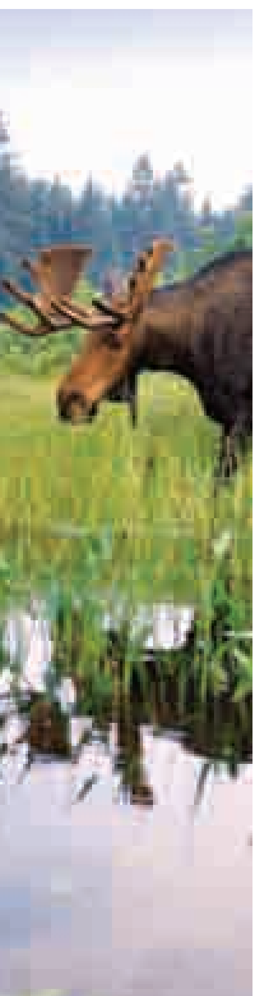
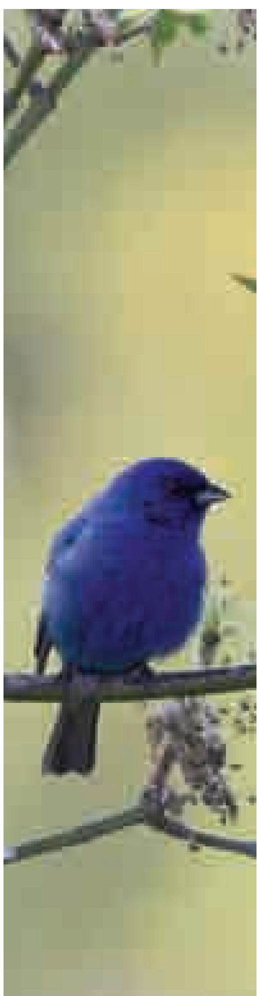
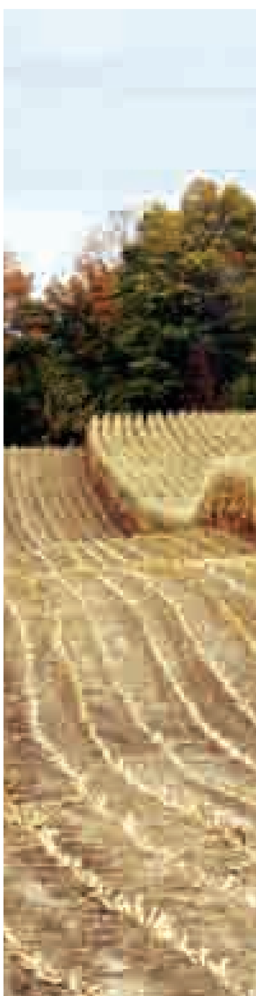
2010 International Year of Biodiversity

State of Ontario's Biodiversity 2010

A Report of the Ontario Biodiversity Council



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Message from the Ontario Biodiversity Council

In 2005, the province released Ontario's Biodiversity Strategy, a blueprint to help conserve the province's biodiversity and to "protect what sustains us." The effort to conserve biodiversity requires the commitment and coordinated effort of government, industry, non-governmental organizations and the general public, all working towards the same goals. The Ontario Biodiversity Council (**www.ontariobiodiversitycouncil.ca/**) was formed to guide the implementation of Ontario's Biodiversity Strategy. The Council is composed of members from a variety of backgrounds who are committed to biodiversity conservation.

Ontario's effort is part of a larger effort to conserve the world's biodiversity. Biodiversity needs to be conserved for its own sake. We also need to conserve biodiversity for our sake—for clean air and water, productive soils, and for healthy food and other renewable resources that help to sustain us and our economy.

The United Nations declared 2010 to be the International Year of Biodiversity. It is a time to celebrate the variety of life on Earth and the value of biodiversity for our lives. It is a time to take action to conserve what is so important to us.

The State of Ontario's Biodiversity 2010 report has been produced by the Ontario Biodiversity Council. It will introduce Ontario's biodiversity in terms of what it means and why it is so vitally important to conserve it. The report provides Ontario's first benchmark on the state of biodiversity. It meets a commitment made in Ontario's Biodiversity Strategy and also represents Ontario's contribution to the International Year of Biodiversity, in which all representatives of the United Nations' Convention on Biological Diversity have agreed to report on their progress to meet the goal of "making a significant reduction in the loss of biodiversity."

We encourage everyone to become engaged in both appreciating and conserving biodiversity. Every effort to become a more sustainable community will contribute to the future recovery of biodiversity. Every one of us has a role to play in reducing pressures on nature. We invite you to join our efforts to protect what sustains us.

Executive Summary

Biodiversity is the variety of life on Earth expressed through genes, species and ecosystems. This variety of life is essential to sustaining the living systems we depend on for our health, economy, food, and other vital ecosystem services. To effectively protect and conserve biodiversity, it is necessary to understand biodiversity, the pressures that are acting upon it, and where there may be opportunities for improvement. Reporting on the State of Ontario's Biodiversity every 5 years is identified as one of the actions in Ontario's Biodiversity Strategy to improve this understanding. This report represents the first effort in this regard. It examines the status and trends of 29 indicators related to pressures on Ontario's biodiversity, the state of Ontario's biodiversity, and conservation and sustainable use of Ontario's biodiversity. Information is presented in the context of Ontario's four major ecozones—the Hudson Bay Lowlands, the Ontario Shield, the Mixedwood Plains, and the Great Lakes.

Pressures on Ontario's biodiversity include habitat loss, invasive alien species, pollution, overharvesting and climate change. The combined effects of these stressors are increasingly placing biodiversity at risk, particularly in southern Ontario. A driving force behind pressures on Ontario's biodiversity is the province's growing human population and associated consumption patterns. An analysis of Ontario's Ecological Footprint, shows that on a per person basis, Ontario residents are among the global populations placing the highest demands on the planet's resources. Most indicators related to pressures and the state of biodiversity show there is concern for the ongoing loss of biodiversity, particularly in southern Ontario. Conversely, most indicators related to conservation and sustainable use show a more positive picture, reflecting recent efforts to protect and restore biodiversity in the province.

The biodiversity of the Hudson Bay Lowlands Ecozone has been the least affected by human activity and is still largely intact. Almost all of the ecozone consists of natural land cover. Climate change is expected to have a proportionally larger impact on the Hudson Bay Lowlands as temperatures will likely increase to a greater extent than in areas further south. The Ontario Shield Ecozone is the largest ecozone in the province and two thirds of the landscape is forested with limited loss of habitat. Human impacts on biodiversity have occurred to a greater extent in the southern part of the ecozone. The biodiversity of the Mixedwood Plains Ecozone has been significantly affected by human activity. It is the smallest terrestrial ecozone in Ontario, but is home to the majority of the province's population. The landscape has been highly altered with 68% of the ecozone made up of built-up areas, agriculture, roads and other unnatural cover. The cumulative impacts of habitat loss, pollution, and invasive alien species have negatively impacted biodiversity in this ecozone. The biodiversity of the Great Lakes Ecozone has been impacted by a long history of human use of the Great Lakes and their watersheds. The ecozone has been subject to many changes over the last century associated with multiple stresses. Invasive alien species have been a particular pressure on Great Lakes biodiversity. Lake Superior is generally in good condition and has not been impacted by human activity to the same extent as Lakes Huron, Erie and Ontario.

Information is a cornerstone for the effective protection and conservation of biodiversity. Only one third of the indicators assessed for this report were considered to have high data confidence, and two indicators were not assessed. Additional potential indicators were not included because of the lack of suitable data to provide reliable reporting. Information gaps that became apparent during the development and assessment of biodiversity indicators include the lack of standardized, province-wide monitoring for many aspects of biodiversity, the lack of comprehensive analysis of some existing data sets, out-dated data sets, and the identification of suitable indicators to assess some aspects of Ontario's biodiversity.

This 2010 report shows that Ontarians are placing large demands on the province's biological resources and that biodiversity losses are occurring, particularly in southern Ontario. Given that Ontario's population is projected to grow by almost 5 million people by 2036, the province's biodiversity will continue to be eroded if current trends continue. Although efforts and expenditures to protect and conserve biodiversity have increased over the last decade, these have not been sufficient to prevent the continued loss of the province's biodiversity.

Summary of status, trends, and data confidence for each indicator used in the State of Ontario's Biodiversity 2010 report.

	INDICATOR	STATUS	TREND	DATA
Pressures on Ontario's Biodiversity	Ecological Footprint	high per capita footprint and limited biocapacity	Baseline	Medium
	Habitat Loss—land cover	significant habitat loss in Mixedwood Plains, but limited habitat loss in the Ontario Shield and Hudson Bay Lowlands	Baseline	Medium
	Habitat Loss—road density in southern Ontario	67% increase in total length of road from 1935–1995, length of paved road increased almost 5-fold over this period	Deterioration	Medium
	Habitat Loss—corridors in the Ontario Shield	low road densities except southern portion and near urban centres, small increase in road area 2001–2005 (0.02%)	Baseline	Medium
	Habitat Loss—aquatic stress index	high stress index values in Mixedwood Plains and southern Ontario Shield, low values in Hudson Bay Lowlands	Baseline	Medium
	Invasive Alien Species—Great Lakes	large number of alien species present in Great Lakes (186) and invasion rate has increased	Deterioration	High
	Pollution—ground-level ozone	increasing background levels and increasing 8-hour peak levels during the summer	Deterioration	High
	Pollution—freshwater quality index	58% of sites with good or excellent ratings, but 41% with fair, marginal or poor ratings mostly in southwestern Ontario	Baseline	High
	Climate Change—Great Lakes ice cover	decline in percentage of ice cover on all five Great Lakes between 1970–2008	Deterioration	Medium
	Climate Change—condition and survival of Polar Bears	reduced condition and survival rates for male and female Polar Bears in all age classes	Deterioration	High

TREND: Improvement, Deterioration, No Change, Mixed, Baseline, Undetermined

DATA CONFIDENCE: High, Medium, Low, N/A

Summary of status, trends, and data confidence for each indicator used in the State of Ontario's Biodiversity 2010 report *(continued).*

	INDICATOR	STATUS	TREND	DATA
State of Ontario's Biodiversity	Forests—extent of forest cover and disturbance	amount of forested land remained stable between 1998 and 2002	No Change	Medium
	Forests—fragmentation in Mixedwood Plains Ecozone	4 of 5 zones have >30% forest cover, but largest zone (SW) has only 17% with limited habitat for forest-interior birds	Baseline	Medium
	Wetlands—losses in southern Ontario	from 1982–2002, wetland losses continued in the Mixedwood Plains at a rate of 0.17% per year.	Deterioration	Medium
	Rare Ecosystems—extent and protection	54% of prairie/savannah habitat legally protected, 92% of dune habitat protected, only 21% of alvar protected	Baseline	Medium
	Great Lakes—Great Lakes shoreline hardening	> 30% of Lake Erie shoreline and 25% of GL connecting channels have high proportion of hardened shoreline	Deterioration	Medium
	Great Lakes—*Diporeia* abundance in Great Lakes	drastic declines in abundance in all Great Lakes except Lake Superior over the last 10–20 years	Deterioration	Medium
	Inland Waters—alterations to stream flow	not assessed	Undetermined	N/A
	Inland Waters—fragmentation by dams	not assessed	Undetermined	N/A
	Species Diversity—changes in General Status rankings	919 of 1,063 species had same ranks in 2000 and 2005. 10 species moved to higher ranks because of increased risks	Mixed	High
	Species Diversity—trends in Ontario's breeding birds	most species increasing or stable (especially forest birds and northern birds), aerial foragers and grassland birds declining	Mixed	High
Conservation and Sustainable Use	Protected Areas—protected areas and conservation lands	11.3% of Ontario Shield, 10.0% of Hudson Bay Lowlands, and 3.5% of Mixedwood Plains protected	Baseline	Medium
	Protected Areas—ecological representation	minimum representation thresholds have not been achieved for any ecodistrict, Ontario Shield has best representation	Baseline	High
	Sustainable Management—forest certification	area under forest certification increased dramatically since 2002, 80% of licenced land base certified in 2008	Improvement	High
	Sustainable Management—agriculture	65% of Ontario farms (35,000) have participated in environmental farm plans since 1992	Improvement	High
	Stewardship—area enhanced for biodiversity	cumulative and annual area enhanced for biodiversity continued to increase from 2002 to 2008	Improvement	Medium
	Stewardship—volunteer efforts to conserve biodiversity	between 2006 and 2008, 33,000 Ontarians volunteered annually on biodiversity conservation initiatives	Baseline	Medium
	Stewardship—participation in tax incentive programs	participation rate in conservation tax incentive programs (CLTIP and MFTIP) increased 11% between 2002 and 2008	Improvement	High
	Urban Biodiversity—wooded area in urban landscapes	wooded areas account for 7.8% of the 4,765 km^2 of urban landscape within the Mixedwood Plains Ecozone	Baseline	Medium
	Financing—expenditures and charitable giving	since 2001, spending by biodiversity-related ministries has increased significantly	Improvement	Medium

TREND: Improvement, Deterioration, No Change, Mixed, Baseline, Undetermined

DATA CONFIDENCE: High, Medium, Low, N/A

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Introduction

Biodiversity—What is it and Why is it Important?

Ontario's Biodiversity Strategy (OBS 2005) defines biodiversity as follows:

> *Biological diversity or biodiversity refers to the variety of life, as expressed through genes, species and ecosystems, that is shaped by ecological and evolutionary processes.*

The variety of life on Earth is essential to sustaining the living systems we depend on for health, wealth, food, and other vital ecosystem services. The diversity of natural life provides enormous economic and community benefits through the use of biological resources in forestry, farming, fishing, recreation and other activities. Many Ontarians' livelihoods depend on the natural capital that is made possible by Ontario's rich biodiversity. Biodiversity also has intrinsic value regardless of specific values to humans. Biodiversity includes the genetic variation that allows species to adapt to environmental change and persist through time, as well as all of the building blocks that make up larger complex ecosystems such as the boreal forest or the Great Lakes. Biodiversity is the planet's collective life support system that sustains us.

Nelly Lake

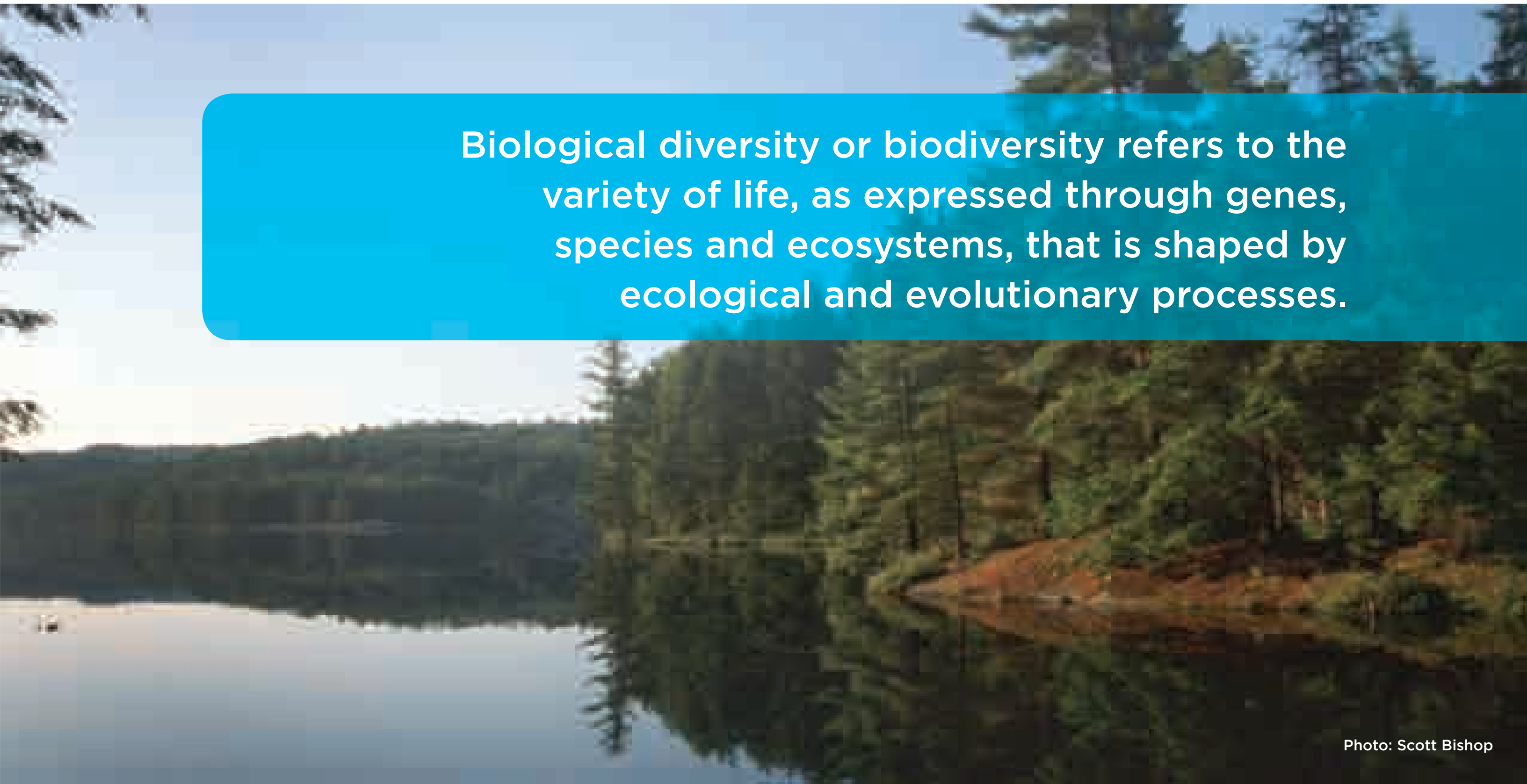


Photo: Scott Bishop

Humans are a part of this living system and have the ability to protect, destroy, or conserve it. With growth in the world's population and increasing consumption, human activities have resulted in an accelerated loss of the diversity of life on the planet. The spread of industrialization, the sprawl of urban settlement and the intensive use of natural resources are overwhelming the capacity of our natural life support system to cope. Biodiversity losses are often irreversible, so efforts to conserve biodiversity are of paramount importance.

Biodiversity and Ecosystem Services

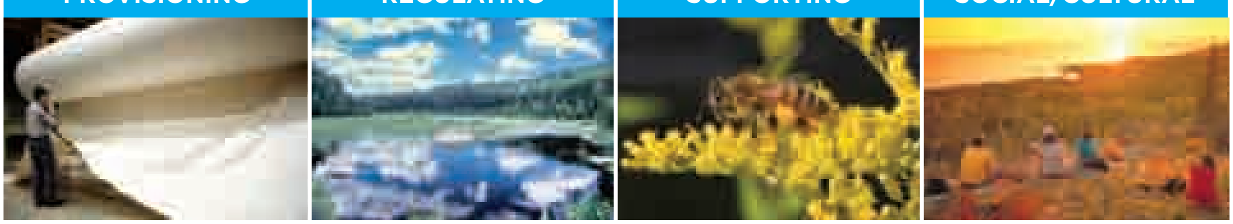
Biodiversity is the source of our natural wealth and provides the foundation of human economic and social well-being. Beyond providing people with material welfare and livelihood, biodiversity contributes to the stability and resiliency of our communities, as well as to human health, and represents unexplored options for the future.

Collectively, the benefits that humans derive from biodiversity are known as ecosystem services. These services arise from biodiversity at the genetic, species and ecosystem scale from species such as bees, features such as forests and wetlands, and natural processes such as carbon sequestration. Ecosystem services are usually categorized as: *provisioning services* that provide essential raw materials such as food, water, timber, and fibre; *regulating services* that maintain essential life support services such as climate, flood and disease prevention, waste treatment, and water quality; *supporting services* that are essential for the ecosystem to function such as soil formation, photosynthesis, and nutrient cycling; and, *social/cultural services* that provide recreational, aesthetic, and spiritual benefits (Figure 1).

At a global level, the Millennium Ecosystem Assessment (MEA 2005) examined the consequences of ecosystem change for human well-being and concluded that biodiversity loss and changes in ecosystem services are most affected by habitat change, climate change, invasive alien species, overharvest and pollution. The report also concluded that approximately 60% of the planet's ecosystem services studied have been degraded in the last 50 years with human impacts as the root cause.

Our knowledge of ecosystem functions and the study of ecosystem services is still evolving. There is emerging evidence that areas with the most intact biodiversity also have the highest value for providing ecosystem services. Therefore trends in biodiversity may also affect trends in

PROVISIONING	REGULATING	SUPPORTING	SOCIAL/CULTURAL



Food	Climate	Pollination	Recreation
Raw materials	Flood prevention	Soil formation	Culture
Water supply	Safe shorelines	Habitat	Mental health

Figure 1. Categories of ecosystem services.

Photo credits (L–R): Heather Bickle, OMNR; NHIC Archives; Don Sutherland; Ontario Tourism

> **At present there is no demonstrated alternative to maintaining the viability of the Earth. No one yet knows how to engineer systems that provide humans with the life-supporting services that natural systems provide for free... Despite its mysteries and hazards, planet Earth is the only known home that can sustain life.**
>
> *Joel E. Cohen & David Tilman*
> *Reflecting on the lessons of 'Biosphere 2'*

ecosystem services. We don't know if there are thresholds beyond which the loss of biodiversity disrupts or degrades critical ecosystem functions and services. We do know the cost of losing and replacing ecosystem services is high. The link between biodiversity and ecosystem services is complex but the connection of nature's benefits to humans is clear and provides a strong and urgent need for the conservation of biodiversity.

Reporting on Biodiversity

To effectively protect and conserve biodiversity, it is necessary to understand biodiversity and the threats that are acting upon it, and where there may be opportunities for improvement. Reporting on the State of Ontario's Biodiversity every 5 years is identified as one of the actions in Ontario's Biodiversity Strategy (OBS 2005) to improve understanding about the composition, structure and function of the province's ecosystems and the impacts of human activities on these systems. The Strategy identifies 2010 as the year for the first report on the State of Ontario's Biodiversity. This report fulfills that commitment.

In May 2008, the Ontario Biodiversity Council released the Interim Report on Ontario's Biodiversity (OBC 2008). The interim report was not a comprehensive report, but contains background information on Ontario's biodiversity, a discussion of threats to biodiversity, and a description of some of the efforts underway across Ontario to conserve biodiversity. The State of Ontario's Biodiversity 2010 report goes beyond the interim report by providing an indicator-based assessment in all of these areas. The 2010 report focuses on the 'state of' various aspects of Ontario's Biodiversity. It does not directly assess progress in implementing Ontario's Biodiversity Strategy or make recommendations regarding additional efforts that are needed to protect Ontario's Biodiversity. Progress in implementing the Strategy is the subject of a companion report that is being released this year (Ontario's Biodiversity Strategy Progress Report, 2005–2010).

The United Nations has declared 2010 the International Year of Biodiversity. In addition to the activities associated with this year-long celebration, all countries that are signatory to the international Convention on Biological Diversity (including Canada) are preparing national reports on the state of biodiversity (**www.cbd.int/reports/**). The State of Ontario's Biodiversity 2010 report represents a contribution to this global reporting effort. In addition to its national report, Canada is preparing detailed Ecosystem Status and Trends Reports (ESTR) for each of the country's 25 major marine and terrestrial ecozones. Some of the indicators in this report draw on information from these detailed national assessments.

Point Pelee

About This Report

This report provides easy access to at-a-glance information on the state of Ontario's biodiversity. By design, the information presented here is concise and draws from existing detailed and more technical reports such as the State of the Forest Report 2006 (OMNR 2007a). Readers wishing to explore these reports in more detail can follow the links to source documents and other resources.

Biodiversity indicators are measures that summarize data from monitoring programs and other sources to convey information on pressures, states, impacts or societal responses related to biodiversity. Indicators were chosen to provide key information on a suite of topics relevant to biodiversity conservation. Ontario's 2010 biodiversity indicators are reasonably consistent with the Convention on Biological Diversity's reporting framework and biodiversity indicators in other jurisdictions. As the 2010 report is the first report of its kind in Ontario, it uses the best available data. Future reports may evolve to suit future biodiversity reporting needs in Ontario, take advantage of new data, science, and Aboriginal Traditional Knowledge, and maintain consistency with evolving global biodiversity reporting efforts.

Each indicator has been evaluated for "status", "trend" and "data confidence". In the absence of formally identified targets or criteria, the status of each indicator is presented in bullets as an objective statement of the current condition based on available data and expert review. Evaluations of trend and data confidence relate specifically to the data presented. In some cases, trends were assessed as "baseline" for indicators that are assessing an aspect of Ontario's biodiversity that has been negatively impacted over a long time period, but there are no data or analyses available to assess changes in recent decades. Indicators were only included when data confidence was medium or high. Some topics for which indicator-based data were unavailable have been addressed in the text.

TREND	
Improvement	Improvement based on time series data
No change	No clear change based on time series data
Mixed	Fluctuating or divergent trends based on time series data
Deterioration	Deterioration based on time series data
Baseline	Less than 3 years time series data available, no historical data available, or no data available to assess recent trends
Undetermined	Not enough comprehensive data at appropriate scale of analysis to determine a baseline

DATA CONFIDENCE	
High	• Complete data coverage at appropriate spatial and temporal scale of analysis (i.e., provincial, regional) • High data currency (i.e., collected 2005 or later) • Frequent data collection (i.e., annually to every 5 years)
Medium	• Partial data coverage in relation to scale of analysis • Satisfactory data currency (i.e., collected 1990–2005) • Incomplete/inconsistent data collection (i.e., > every 5 years)
Low	• Limited or no data • Data out of date (i.e., collected before 1990) • One time data collection

The report has four main sections. The first part provides a descriptive overview of each of Ontario's four major ecozones. The next three sections include a series of indicators that assess the status and trends related to pressures on Ontario's biodiversity, the state of biodiversity in the province (key natural systems, species diversity, and genetic diversity), and conservation and sustainable use. The report concludes with a summary of the state of Ontario's biodiversity and a discussion of information gaps with respect to biodiversity indicators.

Ontario's Ecozones—An Overview

Ontario is a vast province that covers more than 1,000,000 km^2 of the Earth's surface. The province has a wide range of climates, which, along with geology and other factors, shape its diverse landscapes and waterscapes. The diversity of ecosystems ranges from tundra habitats along the Hudson Bay coast to Carolinian forests bordering Lake Erie. For the purposes of this report, the province is divided into four ecozones based on Canada's National Ecological Framework that identifies 25 national terrestrial and marine ecozones (Figure 2). Ecozones are broad units based on ecological, climatic and topographic factors.

Canadian Ecozones

Figure 2. Ecozones of Canada (note: in this report, the Hudson Plains Ecozone is referred to as the Hudson Bay Lowlands Ecozone, and the Boreal Shield Ecozone is referred to as the Ontario Shield Ecozone).

Ecozones do not respect political boundaries and each of Ontario's four ecozones is shared with other provincial or U.S. jurisdictions. This section provides an overview of the physical and biological characteristics, human uses, and related stresses of Ontario's four ecozones.

Hudson Bay Lowlands

The Hudson Bay Lowlands is the northernmost ecozone in Ontario and covers almost 25% of the province. The distribution of ecosystems in this region is largely dictated by changes in climate and soil conditions from the coast to inland, and from north to south. The ecozone is dominated by wetlands and also supports saltmarshes, tundra, boreal and subarctic forests, and numerous rivers, streams, and lakes.

The extensive wetlands provide essential migratory and breeding habitat for many breeding birds, including about one million Canada Geese and 400,000 Snow Geese. For some species, like the Hudsonian Godwit and Whimbrel, this ecozone represents most of their breeding range. Several species at risk, like the Short-eared Owl, Yellow Rail, and Red Knot depend on these wetlands for habitat.

These wetlands are also important for carbon storage and cycling at the global scale (Tarnocai 2000). They act as "sinks", storing large amounts of carbon in their soils. This carbon can be released into the atmosphere at a faster rate when wetlands thaw, the number of fires increases, and plant and animal material in the soil is exposed to air and decomposes. These changes can be brought on by climate change. A release of large quantities of carbon stored in wetland soils could significantly affect the Earth's climate system and biodiversity.

Saltwater tidal communities are also found in the Hudson Bay Lowlands ecozone. The coastal saltmarshes and adjacent freshwater marsh communities support large numbers of waterfowl and are used by these and other waterbird and shorebird species as important resting areas

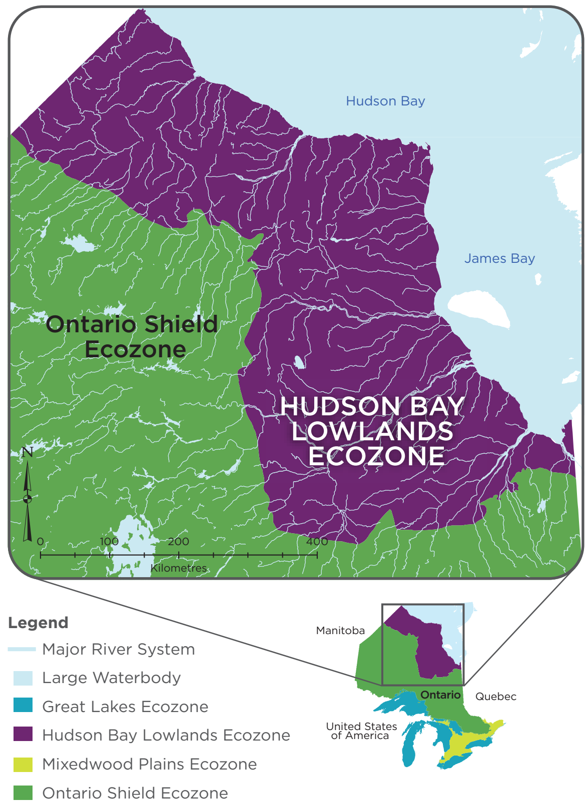


Figure 3. The Hudson Bay Lowlands Ecozone within Ontario.

during migration. There are 17 Important Bird Areas (places of international significance for the conservation of birds and biodiversity) in this ecozone.

The Hudson Bay Lowlands also support boreal and subarctic forests. Since soils in much of this area are wet, the forests are primarily open and have small trees. These forests are an important part of the largest undeveloped tracts of forest in Canada. They support species such as the Gray Wolf, Woodland Caribou and Wolverine.

The many lakes, rivers, and streams in the Hudson Bay Lowlands provide important habitat for species, like Lake Sturgeon, that are in decline or have been extirpated in more developed areas. Most of the ecozone's coastal rivers and streams also support a number of fish species, like sea-run Brook Trout, that breed in fresh water and migrate to the sea to feed and grow.

In 2006, the Hudson Bay Lowlands Ecozone was home to an estimated 4,275 people, about 0.04% of Ontario's population (Statistics Canada 2009). Most residents of this region are of Aboriginal (Cree) descent. The traditional, subsistence way of life is socially and culturally important to the region's Aboriginal peoples. The coast and the waterways are regularly used. Most of the landscape remains largely undeveloped. There is less habitat loss and fragmentation in the Hudson Bay Lowlands Ecozone than in the Mixedwood Plains Ecozone or the southern portion of the Ontario Shield Ecozone. Habitat loss and fragmentation in the Hudson Bay Lowlands is concentrated around the ecozone's coastal villages and abandoned military sites. It is also associated with mining activities and hydroelectric developments.

Hydroelectric developments have been important to the economy of the Hudson Bay Lowlands since the early 1900s. Ontario is considering establishing new hydroelectric developments in this region to meet energy demand across the province. There is also potential for wind farms along the coasts of Hudson Bay and James Bay.

Mining and forestry activities also take place in this ecozone and have some potential to increase in the future. Such activities provide jobs and help some communities grow and prosper. They also pose potential threats to natural resources, habitat and biodiversity.

Climate change is expected to influence the Hudson Bay Lowlands Ecozone more than many other regions in Ontario. Changes in the length of the ice-free season and in the fitness of some species have been observed. From 1971 to 2003 the length of the ice-free season in Hudson Bay and James Bay increased significantly (Gagnon and Gough 2005). Sea ice provides important habitat for polar bears and declines in their health and physical fitness have been observed (Obbard et al. 2006). Potential impacts such as the melting of permafrost (soil or rock below the Earth's surface that is below 0°C for at least 2 consecutive years) are expected to lead to changes in the types of ecosystems and species that the ecozone can support. Some models predict that at least 50% of permafrost in the region may be lost by 2100 (Gough and Leung 2002). Rising temperatures are expected to lead to the increased presence of species that were formerly limited to more southern regions (Malcolm et al. 2005). The impacts of climate change in this ecozone are already a reality for remote Aboriginal communities that rely on winter roads for transportation and wild species for food.

Coastal tundra

Photo: Michael J. Oldham, NHIC Archives

Ontario Shield

The Ontario Shield is Ontario's largest ecozone and covers about 61% of the province. In 2006 it was home to an estimated 943,313 people, about 8% of Ontario's population (Statistics Canada 2009). There are large variations in topography, climate, and natural disturbance patterns in this ecozone. This means different parts of the ecozone support different types of species and ecosystems. In the northwest forests grow on rugged and rocky terrain. Clay soils and flat terrain in the northeast support wetlands. About 68% of the ecozone is covered by forests. Lakes, ponds, rivers and wetlands are scattered throughout the forests.

There are two distinct forest regions in this ecozone, the Boreal Forest Region and the Great Lakes—St. Lawrence Forest Region. The Boreal Forest Region in the northern portion of the ecozone supports a small number of tree species, including: Black Ash, Black Spruce, Balsam Fir, Balsam Poplar, Eastern Larch, Jack Pine, Trembling Aspen, White Birch and White Spruce. The Great Lakes—St. Lawrence Forest Region to the south has a warmer climate and supports a wider variety of tree species than the Boreal Forest Region. These species include: American Basswood, American Beech, Black Cherry, Eastern Hemlock, Eastern White Cedar, Eastern White Pine, Green Ash, Large-tooth Aspen, Red Maple, Red Pine, Red Oak, Sugar Maple and Yellow Birch.

Frequent disturbances such as fire and insect outbreaks are a natural part of the forest ecosystems of the Ontario Shield Ecozone and help maintain biodiversity. Fires happen more frequently in the Boreal Forest Region than in the Great Lakes—St. Lawrence Forest Region. The intensity of forest fires also varies among regions. Many plant species have developed adaptations to take advantage of this variety of disturbance types.

There is natural variation in the age and structure of forests in the ecozone. Young and old forests support mammal species that have large ranges and require a variety of habitats to meet their breeding, feeding and over-wintering needs. For example, Moose feed in open plant communities in the summer and prefer forested areas in the winter. These forests also provide important habitat for American Black Bear, Gray Wolf, Canada Lynx, Wolverine and Woodland Caribou.

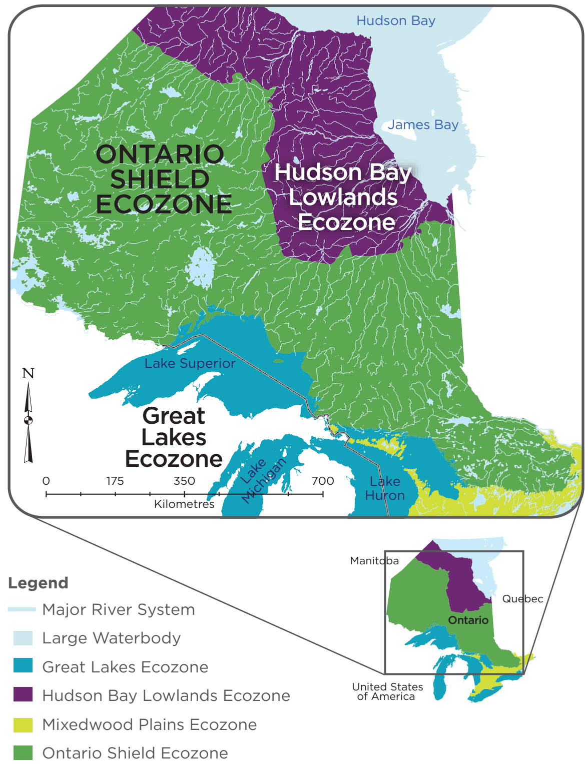


Figure 4. The Ontario Shield Ecozone within Ontario.

Lakes, ponds, and wetlands cover almost 23% of the ecozone. They support diverse and biologically productive vegetation communities and a variety of waterfowl species such as the Bufflehead, American Black Duck, Ring-necked Duck, Common Goldeneye, and Common Merganser. Aquatic furbearers, such as Beaver, Muskrat and American Mink also rely on these aquatic environments.

