SUMMARY REPORT

CLIMATE CHANGE INFORMATION SERIES: IMPACTS AND ADAPTATION IN THE PRAIRIE PROVINCES FORESTS AND FOREST INDUSTRY

Monday, March 10, 2003
University of Winnipeg, Eckhardt-Gramatte Hall

CONTENTS

Acknowledgements

The Manitoba Model Forest (MBMF) in cooperation with numerous partners presented a very successful and well-attended one-day seminar on "IMPACTS AND ADAPTATION IN THE PRAIRIE PROVINCES FORESTS AND FOREST INDUSTRY". The Prairie Adaptation Research Collaborative (PARC) Manitoba office assisted in organizing the seminar at the University of Winnipeg. Funding and in-kind support was provided by: Manitoba Model Forest, Manitoba Hydro, Tembec Paper Company, MB Dept. of Energy, Science & Technology-Manitoba Climate Change Action Fund, MB Conservation, MB Agriculture & Food, Canadian Forestry Services, Canadian Climate Impacts & Adaptation Network , Center for Forest Interdisciplinary Research, Manitoba Forestry Association, Clean Environment Commission, Climate Change Connection and PARC.

Appreciation is extended to the seminar's steering committee members, the organizing committee, MBMF staff and to all volunteers at the event. Ideas and input from the steering and organizing committee members were welcomed. Thanks to the University of Winnipeg for providing a meeting space for the seminar and to the catering staff and audio-visual staff for their services. And, thanks to all the presenters and participants for taking time to attend and contribute very useful information at this event.

Introduction

The Manitoba Model Forest (MBMF) Incorporated is one of eleven Model Forests in Canada. The Canadian Forest Service and numerous other managing partners including the forest industry, Manitoba Conservation, First Nations, Environmental non-government organizations, local municipalities, and universities support the Model Forest. The MBMF works in partnership with these groups and many others to research, develop, and practice new and innovative ways to implement sustainable forest management. Established in 1992 as a non-profit corporation in Manitoba, the MBMF had conducted over 160 programs and projects related to social, environmental, and economic sustainability in forest management. In 1996, the MBMF won the Sustainable Development Award of Excellence for Non-Government Organizations.

Manitoba Model Forest Seminar Series Objectives

MBMF activities include communication, education and outreach programs. The MBMF in cooperation with numerous partners presented three very successful and well-attended climate change education and outreach events.

Two workshops were community-based and one was more scientifically oriented. The seminar in Winnipeg was the scientific and final forum of the three-part communication and outreach series for the 2002-2003 year. The Prairie Adaptation Research Collaborative (PARC) Manitoba office assisted in organizing the seminar at the University of Winnipeg. ***Appendix I*** includes a list of the Winnipeg seminar organizing committee, presenters and other assistants. ***Appendix II*** contains a brief synopsis of PARC network. The primary, general goals for the workshop series included:

Dissemination of information to the communities and individuals living and working in the eastern Manitoba forests and surrounding areas. Information was provided on climate change processes including a description of the greenhouse gases, as well as the frequently used but not well understood terms such as carbon sequestration, carbon credits and carbon trading.
Discussion of challenges and opportunities in the forest sector resulting from potential changes to composition and distribution of forests, tree growth yields, allowable harvest levels, susceptibility to pests, diseases and forest fires, carbon sinks was initiated.
Consultation with Aboriginal peoples of south eastern Manitoba and documenting traditional knowledge to capture the historical record and evidence related to climate change.
Identification and development of pilot projects and action plans that could be implemented at the community level as mitigation/adaptation measures dealing with climate change.
Raising awareness of forest mangers both in government and industry to the expected impacts of climate change on the forest so they can be positioned to take advantage of any opportunities arising from changes or to adapt to any adverse effects.
Providing access to information learned from the workshops to the to participants and to the general public.

The two local community *Adaptation to Climate Change* workshops were held in January 2003 (***Appendices III and IV*** show the workshop announcements). These two community workshops were intended to educate and raise awareness of climate change in Manitoba's forests for both the

public and the forestry profession. Experts from the Canadian Forest Service (CFS), the Canadian Climate Impacts and Adaptation Research Network, Forest Sector (C-CIARN), PARC, the Climate Change Connection and other organizations were invited to explain the potential impacts, adaptation and opportunities related to climate change. In addition, the community workshops provided opportunities for community members to interact with forestry professionals and give personal feedback on perceptions and observations of any observed, local climate changes.

The first community workshop of the MBMF series was held on January 22, 2003 in Lac du Bonnet, an agro-forestry community in southeastern Manitoba. The second community workshop occurred on January 23, 2003 at the Black River First Nations Reservation on the east coast of Lake Winnipeg. These workshops provided information on potential climate change impacts to each community. Dialogue was also initiated to identify possible adaptation measures within a community context and to develop action plans and pilot projects for the communities.

The final workshop of the series was held at the University of Winnipeg with assistance from the Centre for Forest Interdisciplinary Research and PARC. This one-day seminar was structured to allow for scientific presentations focussing on the Prairie Provinces forestry sector and impacts of climate change. Boreal and Aspen Parkland forests are very sensitive to climate and therefore it is very important to understand the potential changes that can result in composition and distribution of the future forests. These changes could significantly impact communities dependant on forest resources and the timber industry.

