Project Title: An integrated assessment of the cumulative impacts of climate change and industrial development on salmon in Western British Columbia

Project Term: 2 years

Project Leader: Don Morgan, Bulkley Valley Research Centre and BC Ministry of Environment, Smithers, BC

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Introduction

This proposal addresses the Moore Foundation's goals of scientific research and advancing environmental conservation in northwest British Columbia. Under the Wild Salmon Ecosystem Initiative the Moore Foundation is funding a range of projects in north western BC in an effort to preserve salmon stocks and the terrestrial and aquatic ecosystems that they depend (http://www.moore.org/). The provincial government is currently considering an expansion of industrial development including, mining, and hydroelectric development triggered by the extension of electrical power into the northwest. There is an urgent need to synthesize the existing science on salmon, aquatic and terrestrial ecosystems, wildlife, climate change and industrial development, and to integrate this information into current decision making in north western BC.

The project has two main objectives. The first is related to resource management operations, at the watershed scale, and it will conduct an assessment of the cumulative effects of a set of ecological and industrial scenarios on aquatic, and their dependent terrestrial, ecosystems in two study areas. The second is strategic, at the provincial scale, and is focused on methods for government/non-government collaboration on decision making and longer term environmental monitoring.

Operationally, this project proposes to collate existing science and data in order to conduct a systems assessment of the cumulative effects of climate change, hydroelectric, mining and forest development in the Skeena, Nass, Iskut and Stikine watersheds of north western BC. By taking a systems approach the project can focus on the larger context and dynamics that interact in the northwest. Detail on specific elements that are being considered under a cumulative effects assessment can be drawn from existing knowledge and research and summarized to a system level scale that is appropriate for strategic scale natural resource management decisions. Through such assessments knowledge gaps can be identified and prioritized for further research.

There is an opportunity to provide science-based information to current land use management initiatives in north western BC, including:

- Government lead cumulative effects assessment project surrounding the NTL in the Nass, Iskut and Stikine watersheds – Fred Oliemans and Don Morgan
- Individual proponent lead environmental impact assessments

- Skeena monitoring - Skeena Wild Conservation Trust – Greg Knox
- Regional First Nations – consultation on resource development impacts on wildlife and fish

Strategically, the project will be structured to integrate with existing decision making processes, including the government lead cumulative effects initiative surrounding the Northwest Transmission Line (NTL), climate change adaptation assessments and sustainable forest management planning. Further, the project will assist in establishing the technical basis for structuring long term research and monitoring systems in BC.

Managing for social-ecological resilience is emerging as an approach to resource management that recognizes the role of people in ecosystems and the inherent dynamic nature of forest and hydrological ecosystems (MA 2005, Chapin et al. 2009). Applying a social-ecological systems approach in north western BC, focused on the ecosystem services of salmon and water, would consider the dynamics of terrestrial and aquatic ecosystems, and human use of services across a range of plausible social-ecological scenarios. This will help inform decision making such that the ecosystems of north western BC can continue to provide valued ecosystem services. As part of the considerations of human dimensions, First Nations' insights into current and historic systems resilience are another invaluable source of information for decision makers. Communications with First Nations groups within the geographic region will be a significant contribution to this project.

The results of this project will provide government and stakeholders with key metrics to assess the long-term impacts of different development scenarios on the abundance and diversity of wild salmon and habitat disturbance measures, including shifts in hydrology, road development and extent of industrial development. Further, it will provide a context for First Nation and community engagement in the northwest on the impacts of a changing climate and expanded human development on ecosystem services. As well, it will provide a foundation for providing more detailed, scientifically credible information to government decision making.

Project Objectives

The project has two high level outcomes, each with a series of objectives:

1. Technical assessment of cumulative effects of two study areas in Northwest British Columbia
    a. Organizing existing knowledge of the current and historic system dynamics;
    b. Models of social, economic and ecological metrics;
    c. Cataloging potential future system dynamics; and
    d. Developing scenarios of possible futures.
2. Integrating independent science into government decision making in British Columbia

a. Alternative institutional mechanisms for government/non-government collaboration on cumulative effects assessments and decision making; and

b. Evaluating risk and trade-offs from cumulative effects;

c. Project extension.

