2013 ADAPTool Application

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Adaptive Policy Analysis of Forestry and Wetlands Policies in Manitoba

Prepared by:
International Institute for Sustainable Development

Prepared for:
Province of Manitoba

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With support from Natural Resources Canada through the Adaptation Platform

Natural Resources Canada / Ressources naturelles Canada
Canada

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1.0 Introduction

Public policy operates in a dynamic and complex environment. As conditions change, policies and programs may become less effective, or even counterproductive. Adaptive policies and programs help avoid these kinds of failures. While policies aim to achieve certain objectives—for example, improve water quality or regulate forest harvesting—they also should avoid failures and unintended consequences as conditions change (Walker et al., 2002). Swanson & Bhadwal (2009) describe such policies as designed to function more effectively in complex, dynamic and uncertain conditions. They describe seven key guidelines for adaptive policies, based on observations of policies that perform well in the face of change, and on insights from the recent policy literature dealing with complex systems. These guidelines are summarized below.

Policy-makers and the public are increasingly aware of the potential impacts of climate change, vulnerability to climate change and adaptation needs. Adaptation in this context is defined as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, in order to reduce harm or take advantage of opportunities (Intergovernmental Panel on Climate Change, 2007). There is also a growing body of literature on the role of policies and strategies in adapting to climate change, including assessing the ability of current policies to address adaptation.

The Adaptive Design and Assessment Policy Tool (ADAPTool) was developed by the International Institute for Sustainable Development (IISD) with support from Adaptive Resource Management Ltd, Novel Futures Corporation and The Energy and Resources Institute (TERI) and with financial and in-kind support from the International Development Research Centre (IDRC), Natural Resources Canada's (NRCan) Prairie Regional Adaptation Collaborative, Manitoba Conservation and Water Stewardship, Manitoba Agriculture, Food and Rural Initiatives and the Saskatchewan Water Security Agency. The ADAPTool is based on the 2009 book *Creating Adaptive Policies: A Guide for Policy-Making in an Uncertain World* (Swanson & Bhadwal, 2009).

In 2013, Water Security Agency (WSA), Saskatchewan led a collaborative project with IISD and three other provinces with support from NRCan to analyze diverse sectorial policies using the ADAPTool. This analysis aimed to assess the ability of these policies to contribute to both anticipated and unanticipated uncertainties, contributing to their planned and autonomous adaptability. This report provides insights on the use of the ADAPTool to analyze a number of Manitoba policies. The analysis was performed by analysts from IISD and the Province of Manitoba. The objective of the analysis was to provide the government with a systematic assessment and understanding of the potential for its policies and programs to support climate change adaptation, to raise awareness and "mainstream" consideration of adaptation, as well as assess the policies themselves against elements of adaptive policy-making identified by IISD's prior research and application of the ADAPTool.

This iteration of the ADAPTool analysis had two main goals: (1) to evaluate a suite of policies from the forestry sector using the ADAPTool for existing policies and (2) to pilot a version of the ADAPTool for new policies to inform the design and details of a Manitoba wetlands policy still in development. This report provides details on the process and results for the use of the two versions of ADAPTool for existing suite of policies and the design of a new policy.

2.0 What Is Adaptive Policy[1]/Programming?

Over the past several decades, there has been recognition that public policies and programs intended to achieve stated objectives can, even if well-designed, lead to unintended consequences as conditions change. Public policy operates in a dynamic and complex environment—actors in the policy domain interact with new external factors, changing economic and market conditions, new information, changing technology, and evolving networks of exchange. With increased global interconnection, dynamic economic conditions, shifting climate and rapid changes in technologies, the resulting complexity and pace of change make outcomes difficult to predict. As conditions change, policies and programs may become less effective, or even counterproductive. The idea of adaptive policies is to design policies and programs to increase their adaptability and help avoid these kinds of failures.

IISD collaborated with TERI in India over a four-year research project to explore case studies of policies in the agriculture and natural resource management sectors in both countries and identify characteristics of adaptive policies based on evidence of their actual performance. The results are described Swanson and Bhadwal (2009).

This research identified seven characteristics of policies that were adaptable to changing conditions. Some of these characteristics were designed to build-in adaptability to anticipated change and projected future conditions, while others are useful in helping policies adapt to unanticipated conditions. The ADAPTool version used in this project is structured around these seven characteristics. Different questions in the tool are used to assess and score policies in relation to these factors.

The characteristics of adaptive policies/programs are: 1) integrated and forward-looking analysis, 2) multistakeholder deliberation, 3) automatic policy adjustment, 4) self-organization and social networking, 5) decentralization of decision making 6) promoting variation and 7) formal policy review and continuous learning.

These characteristics of adaptive policies/programs are summarized below, and described in more detail, with case studies, in Swanson and Bhadwal (2009).

2.1 Integrated and Forward-Looking Analysis

Integrated and forward-looking analysis can identify key factors that affect policy/program performance and scenarios for how these factors might evolve in the future, so that policies and programs can be made robust to a range of anticipated conditions. These tools can also be used to develop indicators that will trigger adjustments when needed. Modelling tools of varying sophistication can be used to support this kind of analysis, which is often integrated through scenario planning.

2.2 Multistakeholder Deliberation

Multistakeholder deliberation is a collective and collaborative public effort to examine an issue from different points of view as part of a decision-making process. Deliberative processes strengthen policy and program design by building recognition of common values, shared commitment and emerging issues, and by providing a comprehensive understanding of causal relationships. The key aspects of this process are that it involves participants in sharing multiple perspectives in an attempt to reach consensus on a relevant decision. This approach goes beyond stakeholder consultation.

[1] Note: In this context, the term "policies" may refer also to programs, legislation and other policy instruments.

2.3 Automatic Policy Adjustment

Automatic adjustment mechanisms can speed up the process of response to conditions that are more or less anticipated. They can be used in complicated policy/programmatic environments by separating the various issues into units in which the understanding of the system is high, allowing for fine-tuning of the system and making adjustments that help reduce risks and maintain performance. Automatic adjustment can be both fully and semi-automatic.

2.4 Enabling Self-Organization and Social Networking

The intent of this characteristic is to ensure that policies do not undermine existing social capital, but instead create forums that enable social networking, facilitate the sharing of good practices and remove barriers to local self-organization. Local responses, self-organization and shared learning all strengthen the ability of stakeholders to respond to unanticipated events through innovation.

These practices take advantage of the capacity of complex adaptive systems to generate solutions without external input or formally organized interventions. The ability of individuals and groups to self-organize in response to stresses, crises or unexpected problems is well documented in social and ecological literature, and a key aspect of healthy adaptation. For policy-makers and program managers, the idea is to foster self-organized responses to unexpected conditions by enabling and supporting interaction, learning and networking, without trying to control or dictate outcomes. This includes facilitating sharing and copying of best practices, providing resources to reduce barriers to self-organization and creating spaces for adaptive collaboration.

2.5 Decentralization of Decision Making

In governance terms, the principle of "subsidiarity" means decentralizing decision making to the lowest effective and accountable unit of governance. This has adaptive advantages because there are better opportunities for feedback and information sharing to ensure that decision-makers are aware of unexpected problems and effects of proposed interventions, as well as the nature of different interests. For policies/programs directly concerning natural resources and ecosystems, field staff typically notice significant change earlier, and can mobilize affected local interests to address these changes more simply. Because local conditions vary widely, decentralization provides a way to implement policies and programs more flexibly, to ensure effectiveness and adaptation to change. The potential for decentralization in any particular policy or program area will depend on the scale of intervention needed, the extent of local knowledge and capacity, and the structure of governance mechanisms for accountability and coordination.

2.6 Promoting Variation

Given the complexity of most policy settings, implementing a variety of policies to address the same issue increases the likelihood of achieving desired outcomes. Diversity of responses also forms a common risk-management approach, facilitating the ability to perform efficiently in the face of unanticipated conditions. Variation may be actively designed, as when a range of alternative options is provided to meet the diverse needs of different stakeholders. This can be facilitated by:

- Using a mix of policy instruments
- Exploring synergies with other policies
- Providing opportunities for risk-spreading.

Another approach is to use policy tools to facilitate variation by removing barriers to alternative solutions and providing information to support exploration of options.

2.7 Formal Policy Review and Continuous Learning

Regular review, even when the policy or program is performing well, and the use of well-designed pilots throughout the life of the policy/program to test assumptions related to performance can help address emerging issues and trigger value-added policy adjustments. Formal review is different than automatic adjustment, where triggers and responses may be determined in advance. Formal review is a mechanism for identifying and responding to unanticipated circumstances and emerging issues. This assessment process can be very useful in detecting emerging issues that can affect the policy's performance. A formal review mechanism includes triggers for the review, definition of the nature of the review, and a learning process—that is to say, who needs to be involved in the review, who will take action on the results and what kinds of action are to be considered.

Together, these seven characteristics of adaptive policies are relevant in the planning and design of policies and programs, as well as in their implementation and evaluation. The ADAPTool is intended to encourage assessment and discussion of these characteristics in various phases of the policy cycle.

3.0 The ADAPTool

The ADAPTool is an Excel-based spreadsheet designed to evaluate a suite of public policies and/or programs for their ability to contribute to the capacity of key economic sectors (e.g. mining, agriculture, forestry) to adapt to a specific socioeconomic or ecologic stress, such as climate change or market price volatility. A policy's ability to help stakeholders adapt to the stress and the policy's ability to adapt itself to the stress is assessed by answering fifteen questions across three worksheets, with a fourth worksheet aggregating results. The ADAPTool is based on the 2009 book *Creating Adaptive Policies: A Guide for Policy-Making in an Uncertain World* (Swanson & Bhadwal, 2009).

Based on the adaptive policy theory, the work in Manitoba used two different versions of the tool: (1) ADAPTool for existing policies to analyze a suite of existing forestry sector policies (Timber Quota Allocation Policy, Forest Renewal Program and Wood supply Process) and (2) ADAPTool for new policies design of a policy (Wetlands Policy).

In the ADAPTool for existing policies, the spreadsheet workbook serves as the basis for scoring each of the programs in response to the assessment questions identified below in Box 1. The questions cover both planned adaptability (i.e. how well the policy or program anticipates the likely impacts of the stressor) and autonomous adaptability (or adaptability to unanticipated impacts of the stressor).

BOX 1: ADAPTOOL QUESTIONS AND WORKSHEET STRUCTURE

I. Scope of Evaluation Worksheet:

1) What is the geographic scope of the analysis (e.g., watershed, conservation district, municipality, region, province)?
2) What is the stressor of concern (i.e., climate change, market price instability)?
3) What are the policies/programs to be assessed?

II. Vulnerability & Adaptation Analysis Worksheet (for planned adaptability):

4) What are the main sectors active in the geographic area?
5) In what ways are the sectors vulnerable to the stressor?
6) What adaptation actions might be necessary if this stressor becomes more severe in the future?
7) Are the identified adaptation actions supported by the policies/programs?

III. Adaptive Capacity Analysis Worksheet (for both planned and autonomous adaptability):

8) Is the policy itself vulnerable to the stressor identified?
9) Does the policy enhance the capacity of actors within each sector to adapt (with respect to access to finances, technology, infrastructure, information and skills, institutions and networks, and equitable access) (Smit & Pilofosova, 2001)?
10) Were foresight methods and multistakeholder deliberation used in the scoping and design of the policy?
11) Are foresight methods and multistakeholder deliberation used in the implementation of the policy?
12) Does the policy enable self-organization and social networking among affected stakeholders? (Does the policy provide mechanisms for the sharing and copying of best practices and lessons learned?)
13) Is decision making for policy implementation adequately decentralized?
14) Is there adequate variety in the suite of policies and programs directed at the policy issue (e.g., economic, regulatory, expenditure, institutional policy instruments)?
15) Does the policy have a regular formal review process in place that can detect emerging issues?

