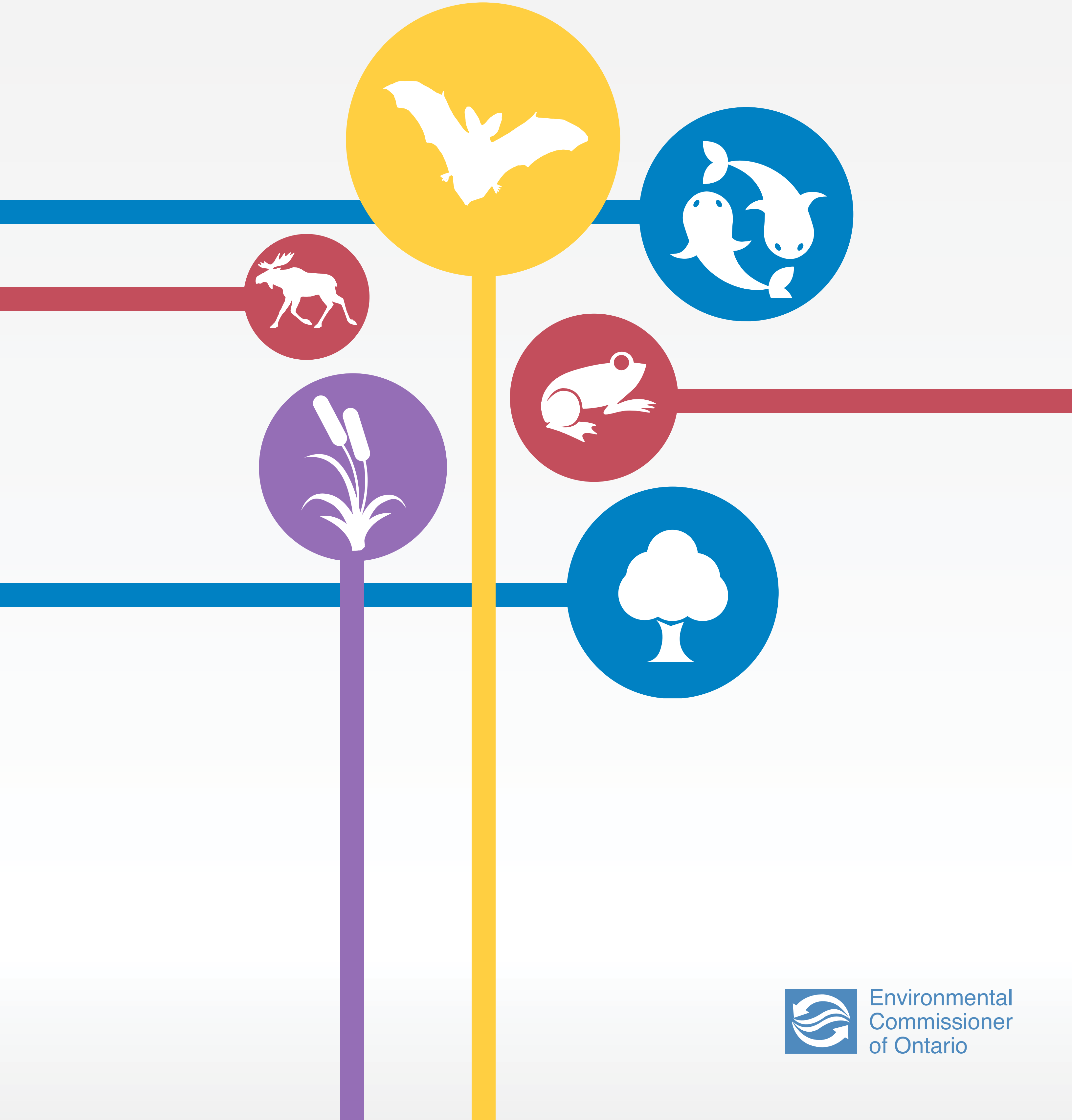
SMALL STEPS FORWARD

Environmental Protection Report 2015/2016

VOLUME TWO: BIODIVERSITY



Environmental
Commissioner
of Ontario

Select citations have been included to help readers understand where the information the ECO cites comes from and to assist them in investigating an issue further should they be interested. Citations may be provided for: quotes; statistics; data points; and obscure or controversial information. Endnotes for these facts are generally only included if the source is not otherwise made clear in the body of the text and if the information cannot be easily verified. Exhaustive references are not provided.

Table of Contents

CHAPTER 1
WALKING THE FIRE LINE: MANAGING AND USING FIRE IN ONTARIO'S NORTHERN FORESTS

Abstract

Ontario's forests need regular renewal by fire. But Ontario doesn't allow enough managed fire in our forests to provide ecological benefits and prevent future catastrophic fires. The Ministry of Natural Resources and Forestry is taking some steps in the right direction with a new policy that could allow more fires to be left to burn in northern Ontario to provide ecological benefits and reduce safety risks. Now the ministry needs to let more fires burn when and where they are needed and appropriate.

Executive Summary

What We Examined

The Ministry of Natural Resources and Forestry (MNRF) is responsible for managing wildland fire (forest fire) in all of Ontario except the developed south. For this report, we examined how well the MNRF is balancing protecting communities, infrastructure, standing timber allocated for harvest, and other human values with the need to allow fires to burn in northern forests that depend on them for their health and renewal. We looked at how the MNRF has managed forest fire historically, including the extent to which it has adopted proven fire management tactics, such as using prescribed fire and burning on Crown land and in provincial parks and conservation reserves, and implementing forest fire prevention and mitigation programs for northern Ontario communities. Finally, we analyzed how the MNRF's new *Wildland Fire Management Strategy* for Ontario might change forest fire management practices going forward.

Why We Did This Review

For much of the 20th century, forest fire management consisted of blanket suppression of all forest fires wherever and whenever possible. Scientists now know that forest fires are necessary for the ecological health of many forests, and that suppression can actually result in more catastrophic forest fires. Climate change will also increase the number of forest fires as a result of warming temperatures and changing precipitation patterns. Restoring regular fire cycles where human values, such as buildings, infrastructure and timber allocated for harvest are not threatened, and conducting prescribed burns where human values are at risk, could help make those fires less catastrophic.

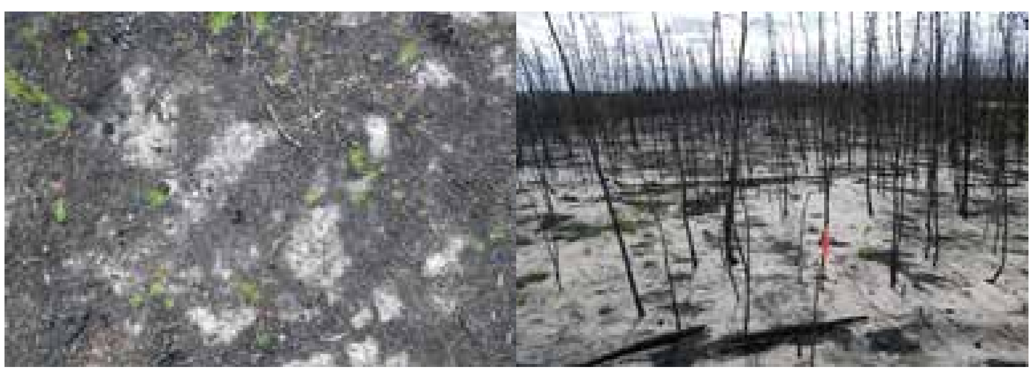
The new W*ildland Fire Management Strategy* contains broad direction that allows more fires to be left to burn in northern Ontario to provide ecological benefits – most notably in the "Area of the Undertaking" where commercial forestry takes place on Crown Land. However, the strategy also recommits the government to protecting values such as allocated timber. This review explores how the government has historically balanced these competing demands and how they could do so successfully going forward.

What We Concluded

We concluded that more forest fires must be allowed to burn in northern Ontario forests to prevent permanent ecological change and more catastrophic fires in the future. The MNRF's new strategy includes increased flexibility for fire-response decision making, which enables the ministry to assess each forest fire individually, regardless of its location, to determine the most appropriate response in order to safeguard human life, property and infrastructure, and maintain and enhance forest health. This is a good approach.

The MNRF should ensure that the fire-dependent forests it is responsible for managing, including those in the Area of the Undertaking and in protected areas, experience fire, either by letting forest fires burn or, where forest fire poses a risk to human values, by conducting prescribed burns (fires deliberately started and directed in a controlled manner to achieve predetermined outcomes). To this end, the MNRF must follow through on the new strategy's commitment to build and maintain a workforce capable of executing prescribed burns, and should also create a team of dedicated burn personnel. Conducting more prescribed burns could help the ministry protect human values while promoting natural and necessary ecological processes in the Area of the Undertaking, and in provincial parks and conservation reserves.

Northern communities must also increase their resistance and resilience to forest fire by preparing and implementing prevention and mitigation plans. The Ontario government, for its part, must ensure all communities near flammable forest become "FireSmart" by making prevention and mitigation plans mandatory, and providing adequate funding to communities to develop and implement them.



Jack pine seedlings regenerating as expected in an area burned by the Richardson fire (left), compared to little regeneration in an area where the fire was more severe (right). Source: Brad Pinno, Canadian Forest Service (Natural Resources Canada), reproduced with permission.

1.0 Introduction

The 2016 Fort McMurray forest fire caused the snap evacuation of more than 80,000 people and the destruction of 2,400 buildings. It cost an estimated $3.6 billion in insured damages, and spanned 500,000 hectares (ha) at its largest. Five years prior, another devastating fire destroyed over 400 homes in and around Slave Lake, Alberta. Ontario has also experienced catastrophic forest fires that took lives and destroyed communities, including the infamous Matheson fire of 1916 that killed 224 people, and the Mississagi fire of 1948 that burned over 3,000 square kilometres of forest. The Fort McMurray fire, like approximately half of all forest fires in Canada, was ignited by human action.

Scientists and policy makers agree that forest fires will increase in severity and frequency across Canada, including in northern Ontario, as a result of climate change. Governments must prepare for this challenge by continuing to manage wildland fire to protect communities, resources and infrastructure. But they must also enable fire to play its essential ecological role as the most important natural disturbance in the boreal forest.

Like floods, storms, and other major natural events, fire is a phenomenon that shapes the landscapes it touches. In forests, fire creates patches of different vegetation and different-aged trees, influencing the evolution of plants and animals. In an ecosystem that has evolved with periodic fire, it creates the conditions necessary for a new forest to rise from its own ashes; and periodic fire can actually prevent or lessen the risk of catastrophic wildfires by reducing forest fuels. But communities and infrastructure are not necessarily fire resilient, and mature trees that forest companies are planning to harvest take decades to grow back, making forest fire management a complex balancing act.

The Ministry of Natural Resources and Forestry (MNRF) is responsible for forest fire management and safety in all of Ontario except the developed south. The ministry must weigh the ecological need for fire with the risk it can pose to homes, businesses, infrastructure and timber that is allocated for harvest.

Forest fires will increase in severity and frequency across Canada, including in northern Ontario, as a result of climate change.

The MNRF released its new *Wildland Fire Management Strategy* in 2015. It sets out three main challenges the ministry faces in managing forest fire:

- population and industrial activity expansion in areas susceptible to fire, likely increasing the number of fires that require action to reduce their threat to people and infrastructure;
- more variable and extreme weather patterns due to climate change, which could cause longer and more severe fire seasons in some areas, and more fuel for forest fire because of drought-, wind-, disease- or insect-damaged forests; and
- limited program capacity for staff, equipment and funding, and increasing costs of firefighting.

Key Terms

Prescribed Fire: Forest fires that fire managers choose not to suppress, or choose to direct or modify, to provide ecological, safety or other benefits.

Prescribed Burn: Fires deliberately started by managers and directed in a controlled manner to achieve predetermined outcomes.

Ground Fire: Fires that burn deep within the forest floor. While these fires burn slowly, they can be very difficult to put out and can smoulder for long periods of time.

Surface Fire: Fires that burn organic material and litter along the top of the forest floor. These are the easiest fires to control.

Crown Fire: Intense fires that extend to the tree canopy, which often burn trees up their entire length.

Severe Fire: For the purposes of this article, we describe stronger, hotter fires that burn more organic matter on the forest floor and reach into the canopy as "severe."

Catastrophic Fire: Very large and hot fires that elude control and may destroy values like buildings and infrastructure and/or become a safety threat to communities. Such fires often occur during periods of drought or severe wind, and are more likely to occur in mature forests where fuel has built up.

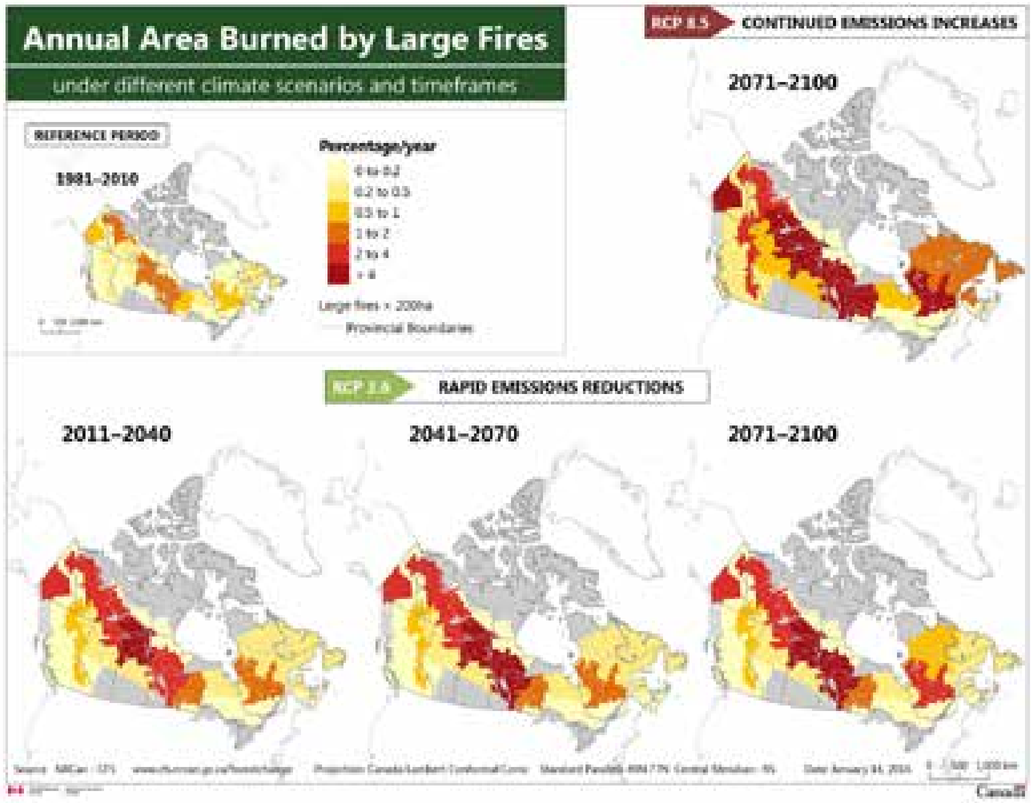


Figure 1. Historical (reference period 1981–2010) and projected annual area burned in Canada under two climate change model scenarios: Representative Concentration Pathway (RCP) 2.6 (2011–2041, 2041–2070, and 2071–2100), and RCP 8.5 (2071–2100). Source: Natural Resources Canada.

Scientists predict that climate change-driven forest fire and forest health issues, such as drought and insect-damage, will cause an increase in the number of large fires and the annual area burned across Canada. The annual area burned could increase three-fold[1] by 2100 (see Figure 1). Climate change is also expected to increase the length of the forest fire season, and this may already be happening – for example, the Fort McMurray fire occurred before Alberta's official forest fire season had even begun.

Given climate change-driven forest fire and forest health issues, current levels of fire protection are undesirable ecologically and may become impossible economically. Fire management is already the most expensive element of forest management in Canada, costing federal and provincial governments[2] close to $800 million annually, and expenditures have risen by about $120 million per decade since 1970. In this report, we highlight the importance of forest fire to the health of northern Ontario forests and examine how well the MNRF is balancing protecting communities, infrastructure, allocated timber and other human values with the need to allow forest fires to burn to both provide an ecological benefit and prevent more catastrophic fires in the future. We also look at how the MNRF has managed forest fire historically, including the extent to which it has adopted proven fire management tactics, such as using prescribed fire and prescribed burns (see sidebar for definitions) on Crown land and in protected areas, and implementing fire prevention and mitigation programs for northern Ontario communities. Finally, we analyze how the MNRF's new *Wildland Fire Management Strategy* for Ontario might change forest fire management practices going forward.

Current levels of fire protection are undesirable ecologically and may become impossible economically.

1.1 Fire's Influence on Ontario's Northern Forests

Fire is an essential ecological process in Ontario's boreal forest, which covers 50 per cent of the province. Tree and forest age and size, and the tree species in a forest and their relative proportions, affect the habitat the forest provides for wildlife. Fire creates a mosaic of differently sized and shaped patches of forest with different tree ages and species. If fire is eliminated from a forest, or the frequency of fire changes, the pattern and composition of forest patches will change, affecting wildlife that depend on that forest mosaic for habitat and food.

The boreal region is dominated by coniferous and mixed-wood forests, including species like black and white spruce, jack pine, balsam fir, tamarack, eastern white cedar, poplar and white birch. Most boreal tree species are individually adapted to severe fires that occur relatively frequently and cover large areas. For example, jack pine requires fire to regenerate – fire melts the resin that seals its cones, freeing the seeds inside. Boreal black spruce forests can experience a build-up of organic matter that doesn't decompose (a state called "paludification"), causing them to grow more slowly and become less productive. Severe fire burns this organic matter, but leaves many surviving seeds, ultimately helping seedlings establish and grow.

If there is no fire for long periods in a forest that evolved with more frequent fires, dead wood, brush and organic matter can build up and fuel larger and hotter fires. If a fire gets hot enough, it can burn up even tree seeds. The 2011 Richardson "megafire" in northern Alberta is one such

A jack pine cone opened by forest fire in Woodland Caribou Provincial Park. Source: Ontario Parks.

example. The Richardson fire burned hot and deep into the organic layer, and in some areas destroyed jack pine seeds instead of just releasing them from their cones. The result was much less jack pine regeneration than would be expected after a fire, and in some areas none at all.

Indigenous peoples across North America have used fire to manage the landscape for millennia, and fire is recognized as the key agent of change in the boreal forest, able to affect what plant and animal resources are available, and when.

The boreal forest is dominated by coniferous and mixed-wood forests (left). The Great Lakes-St. Lawrence forest is dominated by hardwood tree species like maple and white pine (right). Source: Larry Watkins.

The Great Lakes-St. Lawrence forest region, south of the boreal, covers about 20 per cent of Ontario (see Figure 2). This forest is dominated by hardwood species like maple, oak, yellow birch, red and white pine. The species in the Great Lakes-St. Lawrence forest are adapted to less severe surface fires that do not kill mature, thick-barked overstory trees like red and white pine, and red oak. Surface fires help these trees' offspring establish and thrive by opening gaps in the tree canopy, burning away the layer of organic material on the forest floor to expose mineral soil in which tree seeds can germinate, and controlling vegetation that competes with tree seedlings.

Ontario's Forest Regions

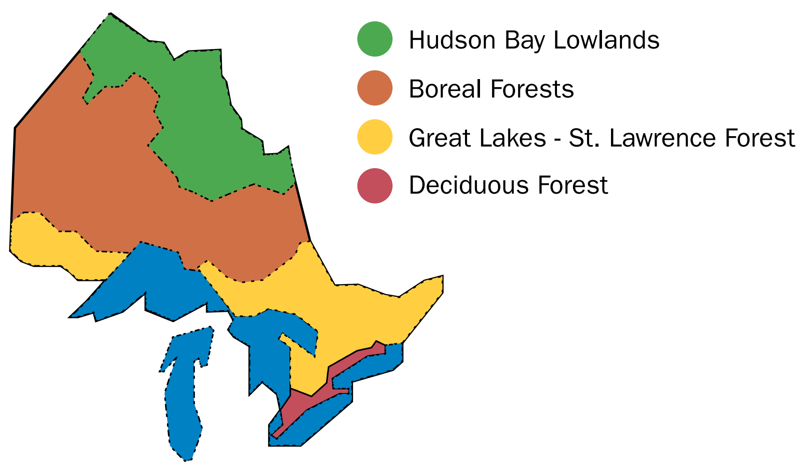


Figure 2. Forest Regions of Ontario. Source: MNRF.

The Boreal Forest

The boreal forest circles the Northern Hemisphere of the earth, south of the Arctic Circle. It encompasses forests in Canada, the United States (Alaska), Scandinavia, Russia, China, Kazakhstan, and Mongolia.

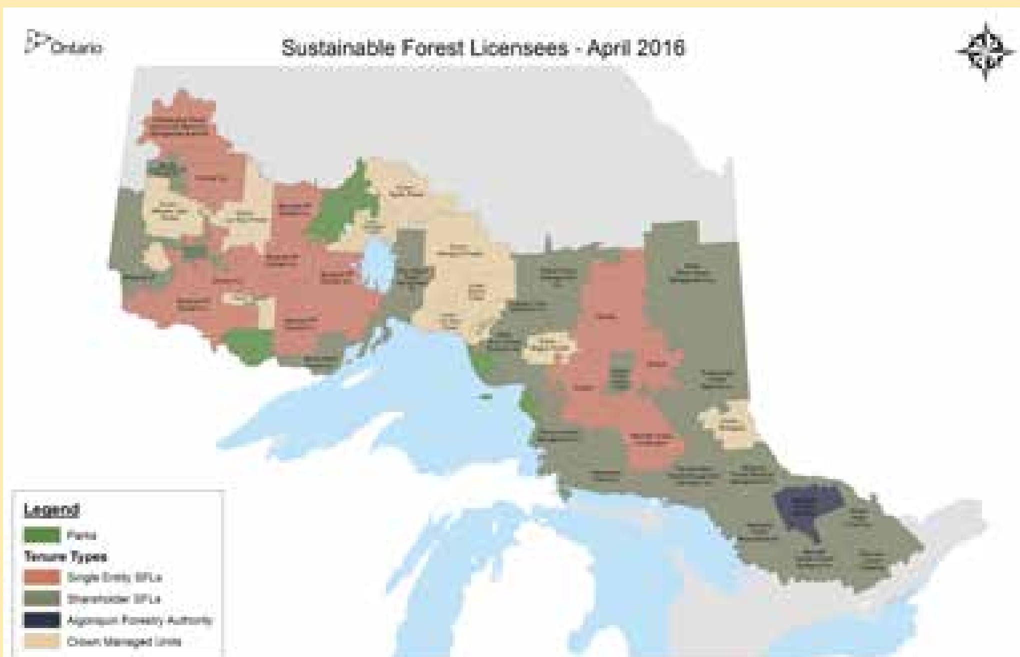
The Boreal Zone, which includes the boreal forest and treeless areas, covers 14 per cent of the earth's land area and contains 33 per cent of the earth's forested area. In North America, the Boreal Zone's northern boundary is generally the northern tree limit, and its southern boundary is generally the northern limit of temperate forests.

Canada contains 28 per cent of the global Boreal Zone – 552 million hectares – stretching from Newfoundland to British Columbia and the Yukon. It is home to 150 bird species – about half of all bird species in Canada – and many plants, animals, insects and fungi, including the woodland caribou, which is a species at risk in Ontario and under the federal *Species at Risk Act*.

The Boreal Zone in North America. Source: Canadian Forest Service (Natural Resources Canada), reproduced with permission.

Ontario's Crown Land Forests

- 66 per cent of Ontario is forested – Ontario contains 17 per cent of Canada's forests and 2 per cent of the world's forests
- 85 per cent of Ontario is Crown land – owned by the province
- 44 per cent of Ontario's Crown land is the "Area of the Undertaking" where commercial forest management takes place
- Crown land covers 95 per cent of northern Ontario
- 10 per cent of Ontario is provincial protected areas (provincial parks, conservation reserves, dedicated protected areas, and wilderness areas)



Sustainable Forest Licensees in the Area of the Undertaking where commercial forest management takes place on Crown land. Source: MNRF.

1.2 History of Forest Fire Management

1.2.1 The Legacy of Aggressive Fire Suppression

Forest fire management efforts by the Ontario government date back to the late 1800s; the first forest fire prevention legislation was introduced in 1878. For over a century, the goal of forest fire management in Ontario was to suppress all fires in most parts of the province, which artificially prolonged fire cycles.[3]

Since the 1950s, when Ontario started to use aerial water bombing to fight wildfires, fire suppression and prevention efforts have been very successful, resulting in fewer large-scale fires. Comprehensive historical data on Ontario's forest fires is not available; however, data from the Daily Fire Operation Support System, which was started in 1994, shows some telling trends. For example, the annual number of fires larger than 40 ha declined between 1998 and 2014 (see Figure 3), and the area disturbed by fires greater than 40 ha is shown on Figure 4. A century of forest fire suppression throughout Ontario has resulted in a disproportionately large amount of older forests with more shade-tolerant species (such as balsam fir, which is susceptible to the destructive budworm), as well as more insect damage and more woody debris. Suppression has also adversely affected the native wildlife that are part of Ontario's fire-dependent forest ecosystems, and increased the risk of more severe forest fires.

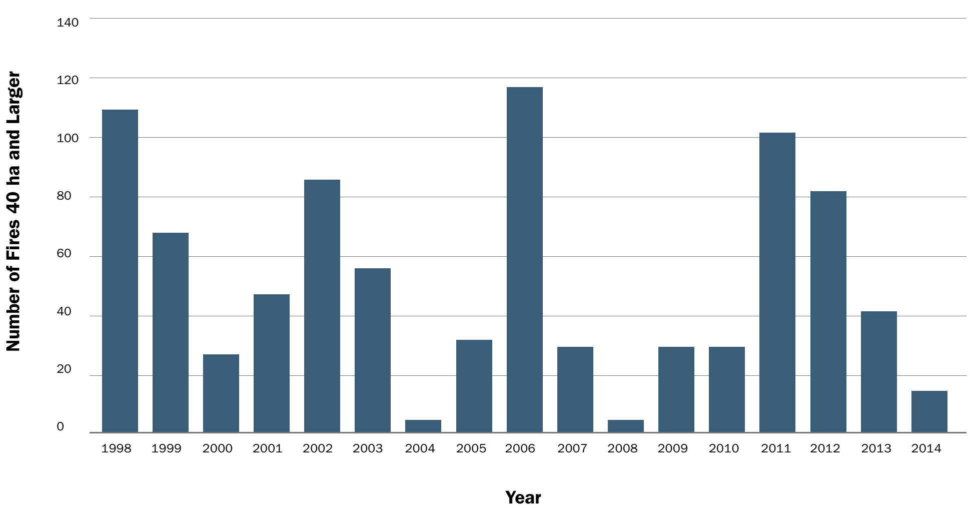


Figure 3. Annual Number of Forest Fires 40 ha and larger 1998 to 2014. Source: Data from MNRF.

