

ADAPTING TO CLIMATE CHANGE

Future Forest Ecosystems Scientific Council 2008-09 Year End Report

I INTRODUCTION

British Columbia's Chief Forester established the Future Forest Ecosystems Initiative (FFEI) in 2006 to adapt B.C.'s forest and range management framework¹ to a changing climate. The purpose of FFEI is to:

- increase our understanding of ecological changes associated with climate change, and consequent risks to ecosystem services and products (through research, modeling, monitoring, and impact and vulnerability assessments); and
- use that knowledge to adapt the forest and range management framework to changing ecological conditions (through policy analysis and adaptation).

In March 2008, the B.C. Ministry of Forests and Range (MFR) established the Future Forest Ecosystems Scientific Council (FFESC) to guide the allocation of a \$5.5 million grant-in-aid to research that supports FFEI objectives.

The FFESC is a cooperative council comprising representatives of the MFR, the University of British Columbia (UBC), and the University of Northern British Columbia (UNBC).

II FFESC MEMBERSHIP

Council

Affiliation	Role	Member	Title
MFR	Chair	Jim Snetsinger	Chief Forester
	A/Chair	Gerry Still	Director, Research Branch
	Member	Evelyn Hamilton	Manager, Ecology and Earth Sciences, Research Branch
	Member	Tom Niemann	Manager, Climate Change & Forest Carbon, Forest Practices Branch
UBC	Member	Dr. Jack Saddler	Dean of Forestry
	Member	Dr. Cindy Prescott	Associate Dean of Forestry
UNBC	Member	Dr. William McGill	Dean of College of Science and Management
	Member	Dr. Kathy Lewis	Chair, Ecosystem Science and Management Program

Secretariat

Affiliation	Role	FFESC Secretariat
MFR	FFESC Secretary	Sylvia Lak, Paul Rehsler (2008-09 fiscal year)
	FFESC Secretary	Kristine Weese (started April 2009)
UBC	Financial Administrator	Wendy Johnston
	Research Administrator	Suzi Malan (started April 2009)
UNBC	Research Coordinator	Sybille Haeussler

¹ The forest and range management framework includes legislation, policies, procedures and systems under the MFR's jurisdiction that support: biogeoclimatic classification; timber supply planning; and, management and conservation of ecosystem services, biodiversity, wildlife, fish, riparian, water, soil, terrain, tree species and genes, forage and rangeland plant communities, biotic and abiotic agents, exotic and invasive species, and fire. The management framework applies to lands subject to the Forest Act and the Range Act (primarily provincial forests and Crown range).



Ministry of
Forests and Range



III PURPOSE OF FFESC

The purpose of the Future Forest Ecosystems Scientific Council (FFESC) is to promote research that supports adaptation of B.C.'s forest and range management framework to climate change. Specifically, climate change adaptation research is intended to:

- Increase our understanding of how forest and range ecosystems can be expected to change over time as a result of climate change;
- Develop projections to forecast those changes;
- Develop methods of adapting forest and range management in response to climate change that will help reduce the impacts on forest and range ecosystems and productivity; and,
- Determine the economic and social consequences to B.C. of the changing forest and range ecosystems, and of the effects of the proposed adaptation options.

Consistent with these objectives, the scope of research funded by the FFESC is further refined to include:

1. *Impact Assessments*: evaluating the potential social, economic, and ecological consequences of climate change to forest and range ecosystems and their dependent communities;
2. *Vulnerability Assessments*: evaluating where a forest or rangeland socio-ecological system is most exposed and sensitive or least capable of adapting and identifying barriers to adaptation;
3. *Adaptation*: designing and implementing adaptive actions to reduce the vulnerabilities of forest and rangeland socio-ecological systems to climate change; and,
4. *Integration*: monitoring the response of forest and rangeland socio-ecological systems to climate change, identifying interactions, feedbacks and cumulative effects, and adjusting adaptation approaches as necessary.

IV HIGHLIGHTS OF 2008-09

In the first half of the 2008-09 fiscal year, the FFESC established its charter, terms of reference, and secretariat, and allocated funding to four high priority research projects. Three of the projects investigated the impacts of climate change on tree species, and the fourth was a climate change and fire management research strategy forum. In the second half of the fiscal year, the FFESC began preparing for the March 2009 call for research proposals by conducting an analysis of climate-change adaptation research needs, initiating development of the 2009 research program, and initiating the 'expression of interest' (EOI) process.