IV. Synthesis Worksheet

An aggregate ranking of planned adaptability and autonomous adaptability is provided for the overall suite of policies, as well as for each individual policy.

For the version of ADAPTool for new policies, the ADAPTool questions have been adapted for use to think through a new policy design and development. As in the ADAPTool for existing policies, the Excel-based workbooks in ADAPTool for new policies go through questions to assess how the policy will support sector-specific adaptation needs to identified stressor or stressors. As well, the tool helps identify how the policy can include elements that will allow it to be adaptive in the face of anticipated and unanticipated uncertainty. Box 2 illustrates the guiding questions found in the ADAPTool for new policies.

BOX 2: ADAPTOOL FOR NEW POLICIES QUESTIONS AND WORKSHEET STRUCTURE

Policy Objective Worksheet:

1) What is the geographic scope of the analysis (e.g., watershed, conservation district, municipality, region, province)?
2) What are the policy objectives and specific purposes?
3) What sectors and stakeholders are meant to be impacted by and to benefit from this policy?
4) What policy instruments are envisioned (regulatory, expenditure, economic, institutional)?

Stressor Worksheet

5) What are the important stressors (i.e., climate change, market price instability)?
6) How might these stressors evolve in the years and decades ahead?

Vulnerability & Adaptation Analysis Worksheet (for planned adaptability):

7) What are the main sectors affected by this policy?
8) In what ways are the sectors vulnerable to the stressor?
9) What adaptation actions might be necessary if this stressor becomes more severe in the future?
10) Could the policy objective potentially support adaptation action?

Adaptive Capacity Analysis Worksheet (for both planned and autonomous adaptability):

11) How can the policy be designed to be resilient to the stressor?
12) How could the policy potentially enhance the capacity of relevant stakeholders to adapt to the selected stressors (Smit & Pilofosova, 2001)?
13) How could multistakeholder engagement be used in the scoping design and implementation of the policy?
14) How could the policy enable self-organization and social networking?
15) How could the policy be decentralized to ensure responsiveness to the adaptive needs of stakeholders?
16) What should be the mix of policy instruments directed at the policy objective and purpose?
17) What type of formal policy review process could be put in place to help ensure the long-term adaptability of the policy (including performance indicators and outcome frameworks)?

Synthesis Worksheet

A policy brief on planned adaptability and autonomous adaptability is provided for the design of the policy: including background information, synthesis of key adaptation actions and ways the policy can support adaptation, adaptive policy recommendations.

4.0 Policy Analysis

4.1 NRCan Project Process Overview

The province of Manitoba has been actively working on adaptation-related issues through its provincial processes and its involvement with the Prairies Regional Adaptation Collaborative (PRAC). Adaptation is being actively considered in sectors such as agriculture, forestry and water resources management where climate change impacts are expected to affect decision-making, management and planning. Manitoba used the ADAPTool in 2012 to analyze a suite of agriculture-related policies. The results of this analysis were published and are available in the report *Adaptive Policy Analysis of Drought and Excess Moisture Programmes in Manitoba: 2012 Pilot Application* (IISD Foresight Group, 2012).

Manitoba has a thriving forestry sector and has 26.3 million hectares of forests. The main types of forest in Manitoba include boreal forest, broadleaf/mixed wood forest and small broadleaf forest stands (Manitoba Forestry, n.d.). The Forestry Branch of Manitoba Conservation and Water Stewardship ensures sustainable resource management for present and future generations of Manitobans (Conservation and Water Stewardship, n.d.). **One part of the Manitoba analysis focused on three existing forestry related policies using the ADAPTool for existing policies.**

Manitoba has about 22 million hectares of wetlands and 17 per cent of Canada's wetlands (Manitoba Water Caucus, n.d.). Wetlands such as marshes, bogs, swamps, and fens are essential for a number of environmental services such as flood and drought protection, storing carbon to prevent global climate change, water purification and replacement of groundwater. Due to the importance of wetlands for the delivery of environmental, economic and social benefits, the Province of Manitoba is in the process of developing a provincial wetland policy to ensure the conservation and management of wetlands. **The second part of the Manitoba analysis focused on this unwritten policy using the ADAPTool for new policies.**

These two versions of the ADAPTool analysis involved several common steps, described in more detail in subsequent sections of this report:

- Initial project scoping (for the forestry analysis, this included the choice of policies to be analyzed)
- Staff training in the use of the ADAPTool
- Literature review on vulnerability assessment for the sectors
- Adaptation analysis
- Adaptive Policy analysis
- Reporting

IISD analysts met with representatives from forestry, water policy and climate change branches of Manitoba Conservation and Water Stewardship to formalize the scoping of the project, including area of focus, policy selection (forestry sector) and sector selection (new wetland policy).

Once the scoping process was complete, representatives from the relevant departments attended an ADAPTool a day-long training workshop held on April 16, 2013, for participants and interested individuals from across the Manitoba government. The workshop was attended by 15 people and offered a broad introduction to adaptive policies and programming. The second half of workshop was divided into two focus groups; forestry and water stewardship to discuss the two analyses in some detail.

Both focus groups worked on the vulnerability and adaptation worksheet for the relevant sectors. For the forestry analysis, this was based on a literature review. For the wetland analysis, an initial list of relevant sectors was identified and literature reviews and previous analyses were used to create an initial list of vulnerabilities and necessary adaptation actions. After an initial vetting at this workshop, the forestry branch representatives reviewed and provided input on the forestry analysis, while IISD analysts worked further on enhancing the wetland policy vulnerability/adaptation worksheet.

For the analysis of the individual workbooks, the suite of polices were assessed by the Forestry Department, headed by Paul Nikiema, their climate change specialist, while IISD worked with the Water Stewardship department on further vetting the wetlands vulnerability list as well as identifying a second stressor based on feedback, an economic stressor on land-use practices.

For both workbooks, the experts provided their review on the policies through face-to-face meetings, workshops and/or via email correspondence. For the forestry sector, IISD reviewed the analysis conducted by the Forestry Branch and together we finalized the program scoring and analysis. For the analysis using the ADAPTool for new policies for the wetland policy, IISD worked closely with Water Stewardship on each of the workbook sheets in a consultative process. The wetlands policy's synthesis was finalized by IISD experts, and initial findings were checked and summarized with project members and lead authors. These finding were presented at a half-day workshop held on October 18, 2013, with participating government officials from the Mines Branch and relevant branches of Conservation and Water Stewardship.

4.2 Policy Selection

The geographical scope for both sectors was Manitoba. For the forestry sector, the primary stressor of interest in this analysis is climate change. More specifically, increased drought, excessive moisture and increased temperatures are some of the most problematic impacts due to climate change, and may have significant implications for the sector. For the wetlands policy, in addition to the climate change stressor, a secondary stressor was identified: land-use competition and conversion. Ensuring that policies and programs are able to positively influence adaptive capacity is an important part of climate change adaptation as well as being able to adapt to economic stressors. Box 2 and Box 3 illustrate the stressors used for this analysis. Box 2 describes the climate stressor that was used for both the forestry and wetlands policies analyses, while Box 3 describes the economic stressor that was also used as a second stressor for the wetlands policy analysis.

TABLE 1. CLIMATE CHANGE STRESSOR

VARIABLE	PROJECTED CHANGE
Temperature Projections	
Annual mean temperature	Increase of +1° to +3°C by 2050
Warm season heat waves	Warmer and more frequent
Heat extremes	Warmer and more frequent
Frost-free season	Much longer
Mild winter thaws	Warmer and more frequent
Length of winter season	Much shorter
Winter freeze-thaw cycles	More frequent
Precipitation Projections	
Annual precipitation	Modest increase
Winter precipitation	Substantial increase
Summer precipitation	Lower
Droughts	More and longer
Intense rain events	More and more intense
Surface water amount	Less
Extreme Weather & Other Projections	
Lightning	More frequent
Spring flooding	More frequent
Local summer flooding	More frequent

Source: Blair (2012).

TABLE 1. CLIMATE CHANGE STRESSOR

LAND USE COMPETITION AND CONVERSION STRESSOR
Market forces that force producers to maximize land production
Land taxes that disincent wetlands
Market forces for inexpensive food and impact commodity prices
Mining and forestry pressure on boreal wetlands
Short-sighted thinking around competing land uses
Wetland draining for new developments and cottage development
Artificial control of water levels
Large scale forestry speeds up loss of small woodlots and associated wetlands
Demand for peat and peat mining
Wetland recreational activities including mud bogging with ATVs are destructive to prairie and boreal wetlands

Source: Manitoba Water Council. (2011).

4.2.1 Forestry Policy Selection

Based on provincial priority and the availability of "champions" for policy analysis, the Forestry Branch identified the three polices to be analyzed. These are:

- **Timber Quota Allocation Policy:** The quota provides timber producers with a five-year allocation authorized by a Timber Sale Agreement or Timber Permit. The latest Timber Quota Allocation is for the operating period starting April 1, 2010 to March 31, 2015. Under this policy, each timber producer is bound to an annual quota volume number under the policy's Annual Allowable Cuts, with a one-time harvest that is up to five times the annual volume within the five-year period (Manitoba Conservation, 2010).
- **Forest Renewal Program:** The program is designed to ensure the regeneration of forests within Manitoba in order to maintain the existing mosaic of forest ecosystems stand types. The program includes: (1) promotion of natural regeneration on Crown Lands; (2) continued site preparation and tree planting on Crown Lands; and (3) the implementation of stand tending, competitive vegetation management and intensive silviculture in renewed forests and plantations (Manitoba Conservation and Water Stewardship, n.d.)
- **Wood Supply Process:** This is the Forestry Branch's inventory of wood supply in Manitoba, and provides information on the best available information and current management and harvesting process among the different forest management licence areas within the province. (Manitoba Conservation, 2004; 2006; Manitoba Conservation and Water Stewardship, 2013b)

Based on the initial literature review presented at the training workshop, the Forestry Branch narrowed the focus down to six main vulnerabilities and 86 adaptation actions (see Appendix A.1 for a list of these). The six main vulnerability areas relevant to the Manitoba forestry sector are: reduced regeneration success; alteration/change in tree species composition; change in forest growth and productivity; increased tree mortality caused by increased forest insects and pathogens; increased frequency of fire and extreme weather events; and reduced access from winter logging. The list of identified adaptation actions is not meant to be definitive, but to provide examples of the types of actions that would be constructive in response to climate impacts identified. The main sources that informed the literature review for the vulnerability assessment and adaptation actions included forestry reports from the Prairie Adaptation Research Collaborative, Standing Senate Committee on Agriculture and Forestry, Canadian Council of Forest Ministers, and the Saskatchewan Research Council.

4.2.2 Wetlands Policy Elements

For the wetlands policy, the Province of Manitoba had previously carried out public consultations and produced background information that provided helpful inputs for the scoping, vulnerability and adaptation worksheets of the ADAPTool analysis. For example, the policy objectives of wetland conservation and restoration, specifically for maintaining water quality and quantity, climate change adaptation and mitigation, and biodiversity were articulated in the background paper. In addition, for this pilot ADAPTool application, information on the two stressors—climate change and land use competition and conversion—were derived from information in the background paper.

Through analysis and deliberations between IISD and members of the water policy branch, the following sub-sectors were identified as being relevant to the ADAPTool analysis for the new wetland policy: agriculture, municipal, forestry, recreational (including cultural activities) and environment. A list of vulnerabilities was identified using previous vulnerability and adaptation action lists from the identified subsectors that IISD carried out in previous and current

ADAPTool analysis (see Appendix A.2 for full results). In addition, the environment sector was identified as a key sector relevant to the wetland policy, with biodiversity and water identified as key sub-sectors during a focus group session between IISD and the water stewardship team. This analysis was developed further by IISD analysts with inputs from the water stewardship team. Two sets of vulnerabilities and adaptations were developed for the two distinct stressors.

