Climate Change and Forests:

Making Adaptation a Reality

A Report on the Workshop

by

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and

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Climate Change and Forests: Making Adaptation a Reality

Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts

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Foreword:

On November 18 and 19, 2003, The Canadian Climate Impacts and Adaptation Research Network together with the Manitoba Model Forest hosted a workshop on climate change impacts and adaptation in the forest sector. The workshop, held in Winnipeg, Manitoba, attracted a total of 83 participants, representing three levels of government, Model Forests, First Nations, community representatives, researchers, and representatives of the forest industry.

The workshop was designed to demonstrate the practical application of vulnerability assessment concepts in the development and evaluation of climate change adaptation strategies in the forest management sector. After a brief introduction to climate change and the expected effects on forests and their management, a flexible planning framework was presented and described. Three forest 'system' case studies (representing each of a protected area, a forest management area, and a forest-based community) were provided in pre-workshop materials and participants were asked to choose one upon which to apply the planning framework in break-out sessions. The remainder of the workshop focused on application of the risk-based approach to climate change adaptation to the case studies, presentation of the results of break-out session discussions, and final wrap-up.

This report summarizes the content of the workshop. The oral presentation abstracts are presented first, followed by a summary of break-out session discussions and a commentary from C-CIARN Forest on future directions. Materials developed for the workshop are included as Appendices to the report.

Acknowledgements:

The authors wish to thank the sponsors for their valuable contributions to making the workshop possible. Thanks are extended to the workshop organizing committee, comprised of Greg McKinnon (C-CIARN Forest, chair), Stan Kaczanowski (Manitoba Model Forest), Irene Hanuta (Prairie Adaptation Research Collaborative), Kelvin Hirsch (Canadian Forest Service), Paul Hunt and Tanya Maynes (Climate Change Central), Carl Smith (Manitoba Model Forest), Dierdre Zebrowski (Manitoba Conservation), Mark Johnston (Saskatchewan Research Council) and Doug Hunt (Tolko Industries).

Special thanks are extended to Mark Johnston, Ted Hogg (Canadian Forest Service), Tim Williamson (Canadian Forest Service), and Rick Lee (Canadian Institute for Climate Studies) for developing, respectively, the forest management, protected area, and forest-based case studies and the case study climate scenarios used in the workshop, and to Dan Ohlson (Compass Resource Management) for development of the workshop primer and facilitation of the workshop.

A particular note of gratitude is extended to Kelvin Hirsch for taking on the role of Master of Ceremonies at the workshop, to Irene Hanuta, and Bob Austman for making logistical arrangements and interfacing with hotel staff, and to James Matthewson for facilitating the delivery of all the workshop audio-visual and computer requirements. Thanks also to Jack Johnson for report formatting and desk-top publishing.

Lastly, we wish to thank the workshop participants themselves for their energy, insights and enthusiasm towards the workshop, and to their determination to work together to find adaptive solutions to the impacts of climate change on the forest sector.

Section 1: Presentation Abstracts

1. Climate Change and Forests: Making Adaptation a Reality "Setting the Stage"

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Abstract

The global climate is changing; furthermore the rate of change is expected to accelerate in the 21st century. Forests systems (e.g. forest management areas, protected areas, forest-based communities) have strong linkages to climate and climate change. Effects of climate change on the forest and forest-based communities in northern latitudes in the continental interior are numerous and far-reaching, with implications to economic, social and environmental sustainability.

Adaptation to climate change refers to adjustments in the ecological, social and economic systems in response to actual or expected climatic stimuli and their effects or impacts (Smit and Pilifosova, 2001). Forests will adapt naturally to climate change, however these adaptations may not be consistent with the long-term survival of the existing ecological, social or economic systems that depend on the forest. There is need for planned adaptations in the forest sector in order to maximize benefits and minimize adverse effects of climate change. In this regard, climate simulation models do provide forest managers with useful projections of future climate scenarios to support planning and management across a range of space and time scales.

A risk-based approach to climate change adaptation places climate change in a similar context to other risks faced by forest and forest-based community managers. Such an approach:

- includes the notion of the inherent capacity of an affected biophysical or socio-economic system to cope with the potential impacts of climate change, and provides a framework for a move from knowledge and understanding of climate/forest interactions (vulnerability) to proactive and planned adaptation

which may be outside of the inherent coping range.

The objectives of the "Climate change and forests: making adaptation a reality" workshop are to:

- demonstrate the practical application of vulnerability assessment/risk management concepts in the development and evaluation of climate change adaptation strategies in the forest sector, and
- determine knowledge gaps and key impediments to implementing these climate change adaptation strategies.

Multi-stakeholder and public support for many adaptive solutions will be required - most notably for those proposed adaptations that are controversial and/or run counter to current policy or practice.

Reference

Smit, B. and O. Pilifosova (eds.). 2001. Adaptation to Climate Change in the Context of Sustainable Development and Equity. Chapter 18 in *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [McCarthy, J.J., O.F. Canziani , N.A. Leary , D.J. Dokken and K.S. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA.

2. Climate Change Science

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Abstract

Although climate change was largely unknown as an environmental issue a mere 15 years ago, today it is a topic of intense discussion, and often tension within the international science community, amongst politicians, and within almost all sectors of our society. It is, however, a very complex issue that is often misunderstood and/or misrepresented by individuals and within the media.

The presentation will focus on some key conclusions of the latest IPCC assessment, released two years ago, and of subsequent published science. These conclusions indicate that the global climate is indeed changing. Average global surface temperatures are now about 0.6C above pre-industrial levels, and appear to be unprecedented in at least the past millennium. Attribution studies suggest volcanic, solar and human factors were are all implicated in the warming of the first half of the 20th century, but that the warming of the past 50 years is primarily due to human factors alone. Projections for future human induced forcing indicate that global temperatures, by 2100, will almost certainly be unprecedented in human history, and could reach magnitudes similar to past glacial-interglacial climate changes, but occur at rates more than 10 times faster. While these changes will dramatically change weather as we know it, the details of

these changes at the regional scale, as well as their consequences, remain quite uncertain. Some aspects of regional projections, such as frequencies and intensities of heat and cold extremes and wet and dry spells, appear to be quite robust. Others, such as the impacts on storminess, are much less certain. Hence the issue is clearly one of risk management. Various studies indicate that measures to reduce human influences on climate can significantly reduce the risks of the most disastrous aspects of potential climate change, but can no longer prevent significant climate change from happening. Hence, adaptation measures must also be a critical aspect of mitigation strategies.

3. Impacts of Climate Change on Forest Productivity and Large-Scale Disturbance Events

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Abstract

Boreal forests are expected to experience impacts from climate change to a greater degree than other regions. These impacts will be felt at both local and regional spatial scales, over both short and long time horizons. This presentation will focus on impacts especially relevant to boreal forests in the central portion of the prairie provinces, i.e. the area along the current forest-grassland boundary known as the "forest fringe". The main impacts are changes to forest productivity and changes in disturbance regime.

Forest productivity is determined by a number of environmental factors, most of which will be affected by climate change. The most important of these are temperature, moisture availability, nutrient availability (e.g. nitrogen, N) and atmospheric carbon dioxide (CO_2) concentration. By and large, we expect a general increase in temperatures, with temperatures at night rising faster than those in the daytime, and winter temperatures increasing faster than summer temperatures. These changes will result in generally warmer soil temperatures, and fewer frost days. This will change the availability of nutrients and water, and the increase CO_2 will change the ways trees carry out photosynthesis. The ultimate results of these impacts are difficult to predict because of numerous interacting factors, which vary by species and site conditions. However, it appears that there is potential

for increased productivity on sites with adequate nutrients (especially N) and water, due to higher temperatures and increased CO_2 levels. However, sites that are currently marginal with regard to water or nutrients are likely to become less productive. We will probably see an increasing divergence between sites, in which the "good" sites get better and the "bad" sites get worse. This will provide added incentive for concentrating management inputs on the more productive sites and avoiding drought-prone, low nutrient sites.

While the effects of climate change on productivity will occur over many years, changes to disturbance regimes could have important short-term effects. Recent modeling suggests that fires will be more frequent and more intense, with a long fire season and perhaps higher amounts of the main ignition source, lightning. In Saskatchewan, a recent study found that fire intensity could increase by up to three times by 2080 in jack pine fuel types, and could double in aspen fuel types. Insects outbreaks will be affected by climate change in two ways. First, the direct effect of increased temperatures will result in more insect activity and changes to insect distributions as temperature limitations shift northward. For example, there is the possibility that mountain pine beetle, currently restricted to B.C. and small areas in Alberta and the Cypress Hills, could move north and west into the western edge of jack pine range. This would allow the beetle to spread across much of central and eastern Canada, with major economic impacts. Similarly, spruce budworm and forest tent caterpillar are likely to be encouraged by generally warmer conditions. Because fires and insect outbreaks can cover very large areas, the impacts of these changes could be significant to the forest sector.

4. Hazards Risk and Vulnerability Assessment at the Community Level: Approaches, Methods and Application

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Abstract

Climate change is a complex phenomenon and it is difficult to be scientifically certain about its short term trend. However, the current trend of global warming has been an observed phenomenon that has significant implications for our natural resources and environment, and sustainability of social, economic and other aspects of well-being. Our natural resources including forestry resources are at risk of experiencing dramatic shift in their reproduction, growth and long term sustenance. Both the market and non-market cost of such shocks to timber and non-timber resources could be so high that a recovery in the short run may not be possible.

Risk Assessment is an appraisal of both the kinds and degrees of threat posed by an environmental hazard. Such appraisal, conceptually, includes the recognition of a hazard (*hazard identification*), the measurement of its threats (*risk estimation*), and understanding the social meaning of such measurements (*social evaluation*). Risk assessment methodologies have been evolving over the last three decades, and the application of these tools has remained a challenge for practitioners. *Hazard identification* methodology includes an examination of what hazards have occurred, where they have occurred, what kind of damage resulted, and the magnitude of that damage. *Risk estimation* includes intuition of the locals, in which the local community members may be able to predict when another event may occur, based on past experience. *Social evaluation* assesses how the community is prepared, and it asks what resources are available to cope.

In light of the above methodological framework, the Office of Infrastructure Protection and Emergency Preparedness Canada (OCIPEP) sponsored an initiative to explore and determine issues on all hazards risk and its reduction in the non-urban communities in Canada. In this paper, four risk assessment components were addressed: initial issue identification, validating issues, research findings, and lessons learned. It was

found that forestry-based smaller communities face hazards of spill, and agricultural communities are more concerned with weather-related hazards. Immediate and familiar events are recognized by these communities in the first place, and there is a lack of understanding of the increasing vulnerability and the need for long term adaptation strategy and plan. The paper concludes by presenting a number policy prescriptions concerning risk and vulnerability reduction and enhancing adaptive capacity.

5. Risk Management / Vulnerability Approach to Climate Change Adaptation in the Forest Management Sector

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Abstract

Adaptation to climate change refers to adjustments in ecological, social and economic systems in response to actual or expected climatic stimuli and their effects or impacts. In some circumstances, it may be most appropriate to allow such adjustments to occur autonomously, in a natural and unmanaged way. For example, long-term shifts in species composition in a timber supply area (i.e., ecological system change) might be followed by autonomous adaptations in the private sector to utilize the new type of forest resource (i.e., economic systems change). In other circumstances, it may be most appropriate to undertake system adaptations in a planned, proactive manner. For example, long-term shifts in forest disturbance patterns that threaten ecological, social or economic systems might necessitate planned adaptations in the form of targeted regeneration, silviculture or protection strategies. This presentation introduces a framework for approaching this latter form of planned adaptation.

Early management approaches to climate change adaptation emphasized “impact assessment” methodologies, where climate change scenarios were identified, biophysical and socio-economic impacts were estimated, and management strategies were developed or assumed. More recently, climate change researchers are suggesting the use of “vulnerability assessment” methodologies, where key system vulnerabilities are first identified, and adaptive strategies are developed and evaluated in the context of existing planning and decision-making processes. Integrated with the vulnerability assessment methodology is the notion of assessing the “adaptive capacity” of an affected biophysical or socio-economic system to cope with the potential impacts of climate change.

In this presentation, we build on this gradual shift in methodological focus by drawing linkages with practical methods from the general field of environmental risk management. In its broadest sense, risk management refers to the entire process of assessing risks (i.e.,

vulnerabilities), developing and evaluating strategies, making decisions under uncertainty, and communicating effectively with decision makers and stakeholders. Effective implementation and monitoring using an adaptive management philosophy can also be considered as an integral part of a broad risk-based approach to forest management in the face of climate change.

6. Practical Application of a Risk-Based Approach to Climate Change Adaptation in the Forest Management Sector

Climate Change - Past and Future

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Abstract

Warming and increased precipitation has been observed in many regions of Canada during the past century. Climate "normals" and extremes, based on much less than 100 years length often form the basis for decision-making in Canada. These so-called "normals" are affected by climate variability and when taken in a longer context, they are unlikely to represent the full range of climate variability or extremes from the past or indeed, for the future.

In order to determine the future climate, General Circulation Models of the atmosphere-ocean system are used. From these the future climate system can be projected, quantified and the uncertainty estimated. These models are driven by emission scenarios, derived from estimates of population growth and fossil fuel use amongst many others. While there is uncertainty particularly in regard to the magnitude of change, the projected direction of climate change amongst climate models is consistent - warmer and wetter for most of Canada.

Climate model output is presented as a series of 'Climate Scenarios'. They are a tool for those socio-economic sectors that are sensitive to climate and may be

affected by climate in the future. A wide range of projected variables is now available for North America from the Canadian Climate Impacts Scenarios Project. The projections for the Boreal Forest are for increased average temperatures, decreased diurnal range and increased precipitation.

Some of the hard working organizers of the workshop!

Kelvin Hirsch and Greg McKinnon

Kelvin Hirsch and Stan Kaczanowski

Section 2: Break-out Group Sessions

Introduction and Methodology

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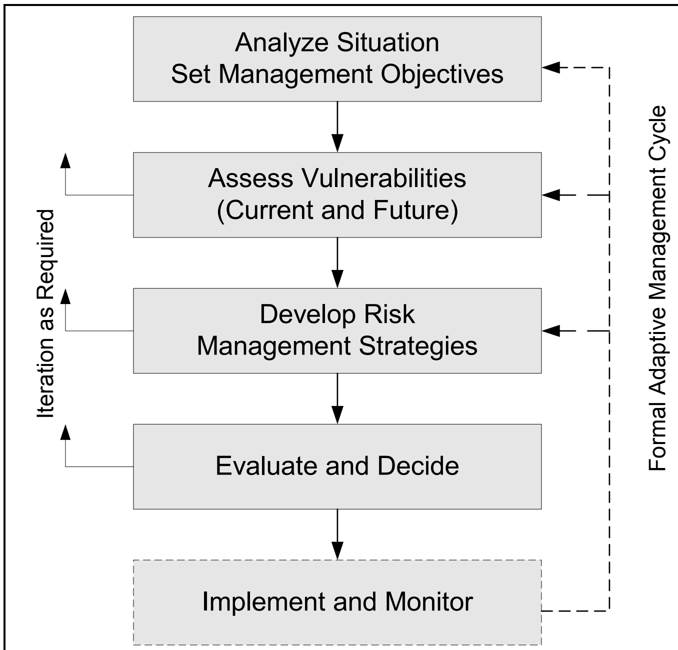
The purpose of this workshop was to demonstrate the practical application of vulnerability assessment concepts in the development and evaluation of climate change adaptation strategies in the forest management sector. Drawing upon recent research that advocates the use of risk analysis and structured decision-making methods, we structured the approach into a generic, flexible planning framework (Figure 2). Our focus as described below was on the planning and decision-making steps, recognizing that effective implementation and monitoring using an adaptive management cycle is also an integral part of a broad risk-based approach to climate change adaptation.

This risk-based adaptation planning/management framework was explained and expanded further in a Workshop Primer provided to workshop participants in advance of the workshop and included in Appendix 2 of this report. Templates were also provided to guide groups through undertaking a situation analysis, setting objectives, conducting a vulnerability assessment and developing adaptation strategies (Appendix 3). Three



case studies were introduced (see Appendices 4,5,6) and participants organized into break-out groups of six to twelve persons, based on indicated case study preference. Vulnerability assessments were based firstly on current climate then on expected future climate as described in climate scenarios centered on Prince Albert Saskatchewan (Appendix 7).

The following sections contain the brainstorming results from the small break-out group sessions.

Case Study 1: A Protected Area under Climate Change

Please see Appendix 4 for a detailed description of the protected area case study.

Situation Analysis:

1. Biophysical / Ecological Considerations
   1. Planning area is a national park in western Canada, with nearly 4000 km2 of boreal forest and lakes.
   2. Key indicators: population levels and health of wildlife species, biodiversity (e.g. number of native vascular plants, number of breeding bird species) annual area disturbed by fire and insects, incidence of exotic species such as weeds and pests, lake levels, water quality, air quality, area of park with minimal evidence of human disturbance, number of large animals killed annually on park highways.
   3. Issues: Insect defoliation (short-term), predominance of old forest and climate change (long-term)
   4. Uncertainty regarding future climate and climate change (droughts, extreme fire weather, damaging winds), risk of widespread outbreaks by insects and diseases (both on trees and wildlife), regional air quality.

