Vancouver Island Blue-Listed Freshwater Sportfish Recovery Plan Year 1 Results and Recommendations for Year 2

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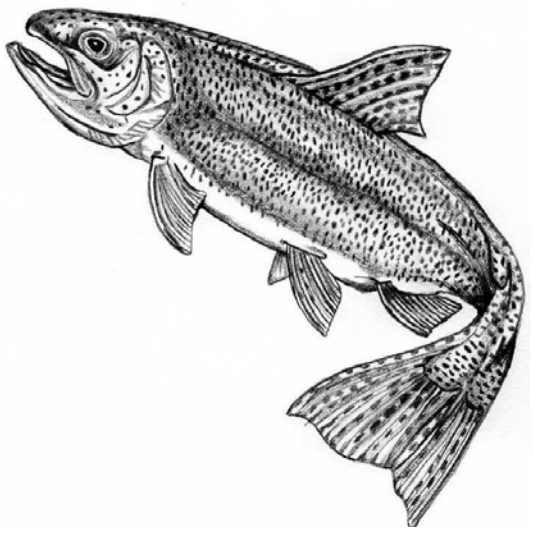

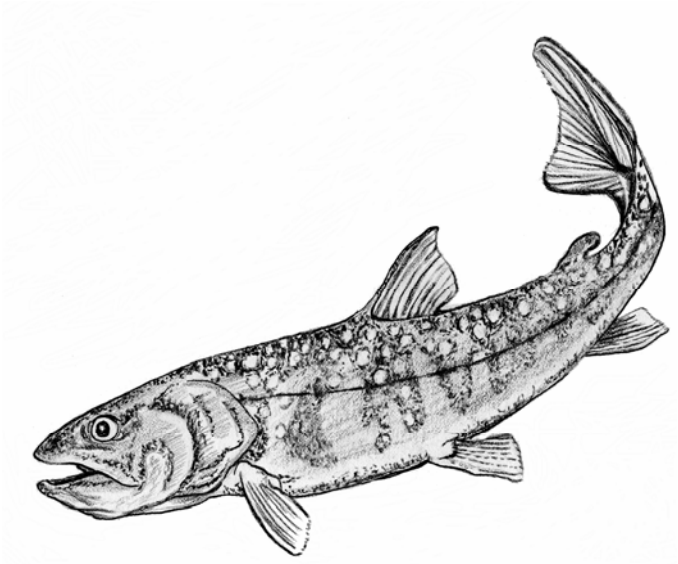

For Central Westcoast Forest Society
Port Alberni, BC, V0R 3A0

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Tracy Michalski and Kevin Jancowski

Vancouver Island Blue-Listed Freshwater Sportfish Recovery Plan
Year 1 Results and Recommendations for Year 2

1.0 Introduction

Dolly Varden (Salvelinus malma) are char, and there are both anadromous and resident forms of the species. In the past, the genus included both Dolly Varden and bull trout (S. confluentus), but the two have recently been split into separate species (Cavender, 1978; Haas and McPhail, 1991). Both species are found in BC, but only Dolly Varden are found on Vancouver Island where they are distributed from Sooke to the northern end of the Island and along the west coast (Haas and McPhail, 1991; Reid and Michalski, 2005; Chris Parks, pers. comm., 2005). Like Dolly Varden, coastal cutthroat trout (Oncorhynchus clarki) also have both anadromous and freshwater forms and are widely distributed on the Island. This species is more commonly found in small streams where they reach their highest densities however, and also appear to be more tolerant of warmer waters than Dolly Varden (Rosenfeld et al., 2000; Langford and Burns, 1977).

Both cutthroat trout and Dolly Varden have adfluvial and fluvial forms, and each of these life history types are documented on Vancouver Island (Reid and Michalski, 2005). Despite the general similarities in occupying similar environments, the two species can occupy different niches within these areas. For example, within lotic and lentic habitats, Dolly Varden commonly occupy benthic or deeper portions of the water column relative to cutthroat trout, as evidenced by the dominance of snails and other benthic macroinvertebrates found in gut contents of some studies (Mundy, 1988; Hindar et al., 1988; Andrew et al., 1992; Michalski, 2005). Northcote speculates that interspecific competition is responsible for Dolly Varden occupying deep water habitats when the species is sympatric with cutthroat since Dolly Varden are known to inhabit the entire water column when in isolation (Hindar et al., 1988; Northcote, T., pers.com., 2006). In contrast to Dolly Varden, cutthroat trout tend to be more general in their feeding habits, although terrestrial and aquatic insects are their main foods.

With respect to spawning, cutthroat trout spawn in the winter and spring, while Dolly Varden tend to be fall spawners. On the north Island, Dolly Varden usually spawn between October and November; however on the west cost, for example in the Robertson Creek spawning channel on the Stamp River, ripe Dolly Varden females have been observed as late as mid-January (Ellis, 1963; Scott and Crossman, 1973; Michalski, 2005).

Over-wintering Dolly Varden are commonly found in deep pools with cover in the form of large woody debris (LWD) and cobble substrate, but they are absent from riffles, glides, and pools without cover (Heifetz et al., 1986). Cover, particularly LWD, is critical for Dolly Varden, and Elliot (1986) found that its removal contributes to reductions in Dolly Varden likely because of reduced available pool habitat created by the wood (Heifetz et al., 1986). LWD is also critical overwintering habitat for cutthroat trout, and large fish are known to be positively related to LWD abundance and the percentage of pool habitat in streams (Rosenfeld et al., 2000; Slaney and Roberts, 2005).

In 1994, the BC Conservation Data Center listed coastal cutthroat trout and Dolly Varden char as Blue-listed to comply with the global listing by the Nature Conservancy of Canada (Pollard and Down 2001; BC Conservation Data Center, 2005). The classification of Blue-listed means that although these species are not immediately threatened, their status is of concern because of characteristics that make them particularly sensitive to human activities or natural events (BC Conservation Data Center, 2005). Reid and Michalski (2002; 2006) postulate that poor land use practices have contributed to the declines of both Dolly Varden in the Lower Campbell Lake watershed, and to cutthroat in small streams along the east coast of Vancouver Island.

The decline of Dolly Varden was suspected for some time prior to its Blue-listing, and in 2002, the Vancouver Island Region implemented a detailed study on the stocks in the Lower Campbell Lake watershed to determine the status and general life history of these populations (Michalski, 2005). That study found a decline in Dolly Varden stocks since the mid-1970s, as well as a downward shift in the average size of adult fish. Based on the preliminary results of the study, the Region received funds from the Habitat Conservation Trust Fund (HCTF) to develop the Vancouver Island Blue-Listed Freshwater Sportfish Recovery Plan (Reid and Michalski, 2006). Although the plan initially concentrated only on Dolly Varden, the Region decided to include resident cutthroat trout because of the similarities in the life histories of the two species, and the fact that both were Blue-listed. The resulting 5-year recovery plan outlines habitat and fish assessments, recovery strategies, management prescriptions and public awareness initiatives to be implemented in the highest priority areas as defined by angler catch, use and success. The present document summarizes the results of the implementation of Year 1 of the Plan, and concentrated on documenting fish and habitat data from areas where both species were known to exist and had data gaps; conducting biophysical and fish assessments to fill those gaps, and developing restoration and management plans. Specific objectives were:

***Objective 1*: Conduct overview and Level 1 Watershed Restoration Program (WRP) fish habitat assessments at Sutton, Cottonwood, Robertson, and Nixon creeks (Nanaimo-Cowichan Planning Unit (PU);**

***Objective 2*: Conduct fish inventories of Sutton, Nixon, Cottonwood creeks and Robertson River (Nanaimo-Cowichan PU); Taylor River, Sutton, Clutesi and Gracie creeks (West Coast PU);**

***Objective 3*: Develop restoration prescriptions and management options and projects based on fish habitat and fish presence information from objectives (1) and (2);**

***Objective 4*: Determine if culverts on four unnamed tributaries to Lower Campbell Lake (Comox-Oyster PU) are fish passage barriers and, if so, develop a barrier removal plan;**

***Objective 5*: Prioritize projects for Year 2 based on the results of Year 1 combined with the original recommendations in the Vancouver Island Blue-Listed Freshwater Sportfish Recovery Plan.**

2.0 Study Area

We show the general study area in **Figure 1** and present details of the Lake Cowichan (Nanaimo-Cowichan PU), Sproat Lake (West Coast PU), and Lower Campbell Lake (Comox-Oyster PU) watersheds in **Figure 2**, **3** and **4** respectively.

Figure 1. Map of Vancouver Island showing the Lower Campbell Lake, Sproat Lake and Lake Cowichan watersheds.

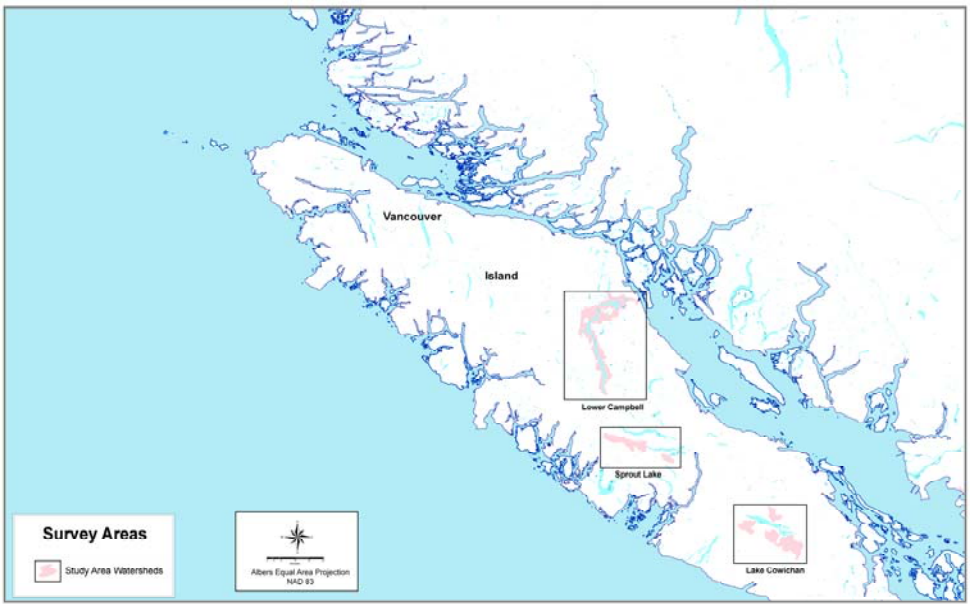


Figure 2. Lake Cowichan watershed showing Nixon and Sutton creeks, and the Robertson River.

