

**ASH RIVER NUTRIENT ENRICHMENT
FOR FISH HABITAT RESTORATION
2006**

prepared by

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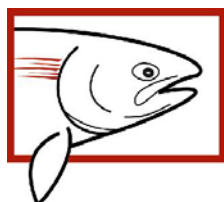
For

Hupacasath First Nation
Port Alberni, BC

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GREATER GEORGIA BASIN
STEELHEAD Recovery Plan
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EXECUTIVE SUMMARY

In 2006, pollock fertilizer additions and salmon carcass plants in the Ash River provided remediation for reduced biological productivity stemming from Elsie Lake Dam and the Ash Hydro Project. Acting as a nutrient sink, the reservoir and diversion have reduced low level nutrients (i.e., orthophosphate and nitrogen) in the Ash River downstream and decreased primary production (BC Hydro 2000). With the addition of fertilizer to affected reaches, increased biological productivity resulted in larger steelhead fry and lead to higher over-winter survival and smolt production. Carcass additions provided both nutrients and a direct source of food to juveniles prior to winter when food becomes scarce.

On June 20 and 22, 2006, technicians installed 1,800 kg of Alaskan pollock bone meal at two sites between Elsie and Dickson lakes. Between October 20 and 23, 2006, 320 chinook carcasses were transported from Robertson Creek Hatchery and distributed at three sites in the same reach.

Staff conducted water quality and flow/temperature monitoring throughout the pollock treatment period. Water chemistry data was collected monthly from four sampling locations in the treatment reach. No adverse changes in water chemistry were documented.

Changes in algal growth were monitored using periphyton collectors. Periphyton accrual was quantified by analyzing chlorophyll *a* concentrations on foam core samples taken from collectors. The effective distance of each application was estimated to be 3.5 km.

Juvenile fish sampling occurred August 13th and September 25th, 2006, to evaluate treatment efficacy. Steelhead fry from treated areas were significantly heavier than those from control areas both days (95% C.I.). Fry in the treated reach were 81% heavier on August 13 and 112% heavier by September 25.

Fisheries staff from the BC Conservation Foundation (BCCF), BC Conservation Corps (BCCC), Ecofish Research Ltd. and Hupacasath First Nation (HFN) conducted project activities, overseen by Ministry of Environment (MoE) staff.

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1.0 INTRODUCTION

Primary nutrients essential for growth of aquatic organisms (algae, aquatic invertebrates, fish) include carbon (C), nitrogen (N), and phosphorus (P). Typically occurring in a ratio of 40:7:1 by mass (Vallentyne 1974), C and N are relatively common in most ecosystems, but P lacks a gaseous phase and is often limiting biotic production in aquatic habitats (Schindler 1980, Stockner 1987). Gresh et al. (2000) found that as little as 6-7% of the historical input of marine-derived nutrients (particularly P) from spawning salmon is currently available in Pacific Northwest streams.

Studies have shown that dams cause nutrient imbalances that affect ecosystem productivity. By increasing water retention, biogenic reduction of organic matter and sedimentation rates increase, leading to effective P-sinks and reduced habitat productivity (Stockner et al. 2000). In the Arrow Lakes system (Columbia watershed), river-borne nutrients that would normally contribute to productivity are now utilized in upstream impoundments (Mica and Revelstoke dams), with most settling in impoundment sediments (Pieters et al. 2003).

In 1958, a dam was constructed by BC Hydro at the outlet of Elsie Lake in Vancouver Island's Ash River watershed. The dam flooded 401 ha of land, thereby expanding the original 271 ha lake to a 672 ha reservoir (BC Hydro 2000). The Ash River watershed is 378 km² and has a mean annual discharge of 16.7 m³/s, measured at WSC station 08HB023 for the period 1961-2005. Naturalized MAD for the same period is 27.5 m³/s, taking into account that BC Hydro has the ability to divert 10.8 m³/s into Great Central Lake¹. Reservoir storage is diverted by penstock to a generating station on Great Central Lake which has an operating capacity of 25.2 MW. The water licence allows for a maximum of 76.5 million cubic meters of storage and 339 million m³ to be diverted into Great Central Lake per annum (Hirst 1991). Similar to other impoundments, nutrient uptake in the reservoir has likely reduced the transfer of phosphorus and nitrogen downstream (Dr. K. Ashley, Vancouver, BC. pers. comm.).

Ash River water samples collected in 2000 and 2001 showed nutrient concentrations were limiting to primary productivity, confirming the stream as an enrichment candidate (McKusker et al. 2002, Hansen 2003). Three 2001 samples taken between August 8 and October 10 had soluble reactive phosphate concentrations below the method detection limit (i.e., <1 µg/L ortho-phosphorus) and dissolved nitrogen (nitrate+nitrite) concentrations ranging from 4 to 24 µg/L.

Lill (2002) described stream enrichment as an effective technique to help recover depressed steelhead populations in Vancouver Island streams. The addition of organic nutrients and/or salmon carcass redistribution² are recommended as short term strategies to replace losses in marine-derived nutrients during periods of poor salmon returns or where cultural oligotrophication has occurred (impoundment-related nutrient sinks).

