Canadian Council of Forest Ministers
Conseil canadien des ministres des forêts

Adapting Sustainable Forest Management to Climate Change:
An Analysis of Canadian Case Studies

This report is a product of the Climate Change Task Force of the Canadian Council of Forest Ministers.

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Adapting Sustainable Forest Management to Climate Change:
An Analysis of Canadian Case Studies

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Canadian Council of Forest Ministers

Climate Change Task Force

"Consideration of climate change and future climatic variability is needed in all aspects of sustainable forest management"

A vision for Canada's forests: 2008 and beyond

(CCFM 2008)

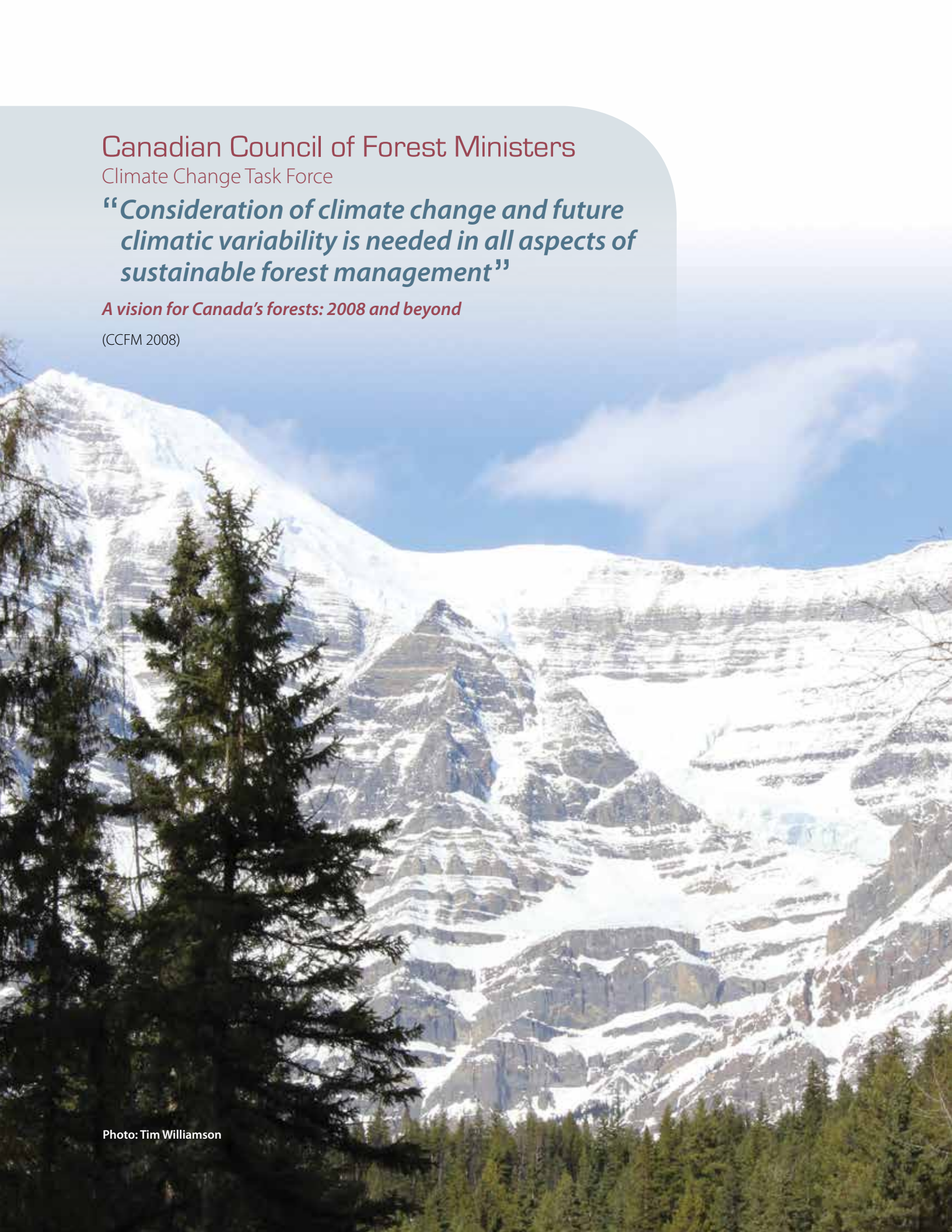

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Photo: Tim Williamson

FOREWORD

Canada has 397 million hectares of forests and other woodlands, representing 10% of the world's forest cover. Our forests constitute a world-class natural treasure providing ecological, economic, social, and cultural benefits to all Canadians, regardless of whether they live in small northern communities or large urban centres. Canada is committed to sustainable forest management, which aims to maintain and enhance the long-term health of forested ecosystems while providing ecological, economic, cultural, and social opportunities for present and future generations.

One of several factors that pose both opportunities and challenges in terms of effectively and efficiently meeting our sustainable forest management goals is climate change and its inherent uncertainties. The Canadian Council of Forest Ministers (CCFM) identified climate change as one of two priority issues for Canada's forest sector. In its *Vision for Canada's Forests: 2008 and Beyond*, the CCFM stated, "Consideration of climate change and future climatic variability is needed in all aspects of sustainable forest management." In addition, to minimize the risks and maximize the benefits associated with a changing climate, Canada's provincial and territorial premiers asked their Ministers responsible for forest management to collaborate with the federal government on adaptation in forestry through the CCFM's Climate Change Task Force. Phase 1 of this work, completed in 2010, involved a comprehensive assessment of the vulnerability of various tree species and identified management options for adaptation. Phase 2 has gone beyond the level of trees to look at climate change adaptation within forest ecosystems and the broader forest sector. The goal of phase 2 was to equip members of the forest sector with a suite of tools and state-of-the-art information to enable them to make better decisions about the need for adaptation and the types of measures that may be most beneficial.

Over a period of two years, nearly one hundred individuals from a wide range of organizations have contributed to achieving this goal. The fruits of their labour have been captured in the CCFM's Climate Change Adaptation series, which comprises several technical reports and review papers. It is our sincere hope that these documents, which will be used in conjunction with workshops, seminars, and presentations, will benefit forest practitioners from coast to coast to coast as they seek innovative ways to adapt sustainable forest management policies and practices for a changing climate.

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ABSTRACT

The Canadian Council of Forest Ministers (CCFM) has developed an approach to identifying options for adapting sustainable forest management (SFM) to climate change through the use of vulnerability assessment. The CCFM climate change adaptation initiative involved collaboration with 10 SFM vulnerability assessment projects to develop examples of good practices and lessons learned for applying this approach to SFM practices and policies. The projects, called case studies, encompassed a range of forest types and a wide variety of stakeholders and focused on a range of topics. These included biophysical modeling, policy analysis, community-based assessments, and integration of climate change into forest management planning. The leaders of each case study were interviewed and asked about three aspects of the case study: the enabling factors that led to establishment of the project, the results of the project, and how the results will be incorporated into policy or practice. Enabling factors included adequate funding, availability of data at relevant temporal and spatial scales, and a local champion to provide a bridge between researchers and local stakeholders. The results of the case studies generally did not lead directly to implementation of adaptation options. Rather, their value has been mainly in raising awareness of climate change as an issue in forest management and in building networks of forestry practitioners, researchers, and stakeholders that will address these issues through continuing collaboration. In some cases, local and provincial governments have incorporated climate change considerations into policy or have plans to do so. Mainstreaming adaptation (i.e., including climate change thinking in day-to-day planning and operations) is critical to ensure continued achievement of SFM in a changing environment.

Key words: Vulnerability assessment, sustainable forest management, adaptation, climate change, best practices, case studies

RÉSUMÉ

Le Conseil canadien des ministres des forêts (CCMF) a mis au point une approche d'évaluation d'options d'adaptation de l'aménagement forestier durable (AFD) aux changements climatiques fondée sur l'évaluation de la vulnérabilité. L'initiative du CCMF sur l'adaptation aux changements climatiques résulte d'une collaboration de dix projets d'évaluation de la vulnérabilité de l'AFD destinée à tirer profit des exemples de bonnes pratiques et des leçons apprises dans l'application de cette approche d'adaptation aux pratiques et politiques de l'AFD. Les projets, appelés ici « études de cas », couvraient un large éventail de types forestiers et d'intervenants en plus de porter sur plusieurs sujets. Ces sujets comptaient la modélisation biophysique, l'analyse des politiques, l'évaluation à l'échelle des collectivités et l'intégration des changements climatiques dans la planification de l'aménagement forestier. Dans chaque étude de cas, les porte-parole ont passé une entrevue qui couvrait trois aspects de l'étude de cas : les facteurs favorables qui ont mené à l'établissement du projet, les résultats et comment ces résultats ont été intégrés dans les politiques ou les pratiques. Les facteurs favorables comprenaient le financement adéquat, la disponibilité des données appropriées, tant à l'échelle spatiale que temporelle, et un chef de file local qui établissait le lien entre les chercheurs et les intervenants locaux. Les résultats des études de cas n'ont généralement pas mené à l'application d'options d'adaptation. Leur valeur réside plutôt dans la prise de conscience de l'enjeu que représentent les changements climatiques pour la gestion forestière et dans la création d'un réseau entre les praticiens forestiers, les chercheurs et les divers intervenants qui permettra de poursuivre la collaboration sur cet enjeu. Dans certains cas, les administrations locales et les gouvernements provinciaux ont intégré des considérations sur les changements climatiques dans leurs politiques, ou planifient de le faire. L'intégration de l'adaptation (y compris la considération des changements climatiques dans la planification et les opérations journalières) est critique afin d'assurer l'atteinte continue de l'AFD dans un environnement en évolution.