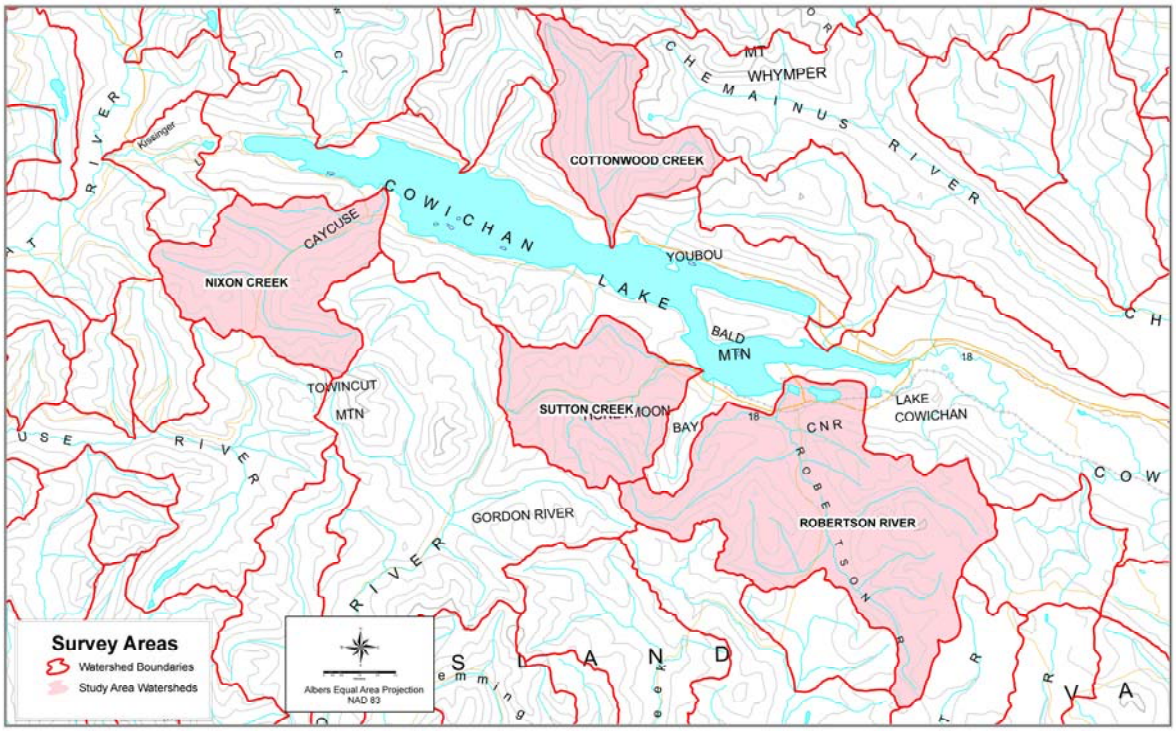


Figure 3. Taylor River watershed showing Sutton and Gracie creeks

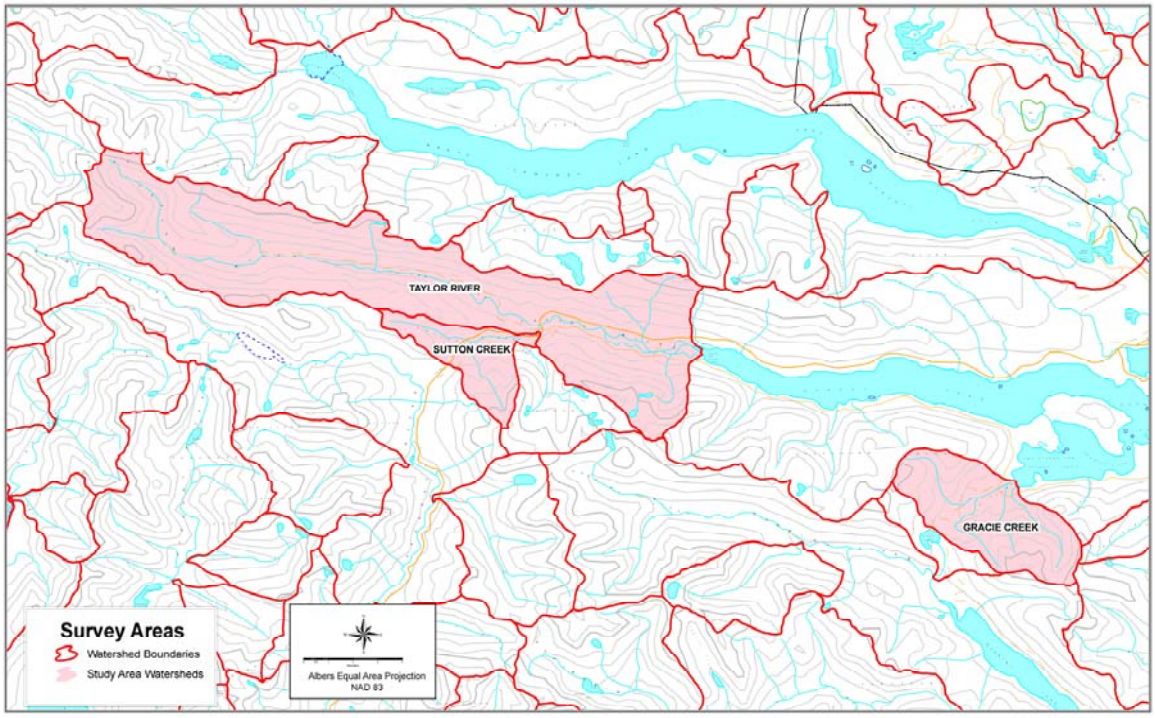
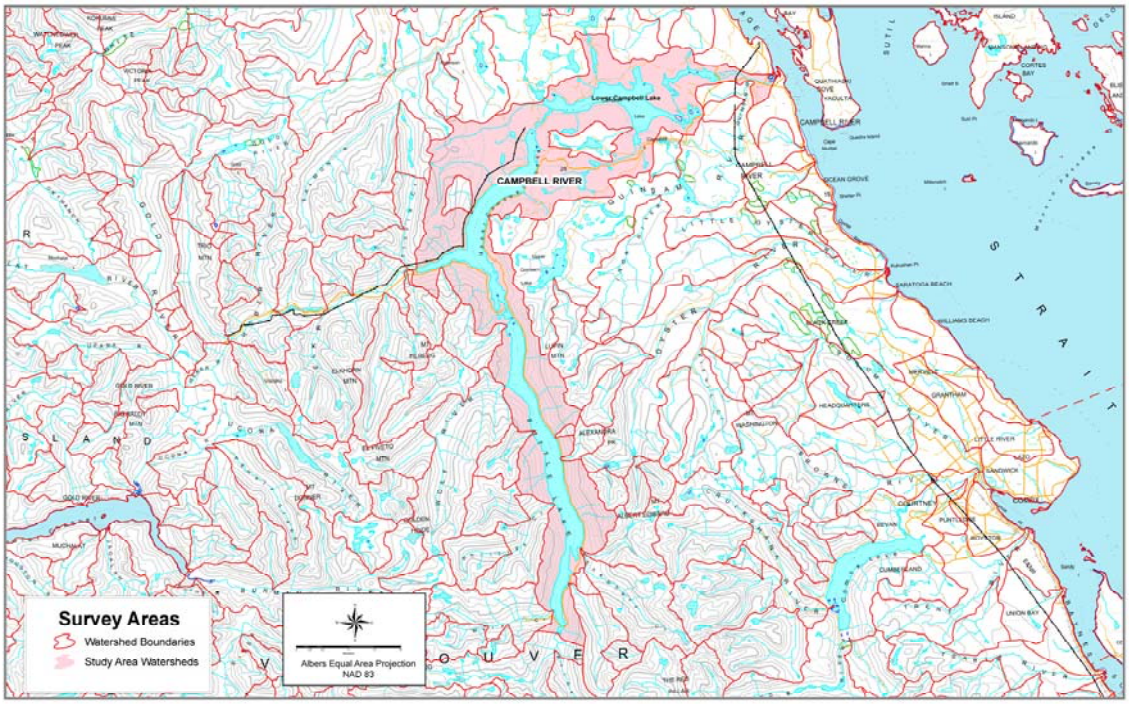


Figure 4. Lower Campbell Lake watershed.



3.0 Methods

3.1 *Objective 1*: Conduct overview and Level 1 WRP fish habitat assessments - Sutton, Cottonwood, Robertson and Nixon creeks (Lake Cowichan PU).

We completed overview habitat assessments of Sutton, Cottonwood and Nixon creeks and the Robertson River September 6-13, 2005, according to procedures outlined in Johnston and Slaney (1996). We included Sixteen Creek, a tributary to the Robertson River, and refer to this site as Reach 6 of the Robertson River. Our assessments involved: reviewing data at the Ministry of Environment; delineating watershed boundaries onto 1:20,000 TRIM maps; determining stream reaches; and developing a field plan for conducting Level 1 WRP fish habitat assessments.

We completed Level 1 WRP assessments September 6-30, 2005, adapting the methods outlined in Johnston and Slaney (1996) according to the size of the creek. In most cases, we sampled a distance of either 10 times the bankfull width, or at least 100 m, whichever was greatest. We measured bankfull width once per reach at the beginning of each sample site, and all habitat units were classified as either pools or riffles. We collected habitat unit lengths and depths; type and proportion of bed material; the type and amount of instream and overhead cover; the presence of off-channel habitat; riparian vegetation type and depth; and adjacent land disturbance. We also took representative photographs of each habitat unit and any other features of note.

We entered the data into the Microsoft Excel spreadsheet provided with the Urban Salmon Habitat Program (USHP) Assessment Methods (Michalski et. al., 2000). This program assigns numerical ratings to each habitat parameter based on how those parameters compare to published biostandards. Good habitat is scored as 1, fair as 3 and poor as 5, so that scores can be totaled to determine priorities for restoration (Michalski et. al., 2000).

3.2 *Objective 2*: Conduct fish inventories of Sutton, Nixon, Cottonwood creeks and Robertson River (Nanaimo-Cowichan PU); Taylor River, Sutton, Clutesi and Gracie creeks (West Coast PU).

We sampled Sutton, Nixon, Cottonwood and Gracie creeks and the Robertson River September 14-30, 2005, using baited minnow traps and according to the procedures outlined by the Resource Information Committee, 2001. We sampled Gracie Creek by electroshocking on October 4 and 7, 2005, also following the RIC procedures. In all cases, we measured fork length and returned fish to the stream. We also took photographs of some sampled fish. We conducted a snorkel survey of the Taylor River on September 26, 2005. We entered all fish data into the USHP Excel spreadsheet. We did not survey Clutesi and Sutton creeks in the West Coast PU because of time constraints.

3.3 *Objective 3*: Develop restoration prescriptions, management options and future projects based on fish habitat and fish presence information from objectives (1) and (2) (Nanaimo-Cowichan and West Coast PUs).

We developed a system to prioritize areas for restoration in the Nanaimo-Cowichan and West Coast PUs by:

a. assigning scores for the presence of cutthroat trout and Dolly Varden char in each stream (score = 0 for neither sp; 1 for one species present; 2 for both species);
b. assigning scores for the estimated cost:benefit to conduct restoration (5 = high, 3 = medium, and 1 = low);
c. summing (1)+(2) above with the overall habitat score for each stream as calculated by the USHP spreadsheet. The highest total scores were given the highest priorities. We then,
d. identifying the highest scoring reaches within each of the highest ranked streams using the USHP scores for each habitat parameter within the reach. We then,
e. developing habitat restoration prescriptions for the highest ranked habitat parameters in each of the highest ranked reaches;
f. reviewing our prescriptions and estimated each for its cost:benefit for the target species;
g. contacting landowners within the highest priority areas including TimberWest Forest Corp., Hancock Forest Management, and other stakeholders including the Cowichan Valley Fish and Game Club to discuss our recommended prescriptions, and request their participation and assistance. In some cases, the assistance of landowners was enough to raise the cost:benefit analysis and raise the priority of a project.

3.4 *Objective 4*: Determine if culverts on four unnamed tributaries to Lower Campbell Lake (Comox-Oyster PU) are fish passage barriers and, if so, develop a barrier removal plan.

We were unable to complete this field assessment because of time constraints but have included this project in our recommendations for Year 2.

3.5 *Objective 5*: Prioritize projects for Year 2 based on the results of Year 1 combined with the original recommendations in the Vancouver Island Blue-Listed Freshwater Sportfish Recovery Plan.

We ranked the projects we recommend for implementation in Year 2 by:

1. listing, in order, all projects outlined in the Blue-Listed Freshwater Sportfish Recovery Plan Recommendations - General Section; followed by;
2. all 2005 and 2006 projects outlined in the Blue-Listed Freshwater Sportfish Recovery Plan Recommendations – Individual Lake Recovery Plan Sections; followed by;
3. all projects resulting from the outcomes of Objectives 2, 3 and 4 (above) from the implementation of Year 1.

We sorted the above master list into completed and uncompleted projects then grouped uncompleted projects into their Planning Unit or watershed, where applicable, and identified

the specific Ministry of Environment, Environmental Stewardship Division, and Fish and Wildlife Section priorities that applied to each project or group of projects. Finally, we ranked that list according to: (1) the total number of Ministry, Division and Section priorities met; and, (2) the total number Section only priorities met. We then listed the resource requirements, and any other concerns or information for each project or group of projects so that Fish Section staff could identify work priorities for 2006.

4.0 Results

4.1 *Objective 1*: Conduct overview and Level 1 Watershed Restoration Program (WRP) fish habitat assessments at Sutton, Cottonwood, Robertson, and Nixon creeks (Nanaimo-Cowichan PU)

4.1.1 Overview Assessment

We reviewed the files and maps in the Ministry of Environment library in Nanaimo and found that all four target streams have extensive forest clearing in their watersheds, that Dolly Varden are confirmed in all streams, and cutthroat trout in all but Cottonwood Creek (**Table 1**).

Table 1. Summary of results of review of Ministry of Environment documents, reports and maps for Cottonwood, Nixon and Sutton creeks and the Robertson River.

Stream	Habitat Assessment/Information	Reference	Dolly Varden	Reference	Cutthroat Trout	Reference
Cottonwood Creek	Large headwater area of Cottonwood Creek cleared; watershed divide between Cottonwood Creek and Wardroper Creek also shows considerable forest clearing.	1999 orthophoto	Yes; found upstream to 2,750 m Resident DV found in reach 3 up to 7,000 m; Widow Creek (tributary) may support resident DV upstream to the 3,500 m	Axford, 1976; Burns, 1990	No	Burns, 1990 Griffith, 1989
Nixon Creek	Patches of forest cleared; 90% of the basin covered by advanced second growth as of 1990.	1999 orthophoto; Burns, 1990	Yes in Nixon creek; 2 unnamed tributaries and Raymond creek Fish found up to 11,000 in Nixon creek and 5,000m in Raymond creek; may be adfluvial from Lake Cowichan	Axford, 1976; Griffith, 1989; Burns, 1990	Yes – Same distribution as DV plus at least 2,250 m of 3 other tributaries.	Burns, 1990
Sutton Creek	Approximately 240 hectares of forest downstream of the South Sutton Creek; this is the largest evidence of recent forest harvesting on the watershed.	1999 orthophoto	Yes – Sutton creek and South Sutton creek; fish found to 10,500m of Sutton Creek and 1,000m of South Sutton Creek; speculate these are residents	Axford, 1976; Griffith, 1989; Burns, 1990	Yes – Same distribution as Dolly Varden plus at least 5,177 m of 4 other tributaries.	Burns, 1990
Robertson River	Large area of forest in the East Robertson River tributary cleared; this is the largest evidence of recent forest harvesting in the watershed. Reaches 1 to 3 have excessive sediment deposition and landowners have removed this, at times without authorization.	1999 orthophoto; Tom Rutherford, pers. com.	Yes; DV also found in to 8,700 m in Nineteen Creek and up to 4,500 m in Sixteen Creek; speculated that fish in Robertson River are adfluvial migrants from Lake Cowichan.	Axford, 1976; Griffith, 1989; Burns, 1990	Yes – occupy same distribution as DV plus 5,000 m more of the mainstem and at least 16 km more of 6 other tributaries.	Burns, 1990
Taylor River, Sutton & Gracie creeks	WRP fish habitat assessment and restoration suggestions completed (Taylor) - summarized below.	Wright, 1999	Yes (only confirmed in Taylor), fish identified between the confluence with Sproat Lake and Sutton Creek confluence .	Rimmer, 1998 and 2000.	Yes, confirmed in Taylor and Gracie.	Rimmer, 1998 and 2000; Burns, 1973

4.1.2 Level 1 Assessments

a) Sutton Creek

Reach 1 of Sutton Creek was dry with areas of scour, un-vegetated mid-channel bars and large sediment wedges, as well as multiple land and stream disturbances caused by logging activities (**Table 1**; **Table 2**; **Appendix 1**; **Figure 5**; **Figure 6**; **Figure 7**). We found fair levels of LWD; poor boulder cover; 23% wetted area and intermittent flows, and no off-channel habitat in Reach 2 (**Table 3**). We also found that Reach 3 had poor amounts of LWD, poor boulder cover, no off-channel habitat and bank erosion (**Figure 8**). We found good LWD and boulder cover and no land disturbances in Reach 4 (**Table 3**; **Figure 9**).

