Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands

Second Information Sharing Meeting

Final Report

March 12, 2020

Black Creek Pioneer Village

North York, Ontario

Great Lakes Protection Initiative

Environment and Climate Change Canada / Environnement et Changement climatique Canada

Ontario Climate Consortium
Supported by Toronto and Region Conservation Authority

Climate Risk Institute

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Disclaimer

The contents of this report reflect the views and opinions of participants in attendance at the workshop, and the interpretation of volunteers recording participant responses and general input. It does not, reflect the complete scope of the **Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands** project. This report was prepared for Environment and Climate Change Canada as a resource for consideration.

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Environment and Climate Change Canada (ECCC) would like to thank participants of the second information sharing meeting. Engagement and participation of partners, rights holders, and stakeholders is fundamental to the Great Lakes Protection Initiative's vulnerability assessment project. ECCC would also like to recognize the following two organizations involved in the planning, organization, facilitation, and delivery of the meeting and this final report:

Ontario Climate Consortium (OCC)

OCC works collaboratively with university researchers and partners from the public, private and non-governmental organization sectors on projects aimed at answering specific questions related to climate change and creating the intelligence necessary to address climate risk. Its mission is to provide decision-makers with regional climate data, intelligence and adaptation services that enable effective policy development and investment in the face of climate uncertainty in Ontario. For more information, please visit: www.climateconnections.ca

Climate Risk Institute (CRI)

CRI is a resource hub for researchers and stakeholders and provides information on climate change impacts and adaptation. CRI communicates the latest research on climate change impacts and adaptation, liaises with partners across Canada to encourage adaptation to climate change, and aids in the development and application of tools to assist with municipal adaptation. CRI is also a hub for climate change impacts and adaptation activities, events and resources. For more information, please visit: www.climateriskinstitute.ca

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Executive Summary

With support from the Great Lakes Protection Initiative (GLPI), Environment and Climate Change Canada (ECCC) is taking action to address climate change through a project called, **Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands**. The purpose of this five-year project (2017-2022) is to develop tools that build on the current understanding of coastal wetland processes, structure, and composition in order to:

- Identify future climate change impacts
- Understand how and where wetlands are most vulnerable to the impacts of climate change
- Bring together all levels of government, Indigenous Peoples, experts and decision-makers, businesses and community groups to develop proactive adaptive strategies and measures for building coastal wetland resilience in the Great Lakes basin.

The project supports Canada's commitments under the Canada-United States Great Lakes Water Quality Agreement (GLWQA) and the Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health (COA) to support healthy and productive wetlands to sustain resilient populations of native species.

On March 12, 2020, ECCC hosted a second information sharing meeting at Black Creek Pioneer Village (North York, Ontario), which was organized in partnership with the Ontario Climate Consortium (OCC) and the Climate Risk Institute (CRI). The meeting had four primary objectives (left), which translated into various presentations and interactive activities (right):

Meeting Objectives	Presentations and Interactive Activities
1. Provide an update to the coastal wetland vulnerability assessment	• Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands • Modelling Wetland Response • Assessing Wetland Sensitivity • Preliminary Results on Wetland Adaptive Capacity
2. Share new climate and water level modelling results and identify associated key risks and impacts	• Climate Change in the Great Lakes basin • Activity on Climate Impacts on Great Lakes Coastal Wetlands by Lake/Region (Activity 1)
3. Jointly develop adaptation strategies, measures and actions to enhance coastal wetland resilience	• Resilience Thinking and Adaptation Planning • Activity on Building Coastal Wetland Resilience: Lake-by-Lake Breakout Sessions (Activity 2)
4. Engage a network of wetland conservation practitioners	• Question and Answer sessions, end-of-day general discussion, and Activities 1 and 2

In total, 59 people attended the meeting, representing a diverse range of expertise, including federal government (20), non-profit organizations (15), Conservation Authorities (14), and Indigenous representatives (5), among others (including municipalities, academics, and private sector representatives) (See Appendix B for a full list of participants).

Following an overview of the coastal wetland vulnerability assessment, and a presentation on future climate and water level projections for the Great Lakes basin, the first interactive activity sought to build on the latest climate analysis results by asking participants to identify place-based climate change impacts of greatest concern on coastal wetlands by lake/region, as well as broader social, environmental and economic consequences of greatest concern.

The climate drivers of wetland change that participants were most concerned about include:

- Increasing water temperatures
- Water levels – including sustained high water levels and sustained low water levels
- Loss of ice cover
- Increasing frequency, intensity and severity of extreme storm events, including extreme winds
- Increasing air temperature
- Changing precipitation patterns, including more precipitation falling as rain in winter and reduced precipitation in dry months
- Increased evaporation.

Many of these changes are already being observed and these changes are happening simultaneously, resulting in compounding impacts. Across the lake-by-lake breakout groups, participants commonly identified the following impacts and consequences of greatest concern that may be experienced across the Great Lakes basin:

Top Climate Change Impacts on Coastal Wetlands	Broader Social, Environmental and Economic Consequences
• Changes in wetland areal extent, structure and composition • Loss of wetland habitat and degradation of riparian areas • Changes in animal and fish patterns (e.g., population abundance, distribution, reproduction) • Increased shoreline erosion • Water quality impacts	• Loss of cultural heritage • Loss of traditional ways of life • Impacts on recreation and loss of associated recreational revenues • Impacts on infrastructure and associated health and safety risks and increased costs • Impacts on water quality and associated health and safety risks and increased costs • Human health impacts

The second interactive activity took place in the afternoon and followed a presentation on resilience thinking and adaptation planning. The focus of Activity 2 was on:

1. Confirming top climate change impacts identified in Activity 1
2. Identifying broad adaptation strategies for enhancing coastal wetland resilience

3. Brainstorming place-based adaptive measures for addressing specific climate impacts
4. Identifying opportunities or pilot projects to build coastal wetland resilience.

Several common themes emerged from the discussion of broad adaptation strategies, including:

- Prevent or minimize any additional loss of wetlands
- Maintain and enhance the fundamental ecological functions and services of coastal wetlands
- Work with natural cycles instead of interfering with them
- Adopt a watershed-scale management approach to protecting and restoring wetlands, recognizing the connections between coastal wetlands and the broader landscape/environment
- Support regional collaboration to enhance integrated coastal management and planning
- Implement nature-based solutions
- Protect people and property (e.g., from flooding and erosion risk)
- Manage water levels regionally and locally
- Enhance education and awareness of the importance of coastal wetlands and management practices that help build coastal wetland resilience.

Participants also identified a variety of potential adaptive measures to address climate change impacts on Great Lakes coastal wetlands. Some were focused specifically on wetlands while others focused more broadly on surrounding communities, recognizing wetlands as social-ecological systems. These adaptive measures were categorized into three groups: **Resist, Recover** and **Transform**, and the following table provides a few examples (see Section 4.0 for more information).

Resist	Recover	Transform
• Strategically armour the shoreline or build protective infrastructure where necessary • Increase the size of culverts to convey greater flows • Manage water levels through regulation at the lake scale while also managing water levels locally	• Facilitate recovery of sediment resources (including sediment sources and sinks) • Support septic system relocation/connection to municipal infrastructure • Managed retreat and turning adjacent lands into habitat areas	• Create new habitats • Hydrologically isolate wetlands to minimize external influences (e.g., the transport of matter, energy or organisms), especially in highly developed landscapes • Coastal renaturalization and remove outdated/ harmful shoreline hardening

Some adaptive measures can fall under more than one category depending on how they are applied. Adaptive strategies and measures can also present trade-offs (e.g., armouring the shoreline versus renaturalization). In selecting which adaptive strategies and measures to adopt, it is essential to establish clear evaluation criteria.

The Resist, Recover and Transform framework was new to many participants. Resistance measures were most intuitive as there are many existing real-world examples that participants can draw from that seek to resist change. Meanwhile, Transformation measures were the most challenging to identify as transformative thinking is still fairly new and requires thinking about systems change, shifting paradigms, and embracing change and uncertainty.

Identifying place-based adaptive measures was also challenging. This was in part due to the lack of more detailed projections of wetland change under future climate change scenarios, which will become available as the coastal wetland vulnerability assessment is completed. However, these initial adaptation strategies and measures identified by participants will be very helpful to provide a basis to further identify and refine necessary strategies, measures, and actions for building coastal wetland resilience when more detailed projections become available.

The purpose of this report is to summarize the presentations and discussions that occurred during the information sharing meeting and highlight general observations of the needs and opportunities for building coastal wetland resilience to the impacts of climate change to help inform the continued efforts to enhance the resilience of Great Lakes coastal wetlands.

Table of Contents

List of Figures

List of Tables

1.0 Meeting Overview

The second information sharing meeting on **Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands** was met with great enthusiasm by a group of wetland conservation practitioners. This section provides a brief overview of the project, the purpose and objectives of the meeting, and who was in attendance.

1.1 About the Project

Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands is a five-year project (2017-2022) supported by the Great Lakes Protection Initiative (GLPI) to help support healthy and productive wetlands and sustain resilient populations of native species. It is a collaborative effort involving coordination across four ECCC Branches. The aim of this effort is to implement a collaborative project with input and involvement from other federal and provincial resource management agencies, Indigenous communities, watershed management agencies, non-governmental environmental organizations, and wetland experts to achieve the following:

Develop tools that build on the current understanding of wetland processes, structure, and composition and assess possible vulnerabilities to projected climate variability and extremes

Share the results of the assessment with stakeholders and rights holders and jointly identify adaptive measures that will enhance coastal wetland resilience under a changing climate

Build consensus on priorities for action and improve the understanding of climate-related impacts on Great Lakes coastal wetlands.

The project consists of two interrelated phases as shown in Table 1. Together, the results of the vulnerability assessment and recommended adaptive measures will provide guidance in setting priorities for wetland conservation action. Findings will potentially inform other work, such as species recovery plans, management plans and habitat restoration project design.

Table 1: Two Phases of the Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands Project

PHASE 1: Vulnerability Assessment	PHASE 2: Enhancing Wetland Resilience
• Site selection, access, local involvement • Physical and biological data collection • Climate and water level projections • Wetland response model development and validation • Wetland sensitivity and adaptive capacity • Spatial analysis and interpretation • Expert input and review	• Outreach and engagement • Literature reviews • Interviews and questionnaires • Focus group discussions and meetings • Synthesis, priority setting and guidance • Reporting

Key Terms

Climate Change refers to a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (Article 1, Framework Convention on Climate Change; Intergovernmental Panel on Climate Change [IPCC], 2014).

Vulnerability is the propensity or predisposition to be adversely affected (IPCC, 2014). In the coastal wetland vulnerability assessment, vulnerability is assessed as a function of the sensitivity of a wetland, its exposure to climate change and its capacity to adapt.

- ***Wetland Sensitivity*** is the degree to which a wetland is affected, either adversely or beneficially, by climate variability or change (IPCC, 2014).
- ***Exposure*** of a wetland to climate change is dependent on where it is located and whether it is in places and settings that could be adversely affected (IPCC, 2014).
- ***Wetland Adaptive Capacity*** is the ability of a wetland to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014).

Resilience is the capacity to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain the system's essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (IPCC, 2014).

The vulnerability assessment will provide details on wetland change over time. While this work is underway, ECCC has begun to identify adaptation strategies, measures and actions for enhancing wetland resilience, which is a key objective of this information sharing meeting. Through outreach and engagement, this project will also help to increase climate change awareness, provide a foundation upon which to build future research on coastal wetland vulnerability and resilience, and enhance the capacity of coastal wetlands to adapt to climate change. In summary, the anticipated outcomes of the project include:

- Improved resolution and understanding of future climate change projections
- Increased understanding of where coastal wetlands are most vulnerable and why
- Improved science-based information to influence local planning and inform place-based decision-making
- Improved understanding of, and collaboration on climate-related conservation issues
- Enhanced communication and development of shared values and priorities.

1.2 Meeting Objectives and Format

The second information sharing meeting was centred on four primary objectives:

1. Engage a network of wetland conservation practitioners
2. Provide an update on the coastal wetland vulnerability assessment
3. Share new climate and water level modelling results and identify associated key risks and impacts
4. Jointly develop adaptation strategies, measures and actions to enhance coastal wetland resilience.

The day began with two presentations by ECCC staff to provide an overview of the coastal wetland vulnerability assessment and share the latest future climate and water level projections for the Great Lakes basin. This was followed by an interactive activity, which sought to build on the latest climate analysis results by asking participants to identify place-based climate change impacts of greatest concern on coastal wetlands by lake/region, as well as broader social, environmental and economic consequences of greatest concern. The morning concluded with a series of presentations, focusing on each component of the coastal wetland vulnerability assessment to provide an overview of assessment methods, results (where available), and some next steps.