Mots clés : Évaluation de la vulnérabilité, aménagement forestier durable, adaptation, changements climatiques, meilleures pratiques, études de cas

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INTRODUCTION

Recognizing the need to minimize the risks associated with and to maximize the opportunities posed by climate change in relation to Canada's forests and forest sector, in 2008 the Canadian Council of Forest Ministers (CCFM) initiated collaborative work on adaptation in forestry. Phase 1 of this interjurisdictional initiative resulted in a review of the vulnerability of Canada's major tree species to climate change and identification of potential adaptation options (Johnston et al. 2009). During Phase 2, various tools, approaches, and state-of-the-knowledge information were developed and made available to members of Canada's forest sector to enable the incorporation of climate change considerations into all aspects of sustainable forest management (SFM).

Proactively and effectively adapting SFM to climate change requires an understanding of the highly variable nature of climate change impacts on Canada's forests, the uncertainty that this variability creates for decision making, and the capacity to implement adaptation options. One approach used to develop this understanding is vulnerability assessment (Williamson et al. 2012), a widely used methodology for evaluating potential climate change impacts and linking this knowledge of impacts to adaptation policy and practice (Smit and Wandel 2006). However, vulnerability assessment can be a complex undertaking, and the science and practice of performing such assessments within SFM contexts are still in their early stages. In addition, every vulnerability assessment is unique, according to its combination of location, purpose, scope, and participants. Nonetheless, collecting insights and lessons learned from a number of early attempts at SFM vulnerability assessment should provide guidance to others planning to use this approach to planning for climate change adaptation.

An important component of phase 2 of the CCFM climate change initiative was to gather information from projects or case studies that focused on climate change vulnerability assessments over a range of landscapes, forest management activities, and policy environments. The diversity of approaches, landscapes, and areas of focus in these case studies provided a rich variety of experience that will help vulnerability practitioners in carrying out similar assessments in the future. This report summarizes the case studies that were included in the CCFM climate change initiative, providing information about why and how each study was established (i.e., the enabling factors), the results and lessons learned from the projects, and the legacy that will remain once they are completed.

Photo: Jason Edwards

THE CASE STUDIES

The CCFM climate change initiative did not fund the case studies directly; rather, existing projects were identified that could contribute to a pan-Canadian understanding of SFM vulnerability and opportunities for adaptation planning. These case studies arose from a variety of sources: some from governmental policy direction (e.g., in the province of Ontario); some from initiatives led by local stakeholders (persons, groups, or organizations with a direct interest in or expected to be affected by a project and its outcomes), with leadership from the relevant provincial government (e.g., the Kamloops Future Forest Strategy); and others from federal funding initiatives (e.g., Natural Resources Canada's Regional Adaptation Collaborative [RAC] program). The objectives of the case studies varied widely, with different projects focusing on

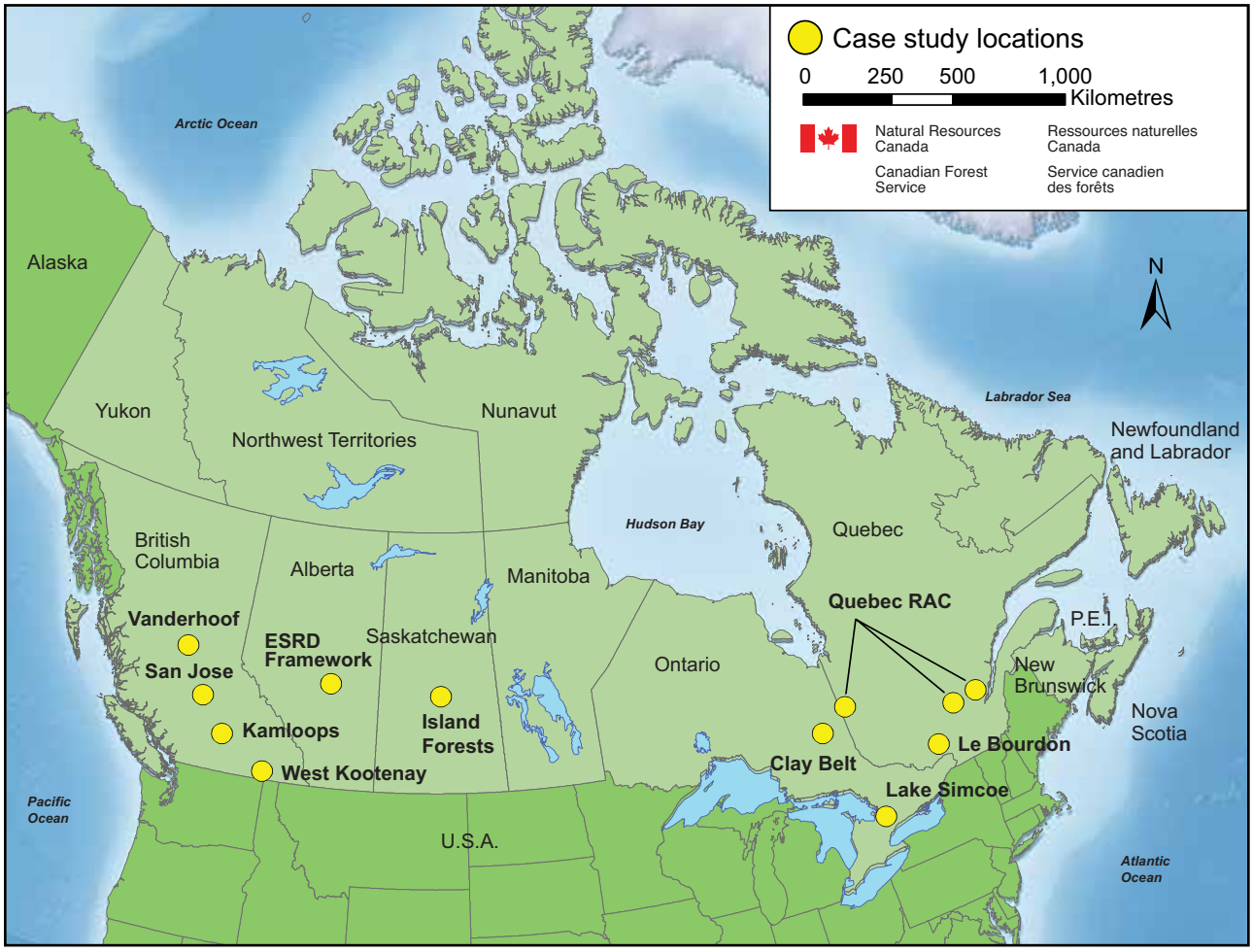

FIGURE 1. Locations of vulnerability assessment case studies included in the CCFM climate change adaptation initiative. ESRD = Environment and Sustainable Resource Development (Alberta), RAC = Regional Adaptation Collaborative (Natural Resources Canada).

biophysical modeling, policy analysis, community-based assessments, and integration of climate change into forest management planning. Some of the case studies described here are substantially complete, whereas others are still in progress; in the latter situation, progress to March 31, 2012, is reported here.

The locations of the case studies are shown in Figure 1. Other details of each case study, including a brief description of its focus, appear in Table 1 and Appendix 1.

Interviews were held with the leaders of the projects between November 2011 and March 2012. The structured interviews consisted of questions about the following topics (see Appendix 2):

- the enabling factors that allowed the project to go forward
- the results of the assessment and the lessons learned
- the ways in which assessment results will be incorporated into planning, practices, or management and additional requirements needed to facilitate the practice of vulnerability assessment

The insights gained and lessons learned from these early attempts at SFM vulnerability assessment are summarized in the following sections. Rather than each case study being analyzed individually, the interview responses have been grouped according to common factors, with examples from specific projects.

Table 1. Vulnerability assessment case studies included in the CCFM climate change adaptation initiative

Title of project[a]	Location[b]	Focus	Key contact
Vanderhoof Community Vulnerability Assessment	Vanderhoof, BC	Community-centered project to examine the severe impacts of the mountain pine beetle on the local forest economy and to address local concerns about the broader impacts of climate change.	Tim Williamson, Canadian Forest Service, Edmonton, AB Email: Tim.Williamson@nrcan-rncan.gc.ca
San Jose Watershed RAC (BC RAC)	Williams Lake, BC Williams Lake, BC	Three issues of importance to communities in the watershed: impacts of mountain pine beetle, change in fire regimes, and climate change.	Harry Nelson, Faculty of Forestry, University of British Columbia, Vancouver, BC Email: harry.nelson@ubc.ca
West Kootenay Climate Vulnerability and Resilience Project	West Kootenay region, BC	Identification of climate change impacts on ecosystem services, determination of which ecosystems may be vulnerable, and identification of management options to enhance resilience.	Rachel F. Holt, Veridian Ecological Consulting, Nelson, BC Email: rholt@netidea.com
Alberta Environment and Sustainable Resource Development Climate Change Adaptation Framework	Edmonton, AB	Development of an adaptation framework designed to mesh with existing government-wide business planning and risk management system.	Stan Kavalinas, Alberta Sustainable Resource Development, Edmonton AB. Email: Stan.Kavalinas@gov.ab.ca
Island Forests Vulnerability Assessment (Prairie RAC)	Island Forests, central Saskatchewan	Development of an understanding of the vulnerability of forests on the southern fringe of the boreal forest, especially because of drought, fire and insects.	Mark Johnston, Saskatchewan Research Mark Johnston, Saskatchewan Research Council, Saskatoon, SK Email: mark.johnston@src.sk.ca
Clay Belt Vulnerability Assessment	Northeast Ontario	Determination of where and how this area is vulnerable, assistance in identifying potential adaptation options, and identification of potential support for forest resource management plans to consider climate change.	Paul Gray, Ontario Ministry of Natural Resources, Peterborough, ON Email: paul.gray@ontario.ca
Lake Simcoe Watershed Vulnerability Assessment and Adaptation Planning	Lake Simcoe, ON	Ecosystem-focused vulnerability assessment, engaging experts and assessing current and future vulnerabilities of selected natural resources and infrastructure assets, with generation of adaptation recommendations to support the climate change adaptation strategy for the Lake Simcoe watershed.	Gary Nielson, Ontario Ministry of Natural Resources, Peterborough, ON Email: gary.nielsen@ontario.ca
Le Burdon Model Forest project	Le Bourdon Model Forest, QC	Forest vegetation change under climate change across the temperate–boreal biome transition.	Frédérik Doyon, Département des sciences naturelles, Université du Québec en Outaouais, Gatineau, QC Email: frederik.doyon@uqo.ca
Quebec RAC projects	Quebec	A climate change vulnerability assessment of three ecosystem-based forest management projects in Quebec: the Tembec Ecosystem-Based Forest Management project (Abitibi region), the TRIAD project (Mauricie Region, and the Laurentian Wildlife Reserve project (Laurentide region).	Héloïse LeGoff, ministère des Ressources naturelles du Québec, Québec, QC Email: Heloise.LeGoff@mrnf.gouv.qc.ca

[a]RAC = Regional Adaptation Collaborative.
[b]Locations are shown in Figure 1.