Chapleau area

The abundant forest, mineral, water, fish and wildlife resources in the Ontario Shield Ecozone provide products and services that are important to the lives of all Ontarians. Anishnabe and Cree Aboriginal communities in the ecozone have traditionally practiced hunting, gathering, fishing and small-scale agriculture. Forest resources are used to produce forest products such as sawlogs, lumber, and paper products. Mineral resources support prospecting, mining, and smelting activities. Water resources drive large-scale hydroelectric developments that supply energy to Ontario's urban and industrial centres. Fish and wildlife resources provide opportunities for recreational fishing and hunting, and nature tourism. There are also agricultural activities in northeastern Ontario, along the north shore of Lake Huron and in the Thunder Bay, Rainy River, Kenora and Dryden areas. These farms are an important source of food for residents of the Ontario Shield Ecozone.

Climate change is affecting the distribution of plants and animals (Root and Schneider 2002; Crozier 2004; Root and Hughes 2005) in the Ontario Shield Ecozone. Over the past century some species have moved northward (Thomas and Lennon 1999; Hitch and Leberg 2007). The migration of plant species is unlikely to keep up with the pace of climate change, so some species may be in jeopardy. Animals that depend on these plants may also be negatively affected (Carlson et al. 2009).

Climate change will also impact wetlands and aquatic ecosystems in the Ontario Shield (Tarnocai 2006; Keller 2007). Warmer temperatures in the Ontario Shield will increase water loss in wetlands (Tarnocai 2006) and lead to drying. This means less habitat may be available for wetland dependent species. Species that thrive in cold water will be threatened by rising water temperatures (Reist et al. 2006). These species may also face more competition for resources and new predators as southern species move northward.

Human impacts such as pollution, hydroelectric developments, the building of roads, and habitat alteration as a result of forestry or mining activities, may make species and ecosystems less able to adapt to climate change. Biodiversity in the Ontario Shield Ecozone is facing increasing threats from climate change, development and resource extraction.

Mixedwood Plains

The Mixedwood Plains is Ontario's smallest and most southerly terrestrial ecozone, making up 8% of the province. The area contains less than 1% of Canada's landmass and is home to about 35% of the country's population (Statistics Canada 2009). It is the most human-dominated ecozone in the country. The Ontario portion of this ecozone encompasses five diverse regions ranging from the bare granite bedrock of the Frontenac Arch to the deep soils of southwestern

Northumberland County

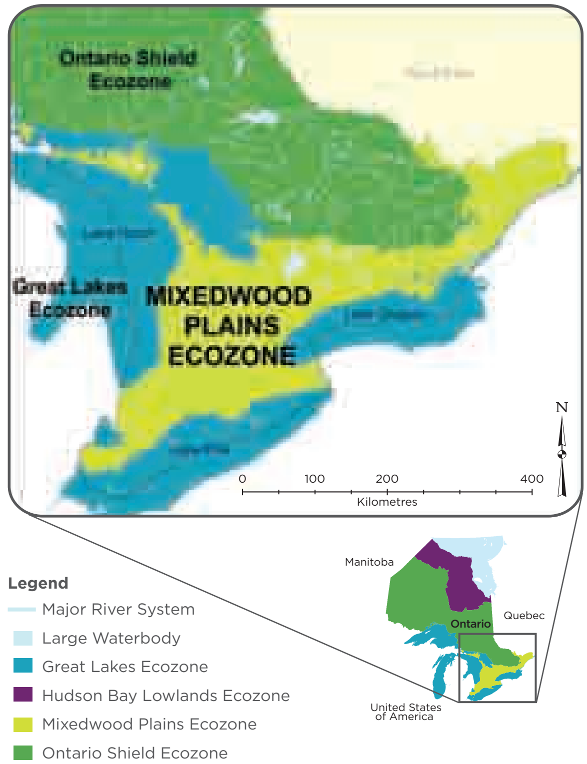


Figure 5. The Mixedwood Plains Ecozone within Ontario.

Ontario. It includes the Niagara Escarpment, the "spine of southern Ontario", characterized by bare bedrock uplands and steep cliffs. Its rich soils, moderate climate and central location made the Mixedwood Plains an attractive place for settlement. Since first European contact, the ecozone has been transformed from a sea of continuous forests and wetlands punctuated by savannahs, prairies and alvars, to a landscape dominated by agriculture and settlement.

Despite the changes that have occurred, the Mixedwood Plains is still the most biologically diverse area of Canada. The area is comprised of Great Lakes-St. Lawrence forest, characterized by American Beech, Sugar Maple and Yellow Birch and also includes the only remnants of Carolinian forests in Canada. Carolinian tree species found in the southernmost part of the ecozone include Black Walnut, Chinquapin Oak, Cucumber Tree (endangered), Sassafras and Tulip Tree. Other Carolinian species include Eastern Mole (special concern), Prothonotary Warbler (endangered), Fowler's Toad (threatened), and Blue Racer (endangered).

This ecozone also supports rare prairie, savannah and alvar habitats. The Pinery Provincial Park–Port Franks area and the Rice Lake Plains contain some of the largest oak savannah woodlands remaining in North America (OMNR 2009a). The Mixedwood Plains contains habitats of continental and global importance such as 48 Important Bird Areas, 3 of Canada's 15 World Biosphere Reserves and six wetlands recognized as internationally significant. The watersheds in the southwestern portion of the Mixedwood Plains have the highest freshwater fish and freshwater mussel diversity in Canada (Staton and Mandrak 2006). Coastal areas adjacent to the Great Lakes provide significant migratory routes for waterfowl, shorebirds, raptors and the Monarch butterfly, and stopover sites for songbirds. Eighty-two percent of Ontario's 199 species at risk are found, or were once found, in the Ontario portion of the Mixedwood Plains Ecozone.

The natural landscape of the Mixedwood Plains provides ecosystem services that are critical to ensuring the high quality of life that the area's residents enjoy. These services include carbon sequestration and air purification from forests and prairies, flood control, water purification and groundwater recharge from wetlands and the recreational opportunities provided by parks and other natural areas. The Ontario portion of the Mixedwood Plains also accounts for almost 25% of Canada's total agricultural production (Statistics Canada 2006). The provision of these ecosystem services to humans depends on the healthy functioning of natural ecosystem processes and functions. Traditional Aboriginal uses include hunting, gathering, fishing and small-scale agriculture. Natural cover remains on significant portions of some Indian Reserves and these areas are important to Ontario's biodiversity.

Habitat loss and fragmentation are the largest pressures on biodiversity in the Mixedwood Plains. Settlement of the area was accompanied by large-scale forest clearance and wetland drainage. In the early 1920s forest cover reached a low of 11% from 90% (Larson et al. 1999). Since then, forest cover has rebounded to approximately 22% (upland forest and swamp), although it is not evenly distributed and some parts of the ecozone have less than 10% forest cover.

CHANGES IN PREDATOR-PREY DYNAMICS IN THE MIXEDWOOD PLAINS ECOZONE

Predator-prey dynamics in the Mixedwood Plains Ecozone have been changed by human settlement, and the associated agricultural, urban and industrial development (Environment Canada 1996). Large predators such as the Wolverine and Cougar no longer occur within the ecozone, and the Gray Wolf, American Black Bear, Canada Lynx, Bobcat, and American Badger, are uncommon and often occur only in small portions of their historic range (Environment Canada 1996). Species more tolerant of conditions in a fragmented, urban landscape, such as the Coyote and Red Fox, have become the primary predators. Mid-size predators like the Raccoon and Striped Skunk have also prospered. Predation by these species is now considered a threat to some species at risk (e.g., turtles).

The absence of large predators, relatively mild winter conditions, abundant food resources, and altered habitat have led to increases in the populations of prey species, such as White-tailed Deer. High densities of White-tailed Deer have been shown to negatively impact forest regeneration and the diversity and abundance of woodland flowering plants in the ecozone (Pearl et al. 2006). This has led to culls to reduce deer densities in some ecologically sensitive areas. Many small mammal populations are also thought to be increasing in the ecozone. For example, the loss of large predators, coupled with a milder climate, have allowed the Virginia Opossum to extend its range (Gardner and Sunquist 2003). The Eastern Cottontail has also become an extremely abundant animal in the region.

Predators are important in the regulation of prey populations and the maintenance of essential ecological processes. Healthy predator populations provide a balance, controlling prey populations and preventing species loss and simplification of the ecosystem. Currently, several species of predators are missing from the Mixedwood Plains Ecozone, fundamentally, and possibly irreversibly, altering the biodiversity of the region.

Aquatic systems have also been affected through the construction of dams and canals, altered flow regimes, habitat alteration, declines in water quality, and the introduction of invasive alien species. The deterioration of cold water lake and stream habitat, and wetland cover has generally continued throughout the last century.

Disturbance of the Mixedwood Plains has had significant, lasting effects. While some species such as Beaver, Fisher and woodland birds are recolonizing parts of their former ranges, habitat loss remains a direct stress and the resulting fragmented habitat limits the ability of species to move, breed and adapt because of a lack of natural corridors and connections. Other trends and impacts related to habitat loss and fragmentation include the rise of opportunistic generalist species (e.g., Raccoon) and the loss of large predators that used to keep the number of prey species (e.g., White-tailed Deer) in check. The ecozone has also been affected by the disruption of natural disturbance regimes (i.e., fire) and the introduction of invasive alien species.

Finally, more than any other ecozone in Ontario, biodiversity in the Mixedwood Plains faces cumulative effects of multiple stressors. While habitat loss is the key issue, pollution, invasive alien species and climate change also pose serious threats to the biodiversity of the Mixedwood Plains Ecozone.

The Great Lakes

The Great Lakes, collectively, are the largest system of surface freshwater on Earth and hold 18% of the world's supply (Government of Canada and United States Environmental Protection Agency 1995). The Great Lakes Ecozone is comprised of five large lakes and their connecting waterways. Parts of four of these lakes occur in Ontario and are shared with the United States (Lakes Superior, Huron, Erie and Ontario). Lake Michigan is entirely within the United States. The Great Lakes include 28,000 km of shoreline (including islands), 5,000 tributaries, 30,000 islands, and have a combined volume of 22,700 km^3.

Shaped by glaciers over 10,000 years ago, the geology of each of the lakes varies significantly from each other. Lakes Huron, Erie, and Ontario are lined by glacial till and outwash deposits, while Lake Superior is lined mainly by bedrock. The Great Lakes reflect the influences of the surrounding terrestrial watersheds, and in turn drain into the Atlantic Ocean via the St. Lawrence River. Coastal areas on the Great lakes contain outstanding examples of cobble beaches, sand dunes, wetlands and alvars. Thousands of islands

Figure 6. The Great Lakes Ecozone.

are scattered throughout the Great Lakes and provide important habitat for nesting and migrating birds (the Great Lakes are located in a significant international migratory bird flyway), and refuges for many additional plant and animal species.

The Great Lakes region is one of the most ecologically diverse regions in North America. Variation in depth, climate, location, and geology all play a role in sustaining a rich diversity of plant and animal species, a few of which are found nowhere else on Earth (e.g., Lakeside Daisy, Dwarf Lake Iris, Kiyi). The Great Lakes once had abundant populations of native fish species, including deepwater ciscoes, Lake Herring, Lake Sturgeon, Lake Trout, and Lake Whitefish. However, human activities such as the construction of dams and other habitat alterations, pollution, historical overfishing, and the introduction of invasive alien species have significantly altered the ecozone and negatively impacted native fish species (OMNR 2009b). Today, aquatic communities are a mix of native and non-native species which continue to develop and change, often in unpredictable ways.

The use of the ecozone's natural resources is directly connected to the health of the Great Lakes. More than forty million Canadians and Americans reside within the Great Lakes basin (SOLEC 2009). The Great Lakes provide water for domestic and commercial use, power for industries, and numerous recreational opportunities. They also support valuable fisheries and are a means for transporting commercial goods. These activities have taken their toll on the ecozone. Water withdrawals, channelization, construction of dams and reservoirs, artificial shoreline hardening, increased runoff, and urbanization have altered the flow and nutrient regimes of the Great Lakes watershed. Climate change has the added potential to further affect this already stressed system. Cumulative effects of multiple stresses have compromised the health of the Great Lakes Ecozone and potentially the health of the human population. Over the last 50 years, there have been many changes to the

Lake Superior

Photo: Ontario Tourism

Great Lakes Ecozone associated with these stresses, and ecosystem changes have often occurred with remarkable speed. Remedial Action Plans have been developed and implemented for specific Areas of Concern where environmental quality has been significantly degraded, and Lakewide Management Plans have been developed that identify actions to assess, restore, protect and monitor the ecosystem health of each Great Lake. Because of the international nature of the Great Lakes, management efforts require the cooperation of state, provincial and national management agencies in the United States and Canada.

The Great Lakes continue to receive significant amounts of nutrients from land-based sources. Changes to the quantity and type of nutrients entering the lakes, shifts in the biological communities, light levels, substrate and temperature have altered the way the lakes respond to nutrient inputs. This has led to harmful algae blooms in the nearshore areas, while at the same time decreasing nutrients and biological productivity in the offshore waters (SOLEC 2009).

Some conditions in the Great Lakes are improving, while others are deteriorating (SOLEC 2009). Lake Superior is generally in good condition with populations of Lake Trout, Bald Eagle, and Peregrine Falcon in recovery. Issues for Lake Huron include major changes in the food web, new diseases, and nearshore algal fouling. Lake Ontario and Lake Erie are facing similar challenges but there has been a significant reduction in some contaminants (e.g., PCBs, DDT) which had previously been of concern.

Interface Between the Great Lakes and other Ontario Ecozones

Although the Great Lakes Ecozone is considered separately from the Ontario Shield and Mixedwood Plains ecozones in this report, the landscapes of these two ecozones are intimately connected to the Great Lakes. The majority of the Mixedwood Plains Ecozone drains into the Great Lakes as does a significant portion of the Ontario Shield Ecozone (Figure 6). These watersheds deliver sediment, nutrients and contaminants to the lakes and provide spawning and nursery areas for many species that reside in the Great Lakes. To a large extent, the physical, chemical, and biological characteristics of the Great Lakes are influenced by the condition of the watersheds on the surrounding landscape and by the stresses that are acting upon them.

Pressures on Ontario's Biodiversity

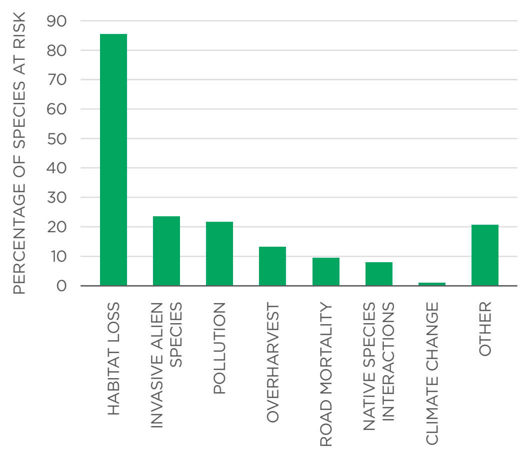
At the global level, human activities over the last 50 years have changed ecosystems rapidly and have resulted in significant and largely irreversible losses in the Earth's biodiversity (MEA 2005). These changes have supported economic development, but have negatively affected the ecosystem services that support life. Ontario's Biodiversity Strategy identifies four main threats to biodiversity that are the result of human actions: habitat loss; invasive species; pollution; and, overharvesting (=unsustainable use) (OBS 2005). The Strategy also acknowledges that climate change and the combined effects of stressors are increasingly placing biodiversity at risk. A driving force behind pressures on Ontario's biodiversity is the province's growing human population. Ontario's population (estimated at 12.9 million in July 2008) is projected to increase by 4.9 million between 2008 and 2036 (OMOF 2009). This section begins with an overall assessment of Ontario's Ecological Footprint, followed by a discussion of each of the threats to the province's biodiversity.

...human activities over the last 50 years have changed ecosystems rapidly and have resulted in significant and largely irreversible losses in the Earth's biodiversity.

Photo: Ontario Tourism

THREATS TO SPECIES AT RISK IN ONTARIO

To help gauge the relative importance of the major threats to species in Ontario, an analysis was conducted of the threat factors affecting species at risk. Information for this analysis was assembled from species status reports prepared by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the Committee on the Status of Species at Risk in Ontario (COSSARO). All identified threats that are currently operating and those that contributed to historical declines for each species were included in the analysis. Most species had more than one known threat.



THREAT FACTORS FOR SPECIES AT RISK IN ONTARIO (*n* = 199)

This analysis shows that the predominant threat to species at risk in Ontario is habitat loss, affecting 85% of 199 species. Similar analyses in Canada, the United States, and globally have also shown that habitat loss is the greatest threat, affecting 79–89% of listed species (Wilcove et al. 1998; Baille et al. 2004; Venter et al. 2006). Invasive alien species and pollution each affected close to 20% of Ontario's listed species. Climate change is identified as a known threat for only two species, although it is mentioned as a possible threat for several species that have recently been assessed.

Ecological Footprint, Biocapacity and Biodiversity

Human activities affect biodiversity directly through habitat alteration, introduction of invasive species, pollution, overharvesting of species, and climate change. These stresses often operate together and result in the unsustainable use of the planet's biological capacity. To manage biological capacity sustainably, resources must not be used more quickly than our ecosystems can regenerate them. At a global scale, our resource consumption levels are estimated to exceed the Earth's regenerative capacity by 30% and have more than doubled over the last four decades. Over a similar time period, global biodiversity has declined (WWF-Canada and Global Footprint Network 2007). While discrete threats to biodiversity can be identified (e.g., the loss of forest habitat to urban development), the overall unsustainable use of biological resources—driven by human consumption patterns, technology and population levels—represents a suite of cumulative stresses on biodiversity and is the overarching factor driving biodiversity loss.

The Ecological Footprint is a metric that assesses humanity's demand for certain natural resources and identifies whether our collective consumption levels are approaching or exceeding the Earth's ecological limits. The Ecological Footprint is widely recognized as an important first measure of environmental sustainability and is used by governments and institutes worldwide. The Conference of the Parties to the Convention on Biological Diversity has included the Ecological Footprint (and related concepts) in its suite of indicators to assess progress toward reducing the rate of biodiversity loss. The strength of the Ecological Footprint as a biodiversity indicator is that it makes a direct comparison between resource availability and resource consumption and looks at total human demand on global ecosystems rather than giving a limited view of the sustainable use of a single commodity or industry.

This metric is divided into two parts. The Ecological Footprint of consumption measures human demand for resources based on a given population's total consumption of goods and services (e.g., food, housing, transportation). This is directly compared to biocapacity which captures the extent and productivity of key ecosystems that support human populations, in terms of the products these ecosystems provide (including food, fibre and timber, and capacity to absorb carbon dioxide emissions). These measures are human-centred and only include products and services provided by ecosystems that can be directly harvested for human use (food, fibre and timber) or that provide carbon dioxide sequestration services.

According to the 2008 National Footprint Accounts, the global Ecological Footprint in 2005 was 17.4 billion global hectares (gha) or about 2.7 gha per person. In comparison, the world's biocapacity (or total supply of bioproductive land) was only 13.6 billion gha, or 2.1 gha per

CALCULATING THE ECOLOGICAL FOOTPRINT AND BIOCAPACITY

The Ecological Footprint is measured in global hectares, or actual hectares of land weighted according to the bioproductive capacity of each type of land. An Ecological Footprint of 5 global hectares per person means that it takes 5 ha of world average productive land and water to support consumption and waste assimilation. This provides a holistic picture of all resource demand regardless of where it takes place or what type of land is utilized.

The Ecological Footprint is calculated by taking the total mass of each product consumed (tonnes of wood, for example), dividing by yield for that product (in tonnes per hectare), then multiplying by the yield and equivalence factors. These two factors account for regional differences in yield for a particular land-use type as well as differences in productivity between different land-use types. Biocapacity is calculated by multiplying the area devoted to each land-use type (e.g., forest land) by these same two factors.

Source data for Ontario's Ecological Footprint and biocapacity come from a number of international organizations, including the United Nations Food and Agriculture Organization and the International Energy Agency, as well as Statistics Canada, the Ontario Ministry of Agriculture, Food and Rural Affairs, and the Ontario Ministry of Natural Resources. More details on how the Ecological Footprint and biocapacity are calculated are available on the Global Footprint Network web site (**www.footprintnetwork.org/**).

person. This situation, in which the Ecological Footprint of consumption exceeds available biocapacity, is termed ecological overshoot. We have been in a mode of deficit spending with our ecological accounts since the mid 1980s. As stated by Mathis Wackernagel, President of the Global Footprint Network: "For years, our demand on nature has exceeded, by an increasingly greater margin, the budget of what nature can produce. The urgent threats we are seeing now—most notably climate change, but also biodiversity loss, shrinking forests, declining fisheries, soil erosion and freshwater stress—are all clear signs: Nature is running out of credit to extend." If humanity continues the trend we see now, by 2050 we will be consuming the resource equivalent of two planets each year. These levels of resource use and waste generation will continue to erode the planet's biodiversity and will degrade the ability of the planet to meet even basic human needs in the future. The information presented for this indicator represents a summary of a technical report prepared by the Global Footprint Network (Stechbart and Wilson 2010).

INDICATOR—Ontario's Ecological Footprint and Biocapacity

On a per-person basis, Ontario residents are among the global populations placing the highest demand on the planet's resources. In 2005, the average Ecological Footprint in Ontario was 8.4 gha per person (Figure 7). Ontario's Ecological Footprint is exceeded only by the United Arab Emirates, the United States and Kuwait. It is also considerably higher than the average Canadian Ecological Footprint of 7.1 gha.

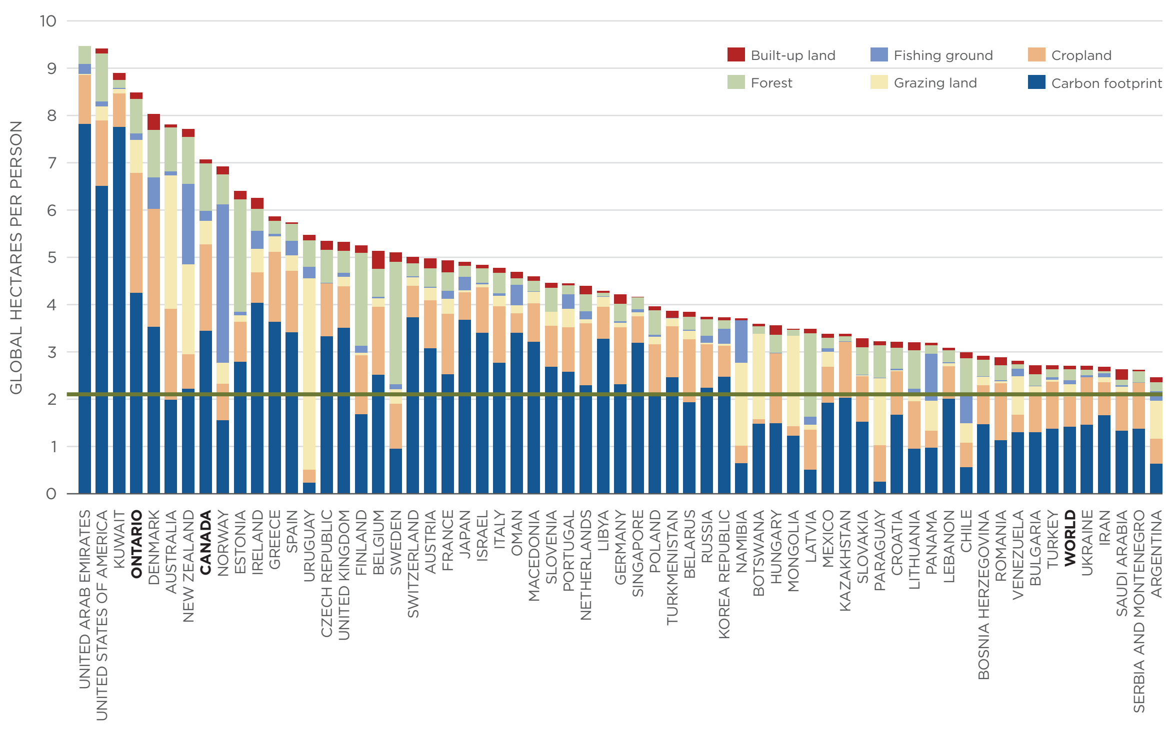


Figure 7. Ontario's Ecological Footprint compared to the Ecological Footprints of a selection of countries with available data, 2005 (horizontal green line represents average world biocapacity of 2.1 gha per person) (source: Stechbart and Wilson 2010).

Ontario's average Ecological Footprint can be attributed to a number of factors, including a high level of affluence and household economic demand, an industrial sector that requires high resource inputs, and a large amount of transportation-based carbon emissions. When assessed by consumption types, products derived from the agriculture sector are the largest contributor to the Ecological Footprint, and Ontarians purchase and use about 40% more than the average Canadian quantities of food and fibre products (derived from cropland). The second largest portion of the Ontario Footprint of personal consumption is associated with housing—both the resources that go into building a home and those that go into maintenance, heating and repair.

When assessed by land use type, the carbon footprint, expressed as the amount of world average forest land required to store carbon dioxide emissions, makes up half of the average Ontarian's Ecological Footprint. The second largest land-use type is cropland, making up almost a quarter of the Footprint (Table 1).

Ontario residents surpass the Canadian average Ecological Footprint of 7.1 gha due to higher levels of overall personal

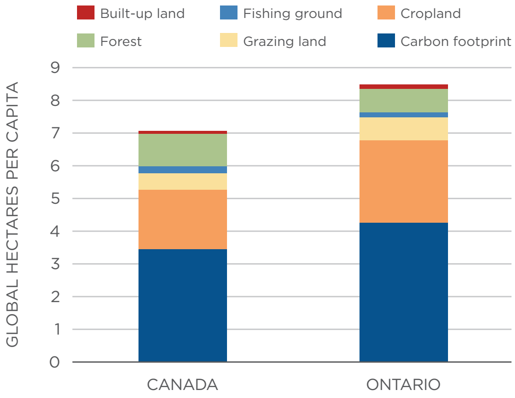


Figure 8. Comparison of the average Ecological Footprints of Canada and Ontario, 2005 (source: Stechbart and Wilson 2010).

consumption of goods and services (Figure 8). The per capita Canadian Ecological Footprint has followed a strong upward trend over the past 40 years. While time series data is not available for Ontario specifically, it is likely that the Footprint of the average Ontario resident has also increased over this time period.

In 2005, the average biocapacity in Ontario was 8.5 gha per person. However, while Ontario enjoys a biocapacity that is four times larger than the world average avail-able per person, Ontario's biocapacity is substantially lower than the Canadian

Table 1. Composition of Ontario's Ecological Footprint in global hectares per capita, 2005 (source: Stechbart and Wilson 2010).

	CROP-LAND	GRAZING LAND	FOREST LAND	FISHING GROUNDS	CARBON FOOT-PRINT	BUILT-UP LAND	TOTAL
Food	0.97	0.27	0.15	0.11	0.88	0.02	2.39
Housing	0.23	0.06	0.16	0.00	0.72	0.02	1.20
Mobility	0.24	0.07	0.09	0.00	0.97	0.02	1.39
Goods	0.52	0.14	0.12	0.01	0.71	0.02	1.53
Services	0.32	0.09	0.09	0.01	0.54	0.02	1.08
Governance	0.24	0.07	0.09	0.01	0.43	0.03	0.86
Total	2.52	0.69	0.71	0.14	4.24	0.13	**8.45**

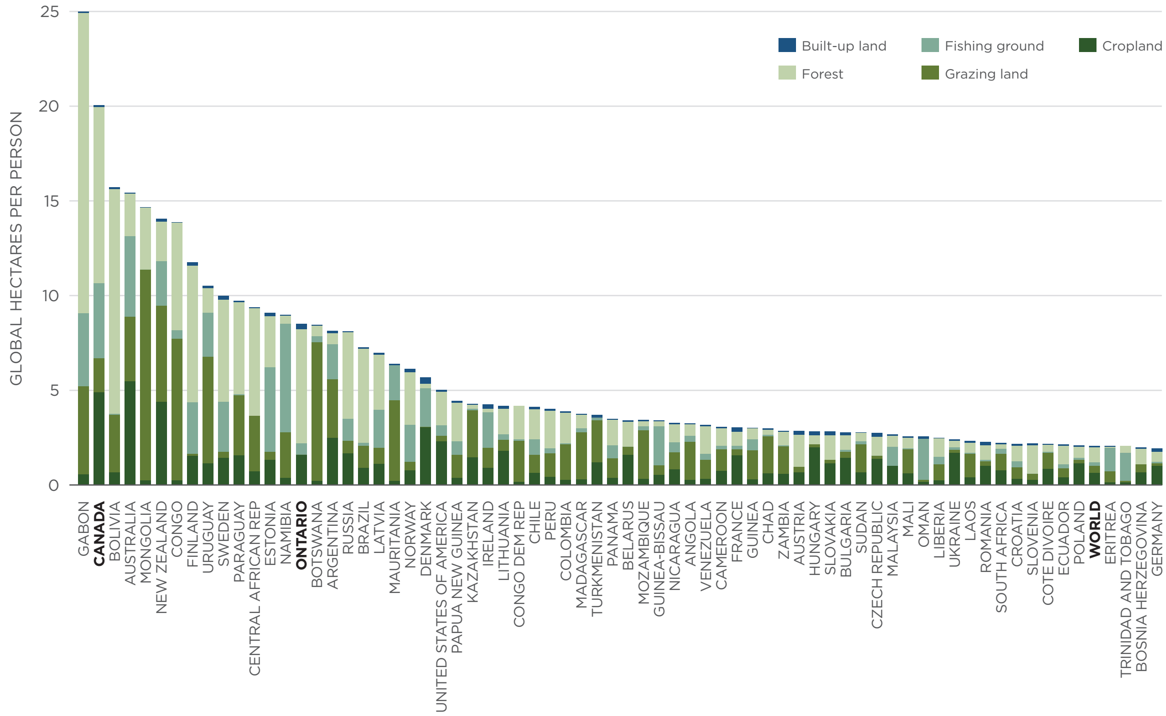


Figure 9. Ontario's biocapacity compared to a selection of countries with available biocapacity data, 2005 (source: Stechbart and Wilson 2010).

average of 20.1 gha per person. This is expected given that Ontario comprises only 11% of the total Canadian land area, but is home to more than 38% of Canada's population. Ontario residents had less biocapacity available in 2005 than the top ten nations as ranked by per capita biocapacity, a group which includes Canada itself (Figure 9). When compared to the Canadian average, Ontario has 33% as much cropland biocapacity, 62% as much forest land biocapacity, and 10% as much grazing land biocapacity (Figure 10).

The bulk of Ontario's biocapacity resides in forests in the Ontario Shield Ecozone where human population density is relatively low and direct impacts on biodiversity are addressed through forest management practices. Most of the agricultural activity in Ontario occurs in the Mixedwood Plains Ecozone where the bulk of Ontario's cropland biocapacity is located. Ontario's biocapacity is equivalent to Ontario's Ecological Footprint on a per-person basis. This means that there will be increased pressures on biodiversity as the population grows unless the average ecological Footprint is reduced or biocapacity is enhanced through restoration efforts.

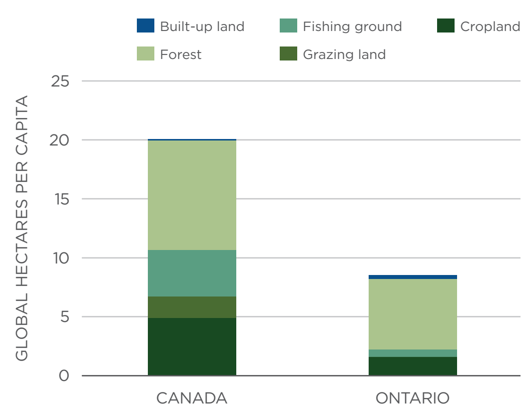


Figure 10. Comparison of biocapacity of Canada and Ontario, 2005 (source: Stechbart and Wilson 2010).

Photo: Ontario Tourism

- The Ecological Footprint provides a good overview of the demands that Ontarians are placing on the province's biodiversity based on their consumption patterns.
- On a per-person basis, Ontario residents are among the global populations placing the highest demands on the planet's resources. If everyone in the world lived comparable lifestyles to the residents of Ontario, humanity would require the resources of four planets to support itself.
- Only three of 150 countries with reported Ecological Footprint data have a higher average per-person Ecological Footprint than Ontario.
- Carbon emissions and cropland are the largest elements of the Footprint by land type. Food is the most significant component of Ontario's Footprint by consumption type, exceeding transportation, the next largest component.
- The capacity of the province's biological resources to support these demands is limited. On a per capita basis, Ontario has much less biocapacity available than Canada overall. Surpassing Ontario's biocapacity can cause the loss of biodiversity and ecosystem services that provide benefits to people.

TREND
BASELINE

DATA CONFIDENCE
MEDIUM

Habitat Loss

Habitat loss and fragmentation are widely recognized as the main causes of increased species extinction, and are perhaps the most important conservation issues in the world today (Sala et al. 2000; Fahrig 2003; Venter et al. 2006). They are major threats to biodiversity across Canada and around the world. Over the past 50 years the Earth's habitats and ecosystems have been altered more quickly and more extensively then in any other comparable period of human history (Secretariat of the Convention on Biological Diversity 2006). Habitat loss is the outright loss of areas used by wild species. It fundamentally impacts the extent to which ecosystems can

CUMULATIVE EFFECTS OF PRESSURES ON ONTARIO'S BIODIVERSITY

Human pressures on Ontario's biodiversity are often treated as if they act in isolation. In reality, Ontario's species and ecosystems usually face more than one pressure at the same time. This can include multiple instances of the same type of pressure (e.g., numerous water withdrawals over a watershed), or different pressures acting on the same system (e.g., fragmentation of forest habitat combined with the invasion of alien plant species). In many cases the combined impacts or cumulative effects of environmental stressors are greater than the sum of their individual effects. Multiple stressors have been demonstrated to impact both aquatic and terrestrial ecosystems (Vinebrooke et al. 2004) and result in a slower recovery time to disturbance (Jones and Schmitz 2009).

Changes observed in Swan Lake, near Sudbury, provide a good illustration of the interactions among stressors. Sulphur and metal emissions from metal smelters in the Sudbury area led to widespread terrestrial and aquatic damage in the region (Gunn 1995). Large-scale emission reduction programs were implemented in the 1970s and 1990s. Like many other lakes in the region, the pH in Swan Lake increased from the early to mid 1980s. The lake then re-acidified in 1988 as the pH declined from about 5.7 to about 4.5 (Keller 2009). A change in the weather caused this re-acidification (Keller 2009). Between 1986 and 1987 there was a prolonged drought that caused watershed soils and sediments on the lake shore to dry. Sulphur and metals stored in these soils and sediments were released and entered the lake when wet conditions returned (Keller et al. 1992). The nature of the lake was changed in many ways. Metal concentrations in the lake increased, temperatures at the bottom of the lake rose, and the water became clearer and could be more easily penetrated by ultraviolet radiation (Yan et al. 1996). This had dramatic effects on the communities of microscopic plants and animals in the water (Arnott et al. 2001).

support viable populations of plants and animals. Habitat fragmentation occurs when large, uninterrupted areas that support wild species are broken into smaller, isolated areas. It occurs across terrestrial and aquatic landscapes and can disrupt essential ecological processes such as pollination, seed dispersal, wildlife migration, and breeding (Fahrig 2003).

In Ontario, habitat loss and fragmentation are defining characteristics of much of the settled landscape. A large amount of natural habitat in the southern part of the province has been altered, degraded, or lost as a result of changes in landuse such as the construction of settlements, buildings, roads and dams, agricultural use of the land, and the extraction of natural resources like gravel and forest products. In southern Ontario, forest cover was reduced from a high of 90% to a low of about 11% by the early 1920s. Forest cover in this region has since rebounded to about 22% (OMNR 2009a). In 1982 there was about 68% less wetland area in southern Ontario than in pre-settlement times (OMNR 2009a). Drainage and filling of wetlands for agriculture and urban development continue to result in the loss, fragmentation and degradation of wetland habitat. In the more northern parts of the province, resource extraction activities like forestry and mining, hydro-electric power development, and the systems of roads and bridges needed to access them, are putting increasing pressure on natural habitats and the diversity of species within them. In this section, indicators are included on land cover types by ecozone, road density, and stresses to aquatic habitats.

INDICATOR—Percentage of Land Cover Types in Ontario

Changes in land cover can provide critical information on broad-scale ecosystem changes and the causes and impacts of these changes. This indicator shows the proportion of land cover types in each of Ontario's terrestrial ecozones. The information presented reflects varying threats to biodiversity, under the assumption that human-modified landscapes experience greater habitat loss and fragmentation than more natural landscapes. Over time, this indicator will provide information on changes in percent cover within each ecozone.

