LAKE PEND OREILLE/CLARK FORK RIVER FISHERY RESEARCH AND MONITORING

2003 PROGRESS REPORT

PROJECT 2: **2003 LAKE PEND OREILLE BULL TROUT REDD COUNTS**

PROJECT 3: **2003 CLARK FORK RIVER FISHERY ASSESSMENT PROGRESS REPORT**

PROJECT 5: **2003 TRESTLE AND TWIN CREEKS BULL TROUT OUTMIGRATION AND LAKE PEND OREILLE SURVIVAL STUDY PROGRESS REPORT**

PROJECT 6: **2003 JOHNSON AND GRANITE CREEKS BULL TROUT TRAPPING**

PROJECT 7: **2003 TWIN CREEK RESTORATION 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 2003

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Idaho Tributary Habitat Acquisition and Enhancement Program,
Appendix A

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Project 2: 2003 Lake Pend Oreille Bull Trout Redd Counts

ABSTRACT

Bull trout *Salvelinus confluentus* redd counts were conducted in 17 tributaries to Lake Pend Oreille and the Clark Fork River, as well as the Clark Fork River spawning channel in 2003. The Middle Fork East River and Uleda Creek, both tributaries to the lower Priest River, were also surveyed. The total number of redds counted in these areas in 2003 was 836, which is one of the higher total counts on record. Six of these tributaries (six index streams; Johnson, E. Fk. Lightning, Trestle, Grouse, N. Gold, and Gold creeks) have been surveyed consistently on an annual basis since 1983, and the 2003 redd count for these six streams combined (591) was also among the higher counts on record, although considerably lower than the previous years record count of 692 redds. Two of these streams, Trestle and Gold creeks, together accounted for the majority (58%) of the total number of redds counted in the Lake Pend Oreille system in 2003. We identified three statistically significant correlations in the 2003 redd count data. Statistically significant correlations between year and redd count for Porcupine Creek (tau-b=-0.5; p=0.007), Trestle Creek (tau-b=0.38; p=0.021) and Gold Creek (tau-b=0.34; p=0.032), indicate a long-term decline in the Porcupine Creek population, and long-term increases in the Trestle and Gold creek populations. Overall, four of the 16 bull trout populations for which long-term redd count data sets are available appear to be stable or increasing. We estimated the probability of population persistence to 100 years using the resident model of BayVAM for Trestle, Gold, Granite, Grouse, and the E. Fk. Lightning creeks. As the model was constructed for resident fish, it has limited utility in applications to adfluvial populations, but when used with other metrics it can assist us in evaluating the relative strength of individual adfluvial bull trout populations. While some populations such as Trestle 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 Creek, where redd counts as high as 52 were documented in 1984, but have averaged only two since 1992. Assessing and addressing the cause for the bull trout decline in the Porcupine Creek drainage, as well as in other Lightning Creek tributaries, should be the among the highest bull trout restoration priorities in the Lake Pend Oreille system. Efforts to improve bull trout habitat in Lightning Creek offer the greatest potential to increase bull trout numbers in the Lake Pend Oreille system.

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INTRODUCTION

Redd counts, or spawning nest 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, and yet provide information on bull trout at the watersheds and/or population scale.

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. Additionally, the Middle Fork of the East River and Uleda Creek (Priest River drainage) were found to support migratory bull trout from LPO (DuPont and Horner, in press). Monitoring of bull trout redds began in these two streams in 2001.

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 2003. 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 and the U.S. Fish and Wildlife Service (USFWS), conducted redd counts on 17 tributaries to LPO, as well as the Clark Fork River, between October 6 and October 17, 2003 (Figure 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 of superimposition, each distinct depression was counted as a redd.

In addition to monitoring direct tributaries to LPO and the lower Clark Fork River, IDFG and USFWS staff counted redds in the Middle Fork East River system, which is a tributary to the lower Priest River. Recent telemetry studies have shown bull trout using this river system 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 Fork East River to spawn (DuPont and Horner, in press).

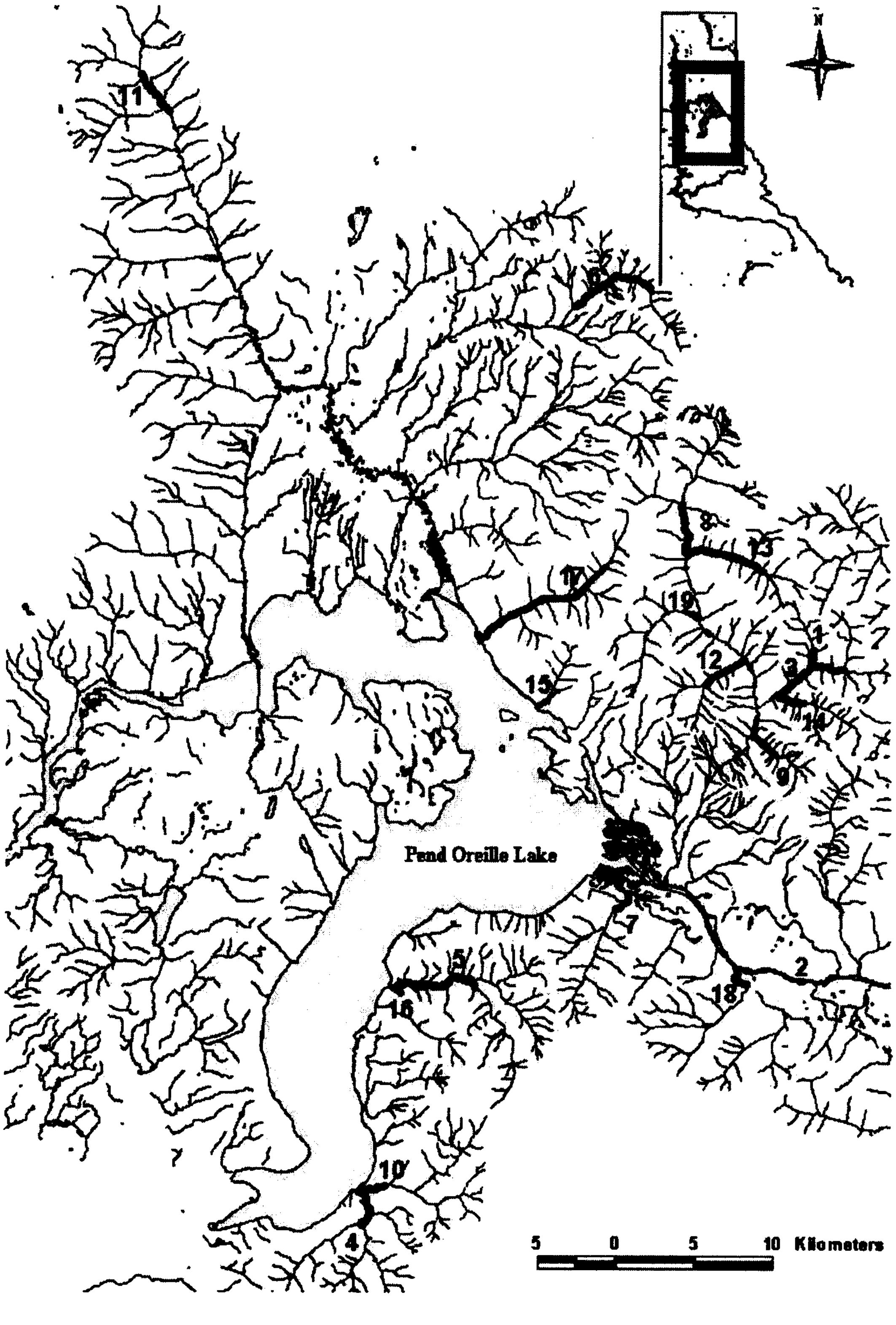

Figure 1. Bull trout redd count sections (with shading) in tributaries of Lake Pend Oreille, Idaho. Numbers denote stream name in Table 1.

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, 1992-2003
Clark Fork River	2	Spawning channel (N/A)	1992-2003
E. Fk. Lightning Cr[a]	3	Savage to Thunder Creek (5.0)	1983-2003
Gold Cr[a]	4	Mouth to 0.2 km upstream of W. Gold confluence (2.4)	1983-2003
Granite Cr	5	Mouth to road 278 crossing (6.4)	1983-1987, 1992-2003
Grouse Cr[a]	6	Flume Creek to end of road 280 (2.4 km beyond gate) (6.5)	1983-2003
Johnson Cr[a]	7	Mouth to falls (1.5)	1983-2003
Lightning Cr	8	Rattle to Quartz (3.2)	1983-1987, 1992-2003
Morris Cr	9	Mouth to trail 132 crossing (N/A)	1999-2003
N. Gold Cr[a]	10	Mouth to falls (1.2)	1983-2003
Pack R	11	Road 231 bridge near McCormick Cr to Falls located 0.4 km downstream of W. Branch (2.8)	1983-1987, 1992-2003
Porcupine Cr	12	Mouth to S.Fk. (3.2)	1983-1987, 1992-2003
Rattle Cr	13	Mouth to falls by upper bridge (5.7)	1983-1987, 1992-2003
Savage Cr	14	Mouth to trail 61 crossing (2.0)	1983-1985, 1987, 1992-2003
Strong Cr	15	Mouth to diversion barrier (N/A)	1996, 2002
Sullivan Springs	16	Mouth upstream 0.4 km (0.4)	1983-1985, 1987, 1992-2003
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 trib (0.5 km)	1983-2003; 2001-2003
Twin Cr	18	Mouth to River Road (1.5)	1983-1987, 1992-2003
Wellington Cr	19	Mouth to falls (0.5)	1983-1987, 1992-2003

[a] Denotes "index" stream

The Lake Pend Oreille Bull Trout Conservation Plan (PBTAT 1999) 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 1999). 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).

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 Lake Pend Oreille Bull Trout Conservation Plan (PBTAT 1999). We used tau-b to compensate for any bias caused by ties in the data, and noted statistical significance at the α = 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 E.Fk. Lightning creeks because some segments of these streams that may have contained relatively substantial numbers of redds were not counted. Where statistical significance could not be statistically concluded, we used the sign of the correlation to infer trend. Specifically, we ran correlations between year and redd count from 1999 through 2003 using the full data set (1983-present). In the absence of statistical significance, if the sign of the correlation is positive for three out of the last five years examined, the population is inferred to be stable or increasing (PBTAT 1999). The alternative is that if three out of the five years exhibit a negative correlation, then the population is inferred to be decreasing. In addition, we tested for short-term trends using data collected since 1993. We used 1993 as the cutoff date for short-term analysis as the draft U.S. Fish and Wildlife Service 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 where statistical significance could not be achieved for the short-term trend analysis.

We also utilized the resident model of BayVAM (Lee et. al. 2000) to explore relative probability of persistence for some individual LPO bull trout populations. We felt the resident model represented our adfluvial bull trout populations better than the anadromous model, although both had substantial limitations in their applicability. Data collected from LPO tributaries were used to select the values for model inputs. Where information was lacking, we used the model defaults or best professional judgment (BPJ) to adjust the inputs. Because the lowest bracket value for population size is 50-450 adult females, we limited application of the model to only those populations with average annual redd counts greater than 35 redds. This is based on an assumed sex ratio of 1:1 and a spawner:redd ratio of 2.9:1 (Downs and Jakubowski 2003). We also adjusted the incubation survival upward to account for the unrealistically low range of fecundity options available in the model.

RESULTS

We successfully completed bull trout redd counts in 19 tributaries to LPO, as well as the Clark Fork River spawning channel in 2003. Redd counts ranged from a low of zero redds in Johnson Creek to a high of 361 redds in Trestle Creek (Appendix A).

The long-term correlation analysis revealed three statistically significant correlations between year and redd count. Correlations for Porcupine Creek (tau-b = -0.5; p = 0.007), Trestle Creek (tau-b = 0.38; p = 0.021) and Gold Creek (tau-b = 0.34; p = 0.032), indicate a long-term decline in the Porcupine Creek population, and long-term increases in the Trestle and Gold creek populations (Table 2). N. Gold Creek bordered on statistical significance for a negative correlation, suggesting a declining population trend. Six out of seven populations monitored in the Lightning Creek drainage also displayed negative correlations, but none were statistically significant with the exception of Porcupine Creek. Rattle Creek, the lone tributary in the Lightning Creek drainage with a positive long-term correlation value, has benefited from three consecutive years of above average redd counts.

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

Stream	Number of years	Tau-b correlation	P-value
Char Cr.	16	-0.08	0.682
E. Fk. Lightning Cr.	18	-0.16	0.344
Gold Cr.	21	0.34	0.032*
Granite Cr.	16	0.24	0.204
Grouse Cr.	19	-0.14	0.415
Johnson Cr.	20	-0.07	0.669
Lightning Cr.	16	-0.20	0.276
N. Gold Cr.	21	-0.30	0.061
Pack R.	16	-0.29	0.114
Porcupine Cr.	16	-0.50	0.007*
Rattle Cr.	15	0.04	0.842
Savage Cr.	15	-0.11	0.571
Sullivan Springs	16	0.18	0.338
Trestle Cr.	20	0.38	0.021*
Twin Cr.	16	-0.08	0.682
Wellington Cr.	16	-0.24	0.196

* Denotes statistical significance

When we apply the criteria for determining if a population is increasing or decreasing in the absence of statistical significance (PBTAT 1999), we conclude that a total of four out of 16 bull trout populations monitored are stable or increasing, while 12 have undergone long-term declines (Table 3).

Population persistence modeling with BayVAM was limited to five populations to meet the minimum female population size of 50 needed for the model. The basic model inputs were identical for all of the populations (Appendix B). We did however increase the adult female abundance variable upward into the 450-850 category for Trestle Creek to reflect a larger population size. We also increased the coefficient of variation in juvenile survival into the two higher categories for the East Fork Lightning Creek to reflect potential harsh rearing conditions from year to year due to habitat degradation. In addition, we lowered adult survival rate and increased the frequency of catastrophic events in the E.Fk. Lightning Creek simulation to reflect potential effects from periodic channel intermittency during the spawning period and unstable stream channels. Probability of persistence ranged from 89% to 90% across the five populations under the initial scenarios (Table 3). We then modified the immigration variable to reflect 100%

certainty that we had at least one to six individuals moving between populations each year, and the probability of persistence increased to between 94% and 95% across the five populations examined.

Table 3. Results of long-term trend analysis and persistence modeling for 16 bull trout spawning tributaries to Lake Pend Oreille, Idaho. All populations have at least 11 years of redd count data.

Stream	Year	Kendall's tau-b	P-value	Trend conclusion	Probability of persistence 100 + years
Char Cr.	1999	0.2	0.369		
	2000	0.16	0.458		
	2001	0.05	0.824		
	2002	-0.02	0.92		
	2003	-0.08	0.682	Stable/Increase	NA
EF Lightning	1999	-0.28	0.171		
	2000	-0.22	0.255		
	2001	-0.22	0.242		
	2002	-0.16	0.37		
	2003	-0.16	0.344	Decline	89%
Gold Cr.	1999	0.13	0.482		
	2000	0.22	0.196		
	2001	0.26	0.122		
	2002	0.33	0.04*		
	2003	0.34	0.032*	Stable/Increase	90%
Granite Cr.	1999	0.23	0.3		
	2000	0.14	0.5		
	2001	0.03	0.868		
	2002	0.13	0.52		
	2003	0.24	0.204	Stable/Increase	90%
Grouse Cr.	1999	-0.27	0.16		
	2000	-0.13	0.494		
	2001	-0.18	0.316		
	2002	-0.17	0.34		
	2003	-0.14	0.415	Decline	90%
Johnson	1999	-0.04	0.82		
	2000	-0.13	0.452		
	2001	-0.02	0.91		
	2002	0.04	0.83		
	2003	-0.07	0.669	Decline	NA
Lightning Cr.	1999	-0.36	0.1		
	2000	-0.37	0.075		
	2001	-0.31	0.123		
	2002	-0.25	0.2		
	2003	-0.2	0.276	Decline	NA

* Denotes statistical significance

Table 3. Continued.

Stream	Year	Kendall's tau-b	P-value	Trend conclusion	Probability of persistence 100+ years
N. Gold Cr.	1999	-0.19	0.298		
	2000	-0.23	0.179		
	2001	-0.29	0.081		
	2002	-0.28	0.08		
	2003	-0.3	0.061	Decline	NA
Pack R.	1999	-0.56	0.009*		
	2000	-0.56	0.007*		
	2001	-0.43	0.033*		
	2002	-0.36	0.06		
	2003	-0.29	0.114	Decline	NA
Porcupine Cr.	1999	-0.65	0.004*		
	2000	-0.55	0.009*		
	2001	-0.59	0.003*		
	2002	-0.62	0.001*		
	2003	-0.5	0.007*	Decline	NA
Rattle Cr.	1999	-0.44	0.059		
	2000	-0.38	0.084		
	2001	-0.17	0.425		
	2002	-0.07	0.74		
	2003	0.04	0.842	Decline	NA
Savage Cr.	1999	-0.51	0.03*		
	2000	-0.43	0.05*		
	2001	-0.35	0.094		
	2002	-0.2	0.33		
	2003	-0.11	0.571	Decline	NA
Sullivan Sp.	1999	0.35	0.11		
	2000	0.35	0.097		
	2001	0.21	0.293		
	2002	0.21	0.27		
	2003	0.18	0.338	Stable/Increase	NA
Trestle Cr.	1999	0.4	0.821		
	2000	0.13	0.482		
	2001	0.22	0.196		
	2002	0.31	0.07		
	2003	0.38	0.021*	Stable/Increase	90%
Twin Cr.	1999	0.05	0.836		
	2000	0.08	0.711		
	2001	-0.03	0.868		
	2002	-0.01	0.96		
	2003	-0.08	0.682	Decline	NA

* Denotes statistical significance

Table 3. Continued.

Stream	Year	Kendall's tau-b	P-value	Trend conclusion	Probability of persistence 100+ years
Wellington Cr.	1999	-0.4	0.07		
	2000	-0.34	0.108		
	2001	-0.31	0.119		
	2002	-0.29	0.13		
	2003	-0.24	0.196	Decline	NA

Examining only the data from 1993 to present to obtain a view of the short-term trends in populations, we find that 12 of the 16 populations evaluated exhibited positive correlation values. This suggests that adult escapement is generally increasing in recent years. However, due to high variability in the redd count numbers and the short-term nature of the data set, only three correlations were statistically significant (Table 4).

Overall, seven of 16 populations monitored since at least 1992, had redd counts in 2003 higher than the long-term average annual redd count. An additional three streams were within 25% of the long-term average. The redd count in the Clark Fork River spawning channel was similar to its long-term average (Figures 2-18).

Table 4. Correlations between year and redd count (trends) for bull trout populations monitored from 1993 to present in tributaries to Lake Pend Oreille, Idaho.

Stream	**Number of years**	**Tau-b correlation**	**P-value**
Char Cr.	10	-0.38	0.128
E. Fk. Lightning Cr.	10	0.29	0.245
Gold Cr.	11	0.33	0.157
Granite Cr.	10	0.32	0.205
Grouse Cr.	10	0.21	0.41
Johnson Cr.	10	0.14	0.587
Lightning Cr.	10	0.5	.047*
N. Gold Cr.	11	-0.43	0.068
Pack R.	10	0.25	0.366
Porcupine Cr.	10	-0.05	0.837
Rattle Cr.	10	0.65	0.009*
Savage Cr.	10	0.28	0.255
Sullivan Springs	11	-0.29	0.209
Trestle Cr.	10	0.51	0.04*
Twin Cr.	10	0	1
Wellington Cr.	10	0.16	0.522

* Denotes statistical significance

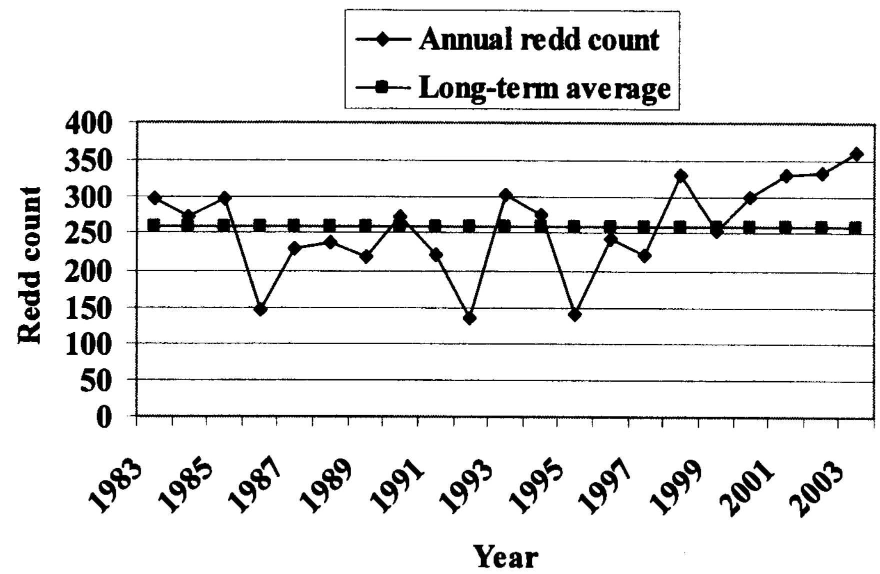

Figure 2. Annual Trestle Creek bull trout redd counts and average redd count, 1983 through 2003, Lake Pend Oreille, Idaho.

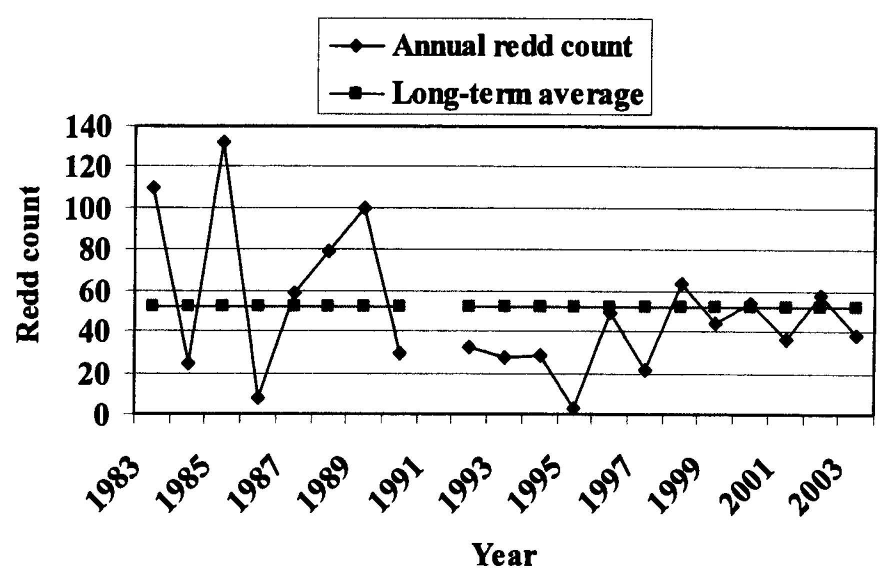

Figure 3. Annual East Fork Lightning Creek bull trout redd counts and average redd count for 1983 through 2003, Lake Pend Oreille, Idaho.

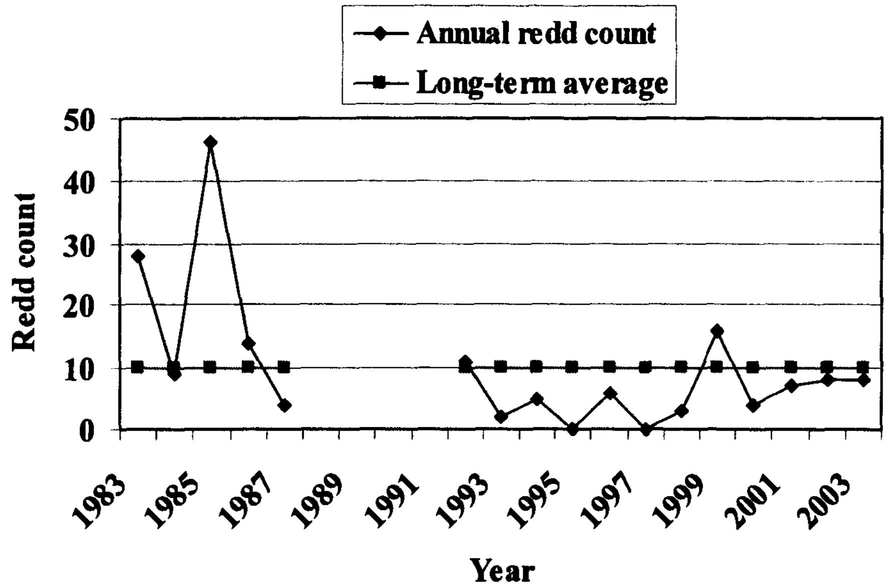

Figure 4. Annual Lightning Creek bull trout redd counts and average redd count for 1983 through 2003, Lake Pend Oreille, Idaho.

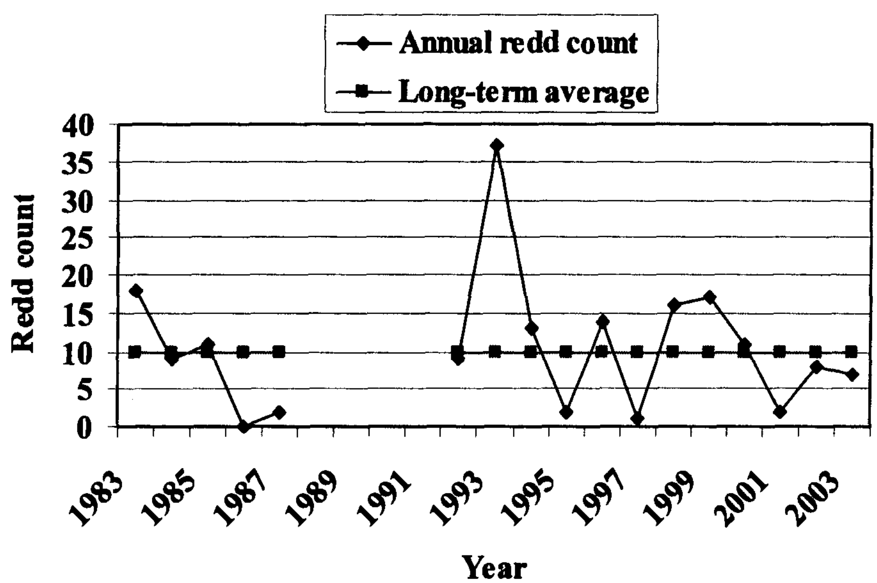

Figure 5. Annual Char Creek, a tributary to Lightning Creek, bull trout redd counts and average redd count for 1983 through 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

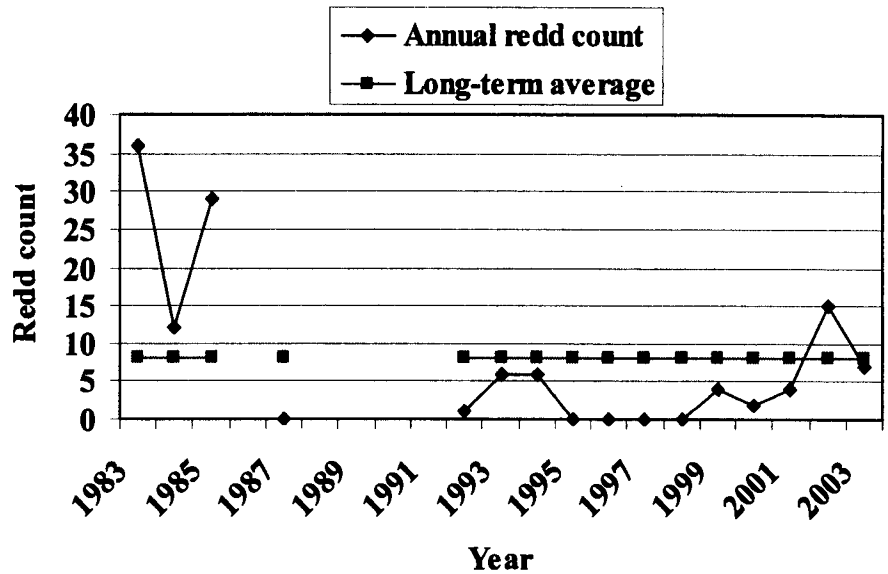

Figure 6. Annual Savage Creek, a tributary to Lightning Creek, bull trout redd counts and average redd count for 1983 through 1985, 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

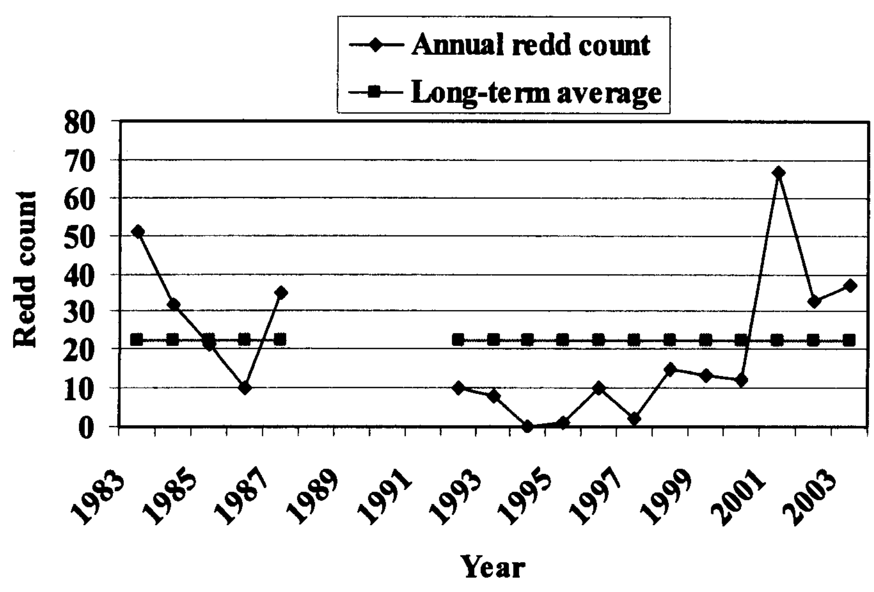

Figure 7. Annual Rattle Creek, a tributary to Lightning Creek, bull trout redd counts and average redd count for 1983 through 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

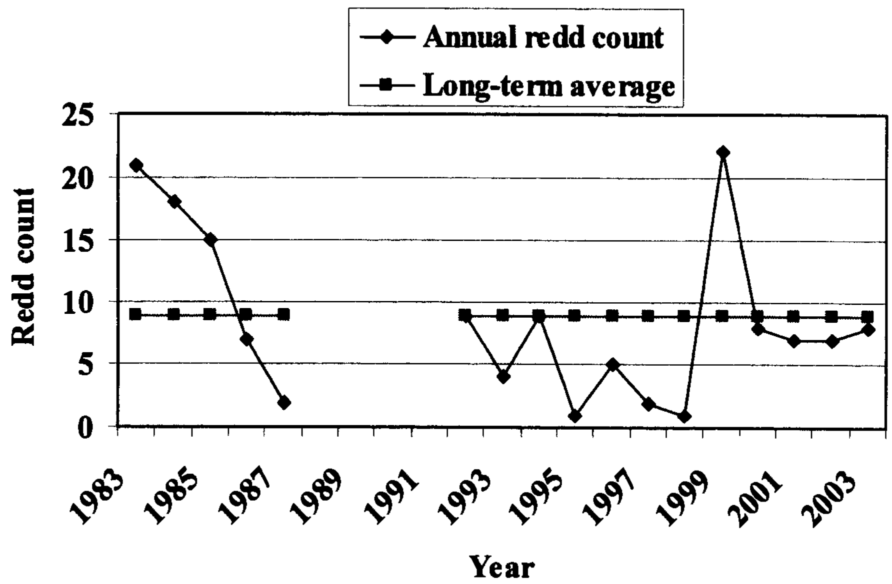

Figure 8. Annual Wellington Creek, a tributary to Lightning Creek, bull trout redd counts and average redd count for 1983 through 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

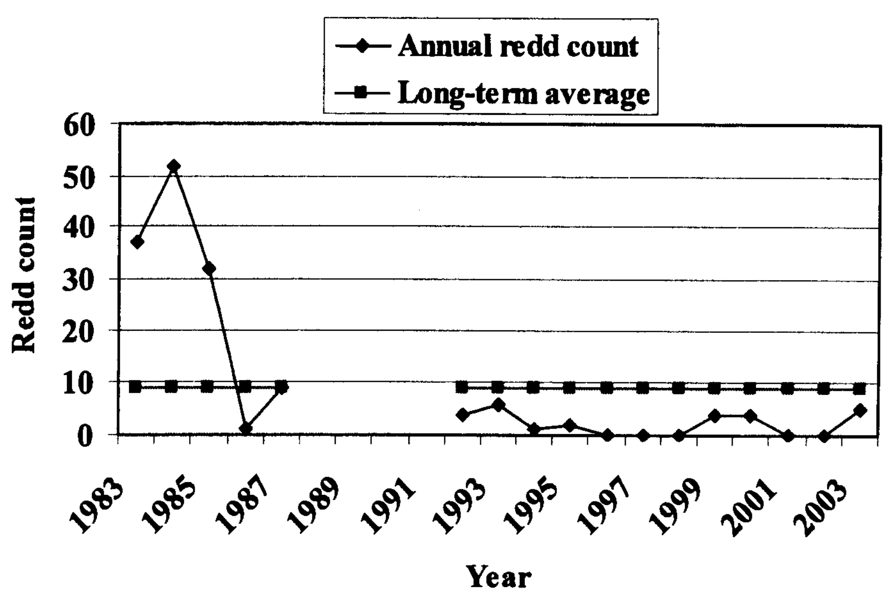

Figure 9. Annual Porcupine Creek, a tributary to Lightning Creek, bull trout redd counts and average redd count for 1983 through 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

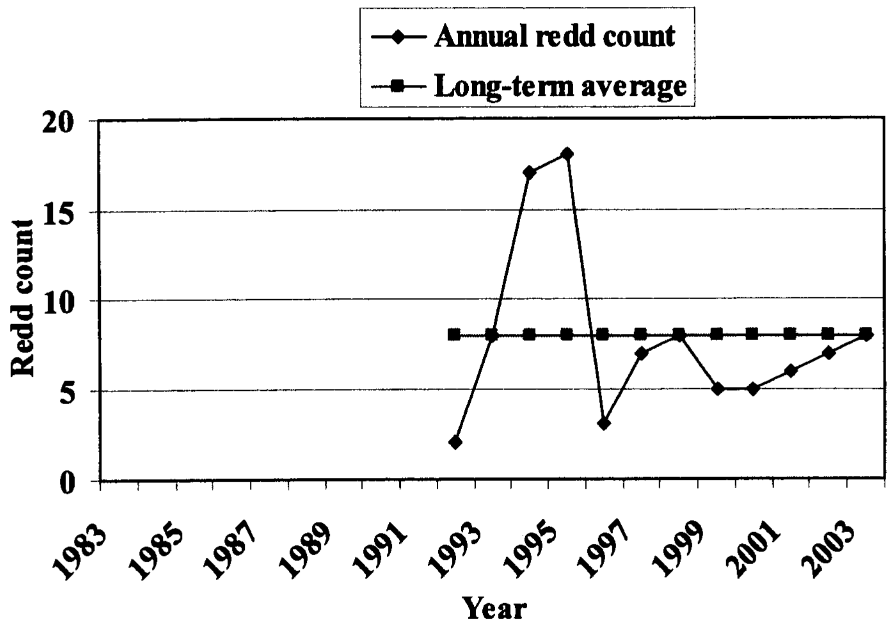

Figure 10. Annual Clark Fork River (Cabinet Gorge Fish Hatchery spawning channel) bull trout redd counts and average redd count for 1992 through 2003, Lake Pend Oreille, Idaho.

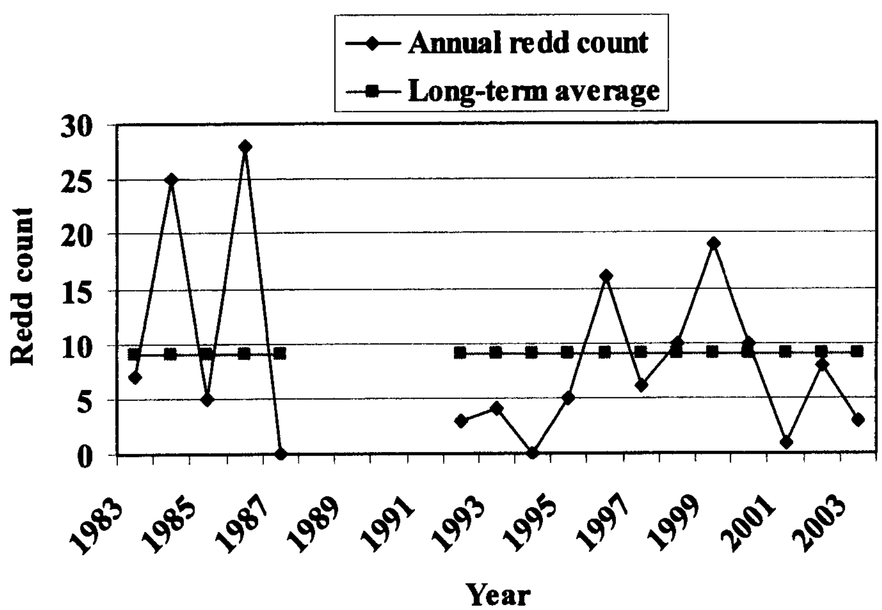

Figure 11. Annual Twin Creek bull trout redd counts and average redd count for 1983 through 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

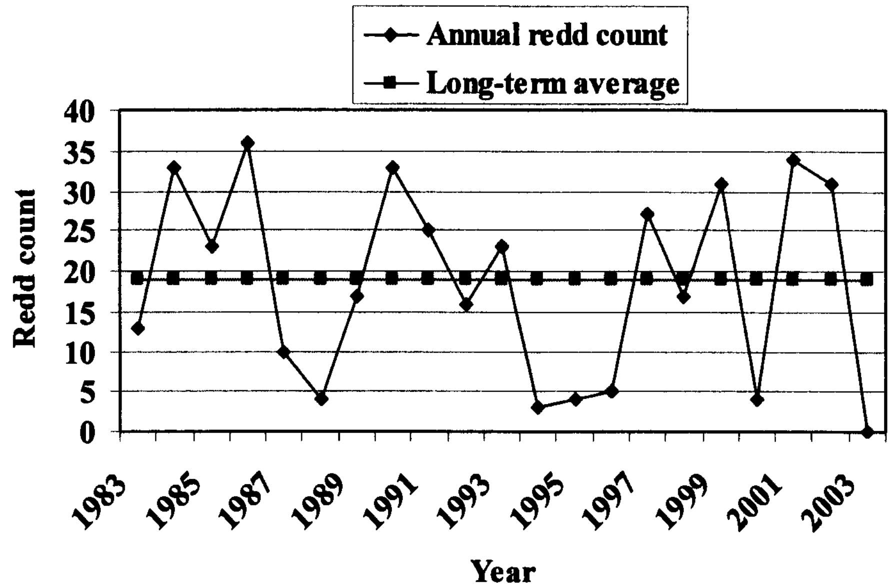

Figure 12. Annual Johnson Creek bull trout redd counts and average redd count for 1983 through 2003, Lake Pend Oreille, Idaho.

