Duncan Dam Water Use Plan

Upper Duncan Bull Trout Migration Monitoring

Reference: DDMMON-#5

Year 3 Data Report - Final

Study Period: August 2012 – May 2013

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REPORT

July 2, 2013

BC HYDRO DDMMON #5
YEAR 1 ANNUAL DATA SUMMARY

Upper Duncan River Bull Trout Migration Monitoring Program

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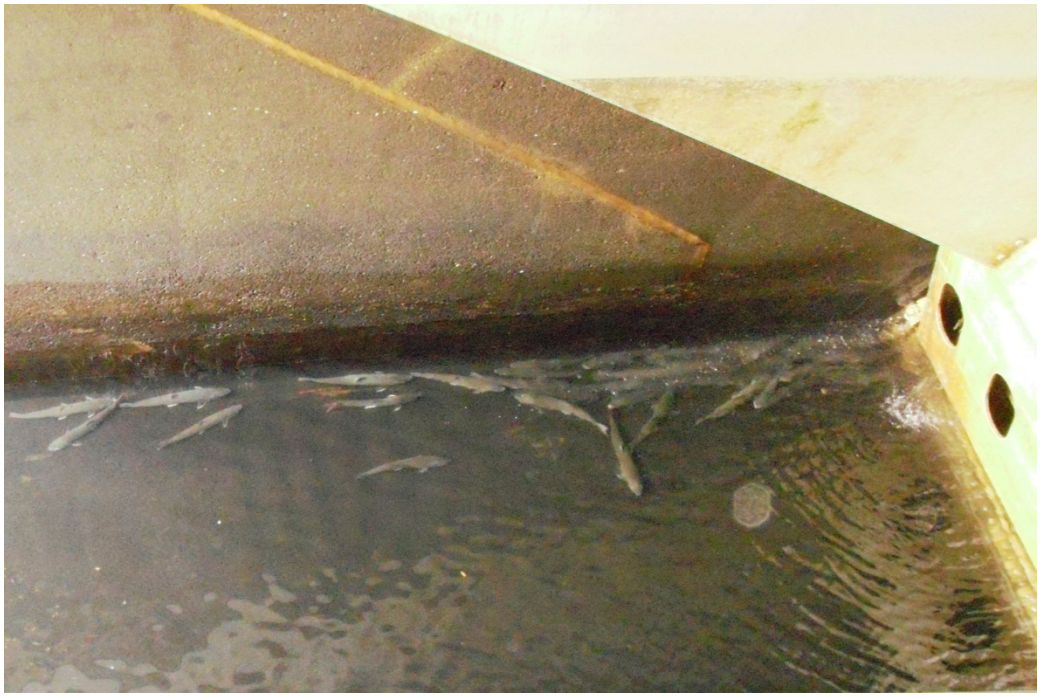

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1.0 INTRODUCTION

BC Hydro recognizes the importance of managing impacts of its dams and reservoirs on fish populations in flow regulated watersheds to ensure that operations are both environmentally and economically sustainable. Duncan Dam (DDM) is unique as it is one of four of BC Hydro's projects that operate an upstream migration facility (A. Leake, BC Hydro, June, 2013 Pers. Comm.). This migration facility focuses on the transfer of Bull Trout (*Salvelinus confluentus*) from the lower Duncan River to the Duncan Reservoir. There is a significant amount of effort and resources expended during the migration period to facilitate each Bull Trout transfer. Furthermore there is an increased spill risk while limiting the low level outlet gate operations and an increased risk of dewatering the tailrace canal during the transfers. In recognition of these issues, the Duncan Dam Water Use Planning (DDM WUP) Consultative Committee (CC) initiated two programs to assess the effects of DDM on the local Bull Trout populations (Upper Duncan River Bull Trout Migration Monitoring (DDMMON-5), and Duncan Dam Bull Trout Passage Monitoring (DDMMON-6). This study (DDMMON-5) is in its third year of a 10 year investigation of Bull Trout Migration by use of Bull Trout otolith micro-chemistry to determine the rearing location of Bull Trout in the Kootenay Lake system. These methods are to understand the importance of the DDM Bull Trout transfers to the overall Bull Trout production in Kootenay Lake.

