CHEAKAMUS RIVER CHAR RADIO TELEMETRY AND ENUMERATION PROGRAM

2007 ANNUAL REPORT

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CN Environment
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2007 Annual Report

Prepared

by

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Project Background

A number of juvenile and adult char were recorded as mortalities in the Cheakamus due to the August 2005 CN spill (McCubbing et al. 2006). The impact of this mortality on the size and distribution of the char population in the Cheakamus is currently unknown.

The number of adult char in the Cheakamus River from the confluence of the Cheekeye River to the anadromous boundary approximately 14 km upstream has been enumerated by snorkel survey since 1996. Counts are auxiliary data collected as part of a snorkel and radio telemetry program to estimate steelhead escapement for BC Hydro. An average, 9 swims have been conducted per year between February and May. The char counts provide information on the distribution of char over the 14 km survey area as well as relative abundance. The data are therefore potentially useful to evaluate the impact of the CN spill that occurred in August of 2005. Abundance and distribution of char from nine pre-spill years can be compared to similar data in 2006 and 2007-2009 to evaluate the extent of the spill impact. Future data collection from BC Hydro steelhead study after 2009 would allow for a continued assessment of recovery if any impact did occur, but is not included in this study plan.

Unlike the Cheakamus River steelhead escapement program, no radio telemetry information is available for char. This information is critical for determining the proportion of fish seen by divers and the survey life or residence time of fish in the survey area. These data are required to translate counts of fish across multiple surveys within a year into an annual population estimate. Variation in survey life, the number of days a fish spends in the survey area, or diver efficiency across years that is not accounted for in the estimation procedure can lead to spurious interannual trends in abundance. Differences in diver observer efficiency in the upper and lower portions of the river (Korman *et al*. 2005 and 2002) will influence the assessment about the distribution of different parts of the char population that may have been differentially impacted by the spill.

Introduction

After the August 2005 Canadian National Railway Company (CN) train derailment and subsequent spill of sodium hydroxide (NaOH) a number of juvenile and adult char (*Salvelinus* sp.) were recorded as mortalities in the Cheakamus River (McCubbing et al. 2006). In developing the Cheakamus Ecosystem Recovery Plan (CERP) (Triton 2006) existing snorkel survey information was identified. This data could potentially be utilized to measure the impacts of the spill on the size and distribution of the char population. InStream Fisheries Research Inc. (InStream) was contracted by CN to implement a three year radio telemetry and an expanded snorkel escapement survey to develop an observer efficiency index (Melville and McCubbing 2006). This report summarizes preliminary observations and results of the char enumeration monitoring program to September 1 2007. The interim results presented here give a snapshot view of the progress of this study to date and, as of this time, do not draw any conclusions as to assessment or impacts of the spill. Further data collected throughout 2007 and beyond will fulfill missing parameters in the enumeration model as well as to determine Cheakamus River char life history factors.

Study Area

The Cheakamus River watershed is a major tributary of the Squamish River and drains an area of 1010 km^2 (upstream of Brackendale gauging station) of the Coastal Mountain range in south-western BC. River flow is affected by BC Hydro through operation of Daisy Reservoir and the Cheakamus generating plant, a 155 MW storage and diversion project. The generation project, completed in 1957, consists of a 28m high, 680m long dam that impounds Daisy Reservoir. From this reservoir, a portion of the river flow is diverted through an 11-km long tunnel to a powerhouse on the Squamish River. The Cheakamus River, downstream of the reservoir, extends 26 km to its confluence with the Squamish River. The lower seventeen kilometers of this river are accessible to anadromous salmon as a number of natural barriers preclude further upstream migration.

The study area for the Cheakamus River Char Radio Telemetry and Enumeration Program can generally be separated into two areas: the snorkel survey area and the radio tracking area. The snorkel survey area encompasses the portion of the Cheakamus River between the confluence of the Cheekye River (river km 3) and the anadromous barrier (river km 16.5). The radio tracking area encompasses the Cheakamus River from the confluence with the Squamish River (river km 0) to the anadromous barrier. In addition opportunistic mobile tracking surveys were conducted in the Squamish River downstream of the Cheakamus River confluence (Fig. 1).