2. Socio-Economic Considerations
   1. Water-based recreation and eco-tourism are key parts of the local economy and provide public support for park mandate, but adjacent forests outside the park are heavily utilized for wood and pulp and paper products (regional economy).
   2. Key indicators: number of tourists and tourist revenue, quality of visitor experiences (through surveys), number of visitors killed or injured by interaction with wildlife and natural hazards.
   3. Key issues: Public safety (e.g. fire, wildlife), controversies about how and whether to protect forests from fire and insects (ecosystem integrity versus aesthetics), how and when to restrict human access to natural areas, ongoing considerations to privatize certain aspects of park operations, pros and cons of promoting park visitation, pressures to expand tourist facilities within the park (question about which activities are compatible with the park mandate).
   4. Uncertainties regarding future human pressures and demands for more facilities (e.g. international visitors), land uses and industrial development near park boundaries, policies affecting park mandate and revenue generating capacity.

3. Policy & Institutional Considerations
   1. National Parks Act stipulates that park is to be managed for ecosystem integrity. Human use must be compatible with the vision of maintaining wilderness environments that will remain unimpaired for future generations.

2. Institutions: Canadian Parks Service (see mandate above), Provincial Forest Management Department (responsible for fire suppression and regulation of forest management in adjacent crown lands), Northern Affairs Department (responsible for enhancing employment opportunities in northern areas), forest companies (traditionally fibre production and revenue generation for shareholders, but increasing mandate for integrated resource management), local municipalities, communities and First Nations adjacent to the park.
3. Resources: Small year-round staff with larger seasonal staff (summer only). Park financial resources are mainly provided by entrance fees (i.e., park budget is largely determined by the number of tourists).

Group Discussion

Management Objectives:

1. Ecological

- managing to "frozen landscape" model (i.e. maintenance of existing plant/animal/human populations is impossible in the face of climate change
- increase landscape/habitat diversity as insurance against climate change. This will lead to a changing but "attractive" park resource.
- maintain regional representation of flora/fauna
- management must be flexible using appropriate tools/actions as situations/challenges arise/change over next 100 years.

Performance measures:

- "natural" age-class distribution and composition of tree species
- ecosystem processes continue to function normally, ecosystem health maintained
- maintenance of biodiversity is maintained
- terrestrial/aquatic ecosystem health is maintained
- successful ecosystem restoration/recovery

2. Economic

- generate income to contribute to the operating costs of park

Performance measures:

- costs of park management
- income from visitations and government revenues

3. Social

- Provide opportunity to experience natural ecosystems (recreation), for present and future generations

Performance measures:

- visitor satisfaction
- general public awareness and support for park management
- public awareness of current and developing issues
- value of experience
- number and frequency of return visitations
- demographics of visitors (numbers, age distribution, education/income level, point of origin, repeat visits)
- involvement in partnerships

Vulnerabilities to current climate:

1. Ecological
   - large fire/insect/windthrow disturbance events due to current fire suppression/forest management policies
   - effects on lake and riparian biota of water level fluctuations

2. Economic
   - aesthetic value is park is decreasing as forest ages and large-scale disturbances are increasing
   - visitor satisfaction decreasing – income loss

3. Social
   - visitor satisfaction decreasing
   - loss of quality of experience
   - climate effects leading to economic downturn
   - societal perception of ecosystem functioning not in accord with current climate

Vulnerabilities to future climate:

1. Ecological
   - fuel buildup and drought leading to more frequent and larger-scale fire events
   - increased nutrient loading to lakes leading to eutrofication, algal blooms
   - shift in species composition due to changing growing conditions/ loss of representation
   - forest regeneration failure
   - shift in vegetation cover due to loss of soil moisture
   - loss of species at risk and ecosystem diversity
   - increased political and social pressure to manage for status quo conditions
   - decreased value of park as baseline ecosystem for education and research
   - possible increased value for monitoring climate effects
   - species migration/species invasion (native and exotic)
   - increase in extreme events, storms, drought/fire, insect/disease,
   - unanticipated effects on wildlife and vegetation

2. Economic
   - loss of income to the park due to extreme conditions/events
   - lower visitor #s – reduced revenue
   - general economic stress may reduce perceived park value, leading to decreased funding
   - current economic vulnerability accelerated
   - more dependent on tax dollars
   - more costs – fire suppression, insect suppression, disease
   - exotic species
   - high cost of restoration

3. Social
   - reduced quality of park experience
   - reduced satisfaction with degraded park values
   - more pressure for recreation
   - introduction/acceleration of exotic and invasive diseases, e.g. West Nile virus, malaria

Risk management strategies*:

*An overall strategy of "managed retreat' is generally considered most viable/attainable.

1. Ecosystem management
   - implement zone management
   - increase fire/fuel management
   - implement control measures for exotic/invasive species

- develop organizational support/commitment

2. Public use
- increase efforts towards public safety
- develop emergency response plans
- adjust and develop park programs consistent with climate change
- promote eco-tourism

3. Communication
- conduct surveys to determine public values
- develop marketing programs/manage expectations
- enhance public education efforts
- develop partnerships with outside organizations/interests

4. Finance
- develop partnerships
- secure base and emergency contingency funding

5. Monitoring/research
- encourage and develop partnerships for monitoring and research
- research required both on biophysical processes and appropriate adaptive management strategies Land and water processes

Brainstorming ideas:

1. Ecological
- implement prescribed burns and selective cutting
- implement manual fuel/vegetation management
- develop policies with respect to use of chemical herbicides, insecticides, etc. in parks
- minimize soil disturbance
- restore disturbed sites
- monitor water level/quality, biodiversity, structure – habitat change,etc.
- remove water control structures
- partner with adjacent land managers and other stakeholders
- collaborate with outside partners on issues/strategies of mutual benefit
- Control exotic species
- re-evaluate/revise strategic objectives for parks
- establish response to extreme events (preparedness)
- reduce ecological footprint
- develop and protect migratory corridors
- increase plant community biodiversity

2. Economic
- obtain guaranteed baseline funding – move towards self-sufficiency
- develop emergency funding source
- re-evaluate park user fee structure
- increase visitation through active marketing
- develop partner agreements
- extend summer recreation season
- develop new recreation opportunities
- develop education opportunities
- prepare for reduced budgets
- sell wood obtained from park interventions
- increase non-consumptive use

3. Social
- communicate climate change risk/vulnerability to public
- advocate environmental stewardship
- adjust park management to address changes in demand/values
- obtain public support for mandate and management objectives
- invest in infrastructure changes
- commemorate heritage sites
- maintain/increase local employment opportunities

Case Study 2: A Managed Forest under Climate Change

Please see Appendix 5 for a detailed description of the managed forest case study.

Situation analysis:

1. Biophysical / Ecological Considerations
   1. An actively managed forest landscape in SW Manitoba of approximately 7,000 km^2. Dominated by aspen-spruce mixed woods, also includes a provincial park. The area is surrounded by agricultural land.
   2. Key indicators: long-term forest productivity, maintenance of ecosystem health (e.g. water quality, biodiversity)
   3. Issues: maintaining long-term forest productivity and ecosystem values (long-term); impacts of changing climate on forest productivity, fire occurrence and insect outbreaks (long-term), maintenance of soil quality/quantity, increasing emphasis on carbon sequestration, conversion of forest land base to agriculture.
   4. Risks: economic instability in forest products and agricultural industries; uncertainty about climate change impacts; loss of ecosystem values under forest management.

2. Socio-Economic Considerations
   1. Forestry production is a major employer of local communities; agriculture also important in this area; recreation important in provincial park; first nations and local communities asking for greater role in decision-making
   2. Key indicators: Annual Allowable Cut; degree of involvement of local residents in decision-making; sustainability of local communities
   3. Issues: integration of forestry and agricultural land use (short-term); need to involve public (including local land owners and First Nations people) in decision-making (short-term) regardless of degree of climate change; flexibility to deal with short-term changes in forestry and agricultural economies, lag effect of forest response to climate change.
   4. Risks: Loss of economic value due to industry downturn; inability of local residents to affect land use decision-making; impacts of climate change on forest production or other services (e.g. water quantity/quality)

3. Policy & Institutional Considerations
   1. Forest management governed by provincial legislation and associated regulations and standards. Sustainable forest management is required, supported by EIA and supporting analysis (e.g. wood supply analysis done with government).
   2. Institutions: Provincial Forest Management Branch (regulation, fire and insect protection); local municipalities (community involvement); provincial agriculture department (agriculture-forestry integration); federal water quality regulator (e.g. DFO, impacts on water quality of forest operations); forest company (local and international offices).

3. Forest company staff (recent cutbacks mean fewer people available); provincial forest management staff (limited provincial budget means increasing load on company staff); increasingly vocal local citizen's group.
4. Bureaucratic resistance to dealing with climate change issues in forest management planning
5. Need for forest policy to allow for climate change considerations

Group Discussion:

Management objectives:

The overall management objectives are threefold:

- To maintain wood supply.
- To maintain biodiversity.
- To maintain recreation opportunities.

1. Ecological:

- maintain ecosystem health
- maintain or enhance forest productivity (non-timber, timber)
- balance age class distribution
- maintain/enhance biodiversity
- maintain or increase the forested land-base
- 'no net loss' or 'net gain' of carbon storage in forest
- maintain water quality and quantity
- maintain soil quality

Performance measures:

- establishment of local level and criteria and indicators
- annual allowable cut
- no net loss or net gain of forest-land base,
- 100% reforestation success
- age-class structure, species composition, degree of fragmentation
- habitat for selected species, community assemblages
- net carbon sequestration
- water potability, volume and seasonality
- soil erosion rates and nutrient/carbon stocks
- ecosystem health – fire rates, severity, spatial patterns, insects – severity, spatial patterns

2. Economic:

- maintain a minimum level of even-flow wood supply
- maintain community forest employment
- maintain non-timber economic values
- maximize recreation/tourism
- maximize economic diversification
- sustain woodlots
- maintain winter access for timber management operations

Performance measures:

- wood volume harvested
- employment level
- number of hunting and fishing licenses issued
- number of tourism operators
- area of actively managed woodlots
- length of frozen road season

3. Social:

- ensure community sustainability
- enhance local and First Nation participation in decision-making
- maintain aesthetic and spiritual values
- maintain cultural values within the forest management area
- maximize employment opportunities for local community residents

- maintain an integrated management process
- maintain opportunities for forest-based recreation
- create knowledge

Performance measures:

- population demographics
- number of active stakeholders – members and communities
- stakeholder influence on forest management
- unemployment rate
- community economic activity and diversity
- building permits issues
- land values
- extent of value-added wood products produced
- conditions for recreational travel

Vulnerabilities to current climate:

1. Ecological:
   - regeneration success/failure on roads and landings
   - forest tent caterpillar/spruce budworm infestations
   - rare, threatened and endangered species at risk
   - fire frequency and intensity
   - forest productivity affected by drought, insects/diseases, fire windthrow
   - water quality issues resulting from weather extremes and water temperature increases
2. Economic:
   - economic viability of local forest industry in global economy
   - global market forces (supply/demand/prices linked to climate)
   - fire/extreme precipitation–caused industry shutdowns
   - winter harvest linked to length of frost period
   - inflexible government forest management policies
   - fuel and transportation costs
   - mean annual increment (timber supply) is linked to climate conditions and forest health
   - linkages to tourism
   - tourism industry linked to forest health and large-scale natural disturbance events
   - seasonal harvest constraints tied to weather/climate
3. Social:
   - unemployment due to industry shutdowns – fire, thaw conditions, precipitation
   - market uncertainly caused by climatic events
   - changing biodiversity – impacts on business
   - climatic effects on wildlife/game populations and behavior have cultural implications

Vulnerabilities to future climate:

1. Ecological:
   - increased threats to forest health
   - increased vegetative competition for seedlings – regeneration failure
   - ncreased fire frequency/intensity
   - implications to rare, threatened and endangered species and ecosystems– inherent lack of resiliency to climatic perturbations
   - shift in agriculture/forestry interface
   - increasing risk of fire/drought/insect/disease leading to lowered forest productivity
   - changing species composition and structure of forested areas –boreal forest in decline, fewer bog areas, generally drier conditions.

- changing fish/wildlife populations presents challenges/opportunities for tourism industry, etc.
- more forest disturbance affecting forest succession
- increased water temperature resulting in changed aquatic systems
- increased erosion and sedimentation (reduced water quality)
- lower water levels (surface and ground water)

2. Economic:
    - increasing fuel costs with effects on profitability
    - global climate change affecting international markets – some winners, some losers
    - effects on transportation – costs, access, seasonal constraints
    - more frequent shutdowns
    - economic viability
    - changing requirements for renewal technologies
    - increased uncertainty of timber supply
    - higher access costs
    - reduced achievability of renewal standards
    - increasing resource conflicts - certain sectors of the local economy may disappear as the resource changes
    - new or resource opportunities may emerge – possibly mitigating some adverse effects
    - wetter weather may decrease tourism activity
    - changing wildlife populations will change use opportunities/patterns

3. Social:
    - increasing employment concerns - increased long term uncertainty of resources and markets
    - changing workforce/business requirements to match resource changes
    - increased forest management complexity with cultural/integrated resource management processes implications

Risk management strategies:

1. Economic:

Access management

- provide road access to most vulnerable stands
- intensify timber production closer to mill
- increase network of all-weather roads
- intensify/increase efficiency of winter operations

Regeneration

- introduce species adapted to changing conditions (e.g. drought)
- provide wide genetic diversity in regeneration stock – mixed species plantings
- provide more flexible seed zone policies and procedures

Thinning

- increased emphasis on density control - thinning and pruning
- carry out less site preparation
- regenerate with larger planting stock
- shorten forest rotations
- diversify mill capabilities to take wider variety of wood quality and species (new products, etc.)
- target old stands for priority harvest
- lower operability limits – piece size, # pieces/m^3
- utilize treatments to increase growth rates, e.g. fertilization

Forest protection

- increased attention to fire proofing, e.g. use of FireSmart techniques
- increased fires and insect suppression

Research

- increase funding levels for climate change/forest management research

2. Ecological

- increase number and diversity of protected areas
- increase landscape level planning
- identify vulnerable species
- control access
- emulate natural disturbance patterns (historic or future?)
- implement adaptive management framework with active monitoring
- provide a provincial context for priority adjustment
- increased research on critical habitat elements, feasibility of management activity
- implement habitat supply management
- assist species migration/introductions

Strategies to maintain recreation opportunities in the face of climate change:

- implement access management
- increase emphasis on buffer management
- focus recreational opportunities on forest areas most resilient to climate change
- focus recreation away from areas of continuing intensive timber production
- consider species introductions
- implement watershed management planning (water quality/quantity)
- increase public education and communications with recreationists
- conduct socio-economic/cultural evaluation for trade-off making
- increased fuels management
- community fire protection planning
- more education and public awareness
- increased forest industry research – products, raw materials
- refine wood supply modeling
- emulate natural disturbance
- even-flow employment
- effective local planning to include community participation

Case study 3: A Forest-based Community under Climate Change

Please see Appendix 6 for a detailed description of the forest-based community case study.

Situation Analysis:

1. Biophysical / Ecological Considerations
    1. The forest west of town is a mature coniferous forest. Mature stands of even-age lodgepole pine and white spruce comprise a significant portion of this forest. The forest east of town is a mid-boreal upland ecoregion type with aspen, jack pine, black spruce, white spruce, fir and birch sometimes combining in mixed stands, sometimes forming pure stands.
    2. Key indicators: forest health, mortality, aesthetics, fire frequency and intensity, infestations, growing season length, seasonal temperature (current and future), precipitation (current and future), water levels, river flows, storm frequency, drought frequency, and heat waves.
    3. Issues: Maintaining a green and healthy forest, adaptive capacity and resiliency of forest ecosystems, water quality and quantity, water levels, fragmentation, access.
    4. Risks: Increase in forest fire or other catastrophic disturbance, increased forest die-back, disruption of hydrological cycles, loss of biodiversity, declines in forest health and resilience.

2. Socio-Economic Considerations
    1. The town has close linkages to the surrounding forest. The pristine nature of the surrounding forest and opportunities for outdoor recreation are attracting a number of individuals who have selected the community as a retirement location. The mill complex obtains timber supply from a large timber lease. The mill contributes significantly to the local economic base of the community. Tourism and visitor income are also important. Large numbers of people from outside the region own cottages on the lake. The area also attracts large numbers of people who travel to the park for winter and summer outdoor recreation activities. The town is concerned about water levels.
    2. Key indicators: timber supply (current and future), forest aesthetics, profitability of the mill, incomes, structure of the economic base of the local economy, municipal tax base, perceptions of forest health, participation in outdoor recreation, values or levels of satisfaction associated with outdoor recreation, water quality and quantity, lake levels, river flows, implications of climate change on health of the local population, perceptions of local forest management by urban residents.
    3. Issues: Perceptions of risks, capacity to adapt to climate risk, lack of information and knowledge about the timing and magnitude of impacts at local levels, community capacity to influence long term forest management planning, municipal planning, fiscal resources, impacts of climate change on supply and demand of local services (e.g. water, power, sanitation, roads, emergency services, health).
    4. Risks: reduction in tourism and outdoor recreation activity from changes in other climate related variables (e.g. snow) and forest

decline, economic losses related to reductions in mill production, risk of property losses from wildfire, reduced property values from change in forest aesthetics or declining water levels, increased demand for emergency services and municipal services, increased demand for health services, reductions in water quality.

