# Arctic Boreal Vulnerability Experiment (ABoVE)

# Canadian Forest Service Research Activities relevant to ABoVE

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## Introduction

The Canadian Forest Service (CFS) carries out research across Canada's boreal and subarctic regions, with the objectives of enhancing the international competitiveness of the forest industry and its provision of goods and employment, while managing forests and woodlands for long term sustainability. It is widely recognized that the climate in this high-latitude region is warming rapidly, posing several major threats to these key management objectives at scales that transcend our national boundaries. The CFS also leads in research and national reporting of greenhouse gas (GHG) accounting in Canada's forests and forest sector, but knowledge gaps currently limit our ability to report on the GHG contributions from Canada's vast area of unmanaged, northern boreal forest. Collaboration with US partners in ABoVE (with its focus on both natural and socioeconomic sciences in Alaska and much of northwestern Canada), would be a major opportunity to increase our understanding of the impacts of climate change on forest and tundra ecosystems, and to develop and improve adaptation strategies for their future management in a changing environment.

This dossier brings together statements of interest from CFS researchers, outlining their expertise, their past and ongoing research in the sub-arctic and boreal regions, and their ideas for potential collaborations with ABoVE researchers based in the US. Clearly we see an opportunity in leveraging the major resources that NASA and other US agencies will be investing in ABoVE over the proposed 10-year duration of this major field experiment. Canadian scientists can participate not only by providing knowledge and data, but also by contributing to the research agenda to make it more relevant and potentially more successful for everyone. Further, some recent and ongoing national initiatives carried out by CFS have direct relevance to ABoVE, including the National Forest Inventory (NFI), the Forest Change Project (which aims to put science knowledge into the hands of managers and policy makers), the National Forest Carbon Monitoring, Accounting and Reporting System (NFC-MARS), as well as contributions to national-scale mapping of Canada's natural resources (e.g., the Earth Observation for Sustainable Development (EOSD) project, and others).

## Range of CFS Research Activities and Interests

To date, several CFS researchers have already expressed interest in participating in ABoVE by providing 1-page summaries of their interests and potential contributions (see attached file). They are:

**Isabelle Aubin** (IA), Great Lakes Forestry Centre, Sault Ste-Marie, ON
**Jag Bhatti** (JB), Northern Forestry Centre, Edmonton, AB
**Celine Boisvenue** (CB), Pacific Forestry Centre, Victoria, BC
**Elizabeth Campbell** (EC), Pacific Foresry Centre, Victoria, BC
**Amy Christianson** (AC), Northern Forestry Centre, Edmonton, AB
**Martin Girardin** (MG), Laurentian Forestry Centre, Québec City, QC
**Ted Hogg** (TH), Northern Forestry Centre, Edmonton, AB
**Dave Langor** (DL), Northern Forestry Centre, Edmonton, AB
**Bonita McFarlane** (BM), Northern Forestry Centre, Edmonton, AB
**Bill Meades** (WM), Great Lakes Forestry Centre, Sault Ste-Marie, ON
**David Paré** (DP), Laurentian Forestry Centre, Québec City, QC
**Marc Parisien** (MP), Northern Forestry Centre, Edmonton, AB
**David Price** (DTP), Northern Forestry Centre, Edmonton, AB
**Anthony Taylor** (AT), Atlantic Forestry Centre, Fredericton, NB
**Dan Thompson** (DT), Northern Forestry Centre, Edmonton, AB
**Graham Stinson** (GS), Pacific Forestry Centre, Victoria, BC
**Kara Webster** (KW), Great Lakes Forestry Centre, Sault Ste-Marie, ON

Their collective expertise ranges from detailed studies of boreal and tundra ecosystem structure and function, to landscape and regional scale meta-analyses of greenhouse gas fluxes and climate feedbacks, and to community-scale assessments of human vulnerability and adaptation to climate change. Their research activities and interests support a common focus on the likely impacts of global change on Canada's unmanaged forest and peatland ecosystems, and how these impacts will affect the human communities that depend on them. Linking Canadian efforts in these research areas to ABoVE would provide some great opportunities to work with funded researchers operating from US research institutions. Specific questions that could be addressed include:

- What are the implications of climate change for the greenhouse gas (GHG) budget of Canada's northern ecosystems?
- How are fire regimes changing in northern Canada and what will be the impacts on ecosystems, C cycling and human communities?
- What is the sensitivity of endemic and invasive insect pests to climate change and human activities in high latitude ecosystems?
- How will climate change affect boreal and tundra ecosystem functioning and provision of environmental services (including fresh water, food and wood fibre)?

## Potential contributions to ABoVE

Within these broad questions, the expressions of interest from CFS scientists cover a wide range of topics and approaches:

**Large-scale (regional to continental) science**

- Improvements to models, particularly DVMs, with detailed species level knowledge and parameters (IA, MG, WM, DTP, AT, EC)
- Identification and mapping of forest ecosystem vulnerability and responses to climate change, including cross-border trends and interactions (IA, MG, TH, DL, WM, MP, DTP, AT, KW, EC)
- Large-scale assessments of GHG fluxes and comparisons among regions (including southerly and westerly sites as proxies for more northerly sites in future climates) (JB, CB)
- Ground-truthing of remote-sensing measurements (JB, TH, GS)
- Collaboration on stand and landscape-level measurements of ecosystem processes (fire, drought, permafrost, vegetation dynamics, pest and non-pest arthropod population dynamics) (JB, CB, MG, TH, DL, MP, AT, KW, DT, EC)
- Sharing of and access to spatial databases (CB, MG, MP, DTP, GS, EC)
- Research on community responses to wildfires, major insect outbreaks and other large-scale disturbances (BM, MP)
- Engaging with Canadian northern communities on climate change impacts, vulnerability and adaptation (AC, BM, DTP, EC)
- Western Canadian boreal forest resilience to climate change: tipping points and implications for land management policies and practices EC)
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**Forest productivity and health**

- Impacts of climate change and variability on forest productivity, based on tree-ring analysis from Canada's National Forest Inventory (NFI), other plot networks, and model simulations. (MG, TH, EC)
- Drought and insect defoliator impacts on growth, health and dieback of aspen forests across Canada (TH)
- Western boreal forest dynamics and productivity in response to climate- altered disturbance regimes: bark beetle, fire and drought (EC)
- Birch decline and its possible environmental drivers in western Canada (DL, with TH).
- Plant species acclimation and adaptation to climate change (AT, IA)
- Importance of understory species to forest dynamics under climate change (input to dynamic vegetation models) (IA)

**Forest carbon cycling**

- Environmental controls on C dynamics (stocks, emissions/uptake) of northern forests and peatlands at landscape to continental scales. (JB, DP)
- BOREAS/BERMS research on interannual variation in carbon and water fluxes (TH, collaboration with A Barr (Environment Canada), TA Black (UBC), and others)

**Forest insect and diseases**

- Environmental triggers for recent range expansion and population growth of bark- and wood-boring beetles, and their adaptation to novel environments. (DL)
- Responses of terrestrial arthropods to wildfire and harvesting in NW Alberta (DL)
- Spread of non-native terrestrial arthropods throughout Canada. (DL)
- Composition of insect communities in northern forests and wetlands (DL)

**Forest fire dynamics**

- Effects of biomass accumulation on wildfire ignition and spread in northern Alberta and NWT (MP, DT)
- Climate change impacts on boreal fire activity, using paleo records, field experiments, and modelling (MG)

**Remote sensing**

- Using airborne LiDAR to map forest/peatland boundaries and estimate C pools. (JB)
- Mapping peatland and permafrost using Landsat-5 TM and Radarsat-2 imagery (KW, collaboration with B Leblon, UNB).
- Validating causes of forest ecosystem "greening" and "browning" through linkage of MODIS and AVHRR observations with plot-based measurements (TH).

