Natural Capital Inventory Aquatic Ecosystem Classification

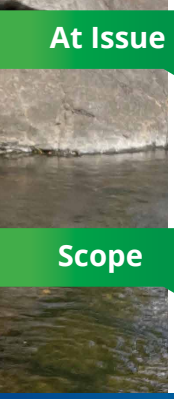
THE DISTRICT MUNICIPALITY OF MUSKOKA

This project is part of the extended **Integrated Watershed Management (IWM)** initiative, focusing on reducing flooding impacts and enhancing Muskoka River Watershed health. It's one of seven chosen for expansion from the original twelve projects. This initiative supports and advances the implementation for an IWM approach for the entire Muskoka River Watershed (MRW).

You can find more information on the Phase One Report – "Hydrological Model" and the accompanying Summary Factsheet on the District of Muskoka Website at: **www.muskoka.on.ca/iwmprojects**

Background

In the initial phase of the model build project, thirty-three scenarios were examined. These scenarios covered aspects like climate change, population growth, alterations in wetlands, deforestation, and extreme events such as 100-year storms and wildfires. The findings from Phase I highlighted that climate change will notably affect the watershed, primarily impacting the hydrologic cycle.



At Issue

The Muskoka River Watershed has faced repeated significant flooding incidents in various areas including the Big East River north of Huntsville, the North Branch of Muskoka River between Huntsville and Bracebridge, Lake Rosseau, Lake Joseph, and Lake Muskoka in 2019, 2016, 2013, and 2008 respectively. These events resulted in road washouts throughout the District and extensive damage to both public and private properties along with infrastructure.

Scope

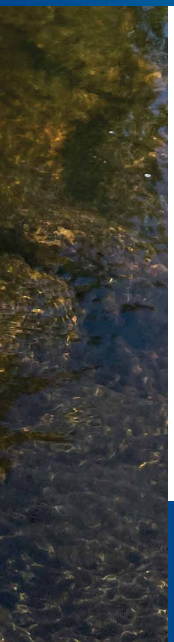
Additional climate change scenarios.

Implementation of manmade wetlands/ponds.

Proposal of structural modifications.

Ecological flow assessment to evaluate impact on channel forming flow and low flows.

Climate Change



Scenarios

- The baseline model was updated with new land cover and topographical data, mainly focusing on wetlands, without needing recalibration.
- Climate change scenarios for the Muskoka River Watershed show potential impacts on precipitation, temperature, and hydrological cycles, with varying predictions of increased precipitation, temperature, and changes in spring flood timing.

Results

- Temperature rise and reduced snowpack change flow patterns and timing.
- Winter flows might increase, while summer flows could decrease in certain scenarios.
- Annual watershed flows generally rise, except in specific dry scenarios.
- Peak flows vary across scenarios and locations, either decreasing or increasing, showing different impacts of climate change on flow timings and magnitudes.

Climate Projections: Anticipate shifts in freshet timing, increased temperatures, and varying precipitation, impacting hydrologic cycles and flow patterns.

Rain on Snow

Scenarios

- Rain-on-snow scenarios applied 2-year 24-hour rain events at specific climate stations in the watershed.
- Four scenarios simulated rain at various locations while keeping zero precipitation at other stations.
- Aimed to analyze flow changes in response to rain-on-snow events across different points.

Results

- Big East River peak flow increased by 117% with elevated flows lasting about two weeks.
- Port Sydney, North Branch Muskoka River, saw flow increases of up to 164% lasting around four weeks post-rain.
- Bracebridge displayed varied responses with peak flows rising from 11% to 112% based on rainfall distribution.
- Downstream locations (Muskoka River Confluence and Muskoka River at Bala) showed sensitivity to upstream rain-on-snow events, exhibiting notable flow increases lasting several weeks.

Rain-on-Snow Impact: Sensitivity in certain areas was observed based on presence of upstream lakes, influencing the extent and duration of flood risks.