3. Policy & Institutional Considerations

1. The municipal government provides local services such as water, sanitation, emergency services, municipal planning, and road maintenance. The province provides other services such as health services. The forest company manages the forest management lease area following provincial forest management legislation, regulations and standards. Compliance and enforcement is provided by the provincial forest management agency. The public has an opportunity to provide input on forest uses and management through public consultation processes.
2. Institutions: Town council, Municipal government, provincial forest management agency, Ministry of Municipal Affairs, Regional Health Authorities, Parks Canada, Ministry of the Environment.
3. There are four main issues that influence community capacity to adapt. First, there is little information regarding the magnitude and timing of climate change impacts at particular locations. Second, there are a number of competing demands for limited government finances. Moreover, there is a tendency to use resources for disaster relief instead of prevention. Third, local people's perceptions of risks related to climate change may be biased in ways that lead to underestimation of risks. Fourth, there may be fewer opportunities for economic diversification in resource-based municipalities compared to larger urban centers and levels of social, human, and economic capital may be lower than in larger metropolitan areas.

Group Discussion

Management objectives:

The overall management strategy is to threefold:

- To promote education
- To invest in community development, and
- To support research.

1. Ecological:

- restore historic range of age classes and species
- maintain water quantity and quality
- maintain green and healthy forest (high biodiversity values)
- maintain/enhance forest resilience

Performance measures:

- mosaic of age and species composition stays within x% of baseline
- maintain water quality and quantity (monitor reference indicator species)
- maintain/enhance biodiversity
- no reduction in forest cover at landscape level

2. Economic:

- maximize community capacity to cope with climate change
- maintain a sustainable wood supply for the primary industry
- implement intensified forest management
- enhance the diversity of the local economic base
- maintain tax base
- maintain tourism
- increase forest industry

- maintain forest aesthetics

Performance measures:
- AAC is kept within an acceptable range
- percent change in types of economic activity no greater than x%
- maintain viability of forest industry
- maintain forest inventory and yield
- maintain or enhance property values

3. Social:
- create/maintain a stable and healthy community (equal opportunity for men, women, cultural groups)
- improved access to services (education, seniors programs)
- maintain environmentally friendly alternatives (e.g. fuel sources)
- maintain employment
- maintain health services
- adjust to demographics
- maintain tourism

Performance measures:
- maintain or enhance rate of employment by demographic group
- maintain or increase education levels attained
- increase enrollment in continuing education
- maintain/increase tourism levels and opportunities

Vulnerabilities to current climate:

1. Ecological:
- drought
- extreme weather events
- fire weather conditions
- reduced snow pack
- higher temperatures earlier in the season compared to historic
- increased degree days
- changes in precipitation amounts and seasonality
- forest age-class gaps
- increased vulnerability to insects and disease
- forest becoming younger on average
- lake levels
- water quality and quantity concerns
- extreme water events – flooding, drying
- increased nutrient load and sedimentation
- increased water temperature affecting aquatic organisms and habitats
- winter kill of aquatic organisms

2. Economic:
- drought
- extreme weather events both summer and winter
- fire weather conditions
- reducing mean annual increment
- trade barriers
- changing income levels
- property values decreasing
- decreased forest aesthetics (forest practices, roads, infrastructure)

3. Social:
- extreme weather events (heat waves, storms)
- air quality issues (smoke, dust)
- mill closures
- water quality issues
- reduced health of population (e.g. seniors)
- declining quality of life in community
- traditional lifestyles increasingly difficult to maintain
- reduced tax-base (reduced services)
- changing perceptions of forest and human/forest interactions
- lack of knowledge or access to useful information on climate change impacts as linked to community and forest objectives
- changing demographics with aging community populations – implications to health services and insurance

Vulnerabilities to future climate:

1. Ecological:
   - forest age-class gaps
   - change in species
   - increased vulnerability to insects and disease outbreaks
   - younger forest
   - reforestation lag
   - longer fire season
   - shorter snow season/reduced snow pack
   - lower lake levels
   - temperature variability
   - decreased stream flow
   - extreme water events – flooding, drying
   - increased nutrient load and sedimentation
   - increased water temperature
   - winter kill of aquatic organisms

2. Economic:
   - AAC reductions and fluctuations
   - decreasing wood quality
   - work shutdowns due to lack of access and higher harvest cost
   - reduced snow pack lowering recreational activities in winter, increasing opportunities for some activities
   - increases in other activities
   - reduced assess access for recreational activities
   - reduced visitors/tourists/residents
   - low water levels affecting water-based recreational activities
   - reduced community growth or decline affecting tax base
   - shifting international conditions affecting trade arrangements

3. Social:
   - reduced health of population (e.g. seniors)
   - decreasing quality of life in community
   - traditional lifestyles may become impossible to maintain
   - reduced tax-base leading to reduced services
   - reduced winter tourism (less snow) and summer tourism (water levels declining)
   - deteriorating municipal water quality/quantity
   - reduced forest aesthetics
   - cottages and lakefront property values affected

Risk Management Strategies:

- scope issues and acquire data
- engage communities/public education and outreach
- produce community development strategy
- develop community-based forest development plan
- develop water management plan (quality/quantity)
- develop hazard mitigation and response plan– manage fire/disease risks around lake and town site

- integrate community plans with broader regional plans
- diversify local economy
  - new products/manufacturing/value added
  - new attractions (living museum, old-time logging camp, etc.)
  - determine feasibility of wood-waste co-generation facility
- develop tourism strategy
  - address shorter winter
  - consider probable “area closures”
  - consider new developments (spas, resorts, services)

- education
  - address changing skills requirement
  - hospitality training

Section 3: Future Directions and Next Steps

Plenary Discussion

Facilitator: Dan Ohlson, Compass Resource Management Ltd.

During this plenary session, seven questions dealing with the theme of the workshop "climate change and forests: making adaptation a reality" were posed to participants. The ensuing discussion is summarized briefly under each of the questions.

Question 1

Should a risk management approach to climate change adaptation be promoted?
Would it work?

- There is need for more knowledge/evidence before forest companies will begin to use this approach.
- There is need for more communication on climate change impacts and adaptation - the message is that climate is changing and that impacts are likely to happen
- Ecosystem responses to climate change are still uncertain and there is a compelling need for research in this area
- A risk management approach to climate change adaptation should be promoted but there is likely to be significant resistance to some of the adaptive solutions that will be advocated. Many of these solutions will fly in the face of existing policy and entrenched views.
- Policy makers need to be convinced of the reality of climate change (irrespective of the Kyoto Protocol) in order for impact and adaptation issues to gain greater urgency.
- Should use a "risk analysis" approach rather than a "risk management" approach. Climate change risk analysis should be incorporated into existing (and well established) forest management planning processes.
- Agencies such as the Manitoba Clean Environment Commission understand the language of risk analysis and are in a position to influence climate change adaptations.
- The Manitoba Forestry Association, a forest environmental education organization focused on forests and forestry, is currently integrating climate change into all of its education programs. As well, Manitoba is advocating that a risk management/risk analysis approach to climate change impacts and adaptation be the central theme of the 2006 Canon Envirothon competition.
- Better communication materials are required both for public and professional audiences.

Question 2

What are you going to do differently tomorrow?

- The Manitoba Model Forest will be encouraging the Canadian Model Forest Network to pursue the risk management (vulnerability) approach to climate change impacts and adaptation as a national strategic initiative
- The Manitoba Model Forest education coordinator will be advocating that the topic of climate change be introduced in the course curriculum for Manitoba schools
- No forest management plan in Canada is known to have been influenced significantly by climate change-oriented risk analysis/assessment. However the situation appears to be changing slowly. At least two forest companies are currently integrating climate change impacts and adaptation analyses into long their long range forest management planning processes. Hopefully

in the next 5 years this number will increase to twenty or thirty companies nationwide.

- The topic of climate change impacts and adaptation and the risk management/vulnerability approach will be on the agenda of the next national Parks Canada managers meeting.
- Manitoba will be providing awards to the Envirothon teams that best demonstrate an understanding of climate change issues during competitions.
- During Manitoba Clean Environment Commission hearings, panel members have begun (in the last three years) to question proponents with respect to the impacts of climate change on their development proposals, and any adaptive solutions proposed to mitigate these impacts. As a result proponents are now beginning to consider the issue.

Question 3

How can we better integrate climate science into forest sector management and planning?
What are the knowledge gaps?

- Need models that better simulate the biophysical impacts of climate change.
- Need to integrate vulnerability to climate and climate change into current forest and forest-based community management processes. There is a sense that if we don't start dealing with these issues now, the issues of tomorrow will become unmanageable
- Need to stimulate new and better science.
- Need to show climate change linkage to issues currently before policy and decision makers. It will not be enough to convince managers that climate change is real, rather climate and climate change must be linked to current forest management objectives.
- Need for more and better communication tools, e.g. powerpoint presentations, guides, etc.
- Need for more policy and decision makers to attend workshops such as these.
- Need new wood supply curves for a future under climate change.
- Growth and yield curves are based on historic climate and growth data and are unlikely to accurately represent growth and yield as climate changes.

Question 4

Why don't we see more long term range plans that incorporate climate adaptation?
What are the barriers?

- We are going to see more! As an example Louisiana Pacific in Manitoba is incorporating climate-oriented analysis in their long term forest management planning. This plan will go before the Manitoba Clean Environment Commission, and the climate and climate change component therein will form a new bench mark for other forest based companies in Manitoba.
- Barriers to climate change adaptation still exist at senior levels in government and industry. Many senior managers still don't believe climate change is a priority issue.
- Need better monitoring tools in order to better quantify impacts.
- Need more research
- There are several forest companies in Canada (e.g. Louisiana Pacific, Millar Western) that are beginning to recognize the seriousness of the climate change issue and contributing funds to climate change planning and research issues.
- Forest managers (both in government and industry) need to demand, support, and help fund more and better research targeted at operational issues. Many of solutions to climate change impacts in the forest sector will not be forthcoming for perhaps decades if the field is left entirely to the research community to lead the charge. Forest managers need to:
  - make their voices heard on the issue of climate change impacts and adaptation,

- encourage research collaboration between governments, universities and industry,
- pressure funding agencies, governments and forest companies to make climate change impacts and adaptation a funding priority,
- encourage governments to institute more flexible forest policies and procedures in the face of the reality of climate change.

Question 5
What would "flexible" forest sector policies look like?

- Have not seen any yet
- The concept of "floating protected areas" was raised – conceptually these would not be fixed in time and space but rather would be able to be moved as conditions changed.
- This would be an approved forest management plan with options and strategies addressing climate change. For this to happen, regulators will need to allow managers greater latitude in their ability to diverge from current policy. For their part, forest managers will need to provide justification for this any divergence.
- Currently regulators in several provinces will not allow forest companies to generate forest management plans for public forest lands in which timber supply analyses have been influenced by climate change impacts.

Question 6
Have you seen any techniques that would work for engaging stakeholders?

- It is important to engage people by using real weather events like hurricanes, tornadoes and forest fires. Pictures from these recently occurring weather events will have currency when it comes to having to deal with adaptations.
- There will be many challenges when dealing with diverse stakeholders. Some of the trade-offs and decisions that will have to be made in the future will not be acceptable by all. In this regard, environmental groups may be particularly concerned.

Question 7
Where to next?
We have had workshops on climate science, climate impacts and now this workshop. What would be a good next step?

- There will be a summary report of this workshop published
- Evidence of climate change must be presented honestly with the latest science.
- Presentations must identify the knowledge gaps, but must also identify a suite of adaptive solutions.
- Need good evidence and a plan of adaptation
- Develop a post workshop statement
- Develop a media statement
- Need to integrate Traditional Ecological Knowledge (TEK) into the process

A Vulnerability Approach to Climate Change Impacts and Adaptation in the Forest Sector

Greg McKinnon
Forest Sector Coordinator,
Canadian Climate Impacts and Adaptation Research Network
Northern Forestry Centre
Edmonton, Alberta

Forests are a vital component of the cultural, social and economic fabric of Canada. They provide both products and services that are essential to Canadians and people around the world. In the global context, Canada's forest mosaic includes some of the largest intact forest ecosystems and represents over 10 percent of the world's forest cover, 25 percent of the world's natural forest, and 30 percent of the world's temperate rainforest. The wise and sustainable management of Canada's forest ecosystems is, therefore a serious responsibility of Canadian governments and institutions.

To date, discussions and actions pertaining to climate change have focused primarily on mitigation. Agreements such as the United Nations Framework Convention on Climate Change (UN-FCCC) and the Kyoto Accord have been essential in promoting reduction of greenhouse gas (GHG) emissions and an increase in carbon sequestration. What is not broadly recognized however, is that even if the Kyoto emissions target is achieved and/or exceeded, CO_2 levels in the atmosphere will continue to grow and influence the climate for the foreseeable future (i.e. next few decades to centuries). Because of this fact, it is necessary to both pursue policies and programs that promote adaptation to climate change, while simultaneously continuing the policy objective aimed at mitigating GHG emissions. This dual focus is recognized by the Intergovernmental Panel on Climate Change and is outlined in the UNFCCC (article 4.1) that commits parties to formulating, cooperating on, and implementing "measures to facilitate adequate adaptation to climate change".

In forestry, the major research focus and budget expenditures have been to support studies on carbon inventories and the potential of forests to offset GHG emissions with particular regard to Canada's responsibility under the Kyoto Protocol. Historically, the broader field of climate change impacts and adaptation has received less attention and funding. As a result is characterized by significant knowledge gaps and a general lack of action. The development or implementation of methodologies to assess vulnerabilities and develop adaptive strategies is in its infancy and policy makers, foresters and forest community leaders have not as yet generally recognized and embraced the need for change.

The traditional approach to impacts and adaptation research has been to rely on modeling to predict future climate, then on the basis of this modeling, to predict impacts in the forest sector. However the uncertainty associated with downscaling GCMs to scales appropriate to local decision-makers (e.g. forest managers, community officials) has created confusion and paralysis. To move forward, adaptation within the forest sector will require two complementary, parallel and integrated initiatives:

1. Adoption of a 'vulnerability' approach to impacts and adaptation. The initiation of projects designed to test the vulnerability of a forest system (e.g. forest management area, forest-based community, protected area, etc.) to current climate and approximate climate change trends are required. From this the adaptive capacity of the forest system can be determined and adaptive strategies can

be tested. Building on concepts pertaining to risk management, such a program will ultimately promote adaptive strategies to minimize the adverse impacts of both current and future climate, and maximize the potential benefits.

2. Downscaling of global circulation models. Further enhancement and downscaling of global, regional, and local models that project climate change and its effects are required, especially pertaining to those factors to which forest systems are most sensitive. This will assist the identification of key climatic trends at spatial scales that are relevant to forest management decision-making.

Significant enhancements of the scientific capacity within government and universities to conduct fundamental and applied research and provide extension services in both a) impacts and adaptation, and b) climate modeling and downscaling, are required to move the climate change agenda forward with respect to the forest sector. In addition, the needs of decision-makers should play and an increasing role in guiding research priorities. Adaptation options for climate change should be developed to fit within the context of existing forest land-use planning systems and multiple resource objectives, rather than being viewed as a new and separate issue. The adoption of a 'vulnerability approach' to climate change impacts and adaptation in the forest sector provides opportunities for forest managers and others to integrate climate change into current forest management decision-making, concurrent with the management of other social, economic and bio-physical risks.