The land cover types are: anthropogenic cover, aquatic cover, disturbance cover, natural disturbance cover and natural terrestrial cover. Built-up areas, agricultural areas, roads, and areas where natural resources such as gravel are extracted are considered anthropogenic cover. Aquatic cover includes inland lakes, rivers and streams, and portions of the Great Lakes. Disturbance cover is defined as forests that were harvested between 2001 and 2005. Natural disturbance cover refers to forests in which there have recently been fires. While some disturbances are caused by human activities, it's important to note that disturbances are a natural part of any ecosystem and are necessary to maintain biodiversity. Natural terrestrial cover includes alvars, mudflats, prairies, savannahs, wetlands, forests, rock and tundra.

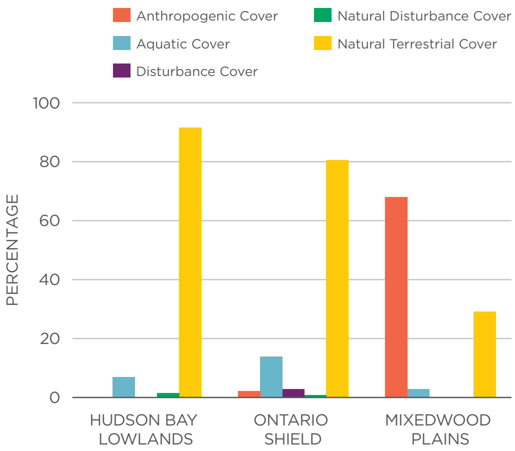


Figure 11. Percentage land cover composition for the Hudson Bay Lowlands, Ontario Shield and Mixedwood Plains ecozones (adapted from Ontario Parks 2009, note: totals may not sum to 100% because of areas not classified due to cloud cover).

- Anthropogenic cover is highest in the Mixedwood Plains (68%), but is very low in the Ontario Shield (2%) and the Hudson Bay Lowlands (< 1%). Agriculture accounts for 55% of the anthropogenic cover in the Mixedwood Plains. These agricultural landscapes are an important source of food for Ontarians and provide food, fuel, and fibre to consumers beyond Ontario.
- Aquatic cover is highest in the Ontario Shield (14%), followed by the Hudson Bay Lowlands (7%) and the Mixedwood Plains (3%).
- Disturbance cover is highest in the Ontario Shield (2.7%) and lowest in the Mixedwood Plains (< 1%).

- Natural disturbance cover is highest in the Hudson Bay Lowlands (1.5%), followed by the Ontario Shield (0.7%), and the Mixedwood Plains (almost zero). In the Hudson Bay Lowlands most fires are allowed to burn naturally. In the rest of Ontario most fires are supressed.
- Natural terrestrial cover is highest in the Hudson Bay Lowlands (92%), followed closely by the Ontario Shield (81%), and the Mixedwood Plains (29%).
- There is significant habitat loss and fragmentation in the human-dominated south and relatively little in the north.

TREND
BASELINE

DATA CONFIDENCE
MEDIUM

INDICATOR—Road Density in Southern Ontario

Southern Ontario is one of the most biologically diverse areas in Canada, but also has a higher density of roads than any other region in the country. Very few areas with natural terrestrial cover within southwestern and central Ontario are more than 1.5 km from existing roads (OMNR 2009c). The Bruce Peninsula, Frontenac Arch and eastern Ontario have more natural terrestrial areas close to roads than any other regions in southwestern and central Ontario (OMNR 2009c). Roads impact biodiversity in a number of ways. Roads have negative effects on wildlife and are recognized as a major contributor to the global biodiversity crisis for some species (Forman and Alexander 1998; Trombulak and Frissel 2000; Coffin 2007). When roads are built, vegetation is cleared and habitat is directly lost. Roads can also act as a barrier to movement for some species and result in populations of some species becoming isolated from one another. They can also prevent some species from accessing resources that they need to survive. Roads directly threaten the lives of wildlife, as some individuals are killed by traffic (Jaeger et al. 2005). There is also evidence that traffic noise can affect breeding behaviour and reproductive success (Warren et al. 2006), and pollution from roads, such as road salt, can affect some species (Forman and Alexander 1998; Sanzo and Hecnar 2006).

Many species, including several of Ontario's species at risk, are negatively impacted by Ontario's road network. Some examples include Blanding's Turtle, Eastern Foxsnake, Massasauga, Eastern Loggerhead Shrike, Eastern Wolf and American Badger (Ontario Road Ecology Group 2010).

Amphibians are very vulnerable to road mortality since they don't tend to avoid roads, move relatively slowly, and have a high tendency to disperse and move about freely (Eigenbrod et al. 2009). A study of 34 ponds along Highway 401 in eastern Ontario showed that amphibian species richness is affected up to 800 m from the highway. Green Frog and Leopard Frog abundance increased with increasing distance from the highway (Eigenbrod et al. 2009).

Changes in the total length of roads over time are used as an indicator of habitat loss and fragmentation in southern Ontario. The information comes from a study by Fenech et al. (2000) that looked at changes in lengths of major roads of different types between 1935 and 1995. They digitized road maps of southern Ontario for each decade from 1935 to 1995 for the analysis. Data are presented for all of southern Ontario, and separately for the Niagara Escarpment and the Oak Ridges Moraine. For this analysis southern Ontario includes Algonquin Park and all of Ontario south of Algonquin Park and the north shore of Georgian Bay (i.e., all of the Mixedwood Plains Ecozone and a small southern portion of the Ontario Shield Ecozone). The Niagara Escarpment and the Oak Ridges Moraine are significant natural features in southern Ontario and support a diversity of species and ecosystems. Figure 12 illustrates how major road networks in southern Ontario changed between 1935 and 1995. Major road changes on the Niagara Escarpment and the Oak Ridges Moraine are presented in Figure 13.

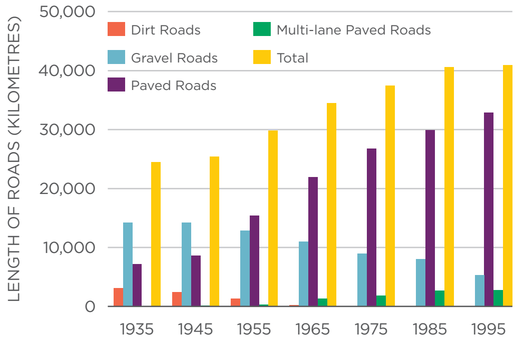


Figure 12. Major road changes in southern Ontario, 1935 to 1995 (source: Fenech et al. 2000).

- The total length of roads in southern Ontario increased from 24,445 km in 1935 to 40,909 km in 1995.
- Paved roads increased from 7,133 km in 1935 to 32,857 km in 1995.
- There were no multi-lane paved roads in southern Ontario in 1935. By 1995 there were 2,780 km of multi-lane paved roads in the region.
- There were 3,084 km of dirt roads in southern Ontario in 1935. Since 1975 no major dirt roads have appeared on southern Ontario road maps.
- Gravel roads decreased from 14,228 km in 1935 to 5,272 km in 1995.

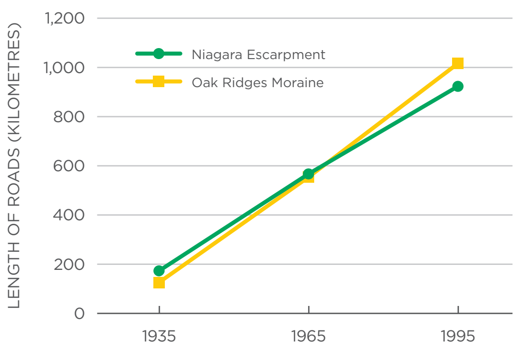


Figure 13. Major road changes on the Niagara Escarpment and the Oak Ridges Moraine, 1935 to 1995 (source: Fenech et al. 2000).

- Major roads on the Niagara Escarpment increased from 173 km in 1935 to 923 km in 1995. The number of roads intersecting the Niagara Escarpment has increased since 1935. In 1995 multi-lane highways crossed the escarpment at nine different spots (Fenech et al. 2000). These intersections are barriers to wildlife movement.
- Major roads on the Oak Ridges Moraine increased from 126 km in 1935 to 1016 km in 1995. In 1995 there were four multi-lane highways crossing the Oak Ridges Moraine (Fenech et al. 2000). Most roads on the Oak Ridges Moraine run north to south, creating a series of barriers to wildlife movement.

TREND
DETERIORATION

DATA CONFIDENCE
MEDIUM

INDICATOR—Extent of Anthropogenic Corridors in the Ontario Shield Ecozone

The effects of roads on biodiversity in the Ontario Shield Ecozone depend on their location, the density of road corridors and their level of use (OMNR 2007a). A higher density of road corridors is more likely to negatively impact upon biodiversity. The construction of roads and their resulting footprints directly remove habitat from the landscape. Although the total landscape area that is affected is relatively small, road corridors can affect biodiversity in several other ways. Some wildlife species are particularly vulnerable to mortality from vehicle collisions (e.g., turtles and amphibians) and the increased access provided by new roads can lead to increased harvest of wildlife species by humans, easier access by predators such as wolves, and facilitate invasions by alien species. Road corridors can also fragment aquatic and terrestrial habitats and affect the use of these habitats by wildlife species.

This indicator assesses the density of anthropogenic corridors (based on unclassified land = roads, landings, gravel pits, railways, utility corridors, airports, built-up lands) within the area of the Ontario Shield Ecozone where commercial forestry takes place (Area of the Undertaking). The analysis is based on information from the Forest Resources Inventory (OMNR 2007a). In forested areas, the majority of the anthropogenic corridors are associated with forest access roads. Information on corridor density is reported based on data from 2005 (Figure 14). Changes in corridor density between 2001 and 2005 are also reported (Figure 15). The proportion of area in anthropogenic corridors in the Area of the Undertaking increased slightly from 1.87% to 1.89% of the land base between 2001 and 2005. Annual construction of forest access roads in Ontario decreased from about 1,000 km in 1997 to 400 km in 2005 (OMNR 2007a, 2008a). A more detailed analysis of trends in forest access road construction, maintenance and abandonment activities is available in State of the Forest Report 2006 (OMNR 2007a).

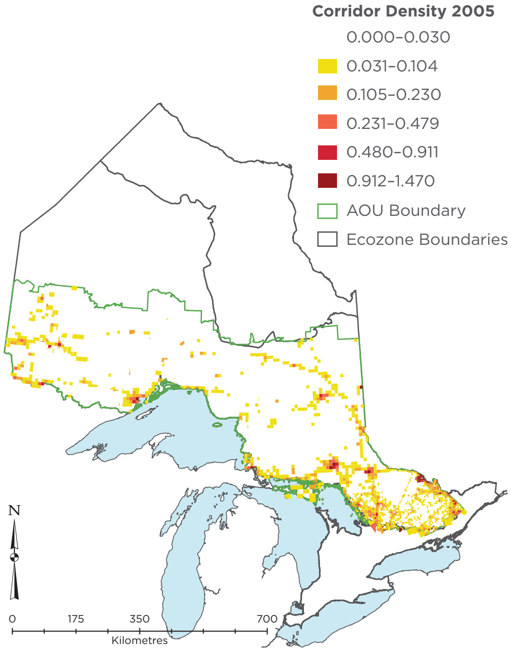


Figure 14. Density of anthropogenic corridors (% of landscape) within the Area of the Undertaking in the Ontario Shield Ecozone, 2005 (source: OMNR 2007a).

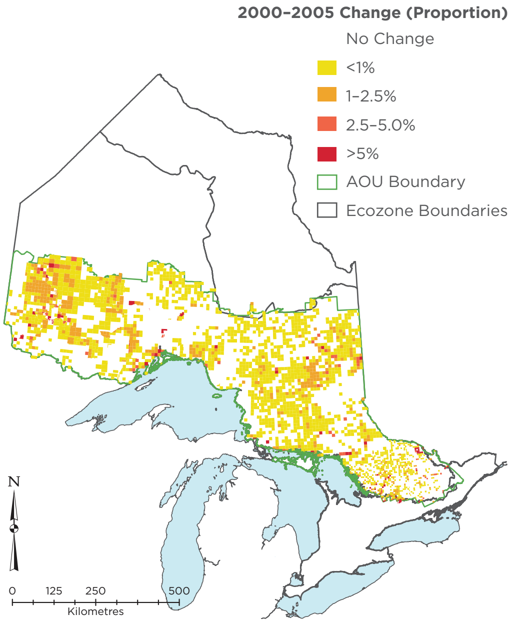
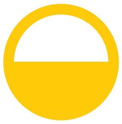


Figure 15. Proportional increase in the density of anthropogenic corridors in the Area of the Undertaking in the Ontario Shield Ecozone, 2001–2005 (source: OMNR 2007a).

- Within the Area of the Undertaking (area of commercial forest activity) in the Ontario Shield Ecozone, road densities are highest in the southeastern portion of the ecozone and in the vicinity of urban centres.
- Between 2001 and 2005, the area of anthropogenic corridors increased by 0.02% associated largely with the construction of new forest access roads. An improved inventory of existing forest access roads also contributed to this increase.
- Annual construction of new forest access roads decreased between 1997 and 2005.

TREND
BASELINE

DATA CONFIDENCE
MEDIUM



INDICATOR—Aquatic Stress Index

Habitat loss is a major threat to freshwater aquatic systems around the world (MEA 2005; Helfman 2007). The loss, degradation and fragmentation of aquatic habitats is the main factor negatively impacting fish species at risk in North America, Canada, and Ontario (Dextrase and Mandrak 2006; Jelks et al. 2008; this document). Aquatic habitats can be affected directly by in-water activities (e.g., dredging, filling, dams), shoreline alterations (e.g., rock and concrete reinforcements, removal of riparian vegetation), as well as by large-scale alterations of the landscape (e.g., urban subdivisions). Because water from rain events flows off the land, the conditions of streams tend to reflect the conditions of their surrounding watersheds.

Despite the well-known impacts of habitat loss and alterations on aquatic biodiversity, the actual amount of aquatic habitat that has been impacted has not been assessed at a broad level in Ontario. Therefore, this indicator uses the Stress Index from Chu et al. (2003) to represent the relative intensity and distribution of threats that are affecting aquatic habitats in Ontario (Figure 16). The Stress Index was developed to identify the intensity of human stressors for each tertiary watershed across Canada and incorporates census data from Statistics Canada on agriculture, waste facilities and discharge sites, petroleum manufacturing, forestry, dwelling density, and road density (Chu et al. 2003). The Stress Index does not include dams, but does consider some factors that relate directly to pollution as opposed to habitat loss (e.g., discharge sites). Although the Great Lakes themselves are not included in the Stress Index, coastal habitats and nearshore areas would be impacted by stresses in adjacent watersheds.

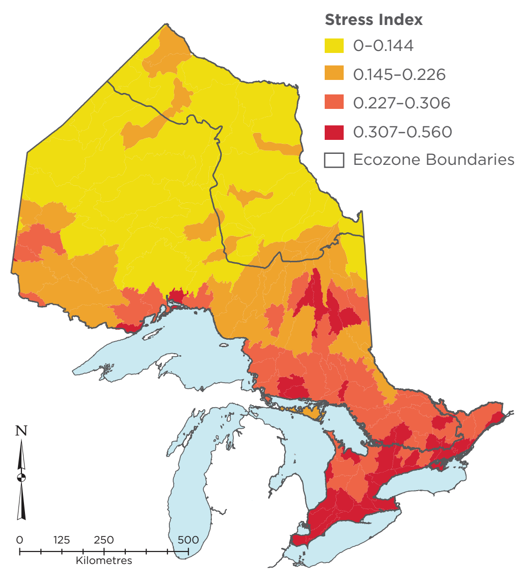


Figure 16. Stress Index for tertiary watersheds in Ontario based on Chu et al. (2003). Higher Stress Index scores represent a higher level of stress to aquatic ecosystems. (© 2003 NRC Canada or its licensors—reproduced with permission)

- Watersheds in the Mixedwood Plains Ecozone have the highest Stress Index values, suggesting that aquatic habitat loss and degradation is highest in this part of the province.

- Watersheds in the southern part of the Ontario Shield Ecozone have high Stress Index values as do watersheds near population centres elsewhere within the ecozone. The northwestern portion of the ecozone has low Stress Index values.
- Watersheds in the Hudson Bay Lowlands Ecozone have low Stress Index values.

TREND
BASELINE

DATA CONFIDENCE
MEDIUM

Invasive Alien Species

Invasive alien species are one of the main threats to biodiversity at the global level (MEA 2005). Alien species are species of plants, animals, and micro-organisms introduced by human action outside their natural past or present distribution (Government of Canada 2004). These species are introduced through a variety of pathways (e.g., fish stocking, ballast water of ships, escape of garden plants). Some alien species thrive due to reduced predation and competition which may lead them to become invasive. *Invasive* alien species are those harmful alien species whose introduction or spread threatens the environment, the economy, or society, including human health (Government of Canada 2004). Invasive alien species often act together with threats such as habitat loss and climate change to accelerate the loss of Ontario's biodiversity. Well-known examples of invasive alien species in Ontario include Zebra Mussel, Emerald Ash Borer, Dutch Elm Disease, Purple Loosestrife, and the European strain of Common Reed (*Phragmites*).

Emerald Ash Borer

...invasive alien species can devastate native species and ecosystems.

Photo: OMNR

With very little limiting their distribution and abundance, invasive alien species can devastate native species and ecosystems. A striking example is the catastrophic decline and elimination of native mussel species from infested areas of the lower Great Lakes within a few years of the Zebra Mussel invasion in the late 1980s (Metcalfe-Smith et al. 1998). Three Ontario tree species have been listed as endangered (American Chestnut, Butternut, Flowering Dogwood) due to the impacts of invasive alien fungal diseases. Even native Ontario species like Rock Bass and Smallmouth Bass can become invasive alien species when they are introduced into water-bodies outside their natural range. In addition to their significant ecological impacts, invasive alien species can have a considerable effect on the economy. Annual costs associated with damages from invasive plant pests on agricultural crops and forestry in Canada are estimated at

$7.5 billion and estimates of cumulative costs of Zebra Mussels alone in the Great Lakes range from $3 billion to $7.5 billion (Government of Canada 2004). Invasive alien species can also affect human health (e.g., West Nile Virus) and have social impacts (e.g., Zebra Mussels fouling beaches and cutting swimmer's feet).

There are far more alien species established within Ontario than in other Canadian provinces and territories. The latest Canadian assessment of the General Status of Wild Species identified 1056 alien species in Ontario for the species groups assessed (vertebrates, vascular plants, five groups of invertebrates) (CESCC 2006). Québec and British Columbia were closest to Ontario with 773 and 699 alien species, respectively. Ontario also has the greatest number of invasive alien plant species (441 species) in Canada (Canadian Food Inspection Agency 2008). Southern Ontario has a relatively high risk of invasion by new alien species due its warmer climate, altered landscapes, dense population and transportation and trade patterns. A recent assessment of 162 invasive alien plant species for which distribution information was available showed that the Mixedwood Plains Ecozone (a portion of which is in southern Québec) had more invasive species (139 species) than any other ecozone in Canada (Canadian Food Inspection Agency 2008).

INDICATOR—Cumulative Number of Aquatic Alien Species in the Great Lakes

This indicator summarizes the cumulative number of alien species in the Great Lakes and the rate at which introductions have occurred. Although it would be more informative to include information on terrestrial and aquatic species in each of Ontario's ecozones, comparable information on the distribution of alien species and their introduction dates is not currently available. The information from the Great Lakes is based on a database developed from published studies (Mills et al. 1993; Ricciardi 2006) that has been updated with unpublished data from Dr. A. Ricciardi from McGill University. There are some important caveats with respect to the information used for this indicator: some species established in U.S. waters of the Great Lakes and not yet found in Ontario waters are included; species native to one part of the Great Lakes basin that have been introduced to a new part of the basin are not included; and potential alien species whose origins are not clearly known are not included. It is also highly likely that additional alien species are present and have not yet been found. However, this database is the best available information and is a good indicator of the risk to Ontario's biodiversity posed by alien species in the Great Lakes Ecozone.

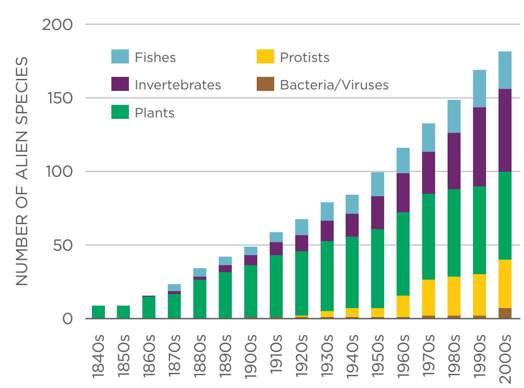


Figure 17. Cumulative number of aquatic alien species in the Great Lakes by decade (note: protists includes algae, diatoms and protozoans) (source: Mills et. al. 1993; Ricciardi 2006; A. Ricciardi, McGill University, unpublished data).

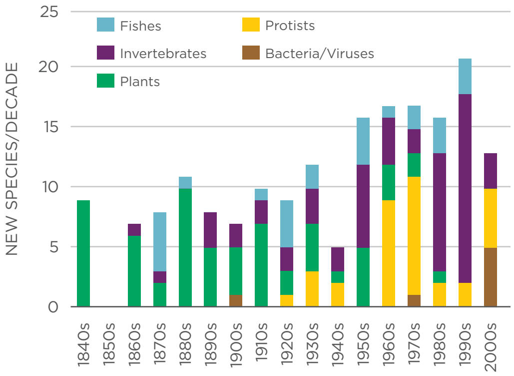


Figure 18. Number of new aquatic alien species discovered in the Great Lakes per decade (note: protists includes algae, diatoms and protozoans) (source: Mills et. al. 1993; Ricciardi 2006; A. Ricciardi, McGill University, unpublished data).

- The number of aquatic alien species in the Great Lakes basin has steadily increased since the first species was documented in the 1840s. As of 2009, 186 alien species were present.
- The rate of new introductions has increased. Between 1840 and 1950, 7.8 new species were discovered per decade. Since 1950, this has increased to 16.8 new alien species per decade. This increased rate of introduction coincides with the opening of the St. Lawrence Seaway in 1959. It may also reflect increased detection efforts.
- The apparent decrease in the rate of new alien species discovered since 2000 may be real or it may reflect that detection efforts for the period 2001–2010 are not yet complete.
- Since 2000, four new alien bacteria and viruses that cause fish diseases have been discovered including Viral Hemorrhagic Septicemia (VHS).

TREND
DETERIORATION

DATA CONFIDENCE
HIGH

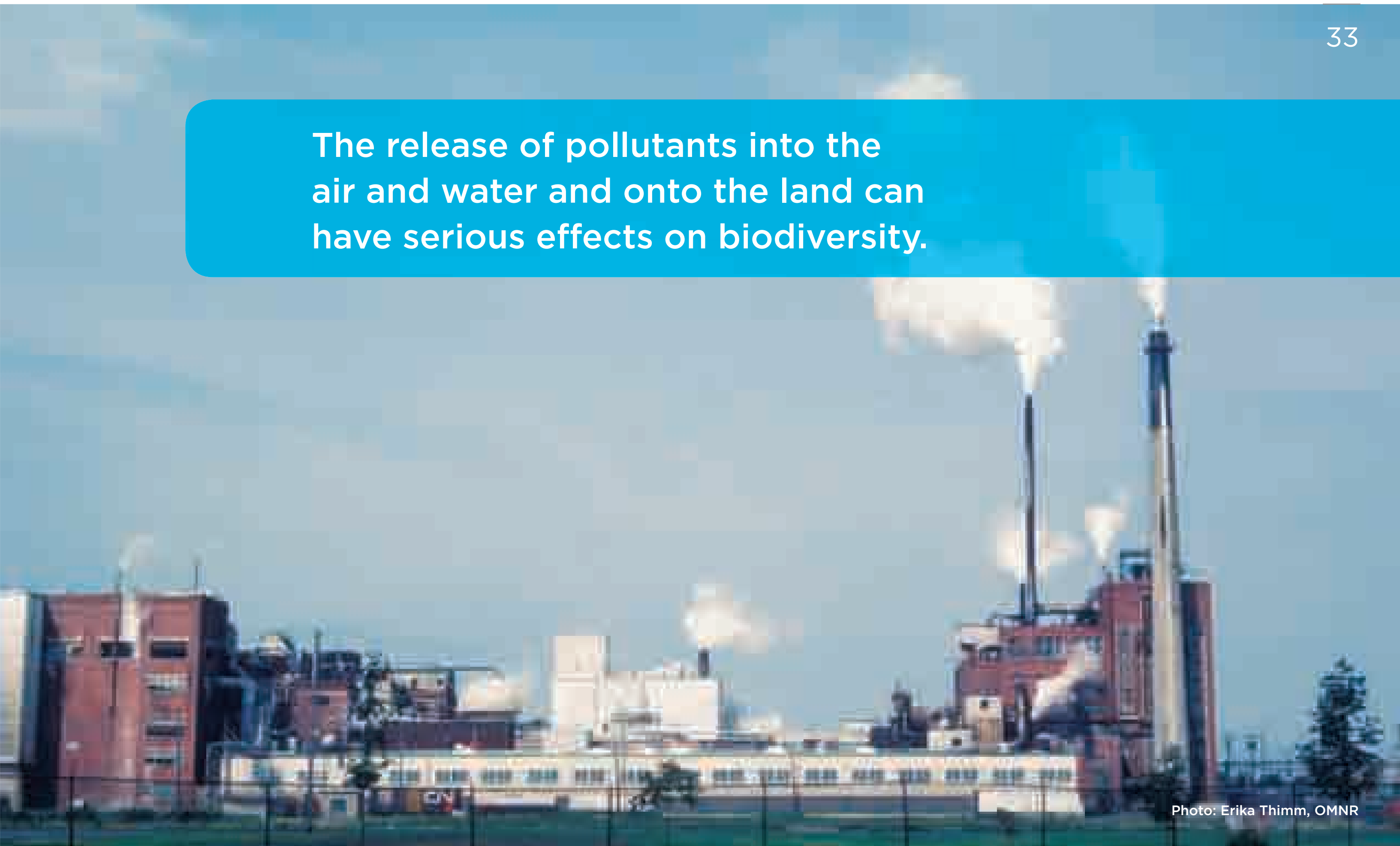
Spiny Water Flea

Pollution

The release of pollutants into the air and water and onto the land can have serious effects on biodiversity. Pollutants can kill organisms outright or can cause chronic impacts that affect reproduction or other life processes. Pollutants can also change the conditions and processes occurring within an ecosystem, and result in systematic changes that degrade habitats and negatively impact ecosystem services. Biodiversity near sites used intensively by humans (e.g., urban areas, agricultural areas, mines, and other industries) may be at most risk from pollution; however, the transport of pollutants to downstream and downwind areas can also have significant effects on biodiversity.

Despite some notable successes in addressing pollution problems (e.g., recovery of Bald Eagle and Peregrine Falcon with the ban on DDT), air and water pollution remain a significant biodiversity concern. Currently, a wide range of pollutants interact with natural and anthropogenic factors to alter ecosystems and impact upon biodiversity in Ontario. There is also growing concern about the impacts of light pollution on biodiversity (e.g., impacts on migratory birds). With thousands of potential pollutants, it is difficult to select representative indicators for pollution in Ontario. Ground-level ozone was chosen as an air pollution indicator since it was recently recognized as an emerging issue for biodiversity at the global level (The Royal Society 2008). The Freshwater Quality Index was chosen as a water pollution indicator because it integrates a series of chemicals (nutrients, heavy metals) based on their expected impacts to aquatic life.

Cornwall



The release of pollutants into the air and water and onto the land can have serious effects on biodiversity.

Photo: Erika Thimm, OMNR

INDICATOR—Ground-Level Ozone

Ground-level ozone is one of the most important air pollutants in terms of impacts to both biodiversity and human health and may become more important in the future (The Royal Society 2008). Ozone irritates the eyes and respiratory tract. Children and people with respiratory disorders are particularly at risk from exposure to high levels of ground-level ozone. Ground-level ozone also reduces crop production, tree growth and carbon sequestration, and can change the species composition of vegetation in terrestrial ecosystems (The Royal Society 2008). Some native plant species are extremely sensitive to ozone. Studies have demonstrated that impacts to terrestrial biodiversity are likely to occur when ground-level ozone concentrations exceed 40 parts per billion (ppb), a frequent occurrence in many parts of southern and eastern Ontario during the summer months (Environment Canada 2007). From 1980 to 2007, there was an average of 16.75 ozone episode days (episode days occur when widespread ozone levels are greater than 80 ppb) per year in Ontario (OMOE 2008).

Ground-level ozone is a major component of smog. It is not an emitted pollutant, instead it is formed by chemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of heat and sunlight. NO_x is emitted by natural sources and by human sources such as cars, trucks, and industrial plants. VOCs may be emitted by natural sources, such as plants and trees, or by human activities. In Ontario, the highest concentrations of ground-level ozone occur in southwestern areas of the province on hot and sunny summer days when conditions are right for ozone to be created from its NO_x and VOC precursors (OMOE 2008). Ground-level ozone and its chemical precursors can be transported by wind over long distances (hundreds or thousands of kilometres) from their sources (Environment Canada 2007).

STRATOSPHERIC OZONE VS. GROUND-LEVEL OZONE: WHAT'S THE DIFFERENCE?

Ozone in the stratosphere and ground-level ozone are the same gas with the same chemical structure (O_3). However, the effects of ozone on living organisms depend upon where the ozone is located. Stratospheric ozone is formed in the upper atmosphere and is the "ozone layer" that protects life on Earth from the sun's damaging ultraviolet rays. Ground-level ozone is formed by chemical reactions near the surface of the Earth and is harmful to people, plants, and animals. In general, very little ozone is transported from the stratosphere to the Earth's surface or vice versa.

Despite efforts to control ground-level ozone, background concentrations in the northern hemisphere have more than doubled since the industrial revolution (The Royal Society 2008), and one-hour maximum ozone concentrations continue to exceed air quality standards in Ontario (OMOE 2008). Future increases in ground-level ozone concentrations will contribute directly and indirectly to climate change and therefore have further impacts on biodiversity (The Royal Society 2008). This indicator evaluates the seasonal averages of ground-level ozone at sites across Ontario (Figure 19) and the highest 8-hour daily average concentrations during summer at sites in southern and eastern Ontario (Figure 20).

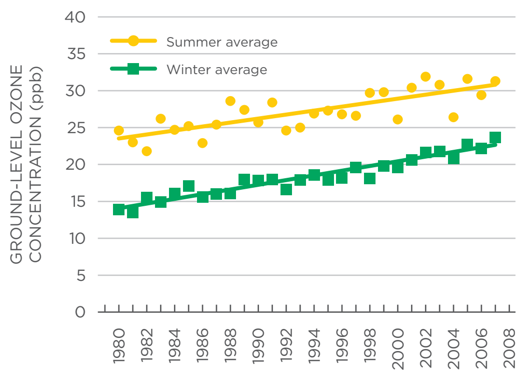


Figure 19. Seasonal means of ground-level ozone at sites across Ontario (1980–2007) (source: OMOE 2008. *Note: Based on data from 19 ozone monitoring stations operated over 28 years; Season definitions—Summer (May to September); Winter (January to April, October to December)).*

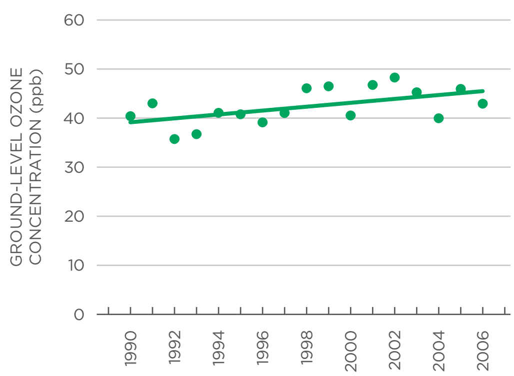


Figure 20. Ground-level ozone exposure indicator for southern and eastern Ontario, 1990–2006 based on the highest 8-hr daily average concentrations recorded at monitoring stations in southern and eastern Ontario during the warm season (April 1 to September 30) (source: Canadian Environmental Sustainability Indicators Map and Charts (**indicateurs-indicators.on.ec.gc.ca/cesi08/files/air/air3_chart_table_en.csv**). *Note: The average concentrations for each monitoring station were weighted by population to estimate potential human exposure to the pollutant (CESI 2007)).*

- From 1980 to 2007, there was an increasing trend in the seasonal means of ground-level ozone across the province. Summer means increased by approximately 30%, and winter means increased by approximately 60%.
- Overall, the increases can be attributed to rising global background concentrations, meteorological factors, and the long-range transport of ozone and its precursors from the U.S.
- From 1990 to 2006, there was an increasing trend in the highest 8-hour daily average concentration of ground-level ozone in southern and eastern Ontario. The average increase was approximately 15%. This indicates that human and environmental health risks from exposure to ground-level ozone increased over this period.
- Most values were above the ground-level ozone threshold of 40 ppb at which impacts to biodiversity can occur.
- The average value for the ozone exposure indicator for southern and eastern Ontario over the monitoring period (42.3 ppb) was higher than for other regions of Canada.

TREND
DETERIORATION

DATA CONFIDENCE
HIGH

INDICATOR—Freshwater Quality Index

Water quality has a major influence on the biodiversity of freshwater systems. Along with aquatic species, many birds, amphibians, and invertebrates are dependent upon freshwater bodies at some point in their life-cycle. Hence, lakes and streams have a very important role in sustaining biodiversity (Environment Canada 2008).

Every day, hundreds of substances are discharged, directly or indirectly, into rivers and lakes in Ontario. This includes point sources (industrial waste, wastewater from urban and suburban development) and non-point sources (runoff from agricultural and urban areas). In Ontario, nitrate and ammonia are the pollutants released into water in the largest quantities, while more highly toxic substances, such as mercury, are released in much smaller but significant amounts (Environment Canada 2008). Many more pollutants make their way into Ontario water bodies indirectly after being released into the air or onto the land. Airborne pollutants are transported long distances and enter aquatic ecosystems. Sulphur dioxide and nitrogen oxides which cause acidification, metals (e.g., lead and mercury) and organic compounds (e.g., PCBs and pesticides) (Environment Canada 2008) are good examples of such pollutants. Run-off from agricultural lands and urban areas also degrades water quality (Coote and Gregorich 2000), threatening the aquatic biodiversity of the province. Fire-retardants, pharmaceuticals, and endocrine disrupting chemicals that are found in Ontario's waterways are emerging issues for biodiversity and human health. A recent review of water quality status and trends for Ontario (OMOE 2009) concluded that water quality improvement strategies have been successful, but that continued efforts were necessary to protect and restore water quality in the province.

ENDOCRINE DISRUPTORS

Endocrine disrupting substances, also called hormone-disrupting substances, alter hormone levels in humans and wildlife. These substances can lead to changes in the growth, reproduction and development of fish and wildlife species and their offspring. Endocrine disrupting substances are found in drugs, pesticides, industrial chemicals and some plastics. They are released into the environment through runoff from agriculture and mining activities, the production of textiles and pulp and paper, and municipal sewage. Endocrine disruptors build up in waterways placing aquatic organisms like fish and amphibians at particularly high risk (Kime 1998; Kloas 2002).

There are many studies demonstrating the impacts of endocrine disrupting substances on Canadian wildlife. These impacts include: deformities and embryo mortality in birds and fish exposed to industrial chemicals or insecticides; impaired reproduction and development in fish related to runoff from pulp and paper mills; feminization of fish exposed to runoff from municipal sources; abnormal development in molluscs exposed to antifouling agents applied to the hulls of ships; and reduced thyroid and immune

This indicator provides an overall measure of the suitability of water bodies to support aquatic life at selected monitoring sites in Ontario using the Water Quality Index (WQI) as endorsed by the Canadian Council of Ministers of the Environment. There were a total of 80 monitoring sites in Ontario with adequate sampling, and using the WQI they were assessed as either poor, marginal, fair or excellent/good for the period 2004–2006. WQI ratings are based on how often and by how much water quality measurements exceeded threshold levels for the protection of aquatic life during seasonal samples over a 3-year period (Table 2). The WQI is a useful tool to evaluate and monitor the quality of freshwater in Ontario, under the assumption that poor water quality has significant impacts on biodiversity. The WQI for Ontario reflects the potential for substances, including ammonia, chloride, chromium, nickel, nitrate, phosphorus, and zinc, to affect aquatic life, and is based on existing knowledge of the toxicity of these chemical substances. Almost all of the

Table 2. The rating system for Water Quality Index values.

