

Ontario Centre for Climate Impacts and Adaptation Resources
(OCCCIAR)

Adapting to Climate Change:

Tools and Techniques for an Adaptive Approach to Managing for Climate Change

A Case Study

including

Recommendations to Inform Development of a Climate Change
Adaptation Strategy for the Lake Simcoe Watershed

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Adapting to Climate Change:

Tools and Techniques for an Adaptive Approach to Managing for Climate Change: A Case Study

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Recommendations to Inform Development of a Climate Change Adaptation Strategy for the Lake Simcoe Watershed

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Executive Summary

The Government of Ontario is committed to managing for climate change through both mitigation and adaptation. The mitigation strategy will reduce greenhouse gas emissions by 80% at mid-century relative to 1990 levels while adaptation planning and management will help Ontarians cope with the unavoidable consequences of climate change. As part of the government's overall strategy to protect and restore the ecological health of the Lake Simcoe Watershed, the *Lake Simcoe Protection Act* was passed by the Legislature and received Royal Assent in December 2008. The Act has provided the authority for the establishment of the Lake Simcoe Protection Plan. The plan builds on climate change work already underway. For example, a number of tools and mechanisms provide for action on climate change in the Lake Simcoe Watershed and more broadly, Ontario – many of these are articulated in the province's Climate Change Action Plan (Government of Ontario 2011). The Lake Simcoe Protection Plan contains a dedicated climate change policy (7.11) that commits the Ontario Ministry of the Environment (MOE), in collaboration with the Ontario Ministry of Natural Resources (OMNR), the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA), First Nations and Métis communities, the Lake Simcoe Region Conservation Authority (LSRCA), municipalities, and interested academic institutions to develop a climate change adaptation strategy for the Lake Simcoe Watershed. This report describes the process used to gather and summarize adaptation recommendations to support development of the Lake Simcoe Watershed climate change adaptation strategy. The process involved engaging experts, assessing current and future vulnerabilities of selected natural and built systems' assets, and generating adaptation recommendations.

More than 900 recommendations submitted by participants were reviewed for redundancies and rewritten into 695 suggestions with consistent format. The 695 recommendations were then screened for priority in each of seven categories as follows: strategic planning, legislation and policy, knowledge management (research), knowledge management (monitoring), knowledge management (inventory), knowledge dissemination (communication), and on-site planning and management. In total, 92 recommendations were identified as first-order priorities and 48 recommendations were identified as first-/second-order priorities. In addition, 76 recommendations and observations related to infrastructure were gathered and summarized. Following a workshop in April 2011, during which participants evaluated the 92 recommendations, 30 strategies were selected and/or written for consideration in the development of the Lake Simcoe climate change adaptation plan. The need for a dynamic, iterative climate change adaptation plan that will enable responsible agencies and organizations to care for the watershed's assets on an ongoing basis is discussed.

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Introduction

Earth's climate is warming and becoming increasingly variable. It is possible that temperature, precipitation, and wind patterns will continue to change for decades, perhaps centuries, and affect the way communities throughout the Lake Simcoe Watershed care for natural assets, infrastructure, and the people who rely on these assets for health and well-being. Ontarians are responding to the known and potential impacts of climate change in two fundamental and related ways, mitigation through emissions reduction and the implementation of adaptation options.

In 2007 the Government of Ontario released 'Go Green: Ontario's Action Plan on Climate Change', which outlines targets to reduce greenhouse gas emissions (green targets) and commits to continued investment in public transit (MoveOntario 2020), jobs, green power, and healthy ecosystems (Grow Green) (MOE 2007). The greenhouse gas emission reduction targets are established at 6% below 1990 levels by 2014 (a reduction of 61 megatonnes relative to business-as-usual), 15% below 1990 levels by 2020 (a reduction of 99 megatonnes relative to business as usual), and 80% below 1990 levels by 2050 (MOE, 2007). These progressive and significant targets were accompanied by a commitment to engage in adaptation programs to help Ontarians prepare for climate-induced change. Subsequently, the Government of Ontario appointed the Expert Panel on Climate Change Adaptation in 2007 with a mandate to evaluate current government programs and recommend a path forward. The Expert Panel released its report in November 2009 with 59 recommendations including recommendation #34, which states that the *"...climate change adaptation strategy called for in the Lake Simcoe Protection Plan should be considered as a pilot project with potential application to strategies for increasing the climate*

resilience of other watersheds" (Expert Panel on Climate Change Adaptation, 2009).

The Lake Simcoe Protection Plan contains a dedicated climate change policy (7.11) that commits the Ontario Ministry of the Environment (MOE), in collaboration with the Ontario Ministry of Natural Resources (OMNR), the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA), First Nations and Métis communities, the Lake Simcoe Region Conservation Authority (LSRCA), municipalities, and interested academic institutions to develop a climate change adaptation strategy for the Lake Simcoe Watershed. In response to the Lake Simcoe Protection Plan and the Expert Panel's recommendation #34, OMOE, OMNR, OMAFRA, the LSRCA, and other partners initiated a process designed to provide recommendations to inform the development of a climate change adaptation strategy for the watershed. This report describes the approach, methods, and results of this process.

Climate Change and the Lake Simcoe Watershed

The average annual global temperature warmed by about 0.76°C over the last century (IPCC, 2007a), but warming in Canada was double the world average. The average temperature in Canada has increased about 1.2°C in the last 58 years (Environment Canada, 2006). However, warming was not uniform across the country. For example, average annual temperatures increased about 2°C in northwestern British Columbia and the Kluane region of the Yukon Territory, and by 1.2°C in south-central Canada, but did not change in Atlantic Canada (Environment Canada, 2006). During this period, temperatures across Ontario increased 0 to 1.4°C (Chiotti and Lavender, 2008). It is possible that this change will continue for decades, perhaps centuries and will affect the way people manage natural assets and construct and maintain buildings, roads, and other types of

infrastructure. While there is little debate over the existence of climate change, the degree and speed of change is uncertain. Accordingly, societies around the world will need to continually evaluate their readiness and adaptive capacity to provide ecologically meaningful and socially responsible decisions in a rapidly changing climate. And the Lake Simcoe Watershed is no exception.

Modelled projections for Ontario indicate that air temperature will increase, but given the uncertainty of human behaviour and associated greenhouse gas emission rates and volumes, we do not know by how much. Generally, the average global temperature is projected to warm 1.1 to 6.4°C during the next century, with land areas warming more than the oceans and higher latitudes warming more than lower latitudes (IPCC, 2007a). The additional heat in the atmosphere will probably increase variability in precipitation and wind patterns. For example, as more heat is trapped in the lower atmosphere by additional greenhouse gases, the frequency and size of extreme weather events such as ice storms, heavy rains, droughts, and wind storms are expected to increase (IPCC, 2007a). Given the increase in air temperature that has occurred in the last 100 years, an increase of another 1°C or more has significant implications to the composition and patterns of natural assets and infrastructure in the watershed. Installing or enhancing adaptive capacity to respond to this change, therefore, will be important to the health and well-being of people living and working in the Lake Simcoe Watershed throughout the 21st century.

Adaptive Management in the Lake Simcoe Watershed

By nature we humans are an adaptive species comprised of people who individually or collectively respond to the ever-changing

challenges of life. Based on our growing understanding of how the world works, we fashion and act on decisions to enhance our health and well-being. Then we learn from our actions and continually improve and adapt our policies and management decisions. The essence of adaptive management, therefore, is to “*learn by doing*” (Lee, 1999). This approach to life is fundamental to successful adaptation in a rapidly changing climate.

In many situations, adaptation to climate change involves continuing on with programs and projects already established in support of ecosystem health and to address the human position (and condition) in it. For example, the objectives for the Lake Simcoe Protection Plan exemplify a suite of conditions to which people can aspire in support of healthy ecosystems, healthy people, and a healthy economy. As a case in point, the first of 11 objectives (*protect, improve or restore the elements that contribute to the ecological health of the Lake Simcoe watershed, including, water quality, hydrology, key natural heritage features and their functions, and key hydrologic features and their functions*) paints a broad picture of the many actions needed to promote and guide an ecologically-oriented approach to the management of the Lake Simcoe Watershed. The process described in this report was designed to provide a climate change perspective or ‘climate lens’ on the commitments contained in the Lake Simcoe Protection Plan and to identify new, complementary ideas and recommendations to assist practitioners in their work to achieve the sixth objective of the Lake Simcoe Protection Plan, “*improve the Lake Simcoe watershed’s capacity to adapt to climate change*”.

While this process resulted in the generation of many ideas and recommendations to inform development of a climate change adaptation strategy in the Lake Simcoe Watershed, it is important to remember that the process itself,

based on a strong commitment to “*learning by doing*”, will also need to be part of any plan designed to guide the way forward in a rapidly changing climate.

Mainstreaming Climate Change into the Lake Simcoe Protection Plan

While this report provides recommendations to support development of a climate change adaptation strategy, it also describes a process for adaptation planning and management. Given that managing for climate change is an ongoing requirement rather than a one-time task, there is merit in transforming some of our decision-making processes by mainstreaming climate change into all levels of planning and management, including current commitments in the Lake Simcoe Protection Plan, the Oak Ridges Moraine Conservation Plan, and other implemented and future plans and policies. For example, strategic plans could explore and articulate a vision of desired future conditions that reflect the known and potential influences of climate, and reflect this climate-sensitive vision in supporting goals and objectives as well as in the design of policies and management programs. Given that effective decision-making is key to managing for climate change and that robust decisions are based on the best available information and knowledge, the quantity and quality of information we gather is also a critical aspect of adaptation in the 21st century.

Methods

The Context for Adaptation

While there is widespread agreement on the need to recognize and prepare for climate change and

to develop and integrate risk management strategies into current and new programs, climate-sensitive adaptive processes are only now being designed and tested. There are a number of steps in an adaptive management process beginning with an assessment of readiness and capacity to respond (e.g., assess organizational readiness and where necessary improve the capacity to respond), followed by vulnerability analyses to identify and prioritize adaptation needs, the development and implementation of adaptation strategies, and monitoring programs to measure adaptation success. Given that this project was implemented to inform development of a climate change adaptation strategy, the following steps were completed:

- Step 1: Engage the experts and identify the indicators.
- Step 2: Assess current vulnerability.
- Step 3: Project future climate scenarios.
- Step 4: Project future vulnerability.
- Step 5: Generate adaptation options (Figure 1).

Step 1: Engage Experts and Identify Indicators

The planning team engaged scientists and practitioners to complete preliminary vulnerability assessments for 11 themes and established a forum of climate change experts to generate adaptation options to address the known and potential vulnerabilities of natural assets and infrastructure to climate change described by the scientists. The 11 themes were hydrology, aquatic habitat, wildlife, insects, species-at-risk, invasive species, vegetation cover, natural heritage areas, agriculture, tourism and recreation, and infrastructure. While the planning team recognized that many additional themes required analysis, time and budget limitations, availability of data and information, and availability of expertise significantly influenced the selection of themes.

Figure 1: Steps in the Lake Simcoe Watershed climate change vulnerability assessment framework.



Step 2: Assess Current Vulnerability

In reference to climate change, vulnerability is the degree to which an asset (e.g., a fish, its habitat, and the ecosystem in which it exists) is susceptible to, and unable to cope with, the forces and factors of a changing climate. A vulnerability assessment uses ecological or socio-economic indicators to quantitatively or qualitatively describe how an asset is being or could be affected by climate change. For example, excessive phosphorous has been the most significant cause of the loss of water quality in Lake Simcoe and its tributaries. This pollution leads to excessive growth of plants, including algae, which contribute to the depletion of dissolved oxygen in the deep waters of the lake and degradation of critical habitat required by coldwater species. The cumulative effects of climate change may exacerbate phosphorous loading to the lake and make recovery of the coldwater fishery more difficult to achieve due to increased runoff resulting from storm events (i.e., phosphorous load and siltation over spawning beds) and reduction in coldwater habitat due to an increase in water temperature. This is a useful indicator of ecosystem condition. Where possible, the scientists and practitioners described the vulnerability of assets under current conditions.

Step 3: Project Future Scenarios

Planning and management responses to global warming require an understanding of how our climate may change. Stabilization of greenhouse gas concentrations in the atmosphere is a critical part of any effort to reduce the effects of global warming. If and when stabilization will be achieved remains uncertain. This is an important issue because it creates significant uncertainty about how to plan for the future. For example, if countries elect to increase their reliance on fossil fuels, greenhouse gas emissions will increase faster than if the countries collectively elect to reduce their use of fossil fuels, introduce more

renewable energy into the mix, and integrate energy conservation measures into their economies. Accordingly, climate models and emission scenarios based on different types of human behaviour are a useful tool to engage people in strategic discussions (e.g., ‘what if questions’) and decisions about potential future climates, associated vision-based targets, and adaptive responses.

Generally, it is recommended that project teams use many different models and scenarios to develop a broad picture of the potential climatic conditions that may require adaptive responses. While climate model ensembles were available, the planning team did not have the time or resources to assemble a package of models for the scientists completing the vulnerability analyses. Alternatively, the scientists and practitioners were provided mapped projections derived from Version 2 of the Canadian Global Climate Model and the A2 scenario prepared by Colombo et al. (2007). While it recognized that a vulnerability assessment based on one climate model was not an optimal approach, the planning team felt that the CGCM2 A2 provided a plausible suite of climatic conditions to inform adaptation discussions. In addition, it is worth noting that the Far North Science Advisory Panel (2010) determined that the CGCM2 A2 analysis discussed by Colombo et al. (2007) was very close to the patterns described by the ensemble analysis completed for Ontario’s Far North planning area. As well, some authors were able to use a selection of different models and scenarios to enhance their examination of the vulnerability of some natural assets.

Step 4: Project Future Vulnerability

Scientists completed vulnerability assessments for 9 of the 11 themes (hydrology, aquatic habitat, wildlife, insects, species-at-risk, invasive species, vegetation cover, natural heritage areas, and tourism and recreation). Indicators used to assess

vulnerability included impacts of warmer temperatures on streamside vegetation, coldwater fish habitat, wetland water levels, tourism activities (e.g., skiing, snowmobiling, and ice fishing), and the composition of tree species in the forest. Each team of scientists prepared a background discussion paper describing methods and results. The vulnerability reports are available online at: www.climateOntario.ca/LakeSimcoeDelphi.php. In addition, scientists provided a list of three primary consequences of climate change for their theme or sector, which were communicated to the forum of climate change experts at a November 2010 workshop (see Step 5).

To assess the vulnerability of agriculture to climate change and generate adaptation options, the planning team completed a literature review of known and potential impacts and prepared a summary report. The summary report can be accessed online at:

www.climateOntario.ca/LakeSimcoeDelphi.php.

Agricultural representatives used the summary report in support of their contribution to the policy Delphi survey described in Step 5.

Potential and known vulnerabilities of infrastructure to climate change were identified in a number of ways:

1. Prior to the November 2010 workshop, Lake Simcoe communities were invited to respond to an on-line infrastructure vulnerability survey (Appendix 1).
2. Representatives from selected provincial agencies were asked to answer a series of questions about infrastructure vulnerabilities (Appendix 2).
3. A roundtable on infrastructure was convened at the November 2010 workshop, during which vulnerabilities and adaptation options were discussed and recorded.
4. A meeting with municipal representatives was convened in February 2011 to compile additional information on infrastructure vulnerabilities. Some adaptive measures were

discussed at this meeting as well. The summary of the meeting with Lake Simcoe municipalities can be accessed online at: www.climateOntario.ca/LakeSimcoeDelphi.php.

5. Vulnerabilities identified in the community survey, by Provincial agency staff, and during the February 2011 community meeting are summarized on page 14.
6. Adaptation options for infrastructure identified at the November 2010 workshop, the February 2011 meeting, and the policy Delphi survey were integrated and summarized (see Appendix 5).

Step 5: Generate Adaptation Options

Many different types of decision-facilitation tools are used to identify and evaluate adaptation options including: scenario planning, emerging issues analysis, multi-criterion analysis, and idea generating strategies using expert judgment such as workshops, focus groups, and the policy Delphi. Each technique has strengths and weaknesses depending on the required outcome, the location, and the stakeholders involved in the process. Given time and budget constraints and experience of some of the planning team members, a policy Delphi was employed to generate a list of adaptation options. The planning team convened a meeting of experts in November 2010 to 1) review the results of the vulnerability assessments, 2) to facilitate an initial round of discussion about adaptation options, and 3) to introduce the policy Delphi procedure:

- **November 2010 Workshop Discussions:** During breakout sessions, workshop participants answered a suite of questions (Appendix 3). The ideas generated during the breakout sessions were used in conjunction with the results of the policy Delphi and in the case of infrastructure, survey and face-to-face meeting results to draft adaptation options.

The workshop proceedings are available online at:

www.climateOntario.ca/LakeSimcoeDelphi.php.

- **Policy Delphi:** In its broadest sense, a policy Delphi is an iterative group-oriented idea generating strategy that seeks to identify the strongest possible opposing views on the potential resolutions of a policy issue. The approach permits a diverse group of experts to interact anonymously on a policy issue and provides a structured method for assembling ideas and recommendations. By design, participants are provided the freedom to present and challenge alternative viewpoints and to think reflectively and independently between iterations. For the Lake Simcoe project, the planning team elected to use an electronic survey with two rounds of questions (Figure 2). The first round provided survey participants with climate change vulnerability reports prepared by the scientists, including the list of three primary consequences of climate change. The survey presented 11 questions organized according to seven general categories of action: legislation and policy, strategic planning, land use and/or resource management planning, management and operations, monitoring, research, and knowledge dissemination (Appendix 4). Recommendations generated by the workshop breakout groups and the first-round Delphi survey were used to develop a synthesized suite of adaptation options for each of the 11 themes. These ideas were then evaluated in the second-round survey for their perceived priority and feasibility (affordability and ease of implementation) (Table 1). The first priority options were identified, aggregated, and edited for presentation at a second workshop convened in April 2011 (Appendix 5).

During an April 2011 workshop, participants evaluated the 92 recommendations and provided recommendations to the planning team regarding the final suite of climate change strategies. On the basis of a review and prioritization of the 92 strategies completed by workshop participants, the planning team drafted a final suite of 30 recommended strategies to inform development of the climate change strategy.

Given that adaptation is a cross cutting issue, fitting the 30 broad recommended strategies into pre-existing categories such as those contained in the Lake Simcoe Protection Plan proved challenging and resulted in significant redundancy. Accordingly, the planning team explored other classification frameworks including the one developed by the Ontario Biodiversity Council for the new Biodiversity Strategy, which is organized according to four primary objectives (Engage People, Reduce Threats, Enhance Resilience, and Improve Knowledge). The planning team opted to organize the 30 strategies according to the objectives in the Biodiversity Strategy. However, in place of 'Enhance Resilience' the planning team substituted 'Enhance Adaptive Capacity'.