Photo: Tim Williamson

ENABLING FACTORS

Vulnerability assessments can be expensive and time-consuming, and to date relatively few such assessments have been carried out in Canada. Case study leaders identified several important factors that led them to undertake a vulnerability assessment: availability of funding, previous experience and expertise of stakeholders, access to appropriate data and models, expert opinion, project champions, clarity of objectives, and the CCFM's vulnerability assessment framework.

Funding

The most commonly cited factor enabling performance of a vulnerability assessment was the availability of funding. Such funding generally came from two sources: either directly from provincial governments' operational budgets, in response to provincial climate change programming and policy direction (e.g., Ontario Ministry of Natural Resources), or indirectly from funding envelopes that solicited proposals for vulnerability assessment and related activities at the provincial level (e.g., Future Forest Ecosystems Scientific Council of British Columbia) or the federal level (e.g., RAC program of Natural Resources Canada). All leaders interviewed agreed that without funding dedicated to vulnerability assessment, their case studies would not have been carried out. Some leaders also indicated that the available funding was insufficient to carry out a full vulnerability assessment. Most of the jurisdictions and organizations involved in the case studies provided substantial in-kind contributions (e.g., staff time, provision of data, assistance in organizing workshops) that were important in ensuring completion of the assessment.

Previous Experience and Expertise

In several case studies, an additional enabling factor was the existence of previous analyses for the same location that identified the importance of potential climate change impacts and the need for further, more detailed vulnerability assessment. In many of these cases, this need had been identified by local stakeholders concerned about some issue related to climate change, for example, availability of water in a drier future climate (as at Williams Lake in British Columbia). In other cases, local forest practitioners had already identified concerns about increased fire risk or drought impacts, such that when a funding opportunity became available, a proposal was quickly developed.

Data and Models

Climate and ecosystem data and models at appropriate temporal and spatial scales are essential to support any vulnerability assessment. For case studies in which policy analysis was the focus, data availability was of less concern. However, for projects based on intensive biophysical modeling, data relating to forest inventory, soils, hydrology, and other factors were required. For some case studies, data were out of date or in an inaccessible format or were lacking altogether. In other cases, previous analyses provided a rich source of data to which the new project could add. For biophysically oriented case studies, simulation modeling was often a large component of the assessment. A key consideration for these projects was to ensure that the results of modeling were presented directly to decision makers, so that the uncertainty associated with the results could be communicated effectively.

A further consideration was the capacity within organizations for modeling and other sophisticated analyses. Larger provincial jurisdictions typically have extensive in-house capacity, whereas smaller jurisdictions and other organizations (e.g., nongovernmental organizations) may not.

Ultimately, the case study leaders agreed that assessing data availability and the organization's science capacity is critical in preparing for a vulnerability assessment. See Gray (2012) for additional detail on how organizations can prepare to undertake a vulnerability assessment.

Expert Opinion

The science and practice of vulnerability assessment are still in their early stages. Although modeling and other technical analyses are important, in many cases the science is still uncertain with respect to ecosystem impacts and even more uncertain as to how the management of resources will have to be adapted. In many case studies, therefore, an important enabling factor was access to expert opinion. Sometimes, gathering expert opinion for impact assessment and adaptation planning was an informal process, accomplished through expert workshops and discussion papers (e.g., the Kamloops Future Forest Strategy). In other cases, a more formal route was taken. For example, the Ontario Ministry of Natural Resources used a policy Delphi process (de Loe 1995) for the Lake Simcoe Watershed Vulnerability Assessment and Adaptation Planning project, in which experts were surveyed and the information gathered was subjected to more formal analysis. Perera et al. (2012) have provided extensive detail and examples of the use of expert opinion in landscape ecology and resource management.

Presence of Champions

For several case studies, a major factor in the success of a vulnerability assessment was the presence of a champion within the local community or stakeholder group. The champion was usually someone familiar with the community and its circumstances, often a resident who was also a community leader (e.g., a key individual in the San Jose Watershed RAC case study). The champion's strong dedication to the project was often transmitted by example to the other stakeholders. A champion typically provides a bridge between the scientists and technical specialists involved in the analysis and the members of the community. The champion may be an individual with a technical background, which will assist with translating the technical analyses for stakeholders, or there may be a group of community leaders (e.g., the mayor and town council in Vanderhoof) who are able to provide leadership to the stakeholders and commit resources from the community.

Clarity of Objectives

Case study leaders were asked whether the objectives of the project were clearly laid out in advance or developed as the project progressed. In nearly all cases, the objectives were identified in advance but evolved as the project progressed. Reasons for modification of objectives included increased understanding of vulnerability assessment as the team gained more experience, availability of new data over time, and better definition of stakeholder needs. Given the complexity of vulnerability assessment, and the relatively few examples on which a new assessment can be based, it is to be expected that objectives will be modified as the project progresses.

CCFM Vulnerability Assessment Framework

The CCFM climate change adaptation initiative has developed a detailed approach to vulnerability assessment for the forest sector (Williamson et al. 2012), and it was of interest to determine whether this approach was considered to be an enabling factor for assessments already completed. Other approaches also exist, so the case study leaders were asked whether they used the CCFM approach or some other method. For the most part, the CCFM approach was not used in the case studies. Many of the case studies were undertaken before the CCFM approach became available, and project leaders established their own individual approaches. In one case study (Kamloops Future Forest Strategy), the current project built on previous extensive work on vulnerability. In other cases, sufficient resources were not available to undertake a full vulnerability assessment, and in yet others, resources were available but an alternative approach was used. For example, the West Kootenay case

study was originally based on an approach pioneered by the Resilience Alliance, an international organization that provides a series of workbooks for communities to use in assessing resilience (Resilience Alliance 2012). However, the resilience approach was abandoned in the early stages of the project, and an ecosystem vulnerability approach was used to identify potential impacts of climate change. The approach to vulnerability assessment developed by Alberta Environment and Sustainable Resource Development (ESRD) is similar to that of the CCFM but includes an additional component of risk assessment. The Government of Alberta already has an Enterprise Risk Management Framework, and it was thought that ESRD's vulnerability assessment would fit easily into broader government business planning. The RAC case studies in Quebec adopted the CCFM framework, although they found that more education on vulnerability assessment was required to allow nonspecialists to make effective use of this approach. The Ontario case studies (Lake Simcoe and the Clay Belt) also used the CCFM approach, complemented by a risk assessment involving nonspecialists (in the case of the Clay Belt), because it was felt that the risk-based approach alone did not provide adequate focus on ecosystem-based analysis.

LEARNING FROM THE ASSESSMENTS

The geographic details, policy environment, and questions to be answered by the vulnerability assessment varied considerably among the case studies. Rather than attempt to summarize the variety of outcomes, this section outlines whether objectives were achieved and adaptation options identified, as well as the kinds of learning that took place as a result of working through a vulnerability assessment.

Achievement of Objectives

The achievement of objectives varied among case studies. In cases where sufficient resources were available (e.g., funding, staff time, participant commitment), the objectives were met. In some cases, the overarching objective of identifying vulnerabilities was achieved, whereas in others, although a full vulnerability assessment was not completed, awareness among stakeholders was raised and linkages between technical specialists and local community members and practitioners were strengthened. Achieving objectives was sometimes affected by changes in community administration (e.g., a new council or mayor) or other changes in participant and stakeholder involvement. Lack of sufficient resources limited the scope of certain vulnerability assessments, which in turn prevented achievement of all objectives.

Role of Team Members

The membership of the vulnerability assessment teams varied considerably among the case studies. Where extensive biophysical analysis was involved (e.g., analysis of timber supply, hydrologic modeling), the team included scientists and technical specialists in fields such as forest management, ecology, wildlife management, and hydrology. Subject matter experts provided expert

opinion and knowledge and also undertook modeling analyses to better understand the nature and extent of ecosystem impacts. These experts also provided insight as to how management practices and policy might need to be changed in response to these impacts. In other cases, the emphasis was on community impacts, with a strong component of social science expertise and significant involvement from community members (e.g., Vanderhoof Community vulnerability Assessment). In a few cases, where the project was strictly an internal government exercise (e.g., development of the Alberta ESRD Climate Change Adaptation Framework, the team consisted of managers and technical specialists developing products that would fit into their jurisdiction's decision-making and planning processes. Also important to providing relevant local and traditional knowledge were forest user groups. For example, the teams for the Quebec case studies (Le Bourdon Model Forest and Quebec RAC case studies) both included snowmobiling groups and took advantage of members' extensive knowledge of local forest conditions. Finally, the forest industry was represented in some case studies, particularly at the local level. However, the recent downturn in the industry meant that industrial partners participated at a lower level than would have been expected if the forest sector were healthy.