Figure 1. Reach breaks, sampling locations, and distributions of Dolly Varden and cutthroat trout in Sutton Creek.

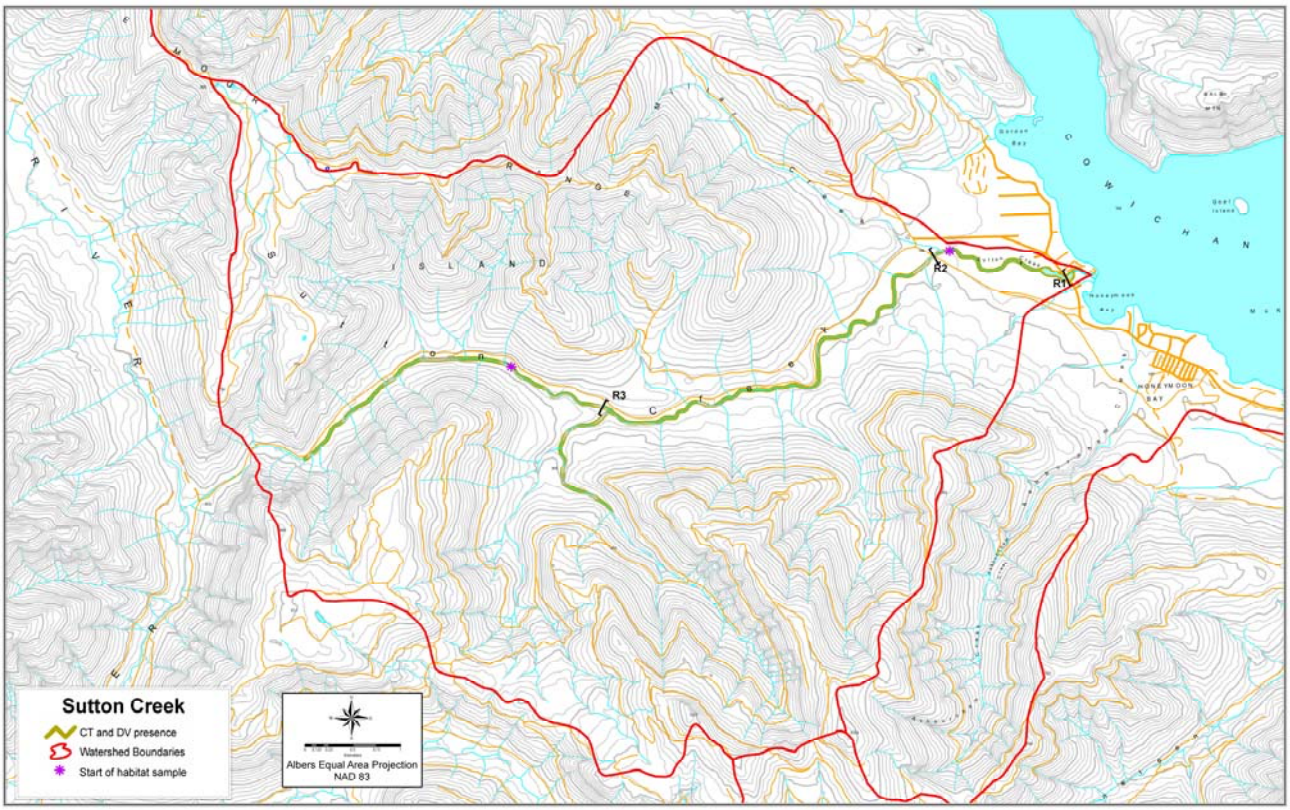


Table 2. Reach length, sample length, gradient, bankfull width, flow and land disturbance in Reaches 1-4 of Sutton Creek.

Reach #	Reach length (m)	Sample length (m)	Gradient (%)	Bankfull width (m)	Flow	Land Disturbance
1	350	N/A	<1	17	no	Extensive areas of scour; extensive areas of unvegetated bar; large, extensive sediment wedges, and eroding banks (rip rap present).
2	1650	233.2	2	18.1	partial (about 50%)	Elevated mid-channel bars, bank erosion
3	5700	152.4	3.5	15	yes	Bank erosion
4	2900	104.2	2	17.5	yes	N/A

Figure 6. Reach 1 of Sutton Creek looking upstream at the Highway 18 bridge.

Figure 7. Reach 2 of Sutton Creek looking downstream.

Table 3. Summary of values and ratings of each habitat parameters compared to published biostandards for each reach of Sutton Creek. For ratings: 1 = good, 3 = fair, and 5 = poor; the higher the rating, the less favorable the comparison to the biostandard.

Reach #	Pool Area (%)		LWD Pieces/ W_b		% Cover in Pools		% Boulder Cover		% Fines		%Wetted Area		% Off-channel Habitat		Score/ Reach
	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	41	1	1.55	3	8	3	3	5	10	3	23	5	0	5	25
3	62	1	0.39	5	8	3	6	5	9	1	47	5	0	5	25
4	40	3	3.36	1	17	3	48	1	2	1	27	5	0	5	19
Score/ parameter		5		9		9		11		5		15		15	69

Figure 8. Reach 3 of Sutton Creek looking upstream. Note the bank erosion on the left bank at the right of the photo.

Figure 9. Reach 4 of Sutton Creek looking upstream.

b) Cottonwood Creek

We found flow in all five reaches of Cottonwood Creek (**Table 4**; **Appendix 1**; **Figure 10**). In Reach 1 we found extensive areas of unvegetated mid-channel bars, no off-channel habitat, and this was the only reach in which we identified land disturbances. We found a fair abundance of LWD in Reach 1 but none in Reach 2 (**Table 5**; **Figure 11**; **Figure 12**). We did not sample Reach 3 due to access problems (**Figure 13**). We did not find any LWD or off-channel habitat in Reach 4, which gave it the highest ratings and therefore the highest number of habitat concerns (**Figure 14**). We found no LWD or off-channel habitat, but a good rating for wetted area in Reach 5 (**Figure 15**).

Figure 10. Reach breaks, sampling locations and distributions of Dolly Varden in Cottonwood Creek.

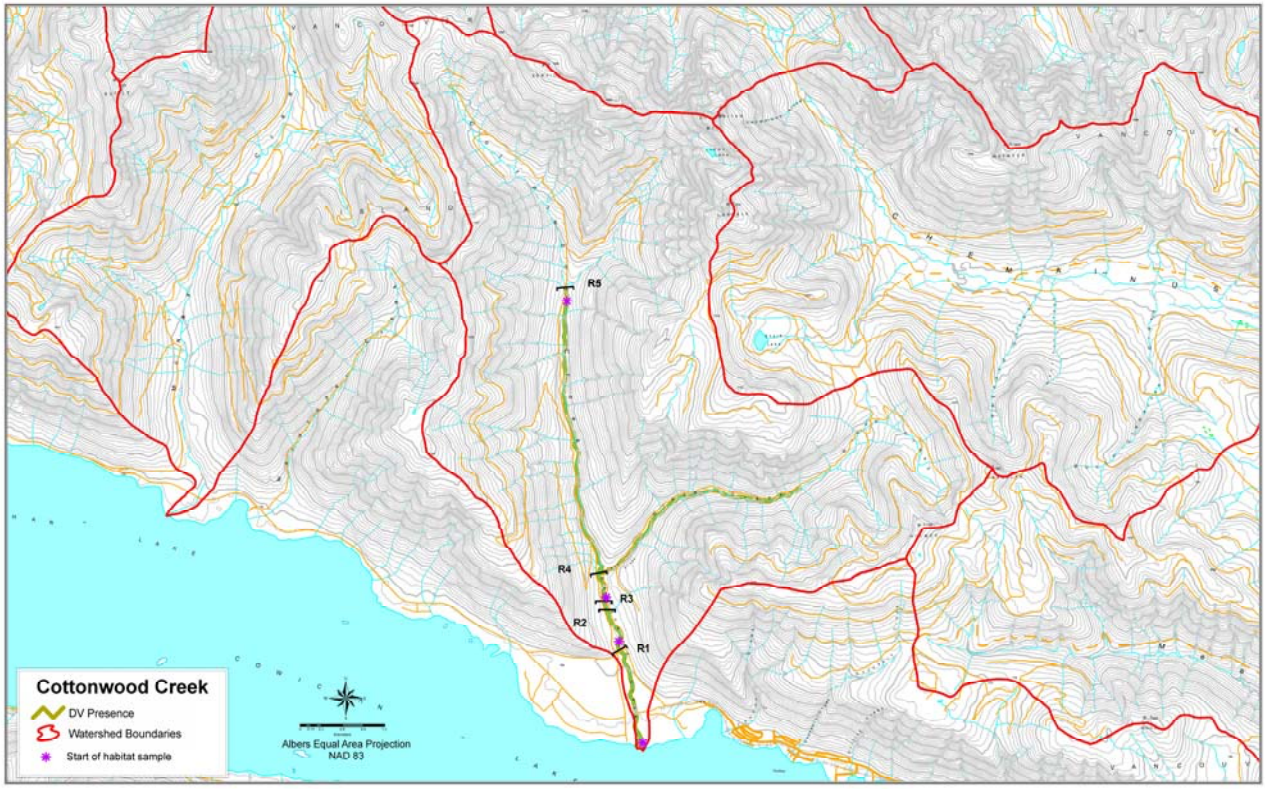


Table 4. Reach length, sample length, gradient, bankfull width, flow and land disturbance in Reaches 1-5 of Cottonwood Creek.

Reach #	Reach Length (m)	Sample Length (m)	Gradient (%)	Bankfull Width (m)	Flow	Land Disturbance
1	1600	259.7	2	21	yes	Extensive areas of unvegetated bar (bedload deposition), recently formed LWD jam.
2	650	232.1	2	15	yes	N/A
3	88	?	?	?	yes	N/A
4	380	127.3	3	11.4	yes	N/A
5	4100	73	3	9.1	yes	N/A

Table 5. Summary of values and ratings of each habitat parameters compared to published biostandards for each reach of Cottonwood Creek. For ratings: 1 = good, 3 = fair, and 5 = poor; the higher the rating, the less favorable the comparison to the biostandard.

Reach #	Pool Area (%)		LWD Pieces/W_b		% Cover in Pools		% Boulder Cover		% Fines		%Wetted Area		% Off-channel Habitat		Score/ reach
	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	
1	63.67	1	1.4	3	29	1	6	5	3	1	22	5	0	5	21
2	42.42	1	0	5	10	3	22	1	0	1	58	5	0	5	21
3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	56.57	1	0	5	15	3	18	3	0	1	65	5	0	5	23
5	49.16	1	0	5	16	3	15	3	0	1	73	1	0	5	19
Score/ parameter		4		18		13		12		4		16		20	84

Figure 11. Reach 1 of Cottonwood Creek looking upstream.

Figure 12. Reach 2 of Cottonwood Creek. Note the absence of LWD.

Figure 13. Reach 3 of Cottonwood Creek looking downstream.

Figure 14. Reach 4 of Cottonwood Creek looking upstream.

Figure 15. Reach 5 of Cottonwood Creek looking downstream. We confirmed juvenile Dolly Varden in this location.

c) Robertson River

Reaches 1 and 2 of the Robertson River were dry, and Reach 2 had bedload deposition and an over-widened channel (**Table 6**; **Table 7**; **Appendix 1**; **Figure 16**; **Figure 17**; **Figure 18**; **Figure 19**). We found intermittent flow resulting in little wetted habitat as well as poor amounts of LWD, boulder cover and off-channel habitat in Reach 3. Reach 4 received poor ratings for the excessive amount of sediment, and low abundance of LWD, boulder cover and off-channel habitat (**Figure 20**). We found less sediment and more LWD compared to other reaches, as well as some off-channel habitat in Reach 5 (**Figure 21**). We found a poor abundance of LWD and no off-channel habitat but no land disturbances in Reach 6 (**Figure 22**). The Robertson River received the highest score of all streams assessed, indicating the highest number of habitat impacts.

Figure 16. Map of the Robertson River showing reach breaks, sampling locations, and Dolly Varden and cutthroat trout distribution.

