

Adapting British Columbia's Forest Practices to Address a Changing Climate

Discussion Paper



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How to use this paper

The purpose of this paper is to stimulate discussion on adapting British Columbia's forest practices for a changing climate. The background information is intended to help you:

1. Conceptualize what a changing climate might look like for BC's forest management framework;
2. Understand the opportunity that adapting BC's forest practices represents;
3. Consider the way forest stands and landscapes are managed and how they can be adapted to a changing climate (*through presentation of some potential opportunities*); and
4. Prepare to contribute your input on the goals, desired outcomes, proposed objectives and opportunities for adapting BC's forest practices framework for a changing climate.

Principles	The proposed principles have guided the development of this discussion paper, and upon finalization after review and input, will guide the policy adjustment process.
Goals	The five goals shape the scope and vision of BC's 'Forest Policy and Practices Framework' adapted to address climate change. Under each goal the current forest policy and management context is presented to focus the discussion on where opportunities may exist to adapt our sustainable forest management framework using a 'climate change lens'.
Desired outcomes	Desired outcomes 'for a changing climate' present a means for introducing 'adaptive thinking' in the management of our forest ecosystems. Desired outcomes help take us from the 'As Is' world to the 'To Be' world where climate change adaptation is considered part of core business. <i>Desired outcomes appear in this document in a shaded 'medium blue' box.</i>
Proposed Objectives	Proposed Objectives help answer "what" we hope to achieve under each goal within the Forest and Range Practices Act (FRPA) statutory and policy implementation framework. <i>Proposed Objectives appear in this document in a shaded 'light blue' box.</i>
Potential Opportunities	The potential opportunities, presented in this discussion paper could be considered for inclusion in British Columbia's forest policy and practices framework to adapt it for a changing climate. These opportunities help answer "how" we could achieve the goals, desired outcomes and proposed objectives through a range of adaptations (e.g. to the scientific foundation, through policy guidance, performance targets/measures, and decision support (data, tools and knowledge), and/or legislative changes.

Contents

- Part One The **conceptual framework** for adapting BC’s forest policy and practices for a changing climate outlines principles, goals, desired outcomes and objectives. These elements provide a foundation for identifying potential opportunities to move forward over the near, short and long term.
- Part Two **Potential opportunities** are presented to start the discussion on ‘What opportunities exist to adapt BC’s forest practices?’ And, ‘How can these opportunities be operationalized – in the near, short and long term?’ Part Two presents potential opportunities and options (for adapting forest practices regulated under the *Forest and Range Practices Act* (FRPA)).
- Part Three **Becoming an adaptation leader** describes how to learn more about climate change adaptation and provide any input you may have on this topic.

Welcome (*letter from the project sponsor, BC's Chief Forester, Jim Snetsinger*)

Adaptation of BC's forest practices to reflect a changing climate is essential if we intend to maintain healthy, productive forests and global leadership in sustainable forest management.

British Columbia's Cabinet-approved [Adaptation Strategy](#) envisions that the Province is prepared for and resilient to the impacts of climate change. That strategy calls for making adaptation a part of the Government's business, and ensuring that climate change impacts are considered in planning and decision-making across government. A key element in the vision of the BC Ministry of Forests Lands and Natural Resource Operations (MFLNRO) is a prosperous forest and range sector based on sustainably managed resources that provide benefits now and for generations to come.

Given that BC's forest resources and forest-dependent communities are sensitive to climate, work has been underway through the Future Forest Ecosystems Initiative (FFEI) to develop the science, modeling, and monitoring that could inform our forest practices policies and decision processes. One project arising from FFEI is this FRPA policy assessment initiative. It aims to assess our policy framework against management approaches that could foster resilience. It also seeks to identify and assess opportunities for enhancing ecosystem resilience that may be available under BC's existing forest practices framework.

The focus of this work is on how we apply climate change information to our forest practices so that BC continues to have resilient, diverse, healthy and productive forest ecosystems. These forest ecosystems help support a strong economy, communities and families, as well as a multitude of other values. While the focus of this work is around forests and not directly towards other values, the thinking is that if we take care of forests, other values will also be enhanced.

The discussion paper, *Adapting British Columbia's Forest Practices to Address a Changing Climate* – see attachment) contains a vision for sustainable ecosystem benefits in a changing climate, and articulates a set of principles, goals, desired outcomes, and objectives that could assist us in realizing these benefits. Our expectation is that this approach, including the conceptual framework and its component parts, will continue to evolve as we learn more about climate impacts. It will also evolve as additional adaptation opportunities present themselves in both the short and long term. In this way, responding to climate change will be part of the continuous improvement process already well established in BC's forest management system. We hope this discussion paper and the outreach activities associated with it help to inform the development of sound and innovative approaches to managing BC's forests sustainably in a changing climate.

Jim Snetsinger

Assistant Deputy Minister - Resource Stewardship

Chief Forester, BC Ministry of Forests, Lands and Natural Resource Operations

Table 1. Summary of proposed goals, desired outcomes, objectives and opportunities for adapting BC's forest practices for a changing climate

Below is a summary of the proposed goals, desired outcomes, objectives and opportunities that form a starting point for conversation and consultation.

