Bull Trout Studies in the Salmo River Watershed: 2000

Report Prepared For:

BC Hydro
Kootenay Generation Area
601 18th Street
Castlegar, B.C.
V1N 4A2

Report Prepared By:

James Baxter
Baxter Environmental
209 Second Street
Nelson, B.C.
V1L 2K9

March 2001

EXECUTIVE SUMMARY

This report summarizes the results of studies that have been undertaken in the Salmo River watershed by BC Hydro in 2000. The work has focussed on documenting the status of the bull trout population in the watershed, and on collecting data that can be used for habitat enhancement purposes. Specific components of the work included redd counts, snorkel surveys, and water quality monitoring.

Water temperature data collected in the spring of 2000 suggested all of the sites that were located in known bull trout spawning areas experienced water temperatures below 9ºC during the spawning period. As in the winter of 1997/98 and 1998/99, water temperatures did not drop below freezing in the winter of 1999/2000 in areas that bull trout spawned.

In total 29 bull trout were captured by angling, measured, Floy® tagged and released. Of the 29 bull trout angled, 6 were males, 22 were females and 1 was of undetermined sex. Females averaged 50 cm in fork length, while males averaged 55 cm. The average catch per unit effort for bait fishing, fly fishing and spoon fishing was 0.33, 0.37, and 0.64 bull trout per angler day, respectively. Five captured bull trout were additionally tagged with a radio tag for the ongoing bull trout radio telemetry study in the Salmo River watershed.

Observations made during snorkel surveys suggested that bull trout were present in high densities in early summer within the surveyed section, but had largely moved out of the section by late August. During the surveys, rainbow trout, eastern brook trout, sucker, northern pikeminnow, and mountain whitefish were also observed. The sightability of bull trout on each snorkel survey increased as water levels dropped and visibility increased. In general, the sightability of bull trout decreased as discharge increased. Using these sightability estimates, the counts of bull trout (>30 cm) were expanded.

In total, 78 redds were enumerated in 2000, and as previously documented, bull trout spawners and redds were observed in Sheep Creek, Clearwater Creek and the upper section of the Salmo River. Sheep Creek was the area of the highest concentration of spawning activity, followed by the upper Salmo River. During the redd surveys, bull trout that were Floy® tagged or radio tagged in the summer of 1999 or 2000 were observed in all of the areas that were surveyed. Rainbow trout were the numerically dominant species observed during snorkel surveys in tributaries to the Salmo River.

ACKNOWLEDGEMENTS

Field and technical support during this work was provided by a number of individuals who insured the project's success: **BC Hydro**: Gary Birch, Ric Olmsted, Dave Wilson, Dean den Biesen, Sean Ord; **BC Ministry of Environment, Lands and Parks**: John Bell, Jay Hammond, Bob Lindsay, Colin Spence, Albert Chirico; **Columbia-Kootenay Fisheries Renewal Partnership**: Kenton Andreashuk; **Baxter Environmental**: Jeremy Baxter, Robyn Roome, John Hagen; **Salmo Watershed Streamkeepers Society**: Gerry and Alice Nellestijn, Peter Neil, the Maloney family.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Since 1997, BC Hydro has taken a proactive role in monitoring the bull trout (*Salvelinus confluentus*) population of the Salmo River watershed as part of the corporation's ongoing commitments with regard to the installation of a fourth turbine at Seven Mile Dam (see Baxter et al. 1998; Baxter 1999). Over the past three years, the projects (focussing on bull trout) that BC Hydro has undertaken, or provided funding for, have included:

- juvenile density and distribution studies through electroshocking;
- water temperature and water chemistry monitoring;
- adult abundance monitoring through snorkel surveys;
- adult escapement monitoring through redd counts; and
- identification of adult movement, life-history and spawning sites through radio telemetry.

In 2000, BC Hydro continued studies in the watershed, specifically focussing on monitoring the abundance of adult bull trout in the drainage, continuing the water temperature monitoring program, and contributing to the ongoing bull trout radio telemetry project. The specific objectives of the work in 2000 were to:

- collect water temperature data at sites within the Salmo River watershed;
- conduct adult abundance surveys (fish capture and tagging, snorkel surveys, and redd surveys) to monitor the status of the spawning population of bull trout in the watershed; and
- contribute funding towards aerial tracking flights of radio tagged bull trout in the watershed.

This report summarizes the results of the water temperature monitoring and adult abundance surveys, while the radio tracking results will be summarized in a separate report (Baxter 2001b [in preparation]). Specific opportunities for enhancement of the bull trout population are also discussed to direct BC Hydro toward meeting its objectives under the Habitat Compensation Agreement (HCA) with the Department of Fisheries and Oceans (DFO) and the Ministry of Environment, Lands and Parks (MELP).

STUDY AREA AND BACKGROUND

The Salmo River rises from the Selkirk Mountains 12 km southeast of Nelson, B.C. (Figure 1). The river flows in a southerly direction for approximately 60 km from its origin to the confluence with the Pend d'Oreille River (Seven Mile Reservoir). Geographic information is summarized in Table 1. The system is a 5th order stream, and has a total drainage basin area of roughly 123,000 ha.

Table 1. Summary of geographic information for the Salmo River study area.

Gazetted Name	Stream Length (km)	Area (ha)
Salmo River	60	123,000
Geographic Information		
Approximate distance and direction to the nearest town, city or landmark	12 km southeast of Nelson, B.C.	
MELP Region	4	
MELP Management Unit	4-8	
DFO District	Interior South East (#30)	
Ministry of Forests Region	Nelson	
Ministry of Forests District	Kootenay Lake	
NTS Base Map Reference	82 F/3 and 82 F/6	

Elevation in the basin ranges from 564 meters at its confluence to 2,343 meters at the height of land. Within this elevation range, the system comprises two biogeoclimatic zones (Braumandl and Curran 1992). At lower elevations, the valley lies within the Interior Cedar-Hemlock zone, while areas in the higher elevations are found within the Englemann Spruce-Subalpine Fir zone. The Salmo River has a total of eight 2nd and 3rd order tributaries (including Apex Creek, Clearwater Creek, Hall Creek, Barrett Creek, Ymir Creek, Porcupine Creek, Erie Creek, and Hidden Creek) and two 4th order tributaries (Sheep Creek and the South Salmo River) (Figure 1). The Water Survey of Canada maintains a gauging station on the Salmo River near the town of Salmo (Anonymous 1977). Mean annual discharge in the Salmo River (1949-1976) was 32.5 $m^3 \cdot sec^{-1}$, with mean monthly minimum and maximum values of 7.5 and 128.5 $m^3 \cdot sec^{-1}$, respectively. Runoff reaches a peak in May, with the highest flows between April and July each year. In addition to bull trout, many other fish species are distributed in the watershed. These include rainbow trout (*Oncorhynchus mykiss*), eastern brook trout (*S. fontinalis*), mountain whitefish (*Prosopium williamsoni*), largescale sucker (*Catostomus macrocheilus*), longnose sucker (*C. catastomus*), northern pikeminnow (*Ptychocheilus oregonensis*), longnose dace (*Rhinicthys cataractae*), redside shiner (*Richardsonius balteatus*), and slimy sculpin (*Cottus cognatus*) (Sigma Engineering Ltd. 1996). Natural populations of steelhead trout (*O. mykiss*) and chinook salmon (*O. tshawytscha*) have been extirpated from this system due to hydroelectric development on the lower Columbia and Pend d'Oreille rivers.

