Office of the Auditor General of Ontario

The State of the Environment in Ontario

May 2023

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Office of the Auditor General of Ontario

To the Honourable Speaker of the Legislative Assembly

In my capacity as the Auditor General, I am pleased to submit to you my report on The State of the Environment in Ontario to lay before the Assembly in accordance with the provisions of section 12 of the *Auditor General Act*.

Bonnie Lysyk, MBA, FCPA, FCA, LPA
Auditor General

May 2023
Toronto, Ontario

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Reflections

Bonnie Lysyk
Auditor General of Ontario

Dr. Tyler Schulz
Assistant Auditor General, Commissioner of the Environment

During my tenure as Auditor General, we have conducted many value-for-money audits on environment-related topics. In the course of that work, we have observed multiple changes made to legislation, regulations, operations and the way issues affecting the environment have been addressed, or not acted on. Actions to address the impacts of climate change, population growth, urban sprawl and the desire for economic growth can strengthen or weaken needed protections on the environment.

Just as past actions have impacted the environment, future actions too will affect the air we breathe, the water we drink, the land we live and grow crops on, how we handle waste, the changing climate, and the state of nature and wildlife in Ontario. Unless the environmental outcomes of actions are effectively measured, monitored and publicly reported, there will be limited transparency, accountability and understanding of their impacts.

However, throughout our work, we have not seen how many of these changes and actions were subsequently evaluated or how the more recent changes and actions will be assessed to determine their longer-term impact on the environment, both positive and negative. From a bottom-line perspective, Ontarians want and need to know whether the Province has been doing a good job protecting our air, water, land, nature and wildlife. Our 2020 value-for-money report Setting Indicators and Targets, and Monitoring Ontario's Environment, and our 2021 value-for-money report Reporting on Ontario's Environment found that relevant data and information on key aspects of the environment were being collected and analyzed in some areas, but not in others. More importantly, little easily understood information is made available telling the public whether the government is doing a good job in protecting our environment.

We found that the Province has not produced a consolidated report on how Ontario is doing in protecting the environment for future generations. This report, The State of the Environment in Ontario, was conceived as an illustration of what can be prepared and provided to the public, based on available information. The report is meant to contribute to the discussion of the benefits of public reporting on the state of the province's environment and serve as an accountability mechanism for government to inform its citizens objectively about how well it is doing in protecting our environment.

We encourage the Province to undertake regular consolidated public reporting on the state of the environment in Ontario. A healthy environment is important to Ontarians, and the more information that is shared, the more there will be a common understanding of how

collective changes and actions impact the environment for present and future generations.

In broad terms, we noted the following on the state of Ontario's environment:

The State of Air: Overall, Ontario's air quality has improved dramatically over the past several decades. However, there are some exceptions to the positive trends, such as the increase in total particulate matter emissions, and the 23% increase in the average concentration of ground-level ozone from 1990 to 2019.

The State of Water: Water quality varies across Ontario by waterbody. Ontario's water resources have improved in many ways over the past half-century. However, many positive water quality trends have stalled or even reversed since the 1990s.

The State of Land and Waste: Southern Ontario has about 25% forest cover today and has lost nearly three-quarters of its wetlands since European settlement began (the majority of wetland loss occurred in the 20th century), primarily to agriculture and development. Land cover in Ontario's Far North has been subject to far less disturbance. Ontario's cropland, which comprises 4% of the province's total land area, has experienced declines in soil quality. In terms of waste management, Ontario's current landfill capacity is capable of accepting up to only 13 more years of waste.

The State of the Climate: Climate trends are largely caused by global greenhouse gas emissions, and are not directly reflective of the impacts of emissions from Ontario alone. Still, the long-term trend shows a clear gradual increase in Ontario's surface air temperature. The number of weather-related disasters such as severe rain or ice storms has grown over the past 100 years from almost one per year in the early 1900s, to an average of about three per year since 2000. The average maximum ice cover across all of the Great Lakes is 26% lower than it was almost 50 years ago. Ontario's average growing season has lengthened by about 13 days from 1950 to 2018.

The State of Nature and Wildlife: Less is known about the state of, and changes over time in, Ontario's natural ecosystems and wildlife. More than two-thirds of southern Ontario has been converted to agricultural land and urban areas since the early 1800s. Ontario had approximately 35 million hectares of wetland habitat remaining in 2011, with 97% of the province's wetland area found in the North. Also, the average number of hectares lost to deforestation each year is almost quadruple the amount established as new forests.

The Province has not met Ontario's Biodiversity Strategy target set in 2011 to conserve at least 17% of land and water systems by 2020. As of October 2022, 10.8% of Ontario's land and water area was being conserved through 1,413 protected and conserved areas. Outside of protected areas, wildlife habitat is highly fragmented—especially in southern Ontario. While the Province does not collect comprehensive, long-term data on wild pollinators (such as bees), evidence shows that some species have declined dramatically. Southern Ontario has one of the highest concentrations of species at risk of extinction in Canada (e.g. Blanding's turtle, barn swallow, American badger), primarily due to habitat loss and degradation. Invasive species (e.g. zebra mussels, emerald ash borer and garlic mustard), which can disrupt ecosystems and affect biodiversity, continue to spread in Ontario.

The Province has made a number of recent decisions (see **Appendix 2**) that have the potential to significantly impact the environment—either positively or negatively. Regular public reporting

on the state of the environment, along the lines of what we have done in this report, would provide information to the public and decision-makers on the impact of these and other changes.

This report was made possible because of the work of many employees within the Ontario public sector, and the other organizations named in this report, who are dedicated to environmental-related work that serves the critical purpose of providing information that can inform important decision-making to prevent or address harm to our environment.

As we stated in our Reflections to the 2021 Annual Report of Environment Audits:

> *It is well worth remembering that protecting, conserving and restoring the environment requires a longer-term perspective. Whatever the politics of the day, elected governments are called upon to hold this longer-term perspective in sight. The actions they take, or fail to take, will be measured in the long run by future generations of Ontarians.*

Sincerely,

Bonnie Lysyk
Auditor General of Ontario

Dr. Tyler Schulz
Assistant Auditor General,
Commissioner of the Environment

The State of the Environment in Ontario

1.0 Summary

Ontarians rely on the natural environment for water, food, energy and resources. Fresh air and access to clean water, beaches, parks, conservation areas and other green spaces are vital for our health and well-being. However, pollution, development, a changing climate and other pressures can negatively affect our environment, natural resources and agriculture. Degradation and damage of ecosystems (see a Glossary of Terms in **Appendix 1**) can, in turn, harm Ontario's economy and Ontarians' health and quality of life.

Businesses, municipalities, citizen groups, government decision-makers and the public need a clear picture of the overall state of the environment, such as information about whether our air, water, soil and wildlife populations are getting better or worse. Ontarians also need to know the impact of government decisions and programs on the environment (see **Appendix 2** for examples of recent decisions made by the Province with the potential to have significant environmental impacts).

At the provincial level, responsibility for monitoring and reporting on the state of Ontario's environment, natural resources and the environmental sustainability of Ontario's agriculture falls primarily to the Ministry of the Environment, Conservation and Parks (Environment Ministry), the Ministry of Natural Resources and Forestry (Natural Resources Ministry) and the Ministry of Agriculture, Food and Rural Affairs (Agriculture Ministry).

In our *2020 Annual Report* audit, Setting Indicators and Targets, and Monitoring Ontario's Environment, we found that these three ministries did not sufficiently monitor and collect data on all key aspects of Ontario's environment and, therefore, often did not have key environmental information to report to the public. In our *2021 Annual Report* audit, Reporting on Ontario's Environment, we found that the three ministries are not providing consolidated provincial reporting to give the public, stakeholders and decision-makers an assessment of the overall condition of Ontario's environment and natural resources.

To help fill this gap in environmental reporting, our Office presents in this report information on the status of select environmental indicators. This information provides an overview of the state of Ontario's environment as well as the Province's progress in meeting its own environmental targets.

There are numerous different indicator categories and metrics that jurisdictions can use to report on the condition of the environment. We reviewed best practices and guidance to select indicators related to five broad categories of Ontario's environment: air; water; land and waste; climate; and nature and wildlife. These indicators are not all-encompassing but are intended to provide a snapshot of the state of Ontario's environment based on available data.

An environmental indicator is a measurable value that can be used to track changes in, or damage or improvement to, environmental quality and human health. There are several different types of indicators. This report applies a combination of the following three broad types of environmental indicators:

- **Pressure indicators** track the human activities that cause changes in environmental conditions, such as contaminant releases to air or water.
- **State indicators** track environmental conditions, such as the pollutant concentrations in a waterbody.
- **Impact indicators** track environmental and human health damage, such as an increase in deaths from a change in environmental conditions.

The information provided here is necessarily limited by the availability of data collected, analyzed and verified by the Environment Ministry, the Natural Resources Ministry, Agriculture Ministry and other organizations. More comprehensive and up-to-date reporting depends on additional and improved data collection and analysis.

Thank you to staff in the following organizations and ministry branches for their assistance and co-operation in providing and reviewing data presented in this report:

- **Ontario Ministry of the Environment, Conservation and Parks** (several Ministry branches)
- **Ontario Ministry of Natural Resources and Forestry** (several Ministry branches)
- **Ontario Ministry of Agriculture, Food and Rural Affairs** (Agriculture Development Branch, and Food Safety and Environmental Policy Branch)
- **Ontario Ministry of Health** (Health Protection and Surveillance Policy and Programs Branch)
- **Agriculture and Agri-Food Canada** (Science and Technology Branch)
- **Department of Fisheries and Oceans Canada** (Canadian Hydrographic Service)
- **Environment and Climate Change Canada** (Canadian Ice Service, Science and Technology Branch, and Strategic Policy Branch)
- **Health Canada** (Healthy Environments and Consumer Safety Branch, and Water and Air Quality Bureau)
- **Natural Resources Canada** (Canadian Forest Service)
- **Public Safety Canada** (Canadian Disaster Database)
- **Ontario Biodiversity Council**

These ministries and other organizations provided data, information and input on their respective data sources. This data was used by the Office of the Auditor General of Ontario in this report.

The State of Air in Ontario

Overall, Ontario's air quality has improved dramatically over the past several decades. Various factors have contributed to this, including improved pollution-control equipment for vehicles and industry, fewer industrial sources of air pollution, and the phase-out of coal-fired electricity between 2005 and 2014. Concentrations in the air of many individual contaminants, including fine particulate matter, sulphur dioxide and nitrogen dioxide, have all decreased over the last three decades.

However, there are some exceptions to these positive trends. For example, air concentrations of ground-level ozone, which can trigger asthma and other breathing problems, have been increasing. Further, some parts of the province, mainly highly urbanized and industrial areas such as the Windsor, Chatham-Kent, Niagara and Sarnia regions, have poorer air quality than the rest of the province.

Despite generally improving trends, air pollution is still estimated to be responsible for about 7% of deaths in Ontario (6,580 premature deaths in 2016, the most recently published data) and over 4,000 hospital admissions and emergency room visits per year, mainly due to respiratory and cardiac issues.

There are no provincial targets associated with air emissions or health risks from exposure to air pollution.

The State of Water in Ontario

Ontario's water resources have improved in many ways over the past half-century. In particular, ongoing work over the past few decades to clean up historically contaminated hotspots in the Great Lakes has resulted in steady progress. Between the 1970s and 1990s, sewage treatment plants greatly reduced releases of phosphorus, which is a water contaminant that is a major contributor to algae blooms. At the same time, industry reduced releases of toxic contaminants such as mercury and polychlorinated biphenyls (PCBs). However, many positive water quality trends have stalled or even reversed since the 1990s.

Water quality varies across Ontario by waterbody. For example:

- **The Great Lakes:** Lake Erie and Lake Ontario are generally more polluted than Lake Huron and Lake Superior. For example, Lake Erie and Lake Ontario experience more frequent algae blooms as well as higher concentrations of microplastics. Though decreasing in phosphorus levels, Lake Erie is not meeting the Interim Provincial Water Quality Objective for phosphorus (20 micrograms/litre), with the 2019 concentration at 20.5 micrograms/litre.
- **Inland lakes:** Water quality varies among Ontario's more than 200,000 inland lakes. For example, phosphorus levels, which contribute to algae blooms, and acidity, which can threaten sensitive aquatic plants and animals, are generally improving, yet some lakes continue to experience excess phosphorus and acidity. In Lake Simcoe—the largest inland lake in southern Ontario—dissolved oxygen concentrations, which are important for the survival of fish and other aquatic organisms, are improving, but the concentrations still do not meet the Environment Ministry's deepwater dissolved oxygen target (7 milligrams/litre). Chloride levels in Lake Simcoe—which come largely from road salt use and can be highly toxic to aquatic organisms—meet the Canadian Council of Ministers of the Environment's (CCME's) water quality guidelines for chloride, but have been steadily worsening. Between 2000 and 2018, Lake Simcoe's average (ice-free) chloride levels, based on an average of readings at all of the Environment Ministry's Lake Simcoe monitoring stations, increased by 76%, from 30 mg/L to almost 53 mg/L.
- **Rivers and streams:** Two key indicators of overall water quality for rivers and streams rate 60% of monitored streams in Ontario as "fairly poor" to "very poor" based on biological health, and 41% of monitored streams as "marginal" to "poor" based on water chemistry. In addition, chloride levels in Ontario streams have been worsening over the past 50 years, with the average chloride concentration of streams in urban areas regularly exceeding the 120 milligrams/litre CCME guideline level for long-term exposure since 2014.
- **Beaches:** Water quality at Ontario's beaches is generally improving. The portion of water quality tests at Ontario's monitored beaches that meet provincial guidelines for E. coli bacteria has been gradually improving since 2011. In 2011, 18% of the water quality tests failed; in 2020, 12% of tests failed, requiring a beach advisory to be posted to advise users of poor water quality.
- **Groundwater:** Groundwater quality and trends vary. About 11% of groundwater monitoring wells sampled by the Province between 2002 and 2019 had chloride levels that exceeded the Ontario Drinking Water Aesthetic Objective—meaning it can affect taste and sodium intake for people who drink the water—and 3% of the monitored wells had chloride concentrations at levels high enough to cause more severe impacts. Overall, 24% of the monitored wells showed an increasing trend in chloride concentrations between 2003 and 2019.

  Nitrate, which has been decreasing slightly, is a more serious contaminant that can cause methemoglobinemia (known as blue baby syndrome because babies' skin turns blue due to insufficient oxygen in their blood), miscarriages and preterm births if consumed at elevated levels. In 2018, two monitoring wells (in Dufferin County and Peel Region) had

nitrate concentrations exceeding the Ontario Drinking Water Quality Standard, representing 0.6% of groundwater monitoring wells. The long-term (2003–2018) average of monitored wells that exceed the standard is 1.6%.

- **Drinking water:** In 2020/2021, 99.87% of municipal residential drinking water systems met Ontario's health-based drinking water standards. Nonetheless, during 2015 to 2020, between 161 and 314 drinking water advisories—issued when there is a concern about the safety of drinking water—were issued each year. The majority of these were boil advisories and on non-municipal systems, which do not serve large populations. As of February 2023, there were 24 Long-Term Drinking Water Advisories at public drinking water systems in Ontario funded by the Department of Indigenous Services Canada, impacting 21 First Nations communities.

The State of Land and Waste in Ontario

Ontario's landscape has been substantially altered since the 1800s by agricultural, residential, industrial and commercial development, especially in southern Ontario. For example, over the past two centuries, southern Ontario went from being almost continuously covered in forests to having only about 25% forest cover today and losing nearly three-quarters of its wetlands. The trend of converting natural land cover in southern Ontario to human use continues but at a much slower pace. Such changes in land cover can affect the plants and animals that depend on these habitats, as well as contribute to climate change and affect Ontario's resilience to a changing climate. In contrast, land cover in Ontario's Far North has been subject to far less disturbance.

Ontario's cropland, which comprises 4% of Ontario's total land area, has experienced declines in soil quality. Agriculture and Agri-Food Canada's 2016 census data (most recent year available) showed that 58% of the province's cropland is at moderate to very high risk of soil erosion, which can reduce long-term crop productivity and yields. The 2016 data also shows that 87% of cropland is losing soil carbon annually, which can contribute to climate change. Once soil has been eroded, it can take many decades to restore it to its previous level. In severe cases of erosion, the land can be permanently unusable as agricultural land.

In terms of waste management, the province's current landfill capacity is capable of accepting up to only 13 more years of waste. Over the past decade, population growth, higher levels of consumption and rising use of single-use items and packaging have led to an increase in waste generation. Ontario has improved its diversion rate—the portion of generated waste that is diverted from landfill through reuse, recycling or composting—from 19% in 2002 to 29% in 2020 (most recent data). However, the annual tonnage of waste sent to landfills has remained high at over 8 million tonnes per year and, despite a longer-term declining trend, increased by 7% between 2016 and 2020.

The State of the Climate in Ontario

Increased levels of carbon dioxide and other global greenhouse gas emissions are altering both global and local climate conditions in many ways. For example, in Ontario:

- **Weather-related disasters:** The annual number of weather-related disasters, such as severe rain or ice storms, has grown over the past 100 years, from at most one per year in the early 1900s to an average of about three per year since 2000.
- **Great Lakes ice cover:** The average maximum ice cover across all of the Great Lakes is 26% lower than it was almost 50 years ago. Changes in ice cover can affect the life cycles of fish and other organisms that live in lakes, as well as affect shipping in the Great Lakes. Changing ice cover can also affect local climate conditions, as ice reflects more sunlight than water.
- **Growing season:** The length of Ontario's average growing season has lengthened from 1950 to 2018 for a total of about 13 days. The length and start of the growing season affect seeding and harvest times, as well as the optimal type of crop to plant.

- **Average air temperatures:** The long-term trend shows a clear gradual increase in Ontario's surface air temperature. From 1948 to 2020, the average annual air temperature in Ontario increased by approximately 0.02°C per year (about 1.5°C over the 73-year record). The increase in surface temperature is most evident during the winter months, with an increase for the winter season of 0.03°C per year (about 2.0°C over the 73-year record).

These climate trends are largely caused by global greenhouse gas emissions, and are not directly reflective of the impacts of emissions from Ontario. Nonetheless, Ontario's annual greenhouse gas emissions contribute to climate change and its impacts. Ontario has committed to reducing provincial emissions by 30% below 2005 levels by 2030. In 2020, the province's emissions were 27% lower than the 2005 level. Ontario's emissions peaked in 2000 and have gradually fallen since then, partly due to phasing out Ontario's coal-fired electricity generation.

In addition, Ontario's forests and northern peatlands store billions of tonnes of carbon, keeping this carbon out of the atmosphere. Ontario's southern wetlands also store carbon, although much less than the northern peatlands, because of their different composition. However, according to a 2018 University of Toronto study, the carbon stock in southern Ontario wetlands has dropped by an estimated 60% since European settlement began, due to wetland loss, including from increased agriculture and urbanization.

The State of Nature and Wildlife in Ontario

Less is known about the state of, and changes over time in, Ontario's natural ecosystems and wildlife. For example, the Province does not measure overall changes in the sizes of wildlife populations in Ontario or collect comprehensive, long-term data on the abundance or diversity of wild pollinators. The results that are available on nature and wildlife are often unfavourable, particularly for southern Ontario. More than two-thirds of southern Ontario have been converted to agricultural land and urban areas since European settlement in the early 1800s. The loss and degradation of natural ecosystems, such as wetlands and forests, can negatively affect ecological processes that benefit humans and wildlife. For example:

- **Wetlands:** Ontario had approximately 35 million hectares of wetland habitat remaining in 2011, with 97% of the province's wetland area found in the North. Between 2000 and 2015, approximately 13,455 hectares (or 1.3%) of previous wetland cover in southern Ontario were lost. The Natural Resources Ministry set targets in 2017 to halt the net loss of wetland area and function in southern Ontario—where wetland loss has been the greatest—by 2025 and to achieve a net gain by 2030. However, the Ministry has not tracked the status of progress in meeting these targets. The Ministry informed our Office in August 2021 that the targets are no longer in effect.
- **Forests:** Forests cover nearly two-thirds of Ontario, and, overall, a diversity of forest types and developmental stages continues to be maintained. However, on average, the number of hectares lost to deforestation each year is almost four times greater than the number of hectares established as new forests. Since 2012, the majority of deforestation has occurred in southern Ontario. Deforestation in southern Ontario has more than doubled from 2009 to 2018, with agricultural development accounting for the majority of the increase.
- **Protected areas:** The Province has not met the Ontario's Biodiversity Strategy's target set in 2011 to conserve at least 17% of land and water systems through well-connected networks of protected areas or other effective conservation measures by 2020. As of October 2022, 10.8% of Ontario's land and water area was being conserved through a total of 1,413 protected and conserved areas. The total size of the protected area system has increased by only 1.98% since 2011.

- **Habitat connectivity:** Outside of protected areas, wildlife habitat is highly fragmented—especially in southern Ontario. This fragmentation affects species' ability to move from place to place, reproduce, feed and maintain genetic diversity.
- **Pollinators:** Pollinators are a critical component of both natural ecosystems and the agricultural sector. While the Province does not collect comprehensive, long-term data on wild pollinators, there is evidence that some species, like the rusty patched bumble bee, have declined dramatically. For managed honeybees, the percentage of colonies that fail to survive each winter has ranged from a low of 11% in 2005/06 to a high of 58% in 2013/14. Canada's beekeeping industry considers 15% overwinter mortality as the maximum acceptable level for populations to be sustainable.
- **Species at risk:** Scientists have assessed the conservation status of 17,867 of Ontario's estimated 30,000 known species. Of these, 9,918 were categorized broadly as either being secure or of conservation concern, which includes species that are presumed or possibly locally extinct, and those that range from very high to moderate risk of local extinction. The other 7,949 assessed species have not been ranked either due to insufficient information or inapplicability, such as with non-native species. As of January 2022, 2,763 (or 28%) of the categorized species were of conservation concern. Reptiles, mosses and freshwater mussels are the most vulnerable to extinction, with 73%, 69% and 49% of those species, respectively, considered species of conservation concern in Ontario. Southern Ontario has one of the highest concentrations of species at risk of extinction in Canada, primarily due to habitat loss and degradation from human activities.
- **Invasive species:** Invasive species, which can disrupt ecosystems and affect biodiversity, continue to spread. There are approximately 1,200 alien plant species in Ontario that have been introduced outside of their normal range, most of which are found in southern Ontario. Based on 2017 data (the most recent available data), at least 441 of these alien plant species were considered invasive. At the end of 2020, 191 aquatic alien species were established in the Great Lakes. Since the first species was observed in the 1830s, the number of Great Lakes aquatic alien species has increased steadily, at an average rate of 10 new species per decade. Likewise, the number of invasive insects and diseases in Ontario's forests continues to increase. There has been a slight increase in the percentage of sampled inland lakes with aquatic alien species between 2008–2012 and 2013–2017, as well as the number found in each lake. However, the total number of aquatic alien species found in sampled inland lakes has remained constant.

2.0 The State of Air in Ontario

The World Health Organization considers air pollution to be the world's greatest environmental risk to human health. Air indicators are almost always included in state of the environment reporting due to the considerable influence of air quality on human and ecological health.

Ontario's air pollutant emissions from human activity tend to be caused by the burning of fossil fuels for electricity, transportation and heating, and from industrial processes. Some of the most harmful air emissions include fine particulate matter, nitrogen oxides, sulphur oxides, volatile organic compounds, carbon monoxide, ammonia, and metals such as lead, mercury and cadmium. Some of these pollutants quickly settle to the ground within a few hours or days after emission. Some react with each other in the air to produce new contaminants such as ground-level ozone.

Air pollutants cause, or are associated with, a wide array of environmental and human health impacts, including acid rain and algae blooms in lakes, and asthma, heart disease, cancer and dementia in humans. Degraded air quality is associated with respiratory and cardiac illnesses, and is estimated to be responsible for thousands of premature deaths in the province each year, and many more hospitalizations.

2.1 Historical Context

Ontario's air quality has improved dramatically over the past several decades. In partnership with the federal government, Ontario has used monitoring equipment at designated stations throughout the province to track this long-term improvement. The Environment Ministry has used the collected data to produce annual air quality reports for almost 50 years.

Ontario's improvement in air quality resulted from a reduction in both domestic and transboundary emissions. Air quality improvements were achieved, in part, from:

- phasing out coal-fired power in the province between 2005 and 2014; and
- improving technological pollution controls such as the adoption of high-efficiency combustion technologies and air pollutant control equipment in industrial facilities and vehicles.

2.2 How Air Quality Affects Environmental and Human Health

Significant and chronic exposure to air pollution can damage environmental and human health, as described in **Figure 1**. Ontario's Air Quality Health Index provides timely information on air quality health risks to enable Ontarians to adjust their activities to reduce potential health impacts. The higher the Air Quality Health Index value, the greater the health risk.

Figure 1: Key Air Contaminants and Human Health and Environmental Impacts

Source of data: Environment and Climate Change Canada, 2022

Air Contaminant	2020 Emissions in Ontario (tonnes)	Primary Emissions Sources	Impacts	
			Human Health	Environmental
Total particulate matter (including fine particulate matter)	2,822,641	Dust, such as from construction sites and unpaved roads, as well as from agricultural activities	Acute and chronic effects including asthma, cardiovascular and respiratory diseases, as well as cancers. Exposure has been associated with dementia, Parkinson's disease, and age-related macular degeneration	Varies with chemical composition of particulates, but can contribute to acid rain and nutrient build-up, which can damage water and land ecosystems
Carbon monoxide	1,128,216	Incomplete combustion in transportation and mobile equipment	Acute toxic effects when inhaled because it reduces the capacity of blood to carry oxygen to organs and tissues	Acute toxic effects for wildlife that inhale the gas
Volatile organic compounds	308,195	Paints and solvents, home firewood burning and off-road vehicles and mobile equipment	Toxic effects on humans, including cancer and damage to the nervous system	Toxic effects on plants and animals in water and land environments
Nitrogen oxides	229,260	Incomplete combustion of fossil fuel or plant or animal materials (such as crop residue or wood waste)	Cause or aggravate asthma, and increase susceptibility to respiratory infections. Contribute to the formation of ground-level ozone and fine particulate matter	Contribute to acid rain and nutrient pollution, which can damage water and land ecosystems

Air Contaminant	2020 Emissions in Ontario (tonnes)	Primary Emissions Sources	Impacts	
			Human Health	Environmental
Fine particulate matter ($PM_{2.5}$)	171,733	Incomplete combustion of fossil fuel or plant or animal materials, and atmospheric chemical reactions between compounds such as nitrogen oxides and volatile organic compounds	Acute and chronic effects including asthma, cardiovascular and respiratory diseases, as well as cancers. Exposure has been associated with dementia, Parkinson's disease, and age-related macular degeneration	Damage varies with chemical composition of the particulates, but can contribute to acid rain and nutrient build-up, which can damage water and land ecosystems
Sulphur oxides	112,762	Combustion and refining of raw materials including coal, oil and metal-containing ores	Cause adverse effects on respiratory systems of humans and animals	Cause damage to vegetation and increase the acidity of water and land ecosystems
Ammonia	91,940	Livestock production and fertilizer application	Irritant to the eyes, nose and throat	Contribute to nutrient build-up, which can damage aquatic ecosystems
Lead	12	Process emissions from base metal mining, smelting and refining, as well as steel manufacturing	Toxic effects on human organs and systems, including the brain, heart, kidney, and reproductive system	Toxic effects on birds, fish, aquatic life, invertebrates, plants and animals
Cadmium	1	Non-ferrous smelting, refining, mining, rock quarrying, and incineration	Accumulates primarily in the kidneys, where it causes toxic effects. Also affects the skeletal and respiratory systems	Birds and mammals experience acute and chronic effects similar to those in humans. Toxic to plants, aquatic organisms and a wide variety of micro-organisms
Mercury	1	Process emissions from the cement and concrete, iron and steel industry, as well as metal mining and refining	Although elemental mercury can have toxic effects, methylmercury, considered the most toxic form of mercury, is a persistent, neurotoxin that can cause physiological, neurologic, behavioural, reproductive and other damage. Mercury can be readily absorbed by eating fish	Mercury can accumulate in organisms, such as fish and bird embryos, with toxic effects

2.3 Indicator—Air Emissions

This pressure indicator tracks the release of pollutants that affect air quality. However, it should be noted that the relationship between the amount of pollutants released into the air and the concentration of pollutants in the air—called ambient levels—is not exact. This is due to several factors including physical and chemical reactions that occur in the atmosphere and because emissions move across provincial and national borders. For example, between 2009 and 2018, Ontario's emissions of nitrogen oxides decreased by 26%, while ambient levels of nitrogen dioxide fell by only 21%. Nevertheless, tracking air emissions offers a useful indication of air quality, as well as of the contribution that Ontario's emitters make to either improving or deteriorating Ontario's air quality over time.

Information on the sources and limitations of estimated air emissions can be found in **Appendix 3**.

2.3.1 Major Factors That Affect Air Emissions

- The rate and type of combustion of fossil fuels
- The rate and type of industrial production
- The adoption of less polluting technologies, including pollution-control equipment
- The use of dust-control measures (such as on unpaved roads or construction sites)

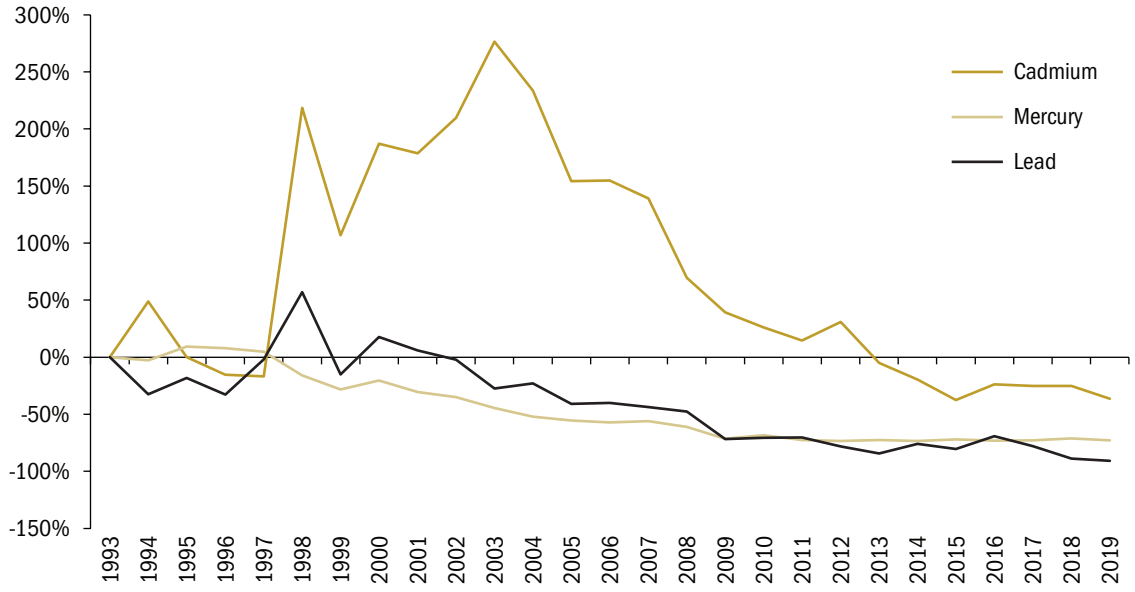
2.3.2 Key Results—Ontario's Air Emissions

Figure 1 shows the key air contaminants released in Ontario, listed in descending order by amount emitted in 2020 (data released in 2022). The largest contaminant release in 2020 was particulate matter (2.8 million tonnes), of which 172,000 tonnes were fine particulate matter, which poses a particularly serious health risk. Carbon monoxide, at 1.1 million tonnes, was the second most common contaminant emitted. Other highly toxic substances, such as lead and mercury, were emitted in much smaller quantities but have serious health and environmental impacts even at low levels. **Figure 1** shows the sources and impacts of each contaminant.

For most contaminants, the estimated amount emitted in Ontario has fallen over the last three decades. As seen in **Figure 2**, emissions of metallic pollutants—cadmium, mercury and lead—have all fallen between 37% to 91% from 1993 to 2019.

Figure 2: Ontario Air Emissions Trends for Metallic Pollutants, 1993–2019

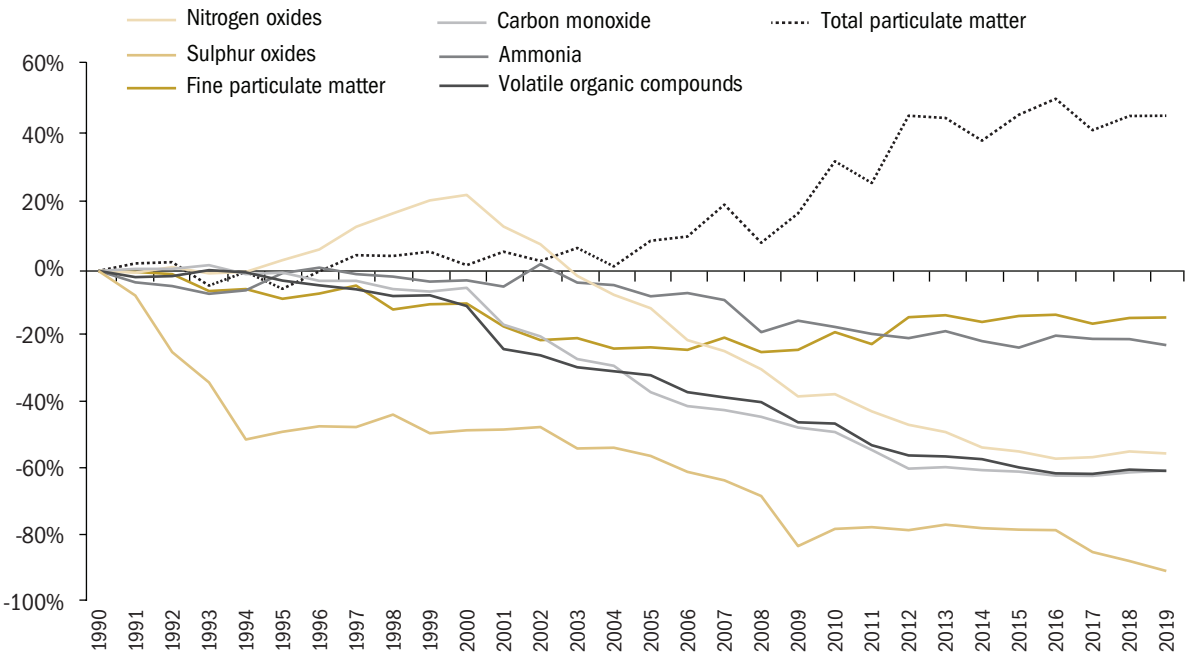
Source of data: Environment and Climate Change Canada's Air Pollutant Emissions Inventory, 2021



Note: The emissions trend lines begin at 1993 to minimize data uncertainty (see explanation in **Appendix 3**).

Figure 3: Ontario Air Emissions Trends for Non-Metallic Pollutants and Particulate Matter, 1990–2019

Source of data: Environment and Climate Change Canada's Air Pollutant Emissions Inventory, 2021



Similarly, as seen in **Figure 3**, emissions of non-metallic air pollutants (ammonia, nitrogen oxides, carbon monoxide, volatile organic compounds and sulphur oxides) and of fine particulate matter fell between 1990 and 2019, with decreases ranging from 14% to 90%. Sulphur oxide emissions fell by the greatest extent (90% between 1990 and 2019), mainly as a consequence of decreased mineral refining and smelting and because coal-fired power generation was phased out in Ontario. Carbon monoxide and volatile organic compounds emissions both decreased by 60%, mainly due to adopting regulations that led to gradually introducing technologies and clean fuel for vehicles.

In contrast, as illustrated in **Figure 3**, while fine particulate matter emissions fell by 14%, total particulate matter emissions increased by 47% between 1990 and 2019. This increase is mainly due to increased dust from unpaved roads and construction operations, which grew by 88% and 58%, respectively.

2.4 Indicator—Air Pollutant Concentrations

Air pollutant concentration is a state indicator that tracks the condition of the air environment. Ontario has an air monitoring program with 39 monitoring stations across the province, operated in collaboration with the federal National Air Pollutant Surveillance program. These monitoring stations measure concentrations in the air of carbon monoxide, fine particulate matter, nitrogen dioxide, ozone, sulphur dioxide and total reduced sulphur. The Environment Ministry also monitors roadside air quality at designated monitoring stations.

Information on the sources and limitations of the data on air pollutant concentrations can be found in **Appendix 4**.

2.4.1 Major Factors That Affect Air Pollutant Concentrations

- The rate of domestic air pollutant emissions, and characteristics of the emissions sources (such as the height of industrial chimney stacks)
- The rate of air pollutant emissions entering Ontario from other locations (a large portion of air pollutants in Ontario come from emissions outside the province's borders, mainly originating upwind from Ontario in the United States)
- The terrain and topography of the land
- Weather and climate change

2.4.2 Key Results—Ontario's Air Pollutant Concentrations

The concentrations of most air pollutants have fallen since 1990, generally due to reduced air emissions (see **Section 2.3**). **Figure 4** shows the trend of concentrations of four key pollutant categories over the last three decades. These results, which are based on an average of the results from Ontario's air quality monitoring stations, indicate an improving trend in the concentrations of the following:

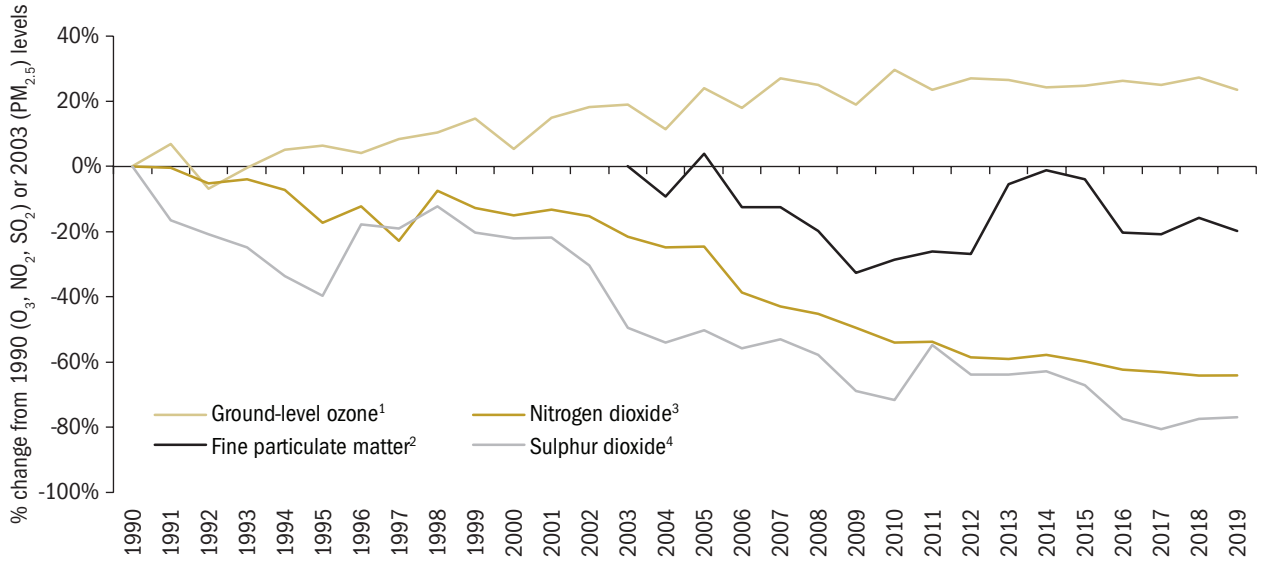
- sulphur dioxide (77% reduction from 1990 to 2019);
- nitrogen dioxide (64% reduction from 1990 to 2019); and
- fine particulate matter (20% reduction from 2003 to 2019).

In contrast, the average concentration of ground-level ozone increased by 23% from 1990 to 2019.

The average annual concentrations recorded from the provincial monitoring stations for nitrogen dioxide (from 2000 onward), sulphur dioxide (from 1991 onward), and fine particulate matter (from 2003 onward) all meet the 2020 Canadian Ambient Air Quality Standards (known as the CAAQS).

Figure 4: Average Ground-Level Ozone (O_3), Fine Particulate Matter ($PM_{2.5}$), Nitrogen Dioxide (NO_2), and Sulphur Dioxide (SO_2) Concentration Trends at Environment Ministry Air Monitoring Stations, 1990–2019

Source of data: Ministry of the Environment, Conservation and Parks



1. The O_3 results are based on measurements taken from between 32 and 45 monitoring stations per year.
2. $PM_{2.5}$ data are not available from before 2003. These results are based on readings from between 28 and 40 monitoring stations per year. In 2013, a new method of monitoring fine particulate matter (SHARP) was introduced, capable of detecting additional components of fine particulate matter relative to the previous detection method.
3. The NO_2 results are based on measurements taken from between 20 and 37 monitoring stations per year.
4. The SO_2 results are based on measurements taken from between 8 and 66 monitoring stations per year.

The standard for ground-level ozone is based on a short-term (eight-hour) concentration, precluding comparisons to data collected on long-term (annual) concentrations.

Air pollutant concentrations vary considerably across the province, meaning that some Ontarians experience more polluted air than others. Health Canada regularly estimates the air pollutant concentrations of three pollutants—fine particulate matter, nitrogen dioxide and ground-level ozone—for each census division to estimate the health impacts associated with exposure to air pollutants across Canada. For each pollutant, **Figure 5** highlights the top 10 of Ontario's 49 census divisions with the highest concentrations between 2015 and 2017. On average, Essex (including Windsor), Chatham-Kent, Niagara and Lambton (including Sarnia) were subject to some of the poorest air conditions.

2.5 Indicator—Air Quality Health Risk

This indicator category tracks the potential health risk from exposure to air pollutant concentrations within Ontario's air quality forecast regions. The Province uses the Air Quality Health Index to indicate the potential health risk from a mix of ground-level ozone,

Figure 5: Ontario Census Divisions with the Highest Air Concentrations[1] of Ground-Level Ozone, Fine Particulate Matter ($PM_{2.5}$) and Nitrogen Dioxide (NO_2), 2015–2017[2]

Source of data: Health Canada

Annual Ozone (parts per billion)		**Summer Ozone** (parts per billion)		**$PM_{2.5}$** (micrograms per cubic metre)		**NO_2** (parts per billion)	
Provincial Avg.	**40.7**	**Provincial Avg.**	**44.4**	**Provincial Avg.**	**5.7**	**Provincial Avg.**	**5.9**
Essex	**47.7**	Essex	**57.1**	Chatham-Kent	**8.8**	Toronto	**12.4**
Haldimand-Norfolk	**46.3**	Chatham-Kent	**53.7**	Essex	**8.6**	Peel	**10.9**
Elgin	**45.4**	Haldimand-Norfolk	**53.3**	Lambton	**8.5**	York	**10.5**
Niagara	**45.4**	Elgin	**52.5**	Hamilton	**7.9**	Halton	**9.7**
Chatham-Kent	**45.3**	Lambton	**52.4**	Niagara	**7.8**	Hamilton	**9.7**
Lambton	**44.6**	Niagara	**52.4**	Toronto	**7.8**	Durham	**8.9**
Brant	**44.4**	Middlesex	**50.8**	Middlesex	**7.6**	Essex	**8.5**
Middlesex	**44.3**	Brant	**50.3**	Brant	**7.5**	Waterloo	**7.9**
Oxford	**44.2**	Prince Edward	**50.2**	Elgin	**7.4**	Brant	**7.6**
Prince Edward	**43.5**	Oxford	**50.1**	Halton	**7.4**	Middlesex	**7.5**

1. Health Canada estimates the ambient concentrations of ground-level ozone (both annual and summer concentrations), fine particulate matter and nitrogen dioxide in each of Canada's census divisions, including 49 census divisions in Ontario.
2. Health Canada uses a three-year average (from 2015 to 2017, except for ozone which used 2014, 2015 and 2017) to estimate air pollutant concentrations.

fine particulate matter and nitrogen dioxide. It also accounts for the individual pollutant concentrations of ozone, nitrogen dioxide, sulphur dioxide, carbon monoxide, and total reduced sulphur compounds in relation to Ontario's Ambient Air Quality Criteria.

The Air Quality Health Index's categories of risk are low, moderate, high and very high. Each risk category has associated health messages for both the general population and at-risk populations. These messages include "Enjoy your usual outdoor activities" and "Ideal air quality for outdoor activities" for the low-risk category, and "Avoid strenuous activities outdoors" and "Reduce or reschedule strenuous activities outdoors" for the very high-risk category.

Since 2015, whenever the Air Quality Health Index forecasts high-risk conditions for a period exceeding one hour, the Environment Ministry and Environment and Climate Change Canada jointly issue either:

- a **Special Air Quality Statement** when the Air Quality Health Index value for one or more regions is forecast to be high risk for one to two hours; or
- a **Smog and Air Health Advisory** when the high-risk period for one or more regions is forecast for at least three hours.

Previously, from 2003 to 2014, the Environment Ministry would advise the public of forecast air quality health risks through "Smog Advisories," which were similar alerts, but were based on slightly different air quality criteria.

Information on the sources and limitations of the data on air quality health risks can be found in **Appendix 5**.