Walking the Fire Line: Managing and Using Fire in Ontario's Northern Forests

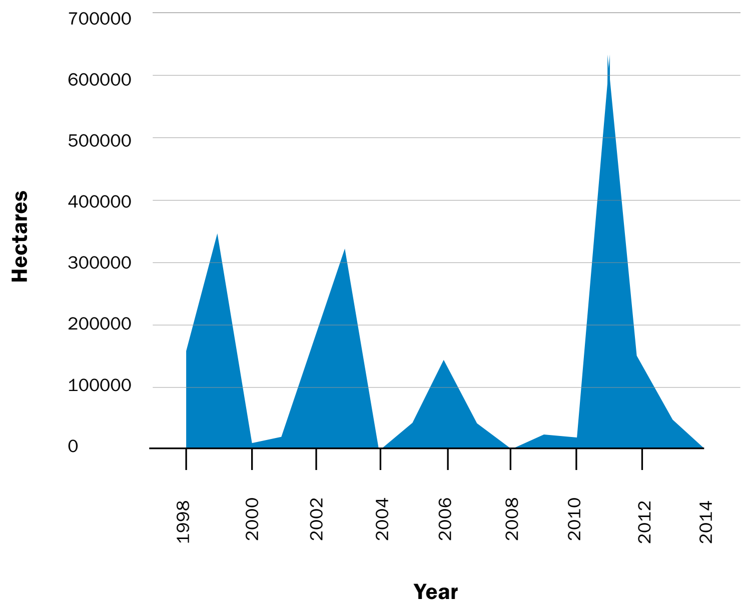


Figure 4. Recorded Area Disturbed by Forest Fire, 1998 – 2014. Source: Data from MNRF.

In response to the 2013 forest fires in Slave Lake, Alberta, a report by a review committee submitted to the Alberta Minister of Environment and Sustainable Resource Development warned that there was an increased risk of catastrophic fires in Alberta's boreal forest, in part because a large proportion of forests are mature and over-mature as a result of fire suppression. Similarly, mature forests predominate in parts of the Area of the Undertaking where commercial forestry takes place on Crown land in Ontario, making it more susceptible to large and potentially catastrophic fires. According to the MNRF's 2011 report, *The Forest Resources of Ontario*, over 60 per cent of the Area of the Undertaking is classified as mature or late-successional forest (Figure 5).

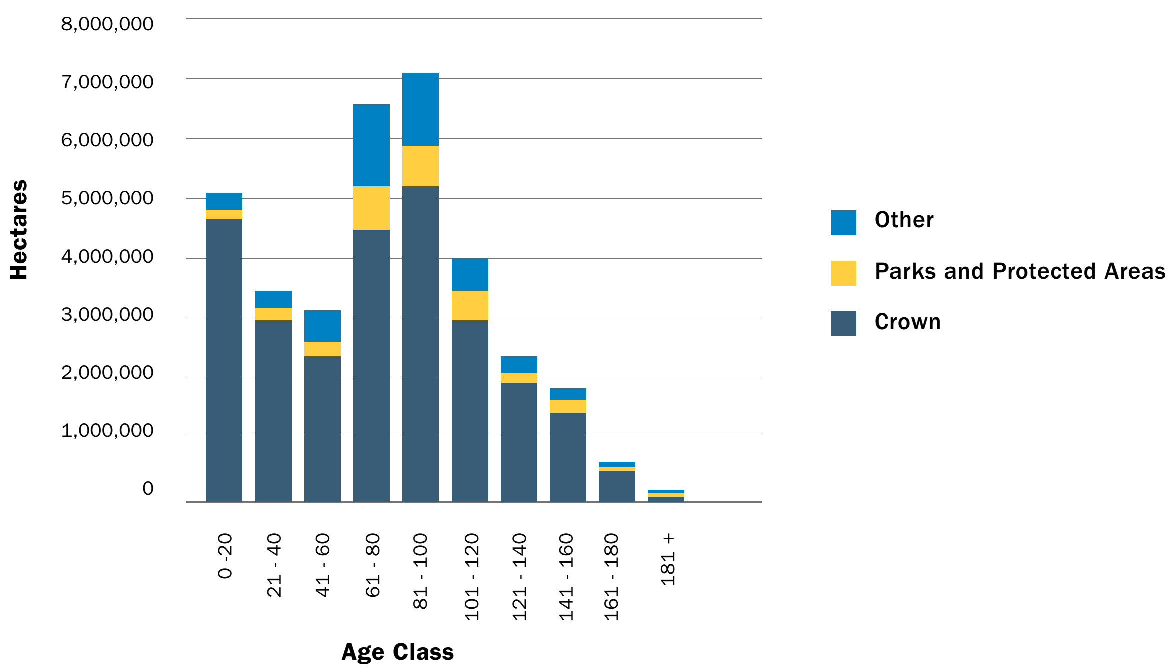


Figure 5. Total Forest Area by Age Class (2011). Source: MNRF.

1.2.2 1980–2014: Moving Away From Automatic Suppression

Since 1980, the MNRF has been slowly shifting its forest fire management policies away from automatic suppression (especially in the Far North), and towards suppressing fires only to protect threatened human values, which include ecological, social and economic resources such as buildings, infrastructure, cultural heritage sites, and allocated timber.

The MNRF established three forest fire management objectives in 1980 that it still pursues today:

- to prevent loss of life and injury and minimize social disruption;
- to minimize the effect of fire on public works, private property and natural resources; and
- to use fire's natural benefits to achieve other objectives for land and resource management.

However, during the 1980s and early 1990s, the MNRF and commercial forest managers used prescribed burns much more often than during the last 20 years. The ministry set and pursued targets for area burned as a result of

Figure 6. Map of the former fire management zones delineated by the 2004 *Forest Fire Management Strategy for Ontario*. Source: MNRF.

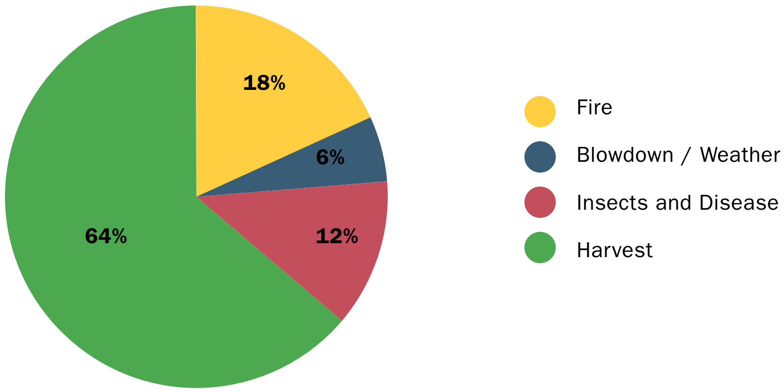


Figure 7. Percent wood volume lost to disturbance or harvest in the Area of the Undertaking 2006/2007–2012/2013. Source: Data from MNRF.

prescribed fire and burns, and covered most of the costs. Prescribed burns in the Area of the Undertaking became extremely rare after the MNRF stopped covering those costs in the mid-1990s.

In 2004, the MNRF released its *Forest Fire Management Strategy for Ontario*, which divided Ontario into six separate fire management zones (Figure 6) and prescribed different fire responses for each zone. The strategy also included quantitative targets for fire response and area burned for each zone. For the boreal zone (which covered most of the Area of the Undertaking), where fire is an essential ecological process, these targets included "area burned for ecosystem renewal" (achieved by allowing forest fires to burn in areas that did not impact wood supply to forestry companies) and "area burned for hazard reduction" (achieved by letting fires burn in areas of forest that were dead or dying from insect or wind damage).

The inclusion of such targets in official policy was a positive shift that publicly acknowledged the need for fire in Ontario's northern forests. However the targets the MNRF set were extremely low. When the ECO reviewed the 2004 strategy in our 2004/2005 report, we expressed several concerns with the ministry's approach to wildfire management, including that the MNRF was prioritizing protecting short-term wood supply above the need to let fires burn in order to renew the forest and reduce fuel loads.

Since 2005, the ministry has suppressed most forest fires that threatened people, communities, and/or merchantable timber. No lives were lost as a result of fires under the MNRF's jurisdiction, and a small volume of merchantable wood from commercial forests on Crown land has been lost to fire compared to the volume of wood harvested (Figure 7). More forest area was burned by fires that the MNRF strategically allowed to burn to provide an ecological benefit than in fires it fought to suppress, further demonstrating the ministry's fire suppression success over the past decade.

The MNRF's Aviation, Forest Fire and Emergency Services Branch – which is responsible for developing and implementing fire policy, as well as fighting fires on the ground – recognizes that fires that burn significant swaths of fire-dependent forest without threatening values are positive. The branch regards reporting years with a high ecosystem renewal area burned metric (e.g., 2011 and 2012) as significant achievements for the fire management program, because they show that some headway is being made in making up for the historically low area-burned metrics over the last few decades. Although the vast majority of forest fires that occurred in Ontario between 2005 and 2014 received a "full response" from fire services (Figure 8), meaning the ministry deployed resources to the fire with the goal of gaining control by noon the day after it was reported, the MNRF has gradually enabled more area to burn to provide ecological benefits.

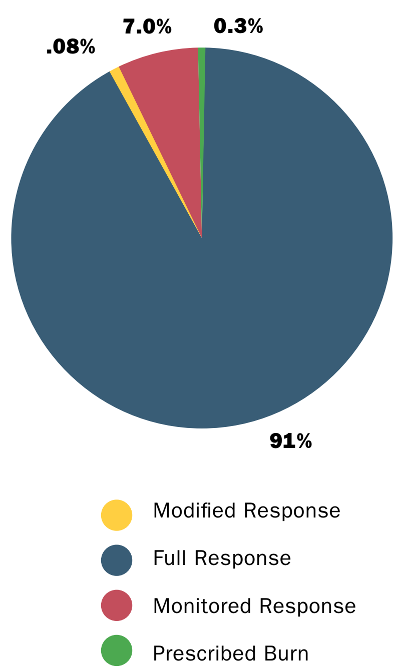


Figure 8. Percentages of fires in Ontario by response-type 2005-2014. Source: Data from MNRF.

Figure 9 shows that since 2010, progressively more forest in Ontario has been burned in forest fires that were deliberately allowed to proceed to enhance ecosystem health ("Ecosystem Renewal Area Burned"), and progressively less forest has burned in forest fires that threatened values, and which the MNRF initially tried to suppress ("Forest Depletion Area Burned"). This is an encouraging trend, but the amount of area burned is likely still far below what it would be without human intervention, and the lack of fire is changing our northern forests and increasing the risk of more severe fires.

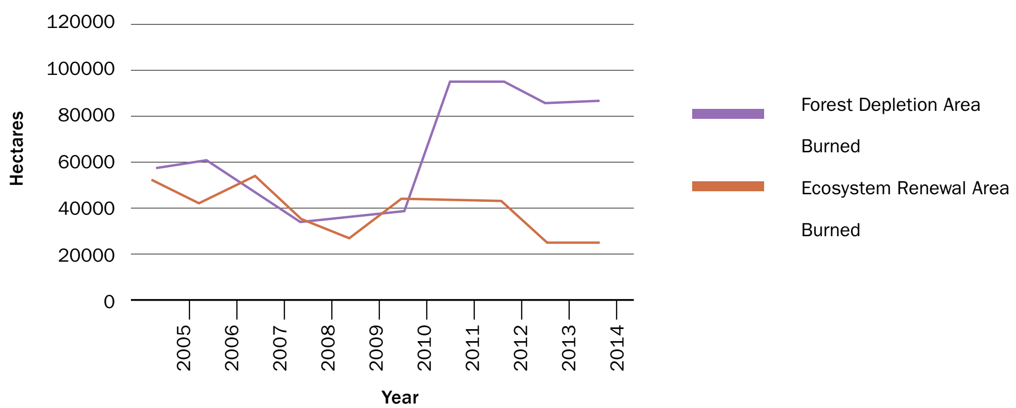


Figure 9. Rolling 10-year average of the number of hectares burned by burn category. Source: Data from MNRF.

1.3 Prescribed Fire and Burning in Ontario

The ecological role played by fire in Ontario's forests cannot be duplicated by any other natural process or human activity. Forestry practices strive to emulate fire in forests where it would otherwise be the dominant natural disturbance, but in the absence of naturally occurring forest fire, only prescribed burns – fire applied deliberately in a controlled manner to achieve predetermined outcomes – produce the effects necessary to ensure sustainability of a fire-dependent ecosystem.

Prescribed burning is not the only way to regrow fire-dependent tree species – mechanical scarification (scraping) to expose mineral soil, herbicide application to control competition, and tree planting and seeding are common silvicultural treatments used to regenerate fire-dependent forests. But a prescribed burn produces forest conditions closest to those created by naturally occurring fire, and has other effects that mechanical and herbicide treatments do not, including changing the pH and chemical composition of the soil. In forests where the amount of fuel has built up to dangerous levels,[4] prescribed burning can reduce the risk of a disastrous and uncontrollable fire if there's a lightning strike or an accidental ignition. Prescribed burns may also increase tree growth rate and the density of young trees.

Thus, forest managers generally use prescribed burns for two purposes: to reduce the amount of fuel in a forest stand in order to lessen the risk of a more severe fire; and to enable the regrowth of fire-dependent tree species. In the 1970s and 1980s, the MNRF used prescribed burns to prepare logged sites for regeneration, but the practice has since become uncommon for a number of rea-

A prescribed burn in Pukaskwa National Park. Source: Parks Canada. Copyright Parks Canada.

sons we discuss in the next section. Between 1998 and 2014, only 8,000 ha of forest were burned in large-scale prescribed burns – less than one per cent of the total area burned by large fires[5] over the same period (Figure 10).

In the U.S., prescribed fire and burning has been used for years in a variety of forest ecosystems to maintain or restore ecological conditions, reduce fuel and regenerate fire dependent tree species. In 2011, 3.1 million ha of prescribed burns took place in American forests.

In Ontario, the Anishinaabeg have traditionally applied fire to wetlands in early spring to burn dead material from the previous spring and improve productivity and habitat for animals they hunt, including muskrat and waterfowl. They also use burns to keep trails open and protect dwelling and camping sites from wildfire by eliminating dead combustible material.

In recent decades, southern Ontario land managers including stewardship groups, provincial parks and municipalities have worked with the MNRF to apply low-complexity[6] prescribed burns to restore fire-dependent ecosystems in the south, which include oak savannahs and tallgrass prairies. Over 40 of these burns were completed in southern Ontario between 2011 and 2015. By contrast, in the vast fire-dependent forests of northern Ontario, less than 20 prescribed burns have occurred in the same time period.[7] Burns in northern Ontario accounted for less than one per cent of the total hectares burned in Ontario between 2005 and 2014, despite prescribed burning's proven benefits for timber regeneration, catastrophic fire prevention and forest health. Between 1998 and 2014, land managers including forestry companies and northern protected areas managers planned to conduct prescribed burns on 34,738 ha of land (and the ministry approved those plans), but only about 24 per cent of those planned and approved burns actually took place. Failing to get the right weather at the right time often prevents a prescribed burn from taking place, but in some cases no MNRF staff were available, indicating there may be a lack of dedicated capacity within the ministry to carry out the number of prescribed burns needed.

A prescribed burn produces forest conditions closest to those created by naturally occurring fire.

There may be a lack of dedicated capacity within the ministry to carry out the number of prescribed burns needed.

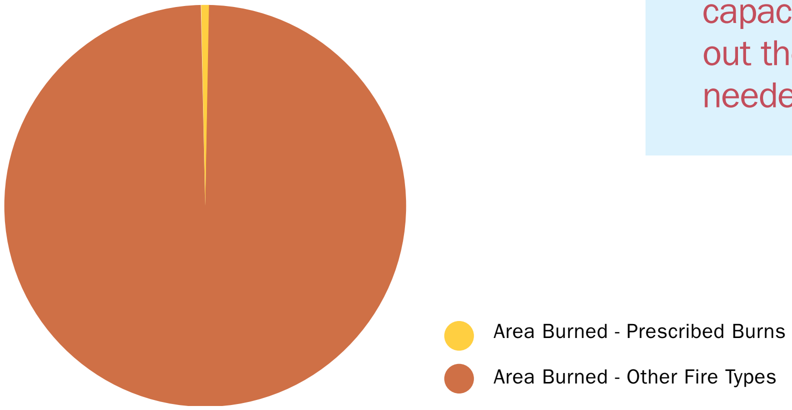


Figure 10. Proportion of area burned in large-scale prescribed burns (>40 ha) of total area burned by large fires, 1998-2014. Source: Data from MNRF.

1.3.1 Barriers to Prescribed Fire and Burning Within Commercial Forestry

The forest industry generally opposes letting any forest fires, including prescribed fires, burn in the Area of the Undertaking where commercial forestry takes place on Crown land, citing potential losses in wood supply. Historically, the MNRF defaulted to deploying a full response to try to suppress any and all fires that started in the Area of the Undertaking. The new *Wildland Fire Management Strategy* for Ontario, discussed later in this report, creates an opening for the ministry to decide to let some naturally occurring forest fires burn in the Area of the Undertaking.

There are several real but surmountable barriers that currently prevent forest management companies, who manage 44 per cent of Ontario's Crown forests (most of it fire-dependent) from conducting high-complexity prescribed burns to reduce the risk of severe forest fire or regenerate fire-dependent tree species. One barrier is that high-complexity prescribed burns on Crown land must be approved by the MNRF, and thus planned and administered by qualified experts. Forestry companies do not generally have this expertise in-house and have to contract ministry staff to help plan and conduct the burns.

A second barrier is uncertainty. Because burn proponents rely on the availability of ministry staff to execute a planned burn, they are at the mercy of the fire season. The MNRF's first priority is to fight wildland fires that are unwanted and threaten values. If staff aren't available during the window where conditions are optimal to conduct a planned burn, the burn won't happen. The same is true for high-complexity burns planned to take place in protected areas – all are reliant on the MNRF's availability and capacity.

A third barrier to prescribed burning is its expense. Before 1996, the MNRF partnered with forestry companies operating on Crown land to plan and administer prescribed burns, with the ministry (and ultimately the public) absorbing most of the costs. But since 1996 the ministry has required all burn proponents to submit detailed plans to the Aviation, Forest Fire and Emergency Services branch, and has charged proponents – including Ontario Parks, even though they are part of the same ministry – for services required from the branch. For example, costs to a proponent for burning in the Great Lakes-St. Lawrence Forest that could have been about $75/ha before 1996 have soared to anywhere from $450 to $900/ha. Mechanical or herbicide treatments are simply cheaper, according to foresters.

Some forestry companies are including prescribed burning in their forest management plans – the companies that manage the Hearst and Whitefeather forests are two examples. But so far they have been largely unable to find a way to actually execute burns. For example, the most recent independent forest audits available of operations in the Algoma, Hearst and Bancroft forests note that prescribed burns had been planned in these forests, but, with one exception, were not executed. The audits state that it is difficult to successfully conduct a high-complexity prescribed burn because of the barriers identified above, and single out the high cost of burning as especially prohibitive. The company managing the Hearst forest did complete one successful high-complexity prescribed burn using the MNRF's services. Their 2012 audit stated that the burn was feasible because it was considered beneficial for future caribou habitat and the company was therefore able to receive government funding through the MNRF's Species at Risk Stewardship Fund.

There are two other significant and more long-standing barriers to conducting prescribed burns on Crown land: the risk of a burn escaping its planned boundaries and threatening standing timber, buildings, infrastructure or communities; and the unpredictability of weather and moisture conditions, which have to be perfect in order to execute a burn safely and successfully. These barriers can be lowered by locating burns away from values and continuing to update protocols and guidelines to reflect the lessons learned from past burns in Ontario and elsewhere.

The current prescribed burn policies, protocols and training requirements were developed primarily as a result of a 1970s prescribed burn near Nakina that escaped control and took the lives of several students. The legacy of this tragedy has arguably continued to influence the MNRF's decisions about prescribed fire and burning in the three decades since, and has resulted in a very low tolerance for risk, and ultimately, less burning. Since then, no lives have been lost, and minimal property has been damaged or destroyed. In fact, Aviation, Forest Fire and Emergency Services staff have pointed out in their annual reports that more ecosystem benefits and fire risk reduction could have been achieved if MNRF district staff had simply considered using managed fire.

1.3.2 Prescribed Fire and Burning in Ontario Parks

The first priority in the planning and management of Ontario's protected areas (i.e., provincial parks and conservation areas) is to maintain ecological integrity and restore it when possible.[8] The majority of the ecosystems represented in northern Ontario's protected areas are adapted to forest fire in some form, and require its presence if their assemblage of species and processes are to be maintained. The ministry's *Fire Management Policy for Provincial Parks and Conservation Reserves* encourages the use of fire to maintain and restore ecological integrity. According to this policy, suppressing forest fire in parks with fire-dependent ecosystems prevents those parks from representing native natural heritage in all its diversity and complexity. However, in areas where human safety and property is at risk, such as campgrounds, cultural or natural heritage features, or areas near private property, fires are often suppressed. In these areas, prescribed burning can emulate a naturally occurring forest fire's effects, according to forest and fire science experts.

Jack Pine regeneration in Woodland Caribou Provincial Park after the spring 2016 forest fire. Source: Ontario Parks.

Protected area managers are required to consider the role of forest fire during management planning, incorporate fire management direction in relevant planning documents, and prepare fire management plans where appropriate. Since 2011, more forest fire response plans that identify areas where fires should be allowed to burn (i.e., that sanction and plan for prescribed fire) have resulted in more park land burning to produce ecological benefits. About 94,000 ha of park land burned between 2011 and 2014.

For example, Woodland Caribou Signature Site's updated Vegetation Management Plan changed the fire response direction should forest fire occur in the protected area. The old direction to deploy a full suppression response to all fires was changed to enable a monitored or modified response to lightning-caused fires that occur in areas where human life, property and values (including timber resources in close proximity to park boundaries and caribou habitat) are not at risk. As a result, a forest fire was allowed to burn 74,300 ha of boreal forest inside the park in spring 2016.

Prescribed burns, however, continue to be virtually unheard of in northern Ontario protected areas, with only three executed since 2005 – two 6 ha burns on islands in a conservation reserve, and one 25 ha burn for fuel reduction in a blowdown. Protected area managers face the same barriers to conducting high-complexity prescribed burns as forestry companies operating in the Area of the Undertaking: they are dependent on Aviation, Forest Fire and Emergency Services staff expertise and capacity, and that expertise and capacity must be paid for. By contrast, the federal government's Parks Canada Fire Program uses prescribed fire and burning regularly, including in Pukaskwa National Park on the north shore of Lake Superior. Directed by a National Fire Management Strategy, Parks Canada has built a dedicated fire management staff capable of executing these burns. In Pukaskwa, 650 ha were burned in prescribed burns between 2004 and 2008, and 425 ha were burned in a single prescribed burn in May 2014. Thousand Islands National Park in southeastern Ontario is using prescribed burns to regenerate pitch pine, a rare tree that isn't found anywhere else in the province, and whose seedlings establish best after fire.

Willow Lake prescribed burn in Pukaskwa National Park, 2014. Source: Parks Canada. Copyright Parks Canada.

1.4 Ontario's New *Wildland Fire Management Strategy*

In 2014, the MNRF approved a new *Wildland Fire Management Strategy* for Ontario to replace the 2004 strategy. The new strategy contains five objectives:

- *Prevent*: the threat to people and values is diminished by reducing the number of human-caused forest fires.
- *Mitigate*: property owners and land managers take action to mitigate the undesirable impacts of forest fires on their property or other values.
- *Respond*: all fires are assessed and receive an appropriate response.
- *Understand*: the people of Ontario are aware of and support the ecological role of fire.
- *Apply*: forest fires and prescribed burns are safely and effectively used to reduce fire hazards and meet ecological and resource management objectives.

The MNRF states that the goals, objectives and actions outlined in the new strategy "strive to balance the needs for public safety and economic protection, the ecological role of wildland fire and the capacity of the fire management program within the MNRF."

More Flexibility to Determine Fire Response

The new strategy allows MNRF staff to make an on-the-spot decision to suppress a forest fire or let it burn rather than locking it into a predetermined response based on a fire's geographic area. For example, instead of spending money and time deploying aircraft and crews and placing those crews in high-risk situations to suppress forest fires that are not threatening values, the MNRF can now leave fires to burn to natural breaks (e.g., a lake or treeless area). The decision whether or not to fully suppress a fire is based on the predicted behaviour of the fire, its potential effects on people, property and values, and how much it will cost to fight. The new strategy also states that fire will be used to reduce fuel loads and create natural breaks to halt or redirect future fires to areas with few values.

The new strategy allows MNRF staff to make an on-the-spot decision to suppress a forest fire or let it burn.

In order to make quick decisions on what fire response to deploy, fire managers need to have accurate information about the locations and relative priority of values, as well as the locations that present opportunities to allow forest fire to burn to provide an ecological benefit. The MNRF continues to co-ordinate the collection of values information and locations with municipalities, forestry companies that harvest Crown land, and private landowners. The ministry is working to improve this collection and advance information systems to determine where opportunities exist to enable forest fires to burn to produce an ecological benefit. It will be important to maintain a centralized repository for such information to keep it current.

The MNRF Can Let Fires Burn in Commercial Forests

The new strategy theoretically enables the MNRF to allow more fires to burn to benefit forest ecosystems anywhere human lives and values are not threatened, including in commercial forests in the Area of the Undertaking and in protected areas. However, standing timber allocated to a forestry company for harvest has been and likely will continue to be defined as a value that needs to be protected. Throughout consultations on the new strategy and in comments submitted to the Environmental Registry, the forest industry's position has been that in order to be successful, forestry companies need to be able to count on the MNRF to protect wood supply by suppressing all fires in commercial forests.

Where the 2004 strategy dictated full suppression in commercial boreal forests, the new strategy frees the ministry to let fires burn as appropriate.

However, where the 2004 strategy dictated full suppression in commercial boreal forests, the new strategy frees the ministry to let fires burn as appropriate. Whether this actually occurs will depend on if the government is serious enough about redressing the lack of fire in the boreal that they are willing to displease some members of the commercial forest industry.

The MNRF Will Develop a Prescribed Burning Workforce

The ministry states it will work with landowners, First Nations communities, municipalities and other stakeholders to "identify opportunities to use wildland [forest] fire." According to the strategy's actions, the MNRF will develop and maintain a knowledgeable workforce of individuals within the Aviation, Forest Fire and Emergency Services branch; Ontario Parks; and partnering organizations, which is capable of managing forest fire for ecological benefits and of delivering prescribed burns. This marks a potential return to dedicating more resources to enabling the use of prescribed fire and burning.

