Fraser Salmon & Watersheds Program

PACIFIC SALMON FOUNDATION | Fraser Basin Council

2009/10 FINAL REPORT

FSWP File Number*	FSWP 09 LR 96 HWRS

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

1. Project Information

1.1. Project Title

How Green is Your Valley? Remote Sensing of Large Watershed Change for ecosystem management

1.2. Proponent's Legal Name

ASL Environmental Sciences Inc.

1.3. Project Location

Sidney, British Columbia

1.4. Contact for this report

Name: Dr. Gary Borstad	Phone: 250-656-0177x135	Email: gborstad@aslenv.com

1.5 Funding Amount

Original Approved Grant Amount:	Total FSWP Expenditures:	Final Invoice Amount:	Final Non-FSWP leveraging, including cash and in-kind:
$46,000	$46,000	$9,200	$19,186

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 looked for high-level indicators of watershed health that will be useful for natural resource management of salmon. We use a well-established remote sensing indicator of the 'greeness' of terrestrial vegetation from studies of forestry, agriculture, and climate change[1] called the Normalized Difference Vegetation Index (NDVI). We obtained a very large NDVI dataset assembled by the Canada Centre for Remote Sensing from daily weather satellite imagery for 1985 to 2006, at 10-day and 1-km resolution for all of BC. Following further corrections and quality control, we extracted spatially averaged time series for several Fraser watersheds and developed a set of secondary indicators, including the long-term trends and annual anomalies of summer greeness, and timing of spring 'green-up'. These show that dramatic, spatially varying, changes in vegetative cover have occurred within the Fraser Basin since 1985. Comparison of with metrics of salmon abundance and survival at the watershed level suggests that changes captured by the NDVI time series relate to salmon success. Much work remains to be done, but these indicators can be mapped at the watershed, basin and province level, and provide a completely new lens though which to examine the salmon life cycle. As

expected in an exploratory project taking a bottom-up data driven approach, we are generating more questions than answers. The work is being followed up by DFO, using a more top-down approach. We have generated mapped indices for use by the Nature Conservancy of Canada, Simon Fraser and DFO, and will participate in the Annual FSWP Meetings to broadcast our results and seek further collaborators.

[1]Myneni et al, 1997. Increased plant growth in the northern high latitudes from 1981 to 1991. Nature 386: 698-702.

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

We asked the question " Can satellite maps of the vegetation cover of the province contribute useful information to the management of salmon?" Our application of powerful new tools to this gigantic dataset (new to fisheries scientists and to most of the public) provides dramatic illustration of the recent natural history of the province. The province-wide maps of 25 years of vegetation change provide a graphic illustration of the massive changes in the Fraser Basin that the salmon must contend with. We are only beginning to understand what these changes imply.

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. Updated and validated NDVI image time series	Our NDVI time series was not updated past 2006 because it was not available from Canada Centre for Remote Sensing. However, we were able to significantly improve the calibration of the dataset through Lowess filtering routine provided by CCRS.
2. Image and watershed averaged time series of secondary indicators, including seasonal and annual anomalies from long-term NDVI averages.	Done
3. Analysis of relationships between NDVI secondary indicators and salmon survival in selected watersheds, including Chilko, Bowron and North, South and LowerThompson Rivers.	Analysis began on Chilko, Thomson and Bowron watersheds but was focused on Chilko at the request of Jim Irvine (DFO)
4. Preliminary analysis of relationships between watershed level indicators and more local indicators derived at the stream level, in conjunction with John Reynolds group at SFU.	Done – expanded to include both image and watershed level indicators
5. An increased level of awareness in the public and First Nations groups about the 'big picture' and the geographical extent of changes in salmon watersheds.	We will present image maps at the Fraser Assembly in Merrit (either as an oral presentation or as a poster) Map products are being provided to the Nature Conservancy.

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.

This project has achieved almost all of its objectives. We were very effective at achieving the objectives under our control, but CCRS were not able to provide the dataset updated to 2008. The delay in getting the new calibration and filtering routines from CCRS (which significantly improved the data) from also delay our analysis. The NDVI time series is immense, and we had to develop new tools to allow us to explore it. RASTAR (Rapid Screening through Analysis and Regression) conducts bottom-up searches for linear correlations between salmon growth and survival metrics and many different indices of greenness. This tool is very effective. It has allowed us to uncover several strong correlations - many of which are not significant, or cannot yet be explained.

We have begun to generate very dramatic map products showing annual summer greenness and anomalies, long-term (25 yr) trends, and catastrophic (year-to-year) loss in summer vegetation across the province.

One of our objectives was to generate questions, not necessarily answers. This was achieved. The most interesting of the correlations are being followed up in work funded directly by DFO, in which a more mechanistic top-down approach is being taken. Thus, the FSWP project has been effective in opening up a new line of research, previously inaccessible to fisheries (and other) scientists.

Another measure of our effectiveness is the strategic partnerships we are making: We have established strong working relationships between ASL, DFO and the Ladysmith Institute. A subset of our map products is being provided to the Nature Conservancy of Canada for eventual inclusion in their models.

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.

Brown, L. N., G. A. Borstad, S. Akenhead, J. Irvine, M. Martinez and R. Kerr, D. Braun, J. Irvine. 2010. How green is your valley? Remote sensing of large watershed change for ecosystem management. Technical report from ASL Environmental Sciences Inc. to Fraser Salmon Watersheds Program.

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 potential application of these data products is extremely wide ranging. DFO is funding further analysis, and we have begun to solicit other provincial and federal agencies, and NGOs for interest. We anticipate many other down-stream studies to come from this work.

One of the benefits of this project is the very large satellite database of vegetation cover now online at ASL. This database contains invaluable information regarding the recent history of British Columbia that will be of interest to managers and scientists of all disciplines. We fully expect that this database will provide the basis for future research projects, as the outcome of this FSWP project, the database and ASL's experience with it become more widely known.

We also value the strategic partnerships we developed as part of this work – with Dr. Jim Irvine at DFO, with the Reynold's group at Simon Fraser and with Pierre Iachetti of the Nature Conservancy.

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. Data quality assurance is an important component of this type of work and takes a *lot* of time. These datasets are enormous and complicated, precluding manual analysis. It was important to derive simple robust indices that would withstand the remaining vagaries of the dataset.
2. Frequent communication between team members is important.
3.

7. Appendices

REQUIRED: attach all DOCUMENTATION of Final Outcomes, listed above in section 3.3. These may include technical reports, maps, photos, evidence of communications, lists of meeting participants, etc.

Brown, L. N., G. A. Borstad, S. Akenhead, J. Irvine, M. Martinez and R. Kerr, D. Braun, J. Irvine. 2010. How green is your valley? Remote sensing of large watershed change for ecosystem management. Technical report from ASL Environmental Sciences Inc. to Fraser Salmon Watersheds Program.

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