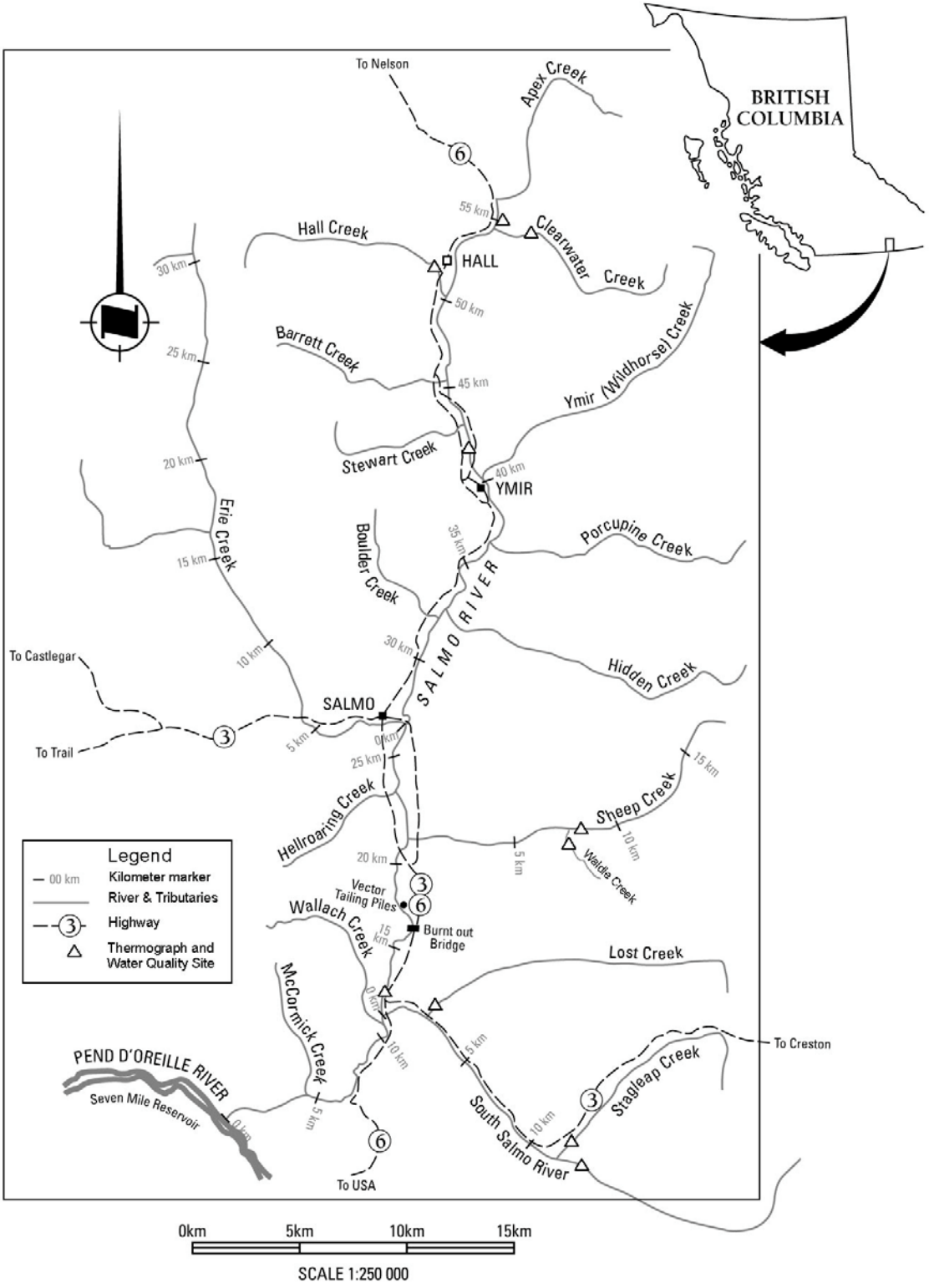


Figure 1. The Salmo River watershed study area.

METHODS

Water Temperature Monitoring

Hobo Temp® data loggers were installed in the late fall of 1997 at ten sites (Figure 1) throughout the Salmo River watershed (see Baxter 1999). These instruments collected water temperature measurements every three hours, and the loggers were downloaded twice annually to retrieve stored data. As of December 1999, eight thermographs were deployed in the watershed, and these were downloaded and removed in the spring of 2000. Graphs of daily temperatures at the sites were constructed using the software provided with the temperature loggers.

Fish Capture and Floy® Tagging

Between June 15 and July 18, bull trout were captured in the mainstem Salmo River by angling, and sampled for biological characteristics. Fish were measured for fork length (cm), sexed and finally marked with a uniquely numbered Floy® tag. The location of capture was also noted. During the surveys, angling effort was also recorded.

Snorkel Surveys

For this component of the study, observations were made during repetitive snorkel surveys over the summer in the mainstem Salmo River from the town of Salmo to the South Salmo River confluence. The river was surveyed by a crew of 2-5 swimmers (depending on water levels), and an appropriate number of swimmers aligned themselves perpendicular to stream flow to ensure adequate coverage of the stream. Each swimmer reported the total number of bull trout and other species observed in the section of river that was surveyed. Generally, counts were recorded every 200 to 250 m at known locations. This work was carried out in conjunction with a study undertaken by the Salmo Watershed Streamkeepers Society (SWSS) to document non-sportfish abundance in the watershed (Baxter and Nellestijn 2000b), and by BC Hydro to document migration patterns of sucker and northern pikeminnow in the Salmo River watershed (Baxter 2001a).

The sightability of bull trout during snorkel surveys was also estimated by using radio tagged bull trout from 1999. To do this, radio tagged bull trout were tracked in the section of stream that was surveyed, and the number of radio tagged fish observed during the snorkel survey were recorded. The sightability of bull trout was then the number observed/the number present. Using the sightability calculation, I expanded the count data to give a representation of how many bull trout (>30 cm) may have actually been in the section that was surveyed by snorkeling. The relationship of sightability to stream discharge was also examined.

Redd Counts

Bull trout redds were enumerated from September through October in the main spawning locations that were identified or suspected from previous work. The areas surveyed were Clearwater Creek, Sheep Creek, and the upper mainstem of the Salmo River. Crews walked and swam sections of the stream looking for spawning fish on redds or the presence of redds. Bull trout redds were easily identified as recently disturbed areas of clean sorted substrate, and had a typical pit and mound associated with the disturbance. The total number of redds and the sex and estimated length of each observed bull trout were recorded during each survey. Surveys were initiated on September 13 and concluded on October 20.

In addition, snorkel surveys were undertaken in several small tributaries where bull trout juveniles had been documented and spawners were suspected from anecdotal reports. The tributaries were surveyed to determine whether there was some minor use of these tributaries by spawning bull trout, and the streams sampled included Barrett Creek, Wildhorse Creek, Porcupine Creek, Hidden Creek, and Hall Creek. Sampling occurred between August 30 and September 15.