Reservoir (R) Storage

Scenarios - Considered for Flood Mitigation

- **R1:** South Branch Muskoka near Purbrook
- **R2:** South Branch Muskoka River/Spence Lake near Muskoka Falls*
- **R3:** Big East River near Highway 11
- **R4:** North Branch Muskoka River between Fairy Lake and Mary Lake
- **R5:** Lake Vernon at outlet of Big East River*
- **R6:** Adjacent to the North Branch Muskoka River between Port Sydney and Springdale Park (an active quarry potentially converted into a reservoir upon closure).
- **R7:** Oxtongue River upstream of Dwight and Lake of Bays (not located on the main branches).
- **R8:** Tributary of the South Branch Muskoka River upstream of Purbrook (not located on the main branches).

**Reservoirs 2 and 5 were excluded from further analysis due to reliance on existing infrastructure for flood control.*

Structural Mitigation Options(O):

- **O1:** Retrofit of the Distress Dam on the Big East River.
- **O9:** Retrofit of the South Bala Dam control structure.

Results

- **R1:** Limited reduction in design flood peak flow rates.
- **R3:** Limited capacity to reduce design flood peak flow rates.
- **R4:** Slight reduction in design flood peak flow rates.
- **R6:** Potential to reduce design flood peak flow rates by approximately 5 m^3/s.
- **R7:** Effective in reducing peak flow rates on the Oxtongue River, but no change on the South Branch Muskoka River.
- **R8:** Significant impact on its tributary but negligible effect on the main Muskoka River branches.

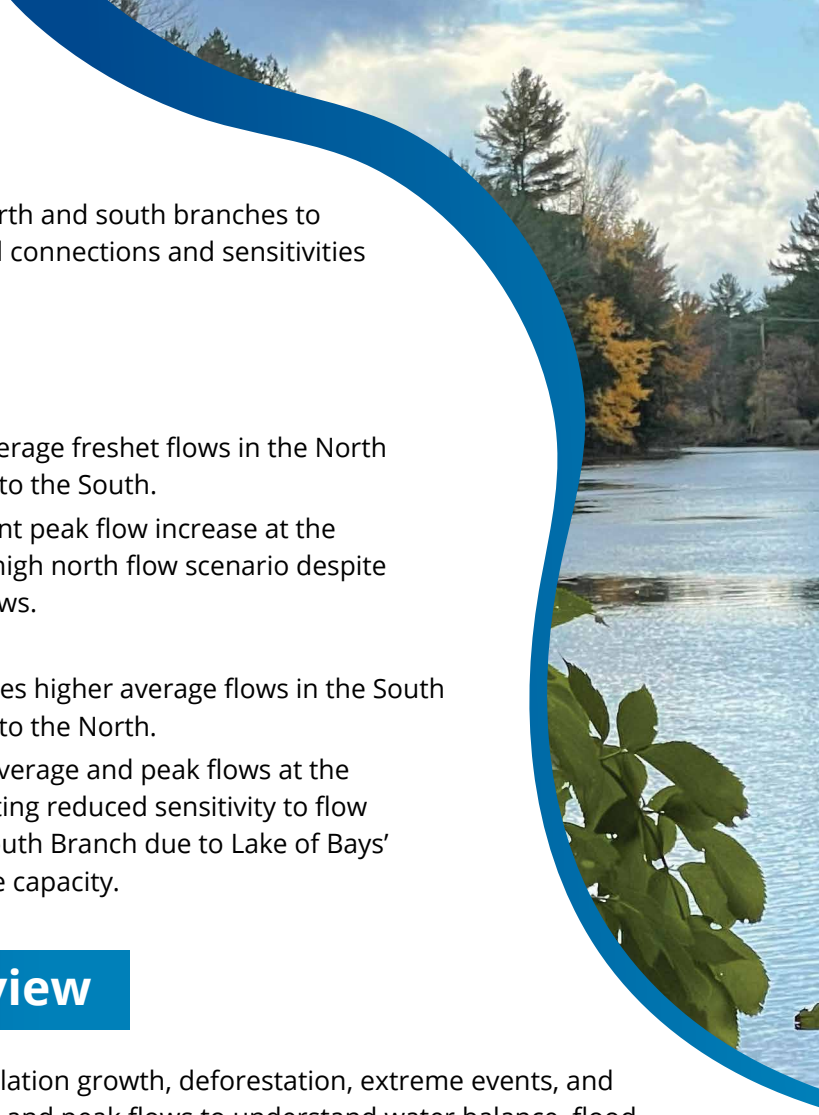
Overall Observations:

- Larger reservoirs show localized reduction but have diminished effects downstream due to larger contributing drainage areas.
- Online storage proves effective for reducing peak flow rates on tributaries and upper reaches of the river system

Peak Flow % Change from Existing Conditions:

- **O1:** Reduction by 6% to 31% in different locations along the Big East River, with diminishing effects downstream.
- **O9:** Dam: Small 1% reduction in peak flow rate downstream on the Muskoka River.