Appendix V contains the Winnipeg seminar announcement. The Winnipeg seminar notice was circulated to members of a variety of mailing lists, including the MBMF, PARC, C-CIARN and the Manitoba Clean Environment Commission. Distribution also included the Universities of Winnipeg, Manitoba and Brandon. The announcement was also posted on the websites of the MBMF and PARC and publicized at the University of Winnipeg web site.

A diversity of speakers were invited to the seminar and covered topics such as the science behind climate change, community perceptions of climate change and carbon sequestration in forests. The complete seminar agenda is shown below. Abstracts for each of the presentations follow. This seminar also included a poster paper session. A total of six posters were displayed. Abstracts for five are included in this summary report.

Agenda for the Climate Change Information Series: Impacts and Adaptation in the Prairie Provinces Forests and Forest Industry

Monday, March 10, 2003, University of Winnipeg, Eckhardt-Gramatte Hall

Agenda	
7:45 to 8:30 AM	**Registration**
8:30 to 8:45 AM	**Seminar Introduction**: Stan Kaczanowski, Manitoba Model Forest
8:45 to 9:30 AM	**The Science and Politics of Global Warming:** Andrew Weaver, University of Victoria, Climate Modeling Centre
9:30 to 10:00 AM	**Sustainable Forest Management Under a Changing Climate: Key Issues:** Greg McKinnon, Canadian Climate Impacts and Adaptation Research Network, Forest Sector, Northern Forestry Centre, Edmonton
10:00 to 10:15 AM	**Break** (Refreshments provided)
10:15 to 11:00 AM	**Linking Climate Change Projections to Impacts on Forests in the Canadian Prairie:** David Price, Canadian Forest Service, Edmonton
11:00 to 11:45 AM	**Climate Change Research in Manitoba's Boreal Forests:** Richard Westwood, University of Winnipeg, Centre for Forest Interdisciplinary Research, Winnipeg
11:45 AM to 1:00 PM	**Lunch (not provided)** See registration desk for lunch options on-campus and off-campus
1:00 to 1:45 PM	**Climate Change and Natural Disturbances: Potential Impacts and Adaptation Strategies:** Kelvin Hirsch, Canadian Forest Service, Edmonton
1:45 to 2:30 PM	**Impacts of Climate Change on Forest Productivity:** Mark Johnston, Saskatchewan Research Council, Saskatoon
2:30 to 3:00 PM	**Break** (Refreshments provided)
3:00 to 3:45 PM	**Climate Change Impacts on the Islands Forests of the Great Plains:** Ted Hogg, Canadian Forest Service, Edmonton
3:45 to 4:30 PM	**Climate Change Impacts and Adaptation in Forest-based Communities:** Tim Williamson, Canadian Forest Service, Edmonton
4:30 to 5:15 PM	**Carbon Sequestration in Canadian Forests:** Ed Banfield, Canadian Forest Service, Edmonton
5:15 to 7:00 PM	**Meet and Greet and Poster Papers** (Manitoba Boardroom, Room 2M70 in Manitoba Hall). Refreshments provided

ABSTRACTS OF PRESENTATIONS

The Science and Politics of Global Warming

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Central to the findings of the IPCC third assessment report was the statement:

> "There is now new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

This represents a significant strengthening of the analogous statement issued by the IPCC in 1996:

> "The balance of evidence suggests a discernible human influence on global climate"

What scientific evidence motivated these IPCC statements and what are their ramifications? A historical perspective of the Earth's climate over the last 400,000 years, and the science of global warming over the last 200 years will be discussed. Where the Kyoto Protocol fits within the framework of necessary actions required toreduce greenhouse gas emissions will also be addressed. Finally, a discussion of some outstanding uncertainties and a vision towards the future of climate modelling will be presented.

Sustainable Forest Management under a Changing Climate: Key Issues

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Climate change is expected to have profound effects on Canada's forests and forest sector. In general, forests appear to be most vulnerable to change during regeneration and through climate's impact on disturbances, such as fire and insect infestation.

Understanding the impacts and devising appropriate adaptation strategies are necessary to make our forests, forest industries, and forest communities more resilient to present and future effects of a changing climate. Sustainable forest management policies and practices should be adapted in recognition of current vulnerabilities as well as expected climate change impacts.

To help meet its commitment to improve Canadian's knowledge of the impacts of climate change and identify appropriate adaptation measures, the Government of Canada, through Natural Resources Canada and the Climate Change Action Fund, has developed the Canadian Climate Impacts and Adaptation Research Network (C-CIARN). C-CAIRN Forest focuses on issues relevant to the forest industry, forest-based communities and other forest users. It connects forest researchers, forest managers, policy makers, and community leaders so that they can better understand the expected effects of a changing climate on forests, and collaborate to develop and implement adaptive strategies.

Linking climate change projections to impacts on forests in the Canadian Prairie Provinces

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The mainstream debate surrounding climate change appears to have shifted from whether it will happen, to whether it is necessary to do anything about it. While there is broad scientific consensus that the first-level response to increasing concentrations of atmospheric greenhouse gases (GHGs) is a generally warmer global climate, there is little hard evidence to support any particular prediction of the rate (or extent) of increase in mean annual temperature. There is some general agreement amongst the established general circulation models (GCMs) that the greatest average warming will occur at higher latitudes and in mid-continental regions, and that it will manifest most noticeably as warmer winters and warmer nights. Hence, it appear that the Canadian Prairie Provinces, together with the northern mainland, are likely targets for significant impacts of climate warming (with some support for this from observations over the last 30 years). The GCM forecasts are far from consistent, however, and the future is very uncertain.