4.3 Analysis Process

Once the vulnerabilities and potential adaptation actions were identified, the Forestry Branch team proceeded to review each of the three identified policies using the ADAPTool workbook, while the Water Stewardship team explored how the policy could support planned and unanticipated adaptation needs. The Forestry Branch carried out the analysis with the support of IISD, while IISD conducted the wetlands-related analysis with inputs from the Water Stewardship team.

Assessing the Ability of Policies to Address Adaptation Needs

When assessing the ability of policies to address adaptation needs, we ranked the levels of support that the policy provides for the adaptation and indicated cases in which the adaptation need is not applicable to the scope of the specific policy (see Appendix A.1 and A.2 for the individual assessments). In the analysis for unanticipated adaptation needs, or the adaptive capacity of the policy itself, only the forestry sector analysis had a scoring attached to it, while the wetlands policy provided guiding questions on how to design the policy with a strong adaptive capacity and space to identify specific actors and actions that are paramount to its adaptive capacity.

4.3.1 Forestry Analysis Results

4.3.1.1 Vulnerability/Adaptation Analysis

For the forestry sector, of the 86 adaptation actions considered, all were indirectly supported by at least one policy in the suite. It is noteworthy that despite having a total of 86 actions, not all policies were applicable to all policies identified. For example, the Timber Quota Allocation Policy had only 14 applicable actions, the Forest Renewal Program had 63 applicable actions, while the Wood Supply Process had 45. Table 3 illustrates findings from the vulnerability analysis.

TABLE 3. FORESTRY VULNERABILITY ANALYSIS RESULTS

	TIMBER QUOTA ALLOCATION POLICY	FOREST RENEWAL PROGRAM	WOOD SUPPLY PROCESS
Applicable adaptation actions	14	63	45
Indirectly Supported (%)	36	32	53
Directly Supported (%)	50	30	24
Not supported (%)	14	38	22
Total Score (out of 2)	1.3	0.8	1.3

The following key trends can be observed for the analyzed policies:

- There was a high degree of direct support for adaptation actions observed from the selected policies. For example, a vulnerability such as tree mortality caused by increased forest insects and pathogens in light of climate change could be dealt with an adaptation action of northern expansion of managed zones—this is supported directly by two of the three chosen policies and indirectly by the third. One reason for this might be the close correlation between the sectors chosen for the vulnerability assessment (stages of forestry) and the policies chosen for review (related to forestry).
- Twenty of the 86 adaptation actions are unsupported. These largely relate to the vulnerabilities around increased frequency of fire and extreme weather events and reduced access from winter logging. These should be looked at to determine if there are other policies supporting these that were not included in this analysis.
- Specific areas of climate vulnerability include vulnerability to increased frequency of fire and extreme weather events, and well as reduced access from winter logging. These ought to be addressed clearly in these and other complementary policies to ensure the long-term sustainability and viability of the forestry sector in Manitoba.

4.3.1.2 Adaptive Capacity

Based on the adaptive capacity analysis, we found that all three selected policies scored fairly high on both autonomous and planned adaptability (see Figure 1). This implies that these policies are fairly flexible in light of uncertainty and have built-in mechanisms that allow them to be responsive to both anticipated and unanticipated climate changes. The Timber Quota Allocation Policy scored highest in both categories, probably because it provides the most support for applicable adaptation actions, is the least vulnerable to the stressor itself and has a formal review mechanism built into it (see Appendix B for details). Table 4 gives a summary of the scoring system.

TABLE 4. SUMMARY TABLE FOR ADAPTOOL SCORING

Colour	Explanatory note	Score
Red	Barrier or hindrance	-1
Red	Not contributing	0
Yellow	Contributing somewhat or indirectly	1
Green	Contributing	2
Grey	Not Applicable	n/a

Table 5. presents an overview of how the selected forestry policies scored on planned and autonomous adaptability. Figure 1 illustrates forestry's suite of policies position within planned and autonomous adaptability diagram.

TABLE 5. FORESTRY SYNTHESIS OF SUITE OF POLICIES' SCORING

Adaptive Policy Questions	Overall Synthesis	Timber Allocation Quota	Forest Renewal Program	Wood Supply Process
Ability to Support Anticipated Adaptation Needs (score out of 10)	6	7	5	6
Are anticipated adaptation actions supported by the policies?	1	1.3	0.8	1.3
Is the policy itself vulnerable to the stressor?	1	2	0	1
Can the existing suite of policies enhance the capacity of actors within each sector to undertake the anticipated adaptation actions?	1	1	2	1
Was multistakeholder deliberation used in the design of the policies?	1	1	1	1
Ability to Respond to Unanticipated Events (score out of 10)	9	9	8	9
Is multistakeholder deliberation used in the implementation of the policy?	2	2	2	2
Does the policy enable self-organization and social networking?	1	1	1	1
Is decision making for policy implementation adequately decentralized?	2	2	2	2
Is there adequate variety in the suite of policies and programs directed at the policy issue?	2	2	2	2
Do the policies have a regular formal policy review?	2	2	1	2

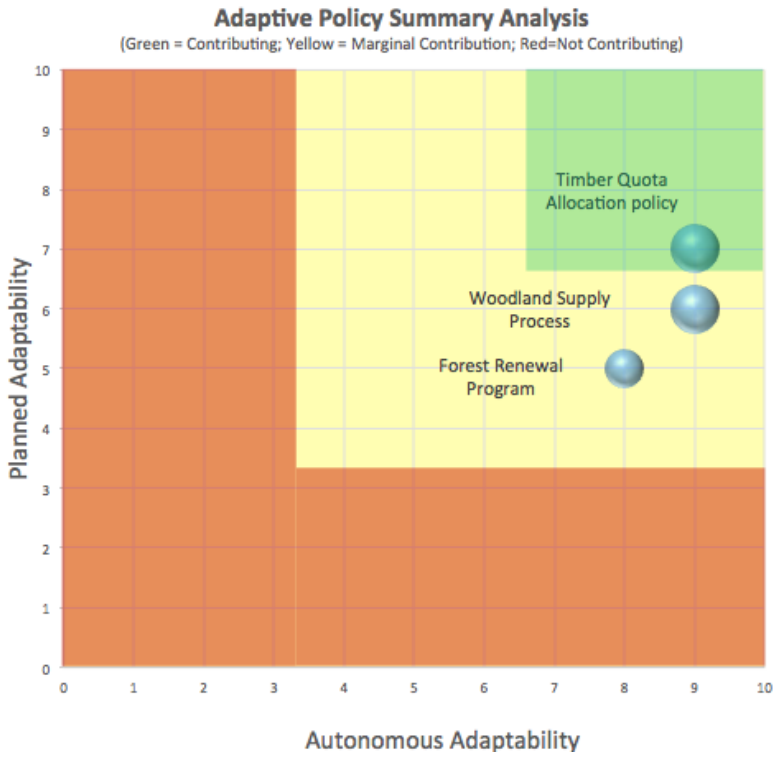

FIGURE 1. ADAPTIVE POLICY SUMMARY ANALYSIS DIAGRAM

Figure 1 presents the relative contributions of each of the forestry policies analyzed in this report to both "planned adaptability"—the ability to support anticipated uncertainties—and "autonomous adaptability"—the ability to support unanticipated uncertainties. More specifically, the position of the policy along the vertical axis of the adjacent diagram reflects its support for anticipated adaptation actions; the potential vulnerability of the policy itself to climate change; the ability of the policy to contribute to key determinants of adaptive capacity (economic resources, access to technology, infrastructure needs, information and management skills, institutions and networks, and equitable access); and the degree to which the policy development process included consultation with stakeholders during its scoping and design phase. A policy's relative position along the horizontal "autonomous adaptability" axis is a reflection of: the degree to which stakeholders have input during policy implementation; the policy's ability to enable self-organization through the sharing of best management practices and lessons learned; whether the policy is sufficiently decentralized to respond to local adaptation needs; and whether or not the policy has a formal review process to trigger key policy improvements and detect emerging issues.

If a policy appears in the green area of the diagram it is contributing well to both planned and autonomous adaptability. A policy appearing in the red area signifies that there are issues to address in either area or in both—its ability to adapt to known and unknown factors related to the selected stressor within climate change. The yellow area signifies that a policy is partially contributing and that some improvements might be warranted to help it better contribute to adaptation needs and be more adaptive itself. It is important to note that these rankings are not an assessment of policy performance relative to their original policy objective and mandate.

As illustrated in the diagram, the Timber Quota Allocation Policy is the only policy that lies within the green area. The position demonstrates that the policy contributes more to autonomous adaptability than to planned adaptability. The Woodland Supply Process ranked the highest within the yellow area, and similar to the Timber Quota, both the Woodland Supply Process and the Forest Renewal Program support strongly autonomous adaptability and, to a lesser extent, planned adaptability. Based on the analysis, all policies scored high for multistakeholder deliberation in implementation, being adequately decentralized, and having a variety of tools within the policies. Within the planned adaptability, the policies scored lower in the use of multistakeholder deliberation used in the design of the policies and supporting mostly indirectly the identified planned adaptation actions under the vulnerability review.

4.3.2 Wetlands Analysis Results

4.3.2.1 Vulnerability/Adaptation Analysis

The ADAPTool analysis for new policies applied to a Manitoba wetlands policy worked through two stressors: climate change and land-use pressures. For the first stressor on climate change, we listed 264 total adaptation actions and determined that 124 of these were applicable in some way to the wetland policy. Of these, 90 per cent could be indirectly supported by the wetland policy, 7.3 per cent could be directly supported and about 1 per cent were not supported.

For the second stressor related to land-use competition and conversion, there were 67 adaptation actions identified, of which 62 were applicable. Since this list was generated largely for this analysis, and to explore the response of the wetland policy, this high degree of applicability was not surprising. Of these actions, 84 per cent were indirectly supported, 13 per cent were directly supported and 3 per cent were not supported. Table 6 illustrates the results from both vulnerability analyses.

TABLE 6. WETLANDS VULNERABILITY ANALYSIS RESULTS FROM CLIMATE CHANGE AND LAND-USE AND CONVERSION STRESSORS

CLIMATE CHANGE STRESSOR		LAND-USE COMPETITION AND CONVERSION STRESSOR	
Applicable adaptation actions	124	Applicable adaptation actions	62
Indirectly Supported (%)	90	Indirectly Supported (%)	84
Directly Supported (%)	7	Directly Supported (%)	13
Not supported (%)	2	Not supported (%)	3
Barrier (%)	2.4	Barrier (%)	0

The following are some key observations from the wetlands vulnerability analyses:

Climate change stressor:

- Since this is an exploratory analysis, a rather low number of unsupported actions is expected as at this stage, the unwritten policy can be seen as being responsive to most applicable adaptation actions.
- A large number of adaptation actions were derived from previous and companion analyses and were deemed by some analysts to be useful as a long checklist to ensure that the new policy is as responsive as possible to regional adaptation needs.
- Others felt like the list was too long and onerous and having a long list of "not applicable" actions was not useful.
- It was determined that the environmental sector was the primary "beneficiary" of the policy while other sectors were indirectly supported and demonstrated co-benefits. A couple of potential areas where the policy could deter specific adaptation actions—such as the case of wetlands enabling water-based parasites and diseases—were seen as potential points to be considered during the design and mitigated where possible.

Land-use competition and conversion stressor:

- Of the adaptation actions, 62 of the 67 were applicable to the policy being considered. Since this list was generated largely for this analysis, and to explore the response of the wetland policy, this high degree of applicability was not surprising.
- An important aspect of this analysis was that it helped articulate primary and secondary objectives of this new policy—actions directly supported were directly complementary to the policy and those indirectly supported were somewhat related to the policy and were seen as "co-benefits" to be enhanced as possible through instrument design and related programming. One example of this was to enable wetland-based recreation judiciously through policy design to improve understanding of the value of wetlands amongst the public.

