Climate Change Impacts and Adaptation Program

FINAL PROJECT EVALUATION REPORT

PLEASE NOTE: All project leaders are being asked to complete this form as part of their final report to the CCIAP.

1. Background Information

Project title: Impacts and adaptation to the effects of climate change on tree adaptiveness and disturbances in the deciduous forests of eastern Canada

CCIAP Project number: ***A634***

Principal investigator(s) and affiliation(s): *Christian Messier*, Professor, Université du Québec à Montréal (UQAM)

Collaborators and affiliations: ***Yves Bergeron***, Director, NSERC-UQAT-UQAM Industrial Chair in SFM; ***Charles Canham***, Scientist, Institute of Ecosystem Studies, USA; ***Mike Flannigan***, Research scientist, Canadian Forest Service; ***John Caspersen,*** Professor, University of Toronto; ***Marilou Beaudet***, Post-doctoral fellow, UQAM; ***Ronnie Drever***, Ph.D. candidate, UQAM; ***Henrik Hartmann***, Ph.D. candidate, UQAM; ***Luc Vescovi***, Scientist and historical climate data analyst, Ouranos; ***Philippe Gachon*****,** Scientist, CCIS-EC-MSC, Ouranos. **Marie-Lou Lefrançois**, M.Sc. candidate, UQAM.

Start date: March 1st, 2004

Completion date: December 31st, 2006

2. Plain language summary

Provide a plain language (understandable by the general public) summary of your project, focusing on its main findings or outcomes as related to the original planned objectives. Maximum length: 500 words.

We studied potential effects of climate in the sugar maple- and yellow-birch-dominated forests of eastern Canada, with a focus on changes in forest fire and tree adaptiveness as a consequence of different projected climatic change scenarios. The research on climate-related changes in fire focused on an 1800-ha landscape in Témiscamingue, as a proxy for what may happen throughout the deciduous forests in eastern Canada. We first conducted a fire history assessment in this landscape using historical air photos, provincial archives and dendrochronological field sampling to understand how much the landscape had burned in the past and the influence of these fires on canopy composition. Our principal observation was that large fires historically burned this area, despite the dominance of relatively fire retardant deciduous tree species, and the fire maintains pine and fire dependent species. We then conducted a regional assessment across the entire deciduous biome to understand how climate and fire weather, relative to a suite of physiographic and human variables such as glacial deposits and road density, affected the occurrence and area burned by large fires. We concluded that fire occurrence and area burned in a given landscape are best explained by the mean of monthly maximum temperatures during the fire season and the length and frequency of dry spells. The third analysis involved projecting these climate variables into the future using output from Global Circulation Models and, with regression, projecting the amount of area burned in Témiscamingue under five different scenarios of climate change. The primary conclusion from these projections is that although area burned may increase in the future, irrespective of scenario, the amount of area burned will likely be less than the amount of harvesting in this managed landscape as well as a smaller influence on composition than natural succession.

3. Project Objectives and Scope

(a) Describe the extent to which you met, did not meet or exceeded the objectives of your project as approved. If the objectives were not met, please explain why.

Objective 1: Characterize trends along W-E and N-S gradients for climatic variables associated with large severe natural disturbances in the deciduous forests of north-eastern North America.

This objective was well met. Using ecodistricts as sampling replicates, we analyzed variation in fire weather severity, precipitation deficit, growing season length and a myriad of other variables as they relate to the occurrence and area burned by large fires across the deciduous forests of north-eastern North America. Moreover, we analysed variation in evapotranspiration in this forest type and how this climatic variable influences aspects of tree adaptiveness. These relationships are available as a Master's thesis (M. Lefrancois) and in two publications (see Drever et al. 2007; Drever et al, submitted in section 4a).

Objective 2: Build and parameterize a landscape model using SELES[1] for the Temiscamingue area of south-western Quebec and link it to a stand-level model, SORTIE[2], to predict how both natural and human disturbances are likely to affect forest community dynamics and species composition at stand and landscape scales.

Instead of a building a spatially explicit model using SELES, time and data quality issues precipitated that we rely instead on a regression approach to investigate how climate change will potentially affect fire in the northern hardwoods. The regression approach allowed an estimate of how much area will burn in Temiscamingue under a variety of different scenarios of climate change. The data and relationships are available in an article submitted for publication by Drever et al. in April 2007 (see section 4a).

Objective 3: Understand and simulate how different stand types and compositions would change under different scenarios of climate change in a deciduous forest landscape and what management strategies and silvicultural interventions should be used to mitigate the effects of climate change.

We addressed this objective by forecasting the climatic conditions conducive to large fires in Témiscamingue using Global Circulation Model (GCM) output for different climate change scenarios. These analyses indicate the climatic conditions conducive to fire are expected to increase in the future, although the different model-scenario combinations are not unequivocal, with some model-scenarios forecasting a decrease in dry spells and others a decrease. All the model-scenarios indicate an increase in temperature, a variable with a well documented association with fire hazard. The management activities that maintain desired ecological attributes and system states in the face of climate change are described in an article published in the Canadian Journal of Forest Research (see Drever et al. 2006 in section 4a).

4. Products

[1] SELES is a very flexible spatially-explicit landscape modelling environment that contains modules for simulating different disturbance regimes and management approaches (Fall & Fall 2001).