In the 1990s, development of slow-release fertilizers was undertaken by Fisheries Research and Development Section, Ministry of Environment (MoE), Vancouver, BC and supervised

¹ Based on the existing water license of 339 million m³ per year which averages to 10.75 m³/s over 365 days.

² Carcass redistribution involves taking post spawn hatchery broodstock and/or carcasses dead-pitched from spawning channels (artificially high abundance) and redistributing them into the upper reaches of the watershed (typically low abundance).

by Dr. Ken Ashley (Mouldey and Ashley 1996, Mouldey et al. 1998, 1998a). In 2001, the Ash River was treated with slow release inorganic fertilizer briquettes called “Nutri-Stones™”, manufactured by Lesco, Inc. of Ohio. The product was applied late due to shipment delays and effectiveness monitoring was confounded by high water in August (Hansen 2003).

Early in 2003, an organic, heat-pasteurized fertilizer product, Alaskan pollock bone meal³, was tested at the MoE Fish Health Lab in Nanaimo and confirmed pathogen free. Testing for other contaminants and metals was also completed and confirmed the product’s suitability for potential stream treatments (Pacific Environmental Science Centre, North Vancouver). From 2003 to 2005, the efficacy of bone meal as a stream fertilizer was documented at the Centennial Research Channels on the Chilliwack River and on select Vancouver Island streams. The logs proved to be good sources of nutrients resulting in improved periphyton biomass and juvenile fish growth. Although effective, pollock logs tended to break down to piles of loose fish meal soon after being placed instream. The product has since been applied as coarse fragmented particles contained in burlap bags.

In 2006, members of the Ash River Restoration Working Group⁴ (ARRWG) met to discuss potential restoration projects on the Ash River. The group decided that organic fertilizer, ideally salmon carcasses, would be preferred over inorganic fertilizers for use in the Ash River. Following recommendations from ARRWG, a stream enrichment proposal utilizing pollock bone meal and salmon carcasses was prepared by BC Conservation Foundation and submitted by Hupacasath First Nation (HFN) to BCRP.

2.0 GOALS AND OBJECTIVES

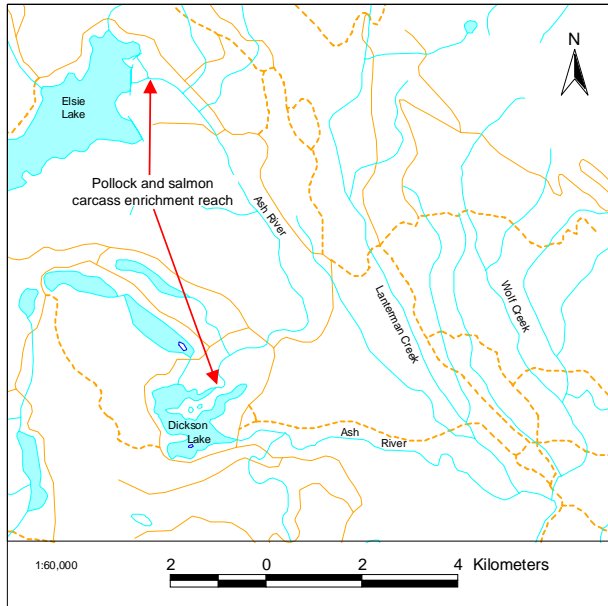
The Ash River Nutrient Enrichment Project was designed to improve the growth and survival of juvenile salmonids, primarily steelhead (*Oncorhynchus mykiss*), through the addition of bone meal and carcasses downstream of Elsie Dam. The objective was to increase the ratio of steelhead smolts generated per spawner, as demonstrated by restoration and monitoring activities on the Keogh River near Port Hardy. Pollock bone meal was applied in the spring as a slow release fertilizer to increase periphyton accrual and invertebrate food supply. Salmon carcasses were applied in the fall to provide a direct food source for juvenile steelhead prior to the onset of winter and to provide additional P in the upper mainstem below Elsie Dam. Limiting factors addressed include reduced biological productivity resulting from dam construction and water diversions. Salmon carcasses and/or pollock bone meal were loaded at a rate intended to increase ortho-phosphate concentrations from <1ug/L to 1-5 ug/L downstream of the treatment sites. Stream flow, water chemistry, periphyton accrual and fish growth monitoring was intended to ensure pollock bone meal loading rates were not excessive and to assess the effectiveness of fertilizer additions. Background details, scientific rationale, and case study examples of stream enrichment are compiled by Ashley & Slaney (1997) and by Kiffney, Bilby, and Sanderson (2005).

³ Imported and supplied by Welcome Harvest Farms, Texada Island, BC.

⁴ Includes representatives of Hupacasath First Nation, Nuu-chah-nulth Tribal Council, Fisheries and Oceans Canada, Ministry of Environment, BC Conservation Foundation, Alberni Valley Enhancement Association, and the West Coast Aquatic Management Board.