Scientific and Traditional Knowledge

Knowledge useful to vulnerability assessment can arise from various sources. Case study leaders were asked if their respective projects had relied mainly on scientific knowledge or local (traditional) knowledge. Most case studies relied on a combination of the two, particularly where practitioners and local community members participated in the project and where local observations of changing climate and the impacts of extreme events were incorporated into the analyses. The experience of nearly all case studies was that both kinds of knowledge were required for a comprehensive vulnerability assessment. As such, it was important that all members of the team be open to making use of knowledge from all sources.

Adaptation Options

Adaptation options were identified in some vulnerability assessments, particularly those with significant resources, in terms of funding and both science and policy capacity (e.g., the Lake Simcoe Watershed Vulnerability Assessment and Adaptation Planning project). In other case studies, adaptation options were developed from the literature rather than from participants' input or will be identified as part of follow-up to the case study. Yet others concentrated solely on the analysis of vulnerabilities and did not identify any adaptation options.

Project Successes

In identifying the main successes of their vulnerability assessments, many case study leaders pointed to the establishment of a process for vulnerability assessment and the education of stakeholders, rather than the technical analysis per se. Again, projects with significant funding and technical capacity seemed to accomplish more than those with fewer resources.

In terms of technical analysis, an additional success was the development of integrated modeling approaches and decision-making toolboxes that are effective for dealing with the complexity and multiple spatial and temporal scales common in vulnerability assessment. Virtually all vulnerability assessments made extensive use of stakeholder workshops to identify local needs for assessment, to solicit local knowledge, and to present results of the technical analyses. Such workshops were seen as an essential element of the assessment in nearly all circumstances. An important outcome of the workshop process was often the formation of a group of educated and motivated stakeholders who would be able to carry on much of the work after the formal vulnerability assessments were completed (e.g., the Vanderhoof Community Vulnerability Assessment). The assessments were also often effective in strengthening linkages between modellers and forestry practitioners, which will enhance the knowledge base for forest management in the future, apart from applications in vulnerability assessment. Through these case studies, other communities, sectors, and parts of government became interested in undertaking additional vulnerability assessments.

Unexpected Outcomes

The process of vulnerability assessment is complex and may result in unexpected outcomes. For example, the case study leaders reported that some stakeholder groups had been surprised by the degree of climate change expected for their region and the anticipated severity of impacts. The degree of uncertainty related to projected climate changes and ecosystem impacts was also a

surprise to some stakeholders unfamiliar with the science of vulnerability assessment. This level of uncertainty argues strongly for the development of approaches to dealing with uncertainty that present results realistically without discounting the value of model outputs. In some cases, the case study leaders were surprised by the variability in level of interest in climate change within the stakeholder group. One response to this variability was to stress the use of the assessment results in doing a better job of forest management today and in the future, rather than focusing exclusively on climate change per se. Some case study leaders reported that some stakeholders were surprised to learn that a changing climate may have benefits as well as posing threats.

Alternative Methods

Many of the case studies have been under way for a few years or are complete, so project leaders were asked whether they would do anything differently if they were starting the vulnerability assessment today. Most leaders said they would do a better job of using nontechnical language in describing future climate and impacts on ecosystems. Some leaders would include other user groups, especially the forest industry, in the vulnerability assessment. Leaders of the more complex projects expressed a desire to do a better job of sequencing the components of the analysis, so that appropriate data were available when needed. In many case studies, the time available was not sufficient to allow substantive stakeholder involvement, and this limitation was seen as a major drawback. In addition, there was a feeling that stakeholders' interest in climate change should have been assessed at the beginning of the process, so that information could be tailored to their level of awareness and sensitivity. Early engagement of stakeholders was also seen as a potential improvement in most case studies.

Additional Learning

The objective of these case studies was to understand some or most aspects of the vulnerability of forest management to climate change. However, when significant human and financial resources are brought to bear on a complex issue such as climate change, learning beyond the original objectives may occur. In several cases, learning from one case study was transferred to another (e.g., from the Lake Simcoe case study in Ontario to the Clay Belt project in the same province). Several leaders reported that the strong linkages that developed between modellers and practitioners would continue after the end of the project, improving the science base for SFM well into the future. In addition, in some projects, stakeholders formed an advisory committee for the modeling work, and such committees will likely continue into the future (e.g., the San Jose Watershed RAC at Williams Lake). Similarly, the Climate Change Adaptation Framework developed by Alberta ESRD was shared with other jurisdictions through the RAC program of Natural Resources Canada. Another key point of learning by the ESRD was the importance of building capacity to carry out adaptation in response to climate change vulnerability and risk assessments. In several cases, the vulnerability assessment led to extensive discussions with First Nations in the study area who were not originally part of the stakeholder group (e.g., Island Forests and Quebec RAC case studies).

Importance of the Climate Change Issue

The forest sector has gone through an economic downturn from which it is just now beginning to recover. Both the forest industry and forest-dependent communities have been severely affected by this situation, and it was of interest to learn whether climate change was considered an important issue, given other pressing concerns. Stakeholders varied considerably in their concern over climate change, with some recognizing it as a serious and long-term problem (e.g., Clay Belt and Lake Simcoe case studies, Alberta ESRD case study) and others indicating that economic issues were far more important (Le Bourdon Model Forest and Quebec RAC case studies). However, the case study leaders of the Quebec RAC vulnerability assessments also indicated that interest in and concern about climate change vulnerability increased when it could be shown that adaptation actions can facilitate achievement of current forest management objectives. This outcome argues for a comprehensive assessment of current climate-related vulnerability, which may have important short-term benefits as well as the longer-term benefit of preparing the forest sector for future climate change.

Photo: Tim Williamson

LONGER-TERM EFFECTS OF THE ASSESSMENTS

The vulnerability assessment work described here took place over a span of two to three years; in some cases, the projects were completed, whereas in others, the work is likely to continue. Even over this relatively short time, much was accomplished, and significant resources were brought to bear on the assessments. Case study leaders were asked about the anticipated long-term legacy of the vulnerability assessments, specifically how the results of the work were expected to be incorporated into forest management activities, planning, or policies.

Incorporation into Forest Management Activities

For the most part, leaders reported that the case studies had not led to adaptation options being incorporated into current forest management, although some respondents thought this might happen over the longer term. An increased level of awareness of vulnerability seemed to be a more important outcome in many case studies. However, the vulnerability assessment exercises have indirectly led to other actions that will help in the adaptation of forest management to future conditions. For example, work related to the Island Forests case study resulted in the establishment by Saskatchewan Environment of a jack pine provenance test to introduce seed sources from areas that currently have the temperature regime expected in central Saskatchewan in the 2050s. The Vanderhoof Community Vulnerability Assessment identified vulnerabilities that will influence the decision about whether to rebuild a local sawmill that burned down in 2011. The Lake Simcoe Watershed Management Plan will consider vulnerability to climate change identified in the case study. As a result of learning from the vulnerability assessment in the Quebec RAC projects, forest managers have decided to use larger-diameter culverts in road construction.

On the basis of the process and results of the Lake Simcoe and Clay Belt case studies, the Ontario Ministry of Natural Resources has produced a practitioner's guide to adaptation (Gleeson et al. 2011) and a portfolio of adaptation options for Ontario's ecosystems. While not specifically focused on forest management, these documents will be valuable resources for future adaptation planning teams in other jurisdictions and for many resource sectors.

Monitoring of Project Outcomes

Where adaptation options have already been implemented, case study leaders were asked about monitoring to determine the efficacy of the adaptation action. Very few case studies included monitoring of adaptation actions, and most study leaders indicated that it was too early for monitoring. Alberta ESRD intends to regularly check the assumptions underlying its risk assessment framework for validity and modify them if required. The Lake Simcoe Watershed Management Plan will likely include a monitoring component, and those data can be used to test adaptation options once they are implemented.

Barriers and Challenges to Adaptation

As noted previously, vulnerability assessment is a complex undertaking and is still relatively new for most stakeholders and technical specialists. Furthermore, most jurisdictions are still in the early stages of incorporating vulnerability assessment as a standard component of SFM, and some have not even begun to do so. Accordingly, case study leaders were asked to identify significant challenges or barriers that might prevent the wider application of assessment results to forest management.

Many of the leaders could not identify any barriers because implementation of adaptation options had not yet occurred. In the Vanderhoof Community Vulnerability Assessment, the momentum generated by the vulnerability assessment was interrupted by a change in town leadership (mayor and council), but the

feeling was that the new administration would continue the work. Case study leaders also suggested that lack of additional funding may prevent further implementation of adaptations in a community.

Leaders of the Alberta ESRD project found that simply providing a framework was not a guarantee that adaptation would be put into operation. Executive support for development and use of the framework was key to progress. In addition, resource limitations meant that not all groups within the department were able to participate in the risk assessment framework. For some climate change impacts, ESRD had not identified adaptation options appropriate to a specific vulnerability, and further assessment will be needed to develop and refine such options.

In most organizations, many priorities compete for time and resources, climate change being only one of them. In the Island Forests case study, there was a steep learning curve when a new modeling platform was adopted, which slowed progress of the vulnerability assessment; this was also the case for other projects in which modeling was a large component. In the Lake Simcoe case study, funding from all levels of government (municipal, provincial, federal) was required for full implementation of adaptations, and commitment from all agencies and decision makers involved in local resource management was important.

The Quebec RAC projects suggested that lack of both awareness and regulations in the professional practice of forestry reduced the likelihood of implementing adaptation. This gap may argue for the incorporation of vulnerability assessment requirements into forest management legislation and planning guidelines; for example, the leader of the Lake Simcoe project identified the need to include a requirement for vulnerability assessment in the Ontario Planning Act. Case study leaders also found that information on climate change vulnerability must be communicated at the level of local forest management units, since this is where implementation of adaptation options will occur.