RATING	INTERPRETATION
Excellent	Water quality measurements **never** or **very rarely** exceed water quality guidelines.
Good	Water quality measurements **rarely** exceed water quality guidelines and, usually, by a narrow margin.
Fair	Water quality measurements **sometimes** exceed water quality guidelines and, possibly, by a wide margin.
Marginal	Water quality measurements **often** exceed water quality guidelines and/or exceed the guidelines by a considerable margin.
Poor	Water quality measurements **usually** exceed water quality guidelines and/or exceed the guidelines by a considerable margin.

functions in fish-eating birds in the Great Lakes (Environment Canada 2001). Observations from Lake Ontario show that Bald Eagles and Double-crested Cormorants experienced full reproductive failure from the 1950s to the 1970s (Fox 2001). Developmental abnormalities have been observed in nine species of fish eating birds in the Great Lakes (Fox 1993; Grasman et al. 1998), and in Snapping Turtles in the Great Lakes basin (Bishop et al. 1998).

Endocrine disrupting substances also have negative impacts on human health and are considered a significant concern to public health (Diamanti-Kandarakis et al. 2009). For example they have documented effects on reproduction, breast development and cancer, prostate cancer, thyroid, metabolism and obesity (Diamanti-Kandarakis et al. 2009). Despite their harmful effects, endocrine disrupting substances continue to be released into the environment. Scientists are trying to better understand the effects these chemicals have on fish, wildlife and humans. More research on the long-term effects of endocrine disrupting substances and their impact on Ontario's biodiversity is needed.

sites are located in areas where land use and other activities are suspected to be affecting water quality. Sixty-nine of the 80 Ontario monitoring sites are in the Mixedwood Plains Ecozone (Figure 21). Most of these sites are within watersheds draining directly into the Great Lakes, but none are within the lakes themselves.

A suite of water pollutants and contaminants in the Great Lakes was examined for SOLEC (2009). Phosphorus levels remain high in near shore areas, but the levels of most contaminants are decreasing in predatory fish and Herring Gulls (levels are still high in some areas).

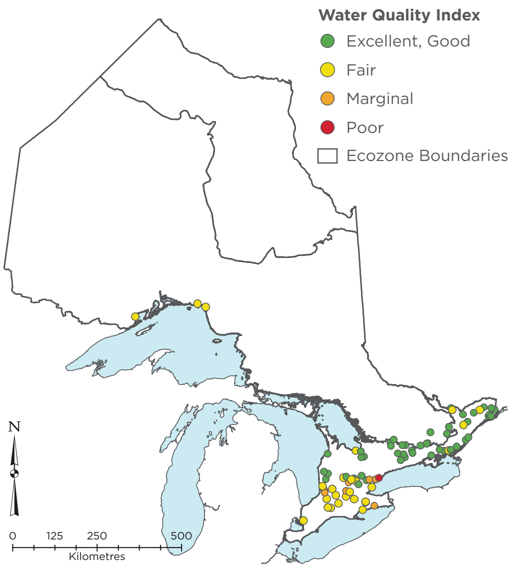


Figure 21. Location of water quality monitoring sites in Ontario for Freshwater Quality Index, 2004–2006.

Figure 22. Status of freshwater quality for protection of aquatic life at monitoring sites in Ontario, WQI—Water Quality Index (adapted from Environment Canada 2008).

- Fifty-eight percent of assessed aquatic monitoring sites in Ontario were considered good or excellent, 33% were considered fair, 8% were considered marginal, and 1% were considered poor.
- The St. Lawrence River drainage basin, which includes southern Ontario and the Great Lakes, had the highest percentage of sites in Canada where water quality was rated marginal or poor; most of the monitoring stations for this basin were located in the Windsor–Quebec City corridor, a heavily populated, farmed, and industrialized region (Environment Canada 2008).
- In the St. Lawrence River drainage basin, phosphorus was the largest driver of index ratings. Forty percent of sites in this basin frequently had higher than recommended levels of this nutrient (Environment Canada 2008).
- All of the sites with marginal and poor ratings were in the southwestern portion of the Mixedwood Plains Ecozone.

TREND
BASELINE

DATA CONFIDENCE
HIGH

Overharvesting

The harvest of plant and animal species can result in a loss of biodiversity if they are harvested at rates that can not be sustained over the long term. Such unsustainable use can have an adverse effect on local populations and ecosystems, and, in turn, on the economy and community social well-being. When species are harvested unsustainably, their ability to support the needs of future generations may be compromised. To conserve biodiversity, resources must be used at a rate that permits them to be maintained indefinitely. No indicators were developed or available for this section, so a brief discussion is provided below.

Unregulated and widespread overharvest has historically been a major threat to several species in Ontario. For example, the disappearance of the Wild Turkey from Ontario and the extinction of the Passenger Pigeon in the early 1900s were associated with unregulated and unsustainable hunting. The Deepwater Cisco and Blue Pike (only found in the Great Lakes) went extinct in the middle of the 20th century largely due to excessive harvest in commercial fisheries. Impacts of overharvest for these species were combined with habitat loss and degradation. For some long-lived, late maturing species such as Lake Sturgeon, the effects of excessive harvest that occurred up to a century ago can still be seen in the status of today's populations.

Today, the development of management programs and the regulation of harvests through education and effective enforcement, along with a commitment to conservation among fishing, hunting and trapping communities, have led to a more sustainable harvest of fish and wildlife species. The restoration of Ontario's Wild Turkey population is a good example of the success of such efforts. Through a reintroduction program and carefully controlled hunting, Ontario's Wild Turkey population increased from 0 birds in the early 1980s to an estimated 70,000 birds in 2007 (OMNR 2007b). The management of harvested species becomes more challenging when there are additional stressors such as habitat loss. For example, angler harvest of Lake Whitefish and Lake Trout in Lake Simcoe is largely maintained by the stocking of hatchery fish.

Despite the success of programs to manage harvest, the unregulated, unsustainable and/or illegal harvest of some species remains a concern. Outside of protected areas, the harvest of most Ontario plant species is not regulated. Overharvest of American Ginseng (a plant used for medicinal purposes) is identified as one of the main threats to this endangered species. The species is now protected under Ontario's *Endangered Species Act, 2007*. Several of Ontario's protected reptiles are subject to illegal harvest because of their value in the pet trade. There have been some high profile convictions of poachers of these species. Although some of these species are probably not being harvested at high levels, the combined effects of illegal harvest and other stressors (e.g., habitat loss, road mortality) take their toll.

Wild Turkey

Photo: JD Taylor

Climate Change

Atmospheric concentrations of greenhouse gases have increased since the pre-industrial era due to human activities like the burning of fossil fuels, and land cover and land use changes. Human activities and natural processes have contributed to changes in the Earth's climate. Over the last century, land and ocean surface temperatures warmed, precipitation patterns changed, the sea level rose, and the frequency and intensity of severe weather events increased (IPCC 2007). Over the last 60 years in Ontario, increases in the average annual air temperature vary from a slight increase in the southeast to an increase of 1.3 °C in the northwestern part of the province (Environment Canada 2009). It is projected that by 2050, the average annual air temperature in Ontario will increase by 2.5 to 3.7 °C over 1961–1990 levels based on a scenario of moderate reductions in greenhouse gas emissions (Environment Canada 2009).

Polar Bear Provincial Park

Photo: Rob Taylor, OMNR

Climate change has the potential to alter biodiversity dramatically:

- Species distributions may change. For example, scientists have observed northward shifts in some species' ranges;
- The timing of events like the flowering of plants and the breeding and migration of animals may change; and,
- Interactions between species may be altered. Predators and prey, insects and host plants, parasites and host insects, and insect pollinators and flowering plants have close interactions and depend on each other for survival. The timing of important events in their life cycles can become out-of-sync (Parmesan and Yohe 2003; Crick 2004; Parmesan 2006).

Stresses from habitat loss and fragmentation, pollution, and invasive species, may make species and ecosystems less able to adapt to climate change. Natural systems in Ontario that are faced with rapidly changing climate conditions may become degraded and may be replaced by new and different ecosystems.

To understand the impacts of climate change on Ontario's biodiversity scientists are comparing current conditions in aquatic and terrestrial ecosystems with observations from the past. Observed changes include:

- the Southern Flying Squirrel expanding its range northward (Bowman et al. 2005);
- rising water temperatures and reduced ice cover in Lake Superior over the last century (Austin and Colman 2008);
- longer ice free season on southern Hudson Bay and James Bay (Gagnon and Gough 2005); and,
- increases in the length of the forest fire season.

Models are used to project future impacts under different climate scenarios. Potential future impacts include changes in the distributions of fishes (Chu et al. 2005) and terrestrial vertebrates (Varrin et al. 2007), and increases in the frequency of forest fires (Wotton et al. 2005). The Black-legged Tick, an arthropod that transmits Lyme disease to humans, is also expected to expand its range (Ogden et al. 2008).

For this report, indicators were chosen based on observed changes. Ice cover on the Great Lakes and Polar Bear body condition and survival are used as indicators of climate change.

IMPACTS OF CLIMATE CHANGE ON SPECIES' DISTRIBUTION AND ABUNDANCE—Range Expansion of the Southern Flying Squirrel

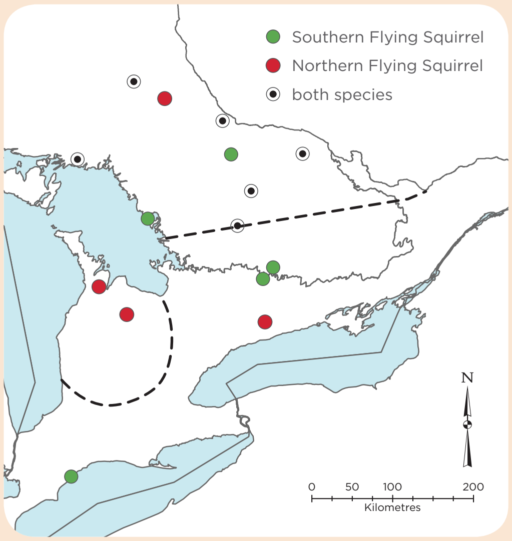
Changing temperatures and precipitation patterns associated with climate change are expected to have a large impact on the distribution and abundance of many species in Ontario. A recent review of climate change impact studies on 175 vertebrate species that occur in Ontario demonstrated that the ranges of 62 species were increasing, the ranges of 10 species were contracting and there were no clear trends for 103 species (Varrin et al. 2007). Predicting the impacts of climate change on species' distributions is difficult because factors such as the availability of habitat and interactions with prey, predator and competitor species are so important in determining the success of individual species.

Southern Flying Squirrel

The Southern Flying Squirrel provides a good example of how changing climate and interactions with other species can affect Ontario's biodiversity. The Southern Flying Squirrel is a small, nocturnal, gliding squirrel found in the hardwood forests of eastern North America. The squirrels are active during the winter when they feed on cached acorns and beechnuts and stay warm by huddling together in tree cavity nests. In Ontario, the northern range boundary of the Southern Flying Squirrel was originally thought to occur at about 45°N latitude where cold winter temperatures limited squirrels from living further north (Stabb 1988). The limited distribution and threats to the species' forest habitat led to national and provincial listings of the Southern Flying Squirrel as a species of Special Concern.

Recent survey work (2002–2004) documented a significant and rapid northward expansion in the Ontario range of the Southern Flying Squirrel (Bowman et al. 2005). In 2003 Southern Flying Squirrels were captured at the most northerly site sampled (Temagami area), more than 200 km further north than the previous northern range limit. The northward expansion was aided by unusually warm winters in the previous decade. Food supply also plays an important role in over winter survival and in maintaining Southern Flying Squirrel populations at the northern limit of their range. A relatively cold winter in 2004, preceded by a failure of acorn and beechnut crops in 2003 led to a significant southward contraction of the range close to the original northern limit for the species (Bowman et al. 2005).

This recent northward expansion has resulted in increased interaction between the Southern Flying Squirrel and the closely related Northern Flying Squirrel. The two species are not normally found together and the smaller southern species is thought to outcompete the northern species (through aggressive behaviour and through an intestinal parasite it carries that may be harmful to the northern species). A recent genetic study (Garroway et al. 2009) found that the two species are now hybridizing (interbreeding) with each other at some locations. The impacts of the hybridization on both species are unclear, but the loss of reproductive barriers may lead to a loss of biodiversity. The increased range of the Southern Flying Squirrel led to it being removed from national and provincial lists of species at risk in 2007. As winter temperatures continue to warm, the expansion of the range of the Southern Flying Squirrel may pose a threat to the Northern Flying Squirrel in areas of the Ontario Shield Ecozone with suitable habitat for both species.



Distribution of Southern Flying Squirrel and Northern Flying Squirrel captured at sites during 2003 in Ontario. The dotted line indicates the northern limit of Southern Flying Squirrel established by Stabb (1988) (modified from Bowman et al. 2005) (©2005 NRC Canada or its licensors—reproduced with permission).

INDICATOR—Changes in Ice Cover on the Great Lakes

Changes in the duration of ice cover on northern hemisphere lakes are a strong signal of global climate change (IPCC 2001). These changes impact aquatic and terrestrial biodiversity. Changes in freeze-up and break-up times can affect the food supply for aquatic life, alter the timing of fish spawning, and cause birds to change their migration patterns. Less ice cover on the Great Lakes means more water may evaporate and be spread across the basin in the form of snow. This can affect animals that dig through the snow to find food in the winter (SOLEC 2009).

This indicator assesses changes in the maximum amount of ice formed on the Great Lakes each year over the last 40 years. Ice cover data are available from the 1970s onwards. Scientists have used air and water temperatures to model expected ice cover in the first half of the 20th century on some of the lakes. On Lake Superior, ice cover may have decreased by almost 50% over the last century. Most of these changes happened in the last 30 years (Austin and Colman 2008). Models for Lake Michigan suggest there was a period of low ice cover in the

1930s similar to what was seen in 2000. However, recent information shows that Grand Traverse Bay, Lake Michigan, didn't freeze-up for five consecutive years. This was the first time in at least 150 years the bay didn't freeze-up for five consecutive winters (**www.glerl.noaa.gov/pubs/brochures/ice/icecover.html**).

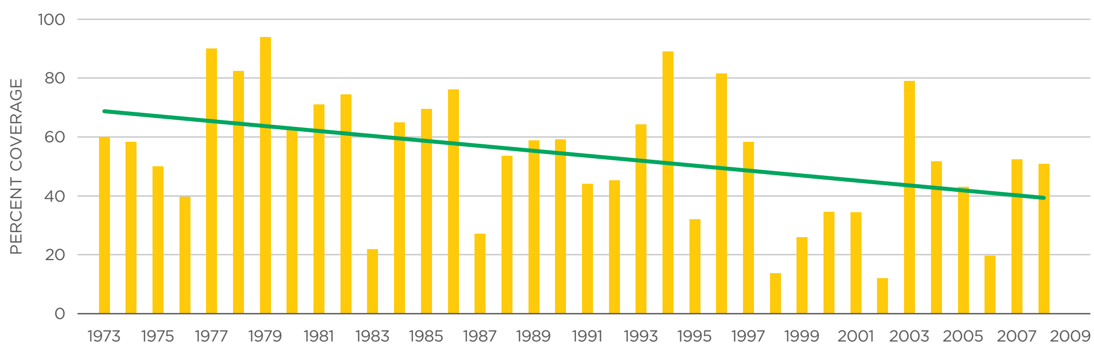


Figure 23. Observed changes in seasonal maximum ice cover on the Great Lakes 1973–2008 (source: Karl et al. 2009—updated from Assel et al. (2003) using data from the National Oceanic and Atmospheric Administration).

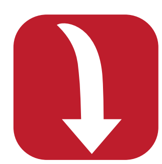
Table 3. Mean maximum ice coverage, in percent, during the corresponding decade.

LAKE	1970–1979	1980–1989	1990–1999	2000–2008	% CHANGE (1970–2008)
Erie	94.5	90.8	77.3	76.4	-19.2
Huron	71.3	71.7	61.3	58.7	-17.7
Michigan	50.2	45.6	32.4	28.4	-43.4
Ontario	39.8	29.7	28.1	23.9	-39.9
Superior	74.5	73.9	62.0	48.0	-35.6

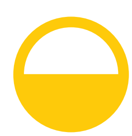
Source: Updated from SOLEC (2009) using data from the Canadian Ice Service Seasonal Summaries for the Great Lakes (2000–2008).

- Between 1970 and 2008, a decrease in the maximum amount of ice that formed each year was observed on all the Great Lakes. There was at least a 17% decline in the percentage of each lake that was covered in ice annually. On Lakes Michigan and Ontario the decline in ice cover was about 40%.
- Between 1970 and 2008, the maximum amount of ice that formed annually declined the most on Lake Michigan, followed by Lakes Ontario, Superior, Erie and Huron.

TREND
DETERIORATION



DATA CONFIDENCE
MEDIUM



INDICATOR—Body Condition and Survival of Polar Bears

It is widely recognized that Polar Bears are among the species most vulnerable to climate change because they are dependent on sea ice for feeding, mating, and resting. In many parts of the northern hemisphere, climate change is causing sea ice to break up earlier and freeze up later. In southern Hudson Bay and James Bay, the period of ice cover has decreased by almost 3 weeks since the mid 1970s (Gagnon and Gough 2005). This reduces the amount of time Polar Bears can spend on the ice feeding on seals and other marine mammals to support reproduction and their seasonal fast (Stirling et al. 1999).

Ontario is home to the southernmost subpopulation of Polar Bears in the world, and therefore the loss of sea ice due to climate change is expected to have an early effect on this population. (Derocher et al. 2004). This subpopulation is currently estimated to contain between 900 and 1000 bears, and a decline in population size is expected as the effects of climate change are realized (Obbard et al. 2007). Such declines have been observed elsewhere. For example, the Western Hudson Bay subpopulation of Polar Bears (shared by Manitoba and Nunavut) has shown declines in body condition, reproductive success, and survival resulting in a 22% reduction in population size over the past 20 years (Stirling et al. 1999; Regehr et al. 2007).

Although studies indicate that the size of the Southern Hudson Bay subpopulation has not changed since the mid-1980s, an assessment of changes in body condition and survival can provide an indication of the status of the population and, more broadly, the current effects of climate change on Polar Bears (Obbard et al. 2006). This indicator assesses changes in the average body condition (defined as the combined mass of fat and skeletal muscle relative to body size) for Southern Hudson Bay Polar Bears captured between 1984–1986 and 2000–2005, as well as changes in survival over the same time period. Survival is presented as the annual survival rate (i.e., proportion of bears surviving a period of a year, if all bears survived, the annual survival rate would = 1).

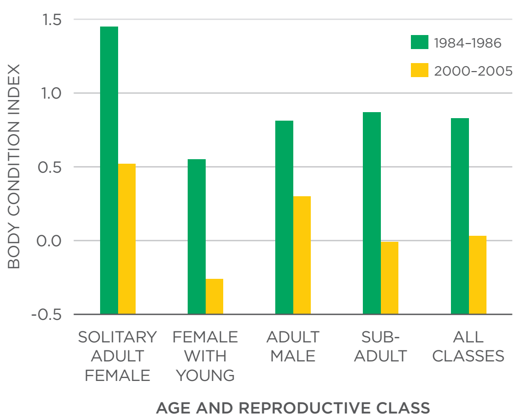


Figure 24. Changes in average body condition index values for Southern Hudson Bay Polar Bears captured in Ontario between 1984–1986 and 2000–2005 (adapted from Obbard et al. 2006).

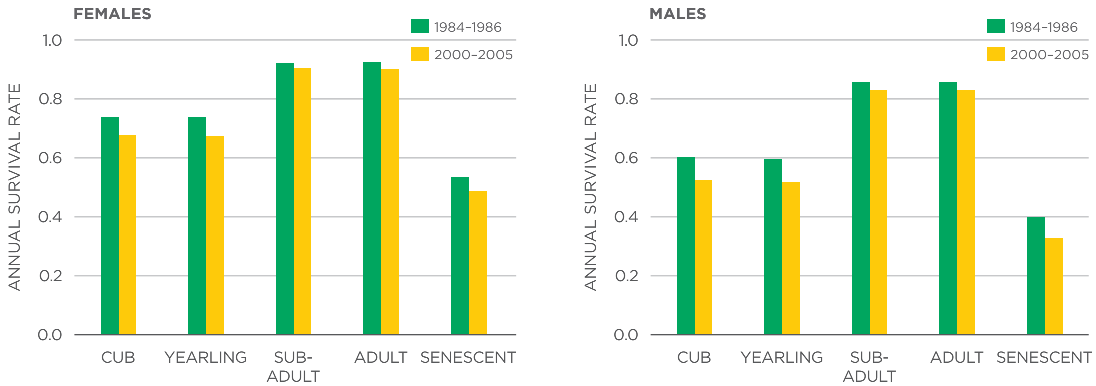
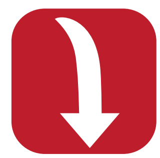


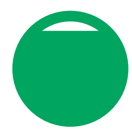
Figure 25. Comparison of annual survival rates of Polar Bears in the Southern Hudson Bay subpopulation between 1984–86 and 2003–05 (adapted from Obbard et al. 2007).

- Significant declines in body condition are apparent for Polar Bears in the Southern Hudson Bay subpopulation; declines are greatest for pregnant females and juvenile (sub-adult) bears.
- Declines in survival are also apparent for both male and female Polar Bears of all age classes in the Southern Hudson Bay subpopulation.
- These data suggest that changes in the structure and duration of sea ice resulting from climate change (Gagnon and Gough 2005) have had consequences for Polar Bears in Ontario in the form of declines in body condition and overall survival.

TREND
DETERIORATION



DATA CONFIDENCE
HIGH



State of Ontario's Biodiversity

Extent and Structure of Key Natural Systems

Despite Ontario's large human population, much of the landscape remains dominated by natural systems. These forests, wetlands, lakes and streams provide the foundation that sustains Ontario's biodiversity. This section examines the current state and trends of these key natural systems.

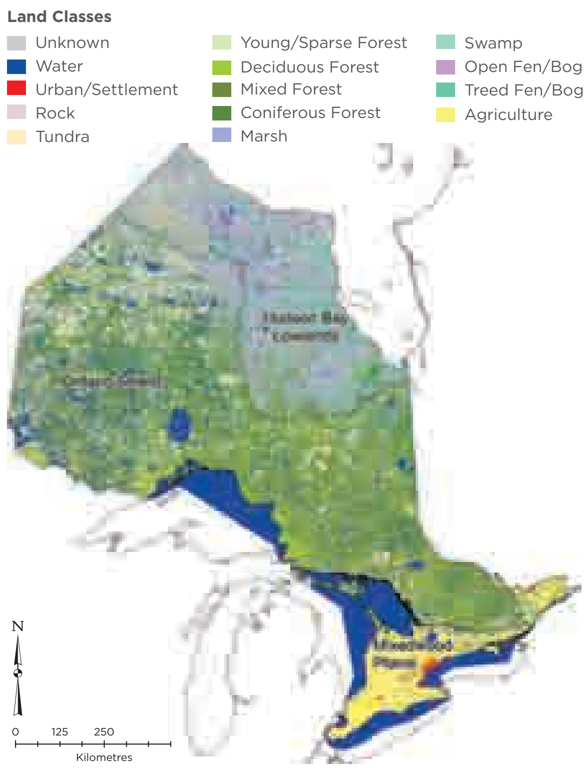
Forests

Forests cover an estimated 30% of the world's land surface and play a disproportionate role in maintaining biodiversity and ecosystem services (MEA 2005). Globally, forests provide habitat for half or more of terrestrial animal and plant species and contain 80% of all terrestrial biomass (living matter) (MEA 2005). In addition to their role in sequestering carbon, forests provide many other ecosystem services, such as recreation, water purification and protection of aquatic

Atikokan

Globally, forests provide habitat for half or more of terrestrial animal and plant species...

Photo: Ontario Tourism



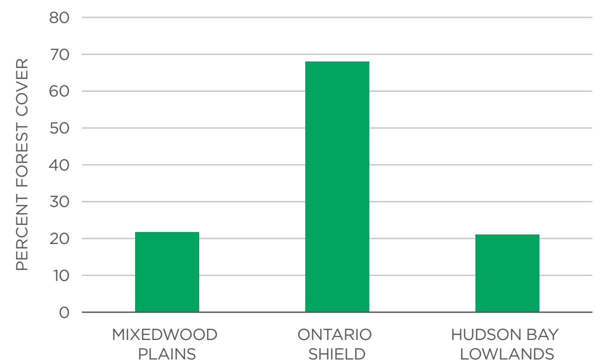


Figure 26. Satellite imagery of land cover types in Ontario ecozones (left) and percent forest cover by ecozone (right) (adapted from Ontario Parks 2009).

habitats, soil retention, and the provisioning of fibre and timber. Forests also provide Ontarians with significant employment opportunities and economic benefits as well as supporting traditional Aboriginal uses such as hunting and trapping. More than one half of Ontario's land base is forested (52%) (Figure 26).

Ontario's forests (areas with more than 30% tree cover) include a broad range of tree species within three ecozones. The Mixedwood Plains Ecozone contains only 22% forest cover, but includes the greatest diversity of tree species in Ontario. Much of the forest in this ecozone consists of isolated remnants interspersed with agricultural and urban areas. The Ontario Shield Ecozone is 68% forest and contains 87% of Ontario's forested landscape. Aside from some small urban and agricultural areas, the ecozone is comprised of continuous areas of forest, wetlands and water. The Hudson Bay Lowlands Ecozone is 21% forest, with nearly half of that considered sparse forest with a very low density of tree cover. The rest of the ecozone is dominated by wetlands, with bogs and fens comprising 41% and 28% of the landscape, respectively.

The extent and composition of today's forests are closely related to climate and landscape characteristics, such as soil and topography, as well as landscape history. Those areas of the province with soil and topography relatively better suited to agriculture and settlement have been most altered. The composition of forests is also affected by timber harvest, fire, insects, disease, and climate change. These natural and anthropogenic processes can affect species composition, forest function, and ecosystem services.

To examine the state and trends in Ontario's forest ecosystems, this report includes information on the extent of forest cover and disturbances. This information is based on analyses conducted for Ontario's State of the

Forest Report 2006 (OMNR 2007a) at the ecoregion level. Ecoregions are subdivisions of ecozones based on geology, climate, vegetation, soil, and landform features. A map of the ecoregions found in each of the three land-based ecozones is shown in Figure 27. Information on fragmentation of forests in the Mixedwood Plains Ecozone is also included. More detailed analysis of the state and trends of Ontario's forests can be found in the Forest Resources of Ontario (OMNR 2006a) and Ontario's State of the Forest Report 2006 (OMNR 2007a).

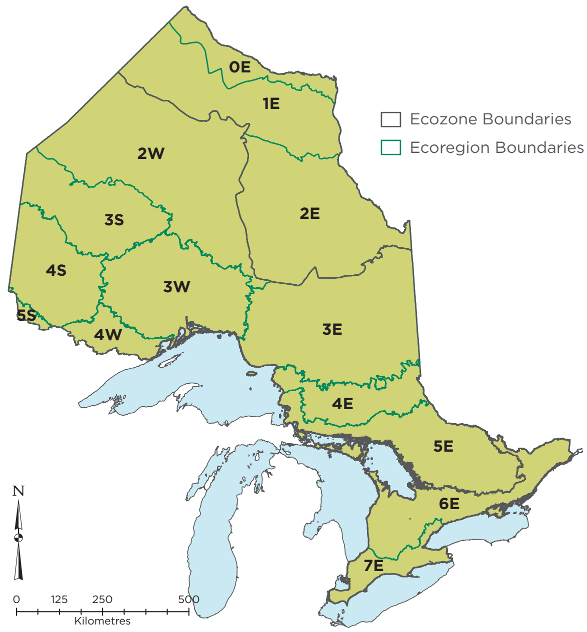


Figure 27. Ecoregions of Ontario.

INDICATOR—Extent of Forest Cover and Forest Disturbances

Permanent loss of forest cover through conversion to other uses (e.g., residential, industrial, agricultural) negatively impacts forest-dependent species. Forest disturbances such as fire, insect damage and timber harvest change the age and composition of forests, but the forest cover on the landscape is maintained through regeneration. At the local level, such disturbances may negatively impact some species and favour others.

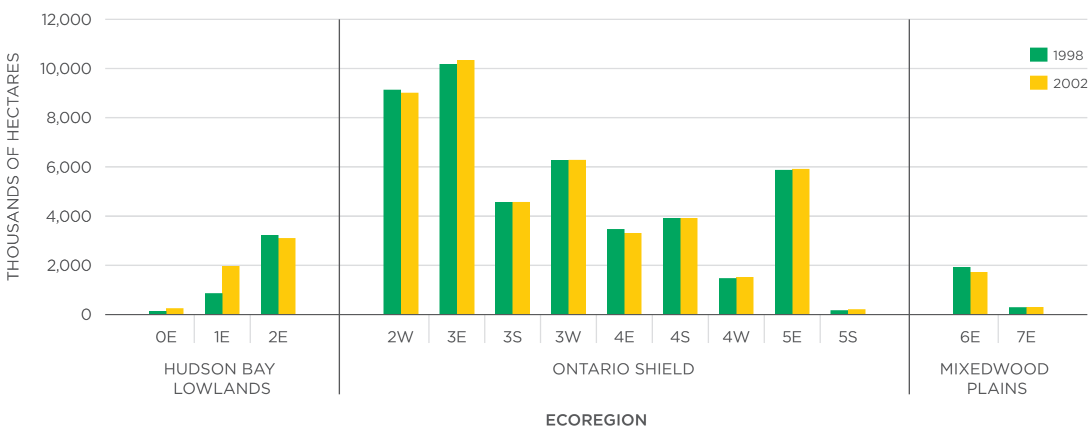


Figure 28. Total area of forested land by ecoregion in each ecozone in 1998 and 2002 (source: OMNR 2006a).

This indicator examines the total area of forest in ecoregions within each ecozone in 1998 and 2002, and the area of disturbed forest as a result of fire and harvest over the same period. The data are based on interpretation of satellite imagery. The 2002 data are based on higher resolution satellite images than those from 1998. As a result, improved mapping and interpretation was responsible for some of the differences between the two time periods (e.g., increase in the amount of sparse deciduous forest in the Hudson Bay Lowlands which was not detected in 1998).

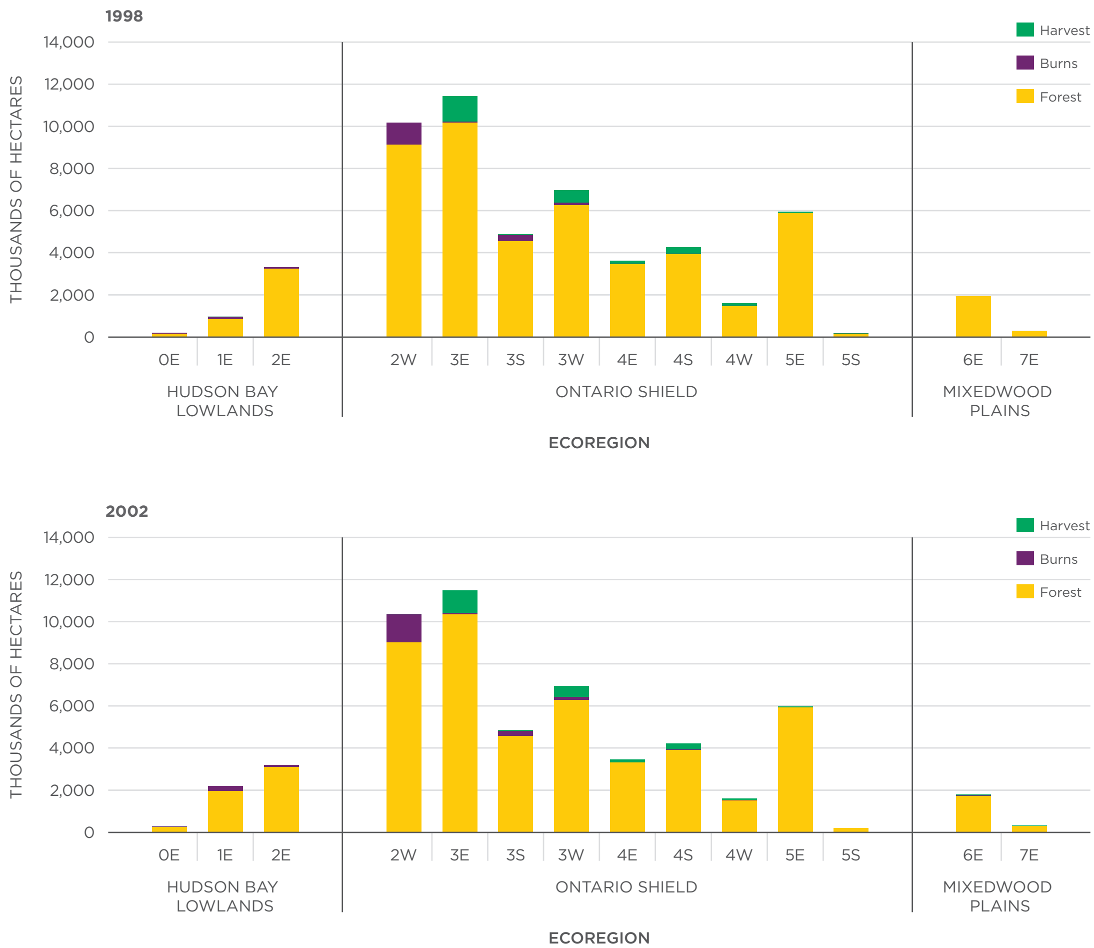


Figure 29. Total area of forest cover and area of recent disturbance from forest harvest and burns in 1998 and 2002 based on satellite imagery (source: OMNR 2006a).

- The total amount of Ontario's forested land remains relatively stable. The total amount of forested land increased slightly between 1998 and 2002, but this was mostly due to increased resolution of satellite images and improved detection of forest cover (OMNR 2006a).
- More than half of Ontario's land base is forested, and 87% of the forested land is found in the Ontario Shield Ecozone.
- Disturbances associated with recent burns and forest harvest assessed from satellite imagery covered about 8% of Ontario's productive forest lands in 1998 and 2002 (OMNR 2006a; 2007a).

- The average Crown forest harvest area was 214,000 ha per year for the 1995 to 1999 period, and 207,000 ha per year between 2000 and 2004 (OMNR 2007a). This represents less than 0.5% of the Crown forest area.
- Although subject to wide variation from year to year, the mean annual area burned in Ontario for the period between 1976 and 2004 was 223,000 ha (OMNR 2007a).

TREND
NO CHANGE

DATA CONFIDENCE
MEDIUM

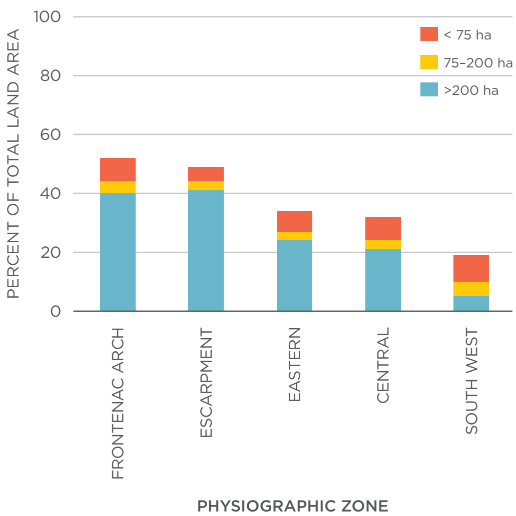
INDICATOR—Forest Fragmentation in the Mixedwood Plains Ecozone

When available habitat drops below 20–30% of the landscape, the fragmentation of the remaining habitat (the separation of remaining habitat patches) may negatively impact biodiversity over and above the absolute loss of habitat (Andrén 1994; Fahrig 2003). Most of southern Ontario was deforested between 1860 and 1920 (Larson et al. 1999). Forest cover has rebounded to an average of 22% compared to a low of 11% in the 1920s. However, more forests were removed from the best lands for agriculture and settlement than from other parts of the landscape. As a result much of the remaining forest is associated with steep or broken terrain, low lying areas, and soils of low productivity. New forests lack the structural diversity (e.g., age and size) and complexity of the pre-settlement landscape and are characterized by declines in some species, such as oaks and pines that historically would have been maintained through fire regimes.

Despite the overall increase in forest cover over the last century, some forest habitats continue to be lost or reduced in size. These losses are associated with urban and industrial expansion.

Much of our understanding of the impacts of fragmentation on biodiversity has come from the study of forest birds. Research has shown that when the percentage of forest cover in a landscape is reduced to less than 30%, many of the normally occurring forest-interior birds are absent (Environment Canada 2004). Similarly, at forest patch sizes over 200 ha, 80% of area-sensitive/edge-intolerant bird species can find suitable habitat. However, forest patches under 75 ha in size tend to be dominated by forest edge bird species (Environment Canada 2004). Austen et al. (2001) found that the number of forest-interior birds in large habitat patches in southern Ontario was also positively related to the amount of regional forest cover.

This indicator assesses the percent forest cover and the size of forest patches in the Mixedwood Plains Ecozone of Ontario. The assessments presented are based on analyses conducted for the Ecosystem Status and Trends Report (OMNR 2009a). Since soils and topography play an important role in determining the structure and use of the landscape, analyses were conducted based on five different physiographic zones: the Southwest, the Escarpment, the Frontenac Arch, and the Central and Eastern zones.



