



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

***#36 -Adapting to Climate and Climate Impacts:
A Conceptual Framework for Western Public Lands***

January 21, 2010



Constance I. Millar

USDA Forest Service
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Abstract

Incorporating climate change, either natural variability or human-driven, into resource management forces a rethinking of basic principles and guidelines. I present a conceptual framework for adaptation strategies, and illustrate this with examples relevant to western North American forest ecosystems. This framework recognizes that because conditions and capacities vary across regions, priorities and solutions will differ.

Three strategic steps are: 1) Review pertinent scientific models and bioclimate projections, 2) Rank priorities, and 3) Resolve plans, prescriptions, and management treatments. A toolbox approach is most useful, where high-order management decisions range from maintaining resistance to change (establishing refugia, habitat reclamation); promoting resilience (reducing stressors and improving health), enabling species and systems to move to new states (using assisted migration, relaxed germplasm transfer rules, anticipating extreme events); and realigning systems far out of natural variability (employing models tuned to the future rather than historic range of variability).

Evaluating options and setting priorities will be increasingly important under uncertain future climates. At an overall level, decision-makers have three options for engaging climate-management, each defensible under different contexts. They can deliberately delay action, react after disturbance or extreme events, or act proactively in advance. Tiered methods such as no-regrets, low regrets, win-win; employing low- to high-technology approaches judiciously; and formal triage approaches are employed. Evaluating vulnerability is an essential first step. We can best learn the range of needs and tools for adaptation by engaging case-studies and sharing concrete ideas offered by field managers. The USFS Westwide Climate Initiative conducts case studies in the Pacific Northwest, Rocky Mountain Region, and Pacific Southwest. I offer a sample of lessons learned from efforts that apply to forested ecosystems.

Bio: Constance Millar

Dr. Millar has long been a leader in developing climate-adaptation tools for management of western public lands, most recently as one of four Principal Investigators of the USDA Forest Service WestWide Climate Initiative. Dr. Millar's focus is on California and Great Basin ecosystems, but her resource-management and decision-support frameworks have applicability throughout western ecosystems. She received her Ph.D. in genetics at the University of California, Berkeley in 1984, and has been with the Pacific Southwest Research Station based in the Bay Area since then. Dr. Millar leads a research team that addresses responses of subalpine forests to historic and current climates; impacts of climate change on American pika; and rock-glacier response to warming climates.



BC Ministry of Forests and Range
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2009

Jan. 06,
2010

Mark Johnston - Topic: *Vulnerability of Tree Species to Climate Change: Species-level impacts of climate change and management options for adaptation*

The Canadian Institute of Forestry sponsored an e-lecture with Mark Jan. 6th at 10:30am PST (1:30pm EST).

Please see details on the CIF website <http://www.cif-ifc.org/site/electure>

For information contact **Matt Meade** Email: mmeade@cif-ifc.org

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BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
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**Drought and Heat-Induced Tree Mortality:
A Global Overview of Emerging Climate Change Risks for Forests**
December 10th, 2009



Craig D. Allen
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Station,
Los Alamos, New Mexico, USA.
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Abstract: Greenhouse gas emissions have significantly altered global climate, and will continue to do so in the future. Increases in the frequency, duration, and/or severity of drought and heat stress associated with climate change could fundamentally alter the composition, structure, and biogeography of forests in many regions. Of particular concern are potential increases in tree mortality associated with climate-induced physiological stress and interactions with other climate-mediated processes such as insect outbreaks and wildfire. Despite this risk, existing projections of tree mortality are based on models that lack functionally realistic mortality mechanisms, and there has been no attempt to track observations of climate-driven tree mortality globally. This talk reviews physiological mechanisms of drought and heat-induced tree mortality, and presents a global assessment of recent tree mortality attributed to drought and heat stress, with examples from Africa, Asia, Australia, Europe, North America and South America. Although episodic tree mortality occurs in the absence of climate change, studies suggest that at least some of the world's forested ecosystems already may be responding to climate change and raise concern that forests may become increasingly vulnerable to higher background tree mortality rates and die-off in response to future warming and drought, even in environments that are not normally considered water-limited. These diverse examples of drought and heat-related tree mortality from around the world suggest that no forest type or climate zone is invulnerable to anthropogenic climate change. These observations further suggest risks to ecosystem services, including the loss of sequestered forest carbon and associated atmospheric feedbacks.

Bio: Craig D. Allen is a research ecologist with the U.S. Geological Survey, and Station Leader of the Jemez Mountains Field Station based at Bandelier National Monument, New Mexico. Recent and ongoing research activities, involving a variety of colleagues and collaborators, include: development of ecological and fire histories in the Southwest; ecological responses of forests and woodlands to climate extremes, including extensive vegetation mortality and fire effects; linked ecological, runoff, and erosion processes in piñon-juniper watersheds; ecological restoration of Southwestern forests and woodlands; and development of long-term ecological monitoring networks across landscape gradients in the Jemez Mountains. He is one of the core principal investigators of the Western Mountain Initiative, an integration of research programs studying global change in mountain ecosystems of the western US (see <http://www.cfr.washington.edu/research/fme/wmi/>), with extensive international collaborations. Craig's place-based ecological research approach is highlighted at: http://www.fort.usgs.gov/resources/spotlight/place/place_home.asp).



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

The Yellowstone to Yukon Conservation Initiative:
A climate change adaptation strategy

December 2, 2009



Wendy Francis

Director, Conservation Science and Action
Yellowstone to Yukon Conservation Initiative
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403.763.8633
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The Yellowstone to Yukon (Y2Y) region stretches 3,200 km over 44 degrees of latitude from the south end of the Wind River mountain range in the greater Yellowstone ecosystem of Wyoming to the Arctic Circle in Yukon Territory. Similar geology, geography, climate, flora, fauna and cultures tie this landscape together. Globally it is significant as the largest remaining intact mountain system that supports the full range of native large mammals, significant ice fields, the headwaters of many of the continent's most important watersheds, iconic landscapes and boundless recreation opportunities.

The Yellowstone to Yukon Conservation Initiative is a visionary effort to preserve these attributes through leadership, partnerships, scientific research, funding and inspiration for a myriad of projects and activities. British Columbia hosts more of the Y2Y region than any other single jurisdiction and is responsible for the management of three of Y2Y's 12 priority areas: the Peace River Break, the Muskwa-Ketchika Management Area, and parts of the Canadian Rocky Mountains. In this presentation, Wendy will highlight the continental role of these important landscapes and relate Y2Y to other initiatives in the province, such as climate adaptation, carbon sequestration and the Future Forest Ecosystems Initiative.

Biography: Wendy Francis is one of Canada's senior conservationists, having worked on provincial and national parks issues for CPAWS Southern Alberta as a volunteer for ten years from 1986, and holding the position as the founding Conservation Director from 1996 to 1999. From 2000 to 2005, Wendy led her own conservation consultancy, where she undertook projects for clients as diverse as the National Round Table on the Environment and the Economy, the Canadian Boreal Initiative (which she helped to launch), several U.S. based philanthropic organizations, CPAWS and Y2Y.

From 2005, she was Director of Conservation Science at Ontario Nature in Toronto until 2007, when she joined the staff of Y2Y. Wendy has extensive non-profit board experience, having held various positions on the CPAWS National board for over a decade and serving as Chair of the Y2Y Board from 2003 to 2005. Wendy is educated in law and biology and has a Master's Degree in environmental law from the University of Calgary. She resides in Banff where she loves to backpack, rock climb, run and ski.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

BC Forest Offset Protocol
November 26, 2009



Brian Raymer
Technical Advisor, Forest Carbon
BC Ministry of Forests and Range
Brian.Raymer@gov.bc.ca

Abstract

The BC Forest Offset Protocol is being developed in support of the current call from Pacific Carbon Trust for forest offset proposals. The Protocol is primarily intended to assist project proponents in preparing their offset project plans and submissions to the Pacific Carbon Trust. It can also support project validation and verification efforts.

The protocol currently includes three eligible types of projects: afforestation, select seed use, and fertilization. The objective of initially focussing eligible projects on a narrow set of project types was to demonstrate a methodological approach in projects that avoid complex issues such as the concern about “leakage” related to conservation offsets. Several benefits of the selected eligible project types are that baselines and additionality are simpler to define and quantification protocols are relatively straightforward. Key legal requirements applicable to forest offset projects are identified and described in the Protocol.

This protocol was developed with the assistance of an inter-agency BC Forest Offset Protocol Working Group and addresses comments received from a public review process. The development of this protocol is the initial step for the development of offset protocols for other types of projects and was favoured over the alternative of “wait and see” what is developed elsewhere. Multiple experiences and protocols can be combined in the future to refine and improve this and other protocols. The seminar will describe other activities currently being considered for future protocol development.

Biography: Brian Raymer

Brian Raymer is a professional forester working in the Climate Change and Forest Carbon section of Forest Practices Branch. He has been working for the Ministry of Forests and Range in Victoria since 1996. Brian is currently working on forest policy related to forest carbon. His goal is to find policy solutions that provide incentives for GHG emissions reductions and provide co benefits for the forest and the forest economy.



