SALMON RIVER NUTRIENT ENRICHMENT FOR FISH HABITAT RESTORATION 2004

prepared by
Loreta Hansen
Fisheries Technician

for
B.C. Ministry of Water, Land and Air Protection
Fisheries Section, Nanaimo

administered by
B.C. Conservation Foundation
Nanaimo, B.C.

funded by
Weyerhaeuser Canada Ltd.
Forest Investment Account (FIA) Number 6353005

and
BC Hydro
Bridge Coastal Fish and Wildlife Restoration Program
Burnaby, B.C.
(Project #04.Ca.05)

November, 2004

EXECUTIVE SUMMARY

From June 8 to September 17, 2004, inorganic fertilizer was added to the Salmon River (Kelsey Bay), Grilse Creek, and the Memekay River for the enhancement of winter-run steelhead (*Oncorhynchus mykiss*) and coho (*O. kisutch*). A total of 2,416 L (11.6 barrels) of liquid fertilizer, ammonium polyphosphate (10-34-0), was dispensed through five drip stations: Grilse Creek – 310 L, Salmon River near Rock Creek Main Line – 624 L, Salmon River at the diversion – 548 L, Salmon River at Memekay Main Line bridge crossing – 624 L, and the Memekay River – 310 L. Fertilizer loading rates were adjusted to changing streamflow throughout the treatment period. Water samples were collected July 8, August 5, and September 6, 2004 and analysed at PSC Analytical Services in Burnaby for low level nitrogen and phosphorus. Juvenile fish were sampling using the electrofishing method at 10 sites within the control and treatment reaches. A new product, providing organic instream nutrients, was tested in the upper Salmon River below Jessie Creek, in 2004. The product was made from organic fish meal (Alaskan pollock), heat-treated to remove pathogens, dried, and pressed into logs. This product was developed under the guidance of Dr. Ken Ashley of the Ministry of Water, Land and Air Protection, Fisheries Research Section, Vancouver and experimentally produced by David Murphy of Welcome Harvest Farm Ltd., Saltspring Island. Water samples were collected and analysed for nitrogen and phosphorus, and periphyton was sampled and analysed for chlorophyll *a* and phaeophytin *a*.

ACKNOWLEDGEMENTS

Funding in part was provided by the BC Hydro Bridge-Coastal Fish and Wildlife Restoration Program to operate project work for sites upstream of the Salmon River diversion dam including Grilse Creek. Sites below the dam and in the Memekay River were funded by Weyerhaeuser's Renewal Investment Corporation. Craig Wightman, Ministry of Water, Land and Air Protection (MWLAP), Nanaimo, supervised the project work. Ken Ashley and Pat Slaney, Fisheries Research Section, MWLAP, produced the spreadsheet for fertilizer addition rates. The design and planning for the pollock logs was provided by Ken Ashley and the logs were produced by Dave Murphy at Welcome Harvest Farm Ltd. The B.C. Conservation Foundation (BCCF) in Nanaimo administered this project under the supervision of Pat Stephenson. Leian Carswell assisted with fieldwork including set-up and dismantling of drip-stations. Juvenile fish sampling within the control and treatment areas was conducted by Scott Silvestri, Harlan Wright and Loreta Hansen. Harlan and Kevin Pellet reported all juvenile fish sampling data and information. Harlan also created the map in Figure 1. MWLAP, Campbell River, under the direction of Dan Dwyer, provided storage space for fertilizer and related equipment. Lynne Campo of Water Survey of Canada, Vancouver, supplied the stream discharge data. Quinsam Hatchery provided temporary freezer storage for the pollock logs. This report was edited by Harlan Wright.

TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF APPENDICES

1.0 INTRODUCTION

The spring and summer of 2004 marked the sixteenth consecutive year of inorganic nutrient addition in the upper Salmon River watershed (Kelsey Bay). Past years have been reported in Perrin, 1989-91; Carswell, 1992-3; Hansen, 1994-5, 1999a-d, and 2001-03; and Hansen & Wright, 2004. This stream enrichment project is designed to enhance the growth and survival of juvenile steelhead (*Oncorhynchus mykiss*) and coho (*O. kisutch*) through increased periphyton accrual and subsequent increases in the invertebrate food supply. Hatchery-reared steelhead fry, progeny of wild Salmon River broodstock, were released into the upper Salmon River and Grilse Creek from 1986 to 1998. The fry were reared at the province's Vancouver Island Trout Hatchery in Duncan. In addition, numbers of wild steelhead in the upper watershed have increased following the construction and operation of the fishway at the BC Hydro diversion dam in 1992. The first year of operation of the fishway (winter 1992/93) allowed adult steelhead to migrate upstream of the diversion dam. Counts of downstreaming kelts at the fish screen and trap in 1998 and 1999, supported by snorkel surveys, indicated that steelhead escapement to the upper Salmon River above the diversion dam was well established. No wild steelhead broodstock was taken after 1998. Enumeration of downstream migrating juveniles has been conducted at the Salmon River fish screen (located in the diversion canal) since 1987, and summarized in contract reports beginning in 1989 (Perrin 1989; Carswell 1990 to 1993 inclusive; Hansen 1994; Hansen & Rimmer 1995; and Hansen 1997 to 2003, inclusive).

Development of a slow-release fertilizer has been undertaken by the Fisheries Research and Development Section, Ministry of Water, Land and Air Protection (MWLAP), Vancouver, B.C. and supervised by Dr. Ken Ashley. Field trials to study the instream application of solid inorganic fertilizer in Salmon River tributaries were initiated in 1995 and continued each season to 1997 inclusive (Mouldey Ewing et al. 1996-8). In 2002, another experimental product, a struvite-coated urea granule, was applied to the upper Salmon River just below the Jessie Creek confluence (Hansen 2003). An organic product made from Alaskan pollock bone meal was developed for initial testing in 2003.

A chronology of stream fertilization treatment in the Salmon River watershed, including Grilse Creek from 1988 to 2003, is detailed in Appendix 1. This was also the eighth year of stream nutrient addition to the Memekay River.

Funding for 2004 was provided by the BC Hydro, Bridge Coastal Restoration Program (year 1 of 3) and Weyerhaeuser's Renewal Investment Corporation. All costs pertaining to sites upstream of the Salmon River diversion dam were covered by BC Hydro and all costs for sites below the dam were covered by Weyerhaeuser.

2.0 MATERIALS AND METHODS

2.1 Site Locations (Tanks)

Five drip-sites for the addition of liquid 10-34-0 were operated in the Salmon River watershed in 2004. A location map is provided in Figure 1. Two of the five drip-sites were located upstream of the BC Hydro Salmon River diversion dam. The first site provided nutrient addition to Grilse Creek at the upper bridge crossing on Grilse Creek Main Line (ML) just below the old Reliable logging camp. The second site provided nutrient addition to the mainstem Salmon River, and

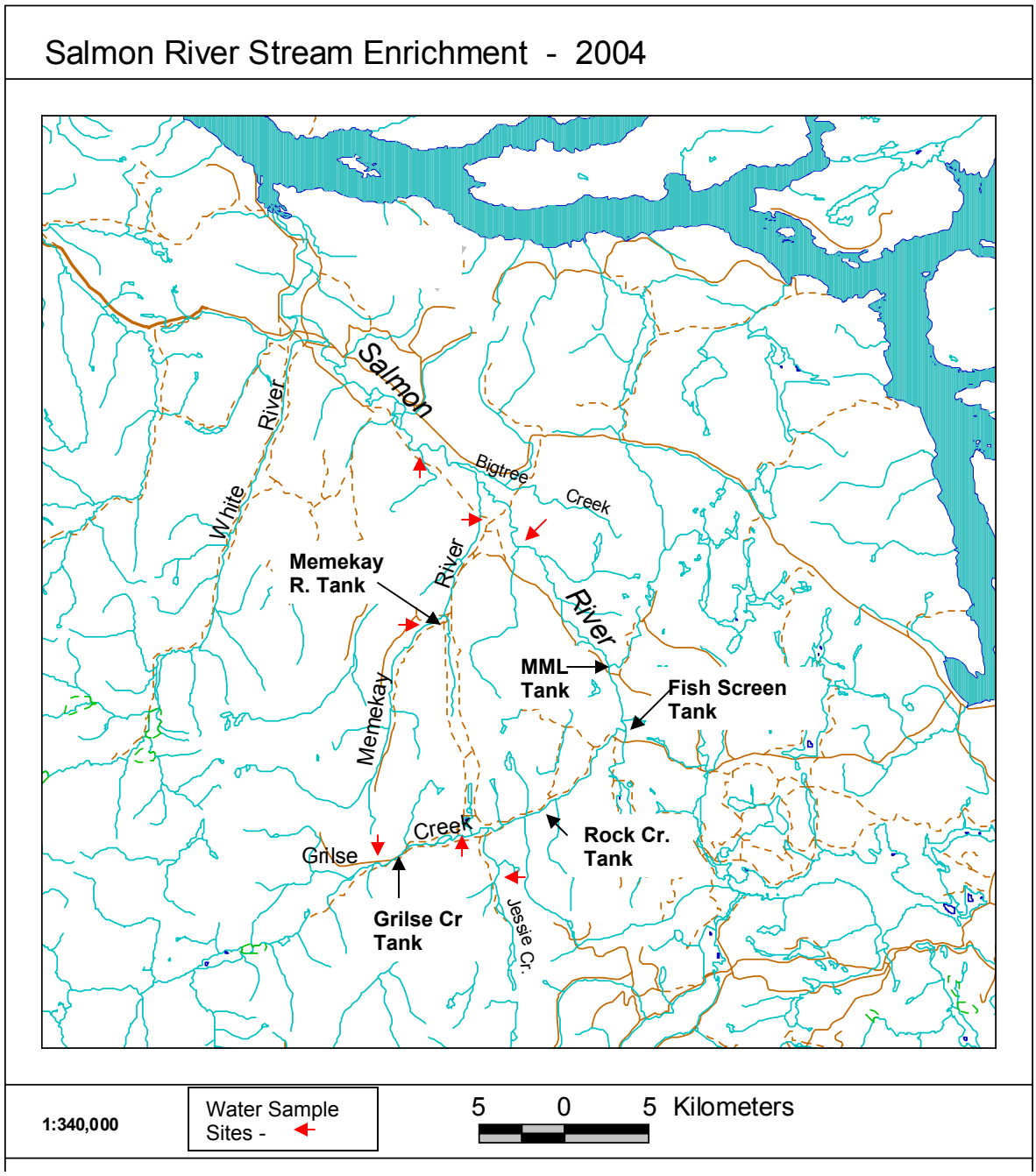


Figure 1. Location of the fertilization area showing liquid fertilizer tank sites and sampling sites on the mainstem Salmon River, Grilse Creek and the Memekay River in 2004.

was located 1 km upstream of the deactivated Rock Creek ML bridge crossing. Drip-sites below the diversion dam included two additional sites on the mainstem Salmon River, one at the Salmon River bridge-crossing adjacent to the diversion fish screen and abnother site at the Memekay ML (MML) bridge crossing. The fifth site was located on the Memekay River, at the Memekay ML bridge crossing and accessed from a short spur road on the west side of the bridge. These locations were accessible by logging roads of Weyerhaeuser Canada Ltd., North Island Timberlands (Figure 1).

2.2 Water Temperatures and Flow Monitoring

Spot water temperatures were noted each day the drip stations were calibrated or samples were collected. Continuous water temperature data were recorded using StowAway® Tidbit® Loggers (Onset Computer Corp.) measuring every 10 minutes +/- 0.1 °C (Onset, 1996-1998). Data loggers were operated at the Grilse Creek site, the Memekay River site and in the mainstem Salmon River at the bridge-crossing site near the BC Hydro diversion.

Daily discharge for the upper Salmon River was obtained from the BC Hydro DCP (data collection platform) website, (http://www.bchydro.bc.ca/info/res_hydromet/data/sam.txt). Discharge was read telemetrically from the gauge at the Water Survey of Canada (WSC) site #08HD015, above the diversion dam. To calibrate the downstream tank on the Salmon River (at the Memekay ML Bridge), daily discharge at the gauging station, #08HD007, was read from the website (http://www.bchydro.bc.ca/info/res_hydromet/data/mky.txt). The preliminary mean daily discharges were provided by WSC, Vancouver. Streamflow was measured in Grilse Creek, the Memekay River and the upper Salmon River below Jessie Creek using a Marsh-McBirney streamflow meter, model 201.

2.3 Installation of Tanks

Polyethylene tanks were placed at stream-bank locations accessible by vehicle, but placed out of view of road traffic. Information signs were posted beside each tank describing the enhancement goal and the sponsoring government agency (Figure 2). Each tank was set fully supported on smooth ground and slightly angled toward the outlet valve (Figure 3). A 1-inch or 3/4 inch PVC ball-valve was installed at the outlet of each tank with Teflon tape to ensure a complete seal. The seal was tested before filling the tank with fertilizer. Each valve outlet was fitted with a fine-mesh in-line filter to remove solid and colloidal material. A stainless steel low-volume output valve was installed on each tank (for fine control of the drip-rate) (Figure 3). A length of 12 mm (I.D.) polyethylene hose was attached to apply fertilizer directly to the wetted stream channel and, where possible, into the thalweg. At suitable locations, the output end of the hose was attached to a steel tripod to dispense the drip at the surface of the water to allow for immediate mixing into the streamflow.

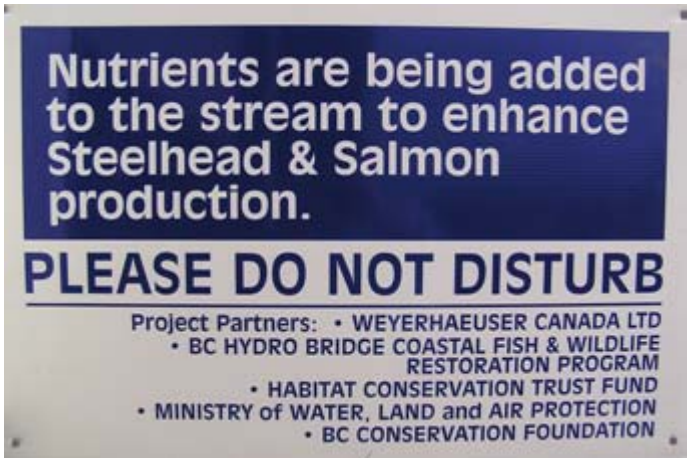


Figure 2.
Information sign posted at each tank location in 2004.

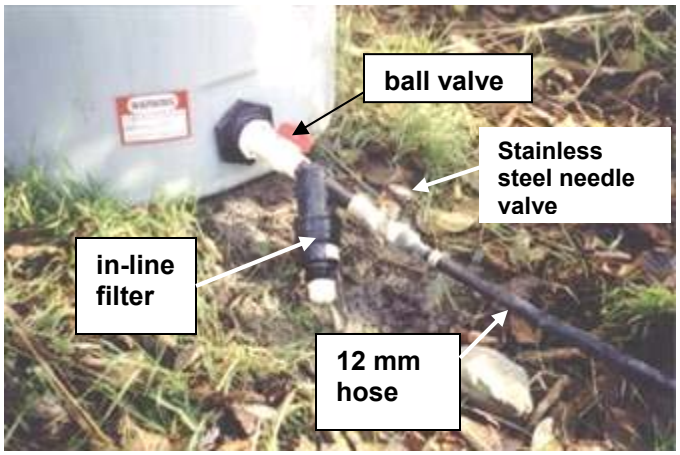


Figure 3.
The valve system installed on all tanks.

Liquid Fertilizer Acquisition and Tank Loading

The fertilizer, liquid ammonium polyphosphate, was purchased from TerraLink Horticulture Inc. in Abbotsford. The barrels were stored in the Ministry of Forests compound in Campbell River. Each barrel contained 208 L of fertilizer, with a density of 1.40 kg/L. Fertilizer specifications (by weight) were 10% N, and 34% P_2O_5 (10-34-0). The mix contained 14.85% P.