Information Availability

Given the complexity of vulnerability assessment, adequate information is essential to its success. Such information may take the form of biophysical data for modeling analyses, knowledge of the policy and regulatory environment, or an understanding of stakeholder needs and priorities. However, most leaders reported that readily available and usable local climate and climate change information was lacking. Many projects made use of down-scaled climate data but had to undertake the down-scaling themselves, a time-consuming and technically challenging task requiring significant expertise. "Off-the-shelf" climate products, such as scenarios for future temperature and precipitation, were seen to be of great assistance in undertaking vulnerability assessment, especially for nonspecialists. Some suggested that the typical 100-year time horizon used in many projects is too long and that assessments should focus more on shorter-term vulnerabilities and opportunities with which stakeholders can identify. Large reports full of technical detail were criticized as being unhelpful; in contrast, awareness-raising, capacity-building, and the formation of social capital related to vulnerability were seen as more important. Lack of

up-to-date information and the need to make sure that existing information (e.g., forest inventory) was updated frequently were identified as barriers by several case study leaders. The lack of social science expertise, despite its importance, was identified by several leaders. Other leaders indicated that climate-related information was difficult for stakeholders to use and that the uncertainty related to future projections must be effectively communicated.

Policy Changes

With the last question in the structured interview, case study leaders were asked to identify what changes to local policy would encourage adaptation. A good example of such changes was the planned incorporation of climate change considerations into the bylaws and policies of Vanderhoof as a result of its vulnerability assessment. The community is also developing a strategic plan, which will include climate change as an aspect of the environment component and will consider climate change with respect to infrastructure, operations, water management, and biodiversity. The town also intends to undertake further vulnerability assessments by applying the community vulnerability guidebook recently developed through the Canadian Model Forest Network (Pearce and Callihoo 2011). Alberta ESRD is considering undertaking annual assessments in which new science will be incorporated. As part of the Island Forests case study, transition rules defining which stand types return to a site following harvesting were modified to recognize the impacts of climate change, and the analysis will be used in wood supply modeling and incorporated into a forest management plan for the area. The Clay Belt case study and similar projects will likely result in changes to forest management planning processes, manuals, tools, and policies in Ontario. The Lake Simcoe project identified the need to incorporate the requirement for vulnerability assessment into provincial legislation (e.g., the Planning Act) and suggested that multilevel government commitment to vulnerability assessment is necessary for a successful outcome. The Quebec RAC projects found that current provincial legislation (specifically, the Forest Act) and policy (the provincial climate change plan) provide high-level direction to undertake vulnerability assessment, but no operational guidelines for applying vulnerability assessment at the local level. Respondents also suggested that adoption of ecosystem-based management principles would help facilitate adaptation because of the long-term and holistic approach of such principles. The Le Bourdon Model Forest case study showed that stakeholders should clearly articulate, from the outset, why vulnerability assessment is necessary, so that local governance institutions will see the benefits of participation.

Photo: Tim Williamson

CONCLUSIONS AND FUTURE WORK

The case studies examined here encompassed a wide variety of landscapes and organizations and focused on a range of topics, including biophysical modeling, community resilience, and government policy support. In spite of this variation, several general conclusions emerged:

- Vulnerability assessments require significant resources, in terms of time, funding, and multidisciplinary expertise, as well as long-term commitments from organizations and individuals. Significant involvement by local stakeholders is essential, and they and subject-matter experts must be willing to work collaboratively to overcome potential difficulties in understanding one another.
- Given the current state of understanding of climate change vulnerability and adaptation planning in Canada's forest sector, most case studies to date have focused on education, raising awareness, and building capacity. This approach will provide a strong foundation for further work in identifying and prioritizing adaptation options and incorporating them into forest management decision making.
- Vulnerability assessment and adaptation planning should be incorporated into business-as-usual decision making (i.e., through mainstreaming), such that climate change becomes a part of SFM. The case studies summarized here used a range of tools and approaches to incorporate climate change into SFM, and these will be increasingly useful as the need for vulnerability assessments expands across the forest sector.
- Changes in forest management policy may be needed to accommodate new approaches to SFM and to encourage the innovation required to adapt to a changing environment. Forest management agencies can encourage and support vulnerability assessment through changes in policy and regulation and can offer expertise if available.

Vulnerability assessments and adaptation planning will become more common as awareness of climate change and related expertise increase across the forest sector. Although a full vulnerability assessment can be expensive and time-consuming, much can be done with existing resources. The products that are being made available through this CCFM project will provide guidance for vulnerability assessment and adaptation planning, and many practitioners have already gained expertise through the case studies and other CCFM activities. This expertise is now available for others to access, and the networks of stakeholder and experts that came together for the case studies will continue to work together on these issues. All of this activity has produced a large body of approaches, experience, and expertise that will assist others in undertaking vulnerability assessments and adaptation planning. In addition, new initiatives in the federal government and a variety of provincial programs will continue to develop expertise and knowledge that will be useful to practitioners across Canada's forest sector.

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Williamson, T.B.; Campagna, M.A.; Ogden, A.E. 2012. Adapting sustainable forest management to climate change: a framework for assessing vulnerability and mainstreaming adaptation into decision making. Can. Counc. For. Minist., Ottawa, ON.

APPENDIX 1. INTERVIEW QUESTIONS FOR CASE STUDY LEADERS

1. Enabling Factors

What precipitated the project /study, i.e. the why or motivation for action?

Who initiated the study? Was it science-driven, policy-driven, practice-driven, etc.?

Who was at the table during the start? Were any 'groups' (scientists, foresters, government reps, community members, etc.) added or lost during the process?

Recognizing there are many approaches to adaptation, why was the vulnerability assessment (VA) approach chosen? If VA was not used, why did you choose another approach?

Were outcomes and goals of the assessment clearly defined at the outset of the study?

Expert knowledge versus tacit and practical knowledge: does your study incorporate both, one more than the other, etc. If so, are there strengths or weaknesses you have found in using one over the other in a climate change vulnerability assessment?

2. Results of Assessments and Lessons Learned

Were the goals met and were outcomes achieved? If not, why not; what were the barriers?

Were there any adaptation options identified?

What would you say are the 2 or 3 most significant successes of your case study thus far?

Has anything unexpected developed from the assessment?

Looking back on what you've done to date and thinking about providing advice to others, what might be 2 or 3 things you would do differently next time around?

Has the learning been taken beyond the original activity or group?

In looking back on the assessment, how important do you now think climate change impacts and adaptation are in relation to other issues facing the forest sector?

3. Incorporation Into Planning, Practices and Management, and Moving Forward

What, if any, specific adaptation options were incorporated into forest management planning or practices?

If assessment has led to changes, are the changes or adaptation options being monitored for efficacy or the need for adjustments?

If assessment has not yet led to changes, what are the 2 or 3 most significant challenges that need to be overcome to make this happen?

Do you think existing systems for acquiring and assessing information regarding climate and climate change in forest management are adequate, and if not how would you change them?

What changes in your local policy or regulatory environment would encourage the development and implementation of adaptation measures?

Photo: Tim Williamson

APPENDIX 2.
CASE STUDY FACT SHEETS

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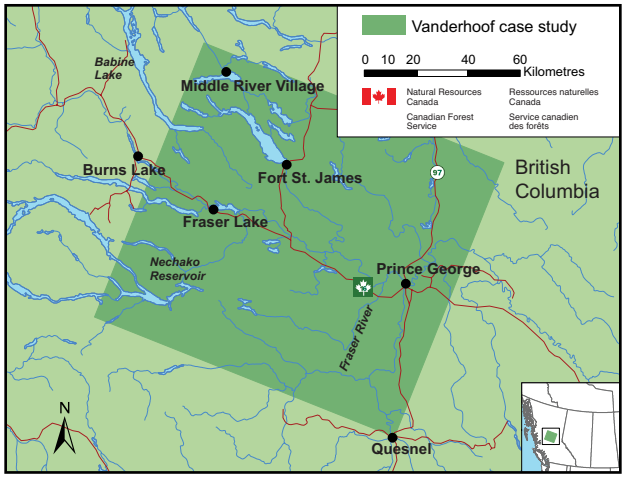
Lake Simcoe Watershed Vulnerability Assessment and Adaptation Planning 32

Le Bourdon Model Forest project 34

Vulnerability Assessment of Three Forest Ecosystem Management Projects in Quebec (Quebec RAC Projects) 35

Vanderhoof Community Vulnerability Assessment

1) Location Map



Vanderhoof case study area (source: Williamson, T.B.; Price. D.T.; Beverly, J.L.; Bothwell, P.M.; Frenkel, B.; Park, J.; Patriquin, M.N. 2008. Assessing potential biophysical and socioeconomic impacts of climate change on forest-based communities: a methodological case study. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB. Inf. Rep. NOR-X-415E).

2) Case Study Leader

Tim Williamson
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Canadian Forest Service, Natural Resources Canada
Email: Tim.Williamson@NRCan-RNCan.gc.ca

3) Partners and Stakeholder Groups

- Len Fox, Mayor, District of Vanderhoof
- Brian Frenkel, Councillor, District of Vanderhoof
- General Manager, McGregor Model Forest

4) Objectives of the Case Study

- To develop and apply an integrated assessment approach at the community level.
- To study the impacts of climate change, such as changes in population dynamics of the mountain pine beetle, on the Vanderhoof community.
- For more information on this study, see Williamson, T.B.; Price, D.T.; Beverly. J.L.; Bothwell, P.M.; Frenkel, B.; Park, J.; Patriquin, M.N. 2008. Assessing potential biophysical and socioeconomic impacts of climate change on forest-based communities: a methodological case study. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB. Inf. Rep. NOR-X-415E.

