Vancouver Island Anadromous Cutthroat Trout Revitalization Program

Project Summary Report 2007

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1.0 Introduction

The coastal cutthroat trout (*Oncorhynchus clarki clarki*) is a blue-listed subspecies of cutthroat trout, ranging from northern California to southeast Alaska up to 150 km from the coast. The anadromous form is found primarily in coastal rivers and low elevation streams. While rainbow trout occupy the mainstems of rivers and lower reaches of streams, cutthroat exploit the highest reaches of headwater streams for spawning and rearing. These streams are often too small for large steelhead to navigate. Cutthroat streams are generally in small drainages (generally <40 km^2 depending on ecosection), 1st or 2nd or 3rd order streams with low gradients (0.5-7%) with summer baseflows averaging 1-60 L/s and a mean annual discharge of <600 L/s (Ptolemy, pers. comm.). Mixes of cutthroat trout and rainbow parr occur in streams of mean annual discharge from 600 to 1000 L/s.

Adults often spend the late fall and early winter in larger streams and rivers where they feed on salmon eggs, fry, and carcasses during their migration to spawning grounds. Adults that are natal to small streams draining directly into saltwater spend little time in fresh water as dictated by freshet duration; consequently they spend most of their time in salt water or estuaries. Spawning occurs from January-May in small (1st or 2nd order) streams that may be headwaters in larger stream networks. Females select gravel substrates with a particle size range of 5-50 mm, frequently at pool tail-outs. Fry emerge from April-June, and generally inhabit riffles although in the absence of predation from parr or competition with coho they may also colonize pools. Parr and adults prefer complex boulder riffles, deep pools with cover, and adequate large woody debris (LWD) structures that increase pool frequency and provide shelter during winter floods. Smoltification occurs in March-June, generally at least one year after fry emergence but with age of smolts depending on stream productivity and growth season length (days/year >7°C). Migratory behaviour in cutthroat trout populations is complex and variable. Smolts may migrate to larger rivers or directly to saltwater where they remain in estuaries or in the nearshore marine environment. Spawning can begin as early as one year after smoltification (ocean age 1), and repeat spawning is common (Slaney and Roberts 2005).

Throughout their range, cutthroat populations have declined from historical levels, mainly due to habitat loss and degradation. Cutthroat trout populations are an important indicator of watershed health, since cutthroat juveniles reside longer in streams than salmon fry and are therefore more vulnerable to habitat degradation than species with a shorter freshwater residence (Slaney and Roberts 2005). On the east coast of Vancouver Island, cutthroat habitat is under pressure from the largest and fastest growing human population in the Georgia Depression EcoProvince. Habitat degradation has occurred from past land clearing, forest harvesting, stream cleaning, existing agriculture and increasing urbanization. These actions have reduced water quality, increased frequency of floods and water velocity, reduced flow, reduced cover and pools, increased sediment loads and sedimentation of spawning gravel, and created barriers to migration. Rearing conditions have also been negatively affected by declines of returning salmon which have deprived cutthroat streams of nutrients (Slaney and Roberts 2005).

In addition to loss of habitat, cutthroat trout are vulnerable to fishing mortality and hybridization (Bettles 2004) with rainbow trout. Cutthroat are particularly vulnerabut to fishing mortality due to their piscivorous nature (Slaney and Roberts 2005). Hatchery programs have been implicated in the extirpation of several populations of anadromous cutthroat in Oregon and southern Washington because of suspected hybridization between cutthroat and rainbow trout. On Vancouver Island, hybridization was documented in approximately 97% of sampled streams where cutthroat were sympatric with rainbow trout, with maximum hybridization levels of 86% recorded in Chase River (Bettles 2004). Hybridization levels were influenced by forest harvesting, stocking, habitat availability, and stream size with effects being magnified in smaller watersheds.

In 2006, the Ministry of Environment in partnership with the B.C. Conservation Corps began preliminary data collection as a basis for creating future recovery plans for selected cutthroat streams on East Coast Vancouver Island (Eastman and Kasubuchi 2006). Presence/absence, juvenile abundance, and adult stock assessments were conducted during the summer of 2006, followed by a review of previous studies of cutthroat streams and stock status (Lough and Rutherford 2007). This research provided objectives for the 2007 field season:

i. Investigate habitat in 15 focus streams to identify potential barriers, habitat restoration opportunities, and estimate quantity (linear length) of available habitat.

ii. Refine and ground-truth coastal cutthroat trout habitat distribution model used to identify potential cutthroat trout-bearing reaches (Ron Ptolemy).

iii. Determine adult population size and composition in three rivers (Englishman, Little Qualicum, and Oyster).

iv. Determine juvenile abundance and biomass in selected watersheds through electrofishing.

v. Assess water quality and nutrient limitation in focus streams (Cold, Whisky, Woodhus, Center, Morrison, Hunts, Little Oyster, and Little Oyster-Cranberry farm tributary) for potential nutrient addition projects.

2.0 Methods

2.1 Habitat investigation

Habitat investigation was carried out on 15 focus streams identified by Lough and Rutherford (2007) from July 5-August 31, 2007. Potential habitat was identified and mapped using a species distribution logistic curve developed by Ron Ptolemy (Rivers Biologist, Ministry of Environment). This model identified reaches with a 90% probability of cutthroat occurrence, and was based primarily on stream size using a mean annual discharge as a proxy for size. A less resolved model uses watershed size as a proxy for discharge; therefore maximum watershed size for primarily cutthroat trout (90% likelihood) depended on Ecosection placement of the stream case or unit runoff (maximum watershed size for Southern Gulf Islands = 43 km^2, Nanaimo Lowlands = 18 km^2, Leeward Island Mountains = 6.7 km^2). Literature reviews (Lough and Rutherford 2007) identified stream reaches with poor habitat or potential barriers to migration. These reaches were investigated to determine the linear length of potential habitat available to cutthroat, to verify identified barriers and habitat condition, and to determine how much additional habitat could become available if barriers were removed or if poor habitat was restored.

Identifying barriers involved walking sections of streams to locate structures such as perched culverts, beaver dams, old dam sites, log/debris jams, bedrock cascades, and waterfalls. It was possible to conclude immediately that the structure was a barrier if it was solid and greater than 2 m in height (McCulloch, pers comm.); however, in most cases further investigation was required. This involved setting G-traps upstream and downstream of the barrier to determine species presence, and in one case, electrofishing. Structures were not considered barriers if coho and large numbers of cutthroat fry were observed upstream of the structure. Structures were considered barriers if no coho were found above it, but were found in downstream habitats. However, if very few coho were detected above the structure, we were not able to conclude that the structure was a barrier, as it could have been a partial barrier passable by few fish only in some years, or the few coho could have been the result of the frequent transplanting that occurs on Vancouver Island (Ptolemy, pers. comm.).

We characterized habitat according to Ministry of Environment Fisheries Inventory Site Card. Information collected included water quality data (temperature, conductivity, pH, and dissolved oxygen), discharge and flow status, bed materials, bank morphology, wetted width and channel width, riparian zone vegetation type, cover components, large woody debris (LWD) presence and function, and stream morphology. Habitat features such as potential barriers, sediment sources, and various observations were documented, photographed and labeled on maps (Appendices 1-4).

2.2 Snorkel surveys

Snorkel surveys were conducted during the last two weeks of August, 2007 along the Englishman, the Little Qualicum and the Oyster rivers. The Englishman and Little Qualicum rivers were divided into two sections based on access and time to conduct the swims. Section 1 of the Englishman River (3.7 km) was from side-channel intake to grassy bank. Section 2 (4.7 km) was from grassy bank to Big Tent RV (surveyed August 22 and 24 respectively). Section 1 of Little Qualicum River (4.8 km) was from the Inland Island Highway crossing to the mid-chum channels (August 22). Section 2 of Little Qualicum River (3.9 km) was from mid-chum channels to Highway 19A bridge crossing (August 22). Oyster River was surveyed as one section (7.2 km) from Little Oyster confluence to Pacific Playgrounds RV on August 28th.

On each survey day, water temperature, visibility, and discharge were recorded.

The number of adult cutthroat trout and all other recognizable adult species (including salmon) were recorded. Surveyors drifted downstream through all probable holding water simultaneously recording numbers, origin (hatchery or wild) and size of adult cutthroat trout (15-25 cm, 25-35 cm, 35-45 cm, 45-55 cm, 55+ cm).

2.3 Electrofishing

Fourteen streams were sampled by electrofishing from September 4-28, 2007. Generally two sites per stream were sampled along representative reaches of the stream. We included as many of the three mesohabitats (glide, riffle, and pool; Table 1) as possible in each site, in an area approximately 100 m^2. Sampled area was measured for each mesohabitat.

Table 1. Mesohabitat classification standards.

Mesohabitat type	Width:Depth ratio
Pool	<12
Glide	12 - 50
Riffle	>50

Habitat assessments were done at each site (Habitat Assessment Form, R. Ptolemy). Parameters recorded include: hydraulic type or mesohabitat class, gradient, average and maximum depth and water velocity, turbidity, temperature, conductivity, discharge, stream bed compaction. Stream stage was estimated as low-, moderate- or high-summer as well as flow determination by estimating velocity, depth and width. Cover components for juvenile salmonids were estimated as a percentage of the entire site; these included log, boulder, instream and overhanging vegetation, and undercut banks. Substrate composition was described by estimating how much of each category of bed material (fines, small and large gravel, cobble, boulder, and bedrock) made up the stream bed. Finally the site was sketched and photographed from upstream and downstream angles.

During total removal sampling and to meet various assumptions, the site was enclosed using stop nets or natural breaks such as plunge pools or extremely low water. Fish were removed using the standard, two-pass removal method. In each pass, the site was sampled progressing upstream and downstream. All fish were anesthetized with clove oil, counted, measured (fork length), weighed, and then returned to the site.

Population estimates by age class were calculated using the Seber equation for two-pass removal:

$$\text{Population estimate} = (\text{Pass 1 total})^2 / (\text{Pass 1 total} - \text{Pass 2 total})$$

Population density in fish/100 m^2 or fish per unit (FPU) was calculated from population estimates of each age class (0+, 1+, and 2+ years). This density was then corrected using a habitat suitability index for different age classes to produce an adjusted FPU. The habitat suitability index is the probability of use for each mesohabitat by age class (Table 2).

Table 2. Habitat suitability index, or probability of occurrence by mesohabitat for cutthroat fry and parr.

	Mesohabitat		
Size Class	Riffle	Glide	Pool
Fry	0.7	0.5	0.1
Parr	0.3	0.7	1

The adjusted FPU for fry and parr were compared to abundance level thresholds (conservation concern, OK, good, and excellent) for Vancouver Island (Table 3). Parr abundance was considered the aggregate total for the community, including steelhead/rainbow parr, 1+ and 2+ cutthroat parr. At the conservation concern level, abundance is too low to maintain the population. The fry or parr density required to sustain maximum parr or adult production in subsequent years is "OK". Good abundance is the density observed in suitable habitat, while excellent abundance is an exceptionally high density from empirical data (Ron Ptolemy, pers. comm.).

Table 3. Abundance level thresholds in preferred habitats for cutthroat fry and parr on Vancouver Island (Ron Ptolemy). Reach level abundance is always lower.

	Abundance level (fish/100m^2)			
Size Class	Excellent	Good	OK	Concern
Fry	100	50	25	12
Parr	60	30	15	7.5

Parr density can also compared to the theoretical maximum FPU of the stream to provide an estimated percentage of the target productivity (see Table 5). The theoretical maximum FPU is calculated for by dividing the theoretical maximum biomass by the mean parr weight at each site. Theoretical maximum biomass is derived from empirical data (Ron Ptolemy) or from an alkalinity-biomass model:

$$\text{Biomass} = 45*\text{alkalinity}^{0.6}$$

The theoretical predicted number of adults (ocean age 1) produced by each stream was calculated using the geomean of adjusted FPU for parr (1+) and estimated area of usable parr habitat in each stream. Linear length of usable habitat was estimated from habitat investigations, and total wetted area was calculated using the average wetted width of the stream. Parr-limiting habitat included pools, and a weighted proportion of riffles and glides (according to the Habitat Suitability Index). Proportion of pool, riffle and glide area came from electrofishing site assessments and previous habitat studies (Michalski and Sala 2007, Shelterwood 1997). Parr-limiting habitat was multiplied by the geomean of FPU (1+) to provide a predicted number of parr for each stream. Number of parr was converted to number of adults using the conversion rates of parr-smolt (40%), and smolt-adult (25%) (Slaney and Roberts 2005). Predicted smolt density (smolts/km) was also compared to the biostandard of 160 smolts/km (Ron Ptolemy, pers. comm.).

2.4 Nutrient levels

Water samples were collected from streams considered suitable for potential nutrient addition (summer baseflow generally greater than 30 L/s, low conductivity or low historic productivity). These included Center, Cold, Hunts, Little Oyster, Morrison, Whisky, and Woodhus Creek. Water samples were analyzed for low-level dissolved nitrite-nitrate as nitrogen, low-level ortho-phosphorus, total dissolved phosphorous, and total phosphorous. In the Little Oyster watershed, water samples were taken on a tributary above and below a cranberry farm, and on the mainstem above and below the tributary confluence to determine the level of organophosphorus input from the farm. Water samples were collected in 1 L plastic bottles, rinsed three times with stream water before sample collection. Samples were analyzed by the Pacific Environmental Science Center (PESC, North Vancouver). Streams were considered orthophosphorus-limited at concentrations of <1 μg/L (McCusker et al. 2002).

3.0 Results

3.1 Habitat investigation

In most creeks, we were not able to confirm barriers to migration. Four of fifteen creeks had definite barriers, while an additional six creeks had potential barriers that we were not able to confirm (Table 4). Individual cases are discussed in Appendix 1.

Table 4. Potential and confirmed barriers to anadromous cutthroat trout migration.

Stream	Type of Barrier	Potential or Confirmed
Center Creek	Waterfall	Barrier
Hunts Creek	Waterfall	Barrier
Chase River	Waterfall/Colliery dam	Barrier
Morison Creek	Waterfall	Barrier
Woodhus Creek	Debris jams/cascade falls	Potential Barrier
Chase River	Debris jam	Potential Barrier
Cat Stream	Buttertubs Marsh culverts	Potential Barrier
Bear Creek	Perched culvert	Potential Barrier
Little Oyster River	Beaver dams/cascade falls	Potential Barrier
Whisky Creek	Perched culvert	Potential Barrier

Indicators of water quality were generally within the range of suitable conditions for cutthroat trout. All creeks were clear, with temperature ranging from 9-16.5°C and a mean of 12°C (Table 5). Conductivity was generally higher in urban streams (Morrison, Craigflower, Colquitz, Cat stream, Chase River) than forest streams such as Woodhus, Little Oyster, and Hunts Creek. Conductivity is highly correlated to the area of imperviousness in the watershed catchment area (Walker and Pan, 2006).

Table 5. Water temperature, conductivity, alkalinity and target biomass for all creeks sampled in 2007.

Watershed	Mean Temperature (°C)	Mean Conductivity (µS/cm)	Alkalinity (mg/L)	Biomass from model (g/100 m^2)	Target biomass (g/100 m^2)
Bear Creek	10.5	163.1	65	552	552
Cat Stream	16.5	344.5	138	864	864
Center Creek	11.0	192.2	77	609	609
Chase River	16.0	170.9	68	568	568
Cold Creek	10.5	132.1	53	486	486
Colquitz Creek	13.8	184.5	74	594	**376**
Craigflower Creek	11.3	362.5	145	891	**409**
Flintoff Creek	9.8	125.9	50	473	473
Hunts Creek	10.0	82.5	33	367	367
Little Oyster River	13.0	81.1	32	363	363
Morison Creek	14.0	99.2	40	410	410
Morrison Creek	14.0	284.0	114	770	**469**
Whisky Creek	9.0	107.9	43	431	431
Willow Creek	12.5	114.9	46	447	447
Woodhus Creek	9.0	54.7	22	287	287
Mean	12.1	166.7	67	541	474

*Target biomass from empirical values indicated in bold.

Low discharge and lack of LWD were common habitat deficiencies. Although cutthroat trout occupy streams with summer base-flows of 1-60 L/s, severe habitat degradation can occur when discharge remains under 10% of MAD (Tennant 1976). When discharge was instantaneously measured, we found that 4 of 13 creeks were below this threshold, despite the apparently rich water year (Ron Ptolemy, pers. comm.). Generally low base-flows resulted in a poor habitat classification for percent wetted area for 11 of 14 streams. Overwidening was a factor in low percent wetted area for Center Creek. Lack of LWD was another common habitat deficiency, with only one stream having abundant LWD that had been added in a restoration project, and three streams having no LWD on surveyed reaches (Table 6).

Table 6. Instantaneous daily discharge, large woody debris (LWD) abundance (A=abundant, F=few, N=none), channel width, wetted width, and percent wetted area from habitat investigation.

Watershed	MAD (L/s)	Discharge (L/s)	% of MAD	LWD	Channel width (m)	Wetted width (m)	% Wetted Area
Bear creek	309	3	1%	F	5.9	2.3	39
Cat stream	74	85	115%	A	2.9	2.8	98
Center creek	588	20	3%	F	11.8	2.8	23
Chase River	771	-	-	F	8.2	4.5	55
Cold creek	96	148	154%	F	5.2	3.2	61

Colquitz creek	605	77	13%	N	4.2	3.2	78
Craigflower creek	307	3	1%	N	4.5	2.8	62
Flintoff creek	126	40	32%	F	2.9	1.5	54
Hunts creek	616	155	25%	F	8.1	4.7	58
Little Oyster River	441	43	10%	N	4.6	2.5	55
Morison creek	-	-	-	F	9.7	7.8	81
Morrison creek	469	170	36%	F	5.0	3.1	62
Whisky creek	300	32	11%	F	5.5	2.3	43
Willow creek	465	14	3%	F	2.7	1.9	70
Woodhus creek	481	75	16%	F	7.9	4.0	51

Stream substrate was generally dominated by cobble (Table 7). Fines were the next most common dominant substrate, often occurring in urban streams (Colquitz, Cat stream, Willow Creek) and as sand in small headwater streams (Cold and Flintoff creeks). Biostandards for instream fish habitat (Johnston and Slaney 1996, Michalski et al. 1998) categorize habitat as poor when total fines are >20% of total bed material, and fair when total fines are 10-20%. According to this standard, seven creeks had poor levels of fine sediment.

Table 7. Substrate composition (% of total) and dominant bed material in electrofishing site habitat assessments. Poor levels of fine sediment indicated in bold.

Watershed	Fines	Small gravel	Large gravel	Cobble	Boulder	Bedrock	Dominant
Bear creek	13	5	20	53	10	0	Cobble
Cat stream	**30**	25	17	15	14	0	**Fines**
Center creek	4	6	13	45	33	0	Cobble
Chase River	5	10	13	55	18	0	Cobble
Cold creek	**43**	22	20	14	2	0	**Fines**
Colquitz creek	**45**	8	15	20	8	0	**Fines**
Craigflower creek	**20**	17	14	28	18	0	Cobble
Flintoff creek	**48**	25	25	3	0	0	**Fines**
Hunts creek	5	18	25	28	25	0	Cobble
Little Oyster River	4	12	18	45	23	0	Cobble
Morrison creek	10	10	20	30	30	0	Cobble/Boulder
Whisky creek	**24**	9	6	20	5	40	Bedrock
Willow creek	**70**	20	8	2	1	0	**Fines**
Woodhus creek	2	8	5	45	40	0	Cobble
Mean	**23**	14	15	29	16	3	Cobble

All creeks had met the biostandard for good levels of instream cover (>20% of site; Johnston and Slaney 1996, Michalski et al. 1998). Most cover was provided by boulders and overstream vegetation, with only small contributions from logs, instream vegetation or undercut banks (Table 8).

Table 8. Instream cover components (as % of site) average for electrofishing sites.

Watershed	Log	Boulder	Instream vegetation	Overstream vegetation	Cutbank	Total
Bear creek	2	10	3	8	3	25
Cat stream	8	14	3	5	8	37
Center creek	4	33	6	8	5	55
Chase River	4	18	1	5	3	30
Cold creek	20	2	6	23	15	66
Colquitz creek	10	13	9	8	10	49
Craigflower creek	0	20	4	18	15	56
Flintoff creek	15	0	8	5	9	37
Hunts creek	5	25	1	20	0	51
Little Oyster River	1	23	2	5	4	35
Morrison creek	1	30	0	5	8	44
Whisky creek	7	4	5	8	6	29
Willow creek	13	1	7	12	13	44
Woodhus creek	2	40	2	15	0	59
Mean	6	16	4	10	7	44

Sections of poor habitat were observed in most creeks, with patterns of habitat degradation varying by land-use type. Generally, sections of creeks bordered by clearcuts had less canopy cover, bank instability and erosion, aggraded and overwidened channels, intermittent flow, lack of deep pools and lack of functional LWD. Stream reaches flowing through agricultural land tended to have extremely low flows, sedimentation, lack of LWD, and lack of deep pools. Urban streams had sections of sparse riparian vegetation, lack of LWD, lack of deep pools, low flow, introduced species, pollution (garbage), and sedimentation. Habitat restoration opportunities were identified at 11 of the 15 creeks. These included placement of LWD, water impoundments, and riparian planting (Table 9).

Table 9. Ranked threats and restoration/monitoring options for watersheds investigated in 2007.

Watershed	Urbanization	Water Abstraction	Agricultural	Forest Harvesting	Fragmentation	Fish Culture (external)	Restoration/Monitoring options
Flintoff Creek				1			• LWD complexing
Cold Creek				1		2	• LWD complexing - 10 restoration sites. Some template prescriptions are available for the sub-basin.
Willow Creek	1	2					• Ensure stormwater management plans are adhered to • Work with local community group to complete riparian planting and sediment management projects
Woodhus				1		2	• Investigate fish passage of potential barriers below Cariboo Main crossing (debris jams, bedrock cascades). • Potential to remove debris jams and/or drill to improve passage past cascades to allow access to viable upstream habitat.
Little Oyster River		3	2	1			• Cascade falls ~800m u/s of Duncan Bay Main crossing-drill to improve/create passage. • Monitor beaver dams throughout watershed.
Bear Creek		1	2	3			• Seed funding proposal - Water storage feasibility in headwater lakes/ponds. Possible partner with DU, LRTF. • Investigate passability of culvert at Macauley Rd • Investigate erosion and sedimentation due to horse trail crossing d/s of Macauley Rd.
Morrison Creek	1	2		4		3	• LWD Prescription development. • Riparian planting in Park at mouth - possible in kind with RDCS/Streamkeeper group. • Investigate headwater habitat.
Whisky Creek	2			1		3	• LWD complexing on 400 - 500 m section of blowdown adjacent to logging block. Excellent opportunity to use existing wood to substantial fish benefit (30 site potential). • Riparian management/planting. • Culvert passage repair of existing works at Melrose Rd crossing.
Hunts Creek				1			• LWD complexing in (1) upper reach negatively affected by logging and blowdown - 12-15 sites (2) lower channelized stream segment - good access and no land tenure issues, 15-20 sites. • Riparian planting adjacent to channelized stream segment and adjacent to blowdown-affected reaches.