The FFESC's key accomplishments for 2008-09 are outlined below, with reference to other sections or the FFESC web site (http://www.for.gov.bc.ca/hts/future_forests/council/index.htm) for more information.

1. **FFESC charter and terms of reference**

The FFESC charter sets out the council's purpose, membership, governance, research objectives, and research priorities. The FFESC terms of reference describes in more detail the council's membership and decision-making, allocation and administration of funds, strategic planning, contributions to the FFESC, reporting, and auditing. The *FFESC Terms of Reference and Charter* is posted to the FFESC web site (http://www.for.gov.bc.ca/ftp/hts/external!/publish/web/ffesc/FFESC_TermsOfReference.pdf).

2. FFESC secretariat

The FFESC secretariat was established in 2008-09 to provide support to the FFESC by planning and coordinating the FFESC research program, preparing materials and organizing FFESC meetings, developing communication and extension plans and materials, managing the FFESC research grant, and preparing annual and financial reports.

The secretariat includes one representative from the MFR, two from UBC, and one from UNBC (see Section II for Secretariat membership). The FFESC terms of reference describes the Secretariat's responsibilities and its working relationship with the FFESC.

3. FFESC research coordinator

As part of its secretariat, the FFESC prepared a research coordinator job description and filled the full-time position in January 2009. The research coordinator's primary roles are:

- To synthesize existing research projects (completed and/or ongoing) that can be drawn together to address important questions related to forest and range adaptation and climate change; and,
- To identify gaps in the knowledge base, determine high priority research needs based on those gaps, and develop strategic research projects that involve multiple researchers to address research priorities.

4. Funding to high priority FFEI research projects

Four research projects received funding and started in 2008-09:

1. Potential impacts of climate change on the distribution of ecosystems and tree species in B.C.
2. Regeneration vulnerability assessment for dominant tree species throughout the central interior of B.C.
3. A study of tree species vulnerability and adaptation to climate change
4. Climate change and fire management research forum

These projects are briefly summarized in Section V, with references to appendices or web site links for more information.

5. 2009 research program (preliminary work)

The FFESC initiated development of its 2009 research program in early 2009 and completed the program in May. The program sets out:

- Guiding principles for the FFESC research program, which address eligible applicants, the interdisciplinary nature of research, scientist-client partnerships, research scope, building on existing knowledge bases, timely products, scientific merit, team competence, value for money, and balance of the portfolio of approved projects;
- The research proposal application and review process, which addresses all three process steps – expressions of interest (EOI), letters of intent (LOI), and full proposals;
- The timeline for applications and FFESC / peer review; and,
- The evaluation criteria and process used by the FFESC for reviewing proposals.

The *2009 Program Overview: Interdisciplinary Climate Change Adaptation Research* is posted to the FFESC web site (http://www.for.gov.bc.ca/ftp/hts/external!/publish/web/ffesc/FFESC_2009ProgramOverview.pdf).

6. Research needs analysis

The FFESC research coordinator completed a research needs gap analysis in 2008-09. The research needs summary outlines the scope of climate change adaptation research within the FFESC mandate, and outlines key research gaps that should be addressed by the FFESC. The gap analysis, as well as work undertaken under the FFEI, recognizes that successful climate change adaptation will require an interdisciplinary approach, including integrated natural and social sciences research, to build the knowledge and approaches required to anticipate and respond to changing forest and range ecosystems and economies.

The *Summary: Climate Change Adaptation Research Needs* and supporting appendices of research projects and topics are posted to the FFESC web site (http://www.for.gov.bc.ca/hts/future_forests/council/index.htm).

7. Call for expressions of interest (EOI)

In March 2009, the FFESC issued a 'call for expressions of interest (EOIs)' from research teams to undertake interdisciplinary research projects that will support adaptation of the forest and range management framework to climate change. 165 EOIs were received by the mid-April deadline.