2.5.1 Major Factors That Affect Air Quality Health Risks

- Ambient air pollutant concentrations
- Proximity to emission sources
- The timing and duration of outdoor activities
- Pre-existing health conditions
- Weather and climate change

2.5.2 Key Results—Air Quality Health Risks in Ontario

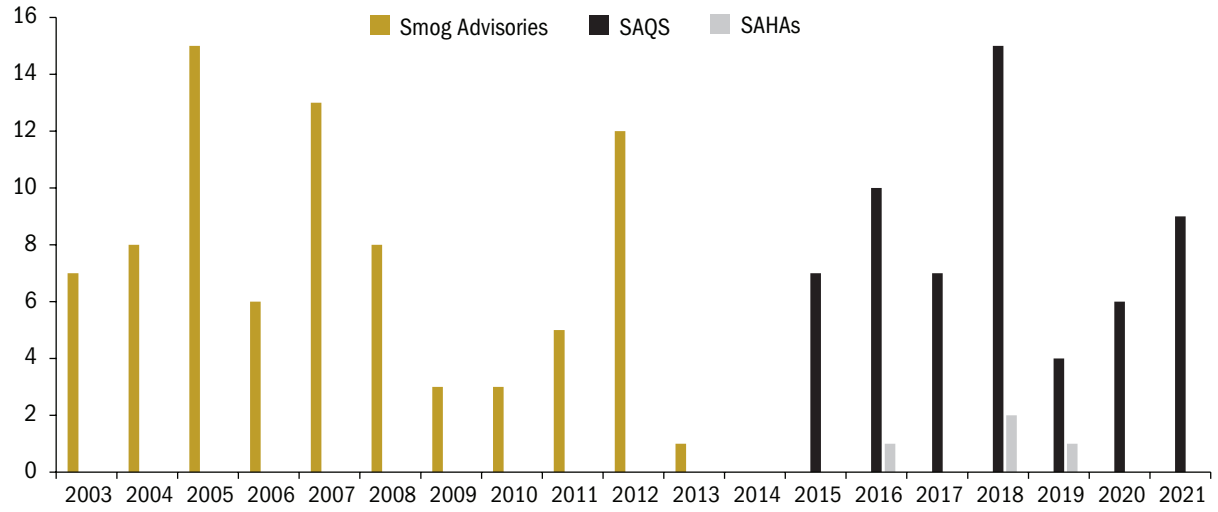
In 2019, the most recent year of summarized data for Air Quality Health Index ratings, Ontario reported:

- low-risk air quality for 94.5% of the year;
- moderate-risk air quality for 5.5% of the year; and
- high-risk air quality for 0.01% of the year.

There has been no clear trend for Special Air Quality Statements or Smog and Air Health Advisories since 2015, when these statements and advisories began

Figure 6: Smog Advisories, Special Air Quality Statements (SAQS) and Smog and Air Health Advisories (SAHAs) Issued per Year, 2003–2021

Source of data: Ministry of the Environment, Conservation and Parks



Note: In 2015, Ontario switched from Smog Advisories to the updated Special Air Quality Statements and Smog and Air Health Advisories.

(**Figure 6**). The annual fluctuation is due in part to variability in the weather, such as heat waves or cool fronts, or other factors, such as forest fires, which may affect air quality. From 2015 to 2021, Ontario had an annual average of eight Special Air Quality Statements, with a range of four to 15 per year. In 2021, nine Special Air Quality Statements were issued. A total of four Smog and Air Health Advisories were issued in Ontario between 2015 and 2021, with no Smog and Air Health Advisories issued in 2016, 2017, 2020 or 2021.

Over the 2003 to 2014 period, the number of annual Smog Advisories also fluctuated without any clear trend, with a maximum of 15 advisories in 2005 and a low of zero in 2014 (**Figure 6**).

Out of Ontario's 61 air quality forecast regions, 16 had no Special Air Quality Statements from 2015 to 2020 while 45 regions had at least one. In 2021, all 61 regions had at least one Special Air Quality Statement. Between 2015 and 2021, the regions of Sarnia-Lambton and Windsor-Essex-Chatham-Kent were subject to the highest number of Special Air Quality Statements. Five regions were subject to Smog and Air Health Advisories: the City of Toronto, Elgin, Huron–Perth, Sarnia–Lambton, and Windsor–Essex–Chatham–Kent.

2.6 Indicator—Health Impacts from Exposure to Air Pollutants

Short-and long-term exposure to air pollution can damage human health (**Figure 1**).

Health Canada periodically publishes reports that estimate health impacts (based on modelling)—morbidity (non-fatal health outcomes, like diseases and illness) and premature deaths—from exposure to atmospheric fine particulate matter, nitrogen dioxide and ground-level ozone.

Information on the sources and limitations of the data on health impacts from air pollutants can be found in **Appendix 6**.

2.6.1 Major Factors That Affect Health Impacts from Exposure to Air Pollutants

- Ambient air pollutant concentrations
- Proximity to emission sources
- The timing of and duration of outdoor activities
- Pre-existing health conditions
- Weather/meteorology (such as air temperature, humidity and wind speed)

2.6.2 Key Results—Health Impacts from Exposure to Air Pollutants in Ontario

Health Canada estimated that exposure to three ambient atmospheric pollutants—fine particulate matter, nitrogen dioxide and ozone concentrations above background levels—contributed to 6,580 premature deaths in 2016 (most recently summarized data) (**Figure 7**). This represents about 7% of total deaths reported for Ontario in that year.

These three air pollutants also result in health impacts that were quantified by Health Canada using morbidity counts for hospital admissions, emergency room visits, symptom days, restricted activity days and child acute and adult chronic bronchitis cases. The morbidity counts for 2016 exceeded 900 hospital admissions and 3,300 emergency room visits (**Figure 8**). Exposure to air pollutants also led to 17.2 million symptom days and 6.9 million restricted-activity days in 2016. This is equivalent to each Ontarian experiencing 1.8 days of pollutant-related symptoms and/or having to restrict their activities (such as work, school or exercise).

Figure 7: Estimated Deaths in Ontario from Modelled Exposure to Ambient Atmospheric Fine Particulate Matter, Nitrogen Dioxide and Ozone above Background Levels, 2016*

Source of data: Health Canada

Acute Exposure Mortality (associated with nitrogen dioxide and ozone)	1,800
Chronic Exposure Respiratory Mortality (associated with ozone)	580
Chronic Exposure Mortality (associated with fine particulate matter)	4,200
Total	**6,580**

* Most recent estimate available.

Figure 8: Estimates of Health Impacts in Ontario from Exposure to Ambient Atmospheric Fine Particulate Matter, Nitrogen Dioxide and Ozone above Background Levels, 2016

Source of data: Health Canada

Types of Health Impacts	
Cardiac hospital admissions	340
Respiratory hospital admissions	570
Total # of Hospital Admissions	**910**
Cardiac emergency room visits	450
Respiratory emergency room visits	2,900
Total # of Emergency Room Visits	**3,350**
Acute respiratory symptom days	15,960,000
Asthma symptom days	1,240,000
Total # of Symptom Days	**17,200,000**
Minor restricted activity days	1,130,000
Restricted activity days	5,780,000
Total # of Restricted Activity Days (including Minor)	**6,910,000**
Child acute bronchitis episodes	19,000
Adult chronic bronchitis cases	4,000
Total # of Child Acute and Adult Chronic Bronchitis Cases	**23,000**

2.7 What Progress Has Been Made Toward Air Targets in Ontario?

The Canadian Council of Ministers of the Environment has established the Canadian Ambient Air Quality Standards (standards). These standards set out health- and environmental-based air quality objectives to further protect human health and the environment, which are intended to guide provinces to continually improve air quality across the country. They set out ambient air quality concentrations for four pollutants: fine particulate matter, ground-level ozone, nitrogen dioxide and sulphur dioxide.

Based on the standards, the Environment Ministry introduced a key performance indicator for improved ambient air quality in 2017/18. The Environment Ministry's key performance indicator sought to achieve ambient pollutant levels in Ontario that were equal to or lower than the standards for ozone, fine particulate matter and sulphur dioxide by March 31, 2021. The Environment Ministry reported that Ontario met the target in 2019/20 but exceeded it in 2020/21, due to more stringent ozone standards coming into effect in 2020. Now that the ambient air quality target deadline of March 31, 2021, has passed, the Environment Ministry advised us that it is reviewing this target.

There are no provincial targets associated with air emissions, the Air Quality Health Index, Special Air Quality Statements, Smog and Air Health Advisories, or mortality and morbidity rates from ambient air pollution.

3.0 The State of Water in Ontario

Ontario, with more than 200,000 lakes and 500,000 kilometres of rivers and streams, has one of the largest supplies of fresh water in the world. These water sources provide essential drinking water for humans and wildlife, and habitat for fish and other aquatic organisms. They also support the growth of vegetation and other life forms on land as well as numerous economic sectors, including agriculture, industry, hydroelectricity production, recreation and tourism.

However, pollutants can degrade water quality, which then affects wildlife, plants and human health. Examples of water pollutants include:

- pesticides and excess nutrients that flow from agricultural lands;
- releases from sewage treatment plants and septic tanks, which can cause algae blooms in lakes;
- pathogens, such as bacteria and viruses, which can cause gastrointestinal illness in humans; and
- chloride, primarily from the use of road salt, especially near urban areas. At moderate to high levels, chloride is toxic to many types of aquatic organisms.

There are also emerging contaminants such as microplastics (plastic particles less than five millimetres in size) that can carry toxins and cause intestinal and other damage if consumed.

The primary water pollution sources in Ontario tend to be associated with agriculture, urban areas, industry and sewage. Another source is from air pollution deposited on waterbodies. Water contaminants may be ingested or absorbed by aquatic and terrestrial organisms, settle to the bottom of a waterbody, or migrate downstream to eventually enter the Atlantic Ocean or Hudson Bay.

3.1 Historical Context

Water quality in the Great Lakes, inland lakes and other waterbodies in Ontario has improved in many ways over the past half-century. Improvements were especially evident between the 1970s and 1990s as sewage treatment plants greatly reduced phosphorus releases. Emissions of toxic contaminants, like mercury and polychlorinated biphenyls (PCBs), were also greatly reduced during this time period. Ongoing work over the past few decades to clean up historically contaminated hotspots in the Great Lakes has resulted in steady progress.

However, many positive water quality trends have stalled or, in some cases, reversed since the 1990s. New and growing threats to water quality, including climate change, invasive species, urbanization, microplastics and pharmaceuticals, have increased pressure on Ontario's water resources.

Between 2009 and 2016, the Province published biennial reports on the state of Ontario's water quality, summarizing the results of multiple water monitoring programs. The Environment Ministry advised us that it stopped publishing Water Quality in Ontario reports as it moved to posting data on the Ontario Data Catalogue. The Data Catalogue contains datasets with the raw data from a number of the Environment Ministry's water-monitoring programs. Posted data supports various water-related reports, however, the posted data is not summarized to explain what it means.

3.2 How Water Quality Affects Environmental and Human Health in Ontario

Changes to either the physical or chemical characteristics of a lake, river or stream can significantly impact fish, plants and other aquatic organisms that live in or rely on those waterbodies. Contaminants can throw off the delicate balance of a lake ecosystem. Through evolution, species adapt to the prevailing ecological conditions. Aquatic organisms require various nutrients and minerals to survive and flourish such that either an excess or a deficiency in any one of them can be harmful. The ecological balance of waterbodies can be disturbed by various threats, including:

- **Releases of excess nutrients**, such as nitrogen and phosphorus, can cause algae and plant growth, which in turn deplete the dissolved oxygen in the water to levels that can no longer

support the fish and other aquatic species living in the waterbody. Excess nutrients can also cause growth of toxic forms of algae that are harmful to ecological health as well as human health (causing nausea, diarrhea, vomiting, sore throat and skin irritation).

- **Releases of other pollutants**, such as metals and chlorides, can be highly toxic to aquatic organisms, causing death. Exposure to pesticides in water can harm human health, as well as cause environmental impacts, including harm to pollinators. E. coli in water can indicate the presence of pathogens, such as bacteria, that cause gastrointestinal illness in humans if ingested, with rare cases leading to stroke or kidney failure.
- **Climate change** can result in warmer water temperatures, which can threaten the habitat of coldwater fish species such as lake trout and lake whitefish.

Some contaminants, whether released into water or air, are especially harmful, most notably:

- **Cadmium** is a carcinogenic metallic element that accumulates in tissues and organs (primarily the kidneys), and causes serious and chronic effects in birds and mammals, including humans. It is also toxic to plants and aquatic organisms.
- **Lead** is a metal that has toxic effects on many types of organisms including birds, fish and other aquatic life, invertebrates, plants and mammals. Infants and children are especially susceptible to the toxic effects of lead on brain development and cognitive functioning.
- **Mercury,** in the form of methylmercury, is a neurotoxin that can cause physiological, neurologic, behavioural, reproductive and other damage in humans. It is absorbed through eating contaminated fish. Mercury exposure can also have toxic effects on wildlife, including bird embryos.

Environment and Climate Change Canada lists cadmium, lead and mercury as toxic under the *Canadian Environmental Protection Act, 1999*. These are also the only substances included in the "Releases of harmful substances to water" indicator in the Canadian Environmental Sustainability Indicators program. See **Figure 1** for more information on the sources and impacts of these three substances.

Exposure to contaminants in drinking water at elevated levels and/or for prolonged periods can cause many types of serious and chronic health effects in humans. Examples include gastrointestinal illness, stroke, kidney failure and seizures. For example, regularly consuming water containing elevated levels of nitrate can cause health problems such as methemoglobinemia (known as blue baby syndrome, when there is insufficient oxygen in the blood), miscarriages and preterm births.

Another threat to the health of waterbodies is taking an excess amount of water compared with the available supply of water. Depleting water in lakes, rivers, streams and groundwater aquifers can negatively impact land and water ecosystems. Excess water takings can also reduce water available for drinking, as well as for agricultural, industrial and electricity production purposes. Drainage of groundwater aquifers can also cause the sinking or downward settling of the ground.

3.3 Indicator—Point-Source Water Contaminant Releases

This indicator measures point-source—specific, single-source—releases of contaminants into waterbodies. Examples of point-source releases include discharges from industrial facilities and sewage treatment plants.

Contaminants from non-point—diffuse, multiple-source—releases to water also can have a significant negative effect on water quality. Examples of non-point releases include:

- stormwater runoff, which can include numerous contaminants such as road salt, pesticides, litter and animal excrement;
- agricultural runoff;
- spills of hazardous substances; and
- the settling of airborne contaminants on water.

However, non-point releases, which are spread out over a wide area, are typically hard to measure and lack identifiable polluters to be held accountable for the releases. As a result, non-point releases are rarely tracked and are therefore not included as an indicator in this report.

Information on the sources and limitations of the data on point-source releases of contaminants to water can be found in **Appendix 7**.

3.3.1 Major Factors That Affect Point-Source Releases of Water Contaminants

- The rate of industrial activity and use of best practices and technological innovations
- Design and operation of sewage treatment and sewer systems

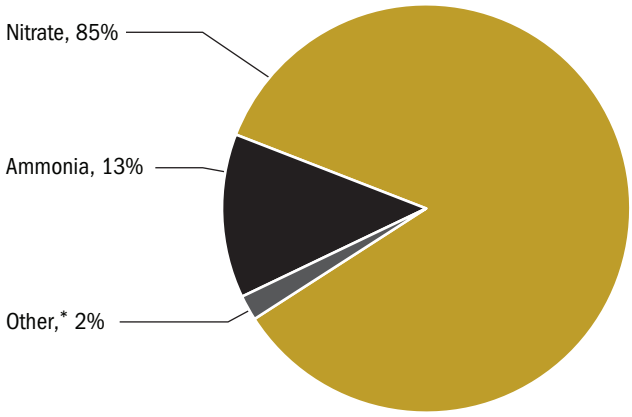
3.3.2 Key Results—Point-Source Water Contaminant Releases in Ontario

Between 1993 and 2020, approximately 90% of all reported point-source discharges to water originated from sewage treatment facilities. Consequently, the overwhelming majority (98%) of point-source contaminants reported by Ontario sources discharging into Ontario's waterbodies in 2020 were nitrate and ammonia (**Figure 9**), which are contaminants commonly contained in sewage. These contaminants were released primarily in the southern Great Lakes watershed.

The remaining 2% of reported releases in 2020, totalling just under 1,500 tonnes, encompass a range of contaminants, such as phosphorus and manganese. Although each of these contaminants were released in smaller quantities, several—including cadmium, lead and mercury—have much more serious impacts on water quality, even at low levels.

Figure 9: Composition of Point-Source Releases of Contaminants to Water in Ontario, 2020 (65,954 tonnes)

Source of data: Environment and Climate Change Canada (National Pollutant Release Inventory)



* "Other" encompasses a large range of contaminants, such as phosphorus, manganese, cadmium, lead and mercury.

Overall, **Figure 10** illustrates that point-source releases of contaminants to water in Ontario increased by 15% from 2004 (57,304 tonnes) to 2020 (65,954 tonnes). There was a spike of reported releases in 2012 that was mainly due to a change in the detection limit for various contaminants that triggered reporting at lower levels.

As shown in **Figure 11**, point-source releases to waterbodies of the three contaminants listed as toxic (cadmium, lead and mercury), which are mostly released indirectly through wastewater treatment facilities, were all considerably lower in 2020 than in 2004.

Figure 10: Total Amount of Contaminant Releases to Water from Point Sources in Ontario, 2004–2020 (tonnes per year)

Source of data: Environment and Climate Change Canada (National Pollutant Release Inventory)

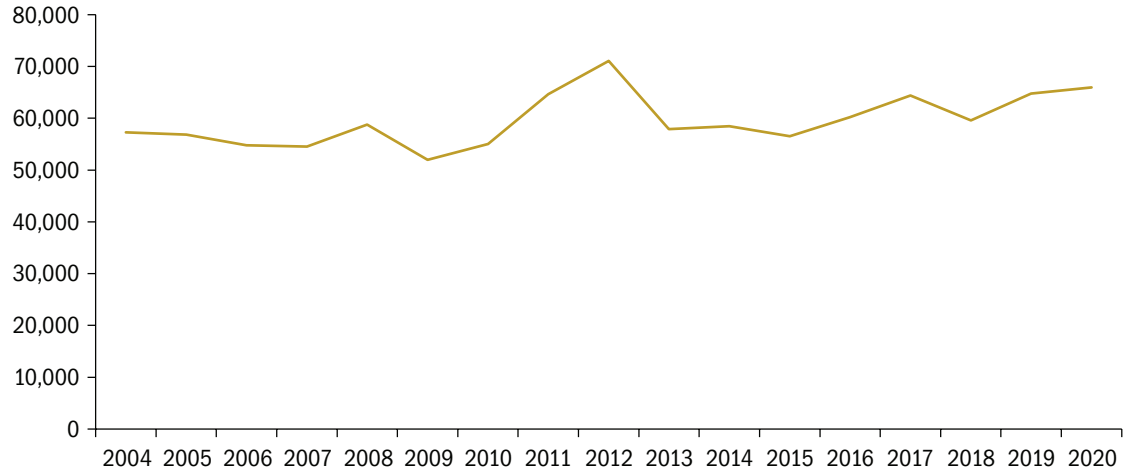
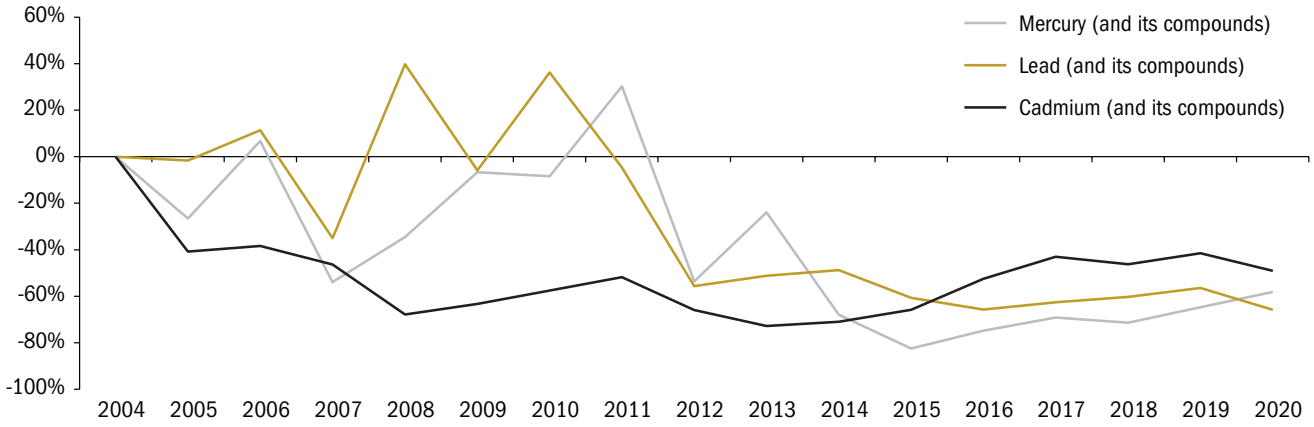


Figure 11: Change in Amount of Cadmium, Lead and Mercury Released to Water from Point Sources in Ontario Relative to 2004

Source of data: Environment and Climate Change Canada (National Pollutant Release Inventory)



3.4 Indicator—Surface Water Quality

The health of a waterbody—lake, river or stream—can be measured by examining its physical and chemical characteristics, as well as the state of the aquatic communities that live there.

There is no fixed optimal condition for the quality of waterbodies in the province. Some normally have more acidic or nutrient-rich water than others. The Great Lakes Water Quality Agreement between Canada and the US sets out different water quality objectives (e.g., for dissolved oxygen or pH levels) for each Great Lake. Further, different species thrive in different conditions. For example, waterbodies that support abundant plant growth are unfavourable for coldwater fish but not necessarily for warmwater species.

Notwithstanding natural variations, experts have identified ranges or thresholds of various water quality

parameters that should be met to avoid toxic effects and other ecological and human health damage. These ranges or thresholds for protection of aquatic life are defined in government documents, including the Provincial Water Quality Objectives and the Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the Protection of Aquatic Life.

For this indicator, we report here on several sub-indicators to track surface water quality in the Great Lakes, inland lakes, rivers and streams, and at beaches. Information on the sources and limitations of the data on surface water quality can be found in **Appendix 8**.

3.4.1 Major Factors That Affect Surface Water Quality

- Rate of runoff of contaminants such as fertilizer, manure, and road salt
- Number, content and magnitude of accidental spills of contaminants
- Amount and content of released sewage and industrial wastewater
- Amount of air emissions that settle in the water
- Invasive species, such as quagga and zebra mussels
- Climate change

3.4.2 Key Results—Ontario's Surface Water Quality (Great Lakes)

About one-fifth of the world's fresh surface water supply is in the Great Lakes, which are shared between Ontario and eight American states. These lakes supply drinking water to tens of millions of people in both Canada and the US. Ontario borders on four of the five Great Lakes—all but Lake Michigan.

We selected two sub-indicators as representative measurements of two different types of surface water quality issues in the Great Lakes:

- microplastics, selected as representative of an emerging contaminant of concern in the Great Lakes that merit additional study; and
- phosphorus, selected as representative of a long-standing surface water quality issue in the Great Lakes.

Microplastics

Microplastics are plastic particles less than five millimetres in size. They originate from a wide variety of sources, including plastic fibres from synthetic clothes, the breakdown of larger plastic particles, films and foams, and from microbeads in personal-care products. They enter streams, rivers and lakes and eventually accumulate at the bottom of waterbodies, along with other sediments. They are slow to degrade in water, which makes them a very long-lasting pollutant.

Microplastics can carry toxins that are ingested by birds and fish, potentially causing intestinal and other damage. Microplastics have been observed in the gastrointestinal tracts of most Great Lakes fish and birds that have been sampled.

Of the five Great Lakes, microplastics have been found to be concentrated most heavily in Lake Ontario—based on the number of particles found per square kilometre in the surface water—and to a lesser extent Lake Erie. This is not surprising given the higher level of urbanization, and therefore potential sources of microplastics to enter these lakes.

There are no long-term studies of microplastic levels in the Great Lakes using consistent methods of measurement, so trends over time are difficult to identify. Nevertheless, analysis of the lake-bottom sediments provides an indication of changes over time. For example, a 2015 study found that microplastics only started to accumulate in sediments in the offshore region of Lake Ontario within the last 40 years.

In central Lake Ontario, microplastic levels in sediments were measured to be approximately 4.7 billion particles per square kilometre, a concentration more than twenty thousand times greater than the average abundance of microplastics per square kilometre in the surface waters. This enormous difference between the concentrations of microplastics in the water and lake-bottom sediments indicates that microplastics settle rapidly.

Phosphorus

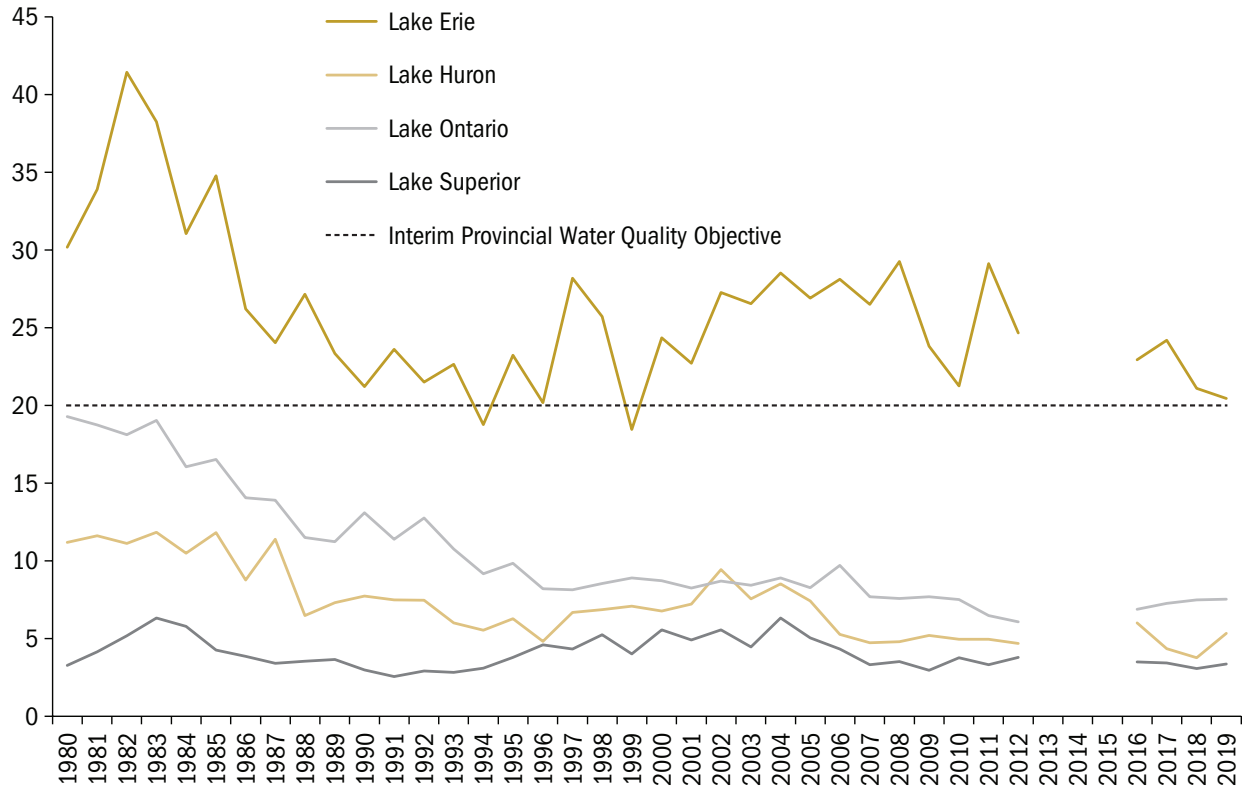
Phosphorus concentrations are an important indicator of nutrient levels in waterbodies. High levels of nutrients can increase the growth of plants and algae in a waterbody. Decomposition of that excess growth decreases the amount of dissolved oxygen in the water, which can result in the death of fish and other aquatic life. Excess nutrients in surface waters increase the risk of harmful algae blooms, which produce toxins harmful to human health and ecosystems, as well as nuisance algae blooms, which do not produce toxins but can impede people's enjoyment of a waterbody.

Phosphorus is the main nutrient that limits the pace of algae growth. Though phosphorus generally occurs in small quantities in the environment, even minor increases can affect water quality.

Total phosphorus concentrations in the Great Lakes are mainly influenced by the inputs from streams and rivers, such as from urban stormwater and agricultural runoff. The concentrations are also significantly affected by the large number of invasive mussels in the Great Lakes. These mussels filter phosphorus from the water and concentrate it at the bottom of lakes, where algae use it to grow. Total phosphorus concentrations—which are determined by comparing average levels in nearshore waters—are highest in Lake Erie (**Figure 12**). Lake Erie has mostly exceeded Ontario's Interim Provincial Water Quality Objective for average

Figure 12: Average Annual Total Phosphorus Concentrations in the Great Lakes (Excluding Lake Michigan), 1980–2019* (micrograms/litre)

Source of data: Ministry of the Environment, Conservation and Parks



* The 2013 to 2015 data are excluded because a change in the method used to estimate total phosphorus concentrations in the Environment Ministry's Toronto laboratory over the 2013–2015 period led to uncertainties in the total phosphorus data.

Figure 13: Status and Trend of Phosphorus Concentrations in the Offshore Waters of Great Lakes (Excluding Lake Michigan)

Source of data: Environment and Climate Change Canada

Lake	Phosphorus Status* (2019)		Phosphorus Trend (1972–2019)
	Rating	Phosphorus Concentrations Relative to Objective	
Lake Erie	Poor	Above objective	Decreasing
Lake Huron	Fair	Below objective	Decreasing
Lake Ontario	Fair	Below objective	Decreasing
Lake Superior	Good	At/near objective	Decreasing

* Phosphorus can have harmful impacts if the level of phosphorus is either too high or too low. The rating is determined by assessing the average total phosphorus concentrations in 2019 relative to each lake's phosphorus objective set out in the Great Lakes Water Quality Agreement between Canada and the US. The phosphorus objectives are: 5 micrograms/litre for Lake Huron and Lake Superior; 10 micrograms/litre for Lake Ontario and the central and eastern basins of Lake Erie; and 15 micrograms/litre for the western basin of Lake Erie.

annual total phosphorus concentrations (20 micrograms/litre) over the past four decades, although its phosphorus concentrations have been decreasing (**Figure 13**).

Average phosphorus concentrations have, in fact, been decreasing across all of the Great Lakes over the past four decades. However, algae blooms near to the shoreline have been increasing in parts of Lake Erie and Lake Ontario over the past decade.

3.4.3 Key Results—Ontario's Surface Water Quality (Inland Lakes)

Ontario has more than 200,000 lakes. About 90% of these lakes each have an area under 50 hectares, while the other 10% each have an area between 50 and 250,000 hectares. The vast majority of these inland lakes are in Northern Ontario, with 58% in northwestern Ontario and 34% in northeastern Ontario. The remaining 8% are in southern Ontario.

Ontario has several monitoring programs that collect data on the physical, chemical and biological properties of lake water to assess the health of the lakes. These programs include, among others, the Environment Ministry's Inland Lakes Monitoring Program, the Natural Resource Ministry's Broad-scale Monitoring Program, and the Lake Partner Program, which is led by the Environment Ministry and includes the participation of hundreds of citizen scientists. Other programs, such as the Environment Ministry's Ontario Benthos Biomonitoring Network (regarding bottom-dwelling aquatic invertebrates) and its Fish Contaminant Monitoring Program, provide supplemental information about lake water quality.

In addition to broad-scale monitoring of inland lakes across Ontario, we also report here specifically on Lake Simcoe, which is an inland lake of particular concern in southern Ontario due to long-standing water quality issues for some sub-indicators.

This indicator category includes four sub-indicators of water quality in inland lakes:

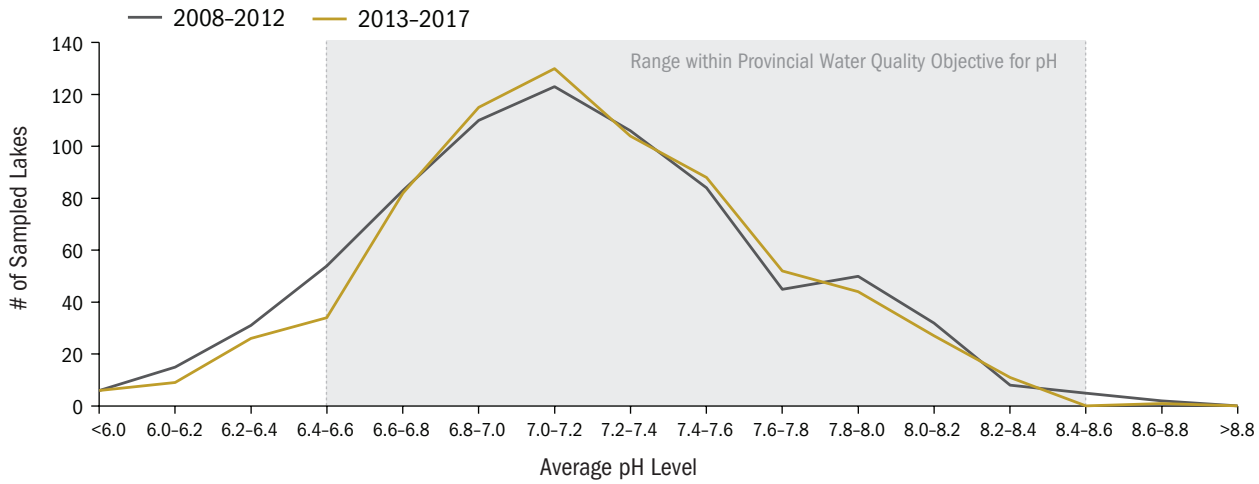
- acidity (pH level);
- chloride;
- total phosphorus; and
- dissolved oxygen concentrations in Lake Simcoe.

Acidity (pH level)

Acidification, measured using the pH scale, can cause toxic effects on ecosystems and human health. Some types of plants and animals are acid-sensitive, meaning

Figure 14: Average pH Levels in Ontario Lakes, during Two Monitoring Cycles (2008–2012 and 2013–2017)

Source of data: Ministry of Natural Resources and Forestry



Note: The Provincial Water Quality Objective for the pH range in lakes, rivers and streams is 6.5–8.5. In the two monitoring cycles, 92% of all sampled lakes had a pH level within this range.

that they cannot tolerate moderately or severely acidic waters, and will die if pH falls below a certain level. For example, at pH 5, most fish eggs cannot hatch. At lower pH levels, adult fish will start to die as well. The Provincial Water Quality Objective for the pH range in lakes, rivers and streams is 6.5 to 8.5.

One main source of acidification is the settling of sulphur dioxide and nitrogen oxide air emissions on lake water. These air emissions come mainly from fossil fuel combustion from gas plants, industry and transportation. Another source is ammonia runoff from agriculture and mining.

The Natural Resources Ministry's Broad-scale Monitoring Program is one of several provincial monitoring programs that tracks the pH of lakes. This program undertakes measurements in five-year cycles. The results from the last two monitoring cycles (2008–2012 and 2013–2017) found that 92% of all sampled lakes had a pH level within the range specified in the Provincial Water Quality Objectives (**Figure 14**). It is important to note that, as with other water quality parameters, pH levels can vary seasonally and geographically, and that some lakes will naturally have pH levels outside the water quality objective range.

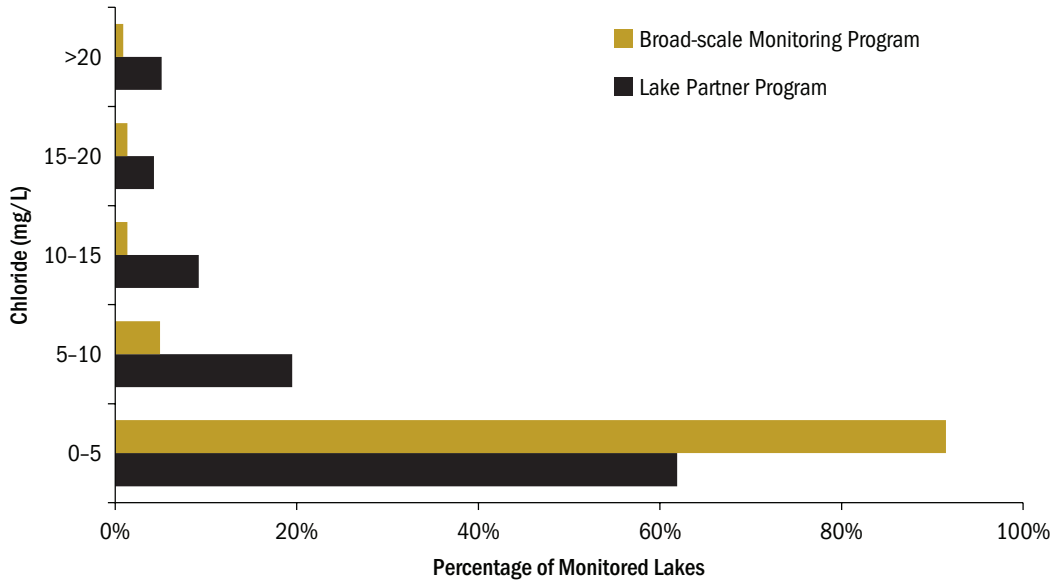
Chloride

Chloride can have both short- and long-term toxic effects on aquatic organisms, including fish, worms and insect larvae. In 2001, road salts, a significant source of chloride, were listed as toxic to the environment in accordance with the *Canadian Environmental Protection Act, 1999*. The Canadian Water Quality Guidelines for the Protection of Aquatic Life set objectives for chloride at below 120 milligrams/litre (mg/L) for long-term exposure, and 640 mg/L for short-term exposure. The guidelines were established by the Canadian Council of Ministers of the Environment (CCME).

The Natural Resources Ministry's Broad-scale Monitoring Program monitored chloride levels in 223 lakes between 2013 and 2017. Of these sampled lakes, 91% had chloride concentrations of five mg/L or less. The Environment Ministry's Lake Partner Program separately monitored chloride levels in 467 lakes between 2015 and 2016. Of these, 62% had chloride concentrations of five mg/L or less during this sampling period

Figure 15: Chloride Concentrations in Ontario Lakes During Two Programs' Monitoring Periods* (milligrams/litre)

Sources of data: Ministry of the Environment, Conservation and Parks and Ministry of Natural Resources and Forestry



* Sampled through the Natural Resources Ministry's Broad-scale Monitoring Program, 2013–2017, and the Environment Ministry's Lake Partner Program, 2015–2016.

(**Figure 15**). The differences between the two data sets are likely due to differences in the location and timing of lake sampling. The Broad-scale Monitoring Program selects lakes to provide a broad provincial picture of inland lake health. The Lake Partner Program is volunteer-based, so likely includes a higher portion of lakes that are more accessible and therefore experience greater human impacts. In total, 26 (4% of all sampled lakes) had chloride concentrations over 20 mg/L. Of these, three lakes had concentrations above the 120 mg/L CCME guidelines for long-term (chronic) exposure.

In Lake Simcoe, chloride levels have increased enormously from the use of winter road salt. For example, long-term monitoring at Lake Simcoe's Atherley Narrows Monitoring Station showed a 365% increase in average annual chloride concentrations between 1971 and 2018, from 11 mg/L to 51 mg/L. Between 2000 and 2018, Lake Simcoe's average (ice-free) chloride levels, based on an average of readings at all of the Environment Ministry's Lake Simcoe monitoring stations, increased by 76%, from 30 mg/L to almost 53 mg/L (**Figure 16**). In spite of these increases over the years, average chloride concentrations remain below the CCME guidelines.

Total phosphorus

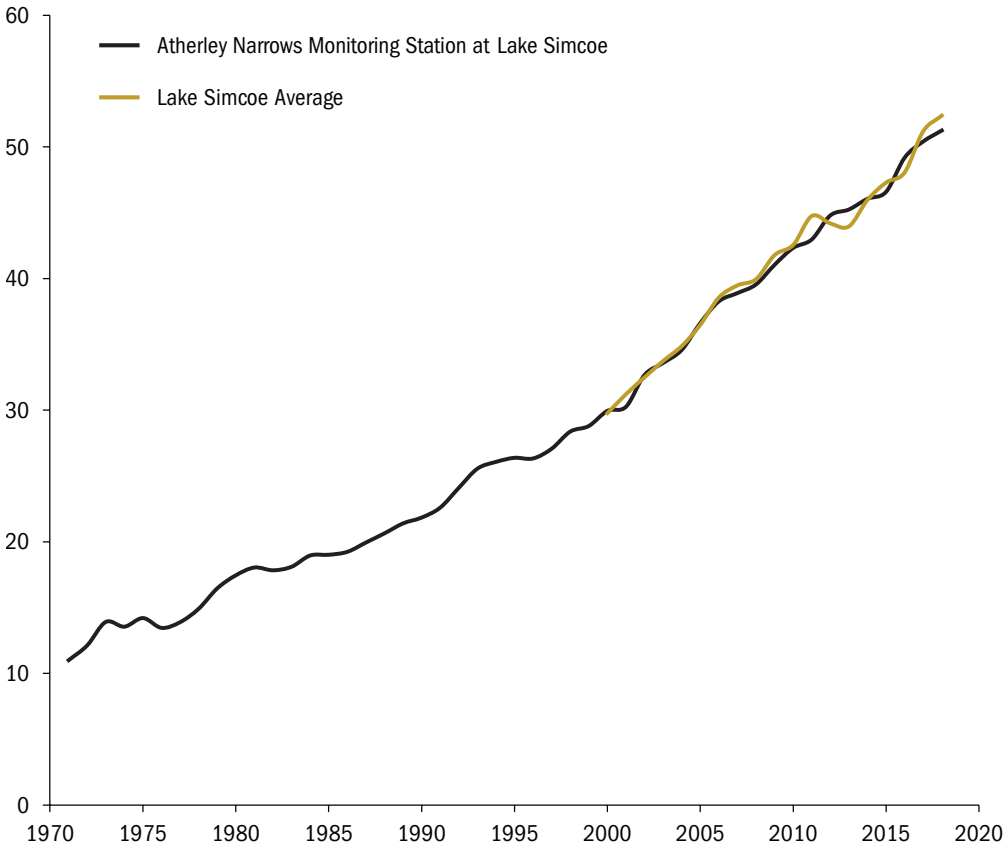
As discussed in the Great Lakes indicator, plant and algae growth in a waterbody are affected by the available nutrients, especially phosphorus. High concentrations of this nutrient foster algae blooms that can produce toxins and deplete dissolved oxygen levels.

Ontario has established Interim Provincial Water Quality Objectives (PWQOs), which are considered general guidelines for phosphorus levels in lakes. A concentration under 20 micrograms/litre (μg/L) is expected to avoid nuisance algae in lakes, and a concentration under 10 μg/L is expected to provide a high level of protection against aesthetic water quality issues, such as an unpleasant taste or odour.

The most recent results (2013–2017) from the Natural Resources Ministry's Broad-scale Monitoring Program show that 37% of the sampled inland lakes exceed this 10 μg/L threshold, including 6% that exceed 20 μg/L (**Figure 17**). Inland lakes in the

Figure 16: Average Chloride Concentrations in Lake Simcoe, 1971–2018* (milligrams/litre)

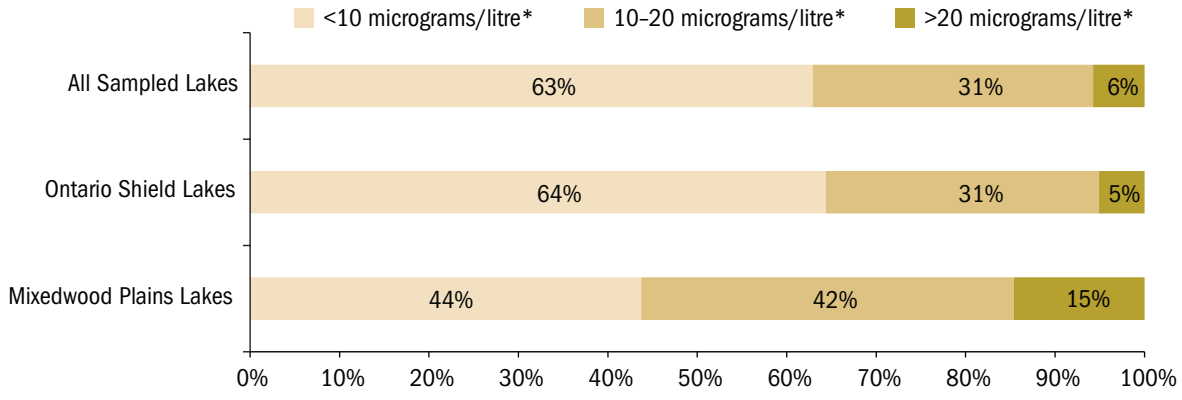
Source of data: Ministry of the Environment, Conservation and Parks



* 2018 is the most recent data available.

Figure 17: Percentage of Sampled Ontario Lakes with Total Phosphorus Concentrations within Specified Ranges, 2013–2017

Source of data: Ministry of Natural Resources and Forestry



* Ontario's water quality guidelines indicate that a phosphorus concentration under 20 micrograms/litre is expected to avoid nuisance algae in lakes, and a concentration under 10 micrograms/litre is expected to provide a high level of protection against aesthetic water quality issues, such us an unpleasant taste or odour.

Mixedwood Plains ecozone (covering southwestern Ontario and parts of central and northeastern Ontario, see **Figure 35**) tend to have higher total phosphorus levels than those in the less population-dense Ontario Shield ecozone, where many lakes have naturally low phosphorus.

