Fraser Salmon & Watersheds Program

2008 Final Report

FSWP File Number*	07350-35 / FSWP 07 H 16

*Please use the FSWP File Number provided in previous FSWP 2008 project correspondence

Contact Information

Sponsoring Organization's Legal Name
University of British Columbia Okanagan

Are you a federally registered Charity, Non-profit organization or Business (Yes /No)?						No
If yes, please indicate which.		Charity		Non-profit organization		Business
Registration number				GST number		
Are you a registered Society (Yes / No)?			Society Registration number			

Mailing Address
3333 University Way, Kelowna, BC, V1V 1V7

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Project Manager[1]

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[1] *All correspondence will be directed to the Project Manager.*

Alternate Project Contact

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Partners / Subcontractors

Name: — Affiliation:

Phone: ( ) — E-mail:

Name: — Affiliation:

Phone: ( )	E-mail:
Name:	Affiliation:
Phone: ( )	E-mail:

Project Information

Project Title

Surface water and groundwater interaction in the Fortune Creek watershed: implications for fish protection and water management (Year 2)

Project Location

Fortune Creek Watershed

Amount Requested	**66,290**	**Total Project Value**	**152,290**	**Non-FSWP funds[2]**	**86,000**

[2] *Non-FSWP funds include both cash and in-kind funding. In-kind funding refers to all non-cash contributions such as equipment, supplies, labour, etc. Please refer to Budget Section for further details.*

Project Summary

Please provide a single paragraph describing your project, its objective, and the results. As this summary will be used in program communications, clearly state the issue addressed and avoid overly technical descriptions. Do not use more than 300 words.

Fortune Creek is a regulated system near Armstrong and the Spallumcheen Valley. The Creek provides habitat for resident rainbow trout, juvenile coho and Chinook salmon. While DFO and the City of Armstrong have worked co-operatively to try and maintain stream flows to sustain fish, water management in the watershed has become increasingly difficult.

A scoping study indicated that the upper creek experienced loss of surface water to groundwater, and also recovery from groundwater. A multi-year research program to fully understand surface-water ground interactions was proposed. Surface water and groundwater interaction is a critical factor for determining water quantity, quality and water thermal regime for fish habitat. In year one, geochemical methods to identify groundwater discharges were found to be confounded by anthropogenic influences on creek water chemistry. Year two proposed to use thermal methods to reveal details of surface water groundwater interactions. Preliminary thermal studies identified that specific stream reaches where groundwater discharged were large in scale, and hence not suited to a discharge/no discharge comparison study.

A revised proposal was submitted in May 2008 which outlined a detailed program of fish enumeration in the creek and comparison to measures of habitat suitability for the whole creek including thermal regime. The program included weekly counts of all fish species from July to October 2008, DNA analysis of the fish populations and detailed continuously datalogged thermal measurements. Thermal conditions were found to be unsuitable for the majority of the creek during summer. Data analysis in winter 2008/2009 is developing specific statistical relationships between thermal conditions and fish presence and quantity. Further analysis is developing heat budgets for the creek to assess the effects of shade and increased flow on temperature regime (ie: two possible remedial efforts), and to quantitatively assess the influence of groundwater on the thermal budget.

OPTIONAL **If your project lends itself to sparking interest through a compelling sound bite (for potential use in FSWP media communications), please tell us what that sound bite would be. Do not use more than 150 words.**

N/A

Species and life stage(s) the project targets: please list
Chinook salmon (*Oncorhynchus tshawytscha*) – juvenile rearing, year-round Coho salmon (*Oncorhynchus kisutch*) – juvenile rearing, year-round Rainbow trout (*Oncorhynchus mykiss*) – all life stages, year-round
Watershed(s) the project targets: please list
Fortune Creek

Project Deliverables and Results

- **Paste in the deliverables outlined in your Detailed Proposal (question #3 under project 'relevance and significance' heading) into the table below. Then, please list the results associated with each deliverable.**
- **Please include copies of any relevant communications products (brochures, posters, videos, website addresses etc.) resulting from this project.**