Watershed	Urbanization	Water Abstraction	Agricultural	Forest Harvesting	Fragmentation	Fish Culture (external)	Restoration/Monitoring options
Center Creek				1			• LWD complexing as per Warttig and Clough 2004. Prescriptions may be adapted for the uppermost reach. Significant impacts from past and recent logging. 15-20 sites recommended. • Riparian planting adjacent to blowdown-affected reaches.
Morison Creek		1	2				• Investigate passability of Triple Falls.
Cat stream/ Chase River	1	3				2	• Monitor past LWD and riparian works in conjunction with MUC. • Develop and implement an integrated riparian and LWD restoration plan with MUC and RDN as partners (15 000 instream works, 10 000 riparian planning and planting). • Investigate and report to City of Nanaimo on culvert related passage concerns near Buttertubs Marsh. • Chase River: clay bank stabilization at 2 sites. • Monitor effects of hybridization.
Craigflower Creek	1	2			3		• Monitor invasive species
Colquitz Creek	1	2			3		• Monitor invasive species

3.2 Snorkel Surveys

Adult cutthroat trout density (cutthroat/km) averaged for all rivers was identical in 2006 to 2007 (17.0 fish/km), while there was an overall decline of 9 % in total cutthroat counted (Figure 1, 2). However, the change in length of survey between 2006 and 2007 should be taken into account when comparing total counts. In 2007, the Englishman survey was 2.56 km longer, the Little Qualicum was 1.3 km longer, and the Oyster survey was 6.2 km shorter. The decline in total counts resulted from decreases of 33% and 48% in the Englishman and Oyster Rivers respectively, which was offset by an increase of 120% in Little Qualicum River. The Little Qualicum River also had the highest density of cutthroat/km. Cutthroat density results were reversed from 2006 to 2007. While density was highest in the Englishman and lowest in the Little Qualicum in 2006, it was the opposite in 2007. Cutthroat density changed little in the Oyster River.

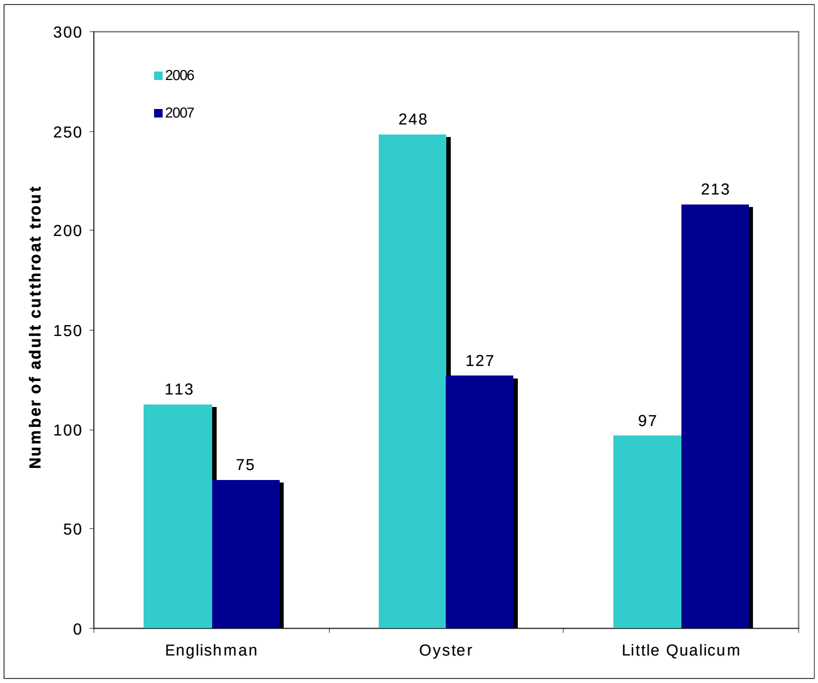


Figure 1. Density of cutthroat trout (fish/km) from snorkel surveys, 2006-2007.

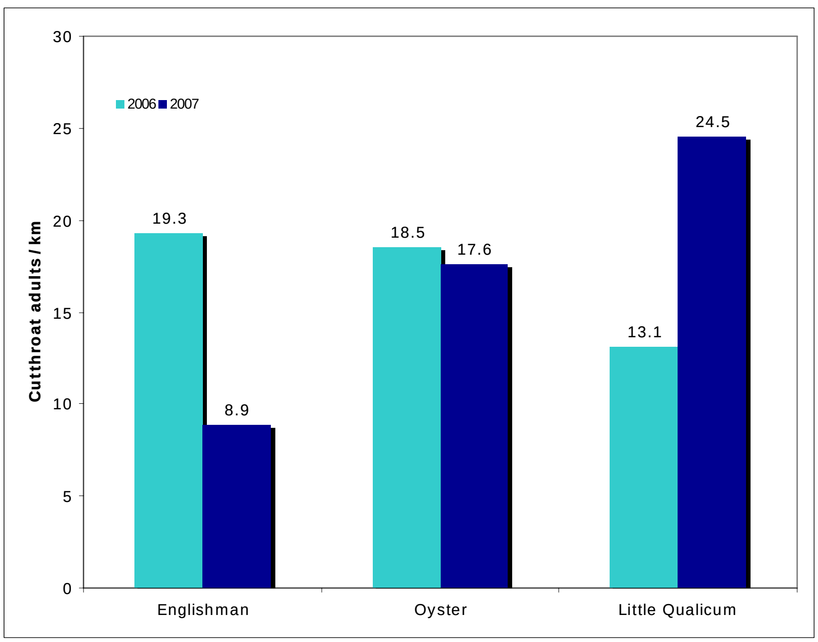


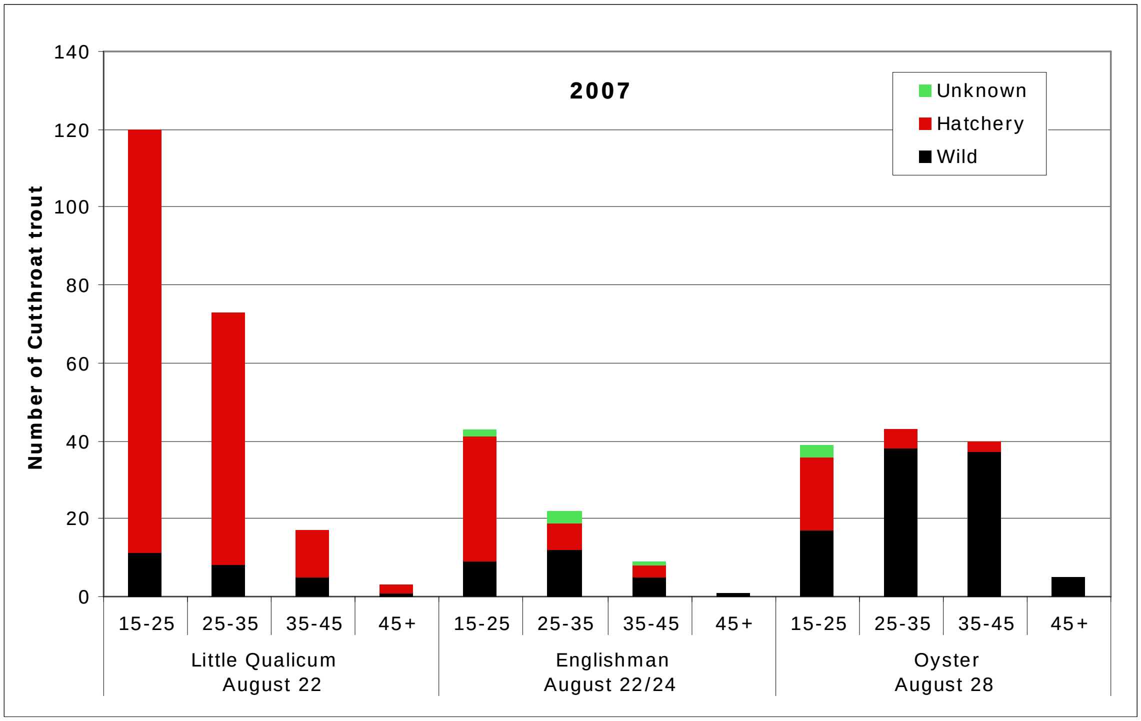
Figure 2. Total count of cutthroat trout from snorkel surveys of rivers in 2006-2007.

Overall abundance of salmon species counted in snorkel surveys showed a significant increase from 2006-2007 (Table 10), most notably Pink salmon which increased by 470% in the two rivers sampled both years (Englishman and Oyster Rivers). Other species observed in low abundance included two Brown trout (Little Qualicum), and one Coho, two Sockeye, and one Chum (Oyster River).

Table 10. Total count of trout and salmon species from snorkel surveys, 2006-2007.

	Cutthroat		Rainbow		Pink		Chinook	
River	2006	2007	2006	2007	2006	2007	2006	2007
Englishman	113	75	13	1	45	571	2	0
Little Qualicum	97	213	-	9	-	986	-	21
Oyster	248	127	3	0	450	1750	2	0
Total	458	415	16	10	495	3307	4	21

In 2007, hatchery production had the greatest influence on cutthroat population size and age composition in the Little Qualicum River, followed by the Englishman, and had the least influence on the Oyster River (Figure 3). The majority of hatchery fish (62%) were small subadults (15-25 cm) or medium sized (30%; 25-35 cm), while 70% wild fish were in the 25-45 cm range (medium-large). The ratio of hatchery to wild fish for all rivers decreased with increasing fish size with a mean ratio of 4.9 hatchery:wild for small fish, decreasing to 2.9 for medium, 1.0 for large, and 0.7 for extra-large fish. These results indicate that survivorship for hatchery fish is much lower than wild fish. Although the Little Qualicum had the highest total count of cutthroat, 88% of these fish were hatchery stock. The Englishman had 36% wild fish, while the Oyster River had the highest proportion of wild (76%) and large (older) fish. Results were similar in 2006, with the Oyster River having the lowest proportion of hatchery fish. However, there were significantly less hatchery fish present in the Little Qualicum in 2006 than 2007.



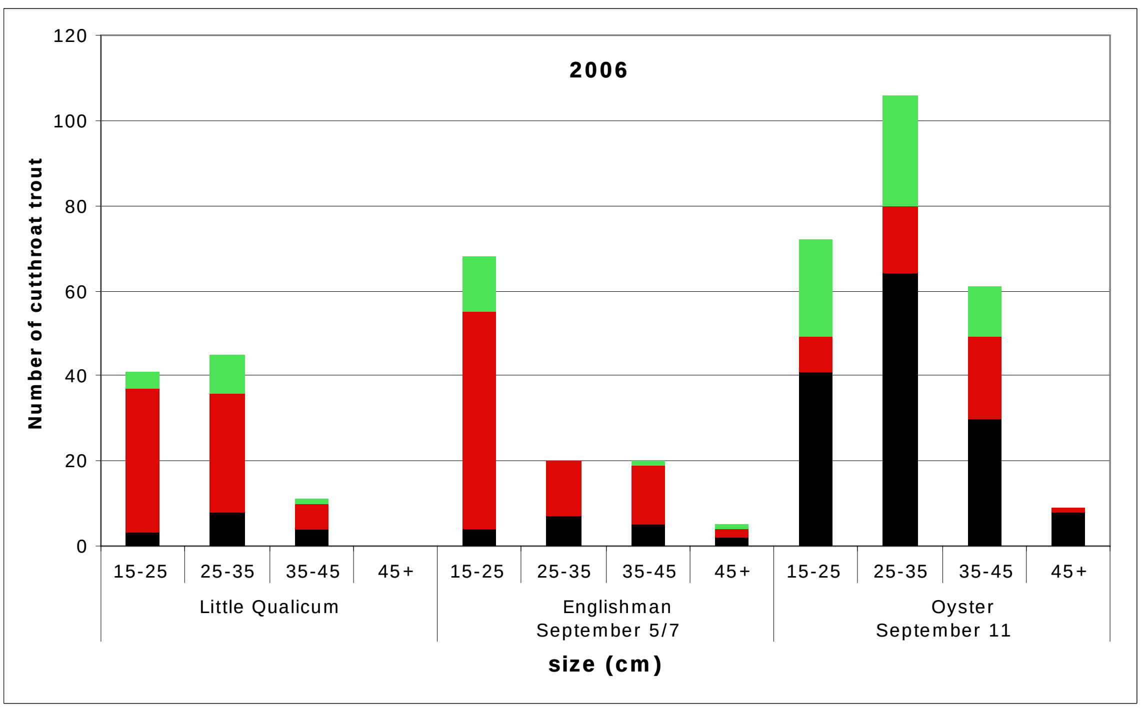


Figure 3. Age class and origin of cutthroat trout counted in snorkel surveys, 2006 and 2007.

Historical data (1981-2006) from snorkel surveys of the Oyster and Little Qualicum Rivers does not show an obvious increasing or decreasing trend in cutthroat abundance (Figure 4). There appears to be a cyclical trend in cutthroat abundance with some agreement in years of low abundance in both rivers. Cutthroat density in the Oyster River was lower in 2007 (18 fish/km) than the historical average (37 fish/km), but was slightly higher for the little Qualicum (28 fish/km) compared to its historical average (24 fish/km).

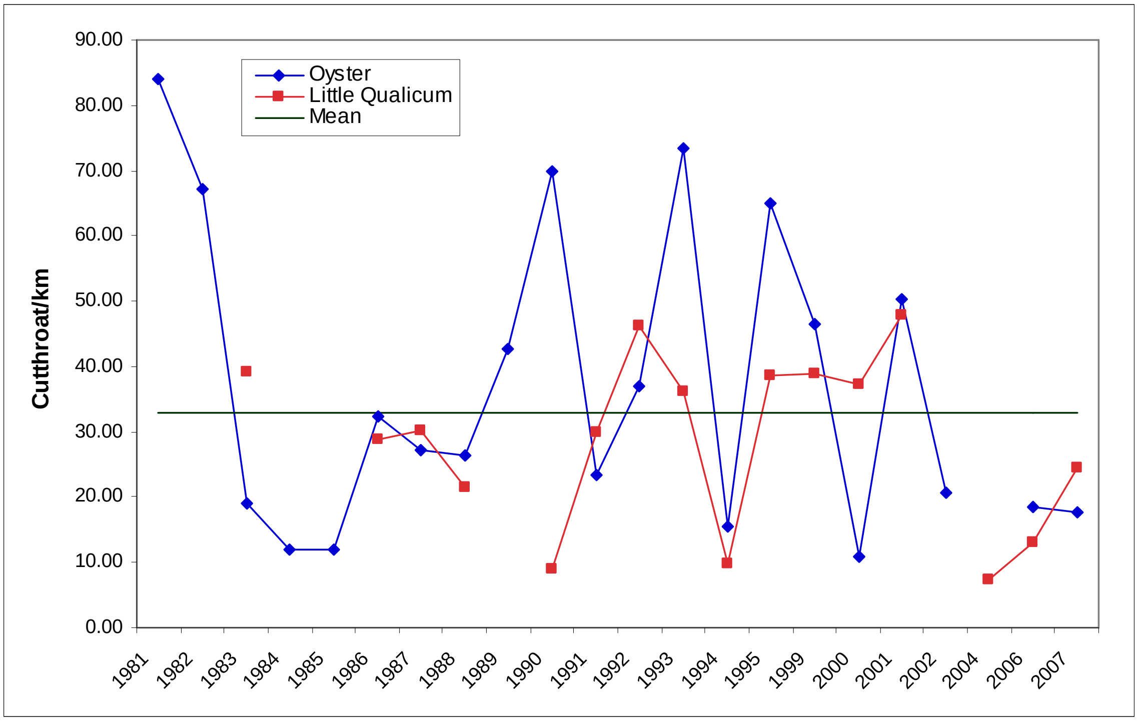


Figure 4. Historical cutthroat density from snorkel surveys of the Oyster and Little Qualicum Rivers, 1981-2007.

3.3 Electrofishing

The adjusted fry FPU was 24% higher (paired $t(11) = 2.04$, $p = 0.03$) in 2007 than 2006. Bear creek had the highest adjusted FPU for fry at 275 (Figure 5), while Woodhus and Morrison Creeks had the lowest (36 and 30 FPU respectively). The mean adjusted FPU for fry was 116. Only Morrison and Woodhus Creeks were below "good" abundance levels for Vancouver Island, but both were still above "OK" abundance levels.

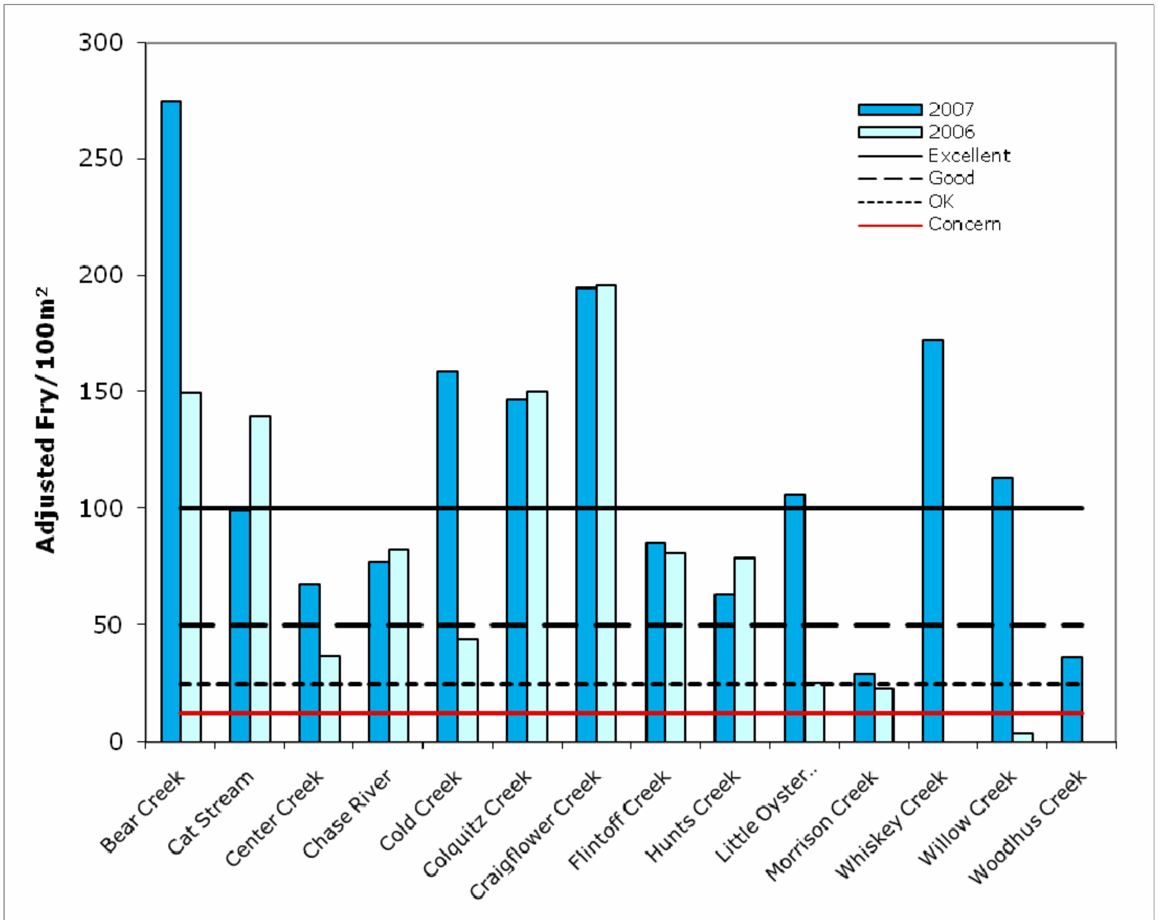


Figure 5. Geomean of adjusted Fish per Unit (FPU) of cutthroat fry for watersheds sampled in 2006-2007 compared to abundance level thresholds for Vancouver Island. (Whisky and Woodhus Creeks were not sampled in 2006).

None of the sampled creeks had "good" abundance levels for parr. Three creeks had OK parr abundance (Colquitz, Flintoff, and Morrison), while most creeks (Cat Stream, Center Creek, Chase River, Cold Creek, Craigflower Creek, Whisky Creek, Willow Creek) were below OK levels but above conservation concern. Bear Creek, Hunts Creek, Little Oyster River, and Woodhus Creek were all below the conservation concern threshold (Figure 6).

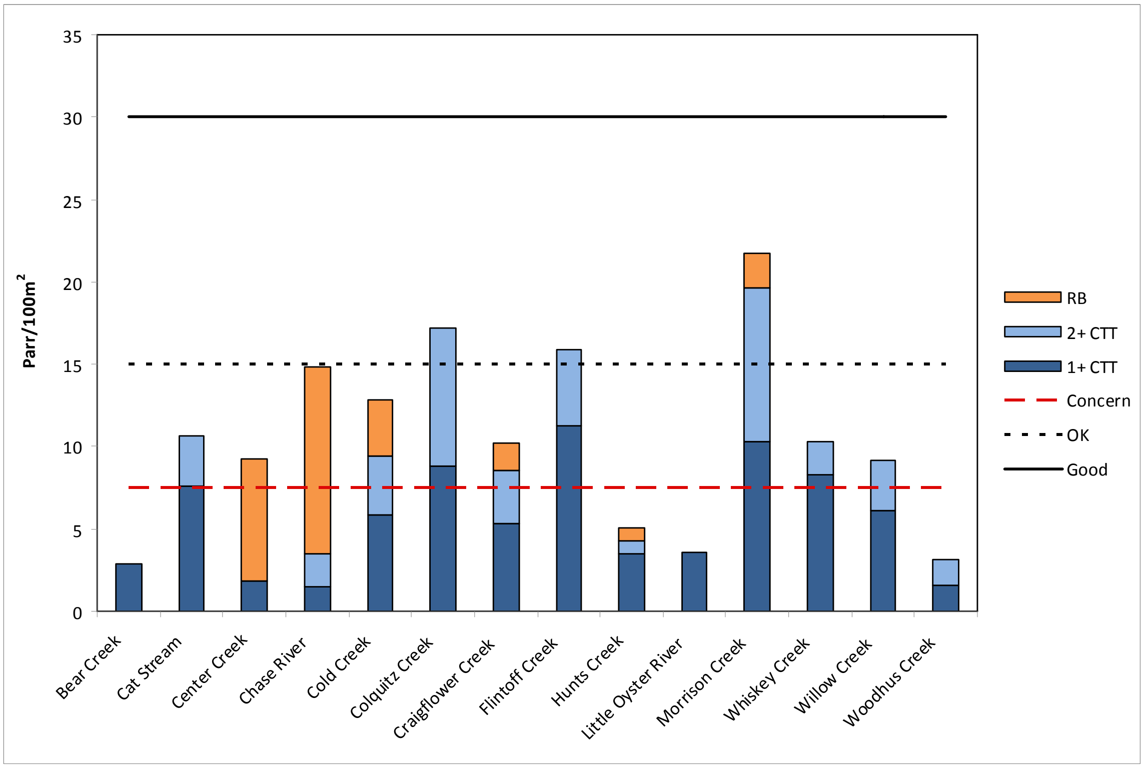


Figure 6. Geomean of adjusted aggregate parr density (rainbow trout, 1+ and 2+ cutthroat parr) by stream compared to abundance level thresholds (Good, OK, Concern) for Vancouver Island.