5) Results

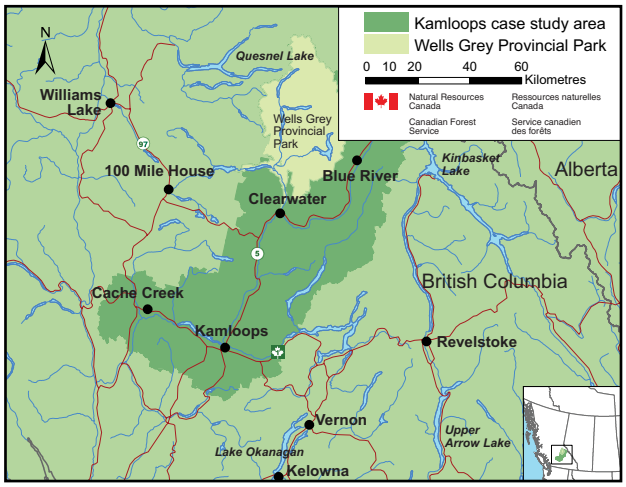
- District of Vanderhoof has developed a vulnerability baseline.
- Municipal administrators in the district now understand climate change and vulnerability.
- Various organizations within the District of Vanderhoof now consider climate change and vulnerability as important issues.

6) Lessons Learned

- The success of the Vanderhoof Community Vulnerability Assessment stemmed from three main factors:
  - Engagement of the community, specifically by capturing local knowledge and observations, establishing the community's trust, and demonstrating commitment to the community.
  - Presence of strong local champions, such as Mayor Fox and Councillor Frenkel, who provided linkage to the District of Vanderhoof's Council.
  - Presence of other "connectors," people who understand both the technical aspects of climate change and the community's needs and can act as a "bridge" to other community members, serving as communicators and educators.
- For future projects of this nature, it will be important to do a better job of putting things into lay terms for decision makers by
  - providing summaries of key findings and implications for the community in plain language;
  - not including modeling details and technical reports in materials supplied to community members; and
  - not using modeling jargon.

Kamloops Future Forest Strategy, Phase II (K2)

1) Location Map



Kamloops Future Forest Strategy, Phase II (K2) study area. TSA = Timber Supply Area (source: k2kamloopstsa.com/kamloops-tsa/). The study area boundary data were obtained from the Province of British Columbia under the Open Government License for Government of BC Information v.BC1.0.

2) Case Study Leader

Harry Nelson
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University of British Columbia (UBC)
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Web site: www.k2kamloopstsa.com

3) Partners and Stakeholder Groups

- Work was conducted by the K2 Research Team:
  - several forestry consultants
  - UBC researchers
- Collaborators:
  - local district and regional staff from BC Ministry of Forests, Lands and Natural Resource Operations
  - BC Ministry of Environment
  - local First Nations
  - local forest licensees
- Champion: District of Clearwater

4) Objectives of the Case Study (adapted from http://k2kamloopstsa.com/k2-introduction/)

- To use stand- and landscape-level models that directly incorporate changes in climatic conditions and effects of management actions to simulate outcomes under different climate change scenarios.
- To use outcomes of the models under different climate change scenarios to test assumptions and explore potential management actions.
- For further detail, see "Climate change adaptation, facilitating action on the ground" (Branchlines [UBC Faculty of Forestry newsletter] 21(2):12–13, Fall 2010 [http://web.forestry.ubc.ca/Portals/0/docs/Branchlines_Sept2010.pdf]).

5) Results

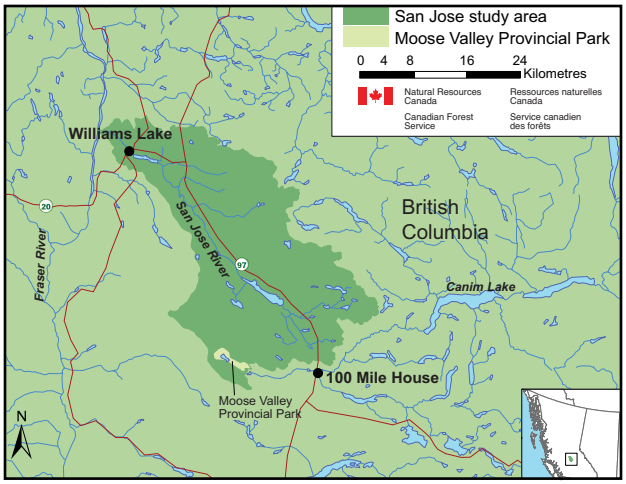
- The project highlighted the need to recognize the following factors and principles:
  - that it is important to consider moisture stress, rather than focusing exclusively on tree mortality;
  - that multiple models and modeling approaches are required for complex problems;
  - that stand-level models should incorporate climate sensitivity;
  - that many questions at the landscape level require answers generated by multiple models; and
  - that certain events (e.g., insect epidemics) cannot be anticipated.

6) Lessons Learned

- The best that can be done is to strive to keep options open over time.
- Climate change provides an opportunity to improve the practice of sustainable forest management, as it exposes difficulties in management frameworks.
- Administrative, policy, and legislative challenges may be more intimidating than the technical challenges.
- It is critical to keep collaborators continuously engaged and to maintain ongoing communication with people both within and outside the project.

San Jose Watershed Regional Adaptation Collaborative (BC RAC)

1) Location Map



Location of the San Jose Watershed Regional Adaptation Collaborative project (source: Nelson, H.; Day, K.; Cohen, S.; Moore, D.; Hotte, N. 2012. Adapting to Climate Change in the San Jose Watershed. Department of Forest Resources Management, University of British Columbia. http://racwilliamslake.files.wordpress.com/2012/11/san-jose-watershed-report-final.pdf). The study area boundary data were obtained from the Province of British Columbia under the Open Government License for Government of BC Information v.BC1.0

2) Case Study Leader

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3) Partners and Stakeholder Groups

- Project was conducted under the Regional Adaptation Collaborative program of Natural Resources Canada.
- Local champion: Ken Day, Manager, Alex Fraser Research Forest, UBC
- Researchers in UBC Faculty of Forestry
- Local decision makers:
  - Staff from the city of Williams Lake
  - Staff from Cariboo Regional District
  - local First Nations
  - regional staff from BC Ministry of Forests, Lands and Natural Resource Operations and BC Ministry of Environment
  - forest licensees

4) Objectives of the Case Study (adapted from http://racwilliamslake.wordpress.com/about/)

- To explore how climate change could affect local forest resources and to define the resulting impacts on the flow of services and values from those forests, e.g., timber supply and water quality and quantity.
- To work with local decision makers and practitioners to better understand the types of outcomes that might be expected with different climate change scenarios under existing and alternative management strategies.
- To use the understanding gained to help inform planning processes and to identify management options that will contribute to the sustainability of local forest resources in the long run.
- For more detail about the objectives of this case study, see "San Jose Watershed Regional Adaptation Collaborative: About" (http://racwilliamslake.wordpress.com/about/).

5) Results

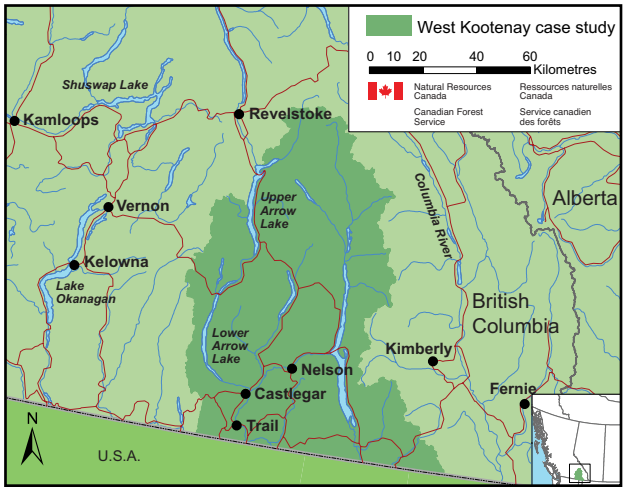
- Stakeholders appeared to have a high level of interest and have formed an ad hoc advisory committee to advise the modellers and provide feedback on their work.
- Project has linked modellers with local stakeholders.
- Project may result in further watershed planning led by local communities.

6) Lessons Learned

- The presence of a champion who can link scientists and local stakeholders is critical.
- Developing strong networks and working relationships among stakeholders that will continue after the project is complete is important.

West Kootenay Climate Vulnerability and Resilience Project

1) Location Map



West Kootenay case study area (source: Holt, R.F.; Utzig, G.; Pinnell, H.; Pearce, C. 2012. Vulnerability, resilience and climate change: adaptation potential for ecosystems and their management in the West Kootenay — summary report. Report #1 for the West Kootenay Climate Vulnerability and Resilience Project [www.westkootenayresilience.org/Report1_Summary_Final.pdf]). The study area boundary data were obtained from the Province of British Columbia under the Open Government License for Government of BC Information v.BC1.0.

2) Case Study Leader

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Web site: www.westkootenayresilience.org/index.html

3) Partners and Stakeholder Groups

- Work was conducted by forest ecology research consultants.
- Results of the work were communicated through a series of workshops presented to local stakeholders:
  - forest practitioners
  - community representatives
  - provincial fish and wildlife managers

4) Objectives of the Case Study

(adapted from Holt, R.; Utzig, G.; Pinnel, H.; Stolte, M. 2010. Resilience and climate change: adaptation potential for ecological systems and forest management in the West Kootenays. Online [www.west kootenay resilience.org/cc-wk-summary_Sept 2010.pdf])

- To increase knowledge about climate change and ecological resilience.
- To work with forest managers, practitioners, stakeholders, scientists, and technical experts to learn about the potential effects of climate change in the region.
- To identify potential impacts of climate change that the region may face.
- To determine which ecosystems may be vulnerable to loss of resilience.
- To identify potential management actions to enhance ecological and forest management resilience.
- To enhance the capacity of forest managers to adapt to the challenges of climate change.
- To advance the practice and science of applying concepts of resilience and integrated vulnerability assessment.

5) Results

- Stakeholder workshops were useful in communicating climate science and potential impacts of climate change to local forest practitioners.
- Stakeholder workshops also provided a venue for starting a dialogue about adaptation.