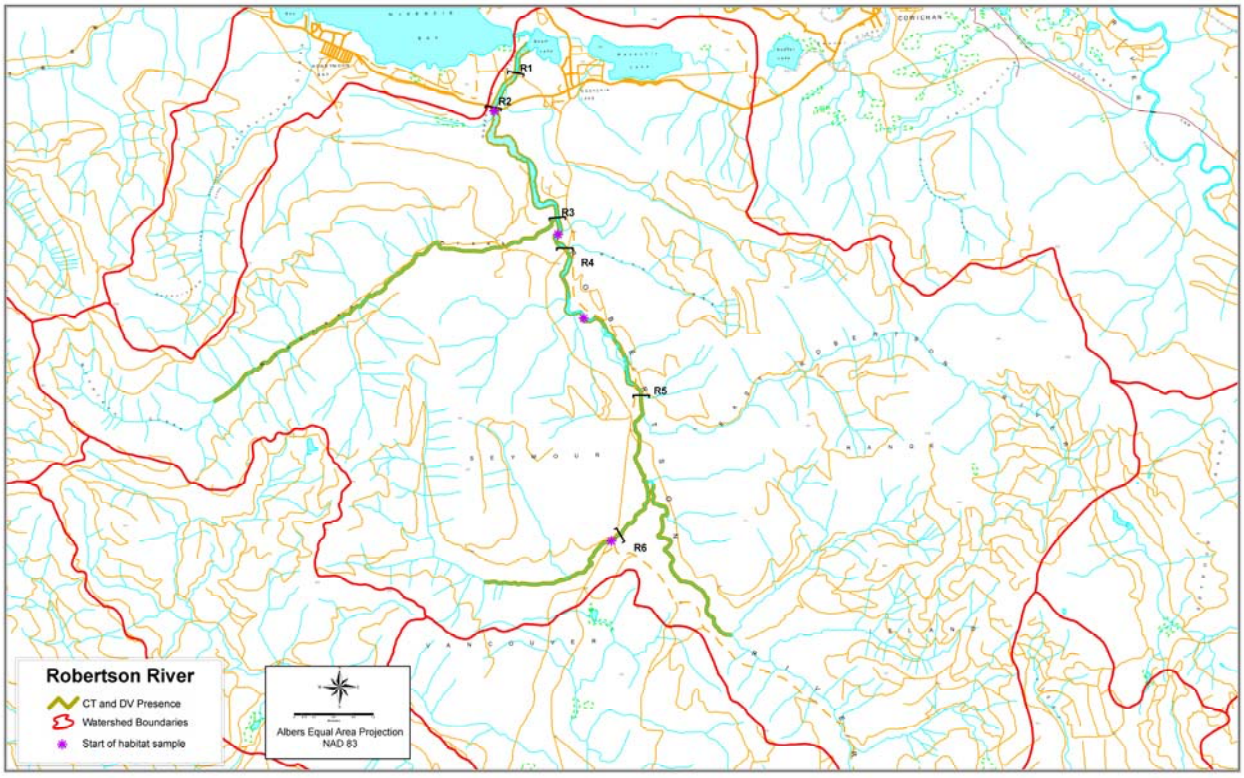


Table 6. Reach length, sample length, gradient, bankfull width, flow, and land disturbance in Reaches 1–6 of the Robertson River.

Reach #	Reach length (m)	Sample length (m)	Gradient (%)	Bankfull width (m)	Flow	Land Disturbance
1	500	N/A	N/A	N/A	no	N/A
2	600	N/A	N/A	29.3	no	Over-widened, dry channel with bedload deposition.
3	3600	310.9	1.5	27	partial	Deposition of bedload on left bank upstream of highway bridge, Bank erosion on right bank is evident from riprap. Mid-channel bar is starting to revegetate.
4	600	266.3	2	26.3	yes	Bank erosion
5	3200	450.7	3	30.5	yes	Extensive areas of unvegetated bar; large, extensive sediment wedges.
6	850	67.4	3	11	yes	N/A

Figure 17. Reach 2 of the Robertson River looking downstream from the Highway 18 bridge.

Figure 18. Reach 3 of the Robertson River looking upstream. The wetted channel is on the extreme right of the photo.

Table 7. Summary of values and ratings of each habitat parameter compared to published biostandards for each reach of the Robertson River. For ratings: 1 = good, 3 = fair, and 5 = poor; the higher the rating, the less favorable the comparison to the biostandards.

Reach #	Pool Area (%)		LWD Pieces/W_b		% Cover in Pools		% Boulder Cover		% Fines		%Wetted Area		% Off-channel Habitat		Score/ reach
	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	poor	N/A
3	96	1	0.26	5	10	3	2	5	4	1	18	5	10	5	25
4	59	1	0.69	5	8	3	3	5	21	5	39	5	0	5	29
5	64	1	1.76	3	10	3	11	3	13	3	59	5	21	3	21
6	72	1	0.33	5	18	3	28	3	0	1	50	5	0	5	23
Score/ parameter		4		18		12		16		10		20		18	98

Figure 19. Reach 3 of Robertson River showing evidence of gravel removal and sorting on the bank.

Figure 20. Reach 4 of the Robertson River looking downstream. Note the bank erosion ahead of the technicians.

Figure 21. Reach 5 of the Robertson River looking upstream.

Figure 22. Reach 6 of Robertson River. We found juvenile Dolly Varden in this reach.

d) Nixon Creek

Reach 1 of Nixon Creek was dry, however both Reaches 2 and 3 were wetted (**Table 8**; **Figure 23**; **Figure 24**). We found heavy bedload and erosion, a fair amount of LWD and no off-channel habitat in Reach 2 (**Table 9**; **Figure 25**). We found a side channel, but poor LWD cover in Reach 3 (**Figure 26**).

Figure 23. Map of Nixon Creek showing reach breaks, sampling locations, and Dolly Varden and cutthroat trout distribution.

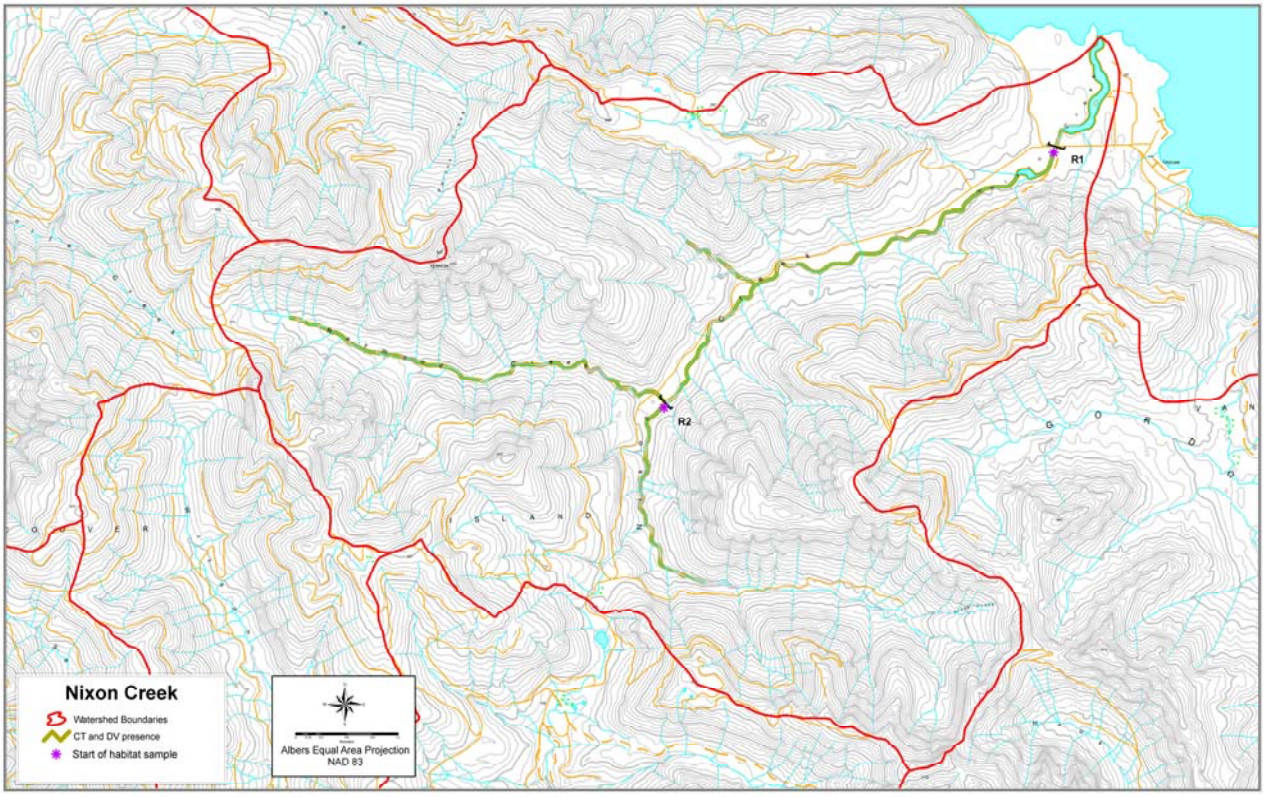


Table 8. Reach length, sample length, gradient, bankfull width, flow, and land disturbance in Reaches 1–3 of Nixon Creek.

Reach #	Reach length (m)	Sample length (m)	Gradient (%)	Bankfull width (m)	Flow	Land Disturbance
1	1650	N/A	2	27	no	Bank erosion
2	5400	159.1	2	15	yes	Heavy bedload deposition, some bank erosion
3	1800	108.6	4.5	11	yes	N/A

Figure 24. Reach 1 of Nixon Creek showing dry channel and bank erosion.

Table 9. Summary of values and ratings of each habitat parameter compared to published biostandards for each reach of Nixon Creek. For ratings: 1 = good, 3 = fair, and 5 = poor; the higher the rating, the less favorable the comparison to the biostandard.

Reach #	Pool Area (%)		LWD Pieces/W_b		% Cover in Pools		% Boulder Cover		% Fines		%Wetted Area		% Off-channel Habitat		Score/ reach
	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	Value	Rating	
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	89	1	1.32	3	12	3	15	3	3	1	53	5	0	5	21
3	62	1	0.33	5	15	3	13	3	0	1	52	5	46	1	19
Score/ parameter		2		8		6		6		2		10		6	40

Figure 25. Reach 2 of Nixon Creek showing a limited amount of LWD on the right side of the pool.

Figure 26. Reach 3 of Nixon Creek looking downstream.

4.2 *Objective 2*: Conduct fish inventories of Sutton, Nixon, Cottonwood creeks and Robertson River (Nanaimo-Cowichan PU); Taylor River, Sutton, Clutesi and Gracie creeks (West Coast PU)

a) Cottonwood, Nixon, and Sutton creeks and Robertson River (Nanaimo-Cowichan PU).

We confirmed Dolly Varden in Reach 5 of Cottonwood Creek and Reach 6 of the Robertson River (**Table 10**; **Figure 27**). In addition to our target species, we also found rainbow trout (O. mykiss) and coho salmon (O. kisutch).

Table 10. Stream, sample date, reach number and location, sampling method, and number and fork length (mm) of each species sampled in Cottonwood, Nixon, and Sutton creeks, and the Robertson River (Lake Cowichan PU).

Stream	Date	Reach	Location from Mouth (m)	Sampling Method	Species	Number Sampled	Fork Length (mm)
Cottonwood Creek	09/21/05	5	5,000	Minnow Trap	Rainbow	2	150-200
	"	"	"	"	Salmonid - unidentified	1	100-200
	"	5	6,900	Minnow Trap	Dolly Varden	2	100-150
Nixon Creek	09/22/05	2	Not recorded but between 1650-7050 m	Minnow Trap	Coho	4	50-100
	"	"	"	"	Rainbow	1	50-100
Sutton Creek	09/23/05	3	2,100	Minnow Trap	Coho	3	50-100
	"	"	"	"	Trout-unidentified	1	50-100
Robertson River	09/27/05	2	1,100	Minnow Trap	Coho	2	50-100
	09/30/05	4	4,200	Minnow Trap	Coho	12	50-100
	10/03/05	6	9,500	Observed	Dolly Varden	1	50-60
Gracie Creek	October 4/05	2	1,000	Electroshock	Coho	2	<50
	"	"	"	"	Coho	2	50-100
	"	2	1100	Electroshock	Coho	2	<50
	"	"	"	"	Coho	2	50-100
	"	"	"	"	Rainbow	2	50-100
	"	2	1,300	Observed	Coho	15	Adult
	"	"	"	Observed	Sockeye	4	Adult
	"	"	"	Observed	Chinook	1	Adult
	"	2	1,500	Electroshock	Rainbow	3	50-100
	"	"	"	"	Coho	3	50-100
	October 7/05	2	2,000	Electroshock	Rainbow	3	<50
	"	"	"	"	Coho	1	<50
	"	"	"	"	Coho	1	50-100
	"	3	2,550	Electroshock	Rainbow	4	50-100
	"	3	2,625	Electroshock	Trout-unidentified	2	<50
	"	"	"	"	Trout-unidentified	1	50-100

Figure 27. Juvenile Dolly Varden sampled from a minnow trap in Reach 5 of Cottonwood Creek in September 2005.

b) Gracie Creek (West Coast PU)

We did not find Dolly Varden while electroshocking Gracie Creek, although we did note other juvenile salmonids and adult coho, sockeye (O. nerka), and chinook (O. tshawytshca) (**Table 10**; **Figure 28**; **Figure 29**).

Figure 28. Electroshocking locations in Gracie Creek, October, 2005.