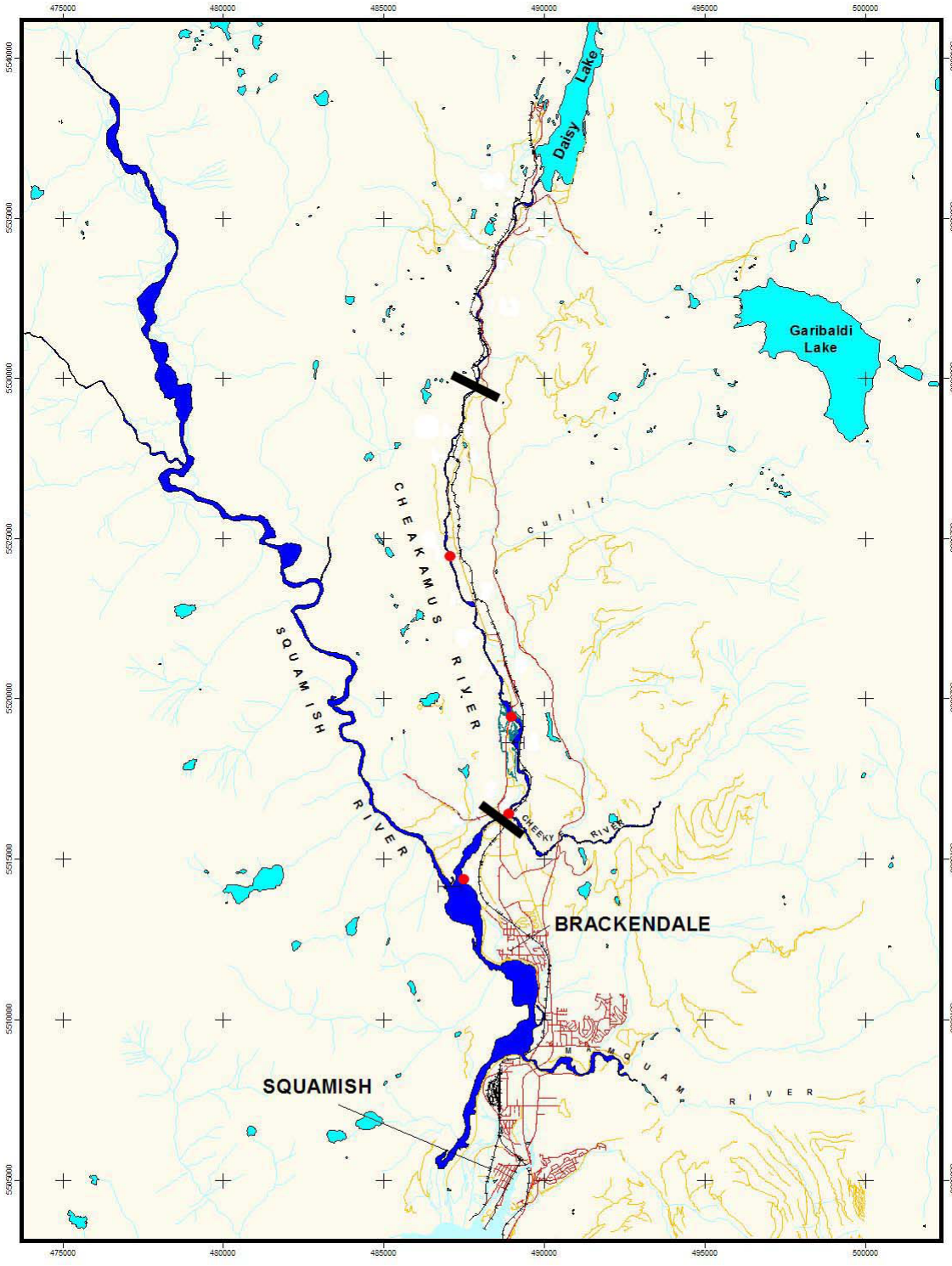

Figure 1. The Cheakamus River and major tributaries. Fixed telemetry stations are indicated by red dots and the snorkel survey area is bounded by black bars

Methods

River Data

Hourly water temperatures over the winter and spring in 2007 were recorded with an Onset Tidbit temperature logger placed at the North Vancouver Outdoor School (section 28). Mean daily discharge (Q) over the survey period was computed from the Water Survey of Canada (WSC) hourly discharge record for the Cheakamus River at Brackendale (WSC 08GA043, Section 27, Figure 1).