BC Ministry of Forests and Range
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Why Forest Genetic Resources Matter in Changing Climates

October 29, 2009-11-03



Judy Loo
Biodiversity International
Rome, Italy



Climate change is expected to have serious impacts on forests and thus on forest genetic resources. Among forest ecosystems, there will be winners and losers and in all cases. Genetic variability is essential for responding to impacts, whether positive or negative. Trees are particularly vulnerable to climate change because of their longevity. According to the IUFRO Expert Panel on Adaptation to of Forests to Climate Change, forest ecosystems have already been affected by climate change and will be more affected in the future. Vulnerability of forest genetic resources to climate change is the likelihood of the genetic resources of particular populations being extirpated over a projected timeframe.

Vulnerability is the probability that populations that contain unique genetic material will be unable to migrate to new environments, adapt in place, or survive (because of phenotypic plasticity). Important research areas include:

- understanding phenotypic plasticity,
- importance of long-distance dispersal, and
- linking variability to adaptive potential.

Useful approaches include: climate envelope modeling, field tests, applying genomic and proteomic advances, and involving local people.

Biography:

Dr. Judy Loo served as a research scientist with the Canadian Forest Service, Natural Resources Canada for 18 years before joining Biodiversity International in early October 2009. In both positions, her primary interest is in conservation and sustainability of forest genetic resources, particularly with respect to threats from invasive alien species and climate change.

	BC Ministry of Forests and Range Future Forest Ecosystem Initiative Seminar Series 2009
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A Framework for Forest Adaptation to A Changing Climate in BC

Thursday October 8th, 2009

	Tongli Wang and Sally Aitken Associate Director, Centre for Forest Conservation Genetics Department of Forest Sciences, UBC	
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Elizabeth Campbell, Dave Spittlehouse, Greg O'Neill and Alvin Yanchuk
Research Branch, Ministry of Forests and Range

Andreas Hamann
Dept. of Renewable Resources, University of Alberta

Abstract

Three major questions asked on how forests will adapt to climate change include:

- 1) How much will the climate change?
- 2) How will climate change impact forest ecosystems, tree adaptation and productivity?
and,
- 3) How should we adjust our management strategies to adapt to the changes?

The questions are related and should be considered within a framework. The Centre for Forest Conservation Genetics (CFCG) in collaboration with Research Branch at Ministry of Forests and Range has been developing several major components for such a framework. They include:

- 1) widely used climate models;
- 2) projections of future climates for BC ecosystems and tree species ranges;
- 3) population response functions to climate; and,
- 4) a climate based seed transfer system.

A large number of research projects on climate change in forestry and other areas have been initiated in BC. Although each of these projects has its own emphasis, many of them can be fit into or associated with this framework. Connecting individual projects in a framework will:

- 1) lead to a better understanding of the projects in a larger context;
- 2) promote communication and collaboration among groups;
- 3) help to identify gaps for future research; and
- 4) increase the efficiency of investments in term of funding and human resources.

Biography

Dr. Tongli Wang earned his M. Sc. in Forest Genetics from the University of Helsinki in 1992. His Ph. D. is in Forest Genetics from the University of Helsinki (1996). Tongli is the Associate Director at the Centre for Forest Conservation Genetics, Department of Forest Sciences, University of British Columbia. His research interests include ecological genetics, quantitative genetics, adaptation to climate change and climate modeling.

	BC Ministry of Forests and Range Future Forest Ecosystem Initiative Seminar Series 2009
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BC Biophysical Vulnerability Assessment

September 17, 2009

	Don Morgan Team Leader Wildlife Habitat Research, Ministry of Forests and Range Research Branch don.morgan@gov.bc.ca
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Abstract:

British Columbia's forest and rangelands already have experienced the possible effects of climate change: from the mountain pine beetle outbreak in the interior, *Dothistroma* needle blight in the northwest, increases in invasive alien species in the rangelands of the southern interior, to extreme windstorms on the coast. These types of events are expected to become the norm. Due to lag effects of global climatic systems, significant climate change will take place despite current efforts to reduce greenhouse gas emissions. Government agencies charged with managing forest and range ecosystems have begun the task to understand how to adjust our expectations to prepare for and adapt to dynamic ecological and climatic systems.

The [Future Forests Ecosystems Initiative](#) (FFEI) was established by the Chief Forester to adapt BC's forest and range management framework to a changing climate. As part of the FFEI, a *Climate Change Impact and Vulnerability Assessment for the Forests and Rangelands of British Columbia* is being conducted. The goals of the assessment are to identify 1) high level implications of climate change on ecosystem components/processes and the likely effects on forest and range values; 2) where opportunities for working with climate change exist; and, 3) the components of the province's forest and range management framework that should be further assessed.

This talk will provide an overview of the provincial forest and range vulnerability assessment, its initial findings, policy maker engagement methods, and future activities.

Biography:

Don Morgan is a natural resource management and systems researcher with the BC Ministry of Forests and Range Research Branch, where he is the Team Leader of Wildlife Habitat Research. His main research area focuses on methods for describing and analyzing socio-ecological systems with an emphasis on wildlife habitat supply. Don applies innovative methods to explore uncertainty, particularly the impact of climate change on ecological processes and its interaction with resource management decisions. Currently he is the team leader of the Future Forest Ecosystem Initiative's Provincial forest and range vulnerability assessment.

Don Morgan is a Registered Professional Biologist in British Columbia, and has a B.Sc. in wildlife biology and computational mathematics from Trent University in Peterborough, Ontario (1984), a B.Sc.(honours) from Carleton University, Ottawa, Ontario in Quantitative Ecology and Computer Science (1991), and is a biology graduate student at the University of Northern B.C.

	BC Ministry of Forests and Range Future Forest Ecosystem Initiative Seminar Series 2009
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	William (Bill) Glen Climate Change and Canadian Maritime Forests The View of a Woodlot Forester	
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September 10th 2009

Abstract

While much good work has been done on the topic of climate change but what does it mean to the forester on the ground, or to the woodlot owner in eastern Canada? This presentation is a woodlot forester's perspective based on forecasts from Environment Canada. It includes my examination and interpretation of the following:

- 1- What area currently has the climate that is forecast for our future in the Canadian Maritimes? (will species migrate?)
- 2- The climate requirements of our tree species (will we still have the climate for these species in the future?)
- 3- How much of our forest may potentially be affected (implications for recoding forest inventories, examples from PEI, NB and NS)
- 4- Will the probable survivors be able to handle droughts (is the pot size big enough?)
- 5- What does the woodlot owner do? (is this woodlot owner ready?)

William (Bill) Glen

Bill Glen graduated from the University of New Brunswick about thirty years ago. After four years as a silviculturist for a private forestry consulting firm in Scotland and England, he spent most of his career with the P.E.I. Forestry Division. He served as Provincial Parks forester, and Manager of the PEI Tree Improvement, Growth and Yield, and Inventory programs. During his tenure there, he directed forest inventory and or mapping for 1980, 1990, 2000, 1935 and 1958. Bill served as the P.E.I. member of the Canadian Forest Inventory Committee from 1982 to 2006. Under the auspices of FAO, he spent six months in the Sudan designing a National Forest Inventory and subsequently reviewing the progress (30,000,000 ha completed).

Over the past three years Bill has been doing consulting work for various agencies including National Parks, Agriculture Canada and Environment Canada. Other interests include travel, forest history, genealogy, British sports cars, and restoring old agricultural equipment as well as managing the family woodlots. His latest project is investigating the potential for growing hazelnuts on P.E.I.



BC Ministry of Forests and Range
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2009

Taking Nature's Pulse –
The Patient is Showing Signs of Heat Stress
July 16, 2009



Matt Austin
Species Specialist,
BC MOE Ecosystems Branch
Environmental Stewardship Division
Matt.Austin@gov.bc.ca

In July, 2008 Biodiversity BC, a partnership of conservation and government organizations, released "Taking Nature's Pulse: The Status of Biodiversity in British Columbia." The report had input from over 50 scientists and included 23 major findings as well as a summary statement that: "British Columbia's biodiversity is globally significant because of its variety and integrity, but without immediate action, it is vulnerable to rapid deterioration, especially in light of climate change." In May, 2009 Biodiversity BC released "The Provincial Biodiversity Atlas of British Columbia" which is a companion document to "Taking Nature's Pulse" that has 60 maps depicting biodiversity values and threats including climate change.

The seminar will be an overview of "Taking Nature's Pulse" and the atlas with particular emphasis on the threat of climate change to the province's biodiversity.

Biography

Matt has a Bachelor of Science (Honours) in Zoology from the University of Western Ontario and a Masters of Environmental Design in Environmental Science from the University of Calgary. His Master's Degree Project was entitled "Wolverine Winter Travel Routes and Response to Transportation Corridors in Kicking Horse Pass Between Yoho and Banff National Parks."

Matt has been with the B.C. Ministry of Environment for 13 years and for about the first decade of that time was the provincial Large Carnivore Specialist. In that role Matt led the implementation of the province's Grizzly Bear Conservation Strategy, chaired the recovery team that developed the first approved recovery plan for a grizzly bear population in Canada, developed the "Bear Smart" Community program which has been adopted in a number of other jurisdictions and coordinated the transformation of grizzly bear harvest management in British Columbia to a more transparent and scientifically defensible process.