V RESEARCH PROJECTS

1. Impacts of climate change on the distribution of ecosystems and tree species

Project title	Potential impacts of climate change on the distribution of ecosystems and tree species in British Columbia
Lead Researchers	Sally Aitken and Tongli Wang, Centre for Forest Conservation Genetics, Dept. of Forest Sciences, UBC
Project term	Two years
Grant	2008-09: \$40 000 (spent); 2009-10: \$40 000 (committed); total \$80 000
Purpose	To better quantify the potential impacts of climate change on the distribution of the climate niches of ecosystems and tree species in B.C. using a modelling approach based on the Random Forest classification algorithm
Progress in 2008-09	The first year of this project focussed on predicting future climates of BEC zones using the Random Forest analytical method. Project work involved optimizing modelling processes through comprehensive calibrations, and developing a model that predicts climate envelopes matching the observed BEC zones with high precision (84%). Shifts, expansion or contraction of climate envelopes of the BEC zones were predicted for mild, moderate and severe climate change scenarios for the 2020s, 2050s, and 2080s. An ecological plot dataset of over 35 000 sample plots was compiled from MFR sources. With this dataset, Random Forest models were built for several tree species (Douglas-fir, ponderosa pine, and whitebark pine). A manuscript has been completed for peer review.
For more information	See Appendix 1

2. Regeneration vulnerability assessment for dominant tree species in central B.C.

Project title	Regeneration vulnerability assessment for dominant tree species throughout the central interior of British Columbia
Lead Researcher	Dr. Craig Nitschke, Bulkley Valley Research Centre
Project term	Two years
Grant	2008-09: \$40 000 (spent); 2009-10: \$40 000 (committed); total \$80 000
Purpose	To understand the response of dominant tree species within their regeneration phase in B.C.'s central interior ecosystems to predicted climate change
Progress in 2008-09	The first year of this project included refining, parameterizing, and initial testing of the ecological model TACA (Tree and Climate Assessment) to improve its ability to model tree species response. Project work included organizing data sets, identifying climate stations, downloading station and climate change data, and testing model parameters (climate, soil-water) and proposed methodology through initial modelling for portions of SBSdk, SBSmc2, and SBSwk2.
For more information	See Appendix 2

3. Canadian trees species vulnerability and adaptation to climate change study

Project title	A study of tree species vulnerability and adaptation to climate change
Lead Researcher	Mark Johnston, Saskatchewan Research Council
Project term	Two years
Grant	2008-09: \$157 143 (spent); 2009-10: \$42 857 (committed); total \$200 000
Purpose	To organize and summarize what is currently known about the vulnerability and adaptation potential of the primary commercial tree species in Canada
Progress in 2008-09	<p>The first year of this project included the following activities:</p> <ul style="list-style-type: none"> • Progress on a literature review that will result in a comprehensive bibliography of topics related to climate change and tree species; • Consultation with government, academic and other experts across Canada; • Establishment of a web-based project management site and a prototype for a project data and networking portal that will enable continued web-based collaboration among project participants once the formal project has concluded; • Commissioning of three reports on climate change and tree physiology, insects, and vegetation modelling; • Workshops to gain insights and gather feedback on important questions and approaches the project should address/use, and how the final report and other products can be tailored to best meet the needs of provincial forest managers; and, • Presentations and publications on the project have been prepared and shared within Canada and internationally.
For more information	See Appendix 3

4. Climate change and fire management research strategy forum

Project title	Climate change and fire management research forum
Lead Researcher	Nathalie Lavoie, Wildfire Management Branch, B.C. Ministry of Forests and Range
Project term	One year
Grant	2008-09: \$40 000 (spent)
Purpose	To hold a climate change and fire management research strategy forum with a wide range of stakeholders to identify research and communication needs related to the impacts of climate change on forest and wildland fire management
Project outcomes	On February 17-19, 2009, 70 experts representing fire, environmental and health agencies, universities and research organizations from across Canada attended a Climate Change and Fire Management Research Strategy Forum in Victoria, B.C. Forum participants identified knowledge gaps related to wildfire management and climate change, and recommended priorities for research that will help strengthen land and fire management in light of climate change. The forum's key outcome was a <i>Climate Change and Fire Management Research Strategy</i> , which was published in June 2009.
For more information	Link to full report: http://bcwildfire.ca/Weather/Climate/index.htm