RESULTS

Water Temperature Monitoring

Water temperature data collected in the spring of 2000 are presented in Appendix I. At the time of temperature downloading, the thermograph at Sheep Creek had been stolen, leaving data available from seven sites. All of the sites that were located in known bull trout spawning areas experienced water temperatures below 9ºC during the spawning period, a suspected thermal cue for bull trout spawning (Baxter and McPhail 1996; McPhail and Baxter 1996). An interesting pattern was the decline in water temperature to about 6ºC near the end of September 1999 that coincided with the peak of spawning activity. As in the winter of 1997/98 and 1998/99, water temperatures did not drop below freezing in the winter of 1999/2000 in areas that bull trout spawned.

Fish Capture and Floy® Tagging

A summary of the bull trout Floy® tagged during this component of the study is presented in Appendix II. In total 29 bull trout were captured, measured, Floy® tagged and released (Appendix II). Rainbow trout and brook trout were also sampled. Of the 29 bull trout angled, 6 were males, 22 were females and 1 was of undetermined sex. Females averaged 50 cm in fork length, while males averaged 55 cm. The average catch per unit effort for bait fishing, fly fishing and spoon fishing was 0.33, 0.37, and 0.64 bull trout per angler day, respectively.

Five captured bull trout were additionally tagged with a radio tag for the ongoing bull trout radio telemetry study in the Salmo River watershed (see Baxter and Nellestijn 2000a for surgery methodology and Baxter 2001b [in preparation] for radio telemetry results).

Snorkel Surveys

In total, five surveys were conducted on the mainstem Salmo River after Floy® tagging of bull trout had been initiated (Table 2). The surveys began downstream of the town of Salmo at Lagoon Road (27.35 km), and were carried out for a minimum distance of 10.1 km (Table 2).

A summary of the total number of each fish species observed during the surveys is presented in Table 3. The observations during the surveys suggested that bull trout (BT) were present in high densities in early summer within the surveyed section, but had largely moved out of the section by late August (Table 3). During the surveys, rainbow trout (RB), eastern brook trout (EB), sucker (SU), northern pikeminnow (NPM), and mountain whitefish (MWF) were also observed (Table 3).

Table 2. Summary of dates, locations, visibility, and the number of swimmers on snorkel surveys in the Salmo River in 2000.

Survey Date	Start Location	End Location	Total Distance	Visibility	Number of Swimmers
June 22	27.35 km	11.55 km	15.70 km	1 m	3
June 30	27.35 km	16.85 km	10.50 km	2 m	5
July 7	27.35 km	16.85 km	10.50 km	3 m	5
July 17	27.35 km	16.85 km	10.50 km	4-5 m	3
August 24/25	33.00 km	16.85 km	16.15 km	4-5 m	2

Table 3. Summary of the number of fish species observed during snorkel surveys in the Salmo River in 2000.

	Total Number Observed				
Species	June 22	June 30	July 07	July 17	August 24/25
BT					
<30 cm	0	4	0	5	2
>30 cm	6	17	26	19	8
RB					
<30 cm	5	33	58	268	245
>30 cm	23	31	107	147	208
EBT					
<30 cm	0	0	2	6	23
>30 cm	0	2	4	6	7
SU	13	80	179	205	221
NPM	0	0	0	3	27
MWF	3	3	2	2	0

The sightability of bull trout on each snorkel survey increased as water levels dropped and visibility increased (Table 4). Using these sightability estimates, the expanded counts of bull trout (>30 cm) are presented in Table 4. In general, the sightability of bull trout decreased as discharge increased (Figure 2).

Table 4. Sightability estimates, and expanded counts, of bull trout during snorkel surveys in the Salmo River in 2000 (using previously radio tagged fish).

Survey Date	Observed Radio Tagged Bull Trout	Radio Tagged Bull Trout Present	Sightability	Expanded Bull Trout Estimate
June 22	1	9	0.11	55
June 30	1	7	0.14	121
July 7	3	7	0.43	61
July 17	3	5	0.60	32

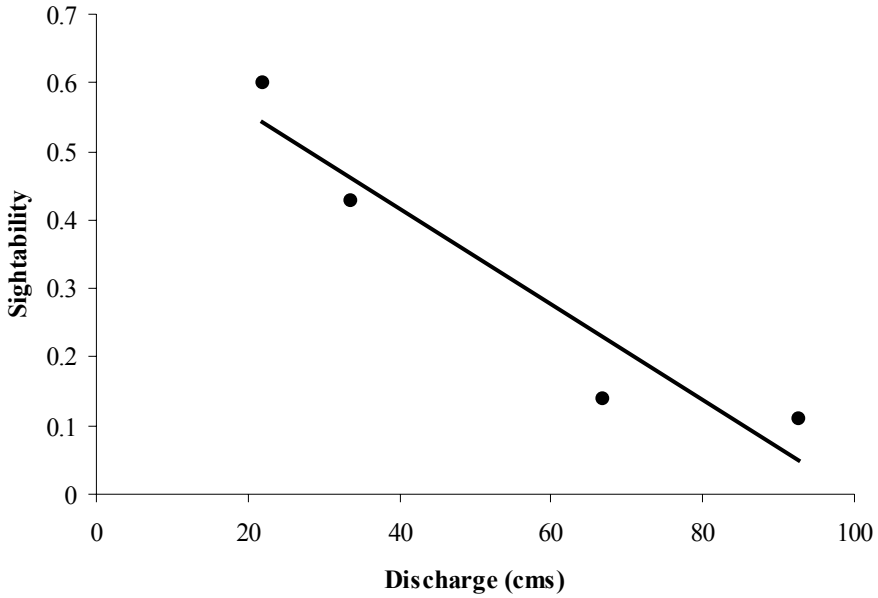


Figure 2. The relationship of sightability of bull trout (during snorkel surveys) to discharge in the mainstem Salmo River.

Redd Counts

The results of the redd surveys for individual systems are presented in Appendix III. In total, 78 redds were enumerated in 2000, and as previously documented, bull trout spawners and redds were observed in Sheep Creek, Clearwater Creek and the upper section of the Salmo River (Table 5). Sheep Creek was the area of the highest concentration of spawning activity, followed by the upper Salmo River. During the redd surveys, bull trout that were Floy® tagged or radio tagged in the summer of 1999 or 2000 were observed in all of the areas that were surveyed (Table 6). All of these fish were tagged in the mainstem Salmo River below the town of Salmo (Figure 1).

A summary of the observations made during snorkel surveys in tributaries to the Salmo River are presented in Table 7. Rainbow trout were numerically dominant species, and bull trout were only observed in Wildhorse Creek (Table 7).

Table 5. Summary of the total number of bull trout and redds observed in the Salmo River watershed in 2000.

Watercourse	Total Number of Redds	Total Number of Bull Trout
Clearwater Creek	20	16
upper Salmo River	28	28
Sheep Creek	30	36

Table 6. Summary of observations of Floy® tagged or radio tagged bull trout during redd surveys in the Salmo River watershed in 2000. These fish were tagged in the summer of 1999 or 2000.