4.3.2.2 Adaptive Capacity Analysis

Because the wetlands policy analysis was at the design stage, scores were only assigned for the vulnerability/adaptation analyses for the two selected stressors, to determine how directly the policy could potentially support the adaptation actions (see Appendix A.2). For the adaptive capacity section, questions are posed to help analysts best identify the necessary tools that would enhance the policy's support to autonomous adaptability within the seven elements of

adaptive capacity (see Box 2). As a result, this portion of the analysis was not quantitative and the analysis does not have a visual representation of how well the policy performs on planned and autonomous adaptability needs.

Based on the questions determining the policy's ability to enable adaptability, specific recommendations were made for adaptive policy elements to be deliberately incorporated into the policy design. For example, means by which the policy itself could be less vulnerable to the selected stressors and specific examples of access to the six determinants of adaptive capacity were identified, such as aerial photography and wetland inventory under access to relevant information and skills (see Appendix C). Specific agencies such as the provincial Wetland Council and Ducks Unlimited Canada were identified as potential agencies for helping decentralize the implementation of the policy. Specific instruments were identified for parts of the policy that contributed to a high level of potential variation in the policy. As well, specific components and aspects of a formal review were discussed and reported, including some suggested indicators to track progress as well as triggers to enable a formal review process. Suggested indicators include the total area of wetlands in the province, wetland habitat monitoring, such as wetland indicator species, and triggers include precipitation and temperature-based triggers, land or agricultural commodity prices, etc.

5.0 Key Conclusions and Recommendations

5.1 Forestry Conclusions and Recommendations

The two ADAPTool analyses in Manitoba yielded fairly different types of results. In the ADAPTool analysis for existing policies applied to three forestry policies, we developed specific recommendations to improve the adaptability of the policies where they were somewhat lacking. Overall, the three policies performed well on the adaptability scale. The overall conclusions and recommendations of the adaptive policy analysis for the suite of policies in the forestry sector in Manitoba are outlined in the table below. An overview of the analyses and specific conclusions and recommendations for each policy are provided in Appendix B.

We found that some of the policies were focussed on and relevant to specific vulnerabilities related to forestry. As a result, not all identified adaptation actions were relevant to all policies. This was particularly apparent in the case for the Timber Allocation Quota Policy. This policy is only focussed on the production side of forestry, and was relevant to only 14 of the identified adaptation actions. Moreover, it is observed that 20 out of the 86 identified actions are not applicable and/or not supported by any of the policies analyzed, thus only 36 per cent of the policies are directly supported and 51 per cent of the policies are indirectly supported.[2]

The policies performed relatively well in their ability to respond to unanticipated events. The analysis concluded that there is a high level of multistakeholder deliberation for the implementation of the policies, policies are adequately decentralized, there is a high degree of variation within the policies, and that all policies have a regular, formalized review process. On the other hand, the analysis concludes that the policies have differing levels of vulnerability to the stressor themselves, and that although there is a degree to which policies support the adaptive capacity of actors, the Timber Quota Allocation Policy scored the highest. Multistakeholder deliberation in the design of the policies was more limited than in the implementation phase.

The overall conclusions and recommendations of the adaptive policy analysis for the selected forestry policies include:

- **Support to Anticipated Adaptation Needs** (planned adaptability). At least 51 per cent of the anticipated adaptation actions are partially supported by at least one policy in the suite of those considered. Many actions were not supported, particularly under the vulnerability to increased frequency of fire and extreme weather events. The unsupported adaptation actions should be examined more closely to determine their importance to the sustainability of the forestry sector and to determine if other policies (not included in the scope of this analysis) might provide the necessary support.
- **Policy Vulnerability** (planned adaptability). The selected forestry policies demonstrate different degrees of vulnerability to the stressor. The Timber Quota Allocation Policy is not vulnerable to climate change at all due to its flexibility to address climate change impacts on the timber allocation for users, while the Wood Supply Process was relatively vulnerable to the stressor due to the stressor's impacts on the planning cycles, and the effects that may have on staff and related policy data. The Forest Renewal Program was deemed vulnerable to the climate change stressor as the projected impacts may prevent provincial standards from being met.

[2] Since there are six policies, and each individual one can (in)directly support or hinder a specific action, therefore the level of support doesn't add up to the total number of adaptation actions.

- **Support to Stakeholder Adaptive Capacity** (planned adaptability). The six determinants of adaptive capacity (access to economic resources, technology, infrastructure, information/skills, institutions/networks, and equitable access to resources) were directly supported by the selected policies in some cases and partially or indirectly supported in others. In cases of partial or indirect support, the policy may not provide direct access to relevant information, technology, skills, institutions and networks, although it does present information or create sources of information for stakeholders on where to obtain access to these. Stakeholders are able to get direct access to relevant infrastructure, institutions and networks. The Forest Renewal Program scored the highest within the suite.
- **Use of Multistakeholder Deliberation** (planned and autonomous adaptability). All policies have some multistakeholder deliberation for the design phase and a higher degree during the implementation of the policies. Increasing multistakeholder engagement in both design and implementation phases to improve knowledge of—and the ability to cope with—anticipated and unanticipated uncertainties is recommended.
- **Enabling Self-Organization and Networking** (autonomous adaptability). The suite of policies provides limited means to enable self-organization and social networking—considered crucial elements of autonomous or unplanned adaptability. For the Timber Quota Allocation Policy, stakeholders are able to exchange information through the quota holders' association. The Forest Renewal Program facilitates the sharing of best practices primarily within governmental stakeholders, and the Wood Supply Process does allow for forest industries to build their own preferred management scenarios; however, this feature is limited from a broader user community due to the complexity of the modelling process.
- **Decentralization** (autonomous adaptability). The suite of policies is sufficiently decentralized to the most appropriate level, primarily within local and regional levels and includes devolution of authority and resources to regional offices and at the foresters' level.
- **Variation in Policy Instruments Employed** (autonomous adaptability). The suite of policies provides variety in policy instruments including regulatory, economic and expenditure.
- **Formal Policy Review and Improvement** (planned and autonomous adaptability). All policies have a formal review process ranging from every year to every five years. The Wood Supply Process does not have a formalized review process articulated in the policy, but does review the policy in practice. The policy is completed and updated regularly with the current information to reflect changing conditions.

The overall conclusions and recommendations of the adaptive policy analysis for the suite of policies considered are outlined in the table below. An overview of the analyses and specific conclusions and recommendations for each policy are provided in Appendix B.

Specific recommendations:

- While the selected policies offer a high degree of support for sector-specific adaptation actions, they also hinder necessary adaptations to climate change in the forestry sector in some select cases. As well, 20 of 86 adaptation actions are completely unsupported. These need to be further reviewed to see if other policies that were not included within the scope of this project provide support or if some enabling mechanisms need to be built in for improving adaptation support.

- Specific areas of unsupported climate vulnerability include vulnerability to increased frequency of fire and extreme weather events, and well as reduced access from winter logging. These ought to be addressed clearly in these and other complementary policies to ensure the long-term sustainability and viability of the forestry sector in Manitoba.
- While the need for consultation is built into all the policies to some extent, broader, multi-perspective deliberation is lacking and should be built in while redesigning these policies, as well through stages of implementation to develop more robust climate adaptability into these policies.
- Consider broadening this assessment to other forestry sector policies to get the full picture on mainstreaming adaptation and adaptive features of policies. The Forestry Branch conducted most of the analysis itself and has the necessary capacity and expertise to conduct such further analyses with guidance and vetting from IISD experts with experience using the tool.

5.2 Lessons Learned From Pilot Test of ADAPTool for new Policies

More detailed observations and recommendations for the Wetland Policy can be found in Appendix C.

Based on a pilot application of the ADAPTool for new policies applied to a new Manitoba wetland policy, the following observations were made:

- While this tool might be more helpful for those just starting to think about a new policy, because the wetland policy had already been in progress for a number of years and some background papers were already written, this process was found to be only mildly useful and not worth the effort of analysis, review and workshop participation.
- The analysis did not provide very specific recommendations—such as a list of wetland policy effectiveness indicators. Instead the recommendations and guidance were fairly broad and focussed on ways to incorporate indicators as part of a formalized review process, with some suggestions for the types of indicators that could be incorporated into a deliberative process.
- The analysis did shed some light on the main objectives and the co-benefits of the policy through direct and indirect support of adaptation actions.
- There were a number of points where new information was incorporated into the worksheet based on new realization, recollection and understanding – for example, the inclusion of a new vulnerability other than climate change, the understanding of the environmental sector as a key beneficiary of the policy and the need for its inclusion in the vulnerability sheet, as well as inputs about wetland being resilient to changing water regimes under climate change. Based on this, ADAPTool analysts felt like perhaps the tool did provide some clarity on the policy and important aspects of it and helped organize policy analysts towards a more effective and holistic policy.

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Appendix A: Forestry Results of Vulnerability and Adaptation Action Analysis

For an explanation of scoring see Box 2

- **Policy 1:** *Timber Quota Allocation Policy*
- **Policy 2:** *Forest Renewal Program*
- **Policy 3:** *Wood Supply Process*