Appendices:

Appendix 1. Workshop Agenda

Climate Change and Forests: Making Adaptation a Reality

Radisson Hotel, Downtown Winnipeg, Manitoba, November 18-19, 2003
Peregrine Room, 12th Floor

Day 1 (November 18)

7:15	**Registration begins** (coffee and cookies available) Sign up for case study groups
8:15-8:30	**Introduction** - Kelvin Hirsch, Research Management Advisor, Canadian Forest Service
8:30-9:00	**Welcome -** The Honourable Steve Ashton, Manitoba Minister of Water Stewardship Mike Waldram, General Manager, Manitoba Model Forest
9:00-9:15	**Setting the Stage -** Greg McKinnon, Canadian Climate Impacts and Adaptation Research Network (C-CIARN) Forest Sector Coordinator
9:15-10:00	**Climate Science Update: Climate physics, change, extremes and variability** Henry Hengeveld, Senior Science Advisor, Meteorological Service of Canada
10:00-10:30	Refreshment Break (Peregrine Room)
10:30-11:00	Impacts of Climate Change on Forest Productivity and Large-Scale Disturbance Events Mark Johnston, Senior Research Scientist, Saskatchewan Research Council
11:00-11:30	**Hazards Risk Assessment at the Community Level** Emdad Haque, Director and Professor, Natural Resources Institute, University of Manitoba
11:30-12:00	Risk Management/Vulnerability Approach to Adaptation in the Forest Management Sector Kelvin Hirsch, Research Management Advisor, Canadian Forest Service, Dan Ohlson, Partner, Compass Resource Management Ltd.
12:00-13:00	Lunch (Peregrine Room)
13:00-15:00	Introduction to Case Studies Breakout group task #1: Management Objectives Setting (Break refreshments available at 14:30 pm in the foyer)
15:00-16:30	Breakout group task #2: Vulnerability Assessment (current climate conditions)
16:30-17:30	**Climate Change – Past and Future** Rick Lee, Climate Applications, Canadian Institute for Climate Studies

Day 2 (November 19)

7:45	**Registration Desk Opens** (coffee and cookies available)
8:15-8:30	Re-cap day 1
8:30-9:15	Breakout group task #3: Re-visit Vulnerability Assessments (future climate conditions)
9:15-11:00	Breakout group task #4: Develop Risk Management Strategies (Break Refreshments available 10:15 am in the foyer)
11:00-12:00	Breakout group task #5: Prepare Group Presentations
12:00-13:00	Lunch (Peregrine Room)
13:00-14:30	Breakout Group Presentations Plenary Discussion of Results
14:30 – 15:00	**Refreshment Break (Peregrine Room)**
15:00- 16:00	**Future Directions and Wrap-up** Kelvin Hirsch, Research Management Advisor, Canadian Forest Service Dan Ohlson, Compass Resource Management Ltd.

Appendix 2. Workshop Primer "A Risk-Based Approach to Climate Change Adaptation in the Forest Management Sector"

A Risk-Based Approach to Climate Change Adaptation in the Forest Management Sector

A Primer for the Workshop
"Climate Change and Forests: Making Adaptation a Reality"

November 18 & 19, 2003
Winnipeg, Manitoba

Foreword

This primer serves as an introduction to the November 2003 workshop *"Climate Change and Forests: Making Adaptation a Reality"*. The purpose of the workshop is to demonstrate the practical application of vulnerability assessment concepts in the development and evaluation of climate change adaptation strategies in the forest management sector. After a brief introduction to climate change and the expected effects on forests and their management, a flexible planning framework is presented that will be applied by workshop participants on a number of forest management case studies.

Climate Change

There is growing consensus in the scientific community that climate change is occurring. Research summarized in the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report indicates that global average surface temperatures are increasing, and that snow cover and ice extent are decreasing in the higher latitudes of the Northern Hemisphere (IPCC 2001a). While the absolute magnitude of predicted changes such as these are uncertain, there is a high degree of confidence in the direction of changes, and in the recognition that climate change effects will persist for many centuries.

Climate change may manifest itself as a shift in mean conditions, or as changes in the variance and frequency of extremes of climatic variables (Figure 1). There is a growing recognition that planning for changes in variance and an increase in the frequency of extreme events may pose the most challenging problems for natural resource managers (IPCC 2001b). While uncertainties remain and must be acknowledged, there is growing confidence in the ability of climate simulation models to provide natural resource managers with useful projections of future climate scenarios to support planning and management across a range of space and time scales.

Globally, two broad policy responses to address climate change have been identified. The first is mitigation, which is aimed at slowing down climate change by moderating greenhouse gas emissions. The second is adaptation, which is aimed at adjusting resource uses and economic activities in order to moderate potential impacts or to benefit from opportunities associated with climate change.

The focus of this workshop is on the latter approach. Specifically, we will explore the use of a risk-based approach to developing climate change adaptation strategies in the forest management sector.

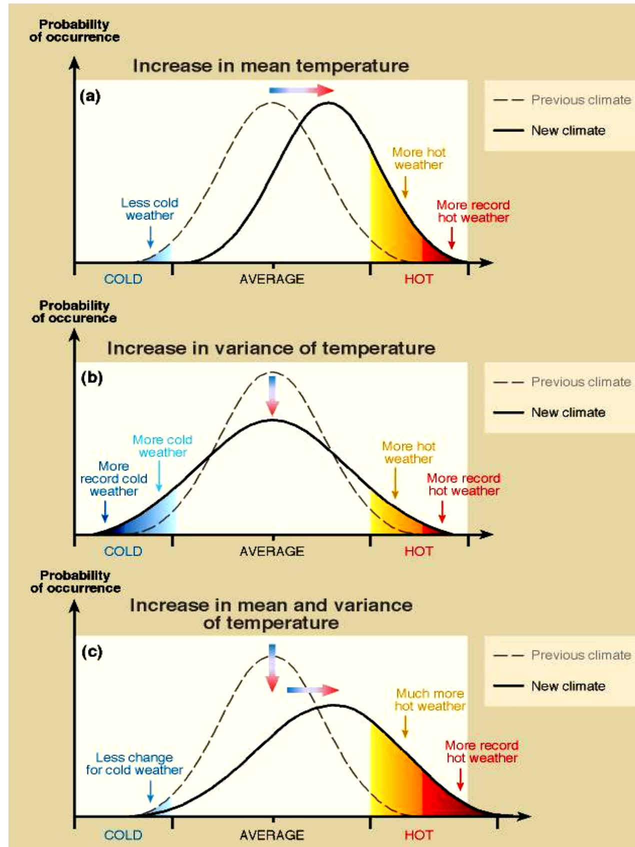


Figure 1: Schematic diagram showing effects on extreme temperature when (a) the mean increases, (b) the variance increases, and (c) both the mean and variance increase. (Taken from IPCC, 2001b)

Climate Change, Forests and Their Management

Climate change effects are expected to occur faster and be more pronounced over the mid- and high latitudes of the Northern Hemisphere continents. With more than 400 million hectares of forested land, including a significant portion of the world's boreal forests, there is keen interest in Canada regarding climate change effects on forests and their management. Recent research into the potential effects of climate change on Canadian forests has raised awareness of the need to address climate change in forest management practices (Standing Senate Committee on Agriculture and Forestry 2003, Climate Change Impacts and Adaptation Directorate 2002). The traditional research focus on the biophysical effects of climate change has, in recent years, been expanded to address socio-economic effects.

Biophysical Effects

The biophysical effects on Canadian forests are expected to be numerous. Effects may be either negative or positive, and they will interact in complex ways over many spatial and temporal scales depending on physical geography, forest type, forest management practices, etc. Table 1 provides a sample list of some of the potential biophysical effects that may be experienced on a local or regional basis.

Table 1: Potential Biophysical Effects of Climate Change on Canadian Forests

Potential Negative Effects	Potential Positive Effects
▪ Increased frequency and severity of fire due to a longer fire season, drier conditions and more lightning storms ▪ Expanded ranges and increased winter survival for insects causing increased defoliation and tree kill ▪ More extreme weather events such as ice storms, heavy winds and severe drought ▪ Reduced snow cover causing more frost heaving and exposure of roots to thaw-freeze events ▪ Individual species niches lost to moisture stress or competition from exotic species	▪ Faster tree growth resulting from a longer growing season / longer frost-free periods ▪ Enhanced plant productivity stimulated by increased levels of carbon dioxide for photosynthesis ▪ Increased plant hardiness in some species ▪ Replacement of slower growing forest tree species with faster growing, higher rotation ones ▪ Forest migration into previously treeless landscapes, and increased afforestation opportunities

Socio-Economic Effects
Biophysical effects will have numerous corresponding and inter-related socio-economic effects. Throughout Canadian forests, many communities are heavily reliant on the forest sector market economy. Significant changes in timber supply, whether through increased forest disturbance or decreased forest productivity, will have wide ranging effects on the profitability of local industries and employment levels in local communities. Effects will also extend to the provincial and federal level, where the revenues from taxes and resource rents provide the basis of program and service provision.

Forests also provide numerous non-market benefits to Canadians by providing aesthetic, cultural and heritage value. Parks and protected areas, which provide valued recreation opportunities and serve important conservation and heritage aims, may face particular challenges if the maintenance of existing, natural species and ecosystems is not possible in a fixed location. Perhaps most overlooked are the potential effects on the ecosystem services provided by Canada's forests, including air and water purification, wildlife habitat, medicinal plants, nutrient cycling, and erosion control to name a few.

As the need to adapt to the effects of climate change become more apparent, there is a growing demand for incorporation of the full range of both market and non-market values into forest planning and management activities.

Risk-Based Approach to Climate Change Adaptation

Adaptation to climate change refers to adjustments in ecological, social and economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change (Smit and Pilifosova 2001).

In some circumstances, it may be most appropriate to allow adaptations to occur autonomously, in a natural and unmanaged way. For example, long-term unmanaged shifts in species composition in a timber supply area (i.e., ecological system change) might be followed by autonomous adaptations in the private sector to utilize the new type of forest resource (i.e., economic systems change). In other circumstances, it may be most appropriate to undertake adaptations in a planned, proactive manner. For example, long-term shifts in forest disturbance patterns that threaten ecological, social or economic systems might necessitate planned adaptations in the form of targeted regeneration, silviculture or protection strategies. This section introduces a framework for approaching this latter form of planned adaptation.

Early management approaches to climate change emphasized impact assessment methodologies where climate change scenarios were identified, biophysical and socio-economic impacts were estimated, and management strategies were developed. More recently, vulnerability assessment methodologies have been promoted where key system vulnerabilities are first identified, and adaptive strategies are developed and evaluated in the context of existing decision processes (Smit and Pilifosova 2002, UNEP/IES 1998, Spittlehouse and Stewart 2003). Integrated with the vulnerability focus is the notion of assessing the adaptive capacity of an affected biophysical or socio-economic system to cope with the potential impacts of climate change.

The purpose of this workshop is to demonstrate the practical application of vulnerability assessment concepts in the development and evaluation of climate change adaptation strategies in the forest management sector. Drawing upon recent research that advocates the use of risk analysis and structured decision-making methods (UKCIP 2003, Turner *et al.* 2003), we structure the approach into a generic, flexible planning framework (Figure 2). Our focus as described below will be on the planning and decision-making steps, recognizing that effective implementation and monitoring using an adaptive management cycle is also an integral part of a broad risk-based approach to climate change adaptation.

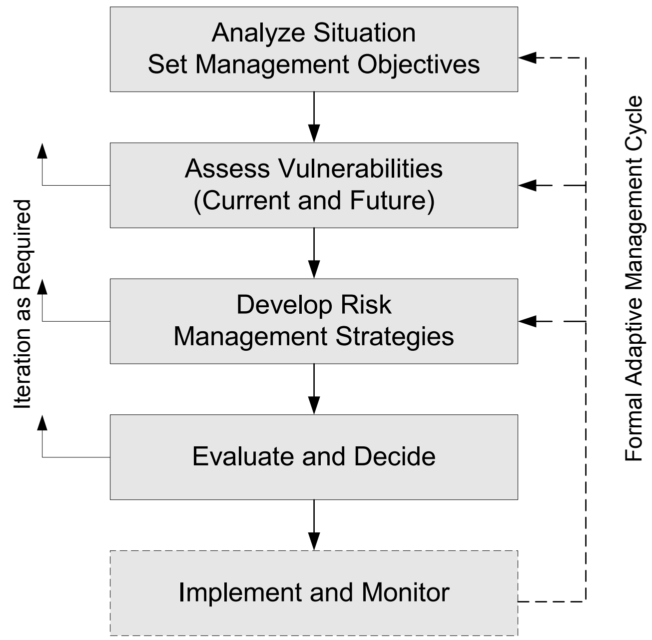


Figure 2: Risk-Based Approach to Climate Change Adaptation

Step 1 – Analyze Situation and Set Management Objectives

Formulating and specifying the forest management context is a critical step. Rarely will forest management planning and decision-making processes be undertaken that are driven solely by climate change issues. More often, climate change will be only one of several important factors to be addressed by a plan or decision.

As a first task, forest managers should undertake a situation analysis to succinctly summarize all key biophysical/ecological, socio-economic, policy and institutional considerations. Specific information to incorporate into a situation analysis is listed in Table 2.

Once the forest planning or decision-making context is defined, management objectives should be clearly articulated. Management objectives define the things that matter, the resources or management endpoints that decision makers and stakeholders care about and that may be vulnerable to climate change.

Table 2: Considerations to Address in a Situation Analysis

Key Biophysical / Ecological Considerations
▪ Define the planning and management area
▪ Identify key issues, differentiating between short and long term
▪ Identify key uncertainties (climate or otherwise) and information gaps
Key Socio-Economic Considerations
▪ Define the linkages with local / regional economic activity and social values
▪ Identify key issues, differentiating between short and long term
▪ Identify key uncertainties (climate or otherwise) and information gaps
Key Policy and Institutional Considerations
▪ Define the existing policy / regulatory framework and constraints
▪ Define the time horizon for the plan / decision
▪ Identify the institutions, jurisdictions and stakeholders involved and their authority / mandates
▪ Identify available resources (e.g., staff, budget, data, models, etc).

A good set of management objectives should be –

- Complete: Addressing everything that matters.
- Concise: Manageable in number so as not to overly complicate the process.
- Measurable: Using either quantitative or qualitative performance measures.
- Controllable: Within the context and authority of the process.

Management objectives can often be derived from existing plans or guiding policy statements. They should be stated by clearly identifying both the object of importance and the *direction of preference*, e.g., *maximize* timber supply, *protect or enhance* recreation, *minimize* implementation costs. In most forest management contexts, objectives can be organized into environmental, social and economic categories. Clearly stated management objectives form the basis on which all risk management strategies are later evaluated.

For each management objective, a corresponding performance measure is required to serve as the basis for describing the absolute or relative performance of alternative risk management strategies in measurable terms. For example, for the general management objective to "maximize timber supply", the performance measure might be "the average annual timber volume available for harvest". This measure meets several important criteria: it is predictive (using basic timber supply modelling techniques), accurate (directly relating to the stated objective), understandable (to all stakeholders) and practical (developed using readily available information and resources). While usually developed in quantitative terms, in some circumstances it might be appropriate or necessary to develop performance measures qualitatively using constructed scales.

In a risk management context, such as when addressing the future effects of climate change, performance measures should also be designed to report the nature, extent and significance of uncertainty and variability. For example, the average annual timber volume discussed above could be represented as a probability distribution. This information can be critical to expose if for instance alternative management strategies have similar 'expected' outcomes (e.g., average harvest volume) but differ widely in the probability of extreme outcomes (e.g., harvest volume falling below levels that would trigger mill shutdown).

Step 2 – Assess Vulnerabilities

The extent to which ecosystems or socio-economic systems are vulnerable depends on both exposure to climate change (or other) effects and on the adaptive capacity of the system.

In order to conduct a vulnerability assessment, the first task is to trace the exposure pathways that lead from climate to our previously stated management objectives. Influence diagrams (Figure 3), also called conceptual models or impact hypothesis diagrams, link stressors (such as climate change or other system influences) to management objectives (such as timber supply or recreation). They can be used to identify important exposure pathways, communicate system vulnerabilities and target information collection efforts.

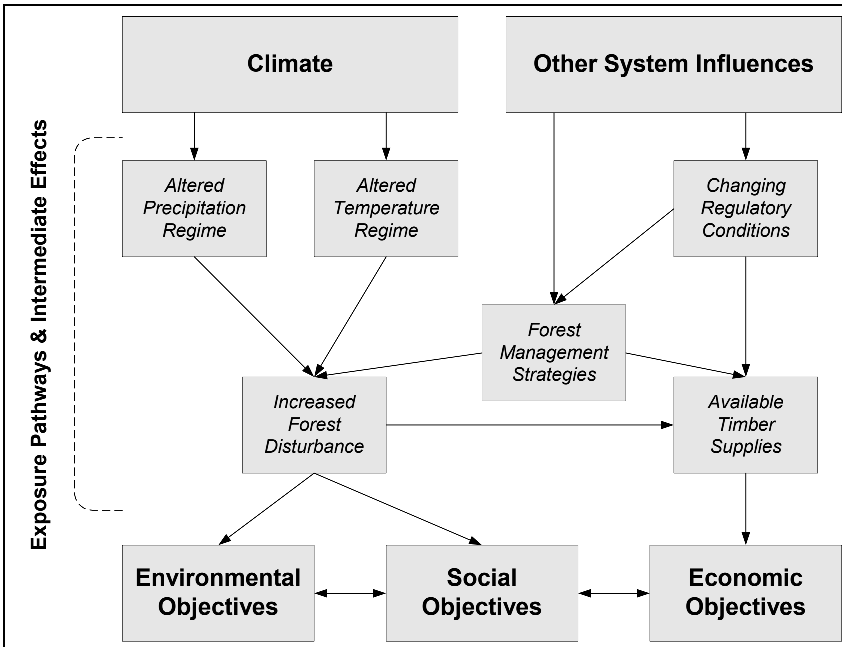


Figure 3: Conceptual Model Relating Climate and Management Objectives

From a planning perspective, it may be beneficial to first assess vulnerabilities under the base case or "current" climate before attempting to address alternative future climate scenarios. The experience and knowledge of managers, experts and stakeholders can often be relied on to quickly document the most important system vulnerabilities. For example, it may be determined that certain management objectives are sensitive to variations in key climate-driven effects such as drought frequency or annual frost-free days. Consideration of past weather variability and extremes may provide useful insight into potential vulnerabilities under different future climate change scenarios.