The afternoon featured a presentation on resilience thinking and adaptation planning as well as a second interactive lake-by-lake breakout activity, where participants were asked to identify broad strategies for enhancing coastal wetland resilience and place-based adaptive measures for addressing specific climate impacts, as well as brainstorm practical opportunities or pilot projects to build coastal wetland resilience. Finally, the day concluded with an open, plenary discussion about key lessons and takeaways, and suggestions for future engagement. See Appendix A for the full meeting agenda.

1.3 Meeting Participants

In total, 59 people attended the meeting and represented a diverse range of expertise (See Figure 1 for an overview and Appendix B for a full list of participants).

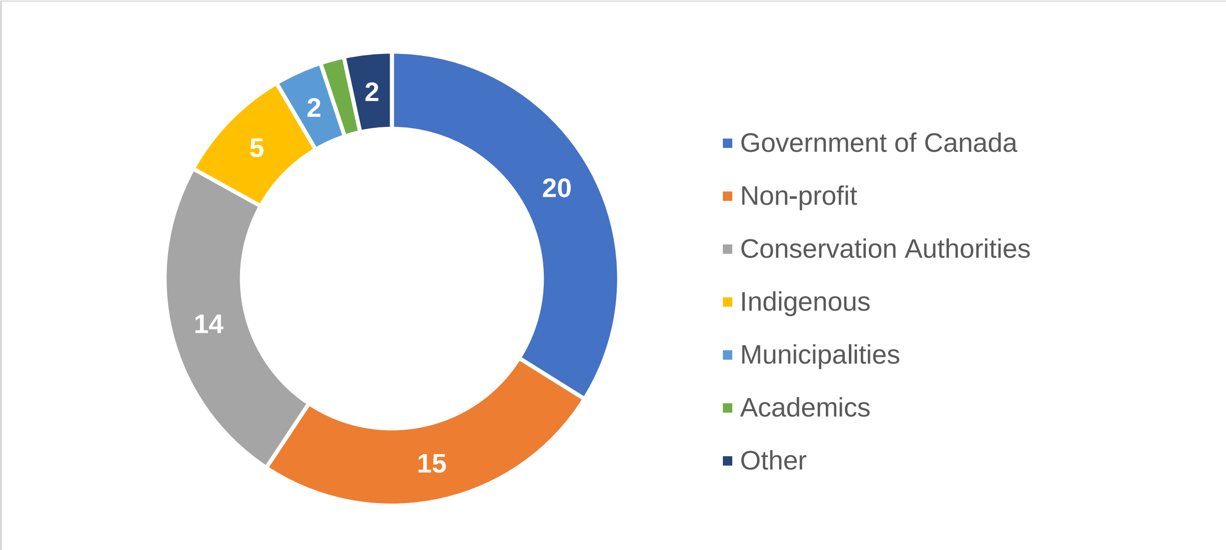


Figure 1: Overview of Meeting Participants

Among federal government participants, there was representation from multiple federal departments including ECCC, Parks Canada, and Fisheries and Oceans Canada. Representatives from a variety of non-profit organizations were also in attendance, including the Ontario Federation of Anglers and Hunters, Ontario Land Trust Alliance, Georgian Bay Association, Royal Botanical Gardens, Georgian Bay Biosphere Reserve, Severn Sound Environmental Association, Georgian Bay Forever, and Georgian Bay Great Lakes Foundation.

Staff from six Conservation Authorities were also present, including Central Lake Ontario Conservation Authority, Credit Valley Conservation, Ganaraska Region Conservation Authority, Lake Simcoe Region Conservation Authority, Nottawasaga Valley Conservation Authority, and Toronto and Region Conservation Authority. We were also pleased to welcome several representatives from Indigenous groups including Magnetawan First Nation, Association of Iroquois and Allied Indians, Batchewana First Nation, and Métis Nation of Ontario. Unfortunately, not all invitees were able to attend and so the lowest representation was among municipalities, academics, utilities, and the private sector. While no representative from the provincial government was able to attend, provincial staff were engaged in an earlier focus group meeting as described below.

1.4 Focus Group Meeting

Prior to the information sharing meeting, a focus group meeting was held on February 13, 2020, at the Canadian Centre for Inland Waters in Burlington, Ontario. The focus group convened approximately 15 wetland conservation practitioners and aimed to develop a preliminary list of major drivers of wetland change and likely climate change impacts, along with a draft set of adaptation strategies and recommended adaptive measures. Focus group participants were guided through the following key concepts, questions and discussions:

- **Resilience to what?**
  Identify the wetland values, processes, and services that should be maintained and/or made more resilient
- **Resilience of what?**
  Explore the climate change drivers, plausible climate change impact scenarios, wetland vulnerabilities, and impacts/consequences
- **How can we build wetland resilience?**
  Discuss best practices, adaptive measures and strategies to enhance wetland resilience, and the types of adaptation related to resilience – resist, recover, and transform.

Details of the focus group are documented in a separate proceedings report (available here). Expert input and recommendations obtained through the focus group meeting provided a basis for the information sharing meeting to move beyond high level concepts of climate change risk and resilience, towards more specific lake-by-lake discussions. This included discussions around climate change impacts, adaptation strategies and measures, and the brainstorming of practical pilot projects for building wetland resilience (see Section 4.0 for further details about the interactive lake-by-lake activities that were held at the information sharing meeting).

The following section brings together several presentations at the information sharing meeting to set the context of how the climate is anticipated to change in the Great Lakes basin and why it is important to build coastal wetland resilience.

2.0 Setting the Context

This section aims to set the context by providing an overview of how climate change is impacting the Great Lakes basin, how climate conditions and water levels may continue to change in the future under climate change, and why assessing and enhancing the resilience of coastal wetlands is important. This section draws upon the following three presentations that were given at the information sharing meeting:

- **Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands** by Greg Mayne (Habitat and Species Program Coordinator, ECCC)
- **Projections of Key Climate Variables and Great Lakes Water Levels Under Climate Change** by Frank Seglenieks (Water Resource Engineer, ECCC)
- **Resilience Thinking for Great Lakes Coastal Wetlands** by Linda Mortsch (University of Waterloo).

Copies of the presentations are available for download here. Please note that the presentation on “Projections of Key Climate Variables and Great Lakes Water Levels Under Climate Change” will become available on the website in late spring or early summer 2020.

2.1 Climate Change in the Great Lakes Basin

Coastal wetlands in the Great Lakes basin provide important habitat for a diversity of plants and animals, and provide a multitude of environmental, economic, social and cultural benefits such as flood mitigation, erosion risk reduction, recreational opportunities, and increased mental health and well-being, among many other benefits. Climate change is affecting the health and productivity of coastal wetlands in many ways, from changing physical and hydrological conditions (e.g., warmer air and water temperatures, decreased ice cover, and changing precipitation patterns) to the exacerbation of existing stressors on coastal wetlands (e.g., from urbanization, stormwater runoff, sewage discharge, and invasive species). Understanding how the climate is changing and how it will continue to impact the Great Lakes basin in the future provides the basis for assessing coastal wetland vulnerability, identifying climate change impacts on coastal wetlands, and identifying strategies, measures and actions for enhancing coastal wetland resilience.

Researchers at the Meteorological Service of Canada (MSC) have been undertaking research to understand climate trends for an array of key climate variables and water levels in the Great Lakes. These include:

- Air temperature
- Precipitation
- Evaporation
- Runoff
- Lake surface temperature
- Ice cover
- Net basin supply (NBS)
- Lake levels.

Their aim is to understand how these variables may change by mid-century (e.g., 2040-2059, or "2050 time slice") and late-century (e.g., 2080-2099, or "2090 time slice") under two climate change scenarios: RCP 4.5 (moderate emissions scenario) and RCP 8.5 (business-as-usual scenario). Modelled future results are compared with current baseline conditions (i.e., measurements taken over a reference period) to understand the extent (or by how much) climate variables are expected to change. Table 2 presents an overview of the preliminary results for climate variables under the RCP 8.5 scenario. It is important to note that the following results are **preliminary** and may be subject to change. Currently, these results are not yet available to the public but will be made available in the near future.

Key Terms

Climate Projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models (IPCC, 2014). The analysis by the MSC has been based on data from Regional Climate Models (RCMs) (at approximately 25km by 25km grid resolution) in order to study changes at the scale of the Great Lakes basin. Global Circulation Models (GCMs) would not provide a fine enough resolution to capture the Great Lakes.

Representative Concentration Pathways (RCPs) are scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover (IPCC, 2014).

- ***RCPs 4.5*** and ***8.5*** are two scenarios defined by the scientific community for the Fifth Assessment Report (IPCC, 2013). RCP 4.5 can be understood as a moderate future scenario of climate change where emissions peak around 2040 before declining and leveling off before the end of the century. RCP 8.5 is often referred as the business-as-usual scenario where emissions continue to rise into 2100 and beyond.

Table 2: Preliminary Results of Projections of Key Climate Variables Under RCP 8.5 for the Great Lakes Basin

Climate Variable	2050 Time Slice	2090 Time Slice
Air Temperature	+1.7ºC to +3.5ºC	+4ºC to +6.9ºC
Precipitation	-12.5% to +16.4%	-20% to +36.5%
Lake Surface Temperature	+0.8ºC to +4.4ºC	+1.8ºC to +6.9ºC
Lake Ice Cover	28.6% to 97.2% reduction	68% to 100% reduction
Evaporation	+8.8% to +14.6%	*In progress*
Runoff	-6.2% to +29.0%	*In progress*

Air temperature is projected to increase across the basin in both RCP scenarios, with higher increases anticipated in winter (i.e., less cold). Higher increases in air temperature are also anticipated in the northern part of the basin. Figure 2 presents the preliminary modelled results for future air temperature under RCP 8.5 for mid- and late-century.

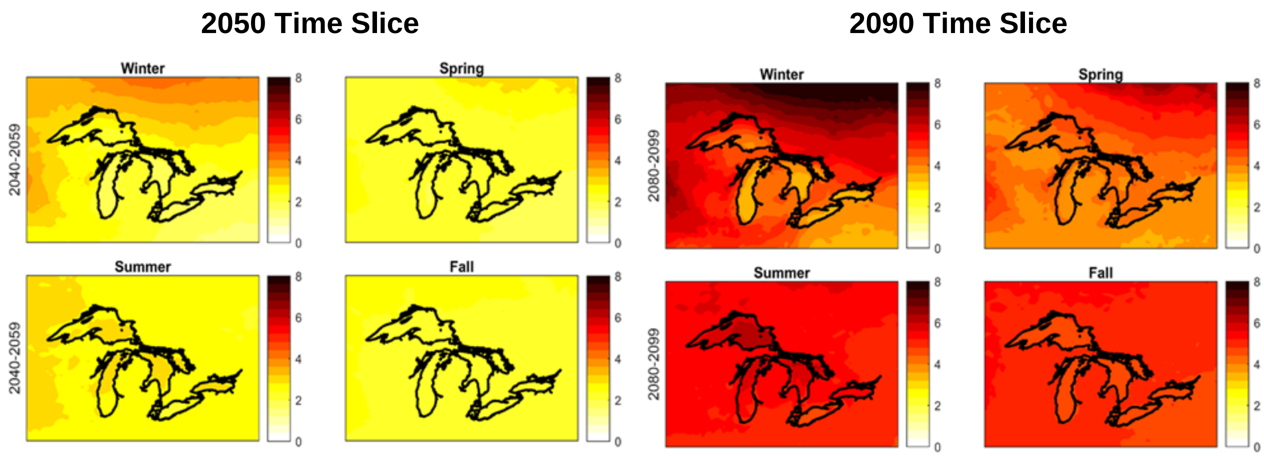


Figure 2: Preliminary Results of Modelled Future Air Temperature Under RCP 8.5 for Mid- and Late-Century across the Great Lakes Basin

Precipitation is projected to be variable across the basin, with increased precipitation generally expected in winter and spring. Meanwhile, it is anticipated that summer will see some reduction in precipitation that may lead to drier summers. Figure 3 presents the preliminary modelled results for future precipitation under RCP 8.5 for mid- and late-century.