Watercourse	Floy® Tagged or Radio Tagged Bull Trout (1999)	Floy® Tagged or Radio Tagged Bull Trout (2000)
Clearwater Creek	1	1
upper Salmo River	2	4
Sheep Creek	0	3

Table 7. Summary of snorkel survey observations in tributaries to the Salmo River watershed in 2000.

Watercourse	Date	Bull Trout	Rainbow Trout	Brook Trout
Wildhorse Creek	Aug. 30	>30 cm=1	>30 cm=11	>30 cm=3
		<30 cm=3	<30 cm=44	<30 cm=8
Porcupine Creek	Sept. 15	>30 cm=0	>30 cm=9	>30 cm=0
		<30 cm=0	<30 cm=72	<30 cm=0
Barrett Creek	Sept. 7	>30 cm=0	>30 cm=3	>30 cm=0
		<30 cm=0	<30 cm=183	<30 cm=0
Hidden Creek	Sept. 7	>30 cm=0	>30 cm=5	>30 cm=0
		<30 cm=0	<30 cm=30	<30 cm=0

DISCUSSION

This year's project has contributed significantly to the ecological understanding of bull trout population dynamics in the Salmo River watershed. Specifically, monitoring trends in bull trout redd abundance over the past four years suggests that there may be an increase in the number of spawning bull trout within the watershed. Additionally, tracking flights have allowed migration timing and key spawning habitats to be identified. Coupled with other projects, the study has identified areas enhancement opportunities could be focussed.

Bull Trout Enumeration and Biology

Enumeration

A result of 2000 studies is the increasing trend in the number of spawning bull trout in the watershed over the past four years (Figure 3; 1999 data excluded due to limited survey effort). This is likely related to the elimination of bull trout harvest that was implemented in 1999 by MELP, and also an increased awareness of the local community as to the status of the bull trout population in the Salmo River watershed (mainly due to BC Hydro projects initiated in the watershed). Continued monitoring of redd abundance will assess the status of the population, and should allow determination of the success of habitat and management manipulations.

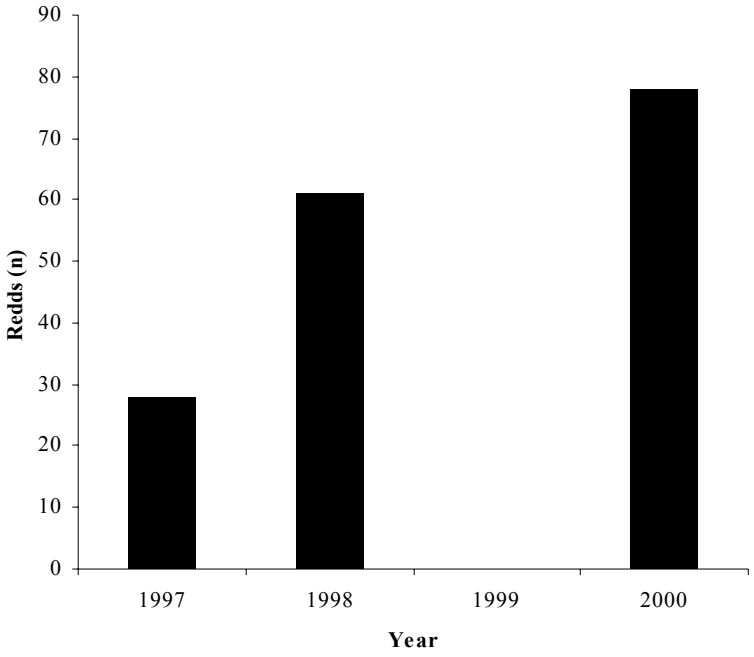


Figure 3. The number of bull trout redds constructed at three sites within the Salmo River watershed over the past four years.

Another result was the use of a combination team (one person snorkeling and one person walking) during 2000 redd counts. This allowed a significant number of bull trout and redds to be enumerated that would not have otherwise been counted if traditional streamwalk surveys were utilized. It is recommended that, using this technique, the annual index redd count program continue in Clearwater Creek, the upper Salmo River, and Sheep Creek, and that the survey be expanded to again include the South Salmo River. An assessment of the South Salmo River with fisheries personnel from Washington state is planned for the summer of 2001, and we will utilize swimming and streamwalks to maximize the possibility of enumerating redds and bull trout in this watershed.

Given the fact that a significant number of bull trout are known to migrate to the South Salmo River (Baxter and Nellestijn 2000a; Baxter 2001c; Baxter 2001b [in preparation]), it is anticipated that redd surveys in 2001 will identify the system as the major bull trout spawning tributary in the Salmo River watershed (despite the fact that redds and spawners have been difficult to enumerate in the past). The counts in all systems should occur between the end of the third week of September and the second week of October. In 2001, we will also conduct a small scale study to quantify the differences in surveying efficiency between snorkel observers and streamwalk observers while enumerating redds and bull trout spawners.

Biology

One aspect of the biology of bull trout in the Salmo River watershed that requires additional discussion is the migratory status of the population. In the summer of 1999 a total of ten bull trout were radio tagged in the watershed (Baxter and Nellestijn 2000a), and in summer of 2000, an additional ten bull trout were radio tagged (Baxter 2001b [in preparation]). Of these twenty tagged fish (including seven fish that were tagged in the South Salmo River or in the mainstem Salmo River downstream of the South Salmo River confluence), one has emigrated downstream to the mouth of the Salmo River. Although this fish has been tracked within the influence of Seven Mile Reservoir at high pool (inundation zone), the fish has not been tracked within the reservoir proper (Baxter 2001b [in preparation]). Additionally, although some large bull trout were sampled by boat electrofishing in Seven Mile Reservoir in 1994/1995 (R.L.&L. 1995), no large bull trout were sampled using the same technique at the same sites in 1999/2000 (Michael Hildebrand, Fisheries Biologist, R.L.&L. Environmental Services Ltd., Castlegar, B.C.; personal communication).

In combination, these results, and the average size of sampled bull trout spawners suggest that, for the most part, bull trout appear not to utilize the reservoir for a significant portion of the adult stages of their life-history. It might be argued that the reservoir could be a rearing area for juvenile bull trout, and that there may be some downstream migration of juvenile bull trout to the reservoir from the Salmo River watershed given the electrofishing catches of small numbers of juvenile bull trout in the reservoir in 1994/95 and 1999/2000 (R.L.&L. 1995; Michael Hildebrand, Fisheries Biologist, R.L.&L. Environmental Services Ltd., Castlegar, B.C.; personal communication). However, the

use of Seven Mile Reservoir by juvenile bull trout from the Salmo River watershed is currently not quantified, and given the fact that resident bull trout may exist in several tributaries to the reservoir, future work on this component of the life-history may be warranted to determine the origin of juvenile bull trout in Seven Mile Reservoir. Based on current data available from radio telemetry, boat electrofishing, set lining, gill netting, and minnow trapping, it appears that adult bull trout abundance in the reservoir is extremely low (R.L.L. 1995; Baxter and Nellestijn 2000a; Baxter 2001b [in preparation]; Michael Hildebrand, Fisheries Biologist, R.L.&L. Environmental Services Ltd., Castlegar, B.C.; personal communication). As such, management and enhancement options for bull trout should focus on the population in the watershed upstream of the Salmo River confluence with Seven Mile Reservoir, until the actual utilization of reservoir habitats, if any, by juvenile Salmo River bull trout is quantified and documented.