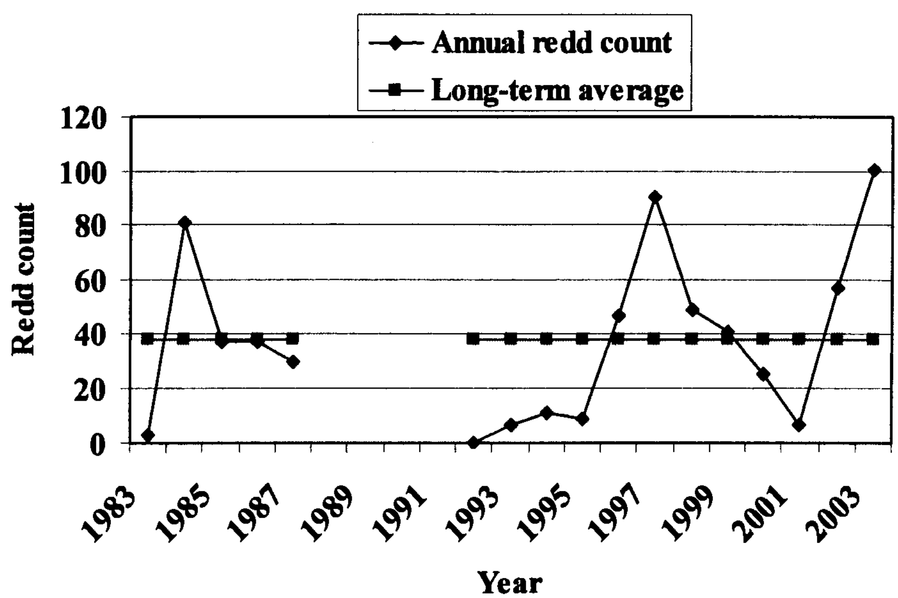

Figure 13. Annual Granite Creek bull trout redd counts and average redd count for 1983 through 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

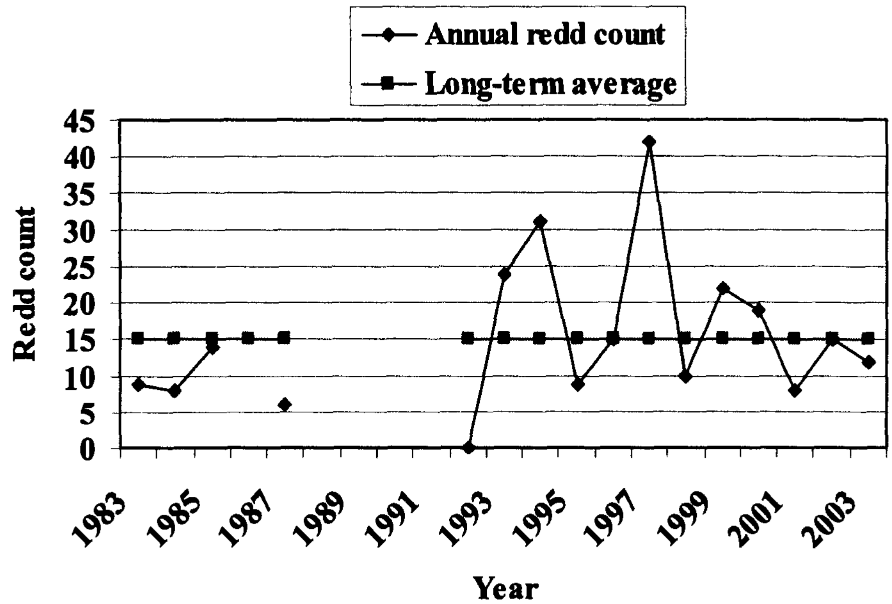

Figure 14. Annual Sullivan Springs Creek bull trout redd counts and average redd count for 1983 through 1985, 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

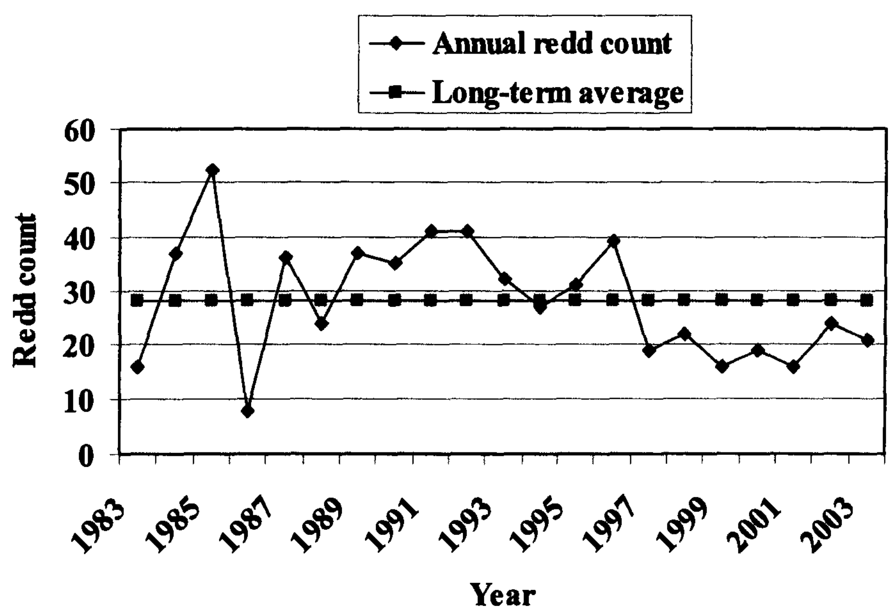

Figure 15. Annual N. Gold Creek bull trout redd counts and average redd count for 1983 through 2003, Lake Pend Oreille, Idaho.

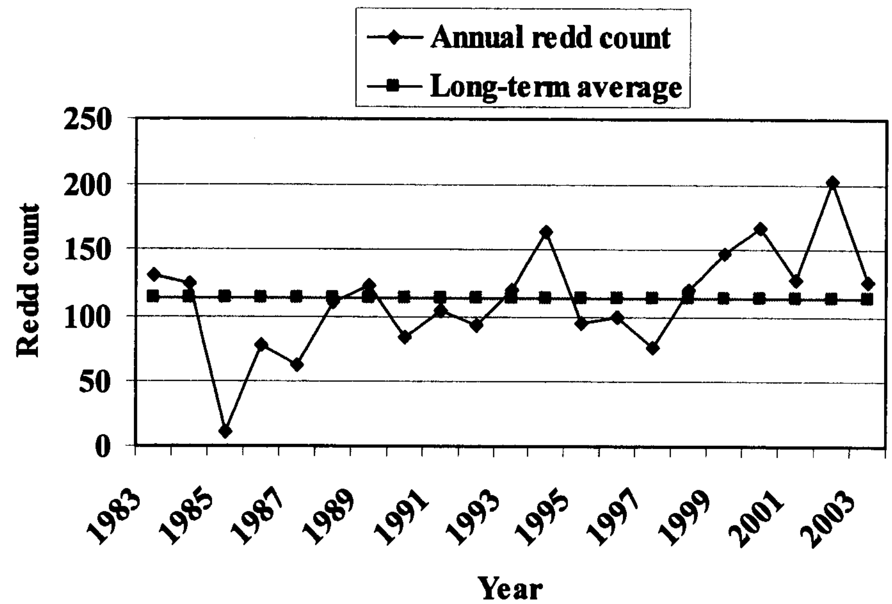

Figure 16. Annual Gold Creek bull trout redd counts and average redd count for 1983 through 2003, Lake Pend Oreille, Idaho.

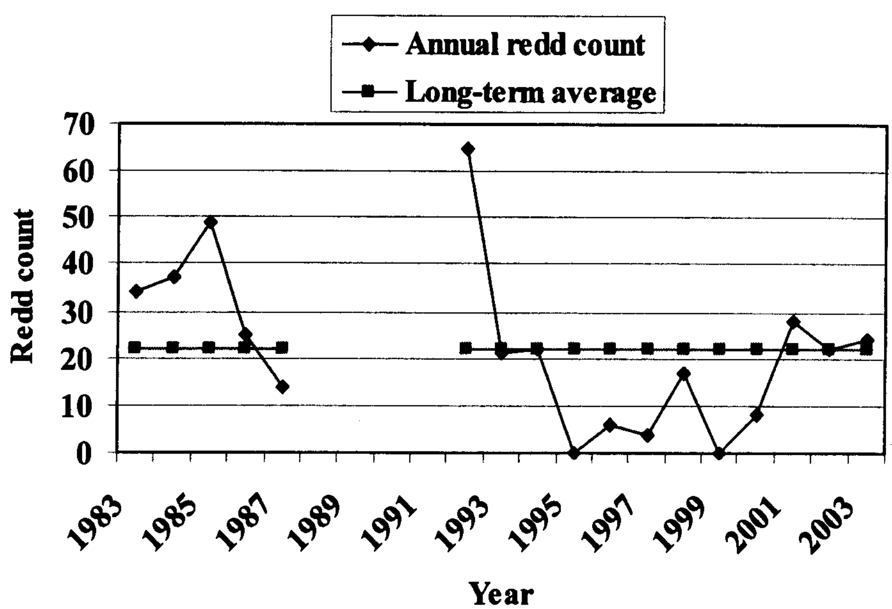

Figure 17. Annual Pack River bull trout redd counts and average redd count for 1983 through 1987, and 1992 through 2003, Lake Pend Oreille, Idaho.

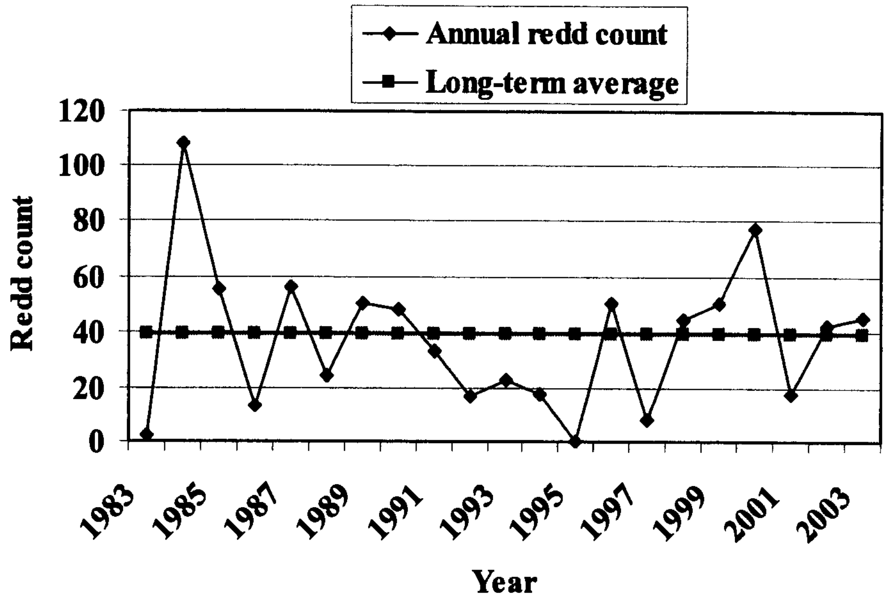

Figure 18. Annual Grouse Creek bull trout redd counts and average redd count for 1983 through 2003, Lake Pend Oreille, Idaho.

DISCUSSION

Six tributaries (index streams; Johnson, E. Fk. Lightning, Trestle, Grouse, N. Gold, and Gold creeks) have been surveyed consistently on an annual basis since 1983, and the 2003 redd count for these six streams combined (591) is among the higher redd counts on record, but considerably lower than the 2002 record count of 692 redds. Two of these streams, Trestle and Gold creeks together, accounted for the majority (58%) of the total number of redds counted in the Lake Pend Oreille system in 2003. These two streams have a large influence on the index stream totals on a year-to-year basis (82% in 2003).

We only identified three statistically significant correlations (trends) at the α=0.05 level among the 17 streams analyzed due to the large variability in redd numbers within the data set. 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). Two streams, Trestle and Gold creeks, maintain relatively strong populations and likely benefit from very cold summer water temperatures (Downs et. al. 2003; Downs and Jakubowski 2003; USFS, unpublished data) and high-quality complex spawning and rearing habitat. Additionally, brook trout *Salvelinus fontinalis*, that pose competition and hybridization risks to bull trout, are not known to be present in either of these streams. Porcupine Creek has apparently undergone a statistically significant bull trout population decline over time. Possible explanations for this may include limited woody debris recruitment/retention to the stream channel, less than optimal water temperatures during the summer and fall (USFS, unpublished data), and the presence of exotic brook trout. Investigating the factors responsible for the decline of bull trout in Porcupine Creek would help identify population restoration options.

Due to its drainage area, numerous physical habitat problems, and the presence of at least five genetically distinct bull trout populations (Spruell et. al. 1999), the Lightning Creek drainage offers the greatest opportunity to increase bull trout numbers in the LPO system. 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 them at an increased risk of local extinction (Spruell 1999). A watershed assessment funded by Avista is currently being conducted 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 Creek, E.Fk. of Lightning Creek, and Savage Creek 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 approximately 1 km in length, in the middle of the bull trout spawning and rearing area, 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.

Redd counts in the mainstem Pack River for the past three years have averaged 25. This is an improvement over redd counts in 1999 and 2000, when redd counts of zero and eight were recorded, respectively. Fine sediment, lack of large woody debris, and elevated water temperatures resulting from loss of shade are believed to be significant limiting factors to bull trout in the mainstem Pack River (PBTAT 1998). A stream channel assessment was recently completed (Golder Associates 2003) on the mainstem Pack River that should assist in identification of stream channel restoration opportunities to benefit bull trout. In addition, the Pack River Watershed Council is working to complete a Watershed Management Plan with the objective of improving water quality and aquatic habitat in the Pack River drainage. If both of these efforts translate into on the ground enhancement or conservation projects and changes in land use practices in the drainage, bull trout should benefit.

Dupont and Horner (in press) reported LPO is close to meeting recovery objectives of the USFWS Bull Trout Draft Recovery Plan (Plan) (USFWS 2002). LPO met the criteria of having six local populations with greater than 100 individuals in each, and is very close to the threshold population size established in the Plan of 2,500 adults. A third criteria is an increasing trend in abundance, and when redd counts for all LPO bull trout populations are combined, a statistically significant positive trend is seen (DuPont and Horner, in press). However, a concern with the Federal Recovery Plan criteria for trend is the combined analysis of redd counts across local populations. Two tributaries to LPO, Trestle and Gold creeks, supported 58% of the total redds counted across all streams surveyed, and 82% of the total redds counted in the six index streams in 2003. Any trend analysis that lumps all of the populations together is likely to be heavily influenced by the trends in these two streams. That would not be a concern if all populations were experiencing similar positive trends in abundance over time, which is not the case in LPO.

Overall, 12 of 17 populations monitored appear to have undergone long-term declines in abundance.

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. Evaluating trends at the local population level is more appropriate to understand the population dynamics of bull trout in LPO. This is the approach taken in The Lake Pend Oreille Bull Trout Conservation Plan (PBTAT 1999). When we evaluate population trends at the local population level, we conclude we are currently not meeting the State of Idaho's (PBTAT 1999) restoration targets for LPO as a whole. Two tributaries however, Trestle and Gold creeks, appear very close to meeting the criteria. Both of these tributaries appear to have stable or increasing trends, and both are close to meeting the 95% probability of persistence criteria, depending on the input values used in the modeling. The difference between the observed 90% and the targeted 95% probability of persistence to 100 years is the result of slightly altering the emigration components of the model to account for some uncertainty in straying rates. Straying does occur in the LPO system (Downs et. al. 2003; Downs and Jakubowski 2003), but at an unquantified rate. Spruell et al. (1999) estimated straying rates between LPO bull trout populations at one individual/year based on genetic analysis. It is unlikely we will be able to quantify straying rates in the near-term without substantial study, and as a result, it is unlikely the model will ever produce a 95% probability of persistence regardless of population trends or sizes unless we assume that annually, at least one individual is moving between these populations. This reflects the importance of straying in the model as it pertains to re-founding populations that have gone extinct due to stochastic events. It is clear that the BayVAM models are of limited utility in assessing probability of persistence to meet recovery criteria. Until a model is developed that more accurately reflects the complicated life-history of adfluvial bull trout, this will be the case. It appears that both the USFWS and PBTAT abundance and recovery criteria have problems in practical application. It may be possible to combine aspects of the USFWS recovery criteria with those of the IDEQ recovery criteria to produce a single set of criteria that are an improvement over both sets of individual criteria. A potential single set of revised abundance and recovery criteria could take the form of:

1) Six local populations with greater than 100 spawning individuals in each, as estimated by redd counts (existing USFWS criteria).
2) A total of at least 2,500 individual adults spread across all of the LPO bull trout spawning streams, as estimated by redd counts (existing USFWS criteria).
3) Stable or increasing trend in spawning escapement in six individual tributaries as evidenced by annual redd counts (existing PBTAT criteria)

The potential criteria listed above appear to be realistic and measurable abundance and recovery objectives for LPO. When fish passage is provided at Cabinet Gorge and Noxon dams, other currently isolated populations upstream in the lower Clark Fork River may be identified and available to help meet the numerical and trend recovery goals for LPO.

We used data we have collected in the Avista mitigation program, literature sources, and best professional judgement (BPJ) to determine model inputs. Obviously models such as BayVAM that rely on 11 or 12 parameters to predict population persistence are limited in predicting the complex synergy of natural systems and may be somewhat biased based on the parameters considered, the range of available inputs for each parameter, and which parameter is given priority. Also, models represent "works in progress" that become more realistic and useful when they are continually updated to reflect the latest understandings and incorporate the most recent data. It should be noted however, that modeling exercises such as this should not be considered as the definitive means for identifying management activities needed to preserve threatened populations, or true probabilities of persistence. Rather, models such as these should be regarded as a "framework for thinking" that when combined with other means of thoughtful analysis, help managers to identify possible avenues for managing threatened fish populations.

Overall, more bull trout populations appear to have declined in the LPO system than have increased since redd counts were initiated in 1983. However, short-term trend analysis suggests that bull trout numbers are increasing in a number of streams that appear to have undergone long-term declines. Changes in fishing regulations may be partially responsible for the 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 survived 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. This situation may currently exist in Trestle Creek. 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 *Salvelinus namaycush* population will overcome the ability of individual tributaries to produce enough juveniles to support current adult escapement levels, even in Trestle and Gold creeks, and conservation priorities may need to shift. 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 assess the feasibility of lake trout control in LPO are currently underway.

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APPENDICES

Appendix A. Annual bull trout redd counts (1983-2003) for tributaries to Lake Pend Oreille, Idaho.

Table A.1. Bull trout redd counts for Lake Pend Oreille basin tributaries, 1983-2003.

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	11	78	62	111	122	84	104	93	120	164	95
Lower Priest R.													
M.F. East River	--	--	--	--	--	--	--	--	--	--	--	--	--
Uleda Cr.	--	--	--	--	--	--	--	--	--	--	--	--	--
Total 6 index streams[d]	570	598	571	290	453	478	543	503	423[a]	333	529	516	273[b]
Total of all streams	814	881	830	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
Clark Fork R.	3	7	8	5	5	6	7	8
Lightning Cr.	6	0	3	16	4	7	8	8
E. Fk. Light. Cr.	49	22	64	44	54	36	58	38
Savage Cr.	0	0	0	4	2	4	15	7
Char Cr.	14	1	16	17	11	2	8	7
Porcupine Cr.	0	0	0	4	4	0	0	5
Wellington Cr.	5	2	1	22	8	7	7	8
Rattle Cr.	10	2	15	13	12	67	33	37
Johnson Cr.	5	27	17	31	4[c]	34	31	0
Twin Cr.	16	6	10	19	10	1	8	3
Morris Cr.	--	--	--	1	1	0	7	1
North Shore								
Trestle Cr.	243	221	330	253	301	331[e]	333[e]	361
Pack River	6	4	17	0	8	28	22	24
Grouse Cr.	50	8	44	50	77	18	42	45
Strong Cr.	2	--	--	--	--	--	0	--
East Shore								
Granite Cr.	47	90[f]	49	41	25	7	57	101
Sullivan Springs	15	42	10	22	19	8	15	12
North Gold Cr.	39	19	22	16	19	16	24	21
Gold Cr.	100	76	120	147	168	127	204	126
Lower Priest R.								
M.F. East River	--	--	--	--	--	4[k]	8[k]	21
Uleda Cr.	--	--	--	--	--	3[k]	4[k]	3
6 index streams[d]	486	373	597	541	631	562	692	591
Total of all streams	608	527	726	705	732	706	891	836

[a] Represents a partial count due to early snow fall because E. Fk Lightning was not counted.

Table A.1. Continued.

[b] Observation conditions impaired by high runoff.
[c] Headcut 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.

Appendix B. Initial values used in BayVAM simulations of bull trout populations.

Table B.1. Initial resident model inputs for BayVAM runs used for assessing probability of persistence for bull trout populations, Lake Pend Oreille, Idaho.

Variable	**Input probability**	**Data source(s)**
Fecundity	100% in 1,100-1,250 (max. value)	Brunson 1952, Heimer 1965, Downs and Jakubowski 2003b
Incubation survival	33% (30-40%), 34% (40-50%), 33% (50-60%)	Weaver 1993, WWP 1996, Liermann and Tholl 2003; BPJ (best professional judgment)
Max. fry survival	20% in all brackets	Uncertainty and BPJ
Parr (age1+) capacity	100% in 1,000-4,000 (lowest value)	Downs and Jakubowski 2003
Juvenile survival	33% (15-21%);34% (21-27%); 33% (27-34%)	WWP 1996, BPJ
Age at first maturity	100% in age 6	Downs and Jakubowski 2003
Adult survival	100% in 45-60%	Downs and Jakubowski 2003; Lockard et. al. 2003
Initial adults (females)	100% in 50-450	Downs et. al. 2003
Risk of catastrophe	33% (120-170 yrs); 34% (70-120 yrs); 33% (20-70 yrs)	Uncertainty and BPJ
CV of juvenile survival	33 % (15-40%); 34% (40-65%); 33% (65-90%)	Downs and Jakubowski 200b; Katzman and Hintz 2003; Katzman and Tholl 2003; Moran 2003b; *BPJ was ultimately used based on the cited studies*
Immigration	10% (zero individuals); 90% (1-6 individuals)	Downs et. al. 2003; Spruell et. al. 1999; BPJ

Project 3: 2003 Clark Fork River Fishery Assessment Progress Report

ABSTRACT

The objective of this research is to measure the intended benefits of increasing the minimum flow from Cabinet Gorge Dam from 3,000 cubic-feet-per-second (cfs) (84.9 cubic-meters-per-second) to 5,000 cfs (141.5 cms) in the Clark Fork River, Idaho. Mark-recapture population estimates were conducted in the fall of 2003 to estimate the abundance of westslope cutthroat trout *Oncorhynchus clarki lewisi* and rainbow trout *O. mykiss*. We estimated 135 westslope cutthroat trout and 86 rainbow trout greater than 200 mm total length in the study reach during the fall sampling period in 2003. 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. 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 salmon *O. 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 brown trout *Salmo trutta* and mountain whitefish in the spring of 2003 of 82.2% and 79.3%, respectively. This indicates a large majority of the electrofishing catch was greater than 305 mm. We summarized our previous electrofishing data for the fall of 1999 through 2003 and compared our CPUE with that of earlier Avista Corporation fishery work conducted in October and early November, 1994. Based on CPUE, the families cyprinidae (minnow) and catostomidae (sucker) were, and continue to be, the most abundant fish present in the Clark Fork River, with salmonids comprising 25.4% of the total catch (excluding kokanee) in the fall of 2003. Based on CPUE, the proportion of salmonids in the catch has increased from 1994 to date. Native fish as a group comprised over 96% of the electrofishing catch in the fall of 1994, whereas they comprised greater than 86% in the fall of 2003. Increases in the catch of brown trout, as well as lake *Coregonus clupeaformis* and mountain whitefish accounted for a large proportion of the increase in the salmonid catch in 2003.

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INTRODUCTION

Avista Corporation (Avista; formerly Washington Water Power (WWP)) recently 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 3,000 cfs to 5,000 cfs (Avista 1999). Cabinet Gorge Dam is operated as a "peaking" facility, with daily flow fluctuations ranging from 3,000 cfs to 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.

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, 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. clarki 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.

STUDY AREA

The Clark Fork River is the largest tributary to Lake Pend Oreille, contributing an estimated 92% of the annual inflow (Frenzel 1991). It drains 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 kilometers (km) of river habitat (Figure 1). 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) (WWP1995). Riffles are located near the mouths of Twin and Lightning creeks, as well as at Foster side-channel (Figure 1). Substrate composition in the river has been described as gravel (26.3%), fines (22.2%), boulder (17.9%) and cobble (16.2%), (WWP 1995).

METHODS

Population Estimates and Catch-Per-Unit-Effort

Mark-recapture population estimates were conducted in the fall of 2003 for westslope cutthroat trout and rainbow trout (target species) greater than 200 mm total length (TL) in the approximately 6.6 km long reach of the Clark Fork River from the USGS gauging station below Cabinet Gorge Dam downstream to the inlet of Foster side-channel (approximately river km 234 – 241). Distances and river km's were initially estimated from previous Avista GIS work (Parametrix 2000a). We previously estimated a total surface area of the study reach at 120.7 hectares (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 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 2003, we conducted our marking runs from October 21 through October 23, and our recapture runs from October 27 through October 30.

Boom-type electrofishing was conducted at night using two crews in 6 m-long jet boats. 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 4 to 12 amps at 150-250 volts.

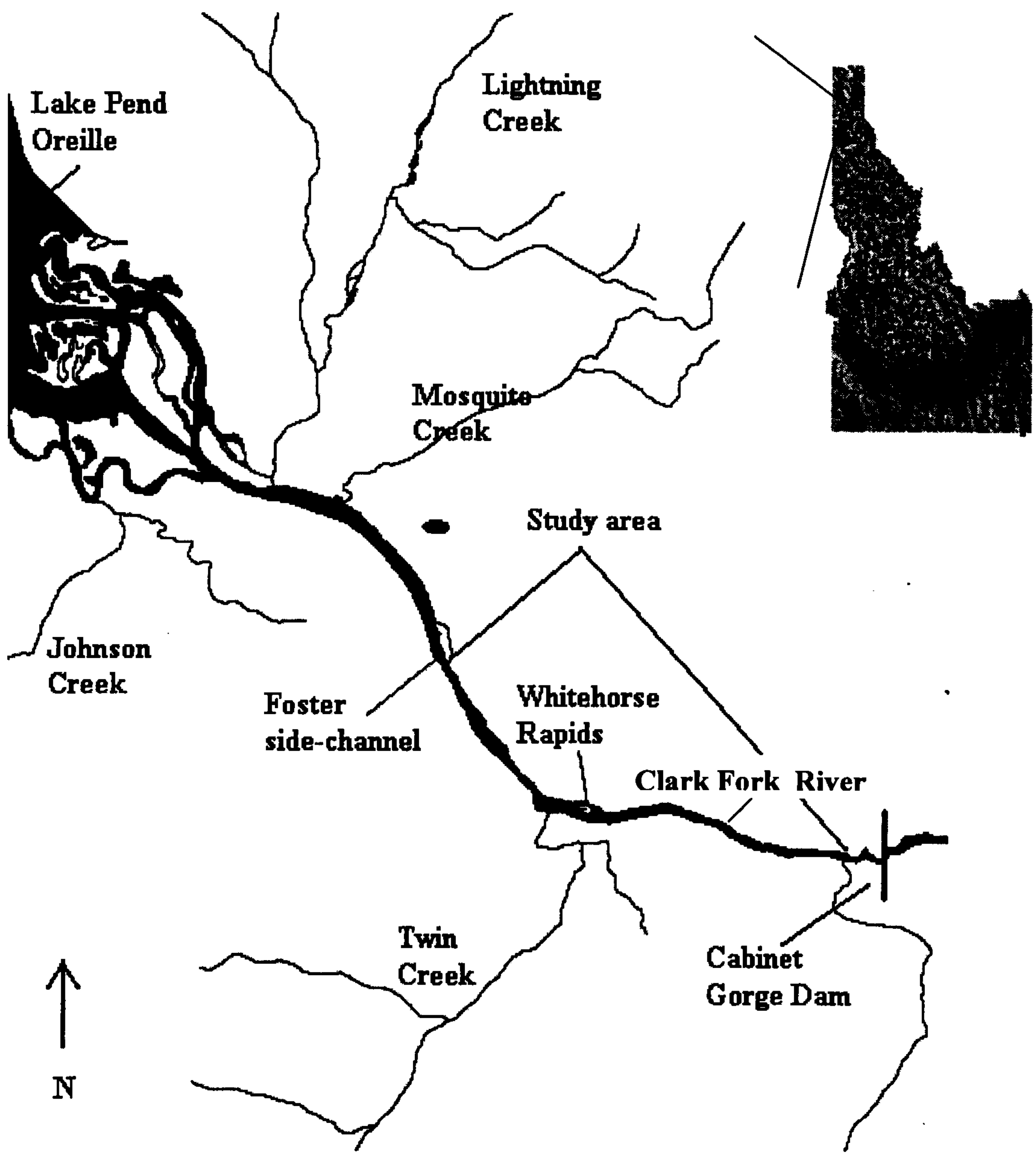

Figure 1. Fishery evaluation study area on the Clark Fork River, a tributary to Lake Pend Oreille, Idaho.

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 0.61 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 two to three-night period in the first week of sampling, and the "recapture" period was conducted over a two to three 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).

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 trout and westslope cutthroat trout, and also to estimate CPUE for all salmonids encountered during fall sampling. Captured fish were anesthetized with clove oil, checked for fin clips, larger fish were weighed to the nearest 25 g (smaller fish to the nearest 1 g), measured (total length (TL), mm), marked with a fin clip, and released. Any captured bull trout *Salvelinus confluentus*, and westslope cutthroat trout were also scanned for the presence of a Passive Integrated Transponder (PIT) tag. CPUE was estimated for salmonids on the first night of the marking run.

We only netted target species for the majority of the sampling period due to low densities of target fish and the large amount of effort (time) required to successfully complete mark-and-recapture population estimates for these species. We did net all fish stunned by electrofishing on the final night of the "recapture" run to estimate CPUE of non-target species (e.g. kokanee, northern pikeminnow *Ptychocheilus oregonensis*, peamouth *Mylocheilus caurinus*, etc.) for long-term monitoring purposes. CPUE was estimated for all species from data collected from both banks on the last night of electrofishing, over the entire study reach.

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

Binomial confidence intervals were estimated as recommended by Seber (1982) using the relationship between the F and the binomial distribution (Zar 1996). Poisson confidence intervals were developed where appropriate using the tables and recommendations provided in Krebs (1989).

Age, Growth, and Condition

In addition to collecting length and weight data, a sample of scales was collected from captured salmonids for estimation of age and growth. Scales were impressed onto plastic slides and viewed on a microfiche reader at 42X. We used the Fraser-Lee method of back-calculation to estimate length-at-age for selected salmonid species (Devries and Frie 1996). Because our sample contained few fish less than 250 mm, we relied on intercept values (length at scale formation) from the literature for westslope cutthroat trout (42 mm, Averett 1962), brown trout (38 mm, Jensen and Jonsen 1982), and rainbow trout (35 mm, Smith 1955). A regression of TL at capture on scale radius ($Y = 2.7(X) + 73.6$; $R^2 = 0.72$; $n=46$) was used to estimate the intercept for mountain whitefish using the scales collected in 2000. Mean length-at-age and annual growth increments were estimated from the back-calculation data. In addition to ageing the scales collected in 2003, we also re-aged a sample of scales collected in 2000 to ensure consistency between readers.

The Fraser-Lee method can be described as:

$$L_i = ((L_c - a) / S_c) S_i + a \quad (2)$$

Where:

- L_i = back-calculated TL at the *i*th annulus formation
- S_c = radius of hard part at capture
- L_c = TL at capture
- S_i = radius of hard part at increment
- a = estimated TL of individual at hard-part formation derived from regression technique or literature.

We re-aged the earlier age structure samples reported in Downs et. al. (2003) to ensure consistency across readers for comparison. After ageing the earlier samples again (collected in 2000), we aged our scale samples collected in 2003. The age structure samples collected in 2003 were compared to the samples collected in 2000 from the study area. Average lengths and weights of other fish species collected in the fall 2003 were compared with data from fall sampling in 1999 and 2001.

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 (PSD) and the proportion > 406 mm (Quality Stock Density, QSD) using 200 mm (TL) as stock length (Schill 1991). We used 250 mm as stock length for walleye *Sander vitreus* (formerly *Stizostedion vitreum*) (Anderson and Neumann 1996) and 400 and 500 mm for PSD and QSD estimates, respectively.

RESULTS

Population Estimates and Catch-Per-Unit-Effort

We estimated 135 westslope cutthroat trout and 86 rainbow trout greater than 200 mm total length occupied the study reach during the fall sampling period in 2003 (Table 1). CPUE for all salmonids reflected a dominance by mountain whitefish (Table 2). In addition to captured salmonids, we also captured ten walleye, and estimated a CPUE of 0.005 fish/minute over the entire sampling period (10 walleye/1,947 minutes of electrofishing). Upon subsequent laboratory examination, five of the walleye were determined to be mature males, and two others were determined to be mature females. Sex was not determined for the remaining three fish. Both the 570 mm and the 640 mm females each contained adult kokanee in their stomachs. The stomachs from the males were not examined. Dorsal spines and scales were collected for future ageing.

We captured 18 species of fish during the fall 2003 sampling period (Table 3). CPUE for all fish species combined was highest for northern pikeminnow in the fall of 2003. Black bullhead *Ictalurus melas* and pumpkinseed *Lepomis gibbosus* were the rarest fish in our catch based on CPUE .

Table 1. Population estimate statistics for westslope cutthroat and rainbow trout >200 mm captured in the 6.6 km study reach of the Clark Fork River, Idaho, in October 2003.

Species	**M**	**C**	**R**	**Population estimate**	**Lower 95% CI**	**Upper 95% CI**
Westslope cutthroat trout	25	25	4	135	69	553
Rainbow trout	36	13	5	86	59	170

Table 2. Electrofishing catch-per-unit-effort (CPUE) (fish/minute and fish/1000 m) for salmonid species captured along both banks in the 6.6 km study reach of the Clark Fork River, Idaho, during the first night of marking in October 2003.

Species	**Number captured**	**Time electrofished (minutes)**	**CPUE (fish/minute)**	**CPUE (fish/1000 m)**
Bull trout	3	357.52	0.008	0.23
Brown trout	64	357.52	0.179	4.84
Lake whitefish[a]	7	357.52	0.020	0.53
Lake trout[b]	1	357.52	0.003	0.08
Mountain whitefish	182	357.52	0.51	13.77
Rainbow trout	19	357.52	0.053	1.44
Westslope cutthroat trout	15	357.52	0.042	1.14

[a] Lake whitefish *Coregonus clupeaformi*

[b] Lake trout *S. namaycush*

Table 3. Catch Per Unit Effort (CPUE) for all species captured over 303.3 minutes of electrofishing along both banks of the 6.6 km study reach in the Clark Fork River, Idaho, on the last night of the recapture run, October 2003.

Species	**Scientific name**	**Number captured**	**CPUE (fish/minute)**
Black bullhead	Ictalurus melas (BBH)	1	0.003
Brown trout	Salmo trutta (BRN)	33	0.109
Bull trout	Salvelinus confluentus (BLT)	0	0.00
Lake trout	Salvelinus namaycush (LKT)	0	0.00
Lake whitefish	Coregonus clupeaformis (LWF)	37	0.122
Largemouth bass	Micropterus salmoides (LMB)	8	0.026
Largescale sucker	Catostomus macrocheilus (LSS)	167	0.551
Mountain whitefish	Prosopium williamsoni (MWF)	98	0.323
Northern pikeminnow	Ptychocheilus oregonensis (NPM)	225	0.742
Peamouth	Mylocheilus caurinus (PEA)	64	0.211
Pumpkinseed	Lepomis gibbosus (PUM)	1	0.003
Rainbow trout	Oncorhynchus mykiss (RBT)	4	0.013
Redside shiner	Richardsonius balteatus (RSS)	45	0.148
Smallmouth bass	Micropterus dolomieui (SMB)	2	0.007
Tench	Tinca tinca (TEN)	2	0.007
Walleye	Sander vitreus (WAL)	3	0.010
Westslope cutthroat trout	Oncorhynchus clarki lewisi (WCT)	7	0.023
Yellow Perch	Perca flavescens (YLP)	6	0.020

Age, Growth, and Condition

We estimated annual back-calculated growth rates for brown, rainbow, and westslope cutthroat trout, as well as mountain whitefish collected in 2003 (Table 4). Of the salmonid species evaluated, mountain whitefish generally had the fastest growth rates. We also re-aged the sample of scales collected in 2000 for comparison with the 2003 data (Table 6). During the report period, average length-at-capture across all salmonid species ranged from 319.3 mm (westslope cutthroat trout) to 765.3 mm (lake trout) (Table 7; Figures 2 through 7) PSD's (proportion of catch > 305 mm) for all salmonid species except lake whitefish ranged from 60.9 for westslope cutthroat trout to 89.9 for mountain whitefish. QSD's (proportion of the catch > 406 mm) ranged from 4.4 for westslope cutthroat trout to 27.3 for brown trout across all salmonid species (Table 8). Estimated *Wr* for salmonids ranged 80.3 for brown trout to 109.4 for lake trout (Table 9). Walleye averaged 508.7 mm (s.d.=59.9; n=10) in length (Figure 8). The average weight was 1,441.8 g (s.d.=717.6; n=10). PSD (proportion of catch > 400 mm) for walleye was 100, and QSD (proportion of catch > 500 mm) was 40. Mean *Wr* was estimated at 94.8 (s.d.=8.1; range=84.1-107.4; n=10). Average total lengths for non-salmonid species captured ranged from 35.0 (pumpkinseed) to 508.8 (walleye) mm. Average weights for non-salmonid species captured ranged from 1.0 (pumpkinseed) to 1,448.0 (walleye) g (Table 10).

Table 4. Back-calculated growth rates for target salmonid species in the 6.6 km long study reach of the Clark Fork River, Idaho, estimated from scale samples collected in October 2003.

Brown trout	**Age**					
	1	**2**	**3**	**4**	**5**	**6**
Mean TL (s.d.)	99.8 (13.0)	159.1 (29.6)	233.9 (45.7)	308.9 (62.8)	382.7 (50.1)	455.8 (71.3)
Mean increment	99.8	59.3	74.9	74.9	73.9	73.0
n	84	84	81	59	30	11

Mountain whitefish	**Age**					
	1	**2**	**3**	**4**	**5**	**6**
Mean TL (s.d.)	157.2 (20.0)	242.2 (41.7)	298.1 (30.3)	318.8 (25.6)	347.9 (26.4)	381.5 (17.5)
Mean increment	157.2	85.0	55.9	20.7	29.1	33.6
n	72	71	60	29	9	3

Rainbow trout	**Age**					
	1	**2**	**3**	**4**	**5**	**6**
Mean TL (s.d.)	90.4 (11.0)	149.8 (26.0)	218.5 (36.9)	299.3 (43.5)	377.1 (61.9)	364.1 (N/A)
Mean increment	90.4	59.4	68.7	80.8	77.8	
n	33	33	33	22	7	1

Table 4. Continued.

Westslope cutthroat trout	Age					
	1	2	3	4	5	6
Mean TL (s.d.)	97.5 (14.7)	151.7 (25.7)	221.7 (33.6)	285.0 (32.3)	321.2 (38.2)	(N/A)
Mean increment	97.5	54.2	70.0	63.3	36.2	
n	41	41	41	27	6	

Table 5. Back-calculated growth rates for mountain whitefish captured in October 2000, and for other salmonid species captured in March/April 2000, in the 6.6 km long study reach of the Clark Fork River, Idaho.

Brown trout	Age					
	1	2	3	4	5	6
Mean TL (s.d.)	104.9 (11.1)	197.6 (27.6)	311.8 (35.0)	394.1 (35.7)	450.5 (5.1)	509.5 (N/A)
Mean increment	104.9	92.6	114.2	82.3	56.4	59.0
n	21	21	19	13	3	1

Mountain whitefish	Age					
	1	2	3	4	5	6
Mean TL (s.d.)	168.1 (22.1)	266.0 (38.1)	327.6 (35.9)	348.7 (31.4)	376.3 (N/A)	N/A
Mean increment	168.1	97.9	61.6	21.2	27.6	N/A
n	44	38	26	8	1	N/A

Rainbow trout	Age					
	1	2	3	4	5	6
Mean TL (s.d.)	92.2 (11.3)	157.2 (27.1)	278.4 (43.4)	365.4 (33.1)	419.6 (35.9)	N/A
Mean increment	92.2	65.0	121.2	87.0	54.2	N/A
n	46	46	44	31	13	N/A

Westslope cutthroat trout	Age					
	1	2	3	4	5	6
Mean TL (s.d.)	106.1 (17.5)	174.5 (32.9)	283.6 (35.8)	352.7 (26.8)	430 (N/A)	N/A
Mean increment	106.1	68.3	109.2	69.1	77.3	N/A
n	21	21	20	7	1	N/A

Table 6. Mean total length TL (mm) and weight-at-capture (g) for salmonid species inhabiting the 6.6 km long study reach on the Clark Fork River, Idaho, in October 2003.