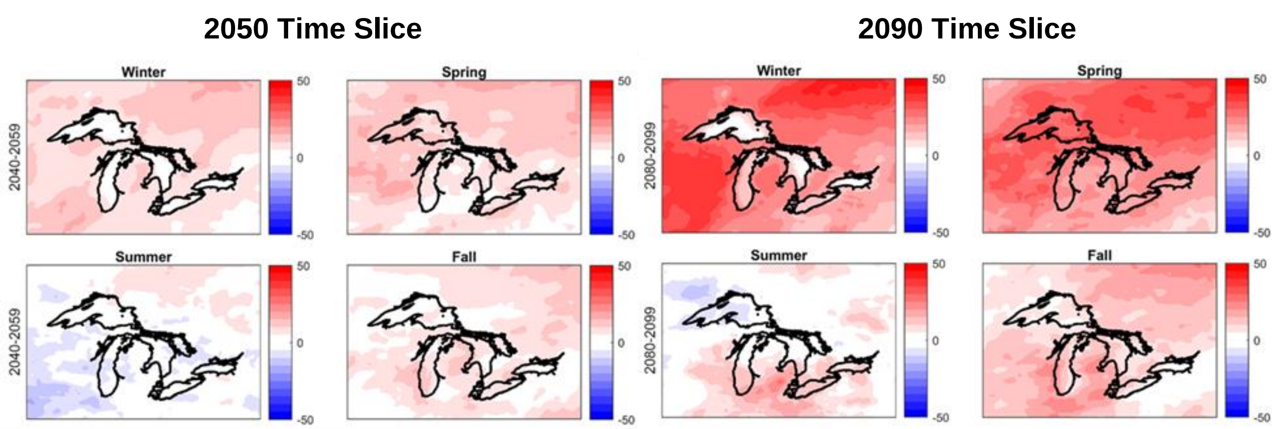


Figure 3: Preliminary Results of Modelled Future Precipitation Under RCP 8.5 for Mid- and Late-Century across the Great Lakes Basin

Lake surface temperature is projected to increase across the basin, with higher increases anticipated in summer. Figure 4 presents the preliminary modelled results for future lake surface temperature under RCP 8.5 for mid- and late-century.

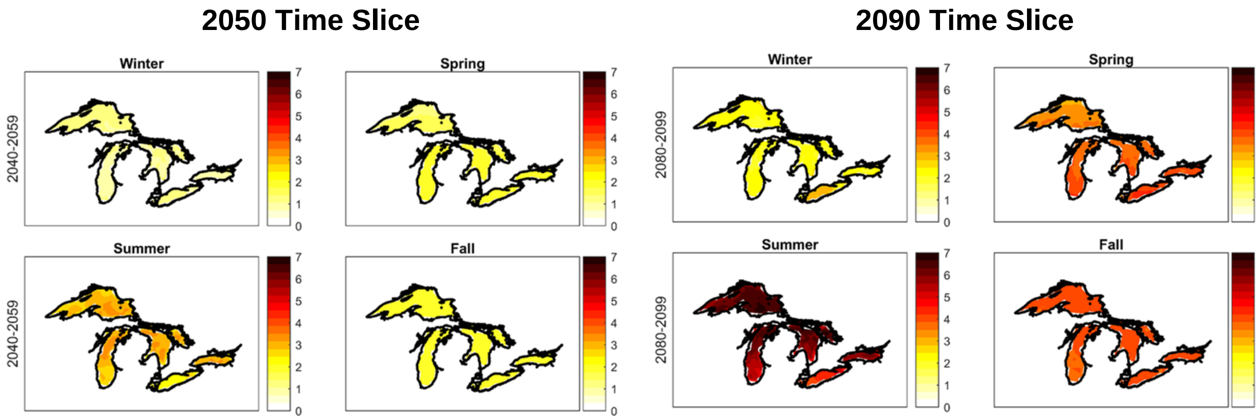


Figure 4: Preliminary Results of Modelled Future Lake Surface Temperature Under RCP 8.5 for Mid- and Late-Century across the Great Lakes Basin

Ice cover is projected to decrease across the basin with significant losses or absence of ice cover in winter and spring by late-century.

Projections of future water levels are based on estimations of net basin supply (NBS), which refers to the net volume of water that come in or out of the lake over a period of time, not including the flow in from the upstream lake or flow out to the downstream lake. Components of NBS that were analyzed include: precipitation, runoff, and evaporation. **Evaporation** is generally expected to increase across the basin, while changes in **Runoff** are anticipated to be variable across the basin. To date, researchers at the MSC have generated projections for future water levels for Lakes Superior, Michigan-Huron, St. Clair, and Erie (see Figure 5). Projections show the 50th (blue), 95th (yellow), and 99th (orange) percentiles of projected future water levels compared to historical values, demonstrating the range of values that might occur in the future. Results for Lake Ontario are still in progress to account for the new regulation plan (i.e., Plan 2014 which was brought into effect in 2017). Current preliminary results for projected lake levels indicate that an increase in variability can be anticipated under both RCP scenarios. This means that both higher and lower extreme water levels can be anticipated across each of the Great Lakes.

A final report entitled “Projections of Key Climate Variables for the Great Lakes Basin” is underway by MSC staff and will be made available as part of this project.

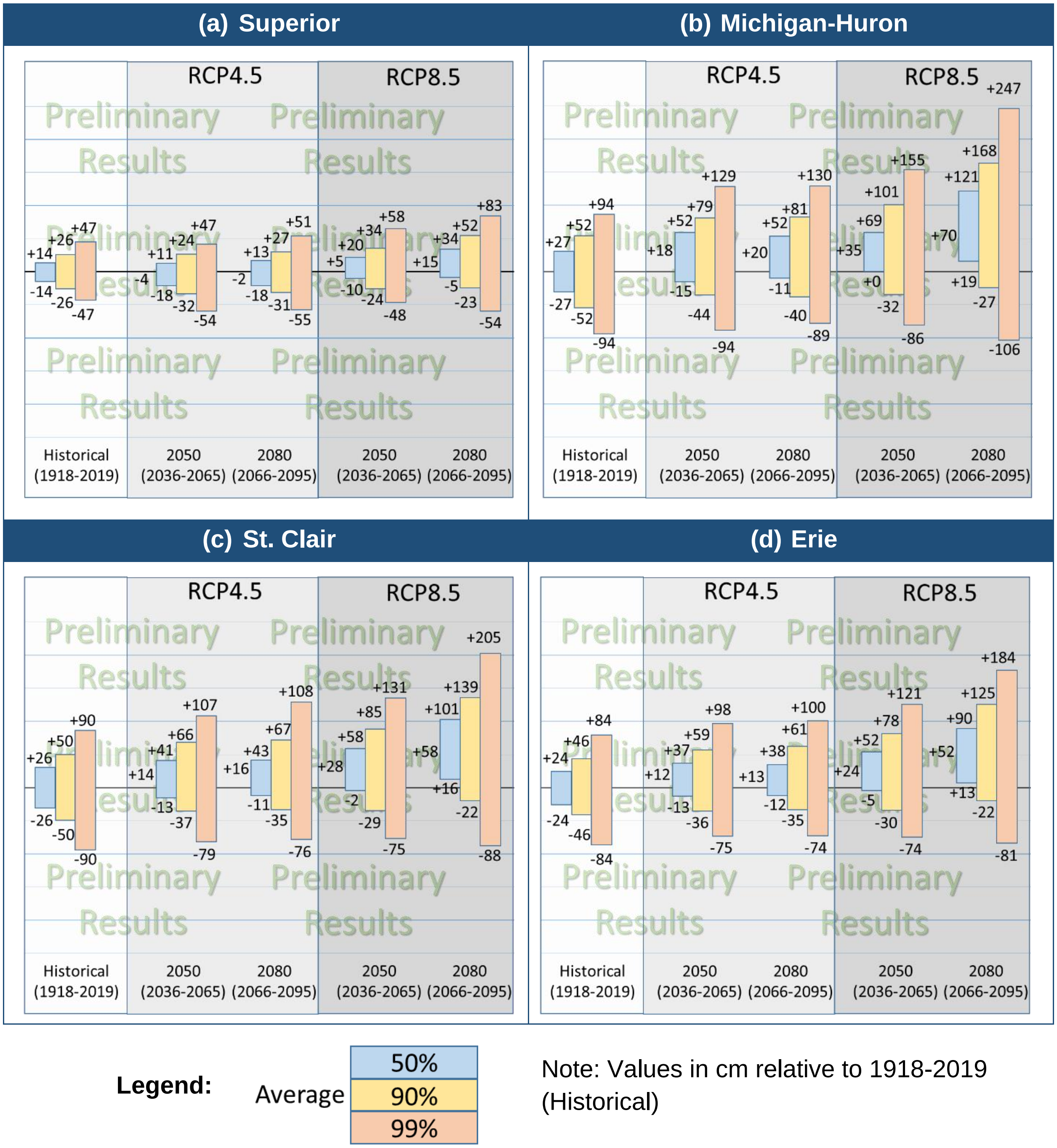


Figure 5: Preliminary Results of Modelled Changes in Future Water Levels Under RCPs 4.5 and 8.5 for Mid- and Late-Century as Compared to the Reference Period (1918-2019) for: (a) Lake Superior, (b) Lakes Michigan and Huron, (c) Lake St. Clair, and (d) Lake Erie

Participants demonstrated a high level of interest in the preliminary results outlined above, particularly the projections of future water levels by lake. Some of the questions were technical in nature (e.g., seeking clarification in model parameters), while others were interested in translating the technical results to increase understanding of how these results can be utilized or applied. The following is a summary of some of the key questions and answers that emerged, which have been edited for length and clarity:

- **Q1: Did you look at diversions into the lake or did you assume no change when estimating net basin supply?**
  A1: It is assumed that there is no change to diversions into or out of the Great Lakes basin in the future climate simulations.
- **Q2: Did you look at how stormwater runoff rates might increase in the future and how this might impact water levels in the Great Lakes?**
  A2: MSC is looking at changes in water levels on a monthly scale. Changes in stormwater runoff as a result of urbanization tend to occur on a timeline of hours and days, which when analyzed on a monthly scale is not significant. However, this could be incorporated in future analyses conducted at shorter temporal scales.
- **Q3: Are there plans to downscale the modelling from a monthly scale to a weekly scale?**
  A3: There is another research group at ECCC that is working with the U.S. Army Corps of Engineers to analyze climate projections at the daily scale. Therefore eventually, there is potential to generate results at a weekly scale, but we do not yet know how long this analysis will take to develop.
- **Q4: Can you please explain how the conveyance capacity of the St. Clair River would affect future water levels across the entire basin?**
  A4: This study does not examine changes in the St. Clair River. However, if the conveyance capacity of the St. Clair River were to change, it may influence water levels in the upper Great Lakes. Future St. Clair River water conveyance is challenging to predict because it can be affected by many factors, such as scour by ice flows, erosion of the riverbed surface, and fill placement in the river.
- **Q5: Can we predict what water levels will be like a year from now or five years from now to inform adaptation and flood prevention and mitigation efforts if we continue to see high water levels?**
  A5: Forecasting water levels over the short-term is challenging because water levels are affected by weather, which can change rapidly. Just as we cannot predict what the weather will be like a year from now, we cannot predict what water levels will be like in a year or five years from now. This is why we study climate instead of weather to understand changes over the long term.
- **Q6: Do the high ranges in water levels mean that I should tell my grandchildren one day to not visit or go near the Great Lakes because water levels could be 2.5m above what they are today by the end of the century? What's actually being said here?**
  A6: What the bars (furthest to the right in each of the graphs in Figure 5) mean is this: at some point within that 30-year time slice (i.e., 2036-2065 or 2066-2095), there's a one percent chance that we will see a year where high water levels exceed 2.5m above historical levels. There's also a 99 percent chance that this will not happen in any given year within the 30-year time slice. That being said, these are predictions of future climate

conditions; we cannot say for sure that this will indeed happen in the future. A major mediating factor is the degree to which we can reduce greenhouse gas emissions, which will be a key driving force behind which future scenario will likely become our new reality.

- **Q7: We're on the eastern end of Lake Superior. We've used this land forever. We have 20 captains that fish here. What is the message I can take back home to my community? What can we do in our community to reduce vulnerability and help reduce the impacts of climate change?**
  A7: This is a very important question and one that we should seek to answer throughout the day. What the preliminary climate analysis results show is that under the two greenhouse gas emission scenarios, we can anticipate that the future will look different but how different will depend on us – what we do to reduce our greenhouse gas emissions and how we adapt to the impacts of climate change. If we do nothing, our chances of seeing more extreme conditions will be higher and if we act now, we may experience less variability.

2.2 The Resilience Imperative

The climate is changing and its impacts are being felt across the Great Lakes basin, affecting the health and integrity of coastal wetlands, as well as the ecological systems and communities that depend on them. Resilience thinking offers a new way of addressing our current climate change challenge by helping to identify opportunities to increase resilience and reduce the vulnerability of ecosystems and people. A more resilient system is better able to adapt to changes in climate and continue to function. A less resilient system transitions to a degraded or entirely new state, resulting in the loss of ecosystem functioning, species populations, and the services they provide. The resilience of wetlands can be affected by existing system stressors such as land use and land cover change (e.g., encroachment), erosion, water level variability, and lack of wetland protection policy. If certain limits or thresholds are exceeded, this may become a tipping point that leads to the loss of a wetland. As one participant pointed out, there are many small wetlands in Georgian Bay that will likely not be able to adapt and recover, and when tipping points are reached in the future, these systems may not be able to bounce back and could disappear entirely.