The strategy also lists tactics that the ministry intends to use to teach the public that prescribed fire and burning are necessary to prevent more severe fires and maintain ecosystem health.

Barriers to Prescribed Burning in Commercial Forests Not Addressed

The strategy does not address the barriers to using prescribed burns that forest management companies face, including substantial uncertainty of project completion and a high cost. Unless these barriers are addressed or unless burning is mandated by the MNRF in forest management and/or fire management policy, high-complexity prescribed burns will likely continue to be rare in Ontario's fire-dependent Crown forests.[9] It is encouraging, however, that the ministry will be reporting on the "utilization of the beneficial role of fire" as part of a five-year performance measurement, and will continue to report annually on the use of prescribed burns. This should ensure that any efforts to increase the use of prescribed fire and burning for ecosystem benefits can be assessed.

More Support for FireSmart Program for Community Fire Prevention and Mitigation

The new strategy lays out actions aimed at increasing fire prevention and mitigation efforts in communities located at the wildland-urban interface. These actions include educating communities and collaborating with northern industries such as forestry and mining to reduce forest fire risk.

In 2004, the MNRF and the Provincial Office of the Fire Marshal and Emergency Management adopted the FireSmart program, originally conceptualized by a non-profit organization called Partners in Protection, which was formed in Alberta and made up of members representing all levels of government as well as private business and industry. The program has since developed into a national initiative – FireSmart Canada – which is supported by membership across the country.

FireSmart provides a framework and guidance for communities, private landowners and business owners to help them develop

Figure 11. Illustration of a FireSmart Protection Plan for a private home from The Homeowners FireSmart Manual. Source: Ontario Government and Partners in Protection.

and implement fire prevention and mitigation plans. Such plans could include actions like:

- reducing forest fuels surrounding a community, new developments or buildings, and creating buffer areas kept free of trees and ground fuels;
- prohibiting development in areas with high forest fire risk;
- creating by-laws that require homeowners to thin forest cover on their properties and remove flammable fuels, vegetation and forest debris from the areas around their properties;
- adopting protocols for new buildings and retrofits that incorporate the use of fire-resilient building materials;
- and providing incentives to homeowners for using fire-resistant building materials and practices (e.g., fire-resistant roofing).

The MNRF is encouraging the implementation of the FireSmart program in Ontario communities and supporting it with training, facilitation, guidance documents (see Figure 11), and by reviewing plans. However, the program is not mandatory. To date, no Ontario municipality has voluntarily developed a fire preparedness plan, or become recognized as a FireSmart community.

By contrast, communities in western Canada have been participating in FireSmart for a number of years. Some municipalities such as Jasper, Alberta, have implemented many of the program's suggested actions, including creating fire breaks of sparsely treed parkland around vulnerable communities. The Government of British Columbia has spent approximately $78 million helping local governments and First Nations develop Community Wildfire Protection Plans and reduce wildfire risks around their communities by managing fuels.

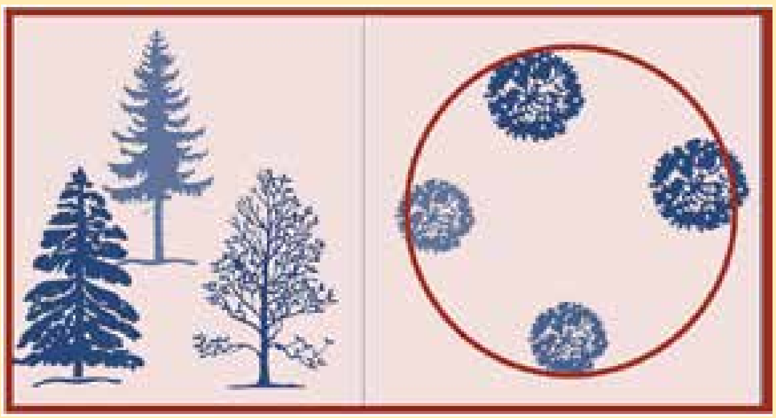
The 2015 strategy renews the MNRF's commitment to the FireSmart program, and the government is now providing some financial support to communities who wish to participate. The MNRF has budgeted $60,000 per year for a pilot project to provide up to $15,000 over two years to each community that successfully applies for the grant. The money is disbursed in installments after communities complete the following: 1) an approved Project Plan; 2) hazard forest mapping; and 3) a draft or completed Community Wildland Fire Protection Plan. The annual budget would allow eight communities to be issued grants over a two-year period, and MNRF staff hope to increase funding based on a successful pilot. There are currently five northern Ontario communities signed up to participate, with potentially two more on the horizon.

The implementation of FireSmart by communities inside the fire regions could theoretically free the MNRF's resources from protecting communities with unknown fire resilience to directing forest fires productively without fear that communities are at risk. The strategy states that "in the best case, wildland fire direction will be included in other planning activities such as land use or forest management plans," but the responsibility to develop those plans lies with communities and the forestry industry.

FireSmart Actions for Homeowners

Manage vegetation on your property

- Manage or remove fuels such as trees, shrubs, dead grass, and woodpiles from the first 10 metres of space around your home.
- Reduce fuel sources in the area 10 to 30 metres from your home by thinning trees (the crowns of individual trees should not touch), removing dead woody debris and thick shrubbery, and pruning to avoid “ladder fuels” – trees with low branches or shrubs beneath trees that could allow a fire to climb into the tree crowns.
- Consider reducing the number of evergreen trees on your property.
- Thin or remove trees and shrubs that make up the understory of the area 30 metres from your home, retain deciduous trees, and manage the canopy to reduce the potential for a crown fire.



Thin trees so they are widely spaced and the crowns do not touch or overlap.
Source: *The Homeowners FireSmart Manual*. Ontario Government and Partners in Protection.

Choose fire-resistant building materials

- Use fire-resistant roofing materials such as metal, asphalt or treated shakes. Shingles and untreated shakes can easily ignite from sparks or embers.
- Use fire-resistant materials for the exterior of your home such as stucco, metal, brick and concrete. Logs and timbers are less fire resistant, and wood and vinyl are the least fire resistant.
- Use tempered glass for your doors and windows for the best fire resistance. Double or thermal pane windows offer some protection, but single pane glass provides virtually none.
- Close in your eaves, screen your soffits and close in or screen decks and balconies – keeping these areas open increases the vulnerability of your home to wildfire.

For more information visit www.firesmartcanada.ca

1.5 Conclusion and ECO Comment

The health of Ontario's northern forests requires forest fire. Periodic forest fire is essential for inherently fire-dependent ecosystems, which include wildlife that depend on the unique forest structure and composition that fire creates. Without fire, forest fuels can build up, increasing the risk of catastrophic forest fires like the one that engulfed Fort McMurray. Climate change will bring about more forest fires in Ontario, but restoring regular fire cycles where values are not threatened and conducting prescribed burns where human safety or other values are at risk could help make those fires less severe.

Forest fire staff have been calling for a greater commitment to managing forest fire for ecosystem renewal and fire risk reduction for years.

The MNRF's new *Wildland Fire Management Strategy* for Ontario provides sound overall direction that enables the ministry to let more fires burn to produce ecological benefits in the boreal forest, setting the stage for the return of more natural fire cycles. The new strategy also promotes the use of prescribed fire and prescribed burning. The increased flexibility for forest fire-response decision making built into the strategy enables ministry staff to assess each fire individually, regardless of its location, to determine the most appropriate response in order to safeguard human life, property and infrastructure, and maintain and enhance forest health. This is a good approach. Indeed, forest fire staff have been calling for a greater commitment to managing forest fire for ecosystem renewal and fire risk reduction for years. Not every fire can be suppressed, nor should every fire be suppressed. Now that the government has cemented this flexibility in the new strategy, MNRF staff should be free to let more forest fires burn in forests that require them – including within the Area of the Undertaking where commercial forestry takes place on Crown land, and in protected areas.

The ministry's Aviation, Forest Fire and Emergency Services branch does an excellent job of protecting communities and commercial forests from unwanted fire, consistently suppressing forest fires targeted for full response. Communities, business owners, and the forest industry should be reassured by its track record. But in the face of increasing fire risk due to climate change, communities must prepare and implement prevention and mitigation plans guided by the FireSmart program's principles and tactics.

So far, there are no certified FireSmart communities in Ontario. Although the government encourages and supports the adoption of the program and the completion of fire prevention and mitigation plans, they are not mandatory. A grant program is a good first step – many smaller northern communities will require financial support to develop and implement community forest fire protection plans. **The ECO recommends that the Ontario government ensure all communities near flammable forest become "FireSmart" by making prevention and mitigation plans mandatory, and providing adequate funding to communities to develop and implement them.**

Prescribed fire and burning are two of the most effective tools for lowering the risk of more severe fires. Prescribed burning is also often the most effective treatment for both ensuring regeneration to desired and/or historical fire-dependent species such as pine, spruce and oak in commercial forests, as well as helping those forests retain essential ecological processes and systems.

It can be reasonable to suppress fires in forests where mature allocated timber is at risk. However, in doing so, we deprive these forests of the natural disturbance that has shaped them. Without fire, these ecosystems change. The *Crown Forest Sustainability Act, 1994* directs that "the long term health and vigour of Crown forests should be provided for by using forest practices that, within the limits of silvicultural requirements, emulate natural disturbances and landscape patterns." Managing fire-dependent forests without fire is not meeting this standard.

Too much weight has been given to the future value of timber within the Area of the Undertaking, and too little to the ecological health of the boreal forest. Given that only a small portion of the area is harvested each year, and that the forest management planning regime tells the ministry exactly which portions will be harvested in advance, the MNRF should be able to determine where forest fires can be allowed to burn without negatively affecting the forest industry – and then to let those areas burn.

> Too much weight has been given to the future value of timber within the Area of the Undertaking, and too little to the ecological health of the boreal forest.

To help prevent both catastrophic forest fires and permanent ecological change, the MNRF must ensure that fire-dependent commercial forests experience fire, either naturally or through prescribed burning. This can be accomplished by: (1) letting more forest fires burn; and, (2) ensuring prescribed burns are applied where forest fires would threaten valuable timber or other values.

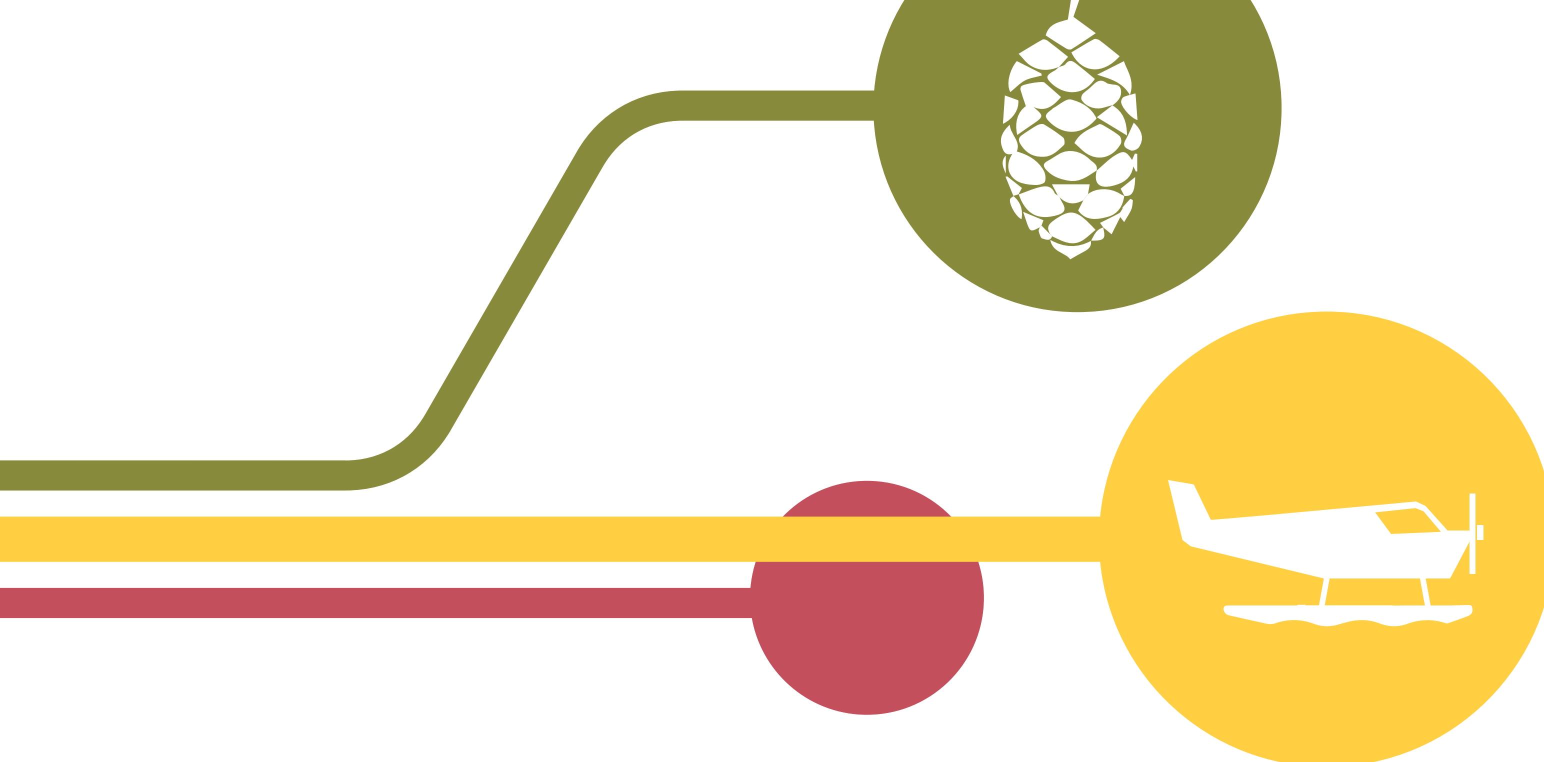
Prescribed burning can be beneficial to silviculture in fire-dependent forests. Many foresters are strong proponents of prescribed burning. They want to conduct burns, but are often stymied by the high cost, a lack of internal expertise that causes them to rely on ministry staff, and great uncertainty about whether an approved burn will actually take place – uncertainty that is difficult to accommodate in the forest management planning process.

Actions the MNRF could undertake to help enable more fire in the Area of the Undertaking include simplifying the process for incorporating prescribed burning into forest management plans, and covering more of the costs of burning in Crown forests like it did decades ago. It could also change forest management guidance to make prescribed burning mandatory, forcing forest management companies to plan for the costs and perhaps encouraging them to find a way to build internal capacity to conduct burns.

Most protected areas in northern Ontario contain forests that require periodic fire for their health and renewal. By law, maintaining the ecological integrity of Ontario's protected areas is the government's first priority in planning and management. Where an ecosystem is fire dependent but also contains or is close to values that must be protected from forest fire, the ministry should ensure prescribed burns are applied. It could do this by deliberately setting aside funds to pay any costs of burning in protected areas. The ministry should also build expertise and capacity within Ontario Parks to execute more prescribed burns.

To decrease the uncertainty of whether a planned prescribed burn will go forward, **the ECO recommends that the Ministry of Natural Resources and Forestry follow through on the new strategy's commitment to build and maintain a workforce capable of executing prescribed burns, and to go further towards solving capacity shortfalls by creating a team of dedicated burn personnel.** Forest fire suppression costs can be exorbitant. The money the government could save by letting more forest fires burn to provide ecological benefits could be spent on lowering the risk of future severe fires and improving the health of fire-dependent forests by assuming more of the costs and thereby enabling more prescribed burns.

The ECO recommends that the Ministry of Natural Resources and Forestry ensure that the fire-dependent forests it is charged with sustainably managing, including those in commercially harvested Crown forests and protected areas, experience forest fire, either by letting forest fires burn or by conducting prescribed burns. The new fire management strategy sets the stage, now the ministry must follow through and act.



1.5.1 Recommendations

The Ministry of Natural Resources and Forestry should ensure that the fire-dependent forests it is charged with sustainably managing, including those in the Area of the Undertaking and protected areas, experience forest fire, either by letting forest fires burn or by conducting prescribed burns.

The Ministry of Natural Resources and Forestry should follow through on its commitment to build and maintain a workforce capable of executing prescribed burns, and create a team of dedicated burn personnel.

The Ontario government should ensure all communities near flammable forest become "FireSmart" by making prevention and mitigation plans mandatory, and providing adequate funding to communities to develop and implement them.

Appendix 1: Ministry Comments

Comments from the Ministry of Natural Resources and Forestry

The new Wildland Fire Management Strategy provides broad direction to MNRF and sets out actions for the future in order to advance wildland fire management in Ontario. MNRF is pleased that the ECO is supportive of the increased flexibility that the strategy provides for fire response. Each fire can receive an appropriate response to achieve the goals of preventing loss of human life, mitigating economic and social disruption, and promoting the ecological role of fire. As the ECO recognizes, this makes forest fire management a complex balancing act.

The Wildland Fire Management Strategy sets out actions to prevent forest fires, mitigate the impact of fires, respond appropriately, and understand and apply fire. Whereas, FireSmart is the approach to mitigate the impact of fire on people and their property. MNRF has ensured that direction for communities to assess the threat from wildland is in the Provincial Policy Statement (PPS). To support the PPS, MNRF developed the document “Wildland Fire Risk Assessment and Mitigation: A Guidebook in Support of Provincial Policy Statement, 2014” and posted this to the Environmental Registry in June 2016 (Registry #012-7075).

The Wildland Fire Management Strategy identified actions to advance the use of fire for resource management and ecological benefit. MNRF is working with partners and Indigenous communities to ensure that prescribed burns are planned and delivered safely and effectively. To ensure this occurs, training of Low Complexity Prescribed Burn Workers and Prescribed Burn Bosses was initiated in 2015. For high complexity prescribed burns, there is planning and risk analysis training for High Complexity Burn Bosses. MNRF is presently reviewing and revising this training material.

Endnotes

[1] Compared to Annual Area Burned values for 1961–1990.

[2] The MNRF’s Aviation, Forest Fire and Emergency Services Branch’s annual expenditures have varied dramatically over the last decade, from $75 to $231 million, with higher expenditures in years with more fires (e.g., over $200 million was spent in 2011, which was the busiest fire season in over a decade with more than 600,000 ha burned). The MNRF required an estimated $92.8 million for firefighting activities during the 2015 fire season.

[3] The term “fire cycle” refers to the number of years it would take for a given area (delineated by forest type/composition, soil, weather patterns, etc.) to be burned by wildfire at least once. Fire cycles vary according to a number of factors including temperature, soils, precipitation, and forest composition. If a given forest has a fire cycle of 100 years, it doesn’t mean that over the span of 100 years an area equivalent to the size of the entire forest will have burned – parts of the forest might burn more than once while other parts might remain untouched, creating patches of forests with different ages and species compositions.

[4] A build-up of fuel in a forest stand can result from prolonged fire suppression, damage from insects, a blow-down, ice storm or other natural disturbance.

[5] Fires that burned more than 40 ha.

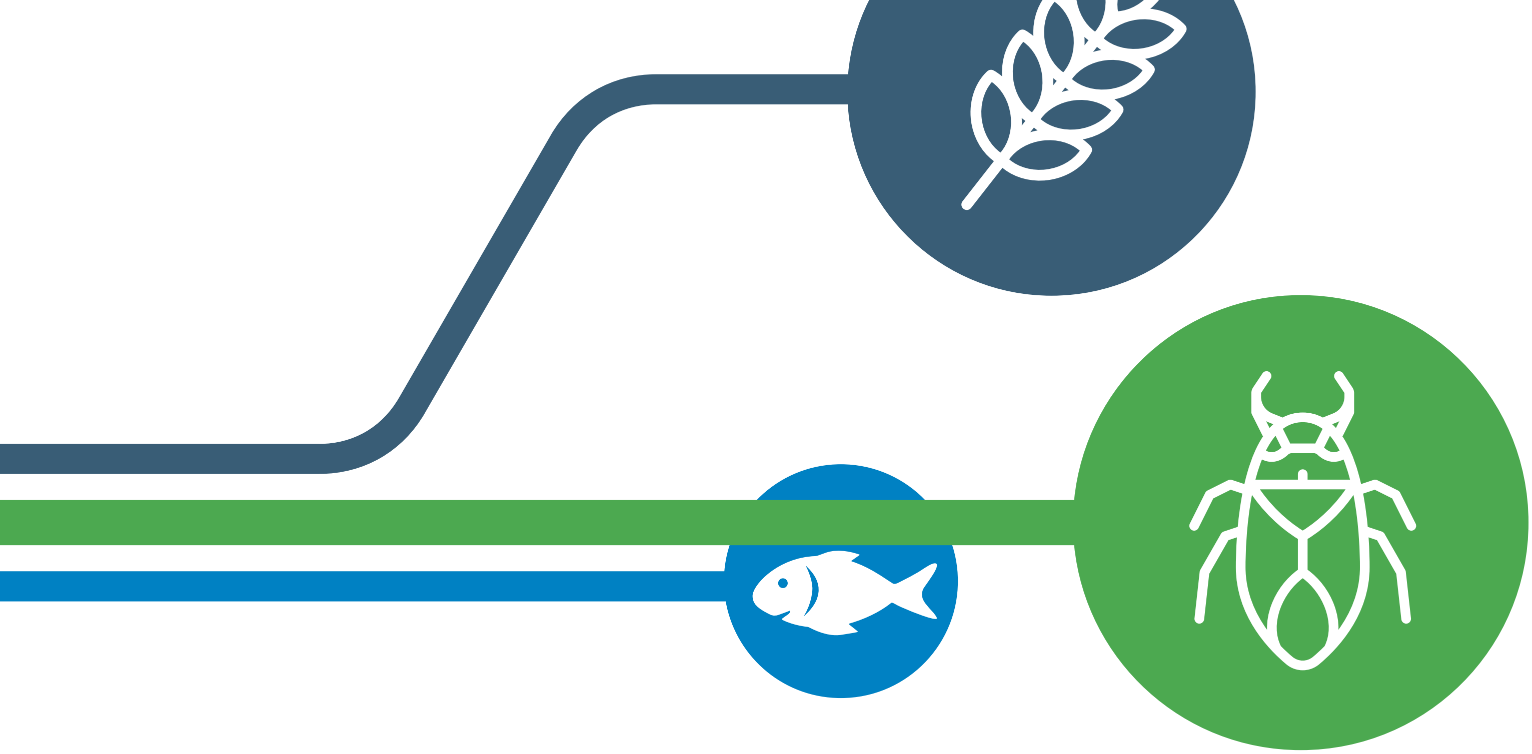
[6] “Low complexity burns” are generally simpler to plan, cover smaller areas, burn for shorter times, require less resources, and have lower potential for social disruption, negative environmental consequences and fire escape than “high complexity” burns. Every burn conducted on Crown land must be assessed and given a complexity rating based on predetermined, weighted parameters. See the MNRF *Prescribed Burn Manual* for greater detail.

[7] All prescribed burns recorded by the MNRF were those with which Aviation, Forest Fire and Emergency Services Branch was directly involved or for which the branch provided review and approval of a burn plan.

[8] For a detailed discussion about the MNRF’s responsibility to preserve ecological integrity in protected areas and conservation reserves, read the ECO’s article “Protected Areas Planning: A Lost Priority” in Part 4.6 of *Serving the Public: Annual Report 2012/2013*.

[9] The largest prescribed burn on record was executed in fall 2015 on MNRF-controlled land in northwestern Ontario: 3,297.6 ha were successfully burned to remove slash, create planting sites, and reduce the forest fire hazard for the area.

CHAPTER 2
INVASIVE SPECIES MANAGEMENT IN ONTARIO: NEW ACT, LITTLE ACTION



Abstract

The spread of invasive species is one of the biggest threats to biodiversity globally. Ontario has Canada's highest risk of invasions by non-native species (e.g., emerald ash borer, Phragmites, zebra and quagga mussels, and Asian carp).

Ontario's new *Invasive Species Act, 2015*, and the 2012 *Ontario Invasive Species Strategic Plan* are useful tools for managing invasive species. But with few exceptions, there is little indication that the Ontario government is taking concrete actions to prevent the introduction of invaders, detect them early on in an invasion, or manage and monitor species that are already doing damage. The ECO recommends that the Ministry of Natural Resources and Forestry take actions now to:

- restrict known pathways of invasive species spread;
- tackle invasive species in provincial parks;
- establish advisory panels with scientific expertise and local and Aboriginal knowledge to propose species for regulation; and
- report publicly on progress to manage invasive species regulated under the *Invasive Species Act, 2015*.

Executive Summary

What We Examined

The *Invasive Species Act, 2015* comes into force on November 3, 2016. To coincide with the implementation of this new legislation – the first stand-alone invasive species statute in Canada – the Environmental Commissioner of Ontario examined the state of invasive species management in the province. We highlight current threats to Ontario's biodiversity from invaders, discuss who is doing what to manage invasive species, describe effective approaches to combatting invasions, and analyze the opportunities and challenges presented by the new act.

Why We Did This Review

The spread of invasive species is one of the biggest threats to biodiversity globally. There are countless invasive species already present and doing damage to ecosystems in Ontario, including emerald ash borer, Phragmites, and zebra and quagga mussels; and Asian carp present an imminent threat to the Great Lakes.

What We Concluded

Four years after the release of the *Ontario Invasive Species Strategic Plan*, with few exceptions, the Ontario government has done little to prevent, detect or manage invasive species on the ground. The *Invasive Species Act, 2015* gives the Ontario government total discretion to decide whether and when to regulate invasive species and their carriers, and to use any information or rationale it chooses to make those decisions. The act will only be as effective as the regulations made under it.

To make real progress towards managing invasive species, the government should take actions now to restrict known pathways of invasive species spread including prohibiting the sale of invasive plants, requiring boats to be cleaned and inspected before entering new water systems, and banning live bait from protected areas (i.e., provincial parks and conservation reserves). In addition, protected areas – crucial to preserving Ontario's biodiversity and fully within the Ministry of Natural Resources and Forestry's (MNRF's) jurisdiction – should be prioritized for invasive species prevention, detection and management.

The MNRF must use the best available information to choose the most threatening species for regulation, restrict their pathways, and protect the most vulnerable sites without delay. To get this information, the MNRF should establish advisory panels with scientific expertise and local and Aboriginal knowledge to propose species for regulation. Finally, we concluded that the MNRF should report publicly on its progress to manage invasive species regulated under the *Invasive Species Act, 2015* to enable meaningful evaluation of the act's efficacy and allow the public to hold the government accountable for its successes or failures in managing regulated species.