How then can we perform regional assessments of the likely impacts of future climate change, for example, on forests and forestry in central Canada? In essence, the only method is to perform computer simulations of the impacts of different scenarios of future climate, supported wherever possible by experimental and observational evidence. In the case of forests and other ecosystems, however, the effects of climate are many and varied. No single model can be expected to provide the "correct" answers for all regions under all scenarios. Our approach then is to test and validate models exhaustively, and work towards performing simulations with multiple ecosystem models, each driven by climate forecasts derived from different GCMs with varying assumptions about future GHG emissions.

The final problem is to try to make sense of the range of forecasts and to present our analysis to the stakeholder community with as much clarity as the results permit. We must be careful to understand the major implications as a basis for developing adaptation strategies, but at the same time we must not impute too much confidence in any particular prediction. In this presentation, I will attempt to outline progress along these lines and to show some preliminary results.

Climate Change Research in Manitoba's Boreal Forests

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This presentation summarizes to major research projects in Manitoba's boreal forest. The first project taking place in Thompson, Manitoba will examine the effect of warming on ecosystem carbon budgets, quantify microbial dynamics and soil respiration to identify causes for the hypothesized acclimation of soil respiration to warming, quantify the effect of warming on nitrogen use by vegetation and microbes and examine the effect of warming on phenology and stand structure.

The second project, examines the potential of using butterflies as bioindicators of climate and habitat in Manitoba's forests on the east side of Lake Winnipeg. The presentation will describe the infrastructure development at the Thompson research site and provide preliminary results of the butterfly forest climate change project.

Climate Change and Natural Disturbances: Potential Impacts and Adaptation Strategies

Kelvin Hirsch
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Climate change is projected to have a significant impact on natural disturbances in the boreal forest of western Canada. In terms of forest fires, this includes more fire ignitions, a longer fire season, higher fire intensities, and more escaped fires, which ultimately would lead to increased area burned. With respect to forest pests, climate change will have demonstrable effects on the frequency and intensity of pest outbreaks, particularly at the margins of host ranges. This presentation will provide an overview of the current assessments of how natural disturbances may be altered under a changing climate and discuss the implications for sustainable forest management, management of protected areas, and opportunities for carbon sequestration. Examples of possible adaptation strategies for both fire and pests will also be provided.

Impacts of Climate Change on Forest Productivity

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Forests at northern latitudes are expected to be affected by climate change to a greater degree that most areas around the globe. Impacts include changes to fire regimes, increases in insect pests, and changes to forest productivity. A number of climate-related factors affect forest productivity, including air and soil temperature and moisture availability. In addition, climate change will occur in association with higher atmospheric CO_2 concentrations and changes to nutrient availability. All of these factors will affect the level of forest productivity at a give site for a given species. Higher air temperatures will increase the levels of both carbon gain through photosynthesis and carbon loss through respiration, and the net effect on productivity will depend on the balance of these processes. Higher soil temperatures have the potential for increasing the availability of nitrogen, but this will depend on other limiting factors such as moisture availability. Higher CO_2 levels might cause an increase in growth, but this effect is limited by nitrogen and water availability, so the net effect will depend on the availability of these other resources. Water-use efficiency may also be higher in elevated CO_2 levels, but the effects on growth will depend on site factors, especially water availability. Water availability is a crucial limitation on productivity, and is highly dependant on soil water-holding capacity. Drought-prone sites are likely to decline in productivity due to increasing water stress, but sites with higher soil water-holding capacity may enjoy increased productivity due to warmer temperatures. Large-scale integrated studies generally find an increase in forest productivity which results in increased harvest levels and declines in prices, thereby benefiting the consumer at the expense of the producer. In summary, the potential exists for higher levels of productivity on sites where water and nutrients are not limiting. In contrast, managers may find that it is no longer useful to manage forests on drought-prone sites, and that management efforts should be increasingly focused on sites where growth is likely to increase. A number of research teams across the country are currently addressing these questions.

Climate change impacts on the island forests of the Great Plains

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Elaine Barrow, Adjunct Professor, University of Regina, Regina, Saskatchewan
Brett Dolter, Prairie Adaptation Research Collaborative, Regina, Saskatchewan
*Presenter

This study investigates future climate change impacts on five island forest sites in the northern Great Plains ecoregion: Sweet Grass Hills (Montana), Cypress Hills (Alberta-Saskatchewan),

Moose Mountain (Saskatchewan), Spruce Woods (Manitoba) and Turtle Mountain (Manitoba-North Dakota). The sites are relatively small forests, isolated from other woodlands by intervening grassland. They have high nature conservation, recreational and cultural value. Their smallness, isolation, restricted number of keystone species and ecotone nature make the island forests very vulnerable to climate change.

Using 3 different global climate models (GCMs) incorporating the latest emissions scenarios we construct climate scenarios for the 2020s, 2050s and 2080s according to standard Intergovernmental Panel on Climate Change (IPCC) guidelines. From these scenarios we derive climate moisture indices (CMIs) based on projected precipitation, temperature and evapotranspiration to model available moisture for vegetation growth. All GCM scenarios indicated declines in moisture levels over time.