Radio Telemetry

Adult char were captured by angling in the Cheakamus River between January 15 and May 23, 2007. Captured fish were held in a fish tube for a short period of time to allow them to calm and then placed in an anesthetic solution. Char were anesthetized in a large tote using a clove oil solution. Fish length and weight were recorded, genetic and ageing samples obtained and a brightly colored external floy tag attached posterior to the dorsal fin prior to surgery. When the char had reached level 4 anesthesia (total loss of equilibrium and swimming motion, weak opercular motion) they were placed dorsally on a neoprene-lined, V-shaped surgical table. From this point until the completion of surgery, the head and gills were gently bathed in anesthetic solution.

A small (approx. 3cm) incision was made in the belly just off the mid-line and between the pectoral and pelvic girdles. A curved needle attached to the radio tag antenna was inserted through the incision posteriorly and exiting the body wall several centimeters from the incision. The antenna was then pulled through the body wall and the radio tag inserted into the body cavity. The incision was then closed with 2 surgical knots and the char placed in a fish tube located in slow moving water within the river. Char were not released until they exhibited orientation to the current and strong swimming movements.

Post –surgery observations and mobile tracking did not indicate any mortality occurring from surgical procedures. With the exception of one fish, which migrated out of the Cheakamus River after tagging, tagged char generally remained in close proximity to their point of capture and release after tagging

Snorkel Surveys

Eighteen snorkel surveys were conducted between January 29 and May 23, 2007. On each survey, a team of three divers floated the 13.5 km survey area from river km 16.5 to km 3.0 in 4-6 hours. The survey area was previously divided into 34 sections averaging 380 m in length (Korman et al. 2004) The number of tagged and untagged char observed in each section by survey was recorded. A technician in a small raft floated 50-100 m behind the swim crew and determined the location and number of tagged char in each river section using a Lotek SRX 400 version 4.01/W5 mobile receiver outfitted with a 3-element Yagi antenna (model F-3FB).

Procedures during each snorkel survey followed those outlined in Korman *et al.* (2005) for adult steelhead enumeration. Horizontal visibility (HV) was estimated by measuring the maximum distance from which a diver could detect a dark object held underwater at 1 m depth. Horizontal visibility was measured in sections 4 and 21 to index conditions in the upper and lower survey areas, respectively.

Adult Enumeration

Char abundance in the Cheakamus River in 2007 was calculated using a model similar to that used for steelhead escapement (Korman et al. 2007). Briefly, the escapement model consists of three main elements. A simple process model predicts the number of fish present on each day of the run and the departure schedule based on the total escapement and parametric relationships simulating arrival timing and survey life. An observation

model simulates the number of marked and unmarked fish observed on each survey based on the number of tags known to be in the survey area, and predictions of the number of unmarked fish that are present and catchability (proportion of fish observed). Process and observation model parameters are estimated by maximizing the value of likelihood function that integrates data on the number of marked and unmarked fish observed on each survey, and survey life and departure schedules measured by radio telemetry.

Observer efficiencies for char were estimated using the same qP-HV/Q function (where, qP_i is the physically based prediction of catchability, HV/Q is the ratio of horizontal visibility to discharge) whose parameters were fitted to the char mark-recapture data collected in 2007. Char counts were also expanded using the survey specific efficiency estimates obtained in 2007. Details of the model are presented in Korman and McCubbing (2007).