Proposed Methods

1. Technical assessment of cumulative effects in Northwest British Columbia

The project will collect data and information for the Skeena, Iskut, Stikine and Nass drainages. For the more detailed work the project will initially focus on two proof of concept areas; one the "Iskut", containing the Iskut, Stikine, Nass area that is aligned with a current government lead cumulative effects pilot project, and the other is in the upper Morice river in the Skeena River basin.

a. Current and historic system dynamics

i. Assemble background information: Collate existing and emerging science relevant to project area (see linkages section below).

ii. Assess past and current human and ecological processes – traditional use, forest dynamics, climate change, hydrology, forestry, hydroelectric power, etc – and their interaction with terrestrial and aquatic ecosystems, and salmon habitat integrity. Use paleoecological information and other sources to determine past shifts in climate and resulting changes and dynamics of natural processes, such as the influence of the Pacific Decadal Oscillation (PDO).

iii. Assess current decision processes, such as environmental impact assessment and government tenure approval process. Document legal land use designation from existing legislation and land use plans.

b. Models of key metrics

i. Identify the species and ecosystem components that are most likely to be adversely impacted by climate change and industrial development in the study area, such as:

1. Wildlife – wildlife habitat implications of increased road density, wind power installations, mining roads, etc.

2. Fish – implications for fish habitat and populations of hydroelectric and mineral development

3. Hydrological stream flow - Approaches to estimating or quantifying relative streamflow (flood, debris flow, low flow) response in un-gauged basins based on readily available metrics of watershed sensitivity, land use, natural disturbance, climate change and run of river hydrological development.

4. Sediment generation - Estimating and quantifying relative changes in rate of sediment generation based on watershed characteristics and land use activities such as Placer mining , Road density, road location, use and maintenance

5. Riparian function - Estimating or quantifying relative changes in stream temperature due to effects of loss of streamside vegetation

6. Ecosystems – Dendrochronology and historic disturbance regimes

7. Ecosystems – stand dynamics and vegetation re-colonization following multiple overlapping or interacting disturbances including interaction with a changing climate.

8. Ecosystem – landscapes –estimating and quantifying combined effects of habitat loss due to insects, forest harvesting and or industrial development on population dynamics of wildlife (direct habitat loss, human induced harassment or direct mortality, predator prey interactions)

ii. Using analytical methods, such as Bayesian statistics, develop a set of species and ecosystem component models to be used as key metrics in the project and that document the uncertainty associated with both input parameters and model outputs (McNay et al. 2011).

iii. Develop a set of decision making metrics that capture the potential shift in regional decision making resulting from the project.

c. Future system dynamics

i. Climate change scenarios downscaled to the study area and the construction of climate-envelope models for interpreting ecological change (Hamann and Wang 2006).

ii. Develop conceptual models of the major natural and human processes influencing salmon and related aquatic and terrestrial ecosystems based on existing research and expert workshops.

d. Future scenarios

i. Develop a set of future scenarios for assessment. The current climate is changing at an accelerated rate and is already affecting hydrological and forest ecosystems through changes in stream flow and temperature, and patterns and rate of natural disturbance (Pojar 2010). At the same time there is increasing demand for alternative supplies of energy, such as hydroelectric and wind farms as well as commodities to supply emerging Pacific economies. Scenarios will be developed that capture the possible range of social-economic and environmental change.

ii. Scenario assessment. The conceptual models of system change will be implemented in a landscape scale simulation model and parameterized according to the proposed future scenarios. A scenario based approach exposes the range of uncertainty in how drivers of change could influence the supply of ecosystem services through time. The future scenarios will be assessed for key metrics of focal species and ecosystem components, including salmon and grizzly bears. The state of the system, and its resilience to future perturbation, will be used to interpret the scenario's capacity to continue to provide ecosystem services (Morgan 2011). Provisioning services Indicators will also be generated from the model, such as power production and timber supply.

2. Integrating independent science into government decision making in British Columbia

a. Alternative institutional mechanisms for government/non-government collaboration on cumulative effects assessments and decision making

i. Investigate alternative institutional arrangements for organizations to collaborate with the Provincial government on cumulative effects assessment and monitoring.

b. Evaluating risk and trade-offs from cumulative effects

i. Develop a risk management framework to assist decision makers in assessing the level of risk to ecosystem services, such as water and salmon, under a range of development and environmental scenarios.

ii. Link to monitoring and research initiatives to assist with the further development of monitoring frameworks and future government lead decision processes.

iii. Identify risk assessment linkages to decision making processes and develop a methodology to integrate with existing decision making processes, such as Timber Supply Review and government cumulative effects initiatives.

c. Project extension and outreach

i. Peer review - engage academia, government and non-government personal throughout the project.

ii. Assist with the delivery of a cumulative effects conference in Smithers, BC intended to systematically gather and share information needed for cumulative effects analysis and regional development planning.