In recent years Matt has become increasingly involved in broader conservation initiatives. Matt co-chaired the group that produced "Taking Nature's Pulse: The Status of Biodiversity in British Columbia" and was the lead author of "The Biodiversity Atlas of British Columbia." Matt is currently leading the Hectares BC project which is a web application that allows users to analyze geospatial information without the need for GIS software or skills. Currently he is working on adding range maps for >1,000 species and >500 ecological communities to Hectares BC along with a real time link to their conservation status, priority and action bins under the province's Conservation Framework from prioritizing conservation actions.



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Climate Change and Rangelands

July 9, 2009



Matthew Braun
Range Agrologist
Range Branch
Ministry of Forests and Range in
Prince George, BC

Abstract: Climate change, efforts to mitigate it and attempts to adapt to it will have a profound effect on the rangelands of British Columbia. The Ministry of Forests and Range issues approximately 1800 range tenures that cover more than 30 million hectares of the province and provide forage to more than 150 thousand head of livestock every year. Rangelands include everything from closed forests to open grasslands, from cutblocks to roadways. Increases in precipitation, average annual temperature and extreme weather events will change how rangelands can be used. An increase in CO₂ concentration and average annual temperatures may shift the composition of available forages. Invasive plants are expected to spread further north and higher in elevation. Fire may become more frequent in grasslands, open forests, and closed forests. Pressure to restrict water use or restrict activities in watersheds may increase. Range users can contribute to carbon sequestration by improving their management. This will also increase adaptation to changes in climate, while increasing their viability. Forest management aimed at addressing climate change will affect rangelands and rangeland users. The ministry faces the challenge of balancing the needs of multiple resource users when implementing strategies to counter climate change. Management tools available to range managers will be useful to this end.

Biography:

Matthew Braun is a range agrologist with the Range Branch of the Ministry of Forests and Range in Prince George, BC. Originally from Saskatchewan, he holds a Bachelor of Science in Agriculture and a Master of Science, both from the University of Saskatchewan. Matthew has become a key climate-change resource within the Range Branch as his MSc involved greenhouse gases from grasslands. When he is not assessing the impact of livestock grazing on crown lands, Matthew has been presenting a rangeland management view on climate change to various audiences and is the co-author of the Range Branch's climate change position paper. He believes the flexible nature of the livestock industry allows it to sequester carbon and adapt to climate change while improving sustainability. He also hopes to get people and their organizations to think about the impact climate change may have on rangelands and how mitigation efforts in forestry may have unintended impacts on the rangeland resource. Other than that Matthew spends his spare time playing with his baby girl, explaining to people what an agrologist is, and baking bread in his homemade, wood-fired outdoor oven.



**BC Ministry of Forests and Range
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2009**

**The New Economy:
Carbon and Ecosystem Values
July 2, 2009**



Special Guest Speaker

Jon O'Riordan PhD <retired>
Victoria BC

Jon O'Riordan [joriorda@shaw.ca]

Abstract:
<not available>

Biography:

Jon O'Riordan earned a Masters in Arts in Geography from Edinburgh University in 1964, and a PhD in Geography from UBC in 1968. He worked for the Federal Government—Energy Mines and Resources 1969-1973, prior to joining the ELUC Secretariat from 1973-1979. He served as ADM within the BC Provincial Ministry of Environment from 1989-2001, and Deputy Minister for the Ministry of Sustainable Resource Management from 2001-2004.



BC Ministry of Forests and Range
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2009

Ecological Impacts of Climate Change

June 25, 2009



Dr. Richard Hebda

Curator of Botany and Earth History, Royal British Columbia Museum

Adjunct Faculty Member

Biology, Earth and Ocean Sciences, Environmental Studies

University of Victoria

Abstract: Globally and locally rapid warming is underway and changing the environment, the economy and our communities. Studies of the recent fossil record and models of climate change impacts reveal wide-ranging changes in forest structure, composition and distribution in the coming decades. Even with major action to counter climate change, ecosystem changes will impact human communities. Humanity has to go on a 'carbon diet' where we not only use less ancient (fossil) carbon, but dramatically reduce our demand on the living carbon of natural and managed ecosystems.

We will all have to learn more than we ever have before, accept that technology cannot solve our problems and begin to work with and foster the critical natural processes that sustain us. There will be a diversity of new and different jobs and fostering and sustaining highly diverse and productive forest ecosystems will be required. Ecosystem service and carbon offset projects may create opportunities for very different economies as highly settled regions invest in maintaining basic global ecological functions such as natural carbon storage and sequestration through healthy forests. British Columbia is particularly well poised to face the challenges of climate change with its well-educated population, stable social and government systems and rich natural forest legacy to be a leader in the global transformation ahead.

Bio: Dr. Richard Joseph Hebda

Richard Hebda has a Ph D. in Botany from the University of British Columbia and has been a Curator (Botany and Earth History) at the Royal British Columbia Museum for more than 29 years and an adjunct faculty member (Biology, Earth and Ocean Sciences, Environmental Studies) at the University of Victoria for more than 25 years. He curated the Dragon Bones (Chinese dinosaurs) and Climate and Climate Change exhibits at the Royal BC museum. He was the first faculty coordinator of the Restoration of Natural Systems Program and the Univ. of Vic. and the Province of B.C.'s expert advisor on Burns Bog (purchased as a globally unique ecosystem). His research areas include understanding vegetation and climate history of British Columbia, Ethnobotany of BC First Nations, climate change and its impacts, restoration of natural systems and processes, ecology and origins of Garry oak and alpine ecosystems and botany of grasses. Richard Hebda, with his graduate students, is author of 100+ scientific papers; 200+ popular articles mainly on bulbs and native plants, climate change; (co)author of five books and major reports, and (co)editor of three books. He appears often on TV and radio, in newspaper interviews, and speaks to a wide range of public audiences.



BC Ministry of Forests and Range
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**Monitoring forest and rangeland species and ecological processes in
British Columbia in light of climate change**

Dr. John Innes, Margie Eddington, Alyson McHugh, Alanya Smith
June 18, 2009



Margie Eddington
Sustainable Forest Management Research Laboratory
University of British Columbia

Abstract

In 2008, the Ministry of Forests and Range engaged researchers from the University of British Columbia's Sustainable Forest Management Research Laboratory to develop a monitoring strategy for the Future Forest Ecosystems Initiative (FFEI). Information is needed to determine the biophysical changes that are occurring in the forests and rangelands of BC as a result of climate change and how they are manifesting. After detailed research, analysis, and liaison involving experts from across a broad range of topic areas and organizations, a series of parameters were recommended for monitoring. These parameters, termed 'indicators', fell within the subject areas of biodiversity (5 indicators), natural disturbance (4 indicators) and ecosystem drivers (7 indicators). The project identified almost thirty diverse data sources and data collection channels that could be used to support reporting against the indicators. This presentation will explore the path taken in developing the indicators and identifying their data sources. It will examine the resulting framework looking in more detail at the recommended approach to monitoring for a selection of the indicators. Finally the presentation will outline some of the potential areas for further work including the need to better examine data gaps to determine where and how it may be necessary to increase current forest and rangeland monitoring and inventory programs to support the framework and the development of a web-based Climate Change Monitoring and Trend Reporting System.

Biography: Margie Eddington

Margie has an academic background in science and law and is currently completing her PhD within the UBC Sustainable Forest Management Research Laboratory. Margie has worked on the science/policy interface for many years, most recently being engaged as a contractor on the above project. Prior to this Margie was a Senior Forest Scientist/Policy Advisor with the Australian Government's Bureau of Rural Sciences. At the Bureau, Margie played a lead role in the review and development of *Australia's Criteria and Indicators of Sustainable Forest Management* and the production of Australia's major national report on forests, *Australia's State of the Forests Report 2008*. She was also extensively involved in developing Australia's position on the revision of the international set of indicators agreed to under the *Montreal Process Agreement for the Management of Temperate and Boreal Forests*, and is directly responsible for the production of Australia's foremost website for reporting forest related monitoring and trend information, Forests Australia (www.daff.gov.au/forestsaustralia).



Potential supply of biomass for bioenergy from Canada' forests

C.C. Dymond, B.D. Titus, G. Stinson and W.A. Kurz

June 11, 2009



Caren Dymond,
Research Branch,
BC Ministry of Forests and Range,
Victoria, BC, Canada



Abstract

There is increasing interest in the use of bioenergy to mitigate climate change, because of the increasing costs and finite supply of fossil fuels and because of a desire for energy security. Sound bioenergy policies must be formulated with accurate estimates of potential feedstock supply. There are two main potential sources of feedstock from forests: (i) harvest residue (any part of a freshly-cut tree), and (ii) deadwood (resulting from natural disturbances). In this study, we simulated future supply of biomass for bioenergy from 2005-2020 for the forests of southern Canada. Predicting the future availability of harvest residue is relatively straightforward because of its industrial origin, although estimates vary from 20 to 92 Mt yr⁻¹. Natural disturbances result in vast quantities of dead trees on the landscape, but estimates of future stocks and annual production of deadwood had not previously been made. Our results showed deadwood (standing snag) stocks in 2005 were 3.8 – 7.6 t ha⁻¹ within Canada's forest. For British Columbia's interior, we estimated the future supply of harvest residues at 2 900 kt yr⁻¹, deadwood supply due to insects at 222 kt yr⁻¹ and due to fire at 550 kt yr⁻¹. These estimates include a preliminary allowance for ecological factors such as nutrient supply. While bioenergy use will accelerate the release of greenhouse gases compared to the decay of the harvest residues and deadwood, the energy can substitute energy from fossil sources. The net benefit to the atmosphere of such a strategy is affected by many factors, and future research should further assess which salvage logging operations yield the greatest net GHG benefits.