Identified Vulnerability	Adaptation Action	Policy 1	Policy 2	Policy 3
5.1-Reduced regeneration success	Facilitating migration, managing gene pool and taking account of the potential range of future conditions when selecting species for stand regeneration	N/A	1	1
	Identifying more suitable genotypes through provenance trials	N/A	1	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A	1	N/A
	Increasing experimental plantings to test options for new genotypes or species, and reviewing existing plantations of exotics across provinces	N/A	2	N/A
	Examining potential for establishing genetic outposts (small plantations of seed sources that are adapted to predicted future climates in remote locations) to hasten the adaptation of forests in unmanaged areas	N/A	1	N/A
	Planting alternative tree species (e.g., planting drought-resistant species in areas that are prone to drought)	N/A	-1	2
	Thinning stands on drought-prone sites to reduce water use where it will not increase susceptibility to wind throw or disease	N/A	0	2
	Reducing reliance on natural regeneration where naturally regenerated forests will be significantly maladapted to future climates	N/A	2	2
	Expanding seed zone transfer - providing some flexibility	N/A	1	N/A
	Flexibility in timing in tree planting programs; reducing reliance on snow cache,	N/A	2	N/A
	Examining opportunities to increase genetic and species diversity when planting forests as a means of increasing capacity to buffer climate uncertainty.	N/A	-1	1
	Introducing exotic tree species that are better adapted to drier conditions in order to maintain a desired landscape and ecosystem function; active manage activities (endangered species protection, controlled burns, exotic species management, fire protection) in light of climate change and determining if changes are necessary	N/A	-1	1
	Tree improvement/ developing genotypes that are drought tolerant and resist insects and diseases	N/A	1	2
	Changing stock types	N/A	2	2
5.2-Alteration/ change in tree species composition	Identifying more suitable genotypes through provenance trials	N/A	1	N/A
	Increasing experimental plantings to test options for new genotypes or species, and reviewing existing plantations of exotics across provinces	N/A	2	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A	1	N/A
	Examining potential for establishing genetic outposts (small plantations of seed sources that are adapted to predicted future climates in remote locations) to hasten the adaptation of forests in unmanaged areas	N/A	1	N/A
	Enhancing forest monitoring networks (established and maintained) to provide early-warning signals for impending climate change impacts	N/A	2	N/A
	Examining opportunities to increase genetic and species diversity when planting forests as a means of increasing capacity to buffer climate uncertainty	N/A	-1	1
	Alternative tree species being planted	N/A	-1	1
	Introduction of exotic tree species that are better adapted to drier conditions in order to maintain a desired landscape and ecosystem function; active manage activities (endangered species protection, controlled burns, exotic species management, fire protection) in light of climate change and determine if changes are necessary	N/A	-1	1
	Controlling undesirable plant species that are likely to become more competitive in a changed climate	N/A	0	N/A
5.3-Change in forest growth and productivity	Identifying more suitable genotypes through provenance trials	N/A	1	N/A
	Increasing experimental plantings to test options for new genotypes or species, and reviewing existing plantations of exotics across provinces	N/A	2	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A	1	N/A
	Thinning stands on drought-prone sites to reduce water use where it will not increase susceptibility to wind throw or disease	N/A	0	1
	Examining opportunities to increase genetic and species diversity when planting forests as a means of increasing capacity to buffer climate uncertainty	N/A	-1	1
	Alternative tree species being planted	N/A	-1	1
	Northern expansion of managed zones	N/A	2	1
	Enhancing forest monitoring networks (established and maintained) to provide early warning signals for impending climate change impacts	N/A	2	N/A
	Managing species for shorter rotations (planting)	N/A	2	1
	Gene conservation	N/A	2	N/A
	Focusing harvest activities on stands that are most susceptible to pests, or conducting sanitation cutting in stands that are already infected	1	N/A	1
	More frequent AAC calculations and reduced harvest levels	2	N/A	2
	Tree improvement/developing genotypes that are drought tolerant and resist insects and diseases	N/A	1	N/A
	Managing for different forest products than traditional	N/A	1	2
	Planning for shorter rotations (harvesting earlier)	1	1	2
	Controlling undesirable plant species that are likely to become more competitive in a changed climate	N/A	0	1
5.4-Increased tree mortality caused by increased forest insects and pathogens	Planning for shorter rotations (harvesting earlier)	2	1	2
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A	1	N/A
	Gene conservation	N/A	2	N/A
	Northern expansion of managed zones	1	2	1
	Flexibility in timing in tree planting programs; less reliance on snow cache	N/A	2	N/A
	Enhancing forest monitoring networks (established and maintained) to provide early warning signals for impending climate change impacts	N/A	2	N/A
	Examining opportunities to increase genetic and species diversity when planting forests as a means of increasing capacity to buffer climate uncertainty	N/A	-1	1
	Identifying stands and forests structures that are susceptible to large scale disturbances, and using forest management to favour species and structures that are less vulnerable	N/A	N/A	1
	Introduction of exotic tree species that are better adapted to drier conditions in order to maintain a desired landscape and ecosystem function; active manage activities (endangered species protection, controlled burns, exotic species management, fire protection) in light of climate change and determine if changes are necessary	N/A	-1	NA
	Maintaining a diversity of age classes and species where it does not increase susceptibility to insects, disease or fire	N/A	N/A	2
	Implementation of a control program—i.e., spray program	N/A	2	1
	Focusing harvest activities on strands that are most susceptible to pests, or conducting sanitation cutting in stands that are already infected	2	N/A	1
	More frequent AAC calculations and reduced harvest levels	2	N/A	2
	Tree improvement/ developing genotypes that are drought tolerant and resist insects and diseases	N/A	1	N/A
	Harvesting design and regimes	N/A	N/A	N/A
	Planting shorter rotation trees based on climate	N/A	2	1
	Diversity of plantings (e.g., planting species as fire breaks, to mitigate monoculture)	N/A	2	1
5.5-Increase frequency of fire and extremes weather events	Examining opportunities to increase genetic and species diversity when planting forests (as a means of increasing capacity to buffer climate uncertainty)	N/A	-1	NA
	Managing for non-traditional forest products	1	1	2
	Planning for shorter rotations (harvesting earlier)	2	1	2
	Thinning stands on drought-prone sites to reduce water use where it will not increase susceptibility to wind throw or disease	N/A	0	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A	1	N/A
	Gene conservation	N/A	2	N/A
	Northern expansion of managed zones	2	2	N/A
N/A	Identifying stands and forests structures that are susceptible to large scale disturbances, and using forest management to favour species and structures that are less vulnerable	N/A	N/A	1
	Maintaining a diversity of age classes and species where it does not increase susceptibility to insects, disease or fire	N/A	N/A	1
	Introduction of exotic tree species that are better adapted to drier conditions in order to maintain a desired landscape and ecosystem function; actively manage activities (endangered species protection, controlled burns, exotic species management, fire protection) in light of climate change and determine if changes are necessary	N/A	-1	NA
	Focusing harvest activities on strands that are most susceptible to pests, or conducting sanitation cutting in stands that are already infected	1	N/A	1
	Sharing the losses (through insurance, disaster relief)	N/A	N/A	N/A
	Modifying the threat (using fire breaks)	N/A	N/A	N/A
	Preventing effects (rapid initial attacks on fires)	N/A	N/A	1
	Changing use (from coniferous to deciduous trees)	-1	-1	1
N/A	change location (to places less vulnerable to fire)	N/A	N/A	N/A
	Increase research (new fire suppression technologies, improved fire models)	N/A	N/A	0
	Educate, inform, and encourage behavioural change; enhance forest recovery and regeneration disturbances	N/A	N/A	N/A
	Anticipatory adaptation fire management (estimations of the areas of the forest and times that are most susceptible to fire and other disturbances given the expected changes in climate)	N/A	N/A	0
N/A	More frequent AAC calculations and reduced harvest levels	2	N/A	2
	Modifying harvesting design to reduce site specific fire risk	N/A	N/A	N/A
	Diversity of plantings (e.g., planting species as fire breaks, to mitigate monoculture)	N/A	-1	1
5.6-Reduced access from winter logging	Including climate change considerations when planning maintenance and replacement of infrastructure	N/A	N/A	0
	Developing alternate harvesting systems	N/A	N/A	N/A
	Using different equipment, all season roads vs. winter roads, flexibility in regulatory/policy requirements for storage and transportation	N/A	N/A	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A	1	N/A
	Implementing assisted migration may provide managers with several options for introducing planting stock that is better adapted to the new climate	N/A	-1	N/A
	Implementing long-term, multi-species provenance field trials to assess the climatic tolerance of seed sources in order to optimize assisted migration strategies (e.g., trials including seeds from northern U.S., including U.S. locations that have climates similar to those that will occur in Canada)	N/A	1	N/A
	Manage winter vs. summer harvest areas	N/A	N/A	2
	Flexibility in timing in tree planting programs; reducing reliance on snow cache	N/A	2	N/A

Appendix B: Wetlands Results of Vulnerability and Adaptation Action Analysis

Identified Vulnerability	Adaptation Actions	Wetland Policy Support
	Municipal	
Water shortages. Decreased water availability due to drought can result in increased costs for water.	Increased efficiency, reduced demand (e.g., through xeriscaping); Improved infrastructure; New infrastructure to bring in water	1
Flooding. Damage to residential, industrial, commercial and public property from flooding; interruption of services; increased costs related to mitigation	Improved infrastructure (e.g., sewers and culverts, dikes); Integrated stormwater management plans; Relocate homes from flood zones; "High-resolution mapping of possible future flood levels"	1
Infrastructure damage. Buildings, roads, and other critical infrastructure; damage from melting permafrost	Improved infrastructure	1
Impacts on community (reduced agricultural income). Reduced incomes have secondary impacts	TBD	1
Loss of biodiversity as invasive species replace native species	Programs to counter invasive species	1
Increased demand for electricity (due to heat waves)	Renewable energies, increase efficiency, reduce demand, improved infrastructure	1
Drinking water quality	More drinking water treatment	1
Health impacts. E.g., West Nile; Extreme heat can cause heat-related illness and death	Health programs: Education, assistance for those in need, distribution of water; Establish cooling centers at public locations	0
Snow load	Revised building codes	N/A
Increased snow removal	Revised budget allocation	N/A
Increased risk from wildfires. Damage from wildfire; Interruption of services; Increased costs related to mitigation	Forest fuel management plan; Wildfire mitigation requirements for approval of new developments	1
Increased pressure on wastewater treatment	Use less water	1
Increased urban forest tree losses. Losses due to drought, pests. Results: decreased air quality; decreased wildlife habitat; increased temperatures in urban areas; increased stormwater runoff; increased erosion	Increase tree planting; Change selection of tree species planted	1
Agriculture: Beef Cattle		
Shortage of feed (excess moisture = can't get it off; drought—there isn't any feed)	Alternative feeding methods alternative feed sources (e.g., grain, pellets, ***feed from other sources); Stockpile feed; Improving feed efficiency through good quality feed and forages Promoting rotational grazing and maintaining ground cover	1
Grazing season length	Improving feed efficiency through good quality feed and forages Promoting rotational grazing and maintaining ground cover	N/A
Water quality (manure—how much is running off => impact both on cattle, and on watersheds—nutrient loading) Cattle are often watered from wells, dugouts— both of these could be contaminated—a heightened stakeholder issue.	Nutrient management;	1
	Alternative watering sources	1
Feed quality (drought)	New varieties of feed	N/A
	Alternative feed sources (e.g., grain, pellets)	N/A
	Grazing management plan	N/A
	Feeding management plan	N/A
	Feed testing	N/A
	Nutritional monitoring & ensuring proper supplementation	N/A
Health (Access to water & heat stress) (excess moisture - depending on where they are. If in corrals, the cattle are standing in mud = foot rot)	Shading structures;	N/A
	Transition to different livestock types (e.g., Texas types of cattle, elk, llamas)	N/A
	Health (foot rot): prevention; raising the feedlots/better feedlot design	N/A
	Feedlot location	N/A
Water quality (decreased quality with decreased quantity)	Nutrient management Best Management Practices; alternative watering sources; ***farmyard runoff control	1
Water quantity / supply	Alternative water sources, water storage	1
Natural shelter diminished - in long run the loss of cover (drought)	Shading structures	N/A
	Woodlot management—species, etc. to keep it viable	N/A
Manure, compost, and dead stock management (floods)	Covering compost facilities	N/A
Agriculture- Forage		
Feed quality	New varieties of feed	N/A
	Alternative feed sources	N/A
	Grazing management plan	N/A
	Feed testing	N/A
	Forage blends	N/A
	Use of legumes	N/A
	Drainage (excess moisture)	N/A
	Equipment modification to prevent shattering (dry conditions)	N/A
Access to the field for harvest and grazing	Equipment modification (e.g., reducing ground pressure by using oversized wheels on balers) All about reducing pressure on the ground	N/A
Length of the grazing season	Different forage species on pasture and haylands (e.g., Tall Fescue Grass)	N/A
	Rotational grazing	N/A
	Managing your carrying capacity	N/A
Loss of stands and legumes due to drowning out	Different forage species on pasture and haylands (e.g., Tall Fescue Grass)	N/A
	Equipment modification (Broadcasting of seed in drowned-out areas)	N/A
	Improved drainage	1
Decreased yields	Different forage species on pasture and haylands (e.g., Tall Fescue Grass, legumes)	1
	Maintaining ground cover/rotational grazing/residue	N/A
	Management (windrows)	N/A
	Improving drainage	1
	Forage blend	N/A
Decreased soil quality	Maintaining ground cover/ rotational grazing	N/A
	Improving rotations, use of legumes in rotations	N/A
Irrigation	Different forage species on pasture and haylands (e.g., Tall Fescue Grass)	1
	Irrigation	1
Early dormancy (length of grazing season) (drought)	Different forage species on pasture and haylands (e.g., Tall Fescue Grass)	1
	Maintain ground cover / rotational grazing	N/A
Grasshoppers	Maintain ground cover (***not sure about ground cover)/rotational grazing	1
Agriculture: Cropping (annual grains and oil seeds)		
Access to the land (for seeding and for harvest)	Improved surface and tile drainage equipment modifications	N/A
	Flexibility: flexibility in operations and equipment and crop residue management to make decisions based on conditions—possibly involving equipment modification	N/A
Yield	Diversify crops, including specialty crops and increasing rotations	N/A
	Flexibility: flexibility in operations and equipment to make decisions based on conditions—possibly involving equipment modification	N/A
	Assistance programming; R&D in crop breeding and development ***Assistance programming for equipment modification	N/A
Quality	Diversify crops, including specialty crops and increasing rotations	1
	Flexibility: flexibility in operations and equipment to make decisions based on conditions—possibly involving equipment	N/A
	Modification and crop storage technology	1
	Better storage of water on land	2
	R&D in crop breeding and development;	1
	Marketing strategies	1
Pests & disease (insects and weeds)	Flexibility: flexibility in operations and equipment to make decisions based on conditions—possibly involving equipment modification Assistance programming ***Information sharing re: cultural control methods—for pests and disease; actions depend on the scale Flexibility: flexibility in operations and equipment to make decisions based on conditions—possibly involving equipment modification Assistance programming ***Information sharing re: cultural control methods—for pests and disease	N/A
Increase in summer fallow & unseeded acres	Flexibility: flexibility in operations and equipment to make decisions based on conditions—possibly involving equipment modification; inclusion of forage in crop rotation	N/A
Soil quality - soil blows away; salinity; erosion; compaction	Erosion controls (maintaining ground cover, shelter belts); Diversify crops, including specialty crops and increasing rotations (for salinity); ***Deep-rooted and perennial crops for salinity and compaction	N/A
Multi-year crop loss	Assistance programming—staffed by technically sound staff; Beefed up insurance mechanisms/enhanced insurance, alternative sources of income)	N/A
	Mixed farming (promoting, encouraging as a fall back—for moderate cases); land-use management; water storage	1
Agriculture: Forage Seed		
Access to fields	Maintaining ground cover	1
	Improved drainage	1
	Equipment modification—reducing pressure on the ground	N/A
Disease (e.g. mildew) in forage and bees	Increase crop rotations	N/A
	Effective and proper timing of fungicide application (more research is needed in this area because there are many unknowns due to field conditions)	N/A
	For bees (chalkbrood—prevalence is increasing due to high relative humidity): research re: the disease itself as well as pesticide options.	N/A
	For bees (foliar mould—moisture related): treatment of nests and cocoons (e.g., paraformaldehyde at the beginning of the season)	N/A
No harvest	Assistance programming - staffed by technically sound staff; Strengthened insurance mechanisms/enhanced insurance, alternative sources of income;	N/A
Field conditions poor due to standing water (loss of forage stand)	Improved drainage	1
Reduced bee pollination due to excess moisture; Death of bees due to rainfall	Researching artificial pollination	1
Increased grasshopper population	Forage mix	N/A
	Improved pesticide management and varieties	N/A
	Border management—a buffer between the ditches and the edge of the field.	1
Agriculture: Hogs		
Water quality	Water treatment	1
	Farmyard runoff control	1
Possible feed shortages (less likely because it can be sourced from many places)	Feed storage	N/A
Barns could flood (possibility of death)	Raising barns	N/A
	Farmyard runoff control	1