General information on future climate scenarios is often readily available from established sources (e.g., the Canadian Climate Impacts Scenarios Project, the IPCC). Depending on the planning circumstances and available resources, regionally-specific future climate scenarios can be developed in a number of different ways. First, it may be possible to use additional bio-climate modelling to "downscale" global climate change scenario predictions into useful regional-scale predictions. Alternatively, experts can be consulted or simple "what if" gaming can be used to develop future climate scenarios.

The overall intent of the vulnerability assessment step is to document key exposure pathways and to identify which management objectives are sensitive to change under both current and future climate scenarios.

Step 3 – Develop Risk Management Strategies

While some adaptive responses to climate change will be autonomous (i.e., those that occur naturally without public sector intervention), others will need to be planned and proactive. Step 3 involves developing a sound risk management strategy as a collection of planned, proactive actions using a structured approach.

The first task in developing a risk management strategy is to brainstorm and categorize a list of all possible management actions. In most cases there will be a range of specific options that are possible for any given management objective identified in step 1, or any given vulnerability identified in step 2. For instance using the example of managing a timber supply area, different options will be available for fire protection (e.g., increase suppression capability, develop fire-smart landscapes), forest regeneration (e.g., planting drought-tolerant genotypes, controlling invasive species), and silviculture treatment (e.g., managing tree densities and species composition, altering rotation age). An emphasis should be placed during the development of an overall risk management strategy on identifying *no regret* actions, that is, those management actions that perform well under current climate or any future climate scenario.

From a complete and categorized list of all possible management actions, we can then begin to develop a range of broader management strategies made up of different combinations of management actions from each category. Figure 4 shows how a strategy table can be used to assemble alternative management strategies from a set of categorized lists of management actions. In the conceptual example, strategy 'A' is comprised of forest protection actions 1.1 and 1.2, regeneration actions 2.1 and 2.2, and silviculture action 3.1, etc. Alternative strategies can be developed to address specific climate change scenarios (e.g., major increase in drought frequency or decreases in annual frost-free days) or to represent different management goals (e.g., to target a more diverse tree species mix, or alternative size class distribution).

The goal in this step is to systematically develop alternative, internally consistent forest risk management strategies that will address long-term vulnerabilities to climate change or take advantage of opportunities.

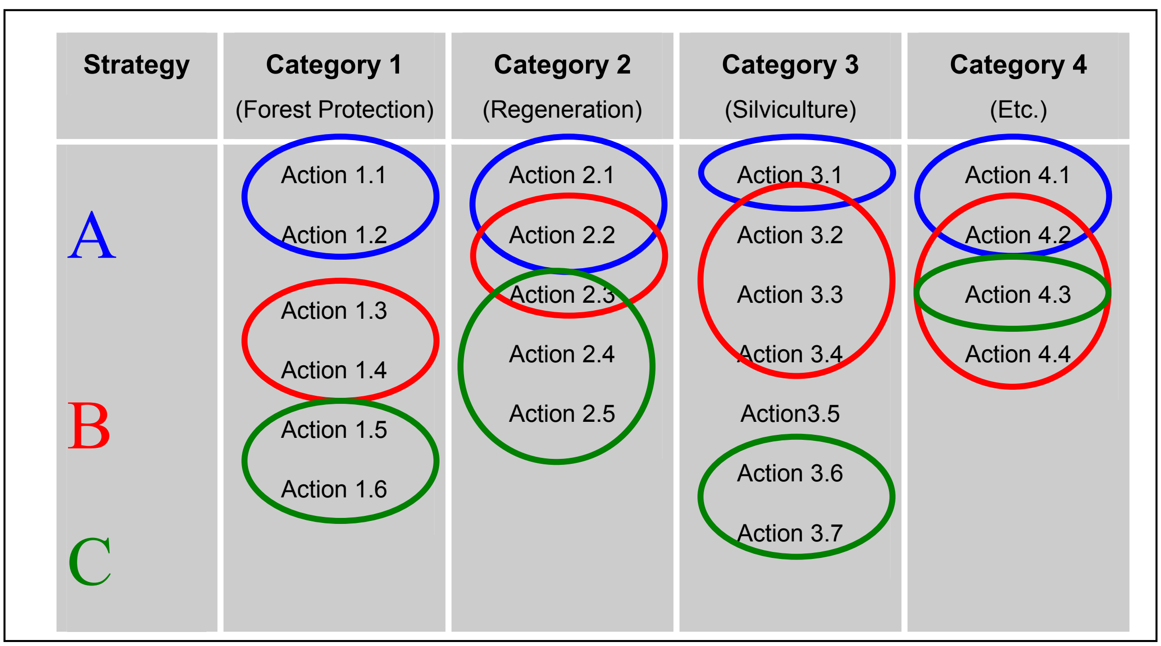


Figure 4: Use of a Strategy Table to Guide Development of Management Strategies

Step 4 – Evaluate & Decide

Once alternative risk management strategies are defined, they must be evaluated in terms of their effects on the stated management objectives. A simple format for structuring the evaluation is shown in the consequence table of Figure 5, where the cells of the matrix are filled in with expected consequences of each strategy on each management objective using the performance measures.

The value of the consequence table format is that it efficiently summarizes the trade-offs that may exist either across strategies or across objectives. Selection of the "best" strategy is based on the values and risk tolerances of the given decision maker, which can vary across stakeholders and across circumstances. [1] Therefore it is important to distinguish between the technical task of describing consequences, and the values-based task of evaluating consequences and trade-offs. In most planning and management processes and contexts this process is an iterative one during which multiple strategy refinements are made until an optimal balance of all consequences is found.

Management Objectives	Strategy A	Strategy B	Strategy C
Environmental		*Trade-offs across strategies*	
Social		*Trade-offs across objectives*	
Economic			

Figure 5: Consequence Table for Evaluation of Risk Management Strategies

The description of consequences during the evaluation and decision step should include an explicit and understandable expression of underlying uncertainties. For example, one strategy may have a higher expected area of old growth forest, but also a high probability of catastrophic disturbance, whereas another strategy may have a lower area of old growth forest, but also a lower probability of catastrophic disturbance. These types of trade-offs should be exposed to decision-makers. The goal is to identify and select those management actions and strategies that are robust in the face of uncertainties presented by alternative future climate scenarios.

[1] There are a variety of tools and techniques described in guidebook style documents that describe in detail the various tools and techniques to support the evaluation of management strategies (UNEP/IES 1998, UKCIP 2003). These include cost-benefit analysis and multi-criteria analysis (e.g., scoring and weighting) to name a few.

Workshop Approach

In the November workshop we will explore the application of this risk-based approach to climate change adaptation in the forest management sector by applying the four-step framework on a series of different case studies. Small working groups will be formed to work on the following case studies:

- Park / Protected Area Management
- Forest Management Unit Planning
- Regional-scale Land Use Planning for Forest-Dependant Communities

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Appendix 3. Break-out group guidance templates

1. Structuring a Situation Analysis

Biophysical / Ecological Considerations 1. Define the planning and management 2. Identify key indicators & describe their current status & future trends 3. Identify issues – differentiate between short term vs. long term 4. Identify risks & uncertainties
Socio-Economic Considerations 1. Describe the key linkages with local economic activity and social values 2. Identify key indicators & describe their current status & future trends 3. Identify issues – differentiate between short term vs. long term 4. Identify risks & uncertainties
Policy & Institutional Considerations 1. Define the existing policy/regulatory framework (policies, regulations, standards) 2. Identify the institutions / jurisdictions involved: a. authority & mandate b. roles & responsibilities c. specific programs and initiatives (including stated goals) d. decision making mechanisms (including public consultation requirements) 3. Describe availability of resources (staff, budget, information, models, etc.)

2. Setting Management Objectives

Management Objectives	Performance Measures	Required Data, Tools and Information Sources
• Identify an object and a *direction of preference* • Focus on ends rather than means • Categorized into environment, social, and economic	• Predictive • Measurable • Understandable • Practical	• Documents • Interviews • Existing Databases • New Field Work • Models • Etc.

3. Conducting a Vulnerability Assessment

Focus on Management Objectives

1. Identify the management objectives that are sensitive to change/impact.
2. Identify specific assessment endpoints and exposure pathways
3. Analyze your adaptive capacity

Consider Time Scales and Extreme Possibilities

1. Assess across time scales: current, future at year 20, or over tow rotations, etc.
2. Consider 'extreme' conditions (climate extremes, market extremes, etc.)

Conduct Tiered Assessments

1. Screening Assessments: qualitative only, use expert judgements/local knowledge
2. Generic Assessments: semi-quantitative
3. Detailed Assessments: fully quantitative

4. Developing Risk Management Strategies

Brainstorm and categorize individual actions

1. Brainstorm ways to meet each management objective
2. Brainstorm ways to address each system vulnerability
3. Try to identify *no regrets* options

Assemble alternative strategies as logical, internally consistent sets of actions

1. Start with a 'status quo' strategy
2. Develop alternatives:

- By budget level: "do a little" vs. "do a lot"
- By theme: "diversification", "transition with natural systems", or "active intervention"

Strategies	Category 1	Category 2	Category 3	Category 4	Category 5
	Action # 1.1	Action # 2.1	Action # 3.1	Action # 4.1	Action # 5.1
	Action # 1.2	Action # 2.2	Action # 3.2	Action # 4.2	Action # 5.2
	Action # 1.3	Action # 2.3	Action # 3.3		Action # 5.3
	Action # 1.4				Action # 5.4

Appendix 4. Case Study 1: A Protected Area under Climate Change

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Date: 15 October 2003

Background

The case study is a national park that occupies an area of nearly 4000 km^2 of southern boreal forest in western Canada. Originally established in the 1920s, the park is part of a national network of protected areas that were "dedicated to the people of Canada for their benefit, education, and enjoyment", and that were to be managed in such a way as to "leave them unimpaired for future generations". The focus on protection of natural resources was strengthened in a recent amendment to the National Parks Act, which states that the maintenance or restoration of ecological integrity is to be the first priority in managing national parks.

Some of the major natural features of the park include a protected colony of white pelicans, woodland caribou and plains bison. Other wildlife includes wolves, lynx, black bear, moose, elk, and over 200 species of birds. The park is dominated by pure and mixed forests of spruce, jack pine and aspen on a rolling landscape, but numerous lakes and wetlands occupy nearly 30% of the park's area. The southwestern portion of the park includes small areas of mixed grass and fescue grasslands that are more typical of the aspen parkland zone to the south.

The earliest confirmed record of human inhabitants date back more than 7000 years ago. European settlement dates back to the 1880s, when a fur trade post was established. Subsequently, a resort village was established on one of the major lakes, serving as a major focus for tourism, water-based recreation, golf, and a local community of summer cottage owners. This community is the only year-round, human settlement in the park, and it also serves as the park's headquarters. Timber harvesting formerly occurred in the southern third of the park during the early 1900s, and commercial fishing continued until about 40 years ago. Forest fire affected large areas of the park in 1919, but since then, fire suppression has resulted in a shift in the age-class distribution toward older forests.

Part of the more recent vision for the park is to protect healthy, functioning ecosystems that represent the mid-boreal and boreal transition ecoregions through maintaining or restoring natural processes such as fire and naturally fluctuating water levels. Human use of the park is to be encouraged, as long as it is compatible with National Park values and the maintenance of ecological integrity (see Parks Canada web site).

Potential impacts of climate change

In a recent analysis, Scott and Suffling (2000) examined potential impacts of climate change on Canada's national parks, including those located in the western boreal forest. Under a doubling of CO_2 levels the various model scenarios projected future temperature increases of 1^o to 4^o C in summer and 3^o to 8^o C in winter. The model scenarios were highly variable in terms of projected future changes in precipitation, leading to uncertainties as to how soil moisture and water runoff patterns may be affected (see also Herrington et al. 1997). It is important to note, however, that warming leads to an increase in the rate of evaporation and transpiration (water use by vegetation). Thus, the projected warming is likely to lead to more severe drought, if precipitation remains the same or even if it increases slightly. If such a drying trend takes place, all aspects of ecosystem functioning would be fundamentally affected (Hogg and Hurdle

1995). The impacts would likely include increases in fire and insect defoliation, potentially leading to losses of forest cover as conifers fail to regenerate from seed when soil moisture is low. Drought-induced forest dieback, especially of aspen and birch, would become more frequent. Such changes would have a negative effect on caribou, but would be favourable for bison as the area of grasslands increases. Climatic drying would also have direct impacts on wetlands, peatlands, streams and lakes in the park. Low lake levels would not only affect water-based recreation, but could have profound implications for wildlife, such as the exposure of the pelican nesting colony to predators.

Recent and emerging issues

Like many other protected areas within the region, the age-class structure of the forest in the park has become increasingly skewed toward older age classes of forest, due in part to fire suppression. Another recent development within the park has been a major outbreak of insects that are causing heavy mortality of spruce. This has led to controversy as to whether spraying is an appropriate measure to control this insect outbreak within the park, especially in the resort community where numerous trees are threatened by this insect. Insect-induced death of spruce forests is also thought to increase the risk that large, catastrophic fires may occur. Thus, there is a concern about how the management of fire and insects within the park may pose risks for the timber and non-timber values of forests outside the park.

Another issue relates to the management of water levels and aquatic ecosystems, notably questions about the removal or modification of water control structures that were thought to interfere with the natural functioning of these ecosystems in the park. These changes, in combination with drier than normal weather conditions, have led to reductions in stream flow and a lowering of water levels. Thus, there have been local concerns about the impact of water management policies on tourism and water-based recreational activities within the park.

One of the ongoing concerns in the management of natural areas is the risk that natural ecosystems may be disrupted by the introduction of exotic species such as European weeds. During the early 1900s, a several types of exotic trees and shrubs were introduced into the park, as plantations and as hedges around cottages. Since the 1990s, however, there has been a program of exotic species eradication in certain areas of the park, in response to concerns that they are aggressively spreading into natural ecosystems. With climatic warming and increased international trade, there is an increased the risk of accidental invasions by new and potentially damaging exotic species, especially forest insects.

One of the major challenges for the future management of protected areas is that under a changing climate, the maintenance of existing, natural species and ecosystems may not be possible. If, for example, the projected future climate of the park becomes much drier, natural regeneration of the native forest might become impossible. In such a situation, one of the questions that could be asked is what types of human intervention (if any) would be appropriate to maintain areas of forest cover within protected areas under climate change. In the discussion, it may be helpful to examine the three management models presented by Henderson et al. (2002) and summarized in Appendix 1 (below).

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Management Objectives:

Some options (adapted from Henderson et al. 2002):

1. "As-if Wilderness" Management Model

Treat climate change as a "natural process"
(if forests disappear because of increased drought , then so be it)
Inexpensive in management terms
Risk of losing biodiversity
Risk of losing valued landscapes
Public concerns if trees disappear!