There is a significant amount of research on what contributes to wetland resilience. For example, through interviews with wetland managers within the Great Lakes basin, some common themes have emerged regarding what makes a wetland resilient. These include:

- The size, complexity, diversity, and location of wetlands in the landscape
- The ability of system functions to be maintained (e.g., connectivity to lake, watershed hydrology, and disturbance regimes) and level of disturbance
- The connectivity of the wetland to other water bodies at the landscape level (accounting for surrounding influences such as land use, management and inputs to wetlands, and coastal infrastructure)
- Minimal or no invasive species or presence of active monitoring and response control program

- The presence of a strong policy and regulatory regime with clear roles and responsibilities for wetland conservation
- The support from the public and surrounding communities for wetland conservation and preservation.

These qualities are helpful for building the general resilience of wetlands to enable them to cope with disturbances of all kinds so that they continue to function. However, the impacts of climate change will not affect all coastal wetlands in the same way. Figure 6 presents a helpful framework to guide resilience and adaptation planning, starting with high level strategies, followed by more specific measures, and right down to place-based and context-specific actions.

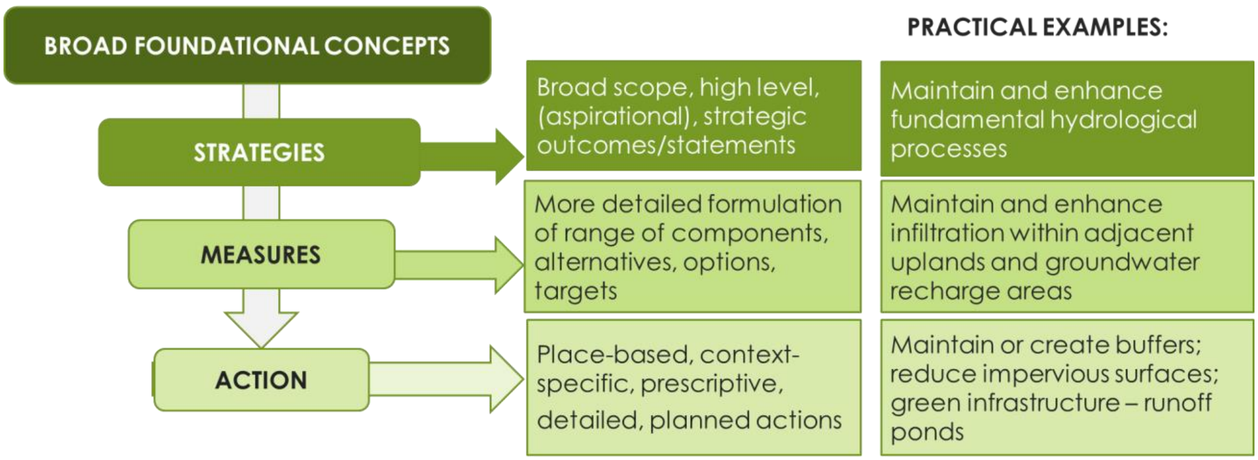


Figure 6: Conceptual Framework for Resilience and Adaptation Planning

Resilience and adaptation strategies, measures and actions can generally fall under three main approaches: Resistance, Recovery and Transformation. When a hazard or climate stressor occurs, Resistance, Recovery and Transformation approaches generally result in different pathways (see Figure 7). **Resistance** is the ability of a system to withstand a disturbance or change without significant loss of ecological function. **Recovery** is the ability of a system to recover from perturbations; it may return to its original state or change in response to external forces and continue to function, although potentially differently. **Transformation** is the ability to anticipate and facilitate ecological transitions that reflect the changing environmental conditions and are designed to promote change or help move a system from one state to another, which may be contentious at times (e.g., facilitated migration of species).

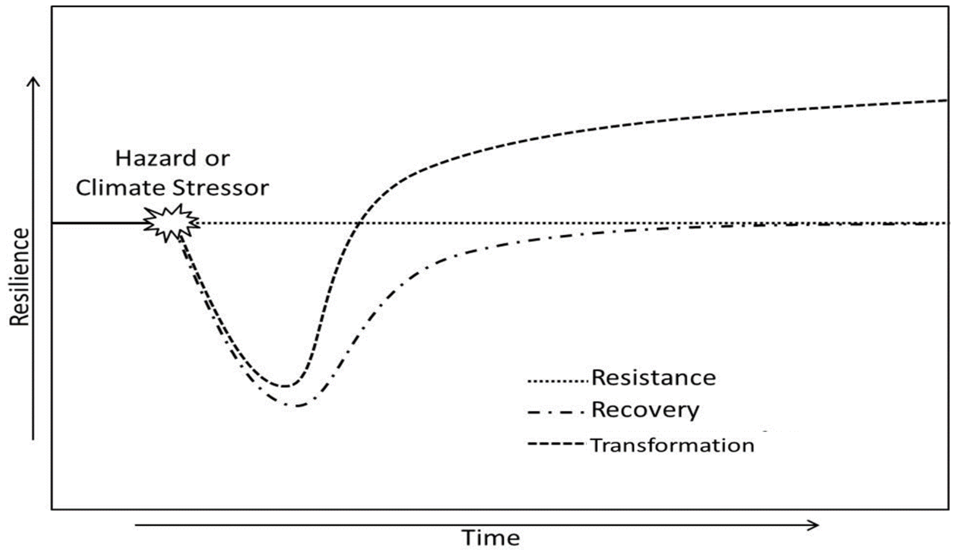


Figure 7: Three Resilience Approaches: Resistance, Recovery and Transformation

For the most part, resilience and adaptation strategies, measures and actions have traditionally focused on **Resistance**, which may be related to an inherent human tendency of wanting to keep things as they are instead of change. **Recovery** recognizes that not all changes can be averted, and when perturbations do occur, the system needs to be able to recover. However, with the rate and magnitude of change in association with existing and future stressors on coastal wetlands, **Transformation** may also be necessary to deliberately transform the system so that it becomes better suited to changing conditions. As participants at the February 13 focus group meeting suggested, perhaps there are opportunities to combine these approaches and phase them over time. For example, in the short-term, Resistance and Recovery may be the most cost-effective strategies but in the long-term, a focus on achieving Transformation may be needed to achieve resilience in some wetlands.

Table 3: Examples of Resistance, Recovery and Transformation Strategies

Key Driver	Resist	Recover	Transform
Water level extremes	• Control water levels through dykes, berms, and/or water level regulation	• No control; allow the wetlands to move • Communication with landowners; Green Shores program • Expand wetland area through voluntary land acquisition and landowner incentive program	• Coastal corridor concept; integrated systems planning and management of coastal zone • Multi-partner, multi-agency • Acquisition of wetlands, parks, hazard lands etc.
Invasive species	• Monitoring, early detection and rapid response • Physical removal	• Conservation efforts • Reduce stresses	• Accept ecosystem in a new state

Key Driver	Resist	Recover	Transform
	• Herbicides	• Create environment benefiting native species	• Translocate/assisted migration of species that are more suitable

Some further considerations suggested by participants at the February 13 focus group meeting included the importance of science-based decision-making, risk assessments, and adaptive management. Understanding risks and consequences includes the risk of doing nothing, unintended consequences, and monitoring and adaptively changing as you go. Participants also emphasized the importance of the timeline for implementation (e.g., immediate, short, medium, and long-term) and the scale of response that corresponds with the scale of impact.

Resilience thinking also means thinking holistically about the social-ecological system, which includes its ecological, cultural, political, social, economic, technological, and institutional components. The focus should be on restoring or protecting functions, processes, and services rather than recreating or protecting species composition. Wherever possible, biodiversity and ecosystem services should be integrated into climate change adaptation measures and combined with engineering or social/institutional approaches for more ecosystem-based adaptation. Building resilience also requires an expanded spatial and temporal scale in terms of monitoring, planning and management. It will also take coordination, engagement, and collaboration.

As part of assessing and enhancing the resilience of coastal wetlands, the vulnerability assessment aims to provide the evidence base to inform resilience and adaptation planning, and other wetland conservation efforts. The next section will provide further details and latest updates on the assessment.

3.0 Updates on the Coastal Wetland Vulnerability Assessment

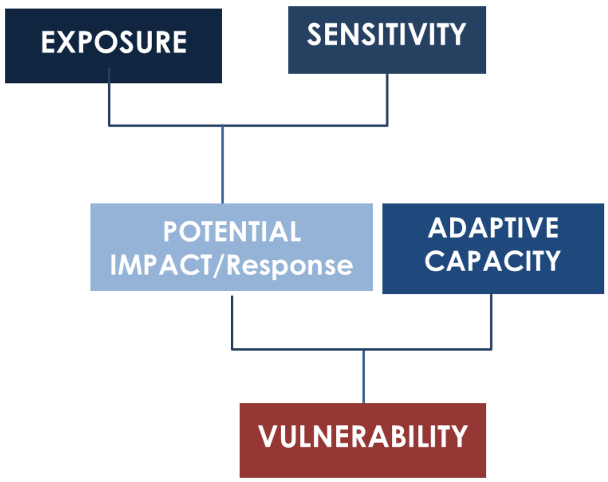
A total of 26 coastal wetland sites were selected as part of the vulnerability assessment depending on available information, human resources, and access to the national supercomputer (see Figure 8). With input from Indigenous communities, national and provincial parks staff, businesses and landowners, these sites represent a variety of hydro-geomorphic types, disturbance gradients, ecological significance, and local interest. The analysis of each site involves field surveys, modelling and spatial analyses.

Figure 8: Map of Study Sites for the Coastal Wetland Vulnerability Assessment

In this vulnerability assessment, vulnerability is assessed as a function of the wetland's exposure to climate change, the sensitivity of a wetland, and its capacity to adapt (see Figure 9). This section presents brief summaries of presentations by ECCC scientists, providing an overview of each study component and progress to date:

- **Modelling Wetland Response through the Coastal Wetland Response Model (CWRM)** by Marianne Bachand (Ecologist, ECCC) and Antoine Maranda (Geospatial Data Analyst, ECCC)
- **Assessing Wetland Sensitivity to Climate Change** by Pauline Quesnelle (Wetland Ecologist, ECCC)
- **Preliminary Results on Wetland Adaptive Capacity** by Morgan Hrynyk (Physical Scientist, ECCC).

Copies of each presentation are available for download [here](#).



Exposure: Amount and rate of climate change to which wetlands are likely to be exposed.

Sensitivity: The degree to which wetlands are likely to be affected by or responsive to climate change.

Adaptive capacity: Ability of wetlands to cope and persist under changing climate conditions.

Figure 9: Conceptual Framework of the Great Lakes Coastal Wetland Vulnerability Assessment (Source: Glick et al. 2011)

3.1 Modelling Wetlands Response through the Coastal Wetland Response Model (CWRM)

Marianne presented the Coastal Wetland Response Model (CWRM) used to model coastal wetland **response** under different climate scenarios. The CWRM is an integrated 2D habitat modelling platform that integrates climate exposure (i.e., water levels and waves) obtained from physical modelling and land information data to predict the distribution of wetland classes. Using a collection of georeferenced layers, the CWRM evaluates the effect of long-term hydroclimatic time series on wetland plant communities. The CWRM consists of four layers:

1. **Digital Elevation Model (DEM)** for each of the study sites based on bias-corrected LIDAR datasets for improved accuracy of topographic data
2. **Physical models**, including:
    a. 2D hydrodynamic model (H2D2), which provides spatial and temporal description of the hydrodynamics in response to fluvial (e.g., Detroit and Niagara Rivers and tributaries) and atmospheric (winds) forcing
    b. Wave model (Wave Watch 3/SWAN), which estimates the orbital energy near the bottom of a wetland, which has an important impact on the distribution of submerged vegetation
3. **Climate scenarios** (1980-2100) based on RCP 4.5 and 8.5 to estimate the impacts of climate change that will provide a range of boundary conditions relating to tributary discharge and winds. Projections of future water levels developed by the MSC (see Section 2.1 Climate Change in the Great Lakes Basin) will be fed into the CWRM

4. **Vegetation** – based on wetland succession modelling, which involves field vegetation surveys, clustering analysis, interpolation of physical variables at observation points from CWRM, statistical analysis and deep learning, and succession algorithm.

Figure 10 presents an overview of the four layers and the progress achieved to date. In summary, the study of the 26 sites will cover 1,388 km^2 at 10-m resolution, representing over 138 million grid points, and will include predictions of the distribution of wetland classes (e.g., submerged vegetation, emergent marsh, meadow marsh, swamps, and *Phragmites* etc.) for 68 growing seasons (1980-22018 and 2070-2100).