Dissolved oxygen concentration in Lake Simcoe

Lack of dissolved oxygen can seriously harm and kill fish and other aquatic organisms. It degrades habitat quality, especially for coldwater fish species such as lake trout and lake whitefish. The Provincial Water Quality Objectives for dissolved oxygen concentrations in lakes are dependent upon the type of fish and other aquatic species that inhabit the lake. For this sub-indicator, we focused on the dissolved oxygen concentration in Lake Simcoe because of this lake's historically low dissolved oxygen levels.

The Environment Ministry has a dissolved oxygen concentration target of a minimum of 7 mg/L in the deepwater of Lake Simcoe at the end of summer in each year. The dissolved oxygen concentrations in Lake Simcoe have generally been improving over the past four decades, due in part to decreasing phosphorus concentrations. However, deepwater dissolved oxygen concentrations in Lake Simcoe continue to fail to meet the Environment Ministry's target (**Figure 18**).

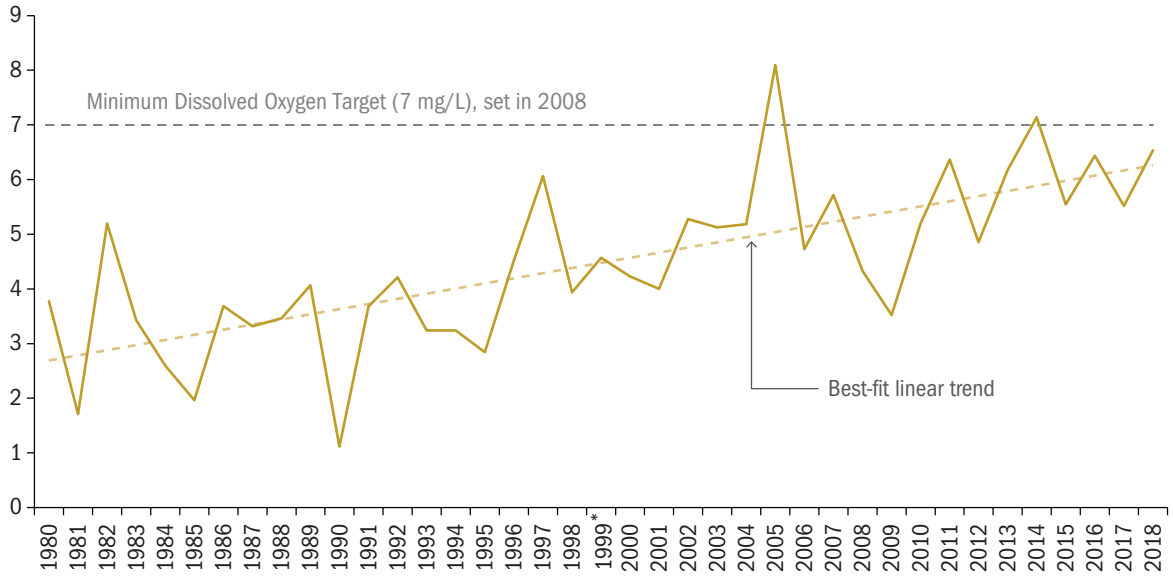
3.4.4 Key Results—Ontario's Surface Water Quality (Rivers and Streams)

The water quality indicators used in this report to describe the state of Ontario's rivers and streams are based on indicators included in environmental monitoring programs led by the Environment Ministry and Environment and Climate Change Canada. There are five sub-indicators:

- Water quality based on biological conditions
- Water quality based on a suite of water chemistry indicators
- Chloride
- Nutrients (phosphorus and nitrates)
- Pesticides

Figure 18: Deepwater Dissolved Oxygen in Lake Simcoe, 1980–2018 (milligrams/litre)

Source of data: Ministry of the Environment, Conservation and Parks



* The Environment Ministry notes that the 1999 dissolved oxygen data may have been biased by a faulty meter, and therefore may be erroneous and should be interpreted with caution.

Water quality based on biological conditions

The Environment Ministry uses the Hilsenhoff Biotic Index as one indicator of stream water quality in the province. The Hilsenhoff Biotic Index combines information about the abundance and pollution tolerance of certain invertebrate species to classify a stream's water quality from excellent to very poor. The high sensitivity of certain bottom-dwelling (called benthic) invertebrate species to pollutants and other habitat conditions, along with their limited mobility, make them good indicators of aquatic ecosystem health.

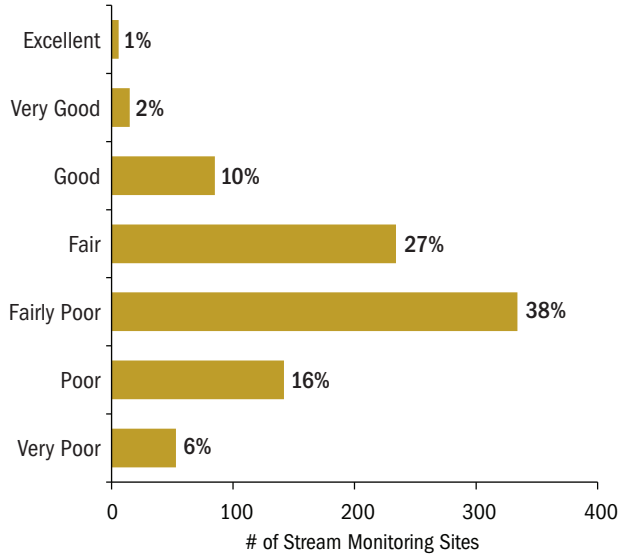
The Environment Ministry analyzed benthic invertebrate data from 869 streams, encompassing 6,090 samples from 2001 to 2018. The results in **Figure 19** indicate that:

- 40% (340) of sampled streams are in "fair" to "excellent" condition; and
- 60% (529) of sampled streams are in "fairly poor" to "very poor" condition.

There is no trend information available for this indicator.

Figure 19: Biological Conditions of 869 Sampled Streams,* 2001–2018

Source of data: Ministry of the Environment, Conservation and Parks



* Based on data from the Hilsenhoff Biotic Index. To classify water quality, the Hilsenhoff Biotic Index combines information about the abundance of certain invertebrate species in a river/stream ecosystem and those species' pollution tolerances.

Water quality based on water chemistry

The Water Quality Index (WQI) was introduced by the Canadian Council of Ministers of the Environment (CCME) as a means of conveying the state of water quality at a monitoring site, based on a suite of water chemistry parameters. This index addresses several parameters at once, comparing measured results against published concentration guidelines. The index considers the number of parameters that exceeded guidelines, how frequently the exceedances were observed, and by how much guidelines were exceeded. If all guidelines for protecting aquatic life are met for all samples, the WQI score reaches a value of 100, whereas a score of 0 means all guidelines have been exceeded. Category ranges are used to describe overall water quality: excellent (95–100); good (80–94); fair (65–79); marginal (45–64); and poor (0–44).

Between 2015 and 2019, the Environment Ministry sampled 280 rivers and streams and performed an analysis of the WQI that included metallic pollutants (such as copper, zinc and lead) and other water chemistry parameters such as chloride, nitrate, pH and phosphorus. As shown in **Figure 20**:

- 26% scored excellent or good;
- 31% scored fair; and
- 43% scored marginal or poor.

In a second analysis of the WQI, shown in **Figure 21**, which excluded metallic pollutants and only addressed chloride, nitrate, pH and phosphorus levels in 421 rivers and streams:

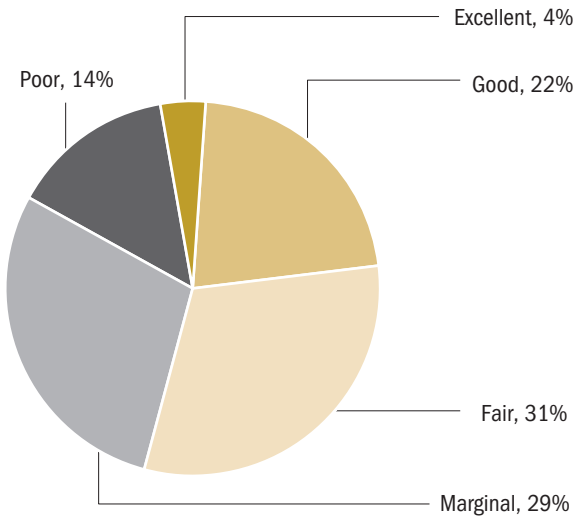
- 35% scored excellent or good;
- 24% scored fair; and
- 41% scored marginal or poor.

A map of all sampled rivers and streams, classified in terms of their WQI scores, reveals in **Figure 22** an abundance of poor and marginal water quality in southwestern Ontario. The Environment Ministry analyzed a subset of rivers and streams for the State of the Great Lakes 2019 report and found evidence of an association between the percentage of a watershed occupied by human land use and lower WQI scores for those rivers and streams.

There is no trend information available for this indicator.

Figure 20: Water Quality of 280 Ontario Rivers and Streams,* 2015–2019

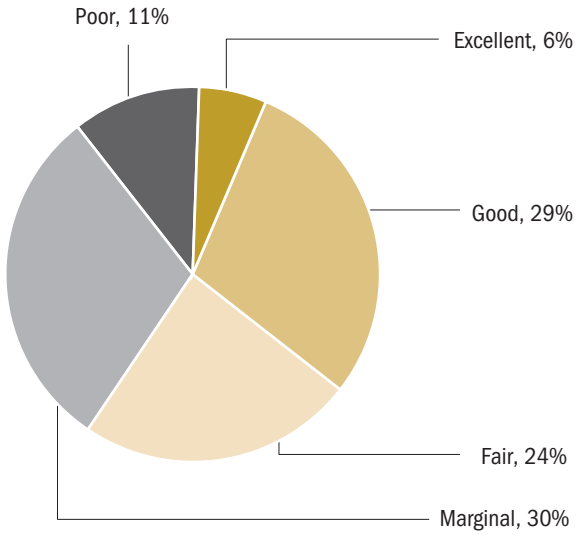
Source of data: Ministry of the Environment, Conservation and Parks



* Based on the Canadian Council of Ministers of the Environment's Water Quality Index with metallic pollutant measurements.

Figure 21: Water Quality of 421 Ontario Rivers and Streams,* 2015–2019

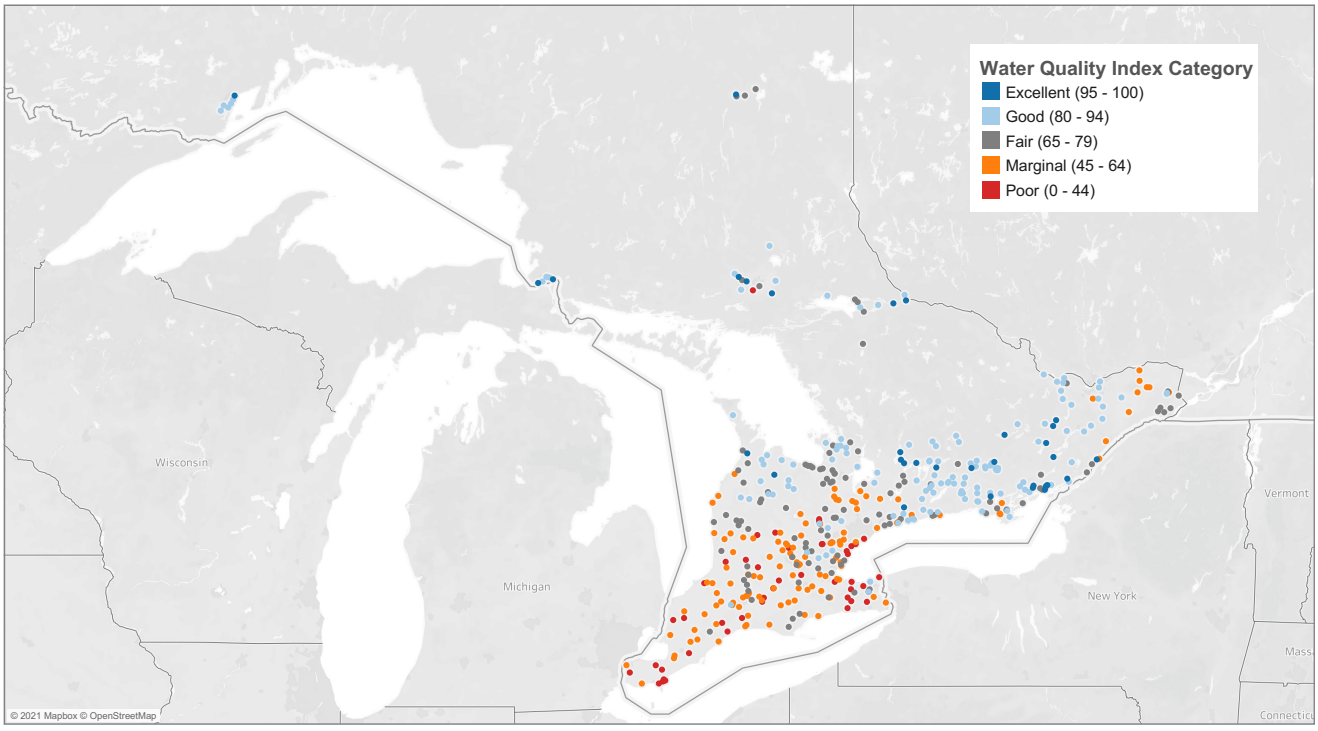
Source of data: Ministry of the Environment, Conservation and Parks



* Based on the use of the Canadian Council of Ministers of the Environment's Water Quality Index with non-metallic pollutant measurements at 421 rivers and streams.

Figure 22: Water Quality of Ontario Rivers and Streams, 2014–2018

Source: Ministry of the Environment, Conservation and Parks



* Based on the Canadian Council of Ministers of the Environment's Water Quality Index.

Chloride

As noted above for inland lakes, chloride concentrations in rivers and streams should likewise not exceed 120 mg/L for long-term (chronic) exposure and 640 mg/L for short-term exposure, according to the Canadian Water Quality Guidelines for the Protection of Aquatic Life. The guidelines were established by the Canadian Council of Ministers of the Environment (CCME).

In 2017, average chloride concentrations in Ontario's streams were 56 mg/L, which is below the 120 mg/L CCME guideline for long-term exposure. However, as illustrated in **Figure 23**, average chloride concentrations in Ontario streams have been increasing over the past 50 years.

The primary sources of chloride in rivers and streams are road salt (and other de-icers) and water softeners. The Environment Ministry found a strong relation between road density (kilometres of road per 1,000 square kilometres) and chloride concentrations in Ontario streams. As seen in **Figure 24**, the increases in chloride concentrations are almost entirely in streams located in urban areas, perhaps due to road-salting activities. The average concentrations in urban areas have exceeded the 120 mg/L CCME guideline for long-term exposure since 2014.

Nutrients (phosphorus and nitrates)

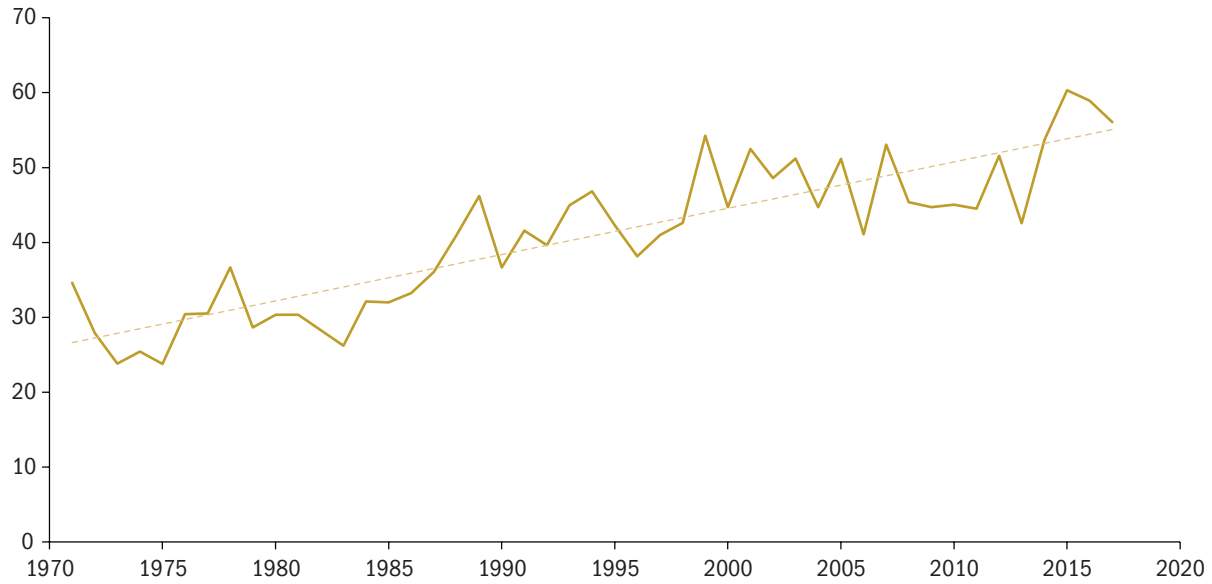
As noted with the Great Lakes and inland lakes indicators, excess concentrations of nutrients, particularly phosphorus and nitrate, can negatively impact aquatic ecosystems.

Nitrate concentrations in Ontario's streams are highest in agricultural areas but remain below the CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life of 2.93 mg of nitrate per litre of water (**Figure 25**). Over the past two decades, nitrate concentrations in Ontario's streams have fallen, especially in agricultural areas, although this decrease has levelled off over the past decade.

Average annual phosphorus concentrations in Ontario's rivers and streams exceed the Interim Provincial Water

Figure 23: Average Chloride Concentrations in Ontario Streams, 1971–2017* (milligrams/litre)

Source of data: Ministry of the Environment, Conservation and Parks

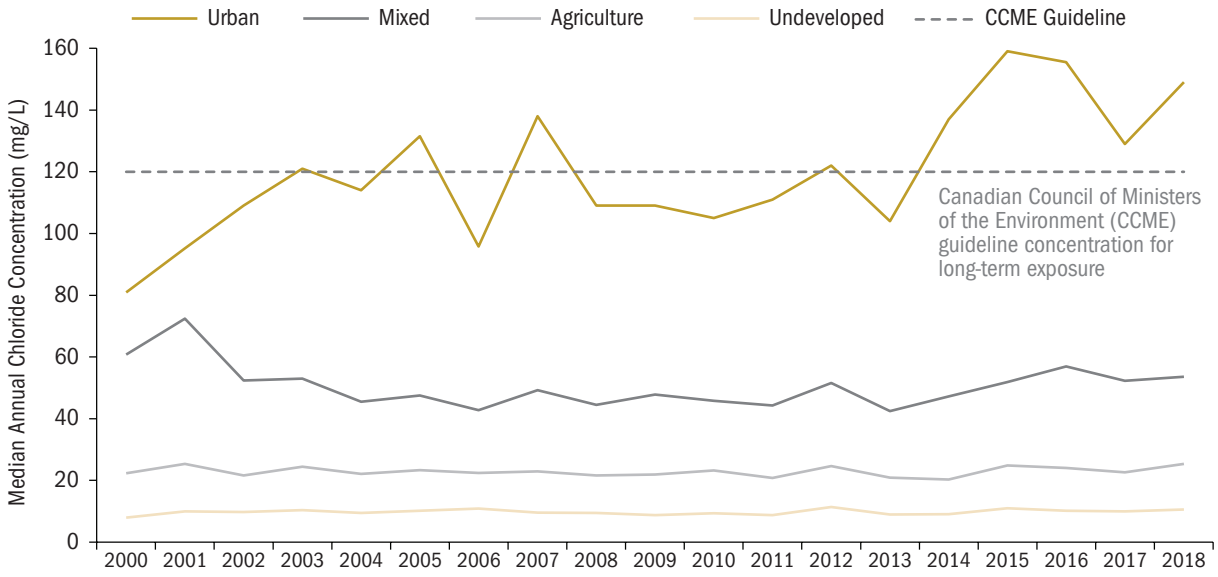


Note: The dotted line represents a best-fit linear trend line. The data point from 1982 is omitted due to data quality issues for that year.

* 2017 is most recent data available.

Figure 24: Annual Chloride Concentrations in Ontario Streams,* Classified by Watershed Land-Use Type, 2000–2018 (milligrams/litre)

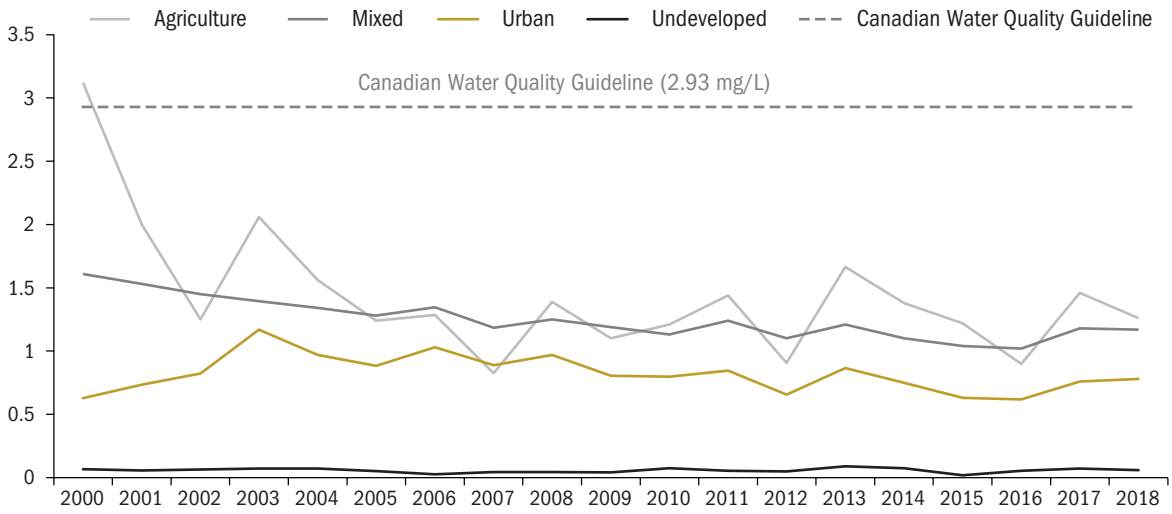
Source of data: Ministry of the Environment, Conservation and Parks



* Chloride concentrations are shown based on the median annual concentration, which is the middle number of the sampled results each year.

Figure 25: Annual Nitrate Concentrations in Ontario Streams,* Classified by Watershed Land Use Type, 2000–2018 (milligrams/litre)

Source of data: Ministry of the Environment, Conservation and Parks



* Nitrate concentrations are shown based on the median annual concentration, which is the middle number of the sampled results each year.

Quality Objective (30 $\mu g/L$) in agricultural, urban and mixed settings (**Figure 26**). Similar to nitrate, average phosphorus levels during the ice-free season appear to have decreased from 2000 to 2018. However, recent Environment Ministry studies have observed increases in some nutrients in rivers when measured year-round, especially in the winter months.

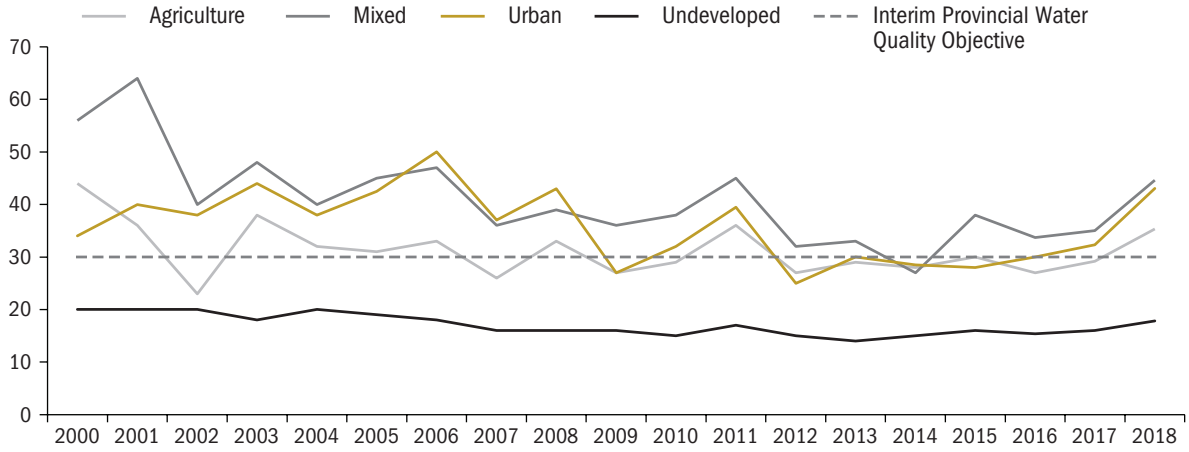
Pesticides

Pesticides are commonly used in agriculture, forestry and other sectors (such as residential communities and golf courses) to control, suppress or repel pests. Spills and excess or poorly timed pesticide application on agricultural fields and other areas can result in contamination of surface water. Pesticides in surface water can impact the environment as well as human health if people are exposed to them at high concentrations.

The most frequently detected pesticide in southern Ontario agricultural streams is 2,4-D herbicide, which was detected in 92% of samples from 2015 to 2019 (**Figure 27**).

Figure 26: Annual Phosphorus Concentrations in Ontario Rivers and Streams,* Classified by Watershed Land-Use Type, 2000–2018 (micrograms/litre)

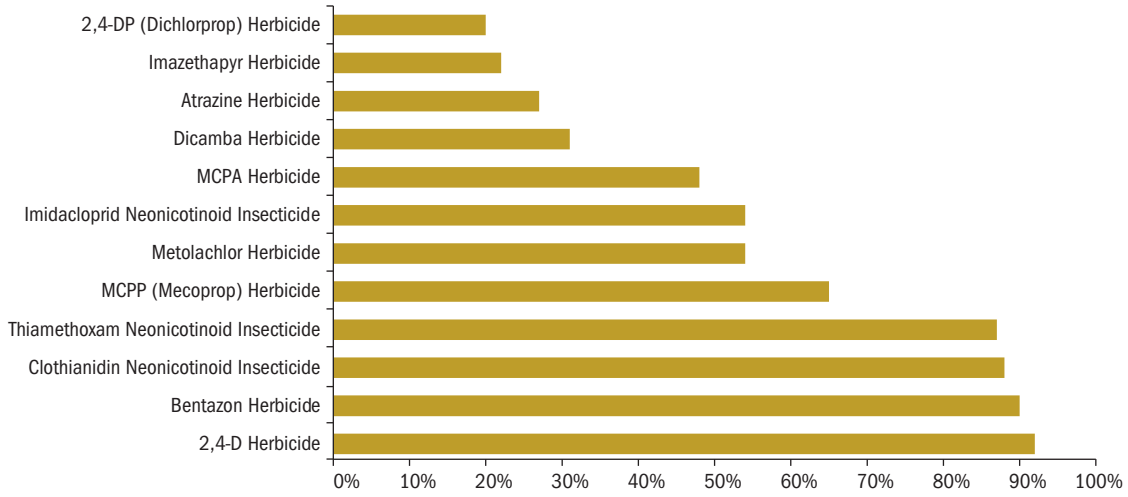
Source of data: Ministry of the Environment, Conservation and Parks



* Phosphorus concentrations are shown based on the median annual concentration, which is the middle number of the sampled results each year.

Figure 27: Pesticide Detection Frequencies* in Southern Ontario Agricultural Streams, 2015–2019

Source of data: Ministry of the Environment, Conservation and Parks



* Frequencies are measured relative to the total number of samples tested for the pesticide.

In southern Ontario agricultural streams, the highest observed pesticide concentrations were of metolachlor and atrazine. Though not detected with great frequency or at levels considered detrimental to aquatic life, glyphosate, an herbicide that some agencies consider to be a carcinogen, was also detected in several streams, including Reynolds Creek (near Ingersoll), Decker Creek (near Grand Bend) and McGregor Creek (near Chatham). As noted in our *2019 Annual Report* audit, Food Safety Inspection Program, glyphosate is banned in some countries but commonly used on Ontario soybean and corn farms.

There is no trend information available for this indicator.

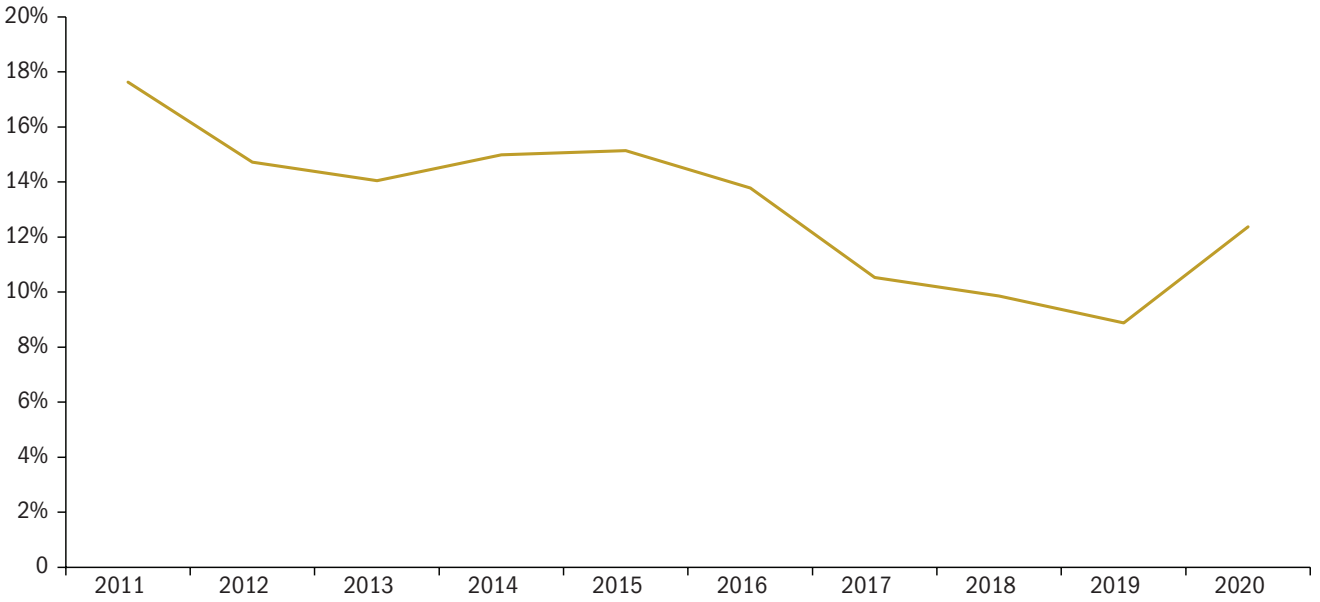
3.4.5 Key Results—Ontario's Surface Water Quality (Beaches)

The state of Ontario's beaches and recreational water quality can be assessed, in part, by the number of beach postings or water quality advisories declared at Ontario beaches each year. Recreational water is monitored by public health units to protect users from poor water quality. The Ministry of Health's Operational Approaches for Recreational Water Guideline, 2018 (Guideline) sets threshold levels for E. coli bacteria after which a beach advisory should be posted. E. coli is used as an indicator of fecal bacteria in water, which can lead to a number of illnesses or infections if beach users swim in the water. Bacteria in water can come from various pollution sources, including sewage, industrial wastewater, stormwater, agricultural runoff and waterfowl. Environmental factors, such as water and air temperature, rainfall, wind and UV index, can also affect bacterial test results.

In 2020, 12% of all beach tests administered by public health units exceeded the threshold. The general trend was improving for many years since 2011, but worsened in 2020 (**Figure 28**). The Ministry of Health notes that the 2020 data may have been affected by the reduced capacity of public health units during the COVID-19 pandemic, such as by the need to prioritize water testing based on risk. The Ministry of Health informed us that, because the responsibility for posting beach water advisories rests with each public health unit, the Ministry does not have direct access to, and cannot validate, recreational water quality data.

Figure 28: Percentage of Water Quality Tests at Ontario Beaches Monitored by Public Health Units That Failed to Meet E. coli Recreational Water Guidelines, 2011–2020

Source of data: Swim Drink Fish (based on data from Ontario Public Health Units)



3.5 Indicator—Groundwater Quality

Groundwater is fresh water that is present underground in rock crevices and cracks, and between particles of rock and soil. About one-fifth of Ontarians rely on groundwater extracted from wells for their drinking water. Groundwater also supplies water for agricultural and industrial use. Depending on the depth of the water table—the level at which the ground is saturated—groundwater can directly nourish plants through their roots.

Information on the sources and limitations of the data on groundwater quality can be found in **Appendix 9**.

3.5.1 Major Factors That Affect Groundwater Quality

- Quality of well construction and maintenance
- Application of manure, fertilizer and pesticides to soil, and of salt to roads
- Spills or leakages into the soil and groundwater, such as from landfills, manure storage tanks, septic tanks, liquid or solid waste storage drums, fuel storage tanks, vehicles or factories or workshops
- The natural bedrock and soil mineral composition of the groundwater aquifer

3.5.2 Key Results—Ontario's Groundwater Quality

This indicator category tracks two types of contaminants: chloride and nitrate. The chloride and nitrate sub-indicators were selected in keeping with the groundwater quality indicator used in the State of the Great Lakes 2019 report.

Chloride

As noted with surface water, chloride can have negative impacts on water quality.

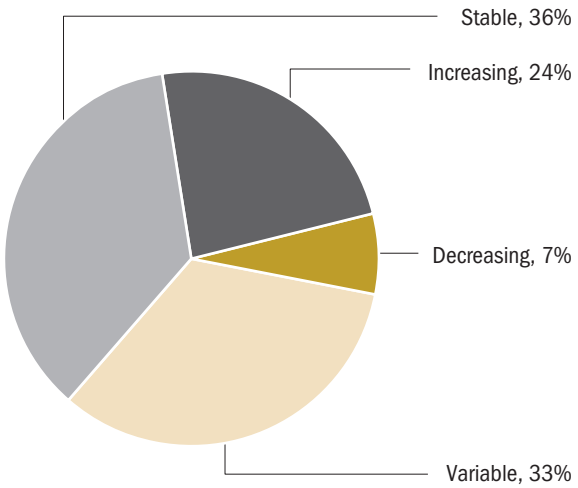
The Environment Ministry's analysis of chloride concentrations in 507 monitoring wells, sampled as part of its Provincial Groundwater Monitoring Network between 2002 and 2019, found that 104 (21%) had concentrations above the 120 mg/L CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life for long-term exposure. Note that these monitoring wells do not themselves supply water to users, but are frequently part of the same groundwater sources that do supply water for human use. Of the 104 wells that exceed the 120 mg/L CCME guideline level:

- 56 (11% of all sampled wells) had concentrations above the 250 mg/L Ontario Drinking Water Quality Aesthetic Objective, which can affect taste and increase sodium intake by people who consume the water; and
- 17 of the 56 wells that exceeded 250 mg/L (3% of all sampled wells) had concentrations above the 640 mg/L CCME Canadian Water Quality Guideline for severe impacts to water quality, such as causing death to aquatic organisms.

Of the 444 wells for which the Ministry took at least three samples (the minimum number to identify trends) between 2003 and 2019, 69% had either stable or variable chloride concentrations, 7% had decreasing concentrations, and 24% had increasing concentrations (**Figure 29**). These changes in chloride levels in groundwater can be due to human causes, such as use of road salt, and/or the natural mineral conditions of the aquifer.

Figure 29: Chloride Concentration Trends in the Environment Ministry's Provincial Groundwater Monitoring Network Wells, 2003–2019

Source of data: Ministry of the Environment, Conservation and Parks



Note: This figure is based on changes in concentrations from the 444 wells for which the Ministry took at least three samples between 2003 and 2019.

Nitrate

Nitrate can cause health problems, such as methemoglobinemia (also called blue baby syndrome, when there is insufficient oxygen in the blood), miscarriages and preterm births, and increased risk of colon cancer, if consumed in excess.

Across Ontario, 16% (56) of the 353 monitored wells in 2018 (most recent data) had nitrate levels above the 1 mg/L natural background level, with 0.6% (two) of the monitoring wells (in Dufferin County and Peel Region) exceeding the 10 mg/L Ontario Drinking Water Quality Standard (**Figure 30**). A map of monitoring wells and their results in 2018 can be found in **Figure 31**. The 2018 nitrate results are consistent with long-term average nitrate levels. Between 2003 and 2018, an annual average of 16.4% of monitored wells were above one mg/L but below 10 mg/L, and 1.6% of monitored wells exceeded the Ontario Drinking Water Quality Standard (**Figure 30**).

Of the 357 Provincial Groundwater Monitoring Network Program wells monitored by the Environment Ministry with three or more nitrate concentration samples taken between 2003 and 2018:

- 251 wells (70%) had stable nitrate concentrations;
- 70 wells (20%) showed variable concentrations;
- 21 wells (6%) showed decreasing concentrations; and
- 15 wells (4%) showed increasing concentrations.

3.6 Indicator—Drinking Water Quality

Drinking water is produced by treating withdrawn surface water and groundwater (also known as source water). The greater the contamination level of the source water, the more important the treatment process is in ensuring that the drinking water is clean and safe.

This indicator category includes three sub-indicators:

- drinking water tests that meet the health-based Ontario Drinking Water Quality Standards;
- drinking water advisories (number of advisories issued per year, excluding First Nations communities); and
- long-term drinking water advisories in First Nations communities.

Information on the sources and limitations of the data on drinking water quality can be found in **Appendix 10**.

3.6.1 Major Factors That Affect Drinking Water Quality

- Direct releases of contaminants to water
- Runoff and leaching of land contaminants
- Air contaminant emissions
- The drinking water treatment process
- The natural bedrock and soil mineral composition that interact with the water

3.6.2 Key Results—Drinking Water Quality in Ontario

Drinking water tests that meet standards

In 2020/21, 99.87% of drinking water tests from municipal residential drinking water systems met the health-based Ontario Drinking Water Quality Standards listed in Ontario Regulation 169/03 under the *Safe Drinking Water Act, 2002*. The target value is 99.75%, and has been met annually from at least 2015 onward.

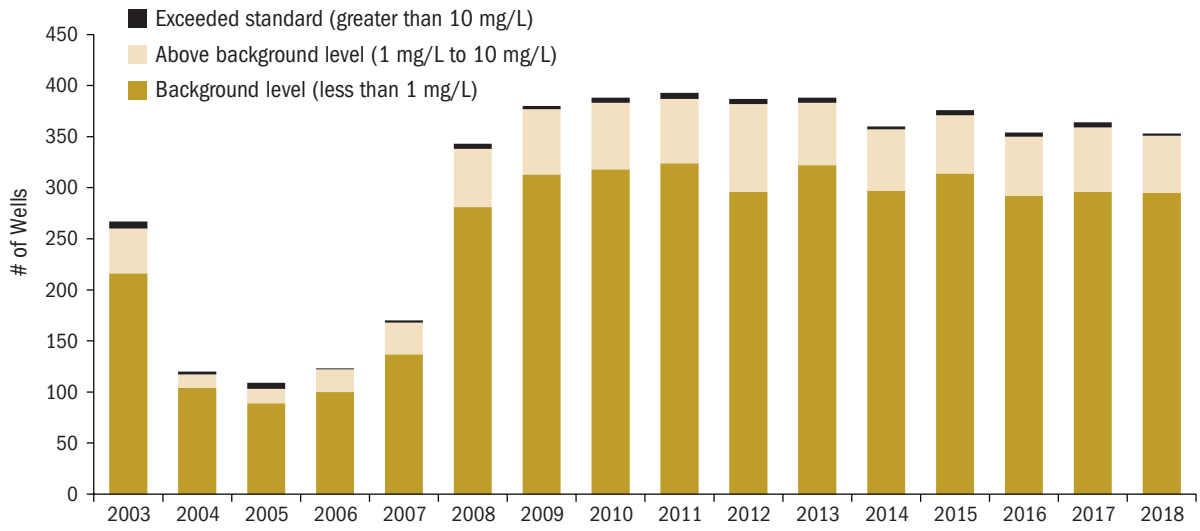
From 2015/16 to 2020/21, the percentage of drinking water tests from municipal residential drinking water systems meeting standards increased from 99.84% to 99.87%.

As shown in **Figure 32**, the percentage of drinking water tests meeting standards improved from 2004/05 to 2020/21 for all of the following categories:

- municipal residential drinking water systems (99.74% to 99.87%);
- non-municipal year-round residential drinking water systems (99.41% to 99.69%); and
- systems serving designated facilities (99.06% to 99.72%).

Figure 30: Nitrate Levels in Ontario's Monitored Wells,* 2003–2018

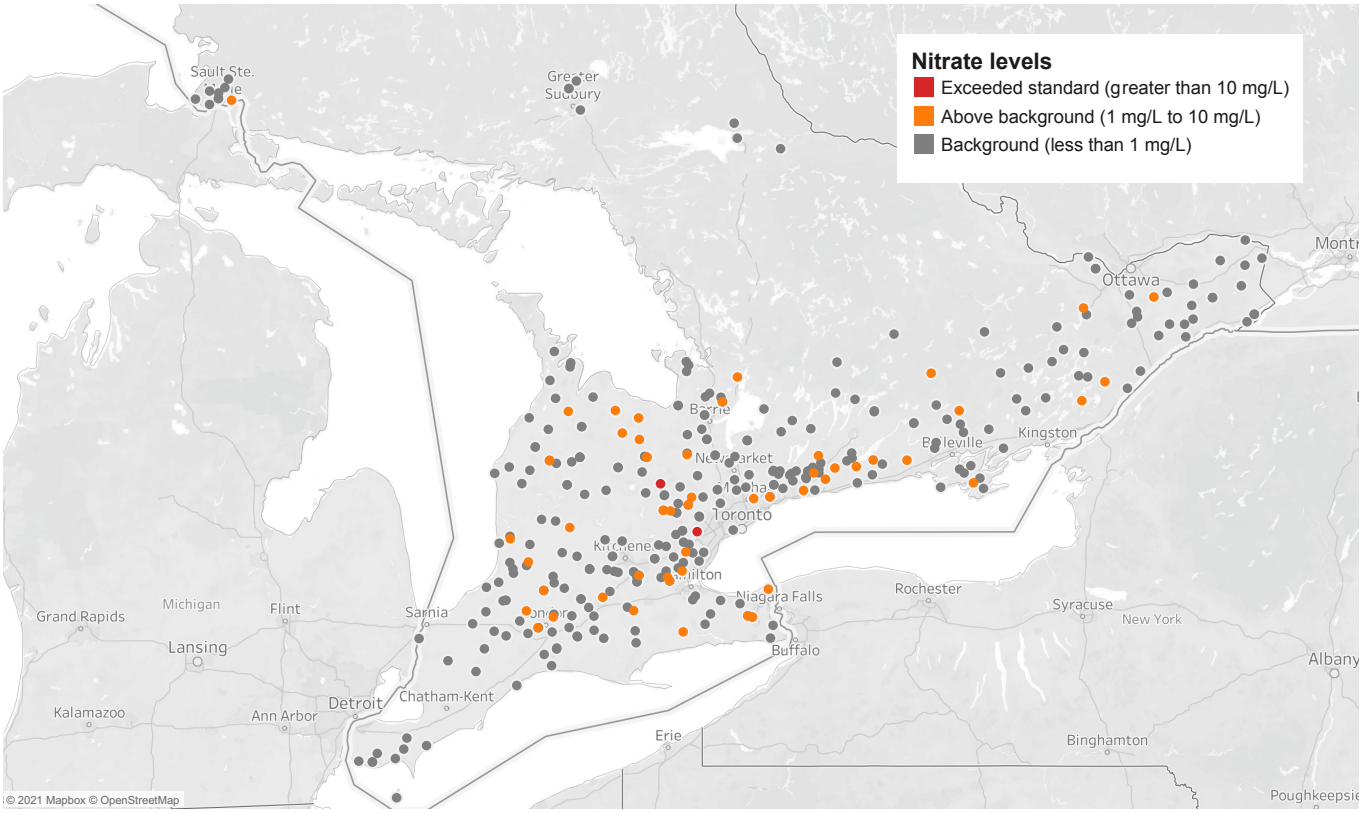
Source of data: Ministry of the Environment, Conservation and Parks



* Relative to background levels and the 10 mg/L Ontario Drinking Water Standard.

Figure 31: Location and Measurement of Nitrate Levels in Ontario's Monitored Wells,* 2018

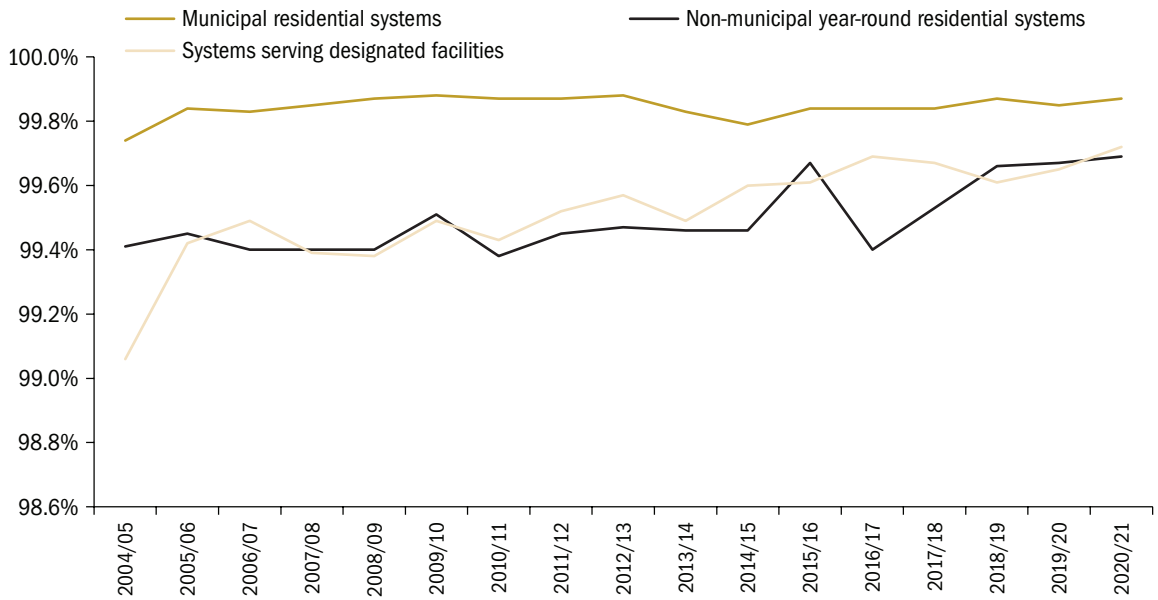
Source: Ministry of the Environment, Conservation and Parks



* Relative to background levels and the 10 mg/L Ontario Drinking Water Quality Standard.