As moisture availability is a critical determinant of forest structure and health at Plains forest sites, the loss of such substantial amounts of moisture is expected to have severe impacts, including the conversion of large areas of forest from trees to scrub or grass cover, the possible extirpation of some tree species, and negative impacts on biodiversity, landscape diversity, and recreational and cultural values. Landscape change may be sudden and dramatic, via vectors such as fire, insect attack or severe drought. Traditional minimal-intervention management will not prevent loss of diversity and risks catastrophic and permanent landscape change. Management that aims simply to retain existing vegetation, or to restore historical vegetation distributions and ecosystems, will fail as the climate steadily moves farther away from recent and current norms.

We examine past and current forest management at each of the study sites and find that climate change is not considered within management plans. Given the island forests' vulnerability and the magnitude of probable climate change impacts, an interim strategy of "managed retreat", incorporating active, anticipatory management, may be the best risk management approach.

Climate Change Impacts and Adaptations in Forest Based Communities

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Forest-based communities have strong social, cultural and economic ties with climate sensitive forest environments. Also, the characteristics of forest-based communities define a particular social context for climate change that contributes to additional concerns about their vulnerability to climate change effects. For example, capacity to adapt to climate change may be impaired somewhat by a) low investment in higher education, b) general declines in autonomy, c) potential tendency to underestimate climate risk, d) institutional inflexibilities, and e) a general lack of scientific information regarding climate change effects at local levels. At the same time the long term and irreversible nature of forestry investments and forest management decisions increases the imperative for incorporating climate change into current policy and decision-making. There is significant uncertainty about the magnitudes and timing of climate change

effects in forest-based communities and the lack of information on local effects will limit the development of adaptation strategies. One approach for providing communities with a better information base upon which to evaluate the need for action is to undertake risk analysis. A risk analysis framework is described. The framework includes evaluation of adaptation capacity, scientific risk assessment, and understanding risk perceptions as its main components. Effective risk management and risk analysis, however, requires that each of the components are linked by a systematic and structured approach to risk communication.

Carbon Sequestration in Canadian Forests

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Canadian forests play an important role in the global carbon cycle. In response to the issue of climate change, along with many other countries, Canada has signed the Kyoto protocol, with the target of reducing green house gas emissions to 6% below 1990 levels. As part of the strategy to reduce green house gas emissions the Kyoto Protocol recognizes the important contribution of forests to the global carbon cycle. Carbon stock changes resulting from land use changes (afforestation, reforestation, deforestation) since 1990 must be accounted for during the Kyoto commitment periods. Where afforestation and reforestation activities result in carbon stock increases, credit will be awarded. Likewise where deforestation activities lead to a carbon stock decrease a debit will be incurred. Although Canada must account for land use change, countries must decide by 2006 whether or not to include carbon stock changes from land management (including forest management) in their national GHG balance. Currently the Canadian Forest Service is developing a National Forest Carbon Accounting framework in order to assess the contribution of Canadian forests to the global carbon budget. This program, while supporting policy analyses and international reporting, also supports project level forest carbon stock accounting. In recognition of the role that forest management has in the forest carbon budget, the CFS carbon accounting team and the Model Forest Network have entered in to a partnership to develop a forest C accounting tool that will help forest managers consider the effects of their actions on forest C stocks given alternate management scenarios.

ABSTRACTS OF POSTER PAPERS

Poster title: A 380-year reconstruction of the Canadian Drought Code: impacts of atmospheric circulation anomalies on climate and forest fire frequency, eastern Canada. Climate Dynamics

Martin Girardin, Centre for Forest Interdisciplinary Research, University of Winnipeg
Tardif, Jacques, Centre for Forest Interdisciplinary Research, University of Winnipeg
Flannigan, M.D., University of Quebec at Montreal
Bergeron, Y., University of Quebec at Montreal

Inter-annual and -decadal scale variability in drought over the Abitibi Plains ecoregion (eastern Canada) was investigated using a 380-year dendroclimatic reconstruction of the Canadian Drought Code (CDC; July monthly average) i.e., a daily numerical rating of the average moisture content of deep organic layers. Spectral analyses conducted on the reconstructed CDC indicated a shift in spectral power after 1850 leading toward a reduction in interdecadal variability and an increase in interannual variability. Investigation on the causes for this shift suggested a decrease in North Pacific forcing after the mid-19th century. Cross-Continuous Wavelet Transformation analyses suggested coherency in the 8-16 and 17-32-years/cycle oscillation bands between the CDC reconstruction and the Pacific Decadal Oscillation (PDO) prior to 1850. Following 1850, this coherency shifted toward the North Atlantic Oscillation (NAO) in the 17-32-years/cycle band, and toward the Southern Oscillation (SO) in the 8-16-years/cycle band. Principal Component Analysis conducted on varying time window suggested that the Pacific forcing (SO and PDO) was restricted to the period approximating 1750-1850. Prior and after this period, the CDC was correlated with the NAO. The shift around 1850 could reflect a northward-displacement of the polar jet stream induced by a warming of the sea surface temperature along the North Pacific coast. A northward displacement of the jet stream, which inhibits the outflow of cold and dry Arctic air, could have allowed the inclusion of air mass from the Atlantic subtropical regions. Similar investigations are underway in the Manitoba boreal forest and across Ontario.