Species	Mean TL (s.d.)	Length range (mm)	Mean weight (g)	Sample size
Bull trout	720.0 (107.3)	700-745	3,528.7	3
Brown trout	392.2 (107.3)	214-765	692.4	253
Lake trout	765.3 (104.6)	602-870	5,264.0	9
Lake whitefish	414.1 (38.9)	350-490	660.9	14
Mountain whitefish	341.4 (34.2)	245-440	392.7	79
Rainbow trout	350.1 (44.9)	255-482	397.7	44
Westslope cutthroat trout	319.3 (39.6)	255-421	324.4	46

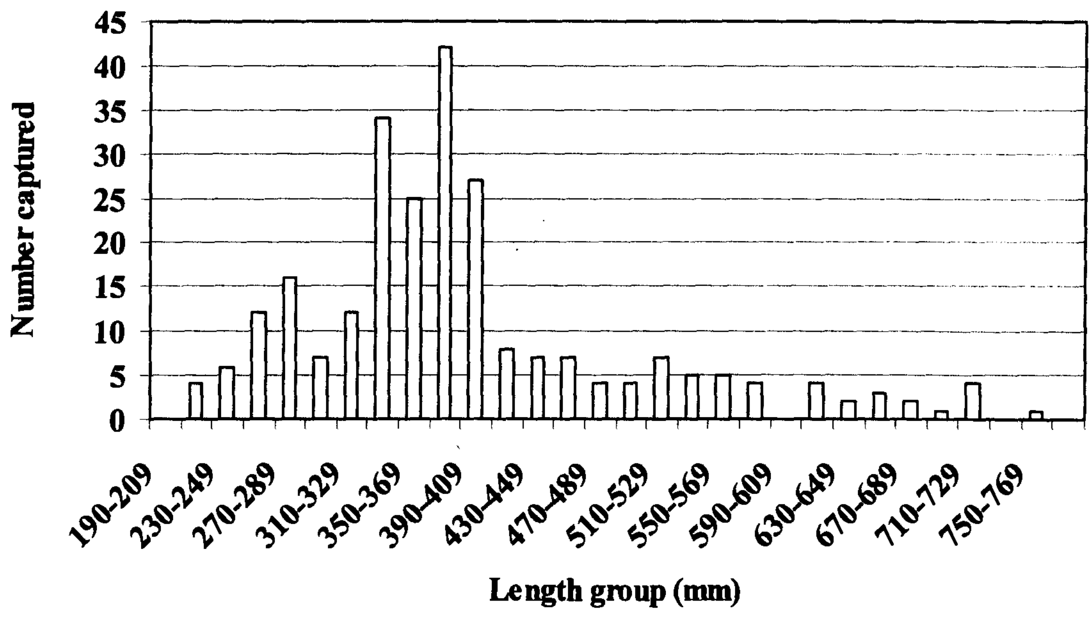

Figure 2. Length frequency histogram for brown trout (n=253) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

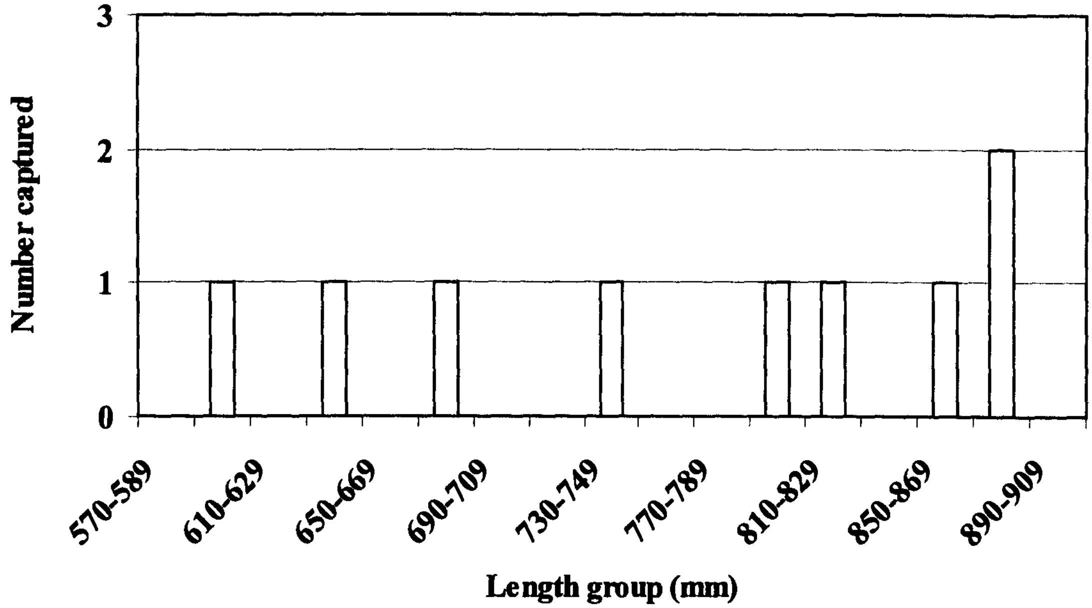

Figure 3. Length frequency histogram for lake trout (n=9) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

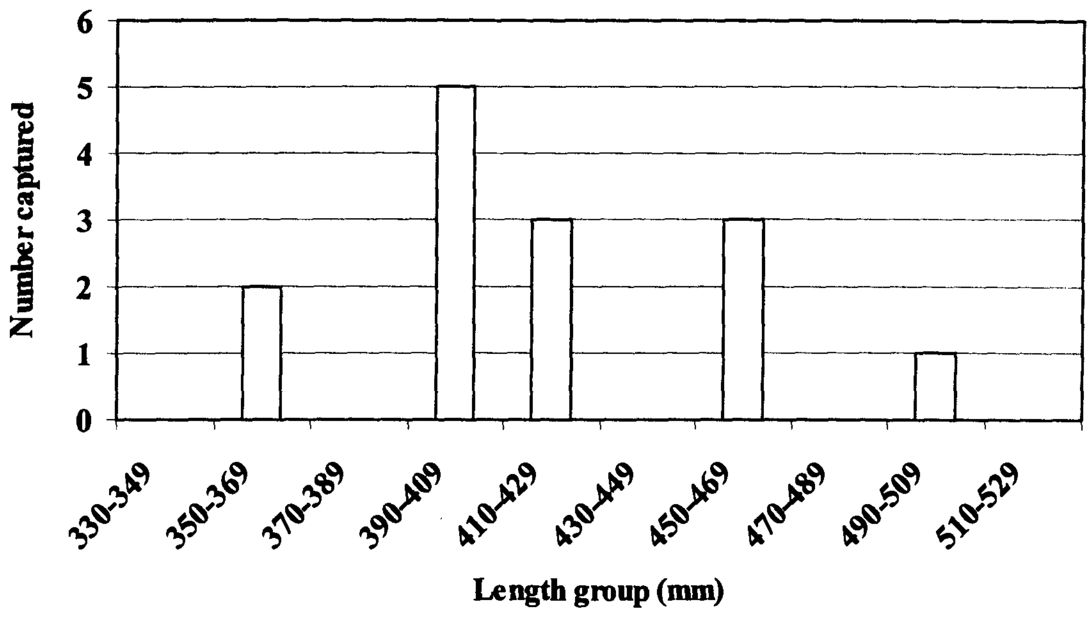

Figure 4. Length frequency histogram for lake whitefish (n=14) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

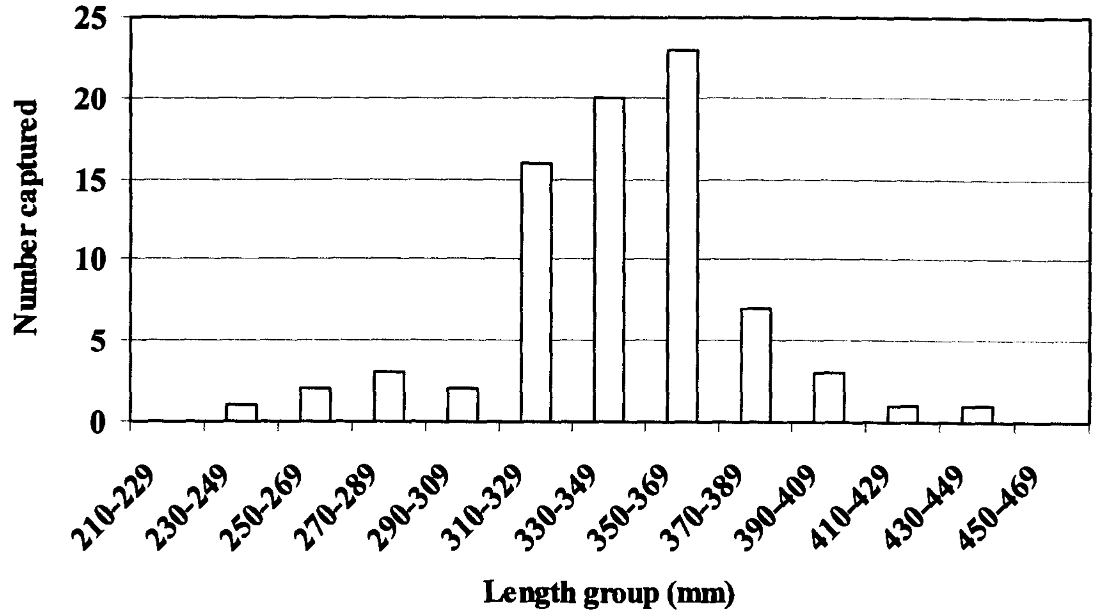

Figure 5. Length frequency histogram for mountain whitefish (n=79) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

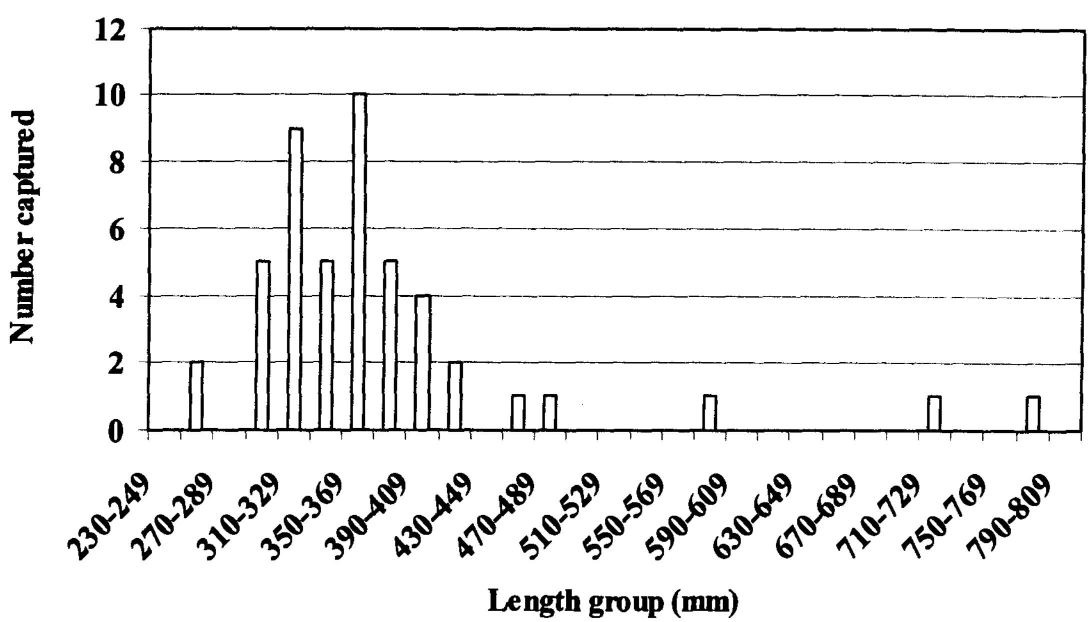

Figure 6. Length frequency histogram for rainbow trout (n=44) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

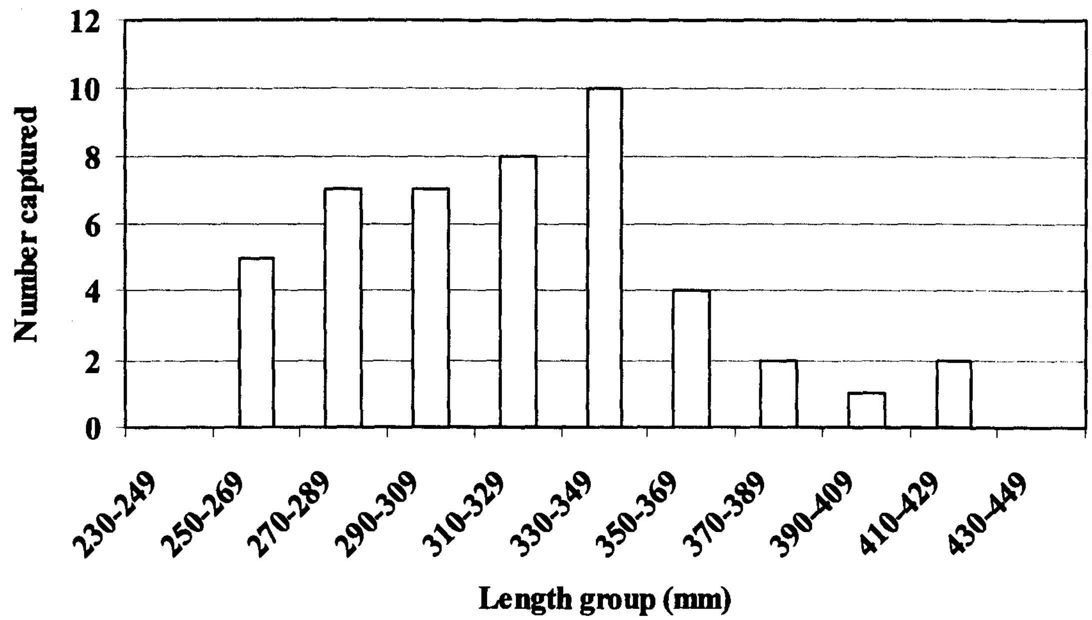

Figure 7. Length frequency histogram for westslope cutthroat trout (n=46) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

Table 7. Proportional (PSD) and quality (QSD) stock densities for target salmonid species from the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

PSD >305 mm (QSD > 406 mm), stock length = 200 mm		
Species	**PSD (%)**	**QSD (%)**
Brown trout	82.2	27.3
Mountain whitefish	89.9	2.5
Rainbow trout	86.4	9.1
Westslope cutthroat trout	60.9	4.4

Table 8. Mean relative weights (*Wr*) for the captured salmonid species and walleye, from the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

Species	Mean *Wr* (s.d)	*Wr* range	Sample size
Brown trout	80.3 (13.2)	39.7-132.6	251
Lake trout	109.4 (27.8)	90.8-182.2	9
Mountain whitefish	95.7 (10.7)	72.6-116.3	79
Rainbow trout	84.3 (10.4)	63.9-114.8	44
Westslope cutthroat trout	84.9 (9.4)	71.2-118.9	46
Walleye	94.8 (8.1)	84.1-107.4	10

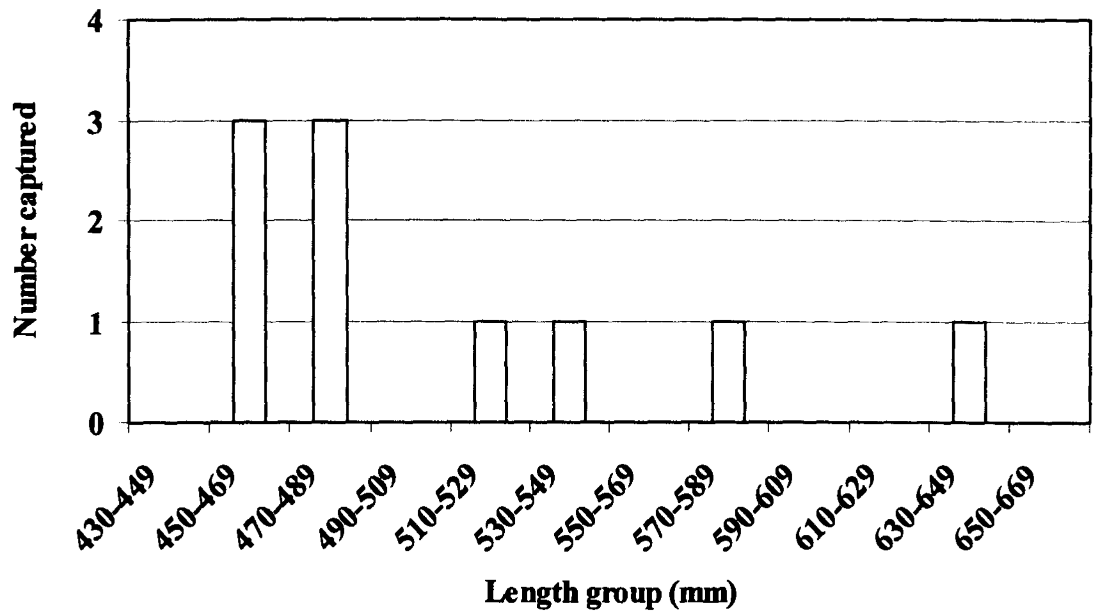

Figure 8. Length frequency histogram for walleye (n=10) captured in the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

Table 9. Average length (TL;mm) and weight (g) for non-salmonid species captured in the 6.6 km long study reach of the Clark Fork River, Idaho, in October 2003.

Species	Mean length (s.d.)	Length range	Mean weight (s.d)	Sample size
Black bullhead	180.0	N/A	74	1
Largemouth bass	134.8 (47.0)	79-209	43.1 (47.8)	8
Largescale sucker	460.7 (40.0)	342-560	1,008.7 (239.5)	52
Northern pikeminnow	178.7 (65.3)	80-497	73.7 (191.8)	58
Peamouth	228.8 (41.1)	64-295	103.7 (52.7)	57
Pumpkinseed	35.0	N/A	1	1
Redside shiner	107.6 (20.3)	77-144	11.4 (7.1)	45
Smallmouth bass	310.7 (39.8)	267-345	344.0 (149.9)	3
Tench	197.5 (3.5)	195-200	118.5 (0.7)	2
Walleye	508.8 (59.9)	452-640	1,448 (717.6)	10
Yellow perch	169.0 (55.8)	87-260	71.2 (63.6)	6

DISCUSSION

Population Estimates and Catch-Per-Unit-Effort

Population estimates were relatively similar for westslope cutthroat trout from the fall of 1999 through the fall of 2003 (Figure 9). Population point estimates for rainbow trout have decreased consistently since sampling began in 1999 (Figure 10). However, this decrease was negligible from 2001 to 2003. Annual variability is high in the population estimates, making detecting a statistically significant change unlikely without dramatic changes in abundance. CPUE is also highly variable, but increased for both species from 2001 to 2003 (Figure 11). It is not possible at this time to draw meaningful conclusions regarding the effectiveness of the increased minimum flow to increase salmonid populations due to high variability in the estimates of population size, short-term nature of the data set, and the lack of pre-treatment population estimates. However, it may take a number of years for any benefits resulting from improving rearing conditions to express themselves in terms of adult abundance. This would allow us to use the first couple of years of population estimates as our baseline. 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. We will continue to sample in the fall to monitor westslope cutthroat and rainbow trout, and in the spring to monitor brown trout and mountain whitefish, in alternating years, to identify trends in abundance resulting from the increased minimum flow in the Clark Fork River.

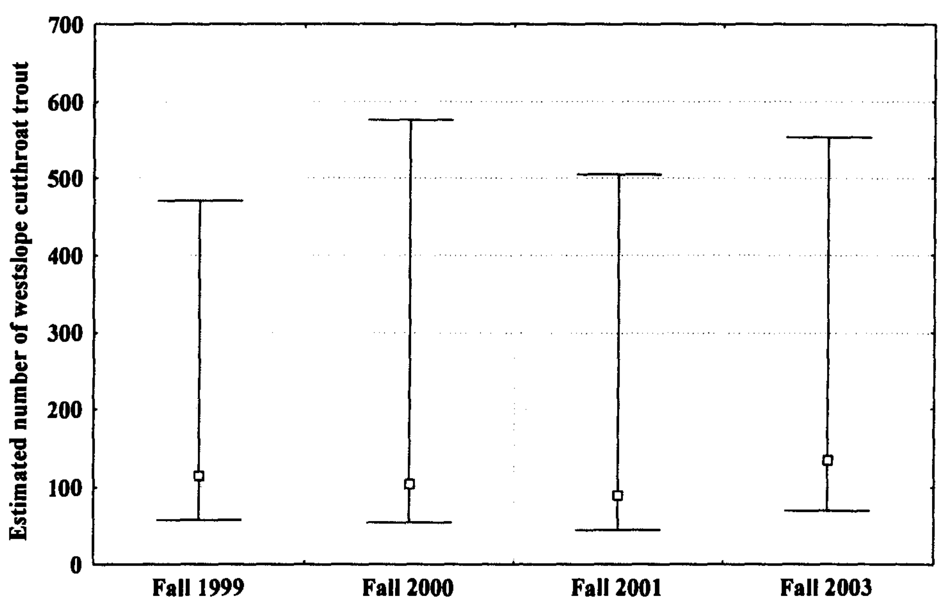

Figure 9. Comparison of population estimates and associated 95% confidence intervals, conducted for westslope cutthroat trout in the 6.6 km long study reach of the Clark Fork River, Idaho, 1999 through 2003.

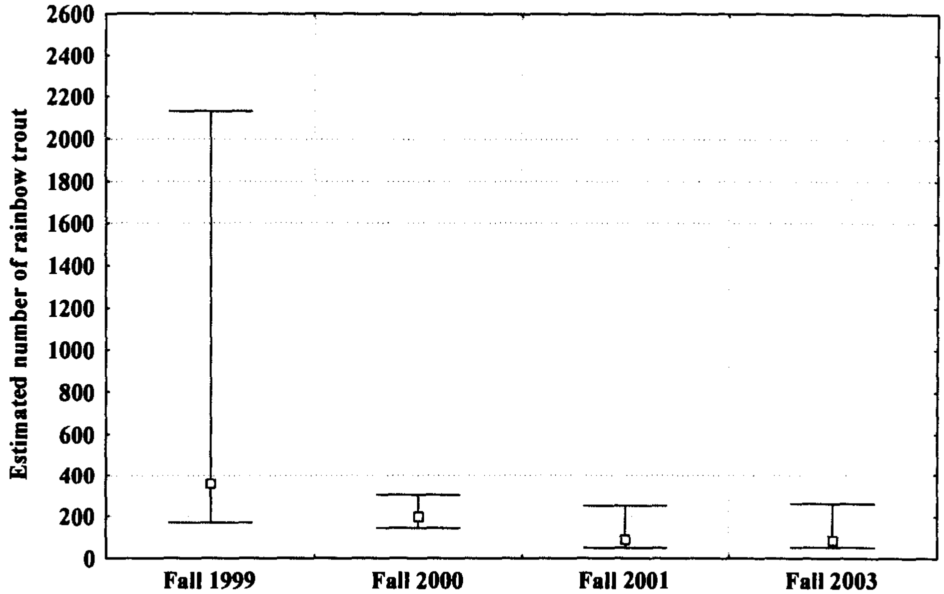

Figure 10. Comparison of population estimates and associated 95% confidence intervals, conducted for rainbow trout in the 6.6 km long study reach of the Clark Fork River, Idaho, 1999 through 2003.

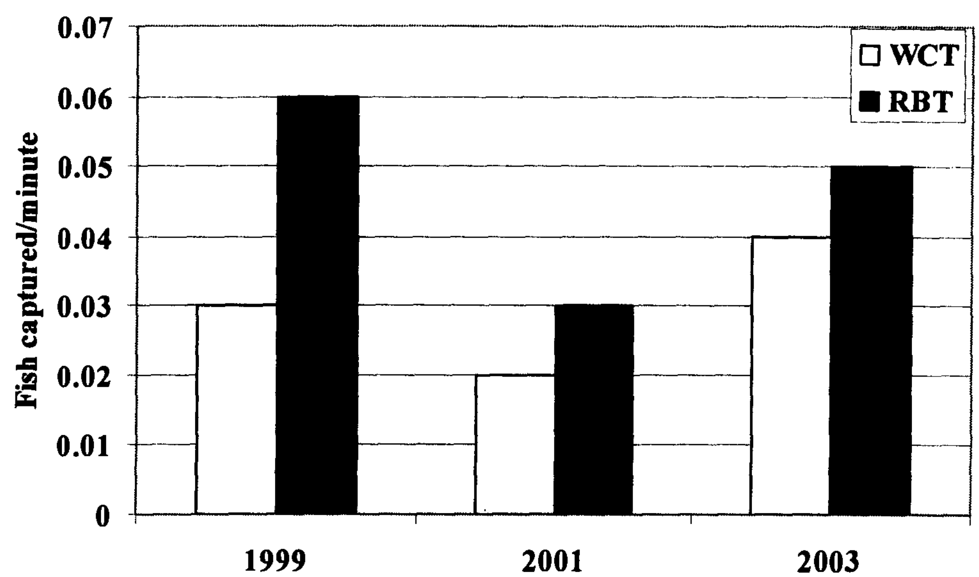

Figure 11. Catch-per-unit-effort for westslope cutthroat and rainbow trout estimated from catch data collected on the first night of marking in each year in the 6.6 km long study reach of the Clark Fork River, Idaho, 1999 through 2003.

A number of factors acting in combination may be regulating salmonid abundance 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^{0}C recorded on July 24, 2002) (C. Downs, IDFG, personal communication), elevated total dissolved gas levels in most years (Parametrix 2000b), and continued power-peaking.

The catch of walleye increased 5-fold from 2002 to 2003, and CPUE increased 4-fold in the Clark Fork River. Walleye were not captured in any IDFG or Avista sampling conducted periodically from 1994 through 2001 in the Clark Fork River. Gill net catches upstream in Noxon Reservoir also increased, and it is now suspected that walleye are successfully reproducing in Noxon Reservoir (L. Katzman, MFWP, personal communication). Due to low hydraulic retention time in the upstream impoundments (Noxon and Cabinet Gorge reservoirs), it is likely that walleye fry will continue to be flushed downstream into LPO, further complicating efforts to effectively manage predatory fish species to recover native species and provide for a recreational kokanee fishery. All 12 walleye captured in the Clark Fork River have been sexually mature adults, and based on the number captured in 2003, it is likely that reproductively mature individuals would be able to locate spawning partners in the Clark Fork River. Spawning habitat in the form of large gravel, cobble, and rip-rap is available for walleye in the Clark Fork River in Idaho, as well as along the shorelines of LPO. Relatively long hydrolic retention times in LPO (PBTAT 1998) would also be favorable to pelagic walleye fry. We recommend continuing to implement electrofishing population monitoring in the Clark Fork River to determine if the walleye population is increasing. If walleye catches continue to increase, we further recommend implementing an evaluation of potential impacts of walleye on existing LPO fisheries, implementing a radio-telemetry study to identify spawning areas and timing, and assessing mechanisms to minimize potential adverse impacts on existing LPO fisheries.

Comparison with 1994-1995 Avista Fishery Assessment

Avista (WWP) conducted fish sampling in the Clark Fork River, Idaho, from June 1994 through June 1995 using electrofishing, gillnetting, beach seining, trap netting, hoop netting, and hook-and-line methods. We compared our data with the earlier Avista raw data using their electrofishing information only, collected in fall (October 5 through November 10, 1994) from the river section (delta data excluded), to make comparisons of CPUE and species composition for all fish species captured. Across all seasons, gear types, and locations, WWP (1996) reported the total catch was dominated by native species, but primarily non-salmonids. Based on sampling in the fall with electrofishing only, our data shows similar trends (Figure 12). We did see an increase in the proportion of salmonids in the total catch in 2003. A large proportion of this increase was in the form of brown trout and lake whitefish.

CPUE for native non-salmonid species from 1994 appeared to be within the range observed in 1999-2003 (Table 11), suggesting we have not seen dramatic changes in the native non-salmonid fish community from 1994 to present. A key assumption in the comparisons is that the previously collected Avista data is representative of the entire study reach and comparable to our work. The 1994 data used in the re-analysis and comparison was collected from 10 different sites in the Clark Fork River on five separate sampling events. These 10 sites were within, or near our current 6.6 km long electrofishing transect (Avista, unpublished data). Typical electrofishing times for each site sampled by Avista were less than 600 seconds. Based on our own sampling experience, fish species have a somewhat patchy distribution in the Clark Fork River. For example, densities of mountain whitefish are high in the vicinity of Whitehorse

Rapids and the inlet to Foster Side-channel, but relatively low along the river margins in other locations. This is likely the reason why our 2001 CPUE for mountain whitefish was so much greater than 1999. Because of this patchy fish distribution, subsequent comparisons should be viewed with caution.

Standardization of sampling locations and methods is key to ensuring meaningful data comparisons in the future. In addition to continued mark-recapture estimates, we will continue collecting CPUE data for all fish species captured in the Clark Fork River in the fall, coincident to fall population estimates. Catches from future electrofishing work on the Clark Fork River should be stratified into six zones within the study reach to ensure consistency (Table 12).

Age, Growth, and Condition

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 less than 100, problems may exist in food or feeding. Our observed values are consistently lower than 100 for most salmonids, suggesting less than optimum foraging conditions may exist in the Clark Fork River (Anderson and Neumann 1996).

Mean *Wr* values for rainbow trout appear to have increased since 1999, but overlapping 95% confidence intervals suggest the difference is not statistically significant (Figure 13). Mean *Wr* values for westslope cutthroat trout are variable, but don't suggest an obvious trend (Figure 14). Mean length of rainbow trout suggests an increasing trend, but overlapping 95% confidence intervals indicate the difference may not be statistically significant (Figure 15). Comparison of mean length of westslope cutthroat trout over time does not reveal any obvious trends (Figure 16).

Our level of confidence was not high in determining ages accurately from scales. Annuli were difficult to distinguish in many cases, particularly for mountain whitefish. However, by using the same scale reader to age the samples from both years consecutively, we minimized the error associated with reader variability. Any ageing error should have been consistent across sample years. There does appear to be some differences in growth rates between years for some of the trout species. However, the differences appear to occur largely during the younger ages, when these fish may be rearing in various tributary streams both in Idaho and Montana. By the time the individuals reach age four or five, when they all would likely be residing (and growing) in the Clark Fork River, differences in annual growth increments between years are not as pronounced. Probably the best species to compare growth rates for in the Clark Fork River is mountain whitefish. Due to their relatively high abundance, we assume they are spawning and rearing either in the mainstem Clark Fork River or its tributaries in Idaho, and would therefore be subject to local growing conditions at younger ages. Growth rates for mountain whitefish are similar between the years 2000 and 2003.

Data collected to date suggests the possibility of an increasing trend in rainbow and westslope cutthroat trout condition since the minimum flow was increased in 1999. Data collected on rainbow trout also suggests the possibility of an increasing trend in length at capture. However, westslope cutthroat trout have not revealed a consistent increasing trend in increasing length at capture. This is not surprising as *Wr* indices are consistently below 100 for both

Table 10. Catch-per-unit-effort for species captured in the Clark Fork River, Idaho, during October and early November of 1994, 1999, and 2001. Data from 1999-2003 was collected on the last night of electrofishing.

Species	Sample year	Number captured	Time electrofished (seconds)	CPUE (fish/minute)	Sample section
Bull trout	1994	1	6,072	0.01	1[a]
	1999	0	3,929	0.0	2[b]
	2001	1	14,724	<0.01	3[c]
	2003	0	18,199	0.00	4[d]
Brown trout	1994	5	6,072	0.05	1[a]
	1999	2	3,929	0.03	2[b]
	2001	16	14,724	0.07	3[c]
	2003	33	18,199	0.11	4[d]
Mountain whitefish	1994	6	6,072	0.06	1[a]
	1999	3	3,929	0.05	2[b]
	2001	113	14,724	0.46	3[c]
	2003	98	18,199	0.32	4[d]
Rainbow trout	1994	4	6,072	0.04	1[a]
	1999	9	3,929	0.14	2[b]
	2001	11	14,724	0.05	3[c]
	2003	4	18,199	0.01	4[d]
Westslope cutthroat trout	1994	0	6,072	0.0	1[a]
	1999	4	3,929	0.06	2[b]
	2001	10	14,724	0.04	3[c]
	2002	7	18,199	0.02	4[d]
Largescale sucker *Catostomus macrocheilus*	1994	55	6,072	0.55	1[a]
	1999	8	3,929	0.12	2[b]
	2001	217	14,724	0.88	3[c]
	2002	167	18,199	0.55	4[d]
Lake whitefish *Coregonus clupeaformis*	1994	0	6,072	0.0	1[a]
	1999	0	3,929	0.0	2[b]
	2001	8	14,724	0.03	3[c]
	2002	37	18,199	0.12	4[d]
Largemouth bass *Micropterus salmoides*	1994	0	6,072	0.0	1[a]
	1999	0	3,929	0.0	2[b]
	2001	3	14,724	0.01	3[c]
	2002	8	18,199	0.03	4[d]
Longnose sucker *Catostomus catostomus*	1994	0	6,072	0.0	1[a]
	1999	0	3,929	0.0	2[b]
	2001	0	14,724	0.0	3[c]
	2002	1	18,199	<0.01	4[d]

Table 10. Continued.

Species	Sample year	Number captured	Time electrofished (seconds)	CPUE (fish/minute)	Sample section
Northern pikeminnow *Ptychocheilus oregonensis*	1994	124	6,072	1.23	1[a]
	1999	88	3,929	1.34	2[b]
	2001	177	14,724	0.72	3[c]
	2002	225	18,199	0.74	4[d]
Peamouth *Mylocheilus caurinus*	1994	16	6,072	0.16	1[a]
	1999	16	3,929	0.24	2[b]
	2001	363	14,724	1.48	3[c]
	2002	64	18,199	0.21	4[d]
Pumpkinseed *Lepomis gibbosus*	1994	2	6,072	0.02	1[a]
	1999	0	3,929	0.0	2[b]
	2001	0	14,724	0.0	3[c]
	2002	1	18,199	<0.01	4[d]
Redside shiner *Richardonius balteatus*	1994	137	6,072	1.35	1[a]
	1999	11	3,929	0.17	2[b]
	2001	393	14,724	1.60	3[c]
	2003	45	18,199	0.15	4[d]
Smallmouth bass *Micropterus dolomieui*	1994	0	6,072	0.0	1[a]
	1999	0	3,929	0.0	2[b]
	2001	2	14,724	0.01	3[c]
	2003	2	18,199	0.01	4[d]
Tench *Tinca tinca*	1994	0	6,072	0.0	1[a]
	1999	0	3,929	0.0	2[b]
	2001	0	14,724	0.0	3[c]
	2003	2	18,199	0.01	4[d]
Walleye *Stizostedion vitreum*	1994	0	6,072	0.0	1[a]
	1999	0	3,929	0.0	2[b]
	2001	0	14,724	0.0	3[c]
	2003	3	18,199	0.01	4[d]
Yellow Perch *Perca flavescens*	1994	0	6,072	0.0	1[a]
	1999	0	3,929	0.0	2[b]
	2001	3	14,724	0.01	3[c]
	2003	6	18,199	0.02	4[d]

[a] River – map of specific sample sites not currently available. Site names: CoBo 28, 35, and 40; Gravel 5, 14, and 15; Ledge 1 and 5; Fines 4 and 15.

[b] Both banks from bottom of Whitehorse Rapids downstream to Foster Bar side channel on the last night of recapture run.

[c] Both banks, entire reach, on last night of recapture run, except for river left from bottom of Whitehorse Rapids downstream to Foster Bar side channel because time was not recorded.

[d] Both banks, entire reach, on last night of recapture run.

Table 11. Ongoing electrofishing sampling sections within the 6.6 km long study reach on the Clark Fork River, Idaho.

Section name	Section description
RR – Dam to Whitehorse	River right looking downstream, starting at the USGS gauge station downstream to the upstream end of Whitehorse Rapids
RL – Dam to Whitehorse	River left - same as above
RR – Whitehorse Rapids	River right - upstream end of Whitehorse Rapids to the mouth of Twin Creek
RL – Whitehorse Rapids	River left - same as above
RR – Whitehorse to Foster	River right - Twin Creek mouth downstream to the inlet to Foster side-channel
RL – Whitehorse to Foster	River left – same as above

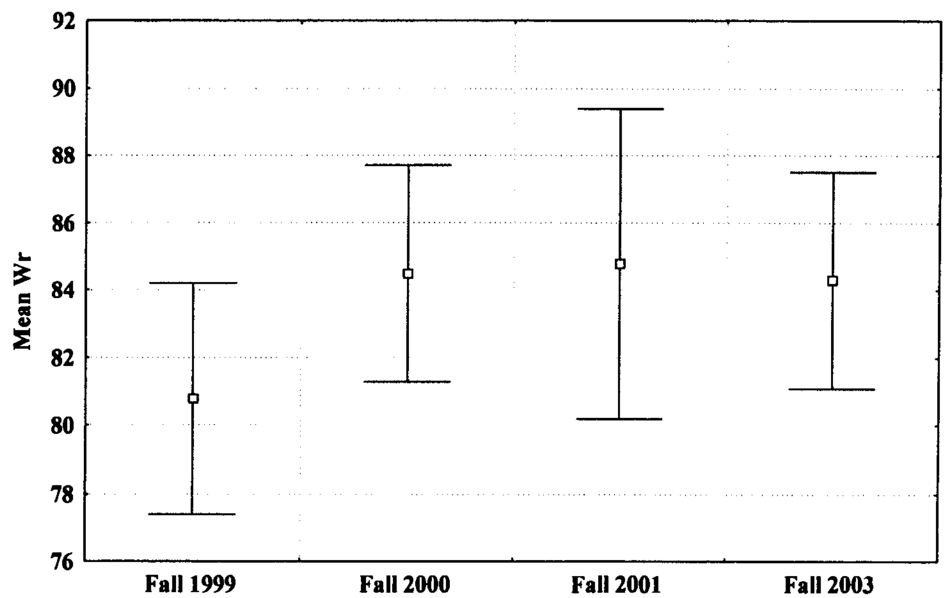

Figure 13. Mean *Wr* and associated 95% confidence intervals for rainbow trout captured in the 6.6 km long study reach of the Clark Fork River, Idaho, from 1999 through 2003.

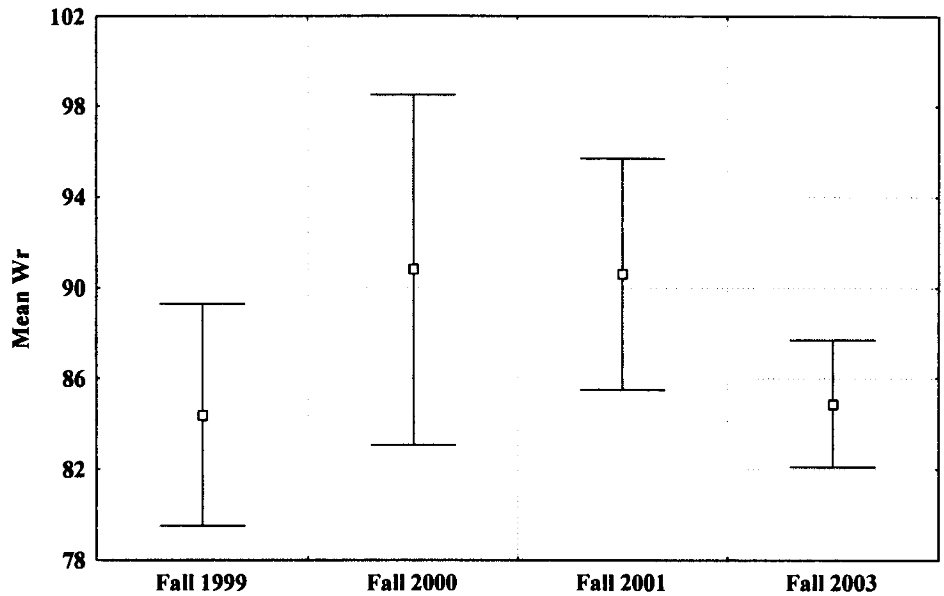

Figure 14. Mean *Wr* and associated 95% confidence intervals for westslope cutthroat trout captured in the 6.6 km long study reach of the Clark Fork River, Idaho, from 1999 through 2003.

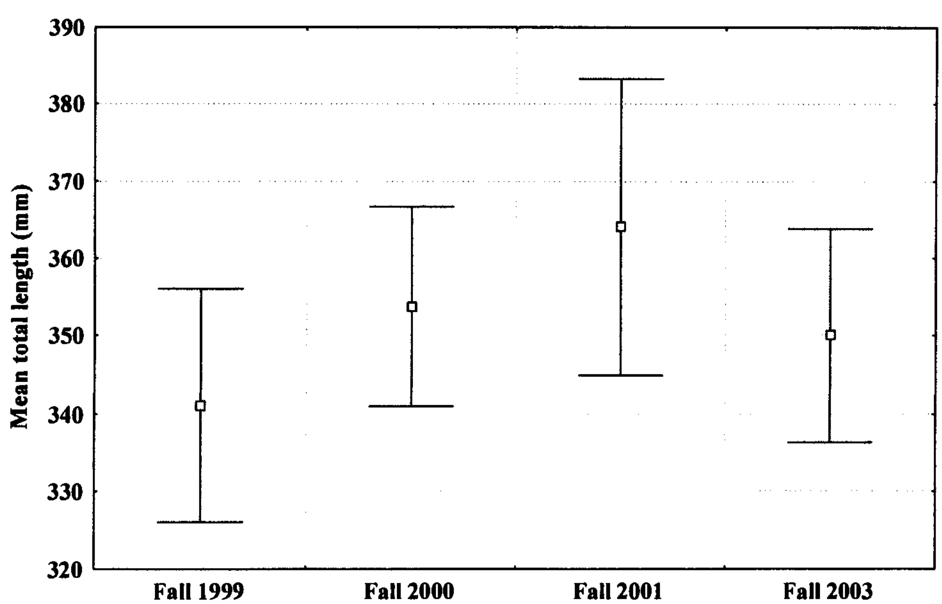

Figure 15. Mean total length (mm) and associated 95% confidence intervals for rainbow trout captured in the 6.6 km long study reach of the Clark Fork River, Idaho, from 1999 through 2003.