During the course of this project, 'adaptive capacity' and 'resilience' were sometimes used interchangeably. Some participants argued that the concepts are different and that this difference should be clarified. Therefore, for the purpose of this report, the IPCC (2007b) definition of adaptive capacity (i.e., the ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences) is used to denote the ability of a system to cope (resilience) and respond to stress. We support use of the term 'adaptive capacity', which includes 'resilience', because the literature consistently states that vulnerability assessment includes exposure, sensitivity, and adaptive capacity.

Use of the same or similar framework developed by the Ontario Biodiversity Council provides the following advantages:

- It will assist natural asset managers in their work to integrate the biodiversity and climate change agendas.
- Given the large number of plans currently being used in the Lake Simcoe Watershed, aligning objectives where possible is efficient and effective.

Results

Participant Response Rate

Of 74 individuals who were invited to participate in the first round of the policy Delphi survey, 20 did not feel qualified to answer the questions. Of the remaining 54 participants, 43 (84%) responded. Of the 43 respondents to the first-round survey, 39 (88%) completed the second-round survey. As well, eight agricultural experts and practitioners provided advice to the agricultural representative who completed the first-round survey. The infrastructure survey was completed by 16 municipal representatives. As well, 16 municipal representatives from 8 communities in the watershed attended the February 2011 face-to-face meeting to further discuss community vulnerabilities.

Vulnerability Assessments: Overview

The vulnerability assessments contain many observations about the known and potential impacts of climate change on selected assets in the Lake Simcoe Watershed. Vulnerabilities include, but are not limited to:

Hydrology

- Increased surface water runoff in winter months and decreased water availability in the summer months.

- Increased frequency of low water levels and droughts in summer; increased potential for flooding in winter.
- Changes to the thermal regime in Lake Simcoe (earlier and lengthening of stratification).
- Potential increased movement of phosphorus due to extreme rainfall events, which could lead to decreased water quality.
- Depletion of soil moisture, notably in the summer months.

Aquatic Habitat

- Drying and shrinking of wetlands from increased temperature and decreased precipitation.
- Threats to coldwater species due to increased water temperatures in streams and rivers.
- Benefits to warmwater fish species.
- Sedimentation and point and non-point source pollution will enter streams and rivers at an increased rate due to extreme precipitation events.

Invasive Species

- Wind, temperature, and rain will help disperse seeds of invasive terrestrial species.
- Increased temperatures will allow invasive species to establish and possibly thrive.
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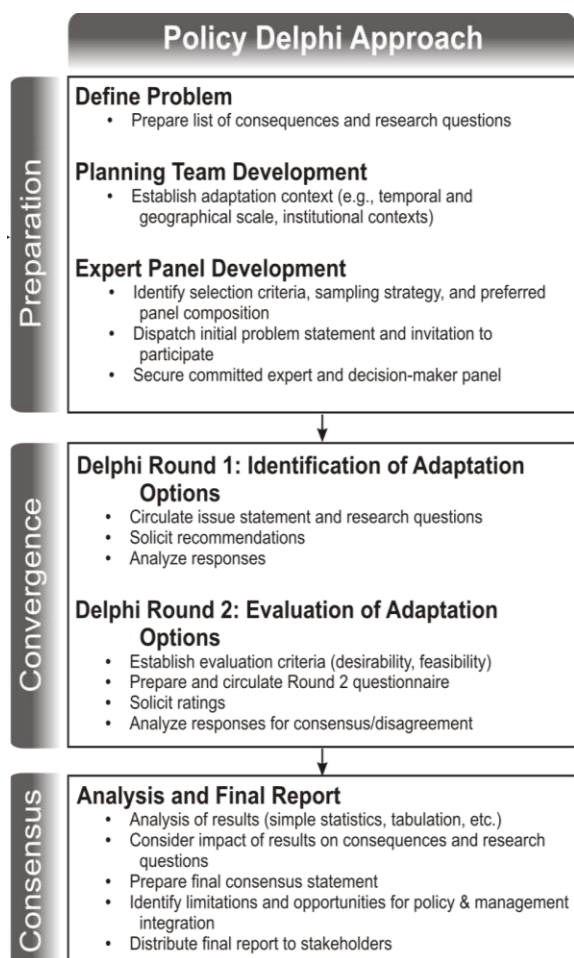
Vegetative Cover

- There will be a suitable climate for a number of new species.
- Some species will decline. For example, continued long term warming could lead to a decrease in sugar maple abundance during the second half of the century.
- Increased landscape fragmentation in the watershed will continue to threaten the ability of species to move in response to climate change.

Table 1: Rating scale and descriptions provided to policy Delphi panellists to aid in the evaluation of climate change adaptation options.

Evaluation Criteria	Rating Score			
	3	2	1	0
Priority	First-order priority; a most relevant point; has direct bearing on major issues; must be resolved, dealt with, or treated	Second-order priority; is relevant to the issue; significant impact but not until other items are treated; does not have to be fully resolved	Third-order priority; insignificantly relevant; has little importance; not a determining factor to major issue	No priority; no relevance; no measurable effect; should be dropped as an item to consider
Feasibility 1: Affordability	Definitely affordable, can be implemented within current fiscal realities <i>AND/OR</i> High cost-sharing possibilities	Some indication adaptation is affordable; possibility that adaptation can be implemented within current fiscal realities <i>AND/OR</i> Some cost-sharing opportunities	Some indication adaptation is unaffordable; additional monetary resources, or re-allocation required to implement <i>AND/OR</i> Low cost-sharing opportunities	Definitely unaffordable; adaptation cannot be implemented within current fiscal realities <i>AND/OR</i> No cost-sharing opportunities
Feasibility 2: Ease of Implementation	No identifiable internal or external barriers (e.g., legal, political, institutional, social, etc.); <i>definitely can be implemented</i>	Some identifiable internal or external barriers (e.g., legal, political, institutional, social, etc.); <i>barriers most likely can be overcome</i>	Some identifiable internal or external barriers (e.g., legal, political, institutional, social, etc.); <i>barriers may be too significant to overcome</i>	Obvious and significant internal and external barriers (e.g., legal, political, institutional, social, etc.); <i>definitely cannot be implemented</i>

Figure 2: Policy Delphi approach adopted to identify and evaluate climate change adaptation options for the Lake Simcoe Watershed (adapted from: Donohoe and Needham, 2009).



Wildlife

- Spring breeding by some amphibian species is expected to begin earlier.
- New species (including competitors) and pathogens are expected to enter the watershed.
- The southern boundary of the range of some species may shift north out of the watershed.
- Bird species richness is expected to increase; however, some species of aerial foragers may suffer due to declines in populations or changes in the behaviour of flying insects.

- Overall, bird and mammal richness is expected to increase under climate change if habitat is available.

Natural Heritage

- The status of ‘representation’ targets in existing parks will change.
- The boundaries for natural heritage areas may require adjustment to help achieve protection commitments within the context of climate change.
- Existing natural heritage areas may not provide suitable habitat for indigenous species under new climatic conditions. Conversely, suitable habitat for invasive species may increase.
- The frequency and scale of disturbances such as insect outbreaks, extreme weather events, and the distribution and abundance of terrestrial and aquatic invasive species could affect the ecological health of the natural heritage system in the watershed.

Insects

- Increased temperatures will lead to potential over-wintering and increased abundance of certain species.
- Species that are well-suited to northern conditions may struggle to survive and new species will enter the watershed.

Tourism and Recreation

- Potential shortening of the ice-in period on Lake Simcoe leading to a reduction in the ice fishing season.
- Warmer temperatures and variability in precipitation patterns could lead to shortened seasons for cross-country skiing, downhill skiing, and snowmobiling.
- Potential increases in park users may place additional stress on park ecosystems and require additional upkeep and maintenance.

Species at Risk

- Six of the 17 species at risk assessed in the Lake Simcoe Watershed (there are 62 known species at risk in Ontario) are vulnerable to climate change.

Agriculture

- The Schomberg River quaternary watershed is the most sensitive to climate change based on the following indicators: number of animals, number of irrigated hectares and water erosion potential.
- Drier conditions will lead to impacts on water availability and will affect irrigation.
- Extreme rainfall events could impact water quality through increased runoff.

Infrastructure

- Potentially, climate change will significantly impact stormwater, transportation, and drinking water.
- Most communities have experienced weather variability and extreme events in the recent past (5 years). These events have caused moderate impacts on buildings, stormwater systems, drinking water systems, information technology and communication infrastructure, and transportation.
- Intense precipitation events including rainfall during the winter months pose the greatest threat to infrastructure.
- Generally, extreme precipitation events will affect transportation and stormwater infrastructure.
- Drought will impact drinking water systems.
- Lightning and wind storms will impact buildings.
- Non-climate stressors will likely affect transportation, buildings, and stormwater infrastructure the most.

Recommendations

More than 900 recommendations were submitted by the 43 respondents to the first-round survey. Recommendations ranged from bulleted lists of action items to detailed descriptions in paragraph form. The planning team reviewed the 900 recommendations, eliminated redundancies, and re-drafted 695 recommendations in a consistent format (Appendix 6) for use in the second-round survey. With the ranking system developed for the round-two survey, the planning team identified first-order or high priority adaptation options (see Table 1). In total, 92 ideas (Appendix 5) were identified as first-order priority and an additional 48 ideas were identified as second-order priorities (denoted by ** in Appendix 6). From the 92 ideas, the following 30 strategic options were composed using the priorities identified and direction provided at the April 2011 workshop:

Engage People

1. Ensure that community engagement and interagency cooperation and coordination become part of all climate change and adaptation-related planning and management in the watershed.
2. Develop a climate change education and extension program for use by people living and working in the watershed. This program could include an introduction to climate change and climate modelling, examples of known and potential impacts to natural assets and human health, and examples of adaptive management options.
3. Encourage programs to develop and foster early adoption of adaptation measures.

Reduce Threats

1. Encourage municipal councils to formally recognize climate change adaptation in business and the provision of services.
2. Develop a cumulative effects assessment process for the Lake Simcoe Watershed that includes climate change.
3. Encourage and support water conservation through implementation of watershed-wide water conservation strategies under the auspices of the *Water Opportunities and Water Conservation Act*.
4. Include a requirement for stormwater master planning in the *Planning Act* and streamline approval processes for innovative new technology that helps manage stormwater in the watershed.
5. Develop realistic, sustainable strategic land-use policies that balance human population growth with ecosystem structure and function.
6. Promote 'green infrastructure' and water re-use as an important part of land-use planning including, but not limited to green roof and green wall technology, communal gardens, parks, walkways, riparian buffer zones, urban and rural (including transportation and utility corridors) tree planting.
7. Update design standards and codes to mitigate the impacts of climate change, and where possible mimic natural processes in the planning and design or retrofitting of built infrastructure.
8. Manage invasive species by developing and/or implementing early detection techniques and response strategies.
9. Develop emergency management strategies that help communities prepare for increased

flooding, drought, and erosion due to more frequent extreme weather events.

10. Ensure the recreational strategy being developed as part of Policy 7.12-SA of the Lake Simcoe Protection Plan considers the need to diversify attractions and destinations in order to “climate proof” the industry.

Enhance Adaptive Capacity

1. Develop a watershed-wide terrestrial and aquatic natural heritage strategy resulting in the development of a protected system of large core areas connected by sustainable linkages.
2. Normalize adaptive management in planning and management programs to address climate change.
3. Review official plans, land use plans, infrastructure plans, by-laws, and associated policies in all 18 municipalities to determine how well they account for and protect important natural assets such as woodlands and wetlands in a changing climate.
4. Ensure implementation of the recommendations in the Lake Simcoe Protection Plan to improve environmental health and ecological resilience of the watershed to the impacts of climate change.
5. Integrate use of climate change scenarios and vulnerability assessments into land-use plans and resource management plans, including but not limited to economic development plans, nutrient management plans, municipal official plans, fisheries management plans, wildlife management plans, forest management plans and Species at Risk Recovery plans.

Improve Knowledge

1. Ensure the Lake Simcoe Monitoring Plan contains indicators to detect climate-induced change, human health monitoring programs address the impacts of climate change, and effectiveness monitoring is employed in all adaptive management decision-making processes.
2. Institute standardized sampling to monitor the distribution and abundance of species-at-risk across the Lake Simcoe Watershed and promote its use in other Ontario watersheds.
3. Establish and maintain an appropriately scaled land cover mapping program to monitor vegetation and land-use change throughout the Lakes Simcoe Watershed.
4. Use integrated, multi-thematic information management tools and techniques in support of the sustainable management of natural assets in the watershed.
5. Develop socio-economic impact assessment tools for use with climate models and scenarios for the Lake Simcoe Watershed.
6. Apply socio-economic models to estimate the cost of implementing versus not implementing adaptation options in the Lake Simcoe Watershed climate change adaptation strategy.
7. Update manuals and guidelines to reflect climate change mitigation and/or adaptation options available to people working in agriculture, water conservation, and other sectors.
8. Inventory and assess the capacity of built infrastructure to withstand projected and known climate change impacts.

9. Continue to support and enhance scientific research designed to understand ecosystem resilience to climate change and other cumulative effects.
10. Sponsor research to project the potential arrival of invasive species, to prevent their establishment, to detect their presence, and to manage them should they establish.
11. Make climate models and scenarios available and accessible to inform large and small-scale natural resource management decisions, growth plan decisions, and socio economic analyses.
12. Support education and awareness programs to help people understand climate change, impacts, and adaptive management tools and techniques.

Discussion

Need for an Ongoing, Dynamic Decision-Making Process

In a rapidly changing climate, it is anticipated that responsive planning and management will aim to maintain or enhance ecological sustainability, will be socially acceptable, and will address the known and potential changes to the natural assets in the Lake Simcoe Watershed. While there is widespread agreement on the need to prepare for climate change in sustainable ecosystem planning and management, and to develop and integrate risk management strategies into current and new programs, adaptive processes are only now being described and operationalized.

Many existing, modified, and new tools and techniques will form the basis of a community's response to climate change, some of which are identified in this report. However, there is much

to learn and given the constant, often unpredictable forces and factors of climate change, a single static strategic plan will quickly lose relevance and fail to meet the needs of a society that is best served by nimble and engaged adaptive decision-making. Therefore, a dynamic, iterative climate change adaptation plan will enable responsible agencies and organizations to care for the watershed's assets on an ongoing basis. While designs for climate-sensitive adaptive management processes are beginning to appear in the academic and operational literature, there are a number of generic components that merit consideration, including:

1. Assessment of organizational readiness and where necessary improvement to the capacity of an organization's ability to respond.
2. Establishment or reconfiguration of a baseline upon which to measure change and adaptation success.
3. Development and use of climate scenarios and socio-economic scenarios to help envision future conditions.
4. Ongoing completion of vulnerability analyses using the future scenarios to assess strengths and weaknesses.
5. Identification and development of adaptation strategies.
6. Implementation of the adaptation strategies.
7. Monitoring to determine if vulnerabilities have been reduced or eliminated as a result of implementing the adaptation strategies.
8. Adjustment of the management strategies decisions where needed.

Recommendations for Future Strategic Assessments and Idea Generation

A number of observations and recommendations about project design and implementation were collected by the planning team during the project:

Use an ensemble of climate models and scenarios when possible: Access to a number of climate change projections and scenarios can significantly improve the robustness of analyses and strategic planning discussions. Many global climate models are now available on the web and work progresses on the development of regional climate models.

Engage stakeholders and experts early and substantively: The success of any project with outcomes that will impact the daily lives of people living and working in an area will, in large measure, depend on the participation and uptake by stakeholders. Therefore, stakeholders and resource experts should be engaged early and substantively.

Scope: Given the complexity of ecosystem composition, structure, and function and the human position in it, it is important to complete, the greatest extent possible, vulnerability assessments for the suite of forces and factors that shape the ecosystem and affect human health and well-being.

Ensure that appropriate expertise (capacity) is in place: The project planning team should determine and secure the expertise needed to successfully complete the project.

Allow adequate time to participate in climate change adaptation planning: The policy Delphi process for the Lake Simcoe project was completed in about three months. This amount of time was inadequate given the complexity and novelty associated with climate change

adaptation planning, the scope of the research, the time and intellectual demands placed on survey respondents, and the time required by the research team to develop the survey, synthesize results, and write a final report.

Enable completion of vulnerability analyses: Program sponsors should ensure that adequate and time and resources are available to secure climate models and scenarios and complete vulnerability analyses.

Carefully select idea generation tools to match needs and expectations: Every situation and strategic planning process is unique. There are a variety of idea generation tools and techniques available to support strategic thinking and option development. Many of these techniques can be used in various combinations. For example, the process described in this report involved the use of workshops (including a global café approach), face-to-face meetings, e-mail surveys, and a policy Delphi process.

Provide incentives to participants: The policy Delphi is an idea generating technique that often places substantial time and intellectual demands on participants. Incentives could improve survey response rates. In addition, experience with the use of incentives in other jurisdictions suggests that they will increase respondents' willingness to participate in future studies and follow-up activities, including workshops.

Improve the capacity of the on-line survey engine: The online surveys were cost effective and efficient. However, the first-round survey, which used a web-based browser application, did not allow respondents to save their responses. Consequently, respondents were forced to complete their surveys in a single session. Given the time and intellectual demands placed on respondents, a word processor or Adobe® version

of the software is recommended for on-line surveys.

Engage communities on an ongoing basis: Given the site-specific and dynamic nature of climate change impacts, ongoing planning and management strategies developed at the local level are key.

Assessment of Risk: Traditionally, vulnerability assessments have used historical data and information to identify impacts, system change, and the efficacy of previous coping mechanisms. Managing for climate change, however, requires use of tools and techniques that allow scientists and decision-makers to project into the future, identify the range of potential conditions, and identify the spectrum of adaptation options available to respond to emerging conditions. Therefore, a robust approach to evaluating the risks of climate change requires an estimate of the probability that an area will be impacted and a list of the associated consequences. This type of risk assessment permits planning teams to identify the range of ecological and socio-economic vulnerabilities that may result from climate change.

Concluding Remarks

Biodiversity will change in response to the combined influence of climate change, human activity, the movement of indigenous and invasive species, and natural disturbances such as flooding and drought. Some species will adapt to these changing conditions and others will not. Species with high reproductive rates that can migrate long distances, rapidly colonize new habitats, tolerate human activity, and survive within a broad range of biophysical conditions are likely to be most successful. In some Lake Simcoe Watershed ecosystems, novel species assemblages may emerge. Climate change will also affect many socio-economic values that are important to

people living and working in the watershed. For example, shorter winters and reduced lake ice cover will affect recreational activities such as skiing, snowmobiling, and ice fishing, but may extend opportunities to pursue other outdoor activities such as camping, canoeing, and open water fishing. Therefore, managing climate-driven changes to natural assets and built infrastructure will constantly challenge watershed communities as temperatures increase and precipitation and wind patterns change.