No.	Goal	Desired Outcome	Objective	Opportunity
1	Keep Pace with a Changing Climate	Managed forest ecosystems that are suited to a changing climate so that forest productivity and associated ecological, social, and economic benefits are maintained or enhanced	Managed forest ecosystems that are suited to a changing climate.	1.1 BC's forests are planted with stock suitable for a changing climate. 1.2 increase adaptation of planted trees through the use of assisted range expansion.
2	Maintain Diversity	Ecosystems and landscapes that are complex and diverse (e.g. biological, genetic, and functional diversity; and diverse forest species and age class distributions) to foster resilience to impacts of climate change	Complex and diverse ecosystems and landscapes that foster resilience to impacts of climate change.	2.1 BC's reforested stands and landscapes have no less tree species diversity than that prior to harvest. 2.2 Reforested stands and landscapes should have sufficient stocking in secondary species to meet minimum stocking levels for the site.
3	Manage and Protect Resources and Values	A full suite of resources and values are maintained to safeguard future forest management options and ecosystem benefits.	Adequate biological legacies (e.g. seed and areas that are likely to tolerate climate change impacts) are managed to safeguard future forest management options and benefits.	3.1 BC has a mechanism in place to ensure the adequacy of biological legacies to safeguard future management options and benefits. 3.2 Manage the suite of biodiversity and forest management reserves and retention areas as a dynamic portfolio with sufficient

No.	Goal	Desired Outcome	Objective	Opportunity
				flexibility, diversity and redundancy to take climate change impacts and risks into account.
4	Manage Risks and Enhance Opportunities	Enhanced returns and reduced climate change impacts and risks over a rotation.	Enhanced returns and reduced climate change impacts and risks over a rotation	<p>4.1 BC's forests are managed in a way that captures opportunities and addresses climate change risks and impacts.</p> <p>4.2 Cumulative impacts associated with climate change are considered in forest management decisions.</p> <p>4.3 BC has measures in place to assess the achievement and progress in sustaining ecosystem benefits in a changing climate.</p>
				<p>4.1 Forest management practices capture productivity and forest carbon opportunities</p> <p>4.2 Forest management practices address climate change risks and impacts over a rotation.</p> <p>4.3 Actions identified in sustainable forest management plans and results and strategies identified within forest stewardship plans address cumulative impacts associated with climate change.</p>
5	Build Adaptive Capacity	Increased capacity to apply climate change information, knowledge and tools in BC forest management	Increased knowledge, awareness and organizational capacity of forest and natural resource policy makers, practitioners and decision makers to consider climate change adaptation within BC forest management.	<p>5.1 BC's forest managers have the knowledge, tools and organizational capacity to adapt BC's forest practices for a changing climate.</p> <p>5.2 Research, extension, monitoring and training support the development of policy, guidance and decision support tools that address climate change adaptation in BC forest management.</p>
				<p>5.1 Knowledge transfer, training and communication tools support BC forest management climate change adaptation actions.</p> <p>5.2 An 'Action Plan' and scorecard support the prioritization, progress and achievement of BC's climate change adaptation goals for forest practices</p>

Part One **Conceptual Framework** for **Adapting** British Columbia's **Forest Practices** for a Changing Climate

Principles

Goals

Desired Outcomes

Proposed Objectives

Adaptation Opportunities

A note about Managing for Resilience

A goal of managing for resilience is to minimize the risk of rapid, unexpected ecosystem changes that could generate negative socio-economic pressures (Campbell et al. 2009). The risk of unexpected change can be reduced by managing for structural and functional diversity of ecosystems across all scales - micro, stand, watershed, and landscape. These actions can also increase the capacity of ecosystems to recover from disturbances. Resilience can be improved by diversifying management practices, such as by varying timber harvesting and reforestation patterns.

Adapting British Columbia's Forest Practices for a Changing Climate

Purpose and Introduction

Forest practices afford many opportunities to reduce climate change impacts and risks to British Columbia's forest resources. The purpose of this **policy assessment** and **climate change adaptation dialogue** is to identify and evaluate potential policy opportunities within the broad policy framework of *Forest and Range Practices Act* (FRPA) to improve the resilience of BC's forest ecosystems. Improving the resilience of forest ecosystems is intended to maintain or enhance the benefits British Columbians receive from forests. Our desired end results are a sustainable forest economy with ecosystem goods and services that are valued by society in the future. We want forests to survive. We want the economics to work. The end use of the products may be different, but we want value to society from our forests.

This project will identify strategies for BC forest managers to succeed at adapting to a changing climate in order to deliver these diverse values to society. And it assumes that forest management in BC follows a professional reliance model. Therefore, the availability and accessibility of good information, adaptation planning tools for decision-makers, and expertise are crucial to effective adaptation. Climate change adaptation will be a core part of the forestry business in BC. This will mean broad engagement in understanding the opportunities for reducing the risks and impacts of climate change effects, and incorporating this understanding into activities on the land base.