3.0 STUDY AREA

The Ash River is one of the main tributaries to the Stamp-Somass River, located near the municipality of Port Alberni. The section of river targeted for nutrient enrichment includes 11 km of mainstem extending from Elsie Lake Dam to Dickson Lake. Though not accessible to most anadromous salmonids due to selective barriers below Dickson Lake, this reach does



support summer run steelhead and resident/adfluvial populations of trout and char. In addition, a few coho fry have been captured above Dickson Falls by electrofishing crews on occasion (M. McCulloch, MoE, Nanaimo, pers. comm.). Kokanee (*O. nerka*) are present in Elsie Lake, and small numbers may also occur in Dickson Lake (C. Wightman, MoE, Nanaimo, pers. comm.). Elsie Lake is a BC Hydro storage reservoir with a penstock diversion to a powerhouse on Great Central Lake. Dickson Lake empties into the lower Ash River which eventually joins the Stamp River 6 km downstream of Great Central Lake.

Figure 1. Nutrient enrichment and salmon carcass distribution reach on the Ash River, 2006.

Burt and Horchik (1999) identified the Ash River as one of the main spawning areas for summer run steelhead in the Somass River watershed. Adult migration occurs between July and October, and the spawning period is January to the end of April. For juvenile steelhead, the growth period extends from April to October, and overwintering occurs between November and March. The majority of steelhead smolts are two years old when they leave the system in April and May (Hansen 2003).

Recent monitoring by BCCF staff has documented a significant presence of summer run steelhead in the reach between Elsie and Dickson lakes. On February 1, 2001, 54 adult steelhead were observed in 1.2 km of the Ash River downstream of Elsie Lake. On January 24, 2002, 18 were observed in the same area. Numerous fresh redds were noted as well (MoE files). WUP related steelhead monitoring in the summer of 2006 indicated a significant presence of adult summer steelhead above Dickson Falls to the base of Elsie Lake Dam (C. Robert, ECODynamic Solutions Inc., pers. comm.)

3.1 Site Locations

Fertilizer application sites were chosen by considering the estimated effective distance of the product and ease of access. Sites were also selected based on known rearing areas to provide the maximum benefit for juvenile salmonids. Two pollock sites were spaced 4 km apart to allow most of the nutrients to be bound up in primary production between treatment

locations (Figure 2). Carcass distribution locations were determined following similar rationale, though access was a greater consideration.

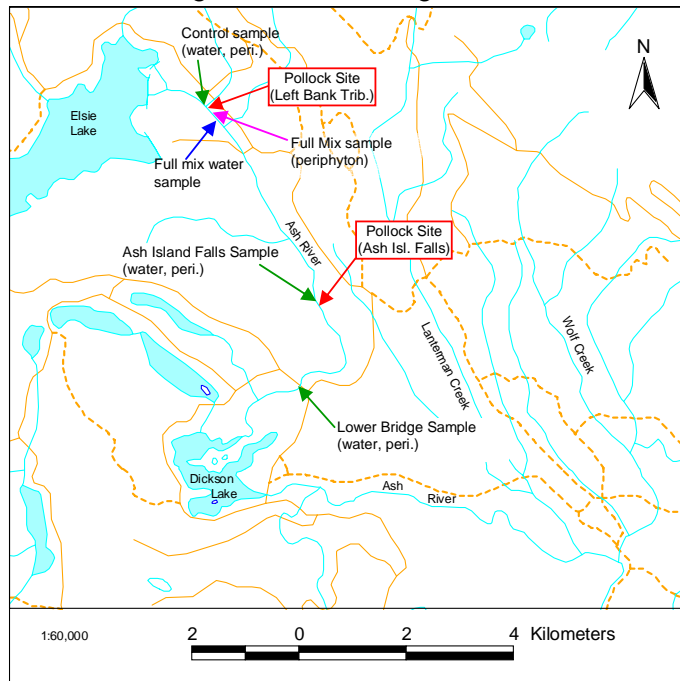


Figure 2. Pollock fertilizer locations on the Ash River including water and periphyton sampling sites.

4.0 MATERIALS AND METHODS

4.1 Fertilizer Application

Loading rates for pollock application were calculated to achieve a target concentration of 2.5 µg/L orthophosphate (PO₄). Pollock bone meal is 7.69% P (17.6% P₂O₅) and estimated to release most of the nutrients over a 90 day period. Equation 1 describes how these parameters were used to calculate the amount of pollock loaded at each site. Calculations assumed a discharge of 3.5 m³/s below Elsie Lake for the treatment period (licensed minimum fish flow release).

Equation 1. Pollock loading rate calculation.

$$\text{Kg pollock needed} = (\text{average flow m}^3/\text{s}) \times (90 \text{ days}) \times (2.5 \text{ } \mu\text{g/L}) / (0.0769 \text{ } \mu\text{gP}) \times (1000\text{L/m}^3) / (1 \times 10^9 \text{ } \mu\text{g/kg}) \times (86,400 \text{ seconds/day})$$

Simplified:

$$\text{Kg pollock per site} = 252.80 \times (\text{average flow m}^3/\text{s})$$

Table 1. Pollock loading rate targets for the treatment reach by site.