2.0 Introduction

The spread of invasive species is one of the biggest threats to biodiversity globally. Invasive species are (normally) non-native organisms that harm established ecosystems. They are able to disrupt ecosystem processes, introduce diseases, and reduce numbers of native plants and animals because of abilities and characteristics like rapid growth, prolific reproduction, and tolerance for many different environmental conditions.

Ontario has the highest risk of invasions by non-native species in Canada because large amounts of goods and people move within and across the province's borders. Species native to one region of Ontario can be considered invasive in another region if they produce negative effects and have been introduced by human activity, or if their introduction and spread is linked to climate change. Invasive species, especially when added to other threats like climate change and habitat loss, can rapidly reduce biodiversity, and conservation efforts are often not able to keep pace. As much as 66 per cent of Ontario's species at risk are threatened by established invaders such as garlic mustard (a forest herb), Phragmites (a grass), and round goby (a fish).

As much as 66 per cent of Ontario's species at risk are threatened by established invaders.

Invasive species have negative economic, social and health effects. For example, the Ministry of Natural Resources and Forestry (MNRF) estimates that the total annual economic impact of zebra mussels in Ontario is $75-91 million. The emerald ash borer, a wood boring beetle, is killing millions of ash trees across North America. The total cost in the U.S. could amount to an estimated $25 billion by 2019.

To coincide with Ontario's new *Invasive Species Act, 2015*, which comes into force on November 3, 2016, the ECO examined the state of invasive species management in Ontario. In this report we highlight some of the current threats to Ontario's biodiversity from invaders, discuss who is doing what to manage invasive species, describe effective approaches to combatting invasions, and analyze the opportunities and challenges presented by the new act.

Tree-Killing Beetles: Emerald Ash Borer and Asian Long-Horned Beetle

The emerald ash borer, an invasive wood-boring beetle from Asia, is steadily chewing its way through millions of ash trees across North America, threatening the species' very survival. It likely arrived in larval form, hidden away in ash-wood packing crates from Asia. Various species of ash trees are particularly common in upland deciduous forests, along rivers and creeks, and as a pioneer species on abandoned agricultural fields in southern Ontario. They are also a hardy and commonly planted street tree.

The total extent of emerald ash borer's establishment in Ontario is not known, but the MNRF is certain it has invaded all of southern Ontario, and spread north to Grey County and east through the Ottawa Valley, with satellite populations in Algoma and Thunder Bay. Emerald ash borer is costing city governments and the forestry industry billions of dollars. According to the MNRF, municipal costs were estimated to be in the range of $280 million over 10 years.

The Asian long-horned beetle is another invasive wood-boring beetle from Asia, but eats several species of hardwood trees including maple, birch, poplar and willow. It has the potential to devastate the deciduous and mixed forests of northeastern North America, not to mention the maple syrup industry. Two infestations have been recorded to-date in Ontario: one discovered in 2003 that straddled the border between Toronto and Vaughan, and another detected near Toronto Pearson International Airport shortly after the first infestation was officially declared eradicated. A quarantine is still in place, and the destruction of host trees (over 7,500 and counting) and surveillance is ongoing. So far Ontario has escaped disastrous Asian long-horned beetle infestations such as the one still being suffered in Worcester, Massachusetts, where more than 25,000 trees have been removed from city streets, parks and private property, costing tens of millions of dollars. Asian long-horned beetle also likely arrived in the U.S. in larval form inside wood packing material from China. People losing trees on their private properties, along their streets, and throughout their neighbourhoods are a real demonstration of how invasive species affect our communities and what we value about them.

Emerald ash borer beside a borer hole in ash bark (left) and an Asian long horned beetle (right). Source: Pennsylvania Department of Conservation and Natural Resources - Forestry, Bugwood.org.

2.1 Current Status of Invasive Species Management in Ontario

Invasive species remain a significant and complicated problem. The ECO began calling for strong action from the Ontario government on this issue over ten years ago.

Actions by the Federal and Provincial Governments

When Canada signed the *Convention on Biological Diversity*[1] in 1992, it agreed to work to prevent, control and eradicate invasive species. The federal government completed an *Invasive Alien Species Strategy for Canada* in 2004, and subsequent action plans for aquatic invasive species, and invasive plants and plant pests. Some Ontario legislation, including the *Fish and Wildlife Conservation Act, 1997* and the *Weed Control Act, 1990*, partially address invasive species. However, invasive species remain a significant and complicated problem. The ECO began calling for strong action from the Ontario government on this issue over ten years ago.

The Ontario government released the *Ontario Invasive Species Strategic Plan* in 2012 (see Part 4.2 of the ECO's 2012/2013 Annual Report). It contains 27 strategic actions to manage invasive species, with specific objectives to prevent new invaders, slow and where possible reverse the spread of existing invasive species, and reduce their harmful impacts. The Ontario government recently passed the first standalone invasive species legislation in Canada: the *Invasive Species Act, 2015*, which comes into force on November 3, 2016.

Both the *Ontario Invasive Species Strategic Plan* and the new legislation are potentially useful tools for managing invasive species. But with few exceptions, there is little indication that the Ontario government is taking concrete actions to prevent the introduction of invaders, detect them early on in an invasion, or manage and monitor species that are already doing damage. There are no published management plans for priority invasive species in Ontario, no government-produced priority lists (or "watch-lists") of the most damaging invaders already here or those most likely to invade, and no progress reports on the implementation of the 2012 *Ontario Invasive Species Strategic Plan*.

The MNRF is undertaking a number of activities to help implement the *Ontario Invasive Species Strategic Plan*, including:

- The MNRF is working with partners to develop ecological and socio-economic risk assessment methodologies for invasive species, and has undertaken risk assessments on a variety of species, focusing on the *Least Wanted Aquatic Invasive Species List* for the Great Lakes Basin produced by the Conference of Great Lakes and St. Lawrence Governors and Premiers.
- The MNRF surveys for Asian carp in the Great Lakes in partnership with the federal Department of Fisheries and Oceans (DFO).
- The Ontario Federation of Anglers and Hunters, in partnership with the MNRF and the Invasive Species Centre, launched a crowd-sourced online database and map of invasive species in Ontario called EDDMaps (Early Detection and Distribution Mapping System – www.eddmaps.org/ontario).
- The MNRF identified invasive species knowledge as a priority science need for the ministry, including improving methods for detection, prevention and control, and predicted effects of invasive species.
- The MNRF is leading projects to eradicate two invasive aquatic plants: water soldier from the Trent River and Black River, and

Fresh Water Transformers: Zebra and Quagga Mussels, and Round Goby

Zebra and quagga mussels, introduced from Eurasia in ballast water in the 1990s, are extremely efficient at eating plankton – depriving native mussels and plankton-eating fish from their once-abundant food source and making freshwater lakes clearer, forcing light-sensitive fish like walleye into deeper waters and encouraging aquatic vegetation growth. They have also caused native clam populations in Lake Erie and Lake St. Clair to decline significantly by attaching to the clams and hindering their movement, feeding and respiration. Zebra mussels also build up around underwater infrastructure such as outflow and intake pipes, costing millions in cleaning and replacement costs. Unfortunately, these invasive mussels have passed the population tipping point beyond which eradication is impossible. In Ontario, zebra and quagga mussels may be considered naturalized, which means managing them involves preventing their spread beyond existing ranges (which for zebra mussel encompasses all of the Great Lakes, waterways throughout southern Ontario, and north almost to Lake Nipigon), adapting to their effects, and reducing those effects. Eradication of these mussels is not possible with existing techniques.

The round goby is a small, prolific fish also native to Europe and transported to North America in ballast water. It can now be found throughout the Great Lakes and in some inland waters including Lake Simcoe and the Trent River. Round gobies outcompete and prey on small native bottom-dwelling fish and sport fish eggs. They may also contribute to outbreaks of botulism type E in Great Lakes fish and fish-eating birds by transmitting a toxin from the zebra mussels they consume to the goby's predators up the food chain.

Zebra mussels (left), a quagga mussel (centre), and round goby (right). Sources: Amy Benson, U.S. Geological Survey (mussels); and Eric Engbretson, U.S. Fish and Wildlife Service. Bugwood.org.

European water chestnut from Voyageur Provincial Park.

- Ontario signed a Governors' and Premiers' Mutual Aid Agreement to Combat Aquatic Invasive Species Threats to the Great Lakes Basin.
- The MNRF is the co-lead for all commitments in a new annex on Aquatic Invasive Species to the *Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health*, which outlines commitments by both parties to address this threat.
- The MNRF is co-chairing the Conservation and Wildlife Biodiversity Ministers' Invasive Alien Species Task Force to review progress on *An Invasive Alien Species Strategy for Canada*.

While these commitments are in and of themselves positive, they do not reflect the necessary urgency to address the sheer scale and scope of the problems.

Actions by Non-Governmental Organizations

Most invasive species outreach and education in Ontario is provided by a handful of non-governmental organizations. Their activities include providing information on effective detection and control methods, running citizen science monitoring programs and volunteer prevention programs, and providing forums for land managers to learn about and apply management techniques. The organizations include the following:

- The Ontario Federation of Anglers and Hunters Invading Species Awareness Program, which operates with funds from the MNRF, provides public education and awareness campaigns; extensive information on common invasive species through their website (www.invadingspecies.com); runs citizen science monitoring programs for aquatic invasive species; and partnered with the MNRF and the Invasive Species Centre to develop an online early detection and mapping program for invasive species in Ontario (EDDmaps), among other activities.
- The Ontario Invasive Plant Council is a non-profit organization with paying members housed at the Ontario Federation of Anglers and Hunters. It provides leadership, expertise and public education on invasive species, focusing on invasive plants. It also helps develop best management practice documents, delivers webinars, and houses an Ontario Phragmites Working Group.
- The Invasive Species Centre (established as a federal and provincial partnership) disseminates government funds for research, outreach and education; puts on workshops for land and resource managers and other professionals; and hosts websites aggregating information on invasive species including asiancarp.ca and forestinvasives.ca. The *Ontario Invasive Species Strategic Plan* specifically tasked the Invasive Species Centre with implementing many of the Plan's actions.

These organizations are doing essential work, and should be congratulated for their efforts.

Actions by Municipal and Other Land Managers

Municipalities, conservation authorities and private landowners are engaged in invasive species management and control on an ongoing basis. Many of these land managers also mount education and outreach efforts and citizen science programs, sometimes partnering with the organizations listed above. These efforts are costly – requiring substantial investments of staff time and money over the long term in order to have effective and lasting outcomes. For example, the Regional Municipality of York is spending $10 million over 10 years on emerald ash borer and other invasive species management.

Public land managers generally do this work without guidance, co-ordination, expertise or funds from the provincial government (with the exception of projects that may qualify for funding through various programs such as the Species at Risk Stewardship Fund, Land Stewardship Habitat Restoration Program, and Great Lakes Guardian Community Fund). Some of these organizations and landowners are relatively successful despite this lack of provincial support, but ongoing success is always in jeopardy because of their competing priorities for resources.

Persistent Plants: Dog-Strangling Vine and Phragmites

Dog-strangling vine is an invasive twining and trailing plant from Eurasia that out-competes native herbaceous plants and tree seedlings. It can turn a forest floor or field into a mass of impassable knotted stems that prevent native trees and plants from regenerating.[2] Dog-strangling vine can cost a forest manager thousands of dollars to chemically control in a pine plantation in order to enable tree regeneration. Dog-strangling vine also threatens plant biodiversity in natural forests, and can have a negative impact on monarch butterflies – the butterflies mistake dog strangling vine for milkweed and lay their eggs on its leaves, which don't sustain monarch caterpillars. Dog-strangling vine can be found in forests, fields and natural and abandoned areas in southern Ontario, with large concentrations in the greater Toronto and Ottawa areas. It has also invaded urban ravines, blanketed the Don Valley Parkway, and (stealthily) established in many urban backyards.

Phragmites is an invasive reed also from Eurasia that chokes out native plants in wetlands, beaches and on riverbanks, and changes water levels. It grows in dense, monoculture stands that provide poor habitat and food for wildlife. It can also impact agriculture, lower property values by blocking views, and prevent swimming, boating and fishing. The dense, dry stems are also a fire hazard. Phragmites stands are particularly extensive in the Lake Erie, Lake Huron and Huron/Erie Corridor coastal ecosystems, where they could devastate a number of species at risk that depend on habitats that Phragmites takes over and makes unsuitable. Phragmites is also common in ditches, along highways and in wetlands throughout southern Ontario and north into Grey County Muskoka and Parry Sound, the Ottawa Valley and beyond.

Phragmites with full seed heads (left) and a mat of dog-strangling vine (right). Sources: Leslie J. Mehrhoff, University of Connecticut; and David Nisbet, Invasive Species Centre. Bugwood.org.

Actions by the General Public

To date, the government has relied heavily on the public's voluntary adoption of prevention and control measures to slow the spread of invasive species in Ontario. For example, through outreach and education, recreational boaters are encouraged to voluntarily use boat-washing stations before entering new waters (many of which are provided through the OFAH Invading Species Awareness Program). No law or policy requires this precaution be taken before entering any waterbody – including in protected areas – even though transient boating poses the greatest risk for spreading aquatic invasive species within Canada.[3] The reliance on voluntary measures alone is unlikely to provide the certainty of protection needed to protect our native aquatic species.

Fighting Phragmites: Lambton Shores Volunteer Group Galvanizes Community to Save their Beaches

A group of dedicated and hardworking volunteers, and municipal and conservation authority employees have been fighting invasive *Phragmites australis* (common reed) on the shores of Lake Huron and the Ausable River in Lambton County since 2009.

Phragmites has been labelled the nation's "worst" invasive plant species by Agriculture and Agrifood Canada. Phragmites spreads very quickly along shores, edges of wetlands and roadside ditches. This reed forms dense monocultures up to five metres tall, with dense root systems, often blocking out all other plant and animal species, including species at risk. Phragmites has severe, long-term detrimental effects not only on wildlife habitat, but on recreational opportunities and property values too, since it often completely blocks off access to water and views.

The Lambton Shores Phragmites Community Group has a viable and comprehensive management approach and some good successes with controlling infestations of Phragmites. They also have good working relationships with local municipal and county agencies, with several Ontario ministries, cottage associations and the support of many community residents. They have obtained funding year to year through a variety of grants. What they don't have is any ongoing multi-year funding to allow them to monitor and quickly catch small re-infestations of cleaned up areas. Only the smallest infestations can be eradicated with spades, so early detection and rapid response is critical. This means a broad public awareness and education campaign would be key, to ensure more alert eyes on the ground. But the working group still relies largely on volunteer co-ordination by a few determined retirees, who find themselves battling not only Phragmites in the ditches, but also thickets of paperwork for approvals and work permits. The group sees a need for a dedicated agency that could act as a Phragmites Control Centre – and could offer affected communities an integrated, one-stop shop of solutions.

2.2 Effective Approaches to Managing Invasive Species

Prevention and Early Detection and Control

The longer an invasion is allowed to progress, the more widespread the populations of invaders become, until the invasion reaches a tipping point where it worsens, often exponentially, and the invader becomes established or naturalized (Figure 1). Eradication is not possible after this tipping point, and management efforts can only focus on minimizing damage and adapting to the invader's effects. The cost of management and control efforts also climbs precipitously as time goes on. However, if action is taken at an early enough stage of invasion, invasive species can be kept from harming ecosystems, society and the economy, and control efforts are feasible.

Actions to prevent invasive species from becoming established are usually the most cost effective because they avoid the economic,

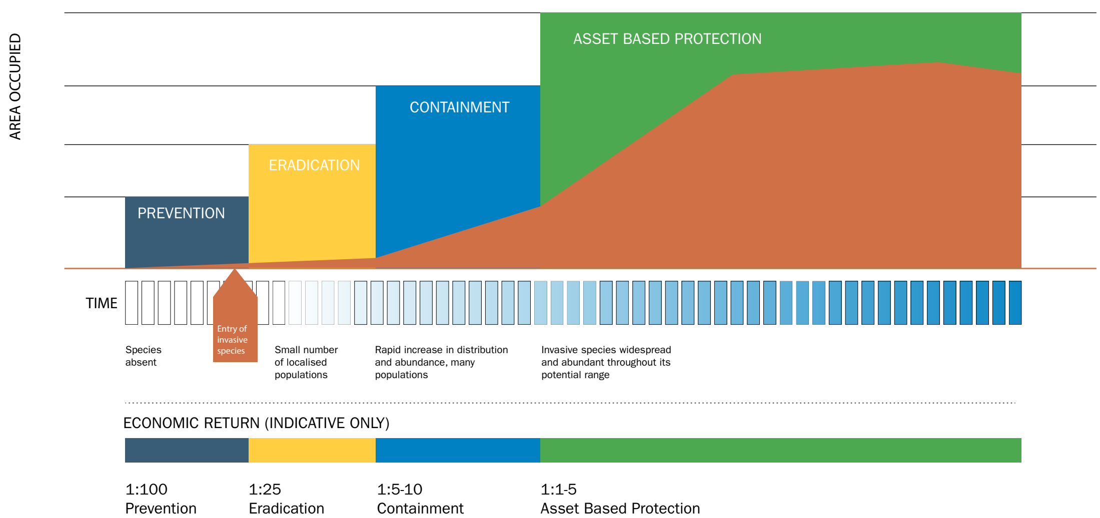


Figure 1. The degree of infestation rises with time since invasion, until only local control is possible – and at a high cost. Source: © State of Victoria, Department of Economic Development, Jobs, Transport and Resources. Reproduced with permission.

If action is taken at an early enough stage of invasion, invasive species can be kept from harming ecosystems, society and the economy, and control efforts are feasible.

environmental and social costs the invaders would cause. For example, the Sea Lamprey Control Program for the Great Lakes, implemented in 1955 to control the invasive sea lamprey and mitigate its devastating effects on native fish, has successfully reduced lamprey populations by 90 per cent – but it costs Canada and the U.S. $22 million every year. Where prevention fails or was not attempted, detecting invasive species populations at an early stage of invasion allows quick eradication efforts to take place, which can be very successful. Examples of successful detection and eradication efforts within Ontario include an ongoing water chestnut (an invasive aquatic plant) eradication program at Voyageur Provincial Park on the Ottawa River, which has resulted in an annual reduction in population size;[4] and the successful eradication of an Asian long-horned beetle population from Toronto and York Region in the 2000s.

Biological Control of Invasive Species

Biological control may help eradicate or suppress established populations of invasive species, and it has been commonly and effectively used for invasive plants and insects. Biological control entails using a living organism, usually from the invasive species' native range, to combat its population by eating it or causing it to become diseased.

There have been documented successes in Ontario, including the suppression of the invasive wetland plant purple loosestrife by two leaf-eating beetle species. Current biocontrol efforts ongoing in Ontario include the release of parasitic wasps that lay their eggs on the emerald ash borer's larvae, and a defoliating moth that feeds exclusively on dog-strangling vine.

The research, risk assessment, and approvals process to use biological control can be very time consuming because of the complicated and wide-ranging potential consequences of introducing a non-native organism. As a result, the introduction of a biocontrol often occurs long after severe environmental, economic and social damage has already been done by the invasive species. When possible, resources are more efficiently spent on prevention, early detection and rapid response, because the cumulative costs of biocontrol can be much higher.

Purple loosestrife. Source: Steve Dewey, Utah State University, Bugwood.org.

Prioritizing Species, Pathways and Sites

Prioritizing the most threatening invasive species and invasion pathways as well as the most sensitive and susceptible sites to invasive species is crucial to allocating resources effectively and achieving successful prevention and/or control. Aichi Target 9 of the *Strategic Plan for Biodiversity 2011-2020*, adopted by the Conference of the Parties to the United Nations Convention on Biological Diversity (including Canada), includes the prioritization of species and pathways.

The fact that no new aquatic invasive species have been found in the Great Lakes since 2006 when Canada and the U.S. passed regulations governing ballast water control and management exemplifies that success can be achieved by appropriate regulation of invasive pathways. Some researchers suggest the integrated prioritizing of pathways, sites and species may provide the best outcomes and efficiencies.

A 2012 MNRF review of bait management in Ontario warned that harvesting and using live bait in protected areas may introduce invasive species.

The spread of emerald ash borer provides an unfortunate example of what can happen when government fails to correctly identify and prioritize invasion pathways. When emerald ash borer was detected in 2002, the federal Canadian Food Inspection Agency (CFIA) cut down approximately 150,000 ash trees in southwestern Ontario in an unsuccessful attempt to slow the beetle's spread northward by creating a buffer between the known infestation and the rest of the province. This natural dispersal pathway was targeted despite the fact that the wood-boring beetles generally do not move from the immediate area where they emerge. Meanwhile, the emerald ash borer continued to spread rapidly in firewood and other untreated ash wood products, moved by humans along major transportation corridors. This pathway had not been prioritized. The CFIA established and continually expanded quarantine areas around confirmed infestations, but it proved too late to prevent emerald ash borer from spreading across all of southern Ontario and into central Ontario and Quebec.

An example of a known pathway of invasive species introduction in Ontario that could be prioritized (but does not seem to be) is anglers moving live bait including potentially invasive fish and earthworms around the province. Anglers sometimes dump extra bait worms on land; small invasive aquatic organisms can travel in bait buckets, which are often illegally emptied into a waterbody; and invasive organisms can also be transported on gear for harvesting wild bait. The national *Action Plan for Aquatic Invasive Species* notes that anglers sometimes release baitfish into water bodies at the end of fishing trips despite prohibitions on such releases, and states that "compliance and enforcement remain major issues." A 2012 MNRF review of bait management in Ontario warned that harvesting and using live bait in protected areas may introduce invasive species, and called for a broad review of commercial bait harvesting on protected areas of Crown land.

The need for more preventative and proactive research and management actions is not limited to aquatic invasive species; a 2014 report by the Canadian Council of Forest Ministers stated that "the ability to practise proactive forest pest management…may be compromised or threatened if research and management efforts remain focused strictly on responding reactively to new introductions or to uncertainties around native pests."

As the ECO noted in our 2012/2013 Annual Report, the *Ontario Invasive Species Strategic Plan* is thorough, detailed, and action-oriented. The fact that little on-the-ground action has been undertaken by the MNRF and other ministries could be a symptom of not knowing where to start. Risk assessments of species, pathways and sites, the results of which would feed into an integrated prioritization scheme for prevention and control efforts, could break such a standstill. There are examples of prioritization schemes that can be applied to species across or within taxonomic groups – some of which are in use in Europe – as well as for pathways and sites. The *Convention on Biological Diversity* suggests escape pathways such as horticulture; transport contaminants (invaders that arrive in packaged goods); and transport stowaways (invaders that arrive in transport vessels) are invasion pathways that can be universally prioritized, regardless of country or region.

Asian Carp Threaten the Great Lakes

Invasive Asian carp species including grass, silver, bighead and black carp were originally introduced to the southern U.S. in the early 1970s to control algae, plants and snails in aquaculture ponds. Carp escaped into the Mississippi River system during flooding, and silver and bigheaded carp have since travelled as far as the Illinois River and its tributaries, leaving ecological devastation in their wake. For example:

- their comparatively prolific breeding has crowded out native fish species, and in some areas they now make up as much as 80 per cent of the biomass – causing a significant loss of biodiversity;
- Asian carp's voracious appetite severely reduces the abundance of phytoplankton and zooplankton in waters in which they establish, leaving little for native fish to eat;
- declines in aquatic plants as a result of their feeding decreases cover for young native fish and reduces potential spawning habitat; and
- silver carp (which can grow to more than 40 kilograms) jump from the water when startled, damaging commercial fishing gear and potentially harming boaters and anglers.

Asian carp grow fast, produce many offspring, often outgrow any predators, and are very adaptable to different habitat conditions. They are, in short, hard to kill.

Asian carp are a serious threat to the Great Lakes – all five lakes provide suitable spawning conditions and habitat for Asian carp, and if as few as 10 females and 10 males are present in a waterway together, they have a 50 per cent chance of successfully spawning annually. Preventing such an establishment is the focus of the federal DFO Asian Carp Program, in which Ontario's MNRF is a partner. The program was initiated in 2012 with a goal of preventing the introduction of all four species of Asian carp. It includes early detection and monitoring efforts, research to determine the best methods of control should a population reach the Great Lakes, and inspections of live fish shipments (it is illegal to buy, sell or possess live Asian carp).

The MNRF's role includes enforcing the prohibition on live Asian carp, which were historically imported to the province to sell at fish markets. According to one media report, Ontario conservation officers working with Canada Border Services agents intercepted over 40,000 pounds of live Asian carp between 2005 and 2013, but no seizures have been made and no charges have been laid since 2013. The MNRF also works with the DFO to establish and monitor early detection sites throughout the Great Lakes (34 have been established to date), and participates in and helps develop readiness training should detections occur. The province is also working on an Asian carp surveillance plan, and to clarify response actions when Asian carp is detected. The Invading Species Awareness Program, run by the Ontario Federation of Anglers and Hunters with financial support from the MNRF, is engaged in public education and outreach to prevent introductions.

The most imminent Asian carp threat to the Great Lakes is from populations in the upper Illinois River and Chicago Area Waterway System, which are linked to the Great Lakes basin. Electrical barriers have been installed in one of the Chicago Area waterways, and the Chicago Area Waterway System Advisory Committee recently requested funding from the U.S. government to study a permanent system of locks as control points between the two basins. Some experts believe that installing such a hydrologic barrier would be the most effective preventative measure, with a cost ten to one hundred times less than the cost of Asian carp becoming established in the Great Lakes.

In summer 2015, nine grass carp were caught in Ontario waters in and connected to Lake Ontario and Lake Erie. Six of the fish were fertile grass carp – the first fertile Asian carp ever caught in Canadian waters. The response efforts by the DFO, the MNRF and the Toronto and Region Conservation Authority included over 550 man hours of onsite activity including electrofishing and various netting operations to detect any other Asian carp specimens. Analysis conducted on the specimens confirmed that all the fish captured were born in hatcheries and introduced to the wild (some U.S. states still allow grass carp cultivation and stocking of sterile fish in private ponds). The DFO states that there is no evidence of an established grass carp population in Canadian waters. However, new evidence that grass carp is successfully spawning in the Sandusky River, a major U.S. tributary to Lake Erie, is cause for grave concern.

The MNRF and the DFO continue to survey for Asian carp in the Great Lakes. Additionally, the Toronto and Region Conservation Authority launched a surveillance program for Asian carp.

Silver carp leaping from the water (left). Source: jhy5187/Shutterstock. Grass carp (right). Source: Eric Engbretson, US Fish and Wildlife Service, Bugwood.org.