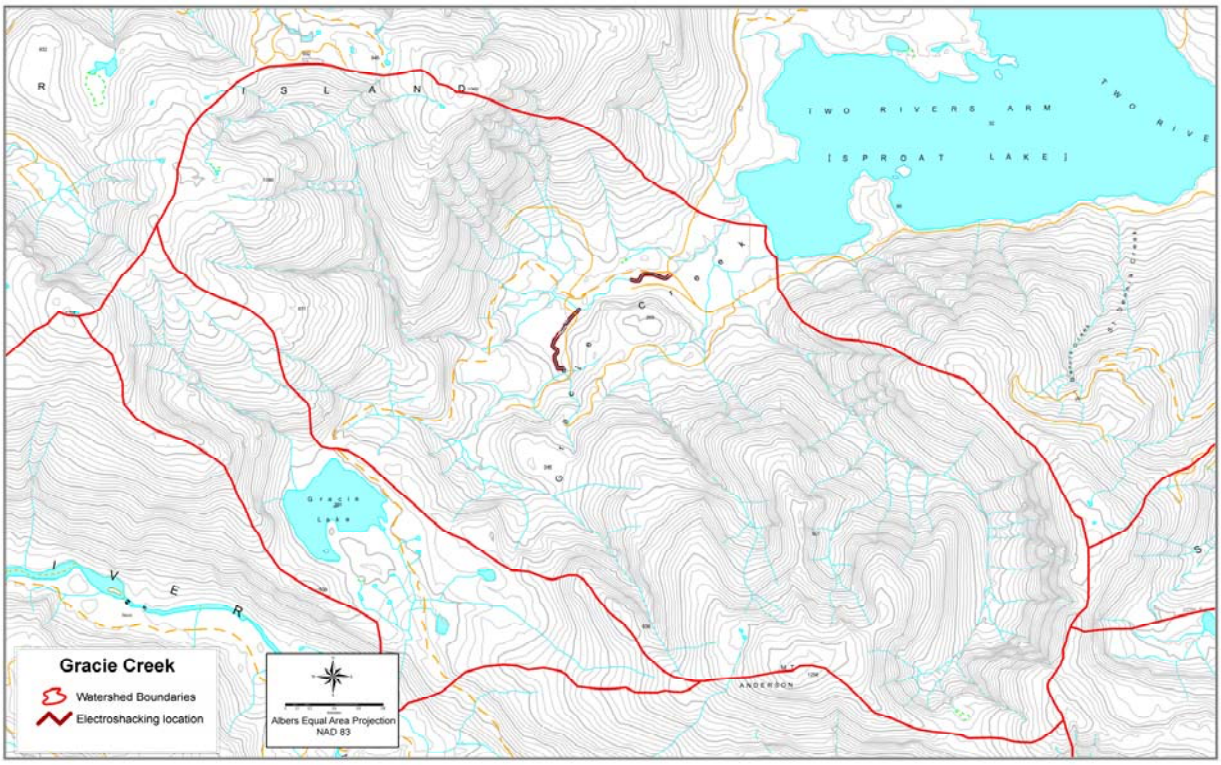


Figure 29. Electroshocking Gracie Creek in early October 2005.

c) Taylor River (West Coast PU)

We found 10 Dolly Varden between 50-100 mm during our snorkel survey of the Taylor River (**Table 11**; **Appendix 2**; **Figure 30**; **Figure 31**; **Figure 32**).

Figure 30. Location of the Taylor River snorkel survey.

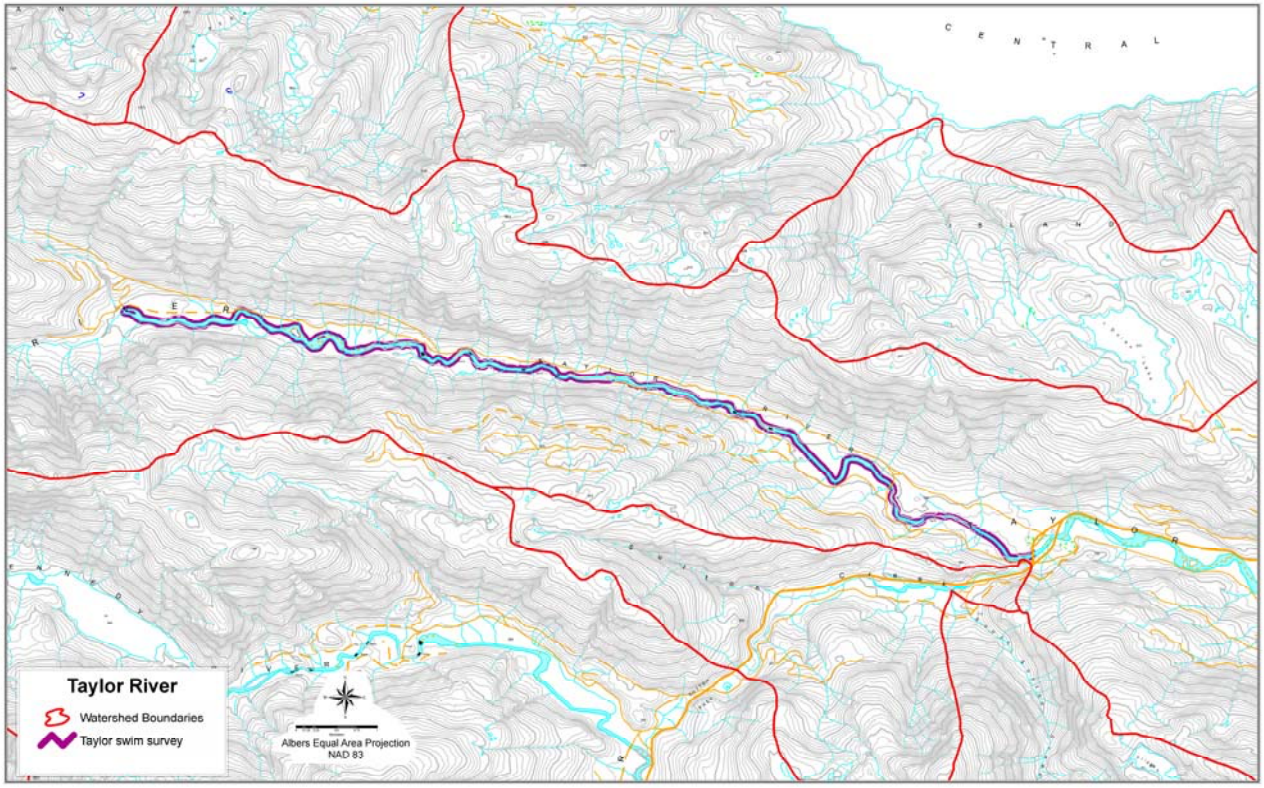


Table 11. Life history stage, number and fork length (mm) of each species noted during a snorkel survey from the headwaters bridge to the highway bridge of the Taylor River, September 26, 2006.

Species	Life History Stage	Number	Fork Length (mm)
Coho	Adult	3	600-700
	Adult	2	700-800
	Juvenile	189	50-100
	Juvenile	10	150-200
Rainbow	Adult	3	200-300
	Unknown	12	150-200
	Juvenile	4	100-150
Dolly Varden	Juvenile	10	50-100

Figure 31. Taylor River looking downstream from the headwaters bridge at start of snorkel survey, September 2006.

Figure 32. Technician conducting snorkel survey of upper Taylor River, September 2006.

4.3 *Objective 3*: Develop restoration prescriptions and management options and projects based on fish habitat and fish presence information from objectives (1) and (2)

4.3.1 Restoration Prescriptions and Plans

a) All Streams in Nanaimo-Cowichan PU

We present the prioritized list of all Lake Cowichan streams in **Table 12** and details of the limiting factors, restoration recommendations and feasibility of restoration projects in the highest priority reaches in these streams in **Table 13**.

Table 12. Stream, habitat rankings average score/reach, fish species, benefit:cost estimates, access and overall score for Sutton, Cottonwood and Nixon creeks and the Robertson River.

Stream	Habitat Rating Score	Average Score/Reach	Dolly Varden*	Cutthroat *	Estimated benefit:cost (high=5; med=3; low=1)**	Access (good=1; poor=0)	Overall Score
Sutton Creek	69	23	1	1	3	1	29
Robertson River	98	25	1	1	1	0	28
Cottonwood Creek	84	21	1	0	5	1	28
Nixon Creek	40	20	1	1	3	1	26

* FISS Data; Year 1 Recovery Plan sampling; 1=fish present

** high=reaches with summer flow

Table 13. Stream, reach, distance, habitat rating, limiting factors, restoration recommendations and feasibility of recommendations for Sutton, Cottonwood, Nixon creeks and the Robertson River. Note, streams and reaches are listed in order of priority.

Stream	Reach	Distance Upstream	Habitat Rating Score (max= 35)	Limiting Factors	Restoration Recommendations	Feasibility/Concerns
Sutton Creek (average score/reach = 23)	1, 2	0.35 to 2 km	25	Wetted Area; poor instream cover (LWD and LWD/boulders); sediment deposition.	Flow monitoring; evaluate storage potential; place instream cover; use bioengineering to address erosion (Table 14).	Right bank of stream is adjacent to golf course making access for instream work feasible.
Sutton Creek (average score/reach = 23)	3	2.0 km to 7.7 km	25	Poor instream cover (especially boulder); possible off-channel habitat	Place instream cover; monitor DFO off-channel to determine use by char and trout; possible future off-channel construction (Table 14).	Most side roads appear deactivated. Reach starts at a bridge crossing so access for instream work good here.
Robertson River (average score/reach = 25)	4	4.7 to 5.3 km	29	Poor instream cover and high % of fines and bed load.	Normally, installation of cover would be recommended, however, see Feasibility/Concerns and Table 15.	Instream work NOT recommended because of channel size and ongoing impacts; Watershed Management Plan recommended instead (Table 15).
Robertson River (average score/reach = 25)	3	1.1 to 4.7 km	25	Poor instream cover and high % of fines and bed load; possible off-channel habitat	Normally, installation of cover would be recommended, however, see Feasibility/Concerns and Table 15. To address possible off-channel habitat limitation – evaluate results of monitoring suggested for Sutton Creek (Table 14, Table 15).	Instream work NOT recommended Watershed Management Plan recommended instead (Table 15); Evaluation of Sutton Creek off-channel recommended before off-channel constructed in Robertston (Table 14; Table 15).
Cottonwood Creek (average score/reach = 21)	4	2.3 km to 2.7 km	23	Poor instream cover	Place instream cover (LWD and LWD/boulder complexes).	Roads on either side of the stream in this reach make access easy.
Cottonwood Creek (average score/reach = 21)	2	1.6 to 2.2 km	21	Poor instream cover	Place instream cover (LWD and LWD/boulder complexes).	Access should be available from one of two roads that follow the banks in this reach.
Nixon Creek (average score/reach = 20)	1, 2, 3	1.6 km to 7.0 km	21	Wetted area, instream cover (LWD).	Suspect bedload is creating subsurface flow; recommend investigating bedload movement and developing mitigation if possible; flow monitoring and possible water storage if required; place instream cover (LWD)	Other than the highway crossing at the reach start, access may be difficult off the road further upstream.
Nixon Creek (average score/reach = 20)	3	7.0 to 8.8 km	19	Instream Cover (boulders)	Place instream cover (boulders)	Access is limited; bank and stream slopes tend to be relatively high.

b) Sutton Creek

Wetted Area

We found poor ratings for wetted area in all reaches of Sutton Creek but particularly in Reach 2 which consisted only of isolated pools (**Table 2**; **Table 13**). We recommend flow monitoring to determine the Mean Annual Discharge and the percent of flow available particularly during spawning seasons of Dolly Varden and cutthroat trout. We also recommend a hydrological assessment to determine the flow requirements during critical times, and if water storage is possible in wetlands or lakes in the watershed. A flow release schedule and agreement will be necessary, as will an agreement regarding structure maintenance constructed as part of any future water storage/release program. We therefore recommend the ministry include in the initial and monitoring phases of this project all watershed stakeholders and landowners, including Honeymoon Bay Enterprises which holds a 60-acre feet irrigation licence for the March Meadows Golf Course.

Table 14. Limiting factors, reach, goal and objective, activities, resources and start and end dates for restoration projects recommended for Sutton Creek.

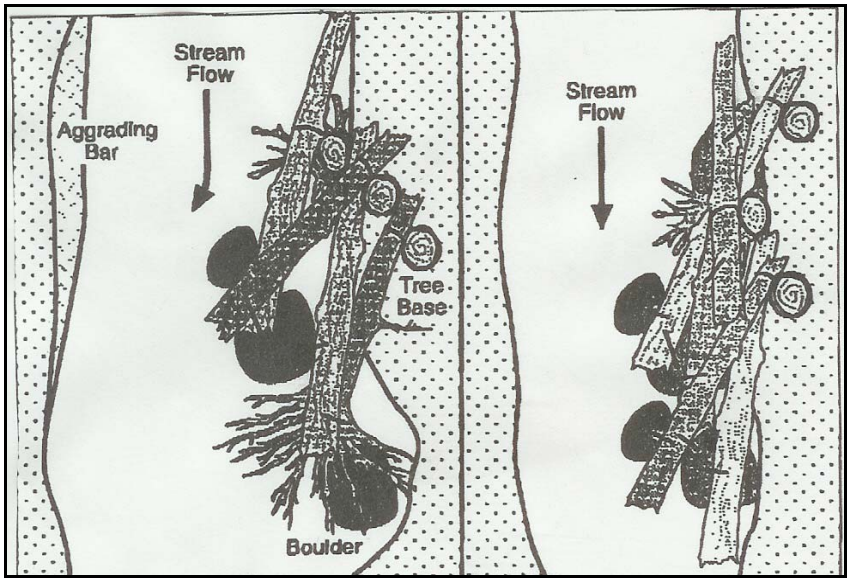
Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Time Frame
Wetted Area	1, 2	Restoration	Monitor stream flow and assess future water storage possibilities in Sutton Creek.	Collect flow data; evaluate potential or existing water storage sites in the watershed and recommend water storage possibilities; implement water storage project and conduct monitoring/maintenance	Existing data; Equipment including flow meter; Technical advice from hydrologist/engineer hydrological assessment; Technicians for sampling/ monitoring.	Summer-Fall 2006 - 2007
Instream Cover (LWD/boulder)	2 and 3	Restoration	Increase cover for fish by placing LWD/boulder complexes	Identify locations for structure placement; outline project and obtain landowner approval and participation where possible; place LWD complexes; continue to monitor changes in fish populations to determine success and structure changes/maintenance required. NOTE: Addition of 40 pieces LWD in Reach 2 and 600 pieces in Reach 3 will bring current levels to good biostandard.	Technical advice; Project Manager Potentially all or a combination of: helicopter, excavator, and field crew; Equipment: cables, epoxy etc; Technical support for field work; Permits; Technical support for monitoring/maintenance	Summer 2006 - ongoing