2. "Frozen Landscape" Management Model

Management objective is to maintain or recreate the natural landscapes of the past
Easily understood concept
Success is measurable (historic records)
These landscapes really did exist
But even natural systems are dynamic
May be impossible under climate change

3. "Managed Retreat" Management Model

Accepts landscape change as inevitable
Management objective includes the maintenance of forest cover under a changing climate
Strategy may include active management options, for example:
- control of fire and pests
- enhancing regeneration of existing species
- "human-assisted migration" of regionally native species
  (e.g. drought-tolerant trees from Montana)

Disadvantages: expensive, increasingly intrusive, some options may be controversial
Advantages: good risk management, may help to maximize biodiversity under climate change

Appendix 5. Case Study 2: A Managed Forest under Climate Change

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Date: 31 October, 2003

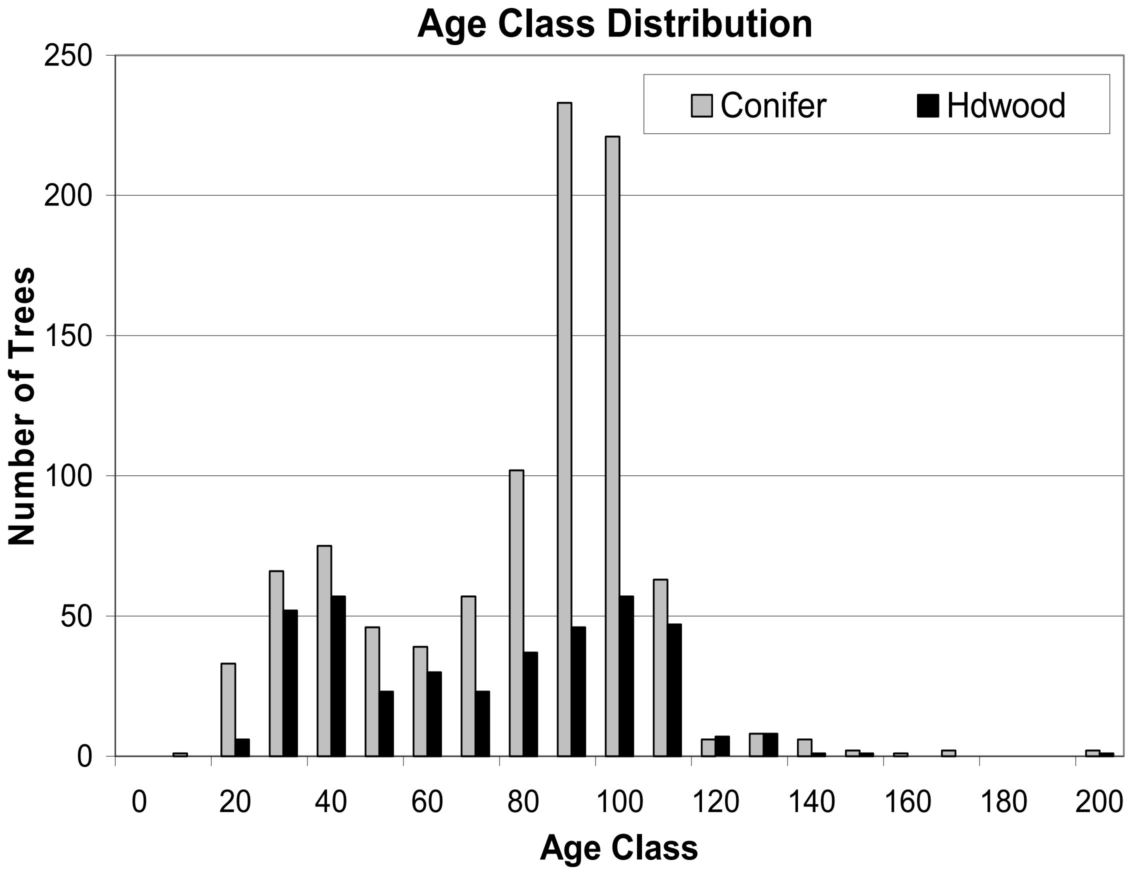
The Duck Mountains Forest Management Units (DMFMU) occupies a portion of the Manitoba Escarpment in SW Manitoba and SE Saskatchewan, comprising an area of approximately 7,000 km^2. The area occupies a region of elevated terrain relative to the surrounding area, with an elevation averaging 600 m above sea level. Soils are generally luvisols with moderate fertility and moderate water-holding capacity. The area has a mean annual temperature of 1.2 °C and receives 500 mm of precipitation annually. Growing season precipitation is 327 mm and growing season potential evapotranspiration is 528 mm, suggesting that droughts can occur during the growing season.

Land use in this area includes Duck Mountain Provincial Park and the operating area for a large forest products company operating out of a nearby community. The company has a provincial Forest Management Agreement area of about 600,000 ha. The annual allowable cut for the FMA is about 600,000 m^3, with another 200,000 m^3 purchased from other crown or private land. Harvest is 70% aspen, 25% balsam poplar and 5% white birch, with markets in the mid-west US (85%) and the prairie provinces (15%). Recent annual OSB production was about 50,000,000 m^2. Major competitors include OSB producers in the other prairie provinces. Hardwoods are used in the OSB mill and the conifer volume is managed on behalf of small sawmill operators in the area. About 2/3 of the volume is harvested in winter and 1/3 in the summer. Regeneration is largely natural for aspen and planted for spruce.

Forests in the DUFMU are mainly aspen-spruce mixedwood stands and black spruce (see table below for an approximate breakdown of species distribution). The age of the forest ranges from about 30 to 110 years, with conifer stands generally older than the hardwood stands. The figure below shows a representative age-class distribution for this area.

Species distribution

Species	% of total
Balsam Fir	3
Black Spruce	30
Jack Pine	9
Tamarack	2
White Spruce	27
Balsam Poplar	3
Trembling Aspen	23
White Birch	3



Impacts of Climate Change

Recent results from the Canadian Global Climate Model (CGCM2) for the time period 2040-2069 indicate that mean annual minimum temperatures will increase by about 3°C, mean annual maximum temperatures by about 4°C, and mean annual precipitation will remain approximately the same as at present.

Rapid changes in forest age class distribution and landscape patterns could be induced through altered timing and increases in the frequency and intensity of disturbances, such as fire (Stocks et al. 1998; Wheaton 2001), wind (Petersen 2000), ice storms (Irland 2000), and pests (Sieben et al. 1997; Volney and Fleming 2000). With respect to the latter, the DMFMU is currently vulnerable to spruce budworm and forest tent caterpillar (FTC) , and this vulnerability can be expected to increased with climate change.

Because the potential for wildfire often increases in stands after insect attack, uncertainties in future insect damage patterns magnify uncertainties in fire regimes. In addition, changes in damage and disturbance patterns can indirectly alter competitive relationships between plants and hence successional pathways, species composition, and forest distribution (Fleming 2003).

With increased temperatures and no increase in precipitation, the frequency and severity of drought is likely to increase. Work in other areas of the prairies has shown that FTC, especially when it occurs in periods of drought, can have major influences on tree growth (Hogg and Schwarz 1999). This is particularly important in the DMFMU due to the importance of aspen harvesting for the local OSB mill. Work by the Canadian Forest Service has shown that the Seasonal Severity Rating (a measure of the cumulative severity of an entire fire season) could increase by 40-50% for this area by the 2050s (Flannigan et al. 2000).

Future climate change may increase the thermal and moisture stress on the existing forest. Stressed and aging tree populations will be more vulnerable to insects and disease and the regeneration phases of forest succession will be particularly susceptible to a changing climate. Forest disturbances can be viewed as a way to speed adjustment to climate change by facilitating the spread or planting of genotypes or species more suitable to the new climate (Spittlehouse and Stewart 2003). However, non-commercial tree species and understory vegetation will have to migrate without intentional intervention. In addition, tree species more suitable for a changed climate may not provide appropriate fibre and aesthetic qualities for the extant timber and non-timber forest industries.

Isolated areas of forest cover in the prairie region have been shown the particularly vulnerable to drought under future climate scenarios. Henderson et al. (2002) showed that "island forests" such as the Cypress Hills, the Turtle Mountains and Moose Mountain in the southern prairies are likely to loose forest cover in the later half of the 21st century. Areas such as the DMFMU have some of the same vulnerabilities and may be at high risk in the future.

Future climate change may increase the productivity of northern forests, at least in the near term (Cohen and Miller 2001). Nutrient availability and acclimation by trees are likely to limit the potential for increased growth due to the higher concentration atmospheric carbon dioxide. Warmer sites may see increased respiration, offsetting any gains. As well, markets and trade in forest products play important roles in whether a region realizes any gains associated with climate change. In general, regions with the lowest wood fibre production cost will be able to expand harvests. Forest policies addressing climate change will need to account for regional and market impacts that are not uniformly distributed (Perez-Garcia et al. 2002).

At the drier end of forested zones, grassland encroachment can be expected (Hebda 1997). Consequently, maintaining forest ecosystems in the face of progressive climate change will require silvicultural systems to manage declining and disturbed stands. Declining stand quality and increased disturbance will affect wood quality and timber supply locally and globally (Solomon et al., 1995; Perez-Garcia et al., 2002).

Biological and climate changes have implications for forest operations. Increased winter precipitation could affect water management in forests. An increased risk of sediment transport to streams could degrade water quality and fish spawning habitat. Warmer winters will reduce the opportunities for winter logging in areas where the frozen surfaces of forest roads and ice bridges are essential for site access and where a snow pack is necessary to protect the land during harvesting (Pollard 1991; Donnelly 2001).

Climate change will affect habitat quality and availability for wildlife and influence predator/prey synchrony (Harding and McDullum 1997; Stenseth et al. 2002). Species ranges are expected to shift upward in elevation and northward in latitude in the Northern Hemisphere (Kirschbaum 2000).

There is increasing pressure on forest managers to incorporate biodiversity and recreational use into their long-term planning. A portion of the DMFMU is occupied by a provincial park, and there are questions about how to ensure that long-term planning for forest management will support long-term park planning and management. The steady-state protected area system plans adopted by most federal and provincial-territorial jurisdictions were developed with the assumptions of climatic and biogeographic stability;

assumptions that an accumulating body of research indicates are no longer valid. Individual park objective statements, wildfire management strategies, non-native species management programs, species reintroduction programs, and visitor management plans are also vulnerable to the impacts of climate change (Scott 2003).

Global warming is recognized as a key threat to biodiversity. For example, a spatially explicit example of projected tree migration for Ontario, coupled with global climate model projections, suggest that global warming could result in considerable species loss, especially if migration fails to keep pace with the warming (Malcolm 2003). The effects of climate change on biodiversity in the local area comprising the DMFMU are unknown but can be expected to be adverse given intrinsic low migrational capabilities of many species and local barriers to migration, e.g. Swan River valley.

A number of other issues are important in this area. Agriculture is an important land use in areas surrounding the Duck Mountains and climate change could bring new practices into the area. One possibility is large-scale afforestation on private agricultural land. This could provide additional wood supply to the OSB mill, but the economic and social impacts of large-scale afforestation on agricultural landscapes and communities may be significant. Additionally it needs to be considered whether climate change itself may diminish opportunities for afforestation in the DMFMU.

Changes in resource availability will have a large impact on communities where lifestyle is strongly tied to these resources for food and culture. Also, the characteristics of forest-based communities define a particular social context for climate change that may contribute to additional concerns about the forest's vulnerability to climate change effects. For example, capacity to adapt to climate change may be impacted 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 (Williamson 2003). In particular, First Nations communities occur in the DMFMU area, have a large stake in the long-term condition of the forest, and may be particularly vulnerable. Treaty rights guarantee access to hunting and trapping, and the forest company has a role in trying to maintain these resources to the extent they can. The company is also committed to providing employment to First Nations people in the area and has provided significant resources in recruiting and training to deliver on this promise.

Policy/Regulatory Framework

The government requires an environmental impact assessment for new forestry developments. Once a forest management agreement is in place, the forestry company is required to produce a 20-year management plan outlining the general direction of forest harvesting and their plans for long-term sustainable management including protection of environmental values (e.g., fish and wildlife habitat, water quality, etc.). This plan is updated every 10 years, and is supported by five-year management plans and annual operating plans. Provincial environmental regulations also require the maintenance of water quality and quantity to communities surrounding the DMFMU.

Provincial regeneration standards require the companies to regenerate all areas that are harvested, either by planting or natural regeneration. Provincial biodiversity policy stipulates that forest companies replace the same species that was harvested when they undertake regeneration, yet exotic species (i.e. those from outside of the province) may hold particular promise under future climatic conditions.

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Appendix 6. Case Study 3: A Forest-Based Community under Climate Change

Prepared by: Tim Williamson, Canadian Forest Service, twilliams@nrcan.gc.ca , ph. 780-435-7372
Date: 23 October, 2003

Duck Lake is a medium sized resource and tourism based community located on the edge of the Rocky Mountain foothills north of the agriculture forestry fringe. The community is located about 200 kilometers northwest of Edmonton. The community is situated on Duck Lake, a large, clean lake surrounded by mature and undisturbed boreal forest. Approximately 20 kilometers of shoreline is developed with cottages. Duck Lake is fed by the Duck River. Duck River is a glacier fed river that originates in the eastern slopes of the Rockies and eventually drains into Hudson Bay.

Duck Lake is a rapidly growing community. According to the Canada Census there was a 20 % increase in the population of Duck Lake between 1991 and 1996. Population growth seems to be mainly attributed to people moving to the community for retirement. The proportion of the local population in the 55 – 64 age category is significantly higher than the provincial average and this trend is expected to continue. An important feature that is not shown by the census data is that the total population of both permanent residents and visitors is significantly higher than what is shown by the Census data. During the winter, miles of groomed snowmobile and cross-country ski trails attract large numbers of visitors and the population of the town and surrounding area doubles. During the summer, the area attracts recreationists and cottagers and during weekends population levels within or near the community are 10 times higher than normal. A healthy and green forest is vital to the health and prosperity of the community of Duck Lake.

Duck Lake's economy is based on forestry production and tourism income. The majority of forestry income comes from a large integrated market pulp and dimension lumber processing facility within the community. The majority of timber-supply supporting the mill complex comes from a large Forest Management Agreement lease held by the company. This is a highly efficient mill that produces and sells forest products into global markets. The mill creates highly paying, skilled employment opportunities for community residents and is very important to the local tax base. Tourism income is also very important. Provincial and National Parks are located close by. There are a number of private campgrounds, resorts, hotels, motels and tourism lodges within or near the community.

The community of Duck Lake and the surrounding area are important destinations for both summer and winter outdoor recreation. Tourism is an important component of the Duck Lake economy. A number of people from Edmonton visit the community of Duck Lake in order to participate in outdoor recreation activities. A number of people also travel to Duck Lake because they own cottages around the lake. The population of Edmonton is also very active in environmental issues. Environmental organizations based in Edmonton have been known to demonstrate in front of the legislature of Alberta in order to express their views about how they think the forests around Duck Lake should be managed.

The median household income of Duck Lake significantly exceeds provincial and national averages, however, the level of education attainment of the local population is lower than the provincial average.

Description of the forest
The forests surrounding Duck Lake is a transition forest. West of town, the forest is classified as upper foothills / montane type forest. Highly productive, continuous, even-age stands of lodgepole pine and white spruce dominate this forest with occasional mixed stands of poplar and aspen. The forest east of town is part of the mid-boreal upland ecoregion. Common tree species include aspen, balsam poplar, jack pine, black spruce, white spruce, white birch, and balsam fir.

The forest around Duck Lake is a flammable forest that has evolved in the presence of natural disturbances such as wildfire, and insect disturbance. However, the forest has been subjected to intensive forest fire protection and suppression for the last 50 years. This may have resulted in fuels build up and/or an increase in fuel continuity and a general increase in flammability. At the same time the incidence of anthropogenic wildfire ignitions has increased in the area as access and use of the backcountry for recreational purposes has increased. Forest fire suppression is generally thought to currently be near maximum efficiency and capacity, with further efforts subject to diminishing returns and rapidly escalating costs.

The region surrounding Forestville is currently undergoing a drought. This is resulting in lower lake levels, higher levels of fire risk, and increased susceptibility of trees to insects and to die back. This is currently causing concern within the community and has the potential for community level impacts.

Potential impacts of climate change
Increasingly warmer and perhaps drier conditions as a result of climate change have the potential to increase the flammability of the forest surrounding Duck Lake. In addition, the population Edmonton is expected to grow over the next 50 years and therefore it is expected that visitation to the Duck Lake area, especially to backcountry areas, will increase dramatically. This has the potential to result in an ncrease in the incidence and severity of fire events within the area over the next few decades. Potential implications for residents of Duck Lake include a) increased risk of property loss, b) adverse impacts on the local economy (due to changes in timber supply and tourism activity), c) health effects (due to increased smoke), d) reductions in visual quality of the surrounding area, e) rapid changes in ecosystems and loss of ecosystem values, and f) temporary reductions in outdoor recreation benefits for local residents.

It is currently thought that the range of mountain pine beetle is currently constrained by severe winter conditions that exist in northern BC and areas east of the Rocky Mountains. However it is believed that, as winters become generally milder and with less incidence of severe cold, the range of mountain pine beetle and other forest pests will expand into these areas. Additionally there appears to be no natural barrier that limits infestation to lodgepole pine and jack pine may be equally susceptible. Lodgepole pine and jack pine constitute a significant proportion of the forest surrounding Duck Lake. Moreover, a high percentage of the pine stands are in mature and overmature age classes. The establishment and spread of mountain pine beetle in the surrounding pine forest could have important adverse impacts on local timber supply.

Significant die back of trees and stands due to mortality from drought or due to major infestations of insects and diseases or due to major fire events could have significant consequences on the aesthetics of the area and reduce both the attractiveness of the area as a recreation destination as well as the scenic benefits enjoyed by local citizens. It may also reduce the attractiveness of the area as a retirement destination. Winter recreation is also important to the local economy.

Climate change could have positive effects on forest productivity and timber supply. There is some evidence to suggest that longer growing seasons, warmer soil temperatures, and CO2 fertilization effects could increase forest productivity. This could have positive effects on the local economy, most notably forestry production.

Increased warming associated with climate change and the resultant increases in evaporation and evapotranpiration have the potential to increase the incidence of drought in the area, with consequent adverse impacts on the community. As well local precipitation levels, both in the form of rain and snow, directly affect stream and lake levels and have indirect effects on both summer and winter recreational activities. Temperature and precipitation in the Rocky Mountains affect glacial advance and/or retreat and glacial outflows provide base flows for many streams in the area. Currently many glaciers have retreated to the point to virtual non-existence as a result of warming over the last century. The water supply of Duck Lake originates from mountain glaciers and over time this supply may be further reduced as climate continues to warm. This could have future implications for seasonal water supplies to the pulp mill as well as the town itself.

Studies of the potential health effects of climate change suggest that potential effects include a) increased incidence of heat stress, b) health effects due to declines in air quality, c) health effects related to declines in water quality, d) respiratory illnesses related to increased pollen concentrations, and e) health effects related to increased exposure to new invasive or existing infectious diseases or diseases spread by vectors (e.g. west nile virus). These effects are of particular concern in communities where a high proportion of the population is comprised of seniors.