2.0 BACKGROUND

The main original objective of the ten year study is to determine whether the Bull Trout transfer program facilitates the recruitment of Bull Trout populations above and/or below DDM (BC Hydro 2008). The specific objectives that have been outlined in the RFP terms of reference are to:

1. estimate the proportion of Bull Trout entering the Duncan Reservoir that originate from the Duncan Reservoir system;
2. document the life histories of Bull Trout sampled from the Kootenay and Duncan systems; and,
3. identify differences in life histories between systems that may be associated with migration between systems.

In addition to the specific original RFP objectives, we have also proposed to:

4. quantify the seasonal, inter-annual and spatial variation in selected stream chemistries;
5. determine the association of otolith and fin ray chemistries of juvenile Bull Trout with those of their natal streams;
6. quantify the variation within and compare the results between otoliths and fin rays; and,
7. evaluate the potential application of otolith/fin ray chemistry for describing Bull Trout movements throughout the Duncan River/Kootenay Lake basin.

These objectives have been identified to address the overall management question in the RFP terms of reference:

"Does the Bull Trout transfer program contribute to the recruitment of Kootenay Lake or Duncan Reservoir?"

This management question will be answered by addressing the following questions:

- *"What are the origins of Bull Trout individuals sampled in Duncan reservoir and Kootenay Lake watersheds?"*
- *"Do the distribution and analyzed life histories of the sampled fish denote a bottleneck to recruitment ay Duncan Dam?"*

Once these questions have been answered, the final management question can be investigated:

"What changes to the Bull Trout transfer program are recommended to improve Bull Trout in the Duncan Reservoir and Kootenay Reservoir?"

The program has been designed to test two hypotheses. These hypotheses have been proposed to test the validity of analytical methodology used in this study to facilitate answering the previously defined management questions. In addition, the second hypothesis was proposed to determine whether recruitment is disproportionate between systems, as the program is not designed to identify all of the contributing factors related to Bull Trout recruitment variability in the Kootenay and Duncan systems (BC Hydro 2008). The hypotheses in the RFP terms of reference are as follows:

H01: "Stream chemistry is not sufficiently different between tributaries of the Kootenay and Duncan watersheds to determine the natal origins of Bull Trout sampled in the area."

H02: "The proportion of natal to non-natal Bull Trout is not statistically different between the Kootenay and Duncan watersheds."

We have interpreted these null hypotheses with the following clarifications:

H01: As the Kootenay watershed, includes the Duncan watershed, we define for purposes of this study, the Kootenay watershed as all adfluvial Bull Trout spawning and rearing areas except those above Duncan Dam. In addition to stream chemistries, the water chemistry and otolith microchemistry associated with Duncan Reservoir is of equal importance in determining watershed of origin of Bull Trout that have natal areas above Duncan Dam.

H02: We are interpreting this as follows: "The proportion of Bull Trout that spawn above Duncan Dam has the same proportion of Bull Trout that originated from above Duncan Dam to those that have natal areas from other areas, as compared with Bull Trout spawners that are found in other tributaries below Duncan Dam throughout the remainder of the Kootenay watershed." To falsify this hypothesis, we will need to find statistical differences between: 1) spawning fish that are in their natal area as a ratio with those that are spawning in non-natal areas that are moving through or that are above Duncan Dam, compared with 2) the spawning populations using natal areas as a ratio with those using non-natal areas that are found spawning in other tributaries below Duncan Dam.

These hypotheses will be addressed using the results from years 1 and 2 with the current year 3 field program and planned 2013-2014 field program and associated data analysis. The third year of the investigations is reported in this document.