Future Enhancement Opportunities

The results of this continued project, and other ongoing studies, have suggested that there are several specific areas that BC Hydro could advance to address the company's commitments under the HCA. These include stream fertilization of the South Salmo River following pre-treatment assessment of the system and a control system, and potential support for the removal of a recurring barrier/log jam on Sheep Creek.

Stream Fertilization

After ongoing studies, site visits, and regular meetings between the agencies (DFO and MELP), the Canadian Columbia River Inter-Tribal Fisheries Commission (CCRFIC) and BC Hydro, consensus has been reached that, for the most part, adult spawning and juvenile rearing habitat for bull trout is not limited in the Salmo River watershed. As such, enhancement options focussed on creating spawning or rearing habitat would likely have a limited effect on increasing bull trout production, and would not be the best use of available enhancement funding (Hagen and Baxter 2001).

During the summer growing season of 1998, nutrient levels (nitrogen and phosphorous) in tributaries and mainstem sites were measured (see Baxter 1999). From the data collected, further consensus was reached that stream fertilization would offer the best technique at either increasing juvenile bull trout production or survival. Data indicated that the South Salmo River was nutrient limited to the greatest extent, and that coupled with habitat impacts associated with linear development along the stream channel, this system should be the focus of an experimental stream fertilization project.

For the summer of 2001, a program of assessing the South Salmo River and a control system (Sheep Creek) is being developed, and this program will be implemented to collect data prior to fertilization (see Ashley and Slaney 1997 for methodology). Pre-treatment data collection in the South Salmo River and Sheep Creek will include:

1. water quality and water temperature data during the summer growing season (July,

August, and September) at three sites;
2. periphyton and benthic invertebrate data during the summer growing season (August or September) at three sites;
3. density, biomass, and standing stock estimates of juvenile fish production; and
4. adult abundance and redd count data during the spawning period in both systems.

Collected data will be used to assess the response of the biological community in the South Salmo River to stream fertilization (planned for summer 2002) and will allow comparisons against a control site. Further assessments are planned on an annual basis from 2002-2005 (4 years).

Barrier/Log Jam Removal

Sheep Creek has been documented as a major spawning area for bull trout, and significant redd superimposition has been noted in past years (see Baxter et al. 1998; Baxter 1999). As such, it was felt that the potential to enhance spawning habitat may have been an option in Sheep Creek, and an assessment was conducted in the summer of 2000 to determine the feasibility of constructing spawning platforms. The results of the assessment identified four potential sites to consider constructing spawning platforms, but concluded that further study by a hydrologist was required to assess the probability of structure failure once installed (Hagen and Baxter 2001). Thus, it was recommended that high cost structures may not be cost-effective, but the annual placement of gravel may provide suitable spawning habitat as a low cost option.

One further point that was identified for potentially increasing the amount of spawning habitat available to bull trout in Sheep Creek was the removal of a recurring barrier/log jam that limits the upstream migration of mature bull trout. This barrier was identified in previous surveys (see Baxter et al. 1998; Baxter 1999) and was known to actually strand spawners that that were trying to ascend the barrier. In the spring of 1999, the barrier and associated sediment wedge broke down during freshet, and spawning bull trout were observed above the blocked site (Baxter 1999). However, the barrier reformed in 2000 and has again limited the upstream migration of bull trout (Hagen and Baxter 2001). It is recommended that the annual removal of this barrier be considered as a community project in June of each year, and that the potential exists for BC Hydro to become involved with this type of project. The community is very interested in undertaking this project, and if BC Hydro is involved it may further satisfy requirements under the HCA.

RECOMMENDATIONS

1. Continue the bull trout redd and spawner enumeration program in the Salmo River watershed, and expand the survey to the South Salmo River watershed. The combination streamwalk/snorkeling methodology should be utilized in all systems.

2. Where possible, provide funding that will assist the continued monitoring of currently radio tagged bull trout.

3. Advance with the stream fertilization project on the South Salmo River with pre-treatment data collection in the South Salmo River and a control system (Sheep Creek) in 2001.

4. Consider involvement with a community group in removing the recurring barrier/log jam on Sheep Creek in order to allow bull trout access to additional spawning habitat.

REFERENCES

Anonymous. 1977. Historical streamflow summary, British Columbia. Inland Waters Directorate, Water Survey of Canada, Ottawa, Canada, 758 p.

Ashley, K.I., and P.A. Slaney. 1997. Accelerating recovery of stream, river and pond productivity by low-level nutrient replacement. Chapter 13 *In* Slaney, P.A. and D. Zaldokas, editors. Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No. 9. Watershed Restoration Program, Ministry of Environment, Lands and Parks, Vancouver, British Columbia.

Baxter, J.S. 1999. Bull trout studies in the Salmo River watershed: 1998 and 1999. Report to BC Hydro, Castlegar, B.C. Report by Baxter Environmental, Nelson, B.C.

Baxter, J.S. 2001a. Assessment of a constructed non-sportfish migration barrier on the Salmo River using radio telemetry and Floy tagging. Report to BC Hydro, Burnaby, B.C. Report by Baxter Environmental, Nelson, B.C.

Baxter, J.S. 2001b. Aspects of the biology of bull trout (*Salvelinus confluentus*) in the Salmo River watershed as identified through radio telemetry (2000 and 2001 data) and a watershed management plan for the species. Report to Columbia-Kootenay Fisheries Renewal Partnership, Cranbrook, B.C, and BC Hydro, Burnaby and Castlegar, B.C. Report by Baxter Environmental, Nelson, B.C. [in preparation].

Baxter, J.S. 2001c. Summary of the South Salmo River bull trout enumeration project (2000). Report to Columbia-Kootenay Fisheries Renewal Partnership, Cranbrook, B.C. Report by Baxter Environmental, Nelson, B.C.

Baxter, J.S., and J.D. McPhail. 1996. Bull trout spawning and rearing habitat requirements: summary of the literature. B.C. Fisheries Technical Circular No. 98.

Baxter, J.S., and G. Nellestijn. 2000a. Aspects of the biology of bull trout (*Salvelinus confluentus*) in the Salmo River watershed as identified through radio telemetry. Report to Columbia-Kootenay Fisheries Renewal Partnership and Columbia Basin Trust, Cranbrook, B.C. Report by Salmo Watershed Streamkeepers Society, Salmo, B.C. and Baxter Environmental, Nelson, B.C

Baxter, J.S., and G. Nellestijn. 2000b. Report on non-sportfish abundance and migration patterns in the Salmo River: winter 1999 to summer 2000. Report to Columbia-

Kootenay Fisheries Renewal Partnership and Columbia Basin Trust, Cranbrook, B.C. Report by Salmo Watershed Streamkeepers Society, Salmo, B.C. and Baxter Environmental, Nelson, B.C.