Other species observed during sampling included coho (at 11 of 14 creeks), rainbow trout (6 of 14 creeks), Dolly Varden (at Woodhus creek only), pumpkinseed sunfish (Colquitz and Craigflower creeks) and smallmouth bass (Colquitz creek only). Most creeks had higher densities of cutthroat fry than coho, but higher densities of coho occurred at Center creek, Chase River, and Morrison Creek (Figure 7). Parasites were only observed at one site in Whisky Creek, where approximately 15% of fish sampled were infected with a copepod parasite (fry and parr) and one fry was infested with a leech.

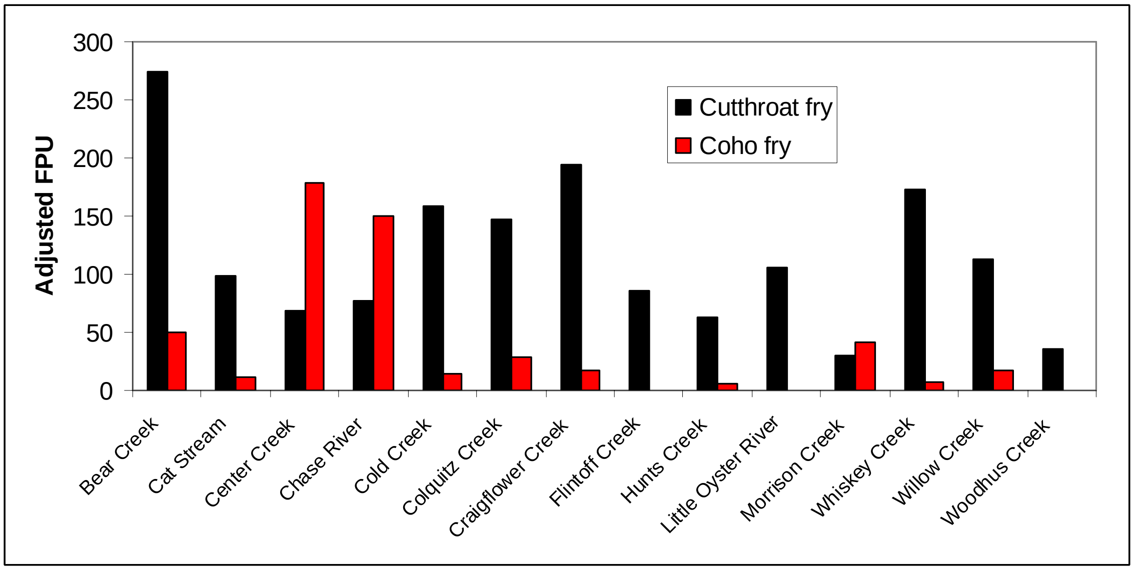


Figure 7. Geomean of adjusted FPU for cutthroat fry and unadjusted coho fry in all sampled watersheds.

The most productive creeks in terms of predicted number of adults (ocean age 1) produced are Morrison Creek, Little Oyster River, and Whisky Creek (Table 11). The Little Oyster River had by far the most parr-limiting habitat due to a low proportion of riffle mesohabitat. Whisky creek also had a large area of parr habitat combined with relatively high density of parr (1+), while Morrison Creek had one of the highest parr densities and a moderately large area of parr habitat.

Table 11. Predicted number of adult cutthroat trout produced by each stream based on geomean of adjusted FPU (1+) and total parr-limiting habitat.

Stream	Usable linear length (m)	Total Area of Parr-limiting habitat (m^2)	Geomean Adj. FPU(1+)	Predicted no. of parr	Predicted no. of smolts	Smolt density (smolts/km)	% of smolt biostandard (160 smolts/km)	Predicted no. of adult (ocean age 1)
Bear creek	2600	3390	3	102	41	16	10	10
Cat stream	3900	3877	8	310	124	32	20	31
Center creek	5200	5652	2	113	45	9	5	11
Chase river	4900	5557	1	56	22	5	3	6
Cold creek	2200	4525	6	272	109	49	31	27
Colquitz creek	7900	8895	9	801	320	41	25	80
Craigflower creek	10050	15226	5	761	305	30	19	76
Flintoff creek	5100	4361	11	480	192	38	24	48
Hunts creek	7230	18017	4	721	288	40	25	72
Little Oyster river	18500	27880	4	1115	446	24	15	112
Morison creek	2300	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Morrison creek	7630	13063	10	1306	523	68	43	131
Whisky creek	10800	15336	8	1227	491	45	28	123
Willow creek	8200	11021	6	661	264	32	20	66
Woodhus creek	8000	8040	2	161	64	8	5	16

3.4 Nutrient analysis

Three of seven sampled creeks were limited by orthophosphorus (Little Oyster Tributary, above the cranberry farm, Whisky and Woodhus Creeks) (Table 12). Samples downstream of the cranberry farm on the Little Oyster tributary and mainstem had extremely high orthophosphorus concentrations indicating a significant anthropogenic input. Nitrogen concentrations were very high in Cold Creek, Whisky Creek, and Woodhus Creek.

Table 12. Nitrogen and phosphorus concentrations from sampled creeks, 2007. Limiting orthophosphorus concentrations indicated in bold.

Watershed	Sample site	Sample date	Nitrate & nitrite (µg/L)	Orthophosphorus (µg/L)	Total Phosphorus (µg/L)
Center Creek	E/F site 1	18-Sep-07	166	2	3
Cold Creek	U/S side of Hatchery Rd Bridge Crossing	3-Oct-07	29 200	11	17
Hunts Creek	E/F site 2	12-Sep-07	137	6	9
Little Oyster Trib	U/S of Cranberry Farm (Duncan Bay Main xing)	6-Sep-07	23	**<1**	19
Little Oyster Trib	D/S of Cranberry Farm	6-Sep-07	40	81	159
Little Oyster	U/S of Trib	6-Sep-07	32	4	23
Little Oyster	D/S of Trib	6-Sep-07	25	15	65
Morrison Creek	E/F site 1	12-Sep-07	23	2	7
Whisky Creek	E/F site 2	24-Sep-07	22 900	**<1**	3
Woodhus Creek	D/S side Duncan Bay Main xing	3-Oct-07	1 140	**<1**	8

4.0 Discussion

4.1 Habitat investigation

Our habitat investigation concurred with results of a survey of 90 East Coast Vancouver Island streams (Michalski and Sala 2007) in which the majority of streams were surveyed as having serious habitat deficiencies. The main problems identified in this report were lack of instream cover (particularly LWD), low summer flows, and excessive sediment in bed materials. Our results showed that only one stream surveyed had abundant LWD, which had been recently added in a restoration project. Ten of fourteen creeks had few functional pieces of LWD, and three creeks had none. Ideal summer base-flows for cutthroat are dependent on stream size or mean annual discharge (1-60 L/s; Ptolemy, pers. comm.), with <10% of MAD considered detrimental to fish. Despite the high precipitation throughout the summer, we found four streams having flow under 10% of MAD (Bear, Centre, Craigflower and Willow). Bear Creek was the worst case, with severe low flow resulting in dry riffles and habitat made up of shallow pools, and having only 39% wetted area. In our analysis of bed materials, we found excessive levels of fine sediments (characterized as poor habitat; Johnston and Slaney 1996, Michalski et al.

1998) in half of the creeks analyzed; we also found fine sediment as the dominant bed material at five of fourteen streams. Other habitat concerns identified in our investigation included lack of deep pools, aggraded and over-widened channels, intermittent flow, large debris jams and beaver dams, pollution in urban streams, and invasive species.

The generally poor state of "small-stream" fish habitat illustrates the need for long-term habitat stewardship including restoration, continued monitoring, and increased protection. Overall we identified 15 potential restoration projects on 11 streams, which often relied on support from local stewardship groups. Such groups are also an essential component of habitat monitoring, since watersheds can be very large and require frequent assessments. Habitat concerns requiring monitoring existed on most creeks; these included potential barriers (large debris jams and beaver dams), bank stability and erosion, riparian zone health adjacent to clearcuts, invasive species (Craigflower, Colquitz), and hatchery fish (Whisky Creek).

Increased protection of habitat should be considered a priority on all streams surveyed because of imminent threats from forest harvesting and urbanization (the highest ranked threats in our analysis). The habitat deficiencies identified in this report and by Michalski and Sala (2007) suggest that past legislation was ineffective in protecting fish habitat, and that the Streamside Protection Regulation designed in 1997 to address these shortcomings is still deficient in some areas. Most of these streams could be considered for Sensitive Stream designation due to the threatened status of the cutthroat trout and impacts from human activity. Sensitive Stream designation would help to maintain base-flows and riparian habitat, in addition to creating and recovery plan initiatives if necessary. Existing legislation could also be improved by enabling stewardship-group developed watershed management plans to guide Development Permit Areas and Official Community Plans, implementing legislation restricting water extraction during critical times, and implementing public awareness and landowner contract programs (Michalski and Sala 2007).

Our investigation of habitat identified only two cases where the species distribution rule for cutthroat trout was incorrect (lower Cold Creek, Woodhus Creek). These sites were outliers mainly due to insufficient detail in maps. In the case of Cold Creek, the lower reach had been modified to receive additional flow, and rerouted through a former oxbow of the Quinsam making the habitat more suited to rainbow trout than indicated by the map. This resulted in the presence of 100% rainbow trout in habitat identified as 90% cutthroat. At Woodhus Creek, we sampled 100% cutthroat in habitat predicted to be a mixture of rainbow and cutthroat. This could have been due to a partial barrier near the mouth of the creek, preventing recruitment of rainbow trout, which are also currently at extremely low abundance levels in the Oyster River.

Additional errors in mapped habitat identified by the species distribution rule was a result of missing information such as the presence of waterfalls or tributaries, channel width, accurate discharge, and up-to-date forest cover or road locations. This resulted in the false positive identification of non-anadromous habitat in the upper reaches of three streams due to barriers (Morison, Hunts, and Woodhus Creeks). Another mapping deficiency was that the maps did not identify where water abstraction had caused reduced base-flows relative to those predicted by catchment area. We found cases where severely reduced flow caused the upper reaches of streams to become dry; this resulted in a false positive identification of habitat which was non-existent (e.g. Bear Creek, Morison Creek). The effects of forestry can also cause channel aggradation and subsurface flow, making hundreds of meters of otherwise viable habitat unusable (e.g. Hunts Creek).

4.2 Snorkel Surveys

Higher adult counts in 2006 could correspond to high fry densities observed in 2007, however, survey length was not held constant between years, and adult density may be a better measure to compare between years. Changes in density between 2006 and 2007 in the Englishman and Little Qualicum rivers were largely driven by increases or decreases in hatchery fish, and not by wild stock. The Oyster river had the smallest proportion of hatchery fish in both years and the least change in density. However, fish density in the Oyster river is significantly lower than the historical average (1981-2006) for the river, while density on the Little Qualicum is not. While it appears that cutthroat abundance has not declined on the Little Qualicum, our data does not describe the relative contribution of hatchery fish to fish density over time. It is possible that the proportion of wild fish could have decreased from historical levels since the current abundance is made up of a high proportion of hatchery fish (88%). Comparatively, the current Oyster river cutthroat population was made up of mostly wild fish (76%), despite large historical contributions of hatchery fish which resulted in increases of up to 60 fish/km within a decade (Lough and Rutherford 2007).

The high variability in historical data could be due to variation in actual cutthroat presence (influenced by the date of survey, location of swim, discharge, and timing of salmon runs) or variation in observation conditions (visibility, observer bias). It is unclear how environmental variables interact to affect cutthroat numbers. For example, there was a large increase in the number of salmon observed between 2006 and 2007 on both the Englishman and Oyster River, however, fish density was lower in 2007 on the Englishman and did not change between years on the Oyster River.

When the predicted number of adults from available habitat and parr density estimates were compared to the total counts from snorkel surveys by watershed, each of the focus creeks made up a significant proportion of the fish counted within their watershed. However, the predicted number of ocean age 1s (adults) is more useful as a relative comparison of productivity between streams rather than as an absolute value, due to the nature of estimating quantity of habitat and survivorship of parr. There was significant room for error when estimating the linear length of stream habitat available for cutthroat parr, since we were not able to survey each stream entirely and could only make assumptions based on our limited habitat investigation.

4.3 Electrofishing

The overall increase of 24% in fry density from 2006 to 2007 is likely to indicate a healthier returning adult population, but could also be a reflection of milder summer conditions in 2007. The mean fry density for 2007 was above excellent abundance, and no stream had fry density below "OK" abundance. In contrast, the mean aggregate parr density was below the abundance level required to sustain maximum adult production, and no streams had parr density typical of suitable habitat ("good" abundance).

Several streams exceeded excellent abundance levels for fry density (Bear, Cold, Colquitz, Craigflower, and Whisky). Bear creek had the highest adjusted fry density in 2007 at 275 fry/100 m^2, but this appears to be a sampling error since severe low flow during the summer caused fry to become concentrated in shallow pools and glides. This poor habitat condition evidently limited parr survival, which was at a conservation concern level.

Woodhus and Morrison Creeks had the lowest adjusted fry densities at 36 and 30 FPU respectively. This is still considered an adequate density to sustain maximum parr production, however, parr abundance was at a conservation concern level on Woodhus Creek. Low fry and parr density on Woodhus Creek could be due to a partial barrier (cascade falls, debris jams) combined with nutrient limitation, which could be a function of restricted salmon returns. Excellent habitat in the upper reaches of this creek was devoid of any fish, while lower in the watershed, small numbers of coho fry, Dolly Varden, and cutthroat parr were found in pools.

The low cutthroat fry density on Morrison Creek is consistent with 2006 results. This could be a result of competition from coho fry (Sabo and Pauley 1997), which were at higher densities than cutthroat fry. Bettles (2004) found high incidence (55%) of hybridization with rainbow trout on Morrison Creek, which could reduce fitness and competitive ability in fry. Other urban creeks (Craigflower and Colquitz) with less competition from coho and similar alkalinity have higher cutthroat fry density. Although Morrison Creek has the lowest fry density of any creek in 2006 and 2007, it has one of the highest parr densities, which provides strong evidence that fry were not limiting parr production at this density.

While none of the creeks had "good" abundance levels of parr, three creeks had parr density sufficient to maintain maximum adult production (Colquitz, Flintoff, and Morrison). Colquitz Creek in particular was remarkable in that it had a large number of introduced species that all have presumed documented impacts on cutthroat populations (smallmouth bass, pumpkinseed sunfish, and American bullfrogs). However, this fish community state has not changed since 1975 fisheries surveys and cutthroat trout densities have remained moderate to high (Ron Ptolemy, pers. comm.).

The majority of streams had parr abundance levels above the conservation concern threshold, but below the density required to sustain maximum adult production. Limited parr production has a multitude of potential causes, but the most overwhelming trend evident from habitat investigation was that all creeks lacked LWD and pools. In addition, many streams lacked adequate base-flows and % wetted area. Additional limiting factors for parr were nutrient limitation (Whisky, Woodhus Creeks), and introduced species (Craigflower).

The four creeks at the conservation concern level for parr abundance all had obvious habitat degradation. Bear creek had severely low flow. Sections of Hunts Creek bordered by clearcuts were intermittent, overwidened, aggraded, and had no functional riparian zone, instream cover, or canopy closure. The Little Oyster River and Woodhus creek both had suspected fish passage problems from debris jams or beaver dams and bedrock cascades. The Little Oyster River also had a fry density at the conservation concern level in 2006 which could have resulted in limited parr recruitment for 2007.

The main sources of error in estimating adjusted FPU involve sampling a site that is not representative of the stream as a whole, or does not adequately sample all mesohabitats. Overestimating fish numbers can occur when sampled fish density for a given size class is not representative of the entire creek. For parr, this can occur when a stream contains few pools; if a pool is sampled, it could contain a high density of parr forced to occupy the only available habitat. For fry, a similar situation occurs when low water levels crowd fry into small shallow pools or glides, and riffles are dry. When the habitat suitability index is applied to calculate adjusted FPU, the fry density is further inflated by the fact that probability of occurrence of fry in glides is 0.5 (Table 2), but the realistic probability of occurrence should be 1.0 since no other habitat is available. Underestimation of cutthroat density can occur when one or more mesohabitats are not adequately sampled (e.g., no pools sampled would reduce the number of parr recorded). Additionally, habitat classified as pool may not always realistically support parr due to its limited size and depth. Therefore counts of zero parr in a given area of pool may not indicate a reduced population but simply a poor choice of sample site. Fry density can be overestimated if rainbow trout are counted as cutthroat fry, which can occur when both species are present in the same habitat. Hybridization also makes positive identification of parr more difficult.

4.4 Nutrients

Most sampled streams were not nutrient-limited as is typical of the Nanaimo Lowlands EcoSection. Of the three creeks identified as orthophosphorus-limited, nutrient addition is recommended for Whisky and Woodhus, using regular slow-release fertilizer (McCusker et al. 2002). Both creeks have low population density at sites where water samples were taken which could be due to nutrient limitation, past or partial barriers. In Whisky Creek, a dam was removed within the last 10 years which has prevented the transport of nutrients to the headwaters via anadromous fish. While we suspect that Woodhus creek is nutrient-limited, the main limitation of cutthroat populations may be access to habitat; this is due to the presence of debris jams and cascade falls that could make migration impossible in some years. We do not recommend nutrient addition to the upper section of the tributary of the Little Oyster River because of a waterfall barrier downstream of the cranberry farm.

High nitrogen concentrations were observed in all of the creeks sampled in late September and early October, possibly due to increasing abundance of decaying organic material and precipitation.

Conclusion

The conclusion of our assessment of cutthroat trout habitat and population status is that both are suboptimal and at risk of further decline. Parr production was consistent with suboptimal habitat in all creeks, and was at a conservation concern level in over a quarter of sampled streams. Combined with further habitat degradation, invasive species, continued mortality from fisheries, and greater extremes of climate, cutthroat trout populations are at considerable risk on East Coast Vancouver Island, with the health of most populations reflecting their blue-listed status.

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Appendix 1

Cutthroat Trout Investigations 2007

Bear Creek
Watershed Code 920-600400-07000; stream length = 5.67km; stream order=2

Date: July 24, 2007
Weather: sunny, ~22°C (previous 5-7 days overcast and rain)
Surveyors: Tera Kasubuchi, Jim Loring (volunteer, ORES)

Water Features:

Flow	20-30L/s
Temp	13°C
TDS	149µS/cm
CW	3-7m
WW	1-7m

Notes:
(★1)-survey start at mouth to Oyster River (from bottom of hatchery) to old bridge crossing which is near the end of Laforce Road (section ~400m)
(★2)-future plans to update gravel road and create new access to hatchery (southeast of present access), which will cross Bear Creek. A bridge will be built at this crossing.
-this section of stream was semi-confined in a gully, surrounded by maple and alder trees
-flow was surprisingly low as the previous days were overcast and rain; flow was visible throughout section
-areas of wider channel widths were generally where pools located
-few functional in-stream LWD; logs mainly above channel, providing only cover for fish and not influencing stream morphology
-stream cover (mainly over-stream vegetation and boulders) and canopy cover were fairly abundant and frequent
-pools were infrequent, yet some were of considerable size compared to channel widths
-very few fry/parr visible; fish observed were mainly in pool habitat
-two corners had some minor bank stability problems; sites showed evidence of slumping and some potential for future activity. Both sites adjacent and were located on the left bank for the downstream site and on the right bank for the upstream site (~30m apart)
-water had slight brown tinge to it, but could be due to substrate below and high amount of shade/cover
-(★2)first RB tributary on map is actually a ditch which was not visible along Bear creek. During walk back from Macauley Rd along dirt road, this ditch channel was crossed (culvert was too high on the u/s side at this low water height) see photos

Photo Summary:

245	Looking d/s at lower hatchery road/path crossing
246	u/s at lower hatchery/path crossing; cw ~3m, ww ~1.5m, deciduous cover, boulders, o/s veg
247	Typical LWD- limited in function; undercut bank-pool habitat; boulder cover
248	Low flow through boulder/cobble; o/s veg
249	Cw ~4m, ww ~2m; pool on left bank of channel; o/s cover
250-253	Larger pool with parr visible; approx 6mx4m area; depths over 1.2m; small gravel/sand bottom; LWD laying across pool
254	Ww ~70% of cw; low flow; good o/s cover, riffle/glide habitat
255-256	Site of LB slump on corner; side bank covered by ferns; some large boulders present
257	RB slump (u/s of LB slump); shows site of sediment deposit
258	Low flow; glide habitat; boulder/cobble substrate, o/s cover
259-261	Larger pool area confined on RB by bedrock that is undercut; pool ~8mx5m; depth of ~1m; small/large gravel substrate; LWD 1.2m above pool
262	Ditch shown as tributary on map, looking u/s from gravel road crossing
263,265	u/s side of culvert, ~30 cm drop and ~30cm distance between water's edge and lip of culvert
264	d/s side of culvert; becomes small pool ~1mx1m

Date: Aug 27, 2007
Weather: sunny, ~20°C
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	Low-intermittent
Temp	13°C
TDS	170-179μS/cm
CW	6-8m
WW	0-4m

Notes:
- (★3) survey start @ Macaulay Rd crossing; 2 culverts on south side of Macaulay road
-culvert crossing for mainstem has no flow u/s of it; water u/s contains green algae
-d/s side of culvert is perched (30-40cm) at low flow
-from Macaulay Rd, follow horse trail to d/s crossing: g-trap #1 set near pool below culvert, #2 set approx 50m d/s of #1
-from culvert d/s for ~100m, intermittent pools, lots of algae, shallow pools, lack LWD, cw 6-8m, ww 0-4m
-d/s another horse trail crossing: over-widening of channel, alluvial deposit
-a few debris jams over ~500m surveyed
-observations at 3091 Macauley road property: large (20mx20m) pool/pond with high out-take (raised rocks). Very little flow u/s of d/s of pond; intermittent pools; sediment/turbid water/ dark color
-~75m u/s of pond there was a dead frog (fungal infection), hay bails in-stream, log bridge with 2 culverts, evidence of bank/excavator activity and restoration
-10m d/s of pond: g trap #3
-very few fry visible in this section

- (★4) Maplecroft Farms: road crossing ok; habitat good; stagnant pool with little water and no flow. Landowner states Ministry put road crossing in.