VI FFESC BUDGET AND EXPENDITURES FOR 2008-09

Item	Allocation	Expenditures	Balance
One time budget allocation for FFESC	\$5,500,000		
UBC - Secretariat: Financial Administration		-\$275,000	
Grant to UNBC – Secretariat: Research Coordination		-\$160,000	
Grant to Saskatchewan Research Council (Dr. Mark Johnston)		-\$157,143	
Grant to BC Ministry of Forests and Range (Dr. Nathalie Lavoie)		-\$40,000	
Grant to Bulkley Valley Centre for Natural Resources Research and Management (Dr. Craig Nitschke)		-\$40,000	
Grant to UBC Department of Forest Science (Dr. Sally Aitken)		-\$40,000	
FFESC travel expenses to attend meetings		-\$1,601	
FFESC meeting expenses		-\$107	
TOTAL	\$5,500,000	-\$713,851	
Balance available at March 31, 2009			\$4,786,149

VII FFESC PLANS FOR 2009-10

In the 2009-10 fiscal year, the FFESC plans to solicit research proposals through the expression of interest (EOI), letter of intent (LOI), and full proposal processes. Successful EOI proponents will engage in a 'collaborative planning' workshop in late April 2009, and the FFESC will work directly with successful LOI proponents to ensure full proposals meet the needs and objectives of the FFESC research program before they are approved. Approved projects will receive funding and get underway in Fall-Winter 2009. Efforts to coordinate project approaches and methodologies, and to ensure information-sharing among project teams and organizations, will be undertaken in 2009-10 to ensure optimum value for FFESC resources expended.

VIII FFESC Website

For more information on the Future Forest Ecosystems Scientific Council and its activities, visit the FFESC web site at http://www.for.gov.bc.ca/hts/future_forests/council/index.htm.

VIV APPENDICES

1. Potential impacts of climate change on the distribution of ecosystems and tree species in British Columbia, *Progress Report Mar. 31, 2009 – Year 1 of 2* (Sally Aitken and Tongli Wang, Centre for Forest Conservation Genetics, Dept. of Forest Sciences, UBC)
2. Regeneration vulnerability assessment for dominant tree species throughout the central interior of British Columbia (Dr. Craig Nitschke, Bulkley Valley Research Centre)
3. Progress report for the Canadian CFM trees species vulnerability and adaptation to climate change study (Mark Johnston, Saskatchewan Research Council)

FFESC 2008-09 Year End Report

Appendix 1

Potential impacts of climate change on the distribution of ecosystems and tree species in British Columbia

Progress Report Mar. 31, 2009 – Year 1 of 2

Sally Aitken and Tongli Wang

Centre for Forest Conservation Genetics, Dept. of Forest Sciences, UBC

The objective of this project is to better quantify the potential impacts of climate change on the distribution of the climate niches of ecosystems and tree species in British Columbia using a modelling approach based on the Random Forest classification algorithm. We are working closely with Dr. Elizabeth Campbell in Research Branch, MFR, to complete this project. The first part of the project for predicting future climates of Biogeoclimatic Ecosystem Classification (BEC) Zones has been completed. A manuscript is ready for peer reviewing. The second part is to predict climate habitats of major native forest species in future climates. This part is to be continued in next fiscal year (2009 - 2010).

In modeling observed BEC Zones with climate variables, we used Random Forest, a new analytical method, to replace the Discriminant analysis used in a previous study (Hamann and Wang 2006 Ecology). Random Forest is a machine-learning classifier that has proven to be superior to other statistical approaches in modeling complex cases such as ecosystems and species ranges with climate variables. In this study, we have optimized modeling processes through comprehensive calibrations including selection of climate variables, optimization of the number of the subset of predictors chosen for splitting each node of a decision tree, and application of a sampling strategy to balance the sample size and the area covered by each BEC Variant. The selection of climate variables was achieved by comparing annual, seasonal, monthly and combined climate variables for their modeling precision at the BEC Subzone and Variant levels. A combination of climate variables from different categories was selected for optimal modeling results.

Due to the large number of data points (1 million data points at the resolution of 1km) and climate variables (78 in testing and 44 in the final model), the requirement for computing power is beyond the capacity of a Desktop PC and a MS window operation system. Therefore, we built a workstation with Linux operating system to handle the computing for modeling and predictions.

Through optimization, we developed a model that predicts climate envelopes matching the observed BEC Zones with high precisions (84%) in an independent test, substantially superior to the model built with conventional statistical approaches. While low-elevation ecosystems were predicted with high accuracy, relatively high mismatch rates were found for subalpine and alpine ecosystems. The climatic spaces of alpine zones were contracted and that of the Mountain Hemlock zone was expanded into alpine zones compared to mapped distribution of these ecosystems. Identified mismatch areas may be used as references for improving the ecosystem classifications.