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Time Frame
Instream Cover (Boulder)	3	Restoration	To increase cover for fish by placing boulders.	Identify locations for structure placement; outline project and obtain landowner approval and participation where possible; place LWD complexes; continue to monitor changes in fish populations to determine success and structure changes/maintenance required.	Technical advice; Project Manager Potentially all or a combination of: helicopter, excavator, and field crew; Equipment: cables, epoxy etc; Technical support for field work; Permits; Technical support for monitoring/maintenance	Summer 2006 - ongoing
Sediment Deposition	2	Restoration	Stop sediment inputs.	Identify locations of unstable and eroding banks; hold discussions with landowners and obtain approval/participation where possible; use bioengineering techniques to reduce sediment inputs by stabilizing banks; monitor changes in sediment deposition, and at sites of concern and restoration.	Technical advice Project manager Planting/restoration material and equipment; Technical support (possibly volunteers) for implementation, photo documentation of restoration sites (including % plant survival) Technical support for monitoring sediment levels.	Fall 2006 - ongoing
Off-channel Habitat	3	Assessment or collection of data on existing channel/Restoration possible	To evaluate constructed off-channel use by char and trout in Sutton Creek; Possible future off-channel construction	Identify existing information on off-channel monitoring; design monitoring study (may require: electroshock channel to determine relative frequency of target species; electroshocking a natural side channel from Sutton Creek or another of the Cowichan targeted streams known to support char and trout; recommend the need to construct off-channel habitat in future.	Project manager; Field Crew; Electroshocking equipment, field crew, permits; data summary/report including recommendations for future construction.	Summer 2006 - 2007

Instream Cover

We recommend adding LWD/boulder clusters in Reaches 2 and 3 of Sutton Creek (**Table 12**; **Table 13**; **Table 14**). We present a conceptual drawing in **Figure 33** of lateral log jams and rootwads secured to boulders which we recommend form the basis of LWD/boulder configurations in Reach 2 (Slaney et. al, 1997; Johnston and Slaney, 1996). We also recommend LWD/boulder clusters be added to Reach 3, however, only where site-specific gradients allow. We recommend reconnaissance assessments determine site locations and LWD/boulder configurations as it may be that boulders should form the majority of these configurations given the higher gradient in this reach. We also recommend field reconnaissance to determine access in Reach 3 as it may be most efficient to use helicopters to deliver supplies. If helicopter transport is required, materials can be trucked to central drop-off points close to worksites, and these sites should be identified during the reconnaissance.

Figure 33. Conceptual drawing of lateral log jams, constructed of logs and rootwads secured to large boulders, aligned with the stream banks and attached to tree bases (from Slaney et. al, 1997).



Sediment Deposition

We recommend discussions with March Meadows Golf Course to determine if there are sediment inputs to Reach 2 from course operations. If potential sediment introductions and sources are identified, we recommend the ministry partner with the golf course to first monitor, then develop a plan to remediate the situation (**Table 12**; **Table 14**). According to Burns (1990), other sources of sediment to this creek include inputs from crossings of the Gordon Main road, and we suggest similar discussions be held with logging companies to determine joint monitoring and remediation solutions to these situations. With respect to remediation, we recommend that wherever possible, bioengineering including planting and the use of vegetative mats and biologs be given priority over hard engineering solutions such as rip-rap, which can transfer energy downstream and create additional problems.

Off-Channel Habitat

We found a lack of off-channel habitat in Sutton Creek, however, recent work by Morley et al. (2005) suggests that while constructed side channels are used extensively by coho, these areas are not important habitats for juvenile cutthroat trout. In the past, Hancock Forest Management worked with Fisheries and Oceans Canada to create off-channel habitat in Reach 3 of Sutton Creek, and this company spoke with us about doing similar or other additional restoration work for Dolly Varden and cutthroat (Ian De Lisle, pers. com., 2006). We recommend the company be involved in monitoring of constructed off-channel to determine if Dolly Varden and/or cutthroat are using this habitat before plans to create additional off-channels are contemplated (**Table 14**).

c) Robertson River

Land Use Impacts

We found high ratings throughout the Robertson River, however, given its size (>15 m bankfull width) and, therefore, the cost and high likelihood of failure, this river should only be considered for off-channel improvement (Johnston and Slaney, 1996). In addition, not only will ongoing land-use, including gravel extraction and forest harvesting, affect the stability of constructed structures, but these activities, unless addressed at their source, will continue to compromise channel stability, and habitat quantity and quality. We recommend the formation of a Robertson River Watershed Management Steering Committee comprised of watershed landowners, stakeholders, stewardship groups and federal, provincial and local governments to address land-use issues through the development of a watershed management plan (**Table 15**). We recommend the objective of this committee be to develop a Watershed Management Plan to guide land use decisions and ensure the protection of fish and wildlife in the Robertson River watershed.

We recommend the ministry convene a stakeholder meeting to introduce this idea and to develop Terms of Reference for the committee. We also suggest that a facilitator be retained to ensure committee continuity, and that a consultant be hired to develop the plan which should include, at a minimum:

1. Gathering data on land use activities including logging plans and gravel extraction amounts and timing. We suggest reviewing existing Watershed Assessment Procedure (WAP) reports to identify flow changes; landslide and bank and channel erosion potential; morphology changes and the interaction of these processes as a result of forestry activities and in light of further forest development;
2. Determining data gaps and developing a plan to fill those gaps;
3. Gathering data on bedload deposition and gravel extraction to identify threshold limits and the development of an interim gravel management plan;
4. Using data to develop a long-term (10 year) land use management plan including threshold-limits for gravel extraction;
5. Developing monitoring projects to ensure the watershed plan is adhered to and forest harvesting complies with the Forest Practices Code (Resource Information Standards Committee, 2002);
6. Agreement and plan sign-off by all stakeholders and participants;
7. Introducing the plan to the Lake Cowichan community;
8. Plan implementation by watershed stakeholders and government partners.

We recommend the formation of the Steering Committee in 2006 because there are pending issues which will impact this river immediately. For example, there are currently plans to remove bed material from the Robertson River and use it to help restore the Stoltz Slide on the Cowichan River mainstem (Dave Lindsay,

pers. com., 2006). This proposal needs to be evaluated in light of the impacts it will have on the already compromised Robertson River.

In addition, we suggest the amount of gravel in the lower 5 km of the river be re-assessed as Burns (1990) estimated at least 3 m of excess gravel in this area, and our estimates suggest more in some areas. We also suggest some data collection begin immediately, for example, the amount of bed material deposited and removed by machine. This information should be used to develop an interim gravel management plan including target-extraction levels to be adhered to until the long-term watershed management plan is developed.

Off-Channel Habitat

Finally, as with Sutton Creek, we suggest the development of off-channel habitat may be an option if monitoring the original off-channel work outlined for Sutton Creek proves beneficial to Dolly Varden and/or cutthroat (**Table 15**).

Table 15. Limiting factors, reach, goal and objective, activities, resources and start and end dates for restoration projects recommended for the Robertson River.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Time Frame
Land Use Impacts (Logging, Bedload Deposition and Removal)	2 and 3	Land Use Planning and Management River; Species Protection	To develop a watershed management plan to guide land use decisions and ensure the protection of fish and wildlife in the Robertson River watershed.	Form watershed management steering committee; define Terms of Reference; hire facilitator and consultant; collect required data for 2006 (see details above); develop interim gravel management plan; develop watershed management plan; obtain approval and plan sign-off by all stakeholders; introduce plan to community and implement plan; monitor and update plan as required.	Facilitator; Steering committee (stakeholders; local and senior governments); Meeting Space and times/supplies; Consultant for plan development; Reports from Industry (WAP reports) or government or collection of data by technicians. Administration (plan distribution/brochures/ other public awareness tools including print media. Technical advice, support and equipment for sampling/ monitoring.	1. Summer-Fall 2006 – ongoing 10 years
Off-channel habitat	2, 3, 4	Restoration	Possible future off-channel construction in Robertson River depending on evaluation of Sutton off-channel	Wait until outcome of Sutton creek off-channel habitat monitoring outlined above; creation of off-channel habitat in Robertson may be possible at later date.	None	N/A

d) Cottonwood Creek

Instream Cover

We found flow, relatively little habitat degradation, and no indication of current logging in Cottonwood Creek. The only habitat limitation we identified was the lack of LWD in Reaches 2 and 5, and the lack of LWD and boulder cover in Reach 4 (**Table 16**). We recommend conducting a reconnaissance to determine site locations and access points for installing these structures which we suggest follow the conceptual drawings in **Figure 33**. As with Sutton Creek, helicopter delivery of materials may be the most efficient use of resources given TimberWest has offered to assist with future restoration projects in this watershed (Dave Lindsay, pers. com., 2006). This company may also provide other equipment including excavators and backhoes, and possibly volunteer support. An increasing number of companies are encouraging employees to become involved in stewardship programs and are providing limited time-off for these endeavors. The restoration projects suggested for Cottonwood Creek could be implemented through this type of partnership, whereby the Ministry provides technical guidance and financial resources and TimberWest provides equipment and volunteer support.

Table 16. Limiting factors, reach, goal and objective, activities, resources and start and end dates for restoration projects recommended for Cottonwood Creek.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Time Frame
Instream Cover (LWD/boulders)	2, 4, 5	Increase cover for fish by placing LWD/boulder complexes	Identify locations for structure placement; outline project and obtain landowner approval and participation where possible; place LWD complexes; continue to monitor changes in fish populations to determine success and structure changes/maintenance required.	Technical advice; Project Manager Potentially all or a combination of: helicopter, excavator, and field crew; Equipment: cables, epoxy etc; Technical support for field work; Permits; Technical support for monitoring/maintenance NOTE: Addition of 87 pieces of LWD to Reach 2 and 67 pieces to Reach 4 will bring current levels to good biostandard.	Summer 2006 - ongoing	Increase cover for fish by placing LWD/boulder complexes

e) Nixon Creek

Wetted Area

Reach 1 of Nixon Creek was dry and we found poor ratings for percent wetted area in Reaches 2 and 3 (**Table 8**; **Table 9**). We suspect the heavy bed load in Reach 2 may be causing subsurface flow and, as a result, we recommend assessing the amount of bed load deposition and hiring a river engineer to develop a mitigation plan if feasible (**Table 17**). We also recommend flow monitoring to determine if this is limiting fish during critical times. If so, as with Sutton Creek, we recommend developing a water storage project which includes watershed landowners in the planning and initial monitoring stages, and a subsequent hydrological study to determine flow requirements during critical periods and the identification of potential water storage sites.

Table 17. Limiting factors, reach, goal and objective, activities, resources and start and end dates for restoration projects recommended for Nixon Creek.

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Time Frame
Bedload Deposition/ Wetted Area	1, 2, 3	Restoration	Assess and monitor bedload deposition Monitor stream flow and assess future water storage possibilities in Nixon Creek.	Collect data on bedload existing and ongoing deposition; speak with landowners to determine if bedload will continue; hire an engineer to develop removal and mitigation plan Collect flow data; evaluate potential or existing water storage sites in the watershed and recommend water storage possibilities; implement storage project; monitor flows	Biologist/engineer for monitoring design; Technicians/for study implementation Engineer for mitigation plan; Engineer, biologist, technicians for implementation of mitigation plan Existing data; Equipment including flow meter; Technical advice from hydrologist/engineer hydrological assessment; Technicians for sampling/ monitoring	Summer-Fall 2006 -2007 Summer 2007 - 2008
Instream Cover (LWD)	2, 3	Restoration	Increase cover for fish by placing LWD	Identify locations for structure placement; outline project and obtain landowner approval and participation where possible; place LWD; monitor changes in fish populations to determine success and structure changes/maintenance required. NOTE: Addition of 119 pieces of LWD to Reach 2 and 325 pieces to Reach 3 would bring current levels to good biostandard.	Technical advice; Project Manager Potentially all or a combination of: helicopter, excavator, and field crew; Equipment: cables, epoxy etc; Technical support for field work; Permits; Technical support for monitoring/maintenance	Summer 2006 - ongoing

Limiting Factor	Reach	Goal	Objective	Activities	Resources Required	Time Frame
Instream Cover (Boulders)	2, 3	Restoration	To increase cover for fish by placing boulders.	Identify locations for structure placement; outline project and obtain landowner approval and participation where possible; place boulders; monitor changes in fish populations to determine success and structure changes/maintenance required.	Technical advice; Project Manager; Equipment and supplies (excavator etc) Field crew; Technical support for field work; Permits; Technical support for monitoring/maintenance	Summer 2006 - ongoing

Instream Cover

We recommend LWD and boulder placements in Reaches 2 and 3 of Nixon Creek (**Table 9**; **Figure 8**; **Figure 33**; **Table 17**). This stream is accessible from Highway 18 to Reach 3, however, because of distance, helicopter transport of materials may be the most efficient use of resources. As with other streams, we recommend a field reconnaissance to determine access and site locations, and to identify if LWD is available near the restoration sites and can be used without compromising other habitat values.

4.3.2 Future Assessments

a) All streams in Nanaimo-Cowichan PU

Burns (1990) identified Dolly Varden and cutthroat trout in South Sutton Creek, therefore, we recommend Level 1 habitat assessments to determine limiting factors and the identification of restoration priorities and projects for this tributary (**Table 18**). We also recommend Level 1 assessments and restoration prescriptions for Nineteen and Sixteen creeks, both tributaries to the Robertson River and both with Dolly Varden and cutthroat trout. Given the mainstem of this river is not suitable for restoration, some projects may be appropriate on these tributaries and these restoration plans can be incorporated into the Robertson River Watershed Management Plan.

Widow Creek, a tributary to Cottonwood Creek supports Dolly Varden, therefore, we recommend a habitat assessment and the development of restoration priorities and plans for this area, as well as for Raymond Creek and another unnamed stream, both tributary to Nixon Creek (**Table 18**).

Table 18. Tributaries, of the four Cowichan Lake streams, recommended for future WRP Level 1 Fish Habitat assessments.