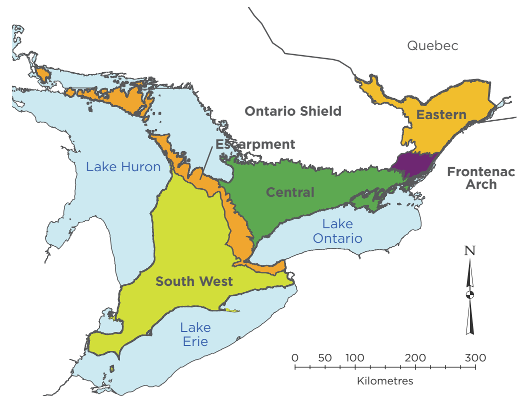


Figure 30. Percent forest cover and size of forest patches by physiographic zone in the Mixedwood Plains Ecozone (source: OMNR 2009a).

- Four out of the five physiographic zones have more than 30% forest cover; however, the largest physiographic zone (Southwest zone) has only 17% forest cover, suggesting that forest fragmentation may be affecting bird species diversity and biodiversity in general.
- The Escarpment and Frontenac Arch zones, with 41% and 40% land area in forest patches >200 ha, respectively, have extensive habitat for forest-interior bird species compared to other areas of the ecozone.
- The Southwest Zone has only 5% of its land area in forest patches >200 ha, suggesting that it has much less capacity to support populations of forest-interior bird species. This zone represents 44% of the area of the Mixedwood Plains Ecozone.

TREND
BASELINE

DATA CONFIDENCE
MEDIUM

Wetlands

Wetlands are lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water produces water-logged (hydric) soils and favours the dominance of either water-loving plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens (MMAH 2005). Wetlands lie at the interface of terrestrial and aquatic habitats and as a result possess a unique mixture of species, conditions and interactions. This makes wetlands among the most dynamic, diverse and productive ecosystems on the planet. Canada has approximately 25% of the world's remaining wetlands (Natural Resources Canada 2009). Ontario has particular responsibility for wetland resources because it contains approximately 22–29% of all Canadian wetlands and 6% of the world's wetlands (OMNR 2008b). The majority of the province's wetlands are found in northern Ontario. The Hudson Bay Lowlands Ecozone has more than 17,000,000 ha of wetlands that account for 69% of the landscape. The Great Lakes are a globally significant ecosystem that includes numerous coastal wetland habitats, some of which support globally rare animals and vegetation communities (OMNR 2008b).

Wetlands provide a wide variety of ecosystem services that benefit people and the environment. These include shoreline stabilization, water purification and groundwater recharge and discharge, and flood control/attenuation. Wetlands help limit greenhouse gases in the atmosphere by acting as carbon sinks and stabilizing climate conditions. Wetlands also provide valuable economic products such as timber, commercial baitfish, and natural medicines as well as recreation and tourism opportunities. Wetland losses impact a wide variety of species. In Canada, over 200 bird species, including 45 species of waterfowl, and over 50 species of mammals depend on wetlands for food and habitat (Natural Resources Canada 2009). Many of these species are at

Chapleau Crown Game Preserve

Wetlands provide a wide variety of ecosystem services that benefit people and the environment.

Photo: Ontario Tourism

risk. Wetlands also provide essential habitat for many of Ontario's amphibian species. Wetland habitats are important to several species of fish that reproduce or spend all or part of their life cycle in wetlands. Some examples include Largemouth Bass, Muskellunge, Northern Pike and Yellow Perch.

When wetlands are lost or destroyed the important ecosystem services they provide are also lost. For example, wetlands help control floods by temporarily holding back water that would otherwise run downstream and, in the longer term, by allowing water to seep into groundwater or to be taken up and released by plants. At least 10% of a watershed should consist of wetlands in order to mitigate flooding and erosion events (Detenbeck et al. 1999). The probability of flooding and floodwater damage increases considerably when a significant number of wetlands are lost from a watershed. Despite their important values, wetlands continue to be lost. Currently, up to 70% of wetlands have been lost in settled areas of Canada (Ducks Unlimited Canada 2006). Historically wetlands have been drained for agriculture, filled for development, polluted by toxic runoff, and damaged by artificial changes in water levels (Environment Canada 2005). Despite some localized losses or alteration, the wetlands in the Hudson Bay Lowlands and Ontario Shield ecozones are largely intact. Approximately two-thirds of wetlands in southern Ontario have been lost or severely degraded, and the health of those that remain is threatened (Environment Canada 2005).

INDICATOR—Wetland Losses in Southern Ontario

This indicator assesses changes in wetland abundance in the Ontario portion of the Mixedwood Plains Ecozone (excluding Manitoulin Island) from pre-settlement (circa 1800) to 2002. Wetland extent and loss were assessed at three points in time using Canadian Land Inventory (CLI) Present Land Use, Ontario Ministry of Agriculture, Food and Rural Affairs' (OMAFRA) Land System and Ontario Ministry of Natural Resources' (OMNR) Southern Ontario Land Resource Information System (SOLRIS) mapping from circa 1966, circa 1982 and circa 2002, respectively. A brief discussion of the resulting extent and loss trends is provided below. A complete description of the assessment methods used and detailed information on wetland extent and loss by county can be found in Ducks Unlimited Canada (2010). This most recent work on wetland loss in southern Ontario builds on work done in the 1980's (Snell 1987). Wetlands less than 10 ha in size and Great Lakes coastal wetlands were not included in the original analysis or this most recent work.

Distribution of Wetlands

Prior to European settlement there were an estimated 2,026,591 ha of wetland in the Ontario portion of the Mixedwood Plains Ecozone. This is equivalent to 25% of the ecozone's total area (Figure 31). At that time the highest concentration of wetlands occurred in counties of southwestern and eastern Ontario with 50–85% of their total area covered by wetland. Essex had the greatest wetland coverage in southwestern Ontario at 83%, followed by Kent and Lambton with wetland coverages of 56% and 50% respectively. In eastern Ontario, Prescott had the greatest wetland coverage (51%). Smaller concentrations of

Point Pelee

wetlands (20–40%) existed in the counties surrounding Lake Erie and along the east side of Lake Huron, the Kawartha Lakes (Victoria County) and several counties of eastern Ontario. Wetlands were found in lower concentrations within central southern Ontario counties and the counties surrounding Lake Ontario (Golden Horseshoe) covering only 5–20% of the total area.

The total area of wetlands in southern Ontario had declined drastically by 1967 and continued to decline with only 631,699 ha (8% of ecozone area) of wetlands remaining by 1982. By 2002, it was estimated that only 560,844 ha (7% of ecozone area) of wetlands remained. Southwestern Ontario saw the greatest change in wetland coverage. In some counties the total remaining wetland area (Figure 31) is almost a complete reversal of the pre-settlement coverage. A significant change in wetland coverage can also be seen in the eastern Ontario county of Frontenac and the four Golden Horseshoe counties, Toronto, Peel, Halton and Hamilton-Wentworth.

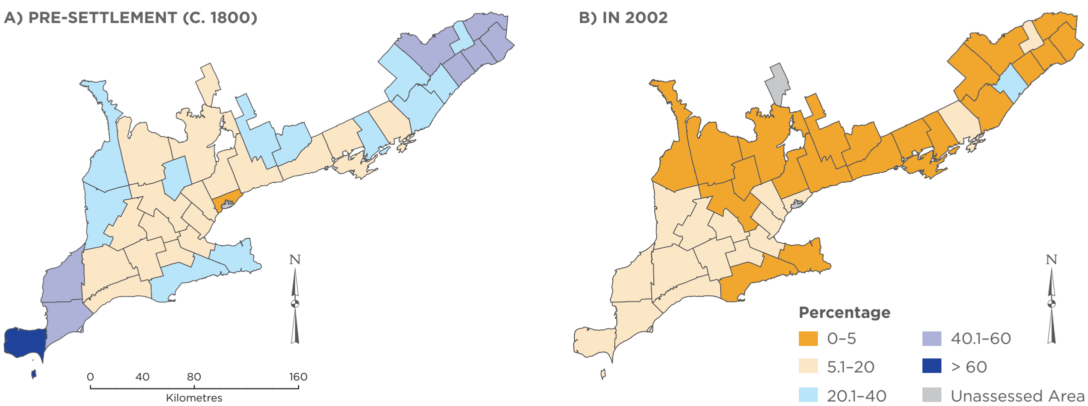


Figure 31. Wetland coverage by county in the Mixedwood Plains Ecozone in 1800 and 2002 (source: Ducks Unlimited Canada 2010).

Wetland Conversion from Pre-Settlement (c.1800) to 2002

By 2002, the wetland area in southern Ontario was estimated to have been reduced by approximately 1,465,747 ha or 72% of the total pre-settlement wetland area. The largest losses of wetlands have occurred in counties that had the greatest concentration of wetlands pre-settlement (southwestern Ontario and parts of eastern Ontario) (Figure 32). The counties of Essex, Kent and Lambton have undergone wetland losses greater than 90% followed closely by the counties of Russell and Prescott, with losses of 89% and 84%, respectively. Metro Toronto, Middlesex and Perth all underwent large losses as well. Counties that had fewer than 50,000 ha of wetlands in the pre-settlement coverage experienced less loss (< 35%), with the smallest losses occurring in Durham, Peterborough, Northumberland, Prince Edward and Grenville.

Although wetlands are being restored and protected on the landscape, the trend of loss continues. Between 1982 and 2002, 3.5% (70,854 ha) of the wetlands in the Mixedwood Plains Ecozone were lost through conversion to other land uses. This is an average loss of 3,543 ha per year. This is equivalent to the loss of approximately 354 10-ha wetlands per year for the last 20 years. If smaller wetlands had been included in the analysis, the annual loss would be even more significant.

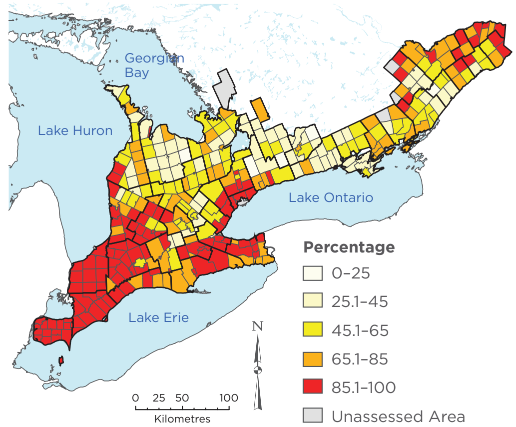


Figure 32. Loss of original wetland area in the Mixedwood Plains Ecozone by township, c.1800–2002 (source: Ducks Unlimited Canada 2010).

- Historically the Mixedwood Plains had about 2 million ha of wetland representing 25% of the ecozone.
- By 1982, 69% or 1.4 million ha of wetlands had been lost to other uses.
- An additional 70,854 ha (3.5%) of wetlands had been lost by 2002, representing a continuing loss of 0.17% per year.
- The majority of this conversion occurred within the counties of southwestern Ontario, along Lake Erie and Lake Huron, around the Golden Horseshoe and several eastern Ontario counties.
- Trends in the loss of Great Lakes coastal wetlands and smaller wetlands below the 10 ha size threshold are not reflected in this analysis.

TREND
DETERIORATION

DATA CONFIDENCE
MEDIUM

Rare Ecosystems

Ontario's diverse ecosystems include some that are uncommon and limited in their distribution, such as prairies and savannahs (prairies with scattered trees), alvars (flat open limestone habitats with thin soil), and freshwater coastal dunes. Although they are generally small in size, these habitats are home to species and species assemblages (groups of species found together) that are uncommon or absent from other ecosystems in the province. As such, they are fundamentally important for the maintenance of biodiversity in the province.

The distribution and status of these rare ecosystems is tracked by Ontario's Natural Heritage Information Centre (NHIC) based on vegetation communities (assemblages of plant species with a consistent composition, structure and habitat). To date, 403 occurrences of vegetation communities that are considered to be globally rare by NatureServe have been documented in Ontario

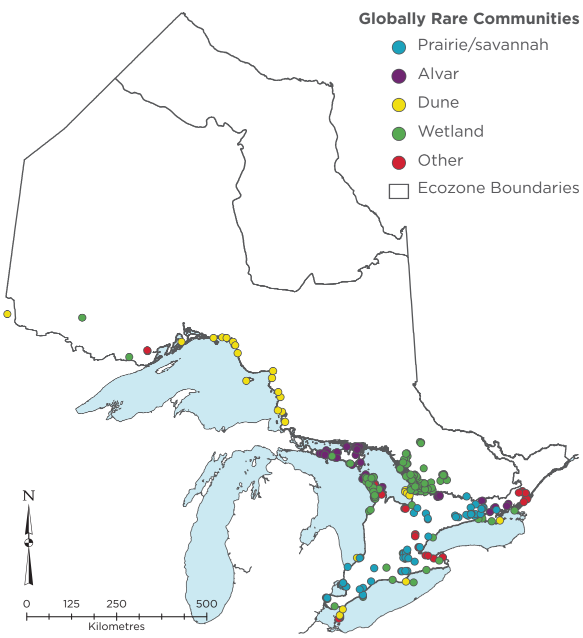


Figure 33. Distribution of globally rare vegetation communities in Ontario (other category—includes cliff, talus, beach, forest, and rock barren) (source: NHIC database, OMNR, Peterborough, Ontario).

(NatureServe is an organization that represents the network of provincial and state natural heritage programs in the western hemisphere, and based on the levels of rarity within these jurisdictions, determines rarity of species and communities at a global level) (Figure 33). Seventy-five percent of these globally rare communities occur within the Mixedwood Plains Ecozone. There are likely additional rare communities in the Ontario Shield and Hudson Bay Lowlands ecozones that have yet to be documented. A brief summary of the types of globally rare communities in Ontario is provided below.

Prairies and Savannahs

Historically, the Mixedwood Plains Ecozone in Ontario was home to locally extensive areas of tallgrass prairie and savannah ecosystems. One of the largest areas extended in an almost continuous band on the Norfolk Sand Plain, from Turkey Point northward to Brantford and Cambridge, and from there eastward to Hamilton. Other large areas existed along the nearshore areas of Lake St. Clair inland to Chatham, and the Detroit River on the present-day site of Windsor. The Oak Ridges Moraine in the vicinity of Rice Lake also supported extensive prairie and savannah landscapes. It is estimated that approximately 82,000 ha of prairie and savannah vegetation were present in southern Ontario at the beginning of European settlement (Rodger 1998). There are also numerous areas of tallgrass prairie and savannah in the Ontario Shield Ecozone in northwestern Ontario, but these are much less extensive than the historical levels in the Mixedwood Plains Ecozone.

In the Mixedwood Plains Ecozone, only a fraction (2–3%) of the original prairie and savannah habitat remains (2,200 ha; Rodger 1998). The little that persists is threatened by habitat destruction, invasive alien species, and succession to forest due to fire suppression. The largest remaining example of this community type, over 900 ha, is found in the Grand Bend–Port Franks area

CHANGE TO FIRE REGIMES

Fire is a major disturbance that affects the structure, composition and successional status of ecosystems across the landscape. The effects of fire on ecosystems include the reduction of woody species, the release of nutrients contained within plants, an increase in vegetative reproduction, enhanced seed release for some species, and exposure of soil seedbeds (Van Sleeuwen 2006). The frequency and patch size of landscape-level fires varies across the province. Forest fires are recognized as being one of the key disturbances in the Ontario Shield. Fires in northwestern Ontario are more frequent than in the northeast, which experiences a cooler and more humid climate. Additionally, there is variation within forest types—coniferous forests tend to burn more readily than those that are deciduous (Thompson 2000).

Fires initiate naturally from lightning strikes, but many are caused by humans. It is recognized that First Nation peoples exerted an influence on the landscape by setting fires for various purposes, including clearing land for villages, enhancing the growth of grasses to attract game, and some that were purely accidental (Day 1953). The extent to which Aboriginal burning influenced the vegetation in Ontario prior to European colonization is not clear, however, evidence suggests the use of fire was common. Catherine Parr Traill noted that the aboriginal Mississaugas had a tradition of burning the plains vegetation around Rice Lake, to encourage the growth of prairie grasses relished by deer. The lake itself was called *Pem-e-dash-cou-tay-ang*, which means Lake of the Burning Plains (Martin et al. 1986).

In the early 1800's, the frequency of fires on settled landscapes decreased dramatically due to land clearing. After a series of huge forest fires in northern Ontario, which included loss of life (in some cases hundreds of lives were lost), the *Forest Fires Protection Act* was passed in 1917, and the era of forest fire control in Ontario began (Armson 2001). In addition to fire prevention and suppression, the spread of fire on the landscape is disrupted by ecosystem fragmentation associated with agriculture, transportation and utility corridors, urban areas, logging and mining. This has led to increases in the average time interval between fires in most areas, a reduction in the area of burns, and an increase in the amount of biomass which may burn. It has also nearly eliminated low-intensity burns which spread slowly over the landscape (Thompson 2000). This has resulted in prairies, savannahs and open forests uniformly succeeding into denser forest throughout northeastern North America (Curtis 1959), including Ontario's settled south (Traill 1885; Catling and Catling 1993). In southern Ontario, tallgrass prairies and savannahs occupy less than 3% of their extent prior to European settlement. These biologically rich ecosystems support approximately 22% of Ontario's rare plant species, as well as a rich assortment of insects and vertebrates, and in the absence of fire are succeeding into shaded thicket and forest, which do not support the rare prairie species that require full sunlight (Rodger 1998).

In northern Ontario, ecosystems have changed, creating a landscape with older forests, whose composition is succeeding toward more shade tolerant species which are sensitive to fire, at the expense of fire-tolerant species which are intolerant of shade (Carleton 2000). The importance of understanding the fire regime in managing ecosystems has now been recognized in policy to promote and implement fire as a resource management tool both on Crown land and in provincial parks, in an effort to reduce the current successional trends on the landscape (OMNR 2004a, 2004b).

(including The Pinery Provincial Park). A further 600 ha remain at Windsor and Walpole Island First Nation. Together, these three large sites represent a mere 1.8% of the estimated original extent in Ontario. Aside from a few other remnants over several hectares in size, most other remaining fragments are less than 0.5 ha in area, and often in the order of 0.1 ha. Prairie and savannah habitats in the Ontario Shield Ecozone do not face the same levels of threats that are acting in the Mixedwood Plains Ecozone, as they are not declining in extent due to the absence of fire, and the majority occur in Conservation Reserves.

Since prairies and savannahs are provincially rare, it is not surprising that a high proportion of associated plants and animals are also rare. Twenty-two percent of rare vascular plant species in Ontario are found in prairies and savannahs. A number of rare grassland bird species (e.g., Henslow's Sparrow, Northern Bobwhite, Greater Prairie-chicken [now extirpated]), savannah species such as Bewick's Wren [also extirpated], as well as several rare insect species (e.g., Barrens Daggermoth, Aweme Borer, Glorius Flower Moth, Frosted Elfin [also extirpated], and several species of leafhoppers) are associated with this important habitat type (NHIC database, OMNR, Peterborough, Ontario).

Alvars

Globally rare alvar communities occur only in the Baltic region of Estonia and Sweden, in western Russia, and within the Great Lakes basin of North America. With approximately 8,100 ha of alvar ecosystems, Ontario contains 75–80% of the North American total, including sites on the Bruce Peninsula, Manitoulin and Pelee islands, near Napanee, and the Carden Plain. Almost all of Ontario's alvar ecosystems are in the Mixedwood Plains Ecozone. Although the historical extent of alvar communities in Ontario is not well understood, logging and subsequent conversion to ranch lands is thought to be responsible for increasing the extent of alvars in many areas throughout the province (Schaefer 1996; Brownell and Riley 2000). Alvar communities are threatened by habitat fragmentation and loss, trails and off-road vehicles, resource extraction uses such as quarrying, adjacent land uses such as residential subdivisions, over grazing and invasion by alien plants (SOLEC 2009).

At least 12% of vascular plant species known from Ontario occur in alvar communities, including seven species only known from alvars. Ten plant species that occur in Ontario alvars are considered to be globally rare and four others are considered to be nationally rare. Four provincially rare moss species and one lichen species also occur in Ontario alvars, as do a variety of rare and endangered animal species (Brownell and Riley 2000). One of Ontario's most endangered species, the Loggerhead Shrike, is restricted to grazed alvars in the Mixedwood Plains Ecozone. Alvars also are important habitat for several of Ontario's threatened and endangered reptiles (e.g., Blue Racer and Massasauga) (Brownell and Riley 2000).

Alvar pavement in Misery Bay

Photo: Wasyl D. Bakowsky, NHIC Archives

Freshwater Coastal Dunes

Great Lakes sand dunes make up the world's largest collection of freshwater coastal dunes (SOLEC 2009). Ranging from the high forested dunes and linear dune ridges commonly backing sand beaches, to active, moving dune fields, sand dunes can be found along the coasts of all the Great Lakes, with approximately 2,200 ha found in Ontario (NHIC database, OMNR, Peterborough, Ontario). Freshwater coastal dunes are fragile ecosystems that are easily disturbed by natural forces and human activities. Artificial shoreline hardening and stabilization, and structures such as groins, piers, and breakwalls that change the natural erosion and deposition of sand by long-shore water currents, are probably the most serious threats to dune systems (Jalava 2004). Foot and vehicle traffic can severely impact dune systems and lead to their degradation and destruction. Other threats include encroachment by cottage development, erosion during periods of high controlled water levels, and invasion by invasive alien species.

Freshwater coastal dunes are home to a variety of endemic, rare, endangered, and threatened species in Ontario, and contain globally significant shorebird habitats. At least 26 provincially rare plant species are known to occur in the freshwater coastal dunes surrounding the Great Lakes, including the Pitcher's Thistle and Long-leaved Reed Grass. The Piping Plover, which disappeared from the Ontario portion of the Great Lakes for 30 years, has recently reappeared at a number of freshwater coastal dune locations on Lake Huron. Finally, there are many rare insects found in coastal dunes, including tiger beetles, locusts, butterflies, and moths. Some of these, such as the Lake Huron Locust, are globally rare.

INDICATOR—Extent and Protection of Ontario's Rare Ecosystems

This indicator assesses the total area of prairie, savannah, alvar, and dune ecosystems in Ontario, and the area of each that is legally protected in the province. Although there are estimates of historical extent of prairie (described above), the extent of all rare ecosystem types has not been adequately tracked over time and so the information reported here is considered as the baseline for assessing future trends. Protection includes areas regulated as Provincial and National Parks, National Wildlife Areas, and Conservation Reserves. Rare communities in protected areas are sometimes subjected to disturbance and threats from human use, but are generally not subject to development and the same level of threats as non-protected areas. Data for this indicator were derived from the NHIC database.

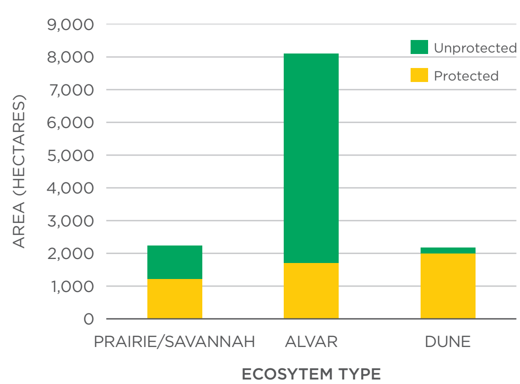


Figure 34. Total area of prairie/savannah, alvar and dune ecosystems in Ontario showing amount of each type that is legally protected (source: NHIC database, OMNR, Peterborough, Ontario).

- Alvar ecosystems cover more area than the other rare ecosystem types, but only 21% of their total area is legally protected.

- Just over half (54%) of the prairie/savannah area in the Mixedwood Plains Ecozone is legally protected.
- Ninety-two percent of the area of dune ecosystems is legally protected.

TREND
BASELINE

DATA CONFIDENCE
MEDIUM

Aquatic Ecosystems

Ontario has an abundance of water resources with more than 250,000 lakes and 500,000 km of streams (Figure 35). Most of our drinking water, as well as water used for irrigation, industry and hydroelectric power come from Ontario's freshwater lakes and streams. Ontario's aquatic ecosystems also provide significant social and economic benefits through recreational and commercial fisheries, transportation, tourism, water-based recreation, and traditional Aboriginal uses.

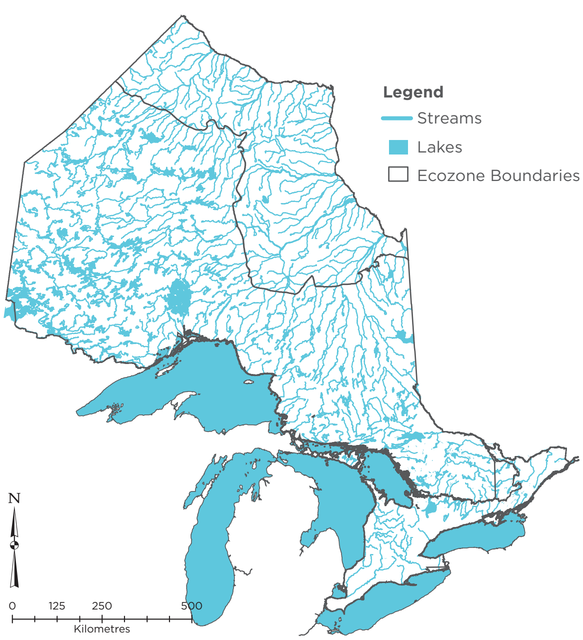


Figure 35. Ontario's lakes and streams.

Ontario's aquatic ecosystems support a large diversity of species from a variety of habitat types ranging from small headwater streams to the vast open waters of the Great Lakes. Ontario has more native freshwater fish species (129) than any other province in Canada (CESCC 2006). Although the extent of aquatic ecosystems in Ontario is relatively stable, the quality of aquatic habitats and the composition of aquatic communities in parts of the province have been compromised by habitat degradation, flow modification, pollution, invasive alien species, and overharvest. To examine trends in Ontario's aquatic ecosystems, information is presented separately for the Great Lakes and inland waters.

Great Lakes

The Great Lakes—Erie, Huron, Michigan, Ontario and Superior—together represent the largest collection of surface fresh water on Earth, with the exclusion of the polar ice caps. The Ontario portion of the Great Lakes and connecting waterways represents 8% of the area of the province. The Great Lakes and their surrounding watersheds make up a rich and diverse system that supports a wide variety of aquatic and terrestrial life. Great Lakes ecosystems have undergone significant and sometimes rapid ecological change associated with a long history of intensive human use. Indicators on shoreline alteration and the deepwater community in the Great Lakes presented below are based on analyses done for the State of the Lakes Ecosystem Conference (SOLEC 2009). The information presented includes data from the American waters of the Great Lakes as well as Lake Michigan (entirely within the United States), recognizing that these waters are not part of Ontario, but are part of a larger, shared system. More detailed analyses and indicators on the status and trends of the Great lakes can be found in SOLEC (2009).

INDICATOR—Extent of Shoreline Hardening in the Great Lakes

Over time, shoreline hardening (replacement of natural shoreline with concrete or rock structures to prevent erosion) has occurred along Great Lakes coasts, following, or as part of, extensive coastal development and alterations. These structures act as barriers to natural coastal processes and destroy shoreline habitat (SOLEC 2009). They also modify the land-water interface which can impact surface flow, groundwater infiltration and coastal processes. Many of the nearshore biological communities along the Great Lakes are dependent upon the transport of shoreline sediment by lake currents. This process is interrupted when shorelines are artificially hardened.

Over the long term, the disruption of the natural erosion and sediment transport by shoreline hardening can have large impacts. Dune formations are lost, beaches are reduced, and coastal wetlands vanish. Since 1931, the total beach area at Point Pelee National Park has declined by more than 50% due to the combined effects of harbour structures, public and private armouring of shoreline outside the park and historical sand mining (Parks Canada 2007). Continued losses of the eastern barrier beach due to changes in sand deposition and erosion now threaten crucial wetland and forest habitats in this important ecological area of the Mixedwood Plains Ecozone.

Shoreline hardening is not easy to reverse and a hardened shoreline can become a permanent feature in the ecosystem without restoration efforts. Maintaining a

Great Lakes shoreline hardening

Photo: OMNR

natural connection at the land-water interface is critical to preserving the chemical, physical and biological integrity of the Great Lakes ecosystem. This indicator assesses the extent to which shoreline hardening has occurred along the Great Lakes. The analysis (taken from SOLEC 2009) is based on interpretation of aerial photography from 1987–1989. Analysis of 22 km of the Canadian side of the St. Clair River revealed that an additional 32% of the shoreline was hardened between 1991–1992 and 1999. Shoreline hardening in inland waters with adjacent urban areas, homes and cottages is also an issue; however, similar measures of hardening are not available for these areas.

- Of the five Great Lakes, Lake Erie has the highest percentage of hardened shoreline, and lakes Huron and Superior have the lowest.
- More than one fifth of Lake Erie's shoreline is 70–100% hardened.
- The connecting channels have experienced a higher percentage of shoreline hardening than all of the Great Lakes except Lake Erie.

TREND
DETERIORATION

DATA CONFIDENCE
MEDIUM

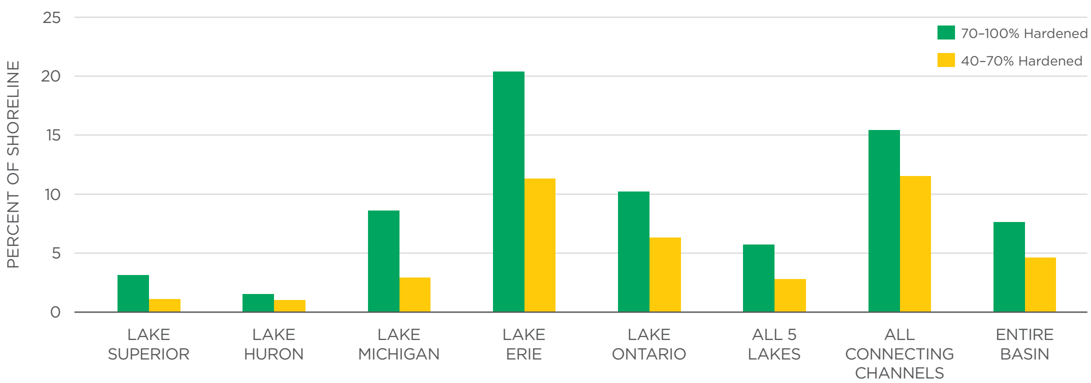


Figure 36. Extent of shoreline hardening within the Great Lakes and connecting channels. Connecting channels include: St. Mary's River, St. Clair River, Lake St. Clair, Detroit River, Niagara River and St. Lawrence Seaway (source: SOLEC 2009—from Environment Canada and National Oceanic and Atmospheric Administration).

INDICATOR—Distribution and Abundance of *Diporeia* spp. in the Great Lakes

Diporeia spp. are species of small crustaceans that live at the bottom of deep cold lakes. Historically, *Diporeia* was the most abundant bottom-dwelling organism in the cold, deep offshore areas of the Great Lakes. It was present in smaller numbers in nearshore areas, but naturally absent in shallow, warm bays and river mouths (SOLEC 2009). *Diporeia* lives in the bottom sediments where it feeds on algae that has settled out of the water column. It plays a key role in the food web as many smaller fish eat *Diporeia*, and these fish are then eaten by larger fish like Lake Trout and salmon. *Diporeia* is also one of the main food items for Lake Whitefish, an important component of the fish community in the Great Lakes. The growth and condition of Lake Whitefish has declined in areas of the Great Lakes with low *Diporeia* abundance (SOLEC 2009). The central role played by *Diporeia* in the offshore food web makes it a good indicator of the condition and productivity of the deep, coldwater communities of the Great Lakes.

Populations of *Diporeia* have been declining in most of the Great Lakes since the 1990s. Although abundance of *Diporeia* may be affected by changes in the fish populations that eat it, and by local sources of pollution in nearshore areas, the observed declines over broad areas have coincided with the invasion and establishment of the Zebra Mussel and the Quagga Mussel. These invasive mussel species may be competing with *Diporeia* for food, however, the reasons for the decline in *Diporeia* are not clearly understood (SOLEC 2009). This indicator assesses trends in *Diporeia* distribution and abundance, reflecting changes in Great Lakes food web dynamics. The information on trends is presented for each lake in Table 4, as well as with time series maps that are available for Lake Huron and Lake Ontario (Figures 37, 38). Comparable information is not available for deep, inland lakes in Ontario with *Diporeia* populations.

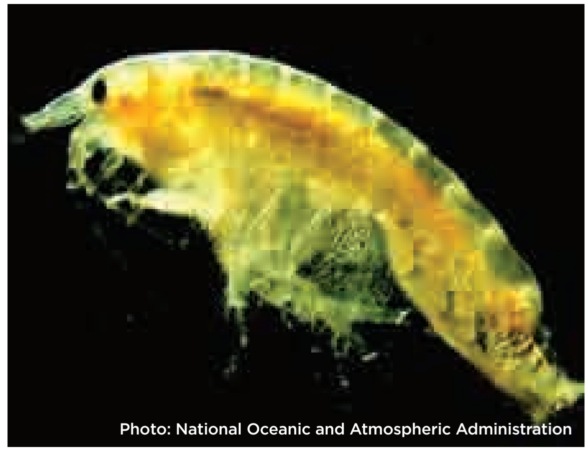


Photo: National Oceanic and Atmospheric Administration

Diporeia ***sp.***

Table 4. Trends in distribution and abundance of *Diporeia* spp. in the Great Lakes.

LAKE	DISTRIBUTION AND ABUNDANCE TREND
Superior	no overall trend, annual population fluctuations evident
Michigan	84% decline between 2000 and 2005, *Diporeia* have disappeared from depths less than 80 m
Huron	93% decline between 2000 and 2007, *Diporeia* have disappeared or are rare at depths less than 60 m
Erie	*Diporeia* only occurred historically in the eastern basin because the western and central basins are too warm and shallow; declines began in the early 1990s and *Diporeia* has not been found in the lake since 1998
Ontario	declines are evident since 1995, *Diporeia* have disappeared from most sites at depths < 90 m

Source: modified from SOLEC (2009).

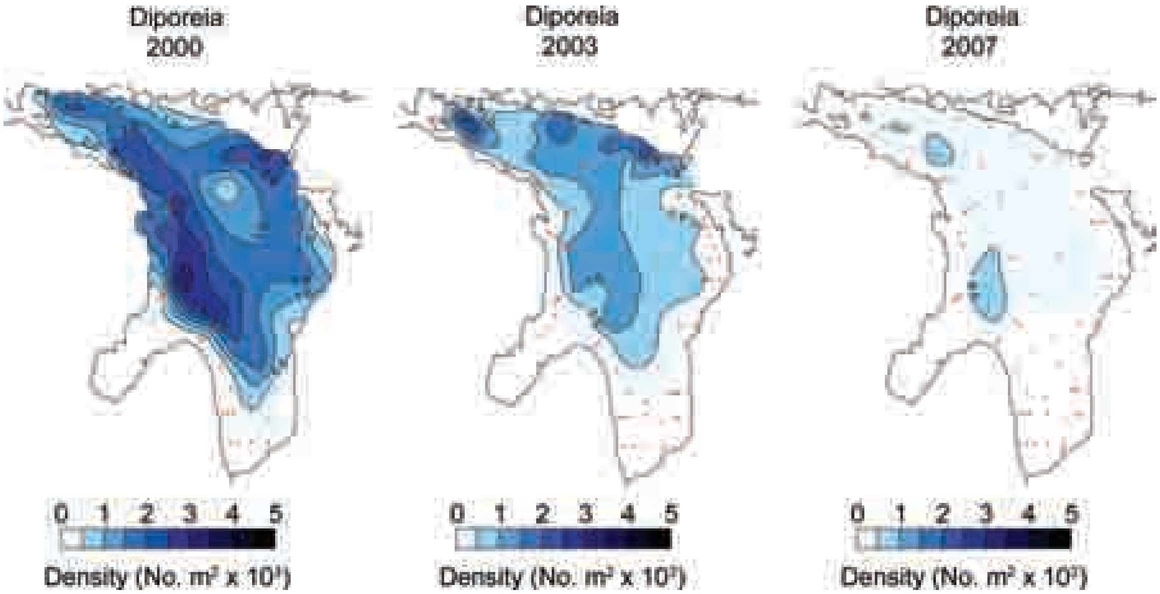
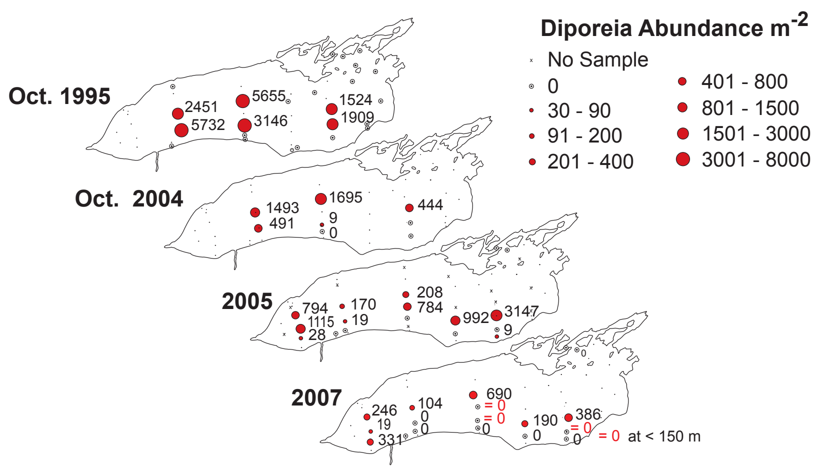


Figure 37. Distribution and abundance (number per square metre) of *Diporeia* spp. in Lake Huron in 2000, 2003, and 2007 (small crosses indicate sampling locations) (source: SOLEC 2009—National Oceanic & Atmospheric Administration (NOAA) Great Lakes Environmental Research Laboratory).

