Bull Trout Studies in the Salmo River Watershed: 1998 and 1999

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EXECUTIVE SUMMARY

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INTRODUCTION

BC Hydro entered into a Habitat Compensation Agreement (HCA) with the Department of Fisheries and Oceans (DFO) and the Ministry of Environment, Lands and Parks (MELP) with the proposed installation of a fourth turbine at the Seven Mile Powerplant. As a result, studies on the bull trout (*Salvelinus confluentus*) population in the Salmo River watershed were initiated in 1997 as part of the requirements under this agreement. Work in 1997 focussed on defining the distribution of bull trout in the watershed, as well as estimating juvenile and adult abundance and identifying possible habitat compensation opportunities (Baxter et al. 1998).

The results of the work carried out in 1997 suggested that the population of mature bull trout was relatively small (likely less than 200 individuals) and was possibly depressed due to recreational over harvest and potential habitat degradation. Key spawning and rearing areas identified were in the upper Salmo River above the town of Ymir, Clearwater Creek, Sheep Creek, and the South Salmo River. Although this initial work focussed primarily on quantifying the abundance and distribution of bull trout in the watershed, potential habitat enhancement opportunities were also examined. The general conclusions of the study were that habitat appeared not to be a limiting factor for bull trout production in the system, particularly with regard to a lack of spawning and rearing habitat. Specific recommendations about enhancement opportunities in Sheep Creek (log jam barrier and sediment wedge removal, limitations in spawning habitat) were identified and described in the final report. The possibility of stream fertilization as an enhancement technique was also discussed, but further enhancement work was not initiated prior to review of the studies by DFO and MELP.

In 1998 and 1999 BC Hydro continued studies in the watershed, specifically focussing on water quality and water temperature data collection, and monitoring the abundance of adult bull trout in the system. The specific objectives of this work were to:

- collect water quality and water temperature data to identify nutrient-limited sites within the Salmo River watershed (it was hoped that these data could be used to assess the feasibility of stream fertilization as an enhancement option);
- conduct adult abundance surveys (snorkel counts and redd surveys) to monitor the status of the spawning population of bull trout in the watershed; and,
- conduct a survey on Sheep Creek to assess the potential spawning habitat located above the log jam debris that limits upstream migration of spawners.

This report summarizes the studies conducted in 1998 and 1999, and provides recommendations for further work that should focus on bull trout. Opportunities for enhancement of the bull trout population are also discussed to direct BC Hydro towards meeting its objectives under the HCA.

STUDY AREA AND BACKGROUND

The Salmo River rises from the Selkirk Mountains 12 km southeast of Nelson, B.C. (Figure 1). The river progresses 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 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 Columbia and Pend d'Oreille rivers.

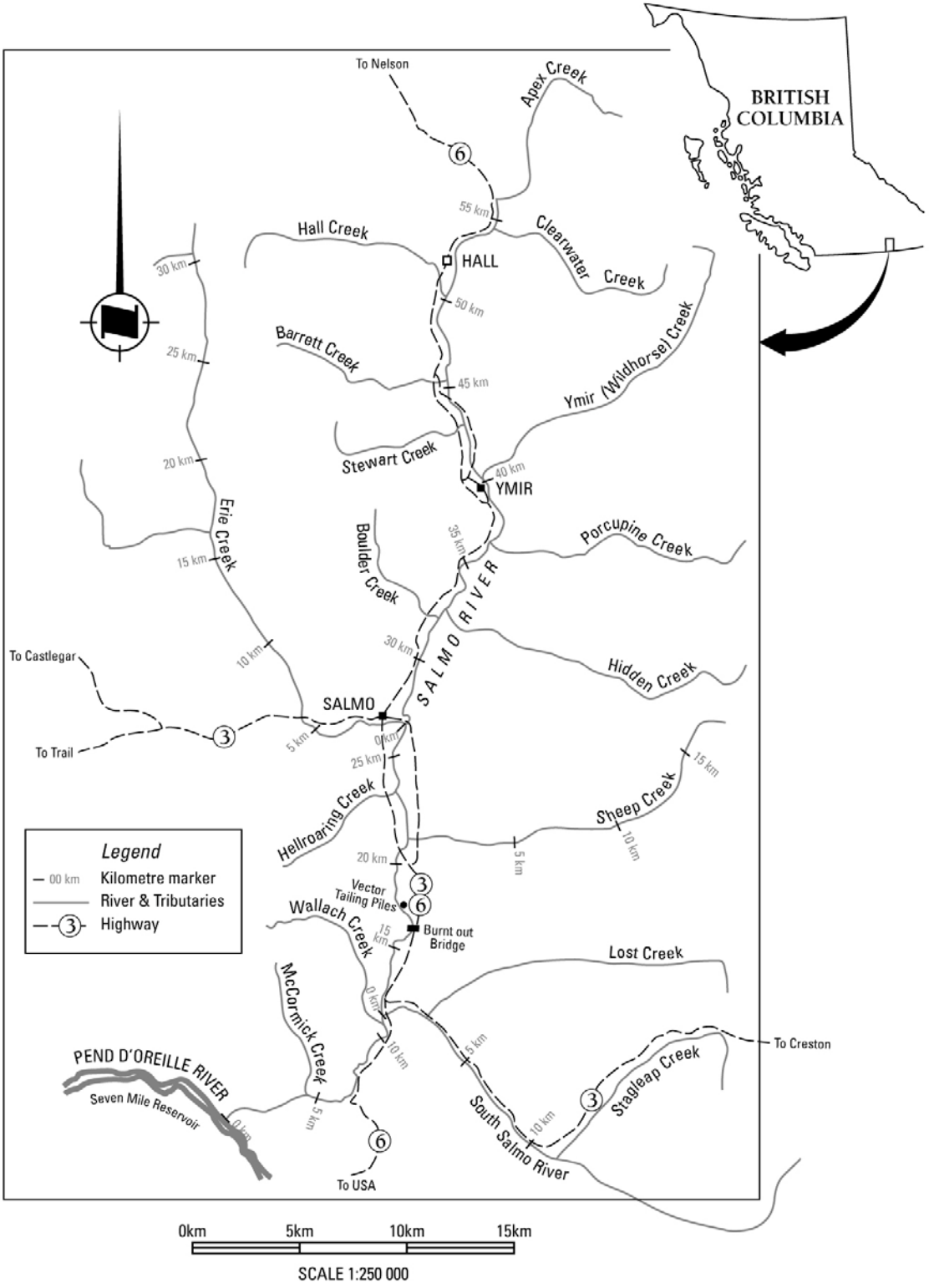

Figure 1. The Salmo River watershed study area.

METHODS

1998 Studies

Water Temperature Monitoring

Hobo Temp data loggers were installed in the late fall of 1997 at ten sites throughout the Salmo River watershed. These instruments collected temperature measurements every three hours, and the loggers were downloaded twice annually to retrieve the stored data. Temperature loggers were downloaded on two occasions in 1998 (late April and mid July). Graphs of daily temperatures at the sites were constructed using the software provided with the temperature loggers.

Water Quality

Water samples were taken at ten locations throughout the Salmo River watershed on July 20, 1998. The samples were taken at this time to provide analysis of water quality during the summer high level of productivity, and to contrast water samples that were taken in the winter of 1997 (winter low level of productivity). Samples were sent to the Pacific Environmental Science Centre of Environment Canada for analysis. The samples were screened for general water chemistry information, the concentrations of various metals, and low level orthophosphate concentration.

Snorkel Surveys

Two snorkel surveys on the mainstem Salmo River were conducted by BC Hydro and Baxter Environmental personnel on August 5 and 7, 1998. The initial snorkel survey occurred from the Highway 3 rest stop south of the town of Salmo to the burned out bridge over the Salmo River (Figure 1). The second survey focussed on two locations in the upper river. The first section was from the confluence of Clearwater Creek to the Hall Creek confluence. The second section was from the Porcupine Creek bridge over the Salmo River to the Hidden Creek confluence (Figure 1). On each swim individual fish observed were identified to species and estimated for their total length.

Redd Counts

Bull trout redds were enumerated through September and October in main spawning locations that were identified or suspected from the study conducted in 1997. The main areas surveyed were Clearwater Creek, Sheep Creek, the South Salmo River, and the upper mainstem of the Salmo River. Crews walked 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 15, 1998 and concluded on October 22, 1998.

Above Barrier Survey

The mainstem of Sheep Creek above the log jam barrier identified in 1997 was surveyed On August 29, 1998. This survey was initiated in order to determine if habitat above the barrier was suitable for bull trout spawning, and to assess if there were bull trout present above the log jam. The spawning habitat survey consisted of a crew walking the system and identifying suitable spawning substrate and cover.

A juvenile survey was also conducted immediately above the log jam to determine if bull trout were present above the barrier or had likely spawned above the barrier in previous years. This survey consisted of placing an upstream and downstream stop net across the river, and sampling the fish within the site using an electroshocker. The two pass method utilized in the 1997 study was used on this survey so densities of various fish species sampled could be estimated.

Adult Bull Trout Salvage

While conducting the Sheep Creek above barrier survey on August 29, 1998, stranded mature bull trout were observed in a small pool below the log jam barrier. These fish were isolated in a small pool that was drying up, and had no access downstream. The fish were removed from the pool with an electroshocker, and transferred to the free flowing portion of Sheep Creek.

1999 Studies

Water Temperature Monitoring

As in 1997 and 1998, the Hobo Temp data loggers were maintained at the ten sites throughout the Salmo River watershed (Figure 1). These instruments collected temperature measurements every three hours, and were downloaded twice in 1999 (late April and late August). Graphs of daily temperatures at the sites were constructed using the software provided with the temperature loggers.

Redd Counts

As in 1997 and 1998, bull trout redds were enumerated through September and October in the main spawning systems previously identified. The main areas surveyed were Clearwater Creek, Sheep Creek, and the upper mainstem of the Salmo River. The upper South Salmo River was not surveyed due to limited success in observing fish or redds in 1997 and 1998. Crews walked sections of the stream looking for spawning fish on redds or the presence of redds. 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 August 31, 1999 and concluded on September 25, 1999.

RESULTS

1998 Studies

Water Temperature Monitoring

Water temperature data collected in the spring of 1998 are presented in Appendix I. At the time of date recovery, it was impossible to access the site on the mainstem Salmo River at reach 3. None of the sites experienced water temperatures consistently below 0ºC, suggesting that the areas sampled would be suitable for bull trout egg incubation over the winter.

The water temperature data collected in the summer of 1998 are presented in Appendix II. At this sampling event, the temperature loggers at Hall Creek and Waldie Creek were lost due either to vandalism or freshet events. The logger at reach 6 of the upper Salmo River had also malfunctioned. The majority of the sites experienced summer water temperature that did not rise above 15ºC. This suggests these sites were suitable rearing areas for juvenile bull trout. Water temperatures in tributaries were generally cooler than the sites on the mainstem Salmo River.

Water Quality

All water quality data are for two time periods, the winter of 1997 and the summer of 1998. Water quality data for all sites are presented in Appendix III. None of the measured parameters in the water samples suggested that water quality would negatively impact fish populations. The main objective of the water chemistry component was to identify if systems within the Salmo River watershed were nitrogen (N) and/or phosphorous (P) limited, and whether stream fertilization might be a feasible enhancement option for BC Hydro. Concentrations of dissolved inorganic nitrogen (DIN) less than 50 µg/L and concentrations of soluble reactive phosphorous (SRP) less than 1 µg/L can be indicative that a system is nutrient deficient (Ken Ashley, Ministry of Fisheries, Vancouver, B.C.; personal communication). The DIN and SRP concentrations at all sample sites during the summer growing season are presented in Table 2. It was noted that some of the sites where N limited, some of the sites were P limited, and some of the sites were N and P co-limited (Table 2; Ken Ashley, Ministry of Fisheries, Vancouver, B.C.; personal communication). One site was identified as not being N or P limited (Table 2; Ken Ashley, Ministry of Fisheries, Vancouver, B.C.; personal communication).

Table 2. Total dissolved inorganic nitrogen (DIN) concentrations and total soluble reactive phosphorous (SRP) concentrations from water samples collected at ten sites in the Salmo River watershed on July 20, 1998.

Watercourse	DIN (µg/l)	SRP (µg/l)	Comments
Salmo Reach 6	70	1	Likely P limited
Salmo Reach 4	18	<1	Likely N + P co-limited
Salmo Reach 3	16	<1	Likely N + P co-limited
South Salmo	9	<1	Likely N + P co-limited
Stagleap	12	<1	Likely N + P co-limited
Lost	7	2	Likely N limited
Clearwater	38	2	Doesn't need any N or P
Hall	19	<1	Likely N + P co-limited
Sheep	12	1	Likely N + P co-limited
Waldie	21	<1	Likely N + P co-limited

Snorkel Surveys

The results of the two snorkel surveys are presented in Appendix IV. These surveys identified that low numbers of adult bull trout were present in the sections that were surveyed, but relatively high numbers of rainbow trout and non-sportfish were documented (Table 3). Non-sportfish such as suckers and northern pikeminnow were most abundant in the lower river below the town of Salmo (Table 3).

Table 3. Summary of the number of fish species observed during snorkel surveys in the Salmo River in 1998.

