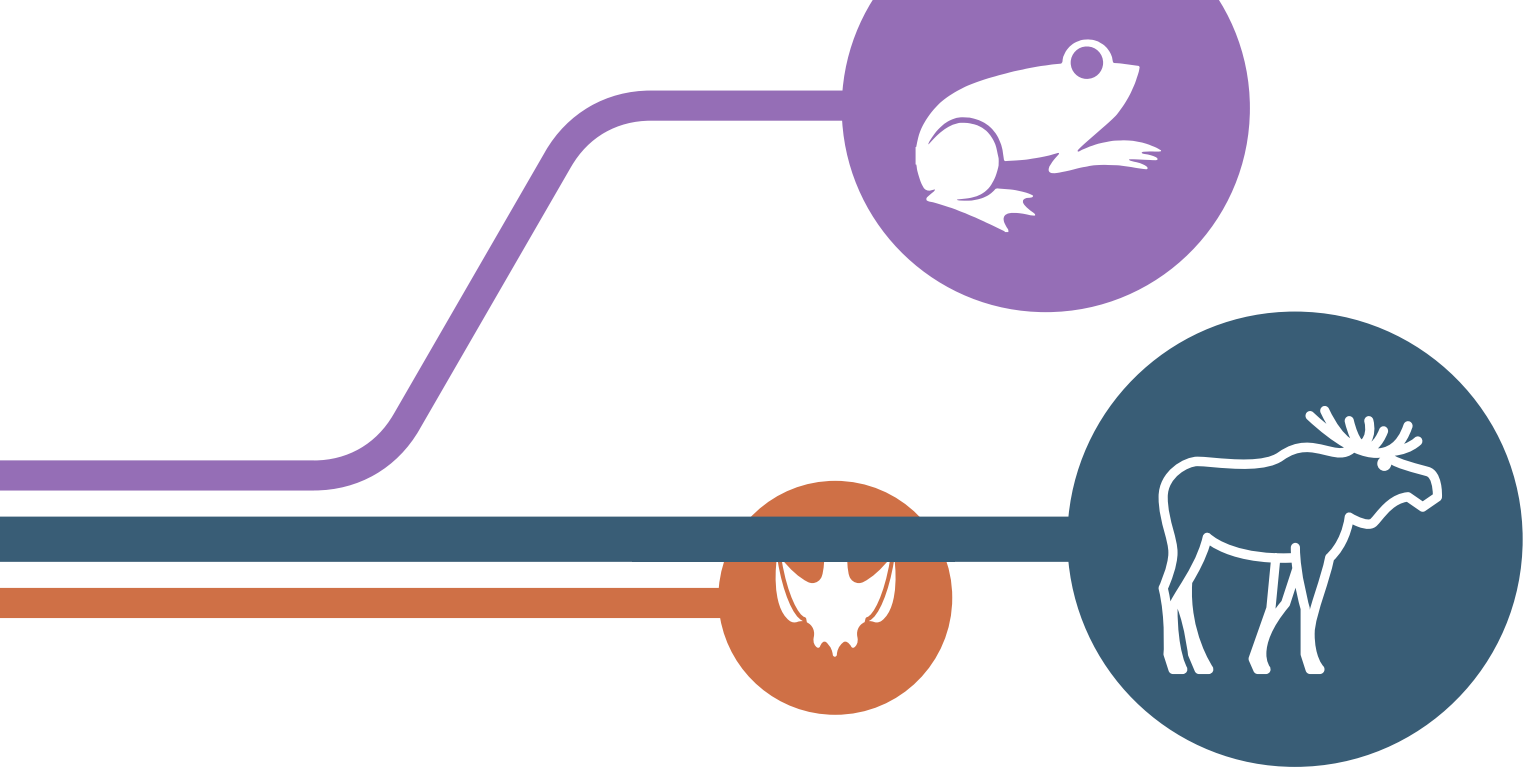
CHAPTER 3
BIODIVERSITY UNDER PRESSURE: WILDLIFE DECLINES IN ONTARIO



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-

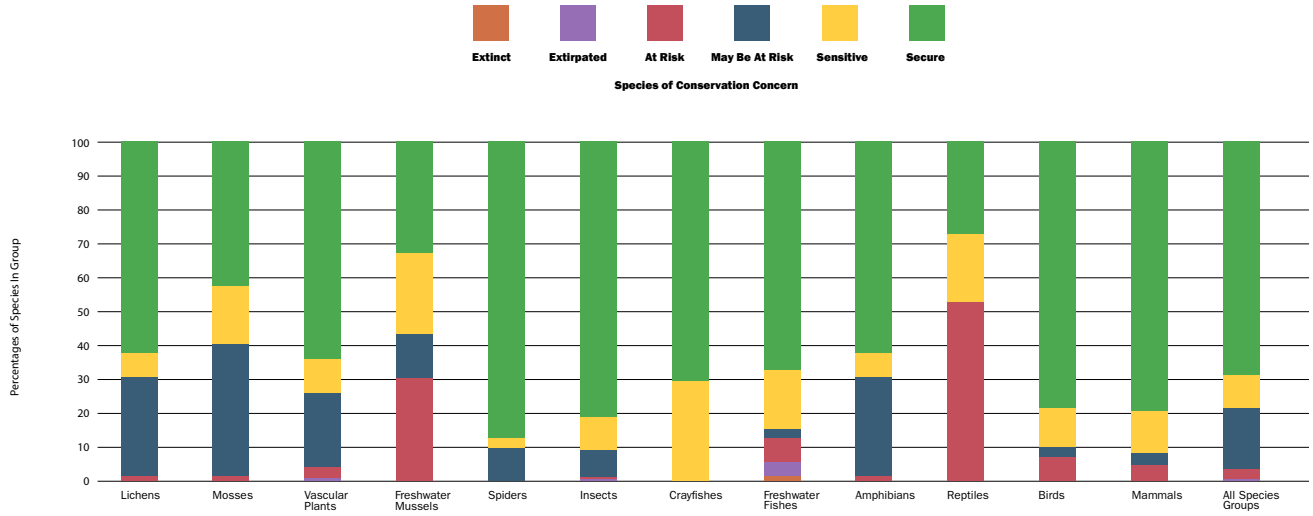


Figure 1. Proportion of Ontario native wild species in secure and conservation concern categories. Source: Ontario Biodiversity Council(2015). State of Ontario's Biodiversity. Available at: http://ontariobiodiversitycouncil.ca/sobr.

