Effectiveness Monitoring of Fish Habitat Restoration/Enhancement Projects on Vancouver Island (2003-04)

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GREATER GEORGIA BASIN
STEELHEAD Recovery Plan
www.SteelheadRecoveryPlan.ca

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1.0 INTRODUCTION

In 1998, provincial fisheries staff drafted a recovery plan for east coast Vancouver Island (ECVI) steelhead trout in response to significant declines in wild and hatchery stocks since the early 1990's. Public consultation through "Steelhead Workshops" prioritized key factors limiting steelhead stocks, and/or government's ability to effectively conserve the resource (Wightman et al. 1998). From this, numerous concepts were adopted as the "cornerstones" for the Recovery Plan, including aggressive habitat restoration projects designed to increase wild steelhead smolt yields in priority watersheds where adult returns had declined.

In 2002, the Pacific Salmon Foundation (PSF) and the Province of BC released the Greater Georgia Basin Steelhead Recovery Action Plan. The primary objective of the Plan is "to stabilize and restore wild steelhead stocks on the east coast of Vancouver Island, adjacent mainland inlets, and the lower Fraser River" (Lill 2002). The Plan states that "recent advances in research and development have shown that a combination of habitat restoration and stream enrichment can increase freshwater productivity sufficiently to reverse declines in steelhead abundance." Further, Slaney and Zaldokas (1997) state that "project effectiveness evaluations are essential for improving fish habitat restoration work and to demonstrate program effectiveness or wise spending in the long term."

With support from the Ministry of Water, Land and Air Protection (MWLAP), the Habitat Conservation Trust Fund (HCTF) and other partnerships, the British Columbia Conservation Foundation (BCCF) has completed numerous habitat restoration and enhancement projects on Vancouver Island since 2000 (Figure 1).

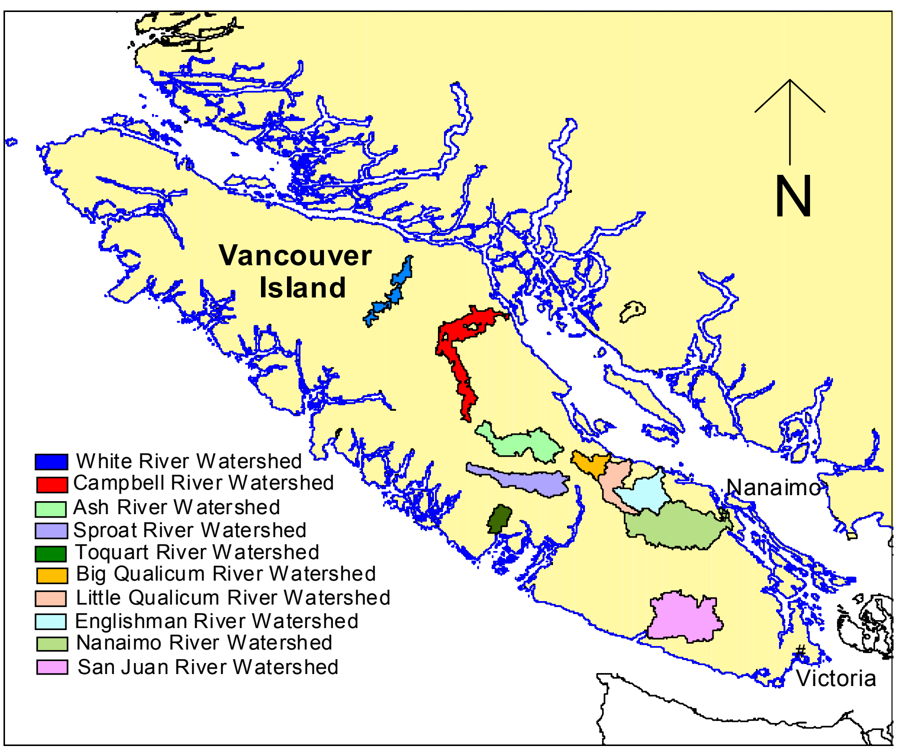


Figure 1. Vancouver Island watersheds with BCCF habitat restoration/enhancement works monitored in 2003-04.

To determine the success of previous works and to improve the effectiveness of future restoration/enhancement projects, BCCF conducted effectiveness evaluations on a majority of projects completed since 2000, including:

- Big Qualicum River riffle enhancements (2000);
- Little Qualicum River LWD and boulder riffle enhancement (2002 and 2003);
- Englishman River LWD and boulder riffle enhancement (2003);
- Sproat Lake outlet spawning gravel placement (2002);
- Toquart Lake outlet spawning gravel placement (2002);
- Stewart Lake outlet spawning gravel placement (2002);
- Elk Falls Canyon (Campbell River) spawning gravel placement (2002);
- Lens Creek (San Juan watershed) side-channel spawning gravel placement (2002);
- Dickson Lake (Ash River) outlet spawning gravel placement (2003);
- Second Lake (Nanaimo River) outlet spawning gravel placement (2003);
- South Nanaimo River spawning gravel placement (2003); and,
- San Juan watershed nutrient enrichment (2003).

1.1 Background Information

Background material presented in this section has been summarized from individual project reports. Additional project details can be obtained from BCCF or its steelhead website (www.steelheadrecoveryplan.ca).

1.2 Fish Habitat Restoration

1.2.1 Big Qualicum River Riffle Enhancements

The Big Qualicum River, located approximately 45 km northwest of Nanaimo, flows northeast for 10 km from Horne Lake to the Strait of Georgia (Figure 1). The river supports runs of coho, chinook, chum and pink salmon, as well as resident and anadromous cutthroat, rainbow and steelhead trout.

In late July and early August 2000, BCCF constructed nine boulder riffle structures between 3.5 and 9 km upstream of the river mouth (Figure 2) to improve rearing habitat for juvenile steelhead trout. The lower eight sites used riffle-crest construction and the strategic placement

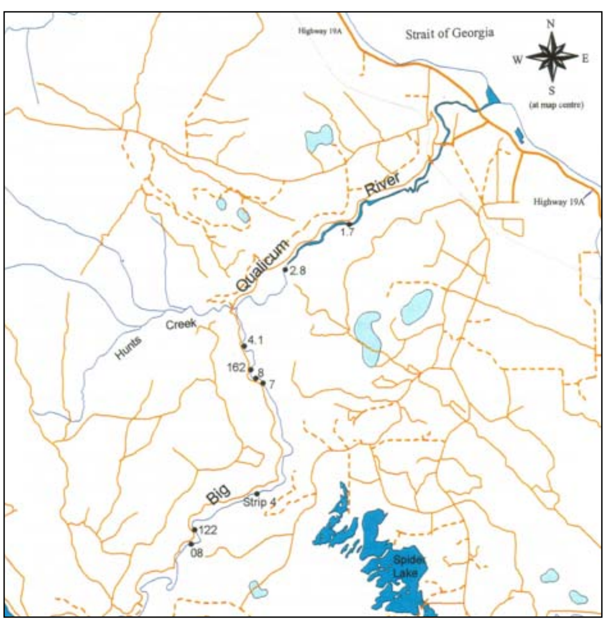


Figure 2. Location of constructed boulder riffle sites on the Big Qualicum River, 2000.

of boulders on the riffle faces to create "pocket water" suitable for rearing rainbow trout fry and parr (McCulloch 2001). One site contained a backwatered area and three sites incorporated LWD found on site. Monitoring of fish use in the newly created structures was performed in September 2000, with general fish use rated as good in most structures. Colonization appeared to be well underway when monitoring was conducted five weeks after construction had concluded.

1.2.2 Little Qualicum River Fish Habitat Restoration

The Little Qualicum River is located approximately 40 km northwest of Nanaimo on the ECVI (Figure 1). The river supports chinook, chum, coho and pink salmon, as well as Dolly Varden char, rainbow/steelhead, cutthroat and German brown trout.

In 1997, in response to record low snorkel survey counts of winter steelhead, provincial fisheries staff closed the Little Qualicum River and several other ECVI streams to sportfishing. In 2001, with the steelhead stock status still a conservation concern, the Little Qualicum River was one of six key watersheds identified as priorities for in-stream habitat restoration (Craig 2003).

In 2002, BCCF constructed 20 LWD structures and four boulder riffle sites in the mainstem (Figure 3). In 2003, an additional seven mainstem LWD sites and two boulder riffle sites (Figure 4) were built (Craig 2004). Construction occurred from August 7-13, 2002 and from September 4-10, 2003. The prime area of restoration was focused from approximately 1.1 km upstream of the DFO hatchery fence to 400 m downstream of Kinkade Creek confluence.

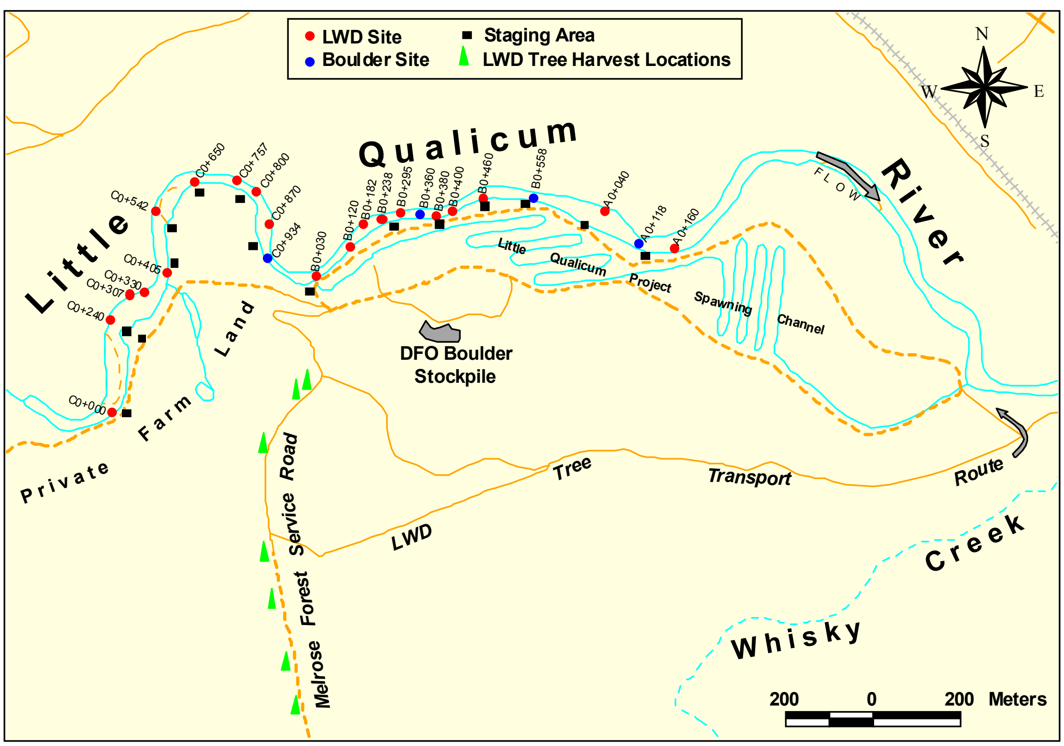


Figure 3. Restoration sites constructed on the Little Qualicum River in 2002.

In the third week of October 2003, a large rain on snow event in the upper watershed resulted in a significant channel avulsion (i.e., bypass or new channel formation) through a farm field immediately above most of the 2003 restoration sites (Craig 2004). An inspection five days after the avulsion event revealed the river had left its historic channel approximately 250 m upstream of the Kinkade Creek confluence, and re-entered 250 m downstream of the confluence. As a result, two of nine sites were isolated from the mainstem and are now located in lower Kinkade Creek (Craig 2004).

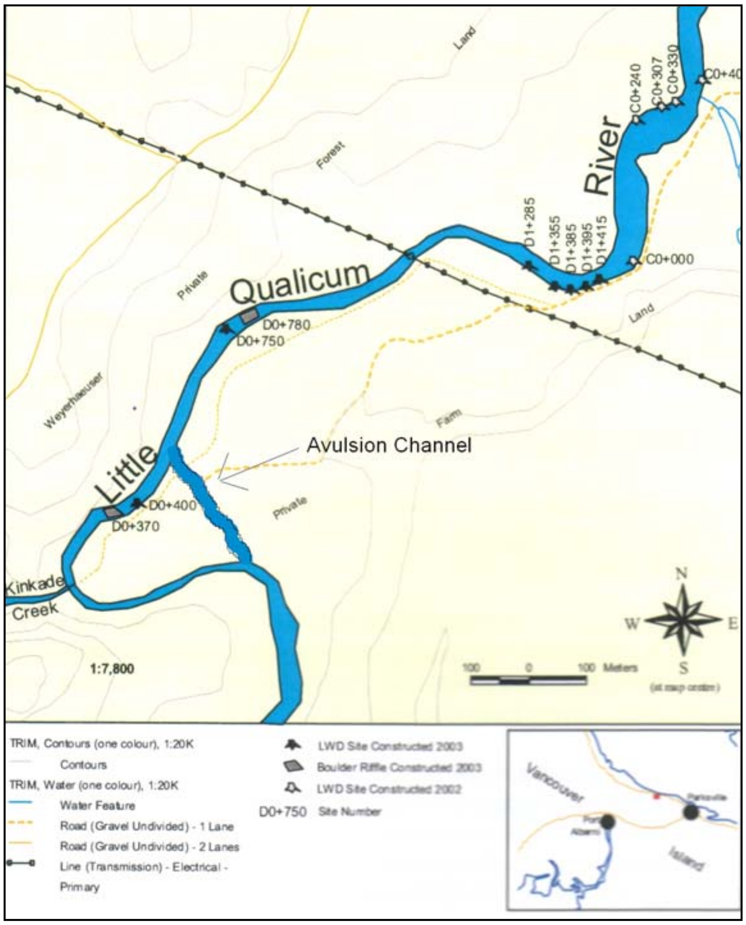


Figure 4. Restoration sites constructed on the Little Qualicum River in 2003.

1.2.3 Englishman River Fish Habitat Restoration

The Englishman River, located near the City of Parksville, is an ECVI stream that supports runs of resident and anadromous cutthroat and rainbow/steelhead trout, as well as all five species of Pacific salmon. The Englishman River has been identified as a "*sensitive stream*" by the province and is continually listed as one of the most threatened watersheds in BC by the Outdoor Recreation Council of British Columbia (McCulloch 2004).

In 2001, the Pacific Salmon Endowment Fund (PSEF) Society selected the Englishman River as the first stream in the Georgia Basin to receive funding for a watershed recovery plan. The plan targeted coho and steelhead for recovery, and projects benefiting these two stocks have been prioritized and implemented since 2002.

In 2002, BCCF was contracted by PSEF to identify and prescribe mainstem restoration sites and to source materials for in-stream construction. In 2003, a total of 15 mainstem habitat structures identified in Fish Habitat Restoration Designs for the Englishman River (Gaboury 2003) were constructed. From July 22 to August 2, 2003, 12 LWD and three boulder-riffle sites were installed between Morison Creek and Allsbrook Canyon (Figure 5).

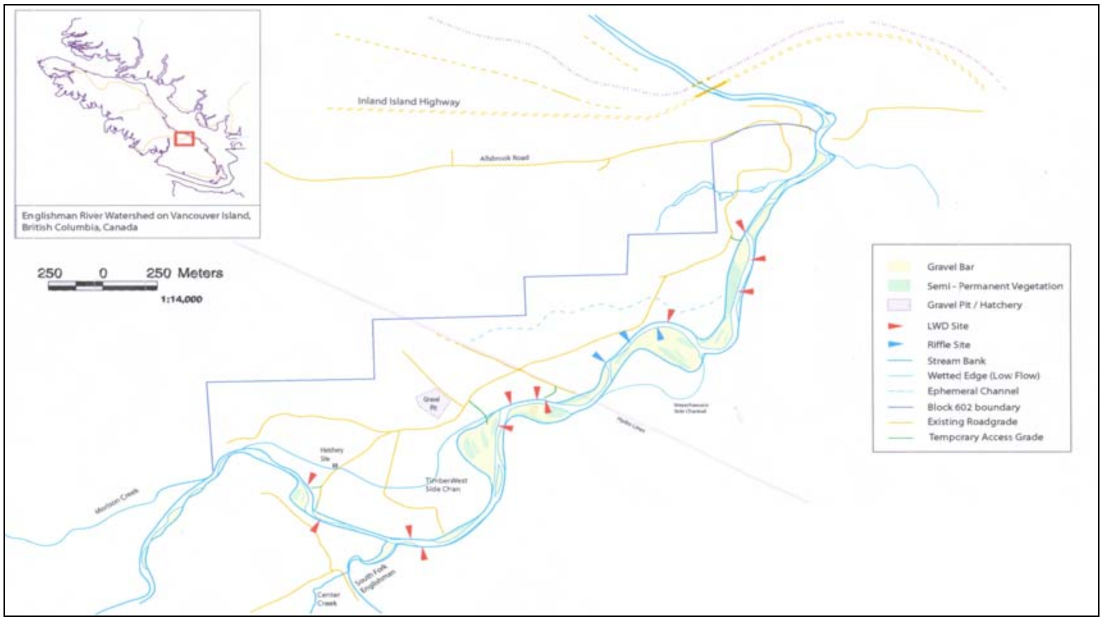


Figure 5. Constructed LWD and boulder riffle sites on the Englishman River, 2003.

1.3 Spawning Gravel Placements

1.3.1 Elk Falls Canyon (Campbell River) Spawning Gravel Placement

The Campbell River flows east from Strathcona Park and enters the Strait of Georgia at the city of Campbell River (Figure 1). The Campbell River supports chinook, chum, coho and pink salmon, as well as rainbow, steelhead and resident and anadromous cutthroat trout. The Campbell River supports both summer and winter steelhead trout, but both stocks are listed in the "extreme conservation concern " zone by Lill (2002).

In 1999, LGL Limited (Sidney, BC) was contracted to heli-place 75 m^3 of spawning gravel in the tailout of the Elk Falls plunge pool (McCulloch 2003a). In 2002, BCCF heli-placed an additional 94 m^3 of spawning gravel in the Elk Falls Canyon, with 31 m^3 in the plunge pool and 63 m^3 in a site 250 m downstream (Figure 6). Post construction monitoring on October 9, 2002 documented a high use of the platforms by chinook and sockeye salmon. During a November 5, 2002 snorkel survey, technicians recorded use of the installed gravel by coho and chinook (McCulloch 2003a).

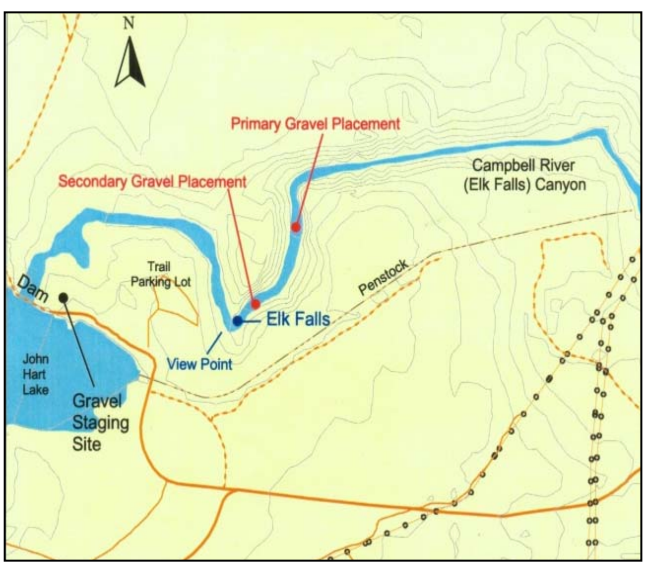


Figure 6. Locations of installed spawning gravel platforms in the Elk Falls Canyon, Campbell River, 2002.

1.3.2 Lens Creek Side-Channel Spawning Gravel Placement

Lens Creek, located on southwest Vancouver Island near the town of Port Renfrew (Figure 1), is the second largest sub-basin in the San Juan watershed and has an anadromous length of 6.1 km. The San Juan supports populations of rainbow, steelhead and cutthroat trout, as well as chinook, chum, coho and pink salmon.

Constructed in two phases (2000 and 2001), the Lens Creek side-channel provides an additional 3.8 km of habitat, including a 7.5 ha wetland. On August 27-28, 2002, 22 m^3 of spawning gravel were placed at five sites in the Lens Creek side-channel (Smith et al. 2003). Gravel was distributed evenly at each site, with depths ranging between 0.15-0.4 m. Sites included:

- 2.5 m^3 – under the footbridge (Phase 1);
- 2.0 m^3 – upstream of the control structure (between Phases 1 and 2);
- 2.0 m^3 – 75 m downstream of the control structure;
- 5.5 m^3 – upper old road grade crossing (Phase 2); and,
- 10.0 m^3 – Phase 2 outlet at the lower old road grade crossing.

1.3.3 South Nanaimo River Spawning Gravel Placement

The South Nanaimo River, the largest tributary of the Nanaimo River, is flow controlled by the City of Nanaimo at the South Fork Dam (Figure 7). This impoundment stores water for the Greater Nanaimo Water District (GNWD) and is used as a secondary source to the primary reservoir at Jump Lake. Water stored behind the dam is also used to maintain annual fisheries flows in the South Nanaimo River. Construction of the South Fork Dam has since prevented natural recruitment of gravel to the reach immediately downstream, leading to a reduction in the amount of usable spawning gravel for salmonids (Smith 2004).

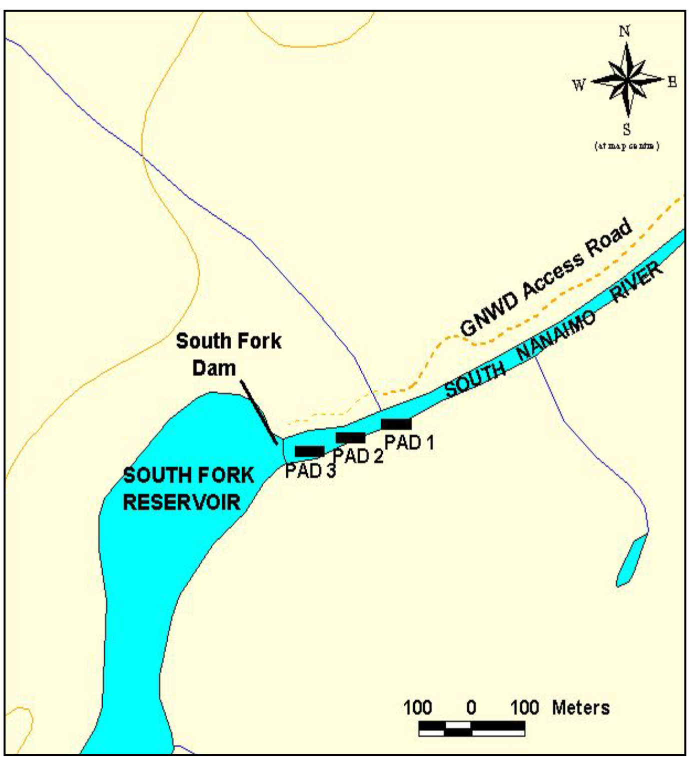


Figure 7. South Nanaimo River spawning gravel placement locations, 2003.