Knowing when to act and what actions to take depend on understanding and projecting the effects of climate change on the watershed's natural assets, built infrastructure, and human activities. Uncertainty about future greenhouse gas emissions and the spatial distribution of climate change effects require that we use a dynamic and ongoing approach through adaptive management.

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Appendix 1: Questions Used in the On-line Survey of Lake Simcoe Watershed Communities

1. In its current state, has your community experienced: long term changes in average temperature or precipitation; variability of weather such long dry periods, excessive snow, cumulative rainfall; extreme events such as wind storms, rain storms, or drought?
2. Have your operations been challenged by the weather events? Consider geographic areas within the community, portions of the population, specific types of infrastructure, etc. Also consider the current state of the infrastructure as well as where it is in the life cycle, whether maintenance has occurred, etc.
3. Have you experienced losses due to weather events? Consider economic, social, and environmental losses.
4. What have you done to cope with the changes in weather (extremes), have these been acceptable responses and will they continue to be effective into the future if weather and climate continue to change?
5. Given the trends in climate and weather data as well as the projections of future climate, do you intend to take action in some way? Develop a CCA strategy? Assess potential climate change impacts? Conduct further vulnerability assessments? Assign staff to undertake CCA training or further education in some way? Conduct a risk assessment?

Appendix 2: Questions Used in the Survey Completed by Provincial Agency Representatives

The following questions move through the different steps of a vulnerability framework and attempt to assess current and future vulnerabilities to both climate and non-climate related stressors. It also attempts to assess the degree of sensitivity and exposure for each pertinent area and its capacity to adapt to historic and future climate variability and change.

Following a review of historic and current vulnerability, experts will try to understand how those system(s) coped with climate variability and change in the past. This assessment of adaptive capacity gives insight as to how the system(s) will hold up to continued and increased future climate stresses. The next phase uses projections of future climate, through the use of scenarios, to assess how the current vulnerabilities will be enhanced and what new climate stressors will arise. These scenarios also need to include the non-climate factors (projections of future growth in the watershed). Historic coping mechanisms or adaptive measures can then be evaluated for efficacy and future vulnerabilities translated into risks.

Consider the following framework and questions in the context of your area of responsibility (group, branch, division). Focus your thinking on the built infrastructure and policies that govern their development and use. The geographic scope of this exercise includes the Lake Simcoe watershed. Scenarios for future growth and future climate will be provided. Temporal scope will extend to 2050.

1. Built systems face stresses from non-climate related factors including population increase,

economic growth and diversification, land use changes and other external influences. Please list these factors and state specifically how they may have contributed to creating vulnerability in the built system(s). Examples include population growth, land use changes, economic diversification, lifestyle changes, etc. Consider the infrastructure age, point in lifecycle, maintenance record, capacity and design criteria.

2. In order to fully understand the impacts of climate variability and climate change on built systems, reveal how the infrastructure [has] been challenged by historic weather extremes and/or long term changes to average temperature and precipitation? Consider the following climate factors: periods of extreme precipitation (rain/snow, hail [and] sleet), extreme wind events, periods of extreme heat, warmer average temperatures (seasonal, annual), warm winter days (temperature > 0°C), periods of drought and any examples of cumulative hazards.
3. The above 2 factors (climate and non-climate stressors) give an indication of historic and current system vulnerability. Consider how the infrastructure/system(s) has responded to these stressors. This gives an indication of carrying/coping capacity of the infrastructure/system(s) including whether historic methods of coping and adapting have been sufficient.
4. Given the historic vulnerabilities of the infrastructure/system(s), and given the climate will continue to change, both through long term average changes and changes to the extremes, how might the existing vulnerabilities be enhanced? Consider both non-climate stressors and climate-stressors. To quantify what climate change means, consider developing scenarios which give a range of plausible futures. We suggest 2 futures – a low climate future would equate to weather functioning more or less within

the range of historic variability with minimal exceedances beyond the traditional coping zone. A high climate future would see more intense extremes happening more often. It would also include continued increases in average temperatures with shortening of the winter season.

5. Given the vulnerability of the system(s), evaluate how these vulnerabilities translate into future risks. Evaluate the risks based on the impacts to social systems, the environment and the economy.

Appendix 3: Questions used in the November Workshop to Identify Adaptation Strategies

1. What information is required to support robust and flexible decision-making?
2. What goals or objectives are needed to guide future municipal or watershed strategic plans?
3. What are some examples of barriers to adaptation that can be eliminated by modifying legislation and/or policy?
4. What communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts?
5. What potential management actions and enhanced education, extension, and training opportunities exist within management agencies to enhance the understanding of climate change impacts?
6. What management actions are needed to mitigate the negative impacts and exploit any beneficial opportunities associated with the known and potential consequences?

Appendix 4: Questions Used in the Policy Delphi First Round Survey

Legislation and Policy

1. What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).
2. What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

Strategic Planning

1. Given the vulnerabilities to climate change, what goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?
2. List any targets or recommended actions from the Lake Simcoe Protection Plan, 2009 that relate directly to Climate Change Adaptation and state how you think they could be improved.

Land Use and/or Resource Management Planning

1. Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

Management and Operations

1. What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

Monitoring

1. What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?
2. Given your answer to question #1 above, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

Research

1. Given the vulnerabilities, what research priorities are needed to support adaptive decision-making in a rapidly changing climate?

Knowledge Dissemination (Communication)

1. What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?
2. What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

Appendix 5: The 92 First-Order Recommendations Selected from the Results of the Policy Delphi

Strategic Planning

1. The implementation of all recommendations in the *Lake Simcoe Protection Plan* will significantly improve the environmental health and ecological resilience of the Watershed to the impacts of climate change.
2. Develop a comprehensive terrestrial and aquatic natural heritage area system

containing large core areas and exhibiting high connectivity throughout the Watershed in order to:

- Enhance the resilience of ecosystems and species under changing climatic conditions;
 - Ensure the persistence of species at risk; and,
 - Facilitate species response to climate change.
3. Develop explicit terrestrial and aquatic natural heritage protection targets for the Watershed and encourage all levels of government and environmental groups to work toward the mutually beneficial and consistent goals.
 4. Develop restoration targets and goals through a collaborative process that engages conservation agencies and organizations and local communities.
 5. Develop goals for sustainable tourism for the Watershed that address climate change.
 6. Develop a strategic plan for tourism in the Watershed that focuses on diversifying attractions and destinations in order to “climate proof” the industry by reducing disparities in tourism demand between high and low seasons and to mitigate losses in demand for sectors expected to suffer disproportionately from climate change in the future (e.g., winter activities such as ice fishing).
 7. Develop a *Lake Simcoe Climate Change Adaptation Plan* that includes quantified targets and objectives for socio-economic and ecological conditions that are resilient to the impacts of climate change.
 8. Encourage and support water conservation and the preservation and enhancement of agricultural lands, forests, and wetlands, by focusing on densification in urban areas and low impact development in rural areas.

9. Include climate change considerations and socio-economic analyses in economic development and related business plans.
10. Review the *Integrated Monitoring Strategy* for the Watershed and revise it to include climate change indicators such as stream and lake water temperatures, timing and duration of ice cover, lake stratification, and oxygen levels.
11. Make climate models and scenarios available and accessible to inform large and small-scale natural resource allocation decisions to ensure sustainability of ecological goods and services.

Legislation and Policy

1. Climate change should be integrated into species at risk assessments and *Species at Risk Act* (SARA) recovery strategies.
2. The *Provincial Policy Statement* (PPS) should be revised to include protection for all representative habitat types, not just wetlands.
3. Build adaptive management principles into water withdrawal regulations to ensure that water levels can be maintained and managed sustainably in response to changing climatic conditions.
4. Develop a tourism promotion policy that includes adaptive management principles in order to contribute to the local economy and respond to the needs of recreationists without compromising the sustainability of the natural assets of the Watershed in a rapidly changing climate.
5. Develop realistic, sustainable, and strategic land-use policy that balances human population growth and needs, ecosystem carrying capacity, and ecological goods and services.
6. Conduct a review of current official plans and associated policies in all 52 municipalities to determine how well they serve to protect remaining woodlands and wetlands.

7. Develop a watershed level forest management policy that addresses the protection and restoration of woodlands in response to a changing climate.

Knowledge Management: Research

1. Complete a spatial and quantitative analysis of the greenways and blueways that will be delineated and protected under the auspices of a fully implemented *Lake Simcoe Protection Plan* and determine if these areas provide optimal connectivity to mitigate climate change impacts.
2. Ensure that scientific and local knowledge is used to identify known and potential impacts of climate change and ensure that this knowledge is used to inform the development of future strategic plans.
3. Complete research on ecologically and socially meaningful planning objectives or targets for terrestrial and aquatic ecosystems.
4. Explore use of targets, thresholds, and the “no net loss” concept in the allocation of ecological goods and services.
5. Continue to support and enhance scientific research designed to understand and predict ecosystem change in-space-in-time (e.g., the conditions under which a wetland changes into a completely different ecosystem such as a dry land habitat of some kind).
6. Conduct research on tools and techniques to conserve and enhance biodiversity (e.g., populations and habitat) in a rapidly changing climate.
7. Complete research on the cumulative impacts of multiple stressors (of which climate change is only one) on ecosystem composition, structure, and function.
8. Complete research on the prevention, management, and/or elimination of invasive species.
9. Carry out the research necessary to be able to explicitly define and describe “resilient ecosystems” in the context of climate change.

10. Conduct an assessment of the risk associated with the movement of wood products (e.g., trends in firewood use) as disturbance vectors (e.g., Emerald Ash Borer, Asian Long Horn Beetle, 1000 Canker Disease, and Butternut Canker) for the potential impact on natural and urban forests.

11. Research on cumulative impacts and interacting stressors related to each invasive species in the Watershed is required.
12. Research into alternative drainage and irrigation practices in the Watershed to conserve water and prevent nutrient leaching during rainfall events.

Knowledge Management: Monitoring

1. Implement all monitoring programs developed as part of the *Lake Simcoe Protection Plan* (i.e., water chemistry, nutrient load, flooding, ground water, land-use change, tracking of best management practices, atmospheric monitoring and fish population indicators in the lake, stream monitoring of fish and invertebrates at sites throughout the watershed) and enhance monitoring programs with climate change indicators.
2. Develop an Integrated Monitoring Program that increases effectiveness by fostering interagency cooperation and maximizes data collection at each site and within each program.
3. Develop monitoring priorities by identifying and describing all natural capital, replacement rates, terrestrial and aquatic ecological services, and natural processes related to water quality and quantity in the Lake Simcoe Watershed.
4. In collaboration with health officials, develop a climate impact human health and well-being surveillance system that tracks and reports on heat stress, vector and water borne diseases, extreme weather threats, and other health and well-being related impacts.

5. Institute standardized sampling to monitor distribution and abundance of Species at Risk (absolute and relative) on a regular basis across in the Lake Simcoe watershed and the rest of Ontario.
6. Ensure that an adaptive management framework is incorporated into the Integrated Monitoring Strategy so that monitoring can proactively adapt to shifts in species distribution as climate changes to detect species declines before they become species-at-risk.
7. Develop an Effectiveness Monitoring process to evaluate land-use plans in the Watershed for their effectiveness in protecting aquatic and terrestrial ecosystem assets and values.
8. Target species that are most common to the region and known to be sensitive to change.
9. Track changes in diversity and distribution of targeted species in the Watershed at a fine enough scale so that climate sensitive and climate tolerant taxa are not clustered together giving wrong conclusions.

Knowledge Management: Inventory

1. Commit to updating land-use and land cover mapping on a regular basis using new technologies, such as remote sensing.
2. Carry out a comprehensive, fine-scale vegetation inventory for the Watershed.
3. Design and implement a data collection process to gather vegetative cover data using state of the art remote sensing, GIS techniques, and ground plots.
4. Collect data and information at local to regional planning scales.
5. Employ tools and techniques that permit planning teams to complete integrated assessments (e.g., GIS overlay mapping) for the sustainable allocation of ecological goods and services at the Watershed scale.

Knowledge Dissemination (Communication)

1. Develop a climate change education strategy that will provide local examples of future scenarios, vulnerabilities, and impacts to better link adaptation and mitigation actions with communities located within the Watershed.
2. Create demonstration sites at specific locations within the Watershed (e.g., natural heritage areas and other tourism locations) to educate visitors on climate change impacts and sustainable responses (e.g., energy efficiency).
3. Carry out a public awareness campaign, similar to the “Plant Me Instead” program with landscapes, garden centers, and the public to reduce the use of invasive species for horticultural purposes.
4. Develop outdoor experiential education programs to connect people to the ecosystems in which they live and to educate them about local and global climate change impacts and management responses.
5. Use the term “Green Infrastructure” to convey the concept that healthy and functional natural systems are required all around us to sustain human social and economic systems.
6. When developing monitoring programs, include priorities for monitoring indicators that will lead to changes in human behaviour, quality and quantity of drinking water, flood attenuation, and conserving habitat for pollinators.
7. Train agency staff on inventory and monitoring of indicators that may be currently underutilized such as insects.
8. Ensure that community engagement is built into all climate change and adaptation related planning in the watershed.
9. Create a communications program for the Lake Simcoe Watershed that includes information about trends in ecosystem health, the results of research, management tools and techniques.

10. Produce a series of fact sheets to inform business people of climate change adaptation and mitigation actions that could be pursued to make their operations more sustainable.
11. Revise the *Environmental Farm Plan* and *Stewardship Handbook* to include climate change adaptation measures.
12. Revise rural land management Best Management Practices handbooks and material to include climate change adaptation measures.

On-Site Planning and Management

1. Develop a Watershed-wide restoration/rehabilitation plan to provide direction to agencies involved in afforestation to optimize connectivity in the Watershed to enhance ecosystem resilience to climate change.
2. Develop early detection and management strategies for terrestrial and aquatic invasive species (including vectors) for the Lake Simcoe Watershed.
3. Develop habitat-specific response plans for harmful invasive species in order to allocate resources for control or eradication in a timely manner to reduce their impact on native biodiversity and avoid greater economic consequences in the future.
4. Develop emergency management strategies that help communities and businesses prepare for increased flooding, drought, and erosion due to more frequent extreme weather events in the Watershed.
5. Develop and implement Watershed-wide water conservation strategies to decrease water demand and use.
6. Develop and implement specific greenhouse gas (GHG) reducing initiatives in the Watershed. Examples include:
 - “car free” resorts/destinations;
 - public transport;
 - pedestrian friendly sidewalks, trails, and cycling paths and networks; and,
 - incentives for non-mechanized travel.

7. Green infrastructure should be promoted and integrated into all economic development and land-use planning initiatives in the Watershed. Examples include:
 - Parks;
 - Green walkways and corridors;
 - Riparian buffer zones;
 - Green roofs technology;
 - Green wall technology;
 - Urban and rural tree planting; and,
 - Tree planting along transportation and utility corridors.
8. Tree planting initiatives should be promoted by all levels of government to improve air quality, conserve water, regulate climate, save energy, provide habitat, and improve economic sustainability.
9. Use scientific knowledge about tree species survivability and growth in a changing climate to design and implement afforestation and other tree planting programs in the Watershed.
10. Design watershed-wide ecological restoration programs to increase biodiversity and create linkages between natural areas using explicit targets and goals such as leaf area index in urban areas and percentage natural cover in rural areas.
11. Integrate use of climate change scenarios and vulnerability assessments into land-use plans and resource management plans, including but not limited to nutrient management plans, municipal official plans, fisheries management plans, wildlife management plans, and forest management plans.

Enablers (Including Principles)

A number of recommendations were categorized as ‘enablers’ or strategies that can help practitioners design and engage in active adaptive management:

1. Adaptive management should be a principle embedded in all climate change related planning. As a case in point, given the

uncertainty of climate change impacts in the future, constant monitoring and re-evaluation of decisions will enhance a community's chances of success.

2. The Ministry of Natural Resources (MNR) and Ministry of Environment (MOE) need to improve interagency communication and cooperation to ensure water quality and quantity are protected and ecosystem health and resilience are enhanced in a rapidly changing climate.
3. Incentive programs are required to foster early adoption of adaptation measures (e.g., to keep marginal land in pasture and manage lands to maintain and enhance biodiversity).
4. Adapting to climate change will require increased levels of collaboration and cooperation at many levels, including between agencies, between different levels of management with agencies; and, between themes and sectors. This needs to be made explicit in the design of policy, strategic plans, work plans and project charters.
5. Achieving the consensus required to move forward on climate change adaptation programs will require the design a specific process to engage and include local communities in the development of adaptation policies, frameworks, and plans.
6. Government agencies responsible for the Lake Simcoe watershed should foster a culture of decision-makers who continually use short- to long-term visioning processes (e.g., 5-50 years) to identify policy and management options to address pressures resulting from human population growth, climate change, and other cumulative impacts.
7. The provincial government should sponsor a cumulative effects assessment process for the Lake Simcoe Watershed that reflects the Statement of Environmental Values prepared by ministries under the auspices of the

Environmental Bill of Rights, and addresses the impacts of climate change.

8. Ensure an accessible knowledge management system is developed and used in support of adaptive decision-making in a rapidly changing climate. The science must be conveyed to decision makers in clear, accessible, and unambiguous terms.

Infrastructure

A number of infrastructure-related adaptation options were identified by the November workshop participants and representatives attending the February face-to-face meeting:

1. Develop an inventory of current infrastructure to measure baseline conditions, performance and capacity constraints.
2. Assess whether design standards are adequate and whether codes need to be changed and/or updated.
3. Develop guidelines and policy to encourage and support the use of rainwater capture and reuse technology at houses and other buildings.
4. Integrate stormwater master planning into the *Planning Act*.
5. Remove the barriers that prevent the integration and harmonization of F/P/M legislation that governs climate change adaptation.
6. Streamline approvals processes for innovative, new technology that helps manage stormwater.
7. Integrate adaptation into school curricula.
8. Develop clear messaging about how to deal with the uncertainty of the scale and pace of future climate change as depicted in the variety of models available to practitioners.
9. Make every effort to mimic the natural environment when planning and/or retrofitting subdivisions.
10. Mandate an increase on design standards.

Appendix 6: Policy Delphi First-Round Survey: Climate Change Adaptation Options for the Lake Simcoe Watershed

Note that 48 recommendations marked ** are second-order priorities.

Theme 1: Natural Heritage Areas

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. **Require natural heritage systems to be established using existing statutes and policies (e.g., Planning Act, Provincial Policy Statement).
2. Amend the Provincial Policy Statement (PPS) to include the identification of key natural heritage areas for climate change adaptation as part of a larger natural heritage strategy.
3. Strengthen the auspices of the Provincial Policy Statement (PPS) to maximize connectivity and ecosystem resilience in a rapidly changing climate.
4. Increase protection of Areas of Natural and Scientific Interest (ANSIs) by prohibiting development.
5. Work on developing a new definition of ecological integrity and ecological resilience for integration into legislative amendments (e.g., the Provincial Parks and Conservation Reserves Act), new legislation, and policies.
6. Re-evaluate and where necessary redefine Ontario Parks' "guiding principles" such as 'representation' and 'permanence'.

