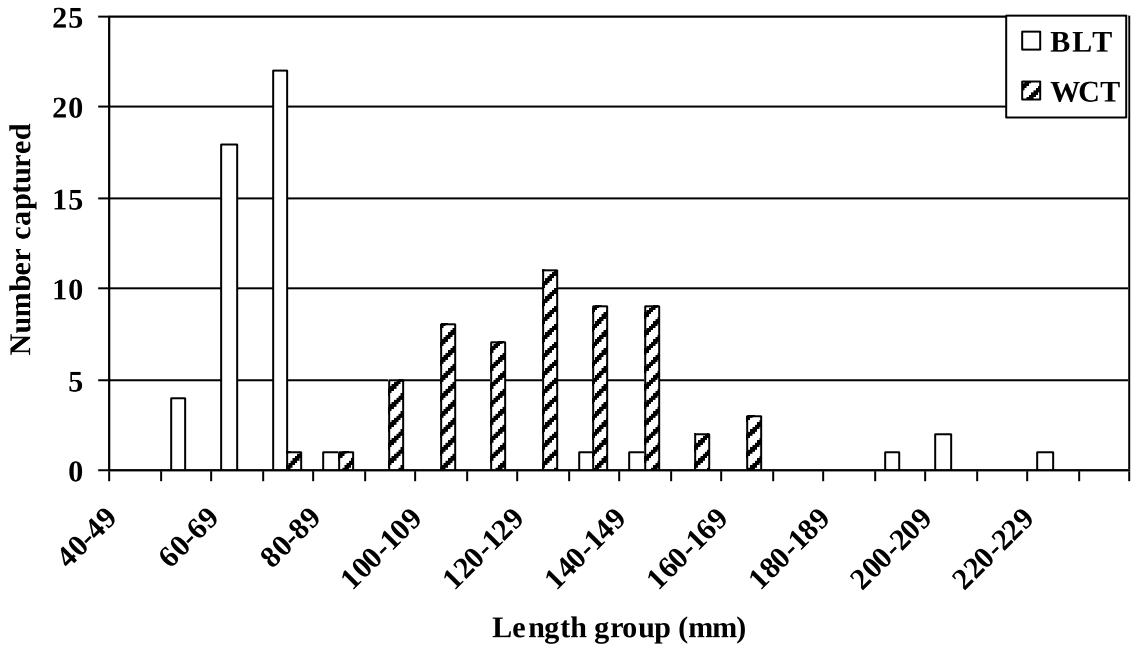

Figure 2. Length frequency histograms for bull trout (BLT) (n = 51) and westslope cutthroat trout (WCT) (n = 56) captured in Section 1, Granite Creek, a tributary to Lake Pend Oreille, Idaho, in 2007.