On August 21 and 22, 2003, BCCF installed washed gravel at three locations in a 200 m section immediately downstream of the dam (Figure 7). The project's objectives were to 1) introduce gravel immediately below the dam for natural displacement downstream by the river, and 2) create several spawning areas in proximity to the dam for use by fall salmon and winter steelhead. The spawning area created totaled 425 m^2 and varied in depth from 0.7-1.0 m.

1.3.4 Lake Outlet Spawning Gravel Placements

Over the past several decades, the quality and quantity of spawning gravel in streams on Vancouver Island have generally declined as a result of forestry, mining, agriculture, hydro developments and urbanization (Smith 2004). Increased sediment loads and floods have resulted in spawning areas being in-filled with sand and silts or scoured away during large runoff events. Lake outlets are typically less affected, with lakes acting as sediment traps and buffers against extreme flood events (McCulloch 2003b).

Lake outlets typically provide excellent rearing habitat for juvenile salmonids, due to the stabilizing influences of the lake (Smith 2004). Aquatic invertebrate production is generally good as warmer water and increased nutrients from the lake stimulate periphyton growth.

Between August 10 and September 12, 2002, approximately 374 m^3 of washed spawning gravel were added to the outlets of Sproat (Somass River watershed), Toquart, and Stewart (Salmon River watershed) lakes. Between July 23 and September 19, 2003, 590 m^3 of spawning gravel were added to the outlets of Dickson (Ash River watershed) and Second (Nanaimo River watershed) lakes.

<u>Sproat Lake</u>

The Sproat River is a migration corridor and spawning tributary for chinook, sockeye, and coho salmon, as well as resident and anadromous cutthroat and rainbow/steelhead trout. The river also provides important rearing habitat for all species except sockeye salmon, which rear in Sproat Lake (McCulloch 2003b).

On August 29, 2002, a total of 278 m^3 of washed spawning gravel was placed in the outlet of Sproat Lake (Figure 8). The completed platform covered an area of approximately 400 m^2, with an average depth of 0.7 m.

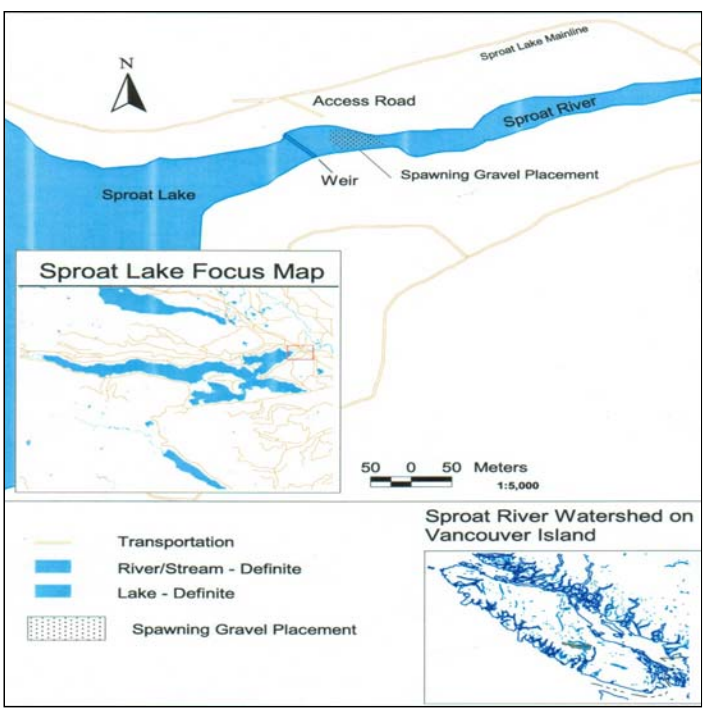


Figure 8. Gravel pad location at the outlet of Sproat Lake (Somass River watershed), 2002.

Toquart Lake

The Toquart River is located 22 km northeast of Ucluelet, on the west coast of Vancouver Island, and contains populations of sockeye, summer and fall coho, chinook, summer and winter steelhead and cutthroat trout (McCulloch 2003b). Natural falls, approximately 1.0 km downstream of Toquart Lake, restricts access to the lake for all anadromous species except summer run coho and steelhead.

Placement of spawning gravel occurred at the outlet of Toquart Lake (Figure 9) by helicopter on September 12, 2002. A total of 40 m^3 of washed gravel was placed over an area of 120 m^2 to depths of 0.1-0.6 m.

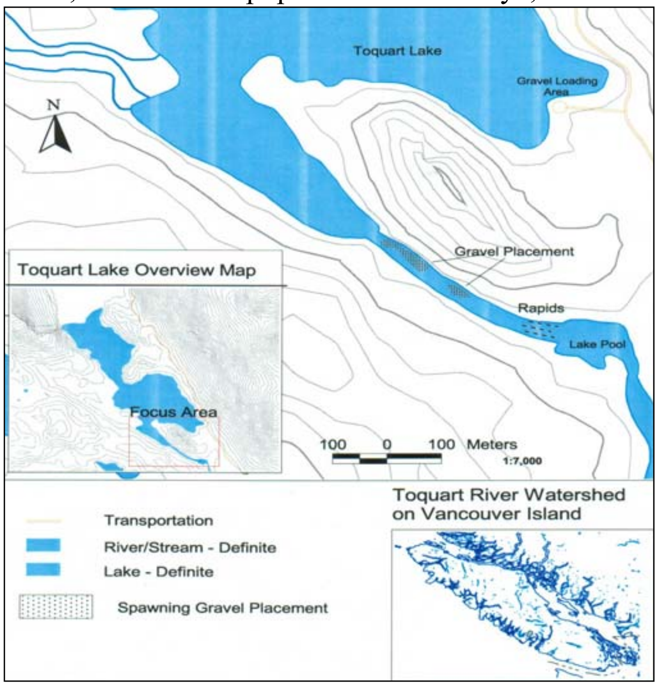


Figure 9. Gravel Pad Locations at the outlet of Toquart Lake, 2002.

Stewart Lake

Stewart Lake is located in the Consort Creek drainage of the upper White River watershed (Salmon River) on the ECVI. The Consort Creek sub-basin supports populations of summer run steelhead and coho, anadromous and resident Dolly Varden char and cutthroat trout, as well as resident rainbow trout (McCulloch 2003b).

On August 10, 2003, 56 m^3 of washed spawning gravel was placed in the outlet of Stewart Lake. The constructed gravel pad measured 140 m^2, with average water depths of 0.4 m over the platform.

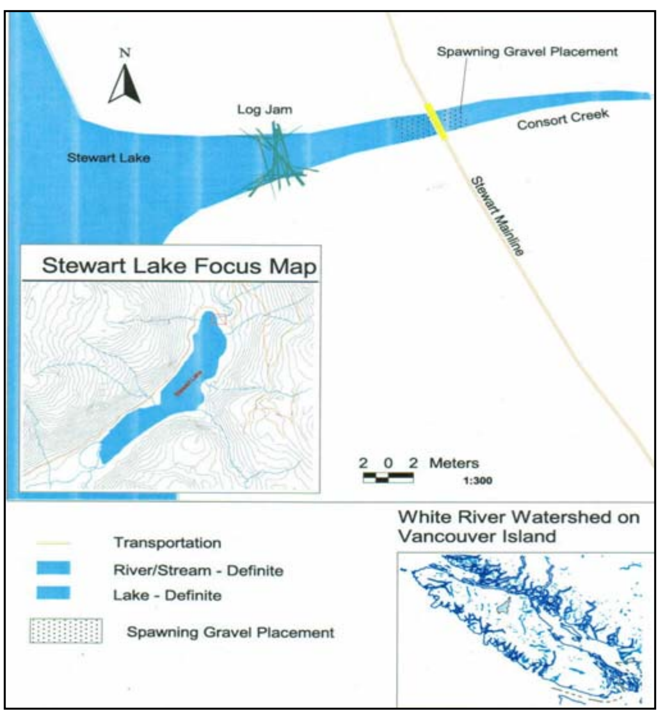
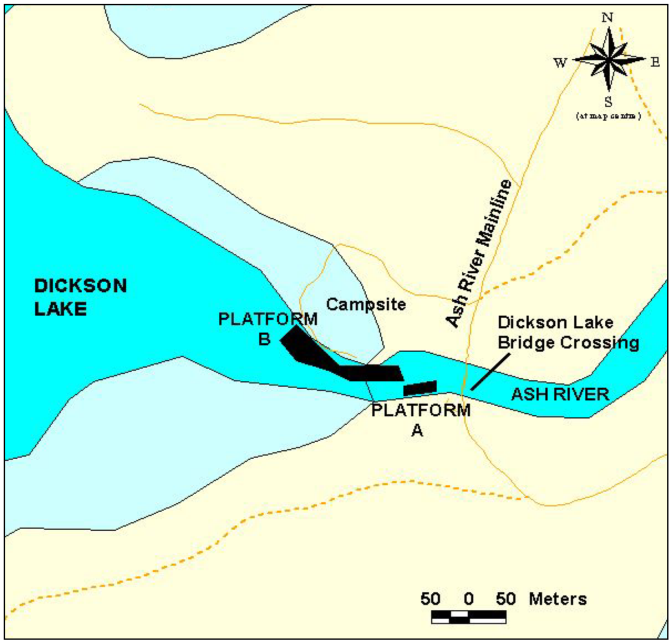


Figure 10. Gravel pad location at the outlet of Stewart Lake, 2002.

Dickson Lake

The Ash River, a sub-basin of the Stamp River watershed, is located 22 km northwest of Port Alberni. The river, above the partial barrier at Dickson Falls (2 km downstream of Dickson Lake), supports a significant run of wild summer steelhead (Smith 2004). Dickson Lake contains resident rainbow and cutthroat trout, as well as Dolly Varden char. In 1990, spawning gravel was placed at the outlet of Dickson Lake (Griffith 1990). In 2001, a new gravel prescription assessment noted the use of this gravel (displaced downstream) by spawning steelhead (MJL Environmental Consultants 2001).

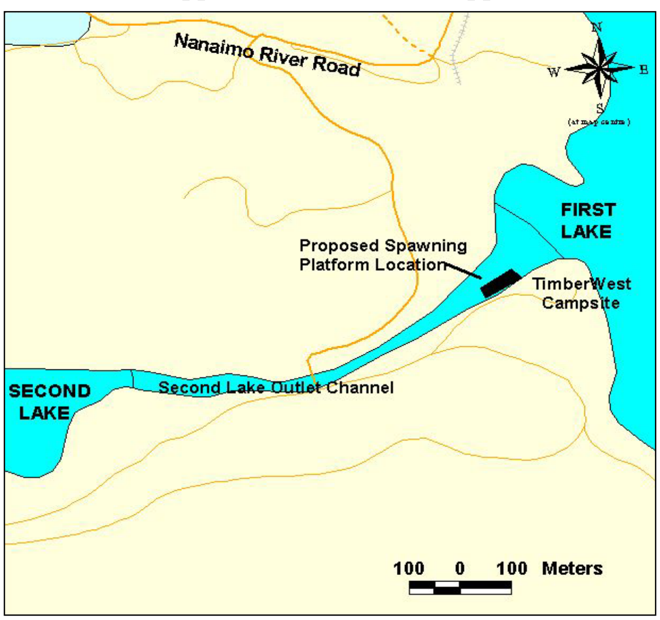


On September 18 and 19, 2003, 400 m^3 of washed spawning gravel were placed in two locations at the outlet of Dickson Lake (Figure 11). Platform A, located along the right bank adjacent to the willow island, received 125 m^3 of material, while platform B, located on left bank, received 275 m^3 of spawning gravel. Gravel pads had depths ranging from 0.6-1.0 m and totaled 665 m^2 in area.

Figure 11. Gravel pad locations at the outlet of Dickson Lake, 2003.

Nanaimo Lakes

Second Lake, in the Nanaimo River watershed, is located 18 km southwest of Nanaimo. This section of the upper Nanaimo River supports chinook, coho and kokanee salmon, as well as winter steelhead, resident cutthroat and rainbow trout and Dolly Varden char.



On July 23, 2003, a total of 150 m^3 of washed spawning gravel was added to the downstream end of the channel between First and Second lakes (Figure 12). The platform had an area of 240 m^2 and depth ranging from 0.6 - 1.0 m.

Figure 12. Gravel pad location between First and Second lakes, 2003.

1.4 Nutrient Enrichment

Watersheds in the Pacific Northwest have seen a precipitous decline in salmon returns over the last half century, due in part to fishing, forestry and urbanization impacts. Recent declines in marine survival have led to further reductions in salmon escapements (McCusker et al. 2002).

The yearly input of salmon carcasses to rivers provides critically important marine-derived nutrients (primarily phosphorous and nitrogen) that are typically limiting in many Vancouver Island streams. This loss of macro-nutrients can have dramatic effects on the growth/survival of juvenile salmonids, particularly stream-rearing species like steelhead and coho. Nutrient enrichment projects completed in a number of BC rivers since the mid 1980s have been successful in increasing growth and biomass of periphyton, invertebrates, and juvenile fish populations (McCusker et al. 2002).

1.4.1 San Juan Nutrient Enrichment

In the spring of 2003 and for a third consecutive year, BCCF and fisheries staff from the Pacheedaht First Nation applied *Nutri-Stone Aquatic Restoration Fertilizer Briquettes*[3] by hand to four San Juan River tributaries (Figure 13) at six sites including:

- Upper Harris Creek near "Big Spruce";
- Harris Creek, 1.4 km downstream of Hemmingsen Creek confluence;
- Hemmingsen Creek, 4 km upstream of Harris Creek
- Renfrew Creek, at hatchery seining pool (0.5 km downstream of anadromous barrier);
- Lens Creek, 0.5 km downstream of anadromous barrier;
- Lens Creek side-channel Phase 1, immediately downstream of footbridge.

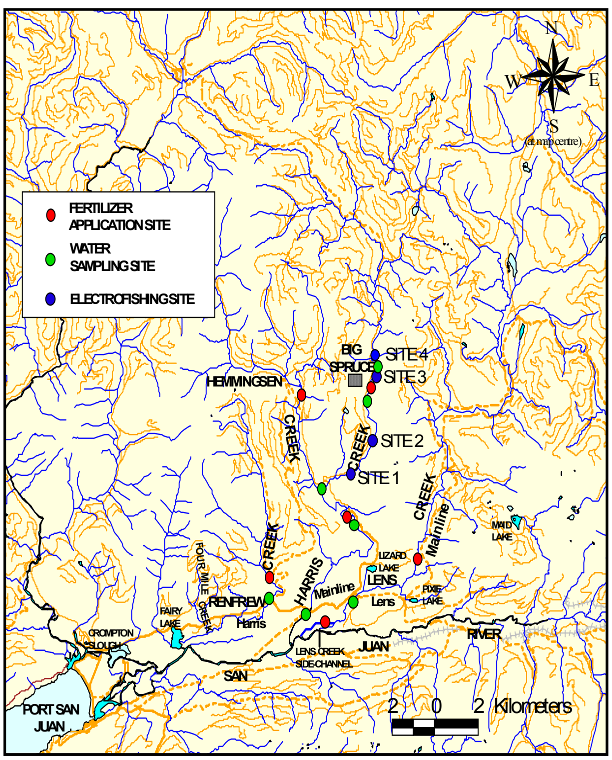


Figure 13. Nutrient application, water sampling and electrofishing sites in Harris, Hemmingsen, Renfrew and Lens creeks, 2003

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[3] Nutri-Stone Aquatic Restoration Fertilizer Briquettes were manufactured by Lesco Inc. (Strongsville, Ohio) and were used as an aquatic slow release fertilizer. The fertilizer briquettes contained 16% nitrogen and 30% "food grade" phosphoric acid (16-30-0).

2.0 METHODS

2.1 Fish Habitat Restoration

Monitoring techniques for all fish habitat restoration works followed those identified in *Guidelines for In-Stream and Off-Channel Routine Effectiveness Evaluation* (Anonymous 2003). Evaluations of installed LWD and boulder-riffles determine each site's physical (structural) and biological performance. Photographs were taken at each construction site, and a selection is included in Appendix A.1.

LWD and boulder riffle sites constructed on the Big Qualicum River (2000), Little Qualicum River (2002 and 2003) and the Englishman River (2003) were evaluated. Site descriptions for each constructed habitat included reach, chainage from a known location, site identification number, structure type and site objective(s). For physical performance, each site was rated on how well it met design objectives (Table 1), including creation or maintenance of pool and/or riffle habitat, and/or protection of stream banks, supplying stream cover, and an overall rating. Biological performance objectives assessed included how well each site supplied overwintering, rearing and holding habitats for fish of all species.

Table 1. Rating system for physical and biological performance of artificial fish habitat structures created in the Big Qualicum, Little Qualicum and Englishman rivers.

Rank	Condition
1	Site conditions resulting from works fail to meet objectives. Expectations are not met.
2	Site conditions resulting from works are failing to meet expectations and objectives.
3	Site conditions resulting from works are meeting expectations and objectives.
4	Site conditions resulting from works are exceeding expectations and objectives.

Snorkel surveys were conducted at the Big and Little Qualicum rivers to assess juvenile and adult salmonid densities at LWD and boulder riffle sites.

At each site in the Big Qualicum River, the plunge pool was snorkeled first. Riffle structures were then examined from bottom to top, with two swimmers positioned middle-left and middle right. Within each boulder structure, the degree of fish use by each species and age class was ranked in degrees of abundance (Table 2).

Table 2. Fish abundance observed (each species and age class) per pocket in each boulder riffle on the Big Qualicum River.

Number of fish (of each species/age class) / Pocket in structure	Degree of abundance
<0.5	Very Low
0.5-1.0	Low
1.0-2.0	Low to moderate
2.0-4.0	Moderate

2.2 Spawning Gravel Placements

Snorkel surveys were conducted at gravel placement sites to counts redds and evaluate spawning activity. Physical measurements of gravel pad size, depth and distribution were noted. Photos were taken at each of the gravel placement sites (Appendix A.2). Snorkel surveys were not conducted in Lens Creek due to low water levels, however, visual inspections at each of the side-channel gravel placement sites were completed to document spawning activity.

Juvenile densities were assessed at three of the gravel placement sites. Fish were sampled using roe baited Gee-minnow traps at the outlet of Stewart and Toquart lakes, as well as spot electrofishing at the outlet of Sproat Lake.

2.3 Nutrient Enrichment

Water samples to monitor low-level nutrient concentrations (µg/L) were collected four times over the summer growing season (June-September) at the following locations:

- Harris Creek, 100 m above the upper treatment site(control);
- Harris Creek, 50 m downstream of upper treatment site;
- Harris Creek, at Hemmingsen Creek confluence;
- Harris Creek, 25 m downstream of lower treatment site;
- Harris Creek, at the Harris Mainline lower bridge crossing;
- Renfrew Creek, at the Harris Mainline bridge crossing; and,
- Lens Creek, at the Renfrew Road bridge crossing.

Collection and analysis of samples were in accordance with the *Compendium of Methodologies of Standard Operating Procedures: Organic and Inorganic Analytical Procedures for the Pacific Environmental Science Center* (PESC). Classification of low level nutrients (Table 3) followed the Watershed Restoration Technical Circular No.8 (Johnston and Slaney 1996). Two water samples were collected at each site; one non-filtered sample contained in a 1 L polyurethane bottle, and one 0.45 µm filtered sample contained in a 100 mL brown glass bottle. Samples were stored in an ice-filled cooler and received by Philip Analytical Services Corporation[4] (PSC) within 24 hours of field collection. Sample parameters included:

- low level ortho-phosphate;
- total dissolved phosphorus;
- total phosphorus;
- ammonia; and,
- low-level nitrate + nitrite.

[4] Philip Analytical Services Corporation (PSC), 8577 Commerce Court , Burnaby, BC, V5A 4N5

Table 3. Low level nutrient classification used during monitoring in the San Juan watershed, 2003.

Nutrient Classification	Amount of Nitrate + Nitrite (mg/L)	Amount of Ortho-phosphate (mg/L)
Poor	<0.02	<0.001 (undetectable)
Fair	0.02 - 0.04	0.001 - 0.002
Good	> 0.06	> 0.003

To determine fish growth in response to fertilizer additions, juvenile steelhead were sampled in control and treated reaches using standardized closed-site electrofishing. Suitable steelhead sites in upper Harris Creek monitored in 2002 were re-sampled for this year's program. In total, two control and two treated sites of 50-85 m^2 were sampled using a 2-pass removal method (deLeeuw 1981). Fish captured were anaesthetized and measured for fork length (mm) and weight using an Ohaus top loading scale (model CS 200) accurate to 0.1 g. Upon removal of stopnets, a depth/velocity profile across a representative transects within the site was recorded using a Swoffer current velocity meter, model 2100. Population estimates were calculated using the Seber equation for two-pass removal and adjusted based on depth/velocity profiles using Habitat Suitability Index (HSI) curves developed in February 2001. Steelhead fry densities are typically expressed as fry per 100 m^2, or per unit (FPU).

The Ptomely alkalinity model (1993) was used to predict habitat capacity, or biomass of species per age class (0+ steelhead fry in this case) that can be supported per 100 m^2 of suitable habitat. The calculation for predicted FPU is as follows:

$(\text{total alkalinity})^{1/2} \times 36.3 = \text{biomass (g) per } 100\ m^2$

3.0 RESULTS AND RECOMMENDATIONS

3.1 Fish Habitat Restoration

3.1.1 Big Qualicum River Riffle Enhancement

On October 7, 2003, BCCF fisheries technicians surveyed nine boulder-riffle sites in the Big Qualicum River. Weather conditions were 100% overcast and mild. Stream discharge was 2.55 m^3/s (pers. comm.., DFO hatchery staff) and water temperature was 10.0°C. Rainbow parr densities in 2004 were similar to those observed in 2000 (Figure 14, Appendix B.1.).

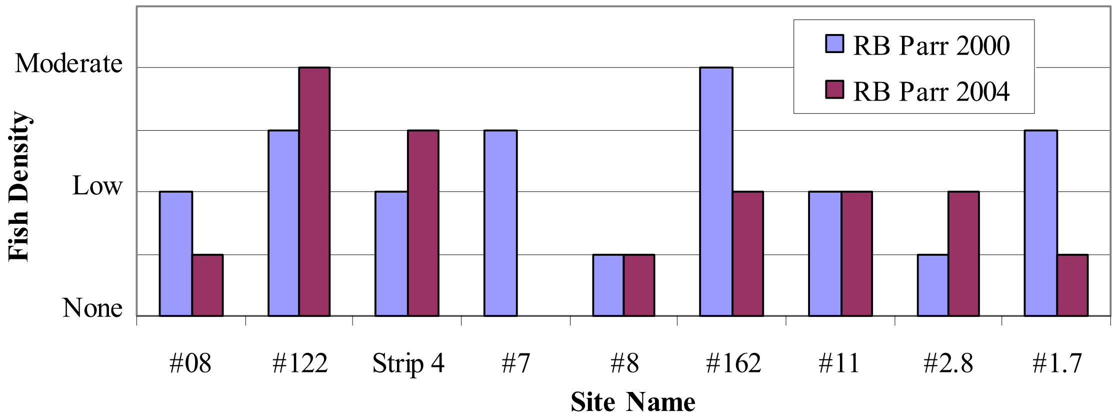

Figure 14. Comparison of rainbow parr densities in nine constructed boulder-riffle sites in the Big Qualicum River, fall 2000 and 2004.