7. All policies and legislation should incorporate adaptive management to address climate change on an ongoing basis.
8. Policy should adopt a greater ecosystem approach concept to better integrate natural heritage areas in the wider landscape context.
9. A coordinated and complimentary approach to natural heritage areas system planning that includes all levels of government and private organizations needs to be developed.
10. Develop strategy/protocol/guidelines to identify gaps in the natural heritage system.
11. Define new protection commitments taking climate change into consideration.
12. Integrate species-at-risk protection into long-term natural heritage area protection.
13. Create or ensure instruments to use parks, conservation reserves, easements, or strong zoning into a network of greenspace and bluespace.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. **Natural heritage areas systems need to be robust (i.e., exhibit high connectivity), with large core areas, as defined in the Natural Heritage Reference Manual.
2. Ecological integrity objectives should be used to implement greater protection mechanisms in the Watershed.
3. The Provincial Policy Statement (PPS) should incorporate climate change and be used to identify corridors to maintain ecosystem resiliency, protect vulnerable species, and facilitate natural movement of organisms in response to changing conditions.

4. Climate change should be used to help rationalize and compel the implementation of ecological integrity objectives.
5. The relevance of Ontario's ecosystem framework should be reviewed regularly in the context of a rapidly changing climate.
6. Selection criterion of "ecological functions" should receive greater emphasis in natural heritage system design to better ensure the long-term persistence of species in the Watershed.
7. Ecological integrity assessments should be made relative to the prevailing climate at the time and not historical benchmarks.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. A target of 50% or more natural heritage areas needs to be established throughout the Watershed to enhance ecosystem resilience to climate change and ecosystem regulating services (such as climate regulation).
2. Large scale ecological restoration in strategic areas is needed to enhance landscape connectivity between core areas and to build resilience against long-term climate change and short-term extreme weather events.
3. By 2012, the Wetland Evaluation System for Southern Ontario needs to be updated to include a scoring component on the contribution of wetlands to climate change adaptation.
4. By 2012, all municipalities in the Lake Simcoe Watershed should go beyond the Provincial Policy Statement (PPS) and protect all wetlands.
5. **The goal of strategic planning in the Watershed should be to maintain/enhance ecosystem resilience.

6. The objective of strategic planning in the Watershed should be to reduce existing pressures on natural systems (e.g., avoid or mitigate impacts from land uses outside natural heritage areas), ensure no net loss of natural cover, and improve connectivity (through the restoration degraded ecosystems).
7. An integrated natural heritage area climate change strategy should be developed to ensure that natural heritage area systems are integrated into a plan to achieve three primary goals: (1) biodiversity conservation; (2) ecosystem health; and, (3) human health and well-being.
8. Adaptive management should be explicitly incorporated into strategic planning to anticipate uncertainties associated with climate change.
9. Principles of adaptive management and the ecosystem approach should be incorporated into all strategic planning initiatives (e.g., strategic/corporate systems planning, site level management plans).
10. **Strategic planning should provide for collaboration and consultation between natural heritage area agencies in the Watershed.
11. Strategic planning should be explicitly tied to and integrated with provincial and national strategic plans for water, biodiversity, and natural heritage areas.
12. Climate models should be used to plan strategically.
13. Using an ecosystem approach, watershed management agencies should plan for the care and management of natural assets that may end up completely or partially outside of protected area boundaries.
14. Policies and strategies should recognize that natural adaptation of species and ecosystems can be fostered through healthy, resilient, unstressed populations and environments free from pollution and invasive species.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. Actions noted in the Lake Simcoe Protection Plan need to be more specific. For example, specific measures for achieving naturalized riparian areas on Lake Simcoe and along streams are required.
2. Strategic planning should focus on achieving the 40% high-quality natural cover noted in the Lake Simcoe Protection Plan.
3. Policies and targets should not only address elements of biodiversity pattern, but should also include the spatial and temporal aspects of natural processes, including population sizes, movements, metapopulation dynamics, disturbance regimes, ecological refugia, and adjustments.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

1. Principles of adaptive management and the ecosystem approach should be incorporated into all land-use planning initiatives (e.g., preparing and implementing resource management plans and their subset of interventions).
2. More aggressive requirements for ensuring and enhancing ecological functional connectivity are required within land-use and/or resource management plans.

3. Newly exposed shorefront lands on lakes in the Watershed should be secured under public protection and managed for the new biological communities that will evolve there.
4. Management plans for all natural heritage area types needs to specifically address how climate change is likely to affect ecological integrity and provide management direction to help address the issues.
5. Natural heritage agencies and organizations in the Watershed should use the climate change issue as a catalyst to accelerate the process of establishing additional protected areas.
6. The Lake Simcoe Protection Plan should be used to improve the permanent protection of wetlands.
7. Climate change adaptation indicators need to be identified, defined, and used to assess the successes and challenges of specific management plans.
8. Ensure that all natural resource management plans are reviewed to examine the implications of climate change to the plan, given that it is a significant force that shapes ecosystem composition, structure, and function.
9. Management plans should be based on the most relevant definition of invasive species.
10. Management plans should address 'assisted migration' as a management tool in a rapidly changing climate.
11. Remediation plans that address water quality issues that might arise as a result of warmer temperatures in summer need to be developed to ensure visitor safety to natural heritage areas.
12. Management and visitor management plans need to address the potential for increased numbers of people wanting to access natural heritage areas in the Watershed.
13. Management plans and visitor management plans need to address an increase in park operating season length.
14. Management plans and visitor management plans need to address new and emerging

- diseases and parasites, such as Lyme disease, that may affect visitor health and safety.
15. Vegetation rehabilitation strategies in natural heritage areas need to be developed in light of climate change.
 16. Management plans should explore opportunities to increase connectivity of greenspace and bluespace by providing underpasses/overpasses to ensure the movement of species.
 17. Use climate models to identify potential climate change impacts and to establish strategic adaptation targets accordingly.
 18. “Clustered” management plans that provide a generic management prescription for similar natural heritage areas should be used to provide the flexibility needed to incorporate climate considerations.
 19. A Land Trust that covers the southern part of the Lake Simcoe Watershed is required to implement conservation actions in priority areas aimed at enhancing ecological resilience in required.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. Enhance habitat connectivity and habitat corridors along natural linear features (e.g., streams).
2. Strategic habitat restoration to enhance the size (area) of significant natural areas to enhance the resiliency of natural heritage areas to the effects of extreme weather events.
3. Planting and other restoration programs in natural heritage areas need to consider the tolerance of species to future predicted regional climate scenarios, most notably for long-lived tree species.
4. Based on future climate scenarios, and species tolerance assessments, assisted migration should be studied, and where reasonable, implemented and monitored within an adaptive management framework.
5. Implement the Area of Natural and Scientific Interest (ANSI) confirmation procedure to confirm candidate ANSIs and secure the natural heritage area system (and the ecological functions and services that these areas provide).
6. Public and private stewardship initiatives could be used to restore degraded ecosystems and improve ecological connectivity in the Watershed.
7. Naturalize and de-channelize streams where possible.
8. Natural heritage area planning by Ontario Parks should incorporate ‘redundancy’ into representation requirements to better ensure the perpetual representation of species in an era of rapid climate change.
9. Natural heritage area agencies and organizations within the Watershed should become provincial leaders in the reduction of GHGs associated with their operations.
10. Permanent dock fixtures within natural heritage areas should be replaced by floating docks to facilitate annual relocations subject to water levels and to reduce impacts on aquatic ecosystems.
11. Coastal natural heritage areas within the Watershed should seek opportunities to re-design access and pedestrian traffic controls with greater environmental and climate change considerations where marked beach regression is occurring.
12. Recreational uses (e.g., swimming, walking, day-use, mechanized travel, etc.) could be altered (e.g., decreased/eliminated) to protect newly exposed shorelines and allow for stabilization through natural succession.
13. Mandatory check-points and cleaning stations should be installed in coastal heritage areas to

ensure boats are clean of non-native/invasive species prior to their launch.

14. Natural heritage area jurisdictions should invest fewer resources into winter programs due to the anticipated reduction in seasonal use and invest more in warm weather recreation options.
15. Camping seasons should be extended in selected provincial parks to take advantage of potential increases in visitor use.
16. Species-at-risk planning within the Watershed should address expansion and contraction of habitat within and beyond natural heritage areas.
17. Develop and apply adaptation indicators to help evaluate success in implementing an approach to management.
18. Protected area managers should re-assess definitions, policies, and management approaches to alien species.
19. Natural heritage area managers should assess and modify prescribed burning programs in light of climate change.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. Existing watershed monitoring (report cards) should be maintained linked to climate data.
2. A system of permanent monitoring plots for various taxa should be established.
3. Monitor and report changes in species distributions relative to historic data (e.g., to determine if there is a northwards spread of historical southern species, or conversely, a retreat of more northerly species from the Watershed).
4. The northwards spread of exotic invasives and disease agents/pathogens should be selectively monitored.

5. Monitor changes in the area and composition of natural cover (e.g., to ensure no net loss of natural cover).
6. Monitor indicator species with narrow climate envelopes.
7. Establish indicators of ecological integrity.
8. Management plans should incorporate long-term trends analysis to help guide longer-term actions and priorities.
9. Vulnerable coastal facilities should be inventoried and monitored (inform decisions about possible closures of some areas to public use).
10. Jurisdictions needs to more aggressively monitor lake ice conditions to help inform decisions related to public access and travel in the shoulder seasons and ensure visitor safety in natural heritage areas.
11. Status of rare, threatened, and endangered species needs to be established.
12. Socio-economic indicators need to be monitored in natural heritage areas (e.g., types of activities, expenditures, demographics, satisfaction with experience in natural heritage areas, etc.).
13. Develop and implement a monitoring mechanism to assess effectiveness of decisions of the Lake Simcoe Protection Plan with respect to natural heritage.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. Encourage the use of time-series maps to highlight the extent and speed of potential changes in climate.
2. Consider establishing a program for ecological inventory, monitoring and reporting that enables natural heritage managers to

effectively assess ongoing and emerging climate change impacts.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Research on ‘activity substitution’ is required to help minimize revenue losses within natural heritage area agencies and organizations.
2. Key wetland and riparian areas important to climate change adaptation need to be identified for the Watershed.
3. Establish management approaches and techniques for cost-effectively managing more severe and frequent disturbance regimes, both in terms of weather events and invasive or eruptive insect outbreaks or other pathogens.
4. Research on management prescriptions is required to strengthen the likelihood of long-term success of active management activities such as assisted migration.
5. Research on possible “collateral damage” (population eruptions or community level changes) arising from assisted migration activities is required.
6. Research on optimal habitat connectivity aimed at facilitating species dispersal to more favourable habitats.
7. Develop risk assessment tools to assist managers with evaluating the potential effects of climate change on specific values and/or pressures.
8. Complete comparative studies of species movements and ecological fluxes in fragmented versus connected landscapes.
9. Policies for natural heritage areas in the Watershed should embrace a science-based adaptive management approach to better deal with potential climate change impacts.

10. A research strategy for the Watershed, which includes the roles of natural heritage areas, needs to be developed.
11. A research strategy on how to protect cold-water habitats is required.
12. Research on habitat rehabilitation techniques in a rapidly changing climate is needed.
13. As per the Provincial Parks and Conservation Reserves Act (PPCRA), natural heritage areas should be used to facilitate research and provide points of reference to support monitoring of ecological change.
14. Research on the effects of climate change on ecological integrity and the implications for human health and well-being is required.

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Natural heritage area agencies should use social media technologies (e.g., Facebook, Twitter, Digg, YouTube) to inform visitors and the public about climate change impacts.
2. Climate change information in natural heritage education programming (e.g., interpretation activities) should be included at provincial parks and other natural heritage areas in the Watershed.
3. Natural heritage area agency websites should provide information on climate change and mitigative and adaptation actions.
4. Natural heritage area jurisdictions should establish a warning system for visitors through websites, campsite reservation site and reservation confirmation letters about the health and safety (e.g., beach closures), forest fires, and invasive species.
5. Demonstration monitoring should be employed to illustrate to visitors some of the

environmental changes caused by climate change within natural heritage areas.

6. A standard educational package at the provincial level should be developed with regional specialists disseminating information and training staff at the park level.
7. Natural heritage areas should be used to educate the public (e.g., through interpretation activities) about climate change impacts and the implications of these impacts for park features (e.g., species, habitats, ecoregions, physiography, etc.) and to build public support on climate change initiatives.
8. "State of" natural heritage area resource reporting should include a climate change component.
9. Agencies and organizations should work with the provincial government, professional organizations, the public, and lake associations, on climate change education initiatives in natural heritage areas.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

1. Inter-agency climate change forums should be developed to share information and expertise.
2. Tools and techniques that indicate the risks of 'not doing anything' need to be developed.
3. Natural heritage area agencies need to ensure that all staff has a level of understanding of, and capacity to respond to, climate change impacts and adaptation appropriate to their mission.
4. Climate change impacts and actions should be explicitly recognized as an ecosystem management issue in state of the protected areas reporting and monitoring frameworks.

Theme 2: Wildlife

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. The Planning Act and the Conservation Authorities Act should be used to improve landscape connectivity for wildlife in the watershed.
2. The current Greenbelt Plan does permit conversion of forest and wetland cover to agriculture, and the extent of such activities should be evaluated in 2015 when this policy is due for review.
3. To augment the resilience of all wildlife populations to the impacts of fragmentation under projected climate changes, land managers should attempt to increase landscape connectivity in the Lake Simcoe basin by promoting establishment of natural cover, with a focus on highly fragmented subwatersheds.
4. **Planning and Conservation Authority Acts should mitigate further loss of natural cover, and work towards increasing natural landscape connectivity in the watershed.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. **Municipal Official Plans should be evaluated to determine how well their policies protect remaining woodland and

wetland cover and to identify key gaps in the natural heritage system.

2. The Planning Act and Conservation Authorities Act should be used to mitigate the loss and fragmentation of habitat in the watershed.
3. **As per the Provincial Policy Statement (PPS), the diversity and connectivity of natural features in an area and the long-term ecological function of natural heritage systems should be maintained, restored or improved, recognizing linkages between and among natural heritage features and areas.
4. As per the Greenbelt Plan, promote connections between lakes and the Oak Ridges Moraine and Niagara Escarpment as well promote linkages between ecosystems and provincial parks and public lands.
5. As per the Provincial Parks and Conservation Reserves Act (PPCRA), protect representative ecosystems, biodiversity and provincially significant elements of Ontario's natural... heritage and manage these areas to ensure that ecological integrity is maintained.
6. Maintain ecological processes at the community level, which are dependent upon connections for gene flow and dispersal with other preserves or large high quality habitat patches in the region.
7. Increase natural cover in highly fragmented subwatersheds to increase landscape connectivity in the watershed.
8. The Provincial Policy Statement (PPS) should be updated and harmonized with the Greenbelt Plan and Oak Ridges Moraine Conservation Plan in the Lake Simcoe Watershed by including all wetlands as significant features, rather than just evaluated wetlands.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. The 6th objective in the Lake Simcoe Protection Plan (LSPP) (p.5) should also include the notion of resilience of the ecosystems, e.g., "improve the resilience of the Lake Simcoe watershed to significant environmental change including its capacity to adapt to climate change."
2. An explicit link to the Ontario Biodiversity Strategy at the level of the statement of Lake Simcoe Plan Objectives should be made.
3. The increasing range of Virginia opossum is cause for concern since they carry a disease that is fatal to horses. Veterinarians that are responsible for reporting horse mortality should be instructed to document the geographic location of horse mortalities (e.g., ranch location).
4. Future strategic plans should prioritize the maintenance of current natural cover in the Lake Simcoe watershed (and surrounding area) and encourage the establishment or preservation of habitat linkages between large patches of natural land cover (core areas) and government protected areas.
5. Plans should seek to limit and discourage development in areas that contribute to landscape connectivity (e.g., restrict development in movement corridors).
6. A Natural Heritage System (NHS) should be developed for the Lake Simcoe watershed using an objective approach and decision support system that establishes specific wildlife habitat targets, e.g., amount of forest interior, large >50 ha forest patch size, largest natural patch in a watershed, etc.
7. The design of the Natural Heritage System (NHS) should incorporate restoration targets, e.g., to strategically identify medium (30-50

ha) size forest patches in close proximity that are candidates for restoring a large > 100 ha forest patch.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. **An assessment of adaptation management performance should be included in policies (e.g., tree planting, natural heritage system migration corridor enhancement).
2. Strategic planning should work towards enhancing ecological health based on the status of indicator species and maintenance of natural biodiversity.
3. To improve on the targets of the Lake Simcoe Protection Plan, a more specific definition of a 'healthy ecosystem' needs to be established.
4. A reference point or condition needs to be identified to direct target-oriented management activities.
5. To ensure that wildlife populations can adapt to climate change, gene flow and dispersal across the landscape should be facilitated, which can only be achieved by focusing restoration effort in areas that increase connectivity within and beyond the Watershed.
6. Targeted re-vegetation/restoration work could focus on creating buffers around Areas of Natural and Scientific Interest (ANSIs) and other areas known to sustain species-at-risk or threatened populations.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions

are needed to ensure that these plans account for the potential and known impacts of climate change?

1. Resource management plans need to assess whether the desired state of the Watershed is achievable under the pressures imposed by the cumulative effects of climate change, population growth, and expected land use changes (e.g., agricultural changes).
2. Harvest seasons for various fish and wildlife species may need to be changed in many cases (e.g., Fish and Wildlife Conservation Act).
3. Implement and maintain legislated riparian buffers on private lands, ensuring that animals have water sources for drinking and cooling off.
4. **Tree planting activities need to be strategic and at a larger scale in order to decrease landscape fragmentation and provide climate change adaptation benefit.
5. Sufficient amounts of relatively undisturbed natural areas (i.e., woodland, wetland, grasslands) of high quality are required in the Watershed to facilitate wildlife movements.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. To achieve the quantity (area) goals for natural cover (and agricultural land uses) and to accommodate projected population growth in the Watershed, careful planning of the distribution of human population density must occur at a watershed scale.
2. There must be intensification of developed land uses (higher population densities in already settled, or to be settled areas) that would support social and psychological well-

being as well as providing a vehicle for increasing residents' connection, appreciation, and understanding of "Nature."