The fertilizer was pumped from barrels in storage into empty barrels in the transport vehicle and driven to the sites. A small gas-operated pump was used to download the fertilizer into the drip tanks. Once filled, the tank load needed to settle (24 hours) before a reliable drip-rate could be maintained. The in-line filters were checked periodically and cleaned if necessary. Tanks and equipment were removed, cleaned, and returned to storage at the end of the season.

2.5 Calibration of Liquid Fertilizer Additions

Head reduction in the tank, variations in humidity, and air temperature affect drip-rates; therefore, tanks were calibrated every few days. Stream discharge for the Salmon River was estimated using information from the gauge stations at the BC Hydro diversion dam (#08HD015) and above the Memekay River confluence (#08HD007). Stream discharge was also measured in Grilse Creek and the Memekay River on five occasions through the summer. Tanks were calibrated using measured and estimated streamflow. Target rates were determined from tables provided by K. Ashley and P. Slaney (Fisheries Research Section, MWLAP) shown in Appendix 2. The output of each tank was measured in ml/min and recorded. Drip-rates were then re-calibrated to match the target rate of 5 μg/L soluble reactive phosphorus (SRP).

2.6 Organic Fertilizer Experiment (Pollock logs)

Each pollock log contains 17.6% P_2O_5 or 7.7% P (P_2O_5 is 43.7% P) (Harlan Wright, pers. comm.). The following example calculation shows the loading rate of pollock logs based on a streamflow dilution of 0.8 m^3/s and an estimated release rate of 30 days.

Loading rate for pollock logs:

Water discharge during fertilization period=				
Average flow ($m^3 \cdot sec^{-1}$)	$Sec \cdot day^{-1}$	Days	$L \cdot m^{-3}$	Litres of water
0.8	86,400 x	30 x	1000	**= 2.07×10^9**
Kilograms of pollock needed =				
Target concentration. ($\mu g \cdot L^{-1}$ P)	(μg fertilizer)$\cdot$ (μg P)$^{-1}$	$kg \cdot \mu g^{-1}$	Litres	Kg of fertilizer needed
2.5 x	1/0.077 x	1×10^{-9} x	2.07×10^9	**= 67.32 kg**
2.5 x	1/0.077 x	1×10^{-9} x	2.07×10^9	**= 67.32 kg**

- Pollock logs varied in weight due to an inconsistency in size.

On June 17, 2004, 135 kg of pollock logs (Figure 4) of varying sizes and un-compacted pollock meal were placed in the upper Salmon River just below Jessie Creek (right fork) to observe the dissolution rate of the fishmeal and also the rate of downstream movement within measured stream velocities.

On July 22, 2004, 120 kg of pollock logs and un-compacted fishmeal were placed over a 20 m riffle section of the upper Salmon River just below Jessie Creek (right fork). Periphyton plates (Methods 2.8) were placed at the control site below Jessie Creek above the pollock placement. A plate was also placed in a location 33 m downstream of the visible fan from the last pollock placement (Full Mix). A plate was placed at a second treatment location 3.5 km downstream of the pollock placement at the bridge washout on South Fork A (Washout). A map showing the sites can be found in Appendix 3.

Figure 4.
A segment of a log of compressed pollock.

2.7 Water Sampling

Water samples were collected three times throughout the treatment period on the Salmon River. Two sampling dates included the upper Salmon River sites.

Water chemistry samples were collected in 1 L plastic bottles supplied by PSC Analytical Services. The bottles were rinsed three times with stream water in the field before being filled with sample water. For low-level nutrient samples, 100 ml sterile brown-glass bottles were used, provided by PSC. Stream water was field-filtered through a 0.45 μm cellulose acetate disposable filtration unit using a 60 ml syringe. The syringe was rinsed with stream water before being filled with the sample water. The 100 ml sample bottle was rinsed with filtered stream water before filling. The samples were packed with ice in a cooler and shipped by courier to the lab within 24 hours.

Water Sample Sites - Liquid Fertilizer Application
The sample sites for liquid fertilizer applications are shown in Figure 1 and described as follows:
Grilse Creek:
Grilse Creek control – 0.8 km upstream of the Grilse Creek ML bridge crossing, accessed along a small ephemeral tributary.
Grilse Creek bridge – just above the lower bridge on South Fork (SF) ML, accessed from the south side approximately 100m west along SF-B.
Salmon River mainstem:
Salmon River control – 10 m below the Jessie Creek confluence
Salmon River- WSC – at the WSC site at the end of the BigTree- 2 (BT-2) spur.
Salmon River Pallan's – the old Pallan's bridge site, opposite bank from Spur DY-R.
Memekay River:
Memekay River control – just upstream of the drip station at the Memekay ML bridge.
Memekay River bridge – just downstream of the bridge crossing on Airstrip Road.

Water Sample Sites - Pollock Log Test
Three sites were included for water samples and periphyton samples for the pollock log test:
Salmon River control - just below Jessie Creek (served as the control for this test also),
Full Mix - 33m downstream from the closest pollock log application ,
Washout – 3.3 km downstream of the treatment at the Washout on South Fork Main Line.

2.8 Periphyton Sampling (Pollock Log Test)

Periphyton blocks were placed at three sample sites in the upper Salmon River below the Jessie Creek confluence on July 23, 2004 (Figure 3). Blocks consist of a sheet of white florist's foam, 1.25 cm thick, attached to Plexiglas plates with electrical ties. The plates were bolted to concrete blocks and placed in the stream, tipped slightly into the direction of flow. Rocks were placed around the block edges for extra stability. Each block was submerged under at least 12 cm of water to allow for decreasing streamflow. Each site location was selected to approximately replicate similar solar exposure, water depth, and water velocity.

Using a 7 dram plastic vial, two cores of foam (each 2.7 cm in diameter and 5.73 cm^2 area) were punched out of each periphyton block (Mouldey Ewing et al.). Each sample was drained and placed in the vial. The vial was vented with holes through the cap to allow the sample to dry. The vials were placed in a sealed, light-proof container and kept cool with ice. The samples were frozen as soon as possible. Samples were taken at August 5, August 18 and September 6, 2004. At the end of the sampling period, all samples were shipped frozen, in a cooler with dry ice, to the lab. The samples were measured for chlorophyll *a* and phaeophytin *a* in $\mu g \cdot cm^{-2}$.

2.9 Juvenile Fish Sampling

Juvenile sampling was conducted by Scott Silvestri and Harlan Wright (BCCF Steelhead Crew, Nanaimo) and Loreta Hansen in September, 2004. Ten sites, consisting of treatment areas and controls, were sampled on the Salmon River mainstem, Grilse Creek and the Memekay River.

The following sampling description was provided by the Steelhead Crew.
Sampling was conducted using closed-site electrofishing techniques. At each electrofishing site, about 100 m^2 of suitable steelhead fry habitat (typically cobble/gravel riffles, <30 cm in depth, and <25 cm/sec in velocity) was enclosed with small mesh stopnets, and all fish were removed using the standard, 2-pass removal method (deLeeuw 1981). Lengths were recorded for all fish captured, and 30+ juveniles per species and age class were weighed using Ohaus top loading scales (model CS 200) accurate to 0.1 g. Habitat parameters were documented consistent with current Fisheries Branch techniques (methodology by R. Ptolemy, Rivers Biologist, MWLAP, Victoria), and each site was photographed. Upon removal of the stopnets, a depth/velocity profile across a representative transect within the site was recorded using a Swoffer current velocity meter, model 2100. Population estimates were later derived and depth/velocity profile adjusted using Fisheries Branch habitat suitability index curves. Sites on the Salmon River were chosen to monitor stock abundance in general and also to monitor enhancement by fertilizer additions. (Craig, J. et al. 2001)

3.0 RESULTS

3.1 Water Temperatures and Stream Discharge

Water temperature measurements for the Salmon River, Grilse Creek and the Memekay River are summarized by month in Table 1. Daily mean, minimum and maximum temperatures are shown in Appendix 4. Dataloggers were placed in the Salmon River at the bridge crossing near the diversion, and in Grilse Creek and the Memekay River at the respective tank sites. Spot temperatures were recorded using a hand-held thermometer each day of field work. The results are listed in Appendix 5.

Table 1. Water temperature data collected from Grilse Creek at the upper bridge crossing, the mainstem Salmon River near the diversion and the Memekay River at the tank site from June to September, 2004.

Stream	Month (2004)	Monthly Mean (°C)	Range of Daily Mean (°C)	Minimum Temp (°C)	Maximum Temp (°C)
Grilse Ck.	July	14.1	11.2 – 16.8	10.0	20.1
	August	14.8	12.5 – 17.2	10.9	20.6
Memekay R.	July	15.1	12.3 – 17.7	11.4	20.7
	August	15.6	12.7 – 18.0	12.2	19.3
Salmon R – near Diversion	July	16.7	12.9 – 19.5	11.7	21.1
	August	17.4	14.3 – 20.2	13.7	21.7

Streamflow measurements for Grilse Creek, the Memekay River and the upper Salmon River (Washout- South Fork ML) are shown in Table 2. The mean daily discharge (preliminary data) for the Salmon River above the diversion is shown as a comparison. Mean daily discharge data (preliminary) provided by WSC are shown in Appendix 6.

Table 2. Streamflow measurements (m^3/s) from Grilse Creek, the Memekay River, and the Salmon River above the diversion in 2004.

Date (2004)	Grilse Ck.*	Memekay R.*	Salmon R. at SF Washout*	Salmon R. – WSC (preliminary)	
				above Memekay	above diversion
Jun 10	2.5				9.63
Jun 17			4.64 (below Jessie Ck)		6.88
Jun 21	1.31	1.48			6.77
Jul 2	0.84	0.74			3.25
Jul 16			1.36		2.08
Jul 23	0.32	0.30			1.52
Aug 18	0.13	0.12	0.40		0.72

* Measured with a Swoffer current velocity meter, model 2100.

3.2 Liquid Fertilizer Output

The total load of 10-34-0 applied at each site over approximately 97 days was as follows: Grilse Creek- 310 L; Salmon River near Rock Creek ML – 624 L; Salmon River at the diversion – 548 L; Salmon River at the Memekay ML bridge – 624 L; and the Memekay River – 310 L. The total load for the Salmon River watershed was 2,416 L. The calibrated and output rates of each tank are shown in Appendix 7. The tanks were calibrated 24 times from June 8 to September 17 (102 days). The period of low growth in the river was first noted around July 6 and lasted until approximately July 16. Poor algal production was observed again in early August. During this period the drip rate was set slightly higher than the 5 µg/L rate normally calibrated, without noticeable improvement to the growth rate.

Water chemistry results indicated possible nitrogen-limitation (nitrate+nitrite) in the July 8 sample in Grilse Creek and the upper Salmon River. However, nitrogen (N) levels were sufficient for

growth in the Aug 5 and September 6 samples. Complete water chemistry results are listed in Appendix 8.

3.3 Pollock Log Applications

3.3.1 Upper Salmon River

On June 17, 2004, 135 kg of pollock logs of varying sizes and un-compacted pollock meal (Figure 5) were placed in the upper Salmon River just below Jessie Creek (right fork). The discharge in the right fork was 2.41 m^3/s. Discharge in the left fork was 2.23 m^3/s. The two forks merged 50 m below the application site with a combined discharge of 4.63 m3/s. Water temperature at the application site was 9.6° C. at 11:55. All pollock logs had re-hydrated into piles of loose fishmeal within 12 minutes of placement in the stream (Figure 6 & 7). Velocities were recorded at a sample of the pollock log locations instream. These sample sites were visually assessed for remaining pollock on June 18. Pollock logs that had been placed in water with a velocity of approximately 0.5 m/s had completely migrated downstream. Visual assessment determined that small pockets or an estimated < 1% of the original placement at 0.5 m/s could be found in a 10 m stretch downstream. Twenty percent (visual estimate) of the pollock placed in water velocity of 0.3 m/s remained in place. Eighty percent had migrated.

Stream velocities measured near each placement ranged from 0.26 – 0.49 m/s at depths of 0.18 – 0.22 m.

Following the July 22 placement of pollock in the upper Salmon River water samples were collected on August 5 and September 6, 2004. Periphyton samples were collected on Aug 5, Aug 18, and September 6, 2004. Unfortunately, the control plate had been rolled over in the water and no sample could be collected on August 18 or September 6. As field personnel approached the site on August 18 a clicking sound was heard over a period of 5-10 minutes. It was concluded this sound was a bear, jaw-clicking a warning. It is assumed the plate was rolled over by this bear who may have cued into the white color of the foam substrate on the plate. Accrual of algae growth could not be measured for those 2 dates without a control measurement. However, chlorophyll *a* measurements could be compared between the full mix site and the distant site at the Washout.

Figure 5.
Pollock logs breaking apart in the water, 5 min. after application.

Figure 6.
Pollock logs breaking up, 10 minutes after application.

Figure 7.
Pollock logs, 12 minutes after placement in the upper Salmon River below Jessie Creek.

Water chemistry results from the upper Salmon River pollock test indicated sufficient nitrogen levels in the control and treated reaches. At the Full Mix site just downstream of the pollock, ortho-phosphorus (P) measurements were between 0.003µg/L and 0.007 µg/L, confirming that pollock meal is an excellent source of phosphorus. At the Washout, 3.5 km downstream, the ortho-phosphorus (P) was 0.003 µg/L on August 5 dropping to the background level <0.001 µg/L on September 6. Measurements, as well as visual assessment, indicated that 3.5 km was near

the maximum effective treatment distance. Complete water chemistry results are provided in Appendix 9.

Although chlorophyll *a* measurements of growth are not conclusive without a measured control, other information is available from the measurements obtained in the treatment reaches. Figure 8 shows the measured chlorophyll *a* in the treatment reaches along with only one control measurement. Figure 9 shows phaeophytin *a* measured from the same samples. Lab results are provided in Appendix 10.

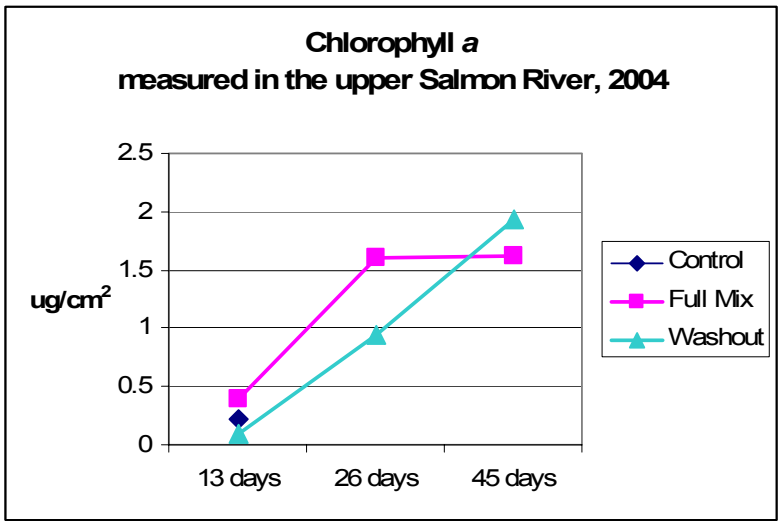


Figure 8. Chlorophyll *a* measured from samples taken in the upper Salmon River, 2004.

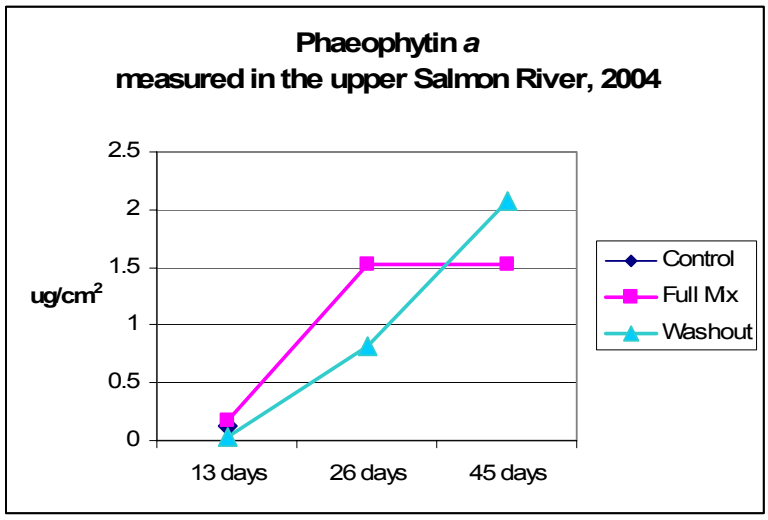


Figure 9. Phaeophytin *a* measured from samples taken in the upper Salmon River, 2004.

