Managing Your Woodlot in a Changing Climate

Ontario

Table of contents

Climate change is real

Take action now to help your woodlot to adapt

Climate change is real and it is happening now. The impacts of climate change in Ontario are already being observed. The impacts of climate change outlined in this document should be considered as part of your forest stewardship plan.

H. Bickle

As a good forest steward, you make wise environmental and economic decisions, and implement the most effective strategies to help your woodlot adapt to climate change. Many of these management options are already part of good stewardship practices to enhance wildlife, timber values, recreation, and other objectives. You may also want to consider how your forests can play a vital role to help capture carbon emissions and minimize the impacts of climate change in the future.

Now is the time to get informed, make plans, and manage your woodlot as an informed land steward. Forests that are well adapted to new and changing conditions will be better able to meet your management goals as you build a more sustainable future for your forest.

Good forest management can save you time and money

Management decisions affect how well your woodlot can withstand damage or recover after damage. It is important that landowners take steps to keep woodlots healthy even as conditions change. Preparing for these changes now will save time and money in the long run, improve forest health, increase your enjoyment of your property, and reduce the risk of losses in the future.

There are several things property owners can do to enhance the ability of woodlots to adapt to climate change and its effects (see the list on the back of this publication). In most cases, these actions are part of normal forest management.

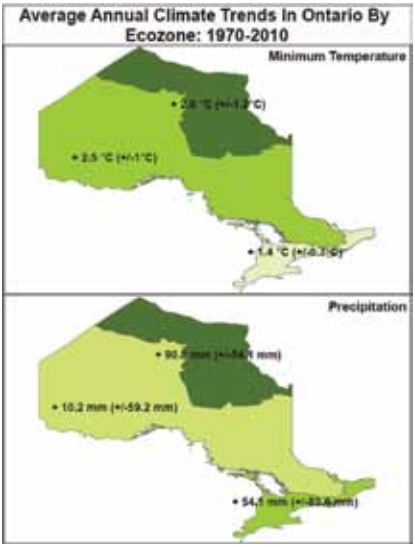
The following pages explain the potential impacts of climate change in Ontario and how they may affect woodlots. Management options are described that can help to reduce forest cover loss, declines in forest productivity, and reductions in the environmental benefits of woodlots. In some cases, a management option may be to take no action, and to allow species composition and structure to change naturally over time (natural succession). In other cases, the best management option may be to work with these changes to increase the resiliency of the forest, such as planting genetically adapted and site-appropriate species based on projected future climate. Other options represent common sense or best-bet approaches to dealing with an uncertain future such as enhancing your monitoring activity.

Climate change is already occurring in Ontario

Within the last 40 years, Ontario has experienced changes in temperature, rainfall patterns, and extreme weather events that can have pronounced environmental and economic effects on forests and wetlands.

Temperatures are increasing

40 years of data show that Ontario is getting warmer.[1] Minimum temperatures have increased in northern Ontario between 1.4 and 3.8°C (averages shown on right). By comparison, temperature increases experienced in southern Ontario have been less: between 0.7 and 2.1°C. Concurrently, an earlier start to the vegetative growing season has increased the overall duration of the growing season. This could lead to increased agricultural and forestry opportunities.



1. McKenney, D. W., Hutchinson, M. F., Papadopol, P., Lawrence, K., Pedlar, J. H., Campbell, K., Owen, T. (2011). Customized Spatial Climate Models for North America. American Meteorological Society, 1611–1622.