A note about this policy assessment initiative

This discussion paper is part of a Ministry of Forests, Lands and Natural Resource Operations initiative to assess policy opportunities. While the following text presents some potential opportunities to stimulate discussion and explore potential alternatives, any policy development that takes place will be informed by and occur subsequent to this consultation exercise by the appropriate responsibility centers.

Scope

The scope of this policy assessment initiative covers both the statutory framework and policy implementation aspects of the *Forest and Range Practices Act* (FRPA). Consultation will include climate change adaptation leaders, policy specialists, forest practitioners, and decision makers from government, industry, and community forests.

Policy and/or policy implementation elements that reside outside of FRPA (e.g. *Land Act*, *Wildfire Act*, *Drinking Water Protection Act*, *Wildlife Act*) are considered out of scope for this project. Linkages will, however, be documented for future consideration.

A note about 'rangelands' regulated under the Forest and Range Practices Act

BC's *Forest and Range Practices Act* (FRPA) comprises legislation applicable to both forest and range lands. While adaptation of policies pertaining to range lands are equally important in responding to 'BC's Climate Change Action Secretariat vision and strategy, this policy assessment is limited to forest lands regulated under FRPA. Any future assessment of the FRPA policy framework for rangeland adaptation opportunities will be undertaken by or with appropriate responsibility centers.

FRPA Policy Assessment – A Phased Approach

The first phase of the project asked whether the statutory provisions in the *Forest and Range Practices Act* (FRPA) enable or impede practices that could contribute to forest ecosystem resilience to climate change. The Phase 1 assessment found that the FRPA statutory provisions provide much flexibility for adaptation actions to occur, but contain few objectives and practice requirements to achieve the desired outcomes, and a few impediments such as a geographically based (rather than a climatically-based) seed transfer system.

Adapting British Columbia's Forest Practices for a Changing Climate

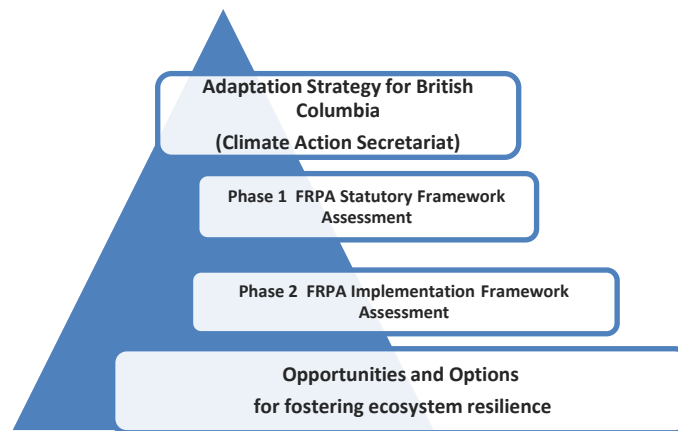


Figure 1: Schematic diagram of BC's **Climate Change Adaptation: Forest Policy Assessment** initiative.

Phase 2 of the FRPA policy assessment, currently underway, is focused on identifying opportunities to adapt BC's forest policies and practices for a changing climate, specifically for the purpose of addressing tree species vulnerability and ecosystem resilience. It asks, 'What are the opportunities?' and, 'How can they be operationalized?' While the whole project deals with BC's *Forest and Range Practices Act* broadly, the Phase 2 assessment pays particular attention to potential opportunities that may lie within the FRPA **policy implementation** realm.

Assessment of potential mechanisms for appropriate cost and risk sharing will be addressed in a future phase (Phase 3).

What might a changing climate mean for BC's forests?

According to **Technical Report 045** Climate Change, Impacts, and Adaptation Scenarios: Climate Change and Forest and Range Management in British Columbia

(<http://www.for.gov.bc.ca/hfd/pubs/docs/Tr/Tr045.pdf>), over the next century:

“British Columbia will have greater warming and changes in the precipitation regime than the global average. All models and emissions scenarios predict an increase in winter and summer temperature. Warming would be greater in northern British Columbia than in southern British Columbia and larger in the winter than in the summer, particularly in the winter minimum temperature. Warming is least in coastal areas where it is moderated by the oceansⁱ.

Changes in precipitation will accompany changes in temperature. Southern and central British Columbia are expected to see the summer precipitation decreasing by 10–40% by the 2080s under all emission scenarios. Summers in northern British Columbia range from a small precipitation decrease to a 25% increase. Winters will be wetter across British Columbia, with increases ranging from 5 to 40%, depending on the emissions scenario and global climate model. We can expect an increase in precipitation intensity and reduction in the return period of extreme events. Warming will result in less snow and earlier snowmelt by up to a month under the highest warming scenarios.