Increasing accrual of growth was indicated for the Washout site, 3.5 km downstream. Growth at the Full Mix site did not increase after 26 days even though water chemistry results indicated available N and P.

3.3.2 Paterson Creek

On June 17, 2004, 26 kg of pollock logs and uncompressed pollock meal were placed in Paterson Creek, divided into two piles of 13 kg each (Figure 10). The stream velocity in the left bank location was 0.13 m/s, and 50% (estimated) of the fishmeal remained in place in the stream. The stream velocity in the right bank location was <0.1 m/s and an estimated 80% of the fishmeal remained in place in the stream. On June 25, fungal caps had formed on top of the fishmeal.

Figure 10. Pollock meal placed in Paterson Creek, June 17, 2004

The pollock placement in Paterson Creek was for observation purposes only, to determine the breakdown of the pollock logs and the stability of the fishmeal in a low velocity placement. The complete re-hydration of the logs within minutes of placement, had previously been reported by Fisheries Research personnel in Vancouver.

3.4 Juvenile fish sampling results (Provided by Harlan Wright, BCCF)

Juvenile fish sampling conducted in treated and control sites in Grilse Creek confirmed there was a positive growth response to the liquid ammonium polyphosphate (Figure 11). Steelhead fry sampled in the uppermost treated site were approximately three times larger than those sampled in the un-treated control, 1.3 km upstream. In addition, the condition factor calculations indicate much higher weight to length ratios for fish in the treated site (Appendix 11). Greater mean size and condition factor should contribute to improved over-winter survival, and potential shift from 3 to 2 year smolt age.

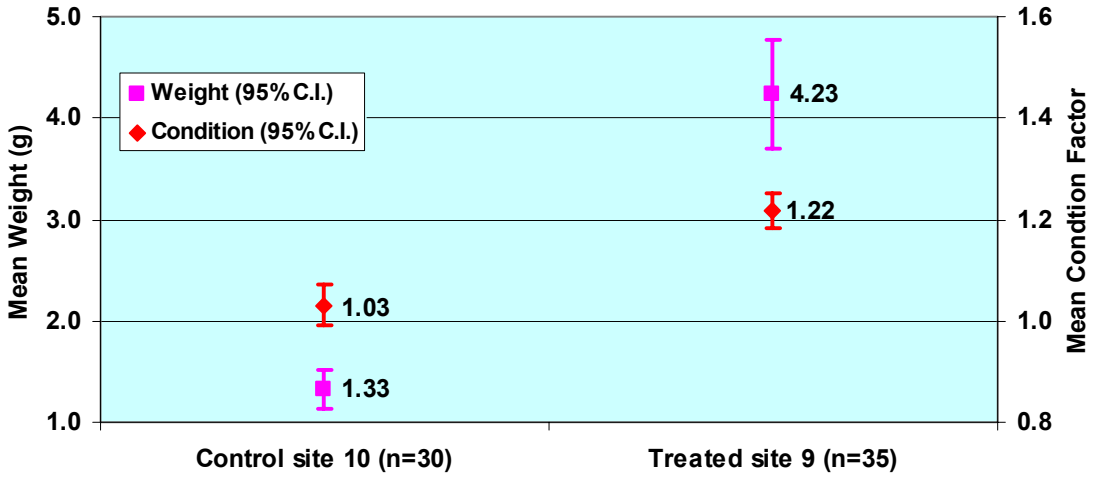


Figure 11. Mean weights and condition factors of steelhead/rainbow fry captured in the upper two sites in Grilse Creek, September 10, 2004.

The mean steelhead fry density sampled by electrofishing indicates that the 2004 density is well below the target of 60 fry per 100 m^2, and slightly below the extreme conservation threshold of 20 fry per 100 m^2 (Figure 12). This very low fry density followed the lowest observed adult winter steelhead abundance in the last 7 years. Thirty-three steelhead were observed during the annual mid-March snorkel survey in the 11.5 km index for a density of 2.9 fish per km. Peak adult steelhead densities in the same index from 1998 to 2003 have ranged between 3.4 and 18.9 fish per km.

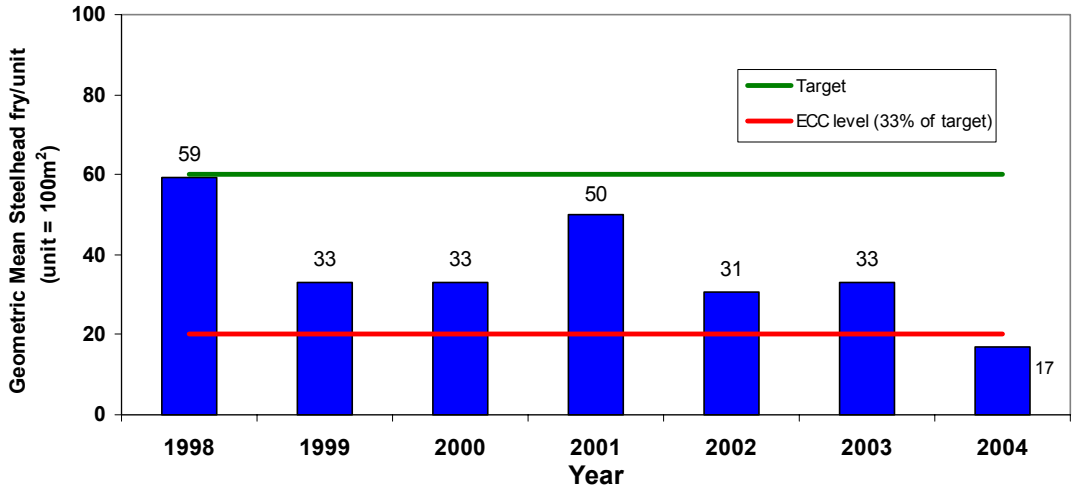


Figure 12. Mean depth/velocity adjusted steelhead/rainbow fry abundance sampled at 10 sites in the Salmon River, 1998-2004.

3.0 CONCLUSIONS

LIQUID NUTRIENT APPLICATION

Throughout the 16 years of nutrient addition to the Salmon River watershed, there is commonly a period of very little growth, and die-off of existing growth, generally observed over a period of approximately 10 days to two weeks. This period coincided with the period of highest water temperatures in late July and early August. In 2004, the die-off period was extended, beginning earlier and ending later in August. No chlorophyll sampling was conducted to accurately determine the length of this die-off period. A similarly extended period was also observed in 2003. Weather conditions during both seasons were very dry, with little rainfall. In 2003, water sampling showed levels of nitrogen limitation which may account for the low growth, even though the addition of 10-34-0 was continuous throughout the season. An investigation of this phenomenon is recommended to determine if this change is an effect of seasonal weather differences, changing weather patterns or an effect of nutrient addition.

POLLOCK TEST

Results indicate that the upper Salmon pollock log application was successful in increasing nutrient levels and algae growth. Unfortunately a good control sample for algae was not maintained due to bear activity, although there was a visible increase in algal growth in the treated reach.

It is recommended that two periphyton plates be placed at each test site. This may increase but not guarantee usable samples should bears be attracted to the white surface again. If plates are destroyed for any reason the test should be re-started if sufficient time is left in the growing season.

In the upper Salmon River, the Washout site was 3.5 km downstream of the Pollock application and an accrual of growth occurred over the 45 day period of testing. This may indicate an effective downstream drift of nutrients for 3.5 km at the measured discharge of 1.36 m^3/s declining to 0.40 m^3/s. There was little difference between the 4-week and 6-week measurement at the Full Mix site, even though nutrients were available.

5.0 REFERENCES

Carswell, L. 1992. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) including Norris Creek and Grilse Creek, May-July, 1992. Report for MELP, Fisheries Section, Nanaimo, B.C. 11 p. + app.

Carswell, L. 1993. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) including Norris Creek and Grilse Creek, May 25-August 8, 1993. Report for MELP, Fisheries Section, Nanaimo, B.C. 13 p. + app.

Craig, J. et al. 2001. Fish Habitat Restoration Monitoring and Assessment Projects in the San Juan Watershed (2001). B.C. Conservation Foundation report.

deLeeuw, A.D. 1981. A British Columbia stream habitat and fish population inventory system. Unpubl. MS, B.C. Fish and Wildlife Branch, Victoria. 22 p.

Hansen, L. 1994. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) including Norris Creek and Grilse Creek, May 19-August 14, 1994. BCCF report for MELP, Nanaimo, B.C. 11 p. + app.

Hansen, L. 1995. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) below Grilse Creek, May 25-August 25, 1995. BCCF report for MELP, Nanaimo, B.C. 15 p. + app.

Hansen, L. 1999a. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) below Grilse Creek, June 1 – September 5, 1996. BCCF report for MELP, Fisheries Section, Nanaimo, B.C. 10 p. + app.

Hansen, L. 1999b. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) below Grilse Creek, and Salmon River tributaries- the Memekay River and Cooper Creek – 1997. BCCF report for MELP, Fisheries Section, Nanaimo, B.C. 10 p. + app.

Hansen, L. 1999c. Stream enrichment of Vancouver Island's upper Salmon River including Norris Creek, Grilse Creek, Cooper Creek, and the Memekay River, June 10 – August 19, 1998. Report for MELP, Fisheries Section, Nanaimo, B.C. and BC Hydro, Burnaby, B.C. 8 p. + app.

Hansen, L. 1999d. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek and the Memekay River, August 9 – September 28, 1999. Report for MELP, Fisheries Section, Nanaimo, B.C. and BC Hydro, Burnaby, B.C. 7 p + app.

Hansen, L. 2001. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek, Memekay River and Cooper Creek, June 19 – September 12, 2000. Report for MELP, Nanaimo, B.C. and BC Hydro, Burnaby, B.C. 8 p. + app.

Hansen, L. 2002. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek, and Memekay River, July 5 to August 24, 2001. Report for MWLAP, Nanaimo, B.C., Weyerhaeuser (FRBC) and BC Hydro, Burnaby, B.C. 13 p. + app.

Hansen, L. 2003. Stream enrichment of Vancouver's upper Salmon River including Grilse Creek and Memekay River, June 18 to August 19, 2002. Report for MWLAP, Nanaimo, B.C., and BC Hydro, Burnaby, B.C. 14 p + app.

Hansen, L. and H. Wright. 2003. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek, Memekay River, and Paterson Creek, 2003. Report for MWLAP, Nanaimo, B.C., Weyerhaeuser Canada Ltd., Renewal Investment Corp. and BC Hydro, Burnaby, B.C. 16 p. + app.

Mouldey, S. E. and K.I. Ashley. 1996. Development and testing of slow release fertilizer for restoring salmonid habitat: 1995 progress report. Fisheries Project Report No. RD 54, MELP, Fisheries Branch 1996, 114 p. + app.

Mouldey Ewing, S. E. and K. I. Ashley. 1998. Development and testing of slow release fertilizer for restoring salmonid habitat: 1996 Progress Report. Watershed Restoration Project Report No. 9, MELP, Fisheries Branch, and Ministry of Forests, 98 p. + app.

Mouldey Ewing, S. E., K. I. Ashley and G. Wilson. 1998. Development and testing of slow release fertilizer for restoring salmonid habitat: 1997 Progress Report. Watershed Restoration Project Report No. 10, MELP, Fisheries Branch, and Ministry of Forests, 30 p. + app.

Perrin, C.J. 1989. The feasibility of inorganic fertilization for salmonid enhancement in the Salmon River, Vancouver Island. Limnotek Research and Development Inc. Report for MELP, Nanaimo, B.C. 63 p.

Perrin, C.J. 1990. Steelhead enhancement by nutrient addition to the Salmon River, Vancouver Island: First year assessment. Limnotek Research and Development Inc., Vancouver, B.C. Report for MELP, Nanaimo, B.C. 54 p.

Onset Computer Corporation. 1996-1998. StowAway® Tidbit® User's Manual, Onset Computer Corporation, Pocasset, Ma.

Perrin, C.J. 1991a. Steelhead enhancement by nutrient addition to the Salmon River, Vancouver Island: monitoring in the second year of treatment. Limnotek Research and Development Inc. Report for MELP, Nanaimo, B.C. 29 p.

Perrin, C.J. 1991b. Steelhead enhancement by nutrient addition to the Salmon River, Vancouver Island: monitoring in the third year of treatment. Limnotek Research and Development Inc., Vancouver, B.C. Report for MELP, Nanaimo, B.C. 25 p.

Reports of operation of the Salmon River fish screen 1989 - 2003

Carswell, L. 1990. Results of fish enumeration at the Salmon River smolt screen, April-June 1990. BCCF report for MELP, Fisheries Section, Nanaimo, B.C.

Carswell, L. 1991. Results of fish enumeration at the Salmon River smolt screen, April-June 1991. BCCF report for MELP, Fisheries Section, Nanaimo, B.C.

Carswell, L. 1992. Results of fish enumeration at the Salmon River smolt screen, April-June 1992. BCCF report for MELP, Fisheries Section, Nanaimo, B.C. 24 p. + app.

Carswell, L. 1993. Results of fish enumeration at the Salmon River smolt screen, April-June 1993. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1994. Results of fish enumeration at the Salmon River smolt screen, April-July 1994. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1997. Results of fish enumeration at the Salmon River smolt screen, April 1 – June 21, 1996. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1999. Operations at the Salmon River smolt screen, April 2 – May 6, 1997. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1999. Results of fish enumeration at the Salmon River smolt screen, April 24 – June 30, and October 14 to November 12, 1998. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1999. Operations at the Salmon River smolt screen: March 29 – May 17, June 4- 15, and November 4- 9, 1999. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 2001. Results of fish enumeration at the Salmon River smolt screen, April 4 to July 5 and October 22 to November 3, 2000. BCCF report for BCH, Burnaby, B.C. and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 2002. Results of fish enumeration at the Salmon River fish screen, April 3 – June 30, 2001. BCCF report for BCH, Burnaby, B.C. and MWLAP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 2003. Results of fish enumeration at the Salmon River fish screen, March 28 – July 12, 2002. BCCF report for BCH, Burnaby, B.C. and MWLAP, Fisheries Section, Nanaimo, B.C.

Hansen, L. and S. Rimmer. 1995. Results of fish enumeration at the Salmon River smolt screen, April – July 1995. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Perrin, C.J. 1989. Results of fish enumeration at the Salmon River smolt trap, 1989. Limnotek Research and Development Inc. Report for MELP, Nanaimo, B.C.

6.0 APPENDICES

APPENDIX 1.

Salmon River Fertilization Project 1988 – 2003: Chronology of Treatments

The Salmon River fertilization project has been initiated and supervised by the Ministry of Environment, Lands and Parks (MELP), Fisheries Section, in Nanaimo (now Ministry of Water, Land and Air Protection (MWLAP)). Other agencies and contractors involved are listed below, along with specific details of each year of application. Juvenile sampling by electrofishing was carried out every year in the late summer. MWLAP records are computer filed at the Nanaimo office and the B.C. Conservation Foundation office in Nanaimo.

Water chemistry analysis included low-level measurement of nitrogen-ammonia, nitrogen-nitrate, total nitrogen, dissolved ortho-phosphate, total dissolved phosphorus, and total phosphorus. In some years, additional tests were conducted. Periphyton samples were collected on artificial substrate and analysed for chlorophyll *a* and phaeophytin *a*. Sample sets were collected at intervals throughout the fertilizer application period.

Pre-fertilization sampling

1988 **Agencies:** MELP, NANAIMO. Contractor: Limnotek Research and Development Inc.
Water chemistry samples: ✔ Five sample sets from 2 sites.
Periphyton samples: ✔ Two series of 3 sample sets over 21 days- from 2 sites.
Taxonomy samples: Algae. ✔
References: Perrin (1989).