3. There is a need to develop a common understanding among agencies, the Ministry of Natural Resources, Conservation Authorities, Nature Conservancy Canada, and other NGOs of the definition and criteria for optimal Natural Heritage System design.
4. **Natural heritage systems for the Watershed should also encompass aquatic ecosystems.
5. All of the municipalities around the basin, except City of Kawartha Lakes, have either Forest Conservation or Tree Bylaws, and these might be examined for consistency as well as implementation effectiveness.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. Climate change impact modelling is needed to estimate future ecosystem status (e.g., population change) and resilience.
2. Indicators related to climate change impacts, such as species range shifts, including changing patterns (temporal and spatial) of disease incidence (e.g., Lyme disease, beech bark disease, and species composition changes) should be developed.
3. The adequacy of current monitoring activities (Bird Studies Canada, primarily) needs to be established.
4. **4. An integrated monitoring program is needed to proactively adapt to shifts in distribution and to identify declining populations before they become species-at-risk.
5. Increased monitoring of horse fatalities should be promoted.

6. The "ecological footprint" as a means of reporting the impact of society on the watershed should be used as an indicator in the Watershed.
7. Ecological values such as arrival dates of migratory birds, reproductive phenology of turtles and amphibians, species occurrence of birds and mammals, as well as trends in flying insect populations, need to be monitored.
8. **Monitor mammals, reptiles, and insects (in addition to birds) to report on the occurrence, demography, and population trends of these species in the watershed.
9. **If we want to motivate changes in human behavior, ecosystem service values (e.g., quality and quantity of drinking water, pollinators, flood attenuation capacity, etc.) are the most important to monitor in a rapidly changing climate.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. **Improved land cover and land use monitoring data with a firm commitment that it be updated on a regular basis is required.
2. A common ecologically based classification scheme acceptable to all stakeholders and ideally, integrated with, or at least consistent with, other land use/land cover classification schemes in use in the province, is required.
3. Monitoring of wildlife, vegetative cover, and Natural Heritage systems and areas, for climate change adaptation in particular, should be integrated with Ontario Biodiversity Strategy monitoring and reporting.
4. Ensure that there are systematic, annual, or nearly annual, surveys for selected species.

5. Flying insect populations that are highly sensitive to winter severity and the frequency of freeze thaw events requires monitoring in the Watershed.
6. Monitoring of the reproduction of representative reptile species (who exhibit temperature dependent sex determination) is necessary in order document how these species will be affected by a changing climate in the Lake Simcoe region.
7. Monitoring in wetland ecosystems should focus on evaluating wetlands that have not yet been evaluated (for ecological significance).
8. Baseline inventories to assess species composition in the different wetlands, particularly plant species, are required.
9. More frequent and higher resolution sampling for mammalian species is required to allow for a comprehensive analysis of the impacts of climate change on mammalian communities.
10. Mammal occurrence monitoring should be evenly distributed throughout the Watershed.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Research on criteria for natural heritage system design is required to better ensure that ecosystems are resilient to climate change impacts and human disturbance.
2. “High” quality natural cover patches needs to be defined.
3. The identification of thresholds for amount, types and appropriate widths of watercourse and shoreline buffers would be useful to support Lake Simcoe Protection Plan (LSPP) stipulations of setback and allocations of “idle” land.

4. Research should include spatial analyses comparing species distributions to natural land cover.
5. Experiments on local adaptation and potential translocation success are required.
6. Identify habitat linkages/corridors between large high quality patches and protected areas in the Lake Simcoe watershed in the context of the surrounding landscape.
7. Research should seek to quantify the impacts of climate change on wildlife in the watershed by measuring rates of species turnover.
8. Research should seek to quantify the impacts of climate change on wildlife in the watershed by measuring rates of spread of southern species into the watershed.
9. Research should seek to quantify the impacts of climate change on wildlife in the watershed by measuring phenological changes in the ecology (e.g., reproduction and emergence) of sensitive taxonomic groups (e.g., reptiles, amphibians, and insects).
10. Research should also attempt to determine the impacts of recently occurring species, whose ranges have expanded into the watershed, on endemic populations, and species.
11. More research is needed into the critical role of natural and created wetlands in moderating floods, water temperatures, and nutrient loadings.
12. Investigations into causes of amphibian and flying insect declines are required.

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Planners need to be informed about areas that act as corridors for wildlife.

2. The focus of communication tools should be on the engagement and education of residents of the Watershed about critical ecological processes and how they are affected by climate change.
3. Ecosystem science should be incorporated into the public education curriculum to educate students and parents on climate change.
4. Resources are required to build curriculums and advocacy/promotion of that curriculum in the schools of the Watershed.
5. Agency supported high-school (grade school) classroom materials to educate students on collecting relevant monitoring data.
6. The value of ecosystem functions and processes, not just structures (woodlots), and composition (species richness and ecological communities), and how these processes achieve resilient ecosystems needs to be communicated to the public.
7. Outdoor experiential education programs need to be developed to connect people to the ecosystems in which they live.
8. Provide access to tools that clearly demonstrate the changes in climate and the various responses from ecological and social systems.
9. Public workshops and presentations in major urban centres in and around the Watershed (Orillia, Barrie, and Newmarket) are required to enhance understanding of climate change impacts in the region.
10. Short T.V. commercials could be developed to relay information on the impacts of climate change and adaptive responses.
11. Scientific results should be published in provincial internal reports and international peer-review journals to invite input and scrutiny from a wider professional audience and to demonstrate the high quality of research that is being carried out on this issue in Ontario.
12. Support demonstration farms, houses, and developments that show how GHGs can be reduced.
13. Show how development can be done with a small footprint to minimize effects on wildlife and climate change.
14. Support and develop “citizen science” projects that allow the public to get involved in reporting on species arrival dates, insect emergence, frog calling, leaf out, flowering, etc.
15. Online databases and websites should be created to inform interested people about tree flowering dates are linked to temperature (for example).
16. Video games that help children and parents identify species (by sight and sound) are required so that they can go out and collect usable scientific data.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

1. Ecological Sustainability Leadership training should be required for all professional managers who do not necessarily have a background in ecology so that they can value what they manage, and more effectively manage what they should value.
2. Conferences and workshops would be an effective means of enhancing adaptive capacity within management agencies.
3. The Lake Simcoe Protection Plan (LSPP) would benefit from incorporating a governance model that promotes collaboration.

Theme 3: Aquatic Habitat

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. ****Integrate an adaptive management framework into policies where possible. For example, ensure that any legislation or policy used to control water taking/water use is adaptive.**
2. ****In support of adaptive policy, develop a framework for the continual assessment of vulnerabilities in order to determine the success of adaptation measures and the ongoing state of the ecosystem.**
3. **Develop policy that promotes and enables the maintenance and functioning of stream corridors to optimize ecosystem resiliency.**
4. **Renewable energy policies should address the sustainability of aquatic ecosystems in a rapidly changing climate. For example, the installation of new hydropower facilities should consider the impacts of dams given that stream and river water levels and flow dynamics will change with climate change.**
5. **Review Planning Act 1980 hazard lands policies and growth-settlement policies around nearshore areas to deal with increased variability of water levels, erosion, contamination, and other ecological issues.**
6. **Ensure legislation addresses enforcement of excess nutrient releases and other types of pollution.**

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or

management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. **Incorporate the need to manage climate change in all existing policies affecting aquatic assets in the Lake Simcoe watershed.**
2. ****To enhance an adaptive approach to management, ensure the current regulatory framework is flexible enough to effectively respond to unanticipated events or surprises that impact the status of fish populations and other aquatic assets. This may require a re-assessment and modification of current regulatory frameworks.**
3. **Employ the subwatershed working groups to oversee effective implementation at the local level because they are comprised of representatives from local government, provincial agencies, and conservation authorities.**
4. **Ensure the Fisheries Act is applied to avoid or minimize habitat alteration, including stream/river dams constructed to meet increased demand for access to water. One mitigation option could be to retrofit existing top-draw dams so that they release cooler bottom waters to mitigate warming impacts on downstream waters.**
5. **Continually re-evaluate allocation and harvest management policies for the Lake Simcoe watershed in the context of climate change.**
6. ****With existing legislation and policies such as the Fisheries Act and the Lake Simcoe Protection Act, protect and rehabilitate habitats for exploited species that are vulnerable to climate change.**
7. **Ensure that provincial fish stocking guidelines require that stocking plans account for climate change.**
8. **Evaluate all existing relevant legislation and policies with the goal of ensuring a rapid and effective response to emergent diseases and**

parasites that result from a rapidly changing climate.

9. **Ensure continued and enhanced integrated management of water quantity and water quality by MNR/MOE in support of maintaining and enhancing ecosystem resilience in a rapidly changing climate.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. **The goals and objectives of future plans should balance the increasing demands of a growing human population with the limits of Lake Simcoe ecosystems to provide ecological goods and services. For example, sustainable water use could be one goal.
2. **Ensure multi-agency and multi-organization involvement is coordinated at managerial as well as practitioner levels of management.
3. **Regulation of water withdrawal for different purposes such as agriculture and domestic uses should ensure that water levels are maintained and managed adaptively in response to changing climatic conditions.
4. **Protect wetlands including continued prohibition of infilling and drainage.
5. Wherever possible, avoid or minimize shoreline development on Lake Simcoe.
6. Manage surrounding lands and land use such as sewage effluent and nutrient loading to prevent or mitigate an impact on aquatic habitats.
7. For cold water species, protect thermal habitats and manage the fishery with appropriate catch limits, slot size limits, season length, sanctuaries, and other protected areas.
8. Create a science working group to assess sustainability targets and harvest

commitments for cold-, cool-, and warmwater species on an ongoing basis.

9. Evaluate the utility of all fish stocking programs in a changing climate and ensure that any changes or decisions about the stocking programs are scientifically sound.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. **Promote integrated watershed planning as an optimal approach to caring for aquatic assets.
2. Incorporate climate change adaptation on an ongoing basis through working groups or action teams created to oversee plan commitments such as phosphorous reduction and oxygen thresholds targets.
3. Ensure the precautionary approach to fisheries management that employs climate model projections is considered in fisheries management plans.
4. Plan implementation should address funding for adaptation initiatives, including monitoring.
5. Ensure the plan is serviced by enough scientists with mandates to provide objective estimates of distribution and abundance in support of an adaptive approach to fisheries management.
6. Sponsor surveys to monitor the distribution and abundance of food chain biota and their habitats to detect changes in response to climate change.
7. **Plan implementation should ensure a comprehensive monitoring program is in place to monitor the success of decisions and the state of natural assets in the watershed.

8. Inform the public about the threat of Asian carp and other invasive species that could radically alter the ecological function in the Lake Simcoe watershed.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

1. Assuming that Lake Simcoe management authorities embrace an adaptive approach to management, ensure that new knowledge is integrated into adaptation plan updates. For example, it is likely that targets for subwatersheds and associated mitigation actions will need to be adjusted in light of anticipated climate change impacts, and also will need to be updated as technology evolves or new practices are developed.
2. Meet existing protection targets for natural areas.
3. Explore protection targets for an 'aquatic areas' contribution to a natural heritage area 'system' in the Lake Simcoe watershed.
4. Ensure suitably scaled climate change scenarios are available from which informed decision options and recommendations within management plans can be made. For example, incorporate the effects of climate change into fisheries management planning, such as the timing and duration of fisheries seasons, the location of sanctuaries, etc.
5. Where feasible, incorporate the effects of climate change into other planning programs that affect the function of aquatic ecosystems.
6. For the sport fishery, promote the use of underutilized species where appropriate (e.g., where sustainable), particularly species with

populations that are increasing in response to climate change.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. **Ensure that fisheries management decision-making is integrated, flexible and adaptive. For example, under the auspices of a commitment to protect and expand a cold water fishery, it will be necessary to manage for nutrients, oxygen, water temperature, and harvesting rates simultaneously within the context of a systems approach to adaptive management.
2. Sponsor further reductions in nutrient loads to help mitigate habitat loss of coldwater fisheries.
3. Phosphorous control actions should incorporate climate change impacts and potential impacts on cold water fish habitat.
4. **Strong protection of natural areas in the watershed is needed, including all wetlands.
5. Investigate the support for and feasibility of enhancing the warm-water fishery in Lake Simcoe.
6. Develop guidelines and recommendations to reduce non-climatic stresses on fish populations and other aquatic organisms and their habitats.
7. Use a risk management approach to set priorities to prevent or mitigate the establishment of invasive species in the Lake Simcoe watershed.
8. Concentrate prevention and control methods and rapid response protocols in areas at risk from invasive species.
9. Use climate models to help identify where and how habitat rehabilitation efforts should be focused – complete 'best bets' analyses.

10. Ensure recovery plans account for changing habitat in response to climate change.
11. Protect, rehabilitate, and enhance streams and lakes and their shorelines and corridors to ensure they are as healthy and resilient as possible. For example, where possible, increase buffer zones around aquatic assets such as streams, rivers, and lakes.
12. Mitigate the impacts of thermal pollution as much as possible.
13. Revise Best Management Practices and Guidelines where necessary to account for the impacts of climate change.
14. Explore opportunities for greater involvement and partnership by local, regional, provincial, and federal agencies in Lake Simcoe planning and management.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. **Existing lake monitoring programs should be supported and maintained.
2. **Re-evaluate all monitoring programs and develop an integrated approach that includes climate change.
3. Ensure ecological monitoring addresses lake trophic dynamics and ecological communities (e.g., algae, zoo/phytoplankton cover, water temperatures, and dissolved oxygen levels), the effectiveness of stormwater control actions (e.g., stormwater ponds), the ongoing interaction of nutrients and fish, contaminants, the status of infrastructure, the health/quality of the terrestrial habitats and natural areas in the watershed, and land use change.
4. Ensure physical monitoring includes stream and lake water temperature (seasonal), timing and duration of ice cover and stratification

(i.e., monitoring thermal stability), oxygen levels, Secchi depth, etc.

5. Monitor the effectiveness of 'Best Practice Guidelines'.
6. Monitor angler satisfaction.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. **Ensure the LSPP monitoring program addresses climate change impact monitoring.
2. **Ensure the LSPP monitoring program monitors the success of adaptation measures.
3. Ensure the biomonitoring components of the LSPP monitoring program are established for the lake and streams and rivers at the sub-watershed level.
4. Expand the hydrology network to include all major sub-watersheds.
5. Establish a Lake Partner Program designed to facilitate participation of people who live on or near the lake to participate in monitoring programs.
6. Monitor dynamic interactions among biological communities (trophic dynamics) as well as understanding how this changes with seasons (seasonal dynamics).
7. Monitor the status of all natural heritage areas, including all wetlands.
8. Implement a program to monitor angler expectations for fishing opportunities and acceptance levels for available management options in a changing climate.
9. **Develop and/or apply existing benchmark indicators to monitor the status of fish populations in a rapidly changing climate.
10. Monitor the effectiveness of fish stocking programs and habitat rehabilitation, and management options in a changing climate.

11. Continue and where necessary enhance contaminant monitoring for the watershed's aquatic ecosystems.
12. **Monitor the effectiveness of watershed-level land use plans and assess their effectiveness in protecting aquatic ecosystem assets in a rapidly changing climate.
13. Monitor and report on the status of the suite of ecological goods and services provided by the Lake Simcoe watershed.
14. Ensure monitoring programs are geographically broad and sensitive enough to detect specific point-source polluters.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Quantify the link between land use and nutrient levels.
2. In support of adaptive strategic planning, use climate models to evaluate how ecological processes may respond to climate change. For example, complete vulnerability assessments for fish species and the prey species they depend on for food using an ensemble of climate models.
3. Conduct research on how climate affects aquatic ecosystem productivity, including fish community dynamics.
4. Evaluate the merit and feasibility of stocking vulnerable species and/or species at risk in a rapidly changing climate.
5. Develop methods to quantify the effects of invasive species on fish species and their habitats in response to changing climatic conditions.
6. Develop a cumulative effects assessment process that allows managers to examine the impacts of climate change and other cumulative effects on aquatic ecosystems.

7. Identify all sources of thermal pollution in support of mitigation strategies.
8. Complete a cost-benefit analysis of the impacts of climate change scenarios on the recreational fishing industry.

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Develop a public education strategy. For example, provide outputs of climate model and scenario projections at the local scale to assist people to visualize potential future climates and explore the implications of the change to their health and well-being.
2. Develop a locally relevant communication strategy to describe what climate change means to people living and working in the Lake Simcoe and watershed.
3. Ensure frequent (annual) and ongoing state of the lake reporting for use in decision-making processes and public forums to help people understand what is changing in the watershed and what it means to ecosystem health and human wellbeing. This could include regular reporting in the local media (e.g., newspaper and radio spots) as well.
4. Sponsor community workshops, town hall meetings, and interactive websites. Ensure the interactive sites are useful to children and adults living in the watershed, as well as potential visitors who are thinking about engaging in recreational activities that are affected by climate (e.g., fishing and skiing).
5. Develop public education materials that provide information about how people can help to reduce the impacts of invasive species.
6. Ensure education and awareness programs talk about the fact that healthy streams and

natural corridors help reduce the impacts of climate change.

7. Provide information about how agencies and organizations are sponsoring work targeted at addressing the impacts of climate change.
8. Ensure that scientific results are available to the public in an understandable and accessible manner.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

1. Develop a watershed communications strategy that explains agency roles in managing for climate change.
2. Develop and disseminate information with different levels of detail, including summaries for people who need synthesized and general information or more detailed technical and scientific accounts for people involved in technical planning and decision-making.
3. Agencies should commission regular information updates and exchange for managers and practitioners, including known and potential impacts of climate change and state of the lake reports.
4. Sponsor workshops, work-place dialogue, and collaboration among various agencies.
5. Establish a website for agency staff that contains fact sheets, technical reports, Q&A briefs, links to other useful sites, etc.
6. Agencies should allocate and dedicate funding to train staff (or seek out experienced staff) who can address the knowledge needs of agencies responsible for managing for climate change.
7. Encourage agencies and organizations to collaborate in the development of proposals and the implementation of programs to efficiently use allocated funds and to optimize

integration of ideas and decision-making where possible.

Theme 4: Hydrology

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. Incent developers to use LID technologies.
2. Reduce and where possible eliminate barriers to water reuse at all levels of government.
3. Define and describe the authority for declaring a level 3 water response. Level 3 low water response (as outlined in the Ontario Low Water Response Plan) requires a demonstration of socio-economic impacts. This requirement places too much responsibility on the water-response teams and, while the technical criteria for Level 3 are met, no Level 3 water response has ever been declared as a result of this requirement. As a result of this barrier, water conservation measures are not being implemented.
4. Ensure groundwater recharge areas are protected and enhanced under the auspices of land use planning because these areas will become more critical as climate change progresses.
5. The Provincial Floodplain Standard should be updated to reflect the changes to the hydrologic cycle resulting from climate change.
6. Increase the adaptive capacity of the building code that includes options for more flexible requirements and more frequent updating in support of innovation and adaptation, such as grey water reuse.
7. Update the Stormwater Master Planning and Design Manual (current edition May 2003) so

that evapotranspiration is included as part of the hydrological cycle calculations and considerations.