Figure 38. Distribution and abundance (number per square metre) of *Diporeia* spp. in Lake Ontario in 1995, 2004, 2005 and 2007 (source: SOLEC 2009—Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada).



- *Diporeia* has declined drastically over the last 10–20 years in all of the Great Lakes except Lake Superior.
- Diporeia declines have coincided with the establishment of invasive Zebra Mussels and Quagga Mussels in each lake, but the reasons for the declines are not well understood.

TREND
DETERIORATION

DATA CONFIDENCE
MEDIUM

Inland Waters

Ontario's vast network of inland lakes and streams covers 9% of the province's surface area. The majority of Ontario's lakes are found within the rugged terrain of the Ontario Shield Ecozone. Small streams and rivers are the most common aquatic ecosystem in the Mixedwood Plains Ecozone, while the landscape of the Hudson Bay Lowlands is dominated by wetlands intersected by large rivers. In addition to lakes and rivers, associated wetlands are vitally important as habitat for many aquatic species. The diversity of aquatic species inhabiting Ontario's inland waters is highest in the Mixedwood Plains Ecozone. Some individual watersheds in this region have close to 100 species of fish and 30 species of freshwater mussels (e.g., Grand, Thames and Sydenham rivers) (Staton and Mandrak 2006). In contrast, only 53 freshwater fish species are found in the Hudson Bay Lowlands Ecozone and the northwestern portion of the Ontario Shield Ecozone combined (Browne 2007).

Information on habitats and aquatic communities from a wide range of Ontario lakes that would be suitable to develop provincial biodiversity indicators was not available for this report. Ontario has recently initiated a Broad-scale Monitoring Program to assess and report on the status and trends in fishery resources, aquatic communities, habitats and stressors in Ontario lakes. This program will be valuable in contributing to biodiversity indicators for Ontario lakes in future reports. More information is available for streams, and indicators are included on stream flow and fragmentation by dams.

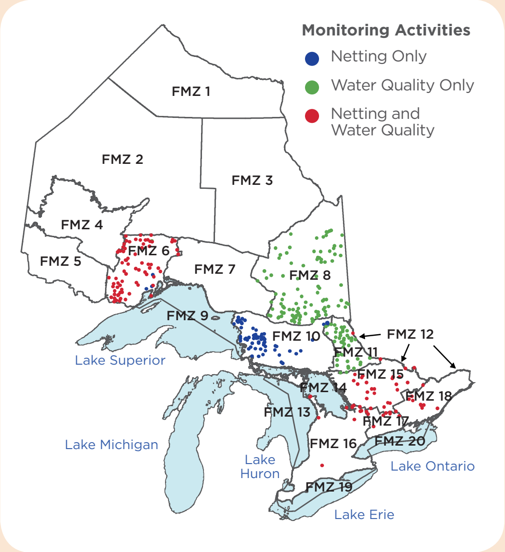
MONITORING THE HEALTH OF ONTARIO'S INLAND LAKES

Ontario's Ecological Framework for Fisheries Management, introduced in 2004, takes a landscape, rather than a lake-by-lake approach to fisheries planning, management, and monitoring. Increasing knowledge of inland lakes, their fisheries, and aquatic biodiversity, is an important part of the framework. In 2008, the Ontario Ministry of Natural Resources began the Broad-scale Monitoring Program, a long-term effort to monitor the health of Ontario's lakes and their fisheries. The goals of the program are to: describe the distribution of aquatic resources in Ontario lakes; identify stresses on these resources; track trends in indicators of the health of Ontario's fisheries, lake ecosystems, and aquatic biodiversity; and, assess and report on the status of fisheries in Ontario.

Because Ontario is large and has a wealth of inland lakes, monitoring all lakes isn't possible. Instead, the Broad-scale Monitoring Program was designed to sample representative lakes across the province every 5 years, using standardized data collection methods. A wide range of variables are monitored: fish are netted to determine abundance, sex, length and weight, and to test for contaminants; water quality is analyzed; invasive species are recorded; and fishing effort is estimated. The sampling approach will allow scientists to measure and evaluate the health of Ontario's lakes and their fish communities, and track changes through time over broad areas of the province.

Since the program began in 2008, 378 lakes have been sampled across the province.

This work has already made important contributions to our understanding of inland lakes, their fisheries and aquatic biodiversity in Ontario. The first round of sampling, planned to conclude in summer 2012, will provide an unprecedented snapshot of fish populations and the status of inland lakes across the province. This new information will provide an important baseline for examining future trends. However, the true value of the monitoring program for supporting fisheries management and biodiversity conservation will only be realized in the long term (10+ years), as lakes are repeatedly sampled.



Broad-scale Monitoring sites 2008

INDICATOR—Alterations to Stream Flow

Stream flow is determined by climate and local environmental factors including the shape and size of the stream and its watershed, and the geology of the landscape (Poff et al. 1997). Aquatic species living in streams are adapted to regular, predictable changes in stream flow that occur seasonally. Because of the overwhelming influence of flow on the physical habitat present in streams (e.g., channel form, substrate composition), flow is an important factor in determining the species that are present in stream communities. Aspects of flow that have an important influence on biodiversity include the amount of flow, frequency (how often particular flow levels occur), duration (time that a particular flow lasts), timing (when a particular flow event such as the spring freshet occurs), and variability (how quickly flows change) (Richter et al. 1996; Poff et al. 1997). Changes to these hydrological characteristics outside of the range of normal variation can be expected to impact stream biodiversity.

Long-term changes to flow regimes are often related to climate and patterns of precipitation, but can also be brought about directly through the construction of impoundments and urbanization of watersheds (Poff et al. 2006). Climate change will likely impact many aspects of flow regimes (Bates et al. 2008). While there are several alterations to flows that may impact biodiversity, the greatest impacts will likely be related to changes in the spring freshet (peak stream flow

Harris Creek

associated with melting snow pack), and summer low flows. Some climate change models predict a reduction in the size and duration of the spring freshet due to an increase in snow melt events during the winter. The spring freshet is also expected to occur earlier in the year and the frequency of droughts (low flow events) is expected to increase in southern Canada (Bates et al. 2008).

Recent reviews of long-term stream flow data from reference sites across the country have shown that annual and late summer flows tend to be decreasing in southern Canada and that the spring freshet is occurring earlier in the year (Zhang et al. 2001; Government of Canada 2009). Reference sites are located on natural streams with limited modifications in their watersheds to provide monitoring of long-term trends and climate effects. A detailed analysis of the Winnipeg River watershed (regulated by numerous dams) in the Ontario Shield Ecozone showed that annual flows have actually increased by 58% since 1924, largely associated with increased precipitation in the summer and fall (St. George 2007). A stream flow biodiversity indicator should include a representative cross-section of streams that have experienced various degrees of watershed modification. Although there are suitable data available from streams across Ontario, the detailed analysis of these long-term data sets could not be completed for this report. Therefore, the stream flow indicator is included in this report as 'not assessed', but will be assessed in future reports.

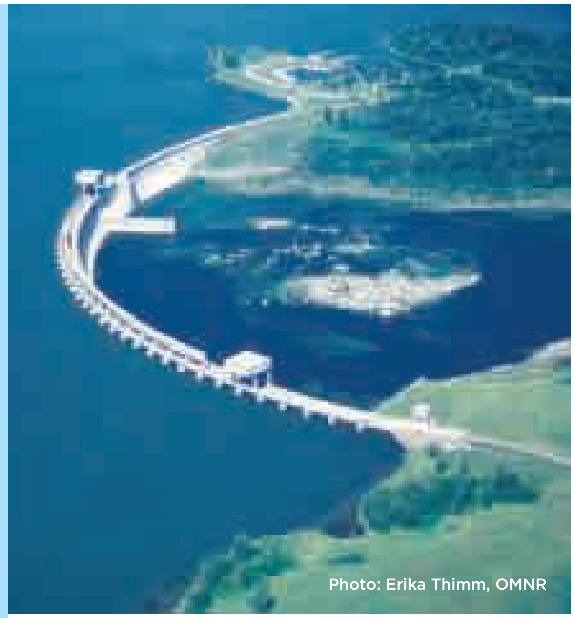
TREND
UNDETERMINED

?

DATA CONFIDENCE
N/A

INDICATOR—Stream Fragmentation and Flow Regulation by Dams

Dams can adversely affect aquatic biodiversity on multiple fronts. Dams interrupt the flow of streams and can alter the natural variation in the size, timing, frequency and variability in flows (Helfman 2007). Upstream areas are often flooded, changing habitats into warmer more lake-like conditions, and the habitat in downstream channels is sometimes changed dramatically due to erosion. Dams also fragment linear aquatic habitats preventing access to important habitats for migratory species and preventing gene flow between local subpopulations. Impoundments associated



Long-Sault Dam, St. Lawrence River

with dams can also facilitate the invasion of alien species (Johnson et al. 2008). Although the impacts of large dams have received much attention, the cumulative impacts of multiple small dams that exist on the tributaries of many watersheds can also be significant (Helfman 2007).

Nilsson et al. (2005) conducted an assessment of dam-based impacts on the world's large river systems including those in Ontario (Figure 39). Large river systems were classified as unaffected, moderately affected, or strongly affected based on the degree of fragmentation and flow regulation attributed to dams in their main stem and tributaries. This analysis was done at a very coarse scale—for example the entire St. Lawrence River drainage (including the Great Lakes watershed) was assessed as a single large river system. Because of the coarse scale of this analysis, it is not possible to reliably assess status and trends for this report. However, the information is provided here due to the impacts of stream fragmentation on biodiversity. The assessment by Nilsson et al. (2005) shows that all of the watersheds in the southern half of the province are strongly affected by dams. Watersheds in the northwestern portion of the Ontario Shield Ecozone and the northern portion of the Hudson Bay Lowlands Ecozone are unaffected by dams. Globally, only 12% of the total watershed area assessed is unaffected by dams. A similar assessment for Ontario at a finer scale was not available for inclusion in this report. Therefore, the stream fragmentation indicator is included in this report as 'not assessed', but will be assessed in future reports.

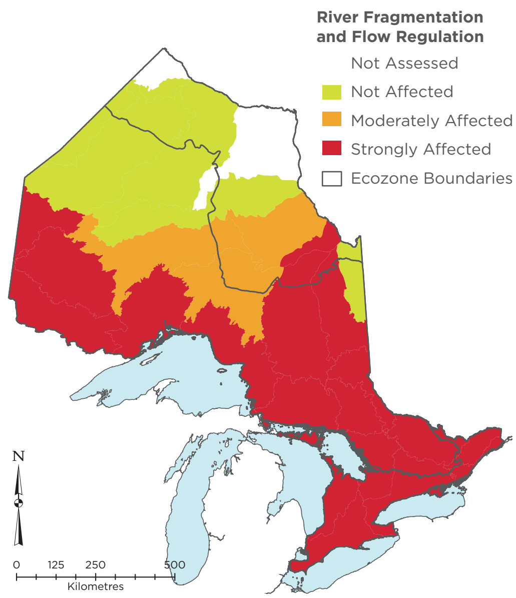


Figure 39. Impact classification of Ontario's large river systems based on river channel fragmentation and water flow regulation by dams (based on data from Nilsson et al. 2005).

TREND
UNDETERMINED

DATA CONFIDENCE
N/A

AQUATIC HABITAT FRAGMENTATION AND LAKE STURGEON

Historically, Lake Sturgeon were abundant in Ontario, but overharvest, habitat loss, habitat fragmentation, and pollution severely reduced populations by the turn of the 20th century. Despite improvements in water quality and much tighter regulation of commercial and recreational fisheries, most Lake Sturgeon populations have not recovered. In 2009, the statuses of Lake Sturgeon populations in Northwestern Ontario and the Great Lakes/ Upper St. Lawrence River watershed (including the Ottawa River) were elevated to Threatened on the Species at Risk in Ontario List.

Lake Sturgeon in the Ottawa River provide a good case study on the potential effects of habitat fragmentation by dams on fish and aquatic biodiversity. The Lake Sturgeon's life cycle—migratory, long-lived, slowly-maturing, and with intermittent reproduction—as well as its dependence on flowing waters, make it particularly susceptible to habitat loss and fragmentation. Humans have been building dams and modifying water flows on the Ottawa River for more than a century. The dams have created physical barriers to the movement of Lake Sturgeon and significantly altered the timing and magnitude of flows. This has negatively impacted the quality and availability of Lake Sturgeon habitat.

Lake Sturgeon

To understand the impacts of habitat fragmentation on Ottawa River Lake Sturgeon, scientists recently examined populations in parts of the river with and without dams (Haxton and Findlay 2008, 2009). They found that Lake Sturgeon populations are larger in parts of the river with more natural flow regimes than in areas where flows are more actively regulated by dams. There was no evidence that commercial fishing or contaminants are impeding Lake Sturgeon recovery. The results suggest that not enough young Lake Sturgeon are being produced to allow populations to recover in reaches that have dams. Habitat alterations, including changes in flow, water temperature, and the availability of food and suitable spawning habitat, have been identified as the likely causes.

Lake Sturgeon is not the only species affected by habitat loss and fragmentation on the Ottawa River. The researchers also found differences in the types and numbers of fish species between areas regulated by dams and parts of the river with more natural flows. These results, as well as those from other similar studies, suggest that dams and dam operations strongly affect the structure of fish communities and aquatic biodiversity.

Species Diversity

Status of Native Species in Ontario

Human activities are altering the natural world at an unprecedented scale, causing global extinction rates to rise an estimated 100 to 1000 times beyond the natural extinction rate (Pimm et al. 1995). Our activities can fundamentally and, to a certain extent irreversibly, change the diversity of life and negatively affect the health and well-being of all Ontarians. Although many Ontario species are managed to provide sustainable harvests, numerous species are at risk of disappearing from the province due to threats such as habitat loss and invasive alien

DECLINING POLLINATORS

Bumble Bees on Blueflag

Pollination by animals (movement of pollen from male to female flowers) is an essential ecosystem service that is required for most of the world's flowering plants. Animal pollination is important to the structure of natural ecosystems and agricultural production. About 35% of the world's supply of food plants comes from crops that rely on animal pollination for the development of seeds, vegetables or fruit (Klein et al. 2007). Animal pollinators include insects (bees, wasps, butterflies and moths, flies and beetles), birds and bats. In North America, bees and flies are probably among the most important pollinators. Because of the economic and ecological importance of pollination, there is currently concern regarding an apparent global decline of pollinating species (MEA 2005).

A recent review of the status of pollinators in North America (NRC 2007) found that the Honey Bee (a managed species introduced from Europe and Africa to enhance crop pollination) has experienced large declines that began in the 1980s with the invasion of two parasitic mite species. More recently in the United States, the Honey Bee has been affected by a new and poorly understood syndrome known as Colony Collapse Disorder that causes the loss of entire colonies (Stokstad 2007). The status of North American native pollinator species is less clear. Although there is evidence of declines in some species, for most native pollinators, there is a lack of long-term monitoring to assess trends (NRC 2007). The biology and taxonomy of many species is also poorly understood. Some species of bumble bees, like the Rusty-patched Bumble Bee found in Ontario, have experienced severe declines. Potential causes of these declines include habitat loss and fragmentation, introduced pathogens and parasites, pesticides, and climate change (NRC 2007).

species. Information about what species are at risk and the factors that threaten them is important in understanding the current state of biodiversity in Ontario and in developing plans for the protection and recovery of species.

Species that are at risk of disappearing from the province are assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO). As of September 2009, there were 199 species listed on the Species at Risk in Ontario List under Ontario's *Endangered Species Act, 2007* (**www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/276722.html**). A few species have recently been moved into lower risk categories on this list or removed from the list due to improving status (e.g., lower risk category—Bald Eagle, Peregrine Falcon, Hooded Warbler; removed from list—Bigmouth Buffalo, Red-shouldered Hawk, Southern Flying Squirrel), but the list continues to grow as new species are assessed. Since 2000, 156 species have been added to the list, 24 species have been moved into a higher risk category, 10 species have been moved to a lower risk category, and 9 species have been removed from the list . There are many potentially at risk species that have not yet been assessed by COSSARO, so the Species at Risk in Ontario List will likely continue to grow.

Ontario's Natural Heritage Information Centre contributes to a national effort to assess the General Status of Wild Species in Canada every 5 years (**www.wildspecies.ca**). The assessment of General Status of wild species is limited to groups of plants and animals for which there is adequate information. All species of vertebrates and vascular plants are covered by the General Status program, but assessments of invertebrates and non-vascular plants are far from complete. Although 4,217 Ontario species were assessed in


Photo: Rob Tervo

Spring Salamander—Extirpated from Ontario

2005, this represents less than 15% of the more than 30,000 species that are estimated to occur in Ontario. Most of the unassessed species are insects—there are probably more than 20,000 insect species in Ontario, but only about 350 species from some of the better known groups were assessed in 2005. The General Status program is a better indicator for Ontario species diversity than the Species at Risk in Ontario List because it considers the status of all species in assessed groups, and also identifies species that may be at risk, but are not yet assessed by COSSARO or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

To assess trends in the status of Ontario's species, this report includes information from the General Status program on the number and proportion of Ontario's native species that are of conservation concern as well as those that are secure, along with changes that have occurred between the 2000 and 2005 assessments. Because there are long-term, standardized monitoring programs for breeding birds in Ontario, a separate indicator on trends in bird populations is also included.

INDICATOR—Ontario Species in Secure and Conservation Concern General Status Categories

2005 General Status Ranks for Ontario Species

An examination of the number and proportion of species in each General Status category, provides an overall indication of how well species are doing in Ontario. It is a tool to help identify which species' populations are sensitive and which ones may be at risk and in need of protection. Equally important, this indicator provides a comparison between species groups, helping to determine patterns of threat that may exist among these groups. General Status ranks of species in Ontario are reviewed and updated every 5 years, thereby allowing changes in the ranks of Ontario's wild species to be detected and reported over time.

The General Status program ranks species into one of ten categories shown in Table 5 below. The first five categories represent species of conservation concern.

The General Status ranks for Ontario species assessed in 2005 are summarised in Table 6. The information is presented as the number of species in each General Status category for each species group assessed. It also includes subtotals for each General Status category and each species group.

Table 5. Definitions of General Status ranks (modified from CESCC 2006).

RANK		DEFINITION
Species of conservation concern	**Extinct**	Species that are extirpated worldwide (i.e., they no longer exist anywhere).
	Extirpated	Species that are no longer present in Ontario, but occur in other areas (e.g., a given species no longer occurs in Ontario, but still occurs in other provinces or another country).
	At Risk	Species for which a formal, detailed risk assessment (COSEWIC or COSSARO status assessment) has been completed and that has been determined to be Endangered or Threatened.
	May Be At Risk	Species that may be at risk of extirpation or extinction and are therefore candidates for a detailed risk assessment by COSEWIC or COSSARO.
	Sensitive	Species that are not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk (includes species listed as Special Concern).
Secure		Species that are not believed to belong in the categories Extirpated, Extinct, At Risk, May Be At Risk, Sensitive, Accidental or Exotic. This category includes some species that show a trend of decline in numbers in Canada but remain relatively widespread or abundant.
Exotic		Species that have been moved beyond their natural range and are found in Ontario as a result of human activity. Exotic species are excluded from all other categories. Exotic species = alien species that are not native to any Ontario ecosystem
Undetermined		Species for which insufficient data, information, or knowledge is available with which to reliably evaluate their General Status.
Not Assessed		Species that are known or believed to be present in Ontario, but have not yet been assessed by the General Status program.
Accidental		Species occurring infrequently and unpredictably, outside their usual range.

- The 2005 ranks show that 987 Ontario species are of conservation concern (i.e., Extinct, Extirpated, At Risk, May Be At Risk, or Sensitive), while 1,867 Ontario species are Secure, representing 23% and 44% of all assessed wild species in the province, respectively.
- Of the assessed groups, vascular plants account for the majority (72% or 3,055 species) of species. Similarly, most of the species of conservation concern (71% or 702 species) are vascular plants.
- 1,057 of the 4,217 species assessed (25%) are exotic species. The majority of these (1,017 species) are vascular plants. Thirty-three percent of Ontario's vascular plants are exotic species.

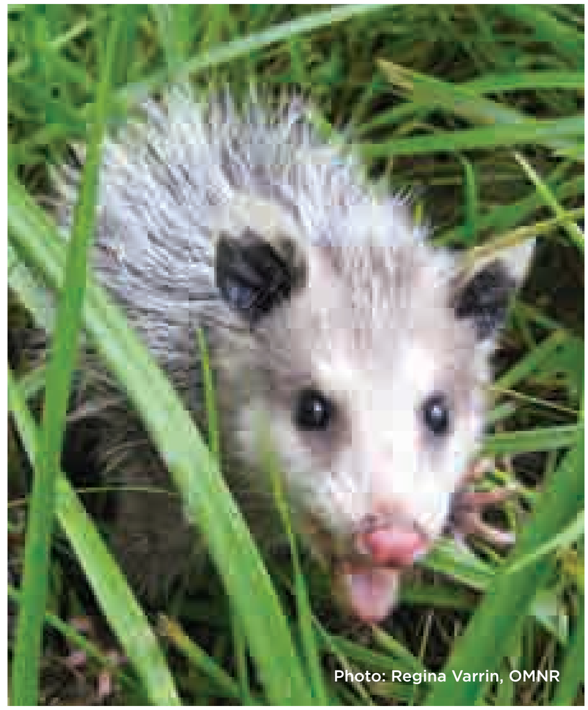


Photo: Regina Varrin, OMNR

Virginia Opossum—Secure in Ontario

Table 6. General Status ranks for Ontario species assessed in 2005 (from CESCC 2006).

GROUP	NUMBER OF SPECIES PER GENERAL STATUS RANK CATEGORY										SUBTOTALS
	Species of conservation concern 987 species										
	Extinct	Extirpated	At Risk	May be at risk	Sensitive	Secure	Undetermined	Not Assessed	Exotic	Accidental	
Vascular Plants	0	22	55	441	184	1255	81	0	1017	0	3055
Freshwater Mussels	0	0	8	10	9	13	0	1	0	0	41
Tiger Beetles	0	0	0	2	1	11	0	0	0	0	14
Dragonflies & Damselflies	0	0	0	43	39	79	5	0	0	2	168
Butterflies	0	2	0	19	22	87	14	0	2	19	165
Crayfishes	0	0	0	0	2	5	0	0	2	0	9
Freshwater Fishes	1	5	10	3	21	87	7	1	19	0	154
Amphibians	0	2	5	1	0	18	0	0	0	0	26
Reptiles	0	0	12	0	5	8	1	0	1	0	27
Birds	1	1	16	10	21	252	0	0	9	167	477
Mammals	0	0	3	2	9	52	4	1	7	3	81
Subtotals	2	32	109	531	313	1867	112	3	1057	191	4217

Figure 40 shows the Ontario distribution of 784 species of conservation concern for which there are detailed geographic location data in the NHIC database. Seventy-three percent of these species (572 species) and 71% of the 13,402 occurrence records are within the Mixedwood Plains Ecozone. Forty percent of the species (311 species) and 26% of the occurrence records are within the Ontario Shield Ecozone. This distribution reflects the higher species diversity within the Mixedwood Plains Ecozone as well as the prevalence of stressors within this region.

An examination of the proportion of species in each General Status category allows for a comparison of the relative risks and status of the different species groups. For this comparison only those species ranked as secure or in categories of conservation concern are considered. This information is presented below for the 11 species groups assessed in 2005 as well as for all species combined (Figure 41).

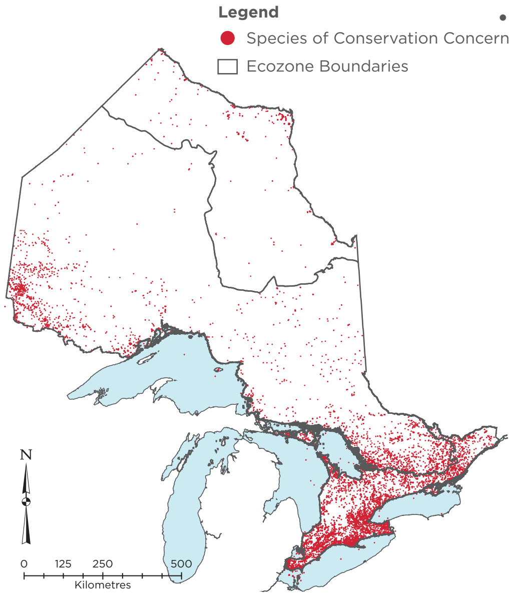


Figure 40. Distribution of species of conservation concern within Ontario (source: NHIC database, OMNR, Peterborough, Ontario).

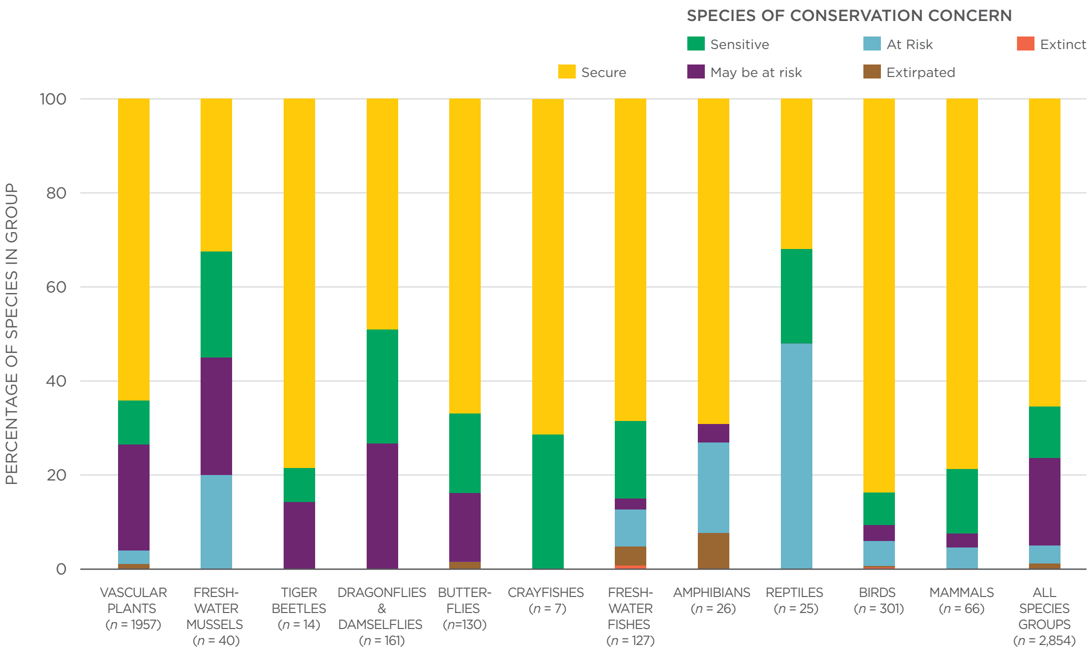


Figure 41. Proportion of Ontario native wild species in secure and conservation concern General Status rank categories, 2005 (*n* = number of secure species and species of conservation concern in group) (source: CESCC 2006).

- Birds have the highest proportion of secure species (84% of 301 species) of the groups assessed.
- Reptiles have the highest proportion of species of conservation concern (68% of 25 species), followed closely by freshwater mussels, and dragonflies and damselflies.
- Amphibians have the highest proportion of extirpated species, while birds and freshwater fishes are the only species groups with extinct species.

Changes in General Status Ranks of Ontario species between 2000 and 2005

The first assessment of the General Status of Wild Species in Canada was conducted in 2000 (CESCC 2001). The reassessment of General Status every 5 years, allows an examination of changes and trends in species' status ranks over each period. Although General Status ranks will be updated in 2010, the timing of the 2010 assessment did not allow the information to be included in this report. Comparison of General Status ranks between 2000 and 2005 is limited to species groups that were included in both assessments. The 2000 assessment was limited to 1,063 of the 4,217 species that were assessed in 2005. This first assessment only included a small subset of Ontario's vascular plants (140 species of ferns and orchids) and did not include freshwater mussels, tiger beetles, dragonflies and damselflies, and crayfishes.

It is important to understand the reasons behind changes in General Status ranks between the 2000 and 2005 assessments. General Status ranks may change to a higher or lower risk category due to an observed change in the actual risks to these species (i.e., biological change in species population size, distribution, threats or trends). However, species may also change ranks because of improved information even though the condition of the species remains unchanged. For example, a species may be moved to a lower risk category if more populations are discovered as a result of monitoring activities. Similarly, a species may be moved to a higher risk category if it is listed as a species at risk following a formal status assessment by COSEWIC or COSSARO. It is important to note that changes in population statuses for some species and the availability of monitoring data may occur over a longer time scale than the 5-year reporting period. Populations of species may also decrease or increase and their General Status Ranks may not change. For example, increases in the population size of a species that is already secure, will not result in a change in its ranking.

A comparison of the General Status ranks for 1,063 Ontario species assessed in 2000 and 2005 is summarised in Table 7. This summary identifies the number of species whose ranks changed, the directions of these rank changes, and the reasons the ranks were changed.

Table 7. Summary of changes in General Status rank of Ontario Species between 2000 and 2005.

DIRECTION OF GENERAL STATUS RANK CHANGE	REASON FOR GENERAL STATUS RANK CHANGE			TOTAL CHANGES	NO CHANGE
	Better information	Increasing risk	Decreasing risk		
into higher risk category	21	10	n/a		
into lower risk category	54	n/a	0		
into Accidental or Exotic categories	5	n/a	0		
into Undetermined category	6	n/a	n/a		
out of Undetermined category	43	n/a	n/a		
taxonomic change, no rank in 2000	5	n/a	n/a		
Total number of changes in rank	**134**	**10**	**0**	**144**	
Number of species with no change in rank					**919**

Note: information in table represents changes in General Status ranks to ferns, orchids, butterflies, freshwater fishes, amphibians, reptiles, birds, and mammals that were assessed in 2000 and 2005. (source: NHIC database, OMNR, Peterborough, Ontario).

- Between 2000 and 2005, the General Status rank did not change for 919 of 1,063 species (86%) assessed, but 144 species changed status rank.
- Thirty-one species were ranked in a higher risk category in 2005 than in 2000. Twenty-one species were changed to a higher risk category as a result of a detailed assessment by COSEWIC and/or COSSARO. Ten species (nine birds and one fish) moved to a higher risk category due to increasing risks to these species (American Eel, Short-eared Owl, Upland Sandpiper, Chimney Swift, Cerulean Warbler, Golden-winged Warbler, American Coot, Yellow-breasted Chat, Red-headed Woodpecker, and Western Meadowlark).
- Fifty-four species were moved to a lower risk category. All of these changes were due to better information being available to assess the statuses of these species.

TREND
MIXED

DATA CONFIDENCE
HIGH

INDICATOR—Trends in Ontario's Breeding Birds


Photo: Simon Dodsworth

Cedar Waxwings

Birds are found throughout Ontario from backyards and parks in large southern cities to the vast wetlands of the Hudson Bay Lowlands. They bring inspiration to our lives through their melodious springtime songs and their striking beauty. They also have important roles as seed dispersers, predators and scavengers. People enjoy birds in many ways—some like to feed birds in their backyard; some make a hobby out of birdwatching and bird photography; some carry on the tradition of hunting waterfowl and upland game birds; while others actively participate in volunteer-based bird surveys such as the Ontario Nocturnal Owl Survey, Ontario Breeding Bird Atlas, Christmas Bird Count, and Project FeederWatch. Due in large part to these keen birdwatchers and volunteer "Citizen Scientists", we know a lot about Ontario's birds—especially in the southern part of the province.

Of the 483 bird species that have been recorded in the province, about 269 species of birds breed regularly in Ontario, including waterfowl (ducks, geese and swans), waterbirds (loons, grebes, herons, gulls and terns, rails and crane), shorebirds, and landbirds (grouse, hawks, doves, cuckoos, owls, goatsuckers, swifts, hummingbirds, kingfishers, woodpeckers and songbirds). Most of these species are migratory, coming to Ontario to nest and then returning to warmer climates of the southern United States, Caribbean, and Central and South America during the northern winter. Some species, such as grouse, most owls and woodpeckers, Common Raven, Gray Jay and Boreal Chickadee are year-round residents. Others pass through the province only during migration, when they stop to rest and refuel at important resting (or staging) areas. Areas along the Great Lakes shoreline and the coasts of Hudson and James Bays are especially important as migratory stop-overs for birds.

Because birds are found almost everywhere, and migrate freely across political boundaries, numerous government agencies and non-government organizations are actively involved in the conservation of wild birds and their habitat. To facilitate an integrated approach to bird conservation at the continental level, 66 Bird Conservation Regions (BCR) across North America have been identified through the North American Bird Conservation Initiative (NABCI). Bird conservation plans are being developed for each BCR, by jurisdiction, that identify priority species, priority habitats, appropriate population targets, and recommended conservation actions to conserve bird populations across the landscape. Ontario includes parts of four bird conservation regions: the Taiga Shield and Hudson Plain (BCR 7) which overlaps with the Hudson Bay

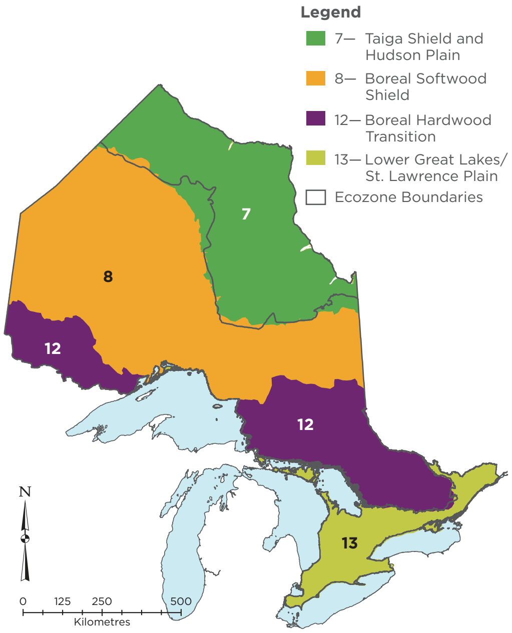


Figure 42. NABCI Bird Conservation Regions within Ontario.

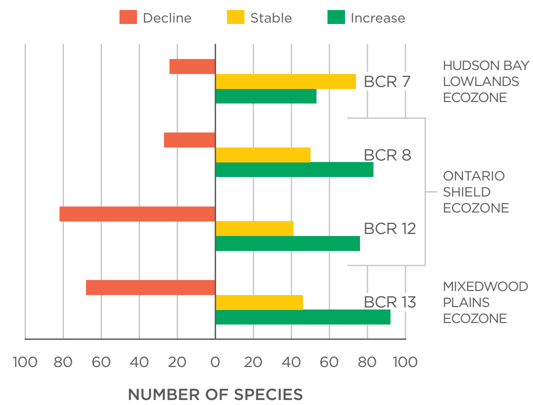


Figure 43. Population trend status for Ontario's Bird Conservation Regions.

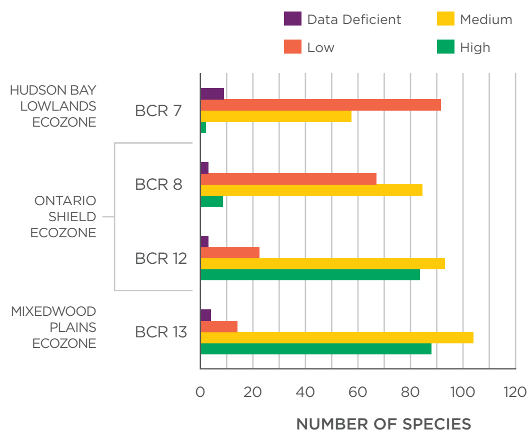


Figure 44. Current population trend status reliability by Bird Conservation Region.