Shifts, expansion or contraction of climate envelopes of the BEC Zones were predicted for three climate change scenarios selected from the IPCC Fourth Assessment for three future periods 2020s, 2050s and 2080s spanning the range of future predictions: one mild scenario with small changes from present to future; one middle of the road scenario, and one severe scenario. Additional predictions for other commonly used GCM scenarios have also been carried out, including several Canadian (CGCM3) and British (Hadley) GCM scenarios. Predicted changes were dramatic. Most BEC zones at higher elevations and in northern B.C. are predicted to have their climate space shrink by up to 90% in area by the 2050s. In contrast, some BEC zones in southern B.C., which could be extrapolated to current ecosystems in Washington and Oregon, were predicted to expand by 30 - 300% in the province in the same period. These predictions will provide guidance for interim policy adjustments and will generate hypotheses about climate impacts that can be further tested with well-designed field experiments (e.g., species trials) in short term. Over the longer term, the results of this research and

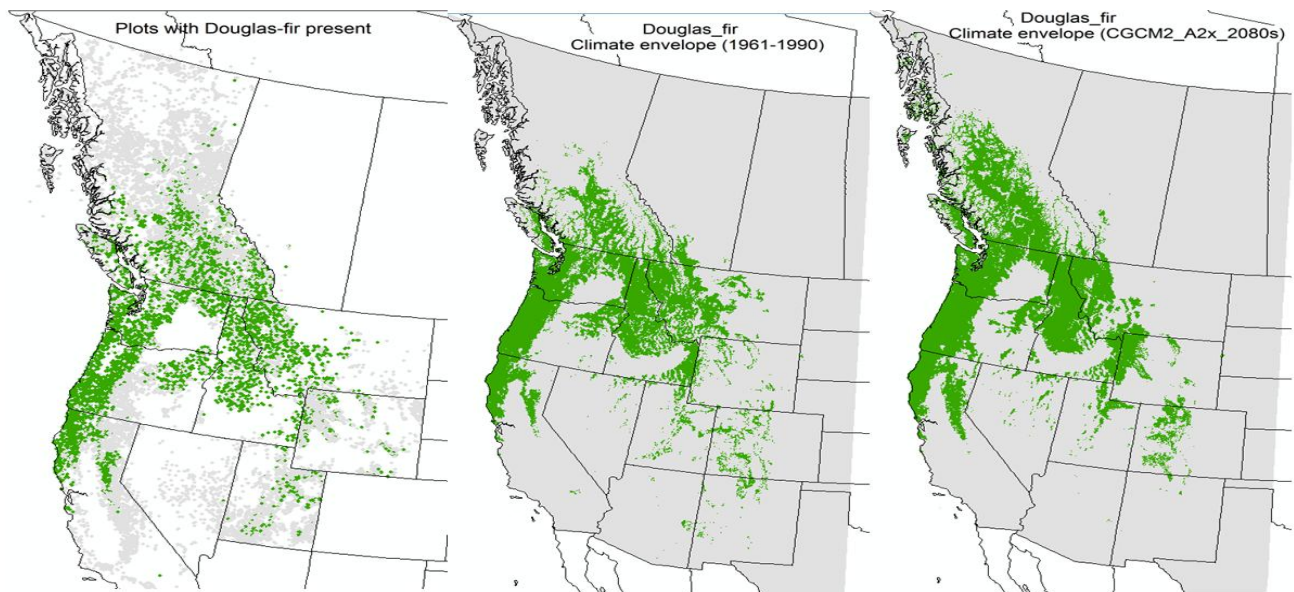
experimental testing of model projections can be used to adapt British Columbia's forest management framework to climate change.

As the future climate in B.C. might be analogous to that in the U.S., we extrapolated the model established for B.C. to predict the current BEC zones to the southern border of Oregon. We found that the predicted BEC Zones in the south match the local forest types very well. The locations of bunchgrass dominated ecosystems and alpine zones were also precisely predicted. The BEC zones predicted to expand in B.C. currently have the bulk of their distributions located south of B.C. Results of this extrapolation increased our confidence in future predictions for our province.