Fertilization and Sampling

1989 **Agencies:** MELP, NANAIMO. Contractor: Limnotek Research and Development Inc. Funding from the B.C. Habitat Conservation Fund.
Fertilizer Applied: prill (solid) form – 34-0-0 and 12-51-0 blend.
Period of Application: June 2 – August 26, 1989.
Sites: Norris Creek, Grilse Creek (upper bridge site).
Water chemistry samples: 10 sample sets from 3 sample sites.
Periphyton samples: ✔ Two series of 35 and 40 days- from 3 sites.
Taxonomy samples: Algae ✔ Three sample sites.
References: Perrin (1990).

1990 **Agencies:** MELP, NANAIMO. Contractor: Limnotek Research and Development Inc. Funding from the B.C. Habitat Conservation Fund.
Fertilizer Applied: Liquid- 32-0-0 (Norris Creek only) and 10-34-0.
Period of Application: May 12 – July 29, 1990.
Sites: Norris Creek, Grilse Creek (upper), Grilse Creek (lower bridge site).
Water chemistry samples: ✔ Seven sample sets from 5 sites.
Periphyton samples : ✔ One series (7 samples over 51 days) from 4 sites.
Taxonomy samples: ✔ One set from 4 sites; one replicate from 2 sites.
References: Perrin (1991b).

1991 **Agencies:** MELP, NANAIMO. Contractor: Limnotek Research and Development Inc. Funding from the B.C. Habitat Conservation Fund.
Fertilizer Applied: Liquid- 32-0-0 (Norris Creek only) and 10-34-0.
Period of Application: May 18 – July 31, 1991.
Sites: Norris Creek, Grilse Creek (upper) and Grilse Creek (lower bridge site).

Water chemistry samples: ✔ Four sample sets from six sites.
Periphyton samples: ✔ Eight sample sets from five sites (one series over 57 days).
Taxonomy samples: Algae ✔ One sample set from 5 sites.
References: Perrin (1991a).

1992 **Agencies:** MELP, NANAIMO. (Administered by B.C. Conservation Foundation (BCCF). Funding from the Habitat Conservation Fund).
Fertilizer Applied: Liquid- 32-0-0 (Norris Creek only) and 10-34-0.
Period of Application: May 15 – July 28, 1992.
Sites: Norris Creek, Grilse Creek (upper bridge), Grilse Creek (lower bridge).
Water chemistry samples: ✔ Three sample sets from six sites.
Periphyton samples: No.
Taxonomy samples: No.
References: Carswell (1992).

1993 **Agencies:** MELP, NANAIMO. (Admin. by BCCF. Funding from the B.C. Habitat Conservation Fund and fertilizer purchased by the Campbell River Chapter of the Steelhead Society of B.C.).
Fertilizer Applied: Liquid- 32-0-0 (Norris Ck. only) and 10-34-0.
Period of Application: May 25 – August 8, 1993.
Sites: Norris Creek, Grilse Creek (upper bridge), Salmon River- Rock Creek ML bridge crossing, Memekay ML bridge crossing.
Water chemistry samples: ✔
Periphyton samples: ✔
Taxonomy samples: unknown (see Comments).
References: Carswell (1993).

Comments: Water, periphyton and insect sampling were conducted by Daiva Zaldokas, MELP, Vancouver, Fisheries Research and Development Section.

1994 **Agencies:** MELP, NANAIMO. (Admin. by BCCF. Funding from the B.C. Habitat Conservation Fund, liquid fertilizer purchased by the Campbell R. Chapter of the Steelhead Society of B.C.).

Fertilizer Applied: Liquid- 32-0-0 (Norris Creek only) and 10-34-0.
Period of Application: May 19 – August 14, 1994.
Sites: Norris Creek, Grilse Creek (upper bridge), Salmon River- Rock Creek ML bridge crossing, Memekay ML bridge crossing.
Water chemistry samples: Two sample sets from ten sites.
Periphyton samples: No.
Taxonomy samples: No.
References: Hansen (1994).

1995 **Agencies:** MELP, NANAIMO. (Admin. by BCCF. Funding from Habitat Conservation Fund, liquid fertilizer purchased by the Campbell R. Chapter of the Steelhead Society of B.C.).
MELP, Vancouver, Fisheries Research and Development Section monitored slow-release briquettes (pucks) in Norris Creek and Grilse Creek.

Fertilizer Applied: Briquettes in Norris Creek and Grilse Creek and liquid 10-34-0 in the mainstem Salmon River.
Period of Application: May 25 – August 25, 1995.
Sites: Norris Creek, Grilse Creek (upper bridge), Salmon River- Rock Creek ML bridge crossing, Memekay ML bridge crossing.
Water chemistry samples: ✔ Two sample sets from five sites on the mainstem Salmon River. Seven sample sets from five sample sites on Norris Creek and Grilse Creek (MELP, Vancouver).
Periphyton samples: ✔ (MELP, Vancouver).
Taxonomy samples: ✔ (MELP, Vancouver).
References: Hansen (1995). Mouldey Ewing, Ashley (1998).

Comments: An in-depth study of the slow-release fertilizer was conducted by the MELP Fisheries Research and Development Section, Vancouver, from 1995 to 1997 inclusive. Three reports are cited in **REFERENCES** (Mouldey Ewing, et al. 1996, 1998, 1998).

1996 **Agencies:** MELP, NANAIMO. (Admin. by BCCF. Funding from the B.C. Habitat Conservation Fund, liquid fertilizer paid for by the Campbell River Chapter of the Steelhead Society of B.C.) .
MELP, Vancouver, Fisheries Research and Development Section, monitored slow-release briquettes in Norris Creek and Grilse Creek.
Fertilizer Applied: Briquettes- Norris Creek and Grilse Creek. Liquid 10-34-0- Salmon River mainstem.
Period of Application: June 1 – September 5.
Sites: Briquettes- Norris Creek, Grilse Creek (upper bridge). Liquid- (Salmon River)- Rock Creek ML bridge crossing, fish screen, and Memekay ML bridge crossing.
Water chemistry samples: ✔ Two sample sets from six sites on the mainstem Salmon River. Nine sample sets of five sites on Norris Creek (2 sites) and Grilse Creek (3 sites).
Periphyton samples: ✔ Nine sample sets from five sites on Norris Creek (2 sites) and Grilse Creek (3 sites).
Taxonomy samples: algae.
Benthic invertebrate biomass measured: ✔
References: Hansen (1999b). Mouldey Ewing and Ashley (1998).

Comments: Fertilizer toxicology testing was conducted by EVS Environmental Consultants (1997) for rainbow trout, chironomids, amphipods and daphnids.

1997 **Agencies:** MELP, NANAIMO. (Admin. by BCCF. Funding by BC Hydro and the Campbell River Chapter of the Steelhead Society of B.C.).
MELP, Vancouver. Fisheries Research and Development Section.
Fertilizer Applied: Briquettes (7-40-0) (Norris Creek and Grilse Creek) and 10-34-0 (mainstem Salmon River).
Period of Application: June 12 – October 6.
Sites: Norris Creek (briquettes), Grilse Creek (upper bridge) (briquettes), Salmon River- Rock Creek ML bridge crossing (liquid), fish screen (liquid), and Memekay ML bridge crossing (liquid).
Water chemistry samples: ✔ Every two weeks (eight sample sets) from nine sample sites throughout 40 km of the river treatment area.

Periphyton samples: ✔ Eight sample sets from nine sample sites.

Taxonomy samples: algae. ✔
Benthic invertebrate biomass measured: ✔
References: Hansen (1999a). Mouldey, Ashley & Wilson (1998).

Comments: In addition to treatment of the upper Salmon River and tributaries, the Memekay River and Cooper Creek were treated with briquettes (7-40-0): 60 kg to Cooper Creek and 599 kg to each of two sites on the Memekay River (total – 1,198 kg).
Water chemistry samples: ✔ Two sample sets. **Periphyton:** none. **Taxonomy:** none.

1998 **Agencies:** MELP, NANAIMO. (Admin. by BCCF. Funding - BC Hydro).
Fertilizer Applied: Briquettes - 7-40-0 (Norris Creek) and liquid 10-34-0.
Period of Application: June 10 – August 19.
Sites: Norris Creek, Grilse Creek (upper bridge), Salmon River- above Rock Creek ML bridge crossing, fish screen and Memekay ML bridge crossing.
Water chemistry samples: No.
Periphyton samples: No.
Taxonomy samples: No.
References: Hansen (1999c).

Comments: In addition to the mainstem Salmon River and upper Salmon tributaries, the Memekay River and Cooper Creek were also treated. Sixty kilograms of briquettes were added to the upper end of Cooper Creek and liquid 10-34-0 was applied by drip station to the Memekay River just below the ML bridge.

1999 **Agencies:** MELP, NANAIMO. (Admin. by BCCF. Funding BC Hydro).
Fertilizer Applied: 10-34-0.
Period of Application: August 9 – September 28.
Sites: Grilse Creek (upper bridge), Salmon River- above Rock Creek ML bridge crossing, fish screen and Memekay ML bridge crossing.
Water chemistry samples: No.
Periphyton samples: No.
Taxonomy samples: No.
References: Hansen (1999d).

Comments: In addition, a liquid drip station (10-34-0) was maintained on the Memekay River just below the Memekay ML bridge. Due to extremely high flows from a record high snow-pack, discharge in the Salmon River and tributaries was too high in June and July for practical delivery of a fertilizer drip-rate. Fertilization did not start until early August when flows had moderated, and was continued later than in previous years.

2000 **Agencies:** MELP, NANAIMO. (Admin. by BCCF. Funding BC Hydro)
Fertilizer Applied: 10-34-0 and briquettes (new formula).
Period of Application: June 19 – September 12.
Sites: Briquettes- Grilse Creek just upstream of the falls, Liquid- Grilse Creek (upper bridge), Salmon River- above Rock Creek ML bridge crossing, fish screen and Memekay ML bridge crossing.
Water chemistry samples: No.
Periphyton samples: No.
Taxonomy samples: No.

References: Hansen (2001).

Comments: Briquettes were placed in Cooper Creek, 7 km upstream of the confluence with the Memekay River. A liquid drip station (10-34-0) was maintained on the Memekay River just below the Memekay ML bridge.

2001 **Agencies:** MWLAP, NANAIMO. (Admin. by BCCF. Funding by Weyerhaeuser (FRBC) & BC Hydro, Bridge Coastal Restoration Program).
Fertilizer Applied: 10-34-0.
Period of Application: July 5 – August 24.
Sites: Memekay River at the ML bridge crossing, Grilse Creek (upper bridge), Salmon River- upstream of Rock Creek ML bridge crossing (deactivated), fish screen and Memekay ML bridge crossing.
Water chemistry samples: Yes.
Periphyton samples: Yes.
Taxonomy samples: No.
References: Hansen, (2002).

2002 **Agencies:** MWLAP, NANAIMO. (Admin. by BCCF. Funding by BC Hydro, Bridge Coastal Restoration Program).
Fertilizer Applied: 10-34-0.
Period of Application: June 18 – August 19.
Sites: Memekay River at the ML bridge crossing, Grilse Creek (upper bridge), Salmon River upstream of Rock Creek ML bridge crossing (deactivated), fish screen and Memekay ML bridge crossing.
Water chemistry samples: Yes.
Periphyton samples: Yes.
Taxonomy samples: No.
References: Hansen, (2003)

Comments: An experimental, slow-release fertilizer product was applied to the upper Salmon River just below the Jessie Creek confluence on July 29, 2002. The fertilizer was a struvite-coated urea granule (18-6-0) produced by PSP Enterprises of Urbana, Ohio.
Water chemistry samples: Yes. **Periphyton samples:** Yes.

2003 **Agencies:** MWLAP, NANAIMO. (Admin. by BCCF. Funding by BC Hydro, Bridge Coastal Restoration Program and Weyerhaeuser Canada Ltd., Renewal Investment Corp.).
Fertilizer Applied: 10-34-0.
Period of Application: June 17 – Sept 6.
Sites: Memekay River at the ML bridge crossing, Grilse Creek (upper bridge), Salmon River upstream of Rock Creek ML bridge crossing (deactivated), Salmon River bridge near the diversion and Memekay ML bridge crossing.
Water chemistry samples: Yes.
Periphyton samples: No.
Taxonomy samples: No.
References: Hansen & Wright, (2003)

Comments: A new product providing organic instream nutrients was tested in Paterson Creek in 2003. The product was made from organic fish meal (Alaskan pollock) pressed into 4 kg logs. **Water chemistry samples:** Yes. **Periphyton samples:** Yes.

References (for APPENDIX 1)

Carswell, L. 1992. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) including Norris Creek and Grilse Creek, May-July, 1992. Report for MELP, Fisheries Section, Nanaimo, B.C. 11 p. + app.

Carswell, L. 1993. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) including Norris Creek and Grilse Creek, May 25-August 8, 1993. Report MELP, Fisheries Section, Nanaimo, B.C. 13 p. + app.

EVS Environment Consultants. 1997. Toxicity of the fertilizer "silver bullet": rainbow trout, *Chironomus tentans, Hyalella azteca*, Daphnids and Microtox™ laboratory report. A report prepared for MELP, Fisheries Branch, Research and Development Section. EVS project number 9/104-28, February 1997. 37 p. + app.

Hansen, L. 1994. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) including Norris Creek and Grilse Creek May 19-August 14, 1994. BCCF report for MELP, Nanaimo, B.C. 11 p. + app.

Hansen, L. 1995. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) below Grilse Creek, May 25-August 25, 1995. BCCF report for the MELP, Nanaimo, B.C. 15 p. + app.

Hansen, L. 1999a. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) below Grilse Creek, June 1 – September 5, 1996. BCCF report for MELP, Fisheries Section, Nanaimo, B.C. 10 p. + app.

Hansen, L. 1999b. Stream enrichment of the upper Salmon River watershed (Kelsey Bay) below Grilse Creek, and Salmon River tributaries- the Memekay River and Cooper Creek – 1997. BCCF report for MELP, Fisheries Section, Nanaimo, B.C. 10 p. + app.

Hansen, L. 1999c. Stream enrichment of Vancouver Island's upper Salmon River including Norris Creek, Grilse Creek, Cooper Creek, and the Memekay River, June 10 – August 19, 1998. Report for MELP, Fisheries Section, Nanaimo, B.C. and BC Hydro, Burnaby, B.C. 8 p. + app.

Hansen, L. 1999d. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek and the Memekay River, August 9 – September 28, 1999. Report for MELP, Fisheries Section, Nanaimo, B.C. and BC Hydro, Burnaby, B.C. 7 p + app.

Hansen, L. 2001. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek, Memekay River and Cooper Creek, June 19 – September 12, 2000. Report for MELP, Nanaimo, B.C. and BC Hydro, Burnaby. 8 p. + app.

Hansen, L. 2002. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek, and Memekay River, July 5 to August 24, 2001. Report for MWLAP, Nanaimo, B.C., Weyerhaeuser (FRBC) and BC Hydro, Burnaby, B.C. 13 p. + app.

Hansen, L. 2003. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek, and Memekay River, June 18 to August 19, 2002. Report for MWLAP, Nanaimo, B.C., and BC Hydro, Burnaby, B.C. 14 p. + app.

Hansen, L. and H. Wright. 2003. Stream enrichment of Vancouver Island's upper Salmon River including Grilse Creek, Memekay River, and Paterson Creek, 2003. Report for MWLAP, Nanaimo, B.C., Weyerhaeuser Canada Ltd., Renewal Investment Corp. and BC Hydro, Burnaby, B.C. 16 p. + app.

Mouldey, S. E. and K.I. Ashley. 1996. Development and testing of slow release fertilizer for restoring salmonid habitat: 1995 progress report. Fisheries Project Report No. RD 54, MELP, Fisheries Branch 1996, 114 p. + app.

Mouldey Ewing, S. E., K. I. Ashley and G. Wilson. 1998. Development and testing of slow release fertilizer for restoring salmonid habitat: 1997 progress report. Watershed Restoration Project Report No. 10, MELP, Fisheries Branch, and Ministry of Forests. 30 p. + app.

