Fraser Salmon & Watersheds Program

PACIFIC SALMON FOUNDATION | Fraser Basin Council

2009/10 FINAL REPORT

FSWP File Number*	07350-35/FSWP 09 D99

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

1. Project Information

1.1. Project Title

Fraser Basin Salmon Ecosystem Project (Year 3)

1.2. Proponent's Legal Name

John D Reynolds

1.3. Project Location

Fieldwork: Takla Lake, North Central BC & Shuswap region, South Central BC
Lab work & Analysis: Simon Fraser University, Burnaby, BC

1.4. Contact for this report

Name: Dr John D Reynolds	Phone: (778) 782-5636	Email: reynolds@sfu.ca

1.5 Funding Amount

Original Approved Grant Amount:	Total FSWP Expenditures:	Final Invoice Amount:	Final Non-FSWP leveraging, including cash and in-kind:
$78,240.00	$78,240.00	$15,648.00	$59,480.00

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.

This project aimed to understand interactions between spawning salmon and their ecosystems and translate this information into policy advice for conservation. We linked data from Fisheries and Oceans Canada (DFO) on salmon population sizes to new data collected through detailed physical and biological assessments of 40 sockeye spawning streams across two regions of the Fraser Basin.

Our first objective was to test quantitative links between proposed physical habitat characteristics and salmon abundance, which is a key goal of Canada's Wild Salmon Policy. We found that a few key habitat features, all of which provide cover to spawning sockeye, predict differences among streams in salmon abundance. Then we analyzed these stream habitat indicators within a cost-benefit framework that quantitatively assessed both the indicator performance and the cost of measuring it. We identified the habitat indicators that would maximize either the total information gained given various budget scenarios or the efficiency (information gained per dollar spent) of a monitoring program.

Our second objective was to test quantitative links between salmon abundance and ecosystem productivity – another key goal of the Wild Salmon Policy. First, we examined how salmon abundance related to the uptake of nutrients from salmon carcasses by stream algae, aquatic insects, and fish, using stable isotope techniques. As predicted, the amount of salmon-derived nitrogen in all three groups of species was strongly related to the abundance of salmon in each stream. Interestingly, we found that this increased uptake of nutrients did not always translate into greater abundance of these three species groups. This means that stream algae, insects, and fish species differ in their value as indicators of the influence of salmon on freshwater ecosystems.

Our third objective was to use these results to inform future management decisions aimed at improving the sustainability of wild salmon populations. We developed collaborations related to implementation of Wild Salmon Policy Strategies 2 and 3 as our work can aid both the development of effective and efficient habitat monitoring programs and the incorporation of ecosystem values into management.

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

The most significant outcome of the project is a better understanding of the role that salmon play in freshwater ecosystems and the relevance to conservation management. This can help the design of habitat monitoring programs and selection of habitat and ecosystem indicators by filling key information gaps identified in the Wild Salmon Policy. This knowledge also contributes to the field of ecology through the publication of peer-reviewed scientific journal articles.

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. To test quantitative links between proposed physical habitat indicators and past and current salmon abundance (Strategy 2 of Wild Salmon Policy).	1a. Manuscript submitted (Appendix 1) showing the influence of key habitat indicators on breeding population density. 1b. Manuscript in preparation showing novel methods for designing optimal stream surveys.
2. To test quantitative links between past and current salmon abundance and various indicators of ecosystem health and productivity (Strategy 3 of the Wild Salmon Policy).	2a. Manuscript submitted (Appendix 2) on quantitative links between salmon and stream algae. 2b. 2 manuscripts in preparation on quantitative links between salmon and stream insects and fish.
3. To use this new information to inform future management decisions aimed at improving the sustainability of wild salmon stocks.	3a. 6 meetings with DFO and environmental NGOs on Wild Salmon Policy implementation. 3b. 21 public talks. 3c. 1 public workshop organized on Wild Salmon Policy implementation. 3d. Ongoing meetings and collaboration with Gary Borstad's FSWP project.

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.

Indicators of Effectiveness
We measure our success at meeting the project objectives using two indicators: 1) peer-reviewed scientific publications, and 2) strategic partnerships.

1) Peer-Reviewed Publications
We have submitted two manuscripts for publication to top-quality peer-reviewed ecology journals *Ecosystems* and *Oikos*. We expect to submit a further three manuscripts by the end of 2010. (See Final Outcomes).

2) Strategic partnerships
We have built strong working relationships with individuals from DFO and Watershed Watch Salmon Society. These partnerships have provided logistical and scientific support that aided our research and facilitated the communication of results to organizations involved in Wild Salmon Policy implementation. We have also partnered with Gary Borstad's FSWP project, combining our salmon and habitat data with their satellite data to facilitate novel analyses of satellite imagery to predict salmon production.

Challenges
We have conducted one of the most comprehensive studies of habitat indicators ever undertaken. We had underestimated two challenges stemming from this. First, sample processing in the lab, especially sorting and identification of stream insects, has taken longer than we had hoped (though this is now finished). Second, we are awash in data, which has required a lot of very sophisticated statistical analyses, which took some time to implement. Although we are now on top of this, and indeed we have started submitting manuscripts, this also slowed us down a little.