According to **Technical Report 055** Ecological resilience and complexity: a theoretical framework for understanding and managing British Columbia's forest ecosystems in a changing climate

(<http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr055.htm>)

Climate change is expected to have impacts on most ecological processes that influence ecosystems. Changes in temperature and precipitation regimes affect the growth, reproduction, and regeneration of trees and other plants, which alter plant community successional trajectories and the quality or quantity of wildlife habitat (Root et al. 2003). Climate change is also expected to alter historical disturbance regimes involving fire (Flannigan et al. 2000; de Groot et al. 2003), insect outbreaks (Volney and Fleming 2000; Carroll et al. 2006; Gray 2006), forest disease (Woods et al. 2005); wind, floods, and drought (Dale et al. 2007), and modify soil processes, nutrient cycling (Swift et al. 2004), and hydrological cycles (Stewart et al. 2003). As a result of all these individual effects of climate change, and their interaction, species ranges will expand or contract, the geographic location of ecological zones will shift (Hamann and Wang 2006; Rehfeldt et al. 2006), forest ecosystem productivity will change (Boisvenue and Running 2006), and ecosystems could reorganize following disturbances into ecological systems with no current analogue.

A Conceptual Framework for Adapting British Columbia's Forest Practices to Accommodate a Changing Climate

Our Vision: Sustainable Ecosystem Benefits

BC's forest ecosystems provide a broad suite of goods and services that benefit society now and in a changing climate. Benefits include, e.g. return on investment, carbon storage, water storage and filtration, habitat, air purification, and connectivity to enable migration of forest, rangeland, and stream-dependent species to suitable habitat in pace with changing climate and wildlife habitat, etc.

Because climate, land use, management actions, and the age and volume profile of BC's forests are changing over time, the mix of ecosystem benefits may change over the course of a rotation or many rotations. This mix includes both the quantity and quality of ecosystem benefits that flow over time. A spectrum of possible benefits is possible, ranging from minimization of timber supply impact by way of rapid and full restocking of all disturbed areas with a diversity of species and genotypes suited to current and expected future climate, to acceptance of some other level of impact. The assumption is not that the flow levels of e.g. annual timber harvest, wildlife, or water supply is constant. Rather, sustainability would look realistically at what the land is capable of producing under changing climate conditions, and seek to balance and ameliorate the supply of benefits over an extended period. By aiming for sustainable ecosystem benefits to provide a broad suite of ecosystem goods and services now and in the future, it may be possible to moderate the boom and bust cycles that can occur when trends and events are not adequately anticipated. This will be predicated upon a long term vision for the maintenance of natural capital: our growing stock.

Principles

Four core principles have been identified to guide the adaptation of BC's forest policies and practices for a changing climate. They are:

- Principle One** An effective response to climate change must **consider both the landscape level and the stand block level**: Both lenses are necessary: the block level alone is insufficient. Stand level strategies must be consistent with the landscape level goals.
- Principle Two** Project outcomes will seek to provide sufficient guidance, empowerment, and flexibility to enable success through **reliance upon professionals**.
- Principle Three** Because of their singular opportunity to influence the future forest estate, **stand establishment practices should consider a full suite of values and objectives over the landscape and the rotation**.
- Principle Four** In order to deal with increasing uncertainty of management outcomes in a changing climate, **future forest management should consider a range of possible outcomes**, and favor those activities that can produce favorable outcomes for society over a range of potential climatic futures.

Goals

Five goals have been identified for adapting British Columbia's forest practices for a changing climate. They are:

- Goal One** **Keep Pace** with a changing climate: Managed forest ecosystems that are suited to a changing climate.
- Goal Two** **Maintain Diversity:** Complex and diverse ecosystems and landscapes that foster resilience to impacts of climate change.
- Goal Three** **Protect Resources and Values:** A full suite of forest resources and values are maintained to safeguard future management options and benefits.
- Goal Four** **Manage Risks and Capture Opportunities:** Enhanced benefits and reduced climate change impacts and risks over a rotation.
- Goal Five** **Build Adaptive Capacity:** Increased capacity to apply climate change information, knowledge and tools in BC forest management.

Desired Outcomes

These desired outcomes are designed to work together toward the objective of ecosystem resilience in a changing climate. Each one alone is insufficient, but together they represent a suite of desired outcomes that could lever practices toward increased ecosystem resilience. Other desired outcomes may be identified to support each goal in the future. The desired outcomes are:

Desired Outcomes in a Changing Climate

- Outcome One** Managed forest ecosystems that are suited to a changing climate so that forest productivity and associated ecological, social, and economic benefits are maintained or enhanced;
- Outcome Two** Ecosystems and landscapes that are complex and diverse (e.g. biological, genetic, and functional diversity; and diverse forest species and age class distributions) to foster resilience to impacts of climate change;
- Outcome Three** Adequate biological legacies (e.g. seed and areas that are likely to tolerate climate change impacts) are managed to safeguard future forest management options and benefits;
- Outcome Four** Enhanced benefits and reduced climate change impacts and risks over a rotation. Can include such elements as increasing productivity on cold sites, increasing forest carbon sequestration, fuel management, etc.
- Outcome Five** Increased knowledge, awareness and organizational capacity of forest and natural resource policy makers, practitioners and decision makers to consider climate change adaptation within BC forest management.

