# Lake Superior Climate Change Impacts and Adaptation Report

Lake Superior LAMP and Binational Program

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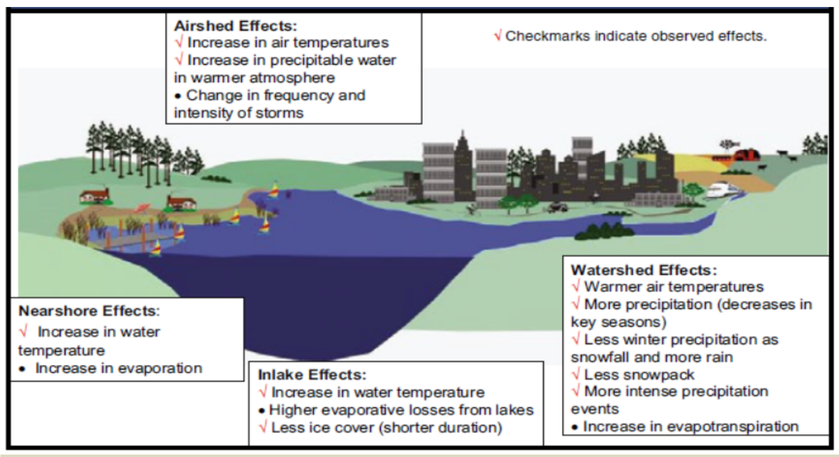
**Introduction and Methods:**

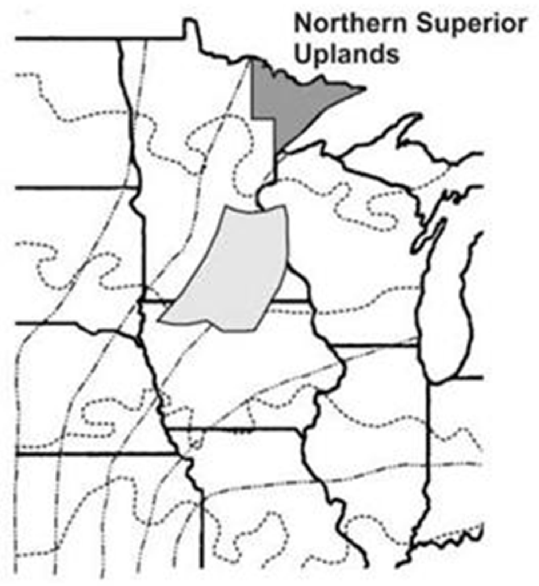
Lake Superior is a unique natural resource that supports an abundance of aquatic communities whose ecological health is vulnerable to changing climatic conditions. The Lake Superior LAMP builds from a 20-year history of successful coordination of Canadian and U.S. federal, provincial, state, tribes, and the public in restoring and protecting the lake. The LAMP recruited an Expert Group of participants from academia, state/provincial agencies, federal agencies, tribes, and environmental groups with expertise in issues related to changing climate conditions in the Lake Superior region. Members of the LAMP and Expert Group provided comment on a) the compilation of climate science and vulnerabilities, b) the discussion of existing climate programs and policies, and c) the synthesis of proposed adaptation options. The Expert Group also provided insight into gaps and uncertainties related to anticipated impacts on the Lake Superior ecosystem. This Report compiles assessments of climate change vulnerabilities and published adaptation actions for the Lake Superior region from the existing literature.



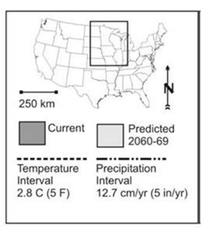

Overview of expected changes in climate for the Great Lakes basin.

**Summary of Projected Changes to the Lake Superior Climate**

- Increase in annual average air temperatures
- Slight increase in annual average precipitation
- Change in seasonal precipitation patterns – less precipitation in summer and more precipitation in winter
- Change in precipitation type – more precipitation falling as rain and less as snow, but little or no change in the frequency of lake effect snow events
- Increase in annual average lake water temperatures
- Increase in the length of the summer temperature stratification season
- Reduction in the extent and duration of ice cover on Lake Superior
- Increase in wind speeds over Lake Superior
- Increase in the rate of evaporation from Lake Superior, resulting in slightly lower water levels
- Increase in the length of the growing season




Migration of climate for the Northern Superior Uplands region of Minnesota, based on annual average temperature and precipitation GCM projections under a medium-high (A2) emissions scenario for 2060–2069, relative to




# Climate Adaptation

# Strategies and Actions for Streams:

## MANAGE

**Non-Climate Stressors**

- Prevent introductions and spread of aquatic invasive species and implement Lake Superior Aquatic Invasive Species Complete Prevention Plan
- Monitor nutrient loading and apply nutrient abatement programs to improve water quality

**Habitats, Species, and Ecosystem Functions**

- Restore or construct riparian buffers to provide adequate shade along existing streams to manage heavy runoff associated with potentially more frequent and intense precipitation events
- Develop and implement increased water temperature thresholds for shifting local stocking and fisheries management from cold water fish to cool water fish
- Upgrade infrastructure to handle the volume associated with more frequent and intense precipitation events
- Establish and expand refugia to link habitats and protect threatened native species
- Implement “slow the flow” strategy into forestry management activities to reduce runoff rates and decrease sedimentation
- Examine and adjust fishing regulations to reflect fluctuations in aquatic carrying capacities and shifting fish breeding and migration patterns associated with climate change
- Revise fish stocking guidelines to incorporate climate change effects
- Develop ordinances to control runoff flow
- Revise current best management practices to prevent non-point source pollution to account for climate change impacts
- Zone development away from sensitive and hazard-prone areas
- Optimize use of restoration and protection funding to projects incorporating the impacts of climate change into project design

## CONSERVE and PROMOTE

**Habitat**

- Identify and conserve areas likely to be resilient to climate change—those supporting a broad range of habitats and species
- Identify minimum standards of water levels required for in-stream biological uses
- Encourage and support water conservation through implementation of watershed-wide water conservation strategies
- Maintain and enhance connectivity in aquatic and terrestrial systems for species migration

**Enhance Adaptive Management Capacity**

- Incorporate integrated watershed planning (managing human activities and natural resources on a watershed basis) into water and aquatic resource management practices
- Integrate use of climate change scenarios and vulnerability assessments into land use plans and resource management plans

## EDUCATE and MOTIVATE

**Increase Knowledge, Assess Vulnerability, Update Maps & Plans**


- Support and enhance scientific research designed to understand resilience of ecosystems to climate change and other cumulative effects
- Make climate models and scenarios available and accessible to inform large and small scale natural resource management decisions, growth plan decisions, and socio-economic analyses
- Improve flood plain mapping to include increasing frequency of major flood events
- Conduct climate change vulnerability assessments for forests, fisheries, ecosystems, near-shore water quality, watersheds, and status of ecosystems in areas directly influenced by high volumes of storm water

**Public Outreach and Motive Action to Adapt**

- Increase public awareness and understanding of climate impacts to ecosystems, natural cultural history, and the principles of climate adaptation
- Regularly discuss climate change issues during teleconferences, webinars, and meetings
- Encourage stewardship groups to protect and rehabilitate aquatic habitat, riparian zones, and wetlands

**References:**

Lake Superior Binational Program. Lake Superior Ecosystem Climate Change Adaptation Plan. Month 2013. Available at http://www.epa.gov/glnpo/lakesuperior/index.html

Several climate change vulnerability and adaptation assessments were used in the development of this Report (e.g., United Nations Framework Convention on Climate Change, 2008; IPCC, 2001).