Mouldey Ewing, S. E. and K. I. Ashley. 1998. Development and testing of slow release fertilizer for restoring salmonid habitat: 1996 Progress Report. Watershed Restoration Project Report No. 9, MELP, Fisheries Branch, and Ministry of Forests, 98 p. + app.

Perrin, C.J. 1989. The feasibility of inorganic fertilization for salmonid enhancement in the Salmon River, Vancouver Island. Limnotek Research and Development Inc. Report for MELP, Nanaimo, B.C. 63 p.

Perrin, C.J. 1990. Steelhead enhancement by nutrient addition to the Salmon River, Vancouver Island: first year assessment. Limnotek Research and Development Inc., Vancouver, B.C. Report for MELP, Nanaimo, B.C. 54 p.

Perrin, C.J. 1991a. Steelhead enhancement by nutrient addition to the Salmon River, Vancouver Island: monitoring in the second year of treatment. Limnotek Research and Development Inc. Report for MELP, Nanaimo, B.C. 29 p.

Perrin, C.J. 1991b. Steelhead enhancement by nutrient addition to the Salmon River, Vancouver Island: monitoring in the third year of treatment. Limnotek Research and Development Inc., Vancouver, B.C. Report for MELP, Nanaimo, B.C. 25 p.

<u>Other reports that provide supportive information:</u>

Ashley, K. I., S. E. Mouldey-Ewing and G. Wilson. 1997. Slow-release nutrient replacement research and development. Streamline. B.C.'s Watershed Restoration Technical Bulletin, Vol. 2, No. 4. Winter 1997, 2 p.

Ashley, K. I., B. Land and S. E. Mouldey. 1996/97. Nutrient assessment, monitoring and augmentation. Streamline. B.C.'s Watershed Restoration Technical Bulletin, Vol. 1, No. 1, Winter 96/97, 1 p.

Ashley, K. and P. Slaney, 1997. Fish habitat rehabilitation procedures. Watershed Restoration Technical Circular No. 9. Chapter 13, Accelerating recovery of stream, river and pond productivity by low-level nutrient replacement, page 13-9.

Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial Advisory Committee on Environmental and Occupational Health. 1987. Guidelines for Canadian drinking water quality. Published by authority of the Minister of National Health and Welfare.

Nordin, R.N., and L.W. Pommen. 1986. Water quality criteria for nitrogen (Nitrate, Nitrite, and Ammonia). MELP Water Quality Unit, Resource Quality Section, Water Management Branch, Victoria, B.C.

Slaney, P., K. I. Ashley, C. Wightman, R. Ptolemy, and D. Zaldokas. 1994. Low-level fertilization as a habitat management option for nutrient deficient trout streams in British Columbia. Proceedings of the 9th International Trout Stream Habitat Improvement Workshop, Sept. 6-9, 1994, Calgary, AB. Published by Trout Unlimited Canada. 23 p.

Slaney, P.A., and B. R. Ward. 1993. Experimental fertilization of nutrient deficient streams in British Columbia. In G. Shooner et al. S. Asselin [éd.]. Le développement du saumon atlantique au Québec: connaître les règles du jeu pour réussir. Colloque international de la Fédération québécoise pour le saumon atlantique. Québec, décembre 1992. Collection Salmon salar n 1:201 p. (128-141).

<u>Reports of operation of the Salmon River fish screen 1989 - 2000</u>

Carswell, L. 1990. Results of fish enumeration at the Salmon River smolt screen, April-June 1990. BCCF report for MELP, Fisheries Section, Nanaimo, B.C.

Carswell, L. 1991. Results of fish enumeration at the Salmon River smolt screen, April-June 1991. BCCF report for MELP, Fisheries Section, Nanaimo, B.C.

Carswell, L. 1992. Results of fish enumeration at the Salmon River smolt screen, April-June 1992. BCCF report for MELP, Fisheries Section, Nanaimo, B.C. 24 p. + app.

Carswell, L. 1993. Results of fish enumeration at the Salmon River smolt screen, April-June 1993. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1994. Results of fish enumeration at the Salmon River smolt screen, April-July 1994. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1997. Results of fish enumeration at the Salmon River smolt screen, April 1 – June 21, 1996. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1999. Operations at the Salmon River smolt screen, April 2 – May 6, 1997. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 1999. Results of fish enumeration at the Salmon River smolt screen, April 24 – June 30, and October 14 to November 12, 1998. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

APPENDIX 1 (cont'd)

Hansen, L. 1999. Operations at the Salmon River smolt screen: March 29 – May 17, June 4- 15, and November 4- 9, 1999. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 2001. Results of Fish Enumeration at the Salmon River smolt screen, April 4 to July 5 and October 22 to November 3, 2000. BCCF report for BCH, Burnaby, B.C. and MELP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 2002. Results of fish enumeration at the Salmon River fish screen, April 3 – June 30, 2001. BCCF report for BCH, Burnaby, B.C. and MWLAP, Fisheries Section, Nanaimo, B.C.

Hansen, L. 2003. Results of fish enumeration at the Salmon River fish screen, March 28 – July 12, 2002. BCCF report for BCH, Burnaby, B.C. and MWLAP, Fisheries Section, Nanaimo, B.C.

Hansen, L. and S. Rimmer. 1995. Results of fish enumeration at the Salmon River smolt screen, April – July 1995. BCCF report for BCH and MELP, Fisheries Section, Nanaimo, B.C.

Perrin, C.J. 1989. Results of fish enumeration at the Salmon River smolt trap, 1989. Limnotek Research and Development Inc. Report for MELP, Nanaimo, B.C.

APPENDIX 2.

Calibrated drip-rate of liquid 10-34-0, given in ml/min, based on streamflow (L/s) to achieve a target addition of 5 µg/L of soluble reactive phosphorus (SRP).

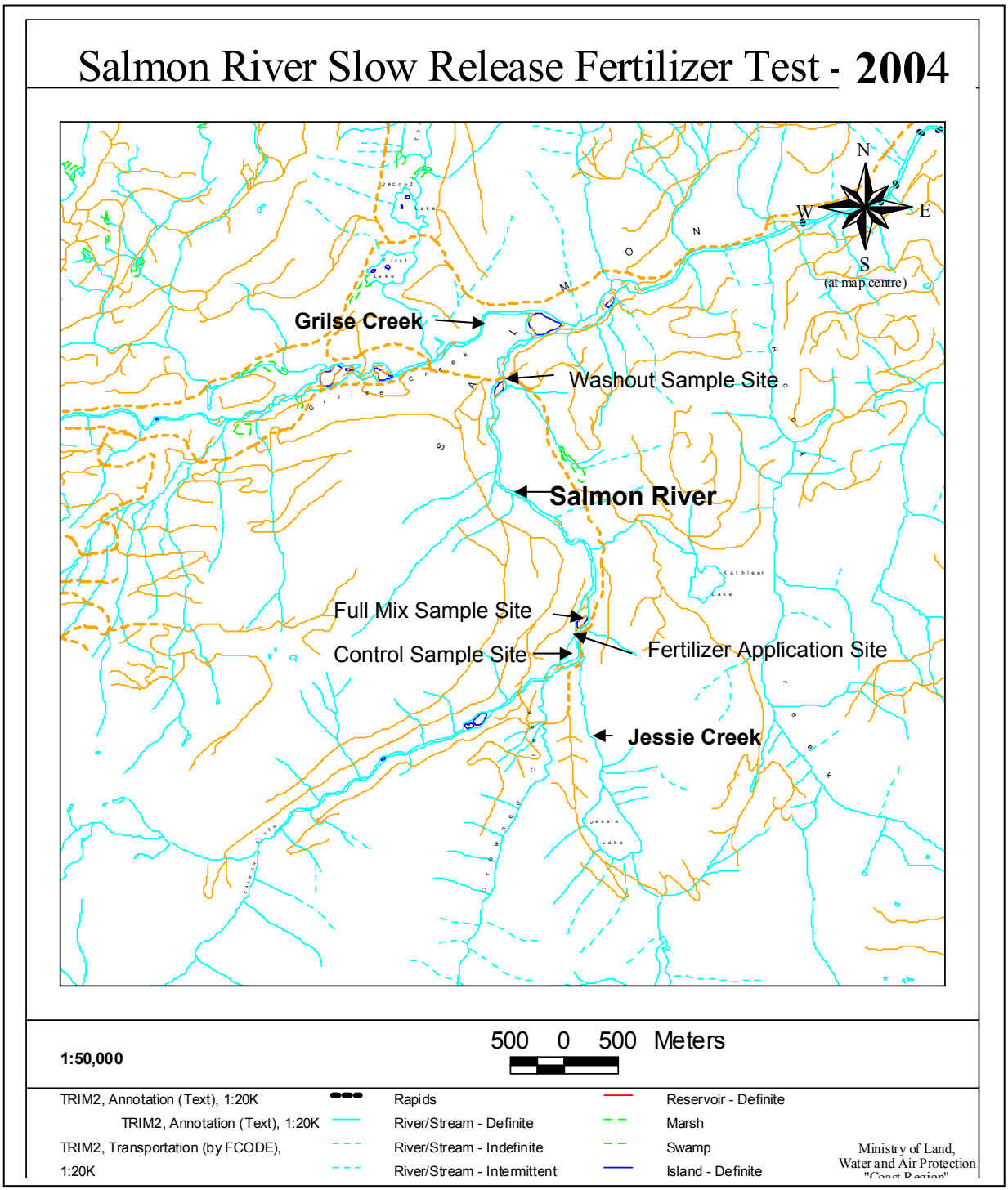
Salmon River (Vancouver Island) fertilizer calculations - K. Ashley, May 21/93)

Tank 3 - Salmon River

Fertilizer is 10-34-0 (liquid ammonium polyphosphate)
Specifications: 10% N by weight; 34% P2O5 by weight, 14.85% P by weight
Density: 1.4, weight is 1.4 kg/L

Applied SRP (ug/L)	Flow L/s	weight/min grams P	weight/min gr 10-34-0	mL/min 10-34-0	L/day 10-34-0	Weight/day kg P	Weight/day kg N
5	100	0.03	0.20	0.14	0.21	0.04	0.03
5	200	0.06	0.40	0.29	0.42	0.09	0.06
5	300	0.09	0.61	0.43	0.62	0.13	0.09
5	400	0.12	0.81	0.58	0.83	0.17	0.12
5	500	0.15	1.01	0.72	1.04	0.22	0.15
5	600	0.18	1.21	0.87	1.25	0.26	0.17
5	700	0.21	1.41	1.01	1.45	0.30	0.20
5	800	0.24	1.62	1.15	1.66	0.35	0.23
5	900	0.27	1.82	1.30	1.87	0.39	0.26
5	1000	0.30	2.02	1.44	2.08	0.43	0.29
5	1100	0.33	2.22	1.59	2.29	0.48	0.32
5	1200	0.36	2.42	1.73	2.49	0.52	0.35
5	1300	0.39	2.63	1.88	2.70	0.56	0.38
5	1400	0.42	2.83	2.02	2.91	0.60	0.41
5	1500	0.45	3.03	2.16	3.12	0.65	0.44
5	1600	0.48	3.23	2.31	3.32	0.69	0.47
5	1700	0.51	3.43	2.45	3.53	0.73	0.49
5	1800	0.54	3.64	2.60	3.74	0.78	0.52
5	1900	0.57	3.84	2.74	3.95	0.82	0.55
5	2000	0.60	4.04	2.89	4.16	0.86	0.58
5	2100	0.63	4.24	3.03	4.36	0.91	0.61
5	2200	0.66	4.44	3.17	4.57	0.95	0.64
5	2300	0.69	4.65	3.32	4.78	0.99	0.67
5	2400	0.72	4.85	3.46	4.99	1.04	0.70
5	2500	0.75	5.05	3.61	5.19	1.08	0.73
5	2600	0.78	5.25	3.75	5.40	1.12	0.76
5	2700	0.81	5.45	3.90	5.61	1.17	0.79
5	2800	0.84	5.66	4.04	5.82	1.21	0.81
5	2900	0.87	5.86	4.18	6.03	1.25	0.84
5	3000	0.90	6.06	4.33	6.23	1.30	0.87
5	3100	0.93	6.26	4.47	6.44	1.34	0.90
5	3200	0.96	6.46	4.62	6.65	1.38	0.93
5	3300	0.99	6.67	4.76	6.86	1.43	0.96
5	3400	1.02	6.87	4.91	7.06	1.47	0.99
5	3500	1.05	7.07	5.05	7.27	1.51	1.02
5	3600	1.08	7.27	5.19	7.48	1.56	1.05
5	3700	1.11	7.47	5.34	7.69	1.60	1.08

APPENDIX 3. Map showing the location of the upper Salmon River pollock test in 2004.



APPENDIX 4.

Daily mean, minimum and maximum temperatures (°C) for Grilse Creek, Memekay River and the Salmon River from June to September, 2004, using StowAway® Tidbit® Loggers (Onset Computer Corp.).

GRILSE CK- 2004. Water Temperature (°C)											
DATE	AVG	MIN	MAX	DATE	AVG	MIN	MAX	DATE	AVG	MIN	MAX
11-Jun-04	9.5	8.3	11.1	15-Jul-04	14.4	12.6	16.6	17-Aug-04	16.9	14.7	20.0
12-Jun-04	9.1	8.6	9.7	16-Jul-04	13.4	12.2	14.8	18-Aug-04	16.9	14.4	20.5
13-Jun-04	9.1	8.3	10.3	17-Jul-04	14.6	12.5	16.6	19-Aug-04	16.6	14.2	19.8
14-Jun-04	8.8	7.3	10.9	18-Jul-04	15.1	13.7	16.7	20-Aug-04	16.3	14.2	18.5
15-Jun-04	9.2	6.9	12.2	19-Jul-04	14.5	13.6	15.8	21-Aug-04	15.9	14.7	16.6
16-Jun-04	10.2	7.7	13.3	20-Jul-04	14.1	12.8	15.9	22-Aug-04	14.8	13.6	16.6
17-Jun-04	11.2	8.7	14.2	21-Jul-04	15.1	12.5	18.3	23-Aug-04	14.4	13.3	15.5
18-Jun-04	11.7	9.4	14.4	22-Jul-04	15.2	12.0	18.7	24-Aug-04	13.9	13.4	14.5
19-Jun-04	11.9	9.5	14.7	23-Jul-04	16.0	13.1	19.2	25-Aug-04	13.6	12.8	14.8
20-Jun-04	12.5	10.1	15.3	24-Jul-04	16.4	14.2	19.5	26-Aug-04	13.9	12.8	15.0
21-Jun-04	12.9	10.9	15.1	25-Jul-04	15.8	13.4	18.8	27-Aug-04	13.5	12.6	14.7
22-Jun-04	13.2	10.9	15.9	26-Jul-04	15.5	12.9	19.0	28-Aug-04	13.4	13.1	14.0
23-Jun-04	13.5	11.4	16.1	27-Jul-04	15.6	13.1	18.8	29-Aug-04	13.6	12.6	15.0
24-Jun-04	13.5	11.4	15.9	28-Jul-04	16.0	13.3	19.3	30-Aug-04	13.2	12.6	13.9
25-Jun-04	12.3	11.7	13.6	29-Jul-04	16.8	14.2	20.1	31-Aug-04	13.2	12.6	14.0
26-Jun-04	11.8	11.1	12.6	30-Jul-04	16.3	13.7	20.0	1-Sep-04	12.2	11.4	13.3
27-Jun-04	11.9	10.1	14.0	31-Jul-04	15.5	12.6	19.2	2-Sep-04	11.5	10.5	12.9
28-Jun-04	12.3	9.8	14.7	1-Aug-04	15.2	12.3	18.8	3-Sep-04	11.7	10.3	13.4
29-Jun-04	12.4	10.1	14.4	2-Aug-04	14.5	12.3	16.1	4-Sep-04	12.0	10.9	13.9
30-Jun-04	13.3	10.5	16.4	3-Aug-04	14.3	13.1	15.3	5-Sep-04	11.8	10.3	14.0
1-Jul-04	13.3	11.2	15.5	4-Aug-04	13.9	12.8	15.5	6-Sep-04	11.2	9.8	12.5
2-Jul-04	13.5	12.2	15.1	5-Aug-04	13.4	11.9	15.0	7-Sep-04	11.1	9.5	12.3
3-Jul-04	13.6	11.9	16.1	6-Aug-04	12.7	12.2	13.1	8-Sep-04	11.9	11.2	13.1
4-Jul-04	13.3	11.1	15.3	7-Aug-04	12.5	10.9	14.4	9-Sep-04	11.7	11.2	12.3
5-Jul-04	12.7	11.1	13.7	8-Aug-04	13.6	10.9	17.4	10-Sep-04	10.1	9.5	11.1
6-Jul-04	13.4	11.7	15.1	9-Aug-04	14.6	11.7	18.5	11-Sep-04	11.0	10.3	11.5
7-Jul-04	11.8	10.8	12.8	10-Aug-04	15.4	12.8	19.0	12-Sep-04	9.9	8.9	10.6
8-Jul-04	11.2	10.0	12.0	11-Aug-04	15.9	13.3	19.3	13-Sep-04	10.3	9.8	10.8
9-Jul-04	11.2	10.3	12.3	12-Aug-04	15.7	13.1	18.5	14-Sep-04	9.6	9.2	10.1
10-Jul-04	11.4	10.0	12.8	13-Aug-04	15.8	12.9	19.3	15-Sep-04	9.6	9.0	10.1
11-Jul-04	11.7	10.8	12.6	14-Aug-04	15.9	12.9	19.3	16-Sep-04	9.4	9.0	9.8
12-Jul-04	12.8	10.8	15.0	15-Aug-04	17.2	14.8	20.6				
13-Jul-04	13.2	11.4	15.3	16-Aug-04	17.1	14.7	20.3				
14-Jul-04	14.0	11.5	16.7								