2.3 Priority Sites for Invasive Species Management in Ontario

Provincial Parks and Conservation Reserves

The 2011 *State of Ontario's Protected Areas Report* warns that invasive species, including zebra mussels, feral pets, and plants such as buckthorn and garlic mustard, remain a significant problem for many protected areas, and are identified as a concern in 50 provincial parks. Protected areas – which include Ontario's provincial parks and conservation reserves – are ecologically important refuges for native wildlife and are protectors of rare ecosystems, landforms and species. As a result, they are particularly sensitive to the effects of invasive species. Parks can also be especially vulnerable to invasion because of the often significant numbers of people that travel to them from different regions, who may accidentally bring invasive species with them – for example, as larvae in firewood, seeds on their bikes or hiking shoes, or as live bait for fishing.

Algonquin Provincial Park, Ontario's flagship protected area, is besieged by invasive species. Activities associated with the use of motorboats and access roads, and cottage activities such as gardening, construction and maintenance, are major pathways for invasive species, according to a 2013 MNRF study. Anglers and boaters have introduced aquatic invasive species to Algonquin Provincial Park, including smallmouth bass. Some of these species were even introduced via intentional government stocking programs. Shockingly, about a quarter of the park's plant species are non-native.

Protected areas should be prioritized for invasive species management, yet there is no overall invasive species management strategy, policy or direction for Ontario's provincial parks and conservation reserves. Individual park management plans, despite some-

What You Can Do to Fight Invasive Species

Prevent

- **Plant native species**
  Purchase native plants and trees for your garden and avoid invasive plants and trees at all costs – check out the Ontario Invasive Plant Council's *Grow Me Instead* guides for southern and northern Ontario for which plants to avoid, and which native plants make good substitutes (many garden centres and nurseries sell invasive plants and trees – so don't assume that just because it's for sale, it's not invasive).
- **Don't move firewood**
  Firewood is a major carrier of invasive insects like emerald ash borer and Asian long horned beetle that can survive in larval stage inside cut wood. Make sure to purchase firewood where you intend to burn it, and ask about its origins before you purchase it.
- **Don't release bait**
  Never release live baitfish into or near a water body – they could establish where you release them.
- **Clean equipment, vehicles, pets, and yourself**
  - Clean boats, including motor propellers, of organisms and plants on dry land before moving to another water body to avoid spreading aquatic invasive plants and organisms.
  - Clean bikes, including tire treads, gears and spokes of dirt and plant materials; bikes are terrific carriers of invasive plant seeds in the muck and soil they pick up from the trail.
  - Clean all-terrain vehicles, including the under-carriage, of muck, soil and plant parts (for guidance, see the Ontario Invasive Plant Council's comprehensive *Clean Equipment Protocol*) before moving to a different area.
  - Clean the soles of your shoes of muck and soil and check your clothing for clinging seeds and plant material after hiking and before moving to a different area.
  - Brush dogs and horses to free any clinging seeds or plant material before leaving a natural area.
- **Don't liberate pets**
  - Never release fish or other creatures into water bodies or storm management ponds.

Detect

- **Report** suspected or known invasive species using EDDMaps Ontario online or on your phone, or by calling the Ontario Invading Species Hotline at 1-800-563-7711.
- **Learn** to identify invasive species and teach others.
- **Tell** your local municipality and conservation authority about invasive species you find on their properties.

Control

- **Remove invasive plants** on your property – for guidance on methods and help from agencies and professionals, check out the Ontario Invasive Plant Council's best management practice guides.
- **Volunteer** with community groups, stewardship teams or your local conservation authority to help remove invasive species from and restore degraded natural areas.

Sources: Ontario Federation of Anglers and Hunters Invading Species Awareness Program, Ontario Invasive Sepcies Council, Ministry of Natural Resources and Forestry.

Algonquin Provincial Park, Ontario's flagship protected area, is besieged by invasive species.

times identifying invasive species as threats to ecological integrity, rarely commit to explicit action (although individual parks may have control and public education programs for specific species). Another barrier to ongoing and strategic invasive species management is the lack of dedicated funds for ecological restoration in protected areas.

Northern Ontario

Northern Ontario presents an opportunity to prevent invasive species from altering relatively intact ecosystems, but it is increasingly susceptible to species invasions due to climate change, and more roads, human activity and resource extraction.

There are about 1,000 non-native species present in the Canadian boreal zone, including over 600 insects, 10 earthworms, 303 vascular plants and 3 birds. Humans are the main facilitators of species invasions into the boreal, whether via commercial transport, on-person (e.g., seeds on shoes or pets), or on vehicles; and by disturbing intact habitats (making them more susceptible to invasion) and abandoning bait.

Conducting risk assessments of species already present in Ontario's boreal, or present in other boreal landscapes in North America (e.g., Alberta, Alaska), should be a priority. Examples of potential priority boreal invaders include non-native earthworms, slugs, insects, plants and pathogens.

As development and resource extraction pressures mount, it is imperative to examine the vulnerability of pathways such as roads, clearcuts and pipelines in order to target actions to prevent priority invaders or contain their spread. However the 2012 *Ontario Invasive Species Strategic Plan* does not mention the boreal or northern Ontario as worthy of special or more urgent consideration, and the ECO is unaware of any northern-Ontario-focused plans or strategies.

MNRF Inaction

The Ministry of Natural Resources and Forestry has made few strides towards implementing the 2012 *Ontario Invasive Species Strategic Plan*, and engaged in few concrete actions to prevent or slow the spread of damaging invasive species in Ontario.

The MNRF has the mandate, knows the need, and thanks to the new *Invasive Species Act, 2015*, it has the necessary powers. But thus far, it seems to have chosen to expend its resources on other things.

2.4 Ontario's New *Invasive Species Act, 2015*

In 2013, the MNRF released an *Invasive Species Discussion Paper* (Environmental Registry #011-9780) that listed the challenges to preventing and controlling invasive species. The ministry stated that the feedback it received on the discussion paper "identified the need for a stronger legislative framework," leading the government to propose and pass the *Invasive Species Act, 2015*.

Although the act is the first stand-alone invasive species legislation in Canada, other jurisdictions including Japan, New Zealand, New York State and the State of Victoria in Australia have also made or are currently proposing invasive species management legislation.

New Powers to Prevent and Manage Invasive Species

Ontario's new *Invasive Species Act, 2015* sets out a legislative framework for restricting the possession, transfer, sale, release or propagation of invasive species that threaten Ontario's natural environment. The provisions of the new act address many of the challenges currently faced by the MNRF in managing invasive species, and include new powers to:

- search for and seize species under certain circumstances;
- protect parks and conservation reserves;
- establish invasive species control areas and restrict movement and activities within those areas;
- prohibit or restrict the possession, sale and release of regulated species; and
- regulate carriers of invasive species (even if the species they could harbour is not prescribed).

These powers should help the government prevent, detect and control invasive species, as long as it identifies and regulates species before they invade or at an early stage of invasion, and commits sufficient resources to exercising its powers.

Ontario's new *Invasive Species Act, 2015* sets out a legislative framework for restricting the possession, transfer, sale, release or propagation of invasive species that threaten Ontario's natural environment.

In order to impose restrictions on a species, the government must prescribe the species in regulation. The government classifies a species as either "prohibited" or "restricted," depending on whether and how long it has been in Ontario, as well as its biological characteristics, dispersal ability, social and economic impacts, and the harm it poses to the natural environment. Prohibited species would be illegal to possess, transfer, buy, sell, release or propagate anywhere in Ontario except in prescribed areas. Restricted species would be illegal to possess in provincial parks and conservation reserves, and illegal to deposit (e.g., in the case of plants or plant parts) or release anywhere in the province. The government can restrict the transfer, sale, purchase, possession, release and/or propagation of a restricted species through regulation.

The first such regulation was proposed in September 2016 (Environmental Registry #012-8310), which, if enacted, would classify the 16 species identified on the Conference of Great Lakes and St. Lawrence Governors and Premiers *Least Wanted Aquatic Species List* and all species in the family *Channidae* (snakeheads) as prohibited, and classify Phragmites, dog-strangling vine and Japanese knotweed as restricted.

For most of the act's powers to actually have any impact, species must first be regulated by the government.

The government can also make regulations to designate certain areas as "invasive species control areas" and to specify control measures within these areas, including restricting movement of a species or its carriers, and certain activities that could cause a species to spread.

Ministerial Powers to Designate Species, and Require Prevention and Response Plans

In cases where immediate action is required to protect the environment from an invasive species, the Minister of Natural Resources and Forestry can temporarily designate a species by ministerial order, thereby immediately prohibiting its possession, transfer, purchase, sale, release and propagation.

The minister can also require the preparation of a prevention and response plan for an invasive species, which could involve strategies for early detection, control or monitoring, and enter into agreements (theoretically with extra-governmental agencies or organizations) in order to prepare such plans, or to detect, prevent, control, or monitor an invasive species, or assess the level of risk it poses for Ontario. The minister can also authorize a person or organization to possess a prescribed invasive species and to carry out the activities set out in the plan.

Compliance and Enforcement Powers

Inspectors can investigate to determine compliance with: the act or its regulations; conditions of authorizations to engage with a prescribed species; or orders made under the act. Inspectors can also make orders to contain species they suspect are invasive, and declare a space to be invaded if they suspect a prohibited invasive species is present[5] in order to prevent its spread or control or remove it.

The act sets penalties for a first offence by a person at up to $250,000 in fines or up to one year imprisonment. A first offence by a corporation is punishable by up to $1 million in fines, while subsequent offences may result in fines of up to $2 million.

Little Guidance for Species Regulation

While the act affords powers that could curb the spread of invasive species, for most of the act's powers to actually have any impact, species must first be regulated by the government. However, the act does not set out processes for when or how the government will choose species for regulation, and it does not require the government to consider scientific or local knowledge. It does not specify any events that would automatically trigger the government to consider regulating a species, such as the presence of a recognized invasive species in a neighbouring province or state, or the inclusion of a species on a federal list of invasive species. There is also no process by which members of the public or an expert panel could request that a species be considered for regulation. In September 2016, the MNRF released a policy that sets out high-level guidance for conducting species assessments.

Automatic Prohibitions on Regulated Species, but not Prescribed Carriers

The law enables the government to impose restrictions on "carriers" of invasive species, which are plants, animals, organisms, conveyances (e.g., vehicle, boat or aircraft) or other things (e.g., firewood) that could host an invasive species and help it move from one place to another. However the prohibitions on the possession, transport, sale, etc. of a regulated species do not automatically extend to carriers of those species.

By contrast, under the *Invasive Species Management Act* currently proposed by the State of Victoria in Australia, prescribing a carrier causes automatic prohibitions on the transport of that carrier to come into effect. If Ontario had a law similar to the act proposed in Victoria when the emerald ash borer was introduced, and ash firewood (known to have played a major role in transporting live larvae throughout North America) had been prescribed as a carrier, the transport of ash firewood within Ontario would have automatically been prohibited, perhaps helping to slow the spread of the wood-boring beetle.

Law More Reactive than Precautionary

The new law only applies to prescribed or designated species and carriers, and to be prescribed or designated, a species must be known to cause harm to the environment, economy and/or society. This is a reactive approach, and precludes the act from being used to prevent the introduction of non-native species whose effects on Ontario's environment are unknown, and which could turn out to be invasive. Legislation in other jurisdictions, such as New Zealand's *Hazardous Substances and New Organisms Act, 1996*, prohibits any alien species from importation or release except in accordance with approvals issued under the law.

In addition, once a species is regulated under the *Invasive Species Act, 2015*, the government or minister can still choose whether or not to use several of the act's tools — for example to designate an invasive species control area, or cause the development of a prevention or response plan.

Lastly, the act does not obligate the government to report on the status of regulated or designated invasive species, depriving the public of any knowledge of whether government actions to control invasive species are making an impact.

Wild Boars on the Horizon

Wild boars, also known as feral pigs, cost $1.5 billion every year in damage and control costs in the U.S. Probably first brought to North America by Spanish explorers, wild boars have spread to at least 39 states over the past 30 years, causing damage to crops, property and natural resources, and even killing young livestock. They also carry diseases that threaten other animals and people, destroy natural habitats by rooting, wallowing and grazing, and compete with native wildlife. Wild boars are already a problem in Saskatchewan and Alberta, and sightings of wild boars, probably escapees from licensed farms, have been recorded in southern Ontario for the past few years. In the United Counties of Prescott and Russell in southeastern Ontario, the MNRF authorizes hunters with small game licences to kill feral wild boars. Wild boars continue to be observed in small numbers in the area of Voyageur Provincial Park, and the park has an approach to manage them, according to MNRF staff.

Wild boars (also called feral pigs). Source: Billy Higginbotham, Texas AgriLife Extension Service, Bugwood.org.

2.5 Conclusion and ECO Comment

Biodiversity is declining at a planetary scale. Biodiversity loss threatens the world's ecosystems, which all living things, including humans, depend on for their survival. Invasive species, climate change and habitat loss are three of the most serious threats to biodiversity. The Ontario government has committed to conserving the province's biodiversity. To fulfill that commitment, the government must take concrete action now to prevent, detect and manage invasive species.

With the passage of the *Invasive Species Act, 2015*, the government has new tools to combat the introduction and spread of invasive species. The *Ontario Invasive Species Strategic Plan*, finalized four years ago, is another tool. But the Ministry of Natural Resources and Forestry has so far made little concrete progress. Instead, municipalities, conservation authorities and the public are doing their best to tackle invasions, often without dedicated funds, a mandate or expert support. The MNRF's decision in 2013 to eliminate funding for 45 community-based Stewardship Councils along with the stewardship coordinator positions tasked with supporting those councils took away an ideal forum and base of support for local invasive species management.[6] The ministry must do more to help land managers, such as conservation authorities and municipalities, and to co-ordinate and prioritize actions to combat invasive species.

The MNRF has retreated from being a hands-on resource manager in recent years. In our 2012/2013 Annual Report, the ECO warned that the MNRF's new emphasis on "risk management" and a "landscape approach" is a step backwards for real on-the-ground conservation and stewardship in Ontario. The threat of invasive species and their already devastating effects on Ontario's biodiversity demands decisive leadership and concrete action. The challenge of managing invasive species is an opportunity for the government to prove that taking a broader landscape approach to natural resource management does not mean passing the responsibility to other jurisdictions and bodies.

The ECO recommends that the Ontario government take actions now to restrict known pathways of invasive species spread, including:

- **prohibiting the sale of invasive plants;**
- **requiring boats to be cleaned and inspected before entering new water systems; and**
- **banning live bait from protected areas.**

> The ministry must do more to help land managers, such as conservation authorities and municipalities, and to co-ordinate and prioritize actions to combat invasive species.

Protected areas are crucial to maintaining biodiversity and should be prioritized for invasive species prevention, detection and management. It may not be possible to protect all of Ontario from invasive species, but it is possible to significantly reduce their impacts on a network of parks already under the direct management of the Ministry of Natural Resources and Forestry. The ministry has the expertise to carry out management efforts and a mandate to maintain ecological integrity in protected areas. The MNRF needs to step up and lead by example.

The ECO recommends that the Ministry of Natural Resources and Forestry combat invasive species in parks now by:

- **assessing and documenting the invasive species threats to each protected area;**
- **developing prevention, detection and management plans; and**
- **allocating funds for ecological restoration that are not tied to visitor revenue.**

The Ontario government deserves praise for introducing and passing the first stand-alone invasive species legislation in Canada. The *Invasive Species Act, 2015* gives the government the tools to prevent or slow the spread of invasive species in Ontario. However, the effectiveness of the law depends entirely on whether the government enacts sound regulations that prohibit or restrict the possession and transfer of specific invasive species and their carriers.

The law also gives the government total discretion to decide whether and when to regulate invasive species and their carriers, and to use any information or rationale it chooses to make those decisions. But time is the enemy in invasive species management; the longer a species is allowed to establish without intervention, the less successful an intervention is likely to be, and the more expensive it is going to get. That is why the government must act now to use the best available information to: regulate invasive species that are the most threatening to Ontario's environment; restrict the pathways and carriers by which they spread; and protect sites that are the most vulnerable to their effects.

To that end, the government's framework and process for assessing the risk of invasive species and prioritizing their regulation[7] must make use of existing local and Aboriginal knowledge and scientific expertise. **The ECO recommends that the Ministry of Natural Resources and Forestry establish and consult with regional advisory groups with scientific expertise and local and Aboriginal knowledge to propose species and carriers for regulation.** This would provide a pool of credible knowledge the government can draw from to determine which invasive species would have (or are having) the most devastating environmental, economic, and social impacts to the province.

Finally the new act does not require the government to report on the status of regulated invasive species. This could prevent meaningful evaluation of the act's efficacy and limit the government's accountability for its successes and failures in managing regulated species. **The ECO recommends that the Ontario government report publicly on progress to manage invasive species regulated under the *Invasive Species Act, 2015*.**

2.5.1 Recommendations

The Ontario government should take actions now to restrict known pathways of invasive species spread, including:

- prohibiting the sale of invasive plants;
- requiring boats to be cleaned and inspected before entering new water systems; and
- banning live bait from protected areas.

The Ministry of Natural Resources and Forestry should tackle invasive species in parks now by:

- assessing and documenting the invasive species threats to each protected area;
- developing prevention, detection and management plans; and
- allocating funds for ecological restoration that are not tied to visitor revenue.

The Ministry of Natural Resources and Forestry should establish advisory panels with scientific expertise and local and Aboriginal knowledge to propose species for regulation.

The Ontario government should report publicly on progress to manage invasive species regulated under the *Invasive Species Act, 2015*.

Appendix 2: Ministry Comments

Comments from the Ministry of Natural Resources and Forestry

The *Invasive Species Act, 2015* (*ISA*) represents a significant step forward in enhancing the suite of management tools available in Ontario to address the broad range of threats and impacts presented by invasive species. The *ISA* is the only stand-alone legislation in Canada and provides a framework for addressing threats posed by invasive species in Ontario.

In preparation for the implementation of the *ISA*, which takes effect on November 3, MNRF has posted to the Environmental Registry a list of 19 species proposed to be subject to restrictions and prohibitions under the act, including Grass Carp, Water Soldier and Phragmites. The ministry will prioritize further species for potential regulatory action under the *ISA* in accordance with the methodological guidelines detailed in "Guidance for Invasive Species Assessments under the *ISA, 2015*", a technical document posted to the ER for public comment in June 2016.

MNRF acknowledges that legislation and regulatory actions can only go so far in managing invasive species. A variety of complementary tools and actions must also be supported to effectively prevent the introduction of new invasive species and reduce the impacts of those that are already established. This multi-faceted approach is reinforced by the wide variety of actions that are identified in the Ontario Invasive Species Strategic Plan, 2012 (OISSP).

Ontario continues to support existing partnerships to address the broader actions set out in the OISSP. Examples include the programs being led by the Invasive Species Centre, the Ontario Federation of Anglers and Hunters (OFAH) Invasive Species Awareness Program and the Ontario Invasive Plant Council.

Combined, these partners received $1.35 million from MNRF in 2015/16 to develop education and awareness programs, enhance detection and monitoring efforts, and to fund research activities and control actions. These partnerships continue to increase Ontario's understanding of the broad impacts of invasive species while also improving public awareness of these impacts and the pathways that contribute to their spread.

MNRF continues to support partners such as Nature Conservancy of Canada, OFAH, and Ducks Unlimited in implementing control actions targeting established species, including NCC's Phragmites control pilot project in Rondeau and Long Point provincial parks, scheduled for Fall 2016. In addition, MNRF continues to provide funding to support research into new control methods such as bio-control where existing methods are ineffective or inefficient.

MNRF continues to make progress towards reducing the ecological risks associated with the bait pathway through the provincial bait review. The ministry has worked with an external advisory group and posted four Environmental Registry notices associated with the review including one focused on provincial parks and conservation reserves.

Responding to the threat of invasive species in Ontario is a shared responsibility, as invasive species do not respect political boundaries. MNRF will continue to work collaboratively with the Canadian federal government, provincial governments and jurisdictions within the Great Lakes Basin to respond to invasive species.

These actions continue to form the core of MNRF's response to the threat of invasive species and will be enhanced through the implementation of the *ISA*.

Endnotes

[1] For information on Ontario's obligations to conserve biodiversity, see the ECO's Special Report, *Biodiversity: A Nation's Commitment, An Obligation for Ontario*.

[2] The Ontario Government recently designated dog-strangling vine as a noxious weed under the *Weed Control Act*, which made it illegal to plant anywhere in the province, and requiring landowners to destroy it and its seeds if it is impacting agricultural or horticultural lands. See Part 5.5 of the ECO's 2014/2015 Annual Report for more details.

[3] Canadian Council of Fisheries and Aquaculture Ministers Aquatic Invasive Species Task Group. Department of Fisheries and Oceans Canada (2004). *A Canadian Action Plan to Address the Threat of Aquatic Invasive Species*.

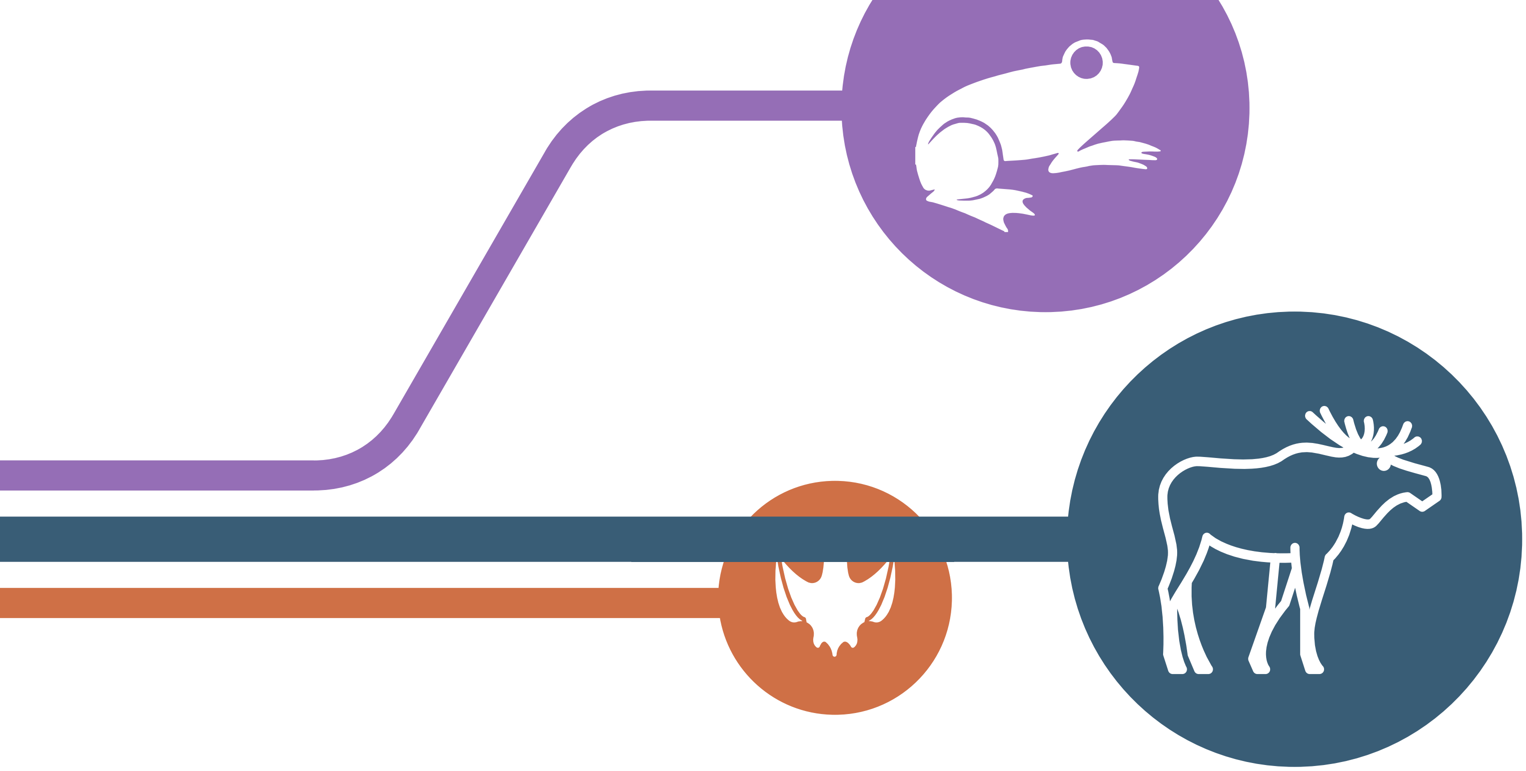
[4] The ECO awarded Ontario Parks staff working on the Water Chestnut program the ECO Recognition Award in 2014.

[5] Inspectors can declare a space to be invaded by a restricted invasive species if the species is prescribed in regulation for this purpose.

[6] For a detailed review of the changes to Ontario's stewardship model, see Part 3.3.1 of the ECO's 2012/2013 Annual Report.

[7] In September 2016, the MNRF released its *Guidance for Invasive Species Assessments Under the Invasive Species Act, 2015* (Environmental Registry #012-7673).

CHAPTER 3
BIODIVERSITY UNDER PRESSURE: WILDLIFE DECLINES IN ONTARIO



Abstract

The large-scale loss of biodiversity is a crisis in Ontario and around the world. The biggest threats are human-caused habitat loss and degradation, invasive species and disease, with climate change playing a growing role. The declines of moose, bats and amphibians in Ontario demonstrate that the Ministry of Natural Resources and Forestry needs to act urgently on two fronts: habitat protection and biodiversity monitoring. It remains to be seen if current harvest limits on moose are sufficient.

Executive Summary

What We Examined

This review examined the issue of biodiversity loss in Ontario, through three case studies of wildlife declines within the province. First, we looked at a disturbing trend of declining moose populations in parts of the province. Second, we looked at the devastating impact of white-nose syndrome on Ontario's cave-dwelling bats. Finally, we provided an update on amphibian declines in Ontario. We examined the factors that have been identified in each of these declines. We used these case studies to assess how the Ministry of Natural Resources of Forestry (MNRF) and other ministries are performing as Ontario's stewards of biodiversity.

Why We Did This Review

The large-scale loss of biodiversity is a crisis in Ontario and around the world. We chose three case studies to illustrate the pressures faced by Ontario wildlife species, and the responses by Ontario ministries. We selected moose, bats and amphibians because of their ecological importance, and because they are facing widespread declines. Moose and bat populations are declining in Ontario and across their North American ranges. Amphibians are the most threatened vertebrate group in the world.

What We Concluded

Pressures to species come in many forms, but the biggest threats are human-caused habitat loss and degradation, invasive species and disease, with climate change playing a growing role. The MNRF needs to act urgently on two fronts: habitat protection and biodiversity monitoring. There are critical gaps in both areas.

Above all, we concluded that Ontario must live up to its commitment to develop a broad-scale biodiversity monitoring program. Without good baseline information on Ontario's wildlife, including population trends and demographics, habitat quantity and quality, etc., the MNRF and the public simply cannot make informed decisions about conservation, or assess whether conservation measures are working. Every year the ministry fails to live up to its obligation to meaningfully monitor the province's biodiversity, the already precarious future of many of Ontario's species is becoming even more uncertain.