	Total Number Observed			
Species	Aug. 5(AM)	Aug. 5(PM)	Aug. 7(AM)	Aug. 7(PM)
SU	1	201	0	0
NPM	1	33	0	0
MWF	10	8	0	0
EBT				
<30 cm	18	5	0	0
>30 cm	2	0	0	3
BT				
<30 cm	3	4	0	0
>30 cm	8	0	0	0
RB				
<30 cm	133	193	3	104
>30 cm	42	78	3	14

Redd Counts

The results of the redd surveys for individual systems are presented in Appendix V. In

total 61 redds were enumerated in 1998, 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 4). Sheep Creek was the area of the highest concentration of spawning activity. No mature bull trout or redds were observed in the South Salmo River.

Table 4. Summary of the total number of bull trout redds observed in the Salmo River watershed in 1998.

Watercourse	Total Number of Redds	Total Number of Fish
Clearwater Creek	15	10
upper Salmo River	10	9
South Salmo River	0	0
Sheep Creek	36	47

Above Barrier Survey

The survey of available spawning habitat upstream of the log jam barrier on Sheep Creek identified that there were numerous locations that had appropriate habitat conditions for bull trout spawning sites (Plate 1). Many pockets of gravel suitable for spawning, and pools that provided cover were present above the barrier. Stream gradient ranged from 3.5-8%, but was generally less than 5%. The river likely has suitable spawning habitat to the Curtis Creek confluence (upstream about 4 km from barrier) where the stream gradient increases to 20%, and appropriate spawning substrate becomes limited.

The above barrier juvenile survey documented the presence of both rainbow trout and bull trout at the site immediately above the barrier. In total 55 rainbow trout and 25 bull trout were sampled. The density of juvenile rainbow trout above the barrier was 24.7 fish·100m^2 (Lower CI = 23.4 fish·100m^2, Upper CI = 27.4 fish·100m^2), while the density of juvenile bull trout was 18.7 fish·100m^2 (Lower CI = 10.6 fish·100m^2, Upper CI = 43.4 fish·100m^2). Average size data for the two species are presented in Table 5, and it is likely that age 0+, 1+, 2+ and 3+ bull trout were represented. The results identified that bull trout had reproduced above the barrier in 1997, but it is unknown if these fish were resident or migratory spawners.

Table 5. Summary of length data for fish species sampled in Sheep Creek on August 29, 1998 above the log jam barrier.

Species	Mean Fork length (mm)	S.D.	Range (mm)	Number Sampled
Rainbow Trout	89.4	54.3	28-200	55
Bull Trout	79.6	31.2	45-155	25

Adult Bull Trout Salvage

In total six bull trout spawners were salvaged from the pool at the base of the log jam barrier (Plate 2). Four fish were female and two were male. Salvaged bull trout ranged in size from 40-50 cm (Plates 3 and 4). All fish were released into the river below the barrier, and recovered well after capture.

1999 Studies

Water Temperature Monitoring

Water temperature data collected in the spring of 1999 are presented in Appendix VI. At the time of temperature downloading, the thermograph at Waldie Creek was missing, the thermograph at Stagleap Creek had malfunctioned, and the Sheep Creek thermograph casing had been destroyed (rendering it inoperable). As a result, the thermograph at Waldie Creek was not reinstalled, and thus only nine thermographs were present in the watershed. None of the sites experienced water temperatures consistently above 18ºC in the late summer. During the spawning period, water temperatures in known bull trout spawning locations had dropped to below 9ºC, a suspected thermal cue for bull trout spawning (Baxter and McPhail 1996). As in the winter of 1997/98, water temperatures did not drop below freezing in the winter of 1998/99.

Water temperature data collected in the summer of 1999 are presented in Appendix VII. During this sampling event, the temperature logger at Hall Creek was inoperable due to water damage, and was not replaced. The logger at reach 3 of the upper Salmo River had also malfunctioned and reset itself, while the temperature logger in Sheep Creek was replaced at this time. The majority of the sites experienced early summer water temperatures that did not rise above 18ºC. As in 1998, water temperatures in tributaries were generally cooler than mainstem sites on the Salmo River. As of December 1999 there are currently eight thermographs deployed in the Salmo River watershed.

Redd Counts

The results of the redd surveys for individual systems conducted in 1999 are presented in Appendix VIII. In total 21 redds were enumerated (Table 6). Sheep Creek was the location of the majority of spawning activity.

Table 6. Summary of the total number of bull trout redds observed in the Salmo River watershed in 1999.

Watercourse	Total Number of Redds	Total Number of Fish
Clearwater Creek	8	10
upper Salmo River	3	6
Sheep Creek	10	13

DISCUSSION

The work undertaken in 1998 and 1999 has supplemented data from the bull trout study conducted in the Salmo River watershed in 1997. In combination, this work has identified the main bull trout spawning areas and tributaries, quantified juvenile bull trout densities and identified key juvenile rearing areas, provided water quality and temperature data, and outlined possible enhancement opportunities that BC Hydro could undertake to meet its requirements under the Seven Mile Powerplant HCA. The following discussion summarizes the current knowledge regarding the biology of bull trout in the Salmo River watershed, and recommends areas where enhancement work could proceed.

Bull Trout Biology

Work in 1997 and 1998 identified that the main spawning areas in the Salmo River watershed were Clearwater Creek (its entire length), Sheep Creek (from a log jam barrier 2.5 km upstream of the forestry rec site to 2.5 km below the Waldie Creek confluence), and the upper Salmo River (upstream of the Hall Creek confluence). It was suspected in 1997 that the South Salmo River and Stagleap Creek might also be spawning areas due to the presence of bull trout fry (Baxter et al. 1998); however, surveys in both 1997 and 1998 failed to located or observed any redds or bull trout spawners. Again in 1999 the three previous locations were confirmed as areas of bull trout spawning activity, as were the South Salmo River and Stagleap Creek from data collected in another study (Baxter and Nellestijn; report in preparation). Radio telemetry studies undertaken by the Salmo Watershed Streamkeepers Society (SWSS) in cooperation with Baxter Environmental, BC Hydro, and MELP, has tracked four of the ten radio tagged fish to the South Salmo River watershed (Baxter and Nellestijn; report in preparation). The tracked fish made migrations that were consistent with typical spawning patterns. Although redds were not identified on the ground, the pattern of an upstream movement, holding period, and rapid downstream emigration is typical of documented spawning activity (O'Brien 1999).

Another aspect of the biology of Salmo River bull trout that was unresolved was whether the population was adfluvial and made migrations to Seven Mile Reservoir, or fluvial and overwintered in the mainstem Salmo River. The size of captured and observed bull trout spawners suggested that the population was fluvial in nature, as fish were not achieving the large size typical of adfluvial populations with a abundant forage base (McPhail and Baxter 1996). To date, information from the ongoing radio telemetry study supports this hypothesis, as the ten radio tagged fish have migrated from spawning locations to the mainstem Salmo River (Baxter and Nellestijn; report in preparation). These fish are currently holding in a 12-15 km section of the mainstem river (where they were originally tagged). In these locations, there is an abundance of suitable overwintering habitat, and the fish have remained in this section of stream for over a month with little movement (Baxter and Nellestijn; report in preparation). Although these bull trout will be monitored over the winter and spring, to date the data suggest the population is fluvial. If Salmo River bull trout are a fluvial population, then the locations where these fish hold

are likely key feeding and overwintering area.

Based on studies to date, a conservation concern may exist for Salmo River bull trout. Fluvial bull trout populations in the West Kootenay area are rare, particularly in the lower Pend d'Oreille River watershed, and the Salmo River spawning population may be at a critically low level. The average number of redds constructed over the past three years is 37, which would place the total number of spawners in the system below 200 individuals, and possibly as low as 100 individuals. Although there was a significant increase in enumerated redds in 1998 (61) compared to 1997 (28), the low numbers of redds suggest the population size is small. As such, rare stochastic environmental events such as the flooding and scour experienced by many West Kootenay streams in mid-November 1999, may have negatively impacted recruitment for such a small population if eggs were scoured from redds or bed load movement was significant. As well fish are overwintering and staging in a confined area located at relatively easy access points, and may experience severe angling pressure with bait. from October 31 to April 1.

Key juvenile bull trout habitat was identified in several areas in 1997, typically in close proximity to spawning sites. Given that many of these systems experienced flood and scour events in mid-November 1999, it is possible that there could have been increased egg mortality and displacement of juveniles. This area of concern should be examined in the year 2000 through juvenile surveys that utilize techniques that minimize possible injury to fish. Such data may support possible regulation amendments to protect possible recruitment losses due to conservation concerns.

Future Enhancement Opportunities

From the 1997 study, there were a number of possible enhancement opportunities identified that BC Hydro could undertake to meet obligations under the HCA. Of those suggested, potential work that could be undertaken based on this further study is discussed, as are other possible options for habitat enhancement.

Stream Fertilization

One possible technique to consider as a feasible enhancement opportunity is the use of stream fertilization. Water samples collected in the summer growing season of 1998 identified that nine out of ten sites in the system were either Nitrogen (N) limited, Phosphorous (P) limited, or both N and P co-limited. In general nutrient levels were very low, and in particular water chemistry at tributary sites suggested limited production and these would be the areas to focus a potential fertilization project (Ken Ashley, B.C. Ministry of Fisheries (MOFs), Vancouver, B.C.; personal communication). Prior to construction of hydroelectric facilities on the Columbia River, a significant number of chinook salmon and steelhead returned to the Salmo River watershed. The annual decaying salmon carcasses in the fall and winter would have added a significant amount of nutrients to the system (Bilby et al. 1996). As such, one type of fertilization technique that might be considered for application is the use of slow release fertilizer briquettes (see

Ashley and Slaney 1997).

This type of treatment has been used with some success in B.C. (Ashley and Slaney 1997), and in the Salmo River watershed could be incorporated in an experimental design to examine the response of bull trout to treated and un-treated sections or tributaries. If fertilization is considered as a possible option by the regulatory agencies, the proposed work should follow a number of steps. The first would be discussion with MELP and MOFs staff on the current status of water chemistry and fisheries data. This would also serve to identify data gaps and would help determine if there would be a possible benefit from stream fertilization. The second would be the collection of pre-treatment data on algae, invertebrates, fish (size and density), and more detailed water sampling. The final step would be application and post-treatment monitoring and sampling.

One disadvantage with stream fertilization as an enhancement option would be ongoing maintenance since the goal of stream fertilization is to input nutrients into a system during nutrient limitations, and then slowly remove fertilization as the system recovers. These goals may not be able to be met in the Salmo River watershed as habitat is in good shape overall, and there would be no opportunity to recover salmon runs to the watershed in the short term (i.e., recover the natural input of N and P). Conversely, fertilization might have the advantage of acting as a "jump start" to bull trout production which would increase watershed productivity over the long term.

Instream Structure Placement

From the work conducted in 1997 and 1998, a large log jam barrier on Sheep Creek was identified as blocking upstream migration of bull trout. It was suggested that the barrier be removed as fish were moving up to it, and in some cases becoming stranded. In the spring of 1999, natural flow events removed the barrier on one side of the river and scoured an unblocked channel to bull trout ascent, and bull trout were confirmed to have spawned upstream of the barrier in 1999. With the natural removal of the log jam, a large sediment wedge was released into sections of the river downstream. However, streamwalks on Sheep Creek still identified that there may be a limitation of suitable spawning habitat (e.g., many cases of redd superimposition were noted over the three years of redd surveys) despite this release. The habitat characteristics of Sheep Creek are dominated by a riffle pool morphology of shallow depth, and there are limited sites where the combination of deeper water is associated with suitable gravel and cover for bull trout spawning (Baxter and McPhail 1996). One opportunity for enhancement on Sheep Creek would be to construct instream structures that would act to scour small pools in association with the movement or placement of suitable spawning gravels to this area.

It is also possible that similar habitat enhancement opportunities to the one previously described on Sheep Creek could be undertaken on Clearwater Creek, as there is also a limitation of spawning gravel in this system. Any habitat enhancements that occur through the placement of instream structures should only be considered in the main spawning areas of Sheep Creek, Clearwater Creek. Given that Cominco is focussing habitat enhancement opportunities on the South Salmo River as one of its ongoing

projects, and that the upper South Salmo River contains limited habitat disturbances, the priority for work in the South Salmo River would be considered low. As Sheep Creek and Clearwater Creek are documented spawning areas in the watershed, and are likely spawning habitat limited, these two systems would be a higher priority for habitat enhancement.

Angling Regulation Amendments

In 1997, regulation amendments were suggested as an option to promote in the recovery of the bull trout population in the Salmo River watershed (Baxter et al. 1998). At that time, there was an allowable daily retention of one bull trout per day over 50 cm, and the study suggested that a non-retention of bull trout should be considered for conservation reasons. As it was estimated that there were likely less than 200 spawners in the watershed based on redd count information, non-retention of bull trout was implemented in April of 1999 by MELP for the entire Salmo River watershed. In conjunction with the bait ban from June 15 to October 31, it was felt that bull trout would be adequately protected. Coupled with an awareness campaign by SWSS as to the status and biology of the bull trout in the watershed, it was believed that the population might be increasing in 1998. If it its determined that there are further conservation concerns with regard to bull trout further regulation amendments may need to be considered.

Brook Trout Removal

Although brook trout are still present in the Salmo River, a large scale removal program is not procedurally or financially feasible. For the most part brook trout are not found in the main areas (tributaries) used for spawning by bull trout, and the two species may be reproductively isolated by this allopatric spawning distribution. Over the past three years the presence of large brook has increased especially in the lower river, and a possible plan to target these fish could be considered. This might include a program similar to one in Alberta where anglers must pass a test that shows they can identify brook trout before they are allowed to harvest them under a special licence. It might also include a removal program of spawning brook trout by BC Hydro, MELP, and community volunteers during spawning time or a no limit harvest on streams that are known to contain only brook trout (Ymir Creek).

