State of Ontario’s Biodiversity 2015
Indicators

Ontario Biodiversity Council

State of Ontario’s Biodiversity 2015 – Indicators

The table below lists the indicators completed for the State of Ontario’s Biodiversity 2015 report. A Summary Report and the individual indicators are available online at the Ontario Biodiversity Council’s reporting web site - http://ontariobiodiversitycouncil.ca/sobr. To navigate to the text for a specific indicator, click on the bookmarked indicator in the table or use the Bookmark feature on the Acrobat navigation pane.

Indicator
• Ontario’s Ecological Footprint and Biocapacity
• Percentage of Land Cover Types in Ontario
• Road Length in Ontario
• Terrestrial Landscape Fragmentation
• Stream Fragmentation
• Aquatic Stress Index
• Aquatic Alien Species in the Great Lakes
• Alien Species in Inland Lakes
• Release of Pollutants Harmful to Biodiversity
• Ground-level Ozone
• Water Quality in Inland Lakes
• Water Quality in Streams
• Changes in Greenhouse Gas Emissions
• Afforestation and Deforestation
• Changes in Ice Cover on the Great Lakes
• Changes in Vegetative Phenology
• Body Condition and Survival of Polar Bears
• Forest Cover and Disturbance
• Extent of Wetland Cover and Wetland Loss
• Extent, Quality and Protection of Ontario’s Rare Ecosystems
• Status of Great Lakes Ecosystems
• Alterations to Stream Flow
• Changes in Status of Species at Risk
• Trends in Species of Conservation Concern Based on General Status Assessment
• Amount of Genetic Variation, Genetic Composition and Spatial Structure of Selected Species
• Protected Areas and Conservation Lands
• Ecological Representation in Ontario’s Protected Area System
• Observed Change in Land Area With Stewardship Activities
• Volunteer Efforts to Conserve Biodiversity
• Participation in Provincial Tax Incentive Programs
• Number of Municipalities with Natural Heritage Systems Plans/Biodiversity Strategies
• Biodiversity Policies and Programs
• Ecosystem Services Policies and Programs
• Implementation Plans in Support of Ontario’s Biodiversity Strategy
• Biodiversity in Ontario’s Business Sectors

Indicator
• Invasive Species Strategic Plans
• Participation in Environmentally Sustainable Agriculture Program
• Forest Certification
• Walleye Harvest in Inland Lakes
• Provincial Expenditure on Biodiversity and Charitable Giving to the Environment
• Biodiversity in Ontario’s Elementary and Secondary School Curricula
• Biodiversity in Ontario’s Postsecondary Curricula
• Awareness of Biodiversity and its Importance to Human Health
• Monitoring and Reporting on Biodiversity

INDICATOR: ONTARIO'S ECOLOGICAL FOOTPRINT AND BIOCAPACITY

STRATEGIC DIRECTION: Reduce Threats

TARGET: 9. By 2020, the growth of Ontario's per-capita resource consumption and waste generation is halted and reversed.

THEME: Pressures on Biodiversity – Consumption

Background Information:

Human activities affect biodiversity directly through habitat loss, introduction of invasive species, pollution, unsustainable use and climate change. The growing population combined with increasing levels of consumption drive these threats and often compromise the ability of our ecosystems to produce natural resources and to absorb waste (i.e., biological capacity or biocapacity). To manage biological capacity sustainably, resources must not be used more quickly than ecosystems can regenerate them.

Since the 1970s, humanity has been in ecological overshoot with annual demand on resources exceeding what Earth can regenerate each year. Recent analyses show that resource consumption levels have doubled over the last 50 years and currently exceed the Earth's regenerative capacity by 51% (WWF 2014, Zokai et al. 2015). Global overshoot can have major environmental implications, including degradation of ecological assets, depletion of natural reserves, biodiversity loss, and ecosystem collapse. 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 a major factor driving biodiversity loss.

The Ecological Footprint is a metric that assesses humanity's demand for 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 a strong measure of environmental sustainability and is used by governments and institutes worldwide. The Ecological Footprint has been used as an indicator at the global level to assess progress on the Aichi Biodiversity Targets (Secretariat of the Convention on Biological Diversity 2014). While the Footprint does not measure biodiversity loss directly, it tracks global pressures on biodiversity and can be used to complement other measures of ecosystem-specific impacts on biodiversity (Galli et al. 2014). The strength of the Ecological Footprint 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 and 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 provided by ecosystems that can be directly harvested for human use (food, fibre and timber).

This indicator examines trends in Ontario's Ecological Footprint and Biocapacity for the years 2005 and 2010 based on analysis completed by the Global Footprint Network.

Data Analysis:

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 hectares of world average productive land and water to support human 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 factor and equivalence factor. The yield factor accounts for differences between provincial and world yields for the land-use type in question. The equivalence factor takes into account differences in world average productivity between the various land-use types (e.g., cropland, forest land, fishing grounds). Biocapacity is calculated by multiplying the area devoted to each land-use type (e.g., forest land) by the respective yield and equivalence factors for that land-use type.

National Footprint Accounts developed by the Global Footprint Network are the basis for all Ecological Footprint analysis. The current analyses for this indicator are based on the 2014 edition of the National Footprint Accounts for the data years 2005 and 2010. Results reported for 2005 in the State of Ontario's Biodiversity 2010 (OBC 2010; Stechbart and Wilson 2010) were based on the 2008 edition of the National Footprint Accounts. The results from 2005 were reanalysed using the 2014 edition to ensure that the two time periods were directly comparable.

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 and Forestry. The Ecological Footprint and Biocapacity for Ontario in 2010 were compared to values from 2005 to assess trends (Figure 1). Trends in the Ecological Footprints of Canada and Ontario were also compared over this period (Figure 2). Ontario's Ecological Footprint was also compared to 2010 levels for other countries with available data (Figure 3).

The information presented in this indicator represents a summary of a technical report prepared by the Global Footprint Network (Zokai et al. 2015).

- View Ecological Footprint and Biocapacity trends for individual nations

Results:

Trend: Mixed | **Data Confidence:** Medium | **Geographic Extent:** Provincial

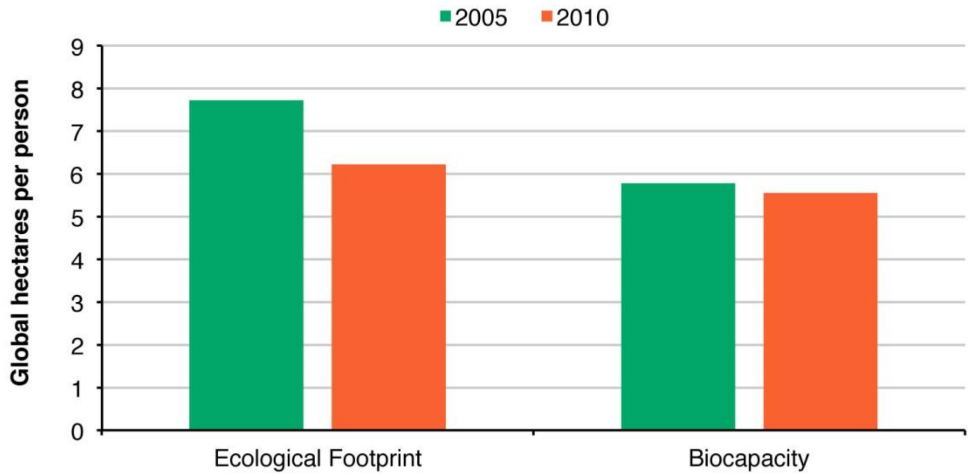

Figure 1. Comparison of trends in Ontario's Ecological Footprint and Biocapacity per person, 2005-2010.

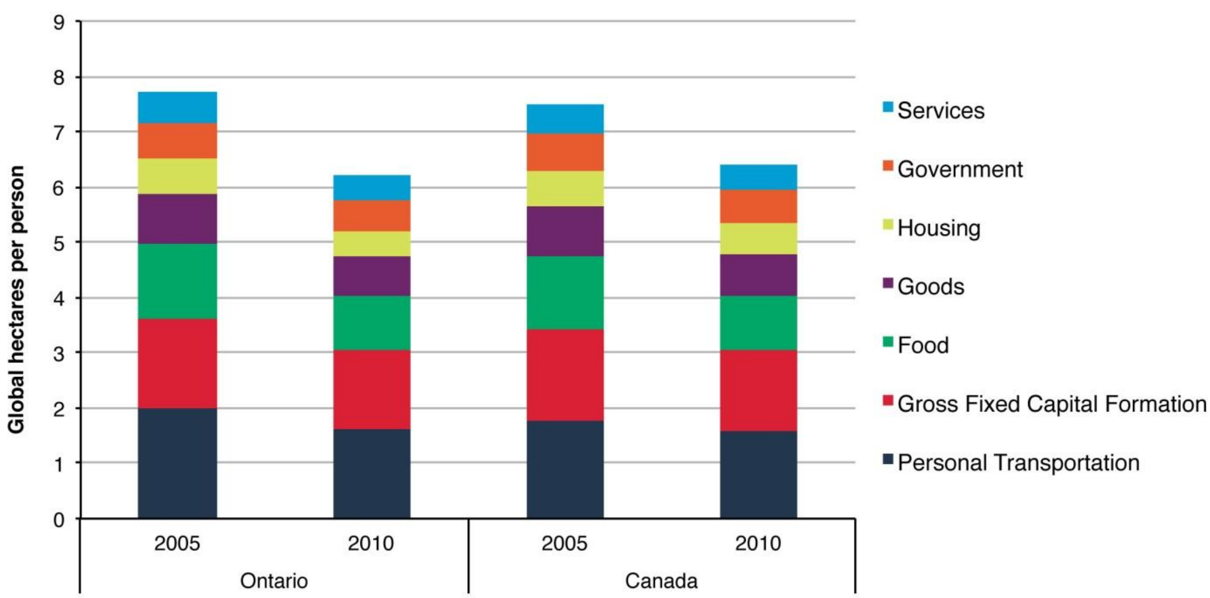

Figure 2. Comparison of trends in the Ecological Footprints per person of Ontario and Canada based on consumption category, 2005-2010.

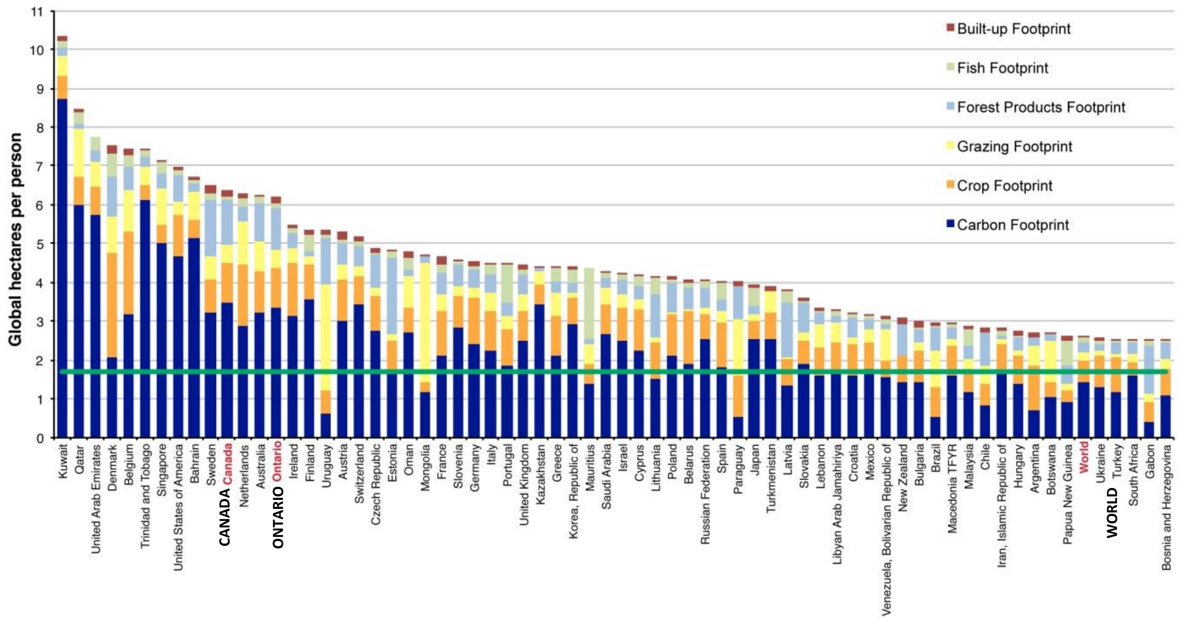

Figure 3. 2010 Ecological Footprint per capita for 66 countries with the highest Ecological Footprint, compared with Ontario (Horizontal green line represents average world biocapacity of 1.7 gha per person)**.**

Status:

- Ontario's per capita Ecological Footprint decreased by almost 20% between 2005 and 2010 (from 7.71 to 6.21 global hectares per person), while Canada's decreased by about 15% over the same period. The overall Ecological Footprint of the Ontario population decreased by 15%. The decrease in Ontario's Ecological Footprint is largely due to decreased energy intensity and is related to reduced greenhouse gas emissions.
- Despite this reduction, Ontario's demands for resources in 2010 remained relatively high with only 13 nations having a higher per capita Ecological Footprint. In 2005, only eight nations were higher than Ontario. If everyone in the world live comparable lifestyles to the residents of Ontario based on the 2010 Footprint results, Humanity would require the resources of 3.7 planet Earths to support itself.
- In 2010, the Carbon Footprint was the largest element of Ontario's Ecological Footprint by demand type. Personal transportation was the most significant component of Ontario's Footprint by consumption type.
- The capacity of the province's biological resources to support these demands is limited. Ontario's per capita biocapacity in 2010 was reduced from 2005 (from 5.8 to 5.6 global hectares per person due to increasing population size), and was about 10% lower than the per capita Ecological Footprint. Overshooting Ontario's biocapacity can cause the loss of biodiversity and ecosystem services that provide benefits to people.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Global Footprint Network http://www.footprintnetwork.org/

References:

Galli, A., M. Wackernagel, K. Iha, and E. Lazarus. 2014. Ecological Footprint: implications for biodiversity. Biological Conservation 173:121–132.

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Secretariat of the Convention on Biological Diversity .2014. Global biodiversity outlook 4. Montréal, QC.

Stechbart, M., and J. Wilson. 2010. Province of Ontario ecological footprint and biocapacity analysis. Copyright by Global Footprint Network, Oakland, CA.

WWF. 2014. Living planet report 2014: species and spaces, people and places. McLellan, R., Iyengar, L., Jeffries, B. and N. Oerlemans (Eds). WWF, Gland, Switzerland.

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INDICATOR: PERCENTAGE OF LAND COVER TYPES IN ONTARIO

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Biodiversity – Habitat Loss

Background Information:

Changes in land cover can provide critical information on broad-scale ecosystem changes and the causes and impacts of these changes. By using land cover mapping developed from satellite imagery, it is possible to track changes in land cover through time over broad areas. For this indicator, individual land cover classes were aggregated into broader land cover types with relevance to biodiversity: anthropogenic cover, aquatic cover, disturbance cover, natural disturbance cover and natural terrestrial cover. At the ecozone scale, anthropogenic cover reflects threats to biodiversity, under the assumption that human-modified landscapes experience greater habitat loss and fragmentation than more natural landscapes. 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.
This indicator shows trends in the proportion of broad land cover types in each of Ontario's terrestrial ecozones over the period 2000-2011.

Data Analysis:

Classes of land cover from digital provincial data sets for the years 2000 and 2011 were aggregated into five broad land cover categories (Table 1). In the Mixedwood Plains Ecozone of southern Ontario (with the exception of Manitoulin Island), land cover information from the Southern Ontario Land Resource Information System was used (SOLRIS; OMNR 2008). SOLRIS version 2.0 (2011 land cover) was developed using a LandSat based change detection analysis process applied to woodlands and wetlands identified in SOLRIS version 1.0 (2000-2002 land cover). For the rest of the province, data from Provincial Land Cover 2000 (PLC2000; Spectranalysis Inc. 2004) were used to assess land cover in the year 2000. The 2011 information for this large part of the province was assessed using two sources: Far North Land Cover 1.4 (FNLC 2014; OMNRF 2014) includes the entire Hudson Bay Lowlands Ecozone and the northern portion of the Ontario Shield Ecozone; and an update to the rest of the PLC2000 that incorporated spatial information maintained by the Ontario Ministry of Natural Resources and Forestry on forest harvest, forest regeneration and burns. Among the various land cover products, the information for southern Ontario (SOLRIS) has the highest resolution (15 m versus 25-30 m).

Table 1. Broad land cover types used in analysis.

Broad land cover type	Land cover classes included
Anthropogenic cover	Built-up/settlement areas, roads, agriculture, and extraction (stone, sand and gravel, mines)
Aquatic cover	Open water of lakes and streams
Disturbance cover	Forest harvested within the previous 5-year period
Natural disturbance cover	Forest with recent burns, insect damage or blowdown
Natural terrestrial cover	alvars, mudflats, prairies, savannahs, wetlands, forests, rock and tundra

Comparing land cover information through time using different datasets presents challenges. It may be difficult to determine if observed changes are related to real changes on the landscape or are related to differences in the accuracy and classification methods used. The use of broad land cover categories in this indicator addresses this concern to some extent. For example, the same area might be assigned to a forest class or a treed wetland class using different classification methods – these two classifications would be considered natural terrestrial cover in this analysis. The 2011 information for southern Ontario and the southern portions of the Ontario Shield were developed by incorporating observed changes into the original 2000 data and so the observed changes will be real. However, the Far North Land Cover was developed using a more accurate classification method than the PLC2000, so distinguishing between real and methodological changes in this area is more problematic (OMNRF 2014).

Results:

Trend: Mixed	**Data Confidence:** Medium	**Geographic Extent:** Provincial

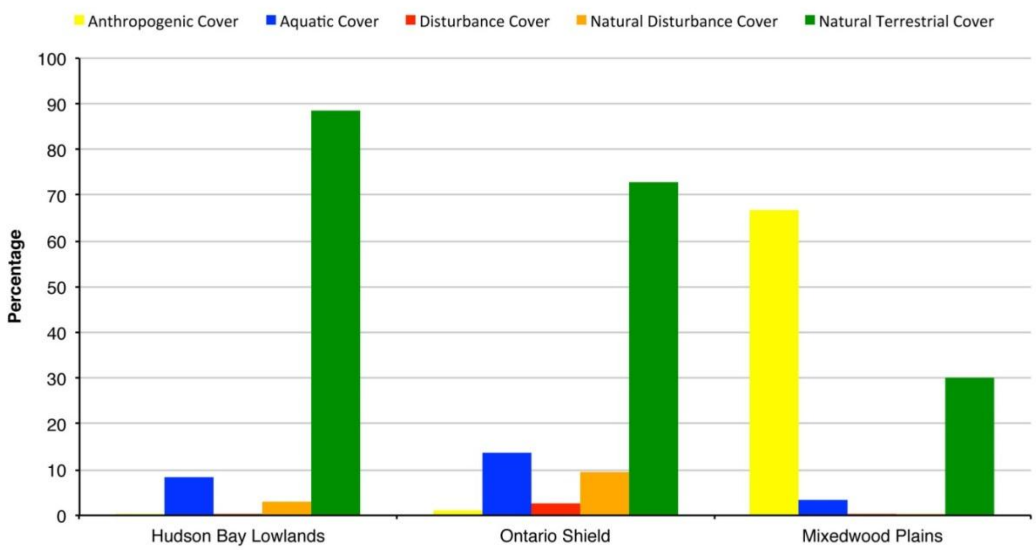

Figure 1. Percentage land cover composition for Ontario's ecozones (based on land cover current to 2011, note: totals may not sum to 100% because of areas not classified due to cloud cover).

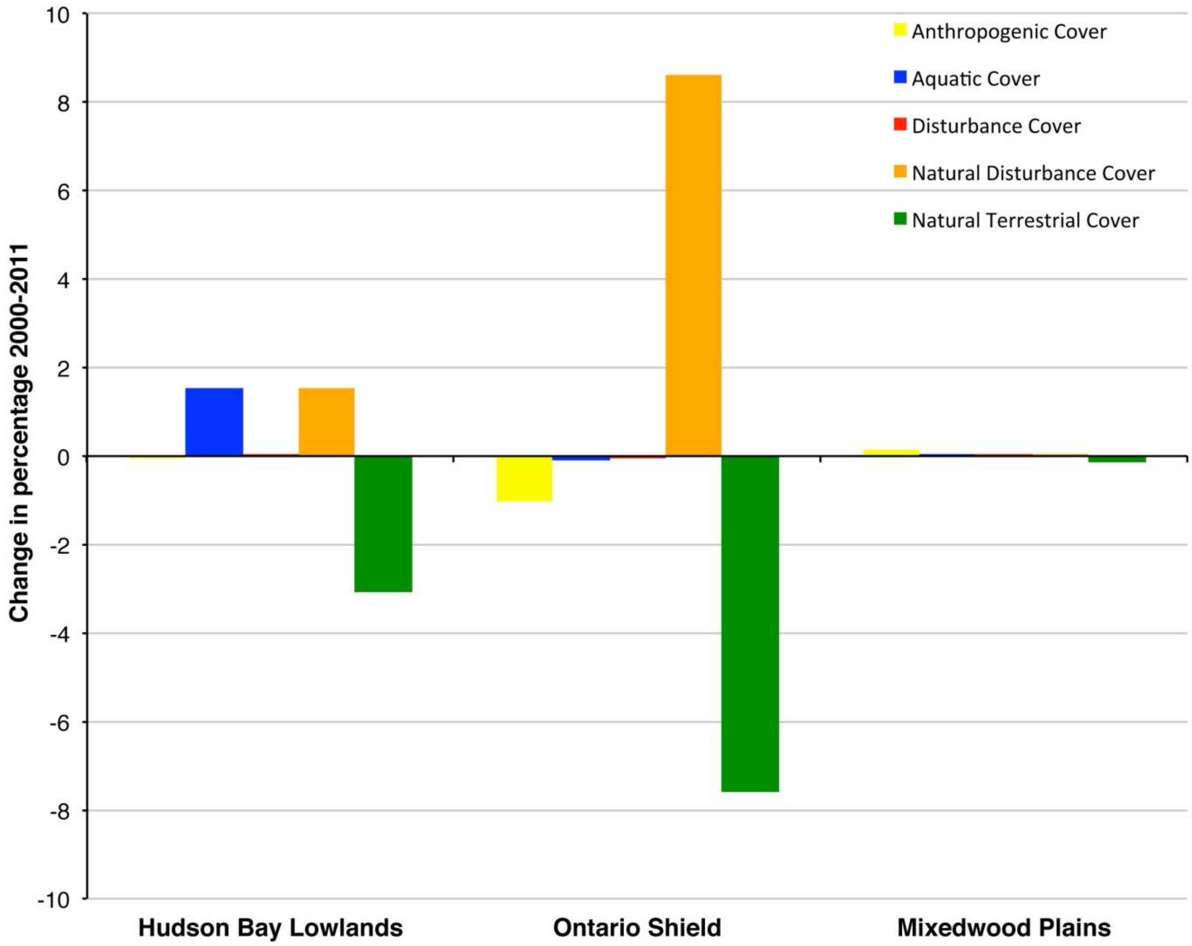

Figure 2. Changes in the percentage of land cover composition for Ontario ecozones between 2000 and 2011.

Status:

- Anthropogenic cover is highest in the Mixedwood Plains (67%), but is very low in the Ontario Shield (1%) and the Hudson Bay Lowlands (< 1%). Agriculture accounts for more than 91% 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.
- In the Mixedwood Plains of southern Ontario, there was a very small increase in anthropogenic cover with a corresponding loss of natural terrestrial cover between 2000 and 2011. The amount of natural disturbance (burns) and disturbance from forest harvest remained extremely low in this ecozone.

- The vast majority of the Ontario Shield (96%) and Hudson Bay Lowlands (> 99%) ecozones remained in natural land cover types (aquatic, natural terrestrial and natural disturbance). Observed changes within these cover types are likely the result of improved information associated with the Far North Land Cover 1.4. The increases in natural disturbance cover in 2011 are related to the longer time frames considered when developing the disturbance classes in this dataset (up to 20 years).
- There is significant habitat loss and fragmentation in the human-dominated south and relatively little in the north.

Links:

Related Targets: N/A

Related Themes: N/A

References:

Ontario Ministry of Natural Resources (OMNR). 2008. Southern Ontario Land Resource Information System (SOLRIS) Phase 2 – Data Specifications Version 1.2. Ontario Ministry of Natural Resources, Peterborough, ON.

Ontario Ministry of Natural Resources and Forestry (OMNRF). 2014. Far North Land Cover – Data Specifications Version 1.4. Ontario Ministry of Natural Resources and Forestry, Peterborough, ON.

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Citation
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INDICATOR: ROAD LENGTH IN ONTARIO

STRATEGIC DIRECTION: Reduce threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Habitat Loss

Background Information:

Roads are a ubiquitous feature of human-modified landscapes and Ontario is no exception. Ontario has a higher density of roads than any other region in the country, particularly in the densely populated southern portion of the province. Major roads in southern Ontario have increased fivefold from 1935 to 1995 (OBC 2010), and very few areas in the region are more than 1.5 km from a road (OMNR 2009). As well, traffic volume on Ontario roads has increased markedly over the last 30 years (OMTO 2010).

The environmental impacts of roads are numerous and their proliferation typically leads to negative impacts on biodiversity. Plant, insect, herptile, bird and mammal richness and community composition have all been shown to be affected by roads (Coffin 2007). Biodiversity loss may occur directly via road-kill events (Jaeger et al. 2005), disturbance or pollution (Sanzo and Hecnar 2006; Warren et al. 2006), or indirectly by stimulating and facilitating loss of habitat, and forming barriers to dispersal and gene flow (Jaeger et al. 2005; Keller and Largiader 2009). Roads may also affect biodiversity through reduction in habitat quality, facilitating human access to less developed landscapes, increasing the risk of the introduction of invasive species, increasing the risk of forest fires and the creation of edge effects at road-habitat boundaries (Forman and Alexander 1998; Gelbard and Belnap 2003; Jaeger et al. 2005; Fahrig and Rytwinski 2009).

The consideration of environmental impacts when roads are constructed or upgraded in Ontario has improved in recent decades. The Environmental Assessment Act sets up a thorough process for assessing the environmental impacts of various alternatives for road development prior to government approvals. This helps to protect the natural environment and mitigate the environmental impacts.

This indicator assesses changes in the length of roads in both southern and northern Ontario based on the Ontario Road Map as an index of habitat loss and landscape fragmentation.

Data Analysis:

The length of road in four different classes (earth/unimproved, two-lane loose, two-lane paved, multilane paved) in southern and northern Ontario was assessed in each decade from 1935-2005 based on the Ontario Road Map (ORM) that is updated by the Ontario Ministry of Transportation every 2 years. Road data from the southern Ontario portion of the ORM by decade for the period 1935-1995 were digitized and summarized by Fenech et al. (2000). The ORM for 2005 were digitized by the Ontario Ministry of Natural Resources and Forestry. Changes in the length of classes of roads for the southern Ontario portion of the ORM were assessed over the period 1935-2005 (Figures 1 and 2). Analyses of changes in the northern Ontario portion of the ORM are ongoing and will be added to this indicator when completed. A preliminary assessment showed that the total length of ORM roads in this part of the province increased from about 3,400 km in 1935 to more than 13,300 km in 2005.

It is important to note that due to limitations of scale, the ORM does not include all roads within the province. The ORM includes about 20% of the roads included in the digital Ontario Road Network (OMNRF 2014). For example thousands of kilometres of municipal streets and forest access roads do not show up on the map. However, using the ORM provides a consistent means of tracking changes in the road network in Ontario through time back to 1935, and provides a reliable index of pressures related to road density.

Results:

Trend: Mixed **Data Confidence:** Medium **Geographic Extent:** Mixedwood Plains/Southern portion of Ontario Shield

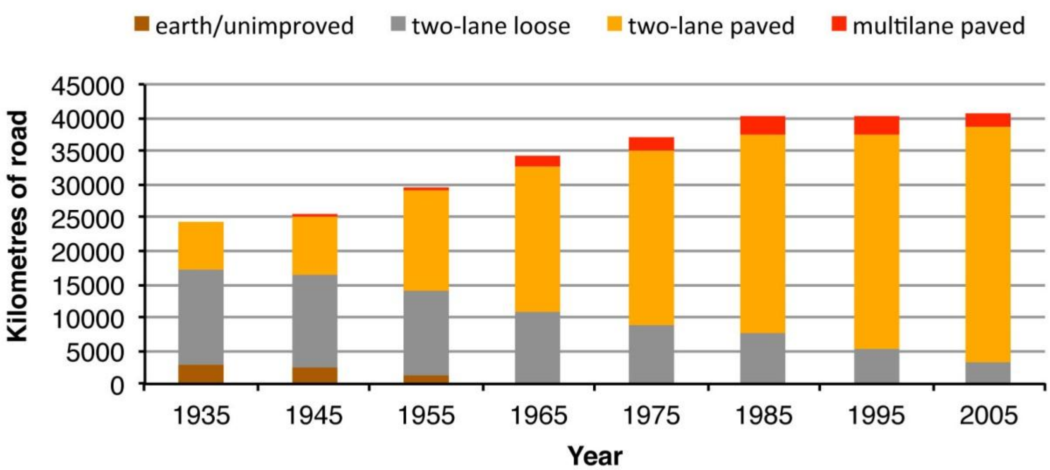

Figure 1. Road changes in southern Ontario based on the Ontario Road Map, 1935-2005.

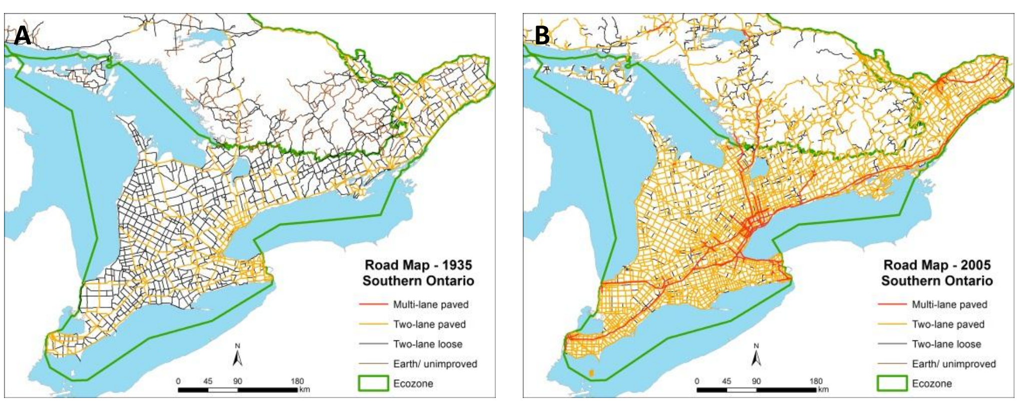

Figure 2A & B. Roads in southern Ontario 1935-2005 (Note: the maps are presented as an animated gif on the website that rolls through each decade).

Status:

- Based on the Ontario Road map, the length of roads in southern Ontario increased from 24,200 km in 1935 to 40,800 km in 2005, representing an increase of 69%.
- Although the rate of increase in total road length has slowed (> 2% increase between 1985 and 2005), the total length of paved roads in southern Ontario has continually increased from 7,000 km in 1935 to 37,400 km in 2005, including 2,300 km of multi-lane paved roads that did not exist in 1935.

Links:

Related Targets: N/A

Related Themes: N/A

References:

Coffin, A.W. 2007. From roadkill to road ecology: a review of the ecological effects of roads. Journal of Transportation Geography 15:396–406.

Fahrig, L., and T. Rytwinski. 2009. Effects of roads on animal abundance: An empirical review and synthesis. Ecology and Society 14:21-41.

Fenech, A., B. Taylor, R. Hansell, and G. Whitelaw. 2000. Major road changes in southern Ontario 1935-1995: Implications for protected areas. University of Toronto, Integrated Mapping Assessment Project, Toronto, ON.

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Gelbard, J. L. and J. Belnap. 2003. Roads as conduits for exotic plant invasions in semiarid landscape. Conservation Biology 17:420–432.

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Citation

Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

Indicator: Terrestrial Landscape Fragmentation

Strategic Direction: Reduce Threats

Target: N/A

Theme: Pressures on Ontario's Biodiversity – Habitat Loss

Background Information:

Landscape fragmentation is the process by which habitat loss results in the division of large, continuous habitats into smaller, more isolated remnants. Recent scientific evidence shows that landscape fragmentation has negative effects on biodiversity (Fahrig 2003), largely resulting from the loss of the original habitat, reduction in habitat patch size and increasing isolation of habitat patches (Andrén 1994). More specifically, landscape fragmentation causes a reduction in habitat area, with associated declines in population density and species richness, and significant alterations to community composition, species interactions and ecosystem functioning (Fahrig 2003). Species occupying fragmented landscapes are also less able to shift their distributions to compensate for altered habitat quality resulting from changing climatic conditions. Thus, there is an important synergy between climate change and landscape fragmentation that may lead to increased loss of biodiversity (Varrin et al. 2008).

Landscape fragmentation not only deprives plants and animals of habitat, but also has indirect impacts, generating noise, light and air pollution or changing microclimates. Some species avoid human structures, which reduces their potential habitats even more. As a result, areas in which animals feel undisturbed become ever more scarce due to landscape fragmentation (Jaeger 2000). Further, landscape fragmentation results in an abundance of edge habitat, where edge-sensitive species or those that require large, undisturbed habitat are excluded (Fahrig 2003).

Landscape fragmentation is most evident in intensively used regions, where the habitat is divided by urbanization, agriculture, roads or other human developments (Fahrig 2003). Fragmentation has been rapidly increasing in Ontario, particularly in the south where human development is greatest (OBC 2010). This trend is likely to continue as Ontario's population is projected to grow by 31% over the next 28 years, from an estimated 13.5 million in 2013 to almost 17.8 million by 2041, resulting in greater fragmentation of the remaining ecological network (Ontario Ministry of Finance 2014).

This indicator assesses terrestrial landscape fragmentation in Ontario using effective mesh size, an unbiased measure of the sizes of habitat patches within regions.

Data Analysis:

Terrestrial landscape fragmentation in southern Ontario was assessed based on natural and anthropogenic land cover types in 2011 aggregated from the Southern Ontario Land Resource and Information System (SOLRIS v 2.0; OMNRF 2015). Landscape fragmentation was measured using effective mesh size (Jaeger 2000). Effective mesh size (m_{eff}) is a method to quantify fragmentation based on the probability that two points chosen at random in a region will be connected (i.e., found in the same habitat patch; Jaeger 2000). It is measured in units of area (i.e., ha or km^2)

Effective mesh size was assessed for each ecodistrict in the Mixedwood Plains Ecozone in Ontario, with the exception of Manitoulin Island (Figure 1). Roads and other infrastructure, urban areas, agricultural lands and extraction areas were considered barriers. It is important to note that as a measuring unit, effective mesh size assigns equal weight to all barriers. In reality, it may make a big difference whether an animal is confronted with a small country road or a highway. While it is possible that for some species, all barriers might constitute insurmountable obstacles, for most species, it will be the nature of the barrier placed in their path (volume of traffic, width, animal-tight fences, etc.) that carries the most weight (Jaeger 2000).

Patch-based landscape metrics can be biased by the boundaries and the extent of a reporting unit if the reporting unit boundaries fragment patches. To overcome this limitation the cross-boundary connections procedure was used, where provincial and/or ecozone borders were considered to be barriers and regional boundaries were not (Moser and Jaeger 2007). As such, m_{eff} was calculated using the following formula:

$$m_{\text{eff}} = \frac{1}{A_{\text{total}}} \sum_{i=1}^{n} A_i \cdot A_i^{\text{cmpl}}$$

where n = the number of patches, A_i = size of patch i inside the boundaries of the reporting unit (i = 1,2,3,…, n), A_i^{cmpl} = the area of the complete patch that A_i is a part of, and A_{total} = the total area of the reporting unit. A high effective mesh size value indicates low fragmentation of the landscape. More detailed information of the analysis of landscape fragmentation in southern Ontario is provided in McIntosh et al. (2015).

- Download m_{eff} data

Results:

Trend:	Baseline	**Data Confidence:** Medium	**Geographic Extent:** Mixedwood Plains

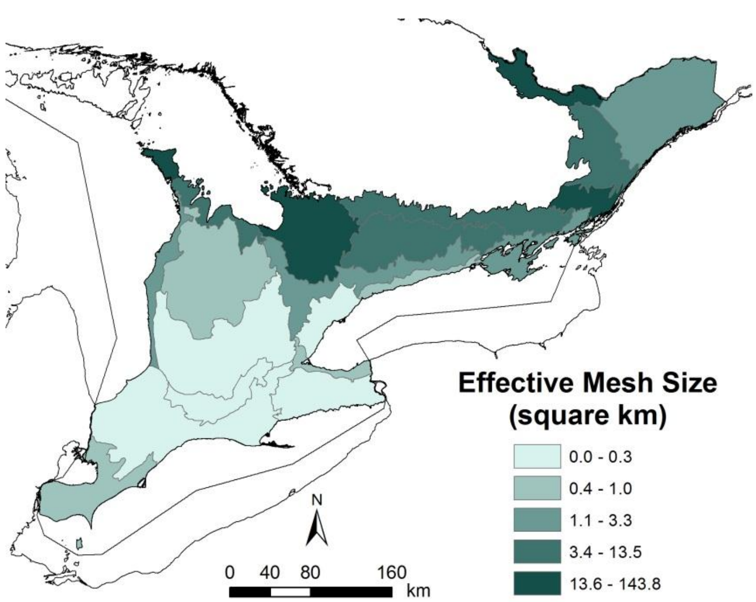

Figure 1. Effective Mesh Size for ecodistricts in southern Ontario (2011).

Status:

- In 2011, the effective mesh size in southern Ontario ranged from a low of 0.03 km^2 in the Toronto Ecodistrict to a high of 144 km^2 in the Charleston Lake Ecodistrict.
- Median effective mesh size for ecodistricts in the Mixedwood Plains Ecozone was 1.3 km^2. The effective mesh size for all seven ecodistricts in the southwestern portion of the ecozone was less than the median value.
- Analysis of effective mesh size in Ontario is ongoing (Ontario Shield and Hudson Bay Lowlands ecozones as well as an examination of trends in the Mixedwood Plains Ecozone).

Links:

Related Targets: N/A

Related Themes: N/A

References:

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INDICATOR: STREAM FRAGMENTATION

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Habitat Loss

Background Information:

Dams can provide several benefits including renewable hydroelectric power generation, flood control, the creation of wetlands and recreational opportunities associated with reservoirs. However, they can also negatively affect aquatic biodiversity. Dams interrupt the flow of streams and can alter the natural variation in the size, duration, timing, frequency and variability in flows (Poff and Hart 2002; Helfman 2007). Upstream areas are often flooded, changing habitats into warmer, more lake-like conditions, and the habitat in downstream channels is sometimes changed by alterations to flow, erosion and sediment deposition. Dams also fragment aquatic habitats preventing migratory species from accessing important habitats and interrupting gene flow between local subpopulations. Sometimes dams can act as beneficial barriers that stop some invasive species from reaching upstream habitats. However, there is also evidence that dams can facilitate the establishment of invasive 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; Stanfield 2012, Mahlum et al. 2014).

In the first State of Ontario's Biodiversity Report (Ontario Biodiversity Council 2010), this indicator was included, but was ranked as 'not assessed' because information on the location and number of dams in Ontario had not been assembled and verified. A spatial dataset of Ontario's medium and large dams is now available allowing the development of this indicator (Ontario Dam Inventory). The dataset includes 1,596 dams, 40 of which were identified as having a fishway designed to allow upstream movement of at least some fish species. Dams included in the Ontario Dam Inventory were determined through visual inspection of orthophotography. The medium and large dams identified in the database are those on larger systems and those that appeared to have an impact on water flow. Small dams on small creeks and ditches are more numerous (at least 2,000 in Ontario), but have not been incorporated into the database.

This indicator includes information on the distribution and numbers of medium and large dams to assess the degree to which Ontario's aquatic ecosystems are fragmented by engineered barriers. Consideration of aquatic connectivity is incomplete without considering road crossings as potential barriers (Januchowski-Hartley et al. 2013). Therefore this indicator also includes information on the numbers and distribution of road crossings. Bridges usually have no effect on connectivity, but culverts can sometimes become perched and impassable to fishes and other aquatic species, and can act as a barrier similar to dams. Unfortunately it is not possible to determine the passability of road crossings without doing site inspections. Case studies of four American watersheds in the Great Lakes basin revealed that 13 to 58% of road crossings per watershed were barriers for a range of native fish species (Januchowski-Hartley et al. 2013). There is also ongoing work to inventory culverts that are perched above the water level at the downstream end and therefore also increase fragmentation in Ontario's watersheds

(Stanfield, 2013). Where these have been inventoried, they result in significant increases in measures of fragmentation and have been shown to be correlated with altered fish assemblages (Stanfield, 2012, Mahlum et al. 2014). In the Greater Toronto Area, 11% of Etobicoke Creek road crossings and 13% of Mimico Creek road crossings assessed were barriers to fish passage (TRCA 2010). In the Rouge River watershed, 31% of 806 in-stream structures assessed were barriers and most of these were perched culverts (TRCA and OMNR 2010). Twenty-three percent of 1,171 culverts assessed in 17 Lake Ontario watersheds were perched (Chau and Lancaster 2012).