Monthly Average	Average (°C)	Minimum (°C)	Maximum (°C)
June 11-30		6.9	16.4
July 1-31	14.1	10.0	20.1
August 1-31	14.8	10.9	20.6
September 1-16		8.9	14.0

APPENDIX 4 (cont'd)

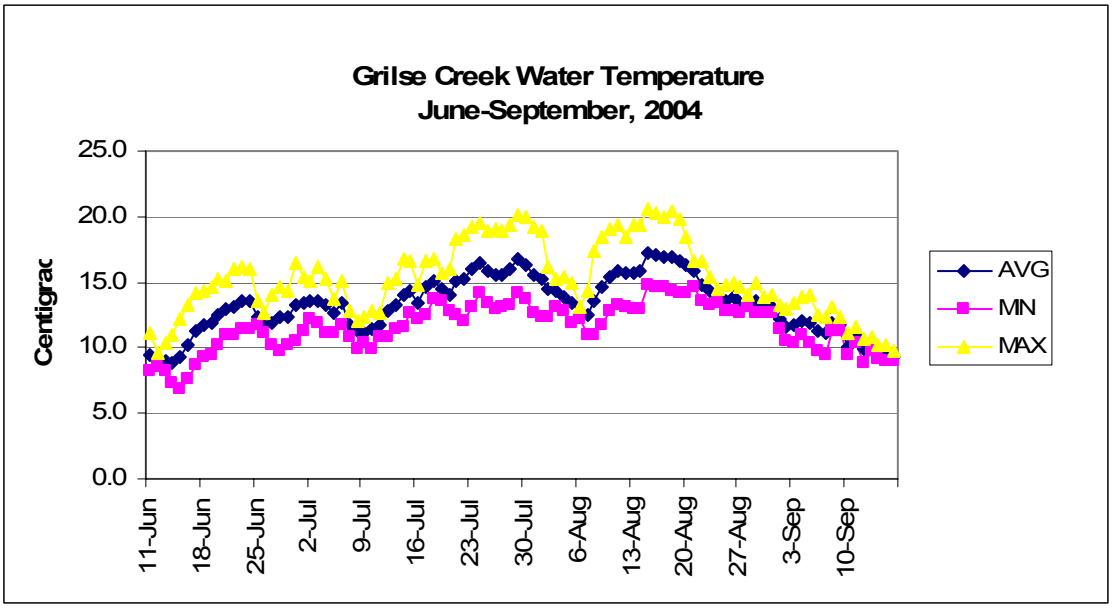
MEMEKAY RIVER- 2004. Water Temperatures (°C).											
DATE	**AVG**	**MIN**	**MAX**	**DATE**	**AVG**	**MIN**	**MAX**	**DATE**	**AVG**	**MIN**	**MAX**
11-Jun-04	8.9	7.8	9.8	13-Jul-04	14.1	12.5	15.7	14-Aug-04	16.5	14.6	18.1
12-Jun-04	8.6	8.3	9.1	14-Jul-04	14.7	12.3	17.3	15-Aug-04	17.5	16.4	18.8
13-Jun-04	8.8	7.5	11.1	15-Jul-04	15.3	13.1	17.8	16-Aug-04	17.9	16.5	18.9
14-Jun-04	8.3	7.0	9.5	16-Jul-04	14.9	13.4	16.4	17-Aug-04	18.0	16.7	18.9
15-Jun-04	9.0	6.6	12.5	17-Jul-04	15.5	13.5	17.5	18-Aug-04	18.0	16.5	18.9
16-Jun-04	10.0	7.4	13.4	18-Jul-04	16.6	15.3	18.8	19-Aug-04	17.4	15.7	18.8
17-Jun-04	10.8	8.1	14.2	19-Jul-04	16.2	15.4	17.0	20-Aug-04	17.0	15.6	18.1
18-Jun-04	11.3	8.9	14.6	20-Jul-04	15.1	14.3	15.9	21-Aug-04	17.1	16.2	17.8
19-Jun-04	11.8	9.2	15.1	21-Jul-04	15.6	13.2	18.6	22-Aug-04	15.9	14.8	16.8
20-Jun-04	12.3	9.8	15.6	22-Jul-04	16.0	13.2	19.4	23-Aug-04	15.0	14.3	15.7
21-Jun-04	12.7	10.4	15.3	23-Jul-04	17.1	14.3	20.4	24-Aug-04	14.5	14.0	14.9
22-Jun-04	13.2	10.8	16.5	24-Jul-04	17.5	15.4	19.9	25-Aug-04	14.7	13.7	16.2
23-Jun-04	13.6	11.4	16.5	25-Jul-04	16.9	14.8	19.3	26-Aug-04	14.2	13.4	15.3
24-Jun-04	13.6	11.4	16.5	26-Jul-04	16.2	13.7	19.1	27-Aug-04	13.6	12.8	14.6
25-Jun-04	12.5	12.0	14.3	27-Jul-04	16.4	14.0	19.1	28-Aug-04	13.6	13.4	13.8
26-Jun-04	12.7	11.5	14.3	28-Jul-04	16.8	14.3	19.7	29-Aug-04	13.4	12.5	14.5
27-Jun-04	12.6	11.2	13.8	29-Jul-04	17.7	15.3	20.7	30-Aug-04	12.8	12.5	13.7
28-Jun-04	13.0	10.6	15.6	30-Jul-04	17.3	14.8	19.9	31-Aug-04	12.7	12.2	13.4
29-Jun-04	13.5	10.9	16.1	31-Jul-04	16.4	13.8	19.1	1-Sep-04	12.1	11.2	13.1
30-Jun-04	14.1	11.5	17.0	1-Aug-04	16.0	13.4	18.8	2-Sep-04	11.8	10.4	13.5
1-Jul-04	14.3	12.2	16.2	2-Aug-04	15.6	13.4	17.6	3-Sep-04	12.2	10.9	13.8
2-Jul-04	14.5	13.4	16.4	3-Aug-04	15.8	14.3	17.0	4-Sep-04	12.4	11.5	13.1
3-Jul-04	14.3	12.6	16.7	4-Aug-04	15.5	14.5	16.5	5-Sep-04	11.8	10.6	13.2
4-Jul-04	14.5	12.2	17.0	5-Aug-04	14.9	13.5	15.9	6-Sep-04	11.5	10.4	12.5
5-Jul-04	14.1	12.9	15.1	6-Aug-04	14.5	13.8	15.1	7-Sep-04	11.3	10.0	12.3
6-Jul-04	14.5	13.2	16.7	7-Aug-04	14.2	12.5	16.1	8-Sep-04	12.3	11.8	12.8
7-Jul-04	12.7	11.7	14.2	8-Aug-04	15.0	12.5	18.0	9-Sep-04	12.1	11.4	12.5
8-Jul-04	12.3	11.4	12.9	9-Aug-04	16.1	13.5	19.1	10-Sep-04	10.3	9.7	11.4
9-Jul-04	12.6	11.5	14.5	10-Aug-04	16.8	14.5	19.3	11-Sep-04	11.0	10.4	12.2
10-Jul-04	12.7	11.5	13.8	11-Aug-04	17.2	15.3	19.3	12-Sep-04	10.3	9.4	11.2
11-Jul-04	12.4	11.5	13.1	12-Aug-04	16.9	14.8	18.6				
12-Jul-04	13.4	11.7	15.1	13-Aug-04	16.4	14.3	18.1				

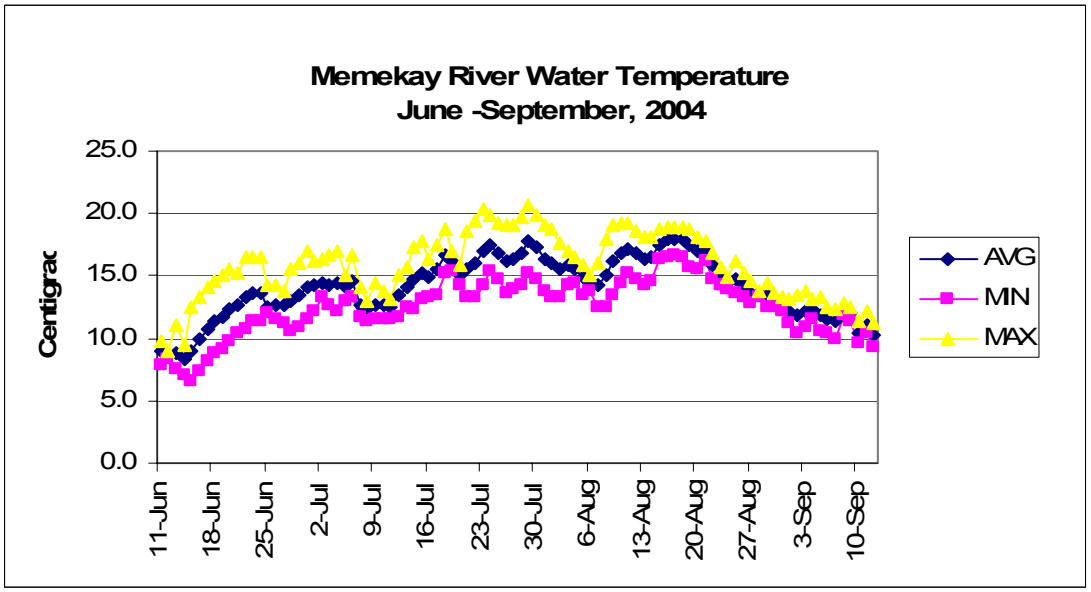
Monthly Average	Average (°C)	Minimum (°C)	Maximum (°C)
June (11-30)		6.6	17.0
July (1-31)	15.1	11.4	20.7
August (1-31)	15.6	12.2	19.3
September (1-12)		9.4	13.8

APPENDIX 4 (cont'd)

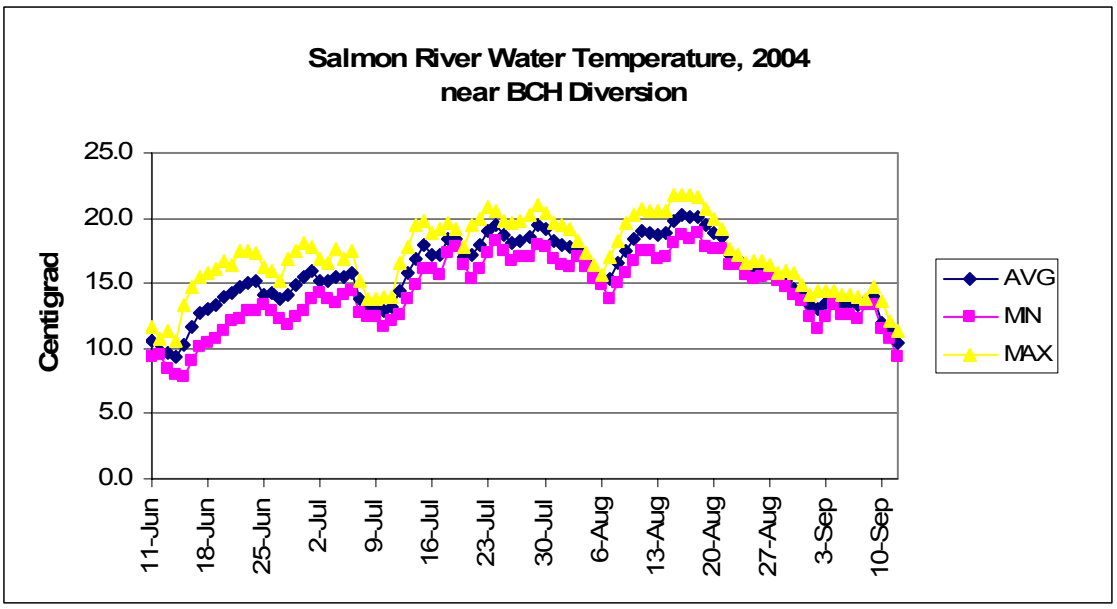
SALMON RIVER (bridge near BCH Diversion)- 2004. Water Temperatures (°C)											
DATE	**AVG**	**MIN**	**MAX**	**DATE**	**AVG**	**MIN**	**MAX**	**DATE**	**AVG**	**MIN**	**MAX**
11-Jun-04	10.6	9.4	11.7	13-Jul-04	15.8	13.9	17.8	14-Aug-04	18.8	17.0	20.6
12-Jun-04	9.8	9.5	10.8	14-Jul-04	16.9	14.8	19.5	15-Aug-04	19.8	18.2	21.7
13-Jun-04	9.7	8.5	11.4	15-Jul-04	17.9	16.1	19.8	16-Aug-04	20.2	18.6	21.7
14-Jun-04	9.3	8.0	10.6	16-Jul-04	17.2	16.1	18.8	17-Aug-04	20.1	18.5	21.7
15-Jun-04	10.4	7.8	13.4	17-Jul-04	17.2	15.6	19.1	18-Aug-04	20.1	18.8	21.6
16-Jun-04	11.7	9.1	14.7	18-Jul-04	18.4	17.4	19.6	19-Aug-04	19.4	17.8	20.8
17-Jun-04	12.7	10.2	15.5	19-Jul-04	18.4	17.8	19.1	20-Aug-04	18.8	17.7	19.9
18-Jun-04	13.0	10.5	15.8	20-Jul-04	17.0	16.4	17.8	21-Aug-04	18.5	17.7	19.1
19-Jun-04	13.3	10.8	16.1	21-Jul-04	17.1	15.3	19.5	22-Aug-04	17.1	16.4	17.7
20-Jun-04	13.9	11.4	16.7	22-Jul-04	17.9	16.1	19.9	23-Aug-04	16.8	16.4	17.2
21-Jun-04	14.3	12.2	16.4	23-Jul-04	19.0	17.4	20.9	24-Aug-04	16.2	15.6	16.6
22-Jun-04	14.7	12.3	17.5	24-Jul-04	19.4	18.3	20.6	25-Aug-04	15.9	15.3	16.7
23-Jun-04	15.1	13.0	17.5	25-Jul-04	18.7	17.5	19.8	26-Aug-04	16.1	15.5	16.7
24-Jun-04	15.1	13.0	17.4	26-Jul-04	18.1	16.7	19.6	27-Aug-04	16.0	15.6	16.4
25-Jun-04	14.1	13.4	16.2	27-Jul-04	18.3	17.0	19.8	28-Aug-04	15.5	15.1	15.8
26-Jun-04	14.2	13.0	15.9	28-Jul-04	18.6	17.0	20.3	29-Aug-04	15.1	14.7	15.9
27-Jun-04	13.8	12.3	15.1	29-Jul-04	19.5	18.0	21.1	30-Aug-04	14.6	14.2	15.8
28-Jun-04	14.1	11.9	16.9	30-Jul-04	19.1	17.8	20.4	31-Aug-04	14.3	13.7	14.8
29-Jun-04	14.9	12.5	17.5	31-Jul-04	18.2	16.9	19.6	1-Sep-04	13.3	12.5	14.2
30-Jun-04	15.5	13.0	18.2	1-Aug-04	17.9	16.4	19.5	2-Sep-04	13.0	11.6	14.5
1-Jul-04	16.0	13.9	17.8	2-Aug-04	17.8	16.2	19.1	3-Sep-04	13.6	12.5	14.5
2-Jul-04	15.1	14.3	16.9	3-Aug-04	17.6	17.0	18.3	4-Sep-04	13.9	13.4	14.5
3-Jul-04	15.2	13.9	16.6	4-Aug-04	16.7	16.2	17.4	5-Sep-04	13.4	12.6	14.2
4-Jul-04	15.5	13.6	17.7	5-Aug-04	15.9	15.3	16.4	6-Sep-04	13.5	12.6	14.2
5-Jul-04	15.4	14.2	16.9	6-Aug-04	15.2	14.8	15.6	7-Sep-04	13.3	12.3	14.0
6-Jul-04	15.7	14.5	17.5	7-Aug-04	15.3	13.9	17.0	8-Sep-04	13.7	13.4	13.9
7-Jul-04	13.7	12.8	15.1	8-Aug-04	16.6	15.0	18.3	9-Sep-04	14.0	13.4	14.7
8-Jul-04	13.2	12.5	13.9	9-Aug-04	17.6	15.8	19.6	10-Sep-04	12.0	11.6	13.7
9-Jul-04	13.1	12.5	13.9	10-Aug-04	18.4	16.7	20.3	11-Sep-04	11.4	10.8	12.2
10-Jul-04	12.9	11.7	14.0	11-Aug-04	19.0	17.5	20.8	12-Sep-04	10.5	9.4	11.4
11-Jul-04	13.2	12.2	14.0	12-Aug-04	18.9	17.5	20.6				
12-Jul-04	14.4	12.6	16.6	13-Aug-04	18.7	16.9	20.6				

