Biodiversity in a Changing Climate: Impacts and Adaptation in Ontario

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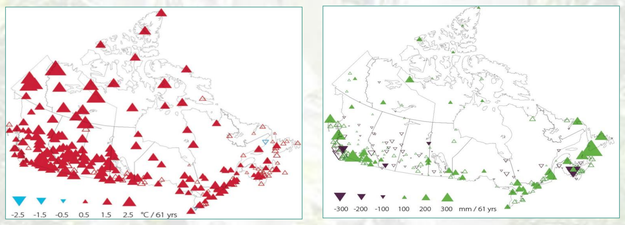
Climate Change is Real, and the Evidence is Compelling

There is overwhelming evidence that climate change is real, and we are already experiencing changes in temperature, precipitation, and extreme weather. In Canada, **average surface air temperature has increased by 1.5°C** between 1950 and 2010 (Bush et al., 2014). Although the strongest trends have been observed in the north and west of the country, warming has been observed consistently across all of Canada (Bush et al., 2014; Vincent et al., 2012).

Between 1948 and 2008, almost every region in Ontario experienced an increasing temperature trend, with **mean annual temperature increasing by 1.4°C** (CCDS, 2009). This seemingly small number may look insignificant, but small changes in average temperatures can result in significant impacts.

Daily precipitation data demonstrate that Canada has generally become wetter in recent decades, with an **increase in average annual precipitation of approximately 16%** between 1950 and 2010 (Bush et al., 2014). In Ontario, the southern region has experienced increases in precipitation, however lack of monitoring stations in the north make it difficult to detect strong precipitation trends (Bush et al., 2014). Warmer temperatures have also impacted the type of precipitation; several regions of Canada and Ontario have experienced a **decrease in snowfall and an increase in rainfall** (Mekis and Vincent, 2011).



These graphs show trends in annual mean temperature (left) and precipitation (right) from 1950-2010. Upward- and downward-pointing triangles indicate positive and negative trends, respectively. Filled triangles correspond to trends significant at the 5% level. The size of the triangle is proportional to the magnitude of the trend (Vincent et al., 2012).

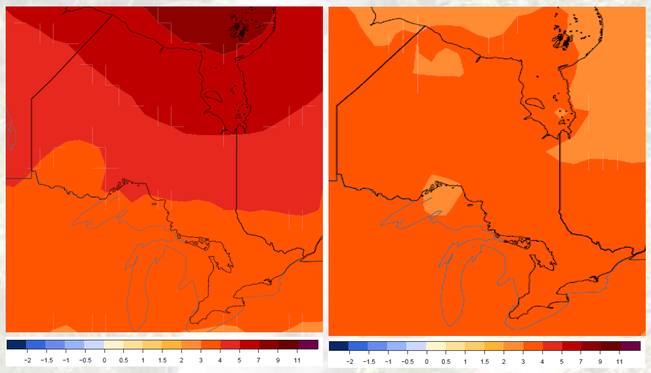
What Type of Climate can we expect in the Future?

With the help of global climate models, scientists are able to simulate changes in climate based on a set of scenarios of anthropogenic forcings. In northern countries such as Canada, **the largest temperature change is likely to occur during the winter season** (e.g. winters in northern Ontario are projected to be 5 to 7°C warmer by 2065). Furthermore, projections suggest that **annual precipitation is expected to increase in Ontario**, with the largest changes in the northeast and the lowest changes in the western part of the province (CCDS, 2015).

In Ontario, warming temperature trends and changing precipitation patterns are expected to result in a variety of environmental, social and economic impacts. Some of these impacts include: **reduced ice cover** on the Great Lakes, **increased snowfall, increased freeze-thaw cycles**, increased viability of **pests and diseases**, increased **flooding**, increased **soil erosion**, degraded **water quality**, **earlier peak flow** in streams and rivers, **decreased total flow** in streams and rivers, and potential for **drought** conditions and forest fires. Since warmer air can hold more moisture, climate change will also result in more **frequent and intense extreme weather events** (Warren and Lemmen, 2014).