3.0 Introduction

Ontario has a precious responsibility. Our province is home to more than an estimated 30,000 species of flora and fauna.[1] This vast biodiversity provides invaluable benefits to all Ontarians, including key ecosystem services that produce clean air and water, climate resilience, recreational opportunities, and support for the province's natural resource economy. But Ontario's species vary widely in their abundance, rarity and overall vulnerability (Figure 1). Two hundred and thirty-one of Ontario's species are currently designated as "at risk" under the *Endangered Species Act, 2007*– but there are many more species that have not been listed that are under pressure, and some are already declining.

Wildlife declines are a global crisis. The WWF's 2014 *Living Planet Report* estimates that global vertebrate populations decreased by 52 per cent between 1970 and 2010. Researchers believe that species are currently going extinct at about 1,000 times the expected natural rate.[2] This devastating loss of biodiversity has led many scientists to conclude that life on Earth is in the midst of a sixth "mass extinction" event.[3]

The collapse of vertebrate populations is slower, but still serious in our region. In the Neartic region, which covers Greenland and most of North America, this decline is closer to 20 per cent.

Even if declines do not result in the actual extinction or extirpation of species, reductions in the abundance of species decrease resilience and threaten ecosystem functions.[4] Although natural factors can drive declines (e.g., disease, predator-prey cycles, weather, etc.), most declines are related to human activity, including habitat destruction and degradation, overexploitation, the human-assisted spread of invasive species and disease, and climate change.

The Ministry of Natural Resources and Forestry (MNRF) is tasked with managing Ontario's wildlife and conserving the province's biodiversity. This responsibility includes un-

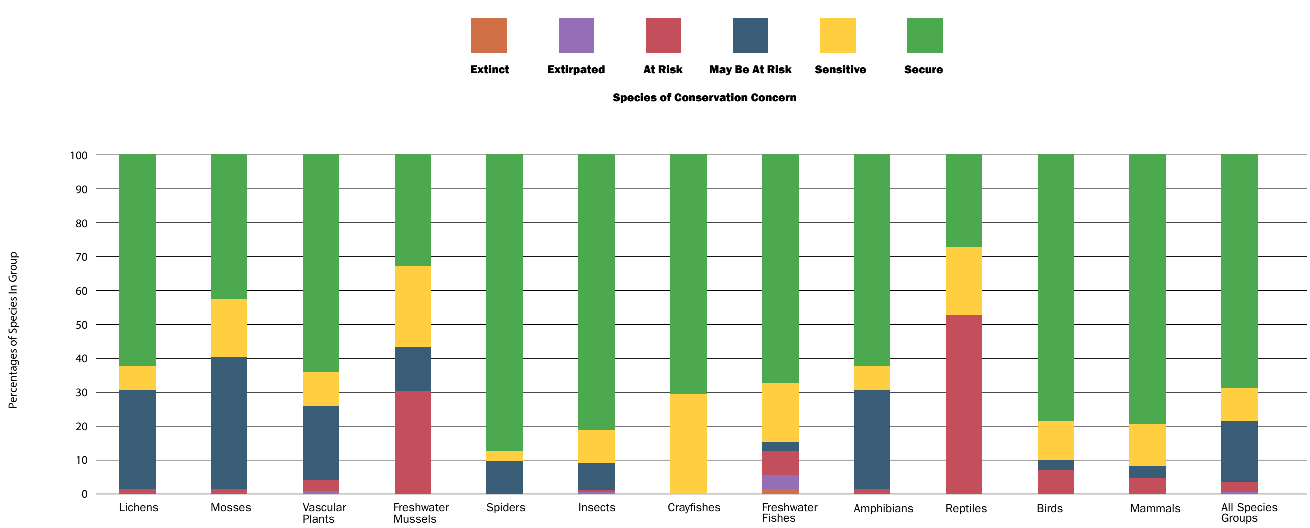


Figure 1. Proportion of Ontario native wild species in secure and conservation concern categories. Source: Ontario Biodiversity Council(2015). State of Ontario's Biodiversity. Available at: http://ontariobiodiversitycouncil.ca/sobr.

Wildlife declines are a global crisis.

dertaking activities like conducting research, monitoring wildlife populations, regulating hunting, and managing habitat – all while also enabling resource development. Other ministries of the Ontario government have a role to play in conserving biodiversity, but the bulk of the responsibility for species declines falls on the MNRF. Given the current global crisis of declining biodiversity, and the challenges of trying to conserve species once they become imperiled, it is critical that the MNRF takes early and effective action when declines are identified – particularly when they concern ecologically important species.

This report examines three ongoing wildlife declines in Ontario: moose, bats, and amphibians. These animals hold immense ecological, cultural and/or economic importance in Ontario. Their declining populations represent a tragic loss of biodiversity, decreased hunting opportunities and tourism, and increased pest control costs. Declines in moose and bat populations in Ontario are part of a larger decline across their North American ranges, while amphibians are the most threatened vertebrate group in the world. Each of these situations presents its own particular challenges, spanning from a lack of data to scientific uncertainty to enforcement capacity. But the message that emerges is clear – there is an urgent need for the Ontario government to get serious about conserving the province's key species.

3.1 Ontario's Declining Moose Populations

Moose are an iconic Ontario species that hold particular cultural and economic significance for many northern and Aboriginal communities. However, Ontario's moose are in trouble. In the 1980s, Ontario's moose population reached a low of just 80,000. This prompted the MNRF to implement new hunting restrictions and management policies, which helped restore the population to about 115,000 moose in Ontario by the early 2000s. But today, moose are declining again. There are now an estimated 92,300 moose – amounting to a decline of about 20 per cent over the last decade.

Although all species experience some natural population fluctuation, this decline is a concern. Some regions of the province have seen severe drops in moose numbers: populations near Cochrane and Thunder Bay are roughly 60 and 50 per cent lower than a decade ago, respectively. In addition, moose population densities are below MNRF objectives[5] in many areas.

Unfortunately, this problem is not limited to Ontario – declining moose populations have been observed across the species' North American range – including parts of Montana, Wyoming, Utah, Minnesota, Michigan, New Hampshire, Vermont, British Columbia, Manitoba, Quebec, Nova Scotia, and New Brunswick.

In some areas, these declines have been drastic. For example, in British Columbia, some regions have seen population declines of 20 to 65 per cent. Similarly, the number of moose in Minnesota has dropped by about 60 per cent over the past decade. In June 2016, the U.S. Fish and Wildlife Service announced that it would be initiating a status review to determine whether moose in Michigan, Minnesota, North Dakota and Wisconsin should be listed under the U.S. *Endangered Species Act*.

Source: Ryan Hagerty, U.S. Fish and Wildlife Service (https://www.flickr.com/photos/50838842@N06/6862339335/) used under CC BY 2.0.

Hunting opportunities in many of these jurisdictions have been restricted as a result of these declines, including in parts of British Columbia and Manitoba. Moose hunting has been suspended indefinitely in Minnesota.

No single cause of these declines has been identified, but the broad geographic scale and synchronous nature of these population trends suggests that there may be common factors driving moose declines across the region.[6] These could include some or all of the numerous pressures on moose, which include habitat degradation, disease and parasites (e.g., winter ticks, liver fluke, brainworm), hunting, predation, weather, etc.

Many of these pressures will be exacerbated by climate change, which is expected to contribute to moose declines in the southern parts of the range due to higher parasite loads, increased predation, heat stress and decreased nutritional availability.[7] In fact, the optimal climate envelope for moose is projected to gradually shift northward (Figure 2).

With shorter and warmer winters, Ontario is seeing favourable conditions for an increase in parasites such as ticks.[8] Ticks negatively impact moose in a number of ways, including blood loss, which can lead to death from anemia. Hairless patches from an individual's attempts to rub off the parasite can sometimes result in hypothermia.

Recent research in other jurisdictions suggests that increased tick loads may be playing a role in local population declines. For example, research from New Hampshire found that 41 per cent of the moose deaths that occurred between 2002-2005 (in the study's sample of 92 moose) were parasite-related.[9] Research on the impact of winter ticks on Ontario's moose is underway.

Moose are well adapted for life in the north and can endure cold conditions – but they do not fare well under extremely high temperatures. Climate change is altering the thermal conditions moose face in both the winter and summer seasons. In high temperatures moose can experience heat stress, which can reduce foraging time and make it difficult to meet their energetic and nutritional demands, possibly reducing their ability to reproduce and survive. Moose in poor health (e.g., suffering from parasites or pathogens) may be more susceptible to heat stress.[10]

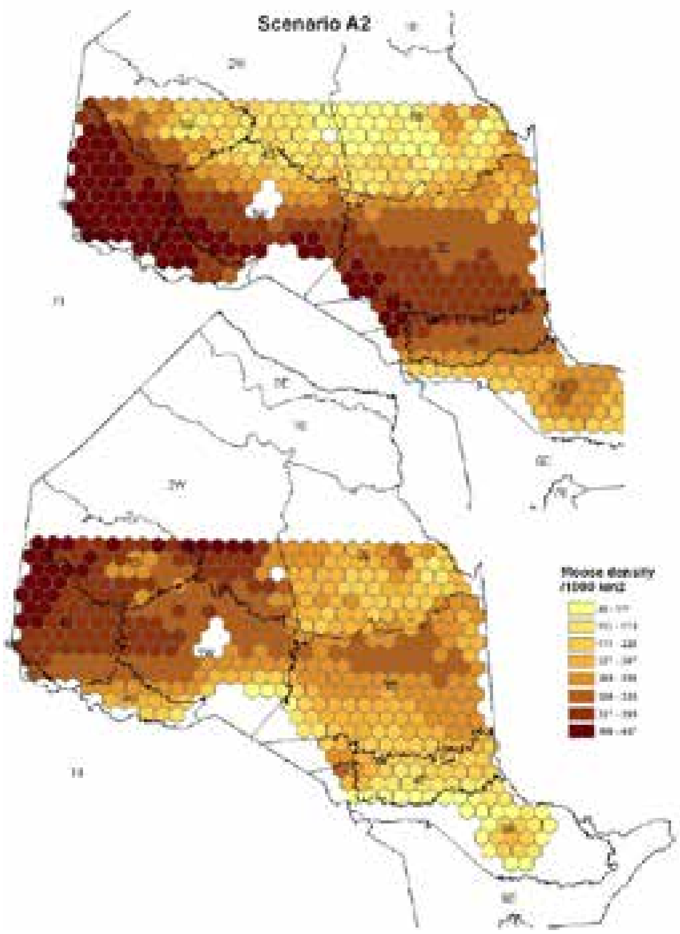


Figure 2. Spatial projection (provincial scale) of moose density (per 1,000 km^2) under the current climate, T1 (1971– 2000), and future climate, T4 (2071–2100), for IPCC (2000) emissions scenario A2 using version 3 of the Canadian Global Climate Model (CGCM3). Modelled areas are monitored through regular moose aerial inventory surveys. Source: Robert S. Rempel, MNRF (2012). *Effects of Climate Change on Moose Populations*.

Ontario's moose live in an ecological community that has been highly modified by resource extraction, suppressed wildfire regimes, and hunting.

3.1.1 What is the MNRF Doing to Support Moose Populations?

Managing moose is complicated because Ontario's moose live in an ecological community that has been highly modified by resource extraction, suppressed wildfire regimes (see Chapter 1 of this report – *Walking the Fire Line: Managing and Using Forest Fire in Northern Ontario*), and hunting. In fact, the MNRF's primary means of managing moose are by regulating hunting and through the forest management planning process.

The MNRF launched a Moose Project in 2014 to address pressures on moose and help moose numbers reach expected and desired levels. Key aspects of the project include: new moose population objectives and changes to moose hunting seasons, including a reduced calf hunting season, to further restrict moose harvest. Season changes were in addition to reductions in tags for harvesting adult moose that were made prior to and during the project.

New Changes to Moose Hunting Seasons and Quotas

Ontario has approximately 98,000 licensed moose hunters – that's over one licensed hunter for every moose in Ontario. However, one of the ways the ministry controls moose hunting is by issuing a limited number of validation tags to licensed hunters through a lottery. Validation tags specify the management unit,[11] time period, class of firearm and type of moose (i.e., bull, cow, calf) that can be hunted. All licensed hunters need to obtain a validation tag in order to legally kill an adult moose.[12]

Each year there are many more applicants than there are available tags. For example, in 2015 only 12 per cent (10,424 of the 88,115 applicants) successfully obtained a validation tag in the draw. In recent years, these hunters harvested about 5,700 moose annually.[13]

The MNRF has introduced several new restrictions on hunting adult moose. The MNRF reduced the number of validation tags for resident moose hunters by almost 18 per cent in 2014, and an additional 15 per cent and 6 per cent in 2015 and 2016, respectively. In addition, as of 2016, the moose season will start one week later in parts of northern Ontario. This delay will further separate the firearm moose hunting season from the primary early moose breeding period when male moose are more vulnerable, allowing breeding to occur uninterrupted and possibly reducing the number of adult moose killed.

Moose Population Decline	Adult Moose Harvest (2014)	Calf Moose Harvest (2014)
-22,700 since early 2000s	Legal limit: 13,499 tags	Legal limit: one for each of the 98,000 licensed hunters
	Estimated resident harvest: 3,020	Estimated resident harvest: 1,403
	Aboriginal harvest: Unknown	Aboriginal harvest: Unknown
	Tourism industry harvest: 601	Tourism industry harvest: 26

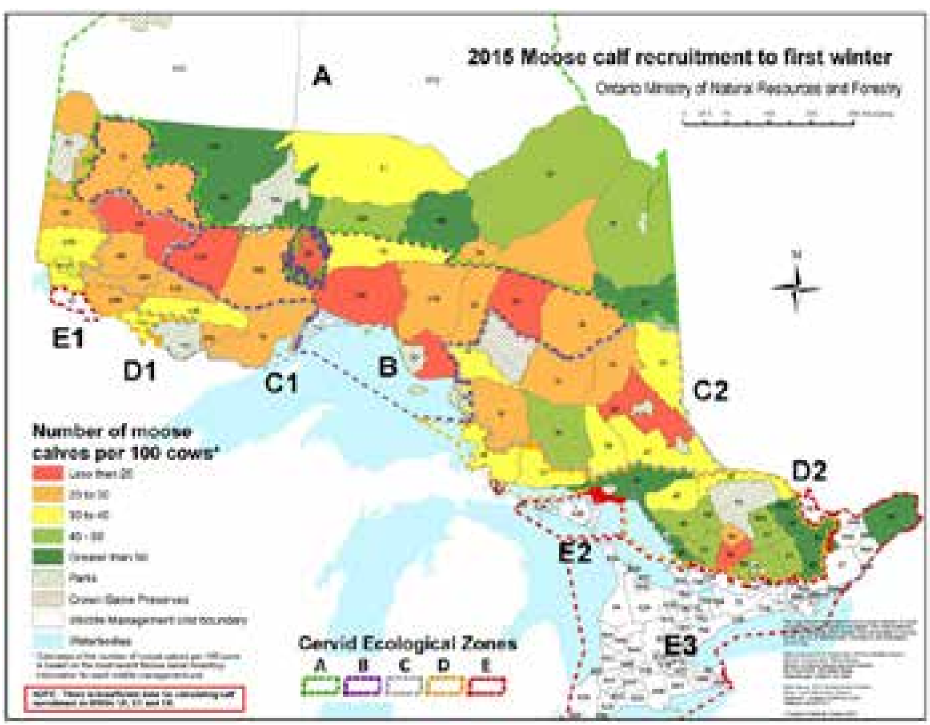


Figure 3. 2015 moose calf recruitment. Source: MNRF

New Restrictions on Hunting Calf Moose

Although the adult moose hunt is tightly controlled by the number of available validation tags, in all but a few management units (in southeastern Ontario), hunters can kill any one calf moose after purchasing a moose licence – no validation tag required. Validation tag holders may also opt to take a calf instead of an adult moose. This means that in most of the province, every licensed hunter could at least theoretically kill one calf. The proportion of calves in the moose population varies between areas and from year to year. In recent years, resident hunters harvested an average of about 1,675 calves.[14]

A key element of maintaining a stable moose population is ensuring that enough calves are born and survive to adulthood to join the reproductive population; this is known as "calf recruitment." The MNRF's minimum desired recruitment each year is at least 30 calves per 100 cows. However, calf recruitment in many management units falls below this threshold. Ministry data reveal problems with low calf recruitment in more than 45 per cent of the management units in northern Ontario (Figure 3).

The MNRF does not limit the calf harvest in most of the province because it assumed until recently that many of the harvested calves would have died anyway over the winter. However, new research in Ontario shows that calf deaths from hunting increase net mortality rates.[15] Removing moose calves from a population may also shift greater predation pressure to the adult population. The ministry has acknowledged that "recent science suggests we need to reconsider how hunter harvest influences calf recruitment into the adult population."

As a result, the MNRF recently introduced new restrictions on calf hunting in northern Ontario. Although hunters still do not require a validation tag to hunt a calf moose, the ministry has shortened the calf hunting season. In northern Ontario, the open season for moose varies across management units – ranging from about 3 to 12 weeks between late September and mid-December. Previously, calves could be hunted during the entire moose season, but as of 2015, calf moose can only be hunted during a two-week period within the season.

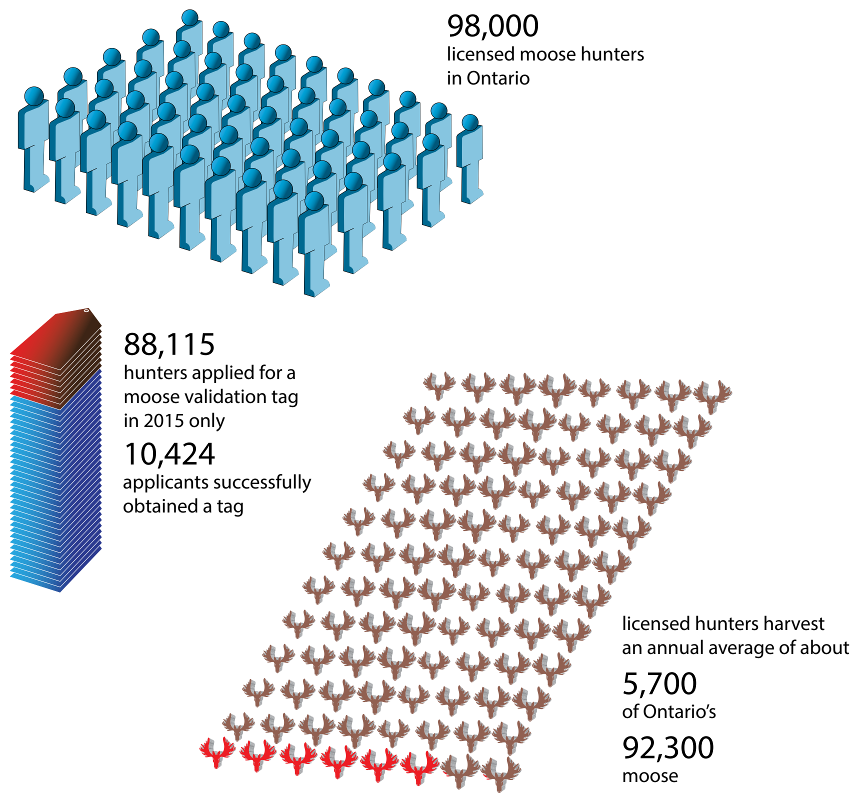
In southern Ontario, moose hunting is open only to resident hunters, and generally only during one week in October. Beginning in 2017, the southern moose season will be extended by one day and synchronized with the northern calf season, limiting hunters' ability to hunt calf moose in both the southern and northern seasons.

> In most of the province, every licensed hunter could at least theoretically kill one calf.

However, efforts to manage the impact of hunting on moose populations through adjusting seasons or tag numbers are not always effective.[16] The success of the MNRF's new moose hunting restrictions will largely depend on how hunters respond. Over time, hunters may change their behaviour to have greater success (e.g., put in more effort or become more efficient). Illegal moose hunting is also a problem in Ontario, which may undermine the ministry's efforts to reduce hunting pressure on moose.

Source: Doug Brown used under CC BY 2.0.

MOOSE HUNTING BY THE NUMBERS



The MNRF Rejects its Own Proposal for Killing More Wolves and Coyotes

Aside from humans, wolves and black bears are the primary predators of moose in Ontario. As part of its Moose Project, in January 2016 the MNRF proposed to reduce restrictions on wolf and coyote hunting, ostensibly to "address concerns in recent years about the impacts of wolf predation on moose in northern Ontario," among other reasons.

Licensed hunters in northern and parts of central Ontario are required to have a small game licence and purchase game seals in order to hunt wolves and coyotes. The MNRF's proposal would have seen the elimination of the requirement to purchase a game seal in northern Ontario, while maintaining a harvest limit of two wolves per licensed hunter in the north and central regions. The ministry also proposed to remove the limit on coyote harvest in the north. The proposal did not involve any changes to the closed hunting season for wolves and coyotes in Algonquin Provincial Park and the surrounding townships.

Source: John and Karen Hollingsworth/U.S. Fish and Wildlife Service used under CC BY 2.0.

Essentially, this proposal would have reduced the administrative barriers to killing wolves and coyotes, allowing for more opportunistic hunting, and increasing the likelihood that the annual wolf and coyote harvest would rise.

This proposal sparked an overwhelming public reaction. After receiving more than 12,000 comments on the Environmental Registry, and several petitions with over 200,000 signatures combined, the MNRF announced that it had decided not to proceed with the proposal.

The public opposition was well founded – killing predators can have serious ecological consequences and is not likely to help moose.

The MNRF does not have reliable data on wolf populations or predation rates – despite the formal commitments to gather this information made in the ministry's 2005 *Strategy for Wolf Conservation in Ontario* (see pages 73-76 of the ECO's 2005/2006 Annual Report). Moreover, killing wolves is unlikely to decrease moose predation unless large numbers of wolves are killed.[17] The MNRF has acknowledged that, "The number of moose killed per wolf pack will not significantly decrease as the pack size is reduced, so removing just a few wolves from each pack will not decrease overall predation on moose. Only the removal of an entire pack can substantially reduce predation but this practice may not be ecologically or socially desirable."

Interfering with this immensely important apex predator community could have unanticipated effects.[18] For example, distinguishing between wolves and coyotes in the wild is difficult. Although the MNRF asserted that hunters are able to distinguish wolves and coyotes, this conflicts with many documented cases of hunters mistaking wolves for coyotes and killing them in error.[19] This means that despite any limits placed on the number of wolves that can be hunted, many more could actually be killed (particularly if the coyote harvest is unlimited), which could have serious adverse impacts on wolf populations.

Potential changes in wolf pack dynamics could also have unpredictable ecological effects, which go well beyond their impact on moose populations.[20] For example, hunting can encourage wolf-coyote hybridization.[21] Moreover, because wolves are a top predator, there could be cascading effects on other species, some of which have huge economic value in Ontario (e.g., fox).[22]

Counterintuitively, reducing restrictions on wolf and coyote hunting could increase the number of coyotes (unless at least 75 per cent of the coyote population is eliminated[23]): coyotes are known to breed more in response to hunting;[24] and fewer wolves means that wolves will not control coyote populations.[25]

No Changes to Moose Habitat Management

The MNRF's Moose Project did not result in immediate changes to moose habitat management. There are many questions about moose habitat that need to be addressed in the coming years. Moose require a mosaic of different types of habitat – a key part of this mosaic is young forest that is in the process of regenerating following a disturbance. But fire, the most significant natural disturbance in the boreal forest, has been actively suppressed for well over 100 years (see Chapter 1 of this report – *Walking the Fire Line: Managing and Using Forest Fire in Northern Ontario*). In the absence of fire, Ontario's forest management guides contain prescriptions for moose habitat that are meant to mimic natural disturbance. It is unclear how fire suppression, combined with less wood harvesting over the past decade (see Part 3.5 of the ECO's 2013/2014 Annual Report), has affected moose habitat and/or future habitat. For example, according to Anishinaabeg elders of northwestern Ontario and northeastern Manitoba, the longer a forest goes without burning, the fewer moose there will be in that forest. The MNRF states that it is using new methods to analyze moose habitat to inform the next review of the *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales*.

Increased road density can lead to local population declines from increased hunting and predation pressure.

Road density, which is increasing throughout most of the province, could also affect the success of the new hunting restrictions, especially resource roads for logging or mining. Increased road density can lead to local population declines from increased hunting and predation pressure.[26] The ministry states that it is assessing the effectiveness of access controls on operational roads during the moose hunting season.

3.1.2 Decisions Without Data

The MNRF invests substantial resources in monitoring moose populations. The ministry conducts aerial surveys of each management unit every three to five years. But while this enables the MNRF to track the status of moose populations, these monitoring efforts generally do not provide much insight into why populations are increasing or decreasing. Given the large number of factors that influence moose population dynamics it is critical that the ministry conduct ongoing research, and closely track the on-the-ground effects of its management efforts.

Unfortunately, the MNRF may not be able to know whether the recent changes to moose hunting will reduce hunting mortality and support moose populations because it collects incomplete information from hunters. The ministry gathers information on hunter success rates through surveys and reports. However, only tourist outfitters and hunters in five management units are required to report their hunting activities to the MNRF. In the rest of the province, hunters are asked to voluntarily complete a randomly distributed questionnaire. Overall, the ministry collects information on hunting activity from about a third of the licensed resident moose hunters in the province. The MNRF also does not have good information on Aboriginal moose hunting, in large part because subsistence hunting by Aboriginal peoples does not fall under provincial jurisdiction.

In effect, the MNRF is making critical decisions with one eye closed, and gambling with Ontario's moose populations.

3.1.3 ECO Comment

A decline of almost 20 per cent in Ontario's moose population over the last decade, in combination with losses across the North American range, is cause for concern. Many different stakeholders have a shared interest in a healthy and stable moose population in Ontario – whether their primary concern is the ecological role of moose or the economic and cultural importance of moose hunting. It is critical that the MNRF do everything it can to ensure the health and resilience of Ontario's moose, before local population declines become a province-wide crisis. Given the current lack of knowledge about the drivers of the population decline, precautionary approaches are appropriate.

Although hunting is just one of several major pressures on Ontario's moose, it is one of the few directly within the MNRF's control. This makes it imperative that the ministry minimize the contribution that hunting makes to moose mortality – whether or not hunting is primarily responsible for the decline. The new restricted calf hunting season and the delayed open season in northern Ontario are reasonable first steps toward reducing hunting pressure on moose populations. But whether these measures go far enough is uncertain. Because the actual number of calves that can be killed during the hunting season is still unrestricted, calf recruitment may not improve. Limiting the calf harvest by requiring hunters to obtain a validation tag may be necessary if the shorter calf hunting season does not produce the needed results. Close monitoring is required, but the MNRF collects incomplete information about hunting activities and harvest. **The ECO recommends that the Ministry of Natural Resources and Forestry implement mandatory reporting for all licensed moose hunters.**

In addition, **the ECO recommends that the Ministry of Natural Resources and Forestry examine and publicly report on whether habitat-related issues are playing a role in moose declines.** Additional management actions by the MNRF such as limiting and decommissioning forest access roads, and restricting hunting in recently logged areas may be needed. The effectiveness of forest management prescriptions in providing moose habitat should also be assessed by the ministry.