Bio: – Caren Dymond

Caren is a forest ecologist with a background in forest carbon modelling, natural disturbances, ecological modelling and geomatics. She has a M.Sc. and a B.Sc. in Ecology from the University of Calgary and is a member of the BC College of Professional Biologists and the BC Institute of Agrologists. After finishing her masters, Caren started her career in a landscape ecology lab at the University of Wisconsin Madison. Since then, she worked for the Canadian Forest Service on various projects over eight years. She came to MFR from Werner Kurz's Carbon Accounting Team at the CFS and will continue to work with them on mutually beneficial projects including developing a research program in forest carbon and climate change.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
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**To Move or Not to Move:
The multiple meanings, risks, and benefits of assisted migration of trees in
a changing climate**

June 4, 2009



Dr. Sally Aitken
Director of the Centre for Forest Conservation Genetics
Sally Aitken, University of British Columbia
UBC

Abstract

Assisted migration is a more controversial practice than many forestry professionals recognize. To a forester or forest geneticist it may seem logical to move populations or even species to track their climatic niches spatially as they shift temporally. However, to many conservation biologists, ecologists, and other concerned individuals, assisted migration is code for introduction of yet more invasive species. I will discuss assisted migration in context of forestry, by first reviewing some recent predictions of shifts in climatic niche spaces of indigenous tree species from climate envelope modeling using the program Random Forest. Alternative definitions of human-mediated assisted migration of tree populations or species relative to natural ranges will be discussed, and the potential risks and benefits associated with these different scales of movement will be reviewed. Alternative terminologies that better describe and differentiate these various scales of movements and their associated risks will be proposed. Finally, draft frameworks for decision making for assisted migration of trees will be presented for: 1) forest productivity and resilience; and 2) conservation of rare or threatened tree species

Biography: Sally Aitken

Sally Aitken received her Bachelor's degree in the Faculty of Forestry at UBC in 1984, and her M.Sc. (1986) and Ph.D. (1990) at the University of California at Berkeley. She was a Research Assistant Professor and Associate Director of the Pacific Northwest Tree Improvement Cooperative in the Department of Forest Science at Oregon State University from 1991 through 1996. She is currently in the Department of Forest Sciences at the University of British Columbia, where she is a Professor, Director of the Forest Sciences undergraduate program, and Director of the Centre for Forest Conservation Genetics (www.genetics.forestry.ubc.ca/cfcg). She teaches forest biology to undergraduates in the Faculty of Forestry, conservation genetics to graduate students from several life science faculties, and a field module in alpine ecology to undergraduate students in conservation. Her research interests include local adaptation to climate in forest trees; conservation genetics of indigenous tree species; population genomics of local adaptation; and the ability of tree populations to adapt to rapid climate change.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

**Forest Landscape Sustainability in a Highly Dynamic World:
Challenges for Ecosystem Management**
May 28, 2009



Dr. Robert Scheller
Senior Ecologist
Conservation Biology Institute
Corvallis, Oregon

Abstract:

Northern forests are subjected to an increasing number of stressors and drivers of change, including climatic change, alterations to the natural disturbance regime, development and fragmentation, introduced species, and others. Forest ecologists frequently turn to models in order to integrate all of these potential drivers and to learn how they will affect forest landscapes sustainability. Dr. Robert Scheller will discuss the opportunities and challenges for using models to understand how northern forests may respond to anticipated climate change. What can we learn from models of forest change? What should be our expectations? What are our limits to understanding the future? Finally, is sustainability a reasonable goal given what we know about climate change effects on northern forests?

Biography:

Dr. Scheller from the Conservation Biology Institute in Corvallis, Oregon, has studied forest landscape dynamics in across N. America and Asia. His research examines the biotic, abiotic and anthropogenic processes that drive potential long-term change in forested ecosystems with particular emphasis on climate change, wildfire, harvesting, insect defoliation, and invasive species. Dr. Scheller uses forest landscape models to explore how disturbances and climate interact and alter forest diversity and carbon and nitrogen cycles. Ultimately, his research informs how landscapes can be managed to sustain ecosystem services.

Robert M. Scheller, Ph.D.
Senior Ecologist
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BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

Managing for Complexity

May 14, 2009



K. David Coates
British Columbia Forest Service,
Bag 6000, Smithers, British Columbia, V0J 2N0, Canada.
Dave.Coates@gov.bc.ca

Increasing concerns about the maintenance of biodiversity and the uncertainties caused by global change have increased pressures to re-evaluate forest management strategies. Silviculture now faces the challenge of maintaining a flow of forest products while at the same time ensuring the ability of forests to adapt to diverse and unexpected future conditions, such as global changes in climate, disturbance, and spread of invasive species. Projected climate change and the associated stresses imposed on forested ecosystems are driving forces behind the need to think about how we manage forests.

We can no longer assume our forests are not impacted by influences beyond their boundaries or that tree species we select will survive and grow as they did in the past. The old world-view of nature being a rather static and predictable system must be replaced by a view which emphasizes continuous change and uncertainty. We need a new conceptual approach on which to base our scientific understanding of forest ecosystems and to develop a new forest management framework. Complexity science provides such an approach. Viewing forest ecosystems as complex adaptive systems can be helpful in furthering a silviculture aimed at maintaining resilient ecosystems that provide the variety of desired ecosystem goods and services at an acceptable cost. We must think about how forests are put together as adaptive systems, and how we might deliberately create complex forest mosaics that are pre-adapted to climate change. The list of characteristics of complex adaptive systems can be used by silviculturists to develop guiding principles for management.

Dave Coates – Biography

Dave has a BSF (UBC), M.Sc. (Oregon State University) and Ph.D (UBC) in silviculture and forest ecology. He has lived in Smithers since 1979 and he has held the position of Research Silviculturist with the B.C. Forest Service since 1989. His research interests include: linking tree population dynamics to ecosystem processes, canopy understory interactions, spatially-explicit stand dynamics, gap dynamics and simulation modeling. Much of the research undertaken by Dr. Coates in the past few years has been focused on linking empirical studies with model development. He is a lead developer of the complex stand dynamics simulator SORTIE-ND. Mountain pine beetle issues have eaten up a lot of his time in the past few years, but he is now emerging from that and looking at new issues. Dave is very interested in how silviculturists should adapt their practices in the light of projected climate change. He was Professional Forester of the Year in 2006 in British Columbia for his work on improving silvicultural practices in British Columbia and across Canada. He is co-author of a new book titled "A critique of silviculture: managing for complexity".



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

Fire Effects on Regeneration Cycles in Northern Boreal forests

May 14, 2009



Dr. Jill Johnstone

Assistant Professor, Department of Biology
University of Saskatchewan
112 Science Place, Saskatoon SK S7N 5E2
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The boreal forests of western North America are experiencing rapid directional changes in climate that are predicted to continue into the next century. The responses of boreal forest plant communities to climate change may be constrained over the short term by factors that create resistance to change, such as slow population turnover rates and strong plant-environment interactions. In this situation, disturbance may act as a key catalyst for ecosystem change. However, important disturbance agents such as fire are also sensitive to climate, and climate-induced changes in disturbance regime are likely to have direct effects on ecological communities.

In my research, I have been examining how changes to different components of the fire disturbance regime, such as fire frequency and severity, may drive forest community responses to climate change. This research focuses on spruce-dominated boreal forests of Alaska and Yukon, and their potential to shift to deciduous-dominated forests. I have used a combination of experimental and observational approaches to assess how interactions between reproductive traits and disturbance characteristics influence the long-term resilience of boreal systems. My most recent research aims to understand the combinations of abiotic conditions and fire effects that influence forest resilience across heterogeneous landscapes.

Bio:

Dr. Jill Johnstone is an assistant professor leading the Northern Plant Ecology Lab in the Department of Biology at the University of Saskatchewan, Saskatoon, Canada. She holds a Ph.D. in Biology from the University of Alaska Fairbanks and a M.Sc. in Physical Geography from the University of British Columbia. Dr. Johnstone conducts research in the areas of plant ecology and environmental biology, with a focus on boreal forest and tundra ecosystems. She has almost two decades of experience in working in northern ecosystems to examine population, community, and ecosystem responses to disturbance and variations in climate.

Her current research program focuses on understanding how disturbance may play a key role in catalyzing ecosystem responses to directional changes in climate in the North. Her research program is supported by NSERC, Canadian Program for the International Polar Year, NASA (USA), Canadian Foundation for Innovation, and the NSF Long Term Ecological Research program. She holds a NSERC University Faculty Award at the University of Saskatchewan and is an affiliate researcher at the University of Alaska Fairbanks. Dr. Johnstone teaches graduate and undergraduate courses in the areas of community ecology, botany, and multivariate statistics, and currently supervises five graduate students conducting research in boreal forest and tundra ecology.