6) Lessons Learned

- Local forest practitioners are interested in the topic of climate change impacts, but it takes time to build a common understanding of the issues.
- Adequate funding is critical to initiate and complete a vulnerability assessment for a forest ecosystem.
- Various tools and approaches (e.g., resilience concepts, vulnerability assessment, risk assessment) are useful in dealing with the complex issues of climate change impacts and adaptation.
- Additional lessons learned are presented in the final project reports (www.kootenayresilience.org/page04.html). These final reports reflect significant additional progress made between date of interview (November 2011) and publication of this summary.

Alberta Environment and Sustainable Resource Development Climate Change Adaptation Framework

1) Location

Edmonton, AB (through Alberta Environment and Sustainable Resource Development [ESRD])

2) Case Study Leader

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3) Partners and Stakeholder Groups

- Team Taking Action on Climate Change, a cross-ministry group specializing in fish and wildlife, forestry, rangelands, and corporate business support

4) Objectives of the Case Study

- To increase the understanding of how climate change will affect Alberta ESRD's core business areas.
- To build a foundation for developing Alberta ESRD's adaptation strategies.

5) Results

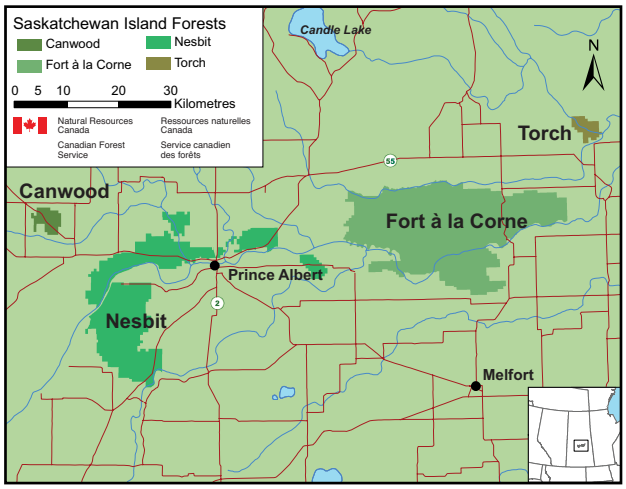
- Alberta ESRD developed the Climate Change Adaptation Framework to provide guidance to ministry staff in assessing vulnerability and planning adaptations.
- Alberta ESRD used the framework and the associated manual to assess and identify vulnerabilities, risks, and adaptation options for key ecosystem services managed by the department and incorporated the risks identified into its business plan.
- The department's capacity and preparedness to deal with potential risks associated with climate change have increased, along with awareness, knowledge, and discussions of these potential risks on the part of departmental staff members.

6) Lessons Learned

- The Climate Change Adaptation Framework has yielded the following benefits:
  - enabled policy makers and scientists to start talking in the same language (i.e., using a common vocabulary for concepts of interest).
  - raised awareness within Alberta ESRD about potential impacts of climate change.
  - encouraged people to think about and discuss climate change issues.
  - identified specific evidence-based adaptation options.
  - built internal capacity, which allows continued development of a climate change adaptation strategy.
  - presented projects and initiatives as work that is widely applicable (i.e., not related solely to climate change), which allowed garnering of support from the executive level of the department.

Island Forests Vulnerability Assessment (Prairies RAC)

1) Location Map



Location of the Island Forests in central Saskatchewan (source: Qualtiere, E. 2012. Climate change impacts and adaptations for the Island Forests of Saskatchewan. Saskatchewan Research Council, Saskatoon, SK. SRC Publ. No. 12855-3C12).

2) Case Study Leader

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3) Partners and Stakeholder Groups

- Project was conducted under the Regional Adaptation Collaborative program of Natural Resources Canada.
- Participants:
  - Alberta Environment and Sustainable Resource Development
  - University of Alberta
  - Saskatchewan Ministry of Environment
  - Manitoba Conservation and Water Stewardship
  - scientists from SRC and the governments of Alberta, Saskatchewan, and Manitoba
  - forest managers from the governments of Alberta, Saskatchewan, and Manitoba
  - Prince Albert Model Forest

4) Objective of the Case Study

- To conduct a forest ecosystem vulnerability assessment in support of adaptive approaches to management in the Island Forests region of Saskatchewan.

5) Results

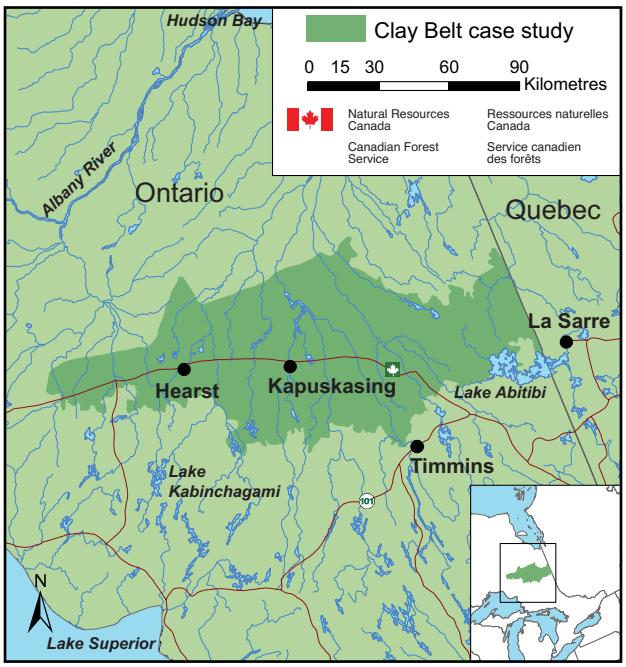
- Identified where and how ecosystems in the Island Forests are vulnerable to climate change.
- Worked with stakeholders and partners by presenting vulnerability findings and identifying potential adaptation options.
- Developed and tested climate change tools and techniques that are available for translation and application to other areas in the future.
- Raised awareness of the value of an adaptive approach to management and vulnerability assessment within and outside Saskatchewan Ministry of Environment.

6) Lessons Learned

- Engage stakeholders and partners early and often to secure their confidence in the process and to enhance their understanding of the objectives and the process.
- Focus strongly on building partnerships.
- Identify team members' knowledge of and experience with vulnerability assessment. Work more directly with those who are new to vulnerability assessment.
- Before directly engaging researchers to conduct a new analysis, do a preliminary scan of existing science to see if it can be used, re-examined, and/or built upon.
- Take the time to thoroughly consider and identify the most appropriate spatial and temporal scales for the assessment.
- Ensure that model results are treated as estimates with high uncertainty.
- Gather baseline data to help understand current vulnerabilities.

Clay Belt Vulnerability Assessment (Ontario Ministry of Natural Resources)

1) Location Map



Location of the Clay Belt ecodistrict 3E-1 in Ontario (source: Climate change vulnerability assessment and adaptation options for Ontario's Clay Belt – a case study. Ont. Minist. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Rep. CCRR-24).

2) Case Study Leader

Paul Gray, Senior Advisor, Climate Control and Natural Heritage, Applied Research and Development Branch
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Web site: http://www.mnr.gov.on.ca/en/Business/ClimateChange/2ColumnSubPage/STDPROD_090188.html#Climate Change Vulnerability Assessment and Adaptation Options for the Northeast Clay Belt

3) Partners and Stakeholder Groups

- Project was designed by MNR and Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR).
- Participants:
  - MNR
  - OCCIAR
  - communities
  - industry
  - scientists
  - forestry practitioners
  - public
  - other organizations, stakeholders, and professionals

4) Objective of the Case Study

- To conduct an ecosystem vulnerability assessment in support of adaptive approaches to management, as part of a response to the strategic actions in "Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011–2014" (http://www.ene.gov.on.ca/environment/en/resources/STDPROD_081665.html)

5) Results

- Identified where and how ecosystems in the Clay Belt are vulnerable to climate change.
- Worked with stakeholders and partners by presenting vulnerability findings, conducting a risk assessment, and identifying potential adaptation options.
- Developed and tested climate change tools and techniques that are available for translation and application to other areas in the future.
- Raised awareness of the value of an adaptive approach to management and vulnerability assessment within and outside the ministry.

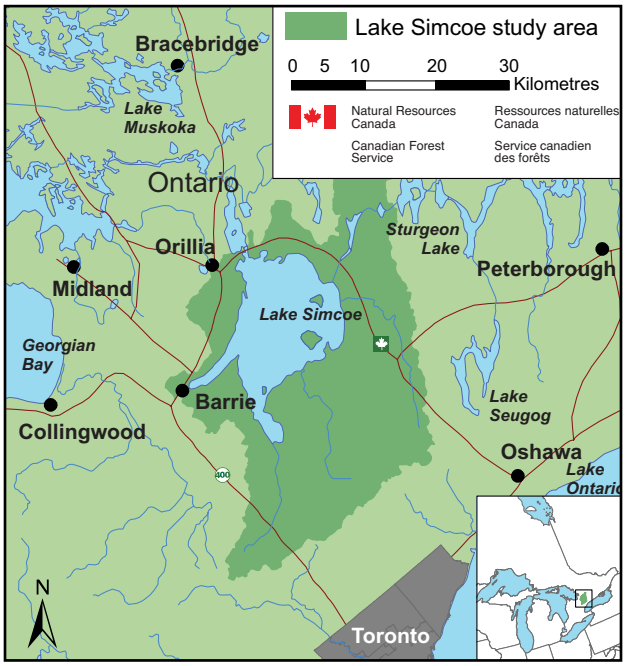
6) Lessons Learned

- Engage stakeholders and partners early and often to secure their confidence in the process and to enhance their understanding of the objectives and the process.
- Use idea-generating tools that require assistance from project stakeholders and partners to take into account scope of the project, target audience, financial constraints, travel restrictions, and other logistical issues.
- Focus strongly on building partnerships.