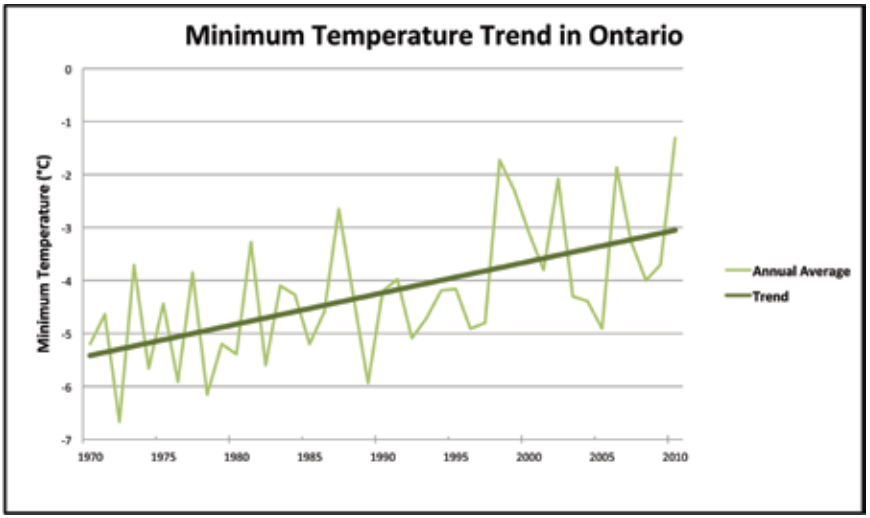
Rainfall patterns are changing

As temperature increases, we have experienced changes in rainfall patterns. Over the last century, Ontario has become slightly wetter in some parts of the province, but the slight increase is well within the variability of annual precipitation over time. Smaller increases in precipitation may not be sufficient to offset the more significant rises in temperature and the evapotranspiration of trees associated with increased temperatures. This may mean forests will experience increased moisture stress and the risk of wildfires in some cover types may increase.

Extreme weather events are more frequent

Ontario is experiencing more frequent extreme rain and storm events, and more flooding and drought. Woodlands affected by extreme events such as tornadoes, wind storms, ice storms, summer heat waves, droughts, floods, and wildfires can take decades to recover after disturbance, and forest ecosystem structure and productivity may change as a result.

It is projected that temperature, precipitation, and wind patterns will continue to change for decades, perhaps centuries, affecting the way communities throughout Ontario manage their natural resources and infrastructure. This will change the lives of Ontarians who depend on these assets for their health and well-being.



Forests help fight climate change

Healthy forests store carbon as biomass and in the soil

Scientists agree that our climate is changing and that these changes are caused by human activities, particularly the increase in greenhouse gas emissions from burning fossil fuels.

Forests naturally capture carbon dioxide from the atmosphere which is then stored as carbon in live trees, downed woody debris, and in the soil. This carbon can be stored for decades and centuries in living trees or in durable wood products like furniture or building frames until it is released when vegetation either decays or is burned. Maintaining or increasing the amount of carbon that can be stored by your woodlot is crucial to help reduce atmospheric carbon dioxide emissions and the effects of climate change in the future.

D. Tanier

Maintaining healthy forests is an important contribution that landowners can make.

D. Tanier

When mature forests are harvested sustainably, the carbon that was removed by the forest over time is stored in lumber or other wood and paper products. After a harvest, carbon will be removed from the atmosphere at a slower rate at first, but once new forest becomes established the rate of carbon being removed from the atmosphere will speed up because young trees have a faster growth rate than mature forests. For example, planting 50 million trees on southern Ontario sites is expected to sequester 6.6 megatonnes of carbon dioxide equivalents by 2050.

If forested land is converted into another use, the total amount of carbon dioxide in the atmosphere increases due to the loss of carbon storage capacity on that land. Maintaining healthy forests is an important contribution that landowners can make. These forests also provide other natural benefits such as producing clean air and water, creating wildlife habitat, and other aesthetic values. Climate change itself will affect how much carbon can be stored in forests. With increased temperatures and drought, trees may be stressed and less successful at reproduction and seedling survival may decline. Trees typically store more carbon than grasses or other vegetation and in extreme cases such as in the western prairie fringe, aspen parklands may give way to grassland ecosystems as soils dry resulting in a net reduction in stored carbon at a regional scale.