Poster title: Aspen Parkland Forest, Prairie Fires and Climate in the 1870s in Southern Manitoba

Irene Hanuta, Prairie Adaptation Research Collaborative, Centre for Forest Interdisciplinary Research, University of Winnipeg

Dominion Land Survey (DLS) maps produced in the 1870s were used to map forested land cover in a part of southern Manitoba. The 1870s distribution of Aspen Parkland was compared to the distribution in the 1990s. Changes in the extent of the Aspen Parkland were evident, with the forested area covering much less of the landscape in the study area in the present day. These changes likely resulted from land-use management and the expansion of agriculture in the area. Locations of fires in the 1870s was also identified and mapped. Large burned areas were found between 1871 and 1873. Fires during this period were attributed to predominately dry conditions and some severe lightning storms.

Poster title: Climate change impacts on the island forests of the Great Plains

Norman Henderson, Prairie Adaptation Research Collaborative, Regina, Saskatchewan
E.H. (Ted) Hogg, Natural Resources Canada, Canadian Forest Service, Edmonton, Alberta
Elaine Barrow, Adjunct Professor, University of Regina, Regina, Saskatchewan
Brett Dolter, Prairie Adaptation Research Collaborative, Regina, Saskatchewan

This study investigates future climate change impacts on five island forest sites in the northern Great Plains ecoregion: Sweet Grass Hills (Montana), Cypress Hills (Alberta-Saskatchewan), Moose Mountain (Saskatchewan), Spruce Woods (Manitoba) and Turtle Mountain (Manitoba-North Dakota). The sites are relatively small forests, isolated from other woodlands by intervening grassland. They have high nature conservation, recreational and cultural value. Their smallness, isolation, restricted number of keystone species and ecotone nature make the island forests very vulnerable to climate change.

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We examine past and current forest management at each of the study sites and find that climate change is not considered within management plans. Given the island forests' vulnerability and the magnitude of probable climate change impacts, an interim strategy of "managed retreat", incorporating active, anticipatory management, may be the best risk management approach.

Poster title: Climate Change Impacts on Productivity and Health of Aspen

E.H. (Ted) Hogg and James P. Brandt, Natural Resources Canada, Canadian Forest Service, Edmonton, Alberta
Bob Kochtubajda, Environment Canada, Meteorological Service of Canada, Edmonton, Alberta

Trembling aspen (*Populus tremuloides* Michx.) is the most important deciduous tree species in the Canadian boreal forest. In the early 1990s, dieback and reduced growth of aspen was noted in some areas of Saskatchewan and Alberta. Early studies suggested that drought, in combination

with insect defoliation and fungal pathogens, played a major role. This led to concerns about the current status of aspen health, including the question of how aspen may be responding to climatic warming that is already evident in western Canada. To address these concerns, we established a regional study (CIPHA) that includes annual forest health monitoring of 75 aspen stands in climatically-sensitive areas of western Canada, extending from the southwestern Northwest Territories and northeastern British Columbia to western Manitoba.

Field measurements on these stands showed that the aspen in the climatically-dry parkland zone are significantly stunted in height, and have a smaller basal area compared to aspen of similar age (mean of 60 years) in the boreal forest. As a result, average aboveground biomass was 37% smaller in the parkland stands (105 T/ha) compared to the boreal stands (166 T/ ha).

Tree-ring analysis was conducted on disks collected at three heights from 432 aspen stems at these sites. The results showed that regional aspen growth from 1950 to 2000 has undergone several periods of reduced growth and recovery. Growth was dramatically reduced during 1961-1964, 1979-1984, and 1988-1995, corresponding to periods with regional drought and large-scale outbreaks by forest tent caterpillar (*Malacosoma disstria* Hbn.). The last peak in aspen growth was in 1997, following a cool, moist period with little defoliation. Regional aspen growth started to decline during the unusually warm, dry "El Nino" year of 1998, and had decreased by a total of 30% between 1997 and 2000.

During 2001-2002, the region was affected by one of the most severe droughts on record. The 2002 forest health assessments showed that the drought had not yet caused widespread aspen dieback within these stands. However, a preliminary analysis indicated an increase in the incidence of poplar borers in some parts of the drought-affected region. Continued monitoring will provide an early indication of any long-term impacts of this drought on the health of the aspen forests in this region. Future directions include the "scaling up" of tree-ring analyses for annual estimates of net primary production, and the validation of models for projecting future impacts on the aspen forests of western Canada.

Poster title: Paleoenvironmental Evidence for Hydroclimatic Change and Extreme Flooding in the Red River Basin over the last 700 years

St. George, S., Geological Survey of Canada
Nielsen, E., Manitoba Geological Survey
Ferguson, G., University of Manitoba, Faculty of Engineering

A regional tree-ring network developed within the Red River basin has been used to develop proxy records of extreme floods, annual precipitation and groundwater fluctuations spanning the last several centuries. Inundation at the beginning of the growing season disturbs cambial processes in Quercus macrocarpa (Michx.) and causes unusual anatomical features to develop within the annual ring, including small earlywood vessels, disrupted flame parenchyma and less wood fiber. Such signatures can be used to determine the frequency and magnitude of past floods, provide a long-term context for contemporary observations and clarify the relative timing of extreme floods and potential forcing mechanisms. High flood modes have been documented for the lower Red River during the mid 1700s, the early to mid 1800s and the latter half of the 20th century. Records for the Assiniboine River and the American portion of the Red River are not as

robust, but suggest that severe floods in the Red and Assiniboine basins have coincided, albeit infrequently, during the past 500 years. A reconstruction of annual precipitation indicates that hydroclimate in southern Manitoba has been relatively stable over the last two hundred years, although interrupted briefly by pronounced wet intervals in the late 1820s and 1850s. Prior to this, the Red River basin experienced extremely dry conditions between AD 1670 and 1775, with below-normal precipitation occurring approximately two years out of three. Individual dry years were usually associated with larger-scale drought across much of the North American interior. Comparisons with limnological records from North Dakota and Minnesota suggest that multi-decadal fluctuations in regional hydroclimate have been consistent across the northeastern Great Plains during the last 600 years. Estimated hydraulic heads near Winnipeg, derived from a suite of climatic and tree-ring data, suggest that natural variations during the first half of the 20th century were much smaller than the effects of groundwater withdrawals.