While the number of dams is unlikely to change quickly, many dams are nearing the end of their life cycle and mitigation projects that may include installation of fish passage structures or dam removal and habitat restoration are being considered for several dams within the Great Lakes basin (EC and USEPA 2014). Field assessments of stream crossings and other potential in stream barriers can be used in conjunction with network analysis to determine priority sites for enhancing aquatic connectivity (Cote at al. 2009; Januchowski-Hartley et al. 2013).

Data Analysis:

The locations of medium and large dams in the Ontario Dam Inventory were mapped at the provincial scale using GIS software (Figure 1). The dam locations were overlaid with the boundaries of Ontario's tertiary watersheds to determine the density of medium and large dams in each watershed (Figure 1). The location of road crossings on streams was determined using GIS software by intersecting the Ontario Road Network (excluding winter roads) with the Ontario Hydro Network. The density of crossings in each watershed was then determined by overlaying tertiary watershed boundaries (Figure 2).

Spatial data used to develop this indicator (Ontario Dam Inventory, Ontario Road Network, Ontario Hydro Network, Watershed Tertiary) are available through the Land Information Ontario (LIO) web site - http://www.giscoeapp.lrc.gov.on.ca/web/mnr/gib/dds/viewer/viewer.html.

- download stream fragmentation summary data

Results:

Trend: Baseline **Data Confidence:** Medium **Geographic Extent:** Provincial

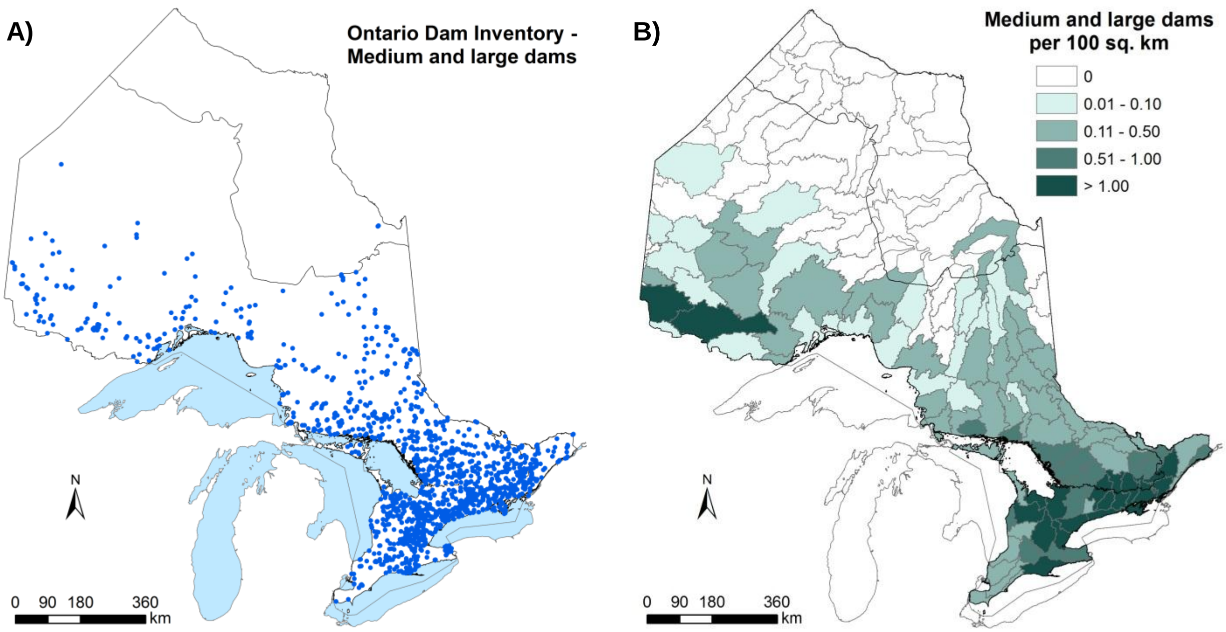

Figure 1: A) Location of medium and large dams in Ontario; B) Number of medium and large dams per 100 km^2 by tertiary watershed in Ontario (Ontario Dam Inventory 2014).

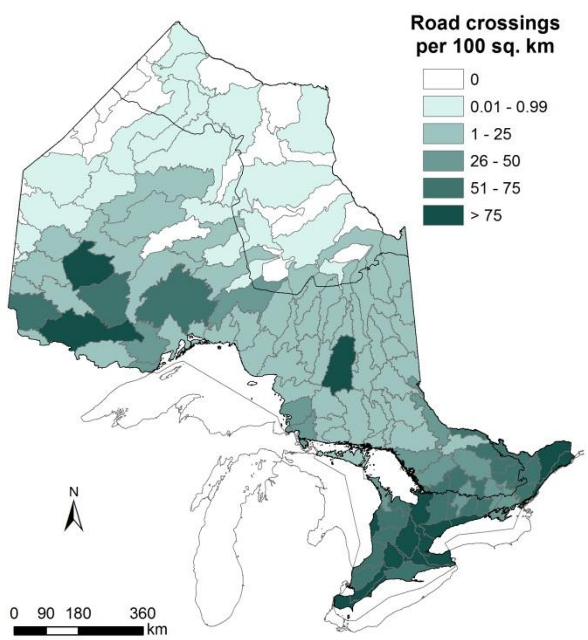

Figure 2: Number of road crossings per 100 km^2 by tertiary watershed.

Status:

- A total of 1,596 medium and large dams have been identified in Ontario. The density of medium and large dams is highest in the watersheds of the Mixedwood Plains Ecozone and the southern Ontario Shield Ecozone
- There are no medium and large dams in most tertiary watersheds in the Hudson Bay Lowlands Ecozone and some watersheds in the northern portion of the Ontario Shield Ecozone.
- There are more than 120,000 road crossings of streams in Ontario. The highest densities of crossings tend to be in the Mixedwood Plains Ecozone, but most of the Ontario Shield Ecozone also has significant densities of stream crossings.
- The majority of road crossings are on smaller streams where culverts are often used instead of bridges (78% of crossings are on 1st and 2nd order streams). Culverts can act as barriers to the movement of aquatic species. The number of culverts that act as barriers to aquatic species is unknown.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

SOLEC 2011 [Aquatic Habitat Connectivity – p. 34] http://binational.net/wp-content/uploads/2014/11/sogl-2011-technical-report-en.pdf

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Helfman, G. 2007. Fish conservation: a guide to understanding and restoring global aquatic biodiversity and fishery resources. Island Press, Washington, DC.

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INDICATOR: AQUATIC STRESS INDEX

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Habitat Loss

Background Information:

Habitat loss is a major threat to freshwater ecosystems globally (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). 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 watershed (e.g., urban subdivisions). Streams and lakes 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 Aquatic Stress Index from Chu et al. (2003, 2015) to represent the relative intensity and distribution of threats affecting aquatic habitats in Ontario. The Stress Index was developed to identify the intensity of human stressors for each tertiary watershed across Canada and incorporates information on population density, roads, industrial activity, agriculture and forestry. The Stress Index does not include dams, but does consider some factors that relate directly to pollution as opposed to direct habitat loss (e.g., waste facilities). Although the waters of the Great Lakes are not included in the Stress Index, coastal habitats and nearshore areas would be impacted by stresses in adjacent watersheds that have been assessed (Chu et al. 2014). Similar information on impacts to habitats within the Great Lakes is available through the Great Lakes Environmental Assessment and Mapping Project web site (GLEAM) and the Great Lakes Aquatic Habitat Framework web site (GLAHF).

Data Analysis:

Aquatic Stress Index values for this indicator are from the work of Chu et al. (2003, 2015). They estimated the stress placed on each watershed based on the distribution of stressors using census and business pattern data from Statistics Canada. Crop agriculture density, waste facilities, petroleum manufacturing, forestry, dwellings, discharge sites, and roads were selected for further analysis from a list of potential stressors. Values for the density of these stressors in each watershed were standardized by dividing each value by the maximum value across all watersheds. An overall watershed Stress Index was calculated (on a scale of 0-1) as the average of all the agricultural, industrial, and population stress values in each watershed.

Data for the 2003 Stress Index were from the 1996 Census and data for the 2013 Stress Index were from the 2006 Census. The change in the Stress Index between the two time periods was calculated as the simple difference between the 2013 and 2003 values for each watershed (Figure 1).

- download Aquatic Stress Index data

Results:

Trend: Mixed **Data Confidence:** Medium **Geographic Extent:** Provincial

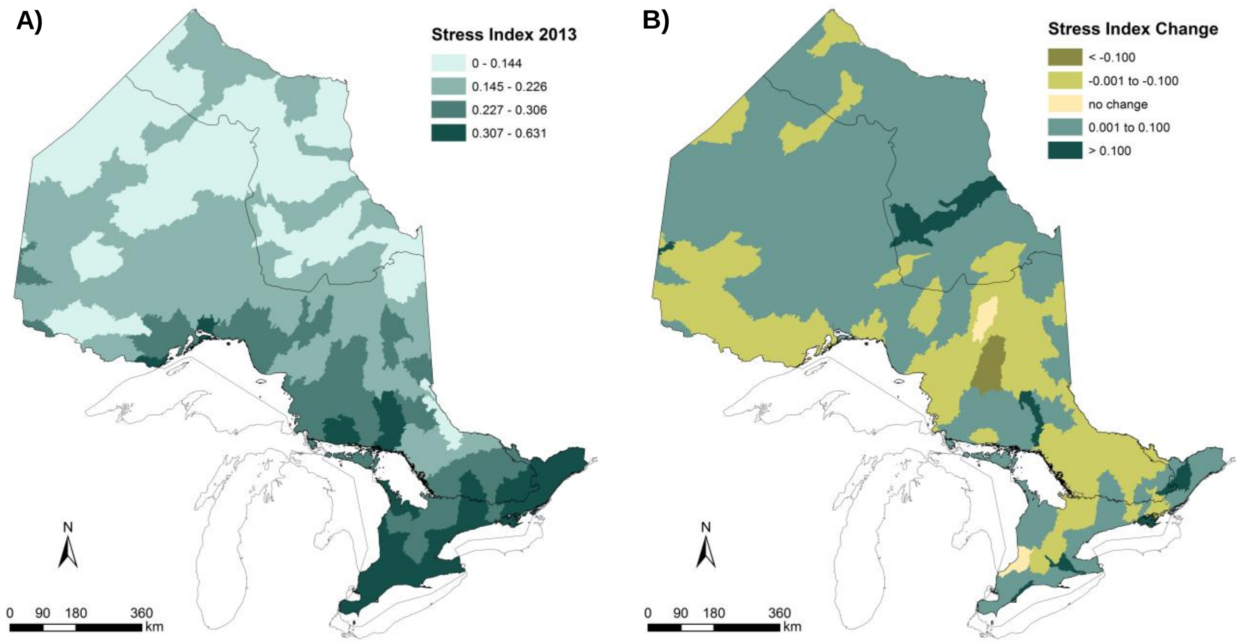

Figure 1. A) 2013 Stress Index for tertiary watersheds in Ontario based on Chu et al. (2015). Higher Stress Index scores represent a higher level of stress to aquatic ecosystems; B) Changes in Stress Index scores between 2003 and 2013 (negative values indicate reduced stress; positive values indicate increased stress).

Status:

- The average Stress Index for Ontario tertiary watersheds increased by 0.018 between 2003 and 2013, representing a 7.5% increase. The Stress Index increased for 90 watersheds (62%) and decreased for 53 watersheds (37%).
- 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. The Stress Index has increased in 73% of watersheds in this ecozone since 2003.
- 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. The Stress Index has increased in just over half (54%) of these watersheds since 2013
- Watersheds in the Hudson Bay Lowlands Ecozone have comparatively low Stress Index values, however the Stress Index in most of these watersheds (76%) has increased since 2003.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

SOLEC 2011 [Watershed Stressor Index – p. 514] http://binational.net/wp-content/uploads/2014/11/sogl-2011-technical-report-en.pdf

Great Lakes Environmental Assessment and Mapping Project http://greatlakesmapping.org/

Great Lakes Aquatic Habitat Framework http://ifr.snre.umich.edu/projects/glahf/

References:

Chu, C., M.A. Koops, R.G. Randall, D. Kraus, and S.E. Doka. 2014. Linking the land and the lake: a fish habitat classification for the nearshore zone of Lake Ontario. Freshwater Science 33:1159–1173.

Chu, C., C.K. Minns, N.P. Lester, and N.E. Mandrak. 2015. An updated assessment of human activities, the environment, and freshwater fish biodiversity in Canada. Canadian Journal of Fisheries and Aquatic Sciences 72: 135-148.

Chu, C., C.K. Minns, and N.E. Mandrak. 2003. Comparative regional assessment of factors impacting freshwater fish biodiversity in Canada. Canadian Journal of Fisheries and Aquatic Sciences 60:624–634.

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Indicator: Aquatic Alien Species in the Great Lakes

Strategic Direction: Reduce Threats

Target: N/A

Theme: Pressures on Ontario's Biodiversity – Invasive Species

Background Information:

Invasive species are one of the main threats to biodiversity at the global level and are a growing environmental and economic threat to Ontario (MEA 2005; OMNR 2012). Invasive species often act together with threats such as habitat loss and climate change to accelerate the loss of Ontario's biodiversity. Ontario's aquatic ecosystems have been particularly impacted by invasive species. Well-known examples of aquatic invasive alien species in Ontario include Round Goby, Zebra Mussel, Purple Loosestrife, and the European sub-species of Common Reed (*Phragmites*). The Great Lakes have a long and well-documented history of aquatic alien species invasions (Mills et al. 1993, Ricciardi 2006). The Great Lakes are also the entry point for many alien species that subsequently invade Ontario's inland lakes and streams.

This indicator summarizes the cumulative number of aquatic alien species in the Great Lakes and the rate at which introductions have occurred. Not all of these species are considered invasive – invasive species are those harmful alien species whose introduction or spread threatens the environment, the economy or society, including human health (OMNR 2012). Risk assessments to determine which species are invasive have not been completed for all alien species in the Great Lakes, so this indicator uses the number of alien species as an index of risks related to invasive species.

A companion indicator that provides an index of alien species in Ontario's inland lakes has also been developed. Comparable, comprehensive information on the distribution of terrestrial alien species and their introduction dates is not currently available, but is being assembled for the possible development of a terrestrial indicator.

Data Analysis:

The current list of alien species in the Great Lakes was downloaded from the Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS - NOAA 2014). Species included are not native to any part of the Great Lakes basin, but are established in the Great Lakes and connecting waters. The database includes information on the origin of species and the year that they were first collected. Species were grouped into five taxonomic categories (bacteria/viruses, protists, plants, invertebrates and fishes) and the cumulative number and number of invasions per decade were graphed (Figures 1, 2).

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. Additional alien species are likely present and have not yet been found. Concern regarding ecological impacts of alien species over the last two decades has resulted in increased surveillance effort during this period.

There has also been no overall assessment to determine which species have been harmful. Some species, such as Rainbow Trout and Pacific salmon are stocked and managed to provide continued economic and societal benefits. 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.

- Access GLANSIS database

Results:

Trend: Improvement **Data Confidence:** High **Geographic Extent:** Great Lakes

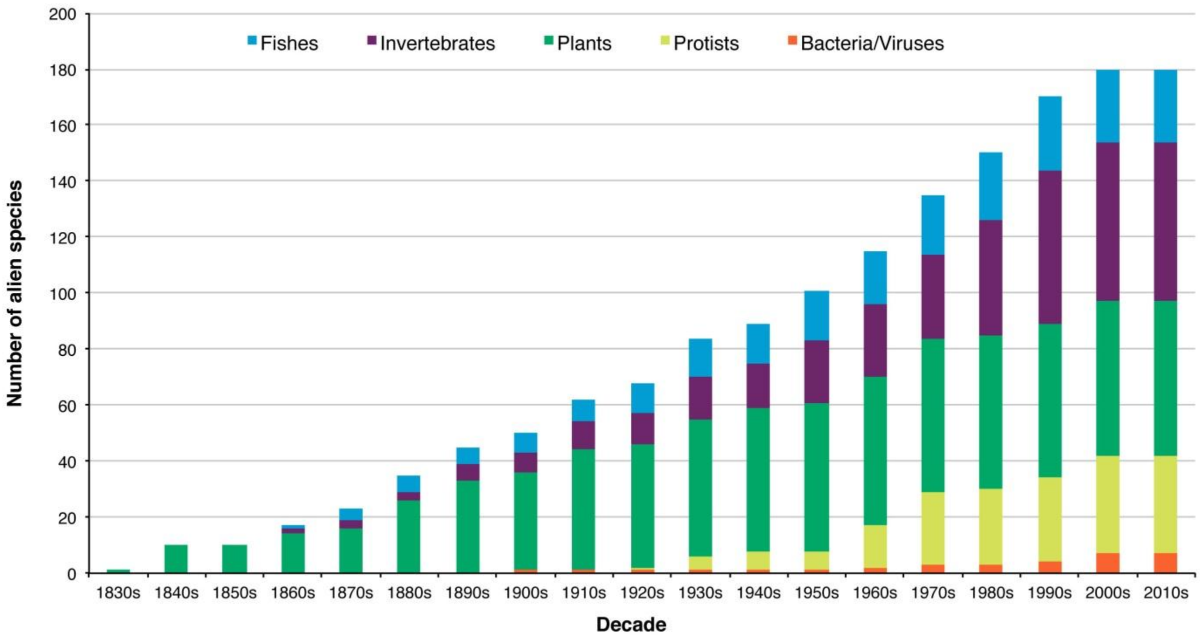

Figure 1. Cumulative number of aquatic alien species in the Great Lakes by decade (note: protists includes algae, diatoms and protozoans).

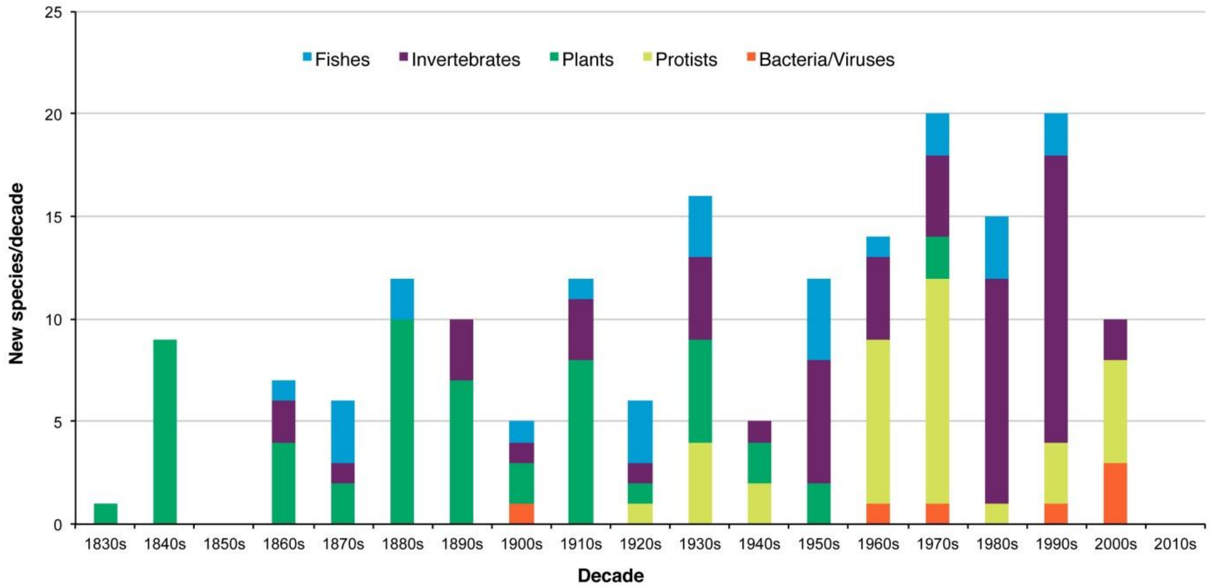

Figure 2. Number of new aquatic alien species discovered in the Great Lakes per decade.

Status:

- 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 2014, 180 alien species were present.
- The rate of new introductions increased up to decade ending in 1999. Between 1839 and 1950, 7.4 new species were discovered per decade. Between 1950 and 1999, the rate increased to 16.2 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.
- No new alien species have been discovered as established in the Great Lakes since 2006. The lack of new alien species discovered since 2006 may reflect a decrease in the invasion rate due to increased prevention efforts as well as the fact that accounting for the current decade is incomplete. No new fish species and a reduced number of invertebrate species have been detected since 2000.

Links:

Related Targets: 7. By 2015, strategic plans are in place to reduce threats posed to biodiversity by invasive species.

Related Themes: Pressures Ontario's Biodiversity – Invasive Species

Web Links:

Great Lakes Aquatic Nonindigenous Species Information System
http://www.glerl.noaa.gov/res/Programs/glansis/glansis.html

Ontario Ministry of Natural Resources and Forestry – Invasive Species
https://www.ontario.ca/environment-and-energy/how-government-combats-invasive-species#section-8

Ontario Federation of Anglers and Hunters – Invading Species Awareness Program
http://www.invadingspecies.com/

Ontario Invasive Plant Council http://www.ontarioinvasiveplants.ca/

Invasive Species Centre http://www.invasivespeciescentre.ca/SitePages/default.aspx

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Mills, E.L., J.H. Leach, J.T. Carlton, and C.L. Secor. 1993. Exotic species in the Great Lakes; a history of biotic crises and anthropogenic introductions. Journal of Great Lakes Research 19:1-54.

National Oceanic and Atmospheric Administration (NOAA). 2014. Great Lakes Aquatic Noninidigenous Species Information System. [Available at: http://www.glerl.noaa.gov/res/Programs/glansis/glansis.html (Accessed September 29, 2014)]

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INDICATOR: ALIEN SPECIES IN INLAND LAKES

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Invasive Alien Species

Background Information:

Invasive species are one of the main threats to biodiversity at the global level and are a growing environmental and economic threat to Ontario (MEA 2005; OMNR 2012). Invasive species often act together with threats such as habitat loss and climate change to accelerate the loss of Ontario's biodiversity. Ontario's aquatic ecosystems have been particularly impacted by invasive species. Well-known examples of aquatic invasive species in Ontario include Round Goby, Zebra Mussel, Purple Loosestrife, and the European sub-species of Common Reed (*Phragmites*).

The State of Ontario's Biodiversity 2010 report (Ontario Biodiversity Council 2010) included an indicator on aquatic alien species in the Great Lakes (updated for 2015) as an index of pressure related to invasive species, but there were no comprehensive data to develop an alien species indicator for inland lakes. A Broad-Scale Monitoring Program of lakes was established in 2008 to assess the current state of fishes and other aquatic resources, identify stresses on these resources, and report on changes over time. The program monitors a subset of lakes across the province on 5-year cycles to provide information critical to effective fisheries management.

This indicator uses information on alien species detected in the Broad-Scale Monitoring Program as an index of the number and distribution of alien species in inland lakes in Ontario. Not all of these species are considered invasive – invasive species are those harmful alien species whose introduction or spread threatens the environment, the economy or society, including human health (OMNR 2012). Risk assessments to determine which species are invasive have not been completed, so this indicator uses the number of alien species as an index of risks related to invasive species. The current assessment is the first time this indicator has been assessed. Future assessments will allow an analysis of trends as the Broad-Scale Monitoring cycle is repeated every 5 years. Further details regarding the development of this indicator are available in a separate technical report (Dextrase et al. 2015).

Data Analysis:

The first 5-year cycle of the Broad-scale Monitoring program (2008-2012) provided information on the fish and invertebrate communities for 721 Ontario inland lakes (5-250,000 ha in area). Sampling included the use of small mesh and large mesh gillnets to capture fishes and hauls with zooplankton nets to capture invasive invertebrates such as larval Zebra Mussel and Spiny Water Flea (OMNR 2012). Lists of species caught in each lake were examined to determine if alien species were detected and the number of alien species detected in each lake. Alien species included species not native to Ontario (e.g., Round Goby, Zebra Mussel) and species native to Ontario that have been introduced beyond their natural range limits (e.g., Smallmouth Bass, Rainbow Smelt). Natural ranges of species native to Ontario were determined by examining range maps in *The ROM Field Guide to Freshwater Fishes in Ontario*

(Holm et al. 2009) supplemented with Fisheries Management Zone Plans and background documents (OMNRF 2014). For each Fisheries Management Zone, the percentage of sampled lakes where alien species were detected and the mean number of alien species per sampled lake were calculated and mapped (Figure 1).

- download alien species summary data by Fisheries Management Zone

Results:

Trend: Baseline **Data Confidence:** High **Geographic Extent:** Provincial

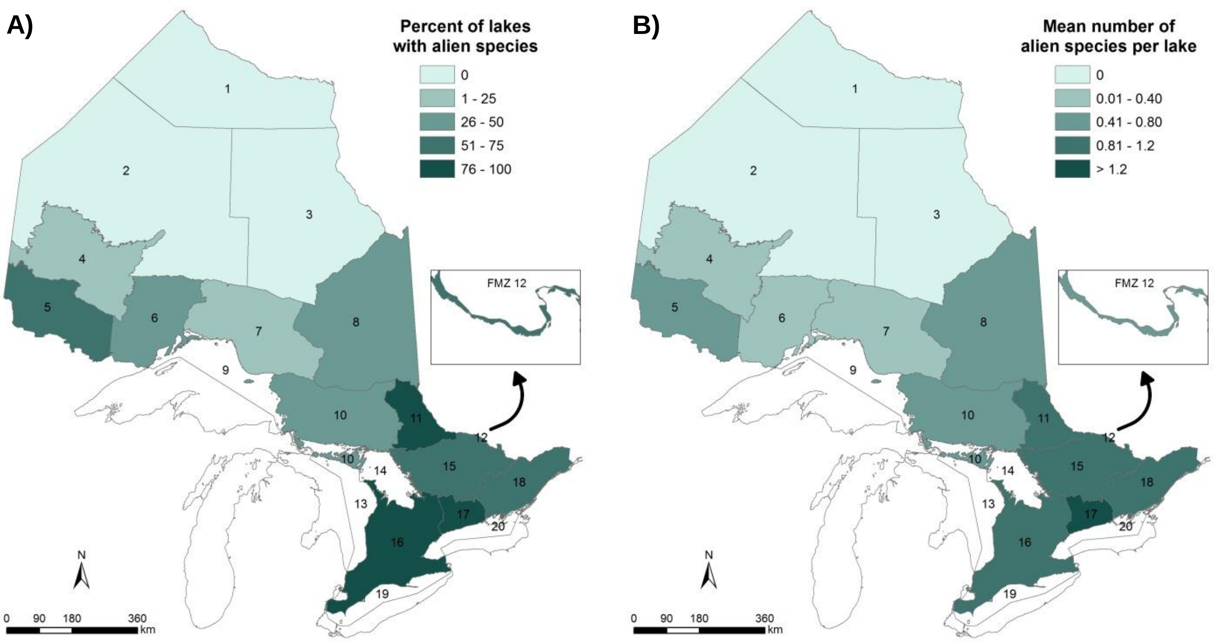

Figure 1. A) Percent of sampled lakes with alien species detections in each Fisheries Management Zone, 2008-2012; B) Mean number of alien species detected per sampled lake in each Fisheries Management Zone, 2008-2012 (total number of lakes = 721; source: Broad-scale Monitoring of lakes; Dextrase et al. 2015).

Status:

- Alien species were detected in 333 of the 721 lakes sampled (46%) in the first 5-year cycle of the Broad-scale Monitoring program.
- Ten alien fish species were detected – Smallmouth Bass (200 lakes) and Rainbow Smelt (49 lakes) were the most commonly encountered. Four alien invertebrate species were detected – Spiny Water Flea (57 lakes) and Zebra Mussel (54 lakes) were found in the most lakes.
- Fisheries Management Zones 16 and 17 in the Mixedwood Plains Ecozone and Fisheries Management Zone 11 had the highest proportion of lakes with alien species (> 75%). No alien species were detected in the 22 lakes sampled in Fisheries Management Zones 1-3 in the northern part of the province.

- The mean number of detected alien species per lake in each Fisheries Management Zone ranged from 0 to 2.3 species per lake (average of 0.63 species per lake) and increased from north to south.

Links:

Related Targets: 7. By 2015, strategic plans are in place to reduce threats posed to biodiversity by invasive species.

Related Themes: N/A

Web Links:

Fish Ontario – Broad-scale Monitoring of lakes program https://www.ontario.ca/environment-and-energy/methods-monitoring-fish-populations

References:

Holm, E., N.E. Mandrak, and M.E. Burridge. 2009. The ROM field guide to freshwater fishes of Ontario. Royal Ontario Museum, Toronto, ON.

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Ontario Ministry of Natural Resources and Forestry (OMNRF). 2014. Fisheries management zones. Ontario Ministry of natural Resources and Forestry, Queen's Printer for Ontario, Peterborough, ON. [Available at: https://www.ontario.ca/environment-and-energy/fisheries-management-zones]

Citation
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INDICATOR: RELEASE OF POLLUTANTS HARMFUL TO BIODIVERSITY

STRATEGIC DIRECTION: Reduce Threats

TARGET: 8. By 2015, the release of pollutants harmful to biodiversity is reduced.

THEME: Pressures on Ontario's Biodiversity

Background Information:

The release of pollutants into the air and water and onto the land can have significant effects on biodiversity. Pollutants can kill organisms outright, change the conditions and processes occurring within an ecosystem, and result in broad changes that degrade habitats and ecosystem services. Biodiversity associated with areas used intensively by humans (e.g., urban areas, agriculture, forestry, mining, and other industries) may be most at risk from pollution; however, non-point-based effects of pollution on biodiversity (e.g., downstream water pollution and downwind air pollution) can also be significant. Currently, a wide range of pollutants interact with natural and other human created factors to alter ecosystems and impact Ontario's biodiversity. Three pollutants in particular - nitrogen oxides, sulphur oxides and mercury - have all been shown to impact on biodiversity in Ontario and were used in this indicator as an index to examine trends the release of pollutants harmful to biodiversity.

Nitrogen and sulphur oxides are primarily released into the air by fossil fuel combustion and these gases can be transformed in the atmosphere to acidic particles and acidic rain (Driscoll et al., 2001). The effects of nitrogen and sulphur oxides on the environment are generally not caused by direct exposure to the gases themselves, but are related to chronic accumulation in plants and soils and long-term changes in soil and water chemistry (Lovett et al. 2009). Nitrogen and sulphur oxides in the air can damage the leaves of plants, decrease their ability to produce food – photosynthesis – and decrease their growth. In addition, when deposited on land and in estuaries, lakes and streams, nitrogen and sulphur oxides can acidify and over fertilize sensitive ecosystems resulting in a range of harmful deposition-related effects on plants, soils, water quality and fish and wildlife (e.g., loss of habitat, reduced tree growth, loss of fish species, and harmful algal blooms) (Lee 1998; Bobbink and Lamers 2020). This can result in an overall loss of biodiversity and subsequent reduction in ecosystem services (e.g., water quality, soil quality and species diversity) (Aherne and Posch 2013). These impacts are likely to occur where the accumulation of nitrogen and sulphur crosses a threshold known as the critical load. For more than a decade, Canada has worked to reduce nitrogen and sulphur oxides by implementing the Canada-wide Acid Rain Strategy for Post-2000.

Mercury is a highly toxic element released primarily from coal combustion, waste incineration and industrial processes (Lovett et al. 2009). Mercury, primarily methylmercury, is quickly accumulated by aquatic species and causes adverse effects. Biomagnification of mercury up the food chain has been shown, especially in aquatic systems where predators at the top of the food chain accumulate the highest concentrations of mercury (Lovett et al. 2009). There has been increasing recognition that mercury affects fish and wildlife health, in ecosystems both severely and moderately polluted with mercury. In particular, studies have documented diminished reproductive success, behavioural changes and reduced survival of fish, fish-eating birds and mammals due to mercury contamination in aquatic ecosystems (Scheuhammer et al. 2007). There has been effort to reduce the amount of mercury released into the environment. Most recently, Canada became a signatory to the Minamata Convention on Mercury, a global treaty to protect both human health and the environment from the adverse effects of mercury.

This indicator assesses trends in the release of nitrogen oxides, sulphur oxides and mercury in Ontario as an index of trends in the release of pollutants harmful to biodiversity in Ontario.

Data Analysis:

Data on the release of nitrogen oxides, sulphur oxides and mercury over the period 2002-2013 were obtained from the National Pollutant Release Inventory (NPRI). The NPRI is Canada's legislated, publicly accessible inventory of pollutant releases to air, water and land. It includes information reported by facilities to Environment Canada under the Canadian Environmental Protection Act, 1999, and air pollutant emission estimates compiled for facilities not required to report and non-industrial sources such as motor vehicles, residential heating, forest fires and agriculture. The NPRI database can be accessed at: https://www.ec.gc.ca/inrp-npri/.

Results:

Trend: Improvement	**Data Confidence:** High	**Geographic Extent:** Provincial

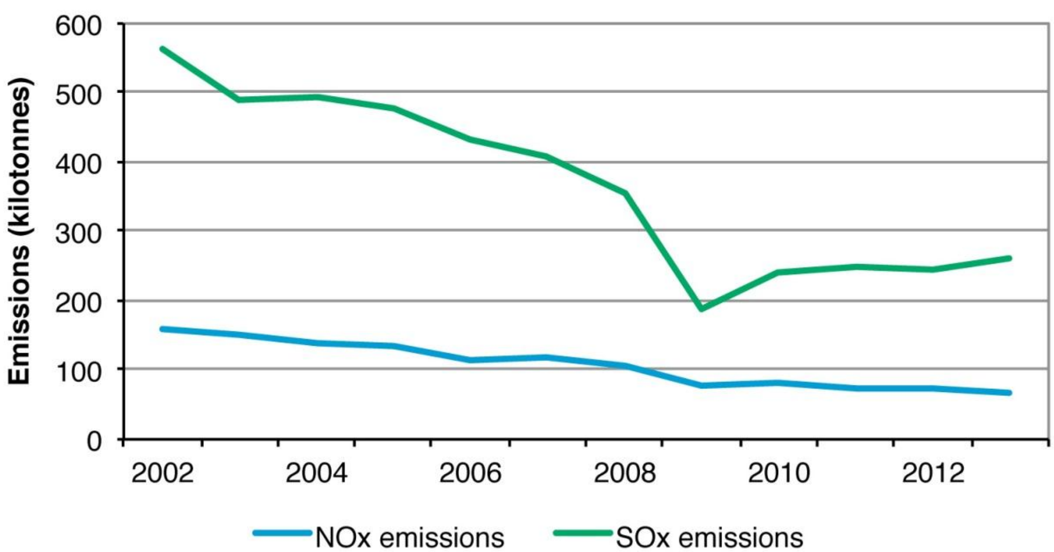

Figure 1. Nitrogen (NO_x) and sulphur oxide (SO_x) emissions in Ontario 2002-2013. Note: Emissions from natural sources and open sources are not included (Source NPRI Database).

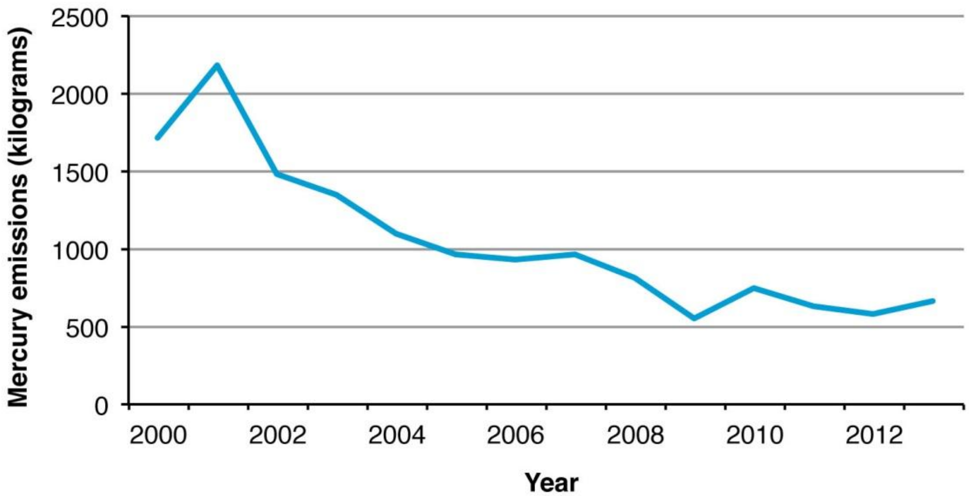

Figure 2. Mercury emissions in Ontario 2000-2012 (Source NPRI Database).

Status:

- Between 2002 and 2013 nitrogen oxide (NO_x) emissions in Ontario decreased by 54%. This decline can be attributed to a reduction in emissions from electricity generation as a result of regulation and domestic and international agreements. Decreases also occurred from industry as a whole.
- Between 2002 and 2013 sulphur oxide (SO_x) emissions in Ontario decreased by 57%. These reductions were largely due to reductions in emissions from fossil-fuel (e.g. coal) fired power-generating utilities, plant closures, as well as a reduction in emissions from the petroleum refining sector.
- Between 2000 and 2013 mercury emissions in Ontario decreased by 62%, mainly due to a reduction of emissions from industrial sources, including metal smelters.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

National Pollutant Release Inventory https://www.ec.gc.ca/inrp-npri/

References:

Aherne, J., and M. Posch. 2013. Impacts of nitrogen and sulphur deposition on forest ecosystem services in Canada. Current Opinion in Environmental Sustainability 5:108-115.

Bobbink, R., and L.P.M. Lamers. 2002. Effects of increased nitrogen deposition. *In*: Bell, J.N.D., and M. Treshow (eds). Air pollution and plant life, 2nd edition. John Wiley and Sons Ltd, Chichester, U.K.

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Scheuhammer, A.M., M.W. Meyer, M.B. Sandheinrich, and M.W. Murray. 2007. Effects of environmental methylmercury on the health of wild birds, mammals, and fish. AMBIO: A Journal of the Human Environment 36: 12-16.

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INDICATOR: GROUND-LEVEL OZONE

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity

Background Information:

Ground-level ozone is a secondary pollutant, formed by chemical reactions between nitrogen oxides and volatile organic compounds in the presence of heat and sunlight. Nitrogen oxides are emitted by natural sources and by human sources such as cars, trucks, and industrial plants. Volatile organic compounds may be emitted by natural sources, such as plants and trees, or by human activities. In addition to having impacts on human health, there is substantial evidence that ground-level ozone can have significant impacts on biodiversity. The most important and well documented impacts are reported for terrestrial vegetation with reductions in crop production, tree growth, and changes in species composition observed (Hayes et al. 2007; Wittig et al. 2009), all of which have downstream consequences for ecosystem services (Royal Society 2008). Evidence suggests that these impacts are likely to occur where ozone concentrations are above a threshold of 40 ppb, a limit which is currently exceeded in most countries around the world, including Canada (Royal Society 2008; Environment Canada 2014).

This indicator is used to assess trends in the seasonal means of ground-level ozone at sites across Ontario, as well as the annual peak (4th-highest) daily maximum 8-hour concentration.

Data Analysis:

Data to assess trends in the seasonal means of ground-level ozone concentrations in Ontario from 1980 to 2012 (Fig. 1) were obtained from the Air Quality in Ontario Reports 2007 and 2012 (OMOE2008; OMOECC 2014). Seasonal means were based on data from several ozone monitoring stations operated across Ontario. A 75% data completeness criterion was used to derive trends. Ozone long-term trends were derived from 19 sites for 1980 to 2007 (OMOE 2008) and from 37 sites from 2003 to 2012 (OMOECC 2014). The stations were largely based in metropolitan areas in Ontario.

Data used to assess annual peaks (4th highest) for daily maximum 8-hour ground-level ozone concentration from 1998 to 2012 (Fig. 2) were obtained from the Canadian Environmental Sustainability Indicator Report 2014 (Environment Canada 2014) which includes data from National Air Pollution Surveillance Program (NAPS) and the Canadian Air and Precipitation Monitoring Network (CAPMoN). The annual peaks for ground-level ozone are calculated using an approach that is aligned with the Canadian Ambient Air Quality Standards (CAAQS). Annual peaks are based on data collected from 34 monitoring stations in southern Ontario. Peaks are based on the 4th-highest of the daily maximum 8-hour average concentrations measured over a given year. Annual peaks for Ontario were obtained for this indicator by averaging all the 4th-highest values from stations in this region.

- Link to Environment Canada Data

Results:

Trend: Mixed **Data Confidence:** High **Geographic Extent:** Provincial

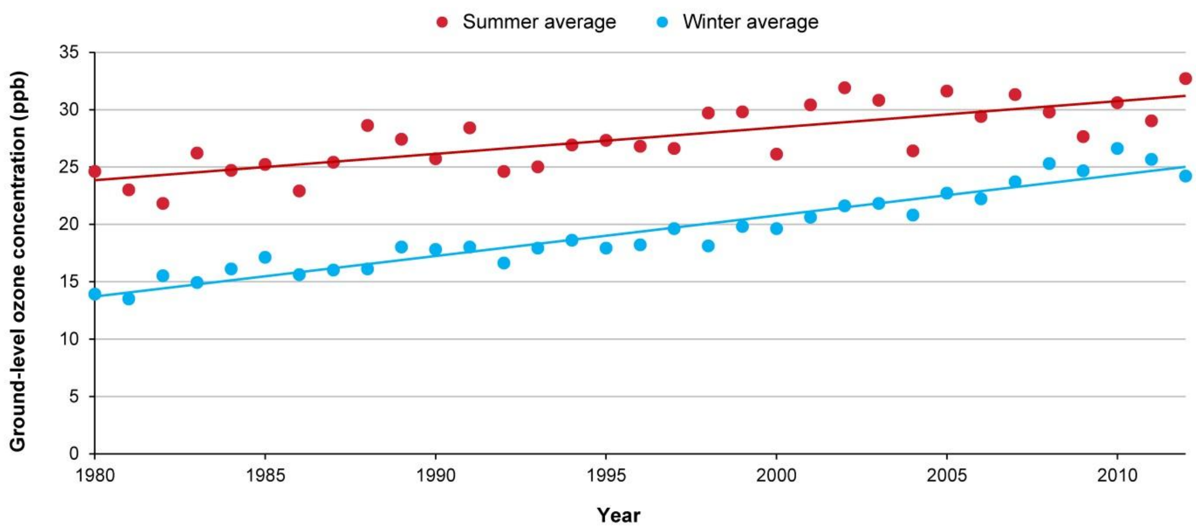

Figure 1. Seasonal means of ground-level ozone at sites across Ontario 1980-2012 (Source: OMOECC 2008 and 2014).