**Database construction (national to global)**

- Expansion of forest plot networks (e.g., NFI) in unrepresented, northerly portions of the western boreal forest (e.g., Yukon) (GS).
- Pan-Canadian standardized approach to analyze understory species' climate change responses and adaptive capacity (IA)
- Building national-level data bases of past forest disturbances (CB)
- Knowledge integration on sensitivity of Canadian tree species to climate change (IA)
- Traits of Plants in Canada (ToPiC) plant traits database (IA)
- Potential natural vegetation in the boreal biome (Arctic Council's Conservation of Arctic Flora and Fauna Working Group) and links to Canadian National Vegetation Classification (WM)

**Process modelling**

- Climate change effects on plant species distribution, diversity and community dynamics in northern ecosystems (AT)
- Mapping fire probability by simulating environmental controls at fine-scale (landscape to regional) (MP, DT)
- Effects of climate change on forest productivity (CB)
- GHG exchange along a permafrost gradient using site-level data (KW)

**Integrated modelling**

- Tracking changes in forest/tundra carbon stocks and GHG exchanges in the Mackenzie valley due to human activities and climate change (effects on permafrost thaw, fire occurrence, vegetation productivity and peat accumulation) (JB, DTP, DT)
- Statistical modeling of large-scale (sub-continental to global) fire activity (MP)
- Using ecological land classification as a surrogate for monitoring arthropod diversity (DL)
- Regional and national scale forest carbon including Canada's National Forest Carbon Monitoring and Accounting System (NFCMARS). (CB)
- Using zonal, azonal and extrazonal vegetation concepts to tease out contributions of climate, geology and disturbance to distribution of boreal vegetation types (WM)
- Assessing ecosystem "tipping points" through regional to national-scale mapping and analysis of simple climate-based site moisture indices (TH, DTP)
- Observed and projected changes in annual tree growth/biomass accumulation (EC)

**Human dimensions**

- Community mitigation and preparedness approaches to reduce wildfire risk (BM)
- Fire management and Aboriginal communities (integrating traditional values; managing (evacuations of threatened communities) (AC)

- Adaptation of Aboriginal communities to climate change (AC, DTP)
- Public perceptions of forest insect disturbance (e.g., mountain pine beetle) (BM)
- Research ethics for working with Aboriginal communities (AC)

# Appendix

## Collated one-pagers from Canadian Forest Service researchers

## Name, position, and contact information:

Isabelle Aubin, Research Scientist (Forest Ecologist), Great Lakes Forestry Centre, Sault Ste-Marie
Email: Isabelle.Aubin@nrcan.gc.ca, Ph: 705-541-5516

**Research activities relevant to ABoVE:**

- Transdisciplinary research team (ecophysiology, community ecology and genetics) investigating understory species response and adaptive capacity to climate change (Munson, Aubin & coll. Co-VITAS: Understory plants as sentinels of changes in ecosystem function). This project includes a pan-Canadian standardised field monitoring and laboratory analysis.
- Theoretical and empirical assessment of the functional importance of understory species to forest dynamics under climate change (including understory role in tree migration dynamics and on soil productivity). In collaboration with modellers to feed vegetation dynamics models. (Co-VITAS, Gravel et al. Quantifying and mapping the impacts of climate change on the productivity of Eastern Canadian forests)
- Vulnerability assessment of Canadian tree species. Knowledge integration on tree sensitivity and exposure to the main climate change driver (Aubin & coll.)
- Head researcher of the Topic network (Traits Of Plants In Canada) facilitating trait data sharing among scientists

**Potential benefits of collaboration with ABoVE:**

- Collaboration with modellers to include in models tree/understory species sensitivity, adaptive capacity and/or key characteristics for ecosystem functions.
- Knowledge integration on vulnerabilities to key climate change drivers (cross-border mapping)

**Types of collaboration of interest:**

- Collaborative, transdisciplinary research/synthesis and review aiming to integrate various key aspects of species exposure, response and adaptation capacity to climate change
- Large-scale standardized/trandisciplinary field monitoring campaign to assess key knowledge gaps (e.g. on adaptive capacity)

**Relevant publications:**

Aubin, I., Munson, A., Cardou, F., Kebli, H., Shipley, B., Burton, P., Isabel, N., Lieffer, V., Paquette, A., Messier, C., Valladares. Key traits of ecological significance for tree vulnerability to climate change. In prep.

Pedlar, J.H., McKenney, D.W., Aubin, I., Beardmore, T., Beaulieu, J., Iverson, L., O'Neil, G.A., Winder, R.S., & Ste-Marie, C. Placing Forestry in the Assisted Migration Debate. 2012. Bioscience. 62 (9): 835-842.

Aubin, I., Garbe, C.M., Colombo, S., Drever, C.R., McKenney, D.W., Messier, C., Pedlar, J., Saner, M.A., Venier, L., Wellstead, A.M., Winder, R., Witten, E. & Ste-Marie, C. 2011. Why we disagree about assisted migration: Ethical implications of a key debate regarding the future of Canada's forests. Forestry Chronicle 87 (6): 1-11.

Laliberté, E., Wells, J., DeClerck, F., Metcalfe, D., Aubin, I., Catterall, C., Queiroz, C., Bonser, S., Ding, Y., McNamara, S., Fraterrigo, J., Morgan, J., Vesk, P. & Mayfield, M. 2010. Land use intensification reduces response diversity in plant communities. Ecology Letters 13 : 76-86.

**Suggestions about your contacts who we could contact for engaging other Canadian researchers:**

Alison Munson, Faculté de foresterie, de géographie et de géomatique Université Laval, Québec, Canada
Alison.Munson@sbf.ulaval.ca

Dr. Dominique Gravel. Laboratoire d'écologie Théorique. Université du Québec à Rimouski, Rimouski, Canada
Dominique_Gravel@uqar.ca

## Name, position, and contact information:

J. (Jag) Bhatti, Research Scientist (Vegetation-Soil Interactions), Northern Forestry Centre, Edmonton
Email: Jagtar.Bhatti@nrcan.gc.ca, Ph: 780-435-7241

### Research activities relevant to ABoVE:

The key science question I am attempting to answer is: Can we improve our assessment of the Mackenzie valley region being a source or sink of C and other GHGs by means of integrated field and *in situ* studies, airborne remote sensing (LiDAR), and detailed process-based modeling? Specific topics include:

- Monitoring and assessment of variations in carbon stocks and GHG exchanges due to climate change and disturbances along a Boreal-Subarctic-Arctic ecoregion gradient in the Mackenzie valley.
- Determining environmental controls on C dynamics (stocks, emissions/uptake) and other GHG emissions (e.g., methane), and how these controls change at landscape and continental scales.
- Use of airborne LiDAR to delineate forest and peatland boundaries by assessing the transition zones between them, and to associate peatland types for mapping purposes and estimate respective C pools.
- Monitoring spatial and temporal changes in C stocks and fluxes in forest, peatlands and transition zones using airborne LiDAR alone, or in combination with field observations and modeling, for forest inventory and C accounting.
- Assessing effects of past climate-driven permafrost thawing and increased frequency of fire events on large-scale C dynamics (including productivity and respiration/decomposition rates) in forests and peatlands along the ecoregion gradient in the Mackenzie valley.
- Attribution of recent changes in above- and below-ground productivity (plant growth and peat accumulation rates) in the Mackenzie valley to climate change, natural climate variability and direct human impacts.

### Potential benefits of collaboration with ABoVE:

- Opportunity to compare and improve estimates of landscape and larger-scale GHG fluxes from northern forests and peatlands.
- Validation of larger-scale remote sensing estimates from ground studies, including airborne LIDAR measurements of forest/peatland boundaries.
- Contribution of combined expertise to assess effects of climate change and changing occurrence of fires, droughts and permafrost melting on regional and continental carbon stocks.