Figure 32: Percentage of Drinking Water Tests Meeting Standards in Ontario, 2004/05–2020/21

Source of data: 2020/21 Chief Drinking Water Inspector Annual Report



Drinking water advisories

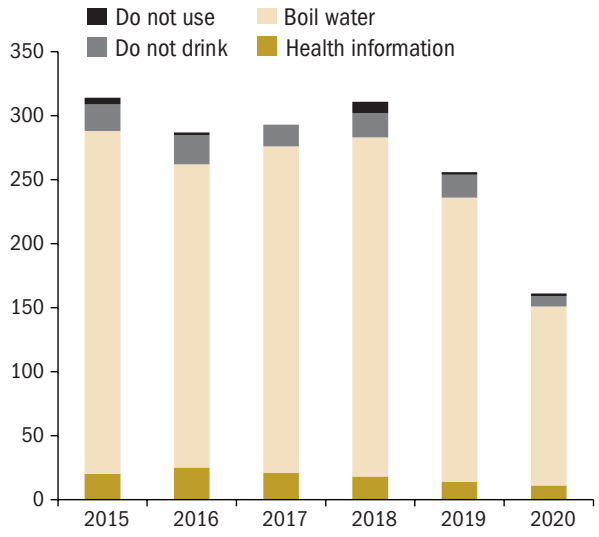
Drinking water advisories are reported by local public health units into the Ministry of Health's Drinking Water Advisory Reporting System. There are four types of advisories issued:

- **Health information advisory:** issued when a contaminant is found to be present in levels that exceed the standard set for drinking water, such as elevated sodium levels that may present health concerns for individuals on sodium-restricted diets. Recommended measures can be adopted to reduce exposure and potential risk.
- **Boil water advisory:** issued when water must be boiled to render it safe for consumption.
- **Do not drink advisory:** issued when actions other than boiling water are necessary to make it safe to consume.
- **Do not use advisory:** issued when boiling or other water treatments are inadequate methods for making the water safe for use.

Between 161 and 314 drinking water advisories were issued annually in Ontario from 2015 to 2020. (These drinking water advisory numbers do not include those in First Nations communities, which are discussed below). **Figure 33** illustrates that the

Figure 33: Number of Drinking Water Advisories in Ontario, by Type, 2015–2020

Source of data: Ministry of Health's Drinking Water Advisory Reporting System



overwhelming majority (86%) of the 1,622 advisories issued during this period were boil water advisories, with a further 7% (109) as health information advisories. Most of these advisories were on non-municipal systems, which serve smaller populations. In 2020, 140 (or 87%) of the 161 drinking water advisories issued were

on non-municipal systems. The overall number of drinking water advisories fell by about 50% between 2018 (311 advisories) and 2020 (161 advisories).

The top three public health units in terms of number of advisories issued between 2015 and June 2021 were North Bay Parry Sound District (301 advisories), Sudbury (270 advisories) and Grey Bruce (132 advisories). Northern and remote public heath units typically have more advisories because there are more small drinking water systems, as well as seasonal systems (e.g., campgrounds), located in Northern and rural areas than in urban areas. In addition, some parts of Northern Ontario experience greater logistical challenges associated with operating in a remote area, and some may also issue precautionary advisories. As of December 31, 2020 (the most recent compiled data), the three Ontario public health units with the highest number of active advisories were all in Northern public health units.

Long-term drinking water advisories in First Nations communities

Drinking water advisories in First Nations communities are the responsibility of the federal government. However, the Environment Ministry included the number of long-term drinking water advisories in First Nations communities as one of its key performance indicators in its 2019/20 Published Plan. The Ministry also included the federal target of eliminating these advisories by March 31, 2021. However, the Ministry did not include this key performance indicator and target in its 2020/21 or 2021/22 Published Plans and Annual Reports.

As of February 2023, there were 24 Long-Term Drinking Water Advisories at public drinking water systems in Ontario funded by the Department of Indigenous Services Canada. These advisories impact 21 First Nations communities in Ontario, though not necessarily all buildings and people in each community.

3.7 Indicator—Water Availability

Ontario has an enormous supply of fresh water, including many lakes, rivers and streams as well as groundwater. However, water takings—for industrial, municipal, agricultural and commercial uses and dewatering purposes (such as for construction)—can deplete local water sources when the water removed and consumed exceeds the new supply from rain, snowfall, runoff and infiltration. Water takings can potentially affect the amount of water locally available for aquatic ecosystems to thrive, as well as the amount that can be used for drinking water supply, agriculture, industry and power production. Local water availability can also be reduced by the natural processes of evaporation and transpiration (the process of plant roots absorbing water and then releasing it as a vapour through the plant's leaves).

This indicator category includes two sub-indicators: water takings (a pressure indicator that measures human activities that affect water availability) and river water availability, a state indicator. The number of low water and drought conditions declared is another indicator of water availability, discussed in **Section 5.10.2**.

Information on the sources and limitations of the data on water availability can be found in **Appendix 11**.

3.7.1 Major Factors That Affect Water Availability

- The volume of water taken from the water sources
- The extent to which the water taken is consumed—that is, permanently removed from the water source—such as when taken for water bottling, fruit and vegetable canning, crop irrigation and concrete manufacturing
- Changes in precipitation

3.7.2 Key Results—Water Takings in Ontario

Based on the data reported to the Environment Ministry, 20 trillion litres of water were taken from the environment in 2019. This included:

- 7 trillion litres used for power production; and
- 13 trillion litres taken for other uses.

Of the total water takings, 97% was taken from surface water, with the remaining 3% taken from

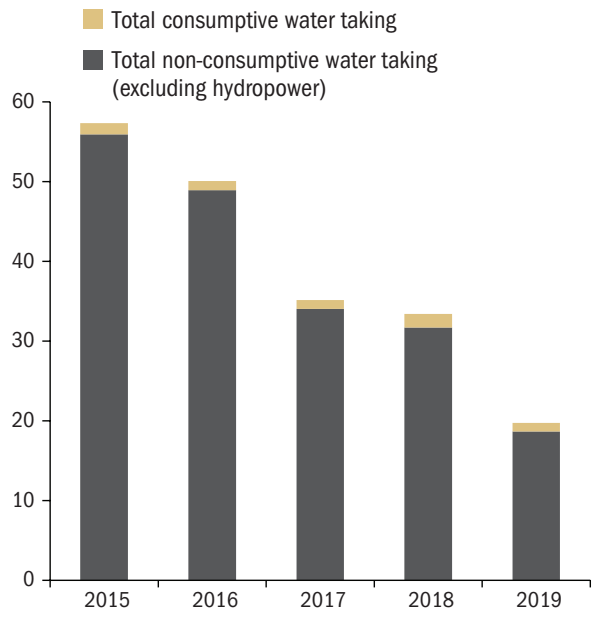
groundwater or a combination of surface and groundwater.

Of the total 20 trillion litres of reported water takings in 2019, 95% of water taken was for non-consumptive purposes. This means the water was circulated back into the waterbody from which it was taken. Examples of non-consumptive uses include water used as cooling water for nuclear and natural gas generation, or for aggregate washing. The remaining 5% of water taken was consumed. Examples of consumptive uses are crop irrigation and bottled water production.

The reported water takings, excluding those associated with hydropower, have fallen by 66% from 2015 to 2019, from about 57 trillion litres to 20 trillion litres (**Figure 34**). According to the Environment Ministry, this drop in volume was mainly from the expiry in 2017 of a single water-taking permit associated with water storage for energy generation in the Sudbury area. Total consumptive water takings have remained a consistently small percentage of total takings, averaging 4% between 2015 and 2019. We excluded water takings associated with hydropower from these figures to enable comparisons over time; beginning in 2019, the Environment Ministry no longer required permits to take water for hydropower production.

Figure 34: Water Takings in Ontario (Excluding Hydropower), 2015–2019 (trillion litres/year)

Source of data: Ministry of the Environment, Conservation and Parks



3.7.3 Key Results—River Water Availability in Ontario

River water availability estimates how water demand by humans is impacting the water supply in rivers and identifies areas where water demand may be putting too much pressure on supplies. Water availability is calculated by dividing the water demand by water supply for each sub-drainage area and classifying the threat based on the resulting water availability ratio. As the vast majority of water withdrawals tracked in Ontario are from surface water, this indicator provides a means to assess the environmental impact of water takings relative to river water supplies.

Under the federal government's Canadian Environmental Sustainability Indicators (CESI) program, the river water availability indicator was last updated in 2012 using 2009 data. These 2009 results show that, in southern Ontario, two sub-drainage basins (Eastern Lake Huron, and Lake Ontario and Niagara Peninsula), which feed Lake Erie, Lake Ontario and Lake Huron, had high threats to water availability, with more than 40% of available water withdrawn for human use.

Neither the Environment Ministry nor Environment and Climate Change Canada has produced a more recent indicator status or trend analysis for river water availability.

3.8 What Progress Has Been Made Toward Water Targets in Ontario?

Ontario has established one target under the *Great Lakes Protection Act, 2015* related to reducing algae blooms in the Great Lakes: to reduce phosphorus loadings to the western and central basins of Lake Erie by 40% compared to 2008 levels by 2025, as outlined in the Canada-Ontario Lake Erie Action Plan. Phosphorus loading to Lake Erie from all sources, including Ontario, vary from year to year due to climatic factors, but according to the 2022 Great Lakes progress report, phosphorus levels remain a long way from the target.

The Environment Ministry also has several targets related to the health of the Lake Simcoe watershed. The first is a minimum 7 mg/L of deepwater dissolved oxygen in Lake Simcoe at the end of summer each year. The Province has not met this target in any year from 2015/16 to 2020/21 inclusive. In 2020/21 (most recent data), the minimum concentration of dissolved oxygen in Lake Simcoe at the end of the summer was 5.9 mg/L.

The second target is to reduce loadings of pathogens (disease-causing organisms) to eliminate beach closures. As of 2017, this target had not been met.

The third target is to reduce contaminants to levels that achieve Provincial Water Quality Objectives or better. While chloride levels have steadily increased, they are still well below Canadian Council of Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life for chronic exposure to chloride. Likewise, spring total phosphorus concentrations in 2018 met the Province's Interim Provincial Water Quality Objective.

With respect to drinking water, the Environment Ministry states its target is: "Maintaining or increasing the percentage of drinking water test results from municipal residential systems that meet the Ontario Drinking Water Quality Standards (O. Reg. 169/03)" under the *Safe Drinking Water Act, 2002*. The target value is 99.75%, and has been met annually from at least 2015 onward, with the most recent 99.87% value recorded in 2020/21.

The Environment Ministry's 2019/20 annual report included a key performance indicator with the following target: "Elimination of all 48 [Long-Term Drinking Water Advisories] since November 2015 (as determined by the federal government) at [Department of Indigenous Services Canada]-funded public drinking water systems in Ontario by March 31, 2021, through the implementation of a trilateral action plan that leverages Ontario's significant drinking water experience and expertise." This target was not met. As of February 2022, there were 26 Long-Term Drinking Water Advisories at Department of Indigenous Services Canada-funded public drinking water systems in Ontario. The Ministry did not include this key performance indicator and target in its 2020/21 or 2021/22 Published Plans and Annual Reports.

Though Ontario has water quality objectives and guidelines, there are no provincial targets associated with groundwater quality or water availability.

4.0 The State of Land and Waste in Ontario

Ontario, at 1.1 million square kilometres (including the Ontario portion of the Great Lakes), is Canada's second largest province. Ontario's large land area incorporates a variety of ecological habitats, which support the growth of different vegetation and life forms, as well as agricultural, industrial, commercial, residential and recreational uses.

This section reports on three indicator categories related to the state of, and pressure on, Ontario's land:

- land cover;
- soil condition; and
- solid waste.

4.1 Historical Context

Since the 1800s, Ontario's landscape has been substantially altered by agricultural, residential, industrial and commercial development, especially in southern Ontario. For example, over the past two centuries, southern Ontario went from being almost continuously covered in forests to having only about 25% forest cover today. As well, it has lost nearly three-quarters of its wetlands. These losses are the result of development, primarily agriculture and human settlement. In contrast, the province's wetlands in the Far North have been subject to far less disturbance.

On agricultural land, intensive farming practices, including the planting of more annual crops, increased tillage and fewer hedgerows to reduce soil erosion, have contributed to declines in soil quality.

Another growing pressure on Ontario's natural resources and land capacity is waste. Population growth, higher levels of consumption, increased use of single-use items and increased packaging, including a shift from refillable to non-refillable beverage containers, have led to a steady growth in waste generation. Since the

1980s, the Ontario Government has aimed to reduce the amount of waste being disposed of in landfill though recycling and composting. Some progress has been made in increasing diversion of residential waste, but Ontario has made little progress in managing the waste from the industrial, commercial and institutional sector (see our *2021 Annual Report of Environmental Audits*, Non-hazardous Waste Reduction and Diversion in the Industrial, Commercial and Institutional (IC&I) Sector).

4.2 How Land Quality and Waste Affect Environmental and Human Health in Ontario

Wildlife, vegetation and other types of organisms require suitable habitat to survive and thrive. Development—including agricultural, residential, industrial and commercial land uses—and resource extraction reduce natural land cover and the amount of habitat suitable for various species of plants, animals and other life forms.

On land that is cultivated, soil erosion decreases the potential long-term productivity of croplands and reduces the amount of soil carbon stored. Some of the eroded soil can enter nearby streams, rivers and lakes, increasing their sediment and nutrient load, with potential negative effects on the aquatic ecosystem.

Solid waste management systems, including disposal in landfills, cause environmental and human health impacts as well. Waste management facilities, especially landfills, require large tracts of land. Landfills can potentially leak toxic contaminants into surface and groundwater. When waste decomposes in the low-oxygen conditions of a landfill, it generates methane, a highly potent greenhouse gas that contributes to global climate change.

Ontario's waste sector, including landfills, anaerobic digestion and composting facilities, collectively contributed about 5% of Ontario's total greenhouse gas emissions in 2020. Hazardous waste, if improperly managed, can have potential toxic ecological and human health effects, such as exposure to infectious biohazards or neurotoxins from lead.

4.3 Indicator—Land Cover

This indicator reports on the changes in land cover types over time, and the causes of such changes. Land cover is divided into five types:

- **Anthropogenic cover**: includes built-up and settled areas (such as homes, commercial buildings and industrial factories), roads, agriculture (cropland, grassland and pasture) and extraction (for stone, sand and gravel, or mining);
- **Aquatic cover**: includes open water of lakes and streams;
- **Harvested forest cover**: includes forests harvested over the previous five years;
- **Natural disturbance cover**: includes forest areas disturbed or damaged from recent natural events, including fires, insect damage or winds; and
- **Natural terrestrial cover**: includes forests (including Ontario's Managed Forest), alvars, mudflats, prairies, savannahs, wetlands, rock and other open country habitat.

Information on the sources and limitations of the data on land cover can be found in **Appendix 12**.

4.3.1 Major Factors That Affect Land Cover

- Industrial, residential and agricultural development
- Resource extraction, such as mining
- Natural disturbances, such as fire

4.3.2 Key Results—Land Cover in Ontario

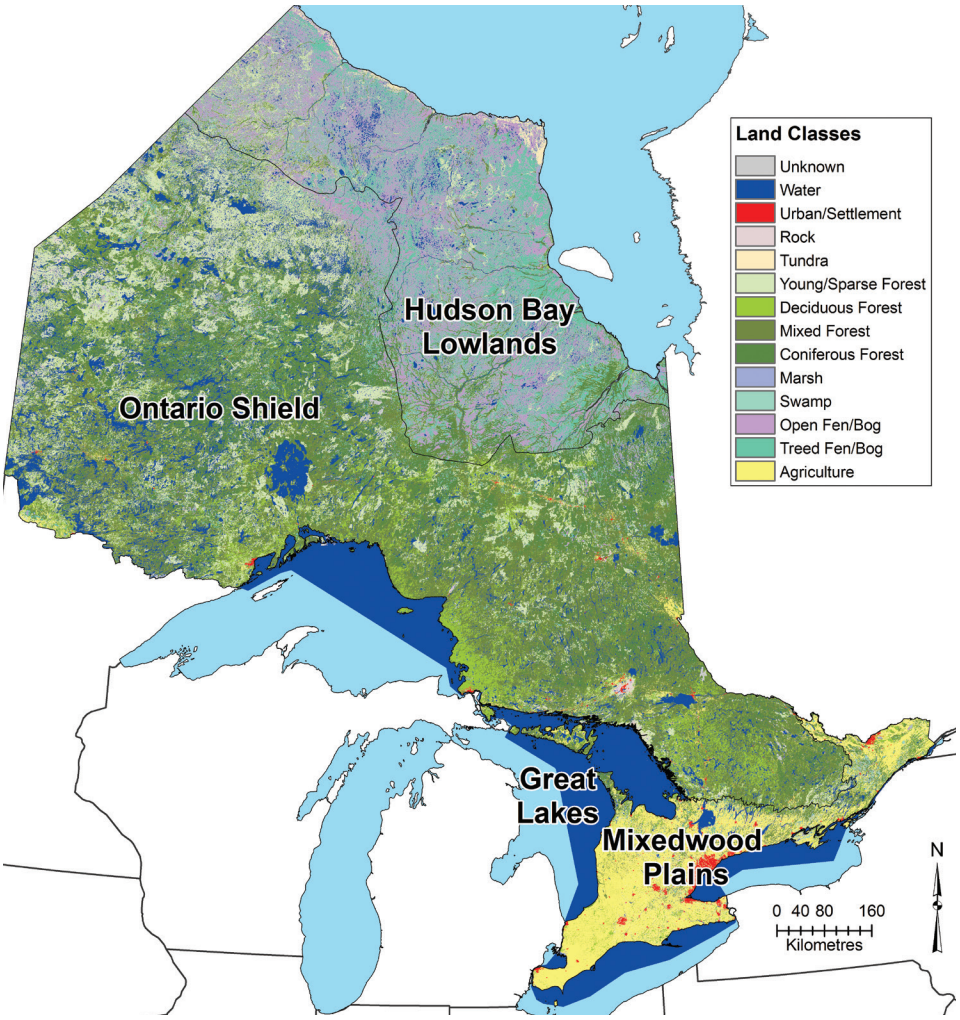
Figure 35 illustrates that Ontario has three ecozones: the Hudson Bay Lowlands in the Far North of Ontario, the Mixedwood Plains in southern Ontario, and the Ontario Shield in between. Out of Ontario's total land area, 66.5% is in the Ontario Shield ecozone, 25.3% is in the Hudson Bay Lowlands ecozone, and the remaining 8.3% is in the Mixedwood Plains ecozone.

By land cover type, Ontario's total land area consists of, from largest to smallest:

- 73% natural terrestrial cover;
- 12% aquatic cover;
- 7% natural disturbance cover;

Figure 35: Ontario's Ecozones*

Source: Ministry of Natural Resources and Forestry



* Canada is divided into 15 terrestrial ecozones, with three in Ontario, plus the Great Lakes ecozone, which borders Ontario. Each terrestrial ecozone represents a large geographic area, based on characteristic underlying bedrock.

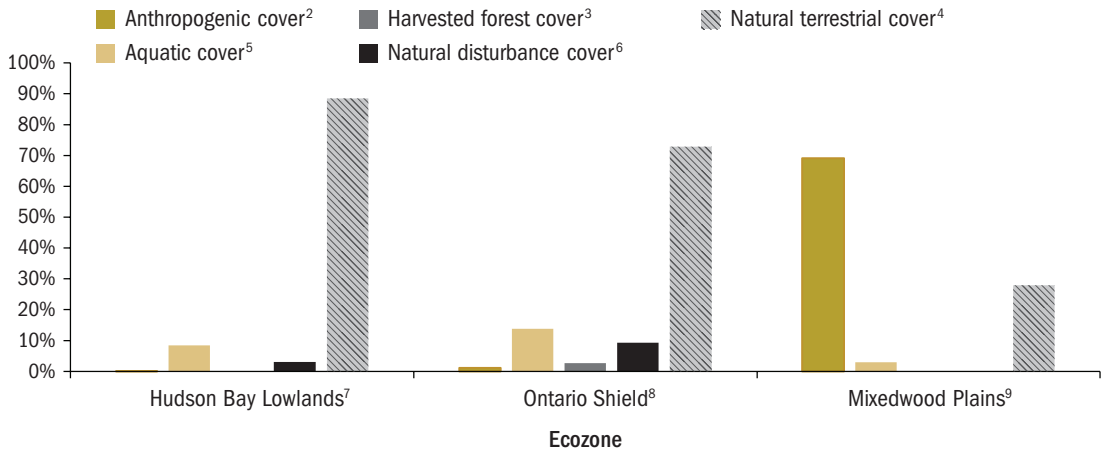
- 6% anthropogenic cover; and
- 2% harvested forest cover.

Out of Ontario's three ecozones, the Mixedwood Plains ecozone has by far the greatest percentage of land cover in the anthropogenic cover category, at almost 70% of the total in 2015 (**Figure 36**). In contrast, almost 90% of the Hudson Bay Lowlands ecozone is categorized as natural terrestrial cover as of 2011 (most recent data).

From 2000 to 2015, the Mixedwood Plains ecozone experienced a 2.5% increase in anthropogenic cover, with a corresponding decrease in natural terrestrial cover, due to human settlement and development (**Figure 37**). The data also shows areas of natural terrestrial cover being reclassified as natural disturbance cover in both the Hudson Bay Lowlands and the Ontario Shield from 2000 to 2011, but this is likely due mainly to changes in methodology and improved information about land cover in Northern Ontario.

Figure 36: Composition of Each Ontario Ecozone[1] by Land Cover Type

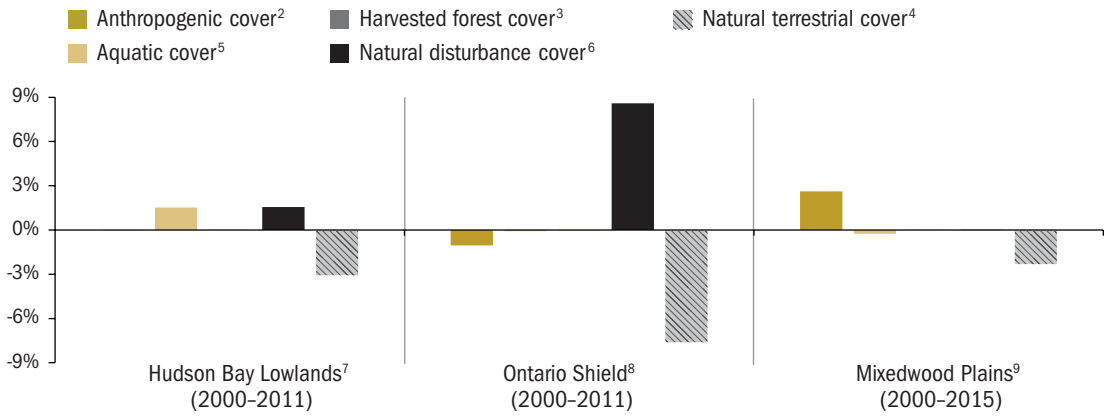
Sources of data: Ministry of Natural Resources and Forestry and the Ontario Biodiversity Council's State of Ontario's Biodiversity Report



1. See **Figure 35** for a map of Ontario's three ecozones.
2. Anthropogenic cover includes built-up and settled areas (such as homes, commercial buildings and industrial factories), roads, agriculture (cropland, grassland and pasture) and extraction (for stone, sand, gravel and mines).
3. Harvested forest cover includes forests harvested over the previous five years.
4. Natural terrestrial cover includes alvars, mudflats, prairies, savannahs, wetlands, forests (including Ontario's Managed Forest), rock and other open country habitat.
5. Aquatic cover includes open water of lakes and streams. The following aquatic features were excluded from aquatic cover: The Great Lakes, Georgian Bay, Parry Sound Lake/Bay, Lake St. Clair, St. Clair River, Niagara River, St. Lawrence River, Detroit River and West Lake.
6. Natural disturbance cover includes forest areas disturbed or damaged from recent natural events, including fires, insect damage or winds.
7. The most recent data available for land cover in the Hudson Bay Lowlands is from 2011.
8. The most recent comprehensive data available for land cover in the Ontario Shield is from 2011.
9. The most recent data available for land cover in the Mixedwood Plains is from 2015.

Figure 37: Percentage Changes in Land Cover Composition in Each Ontario Ecozone,[1] 2000–2015

Sources of data: Ministry of Natural Resources and Forestry and the Ontario Biodiversity Council's State of Ontario's Biodiversity Report



1. See **Figure 35** for a map of Ontario's three ecozones.
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4. Natural terrestrial cover includes alvars, mudflats, prairies, savannahs, wetlands, forests (including Ontario's Managed Forest), rock and other open country habitat.
5. Aquatic cover includes open water of lakes and streams. The following aquatic features were excluded from aquatic cover: The Great Lakes, Georgian Bay, Parry Sound Lake/Bay, Lake St. Clair, St. Clair River, Niagara River, St. Lawrence River, Detroit River and West Lake.
6. Natural disturbance cover includes forest areas disturbed or damaged from recent natural events, including fires, insect damage or winds.
7. The change in land cover in the Hudson Bay Lowlands is from 2000 to 2011, based on the most recent data available.
8. The change in land cover in the Ontario Shield is from 2000 to 2011, based on the most recent data available for the entire ecozone.
9. The change in land cover in the Mixedwood Plains is from 2000 to 2015, based on the most recent data available.

4.4 Indicator—Soil Condition

About 5.6 million hectares of Ontario (about 6% of its area) is farmland. The majority (66%) of this farmland is cropland, with the remainder (34%) classified as pastureland, fallow (temporarily uncropped) land, and other land owned by farmers. Farming practices that promote healthy soil are necessary to ensure that crop productivity is high and remains sustainable. Certain farming practices, such as planting cover crops and hedgerows, can help reduce the risk of soil degradation, including erosion, and increase carbon storage in the soil, which helps to slow climate change. Improper application of some fertilizers and pesticides can negatively affect soil organisms.

Ontario's Agricultural Soil Health and Conservation Strategy (2018) set out three relevant indicators as the best available measures of the status of Ontario's soils. We used these as our three sub-indicators of the soil condition indicator category, as follows:

- soil cover on farmland;
- soil erosion risk on cropland; and
- soil organic carbon on cropland.

Information on the sources and limitations of the data on soil conditions can be found in **Appendix 13**.

4.4.1 Major Factors That Affect Soil Condition

- Farming practices, such as soil tillage, the use of shelterbelts, and the use of cover crops
- Erosion by wind and water

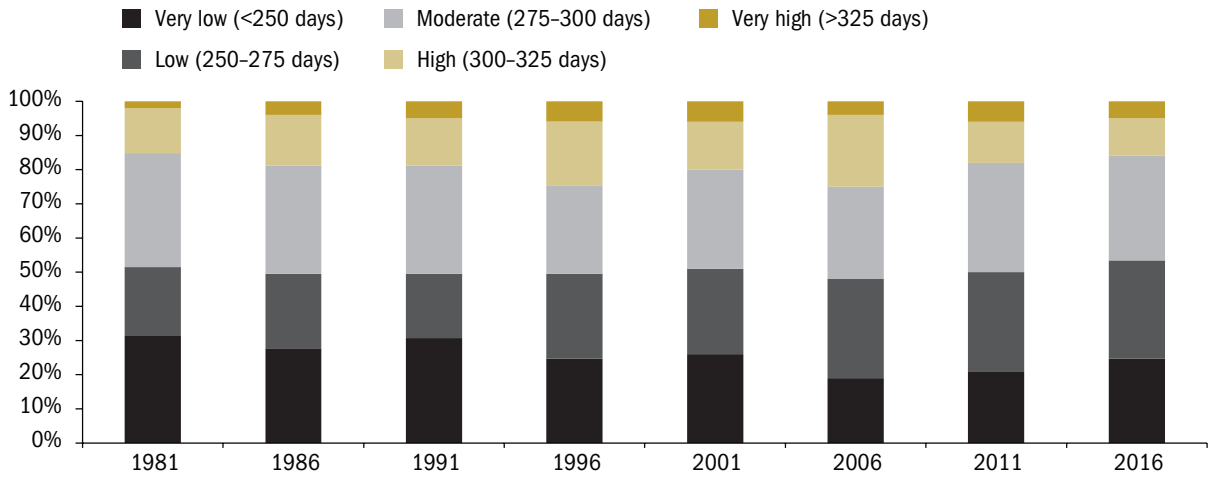
4.4.2 Key Results—Soil Condition (Soil Cover on Farmland)

Bare soil can be degraded by wind and water erosion. Retaining soil cover on farmland—through vegetation, crop residue or snow—makes the soil more resistant to degradation.

In 2016 (the most recent census data available), 54% of Ontario's farmland had very low or low soil cover, meaning that the soil was covered for less than 275 days, and therefore exposed for at least 90 days, of the year (**Figure 38**). There has been a slight improvement across the province in the average number of days that soil was without cover, from 96 days in 1981 to 91.1 days in 2016 (13 weeks or 25% of the year).

Figure 38: Breakdown of Ontario's Farmland by Extent of Soil Cover, 1981–2016*

Source of data: Agriculture and Agri-Food Canada



* Most recent census data available.

4.4.3 Key Results—Soil Condition (Soil Erosion Risk on Cropland)

In 2016 (the most recent census data available), 29% of Ontario's cropland was assessed as being at high or very high risk of soil erosion due to water, wind and tillage (**Figure 39**). A further 29% was assessed as being at moderate risk to soil erosion.

The overall risk of soil erosion decreased slightly from 1981 to 2016. This may be partially attributed to the increase in cropland using winter cover crops—which help protect against soil erosion—from 12% in 2011 to 25% in 2016. However, the percentage of cropland using no till or zero till seeding practices—which also protect against soil erosion—fell from 33% to 28% from 2011 to 2016.

Despite the overall improvement, the most recent census data from 2016 shows risk levels have increased from the previous census year, and the majority of Ontario's cropland remains at moderate to very high risk of soil erosion.

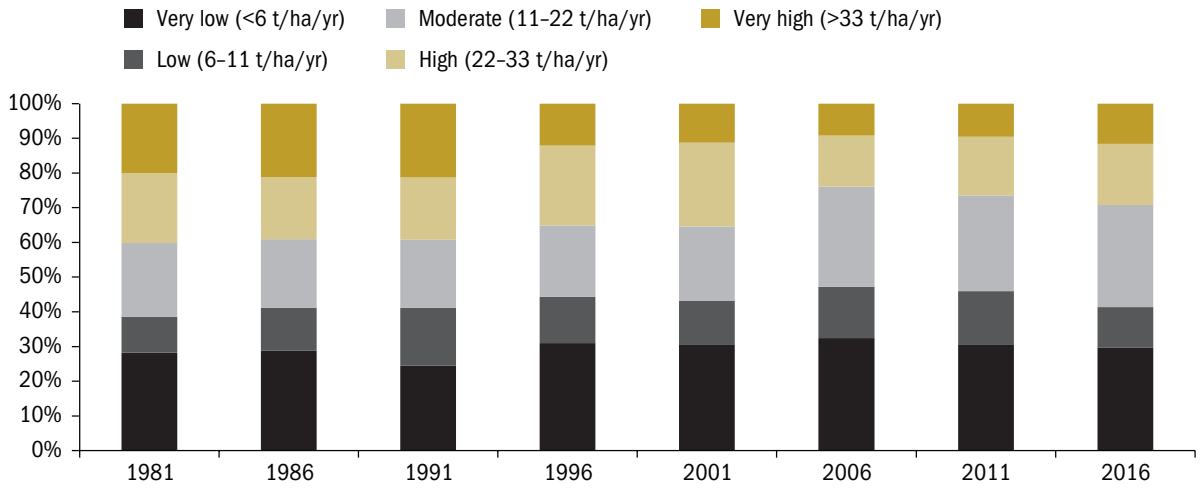
4.4.4 Key Results—Soil Condition (Soil Organic Carbon on Cropland)

Soil organic carbon helps improve soil structure, provides nutrients to plants and soil organisms and reduces negative impacts from heavy metals and pesticides. Soil organic carbon also creates a carbon storage reservoir, or sink, by sequestering carbon dioxide from the atmosphere.

The most recent census data available (2016) shows that 87% of Ontario's agricultural soils lost more carbon as carbon dioxide to the atmosphere than the amount of carbon added to the soil (**Figure 40**). From 1981 to 2016, the portion of cropland experiencing large carbon losses increased substantially, from 49% to 70%.

Figure 39: Breakdown of Ontario's Cropland by Soil Erosion Risk,[1] 1981–2016[2]

Source of data: Agriculture and Agri-Food Canada

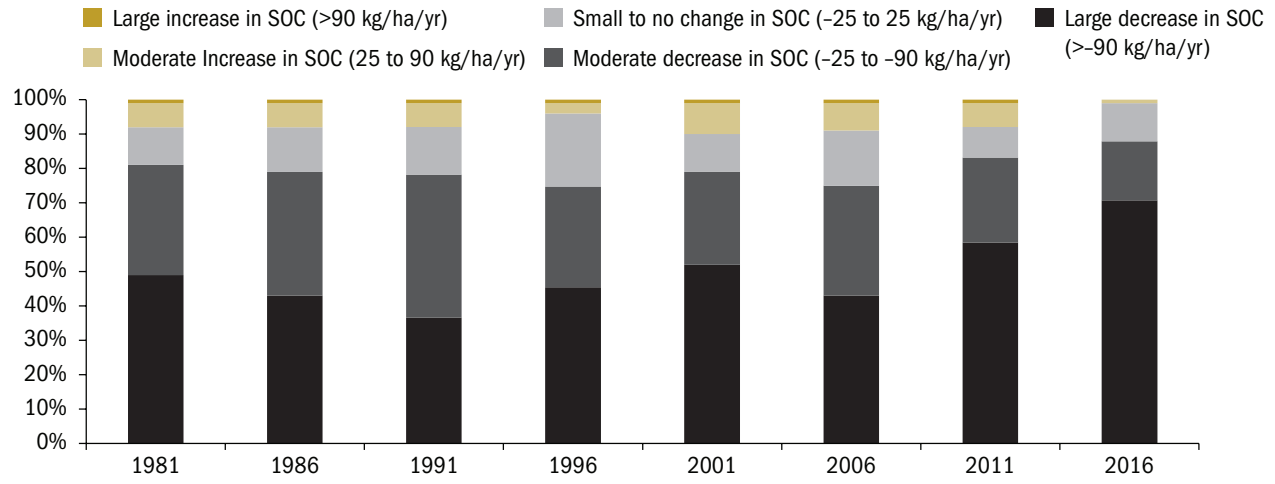


Note: "t/ha/yr" represents the change in tonnes of soil organic carbon per hectare per year.

1. Soil erosion risk includes combined risk of erosion due to water, wind and tillage.
2. Most recent census data available.

Figure 40: Breakdown of Ontario's Cropland by Change in Soil Organic Carbon (SOC), 1981–2016*

Source of data: Agriculture and Agri-Food Canada



Note: "kg/ha/yr" represents the change in kilograms of soil organic carbon per hectare per year.

* Most recent census data available.

However, this trend is partially offset by a decline in the portion of cropland experiencing moderate losses.

As of 2016, no cropland in Ontario showed a large increase in soil organic carbon, and only 1% showed a moderate increase. An increase in soil organic carbon is important when soils are already low in organic matter. Ontario's agricultural soils currently have relatively low levels of soil organic carbon, which, combined with the recent large decreases in soil carbon, means that they are at a high risk of degradation.

The main reason for the decline in soil organic carbon on Ontario farms is the shift from pasture and hayland to annual crops, due primarily to declines across Canada in cattle herds, which feed on hay. Soil organic carbon does not accumulate as rapidly with annual crops compared to perennial crops grown on pastureland. Between 1981 and 2016, the percentage of Ontario's total area in crops devoted to annual crops increased from 59% to 76%. Farmland with annual crops is also subject to greater soil erosion and soil loss than other types of farmland, such as pasture and hayland.

4.5 Indicator—Solid Waste

Waste generation and management practices—such as whether waste is recycled or disposed of in a landfill—determine the level of loss, or recovery, of the resources that went into making the products that become waste. Waste management practices are also an indicator of pollution risks to land, air, groundwater and surface water, such as methane emissions or toxic liquids seeping from a landfill.

This indicator category includes three sub-indicators:

- the amount of non-hazardous waste generated, diverted and disposed of;
- the amount of hazardous waste generated; and
- years of landfill capacity remaining in the province.

Information on the sources and limitations of the data on solid waste can be found in **Appendix 14**.

4.5.1 Major Factors That Affect Solid Waste

- Consumer product consumption habits
- Mining practices
- Industrial processing, manufacturing and packaging practices
- Construction and demolition practices
- Waste management systems
- Recycling and organic waste collection programs

4.5.2 Key Results—Solid Non-hazardous Waste Generation, Diversion and Disposal in Ontario

Based on the Environment Ministry's estimates, in 2020 (the most recent data), Ontario generated 12.3 million tonnes of non-hazardous waste (**Figure 41**). Of this total waste generated, 3.6 million tonnes (29%) was diverted (such as recycled or composted), with the remaining 8.7 million tonnes disposed of in Ontario and US landfills. According to the Environment Ministry's data, 587 kilograms of waste was disposed of per person in 2020.

The annual amount of waste generated in Ontario has increased by about 365,000 tonnes between 2002 to 2020 (**Figure 42**). However, the portion of generated waste that is diverted in Ontario increased from 19% (2.3 million tonnes) in 2002 to 29% (3.6 million tonnes) in 2020, which resulted in a net 10% (almost one million tonnes) reduction in the total amount of waste disposed of in Ontario and US landfills between

Figure 41: Total Non-hazardous Waste Generated, Diverted and Disposed in Ontario, 2020*

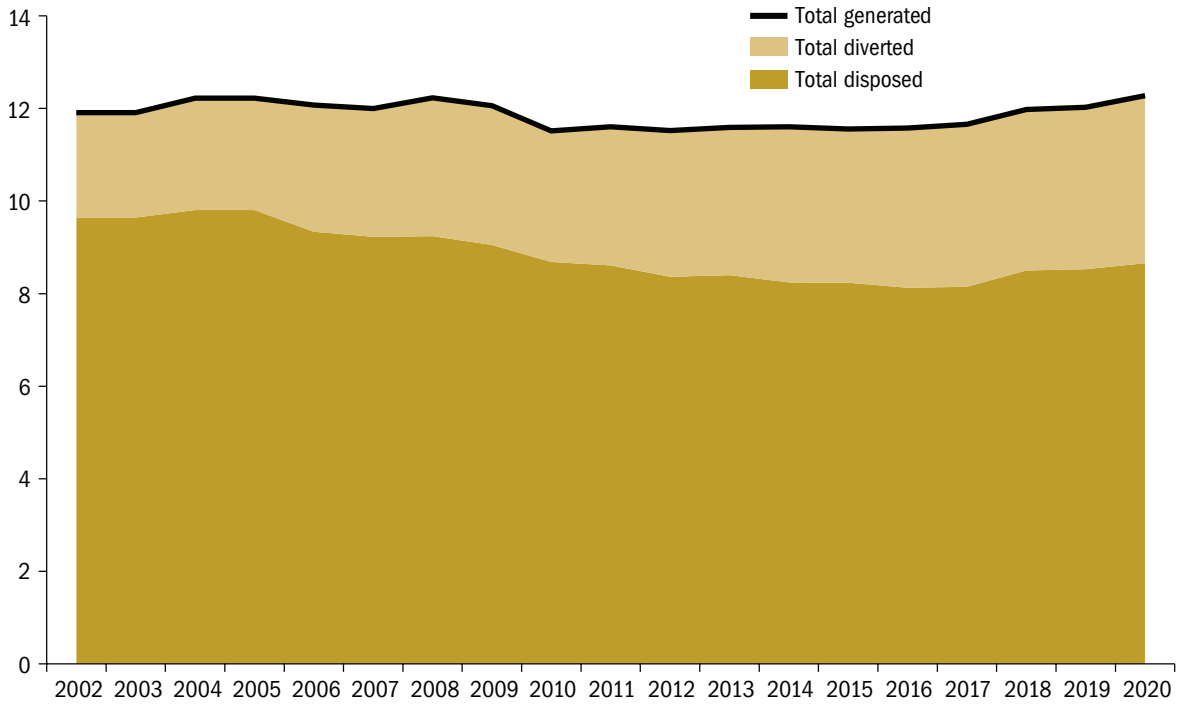
Sources of data: Statistics Canada and Ontario's Datacall

Waste	Million tonnes
Generated	12.3
Diverted	3.6
Disposed	8.7
Waste disposed per person (kilograms)	**587**
% of waste diverted	**29**

* Most recent data available.

Figure 42: Non-hazardous Waste Generated, Diverted and Disposed, 2002–2020 (million tonnes)

Source of data: Statistics Canada and Ontario's Datacall*



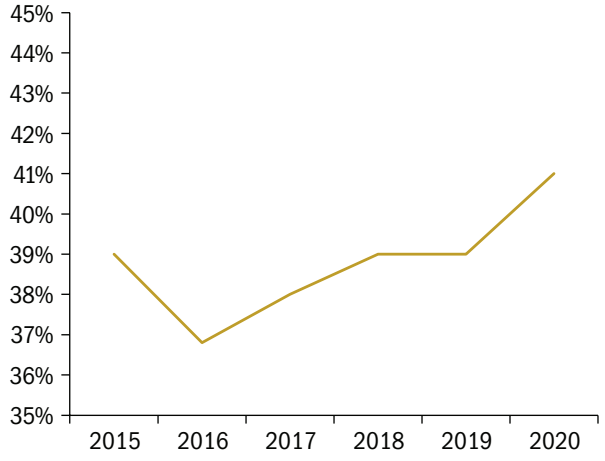
* Figure uses Statistics Canada data, produced biennially from 2002 to 2018, with Ontario's Datacall data, produced annually, for residential waste since 2006. This follows the Ministry of the Environment, Conservation and Parks' methodology for estimating total waste, allowing for consistent trend analysis over time.

2002 and 2020. Despite this longer-term declining trend, due to the increase in the amount of waste generated, the total amount of waste disposed of in landfills increased by 7% between 2016 and 2020.

Food and other organic wastes (such as leaf and yard waste and soiled paper) make up a large portion, almost one-third, of Ontario's non-hazardous waste stream. Diversion of organic waste increased from 39% to 41% between 2015 and 2020 (**Figure 43**).

Figure 43: Percentage of Ontario's Food and Organic Waste Diverted, 2015–2020

Source of data: Ministry of the Environment, Conservation and Parks



4.5.3 Key Results—Hazardous Waste in Ontario

The Environment Ministry regulates the management of hazardous waste in accordance with Regulation 347 (General – Waste Management) under the *Environmental Protection Act*. Hazardous wastes are broadly defined as wastes that can pose a threat to the environment or human health if not managed properly. Examples include wastes that are toxic (such as certain pesticides), corrosive (such as acids), pathological (such as medical wastes), and ignitable (such as used gasoline).

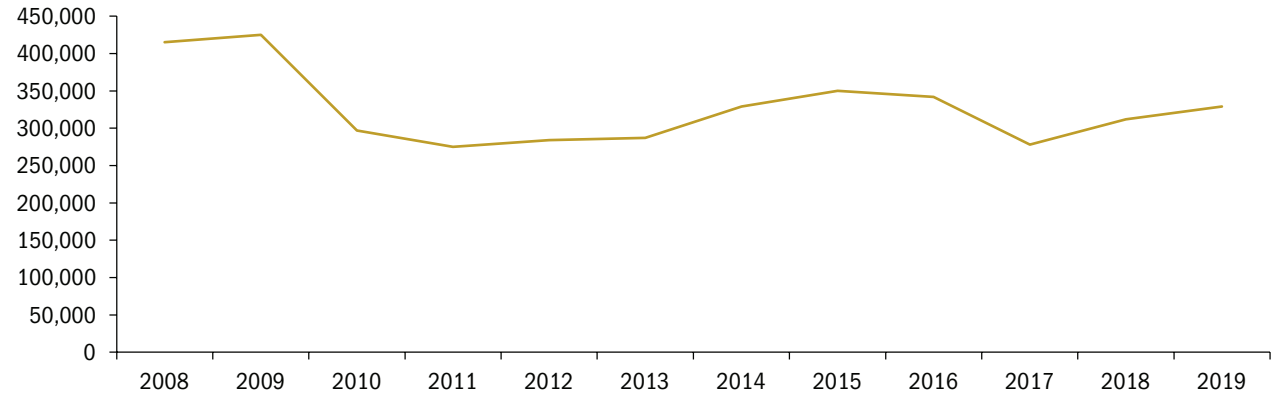
In 2019, 329,000 tonnes of hazardous waste were disposed of in Ontario. This represents a decrease of 86,000 tonnes, or 21%, from 2008 (**Figure 44**). According to the Environment Ministry, this decrease falls within the normal fluctuation in annual amounts of hazardous waste disposed, resulting from changes in the economy, manufacturing and industrial trends and other factors.