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]

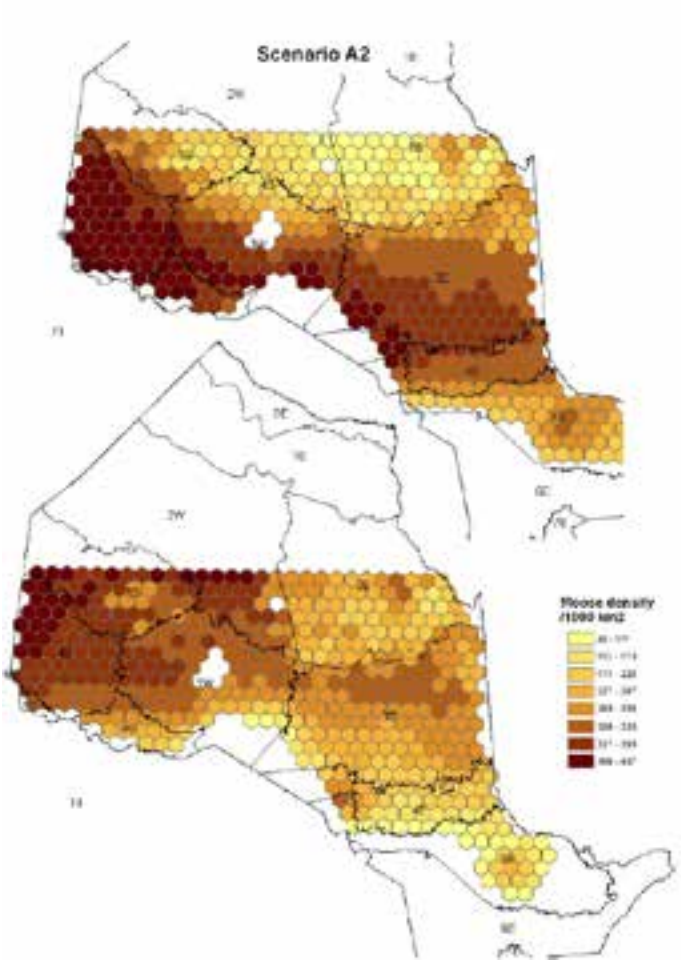


Figure 2. Spatial projection (provincial scale) of moose density (per 1,000 km^2) under the current climate, T1 (1971– 2000), and future climate, T4 (2071–2100), for IPCC (2000) emissions scenario A2 using version 3 of the Canadian Global Climate Model (CGCM3). Modelled areas are monitored through regular 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