8. Update the Stormwater Master Planning and Design Manual (current edition May 2003) to include the appropriate design of Exfiltration Systems (currently underway by Standards Development Branch at MOE).
9. Update the Stormwater Master Planning and Design Manual (current edition May 2003) to include a Decision Matrix format for all SWM Works that accounts for the subwatershed, tributary, catchment, and site level SWM considerations identified in pending Comprehensive SWM Master Plans (CSWM MPs) being developed by Lake Simcoe watershed stakeholders and led by the LSRCA.
10. Update the Stormwater Master Planning and Design Manual (current edition May 2003) that includes source control wherever possible. For example, use of LID to promote infiltration of frequent rainfall events (2 to 5 year storm events). Where possible, design these systems to infiltrate a minimum of 25 to 30 mm rainfall events.
11. Update the Stormwater Master Planning and Design Manual (current edition May 2003) to ensure capture of 90% of rainfall events and 90% of rainfall volume annually.
12. Update the Stormwater Master Planning and Design Manual (current edition May 2003) to ensure that it addresses overall volume of stormwater as well as peak flow.
13. Update the Stormwater Master Planning and Design Manual (current edition May 2003) so that it addresses the need to ensure that SWM Works begin with an understanding of the receiving water body, which in turn means monitoring the receiver one or two years prior to construction to determine background characteristics of the water body (i.e. typical sediment size range and concentration all ready in the water body).
14. Update the Stormwater Master Planning and Design Manual (current edition May 2003) to ensure that hydrologic models used by the development community for SWM Works design include all four seasons.
15. Update the Stormwater Master Planning and Design Manual (current edition May 2003) so that it redefines 'TSS', particularly as it relates to phosphorous loading. It is recommended that 'TSS' be defined as 'Total Suspended Sediments' not 'Total Suspended Solids'.
16. Update the Stormwater Master Planning and Design Manual (current edition May 2003) to ensure that it adequately describes what 80% TSS removal means. Specifically, it is recommended that it explicitly require the removal of the majority of TSS under the 40 micron size because the finer particulate has a greater surface area and therefore contains more particulate-bound phosphorous than larger sediments.
17. Update the Stormwater Master Planning and Design Manual (current edition May 2003) to ensure that site specific considerations are based on subwatershed evaluations, tributary and catchment level characteristics (e.g., endangered species, cold water fish habitat, land use, and phosphorous loading).
18. Update the Stormwater Master Planning and Design Manual (current edition May 2003) to address location and site planning of SWM ponds to ensure that they are not created in close proximity to rivers, streams or lakes, which may result in thermal pollution.
19. Ensure that the Stormwater Master Planning and Design Manual (May 2003) can be easily updated and amended and electronically available to the development community, municipal technical staff, and MOE review engineers.
20. The Stormwater Master Planning and Design Manual should be revised to incorporate climate change adaptation best management practices.

21. Ensure modernization of the approvals process currently underway at MOE requires comprehensive Stormwater Management Planning (and subsequent preliminary design of development sites) in advance of approval of storm and sanitary sewers to ensure SWM systems are adequately designed and subsequent sewers have the capacity to carry anticipated/designed stormwater loads that may result from climate change impacts (i.e., redesign consideration for sewers).
22. Undertake to reduce barriers to adaptation by implementing a process whereby different pieces of legislation and policy are identified, key components that relate to hydrology summarized, aspects that act as a barrier to other pieces of legislation noted, and opportunities for resolving these barriers are explored.
23. Explore opportunities to transfer stormwater management funding from property taxes to a user-fee program.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. Ensure that all ministries subject to the Environmental Bill of Rights (EBR) employ their Statement of Environmental Values (SEV) in decision-making processes that affect the watershed's hydrological cycle (available at: http://www.ebr.gov.on.ca/ERS-WEBExternal/content/index2.jsp?f0=aboutTheRegistry.statement&f1=aboutTheRegistry.statement.value&menuIndex=0_3).
2. Given that most of the policies described in the Lake Simcoe Protection Plan can be used to develop and deliver an integrated and

adaptive response to the impacts of climate change, especially those that are designed to increase resistance and resilience of the entire ecosystem (e.g., phosphorous reduction strategy, source water protection, shoreline protection, riparian habitat protection, water quantity and water conservation policies, natural heritage policies and invasive species policies), the Climate Change Adaptation Strategy needs to explore opportunities for the integrated application of these policies.

3. Given that the Clean Water Act explicitly identifies the need to address climate change impacts (e.g., it calls for local source protection committees to identify future impacts that climate change will have on municipal water supplies, no legislation explicitly addresses climate change), responsible agencies should use the Act as the basis for the development of policies that identify risk mitigation measures to reduce impacts on groundwater and surface water resources.
4. Given that the Lake Simcoe Protection Plan (LSPP) and Phosphorus Reduction Strategy (PRS) are important tools for use in an adaptive approach to management, it is recommended that government actively update these documents as the science supports and experience directs policy and strategy change (e.g., Update the Comprehensive Stormwater Management Master Planning Guide so that it includes consideration of all stormwater impacts in the subwatershed and not just the settlement areas).
5. In order to qualify for approval under the Planning Act, a development proposal should satisfy the policies in the LSPP and the strategic directions outlined in the Phosphorus Reduction Strategy (PRS).

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. Ensure the comprehensive monitoring strategy addresses baselines, targets, and thresholds in support of adaptive sustainable management.
2. Ensure that "no regrets" adaptation measures (i.e., measures that provide benefits now and in the future no matter how the climate changes) are addressed in future strategic plans.
3. Ensure that scientific and local knowledge are used in the development of future strategic plans.
4. Foster a culture of decision-makers that employs short- to long-term visioning processes (e.g., 5-50 years) to address policy issues associated with the pressures resulting from human population growth, climate change, and other cumulative impacts.
5. Given the growing human population in the watershed and potential impacts, strategic plans should address: the ability of the watershed to sustain future human population growth (e.g., is there a point at which zero growth needs to be addressed?); high density urban planning; protection of agricultural lands, forests, and wetlands; and ecological targets (e.g., phosphorous loading and TSS targets).
6. Future strategic plans should explore techniques to integrate climate change risk mitigation measures into operational practice.
7. Future strategic plans should address green plans for new developments and the retrofit of existing developments in support of sustainable development targets, which includes maintaining high water quality.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. Given that climate change scenarios indicate that the greatest potential changes in runoff will occur in winter, land management practices and strategies should account for potential impacts and identify optional management responses. Land management practices and strategies also need to account for summer low flow and how abundance of water in winter can be made available for low water conditions in summer.
2. Given the potential for an increased number of severe rain events in a warmer climate, management should include flooding and runoff mitigation and adaptation strategies.
3. The government should confirm its commitment and provide details about implementation of a number of Strategic Actions and Monitoring requirements in the current plan (i.e., LSPP 4.5-SA, 4.23-SA, 5.3-SA, 6.50-M, 7.12-SA).
4. Under the auspices of the Lake Simcoe Protection Act, current plans and strategies, such as the Phosphorus Reduction Strategy with a time horizon of 35 years, should be modified to account for climate change adaptation.
5. Planning processes should link terrestrial stressors and processes to water quality and quantity, and describe mitigation measures to enhance ecosystem resilience such as the protection of wetlands, shorelines, and riparian areas.
6. Explore the difference and use of the terms 'resilience' (the capacity to return to a former state once a change has occurred) and 'resistance' (the ability of a system to resist

- change) in the context of a commitment to adaptive management.
7. Add the following principle to the LSPP: An integrated ecosystem approach to management includes the participation of the many sectors that will be impacted by climate change.
 8. Clean water in sufficient quantity is a key goal for watershed management agencies and organizations, and therefore responsible agencies should address the human population growth issues that will emerge during the next few decades.
 9. Ensure that responses to the strategic plan are flexible enough to address adaptation on a time scale that is consistent with observed changes and variability in climate.
 10. Complete a detailed assessment of the areas that are most susceptible to wind erosion and are an important source of phosphorous deposition in Lake Simcoe, and then develop operational targets for mitigating wind erosion in these areas.
 11. Examine the impacts of agricultural stormwater runoff on the different types of farms (e.g., dairy, pig, poultry, ostrich, lamb, and crop) and develop pathogen management techniques.
 12. Explore alternatives to the use of stormwater management ponds, such as the Etobicoke Exfiltration System (in use for 20 years and has proven to be more effective than ponds in some situations).
 13. Link and coordinate policy review and development between and among agencies responsible for various components of the hydrological cycle.
 14. Address key knowledge gaps that are impediments to development of climate change adaptation policy for Lake Simcoe, including interactions between climate and other stressors that affect aquatic ecosystems, characterization of important ecological services and supporting processes;

valuation of ecological capital and understanding of renewal rates; and, identification and quantification of the critical linkages between ecological health and human health.

15. Ensure water allocation decisions are made at the watershed level.
16. Continue to encourage and assist in the implementation of strategies designed to decrease the demand for and use of water.
17. Continue to encourage and assist in the implementation of strategies designed to reduce the use of chemicals that degrade ecosystem health.
18. Encourage all sectors to continually examine their readiness and capacity to engage in sustainable ecosystem management in a rapidly changing climate.
19. Develop a strategy for the design and implementation of green infrastructure.
20. Develop and implement water conservation strategies.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

1. Review and ensure application of water-related regulations in the watershed will meet the challenges of climate change.
2. Land use plans need to account for climate change. For example, CANWET evaluations of projected land use to future dates and its impact on the phosphorus loading in the lake should account for impacts of climate change.
3. Government agencies should encourage a transformation in urban planning and development that includes intensification

where high density centres are connected by efficient public transit network systems.

4. Storm management plans should model capacity to deal with storm water runoff and should be required to find and quantify alternative approaches to keep water on the landscape and minimize surface urban runoff.
5. Agencies responsible for managing agricultural activities should ensure that plans incorporate alternative approaches to achieve significantly reduced overland runoff and nutrient and sediment contributions to streams.
6. Integrate agricultural plans with water use and re-use plans.
7. Government agencies should encourage and incent development and application of new farming practices such as organic farming, which will reduce demand for water and decrease phosphorus loading.
8. The MTO should strive to reduce salt concentration spikes that can be lethal to fish.
9. Update assimilative capacity assessment requirements. Assimilative capacity assessments currently use a 20 year 7-day low flow water quantity value to determine critical conditions for rivers and streams that act as receiving waters. This evaluation must be updated to reflect a change in the frequency and extent of low flow conditions expected to occur in a changing climate.
10. Expand policy management working groups to include the range of disciplines and expertise needed to address complex ecological, social, cultural, and economic issues resulting from climate change.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. Engage in management actions that maintain or increase resilience of Lake Simcoe watershed ecosystems during a period of rapid climate change, including but not limited to maintaining shoreline buffers, planting trees around Lake Simcoe, rivers and streams as well as in urban areas to mitigate the heat island effect; stormwater management; and to protect and where possible enhance biodiversity.
2. Use management actions in urban areas, including but not limited to implementing LID, water reuse, water conservation, densification of urban areas, and promoting local business opportunities in support of sustainable development.
3. Ensure the eight categories of stressors, including climate change, provided by the Lake Simcoe Science Advisory Committee are applied to the management of the watershed.
4. Integrate climate change risk management measures into operational plans for different sectors in the Lake Simcoe watershed.
5. Ensure ongoing, long term operation and maintenance of stormwater infrastructure to reduce the impact of climate change.
6. Promote tree coverage in all systems (natural and built) to help offset damage from increased winds, moderate temperatures in summer, and provide habitat.
7. Explore the redesign of sewer systems that incorporates exfiltration systems in conjunction with conventional storm sewers (back up) and ensure the use of dry SWM ponds for quantity control (no wet ponds because of thermal pollution issues).
8. Explore the feasibility of joint programs that are cost-shared, such as rain water harvesting, green roofs, and grey water reuse.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the

Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. Monitor and report on beach closings and any incidences of illness (e.g. gastrointestinal) and/or diseases.
2. The 17 new research and monitoring programs recommended by the Lake Simcoe Science Advisory Committee and current monitoring programs (i.e., water chemistry, nutrient load, flooding, ground water, land-use change, tracking of best management practices, atmospheric monitoring and fish population indicators in the lake, stream monitoring of fish and invertebrates at sites throughout the watershed) are important as sources of knowledge for managing the impacts of climate change and should be implemented (and maintained in the case of monitoring programs).
3. Develop monitoring program priorities by identifying and describing all natural capital, replacement rates, ecological services and underlying processes related to water quantity and quality for the Lake Simcoe watershed.
4. The 'integrated monitoring program' should be modified to account for the impacts of climate change.
5. Monitor a selection of social and economic values to gauge community understanding and health and well-being in a rapidly changing climate.
6. Continually monitor the success of strategic LID works for at least 10 years in different locations of the watershed.
7. MOE should sponsor additional water quality monitoring to identify the key non-point source areas for management in the Lake Simcoe watershed.
8. Ensure that monitoring programs are implemented at all stages of planning and development (e.g., construction, operational, and clean-up phases).

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. Lake monitoring programs require enhancement for upper trophic levels (e.g. planktivorous fishes, and non-exploited fish species).
2. Prepare more quantitative population estimates for fish species.
3. Develop and implement an invasive species tracking program that also examines and reports on ecological assessment of impacts.
4. Enhance wetland inventory programs and monitoring sites to track water levels, soil moisture, vegetation, and other biota annually.
5. Enhance stream inventory and monitoring of physical and biological assets in streams and rivers.
6. Monitor riparian zone status with reference to PSPP targets.
7. Ensure soil erosion patterns are monitored, assessed and used to inform planning and remediation decisions.
8. Model for the impacts of atmospheric transport of dust, nutrients, and contaminants in support of mitigation strategies.
9. Monitor water use by sector (e.g., domestic, industrial, agricultural).
10. Monitor and assess the social value that communities place on water quality and quantity, with a particular focus on preferred actions and behaviours in order to protect Lake Simcoe.
11. Monitor and determine how economic impacts on the community can be mitigated through the selection of climate change risk

mitigation measures in order to minimize these impacts.

12. Develop and implement a monitoring strategy for LID techniques in the Lake Simcoe Watershed.
13. Monitor non-point sources of pollution such as biosolids-amended soils, sod farms, construction sites, and intensive agricultural operations.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Correct and update land and land/use cover maps for the watershed in support of adaptive management decisions.
2. Develop a process for integrating monitoring results, modelling results, and management options of natural assets and effectively communicate the findings.
3. Develop and implement quantitative, cost effective, rapid assessment techniques to track key trophic state indicators (e.g., hydro-acoustic techniques for lower trophic levels - zooplankton), pelagic and piscivorous fish populations and habitat, and to monitor the status of non-exploited species and general biodiversity throughout the watershed.
4. Explore the relationship between climate change and water quality using parameters such as temperature, dissolved oxygen, nutrients, algae, assimilative capacity, and habitat.
5. Identify potential roles and interests of the public in the mitigation of climate change impacts.
6. Establish an integrated monitoring network and a knowledge management system with an internet user interface for easy access to the data and modelling/management tools for interpretation/analysis/reporting of the data.

7. Sponsor scientific assessments that employ an ensemble of climate models and scenarios to explore vulnerability to climate change.

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Communicate trends in meaningful and relevant ways so that the public feels a sense of ownership and relevancy in the adaptation for climate change discussion.
2. Sponsor local events to demonstrate the positive impact that an individual can have on water conservation such as use of rain barrels for lawn and garden watering.
3. Sponsor annual public science forums and web communications including topic specific information and educational videos.
4. Sponsor 'community-of-practice' programs.
5. Sponsor the distribution of knowledge about adaptation options through various social media.
6. Sponsor development of a self evaluation tool to help individuals assess their knowledge about climate change and available mitigation and adaptation techniques.
7. Develop an information program for each homeowner that explains the importance of maintaining stormwater management systems (i.e. rain barrels, rain gardens, etc.) on their property. All homes should be provided with an energy and environmental maintenance guide.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

1. Provincial agencies should sponsor development of evaluation tools for use by agencies electing to assess their readiness and capacity to adapt to the impacts of climate change. The self evaluation tool described in 10.6 should support education, extension and training opportunities both within and by management agencies.
2. Use intranet and internet to optimize access to climate change data and information.
3. Present/communicate information about on-going research to management agencies in an accessible and relevant manner with an emphasis on no-regret decision making via symposia, bulletin, web sites, etc.
4. Provincial agencies should sponsor annual science forums, discussion groups, lecture series, web communications including scans of the published climate change literature.
5. Provincial agencies should sponsor preparation of technical guidance documents on how to use climate change scenarios, assess vulnerability, how to develop adaptation options, how to implement monitoring programs, and how to actively engage in adaptive management.
6. Provincial agencies should sponsor regular meetings between science and policy makers to share ideas and information.

Theme 5: Tourism and Recreation

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

No recommendations.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. Tourism policies should be adaptive in order to respond to the needs of recreationists while simultaneously ensuring that natural assets are managed sustainably in a rapidly changing climate.
2. Legislation and policies for provincial parks and conservation authority areas need be revised to incorporate specific sustainable tourism and recreation objectives.
3. **Climate change adaptation should be mainstreamed and implemented as an integral part of regional tourism development planning, environmental management, and disaster/management in the Watershed.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. Tourism agencies and operators should commit to the development of adaptive business plans that respond to and/or anticipate the impacts of climate change.
2. Tourism agencies and operators in the Watershed must balance the needs of visitors, the tourism industry, local communities and the environment and, ultimately, encourage sustainable tourism practices.
3. Goals for sustainable tourism, of which climate change will be an integrated component, need to be developed for the Watershed.

4. **A policy on sustainable tourism growth is needed for the Watershed.
5. Strategies to increase visitor awareness of climate change impacts on the Watershed's unique environment are required.
6. **Strategic planning for tourism in the Watershed should focus on "climate proofing" (i.e., diversifying) attractions and destinations in order to reduce disparities in tourism demand between high and low seasons and to increase the attractiveness of destinations that may suffer unfavourable climate conditions and losses in demand (e.g., winter activities such as ice).
7. The Watershed's 'Multi-season recreational strategy' (LSPP 7.12) should account for climate change (e.g., diversification).

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. Sustainability indicators related to the tourism industry's carbon footprint need to be developed.
2. Strategic plans for tourism in the Watershed should observe the carrying capacity of natural systems.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

1. Human health and safety procedures for dealing with climate-related issues such as

extreme events (e.g., storms) and seasonal lake-ice regimes should be continually reviewed and modified where necessary.

2. **Management plans (business plans) should incorporate long-term socio-economic and environmental trends analyses with climate change considerations to help guide adaptive decision-making.
3. Tourism and recreation plans should be addressed in natural resource management plans.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. Recreation and tourism seasons and quotas should be continually revised to ensure a sustainable approach to management in a rapidly changing climate.
2. Recreational activities should not impact ecosystem composition, structure, and function.
3. Tourism operators in the Watershed should adopt less carbon-intensive fuel sources and alternative technologies for transport including electric, hybrid, hydrogen vehicles, and biofuel.
4. **Specific GHG reducing transport initiatives should be implemented in the Watershed (e.g., "car free" resorts/destinations, encouragement of public transport usage, establishing pedestrian friendly sidewalks, trails and cycling paths or networks, and/or benefits/incentives offered at tourist attractions or accommodation for non-car users).
5. The provincial park "Park Once" challenge should be extended to all natural heritage areas operating in the Watershed.

