Fraser Salmon & Watersheds Program

PACIFIC SALMON FOUNDATION | Fraser Basin Council

2009/10 FINAL REPORT

FSWP File Number*	07350-35/FSWP 09 D HWRS 24

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

1. Project Information

1.1. Project Title

Surface water and groundwater interaction in the Fortune Creek watershed: implications for fish protection and water management (Year 3)

1.2. Proponent's Legal Name

University of British Columbia

1.3. Project Location

Fortune Creek Watershed

1.4. Contact for this report

Name: Dr. Adam Wei	Phone: (250) 807-8005	Email: adam.wei@ubc.ca

1.5 Funding Amount

Original Approved Grant Amount:	Total FSWP Expenditures:	Final Invoice Amount:	Final Non-FSWP leveraging, including cash and in-kind:
63,000	63,000	63,000	51,000

2. Project Summary

Please provide a single paragraph describing your project, its objectives, and the results. As this summary may be used in program communications, clearly state the issue(s) that were addressed and avoid overly technical descriptions. Maximum 300 words.

Fortune Creek is a regulated system that supplies water to approximately 4,500 residences in Armstrong and the Spallumcheen Valley. The creek provides habitat for resident rainbow trout, juvenile coho and Chinook salmon. Due to low flows in the summer, water temperature often becomes lethally warm to salmonids. A three-year project was approved in principle by the Pacific Salmon Foundation in May 2007. The objectives were:

1) to understand surface water and groundwater interactions, and their relationship to fish needs; and

2) to assess impacts of various management strategies on fish protection and human needs.

Work in the first year (2007/08) used several techniques to quantify surface water and groundwater interactions. The objective in the second year (2008/09) and the third year (2009/2010) was to assess

the relationships between groundwater flow regimes and specific fish habitat and population indicators. Fish habitat quality indicated by flow rate, temperature, cover and water chemistry were monitored along the whole creek. Fish enumerations were used to quantify temporal variations in fish populations, and their relations to groundwater discharge and water temperatures.
Statistical analysis of salmonid distribution in relation to habitat indicators indicated that high water temperatures limit juvenile salmonid use of Fortune Creek. Low and erratic stream flows limit rearing by drying out the shaded upper reaches and causing water temperatures to escalate in the lower reaches. Groundwater discharges to the stream throughout the valley bottom. However, no localized thermal refugia were identified and groundwater cooling of the stream is too small to provide thermal relief for salmonids. Maintaining thermally suitable habitat for salmonids could be achieved with increase shade, especially on select reaches. Several options exist for using in-stream flow to maintain temperatures ranging from using flows above 0.1 m^3/s in the absence of shading, to potentially lower values with strategic shading.

OPTIONAL **Please give a short statement (up to 100 words) of the most compelling activity or outcome from your project.**

3.Final Project Results and Effectiveness

3.1 Copy EXPECTED OUTCOMES from your detailed proposal and insert into this section. Add additional rows as needed. Then please list the FINAL OUTCOMES (the tangible end products resulting from this work) associated with expected outcome.

If FINAL OUTCOMES differ from the original EXPECTED OUTCOMES please describe why, and the implications for the project.

EXPECTED OUTCOMES	FINAL OUTCOMES
1. The relationships between surface flow, groundwater regimes and fish habitat indicators (temperature, DO and other water quality parameters).	Completed, see Appendix A.
2. The spatial and temporal distribution of salmonid species within the stream over the annual cycle, and its association with hydrology	Completed, see Appendix A.
3. A final report summarizing data and analytical results (Year 3) will be provided	Completed, see Appendix A and B.
4. One workshop or extension activity involving all partners, collaborators and local communities will be organized	Completed, see Appendix C. (the extension note will be distributed to all partners, collaborators and local communities)
5. One Master's student and one or two undergraduate students will be trained through their involvement in field data collection	One Master's student was trained in field data collection and analysis of fish habitat indicators and surface water – groundwater interactions. Several undergraduate students and technicians were trained in field data collection.