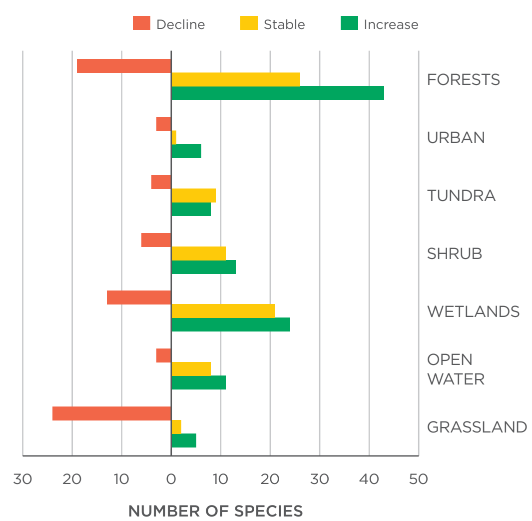


Figure 45. Number of bird species showing long-term declining, stable or increasing trends in Ontario by habitat class.

Lowlands Ecozone; the Boreal Softwood Shield (BCR 8), and Boreal Hardwood Transition (BCR 12) which are found within the Ontario Shield Ecozone; and the Great Lakes/St. Lawrence Plain (BCR 13) in the Mixedwood Plains Ecozone (Figure 42).

This indicator assesses the status of Ontario's breeding birds by looking at long-term trends in abundance and distribution for each species. To assess the status of Ontario's breeding birds, data were pooled from 11 bird monitoring surveys to evaluate long-term changes (generally 16–38 years) in bird populations and assess the reliability of the data. For each bird species, in each Bird Conservation Region of Ontario, teams of experts categorized each species as declining, stable, or increasing (Figure 43). Reliability scores (high, medium, low or data deficient) were assigned for each species in each region based on confidence in the data (Figure 44). Trends are also reported for the birds in each of the major habitat types used by Ontario's breeding birds on a province-wide basis (Figure 45). A discussion of the characteristics and trends for each Bird Conservation Region is provided below. A complete description of the assessment methods used can be found in Blancher et al. (2009).

Hudson Bay Lowlands
(Taiga Shield and Hudson Plain–BCR 7)

The complex of wetlands of the Hudson Bay Lowlands is among the largest in the world and provides globally important habitat for ducks, geese and shorebirds. About a third of the bird life in this region is associated with forests, another third with vegetated wetlands and open water and the remainder with tundra habitats. Forty species of waterfowl and waterbirds, 18 shorebird species and more than 100 landbird species make their home in the Hudson Bay Lowlands. The status of 160 bird species that regularly breed in this region was assessed and more than 80% of them appear to be either stable or increasing (Figure 43). However, almost 60% of the species in this region were assigned a data reliability score of 'low' (Figure 44). Due to the remoteness of this region, there are very few long-term datasets available to evaluate bird status. Declining species were associated with various habitat types. Forest habitat had the largest number of declining species though proportionally similar to the other habitat groups. Eight species were identified as experiencing long-term declines in this region though all had poor data reliability scores (American Wigeon, Blue-winged Teal, Red-necked Phalarope, Little Gull, Eastern Kingbird, Black-throated Green Warbler, Pine Siskin, Evening Grosbeak). The habitat in this region is still relatively pristine, although a superabundance of breeding Snow Geese has resulted in the localized overgrazing and degradation of coastal tundra habitats. Climate change is also likely to affect this region as models predict that average temperatures could increase faster than in other parts of Ontario (EPCCA 2009).

Ontario Shield Ecozone
Boreal Softwood Shield–BCR 8

This northern portion of the Ontario Shield Ecozone is part of the boreal forest referred to as North America's "bird nursery" because of its vital importance to breeding birds (Blancher and Wells 2005). This large region is a mosaic of coniferous and mixed forests interspersed with wetlands, lakes and streams. Not surprisingly, more than 40% of the bird species in this region are associated with forests and about 30% are found in wetlands. More than three quarters of the birds in BCR 8 are landbirds, including the many millions of songbirds that make the boreal forest their summer home, and year-round residents such as Great Gray Owl, Black-backed Woodpecker and Spruce Grouse. The status of 163 species was assessed, and over 80% of these had increasing or stable long-term population trends (Figure 43). The forest birds in BCR 8 appear to be doing well, with only one species experiencing a large long-term decline (Northern Goshawk). Nine other species (grassland and wetland birds) in this region showed large declining population trends (Blue-winged Teal, Great Blue Heron, Solitary Sandpiper, Common Nighthawk, Bank Swallow, Barn Swallow, Bobolink, Red-winged Blackbird, Brown-headed Cowbird). The reliability of the trend data from this rather remote region is fairly poor—more than 40% of species were assigned a low data reliability score (Figure 44).

Boreal Hardwood Transition–BCR 12

The boreal hardwood transition region is the southern portion of the Ontario Shield Ecozone. It also contains extensive forest cover. Open wetlands, rock barrens, lakes, streams and agricultural areas are interspersed among the forests. Like BCR 8, most of the species in this region are associated with forests (39%) or wetlands

(30%), with fewer in grasslands and shrublands. There are three notable differences between this region of the province and those further north. First, species richness is higher—202 species were assessed in this region. Second, a much larger percentage of species are undergoing long-term population declines. Eighty-two species (or just over 40%) had declining trends (Figure 43) and roughly half of those were classified as large declines (more than a 50% decline). Third, the reliability of the data from this region is much higher, with only 11% of species classified with a low reliability score (Figure 44). Among the species showing large declines in BCR 12, are eight species of "aerial insectivores"—birds that feed exclusively on flying insects. This group of birds includes the Whip-poor-will, Chimney Swift, swallows, Common Nighthawk and flycatchers. Declines have been so alarming that Olive-sided Flycatcher, Chimney Swift, Common Nighthawk and Whip-poor-will have all been placed on the Species at Risk in Ontario List. Almost 75% (20 of 27 species) of the birds associated with open country habitats (grasslands, agricultural areas) are showing large or moderate long-term declines in BCR 12 whereas less than 40% of forest birds are declining (31 of 78 species).

Mixedwood Plains Ecozone *(Lower Great Lakes/St. Lawrence Plain–BCR 13)*

This region supports the highest diversity of bird life in Ontario, partly because of the mixture of habitat types including deciduous forests, mixed forests and grasslands, which each support a unique suite of bird species. Although the bird species richness in this region is amongst the highest in Canada, this area is also home to millions of people, and the landscape is heavily influenced by agriculture, urban development and industry. There are more than 150 landbird species in southern Ontario and 25 waterbird species—more than any other part of the province. In addition to breeding birds, BCR 13 hosts some of the largest concentrations of migrant songbirds, hawks, waterfowl and waterbirds in eastern North America.

Of the 210 species in BCR 13 that were assessed, 67% had stable or increasing populations, and 33% of species declined (Figure 43), including 36 species showing large declines. Due to the large number of volunteer-based bird monitoring programs in the south, data from this region have the highest reliability with only 7% of species having a low data reliability score (Figure 44). Although grassland/agricultural birds represent a small proportion (15%) of the total bird life in this region, nearly 40% of the species showing large declines in this region are birds associated with grasslands or agricultural areas. Grassland/agricultural birds are of particular conservation concern in this region because over half of the land in this region consists of agricultural crops and BCR 13 supports a significant proportion of the global population of many grassland birds.

- Overall, the majority of birds that regularly breed in Ontario have either increasing or stable long-term population trends.
- Forest birds in particular seem to be doing well in most of the province and populations of many of Ontario's large bird species (geese, swans, Sandhill Crane, large raptors) are increasing (Cadman et al. 2007).

- Although birds in the north seem to be doing much better than birds in heavily developed areas of southern Ontario, the state of our knowledge of northern breeding birds remains relatively poor.
- The guild of aerial insectivores (Whip-poor-will, Chimney Swift, swallows, Common Nighthawk and flycatchers) is declining at an alarming rate for unknown reasons. Researchers are urgently trying to determine whether this precipitous decline is related to habitat change, decline in insect supply, climate change, or a combination of these or other factors.
- Birds that rely on grassland and agricultural habitats in southern Ontario are also exhibiting steep population declines. Habitat change is most likely the driving factor here, as the extent of suitable agricultural grassland habitat has been much reduced due to agricultural intensification (e.g. cultivation) and some areas have converted to forest through succession.
- Several bird species that occur in Ontario are not native to Canada. Over the last two decades, two of these species (Mute Swan and House Finch) have shown large increases, whereas four species (House Sparrow, European Starling, Ring-necked Pheasant, Gray Partridge) have shown large or moderate declines, and only one (Rock Pigeon) has been stable.

TREND
MIXED

DATA CONFIDENCE
HIGH

Genetic Diversity

Genetic diversity is the foundation of all biodiversity. Individual genes are segments of DNA molecules that provide coding for specific enzymes, proteins, or regulatory pathways that enable individual organisms to survive, grow and reproduce. Genes are also the hereditary basis for traits that are inherited by offspring from their parents. Genetic diversity refers to the sum of genetic resources present within a species. Diversity at the genetic level is essential for species to adapt to environmental stressors (e.g., habitat change, new diseases, climate change) and persist through time (Stockwell et al. 2003; Willi et al. 2006). When a species' genetic diversity is reduced through population declines, isolation from other populations and inbreeding, there can be consequences like reduced survival and reproduction that may lead to the loss of populations. In most of these cases, the reduced genetic diversity is a symptom of habitat loss or other stresses acting upon the species rather than the cause of the problem (Frankham et al. 2002).

Knowledge of the genetic diversity within and between populations of individual species can help to identify conservation concerns (Frankham et al. 2002, Allendorf and Luikart

2007). Information on genetic diversity is also important to ensure management programs such as tree planting and fish stocking use appropriate locally-adapted strains with representative genetic diversity. The genetic diversity of domestic animals and crops used for agriculture is also an important component of biodiversity as these species feed the world's population. The genetic diversity of many agricultural crops and livestock has been eroded. In some cases entire lineages have been lost and replaced by common widespread breeds or varieties with limited diversity.

Characterizing and monitoring the genetic diversity of Ontario's species is a daunting task. Although the investment and amount of research devoted to genetic study has increased exponentially over the last couple of decades, genetic diversity within individual species has been studied for a relatively small proportion of Ontario species and generally has not covered their entire range in the province. For many Ontario species, the state of our knowledge is at the stage of collecting baseline data. This information will enable future assessment of trends in genetic diversity and structure across landscapes and time. This will help in assessing the potential responses of populations and species to changing environmental conditions. Because of the lack of comprehensive information for Ontario, no indicators are included in this report. Information on the genetic diversity of selected Ontario species is provided below. Three focal species of particular interest that represent the current state of knowledge for genetic diversity are Eastern White Pine, American Black Bear and Lake Trout. Similar comprehensive landscape genetics information is being gathered on several other harvested species (e.g., Walleye, White-tailed Deer) and species at risk (e.g., freshwater mussels, Lake Sturgeon, American Badger).

Genetic Diversity for Selected Species

Eastern White Pine

Eastern White Pine, Ontario's provincial tree, can reach heights of 30 m and live for more than 200 years. It grows across Ontario and Québec to the Maritimes and south into the USA. Ontario's Mixedwood Plains Ecozone forms the centre of its range, where it is valued for its distinctive super canopy form, broad adaptation, fast growth, lumber, and dominance in several forest types. The Eastern White Pine also provides habitat, shelter and food for several wildlife species. Unfortunately, its abundance has declined due to historical overharvesting, habitat loss in the south and an invasive alien disease's effect on regeneration. However Eastern White Pine is a valuable afforestation (conversion of open land to forest) species in southern Ontario where it has provided landowners with harvest income and serves as a "nurse crop" to restore sites to deciduous forest. Genetic resource management is ongoing to support basic research, increasing timber yields, and mitigating the effects of invasive species and climate change.

Small, isolated populations of Eastern White Pine are subject to inbreeding and a resulting loss of reproductive fitness (e.g., reduced seed production and lower quality seed) when compared to large populations in the core of the range (Rajora et al. 2002). Such studies demonstrate the importance of maintaining connections between populations in Ontario. Harvest of Eastern White Pine can also result in a reduction in the genetic diversity of local populations (Rajora et al. 2000). Seed source studies have been conducted to assess how closely adapted Eastern White Pine populations are to local conditions and climate (Lu et al. 2003). The results are reflected in Ontario's Tree Seed Zone Directive (OMNR 2006b) which guides the use and movement of tree seed in planting programs. The invasive alien disease, White Pine Blister

Rust, readily kills young Eastern White Pine and reduces the species' range and abundance. As with other tree species threatened with alien diseases (e.g., American Elm, American Chestnut, Butternut), hybridization may prove to be a solution. Research is underway to integrate resistance genes from Eurasian pine species using traditional plant breeding approaches.

Eastern White Pine is known as a genetically diverse species which allows for selective breeding for desirable characteristics. In the 1980's, trees of superior health and form were selected from several breeding zones and cloned to establish seed orchards. The initial plan was to test the progeny, remove the poorer parent trees, and use the resulting improved seed to establish faster growing plantations. However in southern Ontario mounting pressures of forest loss, population fragmentation and climate change are threatening Eastern White Pine genetic diversity. The orchards, each with 200 unique trees, in some cases from stands that no longer exist, now have value as genetic archives. Eastern White Pine seed can be banked for many years to support annual afforestation programs and also mitigate the potentially negative climate change effects on seed crop frequency. As a source of southern material the seed can also support assisted migration efforts for climate change adaptation.

American Black Bear

The American Black Bear is a large, ecologically important species that is adapted to a range of environments across North America. Genetic data from Black Bear populations have largely shown the genetic distinctiveness of populations on moderate geographic scales despite the ability of bears to travel across large distances (e.g., Oronato et al. 2004, 2007; Dixon et al. 2006, 2007). This distinctiveness has been attributed to population fragmentation from human influences and activities such as transportation corridors (roads and railways), resource extraction, and urban and industrial development. In light of continued and increasing human pressures on wildlife habitat and the environment, it is important to understand the levels of present genetic diversity to interpret how these human influences impact on the genetic diversity and viability of the Black Bear across North America.

Eastern White Pine

Photo: Heather Bickle, OMNR

American Black Bear

In Ontario, Black Bear populations occur within a region of primarily continuous boreal and mixed deciduous forest habitat with no obvious barriers to dispersal except in far southern regions of the province. Four genetic groups of Ontario Black Bear have been identified. They are made up of three closely related regional populations in central and northern Ontario and one fragmented group within Bruce Peninsula National Park (BPNP) (Mills 2005; Kyle et al. in prep.). The central and northern Ontario populations show higher levels of genetic diversity and gene flow than most Black Bear populations elsewhere in the species' range. However, Black Bears from Bruce Peninsula National Park (where intervening landscapes of unsuitable bear habitat exist—e.g., road density >0.5km/km^2) are genetically isolated with relatively low levels of genetic variability. Where human impact on the landscape is high (Bruce Peninsula population), bears are susceptible to isolation and loss of genetic diversity over short time intervals. In continuous habitats, Black Bear populations have greater genetic diversity and are genetically structured over large geographic scales (>1,500 km).

Lake Trout

The Lake Trout is an important top predator in coldwater fish communities in lakes of the Ontario Shield Ecozone and in the Great Lakes. Evidence from genetic data suggests that Lake Trout survived the last Ice Age in six glacial refuges (areas that remained ice free), which contributed in varying degrees to modern populations in Ontario (Wilson and Hebert 1996, 1998). Populations in northwestern Ontario are descended from all six genetic lineages; eastern Ontario was mostly colonized by Lake Trout that survived south of the Great Lakes and in eastern North America (Wilson and Hebert 1998). The genetic diversity of today's Lake Trout populations has been both influenced and limited by their ancestry and subsequent habitat conditions in isolated lakes (Wilson and Mandrak 2004). Ontario populations of Lake Trout are particularly significant because almost a quarter of all known global populations occur in this province. Ontario has a larger temperature gradient than any other part of their native range and Ontario populations are exposed to multiple stresses (invasive alien species, emerging diseases, warming temperatures, changing lake habitats associated with development, and harvest) (Wilson and Mandrak 2004). In addition, the natural genetic structure of some populations has been altered by stocking of hatchery fish in lakes with native populations (Halbisen and Wilson 2009).

To identify the genetic diversity of Lake Trout in Ontario, over 200 Lake Trout populations have been sampled across Ontario, including multiple sites from the Great Lakes (Wilson and Hebert 1996, 1998; Halbisen and Wilson 2009). Genetic mapping has resolved the genetic ancestry and diversity of over 60 Lake Trout populations across southern Ontario, and identified several regional "gene pools" that reflect different colonization histories after the glaciers retreated (Halbisen and Wilson 2009). Remarkably, some populations that were stocked for decades show little or no traces of hatchery ancestry, whereas others show clear evidence of historical stocking, even generations after stocking ended (Halbisen and Wilson 2009). Within each of the regional gene pools, levels of genetic diversity in local populations reflect lake habitats and ecological conditions.

Traits that are important to the survival of wild and captive populations vary in the degree to which they are controlled by environmental and genetic factors (McDermid et al. 2007). Traits such as body size and age at maturity vary across the species range and are influenced by local climates and ecological opportunities as well as ancestry (McDermid et al. 2010). Other traits such as temperature tolerance show relatively little variation among populations that have been tested so far, although some populations in southern Ontario show a greater ability to cope with increased temperatures than populations from the Great Lakes. Ontario Shield Lake Trout populations are naturally isolated from each other, which limits their adaptive capacity to the genetic resources found within each isolated population (Wilson and Mandrak 2004). Current studies are examining the adaptive potential of wild and mixed-ancestry populations to assess their relative abilities to cope with anticipated stresses.

Spawning Lake Trout


Photo: OMNR

Conservation and Sustainable Use

The establishment of protected areas and conservation lands is an essential component of biodiversity conservation programs. The effective management of the intervening landscape is also of paramount importance to ensure connectivity and maintenance of biodiversity over a large scale. This section examines the extent of Ontario's protected areas and conservation lands, participation in sustainable management systems, participation in stewardship programs, the extent of stewardship activities, and the financing of biodiversity conservation programs.

Killarney Provincial Park

The establishment of protected areas and conservation lands is an essential component of biodiversity conservation programs.

Photo: Ontario Tourism

Protected Areas and Conservation Lands

Protected areas and conservation lands include a wide variety of lands that are managed for conservation. They are fundamental building blocks in virtually all regional, national, and international biodiversity conservation strategies. A comprehensive and effectively managed system of protected areas and conservation lands is a critical element for the conservation of biodiversity and a cornerstone of healthy, functioning ecosystems in altered landscapes. In addition to their ecological value, protected areas and conservation lands contribute to the economic well-being of our communities, provide opportunities for recreation, and are places to reflect on the beauty and wonder of the natural world.

Regulated protected areas include provincial and national parks, conservation reserves and wilderness areas. While the earliest parks were established largely for recreational use and nature appreciation, today those goals are complemented by biodiversity conservation, scientific research, and public education. Other types of conservation lands include municipal parks, conservation areas, and land secured through land trusts and conservation easements. These areas do not reflect a single approach to conservation, but instead show an extraordinary range of management objectives from the protection of wilderness values to sites where human activities are integrated with biodiversity conservation. Additional areas on private land with significant biodiversity values receive some protection from development through planning policies (e.g., Provincially Significant Wetlands, Areas of Natural and Scientific Interest)—these areas are not specifically considered in this section.

INDICATOR—Protected Areas and Conservation Lands in Ontario by Ecozone

Ontario's regulated protected areas include 650 provincial parks, conservation reserves, wilderness areas, and national parks. In the Hudson Bay Lowlands and the Ontario Shield, protected areas include many sites of Ontario wilderness, such as Polar Bear, Wabikimi, Woodland Caribou, Quetico, and Algonquin Provincial Parks. The Great Lakes Ecozone includes Fathom Five National Marine Park and Lake Superior National Marine Conservation Area. In the Mixedwood Plains Ecozone, areas such as The Pinery Provincial Park and Rondeau Provincial Park protect some of the area's best remaining natural features.

The conservation efforts of private landowners, non-governmental organizations, municipal governments, and conservation authorities also contribute sizeable areas to biodiversity conservation, especially in the Mixedwood Plains Ecozone. This includes lands and easements held by the Nature Conservancy of Canada (NCC) (15,588 ha), Ontario Nature (2,437 ha), Ducks Unlimited Canada (DUC) (368,054 ha), and Ontario's 36 conservation authorities (CAs) (141,838 ha). This indicator assesses the percentage of regulated protected areas and conservation lands within Ontario by ecozone, under the assumption that biodiversity is better served when more area is protected and conserved.

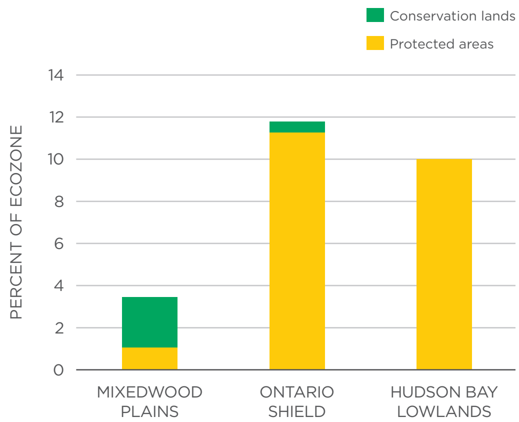


Figure 46. Percentage of protected areas and conservation lands in each terrestrial ecozone (adapted from: OMNR 2008c). Protected areas include provincial and national parks, conservation reserves and wilderness areas. Conservation lands include conservation lands and easements held by conservation authorities, Nature Conservancy of Canada, Ducks Unlimited Canada, Ontario Nature and affiliated clubs, Ontario Heritage Trust, and member associations of the Ontario Land Trust Alliance).

- 9.1% of Ontario's land base is protected within provincial and national parks, conservation reserves and wilderness areas. This is slightly lower than the national average of 9.9%. In absolute terms, Ontario's protected area system is the fourth largest in the country, with 9,927,215 ha protected.
- Seventy-four per cent of Ontario's protected areas occur within the Ontario Shield Ecozone.
- The proportion of ecozone area in protected areas and conservation lands is highest in the Ontario Shield Ecozone (11.8%), followed by the Hudson Bay Lowlands Ecozone (10.0%), and the Mixedwood Plains Ecozone (3.5%).

TREND
BASELINE

DATA CONFIDENCE
MEDIUM

(Data Confidence for conservation lands is medium to low)

INDICATOR—Ecological Representation in Ontario's Protected Area System

The important role that protected areas play in biodiversity conservation has driven the refinement of a science-based approach to protected area selection and design. Ecological representation, one of the five criteria used by the Ontario Ministry of Natural Resources for establishing protected areas, is based on the principle that the full range of Ontario's natural diversity should be systematically identified and protected. Other ecological criteria for the selection and design of protected areas include the condition and diversity of an area, the role the area plays in supporting the ecological function of the broader landscape, and special features such as the occurrence of species at risk and their habitats. In the Far North the identification of protected areas will be done through community-based land use plans that are led by First Nations and developed jointly with Ontario.

Candidate protected areas will be assessed for their contribution to ecological representation and may also be identified to protect cultural values.

This indicator assesses the degree to which Ontario's protected areas system has achieved ecological representation of the different landform and vegetation types found in Ontario. It is based on analyses completed by the Ontario Ministry of Natural Resources using a GIS-based analytical tool called GapTool. GapTool is used to help prepare tabular reports and maps on ecological representation (including gaps in representation), based on the Ministry's framework for representing terrestrial life science features. In the map below, ecodistricts are shaded in three different colours that signify the degree to which the minimum representation thresholds have been met for ecological features within the ecodistrict (Figure 47).

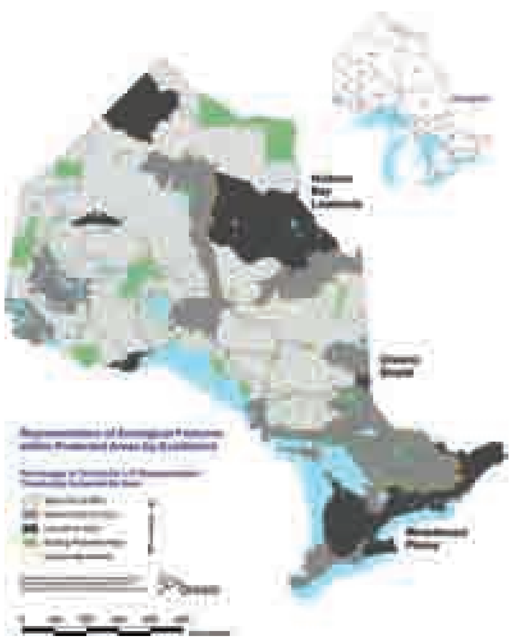


Figure 47. Representation of terrestrial life science features by ecodistrict in Ontario's protected area system (source: OMNR 2010).

Minimum thresholds are set at 1% of the total area of the landform-vegetation type in each ecodistrict or 50 ha, whichever is greater (there are 71 ecodistricts in Ontario—ecodistricts are subdivisions of ecoregions that are characterized by distinctive groupings of landform, relief, surficial geologic material, soil, water bodies, and vegetation; Ontario Parks 2004). Including only a small portion of an ecodistrict in protected areas can often meet the minimum representation thresholds.

Ontario does not have an established framework for the representation of aquatic ecosystems in Ontario's protected areas. However, some aquatic ecosystems are included in protected areas designed to represent terrestrial features, and can be protected based on criteria other than representation (i.e., ecosystem function, special features). Additionally, following the development of the Canada National Marine Conservation Areas Act (2002), the amount of protected aquatic habitat will soon increase. Two national marine conservation areas have been created by Parks Canada within the Great Lakes, Fathom Five National Marine Park (Lake Huron) and the Lake Superior National Marine Conservation Area (this large area has not yet been regulated under federal legislation); additional national marine conservation areas are being developed to represent diverse Great Lakes ecosystems. A recent review of aquatic features within Ontario's protected area system for watersheds with data available in the Mixedwood Plains Ecozone and the southern portion of the Ontario Shield Ecozone showed that 17.1% of the lake area and 10.9% of the stream length was within protected areas (OMNR 2008c). Only 3.4% of the evaluated wetland area was within protected areas.

- Protected areas are best distributed among natural features in the Ontario Shield; the most commonly under-represented features are those that are relatively rare or have high commercial value.
- Nearly all of the protected area in the Hudson Bay Lowlands is within Polar Bear Provincial Park. The identification of additional protected areas in this ecozone (and the northern portion of the Ontario Shield Ecozone) will be accomplished in partnership with First Nations through community-led land use planning for traditional territories as part of the Far North Land Use Planning Initiative.
- Nearly all natural features in the Mixedwood Plains are underrepresented. Most of the land in the Mixedwood Plains Ecozone is privately owned and therefore could not become regulated protected areas unless secured through acquisition or some other method; if this analysis had included privately held conservation lands representation would be somewhat improved, though still very low.
- Minimum ecological representation thresholds have not been achieved for any ecodistrict in the province. However, in many ecoregions and ecodistricts, Ontario has met its park class targets, which help to ensure that appropriate sizes and classes of parks are distributed throughout the province.

TREND
BASELINE

DATA CONFIDENCE
HIGH

Area Under Sustainable Management Systems

Use of natural resources can have an adverse effect on biodiversity and, in turn, the economy and community social well-being. To conserve biodiversity, resources must be used in ways that permit them to be used indefinitely. Such use is referred to as sustainable use. Sustainable use requires that social, economic and ecological values and priorities related to resource use be balanced. For example, Ontario's forests are an important source of income and jobs, and forest resources are used to make products such as pulp and paper, chemicals, clothing and homes. Forests are also sources of food and medicines, provide essential ecological services and opportunities for recreation and emotional and spiritual enrichment, and support traditional Aboriginal uses. They also provide habitat for an enormous diversity of plants and animals. Using forest resources sustainably requires that none of these uses or values be compromised.

Forest certification and the Environmental Farm Plan program are examples of ongoing initiatives that promote the sustainable use of Ontario's natural resources. They are used as indicators to assess changes in the area under sustainable management in Ontario.

INDICATOR—Sustainable Forest Management and Certification

Forests cover more than half of Ontario's land base and are essential components of the province's biodiversity. They are also important to the provincial economy and provide jobs to many Ontarians. Over half of Ontario's forests are managed for production in an area known as the Area of the Undertaking (AOU) that makes up a large portion of the Ontario Shield Ecozone (Figure 48). Most forests in the AOU are publicly owned. Forest companies can hold Sustainable Forest Licences and manage Forest Management Units in the AOU. Under the *Crown Forest Sustainability Act* and related regulations and policies, these forests must be managed sustainably and biodiversity must be maintained in the short term and the long term.

Forest certification provides independent 'third Party' verification that a forest is well-managed, as defined by a particular standard. Certification often increases the marketability of forest products. Forest certification is a costly process and a lack of certification does not necessarily mean a forest is being unsustainably managed.

This indicator reports on the area of forest in the AOU certified under a sustainable forest management standard from 2002–2008: Canadian Standards Association (CSA), Forest Stewardship Council (FSC), or Sustainable Forestry Initiative (SFI).

CSA, FSC and SFI sustainable forest management standards are internationally recognized forest certification programs. They all include requirements for the conservation of biodiversity, the maintenance of wildlife habitat and species diversity, the protection of special biological and cultural sites, the maintenance of soil and water resources, the reforestation of harvested areas and the protection of forestlands

FSC Certified logo with stamp of approval

from deforestation or conversion to other uses. Recognition of Aboriginal rights and Aboriginal involvement in forest management are also important parts of these programs.

Specific requirements for certification differ among these programs. Some examples of the differences among these forest certification standards are given in Table 8. Trends in the amount of certified forest from 2002-2008 and the percentage of forest in the AOU that was certified under each of these standards in 2008 are shown below (Figures 49, 50).

Figure 48. Area of the Undertaking (AOU) and Ontario's ecozones.

Table 8. Examples of differences among CSA, FSC and SFI standards for sustainable forest management.

MANAGEMENT ASPECT	CSA	FSC	SFI
Ecosystem Diversity	• Requires that the variety of communities and ecosystems occurring naturally in a defined forest area be maintained	• Representative samples of existing ecosystems within a landscape must be maintained in their natural states and recorded on maps	• Requires that occurrences of endangered communities be located and protected • Requires that forest cover types across the landscape be assessed and encourages including this information in planning and management activities
Species Diversity	• Requires that habitats and native species be maintained over time	• Requires that rare, threatened and endangered species and their habitats be protected	• Requires that threatened and endangered species be protected • Requires that wildlife habitats like snags, den trees and nest trees be retained
Clearcuts	• Requires following government regulations	• Places restrictions on the size and locations of clearcuts	• Requires that clearcut areas have an average size of 49 hectares
Exotics	• Requires following government regulations	• Use of exotic species is permitted but not promoted • Monitoring is required so that adverse environmental impacts are avoided	• Forest management must emphasize natural plant and animal communities
Herbicides & Pesticides	• Requires following government regulations	• Requires minimizing the use of chemicals; alternative methods of pest control are preferred • Requires documenting, monitoring and control of chemicals that are used • Use of certain chemicals is banned	• Requires minimizing the use of chemicals • Promotes the use of alternative methods of pest control when possible
Plantations	• No specific policy	Forest conversion to plantations or non-forest land use is only allowed if: • Converted areas represent a very limited portion of the forest management unit • Converted areas are not high conservation value forest areas • This will enable long term conservation benefits across the forest management unit	• No specific policy

Table 8. Examples of differences among CSA, FSC and SFI standards for sustainable forest management *(continued)*.

MANAGEMENT ASPECT	CSA	FSC	SFI
Reserves	• Requires that government protected areas be respected • Requires that biologically significant sites in a defined forest area be identified and protected	• Requires the maintenance of conservation zones to protect rare, threatened and endangered species • Requires that representative samples of ecosystems on the landscape be mapped and maintained • Requires maintaining and enhancing attributes of High Conservation Value Forests	• Requires the identification and management of culturally, ecologically, geologically and historically significant sites; it is up to the manager to decide how to best manage these sites

Adapted from: Hansen et al. 2006 (note: CSA source—2002 Sustainable Forest Management: Requirements and Guidance Document (CAN/CSA-Z809-02); FSC source—FSC's International Principles and Criteria, April 2004 version; SFI source—the 2005-2009 version of the SFI Standard).

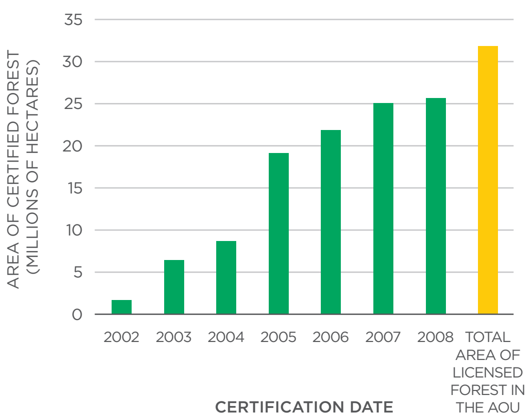


Figure 49. Area of management unit forest in the AOU under forest certification (2002–2008) compared with total area of licensed forest in the AOU (source: Annual reports on Forest Management, OMNR [www.mnr.gov.on.ca/en/Business/Forests/Publication/MNR_E000163P.html]).

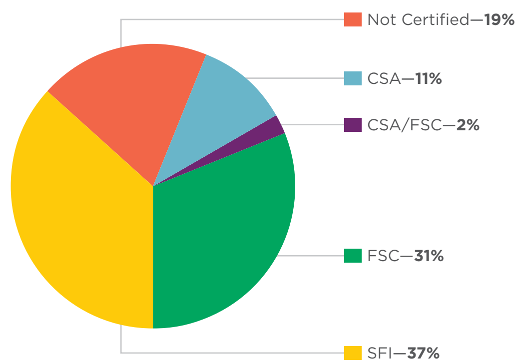


Figure 50. Percentage of management unit forest in the AOU certified under each standard in 2008 (source: Annual reports on Forest Management, OMNR [www.mnr.gov.on.ca/en/Business/Forests/Publication/MNR_E000163P.html]).

Area of the Undertaking

- In 2009, Ontario had 31.9 million hectares of management unit forest in the AOU.
- The amount of management unit land base that has been certified grew from about 8 million ha in 2004 to over 25 million ha in 2008 (80% of the licensed area).

Southern Ontario

- About 3.6 % of the province south of the AOU (i.e., Mixedwood Plains Ecozone) is publicly owned. Although there are legislative requirements in some areas (i.e., the Oak Ridges Moraine, the Niagara Escarpment, the Greenbelt, and some municipalities) conservation and sustainable management of southern Ontario forests often occurs on a voluntary basis. Almost 82,000 ha of privately owned forest have been certified since 2004 (Forest Products Association of Canada 2008).

TREND
IMPROVEMENT

DATA CONFIDENCE
HIGH

INDICATOR—Participation in Environmentally Sustainable Agriculture Program

Ontario has about 57, 000 farms and over 5 million ha of farmland. This represents about 8% of Canada's farmland (Statistics Canada 2006). Almost 25% of farm revenue in Canada comes from Ontario (Statistics Canada 2006). The Canada-Ontario Environmental Farm Plan (EFP) program was established in 1992. It encourages farmers to incorporate sustainable practices in their farming activities. Under the EFP, farmers must complete environmental risk assessments of their farming practices, and create action plans that identify best management practices.

Best management practices include runoff control, improved manure storage, and nutrient management planning. These practices have broad environmental benefits and benefit biodiversity. Actions such as restricting livestock access to waterways, establishing buffers, restoring wetlands, and controlling invasive plant species provide direct benefits to biodiversity. This indicator reports on the number of participants preparing EFPs (Figure 51) and the implementation of best management practices (Figure 52). Although the specific benefits of these activities to biodiversity have not been individually measured, it is assumed that the development of EFPs and the implementation of best management practices benefit biodiversity conservation.

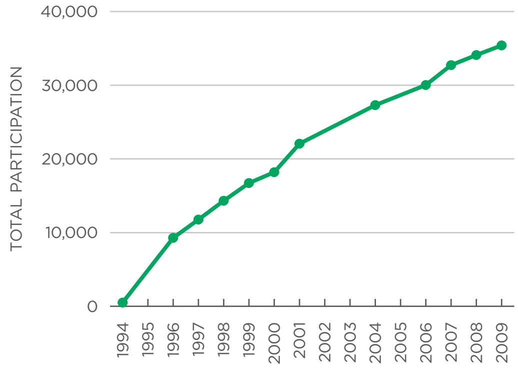


Figure 51. Number of participants in Canada-Ontario Environmental Farm Plan program, 1994–2009 (source: OMAFRA, Guelph, Ontario).