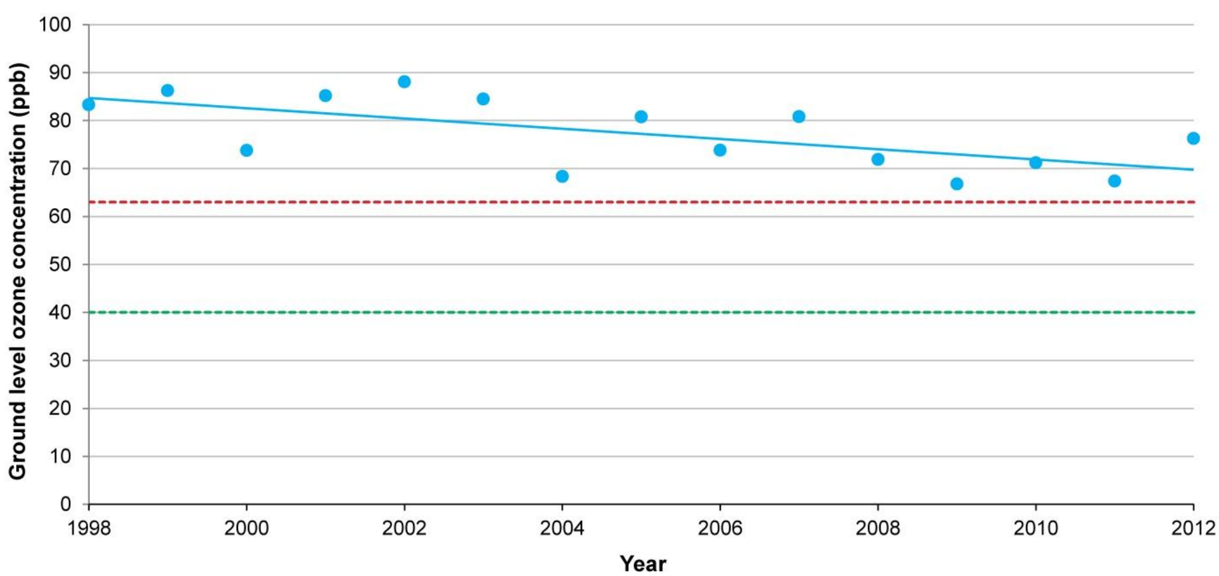

Figure 2. Annual peak (4th-highest) daily maximum 8-hour ground-level ozone concentration at sites across Ontario 1998-2012 (*n* = 34) (Source: Environment Canada 2014) (Note: The red horizontal dashed line represents the value of the Canadian Ambient Air Quality Standards (CAAQS) for 2015 and is shown for indicative purposes only, and not for evaluation of the achievement status of the standard. The green horizontal dashed line represents the environmental threshold above which impacts are likely on vegetation (Royal Society 2008)).

Status:

- Between 1980 and 2012 seasonal means of ground-level ozone in Ontario increased in both the summer and winter seasons. However, during the past 10 years the trend in summer means has remained constant, while the winter means increased by 16% over the same 10-year period. The increase in ozone winter means is mainly attributed to rising global background concentrations.
- A decreasing trend was detected in the annual peak concentrations of ground-level ozone from 1998 to 2012, representing a decrease of 17% (or an average of 1.2% per year) over that period. A reduction in emissions of ground-level ozone precursor gases (nitrogen oxides and volatile organic carbons) from Canada and the United States is likely an important factor in this downward trend. However, the annual peak ground-level ozone concentrations were above the 2015 CAAQS and environmental threshold for all years.

Links:

Related Targets: 8. By 2015, the release of pollutants harmful to biodiversity is reduced.

Related Themes: N/A

Web Links:

Canadian Environmental Sustainability Indicators http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En

Ontario Ministry of Environment and Climate Change Air Quality Reports http://www.airqualityontario.com/press/publications.php

National Air Pollution Surveillance Program (NAPS) http://www.ec.gc.ca/rnspa-naps/

Canadian Air and Precipitation Monitoring Network (CAPMoN) https://www.ec.gc.ca/rs-mn/default.asp?lang=En&n=752CE271-1

Canadian Ambient Air Quality Standards (CAAQS) http://www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=A4B2C28A-2DFB-4BF4-8777-ADF29B4360BD

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INDICATOR: WATER QUALITY IN INLAND LAKES

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Pollution

Background Information:

Lakes and streams have a very important role in sustaining biodiversity (Environment Canada 2008). Along with aquatic species, many birds, amphibians and invertebrates depend on freshwater bodies at some point in their life-cycle. Ontario has more than 225,000 lakes greater than 1 hectare in area (Cox 1978). Most of these lakes are found in relatively natural settings and their water chemistry reflects the geology of the surrounding landscape and inputs from inflowing streams. Pollution alters the water quality of lakes directly from point sources (industrial waste, wastewater from urban and suburban development), non-point sources (runoff) and indirectly from airborne pollution deposits.

In 2008, Ontario initiated the Broad-Scale Monitoring Program of lakes to assess the current state of fishes and other aquatic resources, identify stresses on these resources, and report on changes over time. The program monitors lakes (20 - 250,000 ha in size) across the province on 5-year cycles to provide information critical to effective fisheries management, including water quality.

This indicator provides an assessment of water quality in Ontario's inland lakes by examining three parameters that have a strong influence on aquatic biodiversity – pH, and concentrations of calcium and total phosphorus. This initial assessment of lake water quality, based on the first 5-year cycle of sampling, compares measured levels to those that can impact biodiversity (Table 1). Trends will be assessed in this indicator after subsequent cycles of Broad-Scale Monitoring have been completed.

Table 1. Lake water quality parameters used in indicator assessment.

Parameter	Relevance to biodiversity[1]
pH	pH is a measure of the concentration of hydrogen ions in the water. Acidic water below pH 6.5 and basic water above 8.5 can cause problems for aquatic life (MOEE 1994). pH levels can be affected by industrial effluents and runoff or atmospheric deposition (acid rain).
Calcium	Calcium is a mineral that organisms require to survive. Low levels of calcium (< 1.5 mg/L) can cause problems for small planktonic crustaceans and affect the food chain. There is recent evidence of widespread calcium declines in many lakes including in Ontario (Jeziorski 2008, OMOE 2013). Calcium rich lakes (> 20 mg/L) with high pH (> 7.4) are most vulnerable to invasion by Zebra Mussel (Neary and Leach 1992).
Total Phosphorus	Phosphorus is an important nutrient in lakes. However, too much phosphorus can lead to blue-green algal blooms and excessive plant growth that reduces oxygen levels in lakes. These impacts are generally avoided when total phosphorus levels are below 20 µg/L (MOEE 1994).

[1] some lakes may naturally have water quality values that are beyond the threshold levels that can have impacts on biodiversity (e.g., low pH, high phosphorus).

Data Analysis:

During the first 5-year cycle of Broad-Scale Monitoring of lakes (2008-2012), water quality samples were collected from 827 lakes across Ontario using a standard protocol (unpublished, modified from Ingram et al. 2011). All samples were analyzed at the Ministry of the Environment and Climate Change laboratory in Dorset, Ontario. The majority of sampled lakes were in the Ontario Shield Ecozone (768 lakes or 93%). Only 5 lakes from the Hudson Bay Lowlands Ecozone were sampled. Sampled Lakes include only lakes greater than 5 hectares in area, so the more numerous smaller lakes are not represented in the indicator.

Three water quality parameters that have a strong influence on biodiversity in Ontario's lakes were included in this indicator – pH, calcium and total phosphorus. For each water quality parameter, lakes were mapped showing their status with respect to levels that can have impacts on aquatic biodiversity (Figure 1). In addition to mapping the status of the water quality parameters for each lake, the status of lakes was summarized by ecozone (Figure 1).

It is important to note that some lakes may naturally have water quality values that are beyond the threshold levels that can have impacts on biodiversity (e.g., low pH, high phosphorus). It will be important to assess the trends in these key water quality parameters as successive 5-year cycles of the Broad-Scale Monitoring Program are completed. Additional information of the water quality of Ontario's inland lakes is available from sampling conducted by the Ministry of Environment and Climate Change and its Lake Partner Program, as well as the Ontario Geological Survey.

- download BSM lake water quality data (summaries by ecozone, individual lakes)

Results:

Trend: Baseline **Data Confidence:** High **Geographic Extent:** Provincial

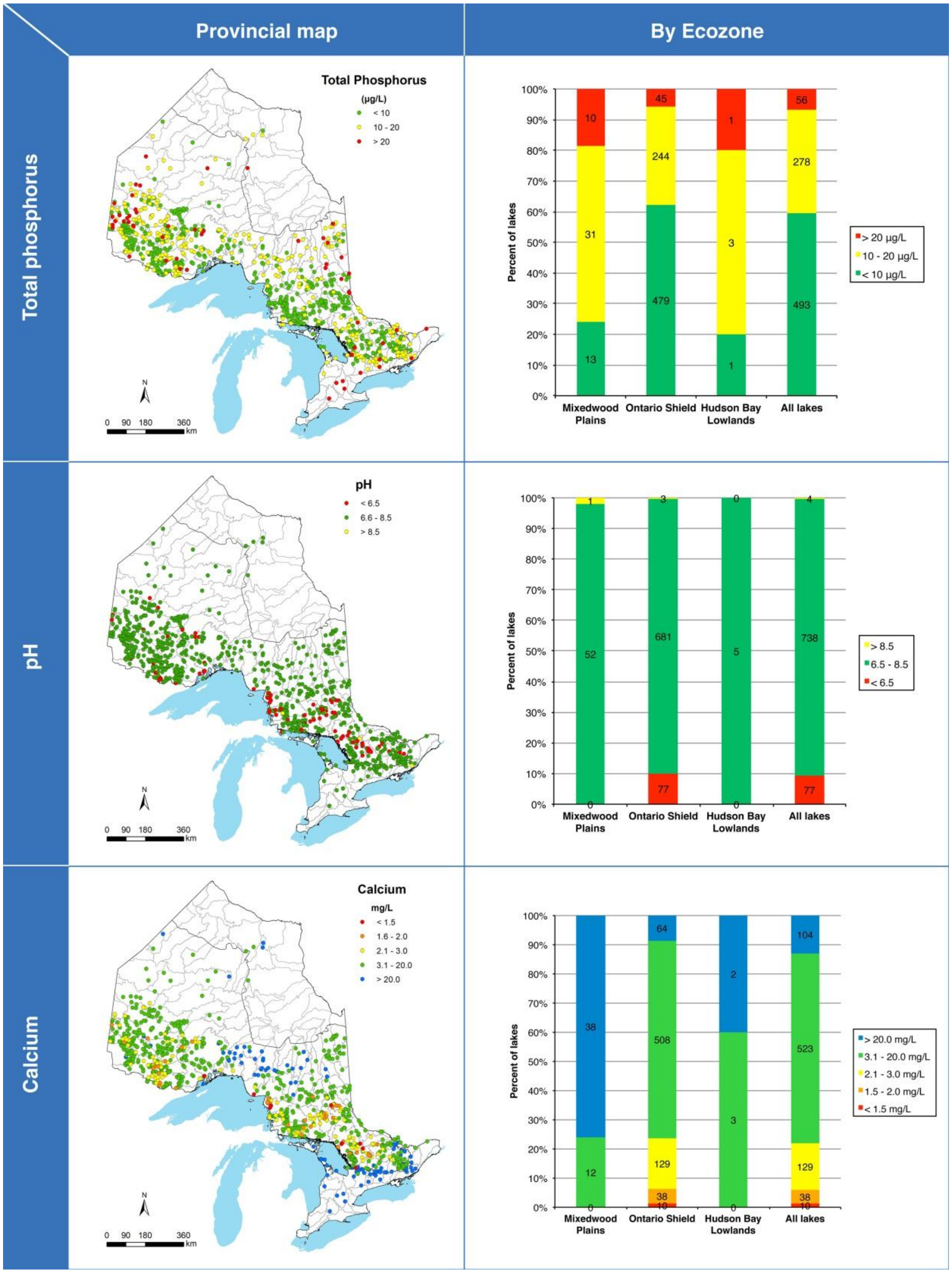

Figure 1. Status of total phosphorus, pH and calcium levels in Ontario lakes sampled from 2008-2012 (*n* = 827).

Status:

- More than 90% of sampled lakes are below the recommended level of 20 µg/L for total phosphorus above which algal blooms and excessive plant growth can occur. The majority of sampled lakes in the Ontario Shield Ecozone (62%) have low levels of total phosphorus (< 10 µg/L).
- More than 90% of sampled lakes had pH values within the 6.5-8.5 range recommended for the protection of aquatic life. All 77 lakes with low pH (< 6.5) are found in the Ontario Shield Ecozone.
- Only 10 of the sampled lakes (1%) had critically low calcium levels (< 1.5 mg/L), but 21% had calcium levels close to this threshold (1.5 – 3.0 mg/L). All of these lakes are in the Ontario Shield Ecozone where calcium levels are naturally low in most areas and there is a concern because of declining calcium levels in soils and aquatic ecosystems.
- Most lakes in the Mixedwood Plains Ecozone (76%) are calcium rich (> 20 mg/L) and are therefore more vulnerable to Zebra Mussel invasion. Calcium rich lakes also occur in the northern part of the Ontario Shield Ecozone and the Hudson Bay Lowlands Ecozone. All but three of the 102 calcium rich lakes also have pH values (>7.4) conducive to supporting Zebra Mussel.

Links:

Related Targets: 8. By 2015, the release of pollutants harmful to biodiversity is reduced.

Related Themes: N/A

Web Links :

MOECC – Dorset Environmental Science Centre http://desc.ca/

Lake Partner Program http://desc.ca/programs/lpp

Ontario Geological Survey data http://www.geologyontario.mndm.gov.on.ca/

References:

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Jeziorski, A., and 14 co-authors. 2008. The widespread threat of calcium decline in freshwaters. Science 322:1374-1377

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INDICATOR: WATER QUALITY IN STREAMS

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Pollution

Background Information:

Water quality has a major influence on the biodiversity of freshwater systems. Water quality in streams is influenced by climate, geology of the watershed, flow regime and land use (Metcalfe et al. 2013). Water quality can also be affected directly by the discharge and of substances in effluents or their application on the landscape. Along with aquatic species, many birds, amphibians and invertebrates are dependent upon freshwater bodies at some point in their life-cycle. Hence, the water quality of 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 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. A recent review of water quality status and trends for Ontario (OMOE 2013) concluded that there have been some improvements, but that continued efforts were necessary to protect and restore water quality in the province.

This indicator provides an assessment of trends in water quality of Ontario streams by examining three parameters that have a strong influence on stream biodiversity – chloride, nitrates and total phosphorus. High levels of chloride ions can result from the use of de-icing road salts and dust suppressants and are toxic to aquatic life (CCME 2011). Excessive nitrates can arise in streams from nitrogen inputs related to industrial and municipal wastewater and urban and agricultural runoff. High levels of nitrates can be toxic to aquatic life and can promote algal blooms (CCME 2012). High phosphorus levels can cause excessive plant growth that can in turn reduce oxygen levels (MOEE 1994). Chloride and nitrate levels from Ontario streams are assessed against long-term exposure thresholds from the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 2011, 2012). Total phosphorus levels are assessed against the threshold to prevent excessive plant growth from the Interim Provincial Water Quality Objectives (MOEE 1994, Table 1).

Table 1. Threshold levels for water quality parameters used in indicator assessment.

Parameter	Threshold
Chloride	120 mg Cl^- / L
Nitrates	3.0 mg NO_3^- / N·L
Total Phosphorus	0.03 mg P / L

Data Analysis:

Stream water quality data from the Provincial Water Quality Monitoring Network (PWQMN) for two 5-year periods (2003-2007 and 2008-2012) were downloaded from Ontario's Open Data Catalogue (see link below). Five-year median concentrations (middle values) of total chloride, total nitrates and total phosphorus were calculated for each station using results from samples collected between April and November. Samples collected between the months of December and March were excluded from the median calculations to ensure comparability among stations as only a portion of the stations have winter sampling. Median concentrations for stations with a minimum of 10 samples over the 5-year period were included in further analyses.

For each time period, stations were mapped showing whether median values were above or below thresholds for each water quality parameter (Figure 1). Stations with median values above the threshold value have levels higher than the threshold in at least half of the samples taken at the site. In addition to mapping all of the stations, the proportion of stations above threshold values was summarized by ecozone (Figure 2) and stations that were sampled in both time periods (n = 361) were compared to examine trends (Figure 3).

It is important to note that the PWQMN is designed to provide coverage in populated areas of Ontario, or areas where land uses may be affecting water quality. The network relies heavily on Conservation Authority partners for sample collection. The majority of stations are therefore found in the Mixedwood Plains Ecozone of southern Ontario.

- download PWQMN stream water quality data

Results:

Trend: Mixed **Data Confidence:** High **Geographic Extent:** Mixedwood Plains/Ontario Shield ecozones

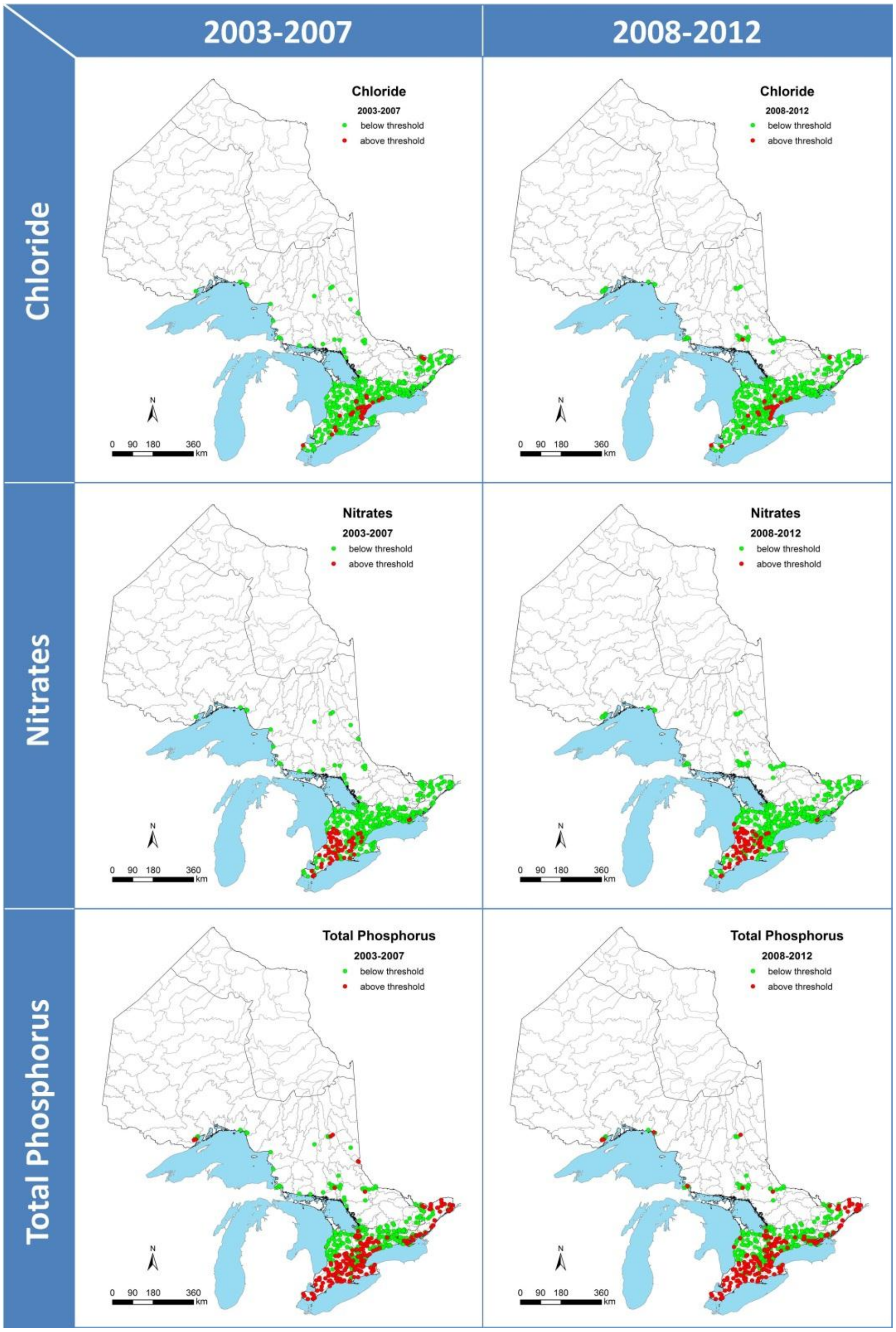

Figure 1. Status of median chloride, nitrate and total phosphorus levels against thresholds for supporting aquatic life for Ontario streams sampled during 2003-2007 (*n* = 404) and 2008-2012 (*n* = 431).

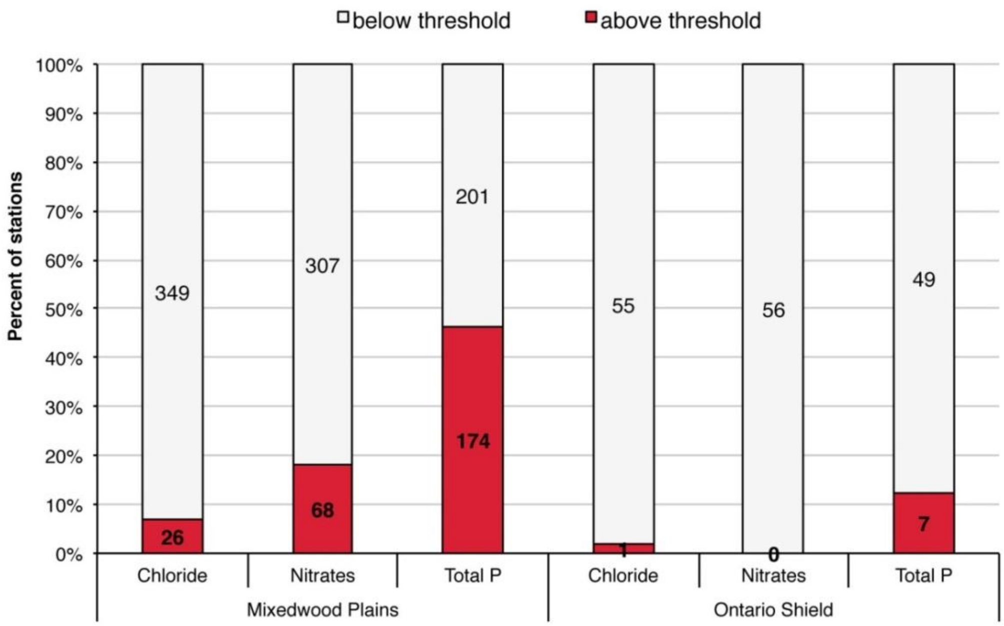

Figure 2. Proportion of water quality stations above thresholds in each ecozone for Ontario streams sampled during 2008-2012 (*n* = 431) [numbers on chart are the number of stations in each category].

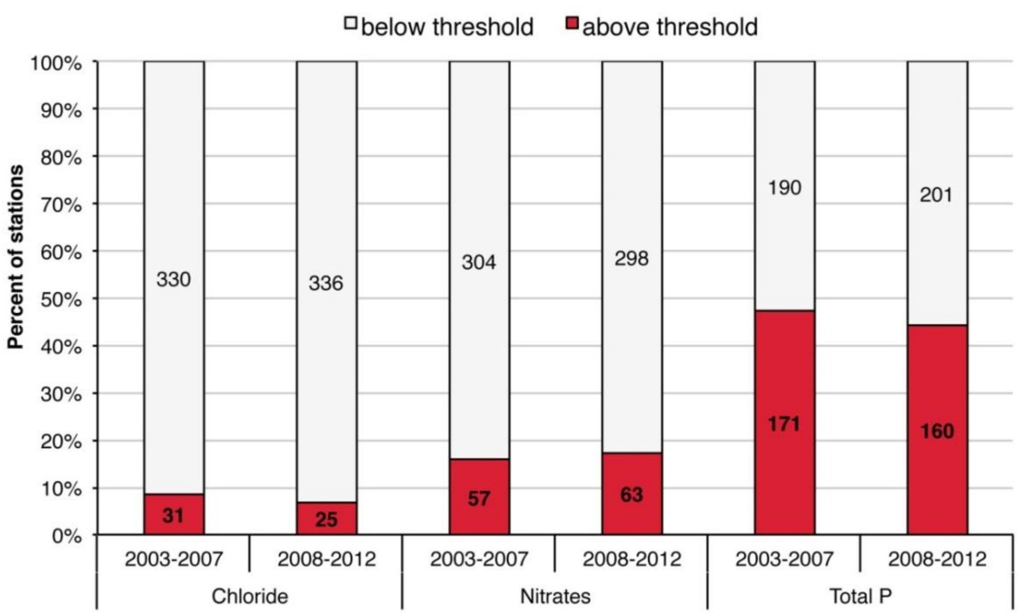

Figure 3. Proportion of water quality stations above thresholds for Ontario streams sampled during 2003-2007 and resampled during 2008-2012 (*n* = 361) [numbers on chart are the number of stations in each category].

Status:

- Median chloride levels were below thresholds at more than 90% of stations during both time periods and there was a small decrease between time periods. Most stations with chloride levels above long-term exposure thresholds are in or adjacent to urban areas.
- Median nitrate levels were above thresholds at 15-16% of stations with a slight increase between time periods. Stations above threshold levels are concentrated in southwestern Ontario.
- Median total phosphorus levels were above thresholds at almost half of stations (42-47%) with a slight decrease between time periods. Stations with excessive phosphorus were distributed across the sampled area.
- Water quality at stations in the Ontario Shield Ecozone was consistently better than in the Mixedwood Plains Ecozone where urban and agricultural land use is more prevalent.

Links:

Related Targets: 8. By 2015, the release of pollutants harmful to biodiversity is reduced.

Related Themes: N/A

Web Links:

Ontario Ministry of Environment and Climate Change - Provincial (Stream) Water Quality Monitoring Network https://www.ontario.ca/environment-and-energy/provincial-stream-water-quality-monitoring-network-pwqmn-data

References:

Canadian Council of Ministers of the Environment (CCME). 2011. Canadian water quality guidelines for the protection of aquatic life: Chloride. *In*: Canadian environmental quality guidelines, Canadian Council of Ministers of the Environment, Winnipeg, MB. [Available at: http://ceqg-rcqe.ccme.ca/download/en/337/]

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INDICATOR: CHANGES IN GREENHOUSE GAS EMISSIONS

STRATEGIC DIRECTION: Reduce Threats

TARGET: 6. By 2015, plans for climate change mitigation are developed and implemented and contribute to Ontario's target to reduce greenhouse gas emissions by 6 per cent below 1990 levels.

THEME: Pressures on Ontario's Biodiversity – Climate Change

Background Information:

Greenhouse gases (GHG) from human activities trap heat in the atmosphere and are the most significant driver of observed climate change (IPCC 2014). The link between climate change and biodiversity has long been established, with climate change affecting ecosystems and species ability to adapt, thereby increasing the loss of biodiversity. In particular, climate change can alter the timing of species' life cycle events, change species distributions, impair trophic networks and ecosystem functioning, and, in the worst cases, result in species extinctions (Bellard et al. 2012; IPCC 2014).

In 2007, the Ontario government released a Climate Change Action Plan that established GHG emission reduction targets of 6, 15 and 80 percent below 1990 levels by the years 2014, 2020 and 2050, respectively (OMOE 2007). These targets are comparable to those set by the governments of Quebec, New Brunswick and British Columbia, as well as with the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Given the actual and projected impacts of climate change on biodiversity, the Ontario Biodiversity Strategy 2011 supports Ontario's Climate Change Action Plan, and has established a 2015 target for the development and implementation of plans for climate change mitigation that contribute to Ontario's target to reduce GHG emissions by 6% below 1990 levels by 2014 (OBS 2011).

This indicator reports on the development and implementation of some key plans for climate change mitigation, as well as progress in achieving Ontario's Climate Change Action Plan target to reduce GHG emissions by 6% below 1990 levels by 2014.

Data Analysis:

Information about Ontario's Climate Change Action Plan, Ontario's 2014 Climate Change Update and other provincial climate change initiatives were obtained from the Ontario Ministry of the Environment and Climate Change.

Information about GHG emission in Ontario is based on Environment Canada's National Inventory Report 1990–2012: Greenhouse Gases Sources and Sinks (2014). Canada's National Inventory Report is prepared and submitted annually to the United Nations Framework Convention on Climate Change. The inventory estimates include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs) in the following six sectors: energy; industrial processes; solvent and other product use; agriculture; waste; and land use, land-use change and forestry.

Environment Canada is responsible for the preparation and submission of the National Inventory Report using data provided by the provinces. Data for GHG emissions have been calculated annually and 1990 data is internationally recognized as the baseline level for all reduction targets. Emissions data for Ontario are also categorized by the following sectors: transportation, industry, buildings, electricity, agriculture and waste (Table 1). Emission data for Ontario from 1990 to 2012 were plotted against the 2014 target (Figure 1). The proportions of GHG emissions by sector for 2012, (Figure 2) as well as the percent change in GHG emissions by sector are presented in Figures 2 and 3.

Table 1. Sector descriptions for sources of greenhouse gas emissions (Source: OMOECC 2014).

Sector	Sources of Greenhouse Gas Emissions
Transportation	The combustion of fossil fuels such as diesel, gasoline and propane by passenger and commercial vehicles on and off roads, as well as rail and Ontario's share of domestic marine and air travel.
Industry	Some industrial processes and stationary combustion of fossil fuels such as coke, natural gas and coal used in mining; pipelines; construction; greenhouses; production of cement, iron and steel, chemicals, paper and wood products; and other manufacturing.
Buildings	The combustion of fossil fuels such as natural gas in residential, commercial and institutional buildings for space and water heating.
Electricity	Generating electricity and heat by electric utilities using fossil fuels such as natural gas.
Agriculture	Enteric fermentation, manure management and fertilizer application.
Waste	Solid waste disposal on land, wastewater handling and waste incineration.

Results:

Trend: Improvement **Data Confidence:** High **Geographic Extent:** Provincial

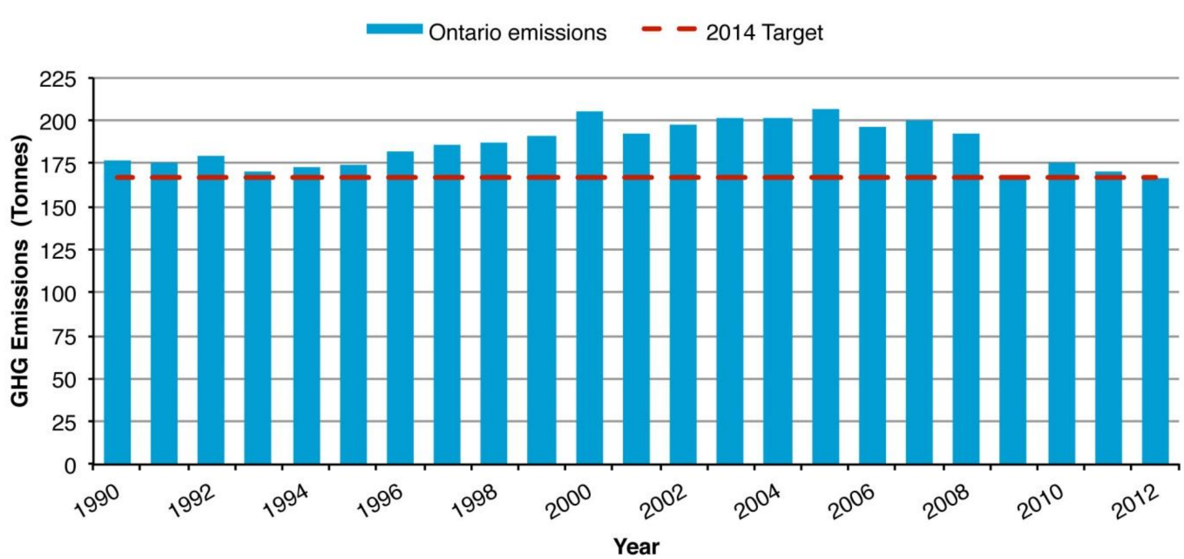

Figure 1. Greenhouse gas emission summary for Ontario 1990-2012 (Source: Environment Canada 2014).

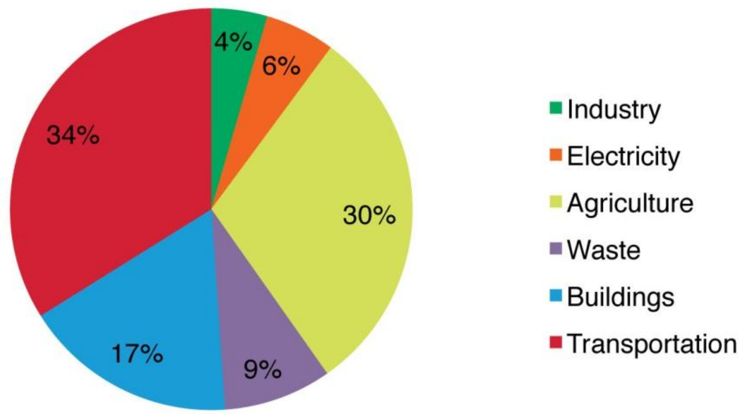

Figure 2. Greenhouse gas emissions in Ontario by sector 2012 (Source: OMOECC 2014).

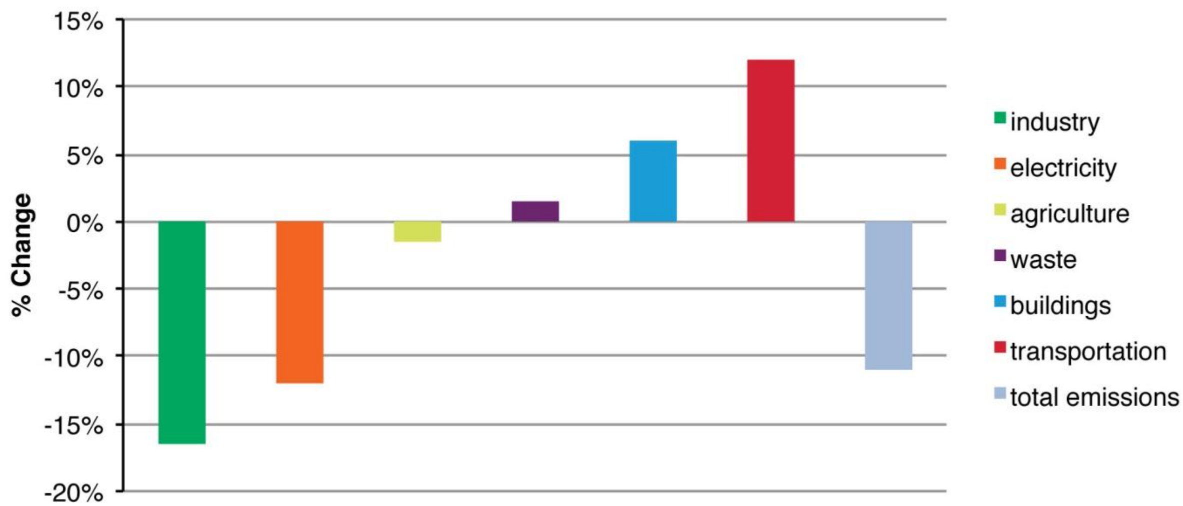

Figure 3. Changes in Ontario's greenhouse gas emissions by Sector 1990–2012 (Source: OMOECC 2014)

Status:

- Plans for climate change mitigation in Ontario have been developed and implemented. These include Go Green: Ontario's Climate Change Action Plan (2007), The Big Move Transportation Plan (2008), Green Energy Act (2009), Building Code Amendments (2012), as well as a number of supporting plans at the provincial, regional and municipal level.
- GHG emissions in Ontario grew from 1990 to the early 2000s, then stabilized and declined in recent years. Since 1990, total emissions in Ontario have declined by approximately 11%, with the greatest reductions in the electricity and industrial sectors. The reduction in electricity is attributable to the phasing out of coal-fired electricity generation, while the reduction in the industry sector is attributable to reduced production, including plant closures and improved emissions intensity.

- Based on current data[1], in 2012 total GHG emissions in Ontario were 167 Mt, achieving Ontario's target to reduce GHG emissions by 6% below 1990 levels.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Ontario Ministry of the Environment and Climate Change http://www.ontario.ca/ministry-environment

Ontario Ministry of Natural Resources and Forestry http://www.ontario.ca/ministry-natural-resources-forestry

United Nations Framework Convention on Climate Change http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php

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Ontario Ministry of the Environment and Climate Change (OMOECC). 2014. Ontario's climate change update 2014. Queen's Printer for Ontario, Toronto, ON.

[1] The latest Ontario Climate Change Update (OMOECC 2014) provides data to 2012. Data for 2014 emissions will not be available until 2017.

Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: AFFORESTATION AND DEFORESTATION

STRATEGIC DIRECTION: Reduce Threats

TARGET: 6. By 2015, plans for climate change mitigation are developed and implemented and contribute to Ontario's target to reduce greenhouse gas emissions by 6 per cent below 1990 levels.

THEME: Pressures on Biodiversity – Climate Change

Background Information:

Although climate change poses a serious threat to biodiversity, conservation of biodiversity can play an important role in mitigating climate change. For example, ecosystems such as forests and wetlands are important carbon sinks that help reduce greenhouse gas emissions. The forests and treed wetlands in Ontario's Crown forest management units (portion of the Ontario Shield Ecozone) are estimated to store 4.3 and 3.0 billion tonnes of carbon, respectively (OMNR 2012). It is estimated that non-treed peatlands in Ontario's Far North store 36 billion tonnes of carbon (McLaughlin and Webster 2013). The protection and sustainable management of forests and wetlands, effectively managing and expanding protected area networks, afforestation (planting trees on currently non-forested land) and wetland restoration can all play a role in climate change mitigation (SCBD 2009).

Climate change mitigation is the focus of *Go Green: Ontario's Action Plan on Climate* Change (Government of Ontario 2007). The action plan commits to reduced emissions associated with energy production, transportation and energy conservation, as well as planting 50 million trees on 25,000 ha of private and public lands by 2025. The 50 Million Tree Program was established in 2008 as a partnership between the Ontario Ministry of Natural Resources and Forestry and Forests Ontario. The program is implemented through partners such as conservation authorities, stewardship councils and municipalities. In addition to enhancing biodiversity and ecosystem services, it is estimated that the trees in each hectare of forest will help to mitigate climate change by storing more than 5.5 tonnes of carbon dioxide annually over their lifetime (Government of Ontario 2007).

While recognizing the importance of afforestation efforts to climate change mitigation through the sequestration of carbon, deforestation (conversion of forested land to other uses such as roads, urban development and agriculture) must also be accounted for on the balance sheet. Forest harvest is not considered deforestation as the forest is re-established post-harvest. Deforestation results in the release of carbon and diminishes the ability of ecosystems to remove carbon dioxide from the atmosphere and store carbon on the landscape. Article 3.3 of the Kyoto Protocol requires accounting for carbon sequestration due to afforestation and carbon emissions due to deforestation.

This indicator examines trends from 1990-2013 in the annual area of land in Ontario that has been afforested, compared with the area that has been deforested.

Data Analysis:

Afforestation

Afforestation was estimated as the area of land converted to forest by examining annual records of tree planting on previously un-forested lands. Only afforestation projects with a minimum area of 1 ha and 25% canopy cover of trees that have the potential to reach 5 m in height at maturity are included. Information from 1990-2007 are based on records maintained by the Ontario Ministry of Natural Resources and Forestry with input from partners. Since 2008, more detailed information on the species, area planted and planting locations has been maintained by Forests Ontario through the 50 Million Tree Program. The vast majority of planting projects have occurred in the Mixedwood Plains Ecozone (95% of area planted from 2008-2013), but there have also been afforestation efforts in ecodistricts on the southern edge of the Ontario Shield Ecozone. The analysis does not include abandoned lands that have gradually succeeded to forest condition or any tree planting that is not associated with the 50 Million Tree Program.

Deforestation

Data on deforestation were derived from several sources:

In the Mixedwood Plains Ecozone of southern Ontario (excluding Manitoulin Island), data from 1990-1999 were based on observed forest loss in a sample of National Forest Inventory plots followed by extrapolation to larger areas (see OMNR 2012). For the period 2000-2011, estimates of deforestation were made using land cover information from the Southern Ontario Land Resource Information System (SOLRIS; OMNR 2008). SOLRIS version 2.0 (2011 land cover) was developed using a LandSat based change detection analysis process applied to woodlands and wetlands identified in SOLRIS version 1.0 (2000-2002 land cover). Estimates of deforestation over two time periods (2000-2005 and 2006-2011) were averaged to produce annual estimates. There were no available data to reliably assess deforestation after 2011 which is the year for the latest SOLRIS land cover.