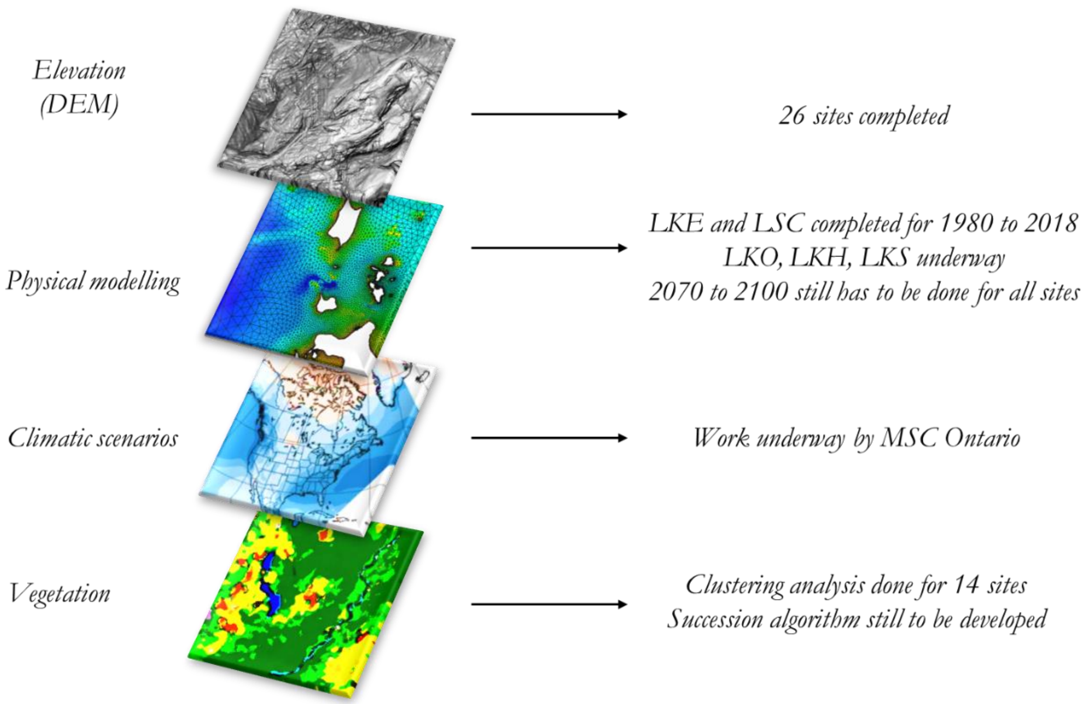


Figure 10: Conceptual Framework of the Coastal Wetland Response Model

Following the presentation, some technical questions were asked, including:

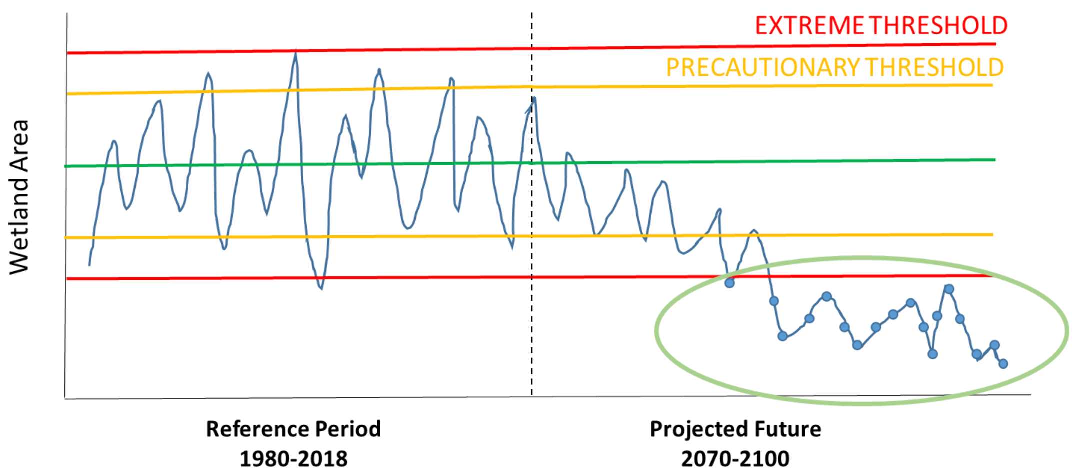
- **Q1: Is the two metre DEM resolution available for all wetland sites?**
  A1: Yes, except that some are of better quality than others due to quality of the base data.
- **Q2: Will latifolia (bulrush) respond differently than cattails?**
  A2: Even if water levels are altered in the model, cattails will inherently respond differently than latifolia.
- **Q3: How easy is it to delineate cattails from *Phragmites* in the model?**
  A3: To be determined – this will be part of the next phase of research.

3.2 Assessing Wetland Sensitivity to Climate Change

Wetland sensitivity will be determined based on the degree to which the abundance and distribution of wetland vegetation communities respond – either increasing, decreasing or no change – to the physical variables in the CWRM projected under climate change relative to a recent hindcast. In order to determine this, a change-detection analysis will be conducted for the following set of wetland indicators:

1. **Wetland size** – total surface area of wetland
2. **Area of floating and submerged vegetation community** – total surface area of submerged and floating vegetation class
3. **Wetland interspersion** – Hemi-marsh index, an important structural component of habitat for wetland wildlife
4. **Wetland diversity** – vegetation class diversity (Shannon diversity index).

The aim of the change-detection analysis is three-fold: to detect change, quantify change, and score change. This will be based on developing response thresholds for each wetland indicator (see Figure 11 for an example). Currently, the scoring criteria are in development based on existing literature and expert opinion, and the analysis approach is currently under external scientific review.



Wetland Sensitivity =

Percent of projected years exceeding extreme (+2 SD) threshold

$$= \frac{\text{\# extreme forecast years}}{\text{\# total forecast years}} \times 100$$

Figure 11: Example of Potential Response Thresholds and How Wetland Sensitivity can be Calculated

Participants showed a high level of interest in the assessment methodology and the following questions were asked:

- **Q1: The reference period only goes as far back as 1980, which does not account for conditions of pre-European settlement. Would it be possible to go back further to look at conditions then? Another related question is whether you think the period between 1980 and 2018 is adequate for analyzing the range in natural variability?**
  A1: This analysis is being conducted based on the best available data, and the most reliable and consistent data within this time period. That being said, even if we are able to account for pre-European settlement conditions, these conditions may not be very relevant as it is impossible to go back to the same pristine states as they were before mass settlement and destruction of wetlands. We also believe that 40 years is a good amount of time that aligns with other climate change studies, which already encompasses a significant amount of data and processing time.
- **Q2: Given that there are multiple indicators, how will these indicators be expressed into a final score?**
  A2: We will be taking the average across all indicators and are in the process of developing associated weighting for each indicator.

3.3 Preliminary Results on Wetland Adaptive Capacity

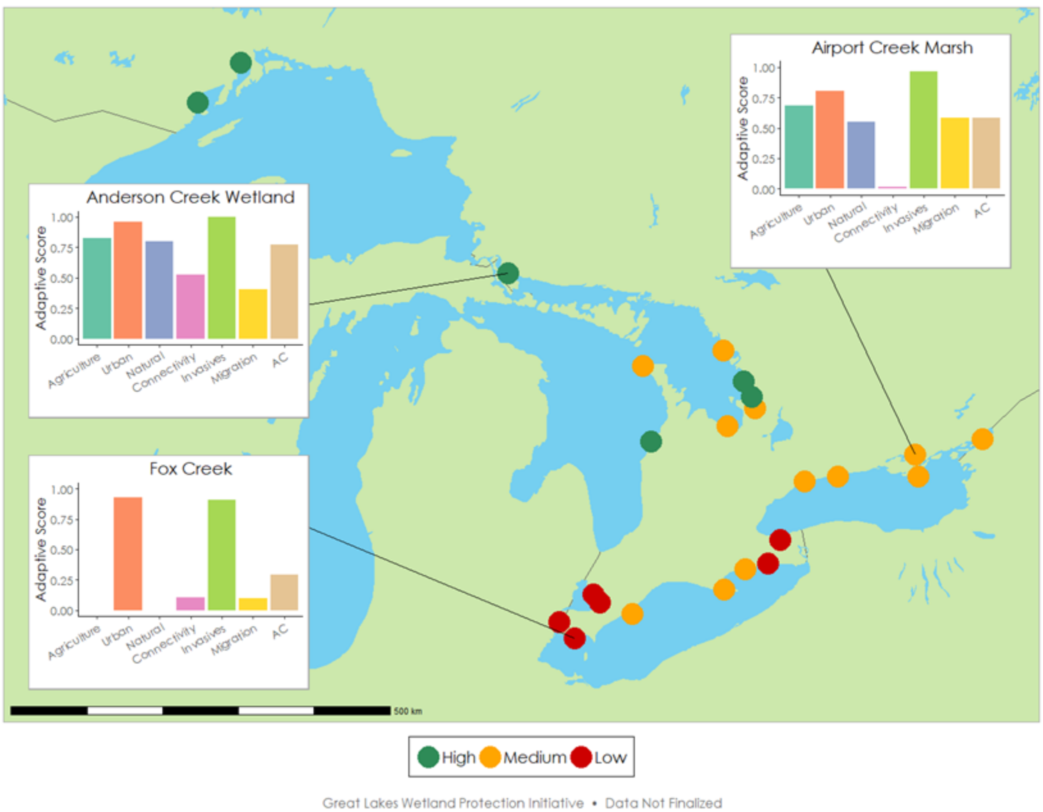
The operational definition of adaptive capacity that forms the basis for analyzing wetland adaptive capacity is:

> *"Contemporary estimate of a wetland's ability to persist under changing conditions, moderate potential damages or to cope with consequences. This includes a wetland's capacity to adjust to climate change, including climate variability and extremes."*

The indicators used to assess wetland adaptive capacity include:

- **Landscape conditions** – a measure of the broad land use types surrounding wetlands based on percentage of urban, agricultural, and natural lands within a buffered area
- **Invasive species** – the proportion of *Phragmites australis* surrounding a wetland
- **Wetland connectivity** – the proportion of wetlands in the surrounding landscape, assuming that an isolated wetland will have a lower capacity to adapt to climate change
- **Conservation capacity** – the proportion of protected lands surrounding a wetland
- **Water quality** – a measure of physical and chemical properties of a wetland related to human disturbance
- **Wetland condition** – a measure of wetland health using Indices of Biotic Integrity (IBIs), which are composite measures of biological variables weighted to reflect human disturbance
- **Potential to migrate** – suitable areas that a wetland may expand to in the future, which is based on a combination of suitable habitat and connectivity between suitable habitat
- **Sediment dynamics** – a measure of sediment budgets and erosion.

After collecting data for all indicators, each indicator has to be rescaled on a scale of 0 or 1 to reflect their adaptive score (0 being low, 1 being high), weight each indicator, and then combine the indicators in order to determine the wetland's final adaptive capacity score. Currently, results are available for four indicators (i.e., landscape condition, invasive species, connectivity, and potential to migrate), as part of the preliminary analysis results for wetland adaptive capacity (see Figure 12). All four indicators have been given equal weighting, which is subject to change. Among the remaining indicators, some are under development or require updated datasets. As many of the indicators are based on geospatial analysis, there is the potential to scale up this assessment approach and apply it to other wetland sites across the Great Lakes basin where data are available.



Note: the last bar in each graph (AC) represents the overall Adaptive Capacity score.

Figure 12: Preliminary Results of Coastal Wetland Adaptive Capacity based on Four Indicators.

Following the presentation, participants were interested in both the technical data inputs as well as the broader applications of this analysis:

- **Q1: For the water quality indicator, why was the CCME water quality index not used?**
  A1: The CCME water quality index is used more for lakes and streams. Wetland nutrient levels can often be high due to the nature of them. Therefore, we used the Water Quality Index developed by Dr. Pat Chow-Fraser, which was specifically developed for assessing wetland water quality.

- **Q2: Are there broader management applications of this analysis? For example, could it be used in monitoring and inform planning and management?**
  A2: Yes, as part of the coastal wetland vulnerability assessment, the aim is definitely to inform future policies and the management and conservation of wetlands.
- **Q3: What kind of consultation and engagement went into the development of this framework?**
  A3: We engaged many people in the development of this framework, including an expert workshop last year where we received input from scientists who have worked in this field for many years.

3.4 Bringing It All Together

All three presentations help to demonstrate how this coastal wetland vulnerability assessment has involved significant time investments in field work, physical and biological data collection, climate and water level modelling, spatial analysis and stakeholder engagement. Once analyses for all three components of vulnerability have been completed, the aim is to integrate them in order to identify a final vulnerability score for each wetland that will range from low to very high (see Figure 13).