During fall 2012 a detailed literature and study plan was provided to BC Hydro to outline the most effectual plan to answer these management questions, hypothesis and objectives for DDMMON #5 (Golder & ONA 2012),

given the data collected during the first two years of the study. The study plan took into consideration the late start of the field data collection and the problems associated with the high water runoff during summer 2012 (primarily access restrictions). These issues were addressed by postponing the majority of the field data collection until summer/fall 2013, which in turn postponed the majority of the laboratory analysis work. This data report summarizes the data collection efforts and analysis that were conducted from August 2012 to April 2013. The detailed examination of the hypothesis and management questions will be conducted in the 2013-2014 report.

3.0 SAMPLING CONDUCTED

3.1 Adult Bull Trout Otolith Collection

3.1.1 Duncan Dam Transfer Station Sampling

To meet the monitoring requirements, the initial study methodology recommended that a total of 30 otoliths be collected from Bull Trout migrating through the dam over the migration window. A collection schedule (the number or proportion of fish to be collected during each transfer and the time period of each of the transfer events that were to be sampled) was designed to ensure adequate representation across the migration window, coincidental with the transfer schedule provided by BC Hydro. Ideally, samples would be proportionate to abundance being transferred at any time period. Because of the maximum limit of 30 fish based on collection permits, and because there is no way of knowing what the total number transferred in any given year, it is not possible to obtain an exact sampling regime program beforehand. To approximate this ideal, an estimate of the total number of Bull Trout likely to be present during each transfer was established prior to sampling, based on previous years data. To minimize the potential impacts on different parts of the Bull Trout migration period, no more than 10% of the fish could be sacrificed from an individual transfer. Staff randomly selected the fish, attempting to distinguish gender externally with a preference for sacrificing males at the request of Ministry of Environment. Because gender cannot be positively identified in the field using external characteristics, it was not possible to sample only male fish. The fish collected had meristic data recorded (weight, fork length, gender and other information as requested) and the heads were collected. Each head was labeled, stored in a plastic bag in a cooler and then frozen until the otoliths were removed. Otolith removals were conducted subsequently in the laboratory.

High water runoff (which effected site access) and contract delays shortened the field season considerably during the third year (2012) of this study and the majority of the sample collection (all of the juvenile Bull Trout collection and water sampling) was deferred to the fourth year (2013). The 2012 Transfer Station adult Bull Trout collection was also compressed into a shorter period (5 transfers at the end of August and the first half of September). In total 18 adult Bull Trout were collected (Table 1). The otoliths were removed in March 2013 and were stored for analysis. The microchemical signatures of these Bull Trout in addition to the adult Bull Trout collected during the 2013 sampling period will be analyzed during 2013/2014 and this data will be used to refine the statistical model that was prepared during the first two years of this study (Golder 2010). The new model will focus on increasing the fidelity of the model to distinguish stream of natal origin among Bull Trout signatures from streams having similar water chemistry.

Table 1: Adult Bull Trout Collection from Duncan Dam Transfer Station during August and September 2012.

Date	Length (mm)	Weight (kg)	Sex	Number of Otoliths Removed
21-Aug-12	520.0	1350.0	Female	2
21-Aug-12	690.0	3250.0	Data not recorded	1
21-Aug-12	780.0	4500.0	Data not recorded	2
28-Aug-12	717.0	3890.0	Male	2
28-Aug-12	606.0	2100.0	Male	2
28-Aug-12	658.0	2840.0	Male	1
28-Aug-12	815.0	5050.0	Male	2
28-Aug-12	724.0	3670.0	Male	2
28-Aug-12	735.0	3840.0	Male	1
04-Sep-12	565.0	1720.0	Male	2
04-Sep-12	660.0	2910.0	Male	2
11-Sep-12	660.0	Data not recorded	Male	0
11-Sep-12	700.0	Data not recorded	Male	2
11-Sep-12	590.0	Data not recorded	Male	2
18-Sep-12	720.0	3730.0	Male	2
18-Sep-12	520.0	1520.0	Female	2
18-Sep-12	585.0	2080.0	Male	2
18-Sep-12	490.0	1080.0	Male	2