Photo Summary

902/903	Culverts u/s of Macaulay road leading to roadside ditch and under driveway
904	U/s side of Macaulay road crossing
905	U/s culvert-low flow, green algae
906	Pool d/s side of Macaulay road
907	D/s side of Macaulay road=view of perched culvert
908	Horse trail crossing creek
909	D/s side of culvert from Macaulay road-perched 30-40cm
915/916	Second horse trail crossing
917/918	Debris jam
919/920	Channel
922	3091 Macaulay road property-bridge crossing (922 looking d/s)
924/926	~75m u/s of pond
927-931	Dead frog infected with a fungus found u/s of pond
932-939	Bank erosion/restoration u/s of pond
941	Pond in backyard of 3091 Macaulay Road
942/943	Out-take of pond
957	Looking u/s from road crossing on Maplecroft Farms property
958	Looking at u/s side of road crossing culvert
961	Looking d/s from d/s side of road crossing

G-trap results:

Site # and location	Set	Pulled	Results
1-D/s side pool of Macaulay Rd crossing	Aug.7/07 11:00	Aug.7/071 2:30	19 Coho (50-67mm); 1 Cutthroat (105mm, 10.5g)
2-pool ~20m d/s site 1	Aug.7/071 1:00	Aug.7/071 2:20	16 Coho (48-57mm); 3 Cutthroat (41, 44, 52mm); 10 Stickleback (30-50mm)
3-~10m d/s pond @ 3091 Macaulay Rd	Aug.7/071 4:35	Aug.7/071 4:55	19 Stickleback

Electrofishing and Site Card Information:

Site Type, # and location	Access	Date Sampled
E/s #1-~200m d/s of Macaulay rd cossing	From Macaulay Rd, follow trail north, take first right and follow ~30m to creek	Sept 19, 2007
E/s #2- end of Laforce Rd	Permission from landowner at end of Laforce Road to follow trail behind chicken coop to old bridge crossing. From here, ~50m d/s is site	Sept 19, 2007

Cutthroat Trout Investigations 2007

Cat Stream
Watershed Code 920-389300-22700; stream length=4.5km

Date: August 2, 2007
Weather: sunny (~22ºC)
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	12L/s
Temp	16°C
TDS	~490µS/cm
CW	2.5-3.0m
WW	2.5-3.0m

Notes:
(★1)-Survey from Chase River confluence, upstream for ~400m
-good mix of cover: over-stream vegetation, LWD, canopy
-LWD placed by previous restoration work; LWD still functioning to some degree to create pools and cover, however some structures creating debris jams and no flow at some sites
-First corner u/s of confluence had restoration work to create cover and stabilize the eroding bank: pool depth ~45cm
-Some pools present (~50cm depth)
-substrate mainly cobble, with some boulders present
-small concrete foot path crossing near Park Ave
    -at high water levels this is submerged
    -LB is slightly over-widened and appears to be eroding into stream
-Site card (#1) completed ~70m d/s of foot bridge
-U/s of crossing, channel becomes confined into what is considered a canyon for ~180m
    -this section has some erosion, less cover than d/s section and fewer pool habitats
-section becomes unconfined, wider cw/ww, deeper, less cover, and gravel substrate with little gradient-continues behind Robbins Park and under 5th street
-overall, creek has a lot of garbage and continues through many creek-side yards
-end of Rosamond street=channel in grasslands

-(★2)-investigation u/s in Buttertubs Marsh area and above the new arena at 3rd St crossing that leads up to Malaspina College
-from the footpath along Jingle Pot rd, sites had stagnant waters adjacent to two culverts
-fry were visible in all three pools
-3rd Street crossing had very little water present- flow rate of 1.8L/s, temp 16.5°C, 212 µS/cm, fry visible
-stream heads toward Malaspina College (between 3rd and 4th Street) and becomes a much steeper gradient with no water present

Photo Summary:

302	Mouth of Cat Stream with Chase River
304	Fish passage under Park Ave ~10m u/s of confluence
392/394	First 90° corner u/s of confluence; previous restoration work done to stabilize bank and create cover.
395-411	Confluence to foot path crossing. LWD structures, jams, gravel deposits around logs and banks, garbage present
412	Foot crossing along Park Ave
413-423	Section along canyon: eroding bank, confined channel
435	Upstream of canyon, low gradient, deeper channel, less cover
439-441	End of Rosamond Street: channel in grasslands
443	First culvert along footpath from Jingle Pot road
445	Second culvert along footpath from Jingle Pot road-d/s side
446	Second culvert along footpath from Jingle Pot road-u/s side
447/448	D/s side of culvert along 3rd street
455/456	Dry stream channel along section below Malaspina College (between 4th and 3rd St)
457	Site card #1 photo looking u/s
458	Site card #1 photo looking d/s

Electrofishing and Site Card Information

Site Type, # and location	Access	Date Sampled
E/s and Site #1-~60m d/s Park Ave canyon crossing	Along Park Ave, near 6th street, from foot bridge follow footpath ~60m d/s	E/s-Sept 4,2007 Site Card-Aug 2, 2007
E/s and Site Card #2-Howard Ave crossing	At Howard Ave crossing, site is u/s end of culvert	E/s and Site Card -Sept 4, 2007

Cutthroat Trout Investigations 2007

Center Creek
Watershed Code 920-462800-21300-00900; stream length=10.66km; stream order 2

Date: July 6, 2007
Surveyors: Mike McCulloch, Tera Kasubuchi, Jenna Craig
Weather: sunny, hot (~25ºC)

Water Features:

Flow	~30-50L/s
Temp	15°C
TDS	192µS/cm
CW	~5-7m
WW	~1-4m

Notes:

-(★1)-survey start @ Northwest bay Mainline 155:
0+0 tied on to bridge d/s side
0+100 alluvial channel, low flow, sub-terrain flow in a few sections (intermittent flow)
0+100→0+460 anadromous barrier 5/3 (3m vertical)
- -fish in plunge pool (parr and fry size fish visible)
- -logging within 3m of bank from 0+100→0+460
  - -some riparian stumps
- -channel confined in some areas due to bedrock substrate and banks
- -riparian areas are logged, leaving a thin strip of mixed forest; canopy is small and inadequate for functional LWD contribution

-below anadromous barrier is reach 3
- -site card completed along this reach
- -flow rate ~30-50L/s

-Left bank tributary further d/s than 0+546: survey followed this tributary until bridge crossing of first logging road (follow 155 mainline, turn right after 114, turn right at first side road, follow and turn right at first side road and follow ~100m to bridge crossing). Stream contained fry throughout. This tributary lies within logging areas and is composed of a thin riparian area. Stream channel widths were consistently between 2-5m width, with alternating pool riffle/glide habitat. Flow rate was low at ~5L/s. Stream cover was fairly good with some SWD present within the stream. At the bridge crossing fry were also observed. This tributary is u/s of Norris Creek confluence.

-(★2)Norris Creek tributary (~660m d/s of 155 mainline)
- -channel widths b/n 6-8m, wetted widths between 2-4m, flow rates of ~15L/s
- -located within logging areas; stream banks mainly comprised of mixed maple and conifers.
- -Ct fry were visible within this system

-stream cover was variable and stream contained areas with LWD, pool and riffle/glide habitat. Fewer fry visible in this system than mainstem and other tributary

- ~250m u/s of confluence was (steeper section thought to be an anadramous barrier). Above this steeper section of stream densities of fish drastically reduced.

-Further u/s channel was less defined with little stream flow

Photo Summary:

084	Anadramous barrier: falls 5/3
095,099,100	Center Creek d/s of falls
097	Site Card Site #1: looking u/s
109-112	Tributary (Norris Creek) possible anadramous barrier
098	LB tributary confluence
102/103	Following tributary u/s
104	Tributary bridge crossing

Electrofishing and Site Card Information:

Site Type, #, location	Access	Date Sampled
E/s Site #1~250m u/s confluence with S.Englishman	From 155main, turn right after 155-014, follow for ~6km, turn right on road just before confluence, follow to slashpile and walk across clearcut to creek	Sept 18, 2007
E/s Site #2 ~370m u/s confluence with S. Englishman	From 155main, turn right after 155-014, follow for 5.5km, turn right and follow to end, walk across clearcut to creek	Sept 18, 2007
Site #1-upper Center Creek	From 155main, follow mainstem past anadramous barrier approx ~150m	July 6, 2007

Date:Sept 18,2007:

-(★3)-Water sample collected ~20m u/s of E/s site #1

- electrofishing – 2 sites

-Overall, recommend LWD complexing as per Clough and Wartig (2004) report (15-20 sites)

Cutthroat Trout Investigations 2007

Chase River
Watershed Code 920-389300; stream length=13.8km; stream order=3

Date: July 26, 2007
Weather: sunny (~22ºC)
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	
Temp	17°C
TDS	~127µS/cm
CW	7-10m
WW	1-7m

Notes:
-(★3)-survey start @ Howard Ave Crossing upstream 450m to Colliery Dam (considered Reach 8)

-some deep pools present (~1m deep); low summer flow
-mainly deciduous forest, with Cedars more dominant just below falls
-lack LWD; and logs present are not very functional
-some areas of undercut banks (under some very large stumps)
-lots of garbage throughout section; house properties to edge of creeks
-mainly riffle/glide habitat
-some Ct parr/adults visible (>20cm length) in deep pools, fry visible throughout section
-channel bed covered with brown material, water has slight brown/yellow tinge
-canopy cover and stream cover moderate-mainly o/s veg and some boulder/cutbank cover
-undercut clay bank left bank on slight bend~60m u/s of Howard Ave
- ~170m u/s RB property to edge of creek, split channel around trees, home-made platform above creeks edge
-~175m u/s= large pool-3mx2m, 0.6m depth
-Colliery dam-anadromous barrier (~20m falls)

Photo Summary:

270/271	Garbage under Howard Ave crossing
272	~40m u/s of Howard; stream low summer flow; cw 9.8m
273	LB ~60m u/s of Howard Ave: undercut clay bank
276	~170m u/s RB property to edge of creek: split channel around trees, home-made platform above creeks edge
280	~175m u/s: pool 3mx2m, 0.6m depth
282	Falls at Colliery dam-anadromous barrier

-(★4) survey from Howard Ave downstream for 250m towards Bruce Ave

- -bank erosion present on LB-clay bank, with alluvial gravel deposit on RB
- -cw start to narrow ~7m; ww range ~1m-7m
- -lack of LWD; canopy cover a bit thinner than reach u/s but still >50%
- -moderate levels of o/s and boulder cover
- -mainly deciduous riparian forest
- -garbage visible throughout reach
- -close proximity to school/trails/houses
- -section of stream (RB) next to school grounds has been re-enforced by cabled rip-rap
- -Site card #1 completed: cw 5-7m, ww 5-6m; mainly cobble bed and bank material; trace amounts of SWD and LWD cover and mainly o/s and boulder cover; TDS 126 µS/cm and water temp 18ºC

Photo Summary:

293/294	~50m d/s Howard Ave: alluvial deposits on RB, clay bank on LB side
295/296	Cable from a tree on the LB, crosses creek and goes through log in stream channel
297	Site card #1 u/s photo
298	Site card #1 d/s photo

-(★5) survey from Hewgate St to Park Ave

- -section started with average channel/wetted width, complete cover, lack LWD
- -on first corner ~50m d/s Hewgate St start, cw overwidened to 12.2m, gravel deposit on LB, very little canopy cover
- -just d/s of first corner, canopy cover improves and channel widths go back to 8-10m, large pool present (2mx6m, depth >1m) around log jam
- -canopy cover reduced in some areas (mixed forest)
- -site of Cat Stream confluence on LB- flow visible, water levels good for fish ladder and through Park Ave culvert.
- -residential areas have some influence on stream-streamside tree pruned and dropped in-stream (site just upstream of 7th street crossing)
- -small unknown tributary present on RB, ~80m u/s Park Ave (photo 312); stream comes from Nova/Stirling intersection; quick 50m survey revealed a cw 1-2m, ww 0.5-1.5m within a narrow gully; fry visible-trib investigated Aug 2
- -large eroding clay bank (RB-8m high and 28m long) on corner ~75u/s of Park Ave
- -fry/parr still visible in sections of stream
- -Site card #2 completed: conductivity increase to 259µs/cm; cw 7-10m, ww 4-7m, resident pools (depths 65 and 90 cm); canopy cover of 20-40% mainly mixed forest; stream cover mainly deep pool, channel bed dominated by cobble

Photo Summary:

299	>50m d/s of Hewgate Rd, looking u/s at log jam/pool
301	Looking d/s at log jam/pool
302	Cat stream confluence on LB of Chase
304	Cat stream-culvert under Park Ave
311	Backyard/streamside pruning of deciduous tree and cuttings left in-stream
312	RB of small unknown tributary
314	Clay bank on RB-looks unstable with overhanging trees
321	Section where site card #2 completed
323	Looking u/s for site card #2

- (★6) survey for Douglas Ave to Railway crossing
  - -from Douglas Ave, climb down gully to Chase River
  - -this reach was a lush cedar forest, with abundant riparian vegetation
  - -small amounts of garbage still in-stream
  - -abundant canopy cover and stream cover-mainly boulder, with some LWD and pools present
  - -conductivity 263 µS/cm, water temp 17°C
  - -cw still between 9-11m and ww 6-8m
  - -large log jam present approx 200m d/s from Douglas Ave start; jam ~20m wide, 5m length and over 5 ft high in some parts. The stream seemed to flow a bit under the jam and has created a path around it on the left bank. The RB is slightly undercut and is bedrock. There is a large boulder on the d/s side of the log jam. The stream is split and then seems to run underground (sand/gravel deposit) and meet up again. This whole section is approximately 50 meters in length. See photos 335-351
  - -fry/parr visible in pools and sections around debris jam
  - -site card #3 just downstream from Douglas Ave start: conductivity 242 µS/cm, temp 17°C; cw 11m/ww 6-8m; some LWD and pools present, crown closure >50%, stream cover mainly boulder.
  - -culvert crossing under railway seems passable except at extremely low water level. Pool of depths to 0.6m present right below culvert entry and gradient of culvert is very little, u/s side of culvert does not seem to pose any problems

Photo Summary:

325	Start of survey below Douglas Ave entry
336	u/s side of log jam
337	LB side of channel going around debris
338/339	RB side around jam showing more debris d/s of main log jam
341/347	D/s side showing debris piled up on boulder
342	D/s of log jam
351	D/s RB of jam has another pile of debris on it's LB
352	Concrete wall leading up to culvert under railway crossing
353	U/s end of culvert
358/359	D/s end of culvert
360	Site card #3 d/s view
361	Site card #3 u/s view

Date: August 2, 2007
Surveyors: Tera Kasubuchi, Jenna Cragg

- (★7) survey of unknown RB tributary on Chase River-approx 30m d/s of 7th St
  -original investigation from Chase river- cw/ww- 1-2 m, enclosed gully, fry visible, little stream cover

-investigated from Stirling Ave area: small, low flowing stream adjacent to road. Comes from 8th street, adjacent to empty lot at the end of Stirling Ave and Murray St (currently under construction-clearing property, road building, etc), follows Stirling Ave and crosses under Nova street and into gully towards Chase River. Stream is mainly covered by shrub-blackberry, water plants, etc. Stream became dry at Murray St/Stirling Ave crossroad.

Photo Summary:

377	Jenna standing road side along Stirling Ave at d/s side of construction (photo looking u/s)
378	Stream along Stirling Ave
379	Culvert at u/s side of Murray St
380	Jenna along streambank construction u/s of Murray St (photo looking u/s)
381	Out-take pipes at u/s end of construction-no flow
382	8th street culvert which appears to be the beginning of tributary
383/384	Small foot path crossing along Stirling Ave behind electrical feature; shopping cart in-stream
385/386	Nova St bridge crossing
391	D/s side of Nova St crossing

Electrofishing and Site Card Information:

Site Type, # and Location	Access	Date Sampled
Site Card #1-Howard Ave crossing	~150m d/s from Howard Ave crossing	July 26/07
Site Card #2-Park Ave crossing	~50m u/s of Park Ave crossing	July 26/07
Site Card #3-Douglas Ave crossing	From end of Douglas Ave south side, hike down bank and follow creek ~75m	July 26/07
E/s #1-Park Ave crossing	D/s side of Park Ave crossing bridge	Sept 5/07
E/s #2-Howard Ave crossing	Follow trail ~50m d/s of Howard Ave crossing	Sept 5/07

Cutthroat Trout Investigations 2007

Cold Creek
Watershed Code 920-627900-03600-04800

Date: Sept 25, 2007
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	147L/s
Temp	10.5°C
TDS	134µS/cm
CW	4.0-7.0m
WW	2.5-4.0m

Electrofishing and Site Card Information:

Site Type, # and location	Access	Date Sampled
E/s Site #1-under powerlines	Follow Argonaut road past hatchery ~3.5km, turn left, follow dirt road past gate to dam and powerlines.	Sept 25, 2007
E/s Site #2-4301 Argonaut Rd	u/s side of bridge crossing along 4301 Argonaut road driveway	Sept 25, 2007

Photos:
1170-1173: E/s Site 1
1175/1177: E/s Site 2

Date: October 3, 2007
-(★)-water sample collected ~15m up-stream of Quinsam Hatchery Road bridge crossing
-weather: cloudy, rain; previous days were rainy
-spawning salmon visible in-sream and carcasses along shoreline

Cutthroat Trout Investigations 2007

Colquitz Creek
Watershed Code 920-079700

Date: Sept 21, 2007
Weather: cool, 12°C, light rain late afternoon (1mm accumulation for day)
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	77 L/s
Temp	12°C
TDS	175μS/cm
CW	~4.0m
WW	2.6-3.8m

Electrofishing and Site Card Information:

Site Type, # and location	Access	Date Sampled
E/s and Site Card #1-Copley Memorial Park	At end of Eastridge Court-take foot path to creek within park boundaries	Sept 21, 2007
E/s and Site Card #2-West Saanich Road crossing	At the downstream side of West Saanich Road bridge crossing	Sept 21, 2007

Notes:
-(★)during electroshocking at Site #2 (W. Saanich rd crossing): 13 pumpkinseed sunfish and 3 smallmouth bass were collected; 1 Bullfrog was observed entering pool at upper end of site
-fish barrier at Beaver Lake outlet

Photo Summary

1129/1146	Pumpkinseed sunfish
1153/1158	Smallmouth bass fish
1138-1142	Electrofishing and Site Card #1
1162/1164	Electrofishing and Site Card #2

Cutthroat Trout Investigations 2007

Craigflower Creek
Watershed Code 920-077200

Date: Sept 20, 2007
Weather: cool, 12°C
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	5 L/s
Temp	11°C
TDS	~350µS/cm
CW	3.0-5.5m
WW	2.0-3.0m

Electrofishing and Site Card Information:

Site Type, # and location	Access	Date Sampled
E/s Site #1-Talcott Road	At Talcott road crossing, follow Galloping Goose trail downstream for ~50m, hike down bank to creek	Sept 20, 2007
E/s Site #2 and Site Card #1-Marler Drive access	At the end of Marler Drive, follow path next to park north, as path starts to climb up, follow side trail east down to creek	Sept 20, 2007

Notes:
-(★)during electroshocking at Site #2 (Marler Drive access): 39 pumpkinseed sunfish were collected within site. A total of 51 coho and cutthroat fry/parr were collected. A large pool ~10m downstream of site was sampled to see the ratio of salmonids:pumpkinseed. Result were: 45 coho, 20 cutthroat, 22 pumkinseed, leaving a ratio of almost 3:1.

Photo Summary:

1125/1226	Electrofishing Site #1
1127/1128	Electrofishing Site #2, Site Card #1
1129/1146	Pumpkinseed sunfish

Cutthroat Trout Investigations 2007

Flintoff Creek
Watershed Code 920-627900-03600-02700

Date: Sept 14, 2007
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	40L/s
Temp	10°C
TDS	125µS/cm
CW	2.0-3.0m
WW	1.8m

Electrofishing and Site Card Information:

Site Type, # and location	Access	Date Sampled
E/s Site #1-Parkside Drive	From Hwy 28, take Parkside Drive, follow gravel road to main horse ring area. Hike down steep bank to creek.	Sept 14, 2007
E/s Site #2	~150m d/s of Site 1	Sept 14, 2007

Photos:
1105-1109: E/s Site 1
1114-1118: E/s Site 2

Cutthroat Trout Investigations 2007

Hunts Creek
Watershed Code 920-490700-17000; stream length=6.87km; stream order=2

Date: July 17, 2007
Weather: overcast, light rain (~18ºC)
Surveyors: Tera Kasubuchi, Jack Dillon (volunteer, 752-9925)

Water Features:

Flow	155L/s
Temp	10°C
TDS	71µS/cm
CW	8-12m
WW	2-4m

Notes:
-(★1)-Survey from old confluence with Big Qualicum (along Hatchery road) to Malma Creek confluence:

-Hunts creek mainstem from 0+0 to 0+800 had visible coho and cutthroat fry. Few Ct parr were visible in deeper pools. The mainstem was mainly surrounded by a healthy mixed forest comprised of mainly cedar, alder and maple. There was a visible abundance of devils club and cow parsnip along the stream banks and also along some of the alluvial deposits. The channel was mainly riffle/glide/pool habitat with areas of LWD deposits. Pools were fairly large, having depths of over 1m for some, and were generally every 50-80m along the channel. Large woody debris was somewhat frequent along the stream, however some debris was jammed in the middle of the stream and not along the edges to help create pool habitat and control proper stream morphology. A lot of logs were present which were not in the channel but laying horizontal approximately 1-1.5m above the channel. The channel was braided at times, with alluvial deposits present throughout. At some debris jams, very small channels were visible going around the debris. Channel width was very large throughout the mainstem, however stream width was smaller, ranging between 2-9 meters on average. Flow was characterized as low summer flow.