Estimates of deforestation in Ontario's Crown forest management units (portion of the Ontario Shield Ecozone) from 1990-2013 are based on the area of forest lost to the construction of forest access roads. Data on the length of various classes of forest access roads (primary, branch and operational) constructed annually are maintained by the Ontario Ministry of Natural Resources and Forestry based on information provided by the forest industry. To convert road lengths to deforested area, buffered widths were assigned to each road based on its class (total width: primary = 19.2 m, branch = 14.2 m and operational = 12.2 m). Industry reporting of data has not always been timely and complete and in some cases, the amount of road construction was estimated based on known harvest areas. Operational roads are normally not maintained after they are no longer required for forest management purposes, and are often site prepared and regenerated. Operational roads are more difficult to regenerate than surrounding harvest areas due to soil compaction. As a result, regeneration can be delayed (10-20 years) and is affected by a variety of factors like the substrate, the amount of gravel, the season of construction, and amount and duration of vehicle traffic. Some operational roads may not completely regenerate if they continue to be used for other purposes (non-forest management). Work is ongoing to determine how operational roads regenerate over time. Deforestation data were not available for pits, quarries, electrical generation facilities or expanding urban areas. A preliminary analysis of deforestation associated with the development of mines in this area of northern Ontario showed a total loss of 3.1 km^2 of forest over the period 1999-2013 (0.22 km^2/yr).

It is important to note that information on deforestation for the two regions used different data sources. The assessment of forest loss in the Mixedwood Plains used remote sensing and could miss small losses (e.g., less than 0.5 ha over 5 years). In the Ontario Shield Ecozone, forest losses were based on the known or estimated length of new forest access roads, but did not include new land uses that would be detected by the remote sensing methods used in the south (e.g., expanding urban areas).

Annual data on deforestation in southern and northern Ontario and data on afforestation were combined into a single graph to compare forest gains and losses over the period 1990-2013 (Figure 1). Areas of afforestation were also subtracted from areas of deforestation to determine the annual net area of deforestation (Figure 2). Because of the uncertainty around forest regeneration on operational roads, the area of deforestation attributed to operational roads has been highlighted in Figure 1. Annual net deforestation in Figure 2 includes scenarios where all operational roads are considered deforested and where no operational roads are considered deforested – the real situation is somewhere between these scenarios and will be reflected in future updates to this indicator.

- download afforestation and deforestation data

Results:

Trend: Improvement **Data Confidence:** Medium **Geographic Extent:** Mixedwood Plains/Ontario Shield

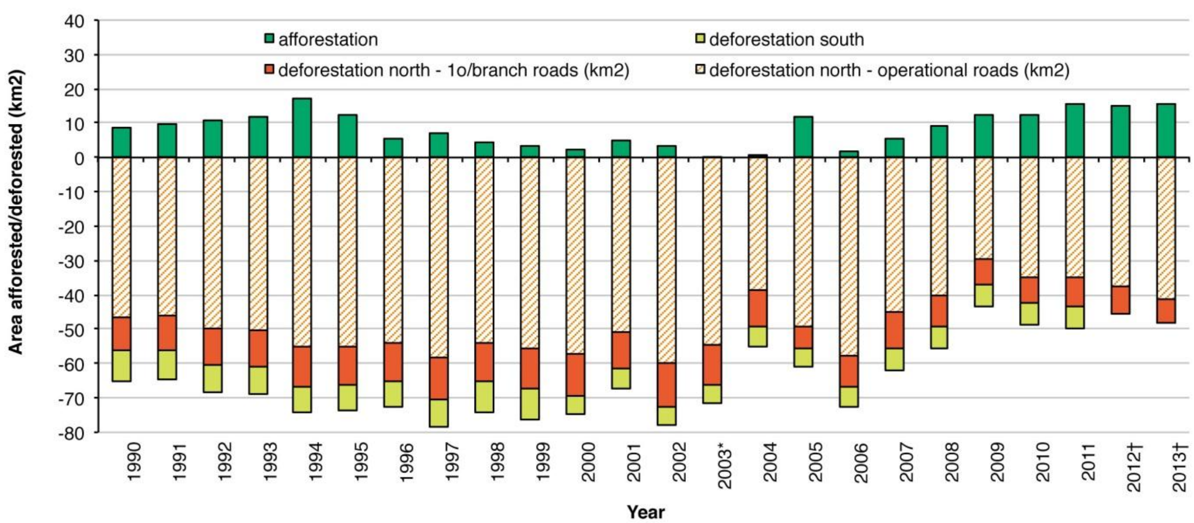

Figure 1. Trends in areas of afforestation (positive values) and deforestation (negative values) 1990-2013 (*afforestation area not available for 2003, † area of deforestation not available for southern Ontario 2012-2013).

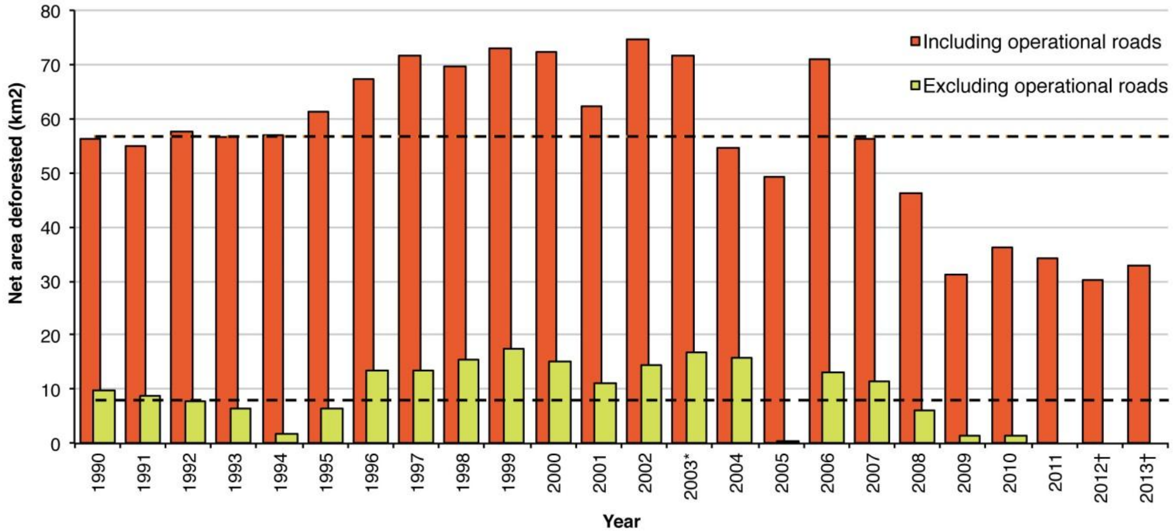

Figure 2. Trends in net area of deforestation in Ontario 1990-2013 under scenarios that include and exclude deforestation associated with operational forest access roads (dashed lines represents net annual average area deforested under each scenario; *afforestation area not available for 2003; †area of deforestation not available for southern Ontario 2012-2013).

Status:

- More than 99 km^2 (9,910 ha) of land have been afforested in Ontario over the last decade (2004-2013; average of 9.9 km^2 per year). Annual levels of afforestation were high in the early 1990s, declined in the late 1990s and early 2000s and have increased since 2008 with the establishment of the 50 Million Tree Program. The highest rates of afforestation are in areas of ecodistricts of southern Ontario that already have relatively high levels of forest cover.
- When operational forest access roads are included, annual deforestation associated with forest access road construction in the area of Crown forest management averaged 63.2 km^2 between 1990 and 2006, but has decreased since (average of 45.9 km^2 From 2007-2013; 0.01% of forested area); at the same time there has been a downturn in the forest industry and forest harvest.
- Most of the area deforested due to forest access road construction was associated with operational roads that provide direct access to harvest areas (83%). If operational roads are excluded from deforestation estimates, annual deforestation in the area of Crown forest management averaged 10.7 km^2 between 1990 and 2006, and 8. 3 km^2 from 2007-2013 (0.002% of forested area).
- In southern Ontario, 71 km^2 (7,115 ha) of forested land were deforested from 2000-2011 (average of 5.9 km^2 per year; 0.05% of forested area). Although this is slightly less than the estimated 82 km^2 over the previous decade, the methods used to calculate deforestation for these two periods were different. About one half of the recent deforestation was converted to agriculture while about one third was related to urban development.
- The annual rate of deforestation has been consistently greater than the rate of afforestation resulting in a net loss of forest cover. The annual net rate of deforestation has decreased substantially over the last decade and represents less than 0.01% of the forested land in Ontario. If operational roads are excluded from deforestation estimates, there has been no net loss of forest over the latest 3-year period (2011-2013).

Links:

Related Targets: N/A

Related Themes: Pressures on Biodiversity – Habitat Loss

Web Links:

Ontario Ministry of Natural Resources – Forestry https://www.ontario.ca/rural-and-north/forestry

Forests Ontario – 50 Million Tree Program http://www.forestsontario.ca/index.php/50mtp

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Citation
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INDICATOR: CHANGES IN ICE COVER ON THE GREAT LAKES

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Climate Change

Background Information:

Lake ecosystems are vital resources for both wildlife and humans. Any change in their quality can have wide-ranging ecological and societal implications. The increasing accumulation of greenhouse gases in the atmosphere as a result of human activities has begun to affect the structure, functioning, and stability of lake ecosystems throughout the world, and much greater impacts are likely in the future (Goldman et al. 2013).

Changes in the duration of ice cover on northern hemisphere lakes are a strong signal of climate change (Rosenzweig 2007). Globally, some inland lakes appear to be freezing up at later dates and breaking-up earlier than the historical average, based on a study of 150 years of data (Magnuson et al. 2000). On Lake Superior, ice cover may have decreased by almost 50% over the last century (Austin and Coleman 2008). These trends add to the evidence that the earth has been in a period of global warming for at least the last 150 years (EC and USEPA 2014).

Changes in the ice cover that forms on the Great Lakes each year affects biodiversity in coastal wetlands and nearshore aquatic and inland environments. For example, 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 (Hellmann et al. 2010). Less ice cover on the Great Lakes also allows more water to evaporate, creating more snow which can negatively affect animals living in the Great Lakes basin (Hellmann et al. 2010; Groenwold et al. 2013).

This indicator provides an assessment of the potential impacts of climate change on biodiversity by examining trends in ice cover on the Great Lakes.

Data Analysis:

Observed changes in seasonal maximum ice cover data are available from the National Oceanic and Atmospheric Administration and the Canadian Ice Service (Figure 1). Ice cover data for individual Great Lakes (Table 1) were obtained from the State of the Great Lakes Report 2009, with the exception of the years 2000-2013, which were obtained from the Canadian Ice Service Seasonal Summaries. Mean maximum ice coverage for each ten year period between 1970 and 2013 was calculated (note: accounting for the current decade is incomplete). Percent change in mean maximum ice coverage 1970-2013 was also calculated for each lake.

Results:

Trend: Deterioration **Data Confidence:** High **Geographic Extent:** Great Lakes

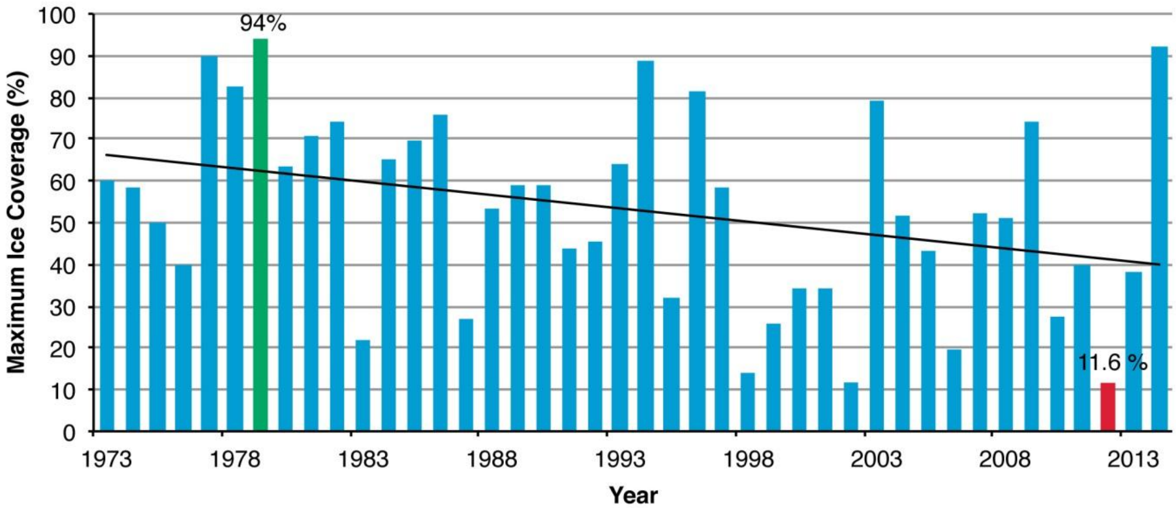

Figure 1. Seasonal maximum ice cover on the Great Lakes 1973-2013 (Source: National Oceanic and Atmospheric Administration and the Canadian Ice Service).

Table 1. Mean maximum ice coverage on the Great Lakes, in percent, during the corresponding decade and percent change 1970-2013.

Lake	1970-1979	1980-1989	1990-1999	2000-2009	2010-2013	% Change (1970-2013)
Erie	94.5	90.8	77.3	80.3	71.2	-24.7
Huron	71.3	71.7	61.3	56.4	57.9	-18.7
Michigan	50.2	45.6	32.4	29.2	39.5	-21.4
Ontario	39.8	29.7	28.1	23.0	27.1	-31.9
Superior	74.5	73.9	62.0	49.0	43.36	-41.8

Source: Updated from State of the Great Lakes Report 2009 using data from the Canadian Ice Services Seasonal Summaries for the Great Lakes (2000-2013).

Status:

- Between 1973 and 2013, ice coverage for all the Great Lakes declined, despite some variability.

- Between 1970 and 2013, mean maximum ice cover declined most on Lake Superior (42%), followed by lakes Ontario (32%), Erie (25%), Michigan (21%) and Huron (19%).

Links:

Related Targets: 6. By 2015, plans for climate change mitigation are developed and implemented and contribute to Ontario's target to reduce greenhouse gas emissions by 6 per cent below 1990 levels.

Related Themes: N/A

Web Links:

NOAA – Great Lakes Environmental Research Laboratory - Great Lakes Ice Cove http://www.glerl.noaa.gov/data/ice/

Canadian Ice Service http://www.ec.gc.ca/glaces-ice/

State of the Great Lakes (SOLEC) 2011 Technical Report http://binational.net/wp-content/uploads/2014/11/sogl-2011-technical-report-en.pdf

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Rosenzweig, C. 2007. Assessment of observed changes and responses in natural and managed systems. pp. 79–131 *In* Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, C.E. Hanson, and others (eds). Climate change 2007—impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, U.K.

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INDICATOR: CHANGES IN VEGETATIVE PHENOLOGY

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Climate Change

Background Information:

Over the last 60 years in Ontario, increases in the average annual air temperature varied from a slight increase in the southeast to an increase of 1.3 ^{o}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 ^{o}C over 1961-1990 levels based on a scenario of moderate reductions in greenhouse gas emissions (Environment Canada 2009).

Changes in climatic variables such as temperature can affect biodiversity both directly and indirectly. In addition to affecting the distribution of species directly (e.g., northward shift of southern species), increasing temperatures can affect the timing of natural events (phenology) like the flowering of plants and the breeding and migration of animals. In some cases 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. Increasing temperatures can cause the timing of important events in their life cycles to become out-of-sync (Parmesan and Yohe 2003; Crick 2004; Parmesan 2006). Further, plants that begin growing earlier in the year due to warmer temperatures may ironically be more susceptible to frost damage (Inouye 2008). A recent assessment of plant flowering data for 19 species across Canada collected through the Plant Watch Canada citizen science program showed that the average first flower bloom advanced by 9 days over the relatively brief period 2001-2012 (Gonsamo et al. 2013).

This indicator examines trends in vegetative phenology across Ontario from 1982-2010 to assess climate change impacts. Trends in the timing of the start of the growing season and the duration of the growing season are assessed using satellite imagery.

Data Analysis:

The Normalized Differential Vegetation Index (NDVI) derived from satellite imagery was used to determine the timing of the start of the growing season and the duration of the growing season for each of Ontario's terrestrial ecozones over the period 1982-2010. NDVI data are a generalized measure of the amount of greenness on the landscape and can be used to estimate important phenological events such as leaf out in the spring. Geo-referenced, bi-weekly NDVI images over a 29-year duration were downloaded for free online (Tucker et al. 2004). The software program TIMESAT was used to model annual phenological cycles and identify the start and duration of the growing season (Jönsson and Eklundh 2004). Estimates were made for every 8 km pixel in Ontario and these were averaged to produce annual estimates for each ecozone. Annual summary data were used to calculate average values for the start and duration of the growing season for the 29-year period. The differences between annual estimates and the 29-year average values (in days) were plotted against year to examine trends for each ecozone (Figures 1, 2). A detailed account of the methods used to model and analyze the NDVI data is provided in Hogg et al. (2014). The relationship between vegetation phenology and climate variables is also assessed in this report.

The NDVI has been used by scientists for over 30 years to inventory, monitor and study various characteristics of vegetation. It is a well-established method of remotely measuring and monitoring vegetation. Research has shown NDVI can successfully monitor and measure phenomena such as seasonal vegetation dynamics, forest clearance, leaf area index, biomass, percentage vegetative ground cover and photosynthetically active radiation (Lillesand and Kiefer 1994). Although, NDVI observations can be influenced by solar radiation, characteristics of the sensor and atmospheric effects, it is an effective and efficient method for examining the effects of climate change on vegetation across broad spatial and temporal scales.

- download vegetative phenology data

Results:

Trend: Deterioration **Data Confidence:** Medium **Geographic Extent:** Provincial

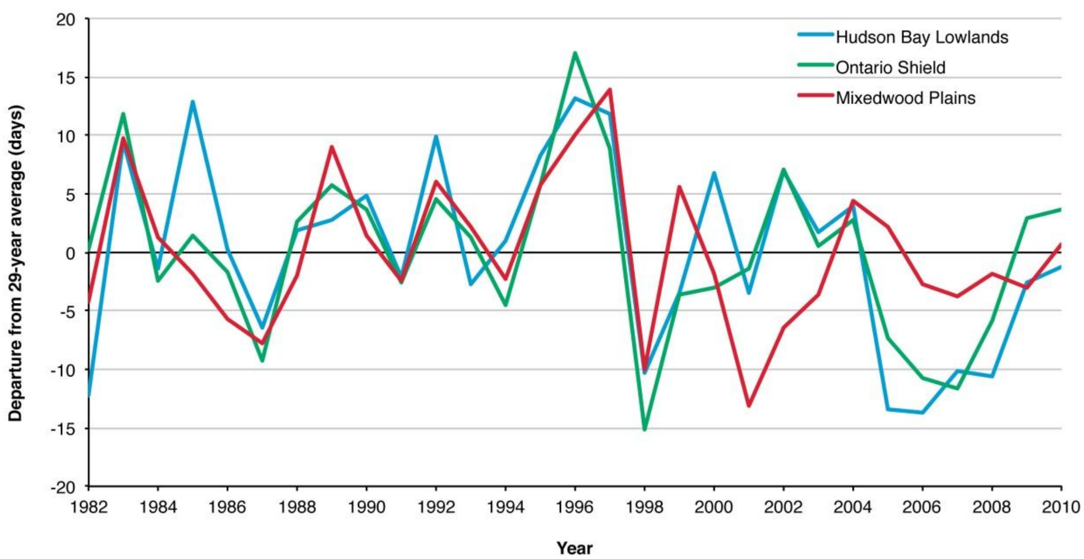

Figure 1. Change in the start of the growing season over the period 1982-2010 for each ecozone based on NDVI data.

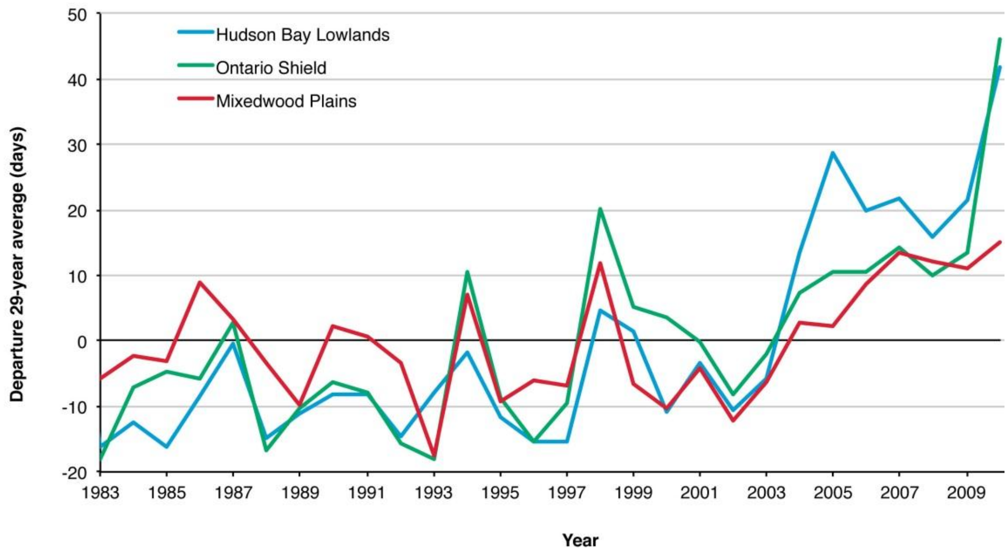

Figure 2. Change in the duration of the growing season over the period 1982-2010 for each ecozone based on NDVI data.

Status:

- There has been a trend to an earlier start to the growing season in all three ecozones over the last decade. The duration of the growing season has similarly increased over the same period.
- Observed changes are correlated with higher spring temperatures and increases in Growing Degree Days.

Links:

Related Targets: 6. By 2015, plans for climate change mitigation are developed and implemented and contribute to Ontario's target to reduce greenhouse gas emissions by 6 percent below 1990 levels.

Related Themes: N/A

Web Links:

USGS – remote sensing phenology http://phenology.cr.usgs.gov/index.php

PlantWatch Canada https://www.naturewatch.ca/plantwatch/

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Citation

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INDICATOR: BODY CONDITION AND SURVIVAL OF POLAR BEARS

STRATEGIC DIRECTION: Reduce Threats

TARGET: N/A

THEME: Pressures on Ontario's Biodiversity – Climate Change

Background Information:

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 (Cavalieri et al. 1996, updated yearly, Gagnon and Gough 2005; Figure 1). 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).

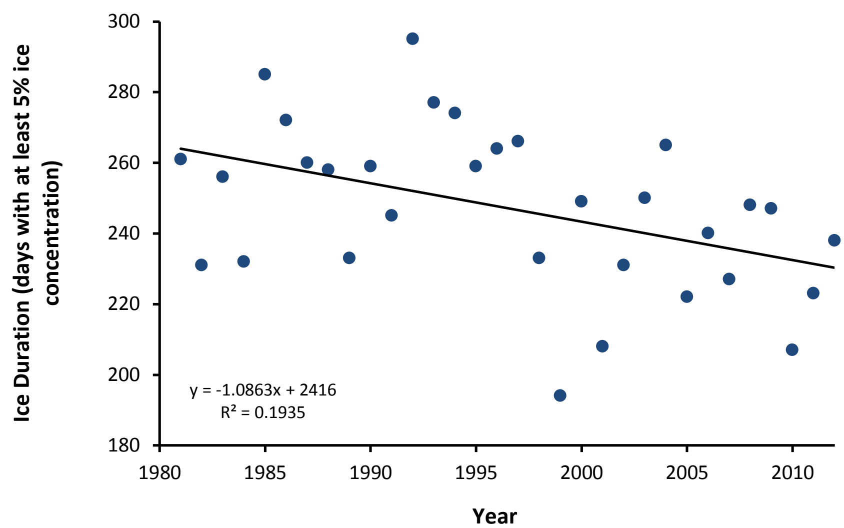

Figure 1. Annual duration of at least 5% ice cover on southern Hudson Bay and James Bay, 1981-2012 (analysis by M. Obbard and K. Middel (OMNRF) based on satellite data from Cavalieri et al. 1996, updated yearly).

Ontario is home to the southernmost subpopulation of Polar Bears in the world (southern Hudson bay subpopulation), 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 about 950 bears (Obbard et al. 2013), 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 between 1987 and 2004 (Stirling et al. 1999; Regehr et al. 2007). The size of the Western Hudson Bay subpopulation has been stable over the last decade (Lunn et al. 2013; Stapleton et al. 2014) a period where there has been no observable trend in adjacent sea ice cover (Lunn et al. 2013).

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; Cattet et al. 2002) for Southern Hudson Bay Polar Bears captured in three periods between 1984 and 2009, as well as changes in survival over the 1984–1986 and 2000–2005 periods.

Data Analysis:

This indicator is based on data collected from the Southern Hudson Bay Polar Bear population over three time periods (1984-1985, 2000-2005, 2007-2009; Obbard et al. 2006, 2007, unpublished data). Individual Polar Bears were captured and immobilized during the ice free season along the Hudson Bay Coast from Point Hook in northwestern James Bay to the Ontario-Manitoba border. The sex, reproductive status, body length, body mass and age were determined for each captured bear. The number of bears sampled in each time period ranged from 298-450.

A Body Condition Index value was calculated for each animal (Obbard et al. 2006). This index is strongly associated with the true body condition (combined mass of fat and skeletal muscle relative to body size), but is not biased by body size allowing comparisons between sex and age groups. The average values for each time period were calculated for adult females with and without young, adult males, sub-adults (< 5 years old) and all bears and compared between time periods (Figure 2).

Annual survival rates (i.e., proportion of bears surviving a period of a year, if all bears survived, the annual survival rate would = 1) of Polar Bears were estimated for the 1984-1986 and 2000-2005 time periods (Obbard et al. 2007). The average survival rate for each period was calculated for five age groups of bears – cubs, yearlings, sub-adult (2-4 years old), adult (5-20 years old) and senescent (> 20 years old) and compared between time periods (Figure 3). Survival rate estimates for the 2007-2009 time period will be added to this indicator when the analysis is complete.

Results:

Trend: Deterioration **Data Confidence:** High **Geographic Extent:** Hudson Bay Lowlands

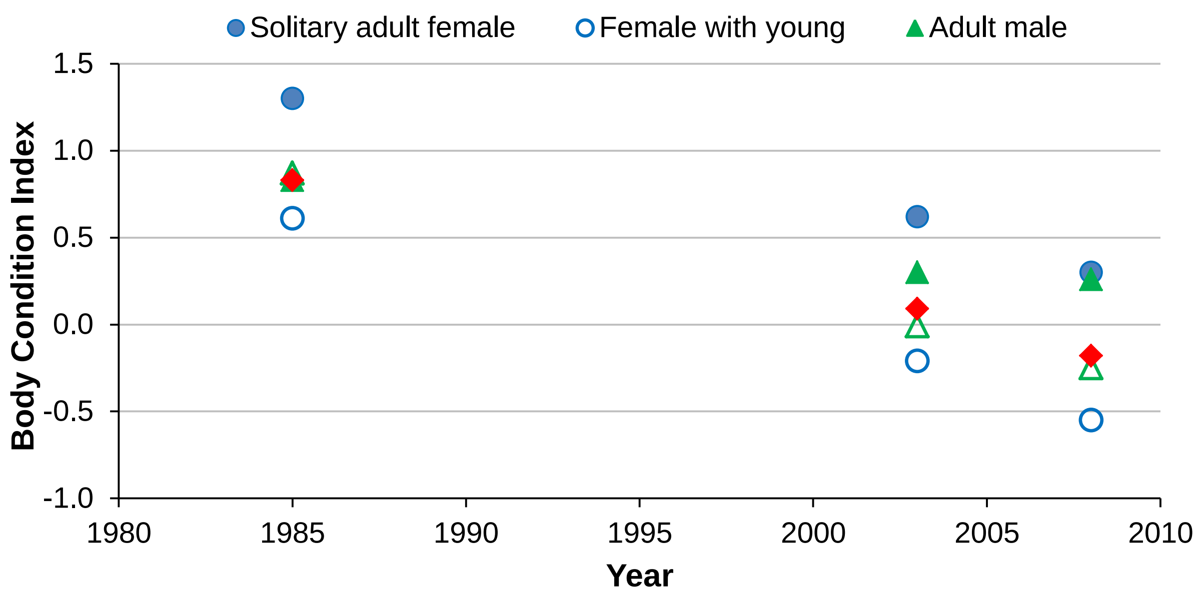

Figure 2. Changes in average body condition index values for Southern Hudson Bay Polar Bears captured in Ontario during 1984-1986, 2000-2005 and 2007-2009 (median year of sample periods plotted; adapted from Obbard et al. 2006 and Obbard, unpublished data).

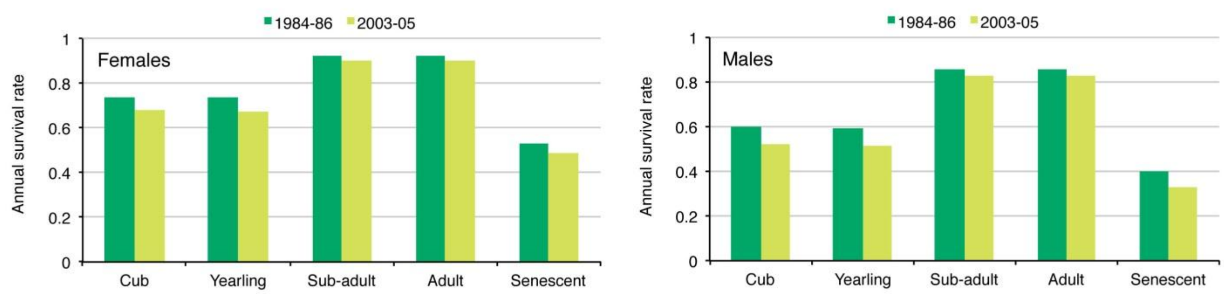

Figure 3. Comparison of annual survival rates of Polar Bears in the southern Hudson Bay subpopulation between 1984-86 and 2003-05 (adapted from Obbard et al. 2007).

Status:

- 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.

Links:

Related Targets: 6. By 2015, plans for climate change mitigation are developed and implemented and contribute to Ontario’s target to reduce greenhouse gas emissions by 6 percent below 1990 levels.

Related Themes: N/A

Web Links:

Polar Bear Administrative Committee for Polar Bear Management in Canada
http://www.polarbearcanada.ca/

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INDICATOR: FOREST COVER AND FOREST DISTURBANCE

STRATEGIC DIRECTION: Enhance Resilience

TARGET: N/A

THEME: State of Ecosystems and Species – Forests

Background Information:

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 ecosystem services, such as water purification and protection of aquatic habitats, the provision of habitat for a multitude of species, soil retention, recreation, 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%) (excluding treed wetlands - Figure 1). Ontario's forests (areas with more than 30% tree cover) include a broad range of tree species within three ecozones. 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. Forests in 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. 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. Fire is a vital ecological component of the boreal forest ecosystem.

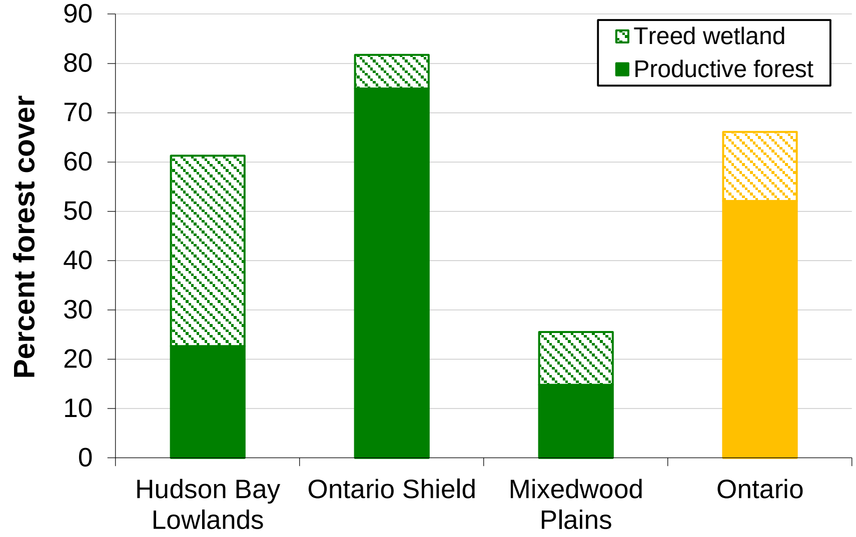

Figure 1. Percent forest cover for Ontario ecozones and entire province (data from Watkins 2011).

This indicator examines the total area of forest in Ontario's ecoregions between 1998 and 2008, and the area of disturbed forest as a result of fire and harvest over the same period. Information on the amount of harvest versus allowable levels for the period 2002-2013 is also included.

Data Analysis:

The area of forested land in each of Ontario's 14 ecoregions was compared for three time periods (1998, 2002 and 2008) based on detailed information presented in The Forest Resources of Ontario (OMNR 2001, 2006; Watkins 2011 – Figure 2). Information on the area of forest disturbance (burns and harvest within the previous 10 year period) were also assessed (Figure 3). The areas with burns also include a small amount of area attributed to other stand-replacing disturbances (severe blowdown). The area of forested land presented in the results section does not include treed wetlands that account for about 14% of Ontario's land area. The annual area of forest harvest compared with the allowable harvest area for Ontario's Crown forest management units from the period 2002-2013 are also presented (Figure 4). This information is maintained by the Ontario Ministry of Natural Resources and Forestry and is summarized in Annual Reports on Forest Management and the State of Ontario's Forest Report (OMNR 2012). Allowable harvest areas are determined through modelling of the age distribution and productivity of forest classes in each forest management unit during the development of forest management plans.

Assessment of forest area and disturbance area for 1998 and 2002 was based on the interpretation of satellite imagery (Landsat 7). For 2008, information on harvest, burns and forest regeneration maintained by the Ministry of Natural Resources was used to update the 2002 forest cover (Watkins 2011). In southern Ontario, the forest cover reported for 1998 and 2002 were based on imagery compiled from 1985 to 1990. In 2008 the Southern Ontario Land Resource Information System (SOLRIS; OMNR 2008) was released providing high resolution land cover data for the period 2000-2002. Therefore, the 2008 figures for forest cover in southern Ontario (ecoregions 6E and 7E) reflect 15 to 20 years of change, rather than 6 years (Watkins 2011). Some of the losses in these ecozones may also reflect reclassification of productive forest into treed wetland classes with more recent data.

Results:

Trend: Mixed **Data Confidence:** Medium **Geographic Extent:** Provincial

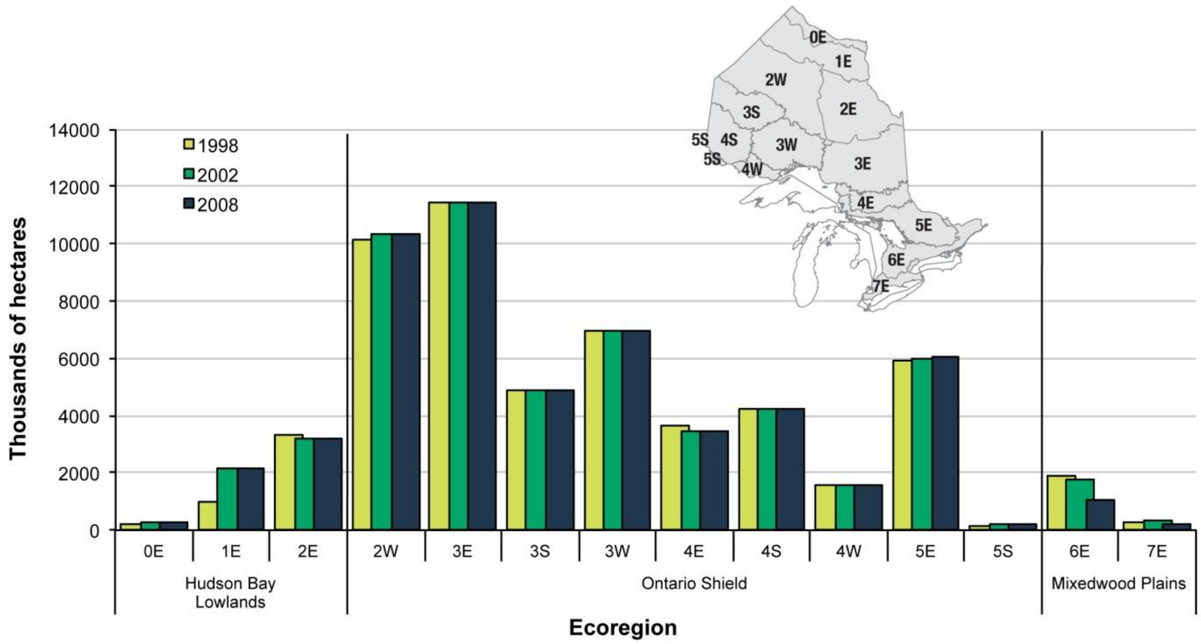

Figure 2. Total area of forested land by ecoregion in each ecozone in 1998, 2002 and 2008 (Inset map – Ontario's ecoregions).

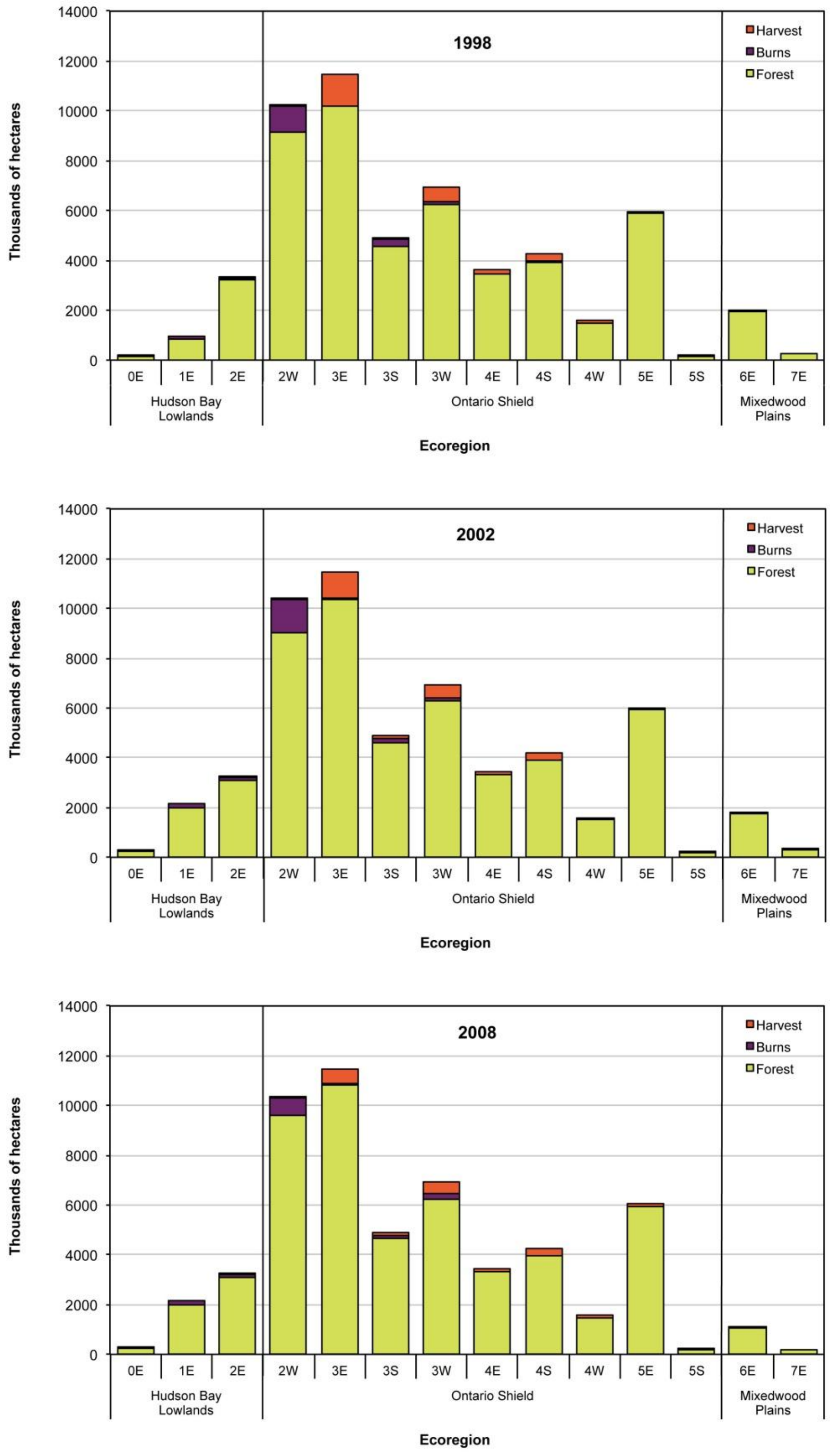

Figure 3. Total area of forest cover and area of recent disturbance from forest harvest and burns (1998-2008) by ecoregion based on satellite imagery.