4.5.4 Key Results—Years of Landfill Capacity Remaining in Ontario

Approximately one-third of Ontario's disposed non-hazardous waste is exported to the United States, mostly from the non-residential sector. The remaining

Figure 44: Hazardous Waste Disposed in Ontario, 2008–2019 (tonnes)

Source of data: Ministry of the Environment, Conservation and Parks



non-hazardous waste is disposed of in Ontario landfills. Assuming current waste generation, diversion and export levels, there is sufficient landfill capacity in the province to support approximately 10 to 13 more years of waste disposal. According to the Ontario Waste Management Association, the province's current landfill capacity, estimated at 144.5 million tonnes at the start of 2020, is expected to be depleted in 2034.

4.6 What Progress Has Been Made Toward Land and Waste Targets in Ontario?

There are no provincial targets with respect to either land cover or soil health conditions on farmlands.

On waste, Ontario has two sets of diversion targets. The first target is to decrease the amount of non-hazardous waste disposed of, measured per person, each year. This target does not set out a specific reduction amount but rather is based on progressive annual reduction in waste disposed of per person. This target was achieved from 2013 to 2017, but was not met in 2018 or 2019.

The second set of non-hazardous waste diversion targets is set out in the Strategy for a Waste-Free Ontario: Building the Circular Economy (2017). It documents the following diversion goals:

- 30% of generated waste is diverted by 2020;
- 50% of generated waste is diverted by 2030; and
- 80% of generated waste is diverted by 2050.

Based on the Ministry's estimates for 2020, Ontario's non-hazardous waste diversion rate was just shy of the target, at 29%.

5.0 The State of the Climate in Ontario

Increased levels of global emissions of greenhouse gases in the atmosphere, along with changes in land use that affect carbon sequestration and storage, are altering both global and local climate (long-term weather) conditions. These changes to the climate are having impacts on our natural world and public health, as well as on our infrastructure and economy.

This section reports on three indicators related to Ontario's contributions to climate change:

- human-caused greenhouse gas emissions;
- wildfire emissions; and
- carbon storage.

We then report on five indicators of Ontario's climate conditions:

- frequency of weather-related disasters;
- Great Lakes ice cover;
- length of agricultural growing season;
- surface air temperature; and
- water levels and scarcity.

As climate trends are largely affected by global emissions of greenhouse gases, changes in Ontario's climate conditions are not directly reflective of Ontarians' emission-reduction actions. However, they do measure the influence of climate change on the environment.

5.1 Historical Context

Globally, the major effects of climate change have been to raise average air temperatures, alter precipitation patterns, raise sea levels, melt ice cover, and increase the frequency of extreme-weather events.

In terms of Ontario's contribution to climate change, the province's greenhouse gas emissions peaked in 2000 and have gradually fallen since then, partly due to phasing out Ontario's coal-fired electricity generation. The province's carbon stock—the amount of carbon

that has been sequestered from the atmosphere and is now stored within soil or vegetation—is enormous, and has been left mostly undisturbed in northern peatlands. In contrast, according to a 2018 study out of the University of Toronto, the carbon stock in Ontario's southern wetlands has dropped by an estimated 60% since European settlement began, due to wetland loss, including from increased agriculture and urbanization.

5.2 How Changes to the Climate Affect Environmental and Human Health in Ontario

Climate change has many impacts on both ecological and human health. Around the world, climate change has caused, and is projected to increasingly contribute to, more frequent and extreme weather events such as flooding, heat waves, storms and wildfires. These weather events can cause environmental damage, affecting vegetation, animals and human health. For example, elevated temperatures and more frequent heat waves can increase the occurrence of heat stroke in both humans and animals. A 2016 study led by a Public Health Ontario scientist indicated that a 5°C increase in daily temperature in the warm months results in a 2.5% increase in non-accidental human deaths. Similarly, the study found that a 5°C decrease in daily temperature in cold months results in a 3% increase in non-accidental deaths.

Changes in ice cover can affect the life cycles of fish and other organisms that live in lakes as well as affect shipping in the Great Lakes. Changing ice cover can also affect local weather and climate conditions, as ice is more reflective of sunlight than water.

Earlier snowmelt, spring runoff and other changes due to climate change can alter the amount and timing of nutrients that enter lakes, affecting the growth of algae in the summer. Changes in the climate can also alter the time periods to successfully plant crops, and potentially alter the species or varieties of crops that could be grown. Each crop species has specific seeding and harvest times, and some crops require specific climate parameters.

Climate change also affects the water cycle through changes in precipitation, snowmelt timing, and evaporation rates, resulting in differing local effects. Fundamentally, all life, whether aquatic or on land, relies on water for habitat and nourishment. People use it for drinking, sanitation, agriculture, industry, electricity production and recreational purposes. Excess or scarce water supplies, as well as high and low water levels, can have wide-ranging effects on these uses.

5.3 Indicator—Human-Caused Greenhouse Gas Emissions

One way to identify Ontario's contribution to climate change is through its annual emissions of greenhouse gases. The greenhouse gas emissions indicator is measured in the standard unit of millions of tonnes of carbon dioxide equivalent emissions (Mt CO_2eq) per year, which is a method to convert various climate change-causing gases to an equivalent amount of carbon dioxide based on the climate impact of each gas.

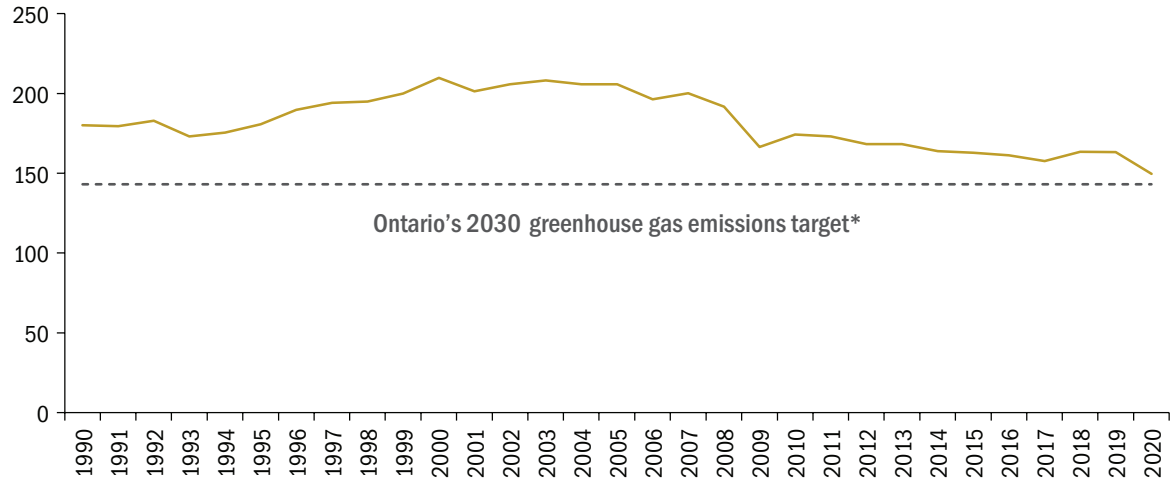
Information on the sources and limitations of the data on human-caused greenhouse gas emissions can be found in **Appendix 15**.

5.3.1 Major Factors That Affect Human-Caused Greenhouse Gas Emissions

- Fossil fuel combustion for electricity generation, transportation, home heating and other uses, which releases carbon dioxide
- Methane releases from farm animals and decomposing waste in landfills
- Nitrous oxide emissions from fertilizer use
- Industrial releases of other greenhouse gases, such as sulphur hexafluoride
- Land use changes

Figure 45: Ontario's Annual Greenhouse Gas Emissions, 1990–2020 (million tonnes of carbon dioxide equivalent emissions per year)

Source of data: Environment and Climate Change Canada's National Inventory Report



* Ontario's greenhouse gas emissions target is to be 30% below the 2005 levels by 2030. This is equal to emitting 144 million tonnes of carbon dioxide equivalent (Mt CO_2eq) per year.

5.3.2 Key Results—Human-Caused Greenhouse Gas Emissions in Ontario

Ontario emitted 149.6 Mt CO_2eq in 2020, which is approximately 22% of Canada's emissions. As shown in **Figure 45**, the province's annual emissions peaked in 2000, and have generally been declining since then, with a substantial drop taking place between 2009 and 2014. This decline has largely been attributed to the reduction in coal-fired electricity generation in the province. Ontario's 2020 greenhouse gas emissions were 17% lower than 1990 annual emissions, and 27% lower than 2005 emissions.

5.4 Indicator—Wildfire Emissions

Climate change is expected to increase the prevalence of "fire weather" (a combination of hot, dry and windy conditions), potentially driving an increase in the number of wildfires, the area burned and the severity of the forest wildfires in many regions, including those in Canada's boreal forests. Future increases in size, frequency and severity of wildfires in Ontario's boreal forests, along with other disturbances such as insects and forest harvest, may lead to the boreal forests becoming net sources of greenhouse gas emissions, instead of acting as a carbon sink.

Information on the sources and limitations of the data on wildfire emissions can be found in **Appendix 16**.

5.4.1 Major Factors That Affect Wildfire Emissions

- Prevalence of extreme "fire weather"—hot, dry and windy conditions
- Persistent drought
- Quantity and type of "fuel"—combustible organic material, including forest floor debris and standing trees

5.4.2 Key Results—Wildfire Emissions in Ontario

The Natural Resources Ministry has reported an overall declining trend in the number of wildfires since 2002. However, wildfire information for Ontario's Managed

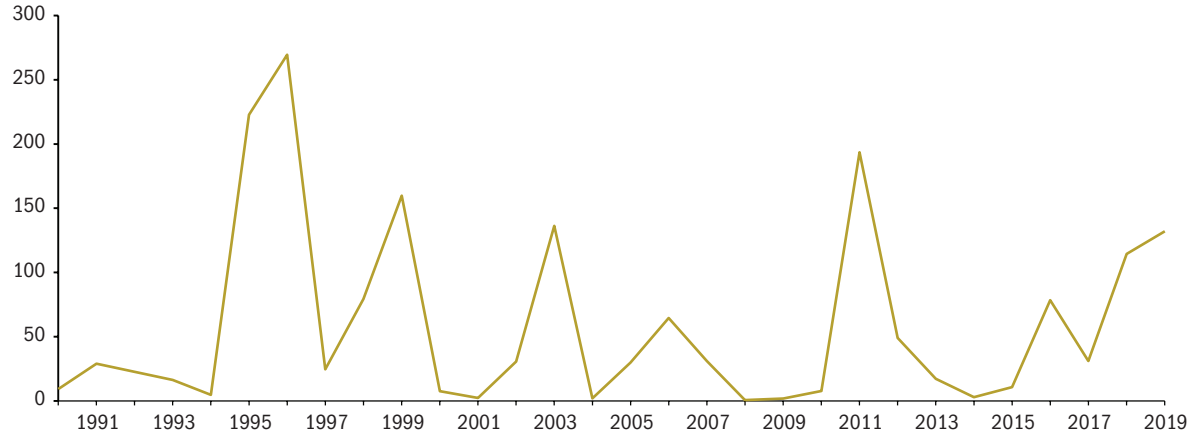
Forests from the past 30 years (1990–2019) shows year-over-year variation in both the area burned (**Figure 46**) and the resulting wildfire emissions (**Figure 47**). In the more recent decade (2010–2019), wildfires in Ontario produced 2.3 times the carbon dioxide emissions of the 2000–2009 decade but 17% fewer emissions than between 1990 and 1999.

5.5 Indicator—Carbon Storage

Carbon naturally accumulates in soil and plants, including trees. Unlike animals, plants and trees absorb carbon dioxide from the atmosphere and store some of this carbon in their tissues. Soils accumulate some of this plant carbon as soil organic matter, while the rest

Figure 46: Annual Wildfire Area Burned in Ontario's Managed Forest,* 1990–2019 (thousand hectares)

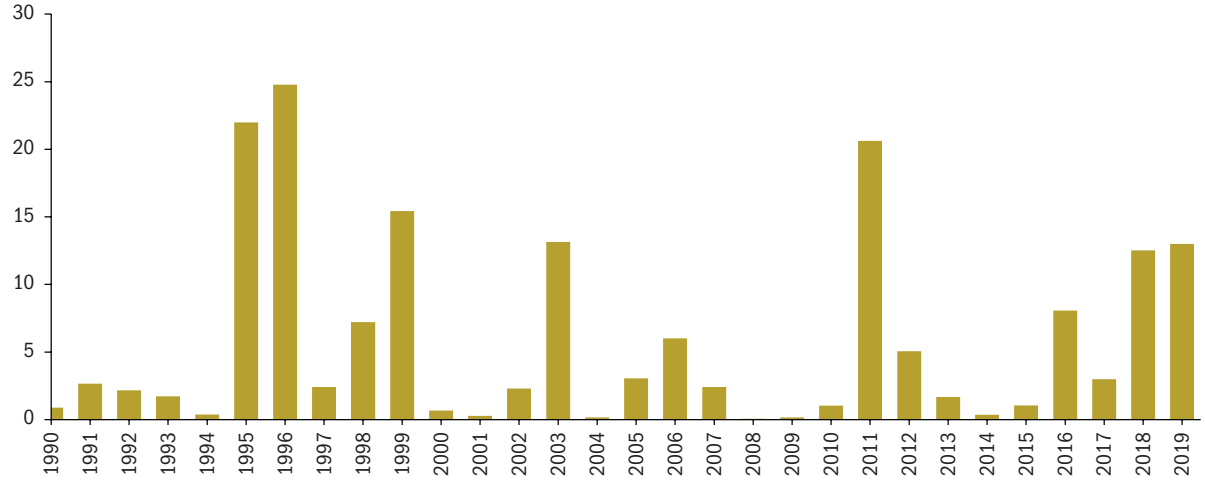
Source of data: Natural Resources Canada



* See map in **Appendix 24b**.

Figure 47: Annual Emissions from Wildfires in Ontario's Managed Forest,* 1990–2019 (million tonnes of carbon dioxide equivalent emissions per year)

Source of data: Natural Resources Canada



* See map in **Appendix 24b**.

is used by soil organisms, like earthworms. So long as the rate of carbon accumulation is greater than the rate of carbon loss through organic matter decomposition and erosion, carbon storage will increase. Peatlands and other types of wetlands are especially effective at accumulating carbon because the high-water tables keep decomposition rates low.

Billions of tonnes of carbon are stored in Ontario farms and forests (in trees and soils), wetlands and wood products, keeping it out of the atmosphere. Should a significant amount of this carbon be released, it would accelerate climate change, which would in turn cause increased damage to biodiversity, human health and infrastructure.

This indicator category is divided into two sub-indicators:

- carbon stored in forests and wood products; and
- carbon stored in wetlands.

Also relevant to carbon storage is the amount of carbon stored in agricultural soil, which is discussed in the soil condition indicator category in **Section 4.4**.

Information on the sources and limitations of the data on carbon storage can be found in **Appendix 17**.

5.5.1 Major Factors That Affect Carbon Storage

- Forestry management practices, including harvesting, regeneration of harvested areas, natural disturbances and conservation
- Frequency, extent and intensity of wildfires
- Domestic and invasive species and pathogens
- Land-use practices, such as drainage of wetlands, urbanization and industrial development
- Climate change, including changes in temperature, precipitation and length of the growing season
- Afforestation (establishing new forests)

5.5.2 Key Results—Carbon Storage in Forests and Wood Products in Ontario

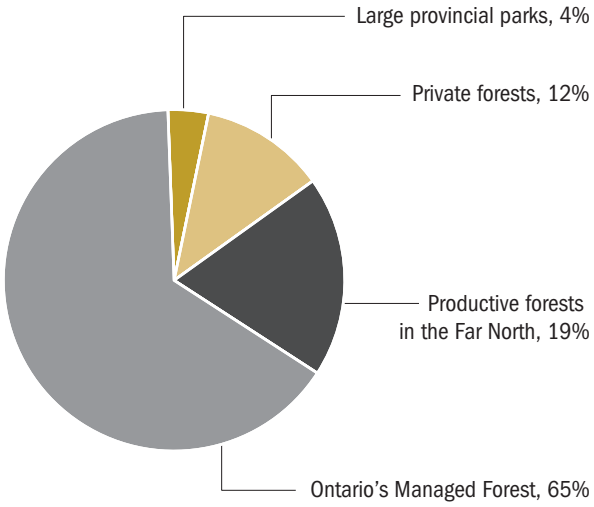
The Natural Resources Ministry estimates that the carbon stored in Ontario's productive forests—forest areas that produce or are capable of producing timber—reached over seven billion tonnes in 2020 (**Figure 48**). This quantity of stored carbon is equivalent to 177 times Ontario's 2020 human-caused greenhouse gas emissions.

The Natural Resources Ministry has projected, based on a 2018 study, that the carbon stock in Ontario's productive forest will increase by 8.5 million tonnes by 2030, and cumulatively by 195 million tonnes by the end of the century (**Figure 49**). This increase in forest carbon stock is largely attributed to increased carbon storage in Ontario's Managed Forest, which makes up two-thirds of the total forest area. Regrowth after harvesting may result in a younger forest age structure, which can increase capacity for carbon uptake from the atmosphere. When including the carbon stored in harvested wood products produced in the future (as well as emissions from the production and landfilling of these wood products), carbon storage in Ontario's productive forests is projected to increase by 269 million tonnes between 2020 and 2100.

While carbon stored in both forests and harvested wood products is projected to increase each decade, the rate of forest carbon storage increase is greater

Figure 48: Carbon Stored in Ontario's Productive Forests,* by Forest Land Type, 2020 (7.23 billion tonnes)

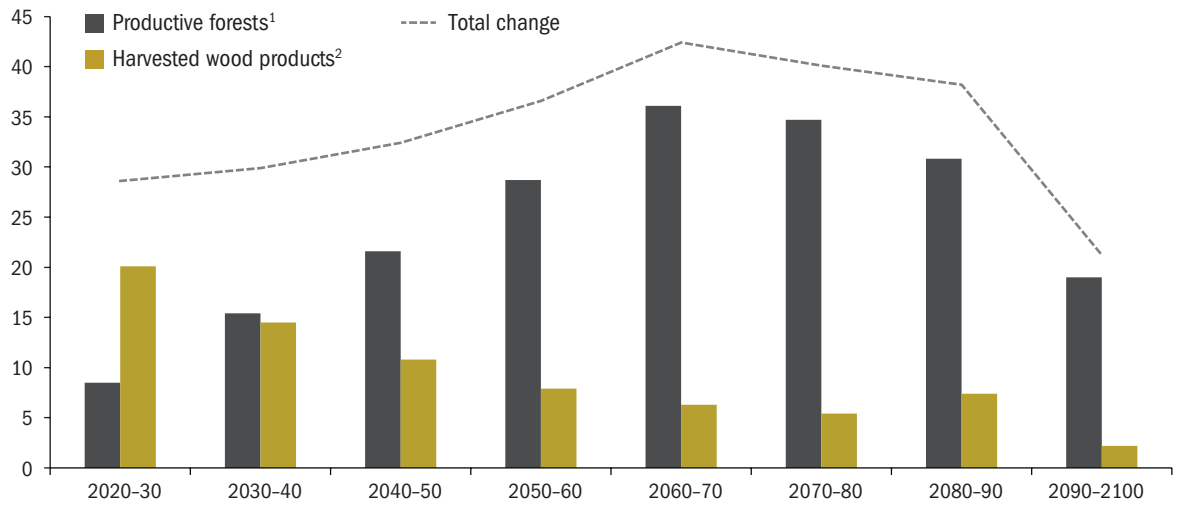
Source of data: Ministry of Natural Resources and Forestry



* Productive forests are areas that produce or are capable of producing timber, and include Ontario's Managed Forest (see map in **Appendix 24b**), private forests, forests in large provincial parks, and productive forests north of Ontario's Managed Forest.

Figure 49: Projected Changes in the Amount of Carbon Stored in Ontario's Productive Forests and Harvested Wood Products per Decade (million tonnes)

Source of data: Ministry of Natural Resources and Forestry



1. Productive forests are areas that produce or are capable of producing timber, and include: Ontario's Managed Forest (see map in **Appendix 24b**), private forests, forests in large provincial parks, and productive forests north of Ontario's Managed Forest.
2. Harvested wood products include the carbon stored in future wood products originating from harvesting in Ontario's Managed Forest and private forests, as well as the carbon and methane emissions from producing and landfilling these products.

during the first 50 years. As forests reach old age, the amount of carbon they can sequester from the atmosphere begins to stabilize, and combined with increasing rates of death and decomposition, results in smaller decadal increases in carbon storage.

Based on these projections, by the end of the 21st century, forest carbon stocks and harvested wood products are estimated to contribute an average of 3.4 million tonnes of carbon per year toward emission reductions.

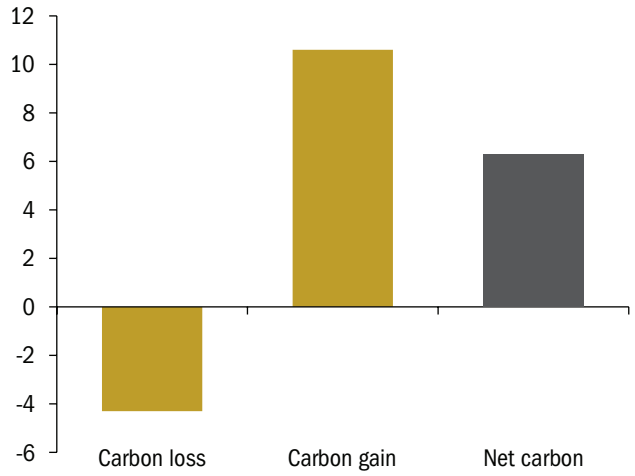
5.5.3 Key Results—Carbon Storage in Ontario's Wetlands

The Natural Resources Ministry estimates that the peatlands (a type of wetland) in Ontario's Far North store 28.2 billion tonnes of carbon, which is equivalent to almost 700 times Ontario's 2020 annual greenhouse gas emissions. These peatlands are a net carbon sink, sequestering about 6 million tonnes of carbon per year, as shown in **Figure 50**.

Yet peatlands also emit methane, a potent greenhouse gas with a climate-warming impact per molecule that greatly exceeds that of carbon dioxide. With methane emissions included, the Ministry estimated that the potential net climate emissions impact

Figure 50: Estimated Average Amount of Net Carbon Stored in Peatlands in Ontario's Far North per Year (million tonnes)

Source of data: Ministry of Natural Resources and Forestry



of peatlands in the Far North ranges from storing 17.2 million tonnes of carbon dioxide equivalent emissions (Mt CO_2eq) per year to releasing almost five times this amount (82.1 Mt CO_2eq) into the atmosphere per year. The Natural Resources Ministry noted that

additional data and analysis on the baseline conditions are required in order to refine this range.

Ontario's southern wetlands store a much smaller amount of carbon than the northern peatlands due to their different composition and glacial history. In addition, the trend over the past century has been a loss of wetlands in southern Ontario (see **Section 6.3**), which has reduced their carbon stock. According to a 2018 study out of the University of Toronto, the carbon stock in Ontario's southern wetlands is currently about 1.3 billion tonnes of carbon, which is about 60% less than the amount present before European settlement.

5.6 Indicator—Weather-Related Disasters

Climate change has increased the frequency of severe weather events, including heat waves and record-breaking storms. The number of weather-related disasters can indicate the extent of climate change and the increases in atmospheric greenhouse gas concentrations that cause it.

This indicator category looks at the number of weather-related disasters per year. To be considered a disaster, a weather event must meet at least one of the following criteria:

- a minimum of 10 people killed;
- a minimum of 100 people affected, evacuated, homeless, infected or injured;
- associated with an appeal for national/international assistance;
- historic significance; or
- due to significant damage or interruption of normal processes, the communities affected are unable to recover on their own.

Information on the sources and limitations of the data on weather-related disasters can be found in **Appendix 18**.

5.6.1 Major Factors That Affect the Frequency of Weather-Related Disasters

- Natural events in weather cycles
- Changing climate patterns due to global greenhouse gas emissions and land-use changes, such as draining wetlands

5.6.2 Key Results—Weather-Related Disasters in Ontario

There has been a considerable increase in the annual number of weather-related disasters in the province from 1911 to 2019, as reported in the Canadian Disaster Database under the Meteorological/Hydrological category (**Figure 51**). The annual number of weather-related disasters has grown from at most one per year in the early 1900s to an average of about three per year since 2000. Ontario experienced four weather-related disasters in 2019 (the most recent year of reported data) and seven weather-related disasters in 2016, the greatest annual number over the entire 1911–2019 period.

5.7 Indicator—Great Lakes Ice Cover

The extent of ice cover on the Great Lakes has been measured for decades by the federal Canadian and US governments. The Great Lakes ice cover indicator measures the annual maximum percentage of the Great Lakes that is covered by ice.

Information on the sources and limitations of the data on Great Lakes ice cover can be found in **Appendix 19**.

5.7.1 Major Factors That Affect Great Lakes Ice Cover

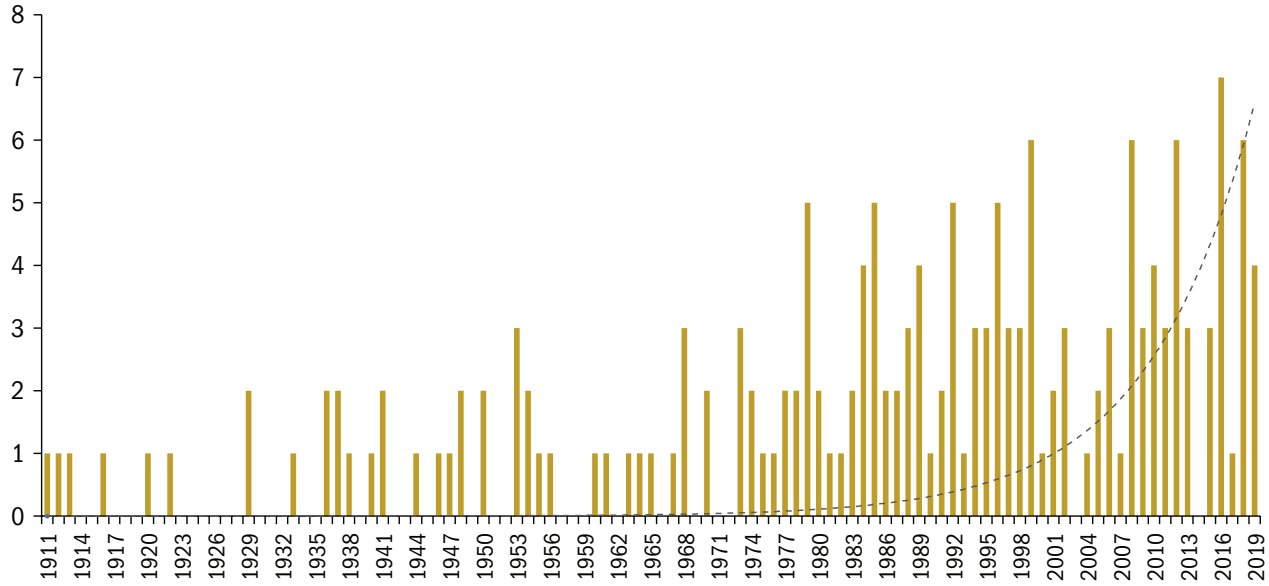
- Air temperature
- Water temperature

5.7.2 Key Results—Great Lakes Ice Cover

The long-term trend in maximum ice cover is declining across all Great Lakes, which is a strong indicator of climate change. On average, ice cover across all Great Lakes is 26% less than it was almost 50 years ago **(Figure 52)**. Between 1973 and 2021, average

Figure 51: Number of Weather-Related Disasters* in Ontario per Year, 1911–2019

Source of data: Canadian Disaster Database, Meteorological/Hydrological category

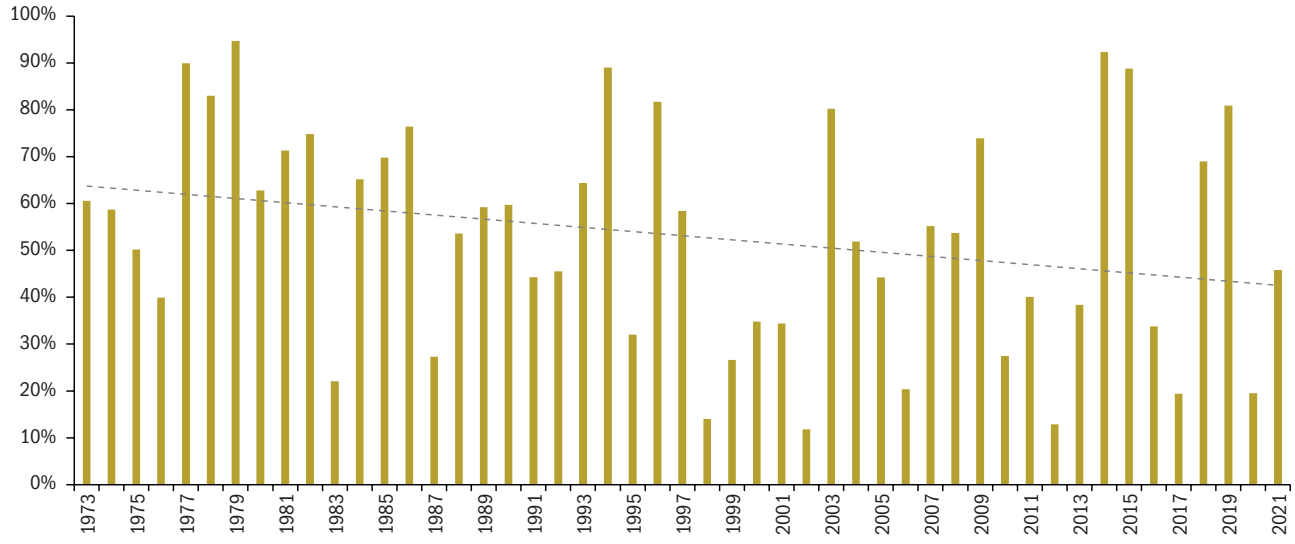


Note: The dashed line represents an exponential trend line.

* The following types of meteorological/hydrological disasters are included: avalanche, cold event, drought, flood, geomagnetic storm, heat event, hurricane/typhoon/tropical storm, storm surge, severe thunderstorm, tornado, wildfire, winter storm and unspecified/other storm.

Figure 52: Estimated Annual Maximum Ice Cover (% of Lake Area) in the Great Lakes,* 1973–2021

Source of data: National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory

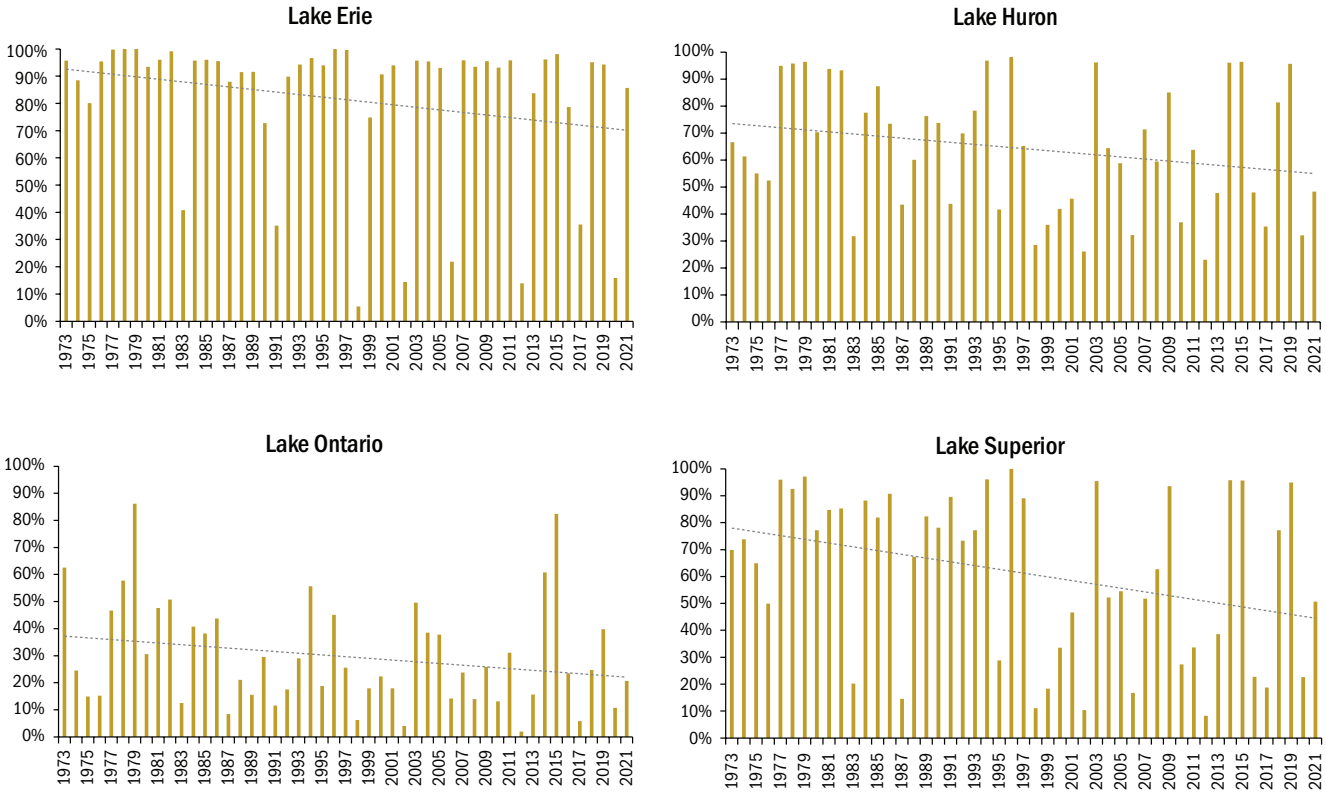


Note: The dashed line represents a best-fit linear trend line.

* Data represents an overall assessment of ice cover on all five individual Great Lakes (Superior, Ontario, Huron, Erie and Michigan).

Figure 53: Estimated Annual Maximum Ice Cover (% of Lake Area) of Each of the Great Lakes Bordered by Ontario, 1973–2021

Source of data: National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory



Note: The dashed lines represent best-fit linear trend lines.

maximum ice cover declined the most on Lake Superior (33%) and Lake Ontario (33%), with less of a decrease on Lake Erie (26%) and Lake Huron (21%) (**Figure 53**).

Best-fit straight trend lines show that between 1973 and 2021, maximum ice cover decreased across all of the Great Lakes by an average of 0.44% per year. Lake Superior showed the most substantial trend, averaging a reduction of 0.7% per year.

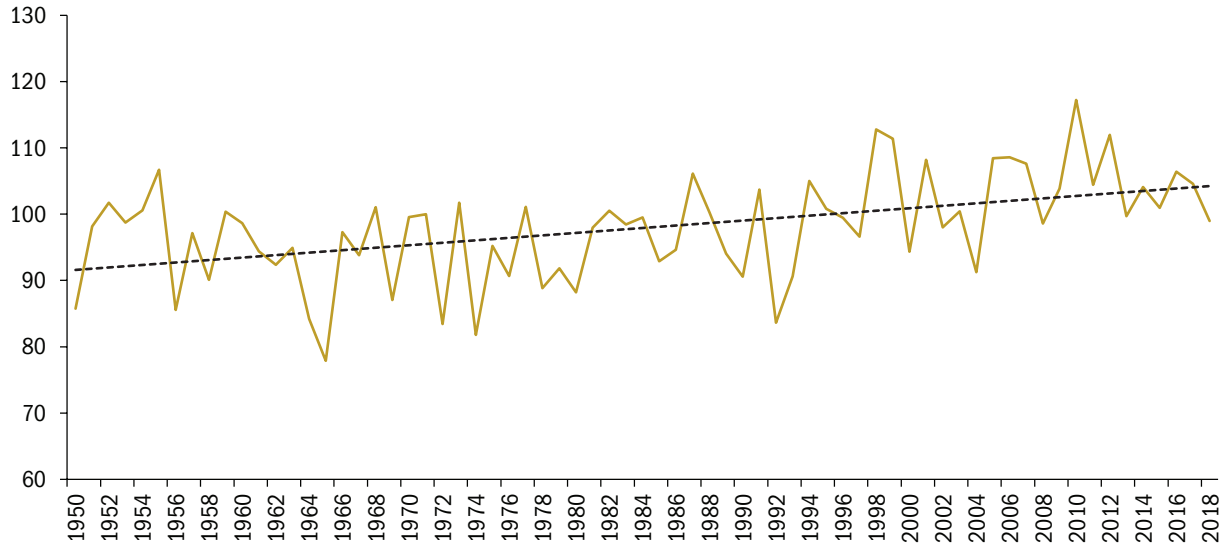
Ice cover plays a critical role in climate regulation, as the light-coloured ice and snow create a more reflective surface than water. A decrease in lake ice cover therefore increases the amount of radiation and heat that is absorbed from the sun, which further warms the water, creating a feedback loop of warmer water and reduced ice cover. This effect is especially pronounced in large lakes, such as Lake Superior.

Maximum ice cover in the Great Lakes has shown considerable annual variability, reflecting the variability in winter temperatures from year to year. Recent ice cover data shows an increase in variability between decades, which may likely also be attributed to climate change. For example, in the most recent decade there was a slight increase in ice cover on Lakes Superior, Ontario and Huron.

The observed declines in ice cover and high year-to-year fluctuations can exacerbate shoreline erosion, reduce habitat availability, impact food supply, and alter the timing of fish spawning or bird migration patterns. Collectively, these changes can degrade aquatic ecosystems and result in a loss of biodiversity.

Figure 54: Average Annual Growing Season Length in Ontario, 1950–2018 (days)

Source of data: Natural Resources Canada



Note: The dashed line represents a best-fit linear trend line.

5.8 Indicator—Length of Growing Season

The growing season is the period in which the weather conditions—including air temperature, rainfall and daylight hours—are favourable for the growth of crops. The length and start of the growing season affects seeding and harvest times, as well as the optimal type of crop to plant. For this indicator, growing season length refers to the number of days between the last occurrence of frost (0°C) in the spring and the first frost (0°C) in the fall.

Information on the sources and limitations of the data on growing season can be found in **Appendix 20**.

5.8.1 Major Factors That Affect the Growing Season

- Air temperature and frost days

5.8.2 Key Results—The Growing Season in Ontario

Based on a linear trend line of the data collected from 1950 to 2018, Ontario's average annual growing season has lengthened about 13 days over this period (**Figure 54**).

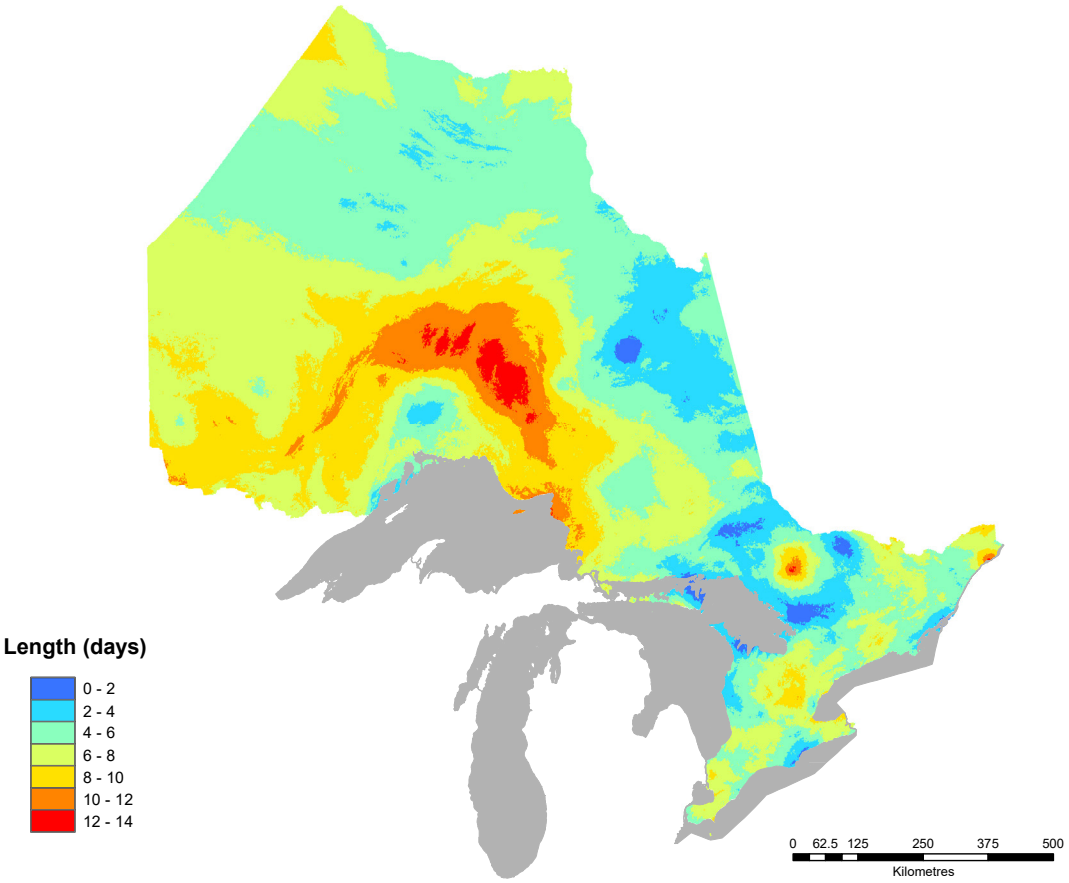
Figure 55 shows the change in average growing season length between the 1951–1980 and 1981–2010 time periods in different regions of the province. The growing season has lengthened the most in parts of the northwest and northcentral regions of the province, reaching up to a 14-day increase in some areas. However, there is some uncertainty in these estimates, especially in more remote regions such as Northern Ontario, where there are far fewer weather stations.

5.9 Indicator—Surface Air Temperature

This indicator shows the fluctuation of Ontario's annual average air temperatures over time as well as long-term changes in annual temperature. The indicator monitors

Figure 55: Increase in Ontario Growing Season Lengths Between 1951–1980 and 1981–2010 Time Periods

Source: Natural Resources Canada



departures of annual average air temperature from their 1961–1990 baseline value.

Information on the sources and limitations of the data on surface air temperature can be found in **Appendix 21**.

5.9.1 Major Factors That Affect Surface Air Temperature

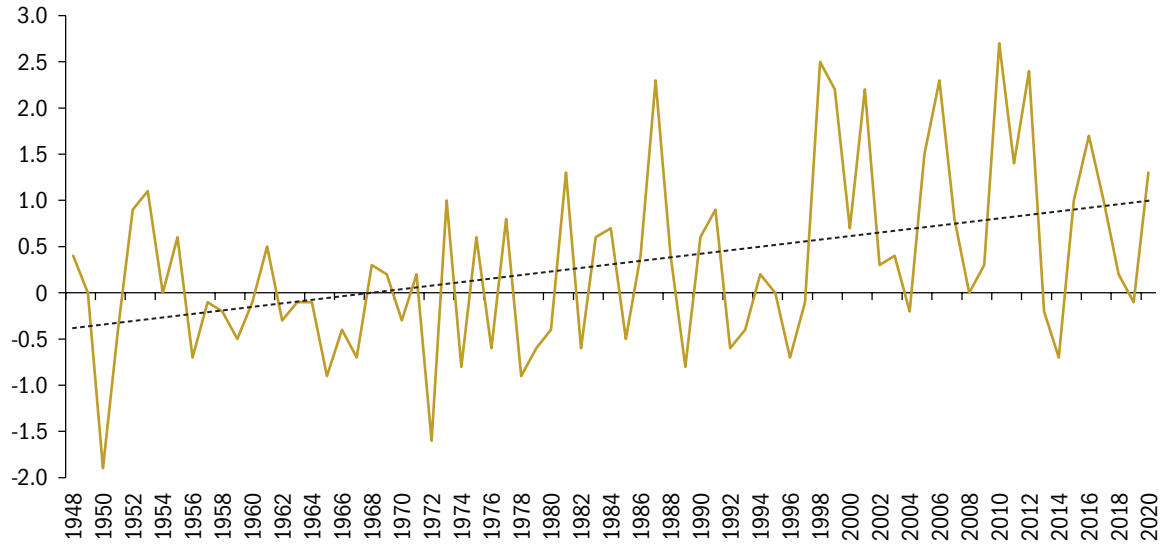
- Amount of incoming sunlight
- Reflectivity of sunlight, which is influenced by surface types such as ice, grass or asphalt
- Global increase in the amount of greenhouse gases in the air, which affects temperatures everywhere

5.9.2 Key Results—Surface Air Temperature in Ontario

Air temperature naturally varies from year to year. However, the long-term trend shows a clear gradual increase in Ontario's surface air temperature. Over the 73 years for which there are comparable records, from 1948 to 2020, the average annual surface air temperature in Ontario increased by approximately 0.02°C per year (about 1.5°C over the 73-year record), based on fitting a linear trend to the data (**Figure 56**). The increase in surface temperature is most evident during the winter months, with an increase for the winter season of 0.03°C per year (about 2.0°C over the 73-year record), based on fitting a linear trend to the data.

Figure 56: Annual Temperature Departures in Ontario Relative to 1961–1990,* 1948–2020 (degrees Celsius)

Source of data: Environment and Climate Change Canada



Note: Departures are presented as the temperature departures from the baseline average (defined as the mean over the 1961–1990 reference period). The dotted line represents a best-fit linear trend line.