Stream System	Tributary Name/ Watershed Code	Dolly Varden Present	Cutthroat Trout Present
Sutton Creek	South Sutton Creek	Yes	Yes
Robertson River	Nineteen Creek	Yes	Yes
Robertson River	Sixteen Creek	Yes	Yes
Cottonwood Creek	Widow Creek	Yes	unknown
Nixon Creek	Unnamed stream (920-257700-91900-42900)	Yes	Yes
Nixon Creek	Raymond Creek	Yes	Yes

4.3.3 Restoration Prescriptions and Plans – West Coast PU

a) Taylor River

Dolly Varden and cutthroat trout have now been documented throughout the Taylor River, therefore this is a good watershed in which to concentrate future habitat assessment and restoration. Wright and Associates conducted a habitat assessment and restoration study on this river in 1999, however their target species were salmon and their recommendations may not have the same benefit for Dolly Varden and cutthroat (**Appendix 2**). For example, these investigators recommended developing a side channel and expanding a constructed groundwater channel in Reach 1; investigating connecting a 0.5 ha pond near Reach 1/2 to the mainstem, and connecting ponds on the north side of the Taylor River Rest Area to the mainstem via a culvert (Wright and Associates, 1999). Given the recent study by Morley et. al. (2005) outlined above, we suggest that any development of this off-channel habitat for char and trout be evaluated in light of results from the Sutton Creek off-channel monitoring project suggested earlier.

Table 19. Stream, priority, future projects and feasibility and estimated benefit:cost for projects recommended on the Taylor River, Sutton, and Gracie Creeks.

Stream	Priority	Future Projects	Feasibility and Estimated Benefit:Cost
Taylor River	1	Level 1 WRP Fish Habitat Assessment to identify habitat limiting factors for cutthroat trout and Dolly Varden	Concentrate first in the tributaries and upstream of the Rest Area
Sutton Creek	2	Fish assessment to confirm Dolly Varden and cutthroat trout presence	Access may be limited for assessments; estimated high benefit:cost for restoration if target species identified
Sutton Creek	3	Introduce LWD in Reaches 2 and 3 as per Wright and Associates (1999) and Chapman Geoscience Ltd. (1999).	Feasibility depends on access; high benefit:cost if Dolly Varden are identified.

In addition to having different target species, the recommendations made by Wright and Associates may have been based more on identifying restoration opportunities, rather than on addressing habitat limitations which we suggest be the first step in developing restoration plans. Rather than assessing the mainstem, however, we recommend habitat assessment and restoration studies be concentrated on Taylor River tributaries and upstream of the Rest Area bridge

because of recommendations by Chapman . (1999) that there be no restoration work in the Taylor mainstem due to the large hydraulic energy of this river.

b) Sutton Creek

We did not conduct a fish assessment of Sutton Creek and suggest that this be completed and if char are confirmed, that recommendations by Chapman (1999) and Wright and Associates (1999) to place LWD in Reaches 2 and 3 be implemented (**Table 19**).

c) Gracie Creek

Burns (1973) documented cutthroat trout in Gracie Creek, however, we did not find Dolly Varden, therefore, we have not recommended any additional work in this stream.

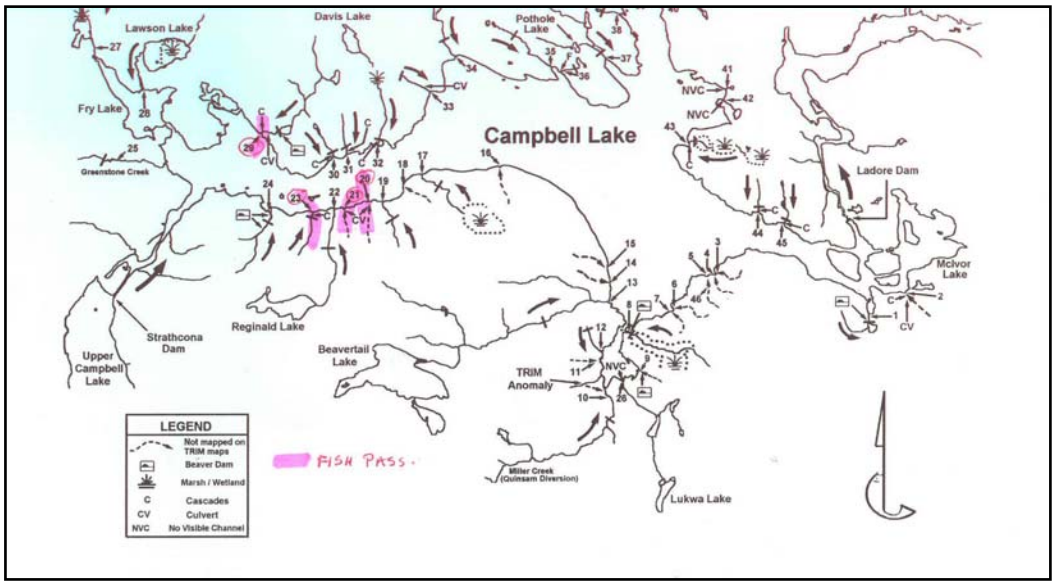
4.4 *Objective 4*: Determine if culverts on four unnamed tributaries to Lower Campbell Lake (Comox-Oyster PU) are fish passage barriers and, if so, develop a barrier removal plan.

This project was not completed, therefore we recommend this project be implemented in 2007. We present a summary of the nature of the problems in **Table 20**, and a map showing the locations of the target streams in **Figure 34**.

Table 20. Stream number, watershed code, barrier location and description of potential fish passage blockages in the Lower Campbell Lake watershed (Lough and Associates, 2000).

Stream # (see Figure 36)	Watershed Code	Barrier Location	Barrier Description
20	920-627900-32345	Reach 1	Fish barrier; collapsed log culvert with 1.3 m drop under old rail grade; located 35 m upstream of Lower Campbell Lake (LCL).
21	920-627900-32849	Reach 1	Partial fish barrier; collapsed log culvert (1.0 m high) under old rail grade located 38 m upstream of LCL.
23	920-627900-33500	Reach 1	Partial fish barrier; cascade (1.0 m high) flows through slumped rail grade located 40 m upstream of LCL.
29	920-627900-35000	Reach 1	Partial fish barrier; culvert (1.0 m high) located at old road crossing immediately above LCL.

Figure 34. Location of the four unnamed Lower Campbell tributaries with complete or partial barriers to fish passage (MJ Lough and Associates, 2000). The four streams with numbers 20 (watershed code: 920-627900-32345), 21 (watershed code: 920-627900-32849), 23 (watershed code: 920-627900-33500), and 29 (watershed code: 920-627900-35000) are highlighted in pink.



4.5 *Objective 5:* Prioritize projects for Year 2 based on the results of Year 1 combined with the original recommendations in the Vancouver Island Blue-Listed Freshwater Sportfish Recovery Plan.

The following tables outline the priority listings for projects recommended for implementation in Year 2 and beyond. In **Table 21** we present, in priority, all of the projects identified in the Blue-Listed Freshwater Sportfish Recovery Plan and in this Year 1 report. **Table 22** outlines uncompleted projects and the Ministry, Division and Fisheries Section priorities that each project meets (**Table 23**). In **Table 24** we present a roll-up of all projects organized according to the number of Ministry, Division, and Fish and Wildlife Section priorities met, and Fish and Wildlife Section only priorities met. We have also listed resource requirements, concerns and other information for each project which can be used to help determine staff-specific work priorities for 2006.

Table 21 List of all projects recommended for implementation listed in priority order according to: (1) recommendations in the Blue-Listed Freshwater Sportfish Recovery Plan – General Recommendations; (2) recommendations in the Blue-Listed Freshwater Sportfish Recovery Plan – Individual Lake Recovery Plans; (3) Year 1 recommendations (this report). Details for individual projects can be found in the in these master documents.

Document/Report of Original Recommendation	Priority	Recommendation/Project
Vancouver Island Blue Listed Freshwater Sportfish Recovery Plan – General Recommendations	1, 2, 3	Continue VI Lakes Questionnaire; break catch into species; analyze data to define future use and catch
	4	Maintain catch-and-release regulation for Dolly Varden
	5	Implement angler-awareness programs
	6, 35	Establish a Blue-listed Sportfish Recovery Plan Steering Committee; host annual meeting to review Plan implementation
	7, 8	Review Nimpkish and Knight PUs; Review all PUs at 5-year intervals
	9	Implement snorkel monitoring program on key streams
	10	Analyze existing nutrient-addition data in Campbell Oyster PU
	11	Restore stocks through habitat restoration
	12	No hatchery introductions of cutthroat in resident wild-stock areas
	13	Give priority to Dolly Varden and cutthroat trout habitat in protection discussions
	14	Develop Dolly Varden and cutthroat trout protection guidelines
Vancouver Island Blue Listed Freshwater Sportfish Recovery Plan – Individual Lake Recovery Plans	15, 16, 17, 18	Conduct Level 1 habitat assessments and develop restoration prescriptions in Nanaimo-Cowichan PU; conduct fish inventories in Nanaimo-Cowichan and West Coast PU
	19	Determine if culverts on unnamed tributaries to Lower Campbell Lake are barriers and remove if necessary
	20, 21, 22	Conduct Level 1 habitat assessment; define restoration priorities and projects in Clutesi, Rees, Erick creeks
	23	Conduct fish inventory in Cruickshank River
	24, 25	Integrate with Bridge Coastal to ensure DV included in Elk River Plan; conduct Level 1 assessment; define restoration priorities for Elk River
	26, 27, 28	Conduct Level 1 habitat assessment; define restoration priorities and projects for Tolowis, Filberg, Cervis creeks
	29, 30	Request Bridge Coastal funds for projects at L. Campbell Lake outlined by Northwest Hydraulics; design and construct flow release structure at outlet of Fry Lake
	31, 32	Meet with UBC staff to discuss analysis of existing fertilization data for Campbell-Oyster PU; develop plan and apply for funds to HCTF/Bridge Coastal
	33, 34	Meet with BC Hydro staff to determine if LWD can be installed for cover

Document/Report of Original Recommendation	Priority	Recommendation/Project
		at Strathcona Dam; develop funding proposal.
Year 1 Recommendations (this report)	35, 36, 37, 38	Monitor stream flow and assess future water storage possibilities; increase cover; stop sediment inputs; evaluate off-channel use at Sutton Creek
	39	Develop Watershed Management Plan for the Robertson River watershed.
	40	Increase cover by placing LWD/boulder complexes at Cottonwood Creek
	41, 42, 43, 44	Collect data on bedload deposition; develop removal and mitigation plan; collect flow data; evaluate water storage; implement storage; increase cover at Nixon Creek
	45, 46, 47, 48	Conduct Level 1 habitat assessment; define restoration priorities and projects for South Sutton, Nineteen, Sixteen and Widow creeks
	49, 50	Conduct Level 1 habitat assessment; define restoration priorities and projects for Raymond Creek and Taylor River
	51	Conduct fish assessment to confirm Dolly Varden and cutthroat trout presence; introduce LWD in R2/R3 (Wright et. al., 1999; Chapman, 1999) in Sutton creek (West Coast PU)

Table 22. Uncompleted projects from the Vancouver Island Blue-Listed Freshwater Sportfish Recovery Plan and Year 1 recommendations with their Ministry of Environment, Environmental Stewardship Division and Fish and Wildlife Section priorities detailed in **Table 23**.

Recommendation/Project	Ministry Priority Number	Division Priority Number	Section Priority Number
Continue VI Lakes Questionnaire; break catch into species; analyze data to define future use and catch	2, 3	4, 6	1, 2, 4, 5, 7
Maintain catch-and-release regulations for Dolly Varden	1, 5	1, 2, 4	1, 2, 4, 6
Implement angler-awareness programs	3	2, 4	2, 4, 5, 7, 8, 10
Establish a Blue-listed Sportfish Recovery Plan Steering Committee; host annual meeting to review Plan implementation	3	2, 4	4, 5, 6, 7, 8, 10
Implement snorkel monitoring program on key streams	2	1, 2, 4	4, 5, 7, 9
Meet with UBC staff to discuss analysis of existing fertilization data for Campbell-Oyster PU; develop plan and apply for funds to HCTF/Bridge Coastal ; analyze existing nutrient-addition data in Campbell Oyster PU	2, 3, 4, 5	3, 4, 6	1, 2, 4, 6, 7, 8, 9, 10
Develop Dolly Varden and cutthroat trout protection guidelines	1, 2, 5	1, 2, 4	4, 6, 9
Determine if culverts on unnamed tributaries to L.Campbell Lake are barriers; remove	-----	2, 3, 4, 5	4, 6
Conduct Level 1 habitat assessment; define restoration priorities and projects in Clutesi, Rees, Erick creeks	2	3, 4	4, 5, 6, 7
Conduct fish inventory in Cruickshank River	2	-----	4, 5, 7
Integrate with Bridge Coastal to ensure DV included in Elk River Plan; conduct Level 1 assessment; define restoration priorities for Elk River	1. 2, 3	1, 2, 4	4, 5, 6, 7, 8
Conduct Level 1 habitat assessment; define restoration priorities and projects for Tolowis, Filberg, Cervis creeks	2	3,4	4, 5, 6, 7
Request Bridge Coastal funds for projects at L. Campbell Lake outlined by Northwest Hydraulics; design and construct flow release structure at outlet of Fry Lake	3, 5	3, 6	4, 6, 8, 10
Meet with BC Hydro staff to determine if LWD can be installed for cover at Strathcona Dam; develop funding proposal.	3	1, 2, 3, 4	2, 4, 6, 8, 10
Monitor stream flow and assess future water storage possibilities; increase cover; stop sediment inputs; evaluate off-channel use at Sutton Creek	2, 5	3, 4	4, 5, 6, 7
Develop Watershed Management Plan for the Robertson River watershed.	1, 2, 3	1, 2, 3, 4	4, 5, 6, 7, 8, 10
Increase cover by placing LWD/boulder complexes at Cottonwood Creek	-----	3, 4	4, 6
Collect data on bedload deposition; develop removal and mitigation plan; collect flow data; evaluate water storage; implement storage; increase cover at Nixon Creek	2, 5	3, 4	4, 5, 6, 7
Conduct Level 1 habitat assessment; define restoration priorities and projects for Raymond Creek and Taylor River	2	3, 4	4, 5, 6, 7
Conduct fish assessment to confirm Dolly Varden and cutthroat trout presence; introduce LWD in R2/R3 (Wright et. al., 1999; Chapman, 1999) in Sutton creek (West Coast PU)	2	3	4, 5, 6

Table 23. Ministry of Environment, Environmental Stewardship Division and Fisheries Section Priorities (Ministry of Environment, 2006; Ministry of Environment, 2005; Benton, 2005; Wilkin, 2005; Hooton, 2005).

