# Ontario's Pollinator Health Action Plan





In January 2016, I requested your feedback on a draft action plan to support pollinator health. The response was excellent and, now that we have analyzed the submissions and considered your recommendations, I am pleased to release Ontario's Pollinator Health Action Plan.

As part of the province's broader Pollinator Health Strategy, this plan is designed to help improve the health of all insect pollinators which supports a strong agri-food sector and a healthy environment. The plan builds in actions, timelines and accountability as we move forward. It is designed to be adaptive and can be adjusted as new, evidence-based research becomes available.

A collaborative approach is at the core of our efforts to protect pollinators. Looking ahead, we continue to welcome and build new partnerships while maintaining current relationships.

As Ontario continues to take a leadership role in the protection of pollinators, I encourage us all to work together and achieve our goals.

Sincerely,

Jeff Leal Minister of Agriculture, Food and Rural Affairs



## Table of Contents

INTRODUCTION	4
OUR POLLINATORS	5
Managed Bees	5
Wild Pollinators	6
WHY ACTION IS IMPORTANT	7
ONTARIO'S POLLINATOR HEALTH STRATEGY	8
The Beekeepers Financial Assistance Program and the Bee Mortality Production Insurance Program	10
Regulation of Neonicotinoid-Treated Corn and Soybean Seed	10
Pollinator Health Action Plan	10
POLLINATOR HEALTH ACTION PLAN	11
Public Engagement	11
Accountability and Oversight	12
The Four Stressors	13
Stressor: Diseases, Pests and Genetics	14
Stressor: Exposure to Pesticides	19
Stressor: Reduced Habitat and Poor Nutrition	24
Stressor: Climate Change and Weather	29
Research and Monitoring	32
Education and Awareness	36
WORKING TOGETHER TO IMPLEMENT THE PLAN	41
GLOSSARY	42
Government Acronyms	42
Other Acronyms Found Throughout the Plan	42
Definitions	43
BIBLIOGRAPHY	44

## INTRODUCTION

Pollinators are vital to a healthy ecosystem and they play a crucial role in Ontario's agriculture sector. They provide one of our planet's most important ecosystem services — pollination. Over one third of our diet comes directly or indirectly from insect-pollinated plants, and about 80 per cent of wild, flowering plant species would not exist without pollination. Pollinators are essential to our agricultural sector: managed and wild pollinators contribute \$992 million annually to Ontario's economy.

Despite the critical importance of pollinators to the economy and the environment, research around the world is showing disturbing declines in pollinator populations due to a number of interacting stressors including disease and pests, exposure to pesticides, reduced habitat and climate change. Ontario has not avoided these challenges: It is also experiencing decreases in pollinators and pollinator health.

#### **Ontario's Pollinator Health Action Plan**

The plan outlines several actions to address broad stressors impacting pollinators. Here are some examples:

- Restore, enhance and protect one million acres of pollinator habitat in Ontario.
- A discussion paper on modernizing the legislative framework for beekeeping will be released for consultation. Among other components, the modernization proposals could include provisions related to beekeeper training, updated requirements for the location of hives, recordkeeping and traceability, and modernized tools for pest and disease management.
- Launch a special research call (\$1 million) to fund new research addressing key knowledge gaps related to pollinator health.
- Launch a digital awareness campaign to encourage Ontarians to plant pollinator-friendly gardens.

- Collect data from government monitoring and surveillance programs to establish baselines on the status of managed honey bees, wild pollinators and pesticide residues in the environment.
- Conduct climate change vulnerability assessments for select wild pollinator species.
- Compile and promote Best Management Practices (BMPs) that beekeepers should follow when wintering honey bee colonies, both outdoors and indoors, which can help optimize winter survival rates by managing colonies to ensure adequate health, strength and food stores.
- Continue education and outreach activities for farmers and other interested stakeholders on BMPs as they relate to Integrated Pest Management (IPM) to support the implementation of the neonicotinoid-treated seed regulation.
  - Continue to work with farmers and other stakeholders through a suite of programs, such as the Great Lakes Agricultural Stewardship Initiative (GLASI), to support pollinators and habitat restoration and enhancement.
  - Develop biosecurity-specific educational materials for greenhouse growers to help reduce pathogen spread from managed bumble bees to wild pollinators.

For a full list of actions and timelines, please read on.

•

By developing partnerships and initiatives that strengthen pollinator health, we are working to achieve Ontario's vision to be home to healthy pollinator populations that contribute to a sustainable food supply and support resilient ecosystems and a strong economy.

## OUR POLLINATORS

Many species throughout the world, including a small number of birds and mammals, provide pollination services. In Ontario, the majority of pollinators are insects. Bees are the most specialized insect pollinator due to a variety of physical traits that allow them to collect and store pollen. Wild bees come in a wide variety of sizes, shapes and colours. They are diverse in their requirements such as habitat, nesting sites, the types of flowers they visit and their season of activity. In Ontario, the two most common groups of wild bees are solitary bees and social ground nesters. This Action Plan focuses on two main groups of insect pollinators:

- wild pollinators such as bumble bees, solitary bees, butterflies and moths, some beetles and flies
- managed bees, including honey bees and certain species of bumble bees

### Managed Bees

Managed honey bees not only produce honey but they also pollinate a broad range of Ontario crops including apples, apricots, asparagus, blueberries, squash, and canola. Honey bees are responsible for pollinating 80 per cent of all agricultural crops requiring insect pollination and are the most economically valuable pollinators world-wide.

In 2016, there were more than 2,800 registered beekeepers in Ontario managing a total of over 97,000 honey bee colonies; Ontario beekeepers produced an estimated 8,880,000 pounds of honey, worth a total of \$27 million. Beekeepers also produce beeswax products for retail sales. Perhaps most importantly, horticulture producers require beekeepers' hives for "pollination services" to increase crop production and yields. Some Ontario honey bee colonies are also transported every year to help pollinate over \$70 million worth of blueberry and cranberry crops in eastern Canada - and the demand for pollination services continues to increase.

Other species of managed pollinators in North America include bumble bees, alfalfa leafcutter bees and blue orchard bees. Bumble bees are increasingly used in Europe and here in Canada as the primary managed pollinator for greenhouse tomato and pepper production. Managed bumble bees are now being tested as potential pollinators for cranberries, blueberries and ginseng.

#### **FACT BOX:**

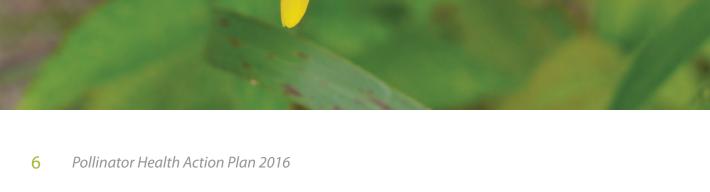
Through Growing Forward 2 (GF2), a federal/provincial funding program, farmers have accessed cost-share funding to enable farm families to increase their environmental awareness and identify areas of environmental concern and action of their farms by developing an Environmental Farm Plan (EFP). Once a farm plan is completed, GF2 supports EFP-identified actions including those that support pollinator habitat such as building wind breaks and planting cover crops.

### Wild Pollinators

Previous studies show Ontario as a Canadian biodiversity hotspot for wild pollinators, with 420 of over 855 nationally-recorded bee species. This is the highest bee diversity of any province. Although the value of wild pollinators to agriculture in Ontario has not been assessed, recent studies elsewhere suggest that wild pollinators may be more important than originally thought.

Pollination plays a fundamental role in sustaining ecosystems and supports all organisms that depend on resources from flowering plants (e.g., seeds for birds, shelter provided by flowering trees and shrubs, etc.). While the managed honey bee is perhaps the most well-known pollinator, wild bees are more effective pollinators on a per bee basis. Some species of wild pollinators carry greater quantities of pollen grains making them more efficient pollinators. Wild pollinators can forage in cooler conditions than honey bees, which allows for pollination of plants blooming in early spring and late fall.

Research has shown that improving honey bee pollinator efficiency in agriculture can be accomplished by encouraging or introducing wild bee species to an area. The presence of wild bees has been found to increase the pollinating efficiency of honey bees when compared to an orchard that was pollinated by honey bees alone.



## WHY ACTION IS IMPORTANT

Worldwide, there are signs that managed bees and wild pollinators are under stress and in a number of cases, in decline. At the same time, the need for pollination services for many agricultural crops continues to grow. Ontario is no exception to these international trends: some Ontario-specific research indicates that the province is experiencing similar declines while facing increasing demands for pollination services, particularly from managed bees.

The beekeeping industry considers a 15 per cent annual overwinter loss sustainable. Since 2007, overwintering losses in Ontario have ranged from a low of 12 per cent in 2012 to an all-time high of 58 per cent in 2014.

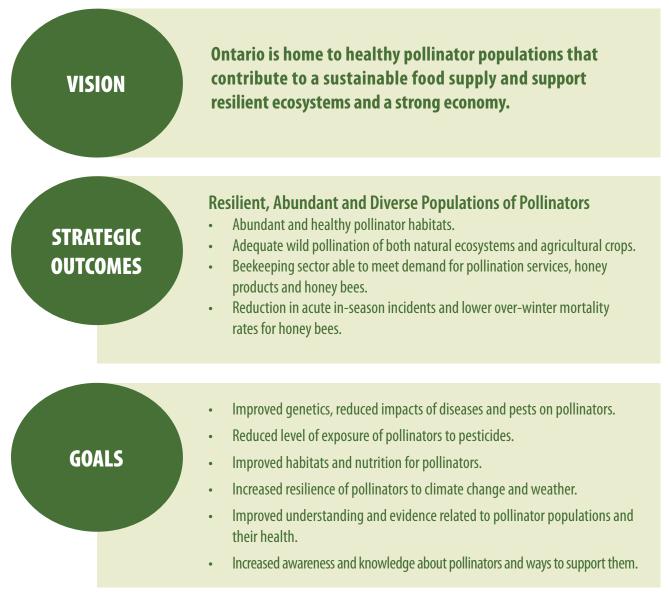
Although information on the populations of wild pollinators in Ontario is limited, studies show some species (e.g., the formerly widespread rusty patched bumble bee, now a Species at Risk), have declined dramatically in number. Declines in wild pollinator populations documented globally show that almost 50 per cent of insect extinctions involve flower-visiting species. International trends suggest that pollinator declines are a result of the interacting impacts of several stressors - including disease and pests, exposure to pesticides, reduced habitat and climate change. Ontario farmers are incredible stewards of our land. Since 2005, they have demonstrated a strong commitment to the environment, completing more than 23,900 voluntary on-farm Environmental Farm Plan projects.. This work represents a total investment of \$366 million in on farm improvements, including \$99 million in federal provincial cost-share funding, approximately \$26 million leveraged from other costshare programs and \$228 million of farmers' money.