* The 1961–1990 reference period is used in keeping with the reference period cited in Environment and Climate Change Canada's Climate Trends and Variations Bulletin.

5.10 Indicator—Water Levels and Scarcity

This indicator category includes two sub-indicators: drought conditions and water levels in the Great Lakes.

Information on the sources and limitations of the data on water levels and scarcity can be found in **Appendix 22**.

5.10.1 Major Factors That Affect Water Levels and Scarcity

- Air temperatures, precipitation, evaporation and transpiration
- Water runoff
- Water takings
- Water control

5.10.2 Key Results—Drought Conditions in Ontario

The Natural Resources Ministry's Ontario Low Water program is considered a mitigation strategy, as defined under the *Emergency Management and Civil Protection Act*. The Natural Resources Ministry compiles data on precipitation and streamflow, and if these levels fall below specified thresholds, the following levels of drought conditions may be declared:

- Low Water Level 1: early indication of a potential drought condition;
- Low Water Level 2: increased likelihood of drought conditions; and
- Low Water Level 3: high likelihood of drought conditions.

We obtained data from the Natural Resources Ministry on the number of low water condition notifications issued between 2000 and 2020. However, due to various limitations in the Ministry's data, it is not possible to accurately track changes in low water conditions over time (see **Appendix 22** for details).

5.10.3 Key Results—Water Levels in the Great Lakes

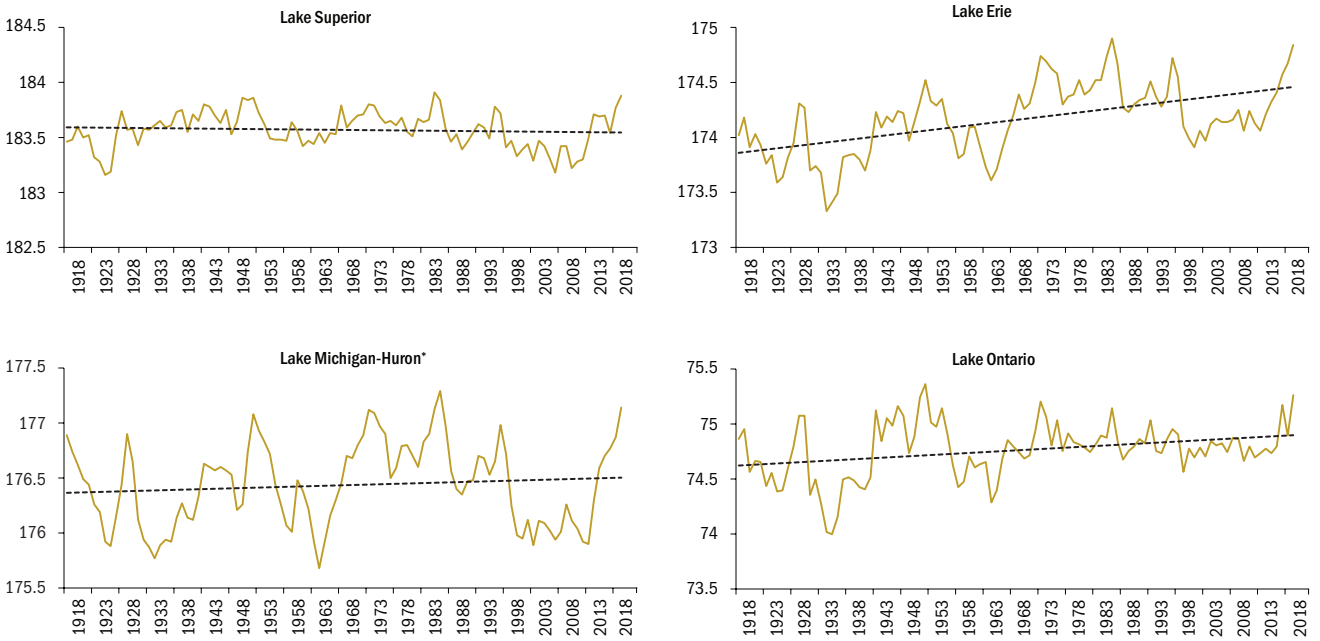
There is natural variation in lake water levels, with neither high nor low levels being inherently harmful, and some fluctuation being beneficial. For example, periodic low water levels foster the natural regeneration of wetlands by exposing sediment where seeds can begin to grow. This process improves the quality of wetland habitat once higher water levels return.

However, extreme water levels can have major impacts on the environment, including coastal flooding, erosion damage and changes to natural habitats within the watershed. Extreme changes to water levels can also negatively affect many human activities, such as recreational boating and use of beaches and shoreline property. Shipping and navigation are also impacted because low water levels decrease the cargo capacity of ships and high flows can make navigating cargo ships difficult. Changes in water levels can potentially also affect hydroelectric power production.

More than a century of monitoring indicates no regular, predictable cycle for water levels in the Great Lakes basin (see **Figure 57**). In general, only Lake Erie and Lake Ontario have shown statistically significant increases in water levels (0.59 cm/year and 0.27 cm/year, respectively), based on the 100-year best-fit linear trend lines, with no significant change in water levels in Lakes Superior, Michigan and Huron. However, a linear 100-year trend does not necessarily indicate a long-term trajectory. As noted in the State of the Great Lakes 2019 report, due to the many factors that influence lake levels, it is difficult to determine with certainty whether these water-level trends are within natural variability or are longer-term trends that will continue.

Figure 57: Great Lakes Yearly Average Water Levels, 1918–2018 (metres)

Source of data: Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data



Note: The dotted lines represent best-fit linear trend lines.

* Lake Michigan and Lake Huron are commonly viewed as a single lake from a long-term hydrological perspective.

5.11 What Progress Has Been Made Toward Climate Targets in Ontario?

Ontario has a target to reduce annual greenhouse gas emissions to 30% below 2005 levels by 2030, which is equal to 144 million tonnes of carbon dioxide equivalent emissions (Mt CO_2eq) per year. The province's 2020 annual emissions were 149.6 Mt CO_2eq, about 18 Mt lower than its annual emissions in 2018 (167.3 Mt CO_2eq) when the government set the target (**Figure 45**). This decrease is largely attributed to the COVID-19 pandemic, coinciding with reduced emissions across numerous sectors—particularly a decrease in the transportation sector (due to fewer kilometres driven). There are no provincial targets associated with carbon sequestration and storage in lands and forests.

6.0 The State of Nature and Wildlife in Ontario

Biodiversity is the biological diversity or variety of life on Earth. It refers to the variety of native species (including plants, animals, fungi and micro-organisms), the variability within species (known as the genetic diversity), and the wealth of ecological systems that form the layer of life around our planet. The more variety present in a population or ecosystem, the more it can withstand changes to the environment and provide the ecosystem services needed to support life, such as clean drinking water and fresh air.

Sufficient habitat, provided through healthy land and water ecosystems, including those in protected areas, are critical for sustaining plant, fish and other animal populations and helping to prevent them from becoming endangered or even extinct.

6.1 Historical Context

Globally, ecosystems and the species that depend on them are deteriorating rapidly. The United Nations Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services found that an average of 25% of assessed animals and plants are threatened globally, meaning that roughly one million species face extinction. The current rate of extinction is already one thousand times higher than the historical rate and could reach 10,000 times higher without action.

Southern Ontario has one of the highest concentrations of species at risk of extinction in Canada, primarily due to habitat loss and degradation from human activities. Before European settlement, wetlands covered roughly 25% of southern Ontario, and forests covered most of the remaining area. More than two-thirds of southern Ontario has now been converted to agricultural land and urban areas.

At least eight species that once lived in Ontario already have gone extinct, and numerous others have declined in population size or range. For example:

- There were once over five billion passenger pigeons in North America, but due to extensive hunting, this species has now gone extinct both in Ontario and globally.
- Ontario's historical boreal caribou distribution has decreased in area by as much as 40% to 50% since the late 1800s, primarily due to human settlement and development activities such as forestry, mining and construction of hydropower transmission corridors and roads.
- American eels were once abundant in Lake Ontario and the St. Lawrence River but have now mostly disappeared from these habitats. Parks Canada suggests the eel's population has declined in Canada by 99%.

6.2 How Changes to Nature and Wildlife Affect Environmental and Human Health in Ontario

The loss, degradation and fragmentation of habitat can affect ecological processes and cycles that benefit humans and wildlife. These include water distribution, flood and drought protection, oxygen production, climate regulation, pollination, resource production and waste decomposition. Ecosystem changes also affect the natural areas that provide recreational opportunities for humans and suitable habitat for

plants, animals and other species. Many species depend on connected areas of habitat for food, reproduction and maintaining genetic diversity.

Changes in fish communities, for example, can alter important aspects of the ecosystem such as food webs and the flow of nutrients and carbon. The loss of fish community species or large-bodied predator fish, or alternatively the introduction of invasive species, can also lead to long-term declines in Ontario's commercial, recreational and Indigenous fisheries.

Protecting natural areas by designating them as provincial parks or conservation reserves helps support a number of environmental goals, including biodiversity conservation and carbon storage. Protected areas provide important health benefits for humans, including air and water purification and ingredients for medicine. They also provide spaces for people to connect with nature, supporting their physical, mental and spiritual well-being.

Increases or decreases in wildlife populations beyond natural variation can destabilize ecosystems. For example, changes in wildlife populations can disrupt predator-prey balance, and in so doing, can alter vegetative cover and lead to broader ecosystem impacts, such as changes in carbon storage.

The unsustainable management of species at risk may result in the permanent loss, or extinction, of species. These losses can reduce biodiversity and potentially create long-term disruptions in ecosystem services, such as water purification, pollination, food production and healthy soil formation.

On the other hand, nature and wildlife can also be threatened by species that spread too much. Invasive species can result in major disruptions to ecosystems, as well as affect human health and commercial, agricultural and recreational activities. For example, some invasive plants in Ontario, like giant hogweed and wild parsnip, produce toxic sap that makes skin more sensitive to sunlight, which can cause severe blistering. The emerald ash borer, which was first found in Ontario in 2002, continues to decimate ash tree populations, despite federal prohibitions of the movement of ash and associated products outside of regulated regions and years of collaboration between the federal, provincial and municipal governments.

Pollinators are an especially vital component of ecosystems. Insect-pollinated plants directly or indirectly provide over one-third of the world's food crops. Globally, about 88% of wild, flowering plants also depend on pollinators. Declines in pollinator populations already have been observed worldwide. These reductions are projected to cause cascading impacts on the plants, wildlife, animals, insects and other organisms, including humans, that directly or indirectly depend on pollinators and the ecosystems they support for habitat and food. The loss of wild and managed pollinators (honey bees) may also impact the availability, productivity and cost of certain crops.

6.3 Indicator—Ecosystems

An ecosystem is a biological community consisting of all living organisms in a particular area, as well as the non-living components like air, water and soil with which the organisms interact. Ontario has many different ecosystems, including wetlands, grasslands, forests, lakes and streams. This indicator measures the extent of three types of Ontario habitat—wetlands, forest and aquatic. We also report here on the state of connectivity among areas of wild habitat.

6.3.1 Major Factors That Affect Ecosystems

- Agricultural land use
- Urban development, such as development for new housing or commercial centres
- Industrial development
- Resource extraction, such as mining
- Natural disturbances, such as fires or insect damage
- Air and water pollution
- Overharvesting; for example, through hunting and fishing
- Invasive species
- Climate change

Figure 58: Ontario's Wetland Area by Ecozone, 2011*

Source of data: Ministry of Natural Resources and Forestry

Ecozone	Wetland Area (million hectares)	% of Ecozone Covered in Wetlands	% of Total Provincial Wetlands
Hudson Bay Lowlands	20	82	57
Ontario Shield	14	22	40
Mixedwood Plains	1	13	3
Total	**35**	**–**	**100**

* Most recent data available.

6.3.2 Key Results—Ecosystems (Wetlands)

According to data from the Natural Resources Ministry, Ontario had approximately 35 million hectares of wetland habitat in 2011, with 97% of the province's wetland area found in the northern ecozones Hudson Bay Lowlands and Ontario Shield (**Figure 58**). **Figure 59** shows the geographic distribution of wetlands in the province.

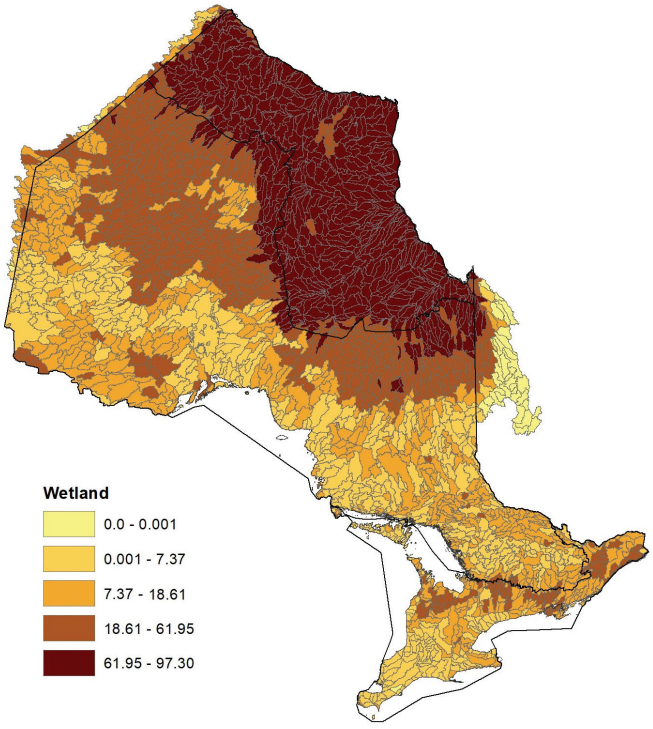
Between 2000 and 2015, approximately 13,455 hectares of wetlands (or 1.3% of previous wetland cover) in southern Ontario were lost. In both assessed periods, (2000–2011 and 2011–2015), the majority of the loss occurred in eastern Ontario (**Figures 60a** and **b**), and is attributed largely to agriculture expansion and, to a lesser extent, urban development and infrastructure projects. Much of the loss has been in wetlands that have not yet been evaluated by the Province, which have fewer protections under provincial, municipal and conservation authority land-use planning and development policies.

The average annual rate of wetland loss between 2011 and 2015 (1,825 hectares/year) was three times higher than the rate of loss between 2000 to 2011 (615 hectares/year). The average annual rate of loss over the previous 20-year period (1982–2002) was 3,543 hectares/year; however, this assessment period cannot be directly compared to the more recent assessments due to changes in methodology.

Information on the sources and limitations of the data on wetland ecosystems can be found in **Appendix 23**.

Figure 59: Wetlands in Ontario, by Percentage Coverage of Total Land Area, 2019*

Sources: Ministry of Natural Resources and Forestry, Ontario GeoHub



* Based on Ontario GeoHub's wetland dataset, last updated in May 2019.

6.3.3 Key Results—Ecosystems (Forests)

Forests cover nearly two-thirds of Ontario. They provide habitat for wildlife, store carbon, support biodiversity and purify the air and water.

Figure 60a: Percentage of Wetlands Lost in Southern Ontario between 2000 and 2011

Source: Ministry of Natural Resources and Forestry

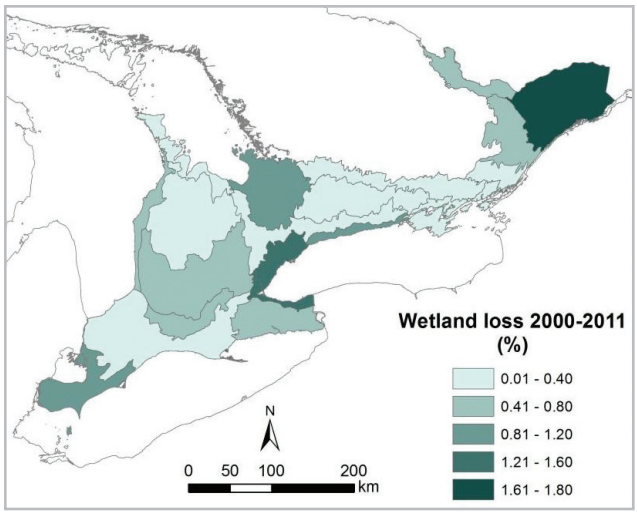
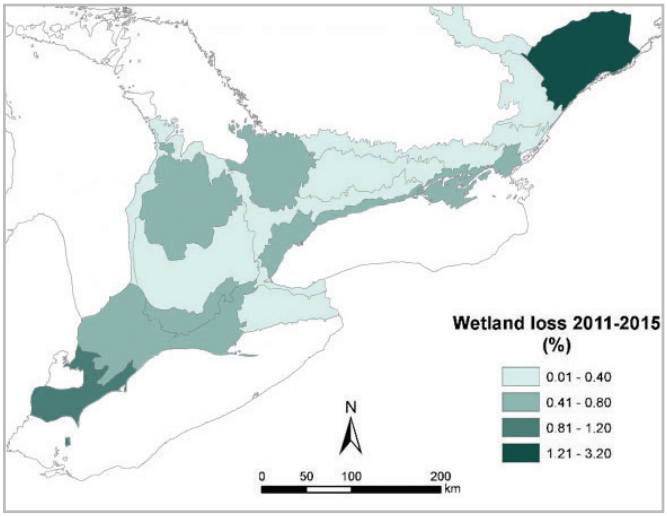


Figure 60b: Percentage of Wetlands Lost in Southern Ontario between 2011 and 2015

Source: Ministry of Natural Resources and Forestry



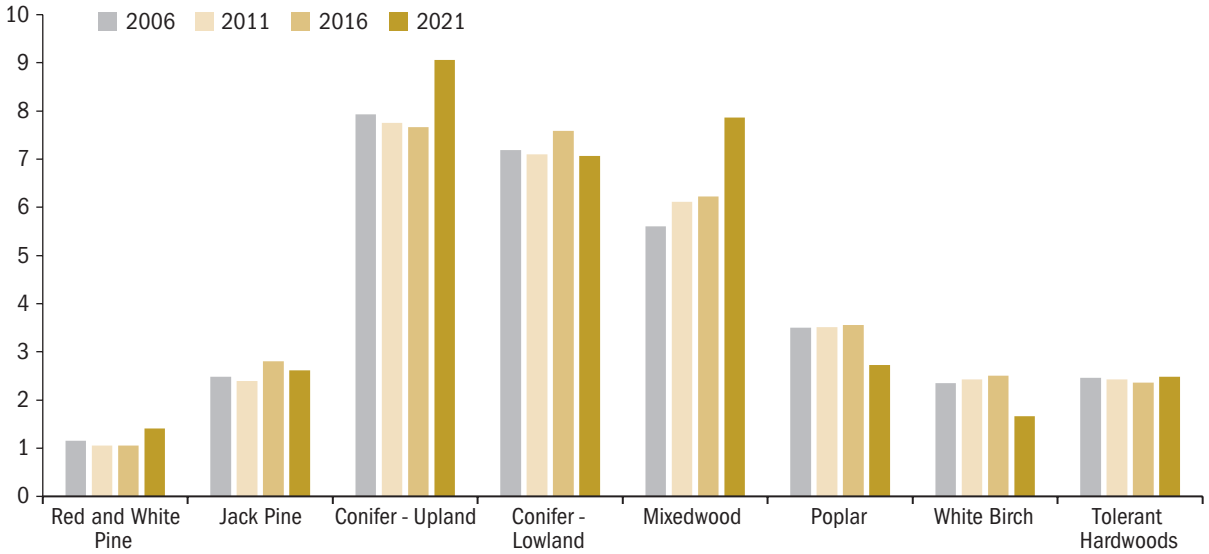
The long-term health of forest ecosystems depends on diversity in forest composition, which includes a variety in both forest type and developmental stage. Overall, a diversity of both forest types (**Figure 61**) and developmental stages (**Figure 62**) continues to be maintained in Ontario. There have been small shifts in forest type and stage since 2006, which have been attributed to natural disturbances such as fires and insect outbreaks, or to advancements in data collection.

Forest productivity, or the rate of accumulation of organic material, is another important aspect of forest health. Productivity directly impacts the degree to which forests can take and store carbon from the atmosphere. It is monitored through forest volume and growth rate, both of which have also remained relatively stable in Ontario's Managed Forest since 1996.

As seen in **Figure 63**, the average annual growth rate was higher in 2021 than 2016, after a downward

Figure 61: Area of Each Provincial Forest Type* within Ontario's Managed Forest (million hectares)

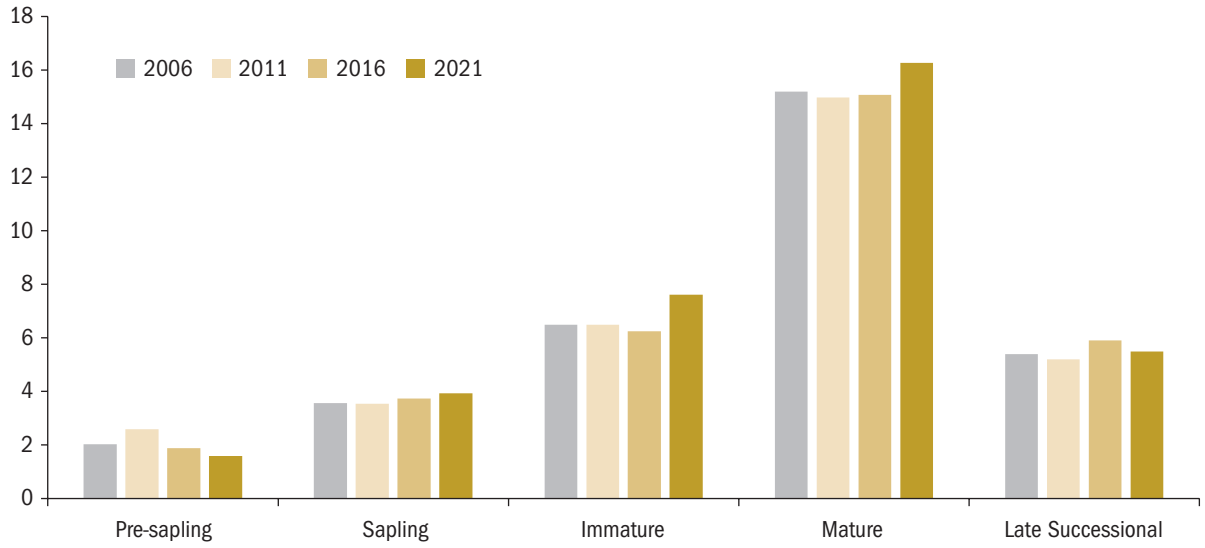
Source of data: Ministry of Natural Resources and Forestry



* The Province classifies Ontario's Managed Forests into eight forest types based on species composition. Some forest types, like jack pine forests, are relatively homogenous (have fewer species). Other forest types, such as mixedwood forests, are more diverse (have a variety of species).

Figure 62: Area of Ontario's Managed Forest Classified by Developmental Stage* (million hectares)

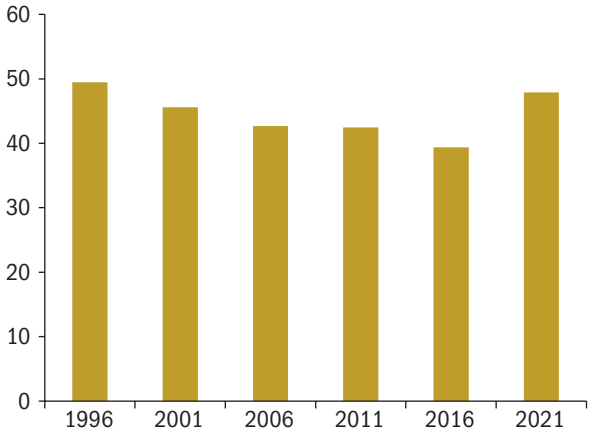
Source of data: Ministry of Natural Resources and Forestry



* The developmental stage is based on a particular age range, which varies for each forest type, with shorter-lived forest types reaching the "late successional" stage earlier than longer-lived forest types.

Figure 63: Average Annual Growth Rate for Ontario's Managed Forest, 1996, 2001, 2006, 2011, 2016 and 2021 (millions of cubic metres per year)

Source of data: Ministry of Natural Resources and Forestry



trend from 1996 to 2016. According to the Natural Resources Ministry's data, forest productivity is stable and growth rates are high enough to offset any losses in volume due to harvesting or natural disturbances.

However, increases in forest age could lead to future declines in productivity. The average forest age appears to have increased for most forest types in Ontario, but this may be partially attributed to changes in methodology. Together, the forest composition, developmental stage and growth indicators suggest that Ontario's forests are currently both diverse and productive.

Another key indicator of forest health is the extent of deforestation and afforestation. Afforestation—establishing new forests on land that has been unforested for at least 50 years—has remained stable with a 0.4% increase in hectares from 2009 to 2018. However, deforestation, or the permanent conversion of forest to other land uses, increased by 77% from 2009 to 2018. On average, the number of hectares lost to deforestation each year is almost four times greater than the number of hectares afforested. Since 2012, the majority of deforestation has been occurring in southern Ontario (**Figure 64**). Deforestation in southern Ontario has more than doubled from 2009 to 2018, with agricultural development accounting for the majority of the increase (**Figure 65**).

Information on the sources and limitations of the data on forest ecosystems can be found in **Appendices 24a** and **b**.

Figure 64: Forest Area Lost to Deforestation in Northern and Southern Ontario, 2009–2018 (hectares)

Source of data: Ministry of Natural Resources and Forestry

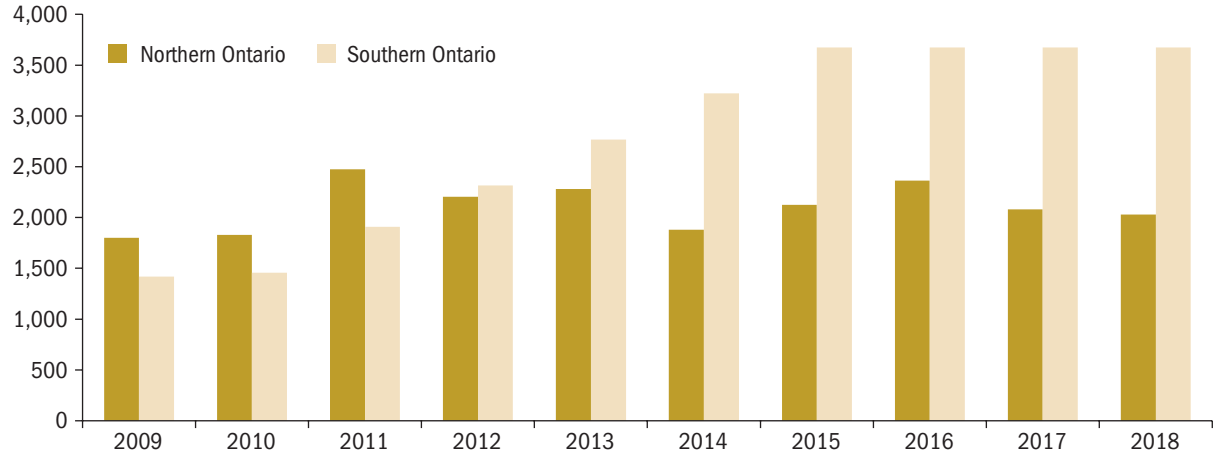
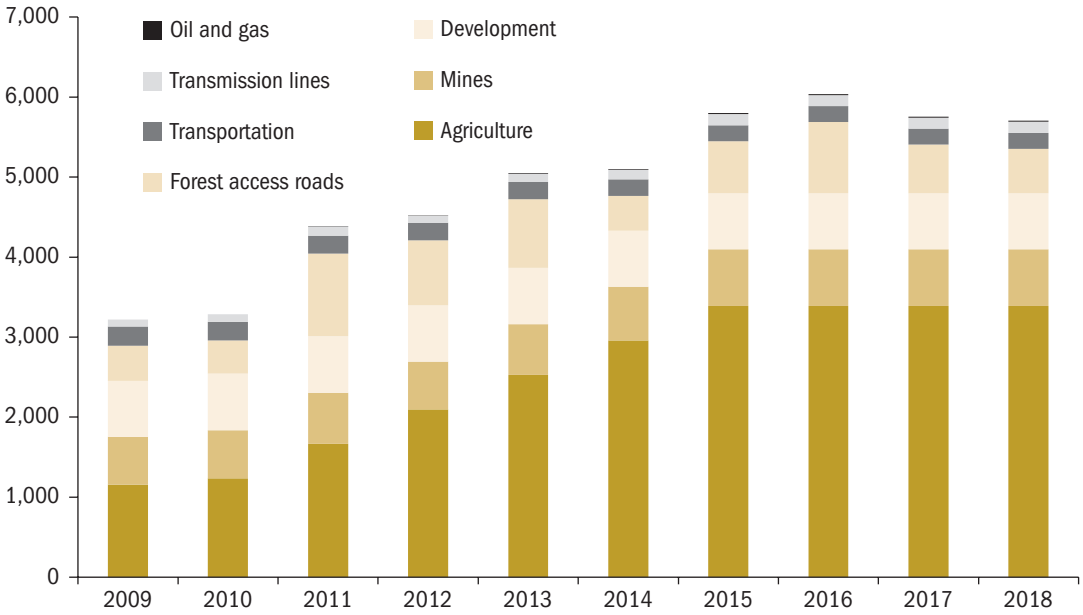


Figure 65: Annual Deforested Area in Ontario by Land-Use Type, 2009–2018 (hectares)

Source of data: Ministry of Natural Resources and Forestry



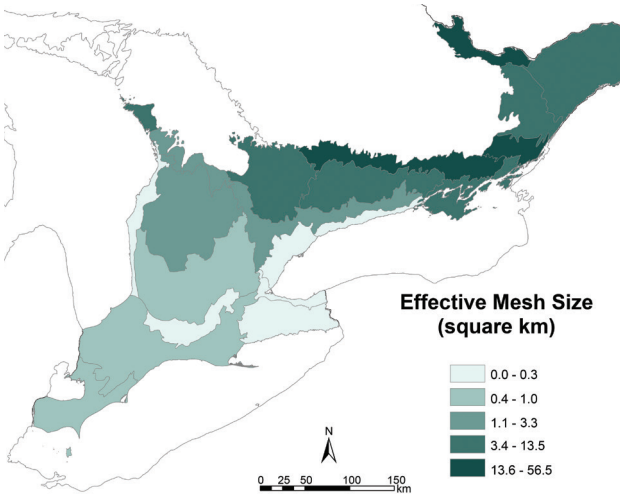
6.3.4 Key Results—Terrestrial Habitat Connectivity in Ontario

Many species depend on areas of relatively intact and connected habitat to feed, reproduce and maintain genetic diversity. Human activities such as urbanization, agriculture and infrastructure development often break up previously connected habitats into smaller and more isolated fragments. Habitat fragmentation can reduce the number and diversity of individual organisms and, in turn, alter species communities, interactions and ecosystems. In some cases, the loss of connected habitat may reduce the ability of a species to migrate and adapt to changing climate conditions.

Habitat connectivity is monitored using a method called "effective mesh size," which determines the probability that two random points will be connected within the same habitat patch. High effective mesh size

Figure 66: Habitat Connectivity (Effective Mesh Size)* in Southern Ontario Ecodistricts, 2015

Source: Ministry of Natural Resources and Forestry



* Effective mesh size is a measure of the size of habitat patches, based on the likelihood that two randomly selected points are connected within the same patch. High effective mesh size indicates high habitat connectivity.

Figure 67: Average Community Size Spectrum Slope[1] by Fisheries Management Zone,[2] 2008–2012, 2013–2017

Source of data: Ministry of Natural Resources and Forestry

Zone[2]	2008–2012	2013–2017
4	(1.33)	(1.41)
5	(2.22)	(1.92)
6	(1.62)	(1.57)
7	(2.02)	(1.39)
8	(1.38)	(1.14)
10	(2.28)	(2.12)
11	(2.42)	(2.27)
12	(0.60)	(0.28)
15	(2.86)	(2.54)
16	(3.59)	(3.10)
17	(4.44)	(3.78)
18	(2.95)	(2.66)

1. The health of an aquatic ecosystem can be assessed by monitoring the size and abundance of different species, and then determining the balance between the number of predator (generally large) and prey (generally smaller) species in a lake or Fisheries Management Zone. This is represented through fish "community size spectrum slopes," which show the relationship between fish length and number of fish of each length. Steeper—more negative—slopes are indicative of less healthy aquatic communities. The parentheses denote negative values.
2. Ontario is divided into 20 Fisheries Management Zones (see **Appendix 26b**), which are used to monitor and manage Ontario's fisheries based on the specific needs and characteristics of each zone. The higher zone numbers are generally in the southern part of the province.

indicates high connectivity, or that the habitat is less fragmented by urban areas, agriculture, mining, roads or other infrastructure. In 2015 (most recent data), the lowest habitat connectivity in southern Ontario was found in Toronto and Kincardine, and the highest in Charleston Lake, in eastern Ontario (see **Figure 66**). All seven ecodistricts in the southwestern portion of the Mixedwood Plains Ecozone (in southern Ontario) had a below-average effective mesh size.

Information on the sources and limitations of the data on terrestrial habitat connectivity can be found in **Appendix 25**.

6.3.5 Key Results—Ecosystems (Aquatic Ecosystems)

Healthy aquatic ecosystems are important for sustaining aquatic biodiversity as well as commercial, Indigenous and recreational fisheries. The health of an aquatic ecosystem can be indicated by the size and abundance of different species, as well as the balance between the number of predator and prey species within a lake or group of lakes. Fish "community size spectrum slopes" show the relationship between fish length and number of fish of each length. In general, predators are larger and prey are smaller. Steeper (more negative) slopes indicate less healthy aquatic communities. Steeper slopes occur either because large predator fish have been depleted due to overfishing, invasive species or habitat changes, or because smaller prey or invasive fish populations have thrived without passing any benefits up through the food chain.

Shallower (less negative) slopes were generally found in Northern Ontario Fisheries Management Zones and within provincial parks. Steeper (more negative) slopes—which indicate less healthy ecosystems—were found in southern Ontario and outside of protected areas. Although there were no substantial changes in slopes between 2008–2012 and 2013–2017 (**Figure 67**), the Natural Resources Ministry informed us that more data is needed to definitively determine improvement or decline of slopes beyond chance.

Information on the sources and limitations of the data on aquatic ecosystems can be found in **Appendix 26a**, and a map of Fisheries Management Zones in **Appendix 26b**.

6.4 Indicator—Inland Fish Communities

Ontario's freshwater fish communities are the most diverse in Canada, and southern Ontario lakes have particularly high fish diversity. Greater native fish diversity helps fish communities be resilient to changes in climate, overfishing or habitat loss. Changes in the diversity, size and abundance of aquatic organisms are important indicators of the health of aquatic ecosystems and can be used as early signals of ecosystem stress or recovery. Sustainable management of fisheries is important for protecting native aquatic biodiversity and supporting their associated economic, cultural and recreational activities.

Information on the sources and limitations of the data on inland fish communities can be found in **Appendix 27**.

6.4.1 Major Factors That Affect Inland Fish Communities

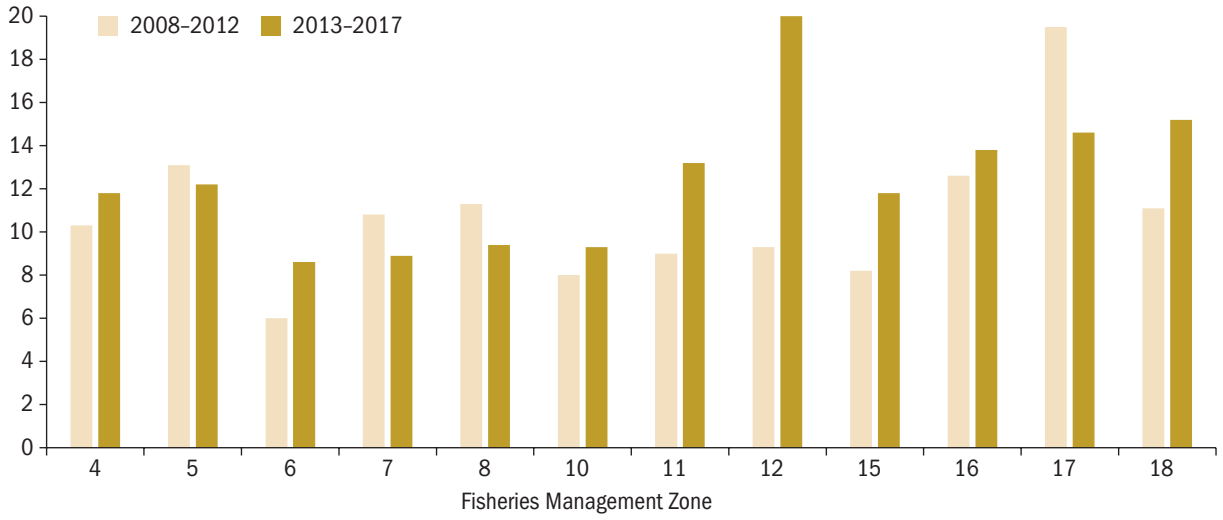
- Habitat degradation
- Climate change
- Invasive species
- Fishing

6.4.2 Key Results—Inland Fish Communities in Ontario

The Natural Resources Ministry reported that, despite some observed differences in the survey data between 2008–2012 and 2013–2017, there was no substantial change in native species richness in inland lakes (**Figure 68**). The Ministry has reported greater

Figure 68: Average Number of Different Native Fish Species Caught per Inland Lake in Fisheries Management Zones* in Southern and Northern Ontario, 2008–2012, 2013–2017

Source of data: Ministry of Natural Resources and Forestry



* See **Appendix 26b** for a map of Fisheries Management Zones. The higher zone numbers are generally in the southern part of the province.

Figure 69: Relative Abundance of Large-bodied Fish, 2008–2012, 2013–2017

Source of data: Ministry of Natural Resources and Forestry

Fisheries Management Zone*	2008–2012		2013–2017	
	Avg. # caught	Avg. weight (kg) caught	Avg. # caught	Avg. weight (kg) caught
4	9.8	7.5	10.2	7.4
5	5.9	4.4	5.5	4.2
6	8.9	6.5	8.7	6.3
7	11.2	7.4	10.7	8.0
8	11.4	6.6	11.9	7.3
10	6.2	3.5	8.6	4.1
11	9.2	3.6	7.7	3.6
12	7.3	4.7	9.1	6.3
15	6.3	3.1	6.2	3.0
16	15.6	3.6	14.1	4.5
17	12.5	2.3	14.5	3.2
18	8.4	2.5	8.7	3.0

* See **Appendix 26b** for a map of Fisheries Management Zones. The higher zone numbers are generally in the southern part of the province.

diversity in native fish species in lakes in southern Ontario than Northern Ontario.

Within some Fisheries Management Zones and for certain species, there were considerable changes in fish abundance or weight between the 2008–2012 and 2013–2017 sampling cycles; however, there is not a clear provincial pattern of change (**Figure 69**). The Ministry expects that a better understanding of whether there are any significant changes in the health of sampled fish populations will be possible after analyzing data collected in the next sampling cycle (2018 to 2023). The abundance and size of large-bodied fish, including walleye, lake trout, brook trout, and northern pike, show greater abundances and larger sizes in Northern Ontario Fisheries Management Zones. This suggests that populations are healthier than in southern Ontario. The average number of large-bodied fish caught per net was highest in zones 7, 8, 16 and 17. The biomass of fish caught was greatest in zones 4, 6, 7, 8 and 12.

6.5 Indicator—Protected Areas

Protected areas are places where terrestrial and aquatic ecosystems are relatively untouched by human activity. Protected areas, such as parks and conservation reserves, help maintain connected habitat for wildlife, and are therefore a fundamental component of biodiversity conservation strategies in Ontario and worldwide. They provide other essential ecosystem services, such as flood and drought protection and carbon storage, which are especially important for lessening the impacts of climate change. For findings and recommendations related to Ontario's protected areas, see our Office's 2020 value-for-money audit report on Conserving the Natural Environment with Protected Areas.

Information on the sources and limitations of the protected areas data can be found in **Appendix 28**.

6.5.1 Major Factors That Affect Protected Areas

- Visitor use
- Air and water pollution
- Climate change
- Resource extraction within protected areas and in the surrounding landscape
- Invasive species

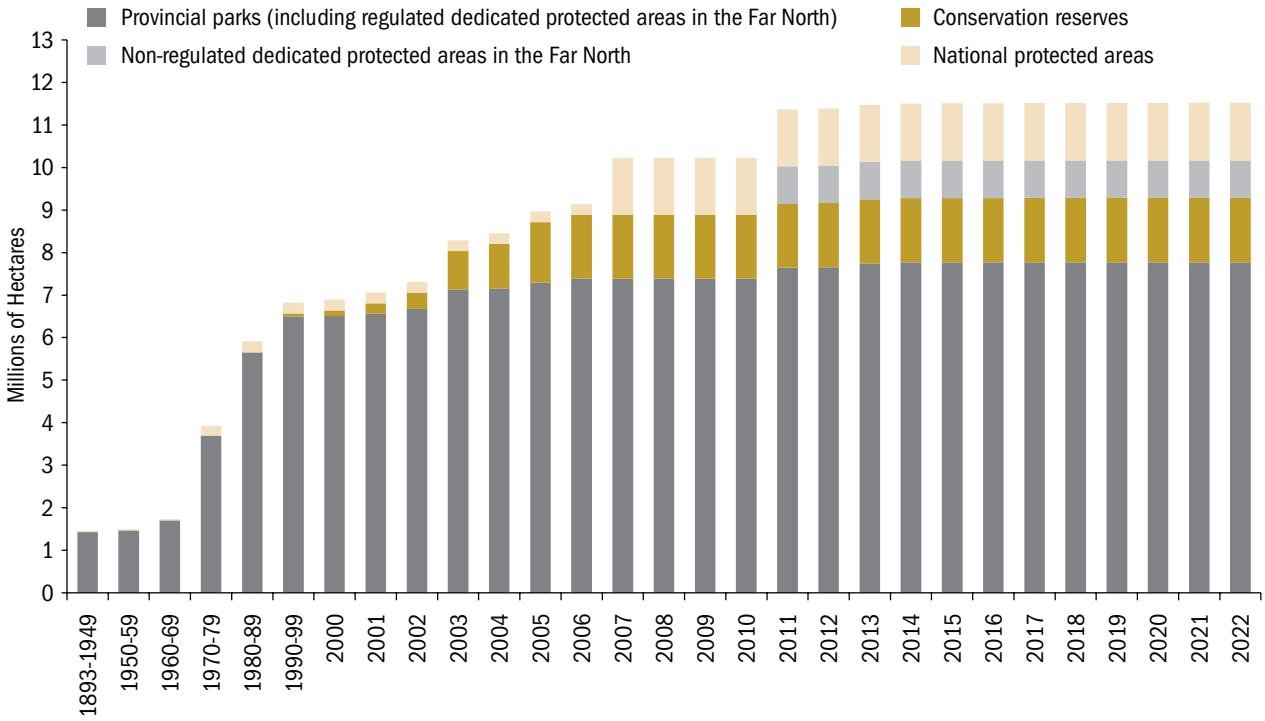
6.5.2 Key Results—Ontario's Protected Areas

As of October 2022, 10.8% of Ontario's land and water area was conserved through a total of 1,413 protected and conserved areas. The majority of Ontario's protected areas are provincial parks (including regulated dedicated protected areas in the Far North) and conservation reserves, which together account for 635 of the total number of protected areas and 80% (9.3 million hectares) of the total land area in the protected area system (11.6 million hectares) (**Figure 70**). Most of the remaining 20% of the protected land area is composed of national protected areas and non-regulated dedicated protected areas in the Far North established through Community Based Land Use Plans. Land trusts, conservation authorities, municipalities, universities and other partners protect a modest percentage of Ontario's total area, but protect important natural areas with high biodiversity, particularly in southern Ontario.

The total size of the protected area system increased by 1.98% from 2011 to 2022. Since 2011, seven new provincial parks, five regulated dedicated protected areas in the Far North, one conservation reserve, and four non-regulated dedicated protected areas in the Far North, and one national urban park have been added. The recent increase in the *number* of protected areas is primarily due to the addition of 718 privately owned protected and conserved areas since 2018. However, as private protected areas tend to be smaller, these areas collectively still make up only 0.6% of the total *area* in the protected area system.

Figure 70: Growth in Total Area of Protected Areas* in Ontario by Park Class, 1893–2022

Source of data: Ontario Parks and the Ministry of Natural Resources and Forestry



Note: The data is presented in inconsistent intervals, annually from 2000 to October 2022 and by decade prior to 2000, in order to provide the most detailed information available from 2000 to 2022, while also providing historical information back to 1893, despite the lack of annual data available from 1893 to 2000.

* The total area of protected areas does not include wilderness areas, privately protected lands or areas of natural and scientific interest that meet the criteria for protected areas. This is because they collectively accounted for only 76,185 hectares in 2022, or 0.66% of the total protected area.