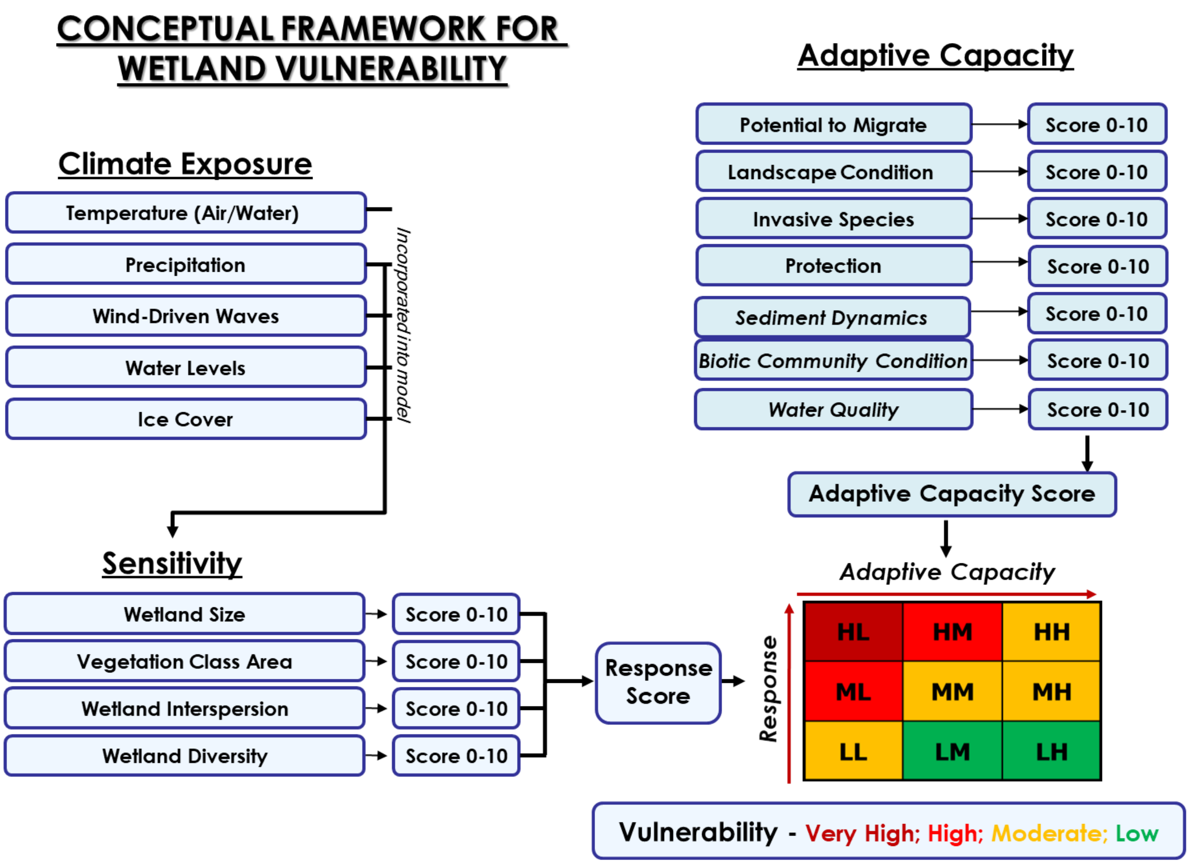


Figure 13: Detailed Conceptual Framework for Determining Final Vulnerability Scores for the Coastal Wetland Vulnerability Assessment

4.0 Building Coastal Wetland Resilience

The following section provides a summary of the two lake-by-lake interactive activities and results from the group discussions. The lakes/regions of focus include:

- Lake Huron (proper) – one group
- Georgian Bay – one group
- Lake Erie – one group
- Lake Ontario – one to two groups.

As the meeting was held in Toronto, few representatives from Lake Superior were able to attend and therefore a breakout discussion on Lake Superior could not be held at the time. ECCC does hope to engage Lake Superior stakeholders and rights holders in the near future.

Activity 1: Climate Impacts on Great Lakes Coastal Wetlands by Lake/Region

Following the presentation on climate change in the Great Lakes basin (see Section 2.1), participants were asked to break out into groups based on their lake/region of interest. Each group was led by a volunteer facilitator and note-taker. The lake/region-based groups allowed for a range of organizations and perspectives to be represented and encouraged greater networking amongst participants.

In this activity, participants were asked to:

- Review the climate drivers of concern for the lake/region
- Identify the top climate impacts on coastal wetlands that are of greatest concern
- Brainstorm broader social, environmental and economic consequences of greatest concern that might stem from direct impacts of climate change on coastal wetlands.

These questions were selected to help build on information obtained through the focus group meeting and the need to obtain place-based information, focusing on specific impacts, risks and consequences for each lake/region. The following sections provide a summary of the discussions and some common themes that emerged.

Key Climate Drivers of Concern

The following climate drivers of wetland change were commonly identified by participants across the different breakout groups as factors of greatest concern:

- Increasing water temperatures
- Water levels – including sustained high water levels and sustained low water levels
- Loss of ice cover
- Increasing frequency, intensity and severity of extreme storm events, including extreme winds
- Increasing air temperature
- Changing precipitation patterns, including more precipitation falling as rain in winter and reduced precipitation in dry months

- Increased evaporation.

Many of these changes are already being observed. In the northern part of Lake Huron, for example, participants noted that with milder winter temperatures, more precipitation is falling as rain instead of snow, leading to an increased risk of flooding as large amounts of water enter streams and lakes in the middle of winter. Loss of ice coverage has also been experienced as participants from Lake Superior noted that Lake Superior used to freeze over but in recent years, there has been a lack of ice cover. This was echoed by participants in the Lake Erie group who noted that the lack of ice cover is leaving wetlands exposed in the winter to further impacts.

Across all groups, there was clear understanding that these changes and their impacts are all connected. As one participant noted: climate change is causing more frequent severe storms; water temperatures are going up, water levels are going up, it's all connected. These changes are happening simultaneously and result in compounding impacts on coastal wetlands and surrounding communities. Some of the top climate change impacts on coastal wetlands that were identified by participants are highlighted below.

Top Climate Change Impacts of Greatest Concern:

The discussion of top climate change impacts on coastal wetlands has resulted in two streams: 1) common/general impacts that may be relevant across the Great Lakes basin, and 2) specific impacts that may be influenced by the unique contexts of each lake/region.

General impacts of climate change on coastal wetlands include:

- **Changes in wetland areal extent, structure and composition** such as loss of vegetated communities (e.g., due to flooding), and changes in species composition (e.g., increased invasive species that are better suited to conditions such as higher water temperatures and lower water quality)
- **Loss of wetland habitat and degradation of riparian areas**, including tree loss (e.g., due to extreme weather events, extreme high and low water levels leading to flooding/inundation or drying out conditions, as well as loss of ice cover), which may in turn further exacerbate flood risk. Loss of habitat also has associated impacts on plant and animal species (e.g., loss of nesting locations for migratory birds)
- **Changes in animal and fish patterns** (e.g., earlier spawning time and increased competition from invasive species)
- **Increased erosion** (e.g., due to loss of ice cover and increased wind/wave action from extreme storm events), which in turn may lead to increased sedimentation and more intensified storm action
- **Water quality impacts** such as increased sedimentation, turbidity, nutrient levels and algal blooms (e.g., due to increased water temperatures, increased runoff, and loss of ice cover).

These changes can lead to reduction in or loss of essential wetland services such as flood mitigation, water filtration, and recreational opportunities. These impacts can also be further compounded by other existing wetland stressors such as agricultural runoff, use of road salt in the winter, urbanization, and changing land use or land cover.

Table 4 summarizes the major specific impacts of climate change on coastal wetlands for each lake/region as identified by participants.

Table 4: Highlights of Specific Climate Change Impacts on Coastal Wetlands of Greatest Concern by Lake/Region

Lake/Region	Highlights of Specific Impacts of Concern
Georgian Bay	• Increase in *Phragmites* in flooded areas with high water levels • Impacts on native species such as lake trout in Perry Sound due to increasing water temperatures • Rare coastal wetland marshes in Collingwood have adjusted to past changes in water levels but uncertain whether they will be able to adapt to sustained extreme high water levels • Remnant shoreline dunes in Wasaga Beach are also under pressure from engineered shoreline protection infrastructure (e.g., from intensified wind/wave action)
Lake Huron	• With lack of ice cover and increased erosion, the nearshore zone is experiencing high wind/wave action • At-risk species are already vulnerable and will continue to be impacted by habitat loss/degradation, invasive species, and changing seasonal patterns • Whitefish Island is a key area of concern – it has long been a gathering place for tribes from across Lakes Superior, Michigan, and Huron. It has been experiencing decreasing whitefish population over the years, in part due to invasive species and increases in water temperature. Salmon population is also declining in Lake Huron
Lake Erie	• Increased wind/wave action has been observed at Long Point, in part due to less ice cover and increased erosion • Increased erosion of barrier beaches that protect wetlands has also been observed as a result of storms, extreme wind/waves and human responses such as shoreline hardening (e.g., Point Pelee and Hillman Marsh) • Wetlands at Long Point and Point Pelee have been affected by flooding • Changes in species composition have also been observed in major wetlands in Rondeau and Long Point • Increase in invasive species has been observed lake-wide, including an increase in *Phragmites*; grass carp and other carp are further compounding the loss of aquatic vegetation • Increase in the number and duration of nearshore algal blooms has also been observed
Lake Ontario	• Overwintering impacts have been observed among fish and reptiles • Impacts on sensitive species and migratory birds have also been observed • Proximity to major urban centres exacerbates increasing temperatures under climate change due to the urban heat island effect

Lake/Region	Highlights of Specific Impacts of Concern
	• Impacts on coastal wetlands may also be compounded by the risk of contamination from closed landfills located near waterways or waterbodies (e.g., in the south eastern part of Lake Ontario) due to flooding

Broader Social, Environmental and Economic Consequences of Greatest Concern

Following the discussion of direct impacts of climate change on coastal wetlands, participants were asked to think about the broader social, environmental and economic consequences that may stem from these impacts. Consequences can again be identified under two streams: 1) common/general consequences that may be experienced across the Great Lakes basin, and 2) specific consequences that may be influenced by the unique contexts of each lake/region.

General consequences that may result from climate change impacts on coastal wetlands include:

- **Loss of cultural heritage** (e.g., loss of traditional powwow grounds and burial sites due to flooding)
- **Loss of traditional ways of life** (e.g., hunting and fishing)
- **Impacts on recreation** (e.g., recreational fishing and birding), which may lead to loss of associated recreational revenues (e.g., tourism)
- **Impacts on infrastructure** (e.g., impacts on septic tanks due to high water levels), which have associated health and safety risks and may lead to increases in maintenance and repair costs
- **Impacts on drinking water** (e.g., shore wells and wells located in floodplains are particularly vulnerable to the impacts of flooding) and associated health and safety risks; furthermore, if water quality changes, this may require changes to water treatment, leading to increase in costs
- **Human health impacts** (e.g., increasing risk of West Nile Virus and Lyme disease, and mental health impacts that may be associated with flooding or loss of green space).

Table 5 summarizes some of the major specific social, environmental and economic consequences identified by participants.

Table 5: Highlights of Specific Social, Environmental and Economic Consequences of Greatest Concern by Lake/Region

Lake/Region	Highlights of Specific Consequences of Concern
Georgian Bay	• Loss of wetland services can lead to impacts on infrastructure such as docks and septic tanks, which are key infrastructures in Georgian Bay and are susceptible to high water levels • Seasonal uses can also be affected by impacts on coastal wetlands including boating, cottages and tourism
Lake Huron	• Whitefish is an important commercial resource, especially for local fishermen of the Batchewana First Nation; loss of whitefish population due to impacts on

Lake/Region	Highlights of Specific Consequences of Concern
	coastal wetlands will result in economic consequences; fishing has also been part of these captains' way of life for as long as they can remember • Road washouts is another key concern with rain falling on frozen ground causing more flooding and road washouts, including impacts on Highway 17; these roads provide important access for the community and their impacts will bring economic consequences, as well as risks to human health and safety
Lake Erie	• Impacts on coastal wetlands can exacerbate flooding of infrastructure along the shoreline of Lake Erie • Decrease in water quality will also affect inland areas that depend on Lake Erie for drinking water
Lake Ontario	• With major urban centres in close proximity, there are pipelines and other key infrastructure going through the Trent-Severn Waterway • Flooding of major transportation corridors is another key concern, especially railway tracks located near the lake and adjacent roadways (e.g., in Lower Trent and north of Kingston)

Activity 2: Building Coastal Wetlands Resilience

After the overview of resilience thinking and adaptation planning, meeting attendees participated in Activity 2, where important considerations for building wetland resilience were discussed. For this activity, participants were asked to break out into the same groups as Activity 1 to build on earlier discussions.

As a part of Activity 2, participants were asked to:

- Review and confirm the top impacts identified in Activity 1
- Confirm broad adaptation strategies for enhancing coastal wetland resilience
- Identify place-based adaptive measures for addressing specific climate impacts
- Identify opportunities or pilot projects to build coastal wetland resilience.

Broad Strategies for Enhancing Coastal Wetland Resilience

During this discussion, participants identified needs and opportunities for broad (aspirational) strategies that may be applicable to the associated lake/region. Below are highlights of common strategies identified by the various groups:

- Prevent or minimize any additional loss of wetlands
- Maintain and enhance the fundamental ecological functions and services of coastal wetlands
- Work with natural cycles instead of interfering with them
- Adopt a watershed-scale management approach to protecting and restoring wetlands, recognizing the connections between coastal wetlands and the broader landscape/environment
- Support regional collaboration to enhance integrated coastal management and planning
- Implement nature-based solutions

- Protect people and property (e.g., from flooding and erosion risk)
- Manage water levels regionally and locally
- Enhance education and awareness of the importance of coastal wetlands and management practices that help build coastal wetland resilience.