Baxter, J.S., Coughlin, W.D., Pennington, B.M., and G.G. Oliver. 1998. Synoptic bioreconnaissance of bull trout distribution and abundance in the Salmo River watershed. Report to BC Hydro, Environmental Department, Castlegar, B.C. Report by Interior Reforestation Co. Ltd., Cranbrook, B.C.

Braumandl, T.F. and M.P. Curran [*eds.*]. 1992. A field guide for site identification and interpretation for the Nelson Forest Region. British Columbia, Ministry of Forests, Land Management handbook No. 20.

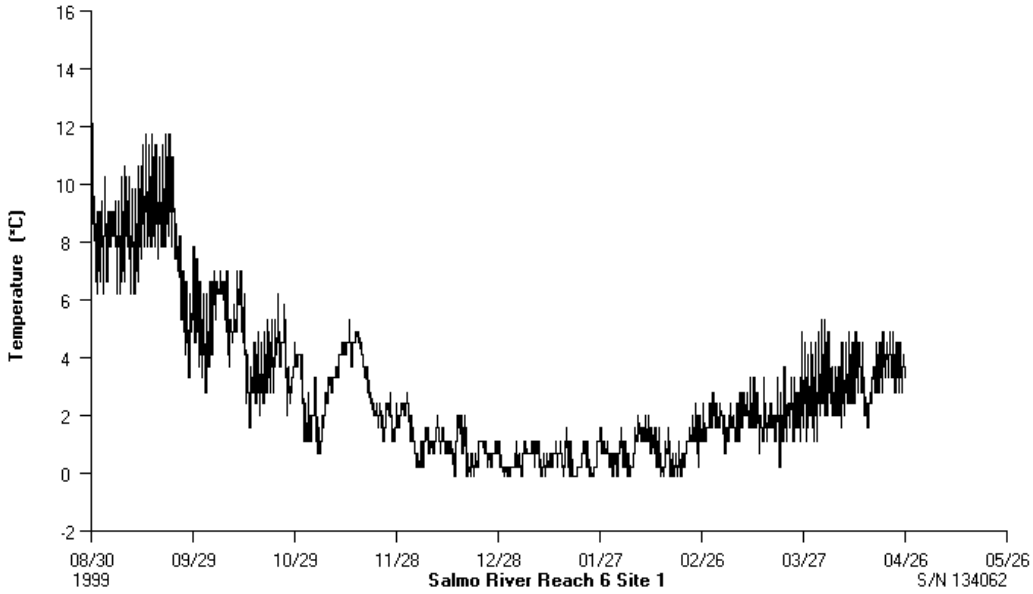
Hagen, J., and J.S. Baxter. 2001. Sheep Creek bull trout spawning platforms: feasibility study. Report to Columbia-Kootenay Fisheries Renewal Partnership, Cranbrook, B.C. Report by Baxter Environmental, Nelson, B.C.

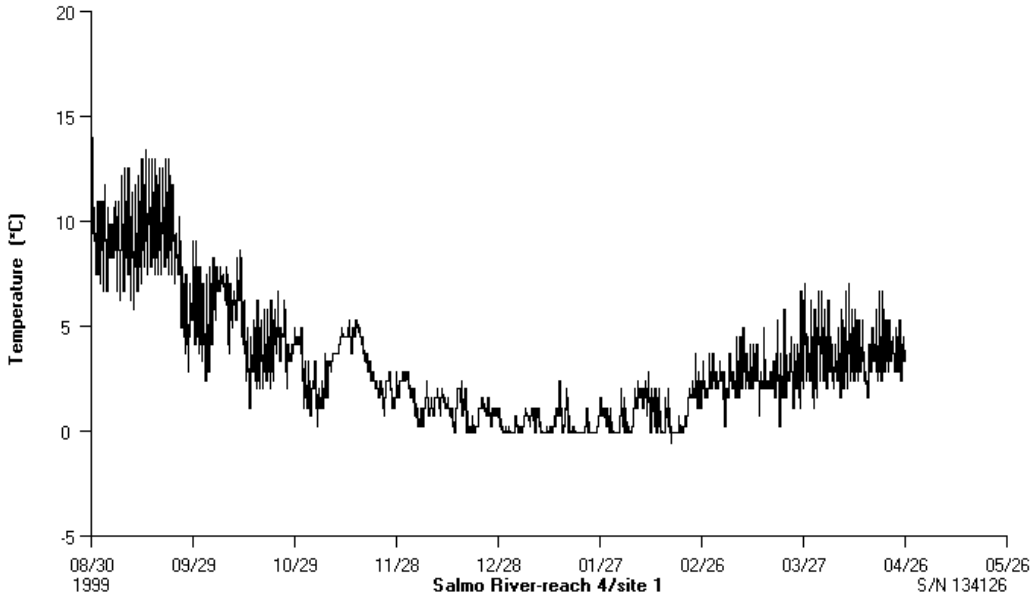
McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life history and habitat use in relation to compensation and improvement opportunities. B.C. Fisheries Management Report No. 104.

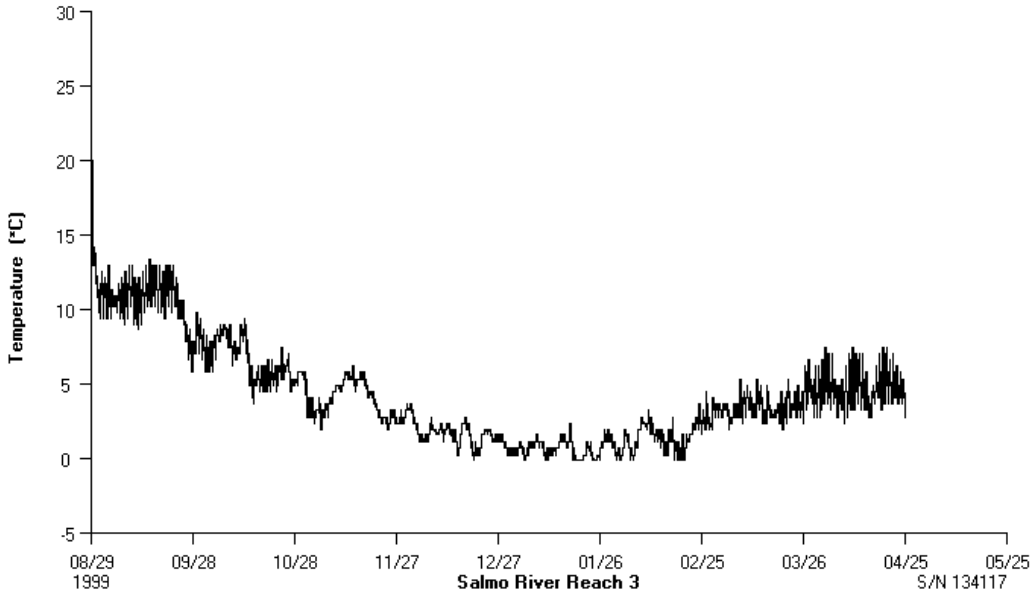
R.L.&L. Environmental Services Ltd. 1995. Seven Mile Unit 4 Study: fish and aquatic investigations, September 1994 to June 1995 - study results and impact discussion. R.L.&L. Report No. 434-95D: 161p. Report to BC Hydro, Castlegar, B.C.