Results

River Data

Discharge over the majority of the survey period, which occurs during winter and spring, was for the most part low and steady (Fig. 2). Discharge over this period since the Water Use Plan WUP-determined flow regime has been in place (2006 and 2007) was generally lower and considerably steadier than in previous years. Water Use Planning is a process involving BC Hydro and participating stakeholders to explore ways to find a better balance among water use interests, such as fisheries, wildlife, recreation, the environment, heritage conservation, flood control, and the need to generate power. Water temperature increased steadily between mid-February and mid-May when the majority of snorkel surveys were conducted. The temperature regime under the new flow schedule was very similar to previous years (Fig. 2).

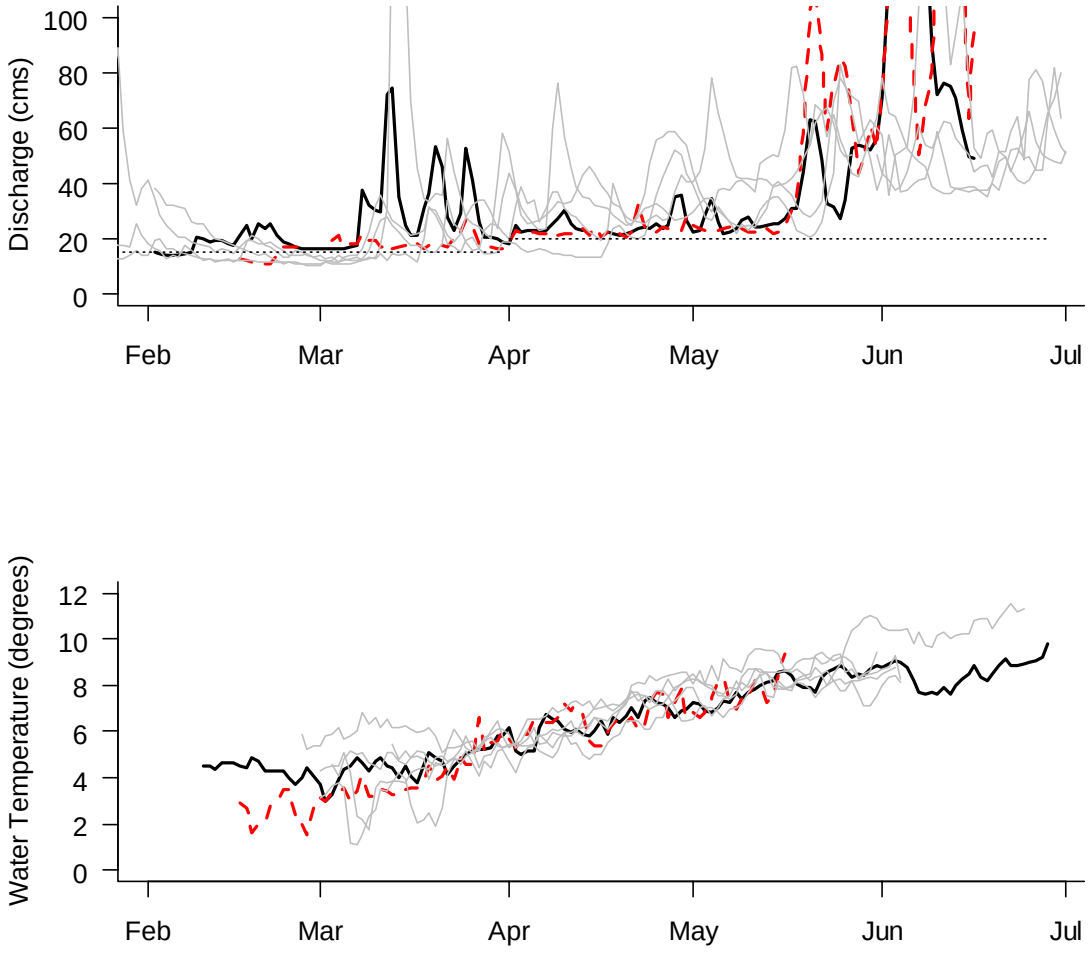

Figure 2. Discharge (top, Brackendale gauge) and water temperature (bottom, North Vancouver Outdoor School) in the Cheakamus River in 2007 (thick black line), 2006 (dashed red line), and in previous years (gray lines, 2001, 2003-2005 for discharge, 2001-2005 for water temperature). The minimum flow requirement up to March 31 (15 cms) and after this date (20 cms) are shown by the dashed horizontal line in the top graph.