Location	Discharge (m ³ /s)	Product	Target (kg)
First left bank tributary downstream of Elsie Dam	3.5	Pollock	885
500 m downstream of Ash Island Falls	3.5	Pollock	885
Total			1,770

Following calculations, fertilizer (pre-bagged in burlap, 10 kg each) was loaded on a pickup truck and trailer (Figure 3). BCCF, BCCC, and First Nations all provided labour during the application (Figure 4a). Bags were anchored with rocks in high flow areas to ensure maximum nutrient leaching and mixing (Figure 4b). Bag placement was clustered to allow for easy removal if necessary. Where possible, site locations were removed from high traffic areas to prevent tampering.

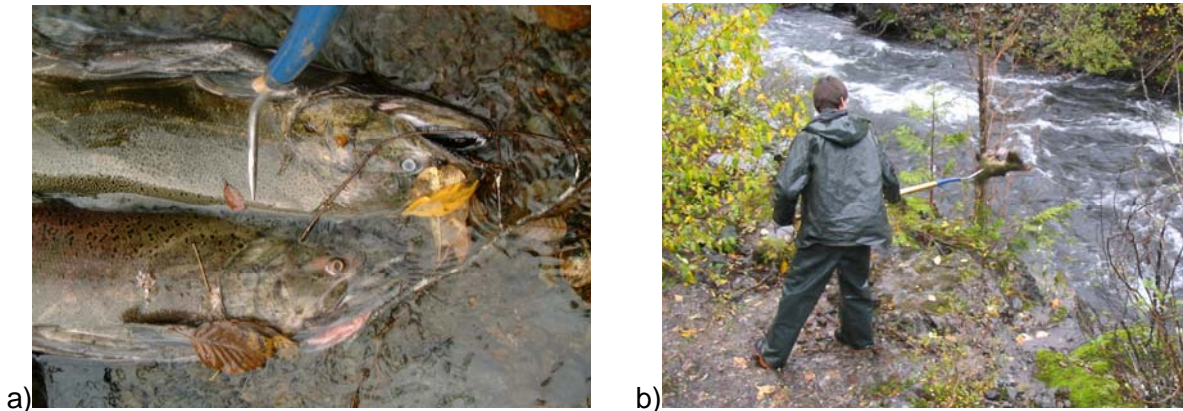
**Figure 3.** Pollock bone meal contained in pre-packaged burlap bags.**Figures 4a and 4b.** Application crew securing pollock filled burlap bags to the bottom of the river using large cobbles.

4.2 Carcass Distribution

A proposal to distribute chinook carcasses was submitted to the DFO Introductions and Transfers Committee prior to carcass plants. Upwards of 1,500 post-spawn chinook and coho salmon from First Nation ESSR allocations at Robertson Creek Hatchery were slated for carcass plants in 2007. The proposal was approved and included:

- Proponent/coordinator contact information;
- Brief rationale;
- Carcass source;
- Carcass planting locations – including a map with sites and access points identified;
- Loading rate – number of carcasses of each species; and,
- Letters/emails indicating support for each project.

In early fall, Robertson Creek Hatchery and HFN staff were contacted by BCCF to confirm carcass availability and develop tentative logistics. Carcasses were collected and loaded into insulated fish totes by staff at Robertson Creek prior to distribution. Totes were trucked to distribution sites where carcasses were pitched into the river by HFN and BCCF staff using peugh sticks (Figure 5a and 5b). Where possible, carcasses were placed in woody debris or in deep pools in order to increase retention.



Figures 5a and 5b. a) Chinook salmon carcasses placed in the Ash River. b) Distributing salmon carcass using a peugh stick.

4.3 Water Temperatures and Flow Monitoring

Technicians used hand-held alcohol thermometers to measure water temperature at sampling sites. Stream discharge was measured using a Swiffer® velocity meter (model 2100) and a 50 m fibreglass surveyors tape. Stream transect locations were flagged to ensure data would be consistent. A minimum of 15 stations were measured on each transect. Temperature and flows were monitored periodically during the treatment period. Due to the regulated releases from Elsie Dam, flow monitoring was less intensive than for other enrichment programs on Vancouver Island. Data were used to decide if in season loading rate adjustments were necessary, and assist loading rate calculations in future treatments.

4.4 Water Sampling

Water samples were collected four times during the treatment period. Sites were selected upstream (control: 1 site) and downstream (full mix/dilution: 3 sites) of treatments to monitor changes in low level nutrient concentrations. Samples were collected in duplicate using 250 ml plastic bottles provided by the Pacific Environmental Science Center (PESC) in Burnaby, BC. Bottles were rinsed three times with stream water in the field before being filled. Samples were packed with ice in a cooler and shipped same day by courier to a lab for analysis within 24 hours. Maxxam Analytics Inc. received samples until August, at which point water samples were re-directed to PESC. Water quality parameters measured including detection limits are presented below in Table 2.

Table 2. Water chemistry parameters tested including associated units and detection limits.