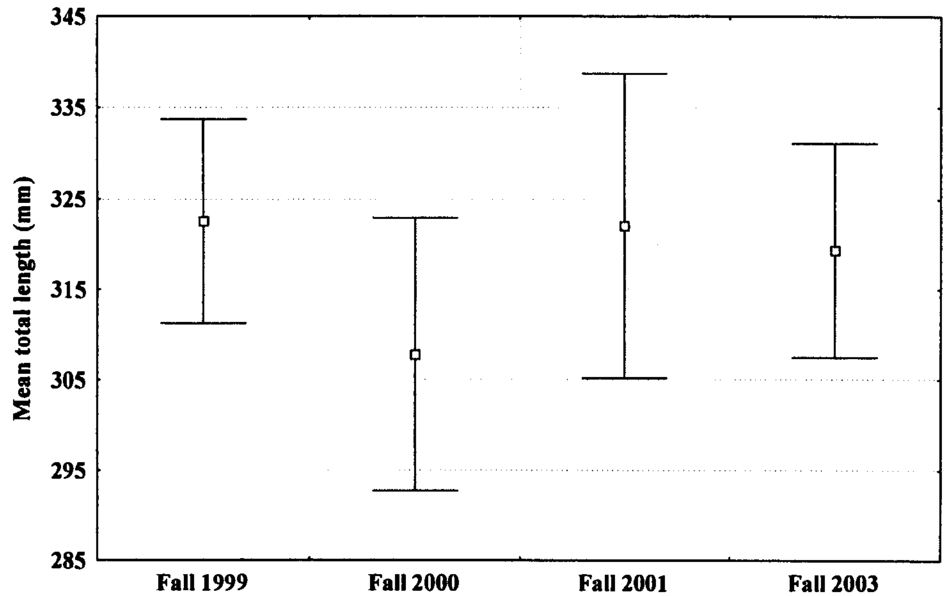

Figure 16. Mean total length (mm) and associated 95% confidence intervals for westslope cutthroat trout captured in the 6.6 km long study reach of the Clark Fork River, Idaho, from 1999 through 2003.

ACKNOWLEDGEMENTS

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Project 5: Trestle and Twin Creeks Bull Trout Outmigration and Lake Pend Oreille Survival Study Progress Report - 2003.

ABSTRACT

We utilized a rotary screw trap and weirs to capture juvenile bull trout *Salvelinus confluentus* from Trestle and Twin creeks, Idaho in 2000 through 2002 in order to estimate their abundance, and evaluate survival rates in the tributary and lake environment. We marked 922 age-1 and older outmigrating juvenile bull trout with Passive Integrated Transponder (PIT) tags from 2000 through 2002 to directly estimate survival from juvenile to mature adults in Lake Pend Oreille (LPO). We developed and operated a remote PIT tag detection weir on Trestle Creek seasonally from 2001 through 2003 to identify bull trout upon their return as adults. We also captured and marked 245 adults in 2002 with PIT tags to estimate the frequency of repeat spawning and annual survival of adult bull trout in the Lake Pend Oreille system. We detected the first returning adults in 2003, originally marked as juveniles in Trestle Creek in previous years. Four of the 270 juveniles originally marked outmigrating from Trestle Creek in 2000, were detected again in Trestle Creek in 2003. One of the 350 juveniles originally marked outmigrating from Trestle Creek in 2001, was detected in Trestle Creek in 2003. No returning adult bull trout have been detected from the 2002 juvenile marking group to date. We anticipate increasing numbers of adults from the 2000 and 2001 juvenile marking groups will be detected at the remote weir in 2004. Of the 245 adult bull trout marked with PIT tags in 2002, 76 were detected again in Trestle Creek in 2003. We marked 42 juvenile bull trout with PIT tags in Twin Creek for lake survival estimation from 2000 through 2002. We did not detect any returns from these marked juvenile bull trout to Twin Creek in 2003. We captured six individual adult bull trout in 2003 at the weir on Twin Creek. Of these, one had been captured and PIT tagged in Twin Creek in a previous year (2002).

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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 outmigrants and their survival back to adult escapement.

Development of juvenile bull trout outmigration 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 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 into the future.

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 most important producer of bull trout in the LPO system (Figure 1). Trestle Creek drains approximately 51 square-kilometers of the Cabinet Mountains and supports an annual run of 500 to over 1,000 fish, representing 30-50% of the bull trout spawning escapement from Lake Pend Oreille (Downs et al. 2003). We are unaware of any other individual stream in the U.S. that supports an annual run of bull trout spawners as large as Trestle Creek. The Lake Pend Oreille Key Watershed Bull Trout Problem Assessment (PBTAT 1998) recognized Trestle Creek as the highest priority tributary stream in the LPO watershed. While rating Trestle Creek's bull trout population 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 under the Idaho Forest Practices Act. In 1995, the Forest Service completed a comprehensive Trestle Creek watershed restoration project that was designed to mitigate the potential 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, has purchased four riparian properties on Trestle Creek totaling 114 acres, reducing 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 clarki 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 Lake Pend Oreille (Figure 1). Brook trout *Salvelinus fontinalus* are also present. Construction of Cabinet Gorge Dam in 1952, located several km's 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 2.9 bull trout spawn for every redd constructed (Downs and Jakubowski 2003), or that approximately 140 to 230 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 stream-side 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 was six. The low number of redds suggests this population is at risk of extinction.

A project was initiated in 1999 to move much of Twin Creek back into its original channel, restore the natural meander pattern, and reconstruct the habitat diversity. The primary goal of the restoration project was to restore numbers of spawning bull trout using Twin Creek to levels observed prior to channelization of the stream.

Our work on Trestle and Twin creeks in 2003 marks the fourth year of what is anticipated to be an eight-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 five years will involve recapture of marked individuals to estimate the desired survival rates and life-history parameters.

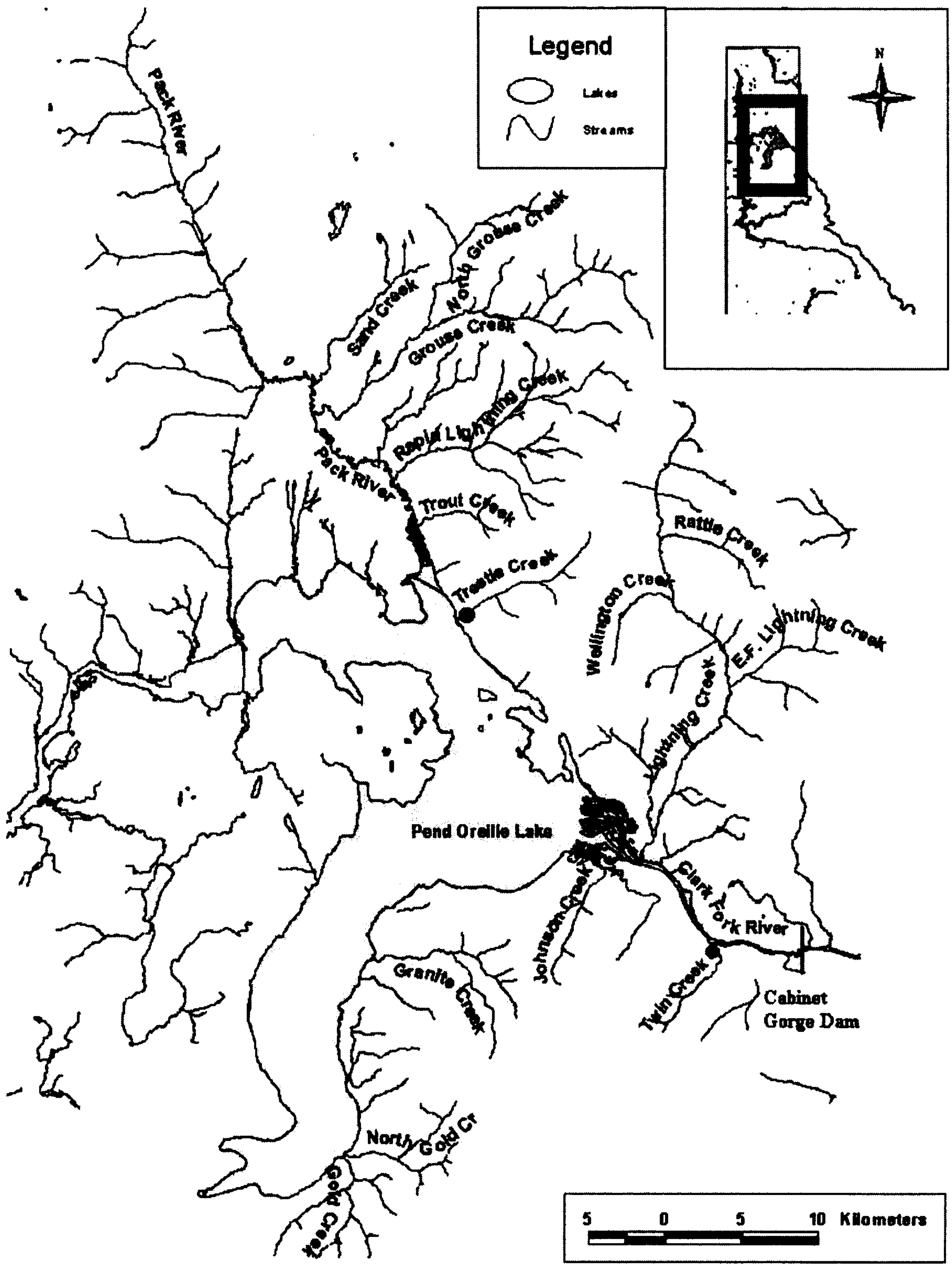

Figure 1. Trap locations on Trestle and Twin creeks, Idaho, tributaries to Lake Pend Oreille and the Clark Fork River, Idaho, below Cabinet Gorge Dam.

METHODS

Survival Estimation Trestle Creek

In 2001, we developed and installed a remote Passive Integrated Transponder (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 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 receiver to a laptop computer for storage and analysis. 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 moving downstream in the screw trap, with the number of these fish subsequently detected at the remote PIT tag receiving station (Downs and Jakubowski 2003).

From 2000 through 2002, 922 juvenile, and 674 adult bull trout were marked for survival estimation using PIT tags in Trestle Creek (Downs and Jakubowski 2003). Juvenile bull trout were tagged in each year, but adult bull trout were only PIT tagged in 2000 and 2002. In 2003, the remote PIT tag detection weir was installed in Trestle Creek on June 26 and operated through October 24. However, due to a problem with the AC power supply, the scanner was not functioning properly and did not detect any PIT tags from July 9 through July 16. Additionally, the night of September 8, the weir was vandalized and fish were able to pass by the weir without being detected. The weir was removed on October 24, 2003 because it sustained heavy damage due to high water and debris.

Survival Estimation Twin Creek

On July 29, 2003, 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 cm spacing in a metal frame, with 1.22m x 0.91m x 0.91m steel frame trap boxes wrapped in 6.35 mm black plastic mesh used to capture the fish (Downs and Jakubowski 2003). This configuration was used for the downstream trap box until it was removed on December 11. However, on October 24, the upstream trap box was removed, and a picket weir designed to catch upstream moving adult kokanee was installed by Idaho Fish and Game hatchery personnel.

Captured bull trout were anesthetized with tricane methanesulfonate (MS-222) at a concentration of 50 mg/L. Captured fish were subsequently 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 (< 275 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 with MS-222 at a concentration of 50 mg/L, identified to species, measured (TL;mm) and weighed (g). An electronic temperature recorder was installed in Twin Creek on May 28 and removed on November 5, 2003.

RESULTS and DISCUSSION

Trestle Creek

Four of the 270 juveniles originally marked outmigrating from Trestle Creek in 2000, were detected again in Trestle Creek in 2003 (1.5 %), (Table 1). One of the 350 juveniles originally marked outmigrating from Trestle Creek in 2001, was detected in Trestle Creek in 2003 (0.3%). This fish was originally tagged on May 11, 2001, at 205mm, and subsequently detected in Trestle Creek on July 8, and again on October 23, 2003. No returning adult bull trout have been detected from the 2002 juvenile marking group to date.

The four individual bull trout detected to date in Trestle Creek from the 2000 juvenile marking group would have spent three years in the lake, including the year in which they outmigrated, before returning to spawn in Trestle Creek. The average length of these individuals at tagging was 178.5 mm (range 163 to 191), which suggests these were two and three year old individuals when they outmigrated (Downs and Jakubowski 2003). The single bull trout that returned in 2003 from the 2001 marking group would have spent only two years in the lake. This individual was marked at 205 mm in length, and based on earlier age-growth analysis, was likely older at the time of marking than those fish that returned during the same year from the 2000 marking group (Downs and Jakubowski 2003). It is too early in the study, and sample sizes are too small, to draw conclusions regarding survival from the return data thus far. We anticipate increasing adults from the 2000 and 2001 juvenile marking groups will be detected at the remote weir in 2004.

Between June 7 and December 5, 2002, we captured 310 unmarked adult bull trout in the screw trap. We marked 245 of these adult bull trout with PIT tags (Downs and Jakubowski 2003). We subsequently detected 76 of those adult bull trout at the remote PIT tag station (31%) in 2003. This is a lower proportion than observed earlier in this study, when 429 individual adult bull trout were marked in 2000, and 237 (55.3%) returned to Trestle Creek in 2001 (Downs and Jakubowski 2003). This could be attributed to actual variability in annual mortality rates, tag loss, or variability in the frequency of repeat spawning. Additionally, some fish may have returned in 2003 but went undetected due to the short periods of time the weir wasn't operating, or the relatively early removal of the weir. Most (72.1%) of the detections of the returning adults occurred between August 28 and September 25 in 2003, suggesting many of these fish had entered Trestle Creek prior to the installation of the weir on June 26.

Twin Creek

We captured 14 species of juvenile fish in the weir moving upstream and/or downstream on Twin Creek from July 29 to December 11 in 2003 (Table 1). Black bullhead *Ictalurus melas*, brook trout *Salvelinus fontinalis*, pumpkinseed *lepomis gibbosus*, redside shiner *Richardsonius balteatus*, sculpin *Cottus sp.*, and tench *Tinca tinca* are included with the juvenile data due to uncertainty about their age and level of sexual maturity. Two juvenile bull X brook trout hybrids (122 and 130 mm) were also captured, but are not included in the species total (Tables 2 and 3). Juvenile brown trout *Salmo trutta* were most abundant in both the upstream and downstream trap box (Tables 2 and 3). A single adult westslope cutthroat trout (292 mm) was captured moving downstream. In the upstream weir, three kokanee *O. nerka* (64, 73, and 84 mm) were captured, as well as two brook trout (234 and 246 mm). A single westslope cutthroat trout (232 mm) was also captured. Average lengths of juvenile salmonids ranged from 74 mm for kokanee to 240 mm for brook trout. (Tables 2 and 3; Figures 2-12).

Table 1. Species captured in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

Species	Abbreviation
Black bullhead *Ictalurus melas*	BBH
Bull trout *Salvelinus confluentus*	BLT
Brook trout *Salvelinus fontinalis*	BRK
Brown trout *Salmo trutta*	BRN
Kokanee salmon *Oncorhynchus nerka*	KOK
Northern pikeminnow *Ptychocheilus oregonensis*	NPM
Oncorhynchus species (unidentified)	ONC
Peamouth *Mylocheilus caurinus*	PEA
Pumpkinseed *Lepomis gibbosus*	PUM
Rainbow trout *Oncorhynchus mykiss*	RBT
Redside shiner *Richardonius balteatus*	RSS
Sculpin *Cottus Spp.*	SCL
Sucker *Catostomus Spp.*	UNS
Tench *Tinca tinca*	TEN
Westslope cutthroat trout *Oncorhynchus clarki lewisi*	WCT

We captured two species of adult fish moving upstream and/or downstream in Twin Creek during 2003 (Table 4; Figures 13-15). A total of five individual adult bull trout were captured moving upstream in Twin Creek between September 15 and September 20. Two were subsequently recaptured moving back downstream through the weir. In addition, a previously untagged adult, 410 mm total length, which had not been captured in the upstream trap, was captured moving downstream and tagged. Five of six adult bull trout had not been previously captured in Twin Creek. The one previously tagged adult captured, 568 mm total length, had been tagged in Twin Creek in 2002.

Table 2. Mean lengths (TL;mm) and mean weights (g) (sample size (n)) and length range for juvenile species captured in the upstream weir on Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

Species	Mean length (n)	Length range	Mean weight (n)
BLT	95.5 (11)	78-124	7.4 (11)
BRK	240.0 (2)	234-246	146.5 (2)
BRN	76.0 (24)	47-98	4.0 (24)
KOK	73.7 (3)	64-84	3.3 (3)
ONC	62 (9)	58-69	2.3 (9)
PEA	110.0 (2)	105-115	9.0 (2)
RBT	126.6 (5)	79-179	22.8 (5)
SCL	62.3 (3)	33-93	3.7 (3)
UNS	86.0 (1)	N/A	4.0 (1)
WCT	232.0 (1)	N/A	99.0 (1)

Table 3. Mean lengths (TL;mm) and mean weights (g) (sample size (n)), length range, 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 2003.

Species	Mean length (n)	Length range	Mean weight (n)	CPUE (fish/trap night)
BBH	122.1 (32)	112-145	23.3 (27)	0.24
BLT	113.7 (39)	43-200	13.5 (37)	0.29
BBHY	126.0 (2)	122-130	19.0 (2)	0.01
BRK	169.0 (6)	102-219	55.3 (6)	0.04
BRN	91.5 (219)	48-275	8.7 (210)	1.62
KOK	83.5 (13)	66-137	11.8 (13)	0.13
NPM	87.5 (28)	32-265	11.3 (28)	0.21
ONC	60.5 (43)	46-69	2.1 (42)	0.32
PEA	96.1 (9)	61-135	7.9 (9)	0.07
PUM	121.0 (1)	N/A	35.0 (1)	<0.01
RBT	89.3 (51)	70-190	9.7 (49)	0.38
RSS	41.0 (2)	40-42	1.0 (2)	0.01
SCL	56.9 (7)	40-87	2.4 (7)	0.05
TEN	187.0 (1)	N/A	90.0 (1)	<0.01
UNS	79.0 (1)	N/A	4.0 (1)	<0.01
WCT	95 (3)	71-123	8.7 (3)	0.02

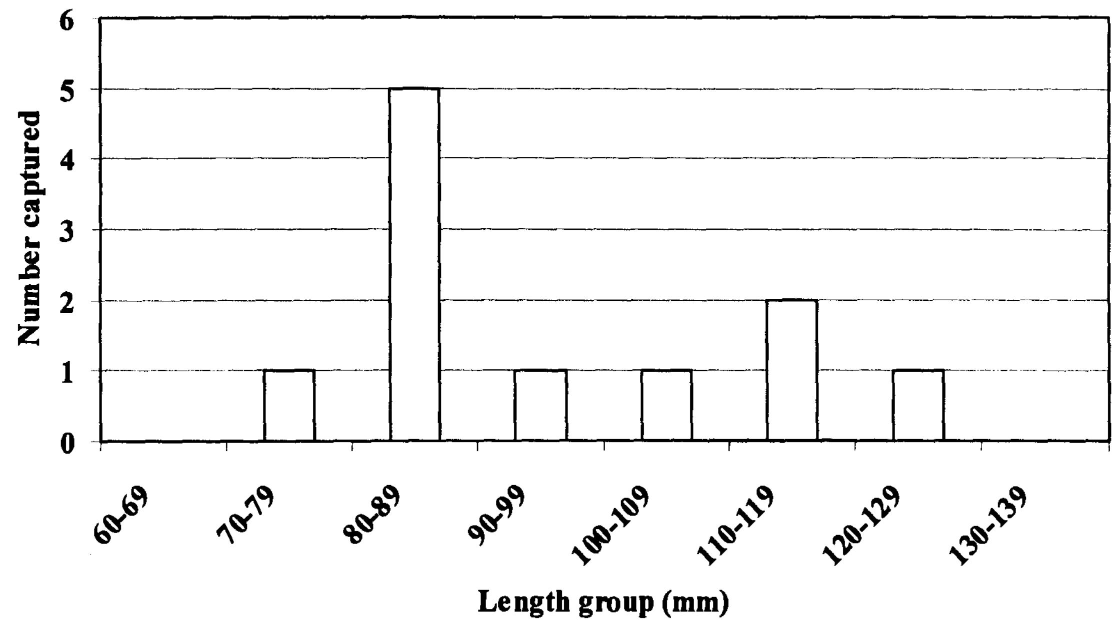

Figure 2. Length frequency histogram for juvenile bull trout captured in the upstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

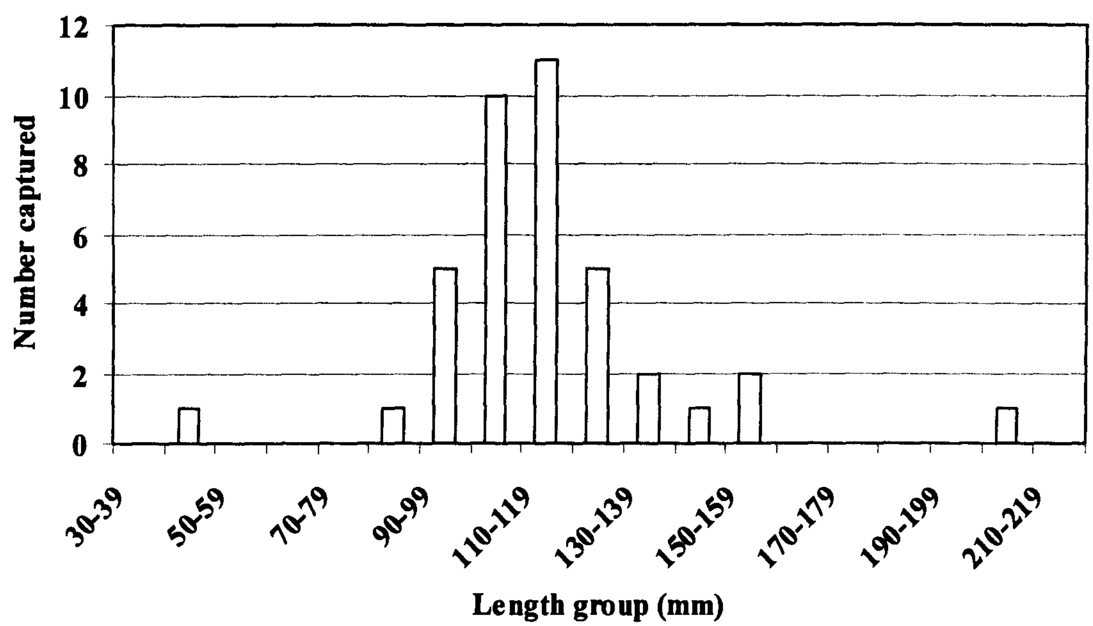

Figure 3. Length frequency histogram for juvenile bull trout captured in the downstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

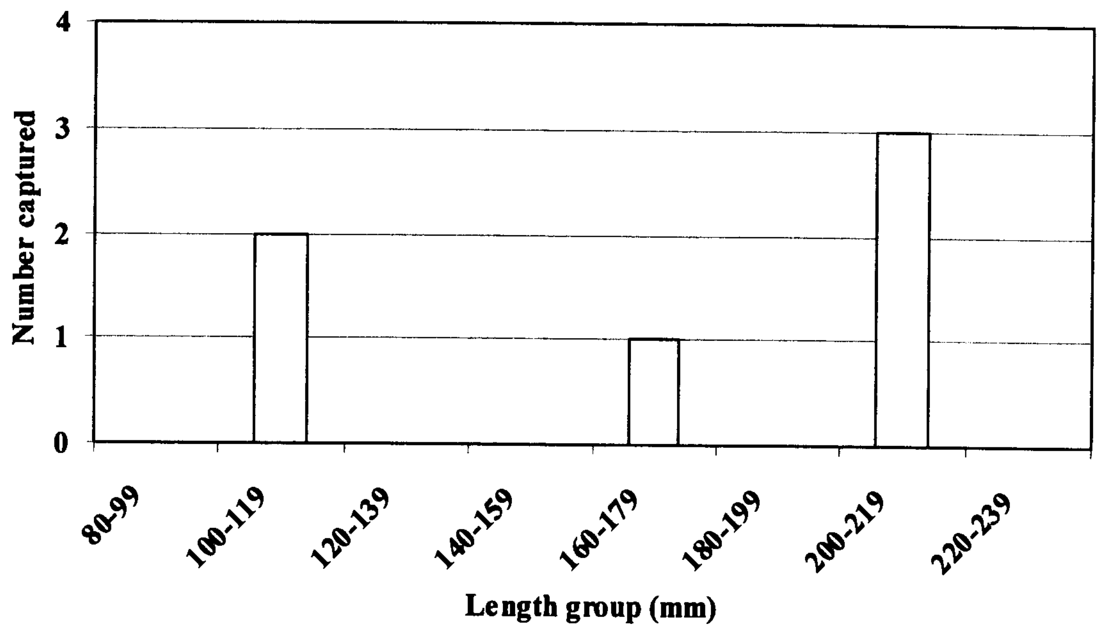

Figure 4. Length frequency histogram for brook trout captured in the downstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

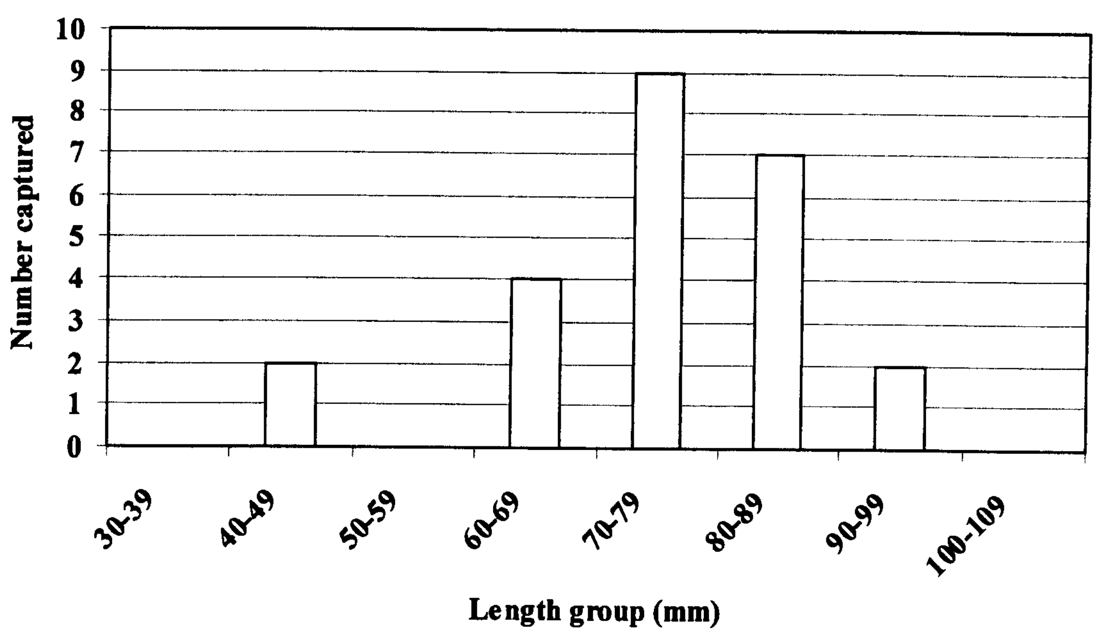

Figure 5. Length frequency histogram for juvenile brown trout captured in the upstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

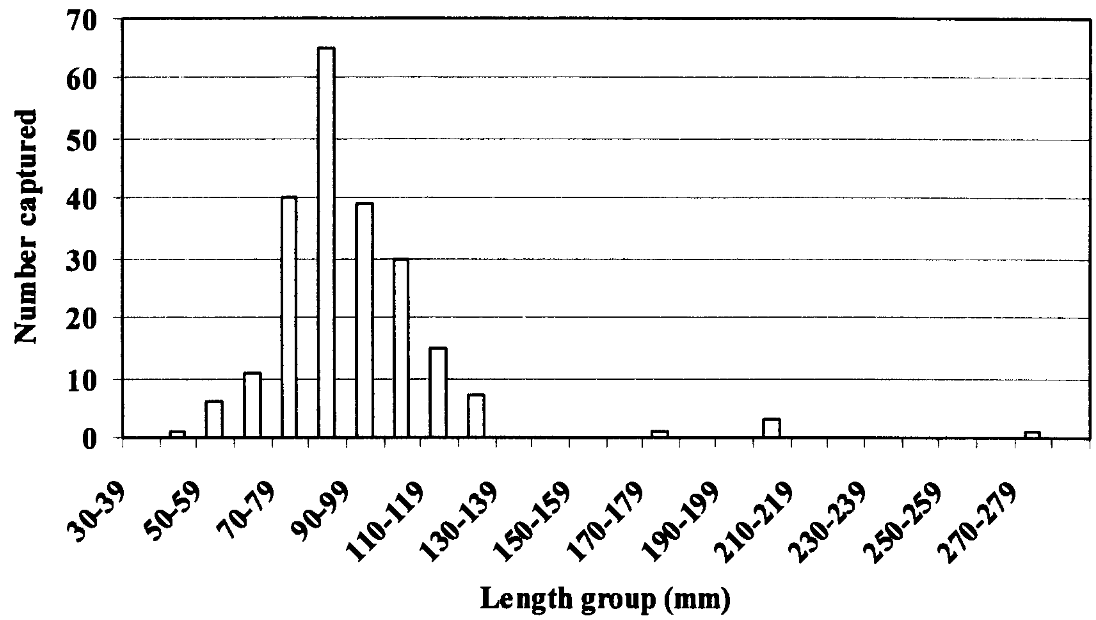

Figure 6. Length frequency histogram for juvenile brown trout captured in the downstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

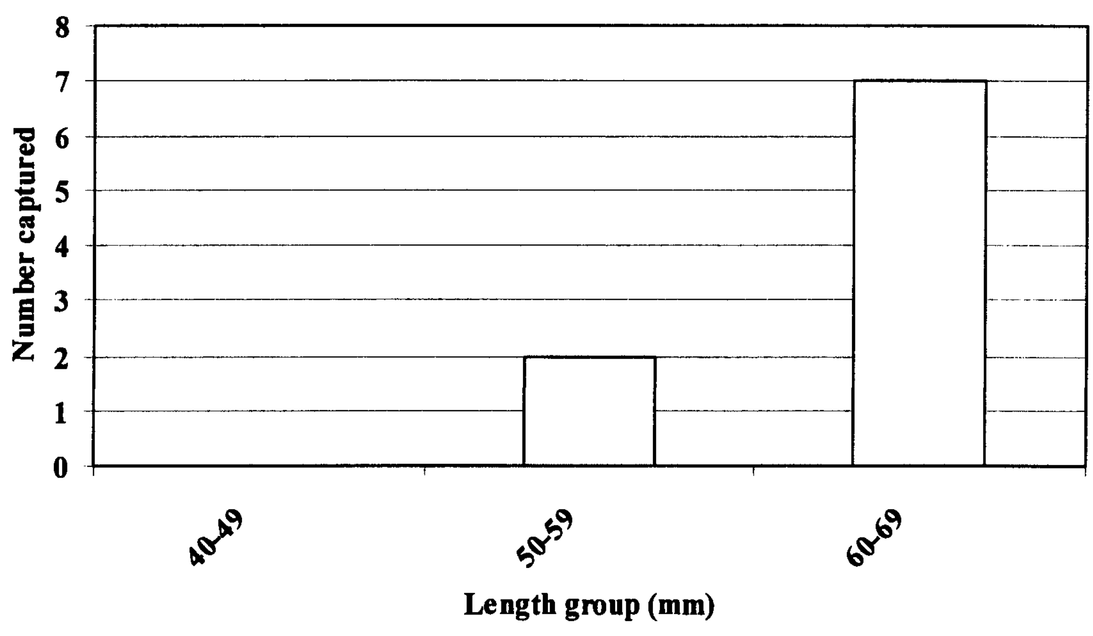

Figure 7. Length frequency histogram for unidentified *Oncorhynchus* species captured in the upstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

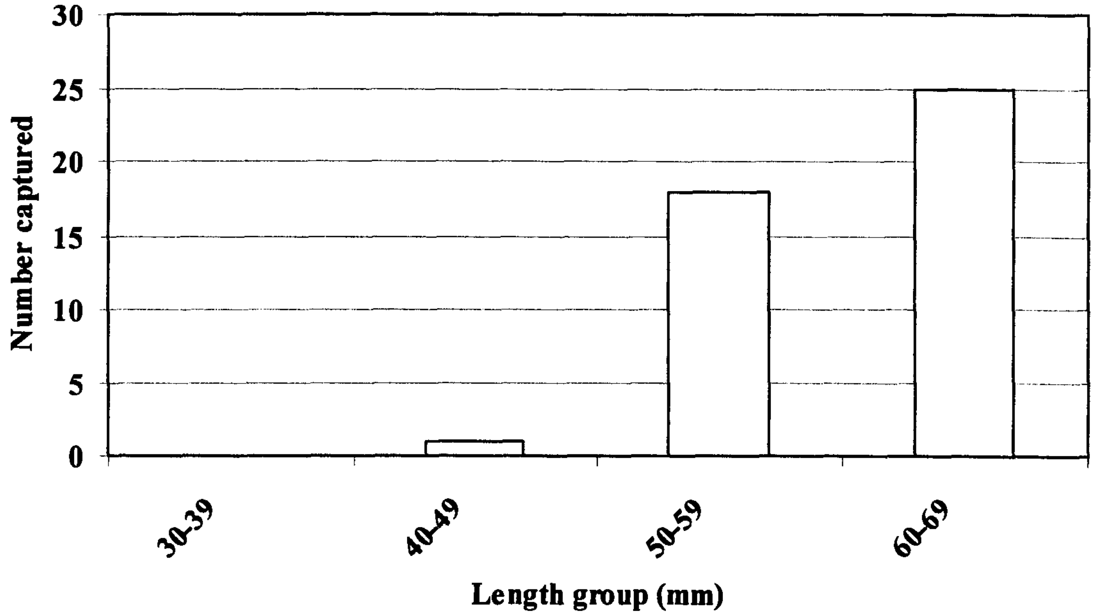

Figure 8. Length frequency histogram for unidentified *Oncorhynchus* species captured in the downstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

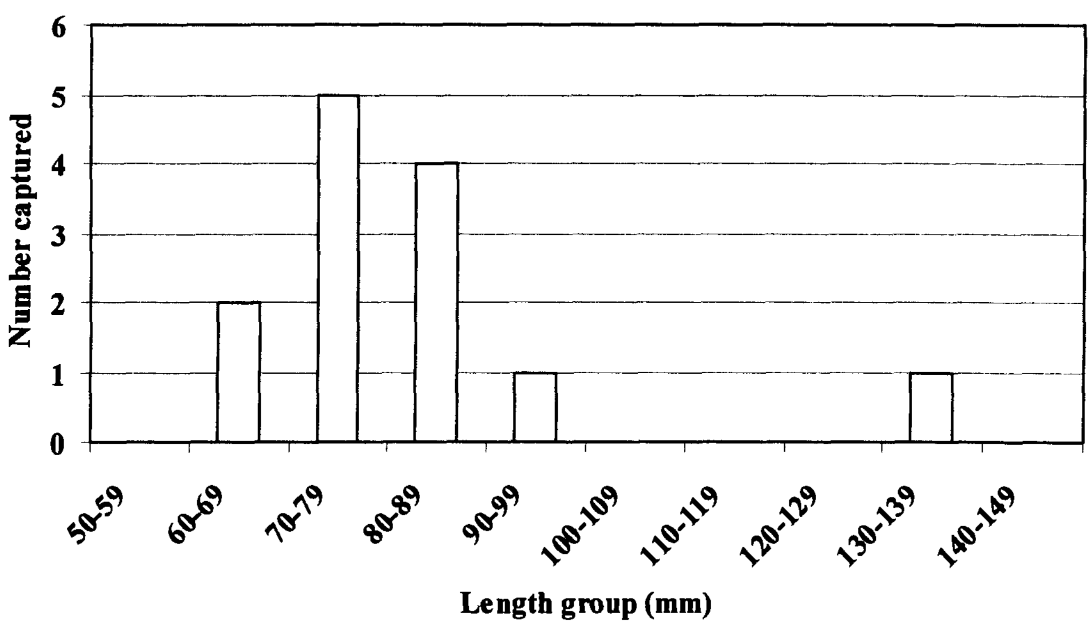

Figure 9. Length frequency histogram for juvenile kokanee captured in the downstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

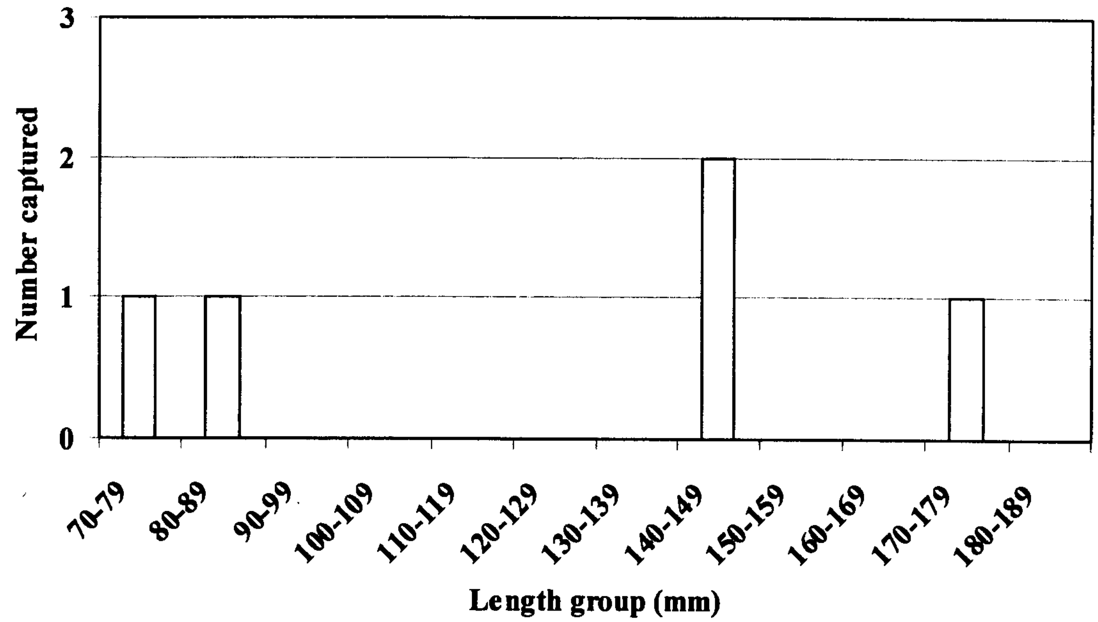

Figure 10. Length frequency histogram for juvenile rainbow trout captured in the upstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

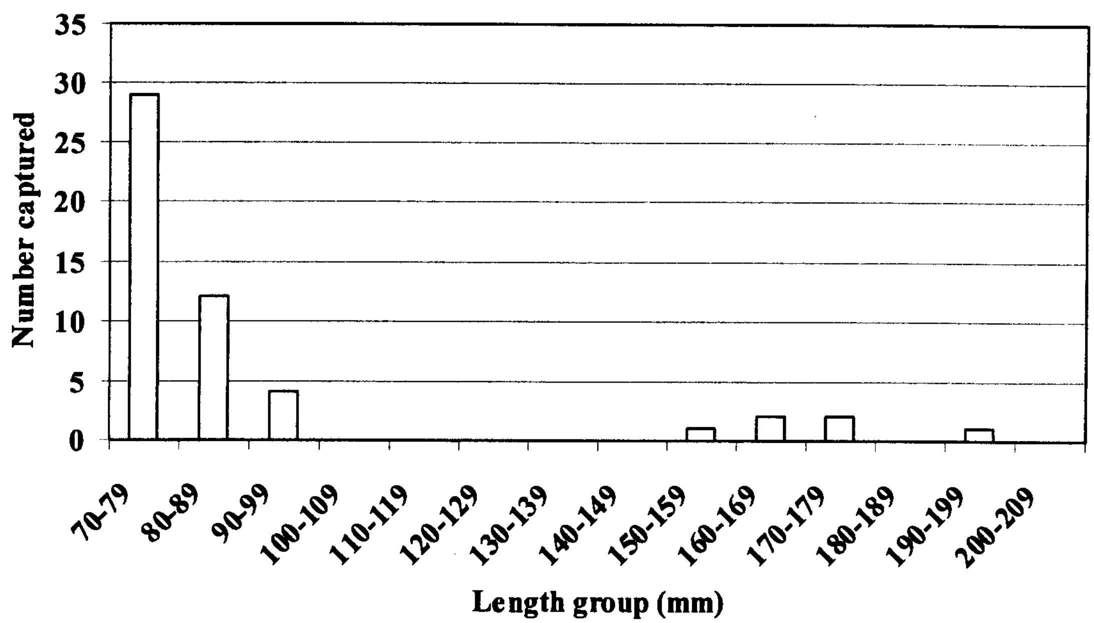

Figure 11. Length frequency histogram for juvenile rainbow trout captured in the downstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