Increased energy costs to cool the barns	Implementing energy efficient heating/cooling options; explore biomass options;	1
	Backup options & temperature management	1
Slowed growth in pigs (if it is really warm)	Implementing energy efficient heating/cooling options; explore biomass options;	1
	Backup options & temperature management	1
Agriculture: Dairy cattle		
Water quality - supply contamination	Alternative watering sources and practices; farmyard runoff control away from wells; access to river systems	1
Water quality - run-off	Water treatment	2
	Farmyard runoff control	1
	Nutrient management Best Management Practices	1
Heat stress	Flexibility in operation; Increase ventilation system and evaporative cooling	1
Shortage of feed for hogs (excess moisture = can't get it off; drought—there isn't any feed)	Alternative feeding methods	1
	Alternative feed sources (e.g., grain, pellets, ***feed from other sources)	1
	Stockpile feed	N/A
	Improving feed efficiency through good quality feed and forages	N/A
	Promoting rotational grazing and maintaining ground cover	1
Water quantity / supply	Regular well maintenance	N/A
Pests & disease	Monitoring; R&D for potential solution	N/A
Increased energy costs to cool the barns	Increase Implementing energy efficient heating/cooling options;	1
	Explore biomass options	1
	Backup options & temperature management	N/A
Agriculture: Poultry		
Water quality	Water treatment Farmyard runoff control	1
Possible feed shortages (less likely because it can be sourced from many places)	Feed storage	N/A
Barns could flood (possibility of death)	Raising barns Farmyard runoff control	1
Increased energy costs to cool the barns	Implementing energy efficient heating/cooling options	1
	Explore biomass options	1
	Backup options & temperature management	N/A
Slowed growth in poultry (if it is really warm)	Implementing energy efficient heating/cooling options	1
	Explore biomass options	1
	Backup options & temperature management	1
Manure, compost, and dead stock management (floods)	Covering compost facilities	N/A
Agriculture: Potatoes		
Accessing water out of rivers (high or low)	Improving technology	N/A
	R&D	N/A
Water supply—dugouts and spring runoff	Rural water supply expansion	N/A
	Dugout filling (pump from rivers)	1
Accessing land during floods	Maintaining ground cover	1
	Improved drainage	1
	Equipment modification—reducing pressure on the ground	N/A
Low yields	Diversify crops, including specialty crops and increasing rotations Flexibility: flexibility in operations and equipment to make decisions based on conditions—possibly involving equipment modification	N/A
	Assistance programming; R&D in crop breeding and development ***Assistance programming for equipment modification	N/A
Pest and diseases	Flexibility: flexibility in operations and equipment to make decisions based on conditions—possibly involving equipment modification Assistance programming ***Information sharing re: cultural control methods - for pest and disease; actions depend on the scale Flexibility: flexibility in operations and equipment to make decisions based on conditions—possibly involving equipment modification Assistance programming ***Information sharing re: cultural control methods—for pests and disease	1
Irrigation (municipality vs sector water access—extreme drought conditions)	Improving irrigation efficiency (technology and use).	1
Forestry		
Reduced regeneration success	Facilitating migration, managing gene pool and taking account of the potential range of future conditions when selecting species for stand regeneration	N/A
	Identifying more suitable genotypes through provenance trials	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A
	Increasing experimental plantings to test options for new genotypes or species, and reviewing existing plantations of exotics across provinces	N/A
	Examining potential for establishing genetic outposts (small plantations of seed sources that are adapted to predicted future climates in remote locations) to hasten the adaptation of forests in unmanaged areas	N/A
	Planting alternative tree species (e.g., planting drought-resistant species in areas that are prone to drought)	1
	Thinning stands on drought-prone sites to reduce water use where it will not increase susceptibility to wind throw or disease	1
	Reducing reliance on natural regeneration where naturally regenerated forests will be significantly maladapted to future climates	N/A
	Expanding seed zone transfer—providing some flexibility	N/A
	Flexibility in timing in tree planting programs; reducing reliance on snow cache,	N/A
	Examining opportunities to increase genetic and species diversity when planting forests as a means of increasing capacity to buffer climate uncertainty.	N/A
	Introducing exotic tree species that are better adapted to drier conditions in order to maintain a desired landscape and ecosystem function; active manage activities (endangered species protection, controlled burns, exotic species management, fire protection) in light of climate change and determining if changes are necessary	1
	Tree improvement/developing genotypes that are drought tolerant and resist insects and diseases	1
	Changing stock types	N/A
Alteration/ change in tree species composition	Identifying more suitable genotypes through provenance trials	N/A
	Increasing experimental plantings to test options for new genotypes or species, and reviewing existing plantations of exotics across provinces	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A
	Examining potential for establishing genetic outposts (small plantations of seed sources that are adapted to predicted future climates in remote locations) to hasten the adaptation of forests in unmanaged areas	N/A
	Enhancing forest monitoring networks (established and maintained) to provide early warning signals for impending climate change impacts	N/A
	Examining opportunities to increase genetic and species diversity when planting forests as a means of increasing capacity to buffer climate uncertainty	N/A
	Alternative tree species being planted	N/A
	Introduction of exotic tree species that are better adapted to drier conditions in order to maintain a desired landscape and ecosystem function; active manage activities (endangered species protection, controlled burns, exotic species management, fire protection) in light of climate change and determine if changes are necessary	1
	Controlling undesirable plant species that are likely to become more competitive in a changed climate	N/A
Change in forest growth and productivity	Identifying more suitable genotypes through provenance trials	N/A
	Increasing experimental plantings to test options for new genotypes or species, and reviewing existing plantations of exotics across provinces	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A
	Thinning stands on drought-prone sites to reduce water use where it will not increase susceptibility to wind throw or disease	1
	Examining opportunities to increase genetic and species diversity when planting forests as a means of increasing capacity to buffer climate uncertainty	N/A
	Alternative tree species being planted	N/A
	Northern expansion of managed zones	N/A
	Enhancing forest monitoring networks (established and maintained) to provide early warning signals for impending climate change impacts	1
	Managing species for shorter rotations (planting)	N/A
	Gene conservation	N/A
	Focusing harvest activities on stands that are most susceptible to pests, or conducting sanitation cutting in stands that are already infected	N/A
	More frequent AAC calculations and reduced harvest levels	N/A
	Tree improvement/developing genotypes that are drought tolerant and resist insects and diseases	1
	Managing for non-traditional forest products	N/A
	Planning for shorter rotations (harvesting earlier)	N/A
	Controlling undesirable plant species that are likely to become more competitive in a changed climate	N/A
Increased tree mortality caused by increased forest insects and pathogens	Planning for shorter rotations (harvesting earlier)	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A
	Gene conservation	N/A
	Northern expansion of managed zones	N/A
	Flexibility in timing in tree planting programs; less reliance on snow cache	N/A
	Enhancing forest monitoring networks (established and maintained) to provide early warning signals for impending climate change impacts	1
	Examining opportunities to increase genetic and species diversity when planting forests as a means of increasing capacity to buffer climate uncertainty	N/A
	Identifying stands and forests structures that are susceptible to large scale disturbances, and using forest management to favour species and structures that are less vulnerable	1
	Introduction of exotic tree species that are better adapted to drier conditions in order to maintain a desired landscape and ecosystem function; active manage activities (endangered species protection, controlled burns, exotic species management, fire protection) in light of climate change and determine if changes are necessary	1
	Maintaining a diversity of age classes and species where it does not increase susceptibility to insects, disease or fire	N/A
	Implementation of a control program—i.e. spray program	N/A
	Focusing harvest activities on strands that are most susceptible to pests, or conducting sanitation cutting in stands that are already infected	N/A
	More frequent AAC calculations and reduced harvest levels	N/A
	Tree improvement/ developing genotypes that are drought tolerant and resist insects and diseases	1
	Harvesting design and regimes	N/A
	Planting shorter rotation trees based on climate	N/A
	Diversity of plantings (e.g. planting species as fire breaks—to mitigate monoculture)	N/A
Increase frequency of fire and extremes weather events	Examining opportunities to increase genetic and species diversity when planting forests (as a means of increasing capacity to buffer climate uncertainty)	N/A
	Managing for different forest products than traditional	N/A
	Planning for shorter rotations (harvesting earlier)	N/A
	Thinning stands on drought-prone sites to reduce water use where it will not increase susceptibility to wind throw or disease	1
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A
	Gene conservation	N/A
	Northern expansion of managed zones	N/A
	Identifying stands and forests structures that are susceptible to large scale disturbances, and using forest management to favour species and structures that are less vulnerable	1
	Maintaining a diversity of age classes and species where it does not increase susceptibility to insects, disease or fire	N/A
	Introduction of exotic tree species that are better adapted to drier conditions in order to maintain a desired landscape and ecosystem function; actively manage activities (endangered species protection, controlled burns, exotic species management, fire protection) in light of climate change and determine if changes are necessary	1
	Focusing harvest activities on strands that are most susceptible to pests, or conducting sanitation cutting in stands that are already infected	N/A
	Sharing the losses (through insurance, disaster relief)	N/A
	Modifying the threat (using fire breaks)	1
	Preventing effects (rapid initial attacks on fires)	N/A
	Changing use (from coniferous to deciduous trees)	N/A
	change location (to places less vulnerable to fire)	N/A