In addition to the efforts of the farming community, when polled as part of Pollinator Health Action Plan consultations, more than 60 per cent of survey respondents indicated that they would be willing to financially contribute to organizations supporting pollinator health and more than 70 per cent would be willing to lead habitat activities, both on the farm and across urban landscapes. These results show a huge willingness to work together, bridge gaps and collaborate from all sides of the issue on a topic as critical as pollinator health.

We challenge all parties, including environmental organizations, conservation groups, academia, industry, and communities to join our farmers and be part of the solution by pooling resources. We invite organizations from across Ontario to invest in the coming years to promote environmental stewardship and pollinator health.

The organizations highlighted in this report are a wonderful example of this work and we encourage it to continue and grow!

## ONTARIO'S POLLINATOR HEALTH STRATEGY

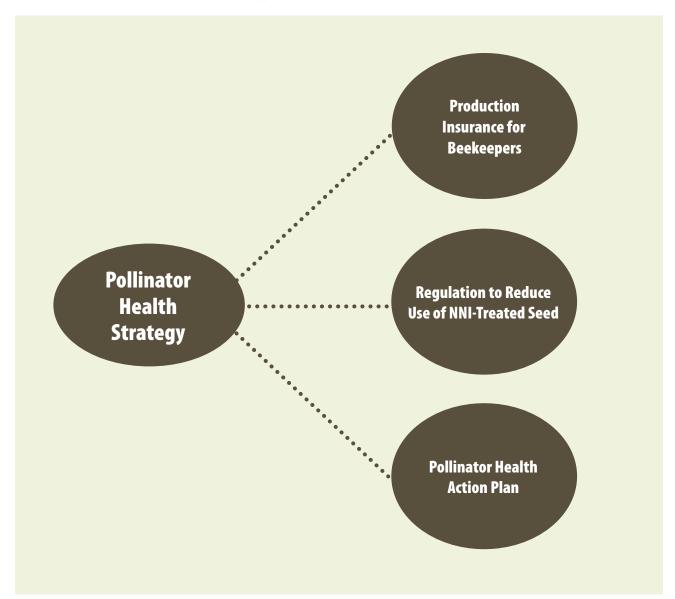


In November, 2014, the Ontario government launched the province's first Pollinator Health Strategy highlighting **two aspirational targets**:

- To reduce overwinter mortality rates for managed honey bees to 15 per cent by 2020.
- To achieve an 80 per cent reduction in the number of acres planted with neonicotinoid-treated corn and soybean seed by 2017.

In 2016, and communicated for the first time in this plan, **a third aspirational target** has been added:

 To restore, enhance and protect 1 million acres of pollinator habitat in Ontario (timelines to be determined by the Habitat Committee; for more information, see the Reduced Habitat and Poor Nutrition stressor beginning on page 24). There are three components to the strategy:



The first two components of the Strategy – financial support for the beekeeping sector and Ontario Regulation 63/09 that reduces the use of neonicotinoid insecticide (NNI)-treated corn and soybean seeds – have been launched. The release of the third and final component of the strategy, the Pollinator Health Action Plan (the plan), completes the launch of all three components of the multi-faceted strategy.

### The Beekeepers Financial Assistance Program and the Bee Mortality Production Insurance Program

A key element of the province's Pollinator Health Strategy is the commitment to establish a financial program to assist beekeepers experiencing high levels of honey bee hive loss. In 2014-15, the Beekeepers Financial Assistance Program (BFAP) was extended to cover bee mortalities. More than \$5.4 million in BFAP payments were distributed over the 2014 and 2015 program years as part of a combined effort to build up healthy bee colonies in the province.

In September 2015, BFAP was replaced with a permanent Bee Mortality Production Insurance plan to cover overwinter losses caused by insured perils, such as excessive cold, ice damage and diseases/pests with no means of adequate control. In its first year, 35 beekeepers with over 13,200 colonies participated in the plan.

### Regulation of Neonicotinoid-Treated Corn and Soybean Seed

On July 1, 2015 Ontario Regulation 63/09 under the *Pesticides Act* came into effect. This NNI-treated seed regulation will be fully phased-in over two growing seasons. The regulation created a new class of pesticides (Class 12) for corn and soybean seeds treated with NNI, and restricted its use to where there is demonstrated need due to the presence of pests.

### Pollinator Health Action Plan

The plan is the third component of the Strategy. By building on existing partnerships and developing new partnerships and initiatives that strengthen pollinator health, we will achieve Ontario's vision to be home to healthy pollinator populations that contribute to a sustainable food supply and support resilient ecosystems and a strong economy.



## POLLINATOR HEALTH ACTION PLAN

### Public Engagement

This plan is the result of significant input from the public and many stakeholders interested in the issue of pollinator health.

In November 2014, the Ontario government released a comprehensive discussion paper on its pollinator health strategy including a regulatory proposal to reduce the use of NNI pesticides in Ontario. Actions proposed in the discussion paper *Pollinator Health: A Proposal for Enhancing Pollinator Health and Reducing the Use of Neonicotinoid Pesticides in Ontario* received tremendous support for enhancing the health of pollinators.

A variety of actions were brought forward which were expanded upon through interactive forums held in Guelph in August 2015 and February 2016 with experts and key stakeholders from across sectors. More than 50 leaders from across Ontario participated in each session to address issues that included:

- Pollinator health stressors
- Improving pollinator health
- Leveraging partnership opportunities
- Identifying actions needed/next steps.

Ontario's draft Pollinator Health Action Plan was posted on the Environmental Registry from January 22, 2016 to March 7, 2016, providing opportunity for public comment. This final, adaptive plan incorporates feedback received during the consultation process and continues to be a call to action for all Ontarians to play a role in enhancing pollinator health. And we know you're ready to participate! As part of plan consultations, respondents who took the online survey indicated a 75 per cent willingness to promote pollinators via education and awareness; 80 per cent willingness to participate in research; and 90 per cent willingness to create and maintain landscapes suitable for pollinator health.

We want to thank all of those who have contributed to this journey and provided feedback that has helped shape Ontario's Pollinator Health Action Plan. Our vision is for Ontario to be home to healthy pollinator populations that contribute to a sustainable food supply and support resilient ecosystems and a strong economy. We thank you for reading this plan – your dedication will contribute to the improvement of pollinator health in Ontario.

#### **PARTNER SPOTLIGHT:**

In 2015, the government kicked off the Bee Health Expert Network - a honey bee specific group that includes experts from the beekeeping industry. Efforts are directed specifically at disease surveillance. This group is part of the larger Ontario Animal Health Network (OAHN), a network that contributes to long-term outcomes for animal health and welfare.

### Accountability and Oversight

An inter-ministerial steering committee will be responsible for overseeing the implementation, and reporting on the progress of the Pollinator Health Strategy. Recognizing that this plan is flexible and adaptive in nature, the government will also engage technical experts to assist in key areas as the implementation of the plan moves forward.

This plan clearly identifies the ministries and organizations accountable for each action with an associated timeline for completion. Identified ministries will be responsible for implementing their individual actions and reporting to the steering committee. Up-to-date information on Ontario's pollinators, including the progress toward each of the targets, will be shared publically through our online pollinator portal (www.ontario.ca/pollinators). Reporting on the progress made towards our overwinter mortality rates and NNI-treated corn and soybean seed reduction aspirational targets will be shared with the public annually. Progress around the habitat target will be shared as information becomes available. Monitoring data and analysis, and new research results, will also be assessed on an ongoing basis and reports shared as available.

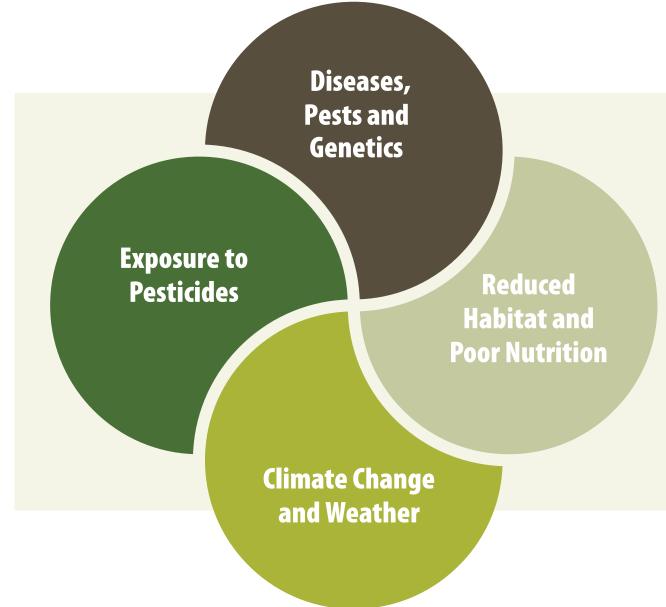


### The Four Stressors

Studies show that pollinators are under increasing stress. Several causes or "stressors" are thought to be responsible for their decline and can be grouped into four broad categories:

- Diseases, Pests and Genetics
- Exposure to Pesticides
- Reduced Habitat and Poor Nutrition
- Climate Change and Weather

To make progress towards achieving our strategic outcomes and vision, Ontario is taking action to address each of the four stressors identified as impacting pollinator health, as well as building on research and monitoring and, education and awareness efforts.



#### **Stressor: Diseases, Pests and Genetics**

The management of honey bee and bumble bee diseases and pests is critical to addressing colony losses and to minimizing the spread of pests and pathogens.