Climate change is being observed in nature

Many changes to the timing, distribution, and interaction between species are already being observed in Ontario. These changes may affect the biodiversity in your woodlot as well as effect both forest and human health. Some examples of observed changes in nature include:

1. The southern **flying squirrel** has expanded its range northward in Ontario while the northern flying squirrel has contracted its range. New interactions between the two species has resulted in a new hybrid zone in central Ontario.[2]

2. Several **frog and toad species** have shifted the timing of spring emergence and calling in southeastern Ontario. In the four decades of observation to date, the northern leopard frog emerges significantly earlier now, by an estimated 22 days. American toads have advanced their start of calling by up to 19 days. This significant shift in breeding behaviour for two species has occurred at the same time as a significant local increase in spring temperatures of an estimated 2.8°C over four decades.[3]

2. Garroway, C., J. Bowman, T. Cascaden, G. Holloway, C. Mahan, J. Malcolm, M. Steele, G. Turner, P. Wilson, 2010. Climate Change Induced Hybridization in Flying Squirrels. Global Change Biology. 16(1): 113-121.
3. Klaus, S. and S. Lougheed. 2013. Changes in breeding phenology of eastern Ontario frogs over four decades. Ecology and Evolution. 3(4): 835–845.

3. **Freezing damage** prior to bud break in eastern larch, balsam fir and black spruce has been observed in northeastern Ontario due to temperature variability in spring 2007. Six years later, the survival and growth of the species following damage was 98% in eastern larch but only 70% in balsam fir and black spruce.[4]

4. The timing of migration for some **North American wood warblers** is not advancing in response to climate change as fast as key prey such as the eastern spruce budworm. Climate change may reduce the synchrony in co-evolved systems because of the variation in individual species' responses to climate change.[5]

5. Until recently, the risk of **Lyme disease**, a bacteria spread by some species of ticks, has been restricted to localized areas along the north shore of Lake Erie, Lake Ontario, and the St. Lawrence River. However, as the climate changes, Lyme disease is emerging as a serious health risk in many parts of Ontario. Models suggest that the geographic range of tick species that transmit Lyme disease may expand significantly due to climate change, with a northern expansion of about 200 km projected by the year 2020. This expansion would likely be due to longer growing seasons resulting from warmer temperatures and decreased tick mortality during milder winters.[5]


MNRF
Southern flying squirrel


M. Oldham
American toad


R. Mann
Bud damage from late frost


B.Small
North American wood warbler


Michigan DNR
Blacklegged tick

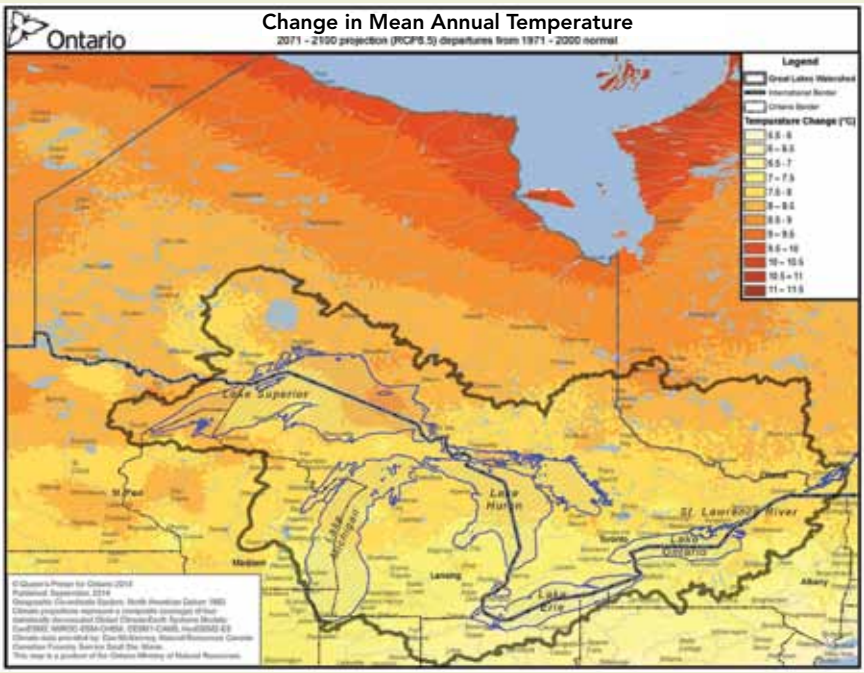
4. Man, R., G. Kayahara, S. Foley and C. Wiseman. 2013. Survival and growth of eastern larch, balsam fir, and black spruce six years after winter browning in northeastern Ontario. Forestry Chronicle 89(6): 777-782.
5. Nituch, L. and J. Bowman. 2013. Community-Level Effects of Climate Change on Ontario's Terrestrial Biodiversity. CCRR-36. Ontario Ministry of Natural Resources.