CONCLUSIONS AND RECOMMENDATIONS

1. It is likely that the bull trout population of the Salmo River watershed spawns in an alternate year pattern, and that redd counts in 2000 should be significantly higher than 1999. It is recommended that an annual index redd count program continue in Clearwater Creek, the upper Salmo River, and Sheep Creek. The counts should occur at the end of the third week of September, and again in the second week of October.

2. The population of bull trout may be less than 200 individuals, and the fact that they are concentrated in a relatively small area of the mainstem Salmo River for the majority of the year should be of concern. It is recommended that further angling regulation amendments be explored by the BC Ministry of Environment, Lands and Parks (MELP) if conservation concerns warrant such changes.

3. There was likely juvenile bull trout displacement and egg mortality in mid-November of 1999 associated with flood events in the Salmo River watershed. A juvenile bull trout survey in the watershed should be considered for the summer of 2000 to determine the possible impacts of the flooding.

4. Nitrogen and phosphorus levels during the summer growing season are at low enough levels at some sites in the Salmo River watershed that stream fertilization could be considered as a habitat enhancement option by BC Hydro. It is recommended that BC Hydro, MELP, DFO, and Baxter Environmental personnel meet to discuss this and other enhancement options. If this option is considered feasible, internal MELP and BC Ministry of Fisheries specialists should explore the possibility of fertilization.

5. Suitable spawning habitat in the form of substrate and cover is limited in the two main bull trout spawning tributaries, Sheep Creek and Clearwater Creek. Possible habitat enhancement could occur in these systems by placing small structures that scour pools. Coupled with the placement or movement of gravel that bull trout use for spawning, this could potentially increase recruitment by limiting redd superimposition.

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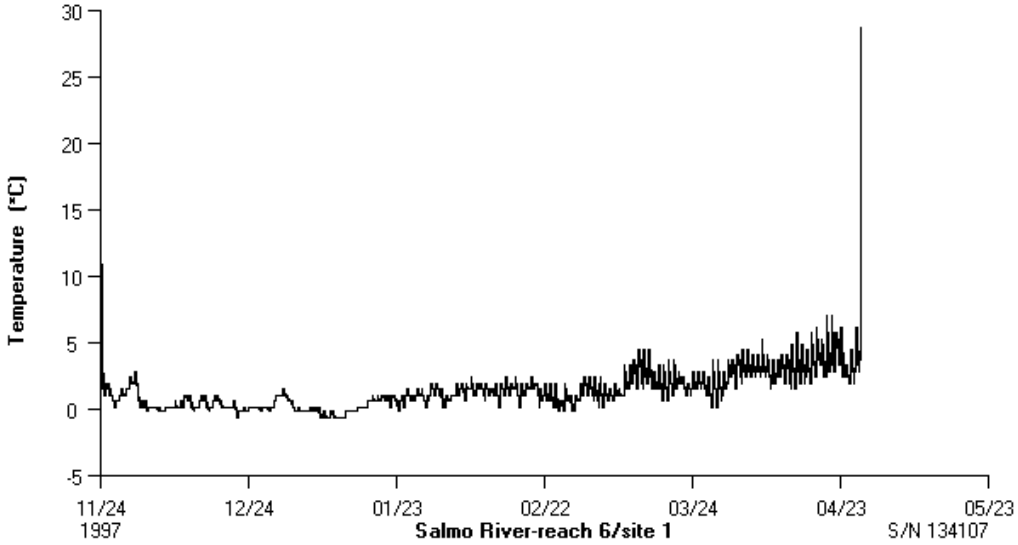
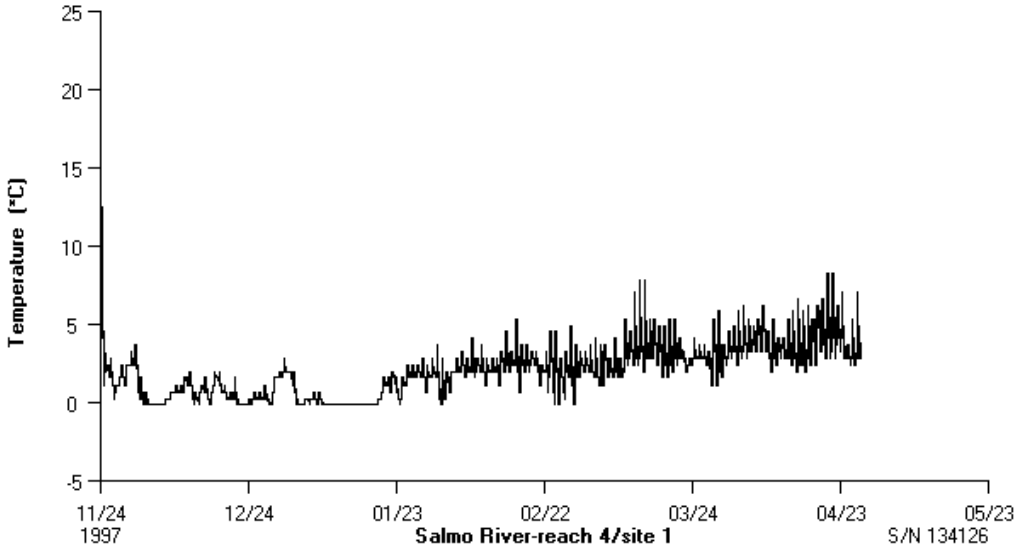
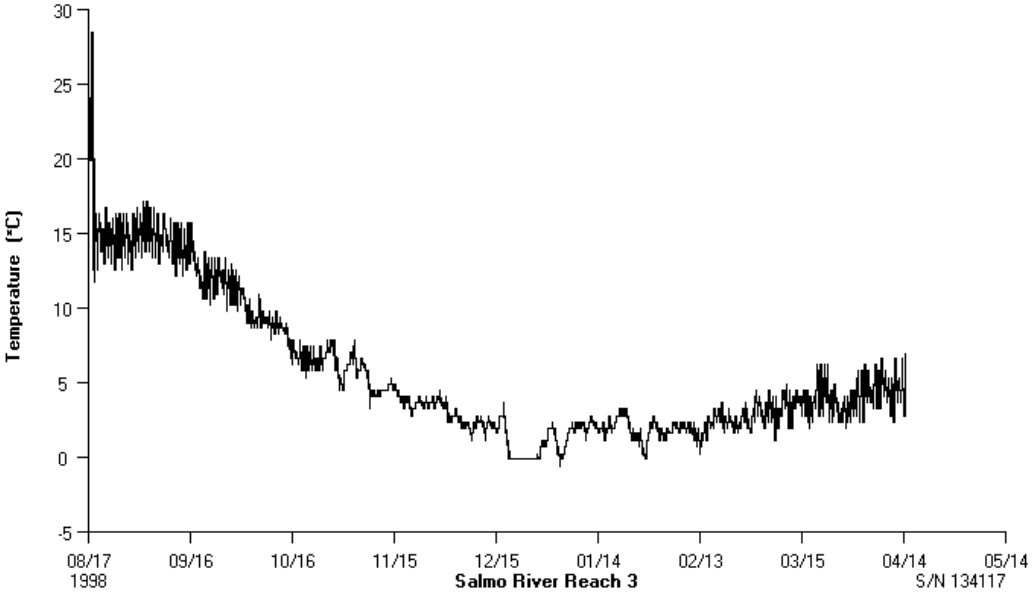
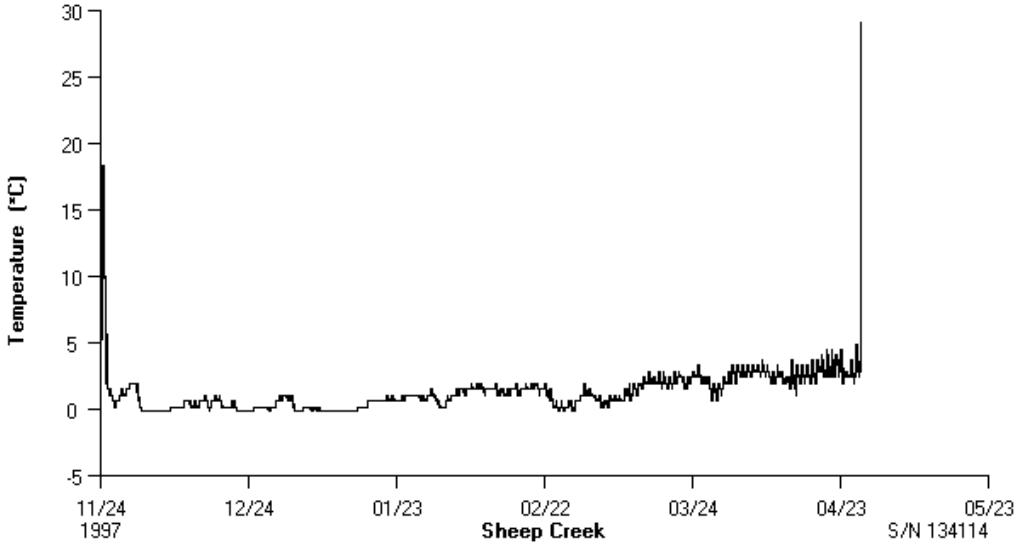
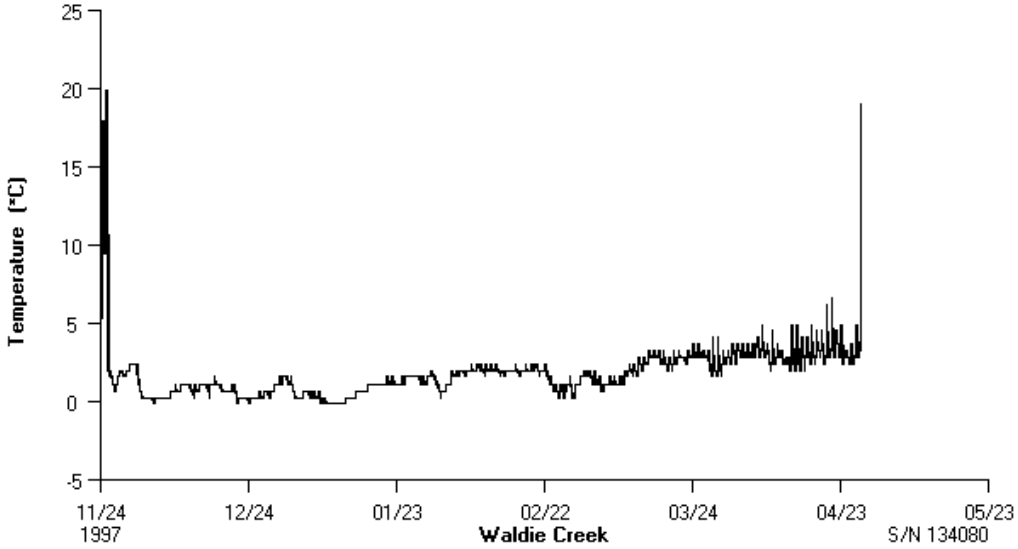
Appendix I. Water temperature profiles (Salmo River watershed-spring 1998).

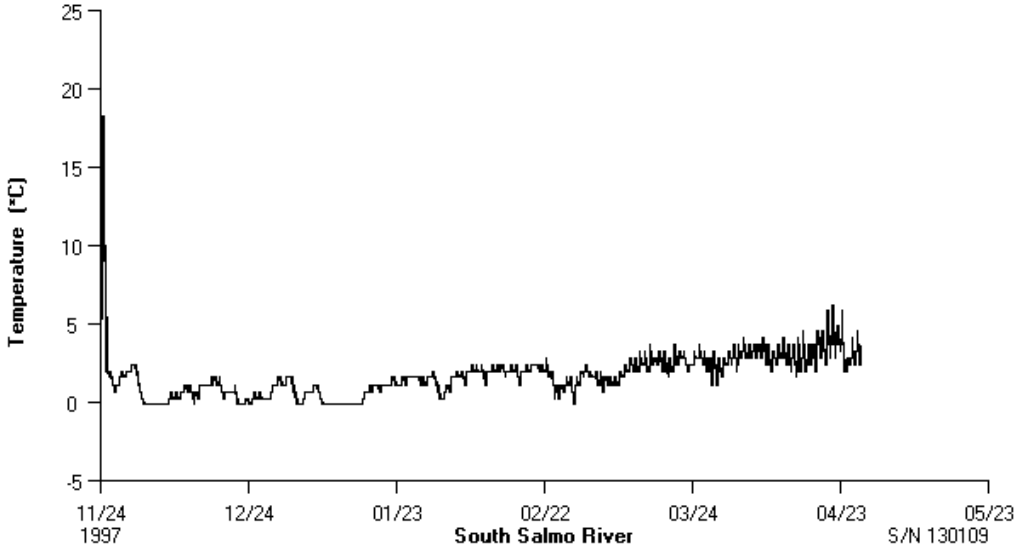

30
25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Salmo River-reach 6/site 1
S/N 134107