Projected Changes in Winter Temperature in Ontario (2046-2065)

Projected Changes in Summer Temperature in Ontario (2046-2065)



Temperature projections for winter season (December-February) and summer season (June-August) for 2046-2065 under an RCP8.5 scenario, 50th percentile (CCDS, 2015).

What does this mean for Ontario's Biodiversity?

Climate change will affect biodiversity by **altering species relationships** and **changing the distribution and configuration of habitats**. This could result in community reassembly in ecosystems throughout Ontario. There will be both winners and losers. For example, mobile species with relatively large geographic ranges with northern range boundaries in Ontario likely will benefit from climate change, while **habitat availability for less mobile species with southern range boundaries in the province may contract** resulting in increased threat from parasitism, competition and other biotic stresses.

LIFE-CYCLE CHANGES: Life cycle changes resulting from warmer winter and spring temperatures are already occurring across Ontario. Shifts include **earlier onset of breeding by amphibians** (e.g. Wood Frog, Northern Leopard Frog and Spring Peeper) and **earlier occupation of breeding habitat and emergence of hatchlings by bird species** (Varrin et al., 2007; Walpole and Bowman, 2011). For example, Eastern Bluebird migration and egg-laying occur earlier in the season and coincidentally correspond to climate-induced changes in insect population distribution and abundance (Varrin et al., 2007). In the long term, this shift may increase Bluebird reproduction.

HYBRIDIZATION: Climate change-related **range expansion may increase the likelihood of interbreeding and hybridization** when two previously distinct populations or species come into contact. For example, the Southern Flying Squirrel expanded its northern range by approximately 200 km during a series of warm winters in Ontario between 1994 and 2003. This range expansion resulted in **increased co-occurrence and hybridization between the Southern and Northern Flying Squirrels**. Hybridization can result in: i) sterile offspring; ii) viable offspring with increased fitness; iii) viable offspring with reduced fitness, or iv) no change in fitness (Hoffmann and Sgrò, 2011; Bowman et al., 2005; Garroway et al., 2010; Nantel et al., 2014).

HABITAT CONTRACTION: The southern range boundary for some species is contracting or projected to contract as a result of **hybridization** (e.g. Black-Capped Chickadee) and **habitat loss** (e.g. the Gray Jay where warmer fall temperatures could result in increased rotting of stored food, which in turn will negatively influence reproduction) (Waite and Strickland, 2006).

AQUATIC HABITATS: Warming water temperatures continue to change the distribution and volume of thermal aquatic habitats. **Habitat for cold-water species such as Lake Trout is decreasing** while habitat for warm-water species such as Smallmouth Bass is increasing. By 2100, lake trout habitat in Ontario could be reduced by 30% due to climate change, with declines of up to 60% in some southern watersheds (Nantel et al., 2014).

INVASIVE SPECIES: Warmer water temperatures will enable **invasive species like Smallmouth Bass and algal blooms** to significantly influence community reassembly in lakes, rivers and wetlands throughout Ontario (Chiotti and Lavender, 2008). The winter range of the **Black-Legged Tick** responsible for the spread of Lyme disease has expanded from southern Ontario and the northeastern USA into central Ontario and is projected to reach northern Ontario by the 2080s (Ogden et al., 2008).

EXTREME EVENTS: Increased extreme weather events such as heavy precipitation, extreme winds and drought will affect ecosystem-level responses through forest fires, blowdowns and flooding. Climate models project that **fires are likely to occur more frequently**, and the length of Ontario's fire season will likely increase (Colombo, 2008).

CUMULATIVE IMPACTS: Climate change works with other cumulative effects to modify ecosystem composition, structure and function. When combined with **human-induced stressors such as habitat fragmentation, water pollution, deforestation and wetland drainage**, these changes can significantly affect survival and adaptation ability of species throughout Ontario (Nantel et al., 2014).