Climate change is projected to accelerate

T. Schwan

As our climate changes, the projected changes in temperature and precipitation that are most likely to affect woodlots and woodlot management are:

- Longer growing seasons
- More winter rain and earlier peak stream flows
- Shorter frozen ground operating season
- Drier soils in summer
- Increasing abundance and outbreaks of pests and disease
- Increasing invasive species and new pathogens from southern climates
- More frequent extreme weather events including heavy rain, wind and ice storms
- Changing habitat ranges, particularly for southern edge species
- Decoupling of co-evolved ecological processes that may affect woodlots in unknown ways (e.g. insect pollination, seed production, host hardiness, wildlife interactions)



Shifting species distribution

Suitable habitat for many species will move north

The composition of forests is largely controlled by past land use history and by what species are adapted to the climate in the area. Slow and subtle changes in forest composition and distribution are determined by a number of factors such as: seasonal temperatures, precipitation patterns, soil moisture patterns, severity of extreme storm events and natural disturbances, deer browsing, and the abundance of pests and diseases. As these factors change, the habitat required for species may shift. Species you find in your woodlot may become maladapted.

It is estimated that the climatic range of some forests species in Ontario will shift hundreds of kilometers northward by the end of 2100 in a business-as-usual scenario (where humans continue to emit the greenhouse gases that we currently emit). Natural migration will be unable to match these projected range shifts as the climate changes faster than some species can handle. Warmer and drier conditions will also impose significant stress on many tree species. The ability of species to migrate naturally will be challenged by the fragmented nature of the landscape and the lack of forest, especially in the southern parts of Ontario. As forest composition changes, the types of wildlife supported will also change, and forest productivity may increase or decrease depending on the tree species present.

Researchers at the Canadian Forest Service and Ontario Ministry of Natural Resources and Forestry have modeled the projected changes in climate in Ontario.[6] An ensemble of several downscaled Global Climate Models are used to look at possible future climate. Scenarios describing possible future climate are based on assumptions of how the earth's climate operates, future world population levels, economic activity and greenhouse gas emissions. The map on the left shows the average annual temperature difference comparing a base historical period (1971-2000) to a future period at the end of the century (2071-2100) using a business-as-usual emissions scenario.

6. Canadian Forest Service: Regional, National and International Climate Modeling http://cfs.nrcan.gc.ca/projects/3/10

Populations of species at the northern limit of their range may become more abundant or colonize new habitat, whereas those species at the southern limit of their range may be threatened.

D. Tanier

White pine

Current white pine distribution

Projected white pine distribution by 2100

Full Range
Core Range

D. Tanier

Red oak

Current red oak distribution

Projected red oak distribution by 2100

Full Range
Core Range

Researchers at the Canadian Forest Service have examined the effect of projected climate change on the climate habitat of 130 North American tree species.[7] To quantify the potential extent of shifting tree species distribution, they determined the current climatic ranges of species and then located those climatic conditions on maps of future climate, indicating where each tree species may be best suited to occur by the end of the century. The maps presented here show current distribution and the Canadian Global Climate Model projected climatic conditions for white pine and red oak distribution, using a business-as-usual emissions scenario.