These strategies are not mutually exclusive; instead, many of these strategies complement one another and their measures and actions could benefit multiple strategies simultaneously. That being said, measures and actions could also lead to trade-offs between strategies (e.g., engineering solutions that help protect people and property may not align with the strategy of implementing nature-based solutions). Maximizing synergies between adaptation strategies, measures and actions could help achieve greater benefits, meanwhile minimizing trade-offs could lead to more balanced outcomes.

Measures to Reduce, Prevent, and/or Prepare for the Top Impacts and Consequences

Following the discussion around broad adaptation strategies, participants were asked to identify needs and opportunities for specific, place-based measures that can be taken to reduce, prevent and/or prepare for the impacts and consequences of climate change (building on Activity 1).

Using the **Resist**, **Recover** and **Transform** framework (see Section 2.2), participants were asked to categorize their measures under each of the three headings. Results have been interpreted and summarized in Table 6 using the Resist, Recover and Transform framework. Some measures have been categorized under more than one heading or under all three headings given their potential to achieve different outcomes depending on how these measures are applied (e.g., to resist change, facilitate recovery, or facilitate systems change). It is important to note that while measures have been summarized under the most relevant strategy for illustrative purposes, there are measures that could support more than one strategy. Additionally, underlying many of these measures are the strategies of implementing nature-based solutions, and enhancing education and awareness.

Table 6: Place-Based Measures Identified by Participants

Strategy/Measure	Resist	Recover	Transform
1. Prevent or minimize any additional loss of wetlands			
a) Provide municipalities with updated coastal wetland maps and scenarios and facilitate their incorporation into municipal policy, regulations and by-laws	•	•	•
b) Update dredging permits to prevent harmful dredging practices	•	•	•
c) Re-vamp development regulations to minimize encroachment and protect wetlands	•	•	
d) Establish and enhance riparian buffers (e.g., vegetated buffers) and maintain net buffer across a municipality		•	•
e) Land acquisition for the long-term protection of wetlands and the resources to maintain them in good health and function		•	•

Strategy/Measure	Resist	Recover	Transform
f) Establish or update policies for enhanced wetland protection (e.g., Provincial Policy Statement, Conservation Authorities Act, Natural Heritage)		●	●
2. Maintain and enhance the fundamental ecological functions and services of coastal wetlands			
a) Dyke removal/realignment	●	●	●
b) Develop a strategy to maintain stream flow regime to reduce water level impacts on coastal wetlands	●	●	
c) Develop a strategy to eradicate invasive species (e.g., by providing practitioners with more options for invasive species removal)	●	●	
d) Implement a community program for *Phragmites* removal	●	●	
e) Enhance the treatment of municipal/industrial wastewater for improved water quality		●	
f) Facilitate recovery of sediment resources (including sediment sources and sinks)		●	
g) Support establishment of more native species		●	●
h) Understand impacts of high water levels on fish		●	●
i) Coastal renaturalization and remove outdated/harmful shoreline hardening		●	●
j) Remove hardened shorelines and groynes to re-establish natural coastal processes and circulation (e.g., Township of Tiny)		●	●
k) Increase consideration/prioritization of biological and ecological factors over hydro power production			●
l) Create new habitats (e.g., the Whitefish Island project is creating islands/shoals to provide habitat for various species; lake-filling at Lakeview)			●
m) Hydrologically isolate wetlands to minimize external influences (e.g., second marsh, CLOCA) such as the transport of matter, energy or organisms			●
3. Adopt a watershed-scale management approach to protecting and restoring wetlands, recognizing the connections between coastal wetlands and the broader landscape/environment			
a) Undertake climate modelling to identify the most important climate drivers in a watershed	●	●	●
b) Protect and restore upland forest to help slow down the amount of water reaching waterways – less clearcutting and more selective cutting and planting	●	●	●
c) Change land use practices at the watershed level		●	●
d) Improve agricultural practices		●	●

Strategy/Measure	Resist	Recover	Transform
e) Encourage Low Impact Development (LID) measures and enhance stormwater management		•	•
f) Restore marginal land (especially east of GTA, for example the Bay of Quinte)		•	•
g) Continue to conduct watershed planning and incorporate climate change considerations into watershed plans		•	•
h) Continue to develop and implement restoration management plans and incorporate climate change considerations		•	•
i) Reduce road salt and sand application in winter		•	
4. Protect people and property (e.g., reduce flooding and erosion risk)			
a) Improve hazard mapping based on buildings impacted due to high water levels and place-based hazard land identification	•	•	•
b) Improve roads so that they are more resistant to washouts	•	•	
c) Increase the size of culverts to convey greater flows	•		
d) Strategically armour the shoreline or build protective infrastructure where necessary	•		
e) Support septic system relocation/connection to municipal infrastructure		•	•
f) Managed retreat and turning adjacent lands into habitat areas (e.g., Port lands)		•	•
g) Stabilize slopes and shores with enhanced natural vegetation (e.g., tree planting)		•	•
h) Implement "soft" erosion protection (e.g., Gibraltar Point)		•	•
i) Implement modern hybrid shoreline protection (e.g., Toronto Waterfront)		•	•
5. Manage water levels regionally and locally, and/or 6. Support regional collaboration to enhance integrated coastal management and planning			
a) Establish Great Lakes Control Board that includes representatives across all five Great Lakes	•	•	•
b) More strategic/coordinated response across agencies for the management of water levels	•	•	•
c) Develop a cumulative efforts framework to assess cumulative impact of adaptation and resilience efforts	•	•	•
d) Manage water levels through regulation at the lake scale while also managing water levels locally (e.g., efforts to enhance natural vegetation and water quality at Tommy Thompson Park are underway)	•		

Strategy/Measure	Resist	Recover	Transform
7. Work with natural cycles instead of interfering with them			
a) Increase soil permeability by capturing more water in winter for use in summer		•	•

Pilot Projects

The final component of Activity 2 provided an opportunity for participants to work together to design at least one pilot project if resources were unlimited. Participants were asked to explain what the project(s) would look like, build the case for why it is needed, and describe how it would help build coastal wetland resilience in the lake/region. Below are brief descriptions of the pilot projects that were developed by each group (Table 7).

Table 7: Summary of Pilot Projects Proposed by Participants for each Lake/Region

Lake/Region	Pilot Project
Georgian Bay	The Georgian Bay group developed two pilot projects. **What would the project look like?** The first pilot project focused on building climate resilient infrastructure and increasing sewage capacity. The project would promote constructed wetlands and LIDs as an adaptive/flexible means to treat urban stormwater runoff, revisiting MECP guidelines and other policies to mandate best management practices, increasing education and awareness, and creating a mapping inventory of planned and implemented projects. **Why is it needed and how would this help build wetland resilience?** Storms are increasing in frequency and intensity, overwhelming municipal infrastructure and private septic systems, which have adverse impacts on natural heritage systems and coastal wetlands (e.g., increased nutrients and algal blooms). Municipal infrastructure and private septic systems are also impacted by high water levels. This project would help to increase the number of wetlands, improve water quality, reduce nutrient loads from septic systems and reverse the trend of infrastructure hardening. **Who needs to be involved?** Everyone **How would we measure its success?** • Water quality testing • Number of retrofits and/or number of pipes replaced • Real-time measurement • Regulation inspections and reporting
Georgian Bay	**What would the project look like?** The second pilot project suggested the development of a collaborative Great Lakes Adaptive Management (GLAM) Committee. This committee would review the Lake Superior Regulation Plan 2012 in light of climate change projections and determine if it meets the needs of Georgian Bay to protect wetlands, people and property. **Why is it needed and how would this help build wetland resilience?** Georgian Bay has the most extensive, diverse and high quality wetlands found anywhere in the Great Lakes and these wetlands should be protected. This project would help increase the range in wetland tolerance and help reduce the risk of flooding of private property.

<table>
<tr><th>Lake/Region</th><th>Pilot Project</th></tr>
<tr><td></td><td>Who needs to be involved?
Control Board representatives, municipalities, NGOs, Indigenous representatives, and representatives from both Canada and U.S.
How would we measure its success?
Health of wetlands
Number of and/or value of property affected by flooding due to high water levels</td></tr>
<tr><td>Lake Huron</td><td>What would the project look like?
The Lake Huron group developed a pilot project focused on erosion of the Goderich shoreline. The project would seek to reduce the impacts of erosion by enhancing breakwalls, increasing planting along the shoreline, innovative design and construction (e.g., instead of a static dock, design one that can rise with the water), changing policies and by-laws to reduce erosion risk, and increasing education and awareness.
Why is it needed and how would this help build wetland resilience?
Located along the Goderich shoreline is a major shipping harbour, as well as coastal communities that are being impacted by intensifying storm action and erosion. Trails are getting destroyed. The project would include a combination of nature-based solutions (e.g., tree planting) and engineering solutions that are flexible/adaptive in nature to reduce the impact of wind/wave action.
Who needs to be involved?
Municipalities, industry, province, federal government (e.g., Transport Canada), Indigenous communities, public interest groups, architects, engineers, communication specialists, and the general public
How would we measure its success?
Measure water quality (e.g., turbidity)
If breakwalls are still standing
Species diversity and abundance
Community participation
Aerial photos, monitoring and/or mapping
Trail usage</td></tr>
<tr><td>Lake Erie</td><td>What would the project look like?
The Lake Erie group developed a pilot project for Rondeau. The project would identify sediment sources/sinks, minimize loss of sediment, restore natural sediment processes (including through land acquisition and naturalizing hardened shorelines), and integrate adaptive management and monitoring.
Why is it needed and how would this help build wetland resilience?
Important lands that protect wetlands are being lost. This project would help by minimizing wave energy to help minimize loss of sediment from rock islands and restore natural sediment processes. An adaptive management approach would be adopted by selecting multiple sites and comparing wetland response.
Who needs to be involved?
Rondeau Provincial Park, municipalities, province, federal government, and NGOs
How would we measure its success?
Comparing results across multiple sites
Comparing against baseline
Modelling wetland response
Remote sensing of wetland and shoreline change to detect change over time</td></tr>
</table>

<table>
<tr><th>Lake/Region</th><th>Pilot Project</th></tr>
<tr><td>Lake Ontario</td><td>The Lake Ontario groups also provided two pilot projects.
What would the project look like?
The first pilot project focused on the development of a five-year Provincial Phragmites Management Strategy. This strategy would undertake a concentrated effort to reduce the distribution of Phragmites, followed by targeted removal. The strategy would also involve restoring seed banks of native species and increasing education and awareness.
Why is it needed and how would this help build wetland resilience?
Phragmites are a major wetland stressor and threatening biodiversity and habitat loss. This project would help enhance wetland resilience by removing Phragmites and reducing their impact.
Who needs to be involved?
Pest Management Regulatory Agency (to change policies), Health Canada, MECP, MTO, municipalities, and landowners
How would we measure its success?
Orthophotos at the landscape scale
Drones at the local scale
Number and/or extent of Phragmites within 5 years</td></tr>
<tr><td>Lake Ontario</td><td>What would the project look like?
The second Lake Ontario pilot project focused on transforming and enhancing Rouge National Urban Park. This project would involve several components including removal of the parking lot and buildings, creating an underpass tunnel for the rail corridor, naturalizing the river mouth, removing invasive species, planting native species, and implementing the watershed plan.
Why is it needed and how would this help build wetland resilience?
Rouge National Urban Park is home to multiple at-risk species and with sustained high water levels, it is impacted by flooding, invasive species (e.g., carp and Phragmites), and erosion of barrier beach. These impacts are further exacerbated by contamination and stressors from urban areas upstream. This project would help to increase wetland health, enhance the climate resilience of native species, and improve water quality.
Who needs to be involved?
Parks Canada, CLOCA, resource management agencies (e.g., MNRF and DFO), TRCA, landowners, canoe club, anglers, and municipalities (City of Toronto and City of Pickering)
How would we measure its success?
Water quality sampling
Inventory of vegetation and aquatic species
Long-term monitoring of erosion rates, sediment deposition, invasive species
Number of park visitors
Reduction in number of at-risk species
Connectivity to other wetlands
Monitoring species migration along the Lakeshore corridor</td></tr>
</table>

5.0 Discussion and Next Steps

This section summarizes recommendations made by participants throughout the meeting as well as during the end-of-day plenary discussion, where participants had the opportunity to share their thoughts and feedback on the meeting and how they would like to be engaged in the future. Key observations and considerations for building coastal wetland resilience are highlighted to help inform future efforts, along with a discussion of next steps.