Predictions of climate envelopes for major tree species will be predicted using two approaches. One approach is to associate the species distributions with BEC Variants. Species occurrence frequencies in each BEC Variant have been estimated in a previous study for an earlier version of BEC (v4). In this study, we have converted them to the latest version of BEC (v7) and associated with future climate of BEC Variants. In this way, future climate envelopes for major tree species have been predicted for two GCM/scenarios CGCM2 A2x and CGCM3 A2 for 2050s.

Another approach is based on ecological plot data. Plot data for B.C. were provided by the Ecology Group at Research Branch of MFR. In order to cover the entire species ranges as much as possible, especially to the south, plot data were also extracted from Forest Inventory and Analysis (FIA) database for nine western U.S. states. In total, we have a collection of over 35,000 sample plots in our dataset. With this dataset, Random Forest models have been built for several species, including Douglas-fir (See the figure below), ponderosa pine and whitebark pine. However, some errors have been identified in the B.C. plot data; the MFR has corrected many of these errors and is in the process of fixing the remainder. The models then need to be calibrated to optimize the predictions, and to build new models for more species.

Figure 1. Distribution of plot data and predicted climate envelopes for current and 2080s for Douglas-fir.



FFESC 2008-09 Year End Report

Appendix 2

Regeneration vulnerability assessment for dominant tree species throughout the central interior of British Columbia

Dr. Craig Nitschke
Adjunct Researcher
Bulkley Valley Research Centre
Smithers, British Columbia

Project Overview

In this study, we are focussing on understanding the response of the dominant tree species within their regeneration phase in the ecosystems of the central interior of British Columbia to predicted climate change. The ecological model, TACA (Tree and Climate Assessment) (Nitschke and Innes 2008), is being refined and parameterised for use in the ecosystems of the Central Interior of B.C. TACA is being used to conduct a vulnerability analysis on the impact of current and future climates and will be used to test the range of species' responses across the Central Interior of B.C. Climate data from around the central Interior is being used to generate the climate scenarios as well as climate change predictions from the Pacific Climate Impacts Consortium (2009). Soil data from long-term BEC plots is being used to parameterise the soil component of TACA. The year one deliverables for this project is to provide an interim report on project progress.

Project Progress

The first year of this project has been spent on further model development to improve the ability of TACA to model species response. Working closely with researchers from the MFR and Canadian Forest Service has lead to refinements of the model and initial testing. This was completed in autumn 2008. The project work over the last year has primarily focussed on organising data sets to parameterise the mode. Relevant climate stations were identified for each subzone (where possible) and the data downloaded from Environment Canada. Climate change data is being downloaded from the Pacific Climate Impacts Consortium (2009) on a station by station basis. This permits us to use regional projections of climate change to cover the entire spatial context of the SBS zone. Data for the parameterisation of the soil component of the model has been collected from the MFR and is being analysed on a subzone level to provide model parameters that represent different edaphic moisture conditions. To test initial model parameters and proposed methodology initial modelling has also been completed this year for portions of the SBSdk, SBSmc2, and SBSwk2. The following sections highlight in more detail the work that has been accomplished to date in this project.

Ecological Model Refinement

The ecological model, TACA (Tree and Climate Assessment) (Nitschke and Innes 2008), was modified and parameterised for use in the Sub-Boreal Spruce (SBS) ecosystems of the province. TACA is a mechanistic model that analyses the response of trees in their fundamental regeneration niche to climate-driven phenological and biophysical variables. It conducts a sensitivity analysis to determine the probability of species presence under a range of climatic and edaphic conditions. The modelling of species presence reflects the fundamental regeneration niche of a species, because presence is directly related to establishment (McKenzie et al. 2003). The original TACA model developed by Nitschke and Innes (2008) was modified to incorporate a frost free period mechanism. Hamann and Wang (2006) found that the annual number of frost days had a significant interaction with observed species ranges in B.C. The phenology component of TACA was also improved to increase the interaction between chilling, heat sum accumulation, frost, and budburst, based on Bailey and Harrington (2006). Previous interaction in the model was limited to the accumulation of a heat sum without considering chilling period length and frost effects during this stage, or frost damage occurring after bud burst. The new phenology component integrates the obtainment of a species chilling requirement with the accumulation of its heat sum which then interacts with frost events that delay bud burst and/ or causes frost

damage after bud burst occurs. The soil moisture function was upgraded to the full Penman-Monteith equation (McNaughton and Jarvis, 1983; Waring and Running, 1998) which is driven by estimates of daily solar radiation based on calculations from Bristow and Campbell (1984) and Ferro Duarte et al. (2006). In addition the soil component of TACA was expanded to allow for three different soil types (texture and depth) to be run simultaneously allowing for the representation of multiple edaphic conditions commonly found within forest ecosystems.