Rainbow fry densities in 2004 equal to or lower than densities documented in the 2000 results (Figure 15). Coho fry densities changed very little when comparing the 2000 and 2004 monitoring results (Appendix B.1.).

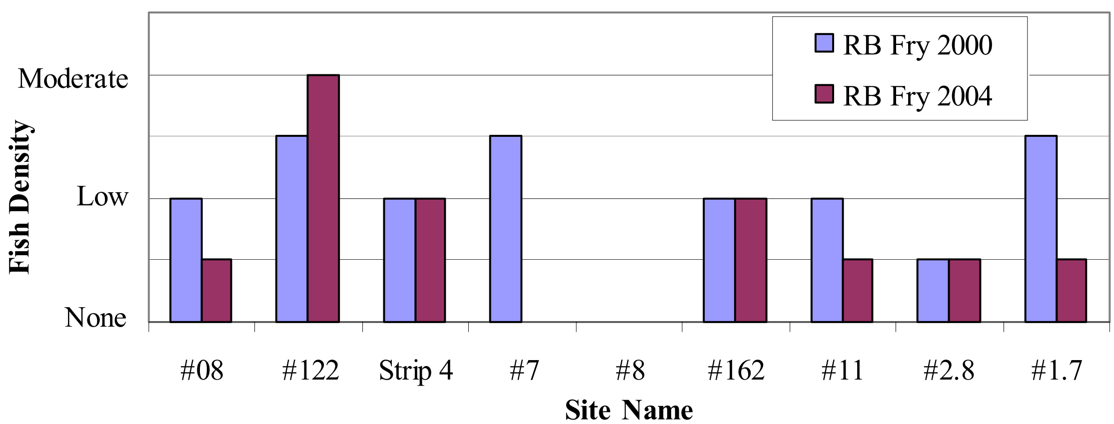

Figure 15. Comparison of rainbow trout fry densities in nine constructed boulder-riffle sites in the Big Qualicum River, fall 2000 and 2004.

Several reasons may account for the differences observed in rainbow parr and fry densities observed in 2000 versus 2004. The increased presence of large adult chinook and chum salmon may have caused some displacement of juvenile rainbow trout in the 2004 observations. Adult salmon were observed at sites # 8, #162, #11, and #1.7. Additionally, structural changes and infilling in sites #08 and #7 have reduced the quality of rearing habitat.

Overall, physical and biological performance evaluations on June 15, 2004 (Appendix B.2) show that site conditions are meeting expectations and objectives (Figure 16). Sites #08 and #7 have experienced shifting and infilling of boulders, resulting in reduced habitat quality and a decrease in the physical and biological ranking.

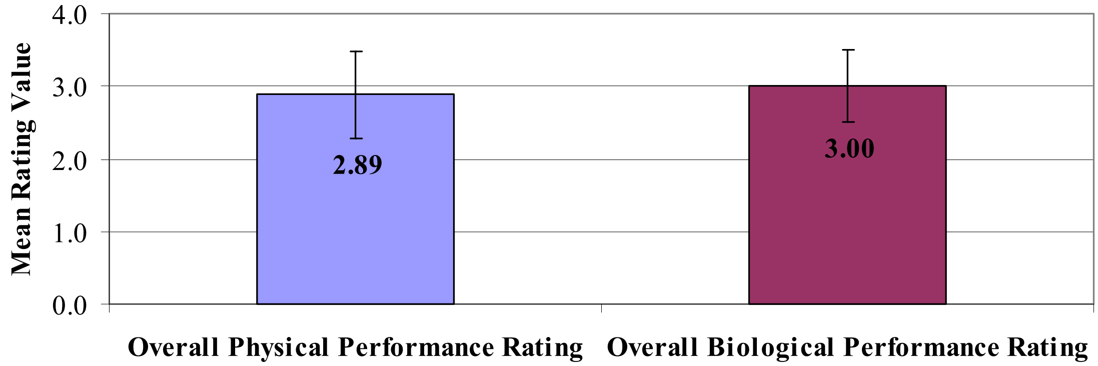

Figure 16. Summary of physical and biological performance ratings of nine boulder riffle sites constructed in 2000 in the Big Qualicum River (95% C.I.).

Site #8 appears to be functioning poorly, as very low densities of fish were observed both in 2000 and 2004. Recommendations include lowering the riffle crest to reduce the overall gradient through the structure and creating more "pockets" with sufficient depth and size for fish rearing. It is also recommended that site #08 be repaired as several boulders have shifted out of position, reducing the quality of the available habitat.

3.1.2 Little Qualicum River Artificial Fish Habitat Restoration

Routine effectiveness evaluations to monitor structures built in 2002 were originally performed in June, 2003 and are included in Appendix B.3 for reference. Structures built in 2003, as well as those built in 2002 were monitored on June 8, 2004 (Appendix B.4 and B.5).

The overall physical and biological performance of 2002 sites was considered good during both evaluations with site conditions generally meeting design expectations (Figure 17). Some scour and additional accumulation of natural LWD and SWD at several sites has further improved rearing conditions for juvenile salmonids.

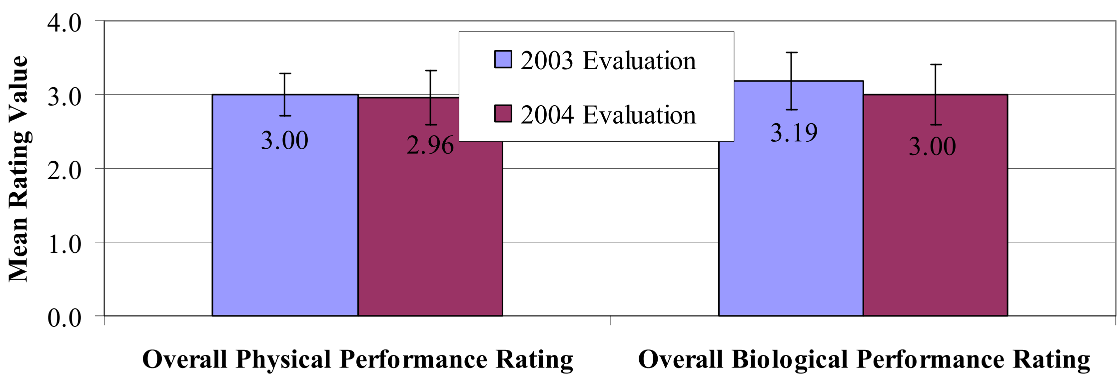

Figure 17. Summary of physical and biological performance ratings for structures built in the Little Qualicum River in 2002 (95% C.I.).

The slight decrease in the overall performance between evaluation years of the 2002 constructed sites is likely related to the large avulsion event that occurred near Kinkade Creek in October of 2003. Large amounts of sediment and bedload from an eroded farm field were washed downstream causing large depositions throughout the lower mainstem. This sediment input resulted in reduced levels of scour and increased deposition in and around restoration structures.

The flood event also likely contributed to the failure of one LWD restoration site (C0+757). The structure had shifted onto a bedrock shelf on the bank and was providing minimal fish habitat. Several sites showed additional bank erosion resulting from installed restoration structures. Repair of these sites is recommended during instream construction planned for 2004.

This year's monitoring results of the nine restoration sites constructed in 2003 were poorer than for the sites constructed in 2002 (Figure 17 and 18).

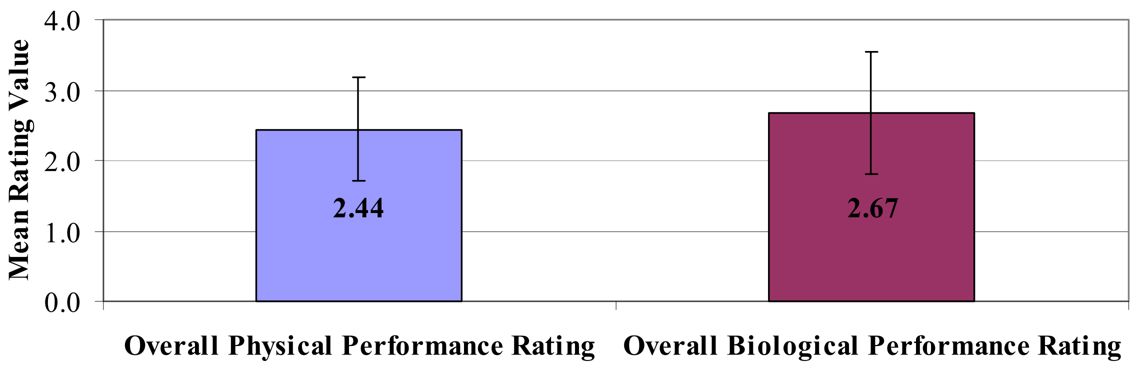

Figure 18. Summary of physical and biological performance ratings for structures built in the Little Qualicum River in 2003 (95% C.I.).

Two of the nine structures built in 2003 were essentially buried and cutoff from the mainstem as a result of the channel avulsion and are now located in lower Kinkade Creek. These structures, one boulder-riffle enhancement and one LWD site, have been partially submerged in fine organic matter and cobble and are not meeting physical or biological performance objectives.

Plans to return the Little Qualicum River to its historic channel are being developed by MWLAP, DFO, BCCF and the local property owner. This will likely entail extensive work around sites built in 2003 and may provide an opportunity to fix infilled and/or damaged structures[5].

A snorkel survey to monitor fish utilization of restoration structures constructed in 2002 was performed on July 18, 2003. High fish utilization was noted in both natural and enhanced

[5] In August 2004 plans were abandoned to return the Little Qualicum River to its original channel due to engineering and high cost considerations. A dispute between MWLAP and the local property owner resulted in no further restoration work being conducted adjacent to the farm site.

LWD structures. Species included rainbow fry, parr and adults, as well as coho fry, cutthroat parr and adults.

Within structures, rainbow fry and parr were observed using edge habitat associated with higher velocities. Structures placed immediately below a riffle showed the highest density of rainbow fry, parr and adults. Pool and glide structures showed low-moderate use by rainbow fry and parr. Cutthroat juveniles and adults where noted in high numbers around most structures.

Coho fry, in very high densities, were noted within structures using interstitial spaces in and around rootwads and the back end of boles, where velocities were reduced.

Rainbow fry densities in natural and enhanced riffle sites were compared. Fish densities appeared lower at natural sites than at enhanced sites, though velocities at the enhanced sites were somewhat higher and may have attracted greater numbers of young-of-the-year fish.

3.1.3 Englishman River Artificial Fish Habitat Restoration

Monitoring of structures built in the Englishman River in 2003 was conducted on June 4, 2004 (Appendix B.6). Fourteen of 15 sites constructed had performance ratings that are meeting or exceeding expectations and objectives, with overall physical and biological performance ratings of 3.1 and 3.3, respectively (Figure 16).

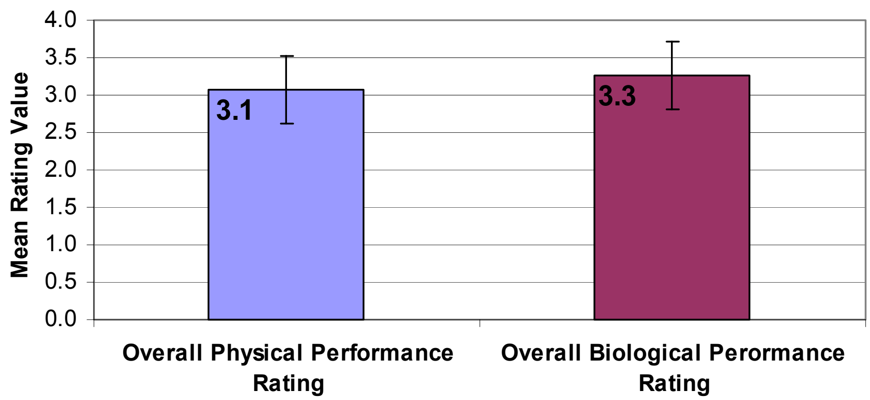

Figure 19. Summary of physical and biological performance ratings for structures built in the Englishman River in 2003 (95% C.I.).

Additional scour and input of natural LWD and SWD has increased the complexity of some structures, providing additional rearing benefits. One site (5+900), would benefit from the addition of extra wood to increase scour and cover. This work could be performed opportunistically with restoration work planned in 2004.

Snorkel surveys performed during the 2003/04 winter steelhead season noted high use of LWD sites by adult steelhead, rainbow and cutthroat trout (Appendix B.7).

Post construction bank observations in the fall of 2003 and spring of 2004 noted the presence of rainbow fry and parr, as well as coho and chinook fry. Snorkel surveys to determine juvenile and adult salmonid densities are scheduled for the summer/fall of 2004.

3.2 Spawning Gravel Placements

3.2.1 Campbell River (Elk Falls) Spawning Gravel Placement

Monitoring of gravel placed in the Elk Falls Canyon of the Campbell River was conducted on August 1 and November 6, 2003 (Appendix C.1 and C.2). During the August survey, fisheries staff from BCCF, D. Burt and Associates and CBR and Associates, measured gravel pads and identified additional sites for future placements in the canyon. BCCF's involvement was opportunistic (part of Campbell River Gravel Committee work) and allowed for additional monitoring of the installed gravel.

Measurements of the primary (250 m downstream of the Elk Falls plunge pool) and secondary (tailout of the Elk Falls plunge pool) gravel pad locations, confirmed usable spawning areas of 277 m^2 and 303 m^2, respectively (Burt 2003). Burt also determined a biostandard for artificial spawning pads (m^2 per pair) on the Campbell River of 7.6 m^2, based on an average adult steelhead length (0.75 m) and average steelhead redd size (3.8 m^2). Using this biostandard, the 2002 gravel project created additional spawning habitat for 36 pairs at the primary pad location, and 40 pairs at the secondary site (Burt 2003).

On November 6, 2003, a snorkel survey was performed to monitor the movement of gravel following a large spill (largest since November 1995) in the Elk Falls Canyon on October 18, 2003 (237.86 m^3/s, C. Wightman, pers. comm.). At both original gravel pad locations, the majority of material was displaced downstream. Only in the tailout of the Falls pool, at water depths greater than 1.4 m, was there undisplaced gravel following the spill event.

Material remaining in the area appeared to settle out between large, angular material ($D50 \approx 0.45$ m) in relatively small patches. Gravel distribution downstream of both locations was noted as far as the next large holding pool (~100-150 m), with small patches remaining in "back-eddies" and other low velocity areas. Spill-related redistribution or "shuffling" appears to have created several gravel accumulations in addition to those which were a result of the recent introductions. Existing material entrained under large boulders may have become mobile and been deposited in areas suitable for spawning.

Given the typical run timing of pink and chinook salmon, it is likely that some redds were scoured during the October 18 spill event. A total of nine individual and/or clustered redds were noted during the snorkel survey, of which two singles and one "cluster" were located in the newly introduced gravel..

Gravel displacement downstream was anticipated given the magnitude of the spill event. Gravel accumulations above the wetted perimeter were noted and were not unexpected, given the survey was conducted at a discharge of 3.5 m^3/s. This discharge more closely approximates rearing flows and not the spawning flow of approximately 10 m^3/s recommended by provincial biologists during Water Use Planning (C. Wightman, pers. comm.).

3.2.2 Lens Creek Side-Channel Spawning Gravel Placement

Monitoring of gravel placed in the Lens Creek side-channel in the summer of 2002 was conducted on December 12, 2003. Spawning coho adults were noted throughout the side-channel, with coho redds observed at four of five gravel placement sites. Physical measurements to document gravel pad size, depth and distribution were not made, given the spawning activity. General comments on gravel pad size and condition as well as spawning activity is summarized in Table 4.

Table 4. Observations of coho spawning activity and gravel pad condition, Lens Creek side-channel, December 12, 2003.

Site Location	# of Redds	Adult Coho Observations	Comments
Under Footbridge (Phase I)	0	None observed	Gravel dispersed downstream, too thin for ideal spawning. Additional gravel required.
Upstream Control Structure	3-4	1 spawning pair	Functioning well, excellent spawning potential.
75 m downstream control structure	3-4	3 fish within reach, 2 carcasses in LWD	Functioning well, excellent spawning potential.
Old road grade crossing	3-4	1 spawning pair, 2 other fish 25 m downstream, 3 carcasses	Some infilling with fines and little compaction. Addition gravel required.
Phase 2 wetland outlet	5-6	4 carcasses downstream of road crossing	Some gravel displaced downstream. Excellent location. More gravel required (35-50 m^3)

On March 4, 2003, BCCF and DFO fisheries staff hydraulically sampled coho redds at four gravel placement locations in the Lens Creek side-channel. In total, six samples were collected from two sites near Phase 2 outlet and four sites upstream of the side-channel control structure (Table 5).

Table 5. Hydraulic sampling of coho redds at two gravel placements in the Lens Creek side-channel, March 4, 2003.

Sample #	Sample Location	Total Eggs	Eyed Eggs	Egg Survival (%)	Live Alevins	Dead Alevins
1	u/s Phase 2 outlet	205	0	0	0	0
2	d/s Phase 2 outlet	210	16	7.6	6	0
3	2 m u/s control blocks	389	385	99.0	7	0
4	2 m u/s control blocks	185	178	96.2	1	0
5	4 m u/s control blocks	331	327	98.8	28	7
6	4 m u/s control blocks	3	1	33.3	118	27

No eggs or alevins were found during inspections using a shovel of the footbridge and old road grade crossing sites, despite the latter showing evidence of 3-4 redds (table 4).

3.2.3 South Nanaimo River Spawning Gravel Placement

Monitoring in the South Nanaimo River occurred on October 24, 2003 and March 10, 2004. The site was walked on October 24 to observe the effects of a high water event on October 18, 2003. Gravel sites 2 and 3 had shifted considerably, with part of the material displaced as far as 300 m downstream.

A snorkel survey on March 10, 2004 (Appendix C.3), confirmed that the amount of spawning area in sites 2 and 3 had been reduced and that material displaced downstream had settled into interstitial spaces between large boulders. However, several areas were identified within 300 m of the placements where enough gravel had accumulated to provide adequate spawning sites. No fish or redds were observed during this survey.

Site 1 appeared more stable as approximately 70 % of the original platform remained intact. Site 1 benefits from the protection of an old log weir immediately upstream of the site, which reduces flow and lessens scour. No signs of spawning activity were noted at site 1.

3.2.4 Lake Outlet Spawning Gravel Placements

Sproat Lake

Monitoring at the outlet of Sproat Lake occurred on June 27, 2003. Snorkel observations revealed that some displacement of gravel had occurred, with downstream accumulations noted in three separate locations. The majority of the primary gravel pad constructed in 2002 appeared to be intact and extended to 54 m past the low head weir. The remaining pad equalled 448 m^2 and had a mean gravel depth of 0.45 m. This pad accounted for approximately 202 m^3 (72.5 %) of the original 278 m^3 of placed material (Table 6).

Table 6. Physical measurements of spawning platforms at the outlet of Sproat, Toquart and Stewart lakes, summer 2003.

Lake Outlet	Site Name	Average Water Depth (m)	Average Water Velocity (m/s)	Average Gravel Depth (m)	Gravel Area (m^2)	Volume of Gravel (m^3)	% Usable (Gravel Area)	Usable Gravel Area (m^2)	Number of Pairs Supported*
Sproat Lake	Primary Gravel Pad	0.9	0.6	0.45	448	201.6	90	403.2	53
	Depostional Pad #1	1.3	0.7	0.25	190	47.5	25	47.5	6
	Depostional Pad #2	0.7	0.4	0.15	36.0	5.4	75	27.0	3.0
	Depositional Pad #3	4	0.2	0.15	247.5	37.1	0	0	0
Toquart Lake	Primary Gravel Pad	1.1	0.3	0.35	40.0	14.0	80	32	4
Stewart Lake	Primary Gravel Pad	0.7	0.35	0.4	116.1	46.44	90	104.49	13
Totals						352.04		614.19	80

* Derived using steelhead spawning biostandard (1 pair = 7.6 m^2) from Campbell River (Burt 2003)

The three downstream accumulations accounted for approximately 27.5 % of the initial gravel placement and ranged from 448 m^2 to 36 m^2 in size, and from 0.1 m to 0.4 m in depth.

The first depositional area was located approximately 11 m downstream of the primary gravel pad and covered an area of approximately 190 m^2. The second was located 115 m downstream of the weir and covered approximately 36 m^2. The final depositional area was in a deep pool 140 m downstream of the weir where approximately 37 m^3 of gravel covered an area of 247.5 m^2 at an average depth of 0.15 m. A clear transitional zone was observed at the midpoint of the pool, where new gravel from the 2002 project covered spawning material from a previous gravel placement in 1994 (Burt and Burns, 1995). Discounting areas where water and gravel depth limit fish use, these three sites provide a total of 65 m^2 of usable spawning area.

During the snorkel survey, were observed holding over the installed gravel pad, however, no fresh redds were noted. Low densities of trout parr were observed, and very low densities of coho and trout fry were noted. Several large remnant redds were observed on the primary gravel pad, possibly from steelhead spawning during the winter and spring of 2003.

Monitoring of gravel conditions at the outlet of Sproat Lake is recommended on a regular basis. Further gravel additions to this location should be undertaken on an “as required basis”, to maintain optimal spawning conditions.

Toquart Lake

The Toquart Lake gravel installation was monitored on June 26, 2003. Snorkel survey results indicated that 30 % of the initial gravel placement remained at the original location, with the rest being displacement up to 100 m downstream.

Gravel placed in the upper half of the drop zone appeared to have remained in place. Pad size was approximately 40 m^2, with a depth of 0.3-0.4 m (Table 6). This area had greater water depth and lower velocities, with conditions reasonably suited for steelhead spawning. No obvious redds were observed at any of the installations, however, a few old redds (likely last fall/winter) were observed at the tailout of the “Lake Pool” (400 m downstream of the lake outlet) and the right bank braid associated with it.

Moderate to high densities of newly emerged salmonid fry were observed in riffles and pool tailouts immediately downstream of the lake outlet. Lower densities of fry were observed in the lake outlet margins adjacent to the gravel placement site, likely the result of downstream recruitment to stream rearing habitats. Results from the Gee-minnow traps confirm the presence of coho and rainbow/steelhead trout fry (Appendix C.4) Complimenting the outlet spawning improvements, riffle habitat below the lake outlet is highly suited for steelhead fry and parr, with good algal growth and low to moderate densities of aquatic invertebrates (i.e., caddis larvae).

Previous recommendations for future gravel placement near the outlet of Toquart Lake suggested additions at the tailout of the “Lake Pool” (McCulloch 2003b). We also found this site to have only low quality spawning substrates. Compaction appeared high and fines were prevalent. Additions of high quality spawning gravel at this location would certainly improve spawning conditions at this site, although access is limited.