7. Canadian Forest Service: Plant Hardiness of Canada – Species-specific Models and Maps, http://planthardiness.gc.ca

Variable temperatures lead to tree damage, bud damage and winter browning

Ice storms will likely occur more frequently with more moderate winter temperatures across most of Ontario in the future. Ice storms occur primarily when surface temperatures are hovering at or just below the freezing point. Ice accumulations on branches can increase branch weight up to 30 times and cause even large branches to break, severely affecting tree growth. Damage to needles and buds due to variable spring temperatures and late spring frosts occurring after bud break is being observed. Damage from frost differs among tree species, indicating that some species may be more able to adapt to temperature fluctuations than others.

Winter browning often occurs during the transition from winter to spring when conifer needles die causing trees to appear brown. During periods of increased sunlight and warm temperatures, conifers lose water from their needles faster than it can be replaced. The tree's dormant roots and frozen ground prevent the tree from replacing lost water, causing the needles to dry out and die. Some winter browning is considered normal, however large scale occurrences are being observed and projected to occur more frequently in the future, affecting forest health and tree survival.

R. Doyle

Ice storm damage

MNRF

Winter browning

C. Roshe

Forest fire

Drought and stress make trees more susceptible to pests and disease

Forests generally adjust to natural disturbances such as drought and increased temperatures through built-in natural recovery systems. Trees pull water up through the soil when it is available, but a changing climate can mean less water in the summer. Larger trees fare better because of their well-developed root systems; however, seedlings and saplings may not survive. Eventually, when droughts last long enough, all trees are affected, reducing productivity and reproduction. As trees and soils lose moisture, trees become stressed and more susceptible to pest attacks and disease.

Pests and disease increase fuel sources for wildfires

When trees are already stressed from drought, pests and/or diseases, the increased amount of dead leaves and branches on the forest floor can create fire hazards in otherwise fire resistant stands. Although wildfires are not currently a serious problem in southern Ontario, fires do occur when there is an absence of healthy ground cover, and when dry vegetation and debris cover the ground. Increasing temperatures and more droughts, combined with less snowfall and snowmelt, could result in earlier and longer fire seasons in all parts of Ontario.

Warmer temperatures help insect pests and disease to overwinter

Insect pests and disease can have a significant impact on woodlots, and a changing climate may affect what kind of pests are seen in Ontario. Many insects and diseases are controlled by winter temperatures, with colder temperatures reducing their populations. As winters get warmer with climate change, the number of these pests and diseases that survive the winter may increase, leading to greater outbreaks and infestations.

Invasive species compete for light, nutrients, and water

Invasive plant species affect forest health and regrowth through competition for light, nutrients, and water. As many of these invasive plant species have been introduced from other regions, the absence of competitors or predators means that they are able to outgrow and replace many native plant species, especially understory species and young trees. A changing climate may also intensify the problem in the following ways:

- A longer growing season can give invasive species a bigger advantage in their competition with native species.
- Higher carbon dioxide levels are linked to a faster spread of invasive plants and increased resistance to herbicide applications.
- Shifting plant species distributions provides an opportunity for invasive species to outcompete native species.

Three of the most aggressive invasive plants that are already stressing Ontario's forests are dog strangling vine, buckthorn and garlic mustard.

A. Hicks

Dog strangling vine

H. Anderson

Buckthorn

K. Towle

Garlic mustard

Invasive Species in your woodlot?

Ontario has an Early Detection and Distribution Mapping System (EDDMapS Ontario) to detect and monitor the spread of invasive species in the province. Through EDDMapS Ontario you can report sightings of invasive species and view their local, regional or provincial distributions. It contains information profiles for over 150 different species, as well as tools for searching and downloading data. You can also set up alerts to be notified when a new species is detected in your area.
Visit *www.eddmaps.org/ontario* for more information.