6. Carbon-compensation programs should be established to provide an option for 'neutralizing' emissions that cannot be avoided by tourism operators (e.g., by investing in energy efficient, renewable energy sources, or carbon sink projections such as tree planting).
7. Government initiatives should provide useful advice and financial incentives to tourism operators to assist them in their transition to sustainable tourism practices.
8. Operators should offer carbon-offsetting programs to tourists.
9. Tourism operators, Conservation Authorities, provincial parks, tourism and recreation associations, and others involved in the construction and maintenance of water access points (e.g. boat launches) should plan for low water levels when sites are constructed or renovated to ensure the continuity of water-based recreation opportunities in the Watershed.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. **The impact of recreational activities on ecosystem resilience in the Watershed should be monitored.
2. **Visitor health and safety should be monitored.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. Design and implement an ongoing monitoring program that gages the level of participation in various recreational activities in the Watershed.
2. Design and implement an ongoing monitoring program that gages the level of visitor satisfaction in the Watershed.
3. Monitor the tourism industry's GHG emissions -- both direct (from tourism activities) and indirect (or embodied) energy impacts (and concomitant GHG emissions) of tourism activity.
4. Energy use data for different types of accommodation and tourist attractions or activities in the Watershed should be monitored.
5. Regional health monitoring systems that provide alerts for heat waves, pollution and disease outbreaks, and health risks (e.g., malaria) need to be developed to ensure visitor health and safety (e.g., at beach locations, ice fishing, etc.).
6. **Early warning systems for human health and safety will need to be developed (e.g., for heat waves).

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. New research using global and regional climate models is needed to assess the known and potential impacts of climate change on winter activities in the watershed (e.g., alpine and Nordic skiing, snowmobiling, and ice fishing).
2. New research using global and regional climate models to assess the known and potential impacts of climate change on spring, summer, and fall activities in the watershed (e.g., recreational fishing, swimming, boating, and camping).

3. Review Watershed decision-making processes with respect to tourism development.
4. Research on "Energy use per passenger kilometer", or energy intensity, should be conducted to determine a tourist's energy requirement to travel a certain distance, and from this, estimate GHG emissions resulting from tourism in the Watershed.
5. Energy-relevant analysis of tourist behaviour using, for example, tourist itineraries, transportation modes, vehicle occupancies, accommodation types and number of nights spent, and attractions visited or activities undertaken.
6. Research on the use of climate data and information by operators and tourists in the Watershed.
7. Conduct community vulnerability assessments and to understand the economic implications of action and inaction with respect to climate change.
8. Research on operator perceptions of climate change and their adaptive capacity is required.
9. Research on the vulnerability of various building structures to climate change in the Watershed is required.
10. Research on future demand trends and consumer motivations is required to assist with diversification planning of opportunities that may be negatively affected by climate change.

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Interactive displays and information on climate change and tourism for distribution at sportsman and nature-related shows and events should be developed.

2. ******Innovative web tools containing climate data and predictions should be developed to help tourism operators and agencies in the Watershed adapt to climate change.
3. Operators should develop green marketing campaigns (e.g., "greenwash") that focus on carbon neutrality and environmental sustainability that are not clearly defined and transparent to consumers.
4. The media should be used to communicate tourism-related climate change impacts occurring in the Watershed.
5. Education strategies for hunters and trappers on the impacts of climate change on the type and amount of wildlife harvest, and on the practices used to carry harvests, is required.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

1. ******A series of fact sheets or guidelines could be developed to inform businesses of climate change adaptation and mitigation actions that could be pursued to make their operations more sustainable.
2. Communications should focus on maintaining the quality of the environment and how sustainability initiatives can reduce operating costs, increase efficiency, enhance visitor experiences, and improve customer satisfaction in light of climate change.
3. ******3. Specific destinations (e.g., natural heritage areas) could be used as demonstration sites to educate visitors on climate change impacts and sustainable responses (e.g., energy efficiency).
4. Education and extension training for tourism associations and counties to enhance capacity to participate in adaptation and increase growth potential for warm-season recreation.

5. Marketing efforts should recognize growth potential of other opportunities, and ensure marketing matches recreational activities available.

Theme 6: Species at Risk

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. Update national Species at Risk Act (SARA) recovery strategies and recovery plans to include climate change.
2. Require that impacts of climate change be considered as part of all recovery and strategies under the Ontario Endangered Species Act.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. **Incorporate climate change impacts into SARA recovery plans.
2. Incorporate climate change impacts into OESA recovery plans.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. Species recovery plans should include explicit recovery targets that include consideration of how climate change is going to change habitat over time.
2. Set explicit goals in strategic plans for reversing population trends of Species at Risk.
3. Set explicit goals in strategic plans for not adding any more species to the SAR list.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

No recommendations.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

1. All Species-At-Risk assessments and recovery strategies should incorporate climate change vulnerability. They should require that only when vulnerability to climate change has been established, can recovery or adaptation strategies be developed.
2. Species identified as being highly vulnerable to climate change should be studied as bio-monitors of climate change impact at sub-ecosystem levels.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated

with potential climate change in natural ecosystems and the built environment?

1. Design adaptive measures to focus on reducing vulnerabilities that affect multiple species to maximize efficiency.
2. Develop a comprehensive natural heritage system that considers climate change in order to conserve SAR.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. Monitor SAR for biological species response and impact to climate change.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. **Institute standardized sampling to monitor distribution and abundance of species at risk (absolute and relative) on a regular basis across Ontario.
2. All species highly vulnerable to climate change need to be monitored at range edges as part of a strategy to develop most sensitive bio-indicators of climate change.
3. Regular monitoring is required throughout the watershed to enable assessment of overall population status (decline, increase or remaining stable), and detection of the expansion and contraction of each species.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. All SAR in Ontario need to be assessed for vulnerability to climate change.
2. Research is needed to gain an understanding of climate change vulnerability as it is integrated with other known stressors for all SAR species so that specific adaptation risks or barriers can be addressed.
3. Identifying gear and effort required for standardized sampling.
4. **Research to better understand the thermal tolerances of SAR, particularly aquatic species.
5. Rapid assessment methodologies are required to evaluate climate change impacts in an efficient way.
6. More life web interaction cause and effect studies are needed to identify species being stressed by climate change.
7. **Investment in baseline data through research, monitoring and assessment is required (e.g., life history requirements and interactions).

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

No recommendations.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

No recommendations.

Theme 7: Insects

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. Develop policy and economic incentives to encourage small family farms to keep marginal land in pasture to encourage the existence of diverse habitats.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

No recommendations.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. Include goals for sustainable land use that encourage rural livelihoods and viable local economies in small towns and rural communities.
2. Recognize that landscape and hydrological connectivity is critically important for insect migration as well as other species.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

No recommendations.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

No recommendations.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. Encourage a diversity of land uses and connected habitats.
2. Increase the percentage of parks and protected areas in the Lake Simcoe watershed using explicit targets.
3. Promote multiple public use of crown land for harvesting, fishing, hunting, and insect collecting to provide public incentives to land habitat preservation.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. Holistic ecological monitoring is essential; measures of ecosystem health should include insect population health.
2. Monitor economically important biting flies (simuliidae, ceratopogonidae, tabanidea, muscidae) and look for a response to temperature change and modes of dispersal.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. Add insect population monitoring to existing protocols at a fine enough scale so that climate sensitive and climate tolerant taxa are not clustered together giving wrong conclusions.
2. Train monitoring staff to target insect species that are most common to the region and known to be sensitive to change.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Time series data of insect populations, insect pests, pollinators, and sentinel groups (e.g., tabanids, aquatic species).
2. Surveys to track changes in diversity and distribution of all insects in the watershed.

Knowledge Dissemination (Communication) 1

What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Inform agencies involved in climate change adaptation and monitoring that insects can be excellent cost effective indicators of changes in thermal regime that are currently under utilized as indicators.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

No recommendations.

Theme 8: Vegetation Cover

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. Develop realistic, sustainable and strategic land use planning policy based on carrying capacity under the Growth Plan.
2. Develop regional forest policies to address protection, conservation and restoration goals.
3. Develop regional Natural Heritage Strategies that recognize the natural environment is the basic building block of a sustainable society.
4. Use the planning act and the Provincial Policy Statement to increase percentage of cover in urban areas.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making

processes? If possible, please identify the statute or policy, and recommended action(s).

1. Land use planning requires a regional context that is large enough to include climate change impacts that can only be measured at large scales.
2. Climate Change implications should be considered under the Species at Risk Act.
3. Climate Change implications should be considered under the Lake Simcoe Protection Act.
4. Climate Change implications should be considered under the Greenbelt Act.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. Social, economic and environmental goals in all levels of planning need to be incorporated into Strategic Planning.
2. Long term impacts need to be considered in strategic plans (e.g., land use planning horizons longer than 20 years).
3. Regional impacts considered into strategic plans.
4. Protection and conservation goals need to be considered in strategic plans.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. Lake Simcoe Climate Change Adaptation strategy should include explicit targets that support and apply to Healthy shorelines.

2. Lake Simcoe Climate Change Adaptation strategy should include explicit targets that support and apply to Natural Heritage System.
3. Lake Simcoe Climate Change Adaptation strategy should include explicit targets that support and apply to preventing new invasive species.
4. Lake Simcoe Climate Change Adaptation strategy should include explicit targets that support and apply to preventing new additions to the Species at Risk list.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

1. Need to institute a hierarchical planning system where by municipal plans are required to conform to regional scale landscape plans.
2. The Lake Simcoe Protection Plan should be updated to include terrestrial ecosystem sustainability goals, manage existing natural areas and plan for more connected green space in rural and urban areas.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. Make the installation of green infrastructure an integral part of land use planning.
2. Recognize that long term management of green infrastructure is critical and requires budget.
3. Plan and organize restoration programs around explicit targets and goals.

4. Ensure adequate supplies of source identified seed stock to support restoration.
5. Design restoration programs to increase biodiversity and create linkages between natural areas.
6. Increase tree planting in urban areas.
7. Increase forest cover, connectivity, and patch size to assist natural species migration.
8. Natural heritage areas should be used as both sources of and centres to reestablish migrating species.
9. Parks and protected areas should serve sources of seed and genetic material for restoration purposes in the adjoining landscapes.
10. Develop models to identify cumulative impacts of stressors in the watershed.
11. Develop and use forest projections that incorporate climate change effects (and elevated CO₂) on growth rates.
12. Plant seed from local sources with some that are expected to be better adapted to climate change and consider moving seedlings along a north–south gradient of seed sources, providing more variability in dates of bud-set and bud-break and therefore reducing risk of widespread frost damage.
13. Less emphasis on hybrid poplar due to intensive management needs, extensive planting of white pine and specific hardwoods (e.g. northern red oak) from the ecoregions to the south.
14. Strategic prioritization of species used in restoration programs needed factoring in extirpation risks and economic/ecological interests.
15. Maintain high levels of genetic diversity, Use a diverse mix of indigenous tree species to reduces the risk of loss to insects and diseases

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the

Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. Up to date and fine scale vegetation inventory and monitoring are critical to inform the development of climate change adaptation strategy.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. Vegetative inventories and monitoring programs are currently ad hoc poorly funded and patchwork across the southern part of the province, long term well planned and adequately funded inventory and monitoring program is the only responsible approach to take in the face of a rapidly changing climate.
2. Monitoring for climate change indicators needs to be integrated into inventory programs.
3. Current inventory techniques that are designed primarily to classify vegetation need to be updated to collect quantitative, multipurpose information that will enable trends and change to be detected as climate change impacts occur.
4. Collect information at scales from local to regional in order to be relevant to climate change.
5. Standardize data collection systems so that data can be aggregated across ownerships, jurisdictions and scales.
6. All cover types including wetlands, grasslands and early successional communities need to be included in inventories in order to predict pathways of vegetative succession.
7. Monitor phenology of native plants as the most obvious and fastest way of detecting

incremental change on the ground (annual bud break, seed maturation date, etc.).

8. Indicators of climate change and monitoring efforts need to be applicable, relevant and interchangeable across provincial, regional, and watershed scales.
9. New technologies, such as the use of remote sensing data, along with inventory, monitoring and on-the-ground observational information could support regional trend analysis and mapping.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Forecast and predict vegetation shifts across regions to detect climate change response.
2. Undertake with stakeholders a regional vulnerability assessment of the Great Lakes-St. Lawrence, Carolinian, and Boreal Forest and their associated communities by the end of 2011.
3. Develop initiatives and incentives for landowners to commit their land to growing plantations.
4. Study and consider the potential for assisted migration techniques to establish threatened native species.

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Use time series maps to highlight the extent and speed of potential changes in climate.
2. Use local specific predicted climate change scenarios and vulnerability assessments to increase personal impact on people and

communities (how will my community and my family be impacted by climate change).

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

No recommendations.

Theme 9: Invasive Species

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. Review provincial legislation pertaining to sales of live non-indigenous species (fish stores, aquarium shops and water gardens sell species considered 'tropical' or 'semi-tropical' the expectation that they cannot survive here over winter cannot be taken for granted).

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. Revise the Provincial Policy Statement (PPS) to include protection for all habitats e.g. wetlands.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. Reduce propagule pressure since we know it is vital to all non-indigenous species to survive introduction.
2. Do not use disturbance alone as a good predictor of invasion success -- it works well for terrestrial plants but is a very poor indicator for aquatic invaders.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. Use presence of invasive species in the Lake Simcoe Watershed region as a clear indicator of risk.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

No recommendations.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. Identify and sever the vectors that transmit some invasive non-indigenous species (e.g. EWM).
2. Keep firewood from being used to disperse the EAB.
3. Quarantine products from affected western states that may transmit the walnut beetle and fungus.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

No recommendations.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

No recommendations.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Develop vector management strategies for all existing and looming invasive species.
2. Research cumulative impacts and interactive stressors related to each invasive species in the watershed (e.g. are climate-stressed trees more susceptible to EAB or walnut disease).
3. Develop early detection strategies for new invasive species.
4. Develop habitat-specific rapid a response plans.

5. Use GCM models, environmental niche models specific to each species (e.g. Hydrilla [Esthwaite waterweed], Eichhornia [water hyacinth]) and an examination of physiological response of each species at cold temperatures to predict future survivability.
6. Understand the physiological response of non-indigenous species to cold. (the invasion process itself in which a few individuals of a species are introduced, is an ideal environment for evolutionary change due to founder effect, genetic drift and/or selection so, species may not perform as we expected them to based on their previous distribution).

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Use authoritative and trusted individuals to calmly lay out the scenarios associated with new introductions along with a plan of action.
2. Implement a public awareness campaign, similar to current ones with Asian Longhorn Beetle, with landscapes, garden centers, and the public to reduce the use of invasive species for horticultural purposes.
3. Institute and promote the “Plant Me Instead” campaign in all nurseries in the watershed.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

No recommendations.

Theme 10: Agriculture

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. Review policies and legislation pertaining to the agricultural sector to assess whether they pose barriers to climate change adaptation.
2. Review the implementation elements of the Lake Simcoe Protection Plan Policies, i.e. Phosphorus Reduction Strategy, Recreation Strategy in light of climate change implications.
3. Assess and document land use policies that favour and promote urban growth at the expense of prime agricultural land.
4. Assess other environmental policies, i.e. Greenbelt Plan to clarify legislative priority and alignment with other plans.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. Review policies and legislation pertaining to the agricultural sector to document whether they encourage climate change adaptation while recognizing that legislation for agriculture is only applicable in the areas where the specific type of agriculture occurs.
2. Assess the provincial Nutrient Management Act and regulations to ensure prudence in the storage and application of nutrients, protection of water, and encourage resilient

land use practices (i.e. planting riparian buffers).

3. Assess the Growing Forward Initiative, specifically the Environment and Climate Change policy that integrates climate change adaptation measures through the Environmental Farm Plan, i.e. Water use management (<http://www.omafra.gov.on.ca/english/about/growingforward/gfontario.htm>).
4. Assess Growing Forward's Business Risk Management Suite which provides protection for different types of losses such as disaster relief (<http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1200408916804&lang=eng>).
5. Review the Animal Health Act, whose regulations will help to improve resiliency for the livestock sector through actions like increased monitoring for disease.
6. Review the Planning Act, Provincial Policy Statement, and Municipal By-Laws that govern land use and enable current policies.
7. Assess the Green Energy and Green Economy Act that encourages development of green, renewable electricity. It will reduce GHG emissions by replacing in part, electricity from fossil fuels.
8. Review the Environmental Farm Plan which helps farms adopt mitigation and adaptation practices around the farmstead and in the fields.

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. Encourage future strategic planning guided by an integrated approach incorporating economic development, environmental sustainability, and social wellbeing. This

planning process should also incorporate non-climatic stressors.

2. Create an advisory body and working group, including researchers, policy-makers, and key stakeholders to support strategic planning related to climate change adaptation.
3. Recognize the relevance and importance of the Holland marsh area and the ongoing Holland Marsh Reconstruction Project which is attempting to recognize potential threats to human safety from storm events (post Hurricane Hazel).

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. Review each policy in the Lake Simcoe Protection Plan to determine how each could be affected by climate change.
2. Recommend that the Lake Simcoe Science Advisory Committee and Lake Simcoe Region Conservation Authority (LSRCA) evaluate and review potential climate change adaptation strategies and include a component of climate resiliency in their protection strategies.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

1. Review current management standards, practices and plans, especially those focusing on pests and disease control, infrastructure standards and risk-insurance policies.

- Incorporate potential impacts of current and future climate variability.
2. Conduct vulnerability assessments of local agricultural systems to better understand those areas (both issues and locations) where sensitivity is high and capacity is lacking, and areas where opportunities may exist to develop adaptation measures.
 3. Incorporate water management innovations into the Lake Simcoe Environmental Strategy to address the risk of moisture deficiencies and potential future droughts.
 4. Adopt “no-regrets” options for land use planning, natural resource development, and capacity development (i.e. decisions that provide benefits with or without impacts of climate change).
 5. Communicate progress and problems through a common, easy to understand reporting portal.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. Create a climate change adaptation evaluation tool to assess areas of risk in the agricultural sector, both at the federal and/or provincial level.
2. Federal and Provincial investment in the development of crop varieties and yields to increase the tolerance and suitability given future climate change predictions.
3. Review Best Management Practices to incorporate climate change adaptation foci.
4. Encourage and incent local businesses to invest in the adoption of farm machinery and equipment versatile enough to adjust production decisions to variable climatic conditions.