## Types of collaboration of interest:

- Regional to subcontinental scale assessments of GHG balances and carbon stocks in forests and peatlands
- Cross-comparison/validation of estimates with other groups
- Site-level measurements of GHG fluxes, particularly methane from wetlands and thawing permafrost

## Relevant publications:

Dimitrov D et al. 2014. Ecological Modelling 274C: 57-70, doi: 10.1016/j.ecolmodel.2013.11.030
Bhatti J S et al 2006. Canadian Journal of Soil Science 86: 321–333

**Name, position, and contact information:**

C. Boisvenue, Research Scientist (Climate Change and Carbon Modelling), Pacific Forestry Centre, Victoria, BC; Email: Celine.Boisvenue@nrcan.gc.ca, Ph: 250-298-2311

**Research activities relevant to ABoVE:**

- Research and modelling regional and national scale forest carbon. Expertise in the National Forest Carbon Monitoring and Accounting System (NFCMARS).
- Development of spatial representation (with all the involved data layers) of carbon modelling inputs and outputs.
- Representation of the effects of climate change on forest productivity for incorporation in modelling systems.
- Established national-level data bases for past and current forest disturbances.

**Potential benefits of collaboration with ABoVE:**

- Opportunity to link into an established system for regional and national forest modelling.
- Opportunity to share spatial data bases.
- Opportunity to advance the representation of forest carbon dynamics for regional and national applications.

**Types of collaboration of interest:**

- Regional and large-scale synthesis incorporating of various research findings into modelling platforms.
- Facilitate data sharing and participate in planning and coordination of data integration into modelling platforms.
- Participate in syntheses and reviews, including the review and analysis of historical, climate-related changes in forest productivity across the ABoVE study domain.

**Relevant publications:**

Wu C, Hember RA, Chen JM, Kurz WA, Price DT, Boisvenue C, Gonsamo A, Ju W: Accelerating Forest Growth Enhancement due to Climate and Atmospheric Changes in British Columbia, Canada over 1956-2001. Sci. Rep. 4, (2014).

Gonsamo A, Chen JM, Price DT, Kurz WA, Liu J, Boisvenue C, et al.: Improved assessment of gross and net primary productivity of Canada's landmass. Journal of Geophysical Research: Biogeosciences 118(4), 2013JG002388 (2013).

Boisvenue C, Running SW: 4.12 - Controls on Provisioning Services and Forest Productivity: Responses and Risk under Changing Environmental Conditions. In: Climate Vulnerability, Pielke RA (Ed.^(Eds). Academic Press, Oxford 129-149 (2013).

Kurz WA, Shaw CH, Boisvenue C et al.: Carbon in Canada's boreal forest — A synthesis1. Environmental Reviews 21(4), 260-292 (2013).

Hasenauer H, Petritsch R, Zhao M, Boisvenue C, Running SW: Reconciling satellite with ground data to estimate forest productivity at national scales. Forest Ecology and Management 276(0), 196-208 (2012).

Deluca TH, Boisvenue C: Boreal forest soil carbon: distribution, function and modelling. Forestry, (2012).

Boisvenue C, Bergeron Y, Bernier PY, Peng C: Simulations show potential for reduced emissions and carbon stocks increase in boreal forests under ecosystem management. Carbon Management 3(6), 553-568 (2012).

Stinson, G., Kurz, W.A., Smyth, C.E., Neilson, E.T., Dymond, C.C., Metsaranta, J.M., Boisvenue, C., Rampley, G.J., Li, Q., White, T.M. and D. Blain. Global Change Biology (2011). An inventory-based analysis of Canada's managed forest carbon dynamics, 1990 to 2008 .

Boisvenue, C., and S. Running. 2010. Simulations show decreasing carbon stocks and potential for carbon emissions for Rocky Mountain forests in the next century. Ecological Applications. Volume 20 issue 5, Pages 1302-1319

Boisvenue, C. and S.W. Running, 2006. Impacts of Climate Change on Natural Forest Productivity – Evidence Since the Middle of the 20th Century. Global Change Biology, Volume 12 Issue 5, Pages 862 - 882.

**Name, position, and contact information:**

Elizabeth Campbell, Research Scientist (Disturbance Ecology/Forest Dynamics), Pacific Forestry Centre, Victoria, BC; Email: Elizabeth.Campbell@canada.ca, Ph: 250-298-2368

**Research activities relevant to ABoVE:**

1. Forest ecosystem vulnerability/resilience to environmental change:
   - Forest structure, dynamics, and productivity along climate and disturbance gradients
   - Impacts of altered disturbance regimes (insects, drought, landuse) on western boreal forests
   - Forecasts of future forest ecosystem structure/productivity

2. Adapting forest management/landuse planning for a changing climate
   - Strategic monitoring of ecosystem change
   - Sustainable forest management:(e.g., harvest and reforestation patterns/silviculture)
   - Conservation of forest biodiversity in protected areas networks

**Potential benefits of collaboration with ABoVE:**

- Opportunity to share current knowledge on western boreal forest dynamics
- Opportunity to share databases and model forecasts of western boreal forest changes in structure, growth, and productivity.
- Opportunity to share experiences on climate change adaptation planning

**Types of collaboration of interest:**

- Large-scale analyses/syntheses of boreal forest responses to climate change
- Targeted field research on altered disturbance regimes and ecosystem trajectories of change
- Developing science-based policies/practices for adapting landuse planning to a changing climate

**Relevant publications:**

Campbell, E., J. Antos. 2015. Advance regeneration and trajectories of stand recovery following mountain pine beetle outbreaks boreal forests of British Columbia. *Canadian Journal of Forest Research.* 45: 1327-1337.

Rehfeldt, J.R, Crookston, N. Sáenz-Romero, C., Campbell, E. 2012. North American vegetation model for land-use planning in a changing climate: a solution to large classification problems. *Ecological Applications*. 22(1): 119-141.

Wang, T., E. Campbell, G. O'Neill, and S. Aitken. 2012. Projecting future distributions of ecosystem climate niches: uncertainties and management applications: *Forest Ecology and Management*. 279:128-140.

Alfaro, R., Campbell, E., Hawkes, B., 2011. Historical frequency, intensity and extent of mountain pine beetle disturbance in British Columbia. Natural Resources Canada.

Campbell, E., S. Saunders, D. Coates, D. Meidinger, G. O'Neill, D. MacKillop, A. MacKinnon, C. Delong and D. Morgan. 2009. Ecological resilience: a framework for understanding and managing British Columbia's forest ecosystems in a changing climate. British Columbia Ministry of Forests Forest Science Program. Tech. Rep. 55.

Haeussler, S., A. Woods, K. White, E. Campbell, A. Banner, and P. LePage. Do Whitebark Pine – Lichen Ecosystems of West Central British Columbia Display Tipping Point Behaviour in Response to Cumulative Stress? 2009. Bulkley Valley Centre for Natural Resources Research and Management. Res. Report 09-06.

**Suggestions about your contacts who we could contact for engaging other Canadian researchers:**

Sally Aitken, Professor, University of British Columbia, sally.aitken@ubc.ca
Tongli Wang, Professor, University of BritishColumbia. tlwang@mail.ubc.ca
Greg O'Neill, Research Scientist, BC Min. For., Lands, Nat. Res.Ops. Greg.ONeill@gov.bc.ca

**Name, position, and contact information:**

Amy Christianson, Research Scientist (Fire Social Science), Northern Forestry Centre, Edmonton
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**Research activities relevant to ABoVE:**

- Fire management and Aboriginal communities
    - Integration of cultural values into fire management
    - Improving wildfire evacuation of remote Aboriginal communities
- Adaptation of Aboriginal communities to climate change
- Research ethics for working in collaboration with Aboriginal communities

**Potential benefits of collaboration with ABoVE:**

- Opportunity to collaborate with/advise other social science researchers working in Canada's North on the adaptation of Aboriginal communities to climate change
- Opportunity to advise researchers on research ethics for engaging Canadian Aboriginal communities

**Types of collaboration of interest:**

- Fire management and Aboriginal communities
- Adaptation of Aboriginal communities to climate change
- Research ethics

**Relevant publications:**

**Amy Christianson** (2014) Social Science Research on Indigenous Wildfire Management in the 21st Century and Future Research Needs. *International Journal of Wildland Fire – special issue: social science*. Online Early.