Model Parameterisation

Climate Parameters

Multiple scenarios of current and future climates are being used to test the sensitivity of species' responses. In modelling climate, we are utilising local climate data and global climate change model (GCM) predictions. A direct adjustment approach is being used to integrate climate change scenarios into the historical climate records for 40 climate stations that represent the SBS subzones (Table 1). A direct adjustment approach was used by Hamann and Wang (2006) and Nitschke and Innes (2008) to model species response to predicted climate change. Three different GCMs are being used, the Canadian GCM2 (Flato et al. 2000), Hadley CM3 models (Johns et al. 2003) and the CSIROmk2b. The regional climate change predictions for the SBS zone are being obtained from the Pacific Climate Impacts Consortium (2009). Multiple climate scenarios are generated following Nakicenovic et al. (2000), who argued that due to the large amount of uncertainty regarding future climate change, multiple scenarios that span a range of possible future climates should be adopted. The Intergovernmental Panels SRES emission scenarios are being used to represent a range of potential future climate conditions (Nakicenovic et al. 2000).

Soil Parameters

The soil-water component of the model are being parameterised from plot data from the Biogeoclimatic Ecosystem Classification Database (BECdb) provided by the Ministry of Forests and Range. Plot data that contains rooting zone depth, soil texture and coarse fragment percentage classes for the SBS subzones within the study region are being analysed to calculate the average available soil water holding capacity and field capacity for each site series (SS) within each subzone. Table 1 summarises the number of plots that are being used for parameterising the soil parameters in each subzone.

Table 1: Climate and Soil Data collected and being used for project modelling

Subzone	# of Climate Stations	Minimum Elevation	Maximum Elevation	# of Soil Plots
SBSdh1	3	746	771	95
SBSdh2	2	1059	1067	1
SBSdk	11	522	884	144
SBSdw1	5	671	795	126
SBSdw2	1	899	899	139
SBSdw3	3	579	686	69
SBSmc1	----	----	----	53
SBSmc2	2	716	722	271
SBSmc3	----	----	----	65
SBSmh	3	541	570	51
SBSmk1	4	690	969	96
SBSmk2	1	732	732	59
SBSmm	----	----	----	38
SBSmw	----	----	----	159
SBSvk	3	610	648	168
SBSwk1	3	586	945	354
SBSwk2	1	680	680	65
SBSwk3	1	854	854	67
Total	43	522	1067	2020

Preliminary Modelling Results

Preliminary modelling has been conducted in the first year of this project for portions of the SBSdk, SBSmc2, and SBSwk2. Modelling was conducted using climate data from the Smithers Airport, Topley Landing, and Pine Pass Mount Lemoray climate stations. The modelling was conducted to represent four edaphic moisture conditions: subxeric, submesic/mesic, subhygric and hygric. The preliminary results are summarised in graphic form in Figures 1 to 12. The preliminary results illustrate differential responses by species between both edaphic sites and SBS subzones. In each subzone, climatic conditions become increasingly favourable for Interior Douglas Fir and Interior Cedar Hemlock zone species with subxeric sites having the most negative impacts on the SBS species in the SBSdk and SBSmc2, while species responses are mediated by hygric sites. In the SBSwk2 (Figs 9-12), the climate and edaphic conditions remain favourable for the current SBS in the 2080s with large increases in climatic and edaphic suitability for Douglas-fir and western hemlock.

FFESC 2008-09 Year End Report

Appendix 3

Progress report for the Canadian CFM trees species vulnerability and adaptation to climate change study

Mark Johnston, Saskatchewan Research Council, 31 March 2009

1. Literature review

A literature review is underway which will address the following topics with respect to climate change and tree species:

- Tree Species of Commercial Importance in Canada
- Species Range Shifts
- Adaptation through physiological adjustments
- Genetic Variation and Adaptation
- Seed Zones and Seed Management
- Forest Health (Insects and Disease)
- Forest Productivity
- Potential Policy Mechanisms and Recommendations

An on-line, publicly accessible bibliography is being established and will be a legacy product of the project.