### How are diseases and pests affecting pollinators in Ontario?

Pests and diseases are considered one of the main risks to pollinators. Managed bees and wild pollinators suffer from a range of diseases and pest infestations. The best documented are those that affect honey bees. However, some viruses, fungi and parasites are also known to infect managed bumble bees and wild pollinator species. In addition to naturally occurring diseases and pathogens, in recent years there have been concerns about pathogens crossing over from managed bumble bee and honey bee populations to Ontario's wild pollinator populations. According to research, a significant destructive factor influencing the loss of honey bee colonies over the winter in Ontario is the varroa mite. While there are treatments that help maintain low levels of varroa infestation, resistance in some varroa populations to particular types of treatment is common and widespread. Varroa continue to be a significant challenge for maintaining honey bee health. As such, mite control is an essential beekeeping practice for the survival of honey bee colonies. It is therefore important for us to understand the best ways to control varroa in honey bee colonies, and finds new ways to treat for varroa, while causing minimal harm to the honey bees themselves. There are other pests and diseases that pose health risks to managed bees, such as:

- American foulbrood (a bacterial disease) is one of the most virulent and contagious honey bee diseases and can destroy colonies and contaminate beekeeping equipment.
- The small hive beetle (SHB) is an emerging and invasive pest in Ontario whose presence can have trade implications for beekeepers, by possibly restricting or limiting the movement of honey bee colonies across provincial borders. However, to date, it has not been implicated in widespread colony losses and, in many cases, this pest has been demonstrated to be manageable. OMAFRA is working collaboratively with the beekeeping industry on a strategy to continue to mitigate the extent of SHB in Ontario and provide beekeepers with the tools they need to manage this pest and keep their colonies healthy.

Researchers are now examining the importance of interactions, not only between diseases and other environmental stressors (e.g., disease and nutrition or exposure to pesticides), but also within the stressors themselves (e.g., varroa infestations with other pathogens) that affect individual bee health and colony resilience.

### How can beekeeper management practices and genetics strengthen pollinators in Ontario?

Through selective breeding, honey bees are bred for a variety of desired traits including docile behaviour, increased honey production and resistance to certain pests and diseases. By identifying different genetic traits, beekeepers may be able to identify traits of interest and selectively breed bees that are more resilient to pathogens. Researchers in Ontario have investigated the role of genetics in resistance to pests and disease with some positive results. Some honey bees, for example, have been found to be less susceptible to the tracheal mite. Selecting for any honey bee genetic trait may provide additional protection against pests and diseases, especially as some pests and pathogens can develop resistance to established methods of treatment.

Proper management of honey bee colonies is essential for their success and survival. Colonies must be properly managed to achieve adequate production and pest control. It is important for beekeepers to consider current recommendations when implementing best management practices (BMPs) within their operation, including following an integrated pest management (IPM) approach. The beekeeping sector is dynamic and techniques to combat pests will evolve as the science behind managing bees continues to advance.

#### **FACT BOX:**

Varroa mites are relatively large external parasites that feed on the body fluids of adult and developing honey bees. Among other things, varroa can transmit pathogens, particularly viruses (e.g., deformed wing virus). Varroa mites have spread from their original range in Asia to most parts of the world, including Ontario in the early 1990s. Although almost all honey bee colonies in North America are now infected with varroa, the main challenge is the ability of beekeepers to effectively control the severity of infestations.

### What is being done to address diseases, pests and genetics in managed pollinators?

Under the province's *Bees Act*, OMAFRA's Apiary Program works with beekeepers to maintain the viability of Ontario's beekeeping sector, through:

- Enforcing Ontario's *Bees Act* by requiring beekeepers to register with OMAFRA, providing inspection services and issuing permits.
- Providing information on BMPs and IPM options.
- Monitoring, assessing and reporting on the state of honey bee health in Ontario (refer to the Research and Monitoring section for more details).

Ontario has had beekeeping legislation for over a century. The current Bees Act, established in 1987, has not been updated in nearly two decades. Since that time, the industry has evolved and there have been new pests and diseases that have emerged as challenges for apiarists in Ontario. There have also been changes in how industry and government approach animal health oversight, including a greater focus on information management, data analysis and biosecurity. Having timely access to accurate and up-to-date information about movement patterns, diseases and pests, and management practices can help promote a more coordinated response and greater cooperation between government and industry partners. Other animal production sectors in Ontario have already made significant strides in this area.

Working with key partners, such as the Ontario Beekeepers' Association (OBA), the Canadian Association of Professional Apiculturists (CAPA), the National Bee Health Roundtable and Pest Management Regulatory Agency (PMRA), the government will continue to build on this important work, concentrating efforts in the areas of:

- Reviewing Beekeeping Sector Legislation;
- Strengthening Beekeeper BMPs; and
- Understanding Honey Bee Genetics.

#### **Review Beekeeping Sector Legislation**

- The government will release for consultation a discussion paper to modernize the province's legislative framework on beekeeping. (OMAFRA; 2017) Among other components, the modernization proposals could include provisions related to:
  - o Beekeeper training.
  - o Updated requirements for the location of hives.
  - o Recordkeeping and traceability (for example, clear requirements for recording colony movements).
  - o Modernized tools for pest and disease management, including improved biosecurity measures.

#### Strengthen Beekeeper Best Management Practices (BMPs) for Diseases and Pests

Recognizing the critical role beekeepers play in managing diseases and pests and supporting overall healthy bees and hives, the Ontario government is partnering with the OBA to support increased education and training opportunities for beekeepers.

 Develop and deliver a suite of activities and programs designed to enhance beekeeper knowledge of emerging issues and research, BMPs and IPM practices. This includes continued delivery of the OBA's Technology Transfer Program that develops material through collaboration with researchers, government and academia and applied research. (OMAFRA and OBA; ongoing).

Knowledge and Technology Transfer activities will include:

- o Organizing and delivering beekeeper education workshops.
- Facilitating the transfer of knowledge on current research and emerging issues to the broader beekeeping sector through online and train-the-trainer programming and at industry conferences and local association meetings.
- Increasing education and training opportunities surrounding beekeeper BMPs, biosecurity and IPM via print and online materials.

- Strategies to specifically address the management of high risk pests – varroa and small hive beetle include:
  - o Collaborating with CAPA on strategies for varroa management.
  - Working with Federal partners to assist in facilitating the registration of new treatments for varroa. Since 2010, OMAFRA staff has assisted in the registration of four new treatments for varroa.
  - o Regular communication with industry and researchers on varroa management needs, including posting of treatment recommendations.
  - o Developing and delivering outreach sessions addressing control and awareness of small hive beetle.
- Continue to require that ministryrecommended BMPs be followed by beekeepers to be eligible for the Bee Mortality Production Insurance program. (OMAFRA and Agricorp; ongoing)
- Incorporate recommended BMPs into mandatory biosecurity workshops that producers must take to receive Growing Forward 2 (GF2) implementation funding. (OMAFRA; ongoing)
- Develop biosecurity-specific educational materials for greenhouse growers to help reduce pathogen spread from managed bumble bees to wild pollinators. (OMAFRA; 2017)

#### **PARTNER SPOTLIGHT:**

The University of Guelph's Animal Health Laboratory has developed laboratory testing for honey bee pathogens and pests. This lab testing supports the Ministry's Apiary Program to enhance honey bee health monitoring.

#### **Understanding Honey Bee Genetics**

Honey bee genetics play a role in how resilient colonies are to pest infestations.

- The government will partner with the OBA's Ontario Resistant Honey Bee Selections Program to continue to maintain the annual availability of genetically selected honey bees to bee breeders in Ontario (OMAFRA and OBA; 2017). Through this program, the OBA will enhance honey bee genetics through selective breeding for the following:
  - o increased resistance to brood diseases and parasitic mites
  - o increased desirable hygienic behaviour
  - o increased honey yield

Modernizing beekeeper legislation, combined with increasing education and training opportunities for beekeeper BMPs and ensuring the resilience of our honey bee colonies, will help Ontario achieve a key goal of our **Pollinator Health Strategy: Improved genetics and reduced impacts of diseases and pests on pollinators**.

#### **PARTNER SPOTLIGHT:**

The mandate of the Ontario Beekeepers' Association (OBA) is to ensure a thriving and sustainable beekeeping industry in Ontario. OMAFRA has partnered with the OBA to support initiatives, including the delivery of specialized training through the Technology Transfer Program and research on high-risk pests and diseases. Throughout 20 years of partnership, OMAFRA has provided over \$3 million to the OBA to support industry activities and outreach efforts in support of increased pollinator health. The OBA and OMAFRA will continue their collaborative partnership, resulting in even stronger beekeeper BMPs for Ontario.

#### **Stressor: Exposure to Pesticides**

The term pesticide refers to a broad category of products that are specifically designed to control a pest. A pesticide can control a fungus, a weed or an insect pest. The category of pesticide that typically poses the greatest potential risk for both wild pollinators and managed bees is insecticides. While insecticides are intended to control insect pests, they can also harm beneficial insects like bees.

### How is pesticide exposure affecting pollinators in Ontario?

In Ontario the use of pesticides in agriculture has changed over the past few decades. There has been more emphasis on reducing the risks to human health and the environment and improving education efforts regarding the safe and proper use of pesticides. Additionally, there have been increased efforts to move toward reduced-risk pesticides that tend to be more targeted to specific pests and, therefore, not as broad-spectrum as the pesticides used in the past.

NNI pesticides, commonly used as a seed treatment, have been widely used in agriculture around the world, and in Ontario, since the mid-1990s. However, a growing body of scientific evidence shows that some NNIs are highly toxic to bees and other insect pollinators. Impacts that have been reported include reduced longevity of adult bees, impaired foraging and navigational abilities, impaired learning and memory performance, reduced tolerance to pathogens and reduced colony growth. Specifically, there are documented incidents in field conditions where honey bees have been impacted by the use of NNI-treated corn and soybean seeds. Research also suggests that negative impacts on bumble bees, some butterflies and aquatic invertebrates are also likely.

### What has been the Ontario government's regulatory response to neonicotinoids?

In July 2015 Ontario became the first North American jurisdiction to legislate restrictions that apply to NNI-treated corn and soybean seeds, under the *Pesticides Act*. The NNI-treated seed regulation created a new class of pesticides for corn and soybean seeds treated with three NNIs (imidacloprid, thiamethoxam and clothianidin) and restricts the use of NNI-treated corn and soybean seed to those areas where there is a demonstrated need. The requirements are being phased in to allow growers time to adjust, with an aspirational target to achieve an 80 per cent reduction in the number of acres planted with neonicotinoid-treated corn and soybean seed by 2017, as outlined in Ontario's Pollinator Health Strategy.

Farmers have also taken an active role to support pollinator health by implementing the PMRA's protective measures for corn and soybean production. These include using dust-reducing seed flow lubricants, following new packaging standards and making changes to planting equipment by installing deflectors.

#### **FACT BOX:**

In 2009 the Ontario government introduced a ban on the use of cosmetic pesticides for lawns, gardens, parks and schoolyards.