5. Diversify crop types and varieties; diversify livestock to address the environmental variations and economic risks associated with climate change.
6. Promote sustainable environmental management practices e.g. plant windbreaks for protection the soil, rotate crops, no/low tillage.
7. Continue to encourage and support nutrient management planning.
8. Review irrigation practices i.e. manage water to prevent nutrient leaching when rainfall occurs.
9. Support local agricultural production in the polders and rest of the watershed.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. Monitor soil health, e.g. organic content, moisture, nutrient availability, and record daily temperatures.
2. Monitor presence of new and invasive species/pests.
3. Encourage and continue to support local food production.
4. Monitor the overall economic and environmental health of the agricultural sector in the watershed.
5. Monitor and document costs associated with climate variability and/or climate extremes.
6. Document the age of farm infrastructure to obtain a sense of potential vulnerability.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or

what missing monitoring programs need to be created?

1. Through increased surveillance, improve the monitoring of new and invasive species/pests within the province as well as changes in native species populations. This will also engage Federal departments.
2. Create monitoring programs for soil health.
3. Monitor the availability of education programs, workshops, and technology access for rural community towards climate change adaptation.
4. Improve the accessibility of data collection between sources to avoid duplication of efforts and to optimize use of scarce resources.

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Research the timing, amount, and nutrient loads of spring freshet.
2. Research the impacts of climate change on soil health, specifically nutrient content, growing degree days and yields in light of changing temperature and precipitation.
3. Identify impacts of greenhouses i.e. if increasing number of greenhouses in the watershed's polders represents an increase in resiliency, as greenhouses remove weather as a factor.
4. Identify impacts of grown crops i.e. does the increase in variety of crops grown (i.e. Asian vegetables) in the marsh represent an increase in resiliency from a greater variety?
5. Research crop market trends to allow producers to choose specific crops based on climate fluxes.
6. Research the potential economic losses associated with pest and disease versus the

costs associated with surveillance and reduction strategies.

7. Research the various technologies available to enable farms to best adapt to climate change i.e. cost of technology adoption for adaptation.
8. Research pressures and effects of land use conversion.

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Include local community members in the creation of climate adaptation policies, frameworks and plans.
2. Have a primary steering group or division dedicated towards communicating the possibilities associated with climate change and adaptation measures.
3. Ensure climate 'message' from local NGOs, conservation authorities, and governments are in line with each other.
4. Provide free public information sessions about climate change and adaptation strategies.
5. Provide free public literature specific and/or pay for value added material to regional changes and adaptation potential.
6. Improve data accessibility to the public: growers should be made aware of the ranges of extreme summer and winter temperatures, potential increases of extreme weather events, and changes in precipitation.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

1. Include local community members in the creation of climate adaptation framework or policies.
2. Provide access to up-to-date climate change research internationally, nationally, provincially, and locally i.e. free access to climate change related articles and reports (where possible).
3. Provide free climate adaptation risk assessment sessions to local NGOs, conservation groups, local governments and farmers.

Theme 11: Infrastructure

Legislation and Policy 1

Question: What barriers to adaptation can be eliminated by modifying existing legislation or policy at any level of government? If possible, please identify the statute or policy, the barrier, and recommended action(s).

1. In general, the current policies and legislations governing infrastructure in Canada prevents innovation and meaningful change. This is partly due to the fact that most statutes are designed to avert risk and real innovation involves taking measured risks. There need to be a fundamental shift in development of policies and legislations to allow for a diversity of actions with respect tot to climate change adaptation. There need to be more policies at the watershed scale enabling those working at the ground level to exert more influence on decisions regarding infrastructure development, renewal and/or upgrades. A major barrier to adaptation is lack of diversity of approach in infrastructure management, partly perpetuated by restrictive and punitive regulations. A shift towards more progressive policies with respect to infrastructure development will

help in allowing more integrated, iterative and adaptive policies and regulations. To summarize, a major barrier to adaptation is risk aversion, partly promoted by current policies. Those policies and regulations that promote alternative approaches to infrastructure management must be promoted. There are not many such regulations or policies. More recent provincial guidelines and policies such as those related to stormwater management (based on low-impact development) should be used as examples. Risk aversion is extensively exercised in municipal water management policies and regulations. These regulations must be modified to allow for experimentation and demonstration of alternative, less centralized approaches to municipal water management.

2. Wastewater treatment and disposal regulations should be modified to encourage water reuse and recycling in an extensive manner.
3. Provincial and municipal regulations must be modified to allow for development of community-based (especially in new developments) solutions to water and wastewater management.
4. In terms of stormwater management, we are faced with two choices, either we build larger conventional systems to deal with the projected increased runoff events, or we can build more resilient systems, using green infrastructure and LID in combination with more conventional systems. While the current Stormwater Management Guidelines do not discourage the use of LID treatments, there is an impression amongst the development community that conventional systems are the preferred option. That is not true, the Guidelines do allow for the use of LID, however municipalities are sometimes reluctant to take on LID assets over maintenance fears. More needs to be done to

educate and to guide municipalities through the process, and with the ongoing use and maintenance of the systems. The MOE is working with our partner ministries, conservation authorities, and municipalities on this, and we will be addressing this need in the future. In terms of modifying an existing policy perhaps the Guidelines could be more explicit in their support and encouragement of LID.

5. Another benefit of LID is that it is effective in the removal of nutrients such as nitrogen and phosphorous from stormwater. By employing LID in the Lake Simcoe water shed we will not only be increasing resiliency in the face of climate change, but will also be working to achieve the water quality objectives as well.
6. Adaptation solutions will all be linked in some way to greenfield development and or redevelopment. There needs to be a way to more closely link land use planning to natural systems that could be used to adapt to climate change (i.e., riparian zones, setbacks etc).
7. The current stormwater management policies do not encourage/require municipalities to implement source controls before looking at end-of-pipe solutions, which result in more robust and adaptable urban drainage systems.
8. Ontario Plumbing Code limits the application of reclaimed (rain) water to use for toilet flushing. Further work is needed to promote the use of reclaimed rainwater, grey water and wastewater to supplement existing fresh water resources and reduce the discharge of P to Lake Simcoe.
9. Government agencies who govern the provincial Environmental Assessment process and land use approval process should keep an open mind to proposed new technology or techniques such as low impact development (LID) technology for subdivisions. Traditionally, new technologies such as LIDs are not always sufficient to satisfy

government approval. Instead, backup traditional technology such as stormwater ponds must be available in case the new technology does not work as expected. As we all know, urban development under climate change environment will accelerate the impacts on our hydrologic cycle resulting in damages to our infrastructure. As a result, we have to promote new technology who may offer comparable control performance to traditional technology.

Legislation and Policy 2

Question: What existing legislation or policies (at any level of government) could be used to help integrate climate change adaptation strategies or management actions into decision-making processes? If possible, please identify the statute or policy, and recommended action(s).

1. The new water conservation and opportunity act is used properly can help bring about new innovations in water management. The focus of this new act should be to promote not the status quo, but to facilitate development of alternative water management and watershed protection approaches that encourage action at the local level.
2. The Clean Water Act - the focus should be on watershed protection. However, this act should also focus on managing human activities around a watershed so the impact is lessened. A major emphasis must be on alternative stormwater management approaches.
3. I believe that the policies and provisions of the Lake Simcoe Protection Act (2008), as amended, and Plan, if fully implemented within the watershed and respected in actions implementing other legislation, acts, etc. (e.g., Planning Act, municipal official plans and bylaws) will be sufficient to begin addressing climate change adaptation. Support with new

language (e.g., standards or policies that "have regard for..." or "must consider the implications of climate change impacts...") within other federal legislation and policies (Building and Engineering codes, Fisheries Act, etc.) would be helpful.

4. In my opinion the Ontario Planning Act, the PPS, Municipal Official Plans, Zoning By-laws should all be amended to include climate change and to provide a framework for adaptation. Floodplain mapping should also be amended to deal with the more severe rainfall events that are predicted to occur. The 'regulatory' storms also need to be amended to reflect increased rainfall.
5. Land use approval and environmental assessment process. For land use approval, new control requirements which address climate change impacts should be specified. For environmental assessment of municipal capital projects, new criteria and processes should be developed to integrate climatic change impacts into the development of these capital projects

Strategic Planning 1

Question: What goals or objectives should guide future strategic plans that will affect the Lake Simcoe Watershed?

1. The main goal must be to diversify watershed protection and water management practices. The focus must be to place more control at the local of watershed levels. A move away from centralized infrastructure and towards a distributed infrastructure must be encouraged. Site-specific water management strategies such as rainwater harvesting, low-impact development and management practices, small-scale water reuse should be implemented. Attention must be paid to low-footprint development to maximize perviousness.

2. A move towards alternative transportation strategies such as rail and away from car and truck transportation will help reduce application of road salts.
3. Resiliency, not only for SWM systems but for all water infrastructure and systems. We need to encourage an integrated water system that can harvest stormwater or recycle sewage for re-use in dry times, and that can manage increased flows during wet periods. That is the dilemma presented by climate change, we know it is going to be warmer, with increased rainfall intensity, but we don't know if it is going to be wetter or drier overall. Harvesting stormwater and recycling sewage for re-use can enable us to achieve our goals for improved water quality.
4. I would segment future strategic planning into two components with respect to climate proofing infrastructure. There is the infrastructure that already exists so it is important to understand the specific risks associated with it. High probability, high consequence has to be acted on. Low risk and high consequence should also be reviewed and appropriate plans need to be developed. For most of the infrastructure the goal isn't to create new capital projects but to make sure that the infrastructure owner considers the risks and puts in place plans to mitigate these during normal lifecycle renewal. For new infrastructure, future weather must be considered in the design so you don't add to the problems. There should be a larger reliance on natural or green infrastructure.
5. As noted in 2, the goals/objectives in the existing Lake Simcoe Protection Act and Plan should guide future plans.
6. Guidance and incentives to area municipalities to start thinking about and implementing fit-for-use water projects, which include water reuse.
7. It may sound overwhelming, municipal capital and operating program should be developed

with goals to evaluate the vulnerability of existing infrastructure and upgrade their capacities to adapt to climatic change.

Strategic Planning 2

Question: List any targets or recommended actions from the Lake Simcoe Protection Plan (2009) that relate directly to climate change adaptation and state how you think they could be improved.

1. Objective 6 states “improve the Lake Simcoe watershed’s capacity to adapt to climate change”.
2. Priority 5 states “addressing impacts of invasive species, climate change, and recreational activities”.
3. Developing Aquatic/Fish Community Objectives for Lake Simcoe and its tributaries. These objectives will be used to increase the resilience of the Lake Simcoe aquatic community to impacts of climate change (see Aquatic Life, Policy 3.1).
4. Conducting research projects on the aquatic communities of Lake Simcoe and its tributaries. The focus of the research will be on filling knowledge gaps and include an evaluation of the impacts of climate change on the fish community (see Aquatic Life, Policy 3.5).
5. Committing municipalities to prepare and implement comprehensive stormwater management master plans which will consider the potential impacts of climate change on the effectiveness of the stormwater management works (see Water Quality, Policy 4.5); AND to review this policies and evaluate their effectiveness every 5 years, or following significant rainfall events (i.e., 1:10 yr storm).
6. Promoting, conducting and supporting water quality scientific research projects that build on existing research and monitoring programs, identify emerging issues, and

support the overall adaptive management principle. Research will include the assessment of the impacts associated with climate change, and other emerging issues (see Water Quality, Policy 4.23).

7. Requiring municipalities to prepare water conservation and efficiency plans that consider the potential impacts of climate change (see Water Quantity, Policy 5.3); and (SEE MY RESPONSE TO NUMBER 3).
8. Implementing a monitoring program in relation to the targets and indicators associated with natural features and areas. The monitoring plan will also gather information on species that are influenced by climate change (see Shorelines and Natural Heritage, Policy 6.50).
9. The key phosphorus and corresponding dissolved oxygen targets are directly related to climate (and therefore changes in climate). When evaluating the success of various interventions (e.g., stormwater management, STP retrofits, etc.) it will be essential to control for climate conditions. It may become necessary to adjust programs (i.e., remove more phosphorus) than originally intended to maintain or improve target levels.
10. The Stormwater 4.5-SA Item d, e, and f and 4.6-SA should incorporate the requirement to address climatic change.

Land Use and/or Resource Management Planning

Question: Based on your knowledge of existing land use or natural resource management plans used in the Lake Simcoe Watershed, what actions are needed to ensure that these plans account for the potential and known impacts of climate change?

1. Ensure that we protect wetlands, forests and green spaces.
2. Minimize development near the Lake Simcoe Watershed. Specify a very conservative buffer.

3. Promote land use practices that minimize dependence on freshwater resources, such as mixed use that allows for resource sharing.
4. My knowledge of specific plans used within the watershed is limited. However in terms of infrastructure, infrastructure plans (short and long-term), maintenance regimes, and asset types will need to consider the impacts of higher intensity rainfall events and be designed accordingly. Flood plain models will need to be updated and floodplain mapping amended accordingly.
5. The areas of risk could be considered on a land use planning overlay so that they don't get missed during land use decisions. This could also include re-plotting of floodways, flood zones and catchments that will require more reliance on low impact development where there are no possibilities for end of pipe solutions.
6. There remain many uncertainties regarding knowledge of specific climate changes at the scale of the watershed. Where land use or resource management decisions are climate-sensitive and likely to have implications for 20+ years, then the development proponents and/or municipal/provincial authorities should be required to consider a range of possible climate futures and propose/develop contingencies. Pooled insurance, special development levies, and other risk management instruments might be invoked where the concern is great but ability of individual proponents to manage (i.e., compensate) future impacts is limited/impractical.
7. Regulatory agencies in land use planning should demand subdivision proposal to address climate change impacts on the proposed infrastructure. For proposals relating to aggregate extraction, proposal should address climate change on the natural resources.

Management and Operations

Question: What actions could help mitigate impacts and embrace opportunities associated with potential climate change in natural ecosystems and the built environment?

1. Revised SWM practices which encourage harvesting and re-use, can both assist with alternative water sources in drier times, as well as to form one component of a SWM program during rainfall events. The use of LID will help protect natural ecosystems by better mimicking natural flow regimes in waterways
2. Potentially, efficiencies can be achieved through better use of weather and climate information (in management and operations). Test beds or similar case studies to reveal such benefits will enhance understanding of weather/climate-operation relationships.
3. Increased education to public to be aware of climate change in natural ecosystems and the built environment.
4. Approval staff of regulatory agencies should be properly trained to review proposal to change natural ecosystems and the built environment.

Monitoring 1

Question: What values (i.e., ecological, social, economic, and/or infrastructure values) of the Lake Simcoe Watershed are important to monitor in a rapidly changing climate?

1. Ecological, economic, and infrastructure will all have an influence on social values. By encouraging diversity and building more resilient systems we can ensure that infrastructure lasts longer, the ecosystems are better protected, and the economy remains stable which in turn lends stability to people lives.

2. The variables targeted in the Lake Simcoe Protection Plan (e.g., phosphorus, dissolved oxygen, invasive/native species abundance, beach closures, etc.). Indicators of impact to specific government operations (e.g., water use, sewage treatment, winter maintenance activities, energy and other utility use, measures of infrastructure deterioration and repair...).
3. Phosphorus concentrations in urban stormwater are very much unknown in the watershed, and need monitoring for different land uses in order to develop more accurate loading and management models.
4. Capacity of existing infrastructure to withstand climatic impact on the design criteria and the economic cost of failure of infrastructure due to climate change in the next few decades.

Monitoring 2

Question: Given your answer to the first monitoring question, what gaps in existing monitoring programs need to be filled and/or what missing monitoring programs need to be created?

1. There needs to be a better appreciation of the ecological (environmental) services offered by the watershed.
2. Watershed's role in ensuring public health (aside from the drinking water perspective) must be better understood.
3. Role of biodiversity in public and ecological health must be better measured and explained.
4. Software models need to be developed to underwrite the conversion to LID and provide surety to municipalities and developers.
5. I'm not certain about needs for specific variables or metrics, but a mechanism for centrally archiving, quality-controlling, and making available data for research and

evaluation is probably missing for the social and economic impact variables.

6. Establish a database of new technologies to document the effectiveness of these technologies in alleviating impacts

Research

Question: What research priorities are needed to support adaptive decision-making in a rapidly changing climate?

1. Demonstration of applicable low-impact development strategies and research into adoption of these strategies for the Lake Simcoe region.
2. Research into effective integrated water management strategies.
3. Research on the loss of perviousness to the health of the watershed.
4. Better understanding road salt application, impact and mitigation.
5. In terms of water quality, I would say the design and function of LID assets, specifically: engineering designs, the filter media used, and plant selection. From a quantity/flood risk perspective, new models and/or IDF curves should be developed to better reflect the changing rainfall patterns.
6. The consequences are essentially speculations at this point and need considerable research, monitoring, and evaluation by practitioners, scientists, and the interested public/stakeholders.
7. Existing water quality and quantify models/guidance must be tested for validity across the full suite of possible climate change scenarios.
8. Science-based, sound guidance to municipal engineers for planning and design of robust and adaptable water management infrastructure.
9. Development and independent testing of new water/wastewater/stormwater treatment

technologies under a variety of loading conditions.

10. Knowledge of technologies that can alleviate climate impacts on urban development.

Knowledge Dissemination (Communication) 1

Question: What types of communication tools and techniques are needed in the public domain to enhance the understanding of climate change impacts and (potential) management actions?

1. Locally-initiated and developed communication strategies often work best. These can be through community organizations, neighbourhood groups, etc.
2. Combine knowledge dissemination with action, i.e. engage people in action at the local level.
3. Outreach through all forms of media, demonstration sites which include interpretive signage, engagement of children through schools, the best way to reach the parents is by engaging the kids.
4. There is a definite need for a good discussion with stakeholders regarding an adaptation plan. These are community based risks that are being managed and not all of the solutions are available on public land. There may be actions for the public that you would want related to protection of natural infrastructure, development, low impact development etc.
5. Lessen the emphasis on "change" and increase understanding of climate-ecosystem-society-economy connections.
6. Adopt a "learning through doing" perspective. Involve the communities and special interests in monitoring impacts, asking questions, and evaluating research as it is conducted.
7. Web site to educate and disseminate climate change impacts and remedial actions.

Knowledge Dissemination (Communication) 2

Question: What types of communication tools, techniques, and resources are needed to enhance education, extension, and training opportunities within management agencies?

1. Tools to enhance continuous interaction such as Wiki-based knowledge sharing tools.
2. Tools to enhance mentorship.
3. Short and hands-on courses and training modules.
4. Engaging management agencies in collaborative actions.
5. Interactive training, hands-on experience, support from all levels of government; policies, guidelines and tool kits.
6. Pooled or special resources could be made available to support 2-3 "climate liaisons" whose job would be to spend 1-3 months in different municipal agencies and key businesses to observe decision-making practices and facilitate the exchange of knowledge.
7. Web, Facebook, newsletters, public workshops, etc.