Currently, the proposed desired outcomes are notional in nature. They should not be interpreted as FRPA objectives which are set by government through regulations. Nor are they equivalent to “results” in Forest Stewardship Plans. There are many possible ways to get to desired outcomes: not necessarily through a result or strategy. In future it may be possible to incorporate some or all of these desired outcomes as policy levers or implementation mechanisms arising from them, within the FRPA policy framework, or elsewhere such as in plans or decision support tools.

Objectives

Objectives help answer “what” we might hope to achieve under each goal. In many cases, multiple objectives could be articulated for any given goal, and the ones presented here represent an initial attempt to articulate what we should be aiming for in order to adapt forest management practices to a changing climate in BC. (Similarly, there may be multiple opportunities available to meet any Proposed Objective). Several proposed objectives have been identified to support the goals and desired outcomes. Over time, it is anticipated that additional objectives could be developed. Just as multiple objectives could contribute to a single goal or desired outcome, a single objective could contribute to multiple goals.

The proposed objectives include:

- Objective 1.1** Forests are planted with stock suitable for a changing climate.
- Objective 2.1** Reforested stands and landscapes have no less diversity than that prior to harvest.
- Objective 2.2** Reforested stands and landscapes should have sufficient stocking in secondary and/or tertiary species to meet minimum stocking levels for the site.
- Objective 3.1** BC has a mechanism in place to ensure the adequacy of biological legacies to safeguard future management options and benefits.
- Objective 4.1** BC’s forests are managed in a way that captures opportunities and addresses climate change risks and impacts.
- Objective 4.2** Cumulative impacts associated with climate change are considered in forest management decisions.
- Objective 4.3** BC has measures in place to assess the achievement and progress in sustaining ecosystem benefits in a changing climate.
- Objective 5.1** BC forest managers have the knowledge, tools and organizational capacity to adapt BC forest practices for a changing climate
- Objective 5.2** Research, extension, monitoring, and training supports the development of policy, administrative guidance and decision support tools that address climate change adaptation in BC forest management.

A note about objectives for climate change adaptation

The objectives outlined in this paper have no legal status of April 2011. Rather, they are notional in nature. The intent of bringing them forward is to initiate a conversation as part of a policy assessment process geared towards managing public forests sustainably in a changing climate. In other words, the proposed objectives outlined here are not FRPA Objectives (Objectives Set By Government for the values outlined in FRPA, nor are they Objectives set by Regulation, etc) at this time.

Part Two Opportunities

Potential opportunities for adapting British Columbia's forest practices for a changing climate

In Part Two, objectives and opportunities for adaptation are proposed for consideration under each goal.

Adaptation Opportunities

Adaptation opportunities are management actions that could be taken to sustain healthy, productive and resilient ecosystems in response to predicted and observed impacts of climate change. For each proposed objective, we ask, "What are the opportunities to move toward objectives proposed to meet goals for adapting BC's forest practices for a changing climate? These opportunities could be implemented over the short, mid and/or long term. For a summary of goals, objectives, and proposed adaptation opportunities, see Table 1 on page 7.

Goal One Keep Pace with Climate Change

Goal Statement: Managed forest ecosystems that are suited to a changing climate

Current Situation

Forest ecosystems in BC are suited to the climate which existed 100-1000 years ago. Climate stressors have already had an impact on ecosystem resilience, productivity and forest health. According to the 2009 CCFM report on *Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation*:

"Over the next several decades, the climate in Canadian forests will shift northward at a rate that will likely exceed the ability of individual tree species to migrate. While most tree species can migrate naturally up to a few hundred metres per year via seed dispersal, the climatic conditions in which each species thrives may move north by several thousand metres per year."

Currently, BC's [seed transfer system](#) is mainly geographically based. Notable exceptions include recent policy changes in BC's [Chief Forester Standards for Seed Use](#) to increase upward elevation so seedlings can be planted at higher elevations than previously allowed; and, range expansion opportunities for western larch. [Research](#) is underway to provide the data and scientific foundation to underpin a climatically based seed transfer system. Such a system is needed to support strategies such as assisted range expansion. Assisted range expansion (based on projected climates) may or may not be a viable option for some species and/or regions as it will largely depend on anticipated benefits and levels of vulnerability (social, economic and environmental).

Desired Outcome 1.1

Managed forest ecosystems that are suited to a changing climate so that forest productivity and associated ecological, social, and economic benefits are maintained or enhanced.

Key words: emerging climates, contemporary and future climates, genetic adaptation, assisted migration, managing across spatial and temporal scales

Characteristics

This desired outcome describes the controlled migration of tree species and genotypes in pace with a changing climate so that forests remain productive while the climate changes around them. It aims to create stands and landscapes that can survive and thrive in the short, mid and long term, given projected changes to climatic envelopes. To succeed at this, genetic stock would need to be successfully established in microenvironments (e.g., considering frost, exposure etc.) where they have a good chance of success both now and in future climates. Success would require consideration of provenance performance under a wide array of environmental conditions. This outcome should consider both naturally regenerated and artificially regenerated forests which are parts of the same whole. Local seed sources will likely become less well adapted to new environments. Species, populations and genotypes that are adapted to a broad range of climatic conditions could contribute to this outcome. It could include local sources of tree seed and/or pollen genetically adapted to current and future climate.