Seminar Attendance and Feedback

A total of 186 participants officially registered for the Winnipeg seminar. It is, however, likely that attendance numbers were greater because not all participants registered with the front desk. Attendance came from a diversity of sectors, including government, academic and students, non-government organizations and industry. **Figure 1** shows the proportion of attendees by sector.

The seminar package contained an audience feedback form requesting an evaluation of the event and comments (**Figure 2**). A total of 55 feedback forms (about 30%) were returned. Evaluation of the seminar was extremely positive (**Figure 3**) with high approval ratings for the presentations and speakers. ***Appendix VI*** includes all written comments provided on the submitted evaluation forms.

Please take a few minutes to fill out the evaluation form. Your input and comments will help us to plan future seminars and workshops. Place an X in the appropriate box. Use the comments section to identify specific issues.

Figure 2: Winnipeg Seminar Feedback Form.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Comments
The presentations were informative						
The information presented was appropriate to the audience						
The speakers did a good job						
The length of the presentations was appropriate						
The location was appropriate for this meeting						

What would you like to see as themes for a follow-up seminar/workshop on Forests and Climate Change in Manitoba and the Prairies?

Please provide any other comments or suggestions about this seminar.

Figure 3: Results of Winnipeg Seminar Feedback Form.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No Response
The presentations were informative	**41.8%**	**50.9 %**	**5.5%**			**1.8%**

The information presented was appropriate to the audience	**21.8%**	**56.4 %**	**12.7%**	**7.3%**		**1.8%**
The speakers did a good job	**32.7%**	**61.8 %**	**5.5%**			
The length of the presentations was appropriate	**16.4%**	**63.6 %**	**14.5%**	**3.6%**		**1.8%**
The location was appropriate for this meeting	**50.9%**	**38.2 %**	**7.3%**	**3.6%**		

* Numbers may not add to 100% because of rounding.

APPENDICES

Appendix I: The Winnipeg Seminar Organizing Committee Members

Greg Carlson, Manitoba Conservation, Manager of Forest Inventory, Forestry Branch.
Greg has knowledge of the forest industry in Manitoba and is manager of the forest inventory section in the provincial Forestry Branch.

Irene Hanuta, Prairie Adaptation Research Collaborative (PARC), Manitoba Climate Change Research Coordinator.
Irene possesses an inter-disciplinary background in the environmental sciences with expertise in Prairies climate change and land use change. She is currently in the PhD program in the Department of Geography, Faculty of Environment at the University of Manitoba. Her duties at PARC include administrating climate change research information for Manitoba and raising awareness of potential impacts and adaptation strategies of climate change.

Stan Kaczanowski, Manitoba Conservation, Eastern Region Forester.
Stan Kaczanowski has also been seconded half time to work as Assistant General Manager, Manitoba Model Forest. Stan has extensive experience in forest management planning and eleven years of involvement with the Manitoba Model Forest as board member, vice-president, president and currently staff.

Brian Kotak, Tembec Paper Group, Environmental Director. Responsible for environmental programs for the Tembec Pine Falls mill and forestry operations including greenhouse gas reduction strategies, wildlife management, watershed issues and forestry certification. Ph.D. in water quality.

Greg McKinnon, Canadian Climate Impacts and Adaptation Research Network (C-CIARN) - Forest Sector Coordinator. C-CIARN is a national network that facilitates the generation of climate change knowledge, identifies information gaps and defines research priorities. Greg is responsible for delivering the Forest Sector component of the Network, which focuses on issues relevant to the many and varied, uses of the forest and to forest-based communities.

Seminar Presenters

Ed Banfield, Carbon Cycling, Canadian Forest Service, Natural Resources Canada (speaker)

Martin Girardin, Centre for Forest Interdisciplinary Research, University of Winnipeg (poster)

Irene Hanuta, Prairie Adaptation Research Collaborative (PARC), Manitoba (poster)

Kelvin Hirsch, Fire Environment, Canadian Forest Service, Natural Resources Canada (speaker)

Ted Hogg, Canadian Forest Service, Natural Resources Canada (speaker and two posters)

Mark Johnston, Saskatchewan Research Council (speaker)

Greg McKinnon, Canadian Climate Impacts and Adaptation Research Network, Northern Forestry Centre

David Price, Integrative Climate Change Impacts Modelling, Canadian Forest Service, Natural Resources Canada (speaker)

Scott St. George, Geological Survey of Canada, Winnipeg (poster)

Andrew Weaver, University of Victoria, Climate Modelling Centre (speaker)

Richard Westwood, Centre for Forest Interdisciplinary Research, University of Winnipeg (speaker)

Tim Williamson, Sustainable Development Economics, Canadian Forest Service, Natural Resources Canada (speaker)