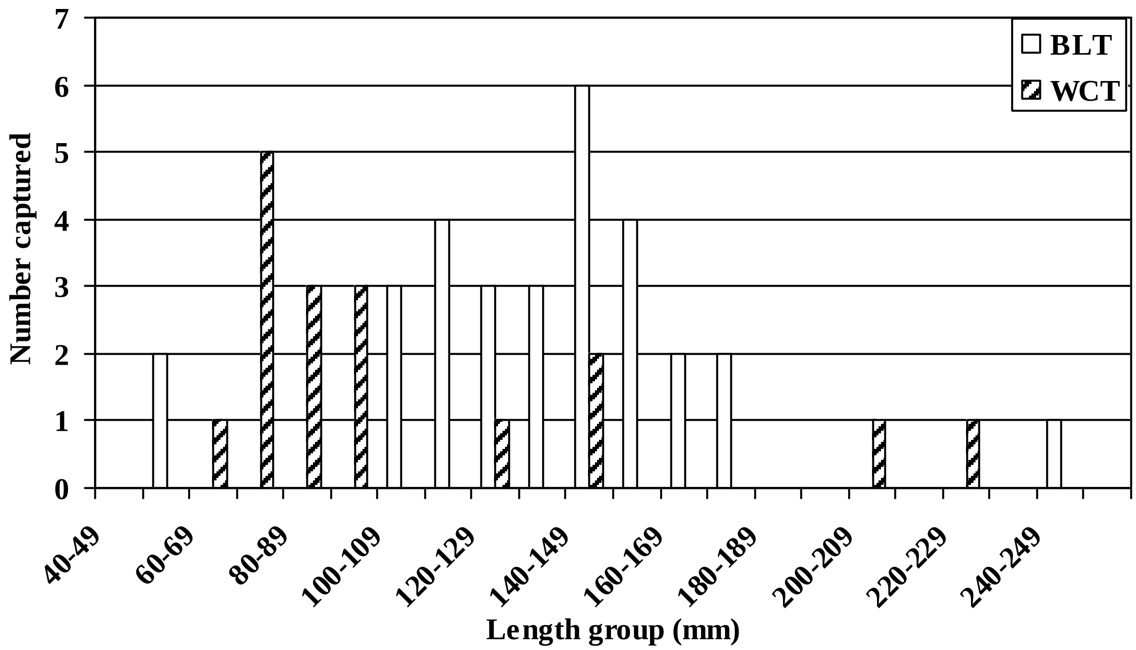

Figure 3. Length frequency histograms for bull trout (BLT) (n = 30) and westslope cutthroat trout (WCT) (n = 17) captured in Section 2, Granite Creek, a tributary to Lake Pend Oreille, Idaho, in 2007.

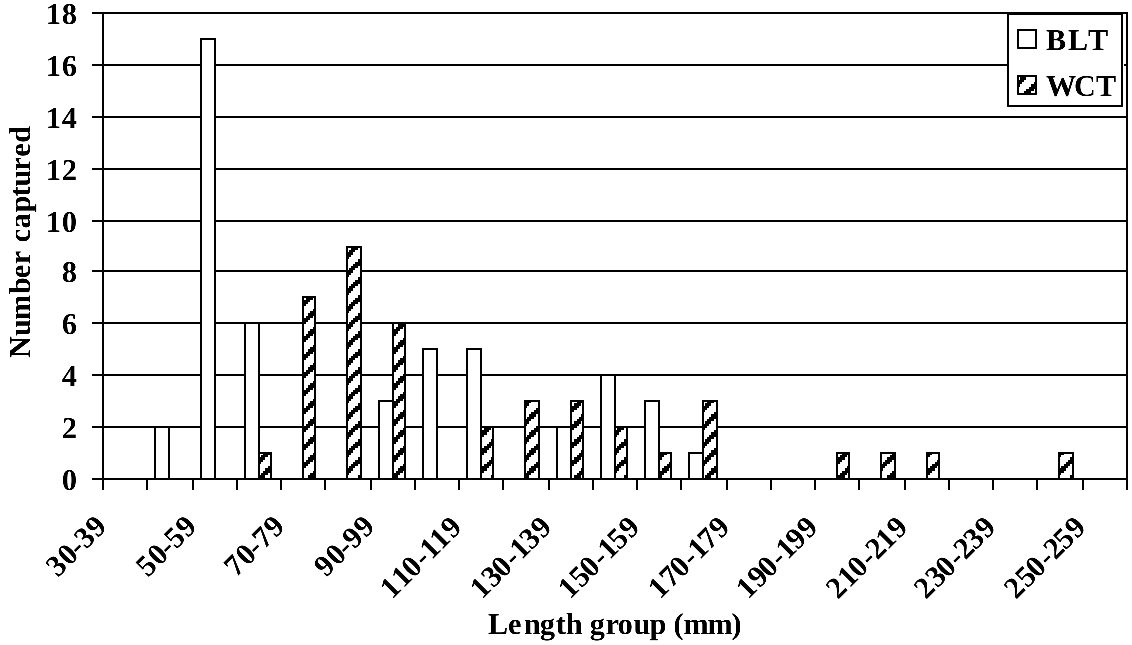

Figure 4. Length frequency histograms for bull trout (BLT) (n = 48) and westslope cutthroat trout (WCT) (n = 41) captured in Section 3, Granite Creek, a tributary to Lake Pend Oreille, Idaho, in 2007.