Water Chemistry Test	Units	Method Detection Limit (MDL)
ALKALINITY		
Total, (CaCO ₃)	mg/L or ppm	0.5
NITROGEN		
Ammonia (N)	mg/L or ppm	0.005
Nitrate + Nitrite (N)	mg/L or ppm	0.002
PHOSPHORUS		
Orthophosphate (PO ₄)	mg/L or ppm	0.001
Dissolved Phosphorus (P)	mg/L or ppm	0.002
Total Phosphorus (P)	mg/L or ppm	0.002

4.5 Periphyton Sampling

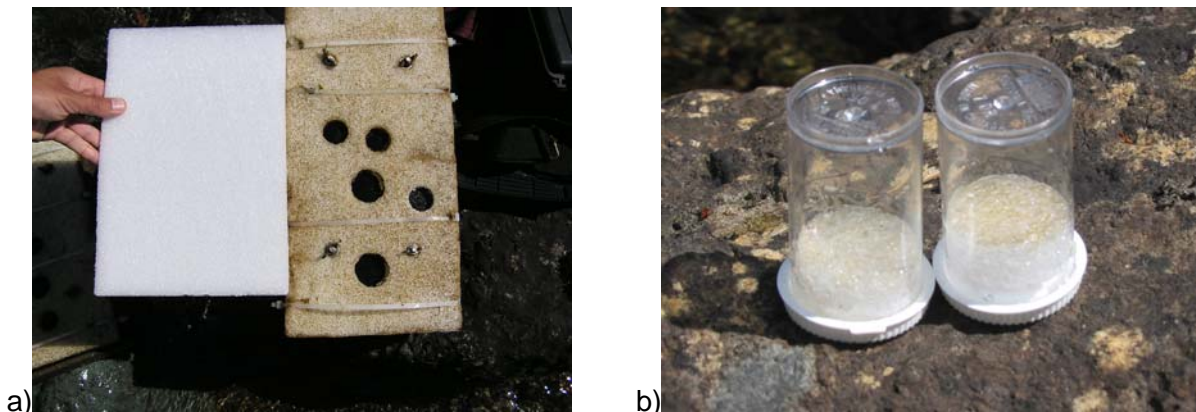
Periphyton growth was quantified by measuring chlorophyll *a* concentrations on core samples taken from collector plates. Plates consist of a sheet of white florist's foam, 1.25 cm thick, attached to Plexiglas plates with electrical ties. Plates were bolted to concrete blocks and placed in the stream, 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. Sites were selected so as to have similar solar exposure, water depth, and water velocity.

Collectors were installed on June 20 and 22, 2006 in pairs at each site. The control site was located 200 m upstream of the first left bank tributary downstream of Elsie Lake. Site two (full mix) was located 100 m below the upper pollock treatment, while site three (dilution) was immediately above the lower pollock treatment. A fourth site (dilution) was located at the Ash Mainline bridge pool before the river empties into Dickson Lake (Table 3).

Table 3. Description of water and periphyton sampling locations on the Ash River, 2006.

Site	Water	Periphyton	Description
Control	X	X	0.3 km upstream of the first left bank tributary confluence downstream of Elsie Lake Dam
Full Mix	X	X	50 m below fertilizer at first left bank tributary confluence 500 m downstream of the first left bank tributary confluence
Ash Island Falls	X	X	750 m downstream of the falls but 150 m above the fertilization site
Lower Bridge	X	X	Pool below the Ash Mainline bridge

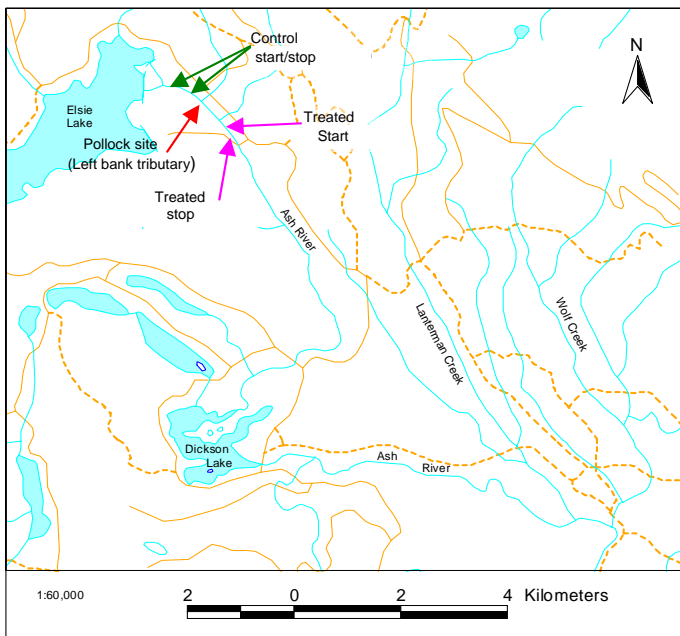
Using a 7 dram plastic vial, two cores of foam (each 2.7 cm in diameter, 5.73 cm² in surface area) were punched (Figure 6a), one from each of the two periphyton blocks (Mouldy Ewing et al. 1998). Each sample was drained and placed in the vial (Figure 6b). The vial was vented with holes through the cap to allow the sample to dry. Samples were placed in a sealed, light-proof container, kept cool with ice and frozen as soon as possible. Periphyton cores were taken every two weeks starting on July 4 and ending on September 10. At the end of the sampling period, all samples were shipped frozen, in a cooler with dry ice, to Maxxam Analytics. Chlorophyll a concentrations were measured in units of µg/cm² by laboratory staff.



Figures 6a and 6b. a) Periphyton collector plate after 54 days vs. a clean sheet of foam. b) Core samples in vials taken from collector plates.