Stewart Lake

Monitoring occurred at the outlet of Stewart Lake on July 1, 2003 and April 10, 2004. Snorkel survey observations on July 1, 2003, from lake outlet to a point 150 m downstream revealed little gravel movement from the constructed platform. With an average gravel depth of 0.4 m and a coverage of 116 m^2, the pads volume was estimated at 46 m^3, compared to the as-built estimate of 44 m^3 (Table 6).

The July 1, 2003 survey also noted excellent trout fry and parr rearing conditions below the platform. Low to moderate densities of trout fry were observed in this section, including 6-8 fry holding over possible redds on the spawning platform. Juvenile collection using Gee-minnow traps resulted in the capture of several cutthroat and Dolly Varden parr (Appendix C.5). Six large depressions, characteristic of steelhead or coho redds, were noted during the initial monitoring survey, indicating possible spawning activity during the previous fall or winter.

Monitoring occurred on April 10, 2004, during higher water levels and velocities well suited for steelhead spawning. No gravel displacement from the initial platform had occurred, and several possible redds (likely new from spring 2004) were noted on the spawning pad.

Recommendations soon after the initial construction of the spawning gravel platform addressed the need for added material above the finished pad (McCulloch 2003b). Smaller material could be distributed to the channel using a “gravel slinger,” extending the platform further upstream into the lake outlet. Four inch minus material, able to pass through the “gravel slinger,” could be placed further upstream in hydraulically stable locations, to further improving spawning opportunities at the outlet.

A May 2001 reconnaissance of Stewart Lake documented a small, natural log jam at the outlet of the lake. This log jam was absent the following year when gravel was installed. Monitoring on July 1, 2003, noted new LWD, possibly from this log jam, approximately 150 m downstream of the Stewart Mainline Bridge. Re-establishing the log jam immediately above the gravel platform would provide excellent cover for salmonids during spawning. A natural boom could be constructed using two or three logs from the nearby shoreline and cabling them together to anchor points on each side of the outlet. Natural movement of large and small woody debris from the lake would likely complex the boom, creating the desired cover.

Dickson Lake

Monitoring of the two gravel pads at the outlet of Dickson Lake occurred in February and March, 2004. During a spot swim of the outlet on February 3, 2004 (Appendix C.6), both pads were completely intact and each showed signs of use by fish. One wild steelhead (fecund female, ~3 kg) was observed 100 m downstream of the Ash River Mainline Bridge.

The north pad (left bank) contained one complete redd, as well as three possible test redds. The south pad (right bank) also appeared to have one complete redd and one possible test redd. Digging was located near the downstream edge of both gravel pads, in higher velocity water. Water depth at the time of survey averaged 35-40 cm over the gravel platform. Additional redds were noted in natural substrates on the left bank, immediately downstream of the installed pads. These redds appeared old, though new redds may have been unidentifiable due to the nature and colour of the substrates.

On March 23, 2004, a second survey of the pads was completed. Very little displacement of gravel had occurred (< 2%), and water depths and velocities over the pad appeared ideal for spawning steelhead. In total, five redds/test redds were observed, including several test redds in deep water (~ 1.5 m) on the front face of the pads. Three adult steelhead (2 females, 1 male) were noted actively spawning downstream of the pad on left bank.

Habitat diversity and cover for spawners is relatively low in and around the installed gravel. Placing boulders (30-50), of various sizes (0.4-0.7 m mean diameter), randomly on the gravel pad to increase diversity and cover elements would make the pad more attractive to spawners.

Three pieces of a remnant log boom have for years been floating against the left bank of the river just downstream of the north pad. These logs provide good cover for holding/spawning steelhead. Liability and navigation issues not withstanding, re-installation of the log boom at the upstream margin of the north pad would collect debris moving from the lake and provide additional cover.

Nanaimo Lakes

Streambank observations of gravel placed at the outlet of Second Lake occurred on October 24, 2003, following a significant high water event. A large portion of the gravel appeared to have been displaced downstream, particularly away from stream margins where velocities were higher. Gravel displacement was confirmed during a snorkel survey on March 10, 2003 from 100 m upstream to 300 m downstream of the site (Appendix C.3). Approximately 30% of the gravel remained at the original pad location. Displaced gravel was noted as far as 250 m downstream, and had settle in interstitial spaces between boulder substrate throughout the inlet to First Lake. Several gravel accumulations were considered suitable for spawning, however no redds or fish were observed during the survey.

3.3 Nutrient Enrichment

3.3.1 San Juan Nutrient Enrichment

Water samples were collected four times between June 25 and September 16, 2003 (Appendix D.1). As expected with low-level nutrient analysis in streams enriched with slow release fertilizer, very little fluctuation in nutrient levels in treated versus control reaches was detected. This usually occurs when algae growth consumes available nutrients.

Ortho-phosphorus concentrations were fair in most of the sample sites, except on June 25 when concentrations were quite high. Nitrate + nitrite concentrations are fair to good, confirming that low nitrogen/high phosphorus fertilizers are suitable for San Juan watershed tributaries.

On all but one of the sample dates, the temperatures inside sample coolers were too warm (5-6^{o}C) when the samples reached the lab in Vancouver. The only date on which temperatures remained very cool (1^{o}C) was July 29, 2003, when ortho-phosphate concentrations were undetectable at all seven sites, and nitrate + nitrite concentrations were much lower than on most of the other dates.

Juvenile sampling occurred at the lower two sites (treated) September 19 and at the upper two sites (control) on September 23 (Appendix D.2). Sites 1 and 2 (treated) were located 2.0 km and 1.5 km downstream of the uppermost fertilizer sites. Sites 3 and 4 (control) were located 350 m and 400 m upstream of the uppermost fertilizer site. Figure 20 compares mean weights and condition factors of fish sampled in treated and untreated sites. Mean weights were two times greater in treated sites than untreated sites, and condition factors were roughly equal.

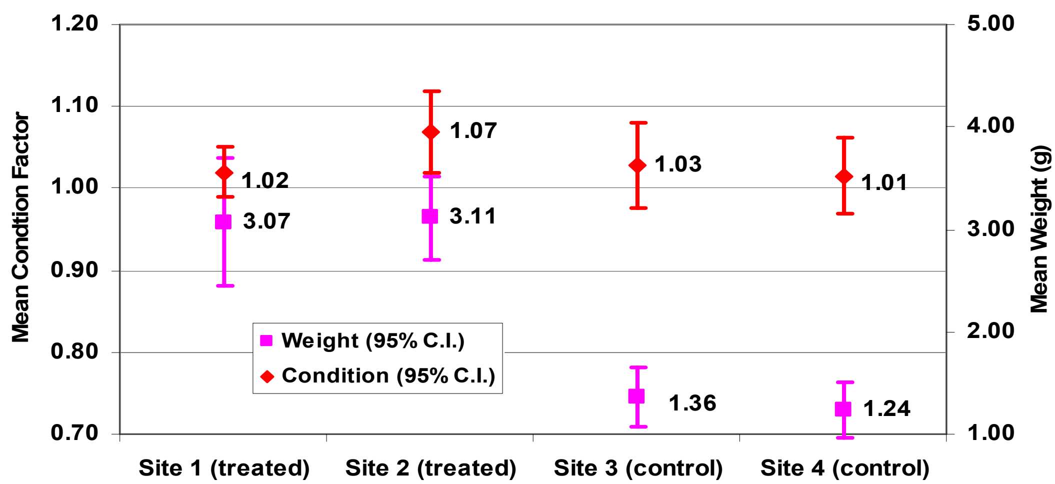

Figure 20. Mean weight and condition factor of rainbow/steelhead trout fry in control and treated sites in Harris Creek, September 19 and 23, 2003.

Although these results indicate a positive growth response to enrichment, control sites (3 and 4) had a much greater FPU than the treated sites (Table 7), which may have lead to density dependent growth differences.

Table 7. Harris Creek steelhead fry data summary, 2003.

Site #	Mean Weight (grams)	D/V Adj'd FPU	Predicted FPU	% of Predicted
1 (treated)	3.07	112.42	90.4	1.24
2 (treated)	3.11	76.53	89.6	85%
3 (control)	1.36	178.43	204.7	87%
4 (control)	1.24	210.99	228.6	92%

Assuming these results are representative of densities throughout the anadromous reach, the Harris Creek steelhead fry stock would be classified in the Routine Management Zone[6], even if the target was set at 100 FPU to service the system's exceptional parr habitat (R. Ptolemy, Standards/Guidelines Specialist, MWLAP, Victoria, pers. comm.).

4.0 CONCLUSIONS

The continual monitoring of past and future restoration works should remain a high priority for the GGBSRP. Artificial fish habitat structures, spawning gravel placements and nutrient enrichment have proved successful in increasing wild steelhead smolt production (Lill 2002). However, limitations likely exist on the duration with which individual sites and/or structures remain highly effective. Repair or enhancement at restoration sites is likely more cost effective in the long term than complete replacement.

Monitoring of restoration/enhancement work is critically important to improving future restoration works. Without sufficient monitoring, a potential exists to repeat techniques that result in a failure of the restoration/enhancement project to meet the designed physical and/or biological objective(s). Results of routine effectiveness monitoring are thus an invaluable resource for project managers implementing future rehabilitation works.

[6] Routine Management Zone classification is defined when stock size is at least 30% of habitat capacity as stated in the Greater Georgia Basin Steelhead Recovery Action Plan (A.F. Lill 2002).

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Appendix A

Photo Documentation

Appendix A.1. Artificial fish habitat restoration monitoring photo documentation.


Photo 1. Big Qualicum River boulder-riffle at site #8 looking cross-stream from R/B.


Photo 2. Big Qualicum River boulder-riffle at site Strip 4 looking cross-stream from L/B.


Photo 3. Big Qualicum River boulder-riffle at site #1.7 km looking U/S.


Photo 4. Little Qualicum River LWD structure at site D0+750 looking D/S.

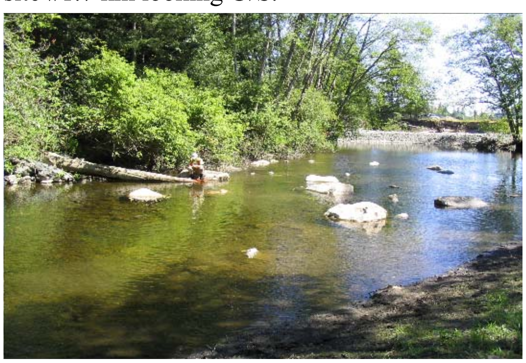


Photo 5. Little Qualicum River boulder-riffle at site D0+370 looking D/S. Note avulsion effects.


Photo 6. Little Qualicum River LWD failed structure at site C0+757 looking U/S.

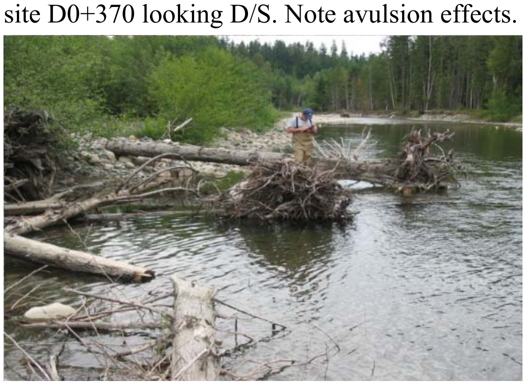


Photo 7. Englishman River LWD structure at site 5+900 looking D/S.


Photo 8. Englishman River LWD structure at site 5+600 looking U/S.

Appendix A.2. Spawning gravel placement monitoring photo documentation.


Photo 1. Campbell River gravel monitoring looking at Elk Falls pool tailout, Aug. 8, 2003.


Photo 2. Lens Creek gravel monitoring looking at side-channel, Dec. 12, 2003.


Photo 3. South Nanaimo gravel monitoring looking at site 1, March 10, 2004.


Photo 4. Sproat Lake gravel monitoring looking at primary gravel pad, June 27, 2003.


Photo 5. Toquart Lake gravel monitoring, boulder infilling with gravel, June 26, 2003.


Photo 6. Stewart Lake gravel monitoring looking D/S at gravel pad, July 1, 2003.

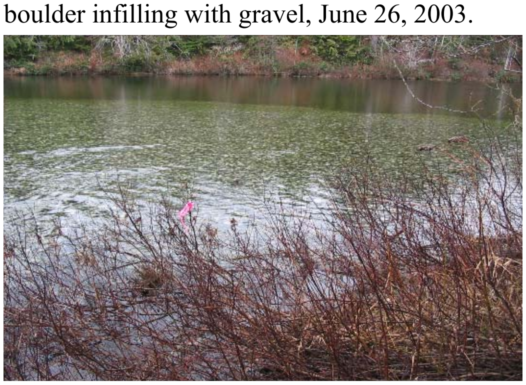


Photo 7. Dickson Lake gravel monitoring looking at north pad, March 23, 2004.

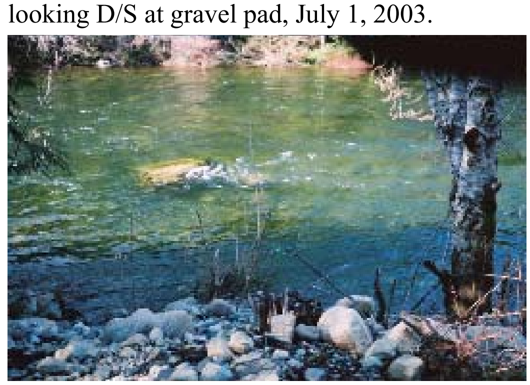


Photo 8. Nanaimo Lake gravel monitoring looking at pad, March 10, 2004.

Appendix B

Fish habitat restoration monitoring data.

Appendix B.1. Observed densities of juvenile rainbow trout and coho salmon during a snorkel survey on October 7, 2003, at nine boulder-riffles constructed on the Big Qualicum River in 2000.

Site Name	Km u/s of DFO fence	Rb parr Abundance (# of fish)	Rb fry Abundance (# of fish)	Co fry Abundance (# of fish)	# of Resident Rainbow in structure/plunge pool	Comments
#08	7.6	Very low	Very low	Low	0	structure changed
Plunge Pool		n/a	n/a	n/a	n/a	
#122	7.5	Moderate	Moderate	Very low	0	moderate rightbank shift of boulders
Plunge Pool		Moderate	Moderate	Moderate	3	
boulder cluster "A"		(1)	(2)	(0)	n/a	
boulder cluster "B"		(1)	(2)	(1)	n/a	
Strip 4	6.5	Low-mod	Low	Moderate	0	upper right bank pocket: 32 co, 8-10 rb parr, 6 rb fry
Plunge Pool		High	Moderate-high	High	2	
#7	4.8	0	0	0	0	function poorly, depth and boulder size possible reasons
Plunge Pool		Very low	0	Moderate	0	
#8	4.7	Very low	0	0	0	15 adult chum present, possible displacing RB parr
Plunge Pool		Very low	Very low	Low	1	
#162	4.35	Low	Low	Very low	0	3 chinook present
Plunge Pool		Low	0	Moderate	4-5	
#11	4.1	Low	Very low	Low	0	greater abundace with depth, 3 chinooks
Plunge Pool		Very low	Low	Moderate	0	
#2.8	2.8	Low	Very low	Low	0	0 adults
Plunge Pool		Low	Very low	Moderate	1	
#1.7	1.7	Very low	Very low	Very low	0	2 adult chinook
Plunge Pool		Low-mod	Low	Moderate	3	

Appendix B.2. Routine effectiveness evaluation performed on June 15, 2004, of nine boulder-riffle sites constructed in the Big Qualicum River in 2000.

Watershed Big Qualicum
Sub-watershed ____________
Date 15 June 04

Survey Crew SS
Weather / Flow Sunny, warm (20 ^{0}C), flow 48 cfs

REE Interval Year 1

				Performance Objectives															Overall						Comments
				Physical							Biological														
Site Name (ID #)	Km u/s DFO fence	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Nutrient	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
#1.7	1.7	Boulder Riffle	Increase ST Parr Habitat		(3)			(4)		3	ST	Parr		(3)				3	3	3	4	3	N	1-4	Site functioning well with good depth and velocity. Good broken water cover. Ave. pocket depth behind boulders = 0.5 m. Minor infilling with cobbles and sediment. Site appears stable.
#2.8	2.8	Boulder Riffle	Increase ST Parr Habitat		(3)			(3)		3	ST	Parr		(3)				3	3	3	3	3	N	5-7	Functioning as expected. Pockets behind rocks moderately deep (0.5 m), good ST parr habitat. Minor shifting of rocks. Minor infilling with cobble and gravel. Good depth (1.0 m) in plunge pool.
#11	4.1	Boulder Riffle	Increase ST Parr Habitat		(3)			(4)		3	ST	Parr		(4)				4	3	3	3	3	N	8-12	Site appears to be functioning very well, with good instream cover from broken water and LWD. LWD at head of site and at bottom pool. Pocket depth ave. 0.6 m, with little infilling. Plunge pool shallow (0.7 m)
#162	4.35	Boulder Riffle	Increase ST Parr Habitat		(3)			(3)		3	ST	Parr		(3)				3	3	3	4	3	N	13-17	Site functioning very well. Pocket depth ave. 0.6 m with some to 0.8 m. Good broken water cover and velocity. Plunge pool fairly shallow (0.6 m), appears like glide and shallows quickly (0.3 m)
#8	4.7	Boulder Riffle	Increase ST Parr Habitat		(3)			(3)		3	ST	Parr		(3)				3	3	3	3	3	N	18-22	Short site (8-10 m long) and steep with fairly shalllow pocket depth (0.35 m). Some infilling has occurred with cobbles/gravels. SWD provides added cover. Good plunge pool depth (1.6 m).
#7	4.8	Boulder Riffle	Increase ST Parr Habitat		(3)			(2)		2	ST	Parr		(3)				3	3	3	3	3	N	23-26	Short site (10 m long) and farily steep. Shallower pocket depth (ave. 0.35 m) with small amounts of cobble/gravel infilling. Minor amounts of added SWD. Moderately deep plunge pool (1.0 m). Some shifting has occurred.
Strip 4	6.5	Boulder Riffle	Increase ST Parr Habitat		(4)			(4)		4	ST	Parr		(3)				3	3	3	4	3	N	27-30	Site with good velocity and good broken water and LWD cover. LWD has accumulated at site. Boulder pockets have good depth (0.5-0.6 m) with minor cobble girdling. Plunge pool is fairly deep (1.5 m). Some minor shifting has occurred.
#122	7.5	Boulder Riffle	Increase ST Parr Habitat		(3)			(3)		3	ST	Parr		(3)				3	3	3	3	3	N	31-33	Whole site functioning well. Depth behind most boulders shallow (0.35 m). Some shifting and infilling has occurred. Plunge pool depth of 1.0 m with added LWD and SWD cover. Boulder clusters have good depth (0.5-0.6 m) and velocity.
#08	7.6	Boulder Riffle	Increase ST Parr Habitat		(2)			(3)		2	ST	Parr		(2)				2	2	2	3	3	N	34-37	Site has changed with boulders pushed towards RB. Added LWD at site has provided more cover. Riffle now small and infilled with pocket depths ave. 0.35 m. No plunge pool exists (more like glide). Minor erosion on RB.

Notes 1. ◯ Denotes the objective of the restoration site.

Appendix B.3. Routine effectiveness evaluation performed on June 18, 2003, of restoration work constructed in the Little Qualicum River in 2002.

Watershed Little Qualicum
Sub-watershed ___________
Date 18 June 03

Survey Crew MM, HW
Weather / Flow 20% OC

REE Interval Annual (Year 1)

				Performance Objectives															Overall					
				Physical							Biological													
Reach	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Nutrient	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers
C	0	LT6	LWD cover	4			3	3		3	ST	PARR	3	3	4			4	4	4	4	3	N	1
C	240	DJ5+LO1	LWD cover		3		3	3		3	ST	PARR	3	3	3			3	4	4	3	4	Y	2
C	307	DJ5 SPUR	LWD cover	2			4	3		2	ST	PARR	3	3	3			3	4	4	3	3	N	3
C	330	L03	LWD cover	3			3	3		3	ST	PARR	3	3				3	4	4	3	3	Y	4
C	405	DJ5 BUS	LWD cover	3			3	3		3	ST	PARR	3	3	3			3	4	4	4	3	N	5
C	542	DJ5	LWD cover	3	4		3	3		3	ST	PARR	3	3	3			3	4	4	3	3	N	6,7
C	650	LX2	LWD cover	3	3		3	4		3	ST	PARR	3	4	3			4	4	4	3	4	N	
C	757	DJ5	LWD cover	3			3	3		3	ST	PARR	3	3	4			3	4	4	4	4	N	10
C	800	LO3	LWD cover	3	3		3	3		3	ST	PARR	3	3	3			3	4	4	3	3	Y	11
C	870	LO1	LWD cover					3		3	ST	PARR		3	3			3	4	4	3	3	N	12
C	934	BC	boulder cover, increase ST parr habitat		3			3		3	ST	PARR		3				3	4	4	3	4	N	13
B	30	LO4	LWD cover					3		3	ST	PARR	4	3				3	4	4	4	3	N	14
B	120	DJ5	LWD cover	4	3		3	3		3	ST	PARR	3	4	3			4	4	4	4	4	N	15
B	182	DJ5+SP	LWD cover	3	3		3	3		3	ST	PARR		3				3	4	4	3	3	N	16
B	238	LO1	LWD cover	3				3		3	ST	PARR		3	3			3	4	4	3	3	N	17
B	295	DJ5	LWD cover	3	3		4	4		3	ST	PARR	4	3	3			3	4	4	3	3	N	18
B	360	RIF-ENH	increase ST parr habitat		4			3		3	ST	PARR		4				4	4	4	2	4	N	19
B	380	LO2	LWD cover	3			3	3		3	ST	PARR	3	3				3	4	4	3	3	N	20
B	400	DJ5	LWD cover	3	3		3	3		3	ST	PARR	3	3				3	4	4	3	3	N	21
B	460	DJ5	LWD cover	3	3		1	3		3	ST	PARR		3				3	4	3	3	3	Y	22
B	558	BC	boulder cover, increase ST parr habitat		3			3		3	ST	PARR		3				3	4	4	3	4	N	23
A	40	DJ5	LWD cover	4			3	4		4	ST	PARR	4	4	4			3.5	4	4	4	4	N	24
A	118	BC	boulder cover, increase ST parr habitat		3			3		3	ST	PARR		3				3	4	4	3	3	N	25
A	160	LO4	LWD cover	3				3		3	ST	PARR	3	3				3	4	4	3	3	N	26

Notes 1. ⬭ Denotes the objective of the restoration site.

Appendix B.4. Routine effectiveness evaluation performed on June 8, 2004, of restoration work constructed in the Little Qualicum River in 2002.