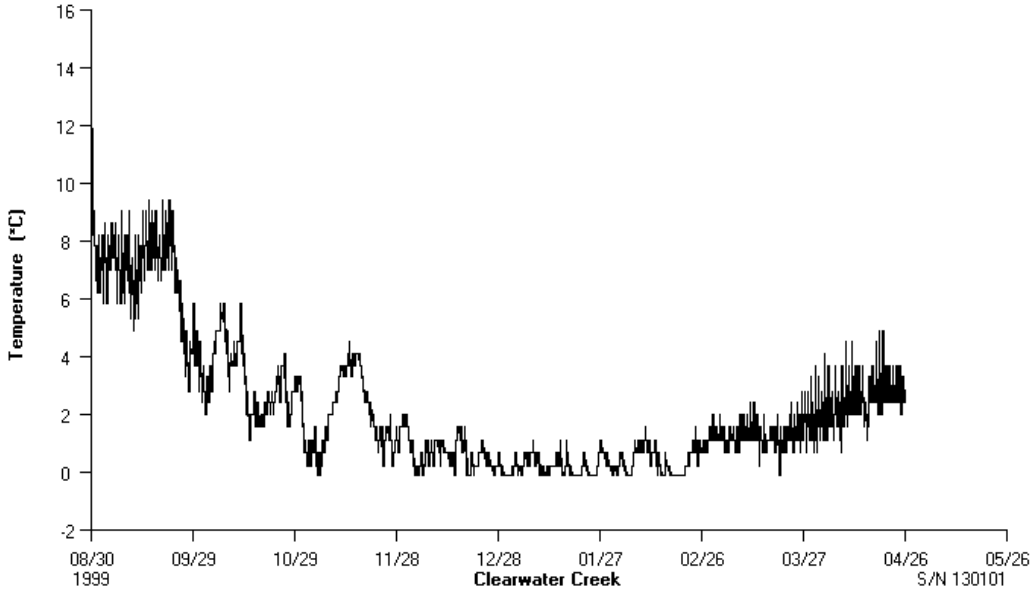
Sigma Engineering Ltd. 1996. Salmo River inventory and assessment. Report to Columbia Basin Fish and Wildlife Compensation Program, Nelson, B.C. Report by Sigma Engineering Ltd., Vancouver, B.C.

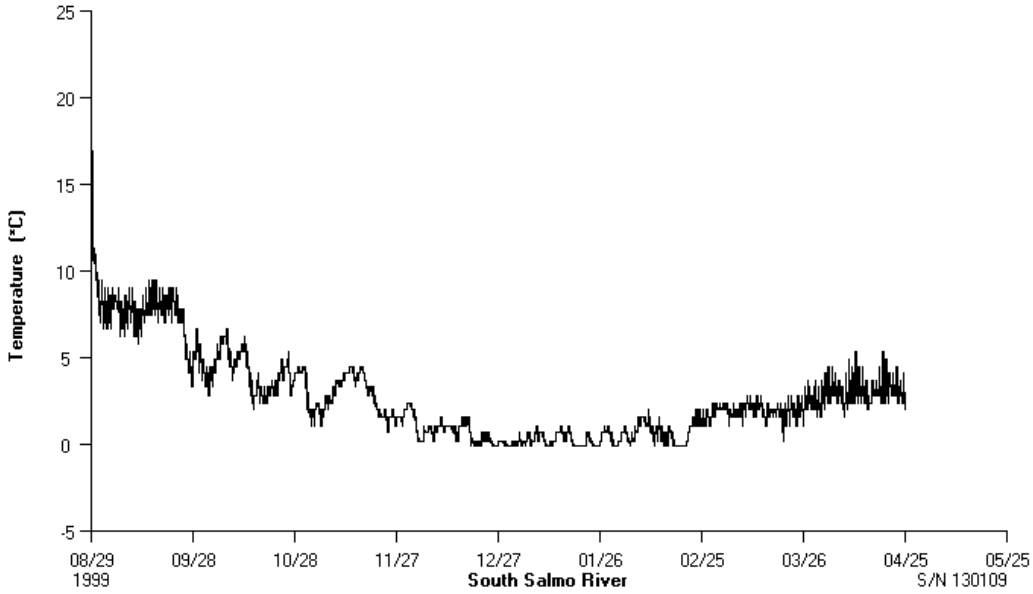
Appendix I. Water temperature profiles (Salmo River watershed-spring 2000).

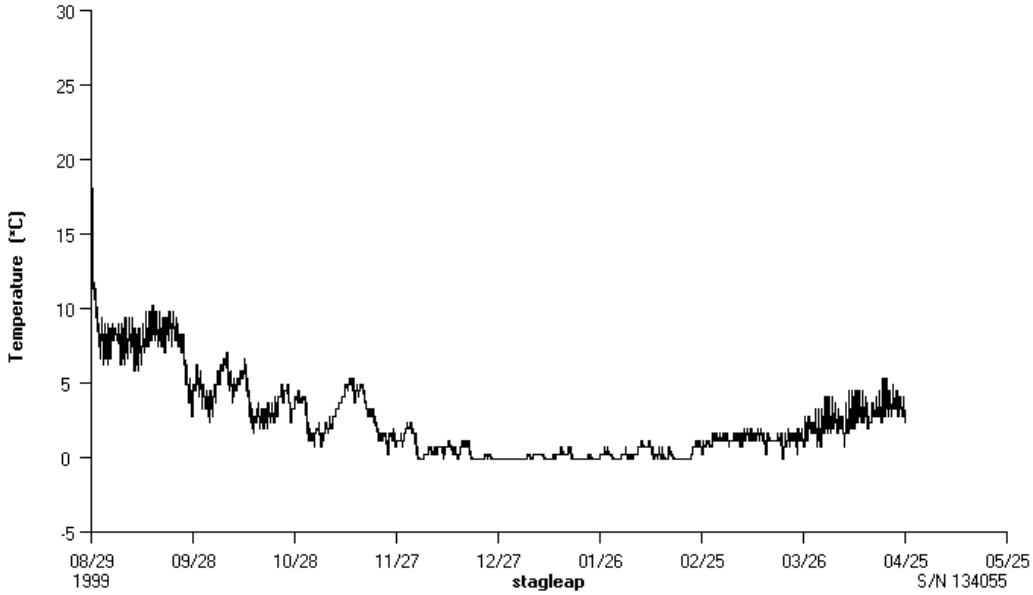

Temperature (°C)
16
14
12
10
8
6
4
2
0
-2
08/30
1999
09/29
10/29
11/28
12/28
01/27
02/26
03/27
04/26
05/26
Salmo River Reach 6 Site 1
S/N 134062