Radio Telemetry

A total of 40 radio tags were implanted in char in the Cheakamus River between 15 January and 23 May, 2007. Radio-tagged char averaged 563 mm in length (range = 420 – 710 mm) and had a mean weight of 1.9 kg (range = 0.8 – 3.2 kg).

As of September 1, 2007, a total of 32 of the 40 (80%) of the radio-tagged char were confirmed to have left the Cheakamus River and moved into the Squamish River. The average post-surgery residence time for char in the Cheakamus River was 64 days (range = 1 – 151 days). Mobile tracking surveys downstream of the Squamish River confluence suggest most of these fish entered Howe Sound although some individuals were identified holding in the Lower Squamish River.

The sex of individual char was determined by examination of external marking, coloration and body shape. Out of a total of 37 fish in which a sexual determination was made, 21 appeared to be males suggesting a sex ratio of 1.3:1 male:female.

Adult Enumeration/Snorkel Survey

Char counts fluctuated around an average of 110 tagged and untagged fish observed per survey (Fig. 3). The minimum count was 20 char and the maximum 180 (Table 1).

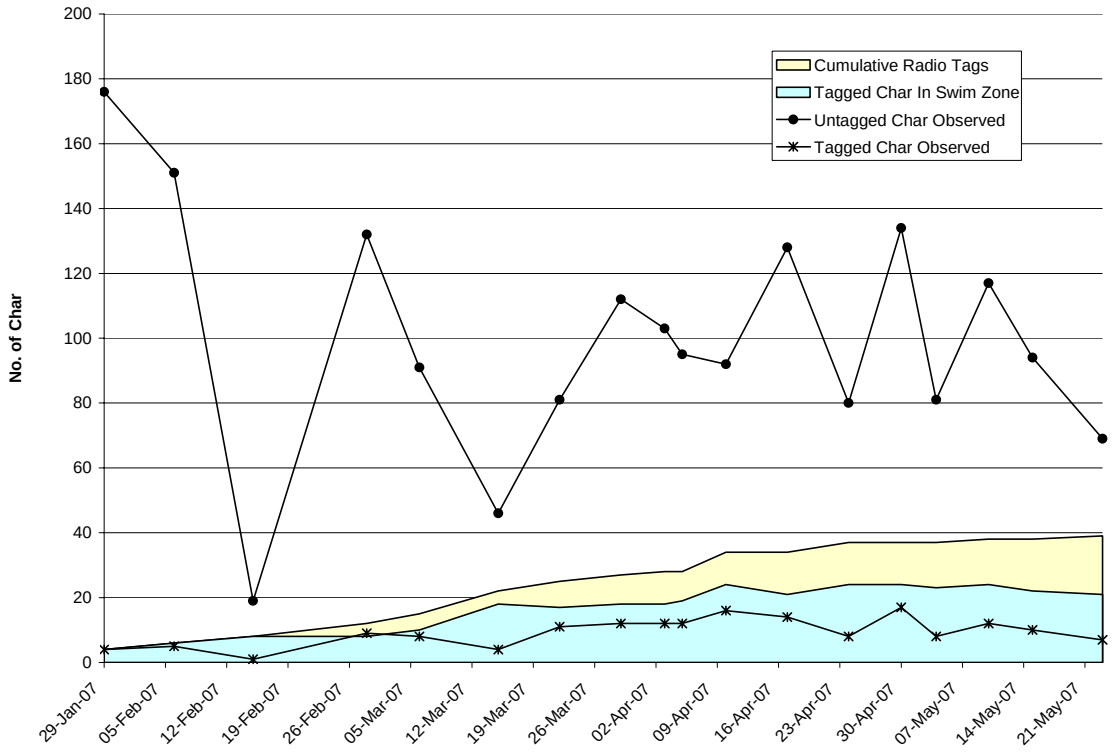

Figure 3. Counts of char encountered during snorkel surveys in the Cheakamus River in 2007. Area lines indicate cumulative radio tags placed in entire river (yellow) and number of radio tagged char remaining within survey swim zone (blue).