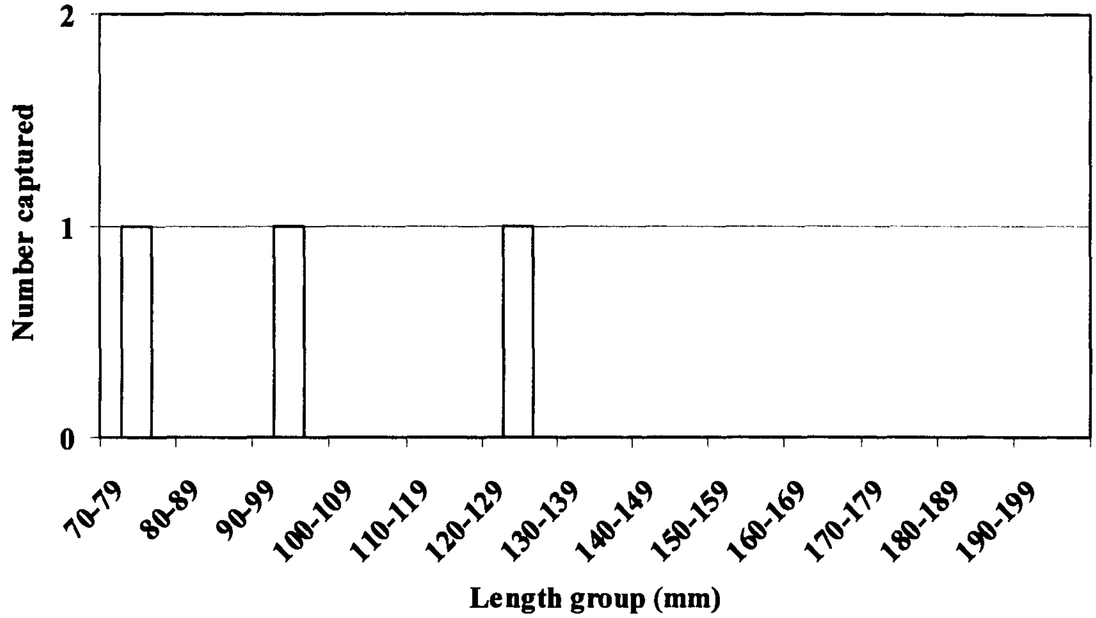

Figure 12. Length frequency histogram for juvenile westslope cutthroat trout captured in the downstream weir in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

Table 4. Mean lengths (TL;mm) and mean weights (g) (sample size (n)) and length range for adult bull trout and kokanee salmon captured in the upstream and downstream weir combined, on Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

Species	Mean length (n)	Length range	Mean weight (n)
BLT	480.7 (6)	410-568	1043.8 (4)
KOK	249.0 (321)	200-346	119.5 (306)

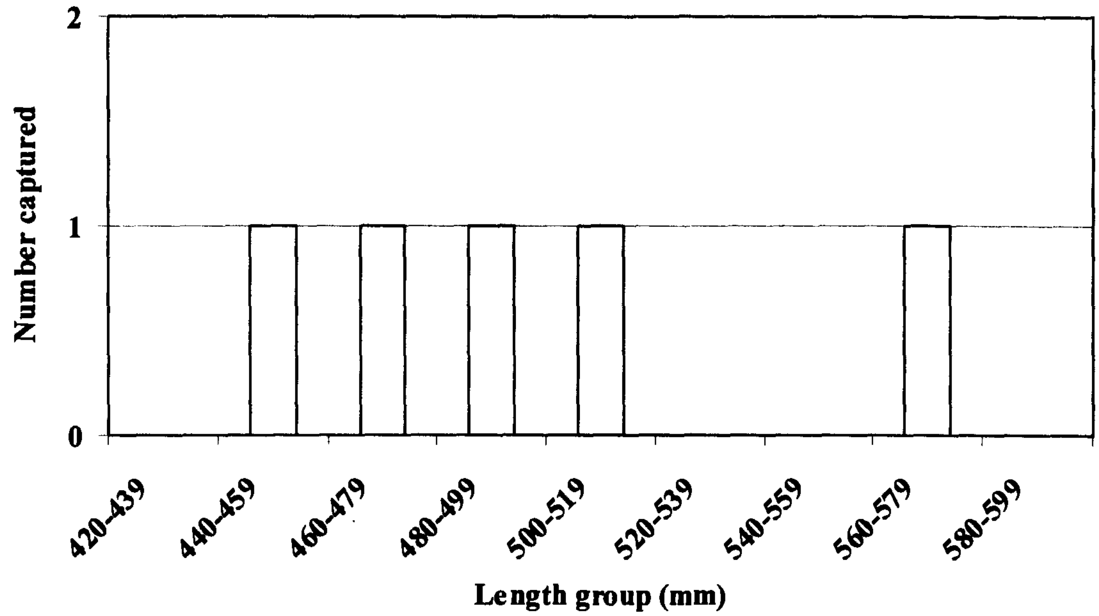

Figure 13. Length frequency histogram for adult bull trout captured in the upstream weir on Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

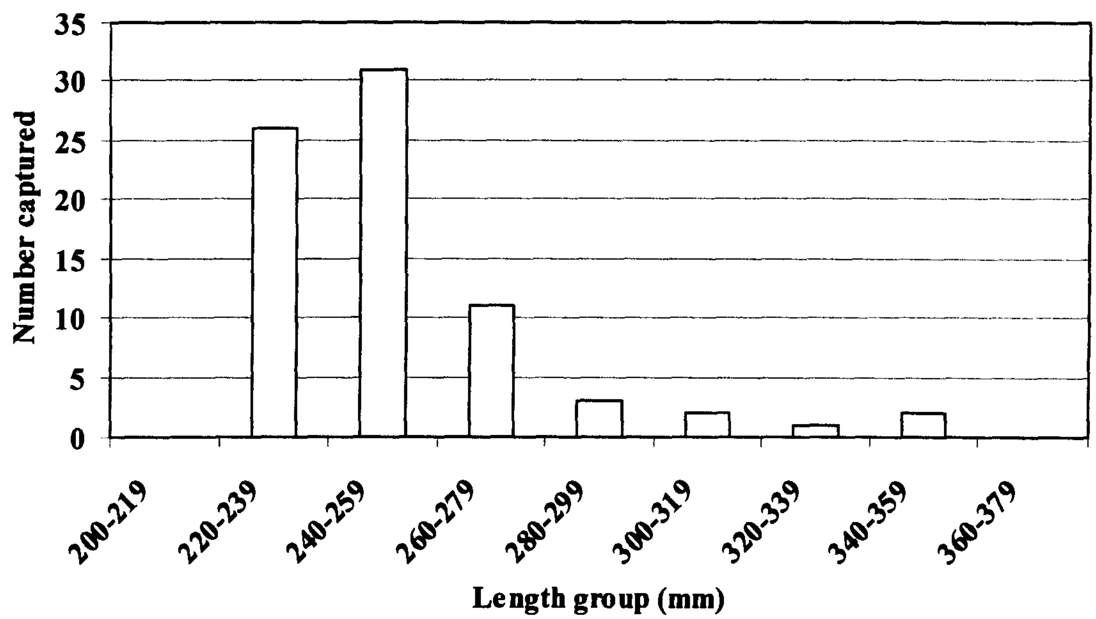

Figure 14. Length frequency histogram for adult kokanee salmon captured in the upstream weir on Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

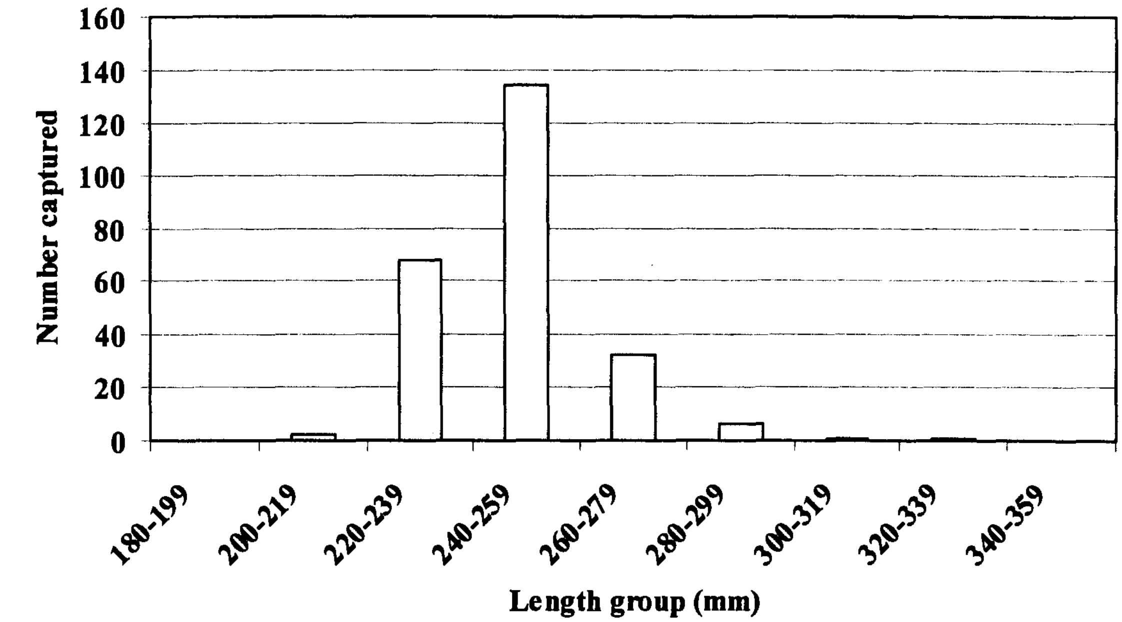

Figure 15. Length frequency histogram for adult kokanee salmon captured in the downstream weir on Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

Timing of upstream migration of bull trout in Twin Creek is later than that of other tributaries, with most upstream movement occurring from late September and early October (Downs et. al. 2003, Downs and Jakubowski 2003). In 2003, we observed a continuation of this trend (Figure 16). However, one individual did appear to migrate upstream prior to the installation of our trap on July 29, which would be consistent with our observations on other LPO tributaries (Downs and Jakubowski 2003). In general, this upstream movement pattern is considerably later than upstream spawning movements observed in other LPO tributaries (Downs and Jakubowski 2003), lending support to the idea that some of the spawners in Twin Creek are individuals who are unable to return to their natal streams due to Cabinet Gorge Dam. Additionally, previous years trapping and PIT tagging work in Twin Creek and the Clark Fork River (Downs and Jakubowski 2003) suggests that some adult bull trout entering Twin Creek are individuals trying unsuccessfully to pass Cabinet Gorge Dam to reach natal streams in Montana. An additional explanation for late entry into Twin Creek could be water temperature, which may be warmer than that desired by bull trout, until early September. Genetic evidence does support Twin Creek as a unique population of bull trout, as genetic assignment rates back to the tributary of origin were higher for Twin Creek than for 39% of the other 17 tributaries to LPO and the lower Clark Fork River studied (Neraas and Spruell 2001). 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 small populations downstream of Cabinet Gorge Dam. Redd counts in recent years have been low in Twin Creek (averaging four annually from 2001-2003) despite relatively strong catches of adult bull trout using electrofishing in the Clark Fork River, and trapping in Cabinet Gorge Hatchery ladder (118 unique adults captured in 2003) (Gillen and Haddix 2003). Recent advances in genetic information currently allow the discrimination of individual stocks of bull trout in the Clark Fork River system using rapid response DNA procedures (L. Lockard, USFWS, personal communication). Use of this technique will facilitate the selective passage of upstream bull trout stocks until appropriate trapping facilities are developed at Cabinet Gorge Dam.

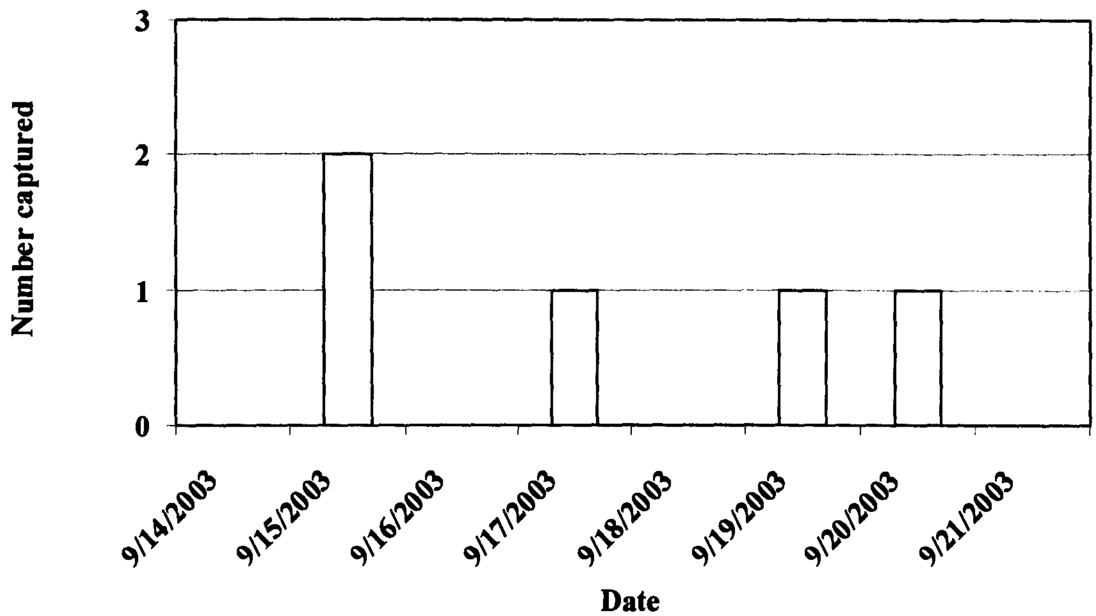

Figure 16. Timing of upstream migration of adult bull trout in Twin Creek, a tributary to the Clark Fork River, Idaho, in 2003.

In 2000, upstream migration of adult kokanee began as early as September 8, and continued through November 1 (n=117). Despite trapping during the same time period in 2001, we only captured 13 adult kokanee. In 2002, upstream migration of adult kokanee began on August 20 and ended on October 20 (n=108). The peak of the run occurred in early to mid-September in all previous years (Downs and Jakubowski 2003). In contrast, in 2003, upstream migration of adult kokanee began on September 10, but peaked more than a month later in the season (Figure 17). These fish would have been progeny from Sullivan Springs, which typically spawn later in the year. The kokanee captured in 2000 through 2001 may have come from releases of early spawning kokanee into Spring Creek, a tributary to Lightning Creek, in 1998 or 1999.

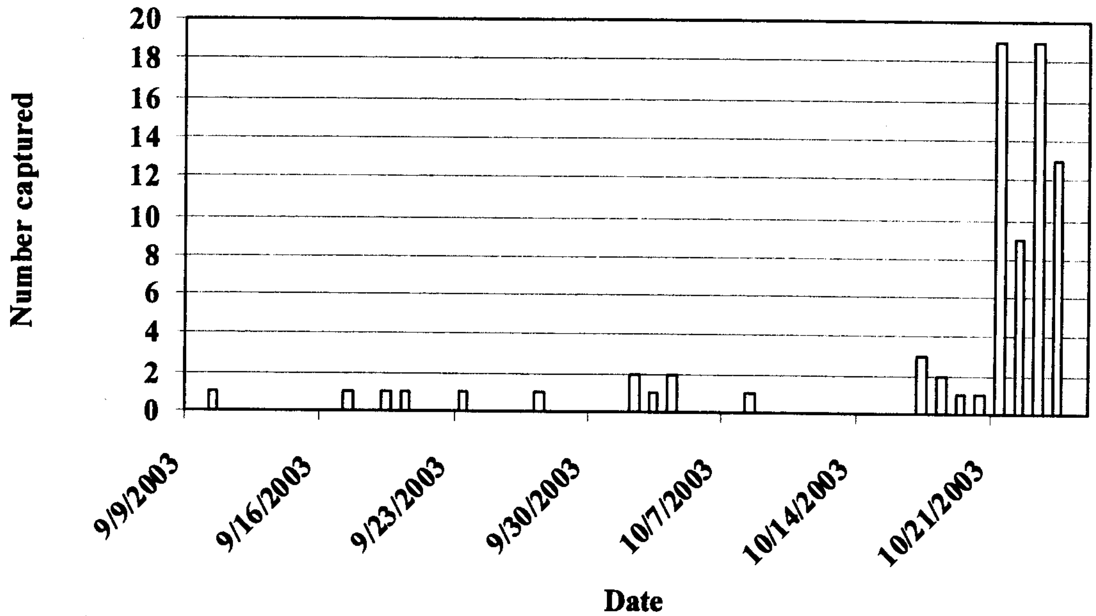

Figure 17. Timing of upstream migration of adult kokanee (n=79) in Twin Creek, a tributary to the Clark Fork River, Idaho in 2003.

Twin Creek Water Temperature

We recorded water temperatures using an electronic temperature logger over the course of the trapping season in 2003 and calculated mean daily water temperatures (Figure 18). The maximum daily water temperature observed in 2003 was 18.8^{0}C measured on July 22. In comparison, the maximum daily water temperature recorded in 2000 was 17.3^{0}C on August 1. In 2001, the Twin Creek stream restoration project was complete and the old stream channel containing the thermograph was dewatered. As a result, the continuous recording data ended in early July in 2001. We did continue to take point measurements of water temperature during trap checks at various times of the day through November and we recorded water temperatures as high as 20^{0}C on August 3, 2001. The maximum daily water temperature recorded in 2002 was 16.8^{0}C on July 10. We would anticipate maximum temperatures to decline over time as vegetation continues to grow and shade the restored channel of Twin Creek, but the two in-channel ponds located on private property on a primary spring tributary to Twin Creek may mute the benefits of the increased shade, by increasing water temperature as water passes through the ponds.

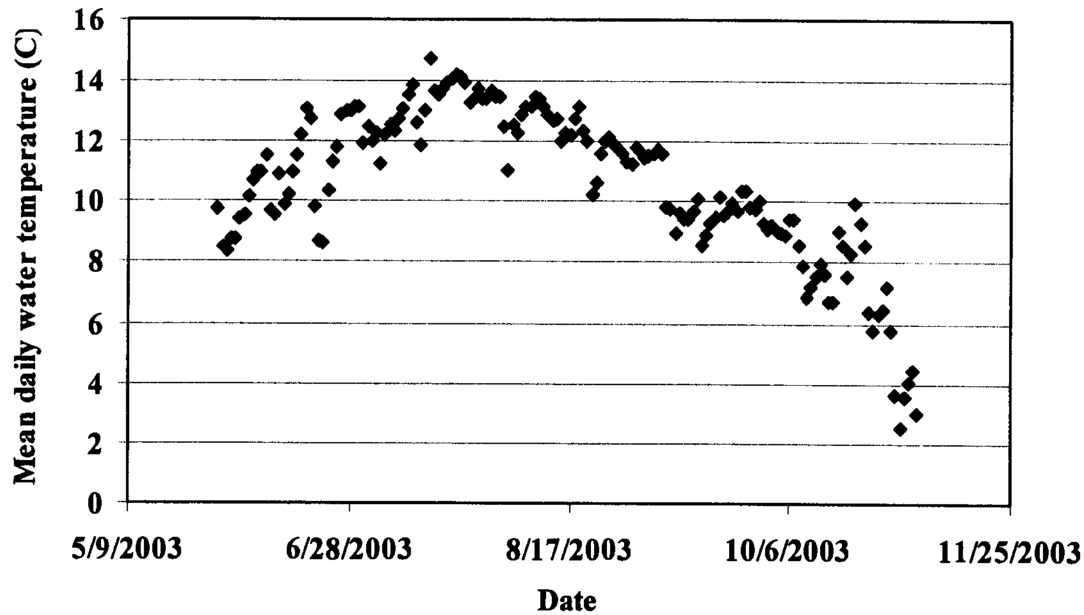

Figure 18. Mean daily water temperatures recorded by thermograph for Twin Creek, a tributary to the Clark Fork River, Idaho, in 2003.

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The authors wish to thank John Suhfras and Steve Lowe of Avista Corporation for their contributions to field data collection. We would also like to thank Mark Gamblin and Ned Horner of the Idaho Department of Fish and Game, Joe DosSantos of Avista Corp., Laura Katzman of Montana Fish, Wildlife, and Parks, and Larry Lockard of the U.S. Fish and Wildlife Service for their reviews of this report.

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Project 6: 2003 Johnson and Granite creeks bull trout trapping

ABSTRACT

In 2000, the Idaho Department of Fish and Game and Avista Corporation identified a headcut in the Johnson Creek channel that was blocking the upstream spawning migration of adult adfluvial bull trout *Salvelinus confluentus* from Lake Pend Oreille. We installed a trap box to capture the spawners and transport them over the headcut to provide access to the known spawning area in 2001, 2002, and 2003. A total of three adult bull trout were captured and transported above the barrier in 2003. One additional adult bull trout was rescued from a drying pool upstream of the trap and released below the trap in 2003. Of the four adult bull trout captured in Johnson Creek in 2003, one was a recapture from Johnson Creek, originally tagged in 2002. The number of adult bull trout captured in Johnson Creek in 2003 is far fewer than returned and were trapped in 2001 and 2002. No redds were counted in Johnson Creek during the October 9, 2003 redd survey, but two were observed in September in a reach of lower Johnson Creek below the headcut. The redds were dry by the October survey date and therefore not included in the survey total. The average length of adult bull trout captured in Johnson Creek in 2003 was 569 mm (range = 510-630 mm).

During flood events in the winter of 1995-96, the reach of Granite Creek between Kilroy Bay Bridge and the mouth of Sullivan Springs underwent significant changes, and now has a diffuse and largely sub-surface flow pattern during low flow conditions. Fish passage is impaired during summer/fall months, or in low flow years in this location on Granite Creek, reducing the numbers of bull trout that can successfully reach their spawning areas. During 2001, we counted only seven bull trout redds in Granite Creek, all of which were located downstream of the intermittent reach and associated channel headcut. We deployed an upstream and downstream trap system to capture adult bull trout and transport them around the intermittent reach in 2002 and 2003. A total of 264 adult bull trout were captured in 2003, and transported above the barrier. Mean length of adult bull trout was 510 mm (range = 351-757 mm). We subsequently recaptured and transported downstream 117 adult bull trout after spawning, 105 of which we had earlier marked and moved upstream. We derived a mark-recapture population estimate of 294 adults (95% CI = 244-314). We subsequently counted 101 redds in Granite Creek in 2003, the highest count on record. A stream restoration design has been completed on Granite Creek and we plan to implement a stream restoration project in 2005. The project should restore natural fish passage to the lower reaches of Granite Creek.

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INTRODUCTION

Johnson Creek

Johnson Creek is an important adfluvial bull trout *Salvelinus confluentus* spawning tributary within the Lake Pend Oreille (LPO) system located in northern Idaho (Figure 1). Bull trout spawning has been documented with annual redd counts from 1983 through 2003 (Figure 2). In 2000, a headcut was observed in the lower reaches of Johnson Creek, approximately 50 meters (m) upstream of its mouth. The barrier was approximately 1 m high and consisted of a dense mat of tree roots (Figure 3). A jump pool was absent below the headcut, and the combination of shallow water depth and the dense root mass likely prevented upstream access during lower flow periods (July – August). In 2000, four bull trout redds were observed below this head-cut in the channel, but none were observed above it, suggesting it was an impassable barrier to migrating bull trout. By virtue of its location approximately 50 m upstream of the mouth of Johnson Creek, the headcut prevented access to the approximately 1.6 km of historical spawning habitat in Johnson Creek.

The stream channel in this reach of Johnson Creek lies in a depositional zone and shows evidence of repeated channel shifts. As bedload is transported from upstream reaches it is likely the channel will shift again in the future. The headcut will likely move with repeated spring flows, roots will decompose, and spawner access will be restored naturally. In order to ensure access to the spawning area in 2002 and 2003, a temporary trap box was installed below the barrier and captured bull trout were released upstream of the headcut.

Granite Creek

Granite Creek is an east shoreline tributary to LPO (Figure 1). The LPO Key Watershed Bull Trout Problem Assessment (Panhandle Bull Trout Technical Advisory Team (PBTAT) 1998) recognized Granite Creek as high priority for bull trout restoration/conservation actions. Redd counts have been conducted from 1983 to 1987, and from 1992 through 2003, and have averaged 37 annually (Figure 4). During flood events in the winter of 1995-96, the reach of Granite Creek between Kilroy Bay Bridge and the mouth of Sullivan Springs underwent significant changes, and consequently now has a diffuse and largely sub-surface flow pattern during low flow conditions (PBTAT 1998). Fish passage is impaired due to the subsurface flow and a headcut in the channel during summer/fall months, reducing the numbers of bull trout that can successfully reach their spawning areas.

In 1997, the Idaho Department of Fish and Game (IDFG) moved nearly 100 adult bull trout around the intermittent reach to provide access to the majority of the spawning habitat in Granite Creek. Subsequent recapture of downstream moving adult bull trout following spawning yielded a mark-recapture population estimate of between 400 and 500 adults (PBTAT 1998), suggesting most of the spawning run moved past the low flow barrier earlier in the year.

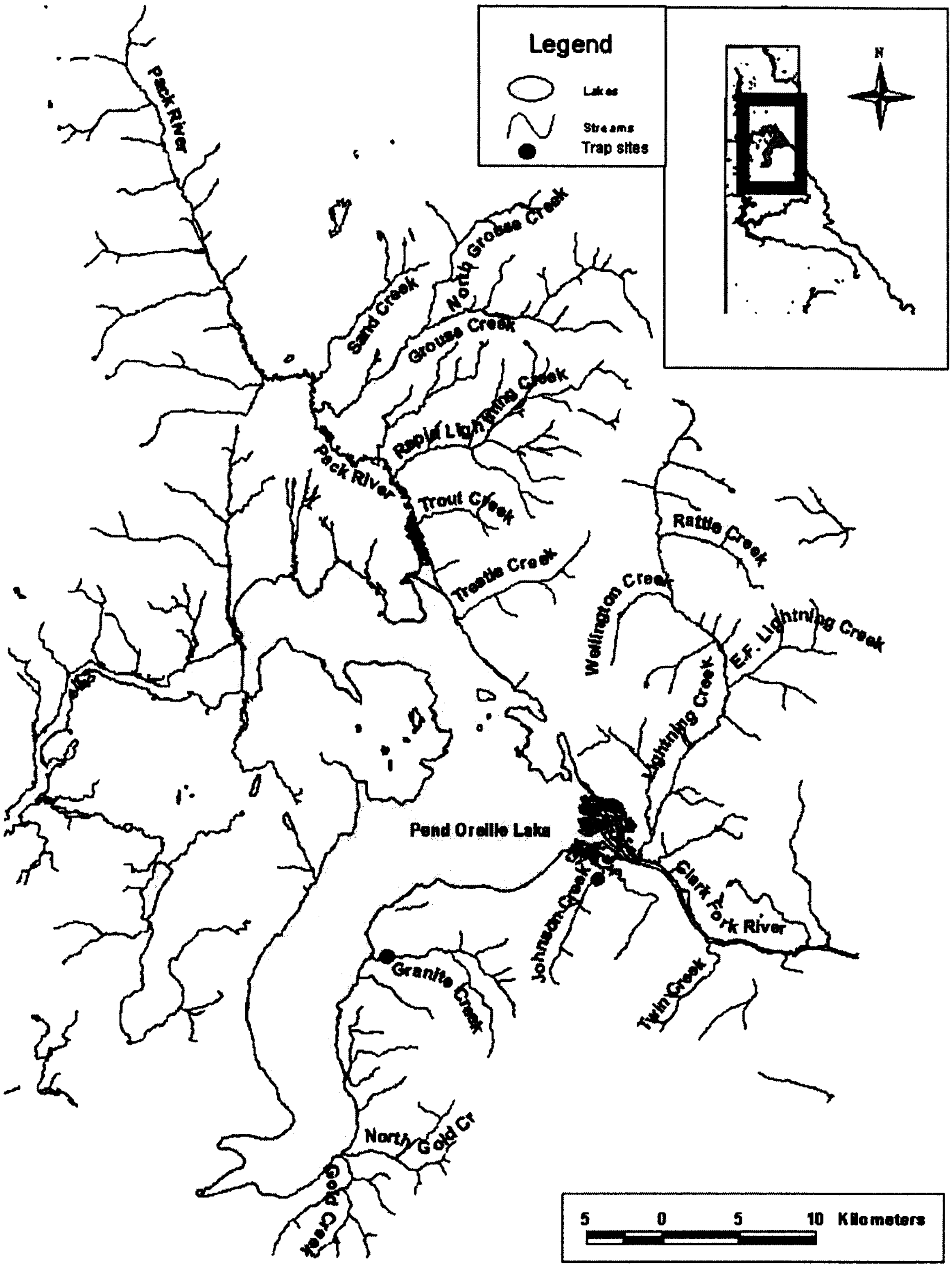

Figure 1. Trap locations in Johnson (2001-2003) and Granite (2002-2003) creeks, tributaries to Lake Pend Oreille, Idaho.

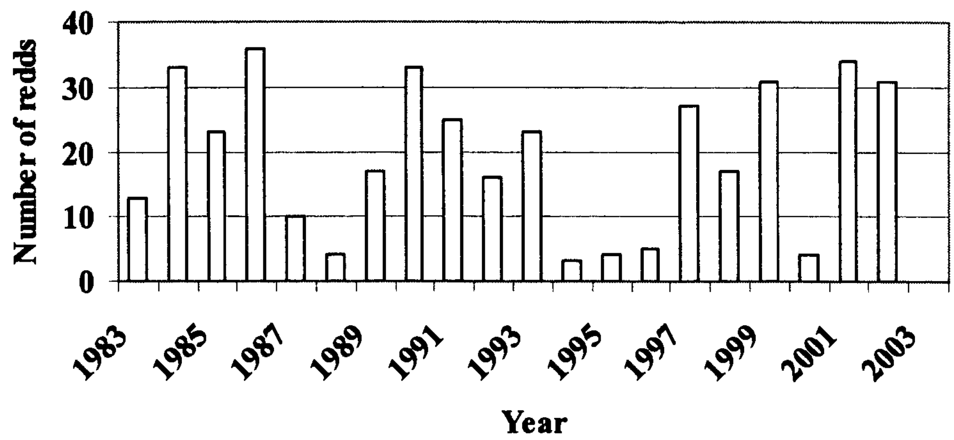

Figure 2. Bull trout redd counts in Johnson Creek, a tributary to Lake Pend Oreille, Idaho, from 1983 through 2003.

Figure 3. Headcut fish passage barrier in 2001 on Johnson Creek, a tributary to Lake Pend Oreille, Idaho.

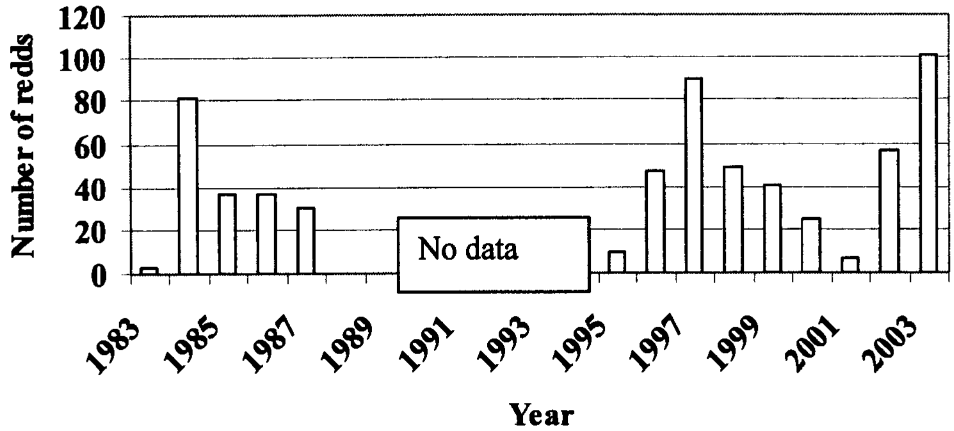

Figure 4. Bull trout redd counts in Granite Creek, a tributary to Lake Pend Oreille, Idaho, from 1983 through 1987, and 1992 through 2003.

In 2001, IDFG and Avista failed to document any bull trout redds upstream of the low flow barrier. This suggested that adult bull trout were unable to access important spawning habitat, and an interim measure of capturing and transporting adults around the low flow barrier would be beneficial until a longer-term solution is developed. We initiated a project to capture adult and juvenile bull trout migrating upstream or downstream in Granite Creek, and transport them around the low flow barrier starting in 2002.

METHODS

Johnson Creek

On July 23, 2003, an attempt was made to improve fish passage conditions at the location of the headcut by removing some of the roots that had been blocking any attempt at jumping up the headcut fish may have made. However, no adult bull trout were observed above the barrier during a snorkel survey two weeks later.

On August 17, 2003, an upstream weir box 0.92 m long, 1.22 m wide and 0.92 m high was placed in Johnson Creek approximately 5 m below the headcut. The trap consisted of a steel frame (25.4 mm X 2 mm angle steel) covered with 6.35 mm black plastic "vexar" mesh (Nelson 1999). The bottom of the trap box consisted of a sheet of 6.35 mm mesh hardware cloth and the top of the trap box consisted of a sheet of 13 mm thick plywood with an access hatch for removing captured fish (Figures 5 and 6). The plywood top was bolted on, while the plastic mesh and hardware cloth bottom were attached with UV resistant (black) plastic tie-wraps. Fish entered the trap through a cone projecting into the box constructed of the same plastic mesh. The entrance of the cone was approximately 30 cm in diameter and the exit diameter within the box was reduced to approximately 18 cm. The entrance of the cone was near the bottom of the box and the exit of the cone within the trap box was approximately 10-15 cm above the trap box bottom. This reduced the chance of trapped fish escaping back out of the box. The trap cone design was similar to common minnow trap designs.

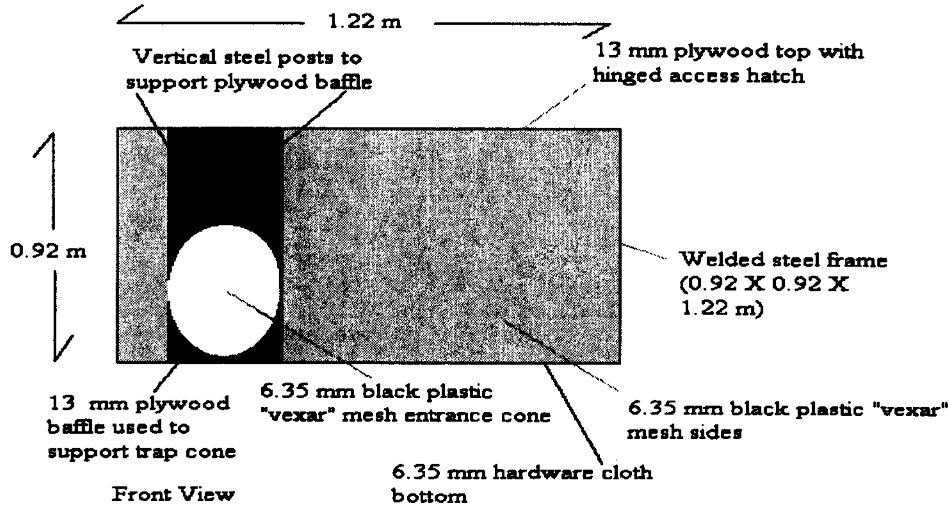

Figure 5. Front view of trap box designed to capture upstream migrating adult bull trout during 2003 in Johnson Creek, a tributary to the Clark Fork River, Idaho.

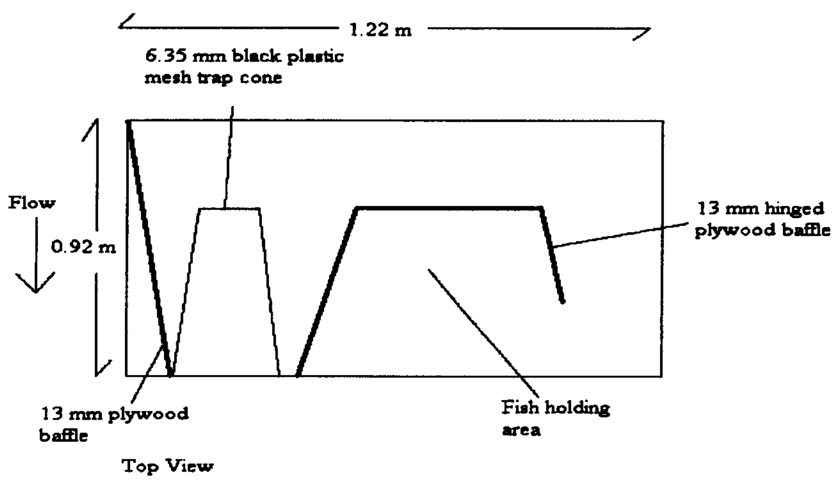

Figure 6. Plan (top) view of trap box designed to capture upstream migrating adult bull trout during 2003 in Johnson Creek, a tributary to the Clark Fork River, Idaho.

A 1.2 m wide weir panel was placed on each side of the trap box and was used to direct fish into the trap. The picket weir panel design was similar to that described by Nelson (1999), and was constructed of welded angle steel with removable support legs. We used 13 mm diameter steel conduit as pickets, with 12.7 mm spacing between pickets. A 30cm gap was left between the end of one panel and the shoreline on the shallow side of the stream to allow for downstream movement.

Bull trout scales were collected from an area approximately 2.5 cm posterior of the dorsal fin just above the lateral line for ageing. In addition, pelvic fin ray samples were collected to examine age and growth rates, as part of a graduate study conducted by Montana State University. All adult bull trout were tagged with 134.2 kHz Passive Integrated Transponder (PIT) tags in the cheek for identification at recapture. The procedure involved marking anesthetized adult bull trout by implanting a PIT tag into the soft tissue of the cheek along the dorsal-ventral plane, at approximately a 90 degree angle (Figure 7). Baxter and Westover (1999) marked adult bull trout using a similar methodology and reported retention rates of 89% (one-year) and 82% (two-year). A 12-gauge syringe was used to inject an 11.5 mm X 2.1 mm, 134.2kHz coded tag into the cheek. The tag was injected into either the left or right cheek from the dorsal surface (depending on the preference of the field worker), as the fish lay on its side in a large measuring board. One hand was used to gently restrain the head to prevent injury from any sudden movement. Juvenile bull trout were also PIT tagged, but the tags were inserted into the abdomen along the anterior-posterior plane, just anterior to the pelvic fins. Fish were then placed in a 76 L plastic tub with approximately 150 mm of water depth (fresh recovery water), and transported upstream to a pool located approximately 100 m above the barrier, where they were released.

After fish were captured and passed around the headcut on Johnson Creek, a redd count was conducted on October 9, 2003. Redds were located visually by walking upstream from the mouth of Johnson Creek to Johnson Creek Falls, a natural fish barrier located approximately 1.6 km above the mouth. Redds were defined as areas of clean gravels at least 0.3 x 0.6 m in size with gravels at least 76.2 mm having been moved, and with a mound of loose gravel downstream from a depression (Pratt 1984) (Figure 8). In areas of superimposition, each distinct depression was counted as a redd.

Figure 7. Location of PIT tag placement in adult bull trout.

Granite Creek

On July 8, 2003, upstream and downstream weir boxes were installed in Granite Creek. The upstream weir box was identical to the Johnson Creek trap box, and was located approximately 50 m upstream of the confluence of Granite Creek with Sullivan Springs Creek, which is used each fall by the IDFG as a kokanee *Oncorhynchus nerka* egg-take station. The downstream weir box was located upstream of the low flow barrier immediately downstream of the Kilroy Bay Road bridge. Weir panels completely spanned the channel and were used to direct fish into both trap boxes. The picket weir panel design was similar to that described by Nelson (1999), and was constructed of welded angle steel with removable support legs. We used 13 mm steel conduit as pickets, with 25.4 mm spacing between pickets because we were targeting large adult bull trout. The downstream weir box design differed only slightly from the upstream box, and was constructed of the same materials. The primary difference was in the baffle design and trap box orientation in the stream (Figure 9).

Figure 8. Bull trout on a redd in Johnson Creek, a tributary to Lake Pend Oreille, Idaho, during October 2001.