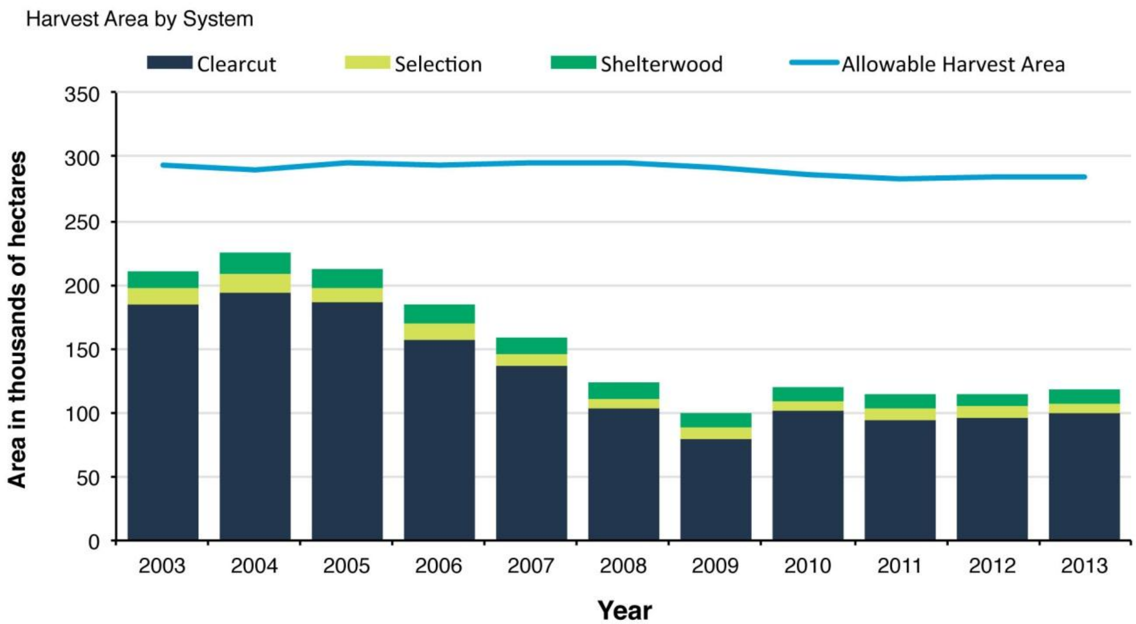

Figure 4. Forest area harvested under different management systems in Ontario's Crown forest management units compared with the total allowable harvest area, 2003-2013.

Status:

- The total amount of Ontario's forested land has remained relatively stable. Increases in northern ecoregions (0E and 1E) between 1998 and 2002 were due to increased resolution of satellite images and improved detection of forest cover (OMNR 2006). Losses of forest cover in southern Ontario (ecoregions 6E and 7E) reflect a longer period of change (i.e., 20 years) and perhaps reclassification of forest to treed wetland with more recent data.
- More than half of Ontario's land base is forested, and 88% of the forested land is found in the Ontario Shield Ecozone.
- Disturbances associated with recent burns and forest harvest assessed from satellite imagery covered 6-8% of Ontario's productive forest lands in 1998 and 2002.
- The average Crown forest harvest area was 152,540 hectares per year for the 2002-2013 period, a little more than 50% of the allowable harvest area. There has been a substantial decrease in annual forest harvest since 2005 associated with a downturn in Ontario's forest industry.

Links:

Related Targets: N/A

Related Themes: Conservation Response – Sustainable Management

Web Links:

Ontario Ministry of Natural Resources and Forestry – Sustainable Forest Management https://www.ontario.ca/environment-and-energy/sustainable-forest-management

Forest Resources of Ontario 2011 https://www.ontario.ca/document/forest-resources-ontario-2011

State of Ontario's Forests 2011 https://www.ontario.ca/document/state-ontarios-forests

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INDICATOR: EXTENT OF WETLAND COVER AND WETLAND LOSS

STRATEGIC DIRECTION: Enhance Resilience

TARGET: N/A

THEME: State of Ecosystems and Species – Wetlands

Background Information:

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. 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. Wetlands provide habitat for a diverse array of species and 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 they provide many recreational opportunities. When wetlands are lost or destroyed the important ecosystem services they provide are also lost.

Canada has approximately 20% of the world's remaining wetlands (Natural Resources Canada 2011). Ontario has particular responsibility for wetland resources because it contains approximately 22-29% of all Canadian wetlands and 6% of the world's wetlands. In Ontario, four major types of wetlands are recognized: marshes, swamps, fens and bogs (OMNR 2014). Shallow open water wetlands are recognized as an additional wetland type in the national wetland classification system. The majority of the province's wetlands are found in northern Ontario (Figure 1). 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. Great Lakes coastal wetlands provide continentally significant migratory bird habitat and support many rare animals and vegetation communities.

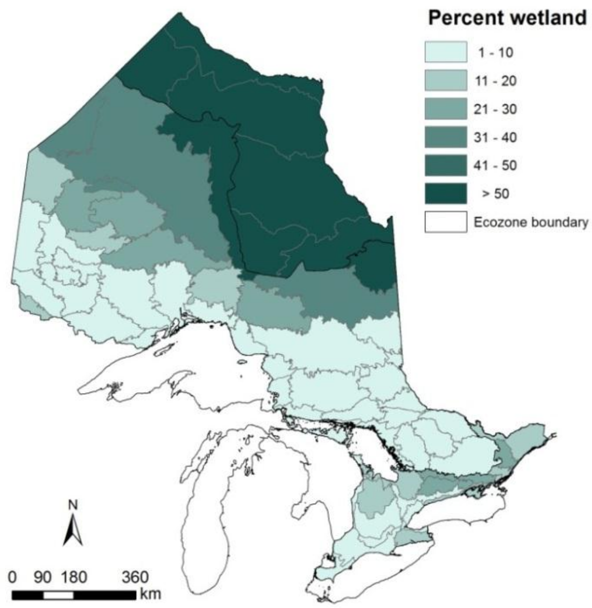

Figure 1. Percentage wetland in Ontario ecodistricts based on 2011 land cover.

Despite their important values, wetlands continue to be lost. It is estimated that up to 70% of wetlands have been lost in settled areas of Canada (DUC 2006). Historically wetlands in southern parts of Ontario have been drained for agriculture, filled for development, polluted by toxic runoff and damaged by artificial changes in water levels (Environment Canada 2010). Despite some localized losses or alteration, the wetlands in the Hudson Bay Lowlands and Ontario Shield ecozones are largely intact. However, about two-thirds of wetlands in southern Ontario have been lost or severely degraded, and the health of those that remain is threatened (Environment Canada 2010). A recent assessment by Ducks Unlimited Canada showed that between 1982 and 2002 an additional 70,854 ha of wetlands (larger than 10 ha) in southern Ontario were lost (DUC 2010; OBC 2010). The loss of wetlands has been greatest in southwestern Ontario, parts of eastern Ontario, Niagara and the Toronto area, where over 85% of the original pre-settlement wetlands have been converted to other uses. Since 1992, significant wetlands (as determined by the Ontario Wetland Evaluation System) have been provided protection from development and site alteration by provincial policies issued under the Planning Act. These policies do not govern all activities that can potentially affect provincially significant wetlands. Regional land use plans for the Niagara Escarpment, Oak Ridges Moraine, the Greenbelt and Lake Simcoe, regulations under the Conservation Authorities Act, the Environmental Protection Act and guidelines used in forest management planning may also provide additional protection for wetlands.

This indicator assesses changes in wetland extent in southern Ontario from 2000-2002 to 2011 based on updated land cover information.

Data Analysis:

Land cover information from the Southern Ontario Land Resource Information System (SOLRIS; OMNR 2008b) was used to assess changes in the extent of southern Ontario wetlands between 2000-2002 and 2011. SOLRIS coverage includes all of the ecodistricts in the Mixedwood Plains Ecozone with the exception of Manitoulin Island and includes wetlands as small as 0.5 ha in area. SOLRIS version 2.0 was developed using a LandSat based change detection analysis process applied to woodlands and wetlands identified in SOLRIS version 1.2. In this application, change detection analyzes the decreases in vegetation greenness, focusing on loss, using full-leaf summer Landsat-5 TM imagery for three time periods from 2000 to 2011. Changes identified during change detection were verified using orthophotography available between 2000 and 2011. The modelling effectively mapped large and dramatic loss events with high certainty. In some cases, subtle and smaller change events could not be modelled with certainty. These events, when occurring in close proximity to high certainty events, were flagged for manual interpretive review. Additional high certainty events were then identified through detailed examination of multi-date digital orthophotos. Although attempts were made to capture all major events, some remain undetected.

The total wetland area was calculated for each time period (2000-2002 and 2011) using a Geographic Information System (GIS) and the area of wetlands lost was mapped for each ecodistrict (Figure 2). The wetland loss was also mapped as the percentage of wetland area from 2000-2002 that had been lost by 2011 (Figure 3).

It is important to note that previous assessments of changes in wetland cover excluded wetlands smaller than 10 ha and many Great Lakes coastal wetlands (DUC 2010). The current analysis addresses smaller wetlands, but could miss the incremental loss of small areas along the edge of larger wetlands (i.e., areas less than 0.5 ha over a 5-year period). For these reasons, the results of the current assessment of wetland loss since 2000-2002 cannot be directly compared to previous assessments of loss for earlier time periods.

While this indicator assesses changes in the extent of wetland coverage, there is no comprehensive, landscape-scale data available for assessment of trends in the quality and function of remaining wetlands. A recent assessment of the quality of Great Lakes coastal wetlands (U.S. and Canada) showed that more than 50% of marshes in lakes Erie and Ontario were degraded while more than 70 % of those in Lake Huron, Georgian Bay and Lake Superior were minimally impacted (Cvetkovic and Chow-Fraser 2011).

- download wetland loss summary data

Results:

Trend: Mixed	**Data Confidence:** Medium	**Geographic Extent:** Mixedwood Plains Ecozone

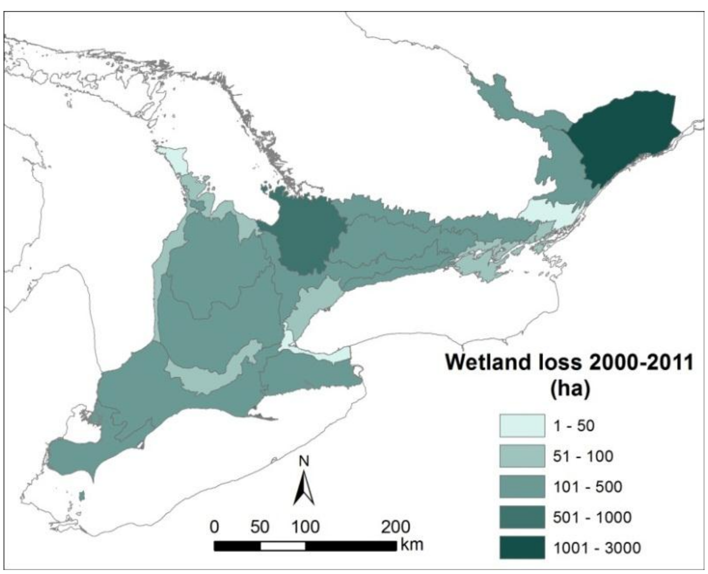

Figure 2. Area of wetlands lost in southern Ontario ecodistricts over the period 2000-2002 to2011.

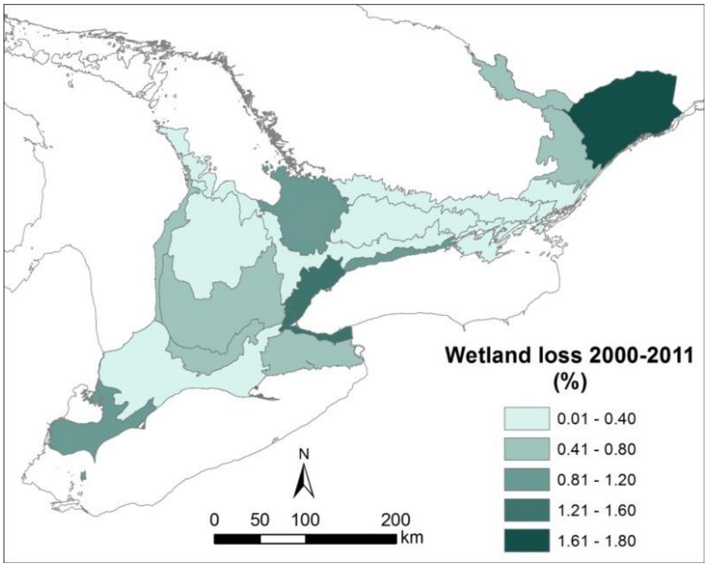

Figure 3. Percentage of wetland area lost in southern Ontario ecodistricts over the period 2000-2002 to 2011.

Status:

- Between 2000-2002 and 2011, a total of 6,152 ha of wetlands were lost representing 0.6% of the wetland area in southern Ontario. The rate of wetland loss over this decade (615 ha per year) is considerably less than the rate of 3,543 ha per year over the previous 20-year period. Due to differing methodologies, these rates of wetland loss cannot be directly compared, but the assessments suggest that the rate of wetland loss may have decreased.
- Wetland losses in the Kemptville Ecodistrict (6E-12) of eastern Ontario accounted for 40% of the total area of wetland losses over the last decade (2,285 ha). This ecodistrict also had the highest percentage of wetland loss (1.8%) followed by the Grimsby (7E-3, 1.6%) and Toronto (7E-4, 1.5%) ecodistricts in the Golden Horseshoe area.

Links:

Related Targets: N/A

Related Themes: Pressures on Biodiversity – Habitat Loss

Web Links:

Ontario Ministry of Natural Resources and Forestry – wetland conservation https://www.ontario.ca/environment-and-energy/wetland-conservation

Ontario Ministry of Municipal Affairs and Housing – Provincial Policy Statement http:/www.mah.gov.on.ca/Page215.aspx

Environment Canada – wetlands of Ontario http://www.ec.gc.ca/tho-wlo/default.asp?lang=En&n=06269065-1

Ducks Unlimited Canada – Ontario wetlands http://www.ducks.ca/

Great Lakes Wetland Conservation Action Plan http://glwcap.ca/

References:

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Citation

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INDICATOR: EXTENT, QUALITY AND PROTECTION OF ONTARIO'S RARE ECOSYSTEMS

STRATEGIC DIRECTION: Enhance Resilience

TARGET: 10. By 2015, the status of species and ecosystems of conservation concern in Ontario is improved.

THEME: State of Ecosystems and Species – Rare Ecosystems

Background Information:

Ontario's diverse ecosystems include some that are of conservation concern due to their limited 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 support many of Ontario's endemic species, and are home to species and groups of species that are uncommon or absent from other ecosystems in the province. As such, they are fundamentally important for the conservation of biodiversity in the province.

The extent of prairie and savannah habitat in Ontario has been greatly reduced – in the Mixedwood Plains Ecozone, only a fraction (2-3%) remains (2,200ha; Rodger 1998) and this is threatened by habitat loss, invasive alien species, and succession to forest due to fire suppression. Globally rare alvar communities occur only in the Baltic region of Estonia and Sweden, in western Russia, and within the Great Lakes basin and the Interlake region of Manitoba of North America. Ontario contains 75-80% of the North American total, including sites on the Bruce Peninsula, Manitoulin and Pelee islands, near Napanee, Smith's Falls and the Carden Plain. Alvar ecosystems in Ontario face similar threats as prairie and savannah habitats. 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. Freshwater coastal dunes are fragile ecosystems that are easily affected by human activities.

The distribution and status of these rare ecosystems is tracked by Ontario's Natural Heritage Information Centre based on vegetation communities (assemblages of plant species with a consistent composition, structure and habitat). To date, more than 1,000 occurrences of vegetation communities that are considered to be globally rare by NatureServe have been documented in Ontario (Figure 1). Seventy-two 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.

This indicator assesses the total area and quality of prairie, savannah, alvar, and dune ecosystems in Ontario, and the area of each that is legally protected in the province.

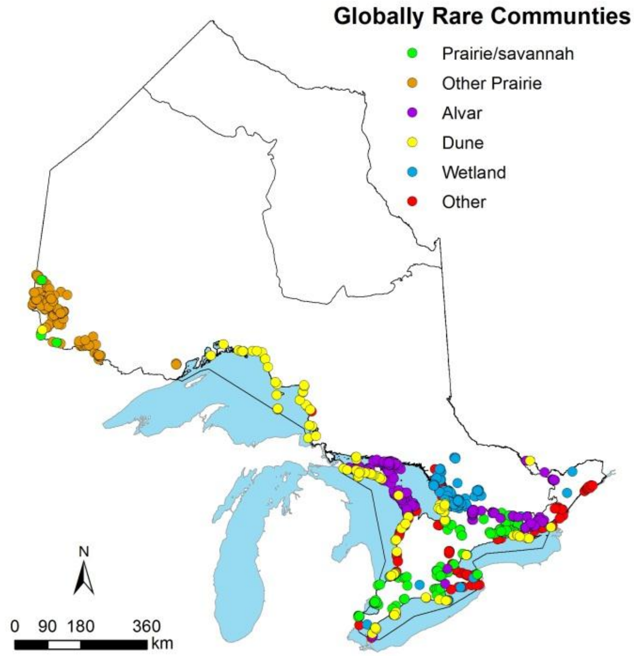

Figure 1. Distribution of globally rare vegetation communities in Ontario (*n* = 1,175).

Data Analysis:

Analysis for this indicator was based on detailed spatial data available through the [Natural Heritage Information Centre](). The areas of rare vegetation communities were summed to assess the total area of prairie, savannah, alvar and dune ecosystems in Ontario (Figure 2). The boundaries of vegetation communities in these rare ecosystems was overlain with the boundaries of protected areas (Provincial and National Parks, National Wildlife Areas and Conservation Reserves) using GIS to determine the proportion of each rare ecosystem type found in protected areas. 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. The total area and proportion of protected area for alvar and freshwater coastal dune communities have been refined from data originally reported in the *State of Ontario's Biodiversity 2010* report based on new survey information (alvars) as well as detailed analysis of orthophotography (dunes - Bakowsky and Henson 2014). Prairie/savannah communities assessed in this indicator are limited to those on deep soils and the analysis does not currently include prairie communities on shallow soils that are found in northwestern Ontario ('other prairie' category in Figure 1).

In addition to the total area and level of protection, the status of vegetation communities was assessed using element occurrence ranks that are based on a recent assessment by the Natural Heritage Information Centre. Extant vegetation communities were assigned element occurrence quality ranks from A - D (Table 1) based on NatureServe data standards. Ranks were based on an examination of the size, condition and landscape context of vegetation communities (Table 2). A full description of the ranking methodology can be found in Henson and Bakowsky (2014). For each rare ecosystem type, the total number and area of element occurrences assigned to each quality rank were tallied and plotted (Figure 3).

It is important to note that the proportion of each rare ecosystem in protected areas is based on legally protected areas and does not include privately owned conservation lands held by conservation organizations. Conservation lands account for important additional protection for some of these ecosystems, but have not been assessed due to the lack of consolidated, comprehensive information on their spatial boundaries. For instance, an assessment of alvar ecosystems by the Nature Conservancy of Canada showed that conservation lands contribute to the protection of an estimated additional 960 ha, almost equal to the amount in legally protected areas (D. Kraus, Nature Conservancy of Canada, personal communication).

Table 1. Element occurrence quality ranks assigned to vegetation communities in Ontario's prairie, savannah, alvar and dune ecosystems.

Quality rank	Description
A	excellent predicted viability
B	good predicted viability
C	fair predicted viability
D	poor estimated viability

Table 2. Description of factors considered when assessing quality of vegetation community element occurrences (see Henson and Bakowsky 2014).

Factor	Component
Size	Area of occupancy
Condition	Development/maturity (stability, old-growth)
	Ecological processes (degree of disturbance by logging, grazing, changes in hydrology or natural fire regime)
	Abiotic physical/chemical factors (stability of substrate, physical structure, water quality)
Landscape Context	Landscape structure and extent (pattern, connectivity e.g., measure of fragmentation/patchiness, measure of genetic connectivity)
	Condition of the surrounding landscape (ie. Development/maturity, species composition and biological structure, ecological processes, abiotic physical/chemical factors)

- Download summary data for rare vegetation communities

Results:

Trend: Baseline **Data Confidence:** High **Geographic Extent:** Mixedwood Plains/Ontario Shield

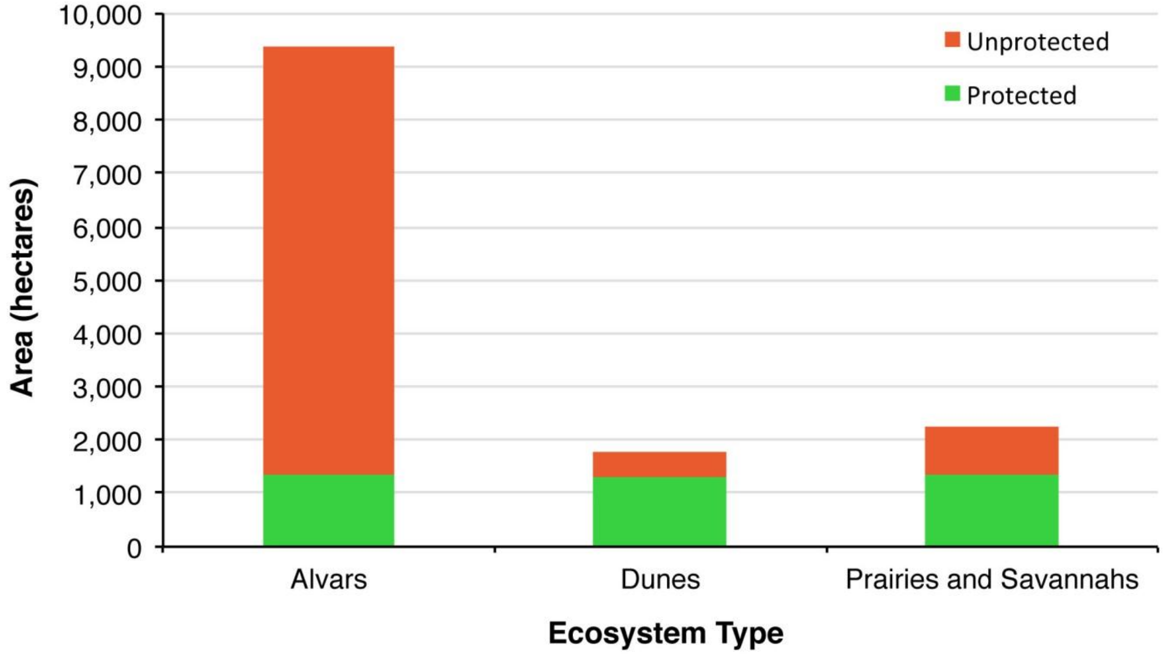

Figure 2. Total area of alvar, dune and prairie/savannah ecosystems in Ontario showing amount of each type that is legally protected (source: NHIC database, OMNRF, Peterborough, ON).

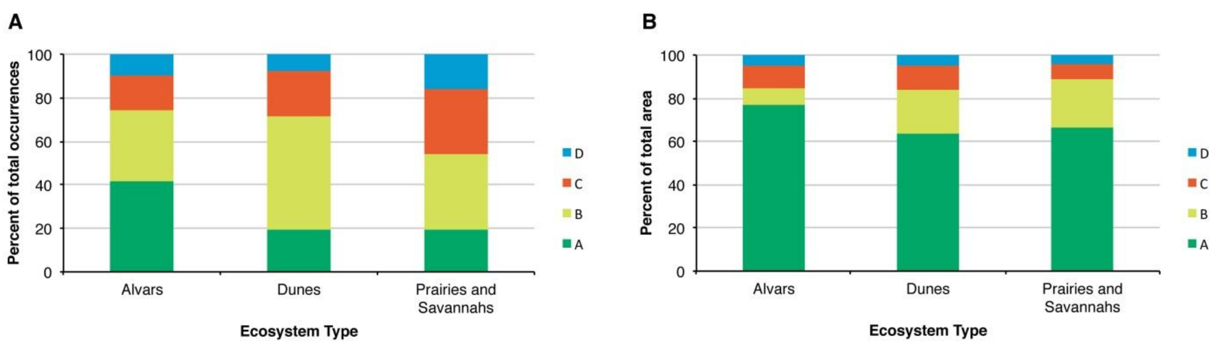

Figure 3. A) Proportion of vegetation community occurrences with quality ranks A-D in alvar, dune and prairie/savannah ecosystems; B) Proportion of area with quality ranks A-D in alvar, dune and prairie/savannah ecosystems (source: NHIC database, OMNRF, Peterborough, ON).

Status:

- Alvar ecosystems cover more area than the other rare ecosystem types, but only 14% of their total area is legally protected. It is estimated that conservation lands contribute to protecting and additional 10% of Ontario's total alvar area.
- More than half (61%) of the remaining prairie/savannah ecosystems are legally protected, while 75% of freshwater coastal dune systems are in protected areas.
- More than half of the occurrences of rare vegetation communities in all three ecosystems types were ranked as A or B meaning they have good to excellent predicted viability. More than 80% of the total area falls into the A and B ranks. This difference reflects the higher quality of larger areas and the consideration of size when assigning ranks.

Links:

Related Targets: 13. By 2020, at least 17 % of terrestrial and aquatic systems are conserved through well-connected networks of protected areas and other effective area-based conservation measures.

Related Themes: Pressures Ontario's Biodiversity – Habitat Loss

Web Links:

Natural Heritage Information Centre https://www.ontario.ca/environment-and-energy/natural-heritage-information-centre

References:

Bakowsky, W.D., and B.L. Henson. 2014. Rare communities of Ontario: freshwater coastal dunes. Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Queen's Printer for Ontario, Peterborough, ON.

Henson, B.L., and W.D. Bakowsky. 2014. Plant community ranking methodology: alvars, dunes, prairies. Natural Heritage Information Centre, Ontario Ministry of Natural Resources and Forestry, Peterborough, ON. [Available at: http://sobr.ca/_biosite/wp-content/uploads/Henson-and-Bakowsky-2014_Plant-Community-Ranking-Methodology-Alvars-Dunes-Prairies.pdf]

Rodger, L. 1998. Tallgrass communities of southern Ontario: A recovery plan. Report prepared for World Wildlife Fund Canada and the Ontario Ministry of Natural Resources.

State of the Lakes Ecosystem Conference (SOLEC). 2009. State of the Great Lakes 2009. Technical report prepared by Environment Canada and the United States Environmental Protection Agency. [Available at: http://www.epa.gov/solec/]

Citation

Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: STATUS OF GREAT LAKES ECOSYSTEMS

STRATEGIC DIRECTION: Enhance Resilience

TARGET: N/A

THEME: State of Ecosystems and Species

Background Information:

The Great Lakes – Erie, Huron, Michigan, Ontario and Superior - and their surrounding watershed make up a rich and diverse system that supports a wide variety of aquatic and terrestrial life. The Great Lakes contain nearly 20 per cent of the fresh surface water on the planet and there are over 4,000 species of plants, fish and wildlife that call this area their home. The Lakes also provide food and recreational opportunities, as well as supply the province with numerous economic advantages (Environment Canada and the US Environmental Protection Agency 2014).

The Great Lakes ecosystem has undergone significant and sometimes rapid ecological change associated with a long history of intensive human use. During the 1970s it became clear that pollution and other pressures were taking their toll on the Lakes. In response, several successful protection and restoration efforts were initiated, including cleaning up several highly polluted harbours, bays and waterfronts; dramatically reducing emissions of many toxic chemicals that were harming fish and wildlife; and reducing Lake Erie algae problems by banning phosphate detergents, upgrading sewage treatment and enhancing adoption of environmental farm practices, to reduce nutrients entering the lake (Government of Ontario 2012).

Despite these successes, the cumulative impacts of many pressures continue to threaten the Great Lakes. Toxic contaminants, invasive species, excessive amounts of nutrients, shoreline and land use changes, and hydrologic modifications are all impacting the Great Lakes ecosystem (Environment Canada and the US Environmental Protection Agency 2014). An understanding of ecosystem conditions and whether they are getting better or worse is necessary to address these problems. This indicator provides a lake-by-lake summary of the state of the Great Lakes based on information provided in the State of the Great Lakes Report 2011.

Data Analysis:

Information for this indicator was assembled from data provided in the State of the Great Lakes 2011 Report (EC and USEPA 2014), which provides science-based trend information on the state of the health of the Great Lakes Basin. The State of the Great Lakes Report 2011 was developed with the involvement of more than 125 scientists and experts from the Great Lakes community within Canada and the United States. The data are based on indicator reports and presentations from the State of the Lakes Ecosystem Conference. Some indicator reports have also been augmented with more recent information. More information about Great Lakes indicators and the State of the Lakes Ecosystem Conference can be found at: http://www.epa.gov/solec/ or https://www.ec.gc.ca/grandslacs-greatlakes/ .

Reporting on a suite of Great Lakes indicators provides a big picture perspective of the complex Great Lakes ecosystem. The State of the Great Lakes 2011 technical report contains indicator reports that assess trends in water quality, aquatic-dependent life and landscapes and natural processes. The state of 44 indicators is also assessed on a Lake-by-Lake basis. The framework for the status assessment is defined in Table 1.

Table 1. Indicator assessment criteria in the State of the Great Lakes Report 2011.

Status	Description
Good	Meeting Great Lakes Water Quality Agreement or other ecosystem objectives or otherwise in acceptable condition.
Fair	Exhibiting minimally acceptable conditions, but not meeting established GLWQA or other ecosystem objectives.
Poor	Severely negatively impacted and not displaying even minimally acceptable conditions.
Undetermined	Data are not available or are insufficient to assess the status of ecosystem components.

To understand the overall state of each Great Lake, the percentage of indicators that were assessed as good, fair, poor or undetermined are presented (Fig. 1). As well, a narrative describing the state of each Great Lake, including ongoing and emerging stressors is included. While Lake Michigan is located entirely within the Unites States, it is included in this analysis as these waters are part of a larger shared system and the state of the Lake has impacts on the entire Great Lakes Basin, including Ontario.

Results:

Trend: Mixed **Data Confidence:** High **Geographic Extent:** Great Lakes

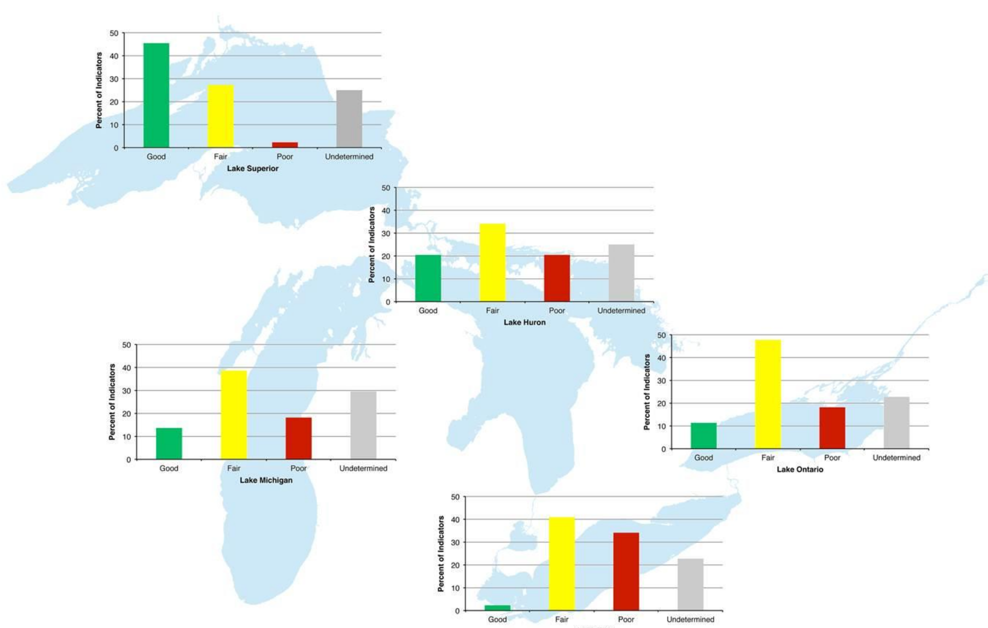

Figure 1. Percentage of indicators that were classified as good, fair, poor or undetermined for each of the Great Lakes in the State of the Great Lakes Report 2011 (n = 44).

Status:

- Lake Superior is in generally good condition, with almost half of indicators assessed as good (46%) and only one (aquatic non-native species) considered poor.
- The largest proportion of indicators for Lake Michigan (39%), Lake Huron (34%) and Lake Ontario (48%) were assessed as fair.
- While the largest proportion of indicators for Lake Erie were also assessed as fair (41%), this Lake also had the highest number of indicators assessed as poor (34%) and only one (drinking water quality) assessed as good.

Lake Superior

Lake Superior is in generally good condition due to its larger size and relatively low development pressure. The fisheries are healthy, the lower food web is strong and toxic chemicals are largely decreasing or remaining stable. Ongoing and emerging stressors include fluctuating water levels and increasing concentrations of contaminants in whole fish. Water levels in Lake Superior have been below average since the 1990s and there are concerns that climate change will cause greater fluctuations and possibly lower water levels. From an ecological perspective, short and long-term lake level fluctuations are critical to maintain healthy coastal habitats, especially wetlands. However, dramatic or sustained long-term changes can degrade these important habitats. Concentrations of PCBs and pentaBDEs are also above guidelines in Lake Trout. Total mercury concentrations, although still below the target, have returned to levels observed in the 1980s and appear to be increasing.

Lake Michigan

Lake Michigan is located entirely within the Unites States; however, these waters are part of a larger shared system and the state of the Lake has impacts on the entire Great Lakes Basin, including Ontario. In general, Lake Michigan is in a state of change with both positive and negative trends. The removal of dams, restoration of wetland habitat and riverine spawning habitat, and continued decline of contaminants such as PCBs in fish have resulted in improvements. However, the aquatic food web is under stress because *Diporeia*, a small crustacean that is an important food for many fish species, has almost disappeared. Several invasive species such as Sea Lampreys, Round Goby, Zebra Mussel and Quagga Mussel continue to cause significant changes in water clarity and fertility, resulting in major changes to Lake Michigan's ecosystem. This includes dense, widespread algal growth which is suspected of playing a role in Type E Botulism outbreaks that have caused the death of large numbers of fish eating birds. Viral Hemorrhagic Septicemia (VHS) has also recently become established in this Lake and has caused significant fish die-offs.

Lake Huron

Lake Huron has been called “the lake in the middle” both geographically and in terms of its environmental quality. In general, Lake Huron has good water quality with low concentrations of toxic chemicals in offshore waters and a decreased concentration of some legacy chemicals, such as PCBs and DDT, in fish. However, development, dams, non-point source pollution, invasive species and climate change are major stressors on the ecosystem and are resulting in habitat degradation and loss. In particular, Lake Huron has suffered due to the recent invasion of Zebra Mussel and Quagga Mussel and the disappearance of *Diporeia*, which impact on the Lake's nutrient cycling and food web dynamics. Prey fish populations have dramatically decreased since 2003 and predator fish species, such as Salmon, have also decreased in number and total biomass. In contrast, near shore nutrient concentrations have increased and populations of Walleye, Yellow Perch and Smallmouth Bass seem to be rebounding.

Lake Erie

Despite early successes in reducing phosphorus loads to the Lakes after the 1972 Great Lakes Water Quality Agreement was implemented, Lake Erie continues to be threatened by excessive nutrient inputs from non-point sources such as urban and rural run-off. Algal blooms have become a regular occurrence throughout the western basin during summer months and *Cladophora* growth has once again become a problem in near shore areas. Compounding this problem, in-lake nutrient cycling has changed due to the spread of invasive Zebra Mussel and Quagga Mussel that became established in the 1980s. This alteration of nutrient flow is contributing to greater nuisance algal growth in the near shore regions, while deeper offshore waters are deprived of oxygen causing "dead zones" for aquatic life. Other changes contributing to the resurgence of algae include the loss of wetlands and riparian vegetation that once trapped nutrients. Shifting communities of phytoplankton, increased water clarity and climate issues such as warmer waters and extreme precipitation events also play a role. As result of these ecological changes the fish community in Lake Erie has also suffered. Some fish species have been extirpated (e.g., Blue Pike, Shortnose Cisco), while others such as Walleye have much smaller populations than they have had in the past.

Lake Ontario

Although Lake Ontario is the smallest of the Great Lakes, its drainage basin is the most densely populated and provides ecosystem services to over 10 million people. Past and current pressures on this ecosystem have led to drastic changes in nutrient dynamics, altered hydrology, loss of coastal habitats, and the introduction of invasive species, all with serious consequences to native species, food webs, and quality of life. Many of these changes have occurred rapidly and the Lake continues to respond in unpredictable ways. Progress has been made to reduce these stressors including decreasing the amount of nutrients and toxic chemicals entering the lake and restoration of degraded habitats. These improvements have led to the return of Osprey and Bald Eagle to the shores of Lake Ontario, and have supported initiatives to restore native Lake Trout and Atlantic Salmon to the region. In contrast, a number of fish, bird and wildlife populations have declined in Lake Ontario, due in part, to destruction of habitat, overfishing, the introduction of invasive species and toxic contaminants. In particular, the invasion of Zebra Mussel and Quagga Mussel and the disappearance of *Diporeia* continue to impact the Lake's nutrient cycling and food web dynamics.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

State of the Great Lakes 2011 Technical Report http://binational.net/wp-content/uploads/2014/11/sogl-2011-technical-report-en.pdf

State of the Great Lakes 2011 Highlights http://www.ec.gc.ca/grandslacs-greatlakes/DEA99937-E0B6-4F10-8F0A-993661A2F9CC/Highlights%20Report%20E%20130827%20FINAL.pdf

State of the Great Lakes Ecosystem Conference http://www.epa.gov/solec/

Ontario's Great Lakes Strategy https://dr6j45jk9xcmk.cloudfront.net/documents/896/5-1-5-great-lakes-strategy-en.pdf

Great Lakes Biodiversity Conservation Strategies https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/wholesystems/greatlakes/basin/biodiversity/Pages/default.aspx

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Citation

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INDICATOR: ALTERATIONS TO STREAM FLOW

STRATEGIC DIRECTION: Enhance Resilience

TARGET: N/A

THEME: State of Ontario's Biodiversity – Aquatic Ecosystems

Background Information:

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 (Metcalfe et al. 2013).

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). Direct water taking and use of surface and ground water by humans can also contributed to altered flow regimes. It is predicted that climate change will likely impact many aspects of flow regimes in Ontario (Bates et al. 2008). In particular, changes in the spring freshet (peak stream flow associated with melting snow pack), and summer low flows are probable. Some climate change models predict a reduction in the amount and duration of the spring freshet due to an increase in snow melt events during the winter. The timing of 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).

This indicator assesses alterations in stream flow variables that are important to biodiversity by examining long-term changes in the amount and timing of annual high and low flows and flow variability (flashiness) for streams across Ontario.

Data Analysis:

Daily flow data were extracted from the Water Survey of Canada HYDAT (Water Survey of Canada 2014) database for 799 continuous stream flow monitoring stations in Ontario. Stations with current data and a continuous record of at least 30 years were included in long-term trend analysis. Stations with less than 90% of daily flow data for any month were excluded from the analysis. The resulting database includes 291 Ontario stations – 20 of these stations are considered as reference stations that have been relatively unimpacted by dams and other human influences on the landscape. Changes through time in annual stream flow metrics based on daily flow data were analyzed using the non-parametric Mann-Kendall rank regression (Helsell and Hirsch 2002, Helsell et al. 2006). Five flow metrics relevant to biodiversity (Table 1) were assessed for each individual station to determine significant long-term trends and their direction (i.e., increasing or decreasing for amount of flow and flashiness; earlier or later in year for high and low flows). Trends were analyzed for the period 1981-2010 (274 stations) as well as for the entire period of record (mean 53 years) for each station. Trends for the 1981-2010 period are presented below on maps at the provincial scale (Figure 1) and are summarized by ecozone (Figure 2). A more detailed account of the analysis and results can be found in a companion technical report (Jones et al. 2015). Caution is warranted.

It is important to note that trends in flow over a specific period of record will be influenced by climate trends (precipitation and temperature) warranting caution when interpreting trends. Longer term trends in flows for the stations included in this indicator are assessed and compared with trends over the most recent 30-year period in Jones et al. (2015).

Table 1. Description of flow metrics assessed for long-term trends.