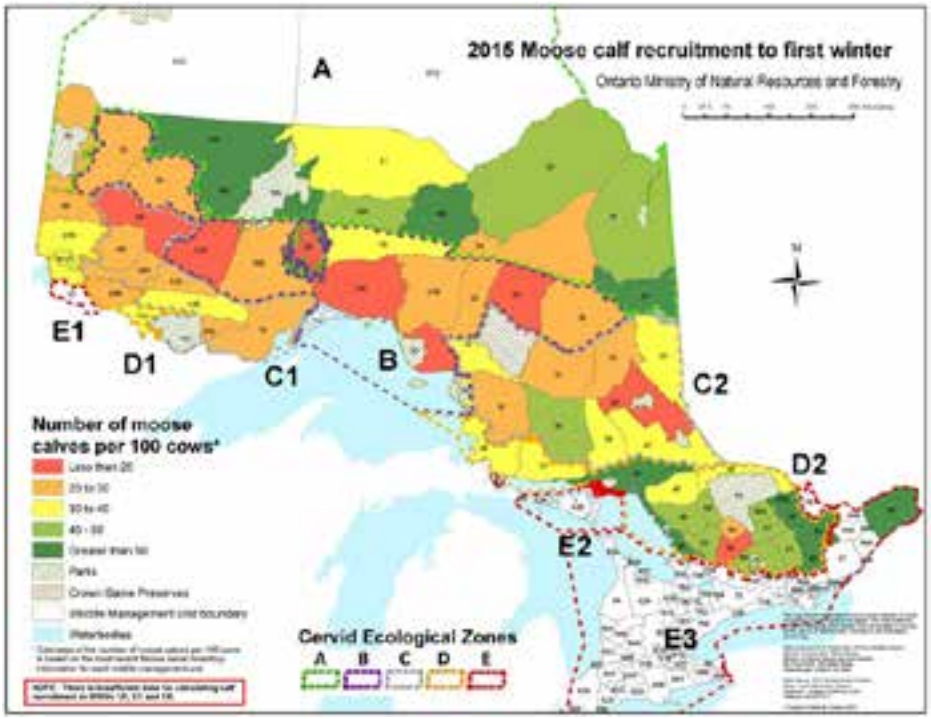


Figure 3. 2015 moose calf recruitment. Source: MNRF

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.

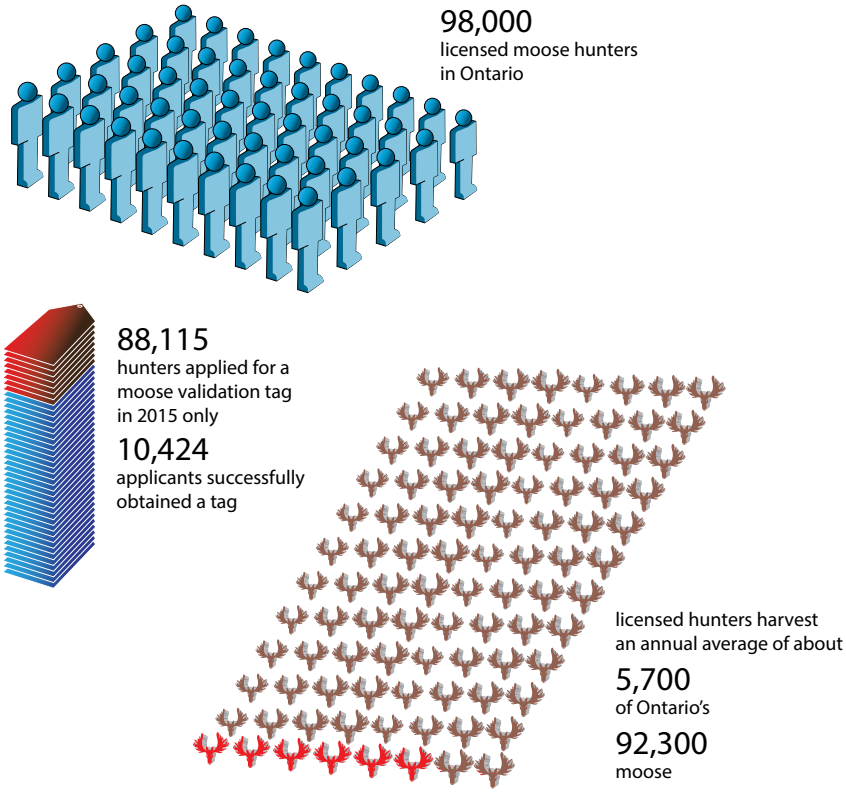
In southern Ontario, moose hunting is open only to resident hunters, and generally only during one week in October. Beginning in 2017, the southern moose season will be extended by one day and synchronized with the northern calf season, limiting hunters' ability to hunt calf moose in both the southern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

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 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.

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

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.

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.

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*)
Source: Peter Paplanus (https://www.flickr.com/photos/2ndpeter/15862551686) used under CC BY 2.0.

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.