Table 1. Counts of total tagged and untagged char in the Cheakamus River survey area in 2007. Cumulative radio tags placed in the entire river and numbers of tagged char remaining in the survey reach are listed.

Survey	Char		Total tags	Tags remaining
Date	untagged	tagged	applied	in survey area
29-Jan-07	176	4	4	4
6-Feb-07	151	5	6	6
15-Feb	19	1	8	8
28-Feb	132	9	12	8
6-Mar	91	8	15	10
15-Mar	46	4	22	18
22-Mar	81	11	25	17
18-Jan	112	12	27	18
3-Apr	103	12	28	18
5-Apr	95	12	28	19
10-Apr	92	16	34	24
17-Apr	128	14	34	21
24-Apr	80	8	37	24
30-Apr	134	17	37	24
4-May	81	8	37	23
10-May	117	12	38	24
15-May	94	10	38	22
23-May	69	7	39	21

Observer efficiency for char, as determined by the best-fit qP-HV/Q relationship, or the ratio of tags observed to tags present (Korman and McCubbing 2007), was 0.61.

Expanded char counts increased modestly over the survey period as most char were already in the survey area before the first survey (Figure 4). Estimated char abundance reached a plateau of approximately 225 fish by mid-April. Expanded char counts based on the best-fit qP-HV/Q relationship, or the survey-specific ratio of tags observed to tags present, were similar.