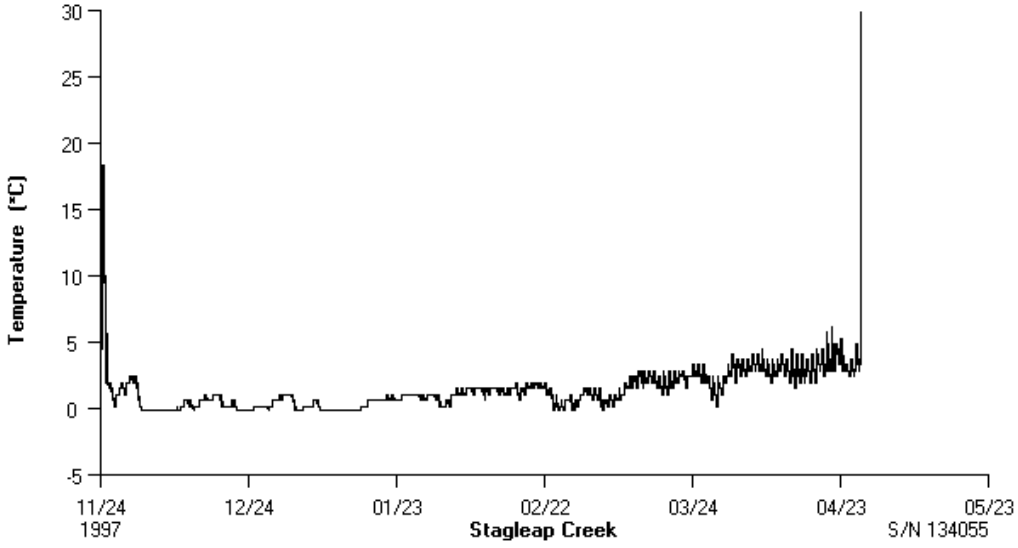

25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Salmo River-reach 4/site 1
S/N 134126

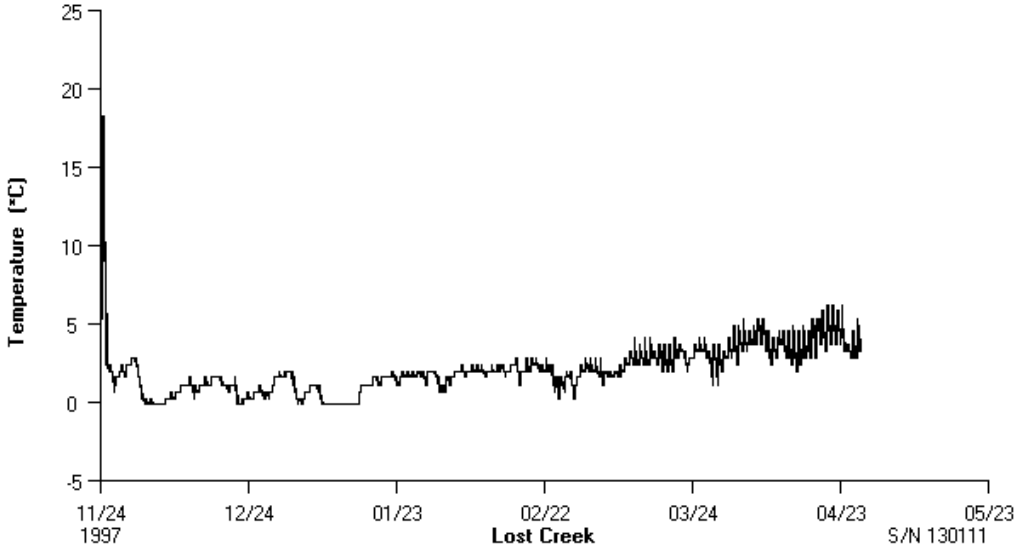

30
25
20
15
10
5
0
-5
Temperature (°C)
08/17
1998
09/16
10/16
11/15
12/15
01/14
02/13
03/15
04/14
05/14
Salmo River Reach 3
S/N 134117


30
25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Sheep Creek
S/N 134114

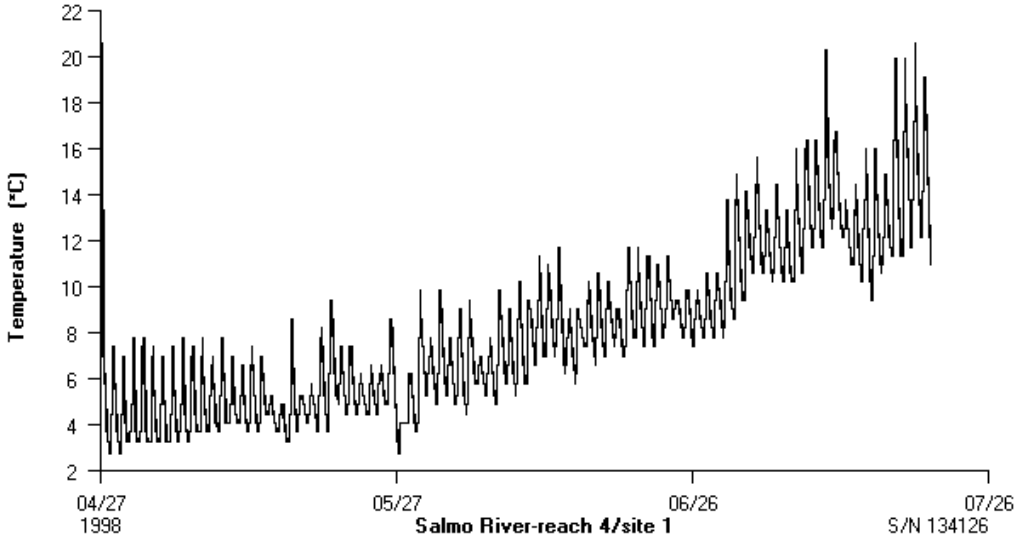

25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Waldie Creek
S/N 134080

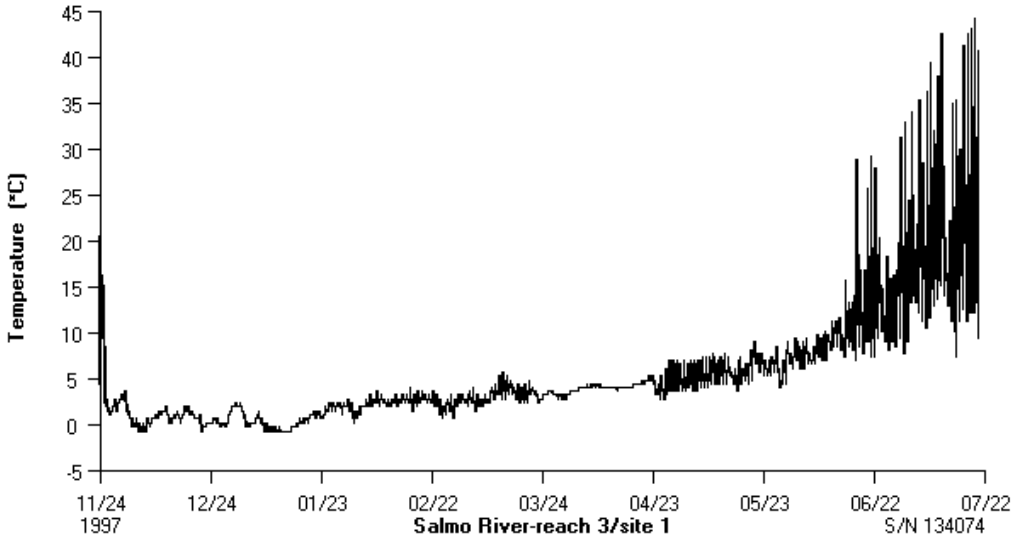

25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
South Salmo River
S/N 130109

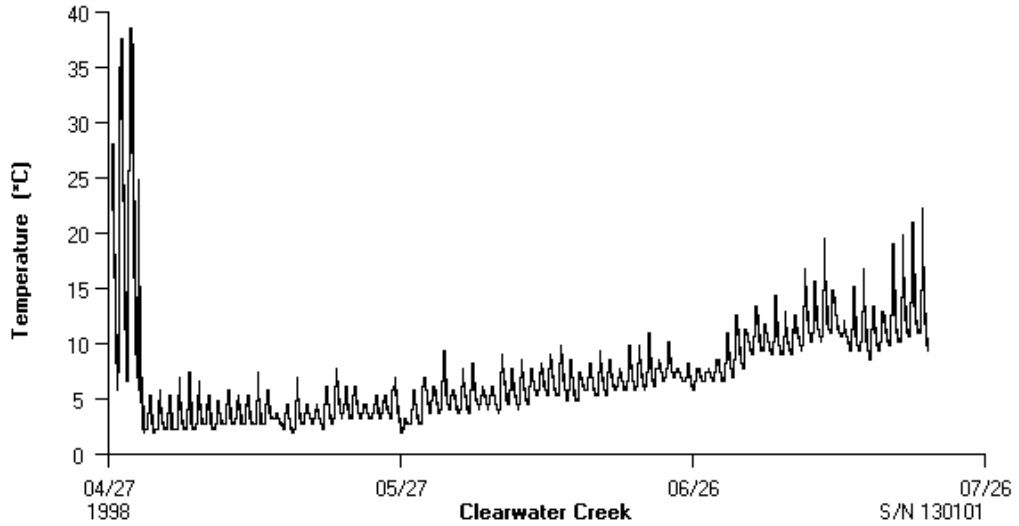

30
25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Stagleap Creek
S/N 134055

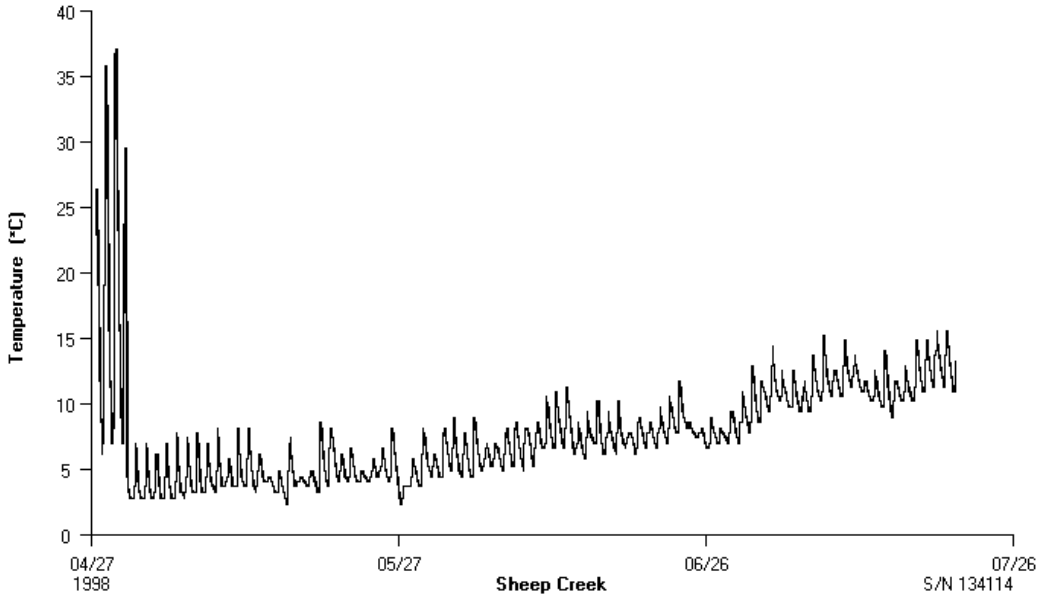

25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Lost Creek
S/N 130111

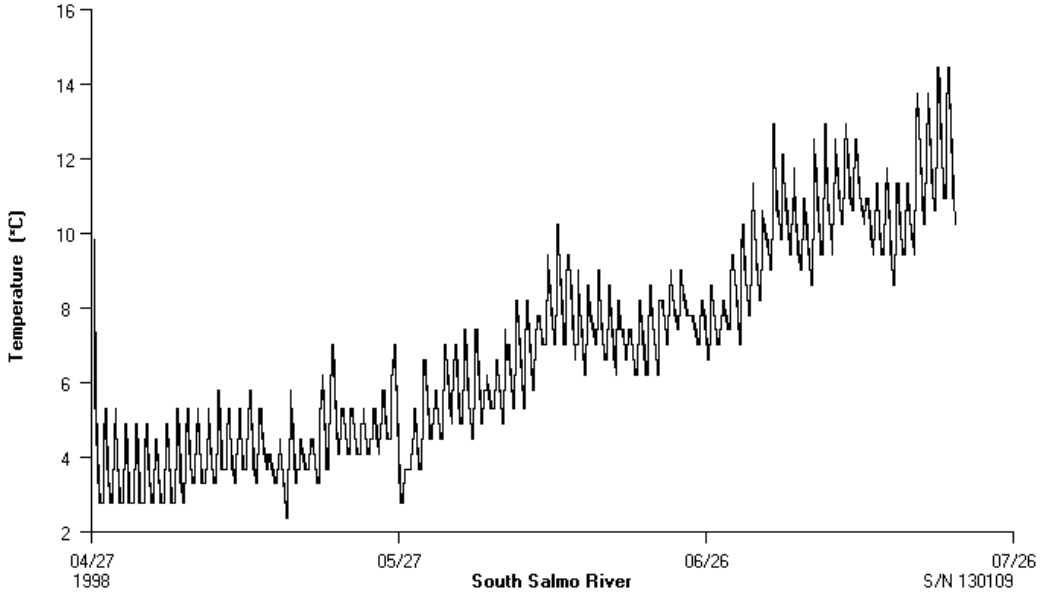
Appendix II. Water temperature profiles (Salmo River watershed-summer 1998).