The traps were checked each day, and water temperature (C) recorded using a hand-held thermometer. Following the protocols described for Johnson Creek, all captured bull trout were placed in a large tub, anesthetized with MS-222, weighed, measured, scanned for the presence of a PIT tag, tagged when needed, and scale and pelvic fin samples were collected. The fish were placed in a 379 L fiberglass "stock tank" located in the bed of the truck. The tank was covered with a sheet of 1.27 cm thick plywood cut to the size and shape of the tank to prevent fish from jumping out during transport. The cover was cut down the middle and a hinge installed to allow easy access. The cover was held in place by two bolts with wing nuts. The tank was fitted with a water circulation pump to aerate the water, and a 12 volt battery was used to run the pump. Fish captured in the upstream weir box were then transported upstream to a release site located approximately 100 m above the weir used for downstream capture, then released in calm water. Fish captured in the downstream weir box were transported downstream in the stock tank to a release site located approximately 30 m below the weir used for upstream capture.

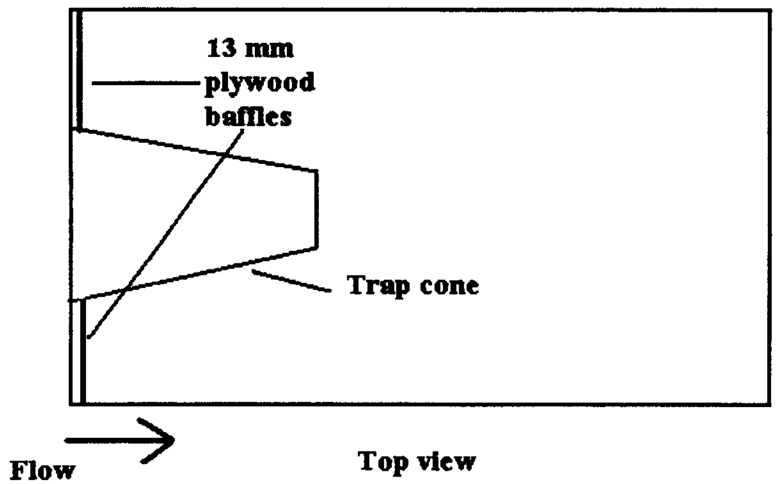

Figure 9. Trap box design for capturing downstream migrating adult bull trout.

Numerous adult bull trout were reported to be stranded between a section of dry creek downstream and the headcut located upstream on Granite Creek, by local landowner Keith Ellingson. On July 18 and July 25, 2003, we snorkeled to capture these adult bull trout using seines and dip nets to move them into the perennial flowing channel, and provide access to spawning areas.

We also used our trapping effort on Granite Creek to conduct a mark-recapture population estimate for adult bull trout in Granite Creek. We used the Petersen estimator for sampling without replacement (Krebs 1998) as:

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

where:

- N = population estimate
- M = number of individuals marked and placed upstream of the barrier
- C = total number of adult bull trout captured moving downstream in the weir following spawning
- R = the number of previously marked bull trout captured moving downstream at the weir following spawning

Approximate 95% confidence intervals were estimated using the normal approximation method (Krebs 1998).

RESULTS

Johnson Creek

The box trap was operated from August 17 through September 12, 2003, and again from September 16 through October 3, 2003. On September 13, surface flow from the trap site to a location 40 m downstream ceased. The trap was relocated downstream to a site approximately 20 m upstream from the creek mouth on September 16, 2003. During this time period, mid-morning water temperatures ranged from $7\,^{0}$C to $13\,^{0}$C (Figure 10). A total of three adult bull trout were captured and transported above the barrier (Figure 11). Of those fish, one was identified as a male, one as female, and one of undetermined sex. The lengths of all adult bull trout captured in the upstream weir were 534, 601, and 630 mm. The mean weight was 1570 g. Two were PIT tagged, while the female was a recapture, which had been PIT tagged in Johnson Creek in 2002.

In addition to the three adults captured in the trap, a 510 mm bull trout which had not previously been PIT tagged was found stranded in a small pool 30 m above the headcut on October 1. It was subsequently tagged and released at the creek mouth.

A total of six juvenile bull trout (< 300 mm) were also captured moving upstream and transported above the barrier in 2003 (Figure 12). The mean length for those juveniles captured was 91 mm (s.d.=34; range=56-132) (Figure 13). Three of the juvenile bull trout were PIT tagged, the other three were not due to small size.

In addition to bull trout, one juvenile rainbow trout *O. mykiss*, and one juvenile brown trout *Salmo trutta,* were also captured in the 2003 Johnson Creek weir. Neither fish were passed above the headcut.

A complete redd count was conducted in Johnson Creek from the mouth upstream to the falls on October 9, 2003. No redds were observed during the redd count. However, two redds had been constructed approximately 20 m upstream from the creek mouth prior to the redd count, but were completely dry due to the stream flowing sub-surface by the time the count was conducted.

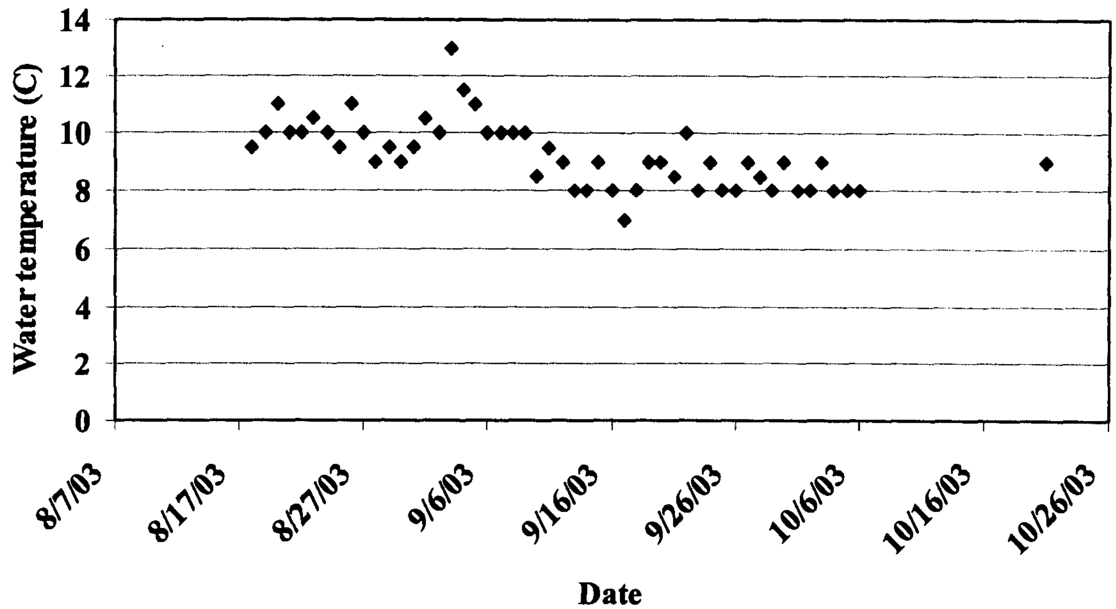

Figure 10. Daily water temperatures typically recorded during mid-morning trap checks in Johnson Creek, a tributary to the Clark Fork River, Idaho, in 2003.

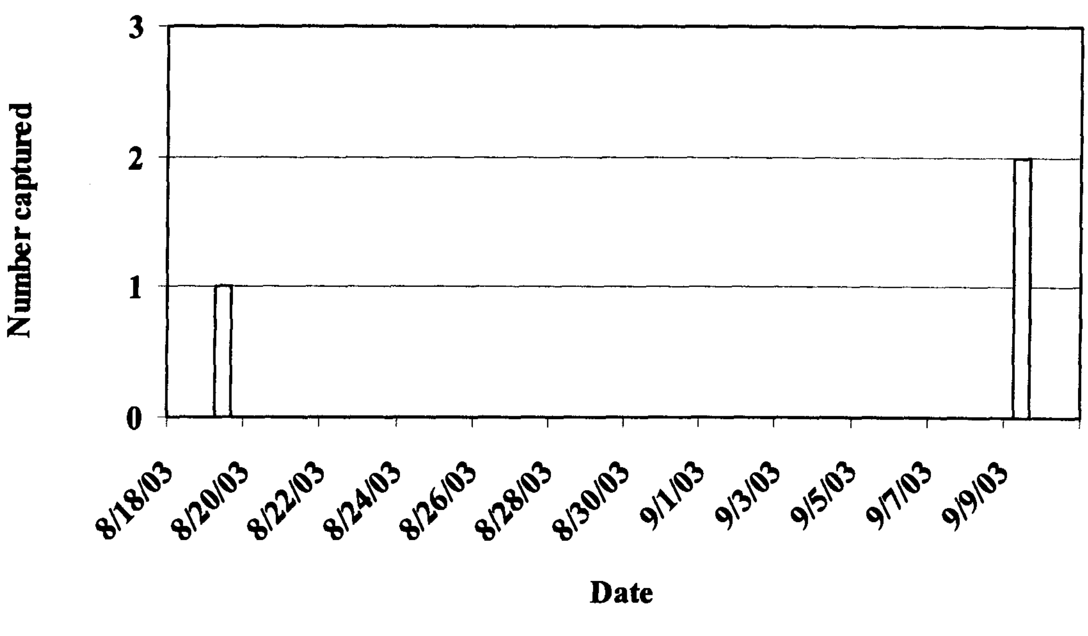

Figure 11. Timing of upstream migration of adult bull trout in Johnson Creek, a tributary to the Clark Fork River, Idaho, in 2003.

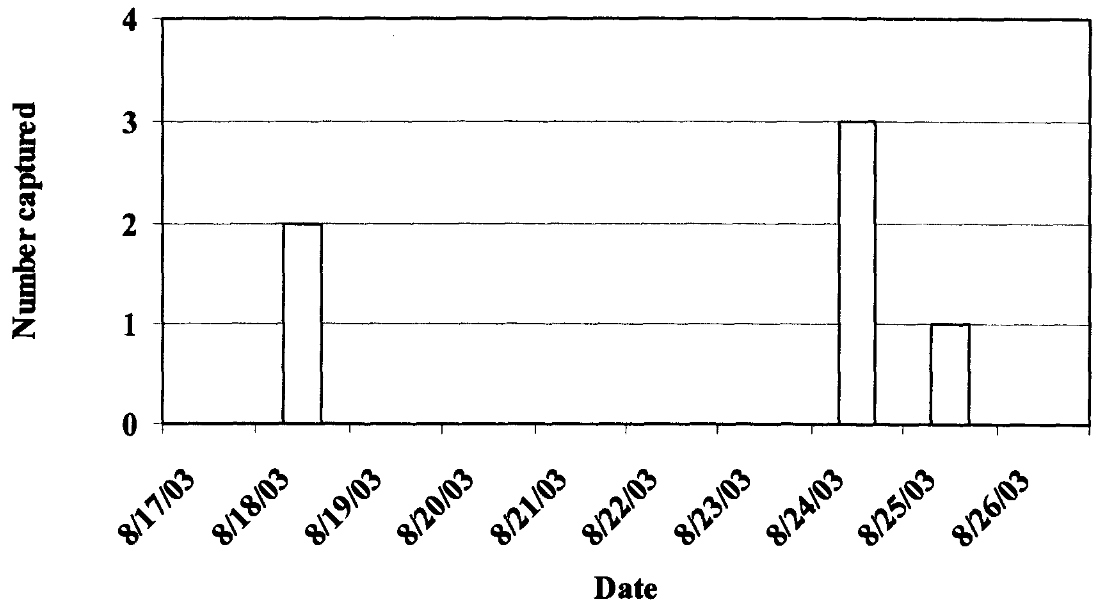

Figure 12. Timing of upstream movement of juvenile bull trout in Johnson Creek, a tributary to the Clark Fork River, Idaho, in 2003.

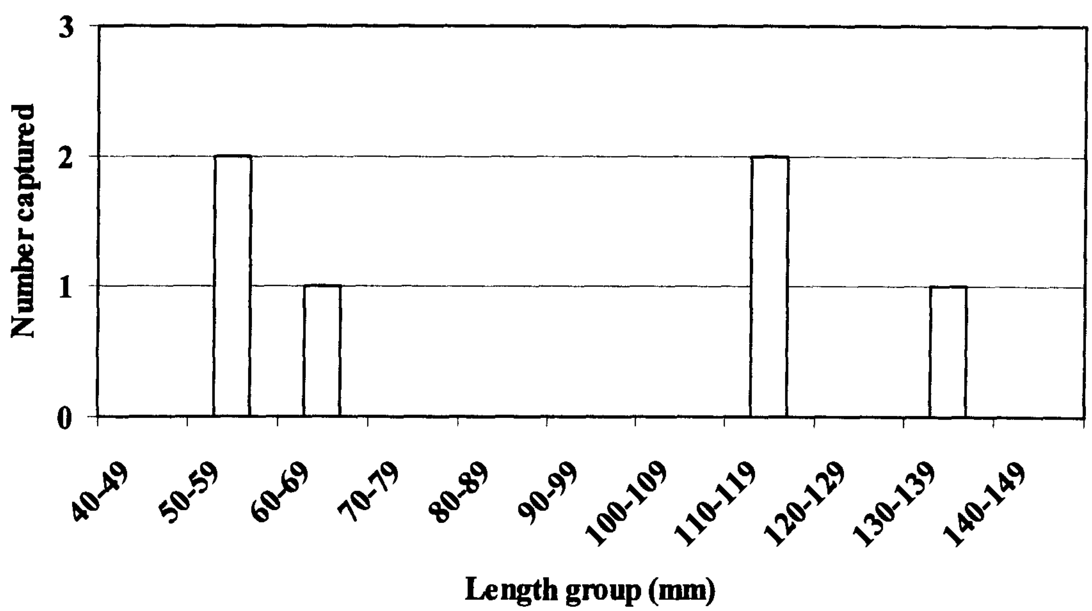

Figure 13. Length frequency histogram for juvenile bull trout captured moving upstream in Johnson Creek, a tributary to the Clark Fork River, Idaho, during 2003.

Granite Creek

Both the upstream and downstream weirs were installed on July 8, 2003. The upstream weir was removed on November 3, while the downstream weir was removed on November 4, 2003. During this time water temperatures taken during trap checks, typically occurring during late morning or early afternoon, ranged from 2° C to 14° C (Figure 14). In the upstream weir, a total of 213 adult bull trout were captured and transported above the barrier (Figure 15). In addition to captures at the weir, we also captured and moved 51 additional adults using snorkeling and dip netting techniques from several holes located on private property. These fish were stranded between a dry reach of channel downstream, and a headcut blocking their migration to the spawning areas upstream. By moving them upstream we provided access to the spawning areas for these individuals.

The mean total length for adult bull trout moving upstream was 510 mm. The mean weight was 1,194 g (Table 1; Figure 16). Of the 264 adults captured, 24 were PIT tag recaptures from 2002. The remaining 239 were unmarked fish, which were subsequently PIT tagged and released to spawn. One additional adult was captured but was not tagged. In addition, 23 juvenile bull trout (< 300 mm total length) were also captured moving upstream and transported above the barrier (Table 1; Figure 17). There were also five juvenile westslope cutthroat trout *Oncorhynchus clarki lewisi* (mean total length = 144.2 mm; range = 57-203) and two juvenile rainbow trout (mean total length = 169 mm; range = 152-186) captured and transported above the barrier in 2003.

In the downstream weir, a total of 117 adult bull trout were captured and transported below the barrier after spawning (Figure 18). One hundred and five of these were previously PIT tagged. The 12 unmarked adults captured moving downstream were subsequently PIT tagged. An additional three marked and one unmarked adult bull trout were found dead near the weir site.

We derived a mark-recapture population estimate of adult escapement of 294 (95% CI: 244-314) individuals. Spawning mortality of marked adult bull trout prior to recapture likely occurred, and we assume that this mortality occurred equally for marked and unmarked individuals in our population estimate. We also assumed no tag loss prior to recapture. Pelvic fin samples were collected from 38 adult bull trout and 54 juvenile bull trout in Granite Creek as part of a bull trout age and growth study being conducted by Montana State University.

A redd count was conducted on October 13, 2003 using the methods described by Pratt (1984). An individual walked from the mouth of Granite Creek upstream to the road culvert on USFS Road 278, counting bull trout redds. In areas of superimposition, each distinct pit was counted as a redd. A total of 101 redds were counted in 2003.

A total of 202 juvenile bull trout were also captured and transported downstream below the barrier (Figure 19). Eighty-nine were large enough to mark and were PIT tagged. The mean total length for juvenile bull was 112 mm (range: 55-222 mm; s.d.=52; n=202) (Figure 20). The mean weight of downstream migrating juvenile bull trout was 19 g (range: 1-104 g; s.d.=22; n=179).

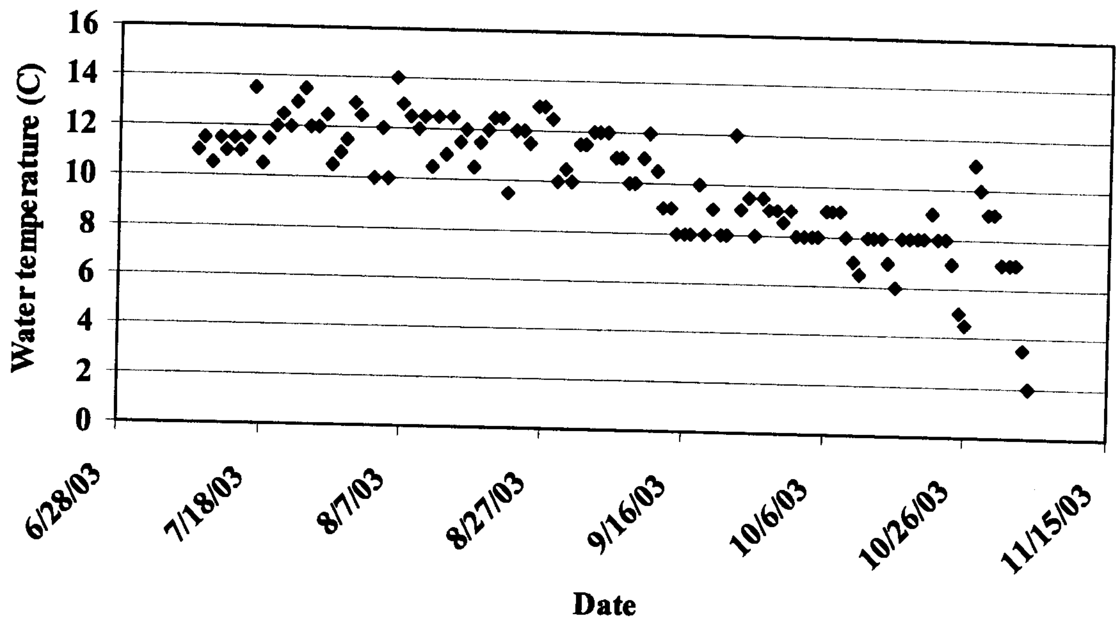

Figure 14. Daily water temperatures typically recorded during late morning/early afternoon trap checks in Granite Creek, a tributary to Lake Pend Oreille, Idaho, during 2003.

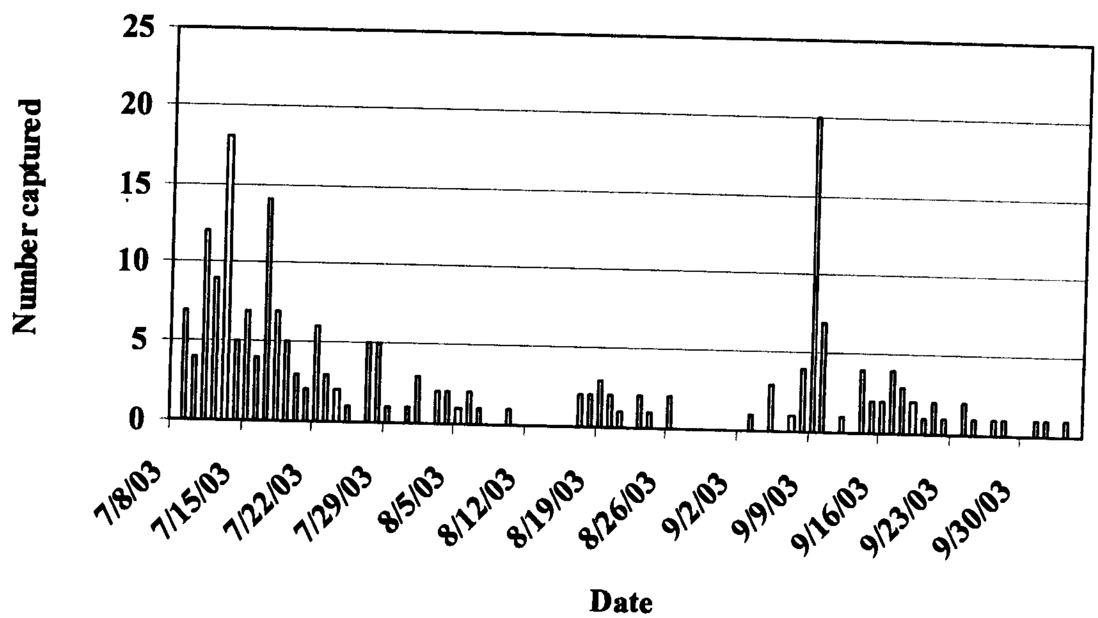

Figure 15. Timing of upstream migration of adult bull trout in Granite Creek, a tributary to Lake Pend Oreille, Idaho, during 2003.

Table 1. Summary total length (TL) and weight statistics for adult and juvenile bull trout captured in 2003 moving upstream in Granite Creek, a tributary to Lake Pend Oreille, Idaho.

	Mean TL (mm)	TL range (mm)	S.D.	Mean weight (g)	S.D.	Sample size
Adults	509.7	351-757	62.5	1,193.6	503.8	264
Juveniles	88.9	67-167	30.3	7.9	10.7	23

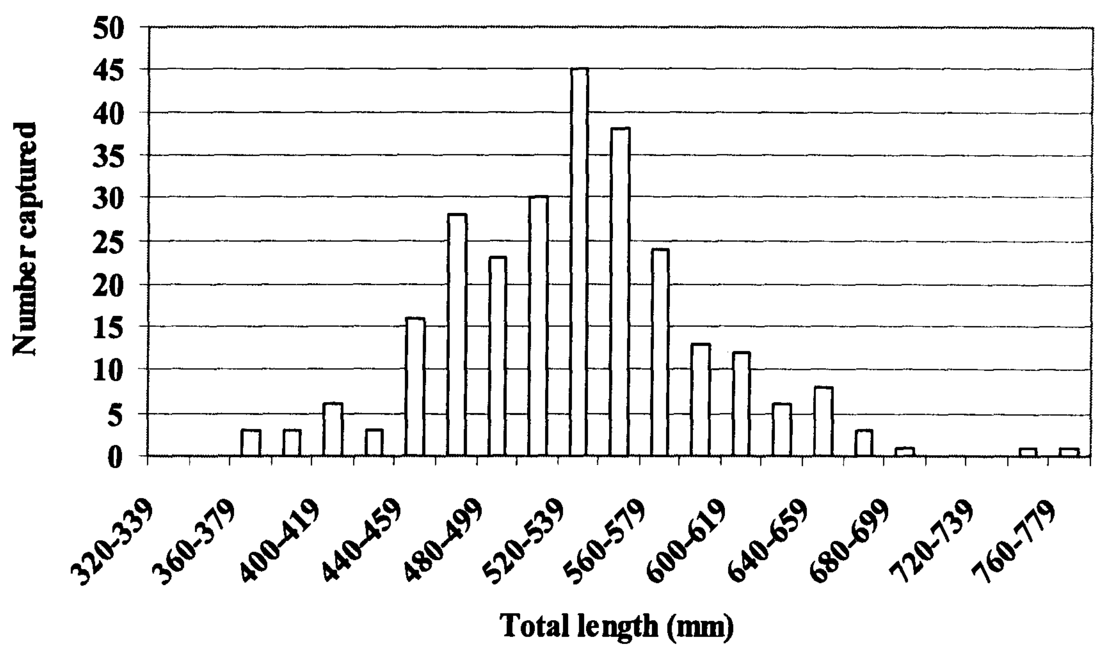

Figure 16. Length frequency histogram for adult bull trout captured moving upstream in the weir and by dip netting on Granite Creek (n = 264), a tributary to Lake Pend Oreille, Idaho, during 2003.

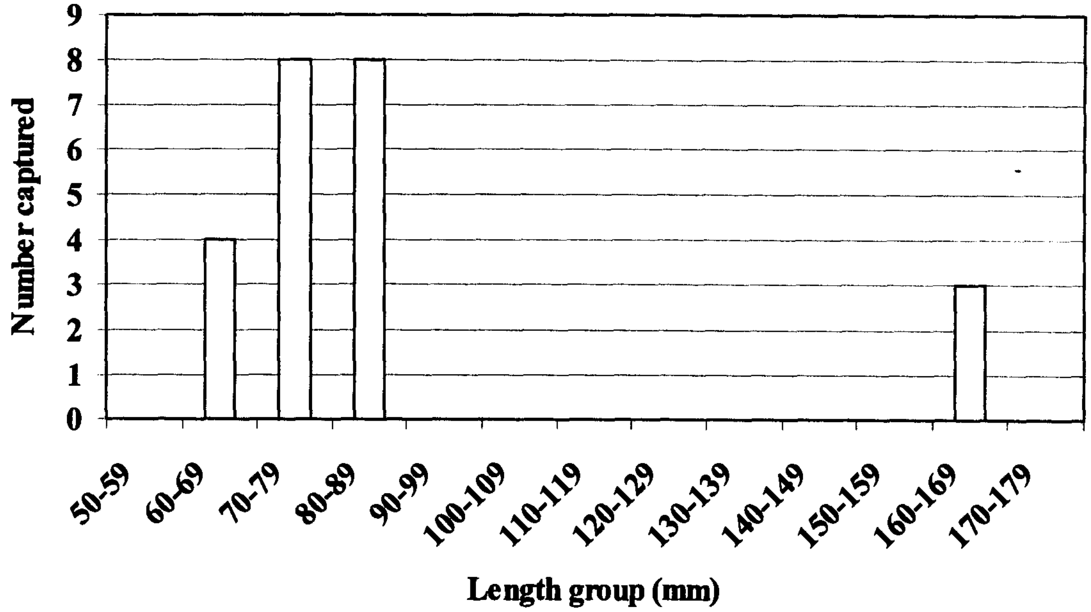

Figure 17. Length frequency histogram for juvenile bull trout captured moving upstream in Granite Creek, a tributary to Lake Pend Oreille, Idaho, during 2003.

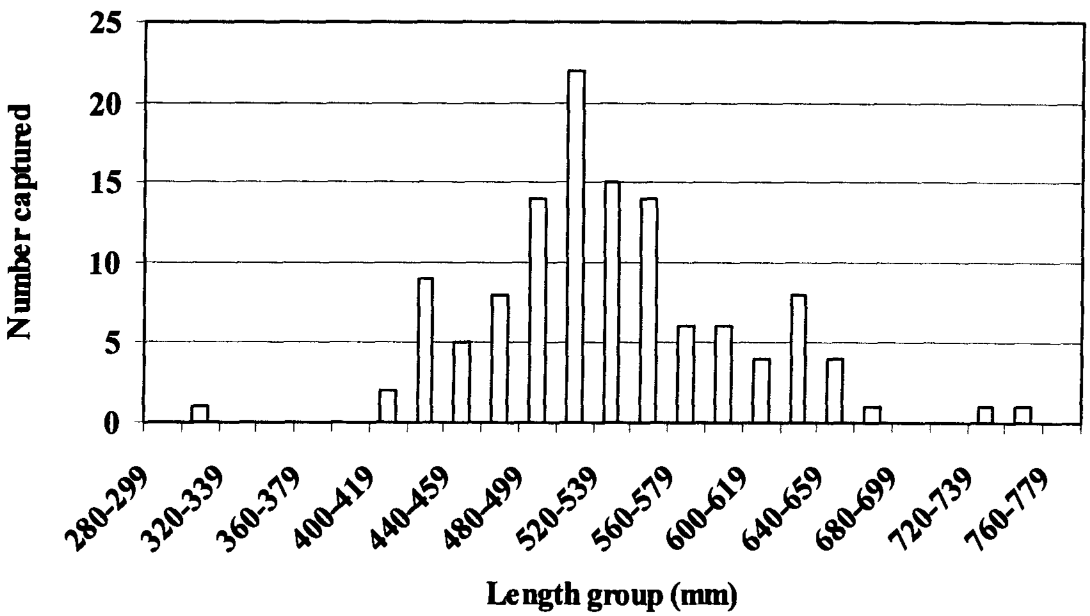

Figure 18. Length frequency histogram for adult bull trout captured moving downstream in the weir on Granite Creek (n = 121), a tributary to Lake Pend Oreille, Idaho, during 2003.

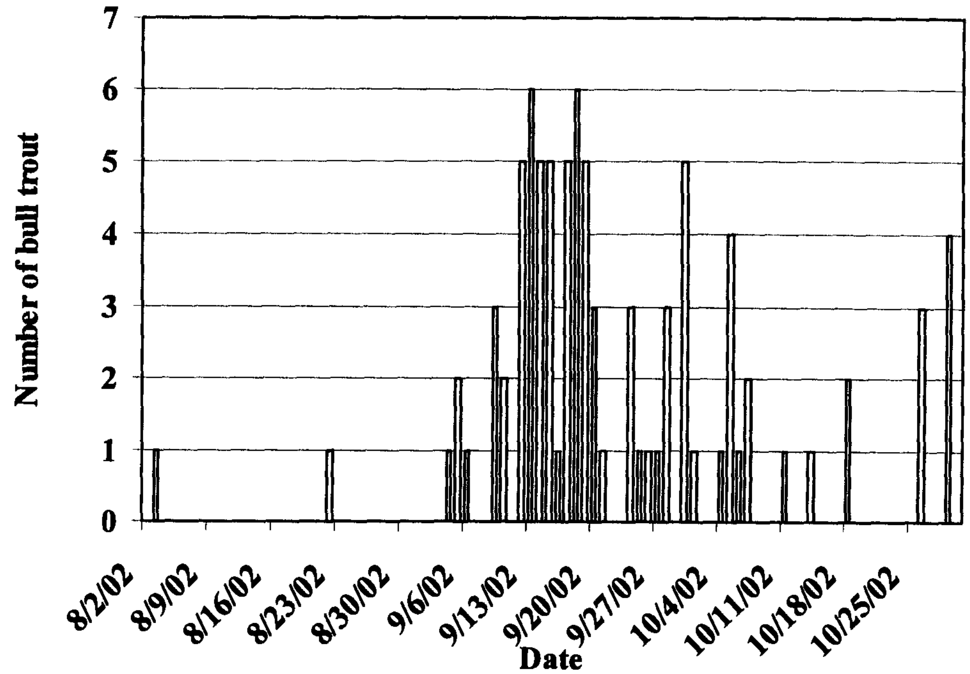

Figure 19. Timing of downstream movement of juvenile bull trout in Granite Creek, a tributary to Lake Pend Oreille, Idaho, during 2003.

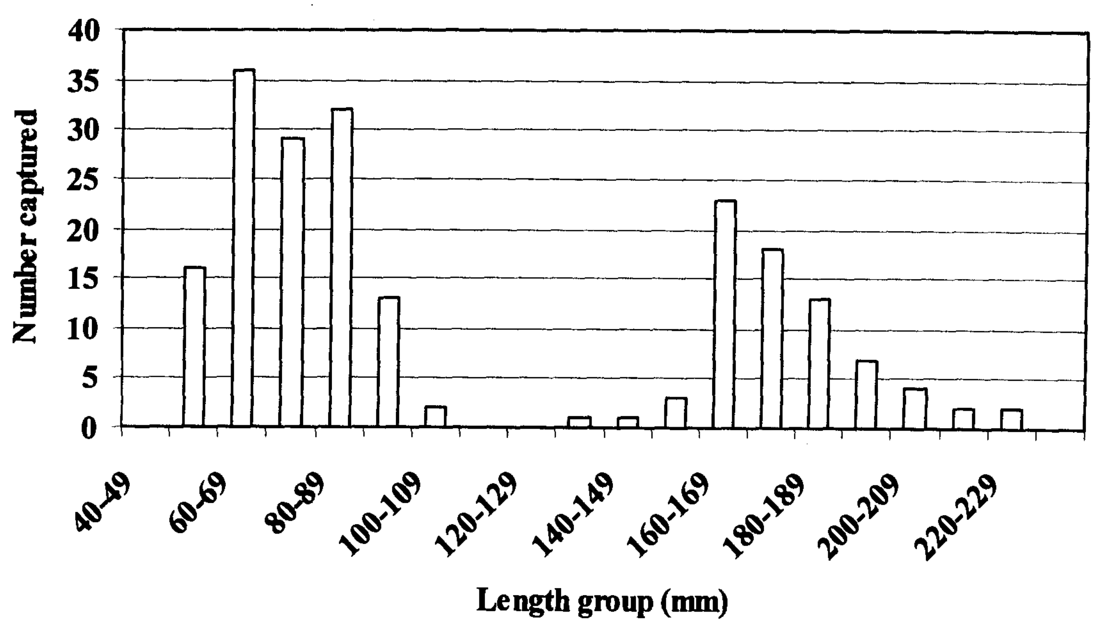

Figure 20. Length frequency histogram for outmigrating juvenile bull trout captured in the downstream weir box in Granite Creek, a tributary to Lake Pend Oreille, Idaho, during 2003.

DISCUSSION

Johnson Creek

We captured far fewer adult bull trout in 2003 than we captured in either 2001 or 2002. Only three adults were captured trying to move upstream, compared to 53 and 60 for 2001 and 2002, respectively. This could be the result of several factors operating alone or in combination. In late summer 2003, flow conditions were very low near the mouth of Johnson Creek, potentially making entering the stream less attractive or more difficult. The extreme lower reaches of Johnson Creek went dry late in the summer 2003, which did not occur in 2001 or 2002. Redd number were also very low from 1994-1996 in Johnson Creek, averaging only four redds. These year classes would likely have been producing the spawners to mature in 2002-2004. The low spawning escapement in Johnson Creek in the mid-1990's may have resulted in weak year classes. The strong adult escapement observed in 2002 may have been supported by repeat spawners from previous years that were produced during relatively strong adult escapement years in the early 1990's. As these fish die, we may expect to see lower escapement levels in 2003 and 2004. The length frequency histogram produced in 2002 does not show strong recruitment by smaller sizes (younger age classes), compared to that of Granite Creek in 2002 (Figures 21 and 22) (Downs and Jakubowski 2003).

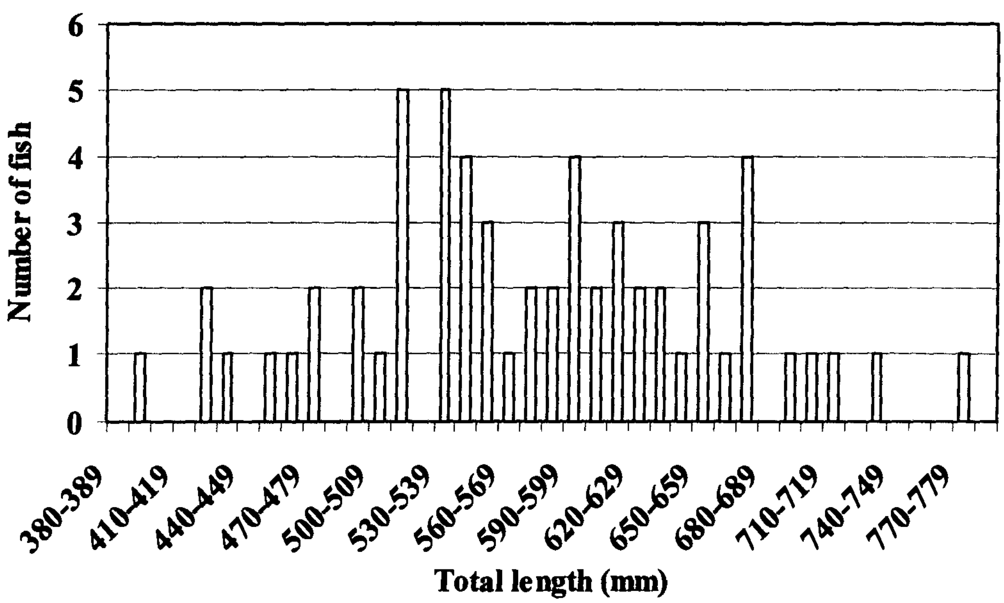

Figure 21. Length frequency histogram for adult bull trout captured moving upstream in Johnson Creek, a tributary to Lake Pend Oreille, Idaho, during 2002 (adapted from Downs and Jakubowski 2003).

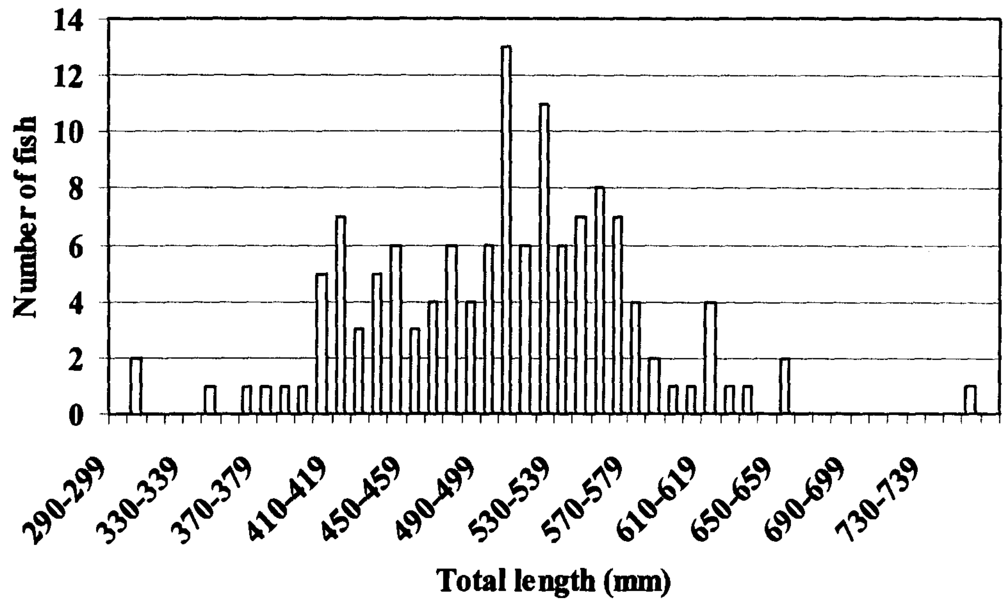

Figure 22. Length frequency histogram for adult bull trout captured moving upstream in Granite Creek, a tributary to Lake Pend Oreille, Idaho, during 2002 (adapted from Downs and Jakubowski 2003).

We did not count any bull trout redds in Johnson Creek during the October 9, 2003 survey. We did however observe two bull trout redds in Johnson Creek near the trap site in September, but the stream channel was dry in this reach by the survey time in mid-October. The two redds observed earlier will not produce any juvenile bull trout and were not counted in the survey. This will result in a year-class failure for bull trout that would have emerged from the gravel in the spring of 2004, and will likely reduce adult escapement in the future. Overlapping year classes of juvenile bull trout in the tributary environment produced in earlier years, as well as repeat spawning by adults, may help to reduce the impact of individual year class failures in adfluvial bull trout populations.

The headcut barrier on Johnson Creek is located in a depositional zone near the mouth, and the channel shows evidence of repeated channel shifts. The existing headcut is likely to be only temporary in nature and is currently held in place by tree root structure. The headcut will likely eventually migrate upstream to a point of equilibrium, or shift again, alleviating the fish passage problem over time. We recommend ensuring fish passage past this point by annual monitoring of the headcut, and providing interim fish passage either with a temporary ladder or continued trapping.

Granite Creek

We captured and transported 264 individual adult bull trout around the low flow barrier on Granite Creek during the summer and fall of 2003 to provide access to the majority of the spawning habitat in Granite Creek. This number is far greater than the nearly 100 adults passed upstream past the low flow barrier in 1997, and 131 passed in 2002. Our trapping and transport efforts in 2003 started earlier than in previous years, and based on the population estimate (294) and redd counts, most of the reproduction in Granite Creek in 2003 came from the fish we captured and moved. We subsequently counted 101 redds in Granite Creek, which is the highest bull trout redd count on record for Granite Creek. When we compare the number of redds counted in Granite Creek between years fish were not transported against the years they were since 1996 (the year the channel changes occurred), we see the benefits of the program (Figure 23).

The 2003 population estimate of 294 (95% CI: 244-314) is somewhat lower than the 1997 estimate of 400-500 individuals, but very close to the 2002 population estimate of 289 individuals (95% CI: 248-350). Our population estimate may have underestimated the total run size into Granite Creek in 2002 and 2003, because some spawning likely took place downstream of our traps and those individuals would not be included in our estimate. Examination of the length frequency histogram suggests continued relatively strong recruitment of younger year classes of bull trout into the spawning run in Granite Creek. The spawner:redd ratio of 2.9 estimated from the 2003 data is lower than the 5.1:1 observed in 2002, but is identical to the average spawner:redd ratio for LPO as a whole (Table 2). It is also consistent with ratios from other bull trout populations across the western U.S. (range: 1.5:1 to 3.2:1; average 2.2:1) (Bonar et al. 1997).