**Amy Christianson**, Tara McGee and Lorne L'Hirondelle (2014) The Influence of Culture on Wildfire Risk Perception and Mitigation Preferences at Peavine Métis Settlement. *Society & Natural Resources.* 27(9): 931-947

**Amy Christianson,** Tara McGee and Lorne L'Hirondelle (2013) How historic and current wildfire experiences influence wildfire mitigation preferences in an Aboriginal community. *International Journal of Wildland Fire.* 22(4): 527-536.

**Amy Christianson**, Tara McGee, and Lorne L'Hirondelle (2012) Community Support for Wildfire Mitigation at Peavine Métis Settlement, Alberta, Canada. *Environmental Hazards: Human and Policy Dimensions.* 11(3): 177-193.

**Name, position, and contact information:**

Martin P. Girardin, Research Scientist (Forest productivity), Laurentian Forestry Centre, Quebec
Email: martin.girardin@nrcan.gc.ca , Ph: 418-648-5826

**Research activities relevant to ABoVE:**

- Research of climate variability and climate change impacts on the growth of boreal forests through Canada, including tree-ring analysis (National Forest Inventory) and model simulations.
- Research of climate change impacts on fire activity of boreal forests of eastern and central Canada, including analyses of paleoecological records (fire scars, stand-replacing fire histories, sedimentary charcoal), field experiments, and model simulations.

**Potential benefits of collaboration with ABoVE:**

- Opportunity to extend our current knowledge of processes driving changes in boreal forest growth and fire activity.
- Opportunity to extend and share data networks for validating model projections of boreal forest growth and fire activity.
- Opportunity to identify ecosystem types most vulnerable to future climatic changes across the ABoVE study domain through harmonized, cross-border analyses and field experimental designs.

**Types of collaboration of interest:**

- Large-scale analyses of boreal forest growth and wildfire responses to climatic variation (including drought and large-scale atmospheric drivers such as Arctic sea ice decline) in combination with impacts of demographic processes and plant functional traits.
- Targeted field research to address key knowledge gaps in northern boreal forests
- Facilitate data sharing and participate in planning and coordination of biophysical, forest-related field research (as funding and our federal government travel policies permit).
- Participate in syntheses and reviews, including the review and analysis of historical, human and climate-related changes in forest productivity and fire activity in the ABoVE study domain
- Preference for informal, science-based collaborations with minimal administrative requirements

**Relevant publications:**

Girardin, M.P., Ali, A.A., Carcaillet, C., Blarquez, O., Hély, C., Terrier, A., Genries, G., Bergeron, Y. 2013. Vegetation limits the impact of a warm climate on boreal wildfires. New Phytol. 199: 1001–1011.

Girardin, M.P., Xiao Guo, J., de Jong, R., Kinnard, C., Bernier, P.Y., Raulier, F. 2014. Unusual forest-growth decline in boreal North America covarying with the retreat of Arctic sea ice. Glob. Change Biol. 20, 851-866.

Girardin, M.P., Guo, J.X., Bernier, P.Y., Raulier, F., Gauthier, S. 2012. Changes in growth of pristine boreal North American forests from 1950 to 2005 driven by landscape demographics and species traits. Biogeosciences 9, 2523-2536.

Terrier, A., de Groot, W.J., Girardin, M.P., Bergeron, Y. 2014. Dynamics of moisture content in spruce-feather moss and spruce-Sphagnum organic layers during an extreme fire season and implications for future depths of burn in Clay Belt black spruce forests. Int. J. Wildland Fire 23: 490-502.

Ali, A.A., Blarquez, O., Girardin, M.P., Hély, C., Tinquaut, F., Guellab, A.E., Valsecchi, V., Terrier, A., Bremond, L., Genries, A., Gauthier, S., Bergeron, Y. 2012. Control of the multimillennial wildfire size in boreal North America by spring climatic conditions. Proceedings of the National Academy of Sciences USA, 109(51), 20966–20970

**Suggestions about your contacts who we could contact for engaging other Canadian researchers:**

Yves Bergeron, Professor, Université du Québec, Yves.Bergeron@uqat.ca

**Name, position, and contact information:**

E.H. (Ted) Hogg, Research Scientist (Forest-climate interactions), Northern Forestry Centre, Edmonton
Email: Ted.Hogg@nrcan.gc.ca, Ph: 780-435-7225

**Research activities relevant to ABoVE:**

- Research and monitoring of drought and insect defoliator impacts on the growth, health and dieback of aspen forests in the west-central Canadian interior, including tree-ring analysis and plot-based measurements (CIPHA study and National Forest Inventory).
- Assessment of ecosystem "tipping points" through regional to national-scale mapping and analysis of simple climate-based indices (Climate Moisture Index and Soil Moisture Index)
- Long-term research on factors affecting interannual variation in carbon and water fluxes at the BOREAS/BERMS Old Aspen site in Saskatchewan (with Barr, Black and others).

**Potential benefits of collaboration with ABoVE:**

- Opportunity to validate and determine causes of forest ecosystem "greening" and "browning" through linkage of remote sensing observations with annual ground-based measurements.
- Opportunity to extend our current knowledge of climate-related changes in aspen forests to include regions "north of 60".
- Opportunity to identify ecosystem types most vulnerable to future warming and drying across the ABoVE study domain through harmonized, cross-border mapping of climatic indices.

**Types of collaboration of interest:**

- Large-scale analyses of aspen forest responses to climatic variation (including drought and permafrost thawing) in combination with impacts of insects and decay fungi.
- Targeted field research to address key knowledge gaps in northerly aspen forests
- Facilitate data sharing and participate in planning and coordination of biophysical, forest-related field research (as funding and our federal government travel policies permit).
- Participate in syntheses and reviews, including the review and analysis of historical, climate-related changes in forest productivity of upland forests in the ABoVE study domain
- Preference for informal, science-based collaborations with minimal administrative requirements

**Relevant publications:**

Allen, C.D., Macalady, A.K., Chenchouni, H., Bachelet, D., McDowell, N., Vennetier, M., Kitzberger, T., Rigling, A., Breshears, D.D., Hogg, E.H.,and others. 2010. A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. For. Ecol. Manage. 259:660–684.

Hogg, E.H., Barr, A.G., Black, T.A. 2013. A simple soil moisture index for representing multi-year drought impacts on aspen productivity in the western Canadian Interior. Agric. For. Meteorol. 178-179: 173-182.

Hogg, E.H., Brandt, J.P., and Michaelian, M. 2008. Impacts of a regional drought on the productivity, dieback and biomass of western Canadian aspen forests. Can. J. For. Res. 38(6):1373–1384.

Hogg, E.H., and P.Y. Bernier. 2005. Climate change impacts on drought-prone forests in western Canada. Forestry Chronicle 81: 675-682.

Hogg, E.H., and R.W. Wein. 2005. Impacts of drought on forest growth and regeneration following fire in southwestern Yukon, Canada. Can. J. For. Res. 35: 2141-2150.

Michaelian, M., Hogg, E.H., Hall, R.J., and Arsenault, E. 2011. Massive mortality of aspen following severe drought along the southern edge of the Canadian boreal forest. Global Change Biol. 17: 2084-2094

Worrall, J.J., Rehfeldt, G.E., Hamann, A., Hogg, E.H., Marchetti, S.B., Michaelian, M., and Gray, L.K. 2013. Recent declines of Populus tremuloides in North America linked to climate. For. Ecol. Manage. 299:35-51.