Figure 71: Province-Wide Achievement of Provincial Park Class Targets, 2011 and 2022

Source of data: Ministry of the Environment, Conservation and Parks

Target	Description	Level of Achievement 2011	2022	# Change
Targets for Provincial Park Classes[1]				
One wilderness park[2] in each of the 14 ecoregions[3]	• Each wilderness park must be at least 50,000 hectares in size • All wilderness parks must average 100,000 hectares	9 of 14	9 of 14	0
At least one wilderness zone[4] in each of the 14 ecoregions	Wilderness zones in other park classes must be between 2,000 and 50,000 hectares	4 of 14	6 of 14	2
One natural environment park[5] in each of the 71 ecodistricts[6]	Each natural environment park must be at least 2,000 hectares	46 of 71	46 of 71	0
At least one waterway park in each of the 71 ecodistricts	Boundaries must be set back at least 200 metres inland from the high watermarks	47 of 71	47 of 71	0

1. Provincial parks are classified by type or class based on their size and purpose.
2. Wilderness parks are larger, where visitors mostly travel on foot or by canoe and leave little or no impact on the area.
3. Ecoregions are large areas within the ecozones defined by their environmental conditions such as climate, landforms and soil characteristics. There are 14 ecoregions across the province.
4. Wilderness zones are areas of provincial parks where limited recreational activities are permitted so that natural ecological processes can occur largely uninfluenced by human activities.
5. Natural environment parks reflect the landscapes and special features of the region in which they are located.
6. Ecodistricts are smaller areas within ecoregions that are defined by a characteristic set of ecological features. There are 71 ecodistricts across the province.

In addition to the number and total area, it is important that protected areas are distributed throughout the province in order to protect and preserve biodiversity and the unique ecological features. The Province has set several targets to ensure that different types of park classes and naturally occurring combinations of vegetation and landforms are represented within protected areas in each region or district. As of 2022, the Province had not fully met any of these targets (**Figure 71**). For example, the target to establish one wilderness park in each of the province's 14 ecoregions was not met in several ecoregions: 5S (Agassiz Clay Plain Ecoregion), 6E (Lake Simcoe-Rideau) and 7E (Lake Erie-Lake Ontario).

The Environment Ministry also has set a target for at least 1% of the total area of each unique, naturally occurring landform and vegetation type within an ecodistrict (or 50 hectares, whichever is greater) to be represented within protected areas. This target has not yet been achieved, because no ecodistrict has achieved the minimum representation threshold for *all* of its naturally occurring landform and vegetation types. Half of the ecodistricts in the Hudson Bay Lowlands and Ontario Shield have achieved high representation, whereas no ecodistricts in the Mixedwood Plains (in southern Ontario) have achieved high representation of vegetation and landform combinations, known as "life science features" (**Figure 72**).

The *Far North Act, 2010* set out objectives to protect areas of cultural value and ecological systems in the Far North by including at least 22.5 million hectares of Ontario's Far North (50% of the region) in an interconnected network of protected areas as determined by the Natural Resources Ministry in collaboration with First Nations communities.

To date, five dedicated protected areas have been established in the Far North under the *Provincial Parks and Conservation Reserves Act, 2006,* as well as four more under the *Far North Act, 2010*, bringing the total protected areas coverage in the Far North to 4.7 million hectares, or 10.4% of the Far North. This represents only approximately 21% of the target established by the *Far North Act, 2010*.

In December 2021, the Province amended the objective in the *Far North Act, 2010* to remove the

Figure 72: Representation of Life Science Features* in Ontario's Protected Areas, as of July 2021

Source of data: Ministry of the Environment, Conservation and Parks

	Ecozone					
	Hudson Bay Lowlands (6 ecodistricts)		Ontario Shield (43 ecodistricts)		Mixedwood Plains (22 ecodistricts)	
	#	%	#	%	#	%
High Representation (70%–99%)	3	50	22	51	0	0
Medium Representation (35%–69%)	0	0	19	44	7	32
Low Representation (0%–34%)	3	50	2	5	15	68

* Life science features refer to the unique combinations, or types, of landforms (bedrock and soil) and vegetation (plants) within each ecodistrict and are used as a proxy for biodiversity. The level of "representation" achieved is based on the percentage of these features (by area) within the ecodistrict that meet the minimum representation threshold, which stipulates that at least 1% (or 50 hectares) of each landform-vegetation type be included within protected areas.

specific area-based objective. The Ministry indicated that the proposed change would help promote economic growth in the Far North.

6.6 Indicator—Wildlife Populations

Collectively, wildlife populations of mammals, birds, reptiles, amphibians and fish are inherent components of biodiversity and provide countless benefits for their associated ecosystems and for people. Data on well-studied wildlife populations can provide a useful indicator of overall environmental health.

Information on the sources and limitations of the data on wildlife populations can be found in **Appendix 29**.

6.6.1 Major Factors That Affect Wildlife Populations

- The abundance, quality and connectivity of wildlife habitat
- Land and water use
- Hunting and fishing
- Invasive species and diseases
- Air and water pollution
- Climate change

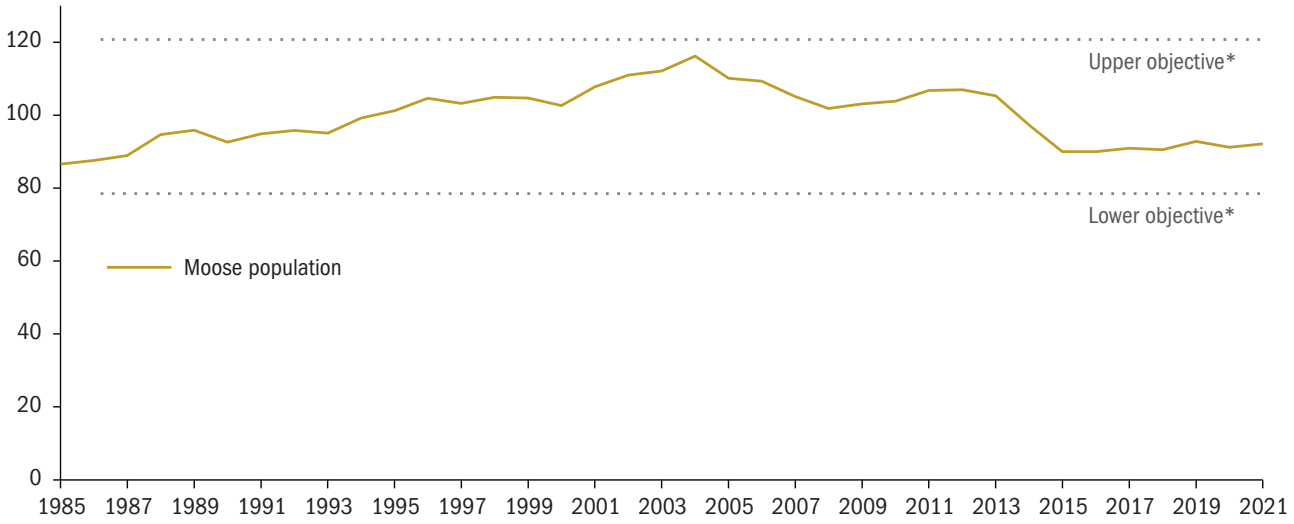
6.6.2 Key Results—Ontario's Vertebrate Populations

Environment and Climate Change Canada uses the Canadian Species Index to measure the overall change in populations of vertebrate species (mammals, birds, reptiles, amphibians and fish) over time. This indicator, which is based on the Living Planet Index, shows an average of a 4% decline in population size of monitored vertebrate species in Canada from 1970 to 2016. The greatest declines have been observed in fish (21% decline) and mammals (42% decline).

Although independent scientists assess the status of species at risk in Ontario (see **Section 6.8**), the Natural Resources Ministry has not yet produced a comprehensive index, similar to the Canadian Species Index, to track the overall change in the sizes of vertebrate species' populations in Ontario. The Ministry advised us that it will consider developing a wildlife population indicator that would report on populations of one or more wildlife species in Ontario. One species indicator that the Ministry has developed tracks changes in Ontario's moose population, which has declined since 2004 but is within the range of the Province's reported upper and lower population objectives (**Figure 73**). Moose are important to

Figure 73: Estimated Moose Population, 1985–2021 (000)

Source of data: Ministry of Natural Resources and Forestry



* The Province aims to maintain moose populations within the range of the reported upper and lower population objectives.

Ontario's biodiversity and have ecological, social, cultural, economic, and recreational importance.

6.7 Indicator—Pollinators

Pollinators are a critical component of both natural ecosystems and the agriculture sector. There are many different types of pollinators in Ontario, including bees (both wild and managed), flies, butterflies, moths, wasps, beetles and one species of hummingbird. Bees are the most specialized insect pollinator.

Ontario is considered a pollinator biodiversity hotspot in Canada, with 420 of 855 nationally recorded wild bee species. Pollinator abundance, diversity and ranges have generally been declining around the world. There is evidence that some species in Ontario have declined dramatically, such as the formerly widespread rusty patched bumble bee, which is now a species at risk.

Information on the sources and limitations of the data on pollinators can be found in **Appendix 30**.

6.7.1 Major Factors That Affect Pollinators

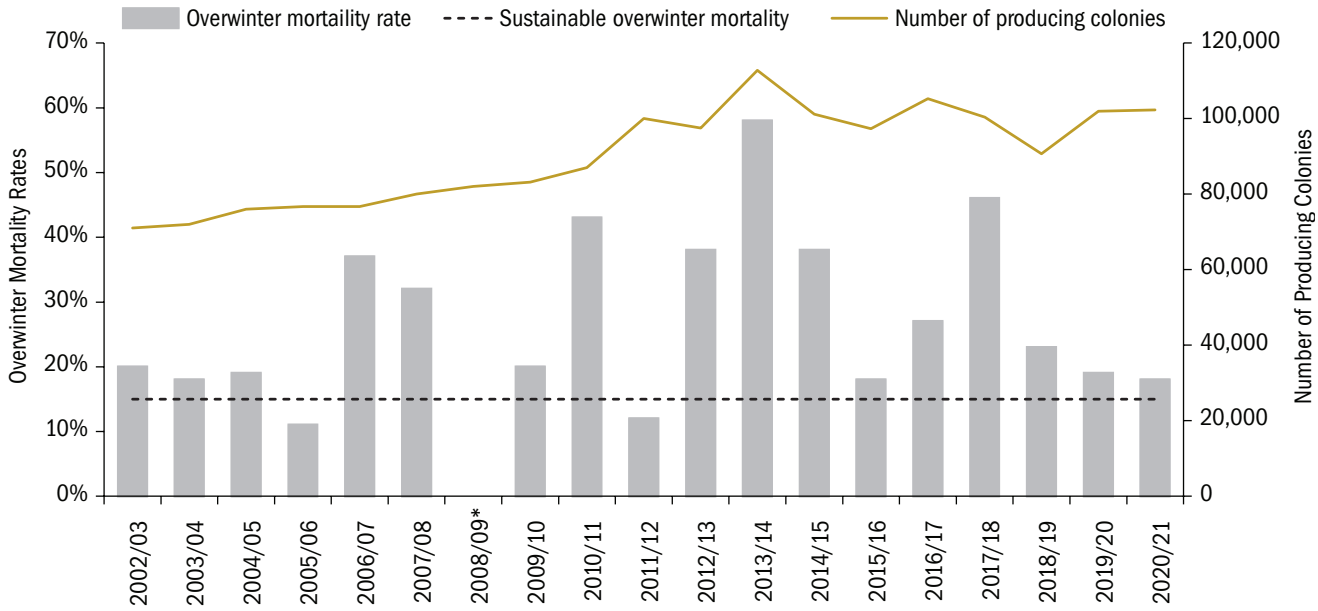
- Changes to habitat
- Urban development
- Invasive species, pests and disease
- Pesticide use
- Climate change
- Beekeeper management practices (for managed honey bees only)

6.7.2 Key Results— Managed Honey Bees

The number of registered commercially managed producing honey bee colonies has increased since 2002 (**Figure 74**). An indicator that can be used to assess the health of these managed honey bee populations is overwinter mortality rates, or the percentage of colonies that fail to remain viable over each winter. The beekeeping industry in Canada considers 15% as the maximum acceptable level of overwinter mortality for populations to be sustainable. Since 2002/03, overwinter mortality

Figure 74: Overwinter Mortality Rates of Commercially Managed Honey Bee Colonies in Ontario and Number of Producing Colonies, 2002/03–2020/21

Sources of data: Ministry of Agriculture, Food and Rural Affairs and Statistics Canada



* No data is available for the 2008/09 overwinter mortality rate.

rates in Ontario have ranged from a low of 11% in 2005/06 to a high of 58% in 2013/14 (**Figure 74**). High overwinter mortality rates are primarily attributed to poor-quality queens, weak colonies in the fall, and ineffective control of varroa mite infestations.

6.8 Indicator—Species at Risk

Species at risk are designated plants, animals and other organisms that are considered in danger of being permanently lost, defined as extinction. Ontario has thousands of species that are deemed "of conservation concern," (i.e., that have a higher likelihood of being or becoming extinct or locally extinct). Some of these species of conservation concern are categorized and regulated in Ontario as "species at risk." Species at risk include species that are:

- extirpated (locally extinct);
- endangered (face imminent extinction or extirpation);
- threatened (likely to become endangered if threats to species are not addressed); or
- special concern (may become threatened or endangered due to biological features and identified threats that are not addressed).

Globally, species are now going extinct tens to hundreds of times faster than the average rate over the past 10 million years, and today's rate of extinction is still accelerating. At least eight species that once lived in the province are extinct. Protecting and recovering species at risk is a critical component of preserving ecosystem health and supporting biodiversity. For findings and recommendations related to Ontario's species at risk, see our Office's 2021 value-for-money audit report on Protecting and Recovering Species at Risk.

Information on the sources and limitations of the data on species at risk can be found in **Appendix 31**.

6.8.1 Major Factors That Affect Species at Risk

- Changes to habitat, such as deforestation
- Air and water pollution
- Invasive species
- Agricultural development
- Urban development
- Climate change

6.8.2 Key Results—Species at Risk

There are over 30,000 known species in Ontario. Scientists have assessed the status of 17,867 of them. Of these, 9,918 have been categorized broadly as either being secure or of conservation concern, which includes species that are presumed or possibly locally extinct, and those that range from very high to moderate risk of local extinction. The other 7,949 assessed species have not been ranked either due to insufficient information or inapplicability, such as with non-native species. As of January 2022, 2,763 (or 28%) of the ranked species were of conservation concern.

Based on a 2015 species assessment, reptiles, mosses and freshwater mussels are the three species groups that are the most vulnerable to extinction (**Appendix 32**):

- 73% (19) of the 26 ranked reptile species are of conservation concern;
- 69% (364) of the 530 ranked moss species are of conservation concern; and
- 49% (35) of the 71 ranked freshwater mussel species are of conservation concern.

In contrast, spiders are the least vulnerable, with 89% (328) of the 368 ranked spider species deemed secure. Of the vertebrate species groups (mammals, birds, amphibians, reptiles and fish), birds are the most secure, at 82% (231 of 282 ranked bird species).

As of February 2023, there were 264 plants and animals classified as at-risk under the *Endangered Species Act, 2007* (**Figure 75**). The Ontario Biodiversity Council previously reported 224 species at risk in 2015, and 199 in 2010. Species at risk are classified based on the degree of risk they face, with extirpated being the most in danger of extinction, as they no longer live in the wild in Ontario. The Ontario Biodiversity Council monitors the number of species that move to higher risk categories (such as "uplisted" from threatened to extirpated) or lower risk categories (such as "downlisted" from endangered to threatened).

In 2021, the Ontario Biodiversity Council reported on species assessed by the Committee on the Status of Species at Risk in Ontario between 1996 and 2017. Of the 151 species reassessed, 31 (20%) moved to a higher risk category, 22 (14%) moved to a lower risk category, and 98 (65%) showed no change (**Figure 76**).

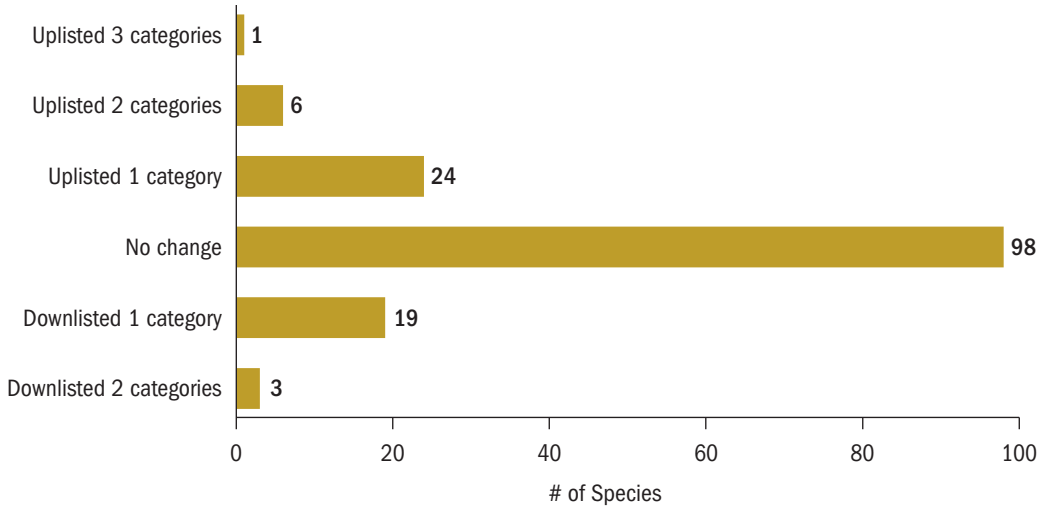
Figure 75: Ontario's Species at Risk under the *Endangered Species Act, 2007*, February 2023

Source of data: *Endangered Species Act, 2007*; O. Reg. 230/08

Classification	Description	# of Species
Extirpated	Lives somewhere in the world, and at one time lived in the wild in Ontario, but no longer lives in the wild in Ontario.	15
Endangered	Lives in the wild in Ontario but is facing imminent extirpation or extinction.	125
Threatened	Lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address threats.	65
Special Concern	Lives in the wild in Ontario, is not threatened or endangered, but may become threatened or endangered due to a combination of biological characteristics and identified threats.	59
Total		**264**

Figure 76: Change in Status Following Reassessment of 151 Species at Risk, 1996–2017

Sources of data: Ontario Biodiversity Council and Committee on the Status of Species at Risk in Ontario



Note: Species at risk are categorized based on the degree of risk that they face, with highest risk being extirpated (extinct within Ontario), followed by endangered, threatened, and of special concern. The reassessment of categories was conducted by the Committee on the Status of Species at Risk in Ontario.

6.9 Indicator—Invasive Species

Invasive species have become one of the main threats to biodiversity in Ontario. Alien species are plants, animals and microorganisms introduced outside of their natural ranges through human activities. Many alien species are considered invasive because their introduction or spread threatens the environment, human health or the economy. Habitat degradation, habitat loss and climate change often contribute to the spread of invasive species. Once established, invasive species can be difficult to manage or eradicate, and may outcompete native species for food, light or other resources. For findings and recommendations related to invasive species in Ontario, see our Office's 2022 value-for-money audit report on Management of Invasive Species.

Information on the sources and limitations of the data on invasive species can be found in **Appendix 33**.

6.9.1 Major Factors That Affect the Introduction and Spread of Invasive Species

- Human travel, including shipping of goods
- Sale of invasive plants and escape from gardens to natural areas
- Movement of watercraft from one waterbody to another, including for recreation
- Live organisms in trade, such as bait for fishing, aquarium fish and garden centres
- Transportation of agricultural materials, such as soil or farm equipment
- Climate change

6.9.2 Key Results—Invasive Species in Ontario

Plants

Approximately 1,200 alien plant species in Ontario have been introduced outside of their normal range, most of which are found in southern Ontario. As of 2008 (the most recent data available), at least 441 of these alien plant species were considered invasive. The Natural Resources Ministry reviewed voluntary data submitted by natural resource agencies and members of the public and found the most commonly reported invasive plant species from 2016 to 2021 were European buckthorn, garlic mustard and dog-strangling vine, as highlighted in **Figure 77**.

Figure 77: Reported Occurrences of Three Commonly Observed Invasive Plant Species, 2004–2021

Sources of data: Ministry of Natural Resources and Forestry and Early Detection and Distribution Mapping System (EDDMapS Ontario)

Common Name	Plant form	Impacts	# of reports		
			2004–2009	2010–2015	2016–2021
Garlic mustard	Herb	Invades undisturbed forests, quickly dominates forest understory, displaces native wildflowers and forest groundcover plants, and slows or prevents forest regeneration	243	2,702	5,193
European buckthorn	Shrub	Forms dense thickets, crowds and shades native plants, and prevents forest regeneration	371	1,929	4,707
Dog-strangling vine (European swallowwort)	Vine	Forms dense stands that overwhelm and crowd out native plants and young trees, preventing forest regeneration	249	2,349	3,338

Aquatic Species

At the end of 2020, 191 aquatic alien species were established in the Great Lakes. Some of these are invasive, such as the round goby, zebra mussels, purple loosestrife and phragmites. Since the first species was observed in the 1830s, the number of Great Lakes aquatic alien species have increased steadily, at an average rate of 10 new species per decade (**Figure 78**). The highest rate of increase was between 1960 to 1999, when an average of 18 new species arrived per decade. This high rate of introduction coincides with the opening of the St. Lawrence Seaway, while the reduction in the 2000s coincides with new Canadian ballast water regulations aimed to reduce the introduction of non-indigenous species. In the past decade (between 2010 and 2020), only four new aquatic alien species were observed in the Great Lakes. This represents the second lowest rate in 19 decades of tracking, aside from the 1940s when four new aquatic alien species were also found, and the 1850s, when no new alien species were found.

The total number of aquatic alien species found in sampled inland lakes has remained constant. Between 2008–2012 and 2013–2017, the percentage of sampled inland lakes with alien species increased slightly, as did the number of different alien species per lake. During the most recent sampling cycle (2013–2017), alien species were found in 48% of the 689 sampled inland lakes. On average, 0.3 to 2.3 alien species were found in each lake. Alien species were not found in most sampled lakes in Northern Ontario, and the percentage of sampled lakes with alien species generally increased from north to south (see **Figure 79**). According to the Natural Resources Ministry, of the 12 alien fish species detected, smallmouth bass and rainbow smelt were the most common. Four invertebrate species were observed, of which the most common were zebra mussels and spiny water fleas.

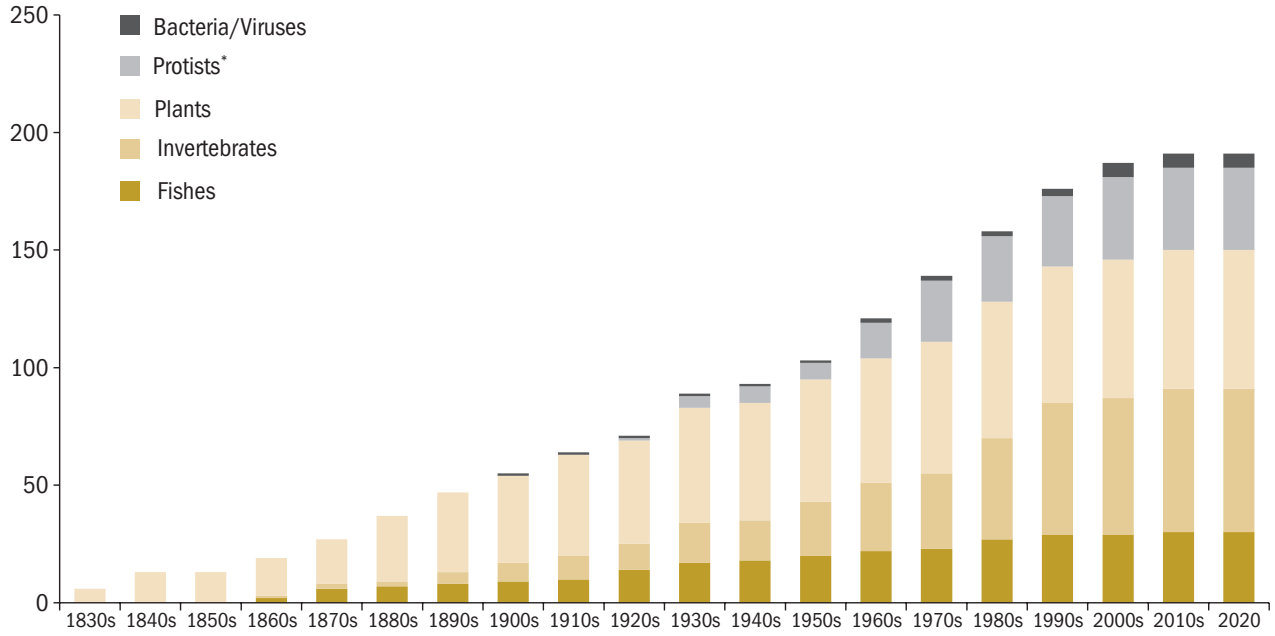
Insects and Diseases

The number of invasive insects and diseases being reported in forests by the Natural Resources Ministry has increased over time. The Ministry identified several invasive insects and diseases that were either new (such as beech leaf disease and hemlock wooly adelgid) or expanding their spread (such as emerald ash borer). The emerald ash borer was detected in 2002 and since 2004 has increased its range across Ontario and North America (**Figure 80**).

The Natural Resources Ministry noted that several other invasive forest insects and diseases are approaching from other parts of North America but are not yet in the province. These include mountain pine beetle, southern pine beetle, walnut twig beetle, brown spruce longhorn beetle, oak wilt, spotted lanternfly and thousand cankers disease of black walnut.

Figure 78: Cumulative Number of Established Alien Species in the Great Lakes by Decade, 1830–2020

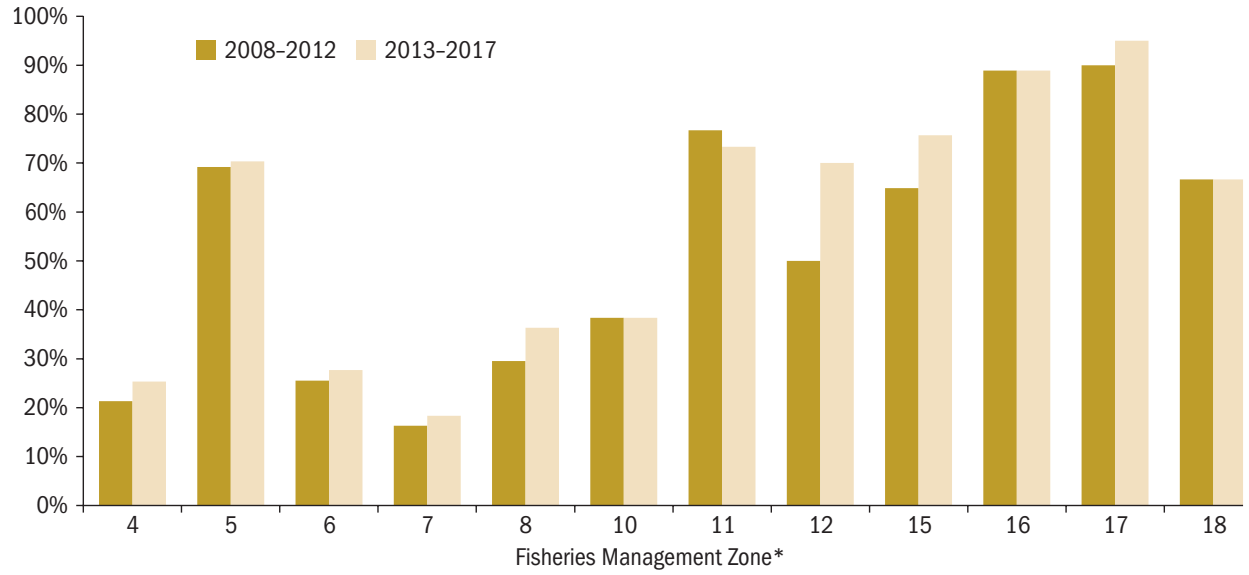
Sources of data: Ontario Biodiversity Council and Great Lakes Aquatic Nonindigenous Species Information System



* Protists are single-celled organisms, such as algae and amoebas.

Figure 79: Percentage of Sampled Lakes with Alien Species in 2008–2012 and 2013–2017

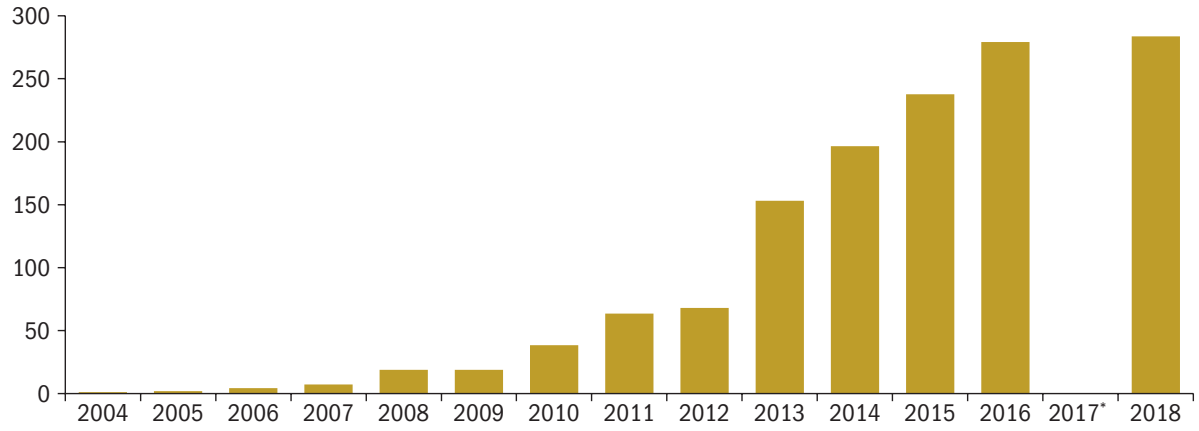
Source of data: Ministry of Natural Resources and Forestry



* See **Appendix 26b** for a map of Fisheries Management Zones. The higher zone numbers are generally in the southern part of the province.

Figure 80: Cumulative Area of Emerald Ash Borer Spread in Ontario, 2004–2018* (000 hectares)

Source of data: Ministry of Natural Resources and Forestry



* 2018 is the most recent data available. There was no aerial mapping in 2017.

6.10 What Progress Has Been Made Toward Nature and Wildlife Targets in Ontario?

In A Wetland Conservation Strategy for Ontario, 2017–2030 (2017), the Natural Resources Ministry set targets to halt the net loss of wetland area and function in southern Ontario—where wetland loss has been the greatest—by 2025 and to achieve a net gain by 2030. The status of meeting these targets is unknown. The Natural Resources Ministry informed our Office in August 2021 that the Wetland Conservation Strategy for Ontario, and its accompanying targets, are no longer in effect. The Ministry also informed our Office that it currently does not have a way to measure wetland function.

Ontario's Biodiversity Strategy, 2011: Renewing Our Commitment to Protecting What Sustains Us, which was developed by the Ontario Biodiversity Council (including the then Minister of Natural Resources), set a target to conserve at least 17% of land and water systems through well-connected networks of protected areas or other effective area-based conservation measures by 2020. As of October 2022, protected areas covered 10.8% of Ontario, which did not meet the target.

The Province also has not met targets to ensure the distribution of protected areas and representation of vegetation and landform (life science) diversity throughout the province. In addition, the Province has not met a previous target to establish an interconnected network of 22.5 million hectares of protected areas in the Far North, which was removed from the *Far North Act, 2010* in 2021. The Province has established only 4.7 million hectares of protected areas coverage in the Far North, representing approximately 21% of the previous target.

The Province has not set any high-level targets under the *Endangered Species Act, 2007*, although it has occasionally set some species-specific targets in government response statements. For example, in 2015 the Province set a goal to maintain a stable and self-sustaining population by 2036 for two birds—bobolink and eastern meadowlark—at 65% and 72%, respectively, of their then population size.

The Natural Resources Ministry has general provincial targets related to having healthy aquatic ecosystems and inland fish communities. However, because the monitoring program has been running for only two cycles, the Ministry advised us that additional data is needed to develop benchmarks and more

specific and measurable provincial targets and to assess whether they are being achieved. The Ministry has, however, established objectives, targets and benchmarks for fish populations in a number of Fisheries Management Zones.

Ontario's Pollinator Health Action Plan (2016) had an aspirational target to reduce overwinter mortality for managed honey bees to 15% by 2020. As of 2020, this target had not yet been met, with the winter 2019/2020 mortality rate for the commercial sector at 19% (see **Figure 74**). The pollinator plan also set targets to reduce the number of acres planted with neonicotinoid-treated corn and soybean seed by 80% by 2017, and to restore, enhance and protect one million acres of pollinator habitat. However, these targets are no longer tracked. While some actions and support work from the plan may continue, the overarching framework of Ontario's Pollinator Health Action Plan, and the targets within it, were cancelled sometime after July 2018.

There are no provincial targets related to habitat connectivity or invasive species. Although there are no provincial targets related to forest growth and composition, each Forest Management Plan is required to contain management objectives, indicators, desirable levels and targets relating to Crown forest diversity objectives. There are over 30 Forest Management Plans in Ontario. We have not reviewed these plans to determine the extent that they contain this information. While our Office's 2011 audit of Ontario's Forest Management Program found that Forest Management Plans had been completed in accordance with legislative requirements, Natural Resource Ministry staff had not ensured that the most accurate and up-to-date information on forest composition, wildlife habitat, and the protection of these habitats was made available at the time the plans were prepared.

Appendix 1: Glossary of Terms

Prepared by the Office of the Auditor General of Ontario

Term	Definition
Acidification	The process by which waterbodies become too acidic (dropping below their natural pH levels) over an extended period of time, which can cause toxic effects on ecosystems and human health.
Alien species	Plants, animals and microorganisms introduced outside of their natural ranges through human activities.
Ambient air quality	The quality of the surrounding air, based on the pollution levels in the air.
Benthic invertebrates	Organisms without a backbone that dwell at the bottom of a waterbody, which are often used as indicators in water quality assessments.
Best-fit linear trend line	A straight line placed through the middle of scattered data points on a graph to show the overall trend.
Biodiversity	The variety of life—including plants, animals, fish and other organisms—in a particular habitat or ecosystem.
Canadian Council of Ministers of the Environment (CCME)	A group of Ministers of the Environment across Canada, who have developed several environmental guidelines intended to improve environmental performance across the country, including the Canadian Ambient Air Quality Standards and the Canadian Water Quality Guidelines for the Protection of Aquatic Life.
Carbon sequestration	The process of taking carbon dioxide out of the atmosphere and storing it, such as in forests, wetlands, soils or wood products.
Carbon stock	The amount of carbon stored in organic matter, such as in forests, wetlands, soils or wood products.
Carbon storage	The storing of carbon dioxide in organic matter, such as in forests, wetlands, soils or wood products.
Climate change	The long-term change in average weather patterns, which may cause shifts in temperatures, precipitation, and/or the timing or length of seasons. The climate change observed since the early 20th century is a result of increased levels of greenhouse gases in the atmosphere due to human activities, primarily fossil fuel burning.
Cover crops	Crops that are grown primarily to protect and improve the soil, rather than for economic gain.
Decomposition	The process of breaking down biological material into smaller compounds, to return it to the ecosystem.
Deforestation	The change in a landscape from a forested to a non-forested state.
Dissolved oxygen concentrations	The amount of oxygen available in water.
Ecological health	The health of ecosystems and the services they provide, including their ability to withstand disturbances and support the organisms within.
Ecosystem	All of the living things, such as plants and animals, and all of the non-living things in their environment, such as water, soil and sunlight, and how these living and non-living things interact with each other.
Ecozone	A very large region with boundaries defined by biology, terrain and climate, that is influenced by long-term global or continental cycles and processes. Ontario has three ecozones (see **Figure 35**): the Mixedwood Plains Ecozone (Ontario's southernmost ecozone); the Hudson Bay Lowlands (the northernmost ecozone); and the Ontario Shield (the largest ecozone in Ontario, between the other two ecozones).

Term	Definition
Effective mesh size	A method for monitoring **habitat connectivity**, by determining the probability that two random points will be connected within the same habitat patch. High effective mesh size indicates high connectivity and low **habitat fragmentation**.
Endangered species	A species that may become extinct in the future.
Extinct species	A species that no longer exists.
Extirpated species	A species that no longer exists locally in an area where it was previously found.
Far North	The northernmost part of the province, covering 42% of Ontario's landmass, beginning about 500 kilometres north of Thunder Bay.
Fine particulate matter	Contaminants in the air that are less than 2.5 microns in diameter, often referred to as $PM_{2.5}$.
Fisheries Management Zone	Zones for managing fisheries in Ontario, each with specific regulations for fishery use.
Greenhouse gas	Carbon dioxide, methane, nitrous oxide, ozone and other gases that absorb and emit infrared radiation in the Earth's atmosphere, causing the greenhouse effect (i.e., letting the sun's energy in, but blocking its heat from escaping). The increase of greenhouse gas emissions from human activities are the primary cause of climate change.
Ground-level ozone	A secondary pollutant that is produced when two other pollutants—nitrogen oxides and volatile organic compounds—react together in sunlight and air. Ground-level ozone is a significant human health risk.
Habitat connectivity	The degree to which habitats are continuous to allow for species movement, typically for food and to reproduce.
Habitat fragmentation	The loss of continuous habitat, such as by urban areas, agriculture, mining, roads or other infrastructure.
Indicator	A variable or metric to describe or measure a condition, phenomenon or dynamic.
Invasive species	Species that are introduced outside of their normal range that establish and spread, and threaten the economy, environment or human health.
Land cover	Represents the physical characteristics of the land, such as the area of forests, wetlands and/or impervious surfaces.
Microplastics	Pieces of plastic with a diameter of five millimetres or less.
Mt CO_2eq	The standard unit—million tonnes of carbon dioxide equivalent emissions—by which greenhouse gas emissions are measured. This method of measurement converts various climate-causing gases to an equivalent amount of carbon dioxide based on the climate impact of each gas.
Natural resources	Renewable and non-renewable resources that naturally occur on Earth and are used for economic consumption.
Ontario's Managed Forest	Ontario's Managed Forest is a large area in the middle of Ontario where forest management occurs on public land (see map in **Appendix 24b**).
Peatlands	A type of wetland characterized by accumulations of peat greater than 40 centimetres, which are found throughout Ontario's Far North. Peat is formed when dead plant material is conserved for thousands of years due to permanent saturation in water at low temperatures.
Pollinators	Species, including bees, flies, wasps, butterflies, moths, beetles and hummingbirds, that rely on plants for food and spread pollen from male to female plants, which helps plants reproduce.

Term	Definition
Productive forest	Forest area that produces or is capable of producing timber.
Protected areas	A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature.
Runoff	Water that runs over land into waterways, often carrying contaminants such as pesticides, road salt or animal manure.
Sediment	Solid material, such as rocks and minerals, that settles at the bottom of a lake or river.
Soil erosion	The process by which the surface of soils wears away and erodes due to natural physical forces (water or wind) or human activities, such as agricultural tillage. Soil erosion can deplete **soil organic carbon**, increase carbon emissions and reduce the productivity of croplands.
Soil organic carbon	The solid carbon stored in soils, which is a component of the total organic matter in the soil that has built up from decaying plants, animals and microorganisms. Increasing carbon in the soil can help slow climate change.
Species at risk	Plants, animals and other organisms in danger of going extinct. Species at risk include species that are **extirpated**, **endangered**, **threatened** and **of special concern**.
Species of conservation concern	Includes species that are presumed or possibly extirpated, as well as those that range from very high to moderate risk of extirpation. In Ontario, some of these species are classified under the *Endangered Species Act, 2007* as species at risk.
Species of special concern	Species that may become threatened or endangered in the future due to biological features or other external threats.
Sustainability	The ability to maintain a state of balance over the long term. Sustainable development refers to the use of resources in a manner that enables the needs of present and future generations to be met.
Target	A future desired value of an indicator. A target is a time-bound benchmark for driving and measuring progress toward meeting an objective.
Threatened species	A species that may become endangered if threats to it are not addressed.
Urbanization	A concentrated human population that alters the landscape away from natural habitat to human-focused land uses.
Waste diversion	When materials that would otherwise be disposed of as waste are instead reused, recycled or composted and therefore not sent to landfill.
Water taking	The removal of water from a waterbody for an industrial, municipal, agricultural or commercial use.
Watershed	An area of land that channels streams and rivers into a reservoir.
Wetlands	Lands that are often covered by shallow water or where the water table is close to the soil surface, which provide transitional habitat where land and aquatic ecosystems are connected.

Appendix 2: Examples of Recent Government Decisions with the Potential to Have Significant Environmental Impacts

Prepared by the Office of the Auditor General of Ontario

The Province has made a number of recent decisions with the potential to have significant environmental impacts—either positive or negative. Regular public reporting on the state of the environment is essential to provide transparent information to the public and decision-makers on the impacts and/or the effectiveness of these and other decisions.

Decision	Environmental Registry Number	Indicator that Can Help Assess Impacts/ Effectiveness of the Decision
Air		
The Environment Ministry: • wound down the emissions testing program for light vehicles, instead relying on on-road enforcement to ensure light vehicles have effective emission-control systems; • made regulatory changes to strengthen on-road vehicle emissions requirements; and • redesigned the emissions-testing requirements for heavy vehicles and heavy diesel commercial vehicles.	013-3867 019-0416	Air emissions (from vehicles) Air pollutant concentrations
The Environment Ministry: • implemented a new regulation to regulate sulphur dioxide air emissions from petroleum facilities.	019-3443	Air emissions (particularly from petroleum facilities) Air pollutant concentrations
The Environment Ministry: • developed a policy for Ministry staff to consider the cumulative impacts of air pollutants from multiple sources when deciding to issue environmental approvals for new or expanded facilities in two areas of the province (Hamilton/Burlington and Sarnia/Corunna).	013-1680	Air pollutant concentrations (particularly in “hot spots”) Air quality health risks Health impacts from exposure to air pollutants
Water		
The Environment Ministry: • revoked regulations that set out monitoring requirements and limits on industrial wastewater discharges, and instead transferred requirements and limits to individual environmental compliance approvals.	019-0773	Point-source water contaminant releases Surface water quality
The Province: • enabled authority to require the expansion of the Duffin Creek Water Pollution Control Plant in Durham Region (which discharges into Lake Ontario), in order to collect and treat more sewage from York Region; and • to require the construction of a new treatment facility to remove phosphorus from drainage water that flows into Lake Simcoe.	019-6192	Surface water quality (particularly phosphorus levels in the Great Lakes and Lake Simcoe)

Decision	Environmental Registry Number	Indicator that Can Help Assess Impacts/ Effectiveness of the Decision
Land and Waste		
The Province: • amended the *Planning Act* and *Conservation Authorities Act* to expand the powers of the Minister of Municipal Affairs and Housing and change the requirements with respect to Minister's Zoning Orders (orders that bypass parts of the land-use planning process that require public consultation, largely at the municipal level and are not subject to appeal to the Ontario Land Tribunal).	019-2811 019-2646 019-3233 019-5284	Land cover (particularly changes to area of natural terrestrial cover)
The Province: • removed, re-designated and added lands in the Greenbelt Area (a protected area of green space, farmland, forests, wetlands and watersheds in southern Ontario); • repealed the *Duffins Rouge Agricultural Preserve Act*, which had restricted the use of these preserve lands to agriculture, in order to implement some of the Greenbelt Area changes; and • made amendments to other acts to accelerate the delivery of major public infrastructure projects, such as transit and highways.	019-6217 019-6304 019-2566	Land cover (particularly changes to area of natural terrestrial cover)
The Agriculture Ministry: • released New Horizons: Ontario's Agricultural Soil Health and Conservation Strategy to support agricultural soil management practices that provide economic, environmental and social benefits to Ontario.	013-1373	Soil condition
The Environment Ministry: • released the Food and Organic Waste Framework to prevent and reduce food and organic waste, rescue surplus food, collect and recover food and organic waste, and support beneficial end-uses.	013-1814	Solid non-hazardous waste generation, diversion and disposal levels (particularly organic waste)
Climate		
The Province: • cancelled Ontario's cap-and-trade program; and • implemented an Emissions Performance Standards program in its place to encourage the industrial sector to reduce greenhouse gas emissions.	013-3738 013-4551	Greenhouse gas emissions (particularly from the industrial sector)
The Ministry of Energy: • launched the Natural Gas Expansion Program to expand access to natural gas to areas of Ontario without access to the natural gas distribution system.	013-4060 019-3191	Greenhouse gas emissions (particularly from natural gas heating from homes and buildings)

Decision	Environmental Registry Number	Indicator that Can Help Assess Impacts/ Effectiveness of the Decision
Nature and Wildlife		
The Province: • amended the *Crown Forest Sustainability Act, 1994*, permanently exempting forest operations on Crown land conducted in accordance with an approved Forest Management Plan from requirements to comply with the *Endangered Species Act, 2007*.	019-1020	Species at risk (number, classification and status of populations)
The Natural Resources Ministry: • made changes to the Ontario Wetland Evaluation System (the policy framework for determining which wetlands are significant and therefore receive additional environmental protections), which could make it harder for individual wetlands to be designated as provincially significant.	019-6160	Wetland ecosystems (area)
The Province: • amended the *Far North Act, 2010*, including cancelling a goal set out in the law to protect 225,000 square kilometres of the Far North in an interconnected network of protected areas.	019-2684	Protected areas (area) Various ecosystem indicators (wetlands, forests, habitat connectivity and aquatic ecosystems) in Northern Ontario
The Province: • amended the *Endangered Species Act, 2007*, to enable proponents to pay a regulatory charge for designated conservation fund species as part of a permit, agreement or conditional exemption instead of undertaking certain on-the-ground actions to provide benefits to species at risk; and • established the Species at Risk Conservation Fund (funded through the species conservation charges as well as other legislated sources) to finance activities to protect and recover conservation fund species (though not necessarily the same species or in the same geographic area as the species harmed by the undertaking).	013-5033	Species at risk (number and classification)
The Natural Resources Ministry: • made regulatory amendments to classify 13 additional invasive species, prohibiting or restricting their possession, transfer, sale or release, to reduce their threat to Ontario's environment; and • added requirements for watercraft users to clean and drain watercraft and related equipment to ensure they are free of all aquatic plants, animals and algae before being placed into waterbodies.	019-3465	Invasive species (e.g., number of reported occurrences of a species, cumulative area of species spread)
The Province: • made legislative and regulatory changes to clarify the mandate of conservation authorities, limiting their work and role in reviewing the impacts of development and other activities before permits are issued.	013-5018 019-2927	Various environmental indicators to assess the indirect impacts of these decisions on natural areas and local ecology

Appendix 3: Information about the Data on Air Emissions

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

Air emissions are generally not measured directly, but are estimated (in tonnes or megatonnes) and are summarized and reported in Environment and Climate Change Canada's Air Pollutant Emissions Inventory report. The Air Pollutant Emissions Inventory combines data from:

- Environment and Climate Change Canada's National Pollutant Release Inventory data, which includes all reported emissions from facilities (stationary point sources) that meet specified criteria or thresholds that trigger mandatory annual reporting obligations; and
- Environment and Climate Change Canada and Ministry of the Environment, Conservation and Parks (Environment Ministry) estimates of emissions from sources that are not covered by the National Pollutant Release Inventory.