Deliverable	Result
1. Fish and habitat: The spatial and temporal distribution of salmonid species within the stream over the annual cycle. An assessment of the manner in which this spatial distribution is affected by groundwater discharge and temperature.	Fish enumeration began immediately following the recession of the freshet at eight locations. Weekly enumeration was reduced to monthly in November, and will continue to July 2009. This level of detail of temperature and fish enumeration is unique to this study. The effects of groundwater discharge on temperature are being assessed by physical and thermal methods. Peizometers and stream bed thermistors were installed to provide continuous datalogging of groundwater gradients at groundwater discharge locations. Data and analysis in support of this deliverable are presented in Appendix A. Statistical analysis will be completed in Year 3.
2. Controls on habitat quality: The relationships between groundwater regimes (different ratios of groundwater to surface water) and physical or chemical fish habitat indicators (temperature, DO and other water quality parameters).	Temperature is the primary driver of habitat quality on Fortune Creek. Stream temperature data, and the relationships of temperature to fish are being used to assess the effects stream cover, flow rate and groundwater discharge on stream temperature. Data to date and analysis methods are presented in Appendix A.
3. Transfer: Two workshops and a final report summarizing data and analytical results.	A public workshop covering the adjacent Deep Creek water resources project and this project was presented at a public session of the Spallumcheen Town Council on June 23rd, 2008. This study was presented at the One Watershed One Water conference put on by the Okanagan Basin Water Board and the Canadian Water Resources Association in Kelowna in Oct, 2009. Representatives of the direct stakeholders such as the Township of Spallumcheen, the City of Armstrong and First Nations were present. Presentations are accepted for the GSA Cordilleran Section meeting in Kelowna May 2009, and at the American Geophysical Union/ Canadian Geophysical Union/ International Association of Hydrogeologists Joint meeting May 2009. A specific workshop for stakeholders on the findings is planned for 2009 on completion of the analysis.

4. Training: One Master's student and one or two undergraduate students will be trained through their involvement in field data collection.	One M.Sc. student has worked full time on the project. An additional undergraduate student was trained in field data collection. An undergraduate honours student has worked on the geological stratigraphy of the Fortune Creek fan complex under separate salary funding.

Project Effectiveness

Please evaluate the effectiveness of the project, using the objective standards, quantifiable criteria and/or quality control measures identified in your Detailed Proposal (under question #1 in the 'performance expectations' heading).

Identification of specific areas of Fortune Creek where groundwater discharges to surface water: A detailed temperature survey of Fortune Creek in March 2008 identified areas of localized groundwater discharge that are likely ephemeral, or constricted to spring runoff, and a larger area of groundwater discharge related to regional groundwater upwelling. The upwelling area was equipped with piezometers which have revealed the presence of an upward hydraulic gradient. Streambed temperature profiles have been monitored at eight study sites and will be used in a model to estimate groundwater flows. This is a very cost effective method of measuring groundwater discharge.

Observation of changes in groundwater discharge contributions over annual cycles: Long term monitoring of groundwater levels in adjacent deep wells and from local scale peizometers indicates a consistent upward hydraulic gradient to Fortune Creek, including during the summer irrigation pumping period. Results of additional analysis will be available in Year 3 when the groundwater discharge modelling is completed.

Collection of stream flow and water quality data: Stream flow has been monitored manually (2 week to 1 month interval) and continuously via datalogging of stream level at multiple locations in the creek. Water quality data has been collected in conjunction with fish enumeration. Streamwater samples were collected during maximum baseflow in March 2009, and analyses are pending.

Enumeration of salmonid species and quantity over an annual cycle: Weekly data was collected from July to October. A reduced counting frequency was used in November, December. Counts were ceased in January and February due to cold temperatures and ice cover. Counts during freshet can not be conducted using the same protocol as summer counts for fish protection during trapping and counting, but will reveal overall fish utilization of the creek. Visual observations in May and June 2008 indicated large numbers of juveniles throughout the Fortune Creek system.