DISCUSSION

We successfully completed depletion population estimates for juvenile salmonids in three sections on Granite Creek. These population estimates will serve to augment bull trout monitoring data collected through annual redd counts. The estimates also provide a mechanism to monitor other native species of interest (westslope cutthroat trout) for which we are unable to conduct redd counts.

Juvenile bull trout density ($\geq$ 75 mm) was highest in the upper-most sampling site of Granite Creek in 2007 (8.0/100 m^2). Both juvenile bull trout and westslope cutthroat trout were present in all sections sampled. For comparison, Liermann et al. (2003) reported maximum densities for juvenile ($\geq$ 75 mm) bull trout in the E. Fk. Bull River, upper Prospect Creek, and Rock Creek (all lower Clark Fork River tributaries in Montana) at 4.1/100 m^2, 6.1/100 m^2, and 3.8/100 m^2, respectively. Liermann (2003) reported maximum juvenile bull trout densities of 5.7/100 m^2 and 9.7/100 m^2 for Fish Trap Creek and the West Fork Thompson River, respectively, both tributaries to the Thompson River which enters the Clark Fork River above Thompson Falls, Montana.

High relative densities of bull trout in the upper most sampled section of Granite Creek suggests the primary fish passage goal of the 2005 in-stream restoration project was met. Section 3 of the abundance survey was located well above the upper most portion of the restoration reach. Age 1+ bull trout as identified by length frequency made up a large portion of those bull trout collected in Section 3 (Figure 4). The presence of these fish above the previous potential passage barrier is an indication bull trout spawned and/or traveled to upstream portions of Granite Creek. Prior to restoration (pre-2005) bull trout had been transported around the in-stream barrier during low flow periods. No such effort was completed from 2005 to 2007.

The estimate and associated density for westslope cutthroat trout in Section 1 increased more than two-fold from 2006 to 2007, with estimated numbers increasing from 23/100 m^2 to 57/100 m^2. However, a significant decline was observed in Section 2 between 2006 and 2007, with estimated numbers dropping from 27/100 m^2 in 2006, to 13/100 m^2 in 2007. In Section 3 in 2007, estimated numbers also showed a substantial increase over 2006, increasing from 21/100 m^2 to 37/100 m^2. This increase in estimated numbers in Sections 1 and 3, and the decline in estimated numbers in Section 2 in 2007, may be partially explained by our sampling efficiency during electrofishing. Average length at capture for individuals $\geq$ 75 mm in Section 1 in 2006 was 108.7 mm, while in 2007 it was 124.3 mm. In Section 2 in 2006, average length was 133.7 mm, while in 2007 it declined to 117.1 mm. In Section 3 in 2006, average length at capture for individuals $\geq$ 75 mm was 108.7 mm, while in 2007 it increased to 119.6 mm. Sampling efficiency generally increases as the size of the fish being shocked increases, due to greater susceptibility to the electrical current being generated, as well as the ease with which the netters are able to see and dip net the fish. It is possible that the increase in estimated numbers observed in Sections 1 and 3, and the decrease observed in Section 2 in 2007, may be a result of increased/decreased average lengths within the sections between 2006 and 2007.

Variation in density estimates among sample years observed in individual sample locations as noted in westslope cutthroat estimates may also be attributable to sample protocol. Sample sections are limited to 100 m reaches. Minor shifts in habitat suitability and fish movements associated or unassociated with these changes may not be detectable within the limits of the sample reach. However, sample reaches collectively should be sufficient for observing long-term trends in abundance and species composition.

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