Proposed Objectives

Proposed Objective 1.1

Forests are planted with stock suitable for the future climate.

Opportunities

Adapting silvicultural and seed use practices through alternative tree species selection choices and climate based seed transfer can help avoid mal-adapted forests and secondary forest health impacts, now and in the future.

Potential Opportunity 1.1

Increase adaptation of trees planted through climate-based seed transfer.

Potential Opportunity 1.2

Increase adaptation of planted trees through the use of assisted range expansion.

Goal Two Maintain Diversity

Goal Statement: Complex and diverse ecosystems and landscapes that are resilient to the impacts of climate change

Current Situation

In BC's forests, ecosystem complexity is enhanced on a macro scale by a mosaic of parks and protected areas, and on a smaller scale by Old Growth Management Areas, wildlife tree patches, riparian areas, and retention. Within the timber harvesting land base, forest regeneration decisions are made at a stand level, but resilience impacts occur at multiple scales. While a tree species may be ecological suitable in a given stand, shifts in diversity across the landscape may limit the desirability of that species in future reforestation areas. For example, in a landscape with high natural tree species diversity, where lodgepole pine has already been regenerated in abundance, lodgepole pine may no longer be as desirable as previously.

Currently, reforestation may be simplifying the species mix across many landscapes. A [recent analysis](#) has shown a shift from mixed to single species stands within a majority of forest districts. In about half of the districts, this shift is between 10% and 30% more single species stands than occurred prior to harvest. Within managed forests there is an opportunity to create more complex stands in some areas.

Desired Outcome 2

Ecosystems and landscapes that are complex and diverse (e.g. biological, genetic, and functional diversity; and diverse forest species and age class distributions) to foster resilience to impacts of climate change.

Key words: species diversity, genetic diversity, landscape mosaics, complex stand composition and stand structure, complexity at multiple scales

Characteristics

This outcome describes highly diverse and well adapted stands and landscapes that are resistant to insects, disease, abiotic agents. At the landscape level, it describes a complex landscape mosaic, with complexity in species, genotypes, age, patterns, stand structures, and composition: landscapes that are less vulnerable to climate stressors and catastrophic weather events. It includes multiple representation of values and species across the landscape to spread risks rather than concentrate them. At the stand level, there would be sufficient species diversity so that if one species succumbs due to climate change etc. others are available. Areas would be restocked with diversity of species and genotypes suited to anticipated or projected future climate.

DESCRIPTION

A desirable breadth of landscape level diversity would offset some of the negative impacts of climate change and/or capture some of the potential benefits. Diversity is a risk reduction strategy: diverse stands resistant or resilient to future disturbance. Benchmarks for both the minimum level and desirable amounts or types of diversity would provide the necessary foundation for moving toward this proposed desired outcome. It will also be important to recognize that diversity will change throughout the life of a stand.

Proposed Objectives

Objective 2.1

Reforested stands and landscapes should have no less tree species diversity than that prior to harvest.

Objective 2.2

Reforested stands and landscapes should have sufficient stocking in secondary species to meet minimum stocking levels for the site.

Potential Opportunities

Options for moving toward **Proposed Objective 2.1** include:

Opportunity 2.1 Reforested stands and landscapes should have no less tree species diversity than that prior to harvest.

Opportunity 2.2

Reforested stands and landscapes should have sufficient stocking in secondary species to meet minimum stocking levels for the site.

How could this be operationalized? (example)

2.1 Develop tools to better measure and maintain diversity on the landscape (e.g. species profile (composition, stand structure), extent and distribution).

Goal Three Protect Forest Resources and Values

Goal Statement: A full suite of forest resources and values are maintained to safeguard future management options and benefits.

While many outcomes may in future be described for this goal, a first step in safeguarding a full range of values includes maintaining the genetic resources to restock future forests.

Current Situation

BC's supplies of forest tree seed are generally adequate, but not necessarily evenly or fully matched to future planting requirements. Climate change is now adding a new layer of complexity to both seed transfer standards and the maintenance of seed supplies¹. Increased wildfires are applying pressure to some seed inventories, and stands affected by mountain pine beetle present fewer opportunities for cone collection.

Desired Outcome 3.1

Adequate biological legacies are maintained and managed to safeguard future management options and benefits. Biological legacies include, for example, seed and areas that are likely to tolerate climate change impacts.