	Increase research (new fire suppression technologies, improved fire models)	N/A
	Educate, inform, and encourage behavioural change; enhance forest recovery and regeneration disturbances	N/A
	Anticipatory adaptation fire management (estimations of the areas of the forest and times that are most susceptible to fire and other disturbances given the expected changes in climate)	N/A
	More frequent AAC calculations and reduced harvest levels	N/A
	Modifying Harvesting design to reduce site specific fire risk	N/A
	Diversity of plantings (e.g. Planting species as fire breaks—to mitigate monoculture)	N/A
Reduced access from winter logging	Including climate change considerations when planning maintenance and replacement of infrastructure	N/A
	Developing alternate harvesting systems	N/A
	Using different equipment, all season roads vs winter roads, flexibility in regulatory/policy requirements for storage and transportation	N/A
	Selecting and breeding to enhance traits that may be more suited to changed environmental conditions	N/A
	Implementing assisted migration may provide managers with several options for introducing planting stock that is better adapted to the new climate	N/A
	Implementing long-term, multi-species provenance field trials to assess the climatic tolerance of seed sources in order to optimize assisted migration strategies (e.g. trials including seeds from northern U.S., including U.S. locations that have climates similar to those that will occur in Canada)	N/A
	Manage winter vs summer harvest areas	N/A
	Flexibility in timing in tree planting programs; reducing reliance on snow cache	N/A
Recreation		
Access to recreation	Infrastructure location and design	1
Usability of sites	Landscape management	1
Damaged infrastructure	Insurance, maintenance	1
Aesthetics	Education	1
Health and habitat of recreation species e.g. fish	Habitat management plans, IWRM, research, hunting and fishing quotas informed by limits, flexibility in management options to rejuvenate species, education	1
Water quality	Integrated management, nutrient management, education	1
Loss of revenue	Insurance, diversification of recreational opportunities	1
Effects on waterfowl and other species (hunting = recreation)	Critical habitat conservation	1
Low snow cover can affect cross-country skiing, snowshoeing and snowmobiling	Flexible programming, alternative revenue, trail management	1
Lake levels may alter and affect the salinity and flora and fauna composition of the lakes	Manage lake levels more aggressively	1
Warmer temperatures and shallow depth would result in warm water, which encourages algae and plant growth—affecting the expiration of fish life due to reduction in dissolved oxygen	TBD	1
Increased amounts of phosphorus and nitrogen are entering Manitoba's waterways from urban and rural sources (fertilizer runoff, livestock manure, urban activities, wastewater treatment facilities and wetland drainage) contributing to the eutrophication of Manitoba's lakes.	Nutrient management	1
	Agricultural BMPs	1
	Wetland conservation, restoration and management	1
Reduced availability of water and riparian areas for First Nations cultural ceremonies	Wetlands provide valuable sites for aboriginal ceremonies and hunting and fishing needs	1
Reduced availability of water and riparian areas for First Nations hunting and fishing	Wetlands provide valuable sites for aboriginal ceremonies and hunting and fishing needs	1
Increase waterborne diseases from pests such as mosquitoes	Improved wetlands management; improved integrated pest management; awareness of value of wetlands for biodiversity etc.	-1
Environment: Biodiversity and species		
Habitat for wetland-dependent species (e.g., ducks, amphibians, other) could be diminished due to increased drought.	Wetland conservation to increase habitat availability. Identify and preserve wetlands that can withstand drought.	2
Habitat for forest and grassland-dependent species could be diminished or lost due to increased drought	Containing forest fires. Aiding prairie habitat restoration after a drought	1
Some species could be affected by changes in water quality—increased eutrophication and algal blooms (increased temperatures fuel algal blooms).	Wetland conservation for water filtration	2
Some species would be affected by increased air temperatures.	Micro-climate management through wetland conservation	1
Some aquatic species would be affected by increased water temperatures (i.e. going beyond their survival thresholds for temperature).	Water cooling mechanisms	0
Increased toxic algal blooms (due to higher temperatures, more phosphorus) in Lakes Winnipeg, Killarney and other waters could lead to ingestion of toxins by some species.	Water filtration	2
Increased fish kills could result from increased algal blooms and resulting dead zones in Manitoban waterways.	Water filtration	2
Drought/flood/increased temperatures could decrease reproduction success (i.e. lower survival rates) for both some flora and fauna.	Cooling and habitat	1
Invasive species, able to gain ground in Manitoba due to warmer temperatures, could displace indigenous species.	Programs to counter invasive species	1
Increased risk of wildfires, which can displace species.	Fire breaks	1
Flooding could displace some species.	Flood mitigation	1
Health impacts—increased West Nile, equine encephalitis (if it's in Manitoba) —these affect birds, other species.	Prevent standing water	-1
Less snow in winter could affect the survival of some plant species (i.e. less insulation for dormant plants).		N/A
Food sources of some species could be affected by droughts (e.g., berries for bears, insects for some birds).	Maintain food sources	1
Migration patterns of birds may be confused/altered.	Habitat protection	1
Competition for habitat could occur in times of drought (less food productivity/acre would mean natural ranges would expand).	Habitat protection	1
If human infrastructure is damaged could enter habitat and harm species.	Flood mitigation	1
Reduced bee pollination due to excess moisture; Death of bees due to rainfall	Water storage, habitat protection	1
lake levels may alter and affect the salinity and flora and fauna composition of the lakes	Distributed storage, flood and drought management	1
Vulnerability of some indigenous plants to pests and disease would increase due to drought, increased temperatures.	Habitat protection	1
Mild winter thaws could affect survival of some plant species.	N/A	N/A
Environment: Water		
Phosphorus loading to waterways may increase due to increased spring and summer flooding (i.e., phosphorus in run-off, in combined sewage overflows etc.)	Preserve/restore wetlands.	2
Drought may increase concentration of pollutants (e.g., phosphorus, other) in water.	Water filtration	1
Increased flooding could increase turbidity of water.	Water filtration	1
Drinking water for some species may be of lower quality due to increase phosphorus loading, sediment loading etc.	Water filtration	1
Groundwater reservoirs could become low during drought	Water storage	2
Increased lightning could spark more wildfires.	Fire buffers	1
Damage to human infrastructure (industry, contaminant storage, farm buildings, houses) could lead to a variety of contaminants in water.	Water storage, water filtration	1
Droughts will decrease the amount of surface water on the landscape.	Distributed water storage	2
Intense rain events could harm water quality (e.g. overload sewage systems, erode soil from fields etc.).	Water filtration	1

Appendix C: Forestry Conclusions and Recommendations for Specific Policies

Adaptive Policy Questions	Score	Timber Quota Allocation Policy
Program's Ability to Support Anticipated Adaptation Needs (Planned Adaptability, score out of 10)	7	**Recommendation**
Are anticipated adaptation actions supported by the policies?	1.3	Yes. However the policy was not previously designed with Climate change adaptation in mind. The next revision should include more proactive direction in the Timber Salvage Section. An example could be that quota holders may be directed into undamaged but threatened (e.g., insect/disease attack, drought, wind throw) timber areas for forest management purposes. Most of the adaptation actions were not applicable to the policy, thus affecting its overall scoring. Nonetheless, those actions that were applicable with the policy were either directly or indirectly supported.
Is the policy itself vulnerable to the stressor?	2	No. Unless the forest within an entire Forest Management Section is disturbed (i.e., fire). This, however, is not predicted to occur
Can the existing suite of programs enhance the capacity of actors within each sector to undertake the anticipated adaptation actions?	1	Yes. However with a significant increase in landscape disturbance (fire, wind, and insects) the Forestry Branch's capacity to recalculate AAC's quickly enough will be stretch and may require additional resources. As well the finite forest resources may not allow moving QH's to adjacent units in all cases (if AAC's drop)
Was multistakeholder deliberation used in the design of the policies?	1	Yes. Winnipeg and regional forestry staff as well as Timber Quota, and FML holders were consulted in the development of the current policy. Other stakeholders may be invited to provide input on the next revision.
Program's Ability to Respond to Unanticipated Events (Autonomous Adaptability, score out of 10)	9	
Is multistakeholder deliberation used in the implementation of the policy?	2	Yes. Winnipeg and regional forestry staff, Timber Quota and FML holders are annually consulted on its effectiveness. As well day-to-day "fine-tuning" of procedures ensures it stays current.
Does the policy enable self-organization and social networking?	1	Yes. Regional QH Associations can be effective; however, they may require more guidance to improve function. QH associations should be encouraged to provide annual recommendations that could be incorporated into next year procedures or future policies.
Is decision making for policy implementation adequately decentralized?	2	Yes. Decisions can be made at an appropriate level (Regional Forester/Timber sales Manager/FMD Manager) to maintain operations while ensuring the policy and procedures are followed.
Is there adequate variety in the suite of policies and programs directed at the policy issue?	2	
Do the policies have a regular formal policy review?	2	Yes. Formal program review is done every five years. QH associations should be encouraged to provide annual recommendations that could be incorporated into next year procedures or future policies.

Adaptive Policy Questions	Score	Forest Renewal Program
Program's Ability to Support Anticipated Adaptation Needs (Planned Adaptability, score out of 10)	5	**Recommendation**
Are anticipated adaptation actions supported by the policies?	0.8	Yes. The program was not previously designed with climate change adaptation in mind. However, the program has a large research component for climate change (e.g., assisted migration trials).
Is the policy itself vulnerable to the stressor?	0	Yes. Renewal activities are directly related to environmental conditions and will require alteration to continue renewal success
Can the existing suite of programs enhance the capacity of actors within each sector to undertake the anticipated adaptation actions?	2	Yes. However regional staff is limited by the constraints of our current policies (e.g., seed zones, transfer of boundaries, no exotics).
Was multistakeholder deliberation used in the design of the policies?	1	Yes. But there is limited consultation with stakeholders (silviculture technical committee consultation)
Program's Ability to Respond to Unanticipated Events (Autonomous Adaptability, score out of 10)	8	
Is multistakeholder deliberation used in the implementation of the policy?	2	Yes. Some analytical and deliberative methods applied (need internal discussion)/ Analysis of survey data are conducted to calculate treatment response which reflect future trends of renewal performance and can be mitigated as necessary.
Does the policy enable self-organization and social networking?	1	Yes. For instance, results with different regions, stock types, seedling handling, sharing of silvicultural best practices (internal only)
Is decision making for policy implementation adequately decentralized?	2	Yes. Regional offices—capacity to make decision
Is there adequate variety in the suite of policies and programs directed at the policy issue?	2	Yes, Forest Renewal Charge (FRC) rates are reviewed annually to determine if rates reflect costs associated with silviculture activities. In the event that FRC rates are raised due to higher operational costs, approvals would still be required to increase renewal program budgets accordingly.
Do the policies have a regular formal policy review?	1	Yes. Annual FRC review, five-year report/annual report.

Adaptive Policy Questions	Score	Wood supply Process
Program's Ability to Support Anticipated Adaptation Needs (Planned Adaptability, score out of 10)	6	**Recommendation**
Are anticipated adaptation actions supported by the policies?	1.3	Yes. But the program was not previously designed with climate change adaptation in mind. However, the re-planning cycle provides a mechanism for adequate adaptive capacity. We have the ability to adapt the wood supply process but require additional data and resources.
Is the policy itself vulnerable to the stressor?	1	Partially yes. Projections and AACs could be less accurate. Planning cycles will need to become shorter but this will put stress on our resources (staff and data).
Can the existing suite of programs enhance the capacity of actors within each sector to undertake the anticipated adaptation actions?	1	Yes, sufficient.
Was multistakeholder deliberation used in the design of the policies?	1	Partially yes. Future wood supply process/ policies should include multi-stakeholder involvement.
Program's Ability to Respond to Unanticipated Events (Autonomous Adaptability, score out of 10)	9	
Is multistakeholder deliberation used in the implementation of the policy?	2	Yes. Examples are TACs and IRMTs
Does the policy enable self-organization and social networking?	1	Yes. Base case analysis is shared with forest industries allowing them to build their own preferred management scenarios. The complexity of the modelling process limits sharing with wide audience.
Is decision making for policy implementation adequately decentralized?	2	Yes. Sufficient flexibility in the development of the base case
Is there adequate variety in the suite of policies and programs directed at the policy issue?	2	No. There is currently no formal wood supply policy, however, wood supply processes are completed regularly and updated with the current information to reflect changing conditions. A formal policy is under development. Although there is no written policy for this action, practice is in place.
Do the policies have a regular formal policy review?	2	No. But future policies will include a regular review.