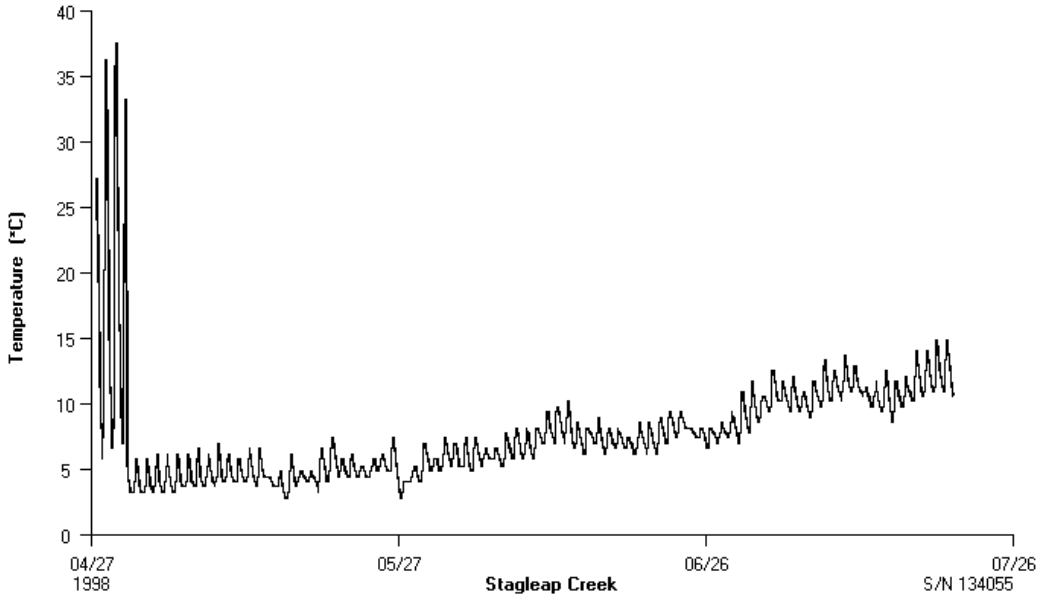

Temperature (°C)
22
20
18
16
14
12
10
8
6
4
2
04/27
1998
05/27
06/26
07/26
Salmo River-reach 4/site 1
S/N 134126

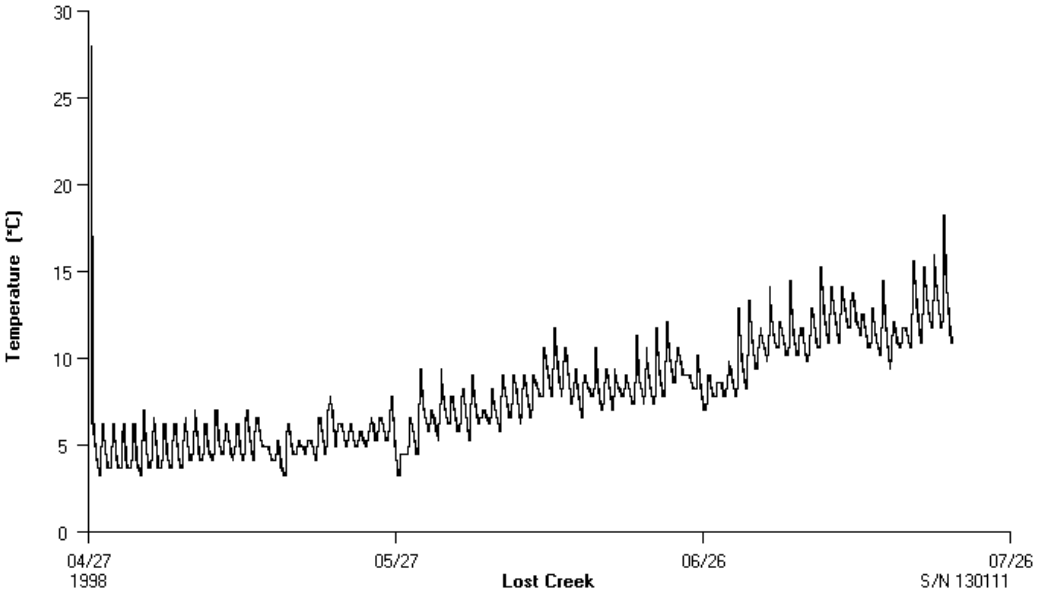

Temperature (°C)
45
40
35
30
25
20
15
10
5
0
-5
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
06/22
07/22
Salmo River-reach 3/site 1
S/N 134074


Temperature (°C)
40
35
30
25
20
15
10
5
0
04/27
1998
05/27
06/26
07/26
Clearwater Creek
S/N 130101


Temperature (°C)
40
35
30
25
20
15
10
5
0
04/27
1998
05/27
06/26
07/26
Sheep Creek
S/N 134114


Temperature (°C)
16
14
12
10
8
6
4
2
04/27
1998
05/27
06/26
07/26
South Salmo River
S/N 130109


Temperature (°C)
40
35
30
25
20
15
10
5
0
04/27
1998
05/27
06/26
07/26
Stagleap Creek
S/N 134055


30
25
20
15
10
5
0
Temperature (°C)
04/27
1998
05/27
06/26
07/26
Lost Creek
S/N 130111

Appendix III. Summary of water quality data for 10 sites in the Salmo River watershed in the winter of 1997 and summer of 1998.

Salmo River

Parameter	Units	Reach 6 – Site 1 Win 1997	Reach 6 – Site 1 Sum 1998	Reach 4 – Site 1 Win 1997	Reach 4 – Site 1 Sum 1998	Reach 3 – Site 1 Win 1997	Reach 3 – Site 1 Sum 1998
Alkalinity	mg/l	45	43.6	46	45.6	46.3	47.4
Conductivity	US/cm	107	97	102	97	101	100
Metals							
AG	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
AL	mg/l	<0.06	0.16	<0.06	<0.06	<0.06	<0.06
AS	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
B	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BA	mg/l	0.017	0.016	0.013	0.014	0.015	0.018
BE	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CA	mg/l	17.1	14.9	17.4	17.1	15.5	16.8
CD	mg/l	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
CO	mg/l	<0.006	<0.006	<0.006	<0.006	0.014	<0.006
CR	mg/l	<0.006	0.024	<0.006	0.007	<0.006	<0.006
CU	mg/l	<0.006	<0.006	<0.006	0.007	<0.006	0.007
FE	mg/l	0.063	0.08	0.015	0.017	0.03	0.045
K	mg/l	1.6	1.6	0.9	0.9	0.8	0.9
MG	mg/l	1.2	1.0	1.0	1.2	1.6	1.9
MN	mg/l	0.006	0.009	<0.001	0.001	0.003	0.007
MO	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NA	mg/l	1.5	2.5	1.0	1.4	1.2	1.2
NI	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PB	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
S	mg/l	2.71	2.32	2.17	1.93	2.15	2.18
SB	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
SE	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
SI	mg/l	4.39	4.17	3.71	4.03	3.83	4.53
SN	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
SR	mg/l	0.074	0.066	0.093	0.093	0.078	0.084
TI	mg/l	0.004	<0.002	<0.002	<0.002	0.004	<0.002
V	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
ZN	mg/l	<0.002	0.017	0.005	0.02	0.01	0.016
Nitrogen							
Ammonia	mg/l	0.011	<0.005	<0.005	<0.005	0.008	<0.005
Rite+Rate	mg/l	0.117	0.065	0.057	0.013	0.034	0.011
Total	mg/l	0.18	0.14	0.06	0.06	0.04	0.08
PH	Rel. U.	7.73	7.64	7.88	7.81	7.84	7.83
Phosphorous							
O-PO4	mg/l	<0.001	0.001	<0.001	<0.001	0.002	<0.001
Total	mg/l	0.007	0.007	0.003	0.004	0.006	0.008
Total Diss.	mg/l	0.004	0.005	0.003	0.005	0.005	0.01
Residue	mg/l	70	60	60	60	70	60

South Salmo River and tributaries

Parameter	Units	South Salmo River		Stagleap Creek		Lost Creek	
		Win 1997	Sum 1998	Win 1997	Sum 1998	Win 1997	Sum 1998
Alkalinity	mg/l	43.9	48.0	48.5	53.0	44.2	48.2
Conductivity	US/cm	88	91	114	115	113	100
Metals							
AG	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
AL	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
AS	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
B	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BA	mg/l	0.014	0.014	0.016	0.02	0.012	0.015
BE	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CA	mg/l	12.0	13.5	15.5	17.8	18.1	17.6
CD	mg/l	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
CO	mg/l	0.006	<0.006	<0.006	<0.006	<0.006	<0.006
CR	mg/l	0.006	<0.006	<0.006	<0.006	<0.006	<0.006
CU	mg/l	<0.006	<0.006	<0.006	0.006	<0.006	<0.006
FE	mg/l	0.009	0.02	0.014	0.012	0.026	<0.006
K	mg/l	0.4	0.4	0.6	0.6	0.5	0.4
MG	mg/l	3.2	3.7	2.1	2.6	2.0	1.5
MN	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
MO	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NA	mg/l	0.6	0.6	3.2	3.2	0.9	0.9
NI	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
P	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PB	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
S	mg/l	1.2	1.18	1.24	1.22	4.6	2.33
SB	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
SE	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
SI	mg/l	2.7	3.28	3.11	3.76	4.44	5.2
SN	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
SR	mg/l	0.044	0.05	0.065	0.075	0.049	0.047
TI	mg/l	0.005	<0.002	<0.002	<0.002	<0.002	<0.002
V	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
ZN	mg/l	0.006	<0.002	0.006	0.029	0.01	0.031
Nitrogen							
Ammonia	mg/l	0.008	<0.005	0.006	0.01	0.005	<0.005
Rite+Rate	mg/l	0.012	0.004	0.011	<0.002	0.006	<0.002
Total	mg/l	<0.02	0.02	<0.02	0.05	<0.02	0.03
PH	Rel. U.	7.84	7.89	7.87	7.96	7.84	7.91
Phosphorous							
O-PO4	mg/l	0.002	<0.001	0.001	<0.001	0.002	0.002
Total	mg/l	0.005	0.006	0.005	0.006	0.006	0.008
Total Diss.	mg/l	0.003	0.009	0.005	0.005	0.005	0.008
Residue	mg/l	50	50	60	70	70	60

Clearwater Creek and Hall Creek

Parameter	Units	Clearwater Creek		Hall Creek	
		Win 1997	Sum 1998	Win 1997	Sum 1998
Alkalinity	mg/l	29	28.7	41	39.4
Conductivity	US/cm	65	60	90	84
Metals					
AG	mg/l	<0.01	<0.01	<0.01	<0.01
AL	mg/l	0.06	0.09	<0.06	<0.06
AS	mg/l	<0.06	<0.06	<0.06	<0.06
B	mg/l	<0.01	<0.01	<0.01	<0.01
BA	mg/l	0.006	0.07	0.01	0.012
BE	mg/l	<0.001	<0.001	<0.001	<0.001
CA	mg/l	10.0	9.4	14.5	14.3
CD	mg/l	<0.006	<0.006	<0.006	<0.006
CO	mg/l	<0.006	<0.006	<0.006	<0.006
CR	mg/l	<0.006	0.037	<0.006	<0.006
CU	mg/l	<0.006	<0.006	<0.006	<0.006
FE	mg/l	0.029	<0.006	0.019	0.015
K	mg/l	0.6	0.8	0.5	0.5
MG	mg/l	0.8	0.6	1.2	1.3
MN	mg/l	0.002	0.002	<0.001	<0.001
MO	mg/l	<0.01	<0.01	<0.01	<0.01
NA	mg/l	0.8	1.8	0.8	1.0
NI	mg/l	<0.02	<0.02	<0.02	<0.02
P	mg/l	<0.1	<0.1	<0.1	<0.1
PB	mg/l	<0.06	<0.06	<0.06	<0.06
S	mg/l	1.5	1.25	1.92	1.81
SB	mg/l	<0.06	<0.06	<0.06	<0.06
SE	mg/l	<0.06	<0.06	<0.06	<0.06
SI	mg/l	3.51	3.36	3.16	3.46
SN	mg/l	<0.06	<0.06	<0.06	<0.06
SR	mg/l	0.057	0.052	0.093	0.093
TI	mg/l	0.005	<0.002	0.003	0.004
V	mg/l	<0.01	<0.01	<0.01	<0.01
ZN	mg/l	0.012	0.003	0.005	0.013
Nitrogen					
Ammonia	mg/l	<0.005	<0.005	<0.005	<0.05
Rite+Rate	mg/l	0.08	0.033	0.076	0.014
Total	mg/l	0.08	0.07	0.08	0.06
PH	Rel. U.	7.71	7.61	7.82	7.77
Phosphorous					
O-PO4	mg/l	<0.001	0.002	<0.001	0.001
Total	mg/l	0.003	0.004	0.003	0.004
Total Diss.	mg/l	0.003	0.004	0.003	0.003
Residue	mg/l	40	30	60	50

Sheep Creek and Waldie Creek

Parameter	Units	Sheep Creek		Waldie Creek	
		Win 1997	Sum 1998	Win 1997	Sum 1998
Alkalinity	mg/l	22	22.8	24.2	23.2
Conductivity	US/cm	49	46	52	84
Metals					
AG	mg/l	<0.01	<0.01	<0.01	<0.01
AL	mg/l	<0.06	0.06	<0.06	<0.06
AS	mg/l	<0.06	<0.06	<0.06	<0.06
B	mg/l	<0.01	<0.01	<0.01	<0.01
BA	mg/l	0.016	0.021	0.017	0.02
BE	mg/l	<0.001	<0.001	<0.001	<0.001
CA	mg/l	7.3	7.9	7.9	7.6
CD	mg/l	<0.006	<0.006	<0.006	<0.006
CO	mg/l	<0.006	<0.006	<0.006	<0.006
CR	mg/l	0.013	<0.006	<0.006	0.006
CU	mg/l	<0.006	<0.006	<0.006	0.006
FE	mg/l	0.017	0.012	<0.006	0.012
K	mg/l	0.3	0.3	0.4	0.3
MG	mg/l	0.8	0.9	0.8	0.8
MN	mg/l	<0.001	0.002	<0.001	0.003
MO	mg/l	0.01	<0.01	<0.01	<0.01
NA	mg/l	0.5	0.5	0.4	0.4
NI	mg/l	<0.02	0.02	<0.02	<0.02
P	mg/l	<0.1	<0.1	<0.1	<0.1
PB	mg/l	<0.06	<0.06	<0.06	<0.06
S	mg/l	1.1	1.26	0.9	0.87
SB	mg/l	<0.06	<0.06	<0.06	<0.06
SE	mg/l	<0.06	<0.06	<0.06	<0.06
SI	mg/l	2.58	2.85	2.22	2.46
SN	mg/l	<0.06	<0.06	<0.06	<0.06
SR	mg/l	0.035	0.038	0.039	0.039
TI	mg/l	<0.002	<0.002	<0.002	<0.002
V	mg/l	<0.01	<0.01	<0.01	<0.01
ZN	mg/l	0.007	0.021	0.003	0.025
Nitrogen					
Ammonia	mg/l	0.006	<0.005	0.006	<0.05
Rite+Rate	mg/l	0.021	0.007	0.025	0.016
Total	mg/l	<0.02	0.02	<0.02	0.04
PH	Rel. U.	7.56	7.52	7.60	7.56
Phosphorous					
O-PO4	mg/l	<0.001	0.001	0.001	<0.001
Total	mg/l	0.003	0.005	0.004	0.005
Total Diss.	mg/l	0.003	0.005	0.003	0.005
Residue	mg/l	30	30	30	30

Appendix IV. Summary data of snorkel surveys conducted on the mainstem Salmo River in 1998.