Keywords: biological legacies, seed and propagule dispersion, future regeneration success, seed banks, climate refugia, reserves and retention areas

Characteristics

BIOLOGICAL LEGACIES: Areas containing biological legacies help buffer against climate change by providing a source of propagules for new forest ecosystems. They should provide sufficient seed and seedling dispersion for both genetic adaptation and evolutionary processes for regeneration success. Important functions include gene flow, seed dispersal, natural selection, and could include germplasm and scion or seed stores. Biological legacies can be of two types:

- Ex situ seed banks: Adequate amounts of tree seed of provenances that are suitable for future climates in BC
- In situ biological legacies are components of forests, landscapes, and stands which remain on site after logging or other disturbances. On-site biological legacies can come from a combination of both natural (seed dispersal, suckering) and artificial regeneration. Natural regeneration may become less and less suitable for its original location; however seed can be collected for use elsewhere. BC's biological legacies include parks, protected areas, Old Growth Management Areas,

¹ <http://web.viu.ca/vallee/FRST%20233/FRST%20233%20Introduction%20article%20by%20Jack%20Woods.pdf>

wildlife habitat areas, riparian areas, and a variety of other biota both in and between harvested areas. The extent to which these areas are adequate to safeguard the genetic capital that will be needed for reforestation in a changing climate is unknown.

Considerations for reserves in a changing climate include ensuring sufficient variation to provide a broad range of genetic source material, including genetic material suited to BC's changing climate.

Because trees in existing mature reserves may become climatically stressed just as newly suitable climates appear northward, legacies can be created by establishing genetic outposts (planting better adapted trees to produce seed in areas where climate is becoming suitable, protecting and buffering climate refugia, and creating multiple legacies.

Proposed Objectives

Objective 3.1

BC has mechanisms in place to ensure the adequacy of biological legacies to safeguard future management options and benefits.

Potential Opportunities

Options for moving toward **Proposed Objective 3.1** include:

Potential Opportunity 3.1

Identify genetic resources important for maintaining biological legacies to safeguard future management options and benefits.

Potential Opportunity 3.2

Manage the suite of biodiversity and forest management reserves and retention areas as a dynamic portfolio with sufficient flexibility, diversity and redundancy to take climate change impacts and risks into account. As landscapes shift due to disturbance, managing a dynamic portfolio could rely upon development of new mechanisms to recruit areas with old growth characteristics. Similarly, mechanisms could enable release of stands that no longer contribute to the desired outcomes.

Goal FourManage Risks

Goal Statement: Reduce climate change impacts and risks over a rotation.

Current Situation

Over the last decade, BC has been dealing with the effects of mountain pine beetle over 14 million hectares, fire seasons that are getting longer, and wildfires that have threatened communities. These situations have been exacerbated by a changing climate, and warming trends are expected to continue. Within the forest itself, simplification of stands due to planting a single species is an increasing concern in some areas. Risks include insect and disease infestation over the course of a rotation, and effects on timber supply and other ecosystem services. In an era where climate change is occurring much faster than historically, actions designed to create stocking in the short term are not necessarily the same actions that will give the greatest societal value at age 50 or rotation age.

Desired Outcome - 4

Enhanced benefits and reduced climate change impacts and risks over a rotation. Can include such elements as increasing productivity on cold sites, increasing forest carbon sequestration, fuel management etc.

Key words: risk-based approach, diverse portfolios, multiple representation, ecosystem stressors, cumulative effects, managing for uncertainty

Description

This outcome describes robust forests, landscapes, stands, and management approaches that respond well to ecosystem stressors (e.g. drought, disturbance) and can absorb significant amounts of environmental change. Included in this outcome are ecosystems that are resistant or resilient to future disturbance over time and at multiple scales, and a diverse portfolio of resource investments to address a range of plausible scenarios and possible outcomes. This outcome could include healthy forest ecosystems (resistant to wildfire) with manageable fuel loads, stand density suitable to availability of moisture on the site, and reduced risk of losing desired ecosystem goods and services. Risk management strategies could aim to reduce or capture benefit from mortality on the Timber Harvesting Land base, or reduce risk of loss to wildfire, insects, and disease over the course of the rotation.

Characteristics

A risk-based approach to forest establishment, management, and investments should be underpinned with sound knowledge of social, economic and environmental vulnerabilities that include climate change and ecosystem effects. On the socioeconomic side, one could aim to optimize the risk-return ratio or enhance investment return. Strategies could include a risk-based approach to harvest scheduling so that stands at imminent risk to climate change exacerbated disturbance agents are harvested while they

are still green. Sustainable forest management outcomes could include improved merchantability, reduced waste, and reduction of risk due to insects and disease. A proactive approach would help to maximize timber recovery over the long term.

Improved accountability through reporting of accomplishments is critical in order to make the necessary adjustments as we move forward. This can be achieved through mechanisms such as monitoring, evaluation, annual reporting, and reporting out through certification processes. Resource inventory & analysis, evaluation and monitoring programs are critical for the establishment of baselines. Indicators are needed to report on status, trends and the condition of our forest resources in a changing climate.

Proposed Objectives

Objective 4.1

BC forests are managed in a way that captures opportunities and addresses climate change impacts and risks.

Objective 4.2

BC has measures in place to assess the achievement and progress in sustaining ecosystem benefits in a changing climate.

Objective 4.3

Cumulative impacts associated with climate change are considered in forest management decisions.