Although we have had good working relationships with key biologists from DFO who are responsible for implementing the Wild Salmon Policy, we have faced two further challenges. First, plans for Strategy 2 (Habitat indicators) have shifted toward measurements that can be done with existing data, rather than those that require field visits. Still, the principles that we have developed concerning maximizing cost-effectiveness and minimizing redundancy of information among indicators are equally relevant to any suite of indicators, and some key variables in DFO's draft list were prominent in our studies, such as stream insects. Furthermore, our new collaboration with Gary Borstadt's group has helped us to keep up with this shift, as our field measurements of habitat variables and compilations of sockeye population trends provide an excellent test case for the usefulness of various satellite-derived indices of "greenness". The second challenge in integrating our results into DFO's implementation of the Wild Salmon Policy is that Strategies 2 (Habitat indictors) and 3 (Ecosystem values) are linked. This means that Strategy 2 will not move forward without further progress on Strategy 3. While this slows things down somewhat, we remain committed to a long-term engagement that has been kick-started by our FSWP grant.

Successes
We have developed successful relationships with various DFO programs, such as Fraser Sockeye Stock Assessment, Fraser River Environmental Watch (E-Watch) and Fish-Forestry. Fraser Sockeye Stock Assessment has provided us with population data and both logistical support and accommodations in the field, which substantially reduced project costs. The E-Watch (head – David Patterson) and Fish-Forestry (head – Erland MacIsaac) programs have provided extensive scientific advice and logistical support for water nutrient analyses and long term temperature monitoring. Further, as the Early Stuart population complex is co-managed by DFO, the Tl'azt'en nation, and the Carrier-Sekani Tribal Council (CSTC), our partnership with Stock Assessment provided the opportunity to interact with members of the Tl'azt'en fisheries program. Our relationship with Watershed Watch is another success, particularly in aiding implementation of the Wild Salmon Policy. Currently, John Reynolds, Doug Braun and Craig Orr of Watershed Watch are organizing another meeting of academics, ENGOs and DFO Wild Salmon Policy staff to identify the current status of Wild Salmon Policy Strategies 2 and 3, present research (this study included) that supports the strategies, and

outline future steps toward their implementation.

The detailed physical and biological assessments that we conducted have resulted in an extremely comprehensive dataset for 40 streams in two regions of the Fraser Basin. These data have already provided insights into how salmon interact with their ecosystems and they are being used in several other research projects, including a study of impacts of climate change. We are continuing to monitor both the salmon populations and their habitats in order to address questions about population and ecosystem dynamics, which extend beyond the scope of this project (see Section 3.4 for details).

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 1. Braun DC and Reynolds JD (2010) The influence of biotic and environmental processes on breeding population density: insights from sockeye salmon. Oikos. (*submitted*)

Appendix 2. Verspoor JJ, Braun DC, Reynolds JD (2010) Quantitative links between Pacific salmon and stream periphyton. Ecosystems. *(submitted)*

Appendix 3. Braun DC and Reynolds JD (2010) Methods for designing optimal stream surveys. (Poster)

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?

One of this project's benefits is the large inventory of stream habitat data for 40 sockeye spawning streams in two regions of the Fraser River. This comprehensive dataset will provide the foundation for three future research projects. First, the stream habitat data are a major component of Doug Braun's PhD research at SFU, which aims to understand the interplay between climate, habitat and life history in determining sockeye salmon population dynamics. These data will be combined with new life history information for individual fish in the populations we surveyed, which were collected in 2009 and will be again in 2010. This research involves collaboration with the Pacific Salmon Foundation, as they will support Doug Braun's salary through an industrial NSERC partnership. Second, in collaboration with David Patterson (head of DFO's Environmental Watch Program), who is providing financial and logistical support, we are continuing year-round temperature monitoring in all 40 streams. After this summer three years of continuous temperature data will exist and monitoring will continue for at least another year. This comprehensive dataset will allow us to examine variation in stream temperature in response to variation in climate across the streams. Finally, through collaboration with ASL Borstad Remote Sensing Inc. we have combined information from their "How Green is Your Valley?" FSWP project with data from this study. Correlations between stream habitat variables and watershed "greenness" metrics were investigated as well as relationships between sockeye survival and greenness metrics. A more detailed discussion of these analyses can be found in the technical report titled: "How Green is Your Valley?" Remote Sensing of Large Watershed Change for Ecosystem Management, which is appended to Gary Borstad's FSWP End of Year Report. The results of this collaboration are promising and there has been discussion of developing the research further.

The third objective of this project was to use the research results to inform future management decisions aimed at improving the sustainability of wild salmon stocks. At a number of meetings throughout the project's duration we have discussed our work with numerous people from DFO. This communication will continue. For example, we have partnered with Watershed Watch Salmon Society to plan a workshop to communicate research findings and continue dialogue on how WSP Strategies 2 and 3 can be implemented. This meeting will include key individuals from DFO, universities and ENGOs, including the Stream Keepers Association. We are hoping to schedule the meeting in early June.

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. Talk to DFO and other partners early and often.
2. Do not underestimate how long it takes to process samples: fieldwork is only the beginning.
3. Use graduate students if you can. They are inexpensive, totally devoted, and leaders of the future.