Reservoir Evaluation: Existing reservoirs showed limited capacity to mitigate downstream flood risk. Addition of smaller reservoirs had localized impacts but did not significantly reduce flood risk downstream.



Branch Impact to Flooding

Objective: Assessing the relative contribution of the north and south branches to flood potential in the watershed to understand watershed connections and sensitivities regarding peak flows downstream.

Scenarios (S)

S1: 'Wet' vs. 'Dry' Year:

Description: Application of 'Wet' year (Winter 1984) vs. 'Dry' year (Winter 1997) climate data to respective Hydrological Response Units (HRUs).

S2: Reverse:

Description: Reverse application of climate data to simulate higher flow in opposite branches.

Results

S1:

- Nearly doubled average freshet flows in the North Branch compared to the South.
- Observed significant peak flow increase at the confluence in the high north flow scenario despite similar average flows.

S2:

- Resulted in 1.5 times higher average flows in the South Branch compared to the North.
- Noticed reduced average and peak flows at the confluence, indicating reduced sensitivity to flow increases in the South Branch due to Lake of Bays' substantial storage capacity.

Ecological Flow Analysis Overview

Objective: Evaluate the impact of climate change, population growth, deforestation, extreme events, and reservoir storage on water flow, focusing on mean annual and peak flows to understand water balance, flood potential, and ecological impact.

Model Enhancements: Integrated detailed reservoir release functions for major lakes (Huntsville Lakes, Mary Lake, Lake of Bays, Lake Muskoka) and considered water surface elevations, operational controls, and seasonal variations for ecological flow requirements.

Assessment Methodology: Analyzed climate change, population growth, land use, and reservoir storage, using the Aquatic Ecosystem Assessment for Rivers (AEAR) to evaluate subsistence and channel forming flow indicators, excluding flood potential scenarios.

Basin Scenarios

B1:

On the Big East River at Williamsport Road northeast and drains into B3.

B2:

Southeast of B1 and drains to the South Branch Muskoka River upstream of the Lake of Bays outlet at Baysville.

Findings

Subsistence Flows: Mostly predicted low alterations, but some dry climate change scenarios showed medium to high alterations, potentially affecting fish habitat.

Channel Forming Flows: Predicted low alterations for most scenarios, but certain climate change scenarios indicated medium to high alterations.

Subsistence Flows: All calculations predicted low alterations, except certain climate change scenarios showing medium to high alterations.