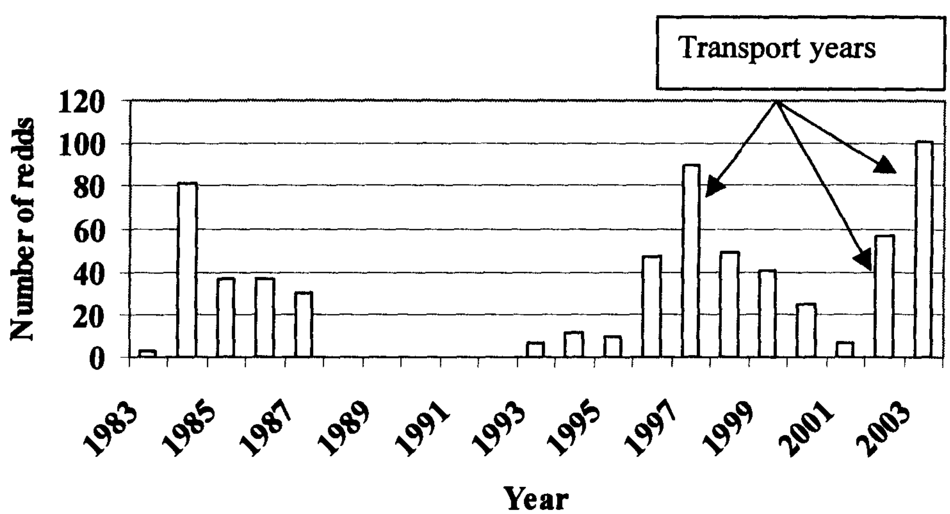

Figure 23. Annual bull trout redd counts compared to transport years on Granite Creek, a tributary to Lake Pend Oreille, Idaho.

Table 2. Bull trout spawner to redd ratios estimated for individual tributaries to Lake Pend Oreille, Idaho, sampled from 2000 through 2003.

Stream	Year	Spawner:redd ratio
Johnson Creek[a]	2001	1.6:1
Johnson Creek	2002	1.9:1
Trestle Creek[a]	2000	3.7:1
Gold Creek[a]	2000	1.9:1
Granite Creek[b]	2002	5.1:1
Granite Creek	2003	2.9:1
Grouse Creek[a]	2000	2.9:1
Average		2.9:1

[a] Downs et al. 2003
[b] Downs and Jakubowski 2003.

The Granite Creek intermittent/impaired reach is located in a low gradient section of the channel, but was likely capable of providing upstream fish passage year-around. Because of the remote location of the site, operating a trap and haul program requires a significant investment of financial resources on an annual basis, doesn't address the cause of the problem, and does not address potential juvenile fish loss in the spring when flows diffuse across the floodplain at an exaggerated rate due to a lack of a defined stream channel in certain areas. This problem has persisted for six years and annually inhibits migration of relatively large numbers of bull trout. For these reasons, a long-term solution is desired. A stream channel assessment and restoration design was completed in 2003 (River Design Group 2003). We plan to implement a stream restoration project to restore year-long natural fish passage in 2005 to this reach of Granite Creek.

ACKNOWLEDGEMENTS

The authors wish to thank John Suhfras and Steve Lowe of Avista for their contributions to completing the field work associated with this project. We would also like to thank Mark Gamblin and Ned Horner of the Idaho Department of Fish and Game, Joe DosSantos of Avista Corp., Laura Katzman of Montana Fish, Wildlife, and Parks, and Larry Lockard of the U.S. Fish and Wildlife Service for their reviews of this report.

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Project 7: 2003 Twin Creek Restoration 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 since the Clark Fork Settlement Agreement was signed in 1999. It is necessary to conduct fish population monitoring in these tributaries 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 2003 we conducted depletion-removal population estimates in four sections of Twin Creek, a tributary to the Clark Fork River, Idaho, to monitor and evaluate the biological effectiveness of a large-scale habitat restoration project conducted in 2000 and 2001. Bull trout *Salvelinus confluentus*, westslope cutthroat trout *Oncorhynchus clarki lewisi*, and mountain whitefish *Prosopium williamsoni* were all present in Twin Creek. Bull trout densities were highest in the lower reaches of Twin Creek, associated with the known spawning area for bull trout in Twin Creek, and were comprised of primarily age-0 individuals. Brook *S. fontinalis*, brown *Salmo trutta*, and rainbow trout *O. mykiss* were also captured in each section. We have observed more age-1 and older bull trout and bull x brook trout hybrids, as well as what appears to be an expanding distribution of juvenile bull trout in Twin Creek, but continued monitoring is needed to determine actual trends in species abundance, composition, and distribution following the stream restoration work.

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INTRODUCTION

Twin Creek is a spring-fed tributary to the lower Clark Fork River in Bonner County, Idaho, and is used for spawning by bull *Salvelinus confluentus*, westslope cutthroat trout *Oncorhynchus clarki lewisi*, brown trout *Salmo trutta* and rainbow trout *O. mykiss* as well as kokanee *O. nerka* migrating from the Clark Fork River and Lake Pend Oreille (LPO) (Figure 1). During the mid-1950's, shortly after Cabinet Gorge Dam blocked upstream migrations of bull trout in 1952, 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 2.9 bull trout spawn for every redd constructed (Downs and Jakubowski, 2003), or that approximately 140 to 230 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. Before the stream restoration project was completed in 2001, 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 was six, representing a tenfold reduction in bull trout spawning activity from the 1950's, putting this population at risk of extinction. A project was initiated in 1999 to move much of Twin Creek back into its original channel, restore the natural meander pattern, and reconstruct the habitat diversity. The primary goal of the restoration project was to restore numbers of spawning bull trout using Twin Creek to levels observed prior to channelization of the stream.

The Twin Creek restoration project was a complete channel reconstruction that involved constructing approximately 1,737 m of new stream channel, diverting water out of the old channel, and filling in much of the old channel with the spoils from construction of the new channel. Construction of the new channel occurred during the summers of 2000 and 2001, and water was turned into the new channel in June 2001. The project resulted in an overall gain in total stream length of 291 m, increased habitat diversity, and restoration of natural stream processes. Because much of the old stream channel was filled in upon completion of the project, the monitoring program does not involve collecting information from the same sections pre and post-treatment over time. We did however, collect pre-treatment baseline information on fish abundance, size structure, and distribution that will be useful in evaluating the effectiveness of the project. Electrofishing is being used to monitor the fish population response to the restoration project.

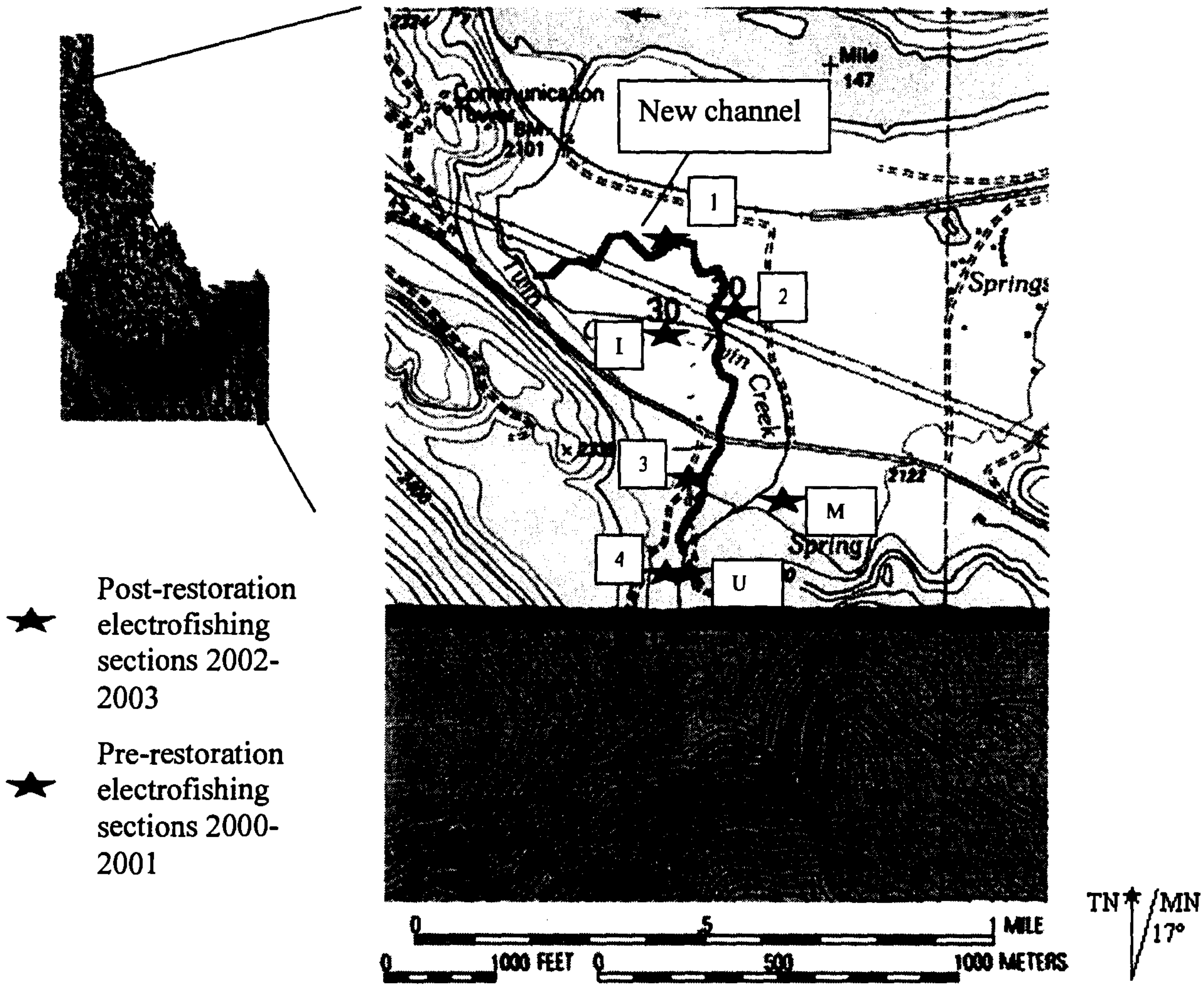

Figure 1. Vicinity map and sample site locations for Twin Creek, a tributary to the Clark Fork River, Idaho (L = lower, M = middle, U = upper pre-restoration sampling sites).

METHODS

We used the removal (depletion) method (Zippin 1958) to estimate abundance and size structure of fish populations in four reaches of Twin Creek following restoration. The software program Microfish (Vandeventer and Platts 1986) was used to derive estimates from the depletion data. Population estimates were conducted for fish greater than or equal to 75 mm (total length;TL). 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. We standardized the results of the population estimates by converting the number estimated per linear 100 m, to the number captured per $100m^2$. This information will be used in combination with trapping and redd count information on Twin Creek to assess the biological effectiveness of the stream restoration project.

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 four). Wetted-widths were recorded every 20 m along the transect to estimate the total area of the section. Crews of two or three individuals slowly progressed upstream within the section carefully shocking the stream. A Smith-Root battery powered backpack shocker, using pulsed DC current, was used to stun fish, which were netted and placed in a bucket carried with the crew while shocking. Typical settings for the electrofishing unit were 300 to 400 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 that were visually classified as hybrids of bull X brook trout were included within the bull trout estimates, and those classified as hybrids of westslope cutthroat X rainbow trout were included within the westslope cutthroat estimate. We did this as different observers will likely vary in their ability to identify hybrids, and by including suspected hybrids in the estimates, we should avoid these problems and reduce the effect observer variability may have on the annual population estimates. This is particularly true when dealing with juvenile fish, which is the typical situation on Twin Creek.

Fish were anesthetized with clove oil, measured (total length; mm), weighed (g), had a sample of scales removed for ageing, and all bull trout $\geq$ 75 mm were tagged with Passive Integrated Transponder (PIT) tags. Fish were allowed to recover their equilibrium and were released back into the stream below the section. All brook trout encountered during sampling were removed to reduce the potential risk of hybridization with bull trout, as well as competition with both bull and westslope cutthroat trout.

Sampling dates were July 22 through July 26, 2002, and July 30 through August 6, 2003.

RESULTS

We captured six salmonid species in Twin Creek in 2002 and 2003 (Table 1). In Section 1, bull trout density ranged from $0.74/100m^2$ in 2002 (including one hybrid) to $4.39/100m^2$ in 2003 ($\geq$ 75 mm). No westslope cutthroat trout were captured in Section 1 in either year (Table 2).

Table 1. Species captured in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

Species	Abbreviation
Brook trout *Salvelinus fontinalis*	BRK
Brown trout *Salmo trutta*	BRN
Bull trout *Salvelinus confluentus*	BLT
Mountain whitefish *Prosopium williamsoni*	MWF
Rainbow trout *Oncorhynchus mykiss*	RBT
Westslope cutthroat trout *O. clarki lewisi*	WCT

Table 2. Population estimates for salmonid species (≥75 mm;TL) captured in Section 1, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

Species	Year	Estimate (95% CI)	N/100m^2
BLT	2002	3[a]	0.74
	2003	18 (17-22)	4.39
BRK	2002	2	0.49
	2003	12 (12-12)	2.93
BRN	2002	2	0.49
	2003	17 (16-18)	4.15
RBT	2002	9 (8-10)	2.21
	2003	2 (0-4)	0.49

[a] Includes one BLTxBRK hybrid.

Average size of salmonids ≥ 75 mm in Section 1 ranged from 83 mm for bull trout in 2003 to 248 mm for brown trout in 2002 (Table 3). Length-frequency histograms for all species captured indicate the presence of multiple age-classes, but a dominance by age-0 individuals (Figures 2 through 6). In 2002, a single bull trout hybrid 201 mm total length was captured.

Table 3. Mean lengths (TL;mm) and mean weights (g) (sample size (n)) for individuals ≥ 75 mm, and length range for all individuals captured in Section 1 in Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

Species	Year	Mean length (n)	Length range	Mean weight (n)
BLT	2002	174 (2)	169-178	48(2)
	2003	83 (17)	64-99	5 (17)
BLTxBRK	2002	201 (1)	N/A	79 (1)
	2003	N/A	N/A	N/A
BRK	2002	147 (2)	51-214	127(1)
	2003	150 (12)	78-222	53 (12)
BRN	2002	248 (2)	137-359	244 (2)
	2003	98 (17)	49-186	15 (17)
ONC Spp.	2002	N/A	N/A	N/A
	2003	N/A	48-61	N/A
RBT	2002	128 (9)	93-174	26 (9)
	2003	120 (2)	82-157	22 (2)

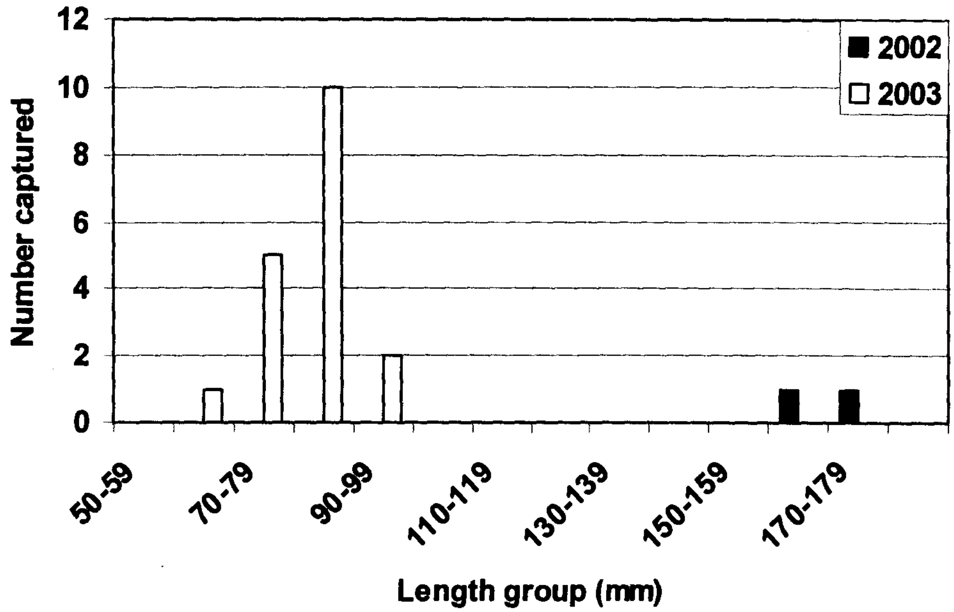

Figure 2. Length frequency histogram for bull trout captured in Section 1, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

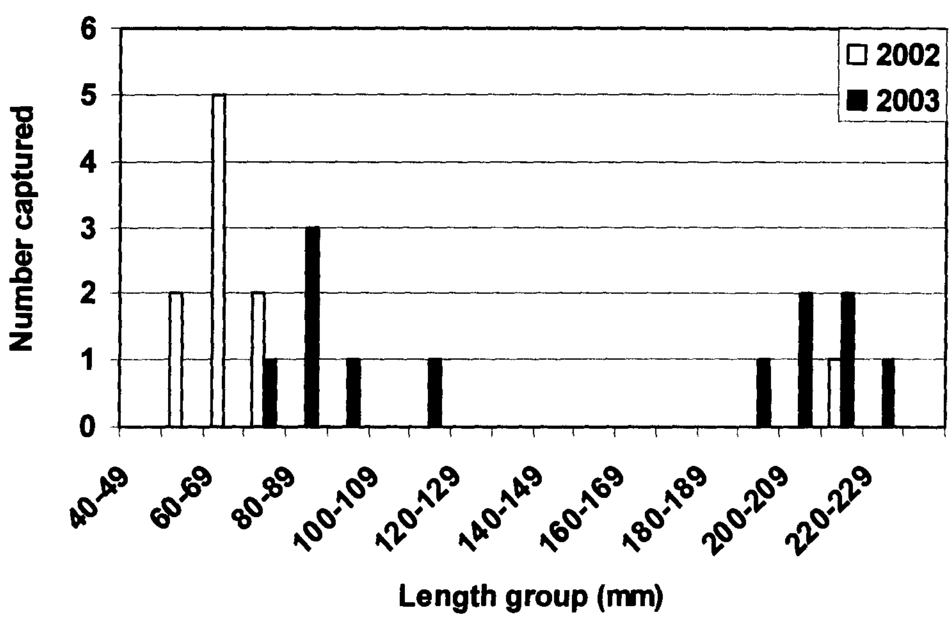

Figure 3. Length frequency histogram for brook trout captured in Section 1, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

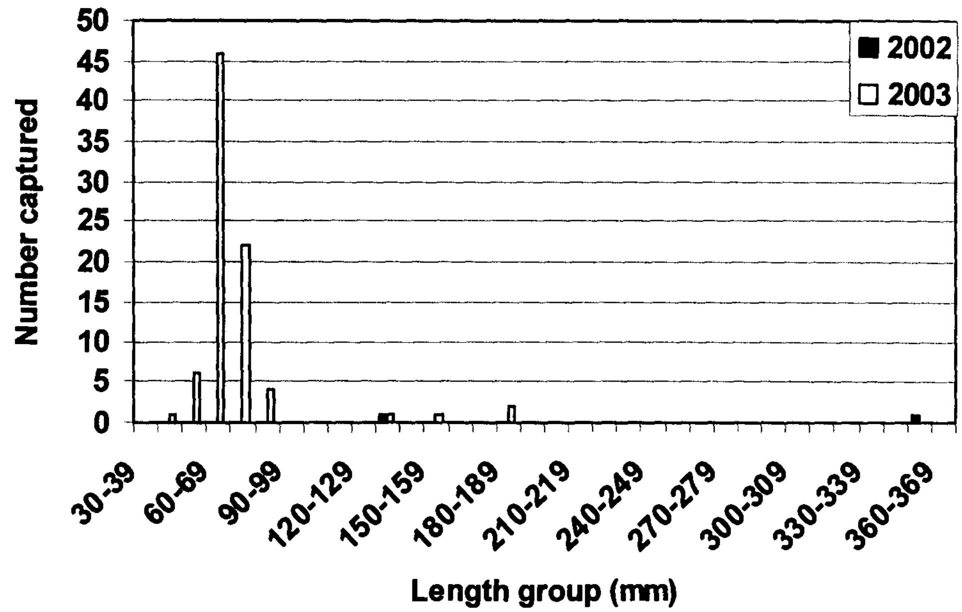

Figure 4. Length frequency histogram for brown trout captured in Section 1, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

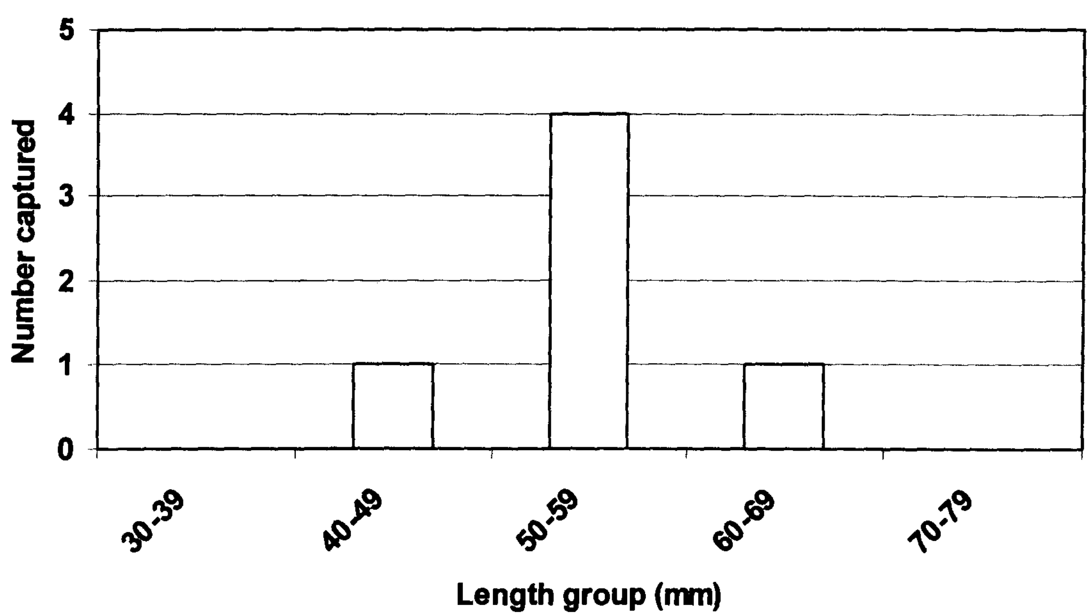

Figure 5. Length frequency histogram for *Oncorhynchus Spp.* captured in Section 1, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

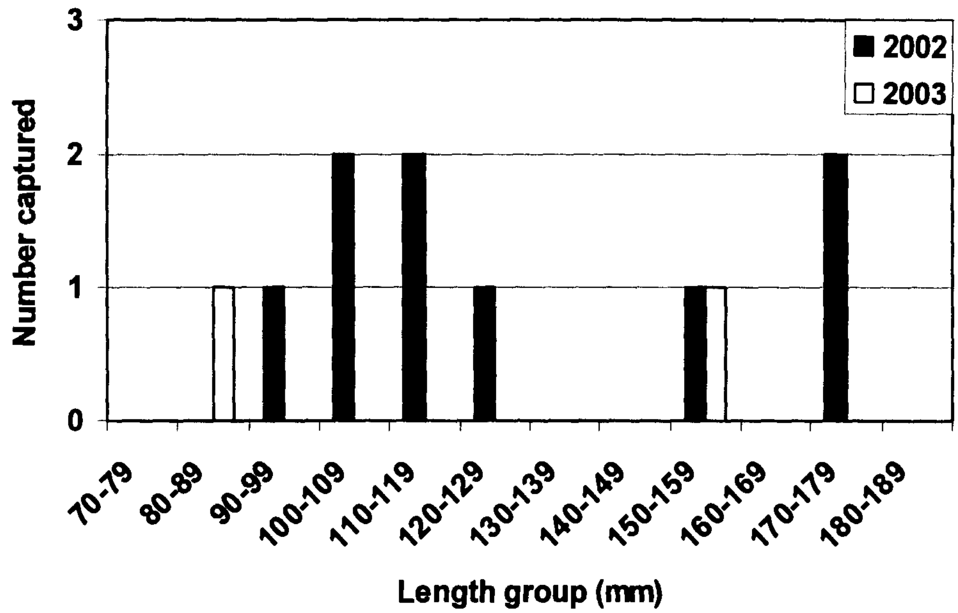

Figure 6. Length frequency histogram for rainbow trout captured in Section 1, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

In Section 2 in 2003, bull trout had the highest density (12.19/100m^2) ($\geq$ 75 mm), while both mountain whitefish and westslope cutthroat trout had the lowest density (0.31/100m^2), also in 2003 (Table 4).

Average size of salmonids $\geq$ 75 mm ranged from 88 mm for bull trout captured in 2003 to 167 mm for a single bull trout captured in 2002. However, four bull trout X brook trout hybrids captured in 2002 had the largest average size of 202 mm (Table 5). Length-frequency histograms from Section 2 for brown and bull trout indicate a dominance by age-0 individuals. Length frequency histograms for brook and rainbow trout indicate not only the presence of age-0 individuals, but also the presence of older age-classes (Figures 7 through 12). A single westslope cutthroat trout 117 mm total length was captured in 2003, while two westslope cutthroat trout hybrids (90 and 112 mm) were captured in 2002. In 2003, one mountain whitefish 103 mm total length was captured.

Table 4. Population estimates for salmonid species (≥75 mm;TL) captured in Section 2, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

Species	Year	Estimate (95% CI)	N/100m^2
BLT	2002	6 (4-8)[a]	1.23
	2003	39 (38-40)	12.19
BRK	2002	6	1.23
	2003	27 (27-28)	8.44
BRN	2002	7 (7.0-7.3)	1.44
	2003	30 (29-31)	9.38
MWF	2002	0.0	0.0
	2003	1	0.31
RBT	2002	13 (12-14)	2.67
	2003	12 (10-14)	3.75
WCT	2002	2 (0-7)[b]	0.41
	2003	1	0.31

[a]Includes four BLTxBRK hybrids.
[b]Includes two WCTxRBT hybrids.

Table 5. Mean lengths (TL;mm) and mean weights (g) (sample size (n)) for individuals ≥ 75 mm and length range for all individuals captured in Section 2 in Twin Creek, a tributary to the Clark Fork River, Idaho during 2002 and 2003.

Species	Year	Mean length (n)	Length range	Mean weight (n)
BLT	2002	167 (1)	N/A	42 (1)
	2003	88 (39)	65-106	7.0 (39)
BLTxBRK	2002	202 (4)	184-216	88 (4)
	2003	N/A	N/A	N/A
BRK	2002	133 (6)	42-245	46 (6)
	2003	142 (27)	64-226	44 (27)
BRN	2002	155 (7)	127-189	41 (7)
	2003	94 (30)	60-185	17 (19)
MWF	2002	N/A	N/A	N/A
	2003	103 (1)	N/A	6 (1)
ONC Spp.	2002	N/A	N/A	N/A
	2003	N/A	39-68	N/A
RBT	2002	131 (13)	97-185	26 (13)
	2003	153 (12)	62-218	43 (12)
WCT	2002	N/A	N/A	N/A
	2003	117 (1)	N/A	15 (1)
WCTxRBT	2002	101 (2)	90-112	12 (2)
	2003	N/A	N/A	N/A

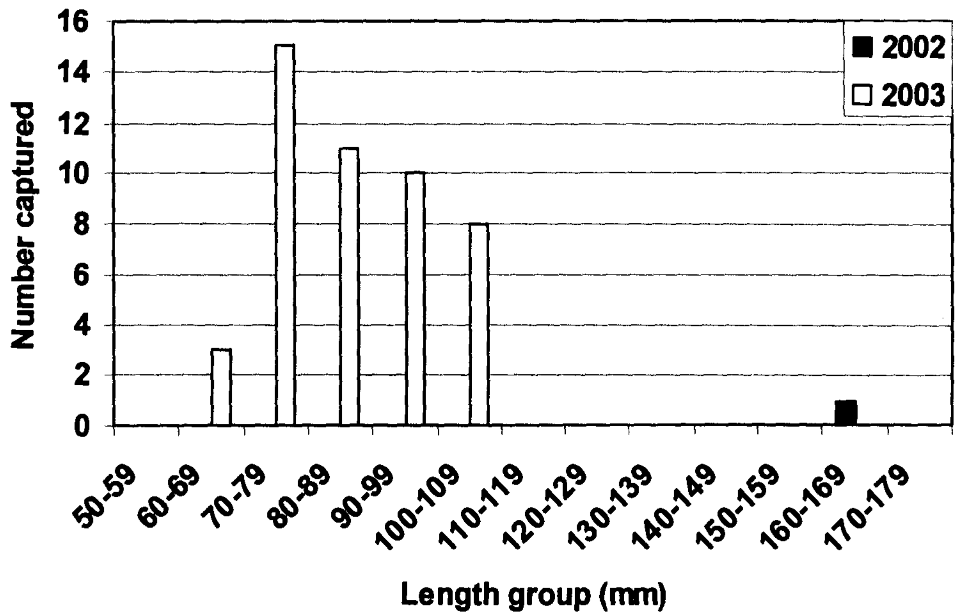

Figure 7. Length frequency histogram for bull trout captured in Section 2, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

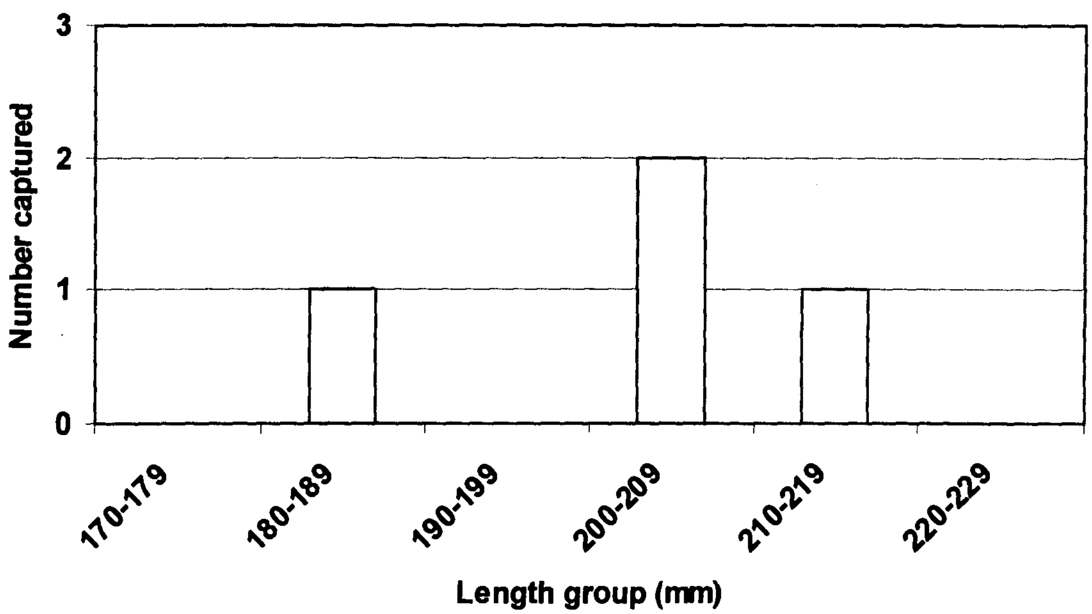

Figure 8. Length frequency histogram for bull trout hybrids captured in Section 2, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002.

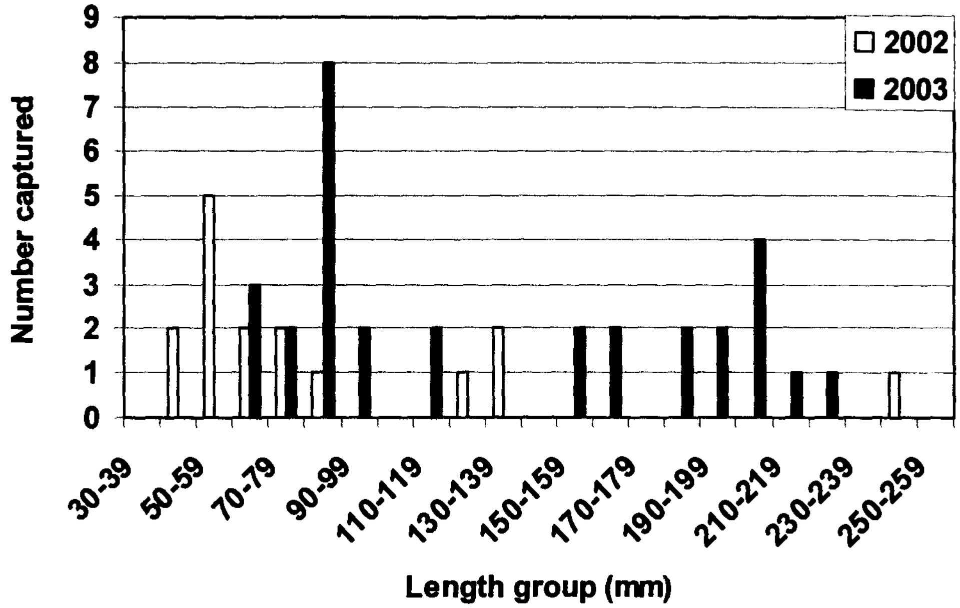

Figure 9. Length frequency histogram for brook trout captured in Section 2, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

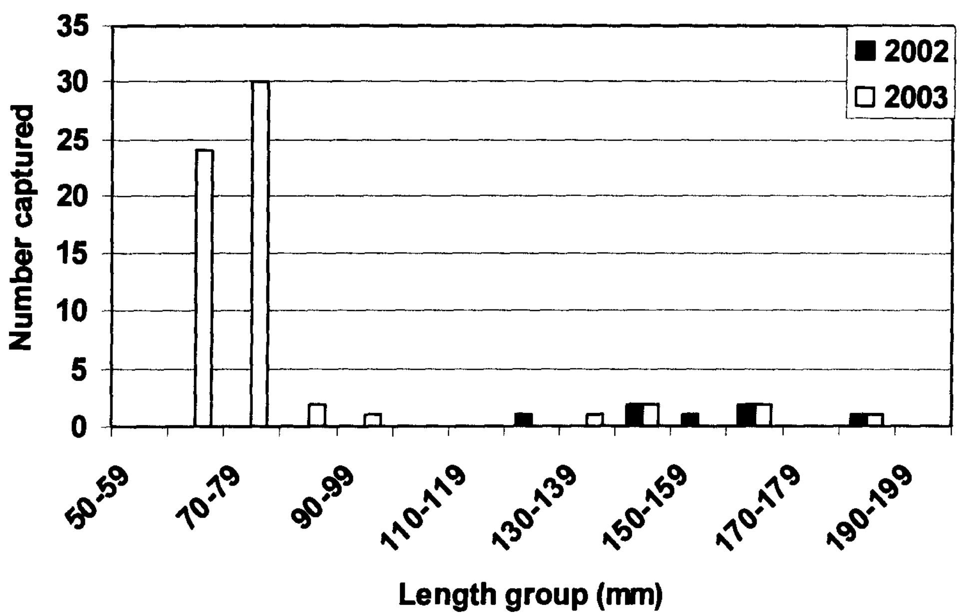

Figure 10. Length frequency histogram for brown trout captured in Section 2, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

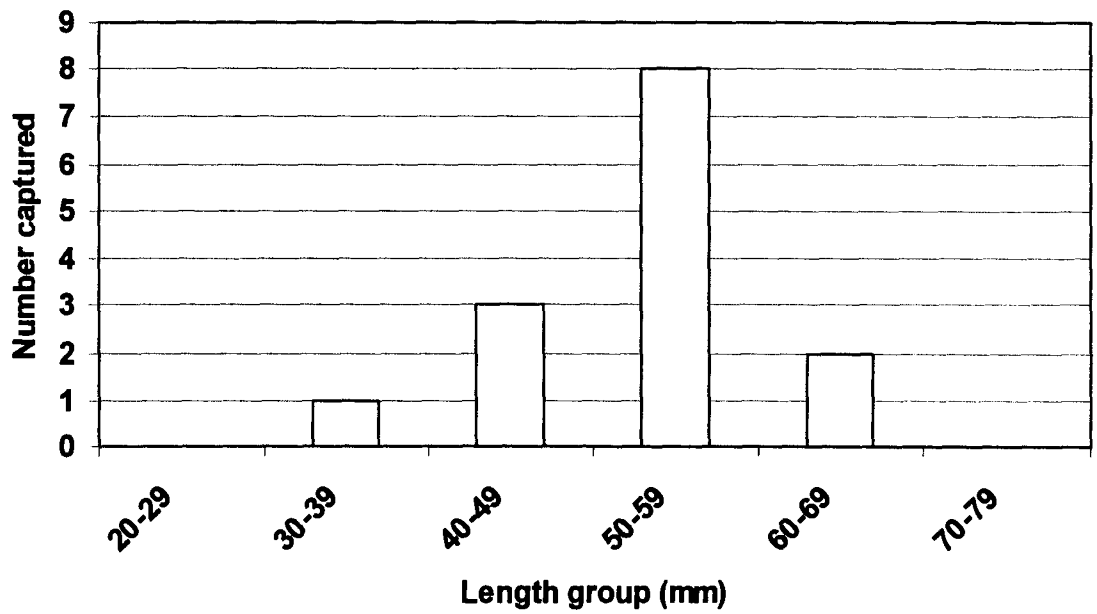

Figure 11. Length frequency histogram for *Oncorhynchus Spp.* captured in Section 2, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

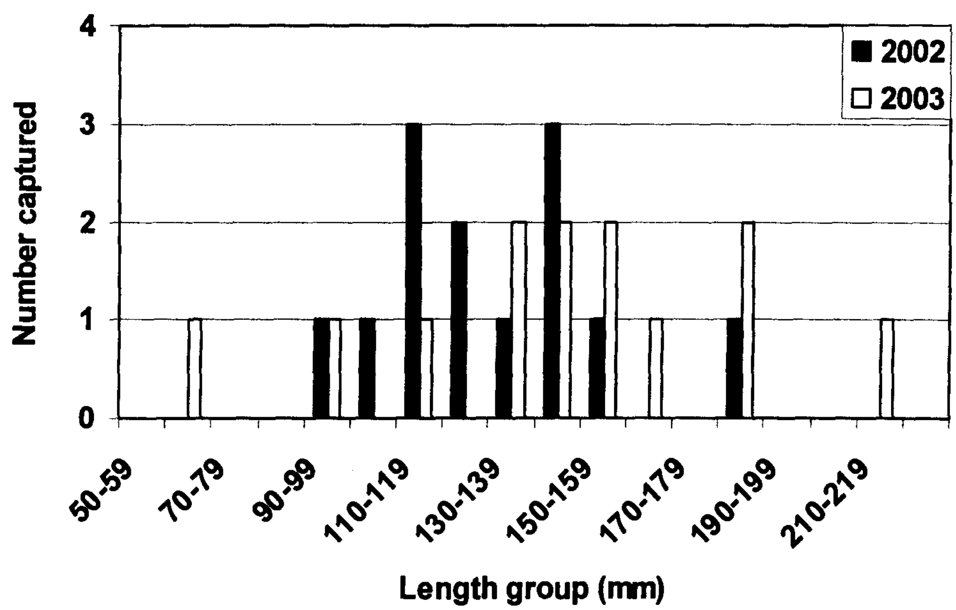

Figure 12. Length frequency histogram for rainbow trout captured in Section 2, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

In Section 3 in 2002, rainbow trout had the highest density (4.0/100m^2) (≥75 mm), while bull trout and westslope cutthroat trout (including hybrids), and brown trout all shared the lowest density (0.27/100m^2) (Table 6).

Average size of salmonids ≥75 mm in Section 3 ranged from 95 mm for bull trout captured in 2003 to 126 mm for brown trout, also in 2003. A single westslope cutthroat trout hybrid and bull trout hybrid of 95 mm were captured in 2002 and 2003, respectively, while a single bull trout hybrid of 187 mm was captured in 2002. In 2003, two mountain whitefish of 107 mm and 114 mm were also captured (Table 7). The length-frequency histogram from Section 3 for bull trout captured indicates a dominance by age-0 individuals. Brook and rainbow trout length-frequency histograms show the presence of multiple age-classes. Westslope cutthroat trout in Section 3 appear to consist largely of a single age-class, most likely age-1(Figures 13 through 18).

Table 6. Population estimates for salmonid species (≥75 mm;TL) captured in Section 3, Twin Creek, a tributary to the Clark Fork River, Idaho during 2002 and 2003.