In addition to pesticides used to protect crops, pesticide exposure can occur when beekeepers apply products directly to their hives to control parasitic mites, fungal and bacterial infections. Research by the Ontario Beekeepers' Association's Technology Transfer Program, supported by the Government of Ontario, is currently underway to examine the effects of pest and pathogen treatments including natural products such as essential oils on honey bee health. Further research into beekeeping management systems, chemical controls and their effect on pollinators is an essential component of an integrated pest management framework.

### What else is being done to reduce pollinator exposure to pesticides?

While progress in pesticide reduction on agricultural lands continues, new efforts are needed to ensure an abundant and healthy pollinator population.

In the fall of 2013, OMAFRA launched a pollinator health-focused research call titled New Directions Bee Health and Related Best Management Practices in Field Crop Production. This call supported the need to gather additional information on pollinator health and explore BMPs to minimize potential risk factors facing managed honey bees. Funding priorities were developed in consultation with the Ontario Bee Health Working Group and key agricultural organizations. A total of five research proposals were awarded totaling close to \$1 million in funding. These projects include examining the effects of neonicotinoids on bee health, and how these risk factors could be managed through alternative pest management tools and BMPs. The results will help inform both the public and the government as we move forward. Project results will be shared as they become available through our online pollinator portal under the research tab.

The Ontario government is also supporting IPM and education for both farmers and beekeepers, to reduce pollinator exposure to pesticides. We are also providing support and monitoring for the NNI-treated seed regulation.

### Support Integrated Pest Management (IPM) and Education for Farmers

Farmers have already made, and continue to make, significant contributions to support pollinator health. To support these efforts, the Ontario government will:

 Continue education and outreach activities to farmers and other interested stakeholders on BMPs as they relate to IPM to support the implementation of the NNI-treated seed regulation. (OMAFRA; ongoing)

#### **FACT BOX:**

OMAFRA and MOECC offer IPM training for corn and soybean producers through the University of Guelph's Ridgetown Campus. This training is required under the NNItreated seed regulation. The course covers topics such as IPM principles including corn and soybean pest identification, planting BMPs, the new regulatory requirements regarding Class 12 pesticides and pollinator protection from NNI exposure. As of October 31, 2016, over 10,000 individuals have completed this training.

- MOECC and OMAFRA will continue education and outreach activities to assist with the understanding of new rules on the sale and use of NNI-treated corn and soybean seed in Ontario.
- As an essential component of this support, emphasis will be placed on IPM training.
- Profile and highlight BMPs for pesticide use in agriculture, including those that reduce exposure of pollinators to pesticides. Publications include: *Field Crop Protection Guide, The Agronomy Guide* and Infosheets. (OMAFRA; ongoing)
- Continue to work with the agriculture sector to support agricultural production and land stewardship practices that reduce pollinator pesticides exposure through GF2. (OMAFRA; 2018)

#### Support Integrated Pest Management (IPM) and Education for Beekeepers related to Pesticide Management in Hive

IPM protocols require beekeepers to use approved products to treat in-hive pests such as mites and bacterial diseases. If used improperly, these treatments can negatively impact honey bee health. Continued efforts to enhance and improve BMPs for beekeepers and IPM recommendations will ensure appropriate use of these products.

### Support for and Monitoring the Impacts of Ontario Regulation 63/09

- In support of the NNI-treated seed regulation, the Ontario government will do the following:
  - Implement a proactive inspection program of treated seed vendors and continue to issue vendor licences to ensure a high level of understanding and compliance with the regulation.

#### **FACT BOX:**

In response to a high number of bee mortality incidents in 2012 and 2013, in 2014 Health Canada's Pest Management Regulatory Agency (PMRA) announced measures to reduce pollinator exposure to dust generated during the planting of treated corn and soybean seed. Measures included:

- The requirement to use a dust-reducing seed flow lubricant when planting NNI-treated corn and soybean seeds.
- BMPs for protecting pollinators during pesticide spraying and an update on best practices for pollinator protection and responsible use of treated seed.
- Enhanced warnings and directions on pesticide and seed package labels on how to protect bees.

Related to these PMRA measures, funding for Ontario producers was made available under the Great Lakes Agricultural Stewardship Initiative (GLASI) to install dust deflectors on planting equipment.

- o Conduct education and outreach with treated seed vendors to ensure the new regulatory requirements are understood.
- OMAFRA developed an online template entitled the *Pest Assessment Report Sketch* to assist farmers in producing the field sketches that are needed to complete the pest assessment forms for the NNI-treated seed regulation. This template is located within the OMAFRA Agricultural Information Atlas tool at <u>ontario.ca/agmaps</u>. It allows farmers to select their farm location(s) and application areas and it will pre-populate the required locational information for the sketch. When complete, farmers can save the sketch and

submit it electronically or print off the sketch and submit it as part of the required forms. (OMAFRA; complete)

- The Ontario government is monitoring the impact of NNI-treated corn and soybean seed (Class 12 pesticides) regulation through a variety of initiatives, such as:
- Establish a baseline of crop system practices (e.g., till versus no till; cover crops used). Currently, the methodology is being established in order to monitor changes in tillage and crop residue cover as a result of the NNI-treated seed regulation. (OMAFRA and U of G; ongoing to 2020)



- Analyze and summarize data collected in support of the NNI-treated seed regulation:
  - Information from Pest Assessment Report forms (both Inspection of Soil and Inspection of a Crop) will allow us to identify potential areas of corn and soybean pest pressure in Ontario and amount of stand loss. (OMAFRA; ongoing)
  - Information from Sales and Transfer Report forms submitted annually by treated seed vendors provides an annual summary of corn and soybean seeds sold or transferred, including those treated with NNIs. (MOECC; annually)

Further to this, monitoring activities will also look at NNI and other pesticide residues in the environment, stream health (including the diversity of health of aquatic macro invertebrates), crop system practices, municipal water quality, and corn and soybean pest pressures. For a description of these environmental monitoring activities, see the Research and Monitoring section.

Continuing our efforts toward a robust integrated pest management framework (through training and tools for beekeepers and farmers and support and monitoring of the NNI-treated seed regulation) will help Ontario achieve a key goal of our **Pollinator Health Strategy: Reduced level** of exposure of pollinators to pesticides.

#### **PARTNER SPOTLIGHT:**

Farms at Work is partnering with the University of Guelph to monitor native pollinators on farms in central Ontario. This project is a first for the province and will allow researchers and the farming community to work together to gather information about native pollinators and their importance on farms. In addition to this project, Farms at Work also installs on-farm plantings for pollinators, pollinator tours and training of new beekeepers.

### Stressor: Reduced Habitat and Poor Nutrition

Pollinator habitat in Ontario is any area that provides nectar and pollen resources, nesting/overwintering sites or larval host plants that support populations of pollinators. Pollinator habitat can occur in natural areas as well as in agricultural and built-up settings.

#### Why is pollinator habitat important?

Wild pollinators have co-evolved with Ontario's native plant communities and, therefore, it is important to conserve pollinators to maintain the health, diversity and function of these important ecological systems. Wild pollinators play an important role in ecosystem maintenance as most flowering plants require insect pollination. This, in turn, provides food and shelter for wildlife species, supports ecosystem services provided by these plant communities (e.g., carbon sequestration, soil stabilization and air purification) and provides us with recreational opportunities. Many of Ontario's Species at Risk depend upon pollinators directly for their reproduction and survival or to provide food plants and habitat. Ten insect pollinators have been listed as Species at Risk and actions are being taken by government to protect these species and their habitats.

Pollinators need habitat (food and nesting sites) to support our agricultural sector and ecological systems. Restoring and enhancing pollinator habitat can have positive impacts, whether enhancing urban gardens and parks, farm field margins and headlands, or land alongside roadways or power lines.

### What is the state of pollinator habitat in Ontario?

Pollinator habitat is being threatened by degradation, fragmentation and direct loss. The majority of habitat impacts have occurred in southern Ontario where the loss of natural habitats has been greatest. Progressive and cumulative habitat changes can have significant effects.

#### **PARTNER SPOTLIGHT:**

Alternative Land Use Services (ALUS) is a community-developed, farmer delivered program that gives Canadians the opportunity to play an active role in building a healthier environment by providing support to farmers to enhance and maintain ecosystem services. ALUS partners with farmers to retain and restore natural areas. These rehabilitated areas have natural benefits such as creating habitat for fish and wildlife, species at risk and native pollinators. Active in Ontario since 2007, hundreds of Ontario farm families are involved in ALUS projects across the province, including pollinator patch planting and environmental stewardship tours.

### What is being done to support pollinator habitat?

The Ontario government recognizes that there are a wide range of groups and organizations involved in restoring, enhancing and protecting pollinator habitat. Here are a few examples:

- Tallgrass Ontario (TGO) is a non-governmental organization (NGO) that was established in 1999 to coordinate work by a variety of groups and organizations wishing to undertake conservation programs to implement the Recovery Plan for Grassland Communities of Southern Ontario. These grassland communities provide ideal habitat for many wild pollinator species as well as forage for managed bees. TGO recently received a \$75,000 Trillium Foundation grant for its Corridors for Pollinators Initiative. The grant will be used to educate and lobby public and private property owners to consider native grasses and plant species for their roadsides, utility corridors and parks.
- In spring of 2016 General Mills Canada Corporation launched its Bring Back the Bees campaign for Honey Nut Cheerios cereal. This successful campaign brought awareness of pollinator health to consumers

through the popular cereal's box, on television advertisements and via social media platforms. General Mills also partnered with Vesey Seeds during this campaign to distribute over 115 million seeds to consumers to encourage planting pollinator-friendly gardens. This number far exceeded their original goal of distributing 35 million seeds (or one flower for every Canadian). The Ministry of Transportation (MTO), the Sydenham Field Naturalists and the Rural Lambton Stewardship Network partnered to provide high-quality habitat to pollinators and other species along the Highway 40 Prairie Passage — a passageway that runs for 39 kilometres and covers approximately 170 acres.

The Ontario government is working to ensure collaboration among these, and many other, efforts, to increase the quantity and quality of pollinator habitat on public and private lands in southern Ontario through restoration and enhancement. These efforts will support both wild and managed pollinators.

We have grouped our habitat actions into three overarching categories: Partnering for Stewardship; Leveraging Current Policies and Programs; and, Providing Grants and Incentives.

#### **FACT BOX:**

A great example of increasing pollinator habitat on Ministry of Transportation (MTO) land is the Rt. Hon. Herb Gray Parkway in Windsor. It includes more than 295 acres of green space, 183 of which are ecological landscapes that include Tallgrass Prairie and Oak Savannah — prime habitats for pollinators. Beyond the corridor, in restoration areas associated with the Parkway an additional 150 acres of Tallgrass Prairie habitat is being restored. MTO is also partnering with the City of Windsor and the Essex Region Conservation Authority on a one time effort to restore approximately 150 acres of Tallgrass Prairie habitat within the Spring Garden Natural Area.