Priority Number	Ministry of Environment (Ministry of Environment, 2006)	Environmental Stewardship Division (Ministry of Environment, 2005)	Fish and Wildlife Section (Benton, 2005; Wilkin, 2005; Hooton, 2005)
1	Clear strategies and legislation to protect and restore species and their habitats.	Management and conservation of the province's biodiversity	Projects that create angling opportunities
2	Improved use of scientific and inventory information for developing standards, management, monitoring and reporting	Protection of species at risk	Projects that sustain angling opportunities
3	Increased partnerships to conserve species and their habitats	Protection and restoration of BC's watersheds	Projects that enhance angling (e.g., docks etc.)
4	High quality park facilities, services and opportunities	Protection of fish and wildlife species and their habitat	Species of concern/species at risk
5	High quality hunting, angling and wildlife viewing opportunities	Stewardship of parks and protected lands	Species/ecosystem monitoring
6		Provision of park, fish and wildlife recreation	Strategies to protect/restore species
7			Use of inventory information for management and monitoring
8			Partnerships to conserve species and habitats
9			Cost
10			Availability of resources through partnerships

Table 24. Recommended projects including resource requirements, concerns and other information. Projects listed in order according to: (1) total number of Ministry, Division, and Fish and Wildlife priorities met and; (2) total number of Fish and Wildlife Section priorities met.

Recommendation/Project	Total Number of Ministry, Division and Section Priorities Met	Number of Fish and Wildlife Section Priorities Met	Resource Requirements, Concerns and Other Information
Meet with UBC staff to discuss analysis of existing fertilization data for Campbell-Oyster PU; develop plan and apply for funds to HCTF/Bridge Coastal ; analyze existing nutrient-addition data in Campbell Oyster PU	15	8	Ken Ashley and Tom Johnston contacted and agree this is a worthwhile project; Tom Johnston to determine if this can be put into his workplan; HCTF has approved carry-over funding can be used for this project in 2006
Develop Watershed Management Plan for the Robertson River watershed.	13	6	Could implement as part of the Lake Cowichan planning process currently attended by federal, provincial, local government, non-government groups and public; contact Region 1 representative to determine if both plans could be amalgamated
Integrate with Bridge Coastal to ensure DV included in Elk River Plan; conduct Level 1 assessment; define restoration priorities for Elk River	11	5	Contact BC Hydro to determine status of Elk River Plan; could be possible through Watershed Monitoring Planning process
Meet with BC Hydro staff to determine if LWD can be installed for cover at Strathcona Dam; develop funding proposal.	10	5	May not be supported by BC Hydro given high flow release at times; consider suggesting this when Campbell River Water Use Monitoring Program is implemented
Implement angler-awareness programs	9	6	Trout Unlimited Canada and Trout Unlimited Nanaimo have agreed to provide funding for these projects in 2006; Parks Section of Environmental Stewardship Division has also agreed to provide in-kind support
Establish a Blue-listed Sportfish Recovery Plan Steering Committee; host annual meeting to review Plan implementation	9	6	Could be done in partnership with Victoria/Headquarters and Ecosystem Branch of Environmental Stewardship Division
Continue VI Lakes Questionnaire; break catch into species; analyze data to define future use and catch	9	5	Implemented through Region 1 Lakes Biologist
Maintain catch-and-release regulations for Dolly Varden	9	4	Status quo
Develop Dolly Varden and cutthroat trout protection guidelines	9	3	Could be done in partnership with Victoria/Headquarters and Ecosystem Branch of Environmental Stewardship Division
Implement snorkel monitoring program on key streams	8	4	Can be implemented through existing Fisheries Section work plans
Request Bridge Coastal funds for projects at L. Campbell Lake outlined by Northwest Hydraulics; design and construct flow release structure at outlet of Fry Lake	8	4	Meetings with BC Hydro regarding this project have been unsuccessful - consider deferring until Campbell River Water Use Plan Monitoring is in place
Monitor stream flow and assess future water storage possibilities; increase cover; stop sediment inputs; evaluate off-channel use at Sutton Creek	8	4	Monitoring, assessment and restoration projects; require technical support/contracts
Collect data on bedload deposition; develop removal and mitigation plan; collect flow data; evaluate water storage; implement storage; increase cover at Nixon Creek	8	4	Assessment and restoration projects; require technical support/contracts
Conduct Level 1 habitat assessment; define restoration priorities and projects in Clutesi, Rees, Erick creeks	7	4	Assessment projects; require technical support/contracts
Conduct Level 1 habitat assessment; define restoration priorities and projects for Tolowis, Filberg, Cervis creeks	7	4	Assessment projects; require technical support/contracts

Recommendation/Project	Total Number of Ministry, Division and Section Priorities Met	Number of Fish and Wildlife Section Priorities Met	Resource Requirements, Concerns and Other Information
Conduct Level 1 habitat assessment; define restoration priorities and projects for Raymond Creek and Taylor River	7	4	Assessment projects; require technical support/contracts
Determine if culverts on unnamed tributaries to L.Campbell Lake are barriers; remove	6	2	Funding provided through Habitat Conservation Trust Fund 2006
Conduct fish assessment to confirm Dolly Varden and cutthroat trout presence; introduce LWD in R2/R3 (Wright et. al., 1999; Chapman, 1999) in Sutton creek (West Coast PU)	5	3	Assessment and restoration projects; require technical support/contracts
Conduct fish inventory in Cruickshank River	4	3	Assessment project; requires technical support/contracts
Increase cover by placing LWD/boulder complexes at Cottonwood Creek	4	2	Restoration projects; require technical support/contracts

5.0 Literature Cited

Andrew, J.H., N. Jonsson, B. Jonsson, K. Hindar, and T.G. Northcote. 1992. Changes in use of lake habitat by experimentally segregated populations of cutthroat trout and Dolly Varden char. Ecography 15(2): 245-252.

Benton, S. August 23, 2005. Email Re: Decision Support Workplans. Ministry of Environment. Environmental Stewardship Division.

British Columbia Conservation Data Center, 2005. Ministry of Environment. Victoria, B.C.

Burns, J.E. 1973. Notes on Sproat Lake tributaries. Unpublished material available from British Columbia Ministry of Environment Library. Nanaimo, British Columbia.

Burns, T. 1990. Habitat Inventory of Tributaries to the Koksilah and Cowichan River Watersheds. Unpublished material available from British Columbia Ministry of Environment Library. Nanaimo, British Columbia.

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, Salvelinus confluentus (Suckley), from the American Northwest. Calif. Fish and Game. 64: 139-174.

Chapman, A. 1999. Taylor River Channel Stability Analysis. Report prepared by Chapman Geoscience Ltd., for British Columbia Ministry of Environment, Lands and Parks, Watershed Restoration Program, Nanaimo, BC.

Delisle, I. 2006. personal communication. Hancock Forest Management Ltd., Nanaimo, British Columbia.

Elliott, S.T. 1986. Reduction of a Dolly Varden population and macrobenthos after removal of logging debris. Trans. Am. Fish. Soc. 115(3): 392-400.

Ellis, D.V. 1963. A Comparative survey of the migratory behaviour of adult salmon in fish control devices. Fish. Res. Board Can., MS Rep. Ser. 749: 50 p.

Haas, G.R. and J.D. McPhail. 1991. Systematics and distributions of Dolly Varden (*Salvelinus malma*) and bull trout (*S. confluentus*) in North America. Can. J. Fish. Aquat. Sci. 48: 2191-2211.

Heifetz, J., M. L Murphy, and K.V. Koski. 1986. Effects of Logging on Winter Habitat of Juvenile Salmonids in Alaskan Streams. N. Am. J. Fish. Manag. 6(1): 52-58.

Hindar, K, B. Jonsson, J. H. Andrew, and T. G. Northcote. 1988. Resource utilization of sympatric and experimentally allopatric cutthroat trout and Dolly Varden char. Oecologia 74(4): 481-491.

Hooton, B. August 5, 2005. Email Re: Recreational S/Ship Criteria. Minsitry of Environment, Fish and Wildlife Section.

Johnston, N. T. and P. A. Slaney. 1996. Fish Habitat Assessment Procedures. British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests, Watershed Restoration Program, Technical Circular No. 9.

Langford, R.W. and J.E. Burns. 1977. Lake and Stream Inventory of the Capital Regional District, A report for the Capital Regional District, Victoria, British Columbia.

Lindsay, D. 2006. personal communication. TimberWest Forest Corp., Nanaimo, British Columbia.

Lough, M.J. and Associates. 2000. Reconnaissance inventory of Campbell Lake tributaries [prepared for: British Columbia Ministry of Environment, Lands and Parks]. Nanaimo, B.C.: MJ Lough & Associates. 23 pp + appendices.

Michalski, T.A., G.E. Reid and G.E. Stewart. 2000. Urban Salmon Habitat ProgramAssessment Procedures for Vancouver Island. Ministry of Environment, Lands and Parks.

Michalski, T. 2005. Preliminary Findings of the Vancouver Island Region Dolly Varden Study April 2002 – December 2004 (draft). British Columbia Ministry of Water, Land and Air Protection.

Ministry of Environment. 2006. Ministry of Environment including Environmental Assessment Office. 2005/06 – 2007/08 Service Plan Update September 2005. Ministry of Environment.

Ministry of Environment, 2005. Introduction to the Environmental Stewardship Division (ESD). Ministry of Environment. Environmental Stewardship Division Intranet site. http://wlapgww.bcgov/esd/esd_intro_htm

Morley, S. A., P. S. Garcia, T. R. Bennett, P. Roni. 2005. Juvenile salmonid (Oncorhynchus spp.) use of constructed and natural side channels in Pacific Northwest Rivers. Canadian Journal of Fisheries and Aquatic Sciences, 62:2811-2821.

Mundy, P.J. Habitat partitioning between sympatric coho salmon and Dolly Varden char juveniles. 61. Ann. Meet., Northwest Sci. Assn., Ashland, OR (USA), 22-25 Mar. 1988.

Northcote, T. 2006. personal communication. Professor Emeritus, University of British Columbia, Vancouver, British Columbia.

Parks, C. 2004. personal communication. Registered professional biologist #1497, Victoria, B.C.

Pollard, S.M. and T. Down. 2001. Bull trout in British Columbia – A provincial prospective on status, management and protection. Pp. 207-214 *in*: Brewin, M.K., A.J. Paul, and M. Monita eds. Bull trout II Conference Proceedings.

Reid, G.E. and T. Michalski. 2005. Vancouver Island Dolly Varden Recovery Program (draft). Central Westcoast Forest Society, Port Alberni, British Columbia.

Reid, G.E. and T. Michalski. 2006. Vancouver Island Blue Listed Freshwater Sportsfish Recovery Plan (draft). Central West Coast Forestry Society, Port Alberni, British Columbia.

Reid, G.E., T.A. Michalski, T. Reid. 2000. Status of fish habitat in East Coast Vancouver Island watersheds. Pp. 335-367 *in*: L.M. Darling, ed. Proceedings of a conference on the biology and management of species and habitats at risk, Kamloops, B.C., 15-19 Feb. 1999. Volume One. British Columbia Ministry of Environmnet, Lands and Parks, Victoria, B.C. and University College of the Cariboo, Kamloops, B.C. 490 pp.

Resource Information Committee. 2001. Reconnaissance (1:20 000) fish and fish habitat inventory: standards and procedures, version 2.0. Available from: http://ilmbwww.gov.bc.ca/risc/pubs/aquatic/recon/index.htm.

Rosenfeld, J., M. Porter, and E. Parkinson. 2000. Habitat factors affecting the abundance and distribution of juvenile cutthroat trout (*Oncorhynchus clarki*) and coho salmon (*O. kisutch*). Can. J. Fish. Aquat. Sci. 57: 766-774.

Rutherford, T., 2005. pers. com. Department of Fisheries and Oceans, Duncan, B.C. Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Bull. Fish. Res. Board Can. 184. 966 pp.

Slaney, P.A, R.J. Finnigan, and R.G. Millar. 1997. Accelerating the recovery of log-jam habitats: large woody debris-boulder complexes. Chapter 9 in P.A Slaney and D. Zaldokas [editors]

Slaney, P. and J. Roberts. 2005 Coastal cutthroat trout as sentinels of Lower Mainland watershed health. British Columbia Ministry of Environment.

Wilkin, N. 2005. Email Re: Outreach Project – Division Survey. Ministry of Environment. Environmental Stewardship Division.

Wright, M.C. and Associates. 1999. Taylor River modified WRP habitat over assessment differential GPS mapping of habitat type, habitat condition and restoration opportunities in selected areas of the Taylor River Watershed. Forest Renewal BC., British Columbia Ministry of Environment, Lands and Parks.

6.0 Appendices