Photo Summary:

123	0+260m looking d/s at channel: wide with alluvial deposits
124-126	124-looking u/s, 125,126 looking d/s: 0+310m; wide channel, LWD, mixed forest
127,129,131 132-135	0+380-565m; LWD in-stream, braided channels, alluvial deposits
137,139	0+600; large pool 6x15m; mixed forest
140-142	0+730-800: noticeable logging in riparian areas, blow-downs, alder dominated, thinning canopy
144-145	Confluence of Malma creek on LB

-(★2)-Survey Malma Creek (confluence to 230m u/s)

-Heading up Malma creek (wc 920-490700-17000-15700), channel initially 7% gradient for first 50 meters. After first log jam (50m upstream), gradient decreases to 1-2%. Channel covered mainly by overstream vegetation for first 50m. Above the log jam, logging is present relatively close to the stream, and cover is less abundant. Channel widths range 5-7m, with wetted width comprising the whole channel at times or only 1-2m in some places. Directly above the log jam, stream only 45cm wide. There is a channel bed of alluvial deposits around this log jam, on the left bank side, which indicates direction of the stream at high flow. Water was dripping through the log jam and subsurface flow around it. Surrounding forest is mixed between cedar, fir, alder and maple. Up-steam of log jam, canopy cover opens up due to the logging activity; over-stream vegetation lessens. Channel is mainly riffle/glide habitat from this point on. Stream does become intermittent with some small pools left for the fry/parr to live in. Logs are lying in the air, across the stream bed, with some areas of in-stream log jams. Alluvial deposits are present along the stream and creek eventually dries up leaving a cobble/boulder bed present.

-Coho and Ct fry visible throughout survey
-flow ~30-50L/s
-lacks deep pools and in-stream LWD

Photo Summary:

144,145	Confluence with Hunts creek
146	0+30m: slope 7%, narrow channel and wetted width
147-154	0+50 LWD, pool, debris jam; 148,149 looking u/s at log jam; 151 looking d/s at log jam; 152,154 looking u/s from log jam at next LWD
155	0+65: logging to within 10m of creek; mixed forest canopy, starting to open, undercut banks
156	0+200: looking d/s
157-159	0+230: intermittent flow, alluvial deposits, LWD jammed across stream, some sub-surface flow
160,161	Riparian area boundaries show evidence of previous logging

July 19, 2007
Weather: overcast, light rain (~18ºC)
Surveyors: Tera Kasubuchi, Jenna Cragg

Notes:
-(★3)-Survey along mainstem from Malma Creek confluence upstream for ~730m

-Channel widths (from the LB trib to the RB trib, 460 m u/s) 7-10m; wetted widths 2-7m. Site card (#1) completed ~300m u/s: photo 202 u/s, cw 7-12m, ww 2-6m, water temp 12ºC,41-70% crown closure, cobble dominated bed and bank material, and overstream vegetation as dominant type of cover. Log/debris jams frequent along either sides or mid-channel. Log jams generally across the whole channel width, causing the channel to split. Pools frequent (every 60-100m) along this stretch of channel as well. Canopy cover (41-70%) along this section is mixed forest. Canopy diminishes upstream due to streamside logging activities and blowdowns. Flow was low summer flow, ranging between 50-75 L/s. Fry and parr were visible for whole section. From the RB tributary upstream, the mainstem becomes steeper (5% gradient), narrower, straighter and had less pools present. The first 100m of this section had high amounts of canopy and overstream vegetation cover. Up-stream of this section, canopy and over-stream vegetation diminished as streamside logging activity was evident. Water temperature was 16ºC along this upper section where site card (#2) was completed: cw ~7m, ww 0-2m, water temp 16ºC, canopy closure 1-20%, cobble dominated bed and bank material, boulder is the dominant cover type. The channel had alluvial deposits and a few log jams. Flow rate dropped drastically to 10-30L/s. Restoration potential for this upper section: LWD complexing 12-15 sites of logged and blowdown section

Other comments: some of the log jams are in the middle of the creek and creating larger debris jams by holding up wood. It could be recommended to move these logs to the side of the creek to help create better fish habitat and natural morphology of the creek.

Photo Summary:

178	Looking u/s from Malma Creek confluence
186	0+140m: LWD across and in-stream, over-stream veg, logging visible ~30m from channel, canopy fairly open
193	0+200m: looking d/s at log jams, blowdowns
202	Site card #1
203	RB logging, start of intermittent flow
204	Mainstem cw 7-9m riffle/pool habitat
205,206	Mainstem steeper gradient
207-209	Blowdowns, logging to within 5m of creek, overwidened, alluvial deposits; intermittent pools;
210	Site card #2

Date: Aug 21/07
Weather: cloudy, light rain; previous 4 days-rain
Surveyors: Jenna Cragg, Tera Kasubuchi

Notes:
- (★4)-Upper watershed investigations:
  - -found 3 set of waterfalls (Barrier)-no fish observed above
  - -habitat was optimal until area of logging (below powerlines)-stream became overwidened in areas, low canopy cover, windthrow, less in-stream functional LWD, Clay/fines bed material.
  - -flow rate varied 12-25L/s, recent rain so stream channel was mainly wet. Lower water levels seem to create intermittent pools/channel.
  - -fry/parr abundance was the same throughout channel below waterfalls

-access upper watershed: Follow Cochrane Rd ~4.1km from Island Hwy crossing (or 1.5km from power station), turn left off Cochrane Rd (follow 0.7km), left at fork, stay right at second fork and follow to tributary crossing. After tributary crossing, turn left, left at fork, follow ~1.0km to end of road. Follow old road path by foot (SE direction) to tributary which eventually meets up with mainstem down steep bank.

-survey was from this point downstream to powerlines

    -approx 60m d/s from survey start: bedrock confined, falls (20%, 4.6/13.4m-vertical) gravel deposit and log jam at bottom; ~10m d/s of 1st falls is a 2nd set (38%, 6.2/7.9m); ~80m d/s 2nd set is 3rd falls (0.5/3.0m)

-~75m downstream of fall, fry visible: g-traps 1-3 in area and site card #4

-stream followed downstream to power lines: site card #3 (upper end of LWD restoration recommendation)

    -logging to within 10m of channel in some areas
    -wind-throw activity
    -cobble/boulder, pools with fry/parr visible

Photo Summary:

769	Tributary followed to get to mainstem
775,776	Begin survey-looking u/s: boulder-dominant, LWD, cascades
784,789	1st set of falls observed
806,807	LWD at bottom of falls; gravel deposit
812,818	2nd set of falls
827	Bottom half of 3rd set of falls
831	Downstream of falls, cobble/boulder habitat
835	Wind throw near power lines
838	Site card #3
844,848	Site card #4
850	Tributary crossing along road-u/s side
851	Tributary crossing along road-d/s side

G-trap Results:

Site # and location	Set	Pulled	Results
1-~100m d/s of falls	12:50	13:10	No fish; 2 fry visible beside trap
2-~120m d/s of falls in deep pool	13:05	14:35	Ct 98mm, 10.2g Ct 56mm, 1.8g
3-~150m d/s of falls	13:10	14:25	Ct 46mm,1.0g Ct 51mm, 1.4g

Electrofishing and Site Card Information:

Site Type, # and Location	Access	Date Sampled
E/s site #1-u/s of old confluence	From corner of old confluence, follow u/s ~150m	Sept 12, 2007
E/s site #2-under highway	Along hatchery road, under Inland Island Hwy bridge	Sept 12, 2007
Site card #1	~300m u/s of Malma creek confluence	July 19, 2007
Site card #2	~700m u/s of Malma creek confluence	July 19, 2007
Site card #3	Under power lines	Aug 21, 2007
Site card #4	~100m d/s of falls	Aug 21, 2007

Date: Sept 11, 2007

-water sample collected from under Inland Island Hwy bridge crossing (at E/s site #2)

Cutthroat Trout Investigations 2007

Little Oyster River
Watershed Code 920-600400-15700 stream length=24.4km

Date: Aug 15, 2007
Weather: sunny, 19°C
Surveyors: Tera Kasubuchi, Mike McCulloch

Water Features:

Flow	~70 L
Temp	~14°C
TDS	~70µS/cm
pH	7.8
CW	Various
WW	Various

Notes:
-(★1)-Survey of Cranberry farm tributary crossing along Duncan Bay Main tributary
 -u/s side of bridge crossing-ponded water, beaver dam (barrier-~1.5m high); d/s of bridge-ponded water; low flow
 -dry side channel near road leading into pond of u/s section: sediment loaded waters in a small hole of side channel
 -tributary from Cranberry farm tributary: intermittent low flow (~2L/s), cw/ww 1-2m, creek within clearcut section (photos)

Photo Summary:

682-686	Looking u/s of bridge crossing
687	Downstream side of bridge
690/692	Dry side channel along road leading into u/s section
694	Sediment loaded water in small hole of side channel
696	Looking d/s under bridge
697/698	Looking u/s at beaver dam
719/720	U/s side of bridge crossing of trib from Cranberry farm trib
721	Looking at landscape d/s of bridge crossing
722-726	Downstream side of bridge crossing-intermittent flow

-(★2)-Survey of Duncan Bay Main crossing:
 -water at low flow, ~70L/s, cw ~4m, ww 1-4m, 14°C, 68.6µS/cm, pH 7.8
 -G-traps #1 and #2 set
 -along right side of road ~20m from LB is a 15m section of sediment deposit into the forest-from road run-off

Photo Summary:

700,701,716,729	Downstream side of Duncan Bay Main crossing
711,712	Sediment deposit into forest

-(★3)-Survey section upstream of Duncan Bay Main Crossing (~600m-1.5km u/s)

-from 600m upstream cobble dominant to bedrock channel

-site card #1 ~660m u/s and E/s ~740m u/s

-9% (3.6m rise over 22m run) cascade falls- ~800m u/s- noted possible barrier to fish migration (blast a few sections to create areas of pool/eddy's for fish to rest)

-upstream ~1km, another section of bedrock cascade ~6% with large pool at d/s corner (~10x15m) with several large ct visible (18-20cm)

-several ct and coho fry visible, as well as crayfish and sticklebacks

-g-trap #3 set at d/s side of wetlands near ~1.2 km u/s

Photo Summary:

730, 731	Mike heading u/s to set g-trap 3 just below wetlands
732, 733	Looking d/s of 6% bedrock cascade
734, 736	Pond d/s corner of bedrock cascade
735	Looking u/s from corner at 6% cascade
737/742	Looking u/s at 9% bedrock cascades ~800m u/s mark – noted possible barrier
738,739	Looking u/s at Site 1
740	Looking d/s at Site 1
741	Looking u/s from top of Site 1

- (★4)-Upper watershed investigations along Gilson Main Rd:

-follow Gilson Main for ~4.2km- location of E/s and Site card 2

-investigation for ~500m upstream from site card to wetland outlet

-large beaver dam (andadromous barrier)

-bedrock section between site card and wetlands with a 1m drop-possible barrier

-Ct fry and parr visible throughout survey

-further upstream along LB trib heading towards Gilson Lake: fry visible, intermittent flow (~1-2L/s), undefined channel and banks, ~2m cw/ww

Photo Summary:

743,744	Headwater LB Tributary
745, 746	View of wetlands from north ridge near Gilson lake
747-749	Beaver dam at wetland outlet
750-751	Possible barrier in bedrock section
754	Site card 2-looking u/s at survey site
755	Site card 2-looking d/s at survey site

- (★5)-Cranberry farm tributary (920-600400-15700-50800)

-Downstream of cranberry farm road bridge crossing ~40m is bedrock cascade (andadromous barrier-8m height, 50m length)

-Conversation with farm owner-creek is usually dry during July/Aug. Creek flow today is from weekend rains. No coho ever seen around his farm (since 1980). In past, DFO/Ministry put trout upstream of farm. Fish live/co-exist in and upstream of his acreage. He is interested in any project to increase water flow/storage-idea of damming up/storage of wetlands of mainstem just downstream of Duncan Bay Main crossing

Photo Summary:

756,757	Looking at downstream end of cascade falls

-(★6)-RB tributary upstream of York Road crossing:

- -cross mainstem along York Road, ~500m turn right on logging road, follow straight to tributary crossing (~800m)
- -trib dry on d/s culvert side
- -a 1x1m puddle on u/s side entering culvert
- -no flow through culvert
- -section within clearcut area with small deciduous riparian on ~5m each side

Photo Summary:

759	Downstream side of culvert
760,761	Upstream side of culvert

G-trap Results:

Site # and location	Set	Pulled	Results
1-Duncan Bay Main	16:40 Aug 14	10:30 Aug 15	5 crayfish, 1 three spine stickleback
2-Duncan Bay Main	10:45	12:45	1 Ct (22.6cm, 130.6g) 3 Coho (79 mm 5.4g/ 90mm 10g/83mm 6.8g)
3-~1km u/s from Duncan Bay Main	10:50	11:40	No fish
4-~4.1 km along Gilson Main (E/s site)	13:45	15:00	Ct-13.5 cm
5-Mainstem ~100m upstream of Inland Island Hwy	12:00	14:50	1 coho (50mm)
6-Cranberry farm tributary ~50m u/s confluence with L.Oyster	12:30	14:15	1 coho (85mm) 1 Cutthroat (63mm)

Electrofishing and Site Card Information:

Site Type, # and Location	Access	Date Sampled
E/s and Site Card #1-~700m u/s of Duncan Bay Main crossing	Heading north, just before Duncan Bay Main xing, turn left and follow road ~600m, hike north down bank to creek	E/s: Sept 7, 2007 Site Card: Aug 15, 2007
E/s and Site Card #2-Gilson Main	Follow Gilson Main for ~4.2 km from Duncan Bay Main, hike ~25m SW into forest to creek	E/s: Sept 7, 2007 Site Card: Aug 15, 2007

Date: Sept 6, 2007
Weather: sunny, cool (15°C)
Surveyors: Tera Kasubuchi, Jenna Cragg

-water samples collected and stream surveyed from Inland Island Highway to cranberry farm tributary

-water samples: Site 1=Little Oyster tributary crossing at Duncan Bay Main (u/s of cranberry farm)
Site 2=Little Oyster tributary downstream of Cranberry farm
Site 3=Little Oyster River upstream of cranberry farm tributary
Site 4=Little Oyster River downstream of cranberry farm tributary

-(★7)-Survey of creek section: flow at 66L/s, low gradient with ponded waters
-cw/ww 2-8m, 14°C, fines/gravel bottom
-fry visible throughout (g-traps 5)
-beaver dam ~150m and at ~250m u/s of hwy, flow going around LB edge of dam
-cranberry trib: (g-trap 6)~16L/s flow, conductivity 162.4µS/cm, cw/ww ~3m, shallow waters, pool/R/G habitat, large gravel dominant substrate

Photo Summary:

1049/1050	Looking u/s at pool/riffle habitat along mainstem
1052	Beaver dam starting to form-~150m u/s from hwy
1054-1057	Beaver dam ~250m u/s from hwy-flow visible at LB edge
1058	Cranberry farm trib ~50m u/s of confluence with L. Oyster River

Cutthroat Trout Investigations 2007

Morison Creek
Watershed Code 920-462800-24400

August 30, 2007
Weather: sunny (18°C)
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	~11L/s
Temp	14°C
TDS	99.2μS/cm
CW	~1-13m
WW	~0.5-9.0m

<u>Notes</u>:
-Stream survey conducted from confluence to Englishman River upstream to Errington Road crossing of Swane and Morison creeks
-(★1)survey from confluence upstream for ~500m
    -cobble/gravel/boulder substrate for first 100m, then bedrock for 100m, then back to boulder-dominated substrate
    -fry visible throughout section, 2 g-traps set
    -fairly wide channel widths (10-13m)
    -Site card completed
    -flagging tape labelled "DFO coho site": conversation with Steve Baillie (DFO) reveals no stock assessment done for over 5 years on Morison, falls known as a steeper section that coho could possibly pass. 2006 (dry year) was a bad run for coho and could be reason for limited observations due to coho not spawning off-stream (as per phone conversation Oct 16, 2007)

Photo Summary:

978	~20m from confluence looking u/s at hanging foot bridge
979	~20m from confluence looking d/s
981	Looking u/s at cobble/boulder wide channel
982	Bedrock dominated section
984	Further upstream, back to boulder-dominated habitat (site card 1 photo)

G-trap Results:

Site # and Location	Set	Pulled	Results
1-first 500m section from confluence to Englishman River	10:20	11:30	None (coho fry visible around trap)
2- first 500m section from confluence to Englishman River	10:50	11:15	12 Coho (length-mm) 55,66,69,64,66,62,56,75,64,65,61,67

-(★2)Survey for ~500m near "triple falls" site (~1.25km upstream)

-access from Sierra Rd on north side of creek, follow trail at end of road down bank to creek
-similar habitat to section downstream
-fry visible (mainly coho in pool); g-trap set
-tributary water flowing down steep cliff ~15m into RB of creek at two spots
-anadramous barrier was not observed in section-however fry visible so barrier thought to be upstream of this survey

Photo Summary:

991/992	Tributary falls down cliff entering RB
995	In-stream vegetation
996	2nd set of tributary water flowing down cliff into RB

G-trap Results:

Site # and Location	Set	Pulled	Results
1-upstream near fall location	12:45	13:30	1 coho

-(★3)-survey Errington Road crossing of Morison creek (under bridge and section ~500m d/s of bridge crossing)

-at bridge channel 2-4 meters with low flow, gravel deposits and substrate. Stream enters into forested area; no fish visible near bridge
-at site ~500m d/s of bridge, very good habitat (cover, flow, substrate, glide/riffle/pool); cobble/gravel bed; pools ~50cm deep; cw 3m, ww 1-3m; two large resident cutthroat visible in pool); LWD present in pool; fry visible in shallows and pool; g-trap set for 25minutes and no fish caught.

Photo Summary

975/976	Looking down from Errington Road bridge at d/s side of channel
977	Stream flows toward forested area
1007/1011	Site ~500m d/s of Errington Road bridge
1012	Looking d/s at g-trap location

-(★4)-Swane Creek investigation(tributary to Morison Creek):end of Leffler Road and Errington Road crossing

-trail crossing at end of Leffler road goes through stagnant pool, low flow, cw 2-4m, ww 1-3m; sticklebacks visible (1 salmonid observed)
-Errington Road crossing: lots of in-stream vegetation; school of ~20 sticklebacks; low flow/stagnant pools; cw 3-4, ww 2-3m; no fish visible

Photo Summary:

1000-1003	Trail crossing stagnant pool at end of Leffler road
1004	Under Errington Road bridge crossing-looking d/s
1005/1006	Under Errington Road bridge crossing-looking u/s

Cutthroat Trout Investigations 2007

Morrison Creek
Watershed Code 920-553200-94200-04800

Date: Sept 11, 2007
Weather: sunny, 18°C
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	174 L/s
Temp	14°C
TDS	284µS/cm
CW	~3.0-5.0m
WW	1.5-4.0m

Electrofishing and Site Card Information:

Site Type, # and location	Access	Date Sampled
E/s and Site Card #1- Powerhouse Rd crossing	Upstream side of Powerhouse Road bridge crossing	Sept 11, 2007

Notes:
-(★1) **Sept 11, 2007**-investigation of Miromar Road crossing: culvert perched ~30cm, high velocity water exiting culvert. Photos (1074, 1075) were taken from above culvert. Fry visible in pool upstream of culvert

-(★2) **August 8, 2007**-investigation of upper headwaters-no access
-checked first LB tributary upstream of Inland Island highway:
-very low flow; cw ~2m, ww ~1.5m; good canopy cover; water 15°C, 113µS/cm; clearcut outside 5m riparian area

Photos:
1077-Site #1 looking d/s
1079-Site #1 looking u/s at top section
1080-Site #1 looking u/s at middle section

Cutthroat Trout Investigations 2007

Whiskey Creek
Watershed Code 920-481800-12700; stream length=6.93km; stream order=2

August 10, 2007
Weather: overcast (~17°C)
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	~125L/s
Temp	12-13°C
TDS	89-119µS/cm
pH	7.88
CW	~4.0-7.5m
WW	~0.8-4.5m

Notes:
-Stream survey conducted from ~150m downstream old dam site to the headwaters
-(★1)creek was dry at: both ends of Winning Way Rd, near end of Chatsworth Rd, and Clark Rd crossing of Crocker Creek (no obvious channel, only skunk cabbage and shrub present, no channel bed visible)
-Flow was observed at: culvert crossing of Chatsworth Rd (near Walz Rd and Kriscott Rd), and Crocker creek tributary crossing at Harris Cres.
-fry and parr visible throughout survey (numerous fry and parr mainly in deeper pool areas of both creeks)

G-trap Results:

Site # and Location	Set	Pulled	Results
1-old dam site	13:30	14:15	4 Coho (50mm, 50mm, 85mm, 60mm) 2 Ct (40mm, 45mm)
2-d/s pool of Melrose Rd crossing	10:30	14:30	None
3-d/s pool of Chatsworth Rd crossing (near Kriscott Rd)	10:15	14:45	1 Ct (95mm, 7,3g)

-(★2)Survey ~150m u/s and d/s around old dam site: access from the end of Stevens Rd, hike down old road off the NW end of the house property and down a small slope to reach the old dam site.

-the dam was removed in 1998, which was a barrier to fish passage.
-upstream section was mainly bedrock substrate; downstream section was mainly gravel substrate
-alluvial deposits present throughout
-small debris jams of LWD and SWD, but still passable by fish at low-high water levels

-large gravel deposits on u/s side of old dam site (appox 10m in length, 1.5m width, 0.5m height
-Site Card #1: flow estimated at 125L/s, and considered summer base flow
    -substrate was mainly gravel or bedrock, lacked cobble/boulder habitat
    -some small pools present with depths up to 75cm
    -adequate amounts of o/s vegetation for cover and LWD for cover
    -water temp 13°C, 119µS/cm, pH 7.88
    -cw 4-5m, ww 1-5m
    - ~50% canopy cover-mixed forest with clearcut sections along LB and forested slope along RB (mainly cedar trees). u/s section was frequently confined by bedrock and rock walls
    -LB vertical, RB sloped: both gravel/fines;d=1.2m; d95=45cm
-fry visible throughout section
-few sections of split channel
-logging to riparian area has created many blowdowns that are lying above the stream banks: ideal area for LWD complexing for 400-500m section

Photo Summary:

589	Looking d/s at old dam site
591-595	Flow around old dam
597	Looking u/s at old dam site-pool where g-trap set
600	Log jam ~30m d/s of old dam site-looking d/s at it, flow continuous around and under jam, gravel deposit on LB
601	Site card 1-looking u/s (approx 100m d/s of old dam site)
607	Site card 1-looking d/s
611	Looking d/s at old and recent trees blown down across creek channel
619	Upstream of old dam site-looking u/s
621	Small drop in stream

-(★3)-Melrose Rd crossing: This site was reconstructed in 2005 with a new culvert crossing, newberry weirs put in and some off-channel habitat produced in 2005. The u/s section of culvert has good off-channel sites with a side channel on the LB and a deep pool with LWD on the RB. The d/s section is comprised of newberry weirs to create a deep pool and backflow into the culvert (this is not present at low flow), and riffle habitat-see photos. Recommendations are to increase height of weir to increase pool height and create backflow into culvert. Very few fish were visible in this section and g-trap captured zero fish.