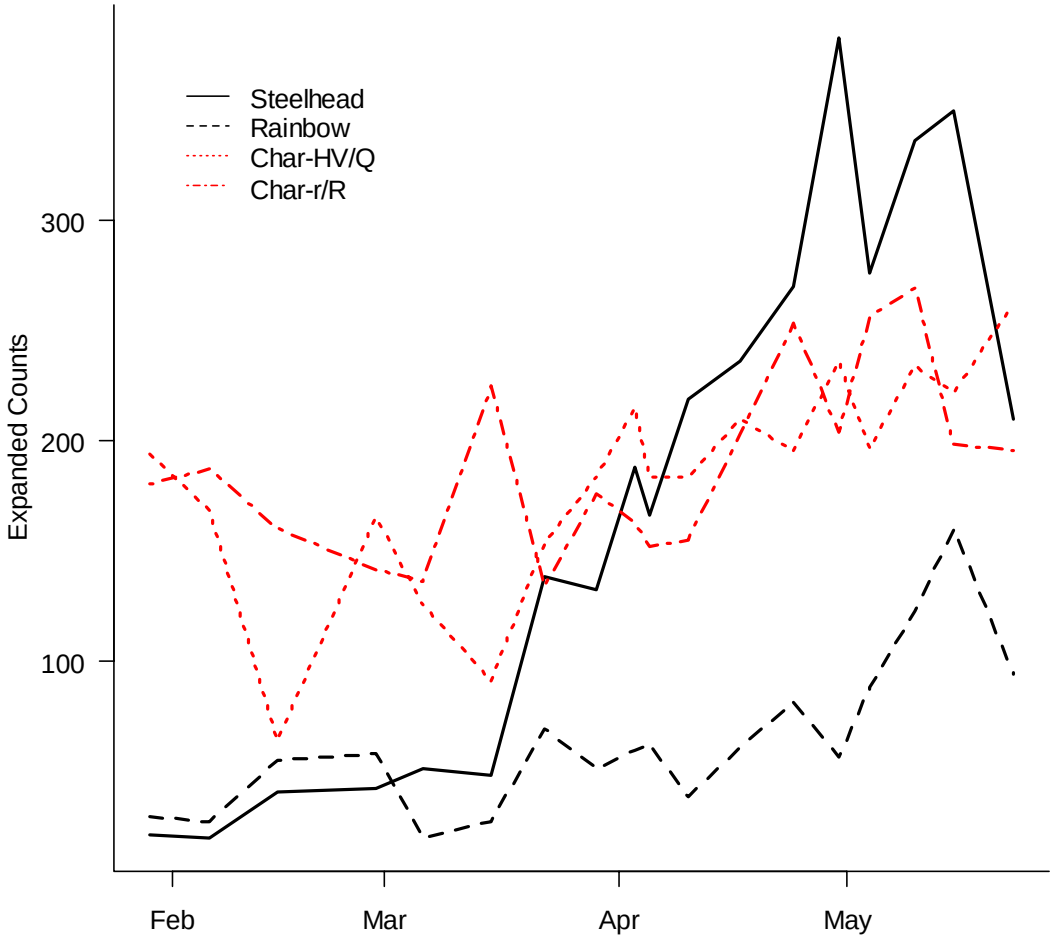

Figure 4. Expanded counts of steelhead, rainbow trout, and char in the Cheakamus River in 2007. Steelhead and rainbow counts were expanded based on the relationship between observer efficiency and the ratio of horizontal visibility to discharge (HV/Q, Korman et al. 2007). Char counts were expanded based on a preliminary relationship between observer efficiency and HV/Q (Korman et al., in prep.) or the survey-specific observer efficiency estimates (r/R).

Summary & Recommendations

The objectives of the first year of this study to identify impacts and recovery of char in the Cheakamus River were achieved. In the first 5 months of 2007 a total of 40 char were captured, radio tagged and released at sites throughout the river. Radio tag numbers released into the upper portions of the river were low increased effort in this area may be beneficial in Year Two. Swim data indicate, however, that relative char numbers are low in the upper river and tags will continue to be distributed in proportion to the observed numbers. Tagging locations in the next two years will take in to account these distributions as well as the locations of returning radio tagged char (from 2007) to the Cheakamus River.

Fixed receiver stations were installed in the upper river, the middle river, at the bottom of the snorkel survey area and at the confluence of the Squamish River. These stations continue to operate and provide information on fish location, and identify entry and exit timing of each fish into the Cheakamus River and the swim zone.

Preliminary findings suggest that the primary life history strategy for the majority of char radio tagged in the Cheakamus River involves an out of basin migration. Whether these fish are anadromous, fluvial or some combination of the two remains unclear although future data may clarify some of these uncertainties. Given the fact a small number of radio tagged char have remained in the Cheakamus River there also appears to be a resident component of the population although behavior may vary between years.

Observations during snorkel surveys indicate sufficient numbers of char were encountered early in the year, based on swim data, to apply the proposed number of radio tags. However, capture of those fish was difficult because of low water temperatures (<4ºC), which limit feeding behavior Future data from fixed receiver stations in the fall and winter of 2007/2008 and 2008/2009 will give a clearer indication of entry timing of

migrants in year two and three of the study, in part negating the requirement for tagging a large number of early migrants.

In future years, as in 2007, the information collected will be modeled to provide an annual escapement estimate based on visual abundance and observer efficiency (Korman et al 2005). Following three years of data collection the combined information will be utilized to reconstruct historic abundance estimates for the river, the distribution of abundance in upper and lower river sections, and to assess pre and post spill variations.

References

Korman, J., Ahrens, R.N.M., Higgins, P.S., and Walters, C.J. 2002. Effects of observer efficiency, arrival timing, and survey life on estimates of escapement for steelhead trout (Oncorhynchus mykiss) derived from repeat mark-recapture experiments. Can. J. Fish. Aquat. Sci. 59: 1116-1131.

Korman, J., P. Higgins, and C. Melville. 2005. Incorporating the effects of migratory behaviour and river conditions into estimates of steelhead escapement, BC Hydro Power Authority and BC Habitat Conservation Trust Fund. 56p.

Korman, J. and D. McCubbing. 2007. DRAFT 2007 Steelhead Escapement to the Cheakamus River. Report prepared for B.C. Hydro Power Authority.