Appendix D: Wetlands Recommendations

Adaptive Policy Brief
Manitoba Wetlands Policy
[November 2013]

Background Information (Objective, geographic scope, relevant sectors)

The objective of this analysis is to inform the design of a Manitoba wetland policy from two perspectives: (i) to help increase the ability of the policy to help sectors including Environment, Agriculture, Municipal, Recreation and Forestry to cope with key future stressors, namely climate change and competing land use and market forces; and (ii) for the policy itself to be adaptive and robust in the face of the uncertainty and surprises that future drivers including climate change and competing land use and market forces.

The geographic scope of the wetland policy is the Province of Manitoba, and the policy's main goal is to conserve and restore wetlands. There are three priority EGS areas, namely: water quality and quantity, climate change adaptation and mitigation and biodiversity.

Synthesis of Key Adaptation Actions and Ways the Policy Can Support Adaptation (refer to Question #6 through 9)

Both stressors had their specific vulnerabilities and adaptation actions. For the climate change stressor, there were a total of 119 vulnerabilities and 264 adaptation actions, while the land-use stressor had a total of 48 vulnerabilities and 69 adaptation actions across all subsectors.

Climate change stressor: 124 adaptation actions were identified as applicable to this policy out of a total of 264 adaptation actions identified for the sectors. Of the 124 applicable adaptation actions, 90 per cent could potentially be indirectly supported through this policy and 7 per cent could be directly supported (primarily in the municipal, environment, recreational, and agricultural livestock sectors). In addition, 2 per cent of actions could potentially be hindered by this policy (through the potential introduction of more mosquitos and related waterborne diseases), while 1 per cent of the relevant adaption actions are not supported (no impact as a water cooling mechanisms for vulnerable aquatic species).

The environment sector is one of the direct benefactors of wetlands conservation and restoration, with 27 applicable adaptation actions out of the total 124 applicable actions. From these, 26 per cent could potentially be directly supported and 70 per cent indirectly supported by the wetland policy, while 4 per cent of actions would likely not be supported, and 4 per cent likely to be hindered by the policy (prevention of standing water to reduce health impacts to species and biodiversity). There are also direct benefits to other sectors such as municipal and agriculture. The adaption actions that are indirectly supported by the policy, particularly in the municipal, agricultural, forestry and recreational sectors help identify co-benefits of the policy. Directly addressed adaptation actions should be considered in the core mandate and target of the policy design.

Land use stressor: there are 62 adaptation actions applicable to this policy out of a total of 69 necessary adaptation actions. Of the 62 applicable adaptation actions to this policy, 84 per cent could be indirectly supported through this policy and 13 per cent could be directly supported. In addition, 3 per cent of actions would likely not be supported (such as the use of regulation for point sources of toxins in the municipal sector).

The environment sector contains 16 applicable adaptive actions, where 37 per cent could be directly supported and 63 per cent indirectly supported. There were no barriers to adaptation to competing land uses and market prices identified by the analysis. The adaptation actions indirectly addressed by the policy help identify co-benefits created by the policy and should be explored to explicitly target, monitor or communicate to other sectoral stakeholders.

Adaptive Policy Recommendations

Integrated and forward-looking assessment (refer to Question #10)

Integrated and forward-looking analysis (i.e., foresight) is crucial for effective policy design. By identifying key factors that affect policy performance and identifying scenarios for how these factors might evolve in the future, policies can be made robust to a range of anticipated conditions, and indicators can be developed to help trigger important policy adjustments when needed.

In relation to the climate change stressor, the wetland policy itself was identified as being vulnerable to prolonged droughts, which may result in loss of wetlands through land conversion or change of ownership and loss of record of the existence of the wetland. An important mitigating measure for this would be to maintain an up-to-date inventory and map of wetlands to ensure that knowledge of wetlands and their function in the local and regional landscape is not lost to the landowners and regional decision makers. A healthy, resilient ecosystem is able to bounce back successfully from climate stressors and is able to continue to roll out co-benefits to other sectors.

In relation to the land-use stressor, changes in market pressures can increase competition in land use by forcing producers to maximize land production, including drainage of wetlands for agricultural production, forestry and mining activities in boreal wetlands, and new residential and cottage developments. An important mitigation measure is regular review of the policy, supported by the monitoring of percent loss of wetlands. This will allow policy-makers to mitigate and make necessary changes within the policy to regulate activates that are detrimental to the health of wetlands, ensure the goal of long-term sustainability, and prevent reaching a tipping point that will lead to the collapse of wetlands and negatively affect other sectors in the long run.

This adaptive policy analysis has helped to identify 119 vulnerabilities and 186 potential adaption actions across five sectors. Some of these potential adaptation actions can be used as performance measures for the co-benefits of municipal and agricultural sector adaptation to climate change and other stressors. Visualization of progress on performance measures can have a greater impact on intended audiences and better impact on the long-term goal of wetland conservation and restoration for water quality and quantity, climate adaptation and mitigation, and biodiversity conservation.

Adaptive capacity of relevant stakeholders (refer to Question #11)

Policies generally speaking can potentially support the adaptive capacity of stakeholders by providing access to: (i) relevant financial resources for adaptive actions; (ii) relevant technology; (iii) relevant information and skills; (iv) relevant infrastructure; (v) relevant institutions and networks; and (vi) equitable access to the benefits of the policy.

The new wetland policy appears to be well positioned to provide financing for incenting best management practices that simultaneously promote wetland protection and establishment and necessary adaptation actions for climate change and land-use pressures, as well as providing important information and skills via aerial photography and wetland inventories, and access to relevant institutions and networks via CDs and IWMPs. The analysis also revealed that the potential of the policy to provide access to relevant technology and infrastructure that have co-benefits for wetland protection and adaptation to climate change and land-use change pressures is less obvious and intuitive. Therefore, some additional thinking and discussion could be directed at how a new wetland policy could help support these two determinants of adaptive capacity.

Multistakeholder engagement (refer to Question #12)

Multistakeholder deliberation is a collective and collaborative public effort to examine an issue from different points of view prior to taking a decision. Policy experience shows that deliberative processes strengthen policy design by building recognition of common values, shared commitment and emerging issues, and by providing a comprehensive understanding of causal relationships.

Establishing a multistakeholder wetland council within the province could help provide the necessary rapid insight that takes into account different points of views for effective policy design and implementation, as well as providing a basis for commenting on ongoing annual progress reports from the provincial government and providing insights for continuous improvement and adaptation of the wetland policy. Engaging with wetland organizations, but also with stakeholders that are affected by the wetland policy (agricultural, municipal and recreation group representatives) provides the policy design and implementation the necessary multiple perspectives it needs to ensure that it is resilient to uncertainty including climate change and economic stresses.

The Manitoba Water Council currently plays this role, and has had consultations on wetland policy. This council will be responsible for any review and further consultations.

Enabling self-organization and social networking (refer to Question #13)

Experience and studies in adaptation to change and disaster risk management reveal that by ensuring that policies do not undermine existing social capital; by creating forums that enable social networking; by facilitating the sharing of good practices; and by removing barriers to self-organization, the ability of stakeholders to respond to unanticipated events in a variety of innovative ways is strengthened.

Enabling self-organization and social networking can be done through a bi-annual wetland conference to review progress, discuss improvements in practice, conduct rapid foresight exercise to detect emerging issues, and to share lessons learned in implementing best practices across the province. The policy will incorporate some key ingredients for enabling self-organization. These include sharing of issues through a website, conferences, information materials, as well as education and capacity building, collaborative research, inventory of existing programs and through active engagements with relevant groups such as the conservation districts and DUC.

The Manitoba Wetland Council should consider these as important parts in implementing and monitoring the success of this policy.

Decentralization of policy design and implementation (refer to Question #14)

Decentralizing the authority and responsibility for decision-making to the most local effective and accountable unit of governance, whether existing or newly created, has been observed to increase the capacity of a policy to perform successfully when confronted with unforeseen events.

Decentralization of the wetland policy design and implementation can be done through a continual co-devolution of responsibilities and function to the CDs and Rural Municipal Governments. As the policy is for all of Manitoba, authority for decision making at the local level will enhance the effectiveness of the policy through the necessary flexibility to respond to unforeseen circumstances locally, enhances the ability to notice significant changes earlier, and mobilize affected local interests to address these changes more simply. A number of relevant organizations have been identified as being relevant stakeholders for this policy. These include CDs, municipalities, provincial departments, MHHC, DUC, Delta Waterfowl, and KAP. The policy could identify clear roles for these organizations as well as clearly identify information, resources and funds to administer locally designed programing by such decentralized bodies.

Variation in policy instruments (refer to Question #15)

Given the complexity of most policy settings, studies show that implementing a variety of policies to address the same issue increases the likelihood of achieving desired outcomes. Diversity of responses also forms a common risk-management approach, facilitating the ability to perform efficiently in the face of unanticipated conditions.
Variation in policy instruments should be kept in mind in the final policy design. The use of a mix of instrument types can help mitigate the failure of one instrument and thereby help ensure delivery of goals and policy objectives over time. Current documentation from the wetland policy consultation indicates the potential use of different policy instruments. These include
Potential **economic instruments** include incentives, offset mechanisms, wetland mitigation endowment funds, etc. Potential **regulatory instruments** include regulation for significant wetlands (under Crown Lands Act); revision of drainage policies under the Water Rights Act to protect class 3 wetland the same way class 4 and 5 are protected and for class 1 and 2 on an ad hoc nature.

Potential **institutional instruments** include a peatlands stewardship strategy (in development); surface water management strategy (in development); Boreal plan (to be developed); Climate Change Adaptation Strategy (to be developed); Tomorrow Now (in development - draft 2); development of a regionally specific mitigation strategy that leads to no net loss of wetlands; NAWMP.

Finally, **expenditure instruments** include wetland inventory; wetland factsheet; Value of Wetlands package (information kit); Manitoba story tellers; capacity building of decision making bodies; Infrastructure: restoration of wetlands, particularly on Crown Lands; water storage; more research needed on all wetland ecosystems in the province with stronger focus on northern wetlands.

Using a range of policy instruments- information, regulation, incentives will strengthen the impact and robustness of this policy.

Formal review mechanisms (refer to Question #16)

Regular review, even when the policy is performing well, and the use of well-designed pilots throughout the life of the policy to test assumptions related to performance, have been shown to help address emerging issues and trigger important policy adjustments.

In the case of the wetland policy, a multi-stakeholder wetland council and a bi-annual or annual wetland conference could be used as the basis for the formal review mechanism built into the policy design. Indicators to track the progress of the policy in achieving it overall goals need to be developed in collaboration with key stakeholders in the province. Total area of wetlands in Manitoba could be used as a high level indicator, along with relevant indicators for water quality and quantity in relation to wetlands. Key indicator species related to wetlands could be monitored to gauge wetland health. As well, carbon sequestered by wetlands would help align with the province's climate change priorities.

A review could be triggered if there is no or negative growth in wetland area. The council could be used to help identify key indicators for the provincial government to track as part of the policy. The annual or bi-annual conference could then be used as the setting to present progress, discuss improvements and adaptations, conduct outreach, and engage in foresight exercises to envision how the indicators might evolve in the future and relevant mitigating actions and triggers to have on record and be ready to implement. This would incorporate the important components of multi-perspective deliberation into the review process. Other than a time-specific review, potential triggers for policy review could include: prolonged period of drought and frequency of flooding; market-price thresholds (e.g., land prices) and follow-up actions would include amendments to related policies and programs.

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