Watershed Little Qualicum
Sub-watershed ___________
Date 8-9 June 04

Survey Crew SS, HW
Weather / Flow Sunny, Warm, Low Spring Flows

REE Interval 1 Year Interval (Evaluated June 18, 2003)

				Performance Objectives															Overall						Comments
				Physical							Biological														
Reach	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Nutrient	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
C	0	LT6	LWD cover	(4)			3	(4)		4	ST	PARR	3	(3)	4			3	4	4	4	3	N	26,27	Good scour depth in pool (1.3 m) with good cover from additional SWD. A few trout present. Site has improved since 2003.
C	240	DJ5+LO1	LWD cover		(3)		3	(3)		3	ST	PARR	3	(3)	3			3	3	3	3	4	Y	28,29	Cable still loose (may have lost ballast rock). Slightly more infilled than previous year. Minimal amounts of scour needed to improve depth. Good habitat for ST parr. Recruited Fir is gone.
C	307	DJ5 SPUR	LWD cover	(3)			4	(4)		3	ST	PARR	4	(3)	3			3	4	4	3	3	N	30-32	Increased scour compared to 2003. Improved rearing conditions. High abundance of LWD + SWD. Site has really jammed up with wood and starting to overlap with d/s site.
C	330	L03	LWD cover	(3)			3	(4)		3	ST	PARR	3	(3)				3	4	4	3	3	N	30-32	Increased scour compared to 2003. Improved rearing conditions. High abundance of LWD + SWD. Site has really jammed up with wood and starting to overlap with u/s site.
C	405	DJ5 BUS	LWD cover	(3)			2	(3)		3	ST	PARR	3	(3)	3			3	4	3	4	3	Y	33-35	Site similar to 2003. Pool in good condition with good cover due to high abundance of LWD + SWD. Continued erosion on d/s portion of structure. ST parr and CT adults observed.
C	542	DJ5	LWD cover	3	(3)		3	(3)		3	ST	PARR	3	(3)	3			3	3	3	3	3	N	36	Root wad 8 m u/s of site is causing added input of sediment to structure. Good depth (1.5 m) and cover on outside of site. No new wood.
C	650	LX2	LWD cover	(3)	3		2	(4)		3	ST	PARR		(4)	3			4	3	2	3	4	Y	37,38	Creating good ST parr habitat. Erosion on LB has caused alder anchor to lean too close to river. Site should be repaired before Alder falls. Cables into Cedar anchor starting to cut in.
C	757	DJ5	LWD cover	(2)				(2)		2	ST	PARR		(2)				2	1	1	2	1	Y	39,40	Structure has failed and has come apart. Most of structure is dry on clay ledge. Providing very little fish habitat in current state. Should be repaired before whole structure washes away.
C	800	LO3	LWD cover	(3)	3		3	(3)		3	ST	PARR	3	(3)	3			3	3	3	3	3	N	41,42	Providing decent rearing conditions with good flow, however, little scour. Large accumulations of SWD. Cedar observed in 2003 is gone.
C	870	LO1	LWD cover					(3)		3	ST	PARR		(3)	3			3	3	3	3	3	Y	43,44	Providing good cover to existing pool. Some SWD has accumulated on front of structure (full span). May pose threat to recreational users.
C	934	BC	boulder cover, increase ST parr habitat		(3)			(3)		3	ST	PARR		(3)				3	3	3	3	3	N	n/a	Creating decent boulder riffle habitat. A few boulders have shifted d/s. Most boulders are girdled with cobbles, thus shallower pockets.
B	30	LO4	LWD cover	3				(3)		3	ST	PARR	3	(3)				3	3	3	4	3	N	64-66	Upper part of site has good depth (1.3 m) and cover. Max. pool depth 1.7 m. Lower part has infilled and shallow, providing little habitat.
B	120	DJ5	LWD cover	(4)	3		3	(3)		3	ST	PARR		(4)	3			4	4	4	4	4	N	63	Good depth (1.5 m) and flow throughout site. Good woody debris recruitment. Site performing very well. Very little depostion.
B	182	DJ5+SP	LWD cover	(2)	3		3	(3)		2	ST	PARR		(2)				2	3	3	3	3	N	62	Little scour due to congested site. One small usable pocket. Some SWD, site structurally stable.
B	238	LO1	LWD cover	(3)				(3)		3	ST	PARR		(3)	3			3	3	3	3	3	N	60,61	Good scour off face. Pool depth 2.0 m. SWD + LWD on face (full span). Good pool cover.
B	295	DJ5	LWD cover	(3)	3		4	(3)		3	ST	PARR	3	(3)	3			3	3	3	3	3	N	59	Decent scour off point (substrate limits depth). Good deflector off bank. Good recruitment of LWD + SWD.
B	360	RIF-ENH	increase ST parr habitat		(3)			(3)		3	ST	PARR		(3)				3	3	3	2	3	N	58	No movement/erosion. Pockets behind rocks slightly infilled. Ave. depth 0.5 m, max. depth 0.75 m. Good depth in plunge pool (0.9 m).
B	380	LO2	LWD cover	(3)				(3)		3	ST	PARR	3	(3)				3	3	3	3	2	Y	n/a	Very little scour created as structure not in main thalweg. Cedar providing some pool cover. No flow through site. One cable pulled out.
B	400	DJ5	LWD cover	(3)	3		3	(3)		3	ST	PARR	3	(3)				3	3	3	3	3	N	56,57	Good scour off point of structure (1.2 m), infilling behind with sediment. Some bank scouring. Some LWD + SWD recruits.
B	460	DJ5	LWD cover	(3)	3		1	(3)		3	ST	PARR		(3)				3	3	2	3	3	Y	55	Little scour off tip of structure (0.8 m). Good rearing for ST parr. Bank eroding on RB ~3.5 m. May require rip rap. SWD + LWD recruits.
B	558	BC	boulder cover, increase ST parr habitat		(3)			(3)		3	ST	PARR		(3)				3	3	3	3	3	N	53,54	Larger upper rocks working well, some infilling of cobble, gravel and sand. Ave. depth behind rocks = 0.4 m. Max. depth in pockets 0.65 m.
A	40	DJ5	LWD cover	(3)			3	(4)		3	ST	PARR	4	(3)				3	3	3	3	3	N	50-52	Good scour off point of structure and in front. Back of site infilled with sediment. Good recruits of SWD +LWD (alder with rootwad). Will continue to collect wood (poss. debris jam).
A	118	BC	boulder cover, increase ST parr habitat		(3)			(3)		3	ST	PARR		(3)				3	3	3	3	3	N	48,49	Decent boulder riffle habitat. Limited depth around boulders as most are 1/3 buried with cobble. A few deeper pockets. Some shifting.
A	160	LO4	LWD cover	(3)				(3)		3	ST	PARR	3	(3)				3	3	3	3	3	N	45-47	Functioning decently. Limited scour and depth (1.2 m). Flow more central in channel. Good cover from added SWD. Previous Alder gone.

Notes 1. ( ) Denotes priority

Appendix B.5. Routine effectiveness evaluation performed on June 8, 2004, of restoration work constructed in the Little Qualicum River in 2003.

Watershed Little Qualicum
Sub-watershed ________
Date 8 June 04

Survey Crew SS, HW
Weather / Flow Sunny, Warm, Low Spring Flows

REE Interval First Time (constructed 2003)

				Performance Objectives															Overall						Comments
				Physical							Biological														
Reach	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Nutrient	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
D	0+370	BC	boulder cover, increase ST parr habitat		(1)			(1)		**1**	ST	PARR	4	(1)				**1**	**3**	**3**	**1**	**1**	**Y**	1,2	Boulder riffle now in lower Kinkade Cr. due to u/s avulsion. Boulders are infilled with sediment and not functioning due to low flow. Max depth of 0.8 m. Possibly fix if avulsion repaired.
D	0+400	LX 2	LWD cover	(2)				(3)		**2**	ST	PARR	3	(2)				**2**	**2**	**2**	**2**	**2**	**Y**	3,4	LX 2 in standing water due to avulsion and low flow. Good depth under root plate. Site partially buried. Structural condition suspect. Possibly fix if avulsion repaired.
D	0+750	LX 2	LWD cover	(3)			3	(4)		**3**	ST	PARR	3	(4)				**4**	**3**	**3**	**3**	**3**	**N**	5-7	Site working very well. Good scour and depth (1.2 m) with good flow through entire structure. Very little deposition. Excelent SWD and LWD recruits: 1-25 cm dbh alder, 2-35cm dbh Alders.
D	0+780	BC	boulder cover, increase ST parr habitat		(3)			(3)		**3**	ST	PARR		(3)				**3**	**3**	**3**	**3**	**3**	**Y**	8,9	Good riffle site with broken water cover, depth 0.9 m near boulders. Re-position bonus boles near water and re-cable at lower point on ballast.
D	1+285	DJ 5	LWD cover	(2)	3		3	(2)		**2**	ST	PARR	3	(3)				**3**	**3**	**3**	**3**	**3**	**N**	10-14	Good riffle habitat off point of structure. Severe infilling in middle and d/s point of structure. Some SWD recruitment. Ballast appears buried.
D	1+355	LSP 6	LWD cover	(2)	3		(4)	2		**2**	ST	PARR		(2)				**2**	**3**	**4**	**3**	**2**	**N**	15-18	Good bank protection. Severe infilling limits use by fish (depth 0.8 m) as little pool depth and scour. Good flow deflector, good depth and velocity off point.
D	1+385	LSP 3	LWD cover	(3)	3		(3)	2		**3**	ST	PARR		(3)				**3**	**3**	**3**	**3**	**2**	**N**	19-21	Good bank protection. Site creates decent riffle habitat with mid stream boulder off point. Very little rearing around structure due to infilling.
D	1+395	LSP 3	LWD cover	(3)			(3)	2		**3**	ST	PARR	3	(3)				**3**	**3**	**3**	**3**	**3**	**N**	22,23	Good bank protection. Provides good rearing habitat due to decent depth (1.0 m). Good interstial space around boulder/rip rap.
D	1+415	LSP 3	LWD cover	(3)			(3)	3		**3**	ST	PARR	3	(3)				**3**	**3**	**3**	**3**	**3**	**N**	24,25	Good bank protection. Limited fish habitat creation due to lack of pool scour (0.9 m) and infilling. Moderate flows off point of structure.

Notes 1. ( ) Denotes objective of the habitat restoration structure.

Appendix B.6. Routine effectiveness evaluation performed on June 4, 2004, of restoration work constructed in the Englishman River in 2003.

Watershed Englishman River
Sub-watershed ___________
Date 4 June 04

Survey Crew MM, SS
Weather / Flow Mainly Sunny, 2.75 m^3/s

REE Interval Year 1

			Performance Objectives: Physical							Performance Objectives: Biological								Overall						Comments
Site ID #	**Structure Type**	**Site Objective**	**Pool**	**Riffle**	**Gravel Bar**	**Streambank**	**Stream Cover**	**Nutrient**	**Overall rating**	**Species**	**Life Stage**	**Overwinter**	**Rearing**	**Holding**	**Spawning**	**Incubation**	**Overall rating**	**Structural Condition**	**Structural Stability**	**High Flow Function**	**Low Flow Function**	**Maintenance Recommendation**	**Photo Numbers**	
8+820	LX Sweeper	LWD Cover	(3)			4	(3)		**3**	St Co	Parr, Fry Fry	3	(3)				**3**	4	4	3	3	N	1,2	Possibly cable add. LWD (on site) to the u/s portion of structure. Max. depth =1.2 m.
8+600	LX Sweeper	LWD Cover	(3)			4	(3)		**3**	St Co	Parr, Fry Fry	3	(3)				**3**	4	4	3	3	N	3-5	Moderate amounts of SWD captured. Provides good bank protection. Max. depth = 1.6 m.
8+240	LX Sweeper	LWD Cover	(3)			4	(4)		**4**	St Co	Parr, Fry Fry	3	(4)				**4**	4	4	4	4	N	6-9	Good flow of water through structure. Max. depth = 1.25 m.
8+140	LX Sweeper	LWD Cover	(3)			3	(3)		**3**	St Co	Parr, Fry Fry	3	(3)				**3**	3	3	4	3	Y	10-13	Good flow along side of structure. 1 cable has pulled out of ballast. Max. depth = 1.1 m.
7+420	LX Sweeper	LWD Cover	(3)			3	(3)		**3**	St Co	Parr, Fry Fry	3	(3)				**3**	4	4	3	3	N	14-17	New alder recruited. Added pieces may be placed to increase complexity. Max. depth = 1.2 m.
7+260	LX Sweeper	LWD Cover	(3)			3	(3)		**3**	St Co	Parr, Fry Fry	3	(3)				**3**	4	4	3	3	N	18-20	Good parr habitat on u/s portion of structure. SWD recruited to structure. Max. depth = 1.1 m.
7+140	LX Sweeper	LWD Cover	(3)			4	(3)		**3**	St Co	Parr, Fry Fry	3	(4)				**4**	4	4	3	3	N	21-23	Moderate flow through structure in back pool area. SWD recruited to structure. Max. depth = 1.0 m
7+120	LX Sweeper	LWD Cover	(3)			3	(3)		**3**	St Co	Parr, Fry Fry	3	(4)				**4**	4	4	4	4	N	24,25	SWD recruited provides added cover. Possible additions of LWD to structure to increase complexity. Max. depth = 1.1 m
6+430	Riffle Enhancement	Improve St Parr Habitat		(3)			(3)		**3**	ST	Parr		(3)				**3**	3	3	3	3	N	26	Good parr velocities at observed flow. No sedimentation behind boulders.
6+550	Riffle Enhancement	Improve St Parr Habitat		(3)			(3)		**3**	ST	Parr		(3)				**3**	3	3	2	4	N	27	Riffle entry point with deeper pocket water behind and good cover by placed rocks.
6+210	Riffle Enhancement	Improve St Parr Habitat		(3)			(3)		**3**	ST	Parr		(3)				**3**	4	4	4	4	N	28,29	Good parr velocities at observed flow. No sedimentation behind boulders.
6+200	Typical Lateral LWD	LWD Cover	(3)			3	(3)		**3**	St Co	Parr, Fry Fry	3	(3)				**3**	4	4	4	3	N	30-32	Appear to fcn best at higher flows. Good flow through structure for ST parr. Max depth 1.0 m.
5+900	LX 4	LWD Cover	(2)				(3)		**2**	St Co	Parr, Fry Fry	3	(3)				**3**	4	4	3	2	N	33-36	Good parr velocities at head of structure. Later part lacks flow and depth. Possibly wood added to increase complexity. Max. depth = 0.8 m.
5+700	LO 1 Cedar	LWD Cover	(3)				(3)		**3**	St Co	Parr, Fry Fry		(3)				**3**	3	3	3	3	N	37-40	Good pool depth and cover on both sides of structure. Some depostion behind structure. Max depth = 1.2 m.
5+600	LX 6		(4)			3	(4)		**4**	St Co	Parr, Fry Fry	3	(4)				**4**	4	4	3	4	N	41-44	Excellent parr rearing habitat in fast water cover. Good bank protection. Some deposition around upper structure. Max depth = 1.5 m.

Notes 1. ◯ Denotes the objective of the restoration site.

Appendix B.7. Snorkel surveys conducted in the Englishman River during the 2003/04 winter steelhead season.

FILE NOTE

Date: March 2, 2004
File: 34560-20/SNORK
xf: 34560-27/*Englishman*

SNORKEL SURVEY REPORT
Englishman River

DATE:	March 1st and 2nd, 2004.
WEATHER:	March 1st –Mainly sunny, warm, air temp 12°C. March 2nd – Mainly sunny, warm, air temp 13°C.
WATER TEMP. (°C):	3.5 on March 1st; 3.5 on March 2nd.
DISCHARGE (m^3/s):	7.56 on March 1st, 6.60 on March 2nd (per WSC website)
VISIBILITY (m):	March 1st – 3.5 m; March 2nd – 8.0 m (visibility reduced d/s of Morison Cr.)
PERSONNEL:	Mainstem section 1: R. Dolighan, S. Silvestri, H. Wright Mainstem section 2: J. Craig, B. Smith Mainstem section 3: M. McCulloch, S. Silvestri
AREA:	Mainstem 1: Grassy Bank to Big Tent Run (4.2 km) Mainstem 2: End of Englishman River Rd. to Grassy Bank (4.6 km) Mainstem 3: Falls Pool to end of Englishman River Rd. (6.2 km)

Total distance surveyed = 15.0 km

1. Fish Observed:

Adult Steelhead:

A total of 21 steelhead (19 wild, 2 unknown) were counted for an observed density of 1.4 fish/km.

Distribution was as follows:

- **Section 1:** one female (holding in fast water @ the Inland Island Hwy Br.).
- **Section 2:** 20 steelhead evenly distributed. 10 fish were observed near the newly created LWD structures.
- **Section 3:** No steelhead observed.

Steelhead ranged in weight from 3-9 kg and were bright to moderate in color. See table below for condition rating:

Condition[1]	1	2	3	4	5
#	1	15	3	1	1
%	4.8	71.4	14.3	4.8	4.8

[1] 1 (bright), 2 (moderately coloured), 3 (mid spawn), 4 (post spawn), 5 (undetermined)

Rainbow/Cutthroat Trout:

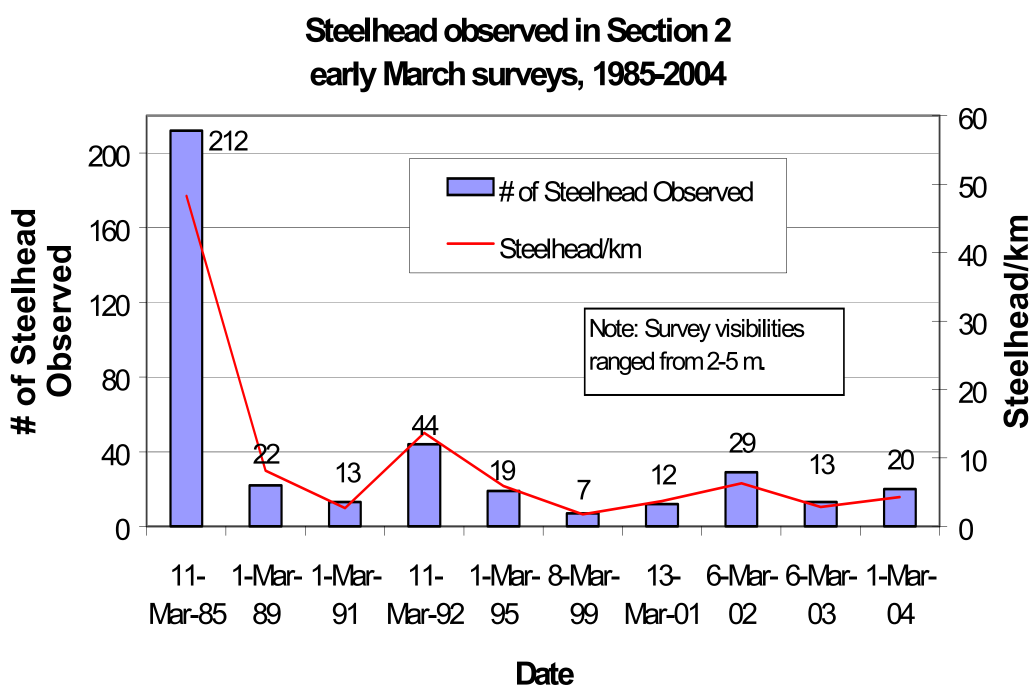
- **Section 1:**
  2 cutthroat trout (1 wild @ 25-35 cm, 1 hatchery @ 25-35 cm)
- **Section 2:**
  4 wild rainbow trout (2 @ 25-35 cm, 1 @ 35-45 cm, 1 > 45 cm)
  11 cutthroat trout (1 hatchery @ 25-35 cm, 3 wild @ 25-35 cm, 1 wild @ 35-45 cm, 6 unknown @ 25-35 cm).
  3 unidentified trout of unknown origin @ 25-35 cm
- **Section 3:**
  2 wild rainbow trout @ 35-45 cm

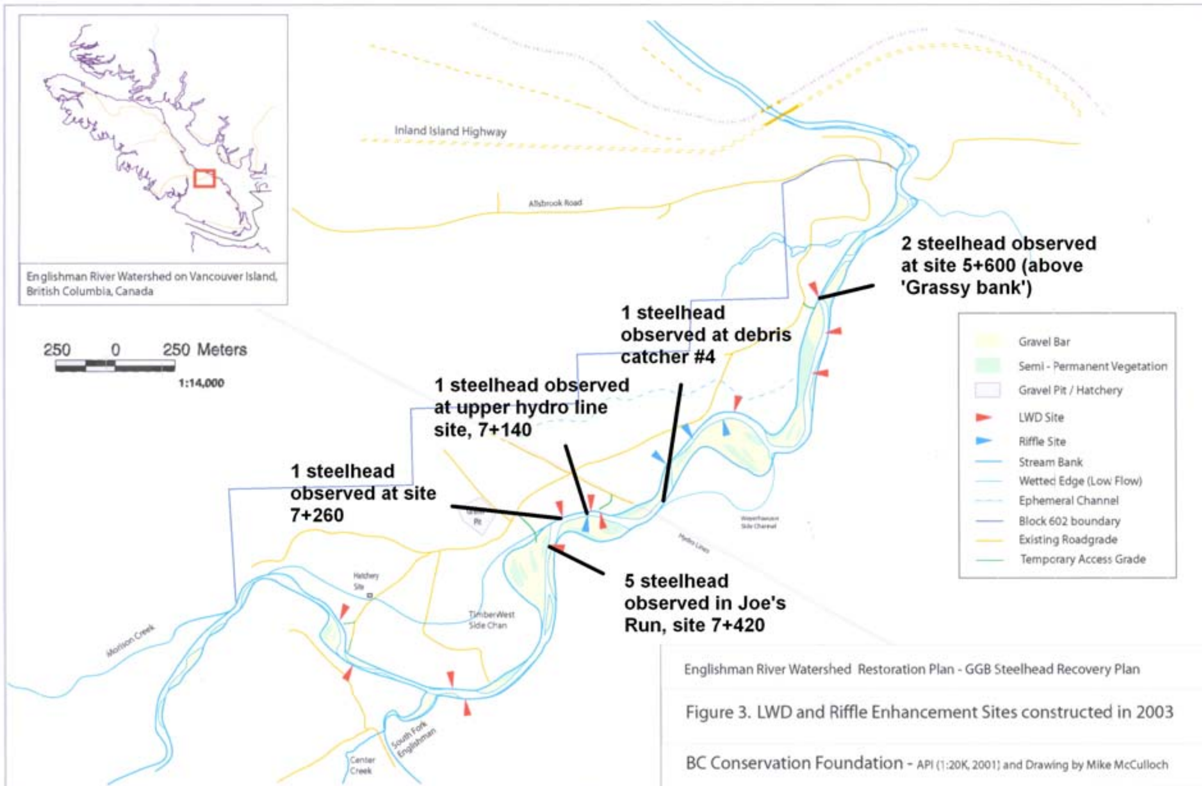
Juveniles:

None observed.

2. **Notes:**

- No anglers or evidence of recent angling were observed (this stream is closed below lower Englishman River falls Dec. 1-May 31).
- The majority of fish observed were 2 ocean (~75%).
- Two large fish (3/4 ocean) were observed in the "Slough Hole". Weights ranged from 7-9 kg.
- One fish observed had obvious predator marks (scratches) on abdomen.
- One redd was observed in the tailout of the S/C intake pool (right bank).
- March snorkel surveys on the Englishman River have been conducted regularly by WLAP and BCCF staff. Results of mainstem section 2 surveys from 1985–2004 are presented below.
- 10 of 21 fish were observed directly under or near the newly created LWD structures. Steelhead locations are presented on map below.