Potential Opportunities to Meet Objectives

Options for moving toward Proposed Objective 4.1 4.2 and 4.3 include:

Opportunity 4.1

Forest management practices capture opportunities for increased productivity and forest carbon sequestration.

Opportunity 4.2

Forest management practices address climate change risks and impacts.

Opportunity 4.3 Actions identified in sustainable forest management plans and results and strategies identified within forest stewardship plans address cumulative impacts associated with climate change.

How could this be operationalized? Develop new indicators to measure and report out on the progress and achievement of climate change adaptation objectives and desired outcomes.

Goal Five Build Adaptive Capacity

Goal Statement: Increased capacity to apply climate change information, knowledge and tools in BC forest management.

Current Situation

Climate-based research, interim measures, and policy initiatives have been undertaken over the past 2-3 years under the Future Forest Ecosystem Initiative (FFEI) and through the Forest Ecosystem Scientific Council (FFESC).

Now What?

Development of a plan to integrate current and planned work, identify gaps and opportunities, develop cost/risk sharing investment and program delivery models, and build partnerships is needed to help us move forward in undertaking management actions to address climate change.

Desired Outcome – 5

Increased knowledge, awareness and organizational capacity of forest and natural resource policy makers, practitioners and decision makers to consider climate change adaptation within BC forest management.

Key words: adaptive capacity, decision support tools, knowledge, skills, information sharing, administrative structure, networks, technology, systems thinking

Characteristics

Adaptive Capacity is the ability of a social, ecological, economic, or other system to cope with new situations without losing options for the future. Adaptation measures that adjust human systems address the need to build awareness through increased knowledge, decision support tools and organizational capacity to allow us to adapt our forest management practices as a means to effectively respond to climate change impacts now, and in the future.

Capacity to adapt to a changing climate in the context of BC forest management may include such elements as:

- Human systems, networks and systems thinking
- Climate change education and awareness, adaptive thinking
- Sharing data, information and technology, science-based decision support tools (policy and administrative guidance)

- Organizational capacity, institutions, multi-disciplinary/multi-agency cross-pollination of ideas

For example, high adaptive capacity for goal 1 would include land managers understanding:

- Baselines - the gain we're getting now with use of select seed on plantations;
- Realized versus fundamental niches - the breadth of climatic amplitude (determining the range of suitable climates where the genetic stock could survive) of the genetic material in the seed; and,
- How to balance conflicting objectives - between diversity, gain and the breadth of climatic amplitude.
- Suitability, adaptation and vulnerability - strengths, limitations and climatic vulnerabilities of species originating on the site relative to their suitability for in situ reforestation.

Proposed Objectives

Proposed Objective 5.1

BC's forest managers have the knowledge, tools and organizational capacity to adapt BC's forest practices for a changing climate.

Proposed Objective 5.2

Research, extension, monitoring and training support the development of policy, administrative guidance and decision support tools that address climate change adaptation in BC forest management.

Potential Opportunities

Potential Opportunity 5.1

Develop knowledge transfer, training and communication tools to support BC forest management climate change adaptation actions.

Potential Opportunity 5.2

Develop an 'Action Plan' and scorecard in which to assess and measure the achievement and progress of BC's climate change adaptation goals for forest practices.

Part Three Inviting Your Input

Becoming an adaptation leader through participation in shaping BC's Adapted 'Forest Policy and Practices Framework' for a Changing Climate

Workshops are planned for Nanaimo, Prince George, Kamloops and Creston in June 2011 to further identify opportunities and determine some ways they could be operationalized. The findings of this policy assessment and dialogue will be reported out to senior managers and policy specialists in the Ministry of Forests, Lands and Natural Resource Operations as well as those who participated in the consultation process. Feedback will be summarized and posted on a website and/or otherwise made available to those who participated in the consultation.

Learning more about adaptation

Preparing for Climate Change: BC's Climate Change Adaptation Strategy (BC Ministry of Environment)
<http://www.livesmartbc.ca/government/adaptation.html>

Climate Change, Impacts, and Adaptation Scenarios: Climate Change and Forest and Range Management in British Columbia (Spittlehouse)
<http://www.for.gov.bc.ca/hfd/pubs/docs/Tr/Tr045.pdf>

Compendium of forest hydrology and geomorphology in British Columbia (R. Pike et al)
http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh66/Lmh66_ch19.pdf

Ecological Resilience and Complexity: A Theoretical Framework for Understanding and Managing British Columbia's Forest Ecosystems in a Changing Climate (E. Campbell et al)
<http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr055.pdf>

Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation (M. Johnson et al) http://www.ccfm.org/pdf/TreeSpecies_web_e.pdf

ⁱ If there is limited success internationally to control future emissions (e.g., the A2 emissions scenario), British Columbia could see a warming of 3–5°C by the 2080s. With significant reduction in emissions (e.g., the B2 emission scenarios), the warming is 2–3°C by the 2080s. These two scenarios have the winter minimums in northern British Columbia increasing by 4–9°C by the 2080s and summer maximums increasing by 3–4°C. The frost-free period, growing-degree days, and frequency of extremely warm days will also increase.