With ratification of the Kyoto Protocol, Canada has committed to reduce greenhouse gas emissions to 6 % below 1990 levels. Part of Canada's strategy might be to increase energy prices. This might have detrimental impacts on local industries that are highly dependent on use of fossil fuels..

Perceptions and adaptive capacity

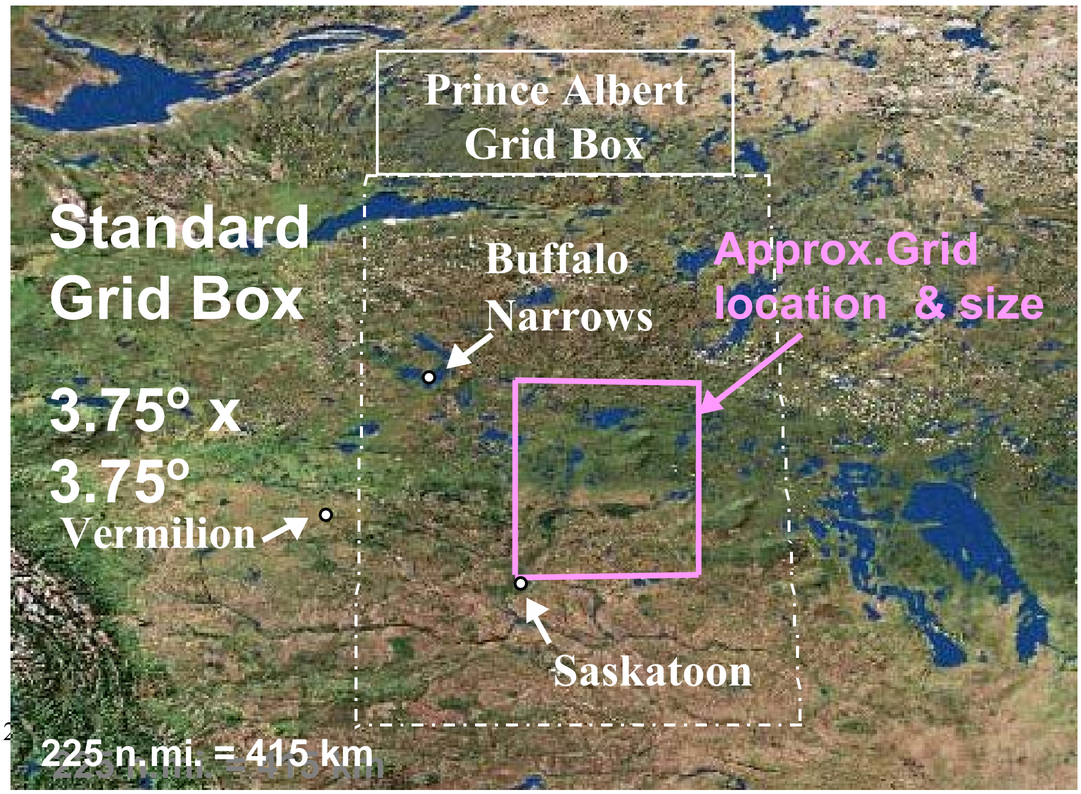
Local leadership in the community of Duck Lake is aware of climate change and concerned about its potential impacts on the community. However, community residents remain unconvinced that climate change poses a serious risk to them, and there is little sense of urgency to the issue.. As well there persists a large degree of confusion with respect to the relationship of issues such as ratification of the Kyoto Protocol, reduction of greenhouse gas emissions, global warming, and likely local climate change effects.

Significant portions of the urban-based population perceive that climate change effects can be mitigated by increased preservation of natural forests and by afforestation of agricultural areas. Increased pressure from environmental groups and the resultant political pressures to preserve and protect forests in areas like Duck Lake may cause local residents to associate climate change with environmentalism. Local residents may feel that their livelihoods are potentially threatened. This could lead to a tendency to discount local climate change effects and reluctance to implement adaptive solutions.

Some issues that might influence community capacity to adapt to climate change include a) education attainment levels that are lower than the provincial average, b) lack of alternatives for economic development, c) reduction in provincial funding of services in rural municipalities, and d) existing forest policies and tenure arrangement that lack the necessary flexibility to adequately respond and adapt to expected forest level changes.

Apppendix 7: Case Study Scenarios

Case Study Climate Scenarios



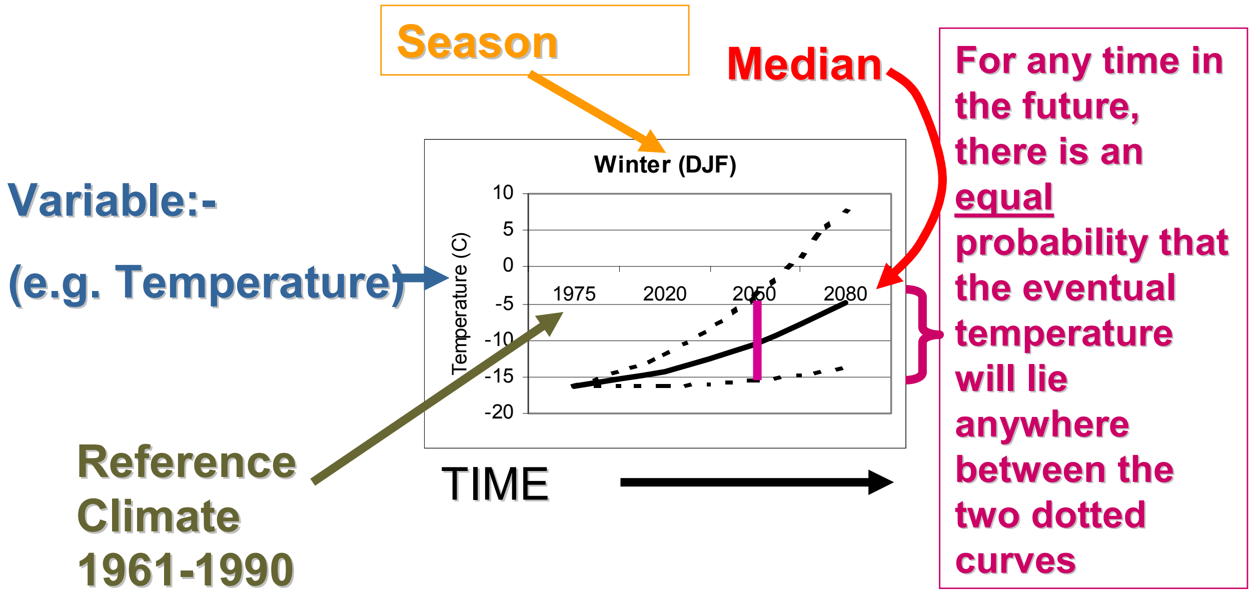
List of Climate Scenarios

– Seasonal Daily Average Temperature
– Seasonal Daily Maximum Temperature
– Seasonal Daily Minimum Temperature
– Seasonal Precipitation
– Seasonal Soil Moisture

(Note: ***Not extreme*** Max or Min Temperatures)

18-Oct-03

Interpreting the graphs



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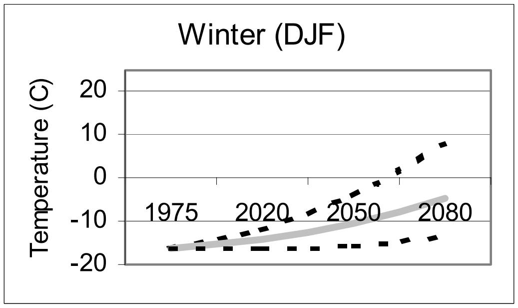
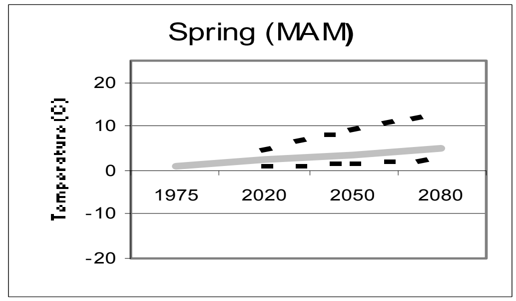
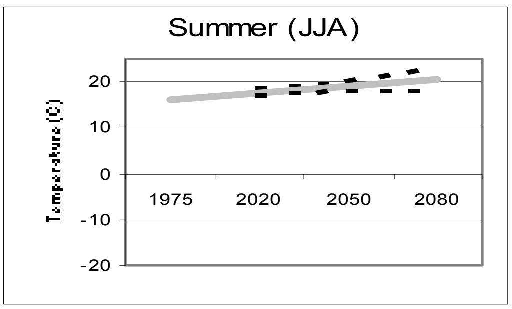
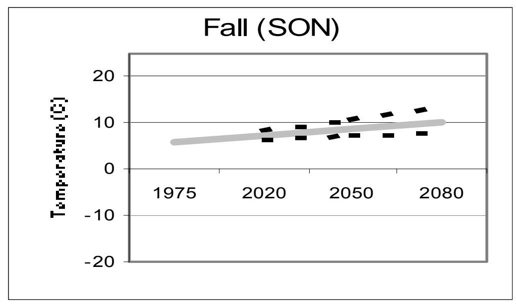
Daily Average Temperature









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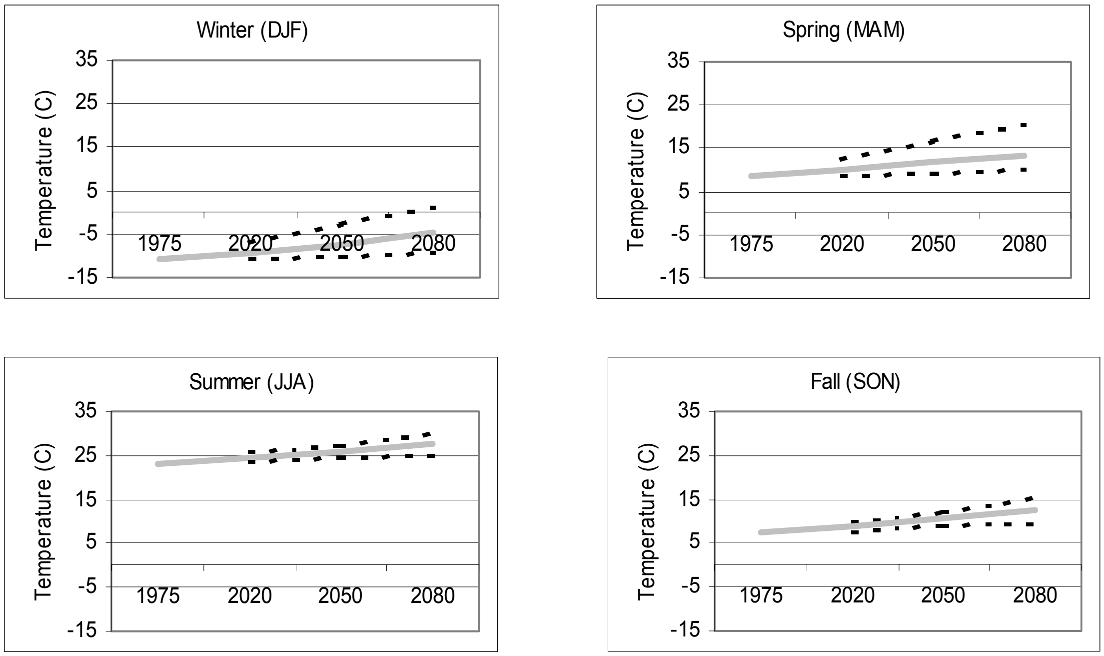
Average Maximum Daily Temperature
- potentially more warm spells



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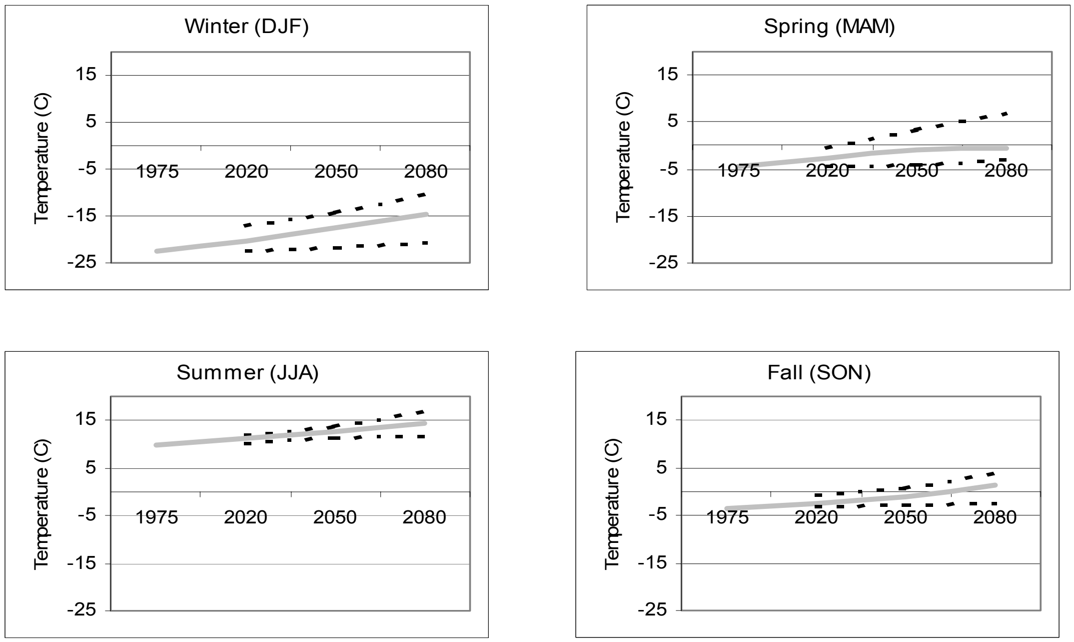
Average Minimum Daily Temperature - potentially fewer cold spells



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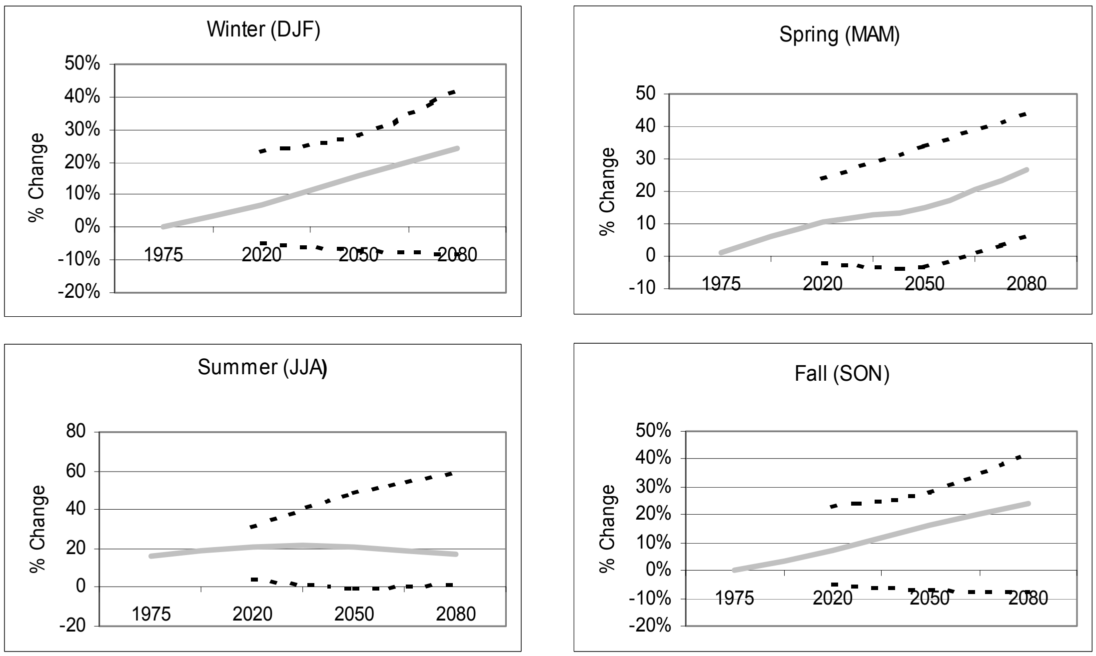
Seasonal Precipitation - wetter