5.1 Emerging Themes

Through the information sharing meeting, several key themes emerged on what is needed to build coastal wetland resilience. One key theme is the need to recognize **wetlands as social-ecological systems** that are connected to the broader landscape and provide important local and regional benefits. This means that adaptation strategies, measures and actions cannot be focused solely on improving wetland conditions; they also need to address the broader social, environmental and economic consequences of climate change. For example, if property owners harden shorelines to protect their properties from flooding and extreme weather, this can in turn increase erosion risk that wetlands are already facing due to climate change (e.g., loss of ice cover), and lead to further wetland damage (e.g., through intensified wind/wave action). Septic systems that are vulnerable to sustained high water levels and flooding could also lead to adverse impacts on coastal wetlands.

Enhancing the climate resilience of coastal wetlands also requires **alleviating existing ecological and anthropogenic stressors** on coastal wetlands. This includes activities such as invasive species removal (e.g., *Phragmites* and carp), improving biodiversity, preventing the encroachment of development on coastal wetlands, enhancing riparian buffers, improving water quality and landscape connectivity, and reducing erosion risk.

Participants also emphasized the need to **improve policies and regulations** to provide greater protection for coastal wetlands and help guide decision-making. Many groups noted the need to improve development policies and regulations to limit encroachment (e.g., Provincial Policy Statement, and municipal Official Plans and by-laws). Through the development of pilot projects, many groups also highlighted the need to update hazard mapping, MECP stormwater guidelines, and other relevant policies. Barriers to policy improvements were recognized by participants (e.g., challenges were discussed by the Lake Ontario group during the development of the provincial *Phragmites* strategy pilot project). While policy improvements are necessary, participants are also aware that these will require a significant amount of collaboration.

The need for **greater education, awareness and outreach** around coastal wetland management is another common theme amongst all groups. Enhancing education and awareness of the importance of coastal wetlands and management practices was identified as a key strategy for building coastal wetland resilience (see Section 4.0, Activity 2). This theme also emerged in the discussion of adaptive measures where many of the measures can help contribute to enhanced public education, awareness and stewardship (e.g., a community program for *Phragmites* removal, and a collaborative Great Lakes Control Board with broad representation). Many of the pilot projects also included an education and outreach component.

Components of a Project that Help Build Resilience

Some common components can be identified across the pilot projects, which could help inform the design of future projects and initiatives to help build climate resilience. One key factor is ensuring that projects are **adaptive and flexible**, which aligns with the concept of adaptive management. For example, adaptability and flexibility were emphasized by the Lake Huron group in highlighting the need to ensure that engineered components in the pilot project are flexible in nature. The Georgian Bay group also highlighted the importance of having flexible and adaptive policies to allow for changes over time.

A wide range of indicators were identified by participants for measuring the success of the pilot projects and their impact on enhancing wetland resilience. These indicators demonstrate the importance of **monitoring and evaluation** and the availability of existing tools to help monitor and evaluate changes over time. For example, the Lake Erie group highlighted remote sensing of wetland and shoreline change over time as a possible tool to help detect issues and improvements after restoration, protection and management efforts. Some of the suggested indicators were focused on components of wetland health (e.g., water quality), while others measured broader community benefits (e.g., trail/park usage, and level of community participation).

Another resilience-building component that emerged from the pilot project activity was the need to **involve a wide range of stakeholders** as a part of the process. Most of the groups identified the need to involve municipalities, provincial and federal governments, NGOs, Conservation Authorities, Indigenous communities, public interest groups, professionals (e.g., architects and engineers), landowners, and the general public. As participants suggested, these stakeholders would not only be helpful to inform the development of a pilot project but would also be helpful in its implementation. The project would in turn enable greater collaboration amongst stakeholders from different sectors and disciplines.

Challenges in Identifying Strategies, Measures and Actions

Recognizing and addressing challenges in identifying adaptation strategies, measures and actions can help inform future discussions. Given that the vulnerability assessment is still underway, the identification of strategies, measures and actions were based on preliminary climate projection results, and participants' observations and experiences to inform what can be expected under climate change. Despite the absence of detailed projections of wetland change under future climate change scenarios, participants were still able to identify a wide range of strategies, measures and actions as highlighted in Section 4.0. When detailed projections do become available, these initial adaptation strategies and measures can provide a basis to further identify and refine necessary strategies, measures and actions for building coastal wetland resilience.

Some participants noted that it would have been helpful to have **more Ontario-specific and local examples** of strategies, measures and actions on how to address the local impacts of climate change. These could take the form of case studies to provide examples of the types of strategies, measures and actions that are being implemented in a given lake/region to help identify what might be working well and what might be missing.

Another key challenge is the need to close the gap between adaptation planning and **implementation** and achieve improvements on-the-ground. The pilot projects helped to highlight that a variety of practical actions can be undertaken. To support greater implementation, several participants suggested that it would be helpful to have an official document outlining adaptation strategies, measures and actions that are supported by the government, which participants could then take to funders and partners. The document could include, but not limited to:

- Guidelines for land managers on how to effectively implement a project
- An inventory of the state of the Great Lakes and different planning scenarios to help prepare for the future impacts of climate change
- Case studies of local examples
- A step-by-step guide to establishing local adaptive management committees (e.g., sample membership, and terms of reference).

Implementation will require continued collaboration and coordination, as well as the alignment of necessary resources. Related to the challenge of implementation is the uncertainty around whether strategies, measures and actions will achieve their intended outcomes and help contribute to enhanced wetland resilience instead of maladaptation. Future discussions could include the development of **performance indicators** for monitoring and evaluation to measure the success of strategies, measures and actions.

5.2 Next Steps

The information sharing meeting sought participants' input in developing adaptation strategies, measures and actions by lake/region that would help build coastal wetland resilience. The ideas and suggestions provided by participants at the meeting will help inform ECCC's continued efforts to assess and enhance coastal wetland resilience, as well as future engagement efforts. Between now and the project's completion in 2022, ECCC staff will continue their work on the vulnerability assessment as well as their efforts to engage partners, stakeholders and rights holders.

Based on the post-meeting evaluation survey, what participants enjoyed most about the information sharing meeting were the presentations and the opportunity to collaborate and network with other organizations and wetland conservation practitioners. Additionally, many participants thought that the activities provided the opportunity for an excellent exchange of information and ideas. Particularly, participants mentioned that they enjoyed developing the pilot projects as well as applying the Resist, Recover and Transform framework to adaptation strategies and measures.

There was great interest in the preliminary climate and water level projection results and update on the different components of the coastal wetland vulnerability assessment. In particular, participants appreciated the ability to visualize future extremes through graphs and charts, as well as wetland response (e.g., through simulation videos). Participants emphasized that local agencies and NGOs would have great use for this data once it is finalized (e.g., to support wetland inventories and assessments), and that making this data open and accessible will be critical (e.g., through a web portal).

In terms of future engagement, participants identified interest in attending regional meetings that would provide greater opportunity to discuss lake- or region-specific impacts. Participants also suggested the need to engage more municipalities, communities and Indigenous groups through future engagements. Overall, there was a high level of interest among participants to continue to receive updates on the project and remain engaged in the effort to enhance coastal wetland resilience in the Great Lakes basin.

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Appendix A: Meeting Agenda

AGENDA - MORNING		
Time	**Item**	**Presenter**
8:30-9:00 AM	**Registration and Networking** *(Coffee and light breakfast provided)*	
9:00-9:10 AM	**Welcome and Introductions**	Ontario Climate Consortium (OCC)
9:10-9:30 AM	**Presentation #1: Assessing and Enhancing the Resilience of Great Lakes Coastal Wetlands** • Overview of vulnerability assessment • Resilience, adaptation and meeting goals	Environment and Climate Change Canada (ECCC)
9:30-10:00 AM	**Presentation #2: Climate Change in the Great Lakes basin** • Future climate and water level projections to late-century	ECCC
10:00-10:15 AM	**Climate Analysis Results - Q&A**	All
10:15-10:30 AM	**Break** *(Refreshments provided)*	
CLIMATE IMPACTS ON GREAT LAKES COASTAL WETLANDS		
10:30-11:10 AM	**Activity #1: Climate Impacts on Great Lakes Coastal Wetlands by Lake/Region** • Review climate drivers of wetland change • Identify place-based impacts of climate change of greatest concern on coastal wetlands by lake/region, as well as broader social, environmental and economic impacts	Facilitated by OCC
MOBILIZING RESEARCH FOR ENHANCING CLIMATE RESILIENCE		
11:10-12:10 PM	**Presentation #3: Modelling Wetland Response** **Presentation #4: Assessing Wetland Sensitivity** **Presentation #5: Preliminary Results on Wetland Adaptive Capacity**	ECCC
12:10-1:10 PM	**Lunch** *(Provided)*	

AGENDA - AFTERNOON		
BUILDING WETLAND RESILIENCE THROUGH ADAPTATION		
1:10-1:30 PM	**Presentation #6: Introduction to Resilience Thinking and Adaptation Planning**	Linda Mortsch, University of Waterloo
1:30-3:10 PM	**Activity #2: Building Coastal Wetland Resilience: Lake-by-Lake Breakout Sessions** • Review and confirm top impacts from Activity 1 • Confirm broad adaptation strategies for enhancing coastal wetland resilience • Identify place-based adaptive measures for addressing specific climate impacts • Identification of opportunities or pilot projects to build coastal wetland resilience	Facilitated by OCC
3:00-3:15 PM	**Break** *(Refreshments provided)*	
3:15-3:50 PM	**General Discussion** • Reflections on the day • Future engagement ideas	ECCC
3:50-4:00 PM	**Closing Remarks and Next Steps**	ECCC

Appendix B: Meeting Participants

Name	Organization	Speaker
Alanna Smolarz	Magnetawan First Nation Department of Lands, Resources, and Environment	
Anders Holder	Environment and Climate Change Canada	
Andrea Court	Royal Botanical Gardens	
Andy Metelka	Georgian Bay Association	
Antoine Maranda	Environment and Climate Change Canada	**SPEAKER**
Amy Buteinhaus	City of Toronto	
Bill Thompson	Lake Simcoe Region Conservation Authority	
Brian Morrison	Ontario Federation of Anglers and Hunters	
Cass Stabler	Parks Canada	
Cherie-Lee Fietsch	Bruce Power	
Christopher Hoyos	Association of Iroquois and Allied Indians	
Dan Moore	Central Lake Ontario Conservation Authority	
Dave Featherstone	Nottawasaga Valley Conservation Authority	
David Bywater	Georgian Bay Biosphere Reserve	
David Sweetnam	Georgian Bay Forever	
Frances Delaney	Environment and Climate Change Canada	
Frank Seglenieks	Environment and Climate Change Canada	**SPEAKER**
Glenn Milner	Savanta	
Greg Mayne	Environment and Climate Change Canada	**SPEAKER**
Gurpreet	Environment and Climate Change Canada	

Name	Organization	Speaker
Harvey Bell	Batchewana First Nation	
Heather Pankhurst	Central Lake Ontario Conservation Authority	
Jacob Orlandi	Metis Nation of Ontario	
Jade Schofield	Town of Whitby	
Jason Solnik	Toronto and Region Conservation Authority	
Jesse Nunn	Environment and Climate Change Canada	
Juliana Skuza	Rouge National Urban Park	
Karen McDonald	Toronto and Region Conservation Authority	
Kathryn Peiman	Ontario Federation of Anglers and Hunters	
Katrina Krievins	Georgian Bay Biosphere Reserve	
Kristin Geater	Environment and Climate Change Canada	
Kristina Dokoska	Ontario Climate Consortium	
Laud Matos	Environment and Climate Change Canada	
Lauren Tonelli	Ontario Federation of Anglers and Hunters	
Lex McPhail	Severn Sound Environmental Association	
Linda Mortsch	University of Waterloo	**SPEAKER**
Lindsay Champagne	Ganaraska Region Conservation Authority	
Marianne Bachand	Environment and Climate Change Canada	**SPEAKER**
Mark McCoy	Batchewana First Nation	
Mary Muter	Georgian Bay Great Lakes Foundation	
Mary Thiess	Parks Canada	
Melanie Shapira	Environment and Climate Change Canada	

Name	Organization	Speaker
Michelle Hudolin	Severn Sound Environmental Association	
Morgan Hrynyk	Environment and Climate Change Canada	**SPEAKER**
Morgan Roblin	Ontario Land Trust Alliance	
Neil Taylor	Toronto and Region Conservation Authority	
Nigel Ward	Toronto and Region Conservation Authority	
Paul Biscaia	Credit Valley Conservation	
Paul Yannuzzi	Rouge National Urban Park	
Pauline Quesnelle	Canadian Wildlife Service	**SPEAKER**
Prabir Roy	Parks Canada	
Rehana Rajabali	Toronto and Region Conservation Authority	
Rhianydd Phillips	Toronto and Region Conservation Authority	
Geoff Simpson	Georgian Bay Great Lakes Foundation	
Rupert Kindersley	Georgian Bay Association	
Sarah Matchett	Fisheries and Oceans Canada	
Sharon Lam	Ontario Climate Consortium	
Viviane Paquin	Parks Canada	
Wes Moir	Royal Botanical Gardens	