4.6 Juvenile Fish Sampling

Juvenile fish were captured using an electrofisher (Smith-Root model LR-24). In 2005, two control and two treated sites were chosen to monitor stock abundance in general and to assess effectiveness of fertilizer treatments. To improve efficiency in 2006, spot shocking in the control and treated reaches was conducted in place of closed-site electrofishing in 2006



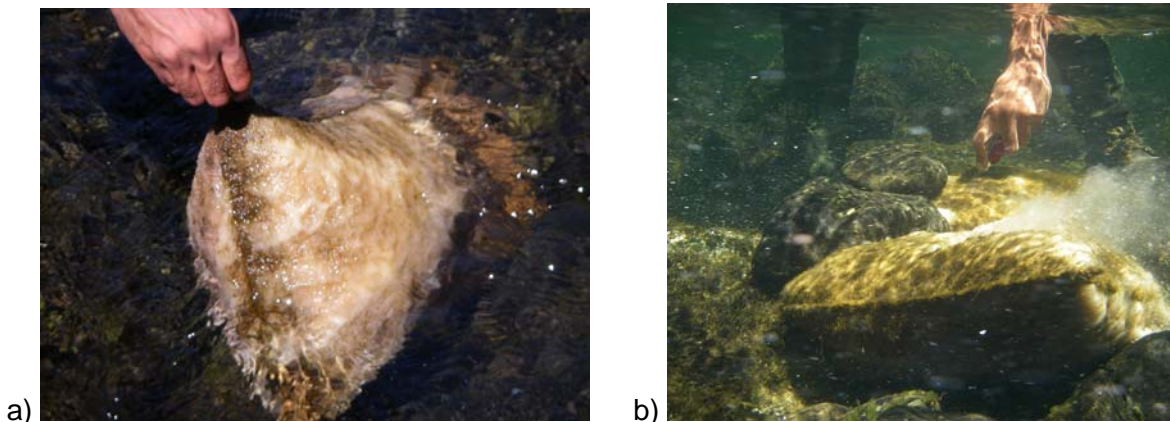
(Figure 7). At least 30 fish in each sample area were briefly anaesthetized using a dilute solution of clove oil and ethanol. Lengths and weights were recorded for all fish captured using measuring boards and an Ohaus top loading scale (model CS 200, accurate to 0.1 g). Consistent with recommendations from 2005, sampling was scheduled prior to and well after pulse flows to avoid displacing juveniles from the control reach.

Figure 7. Juvenile electrofishing sites sampled using closed site and spot shocking techniques.

5.0 RESULTS

5.1 Fertilizer Application

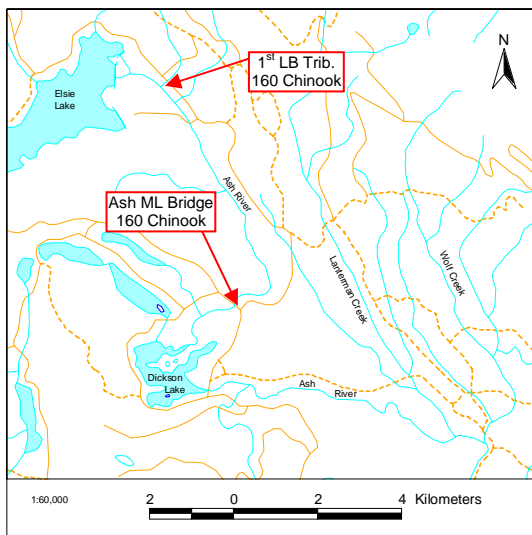
On June 20 and 22, 2006, a total of 1,800 kg of pollock bone meal was evenly split between two sites on the Ash River between Elsie and Dickson lakes (Figure 2). No loading rate adjustments were required with the regulated discharge from Elsie Dam, and as fungal caps formed on their exterior, pollock bags were sliced open during each monitoring visit to expose fresh product (Figures 8a and 8b).



Figures 8a and 8b. a) Pollock bag covered with fungal cap. b) Cutting pollock bags after several weeks to improve nutrient release.

5.2 Carcass Distribution

On October 20 and 23, 2006, a total of 320 chinook salmon carcasses were collected from Robertson Creek Hatchery and split evenly between two locations between Elsie and Dickson lakes (Figure 9). Plants occurred 1 km downstream of the Elsie Lake Dam and at the Ash Mainline bridge above Dickson Lake.



The total weight of the carcasses was estimated to be 2,720 kg based on an average of 8.5 kg for chinook. Carcass availability was reduced from last season when 699 were re-distributed. Surplus coho were not available as the run was much lower than anticipated.

Figure 9. Salmon carcass distribution sites on the upper Ash River, 2006.