3.2 Please evaluate the EFFECTIVENESS of your project in achieving Project Objectives. Please identify the indicators you have used to measure the effectiveness of your project. Please include any notable successes or challenges.

Identification of specific areas of Fortune Creek where groundwater discharges to surface water. Streambed temperature profiles were monitored at eight study sites and were used in a model to estimate groundwater flows. In addition, piezometers revealed the presence of an upward hydraulic gradient throughout the valley bottom reaches. This is a very cost effective method of measuring groundwater discharge.

Observation of changes in groundwater discharge contributions over annual cycles. This task was completed using field observations of groundwater head gradients and thermal groundwater modeling.

Collection of stream flow and water quality data. Streamflow data collection on a biweekly (summer) or monthly (winter) basis was continued from Year 1.

Enumeration of salmonid species and quantity over an annual cycle. Salmonid species enumeration commenced in July of 2008 and was completed on a weekly basis until December 2008. Enumeration was continued from early April November 2009 on a monthly basis to complete a full annual cycle. The use of minnow traps is a cost effective and non-disruptive method to determine salmonid distribution in the creek.

Quantification of the relationships between groundwater discharge, fish habitat indicators, and fish usage of habitat over an annual cycle. Analysis of relationships between groundwater discharge, fish habitat indicators and fish usage were completed in 2009 using open-source free statistical software.

Determination of fish habitat potential in relation to groundwater resource. Based on stream and ground temperature data, groundwater head measurements from the piezometers and combined heat a nd flow modeling of groundwater , we assessed what role groundwater plays in maintaining suitable water temperatures for salmonids in Fortune Creek. Analysis indicated that groundwater played a limited role in maintaining suitable water temperatures for salmonids in Fortune Creek but was critical in maintaining flows during the low flow season.

Partnership building. Various organizations have collaborated during this study. Those organizations include DFO, the City of Armstrong, the Township of Spallumcheen, the Spallumcheen Indian Band, 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, two technicians 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 modeling of groundwater surface water interactions.

3.3 REQUIRED: attach all DOCUMENTATION of Final Outcomes, and LIST attachments here. These may include technical reports, maps, photos, evidence of communications, lists of meeting participants, etc.

Appendix A – Assessment of Relationships Between Groundwater Regimes And Fish Habitat Indicators
Appendix B – Hydrometric Data
Appendix C – Extension Note for Project Communication

3.4 Please describe how the benefits of this project will be sustained and/or be built upon into the future. What are the planned next steps, or recommendations for further work, if applicable?

The results of this project will be useful for the community and City of Armstrong to design water release strategies and water management plans. In addition, the results will be useful for Fisheries and Oceans Canada and the Ministry of Environment to further refine fish temperature thresholds in the study area and determine in-stream flow needs for protection of salmonid species.

Recommendations are 1) inclusion of our results in future water management plans; and 2) another study to further assess the effects of different management strategies (water releases, riparian restoration, increased water demand etc) and climate change on water and fish habitat so that the best solutions can be design to sustain both fish and human needs. Further recommendations are provided in Appendix A.

3.5 What are the top three lessons learned from this project that could be useful to communicate to others doing similar work in the Basin?

1. **Statistical analysis** – statistical analysis on data collected over time from a single creek 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 was completed in collaboration with the statistics department at UBC Okanagan.
2. **Low flow discharge measurement** – In low gradient environments like the lower portions of Fortune Creek, it can be difficult to measure discharge during the low flow season as conventional flow meters do not work in slow water velocities. Although disturbance to watercourses should be minimized, it may be best in such conditions to construct a flume to increase flow velocities and be able to measure discharge. Alternately, acoustic doppler meters may provide measurements at lower flow velocities.
3. **Hydrometric stations** – Watercourses in the Interior of British Columbia tend to have very large hydrograph peaks driven by snowmelt. Under these conditions it may not be possible to conduct streamflow measurements due to safety concerns. If hydrometric stations are installed, they provide a continuous record of stream stage even during conditions where manual measurements are not possible.