Monthly Average	Average (°C)	Minimum (°C)	Maximum (°C)
June (11-30)		7.8	18.2
July (1-31)	16.7	11.7	21.1
August (1-31)	17.4	13.7	21.7
September (1-12)		9.4	14.7


Grilse Creek Water Temperature
June-September, 2004
Centigrac
25.0
20.0
15.0
10.0
5.0
0.0
11-Jun
18-Jun
25-Jun
2-Jul
9-Jul
16-Jul
23-Jul
30-Jul
6-Aug
13-Aug
20-Aug
27-Aug
3-Sep
10-Sep
AVG
MN
MAX


Memekay River Water Temperature
June -September, 2004
Centigrac
25.0
20.0
15.0
10.0
5.0
0.0
11-Jun
18-Jun
25-Jun
2-Jul
9-Jul
16-Jul
23-Jul
30-Jul
6-Aug
13-Aug
20-Aug
27-Aug
3-Sep
10-Sep
AVG
MN
MAX

APPENDIX 4 (cont'd)



APPENDIX 5.

Spot temperatures (and time) recorded at the sample sites in Grilse Creek, Salmon River and Memekay River in 2004. A hand-held alcohol thermometer was used.

Date	Grilse Creek		Salmon River					Memekay River	
2004	Tank	Treatment	Control	Screen	MML	WSC	Pallan's	Control	Treatment
Jun 8	12 (12:45)			12 (14:25)				12 (16:00)	
Jun 10	11 (12:40)				13.5			11.5 (15:45)	
Jun 14	11			10.5	11 (15:30)			9.5 (16:10)	
Jun 18	11 (11:00)		9.6 (11:55)	12 (12:30)	17 (14:00)			12.5 (14:30)	
Jun 21	12		11.5 (12:41)	14.5	18			15	
Jun 25	13 (13:00)			13.5 (14:15)	15 (15:30)			12.5 (16:00)	
Jun 30	16 (14:55)			17 (15:50)	18 (16:16)			17 (16:48)	
Jul 2	13 (12:40)			14.5 (13:30)	16.5 (14:00)			14 (15:00)	
Jul 6	14.5			15.5	16.5 (13:30)			16 (14:00)	
Jul 8	11 (12:18)	13.5 (12:35)	11 (13:00)			14.5 (10:59)	13.5 (10:11)	12.5 (11:35)	13 (10:45)
Jul 9	13 (13:20)			15 (16:20)	14.5			13.5	
Jul 11	13 (13:30)			14 (14:20)					
Jul 16	13 (12:35)			16.5 (14:40)	18 (12:00)			14 (11:15)	
Jul 19	14.5 (13:45)			18.5 (14:20)	19.5 (12:55)			16 (12:20)	
Jul 22			15.5 (15:15)						
Jul 23			16.5 (14:00)		19.5 (11:50)			16 (11:15)	
Jul 26	18.5 (14:15)			19 (15:00)	19.5 (13:20)			16.5 (12:45)	
Jul 30	17 (12:30)			19 (13:00)	18.5 (11:40)			16 (11:12)	
Aug 4	14.5 (15:24)			17 (16:00)	17.5 (14:30)			16 (14:06)	
Aug 5	14.5 (12:45)	16.5 (13:10)	13.5 (13:35)			17 (11:50)	15 (11:18)	15 (12:15)	14.5 (11:35)
Aug 10	14 (11:25)			18 (12:11)	17.5 (10:40)			15 (10:15)	
Aug 13	FIA TOUR								
Aug 18	19.5				22			20	
Aug 21				18.5					
Aug 26	14 (12:41)			15.5 (14:04)	17.3 (11:25)			14 (12:00)	
Aug 30	13 (13:47)			14 (12:28)	15.5 (12:48)			12.5 (13:14)	
Sept 2	11.5 (13:10)			11.5 (11:08)	13.5 (11:45)			11 (12:30)	
Sept 6	10.5 (11:40)	13.5 (12:10)	12.5 (12:57)			14 (14:45)	14 (15:10)	13 (14:10)	13 (15:39)
Sept 13				10.5 (13:00)	11.5 (12:14)			10.5 (11:10)	
Sept 17	8.5 (11:30)				10 (13:30)				

APPENDIX 6.

Water Survey of Canada, discharge data (preliminary) for the Salmon River from June 1 to September 29, 2004.

Salmon River - Above the diversion dam (#08HD015)							
Date	Mean (m^3/s)	Date	Mean (m^3/s)	Date	Mean (m^3/s)	Date	Mean (m^3/s)
1-Jun-04	9.16	1-Jul-04	3.03	1-Aug-04	1.02		
2-Jun-04	10	2-Jul-04	3.25	2-Aug-04	0.97		
3-Jun-04	9.41	3-Jul-04	3.13	3-Aug-04	0.949		
4-Jun-04	10.6	4-Jul-04	2.63	4-Aug-04	1.06		
5-Jun-04	10.8	5-Jul-04	2.41	5-Aug-04	1.09		
6-Jun-04	9.38	6-Jul-04	2.79	6-Aug-04	1.23		
7-Jun-04	9.42	7-Jul-04	2.76	7-Aug-04	1.29		
8-Jun-04	9.89	8-Jul-04	2.28	8-Aug-04	1.11		
9-Jun-04	11.2	9-Jul-04	2.82	9-Aug-04	1.01		
10-Jun-04	9.63	10-Jul-04	4.03	10-Aug-04	0.948		
11-Jun-04	7.11	11-Jul-04	3.26	11-Aug-04	0.905		
12-Jun-04	6.89	12-Jul-04	2.88	12-Aug-04	0.868		
13-Jun-04	11.2	13-Jul-04	2.58	13-Aug-04	0.838		
14-Jun-04	8.89	14-Jul-04	2.44	14-Aug-04	0.807	14-Sep-04	5.12
15-Jun-04	6.89	15-Jul-04	2.26	15-Aug-04	0.771	15-Sep-04	18.6
16-Jun-04	6.11	16-Jul-04	2.08	16-Aug-04	0.754	16-Sep-04	13.3
17-Jun-04	6.88	17-Jul-04	1.88	17-Aug-04	0.739	17-Sep-04	13.6
18-Jun-04	7.62	18-Jul-04	1.78	18-Aug-04	0.72	18-Sep-04	9.35
19-Jun-04	7.12	19-Jul-04	1.79	19-Aug-04	0.7	19-Sep-04	6.47
20-Jun-04	6.65	20-Jul-04	1.84	20-Aug-04	0.678	20-Sep-04	4.83
21-Jun-04	6.77	21-Jul-04	1.85	21-Aug-04	0.793	21-Sep-04	3.75
22-Jun-04	6.34	22-Jul-04	1.65	22-Aug-04	1.49	22-Sep-04	4.03
23-Jun-04	6.11	23-Jul-04	1.52	23-Aug-04	1.42	23-Sep-04	4.38
24-Jun-04	5.9	24-Jul-04	1.44			24-Sep-04	3.72
25-Jun-04	5.46	25-Jul-04	1.39			25-Sep-04	3.12
26-Jun-04	4.69	26-Jul-04	1.3			26-Sep-04	2.68
27-Jun-04	4.27	27-Jul-04	1.22			27-Sep-04	2.37
28-Jun-04	3.84	28-Jul-04	1.19			28-Sep-04	2.15
29-Jun-04	3.37	29-Jul-04	1.15			29-Sep-04	1.95
30-Jun-04	3.12	30-Jul-04	1.13				
		31-Jul-04	1.07				
Average	7.5		2.16				
Min	3.12		1.07				
Max	11.2		4.03				

Note: The diversion was closed on June 27, 2004 and re-opened briefly between September 15 – 19, 2004.

APPENDIX 7.

Fertilizer drip-rates of liquid 10-34-0 at stations on Grilse Creek, mainstem Salmon River and the Memekay River from June 8 to September 17, 2004. The output rates (ml/min) and re-calibration rates (ml/min) are shown.

Date	Grilse Creek		Rock Ck.		Fish Screen		MML bridge		Memekay R.	
2004	Out	Re-cal	Out	Re-cal	Out	Re-cal	Out	Re-cal	Out	Re-cal
Jun 8		5.4		10.3		10.2		10.0		5.0
Jun 10	3.2	5.0	10.0	10.0	7.3	10.3	9.0	9.0	3.3	5.0
Jun 14	3.4	5.4	6.0	10.2	7.4	7.4	5.7	9.0	2.4	4.2
Jun 18	4.2	5.0	11.8	10.2	8.6	8.6	0.2	7.8	4.2	4.2
Jun 21	4.2	4.2	0	10.4	7.8	9.1	2.3	9.6	1.0	4.0
Jun 25	2.6	2.6	1.0	10.3	5.0	9.8	0	10.2	0	5.0
Jun 30	3.2	2.9	6.8	6.8	6.0	6.0	0	6.4	1.8	2.7
Jul 2	2.0	2.4	5.8	5.8	4.0	5.8	2.6	6.4	1.2	2.6
Jul 6	1.7	4.0	4.2	7.5	3.3	7.2	4.2	4.1	1.3	3.8
Jul 9	3.2	3.2	4.8	6.8	4.9	6.7	0.8		2.8	3.6
Jul 16	2.2	3.8	4.4	6.0	1.0	5.8	1.6	6.8	2.2	4.4
Jul 19	2.7	2.7	4.2	6.4	1.0	6.3	0	6.5	3.2	4.0
Jul 22	2.5	7.5	5.8	5.8	6.0	6.9	6.3	5.0	3.1	3.1
Jul 26	2.2	2.2	3.7	5.7	2.8	5.0	3.6	4.8	2.4	1.4
Jul 30	1.4	2.4	2.0	5.8	3.1	4.4	5.3	5.3	1.6	2.6
Aug 4	1.5	2.5	2.5	4.7	1.8	5.2	0	6.0	1.5	3.0
Aug 10	2.0	2.0	4.0	5.1	7.8	4.8	4.4	5.0	2.0	2.8
Aug 18	1.6	1.6	1.0	4.4			4.0	4.0	1.7	1.7
Aug 21					1.0	4.4				
Aug 26	0.6	3.2	1.2	5.0	3.6	3.6	2.4	4.4	0	3.4
Aug 30	2.0	3.6	3.0	6.0	2.2	5.0	1.8	6.4	2.2	3.5
Sep 2	2.8	2.8	4.4	5.6	3.0	6.6	4.6	5.6	2.0	3.6
Sep 13					2.2	Tank Out	3.0		0.6	Tank Out
Sep 17	Tank Out		2.2	Tank Out				Tank Out		
Total Load	310 L (= 97 days) av.- 2.2 ml/min		624 L (= 101 days) av.– 4.3 ml/min		548 L (= 97 days) av.–3.9 ml/min		624 L (= 101days) av.–4.3 ml/min		310 L (= 97 days) av.–2.2 ml/min	

The total load for the Salmon River watershed was 2416 L of 10-34-0.

APPENDIX 8.

Water chemistry results from samples of the mainstem Salmon River, Grilse Creek and the Memekay River: July 8, August 5 and September 6, 2004.

C.O.C. #08140115									
Lab ID :	14034414	14034415	14034416	14034412	14034410	14034413	14034411		
Client ID :	**GRILSE CK. CONTROL**	**GRILSE CK. BRIDGE (SF)**	**SALMON R. CONTROL**	**SALMON R.- WSC**	**PALLAN'S**	**MEMEKAY R. CONTROL**	**MEMEKAY R. BRIDGE**		
GENERAL INORGANICS								unit	MDL
Alkalinity Total as CaCO3	20.3	16.9	16.0	16.8	21.5	41.1	27.6	mg/L	0.5
NITROGEN									
Ammonia Nitrogen (N)	0.010	<0.005	<0.005	0.006	0.008	0.010	0.005	mg/L	0.005
Nitrate Nitrogen Diss (N)	0.030	0.013	0.012	0.032	0.036	0.028	0.034	mg/L	(Calc.)
Nitrate+Nitrite (N)	0.030	0.013	0.012	0.032	0.036	0.028	0.034	mg/L	0.002
Nitrite Nitrogen (N)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	mg/L	0.002
PHOSPHORUS									
Ortho-Phosphorus (P)	0.001	<0.001	0.001	0.001	<0.001	<0.001	0.001	mg/L	0.001
Phosphorus Total Diss (P)	<0.002	0.004	<0.002	0.004	0.004	<0.002	0.005	mg/L	0.002
Phosphorus Total (P)	<0.002	0.003	<0.002	0.003	0.006	0.002	0.003	mg/L	0.002
Sampled on:	**04/07/08**	**04/07/08**	**04/07/08**	**04/07/08**	**04/07/08**	**04/07/08**	**04/07/08**		
Sampled at:	12:18	12:35	13:00	10:59	10:11	11:35	10:45		
C.O.C. #08140118									
Lab ID :	14041229	14041230	14041231	14041227	14041225	14041228	14041226		
Client ID :	**GRILSE CK. CONTROL**	**GRILSE CK. BRIDGE (SF)**	**SALMON R. CONTROL**	**SALMON R.- WSC**	**PALLAN'S**	**MEMEKAY R. CONTROL**	**MEMEKAY R. BRIDGE**		
GENERAL INORGANICS								Unit	MDL
Alkalinity Total as CaCO3	23.4	21.4	22.3	21.4	21.5	55.5	30.9	mg/L	0.5
NITROGEN									
Ammonia Nitrogen (N)	<0.005	0.007	<0.005	0.017	0.018	0.009	0.009	mg/L	0.005
Nitrate Nitrogen Diss (N)	0.047	0.043	0.049	0.054	0.036	0.049	0.069	mg/L	(Calc.)
Nitrate+Nitrite (N)	0.051	0.046	0.052	0.058	0.040	0.052	0.074	mg/L	0.002
Nitrite Nitrogen (N)	0.004	0.003	0.003	0.004	0.004	0.003	0.005	mg/L	0.002