Englishman River Watershed Restoration Plan - GGB Steelhead Recovery Plan

Figure 3. LWD and Riffle Enhancement Sites constructed in 2003

BC Conservation Foundation - API (1:20K, 2001) and Drawing by Mike McCulloch

Scott Silvestri
Fisheries Technician
BC Conservation Foundation

cc: All Fisheries staff
Steelhead Crew
Conservation Officer Service, Nanaimo
B. Bocking, LGL Ltd., Sidney
M. Gaboury, LGL Ltd., Nanaimo
M. Sheng, Biologist, DFO, Nanaimo (Departure Bay Road)
K. Simpson, Biologist, DFO, Nanaimo (PBS)
P. Law, Ecosystems Biologist, WLAP, Nanaimo

FILE NOTE

Date: March 25, 2004
File: 34560-20/SNORK
xf: 34560-27/*Englishman*

SNORKEL SURVEY REPORT
Englishman River

DATE:	March 22nd and 23rd, 2004.
WEATHER:	March 22nd – 50% O.C., mild, air temp. 10°C.
	March 23rd – 100% O.C., light rain, air temp. 8°C.
WATER TEMP. (°C):	5.4 on March 22nd @ 1300 hrs.
DISCHARGE (m^3/s):	8.10 on March 22nd, 9.10 on March 23rd (per WSC website)
VISIBILITY (m):	March 22nd – 6.0 m; March 23rd – 3.5 m
PERSONNEL:	Mainstem section 1: J. Craig, S. Silvestri
	Mainstem section 2: M. McCulloch, S. Silvestri
	Mainstem section 3: R. Ptolemy, H. Wright
AREA:	Mainstem 1: Grassy Bank to Big Tent Run (4.2 km)
	Mainstem 2: End of Englishman River Rd. to Grassy Bank (4.6 km)
	Mainstem 3: Falls Pool to end of Englishman River Rd. (6.2 km)

Total distance surveyed = 15.0 km

1. Fish Observed:

Adult Steelhead:

A total of 24 steelhead (19 wild, 2 unknown) were counted for an observed density of 1.6 fish/km.
Distribution was as follows:

- **Section 1:** Six steelhead (2 immediately above Parry's, 1 above Hwy 19A Br., 3 in riffle below Hwy 19A).
- **Section 2:** 13 steelhead evenly distributed (3 @ S/C intake, 1 @ South Fork conf., 4 @ Joe's Run, 3 @ lower Hydro LWD site, 2 above Grassy Bank). 7 fish were observed near the newly created LWD structures.
- **Section 3:** Five steelhead evenly distributed (2 @ tailout of falls pool, 1 @ half-way point of survey, 2 in alder run 3/4 of the way through the survey).

Steelhead ranged in weight from 2-6.5 kg and were bright to moderate in color. See table below for condition rating:

Condition[1]	1	2	3	4	5

[1] 1 (bright), 2 (moderately coloured), 3 (mid spawn), 4 (post spawn), 5 (undetermined)

#	7	7	9	1	0
%	29.2	29.2	37.5	4.1	

Rainbow/Cutthroat Trout:

- **Section 1:**
  3 cutthroat trout (1 wild @ 35-45 cm, 2 hatchery @ 25-35 cm)
  1 wild rainbow trout @ 35-45 cm
- **Section 2:**
  2 wild rainbow trout (1 @ 25-35 cm, 1 > 45 cm)
  4 cutthroat trout (1 wild @ 35-45 cm, 1 wild > 45 cm, 1 hatchery @ 35-45 cm, 1 hatchery > 45 cm).
- **Section 3:**
  3 wild rainbow trout (2 @ 35-45 cm, 1 > 45 cm).

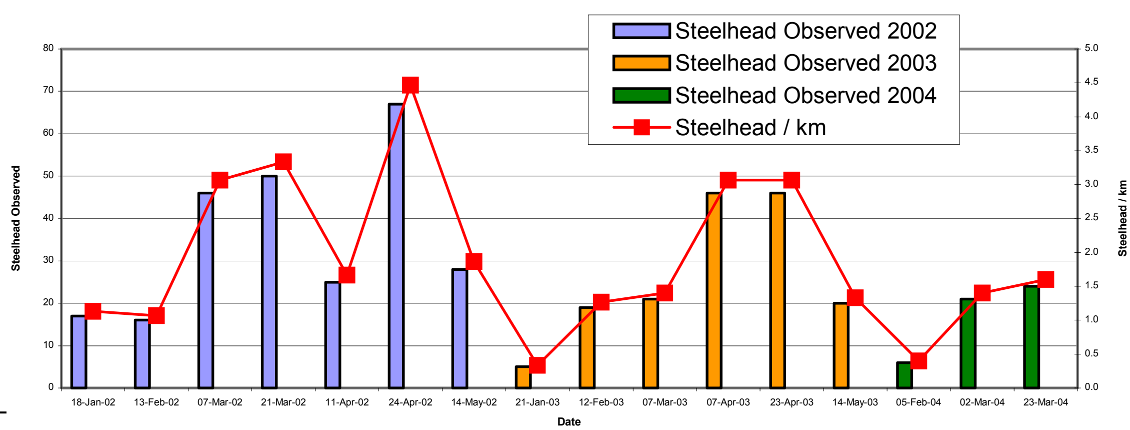
Juveniles:

None observed.

2. **Notes:**

- No anglers or evidence of recent angling were observed (this stream is closed below lower Englishman River falls Dec. 1-May 31).
- The majority of fish observed were 2 ocean (~75%).
- Three possible redds were observed (1 near right bank of S/C intake pool, 1 above Parry's, 1 in the tailout of the HWY 19A Bridge pool).
- This is year three of intense snorkel surveys on the Englishman River during the winter steelhead season by WLAP and BCCF staff. Results of the mainstem surveys from 2002–2004 are presented below.
- 7 of 21 fish were observed directly under or near the newly created LWD structures. Steelhead locations are presented on map below.

Steelhead observed in 3 mainstem section snorkel surveys, 2002-2004.



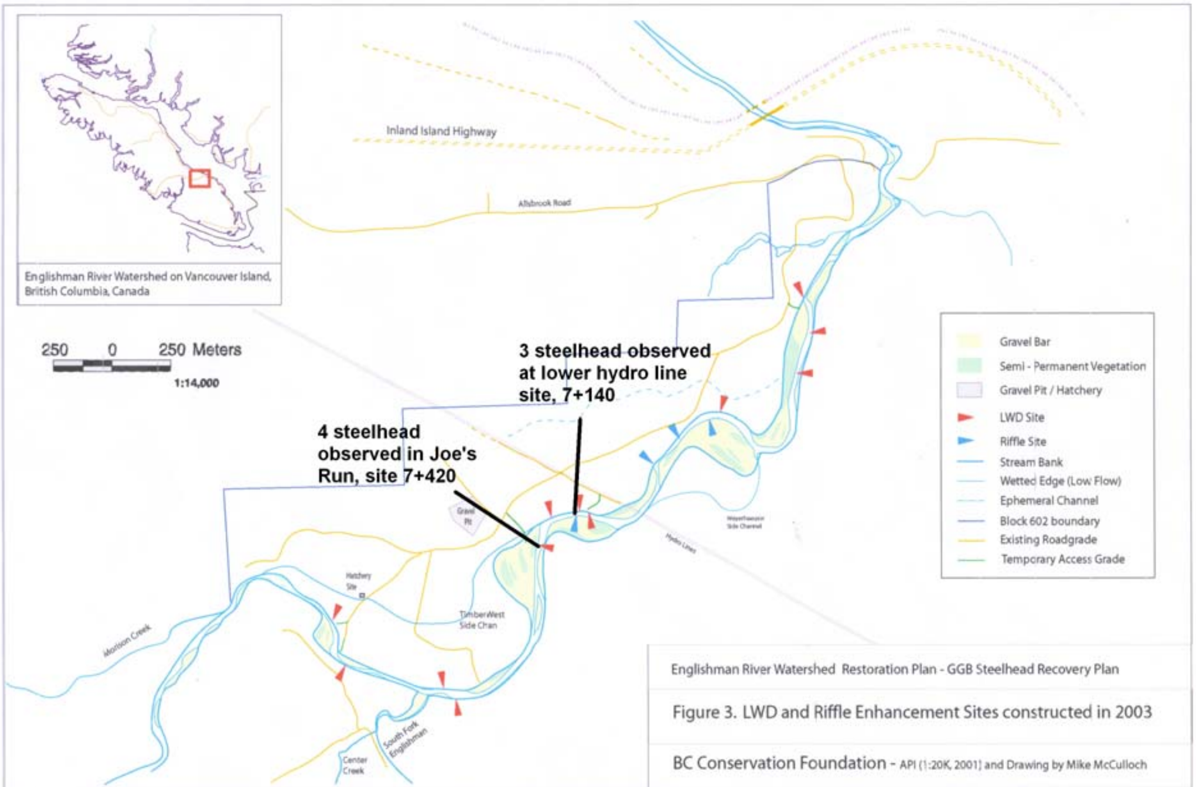


Figure 3. LWD and Riffle Enhancement Sites constructed in 2003

Scott Silvestri
Fisheries Technician
BC Conservation Foundation

cc: All Fisheries staff
Steelhead Crew
Conservation Officer Service, Nanaimo
B. Bocking, LGL Ltd., Sidney
M. Gaboury, LGL Ltd., Nanaimo
M. Sheng, Biologist, DFO, Nanaimo (Departure Bay Road)
K. Simpson, Biologist, DFO, Nanaimo (PBS)
P. Law, Ecosystems Biologist, WLAP, Nanaimo

Appendix C

Spawning gravel placement monitoring data

Appendix C.1. Snorkel survey conducted in the Elk Falls Canyon (Campbell River) on August 1, 2003.

FILE NOTE

Date: August 8, 2003
File: 34560-20/SNORK
xf: 34560-27/*CAMPBELL*

SNORKEL SURVEY REPORT

Campbell River

DATE:	August 1, 2003
WEATHER:	Sunny, air temp 25 ^{o}C
WATER TEMP.(^{o}C):	17.0 (estimate)
DISCHARGE (m^3/s):	3.5 (as per BCH regulation)
VISIBILITY (m):	10+
PERSONNEL:	Mike McCulloch (BC Conservation Foundation), Dave Burt (D. Burt and Associates), Cedric Roberts (CBR and Associates)
AREA:	Elk Falls downstream to BCH John Hart Generation Station **Total distance: ~ 2.0 km**

1. Fish Observed:

Adults

1 summer steelhead.
The steelhead was observed in the John Hart Generating Station tailrace. Although several large rainbows (50 cm) were also present in the tailrace, these rainbows appeared to display resident rainbow morphology and were probably not steelhead.

1 pink salmon. Observed in the upper portion of Elk Falls Canyon, an additional 300 pinks were observed in the large pool at the tailout of Elk Falls Canyon.

15 resident rainbow @ 25-35 cm (1 @ 45 cm) located in the canyon section. Large groups of trout were observed in the John Hart generating station tailrace and were not formally enumerated.

6 cutthroat @ 25-35 cm (3 hatchery, 3 wild), located in the canyon reach.

Juveniles

Steelhead parr abundance was high overall with very high point abundance in suitable habitat. A moderate abundance of coho fry was noted throughout the survey.

2. Notes

- This swim was completed in conjunction with the development of the Campbell River Fish Habitat Restoration Plan (In prep. by D. Burt and Associates). The BC Conservation Foundation's (GGB Steelhead Recovery Plan) involvement in this survey was opportunistic and provided D. Burt with some further insight into potential gravel placements while allowing some additional monitoring of the gravel placement project completed in 2002 within the canyon.
- As the primary focus of the survey was not adult steelhead or juvenile assessments, the numbers identified within this report should be considered minimum abundances.
- The attached photos illustrate the current condition of the gravel placements installed in 2002 and documents one additional gravel placement opportunity in the lower portion of the Elk Falls Canyon.

Mike McCulloch
Fisheries Technician
Greater Georgia Basin Steelhead Recovery Plan

/dm
sns(creek)
cc: All Fisheries staff
Steelhead Crew
D. Burt and Associates
CBR and Associates
District Conservation Officers, Campbell River

Photo Pan 1. Looking upstream at the tailout of the Elk Falls plunge pool. Significant opportunity still exists to increase the quantity of spawning gravel at this location.

Photo Pan 2. Looking downstream at the secondary gravel placement site in 2002. An opportunity exists to place more spawning material at this location.

Photo Pan 3. Looking across-stream at a tail-out identified as a candidate for future gravel enhancement. This location was approximately 1.2 km downstream of Elk Falls.

Appendix C.2. Snorkel survey conducted in the Elk Falls Canyon (Campbell River) on November 6, 2003.

FILE NOTE

Date: November 7, 2003
File: 34560-20/SNORK
xf: 34560-27/*CAMPBELL*

SNORKEL SURVEY REPORT

Campbell River

DATE:	November 6, 2003
WEATHER:	Sunny, air temp near freezing.
WATER TEMP.(°C):	8 at 1100 hours
DISCHARGE (m^3/s):	3.5 (as per BCH regulation)
VISIBILITY (m):	10
PERSONNEL:	M. McCulloch, C. Wightman, J. Craig (+ volunteer journalist Ryan Stuart).
AREA:	Elk Falls downstream to BCH John Hart Generation Station.
	Total distance: approx. 2.0km

1. **Fish Observed**:

Adults

2 wild steelhead (~4 kg), both likely summer runs. These moderately bright fish were observed at the head of the falls pool and in a pool within 400 m of the falls.

52 resident rainbow (40 @ 25-35 cm, 12 @ 35-45 cm). These fish were mostly wild and well distributed throughout the surveyed reach, with concentrations near spawning chum and/or obvious salmon redds.

16 cutthroat trout (20-35 cm). Distributed throughout. Approximately 50% hatchery.

126 chum salmon. Generally mid-spawn, with both kelts and fresh fish also present. Distribution was even, though none were observed in the falls pool.

81 coho salmon (including 6 jacks). Mostly pre-spawn, coloured fish, many with fungus. Distribution was biased toward the upper half of the survey (28 in the falls pool).

3 chinook salmon. Large, post-spawn fish (15-20 kg), very coloured, often with fungus.

1 sockeye salmon. This fish was coloured and appeared to be pre-spawn.

Juveniles

Steelhead parr abundance was moderate relative to the most recent surveys (August, 2003).

Very few steelhead and coho fry were noted.

3. **Notes**

- This swim was completed to monitor the movement of spawning gravel (installed by helicopter in 1999 and 2002) following a large spill in the Elk Falls canyon on October 18 (8,400 cfs, C. Wightman, pers. comm.). The intent was to assess the resiliency and fish use of the previously introduced gravel in relation to a new proposal to the Bridge-Coastal Restoration Program (BC Hydro) for additional heli-placements of gravel in the canyon starting in the summer of 2004.
- In both original gravel pad locations, the majority of material was displaced downstream by the October 2003 spill event. In each situation, much of the gravel remaining lies between the larger, angular parent material (D50~45cm) in relatively small patches. Only in the falls pool tailout at depths greater than 1.4 m was there consistent gravel across the width of the channel (a few heli drops occurred in water as deep as 2.5 m).
- From the uppermost pad (falls pool tailout), gravel appears to have been spread downstream as far as the head of the next large holding pool, a distance of about 100 m. Within this distance, gravel has settled into isolated "back eddy" pockets behind large boulders (photo 1) and other areas that experience reduced scour. Gravel accumulations were noted both in and out of the wetted perimeter (photo 2); those wetted were situated in a mix of functional and non-functional locations.
- Gravel from the lower pad was also distributed downstream over a distance of 100-150 m. Similar to the upper site, a number of the gravel accumulations are currently functioning (photos 3 and 4), while others are located higher in the channel's cross-section and may be functional during higher flows.
- In general, accumulations of gravel throughout the survey section appeared to be somewhat more numerous and of higher quality than in previous surveys. This may be a result of the spill re-distributing or "shuffling" existing bedload that had previously been entrained under large boulders. Existing gravel that had been stable and unavailable prior to the spill may have become mobile and been scoured clean of periphyton, creating the impression of additional new material.
- With the spill event peaking on October 18, it is probable, given typical timing of pink and chinook spawning, that some redds were heavily scoured (though there is no evidence of this).
- Nine individual and/or "clustered" redds were counted in the main channel during the survey, though more on the perimeters of wider pools and tailouts may have been present. Of the nine counted, two singles and one "cluster" were located in the newly-introduced gravel. The other six appeared to be in parent material, based on the angular nature and/or colour of the rock.
- Several trout mortalities (>6) were noted amongst the large substrate on the bottom of the falls pool, close to the head (related to the large spill event?).
- Approximately 80 salmon carcasses (mostly chum) were counted through the reach, all presumably post-spawn. No pink carcasses were specifically noted.
- Recent sloughing from the canyon's right (south) bank was noted near the start of the survey, with fresh angular gravel/cobble in the pool below and at least one large conifer lodged in the tailout.
- The displacement of previously introduced gravel was anticipated given the magnitude of this recent spill (largest since November 1995). The fact that some of this gravel is no longer available to spawning fish at the 3.5cms conservation flow is also not surprising, since this more closely approximates a rearing flow, and not the spawning discharge target recommended by provincial biologists during Water Use Plan discussions (i.e., 10cms or somewhat higher).
- Movement of gravel during large canyon spills is a natural fluvial process that will ultimately lead to gravel recruitment at other sites further downstream, similar to what occurred in the river **before** BC Hydro dam construction in the late 1950's. The addition of gravel to the canyon reach is part of a joint federal-provincial-community strategy to restore the river's spawning capability for two major species, chinook salmon and steelhead trout.
- For steelhead, adding quality spawning gravel at selected sites in the canyon will increase wild fry abundance in immediate proximity to some of the highest quality rearing habitat in the Campbell River system. In time, this should lead to substantial increases in smolt production and hopefully adult returns.

James Craig
Fisheries Technician
Greater Georgia Basin Steelhead Recovery Plan

Photos attached

cc: All Fisheries staff
Steelhead Crew
A. McLean, Biologist, BCH, Campbell River
T. Veary, Production Manager, JHT, BC Hydro, Campbell River
D. Ewart, Manager, Quinsam River Hatchery, Campbell River
M. Sheng, Habitat Restoration Biologist, DFO, Nanaimo
R.A. Ptolemy, Senior Fisheries Biologist, Biodiversity Section, Victoria
D. Burt and Associates, Nanaimo
M. Gage, Chair, Campbell River Gravel Committee
A.F Lill, P.Eng., Co-ordinator, Greater Georgia Basin Steelhead Recovery Plan, North Vancouver

Photo 1. Introduced gravel from the falls pool tailout that has been distributed downstream ~40 m to a right bank location.

Photo 2. Gravel from the falls pool tailout that has been distributed ~80 m downstream on the left bank.

Photo 3. Functioning gravel that has accumulated downstream of the lower installation site.

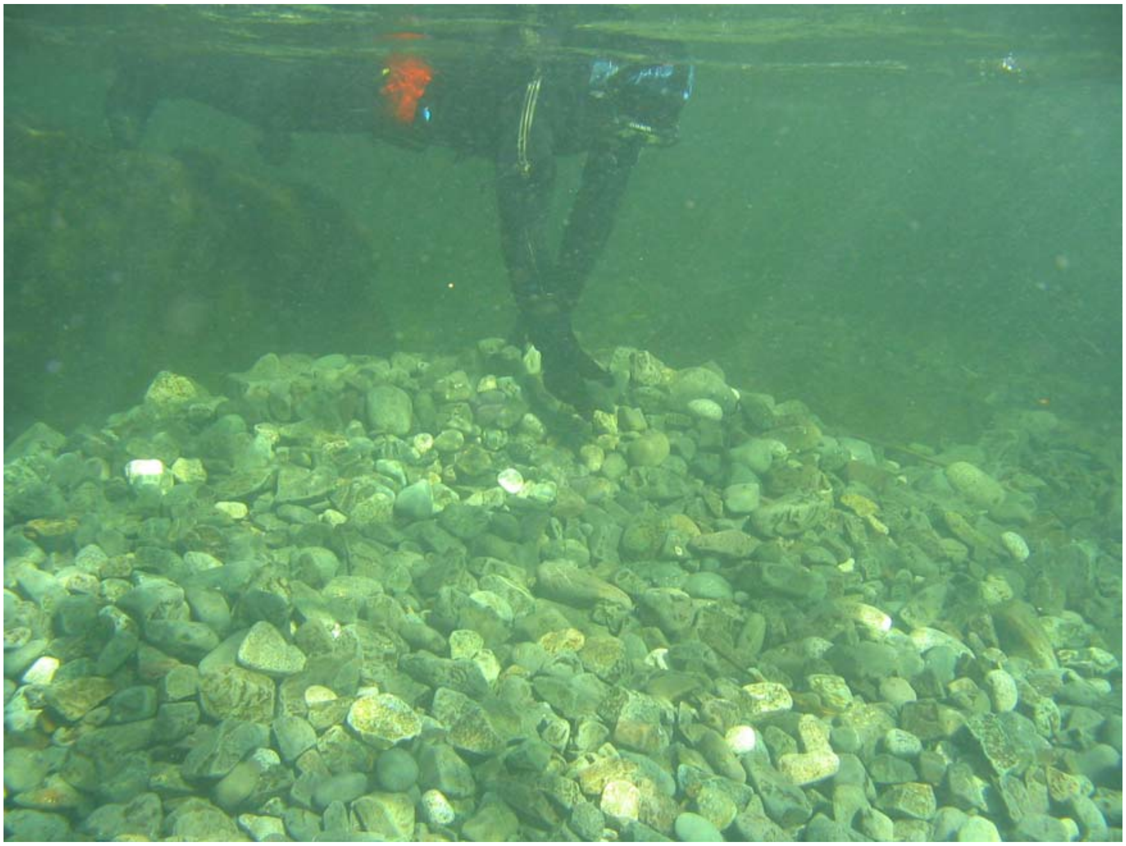


Photo 4. New gravel accumulation downstream of the lower installation site.

Appendix C.3. Snorkel survey conducted in the Nanaimo and South Nanaimo rivers on March 10, 2004.

FILE NOTE
Date: March 15, 2004
File: 34560-20/SNORK
xf: 34560-27/*Ash*

SNORKEL SURVEY REPORT
Nanaimo Lakes/South Nanaimo River

DATE:	March 10, 2004
WEATHER:	Sunny, mild, 12°C air temp.
WATER TEMP.(°C):	6.3 (Nanaimo Lakes) 5.8 (South Nanaimo River)
DISCHARGE (m^3/s):	moderate spring flows
VISIBILITY (m):	5-6 (Nanaimo Lakes) 5 (south Nanaimo River)
PERSONNEL:	B. Smith
AREA:	Spot swim from 100 m of spawning gravel site to 300 m downstream of site (400 m; Nanaimo Lakes) Spot swim from top of site 3 to 250 downstream (250 m: South Nanaimo River)

1. Fish Observed:

Adults

No fish observed in either survey.

Juveniles

None observed in either survey.