Date	August 5, 1998 (AM)
Start Location	Salmo Rest Stop
End Location	Liness Road
No. of Swimmers	5
Personnel	JB/GB/RO/DD/CM
Visibility	Clear

Rainbow Trout	**N**	**Northern Pikeminnow**	**N**
10-20 cm	46	10-20 cm	0
20-30 cm	87	20-30 cm	0
30-40 cm	36	30-40 cm	1
40-50 cm	4	40-50 cm	0
50+ cm	2	50+ cm	0

Bull Trout	**N**	**Eastern Brook Trout**	**N**
10-20 cm	1	10-20 cm	6
20-30 cm	2	20-30 cm	12
30-40 cm	6	30-40 cm	2
40-50 cm	2	40-50 cm	0
50+ cm	0	50+ cm	0

Sucker	**N**	**Mountain Whitefish**	**N**
10-20 cm	0	10-20 cm	2
20-30 cm	0	20-30 cm	6
30-40 cm	1	30-40 cm	2
40-50 cm	0	40-50 cm	0
50+ cm	0	50+ cm	0

Date	August 5, 1998 (PM)
Start Location	Liness Road
End Location	Burned Out Bridge
No. of Swimmers	5
Personnel	JB/GB/RO/DD/CM
Visibility	Clear

Rainbow Trout	**N**	**Northern Pikeminnow**	**N**
10-20 cm	89	10-20 cm	0
20-30 cm	104	20-30 cm	3
30-40 cm	76	30-40 cm	27
40-50 cm	1	40-50 cm	3
50+ cm	1	50+ cm	0

Bull Trout	**N**	**Eastern Brook Trout**	
10-20 cm	0	10-20 cm	3
20-30 cm	4	20-30 cm	2
30-40 cm	0	30-40 cm	0
40-50 cm	0	40-50 cm	0
50+ cm	0	50+ cm	0

Sucker	**N**	**Mountain Whitefish**	**N**
10-20 cm	0	10-20 cm	0
20-30 cm	46	20-30 cm	8
30-40 cm	154	30-40 cm	0
40-50 cm	1	40-50 cm	0
50+ cm	0	50+ cm	0

Date	August 7, 1998 (AM)
Start Location	Clearwater Creek
End Location	Hall Creek
No. of Swimmers	3
Personnel	JB/ DD/CM
Visibility	Clear

Rainbow Trout	**N**	**Northern Pikeminnow**	**N**
10-20 cm	2	10-20 cm	0
20-30 cm	1	20-30 cm	0
30-40 cm	3	30-40 cm	0
40-50 cm	0	40-50 cm	0
50+ cm	0	50+ cm	0

Bull Trout	**N**	**Eastern Brook Trout**	**N**
10-20 cm	0	10-20 cm	0
20-30 cm	0	20-30 cm	0
30-40 cm	0	30-40 cm	0
40-50 cm	0	40-50 cm	0
50+ cm	0	50+ cm	0

Sucker	**N**	**Mountain Whitefish**	**N**
10-20 cm	0	10-20 cm	0
20-30 cm	0	20-30 cm	0
30-40 cm	0	30-40 cm	0
40-50 cm	0	40-50 cm	0
50+ cm	0	50+ cm	0

Date	August 7, 1998 (PM)
Start Location	Porcupine Bridge
End Location	Hidden Creek
No. of Swimmers	3
Personnel	JB/DD/CM
Visibility	Clear

Rainbow Trout	**N**	**Northern Pikeminnow**	**N**
10-20 cm	51	10-20 cm	0
20-30 cm	53	20-30 cm	0
30-40 cm	10	30-40 cm	0
40-50 cm	4	40-50 cm	0
50+ cm	0	50+ cm	0

Bull Trout	**N**	**Eastern Brook Trout**	**N**
10-20 cm	0	10-20 cm	2
20-30 cm	0	20-30 cm	1
30-40 cm	0	30-40 cm	0
40-50 cm	0	40-50 cm	0
50+ cm	0	50+ cm	0

Sucker	**N**	**Mountain Whitefish**	**N**
10-20 cm	0	10-20 cm	0
20-30 cm	0	20-30 cm	0
30-40 cm	0	30-40 cm	0
40-50 cm	0	40-50 cm	0
50+ cm	0	50+ cm	0

Appendix V. Summary data of redd counts conducted in the Salmo River watershed in 1998.

Clearwater Creek

Date	Location	Number of Redds	Number of Fish
September 15	Falls to old bridge	1	4 Males (35-45 cm) 1 Female (40 cm)
October 5	Falls to mouth	15	3 Males (50-55 cm) 2 Females (50-55 cm)

upper Salmo River

Date	Location	Number of Redds	Number of Fish
September 15	Camp Busk to Field	0	0
September 18	Field to Hall Creek	2	5 Males (45-60 cm) 3 Females (40-50 cm)
October 6	Field to Hall Creek	10	1 Male (50 cm)

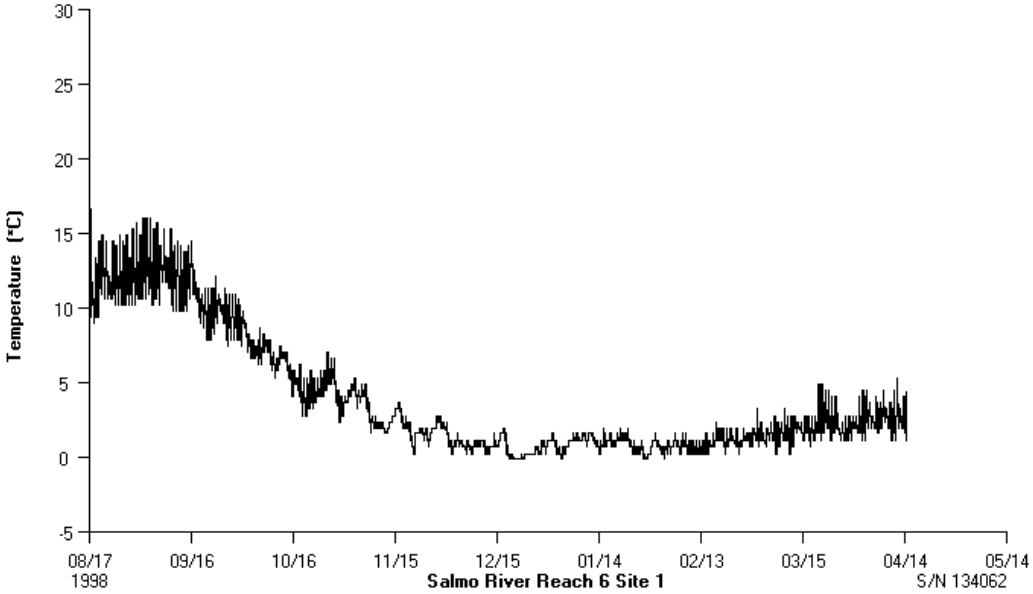
South Salmo River

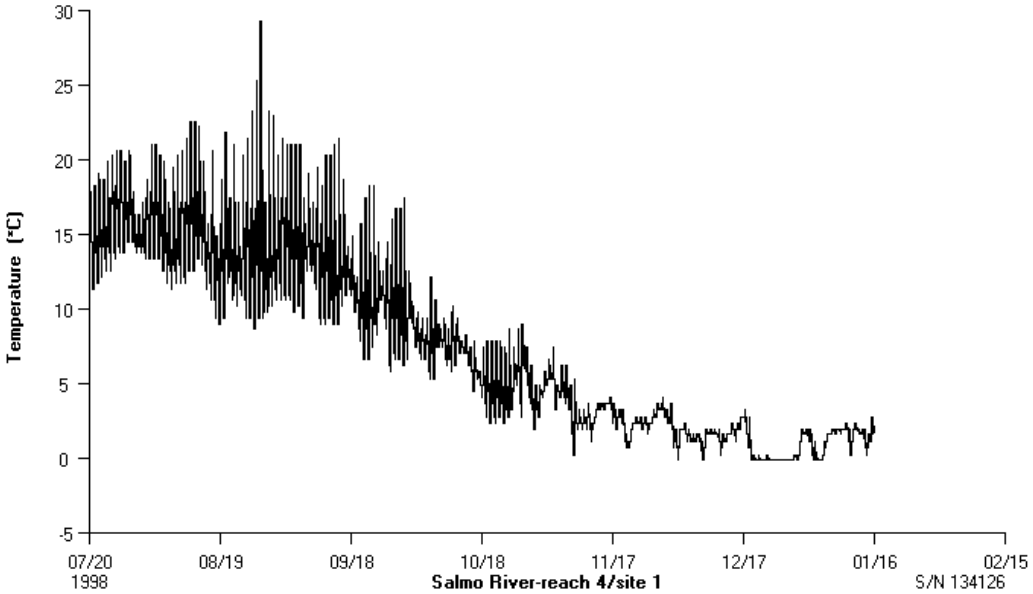
Date	Location	Number of Redds	Number of Fish
September 16	3 km above Atco bridge to Atco bridge	0	0

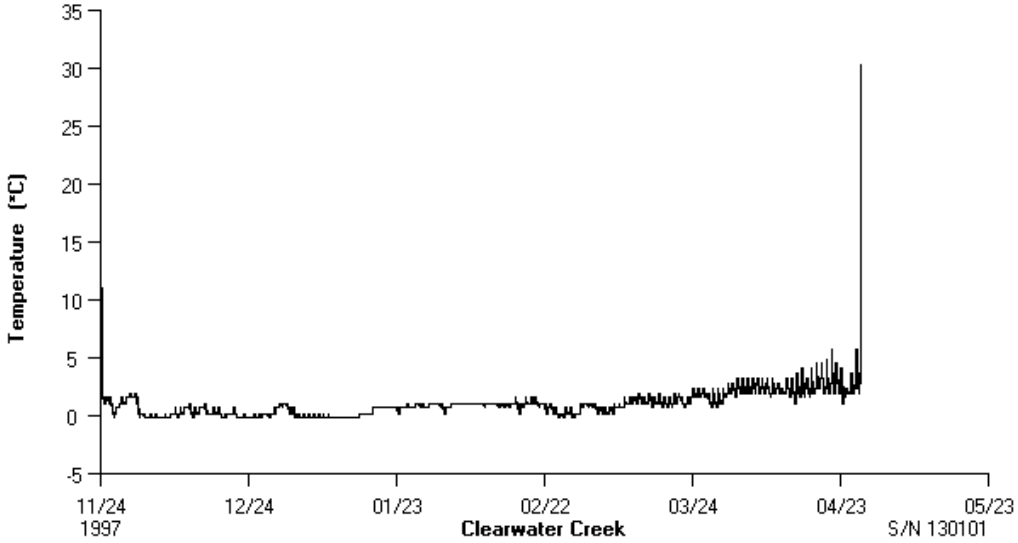
Sheep Creek

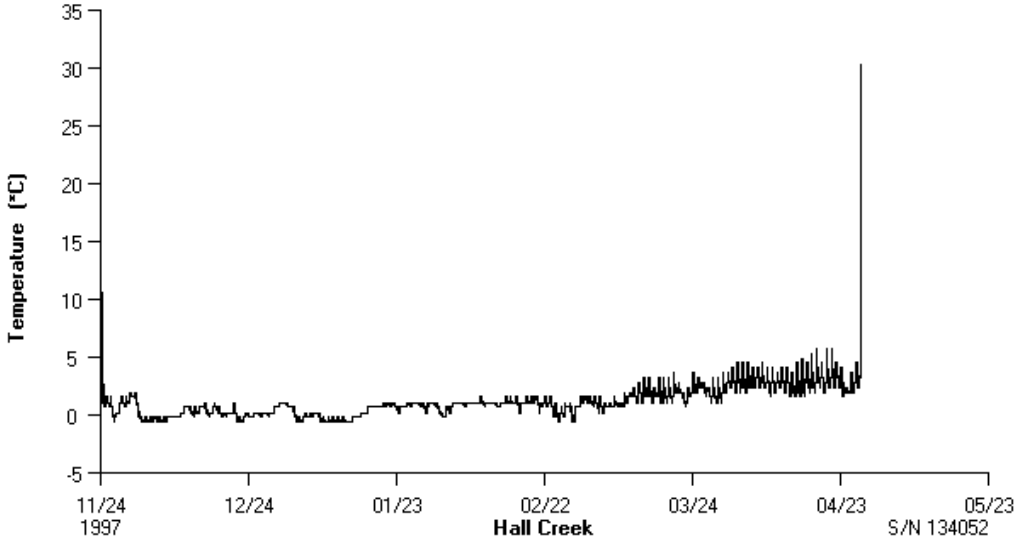
Date	Location	Number of Redds	Number of Fish
September 17	Log jam to 5 km below log jam	1	17 Males (20-60 cm) 12 Females (30-65 cm)
September 25-26	Log jam to 5 km below log jam	14	10 Males (25-60 cm) 10 Females (30-65 cm)
October 7	Log jam to 5 km below log jam	36	7 Unknown Sex (1-6 lbs)
October 7	5 km below log jam to 7.5 km below log jam	0	1 Female (35 cm)