#### Partnering for Stewardship

Ninety-eight per cent of the land in southern Ontario, where pollinator habitat loss and degradation have been greatest, is privately owned. Pollinator habitat restoration will be supported through government leadership and key partnerships to help:

- Restore, enhance and protect one million acres of pollinator habitat in Ontario.
   The government is committing to a new aspirational target for pollinator habitat restoration, enhancement and protection. To achieve this target, we will establish a government habitat committee (MNRF and OMAFRA, ongoing)
  - This committee, consisting of ministries with an interest in pollinator habitat, is committed to habitat restoration, enhancement and protection on government-owned lands, where possible (e.g., conservation areas, landfill sites, highway corridors, etc.), consistent with broad-scale habitat conservation approaches for Ontario. To date, participating ministries confirmed include MOI, MMA, MHO, MOECC, MTO and OMAFRA
  - The committee will also work with key agencies and partners to help support restoration and enhancement activities on their lands (e.g., associations and agencies such as the Ontario Horticultural Association; Hydro One, Ontario Clean Water Agency, Niagara Parks Commission, Royal Botanical Gardens and Ontario Power Generation, as well as conservation authorities, private sector utilities and municipalities)
- Establish and implement a framework to measure and report on the 1 million acre aspirational target (MNRF and OMAFRA; ongoing)
- Continue discussions with industry to ensure availability of native Ontario seed mixes (e.g., native wildflowers and grasses) for planting natural habitat for pollinators. (OMAFRA and MNRF, ongoing)

### Work to help support pollinator habitat restoration and enhancement activities includes:

- Host a pollinator-friendly garden on governmentowned lands around Queen's Park and partner with the Ontario Horticultural Association to encourage the planting of pollinator-friendly communities across Ontario. (OMAFRA and MOECC; 2017)
- Work with Indigenous communities to support their involvement in the stewardship of pollinator habitat. (MNRF; ongoing)
- Create pollinator habitat at waste management sites including introducing native, pollinatorfriendly plants, participating in annual bee counts and assisting with the development of best practices. (MOECC and Ontario Waste Management Association [OWMA]; 2017)
- Work with the Stewardship Network of Ontario (SNO) to encourage pollinator habitat restoration and enhancement on private lands through sharing and exchanging information (e.g., BMPs) with local stewardship groups. (MNRF; ongoing)
   Increase pollinator habitat on MTO lands. (MTO;
- underway) Encourage the establishment of pollinator
- habitat on lands controlled by the Ministry of Infrastructure and incorporate supporting principles into its Realty Policy. (MOI; 2017)
  Facilitate connections with landowners and managers of major parks and open spaces such as municipal park and recreation departments, conservation authorities and Ontario Trails Council to explore pollinator habitat initiatives. (MNRF and OMAFRA, ongoing)

#### Leveraging Current Policies and Programs

We will review and incorporate pollinator guidance into Ontario government policies, guidelines and programs, as opportunities arise, including:

- Build on province-wide efforts to improve natural heritage and biodiversity conservation, including Ontario's Biodiversity Strategy and *Biodiversity: It's in our Nature* (the government implementation plan for the strategy). This strategy and implementation plan provide a broad framework to improve conservation in Ontario through actions that engage people, reduce threats to biodiversity, enhance ecosystem resilience and improve knowledge that will benefit pollinators. (MNRF; underway)
- Work with municipalities to promote the development of well-connected Natural Heritage Systems in southern Ontario that support pollinator habitat. This will include the development of guidance materials on features, functions and criteria for well-designed Natural Heritage Systems to help maintain biological and geological diversity, natural functions, viable populations of indigenous species, and

ecosystems. (MNRF and MMA, MHO; 2018) Strengthen natural heritage protection across the Growth Plan for the Greater Golden Horseshoe as part of the Coordinated Land Use Planning Review. The Province undertook a review of four southern Ontario provincial land use plans in 2015 (Niagara Escarpment Plan, Oak Ridges Moraine Conservation Plan, Greenbelt Plan and the Greater Golden Horseshoe Growth Plan). The Province committed to further consult and update the plans in 2016. Improved natural heritage protections will benefit pollinator habitat. (MMA, MHO and MNRF, 2016)

- Implement recovery actions identified in Government Response Statements and continue to protect habitat under the *Endangered Species Act* for wild pollinators, insect-pollinated plants and other species that share their habitat that are listed on the Species at Risk in Ontario List. (MNRF, ongoing)
- Support implementation of Ontario's Invasive Species Strategic Plan. The passage of the *Invasive Species Act* in the fall of 2015 provides a legislative framework to help with the early detection, eradication and control of invasive species that may threaten pollinator habitats. (MNRF, ongoing)

#### **PARTNER SPOTLIGHT:**

Toronto, Canada's first *Bee City*, leads the way in promoting pollinator health in Ontario. Its efforts include:

- Creating and restoring pollinator habitat in collaboration with local community groups.
- Offering children's programs and public education about pollinators and native plants.
- Training City staff on pollinator-friendly gardens and how to increase native plantings in city parks.
- Including two booklets about pollinators Bees of Toronto and Butterflies of Toronto

   in its Biodiversity Booklet Series with the goal of educating the public, fostering a
   sense of stewardship, and supporting decisions that protect local pollinators.

- Explore opportunities to enhance incentive programs for private landowners to conserve pollinator habitats. (MNRF; 2017)
- Ensure pollinator habitat is considered when undertaking planning for Crown lands. (MNRF; 2018)
- Incorporate guidance to maintain and enhance pollinator habitats into Protected Area Planning Guidelines for Ontario Parks. (MNRF; 2017)
- Increase public awareness of pollinator health through Ontario Parks' Natural Heritage Education Program. (MNRF; ongoing)
- Review the Landfill Standards Guideline to potentially include a pollinator planting strategy for the waste fill zone as final cover and in the surrounding areas. (MOECC; 2017)
- Integrate a pollinator health focus into Environmental Farm Plan fact sheets, BMPs and workshop materials as part of regular review processes. (OMAFRA; ongoing)
- Actions to support pollinator health will be integrated into the development of a Wetland Conservation Strategy and into a new Climate Change Adaptation Plan for Ontario. (MNRF and MOECC; ongoing)

#### **Providing Grants and Incentives**

The Ontario government is leveraging a suite of funding programs across ministries to support pollinator habitat restoration, enhancement and

creation projects. The government will continue efforts that:

Support stakeholders in restoring and enhancing habitat that benefits pollinators and other species through stewardship funding programs -e.g., Land Stewardship and Habitat Restoration Program, 50 Million Tree Program, Eastern Habitat Joint Venture, Great Lakes Agricultural Stewardship Initiative (GLASI), GF2, Species at Risk Stewardship Fund. (OMAFRA and MNRF; ongoing) Work with farmers through the Great Lakes Agricultural Stewardship Initiative (GLASI) to support implementation of BMPs under the Farmland Health Incentive Program (e.g., installation of buffer strips and field windbreaks/ windstrips, tillage and equipment modifications, fragile land retirement), which includes an increase in cost-share for pollinator- focused projects. (OMAFRA; 2017)

Working across the government and with our partners and agencies to lead the establishment of improved habitat on a range of public and private lands, combined with efforts to restore and enhance pollinator habitat through current policies, programs and incentives, will help Ontario achieve a key goal of our **Pollinator Health Strategy: Improved habitat and nutrition for pollinators.** 

#### **PARTNER SPOTLIGHT:**

The Ontario government supported Pollinator Partnership Canada's development of new guidance materials for restoring, maintaining and enhancing pollinator habitat on a variety of landscapes across Ontario. These technical guidance documents identify opportunities to consider pollinators on agricultural lands, along roadsides and utility corridors and at solar and wind farms, and will be an important resource for large-scale landowners and managers.

#### **Stressor: Climate Change and Weather**

The Earth's climate is changing. Globally, there is evidence of increasing air and ocean temperatures, widespread melting of snow and ice and rising sea levels. In Canada, we are already seeing rising temperatures, shifting rainfall patterns and increases in certain types of hazardous weather such as heat waves. Recent studies have shown that wild pollinators are highly vulnerable to climate change.

#### How is climate change affecting pollinators?

Although the precise impacts of climate change are difficult to predict, they could contribute to pollinator declines by modifying the balance between bees and their environment, including increasing their exposure and vulnerability to diseases. There is already evidence in Ontario of climate change causing earlier spring thaws that resulted in many plants flowering earlier than normal. Consequently, pollinator species could undergo population declines if plants bloom at times when pollinators are dormant. Pollinators also require continuous availability of food resources, and shifts in key seasonal changes such as flowering time and emergence of insects, could lead to gaps in the succession of flowers causing a lack of food for longerlived pollinators or colonies.

The geographic ranges of pollinators may also shift as temperatures increase. Bees that thrive in tropical environments are predicted to expand their ranges, whereas bees that thrive in narrow-ranged temperate climates will likely experience range reductions and are at risk of population decline.

In addition to the gradual increase in temperature, climate change causes more frequent extreme weather events like storms, floods, heat waves and droughts. Extreme cold weather can have severe impacts on pollinators already stressed by climate change by causing high overwintering losses. Less mobile pollinators, such as small beetles and ground nesting bees, may be the most seriously impacted by events such as flooding. Extreme weather can kill individual insects, but can also negatively impact entire colonies or local populations (e.g., by interrupting foraging and mating).

#### **FACT BOX:**

Temperature extremes combined with an inconsistent food supply, can put intense pressure on pollinators and may lead to disease and death. An example of extreme weather in Ontario was the record-breaking early spring thaw in 2012. This event, caused by much warmer than normal spring temperatures, significantly impacted Ontario ecosystems. There were reports of fruit trees that bloomed five weeks ahead of schedule which were then extensively damaged by a late April frost. The flash freeze wiped out about 80 per cent of Ontario's apple blossoms, resulting in less than half of the expected yields for tender fruit growers and also reduced the availability of other flowering plant species.

### What is being done to support pollinators in our changing climate?

Ontario has demonstrated leadership and commitment to fighting climate change through releasing both a Climate Change Strategy (2015) and Climate Change Action Plan (2016) which will be implemented over the next five years. Work is also underway to renew Ontario's Climate Change Adaptation Plan (Climate Ready) which will further explore ways to promote pollinator health and food security and support the agricultural sector, as it adapts to climate impacts. Actions outlined in this document are further intended to support the resilience of pollinators so that they are better able to withstand the stresses of a changing climate.