Notes:

- The purpose of the surveys was to evaluate spawning gravel placed at between First and Second lakes (Nanaimo River) and below the South Fork Dam (South Nanaimo River) in summer 2003.
- *South Nanaimo River:* as expected, spawning conditions at sites 1 and 2 were poor, as most material had been displaced downstream. However, conditions at site 1 appeared good, as ~70% of materials still remained in-situ. Material that had been displaced had settled into interstitial spaces between larger substrate throughout the section. A few usable areas for spawning were identified in this section, where enough gravel had accumulated (typically behind large boulder substrate). Furhter monitoring is recommended.
- *Nanaimo Lakes:* A majority of material observed (of the ~30% remaining following the October 18 event) was still in place. Other material had been displaced as far as 250 m downstream, settling in interstitial spaces between larger substrate throughout the lake inlet. A few gravel accumulations were identified in this section as suitable for spawning. No redds or fish were observed during the survey. Further monitoring is recommended.

Brad Smith
Fisheries Technician
BC Conservation Foundation

Appendix C.4. Gee-minnow trapping results at the outlet of Toquart Lake, June 26, 2003.

Set Information					# of Fish Captured				
Gee Trap #	Location	Time In	Time Out	Total Time	# of Resident Rainbows	# of Rb Parr	# of Rb Fry	# of Co Fry	# of DV parr
1	Riffle d/s Lake Pool (RB)	1410	1750	3h 40min				3	
2	Riffle d/s Lake Pool (RB)	1435	1750	3h 15min				15	
3	Riffle 10 m u/s Lake Pool	1500	1745	2h 45min			1	8	
4	Riffle 35 m u/s Lake Pool	1505	1740	2h 35min	1			3	1
5	Riffle 125 m u/s Lake Pool	1525	1730	2h 05min				18	
6	Riffle 165 m u/s Lake Pool	1535	1715	1h 40min			No fish captured		
7	Lake outlet near spawning gravel	1545	1655	1h 10min				7	
8	Lake outlet near spawning gravel	1550	1645	55 min		1		27	

Appendix C.5. Gee-minnow trapping results at the outlet of Stewart Lake, July 1, 2003

Set Information					# of Fish Captured				
Gee Trap #	Location	Time In	Time Out	Total Time	# of Resident Cutthroat	# of CT Parr	# of Rb Fry	# of Co Fry	# of DV parr
1	Top of Spawning Platform	1220	1430	2h 10min		1			
2	Top of Spawning Platform	1220	1430	2h 10min					1
3	Middle of Spawning Platform	1220	1430	2h 10min	2				
4	Middle of Spawning Platform	1220	1430	2h 10min	1				1
5	Bottom of Spawning Platform	1220	1430	2h 10min					1
6	50 m d/s Spawning Platform	1220	1430	2h 10min					

Appendix C.6. Snorkel survey conducted at the outlet of Dickson Lake (Ash River) on February 3, 2004.

FILE NOTE

Date: February 5, 2004
File: 34560-20/SNORK
xf: 34560-27/*Ash*

SNORKEL SURVEY REPORT

Ash River / Dickson Lake Outlet

DATE:	February 3, 2004
WEATHER:	Overcast, cool (about 30 cm of snow on the road)
WATER TEMP.(^{o}C):	4 (est)
DISCHARGE (m^3/s):	low-moderate winter flow (estimated at 100%MAD)
VISIBILITY (m):	6
PERSONNEL:	C. Wightman, J. Craig
AREA:	Spot swim from outlet of Dickson Lake to 200 m below Ash River Road bridge crossing (total distance = 300 m)

1. Fish Observed:

Adults

One steelhead (wild female, ~3 kg) was observed. The single fish appeared fecund and was observed about 100 m downstream of the bridge crossing.

Juveniles

None observed.

4. Notes

- The purpose of the survey was to evaluate spawning gravel placed at the outlet of Dickson Lake in September 2003. This project was intended to improve summer steelhead spawning success, and was funded by the Habitat Conservation Trust Fund and completed by BC Conservation Foundation, with support from Hupacaseth FN.
- Both gravel pads were intact and each showed signs of use by fish. The south pad (right bank) contained one complete redd and one other depression that appeared to be a test redd. Both were located near the downstream perimeter of the pad (fastest velocities at time of inspection). The north pad (left bank) contained what appeared to be one complete redd plus at least three test redds, also located in relatively fast water near the pad's downstream perimeter. Water depth at the time of survey averaged 35-40 cm near the redds, and ranged from 50-60 cm in the depressions associated with the redds.
- Additional redds were noted in natural substrates on the left bank, immediately downstream of the installed pads. These redds appeared to be from previous spawning seasons, though new redds may have been difficult to identify due to the nature and colour of the substrates.
- Banks on both sides of the outlet were used for machine access during pad construction. Both banks appeared to have weathered seasonal high flows well, with the layer of gravel left on each slope minimizing erosion at these disturbed sites. Additional seeding this spring is recommended to further improve slope stability and minimize any potential erosion.

James Craig
Fisheries Technician
BC Conservation Foundation

Appendix D

Nutrient enrichment monitoring data

Appendix D.1.: Water Sampling data from Harris, Lens and Renfrew creeks, June 25-September 16, 2003.

				Sample Location						
Test Description	Units	MDL*	Date	1 Harris u/s Fertilizer	2 Harris d/s Fertilizer	3 Harris u/s Hem. Conf.	4 Harris d/s Fert Site	5 Lower Harris	6 Renfrew Creek	7 Lens Creek
Total Alkalinity (CaCO3)	mg/L	1	Jun-25	25.1	17.5	58.8	58.8	48.2	41.7	37.1
			Jul-29	62.8	61.7	46.9	38.5	38	22.1	24.8
			Aug-28	61.7	59.2	40.9	37.6	34.6	22.1	23.7
			Sep-16	62.8	62	44.1	36.7	34.6	17.3	20.3
Ammonia Nitrogen	mg/L	5	Jun-25	<.005	0.195	<.005	<.005	<.005	<.005	<.005
			Jul-29	<.005	<.005	<.005	<.005	<.005	<.005	0.006
			Aug-28	<.005	<.005	<.005	<.005	<.005	<.005	<.005
			Sep-16	<.005	<.005	0.008	<.005	<.005	<.005	<.005
Nitrogen Dissolved: NO_2+NO_3	mg/L	2	Jun-25	0.085	0.04	0.02	0.021	0.016	0.011	0.024
			Jul-29	0.03	0.022	0.047	0.02	0.039	0.053	0.122
			Aug-28	0.041	0.041	0.057	0.026	0.062	0.114	0.14
			Sep-16	0.095	0.084	0.106	0.094	0.078	0.072	0.183
Ortho-Phosphorus Dissolved	mg/L	1	Jun-25	0.003	null	0.004	0.003	0.002	0.004	0.003
			Jul-29	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
			Aug-28	0.001	0.007	0.001	0.001	0.001	0.002	<0.001
			Sep-16	0.002	0.002	0.001	0.002	<0.001	0.002	0.001
Phosphorus Total Dissolved	mg/L	2	Jun-25	0.002	0.006	<0.002	0.004	<0.002	<0.002	<0.002
			Jul-29	<0.002	0.003	<0.002	0.006	<0.002	0.004	0.004
			Aug-28	<0.002	0.007	<0.002	0.002	0.003	<0.002	<0.002
			Sep-16	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Phosphorus Total	mg/L	2	Jun-25	0.003	0.003	0.002	0.007	0.003	0.004	0.002
			Jul-29	<0.002	0.003	<0.002	0.005	0.003	0.002	0.002
			Aug-28	<0.002	0.007	<0.002	0.003	<0.002	<0.002	0.003
			Sep-16	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
* MDL: Minimum Detection Level				*control*	*+ 50 m*	*+ 4 km*	*+ 25 m*	*+ 4 km*	*+ 1 km*	*+ 4 km*

Appendix D.2.: Harris Creek juvenile electrofishing and habitat data, September 19-23, 2003.

DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET (CALCULATES W.U.A. & DISCHARGE)

This spread sheet is designed for depth/velocity transect data collected within a closed electrofishing site.

Most of the cells in this spread sheet are locked & data entry is possible only in the un-protected (non-shaded) cells

STREAM:	Harris	UTM CODE:	0	
DATE:	19-Sep-03	STREAM CODE:	930-053800-22100	
MAIN/SIDE CHANNEL:	m	SITE REFERENCE:	0	
METERED/EST.:	m	TRANSECT #:	1	
MEAN/SURFACE:	m	SITE #	1	2 km d/s fertilizer (heli-boulder)
TRANSECT WIDTH:	5.0 m	HYDRAULIC TYPE:	R	
		WIDTH : DEPTH RA	47.4496	Feb. 2001 curves applied
SITE LENGTH:	12.2 m	TRANSECT TYPE:	P	
SITE WIDTH:	6.08 m	STREAM WIDTH:	5.0 m	
SITE AREA:	71.9 sq. m	NO. OF STATIONS:	11	
DISCHARGE:	0.1792 cu. m/sec			
SITE WEIGHTED MEANS		**ADJUSTED USABLE AREAS**		
Mean Depth:	0.105 m	% usable by RBT fry	51 %	
Mean Velocity:	0.340 m/sec	% usable by RBT parr	34 %	
Cross-sect. area	0.527 sq. m.	% usable by CT fry	45 %	
		% usable by CT parr	25 %	
		% usable by Chinook	33 %	
		% usable by Coho	18 %	

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data: station length (m)	depth (m)	velocity (m/s)	substrate	Cell Width (m)	cell mean depth (m)	cell mean velocity (m/s)	cell prob. RBT	Usable Width Fry (m)	cell prob. RBT Parr	Jsable Width RBT Parr	cell prob. CT fry	Jsable Width CT fry	cell prob CT parr	Jsable Width CT parr	cell prob. CH	Jsable Width CH (m)	cell prob. CO	Jsable Width CO (m)	Cell Area (sq. m	Cell Discharge (cu. m/sec)
1.5	0	0	CG	0.25	0.0075	0.03	0	0.0	0.00	0	1	0.25	0.03	0.01	0.00	0.00	0.00	0.00	0	5.6E-05
2	0.03	0.06	CG	0.5	0.03	0.06	0.57	0.29	0.01	0.01	1	0.5	0.03	0.02	0.03	0.02	0.20	0.10	0.02	0.0009
2.5	0.07	0.2	CG	0.5	0.07	0.2	1	0.5	0.19	0.09	1	0.5	0.22	0.11	0.17	0.08	0.32	0.16	0.04	0.007
3	0.12	0.35	CG	0.5	0.12	0.35	0.52	0.26	0.42	0.21	0.13	0.07	0.33	0.17	0.41	0.21	0.13	0.06	0.06	0.021
3.5	0.11	0.54	CG	0.5	0.11	0.54	0.12	0.06	0.37	0.19	0	0	0.06	0.03	0.26	0.13	0.00	0.00	0.06	0.0297
4	0.1	0.07	CG	0.5	0.1	0.07	1	0.5	0.13	0.07	1	0.5	0.27	0.14	0.14	0.07	0.61	0.31	0.05	0.0035
4.5	0.13	0.41	CG	0.5	0.13	0.41	0.32	0.16	0.46	0.23	0.04	0.02	0.25	0.13	0.46	0.23	0.03	0.01	0.07	0.02665
5	0.14	0.43	CG	0.5	0.14	0.43	0.27	0.14	0.51	0.26	0.01	0.01	0.30	0.15	0.51	0.26	0.02	0.01	0.07	0.0301
5.5	0.17	0.25	CG	0.5	0.17	0.25	0.86	0.43	0.63	0.32	0.75	0.38	0.71	0.36	0.77	0.39	0.45	0.23	0.09	0.02125
6	0.12	0.47	CG	0.5	0.12	0.47	0.2	0.1	0.42	0.21	0.01	0.01	0.14	0.07	0.34	0.17	0.00	0.00	0.06	0.0282
6.5	0.12	0.25	CG	0.25	0.12	0.36	0.49	0.12	0.42	0.11	0.13	0.03	0.33	0.08	0.41	0.10	0.10	0.02	0.03	0.0108
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0

This spread sheet is brought to you by Poul Bech, Ron Ptolemy, and Rob Knight, B.C. Environment, Fisheries Section, May 1994.

STREAM:	Harris
SITE:	1
LENGTH:	12.2
WIDTH:	6.08
AREA:	71.9
DATE:	19-Sep-03

	Species /age	Mean weight (g)	Catch 1	Catch 2	Estimated population	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	3.08	38	3	41.26	57.39	0.51	112.4
Sp. #2	Rb(1+)	14.40	1		1.00	1.39	0.34	4.1
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.34	#DIV/0!
Sp. #4	Co(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.18	#DIV/0!
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is des
to process electrofishin
Data can only be entere
shaded cells - all shade
protected.
Poul Bech, Reg. 2 Fish
B.C. Environment, Augu

Sp. #1 Length	**Rb(0+)** c1+c2	weights	est wt.	total wgt.	condition
53	1	1.6	1.52	1.517802	1.07E-05
54	1	1.60	1.61	1.605346	1.02E-05
55	1	1.7	1.70	1.696194	1.02E-05
56	1	1.7	1.79	1.790406	9.68E-06
56	1	1.7	1.79	1.790406	9.68E-06
56	1	1.8	1.79	1.790406	1.02E-05
57	1	2.1	1.89	1.888044	1.13E-05
58	1	1.8	1.99	1.989168	9.23E-06
58	1	2.1	1.99	1.989168	1.08E-05
58	1	2.1	1.99	1.989168	1.08E-05
60	1	2.1	2.20	2.202121	9.72E-06
60	1	2.1	2.20	2.202121	9.72E-06
61	1	2.4	2.31	2.314072	1.06E-05
62	1	2.7	2.43	2.429755	1.13E-05
62	1	2.6	2.43	2.429755	1.09E-05
62	1	2.4	2.43	2.429755	1.01E-05
63	1	2.6	2.55	2.54923	1.04E-05
63	1	2.9	2.55	2.54923	1.16E-05
63	1	2.4	2.55	2.54923	9.60E-06
64	1	2.5	2.67	2.672559	9.54E-06
65	1	2.8	2.80	2.799803	1.02E-05
65	1	2.5	2.80	2.799803	9.10E-06
65	1	2.9	2.80	2.799803	1.06E-05
68	1	3.2	3.21	3.205636	1.02E-05
70	1	3.5	3.50	3.496887	1.02E-05
70	1	3.4	3.50	3.496887	9.91E-06
71	1	3.4	3.65	3.648904	9.50E-06
71	1	3.6	3.65	3.648904	1.01E-05
73	1	3.8	3.97	3.96603	9.77E-06
76	1	4.3	4.48	4.475363	9.80E-06
77	1	4.8	4.65	4.654356	1.05E-05
78	1	4.7	4.84	4.83806	9.90E-06
78	1	4.7	4.84	4.83806	9.90E-06
79	1	5.2	5.03	5.026535	1.05E-05
79	1	4.6	5.03	5.026535	9.33E-06
80	1	5.5	5.22	5.219843	1.07E-05
80	1	5.6	5.22	5.219843	1.09E-05
81	1	5.3	5.42	5.418044	9.97E-06
63	1		2.55	2.54923	0.00E+00
67	1		3.07	3.06628	0.00E+00
71	1		3.65	3.648904	0.00E+00

Sp. #2 Length	**Rb(1+)** c1+c2	weights(g)	**Sp. #3** Length	**Rb(2+)** c1+c2	weights(g	**Sp. #4** Length	**Co(0+)** c1+c2	weights(	**Sp. #5** Length	c1+c2	weight	**Sp. #6** Length	c1+c2
110	1	14.4											

DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET (CALCULATES W.U.A. & DISCHARGE)

This spread sheet is designed for depth/velocity transect data collected within a closed electrofishing site.

Most of the cells in this spread sheet are locked & data entry is possible only in the un-protected (non-shaded) cells

STREAM:	Harris	UTM CODE:	0	
DATE:	19-Sep-03	STREAM CODE:	930-053800-22100	
MAIN/SIDE CHANNEL:	m	SITE REFERENCE:	0	
METERED/EST.:	m	TRANSECT #:	1	
MEAN/SURFACE:	m	SITE #	2	1.5 km d/s fertilizer (Faller's Bridge)
TRANSECT WIDTH:	4.4 m	HYDRAULIC TYPE:	R	
		WIDTH : DEPTH RA	18.9109	Feb. 2001 curves applied
SITE LENGTH:	14.5 m	TRANSECT TYPE:	T	
SITE WIDTH:	4.10 m	STREAM WIDTH:	4.4 m	
SITE AREA:	50.5 sq. m	NO. OF STATIONS:	10	
DISCHARGE:	0.1345 cu. m/sec			
SITE WEIGHTED MEANS		**ADJUSTED USABLE AREAS**		
Mean Depth:	0.233 m	% usable by RBT fry	76 %	
Mean Velocity:	0.131 m/sec	% usable by RBT parr	42 %	
Cross-sect. area	1.024 sq. m.	% usable by CT fry	87 %	
		% usable by CT parr	73 %	
		% usable by Chinook	47 %	
		% usable by Coho	72 %	

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data: station length (m)	depth (m)	velocity (m/s)	substrate	Cell Width (m)	cell mean depth (m)	cell mean velocity (m/s)	cell prob. RBT	Usable Width Fry (m)	cell prob. RBT Parr	Jsable Width RBT Parr	cell prob. CT fry	Jsable Width CT fry	cell prob CT parr	Jsable Width CT parr	cell prob. CH	Jsable Width CH (m)	cell prob. CO	Jsable Width CO (m)	Cell Area (sq. m	Cell Discharge (cu. m/sec)
1.6	0	0	BLg	0.2	0.0125	0.05	0.18	0.0	0.00	0	1	0.2	0.03	0.01	0.01	0.00	0.05	0.01	0	0.00013
2	0.05	0.1	BLg	0.45	0.05	0.1	1	0.45	0.07	0.03	1	0.45	0.13	0.06	0.08	0.03	0.34	0.15	0.02	0.00225
2.5	0.17	0.02	BLg	0.5	0.17	0.02	0.7	0.35	0.07	0.03	1	0.5	0.71	0.36	0.12	0.06	0.87	0.44	0.09	0.0017
3	0.19	0.08	BLg	0.5	0.19	0.08	1	0.5	0.32	0.16	0.98	0.49	0.85	0.43	0.47	0.24	0.92	0.46	0.1	0.0076
3.5	0.09	0.23	BLg	0.5	0.09	0.23	0.92	0.46	0.28	0.14	0.9	0.45	0.27	0.14	0.25	0.13	0.34	0.17	0.05	0.01035
4	0.35	0.08	BLg	0.5	0.35	0.08	0.68	0.34	0.45	0.23	0.85	0.43	1.00	0.5	0.52	0.26	1.00	0.50	0.18	0.014
4.5	0.27	0.06	BLg	0.5	0.27	0.06	0.89	0.45	0.33	0.16	0.98	0.49	1.00	0.5	0.41	0.21	1.00	0.50	0.14	0.0081
5	0.4	0.21	BLg	0.5	0.4	0.21	0.5	0.25	0.92	0.46	0.59	0.3	1.00	0.5	0.95	0.48	0.68	0.34	0.2	0.042
5.5	0.37	0.17	BLg	0.5	0.37	0.17	0.62	0.31	0.81	0.41	0.66	0.33	1.00	0.5	0.87	0.44	0.84	0.42	0.19	0.03145
6	0.26	0.26	BLg	0.25	0.315	0.215	0.8	0.2	0.90	0.23	0.77	0.19	1.00	0.25	0.95	0.24	0.68	0.17	0.08	0.01693
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0

This spread sheet is brought to you by Poul Bech, Ron Ptolemy, and Rob Knight, B.C. Environment, Fisheries Section, May 1994.

STREAM:	Harris
SITE:	2
LENGTH:	14.5
WIDTH:	4.10
AREA:	50.5
DATE:	19-Sep-03

	Species /age	Mean weight (g)	Catch 1	Catch 2	Estimated population	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	3.11	23	5	29.39	58.16	0.76	76.5
Sp. #2	Rb(1+)	12.00	1		1.00	1.98	0.42	4.7
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.42	#DIV/0!
Sp. #4	Co(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.72	#DIV/0!
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is des
to process electrofishin
Data can only be entere
shaded cells - all shade
protected.
Poul Bech, Reg. 2 Fish
B.C. Environment, Aug

Sp. #1	Rb(0+)					Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5			Sp. #6	
Length	c1+c2	weights	est wt.	total wgt.	condition	Length	c1+c2	weights(g)	Length	c1+c2	weights(g	Length	c1+c2	weights	Length	c1+c2	weight:	Length	c1+c2
58	1	2.1	2.09	2.085093	1.08E-05	109	1	12											
58	1	2	2.09	2.085093	1.03E-05														
61	1	2.6	2.43	2.425666	1.15E-05														
61	1	2.4	2.43	2.425666	1.06E-05														
61	1	2.1	2.43	2.425666	9.25E-06														
62	1	2.6	2.55	2.546927	1.09E-05														
62	1	2.8	2.55	2.546927	1.17E-05														
64	1	3	2.80	2.801441	1.14E-05														
66	1	3.1	3.07	3.072368	1.08E-05														
66	1	2.9	3.07	3.072368	1.01E-05														
66	1	3.1	3.07	3.072368	1.08E-05														
68	1	3	3.36	3.360224	9.54E-06														
68	1	3	3.36	3.360224	9.54E-06														
68	1	3.1	3.36	3.360224	9.86E-06														
68	1	3.3	3.36	3.360224	1.05E-05														
70	1	3.6	3.67	3.66552	1.05E-05														
71	1	4	3.82	3.824869	1.12E-05														
73	1	3.5	4.16	4.157288	9.00E-06														
73	1	4	4.16	4.157288	1.03E-05														
74	1	4.2	4.33	4.330486	1.04E-05														
75	1	4.7	4.51	4.508429	1.11E-05														
75	1	4.8	4.51	4.508429	1.14E-05														
75	1	4.2	4.51	4.508429	9.96E-06														
53	1	1.8	1.59	1.590996	1.21E-05														
59	1	2.4	2.19	2.194813	1.17E-05														
59	1		2.19	2.194813	0.00E+00														
61	1	3.1	2.43	2.425666	1.37E-05														
65	1	2.7	2.93	2.934821	9.83E-06														

DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET (CALCULATES W.U.A. & DISCHARGE)

This spread sheet is designed for depth/velocity transect data collected within a closed electrofishing site.