Eastern Bluebird


Lake Trout


Black-Capped Chickadee


Black-Legged Tick


Northern Leopard Frog

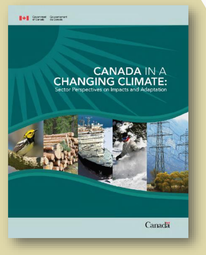
What can we do to Adapt?

As the climate warms and ecosystems change, adaptation will become increasingly more important to Ontarians as they work to cope with these new challenges. **Conservation networks, with parks and other types of protected areas at their core**, are key components of resilient socio-ecological systems because they protect ecosystem structure and function and provide connected habitats that offer the opportunity for organisms to respond to changing conditions.

EXAMPLES OF ADAPTATION:

1. **Protecting intact ecosystems**. Protected areas provide habitat for native species and opportunities for autonomous adaptation, migration, and natural selection processes through maintenance of genetic diversity. This in turn enhances species' capacity to respond to climate change impacts. Ontario currently has over 10 million hectares of protected areas.
2. **Connecting protected areas** through sustainably managed landscapes and waterscapes. Mechanisms for this may include new approaches to habitat protection on intervening landscapes and waterscapes, and increased participation of landowners. For example, the Ontario Ministry of Natural Resources and Forestry's 50 Million Tree program creates corridors between natural areas in order to enhance and diversify southern Ontario's landscape and increase adaptive capacity to withstand climate change.
3. **Supporting species recovery** with ecological restoration of degraded ecosystems.
4. **Encouraging active habitat management**, such as the establishment of nest boxes and the protection of cavity trees to facilitate the colonization of sites by species expanding their ranges. This also includes assisted migration, the human-mediated transport of selected species to more favourable climatic habitat.
5. **Sponsoring programs that subscribe to an adaptive approach** to managing for the effects of climate change. This can include improved institutional coordination, and training and education programs.
6. **Employing knowledge management systems to support research**, inventory and monitoring, as well as communication and education.
7. **Undertaking species vulnerability assessments** to identify species and populations that require active human intervention to mitigate losses. A study of the vulnerability of Ontario's Lake Simcoe watershed to climate change led to the development of *A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems* (Gleeson et al. 2011), a guide to help natural resource managers integrate climate change vulnerabilities and adaptation planning into decision-making processes.
8. **Acquiring longer-term data sets** to assess species responses, and develop models to better understand the complex potential outcomes of climate change on species and their interactions.
9. **Engaging communities** in adaptation programs.

A National Climate Change Assessment



In 2014, the *Climate Change Impacts and Adaptation Division* of Natural Resources Canada released a national science assessment that presents the latest knowledge on climate change impacts and adaptation for Canadians.

The assessment, **Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation**, is an update to the 2008 report, *From Impacts to Adaptation: Canada in a Changing Climate*. The report includes chapters on natural resources (forestry, energy and mining), food production, industry, biodiversity and protected areas, human health, water and transportation infrastructure, and adaptation.

Chapter 6 of the National Assessment is focused on Biodiversity and Protected areas. Climate change affects many components of Ontario's ecosystems, including **soil composition and structure**, the **water cycle**, **species distribution**, the **timing of life-cycle events** such as egg laying, and **plant and animal health**.

As the climate warms and ecosystems change, **adaptation will become increasingly more important** to Ontarians as they work to cope with these new challenges. Natural resource managers will require access to the best information available in order to develop and implement adaptation measures.

Much of the information presented here can be found in the latest national assessment document. **To learn more, please visit:** www.nrcan.gc.ca/environment/resources/publications/10766

For More Information...

Ontario Ministry of Natural Resources and Forestry
www.ontario.ca/ministry-natural-resources-and-forestry.com

NRCan National Assessment
www.nrcan.gc.ca/environment/resources/publications/10766

Ontario Biodiversity Council
www.Ontariobiodiversitycouncil.ca

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