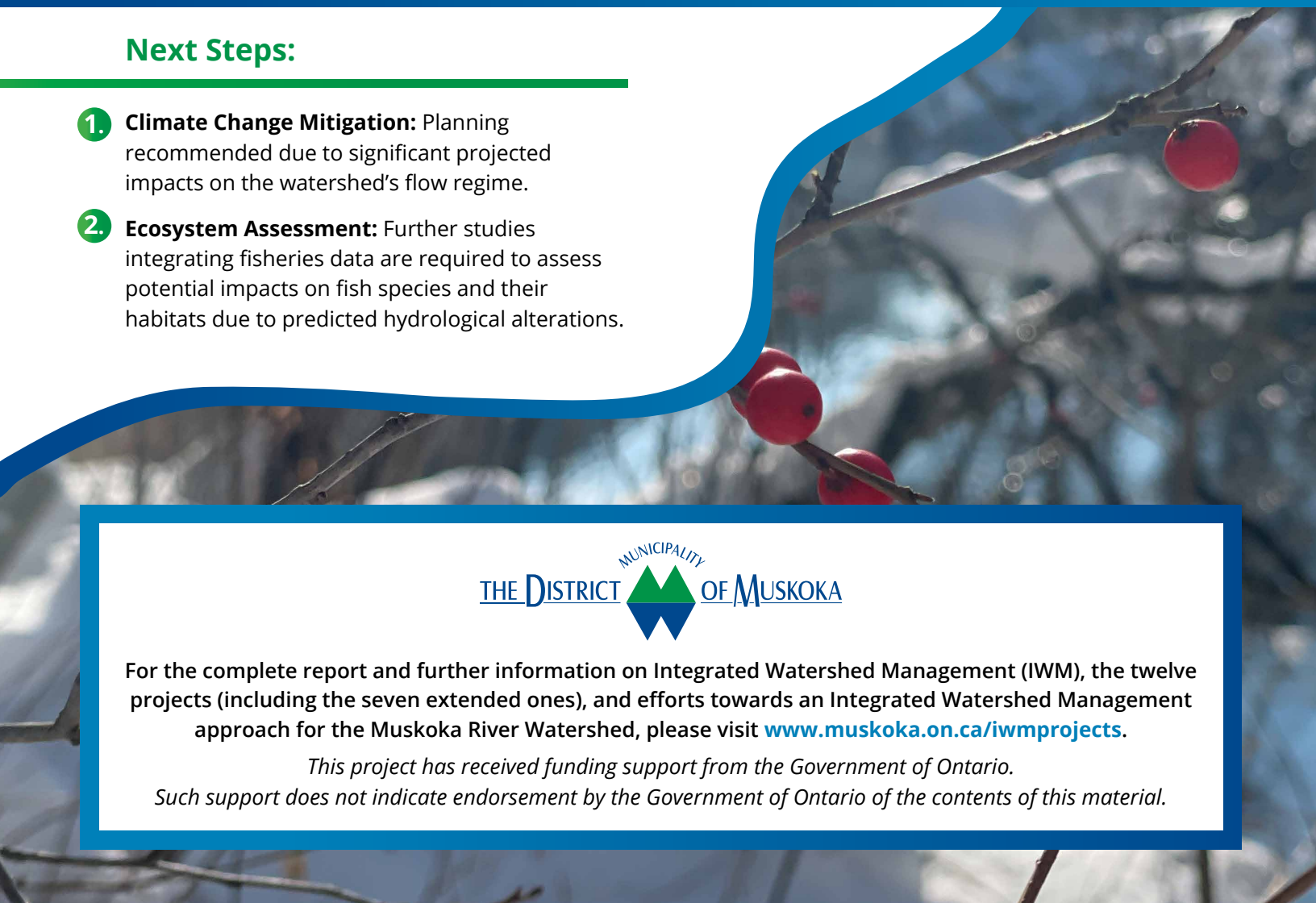
Channel Forming Flows: Predicted low alterations in most scenarios, but some climate change scenarios exhibited medium to high alterations.

Basin Scenarios	Findings
B3: Immediately downstream of B1, and northwest of B2. It receives inflow from B1 and drains into B5.	**Subsistence Flows:** Predicted low alterations across all scenario types. **Channel Forming Flows:** Showed low alterations in most cases, but certain climate change scenarios indicated medium to high alterations.
B4: At the upstream, northwest section of the watershed and drains into B5.	**Subsistence Flows:** Mixed predictions of low, medium, and high alterations in various scenarios. **Channel Forming Flows:** Similar mixed predictions of low, medium, and high alterations across different scenarios.
B5: At the downstream, southwestern end of the watershed and receives inflow from B2, B3, and B4	**Subsistence Flows:** Mostly predicted low alterations, but some climate change scenarios exhibited medium to high alterations. **Channel Forming Flows:** Showed low alterations in most scenarios, but certain climate change scenarios indicated medium to high alterations.

Summary: Population growth, land use change, and physical alterations have minimal impacts on the watershed, but climate change scenarios pose medium to high alterations in subsistence and channel forming flows, potentially affecting the natural flow regime and fish habitat.

Next Steps:

1. **Climate Change Mitigation:** Planning recommended due to significant projected impacts on the watershed's flow regime.
2. **Ecosystem Assessment:** Further studies integrating fisheries data are required to assess potential impacts on fish species and their habitats due to predicted hydrological alterations.



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For the complete report and further information on Integrated Watershed Management (IWM), the twelve projects (including the seven extended ones), and efforts towards an Integrated Watershed Management approach for the Muskoka River Watershed, please visit www.muskoka.on.ca/iwmprojects.

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