Flow characteristic	Flow metric	Description
Amount	3-day maximum	Annual highest average flow over 3 consecutive days
	7-day minimum	Annual lowest average flow over 7 consecutive days
Timing	3-day maximum date	Annual calendar day for 3-day maximum flow
	7-day minimum date	Annual calendar day for 7-day minimum flow
Variability	Richards-Baker Flashiness Index	Annual index of changes in flows from one day to the next

- download stream-flow summary data

Results:

Trend: Mixed **Data Confidence:** High **Geographic Extent:** Provincial

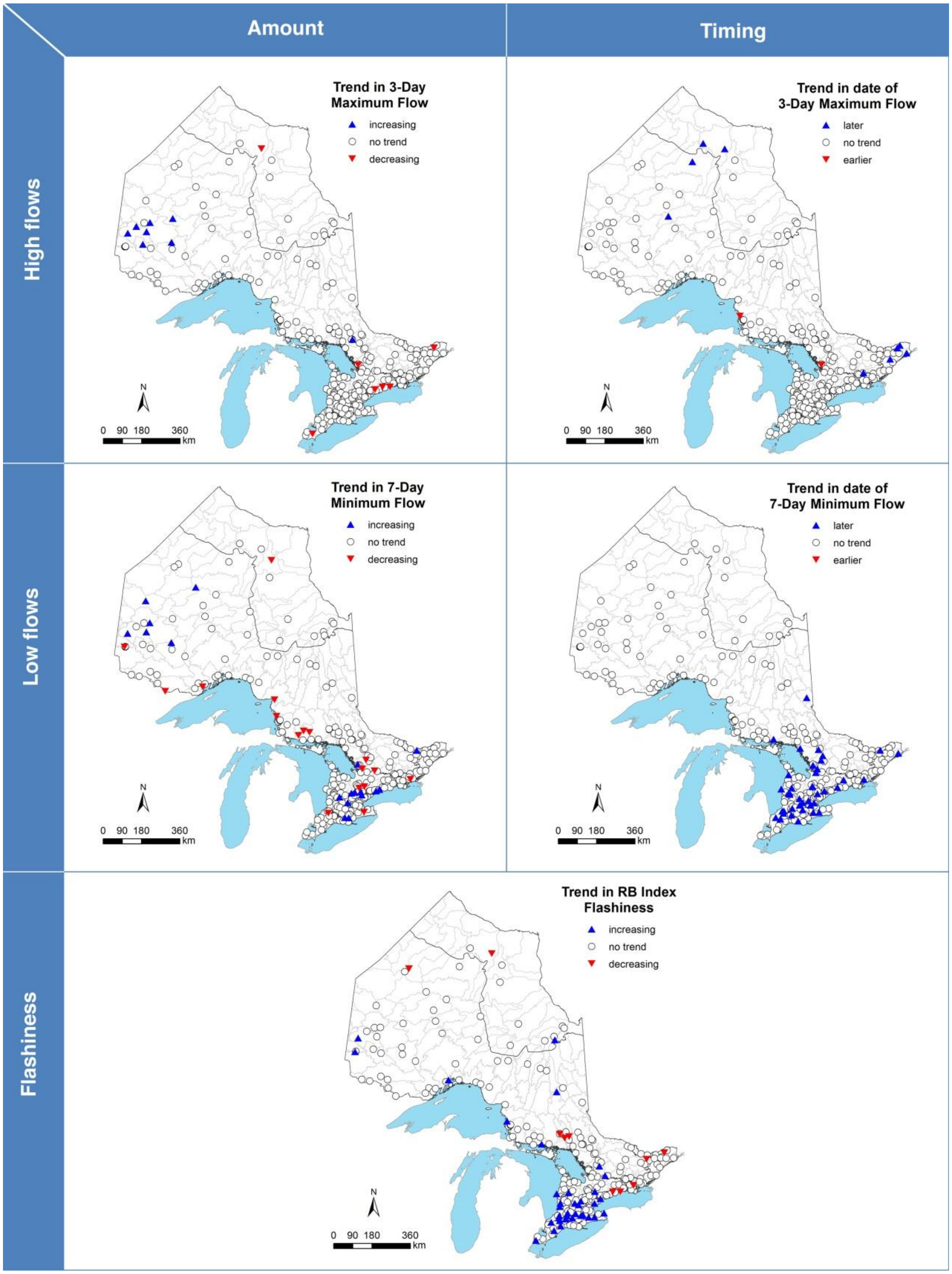

Figure 1. Significant trends in the amount and timing of high and low flows and flashiness for 274 Ontario stream flow stations over the period 1981-2010.

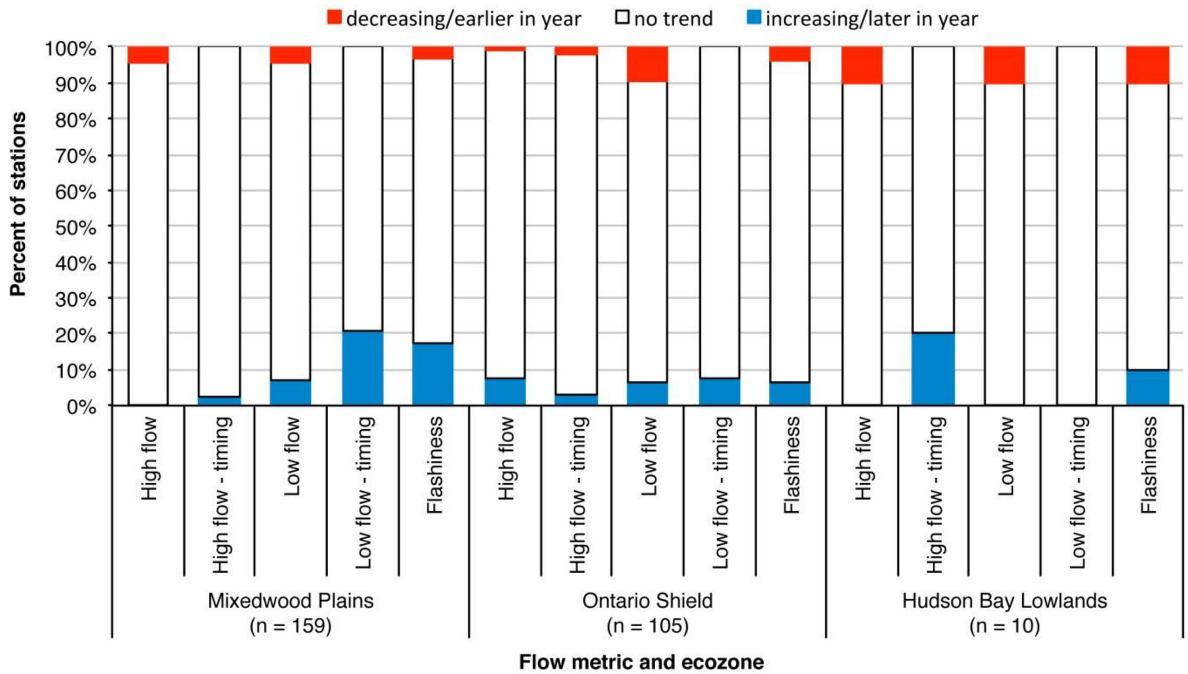

Figure 2. Summary of 1981-2010 trends in ecological flow metrics by ecozone.

Status:

- Forty-two percent of stations (116 stations) had significant trends in at least one of the five ecological flow metrics over the 1981-2010 period. Nine percent (26 stations) had significant trends in multiple flow metrics. Among the 20 reference stations, only 30% showed significant trends and each station showed a trend in only one of the five flow metrics.
- Few stations showed trends in the amount of annual high flows (6%). Trends that were evident included decreasing high flows in some stations in the Mixedwood Plains Ecozone and increasing high flows in some stations in the northwestern portion of the Ontario Shield Ecozone.
- Only 4% of stations displayed trends in the timing of annual high flows and most tended towards later in the year. When examined over a longer period, 8% of 170 stations in the Mixedwood Plains Ecozone had trends of high flows earlier in the year consistent with predicted responses due to climate change.
- Thirteen percent of stations show trends in the amount of annual low flows, with both increases and decreases being equally represented.
- Fifteen percent of stations showed a trend towards a later date in minimum flows and all of these were in the Mixedwood Plains Ecozone and the southern part of the Ontario Shield.
- A higher proportion of stations showed significant trends for flashiness (17%) than for any other flow metric. Most of the stations with trends (78%) were increasing in flashiness and these stations were concentrated in the southwest portion of the Mixedwood Plains Ecozone.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Water Survey of Canada – hydrometric data http://www.ec.gc.ca/rhc-wsc/default.asp?lang=En&n=894E91BE-1

Ontario Ministry of Natural Resources and Forestry – Surface Water Monitoring Centre http://www.ontario.ca/environment-and-energy/surface-water-monitoring-centre

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Poff, N.L., B.P. Bledsoe, and C.O. Cuhaciyan. 2006. Hydrologic variation with land use across the contiguous United States: geomorphic and ecological consequences for stream ecosystems. Geomorphology 79:264–285.

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INDICATOR: CHANGES IN STATUS OF SPECIES AT RISK

STRATEGIC DIRECTION: Enhance Resilience

TARGET: 10. By 2015, the status of species and ecosystems of conservation concern in Ontario is improved.

THEME: State of Ontario's Biodiversity – Species Diversity

Background Information:

Protecting and promoting recovery of species at risk of extinction is a critical component of biodiversity conservation (Favaro et al. 2014). The Endangered Species Act, 2007 (ESA 2007) legally recognizes the Committee on the Status of Species at Risk in Ontario (COSSARO) as the group responsible for determining the classification species at risk in Ontario. Before the ESA, 2007 came into force, COSSARO existed as a committee that made policy recommendations to the Ministry of Natural Resources and Forestry. However, the law gave the group legal recognition and specific responsibilities including maintaining criteria for assessing and classifying species, developing the list of species to be assessed; assessing and classifying species; and providing advice to the Minister of Natural Resources and Forestry.

COSSARO uses the best available scientific information, including community knowledge and Aboriginal Traditional Knowledge, to determine whether a plant or animal should be listed as "at risk". If a species is deemed "at risk", the committee classifies the species into one of four categories, based on the degree of risk it faces. Species may also be categorized as extinct, data deficient or not at risk (Table 1).

Table 1. Categories of Species at Risk in Ontario.

Status	Definition
Extirpated	Lives somewhere in the world, and at one time lived in the wild in Ontario, but no longer lives in the wild in Ontario
Endangered	Lives in the wild in Ontario but is facing imminent extinction or extirpation
Threatened	Lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening it
Special Concern	Lives in the wild in Ontario, is not endangered or threatened, but may become threatened or endangered due to a combination of biological characteristics and identified threats

Species added to the Species at Risk in Ontario List as endangered, threatened or extirpated are automatically protected from being harassed or harmed. Recovery strategies (for endangered or threatened species) and management plans (for species of special concern) are also prepared. Recovery strategies provide science-based protection and recovery recommendations, while management plans provide information regarding the biology of the species and advice on the approaches for reducing threats. Following the completion of a recovery strategy or management plan, a government response statement is prepared. This statement outlines the government's goal for the recovery of the species and summarizes the prioritized actions the government intends to take or support for the protection, recovery and management of the species.

This indicator examines trends in the status of species repeatedly assessed by COSSARO to see if their status has improved.

Data Analysis:

To assess trends in the status of species at risk in Ontario, changes in species status following re-assessment by the Committee on Species at Risk in Ontario (COSSARO) were examined. Between 1995 and 2013, 275 species were assessed by COSSARO. Species that were assessed more than once between 1996 (the year criteria were established for assessing species) and 2013 were included in the analysis (n=117). COSSARO criteria were used for all species reassessments considered in this analysis; however, it is important to note that there have been minor changes to the criteria throughout the years that may affect some reassessments. The numbers of species that were moved into lower risk categories, higher risk categories or experienced no change in status are presented.

Data for this indicator were collected from COSSARO Annual Reports (2008 – 2014) and data maintained by the Ontario Ministry of Natural Resources (1996-2007). COSSARO annual reports are available on the Ontario Ministry of Natural Resources and Forestry Species at Risk website (https://www.ontario.ca/environment-and-energy/classifying-species-risk).

It is important to note that the goal of many Ontario government recovery strategies for species at risk is to maintain the current status. This differs from the Ontario Biodiversity Strategy target to improve the status of species of conservation concern. This indicator reports on progress towards meeting the Ontario Biodiversity Strategy target.

Results:

Trend: Mixed	**Data Confidence:** High	**Geographic Extent:** Provincial

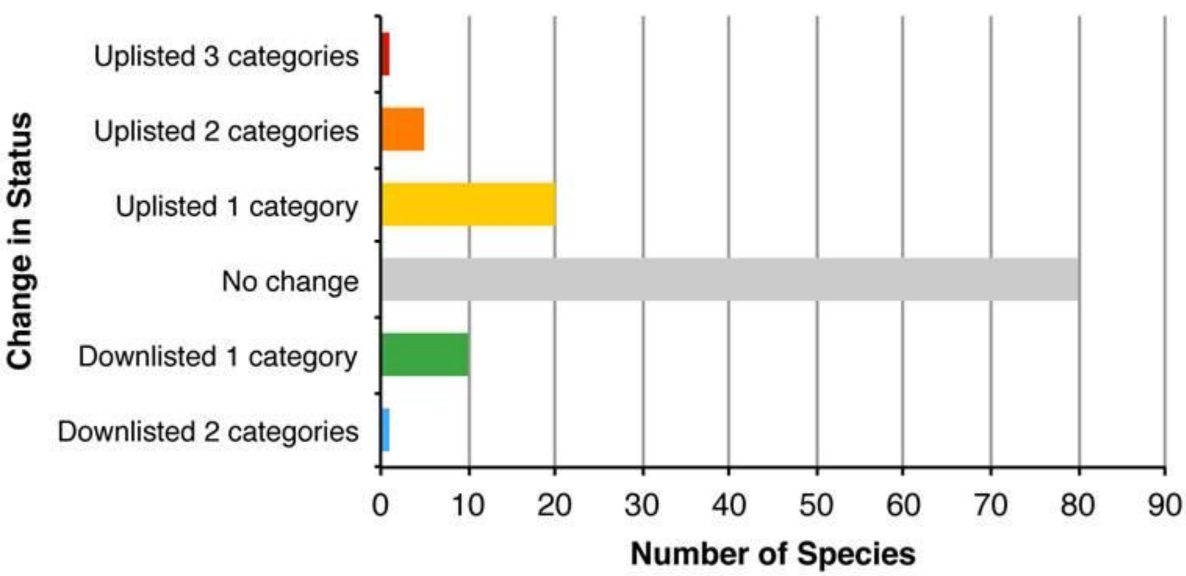

Figure 1. Changes in species status following re-assessment by the Committee on the Status of Species at Risk in Ontario 1996-2013 (*n* = 117).

Status:

- As of January 2015, there were 224 species on the Species at Risk in Ontario List. This represents an increase of 25 species since the State of Ontario's Biodiversity 2010 Report.
- Between 1996 and 2013, 117 species were assessed more than once by the Committee on the Status of Species at Risk in Ontario (COSSARO).
- Following re-assessment, most species showed no change (80 species, 68%) in status, while 26 species (22%) were moved into a higher risk category (shown in Figure as uplisted) and 11 species (9%) were moved into a lower risk category (shown in Figure as downlisted).
- Since 2004, seven species have been removed from the Species at Risk in Ontario List - Great Grey Owl, Hooded Warbler, Red-Shouldered Hawk, Bigmouth Buffalo, Black Buffalo, Greenside Darter and Southern Flying Squirrel.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Ontario Ministry of Natural Resources - Species at Risk http://www.mnr.gov.on.ca/en/Business/Species/index.html

Canadian Environmental Sustainability Indicator – Species at Risk Population Trends http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=79579EFA-1

References:

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Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: TRENDS IN SPECIES OF CONSERVATION CONCERN BASED ON GENERAL STATUS ASSESSMENT

STRATEGIC DIRECTION: Reduce Threats

TARGET: 10. By 2015, the status of species and ecosystems of conservation concern in Ontario is improved.

THEME: State of Ecosystems and Species – Species Diversity

Background Information:

Globally, population sizes of vertebrate species have declined by 52 percent over the last 40 years (World Wildlife Fund 2014). These species are threatened by human activities such as development and the consumption of natural resources. The general status of a broad cross-section of wild species in Canada is assessed every 5 years. General status ranks for species in Ontario are a tool which can help identify which species' populations are sensitive or may be at risk and are in need of further protection. Comparing the rankings between species groups is useful for determining patterns of threats that may be affecting these groups of species and pointing the way to improved conservation practices to mitigate the threats. At the provincial and national levels, each assessed species is assigned a rank in one of 10 general status categories (Table 1). The first five categories represent species of conservation concern.

Table 1. Definitions of general status ranks (modified from CESCC 2006).

	General status 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.
	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 Ontario 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.

This indicator examines the status of Ontario wild species assessed in the 2010 General Status assessment as well as changes from the previous assessment in 2005. It provides an update to information presented in *State of Ontario's Biodiversity 2010* (OBC 2010).

Data Analysis:

General status ranks for Ontario species from the 2005 and 2010 national general status assessments (CESCC 2006, 2011) were downloaded from the national general status assessment web site. For Ontario species, general status ranks are largely based on species subnational status ranks (S-ranks) maintained by the Ontario Natural Heritage Information Centre.

In 2010, 6,995 Ontario species were assessed, including 2,778 species in groups that were not assessed in 2005 (Table 2). The new species groups assessed in 2010 included lichens, mosses, spiders and eight new insect groups (predaceous diving beetles, ground beetles, lady beetles, bumblebees, black flies, horse flies, mosquitoes and selected macromoths). Only three insect groups were assessed in 2005 (odonates [dragonflies and damselflies], tiger beetles and butterflies). To simplify presentation all insect groups have been included in a larger general group named "Insects". The status of freshwater fishes was not re-assessed in the Wild Species 2010, so 2005 data for this group are presented. A summary of the proportion of native species in secure and conservation concern general status categories is presented (n = 4,758) for each taxon group and for all species combined based on the 2010 assessment (Figure 1). This summary excludes species in the exotic, undetermined, accidental and not assessed categories.

For 4,063 species that were assessed both in 2005 and 2010 (Figure 2), the number of species with changes in general status ranks and the reasons for changes were examined (Table 3). The reasons for changes in status are important. Some changes in rank occurred as a result of real changes in the distribution, population size or threats to the species causing ranks to either increase or decrease in risk (see Figure 3). Many of the changes in risk were due to improved information about the species, but do not represent real changes in distribution and abundance (i.e., new survey data provided a more accurate assessment of the status of the species). Some changes in rankings also occurred due to taxonomic changes – a formerly recognized species is combined with another species or a single species is divided into two or more species. Procedural changes and rectifying errors from the previous report also resulted in some changes in the general status of species.

Results:

Trend: Mixed **Data Confidence:** High **Geographic Extent:** Provincial

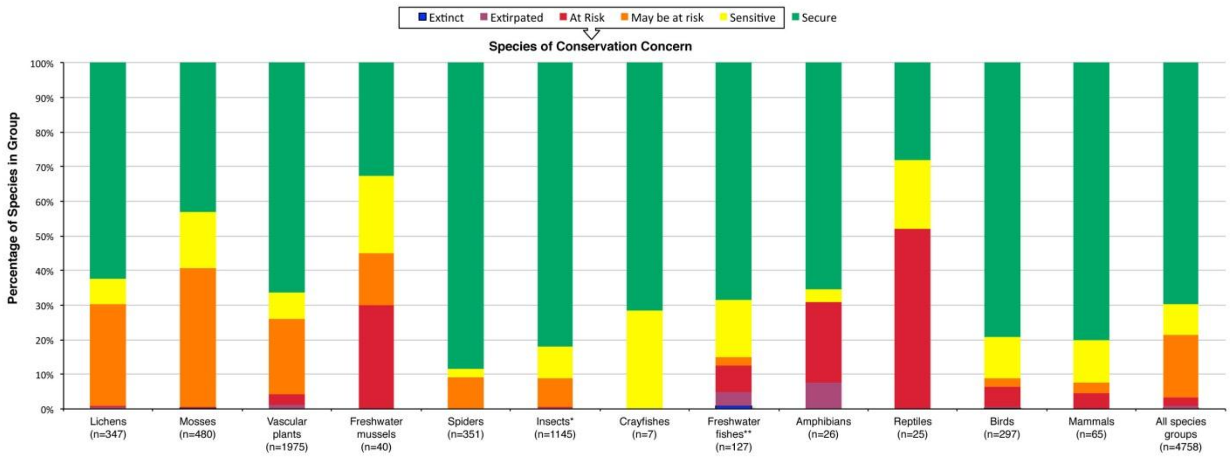
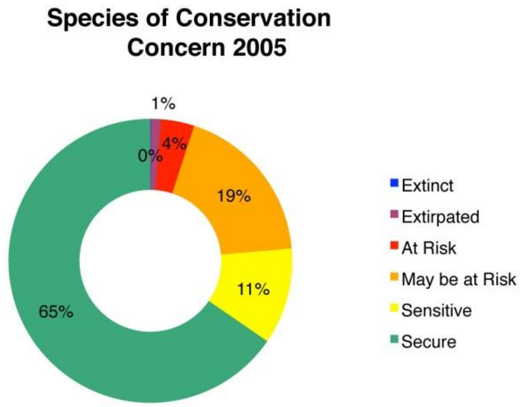


Figure 1. Proportion of Ontario native wild species in secure and conservation concern categories. (*n* = number of secure species and species of conservation concern in group;*Insect groups assessed are odonates, predaceous diving beetles, ground beetles, lady beetles, bumblebees, black flies, horse flies, mosquitoes, butterflies and selected macromoths;**2005 data for fishes - 2010 assessment not complete.) (CESCC 2011).

Table 2. General Status ranks for Ontario species assessed in 2010 (CESCC 2011).

	Species of Conservation Concern										
Taxonomic Group	Extinct	Extirpated	At Risk	May be at risk	Sensitive	Secure	Undetermined	Not Assessed	Exotic	Accidental	Total
Lichens	0	2	1	102	26	216	61	10	0	0	418
Mosses	1	1	1	192	79	206	41	0	1	0	522
Vascular plants	0	25	62	427	149	1312	73	0	1051	0	3099
Freshwater mussels	0	0	12	6	9	13	0	1	0	0	41
Spiders	0	0	0	32	9	310	366	0	34	0	751
Insects*	0	3	3	95	105	939	317	0	33	43	1538
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	6	0	1	17	0	0	0	0	26
Reptiles	0	0	13	0	5	7	1	0	1	0	27
Birds	1	1	17	7	36	235	4	0	9	173	483
Mammals	0	0	3	2	8	52	5	1	7	3	81
All species groups	3	39	128	866	450	3399	875	13	1157	219	7149

*Insects groups assessed are odonates, predaceous diving beetles, ground beetles, lady beetles, bumblebees, black flies, horse flies, mosquitoes and selected macromoths.
**2005 data for fishes - 2010 assessment not complete.



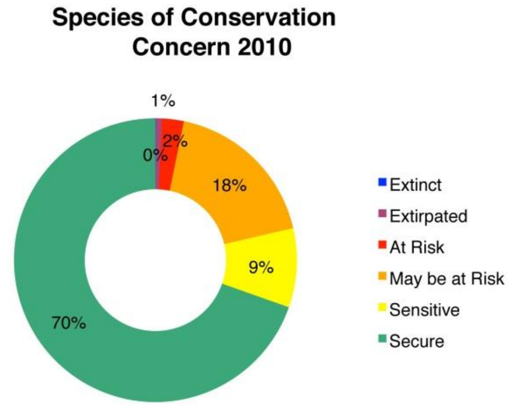


Figure 2. A comparison of the general status of native Ontario species assessed in 2005 (*n* = 2,854) and 2010 (*n* = 4,758).

Table 3. Summary of changes in general status ranks for Ontario species assessed in 2005 and 2010 and reasons for rank change. This table compares species groups that were assessed both in 2005 and in 2010. Species groups that are new in 2010 are not included in this table (lichens, mosses, spiders, new insect groups).

Direction of General Status Rank Change		Reason for Change		
	Total	Better Information	Increasing risk	Decreasing risk
Species in Lower Risk Rank	134	128	n/a	6
Species in Higher Risk Rank	45	32	13	n/a
Into accidental or exotic	16	16	n/a	n/a
Into undetermined	18	18	n/a	n/a
From undetermined to another rank	22	22	n/a	n/a
Total Number of Changes*	235	216	13	6
No Change	3,759			

* This total excludes 69 species that were new to the groups that were assessed in Wild Species 2005: 54% of these species were newly discovered, introduced exotics or have expanded their range into Ontario. 46% were considered "new" due to taxonomic changes.

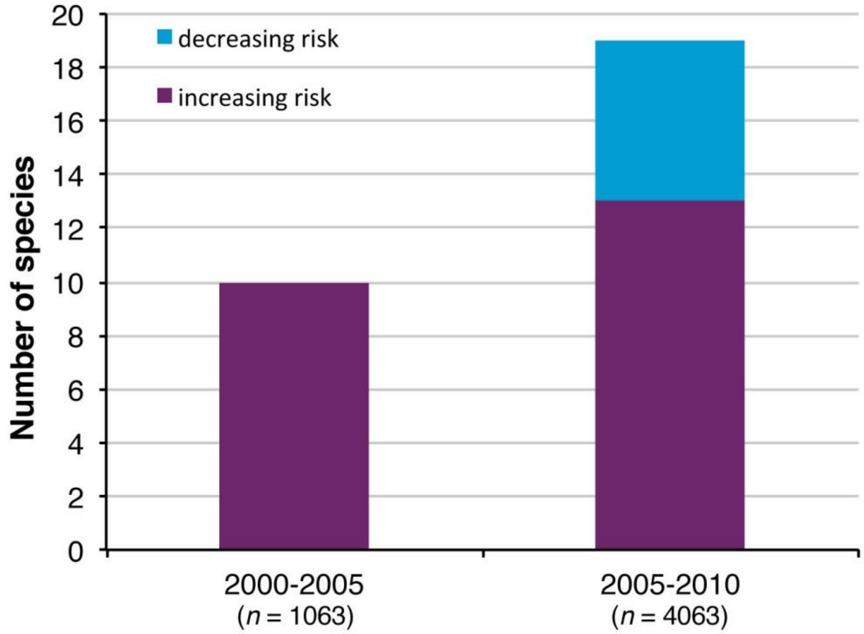


Figure 3. Number of species with real general status rank changes due to increasing risk and decreasing risk between the 2000 and 2005 assessments (OBC 2010) and between the 2005 and 2010 assessments.

Status:

- Reptiles and freshwater mussels are the most vulnerable species groups. 72% of reptiles and 68% of freshwater mussels are of conservation concern (ranked as extinct, extirpated, at risk, may be at risk or sensitive).
- Spiders (88%) and select insects (82%) are the groups with the highest proportion of secure species. However, almost half (49%) of spider species were ranked as undetermined due to insufficient information. Among vertebrate groups, mammals had the highest proportion of secure species (80%).
- General status ranks of 2,778 new Ontario species have been introduced in the *Wild Species 2010* report, including lichens, mosses, spiders, predaceous diving beetles, ground beetles, lady beetles, bumblebees, black flies, horse flies, mosquitoes and selected macromoths.
- 235 of 4,063 species (6%) assessed in 2005 and 2010 had a change in general status rank. The majority of changes in ranks can be attributed to improved knowledge (92%). There were 69 new species added due to introductions, range expansions, new discoveries and taxonomic changes.
- Since 2005, 13 species changed status due to increasing risk. These changes can be attributed to changes in population size, distribution or threats to the species. Only six species changed status due to decreasing risk.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

General Status of Species in Canada http://www.wildspecies.ca/home.cfm?lang=e

References:

Canadian Endangered Species Conservation Council (CESCC). 2006. Wild species 2005: The General Status of Species in Canada. National General Status Working Group. [Available at: www.wildspecies.ca/wildspecies2005/GS2005_site_e.pdf]

Canadian Endangered Species Conservation Council (CESCC). 2011. Wild species 2010: The General Status of Species in Canada. National General Status Working Group. [Available at: http://publications.gc.ca/collections/collection_2011/ec/CW70-7-2010-eng.pdf]

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Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: AMOUNT OF GENETIC VARIATION, GENETIC COMPOSITION AND SPATIAL STRUCTURE OF SELECTED SPECIES

STRATEGIC DIRECTION: Enhance Resilience

TARGET: N/A

THEME: State of Ecosystems and Species – Genetic Diversity

Background Information:

Changing land use and habitat loss increases fragmentation and isolation of populations on the landscape, which in turn reduces population size. Reductions in population size often lead to a loss of genetic diversity and an increase in inbreeding (Frankham et al. 2002). This may result in a reduction in survival and reproductive fitness.

The American Black Bear is an ecologically important species that is adapted to a range of environments across North America. Genetic studies of Black Bears have detected differentiation between populations on moderate geographic scales, despite the ability of bears to travel across considerable distances (e.g., Warrillow et al. 2001; Dixon et al. 2006; Onorato et al. 2007; Pelletier et al. 2011; Puckett et al. 2014). This has largely been attributed to population fragmentation resulting from human influences and activities such as transportation corridors, resource extraction, and urban and industrial development (Scheik and McCown 2014).

Ontario is home to a large number of Black Bears (95,000 individuals – Obbard, unpublished data) that occur within a region of primarily continuous boreal and mixed deciduous forest habitat. No obvious barriers to Black Bear movement exist in the province, except in the southern region, where human density and landscape fragmentation are high (Statistics Canada 2011). In light of increasing human populations, development and landscape fragmentation in the province, and particularly in southern Ontario, it is important to assess Black Bear genetic diversity throughout the province to understand how these growing human influences may affect the genetic diversity and viability of Ontario Black Bears.

This indicator assesses Black Bear genetic diversity and genetic differentiation at the provincial scale, providing an indication of the genetic health of the species in Ontario.

Data Analysis:

Information on the genetic differentiation and genetic diversity of Black Bears in Ontario is based on results detailed in Pelletier et al. (2011 and 2012). Genetic data were obtained from hair collected via baited barbed wire hair traps placed throughout Ontario between 1997 and 2012, as well as from samples obtained opportunistically (livetrapping, hunting, or road kills). A total of 2839 individual Black Bears were sampled from 61 sites throughout Ontario. This initiative was part of the Ontario's Enhanced Black Bear Management Program, whose goal is to monitor the number of Black Bears in the province over time to support Ontario's Enhanced Black Bear management Framework.

Following collection of hair samples, DNA was extracted, amplified and sequenced to obtain individual genotypes and sequences of maternal DNA. As such, individual genotypes provided information about the current genetic diversity of Black Bears in the province. Diversity was assessed by i) looking at the differences between the paternal and maternal genetic information within each individual ("heterozygosity"), and ii) looking at the overall number of potential genetic types (or, "alleles"). Both of these measures were averaged across all individuals in the population, providing an indication of overall genetic diversity.

Sequences of maternal DNA ("haplotypes") provided information on the historical genetic diversity of Black Bear populations in Ontario. Haplotypic diversity (number of haplotypes) was measured for each sampling site as an indication of historical genetic diversity. Analyses were conducted on a subset of individuals (*n* = 660).

Finally, genetic differentiation was examined using a measure called F_{ST}, where 1 indicates complete differentiation and 0 indicates no differentiation between two populations. F_{ST} was calculated among all possible pairs of identified genetic groups. These genetic groups were delineated based on the geographical distribution of similar haplotypes and similar alleles.

Results:

Trend: Baseline **Data Confidence:** Medium **Geographic Extent:** Provincial

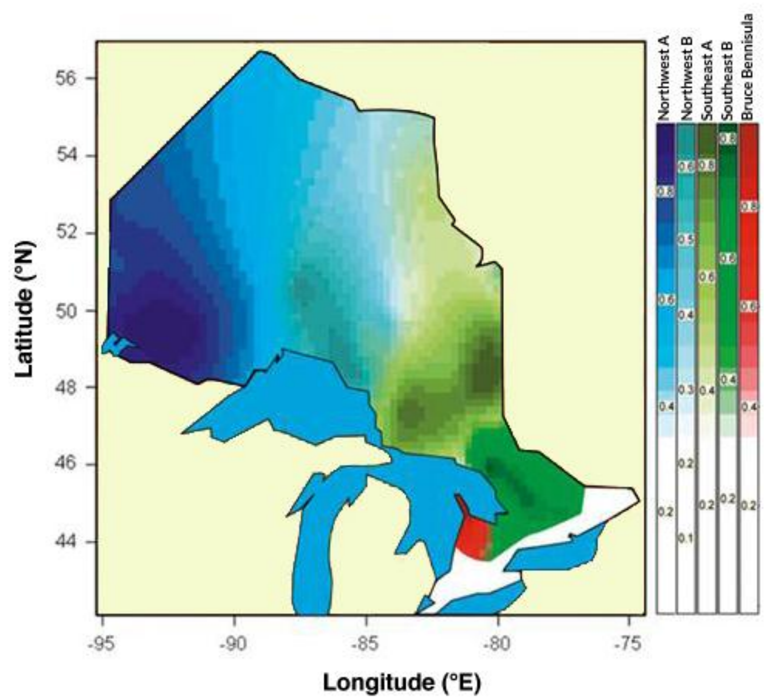

Figure 1. Map representing the 3 genetic groups of American Black Bears identified in Ontario. Blue: northwestern regional population; Green: southeastern regional population; Red: Bruce Peninsula population. The scale on the right indicates the probability that an individual would genetically correspond to the population it was sampled in. The two shades of blue and green respectively indicate the subgroups identified within the northwestern and southeastern populations (Source: Pelletier et al. 2012).

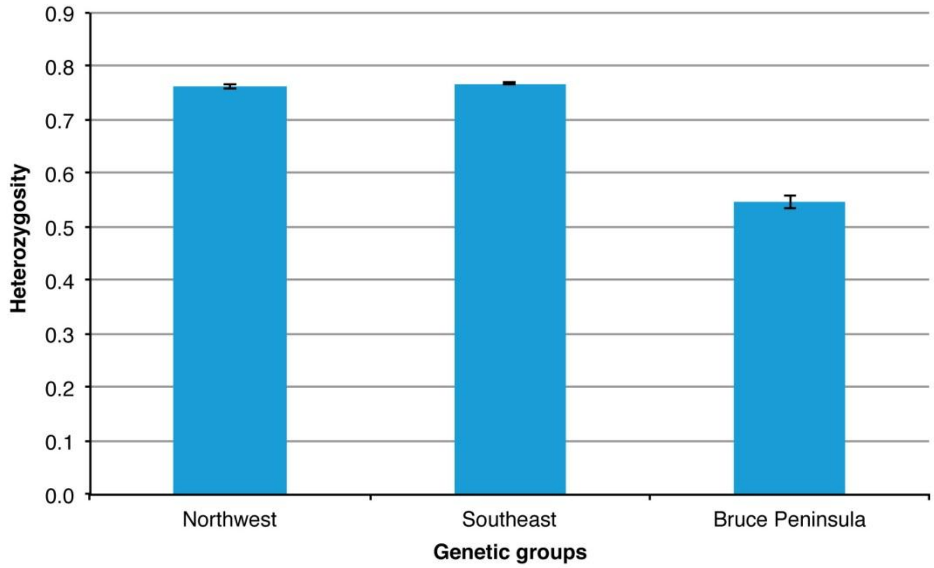

Figure 2. Heterozygosity level (scale 0 to 1) for each American Black Bear genetic group identified in Ontario (*n* = 2839 individuals; error bars represent Standard Deviation) (Source: Pelletier et al. 2012).

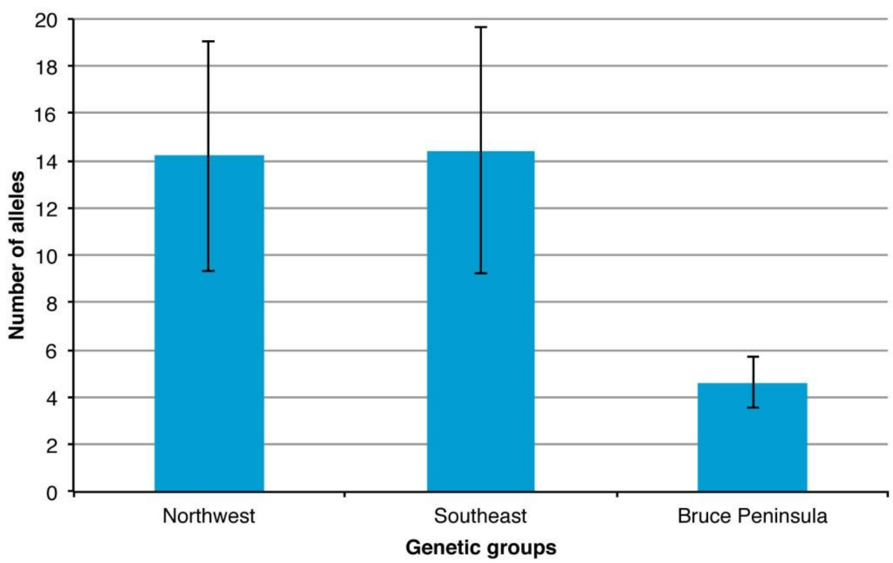

Figure 3. Number of different alleles for each American Black Bear genetic group identified in Ontario (*n* = 2839 individuals; error bars represent Standard Deviation) (Source: Pelletier et al. 2012).

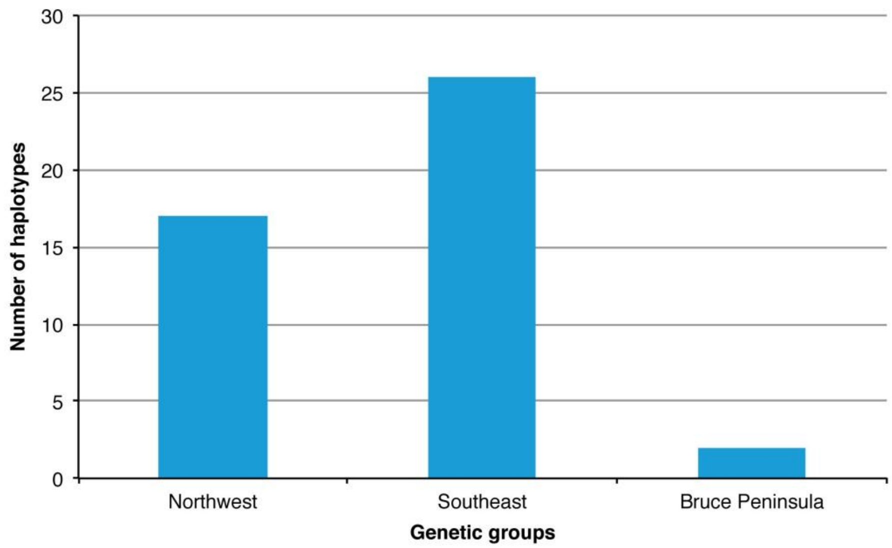

Figure 4. Number of haplotypes present within each American Black Bear genetic group in Ontario. Note: Analyses were conducted on a subset of individuals: *n* = 230, 392, and 38 for the northwestern, southeastern, and Bruce Peninsula populations, respectively (Source: Pelletier et al. 2011).

Status:

- Three distinct genetic groups of Black Bears were identified in Ontario: the northwestern regional population, the southeastern regional population, and the Bruce Peninsula population.
- While overall genetic differentiation among the three groups was generally low, the Bruce Peninsula population showed a level of differentiation with the larger northwestern and southeastern populations (F_{ST} = 0.13 and 0.12, respectively) more than 10 times as high as the level detected between the northwestern and southeastern populations (F_{ST} = 0.01). This indicates a lack of Black Bear movement between the Bruce Peninsula and the other regions of Ontario.
- The northwestern and southeastern Ontario Black Bear populations show high levels of historical (# of haplotypes = 17 and 26, respectively) and contemporary genetic diversity (heterozygosity = 0.76 and 0.77, respectively; # of alleles = 14.2 and 14.4, respectively).
- In contrast, the Bruce Peninsula population shows reduced historical (# of haplotypes = 2) and contemporary genetic diversity (heterozygosity = 0.55 and # of alleles = 4.6), likely related to geographic isolation resulting from habitat fragmentation. This population may be at risk of inbreeding depression and reduced population viability.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Ontario Black Bear Density Map https://www.ontario.ca/document/bear-density-map

References:

Dixon, J.D., M.K. Oli, M.C. Wooten, T.H. Eason, J.W. McCown, and D. Paetkau. 2006. Effectiveness of a regional corridor in connecting two Florida Black Bear populations. Conservation Biology 20: 155–162.

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Pelletier, A., M.E. Obbard, K. Mills, E. J. Howe, F.G. Burrows, B.N. White, and C.J. Kyle. 2012. Delineating genetic groupings in continuously distributed species across largely homogeneous landscapes: a study of American Black Bears (*Ursus americanus*) in Ontario, Canada. Canadian Journal of Zoology 90:999-1014.

Puckett, E. E., T.V. Kristensen, C.M. Wilton, S.B. Lyda, K.V. Noyce, P.M. Holahan, and L.S. Eggert. 2014. Influence of drift and admixture on population structure of American Black Bears (*Ursus americanus*) in the Central Interior Highlands, USA, 50 years after translocation. Molecular Ecology 23:2414-2427.

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Citation

Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: PROTECTED AREAS AND CONSERVATION LANDS

STRATEGIC DIRECTION: Enhance Resilience

TARGET: 13. By 2020, at least 17% of terrestrial and aquatic systems are conserved through well-connected networks of protected areas and other effective area-based conservation measures.

THEME: Conservation and Sustainable Use – Protected Areas and Conservation Lands

Background Information:

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 2010, a global target was established to conserve 17% of the Earth's terrestrial and inland water areas by 2020 through well-managed, representative and well-connected systems of protected areas and other effective area-based conservation measures (CBD 2010). This target was adopted in the 2011 update of Ontario's Biodiversity Strategy (OBC 2011). The Far North Act, 2010 also includes an objective to protect at least 225,000 km^2 of the Far North in an interconnected network of protected areas designated in community based land use plans. This represents about 50% of the Far North of Ontario.

Regulated protected areas include provincial and national parks, conservation reserves and wilderness areas. In the Far North of Ontario, Dedicated Protected Areas (DPAs) are established through community based land use plans which are jointly developed and approved by First Nations and Ontario, and determine which lands are to be set aside for protection and which are suitable for sustainable economic development. Other types of conservation lands include conservation areas and lands and conservation easements secured through conservation organizations. These conservation lands play a particularly important role in landscapes dominated by private lands such as southern Ontario.

This indicator assesses trends in the percentage of regulated protected areas, DPAs in the Far North and conservation lands within Ontario by ecozone.

Data Analysis:

Data on the area and location of regulated protected areas were downloaded from the Conservation Areas Reporting and Tracking System (CARTS). Data on Far North DPAs is contained in (as of December, 2014) four approved community based land use plans (OMNRF 2014). Information on conservation lands and conservation easements was obtained from various conservation organizations (Conservation Ontario, Ducks Unlimited Canada, Nature Conservancy Canada, Ontario Heritage Trust and Ontario Land Trust Alliance). Lands and easements held by these organizations (excluding cultural and built-up areas) were considered to qualify as other effective area-based conservation measures for the purpose of this indicator. The Canadian Council on Ecological Areas is currently developing guidance to identify eligible conservation lands (CCEA 2013). Lands for which there are term-limited conservation agreements that were included in this indicator in 2010 have not been included in this update consistent with interim guidance from the Canadian Council on Ecological Areas (CCEA 2013).