Zhang, K., Kimball, J.S., Hogg, E.H., Zhao, M., Oechel, W.C., Cassano, J.J., and Running, S.W. 2008. Satellite-based model detection of recent climate-driven changes in northern high-latitude vegetation productivity. J. Geophys. Res. 113, G03033, doi: 10.1029/2007JG000621.

**Name, position, and contact information:**

David W. Langor, Research Scientist (Forest-climate interactions), Northern Forestry Centre, Edmonton
Email: dlangor@nrcan.gc.ca, Ph: 780-435-7330

**Research activities relevant to ABoVE:**

- Research on bark- and wood-boring beetles in west-central Canada to understand the environmental triggers for recent expansion or range and unprecedented population growth, and the adaptation of beetles to novel environments.
- Monitoring of birch decline throughout western Canada and investigation of possible environmental causes (with Ted Hogg).
- Long-term research in NW Alberta to understand the responses of terrestrial arthropods to natural (wildfire) and anthropogenic (e.g., harvesting) disturbances.
- Research to explore the utility of ecological land classification systems as a surrogate for monitoring terrestrial arthropod diversity in west-central Alberta.
- Monitoring the spread and population levels of non-native terrestrial arthropods throughout Canada.
- Characterizing baseline insect community composition in various terrestrial habitats (e.g., forest, wetlands) in west-central and eastern Canada

**Potential benefits of collaboration with ABoVE:**

- Opportunity to determine the responses of terrestrial arthropods to forest ecosystem "greening" and "browning", including the impacts of insects (defoliators and bark/wood-boring species) on forest health and productivity, and the responses of non-pest species to environmental changes.
- Opportunity to extend our current knowledge of baseline terrestrial arthropod community composition of forest and non-forest habitats to include regions "north of 60".
- Opportunity to investigate the rate of spread and impacts of invertebrate species into the north.
- Opportunity to investigate the possible impacts of climate change on northern birches.

**Types of collaboration of interest:**

- Large-scale documentation of: 1) composition of terrestrial arthropod communities in northern forested and non-forested ecosystems; current state of birch health throughout the north.
- Targeted field research to address: 1) responses of ground dwelling arthropods to melting of permafrost; 2) spread and impact of non-native species in natural habitats; 3) expansion and impact of native bark/wood-boring insects into northern forests.
- Facilitate data sharing and participate in planning and coordination of biophysical, forest-related field research (as funding and our federal government travel policies permit).
- Participate in syntheses and reviews, including the understanding of historical patterns of biodiversity in the ABoVE study domain

**Relevant publications:**

Buddle, C.M., D.W. Langor, G.R. Pohl and J.R. Spence. 2006. Arthropod responses to harvesting and wildfire: implications for emulation of natural disturbance in forest management. Biological Conservation 128:346-357.

Langor, D.W. and J.R. Spence. 2006. Arthropods as ecological indicators of sustainability in Canadian forests. Forestry Chronicle 82:344-350.

Langor, D.W., J.R. Spence, H.E.J. Hammond, J. Jacobs and T.P. Cobb. 2008. Saproxylic beetle assemblages in Canadian forests: diversity, ecology and conservation. Canadian Entomologist 140:453-474.

Rice, A.V., M.N. Thormann and D.W. Langor. 2008. Mountain pine beetle-associated blue-stain fungi are differentially adapted to boreal temperatures. Forest Pathology 38:113-123.

Work, T.T., M. Koivula, J. Klimaszewski, D.W. Langor, J.R. Spence, J. Sweeney, and C. Hebert. 2008. Evaluation of carabid beetles as indicators of forest change in Canada. Canadian Entomologist 140:393-414.

Safranyik, L.; Carroll, A.L.; Régnière, J.; Langor, D.W.; Riel, W.G.; Shore, T.L.; Peter, B.; Cooke, B.J.; Nealis, V.; Taylor, S.W. 2010. Assessment of range expansion of the mountain pine beetle in the boreal forest. Canadian Entomologist 142:415-442.

Pinzon, J.; Spence, J.R.; Langor, D.W. 2012. Responses of ground-dwelling spiders (Araneae) to variable retention harvesting practices in the boreal forest. Forest Ecology and Management 266:42-53.

Langor, D.W.; Cameron, E.; MacQuarrie, C.J.M.; McBeath, A.; McClay, A.; Peter, B.; Pybus, M.; Ramsfield, T.; Ryall, K.; Scarr, T.; Yemshanov, D.; DeMarchant, I.; Foottit, R.; and Pohl, G.R. 2014. Non-native species in Canada's boreal ecozone. Environmental Reviews (in press)

**Name, position, and contact information:**
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Email: Bonita.McFarlane@NRCan.gc.ca , Ph: 780-435-7383

**Research activities relevant to ABoVE:**

- Community adaptations to natural disturbance
    - Community mitigation and preparedness approaches to reduce wildfire risk
    - Public perceptions of forest insect disturbance (e.g., mountain pine beetle)

**Potential benefits of collaboration with ABoVE:**

- Opportunity to collaborate with other social science researchers working in Canada's boreal forest on the adaptation of communities to changes in natural disturbance

**Types of collaboration of interest:**

- Wildfire management and communities
- Human dimensions of forest insect disturbance

**Relevant publications:**

McFarlane, B.L.; Parkins, J.R.; Watson, D.O.T. (2012). Risk, knowledge and trust in managing forest insect disturbance. *Canadian Journal of Forest Research*. 42: 710-719.

McFarlane, B.L.; Faulkner, H.; McGee, T.K. (2011). Complexity of homeowner wildfire risk mitigation: An integration of hazard theories. *International Journal of Wildland Fire,* 20: 921-931.

Faulkner, H.; B.L. McFarlane; T.K. McGee. (2009). Comparison of homeowner response to wildfire risk among towns with and without wildfire management. *Environmental Hazards,* 1:1–14.

McFarlane, B.L., D.O.T. Watson. (2008). Perceptions of ecological risk associated with mountain pine beetle (*Dendroctonus ponderosae*) infestations in Banff and Kootenay national parks of Canada. *Risk Analysis* 28(1):203-212.

**Name, position, and contact information:** W.J. **(**Bill) Meades, Guest Scientist (CBVM Coordinator), Great Lakes Forestrry Centre, Sault Ste. Marie, Ontario.

Email: Bill.Meades@NRCan-RNCan.gc.ca Ph: (705) 541-5562

**Research activities relevant to ABoVE:**

- Development of a potential natural vegetation map and legend for the Boreal biome in collaboration with the Circumboreal Vegetation Mapping (CBVM) Project of the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) Working Group
- Establish linkages between Canadian National Vegetation Classification (CNVC) and mapping legends for potential natural vegetation.
- Application of concepts of zonal, azonal and extrazonal vegetation to differentiate relative contribution of climate, geology and disturbance regimes to the ditribution of vegetation types in the Boreal zone.

**Potential benefits of collaboration with ABoVE:**

- The development of a Potential Natural Vegetation (PNV) map using concepts of Zonal, Azonal and Extrazonal vegetation can provide a baseline for ecosystem pre-disturbance conditions against which resilience can be assessed.
- Through chronological comparison vegetation on similar sites across disturbance regime successional trajectories can be established from which vulnerability can be assessed.
- A CBVM map of the Study Domain linked to the CNVC and NVC vegetation standards would provide considerable background information on the vegetation composition and structure and component flora and its vulnerability to disturbances.
- Opportunity for national and international collaboration in the study domain and beyond through CBVM collaborators.