Project Benefits

- Organize existing salmon and salmon habitat information in north western BC into a social-ecological system framework providing an integrated perspective on salmon and industrial development.
- Linkage to government initiatives. Provide timely information to government's decision making on the cumulative effects of development in north western BC.
- Provide the necessary background information to assist in the development of north western BC salmon and salmon habitat monitoring systems.
- Create awareness (public, industry, government, First Nations) regarding the importance of conserving salmon habitat and the regional impacts of climate change

Linkages

This proposal has potential links to the following Moore funded initiatives:

- University of Washington
    - Portfolio effect and habitat synthesis.
- Skeena Wild Conservation Trust
    - Adoption of sustainable salmon harvest
    - Habitat protection
- Pacific Salmon Foundation
    - Monitoring baseline information
- Wild Salmon Center
    - Salmon stock assessment
- Tides Canada Foundation
    - Skeena integrated management reform

- University of California, Santa Barbara, National Centre for Ecological Analysis and Synthesis
    - Synthesis of climate effects on salmon

Linkages to other initiatives:

- Provincial Area Based Analysis - developing methods for government led cumulative effects assessment – Leah Malkinson, Ministry of Forests, Lands and Natural Resource Operations.
- Provincial Area Based Analysis, Skeena Region Pilot project – Regional pilot of methods for cumulative effects assessment –Fred Oliemans, Ministry of Forests, Lands and Natural Resource Operations.
- Office of the Wet'suwet'en and Provincial Government Upper Morice Watershed Management Area monitoring plan –Ian Sharpe, Ministry of Environment, David DeWitt Office of the Wet'suwet'en.
- Future Forest Ecosystem Scientific Council (FFESC) Multi-scale Transdisciplinary Vulnerability Assessment project - evaluating climate change vulnerability of ecosystem services in the Skeena basin –Bulkley Valley Research Centre.
- Skeena watershed monitoring initiative – Greg Knox, Skeen Wild Conservation Trust
- Processes and Dynamics of the Ecosystems of the Skeena Islands – BV Research Centre – Adrian de Groot, Anne Hetherington, Sybille Hauseler.
- Skeena River Water Conservation Project – WWF-Canada, Coast Tsimshian Resources, Cortex Consultants, Brinkman Forest.
- Northwest Community College – Earth and Environmental Studies and Cultural Resource Management Degrees, Rick Trowbridge.

Project Team

- Multi-disciplinary team coordinated by the Bulkley Valley Research Centre
    - Project Manager and First Nations Engagement: Rick Budhwa MA, BV Research Centre.
    - Project coordinator: Don Morgan MSc, RPBio, BV Research Centre and BC Ministry of Environment. Has 15 years of experience in decision support of land use planning in BC, developed and implemented decision support systems for a variety of land use planning initiatives, including the North Coast Land and Resource Management Plan. Designed, implemented and managed a natural resource data management system for the Provincial government in northwest BC. He has a Master's of Science

in Biology and specializes in resilience theory, climate change, and the modelling of landscape scale natural and human disturbance and wildlife habitat supply.

- Project Strategic Advisors: Jane Lloyd Smith, Director of Resource Management, Skeena Region, Ministry of Forests, Lands and Natural Resource Operations, Kevin Kriese, Assistant Deputy Minister Northern Region, Ministry of Forests, Lands and Natural Resource Operations, Mark Zacharias Assistant Deputy Minister, Environmental Sustainability and Strategic Policy, Ministry of Environment.

- Project team members: Greg Knox, Skeen Wild Conservation Trust, Andrew Fall PhD, Gowland technologies, SFU adjunct, Dave Daust MSc, consultant, Sybille Haussler PhD UNBC adjunct, consultant, Laurence Turney EIA consultant

- Project advisors: Jim Pojar PhD, Phil Burton PhD and Chris Johnson PhD University of Northern British Columbia, Peter Duinker PhD, Dalhousie University

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