The percentage of protected areas, DPAs and conservation lands was calculated for each ecozone (three terrestrial ecozones plus the waters of the Great Lakes Ecozone) and compared to 2010 values (Figure 1). Spatial data were also used to map the proportion of each terrestrial ecodistrict that consists of regulated protected areas and DPAs (Figure 2). Comprehensive spatial data are currently not available for conservation lands.

- download CARTS data

Results:

Trend: Improvement **Data Confidence:** Medium **Geographic Extent:** Provincial

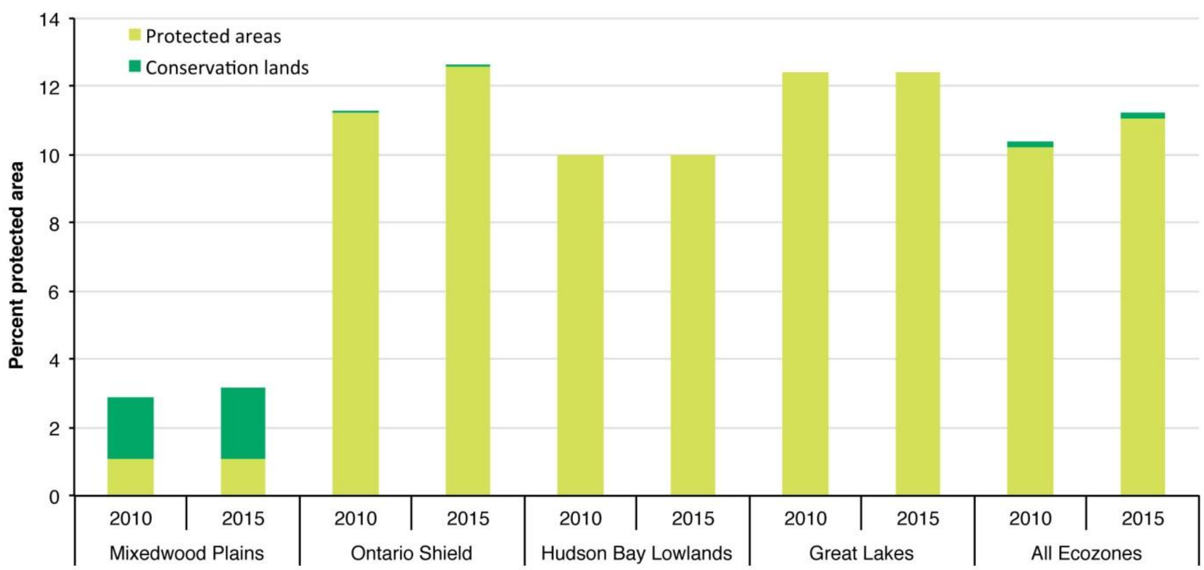

Figure 1. Percentage of Ontario's ecozones that consist of protected areas (including Dedicated Protected Areas in the Far North) and conservation lands.

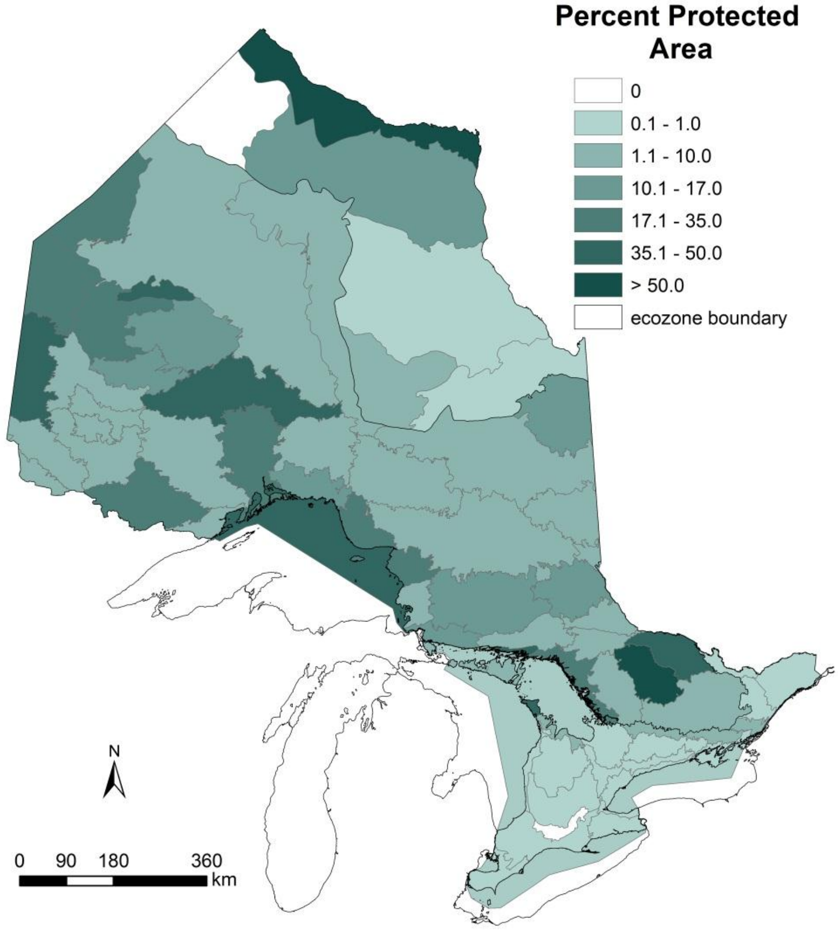

Figure 2. Percentage of each ecodistrict that consists of protected areas (including Dedicated Protected Areas in the Far North).

Status:

- 11.1% of Ontario is protected within provincial and national parks, Dedicated Protected Areas (DPAs) in the Far North, conservation reserves and wilderness areas. A further 0.2% is protected by conservation lands.
- The proportion of ecozone area in protected areas and conservation lands is highest in the Ontario Shield Ecozone (12.6%), followed by the Great Lakes Ecozone (12.4%), Hudson Bay Lowlands Ecozone (10.0%), and the Mixedwood Plains Ecozone (3.1%). The Lake Superior National Marine Conservation Area accounts for 99% of the protected area in the Great Lakes Ecozone.
- Since 2010, there has been an increase in protected areas in the Ontario Shield Ecozone, largely associated with the establishment of DPAs in the Far North. There has also been an increase in the area of conservation lands in the Mixedwood Plains Ecozone.
- While the proportion of the province conserved in protected areas and conservation lands has increased from 10.4% to 11.2% since 2010, it is still well short of the 17% target.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Ontario Parks http://www.ontario.ca/environment-and-energy/provincial-parks-and-conservation-reserves-planning

Ontario Far North Land Use Planning Initiative http://www.ontario.ca/rural-and-north/far-north-land-use-planning-initiative

Parks Canada http://www.pc.gc.ca/progs/np-pn/pr-sp/index_e.asp

Conservation Ontario http://www.conservation-ontario.on.ca/

Ducks Unlimited Canada http://www.ducks.ca/

Nature Conservancy Canada http://www.natureconservancy.ca/

Ontario Heritage Trust http://www.heritagetrust.on.ca/

Ontario Land Trust Alliance http://olta.ca/

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Citation

Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: ECOLOGICAL REPRESENTATION IN ONTARIO'S PROTECTED AREA SYSTEM

STRATEGIC DIRECTION: Enhance Resilience

TARGET: N/A

THEME: Conservation Response – Protected Areas and Conservation Lands

Background Information:

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 and Forestry 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 (called Dedicated Protected Areas) is achieved through community-based land use plans that are led by First Nations and developed jointly with Ontario. Dedicated Protected Areas are designed to protect areas of cultural value and ecological systems in the Far North.

This indicator assesses the degree to which Ontario's protected areas system (including Dedicated Protected Areas in the Far North) has achieved ecological representation of the terrestrial landform-vegetation associations found in Ontario.

Data Analysis:

Ecological representation was assessed by the Ontario Ministry of Natural Resources and Forestry using a GIS-based analytical tool called GapTool (Davis et al. 2006). 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. Minimum representation thresholds are set at 1% of the total area of the landform-vegetation type in each ecodistrict or 50 ha, whichever is greater. Including only a small portion of an ecodistrict in protected areas can often meet the minimum representation thresholds. The percentages of terrestrial landform-vegetation type area thresholds met in protected areas (including Dedicated Protected Areas in the Far North) as of 2015 were summarized by ecodistrict and mapped; changes between 2010 and 2015 were also assessed (Figure 1).

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). A recent review of aquatic features for watersheds with available data showed that 6.4% of aquatic habitat was within regulated protected areas in Ontario (OMNR 2011).

It is important to note that this indicator only considers ecological representation associated with legally protected areas (provincial and federal) and Dedicated Protected Areas in the Far North. Other conservation lands held by conservation authorities, Ducks Unlimited Canada, the Nature Conservancy of Canada, Ontario Nature and Ontario land trusts contribute to ecological representation, but were not included due to the lack of comprehensive and consolidated spatial data required for GapTool analysis.

- download ecological representation data

Results:

Trend: Improvement **Data Confidence:** High **Geographic Extent:** Provincial

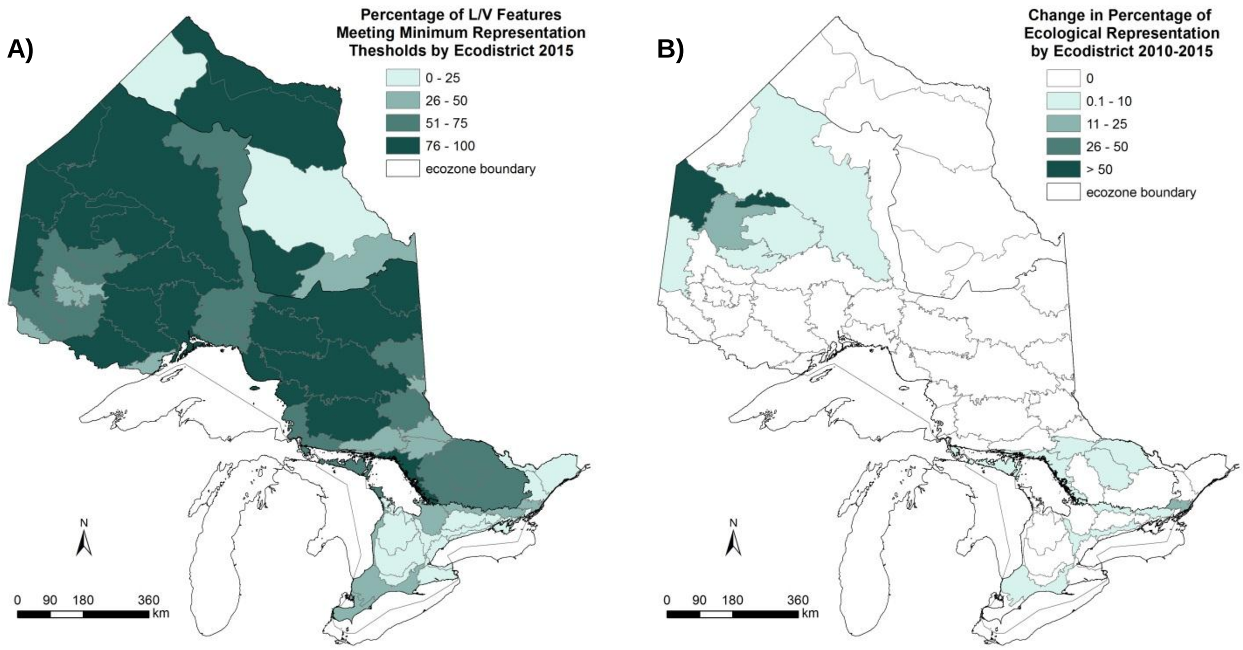

Figure 1. Representation of terrestrial life science features by ecodistrict in Ontario's protected area system (including Dedicated Protected Areas in the Far North): A) Percentage of terrestrial landform/vegetation features meeting minimum representation thresholds in each ecodistrict as of 2015; B) Change in the percentage of ecological representation by ecodistrict between 2010 and 2015.

Status:

- Protected areas are best distributed among terrestrial natural features in the Ontario Shield Ecozone.
- Nearly all of the protected area in the Hudson Bay Lowlands Ecozone 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 based land use planning 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 improved.

- Since 2010, there has been an increase in ecological representation achieved in 17 of Ontario's 71 ecodistricts. The largest increases have occurred in the northwest Ontario Shield Ecozone, largely associated with the establishment of Dedicated Protected Areas in the Far North. Small increases have also occurred in several ecodistricts in the Mixedwood Plains and southern Ontario Shield ecozones.

Links:

Related Targets: 13. By 2020, at least 17% of terrestrial and aquatic systems are conserved through well-connected networks of protected areas and other effective area-based conservation measures.

Related Themes: N/A

Web Links:

MNRF – Ontario's parks and protected areas https://www.ontario.ca/environment-and-energy/ontarios-parks-and-protected-areas

References:

Davis, R., L. Chora, and W.J. Crins. 2006. GapTool: an analytical tool for ecological monitoring and conservation planning. pp. 139-150. *In* 2006 Parks Research Forum of Ontario Proceedings, Niagara Falls, ON.

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Citation
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INDICATOR: OBSERVED CHANGE IN LAND AREA WITH STEWARDSHIP ACTIVITIES

STRATEGIC DIRECTION: Enhance Resilience

TARGET: 11. By 2015, the proportion of private lands in Ontario that are managed for biodiversity is increased.

THEME: Conservation Response – Stewardship

Background Information:

Ontarians place huge demands on the Province's natural resources, with serious consequences not only for biodiversity but also for quality of life and economic prosperity. Environmental stewardship has long been a focus of efforts to mitigate these impacts, particularly in those areas where human development continues to increase. In Ontario, the majority of the land in the south is in private ownership, so stewardship is an important mechanism to conserve Ontario's biodiversity and ensure the future health of the communities.

Stewardship activities in Ontario are increasingly coordinated by non-profit conservation organizations with limited financial support from provincial, federal and international governments. These activities are often undertaken in partnership with private landowners who actively work to steward their lands. A wide variety of stewardship activities are undertaken each year in Ontario. Examples include habitat creation, planting trees, establishing buffers next to wetlands and riparian areas, removing invasive species, building fences to keep livestock away from waterways, and restoring degraded wetland hydrology using water control structures, among others.

This indicator presents an index of the amount of land that is being actively stewarded in Ontario. It is a means of assessing the proportion of private lands that are managed for biodiversity in the province.

Data Analysis:

This indicator presents an index of the amount of land area that is being actively stewarded in Ontario based on data maintained by four conservation organizations (Nature Conservancy of Canada, Ducks Unlimited Canada, Ontario Nature, the Ontario Federation of Anglers and Hunters), and various public bodies (Ontario Ministry of Nature Resources - Ontario Stewardship Program, Ontario Power Generation and the 36 conservation authorities in Ontario). As such, this indicator does not reflect all stewardship activities occurring across Ontario. For the purposes of this indicator, stewardship activities included a variety of habitat restoration, rehabilitation and enhancement activities between the years 2002 and 2012.

Results:

Trend: Improvement **Data Confidence:** Medium **Geographic Extent**: Mixedwood Plains

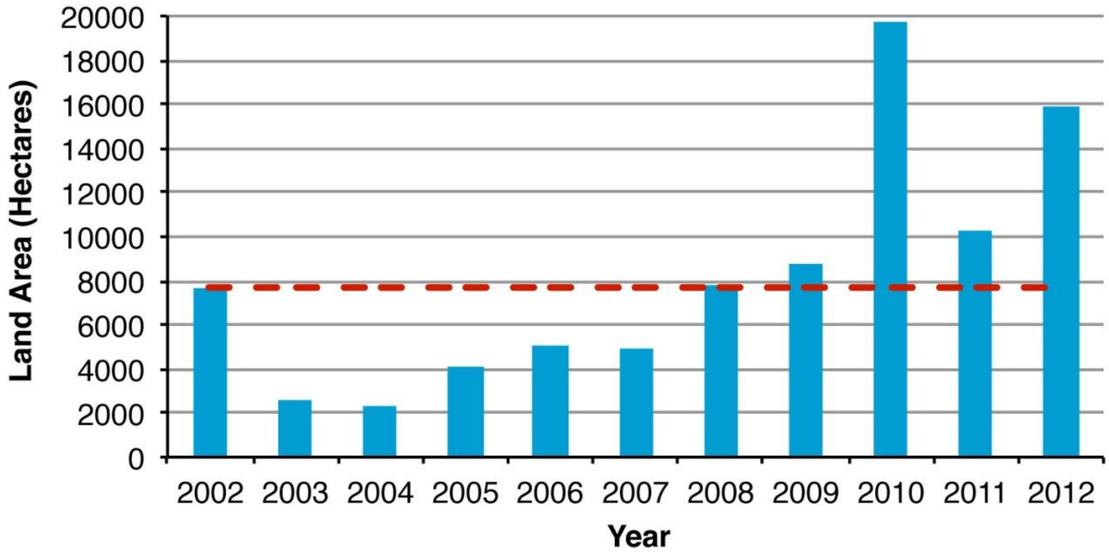

Figure 1. Annual land area with stewardship activities in Ontario, 2002-2012 (dashed line represents average) (Source: Ducks Unlimited Canada, Conservation Ontario, Nature Conservancy of Canada, Ontario Federation of Anglers and Hunters, Ontario Power Generation and Ontario Ministry of Natural Resources Stewardship Program). Note: Data for the Ontario Ministry of Natural Resources Stewardship Program was only available for the years 2004-2012. Data for the Ontario Federation of Anglers and Hunters was only available for the years 2010-2012.

Status:

- Between 2002 and 2012, the annual amount of land stewarded in Ontario increased from 7,395 hectares to 15,893 hectares, representing an overall increase of 115% or an annual increase of 11.5%. This increase is, in part, related to refinement in data collection efforts.
- Between 2002 and 2012, the average amount of land stewarded in Ontario each year was 7,692 hectares.

Links:

Related Targets: 3. By 2015, the number of Ontarians who participate in biodiversity conservation activities is increased by 25%.

Related Themes: N/A

Web Links:

Conservation Ontario http://www.conservation-ontario.on.ca/

Ducks Unlimited Canada http://www.ducks.ca/

Nature Conservancy of Canada http://www.natureconservancy.ca/en/

Ontario Federation of Anglers and Hunters http://www.ofah.org/

Ontario Power Generation http://www.opg.com/about/environment/Pages/environment.aspx

Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: VOLUNTEER EFFORTS TO CONSERVE BIODIVERSITY

STRATEGIC DIRECTION: Engage People

TARGET: 3. By 2015, the number of Ontarians who participate in biodiversity conservation activities is increased by 25%.

THEME: Conservation Response – Biodiversity Stewardship

Background Information:

In recent years, volunteers have played an increasingly important role in the conservation of biodiversity. Many factors have influenced this trend, including limited government budgets for biodiversity conservation, as well as increased awareness about the importance of biodiversity and its conservation. Each year, the conservation of biodiversity in Ontario benefits greatly from the help of thousands of volunteers. These volunteers range from Aboriginal individuals and communities who promote a responsibility for nature, to school children who plant trees to rehabilitate and restore the landscape, to groups who devote their time to organizing and carrying out habitat enhancement activities or fundraising campaigns, to private land owners who donate their time and act as good stewards of their land.

This indicator presents an index of the number of people volunteering to conserve Ontario's biodiversity and provides a means of assessing trends in the level of public participation in biodiversity conservation in the province.

Data Analysis:

This indicator presents an index of the number people volunteering to conserve biodiversity in Ontario based on four conservation organizations (Nature Conservancy of Canada, Ducks Unlimited Canada, Ontario Nature, the Ontario Federation of Anglers and Hunters) and various public bodies (Ontario Ministry of Natural Resources and Forestry, Ontario Stewardship Program and the 36 conservation authorities in Ontario). As such, this indicator does not reflect all people volunteering to conserve biodiversity across Ontario, but provides a means of assessing trends in the level of public participation in biodiversity conservation in the province.

For the purposes of this indicator, volunteering for biodiversity conservation included any activity undertaken by an organization, community or individual to further the understanding, protection or enjoyment of the natural environment; enhance, restore or rehabilitate native habitat or species; or support the organization or administration of biodiversity conservation activities between the years 2006 and 2012. It does not include membership in the select conservation organizations.

Results:

Trend: No Change	**Data:** Confidence: Medium	**Geographic Extent:** Provincial

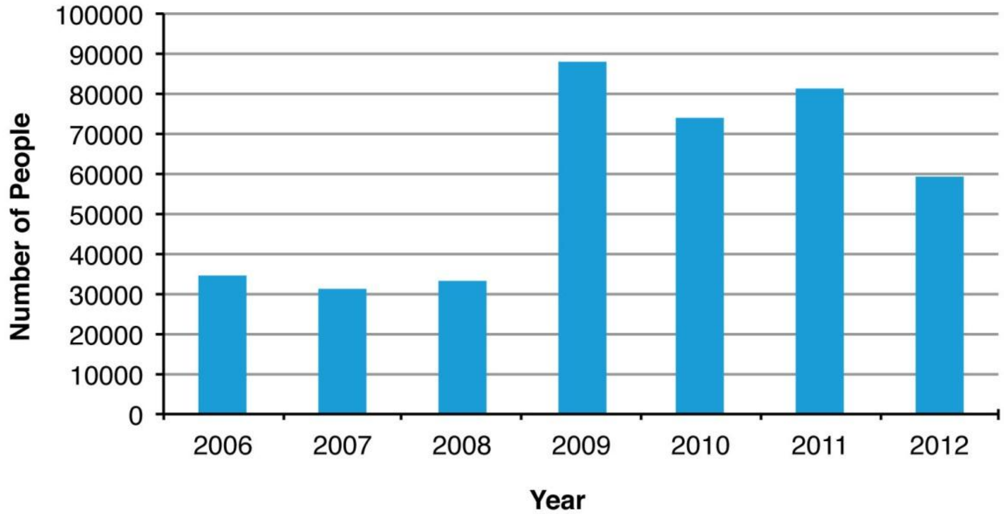

Figure 1: Number of people volunteering to conserve biodiversity in Ontario, 2006-2012. (Source: Nature Conservancy of Canada, Ducks Unlimited Canada, Conservation Ontario, Ontario Nature, Ontario Federation of Anglers and Hunters, and Ontario Stewardship) (Note: Data for Ontario Federation of Anglers and Hunters was only available for the years 2010-2012. Data for Ducks Unlimited Canada and the Ontario Ministry of Natural Resources Stewardship Program were based on financial years rather than calendar years. Financial year data was assigned to the first calendar year).

Status:

- Between 2006 and 2012, the number of people who volunteered with select conservation organizations to conserve Ontario's biodiversity increased from 34,697 to 59,477. Although this represents an increase of 42%, it can largely be attributed a refinement in reporting activities.

Links:

Related Targets: 11. By 2015, the proportion of private lands in Ontario that are managed for biodiversity is increased.

Related Themes: N/A

Web Links:

Conservation Ontario http://www.conservation-ontario.on.ca/

Ducks Unlimited Canada http://www.ducks.ca/

Nature Conservancy of Canada http://www.natureconservancy.ca/en/

Ontario Federation of Anglers and Hunters http://www.ofah.org/

Ontario Nature http://www.ontarionature.org/

Citation

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Indicator: Participation in Provincial Tax Incentive Programs

Strategic Direction: Engage People and Enhance Resilience

Target:

3. By 2015, the number of Ontarians who participate in biodiversity conservation activities is increased by 25%.
11. By 2015, the proportion of private lands in Ontario that are managed for biodiversity is increased.

Theme: Conservation Response – Biodiversity Stewardship

Background Information:

Ontario supports a wide variety of intact, self-sustaining ecosystems inhabited by diverse populations of native species. Many of Ontario's significant natural areas are located on private property and the need for private landowner incentives as part of an overall biodiversity conservation strategy has been widely accepted (Secretariat of the Convention on Biological Diversity 2012). Economic incentives can encourage and assist landowners in taking action to maintain and enhance biodiversity values on private lands.

Two voluntary programs, the Managed Forest Tax Incentive Program (MFTIP) and the Conservation Land Tax Incentive Program (CLTIP), provide tax incentives to private landowners to encourage and support the long-term private stewardship of Ontario's biodiversity. The programs work by providing property tax relief to landowners who protect biodiversity values such as forests, wetlands and endangered species habitat on their lands.

Recent studies of participation rates in Ontario's conservation tax incentive programs show an increasing trend. Between 2002 and 2008 combined participation rates in MFTIP and CLTIP increased by 11% (Ontario Biodiversity Council 2010; FPTGC 2010).

This indicator reports on the number of properties and the total area enrolled in both CLTIP and MFTIP from 2002-2013, as an indicator of both participation rates in biodiversity conservation and the proportion of private lands that are managed for biodiversity conservation.

Data Analysis:

Data for this indicator (2002-2013) were obtained from the Managed Forest Tax Incentive Program (MFTIP) and the Conservation Land Tax Incentive Program (CLTIP), both of which are administered by the Ontario Ministry of Natural Resources and Forestry. The number of properties enrolled, as well as the area enrolled in both MFTIP and CLTIP were compiled for the years 2002-2013. For CLTIP the percentage of eligible properties that participate in the program was also compiled for the years 2002-2013. This represents an index of program uptake. Data for 2002 and 2003 include some properties that were subsequently deemed ineligible, artificially inflating the data. Lands owned by conservation authorities or eligible charitable conservation organizations that have a primary objective of natural heritage conservation are also eligible for CLTIP. These community conservation lands are included in the area analysis.

Results:

Trend: Mixed **Data Confidence:** High **Geographic Extent:** Provincial

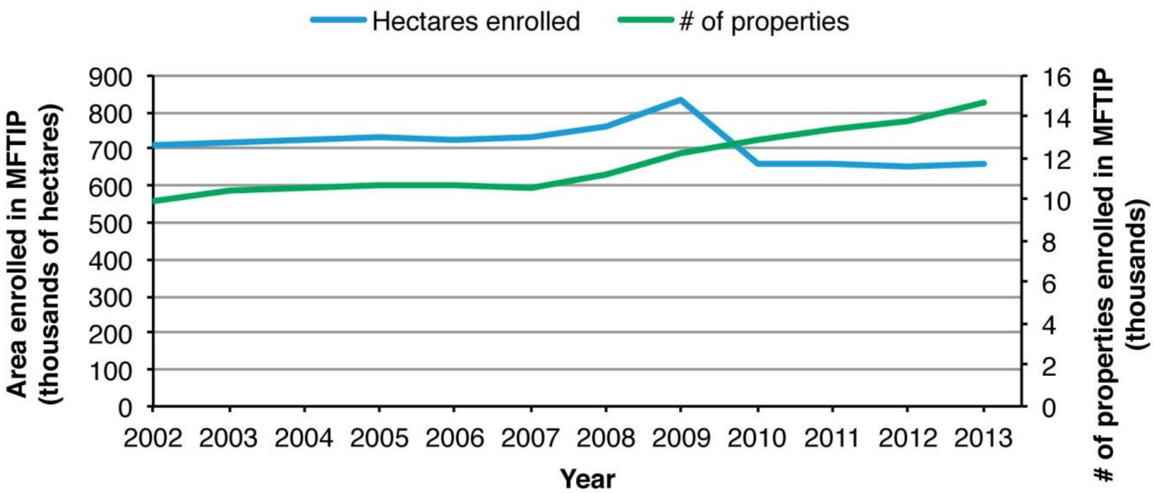

Figure 1. Land area and participation in the Managed Forest Tax Incentive Program 2002-2013.

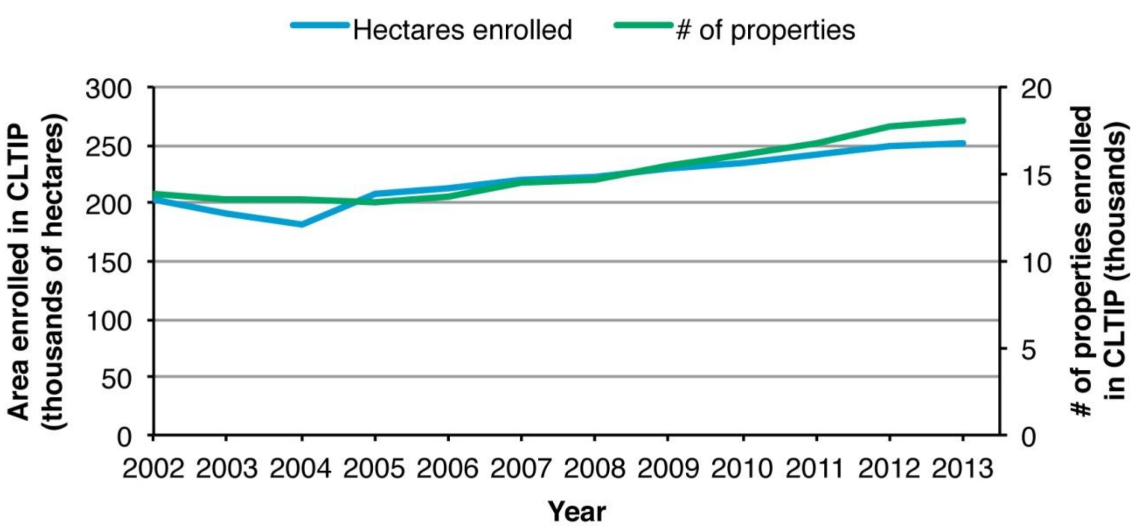

Figure 2. Land area and participation in the Conservation Land Tax Incentive Program 2002-2013.

Status:

- Between 2002 and 2013, the number of properties participating in CLTIP and MFTIP increased by 38% (from 23,714 to 32,643 properties); however, the percentage of eligible properties that participated in CLTIP remained unchanged, averaging 42%.
- Between 2002 and 2009 the area conserved under MFTIP increased by 18% (from 708,000 to 837,000 hectares); however, in 2010 there was a decrease of 178,000 hectares, largely as a result of the sale of large piece of land to American owners that are ineligible to participate in the program.

- Between 2002 and 2013 the area conserved by private land owners and community conservation lands under CLTIP increased by 25% (from 202,000 to 252,000 hectares). Throughout the program approximately 32% of the area was conserved through community conservation lands.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:
Conservation Land Tax Incentive Program https://www.ontario.ca/environment-and-energy/conservation-land-tax-incentive-program

Managed Forest Tax Incentive Program https://www.ontario.ca/environment-and-energy/managed-forest-tax-incentive-program

References:

Federal, Provincial and Territorial Governments of Canada (FPTGC). 2010. Canadian biodiversity: Ecosystem status and trends 2010. Canadian Councils of Resource Ministers. Ottawa, ON. [Available at: http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1]

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Indicator: Number of Municipalities with Natural Heritage Systems Plans/Biodiversity Strategies

Strategic Direction: Enhance Resilience

Target: 12. By 2015, natural heritage systems plans and biodiversity conservation strategies are developed and implemented at the municipal and landscape scales.

Theme: Conservation Response

Background Information:

Buildings, roads, parking lots and other urban developments typically degrade and fragment natural areas (Johnson and Klemens 2005). Natural heritage system planning is a strategic approach to protect, restore and enhance biodiversity in settled landscapes. A natural heritage system is made up of features and areas, connected by corridors/linkages which are necessary to maintain biological and geological diversity, natural functions, viable populations of native species and ecosystems (OMMAH 2014).

Ontario's land use planning system consists of a wide range of legislation, policies and plans (Table 1). The Planning Act and Provincial Policy Statement provide overarching policy direction on land use planning in Ontario. Municipalities use this policy direction to develop their Official Plans and guide and inform policies at the local level (e.g., zoning by-laws, development applications, etc.). Geography-specific legislation and provincial plans such as the Niagara Escarpment Plan, the Oak Ridges Moraine Conservation Plan, the Greenbelt Plan, the Growth Plan for the Greater Golden Horseshoe and the Lake Simcoe Protection Plan provide an additional level of policy direction for municipal planning within these regions. Landscape conservation plans developed by various conservation organizations and partners also provide support for natural heritage planning in the province. Together these plans include an area that covers most of the Mixedwood Plains Ecozone and portions of the Ontario Shield Ecozone.

Table 1. Overview of Ontario's Land Use Planning System.

Land Use Planning Legislation
Planning Act
Greenbelt Act, 2005
Niagara Escarpment Planning and Development Act
Oak Ridges Moraine Conservation Act, 2001
Lake Simcoe Protection Act, 2008
Places to Grow Act
Public Lands Act
Far North Act, 2010
Land Use Planning Direction and Land Use Plans
Provincial Policy Statement 2014
Greenbelt Plan, 2005
Niagara Escarpment Plan
Oak Ridges Moraine Conservation Plan, 2002
Growth Plan for the Greater Golden Horseshoe
Growth Plan for Northern Ontario

Lake Simcoe Protection Plan, 2009
Community-Based Land Use Plans under the Far North Act, 2010 (Whitefeather Forest Land Use Strategy, Cat Lake-Slate Falls Community Based Land Use Plan, Pauingassi Community Based Land Use Plan, Little Grand Rapids Community Based Land Use Plan)
Landscape Conservation Plans
Conservation Blueprints (Great Lakes, Superior Mixed Forest) (The Nature Conservancy Canada)
Original Big Picture, Big Picture 2002 (Carolinian Canada)
Greenway Program (Ontario Nature)
Biosphere Reserves (Niagara Escarpment, Long Point, Georgian Bay, Frontenac Arch) (UNESCO)
Conservation Authority Natural Heritage Strategies (Various conservation authorities)
Great Lakes Biodiversity Strategies (The Nature Conservancy and The Nature Conservancy Canada)
Algonquin to Adirondack Collaborative (various partners)

This indicator assesses trends in the number of Municipal Official Plans that identify natural heritage systems and associated features and areas, and include policies to protect these features and areas. The policies include those protecting the diversity and connectivity of natural heritage features and areas, and the maintenance or improvement of ecological function and biodiversity.

Data Analysis:

This indicator was adapted from the Provincial Policy Statement, 2005: Performance Monitoring Framework and Indicator Results (OMMAH 2014). Data for this indicator were obtained by reviewing a representative cross-section of 40 Municipal Official plans selected from all areas of Ontario. A range of single-tier, upper-tier and lower tier municipalities, as well as planning boards in northern Ontario, were included in the analysis. Care was taken to ensure that large, small, urban and rural municipalities from all regions of the province were also included in the analysis. To capture changes in Municipal Official Plans, the same sample was used in both 2009 and 2013.

Data for this indicator reflect direction provided in the Provincial Policy Statement, 2005. The Provincial Policy Statement was updated in 2014 following extensive public review. The revised Provincial Policy Statement now requires identification of natural heritage systems in the Mixedwood Plains Ecozone (ecoregions 6E and 7E).

Criteria for determining whether a municipality had policies that formally identified and protected natural heritage systems was necessarily broad, as prior to 2014, municipalities in Ontario were not required to identify and protect in policy natural heritage systems. As such, municipal official plans vary in how they identify and protect natural heritage systems.

Results:

Trend: Improvement **Data Confidence:** Medium **Geographic Extent:** Provincial

Figure 1. Change in the number of Municipal Official Plans that identify natural heritage features and areas, and incorporate related policy into to their Municipal Official Plans.

Status:

- The percentage of Municipal Official Plans that formally identify and protect natural heritage features and connectivity is low (< 50%).
- Between 2009 and 2013 the percentage of Municipal Official Plans that had mapped natural heritage features and areas and identified existing and potential linkages increased slightly from 22.5% to 27.5%.
- Between 2009 and 2013 the percentage of Municipal Official Plans that had policies protecting the diversity and connectivity of natural heritage features and areas increased from 35% to 47.5%.

<u>Links:</u>

Related Targets: N/A

Related Themes: N/A

Web Links:

Provincial Policy Statement, 2005: Performance Monitoring Framework and Indicator Results
http://www.mah.gov.on.ca/Page9100.aspx

Provincial Policy Statement 2014 http://www.mah.gov.on.ca/Page10679.aspx

References:

Johnson, A.E., and M.W. Klemens. 2005. The impacts of sprawl on biodiversity. *In* E.A. Johnson and M.W. Klemens (Eds). Nature in fragments: the legacy of sprawl. Columbia University Press, New York.

Ontario Ministry of Municipal Affairs and Housing (OMMAH). 2005. Provincial Policy Statement. Queen's Printer for Ontario, Toronto, ON. [Available: http://www.mah.gov.on.ca/Page1485.aspx]

Ontario Ministry of Municipal Affairs and Housing (OMMAH). 2014. Provincial Policy Statement. Queen's Printer for Ontario, Toronto. [Available: http://www.mah.gov.on.ca/Page10679.aspx]

Ontario Ministry of Municipal Affairs and Housing, Provincial Planning Policy Branch (OMMAH). 2014. Provincial Policy Statement, 2005: performance monitoring framework and indicator results. Queen's Printer for Ontario, Toronto, ON. [Available: http://www.mah.gov.on.ca/Page9100.aspx]

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INDICATOR: BIODIVERSITY POLICIES AND PROGRAMS

STRATEGIC DIRECTION: Engage People

TARGET: 5. By 2020, all relevant policies and programs integrate biodiversity values.

THEME: Conservation Response – Programs and Policy

Background Information:

Conserving biodiversity and using natural resources sustainably are fundamental to the health and well-being of all Ontarians, yet despite this knowledge, biodiversity losses continue (OBC 2010). While no single group can deliver the scale of change required to conserve Ontario's biodiversity, governments, Aboriginal People, businesses, conservation groups, and others can develop policies and programs that work towards conserving biodiversity and protecting the long-term sustainability of our natural resources.

Governments are in a unique position to create the policy conditions that can lead to long-lasting solutions to safeguard biodiversity. Ontario's policy framework currently includes a broad range of policies and programs that are directly or potentially relevant to the conservation of biodiversity. Provincial policies and programs guide the protection, stewardship and use of the natural environment; safeguard the air, water and soil; and provide guidance for the production and use of natural resources including energy, and the mitigation of climate change. They also offer direction for land use planning and transportation systems, which are of critical importance to the conservation of biodiversity (OMNR 2012). Building on this framework will, no doubt, result in progress towards halting the loss of Ontario's biodiversity.

This indicator presents results from a 2014 survey of the Ontario Public Service (OPS) Biodiversity Network. It provides an assessment of the number Ontario government programs and policies that integrate, or have the potential to integrate, biodiversity values. This survey provides baseline data that will be updated to assess trends. A companion indicator provides an assessment of ecosystem services policies and programs.

Data Analysis:

Data for this indicator were collected through a survey of the Ontario Public Service (OPS) Biodiversity Network commissioned by the Ontario Biodiversity Council. The purpose of the survey was to gather information on the number of Ontario government programs and policies that integrate, or have the potential to integrate, biodiversity values. The OPS Biodiversity Network provides a diverse, cross-Ministry forum for the OPS to strategically plan and implement biodiversity-related activities, policies, processes and projects across the Province. Fourteen ministries are currently represented on the OPS Biodiversity Network: Ministry of Natural Resources and Forestry; Ministry of Aboriginal Affairs; Ministry of Agriculture, Food and Rural Affairs; Ministry of Economic Development, Employment and Infrastructure; Ministry of Education; Ministry of Energy; Ministry of Environment and Climate Change; Ministry of Finance; Ministry of Health and Long-term Care; Ministry of Municipal Affairs and Housing; Ministry of Northern Development and Mines; Ministry of Tourism, Culture and Sport; Ministry of Transportation; and the Treasury Board Secretariat.

To help respondents identify programs or policies that integrate biodiversity values a screening tool was provided (Figure 1). Respondents were asked to limit their responses to strategic level policies (i.e., direct the ministry or government as a whole over an extended period; state overall intent, and provide guidance for subsequent policy and program development. This includes legislation and regulations) or program level policies (i.e., address a specific program area; support the direction established in legislation, strategic policies and other government direction), with the understanding that operational policies and other program guidance follow from these policies. Respondents were also asked to identify opportunities to include biodiversity values in new policies or programs, or updates to existing policies or programs.

Because biodiversity initiatives touch on the mandates of several ministries, they often require an integrated and collaborative approach. Where more than one ministry had a role in the implementation of a policy or program, the policy or program was assigned to the lead ministry. Responses were received from 13 OPS ministries, including one ministry that did not identify any programs or policies that included biodiversity values (Figure 2).

Is biodiversity conservation part of the main goals/objectives/purposes of the policy or program? Conservation of biodiversity includes the protection of genes, species and habitats/ecosystems, as well as ensuring their sustainable use.

If biodiversity conservation is not part of the main goals/objective/purpose of the policy or program, do they include provisions to ensure that biodiversity is not negatively impacted?

Does the effect of the policy or program help to reduce the loss of biodiversity? This may include reducing or mitigating against the main threats to biodiversity including habitat loss, invasive species, pollution, population growth, unsustainable use of biological assets and climate change.

Does the effect of the policy or program help mitigate against the loss of biodiversity by building ecosystem resilience (i.e., the capacity of an ecosystem to adapt to changes and disturbances and still retain its basic functions and structures)?

Does the effect of the policy or program promote the sustainable use of biological assets (i.e., genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humans)?

Does the policy or program promote awareness and/or understanding of biodiversity?

If the answer is yes to any of these questions include the policy or program as one that integrates biodiversity values.

Figure 1. Screening tool to aid respondents in the identification of programs and policies that integrate biodiversity values.