The ECO is relieved that the MNRF decided against increasing wolf and coyote hunting in northern Ontario. The MNRF should not damage apex predator communities – especially without evidence that it would improve moose populations. Killing predators would further disrupt an already highly altered ecosystem.

The MNRF may not be able to know whether the recent changes to moose hunting will reduce hunting mortality and support moose populations because it collects incomplete information from hunters.

3.2 White-nose Syndrome: Tragedy of the Bats

Since 2006, an ecological disaster has been quietly progressing in eastern North America. Millions of bats have died from white-nose syndrome (WNS) – a rapidly-spreading disease characterized by the appearance of white fungus on bats' muzzles, ears and wing membranes. First confirmed in Ontario bats in 2010, white-nose syndrome has caused widespread death of cave-dwelling bats, driving four of Ontario's bat species to endangerment.

White-nose syndrome is believed to have been introduced into the U.S. from Europe through human activity and was first detected in North America in February 2006 in caves west of Albany, New York. Since then, it has spread to at least 29 U.S. states and 5 Canadian provinces, including Ontario (Figure 4). In April 2016, the disease was confirmed for the first time on the west coast, in Washington state, sparking fears that the area could become a new epicentre for the disease.

White-nose syndrome is caused by the fungus *Pseudogymnoascus destructans* (Pd), which thrives in cold environments such as the caves where some bat species hibernate. The disease is spread primarily through bat-to-bat transmission, but people who visit caves and old underground mine workings may also accelerate the spread from site to site by transporting the fungus on their clothing and equipment. White-nose syndrome is believed to be spreading an average rate of 200 to 250 kilometres per year.

Bats that are infected with white-nose syndrome wake up more frequently and/or for longer periods of time than normal during winter hibernation. These increased periods of arousal from hibernation lead to dehydration and the premature exhaustion of fat reserves that bats require to survive the winter, leading to a high death rate for infected bats. The high mortality rate of white-nose syndrome (95 to 100 per cent within 2–3 years of detection in many hibernation sites) combined with the naturally low reproductive rates of the affected bat species make for devastating consequences. Although the fungus that causes white-nose syndrome is also found in Europe and Asia, it has not been associated with similar mass mortality events as bat species in those regions appear to have greater resistance.

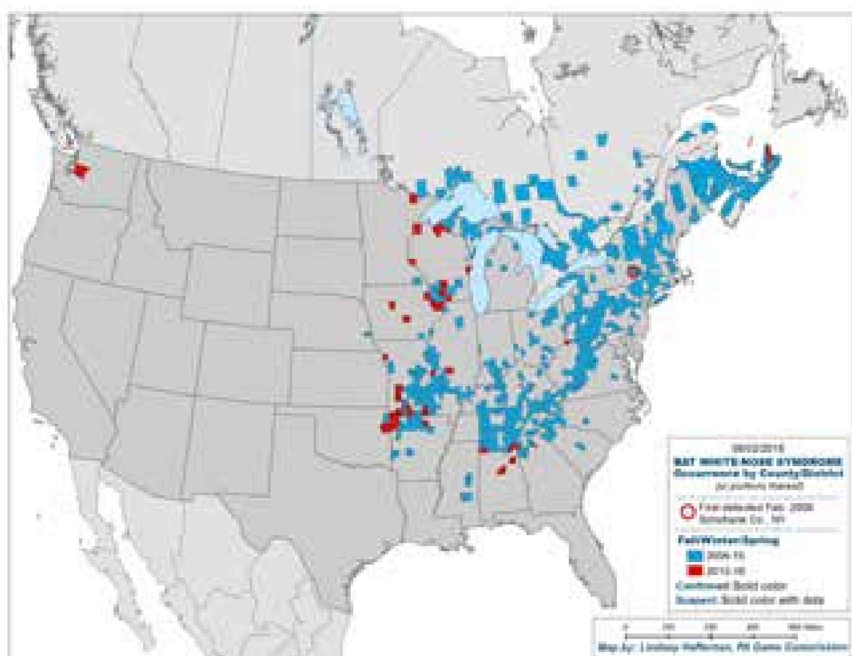


Figure 4. Bat White-Nose Syndrome Occurrence as of August 2016. Source: Lindsey Heffernan, Pennsylvania Game Commission.

A little brown bat infected with white-nose syndrome.Source: Ryan von Linden/New York Department of Environmental Conservation (https://www.flickr.com/photos/usfwshq/5765048289/) used under CC BY 2.0.

3.2.1 The Importance of Bats to the Environment and the Economy

Bats are often misunderstood creatures. Contrary to some commonly held fears and misconceptions, Ontario's bats eat only insects. In fact, bats are a primary predator of night-time flying insects and play an important role in controlling insect pests. Some bat species can eat their own body weight in insects every night. A significant decline in Ontario's bat populations means a significant decline in the volume of insects eaten by bats – which has the potential for big ecosystem and economic impacts.

Reduced insect predation by bats may lead to larger populations of insect pests, which might increase the use of pesticides to prevent damage to forests and agricultural crops. A study in 2011 placed the estimated agricultural losses in the U.S. due to bat population declines at more than $3.7 billion per year.[27] While there is no reliable data for Ontario, one estimate applying the data from the U.S. study puts the annual pest control value of bats to Ontario's agriculture industry at between $100 million and $1.6 billion. Reduced predation by bats could also lead to more mosquitoes and higher rates of mosquito-borne disease, which could affect tourism, and animal and human health.[28] More research is needed to assess the risks in this area.

Some bat species are also important components of cave ecosystems; bat guano (excrement) and decomposing carcases provide nutrients that support communities of some cave-adapted organisms.

Eastern small-footed bat (*Myotis leibii*) Known for its tiny feet – only 7-8 millimetres long – this is the smallest and most rare bat species in Canada. It hibernates in cooler, drier parts of caves and abandoned mines, returning to the same location every year.
Susceptible to WNS: Yes
At-Risk Status: Endangered (*ESA*)
Source: Al Hicks/New York Department of Environmental Conservation (https://www.flickr.com/photos/usfwshq/5881246126/) used under CC BY 2.0.

3.2.2 Ontario's Bat Species

Eight species of bats are native to Ontario. Five of those species hibernate, primarily in caves or abandoned mines, and are known to be susceptible to white-nose syndrome. Four of those hibernating bats, or "cave bats" (eastern small-footed myotis, little brown myotis, northern myotis and tri-colored bat) have been classified as endangered under the *Endangered Species Act, 2007* (*ESA*) as a result of significant declines in their populations due to the disease. Members of the fifth hibernating species, the big brown bat, are "loners" that hibernate in buildings. They are believed to be less affected by white-nose syndrome due to their larger size and broader distribution.

Little brown myotis or little brown bat (*Myotis lucifugus*) This small bat ranges from an olive brown to dark brown colour. Approximately 50 per cent of its global range is in Canada, and before the white-nose syndrome epidemic it was the most common bat species in Ontario. This species hibernates in caves or abandoned mines.
Susceptible to WNS: Yes
At-Risk Status: Endangered (*ESA*; *SARA*)
Source: Ann Froschauer/U.S. Fish and Wildlife Service (https://www.flickr.com/photos/usfwshq/6950623602) used under CC BY 2.0.

The little brown myotis (commonly called the little brown bat) has been hit particularly hard by white-nose syndrome. In Ontario, all known little brown bat hibernation sites are affected. The MNRF has little hope that this species can be recovered in Ontario. Scientists from the U.S. Geological Survey and the U.S. Fish and Wildlife Service have concluded that little brown bat populations affected by white-nose syndrome "are unlikely to return to healthy levels in the near future."

Little brown bat populations affected by white-nose syndrome "are unlikely to return to healthy levels in the near future."

Eastern red bat (*Lasiurus borealis*) This reddish-brown "tree bat" roosts exclusively in trees and migrates south every fall to hibernate.
Susceptible to WNS: Unknown
At-Risk Status: Not listed
Source: Elliotte Rusty Harold/Shutterstock.

The other three species of bats in Ontario do not hibernate, but instead migrate south each winter. Ontario's migrating "tree" bats do not use caves and abandoned mines. Their susceptibility to white-nose syndrome is unknown.

White-nose syndrome is by far the most significant and pressing threat to Ontario's bats, though there are other threats that put additional pressure on bat populations – such as human persecution and wind turbines.[29] Recent estimates of wind turbine-related bat mortality in Ontario suggest that roughly 5,200 endangered bats are killed by turbines each year in Ontario (see also Chapter 3.2 of the ECO's 2011/2012 Annual Report, Part 2).[30]

Classification of some of Ontario's hibernating bat species as endangered means that those bats are protected in Ontario from being killed, harmed or harassed, and from having their habitats damaged or destroyed. It also means that recovery strategies must be prepared for those species. The little brown myotis, northern myotis and the tri-colored bat have been assessed as endangered under the federal *Species at Risk Act*; this means that those species are also legally protected on federally-owned lands (e.g., national parks, etc.) in Ontario.

3.2.3 Research into White-Nose Syndrome

There is currently no treatment for white-nose syndrome. Significant knowledge gaps about the ecology and transmission of the disease have complicated efforts to respond. However, there is some reason to be hopeful that white-nose syndrome can be combatted. While seeking to identify potential biological control treatments for the disease, researchers at Georgia State University recently discovered that a strain of a common soil bacterium, *Rhodococcus rhodochrousin*, produces compounds that inhibit the growth of Pd (the fungus that causes white-nose syndrome) without requiring direct contact.[31] The U.S. Forest Service in Missouri subsequently found that some bats were able to survive infection with white-nose syndrome with the help of exposure to *Rhodococcus rhodochrousin* in field tests.

Similarly, a study by University of California, Santa Cruz found that bacteria naturally occurring on the skin of some bats can inhibit the growth of Pd in laboratory tests.[32] Other potential treatments include controlling climate (e.g., cave temperature and humidity) in hibernation areas to slow the growth of Pd, and developing a vaccine to improve white-nose syndrome resistance.

Research will be needed to determine whether these measures are ecologically safe and effective in protecting bats from white-nose syndrome; but even if they are, it may be too late for areas like Ontario that have already experienced massive die-offs. However, these findings are potentially promising because they could lead to tactics that prevent further expansion of the range of white-nose syndrome, and/or reduce mortality in surviving populations.

Additionally, some bats are surviving in areas affected by white-nose syndrome. In Vermont, researchers found a number of surviving bats in a colony in Addison County. In Ontario, a group of approximately 100 bats in a maternity roost seem to have survived. Research is needed to determine why some individuals are able to survive, and how that information could be used to protect other bats from the disease.

In the absence of a cure for white-nose syndrome, governments and agencies across North America are collaborating to develop plans to respond. A co-ordinated approach across Canada and the U.S. is necessary because of the rapidly spreading range of white-nose syndrome across provincial, territorial and international boundaries. Both the U.S. and Canada have released national plans to respond to white-nose syndrome, and some U.S. states have released their own plans as well. In Ontario, a multi-agency working group including representatives from the MNRF, the Ministry of Northern Development and Mines, and the Canadian Wildlife Health Cooperative (CWHC) have collaborated to prepare *Ontario's White-nose Syndrome Response Plan*, which was released in 2015.

Northern myotis or Northern long-eared bat (*Myotis septentrionalis*) These bats, which resemble little brown bats, are characterized by their long ears. They are found in forested areas, and hibernate in caves or abandoned mines in small groups. Approximately 40 per cent of their global range is in Canada.
Susceptible to WNS: Yes
At-Risk Status: Endangered (*ESA*, *SARA*)
Source: Dave Thomas (https://www.flickr.com/photos/davidjthomas/10138888576) used under CC BY-NC 2.0.

Big brown bat (*Eptesicus fuscus*) This bat species, the second-largest in Canada, can be found in a diverse range of habitats and environmental conditions, even during hibernation. These "loners" are more likely than other species to be found in buildings over the winter.
Susceptible to WNS: Yes
At-Risk Status: Not listed
Source: Ann Froschauer/U.S. Fish and Wildlife Service (https://www.flickr.com/photos/usfwshq/6830043084/) used under CC BY 2.0.

3.2.4 Ontario's White-nose Syndrome Response Plan

Ontario's White-nose Syndrome Response Plan is intended to identify the risks white-nose syndrome presents to Ontario bat populations and to outline a co-ordinated provincial response with respect to prevention, surveillance and monitoring, and research.

The Plan will require Ontario to work collaboratively with five technical working groups established under Canada's national strategy for communications and outreach, data management, mitigation, population monitoring, and surveillance and diagnostics. The working groups co-ordinate provincial, national and international activities to combat white-nose syndrome.

Prevention

Ontario's chief goals related to prevention are to increase awareness about white-nose syndrome, and to limit the inadvertent spread of the disease by human activities.

Public Awareness and Reporting

Working with Canada's WNS Communications and Outreach Working Group, Ontario has identified communications goals aimed at increasing public awareness about white-nose syndrome and informing people that come into contact with bats. Related actions include: maintaining a publicly available source of information about white-nose syndrome; providing information about steps being taken to prevent the spread of the disease; and encouraging the public to report daytime observations of bats, as well as dead, sick or injured bats during the winter months.

Containment

The fungus that causes white-nose syndrome can be spread by humans that visit caves and old underground mine workings even if they don't come into direct contact with bats. The Plan emphasizes the need for people to avoid visiting sites where the disease is present or where bats may be present, and for individuals who have been in a cave or underground mine to disinfect all their clothing and equipment in accordance with decontamination protocols. The MNRF commits to collaborating with the WNS Mitigation Technical Working Group to develop "best practice guidelines for mitigation of WNS, including guidelines for hibernacula protection."

Outreach and Stakeholder Collaboration

The MNRF, in collaboration with the Ministry of Northern Development and Mines and the CWHC, is working with stakeholder groups and the mining industry to educate those entering mines about white-nose syndrome, how to prevent its spread, and how to avoid disturbing and causing further stress to vulnerable hibernating bats. The Plan identifies actions to achieve that end involving the distribution of targeted information notices to the public and stakeholders that may enter caves or old mine workings, mineral exploration and mining industry personnel, and wildlife removal operators.

Species at Risk Status

Under Ontario's *ESA*, the MNRF is required to ensure that within one year of a species being listed as endangered, a recovery strategy is prepared for that species. The Plan commits the MNRF to working with other jurisdictions in preparing co-ordinated recovery strategies under the federal species at risk law for the little brown myotis and the northern myotis across their ranges. The Ontario government anticipates adopting the federal recovery strategies for those species within one year of their completion. It is unclear whether this approach will also be applied to the tri-colored bat, which was listed as endangered under the *ESA* in June 2016 – more than a year after the Plan's release.

The Plan states that "these recovery strategies will support efforts described throughout this response plan" and that the MNRF will consider the actions recommended in recovery strategies when it prepares government response statements that identify the actions it will undertake (a process that will take an additional nine months or more after the recovery strategies are completed).

Meanwhile, a draft recovery strategy for the eastern small-footed bat was released by the MNRF in June 2016 (Environmental Registry #012-7547), nearly a year later than originally expected under the *ESA*'s timelines.

In addition to recovery planning, the Plan notes that habitat protection provisions under the *ESA* may assist in reducing the rate of spread of white-nose syndrome and human disturbance in areas occupied by bat colonies. The Plan also states that "the development of techniques for fungal decontaminating of both natural and artificial bat hibernacula may become important elements in habitat protection/restoration," but does not include any commitments to pursue the development of such techniques.

Surveillance and Monitoring

The Plan emphasizes the need for co-ordinated surveillance for early detection of white-nose syndrome in new areas. A "key goal" of the Plan is "to provide a framework for consistent, co-ordinated WNS surveillance."

Within known affected areas, the purpose of surveillance is to assess the impacts of infection, while in other areas surveillance is needed to detect white-nose syndrome at unconfirmed sites. Surveillance and monitoring techniques include maternity roost surveys, hibernacula entrance sur-

Tri-colored bat or eastern pipistrelle (*Perimyotis subflavus*) The tri-colored bat (named for its grey, yellow and dark brown fur) is one of the smallest bats in North America. It hibernates in caves or abandoned mines in small groups or alone.
Susceptible to WNS: Yes
At-Risk Status: Endangered (*ESA*; *SARA*)
Source: Ann Froschauer/U.S. Fish and Wildlife Service (https://www.flickr.com/photos/usfwshq/6976172577) used under CC BY 2.0.

veys, and acoustic transect surveys. The Plan also identifies public reporting as "an essential WNS surveillance technique," and urges the public to report observations of bats flying during the day in the winter, or dead, sick or injured bats, so that potential occurrences of the disease can be tracked.

While the Plan is light on specifics regarding the actual surveillance and monitoring actions Ontario will undertake, it states that the government will work with the national WNS Bat Population Monitoring and Surveillance Technical Working Groups to implement a national monitoring plan and white-nose syndrome monitoring protocols.

Diagnostics and Testing

Testing that is carried out on bats is submitted to CWHC to determine whether Pd infection can be confirmed. For bats that are found dead or dying, a cause of death is identified if possible. A positive confirmation of white-nose syndrome is usually available within two weeks. When the disease is confirmed, the information is distributed to national and international WNS partners, and public health units may also be informed depending on site location (due to concerns about the handling of bats and the associated risk of rabies transmission).

Data Management and Reporting

The Plan describes the importance of developing uniform standards for data collection and management to allow the sharing of data provincially, nationally and internationally. It notes that the North American Bat Monitoring Program (NABat) "is an important step forward in establishing a standardized, long-term monitoring program and data collection standard for bat species across North America."

Research

The Plan recognizes that although an international community of researchers has been working to increase understanding of white-nose syndrome, there are still significant knowledge gaps. The Plan identifies several areas in which research is needed, including: population-level impacts; relevant aspects of bat ecology and behaviour; epidemiology of white-nose syndrome; and risks to other species and environments.

However, the Plan does not commit the province to any specific research initiatives. The Plan emphasizes the importance of conducting research activities in partnership with academic entities, non-governmental organizations and provincial and federal agencies, and that "it is essential that Ontario-based research connect with the surveillance and research activities of the CWHC and broader international community."

The MNRF's current research initiatives include: developing a citizen science network to contribute to monitoring and identifying natural caves/hibernacula and maternity roosts; monitoring known maternity colonies and hibernacula at appropriate times of the year; evaluating the NABat acoustic transect methodology; acoustic and ground surveys assessing distribution of eastern small-footed bat; and, supporting bat research and stewardship via two research funds.

Disease Management

Because there is no treatment for white-nose syndrome, disease management is focused on monitoring infected sites and preventing the spread of the disease. The Plan notes that it supports an adaptive approach to white-nose syndrome management, and identifies several key questions that will increase understanding of the disease and direct future treatment options (e.g., are there characteristics that make some bats more susceptible than others, and under what conditions can bats survive infection?).

Silver-haired bat (*Lasionycteris noctivagans*) Typified by the silver tips of the hair on their backs, these solitary tree bats migrate south in the fall.
Susceptible to WNS: Yes
At-Risk Status: None
Source: Lassen NPS (https://www.flickr.com/photos/lassennps/9403869552/) used under CC BY 2.0.

3.2.5 ECO Comment

White-nose syndrome – considered to be "the most devastating epizootic wildlife disease of mammals in history"[33] – is an ecological emergency, with the full extent of its consequences still unknown. Ontario's four endangered bat species are now at serious risk of extinction – a tragic and irreversible loss of biodiversity. The ways in which the loss of these species will impact their ecosystems is unknown. People also need to prepare for greater problems with insect pests controlled by bats.

The rapid spread of the disease, combined with its high mortality rate, low reproductive rates of susceptible bat species, and the lack of knowledge about bats and their ecology, present immense challenges to combatting the disease. Prevention and research are both necessary in the fight against white-nose syndrome. Collaboration with other provincial, national and international partners and, in particular, co-ordination with the technical working groups under Canada's national plan, is critical for information and monitoring purposes, and for identifying best practices.

Ontario's White-nose Syndrome Response Plan focuses on preventing the spread of white-nose syndrome through containment and de-contamination actions. Surveillance and monitoring will help identify the emergence of white-nose syndrome in new areas – allowing for rapid response – and assess its impact in affected areas. The MNRF's communication and outreach efforts may discourage people from inadvertently spreading the disease, and help gather information about infected bats. All of these efforts should help limit the spread of white-nose syndrome and, hopefully, limit its devastating impact on bat populations in other parts of Canada.

The communications actions outlined in the Plan have the potential to ensure that the people in Ontario most likely to come into contact with bats (e.g., researchers, wildlife technicians, the mining industry, and recreational cavers, spelunkers and geocachers) are well informed about white-nose syndrome and can avoid spreading it. They could also prompt members of the public to report observations to the CWHC of winter day-flying bat activity, or of dead, sick or injured bats, to help identify potential occurrences of white-nose syndrome. But more than a year after the release of the Plan, there is only minimal publicly available information about white-nose syndrome in Ontario. The Plan's communication actions can be implemented quickly with minimal resources – the ECO urges the MNRF to undertake these actions as soon as possible.

Hoary bat (*Lasiurus cinereus*) This light brown, solitary tree bat is the largest bat species in Canada. It roosts in trees and migrates south every year to hibernate.
Susceptible to WNS: Unknown
At-Risk Status: None
Source: Paul Cryan, U.S. Geological Survey.

Although the Plan identifies several questions that need to be answered to increase understanding of white-nose syndrome survival and treatment, it is unclear whether Ontario is attempting to answer them. In the face of potential extirpation of some of Ontario's native bat species, the Ontario government should urgently undertake (or fund) research of treatment options and other ways to reduce the impacts of the disease in Ontario.

Finally, the Plan states that it is "intended to promote the conservation of Ontario's native hibernating bat species, and recovery of those species that are at risk;" however, the MNRF provides no concrete plan related to recovery. It relies instead on yet-to-be-prepared recovery strategies under the *Endangered Species Act, 2007*. Given that the Plan acknowledges the low likelihood of recovery of affected populations, it is unclear what the recovery strategies for Ontario's affected endangered bat species may recommend – or whether they will be finalized in time to make a difference. **The ECO recommends that the Ministry of Natural Resources and Forestry take accelerated steps to identify and implement potential recovery actions for at-risk bat species as soon as possible.** The *ESA* process can proceed in parallel with any such action.

3.3 Update: Amphibian Declines Continue in Ontario

3.3.1 Amphibians Are Declining Around the World

Amphibians are the most threatened group of vertebrate animals in the world. According to the International Union for Conservation of Nature's *Red List of Threatened Species*, over 42 per cent of amphibian species are in decline, and at least a third of amphibian species are globally threatened or extinct. In 2008, researchers from the University of California, Berkeley and San Francisco State University warned, "[a] general message from amphibians is that we may have little time to stave off a potential mass extinction."[34]

Ontario's amphibians are faring only slightly better: of the 27 native species and subspecies of frogs, toads, salamanders, and newts, 3 are believed to be extirpated (meaning that they no longer live in the wild in Ontario), and an additional 5 species (Allegheny Mountain dusky salamander, northern dusky salamander, Fowler's toad, Jefferson salamander and small-mouthed salamander) are listed as endangered under the *Endangered Species Act, 2007* (*ESA*).[35]

Amphibians are the most threatened group of vertebrate animals in the world.

Over the last several decades, researchers have observed declines (some localized) in several Ontario species, including the Jefferson salamander, pickerel frog, bullfrog, Fowler's toad, boreal chorus frog and western chorus frog.

Since the ECO last reported on amphibian declines in 2009, two species (Fowler's toad and Jefferson salamander) have been uplisted from threatened to endangered under the *ESA* – meaning that these species are now considered to be "facing imminent extinction or extirpation."

One of the major drivers of the international amphibian decline is a chytrid fungal infection that has caused mass mortality of frogs, toads and salamanders. This fungus has not been a major threat to Ontario's amphibians to date, though there are concerns about their potential vulnerability.[36] But both globally and in Ontario, the most significant threat is habitat loss. Habitat degradation (e.g., from pollutants such as agrochemicals, pharmaceuticals and road salt), habitat fragmentation, road mortality, overharvesting, invasive species (see Chapter 2 of this report – *Invasive Species Management in Ontario: New Act, Little Action*), other infectious diseases, climate change, and ozone depletion also put immense pressure on amphibian populations. For a detailed examination of the threats facing Ontario's amphibians, see Part 4.2 of the ECO's 2008/2009 Annual Report.

In recognition of these threats and the associated declines in amphibian populations, in 2009 the ECO recommended that the MNRF develop and lead a co-ordinated interministerial plan to protect and conserve amphibian populations, reflecting the full range of threats and challenges. Seven years later, the government has yet to act on this recommendation.

Blanchard's cricket frog (*Acris blanchardi*) This tiny frog was once found on Pelee Island and Point Pelee, but there hasn't been a confirmed sighting of this species since the late 1970s.
At-Risk Status: Extirpated (*ESA*); Endangered (*SARA*)
Source: Jessica Piispanen/U.S. Fish and Wildlife Service Midwest (https://www.flickr.com/photos/usfwsmidwest/15275071319) used under CC BY 2.0.

Jefferson salamander (*Ambystoma jeffersonianum*) These large salamanders live in deciduous forests that contain suitable breeding ponds. Habitat loss and degradation, including agricultural development, urban expansion, resource extraction and wetland draining are serious threats. Many Jefferson salamanders are also killed on roads during their breeding migration.
At-Risk Status: Endangered (*ESA*); Threatened (*SARA*)
Source: United States Department of Agriculture. Source: Paul Cryan, U.S. Geological Survey.

3.3.2 The Importance of Amphibians

Amphibians have many significant ecological functions, but their central importance lies in their key position in food webs – both as consumers and as prey. As predators, amphibians consume algae, detritus and large numbers of insects. They help control insects, including mosquitoes, reducing the spread of mosquito-borne illnesses. Amphibians are also an important source of food for many predators including snakes and fish. Amphibians play a part in ecosystem processes such as decomposition, nutrient cycling, and primary production, and they may influence the structure of their ecosystems.

Because of their sensitivity to environmental change, amphibians are considered by many researchers to be good indicators of ecosystem health for both terrestrial and aquatic ecosystems.