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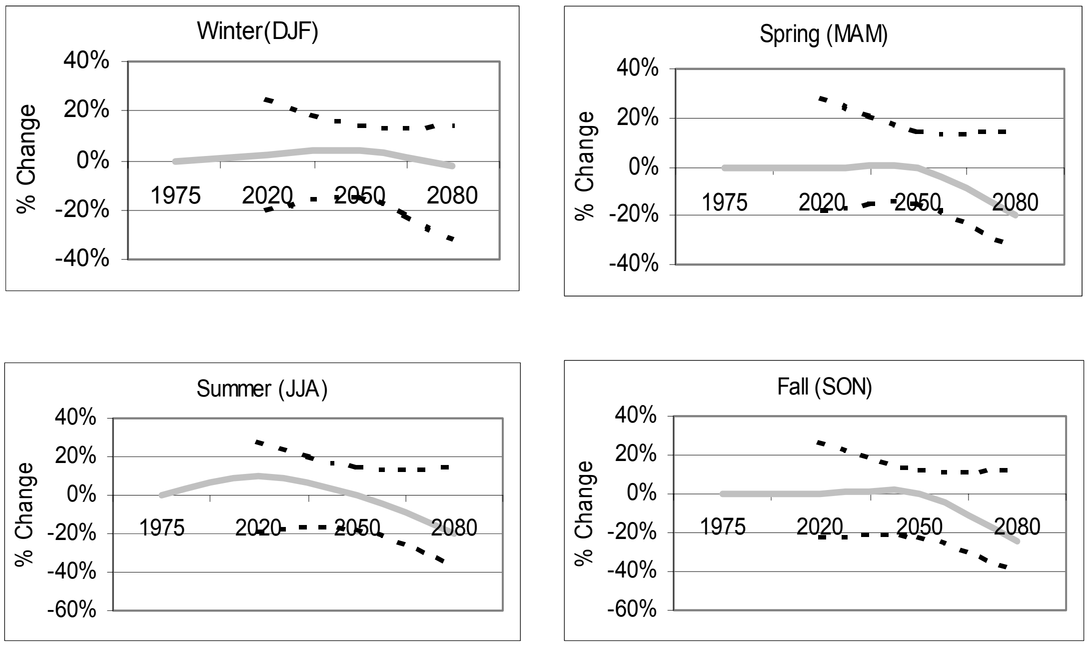
Soil Moisture - drying trend



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Post-workshop Resources

- on the future climate projection
- potential changes in climate extremes
- how to use climate scenarios
- where to get assistance

CCIS Project
elaine.barrow@ec.gc.ca
360-780-6049

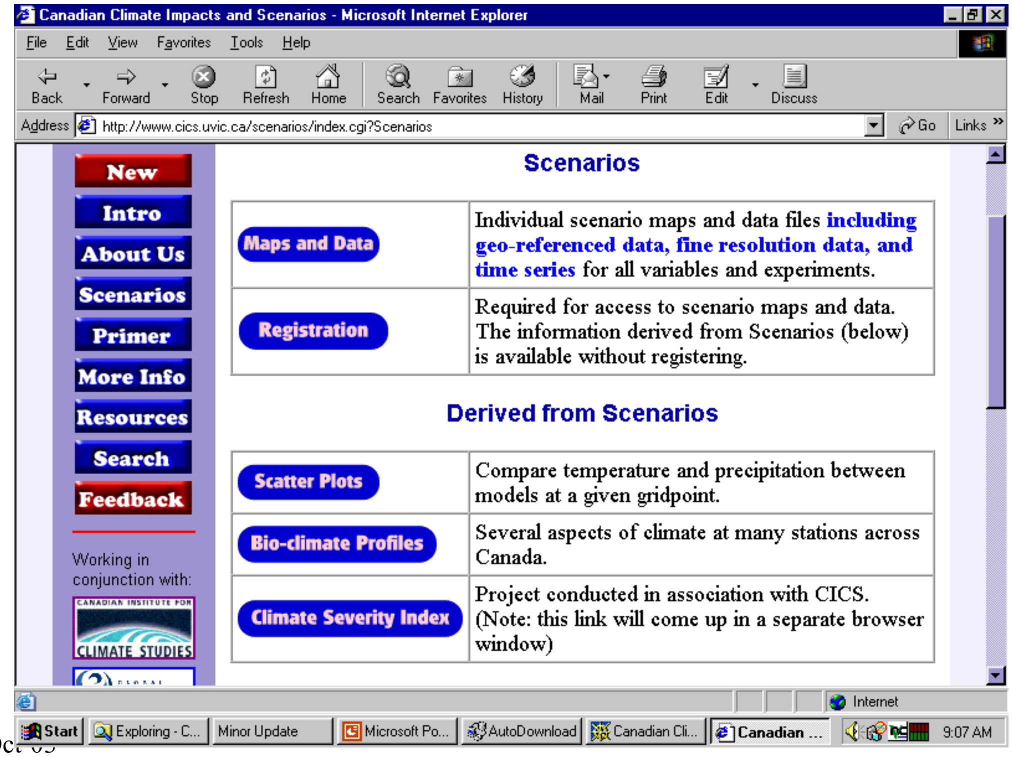
CCIS/CICS
tmurdock@uvic.ca
250-472-4681

CICS
rjlee@UVIC. CA
250-472-4291

18-Oct-03

www.cics.uvic.ca/scenarios

For further information on using scenarios



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Appendix 8: Summary of Post-Workshop Evaluations

Climate Change and Forests:

Making Adaptation a Reality

Tuesday and Wednesday, November 18-19, 2003 Winnipeg

Presentations: How would you rate the following?	**Excellent**	**Good**	**Fair**	**Poor**
Speakers	24	10		
Content	18	15		
Format	9	20	3	
Was there enough time to ask questions?	6	25	2	

Comments

- Excellent overview of climate change. If the proceedings are produced, it would be an excellent primer on climate change
- Very good information
- More emphasis on process needed. Need for clear direction.
- Exceptionally good were: Johnson, Hengeveld & Lee
- Some presentations were too short to adequately cover the topics presented.
- Additional presentations focusing on risk management would have been useful.
- It would have been helpful to have had written copies of the presentations available as handouts prior to each talk.
- Speakers supported each other and were well organized.
- Some talks overlapped in material covered
- Some good speakers. Need other non-scientist speakers who have either worked on or used the models presented here. Need examples in which these models/concepts are being used.
- More baseline (basic) research is needed before attempting to extrapolate of climate and climate change effects on the forest. Dr. Hague has emphasized the need for data before we can assess adaptation. There are lots of research gaps and very little empirical data. Climate change needs to be placed in a historical perspective.

Were the background materials you received prior to the workshop useful?	Very Useful	Somewhat Useful	Not Useful
Primer	20	13	1
Case study descriptions	15	16	1
List of additional references	11	13	5

Comments

- Primers & case studies were excellent
- More access to PowerPoint slides, information and communication tools needed
- Too focused on one method or one process. Examples of different risk management strategies - successful or not – would have provided a better base to learn and stimulate ideas
- Primer was good. Have some questions of clarification. Case study descriptions not as good – in particular they suffered from a lack of clearly-stated management objectives.
- Perhaps participants should have been assigned to their case studies prior to the workshop (based on their experiences on various fields). This would, for example, avoid having all climatologists in one group and none in others.

	Topic/Session Number	Very Useful	Somewhat Useful	Not Useful
Were the break-out sessions useful?	FMA	1	7	
	Protected Area	2		
	Forest Based Community	2	1	
	General	6	13	1

Comments

- The first session was too short. Didn't have enough direction on what to use for management objectives & performance measures. The process, that should have taken us one hour, ended up taking three hours.
- Would have been much more productive if each break-out group had the services of a knowledgeable, experienced facilitator.
- The sessions were too focused on content: the process itself was the key message!
- The capacity of participants to trace relationships between climate variables and forest values was limited. This exercise requires considerable expertise.
- Too long in proportion to rest of workshop but good to hear & learn from others
- We needed more facilitation - someone who was experienced with the process. We spent much of our breakout time trying to figure out what to do and second-guessing whether we were doing the process right. I would very much like more training in order to use this process in my own workplace.
- Some confusion was evident in our group. It may have helped to have a facilitator for each group.
- It would have been better if the "Situation Analysis Template" did not contain examples - the examples tended to "box-in" the discussion instead of promoting a true "blue sky" exercise, e.g. our group tended to mostly go with the considerations provided in the template and got very focused on those instead of coming up with other considerations.
- Would have been better to work on a real case study example rather than a fictitious one.

Was enough time allocated for the break-out sessions ?	Yes-28		No-3

Comments
- Time allotted to break-out sessions on the first day was too short. The time available on the second day was more attuned with the expected deliverables.
- Time was sufficient for our report on vulnerability, however could have been more productive with an effective group facilitator.
- It was nice to have time to work through cases but I would have emphasized other material more.
- Too much time was allocated to break-out sessions.

	Very Clear	Somewhat Clear	Not Clear
Were the instructions and objectives for the break-out sessions clear?	12	19	4

Comments
- It was quite confusing at the start but by the second day things got clearer.
- Facilitator for each group would have been useful.
- Perhaps too much detail.
- Better examples may have helped.
- Break-out activities were complex and would have benefited from the services of a facilitator assigned to the group. A significant amount of break-out time was unfocused and unproductive.
- Could have linked breakout groups by interest areas and then had them share results.

Were you satisfied with the location/facilities?	Very Satisfied	Satisfied	Not Satisfied
Location: Winnipeg	22	11	
Location: Downtown Hotel	20	13	
Hotel Accommodation if used (Radisson Downtown)	9	10	
Meeting facilities	23	9	1
Meals	21	8	

Comments
- Venue closer to the airport would have been preferable.
- Having three break-out groups assigned to one room did not work well.
- Other conversations taking place in the same room were annoying and disruptive.
- Meals were excellent, but could have been “lighter”
- Thanks for having the event in Winnipeg and having the local news attend. This will increase the visibility of this issue and of concerned agencies in the province.

How did you hear about the workshop? Please mark one or more choices.	
Email Invitation	20
Phone Call	1
Colleague	17
Web site (identify site)	
Other? Please indicate: • Member of CCIARN Forest Adv. Committee • Organizer(s)	

	Excellent	Very Good	Good	Fair	Poor
Overall, how would you rate the treatment of the subject matter and the way it was presented?	11	16	5		
Were the key topics addressed?	10	17	5		
Was the selection of speakers appropriate for the topics?	15	15	2		

The most useful part of the workshop was:

- Overview of climate change by speakers.
- Starting to define what is vulnerable to change.
- Case studies were excellent.
- The presentations.
- Very good format. It worked very well in getting ideas & input from all participants. Also created a stimulus for us to take these ideas back to our workplace.
- Some keynote speakers.
- Working group exercises.
- Take home material on climate change.
- The process for incorporating climate change into management decisions.
- Johnson, Hengeveld & Lee presentations.
- Connecting with sharp/pleasant friends/colleagues.
- This was a super "hands on" 2 days.
- The overall framework.
- The speakers –the challenge to come up with solutions- the feedback.
- How to organize the input.
- Risk-based approach.

The least useful part of the workshop was:

- Needed more direction on the various management objectives. Ended up redoing work on the second day.
- Insufficient break-out group time.
- Too much time debating issue details in breakout groups.
- Breakout sessions.
- Presentation from politician on water quality.
- The workshop format - only because of the lack of a facilitator for each group
- The breakout sessions. Although there was real potential - and the process appears to be a good one – I needed to understand it better prior to the break-out sessions.
- Would prefer smaller working groups, i.e. five or so people.

Other comments:

- Felt it was an excellent workshop. Might have wanted to invite some economists, educators and health care workers to help group get around some of the non-forestry issues. Was surprised that most of the groups ended up with similar strategies considering how much we struggled with the topic.
- Facilitator should have been provided for each breakout group.
- Recommend the development of a workshop product that at goes beyond participant training, e.g. an opinion or consensus paper that might be provided to decision makers, gov't officials, sponsors, etc. The paper could provide information (in concise form) and recommendations. For example such a product might recommend 1) that climate change education be integrated into the school system, or 2) that flexibility and a vision of the future be incorporated into forest policy/direction.
- This sort of workshop could be used to enhance public education and awareness (a multiplier effect).
- Looking forward to the next series of workshops.
- Good approach. Now need to apply to real world situations.
- A well planned and executed workshop.
- Nice pen from C-CIARN.
- Too much time on the planning component / objective setting. These could be pre-assigned.
- Keeping lights up/on as much as possible is desirable especially after lunch.
- Did not get the feeling the presenters were listening to people' concerns – some were too concerned with selling their own position.
- Nametags to include affiliation of attendees would be helpful.
- Workshop website with PowerPoint presentations by speakers available for download would help us to get this message out to our units.
- Perhaps more 'real world' examples /case studies should be used rather than hypothetical test cases.
- Approach might have benefited from inclusion of a SWOT (strengths, weaknesses, opportunities, threats) analysis instead of just current/future vulnerabilities. This would have the benefit of directing participants to build on strengths and potential opportunities. Current and future climate vulnerabilities were often only variations in degree of the same issue.
- Kudos to the organizers. Hope to attend more workshops like this one in the future.

Appendix 9: Pre-Workshop Media Release

Manitoba Model Forest Inc.
Pine Falls, MB Canada
Tel: 204-367-5232
Fax: 204-367-8897
November 14, 2003

MEDIA RELEASE

FOR IMMEDIATE RELEASE

Climate Change Workshop
Winnipeg, November 18, 19, 2003

The Manitoba Model Forest has partnered with the Canadian Climate Impacts and Adaptation Research Network (C-CIARN) Forest Sector, Natural Resources Canada's Canadian Forest Service, and other organizations to examine practical approaches in the development and evaluation of climate change adaptation strategies for Manitoba's forest sector.

This workshop is the fourth in a series sponsored by the Manitoba Model Forest focussing on climate change and forests. It will be held in Winnipeg, Tuesday, November 18^{th} and Wednesday, November 19^{th}, 2003, at the Radisson Hotel Downtown, 288 Portage Avenue, Winnipeg, Manitoba.

This workshop will introduce forest managers, policy-makers, community leaders, and all other forest resource users to a "Vulnerability Approach" framework used in appraising risks from climate change and variability. Participants will be given forestry sector case studies and the opportunity to apply this framework in:

- Assessing regional or local forest vulnerabilities to climate changes;
- Evaluating capacity to cope with anticipated climate changes;
- Developing adaptation or risk management strategies in policy and management planning practices;
- Identifying and developing projects demonstrating the application of adaptation management practices in Prairie boreal forest and forest-dependant communities.

The United Nations sponsored Intergovernmental Panel on Climate Change has determined that global average surface temperature during the 21^{st} century is very likely to rise at a rate without precedent during the last 10,000 years. Land areas are very likely to warm more than the global average, with more hot days and heat waves and fewer cold days. Manitoba's forests and forest dependent communities will be especially affected. Some effects include an increased risk of forest fires, disease and insect outbreaks; and increased damage to forests due to extreme weather events.

The recent Standing Senate Committee on Agriculture and Forestry report "Climate Change: We Are At Risk" (released November 6, 2003) has raised awareness of the need for sustainable forest management strategies that incorporate the reality of climate change.

The Manitoba Model Forest sponsored Climate Change Workshop aims to provide a practical approach and structure to help fill the need identified by the Senate Committee. The Canadian Model Forest

Program builds on partnerships locally, nationally, and internationally to generate new ideas and on-the-ground solutions to sustainable forest management issues. These grassroots partnerships include First Nations, Environmental Organizations, Industry, Educational and Research Institutions, all levels of government, community-based associations, recreational forest users, and private landowners.

For additional information contact:

Stan Kaczanowski, Manitoba Model Forest Tel: (204) 345-4291 (cell)

Appendix 10: Post-workshop media release

Manitoba Model Forest
Pine Falls, MB Canada
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MEDIA RELEASE

November 20, 2003 **FOR IMMEDIATE RELEASE**

Climate Change and Forests: Making Adaptation a Reality

Forest managers, researchers, policy-makers, and community leaders from across Canada concluded a 2-day workshop aimed at understanding and developing climate change adaptation strategies. Eighty participants reviewed the state of climate change science; discussed the potential impacts on forest ecosystems; and explored risk management strategies aimed at reducing the vulnerability of forests, forest industries, and forest-based communities to current and future climate.

The attendees agreed with recommendations of a recent report by the Standing Senate Committee on Agriculture and Forestry Committee that stresses the urgency of addressing climate change in order to continue to manage forests in a sustainable way. They identified the need for all levels of government, the forest industry, and non-government organizations to collaborate in the development of adaptive strategies that will minimize the harm and maximize the benefits associated with a changing climate. Scientists and forest managers were encouraged to work together to ensure that the best climate science is brought to bear on issues such as the increased threat of forest fires, disease and insect outbreaks; and increased damage to forests due to extreme weather events.

The workshop was co-organized by the Manitoba Model Forest and the Canadian Climate Impacts and Adaptation Research Network (C-CIARN) Forest Sector. The Canadian Model Forest Program builds on partnerships locally, nationally, and internationally to generate new ideas and on-the-ground solutions to sustainable forest management issues. C-CIARN Forest fosters communication and collaboration between researchers and practitioners on forest and climate change impacts and adaptation issues.

For additional information contact:

Stan Kaczanowski, Manitoba Model Forest (204) 345-4291 (cell)
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Appendix 11: List of Participants

Climate Change Workshop Participants - November 18 & 19, 2003

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1	Alexander, Don	Pembina Valley Conservation District	pvcd@cici.mb.ca
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Media

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CBC TV (French) -Caroline Plante reporter
CBC Radio (English) -Marilyn Maki reporter
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CBC Radio North -Al Foster reporter
Winnipeg Free Press-Aldo Santin reporter
Winnipeg Sun