2. Contact with Experts

The primary objective of this project is to organize and summarize what is currently known about the vulnerability and adaptation potential of the primary commercial tree species in Canada. To this end much of the effort has been spent in consulting with experts across the country. This has taken the form of several face-to-face meeting as well as telephone conference calls. Examples include a two-day tour through B.C.'s southern interior visiting forest management and research projects dealing with the impacts of climate change and potential adaptation. We have consulted with a number of faculty at UBC Faculty of Forestry and have had extensive discussions with a wide range of experts within the B.C. Ministry of Forests and Range. We have held detailed conference calls with forest genetics experts in Alberta, Ontario and members of CONFORGEN (CONservation of FORest GENetics), a national group concerned with conservation and management of Canada's forest genetic resources. We have consulted with provincial and territorial members of the Climate Change Task Force, the subcommittee of the Canadian Council of Forest Ministers that is overseeing the Tree Species Study. Dr. July Loo, forest geneticist with the Canadian Forest Service has shared a great deal of information with us related to CONFORGEN's activities and their on-line database Canadian Forest Genetic Resource Information System.

3. Web-based tools

In addition to the bibliography (established through the site 2Collab), we have established a web-based project management site, set up a project web page on Nature Network (a scientific social networking site) and established a prototype for a project data and networking portal. We feel that paper reports, while valuable, are not necessarily the most valuable tool or product resulting from projects such as this. Therefore we will continue to investigate web-based collaboration tools that can provide a legacy for continued interaction among project participants once the formal project work has finished. Final products and communication needs will be discussed with the Climate Change Task Force.

4. Commissioned reports

In addition to the literature review, we have commissioned three reports from experts which will provide greater depth in several areas. These include a review of climate change and tree physiology by Dr. Terry Blake, former professor of tree physiology at University of Toronto; a review of insects and climate change by Dr. Jan Volney, research entomologist with the Canadian Forest Service; and a review of climate change and vegetation modeling by Dr. David Price, climate change modeler with the Canadian Forest Service. We are also working closely with several experts who will review portions of the final report, including Dr. Rona Sturrock, forest pathologist with the Canadian Forest Service and Dr. Greg O'Neill, research geneticist with the B.C. Ministry of Forests and Range.

5. Workshops

We have been actively engaged in participating and hosting a number of workshops. Personnel associated with the tree species study were invited to participate in two workshops hosted by the B.C. MFR, one on biophysical impacts of climate change across B.C.'s forested landscapes, and one dealing with policy issues arising from the impacts analysis. We have held two workshops for the Climate Change Task Force in which we engaged in extensive discussions as to how the project should be structured, identification of the important questions, and how the final report and other products can best meet the needs of provincial forest managers. We also held an expert workshop dealing with the next phase of the project, soliciting their opinion as to what approaches would be best for addressing questions about ecosystem-level impacts of climate change and how climate change will affect forest management and policy.

6. Presentations and Publications

A number of publications and presentations have been or will be produced as a result of the project. An overview of the project was presented at the workshops mentioned above, and also at a national workshop on forest carbon management hosted by Pollution Probe in Toronto in December 2008. A paper describing the preliminary outcomes of the project has been accepted for presentation at the Engineering Institute of Canada's Climate Change Technology Conference (CCTC 2009) in Hamilton ON May 12-14 and will be published in the conference proceedings. We plan to publish a modified version of the paper in the Forestry Chronicle. In addition, a paper on the project has been submitted for presentation at the World Forestry Congress to be held in Buenos Aires in October 2009. At meetings of the International Model Forest Network in Finland in February 2009, the project was described and plans made to link the work directly with a major pan-European project called MOTIVE (Models for Adaptive Forest Management) that will be addressing many similar questions. Researchers at the European Forest Institute (Joensuu Finland) are particularly interested in collaboration in this area.

7. Timelines

High level summary of preliminary findings	31 March 2009
The substantive draft of final report	30 April 2009
Jurisdictional technical review	01-15 May 2009
Revisions complete and final report due	31 May 2009
Jurisdictions review and accept final report	31 June 2009
Transfer to CCFM and Council of the Federation meeting	31 July 2009