Most of the cells in this spread sheet are locked & data entry is possible only in the un-protected (non-shaded) cells

STREAM:	Harris		UTM CODE:	0		
DATE:	23-Sep-03		STREAM CODE:	930-053800-22100		
MAIN/SIDE CHANNEL:	m		SITE REFERENCE:	0		
METERED/EST.:	m		TRANSECT #:	1		
MEAN/SURFACE:	m		SITE #	3		350 m u/s fertilizer
TRANSECT WIDTH:	5.9	m	HYDRAULIC TYPE:	R		
			WIDTH : DEPTH RA	39.8854		Feb. 2001 curves applied
SITE LENGTH:	10.0	m	TRANSECT TYPE:	T		
SITE WIDTH:	9.91	m	STREAM WIDTH:	5.9	m	
SITE AREA:	99.1	sq. m	NO. OF STATIONS:	13		
DISCHARGE:	0.2038	cu. m/sec				
SITE WEIGHTED MEANS			**ADJUSTED USABLE AREAS**			
Mean Depth:	0.148	m	% usable by RBT fry	63	%	
Mean Velocity:	0.234	m/sec	% usable by RBT parr	38	%	
Cross-sect. area	0.873	sq. m.	% usable by CT fry	73	%	
			% usable by CT parr	46	%	
			% usable by Chinook	42	%	
			% usable by Coho	41	%	

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data: station length (m)	depth (m)	velocity (m/s)	substrate	Cell Width (m)	cell mean depth (m)	cell mean velocity (m/s)	cell prob. RBT	Usable Width Fry (m)	cell prob. RBT Parr	Jsable Width RBT Parr	cell prob. CT fry	Jsable Width CT fry	cell prob CT parr	Jsable Width CT parr	cell prob. CH	Jsable Width CH (m)	cell prob. CO	Jsable Width CO (m)	Cell Area (sq. m	Cell Discharge (cu. m/sec)
1.9	0	0	CG	0.1	0.0425	0	0.16	0.0	0.00	0	1	0.1	0.13	0.01	0.00	0.00	0.27	0.03	0	0
2.1	0.17	0	CG	0.2	0.17	0	0.2	0.04	0.00	0	1	0.2	0.71	0.14	0.00	0.00	0.87	0.17	0.03	0
2.3	0.32	0.01	CG	0.35	0.32	0.01	0.39	0.14	0.05	0.02	0.85	0.3	1.00	0.35	0.08	0.03	1.00	0.35	0.11	0.00112
2.8	0.22	0.26	CG	0.45	0.22	0.26	0.82	0.37	0.81	0.36	0.74	0.33	0.98	0.44	1.00	0.45	0.47	0.21	0.1	0.02574
3.2	0.25	0.44	CG	0.5	0.25	0.44	0.25	0.13	0.91	0.46	0.01	0	0.60	0.3	0.87	0.44	0.01	0.01	0.13	0.055
3.8	0.22	0.46	CG	0.5	0.22	0.46	0.21	0.11	0.81	0.41	0.01	0	0.49	0.25	0.83	0.42	0.00	0.00	0.11	0.0506
4.2	0.22	0.35	CG	0.5	0.22	0.35	0.52	0.26	0.81	0.41	0.13	0.06	0.90	0.45	0.98	0.49	0.17	0.09	0.11	0.0385
4.8	0.15	0.13	CG	0.65	0.15	0.13	1	0.65	0.37	0.24	1	0.65	0.50	0.33	0.47	0.30	0.78	0.51	0.1	0.01268
5.5	0.12	0.16	CG	0.6	0.12	0.16	1	0.6	0.33	0.2	1	0.6	0.36	0.22	0.35	0.21	0.62	0.37	0.07	0.01152
6	0.08	0.13	CG	0.6	0.08	0.13	1	0.6	0.17	0.1	1	0.6	0.22	0.13	0.16	0.10	0.49	0.29	0.05	0.00624
6.7	0.05	0.07	CG	0.7	0.05	0.07	1	0.7	0.05	0.04	1	0.7	0.13	0.09	0.06	0.04	0.34	0.24	0.04	0.00245
7.4	0.04	0	CG	0.55	0.04	0	0.16	0.09	0.00	0	1	0.55	0.03	0.02	0.00	0.00	0.27	0.15	0.02	0
7.8	0	0	CG	0.2	0.02	0	0.08	0.02	0.00	0	1	0.2	0.03	0.01	0.00	0.00	0.12	0.02	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0

This spread sheet is brought to you by Poul Bech, Ron Ptolemy, and Rob Knight, B.C. Environment, Fisheries Section, May 1994.

STREAM:	Harris
SITE:	3
LENGTH:	10
WIDTH:	9.91
AREA:	99.1
DATE:	23-Sep-03

	Species /age	Mean weight (g)	Catch 1	Catch 2	Estimated population	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	1.36	73	25	111.02	112.06	0.63	178.4
Sp. #2	Rb(1+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.38	#DIV/0!
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.38	#DIV/0!
Sp. #4	Co(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.41	#DIV/0!
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

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to process electrofishin
Data can only be entere
shaded cells - all shade
protected.
Poul Bech, Reg. 2 Fish
B.C. Environment, Augu

Sp. #1 Length	Rb(0+) c1+c2	weights	est wt.	total wgt.	condition	Sp. #2 Length	Rb(1+) c1+c2	weights(g)	Sp. #3 Length	Rb(2+) c1+c2	weights(g	Sp. #4 Length	Co(0+) c1+c2	weights	Sp. #5 Length	c1+c2	weight	Sp. #6 Length	c1+c2
37	1	0.5	0.52	0.520628	9.87E-06														
38	1	0.6	0.56	0.563993	1.09E-05														
39	1	0.6	0.61	0.6097	1.01E-05														
40	1	0.5	0.66	0.657813	7.81E-06														
40	1	0.6	0.66	0.657813	9.38E-06														
40	1	0.6	0.66	0.657813	9.38E-06														
40	1	0.7	0.66	0.657813	1.09E-05														
41	1	0.6	0.71	0.708393	8.71E-06														
41	1	0.8	0.71	0.708393	1.16E-05														
42	1	0.8	0.76	0.761501	1.08E-05														
42	1		0.76	0.761501	0.00E+00														
44	1	0.9	0.88	0.875549	1.06E-05														
44	1	0.8	0.88	0.875549	9.39E-06														
44	1	0.8	0.88	0.875549	9.39E-06														
44	1	1	0.88	0.875549	1.17E-05														
45	1	0.9	0.94	0.936613	9.88E-06														
46	1	1	1.00	1.000452	1.03E-05														
46	1	1	1.00	1.000452	1.03E-05														
47	1	1.1	1.07	1.067127	1.06E-05														
47	1	1.2	1.07	1.067127	1.16E-05														
47	1	1.1	1.07	1.067127	1.06E-05														
47	1	1	1.07	1.067127	9.63E-06														
47	1	1	1.07	1.067127	9.63E-06														
47	1	1	1.07	1.067127	9.63E-06														
48	1	1.1	1.14	1.136701	9.95E-06														
48	1	1.1	1.14	1.136701	9.95E-06														
48	1	0.9	1.14	1.136701	8.14E-06														
48	1	1.2	1.14	1.136701	1.09E-05														
48	1	1.1	1.14	1.136701	9.95E-06														
48	1	1.1	1.14	1.136701	9.95E-06														
48	1	1.3	1.14	1.136701	1.18E-05														
48	1	1.2	1.14	1.136701	1.09E-05														
49	1	1.2	1.21	1.209235	1.02E-05														
49	1	1	1.21	1.209235	8.50E-06														
49	1	1.2	1.21	1.209235	1.02E-05														
50	1	1.2	1.28	1.284791	9.60E-06														
50	1	1.4	1.28	1.284791	1.12E-05														
50	1	1	1.28	1.284791	8.00E-06														
50	1	1.1	1.28	1.284791	8.80E-06														
51	1	1.3	1.36	1.363431	9.80E-06														
51	1	1.4	1.36	1.363431	1.06E-05														
51	1	1.4	1.36	1.363431	1.06E-05														
52	1	1.7	1.45	1.445216	1.21E-05														
52	1	1.4	1.45	1.445216	9.96E-06														
52	1	1.4	1.45	1.445216	9.96E-06														
53	1	1.6	1.53	1.530207	1.07E-05														
53	1	1.6	1.53	1.530207	1.07E-05														
53	1	1.6	1.53	1.530207	1.07E-05														
53	1	1.5	1.53	1.530207	1.01E-05														
53	1	1.4	1.53	1.530207	9.40E-06														
54	1	1.8	1.62	1.618467	1.14E-05														
54	1	1.6	1.62	1.618467	1.02E-05														
54	1	1.6	1.62	1.618467	1.02E-05														
54	1	1.5	1.62	1.618467	9.53E-06														
54	1	1.5	1.62	1.618467	9.53E-06														
55	1	1.2	1.71	1.710057	7.21E-06														
55	1	1.6	1.71	1.710057	9.62E-06														
55	1	1.7	1.71	1.710057	1.02E-05														
56	1	1.6	1.81	1.80504	9.11E-06														
56	1	1.8	1.81	1.80504	1.02E-05														
57	1	1.9	1.90	1.903475	1.03E-05														
58	1	2.3	2.01	2.005426	1.18E-05														
58	1	2	2.01	2.005426	1.03E-05														
58	1	2.2	2.01	2.005426	1.13E-05														

DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET (CALCULATES W.U.A. & DISCHARGE)

This spread sheet is designed for depth/velocity transect data collected within a closed electrofishing site.

Most of the cells in this spread sheet are locked & data entry is possible only in the un-protected (non-shaded) cells

STREAM:	Harris	UTM CODE:	0	
DATE:	23-Sep-03	STREAM CODE:	930-053800-22100	
MAIN/SIDE CHANNEL:	m	SITE REFERENCE:	0	
METERED/EST.:	m	TRANSECT #:	1	
MEAN/SURFACE:	m	SITE #	4	400 m upstream fertilizer
TRANSECT WIDTH:	5.7 m	HYDRAULIC TYPE:	R	
		WIDTH : DEPTH RA	39.6824	Feb. 2001 curves applied
SITE LENGTH:	10.0 m	TRANSECT TYPE:	T	
SITE WIDTH:	8.49 m	STREAM WIDTH:	5.7 m	
SITE AREA:	84.9 sq. m	NO. OF STATIONS:	13	
DISCHARGE:	0.1849 cu. m/sec			
SITE WEIGHTED MEANS		**ADJUSTED USABLE AREAS**		
Mean Depth:	0.144 m	% usable by RBT fry	80 %	
Mean Velocity:	0.226 m/sec	% usable by RBT parr	45 %	
Cross-sect. area	0.819 sq. m.	% usable by CT fry	75 %	
		% usable by CT parr	54 %	
		% usable by Chinook	55 %	
		% usable by Coho	46 %	

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data station length (m)	depth (m)	velocity (m/s)	substrate	Cell Width (m)	cell mean depth (m)	cell mean velocity (m/s)	cell prob. RBT	Usable Width Fry (m)	cell prob. RBT Parr	Jsable Width RBT Parr	cell prob. CT fry	Jsable Width CT fry	cell prob CT parr	Jsable Width CT parr	cell prob. CH	Jsable Width CH (m)	cell prob. CO	Jsable Width CO (m)	Cell Area (sq. m	Cell Discharge (cu. m/sec)
1.3	0	0	GC	0.1	0.0075	0	0	0.0	0.00	0	1	0.1	0.03	0	0.00	0.00	0.00	0.00	0	0
1.5	0.03	0	GC	0.35	0.03	0	0.12	0.04	0.00	0	1	0.35	0.03	0.01	0.00	0.00	0.20	0.07	0.01	0
2	0.08	0.06	GC	0.5	0.08	0.06	0.95	0.48	0.09	0.04	1	0.5	0.22	0.11	0.09	0.05	0.51	0.26	0.04	0.0024
2.5	0.15	0.15	GC	0.5	0.15	0.15	1	0.5	0.41	0.21	1	0.5	0.50	0.25	0.52	0.26	0.74	0.37	0.08	0.01125
3	0.18	0.32	GC	0.5	0.18	0.32	0.62	0.31	0.67	0.34	0.25	0.13	0.83	0.42	0.85	0.43	0.23	0.12	0.09	0.0288
3.5	0.18	0.35	GC	0.5	0.18	0.35	0.52	0.26	0.67	0.34	0.13	0.07	0.78	0.39	0.83	0.42	0.16	0.08	0.09	0.0315
4	0.2	0.3	GC	0.5	0.2	0.3	0.68	0.34	0.75	0.38	0.34	0.17	0.84	0.42	0.96	0.48	0.31	0.16	0.1	0.03
4.5	0.22	0.21	GC	0.5	0.22	0.21	0.97	0.49	0.75	0.37	0.88	0.44	0.98	0.49	0.95	0.48	0.66	0.33	0.11	0.0231
5	0.19	0.27	GC	0.5	0.19	0.27	0.79	0.4	0.71	0.36	0.54	0.27	0.85	0.43	0.91	0.46	0.40	0.20	0.1	0.02565
5.5	0.15	0.19	GC	0.5	0.15	0.19	1	0.5	0.48	0.24	1	0.5	0.50	0.25	0.58	0.29	0.62	0.31	0.08	0.01425
6	0.1	0.18	GC	0.5	0.1	0.18	1	0.5	0.28	0.14	1	0.5	0.27	0.14	0.27	0.13	0.49	0.24	0.05	0.009
6.5	0.11	0.1	GC	0.5	0.11	0.1	1	0.5	0.20	0.1	1	0.5	0.27	0.14	0.23	0.12	0.66	0.33	0.06	0.0055
7	0.11	0.15	GC	0.25	0.11	0.125	1	0.25	0.23	0.06	1	0.25	0.27	0.07	0.26	0.07	0.66	0.17	0.03	0.00344
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0

This spread sheet is brought to you by Poul Bech, Ron Ptolemy, and Rob Knight, B.C. Environment, Fisheries Section, May 1994.

STREAM:	Harris
SITE:	4
LENGTH:	10
WIDTH:	8.49
AREA:	84.9
DATE:	23-Sep-03

	Species /age	Mean weight (g)	Catch 1	Catch 2	Estimated population	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	1.22	105	28	143.18	168.68	0.80	211.0
Sp. #2	Rb(1+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.45	#DIV/0!
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.45	#DIV/0!
Sp. #4	Co(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.46	#DIV/0!
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is des
to process electrofishin
Data can only be entere
shaded cells - all shade
protected.
Poul Bech, Reg. 2 Fish
B.C. Environment, Aug

Sp. #2 Length	**Rb(1+)** c1+c2	weights(g)	**Sp. #3** Length	**Rb(2+)** c1+c2	weights(g	**Sp. #4** Length	**Co(0+)** c1+c2	weights	**Sp. #5** Length	**Ct(2+)** c1+c2	weights	**Sp. #6** Length	c1+c2

Sp. #1 Length	**Rb(0+)** c1+c2	weights	est wt.	total wgt.	condition
33	1	0.3	0.36	0.364726	8.35E-06
33	1	0.3	0.36	0.364726	8.35E-06
36	1	0.4	0.47	0.473514	8.57E-06
37	1	0.6	0.51	0.51408	1.18E-05
38	1	0.6	0.56	0.556899	1.09E-05
38	1	0.6	0.56	0.556899	1.09E-05
39	1	0.7	0.60	0.602031	1.18E-05
40	1	0.5	0.65	0.649539	7.81E-06
40	1	0.6	0.65	0.649539	9.38E-06
40	1	0.7	0.65	0.649539	1.09E-05
40	1	0.6	0.65	0.649539	9.38E-06
40	1		0.65	0.649539	0.00E+00
40	1		0.65	0.649539	0.00E+00
40	1		0.65	0.649539	0.00E+00
40	1		0.65	0.649539	0.00E+00
41	1	0.7	0.70	0.699482	1.02E-05
41	1	0.7	0.70	0.699482	1.02E-05
41	1	0.8	0.70	0.699482	1.16E-05
41	1		0.70	0.699482	0.00E+00
41	1		0.70	0.699482	0.00E+00
42	1	0.7	0.75	0.751923	9.45E-06
42	1	0.8	0.75	0.751923	1.08E-05
42	1	0.7	0.75	0.751923	9.45E-06
42	1	0.8	0.75	0.751923	1.08E-05
43	1	0.8	0.81	0.80692	1.01E-05
43	1	0.9	0.81	0.80692	1.13E-05
43	1	0.9	0.81	0.80692	1.13E-05
43	1		0.81	0.80692	0.00E+00
44	1	1	0.86	0.864536	1.17E-05
45	1	0.9	0.92	0.924832	9.88E-06
45	1		0.92	0.924832	0.00E+00
45	1		0.92	0.924832	0.00E+00
45	1		0.92	0.924832	0.00E+00
45	1		0.92	0.924832	0.00E+00
46	1	0.9	0.99	0.987868	9.25E-06
46	1	0.8	0.99	0.987868	8.22E-06
46	1	0.9	0.99	0.987868	9.25E-06
46	1	0.9	0.99	0.987868	9.25E-06
46	1		0.99	0.987868	0.00E+00
46	1		0.99	0.987868	0.00E+00
46	1		0.99	0.987868	0.00E+00
46	1		0.99	0.987868	0.00E+00
46	1		0.99	0.987868	0.00E+00
47	1	1.1	1.05	1.053705	1.06E-05
47	1	1.1	1.05	1.053705	1.06E-05
47	1		1.05	1.053705	0.00E+00
47	1		1.05	1.053705	0.00E+00
48	1	1.1	1.12	1.122403	9.95E-06
48	1	1.1	1.12	1.122403	9.95E-06
48	1	1.1	1.12	1.122403	9.95E-06
48	1	1	1.12	1.122403	9.04E-06
48	1	1	1.12	1.122403	9.04E-06
48	1	1.2	1.12	1.122403	1.09E-05
48	1	1	1.12	1.122403	9.04E-06
48	1		1.12	1.122403	0.00E+00
48	1		1.12	1.122403	0.00E+00
48	1		1.12	1.122403	0.00E+00
49	1	1	1.19	1.194025	8.50E-06
49	1	1.1	1.19	1.194025	9.35E-06
49	1	1	1.19	1.194025	8.50E-06
49	1	1.2	1.19	1.194025	1.02E-05
49	1		1.19	1.194025	0.00E+00
49	1		1.19	1.194025	0.00E+00
50	1	1.4	1.27	1.268631	1.12E-05

Harris Creek
ELECTROFISHING SITE DESCRIPTION FORM

Site 1

Stream:	Harris Creek	
Watershed Code:	930-053800-22100	
Site Number:	1, 2 km d/s fert (Heli-boulder)	
Date:	19-Sep-03	
Surveyed by:	BS, HW	
Hydraulic type:	R	
Main/side-channel (m/sc):	M	
Field gradient:	1.5	%
Stream width:	20	m
Channel width:	27	m
Mean depth:	0.15	m
Maximum depth:	0.28	m
Mean velocity:	0.34	m/s
Maximum velocity:	0.54	m/s
Turbidity:	CLEAR	
Temperature (deg.C):	11	
Stream stage:	LOW (RISING)	
Conductivity (mS*cm-1):	N/A	

COVER (%)		
log:	0	%
boulder:	20	%
instream vegetation:	0	%
overstream vegetation:	0	%
cutbank:	0	%

SUBSTRATE (%)		
fines:	3	%
small gravel:	7	%
large gravel:	15	%
cobble:	55	%
boulder:	20	%
bedrock:	0	%

Compaction:	MOD	
Sand:	TR	
d90:	0.25	m
dMax:	0.45	m
Site length (m):	12.2	m
Site width (m):	6.08	m
Site area (m2)*:	71.89	m2

* At non-symmetrical sites, area is calculated from field measurements, not as site length* site width

Harris Creek
ELECTROFISHING SITE DESCRIPTION FORM

Site 2

Stream:	Harris Creek	
Watershed Code:	930-053800-22100	
Site Number:	2, 1.5 KM D/S FERT (Faller's Bridge)	
Date:	19-Sep-03	
Surveyed by:	BS, HW	
Hydraulic type:	R	
Main/side-channel (m/sc):	M	
Field gradient:	1.75	%
Stream width:	17	m
Channel width:	28	m
Mean depth:	0.28	m
Maximum depth:	0.55	m
Mean velocity:	0.131	m/s
Maximum velocity:	0.26	m/s
Turbidity:	CLEAR	
Temperature (deg.C):	11.5	
Stream stage:	LOW (RISING)	
Conductivity (mS*cm-1):	N/A	

COVER (%)		
log:	0	%
boulder:	35	%
instream vegetation:	0	%
overstream vegetation:	0	%
cutbank:	0	%

SUBSTRATE (%)		
fines:	5	%
small gravel:	5	%
large gravel:	10	%
cobble:	20	%
boulder:	60	%
bedrock:	0	%

Compaction:	HIGH	
Sand:	MOD	
d90:	0.55	m
dMax:	0.9	m
Site length (m):	14.5	m
Site width (m):	4.1	m
Site area (m2)*:	50.53	m2

* At non-symmetrical sites, area is calculated from field measurements, not as site length* site width

Harris Creek
ELECTROFISHING SITE DESCRIPTION FORM

Site 3

Stream:	Harris Creek	
Watershed Code:	930-053800-22100	
Site Number:	3, 350 M U/S FERT	
Date:	23-Sep-03	
Surveyed by:	MM, BS	
Hydraulic type:	R	
Main/side-channel (m/sc):	M	
Field gradient:	0.5	%
Stream width:	7.5	m
Channel width:	23	m
Mean depth:	0.2	m
Maximum depth:	0.45	m
Mean velocity:	0.234	m/s
Maximum velocity:	0.46	m/s
Turbidity:	CLEAR	
Temperature (deg.C):	11	
Stream stage:	LOW	
Conductivity (mS*cm-1):	N/A	

COVER (%)		
log:	0	%
boulder:	5	%
instream vegetation:	0	%
overstream vegetation:	5	%
cutbank:	2	%

SUBSTRATE (%)		
fines:	15	%
small gravel:	10	%
large gravel:	15	%
cobble:	55	%
boulder:	5	%
bedrock:	0	%

Compaction:	MOD	
Sand:	YES	
d90:	0.2	m
dMax:	0.35	m
Site length (m):	10	m
Site width (m):	9.91	m
Site area (m2)*:	99.07	m2

* At non-symmetrical sites, area is calculated from field measurements, not as site length* site width

Harris Creek
ELECTROFISHING SITE DESCRIPTION FORM

Site 4

Stream:	Harris Creek	
Watershed Code:	930-053800-22100	
Site Number:	4, 400 M U/S FERT	
Date:	23-Sep-03	
Surveyed by:	MM, BS	
Hydraulic type:	R	
Main/side-channel (m/sc):	M	
Field gradient:	0.5	%
Stream width:	12	m
Channel width:	18	m
Mean depth:	0.15	m
Maximum depth:	0.3	m
Mean velocity:	0.226	m/s
Maximum velocity:	0.35	m/s
Turbidity:	CLEAR	
Temperature (deg.C):	11	
Stream stage:	LOW	
Conductivity (mS*cm-1):	N/A	

COVER (%)		
log:	0	%
boulder:	10	%
instream vegetation:	0	%
overstream vegetation:	0	%
cutbank:	0	%

SUBSTRATE (%)		
fines:	5	%
small gravel:	10	%
large gravel:	10	%
cobble:	70	%
boulder:	5	%
bedrock:	0	%

Compaction:	MOD-HIGH	
Sand:	MOD	
d90:	0.15	m
dMax:	0.4	m
Site length (m):	10	m
Site width (m):	8.49	m
Site area (m2)*:	84.88	m2

* At non-symmetrical sites, area is calculated from field measurements, not as site length* site width

Appendix E

Financial Summary