- Identify team members' knowledge of and experience with vulnerability assessment. Work more directly with those who are new to vulnerability assessment.
- Before directly engaging researchers to conduct a new analysis, do a preliminary scan of existing science to see if it can be used, re-examined, and/or built upon.
- Take the time to thoroughly consider and identify the most appropriate spatial and temporal scales for assessment.
- Bear in mind that even though a particular theme may appear to be a logical choice for assessment, appropriate knowledge and expertise may be unavailable and pursuing the assessment may require special support.
- Compare and discuss climate model results to minimize redundancy and overlap and to determine which models are most appropriate for the project.
- Ensure that model results are treated as estimates with high uncertainty.
- Gather baseline data to help understand current vulnerabilities.
- Design a structured approach to sequencing and completion of studies.
- Bear in mind that co-leadership is better than individual leadership for complex vulnerability assessment projects.

Lake Simcoe Watershed Vulnerability Assessment and Adaptation Planning

1) Location Map



Location of the Lake Simcoe watershed in Ontario (source: Potential effects of climate change and adaptive strategies for Lake Simcoe and the wetlands and streams within the watershed. Ont. Minist. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. Rep. CCRR-21).

2) Case Study Leader

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3) Partners and Stakeholder Groups

- Project was initiated by Ontario Ministry of the Environment (MOE).
- Stakeholders:
  - various Ontario government ministries (specifically, MOE; MNR; Ministry of Agriculture, Food and Rural Affairs; Ministry of Transportation; Ministry of Municipal Affairs and Housing)
  - scientists from various governmental and academic institutions (specifically, MOE, MNR, Trent University, University of Waterloo)
  - various organizations (Lake Simcoe Science Committee, Lake Simcoe Region Conservation Authority, Ontario Centre for Climate Impacts and Adaptation Resources)

4) Objective of the Case Study

- To conduct an open-ended analysis to inform the development of a climate change adaptation strategy for the Lake Simcoe watershed.

5) Results

- Development of a strategic planning process, which generated a suite of strategic options and associated actions for consideration.
- Development of a learning tool to inform other strategic planning processes for climate change adaptation.
- Experience and knowledge, which served as important sources of information for development of a practitioner's guide.
- Establishment and testing of the vulnerability assessment approach as a viable management tool.
- Creation of a number of products:
  - "A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems" (publication at www.mnr.gov.on.ca/en/Business/ClimateChange/2ColumnSubPage/STDPROD_091863.html)
  - "Cool Tools for a Hot Climate" (web-based toolbox at www.mnr.gov.on.ca/en/Business/ClimateChange/2ColumnSubPage/STDPROD_092481.html)
  - "Wildlife Vulnerability to Climate Change: An Assessment for the Lake Simcoe Watershed" (publication at www.mnr.gov.on.ca/en/Business/ClimateChange/Publication/STDPROD_093356.html)

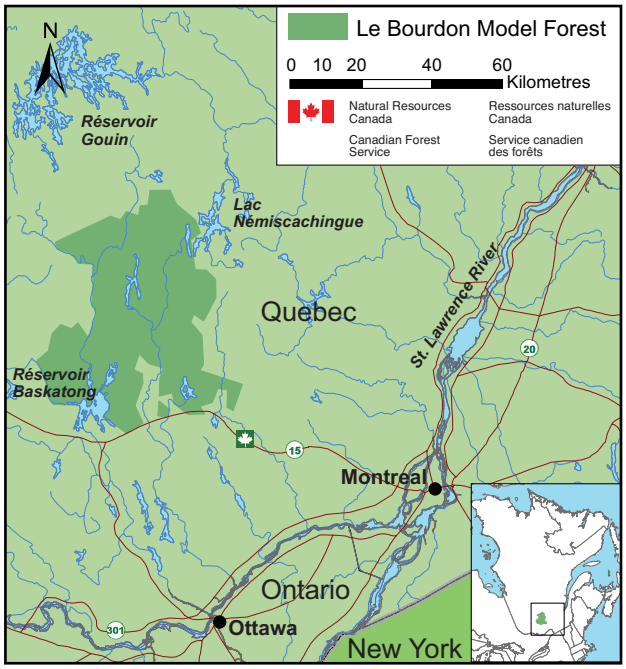
- "Potential Effects of Climate Change and Adaptive Strategies for Lake Simcoe and the Wetlands and Streams within the Watershed" (publication at http://www.mnr.gov.on.ca/en/Business/ClimateChange/Publication/STDPROD_093346.html)

6) Lessons Learned

- If possible, use an ensemble of climate models and scenarios.
- Engage stakeholders and experts early and substantively.
- Remember the importance of completing vulnerability assessments for a comprehensive suite of forces and factors that shape the ecosystem and affect human health and well-being.
- Ensure that the appropriate expertise is in place.
- Allow adequate time for adaptation planning in response to climate change.
- Provide incentives to participants.
- Improve the capacity of the online survey engine used to identify adaptation options.
- Engage communities.
- Remember that a robust approach to assessment of risks requires an estimate of the probability that an area will be affected and a list of the associated consequences.

Le Bourdon Model Forest Project

1) Location Map



Le Bourdon Model Forest case study location (indicated in green) (source: adapted from http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/32647.pdf).

2) Case Study Leader

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Web site: www.notreforet.ca

3) Partners and Stakeholder Groups

- Initiators:
  - Frédérik Doyon, Assistant Professor, Université du Québec en Outaouais
  - Raymond Barrette, General Manager, Le Bourdon Model Forest
- Participants:
  - scientists
  - practitioners
  - government representatives
  - community members
  - municipal representatives
  - forest user groups (e.g., snowmobile association, trappers' association)
  - Bergslagen Model Forest

4) Objectives of the Case Study

- To develop awareness of vulnerability issues related to climate change that have relevance for the values at risk of the model forest partners (Le Bourdon Model Forest, Canada, and Bergslagen Model Forest, Sweden).
- To develop a collaborative framework for climate change adaptation and to help in building the adaptive capacity of forest-dependent communities.
- To develop tools for exploring possible future outcomes under climate change and to test the robustness of adaptation strategies.

5) Results

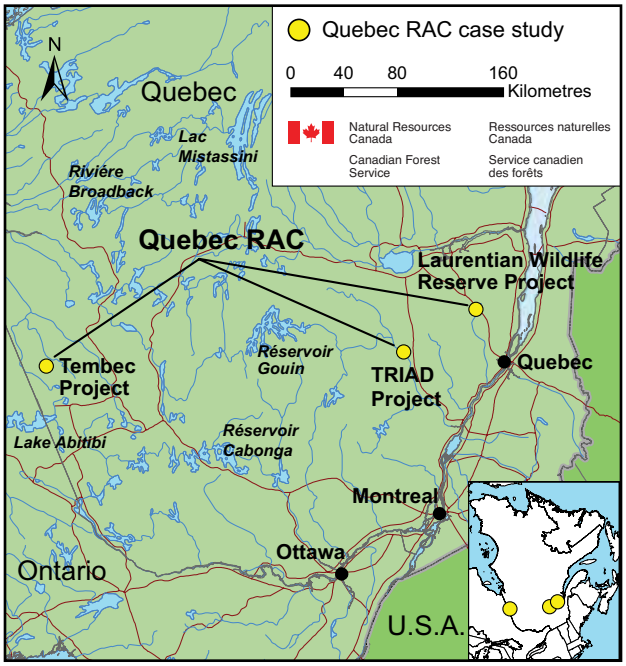
- Creation of new working concept of vulnerability among the stakeholders.
- Regional influence on issues related to biodiversity and climate change, among other topics.
- Identification of priorities by stakeholders.

6) Lessons Learned

- Conducting a vulnerability or impact assessment is a complex task that requires maintenance of mutual respect among stakeholders.
- Keeping stakeholders interested and involved can be challenging.
- Surveying community members can be useful in determining the community's adaptive capacity.
- Conducting a successful vulnerability or impact assessment requires a neutral "champion" with the following characteristics:
  - possesses many competencies (including group management)
  - can connect people who have scientific expertise to local residents
  - has appropriate financial support
- Translating climate model variables into relevant impacts takes a lot of work.

Vulnerability Assessment of Three Forest Ecosystem Management Projects in Quebec (Quebec RAC Projects)

1) Location Map



Map showing three study areas considered in the Quebec Regional Adaptation Collaborative case study: Tembec Ecosystem-Based Forest Management project (Abitibi), TRIAD Project (Mauricie), and Laurentian Wildlife Reserve project (Laurentide region).

2) Case Study Leader

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3) Partners and Stakeholder Groups

- Project was conducted under the Regional Adaptation Collaborative program of Natural Resources Canada.
- Key players:
  - Ministère des Ressources naturelles du Québec
  - Ouranos Consortium on Regional Climatology and Adaptation to Climate Change
  - Canadian Council of Forest Ministers, Climate Change Task Force
  - Yves Bergeron, Université du Québec en Abitibi-Témiscamingue
- Stakeholders:
  - scientists
  - practitioners
  - government representatives
  - community members
  - municipal representatives
  - First Nations
  - forest user groups (e.g., snowmobile association, trappers' association)

4) Objective of the Case Study

- To convey climate change science to forest managers so they can use it to improve their management decisions.

5) Results

- Better knowledge and awareness on the part of stakeholders.
- Awareness that certain forest management practices already in use facilitate adaptation.
- Awareness that adaptation may facilitate achievement of current forest management goals.
- Awareness among stakeholders of the resources available to address climate change issues.

6) Lessons Learned

- Evaluate stakeholders' sensitivity, awareness, and interest in the vulnerability assessment.
- Demonstrate to stakeholders that integrating adaptation now will facilitate the achievement of forest management goals.
- Demonstrate that adaptation as a concept and approach is here to stay; it is not just a passing fad.

For other CCFM Climate Change Task Force reports contact:

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