	BC Ministry of Forests and Range Future Forest Ecosystem Initiative Seminar Series 2009
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Adapting to Climate Change: An Adaptation Policy Assessment for the Canadian Forest Sector

May 7, 2009

	Dr. Mark Johnston Senior Research Scientist, Saskatchewan Research Council Saskatoon, SK, Canada
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Forests in Canada are likely to experience as severe impacts of climate change as forests in any other country worldwide. To begin planning for these impacts and to identify adaptation options, an assessment of vulnerability must be carried out. A vulnerability assessment is made up of three components: exposure, defined by the degree to which the climate will change; sensitivity, defined by the response of the forest ecosystem to the exposure; and adaptive capacity, defined by the ability of biotic and socio-economic mechanisms to adapt successfully to climate change.

Once the degree of vulnerability has been assessed, priorities for adaptation actions can be identified, and policies put in place that facilitate and implement adaptation. The combination of vulnerability assessment and policy insight is called an adaptation policy assessment. We use a framework developed by Füssel and Klein's to design an adaptation policy assessment for the Canadian forest sector, incorporating biophysical impacts of climate change, adaptive capacity of forest ecosystems and the forest sector, and insights for policy change that would enhance the prospects for successful adaptation. We also consider the feedbacks between implementing adaptation policy and how that would enhance adaptive capacity. We then present early findings of a new project being done under the auspices of the Canadian Council of Forest Ministers.

Areas of focus include a species-level analysis of biological adaptation potential, ecosystem-level impacts related to natural disturbance processes and forest productivity, and an assessment of potential adaptation options and policy recommendations for forest managers. This work will result in an adaptation policy assessment made up of a national overview study supplemented by a series of local and regional case studies. The ultimate objective is to provide guidance and assistance to forest managers as they begin to plan for climate-change adaptation.

Dr. Mark Johnston

Mark Johnston received a B.Sc. in Forest Resources Management from the University of Minnesota in 1976, an M.Sc. in Forest Science from the University of Alberta in 1981, and a Ph.D. in Tropical Forest Ecology from the College of Environmental Science and Forestry, State University of New York in 1990. He held post-doctoral fellowships at the University of Stirling, Scotland and at the University of Minnesota. He currently has an adjunct professor appointment with the Soil Science Department at the University of Saskatchewan in Saskatoon. Mark has carried out research on the role of fire in the boreal forest, the impacts of timber harvesting on terrestrial and aquatic ecosystems, and on carbon sequestration in forest ecosystems. In his current position with the Saskatchewan Research Council, he is carrying out research on the impacts of climate change on boreal forests, and on how carbon management can be integrated into sustainable forest management. He is a member of the National Forest Carbon Sinks Committee, a national federal-provincial group developing policy on forest carbon management. He is helping lead a national study of forest sector climate change vulnerability under the auspices of the Canadian Council of Forest Ministers.

	BC Ministry of Forests and Range Future Forest Ecosystem Initiative Seminar Series 2009
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Modelling Climatic Suitability for Douglas-fir and Spruce Forests in British Columbia.

Wednesday April 22, 2009

	Aquila Flower Ecological Impacts Analyst Pacific Climate Impacts Consortium Victoria British Columbia Canada
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Bioclimatic envelope models use historical climate data to define the climatic envelopes that control a species' spatial distribution. In this study, a correlative modelling technique based on principal components analysis was used to assess the impact of projected climate change on spruce and Douglas-fir forests in British Columbia. Present and future climatic suitability for Douglas-fir (*Pseudotsuga menziesii*), Engelmann spruce (*Picea engelmannii*), hybrid spruce (*Picea engelmannii* x *glauca*), and white spruce (*Picea glauca*) was evaluated throughout British Columbia at a resolution of 4 X 4 kilometres. The models were developed using elevation-adjusted interpolated records of the 1961-1990 climate normals.

Future suitability was modelled using downscaled climate data from six different projections derived from five Global Circulation Models (GCMs) run under three emissions scenarios. Projected suitability was computed and analyzed for 30-year time-slices centered on 2020, 2050, and 2080. The results were compared across the province to quantify the variability between projections and to assess the range of predicted suitability distributions. As expected, all projections indicate a rapid shift in suitability for both spruce and Douglas-fir to higher elevations and latitudes than their current range. Significant differences exist between the projections with regard to the pace, extent and fine-scale details of these changes. However, there is considerable agreement between the projections at coarse scales regarding general areas of future climatic suitability. Looking for areas where multiple climate projections agree can give resource managers more confidence when making decisions regarding assisted migration or conservation strategies.

Aquila Flower, MSc. is an Ecological Impacts Analyst at the Pacific Climate Impacts Consortium. She completed a BA degree in geography at Humboldt State University in California, and an MSc in geography at the University of Victoria. Her MSc research focused on using dendroclimatology to explore the relationship between climatic variability and the radial growth of alpine conifers, and to reconstruct records of past climatic conditions in northern British Columbia. As an analyst at the Pacific Climate Impacts Consortium, her research has focused on quantifying the impacts of projected climate change on forest and wetland ecosystems in British Columbia using GIS and statistical techniques.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

Mitigation Strategies for the Forest Sector

Thursday April 16, 2009



Dr. Werner A. Kurz

Natural Resources Canada
Canadian Forest Service
Victoria, BC, Canada
Audio file:

http://www.for.gov.bc.ca/ftp/HTI/external/!publish/Climate%20Change/Seminar_Series_e/Kurz/

Forests store large amounts of carbon in biomass, dead organic matter and soil pools. Forest management and land-use change decisions affect the quantity and dynamics of carbon stored in the forest, and the amounts of carbon transferred to meet society's needs for harvested wood products and energy. Activities aimed at protecting and expanding forest area, increasing carbon density in forests, and using biomass for wood products and energy all affect the carbon (and non-CO₂ greenhouse gas) balance.

The management of forests and wood products can contribute to mitigation portfolios aimed at reducing atmospheric CO₂ concentrations by reducing emissions or increasing sinks relative to a business-as-usual baseline. The design of mitigation portfolios requires an understanding of the processes that contribute to regional carbon balances and of the greenhouse gas costs and benefits of alternative actions: slowing deforestation rates brings a large and immediate reduction of emissions while increasing forest area through afforestation contributes long-term CO₂ uptake, albeit at slower rates per hectare than the losses from deforestation. Ideally, mitigation portfolios should be designed with a systems perspective that takes into account carbon storage in forests, carbon storage in harvested wood products, substitution effects from the use of harvested wood products and bioenergy, as well as the impacts of forest land-use decisions on other sectors such as agriculture. Climate change is expected to reduce the mitigation potential of forests in many regions. Through increases in the area annually affected by natural disturbances such as wildfire and insects, the amount of dead wood potentially available for salvage logging operations is expected to increase. Criteria need to be developed to identify areas suitable for salvage operations, and their net impacts on the greenhouse gas balance needs to be evaluated.

Dr. Werner A. Kurz

Dr. Kurz is a Senior Research Scientist at the Canadian Forest Service (Natural Resources Canada) in Victoria, BC. He holds a Ph.D. in Forest Ecology from the University of British Columbia. He is the lead scientist in charge of the development of Canada's National Forest Carbon Monitoring, Accounting and Reporting System and the development of the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3). His research focuses on the impacts of natural disturbances, forest management and land-use change on forest carbon budgets.

Dr. Kurz was author of five reports of the Intergovernmental Panel on Climate Change (IPCC) including the chapter on Forestry Mitigation Options in the IPCC Fourth Assessment Report (Working Group 3). He served on the BC Premier's Climate Action Team and is appointed as adjunct professor at the University of British Columbia and at Simon Fraser University.

For further information see: <http://carbon.cfs.nrcan.gc.ca>

For publications see: http://bookstore.cfs.nrcan.gc.ca/searchpubs_e.php?AuthorIDs=AU13977



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

Potential Effects of Climate Change on Hydrology and Geomorphology in BC

February 19, 2009



Robin Pike

Watershed Ecosystem Systems Research Geomorphologist/ Hydrologist
BC MFR Research Branch BC MFR Coast Forest Centre



Dave Campbell

Watershed Ecosystem Systems Research Geomorphologist/ Hydrologist
BC MFR Research Branch BC MFR Coast Forest Centre

Abstract

The climate of British Columbia has been changing, and is forecast to continue to change into the future. Recent changes include increases in temperature, variable changes in precipitation, and increases in extreme weather events (storms and dry periods). Climate models in general predict that these trends will continue into the future, with further increases in summer and winter temperatures, wetter winters, and summers that are drier in the south, and wetter in the north.

Projected changes in temperature and precipitation will have a strong influence on watershed processes. Hydrology-related changes include altered timing and magnitude of stream flows, glacial recession, decreased snow accumulation and accelerated melt, increased frequency and magnitude of storm events, increased stream and lake temperatures, increased evaporative demand, and altered evaporation, transpiration and interception dynamics through changes in vegetation composition. Geomorphology-related changes include increased landsliding, flooding, permafrost melting, windthrow, sea-level rise and coastal erosion, changes in riparian conditions and cumulative watershed effects. Complex interactions with hydrology and geomorphology arise through other watershed disturbances affected by climate change such as fire and forest health.

Hydrologic and geomorphic processes are driving forces which affect water supply, water quality, fish habitat, public safety, infrastructure, recreational values, soils, forest health, and timber. Managing for these values under a changing climate will present challenges for future forest management in British Columbia.