Photo Summary

579	Looking d/s at u/s end of Melrose Rd culvert
580	Looking at d/s end of Melrose Rd culvert
582	Looking u/s at first pond and weir
583,585,586	Looking d/s of first pond and weir into second pond
584	Looking u/s from 2nd pool at weir

-(★4)-Downstream side of Chatsworth Rd crossing near Kriscott Rd: narrow stream channel in forested/urban area. Small pool/riffle habitat, with good canopy cover. SWD present and o/s vegetation present. Culvert crossing at this site is pretty good-flat with water flow, deep pool at base of d/s side. Water temp 12°C, 89.1µS/cm, pH 7.80. G-trap collected one cutthroat 9.5cm/7.8g, with white parasite (copepod) on right pelvic fin.

Photo Summary:

576,577	D/s side of Chatsworth Rd culvert near Kriscott Rd-sign post lying in creek
578	Looking d/s from culvert-g-trap set in pool
622-627	Cutthroat trout from g-trap; copepod parasite on pectoral fin

-Chatsworth crossing near Walz Rd: culvert is good, water flow, narrow stream channel
Photos 628-630-d/s side of culvert

-South end of Winning Way: turns into dirt road and crossed dry creek channel bed.
Photo 632-where creek would cross
Photo 633-d/s side of road crossing.

-North end of Winning Way-20m into forest by foot found a dry gravel creek bed.
Photo 634/635 shows this site.

-(★5)-survey ~100m d/s and ~20m u/s of Harris Crescent crossing of Crocker Creek:
-numerous unknown fry and a few parr-sized fish observed
-area is mainly bare of under-story vegetation, and has urban influence of houses, foot/bike paths, erosion, log bridge crossing, yard drainage, invasive plants, undercut banks and erosion-mainly fines/gravel substrate.

Photo Summary:

636	Approaching area directly d/s of Harris Crescent culvert crossing
637/638	Close-up of potential barrier
639	Looking d/s at channel d/s of culvert
640	Looking u/s at culvert
641/642	Debris and logs used to cross creek-creating a potential obstruction to fish passage and build up of fines at u/s side
643	Continuing d/s of debris
645	No defined channel edge on LB, trail influence, no under-story, lots of fines
646	Support structure on RB holding up dirt and debris from entering stream
647	Looking d/s at u/s end of culvert
648	Looking u/s of culvert-black drainage pipe in LB
650/651	~20m u/s of culvert-deep pool with small water drop leading into it

Electrofishing and Site Card Information:

Site Type, # and Location	Access	Date Sampled
E/s and Site Card #1-old dam site	At end of Stevens Rd, follow old road at NW end of house and hike down bank to old dam site	E/s: Sept 24, 2007 Site Card: Aug 10, 2007
E/s Site #2-Chatsworth Rd crossing	~20m d/s of Chatsworth Rd crossing adjacent to Kriscott Rd	Sept 24, 2007

-During electrofishing Sept 24, 2007 at Site #2, one parr-sized cutthroat had 2 copepods

Cutthroat Trout Investigations 2007

Willow Creek
Watershed Code 920-614400-39400

Date: Sept 13, 2007
Weather: sunny, 16°C
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	~15 L/s
Temp	11-13.5°C
TDS	98-131μS/cm
CW	~2.0-4.0m
WW	1.0-3.0m

Electrofishing and Site Card Information:

Site Type, # and location	Access	Date Sampled
★1 E/s Site #1-Jubilee Road crossing	Going north on Inland Island Highway, turn left onto Jubilee road- ~500m from airport, creek crossing; hike down steep bank on downstream side.	Sept 13, 2007
★2 E/s Site #2-Homathco Drive crossing	~30m upstream of Homathco Drive crossing; upstream side of old bridge crossing	Sept 13, 2007

Notes:

Cutthroat Trout Investigations 2007

Woodhus Creek
Watershed Code 920-600400-34300; stream length=13.39; stream order=3

Date: August 8, 2007
Weather: overcast (~17°C)
Surveyors: Tera Kasubuchi, Jenna Cragg

Water Features:

Flow	183 L/s
Temp	14-15°C
TDS	53-61 µS/cm
CW	Varying
WW	Varying

Notes:
- (★1) Survey from end of York Road (fish ladder near confluence with Oyster River) upstream for 500m
    - -fish ladder created to pass cascade section
    - -fish ladder had two places where a boulder blocks flow and has created waterfall drops of ~30cm
    - -flow rate low-moderate; cw consistently ~10m with ww 1-10m
    - -primarily bedrock; boulder is sub-dominant bed material
    - -RB is mainly cleared land with stream channel having very low canopy until further upstream past Inland Island hwy
    - -Cover mainly result of overhanging vegetation, bedrock and some cut-banks
    - -some bedrock sections have small waterfalls (30-50cm, with high velocity-see photos), that could be impassable
    - -deep pools (up to 1.3m) are present within the bedrock
    - -functioning LWD is lacking throughout bedrock section (large trees across channel but not in-stream: 1 to 2m above creek)
    - -riparian veg mainly mixed forest with a range of age classes
    - -some small populations of unknown fry visible-mainly in slower moving waters

Photo Summary:

540	Fish ladder with boulder stuck in it (~30cm drop)
541	Bedrock section with fish ladder to the right
543	Right bank has very small canopy cover
544,547,548,549 552,558	Examples of higher water velocities
555, 557	Bedrock dominant habitat

Notes:
- (★2) Survey from Duncan Bay Main crossing to ~240m upstream of Cariboo Main crossing (approx 1.4km)
    - -water temp 14°C, conductivity 53 µS/cm; stream gradient 0-4%
    - -two g-traps (#1 and #2) set near Duncan Bay Main bridge crossing for 2.5 hours

-habitat features varied throughout this section; cw 4-10m, ww 2.5-8m
-channel splits at times; runs through logging areas and has riparian zones of only 5-10m in some places

-lower section mainly cobble/boulder substrate with a few small areas of bedrock; very few deep pools or LWD structures. ~300m u/s of bridge, small RB trib or side channel observed: dry, eroded, cobble bed, 1.5m channel that runs parallel to mainstem- could be a result of the logging or a result of a log jam u/s creating a side channel. Further u/s there are two more side channels-one on RB and one on LB-both had small amount of water flowing (~1L/s) with channel widths of 1m.

-middle section dominated by gravels and small cobble; frequent pools and a few large LWD structures-some spanning the whole channel width, some created split channels or created a new path around the structure, and one jam created the channel on one side to backflow into a pool. Stream channel seems to be over-widened. This section appears to be good spawning habitat with deep pools for cover and sand/gravel bars along the stream bed. On average this section had shallower stream depth (not including pools), less canopy cover and a more deciduous riparian area. Evidence of beaver activity near log jams (freshly cut branches and shavings in-stream and caught in log jams)

-upper section (final 250m of survey near Cariboo Main crossing) dominated by cobble/boulder materials
-relatively small amount of unknown fry and parr observed throughout survey: more observed in upper portion of this section compared to the lower portion below the log jams.

Photo Summary:

503/504	~20m d/s of Duncan Bay Main crossing-setting a g-trap
506	Looking u/s at Duncan Bay Main crossing
507	Non-functioning LWD high above the creek surface
508	Looking d/s at Duncan Bay Main bridge
509	Split channel and braiding, cobble/boulder substrate
510	Logging to within 5m of bank
511	Cobble/boulder, lack of LWD and pools
513	Low summer flow
515/516	Dry RB tributary
517	Looking u/s at log jam
519/520	Looking d/s at log jam
521	Pool habitat around log jam
523,525,526	Looking d/s at log jam-alluvial deposit, deep pool at upper end of jam
527	Entering glide section, low gradient, narrower channel, overhanging vegetation, smaller substrate (gravel size)
528/529	Beaver evidence
532/533	Location and view of LB tributary
536	Deep pool with undercut bank along 90° corner
537	Below Cariboo Main bridge, deep pool, larger substrate again (cobble/boulder)

Date: August 23, 2007
Weather: sunny (18°C)
Surveyors: Tera Kasubuchi, Jenna Cragg

Notes:
- (★3) survey start Cariboo Main to Cariboo 200 to Cariboo 220
-First bridge crossing (~1.1km from gate along Cariboo Main), two g-trap (#3 and #4) set and site card #1completed
-Second bridge crossing (2.8km from gate): suitable habitat: no fish observed
-Third bridge crossing (~0.9km past 4.0km marker): bedrock dominant; 2 parr observed, no fry visible; good habitat
-Followed Cariboo main (~7.3km from gate): tributary crossing-dry, steep terrain, not passable by fish, intermittent channel. Approx. 150m, second tributary crossing-perched culvert, dry intermittent channel
-0.4 km past 8.0 km marker-G-trap set (#5); water features=DO 8.7ppm, 13°C, pH 7.6, 40.5 µS/cm; 4% gradient, boulder dominated habitat, good canopy cover
-Cariboo 200 junction- tributary crossing: no fish visible, water features= DO 6.5ppm, 14.1°C, 1-2m ww, ~10L/s flow
-next creek crossing along Cariboo 200: DO 8.9ppm, cw 3-4m, ww 0.5-4m
-creek crossing ~150m along Cariboo 220- survey from bridge crossing d/s for ~850m: lots of LWD, pools, cover, and debris jams; cw 4-5m, ww 1-5m, pH 7.6, 25.6 µS/cm, no fish visible, flow ~30-50 L/s; water has rust/brown tinge

Photo Summary:

855	Site card #1-looking upstream
865	Looking at u/s side of tributary crossing (7.3km from Cariboo main gate)
869	Looking at d/s side of tributary crossing
870	Second tributary crossing-d/s side
880,885,893,896	Survey along headwaters near Cariboo 220 to Cariboo 200
897	Just past 8.0km marker on Cariboo main
899	Approx 5.0 marker along Cariboo main-bridge crossing looking u/s
900	Same as 899-looking d/s

Date: September 28, 2007
Weather: sunny, ~12°C
Surveyors: Tera Kasubuchi, Jenna Cragg

-further investigations for fish using electroshocker:
(★4) -8.0km marker along Cariboo Main- no fish
-at 3rd bridge crossing along Cariboo Main (just past 4.0km marker)
- 2 pools e/s found only 4 Ct parr/adult size, 2 Dolly Vardens (75-100mm), 1 adult Rb, and 3 very large coho fry (~100mm)

G-trap Results:

Site # and location	Set	Pulled	Results
1- ~20m d/s Duncan Bay Main crossing	Aug.8/07 11:00	Aug.8/07 13:30	1 coho (~75mm)
2- ~50m u/s Duncan Bay Main crossing	Aug 8/07 11:00	Aug.8/07 13:30	0 fish
3- ~30m u/s first Cariboo Main crossing	Aug 23/07 10:20	Aug23/07 10:55	0 fish
4-in pool under bridge	Aug 23/07 10:20	Aug23/07 14:45	0 fish
5-0.4km past 8.0 km marker along Cariboo Main	Auge23/07 11:20	Aug23/07 13:45	0 fish

Electrofishing and Site Card Information:

Site Type, # and location	Access	Date Sampled
E/s and site card #1, Cariboo main crossing	~1.1 km along Cariboo Main from gate	Sept.28,2007

Date: October 3, 2007

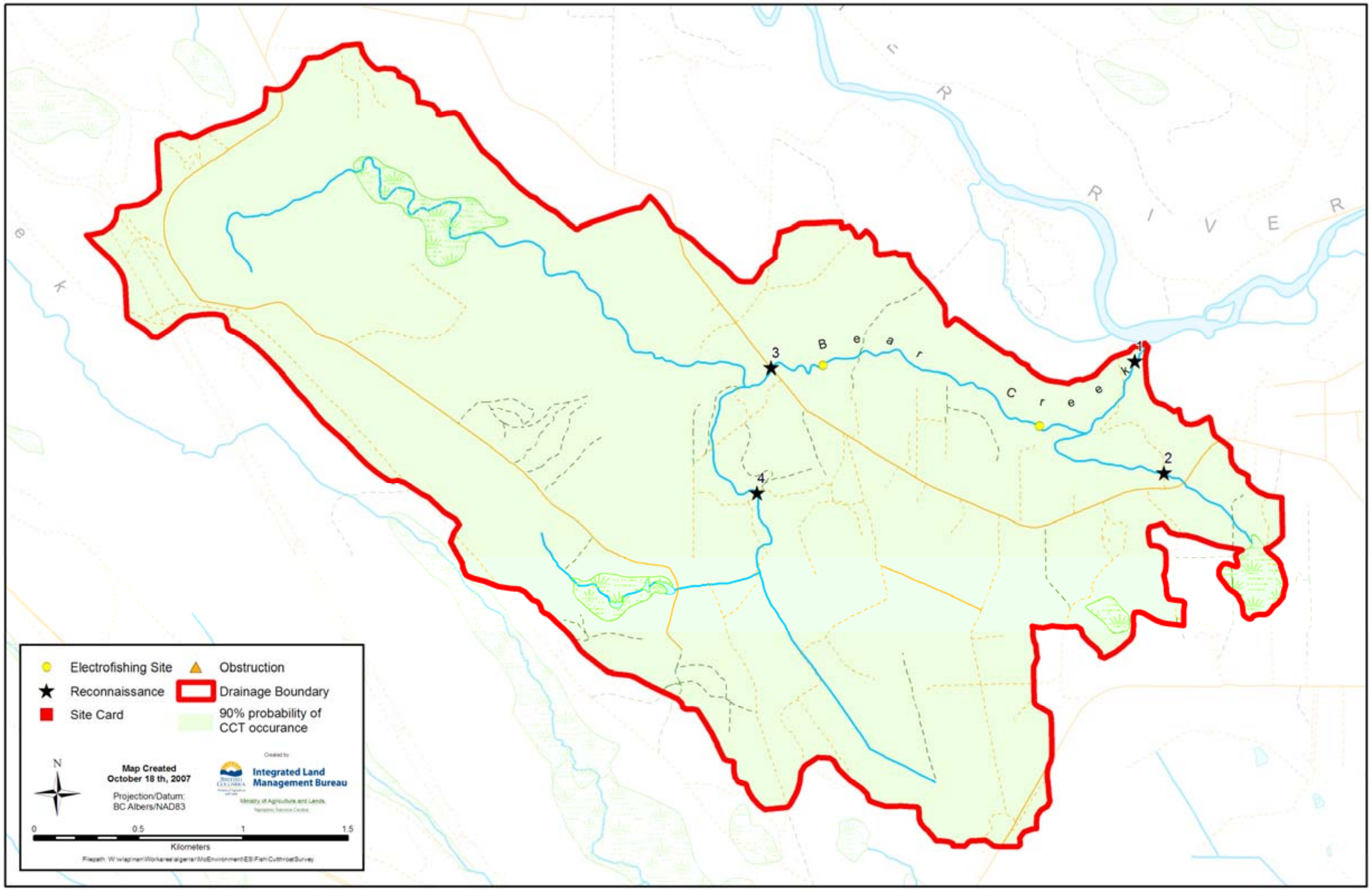
-(★5)-water sample collected from downstream side of Duncan Bay Main crossing

-weather: cloudy, rain; previous days weather was rain

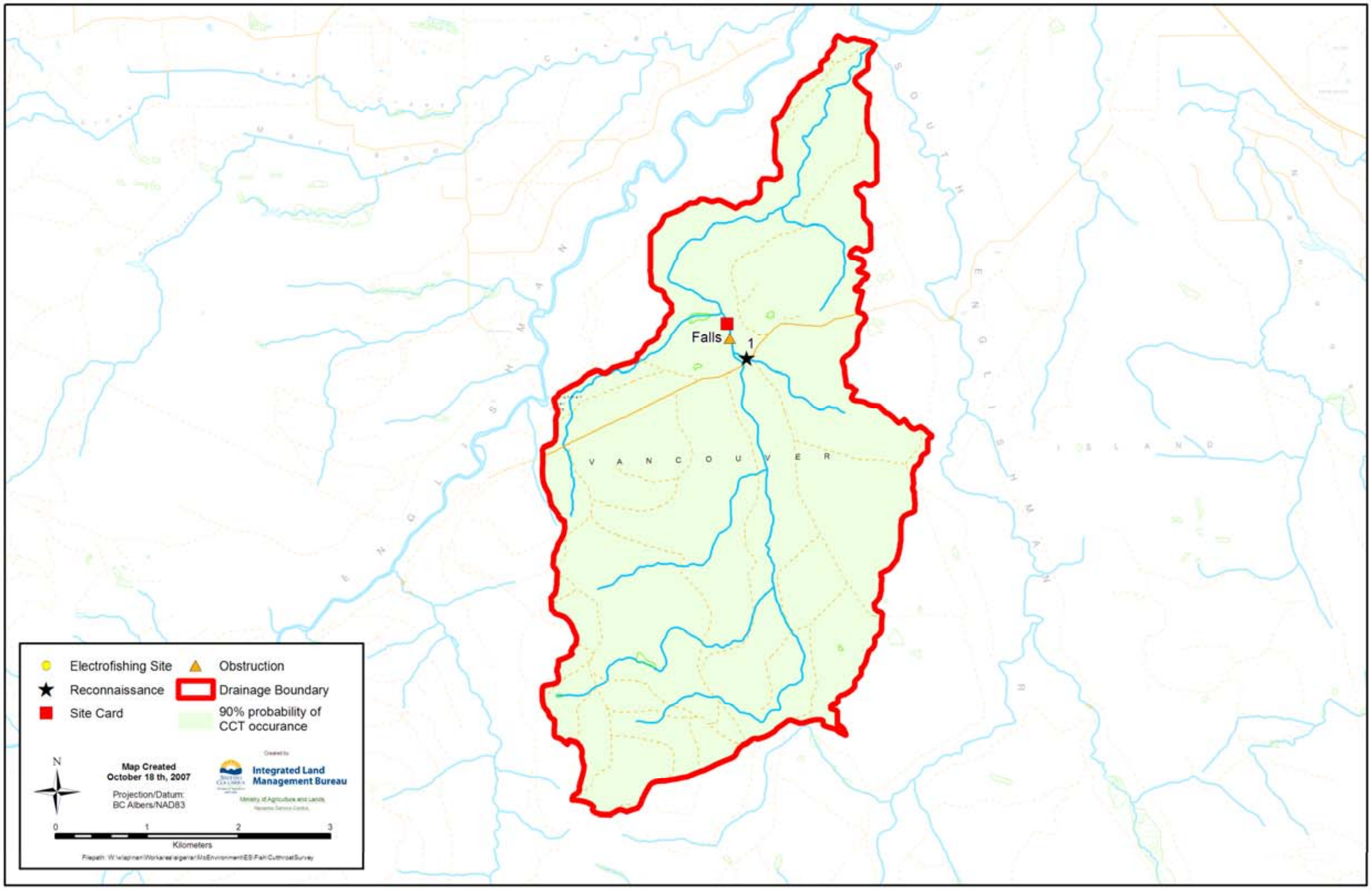
Appendix 2

Anadromous Coastal Cutthroat Trout Assessment Maps

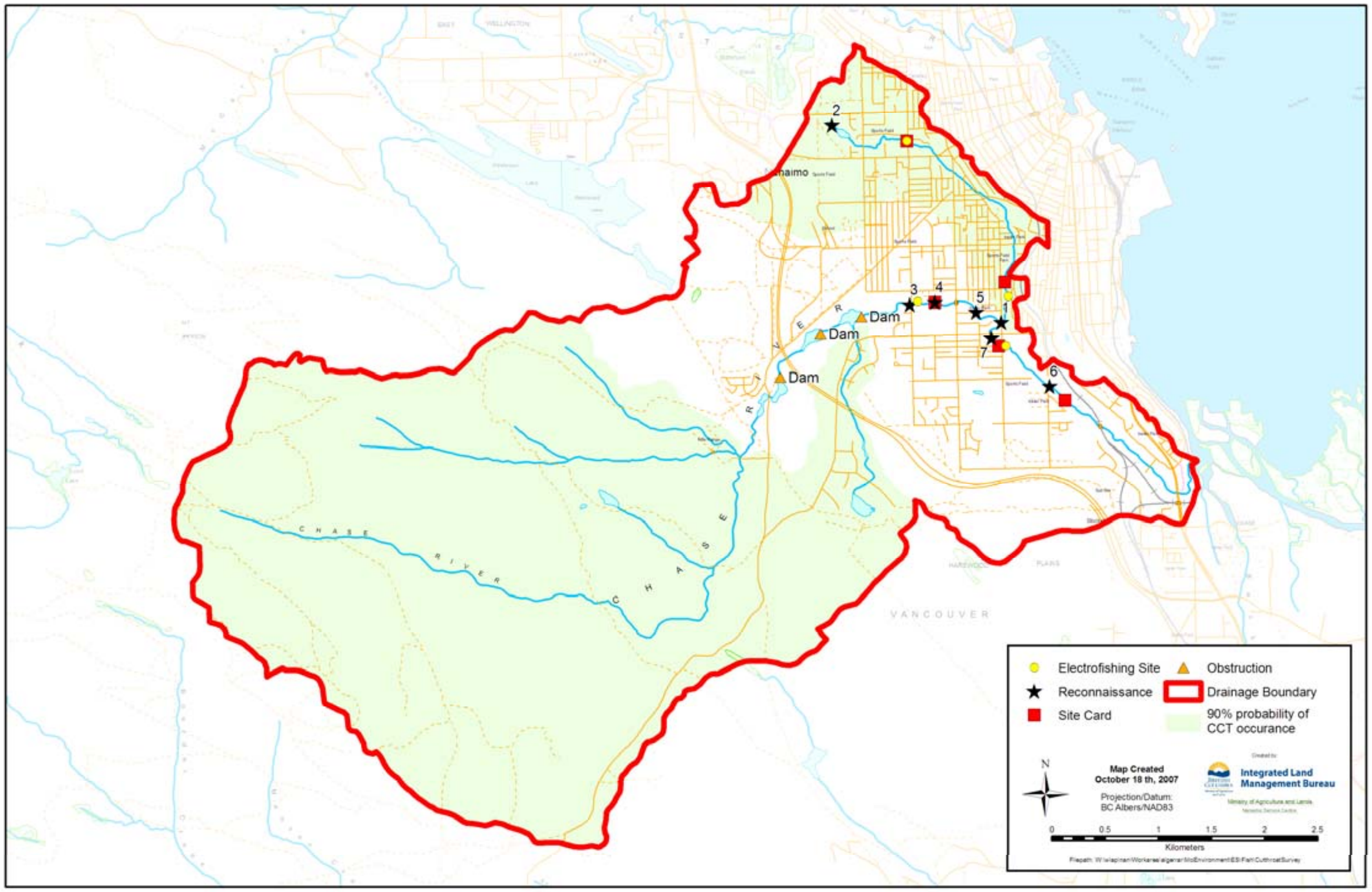
Anadromous Coastal Cutthroat Trout Assessment
Bear Creek