Quantification of the relationships between groundwater discharge, fish habitat indicators, and fish usage of habitat over an annual cycle: The fish enumeration and field data collection is being analysed to provide linkages between fish usage of habitat and habitat quality. Details are included in Appendix A.

Determination of fish habitat potential in relation to groundwater resource: Based on the temperature data and groundwater head measurements from the piezometers collected over the summer and fall of 2008, it will be assessed what role groundwater plays in maintaining suitable water temperatures for salmonids in Fortune Creek. Analysis is still ongoing but preliminary results indicate that groundwater may play a limited role in maintaining suitable water temperatures for salmonids in Fortune Creek. The preliminary data from field work indicates the contribution of groundwater discharge to the valley bottom is relatively insensitive to current groundwater utilization.

Partnership building: Dr. Brian Heise of Thomson Rivers University has participated as a committee member and project reviewer. Various organizations have collaborated during the second year of the study. These organizations include DFO, the City of Armstrong, the Township of Spallumcheen, the Spallumcheen Indian Band, the Secwepemc Fisheries Commission, the White Valley Community Association, the Ministry of Environment, the Fortune Creek Dyking and Drainage District, as well as individual landowners along the creek.

Training of graduate and undergraduate students: One undergraduate and one graduate student have been trained in data collection methods for streamflow, groundwater level measurements, and water sample collection for well chemistry. The graduate student has also been trained by designing a research project for year two and year three of this study to further investigate fish habitat in relation to groundwater – surface water interactions and by conducting statistical analysis and modelling.

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What are the top three lessons learned from this project that would be important to communicate to others doing similar work throughout the Basin?

Statistical analysis: Statistical analysis on data collected over time within a single stream is subject to certain limitations regarding common statistical methods. Such data requires more advanced statistical methods which in many cases need to be undertaken by a statistician. Statistical analysis for this project will be completed in collaboration with the statistics department at UBC Okanagan.

Thermal monitoring: Relatively inexpensive datalogging options have become available. Detailed logging of stream temperatures is feasible. Groundwater contributions can be quantified from detailed profile data in the stream bed. Detailed energy budget modeling requires much more extensive data collection.

Anthropogenic Influences: Discharges from local field ditches, waste discharges, release of stored reservoir water and overflow of artesian wells to the creek all complicate the chemical signature of the creek. Surface water groundwater interaction monitoring by chemical tracing in heavily altered creeks is extremely difficult.

Project Effectiveness

Please describe how your project has addressed each Priority Activity identified in your Detailed Proposal.

Priority Activity[1]	How the Priority Activity has been Addressed
Improved Information/ Approaches for Sustainable Integrated Fisheries Management.	This project has collected data on fish presence and habitat quality parameters at a temporal resolution that exceeds most studies. This will permit new analyses of salmonid responses to thermal measures. The study will use these relations to assess the potential impacts on salmonid habitat usage under different management or remediation options.

[1]Please paste each priority activity identified in your Detailed Proposal in the space provided.

Further Comments

Please provide any further comments including recommendations for future conservation efforts and suggestions for helping partners to meet the goals of the Fraser Salmon and Watersheds Program. If your project produced a narrative or scientific report or additional project products (e.g. maps, photos), attach them as an appendix.

Local residents along Fortune Creek have voiced their interest in organizing and applying for funding to undertake reforestation efforts along the creek. Preliminary examination of the data from summer 2008 indicates that stream temperatures strongly exceed salmonid thresholds in areas without riparian vegetation.

Members of the Drainage and Dyking district have expressed concerns regarding the movement of gravel downstream during freshet, particularly following the high flows of 2008. They have indicated an interest in a particular study of gravel movements in the creek.

Several locations with discharges of cattle waste directly to the creek have been noted during field work. Anoxic and nutrient rich conditions have been noted in the lower reaches.

Submission Instructions

Please send your Final Report electronically to your designated FSWP Staff Contact. If you are uncertain who this person is or how to contact them, please contact Tiffany Pither, FSWP Administrator.
Email: tpither@psf.ca
Phone: (604) 664-7664 Ext 119