Bio

Robin Pike, PAg, is a watershed ecosystems specialist with the BC Ministry of Forests and Range. He received his BSc degree in physical geography and MSc degree specializing in forest hydrology from the University of Victoria. He is a professional agrologist and has been active in the field of BC forest hydrology for more than 15 years. For six years, Robin practised as a watershed management extension specialist with FORREX and managing editor of Streamline Watershed Management Bulletin. Based in Victoria, Robin is the primary hydrologic research partner in the Carnation Creek Watershed Experiment on the west coast of Vancouver Island.

David Campbell, MSc. completed his B.Sc. in Geography/Geology '99 and M.Sc. in Hydrology/Geomorphology in 2005 at UBC, where he conducted research on watershed recovery from logging disturbance, woody debris dynamics in streams, and long-term landscape evolution due to climate change. A decade of hydrology experience includes work for the Geography Departments at UBC and McGill examining the impacts of land-use on river and stream environments. Prior to joining the Forest Service in 2007, David undertook in-river monitoring, hydraulic and hydrologic modeling, flood hazard and environmental assessments, and water management for proposed mining and hydro-electric projects in BC and the Northwest Territories.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

GLOBAL WARMING: THE SCALE OF THE PROBLEM AND THE PATH TO THE SOLUTION

Wednesday February 11, 2009

To listen to the audio-recording, call 1-800-408-3053, and enter passcode 1012694#.



Dr. Andrew Weaver,
Professor and Canada Research Chair in climate modelling and analysis,
School of Earth and Ocean Sciences
University of Victoria
British Columbia Canada

Abstract:

This talk will focus on the content of Dr. Weaver's recently published book: *Keeping our Cool: Canada in a Warming World* (Viking Canada). The foundations of the science of global warming will be presented and a discussion of our present climate will be framed within a historical perspective of the Earth's climate over the last 650,000 years. The range of projections of climate change over the next century will be summarized and the public confusion arising from the media portrayal of the science and its entry into the political arena will be discussed. Finally, how the Kyoto Protocol and other potential international policy options fit within the framework of necessary actions required to reduce greenhouse gas emissions will be reviewed.

Bio:

Dr. Andrew J. Weaver received his B.Sc (Mathematics and Physics) from the University of Victoria in 1983, a Certificate of Advanced Studies in Mathematics from Cambridge University in 1984, and a PhD in Applied Mathematics from the University of British Columbia in 1987. He is a Professor and Canada Research Chair in climate modelling and analysis in the School of Earth and Ocean Sciences, University of Victoria. He was involved as a Lead Author in the United Nations (UN) Intergovernmental Panel on Climate Change second, third and fourth scientific assessments and is currently the Chief Editor of the *Journal of Climate*. Dr. Weaver is a Fellow of the Royal Society of Canada, Canadian Meteorological and Oceanographic Society and the American Meteorological Society. In 2008 he was appointed to the Order of British Columbia. His recent book *"Keeping our Cool: Canada in a warming world"* was published by Viking Canada in the fall of 2008.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

**Modelling Climate Change Impacts in British Columbia's Forest Ecosystems:
A Holistic Approach to Understanding Ecosystem Vulnerability**
Feb 5, 2009



Craig. R. Nitschke
Research Associate,
Department of Forest Resources Management,
Faculty of Forestry,
University of British Columbia

Abstract

Understanding where vulnerabilities lie and when climatic thresholds are reached are important areas of knowledge that must be used to manage the risks associated directly or indirectly with climatic change. Changes in any biotic or abiotic process can alter the stable dynamic equilibrium that exists between structure and function of ecosystems, leading to the creation of new ecosystems. Climate change will directly or indirectly influence these processes which in turn will affect the structure and functioning of ecosystems. This means that climate change may have a significant impact on the natural disturbance regimes, ecosystems, and biodiversity that we currently base our management on. For these reasons, it is important to identify the potential impacts of climatic change on the ecological processes related to forest management.

Understanding which vulnerabilities exist, and where, can reduce the uncertainty and risk to ecosystems and help to determine appropriate adaptation strategies. Spatial and temporal assessments of landscape vulnerability can be used as determinants for providing guidance on how to manage for the risks associated with climatic change by removing some of the uncertainty on how ecosystems will respond. In order to achieve this, we explore the use of meta-modelling to conduct holistic analyses of ecosystem vulnerability to determine the impact climatic change on ecological processes and structure.

Two case studies are highlighted, one completed, in the south-central British Columbia and one, on going, in the northwest region of the province. The results of the case studies suggest that climate change will have large impacts on disturbance regimes and on tree species which in turn will impact ecological resilience and biodiversity over time. The results highlight the need to undertake management actions that are based on an understanding of ecosystem vulnerabilities to reduce climate change impacts. To address this need, we propose a proactive management framework that could be used to reduce climate change impacts in an ecologically and economically feasible way.

Bio:

Dr. Craig Nitschke is a Postdoctoral Research Associate in the Sustainable Forest Management Research Laboratory at the University of British Columbia, an Adjunct Researcher with the Bulkley Valley Research Centre, and a Research Fellow in the Department of Forest and Ecosystem Science at the University of Melbourne. Dr. Nitschke completed his Ph.D. in 2006 on the topic of integrating climate change in forest management planning and has since been working on forest ecosystem - climate change impact projects around British Columbia with the support of FSP-FIA and FFEI. He is also working on an NSERC-Yukon Government funded project in the Southwest Yukon and on a State of Victoria funded project in Southeast Australia.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

Free-growing Policy and Climate Change

January 29, 2009



Alex Woods, MSc
Regional Pathologist,
Ministry of Forests and Range
Northern Interior Forest Region, Smithers, BC.

Heather MacLennan
Forest Health/Stewardship Technician
Headwaters Forest District

Abstract:

After logging public forest land in BC, forest companies are required to establish a new crop of trees, and tend them for a number of years to ensure they survive and grow into a healthy new forest. The goal for forest companies is to establish this free-growing crop quickly and efficiently. To achieve free-growing, the site must have a suitable number of well-spaced trees, ecologically appropriate to the site, of a minimum height, and free from brush competition. This free-growing benchmark could be considered the single most important result that the Ministry holds licensees accountable for in BC's forest management framework.

Climate change interferes with our current free-growing policy in three principle ways. First, the ability of licensees to fund the fulfillment of their basic obligation to create free-growing stands is based on a stable timber supply, a competitive industry, and a profitable marketplace. The current mountain pine beetle epidemic which has been linked to climate change has clearly impacted stable timber supplies. Second, a forest manager's ability to tend stands to reach the free-growing benchmark is being compromised by forest diseases which appear to be increasing their impacts on young stands, preventing the trees from reaching free-growing. This increase in disease impacts coincides with increases in two primary environmental drivers of disease behaviour; summer precipitation and summer overnight minimum temperature. Third, once free-growing has been achieved, climate change is affecting the longevity of that designation again through its influence on insects and diseases and through other natural disturbances.

Management choices made in order to cost-effectively achieve the result of "free-growing" as currently defined may not necessarily be the same choices that would be made in order to establish a resilient stand capable of coping with the effects of climate change.

Bio: Alex Woods

Alex has worked in forestry in BC since 1985, starting as a forest tech for industry in the southern interior. He earned a Forest Technology diploma from BCIT in 1987 a BSF from U of A in 1990, and his MSc. in Forest Science from UBC in May 1994. For his Masters degree he specialized in forest pathology under Dr. Bart van der Kamp. The BC Forest Service hired Alex as the Regional Pathologist for the Prince Rupert Forest Region in Smithers in June 1994, where he's been ever since. Since 2000, foliar diseases, especially an epidemic of *Dothistroma* needle blight and recognition of a possible link between that epidemic and climate change, have been his primary focus. In 2005, he initiated an examination of free-growing policy to see if the expectations that have been placed on free-growing stands are being met.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

**Plant-Climate Relationships:
Biogeographic, Ecologic, and Genetic Impacts of Global Warming**
January 22, 2009



Dr. Gerald E (Jerry) Rehfeldt
(Retired) Research Plant Geneticist,
USFS Rocky Mountain Research Station
Moscow, Idaho,

Abstract

This seminar first considers statistical models that relate with a high degree of accuracy the distribution of biomes, populations and species to climate. The models then are used to predict potential impacts of global warming on the vegetation of western North America, using output for the A and B climate change scenarios for three climate models (GCMs). Management strategies are illustrated for assisting migration while change is rapid. The work not only takes into consideration projected responses but also considers variability among the GCMs and the possibility that future climates may occur that lack contemporary analogs. Engelmann spruce, western larch and Brewer spruce provide case studies. Despite the uncertainties, sound programs can be devised to anticipate the change in climate and thereby lessen the impact.

Biography

Jerry Rehfeldt did his graduate training at University of Wisconsin nearly a half century ago. In his long and distinguished career he held one professional position: that of research plant geneticist, USFS Rocky Mountain Research Station, in Moscow, Idaho, where he now serves in an Emeritus capacity. Here he undertook research programs in ecological and quantitative genetics of Rocky Mountain conifers, with the practical goal of developing the seed transfer guidelines that are needed in reforestation to assure the adaptiveness of planted trees.

I've been studying geographic patterns of genetic variation in forest trees for many years. At the root of these patterns is climate: natural selection along climatic gradients is responsible for genetic variation among populations. When modern computers, their software, and comprehensive climate data became available, my research moved into studies of plant-climate relationships. Now retired, I am still dabbling with the biogeographic, ecologic and genetic impacts of climate and a changing climate.