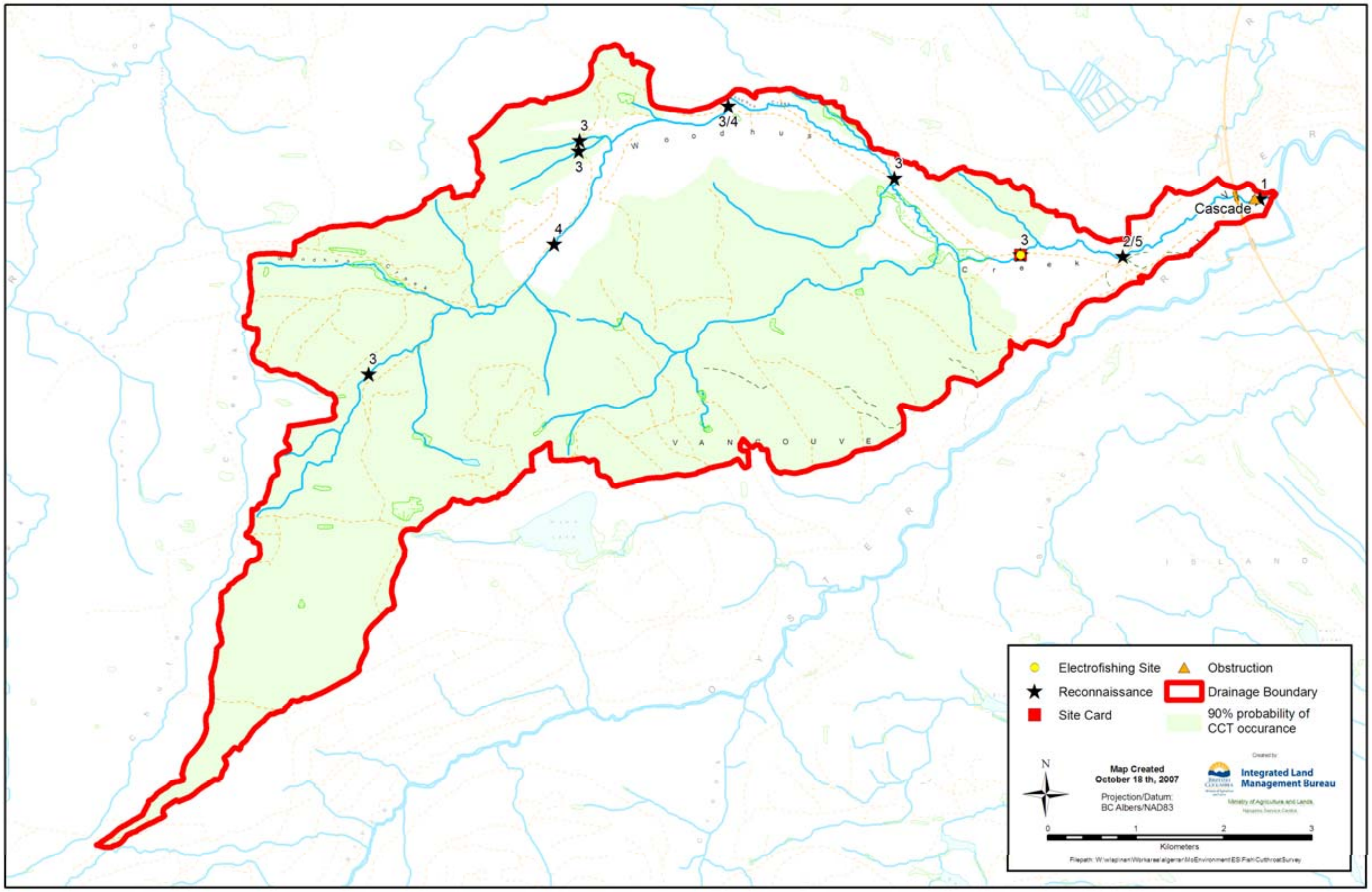
Anadromous Coastal Cutthroat Trout Assessment
Center Creek



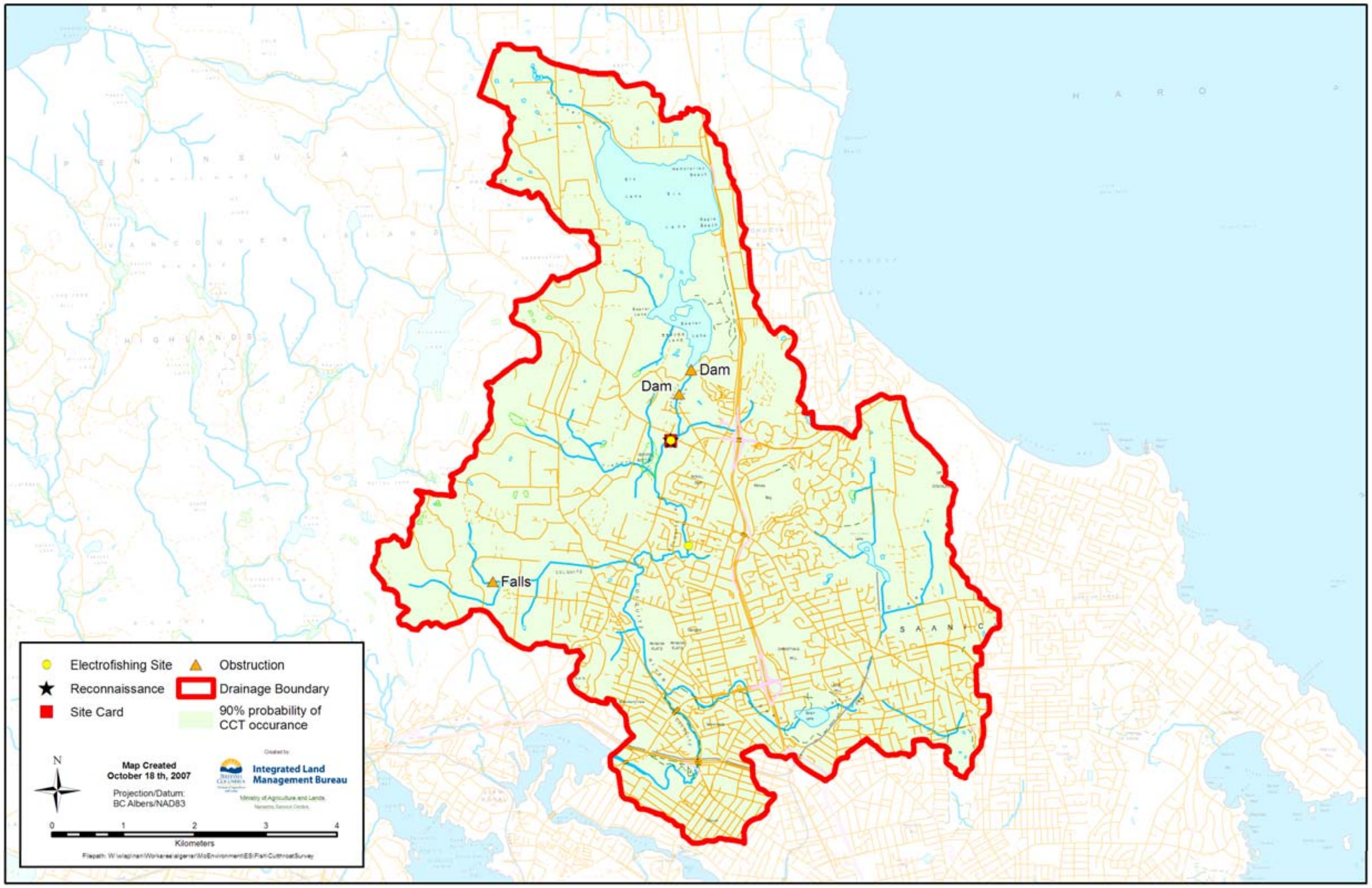
Anadromous Coastal Cutthroat Trout Assessment
Chase River



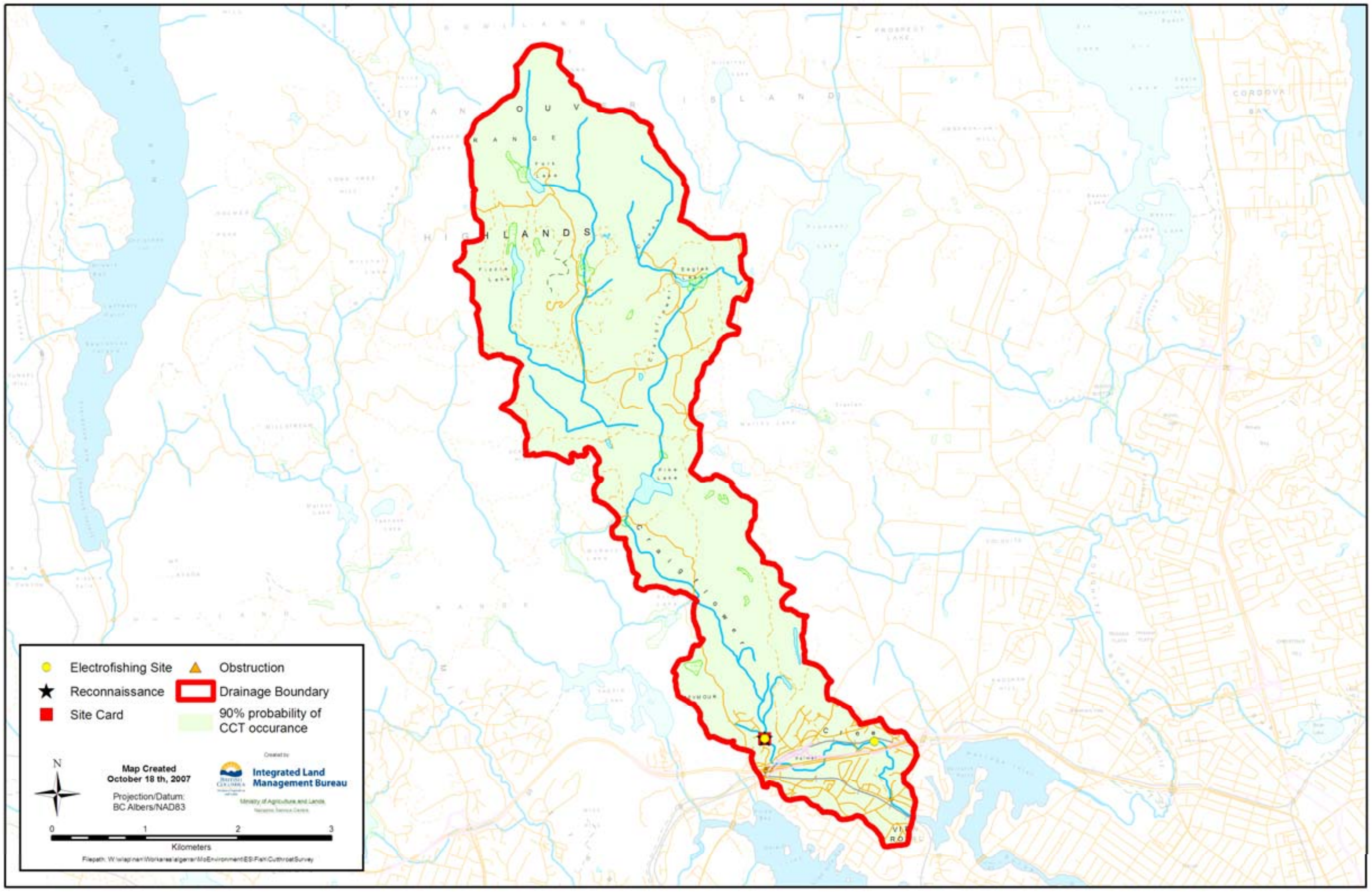
Anadromous Coastal Cutthroat Trout Assessment
Woodhus Creek



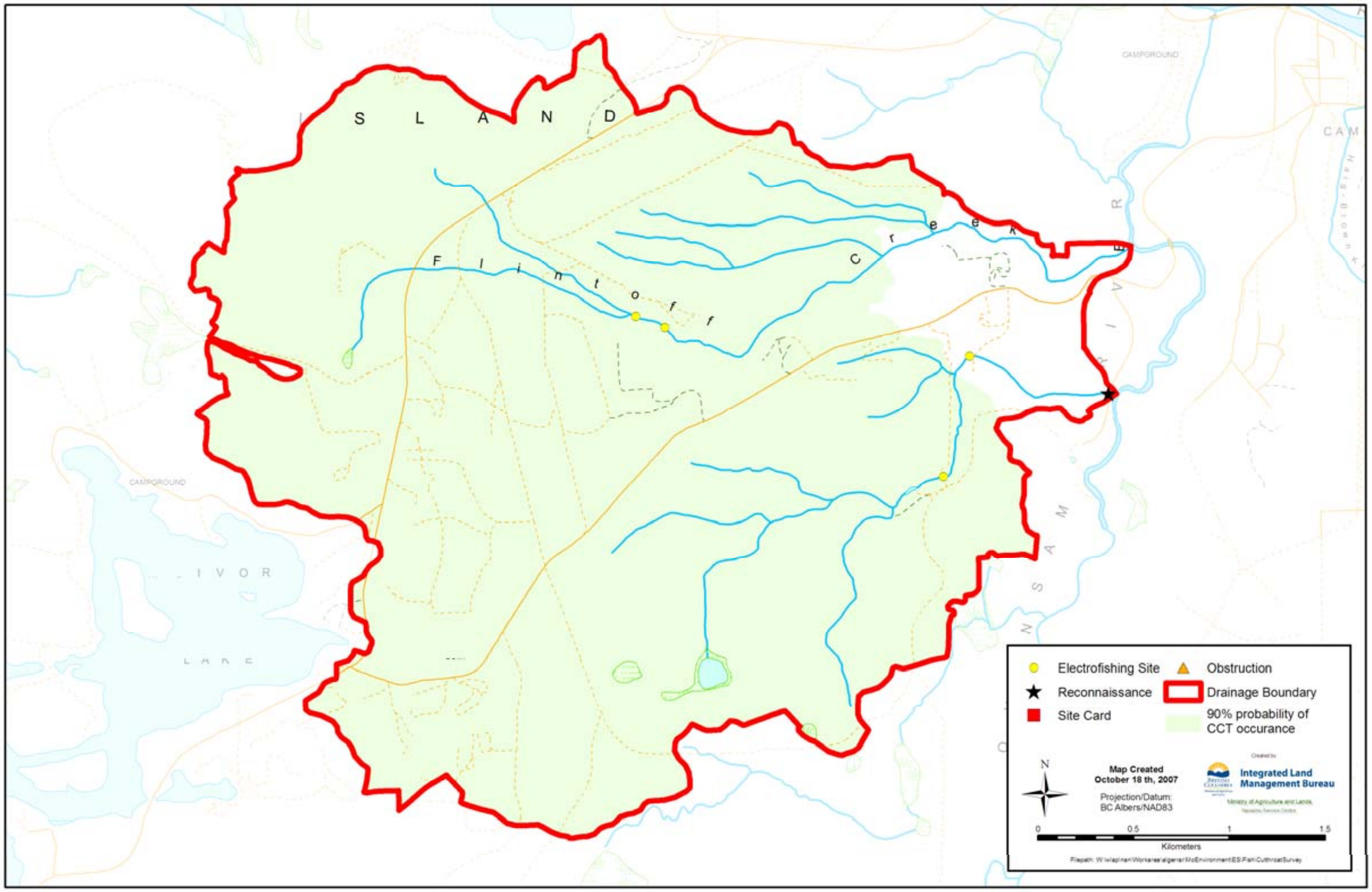
Anadromous Coastal Cutthroat Trout Assessment
Colquitz Creek



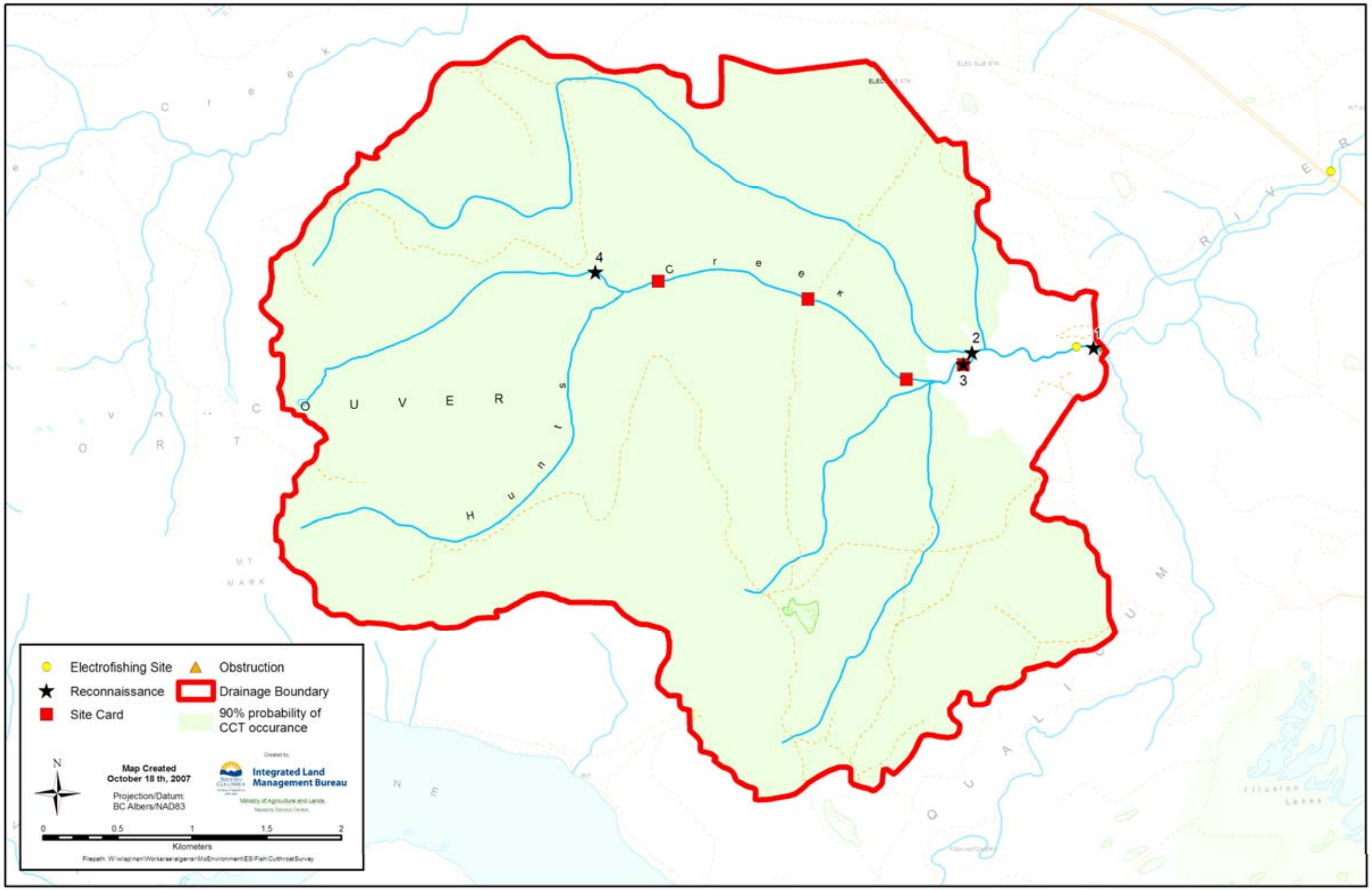
Anadromous Coastal Cutthroat Trout Assessment
Craigflower Creek



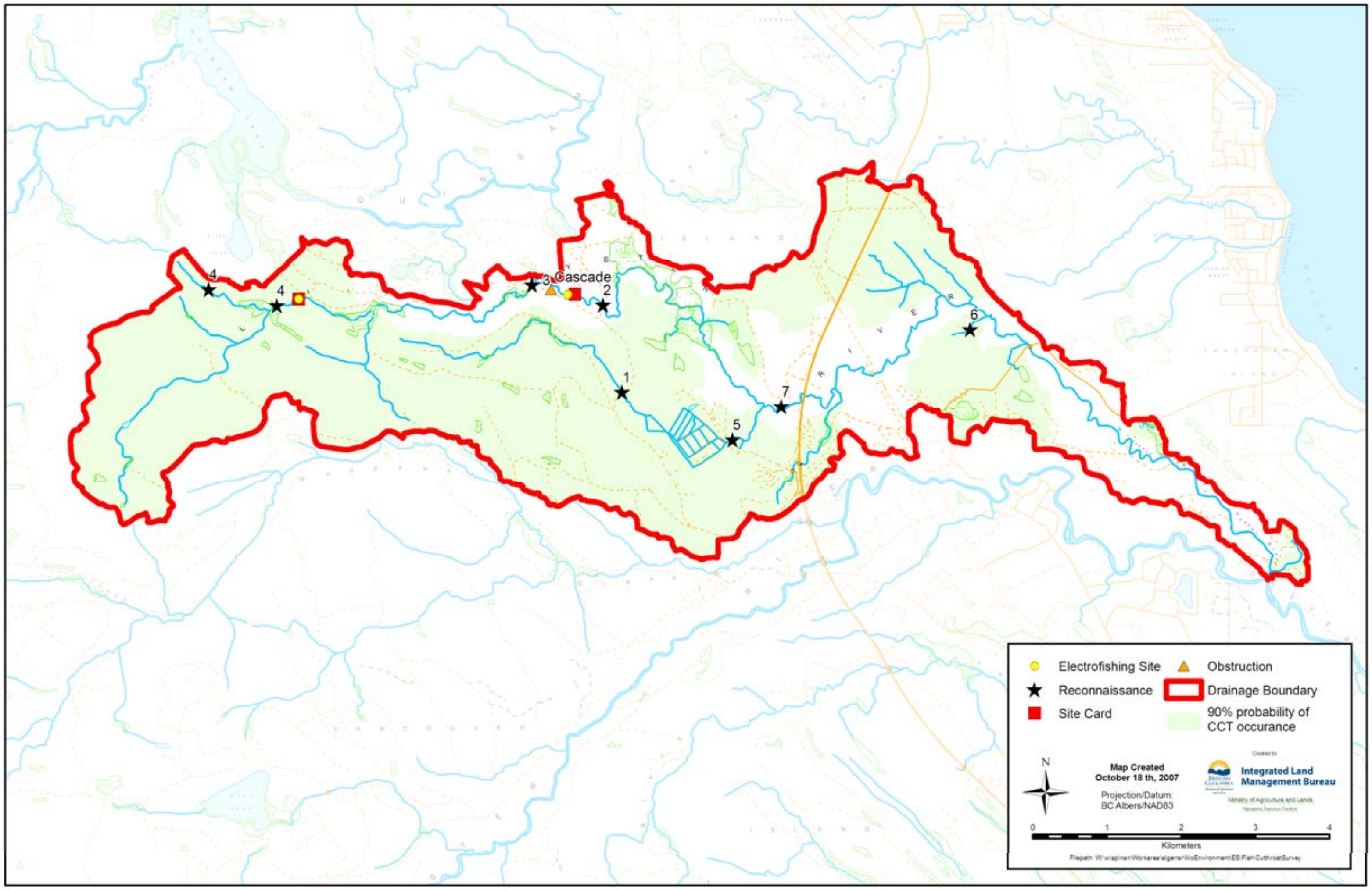
Anadromous Coastal Cutthroat Trout Assessment
Flintoff and Cold Creeks