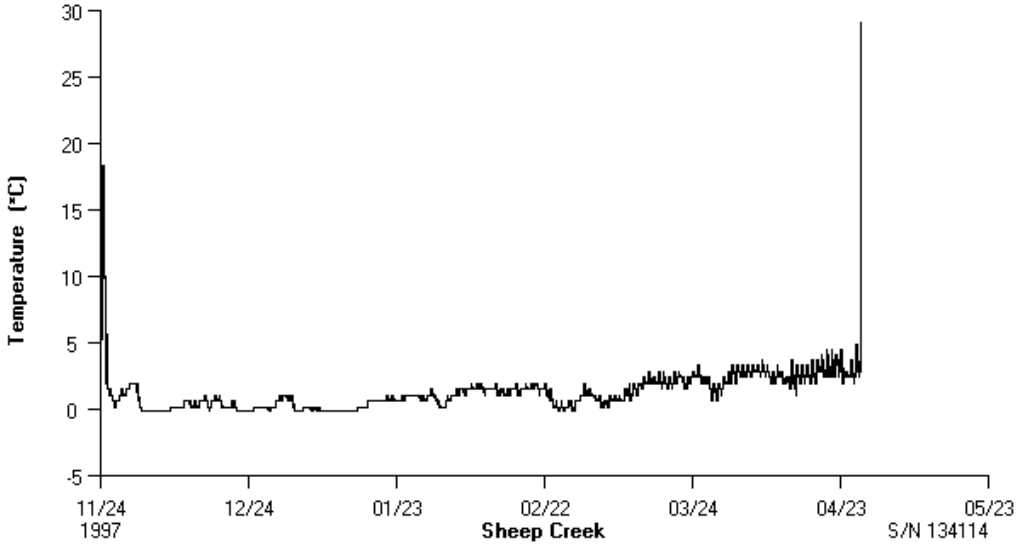
Appendix VI. Water temperature profiles (Salmo River watershed-spring 1999).

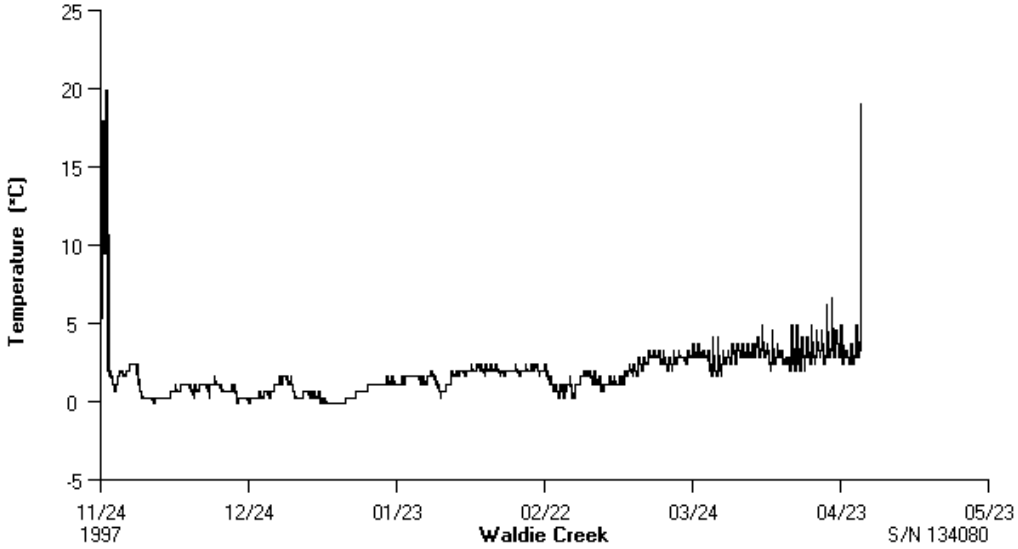

Temperature (°C)
30
25
20
15
10
5
0
-5
08/17
1998
09/16
10/16
11/15
12/15
01/14
02/13
03/15
04/14
05/14
Salmo River Reach 6 Site 1
S/N 134062

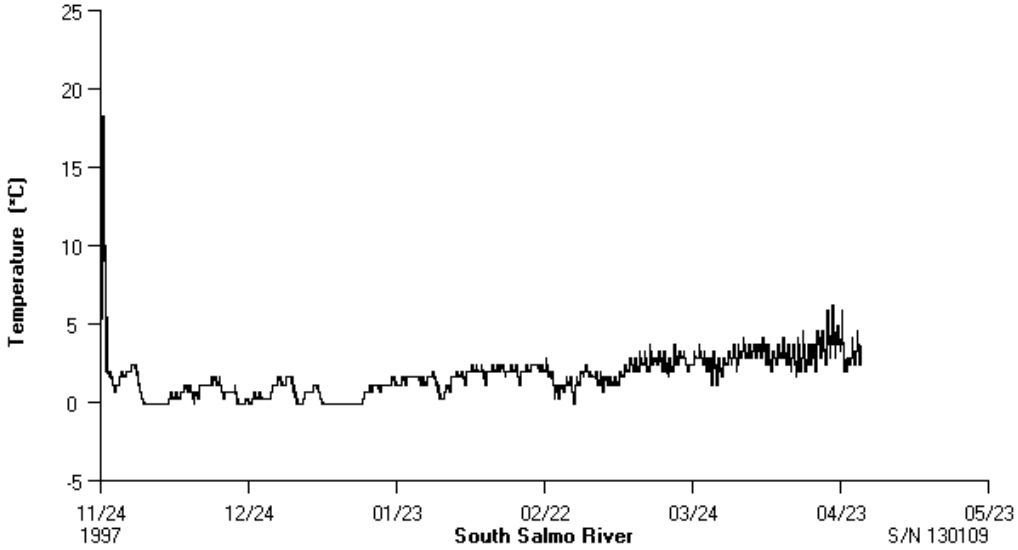

Temperature (°C)
30
25
20
15
10
5
0
-5
07/20
1998
08/19
09/18
10/18
11/17
12/17
01/16
02/15
Salmo River-reach 4/site 1
S/N 134126

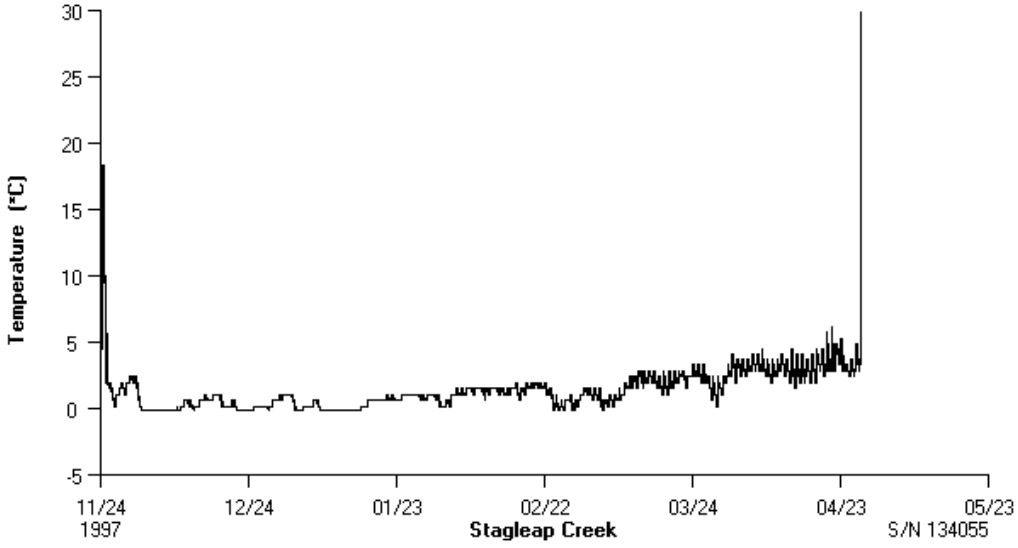

35
30
25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Clearwater Creek
S/N 130101

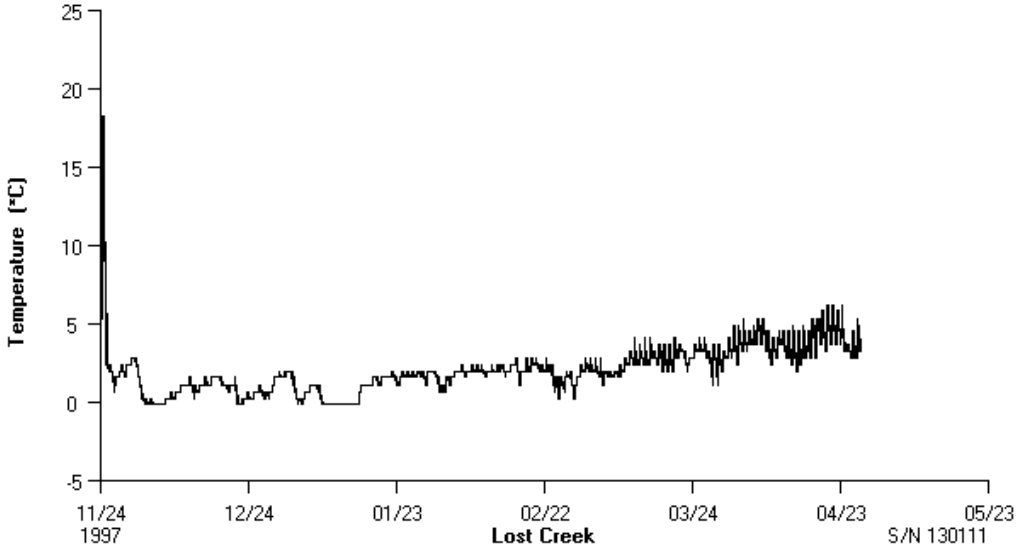

35
30
25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Hall Creek
S/N 134052


30
25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Sheep Creek
S/N 134114

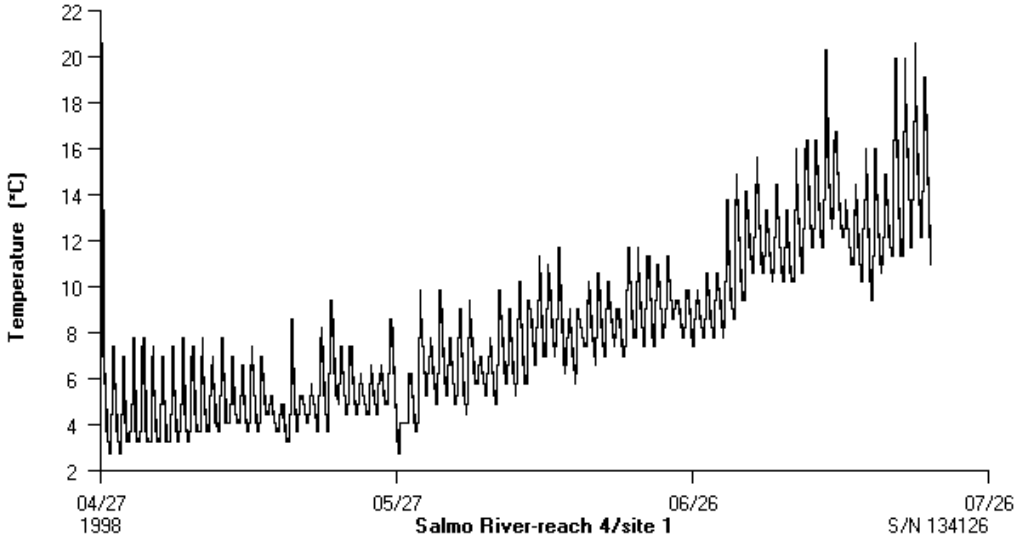

25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Waldie Creek
S/N 134080

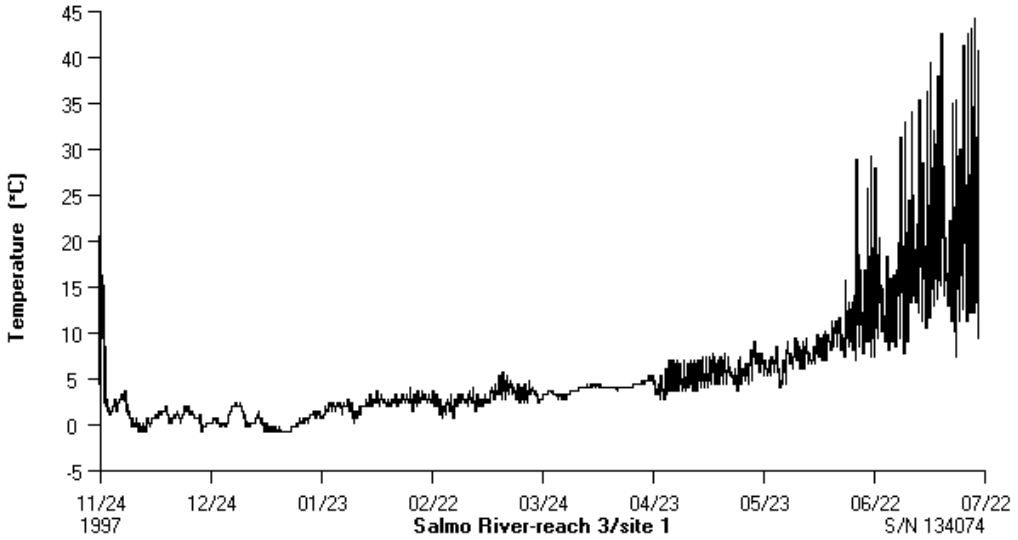

25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
South Salmo River
S/N 130109