#### Managing the Impact of Climate Change

The government of Ontario is taking action to manage the impact of climate change on pollinators, including:

 Compiling and promoting BMPs that beekeepers should follow when wintering honey bee colonies, both outdoors and indoors, that can help optimize winter survival rates, by managing colonies to ensure adequate health, strength and food stores. (OMAFRA; 2017)

- Conducting climate change vulnerability assessments for select wild pollinator species. (MNRF; 2018)
- As part of Ontario's Climate Change Strategy and Action Plan, and development of a new Climate Change Adaptation Plan for Ontario, the government will be exploring opportunities to align climate change objectives with agriculture and the natural system to support pollinator health and strengthen the resilience of natural systems and agriculture. (MOECC, MNRF and OMAFRA; ongoing). These measures include:
  - o Protecting and restoring wetlands, grasslands and forests.
  - o Increasing green spaces that provide habitat for pollinators.
  - o Supporting pollinator health through provincial initiatives related to soil health and climate change.

Alignment with the province's climate change objectives, which will include reducing vulnerabilities to and increasing climate resilience of our ecosystems, will support pollinator health and help Ontario achieve a key goal of our **Pollinator Health Strategy: Increased resilience of pollinators to climate change and weather.** 

#### **FACT BOX:**

In 2015, researchers at the University of Guelph (U of G) undertook a comprehensive literature review titled Status and Trends of Pollinator Health in Ontario (funded through the OMAFRA/U of G partnership). This review identified 18,700 unique articles of which approximately 1,500 were found to be relevant to Ontario. This review was important in the development of this plan and will help assess priorities and allocate future research funds.

#### **FACT BOX:**

**Honey bees:** Climate change may alter the distribution and diversity of flower species. Unusually wet summers or uncharacteristic dry conditions could affect which floral types are found in a given area and the amount of pollen and nectar that they produce. Because honey bees depend on a variety of floral sources and sufficient pollen and nectar to remain healthy, these downstream effects of climate change could impact the type and quality of nutrition that honey bees receive. Climate change may additionally cause indirect stress for honey bees when it is compounded by other factors. For example, pests and pathogens may become a greater burden in the face of warming temperatures.

**Wild bumble bees:** A study from Ontario examining the impacts of climate change on pollinators found that wild bumble bee species with narrow climate tolerances are at greater risk of decline. This study also reported that species living close to their maximum climatic tolerances are more at risk of decline and, ultimately, extinction.

**Natural resources and ecosystems:** "A changing climate with changing patterns of warmer, wetter, and drier conditions also affects the natural environment and threatens biodiversity. For example, climate change could have negative impacts on the lifecycle of both wild and managed pollinator species like bees and butterflies, upon which about 80 per cent of all flowering plants depend. By conserving nature, restoring ecosystems and adapting natural resource management, we reduce vulnerability and increase resilience to impacts."

- Ontario's Climate Change Strategy

### Research and Monitoring

Research and monitoring will be used to track progress towards pollinator goals and targets. The information gained is an integral component of our adaptive management approach.

### How will research and monitoring contribute to the success of the plan?

While we have a great deal of knowledge about honey bees, there is still much to learn about all pollinators. Addressing knowledge gaps, along with the government's environmental monitoring efforts, will contribute to an improved understanding of pollinator populations and their health status across Ontario.

The government recognizes the importance of monitoring of both wild and managed pollinators to:

- Improve foundational knowledge of the abundance, diversity and status of Ontario's managed and wild pollinators (e.g., foundational baseline information about pest and pathogen loading in managed honey bees; status and trends of wild pollinators).
- Provide evidence of the impacts of mitigation measures, including those implemented as part of this plan.
- Provide evidence to inform future decision making and effective mitigation strategies.

The plan highlights the monitoring programs that have been established to obtain baseline data on the status of managed honey bees, wild pollinators, and pesticide residues in the environment. Data collected from these monitoring programs over time will provide an understanding of honey bee health and will measure progress against the plan's many actions and the overall Pollinator Health Strategy. In addition to monitoring, the government will set priorities for pollinator health research and align and leverage existing and new research programs to address key knowledge gaps related to pollinator health. Awareness of key research and monitoring needs can also be used to encourage research collaboration and inform research undertaken by others.

An inter-ministerial committee will coordinate the analysis of our monitoring results and evidence-based research to adapt this plan, as required. Together, we will achieve our vision of making **Ontario home to healthy pollinator populations that contribute to a sustainable food supply and support resilient ecosystems and a strong economy.** 

### What is being done to support research and monitoring on pollinator health?

The Ontario government has already invested in a significant number of research projects and monitoring activities that formed the foundation of this plan. The actions below demonstrate our continued investment in evidence-based knowledge to inform pollinator health initiatives.

#### Research

- Make available results from the 2013-2014
   New Directions Research Program and
   OMAFRA-U of G Partnership Research Program
   (OMAFRA; ongoing).
- Share relevant research and monitoring information on the pollinator health website. (OMAFRA, MNRF and MOECC; 2016)
- Launch a second, special research call (\$1 million) to fund new research addressing key knowledge gaps related to pollinator health. (OMAFRA and Agricultural Research Institute of Ontario; 2017)

- The Ontario government will prioritize and fund research projects that improve our knowledge of the key stressors influencing pollinator health and support research to understand, prevent and recover from pollinator losses.
- Leverage the Highway Infrastructure Innovation Funding Program (HIIFP) to fund research projects that are pollinator relevant, including a research study underway to conduct test plots of native seed mixes and analyse the life cycle costs for native seed mixes versus standard roadside mixes. (MTO; 2016)
- Support research on the relationship between pollinators and at-risk flowering plants in Ontario through the Species at Risk Research Fund. (MNRF, ongoing)
- Assess the relative contribution of wild pollinators to agriculture in Ontario. (MNRF; 2017)

#### Monitoring

#### **Habitat Monitoring**

Habitat monitoring will begin with the assessment of land cover data to identify which lands in Ontario are currently or potentially suitable for pollinator habitat. This will be the initial step in addressing the recognized gap in monitoring programs for wild pollinators.

 Assess land cover data in natural habitats, and in agricultural and urban landscapes in southern Ontario to identify and map probable pollinator habitat. This will allow us to identify priority areas for habitat restoration and enhancement and to track broad-scale changes in pollinator habitat over time. (MNRF, OMAFRA and U of G; 2017)

#### **FACT BOX:**

We are excited to be launching a second, pollinator health-focused research call. The first call – New Directions Bee Health and Related Best Management Practices in Field Crop Production – was launched in the fall of 2013. The priorities were developed in consultation with the Ontario Bee Health Working Group. A total of five pesticide-focused research proposals were awarded close to \$1million in funding, with projects looking at:

- Determining amounts of NNI dust during planting of field crops, and impacts on honey bees.
- The interaction between bee diseases and exposure to NNIs.
- Mathematical models that examine the effect of NNI exposure, combined with pests and diseases, on honey bee health.
- How exposure to NNIs affects brain function in honey bees.
- Assembling multi-year data on risk factors including NNIs to honey bee health

Projects are ongoing and their results will inform our adaptive management approach to the actions we take to improve pollinator health.

#### Wild Pollinator and Honey Bee Monitoring

Wild pollinator monitoring allows us to understand species diversity and track pollinator populations over time.

- Monitor bumble bee species to gather further data on species diversity and relative abundance in southwestern Ontario. Among other uses, this will allow us to observe any difference before and after the 2015 introduction of the regulation to reduce the use of NNI-treated seed (MOECC and MNRF; ongoing to 2020).
- Explore the development of a publicly available web-based *Pollinator Atlas* to store and disseminate information on pollinators gathered through citizen science efforts. (MNRF; 2018)

Honey bee monitoring includes tracking beekeeper BMPs, the prevalence of pests and diseases and colony losses to assess the health status of the honey bee population.

- Monitor honey bee colonies for pests and diseases. Through OMAFRA's Apiary Inspection Program, Ontario tests honey bee samples each season for pests and diseases, to establish baseline information on managed bee health in Ontario. To achieve this, the Apiary program is working directly with beekeepers to conduct enhanced monitoring in bee yards across the province. (OMAFRA and individual beekeepers; 2020)
- Continue to collect information from the beekeeping sector via the annual honey production and beekeeper management practices surveys. This information estimates honey yield and provides insight into beekeepers' colony management. (OMAFRA; ongoing)
- Provide appropriate response to reported incidents of pesticide-related bee mortality. (OMAFRA, MOECC and PMRA; ongoing)
- Provide appropriate response to incidents of NNI related non-compliance. (MOECC; ongoing)



#### **Environmental Monitoring**

Environmental monitoring includes assessing NNI and other pesticide residues in the environment, stream health (including the diversity of health of aquatic macro invertebrates), crop system practices, municipal water quality and corn and soybean pest pressures.

- Measure pesticide residues in pollinator food sources from bee-collected pollen to understand pesticide exposure. MOECC initiated this pollen monitoring network in 2015. Sampling locations and timing occurs in conjunction with OMAFRA's enhanced hive monitoring (described above). (MOECC, OMAFRA, OBA and individual beekeepers; 2020)
- Measure changes in NNI residues in the environment (stream water and soil) in select watersheds. This also includes measuring changes in aquatic benthic invertebrate communities. Baseline characterizations of stream sampling locations were completed in 2015. Follow-up surveys to detect changes over time are underway. (MOECC; ongoing to 2020)
- Monitor and assess NNI concentrations in untreated source water and treated drinking water at selected systems. (MOECC; 2017)
- Analyze data to understand the toxicity of NNIs to non-target species. This data will be used to create Water Quality Criteria to protect aquatic life, as well as observe differences before and after the introduction of new legislation to

reduce the use of NNI-treated seed. Conduct Toxicity Testing for Canadian Water Quality Guideline Development. (MOECC, Environment Canada and U of G; 2017)

 Measure stream water quality at locations across Ontario via the Provincial (Stream) Water Quality Monitoring Network. Samples are analyzed for approximately 400 pesticides, including herbicides, insecticides, fungicides and breakdown products. In 2012, this monitoring began to include NNIs. U of G laboratory detection limits for NNIs were lowered in 2015 to better quantify the range of NNI concentrations in Ontario streams. (MOECC, OMAFRA, Conservation Authorities and U of G; ongoing)

Please refer to the Exposure to Pesticides stressor for monitoring activities specific to information arising from the NNI-treated seed regulation.