**Types of collaboration of interest:**

- Large scale mapping of potential national vegetation using a harmonized legend across international borders.
- Development of correlations between distribution of zonal vegetation types within the study domain and climatic data using a common approach.
- Correlation between mapping legend and floristic composition and distributions of vegetation types based on linkages to NVC and CNVC and existing ground plots in the Study Domain.
- Input to Vegetation Dynamics Model based on increased understanding of the relative contribution of climate, soil and disturbance regimes to distribution of vegetation types in the landscape.

**Relevant publications:**

Talbot, S. S. and Meades, W. J. 2011. Circumboreal Vegetation Map (CBVM): Concept Paper. CAFF Strategy Series Report No.3. CAFF Flora Group (CFG), CAFF International Secretariat, Akureyri, Iceland. ISBN 978-9935-431-05-9.

Meidinger, D. and Mackenzie, W. 2012 Applying the Proposed Circumboreal Vegetation Map Legend to Western Canada.pp 63-67 *In* Talbot, S. S., Proc. 7th Int. Conservation of Arctic Flora and Fauna (CAFF) Flora Group Workshop, Akureyri, Iceland, 2011. CAFF International Secretariat, CAFF Flora Expert Group (CFG), CAFF Proceedings Series Report Nr. 8. ISBN: 978-9935-431-18-9

Robitaille, A., Saucier, J-P., Leboeuf, A. and Dufour, E. 2012. Mapping the Boreal Zone of Northeastern America with the CBVM Legend: Pilot Project in Québec, Canada. pp. 68-81 *In* Talbot, S. S.,Proceedings of the 7th International: Conservation of Arctic Flora and Fauna (CAFF) Flora Group Workshop, Akureyri, Iceland,

January 28-February 3, 2011. CAFF International Secretariat, CAFF Flora Expert Group (CFG), CAFF Proceedings Series Report Nr. 8. ISBN: 978-9935-431-18-9

Saucier, J.P., Baldwin, K.M., Meades,W.J., Meidinger, D., MacKenzie, W., Robitaille, A., Uhlig, P. 2013. The CBVM legend with its application for mapping the Boreal vegetation of Canada.. In Saucier, J.-P., (ed) Synthesis of the CircumBoreal Vegetation mapping legend discussion in Vladivostok, Russia, September 23 to October 4, 2012. CAFF International Secretariat, CAFF Flora Expert Group (CFG), CAFF Proceedings Series Report Nr. 9. ISBN: 978-9935-431-20-2

**Contacts:**

**CBVM Contacts in Alaska**

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**CBVM Contacts in Canada**

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Jean-Pierre Saucier, Québec, QC, Tél: (418) 652-1745, jp.saucier@nemoralis.ca

Antoine LeBoeuf, Direction des inventaires forestiers, Québec, QC
Antoine.Leboeuf@mrnf.gouv.qc.ca

**Name, position, and contact information:**

David Paré, Research Scientist (Forest Biogeochemistry and productivity), Laurentian Forestry Centre, Quebec; Email: dpare@nrcan.gc.ca , Ph: 418-648-7598

**Research activities relevant to ABoVE:**

- Soil organic matter quality, accumulation and cycling. Soil organic matter dynamics as affected by natural disturbance, forest management, climate, and species composition in the boreal.
- Forest paludification: impact of climate and forest management on carbon accumulation in peatland forests.
- Mapping forest soil attributes. 2014: maps of forest properties at a 250m scale for the full Canadian commercial forest zone.
- Understanding the role of fire regime shifts during the Holocene on soil carbon quality and accumulation.

**Potential benefits of collaboration with ABoVE:**

- Extending the climatic gradient of conditions to observe consequences of climate change on soil carbon dynamics. Eastern transect shows same MAT but different fire cycle regime and up to twice the mean annual precipitation encountered in current AboVe investigations. Archived soil samples.
- Access to radiocarbon analysis and soil C modelling.

**Types of collaboration of interest:**

- Collaborative-cross continental approaches to mapping and modelling soil C dynamics. Assessing soil carbon vulnerability to change.

**US Contact:**

**Jason Vogel**, Texas A&M University Jason_vogel@tamu.edu; Drivers of soil carbon cycling in northern ecosystems

**Lucas Nave**, Assistant Research Scientist, University of Michigan Biological Station and Dept. of EEB. Coordinator, International Soil Carbon Network. lukenave@umich.edu

Henry Loescher - NEON Inc, hloescher@neoninc.org

**Relevant publications:**

Ward, C.; Pothier, D.; Paré, D. 2014. Do boreal forests need fire disturbance to maintain productivity? Ecosystems 17:1053-1067.

Mansuy, N.; Thiffault, E.; Paré, D.; Bernier, P.; Guindon, L.; Villemaire, P.; Poirier, V.; Beaudoin, A. 2014. Digital mapping of soil properties in Canadian managed forests at 250 m of resolution using the k-nearest neighbor method. Geoderma 235-236: 59-73.

Poirier, V.; Paré, D.; Boiffin, J.; Munson, A.D. 2014. Combined influence of fire and salvage logging on carbon and nitrogen storage in boreal forest soil profiles. For. Ecol. Manag. 326:133-141.

Laganière, J.; Paré, D.; Bergeron, Y.; Chen, H.Y.H.; Brassard, B.W.; Cavard, X. 2013. Stability of soil carbon stocks varies with forest composition in the Canadian boreal biome. Ecosystems 16:852-865.

Paré, D.; Bernier, P.; Lafleur, B.; Titus, B.D.; Thiffault, E.; Maynard, D.G.; Guo, X. 2013. Estimating stand-scale biomass, nutrient contents, and associated uncertainties for tree species of Canadian forests. Can. J. For. Res. 43:599-608.

Brassard, B.W.; Chen, H.Y.H.; Cavard, X.; Laganière, J.; Reich, P.B.; Bergeron, Y.; Paré, D.; Yuan, Z. 2013. Tree species diversity increases fine root productivity through increased soil volume filling. J. Ecol. 101:210-219.

Bernier, P., Paré, D. 2012. Using empirical ecosystem CO2 measurements to evaluate the benefits of forest bioenergy options for greenhouse gas mitigation. Global Change Biology-Bioenergy. 5: 67-72.

Laganière, J.; Paré, D.; Bergeron, Y.; Chen, H.Y.H. 2012. The effect of boreal forest composition on soil respiration is mediated through variations in soil temperature and C quality. Soil Biol. Biochem. 53:18-27.

Laganière, J., Angers, D., Paré, D., Bergeron, Y., Chen, H. 2011. Black spruce soils accumulate more uncomplexed organic matter than aspen soils. Soil Science Society of America Journal 75: 1125-1132.

Cavard, X., Bergeron, Y., Chen, H., Paré, D. 2011. Effect of forest-canopy composition on soil nutrients and dynamics of understory: mixed canopies serve neither vascular nor bryophyte strata. Journal of vegetation science 22: 1105-1119.

Paré, D., Banville, J.L., Garneau, M., Bergeron, Y . 2011. Soil carbon stocks and soil carbon quality in the upland portion of a boreal landscape, James Bay, Quebec. Ecosystems 14: 533-546.

Laganière, J.; Angers, D.A.; Paré, D. 2010. Carbon accumulation in agricultural soils after afforestation. Global Change Biology 16, 439-453.

Hermle, S.; Lavigne, M.B.; Bernier, P.Y.; Bergeron, O.; Paré, D. 2010. Component respiration, ecosystem respiration and net primary production of a mature black spruce forest in northern Quebec. Tree Physiology 30: 527-540.

Fenton, N.J.; Bergeron, Y.; Paré, D. 2010. Decomposition rates of bryophytes in managed boreal forests: influence of bryophytes species and forest harvesting. Plant and Soil 336: 499-508.

Lafleur, B.; Paré, D.; Munson, A.D.; Bergeron, Y. 2010. Response of northeastern North American forests to climate change: will soil conditions constrain tree species migration?. Environ. Rev. 18: 279-289 DOI:10.1139/A10-013.