5.3 Water Sampling

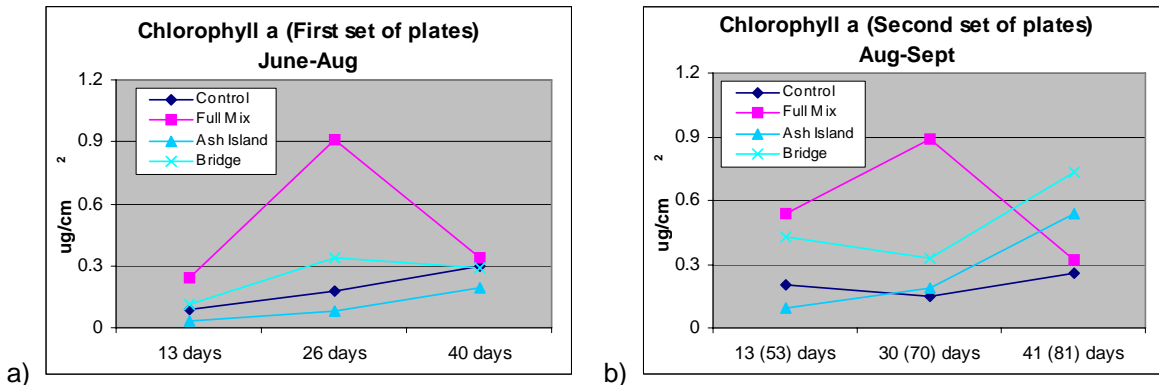
Water chemistry results from the Pacific Environmental Science Centre (PESC) in Burnaby showed orthophosphate concentrations that were consistently low. Pre-enrichment water chemistry (2001) indicated undetectable concentrations of orthophosphate (<0.001 mg/L). All samples in 2006 indicated orthophosphate levels of 0.001 or less with the exception of Ash Island Falls on July 17. Total phosphorous (which includes orthophosphate) in the same sample was less, suggesting this measurement may not be valid. Nitrate and nitrite levels decreased to very low levels following the first water sample. No major changes in the total phosphorous concentration were observed (Table 4).

Table 4. Water chemistry data for Ash River, 2006.

Date	Location	Parameters (mg/L)		
		Orthophosphate	Nitrate + Nitrite	Total Phosphorus
17-Jul-06	Control	<0.001	0.015	0.004
17-Jul-06	1.5 km d/s Elsie Dam	<0.001	0.014	0.006
17-Jul-06	Ash Island Falls	0.005	0.013	0.004
17-Jul-06	Bridge	<0.001	0.011	0.003
13-Aug-06	Control	0.001	0.003	<0.002
13-Aug-06	1.5 km d/s Elsie Dam	0.001	0.003	0.002
13-Aug-06	Ash Island Falls	0.001	0.003	<0.002
13-Aug-06	Lower bridge	0.001	<0.002	0.002
10-Sep-06	Control	<0.001	0.003	<0.002
10-Sep-06	1.5 km d/s Elsie Dam	<0.001	0.005	0.003
10-Sep-06	Ash Island Falls	<0.001	<0.002	0.002
10-Sep-06	Bridge	<0.001	<0.002	0.003

5.5 Periphyton Monitoring

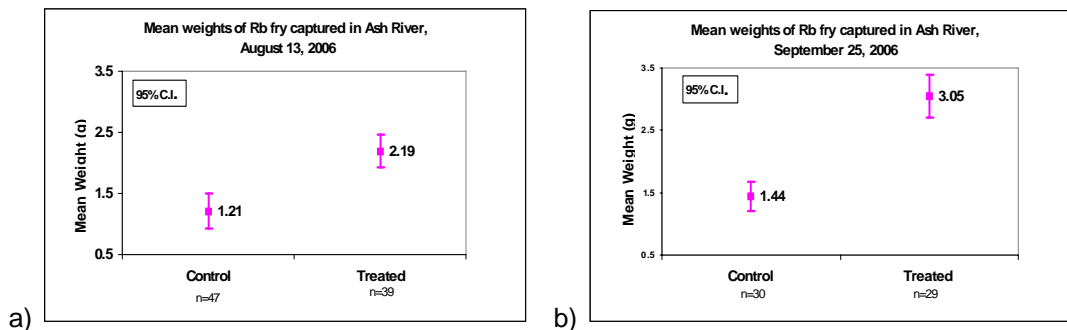
Periphyton core samples were collected six times over an 81 day period from each of the four sites. On July 31, the foam was replaced, as the initial algal growth was starting to die off. Chlorophyll *a* concentrations sampled bi-weekly showed strong growth at the full mix site and Ash Mainline bridge, located 300 m and 650 m downstream of the fertilizer application sites respectively (Figures 10a and 10b). The Ash Island Falls collector, located approximately 4.7 km downstream of the upper treatment site, had growth that was similar to the control. Substrates at the Ash River mainline bridge, located 750 m downstream of the lower treatment site, showed slightly improved growth. At the end of the treatment period algal growth began to slow significantly as indicated by the decrease in chlorophyll *a* at the full mix site (Figure 10 b)



Figures 10a and 10b. Chlorophyll *a* concentrations from periphyton collector plates in the Ash River, 2006.