The data collected from our monitoring programs will establish baseline data on the status of managed honey bees, wild pollinators, and pesticide residues in the environment. This data will help track and measure plan progress. Setting research priorities and aligning and leveraging existing and new research programs will address key knowledge gaps related to pollinator health. Together, monitoring and research will help Ontario achieve a key goal of our **Pollinator Health Strategy: Improved understanding and evidence related to pollinator populations and their health**.

#### **PARTNER SPOTLIGHT:**

OMAFRA & Master Gardeners of Ontario: OMAFRA's pollinator exhibit at the Green Living Show 2016 featured a pollinator-friendly garden. OMAFRA partnered with the Master Gardeners of Ontario to provide volunteer Master Gardeners on-site throughout the 3-day show. The Master Gardeners added tremendous value in educating visitors on gardening and pollinators, as well as answering visitors' questions.

### Education and Awareness

Through education and awareness programs, we have an opportunity to engage Ontarians of all ages in our efforts to help pollinators. From individuals, to schools, community groups and businesses everyone can make a difference. Together, we can help provide pollinators with the resources they need to survive and thrive.

### How is the Ontario government promoting education and awareness of pollinators?

Various actions throughout the plan have an education and awareness component. For example:

- Reduced Habitat and Poor Nutrition: To increase public awareness of pollinator health through Ontario Parks' Natural Heritage Education Program.
- **Diseases, Pests, Genetics:** To support increased education and training opportunities around beekeeper BMPs and integrated pest management practices.
- **Exposure to Pesticides:** To support BMPs and education for farmers and beekeepers on pesticide use and integrated pest management practices.

 Climate Change and Weather: Compile and promote BMPs that beekeepers should follow when wintering honey bee colonies, both outdoors and indoors, that can help optimize winter survival rates, by managing colonies to ensure adequate health, strength and food stores.

In addition, the Ontario government will further engage Ontarians through the actions below, to help provide pollinators with the resources they need to survive and thrive:

- Launched a digital campaign to engage the public on the importance of pollinators and promote planting of pollinator-friendly gardens in Ontario (MOECC, 2016)
- Launch a pollinator health website as a onestop shop for pollinator health information and resources. The website will include tools and information on pollinators, highlight achievements and show how to get involved in improving pollinator health. (OMAFRA, MOECC, and MNRF; ongoing)
- Showcase an interactive pollinator health trade-show booth at a number of events across the province. (OMAFRA; ongoing)

#### **PARTNER SPOTLIGHT:**

To strengthen the management skills of Ontario's beekeeping sector, the Niagara-onthe-Lake campus of Niagara College will be offering a Commercial Beekeeping Program starting in January 2017. This three semester academic program will coincide with the normal annual lifecycle of a honey bee, from winter slumber, to honey extraction, to putting the honey bees back in their hives for overwintering.

- Create a Compendium of Pollinator-Focused Education and Outreach Materials that are relevant to Ontario. (MNRF; 2017)
- Collaborate with existing biodiversity partners to develop education and outreach tools to increase awareness of the role of pollinators and importance of wild pollinator habitat conservation. (e.g., lesson plans, bio-blitz events etc.) (MNRF; 2018)
- Declare a provincial pollinator health day to increase awareness and education around Ontario's pollinators. (OMAFRA; 2017)

The Ontario government also recognizes that there is a need to educate and inspire students about how to take action to protect pollinators. We are exploring opportunities to incorporate pollinator health considerations into student curricula across the province. Several connections have already been made, including with Niagara College, EcoSchools and Earth Rangers.

### What are other organizations doing to increase pollinator health?

Several organizations are making important investments to support pollinator health throughout Ontario. Examples include:

- For more than 25 years, the TD Friends of the Environment Fund has supported more than 24,000 environmental initiatives across Canada, many of which support pollinator habitat.
- The W. Garfield Weston Foundation has awarded \$3 million over five years to fund the Rebanks Family Chair in Pollinator Conservation. This position is currently held by Dr. Nigel Raine of the University of Guelph.
- The David Suzuki Foundation supports the planting of Monarch butterfly-friendly milkweed through various initiatives, including the #gotmilkweed campaign, inspiring more than 10,000 milkweed plantings in Toronto alone. The City of Markham, Metrolinx and Hydro One have also agreed to allow milkweed to be planted on their linear corridor properties.
- Credit Valley Conservation's Landowner Action Fund is an environmental incentive program for rural landowners in the Credit River watershed. Sustainable gardening, pollinator patches and native grassland restoration are all projects supported by the fund that benefit pollinators.
- Nature Conservancy of Canada has led more than 1,400 conservation projects across Ontario, protecting more than 178,000 acres of this province's most ecologically significant land and water. Much of this land is critical pollinator habitat.

#### **PARTNER SPOTLIGHT:**

The Ontario Horticultural Association (OHA) is a volunteer, charitable organization that provides leadership in promoting all areas of horticulture and related environmental issues in Ontario. Through an expanding network of 276 horticultural societies, the OHA supports community beautification projects that create pollinator-friendly habitat throughout the province. Projects include beautifying local parks, planting boxes in downtown areas, and creating and maintaining public gardens, often planted with pesticide free native plants and nesting sites, around government buildings, hospitals, health and hospice centres. The OHA also develops conservation, youth and horticulture programs.

- ALUS Canada has helped to establish over 800 acres of native tallgrass prairie, an excellent form of pollinator habitat, on privately owned farmland in southern Ontario.
- Niagara Parks Commission have implemented native grassland projects with wildflower additions covering over 128 acres of their parkland.
- The rare Charitable Research Reserve owns and stewards over 900 acres of land in Cambridge, 25 per cent of which is grassland including tall grass prairie and meadow habitat.
- General Mills Canada Corporation started the "Bring Back the Bees" campaign with their Honey Nut Cheerios cereal, which brings awareness of the issues regarding bees and promotes planting pollinator-friendly plants. Since the campaign started in 2016, General Mills has distributed 115 million plant seeds.

Other organizations are also supporting pollinators. To acknowledge their support, the Ontario government has summarized the activities of many such organizations in the chart on pages 39 and 40. We hope to expand this list in the future, as we become aware of even more efforts happening to improve pollinator health. If you are an organization contributing to the health of Ontario pollinators and are not listed here, please contact us in order for your efforts to be acknowledged on our website.

Collectively raising awareness of how simple actions - such as planting pollinator-friendly habitats - can improve pollinator health, Ontarians will achieve a key goal of the **Pollinator Health Strategy: Increased awareness and knowledge about pollinators and ways to support them**.



Stakeholders and partners taking actions to improve pollinator health in Ontario, independently and/or working with the Ontario government on actions as outlined in the plan and as part of the Pollinator Health Strategy:	Working with the Ontario government	Taking independent actions	Education	Awareness	Research	Monitoring (including citizen science)	Habitat Improvement
Agricultural Research Institute of Ontario (ARIO)	Y		Y	Y	Y		
Agscape		Y	Y				
Alternative Land Use Services (ALUS)	Y	Y	Y	Y	Y	Y	Y
Bee City Canada		Y	Y	Y			Y
Birks Group		Y	Y	Y	Y	Y	Y
Brock Bee Lab - Dr. Miriam Richards, Brock University		Y	Y	Y	Y	Y	Y
Canadian Association of Professional Apiculturists	Y		Y	Y			
Canadian Wildlife Federation		Y	Y	Y	Y		Y
Certified Crop Advisors Association (CCAA)		Y	Y	Y			
<u>City of Toronto</u>		Y	Y	Y			Y
Communities in Bloom		Y	Y	Y		Y	Y
Conservation Ontario – network for 36 Conservation Authorities							
Credit Valley Conservation Authority		Y	Y	Y	Y	Y	Y
Crowe Valley Conservation Authority							Y
CropLife Canada		Y	Y	Y	Y	Y	Y
David Suzuki Foundation		Y	Y	Y	Y		Y
Earth Rangers		Y	Y	Y			Y
Escarpment Biosphere Conservancy		Y	Y	Y	Y	Y	Y
Farm and Food Care		Y	Y	Y			
Farms at Work		Y	Y	Y	Y	Y	Y
Friends of the Earth		Y	Y	Y	Y	Y	Y
General Mills Canada - Bring Back the Bees		Y	Y	Y			Y
Grain Farmers of Ontario		Y		Y	Y		
Grand River Conservation Authority		Y	Y	Y			Y
Great Sunflower Project		Y	Y	Y	Y	Y	Y
Hamilton Pollinators Paradise Project		Y	Y	Y			Y
<u>Honey Bee Research Centre</u> – Dr. Ernesto Guzman, University of Guelph	Y	Y	Y	Y	Y	Υ	Y
Hydro One	Y						Y
Landscape Ontario		Y	Y	Y			Y
Master Gardeners of Ontario Inc.		Y	Y	Y		Y	Y
Nature Conservancy of Canada		Y		Y	Y	Y	Y
Niagara College	Y	Y	Y	Y	Y		
Niagara Parks Commission	Y	Y	Y	Y	Y	Y	Y
North American Native Plant Society		Y	Y	Y	Y		Y

The province assumes no responsibility for independent stakeholder activity and this list is not a formal endorsement.

"Ys" show their areas of expertise.