[2] SORTIE is a light-mediated, spatially explicit, mixed-species forest dynamics model that makes population forecasts for juvenile (<10 cm DBH) and adult trees by predicting the establishment, growth and survival of every individual tree (Pacala et al. 1993; Coates et al. 2003). Note that SORTIE model development, parameterization, and validation will be performed as part of a different project.

(a) What products have been generated to date as part of the project (publications, web sites)? (Copies should be included with your report)

Forget, É., Drever, C.R. & Lorenzetti, F. 2003. Changements climatiques : impacts sur les forêts québécoises. Rapport IQAFF. Ripon. http://www.iqaff.qc.ca/publications_IQAFF/Changements%20climatiques%20%20impacts%20sur%20les%20forets%20quebecoises.PDF

Bergeron, Y., Cyr, D. , Drever, C.R., Flannigan, M., Gauthier, S., Kneeshaw, D., Lauzon, È., Leduc, A., Le Goff, H., Lesieur, D., Logan, K. 2006. Past, current, and future fire frequencies in Quebec's commercial forests: Implications for the cumulative effects of harvesting and fire on age-class structure and natural disturbance-based management. Canadian journal of forest research 36:2737 - 2744.

Drever, C.R., Messier, C., Peterson, G., Bergeron, Y. & Flannigan, M. 2006. Can forest management based natural disturbances maintain ecological resilience? Canadian journal of forest research 36: 2285-2299.

Drever, C.R., Messier, C., Bergeron, Y. & Doyon, F. 2006. Fires and canopy species composition in the Great Lake-St. Lawrence forest of Témiscamingue, Québec. Forest ecology and management 231: 27-37.

Lefrançois, M.-L. 2006. Effets régionaux, spécifiques et allométriques sur l'ouverture de la couronne du bouleau jaune, de l'érable à sucre et de la pruche du Canada : implication pour la paramétrisation du modèle sortie. Master's thesis, Université du Québec à Montréal.

Drever, C.R., Drever, M.C., Messier, C., Bergeron, Y. & Flannigan, M.D. Fire and the relative roles of weather, climate and landscape characteristics in the Great Lakes-St. Lawrence forest of Canada. 2007. Journal of vegetation science, in press.

(b) Are there plans for additional products to be generated from this project in the future? (e.g. journal publications etc.)

Drever, C. R., Bergeron, Y., Drever, M. C., Flannigan, M., Logan, T. & Messier, C. Effects of climate on occurrence and size of large fires in a northern hardwood landscape: historical trends, future predictions, and implications for climate change in Témiscamingue, Québec. Applied vegetation science, submitted.

(c) Once published, where will your project data sets be stored? If not in a publicly accessible product or web site, please identify the contact person.

All of the studies will be available in the online pages of the journals that accepted the publications, the UQAM university library or the Ouranos Consortium web site. Depending on the data set in question, the actual data will be stored with the students and their advisors.

(c) Describe how your project contributed to building capacity in the field of climate change impacts and adaptation. Where students were involved, indicate number, level and degree of participation (e.g. thesis research, report writing, data analysis, etc.)

The project provided central funding to ttwo students (C. Drever; and M. Lefrançois). These students acquired and honed invaluable skills in study design, data gathering and compilations (both in the

field and from the publicly available sources), data analyses (traditional frequentist methods, nonlinear and linear regression, model selection, spatial analyses, and others), and presentation of scientific information (public presentations, journal publications, research reports).

5. Communication of results

(a) Please list any other events (i.e. presentations, communications events, or media contacts etc.) which communicated this project beyond partners and direct stakeholders and the estimated number of people reached with each. Please include copies of any print media coverage with your report.

Students participated, either by poster, oral presentation or both, in a number of international forest ecology and forestry conferences (listed below). These meetings were open to forest managers, government regulators, academic and government researchers, First Nations, NGOs and other stakeholders, with attendees ranging from in the several hundreds to the thousands.

Drever, C.R., Messier, C., Bergeron, Y. Flannigan, M and Logan, T. 2006. Effects of climate change on large severe fires in the deciduous forest of Témiscamingue, Québec. Second Ouranos Symposium on Climate Change, Montreal, Québec (poster).

Lefrançois, M.-L., Messier, C., Beaudet, M. 2005. Variation in tree allometry and crown openness of sugar maple, yellow birch and eastern hemlock along a potential evapotranspiration deficit gradient. 5th North American Forest Ecology Workshop. Gatineau, Québec (poster).

Drever, R., Messier, C., Bergeron, Y. 2005. Fire history and canopy tree composition in the decidous forest landscape in Temiscamingue, Québec. 5th North American Forest Ecology Workshop. Gatineau, Québec (oral presentation).

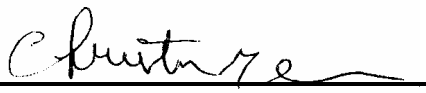
Drever, C.R. Drever, C.R., Messier, C., Peterson, G., Bergeron, Y. & Flannigan, M. 2006. Can natural disturbance-based management maintain ecological resilience in managed forests? The International Union of Forest Research Organizations, Rouyn-Noranda, Québec (oral presentation).

6. Recommendations and Comments

(a) What worked well in this project?

The collaboration with OURANOS worked very well. This allowed us to have access to a great expertise and very useful simulation outputs

8. Signature



August 2nd, 2007

Proponent Date