BC Ministry of Forests and Range
Future Forest Ecosystem Initiative Seminar Series
2009

**THE IMPACTS OF TREE IMPROVEMENT PROGRAMMES ON FOREST HEALTH: PAST AND
FUTURE APPROACHES NEEDED IN CHANGING CLIMATES**

January 15, 2009



Alvin Yanchuk,

Research Branch, B.C. Forest Service, 4th floor, 727 Fisgard St., Victoria, B.C. V8W
E-mail: Alvin.Yanchuk@gov.bc.ca

Gillian Allard, Forestry Department, FAO, Viale Delle Terme di Caracalla, 00153, Rome,
Italy. E-mail: Gillian.Allard@fao.org

Abstract

A substantial body of research is now present examining the projected impacts of climate change on the adaptation of forest trees. While physiological adaptations to climate change scenarios are critical components for forest geneticists to now consider, large impacts are likely to also come from new insect pest and disease introductions as well as increased natural disturbance levels from native pests.

In a recent world-wide survey of research programmes for insect or disease resistance, we identified ~260 'activities' that have been or are underway over the past several decades. In spite of this large volume of documented research, insect and disease resistance breeding programmes have only had impacts for a small number of the major commercial species. Moreover, these targeted resistance programmes have taken decades to develop and our past approaches may not serve us well under rapid climate change.

Additional challenges are: 1) it is likely that fewer resources will be available to study specific host-pest interactions in classical tree improvement programmes; 2) researchers will need to focus on species and programmes that can efficiently use, develop and test for possible 'durable cross resistances' to help thwart off current and new unknown challenges; 3) studies carried out on trees in natural settings will not necessarily assist breeding programmes in developing more resistant germplasm; 4) the enormous investments in molecular biology, while being of great biological interest, must be better aligned with applied programmes; and 5) transgenic technology, while it has the ability to temporarily address some specific pest problems, will still have to operate within well developed breeding programmes that deploy trees at the landscape level, in space and time. Better alignment of forest genetics and forest health research programmes and funding will be necessary if traditional tree improvement is expected to capitalize on past and future investments in pest and disease resistance research, and help mitigate the projected negative impacts of climate change on forest productivity and health.

Bio:

Alvin Yanchuk is currently Manager, Forest Genetics Section, Research Branch, for the BC MFR. He has been with Research Branch since 1988, in various capacities from Technical Advisor, Quantitative Genetics to Group Research Leader, and prior to 1988 spent four years as the lodgepole pine breeder with the Alberta Forest Service. He spent most of 2000 on sabbatical with the FAO, Forest Resources Division as a consultant in forest genetics. Past and current research interests are in the areas of pest and disease resistance breeding, advanced generation breeding strategies, and forest tree gene conservation research.

	BC Ministry of Forests and Range Future Forest Ecosystem Initiative Seminar Series 2009
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Kamloops Future Forest Strategy
December 11 2008 Room 201 727 Fisgard, Victoria
Dial- in 1-866-596-5277 Conference ID 270-4939

	Bryce Bancroft Symmetree Consulting Group Ltd. (Ken Zielke, RPF, Bryce Bancroft,	
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Global climate change presents an uncertain, moving target for forest managers as they try to understand ecosystem attributes and function over the next forest rotation. This influence cannot be ignored and the Kamloops Future Forest Strategy is working to create a vision of future forest conditions in the context of climate change by providing management direction that satisfies overlapping objectives. Specifically, the Kamloops Future Forest Strategy seeks to:

- Understand the range of potential impacts from climate change based on well-informed local climate modeling.
- Identify vulnerabilities to forest management expectations and direction based on the impacts of climate change and other influences.
- Provide options to modify management direction so that it is better aligned with the impacts of climate change and other influences.
- Articulate a robust desired future forest condition to promote general goals for timber and other values so they are not jeopardized over the long term.
- Identify data gaps and uncertainties.
- Provide a template for managing multiple objectives in a changing environment.

Gaining a cohesive perspective on climate change and potential impacts on an integrated management strategy is not simple. It requires best estimates of changing future ecological conditions, a reasonable consideration for the uncertainty tied to those estimates and, management strategies that consider all affected resource objectives.

Thus far, the KFFS project has analyzed future ecological vulnerabilities for twelve important local biogeoclimatic subzones. This was facilitated by mapping predicted biogeoclimatic subzone-climate envelopes based on bookend (best/worst case) scenarios from global circulation models out to 2050 and 2080, downscaled to the Kamloops TSA using ClimateBC. Specialists and practitioners considered this information in the context of current ecosystems to discuss potential ecological trends. Management vulnerability workshops have been done to help identify management direction and implementation options to adapt the future forest conditions. The project will wrap up in March, 2009.

Bio: *Bryce Bancroft has over twenty years of experience in forest management throughout British Columbia and abroad. Together with his Symmetree partner, Ken Zielke, he focuses on designing solutions and strategies for challenging resource management questions using current biological thinking and local operational realities. Bryce has a Bachelor of Science degree in Biology from McGill and Masters of Resource Management from Simon Fraser University. He is married and has two grown boys.*



BC Ministry of Forests and Range
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2009

Implementing Climate Change Reforestation Strategies in BC: Policy Barriers and Opportunities

November 27 2008

To listen to the recorded phone conference, call 416 695-5800 or 1 800 408-3053, and enter 1010820# as the passcode.



Brian T. Barber, MA, RPF
Director, Tree Improvement Branch
Forest Service

Abstract

Climate change will significantly affect our temperate forests. One of the few proactive measures to maintain forest health and productivity is to reforest areas with trees that are resilient or better adapted to changing environmental conditions. Climate change reforestation strategies include: a) increasing species and genetic diversity; b) assisting the migration of species and populations; c) managing for species with shorter-rotations; and d) selecting and breeding for adaptation to environmental stresses.

In this presentation will briefly describe these strategies and their potential benefits and limitations. I will subsequently evaluate BC's forest policy framework - and the Forest and Range Practice Act in particular - for its ability to accommodate these strategies. I will then conclude with an overview of the efforts and policy changes underway in BC to advance assisted migration (e.g. changes to seed transfer standards).

Biography

Brian T. Barber is a registered professional forester (RPF), holding a Bachelor of Science degree in Forestry from UBC (1987) and a Master of Arts degree in Environment and Management from Royal Roads University (2007). His master's thesis was titled *Reforestation strategies for adapting BC's managed forests to climate change: policy barriers and opportunities*.

Brian has worked for the BC Forest Service since 1992 in various capacities: Silviculture, Tree Improvement, Forest Tenures and Corporate Policy. Brian led the development of the Chief Forester's Standards for Seed Use (2004) and the BCFS's Climate Change Task Team (2005-06). Brian was recently confirmed as the Director, Tree Improvement Branch, with oversight for seed policy, planning, information systems, seed orchards and the provincial tree seed centre. He also serves as co-chair for the Forest Genetics Council of BC. Brian, his wife and their 3 children reside in Victoria.



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What's in store for trees in North America with climate change?

To listen to the recorded call: dial 1.800.408.3053 or 416.695.5800, enter [1009034#](#) for the conference pass-code.



Dan McKenney
Canadian Forest Service,
Great Lakes Forestry Centre
Sault Ste Marie, Ontario
Nov. 20/08

(with the assistance of John Pedlar, Kevin Lawrence, Kathy Campbell and Mike Hutchinson)

Abstract: *Climate change is predicted to strongly impact plant distributions, abundance and productivity. I will attempt to summarize some of the implications of projected climate change in the coming century on the habitat of over 125 tree species in North America. One of the major unknowns in this kind of work is the extent to which species will be able to adapt through migration. Therefore, we define 2 extreme scenarios that reflect species moving either entirely, or not at all, into future climate habitats. Based on the full dispersal scenario, future climate habitats are predicted to show both decreases and increases in size, with an average decrease of 12% and northward shift of 700 km. Under the non-dispersal scenario, average future climate habitats are predicted to decrease in size by 58 % and shift northward by 330 km. A major redistribution appears to be in order under both dispersal scenarios.*

Our work is based on a major data-gathering effort that currently includes almost 3.0 million geo-referenced observations for more than 5000 plant species and over 2500 species-specific models. Maps showing the current and future climate habitat for all the species in our database can be viewed at <http://planthardiness.gc.ca>. These models may be useful for thinking about resources management challenges ranging from assisted plant migration to park/reserve network planning. A current collaboration with BC Ministry of Forest and Range staff is developing higher resolution models for species of specific interest to the BC MF&R will also be described.

Biography: Dan McKenney is a senior scientist and Team Leader with the Canadian Forest Service in Sault Ste Marie. His research interests include the development and application of spatial data of the physical environment (such as climate), bio-economic models of trade-offs in forest management and policy and, research priority setting. He has a PhD in Forest Economics and Policy from the Australian National University, Master's in Resource Economics from the University of Guelph and a Bachelors Degree in Science of Forestry from Texas A&M University.