"As we learn about the natural environment and develop respect for the complexity of our planet, we become better human beings." *– Dr. Roberta Bondar*

Learn more about your forest:

Forests Ontario
www.forestsontario.ca

Ontario Woodlot Association
www.ont-woodlot-assoc.org

Landowner Resource Centre
www.lrconline.com

Managed Forest Tax Incentive Program
www.ontario.ca/MFTIP

Ontario Professional Foresters Association
www.opfa.ca

Learn about climate change in Ontario:

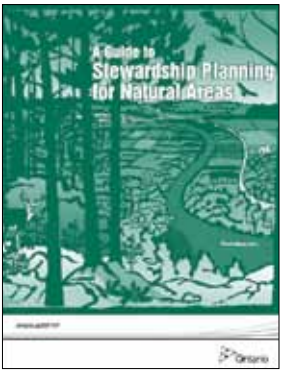
MNRF Climate Change Research Report Series
www.ontario.ca

Ontario Centre for Climate Impacts and Adaptation Resources
www.climateontario.ca

Canadian Forest Service Plant Hardiness of Canada – Species-specific Models and Maps
http://planthardiness.gc.ca

Stewardship Planning and Climate Change

"A Guide to Stewardship Planning for Natural Areas" is a useful guide for private woodlot owners in Ontario to assist in the development of a resource management plan for their property. This guide is available on the Managed Forest Tax Incentive Program website (ontario.ca/mftip). Using this basic guide as an example, the following sections could be used to include information on climate change impacts and adaptation activities.



Section 3: Property History

Provide information on past and projected climate in your local area in your plan. Explore historic data for your local area using Environment Canada weather station information. Use an advanced search by location (or longitude/latitude) to download decades of climate data.

http://climate.weather.gc.ca

Explore what your local climate may be in the future. Use MNRF's Climate Change Mapping Tool to look at projected temperature and precipitation in your area for 2020, 2050 and 2080.

www.ontario.ca

Section 5: Landowner Objectives

Include management objectives and strategies to enhance the resilience of your woodlot to a changing climate. Use the ideas listed on the last page of this document to get you started.

Section 7: "Getting to Know" More about the Values of Your Property

As part of Section 7.6, include short-term activities that you plan on carrying out that will enhance resilience of specific compartments of your woodlot.

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Top 7 actions woodlot owners can take

1 Keep the forest you have and enhance it if possible

Maintain existing forests on the landscape and identify opportunities for afforestation to increase forest cover. Take advantage of opportunities to restore and/or enhance connectivity between natural areas to allow trees and wildlife to migrate more easily as future conditions change.

2 Practice sustainable forestry

Practice sustainable forest management to maximize forest health and the carbon storage potential of your woodlot. Always use a Registered Professional Forester and Certified Ontario Tree Marker when harvesting to ensure sound stewardship of forest resources.

L. Watkins

3 Plant diverse tree species

Before harvest activities, plan for the regeneration and establishment of a diversity of native species by considering both current climate conditions and projected changes over the next 50 to 100 years. Monitor postharvest growth and be prepared to adjust cutting cycle according to how the stand responds rather than to a pre-set time interval.

MNRF

4 Improve forest health

Regularly remove unhealthy trees and reduce overcrowding in your woodlot. Diversify age and structure through stand improvement, thinning, harvesting, and planting. Consider stand edges – keeping out drying winds, conserving snow cover for spring moisture, and reducing the vulnerability of interior stems to windthrow. These actions will increase stand resilience and maintain the health of the remaining trees.

5 Consider new species

Consider adjusting species composition to match current and future site conditions. Establish and maintain more drought resistant species (e.g., oaks, hickories, and pines) when planting or harvesting in areas prone to drought. Additionally, species currently found at the southern edge of their range may persist better in cooler and moister microhabitats, for example on north-facing slopes or near water.

6 Manage pests and disease

Understand which insects, diseases and invasive species might be expected in your woodlot and be on the lookout for them with regular monitoring to enable early intervention and easier management. Monitor deer populations and take steps to control browsing pressure if regeneration is inhibited by high populations.

7 Stay informed

It is important to stay informed and attuned to developments in science and research and incentive programs that may affect you and your woodlot.

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