Stakeholders and partners taking actions to improve pollinator health in Ontario, independently and/or working with the Ontario government on actions as outlined in the plan and as part of the Pollinator Health Strategy:	Working with the Ontario government	Taking independent actions	Education	Awareness	Research	Monitoring (including citizen science)	Habitat Improvement
Nottawasaga Valley Conservation Authority		Y	Y				
Oak Ridges Moraine Land Trust		Y	Y	Y	Y	Y	Y
Ontario Animal Health Network	Y			Y	Y	Y	
Ontario Beekeepers' Association	Y	Y	Y	Y	Y	Y	Y
Ontario Biodiversity Council	Y		Y	Y			
Ontario Clean Water Agency	Y			Y			Y
Ontario Ecoschools		Y	Y	Y			Y
Ontario Horticultural Association		Y	Y	Y			Y
Ontario Invasive Plant Council		Y	Y	Y		Y	Y
Ontario Nature		Y	Y	Y		Y	Y
Ontario Nature Youth Council		Y	Y	Y		Y	Y
Ontario Soil and Crop Improvement Association	Y		Y	Y	Y		Y
Ontario Waste Management Association	Y						Y
Otonabee Conservation		Y	Y	Y			Y
Pollination Canada/Seeds of Diversity		Y	Y	Y		Y	Y
Pollination Guelph		Y	Y	Y	Y		Y
Pollinator Partnership Canada	Y	Y	Y	Y	Υ	Y	Y
rare Charitable Research Reserve		Y	Y		Y	Y	Υ
Rebanks Family Chair in Pollinator Conservation – Prof. Nigel Raine, University of Guelph	Y	Y	Y	Y	Y	Y	Y
Royal Botanical Gardens		Y	Y	Y		Y	Y
South Nation Conservation		Y	Y	Y		Y	Y
Stewardship Network of Ontario	Y	Y		Y			Y
Sustain Ontario (Community Garden Networks)		Y	Y	Y			
Sydenham Field Naturalists		Y	Y	Y			Y
Thickson's Woods Land Trust		Y	Y	Y			Y
Toronto & Region Conservation Authority (TRCA)		Y	Y	Y		Y	Y
Urban Toronto Beekeepers' Association		Y	Y	Y			
Wildlife Preservation Canada		Y	Y	Y	Y	Y	
York University, <u>Packer Lab</u> – Dr. Laurence Packer		Y	Y	Y	Υ	Y	Y
York University, <u>Zayed Lab</u> – Dr. Amro Zayed		Y	Y	Y	Y	Y	Y
York University, <u>Sheila Colla</u>		Y	Y	Y	Y	Y	Y

The province assumes no responsibility for independent stakeholder activity and this list is not a formal endorsement. "Ys" show their areas of expertise.

### WORKING TOGETHER TO IMPLEMENT THE PLAN

Pollinators are vital to a healthy ecosystem and they play a crucial role in Ontario's agriculture sector. By working together as partners and contributors, we can take actions that will support Ontario's pollinator populations and the ecosystem services they provide.

We have already begun work on several parts of the plan. We will be keeping our partners and the public informed on the progress of the plan, including reporting on our aspirational targets. The plan identifies many opportunities for engaging Ontarians of all ages in our efforts to help pollinators. From individuals, to schools, community groups and businesses – everyone has an important role to play. By working together we can collectively take steps to reverse pollinator losses and improve pollinator health across Ontario. Pollinators belong to all of us; we are all accountable for their protection.

We want to hear about what your organization does to help pollinators. Let us know by emailing: pollinatorhealth@ontario.ca.



# GLOSSARY

#### Government Acronyms

Ontario's provincial government is working collaboratively toward improving pollinator health. Each of the following **ministries** is playing an active role in contributing to the goals and action item outcomes of the Pollinator Health Action Plan:

MMA: Ministry of Municipal Affairs

MHO: Ministry of Housing

MNRF: Ministry of Natural Resources and Forestry

**MOECC:** Ministry of the Environment and Climate Change

MOI: Ministry of Infrastructure

MTO: Ministry of Transportation

**OMAFRA:** Ministry of Agriculture, Food and Rural Affairs

#### Other Acronyms Found Throughout the Plan

**OBA:** Ontario Beekeepers' Association

BMPs: Best Management Practices

**GF2:** Growing Forward 2

IPM: Integrated Pest Management

NGO: Non-Governmental Organization

NNI: Neonicotinoid Insecticide

The plan: Pollinator Health Action Plan

U of G: University of Guelph



#### Definitions

Below are a few key pollinator definitions to refer to as you read the plan:

**Best Management Practices (BMPs):** BMP means a practice, or combination of practices, that is determined to be the most effective and efficient means of managing a possible issue or concern.

**Integrated Pest Management (IPM):** IPM is a long term approach to pests that considers all management options to maintain pests below an economic injury level.

**Managed Bees:** Managed bees are those that have some of their needs looked after by humans. In Ontario agriculture, the most common managed bee is the honey bee, which pollinates a wide variety of horticultural crops and some field crops such as soybeans. One species of bumble bee is used extensively for pollination in the greenhouse vegetable sector. To a lesser extent, the alfalfa leafcutter bee and the blue orchard bee are managed to provide pollination services for alfalfa and tree fruits respectively.

**Wild Pollinators:** Wild pollinators exist naturally within the environment. In Ontario, there are more than one thousand species of insects that pollinate flowering plants. Wild bees in particular are wellsuited to pollinate a wide variety of plants. Over 400 species of wild bees have been identified in Ontario alone. To a lesser extent, other insects such as wasps, butterflies, moths, some flies and beetles, as well as one species of hummingbird, are known to pollinate in the province. **Pollinator Habitat:** Pollinator habitat in Ontario is any area that provides nectar and pollen resources, nesting/overwintering sites or larval host plants that support populations of pollinators. Pollinator habitat can occur in natural areas as well as in agricultural and built-up settings.

Habitat Degradation: Land-use changes alter the availability and quality of pollinator food sources, such as flowers providing nectar and pollen, the availability of nesting sites, or the availability of host plants (for butterflies and moths).

Habitat Fragmentation: Habitat fragmentation occurs when habitat loss results in the division of large, continuous habitats into smaller, more isolated remnants. These remnants are surrounded by regions unsuitable for pollinators. Isolated, fragmented habitats lead to loss of genetic diversity and pollinator population declines or losses.

Habitat Loss: The destruction of habitats so they can no longer support the species present. In southern Ontario, the availability of pollinator food sources and nesting sites has been reduced through the conversion of habitat to intensive farmland and urban/industrial use, affecting both wild pollinators and honey bees.

# BIBLIOGRAPHY

- Aizen MA, H. L. (2009). The global stock of domesticated honey bees is growing slower than agricultural demand for pollination. *Current Biology*, 19:915-918.
- CAPA Canadian Association of Professional Apiculturists. (2007). 2007 CAPA Statement on Colony Collapse Disorder. Canada.
- CAPA Canadian Association of Professional Apiculturists. (2008). 2008 CAPA Statement on Honey Bee Losses in Canada (Spring 2008) Final Revision. Canada.
- CAPA Canadian Association of Professional Apiculturists. (2009). 2009 CAPA Statement on Honey Bee Losses in Canada. Canada.
- CAPA Canadian Association of Professional Apiculturists. (2010). 2010 CAPA Statement on Honey Bee Losses in Canada. Canada.
- CAPA Canadian Association of Professional Apiculturists. (2011). 2011 CAPA Statement on Honey Bee Losses in Canada. Canada.
- CAPA Canadian Association of Professional Apiculturists. (2012). 2012 Statement on honey Bee Wintering Losses in Canada. Canada.



- CAPA Canadian Association of Professional Apiculturists. (2013). 2013 CAPA Statement on Honey Bee Wintering Losses in Canada. Canada: CAPA.
- CAPA Canadian Association of Professional Apiculturists. (2014, July). 2014 CAPA Statement on Honey Bee Losses in Canada. Canada.
- CAPA Canadian Association of Professional Apiculturists. (2015, July). 2015 Annual Colony Loss Reports. 2015 CAPA *Statement on honey Bee Losses in Canada*. Canada: CAPA National Survey Committee and Provincial Apiculturists.
- City of Toronto Planning Division. (2013). *City of Toronto Planning*. Consulté le 11 17, 2015, sur City of Toronto: https://www1.toronto.ca/City%20Of%20Toronto/City%20Planning/Zoning%20&%20Environment/ Files/pdf/B/biodiversegreenroofs\_2013.pdf
- Environment Canada. (s.d.). *Climate Adaptations and Impacts Research*. Consulté le 08 31, 2015, sur http://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=9AF9494E-1
- Gashout HA, G.-N. E. (2009). Acute toxicity of essential oils and other natural compounds to the parasitc mite Varroa destructor, and to larval and adult worker honey bees (Apis mellifera L.). *Journal of Apicultural Research*, 48:263-269.
- Harpur BA, M. S. (2012). Management increases genetic diversity of honey bees via admixture. *Molecular Ecology*, 21:4414-4421.
- Health Canada. (2014, 11 25). Update on Neonicotinoid Pesticides and Bee Health. Canada: Government of Canada.
- Isaacs R, K. A. (2010). Pollination services provided to small and large highbush blueberry fields by wild and managed bees. *Journal of Applied Ecology*, 47:841-849.
- Laycock I, C. K.-W. (2014). Effects of the neonicotinoid pesticide thiamethoxam at field-realistic levels on microcolonies of Bombus terrestris worker bumble bees. *Etoxicology and Environmental Safety*, 100:153-158.
- Matteson K, A. J. (2008). Bee richness and abundance in New York City urban gardens. *Annals of the Entomological Society of America*, 101:140-150.
- Mattila HR, O. G. (2006). Effects of pollen availability and Nosema infection during the spring on division of labor and survival of woker honey bees (Hymenoptera: Apidae). *Environmental Entimology*, 35:708-717.

Ollerton J, W. R. (2011). How many flowering plants are pollinated by animals? Oikos, 120: 321-326.

- Ontario Ministry of Agriculture, Food and Rural Affairs. (s.d.). *Economics Information Survey of Pesticide Use in Ontario, 2008 Estimates of Pesticides on Field Crops, Fruit and Vegetable Crops, and other Agricultural Crops*. September 23, 2015, Ontario Ministry of Agriculture, Food and Rural Affairs: http://www.omafra.gov.on.ca/english/crops/facts/pesticide-use.htm#4
- Otterstatter Mc, T. J. (2008). Does pathogen spillover from commercially reared bumble bees threaten wild pollinators? PLoS One, 3:e2771.
- Parmesan C, R. N. (2011). Poleward shifts in geographical ranges of butterfly species associated with regional warming. *Nature*, 399:579-583.
- Parsche S, F. J. (2011). Experimental environmental change and mutualistic vs. antagonistic plant flower-visitor interactions. *Perspectives in Plant Ecology Evolution and Systematics*, 13: 27-35.
- Patricio-Roberto GB, C. M. (2014). Aspects of landscape and pollinators what is important to bee conservation? *Diversity*, 6:158-175.
- Pest Management Regulatory Agency. (2015, June 26). Honey Bee Incidents Reported to the Pest Management Regulatory Agency. *AAFC BHRT update*. Canada: Government of Canada.
- Pindar A, Mullen EK, Tonge MB, Guzman-Novoa E, Raine NE (2017) Status and Trends of Pollinator Health in Ontario. University of Guelph report prepared for Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). 238 pages..
- Yoder, J. J. (2014). In vitro evaluation of sugar syrups, antibiotics and miticides on growth of honey bee pathogen, Ascophaera apis: emphasis for chalkbrood prevention is on keeping bees healthy. *Apidologie*, 45:568-578.