Species	**Year**	**Estimate (95% CI)**	**N/100m^2**
BLT	2002	1 [a]	0.27
	2003	6 (3-9) [b]	3.0
BRK	2002	2	0.53
	2003	6 (5-7)	2.81
BRN	2002	1	0.27
	2003	2	0.63
MWF	2002	0.0	0.0
	2003	2	0.55
RBT	2002	15 (13-17)	4.0
	2003	6 (3-9)	2.73
WCT	2002	1 [c]	0.27
	2003	15 (2-28)	3.55

[a]Includes one BLTxBRK hybrid.
[b]Includes one BLTxBRK hybrid.
[c]Includes one WCTxRBT hybrid.

In Section 4, westslope cutthroat trout (including hybrids) captured in 2003 had the highest density (12.05/100m^2) (≥75 mm), and brook trout captured in both 2002 and 2003 had the lowest density (0.33/100m^2) (Table 8). No bull trout were captured in section 4 in 2002 or 2003, although two bull trout hybrids (102 mm and 103 mm) were captured in 2003.

Average size of salmonids ≥75 mm in section 4 ranged from 92 mm for a single brook trout captured in 2002, to 171 mm for a single brook trout captured in 2003 (Table 9). Length-frequency histograms from Section 4 for all species captured indicate the presence of multiple age-classes, but a dominance by age-0 individuals (Figures 19 through 23).

Table 7. Mean lengths (TL;mm) and mean weights (g) (sample size (n)) for individuals ≥ 75 mm and length range for all individuals captured in Section 3 in Twin Creek, a tributary to the Clark Fork River, Idaho during 2002 and 2003.

Species	Year	Mean length (n)	Length range	Mean weight (n)
BLT	2002	N/A	N/A	N/A
	2003	95 (10)	74-219	11 (10)
BLTxBRK	2002	187 (1)	N/A	56 (1)
	2003	95 (1)	N/A	5 (1)
BRK	2002	124 (2)	55-125	19 (2)
	2003	105 (10)	60-158	12 (10)
BRN	2002	100 (1)	N/A	10 (1)
	2003	126 (2)	69-166	26 (2)
MWF	2002	N/A	N/A	N/A
	2003	111 (2)	107-114	10 (2)
ONC Spp.	2002	N/A	N/A	N/A
	2003	N/A	40-60	N/A
RBT	2002	110 (15)	85-149	15 (15)
	2003	121 (10)	97-177	19 (10)
WCT	2002	N/A	N/A	N/A
	2003	111 (13)	91-164	13 (13)
WCTxRBT	2002	95 (1)	N/A	9 (1)
	2003	N/A	N/A	N/A

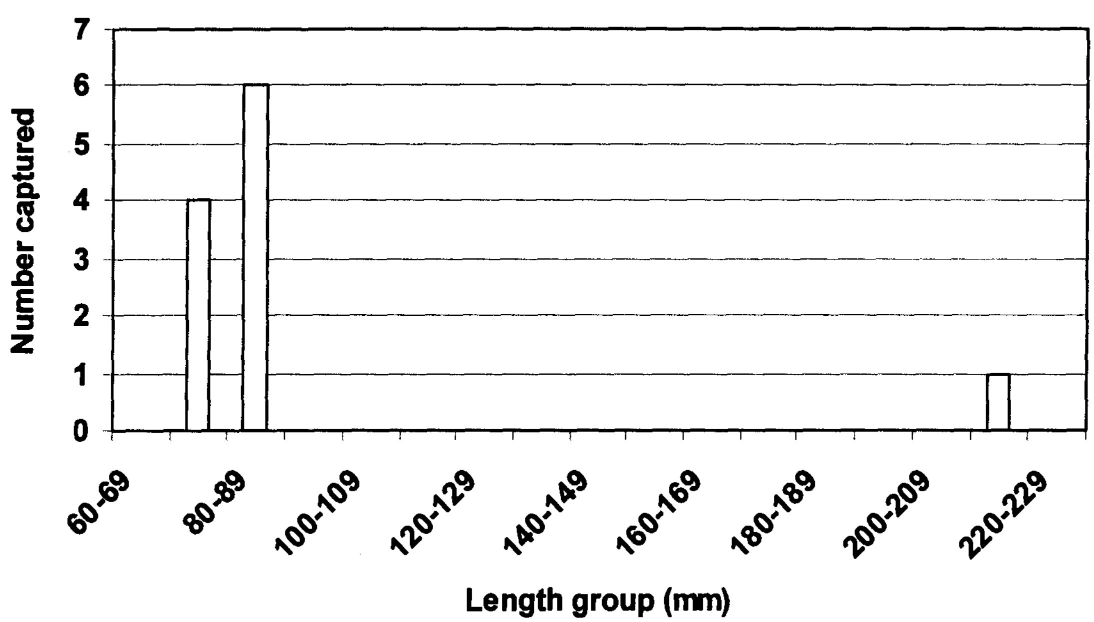

Figure 13. Length frequency histogram for bull trout captured in Section 3, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

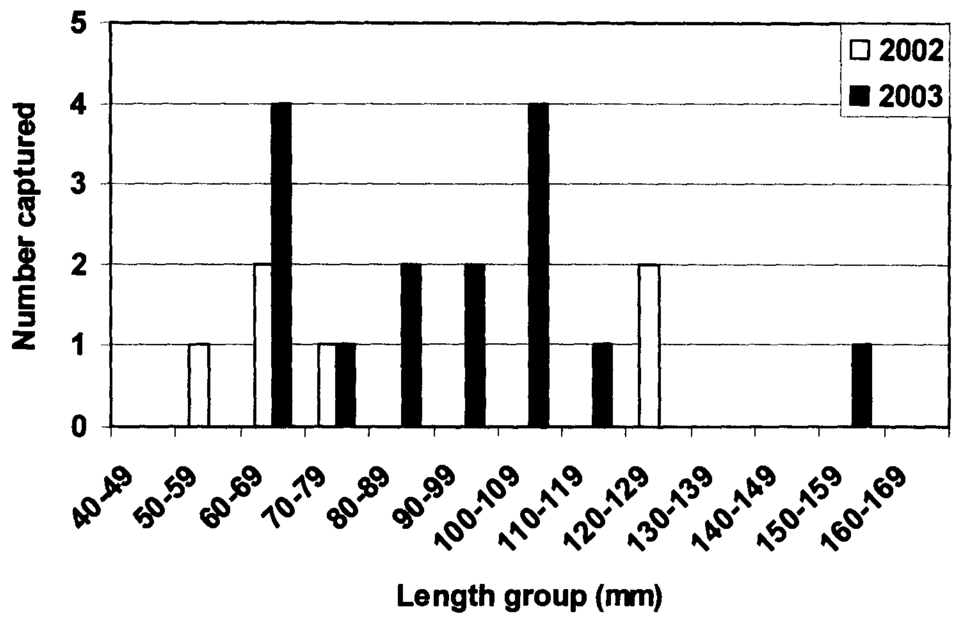

Figure 14. Length frequency histogram for brook trout captured in Section 3, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

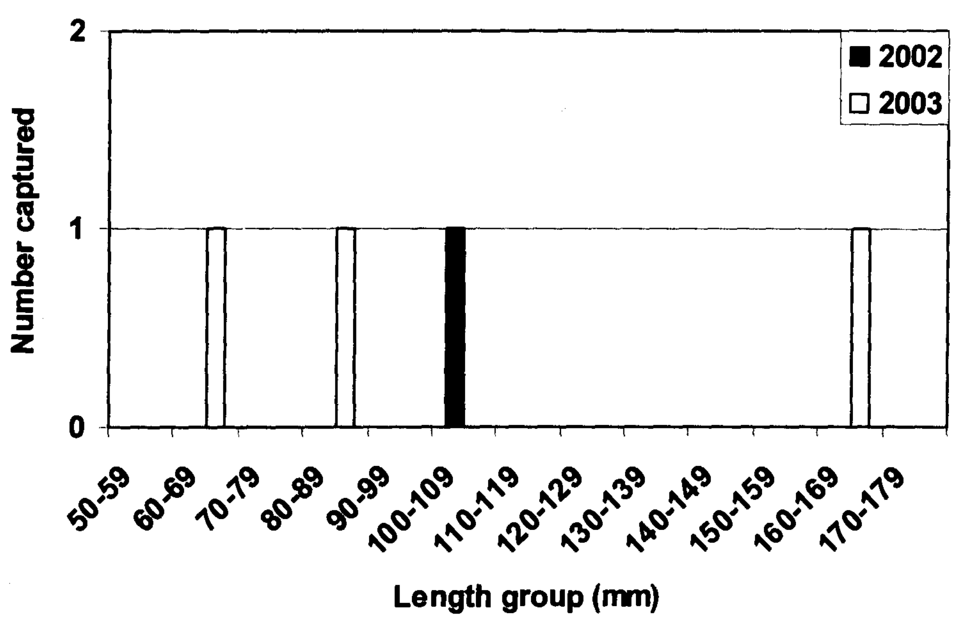

Figure 15. Length frequency histogram for brown trout captured in Section 3, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

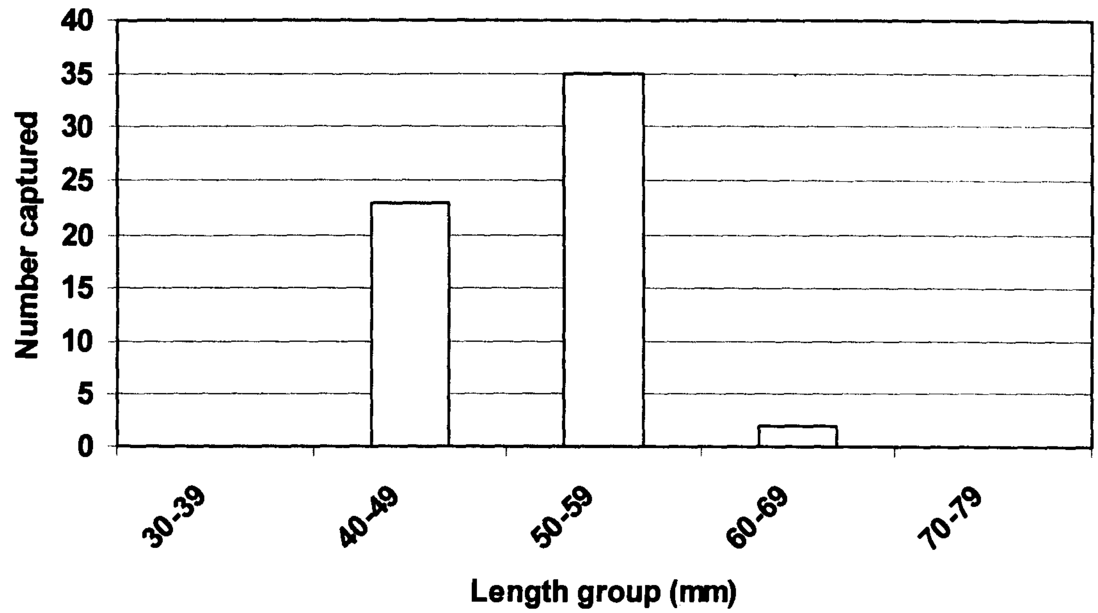

Figure 16. Length frequency histogram for *Oncorhynchus Spp.* captured in Section 3, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

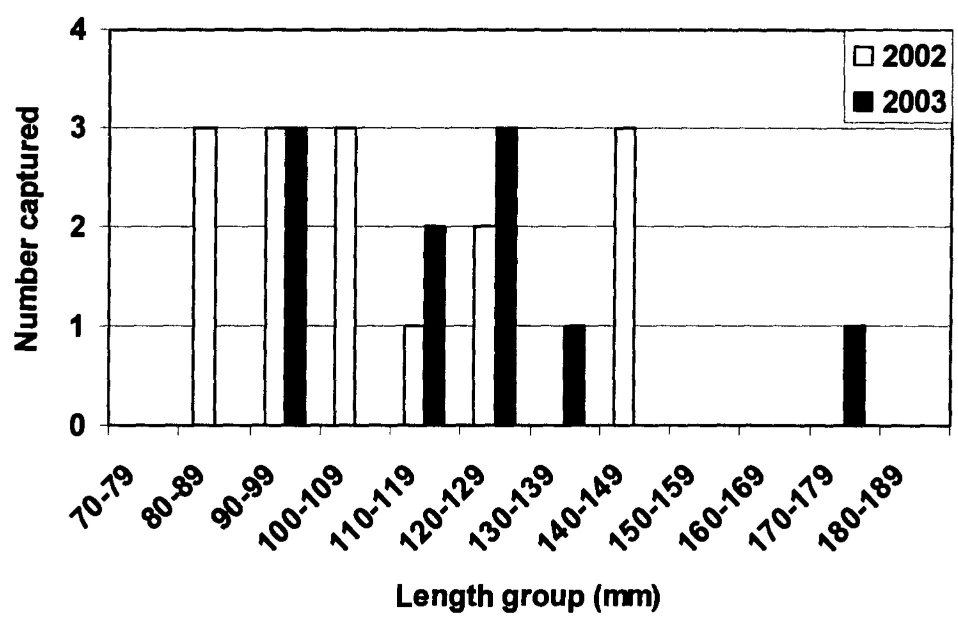

Figure 17. Length frequency histogram for rainbow trout captured in Section 3, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

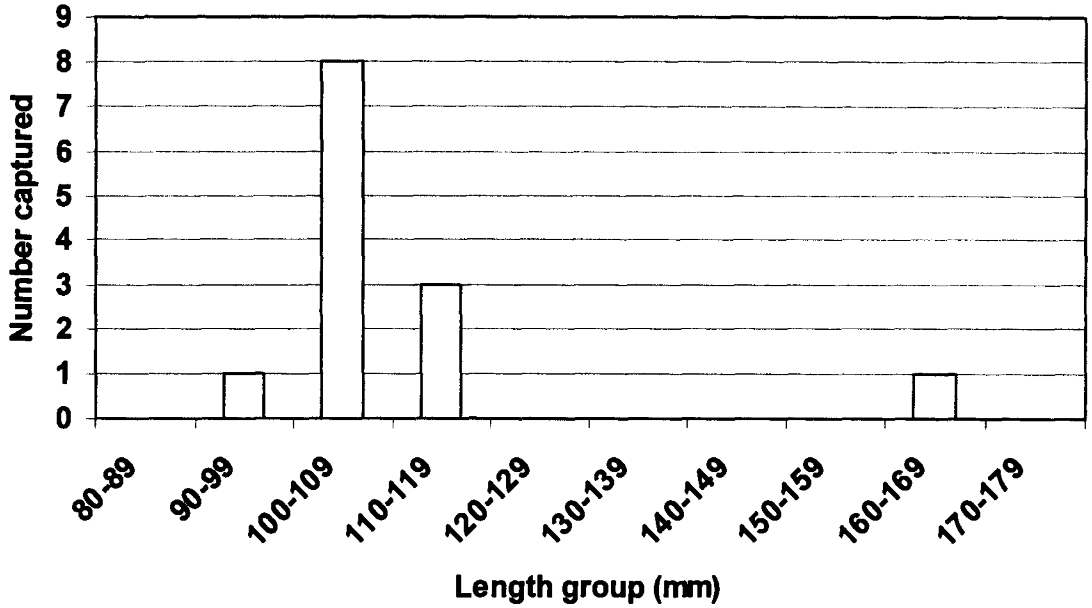

Figure 18. Length frequency histogram for westslope cutthroat trout captured in Section 3, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

Table 8. Population estimates for salmonid species captured in Section 4, Twin Creek, a tributary to the Clark Fork River, Idaho during 2002 and 2003.

Species	Year	Estimate (95% CI)	N/100m^2
BLT	2002	0.0	0.00
	2003	2[a]	0.65
BRK	2002	1	0.33
	2003	1	0.33
RBT	2002	31 (29-33)	9.94
	2003	32 (30-34)	10.42
WCT	2002	2[b] (0-4)	0.64
	2003	37[c] (36-38)	12.05

[a]Includes two BLTxBRK hybrids.
[b]Includes two WCTxRBT hybrids.
[c]Includes two WCTxRBT hybrids.

Table 9. Mean lengths (TL;mm) and mean weights (g) (sample size (n)) for individuals ≥ 75 mm and length range for all individuals captured in Section 4 in Twin Creek, a tributary to the Clark Fork River, Idaho during 2002 and 2003.

Species	Year	Mean length (n)	Length range	Mean weight (n)
BLTxBRK	2002	N/A	N/A	N/A
	2003	103 (2)	102-103	9 (2)
BRK	2002	92 (1)	N/A	8 (1)
	2003	171 (1)	60-171	45 (1)
ONC Spp.	2002	N/A	N/A	N/A
	2003	N/A	39-61	N/A
RBT	2002	102 (31)	77-176	13 (31)
	2003	126 (32)	93-225	23 (32)
WCT	2002	N/A	N/A	N/A
	2003	104 (35)	88-124	10 (35)
WCTxRBT	2002	100 (2)	79-120	11 (2)
	2003	96 (2)	90-101	8 (2)

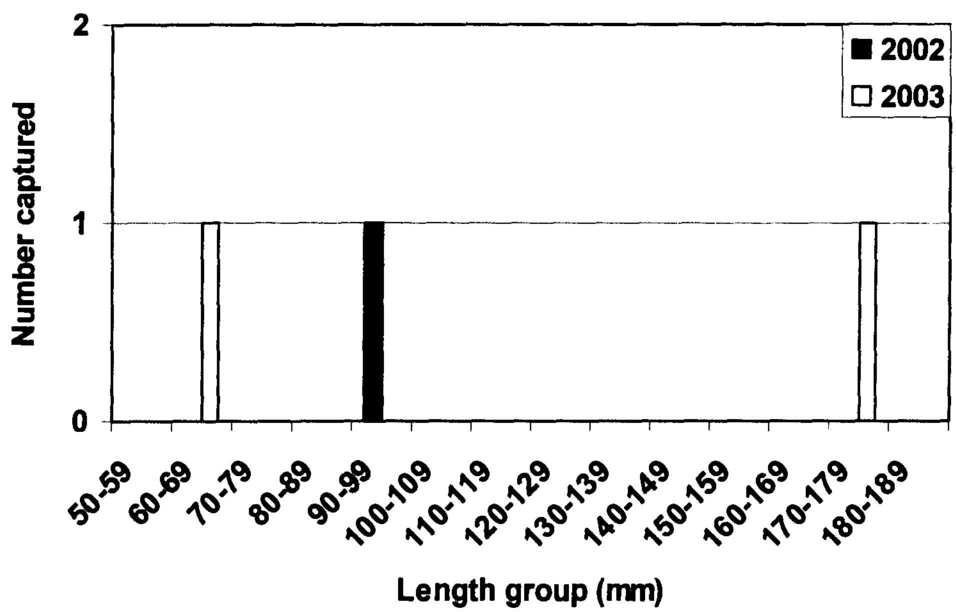

Figure 19. Length frequency histogram for brook trout captured in section 4, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

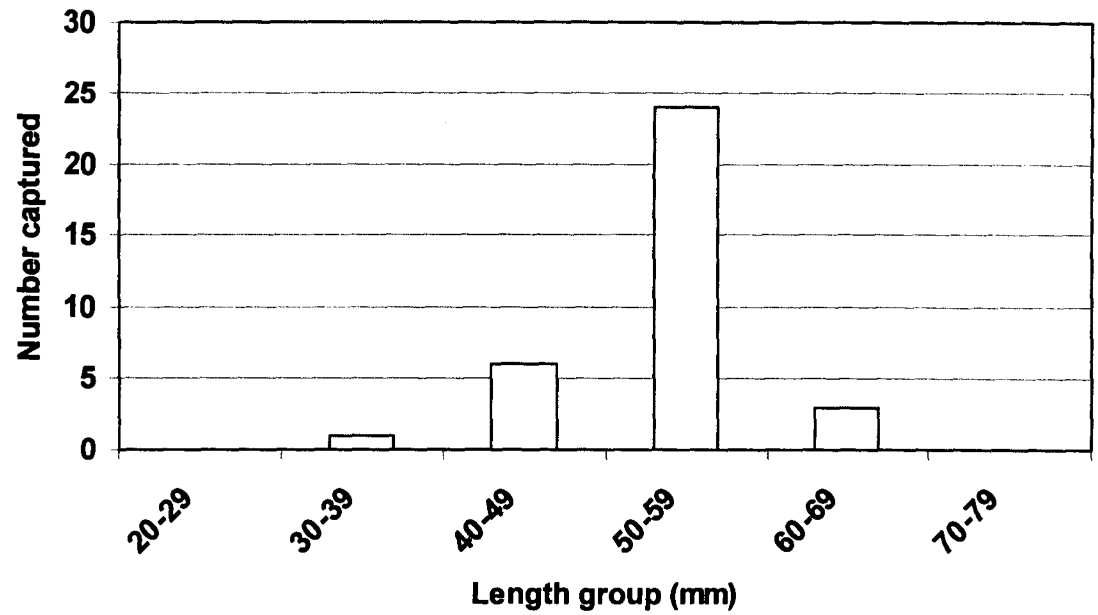

Figure 20. Length frequency histogram for *Oncorhynchus Spp.* captured in section 4, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

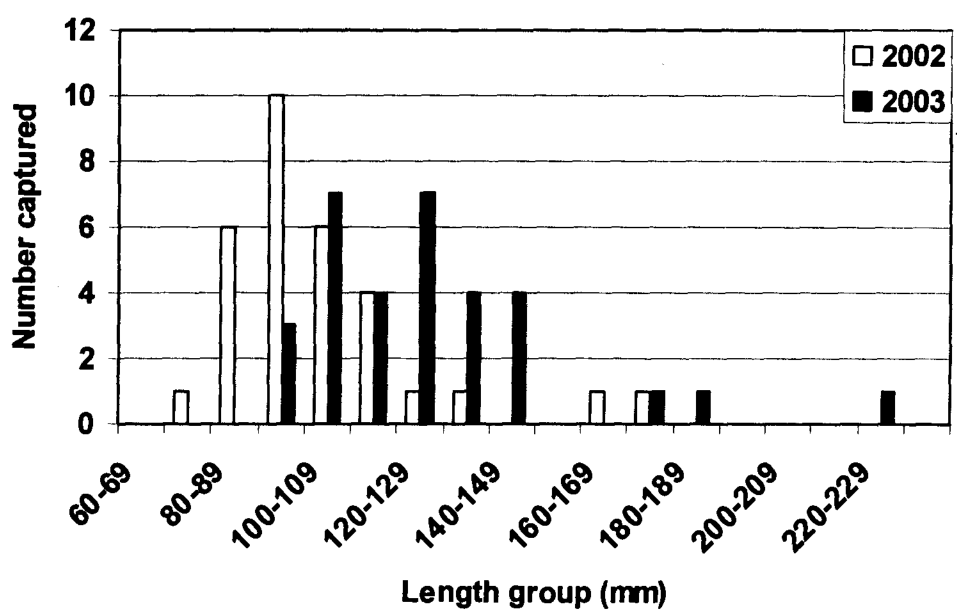

Figure 21. Length frequency histogram for rainbow trout captured in section 4, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

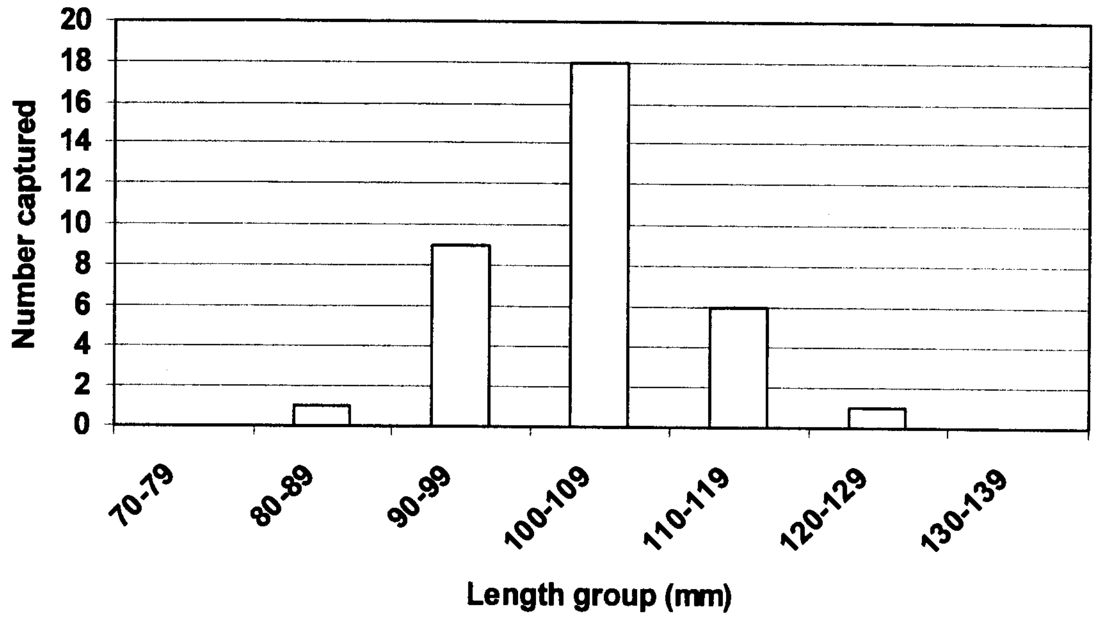

Figure 22. Length frequency histogram for westslope cutthroat trout captured in section 4, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2003.

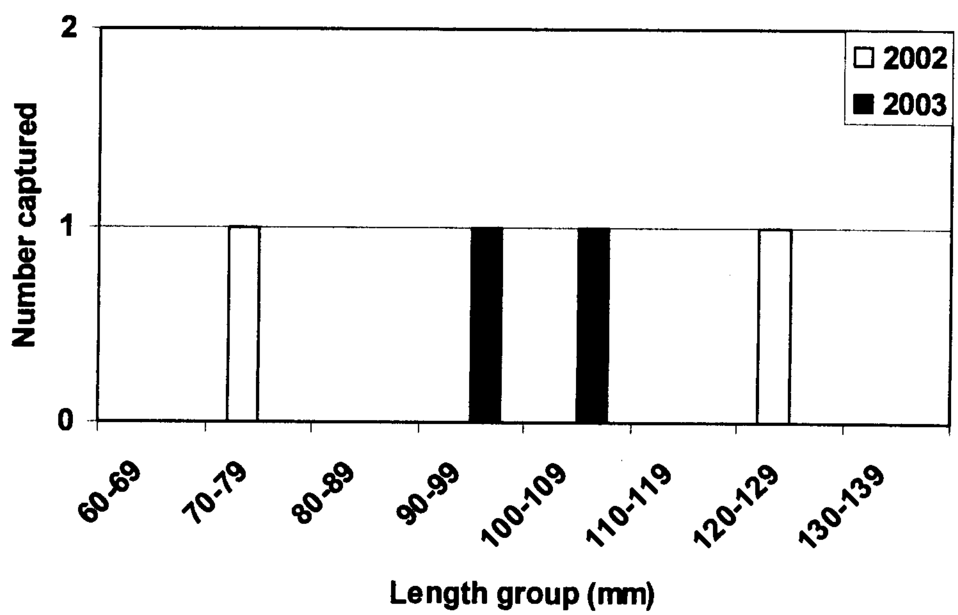

Figure 23. Length frequency histogram for westslope cutthroat trout hybrids captured in section 4, Twin Creek, a tributary to the Clark Fork River, Idaho, during 2002 and 2003.

DISCUSSION

Pratt (1985) observed the same salmonid species assemblage in Twin Creek in 1983 and 1984 as we did in our sampling in 2002 and 2003. Existing data (Downs et. al. 2003, Downs and Jakubowski 2003) suggests that the juvenile bull trout population in Twin Creek is comprised primarily of age-0 individuals. This is in contrast to previous electrofishing results in other LPO tributaries, such as Trestle and Gold creeks, which showed the presence of multiple age-classes of juvenile bull trout in tributaries to LPO (Fredericks et al. 2000). Based on the data in this study and our trapping results, it appears that very few juvenile bull trout remain in Twin Creek beyond age-0. Based on previous otolith microchemical work of Horan and Moran (2001), age-0 outmigrants from Trestle Creek do not appear to make a substantial contribution to adult spawning escapement. If size at outmigration confers a survival advantage in the lake environment, as some of our work on Trestle Creek (Downs and Jakubowksi 2003), and the work of others (Horan and Moran 2001) suggests, the Twin Creek bull trout population should benefit from the creation of more complex tributary habitat in Twin Creek. This habitat should allow juvenile bull trout to spend one to three years rearing in Twin Creek before migrating to LPO, as has been observed in other LPO tributaries, and is more typical for the species (Fraley and Shepard 1989, Pratt 1992).

The presence of exotic species such as brook and brown trout, competing for food and space with juvenile bull trout, may adversely affect the bull trout response to the stream restoration. During the annual population estimates, all brook trout were removed from the sections. In total we removed 40 brook trout and six bull X brook trout hybrids from the four estimate sections in 2002. In 2003, we removed a total of 60 brook trout and five bull X brook trout hybrids from the four estimate sections. Brook trout abundance in the sections did not appear to be impacted consistently by the previous years removal effort, with the exception of section four, which showed a marked decline in brook trout abundance from 2000 to 2003. It is likely that brook trout in habitat adjacent to the depletion sections rapidly recolonized the sections. In a sample of 33 individual juvenile bull trout from Twin Creek, Neraas and Spruell (2001) identified 10 bull X brook trout hybrids, one of which was a second generation hybrid. The continued presence of bull X brook trout hybrids indicates hybridization is an ongoing problem.

Percent species composition pre and post restoration in Twin Creek shows a great deal of variability. This is complicated by the lack of repeatable sampling sections because the project was a complete channel reconstruction. However, if we compare the pre and post-restoration sampling results from similar locations along the longitudinal gradient of Twin Creek, we can get some idea of the amount of change that has occurred. The density of juvenile bull trout was highest in the lowest reaches of Twin Creek. This correlates with the known location of adult bull trout spawning in Twin Creek, which occurs between the mouth of Twin Creek and River Road. Across the four years we have sampled lower Twin Creek, we have not seen a consistent shift in percent species composition (Figures 24 through 26). Variation in sampling dates on Twin Creek may also be partially responsible for the differing proportions of salmonid species captured in the lower reaches of Twin Creek. Juvenile salmonids experience rather rapid growth in Twin Creek as is evidenced by length-frequency histograms, and sampling later in the summer allows for more individuals to grow into the 75 mm and greater length group by the time sampling occurs. For example, in 2001, sampling was conducted in late June, and although large numbers of age-0 bull and brook trout were present in the lowest sampling section, they were less than 75 mm in length at the time of sampling and were not included in the estimate due to electrofishing efficiency concerns. By late July and August, when sampling was conducted in 2000, 2002, and 2003, many of these age-0 bull and brook trout are larger than 75 mm and were included in the population estimate. Greater effort to standardize sampling times annually would reduce this source of variation, but not eliminate it. Variation in water temperature and water quantity annually may also impact age-0 growth rates, even if sampling occurred on the same date every year.

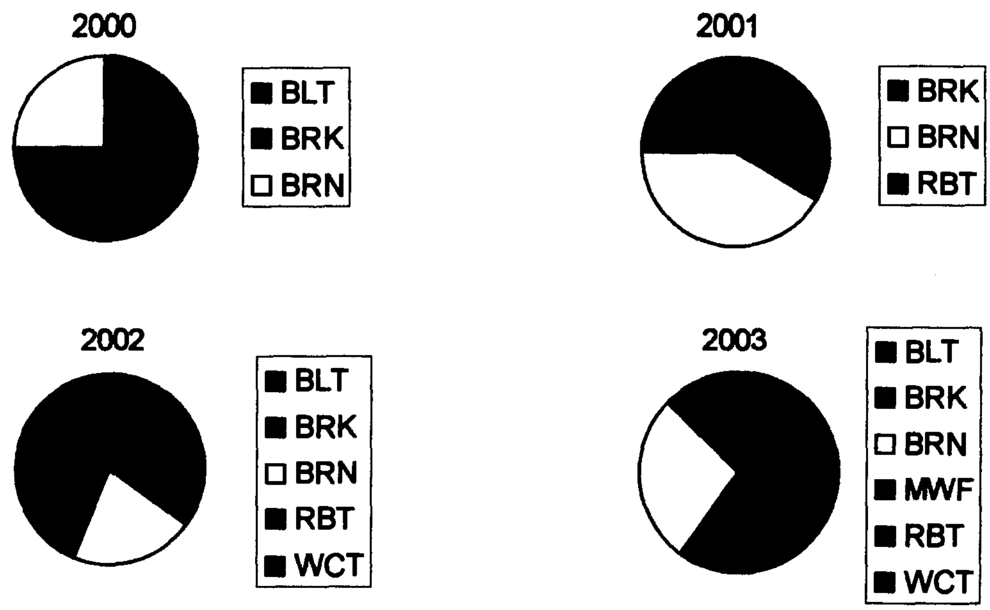

Figure 24. Salmonid species composition in lower Twin Creek pre (2000 and 2001) and post (2002 and 2003) stream restoration efforts. Sample locations differed from the pre to the post sampling periods, but were similar in location along the longitudinal gradient of the stream channel.

Utilizing the abundance of age-1 and older salmonids, rather than all those greater than or equal to 75 mm, by species, would provide a mechanism to minimize the impact of seasonal variation in sampling on the annual population estimates, and provide improved resolution in understanding the projects effects on the bull trout population. Zero age-1 and older bull trout were captured in the lowest electrofishing section in 2000 or 2001 based on fish length (> 125 mm; TL). In contrast, in Section 2 in 2002, one age-1 or older juvenile bull trout (167 mm) and three suspected bull trout X brook trout hybrids (length range = 184-216 mm) were captured post-restoration. In addition, two other juvenile bull trout, 178 and 169 mm in length, as well as a 201 mm suspected bull X brook trout hybrid were captured further downstream, in Section 1 in 2002 (post-restoration). Further monitoring is needed to determine if a trend exists in increased numbers of age-1 and older bull trout, as well as increasing abundance of age-0 bull trout in the lower reaches of Twin Creek.

In the middle reach of Twin Creek in 2000 no bull trout were captured, while in 2001, a single 161 mm bull trout was captured. No age-0 bull trout were captured in this reach in either year. In 2002, the year following the completion of the restoration project, a single 187 mm bull X brook trout hybrid was captured in the comparison Section 3, post-restoration. In 2003, a total of 12 juvenile bull trout were captured in the comparison Section 3. One of these fish was 219 mm in length, while the others were age-0 bull trout. A series of log-drop structures, coupled with low summer/fall flows and stream flow intermittency in the old channel just downstream of the middle electrofishing section (sampled in 2000 and 2001) may have been impeding upstream movement of juvenile or adult bull trout. However, the new channel also experiences intermittency during late summer/fall periods and it appears that either juvenile bull trout are moving upstream into this area at other times of the year when flows permit, or some adult bull trout are moving upstream into this reach to spawn. The scenario of movement of juvenile bull trout upstream into this reach from the known spawning area located farther downstream (Pratt 1985) is more plausible, as channel intermittency on the restored channel likely limits upstream movement of adult bull trout during the periods of the year when adult bull trout are found in Twin Creek (Downs et. al. 2003; Downs and Jakubowski 2003). Further monitoring is needed to determine if a trend exists in increased numbers of juvenile bull trout observed in the middle reaches Twin Creek.

Section 4 (Upper sampling reach) has been consistently sampled from 2000 through 2003 and was not impacted by stream restoration. We observed consistently low numbers of bull trout in this section across all years. Numbers of brook trout appeared to decline over time in this section, but this may be due to annual removal of brook trout associated with our sampling efforts. Rainbow and westslope cutthroat trout had the highest densities, but their numbers did fluctuate relatively widely over the study period. In 2003, we observed an increase in number and the relative abundance of westslope cutthroat trout in both Section 4 ("control" reach), as well as middle reaches of Twin Creek. This would suggest that the observed increase in westslope cutthroat trout abundance in 2003 may be the result of increased reproductive effort or success in a larger area of Twin Creek, beyond that of the restoration area. Continued monitoring will be needed to determine the fish population response to the restoration work.

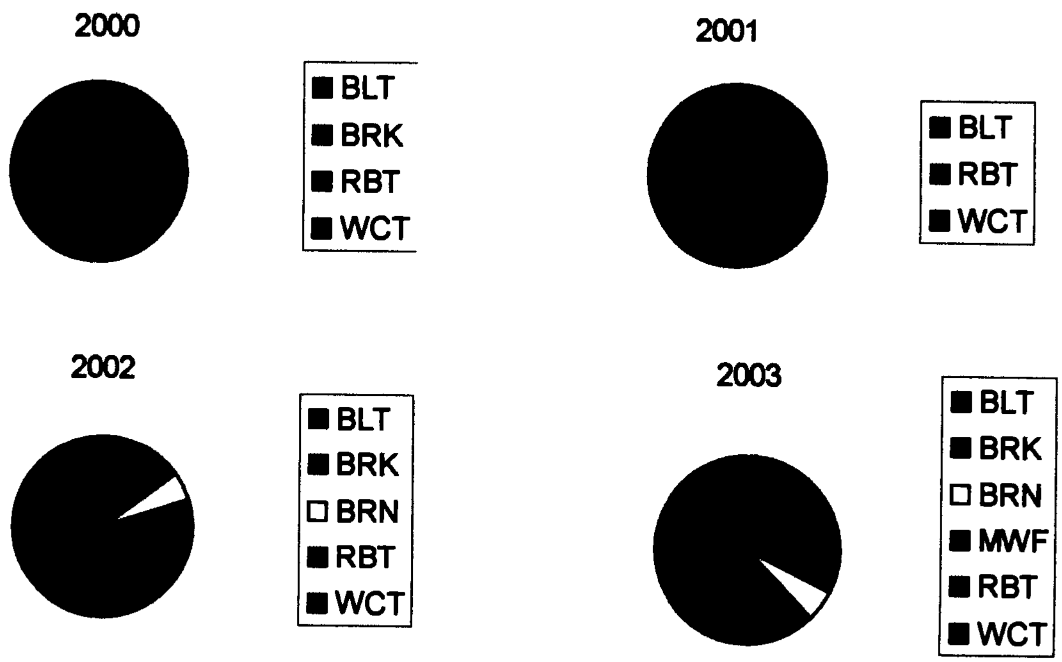

Figure 25. Salmonid species composition in middle Twin Creek, a tributary to the Clark Fork River, Idaho, pre (2000 and 2001) and post (2002 and 2003) stream restoration efforts. Sample locations differed from the pre to the post sampling periods, but were similar in location along the longitudinal gradient of the stream channel.

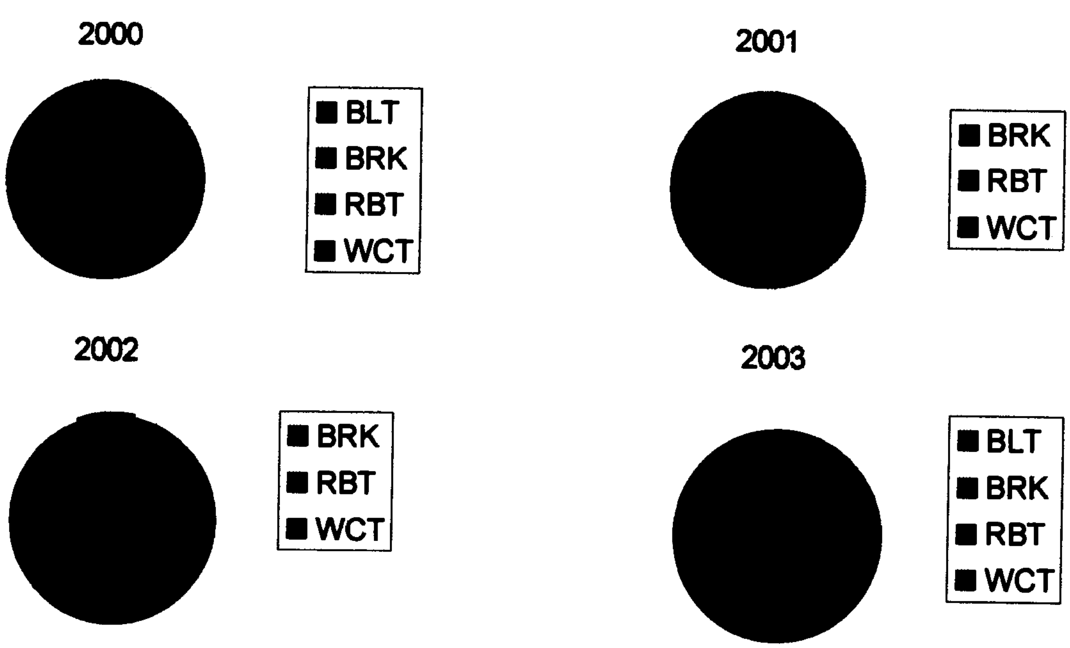

Figure 26. Salmonid species composition in upper Twin Creek, a tributary to the Clark Fork River, Idaho, pre (2000 and 2001) and post (2002 and 2003) stream restoration efforts in the same 100 m untreated reach.

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