Client ID :	GRILSE CK. CONTROL	GRILSE CK. BRIDGE (SF)	SALMON CONTROL	SALMON R.- WSC	PALLAN'S	MEMEKAY R. CONTROL	MEMEKAY R. BRIDGE		
PHOSPHORUS									
Ortho-Phosphorus (P)	0.002	0.001	0.001	0.002	0.002	0.002	0.002	mg/L	0.001
Phosphorus Total Diss (P)	0.003	0.002	<0.002	0.002	0.004	0.003	0.004	mg/L	0.002
Phosphorus Total (P)	0.002	0.003	<0.002	0.007	0.005	<0.002	0.004	mg/L	0.002
Sampled on:	**04/08/05**	**04/08/05**	**04/08/05**	**04/08/05**	**04/08/05**	**04/08/05**	**04/08/05**		
Sampled at:	12:45	13:10	13:35	11:50	11:18	12:15	11:35		
C.O.C. #8140122									
Lab ID :	14047434	14047435	14047436	14047440	14047441	14047439			
Client ID :	GRILSE CK. CONTROL	GRILSE CK. BRIDGE (SF)	SALMON R. CONTROL	SALMON R.- WSC	PALLAN'S	MEMEKAY R. CONTROL	MEMEKAY R. BRIDGE		
GENERAL INORGANICS								unit	MDL
Alkalinity Total as CaCO3	20.9	20.5	20.3	20.3	20.2	46.8	28.1	mg/L	0.5
NITROGEN									
Ammonia Nitrogen (N)	<0.005	0.007	<0.005	0.005	0.006	<0.005	0.009	mg/L	0.005
Nitrate Nitrogen Diss (N)	0.059	0.019	0.037	0.058	0.039	0.036	0.022	mg/L	(Calc.)
Nitrate+Nitrite (N)	0.061	0.022	0.041	0.060	0.041	0.038	0.022	mg/L	0.002
Nitrite Nitrogen (N)	0.002	0.003	0.004	0.002	0.002	0.002	<0.002	mg/L	0.002
PHOSPHORUS									
Ortho-Phosphorus (P)	0.001	0.001	<0.001	0.002	<0.001	<0.001	0.002	mg/L	0.001
Phosphorus Total Diss (P)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	mg/L	0.002
Phosphorus Total (P)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	mg/L	0.002
Sampled on:	**04/09/06**	**04/09/06**	**04/09/06**	**04/09/06**	**04/09/06**	**04/09/06**	**04/09/06**		
Sampled at:	11:40	12:10	12:35	14:45	15:10	14:10	15:39		

APPENDIX 9.

Water chemistry results from samples of upper Salmon River below Jessie Creek: August 5 and September 6, 2004.

Salmon River Fertilization – 2004					
Upper Salmon River below Jessie Creek - Pollock Log Test					
C.O.C.	#08140118	#08140119	#08140119		
Philip ID :		14041232	14041233		
Client ID :	**Salmon R. Control**	**Full Mix**	**Washout (South Fork)**		
GENERAL INORGANICS				Unit	MDL
Alkalinity Total as CaCO3	22.3	22.1	21.4	mg/L	0.5
NITROGEN					
Ammonia Nitrogen (N)	<0.005	0.009	0.031	mg/L	0.005
Nitrate Nitrogen Diss (N)	0.049	0.050	0.056	mg/L	(Calc.)
Nitrate+Nitrite (N)	0.052	0.052	0.058	mg/L	0.002
Nitrite Nitrogen (N)	0.003	0.002	0.002	mg/L	0.002
PHOSPHORUS					
Ortho-Phosphorus (P)	0.001	0.007	0.003	mg/L	0.001
Phosphorus Total Diss (P)	<0.002	0.009	0.003	mg/L	0.002
Phosphorus Total (P)	<0.002	0.012	0.004	mg/L	0.002
Sampled on:	**04/08/05**	**04/08/05**	**04/08/05**		
Sampled at:	13:35	13:50	14:15		
C.O.C.	#08140122	#08140122	#08140122		
Philip ID :	14047436	14047437	14047438		
Client ID :	**Salmon R. Control**	**Full Mix**	**Washout (South Fork)**		
GENERAL INORGANICS				Unit	MDL
Alkalinity Total as CaCO3	20.3	20.6	20.0	mg/L	0.5
NITROGEN					
Ammonia Nitrogen (N	<0.005	0.005	0.005	mg/L	0.005
Nitrate Nitrogen Diss (N)	0.037	0.035	0.026	mg/L	(Calc.)
Nitrate+Nitrite	0.041	0.035	0.029	mg/L	0.002
Nitrite Nitrogen (N)	0.004	<0.002	0.003	mg/L	0.002
PHOSPHORUS					
Ortho-Phosphorus (P)	<0.001	0.003	<0.001	mg/L	0.001
Phosphorus Total Diss (P)	<0.002	0.004	<0.002	mg/L	0.002
Phosphorus Total (P)	<0.002	0.004	<0.002	mg/L	0.002
Sampled on:	**04/09/06**	**04/09/06**	**04/09/06**		
Sampled at:	12:35	12:57	13:17		

APPENDIX 10.

Chlorophyll *a* and phaeophytin *a* (µg·cm^{-2}) measured from periphyton samples of the upper Salmon River below Jessie Creek, August 5, August 18 and September 6, 2004.

Periphyton plates were set in the river on July 23, 2004.

Test (µg·cm^{-2})	Upper Salmon R. below Jessie Ck.		
	13 days (Aug-05-04)		
	Control	**Full Mix**	**Washout**
Chlorophyll *a*	0.22	0.4	0.1
Phaeophytin *a*	0.12	0.17	<0.03
	26 days (Aug-18-04)		
	Control	**Full Mix**	**Washout**
Chlorophyll *a*	*	1.61	0.94
Phaeophytin *a*	*	1.53	0.82
	45 days (Sept-06-04)		
	Control	**Full Mix**	**Washout**
Chlorophyll *a*	*	1.62	1.94
Phaeophytin *a*	*	1.52	2.07

* The control plate was found upside-down in the water on August 18, 2004. Samples were no longer valid. A clicking sound was heard a short distance from the site, believed to be the work of an annoyed bear, jaw-snapping.

APPENDIX 11. Results of juvenile fish sampling in the mainstem Salmon River, Grilse Creek, and Memekay River in September, 2004.

Watershed: Salmon
Stream Code: 925-725300

						Site Dimensions		
System	**Site #**	**Site Description**	**Site Reference (km)**	**Date**	**UTM Code**	**Length**	**Width**	**Area**
Salmon	1	Pallan's	12.24	20-Sep-04	293530,5576518	14.3	6.4	90.60
Salmon	2	WSC Station (Kay Creek)	35.44	21-Sep-04	304045,5564254	12.9	7.0	86.07
Salmon	3	Memekay ML Bridge	52.6	14-Sep-04	309222,5556664	17.3	5.8	97.91
Salmon	4	Smolt Screen	58.02	21-Sep-04	309046,5552313	17.2	5.0	84.71
Salmon	5	Washout	67.73	9-Sep-04	302790,5548002	15.5	6.1	91.60
Salmon	6	Washout 500 m u/s of Grilse confluence	69.25	14-Sep-04	301495,5547162	17.0	6.1	99.96
Salmon	7	Memekay River (lower bridge)	27.93	20-Sep-04	302065,5566098	17.1	5.0	80.37
Salmon	8	Grilse Ck (100 m u/s of lower bridge)	70.77	9-Sep-04	300281,5547288	15.8	6.3	96.78
Salmon	9	Grilse Ck (300 m d/s of upper bridge)	74.27	10-Sep-04	297264,554698	17.3	6.0	98.73
Salmon	10	Grilse Ck (1 km u/s of upper bridge)	75.91	10-Sep-04	296047,5546134	16.4	5.8	89.80

Salmon

Juvenile Steelhead Electrofishing Results

Alkalinity= 16.5
Biomass= 147.5

1998

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.25	189.8	201.90	65.5	308%
2	4.01	31.76	52.10	36.8	142%
3	3.79	63.45	64.10	38.9	165%
4	3.48	60.42	67.10	42.4	158%
5	3.13	75.06	97.50	47.1	207%
6	2.33	27.87	37.20	63.3	59%
7	4.03	25.9	41.10	36.6	112%
8	3.52	49.2	54.70	41.9	131%
9	2.98	20.96	27.60	49.5	56%
10	3.56	34.47	51.10	41.4	123%
MEAN	**3.31**		**59.11 ***		**146%**

1999

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	1.44	59.5	104.40	102.4	102%
2	2.79	42.4	64.30	52.8	122%
3	2.81	10.1	12.00	52.5	23%
4	1.04	26.8	29.50	141.8	21%
5	1.50	18.5	19.90	98.3	20%
6	1.09	11.8	17.90	135.3	13%
7	1.46	21.6	24.60	101.0	24%
8	1.60	64.3	69.20	92.2	75%
9	1.52	16.9	19.40	97.0	20%
10	1.00	49.5	56.30	147.5	38%
MEAN	**1.63**		**33.09 ***		**46%**

Appendix 11 (cont'd)

2000

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	2.83	72.0	130.36	52.0	250%
2	4.70	21.1	50.11	31.3	160%
3	4.31	35.2	133.29	34.2	390%
4	5.25	13.0	15.45	28.1	55%
5	2.98	31.2	43.25	49.4	88%
6	6.63	9.0	11.69	22.2	53%
7	4.30	15.2	17.39	34.3	51%
8	3.71	23.8	31.15	39.7	78%
9	4.62	11.8	16.27	31.9	51%
10	1.46	23.8	25.25	100.8	25%
MEAN	**4.08**		**32.96 ***		**120%**

2001

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.02	46.1	56.84	48.7	117%
2	4.77	22.2	28.52	30.9	92%
3	4.88	32.2	53.29	30.2	176%
4	3.96	18.8	31.76	37.3	85%
5	2.33	81.6	121.04	63.3	191%
6	2.04	13.0	18.02	72.3	25%
7	3.20	37.0	58.91	46.1	128%
8	3.11	60.2	77.94	47.3	165%
9	2.89	31.7	43.95	51.0	86%
10	1.21	55.8	83.14	122.2	68%
MEAN	**3.14**		**50.14***		**113%**

2002

Site #	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1	3.27	32.5	50.56	45.1	112%
2	3.89	22.6	38.54	37.9	102%
3	3.32	61.7	104.68	44.4	236%
4	4.44	7.5	10.31	33.2	31%
5	4.42	2.9	4.38	33.3	13%
6	2.96	11.4	19.71	49.9	40%
7	3.28	33.8	57.43	44.9	128%
8	3.34	34.3	51.14	44.2	116%
9	2.07	21.5	48.06	71.3	67%
10	1.02	22.4	28.17	144.4	20%
MEAN	**3.20**		**30.61***		**86%**

Appendix 11 (cont'd)

2003					
Site #	**Mean Weight (grams)**	**Unadj'd FPU**	**D/V Adj'd FPU**	**Predicted FPU**	**% of Predicted**
1	3.37	22.9	34.19	43.79	78%
2	4.87	13.8	18.89	30.29	62%
3	5.01	43.2	58.97	29.42	200%
4	4.71	49.4	96.12	31.31	307%
5	2.53	29.6	48.21	58.28	83%
6	3.35	6.3	9.50	44.07	22%
7	5.27	22.5	28.12	27.97	101%
8	5.69	19.1	24.43	25.93	94%
9	4.78	12.5	18.59	30.86	60%
10	1.87	37.8	71.92	79.00	91%
MEAN	**4.14**		**33.02***		**110%**

2004					
Site #	**Mean Weight (grams)**	**Unadj'd FPU**	**D/V Adj'd FPU**	**Predicted FPU**	**% of Predicted**
1	1.46	28.7	53.53	101.3	53%
2	3.95	12.9	18.26	37.3	49%
3	4.50	1.0	1.53	32.8	5%
4	4.87	10.8	17.45	30.3	58%
5	3.14	41.4	90.50	47.0	193%
6	2.23	3.0	5.21	66.1	8%
7	6.73	2.5	5.25	21.9	24%
8	3.76	31.2	42.89	39.2	109%
9	3.83	19.9	28.38	38.5	74%
10	1.21	16.0	25.01	121.5	21%
MEAN	**3.57**		**16.96***		**59%**

* NOTE: These are geometric means. To calculate a geometric mean, values in the array must be >0. For the purpose of the calculation, any zero (0) values were assumed to be 0.1

APPENDIX 12. BC Hydro Bridge Coastal Fish and Wildlife Restoration Program Financial Statement (for work done upstream of the diversion dam).

Project # 04.Ca.05

Financial Statement Form

	BUDGET		ACTUAL	
	BCRP	Other	BCRP	Other
INCOME				
Total Income by Source	21,363.00	1,900.00	21,200.49	1,900.00
Grand Total Income (BCRP + other)		23,263.78		23,100.49
EXPENSES				
Project Personnel				
Wages	11,317.18	1,800.00	12,434.33	1,800.00
Consultant Fees				
(List others as required)				
Materials & Equipment				
Equipment Rental	950.00		2,866.60	
Materials Purchased	2,452.00		1,161.86	
Travel Expenses	1,800.00		1,264.40	
Permits				
(List others as required)				
Communications			195.74	
Lab Costs	2,484.00		774.80	
Shipping	270.00		425.36	
GST			137.49	
Administration				
Office Supplies	200.00			
Photocopies & printing			12.59	
Postage		100.00		100.00
(List others as required)				
BCCF admin @ 10%	1,890.60		1,927.32	
Total Expenses	21,363.78	1,900.00	21,200.48	1,900.00
Grand Total Expenses (BCRP + other)		23,263.78		23,100.48
BALANCE (Grand Total Income – Grand Total Expenses)	*The budget balance should equal $0*	0.00	*The actual balance might not equal $0**	0.00

* Any unspent BCRP financial contribution to be returned to: BC Hydro, BCRP
6911 Southpoint Drive (E14)
Burnaby, B.C. V3N 4X8
ATTENTION: JANICE DOANE

APPENDIX 13. BC Hydro Bridge Coastal Fish and Wildlife Restoration Program Performance Measures.

Project # 04.Ca.05

Performance Measures

Using the performance measures applicable to your project, please indicate the amount of habitat actually restored/enhanced for each of the specified areas (e.g. riparian, tributary, mainstream).

Performance Measures – Target Outcomes

Project Type	Primary Habitat Benefit Targeted of Project (m^2)	Primary Target Species	Habitat (m^2)									
			Estuarine	In-Stream Habitat – Mainstream	In-stream Habitat – Tributary	Riparian	Reservoir Shoreline Complexes	Riverine	Lowland Deciduous	Lowland Coniferous	Upland	Wetland
Impact Mitigation												
Fish passage technologies	Area of habitat made available to target species											
Drawdown zone revegetation/stabilization	Area turned into productive habitat											
Wildlife migration improvement	Area of habitat made available to target species											
Prevention of drowning of nests, nestlings	Area of wetland habitat created outside expected flood level (1:10 year)											
Habitat Conservation												
Habitat conserved – general	Functional habitat conserved/replaced through acquisition and mgmt											
	Functional habitat conserved by other measures (e.g. riprapping)	ST, CO, CT, DV		23	10	*Habitat restoration by stream enrichment (km habitat enhanced)*						
Designated rare/special habitat	Rare/special habitat protected											
Maintain or Restore Habitat forming process												
Artificial gravel recruitment	Area of stream habitat improved by gravel plmt.											
Artificial wood debris recruitment	Area of stream habitat improved by LWD plcmt											
Small-scale complexing in existing habitats	Area increase in functional habitat through complexing											
Prescribed burns or other upland habitat enhancement for wildlife	Functional area of habitat improved											
Habitat Development												
New Habitat created	Functional area created											