3.1.2 Recreational Bull Trout Fishery Collection Program

To determine the natal origin of fish caught within Duncan Reservoir and Kootenay Reservoir, a fish head collection program was initiated at several recreation access locations in Duncan and Kootenay reservoirs and was initiated in Year 1 of this study. These data were to be used to compare natal areas from fish caught in the recreational fishery with those caught in the transfer at DDM. The fish-head collection program was re-established in Year 3 (this report) for the Duncan Reservoir and Kootenay Lake targeting the collection of adult Bull Trout. The program included design and display of signage, communication of the program objectives, and establishment of designated drop off locations for each area and the collection and storage of samples. Where possible, fish meristic data was obtained (length and weight before removal of the head and sex) from fish that heads were collected for otolith samples. Fish heads were collected and stored until the otoliths were removed.

During the fall of 2012, 14 adult Bull Trout heads were collected, all from Kootenay Lake (Table 2). One fish was collected, but the capture location was not included, therefore this fish will be excluded from the analysis. Otoliths were removed in March 2013 and stored for analysis.

Table 2: Adult Bull Trout Collection from the Angler Head-Collection Program during 2012.

Date	Location	Length (mm)	Weight (g)	Sex	Number of Otoliths Removed
30-Aug-12	Woodbury	444.5	680.4	Unknown	2
30-Aug-12	Woodbury	444.5	907.2	Unknown	2
31-Aug-12	Woodbury	571.5	2268.0	Unknown	2
02-Sep-12	Riondel	685.8	2268.0	Female	2
02-Sep-12	Woodbury	749.3	4082.3	Unknown	2
05-Sep-12	Woodbury	660.4	2721.6	Female	2
08-Sep-12	Ainsworth	660.4	2154.6	Female	2
08-Sep-12	Woodbury	533.4	1360.8	Female	2
11-Sep-12	Woodbury	482.6	907.2	Unknown	2
11-Sep-12	Woodbury	584.2	2608.2	Unknown	2
01-Oct-12	Woodbury	685.8	3175.1	Female	2
05-Oct-12	Ainsworth	736.6	2721.6	Unknown	2
19-Oct-12	Riondel	Data not recorded	3685.4	Unknown	2

3.2 Juvenile Bull Trout Otolith Collection

No juvenile Bull Trout or water samples were collected during this study period. During the Year 1 and 2 of the study, otoliths that were collected but not analysed due to lack of funds were stored for future use. Otoliths from 40 juvenile Bull Trout were stored and analyzed in the winter of 2013 (Table 3). All of these Bull Trout were captured in September 2008.

Task 3 as described in the proposal for years 3 and 4 of this study included additional stream chemistry analysis and additional juvenile sampling from problematic habitats (Duncan tributaries, Kaslo River, Hamill Creek and Crawford Creek). Further, prior to the finalization of the study plan an evaluation of the seasonal water sampling and juvenile Bull Trout collection was completed to determine any data gaps. Additional water samples and juvenile Bull Trout otoliths that were required were included in the revised study plan. The previous study (Golder 2010) and the literature review (Golder & ONA 2012) completed for the current study recommended that additional juvenile Bull Trout be collected from certain tributaries. These tributaries were chosen based in in part, on the results of the previous study and the level of uncertainty in separating the otolith reading into unique natal streams. For 2013, an assignment of 'high priority' was given to tributaries that had confounding otolith chemistry and the collection of 30 juvenile Bull Trout from these sites will be attempted. 'Low priority' streams will need approximately 10 otolith samples to confirm the unique otolith signatures from these streams that have been established previously.