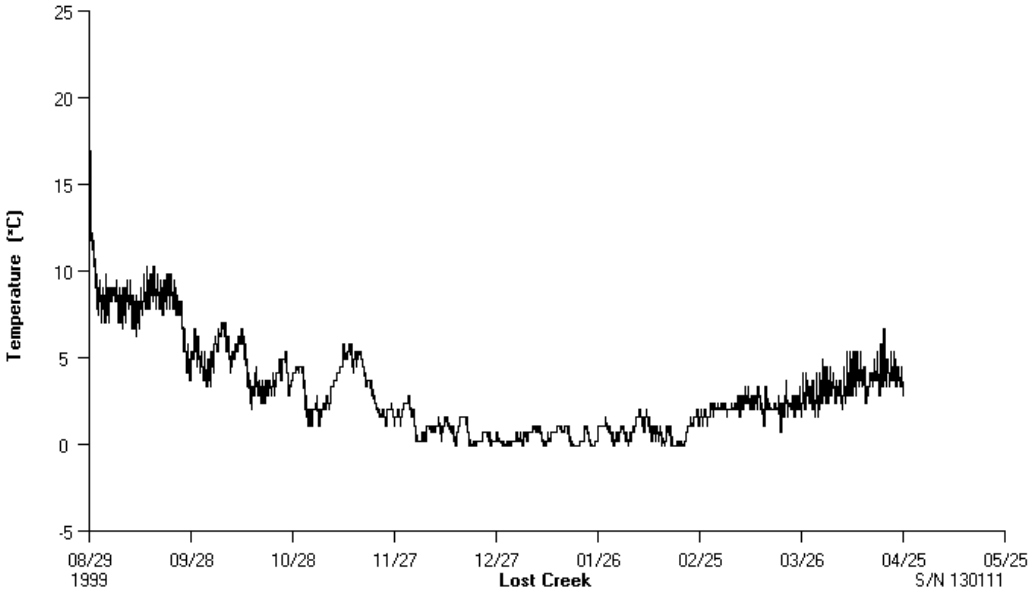

Temperature (°C)
20
15
10
5
0
-5
08/30
1999
09/29
10/29
11/28
12/28
01/27
02/26
03/27
04/26
05/26
Salmo River-reach 4/site 1
S/N 134126


Temperature (°C)
30
25
20
15
10
5
0
-5
08/29
1999
09/28
10/28
11/27
12/27
01/26
02/25
03/26
04/25
05/25
Salmo River Reach 3
S/N 134117


Temperature (°C)
16
14
12
10
8
6
4
2
0
-2
08/30
1999
09/29
10/29
11/28
12/28
01/27
02/26
03/27
04/26
05/26
Clearwater Creek
S/N 130101


Temperature (°C)
25
20
15
10
5
0
-5
08/29
1999
09/28
10/28
11/27
12/27
01/26
02/25
03/26
04/25
05/25
South Salmo River
S/N 130109


Temperature (°C)
30
25
20
15
10
5
0
-5
08/29
1999
09/28
10/28
11/27
12/27
01/26
02/25
03/26
04/25
05/25
stagleap
S/N 134055


25
20
15
10
5
0
-5
Temperature (°C)
08/29
1999
09/28
10/28
11/27
12/27
01/26
02/25
03/26
04/25
05/25
Lost Creek
S/N 130111

Appendix II. Summary data of fish captured and Floy® tagged in the Salmo River in the Summer of 2000.

Date	Species	Sex	Length (cm)	Weight (g)	Floy Tag	Radio Tag Frequency	Radio Tag Code	Location
15-Jun-00	BT	F	71.5	3402	P-3451, P-3452			Hellroaring Creek confluence
18-Jun-00	BT	F	56		P-3926, P-3927			Pool below sewage lagoon
18-Jun-00	BT	M	55		P-3928, P-3929			Hellroaring Creek confluence
18-Jun-00	BT	M	67		P-3930, P-3931			Rest Stop
19-Jun-00	BT	F	54	1500	P-3454, P-3456			Hellroaring Creek confluence
21-Jun-00	BT	M	62.5	2600	P-3932, P-3933			Pool below Hippe Run
21-Jun-00	BT	F	51	1150	P-3934, P-3935			Vector Pool
21-Jun-00	BT	M	64	2400	P-3936, P-3937			400 m d/s BOB
21-Jun-00	BT	F	53	1400	P-3938, P-3939			400 m d/s BOB
24-Jun-00	EB	F	40					Rest Stop
24-Jun-00	RB	F	51	28.5 G	W-C000144			Pool above Sheep Creek
24-Jun-00	BT	F	51	26.5 G	P-3453, P-3455			500 m d/s BO Bridge
27-Jun-00	BT	M	40	560	G-0499, G-0500	149.62	9	Black Bluffs
28-Jun-00	BT	F	51	28.5 G	G-0906, G-0907	149.7	80	
29-Jun-00	RB	F	51	28.5 G	W-C000143			Rest Stop
29-Jun-00	BT	?	37	18 G	P-3457, P-3458			Rest Stop
29-Jun-00	BT	F	44.5	22 G	P-3459, P-3460			Rest Stop
29-Jun-00	BT	F	46	24.5 G	P-3461, P-3462			Pool above Sheep Creek
29-Jun-00	BT	F	51	27 G	P-3463, P-3464			Hippe Run
3-Jul-00	BT	F	41	1000	P-2072, P2071			Pool below sewage lagoon
4-Jul-00	BT	F	54	2200	P-2069, P-2070			500 m u/s Bernerine's
6-Jul-00	BT	F	35.5	17 G	P-3465, P-3466			Mouth of Swift Creek
7-Jul-00	BT	F	50.5	1700	P-2068, P-2067			Vector Pool
16-Jul-00	BT	M	39.5	19.5 G	P-3475			Mouth of Hidden Creek
16-Jul-00	BT	F	44	21.5 G	P-3474			Mouth of Hidden Creek
16-Jul-00	BT	F	45	25 G	G-0001, G-0002	149.7	84	Bill Stockdale's Pool
18-Jul-00	BT	F	44	23 G	P-3467			Wesco Road
18-Jul-00	BT	F	41	19 G	P-3472			Seri's Pool
18-Jul-00	BT	F	65	30 G	G-0004, G-0005	149.7	76	Wesco Swimming Hole
18-Jul-00	BT	F	45.5	22 G	P-3473			100m d/s above
18-Jul-00	BT	F	45	24 G	P-3468			
18-Jul-00	BT	F	56.5	27.5 G	G-0903, G0904	149.7	77	Rest Stop

Appendix III. Summary data from bull trout redd counts conducted in the Salmo River watershed in 2000.

Clearwater Creek

Date	Location	Number of Redds	Number of Fish
September 13	Falls to mouth	3	8 Males (40-70 cm) 7 Females (40-65 cm)
October 9	Falls to mouth	20	0 Males 1 Female (55 cm)

upper Salmo River

Date	Location	Number of Redds	Number of Fish
September 19	Camp Busk to Barrett Creek	10	17 Males (45-75 cm) 11 Females (45-75 cm)
October 20	Camp Busk to Hall Creek	28	0 Males 0 Females

Sheep Creek

Date	Location	Number of Redds	Number of Fish
September 21	Log jam to Aspen Creek	24	18 Males (30-70 cm) 18 Females (35-80 cm)
October 13	Log jam to Aspen Creek	30	0 Males 0 Females