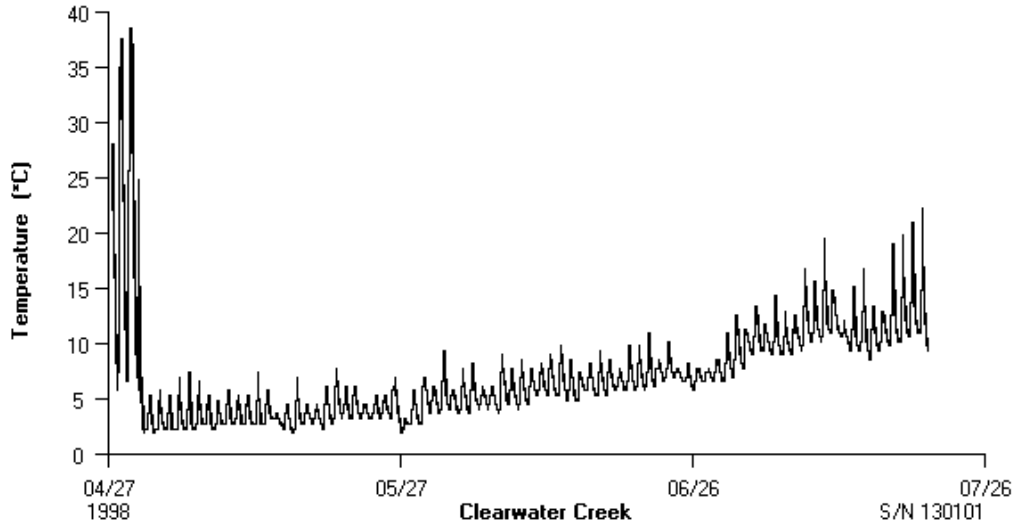

30
25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Stagleap Creek
S/N 134055

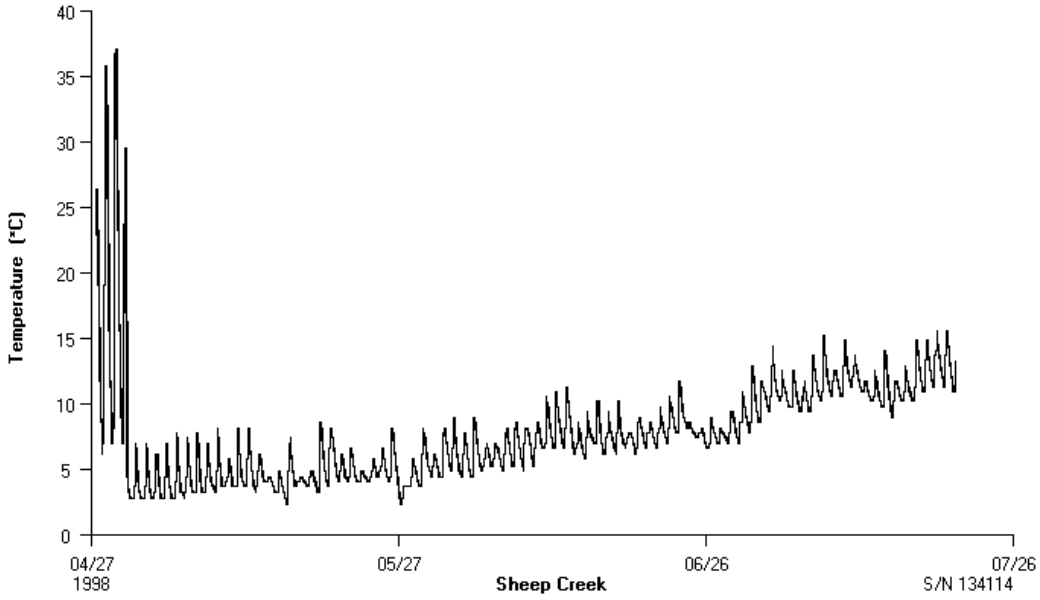

25
20
15
10
5
0
-5
Temperature (°C)
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
Lost Creek
S/N 130111

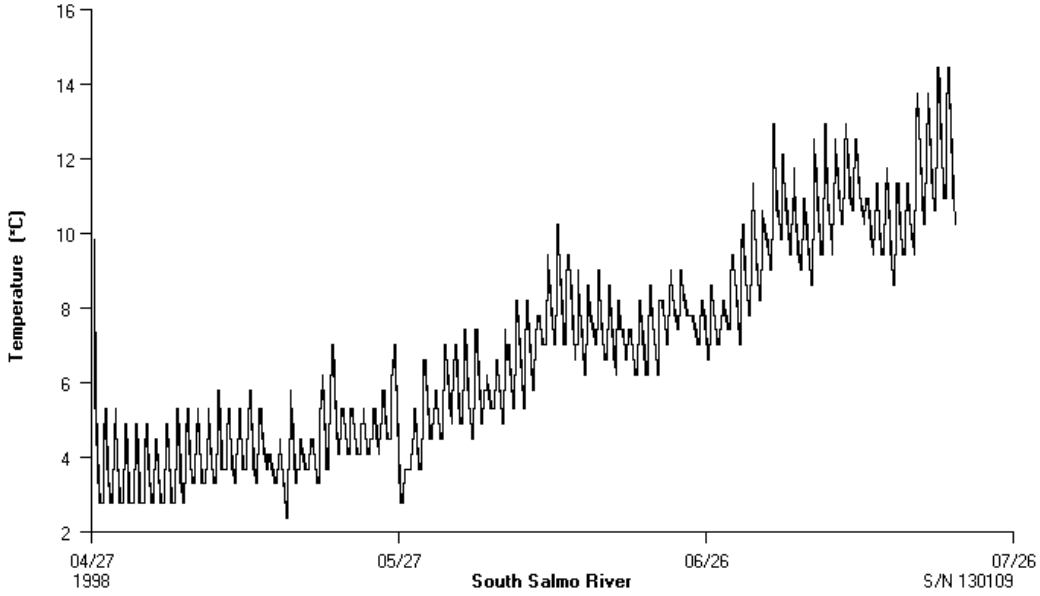
Appendix VII. Water temperature profiles (Salmo River watershed-summer 1999).

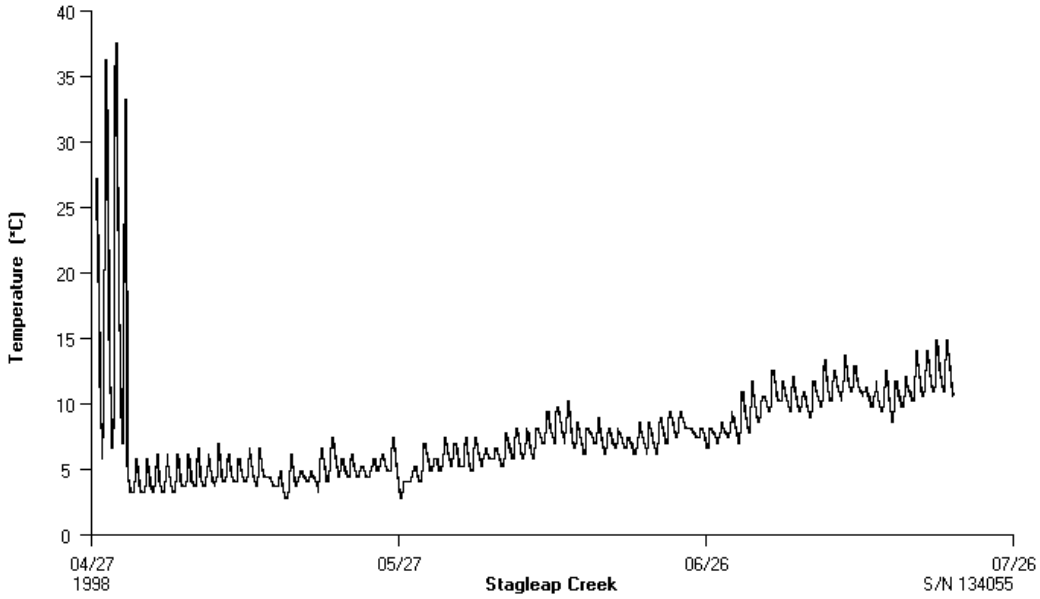

Temperature (°C)
22
20
18
16
14
12
10
8
6
4
2
04/27
1998
05/27
06/26
07/26
Salmo River-reach 4/site 1
S/N 134126

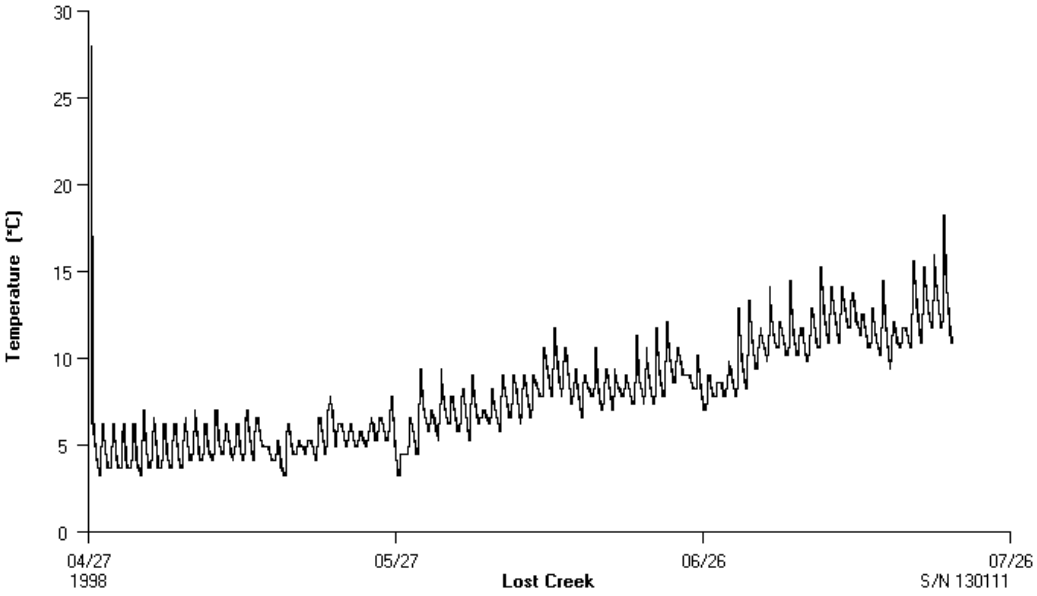

Temperature (°C)
45
40
35
30
25
20
15
10
5
0
-5
11/24
1997
12/24
01/23
02/22
03/24
04/23
05/23
06/22
07/22
Salmo River-reach 3/site 1
S/N 134074


Temperature (°C)
40
35
30
25
20
15
10
5
0
04/27
1998
05/27
06/26
07/26
Clearwater Creek
S/N 130101


Temperature (°C)
40
35
30
25
20
15
10
5
0
04/27
1998
05/27
06/26
07/26
Sheep Creek
S/N 134114


Temperature (°C)
16
14
12
10
8
6
4
2
04/27
1998
05/27
06/26
07/26
South Salmo River
S/N 130109


Temperature (°C)
40
35
30
25
20
15
10
5
0
04/27
1998
05/27
06/26
07/26
Stagleap Creek
S/N 134055


30
25
20
15
10
5
0
Temperature (°C)
04/27
1998
05/27
06/26
07/26
Lost Creek
S/N 130111

Appendix VIII. Summary data of redd counts conducted in the Salmo River watershed in 1998.

Clearwater Creek

Date	Location	Number of Redds	Number of Fish
August 31	Falls to mouth	0	2 Males (55-70 cm) 1 Female (55 cm)
September 24	Falls to mouth	8	4 Males (35-65 cm) 3 Females (35-60 cm)

upper Salmo River

Date	Location	Number of Redds	Number of Fish
August 31	Camp Busk to 1.5 km d/s	0	1 Male (55 cm)
September 25	Camp Busk to Hall Creek	3	3 Males (45-60 cm) 2 Females (40-55 cm)

Sheep Creek

Date	Location	Number of Redds	Number of Fish
August 30	1 km above log jam to 2.5 km below log jam	0	0
September 21-22	Curtis Creek confluence to 5.0 km below old log jam	10*	7 Males (35-65 cm) 6 Females (50-65 cm)

* 7 redds (Curtis Creek to old barrier), 3 redds (below old barrier)