Seminar Assistants and Volunteers

Rene Barker, Manitoba Model Forest (registration desk)
Danny Blair, Geography Department, University of Winnipeg (introductions)
Ed Cloutis, Centre for Forest Interdisciplinary Research, University of Winnipeg (introductions)
Bev Dube, Manitoba Model Forest (administration)
Irene Hanuta, Prairie Adaptation Research Collaborative
Stan Kaczanowski, Manitoba Conservation (introductions)
Brian Kotak, Tembec Paper Group (introductions)
Peter Miller, Centre for Forest Interdisciplinary Research, University of Winnipeg, (introductions)
Bryan Yusishen, Manitoba Agriculture and Agri-Food (gift baskets)

University of Winnipeg Student Volunteers (registration desk)
Stephen Berg
Suzanne Bulloch
Paige Harms
Sarah McFee
Trevor Mueller
Melanie Rose
Della Zubriski

Appendix II: The Prairie Adaptation Research Collaborative

The Prairie Adaptation Research Collaborative (PARC) is an interdisciplinary research network studying physical and socio-economic impacts and vulnerabilities of climate change in the Prairie Provinces. PARC also undertakes research to develop adaptation strategies to climate change – to reduce negative impacts and to take advantage of any new opportunities. PARC serves as a facilitator by bringing researchers together with decision-makers from government, non-government organizations, industry and communities to exchange information on climate change impacts and adaptation research and to identify research needs or gaps and opportunities. PARC staff resides at the University of Regina, Climate Change Central in Alberta and The University of Winnipeg. The *Manitoba Climate Change Action Fund* with matching funds contributed by the federal *Climate Change Action Fund* supports the PARC Manitoba coordinator position.

PARC represents Prairie interests in a larger Canada-wide network, the Canadian Climate Impacts and Adaptation Research Network (C-CIARN). C-CIARN is comprised of six regions and seven national sectors.

C-CIARN Region	**C-CIARN Sector**
British Columbia	Agriculture
Prairies (PARC)	Coastal Zone
Ontario	Fisheries
Quebec	Forests
Atlantic	Health
North	Landscape Hazards
	Water Resources

Additional information about PARC and C-CIARN can be found at their web sites at: www.parc.ca or www.c-ciarn.ca .

Appendix III: Winnipeg Workshop Feedback Comments

Question	Comments
The presentations were informative	Good mix of topics. McKinnon & Williamson were far too general. Quite technical in nature but perhaps the nature of the beast. I'm a high school student so didn't understand some of the info. Interested me in some of their projects. Very good speakers. Most were science based rather than fear mongering of worst case scenarios. Weaver, Price, Banfield & Westwood were highlights also a few presentations were boring (McKinnon, Hogg). Some yes, much we already knew. Some were more so than others. Bad overall where info. Too technical in most cases.

Question	Comments
The information presented was appropriate to the audience	Interactive session by Kelvin Hirsch was excellent. Audience was fairly broad for this topic. Could have been a little less of what we already know. Would like to see more study results, less 'fluff'. The group was very divergent and likely less technical in abilities so much of the information presented was above their abilities. I work for the forest industry & found the info. Very informative & appropriate to my skill level. That's why I came. Wide range of presenters and audience makes it hard to respond. Audience seemed to be very broad (i.e. level of scientific knowledge of climate change issues) however most of the speakers work on climate change and spoke only to others who have a high level of knowledge of climate change issues – scientific jargon, etc. I felt sometimes lost but understood from the graphs. Impossible to do given the diversity of the audience. Most presupposed academic/technical audience. Not all in audience had that background. Some info. Would have been too technical for some of the audience i.e. junior ranger/laypersons. David Prices's presentation was too technical for the majority of audience – the lay/common person – although well presented. Preferred more down-to-earth approach to info.

Question	Comments
The speakers did a good job	Built on one another's information. Most cases. They took too many subjects they then rushed through them. Do one or two & do them well. Some great, some… Some of them explained the info. very well. Most. I was disappointed by the 6th talk which was mostly audience participation. I'd rather hear the expert speak. Good job! Some problems with technology – not problem of presenters. Andrew Weaver was a very captivating speaker. Some speakers needed to engage the audience more to stimulate ideas & questions. Some presenters needed to streamline and punch-up the presentations – some were too technical or too long. Each did well in their own field but it would appear that this particular day was more geared to a technical audience – not the students & grass roots people. I am an arborist & was expecting more pertinent info.

Question	Comments
The length of the presentations was appropriate	Less slides; more time for discussion. But there were too many speakers. Could have easily been compressed to end at 4:30. Some were too long and others were too short. Depends on content and deliver – 45 mins is very long for some topics and speakers. Long, but interesting. Afternoon sessions too long. Boring speakers read their slides. Too long. Perhaps shorter, with discussions time scheduled. Just right! Need more time.

Question	Comments
The location was appropriate for this meeting	A bit cool. Just don't give directions that send us all over again. Great A/V. Comfy seats. I found the location great. Central location was quite accessible. Good central location. Coffee & pastries were appreciated. A bit cramped at times. Downtown parking for us rural people is atrocious! Perhaps a parking pass would be appropriate or a more commuter friendly spot. Poor parking, no lunch.

Question: What would you like to see as themes for a follow-up seminar/workshop on Forests and Climate Change in Manitoba and the Prairies?