Simard, M.; Bernier, P.Y.; Bergeron, Y.; Paré, D.; Guérine, L. 2009. Paludification dynamics in the boreal forest of the James Bay Lowlands: effect of time since fire and topography. CJFR 39: 546-552.

**Suggestions about your contacts who we could contact for engaging other Canadian researchers:**

Michelle Garneau, Université du Québec à Montréal, Géotop, garneau.michelle@uqam.ca

Yves Bergeron, Université du Québec à Montréal , Yves.Bergeron@uqat.ca

**Name, position, and contact information:**
Marc-André Parisien, Research Scientist (fire), Northern Forestry Centre, Edmonton
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**Research activities relevant to ABoVE:**

- Large-scale (sub-continental to global) prediction of fire activity based on statistical modeling for current and future time periods
- Fine-scale (landscape to regional) burn probability mapping using simulation models to identify the environmental controls on fire
- Long-term research on the effect of biomass accumulation on wildfire ignition and spread potential in the boreal plain (Wood Buffalo National Park, Alberta and Northwest Territories)

**Potential benefits of collaboration with ABoVE:**

- Opportunity to spatially assess the sensitivity of wildfires to environmental change through statistical modeling of wildfires across the study area
- Opportunity to develop plausible landscape-level scenarios for mitigation and adaptation to changes in disturbance regimes
- Opportunity to identify potential climate and fire refugia in order to better predict the changes to biological communities
- Opportunity to combine expansive datasets of vegetation, fire history, and hydrology to provide a better understanding of spatio-temporal patters of wildfire activity in the boreal plain

**Types of collaboration of interest:**

- Evaluation of the spatially explicit fire potential in the study area in light of recent advances in landscape fire dynamics and the sensitivity to changes in these dynamics
- Study of current and potential future fire refugia across the study area through a combination of remote sensing analysis, statistical modeling, and field work
- Assessment of potential changes to disturbance regimes, fire in particular, to various scenarios of anthropogenic change using fine-resolution simulation models
- Creation of high-quality fine-resolution datasets for disturbance modeling that can be combined with other studies (e.g., permafrost, carbon dynamics, hydrology, socio-economics)

**Relevant publications:**

Héon, J., Arseneault, D., Parisien, M.-A. 2014 Resistance of the boreal forest to high burn rates. Proceedings of the National Academy of Sciences. (in press)

Parisien, M.-A., Parks, S.A., Krawchuk, M.A., Little, J.M., Flannigan, M.D., Gowman, L.M., Moritz, M.-A. An analysis of controls on fire activity in boreal Canada: comparing models built with different temporal resolutions. Ecological Applications 24: 1341-1356.

Wang, X., Parisien, M.-A., Flannigan, M.D., Parks, S.A., Anderson, K.R., Little, J.M., Taylor, S.W. The potential and realized spread of wildfires across Canada. 2014. Global Change Biology 20: 2518-2530.

Parisien, M.-A., Parks, S.A., Miller, C, Krawchuk, M.A., Heathcott, M., Moritz, M.A. 2011. Contributions of ignitions, fuels, and weather to the spatial patterns of burn probability of a boreal landscape. Ecosystems 14: 1141-1155.

**Name, position, and contact information:**
David Price, Research Scientist, Integrated modelling of climate change impacts, Northern Forestry Centre, Edmonton
Email: David.Price@NRCan-RNCan.gc.ca, Ph: 780-435-7249

**Research activities relevant to ABoVE:**

- Regional to continental scale integrated modelling of forest responses to climate and projected climate change
- Downscaling of general circulation model simulations to continental, regional and site levels
- Mapping projections of future drought (collaboration with Ted Hogg), future fire regimes (collaboration with Marc Parisien), future insect activity (collaboration with Barry Cooke and others)
- Knowledge transfer on impacts and adaptation to forest industry and rural communities

**Potential benefits of collaboration with ABoVE:**

- Opportunities to participate in and contribute to large scale modelling comparisons, including construction of large spatial data sets
- Access to new and better algorithms for integrating disturbances (particularly insect pest outbreaks) into large scale dynamic vegetation models.

**Types of collaboration of interest:**

- Large scale modelling
- Cumulative impacts modelling (e.g., integrating natural vegetation dynamics, climate change and effects of human disturbances such as mining)
- Transfer of knowledge in remote communities to facilitate adaptation to environmental changes.

**Relevant publications:**

Chang, K.-H., Price, D.T., Chen, J.M., Werner A. Kurz, W.A., Boisvenue, C., Hogg, E.H., Black, T.A., Gonsamo, A., Wu, C. Hember, R. 2014. Simulating impacts of water stress on woody biomass in the southern boreal region of western Canada using a dynamic vegetation model. Agric. For. Meteorol. 198–199: 142–154. doi: 10.1016/j.agrformet.2014.07.013

Price, D.T. and K.J. Isaac. 2013. Adapting sustainable forest management to climate change: Scenarios for vulnerability assessment. Report to Canadian Council of Forest Ministers, Climate Change Task Force, 18 pp.

Price, D.T., R.I. Alfaro, K.J. Brown, M.D. Flannigan, R.A. Fleming, E.H. Hogg, M.P. Girardin, T. Lakusta, M. Johnston, D.W. McKenney, J.H. Pedlar, T. Stratton, R.N. Sturrock, I.D. Thompson, J.A. Trofymow, L.A. Venier. 2013. Anticipating the consequences of climate change for Canada's boreal forest ecosystems. Environmental Reviews 21: 322–365.

Gonsamo, A., J.M. Chen, D.T. Price, W.A. Kurz, J. Liu, C. Boisvenue, R.A. Hember, C. Wu, and K.-H. Chang. 2013. Improved assessment of gross and net primary productivity of Canada's landmass, J. Geophys. Res. Biogeosci., 118: 1546–1560. doi:10.1002/2013JG002388.

Cai, T., D.T. Price, A. Orchansky, B. Thomas. 2011. Carbon, water, and energy exchanges of a hybrid poplar plantation during the first five years following planting. Ecosystems 14: 658–671 doi: 10.1007/s10021-011-9436-8

Price, D.T.; McKenney, D.W.; Joyce, L.A.; Siltanen, R.M.; Papadopol, P.; Lawrence, K. 2011. High-resolution interpolation of climate scenarios for Canada derived from General Circulation Model simulations. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB. Inf. Rep. NOR-X-421. 104 p.

Stratton, T., D.T. Price and K. Gajewski. 2011. Impacts of daily weather variability on simulations of the Canadian boreal forest. Ecol. Model. 222(17): 3250–3260. doi:10.1016/j.ecolmodel.06.009

**Name, position, and contact information:**
Anthony R. Taylor, Research Scientist (Plant Ecologist), Atlantic Forestry Centre, Fredericton
Email: Anthony.Taylor@NRCan-RNCan.gc.ca , Ph: 506-452-4144

**Research activities relevant to ABoVE:**

- Modeling climate change effects on plant species distribution and plant community composition in northern forest ecosystems
- Studying climate controls on plant species diversity across North America's northern forest ecosystems
- Studying plant species acclimation and adaption potential to climate change

**Potential benefits of collaboration with ABoVE:**

- Opportunity to further develop and validate empirical and process-based models of vegetation dynamics that can be used to forecast climate change effects on future plant species distribution and forest structure in the north.
- Opportunity to empirically observe and study past and contemporary tree species migration rates and potential shifts in tree species range boundaries in the north.
- Opportunity to assess plant species and ecosystems vulnerability due to rapid climate change in the north.