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Using genetic variation in trees to adapt to climate change

November 13, 2008

	Tongli Wang Associate Director, Centre for Forest Conservation Genetics Department of Forest Sciences, UBC	
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Abstract:

Climate, as a major environmental factor and a dominant selection force, determines forest types and species ranges at large geographic scales, and forest productivity at small scales. Through long term evolution, forest trees are in general adapted to their local climatic conditions. Rapid climate change will likely result in mal-adaptation of local species. A better understanding of genetic and environmental variation in tree growth and health related climate is needed for formulating new strategies to help forest trees to adapt to the changing climate. We have conducted a series of related studies with the main objectives of 1) developing a high-resolution climate model; 2) predicting adaptive responses of populations to climate; 3) quantifying among-population genetic variation for climate-related traits; and 4) predicting potential impacts of climate change on ecosystems and species ranges in British Columbia (BC). Plant materials and data used for these studies are based on one of the most comprehensive provenance test in the world for lodgepole pine and the Biogeoclimatic Ecosystem Classification System.

ClimateBC has been developed to downscale PRISM climate data, and integrates both interpolated historical and predicted future climate data. It has become an essential tool for climate-related studies in BC and it is being expanded to cover much of Canada and the US. We have also developed population response functions, transfer functions, and a universal response function for lodgepole pine to guide seed source selection and predict the impacts of climate change on stand productivity. The universal response function integrates population transfer and response functions into a single model to improve the prediction power and to reduce requirement for sample size of provenance tests for climate change analysis. Modeling and predicting ecosystem and species ranges shifts with different analytical approaches provide options for selecting species for future climates under various climate change scenarios. Results of our studies provide examples of using within- and among species genetic variation in forest trees to adapt to changing climates for reforestation and forest resources management.



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Biography

Dr. Tongli Wang earned his M. Sc. in Forest Genetics from the University of Helsinki in 1992. His Ph. D. is in Forest Genetics from the University of Helsinki (1996). Tongli is the Associate Director at the Centre for Forest Conservation Genetics, Department of Forest Sciences, University of British Columbia. His research interests include ecological genetics, quantitative genetics, adaptation to climate change and climate modeling.



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Climate Change Scenarios

September 24, 2008 1520 Blanchard Street Victoria, Room 355 Executive Boardroom
Dial-in 1-866-596-5277 Conference ID 270-4939



Dave Spittlehouse
Research Branch,
BC Ministry of Forests and Range, Victoria BC

Abstract: *The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states that: the warming of the Earth's climate is unequivocal; most of the warming is very likely due to the increase in greenhouse gases from anthropogenic activity; natural systems are being affected by the warming; continued release of greenhouse gases at or above current rates will exacerbate the warming and change precipitation regimes; and this will have significant social, physical and biological effects. The presentation will briefly explore these findings. I will describe future greenhouse gas emission scenarios and present examples of the possible future climatic conditions in British Columbia. Tools and data bases being developed to aid evaluating impacts of climate change on forest resources will be described.*

Biography: Dave Spittlehouse is a Senior Research Climatologist with the Research Branch, BC Ministry of Forests and Range, Victoria, BC. He has over 25 years experience in forest climatology, eco-physiology, forest hydrology and climate change. He was a member of the forest sector advisory committee for the Canadian Climate Change Impacts and Adaptation Research Network, and has represented the Ministry of Forests and Range at the provincial and national level on climate change, greenhouse gas management and forest carbon balance issues.



Climate Change and Forest Carbon Dynamics 101

October 9th, 11 AM



Caren Dymond
Forest Carbon and Climate Change Researcher
BC Ministry of Forests and Range
Victoria BC

Abstract:

Global climate change is one of the most important environmental challenges facing society today. The burning of fossil fuels and to a lesser extent, changes in land-use patterns have led to increased concentrations of greenhouse gases in the atmosphere, which are affecting the earth's climate. Not all of the greenhouse gases that we produce stay in the atmosphere – almost half are taken up by the ocean and land ecosystems.

Forests are an important part of the global carbon cycle. They take up carbon as they grow and release carbon when they are burned or decompose. Harvested biomass may be used for long-lived products such as construction material, burned for energy, or decompose gradually in a landfill. The net changes determine whether a forest sector is a net source or a net sink for atmospheric carbon. A forest is composed of many stands, some of which may be carbon sinks and some carbon sources. Overall, it is the forest's net carbon balance that must be accounted by adding up the ever-changing contributions of all the stands.

Climate change could subject BC's forests to changes in species communities and their geographic distributions. BC's forests may also be subject to more frequent extreme storms and wind damage, droughts, fires and insects. All of these components of the forest ecosystem affect the carbon balance and will determine whether BC's forests will be a net sink of atmospheric carbon or a net source in the future.

Forests and the forest sector have roles to play in helping mitigate climate change. We can work to reduce sources of greenhouse gas emissions and increase the sinks in the forests. As emissions become capped or taxed there are a number of opportunities for the forest sector in a carbon-constrained world.



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Bio: – Caren Dymond

Caren is a forest ecologist with a background in forest carbon modelling, natural disturbances, ecological modelling and geomatics. She has a M.Sc. and a B.Sc. in Ecology from the University of Calgary and is a member of the BC College of Professional Biologists and the BC Institute of Agrologists. After finishing her masters, Caren started her career in a landscape ecology lab at the University of Wisconsin Madison. Since then, she worked for the Canadian Forest Service on various projects over eight years. She came to MFR from Werner Kurz's Carbon Accounting Team at the CFS and will continue to work with them on mutually beneficial projects including developing a research program in forest carbon and climate change.



SUSTAINABLE FOREST MANAGEMENT UNDER CLIMATE CHANGE: ADAPTATION STRATEGIES BASED ON A COMPREHENSIVE VULNERABILITY ASSESSMENT

Oct 16 **8:45 AM** Room 201 727 Fisgard Street, Victoria

Rupert Seidl, Werner Rammer, Manfred J. Lexer
Institute of Silviculture, Department of Forest- and Soil Sciences, University of Natural Resources and Applied Life Sciences (BOKU) Vienna
Peter Jordan Straße 82, 1190 Wien, Austria
Tel: +43-1-47654-4069; Email: rupert.seidl@boku.ac.at

Abstract

Climate change is rapidly changing the environment of forest ecosystems and confronts forest management with considerable challenges. A particular hotspot are the European Alps, where warming has been proceeding with twofold magnitude of the global trend over the last decades. Moreover, increasing pressures from multiple societal demands add to complexity in forest management decision making. Thus the development of adaptive sustainable forest management (SFM) strategies is strongly needed considering the lead times of silvicultural measures.

The aim of the study was to assess the vulnerability of approx. 165,000 ha mountain forests under the stewardship of the Austrian federal forests and to propose feasible adaptive management strategies for highly vulnerable forest types. To that end we integrated state-of-the-art climate impact assessment tools and methodologies, addressed multiple forest goods and services and engaged in a stakeholder process to develop robust SFM strategies.

Principle tool in studying climate and management effects on forest dynamics was the ecosystem model PICUS v1.4. Model simulations under three climate change scenarios provided data to a framework of vulnerability indicators covering both ecological and socio-economic aspects of SFM. The preferences of involved stakeholders were an essential component in assessing vulnerability as well as in the development of adaptive management measures. Selected adaptation strategies were virtually implemented in the simulation framework. Residual vulnerability under each of the analysed alternatives served as selection and evaluation criterion, i.e. to prioritise adaptation needs and assess potentials of alternative strategies.

Keywords: adaptive management, climatic change, mountain forests, vulnerability assessment

Bio: Rupert Seidl

Rupert Seidl is a researcher at the Institute of Silviculture at the University of Natural Resources and Applied Life Sciences (BOKU) in Vienna, Austria. His research interests include the assessment of climate change impacts on forest ecosystems and the development of silvicultural adaptation strategies. In this context Rupert Seidl is particularly interested in understanding the



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feedbacks between climatic changes, natural disturbance regimes and forest management. He has an extensive background in ecosystem modelling and has previously worked at the Institute of Applied Systems Analysis (IIASA) in Laxenburg, Austria as well as at the European Forest Institute (EFI) in Joensuu, Finland. More information and a full publication list can be found under <http://www.wabo.boku.ac.at/seidl.html?&L=1>



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**A Climate of Change:
Adapting Seed Movement to a Changing Climate**



Greg O'Neill
Forest Geneticist
BC Ministry of Forests and Range, Research Branch
Kalamalka Forestry Centre
Vernon, BC

Summary

A well designed seed transfer system ensures that planted seedlings are adapted to the climate of the plantation, and therefore maximizes plantation productivity and wood quality, ensures the capture of genetic gains, and minimizes the risk of pest infection and epidemics. A revolution in the field of genecology due to new climate models, GIS, the availability of mature provenance data, and new statistical techniques make possible the development of a more effective seed transfer system.

Climate uncertainty compounds the need for a new seed transfer system. A seed deployment strategy that focuses on maximizing tree adaptation *throughout* the rotation by planting trees adapted to future climates (assisted migration) has emerged as a key approach to address climate change in plantation forestry. BC's seed deployment system will be deconstructed and re-constructed from the perspective of adaptation, seed deployability, ease of use and assisted migration.

Bio: Gregory A. O'Neill

Greg O'Neill is a professional forester and holds a Master's degree in Forest Ecology from UBC and a Ph.D. in Forest Genetics from Oregon State University. He has worked in industry, academia, and in international development. He now works within the Forest Genetics division of the Research Branch of the BC Ministry of Forests.

The focus of Greg O'Neill's research is on understanding the climatic tolerances of tree species and developing approaches to apply this understanding to reforestation policy in the face of a changing climate.

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