5.6 Juvenile Fish Sampling

Results indicate that, on average, weights from fish sampled in fertilized areas were significantly larger than those of fish from a control reach (95% C.I.). At the end of the 2006 growing season, a difference of 1.61 g or 112% was documented between mean weights of control and treatment samples. Mean weights differed by 0.96 g in 2005 and were not statistically significant (95% CI). Sampling in 2005 was conducted immediately following a 20 m³/s pulse flow that may have pushed fry from the control reach into the treated reach. In 2006, sampling was conducted on August 13 prior to pulse flows and showed a mean difference in growth of 0.98 g, with fish in the treated sample 81% larger than those in the control (Figure 11 a). To monitor the full effect of the enrichment program, a second sampling was completed on September 25, 2006 and showed a mean difference of 112% (Figure 11 b). This sample occurred well after the August 15 pulse of 20 m³/s and before the September 30 pulse of 10 m³/s. Both samples showed a statistically significant difference in mean weights between control and treated sites.



Figures 11a and 11b. Mean weights of Ash River rainbow trout fry collected from control and treatment reaches on a) August 13, 2006 and b) September 25, 2006.

6.0 DISCUSSION AND RECOMMENDATIONS

Nitrogen concentrations decreased noticeably through the treatment period from 10-15 mg/l (one month after application) to 1-5 mg/l (two and three months after application). In most other enriched streams nitrogen levels are typically 25-50 mg/l (Pellett and Wright 2005). These low nitrogen levels may be a result of the impoundment structure located at Elsie Lake. Though dissolved inorganic nitrogen concentrations less than 20 mg/l may be a limiting factor in streams (Bothwell 1988), this project's fish sampling results indicate the treatment had significant benefits.

Orthophosphate concentrations in water samples were low as expected with the exception of the July sample from Ash Island Falls. This sample's orthophosphate concentration of 0.005 mg/l was higher than the total phosphate concentration of 0.004 mg/l. Orthophosphate, a component of total phosphate, should not be higher, suggesting this result is invalid.

Results from fish sampling in control and treated reaches indicate a significant growth increase for fish in fertilized areas. It is likely this increase occurred in 2005 but

complications with pulse flows likely confounded results. It is recommended sampling occur prior to pulse flows as in 2006.

In order to increase the stream length of the lower treatment, a potential fertilization site will be looked at approximately 2 km upstream of Ash Island Falls. Access permitting, the result will be more kilometres of treated steelhead rearing area with a smaller distance between fertilization sites.

Due to the low availability of salmon carcasses from Robertson Creek Hatchery, the carcass redistribution program was smaller than in 2005. Monitoring was scheduled for November 15, but due to significant rainfall and storm event, the conditions did not permit such activities. It is hoped there will be a stronger salmon return in 2007 and that monitoring can occur prior to fall rains.

7.0 ACKNOWLEDGEMENTS

BC Hydro through their Bridge Coastal Fish and Wildlife Restoration Program provided project funding. The ARRWG made recommendations and provided a letter of support which accompanied the proposal to BCRP. Adam Lewis of Ecofish Research Ltd. coordinated the proposal delivery. HFN and BCCF co-administered project funding. The ESSR program contributed carcasses from Robertson Creek Hatchery, and hatchery staff assisted with salmon carcass collection and co-ordinated distribution days. Loreta Hansen (BCCF) conducted the periphyton and water sampling.

8.0 REFERENCES

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APPENDIX I
Financial Statement

Financial Statement Form

INCOME	BUDGET		ACTUAL	
	BCRP	Other	BCRP	Other
<i>Total Income by Source</i>	20,443.00	8,765.00	20,443.00	8,765.00
Grand Total Income (BCRP + other)				
EXPENSES				
<i>Project Personnel</i>				
Wages (BCCF)	6,890.00		7,982.78	
(HFN)	3,710.00		2,385.00	
MoE Biologists/Vol		1,265.00		1,265.00
Per Diem	187.00		121.50	
Materials and Equipment				
Equipment Rental				
Materials Purchased				
Travel Expenses			225.40	
Vehicle Lease	975.00		551.26	
Fuel	900.00		89.47	
Permits				
Fertilizer	3,773.00		4,320.00	
Salmon Carcasses		7,500.00		1,600.00
Sign Development				
Communications				
Lab Costs	1,800.00		1,308.00	
Shipping	350.00		158.63	
GST			46.76	
Administration				
Office Supplies				
Photocopies and printing				
Postage				
Admininstration (10%)	1,858.00		1,858.00	
<i>Total Expenses</i>	20,443.00	8,765.00	19,046.80	2,865.00
Grand Total Expenses (BCRP+other)	29,208.00		21,911.80	
BALANCE (Grand Total Income -Grand Total Expenses)	0.00		1,396.20	

APPENDIX II
Performance Measures

Performance Measures - Actual Outcomes			Project# 05.Ash.02											
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,CT,DV		9.5	<i>Habitat Restoration by stream enrichment (km habitat enhanced downstream of the Elsie Lake dam)</i>									
Designated rare/special habitat	Rare/special habitat protected													
Maintain or Restore Habitat forming process														
Artificial gravel recruitment	Area of stream habitat improved by gravel plcmt													
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													

APPENDIX III
Confirmation of BCRP Recognition



In the late fall of 2006 an interpretative signboard was installed at the Robertson Creek hatchery. The sign provides background and describes nutrient enrichment activities in the Ash watershed as well as other tools used in river restoration. BC Hydro is acknowledged for their financial support of restoration activities in the watershed through their Bridge Coastal Restoration Program.