Role of forest wetlands in the flow of water and nutrients.The impacts of climate change on these wetlands and implication for forest ecosystem sustainability.
More emphasis on climate change on the Prairies with relation to agriculture only.
Watersheds especially as the current focus on H20 health & the International Year of Fresh H20.
Health impacts and what the common person can do to really make a difference.
Animal Habitat needs to be covered as well & food production.
More social science.
Adaptation options/strategies – "vulnerability approach".
Afforestation and plantations for future fibre allocation.
"Species at risk" and protected area networks.
More presentations on research and possible solutions, technologies, adaptive strategies.
Good topics.
Good to have some updates on monitoring programs in relation to climate change.
Similar to the butterfly presentation today. E.g. results from spruce program at Ospwagon ?spelling
Perhaps policy-oriented.
Need for workshop format which allows more feedback from stakeholders.
More local speakers. Everyone seemed to be from Edmonton.
Forest Health & climate change.
Urban parks? – need more of them.
Progress report on Banfield's prototype of C-budget – maybe a demo?
More information on how cities contribute to global warming, specifically.
Results of some current study (if available).
Actions underway in Canada.
More informative, graphical and interesting slide shows.
Demo discussion: alternatives for paper.
Wildlife, non-timber forest harvest products, remediation, traditional peoples views & utilization & relation to forests.
Science and politics of global warming.
Climate change research in Manitoba and Boreal forests.
Impacts of climate change on forest productivity.
Climate change impacts on the Islands forests of the Great Plains.
*Carbon sequestration in Canadian forests.
More suggests on reusing and stop clear cutting.
Policy implications & required changes including incentives.
Local level concerns – what can the individual do about climate change? Is there any hope?? Generally the workshop made me feel there wasn't much hope & that the effects were overall very negative.
Get more MB speakers.
How to prepare for climate change in the boreal forest?
Impacts on water quality.
This time let's hear a real study on effects of global warming on black spruce forests instead of turning it into a butterfly thing.
More on use of tree farming as a sources of fibre
More on commercial forest implications & adaptations.

Question: Please provide any other comments or suggestions about this seminar.

Nice workshop.
I recognize the importance of trees to society in general, but many parts of the boreal forest contain > 50% wetland coverage* (some places 90%!). Clearly these are important components of "forests" (groundwater recharge, impacts on rates and direction of water flow, etc). My suggestion is: Don't miss the wetlands for the trees…Think of the entire ecological unit or watershed level. * particularly the boreal & taiga plain ecozones.
Improve AV quality. Note: Bad image clarity/focus.
Ranking for each speaker. Community poor.
Please start on time.
Please be more organized for registration.
A welcome seminar for those not available to attend late day sessions.
Kelvin Hirsch – very good presentation – audience participation very good.
Ted Hogg's presentation – relevant very good – need more of these.
Many thanks.
Good show.
Very timely workshop. Well organized.
Would have been nice to see a presentation about the Manitoba Model Forest itself. I know little about it other than information from website, pamphlet.
Incorporate whole watershed/forest shed. Lots of local researchers doing Carbon based research (both province, MB Conservation & Feds., Env. Can., FWI here in Wpg).
Perhaps too may speakers. Cut back by 1 or 2.
I would like to have seen a presentation and the development of models and the parameters set within them to better understand and trust the results produced.
Three presentations had technical difficulties, which detracted from an otherwise excellent day.
Well organized.
Some of the topics seemed a bit redundant.
Afternoon speakers should consider the remaining attention span of their audience i.e. make it a bit more lively/interactive.
Very impressive workshop with good organization and excellent attendance. Great to see school groups and First Nations involvement.
Very interesting seminar, looking forward to the next day.
Was the abundant amount of paper in the attendee packet printed on recycled paper with vegetable inks? This series was not really publicized to the students of UW or their environmental organization, EcoMAFIA.
I liked it.
It was excellent to see the Aboriginal & younger students in attendance. However, most presentation were likely beyond their level of comprehension. Not sure of the best solution to this:

1. Inform presenters before the workshop of expected audience so presentations can be tailored to their needs
2. Hold separate technical sessions for resource managers.

Well organized, good food/drinks.
Best speakers: Weaver, Hirsch, Banfield.
Interesting & knowledgeable speakers. Very nice to have it. There should be fewer speakers that cover more topics more thoroughly and have at least 15 minutes for questions after each. The thing should end by 3 pm if it starts at 8:30 otherwise too long for older people. We lost over ½ the audience by 3 pm.

APPENDIX IV: SELECTED WEB SITES

Manitoba Model Forest:
http://www.manitobamodelforest.net

Prairie Adaptation Research Collaborative:
http://www.parc.ca

Canadian Climate Impacts and Adaptation Research Network:
http://www.c-ciarn.ca

Canadian Climate Impacts and Adaptation Research Network – Forest Sector:
http://forest.c-ciarn.ca/

Natural Resources Canada, Canadian Forest Service:
www.nrcan.gc.ca/cfs-scf/

Natural Resources Canada, Geological Survey of Canada:
www.nrcan.gc.ca/gsc

Manitoba Conservation, Forestry Branch:
http://www.gov.mb.ca/conservation/forestry/index.html

Manitoba Energy, Science and Technology, Climate Change Branch:
http://www.gov.mb.ca/est/climatechange/

Manitoba Climate Change Connection:
www.climatechangeconnection.org

University of Victoria Climate Modeling Centre:
http://www.climate.uvic.ca

University of Winnipeg Geography Department:
http://www.uwinnipeg.ca/~geograph/

Environment Canada, Climate Change:
http://www.ec.gc.ca/climate/home-e.html

Intergovernmental Panel on Climate Change:
http://www.ipcc.ch