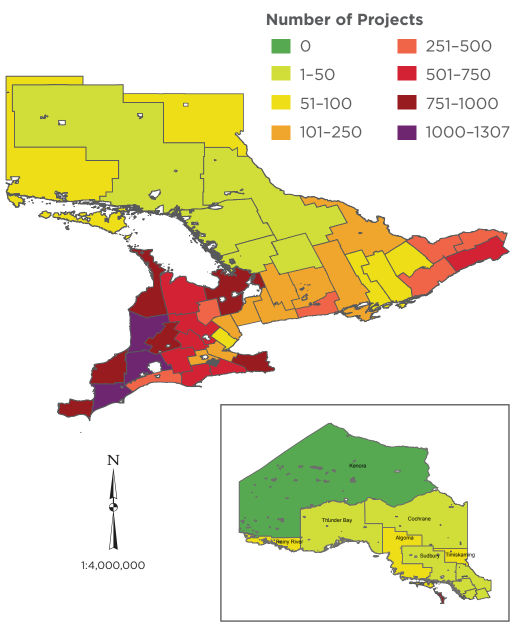


Figure 52. Number of implemented Best Management Practices by county (2005–2009) (source: OMAFRA, Guelph, Ontario).

- Over 35,000 farms (~65% of farms in Ontario) have participated in the Environmental Farm Plan program since 1992. Participation rates have risen substantially since 2005. This is largely due to Ontario's new agricultural policy framework and increased financial incentives to implement best management practices.
- Between April 2005 and November 2009, 17,515 environmental farm projects were implemented. About 25% of these projects relate directly to biodiversity.

TREND
IMPROVEMENT

DATA CONFIDENCE
HIGH

Biodiversity Stewardship

Stewardship activities are defined as actions that lead to responsible land care and sustainable resource use. Such actions help reduce and reverse biodiversity loss. They include planting trees, establishing buffers next to wetlands and riparian areas, removing invasive species, building fences to keep livestock away from waterways, and installing water control structures to improve wetland habitat.

Most stewardship activities are coordinated by non-profit environmental organizations with limited financial support from provincial, federal, and international governments. Aboriginal individuals and communities are also involved in numerous stewardship projects. Significant financial support and commitment comes from private landowners. Stewardship activities are often undertaken in partnership with private landowners. Much of the land in southern and central Ontario is privately owned and many rare plant communities and rare species occur in this part of the province. Stewardship activities are therefore important to maintaining Ontario's native biodiversity.

Stewardship activities are defined as actions that lead to responsible land care and sustainable resource use. Such actions help reduce and reverse biodiversity loss.

Photo: Brianne Fennema

INDICATOR—Area with Stewardship Activities

This indicator reports on trends in the area of Ontario in which stewardship activities have taken place. It does not necessarily reflect all stewardship activities and contributions occurring across Ontario. Data to support this indicator were collected from selected conservation organizations who maintain databases on stewardship activities. Many stewardship projects involve contributions from more than one conservation organization and double counting is possible. Data are presented for the years 2002 to 2008, as cumulative land area with stewardship activities (Figure 53) as well as the annual amount of land (Figure 54). A breakdown of stewardship efforts by individual activity over the period 2004–2009 is also provided for the Ontario Stewardship Program (Table 9).

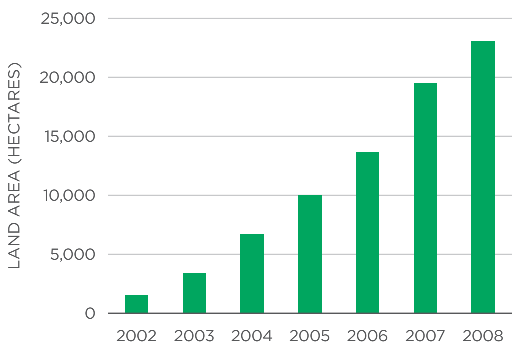


Figure 53. Cumulative area with stewardship activities in Ontario, 2002–2008 (source: Ducks Unlimited Canada, Conservation Ontario, and the Ontario Ministry of Natural Resources' Ontario Stewardship Program. Data from the Ontario Ministry of Natural Resources' Ontario Stewardship Program was only available for 2004 to 2008, and was reported by fiscal year (April–March)).

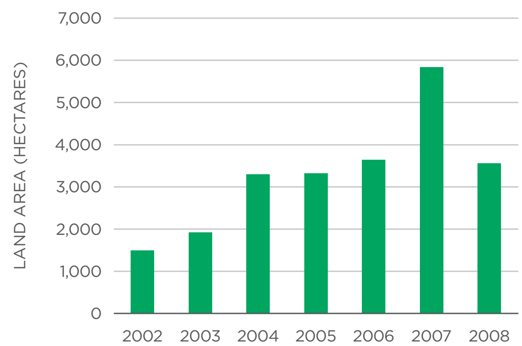


Figure 54. Annual area with stewardship activities in Ontario, 2002–2008 (source: Ducks Unlimited Canada, Conservation Ontario, and the Ontario Ministry of Natural Resources' Ontario Stewardship Program. Data from the Ontario Ministry of Natural Resources' Ontario Stewardship Program was only available for 2004 to 2008, and was reported by fiscal year (April–March)).

Table 9. Activities and annual accomplishments of the Ontario Ministry of Natural Resources' Ontario Stewardship Program, 2004 to 2009.

ACTIVITY/PROGRAM	2004/05	2005/06	2006/07	2007/08	2008/09
Number of Trees Planted	863,165	1,127,804	1,026,385	1,258,899	1,287,635
Area Planted (ha)	455	575	516	1,099	981
Headwaters Restored (ha)	No Data	No Data	70	137	17
Tallgrass Prairie Restored (ha)	No Data	No Data	No Data	237	165
Wetland Restored (ha)	587	1,415	155	212	242
Livestock Fencing (m)	No Data	No Data	10,427	26,010	15,916
Shoreline Restored (m)	44,946	38,292	33,993	81,647	71,987

- Since 2002, stewardship activities have occurred on 23,399 ha of habitat.
- Stewardship activities take place on an average of 3,343 ha of habitat each year.
- Since 2004, 5,563,888 trees have been planted on 3,626 ha of land through stewardship activities supported by the Ontario Stewardship Program.
- Since 2004, 224 ha of headwaters, 402 ha of tallgrass prairie and 2,611 ha of wetlands have been restored through stewardship activities administered by the Ontario Stewardship Program.
- Since 2004, 52,353 m of fencing have been put up to keep livestock away from waterways, and 270,865 m of shoreline have been restored through stewardship activities supported by the Ontario Stewardship Program.

TREND
IMPROVEMENT

DATA CONFIDENCE
MEDIUM

INDICATOR—Number of Individuals Volunteering to Conserve Biodiversity

Public participation in activities that conserve biodiversity has an impact on the current state of biodiversity in Ontario. Participants range from Aboriginal individuals and communities to school children planting trees to rehabilitate barren lands, to groups who devote their time to organizing and carrying out restoration activities or fundraising campaigns, to private landowners who donate their time or act as good stewards of their land. This indicator reports on trends in the number of people in Ontario who volunteer their time to participate in programs and activities that protect and enhance biodiversity. Data to support this indicator were collected from selected conservation organizations who maintain databases on stewardship activities. Public participation in biodiversity conservation is one measure of the value Ontarians place on biodiversity.

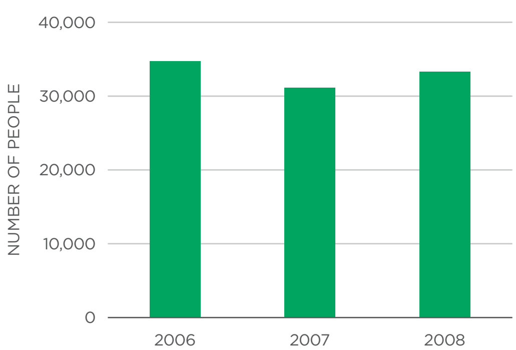


Figure 55. Number of people volunteering to conserve biodiversity in Ontario, 2006–2008 (source: Conservation Ontario, Ducks Unlimited Canada, Ontario Nature, the Nature Conservancy of Canada, and the Ontario Ministry of Natural Resources' Ontario Stewardship Program).

- Between 2006 and 2008, an average of 33,000 Ontarians volunteered annually on biodiversity conservation projects or initiatives surveyed for this report. This represents about 0.3% of Ontario's population.

TREND
BASELINE

DATA CONFIDENCE
MEDIUM

INDICATOR—Participation in Provincial Tax Incentive Programs

This indicator reports on the number of properties enrolled under Ontario tax incentive programs that encourage biodiversity conservation and stewardship. The Conservation Land Tax Incentive Program (CLTIP) is designed to recognize, encourage and support the long-term private stewardship of Ontario's provincially significant conservation lands. It provides property tax relief to landowners who agree to protect the natural heritage values of their properties. The Managed Forest Tax Incentive Program (MFTIP) promotes forest stewardship and minimizes the long-term decline of forest cover. Eligible landowners receive a tax reduction for preparing and following Managed Forest Plans. Both programs are voluntary.

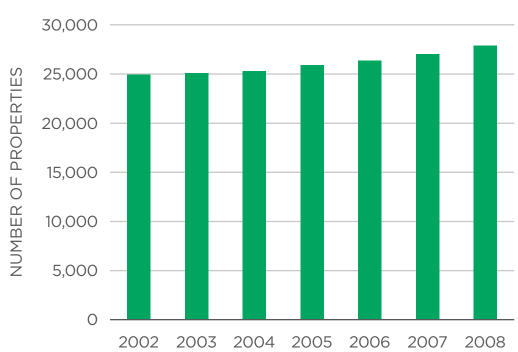


Figure 56. Number of Ontario properties with landowners enrolled in the Conservation Land Tax Incentive Program or Managed Forest Tax Incentive Program, 2002–2008 (source: OMNR, Peterborough, Ontario).

- Participation in biodiversity tax incentive programs in Ontario has increased. Between 2002 and 2008, participation rates for the two programs combined have increased by 11%.

TREND
IMPROVEMENT

DATA CONFIDENCE
HIGH

Urban Biodiversity

Buildings, roads, parking lots and other developments characteristic of urban areas typically fragment and degrade natural habitats (Marzluff 2001), reduce the variety of plant and animal species (McKinney 2008), disrupt hydrological systems (Booth and Jackson 1997) and change energy flow and nutrient cycling (McDonnell et al. 1997; Grimm et al. 2000; Alberti and Marzluff 2004) in natural ecosystems.

The amount of wooded and permeable area in urban environments relative to total urban area reflects how much ecosystems in urban areas are being disrupted. The number of people living in an urban area also influences the degree that natural ecosystems in a given urban area are affected. Degraded urban areas have a low percentage of forest cover and a relatively high proportion of hard non-permeable surfaces such as roads, parking lots and roof tops. When these "hard" surfaces exceed 10% of the area of a watershed, water quality and biodiversity in streams may be negatively impacted (Environment Canada 2004). Higher proportions of woodland and permeable area, and lower human population densities are characteristic of urban sprawl. In these circumstances the amount of land disturbed by each resident may be large and ecosystem impacts can be extensive.

INDICATOR—Wooded Area Within Urban Landscapes in the Mixedwood Plains Ecozone

This indicator assesses the extent of wooded areas in urban landscapes of the Mixedwood Plains Ecozone based on an analysis performed for the Ecosystem Status and Trends Report (OMNR 2009a). Data used for this analysis are from the Southern Ontario Land Resource Information System (SOLRIS). An assessment of woodland cover is perhaps not the best indicator for assessing status and trends in urban biodiversity, but it was chosen because it was the only indicator of urban biodiversity for which suitable data is currently available. The number of cities with natural heritage plans, the amount of protected green space in urban areas and trends in breeding bird populations are examples of indicators of urban biodiversity that should be considered for assessment in the future.

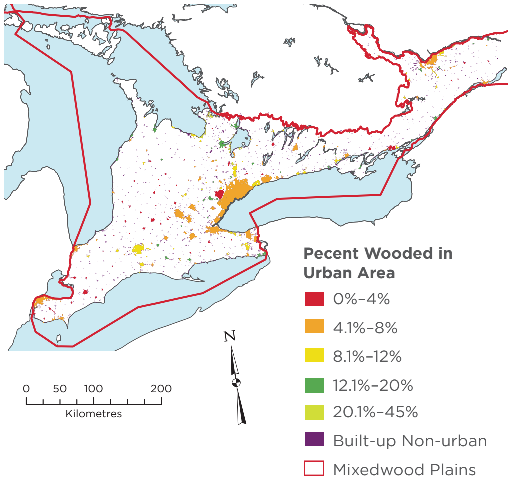


Figure 57. Percentage of wooded area within urban areas in the Mixedwood Plains Ecozone in 2006 (excluding Manitoulin and St. Joseph Islands) (source: OMNR 2009a).

- Total urban land use in the southern Ontario portion of the Mixedwood Plains is estimated at 4,765 km^2. Wooded areas make up approximately 7.8% of this urban landscape.

TREND
BASELINE

DATA CONFIDENCE
MEDIUM

Financing Biodiversity Management and Conservation

Biodiversity management and conservation is supported through public spending, charitable giving by individuals, and donations and management activities of business and industry, Aboriginal communities and conservation groups. While certain programs and activities have obvious benefits to biodiversity, for example the maintenance of a protected areas system, many more activities have either direct or indirect relevance to biodiversity. Some examples include pollution monitoring and prevention, environmental assessments for large projects such as highways, mitigating the effects of climate change, sustainable forest management, and the management of the agricultural landscape and support for best management practices on farms. Specific activities may protect or enhance biodiversity, or monitor and assess impacts of natural and anthropogenic processes.

Ferndale area

Photo: Brendan Toews

INDICATOR—Provincial Expenditure on Biodiversity and Charitable Giving To the Environment

This indicator assesses the absolute and relative amounts of resources allocated to biodiversity conservation from two primary funding sources over the last decade: the provincial public sector and charitable giving of individuals. For the public sector, the Ontario Ministries of Natural Resources (MNR), Environment (MOE), and Agriculture, Food and Rural Affairs (OMAFRA) were chosen because the majority of their programs align with activities relevant to biodiversity. Trends in charitable giving were assessed for environment-related donations based on Statistics Canada surveys conducted for 2004 and 2007.

Any evaluation of expenditure and financial resources faces several challenges, including the possibility of double counting and the lack of a direct relationship between expenditures and benefits for biodiversity.

It is also important to note that not all of the expenditures from the provincial ministries selected or charitable donations to the environment provide direct benefits to biodiversity. For these reasons, this indicator has been deliberately narrowly scoped, knowing that additional support for biodiversity management and conservation is also provided through other means (e.g., academia & corporate) and may also exist in the programs of other ministries (e.g., education). Information on environment-related expenditures of federal ministries and agencies in Ontario was not available for inclusion in this report. For perspective, it is important to note that over the period 2001 to 2008, Ontario's Gross Domestic Product (GDP) at market prices increased from $463 billion to $532 billion when indexed for inflation.

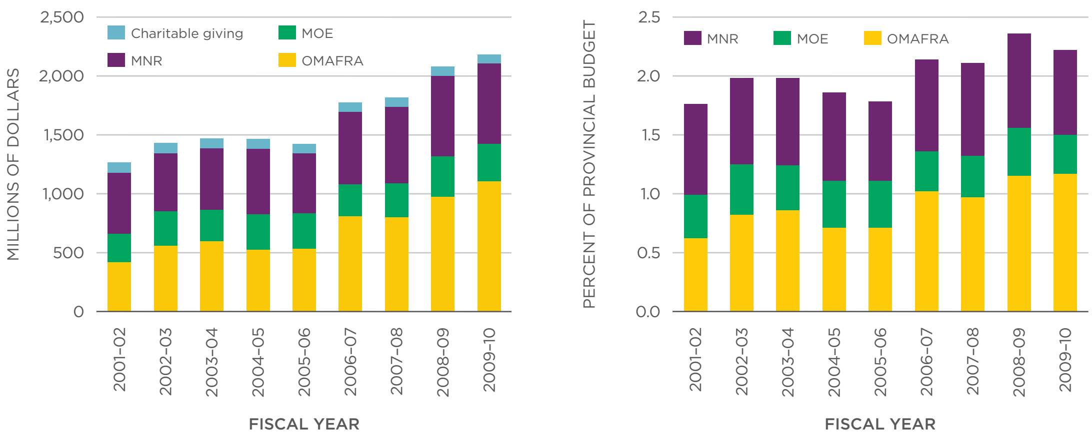


Figure 58. Provincial expenditures (indexed for inflation to 2002 dollars) of Ontario ministries with biodiversity mandates and charitable giving to the environment (left) and percent of provincial budget allocated to these ministries (right). (source: Ministry of Finance—Expenditure Estimates of the Province of Ontario and Hall et al. 2006, 2009. Note: estimates of charitable giving to the environment in Ontario were only available for 2004 and 2007, other values have been interpolated).

- From 2001–02 to 2009–10, expenditures of the biodiversity-related provincial ministries increased by 79% when indexed for inflation. Over the same period, the provincial budget increased by 42% and the GDP increased by 15% (both values indexed for inflation).
- Between 2001–02 and 2009–10, the three provincial ministries most directly involved in biodiversity conservation and management were allocated 1.8–2.4% of the total provincial budget. The percentage has increased slightly since 2005–06.
- Based on surveys conducted in 2004 and 2007, charitable donations by Ontarians to environmental activities amount to $88 to $90 million annually.
- Allocation of resources to biodiversity management and conservation from the provincial public sector and charitable giving represented 0.4% of Ontario's GDP in 2008.

TREND
IMPROVEMENT

DATA CONFIDENCE
MEDIUM

Summary and Conclusions

Indicator Summary

This report examines the status and trends of 29 indicators related to pressures on Ontario's biodiversity, the state of Ontario's biodiversity, and conservation and sustainable use of Ontario's biodiversity (Table 10). Most indicators related to pressures and the state of biodiversity show there is concern for the ongoing loss of biodiversity, particularly in the Mixedwood Plains Ecozone. Conversely, most indicators related to conservation and sustainable use show a more positive picture, reflecting recent efforts to protect and restore biodiversity in the province. Looking at trends for these indicators reveals a similar story (Figure 59). Eight of 18 assessed indicators related to pressures and the state of biodiversity had deteriorating trends, while none showed improvement. Five of nine indicators related to conservation and sustainable use had

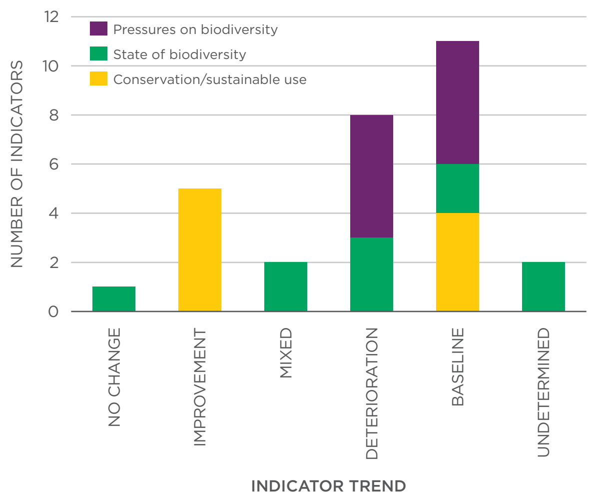


Figure 59. Summary of trends for 29 biodiversity indicators included in the State of Ontario's Biodiversity 2010 report.

Kawartha Highlands

improving trends, but none showed deterioration. Eleven of the indicators had trends assessed as "baseline". Although the status of most of these indicators is assessed and described in the report, there was not sufficient historical or recent information to clearly define trends. A summary of what the indicators are telling us about biodiversity in each of Ontario's four ecozones and for the province as a whole is provided below.

The biodiversity of the Hudson Bay Lowlands Ecozone has been the least affected by human activity and is still largely intact. Almost all of the ecozone consists of natural land cover (wetlands, forest, tundra) and this area includes some of the few remaining large river systems in the world that are unaffected by dams. Most breeding bird species (80%) in this ecozone are stable or increasing. Ten percent of the ecozone is within protected areas. Pressures on biodiversity such as habitat loss, invasive species, and pollution have had a limited impact, likely due to the remoteness and small human population in the ecozone. Climate change is expected to have a proportionally larger impact on the Hudson Bay Lowlands as temperatures will likely increase to a greater extent than in areas further south. The survival and body condition of Polar Bears has decreased associated with reduced ice cover on Hudson Bay and James Bay.

Table 10. Summary of status, trends, and data confidence for each indicator used in the State of Ontario's Biodiversity 2010 report.

	INDICATOR	STATUS	TREND	DATA
Pressures on Ontario's Biodiversity	Ecological Footprint	high per capita footprint and limited biocapacity	Baseline	Medium
	Habitat Loss—land cover	significant habitat loss in Mixedwood Plains, but limited habitat loss in the Ontario Shield and Hudson Bay Lowlands	Baseline	Medium
	Habitat Loss—road density in southern Ontario	67% increase in total length of road from 1935–1995, length of paved road increased almost 5-fold over this period	Deterioration	Medium
	Habitat Loss—corridors in the Ontario Shield	low road densities except southern portion and near urban centres, small increase in road area 2001–2005 (0.02%)	Baseline	Medium
	Habitat Loss—aquatic stress index	high stress index values in Mixedwood Plains and southern Ontario Shield, low values in Hudson Bay Lowlands	Baseline	Medium
	Invasive Alien Species—Great Lakes	large number of alien species present in Great Lakes (186) and invasion rate has increased	Deterioration	High
	Pollution—ground-level ozone	increasing background levels and increasing 8-hour peak levels during the summer	Deterioration	High
	Pollution—freshwater quality index	58% of sites with good or excellent ratings, but 41% with fair, marginal or poor ratings mostly in southwestern Ontario	Baseline	High
	Climate Change—Great Lakes ice cover	decline in percentage of ice cover on all five Great Lakes between 1970–2008	Deterioration	Medium
	Climate Change—condition and survival of Polar Bears	reduced condition and survival rates for male and female Polar Bears in all age classes	Deterioration	High

TREND: Improvement, Deterioration, No Change, Mixed, Baseline, Undetermined

DATA CONFIDENCE: High, Medium, Low, N/A

Table 10. Summary of status, trends, and data confidence for each indicator used in the State of Ontario's Biodiversity 2010 report *(continued)*.

	INDICATOR	STATUS	TREND	DATA
State of Ontario's Biodiversity	Forests—extent of forest cover and disturbance	amount of forested land remained stable between 1998 and 2002	No Change	Medium
	Forests—fragmentation in Mixedwood Plains Ecozone	4 of 5 zones have >30% forest cover, but largest zone (SW) has only 17% with limited habitat for forest-interior birds	Baseline	Medium
	Wetlands—losses in southern Ontario	from 1982–2002, wetland losses continued in the Mixedwood Plains at a rate of 0.17% per year.	Deterioration	Medium
	Rare Ecosystems—extent and protection	54% of prairie/savannah habitat legally protected, 92% of dune habitat protected, only 21% of alvar protected	Baseline	Medium
	Great Lakes—Great Lakes shoreline hardening	> 30% of Lake Erie shoreline and 25% of GL connecting channels have high proportion of hardened shoreline	Deterioration	Medium
	Great Lakes—*Diporeia* abundance in Great Lakes	drastic declines in abundance in all Great Lakes except Lake Superior over the last 10–20 years	Deterioration	Medium
	Inland Waters—alterations to stream flow	not assessed	Undetermined	N/A
	Inland Waters—fragmentation by dams	not assessed	Undetermined	N/A
	Species Diversity—changes in General Status rankings	919 of 1,063 species had same ranks in 2000 and 2005. 10 species moved to higher ranks because of increased risks	Mixed	High
	Species Diversity—trends in Ontario's breeding birds	most species increasing or stable (especially forest birds and northern birds), aerial foragers and grassland birds declining	Mixed	High
Conservation and Sustainable Use	Protected Areas—protected areas and conservation lands	11.3% of Ontario Shield, 10.0% of Hudson Bay Lowlands, and 3.5% of Mixedwood Plains protected	Baseline	Medium
	Protected Areas—ecological representation	minimum representation thresholds have not been achieved for any ecodistrict, Ontario Shield has best representation	Baseline	High
	Sustainable Management—forest certification	area under forest certification increased dramatically since 2002, 80% of licenced land base certified in 2008	Improvement	High
	Sustainable Management—agriculture	65% of Ontario farms (35,000) have participated in environmental farm plans since 1992	Improvement	High
	Stewardship—area enhanced for biodiversity	cumulative and annual area enhanced for biodiversity continued to increase from 2002 to 2008	Improvement	Medium
	Stewardship—volunteer efforts to conserve biodiversity	between 2006 and 2008, 33,000 Ontarians volunteered annually on biodiversity conservation initiatives	Baseline	Medium
	Stewardship—participation in tax incentive programs	participation rate in conservation tax incentive programs (CLTIP and MFTIP) increased 11% between 2002 and 2008	Improvement	High
	Urban Biodiversity—wooded area in urban landscapes	wooded areas account for 7.8% of the 4,765 km^2 of urban landscape within the Mixedwood Plains Ecozone	Baseline	Medium
	Financing—expenditures and charitable giving	since 2001, spending by biodiversity-related ministries has increased significantly	Improvement	Medium

TREND: Improvement, Deterioration, No Change, Mixed, Baseline, Undetermined

DATA CONFIDENCE: High, Medium, Low, N/A

The Ontario Shield Ecozone is the largest ecozone in the province and human impacts on biodiversity have occurred to a greater extent in the southern part of the ecozone. Two thirds of the Ontario Shield's landscape is forested with limited loss of forest habitat. About 0.5% of the Crown forest area is harvested each year which is similar to the average area of forest fires. Over the last decade, there has been a steady increase in the certification of forest harvest companies—80% of the harvested land base is now certified to sustainable forest management standards. Most breeding bird species in this ecozone are stable or increasing, but a much larger proportion of species is declining in the southern portion of the ecozone. Protected areas and conservation lands comprise 11.8% of the Ontario Shield and the representation of natural features in protected areas is higher than in Ontario's other ecozones. Road density is low in the northern portion of this area, although it has increased slightly with the construction of forest access roads. Road densities and pressures on aquatic habitats are higher in the southern portion of the ecozone and near the few urban centres.

Spring Peeper

The biodiversity of the Mixedwood Plains Ecozone has been significantly affected by human activity. It is the smallest terrestrial ecozone in Ontario, but is home to the majority of the province's population. The landscape is largely privately owned and has been highly altered with 68% of the ecozone made up of built-up areas, agriculture, roads and other anthropogenic cover. Forest cover in the ecozone has rebounded to 22% from a low of 11% in the early 1900s, but many of the patches of forest habitat are too small to support species that require forest interior habitats. Despite the altered landscape, the Mixedwood Plains is still home to the highest diversity of species in Ontario, and most species of conservation concern and rare ecosystems are found within this ecozone. Two thirds of the breeding bird species in this ecozone are stable or increasing, but declines have been particularly severe in grassland birds. Protected areas and conservation lands comprise only 3.5% of the landscape and representation of natural features in protected areas is low. Road density is high and increasing. Stresses on aquatic habitats are also high and water quality is an issue in the southwestern part of the ecozone. Ground-level ozone levels are increasing and at levels expected to impact biodiversity. The Mixedwood Plains Ecozone has more invasive alien plant species than any other ecozone in Canada. Over the last decade, stewardship efforts to enhance biodiversity, participation in environmental farm planning and enrolment in conservation tax incentive programs have all increased.

The biodiversity of the Great Lakes Ecozone has been impacted by a long history of human use of the Great Lakes and their surrounding watersheds. The ecozone has been subject to many changes over the last century associated with multiple stresses. Invasive alien species have been a particular problem for Great Lakes biodiversity. There are now at least 186 aquatic alien species and the rate of new invasions has increased. Large declines of the deepwater invertebrate *Diporeia* spp., an important food item for many fish species, may be related to the invasion of the lakes by Zebra Mussels and Quagga Mussels. Although the levels of many contaminants have decreased, phosphorus inputs and algae blooms are a problem in some nearshore areas. Habitat loss is an issue in some nearshore areas—artificial hardening of the shoreline is a problem on Lake Erie and Great Lakes connecting channels. The extent of annual ice cover has decreased on all of the lakes over the last 40 years suggesting that climate change is having an impact. Although the number of protected areas is currently small, the total area of the ecozone protected will be large once the large Lake Superior National Marine Conservation Area is regulated. Lake Superior is generally in good condition and has not been impacted by human activity to the same extent as lakes Huron, Erie and Ontario.

The Ecological Footprint provides a good overview of the demands that Ontarians are placing on the province's biodiversity based on their consumption patterns. On a per person basis, Ontario residents are among the global populations placing the highest demands on the planet's resources. At the same time, the capacity of the province's biological resources to support these demands is limited. Overshooting this capacity leads to the loss of biodiversity and the ecosystem services that provide benefits to people. At the provincial level, there is a gradient of increasing pressure and biodiversity losses from north to south associated with the concentration of human population and activities in the southern part of the province. Efforts and expenditures to protect and conserve Ontario's biodiversity have increased over the last decade.

Knowledge Gaps

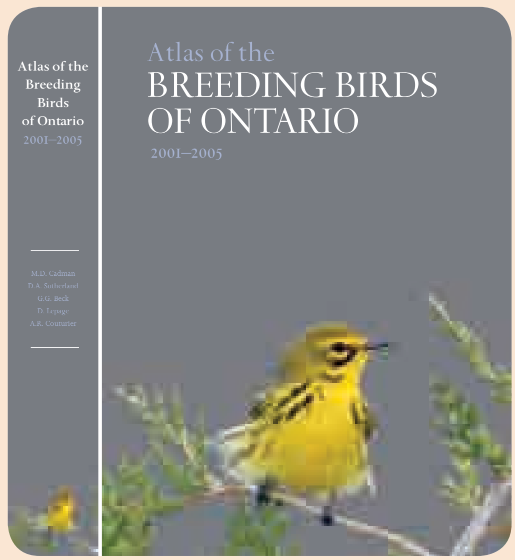
Information is a cornerstone for the effective protection and conservation of biodiversity. Although projects involving the collection and analysis of information on elements of Ontario's biodiversity have been extensive, the purpose of most of these efforts has not been to report on the state of biodiversity through time over a broad geographic scale. Information from these projects is useful for addressing management issues and scientific questions, but may not be particularly well-suited for the development of broad-scale biodiversity indicators. Recent efforts to report on the state of resources at the provincial (State of the Forest Report, State of Ontario's Protected Areas), national (Ecosystem Status and Trends Reports), and binational (State of the Lakes Ecosystem Conference) levels, have provided valuable information that has contributed greatly to the indicators in the State of Ontario's Biodiversity 2010 report.

Only one third of the indicators assessed for this report were considered to have high data confidence, and two indicators were not assessed. Additional potential indicators were not included because of the lack of suitable data to provide reliable reporting. Information gaps that became apparent during the development and assessment of biodiversity indicators include the lack of standardized, broad-scale monitoring for many aspects of biodiversity, the lack of comprehensive analysis of some existing data sets, the currency of existing data, and the identification of suitable indicators to assess some aspects of Ontario's biodiversity.

Standardized, broad-scale monitoring programs are valuable tools to identify the status and trends of Ontario's species and ecosystems. While our knowledge of some species groups and ecosystems is good, we fall short in many areas. In 2005, the General Status program assessed less than 15% of Ontario's species. Although more species groups are being added to the 2010 assessment, most of Ontario's species will remain unassessed—the majority of these are insects. The assessed status of many species improved with increased monitoring efforts.

CITIZEN SCIENCE

Citizen science is work done by volunteers on projects that involve scientific research and monitoring. The National Audubon Society's first Christmas Bird Count in 1900 was among the first citizen science initiatives in North America. Twenty-seven volunteers participated in this count. Today, tens of thousands of volunteers from across North America take part every year. In 2000, Bird Studies Canada partnered with the National Audubon Society and now coordinates Christmas Bird Counts in Canada. One of the most successful and well-known citizen science projects in Ontario is the Atlas of the Breeding Birds of Ontario. The most recent edition (2001–2005) contained more than 1.2 million individual breeding bird records (Cadman et al. 2007). The data gathered through these programs help scientists and managers better understand bird distributions and population trends.



Ontario and Canada are leaders in promoting citizen science. Additional examples of citizen science projects taking place across the province and the country include the Great Lakes Marsh Monitoring Program, the Ontario Herpetofaunal Atlas Program, the Ontario Turtle Tally, Pollination Canada and the NatureWatch series of ecological monitoring programs—IceWatch, FrogWatch, PlantWatch, and WormWatch. Species occurrence data is collected through many of these programs. Participants report sightings made in places like backyards, roads, cottages, lakes and ponds. For example, 3,859 turtle sightings were reported through the Ontario Turtle Tally in 2009 and volunteers also saved 178 turtles found on Ontario's roads (Ontario Turtle Tally 2009). These programs, and many others like them, help scientists assess the status and recovery of wild species and their habitats. Other citizen science projects like IceWatch and the Invading Species Awareness Program help biologists and wildlife managers assess pressures on Ontario's biodiversity. For example, IceWatch volunteers record freeze-up and thaw dates of lakes, rivers and streams in their communities. This information helps scientists improve their understanding of the impacts climate change is having on biodiversity.

Volunteer involvement in scientific research benefits the research project, the volunteer and biodiversity. In citizen science projects more data can be collected over a broader area than scientists could collect alone. This information improves scientists' and decision makers' understanding of species and ecosystems. Through their work volunteers learn about biodiversity and how humans are impacting biodiversity. Some may become more connected with nature and develop a deeper appreciation of the values of biodiversity. Such individuals may become better stewards of the environment and participate in future conservation efforts. All of this benefits biodiversity over the long term.

The breeding birds indicator included in this report is a good example of the value of long-term, standardized monitoring programs. Data from 11 different survey programs were pooled to evaluate trends for all of the breeding birds by ecozone and habitat type. Many of these surveys are "citizen science" conducted by volunteers. Although it would not be possible to conduct similar long-term monitoring on all species, the development of monitoring programs for some of the lesser known species groups or indicator species would be extremely helpful in understanding the state of Ontario's biodiversity. Ecosystem indicators included in this report are largely related to the extent or area of systems and how these have changed through time. It would be valuable to have broad-scale information on the health of these systems for inclusion in future reports. There was not sufficient information from a wide range of Ontario lakes to develop indicators for this report. The broad-scale monitoring program for Ontario's inland lakes that was initiated in 2008 will be useful for future reporting. Such monitoring programs need to be continued over the long term to provide meaningful results.

For some indicators, the amount of information available is quite good, but the appropriate analysis of this information has not yet been conducted to allow the indicator to be assessed. The stream flow and stream fragmentation indicators fall into this category. They were nevertheless included in the report as "not assessed" because of their importance to aquatic biodiversity, and will be assessed in future reports.

The currency or age of existing data is a concern for some of the indicators in this report and reports that will be produced in the future. For example, the indicator on the amount of hardened shoreline on the Great Lakes is based on aerial photography from the late 1980s. This information will need to be updated if this indicator is included in future reports. Several of the indicators relating to the Mixedwood Plains Ecozone (land cover, forests, wetland loss, urban biodiversity) use data from the Southern Ontario Land Resource Information System (SOLRIS) that is based on land cover from the year 2000. If these indicators are used in future reports, it will be important that this land cover layer is updated.

Suitable indicators were not developed for some topic areas (overharvesting, genetic diversity) that are included in the report. Similarly, there are no indicators that specifically assess: the levels and trends of ecosystem services associated with the various aspects of Ontario's biodiversity; the effectiveness of conservation and sustainable use efforts; and, the use of Aboriginal Traditional Knowledge in biodiversity conservation. Efforts should be made to develop indicators related to these subjects in future reports.

Vegetation plot north of Kaladar

Photo: Wasyl D. Bakowsky, NHIC Archives

Blanding's Turtle, Rondeau Provincial Park

Outlook for 2015

Ontario's Biodiversity Strategy identifies the need to report on the state of Ontario's biodiversity every 5 years. The next report is scheduled for 2015. The 2010 report will be used as a baseline for future reporting, but it is likely that some new indicators will be developed to address gaps in the current reporting effort. The Ontario Biodiversity Council intends to update the content of the 2010 report on the Council's web site (**www.ontariobiodiversitycouncil.ca**) as current indicators are updated with new information and as new indicators are developed. The establishment of targets or desired outcomes would be valuable for assessing indicator status in the next report.

This 2010 report shows that Ontarians are placing large demands on the province's biological resources and that biodiversity losses are occurring, particularly in southern Ontario. Given that Ontario's population is projected to grow by almost 5 million people by 2036, the province's biodiversity will continue to be eroded if current trends continue. Although efforts and expenditures to protect and conserve biodiversity have increased over the last decade, these have not been sufficient to prevent the continued loss of the province's biodiversity.

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