**Types of collaboration of interest:**

- Large-scale vegetation modeling and forecasting exercises.
- Tracking and studying plant species range shifts, migration rates, and adaptation potential through targeted field research (e.g., dendrochronological and paleoecological studies conducted in the north) or through usage of historical aerial photography and GIS data to reconstruct plant species northern range limits and boundary shifts.
- Participate in syntheses and reviews, including a review and analysis of historical, climate-related changes in forest plant species migration and distributional shifts in the ABoVE study domain.

**Relevant publications:**

Zhang, Y., H.Y.H. Chen, and **A.R. Taylor.** 2014. Multiple drivers of plant diversity in forest ecosystems. *Global Ecology and Biogeography* 23: 885-893

**Taylor, A.R**., M. Seedre, B. Brassard, and H.Y.H. Chen. 2014. Decline in net ecosystem productivity following canopy transition to late-succession forests. *Ecosystems* 17: 778-791

**Taylor, A.R.**, and H.Y.H. Chen. 2010. Multiple successional pathways of boreal forest stands in central Canada. *Ecography* 34: 208-219.

Gauthier, S.; Lorente, M.; Kremsater, L.; De Grandpre, L.; Burton, PJ.; Aubin, I.; Hogg, EH.; Nadeau, S.; Nelson, EA.; **Taylor, AR**.; Ste-Marie, C. 2014. Tracking climate change effects: potential indicators for Canada's forest and forest sector. Natural Resources Canada, Canadian Forest Service, Ottawa, ON. 86p

**Name, position, and contact information:**

Dan Thompson, Research Scientist (Forest Fire), Northern Forestry Centre, Edmonton, Alberta
Email: danthomp@nrcan.gc.ca; Phone : 780-554-1434

**Research activities relevant to ABoVE:**

- Modelling of physical wildfire processes (moisture dynamics and combustion modelling) in peatlands
- Post-fire observation and modelling (vegetation succession, energy, water, and carbon cycling)
- Field-scale inventory of biomass Mavailable to wildfire and forecasting of fire impacts over space and time

**Potential benefits of collaboration with ABoVE:**

- Extend knowledge of wildfire impacts on peatlands in non-permafrost southern Boreal Plains systems into Taiga Plains subarctic permafrost systems
- Integrating wildfire feedbacks on other natural and anthropogenic disturbances such as permafrost thaw and industrial development

**Types of collaboration of interest:**

- Participate in fieldwork quantifying ecosystem biomass stocks vulnerable to wildfire
- Integrating remote sensing and landscape-scale vegetation and carbon models with both point and landscape-level wildfire models

**Relevant publications:**

Petrone RM, Thompson DK, Chasmer LE, Kljun N, Flannigan MD, Devito KJ, Waddington JM. Impact of Wildfire Smoke on Regional Carbon Exchange During the 2011 Utikuma Complex Fire, Alberta, Canada. Submitted to *Forest Ecology and Management*.

Thompson DK, Wotton BM, Waddington JM. Heat transfer and the initiation of organic soil combustion during wildfire in forested wetlands. *International Journal of Wildland Fire*. Accepted.

Waddington JM, Morris PJ, Kettridge N, Granath G, Thompson DK, Moore PA. 2014. Hydrologic feedbacks in northern peatlands. *Ecohydrology*. DOI: 10.1002/eco.1493

Thompson DK, Waddington JM. 2014. A Markov chain model method for simulating bulk density profiles in boreal peatlands. *Geoderma*. 232-234: 123-129. DOI: 10.1016/j.geoderma.2014.04.032

Pinno, B, Errington R, Thompson DK. 2013. Young jack pine and high severity fire combine to create potentially expansive areas of understocked forest. *Forest Ecology and Management*. 310: 517-522. DOI: 10.1016/j.foreco.2013.08.055

Sherwood J, Kettridge NK, Thompson DK, Morris PJ, Silins U, Waddington JM. 2013. The effect of drainage and wildfire on peat hydrophysical properties. *Hydrological Processes*. 27: 1866-1874.

Thompson DK, Waddington JM. 2013. Wildfire effects on vadose zone hydrology in forested boreal peatland microforms. *Journal of Hydrology*. In Press. DOI: 10.1016/j.jhydrol.2013.01.014

Kettridge N, Thompson DK, Waddington JM. 2012. Impact of wildfire on the thermal behavior of northern peatlands: observations and model simulations. *Journal of Geophysical Research Biogeosciences* 117(G2): G02014.

Benscoter BW, Thompson DK, Waddington JM, Flannigan MD, Wotton BM, DeGroot WJ, and Turetsky MR. (2011). Interactive effects of vegetation, soil moisture, and bulk density on the depth of burning of thick organic soils. *International Journal of Wildland Fire* 20(3): 418-429.

**Suggestions for your contacts who we could contact for engaging other Canadian researchers:**

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Larry Nixon, Wildfire Science Coordinator, Government of the Northwest Territories, Larry_Nixon@gov.nt.ca

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**Research activities relevant to ABoVE:**

- Modelling greenhouse gas exchange in the Hudson Plain (collaboration with Jim McLaughlin, Ontario Ministry of Natural Resources) along a permafrost gradient, with calibration and corroboration data from peat and bog sites along a permafrost gradient and additional intensive sites near the Victor Diamond mine
- Mapping peatland and permafrost using remote sensing (collaboration with Brigitte Leblon, University of New Brunswick).

**Potential benefits of collaboration with ABoVE:**

- Opportunity to extend our current knowledge of climate-related changes on peatlands to carbon "vulnerable" areas in the Hudson Plain, where permafrost thaw is rapid.
- Opportunity to develop maps, and improve on techniques to map peatlands and permafrost and synthesize existing peatland layers.

**Types of collaboration of interest:**

- Facilitate data sharing and participate in planning and coordination of peatland and permafrost research (as funding and our federal government travel policies permit).
- Participate in syntheses and reviews, particularly related to northern peatlands and permafrost peatlands.

**Relevant publications:**

Webster, K.L., I.F. Creed, T. Malakoff, K. Delaney. Potential vulnerability of deep carbon deposits of forested swamps to drought. Soil Science Society of America Journal, in press doi:10.2136/sssaj2013.10.0436.

Ou, C. Y. Zhang, A. LaRocque, B. Leblon, K. Webster, J. McLaughlin, P. Barnett. Model calibration for mapping permafrost using Landsat-5 TM and Radarsat-2 images. Submitted to IGARSS.

Webster, K.L., F.D. Beall, D. Kreutzweiser, I.F. Creed. 2014. Impacts and prognosis of natural resource development on water and wetlands in Canada's boreal zone. Under internal review for Environmental Reviews.

McLaughlin, J.W., K.L. Webster. 2014. Effects of a changing climate on peatlands in permafrost zones: A literature review with application to the Far North of Ontario. Arctic, Antarctic and Alpine Research 46(1): 84-102.

Webster, K.L., JW. McLaughlin. 2014. Application of a Bayesian belief network for assessing the vulnerability of permafrost to thaw and implications for greenhouse gas production and climate feedbacks. Environmental Science and Policy 34: 28-44.

McLaughlin, J.W., K.L. Webster. 2013. Effects of a Changing Climate on Peatlands in Permafrost Zones: A Literature Review and Application to Ontario's Far North. OMNR Climate Change Research Report CCRR-34.

Webster, K.L. J.W. McLaughlin, Y. Kim, M.S. Packalen, C.S. Li. 2012. Modelling carbon dynamics and response to environmental change along a boreal fen nutrient gradient. Ecological Modelling. 248: 148-164.

Webster, K.L., J.W. McLaughlin. 2010. Overview of Carbon Cycling in the Hudson Plains Ecozone. In Canadian Biodiversity: Ecosystem Status and Trends 2010. Federal, Provincial and Territorial Governments of Canada. Canadian Councils of Resource Ministers. Ottawa, ON. www. Biodivcanada.ca/ecosystems

**Suggestions for your contacts who we could contact for engaging other Canadian researchers:**

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