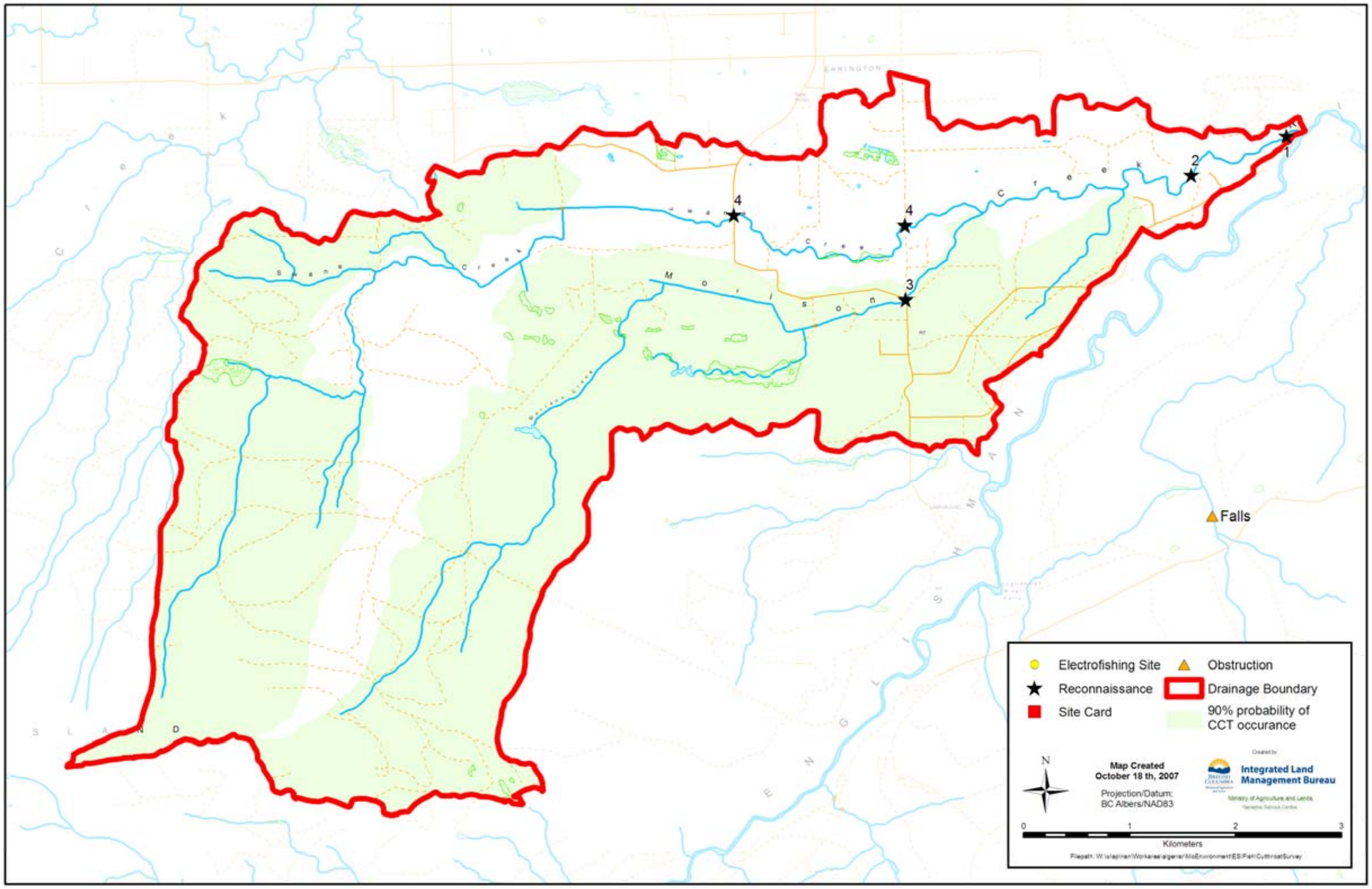
Anadromous Coastal Cutthroat Trout Assessment
Hunts Creek



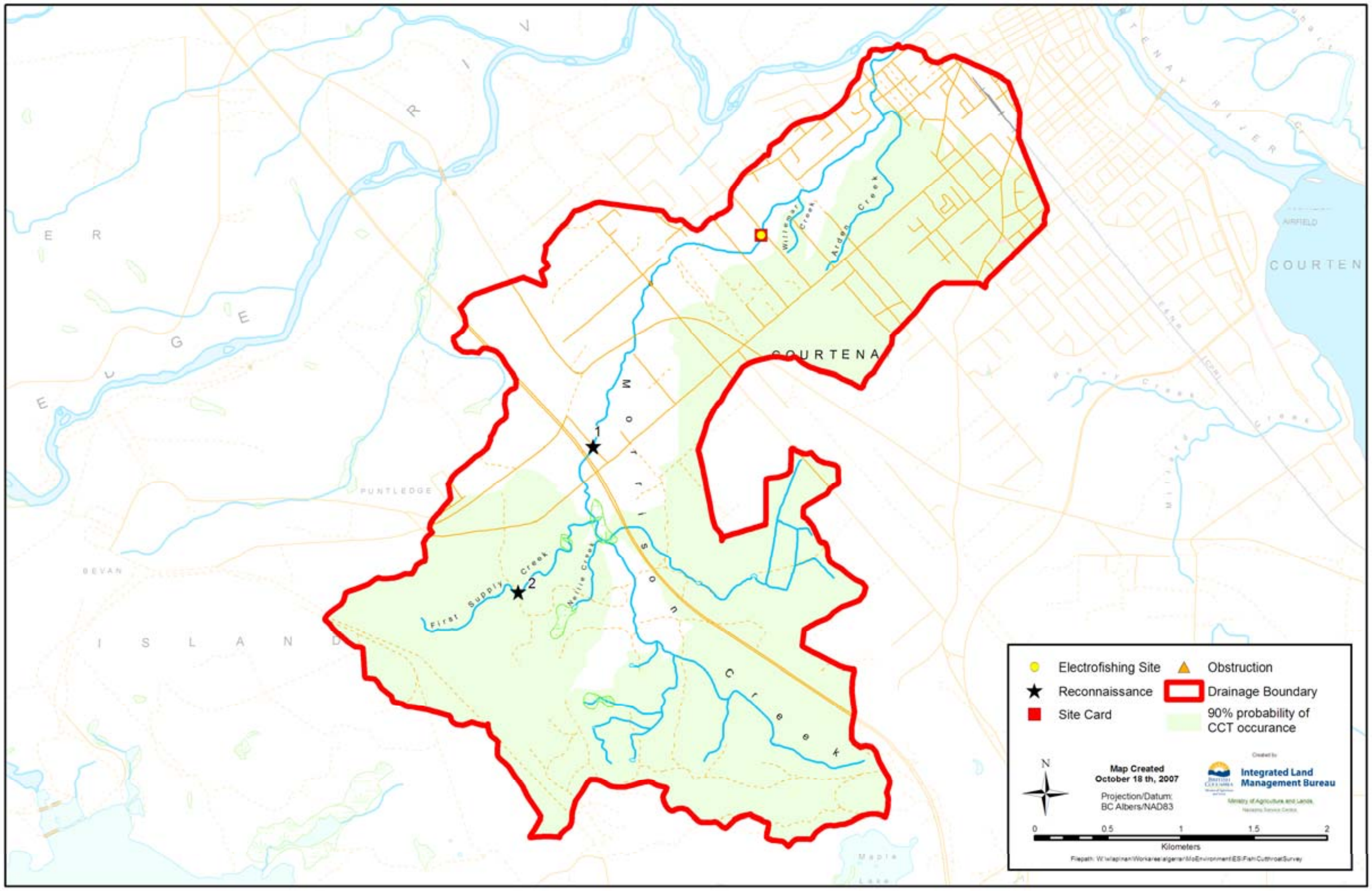
Anadromous Coastal Cutthroat Trout Assessment
Little Oyster River



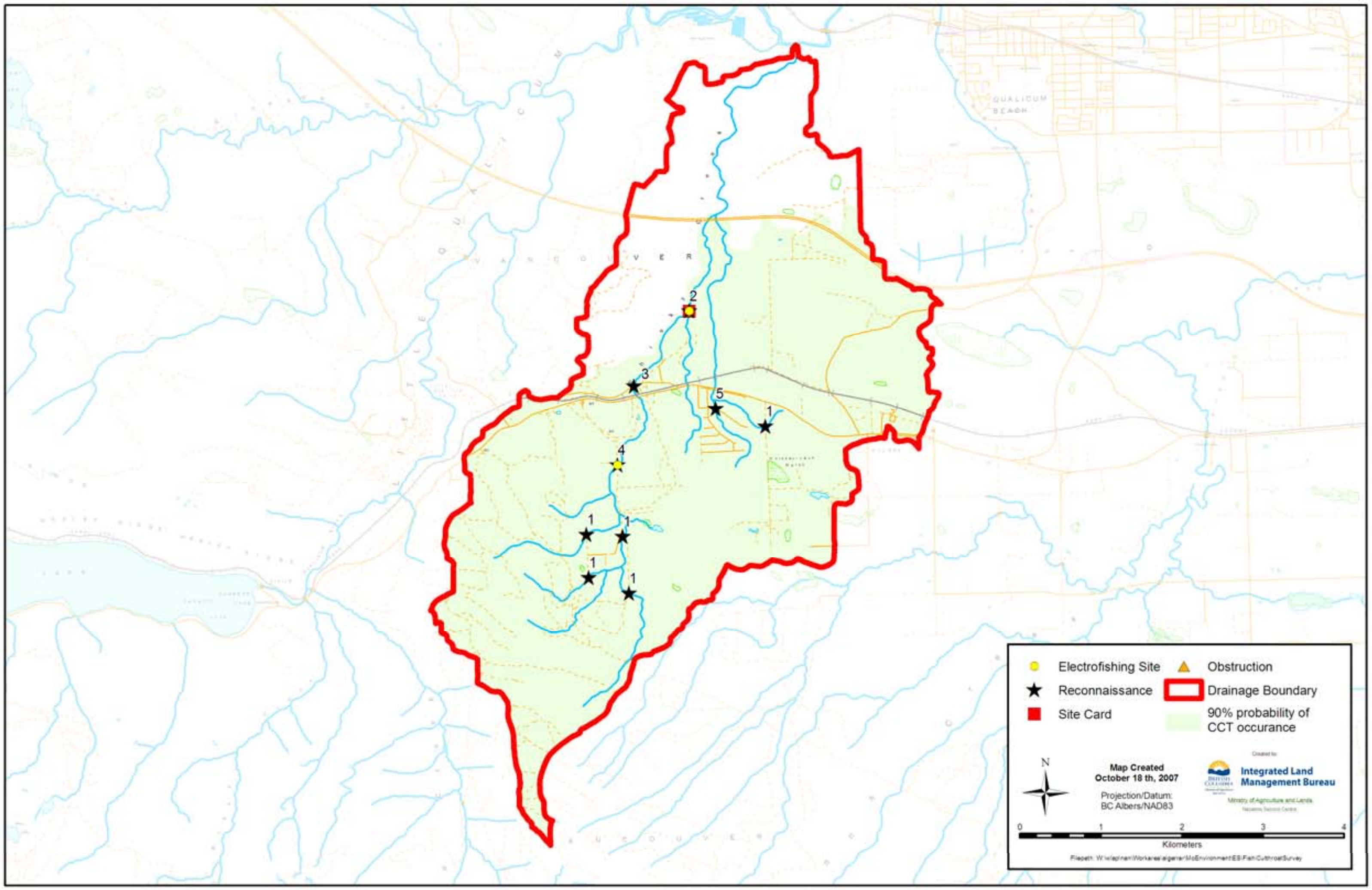
Anadromous Coastal Cutthroat Trout Assessment
Morison Creek



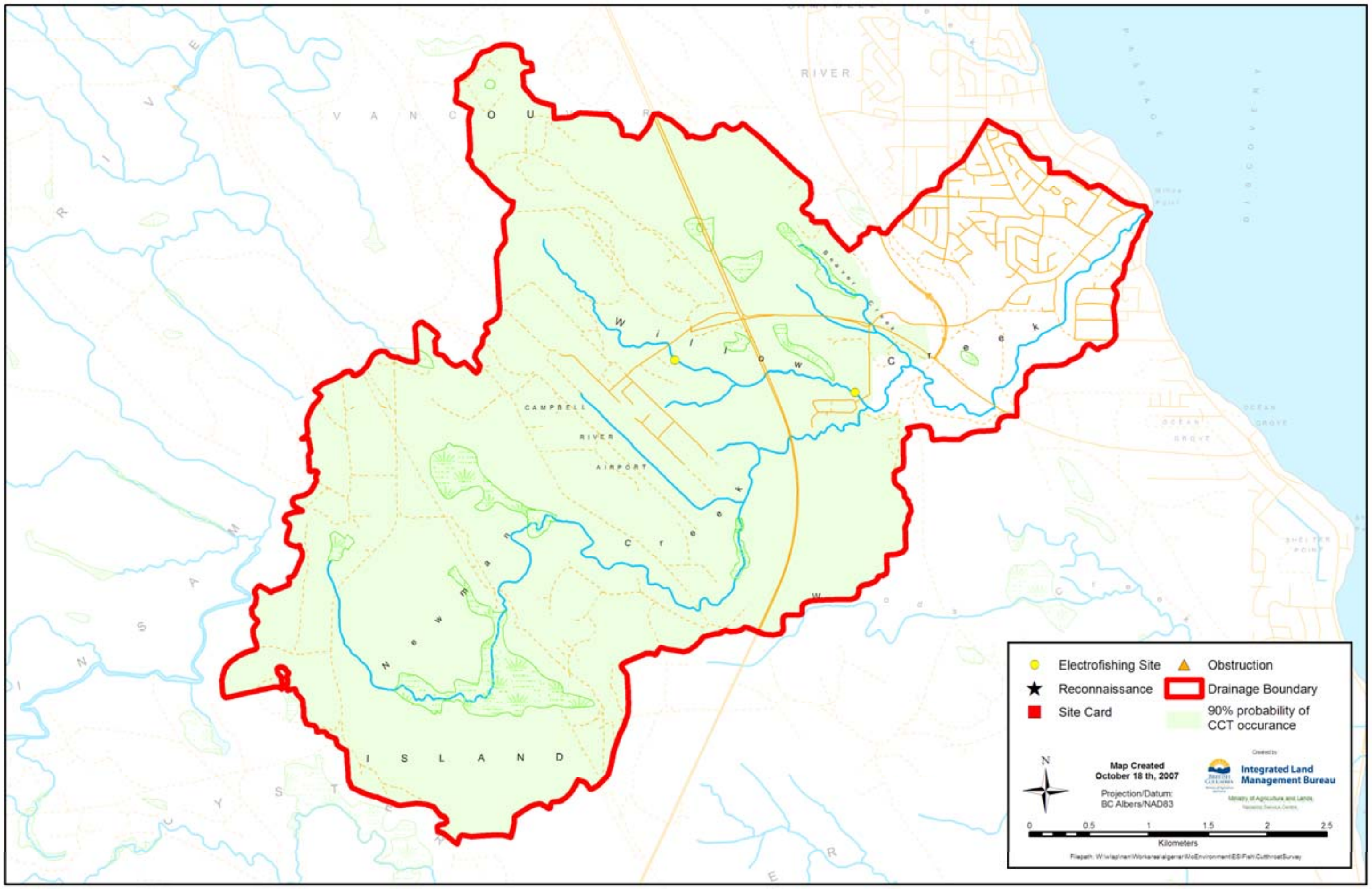
Anadromous Coastal Cutthroat Trout Assessment
Morrison Creek



Anadromous Coastal Cutthroat Trout Assessment
Whisky Creek



Anadromous Coastal Cutthroat Trout Assessment
Willow Creek



Appendix 3

SNORKEL SURVEY REPORT
Englishman River – Section 1

DATE:	August 22, 2007
WEATHER:	Sunny, 17°C
WATER TEMP:	15°C est.
DISCHARGE:	Est. 1.75 m^3/s (1.932 corrected flow)
VISIBILITY:	4-5m
PERSONNEL:	Tera Kasubuchi, Jenna Cragg
AREA:	Section 1 – Side Channel Intake to Grassy bank (3.7 km)

Fish Observed:

<u>Adults:</u>

A total of 38 cutthroat trout were observed.

38 Cutthroat trout (63% hatchery)
- 20 @ 15-25 cm (16 hatchery, 4 wild)
- 9 @ 25-35 cm (5 hatchery, 3 wild, 1 unknown)
- 8 @ 35-45 cm (3 hatchery, 4 wild, 1 unknown)
- 1 @ 45-55 cm (wild)

1 Rainbow trout
- 1 @ 35-45 cm (wild)

61 Pink salmon

<u>Juveniles:</u>
Coho and rainbow/cutthroat trout fry, steelhead parr were observed in large abundance throughout the swim. The ratio of hatchery cutthroat to juveniles was less than 30%.

Notes:

- No anglers observed, fishing line and lure with barbed hook found near Clay Bank
- Erosion at Clay Bank: large sediment chunks falling into river, decreasing visibility to 1-2 m for 500 m downstream
- Swim was ~ 3 h

SNORKEL SURVEY REPORT
Englishman River – Section 2

DATE:	August 24, 2007
WEATHER:	Sunny, 17°C
WATER TEMP:	15°C est.
DISCHARGE:	Est. 1.75 m^3/s (1.932 corrected flow)
VISIBILITY:	4-5m
PERSONNEL:	Tera Kasubuchi, Jenna Cragg
AREA:	Section 2 – Grassy bank to Big Tent Run (500 m downstream of Hwy 19A Bridge crossing). 4.7 km

Fish Observed:

Adults:

A total of 37 cutthroat trout were observed.

37 Cutthroat trout (49% hatchery)
- 23 @ 15-25 cm (16 hatchery, 5 wild, 2 unknown)
- 13 @ 25-35 cm (2 hatchery, 9 wild, 2 unknown)
- 1 @ 35-45 cm (wild)
- 0 @ 45-55cm

510 Pink salmon

Juveniles:

Coho and rainbow/cutthroat trout fry, steelhead parr were observed in large abundance throughout the swim. The ratio of hatchery cutthroat to juveniles was less than 30%.

Notes:
- 4 Anglers observed at pool under Hwy 19A bridge crossing; 2 lures with barbed hooks found snagged near this pool.
- Large schools of pink salmon observed at pool under Hwy 19A bridge crossing (~165), pool 400 m upstream of bridge (~30), and on left bank corner of Big Tent RV park 500 m downstream of bridge (~200).
- Swim was ~ 4 h.

SNORKEL SURVEY REPORT
Little Qualicum – Section 1

DATE:	August 22, 2007
WEATHER:	Sunny, 18°C
WATER TEMP:	15°C est.
DISCHARGE:	
VISIBILITY:	4-5m
PERSONNEL:	Trevor Andrews, Michelle Kehler
AREA:	Section 1 –Inland Island Hwy to Mid-Chum Channels (4.8 km)

Fish Observed:

<u>Adults:</u>

A total of 80 cutthroat trout were observed.

80 Cutthroat trout (84% hatchery)
- 20 @ 15-25 cm (15 hatchery, 5 wild)
- 47 @ 25-35 cm (42 hatchery, 5 wild)
- 12 @ 35-45 cm (10 hatchery, 2 wild)
- 1 @ 45-55 cm (hatchery)

9 Rainbow trout
- 5 @ 25-35 cm
- 1 @ 35-45 cm
- 3 @ 45-55 cm

2 German Brown Trout

SNORKEL SURVEY REPORT
Little Qualicum – Section 2

DATE:	August 22, 2007
WEATHER:	Sunny, 18°C
WATER TEMP:	15°C est.
DISCHARGE:	
VISIBILITY:	4-5m
PERSONNEL:	Mike McCulloch, Tony Massy (VITH)
AREA:	Section 2 – Mid-Chum channels to Hwy 19A bridge (3.9 km)

Fish Observed:

<u>Adults:</u>

A total of 133 cutthroat trout were observed.

133 Cutthroat trout (90% hatchery)
    100 @ 15-25 cm (94 hatchery, 6 wild)
    26 @ 25-35 cm (23 hatchery, 3 wild)
    5 @ 35-45 cm (2 hatchery, 3 wild)
    2 @ 45-55cm (1 hatchery, 1 wild)

986 Pink salmon
2 Chinook Jack
19 Chinook Adult

Notes:
- Moderate →High point density of ST parr, often sharing habitat with hatchery cutthroat trout (15-25 cm range).
- 2 Large groups of pink salmon observed. ~300 observed in Whiskey Creek confluence pool, ~250 observed near trestle.
- Some evidence of angling observed including 2 young anglers in lower river who reported catches of ?? on previous day.

SNORKEL SURVEY REPORT
Oyster River

DATE: August 28, 2007
WEATHER: AM-overcast, light rain PM-cloudy 18°C
WATER TEMP: ~15°C est
DISCHARGE (m^3/s): 3.5 @WSC (3.86 cms corrected flow)
VISIBILITY: 4-5m
PERSONNEL: Jenna Cragg/Tera Kasubuchi
AREA: Little Oyster Confluence to Pacific Playgrounds RV (~7.2 km)

Fish Observed

Adults:

A total of 127 Cutthroat trout were observed

127 Ct trout (23% hatchery)
- 39 @ 15-25cm (17 wild, 19 hatchery, 3 unknown-est 1 wild, 2 hatchery)
- 43 @ 25-35cm (38 wild, 5 hatchery)
- 40 @ 35-45cm (37 wild, 3 hatchery)
- 5 @ 45-55cm (all wild)

Pink Salmon – 1750 estimated

Chum – 1

Juveniles:
Very few juvenile fish observed during swim. Overall, fewer were observed in the upper section compared to the lower half of the survey. In the lower portion of the swim the ratio of adult hatchery cutthroat to juvenile fish was <30%, whereas the upper portion was >70%.

Notes

- 1 angler observed ~500m upstream of Hwy 19A bridge crossing-no fish had been caught. Two pink salmon carcass observed in-stream near bridge crossing.
- Snorkel survey was conducted on the same day the ORES hatchery program was taking brood stock from UBC pool. We observed 9 cutthroat trout (mainly small/medium sized) and 1 chinook in tank. Another 3-4 cutthroat were in the net. ORES staff advised us that they return all cutthroat trout to the mainstem.
- Swim was 5.5 hours

Appendix 4

Electrofishing data and photos