Table 3: Stored Samples of Juvenile Bull Trout Otoliths from Year 1 Analysed during 2013.

Location	Number	Tributary Priority Rating
Coffee Creek	5	Low
Crawford Creek	3	High
Hammill Creek	1	High
Houston Creek	8	High
Poplar Creek	5	Low
Upper Duncan River	11	High
Westfall River	7	High

3.3 Otolith Preparation and Microchemistry Analysis

Sagittal otoliths were analyzed from juvenile Bull Trout (*n* = 40) collected in 2008. Individual otoliths were stored in microcentrifuge tubes in the laboratory at University of Victoria and were shipped to Adelaide Research & Innovation Pty Ltd. in Adelaide, Australia. Concentrations of Strontium, Barium, Magnesium, Calcium, Manganese, Lithium and Zinc were identified in a transect line across the diameter of the otoliths. These samples will be used to build an updated classification model by using all juvenile samples analysed from all years.

4.0 RESULTS AND DISCUSSION

The preliminary results from the laboratory analysis during the spring of 2013 have been provided in Appendix A, Table A1. Because of custom delays in receiving the samples by the laboratory, QA/QC checks have not been completed by the time of this report's submission date. The data need to be thoroughly reviewed and compared with the results from Golder (2010) prior to initiating any refined analysis of the original model. Complete analysis of the data, and inclusion of additional samples collected during the 2013 field season will be included in the Year 4 report (second year of this contract). The management questions and other issues will be addressed in the report to be completed following Year 4 of the studies.

5.0 C LOSURE

We trust that this report meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

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6.0 REFERENCES

BC Hydro. 2008. Q8-8072 Request for Proposals DDMMON-5. Jan 14, 2008.

Golder Associates Ltd. 2010. DDMMON #5 – Upper Duncan Bull Trout Monitoring- Implementation Year 2. Prepared for BC Hydro Environmental and Social Issues Section, Castlegar, B.C. Golder Report No. 09-1480-0051: 49p. + 8 app.

Golder Associates Ltd. And Okanagan Nation Alliance 2012. Upper Duncan River Bull Trout Migration Monitoring-BC Hydro DDMMON #5 Literature Review and Study Plan 2012. Prepared for BC Hydro Environmental and Social Issues Section, Castlegar, B.C. Golder Report No. 12-1492-0078: 14p.

APPENDIX A

Laboratory Analysis

Table A-1 Concentrations ratios of Lithium (Li7) Magnesium (Mg25), Manganese (Mn55), Zinc (Zn66), Strontium (Sr88) and Barium (Ba138) to Calcium (Ca) of juvenile Bull Trout otoliths collected in 2008 and analyzed in 2013.