Data Limitations

Some emissions data tracked in the federal government's Air Pollutant Emissions Inventory are provided in the Canadian total only, rather than a provincial total. This approach affected the reported emissions from Ontario, particularly prior to 1993. For example, between 1992 and 1993, lead emissions listed in the Canadian total fell from 981 to 82 tonnes, while reported lead emissions from Ontario increased from 11 to 161 tonnes. Therefore, the emissions trend lines for **Figure 2** begin at 1993 to minimize this source of data uncertainty.

Emissions of ultrafine particulate matter—a subset of fine particulate matter that includes the very smallest particles that can cross the blood-brain barrier—are not tracked by the Environment Ministry. This pollutant, which is produced during fossil fuel combustion, has been demonstrated to have significant human health impacts such as lung inflammation and asthma, and is linked to diabetes, cancer and damage to the brain.

Other Public Reports

Canada's Air Pollutant Emissions Inventory Report (Environment and Climate Change Canada; published annually)

Appendix 4: Information about the Data on Air Pollutant Concentrations

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Air pollutant data is reported from the 39 ambient air monitoring stations, which cover much of southern, central and eastern Ontario, as well as North Bay, Sudbury, Sault Ste. Marie and Thunder Bay in Northern Ontario.

Sources and Methods

The Ministry of the Environment, Conservation and Parks (Environment Ministry) uses the data collected from its air monitoring stations to assess air quality in the province, using the methods specified in its annual Air Quality in Ontario reports, as well as in the Canadian Council of Ministers of the Environment's Guidance Documents on Achievement Determination for Ozone and for Fine Particulate Matter.

The Environment Ministry has designated 27 air monitoring stations as formal Canadian Ambient Air Quality Standards (CAAQS) reporting stations, which are used to estimate whether Ontario met the CAAQS targets. The CAAQS reporting stations tend to be located in communities with a population of 100,000 or more, or those with large point sources of sulphur dioxide emissions.

Health Canada uses a combination of data from air monitoring stations, satellite data, photochemical models, land use regression models and emissions reports to estimate the ambient pollution concentrations in each of Ontario's 49 census divisions. Health Canada then multiplies the percentage of Ontario's population in each census division by the air pollutant concentrations of the census divisions to estimate provincial population-weighted average concentrations.

Data Limitations

The number of provincially operated ambient air monitoring stations in Ontario fluctuates slightly from year to year, with 38 in 2018 and 39 in 2021. Of Ontario's 61 forecast regions, 36 do not have any monitoring stations that contribute to the Environment Ministry's assessment of the province's air quality using the Air Quality Health Index, including most of the forecast regions in Ontario's North. These areas generally have low populations and/or historically good air quality.

Ultrafine particulate matter ($PM_{0.1}$) emissions are not tracked. However, the Environment Ministry has been measuring $PM_{0.1}$ concentrations at three of its traffic-related air pollution monitoring stations since 2015.

Other Public Reports

Air Quality in Ontario Reports (Environment Ministry; published annually)

Appendix 5: Information about the Data on Air Quality Health Risks

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Air pollutant data is collected from the Ministry of the Environment, Conservation and Parks' (Environment Ministry's) 39 ambient air monitoring stations, which cover much of southern, central and eastern Ontario, as well as North Bay, Sudbury, Sault Ste. Marie and Thunder Bay in Northern Ontario.

Sources and Methods

Indicator results are from the Environment Ministry's reports on air quality risk level, Special Air Quality Statements and Smog and Air Health Advisories, which are, in turn, based on the data collected from the province's air quality monitoring stations. The Ministry also reports hourly pollutant concentrations and air quality trends over time.

Data Limitations

Ontario uses data collected from its ambient air monitoring stations for calculating the Air Quality Health Index. The number of monitoring stations in the province fluctuates slightly from year to year, with 38 monitoring stations in 2018 and 39 stations in 2021.

Other Public Reports

Air Quality in Ontario Reports (Environment Ministry; published annually)

Appendix 6: Information about the Data on Health Impacts from Air Pollutants

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

Indicator results are based on 2016 data from the 2021 Health Canada report entitled Health Impacts of Air Pollution in Canada: Estimates of morbidity and premature mortality outcomes.

Data Limitations

According to Health Canada, the data provided in its reports should not be used for identifying trends, as the model used to produce past estimates is not identical in design to the model used to produce the most recent (2016) estimates.

Other Public Reports

Health Impacts of Air Pollution in Canada (Health Canada, 2021)

Appendix 7: Information about the Data on Point-Source Water Contaminant Releases

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

Indicator results are based on annual water contaminant releases reported in Environment and Climate Change Canada's National Pollutant Release Inventory (NPRI), as published in July 2022. Point-source releases of contaminants from sewage treatment plants and industrial facilities that meet the reporting threshold have been tracked in the National Pollutant Release Inventory since 1993.

Data Limitations

This indicator reflects only point-source releases to water as reported by facilities to Environment and Climate Change Canada. The number and composition of reporting facilities varies each year due to the fact that only facilities that meet or exceed the reporting threshold are required to report.

Other Public Reports

Releases of Harmful Substances to Water Report (Environment and Climate Change Canada, 2021)

Appendix 8: Information about the Data on Surface Water Quality

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

Surface water quality is tracked through various monitoring programs and projects administered by provincial ministries, federal departments, conservation authorities, Public Health Ontario, US government agencies (for the shared responsibility of the Great Lakes) as well as by academic researchers, environmental organizations and research and citizen science groups. The indicator results in this section are based mainly on data from the following monitoring and reporting programs:

- **The Ministry of the Environment, Conservation and Parks' (Environment Ministry's) Great Lakes Nearshore Monitoring Program** tracks and studies various changes and impacts in the nearshore waters of the Great Lakes.
- **The State of the Great Lakes** reports are co-produced by Environment and Climate Change Canada and the U.S. Environmental Protection Agency. They also include data from the Environment Ministry's Great Lakes Nearshore Monitoring Program.
- **The Environment Ministry's Inland Lakes Monitoring Program** has monitored the chemical, biological and physical characteristics of water quality of inland lakes on an ongoing basis since 1973.
- **The Ministry of Natural Resources and Forestry's Broad-scale Monitoring Program** collects water chemistry, dissolved oxygen and contaminant data from approximately 800 lakes every five years (with cycles from 2008–2012 and 2013–2017). This program is focused on lakes with fisheries, with sampled lakes classified into Fisheries Management Zones.
- **The Lake Partner Program** is a volunteer-based citizen scientist program that began in 1996 and collects data on total phosphorus, lake clarity, calcium and chloride in Ontario's inland lakes. In 2019, it monitored 672 lakes, which is broadly representative of medium- to large-sized lakes in the province.
- **The Ontario Benthos Biomonitoring Network** is led by the Environment Ministry. It began in 2003 and produces a database of information on benthic communities from 3,862 locations.
- **The Canadian Council of Ministers of the Environment's (CCME's) Water Quality Index (WQI)** converts measurements of water quality for many parameters and samples at one site into a single value that can represent the overall water quality of this site.
- **The Provincial (Stream) Water Quality Monitoring Network**, led by the Environment Ministry, consists of over 400 monitoring stations and has been in operation since 1964. Not all of the monitoring stations have continuous and long-term records. Historically, over 2,000 stations have been monitored under this program.
- **The Ministry of Health's Operational Approaches for Recreational Water Guideline, 2018**, sets out the method to calculate the geometric mean of E. coli measurements at Ontario beaches. The public health units monitor Ontario's public beaches in accordance with the Ontario Public Health Standards and Protocols.

Data Limitations

The Province collects an extensive amount of data on surface water quality. The Environment Ministry acknowledges that parts of Northern Ontario tend to have less monitoring due to the logistical challenges associated with operating in these remote areas. Due to the large number of surface water quality programs and datasets, it is not feasible to identify here the data limitations associated with each sub-indicator. Of the surface water sub-indicators, microplastics are perhaps the most difficult to assess, as there is not yet a consistent monitoring program or means of measurement to be able to identify trends for this emerging contaminant.

Other Public Reports

- Water Quality in Ontario Reports (Environment Ministry; published biennially from 2009 to 2016)
- The State of the Great Lakes Reports (co-produced by Environment and Climate Change Canada and the U.S. Environmental Protection Agency, with contributions from Ontario ministries)
- Minister's Annual Report (and Five-Year and Ten-Year Reports) on Lake Simcoe (Environment Ministry)
- Watershed Report Cards: Surface Water and Groundwater Quality (published every five years by some of Ontario's conservation authorities)
- State of Ontario's Natural Resources (SONR) Report (Ministry of Natural Resources and Forestry; released publicly in March 2022)

Appendix 9: Information about the Data on Groundwater Quality

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Ministry of the Environment, Conservation and Parks' Provincial Groundwater Monitoring Network consists of 480 monitoring wells. The groundwater monitoring program has been in operation since 2000 and collects data on water levels, water chemistry, soil moisture, precipitation and weather conditions.

Data Limitations

The monitored wells do not themselves supply water to users. Nevertheless, the water sampled from many of these wells are from aquifers that supply water for human use.

Other Public Reports

Watershed Report Cards: Surface Water and Groundwater Quality (published every five years by some of Ontario's conservation authorities)

Appendix 10: Information about the Data on Drinking Water Quality

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Ministry of Health's Drinking Water Advisory Reporting System (DWARS) dataset was used for the drinking water advisories sub-indicator. The data for the sub-indicator on long-term drinking water advisories in First Nations communities were collected by the Department of Indigenous Services Canada.

Data Limitations

Due to the impact of the COVID-19 pandemic on the operations of public health units, the Ministry of Health provided the DWARS data to our Office as raw data. The Ministry noted that, while every effort was made to ensure the quality of data provided by the public health units, data errors/omissions may have occurred. The data includes drinking water advisories that were either initiated or entered in the Ministry's database after January 1, 2015, and therefore may omit ongoing advisories initiated prior to January 1, 2015.

Other Public Reports

- Chief Drinking Water Inspector Annual Report (annual), which provides information on the performance of Ontario's regulated drinking water systems and laboratories, drinking water test results, and the Ministry of the Environment, Conservation and Parks' inspection and enforcement activities.
- Minister's Annual Report on Drinking Water (Ministry of the Environment, Conservation and Parks; annually), which provides an overview of provincial programs, initiatives and actions to reduce contaminants from entering Ontario's waterways and to protect drinking water.
- Indigenous Services Canada – Remaining long-term drinking water advisories (regular online reporting)

Appendix 11: Information about the Data on Water Availability

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Ministry of the Environment, Conservation and Parks (Environment Ministry) issues permits to take water to allow extraction of 50,000 or more litres of water per day from the environment, so long as the proposed water taking does not negatively affect other water users or the environment. Certain prescribed water-taking activities (including eligible highway or transit projects; construction site dewatering taking between 50,000 to 400,000 litres per day of groundwater; and short-term pumping tests taking between 50,000 to 5 million litres per day of groundwater) are not required to obtain a permit to take water, but self-register with the Ministry's Environmental Activity and Sector Registry. Both permit holders and registrants must report annually to the Ministry on their water taking. Annual water taking is based on this data reported to the Environment Ministry.

The water availability indicator produced by the Canadian Environmental Sustainability Indicators (CESI) program compares the amount of freshwater withdrawn for human use from rivers in each sub-drainage area to the volume of water in rivers, assigning a threat classification (Low, Moderate, Medium or High) based on the resulting water availability ratio. The indicator, which is based on the Organisation for Economic Co-operation and Development's Water Stress Indicator, estimates water demand for each sub-drainage area as the sum of municipal, industrial and agricultural water withdrawals from all flowing water. Data to calculate the indicator comes from Environment and Climate Change Canada's Water Survey of Canada HYDAT database, which includes streamflow data for rivers across Canada, as well as water intake data from three surveys: Statistics Canada's Industrial Water Use Survey (2009) and Agricultural Water Use Survey (2010), and Environment and Climate Change Canada's Municipal Water and Wastewater Survey (2009).

Data Limitations

Permit holders must report their water-taking volumes to the Environment Ministry by March 31 each year; at the time of this report, the most recent complete water-taking dataset was for 2019. Further, water takings that are less than 50,000 litres per day, as well as some water-taking activities over 50,000 litres per day, such as certain farming activities and hydroelectric power production, are not required to obtain a permit to take water or to track and report their water-taking volumes to the Ministry.

The river water availability indicator does not account for the water supply in lakes and groundwater aquifers, potentially underestimating water availability for areas that rely primarily on lakes or other sources to satisfy demand. Also, this indicator does not measure how much water is consumed—only the amount of water removed from rivers, some of which may be released directly back into a river system. The river water availability indicator has not been updated with data more recent than 2009. However, there is sufficient data for either the Environment Ministry or Environment and Climate Change Canada (through its CESI program) to produce both a recent indicator status and a trend analysis for river water availability. In 2023, the CESI program advised us that it did not have plans to update its water availability indicator this year, noting that the methodology required updating, and that the process will likely take several years to complete.

Other Public Reports

Canadian Environmental Sustainability Indicators (Environment and Climate Change Canada, updated online)

Appendix 12: Information about the Data on Land Cover

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The land cover indicator uses mapping data from the Ministry of Natural Resources and Forestry, including the following specific sources:

- Ontario Ministry of Natural Resources. 2019. Southern Ontario Land Resource Information System (SOLRIS) 3.0. Ontario Ministry of Natural Resources, Peterborough, ON.
- Ontario Ministry of Natural Resources and Forestry. 2014. Far North Land Cover – Data Specifications Version 1.4. Ontario Ministry of Natural Resources and Forestry, Peterborough, ON.
- Spectranalysis Inc. 2004. Introduction to the Ontario land cover data base, second edition (2000): outline of production methodology and description of 27 land cover classes. Inventory, Monitoring and Assessment Section, Science and Information Branch, Ontario Ministry of Natural Resources, Peterborough, ON.

Data Limitations

The information presented here combines data from sources that use different methods of land cover analysis and classification. Therefore, land cover changes identified by this indicator might not always reflect actual changes on the landscape, but methodological differences between the datasets. The broad land cover categorizations used in the Land Cover in Ontario indicator compensate for this uncertainty to some extent.

Other Public Reports

State of Ontario's Biodiversity Report (Ontario Biodiversity Council; published every five years, most recently in 2021)

Appendix 13: Information about the Data on Soil Conditions

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The soil conditions indicators use data collected in the Census of Agriculture, and in Agriculture and Agri-Food Canada's (AAFC's) Agri-Environmental Indicators.

Data Limitations

The data used for these indicators is produced every five years. The most recent published indicator report was in 2016 (on 2011 data). However, data for 2016 was posted online in 2021.

Other Public Reports

Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series (Agriculture and Agri-Food Canada; published periodically, most recently in 2016)

Appendix 14: Information about the Data on Solid Waste

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

Data sources include Statistics Canada, the Ministry of the Environment, Conservation and Parks (Environment Ministry), and the Ontario Waste Management Association (OWMA).

The Statistics Canada waste disposal and diversion data are collected every two years. These data encompass both residential and non-residential non-hazardous waste.

The Environment Ministry collects the hazardous waste information. The food waste diversion data was compiled by the Environment Ministry based on multiple sources including the Resource Productivity and Recovery Authority's annual municipal datacall, and a consultant's report commissioned by the Ministry.

Data Limitations

The Province collects detailed data regarding residential waste generated and diverted in Ontario through the Resource Productivity and Recovery Authority's annual municipal datacall. The Province does not, however, collect similar data regarding non-residential waste. Instead, it relies on Statistics Canada data, which does not provide complete, up-to-date information on total waste generated, diverted and disposed. (See our *2021 Annual Report of Environment Audits*, *Non-Hazardous Waste Reduction and Diversion in the Industrial, Commercial and Institutional Sector*).

Other Public Reports

Resource Productivity and Recovery Authority Annual Report (annual reporting on residential and select waste materials)

Appendix 15: Information about the Data on Human-Caused Greenhouse Gas Emissions

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

Environment and Climate Change Canada's National Inventory Report is the source of emissions data for this indicator. Emissions estimates are under continual improvement, such that historical emissions may be updated in future publications as new data become available and methods and models are refined and improved.

Data Limitations

The data limitations associated with greenhouse gas emission estimates are described in the annual National Inventory Report by Environment and Climate Change Canada. Some emissions estimates, such as those for land use and waste management, are less certain than others, such as the estimates associated with fossil fuel combustion.

Other Public Reports

National Inventory Report: Greenhouse Gas Sources and Sinks in Canada (Environment and Climate Change Canada; published annually)

Appendix 16: Information about the Data on Wildfire Emissions

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

Estimates of wildfire area burned in Ontario's Managed Forest for the 1990–2003 period are derived from the Canadian National Fire Database, which comprises information from provincial resource management agencies, compiled and updated by the Canadian Forest Service. Estimates of area burned in Ontario's Managed Forest for the 2004–2019 period are obtained from the National Burned Area Composite (NBAC). This composite of data is derived from various remote sensing sources, monitoring data collected by provincial resource management agencies, and a rule set that, for each fire, identifies the most accurate available data source.

Data Limitations

The information on wildfire area burned and wildfire emissions pertain only to Ontario's Managed Forest and do not include the unmanaged forests found in the northern regions of Ontario, for which no greenhouse gas reporting obligations exist.

Other Public Reports

State of Ontario's Natural Resources (SONR) Report (Ministry of Natural Resources and Forestry; released publicly in March 2022)

Appendix 17: Information about the Data on Carbon Storage

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Ministry of Natural Resources and Forestry's (Natural Resources Ministry's) estimates of the carbon stored in Ontario's productive forests are based on research published in 2018 using Ontario's forest carbon budget model.

The Natural Resources Ministry's estimate of wetland carbon storage is based on literature syntheses from 2013 and 2014, as well as peatland carbon research and monitoring studies in the Far North. The Ministry's baseline estimate of peatland carbon was calculated using flows of carbon storage, carbon dioxide, methane and dissolved organic carbon.

Data Limitations

While there is some research into historical changes in both forest and peatland carbon stocks, the Natural Resources Ministry does not include historical trends in either indicator. The forest carbon data available is limited to model projections, and is therefore based on several underlying assumptions, including "business-as-usual" harvesting rates, natural disturbance rates, and production and end uses of wood products. The Ministry reported that the 2013/14 data was the first statistically valid assessment of peatland carbon balance in the Far North. The Ministry also reported a lack of data for baseline conditions, resulting in large variability in some components of the peatland carbon assessment. Further, there is a data gap on carbon storage and sequestration potential in Ontario's agricultural soils.

Other Public Reports

- Ministry of Natural Resources and Forestry – Forest Carbon (published online, most recently in 2017)
- Ministry of Natural Resources and Forestry – Wetland Carbon (published online, most recently in 2017)
- State of Ontario's Natural Resources (SONR) Report (Natural Resources Ministry; released publicly in March 2022)
- State of Ontario's Natural Resources – Forests (Natural Resources Ministry; published every five years, most recently in 2021)

Appendix 18: Information about the Data on Weather-Related Disasters

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The data was sourced from Public Safety Canada's Canadian Disaster Database (CDD), under the Meteorological/Hydrological category. The database displays disaster information on natural, technological and conflict events that is aggregated from various data sources, including federal institutions, provincial/territorial governments, non-governmental organizations and publicly available data sources, but is not a primary data source.

Data Limitations

Public Safety Canada includes a disclaimer that the data in the Canadian Disaster Database may not necessarily be suitable for comparative analysis due to the lack of a standardized guideline for collecting cost and loss data. It also warns that the database is based on information that is sourced from outside parties and may not be accurate.

Appendix 19: Information about the Data on Great Lakes Ice Cover

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

The Great Lakes

Sources and Methods

The data used for this indicator is from the United States' National Oceanic and Atmospheric Administration (NOAA), Great Lakes Environmental Research Laboratory website (1973–2021). The percentage change in maximum ice cover over time was calculated using averages for each 10-year period. Note, the first decade only includes nine years, as 1973 is the first year available.

Data Limitations

The ice cover results presented here are a compilation of data derived from satellite imagery, visual observations from ship and aircraft, as well as from weather information. The State of the Great Lakes 2019 report concluded that the only statistically significant trends in maximum ice cover declines were in the Great Lakes overall assessment and for Lake Superior. However, that report included data only up to 2018, and historical data has since been updated.

Other Public Reports

- State of Ontario's Natural Resources (SONR) Report (Ministry of Natural Resources and Forestry; released publicly in March 2022)
- State of Ontario's Biodiversity Report (Ontario Biodiversity Council; published every five years, most recently in 2021)
- State of the Great Lakes Technical Reports (Environment and Climate Change Canada and the U.S. Environmental Protection Agency)

Appendix 20: Information about the Data on Growing Season

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

Growing season data is based on research undertaken by scientists at Natural Resources Canada that uses daily temperature readings taken at monitoring stations across Canada. Growing season values were calculated for each year from 1950 to 2018, and were then averaged for two 30-year (i.e., climate "normal") periods of interest, 1951–1980 and 1981–2010, to identify the changes in the length of the growing season over the two periods. Results are shown in the map in **Figure 55** with a resolution of approximately two kilometres by two kilometres per grid cell.

Data Limitations

Standardized high-quality daily climate information, such as the temperature readings used to analyze changes to the growing season, were scarce in Canada prior to 1950. There is some uncertainty in the growing season estimates especially in more remote regions, such as Northern Ontario, where there are fewer weather stations.

Other Public Reports

State of Ontario's Natural Resources (SONR) Report (Ministry of Natural Resources and Forestry; released publicly in March 2022)

Appendix 21: Information about the Data on Surface Air Temperature

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The information presented here for Ontario is based on 50-km by 50-km gridded historical temperature data compiled by Environment and Climate Change Canada. The values from each grid cell were averaged together to estimate the annual and seasonal temperature departures from their 1961–1990 baseline for Ontario.

Data Limitations

The monitoring site locations, instruments and procedures used to measure and record air temperatures did not remain the same over the 73-year observation period. Therefore, Environment and Climate Change Canada identified and removed artefacts in the data that may have been introduced from changes in the observing time, location of observing sites, and instruments, to produce a dataset that can be used to produce more realistic and credible comparisons. This is a standard procedure, necessary to produce a homogeneous dataset suitable for trend analysis.

Other Public Reports

Canadian Environmental Sustainability Indicators: Temperature change in Canada (Environment and Climate Change Canada; published annually)

Appendix 22: Information about the Data on Water Levels and Scarcity

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide (except for water levels in the Great Lakes)

Sources and Methods

The drought conditions indicator used information from the Ministry of Natural Resources and Forestry's (Natural Resources Ministry's) Ontario Low Water Program. The water levels in the Great Lakes indicator used data from the Department of Fisheries and Oceans (Canadian Hydrographic Service).

Data Limitations

The Natural Resources Ministry identifies several data quality issues for the Ontario Low Water Program. In particular, the Ministry's data does not include "update" notifications (when a low water condition has already been declared but progresses to a higher level), which omits the tracking of some more serious low water condition (Level 2 and 3) notifications.

Another potential sub-indicator of water levels and scarcity is water quantity of rivers (see **Section 3.7.3**). However, as noted in **Appendix 11**, neither the Ministry of the Environment, Conservation and Parks nor Environment and Climate Change Canada has used the available data from this monitoring program to produce a recent status or trend analysis for river water flows across Ontario.

Appendix 23: Information about the Data on Wetland Ecosystems

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Ministry of Natural Resources and Forestry tracks changes in wetland area in southern Ontario using time-series satellite imagery. Data is collected on cloud-free days and used to generate land cover maps every five years.

Data Limitations

There is no comprehensive, landscape-scale data available for the assessment of trends in the quality and function of remaining wetlands. In addition, the two most recent assessments of wetland loss cannot be directly compared to previous assessments of wetland loss due to changes in methodology. For example, assessments of wetland loss prior to 2002 excluded wetlands smaller than 10 hectares as well as many Great Lakes coastal wetlands.

Other Public Reports

- State of Ontario's Biodiversity Report (Ontario Biodiversity Council; published every five years, most recently in 2021)
- State of Ontario's Natural Resources (SONR) Report (Ministry of Natural Resources and Forestry; released publicly in March 2022)

Appendix 24a: Information about the Data on Forest Ecosystems

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Data on forest type, age and growth is collected from Ontario's Managed Forest, a specific area of the province in central and Northern Ontario where forests are managed on Crown land (see **Appendix 24b**). Forests in southern Ontario and the Far North are not captured in this inventory data. Data on deforestation and afforestation includes southern and Northern Ontario, but not the Far North.

Sources and Methods

Forest composition (type and age) and growth estimates were based on Ontario's Forest Resources Inventory data for managed Crown forests, and growth and yield models. Deforestation was estimated using Canada's National Deforestation Monitoring System and data from the Ministry of Natural Resources and Forestry (Natural Resources Ministry) on permanent forest access roads. Afforestation was estimated using records from Forests Ontario of publicly funded tree planting.

Data Limitations

Observed changes in forest composition, growth and deforestation and afforestation rates may be partially attributed to changes in data sources and methodology. For example, the Natural Resources Ministry added an additional forest management unit to the monitored area since 2016, which likely contributes to some of the changes recorded in forest composition from 2016 to 2021.

Other Public Reports

- State of Ontario's Natural Resources – Forests (Natural Resources Ministry; published every five years, most recently in 2021)
- Report on Forest Management (Natural Resources Ministry; annually)
- Forest Resources of Ontario (Natural Resources Ministry; published every five years, most recently in 2021)
- Forest Health Conditions in Ontario Annual Reports (Natural Resources Ministry; published annually)
- State of Ontario's Natural Resources (SONR) Report (Natural Resources Ministry; released publicly in March 2022)

Appendix 24b: Boundary of Ontario's Managed Forest

Source: Ministry of Natural Resources and Forestry

Appendix 25: Information about the Data on Terrestrial Habitat Connectivity

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Data on habitat connectivity is from southern Ontario.

Sources and Methods

Terrestrial habitat connectivity was assessed using land cover data from the Southern Ontario Land Resources Information System (SOLRIS). Effective mesh size was calculated for each ecodistrict in the Mixedwood Plains Ecozone, with the exception of Manitoulin Island.

Data Limitations

Effective mesh size as a measure of habitat connectivity assigns equal weight to all barriers, such as roads, urban areas or agricultural fields, that fragment a habitat patch. However, some barriers (such as a narrow country road) may be easier to overcome, and the impact of various barriers differs widely across species.

Other Public Reports

- State of Ontario's Biodiversity Report (Ontario Biodiversity Council; published every five years, most recently in 2021)
- State of Ontario's Natural Resources (SONR) Report (Ministry of Natural Resources and Forestry; released publicly in March 2022)

Appendix 26a: Information about the Data on Aquatic Ecosystems

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

The data for aquatic ecosystems is collected from inland lakes within Fisheries Management Zones in Ontario's near-North and the south (see **Appendix 26b**). Inland lakes in the Far North (Zones 1–3) and Great Lakes Fisheries Management Zones were not sampled and included in inland lake reporting.

Sources and Methods

Data was taken from the Ministry of Natural Resources and Forestry's (Natural Resources Ministry's) Broad-scale Monitoring Program for inland lakes and Land Information Ontario. Data is collected every five years from an initially random selection of lakes from each Fisheries Management Zone, and the number sampled is proportionate to the total lakes in each zone. The majority of these lakes were sampled first in 2008 to 2012, and resampled again in 2013 to 2018. The program aims to sample 10% of lakes with larger predators, such as brook trout, lake trout and walleye, as these are important lakes to identify trends in fish populations and aquatic ecosystems over time.

Data Limitations

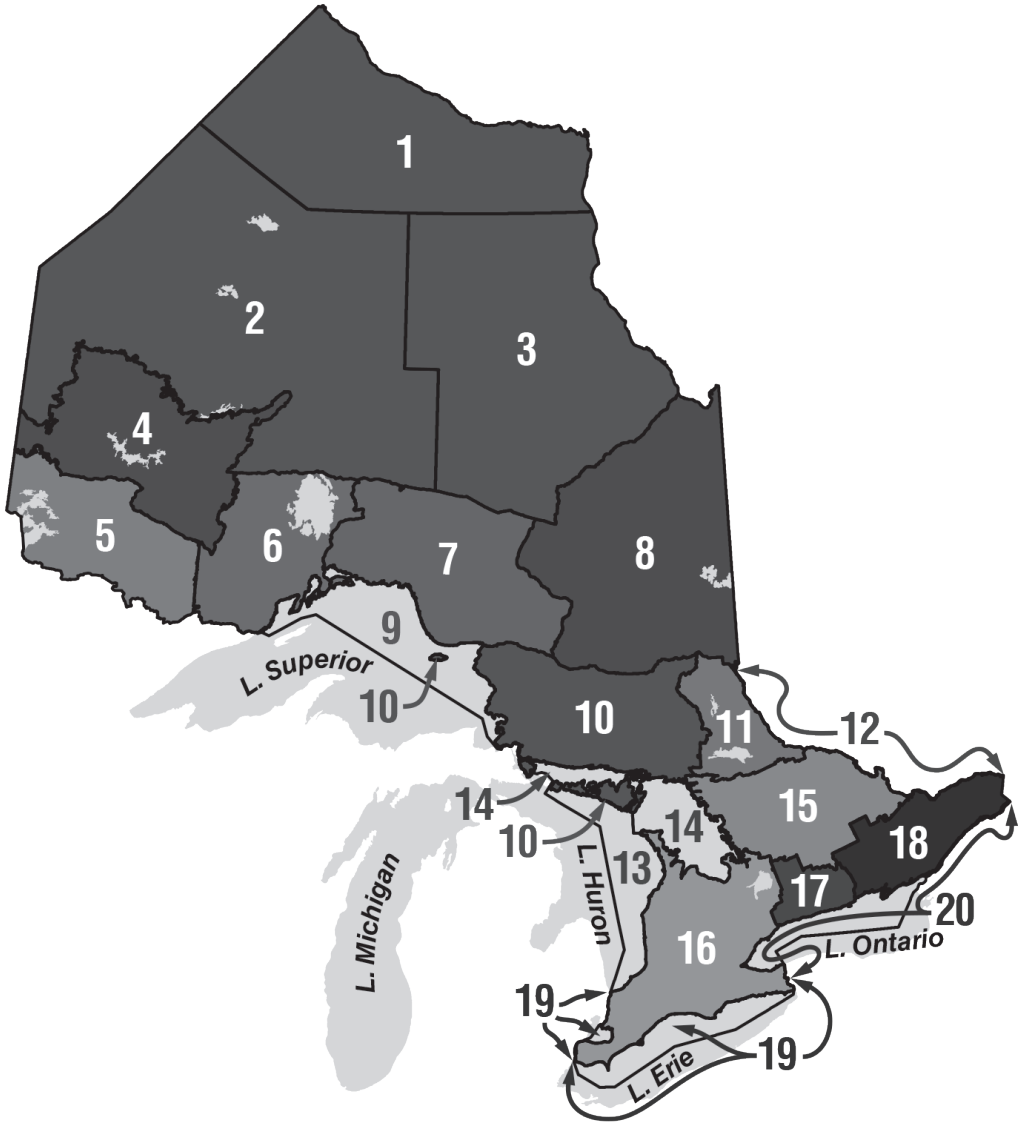
The Natural Resources Ministry collects additional data on aquatic ecosystems in the Great Lakes but does not collect data to analyze the size spectrum slope of fish communities in rivers and streams. Fisheries Management Zone 12 cannot be compared to other zones in Ontario as it comprises a chain of tightly connected lakes, which are not independent of each other.

Other Public Reports

- State of Ontario's Biodiversity Report (Ontario Biodiversity Council; published every five years, most recently in 2021)
- State of Ontario's Natural Resources (SONR) Report (Natural Resources Ministry; released publicly in March 2022)

Appendix 26b: Fisheries Management Zones

Source: Ministry of Natural Resources and Forestry



Appendix 27: Information about the Data on Inland Fish Communities

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

The data for fish communities is collected from inland lakes within Fisheries Management Zones in Ontario's near-North and the South (see **Appendix 26b**). Inland lakes in the Far North (Zones 1–3) and Great Lakes Fisheries Management Zones were not sampled and included in inland lake reporting.

Sources and Methods

Data is from the Ministry of Natural Resources and Forestry's (Natural Resources Ministry's) Broad-Scale Monitoring Program for inland lakes and Land Information Ontario. Data is collected every five years from an initially random selection of lakes from each Fisheries Management Zone, and the number sampled is proportionate to the total lakes in each zone. The majority of these lakes were sampled first in 2008–2012, and resampled again in 2013–2018. Fish are sampled using two types of nets in order to target both large-bodied and small-bodied fish. The Natural Resources Ministry also monitors the number, weight and length of 15 fish species that are particularly important for commercial and recreational fishing.

Data Limitations

The data on fish communities' diversity and the abundance of large-bodied fish represents inland lakes only. The Natural Resources Ministry collects additional data on Great Lakes fish communities, but no data is collected on fish or invertebrate communities in rivers and streams. Fisheries Management Zone 12 cannot be compared to other zones in Ontario as it comprises a chain of tightly connected lakes, which are not independent of each other.

Other Public Reports

State of Ontario's Natural Resources (SONR) Report (Natural Resources Ministry; released publicly in March 2022)

Appendix 28: Information about the Data on Protected Areas

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Province monitors the number, type and size of protected areas that meet criteria developed for Canada's biodiversity targets (developed by the International Union for Conservation of Nature and the Pathway to Canada Target 1 initiative), including:

- provincial protected areas (for example, provincial parks, conservation reserves, dedicated protected areas in the Far North of Ontario and wilderness areas);
- national protected areas;
- private protected areas (for example, qualifying areas managed by land trusts, conservation authorities, municipalities or universities); and
- other effective area-based conservation measures.

The Province tracks the distribution of specific types of provincial protected areas, or park classes, throughout all 71 ecodistricts. The Province uses a mapping analytical tool to track the number and distribution of landform and vegetation types within protected areas in each ecodistrict to determine representation of these life science features.

Data Limitations

The Ministry of the Environment, Conservation and Parks (Environment Ministry) monitors the number, size and distribution of protected areas and their life science features. The Environment Ministry assesses and reports at least once every 10 years on various indicators that help describe the ecological condition of the provincial parks and conservation reserves system. The Ministry also assesses the ecological condition (such as species at risk, invasive species and life science inventories) of individual provincial parks and conservation reserves to inform management decisions. However, unlike Environment and Climate Change Canada, the Ministry does not provide an overall indicator with summarized information on the ecological integrity, or the health or "naturalness," of these protected spaces.

Other Public Reports

- State of Ontario's Protected Areas Reports (Ontario Parks; published every 10 years, most recently in 2021)
- State of Ontario's Biodiversity Report (Ontario Biodiversity Council; published every five years, most recently in 2021)

Appendix 29: Information about the Data on Wildlife Populations

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Ministry of Natural Resources and Forestry (Natural Resources Ministry) monitors moose populations though standardized aerial surveys. Surveys are conducted in mid-winter within 12 to 72 hours of a fresh snowfall, when snow is more than 30 centimetres deep. This increases the visibility of fresh moose tracks and individual moose and helps ensure comparable survey results over time.

Data Limitations

The Ministry has not yet created an indicator for measuring overall changes in the sizes of vertebrate species' populations in Ontario. Global and national-level indices like the Living Planet Index and Canadian Species Index do not provide information on wildlife population sizes at a provincial scale.

Other Public Reports

- Provincial Wildlife Population Monitoring Program Annual Report (Natural Resources Ministry; published annually, most recently in 2018 for the years 2015, 2016 and 2017)
- State of Ontario's Natural Resources (SONR) Report (Natural Resources Ministry; released publicly in March 2022)

Appendix 30: Information about the Data on Pollinators

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Ministry of Agriculture, Food and Rural Affairs' (Agriculture Ministry's) Apiary Program conducts annual, voluntary surveys of beekeepers in Ontario to collect honey bee data, including on overwinter mortality and the number of producing colonies. The Ministry's Provincial Apiarist Reports and Ontario Apiculture Winter Loss Survey Reports provide information on overwinter mortality and producing colonies.

Data Limitations

The data collected serves as an indicator on the health of only one type of native pollinators, managed honey bees. Further, the apiculture winter loss survey is voluntary and all responses are self-reported by beekeepers. Data is not verified by the Agriculture Ministry or any other independent body.

The Province does not collect comprehensive, long-term data on the abundance or diversity of wild (non-managed) pollinators in Ontario. The Ministry of Natural Resources and Forestry assisted with some monitoring on wild pollinators at eight sites in Peterborough and Northumberland Counties from 2016 to 2019 as part of a larger monitoring effort led by the University of Guelph, but not all of the data has been processed and summarized yet. The Ministry of the Environment, Conservation and Parks conducted monitoring on bumble bee diversity and abundance in southwestern Ontario in 2015, 2016 and 2017, but that monitoring stopped in 2018 and the data has not yet been analyzed.

Other Public Reports

- Provincial Apiarist Reports (Agriculture Ministry; published annually)
- Ontario Apiculture Winter Loss Survey Reports (Agriculture Ministry; published in 2011 and annually from 2014)

Appendix 31: Information about the Data on Species at Risk

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Province-wide

Sources and Methods

The Committee on the Status of Species at Risk in Ontario (COSSARO) is responsible under the *Endangered Species Act, 2007* for determining the classification of species at risk in Ontario. Classified species are listed in the Species at Risk in Ontario List in Ontario Regulation 230/08 under the Act. The Ontario Biodiversity Council collected data from COSSARO annual reports and the Ministry of Natural Resources and Forestry (Natural Resources Ministry) to report on changes in the status of species at risk from 1996 to 2017. Data on species of conservation concern was provided by the Natural Heritage Information Centre in the Natural Resources Ministry.

Data Limitations

The Ontario Biodiversity Council's indicator on the change in status of species at risk is updated every five years, with current data based on assessments conducted between 1996 and 2017. There have also been changes in the criteria for assessing species at risk over the years, which may impact reassessment and therefore the reliability of this indicator.

The data only shows the count of species in each category, and how these counts have changed. Environment and Climate Change Canada has developed an indicator that tracks population trends for species at risk, which shows whether population and distribution trends of species at risk are consistent with the objectives in species' recovery strategies or management plans. Ontario has not developed a similar indicator to assess species population and distribution trends over time.

Other Public Reports

- State of Ontario's Biodiversity Report (Ontario Biodiversity Council; published every five years, most recently in 2021)
- Progress Reports on the Protection and Recovery of Ontario's Species at Risk (Natural Resources Ministry/ Ministry of the Environment, Conservation and Parks; published for individual species, generally five years after the publication of a government response statement for the species)
- Committee on the Status of Species at Risk in Ontario Annual Reports (published annually)
- State of Ontario's Natural Resources (SONR) Report (Natural Resources Ministry; released publicly in March 2022)

Appendix 32: Conservation Status Ranks for Ontario Species, 2015[1]

Sources of data: Ontario Biodiversity Council and Natural Heritage Information Centre, Ministry of Natural Resources and Forestry

	Species of Conservation Concern[2]							
Taxonomic Group	Presumed extirpated	Possibly extirpated	Critically imperilled	Imperilled	Vulnerable	Apparently secure[3]	Secure[3]	Unrankable[4]
Amphibians	3	0	3	2	0	8	10	0
Birds	3	3	12	11	22	150	81	204
Decapods[5]	0	0	0	0	2	5		5
Freshwater fishes[6]	3	1	6	13	14	43	46	28
Freshwater mussels	0	0	14	7	14	16	20	8
Fungi	0	0	0	0	2	14	0	31
Insects	2	36	151	125	460	2,375	591	4,397
Lichens	0	23	50	47	33	128	92	54
Mammals	0	1	4	6	5	15	37	15
Mosses	3	2	51	141	167	98	68	150
Reptiles	2	0	1	5	11	3	4	1
Spiders	0	0	0	18	22	229	99	389
Sponges	0	0	0	0	0	0	1	5
Terrestrial and freshwater snails and slugs	0	1	11	18	25	43	18	104
Vascular plants	24	44	253	212	139	591	726	1,129
Total	**40**	**111**	**556**	**605**	**916**	**3,718**	**1,793**	**6,520**

1. This table is based on the National General Status 2015 assessment, which included 2,228 species of conservation concern at that time. In January 2022, the Ministry of Natural Resources and Forestry's Natural Heritage Information Centre provided our Office with an updated list, which includes an additional 535 species of conservation concern that are not included in this table, for a total of 2,763 species of conservation concern. Note, there are approximately 30,000 species in Ontario.
2. Species of conservation concern includes five categories that indicate risk of extirpation (or local extinction): presumed extirpated; possibly extirpated; critically imperilled (very high risk of extirpation); imperilled (high risk of extirpation); and vulnerable (moderate risk of extirpation).
3. Apparently secure species are at fairly low risk of extirpation in Ontario and secure species are at very low or no risk.
4. "Unrankable" includes species that have not yet been ranked due to conflicting or insufficient information, and species where the conservation status rank is not applicable (e.g., non-native species or species appearing outside of their normal range).
5. Decapods include freshwater crayfish, shrimp and crab.
6. Data for fish species is based on a 2005 assessment.

Appendix 33: Information about the Data on Invasive Species

Prepared by the Office of the Auditor General of Ontario

Geographic Scope

Terrestrial alien and invasive plants are reported province-wide in forested regions, which includes all but the Hudson Bay Lowlands in the Far North. Aquatic alien species are monitored in all Great Lakes and inland lakes in Northern and southern Ontario, but not in the Far North (Fisheries Management Zones 1, 2 and 3 in **Appendix 26b**). Invasive forest insects and diseases are monitored in forested areas province-wide.

Sources and Methods

Data on the number of alien and invasive terrestrial plants was collected from forested ecological land class vegetation plots, Forest Resource Inventory plots, forest Growth and Yield plots, and National Forest Inventory plots. This data is supplemented with information submitted voluntarily by members of the public and resource management agencies to the Early Detection and Distribution Mapping System for Ontario (EDDMapS), which is a web-based mapping tool used to document invasive species sightings in all types of terrestrial ecosystems.

Data on the number of alien aquatic species is based on the Great Lakes Aquatic Nonindigenous Species Information System, the Broad-scale Monitoring Program for inland lakes, other provincial monitoring and assessment activities, and voluntary reporting from the public and other resource management agencies. Inland lakes water quality, invertebrates and fish are sampled every five years to determine the percentage of lakes with alien species and the average number of alien species per lake in each Fisheries Management Zone.

Invasive insects and diseases are reported and verified through citizen science, collaborating agencies (Invasive Species Centre) and Ontario's own monitoring initiatives and surveys. The Ministry of Natural Resources and Forestry (Natural Resources Ministry) obtained data on the arrival and spread of invasive forest insects and diseases from the Ontario Forest Health Monitoring Program, the Canadian Food Inspection Agency and Natural Resources Canada. The data is collected through ground surveys, plot assessments, aerial mapping and other methods. Surveys and report verification are based on forest plots in provincial Crown land, federal land, First Nation Territories, parks, private lands and urban areas. The Ministry's data on the spread of invasive insects and diseases include the emerald ash borer, hemlock woolly adelgid, beech bark disease and beech leaf disease.

Data Limitations

The Natural Resources Ministry does not have a program for systematic province-wide monitoring of alien and invasive plants. It does, however, collect incidental observations of these species while conducting other ministry science and monitoring activities in forest plots. This data is supplemented by observations submitted voluntarily by members of the public and other resource management agencies. Collectively, the observations do not cover all areas of the province and are focused largely on forested ecosystems. Therefore, the data can only be used to infer the total number of alien and invasive species at a very coarse, provincial scale.

There are no commonly accepted criteria defining an invasive aquatic species among jurisdictions, due to varying environmental, economic and social impacts from these species. This is further complicated when a species has conflicting impacts, such as negative impacts on the environment but positive impacts on the economy. As such, the data presented in this report is limited to aquatic alien species. The Great Lakes data also only tracks species that are new to the Great Lakes, and does not include the transfer of species between lakes or potential alien species when the species' origin is unclear.

Other Public Reports

- State of Ontario's Biodiversity Report (Ontario Biodiversity Council; published every five years, most recently in 2021)
- Forest Health Conditions in Ontario Annual Reports (Natural Resources Ministry; published annually)
- State of Ontario's Natural Resources (SONR) Report (Natural Resources Ministry; released publicly in March 2022)

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