3.3.3 Barriers to Amphibian Conservation in Ontario

Insufficient Habitat Protection

Large areas of amphibian habitat, particularly woodlands and wetlands, have been destroyed or degraded by development, infrastructure, roads, forestry, aggregate extraction and mine development. For example, wetlands are crucial habitat for many amphibians, but more than 70 per cent of southern Ontario's original wetlands have been lost – driving the extirpation and endangerment of several of Ontario's amphibian species.

There are various provincial policies that are supposed to provide a degree of protection for wetlands and other amphibian habitat. Nevertheless, wetlands continue to be lost. For example, the *Provincial Policy Statement, 2014* (PPS) restricts site alteration and development in some wetlands, woodlands and wildlife habitat, but the protection provided to such features is far from adequate. The PPS protections only apply to certain natural heritage features (e.g., wetlands or other features evaluated and designated as "significant"), and certain parts of the province, and exempt a wide range of habitat-damaging activities (including infrastructure like roads). For a more detailed examination of these protections see Part 5.2 of the ECO's 2013/2014 Annual Report.

Similarly, provincially significant wetlands are not protected from agricultural drainage under the *Drainage Act*. In the ECO's 2009/2010 Annual Report we recommended that the Ministry of Agriculture, Food and Rural Affairs amend the *Drainage Act* and its policies to ensure that provincially significant wetlands are protected from being drained (see Part 4.6). Six years later, the government still has not acted on this recommendation.

There is a greater degree of habitat protection for the five endangered species listed under the *ESA*. The *ESA* prohibits damaging and destroying habitat without first obtaining an authorization from the MNRF; such authorizations generally include conditions that require a proponent to minimize adverse effects on a species, and in some cases, provide an "overall benefit" to the species (for further information see the ECO's 2013 Special Report *Laying Siege to the Last Line of Defence: A Review of Ontario's Weakened Protections for Species at Risk*). However, the ECO is not aware of any circumstances in which the ministry has refused to issue such an authorization.

Fowler's toad (*Anaxyrus fowleri*) In Ontario, Fowler's toads live in a narrow swath of habitat within about 500 metres of Lake Erie, making them extremely vulnerable to the impacts of shoreline development and recreation. Today Fowler's toad is found only in three locations in the province – Rondeau, Long Point and Niagara.
At-Risk Status: Endangered (*ESA*; *SARA*)
Source: Laura Perlick, U.S. Fish and Wildlife Service.

Habitat fragmentation throughout the province takes a serious toll on Ontario's amphibians. Significant numbers of amphibians are killed each year on Ontario's roads. Many amphibian species occupy different habitats throughout their lifecycle, and may migrate (often *en masse*) along and across roads for breeding, dispersal, foraging, etc. These migrations can result in very high mortality, with serious impacts on local amphibian populations, including localized declines and even extirpations. Contaminants from roads, especially road salt, can degrade local habitat as well.

Careful planning by, for example, constructing roads away from wildlife hotspots, can minimize road mortality. Harm can also be mitigated to some extent by incorporating ecopasssages with fencing to allow amphibians to cross roads, and implementing road closures during migrations. Although there are some notable examples of such tactics being used in Ontario, these measures have not been widely implemented. For several years, there has been talk of the Ministry of Transportation developing a province-wide wildlife mitigation strategy to address these very issues. However, to date the ministry has not publicly shared or consulted the public on such a strategy. Public consultation on a major revision to the ministry's *Environmental Guide for Wildlife Mitigation* between July and September 2016 (Environmental Registry #012-7980) is a hopeful sign of renewed government interest in this issue.

Lack of Monitoring

Monitoring is an important element of successful species conservation. Without good information on the locations and sizes of populations over time, it is nearly impossible to determine when and how to take action. A lack of monitoring precludes preventative steps to keep species from becoming "at risk," and makes it difficult to evaluate the effectiveness of conservation actions.

There are few government-led amphibian monitoring efforts in Ontario. For example, only one amphibian species (red-backed salamander) is monitored by the Provincial Wildlife Population Monitoring Program, which aims to evaluate the impact of commercial forestry on Ontario's wildlife. In addition, although monitoring activities are identified as high priority actions in every government response statement for amphibians listed under the *ESA*, they are "government supported" actions, rather than efforts the MNRF will undertake itself.

Allegheny Mountain dusky salamander (*Desmognathus ochrophaeus*) These salamanders depend on groundwater and are especially vulnerable to water loss.
At-Risk Status: Endangered (*ESA*); Threatened (*SARA*)
Source: Dave Huth (https://www.flickr.com/photos/davemedia/14228038818) used under CC BY-NC 2.0.

More than 70 per cent of southern Ontario's original wetlands have been lost.

A number of volunteer-based citizen science programs are filling in some of the gaps in amphibian monitoring in Ontario (see Box: *Citizen Science Plays a Key Role in Ecological Monitoring*). But the full responsibility for monitoring amphibians in Ontario cannot be downloaded to volunteer-based programs; for example, a 2008 study identified gaps in both geographic and species coverage in Ontario's frog and toad citizen science monitoring programs – especially in northern Ontario.[37]

Delayed Recovery Actions Under the *Endangered Species Act, 2007*

The small-mouthed salamander has been listed as endangered since the *ESA* came into force. The only known population of small-mouthed salamander in Ontario is on Pelee Island. Locally abundant as recently as the early 1990s, by 2000, two of the five known breeding sites were eliminated by development activities and the permanent loss of water. In Ontario, the species is now found in only three wetlands: two in nature reserves and one on private land.

Although a recovery strategy[40] for the species was initially expected in June 2013, the MNRF delayed its release until March 2015. The recovery strategy recommended a number of actions, including research, monitoring, habitat protection, and outreach to local residents and visitors.

The MNRF was then required to publish a government response statement setting out the actions that the Ontario government intends to undertake to support the protection and recovery of small-mouthed salamander by December 2015. Instead, the ministry published a notice on the Environmental Registry (#012-3514) advising that the statement would be prepared "at a later date," even though the MNRF does not legally have the discretion to delay a response statement under the *ESA*.[41] This delay has left small-mouthed salamander without any government-led or government-supported recovery actions for the foreseeable future.

For more information on the chronic delays in implementing key steps under the *ESA*, see Section 3 of the ECO's 2013 Special Report, *Laying Siege to the Last Line of Defence: A Review of Ontario's Weakened Protections for Species at Risk.*

Citizen Science Plays a Key Role in Ecological Monitoring

Most of the information Ontario has about its amphibian populations is a direct result of citizen science monitoring programs – including programs led by Ontario Nature, the Toronto Zoo, Environment Canada and Bird Studies Canada. Volunteer-based citizen science programs have also been essential to monitoring Ontario's bird populations.

In 2009, Ontario Nature and its partners initiated the Ontario Reptile and Amphibian Atlas,[38] a project that receives support from the MNRF's Species at Risk Stewardship Fund. Since then, more than 3,000 volunteers have submitted over 250,000 sightings of amphibian and reptile species. Interactive range maps are available online, and all information collected by volunteers is shared with Ontario's Natural Heritage Information Centre. Volunteers can submit species sightings online, by email or mail, and via a new mobile app.

New technologies like mobile apps are increasing the potential power of citizen science by supporting identification in the field and allowing volunteers to instantly submit sightings. In spring 2016, Ontario Nature launched the Directory of Ontario Citizen Science,[39] a new online hub that will connect volunteers with projects across Ontario. The free platform allows organizations to post and promote their projects, and lets participants search for citizen science programs that match their interests and abilities. Such programs are valuable conservation tools, provide opportunities for people to engage with nature, and may promote the public's involvement in environmental decision making.

Left: **Northern dusky salamander (*Desmognathus fuscus*)** There are likely fewer than 250 northern dusky salamanders left in Ontario – found at only one location in the Niagara Gorge.
At-Risk Status: Endangered (*ESA*)
Source: Dave Huth (https://www.flickr.com/photos/davemedia/7461570980) used under CC BY-NC 2.0.

Right: **Spring salamander (*Gyrinophilus porphyriticus*)** These brightly coloured salamanders have not been spotted in Ontario since 1877.
At-Risk Status: Extirpated (*ESA*); Special Concern (*SARA*)
Source: John D. Wilson, United States Geological Survey.

Small-mouthed salamander (*Ambystoma texanum*) These salamanders spend most of the non-breeding season underground. During the breeding season they need ponds that are free of fish to lay their eggs.
At-Risk Status: Endangered (*ESA*; *SARA*)
Source: Greg Schechter (https://www.flickr.com/photos/17004938@N00/5602989740) used under CC BY 2.0.

3.3.4 ECO Comment

Given the grave threats facing amphibians around the world, urgent action is required by all jurisdictions to protect remaining amphibian populations. The ECO is dismayed that seven years after we last reported on this problem, Ontario is still not doing its part.

The Ontario government has long given secondary consideration, at best, to the protection of significant natural heritage features critical to the survival of amphibians and so many other species. The MNRF is currently in the process of reviewing the province's wetland conservation framework and developing a *Wetland Conservation Strategy for Ontario* (see Environmental Registry #012-4464 and #012-7675).

It is imperative that the government heed the countless local, provincial and international calls for better wetland protection by genuinely providing substantive protection to provincially significant wetlands, for example, by prohibiting infrastructure such as roads from being built in these areas. **The ECO recommends that the Ministry of Municipal Affairs and Housing remedy one of the largest gaps in wetland protection by prohibiting infrastructure in provincially significant wetlands.** Moreover, the Ontario government should not continue to ignore the broader issue of road mortality – a major threat to amphibians and many other types of wildlife. **The ECO recommends that the Ministry of Transportation finalize and publicly consult on its draft wildlife mitigation strategy for Ontario.**

The ECO commends the many volunteers and environmental organizations that sustain citizen science amphibian monitoring programs, but the role of the MNRF must extend beyond merely providing peripheral support for these monitoring programs – the ministry can and should be playing a leadership role in monitoring the province's biodiversity. Under *Biodiversity, It's In Our Nature*, the Ontario government's plan to conserve biodiversity, the MNRF (with the support of the Ministry of the Environment and Climate Change) is responsible for establishing an integrated, broad-scale monitoring program for Ontario's biodiversity; but with only four

Urgent action is required by all jurisdictions to protect remaining amphibian populations.

Eastern tiger salamander (*Ambystoma tigrinum)* These spotted salamanders can grow up to 35 centimetres. The eastern tiger salamander has not been seen in Ontario since 1915 – it is uncertain whether there was ever a viable population in Ontario.
At-Risk Status: Extirpated (*ESA*; *SARA*)

years remaining under this plan, such a program has not been initiated (see Part 4.1 of the ECO's 2014/2015 Annual Report). **The ECO recommends that the Ministry of Natural Resources and Forestry develop and implement a broad-scale biodiversity monitoring program**, and urges the ministry to ensure that amphibian monitoring is included as a key part of such a program.

Finally, recovery actions for species at risk are arguably the most critical element of the *ESA*'s protection and recovery framework. But recovery measures are not likely to take place in the absence of government response statements. The ECO is extremely disappointed that the MNRF continues to ignore the statutory deadlines under the *ESA* for the preparation of government response statements, and urges the ministry to immediately finalize the government response statement for small-mouthed salamander. Without concerted government action this rare species could be lost forever from Ontario. **The ECO recommends that the Ministry of Natural Resources and Forestry take steps to remedy the chronic delays in finalizing government response statements.**

3.4 Conclusion: What Gets Measured Gets Managed

The ongoing loss of biodiversity is a global catastrophe – the rate at which species are being lost is without precedent in human history. Ontario's species are not immune from this phenomenon, and the Ontario government must address the fact that wildlife declines are becoming a more frequent reality. There are many challenges in conserving native species, including climate change, land use change, invasive species, competing economic interests, scientific uncertainty, and enforcement capacity. But our economy, our health, food production, ecosystem services, ecological resilience, and our cultural heritage all hinge upon efforts to conserve the diversity of species in our province. Tough choices must be made, because the species conservation measures that the government takes – or doesn't take – today will dictate how biodiverse Ontario remains for future generations.

This report includes a number of recommendations aimed at addressing the declines of moose, bats and amphibians, as well as recommendations that will contribute to biodiversity conservation more broadly. While each of these recommendations would provide a tangible benefit for Ontario's biodiversity, obtaining good information on the province's broader biodiversity must be the government's first priority. In a nutshell, what gets measured gets managed. The ECO first formally recommended that the Ontario government develop a biodiversity monitoring program in 2009 (see *The Last Line of Defence: A Review of Ontario's New Protections for Species at Risk*). And the government eventually agreed – the 2012 biodiversity conservation plan (*Biodiversity: It's in Our Nature – Ontario Government Plan to Conserve Biodiversity, 2012-2020*) commits the MNRF, with the support of the Ministry of the Environment and Climate Change, to develop "an integrated, broad-scale monitoring program for all aspects of Ontario's biodiversity." But now, halfway through the plan period, the MNRF still has not taken any action to initiate such a program. At best, current monitoring efforts are piecemeal projects that do not provide an overall, big picture assessment of biodiversity.

The urgency of comprehensively monitoring Ontario's biodiversity is all the more acute in light of Canada's international obligations under the *Convention on Biological Diversity* and the *Aichi Biodiversity Targets*, and because of the urgent threat that climate change poses to Ontario's species. In October 2010, Canada was one of the many countries that committed to improve the status of biodiversity by 2020 by safeguarding ecosystems, species and genetic diversity. Ontario must do its part to help Canada meet this commitment.

Without good information on Ontario's species, including baseline information on population trends and demographics, habitat quantity and quality, etc., the MNRF simply cannot make informed decisions about conservation, or assess whether conservation measures are working. This lack of action must be remedied without delay. With every year the ministry fails to live up to its obligation to meaningfully monitor the province's biodiversity, the already precarious future of many of Ontario's species is becoming even more uncertain. **The ECO recommends that the Ministry of Natural Resources and Forestry develop and implement a broad-scale biodiversity monitoring program.**

3.4.1 Recommendations

The Ministry of Natural Resources and Forestry should implement mandatory reporting for all licensed moose hunters.

The Ministry of Natural Resources and Forestry should examine and publicly report on whether habitat-related issues are playing a role in moose declines.

The Ministry of Natural Resources and Forestry should take accelerated steps to identify and implement potential recovery actions for at-risk bat species as soon as possible.

The Ministry of Natural Resources and Forestry should take steps to remedy the chronic delays in finalizing government response statements.

The Ministry of Municipal Affairs and Housing should prohibit infrastructure in provincially significant wetlands.

The Ministry of Transportation should finalize and publicly consult on its draft wildlife mitigation strategy for provincial roads.

The Ministry of Natural Resources and Forestry should develop and implement a broad-scale biodiversity monitoring program.

Appendix 3: Ministry Comments

Comments from the Ministry of Natural Resources and Forestry

Ontario's Declining Moose Populations

Moose is one of the most intensively managed species in Ontario and a feature species in forest management planning. Ontario has two primary survey programs for moose – the hunter activity and harvest survey and moose aerial inventory population survey. These surveys provide information on moose hunting and moose populations and allow MNRF to relate habitat condition to moose population status. These surveys are designed to be statistically robust and to complement each other to help overcome any potential uncertainty in the results.

Ontario is considering enhancements to monitoring of both hunter activity and harvesting and will be assessing moose habitat considerations in forest management planning.

Ontario will continue monitoring moose populations and over time will evaluate whether further actions may be necessary to address population trends.

White-nose Syndrome: Tragedy of the Bats

Recognizing the significant decline in Ontario's at risk bats, MNRF has expedited implementation of recovery actions by:

- providing immediate and automatic protection of the species and their habitats through the Endangered Species Act (ESA),
- funding or undertaking research initiatives to address knowledge gaps through the SAR Stewardship Fund, SAR Research Fund, and MNRF's Wildlife Research and Monitoring Section, and
- working in collaboration with federal partners to finalize recovery documents to ensure a coordinated and consistent implementation approach.

Update: Amphibian Declines Continue in Ontario

MNRF is committed to the protection and recovery of at-risk amphibian species in Ontario. The ESA prohibits the damage or destruction of the habitat of endangered or threatened species, unless authorized. Such authorization requires that certain conditions be met, such as minimization of adverse effects and the provision of an overall benefit to the species or its habitat. Ministry staff work with proponents where possible to try to first avoid any adverse effects on the species' habitat, thereby not triggering requirements for authorization. MNRF has also published a best practices technical note on design and installation techniques for reptile and amphibian exclusion fencing to reduce harm to these species along roads.

MNRF is developing a Wetland Conservation Strategy for Ontario, and if approved would establish a coordinating framework to guide wetland conservation across the province and support efforts to protect at-risk amphibians. This includes continuing to improve and develop policy approaches as opportunities arise, such as a wetland offsetting policy to prevent the net loss of wetlands and promote net gain.

The ministry remains committed to completing government response statements for species at risk within nine months of finalizing the associated recovery strategy. In some exceptional cases, it may take longer to develop and consult on meaningful policy direction for the species due to additional complexities regarding the species' recovery needs and/or social, economic, and cultural factors.

Endnotes

[1] Ontario's Biodiversity Council (2015). *State of Ontario's Biodiversity 2015: Summary*.

[2] Stuart L. Pimm et al. (2014). The biodiversity of species and their rates of extinction, distribution and protection. *Science* 344(6187): 1246752.

[3] See e.g., Anthony D. Barnosky et al. (2011). Has the Earth's sixth mass extinction already arrived? *Nature* 471 (7336) 51-57; Malcolm L. McCallum (2015). Vertebrate biodiversity losses point to a sixth mass extinction. *Biodiversity and Conservation* 24(1): 2497-2519; Philip Cafaro (2015). Three ways to think about the sixth mass extinction. *Biological Conservation* 192: 387-393; Gerardo Ceballos et al. (2015). Accelerated modern human-induced species losses: Entering the sixth mass extinction. *Science* Advances 1(5): e1400253.

[4] Rodolfo Dirzo et al. (2014). Defaunation in the anthropocene. *Science* 345(6195): 401-406.

[5] Population objectives set out the desired population density for a specific management area. There are several factors that go into determining the appropriate objective, including habitat suitability, the status of a moose population and other biological, social and economic factors.

[6] Kevin L. Monteith et al. (2015). Effects of climate and plant phenology on recruitment of moose at the southern extent of their range. *Oecologia* 178(4): 1137-1148.

[7] Robert S. Rempel (2012). *Effects of Climate Change on Moose Populations: A Vulnerability Analysis for the Clay Belt Ecodistrict (3E-1) in Northeastern Ontario*. Ministry of Natural Resources Climate Change Research Report 26.

[8] W.M. Samuel (2007). Factors affecting epizootics of winter ticks and mortality of moose. *Alces* 43: 39-48.

[9] Anthony R. Musante, Peter J. Pekins and David L. Scarpitti (2010). Characteristics and dynamics of a regional moose *Alces alces* population in the northeastern United States. *Wildlife Biology* 16: 185-204.

[10] N.P. McCann, R.A. Moen and T.R. Harris (2013). Warm-season heat stress in moose (*Alces alces*). *Canadian Journal of Zoology* 91: 893-898.

[11] Ontario is divided into 95 wildlife management units. Each management unit has its own rules for hunting, though hunting rules for moose are generally similar across broad geographic areas.

[12] In addition to hunting individually, groups of two or more licensed hunters may hunt moose together in the same management (known as party hunting). In this case, a game seal and validation tag held by any member of the group can be applied to a moose killed by another member of the party.

[13] According to the MNRF's annual *Hunting Regulation Summaries* from 2011-2016, estimated moose harvests are as follows: 2014 – 4,423; 2013 – 5,420; 2012 – 5,931; 2011 – 6,260; 2010 – 6,541.

[14] According to the MNRF's annual *Hunting Regulation Summaries* from 2011-2016, estimated calf moose harvests are as follows: 2014 – 1,403; 2013 – 1,504; 2012 – 1,574; 2011 – 1,833; 2010 – 2,061.

[15] See Brent R. Patterson et al. (2013). Moose calf mortality in central Ontario, Canada. *Journal of Wildlife Management* 77(4): 832-841; Glen S. Brown (2011). Patterns and causes of demographic variation in a harvested moose population: evidence for the effects of climate and density-dependent drivers. *Journal of Animal Ecology* 80(6): 1288-1298.

[16] See e.g., Peter Sunde and Tommy Asferg (2014). How does harvest size vary with hunting season length? *Wildlife Biology* 20(3): 176-184; Len M. Hunt (2013). Using human-dimensions research to reduce implementation uncertainty for wildlife management: a case of moose (*Alces alces*) hunting in northern Ontario, Canada. *Wildlife Research* 40(1): 61-69.

[17] Robert B. Wielgus and Kaylie A. Peebles (2014). Effects of wolf mortality on livestock depredations. *PLoS ONE* 9(12): e113505 doi:10.1371/journal.pone.0113505; Barbara Zimmermann et al. (2014). Predator-dependent function response in wolves: from food limitation to surplus killing. *Journal of Animal Ecology* 84(1): 102-112.

[18] Scot Creel and Jay J. Rotella (2010). Meta-analysis of relationships between human offtake, total mortality and population dynamics of gray wolves (*Canis lupus*). *PLoS ONE* 5(9): e12918. doi:10.1371/journal.pone.0012918.

[19] See e.g., Thomas M. Newsome, Jeremy T. Bruskotter and William J. Ripple (2015). When shooting a coyote kills a wolf: mistaken identity or misguided management. *Biodiversity and Conservation* 24(12): 3145-3149.

[20] Bridget L. Borg et al. (2015). Impacts of breeder loss on social structure, reproduction and population growth in a social canid. *Journal of Animal Ecology* 84(1): 177-187; Scott M. Brainerd et al. (2008). The effects of breeder loss on wolves. *Journal of Wildlife Management* 72(1): 89-98.

[21] Linda Y. Rutledge et al. (2011). Intense harvesting of eastern wolves facilitated hybridization with coyotes. *Ecology and Evolution* 2(1): 19-33; John F. Benson, Brent R. Patterson and Peter J. Mahoney (2014). A protected area influences a genotype-specific survival and the structure of a Canis hybrid zone. *Ecology* 95(2): 254-264.

[22] Thomas M. Newsome and William J. Ripple (2014). A continental scale trophic cascade from wolves through coyotes to foxes. *Journal of Animal Ecology* 84(1): 49-59.

[23] See e.g., Guy E. Connolly (1995). The effects of control on coyote populations: another look. *Symposium Proceedings – Coyotes in the Southwest: A Compendium of Our Knowledge* 23.

[24] Frederick F. Knowlton, Eric M. Gese and Michael M. Jaeger (1999). Coyote depredation control: an interface between biology and management. *Journal of Range Management* 52(5): 398-412; Brian R. Mitchell, Michael M. Jaeger and Reginald H. Barrett (2004). Coyote depredation management: Current methods and research needs. *Wildlife Society Bulletin* 32(4): 1209-1218.

[25] Kim Murray Berger and Eric M. Gese (2007). Does interference competition with wolves limit the distribution and abundance of coyotes? *Journal of Animal Ecology* 76(6): 1075-1085; J.A. Merkle, D.R. Stahler and D.W. Smith (2009). Interference competition between gray wolves and coyotes in Yellowstone National Park. *Canadian Journal of Zoology* 87(1): 56-63.

[26] H.R. (Tim) Timmerman and M.E. (Mike) Buss (2007). Population and harvest management - Chapter 17 in Albert W. Franzmann and Charles C. Schwartz, eds., *Ecology and Management of the North American Moose* (Boulder, Colorado: University Press of Colorado); Robert S. Rempel et al. (1997). Timber-management and natural-disturbance effects on moose habitat: landscape evaluation. *Journal of Wildlife Management* 61(2): 517-5248; Scott Moffatt (2012). *Time to Event Modelling: Wolf Search Efficiency in Northern Ontario* (M.Sc. Thesis – University of Guelph).

[27] Justin G. Boyles et al. (2001). Economic importance of bats in agriculture. *Science* 332(6205): 41-42.

[28] Hanna T. Reynolds and Hazel A. Barton (2013). White-nose syndrome: human activity in the emergence of an extirpating mycosis. *Microbiology Spectrum* 1(2): OH-0008-2012 doi:10.1128/microbiolspec.

[29] Thomas J. O'Shea et al. (2016). Multiple mortality events in bats: a global review. *Mammal Review* 46(3): 175-190.

[30] Bird Studies Canada, Canadian Wind Energy Association, Environment Canada and Ontario Ministry of Natural Resources (2016). *Wind Energy Bird and Bat Monitoring Database Summary of the Findings from Post-construction Monitoring Reports*. The database summary estimates that 42,656 bats are killed in Ontario between May 1st and October 31st, based on December 2015 installed capacity. The four endangered bat species comprise 12.17 per cent of the bat species found at wind power projects in Ontario – most of which are little brown bats (11.7 per cent).

[31] Christopher T. Cornelison et al. (2014). A preliminary report on the contact-independent antagonism of Pseudogymnoascus destructans by *Rhodococcus rhodochrous* strain DAP96253. *BMC Microbiology* 14:246

[32] Jopseh R. Hoyt et al., (2015). Bacteria isolated from bats inhibit the growth of *Pseudogymnoascus destructans*, the causative agent of white-nose syndrome. *PLoS ONE* 10(4): e0121329. doi:10.1371/journal.pone.0121329.

[33] Kenneth A. Field et al. (2015). The white-nose syndrome transcriptome: activation of anti-fungal host responses in wing tissue of hibernating little brown myotis. *PLoS Pathogens* 11(10): e1005168. doi:10.1371/journal.ppat.1005168 [author summary].

[34] Dave B. Wake and Vance T. Vredenburg (2008). Are we in the midst of the sixth mass extinction? A view from the world of amphibians. *PNAS* 105(1): 11466-11473.

[35] Several of the province's amphibian species are rare because Ontario represents the northern extent of their distribution; these populations may be even more vulnerable because of reduced genetic variability.

[36] See e.g., Craig Stephan et al. (2015). *Batrachochytrium salamandrivorans – A Threat Assessment of Salamander Chytrid Disease*. Canadian Wildlife Health Cooperative.

[37] Debbie S. Badzinski et al. (2008). *Assessment of Trends in Frog and Toad Populations in Ontario using Citizen Science Monitoring Data*. Prepared for the Ecological Monitoring and Assessment Network Coordinating Office, Environment Canada.

[38] ontarionature.org/protect/species/herpetofaunal_atlas.php

[39] ontarionature.org/directory-of-citizen-science/home.php

[40] A recovery strategy provides recommendations on the protection and recovery of an endangered or threatened species.

[41] This notice also indicated that the MNRF would be delaying the government response statements for blue racer and Lake Erie watersnake.

Environmental
Commissioner
of Ontario

1075 Bay Street, Suite 605
Toronto, Ontario
M5S 2B1 Canada

416.325.3377 tel
416.325.3370 fax
1.800.701.6454

www.eco.on.ca

ISSN 2371-4727 (print)
ISSN 2371-4735 (online)

Disponible en français