Location	Sample Number	Li7:Ca (µmol/mol)	Mg25:Ca (mmol/mol)	Mn55:Ca (µmol/mol)	Zn66:Ca (mmol/mol)	Sr88:Ca (mmol/mol)	Ba138:Ca (µmol/mol)
Coffee Creek	BT47	2.540020471	1.61563574	6.201115356	0.110612115	1.498280086	5.020210209
Coffee Creek	BT48	2.532661763	0.476040712	7.929492155	0.099561308	1.299183731	3.764332239
Coffee Creek	BT49	3.667534761	2.001046884	9.730055105	0.154058065	1.418922691	10.01366058
Coffee Creek	BT50	2.749749406	2.600200599	8.640609356	0.090291713	1.291790911	7.08297901
Coffee Creek	BT52	1.468158999	1.283994054	5.648094524	0.072459581	1.281059038	3.023814117
Crawford Creek	BT73	5.504758565	3.359705925	5.362355236	0.146333226	0.507652897	14.27666812
Crawford Creek	BT76	6.093797378	1.239046482	5.093412628	0.093092223	0.422739687	9.166644575
Crawford Creek	BT78	7.583490283	1.783045329	3.729702144	0.094406184	0.455079429	7.923809124
Hamill Creek	BT19	5.795103109	2.319859241	34.24752309	0.184314219	0.452666784	1.726228374
Houston Creek	BT85	6.838734449	1.720835591	3.265193174	0.125357742	0.869002687	3.919355444
Houston Creek	BT87	7.598477278	3.540282836	15.75142509	0.454700864	0.331100778	2.13553164
Houston Creek	BT88	3.998286351	0.412560855	2.230849029	0.075199789	0.703164261	5.403964469
Houston Creek	BT89	7.191933658	2.487221812	8.893727887	0.335161679	0.575088341	3.603436608
Houston Creek	BT91	9.610318365	2.191356898	15.61531556	0.091633829	0.105797164	2.719203666
Houston Creek	BT93	6.275992607	2.855848237	7.706869055	0.13219223	0.928299831	10.75677066
Houston Creek	BT94	6.510729702	1.547359881	9.253238824	0.103740727	0.906380107	12.50470795
Houston Creek	BT95	6.08222774	1.968308613	3.986271709	0.110875737	0.850139651	6.850788367
Poplar Creek	BT02	3.404697141	0.710644544	3.58175266	0.079017333	4.283015339	19.37257755
Poplar Creek	BT07	4.399424314	0.957573901	5.720492785	0.074637895	5.313885249	27.28857029
Poplar Creek	BT08	3.407900154	2.09009136	5.599752098	0.090772896	5.048040278	25.46912037
Poplar Creek	BT09	3.819546202	2.721625638	5.920049692	0.145978497	5.050701323	23.01246517
Poplar Creek	BT10	2.094836081	2.170110952	9.661961323	0.107278232	6.839189212	41.18347013
Upper Duncan River	BT25	4.32434539	0.774334974	3.990147701	0.041333394	0.438168933	3.667819048
Upper Duncan River	BT26	6.24313338	0.763671981	5.301189983	0.080744438	0.485300407	4.879915733
Upper Duncan River	BT28	3.787144402	1.156803624	4.466500564	0.085457463	0.484597738	4.302609422
Upper Duncan River	BT29	5.250486599	1.364590001	5.502889701	0.078749543	0.438260966	4.220868867
Upper Duncan River	BT30	4.284559292	0.967161804	3.878531345	0.067031849	0.451003286	3.344420307
Upper Duncan River	BT32	6.248444197	0.711301736	6.420530321	0.121398078	0.483173712	2.948478028
Upper Duncan River	BT33	4.741833147	1.158984189	3.610845946	0.040204703	0.401597868	3.757955421
Upper Duncan River	BT35	5.391096831	1.262257811	8.174572813	0.070887553	0.536533802	8.014232106
Upper Duncan River	BT36	4.399907163	1.250395916	3.907552817	0.06444887	0.501989213	6.896276543
Upper Duncan River	BT37	4.663406532	2.552234804	9.011759749	0.101206483	0.592377946	9.575471535
Upper Duncan River	BT38	5.36998089	0.716483031	4.038092552	0.087604518	0.52689905	7.568338385
Westfall River	BT60	10.8842145	7.224457724	35.8250415	0.239412836	0.067295118	1.944607102
Westfall River	BT61	7.120835046	0.842698628	4.537227922	0.09756084	0.438984224	8.238242221
Westfall River	BT65	6.820432427	3.091326189	7.249789732	0.169609479	0.490226653	11.88374088
Westfall River	BT68	6.952030105	1.669155876	10.01035601	0.115814322	0.534868787	13.16496332
Westfall River	BT69	6.371691006	0.73394739	7.585930658	0.077660617	0.519730575	11.19350544
Westfall River	BT71	6.160519795	2.777377427	12.26910273	0.136757795	0.584893381	23.03602857
Westfall River	BT72	8.507650683	1.266289611	9.014006991	0.195323609	0.59195629	13.16407907

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