Korman, J., C. C. Melville and P. S. Higgins. 2007. Integrating multiple sources of data on migratory timing and catchability to estimate escapement for steelhead trout (*Oncorhynchus mykiss*). Can. J. Fish. Aquat. Sci. 64: 1101-1115.

McCubbing, D.J.F., C.C. Melville, G. Wilson and M. Foy. 2006. Assessment of the CN sodium hydroxide spill August 5th, 2005 on the fish populations of the Cheakamus River. Report for Ministry of Environment and Cheakamus Ecological Recovery Technical Committee. 131p.

Melville C. and McCubbing D. November 2006. Use of radio telemetry to calibrate observer efficiency and monitor recovery of Cheakamus River char (*Salvelinus* sp.) using pre and post spill snorkel surveys, FINAL DRAFT. Prepared for Canadian National Railway

Triton Environmental Consultants, Ltd. 2006. Cheakamus Ecosystem Recovery Plan, 2006. Final Report, November 2006. Prepared for Canadian National Railway Company, in Cooperation with Cheakamus Ecosystem Restoration Technical Committee.

Appendix 1

Radio Tag Code	Date Tagged	Floy #	Length (cm)	Weight (g)	Sex	Capture Location	Date OUT	Residence (days)
21	15-Jan	11	46	1350	F	NVOS Pool		
22	15-Jan	12	46	1050	M	NVOS Pool		
23	17-Jan	13	45	1200	F	NVOS Pool	28-Mar	70
24	24-Jan	14	51	1400		NVOS Pool		
25	30-Jan	15	50	1500	M	NVOS Pool	26-May	116
30	3-Feb	20	51	1500	M	Gauge Pool	16-May	102
26	6-Feb	16	54	1750		Gauge Pool	7-Jul	151
29	12-Feb	19	59	2100		Smokehouse		
27	19-Feb	17		2300	M	Smokehouse	12-Jun	113
20	22-Feb	10	65		M	2nd Powerline	14-May	81
16	22-Feb	6	58		F	2nd Powerline	16-May	83
28	27-Feb	18	51	1800	F	1st Powerline	5-Jul	128
19	1-Mar	9	64	3200	M	2nd Powerline	16-Apr	46
18	1-Mar	8	63	2700	F	NVOS Pool	17-Apr	47
17	1-Mar	7	47	1300	M	Gauge Pool	23-Jun	114
14	7-Mar	4	62	2700	M	NVOS Pool		
13	7-Mar	3	59	2200	F	NVOS Pool	15-Jun	100
15	7-Mar	5	70		M	NVOS Pool	21-Jun	106
12	7-Mar	2	51	1800	F	NVOS Pool		
11	8-Mar	1	54	1300	F	Gauge Pool	11-Mar	3
40	8-Mar	30	54	1800	M	Gauge Pool	27-Jun	111
39	10-Mar	29	52	2000	F	Gauge Pool	11-Mar	1
37	15-Mar	27	52	1500	F	Frog Pond	25-May	71
38	15-Mar	28	71		M	Frog Pond	24-Apr	40
31	19-Mar	21	49	1500	F	Big Rock	1-Aug	135
32	27-Mar	22	60	2600	M	2nd Powerline	12-May	46
33	27-Mar	23	57		M	Moodys	19-May	53
34	29-Mar	24	49	1700	M	2nd Powerline	17-Apr	19
35	5-Apr	25	42	800	F	Elkins Rd		
36	7-Apr	26	56	1700	F	Wood Pool	21-Jun	75
46	7-Apr	36	64	2200	M	Wood Pool	17-Apr	10
44	7-Apr	34	61	3000	M	Moodys	3-May	26
41	7-Apr	31	65		F	Moodys	21-May	44
42	7-Apr	32	56	2600	F	Moodys	17-Apr	10
43	20-Apr	33	61	2700	M	Moody's	11-Jun	52
45	20-Apr	35	65		M	Moody's	13-Jun	54
47	20-Apr	37	57	1850	M	Moody's	21-May	31
48	9-May	38	58	2000	F	Moodys		
49	18-May	39	59	2100	M	Bailey Br	25-May	8
50	23-May	40	60	2700	M	RST	30-May	8