Results:

Trend: Baseline **Data Confidence:** Medium **Geographic Extent:** Provincial

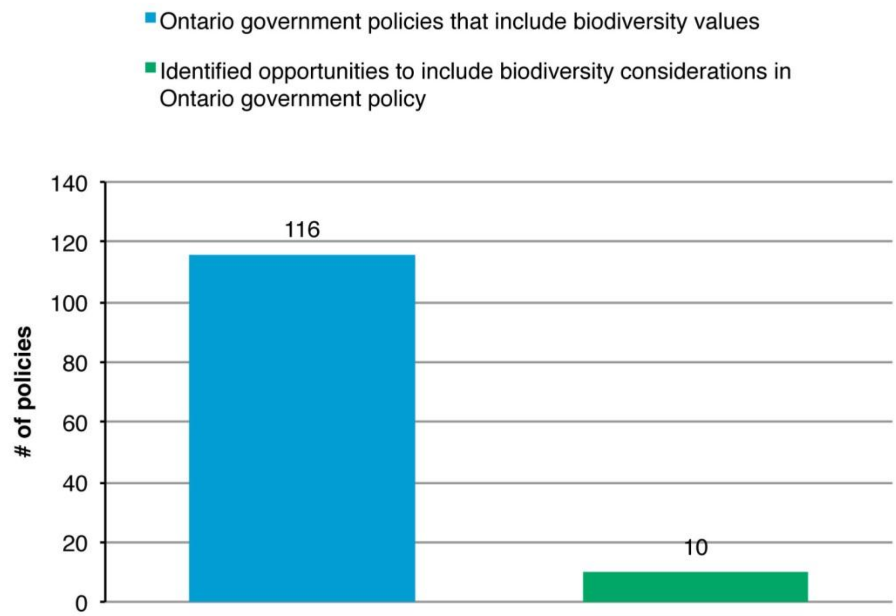

Figure 2. Number of Ontario government policies and programs that include biodiversity values, as well as Ontario government policies and programs that could include biodiversity considerations.

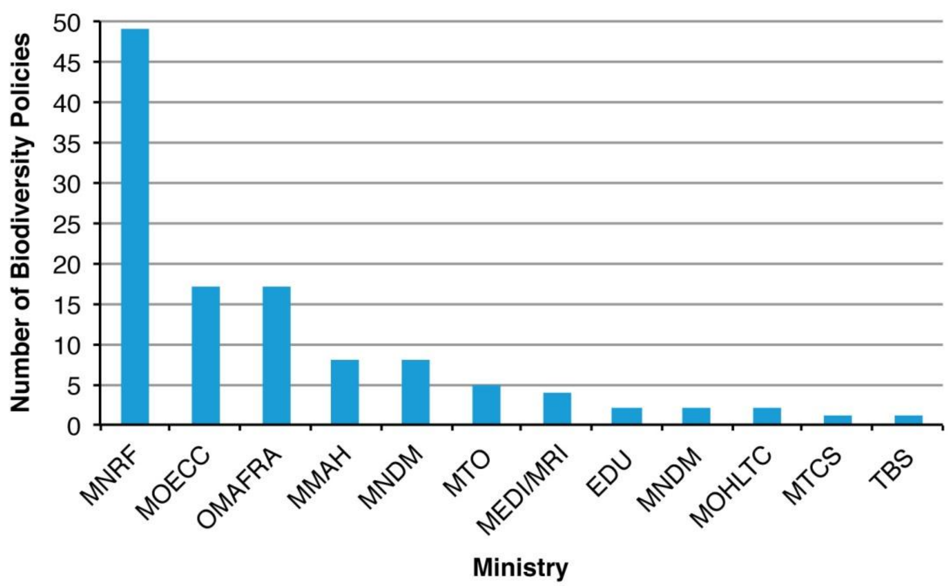

Figure 3. Number of Ontario government policies and programs that include biodiversity values or consideration of ecosystem services by Ministry.

Status:

- In 2014, the OPS Biodiversity Network identified 116 Ontario government policies or programs that integrate biodiversity values. Recently developed policies or programs that integrate biodiversity values include Biodiversity: It's in Our Nature. Ontario Government Plan to Conserve Biodiversity, 2012-2020; Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011-2014; Ontario's Great Lakes Strategy; the Provincial Policy Statement 2014 and Achieving Balance: Ontario's Long Term Energy Plan.

- In 2014, the OPS Biodiversity Network identified 10 opportunities to include biodiversity considerations in new policies or programs or updates to existing ones. Examples include integrating biodiversity in the coordinated review of the Greenbelt Plan, Oak Ridges Moraine Conservation Plan, Niagara Escarpment Plan and Growth Plan for the Greater Golden Horseshoe, as well in the recently proposed Infrastructure for Jobs and Prosperity Act.
- Overall, the largest number of policies or programs that integrate biodiversity values are administered by the Ministry of Natural Resources and Forestry (49), followed by the Ministry of the Environment and Climate Change (17) and the Ministry of Agriculture, Food and Rural Affairs (17). These differences can be attributed to the specific mandates of each ministry, in which some have a larger responsibility for the conservation of biodiversity.

Links:

Related Targets: 14. By 2020, programs and policies are in place to maintain and enhance ecosystem services.

Related Themes: N/A

Web Links:

Biodiversity: It's in Our Nature. Ontario Government Plan to Conserve Biodiversity, 2012-2020
http://viewer.zmags.com/publication/c8f28fef#/c8f28fef/1

References:

Ontario Biodiversity Council (OBC). 2010. State of Ontario's biodiversity 2010. A Report of the Ontario Biodiversity Council. Peterborough, Ontario.

Ontario Ministry of Natural Resources (OMNR). 2012. Biodiversity: it's in our nature. Ontario government plan to conserve biodiversity, 2012-2020. Queen's Printer for Ontario. Toronto, ON.

Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: ECOSYSTEM SERVICES POLICIES AND PROGRAMS

STRATEGIC DIRECTION: Enhance Resilience

TARGET: 14. By 2020, programs and policies are in place to maintain and enhance ecosystem services.

THEME: Conservation Response – Plans and Policies

Background Information:

Biodiversity is the foundation upon which humans derive benefits called ecosystem services. For example, natural systems such as wetlands, free-flowing rivers, forests and grasslands provide services such as water purification, storm and flood protection, air pollution mitigation and recreational opportunities that benefit human well-being (Miller and Loyd-Smith 2012). Estimating the value of ecosystem services can reveal social costs or benefits that otherwise would remain hidden. Once identified and understood, these values can be considered and accounted for in the policy and decision-making process.

Ontario's current policy framework includes a strong commitment to conserving biodiversity. From enacting progressive sustainable forest management legislation, to establishing a network of parks and protected areas, to developing and working with partners to deliver innovative programs to maintain clean air, water and soil, Ontario has long understood the importance of conserving natural resources. While it is clear that many of the programs and policies that conserve biodiversity by their very nature also help to maintain and enhance ecosystem services, the development of policies and programs in which the main objective is to maintain or enhance ecosystem services is just beginning.

The explicit consideration of ecosystem services is not yet common in current policy; however, a growing understanding and supply of valuation information for Ontario is being used to communicate the benefits of conservation and to help assess the hidden costs associated with loss of ecosystem services (Miller and Loyd-Smith 2012). For example, a recent study found that southern Ontario's urban and sub-urban wetlands act as "natural factories" to filter water and produce at least $40 billion in economic benefits each year (Troy and Bagstad 2009). Similarly, urban forests in southern Ontario provide economic benefits of at least $26,000 per hectare each year, including cleaner air and water, enhanced pollination, better storm water management and aesthetic enjoyment for nearby residents (Troy and Bagstad 2009). Within the Ministry of Natural Resources and Forestry, ecosystem services values have also been integrated into the Regulatory Impact Assessment process to help quantify the business case for conservation and clarify the trade-offs discussed in policy proposals (MNR 2014).

This indicator presents results from a 2014 survey of the Ontario Public Service (OPS) Biodiversity Network commissioned by the Ontario Biodiversity Council. It provides an assessment of the number Ontario government programs and policies in place to maintain or enhance ecosystem services. This survey provides baseline data that will be updated to assess trends. A companion indicator provides an assessment of biodiversity policies and programs.

Data Analysis:

Data for this indicator were collected through a survey of the Ontario Public Service (OPS) Biodiversity Network commissioned by the Ontario Biodiversity Council. The purpose of the survey was to gather information on the number of Ontario government programs and policies that are in place to maintain or enhance ecosystem services. The OPS Biodiversity Network provides a diverse, cross-Ministry forum for the OPS to strategically plan and implement biodiversity-related activities, policies, processes and projects across the Province. Fourteen ministries are currently represented on the OPS Biodiversity Network: Ministry of Natural Resources and Forestry; Ministry of Aboriginal Affairs; Ministry of Agriculture, Food and Rural Affairs; Ministry of Economic Development, Employment and Infrastructure; Ministry of Education; Ministry of Energy; Ministry of Environment and Climate Change; Ministry of Finance; Ministry of Health and Long-term Care; Ministry of Municipal Affairs and Housing; Ministry of Northern Development and Mines; Ministry of Tourism, Culture and Sport; Ministry of Transportation; and the Treasury Board Secretariat.

Respondents were asked to identify strategic and program polices in which maintaining or enhancing ecosystem services is explicitly included as a main objective/goal. They were also asked to identify those that include consideration of ecosystem services (e.g., mitigation/compensation for ecosystem services, use of ecosystem service valuation methods or economic instruments, etc.). While it is clear that biodiversity and ecosystem services are inextricably linked and that policies and programs that conserve biodiversity can help to maintain ecosystem services, the intent of this survey was to identify those programs or policies that have been developed with the main purpose of maintaining or enhancing ecosystem services. Biodiversity policies and programs are addressed in a separate indicator.

Because ecosystem services touch on the mandates of several ministries, they often require an integrated and collaborative approach. Where more than one ministry had a role in the implementation of a policy or program, the policy or program was assigned to the lead ministry. Responses were received from 13 OPS ministries, including one ministry that did not identify any programs or policies.

Results:

Trend: Baseline **Data Confidence:** Medium **Geographic Extent:** Provincial

Status:

- In 2014, the OPS Biodiversity Network identified six policies or programs that explicitly work to maintain or enhance ecosystem services. These include policies to safeguard our water, as well as protect important ecosystem services through effective land use planning and support climate change mitigation through carbon sequestration.
- These policies are administered by the Ministry of Municipal Affaires and Housing (3), Ministry of the Environment and Climate Change (2) and the Ministry of Natural Resources and Forestry (1).

Links:

Related Targets: 5. By 2020, all relevant policies and programs integrate biodiversity values.

Related Themes: N/A

Web Links:

Biodiversity: It's in Our Nature. Ontario Government Plan to Conserve Biodiversity, 2012-2020
http://viewer.zmags.com/publication/c8f28fef#/c8f28fef/1

References:

Ontario Ministry of Natural Resources. 2014. Valuing nature: A policy lens. Considering the economic value of nature in policy development and resource management. Peterborough, ON.

Ontario Ministry of Natural Resources. 2012. Biodiversity: it's in our nature: Ontario government plan to conserve biodiversity, 2012-2020. Queen's Printer for Ontario. Toronto, ON.

Miller, E., and P. Loyd-Smith. 2012. The economics of ecosystem services and biodiversity in Ontario (TEEBO). Ontario Ministry of Natural Resources, Peterborough, ON.

Troy, A., and K. Bagstad. 2009. Estimating ecosystem services in southern Ontario. Report for Ontario Ministry of Natural Resources. Peterborough, ON.

Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: IMPLEMENTATION PLANS IN SUPPORT OF ONTARIO'S BIODIVERSITY STRATEGY

STRATEGIC DIRECTION: Engage People

TARGET: 4. By 2015, all sectors have initiated the development of implementation plans in support of Ontario's Biodiversity Strategy, and by 2020, those plans are implemented.

THEME: Conservation Response – Plans and Policies

Background Information:

While government policies and programs can provide a strong framework for biodiversity conservation, the participation of all sectors and individuals is required to achieve success. Ontario's Biodiversity Strategy (OBS) identifies the need for broad societal consensus and participation to protect the variety of life on Earth and that protecting what sustains us "is a challenge not just for some of us, but for all of us" (OBS 2005). When the Strategy was renewed in 2011, this concept was captured in the first goal:

> Goal 1: Mainstream biodiversity by incorporating biodiversity considerations into decision-making across the province, in different sectors and in our homes, workplaces and schools.

To help measure progress on this goal, the renewed OBS 2011 also includes the target that all sectors initiate the development of implementation plans in support of OBS by 2015 and implement those plans by 2020.

This indicator reports on implementation plans that have been developed in support of the OBS. A related indicator on Biodiversity and Business assesses the efforts Ontario's business sectors have made to incorporate biodiversity considerations into their business operations.

Data Analysis:

A list of implementation plans that support the OBS was created through canvassing members of the Ontario Biodiversity Council (Tables 1 and 2). This includes implementation plans specifically created to help achieve the goals, objectives, outcomes and actions of the OBS 2011. It also includes plans that were not specifically created around the OBS 2011, but support the conservation of Ontario's biodiversity consistent with the OBS.

Undoubtedly, there are additional sectoral implementation plans and strategies supportive of the OBS that have not been identified here. Readers are encouraged to identify relevant plans so that they can be incorporated.

Results:

Trend: Baseline **Data Confidence**: Medium **Geographic Extent**: Provincial

Table 1. Implementation plans directly related to the Ontario Biodiversity Strategy.

Sector/organization	Name of plan	Status
Ontario government	It's in our Nature – Ontario Government Plan to Conserve Biodiversity 2012-2020	being implemented
Ontario Biodiversity Council	OBC implementation plan	being implemented
Stewardship Network of Ontario	Stewardship Strategy 2013	being implemented
Halton Region	A Biodiversity Strategy for the Halton Regional Forests	being implemented

Table 2. Implementation plans and strategies consistent with the Ontario Biodiversity Strategy.

Sector/organization	Name of plan	Status
Royal Ontario Museum	ROM 2011-2017 Strategic Plan	being implemented
Ontario Power Generation	Ontario Power Generation Biodiversity Policy	being implemented

Status:

- Four plans have been specifically developed to support implementation of the OBS 2011.
- Two additional plans were identified that indirectly support the Ontario Biodiversity Strategy.
- 34 of 70 Ontario companies examined account for biodiversity in their plans and policies (see Business and Biodiversity Indicator).
- While the existence of these plans is encouraging, more organizations and sectors need to support the OBS to achieve success.

Links:

Related Targets: N/A

Related Themes: Conservation and Sustainable Use

Web Links:

The Ontario Biodiversity Council www.ontariobiodiversitycouncil.ca

The Stewardship Network of Ontario Stewardship Strategy 2013
http://stewardshipnetwork.ca/files/2012/03/SNO-Stewardship-Strategy-May-2013.pdf

Biodiversity: It's in our Nature – Ontario Government Plan to Conserve Biodiversity 2012-2020
http://viewer.zmags.com/publication/c8f28fef

Royal Ontario Museum http://www.rom.on.ca/nature

Ontario Power Generation – Biodiversity
http://www.opg.com/about/environment/Pages/environment.aspx

Halton Region – A Biodiversity Strategy for the Halton Regional Forests
http://sirepub.halton.ca/cache/2/p1vkvjtok04p1ih5evieevw0/17558903162015013355667.PDF

References:

Ontario Biodiversity Council. 2011. Ontario's biodiversity strategy, 2011: renewing our commitment to protecting what sustains us. Ontario Biodiversity Council, Peterborough, ON.

Ontario's Biodiversity Strategy (OBS). 2005. Ontario's biodiversity strategy, 2005: protecting what sustains us. Queen's Printer for Ontario, Peterborough, ON. [Available at: http://ontariobiodiversitycouncil.ca/files/2012/03/OBS_2005.pdf]

Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: BIODIVERSITY IN ONTARIO'S BUSINESS SECTORS

STRATEGIC DIRECTION: Engage People

TARGET: 4. By 2015, all sectors have initiated the development of implementation plans in support of Ontario's Biodiversity Strategy, and by 2020, those plans are implemented.

THEME: N/A

Background Information:

In recent years a critical link has been identified between society, the economy and the natural environment (TEEB 2012). Many business leaders are recognizing that to remain competitive, especially in challenging economic times, biodiversity issues must be factored into their operations. In addition, the public are becoming increasingly aware of the impact their daily lifestyle choices are having on the natural environment both directly and indirectly through issues such as increasing loss of habitat and green space and climate change. Because biodiversity is not an infinite resource, many business leaders are making biodiversity a top priority by factoring biodiversity management into their corporate planning and mainstreaming biodiversity into their decision-making process.

A recent study completed by PricewaterhouseCoopers (2008) for The Economics of Ecosystems and Biodiversity (TEEB) examined the integration of biodiversity into the 100 largest companies internationally. Their results concluded that of the 100 companies' annual reports studied, 2% reported biodiversity as a "strategic issue", 6% identified programs to reduce their negative impacts on biodiversity, and 18% mentioned biodiversity. By contrast, when examining the 89 sustainability reports published, 9% reported biodiversity as a "sustainability issue" and 24% identified programs to reduce their negative impacts on biodiversity (TEEB 2010).

This indicator examines the extent to which Ontario companies have integrated biodiversity in their corporate planning and reporting. As this is the first time this indicator has been assessed, the results will serve as a baseline for future assessments.

Data Analysis:

This index surveyed the integration of biodiversity within the business operations of 70 companies in Ontario. Businesses were categorized into four main sectors: primary (extraction of natural resources), secondary (processing goods), tertiary (service activities) and quaternary (research and information activities) (Mayda 2012). Categorizing sectors in this way allows for a more accurate picture of the relationship between company operations and threats to biodiversity. The four sectors were further categorized into industries identified in Statistics Canada's North American Industry Classification System (NAICS 2012)[1] to produce a sector categorization (Table 1).

[1] Did not include the industries, Information and culture, management of companies, administration, waste management, educational services, health care and social assistance, and public administration because of the size of the study.

Table 1. Industries used to study biodiversity integration into all sectors of business in Ontario.

Primary (n=15)	Secondary (n=15)	Tertiary (n=25)	Quaternary (n=15)
• Agriculture and Forestry • Gas and Oil • Mining and Quarrying	• Construction • Manufacturing • Utilities	• Entertainment • Finance • Food Services • Real Estate • Retail & Wholesale • Transportation	• Communication • Government Funded Recipients[2] • Technology

Within each industry, the five most profitable publicly traded and private companies[3] in Canada, as identified by *The Globe and Mail's* Report on Business[4], were studied. Due to the globalized nature of the business sector in Ontario, companies that were chosen either had headquarters, operated, and/or sold products in Ontario. This decision was based on the interconnectedness and complexity of business supply chains. Companies' publicly available annual corporate social responsibility and sustainability reports, as well as webpages were examined for each business based on key word search terms of biodiversity, biological diversity, ecosystem, nature, and sustainability. These documents were obtained from company websites.

The framework used to examine these companies was based on criteria developed to study the integration of biodiversity into the business sector. This evaluative model was developed based on several studies including *The Economics of Ecosystems and Biodiversity in Business and Enterprise* (TEEB 2012), *The Ecosystem Services Benchmark: A guidance document* (Grigg et al. 2009), *Tread lightly: Biodiversity and ecosystem services risk and opportunity management within the extractive industry* (Grigg et al. 2011), *and Linking shareholder and natural value: Managing biodiversity and ecosystem services risk in companies with an agricultural supply chain* (Grigg et al. 2009). For this index, these documents provided guidance on studies that examined the integration of biodiversity into different sectors. The degree to which the company is concerned with biodiversity conservation was categorized into one of five successive categories. These ranged from companies with no consideration of biodiversity or sustainable development/environmental issues to companies with developed and implemented biodiversity monitoring systems (Table 3). Further details on assessment criteria, analyses and results are available in a companion technical report (Potter et al. 2014).

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[2] While this category was not listed under Statistics Canada's (2012) list of industries, it was added to the index in order to establish a more holistic picture.

[3] Based on after-tax profits from 2013.

[4] The identification of industries was based primarily on The Globe and Mail's "Canada's top companies by industry" article, which outlined top 10 companies for the industries selected for this index. Industries not included in this list were then searched for in the Globe and Mail's "Top 1000 rankings". Both of these lists were based on top revenue companies (based on after tax profits from 2013) as identified on the data presented in the Report on Business.

Table 2. Stages of biodiversity concern for companies. See Potter et al. (2014) for list of criteria.

Category	Companies that:
1	Have no consideration of biodiversity or sustainable development/environmental issues
2	Report on sustainable development/environmental issues
3	Report on biodiversity, including acknowledgement of impacts
4	Consider biodiversity conservation a key strategic issue and have plans/policies to address it
5	Have developed and implemented a biodiversity monitoring system and/report on results of the monitoring

Results:

Trend: Baseline **Data Confidence:** Medium **Geographic Extent:** Provincial

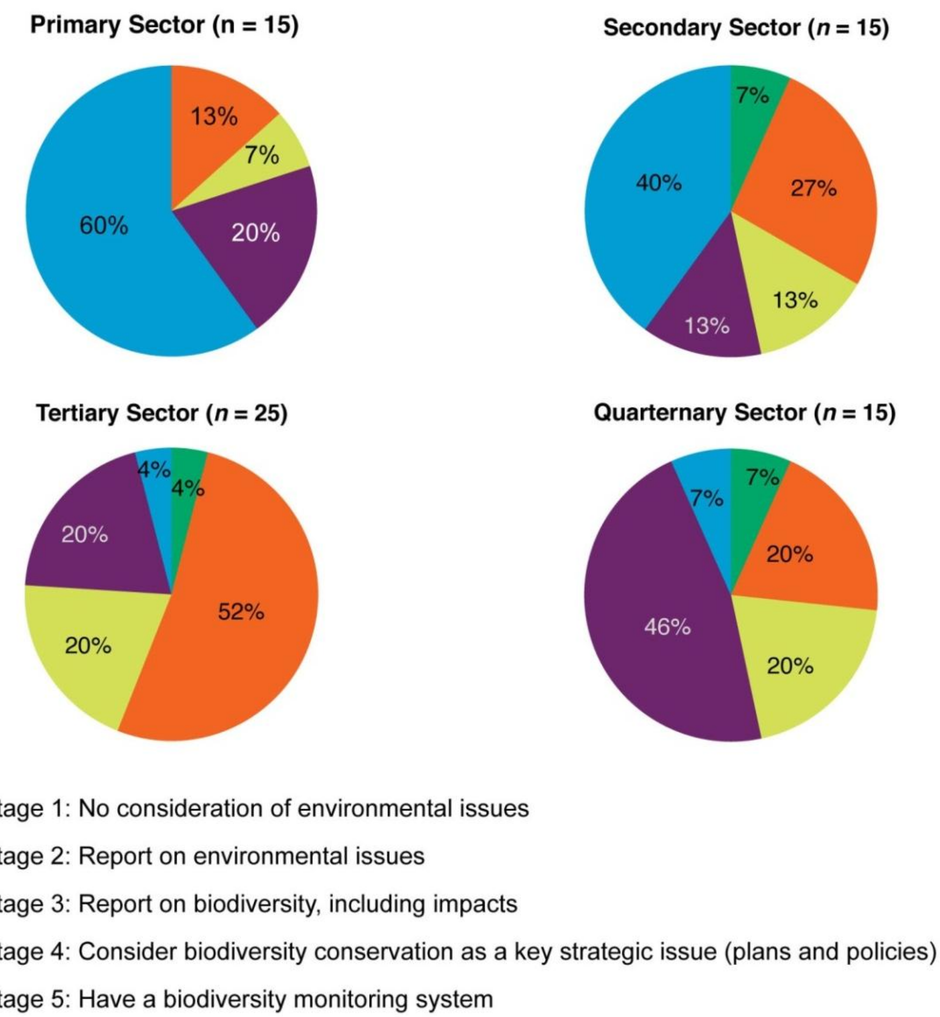

Figure 1. Summary of biodiversity consideration of different sectors operating in Ontario (*n* = 70). See Potter et al. (2014) for list of companies and scores.

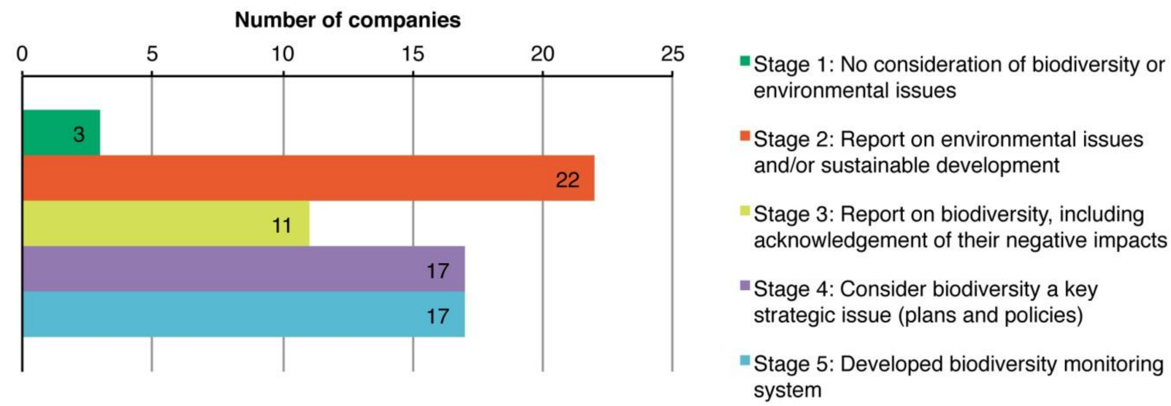

Figure 2. Summary of biodiversity consideration by all sectors operating in Ontario (*n* = 70). See Potter et al. (2014) for list of companies and scores.

Status:

- Only 4% (*n* = 3) of companies in this study did not consider biodiversity or environmental issues in their corporate programs or policies.
- Thirty-one percent (*n* = 22) of companies in this study reported on environmental issues and/or sustainable development, but did not explicitly consider biodiversity.
- Sixteen percent (*n* = 11) of companies in this study reported on biodiversity, including acknowledgement of their negative impacts.
- Twenty-four percent (*n* = 17) of companies in this study considered biodiversity a key strategic issue and had developed plans and policies to address these issues.
- An additional, 24% (*n* = 17) of companies in this study developed systems to monitor their effects on biodiversity and/or their plans and policies to address biodiversity concerns.
- The primary sector had the greatest level of biodiversity integration, recording the largest number of companies with developed biodiversity monitoring systems (60%, *n* = 9). This was followed by the secondary sector (40%, *n* = 6), the quaternary sector (7%, *n* = 1) and the tertiary sector (4%, *n* = 1).

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Canadian Business and Biodiversity Council http://www.businessbiodiversity.ca/

Fauna and Flora International http://www.fauna-flora.org/

Forest Footprint Disclosure Project www.forestdisclosure.com

Global Reporting Initiative www.globalreporting.org

ICMM Good Practice Guidance for Mining and Biodiversity www.icmm.com

Integrated Biodiversity Tool www.ibatforbusiness.org/

IPIECA/API Oil and Gas Industry Guidance on Voluntary Sustainability Reporting www.ipieca.org

The Keystone Centre www.keystone.org

Natural Value Initiative http://www.naturalvalueinitiative.org/

Roundtable on Sustainable Biomaterials www.rsb.org

Roundtable on Sustainable Palm Oil www.rspo.org

Stewardship Index for Specialty Crops www.stewardshipindex.org

The Economics of Ecosystems and Biodiversity Initiative http://www.teebweb.org/

Water Footprint Network www.waterfootprint.org

WBCSD Cement Sustainability Initiative www.wbcsdcement.org

References:

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Potter, K., A. Zohar, and T. McIntosh. 2014. An evaluation of the integration of biodiversity into business in Ontario. State of Ontario's Biodiversity Technical Report Series, Report #SOBTR-02. Ontario Biodiversity Council, Peterborough, ON. [Available at: http://sobr.ca/_biosite/wp-content/uploads/SOBTR-02-Final.pdf]

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The Economics of Ecosystems and Biodiversity (TEEB). 2010. The economics of ecosystems and biodiversity report for business – executive summary [Available at: http://www.teebweb.org/media/2012/01/TEEB-For-Business.pdf]

The Globe and Mail. (25 June 2014). Canada's top companies by industry. [Available at: http://www.theglobeandmail.com/report-on-business/rob-magazine/top-1000/rankings/canadas-top-companies-by-industry/article19344470/]

The Globe and Mail. (27 June 2013). Top 1000: Exclusive rankings of Canada's most profitable companies. [Available at: http://www.theglobeandmail.com/report-on-business/rob-magazine/top-1000/top-1000/article12829649/#dashboard/follows/]

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INDICATOR: INVASIVE SPECIES STRATEGIC PLANS

STRATEGIC DIRECTION: Reduce Threats

TARGET: 7. By 2015, strategic plans are in place to reduce threats posed to biodiversity by invasive species.

THEME: Pressures on Ontario's Biodiversity – Invasive Species

Background Information:

Invasive species are a significant and growing threat to Ontario's biodiversity (OBC 2010). Strategic plans to manage invasive species are an important tool in the fight against the introduction, establishment and spread of these unwanted pests.

At the national level, Canada's provinces and territories along with the federal government contributed to the development of *An Invasive Alien Species Strategy for* Canada that was approved in 2004 (Government of Canada 2004). The national strategy identifies key actions to reduce the risks from invasive species and provides a framework under which provincial plans can be developed. Subsequent national action plans have been developed related to the management of aquatic invasive species, invasive terrestrial plants and plant pests and wildlife disease (CCFAM 2004, CFIA 2005, EC 2004). Some plans have also been developed at the binational level such as the Lake Superior Aquatic Invasive Species Complete Prevention Plan (Lake Superior Binational Program 2014).

Ontario's Biodiversity Strategy, 2011 (OBC 2011) identified the need for enhanced efforts in Ontario to address invasive species prevention, control, rapid response and management. In 2012, the Ontario government released the *Ontario Invasive Species Strategic Plan* (OISSP) that provides a framework and identifies key actions to reduce the threats posed by invasive species in Ontario (OMNR 2012).

This indicator provides an assessment of progress in achieving Target 7 through a narrative description of OISSP as well as an assessment of the number of additional invasive species plans in Ontario that have been prepared by other agencies and organizations.

Data Analysis:

Information about the Ontario Invasive Species Strategic Plan (OISSP) was summarized from the document (OMNR 2012) with additional information obtained from the Ministry of Natural Resources and Forestry.

Specific data about additional invasive species plans in Ontario were collected as part of a larger survey conducted in 2014 by the Ontario Invasive Plant Council (OIPC) and the Ontario Ministry of Natural Resources and Forestry (OMNRF). The purpose of the survey was to identify additional invasive species plans (including strategies and management plans) that have been prepared in Ontario (Fig. 1), their geographic scale (provincial, regional or local) and their species focus. The survey was sent to a large number of organizations and individuals including municipalities, conservation authorities and other stakeholders. Survey responses from 53 different organizations are used for this indicator. Further details on the results of the survey are available in a companion technical report (Higginson 2015).

Results:

Trend: Improvement	**Data Confidence:** Medium	**Geographic Extent:** Provincial

This indicator reviews progress in achieving Target 7 through a narrative description of OISSP as well as an assessment of the number of additional invasive species plans in Ontario that have been prepared by other agencies and organizations.

Status:

- Strategic plans are in place at the national and provincial level to reduce threats posed to biodiversity by invasive species. Several organizations have also developed management plans to address invasive species threats at smaller scales, often for specific species or groups of species.

Provincial Strategy

- The Ontario government published the *Ontario Invasive Species Strategic Plan* (OISSP) in 2012. The development of the plan was led by the Ministry of Natural Resources, in conjunction with other ministries involved in invasive species management in Ontario (Agriculture and Food, Environment and Transportation).
- The goals outlined in OISSP are to prevent, detect, respond to, manage and adapt to invasive species. The OISSP describes actions taken to manage invasive species, identifies gaps in programs, and describes Ontario’s actions/tactics needed to respond to these gaps.
- OISSP provides a provincial framework to enable the provincial government and its partners to address the threats posed by invasive species. An implementation plan has been developed that identifies key priorities for focus over the next few years.

Survey of Invasive Species Plans

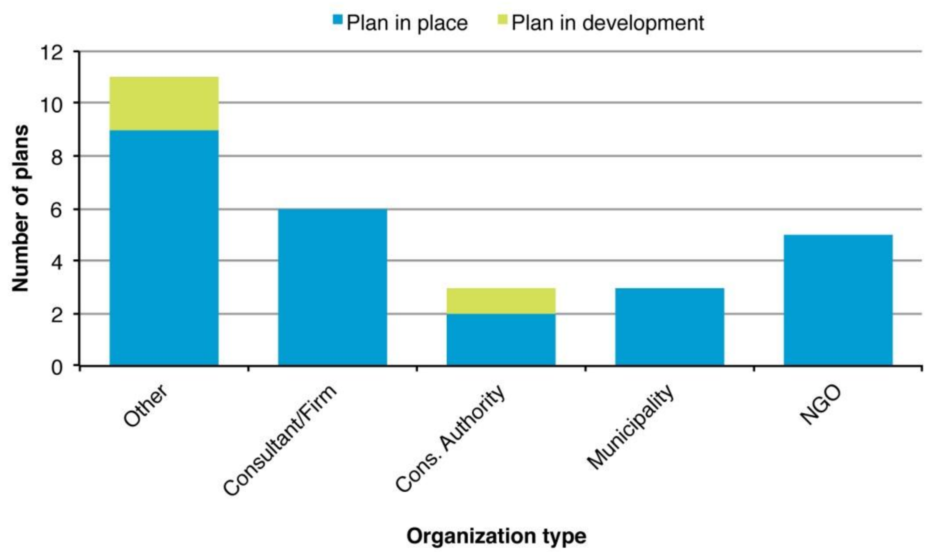

Figure 1. Number of additional invasive species plans in place or in development in Ontario by partner type.

- More than half of the 53 survey respondents (54%) identified that their organization had developed a plan (47%) or was developing a plan (7%).
- Of the 25 invasive species plans that have been prepared, 11 apply to a regional scale, while 10 are local or site-specific in their focus.
- The majority of plans (64%) are directed at terrestrial species, primarily plants and insects.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Ontario Invasive Species Strategic Plan http://viewer.zmags.com/publication/43e2ab69#/43e2ab69/1

Ontario Invasive Plant Council http://www.ontarioinvasiveplants.ca/

An Invasive Alien Species Strategy for Canada
http://publications.gc.ca/collections/collection_2014/ec/CW66-394-2004-eng.pdf

Lake Superior Binational Program http://www.epa.gov/glnpo/lakesuperior/index.html.

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Environment Canada (EC). 2004. National wildlife disease strategy. Environment Canada, Ottawa, ON.

Canadian Council of Fisheries and Aquaculture Ministers (CCFAM). 2004. A Canadian action plan to address the threat of aquatic invasive species. Canadian Council of Fisheries and Aquaculture Ministers Aquatic Invasive Species Task Group, Ottawa, ON. [Available at: http://www.dfo-mpo.gc.ca/science/enviro/ais-eae/plan/plan-eng.pdf].

Canadian Food Inspection Agency (CFIA). 2005. Canadian action plan for invasive alien terrestrial plants and plant pests. Canadian Food Inspection Agency, Ottawa, ON.

Government of Canada. 2004. An invasive alien species strategy for Canada. Ottawa, ON.

Higginson, S. 2015. Invasive species strategic plans. Draft – State of Ontario's Biodiversity Technical Report Series, Report #SOBTR-03. Ontario Biodiversity Council, Peterborough, ON.

Lake Superior Binational Program. 2014. Lake Superior Aquatic Invasive Species Complete Prevention Plan. [Available at http://www.epa.gov/glnpo/lakesuperior/index.html]

Ontario Biodiversity Council. 2011. Ontario's Biodiversity Strategy, 2011: Renewing Our Commitment to Protecting What Sustains Us. Ontario Biodiversity Council, Peterborough, ON.

Ontario Ministry of Natural Resources (OMNR). 2012. Ontario Invasive Species Strategic Plan. Queen's Printer for Ontario, Toronto, ON [Available at: https://dr6j45jk9xcmk.cloudfront.net/documents/2679/stdprod-097634.pdf

Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: PARTICIPATION IN ENVIRONMENTALLY SUSTAINABLE AGRICULTURE PROGRAM

STRATEGIC DIRECTION: Engage People

TARGET: 3. By 2015, the number of Ontarians who participate in biodiversity conservation activities is increased by 25%

11. By 2015, the proportion of private lands in Ontario that are managed for biodiversity is increased

THEME: Conservation and Sustainable Use – Sustainable Management

Background Information:

Ontario has about 52,000 farms and over 5 million hectares of land on farms (2011), which includes 3.6 million hectares of cropland (70.5% of farm area), almost 0.7 million hectares of pasture (12.9%) and about 0.8 million hectares of other lands (15.7%), primarily woodland and wetland. This represents about 8% of Canada's farmland. Almost 25% of farm income in Canada comes from Ontario farms (Statistics Canada 2012).

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 complete environmental risk assessments of their farming practices, and create action plans that identify best management practices to reduce risks (Government of Canada, Government of Ontario and Ontario Farm Environment Coalition 2013).

Evaluations of the implementation of EFPs took place provincially in 1999 (Plummer et al. 2007) and 2010 (Prairie Research Associates 2010). Findings from a survey of EFP participants (n=189) include the following:

- High levels of implementation of EFP action plans, 65% completed in 2010, up from 54% in 1999.
- Significant investments made in on-farm environmental projects, $69.6 thousand per farm on average, up from $10.8 thousand in 1999.
- 77% of the funds were farmers' own funding.
- 42% of actions taken had no reported costs.
- Clear evidence of behaviour change, with the educational workshop influencing priorities (45% changed priorities after workshop).

Best Management Practices projects implemented include runoff control, improved manure storage, and nutrient management planning, practices that have multiple environmental benefits, including reducing threats to biodiversity. Other actions such as restricting livestock access to waterways, establishing vegetative buffers, restoring wetlands and controlling invasive plant species, provide direct benefits to biodiversity.

Many Best Management Practices have been supported through cost-sharing funding under a series of Canada-Ontario agriculture agreements from 2005 to present day including: the Agricultural Policy Framework (2005-2008), Growing Forward (2008-2013) and Growing Forward 2 (2013 to present). The Species at Risk Farm Incentive Program (SARFIP; Ontario Soil and Crop Improvement Association 2014) and Grassland Habitat Farm Incentive Program are two programs that have funded specific biodiversity-related practices (Ministry of Natural Resources and Forestry and Environment Canada funding). Several other programs have been available in specific geographic areas including the Greenbelt, Oak Ridges Moraine and Lake Simcoe.

Geographic analysis of BMP adoption in Ontario by Agriculture and Agri-Food Canada (Ontario Soil and Crop Improvement Association 2012; Wozybun 2012) shows that the adoption of specific practices is linked to the specific agri-environmental risks in those geographic areas. For example, county-level adoption of manure management BMPs is highly correlated with manure production by livestock.

The indicator reports on the number of participants preparing EFPs and the change in numbers over time. Information on the total number and geographic distribution of On-farm Environmental Projects is included to supplement the information on participants and plans.

Data Analysis:

The annual number of participants in the Canada-Ontario Environmental Farm Plan program and the annual number of Environmental Farm Plans reviewed each year at the provincial level were compiled for the years 1994 to 2013 (Figure 1). The cumulative number of participants in the program was also calculated. Information on the number of On-farm Environmental Projects completed from 2005-2013 was mapped at the County level in southern Ontario and at the Region and District level in the north (Figure 2). Data for this indicator are maintained by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) in Guelph, Ontario.

Results:

Trend: Improvement **Data Confidence:** High **Geographic Extent:** Provincial

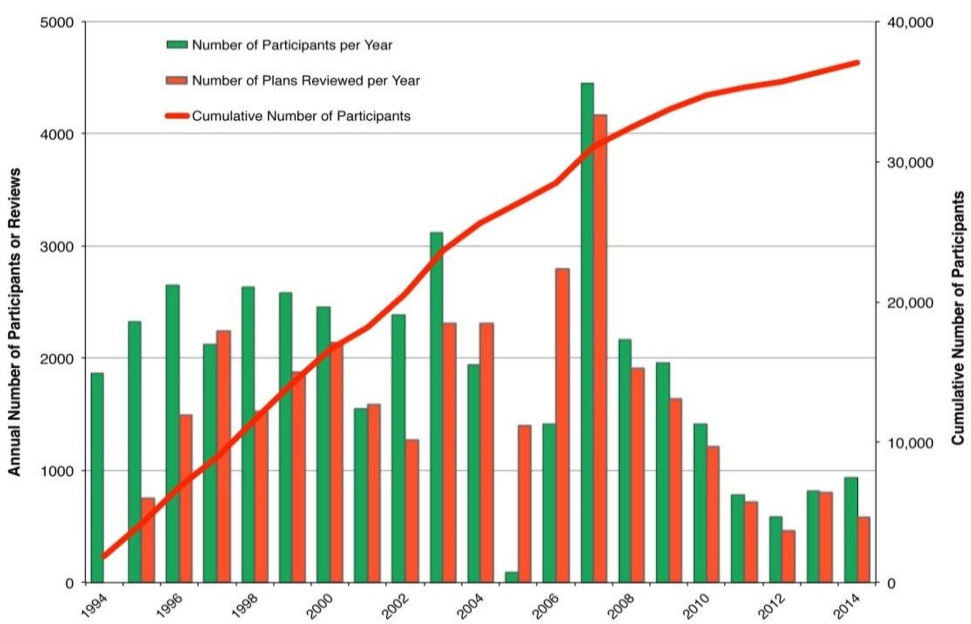

Figure 1. Number of participants in Canada-Ontario Environmental Farm Plan program, 1994-2013 (source: OMAFRA, Guelph, Ontario).

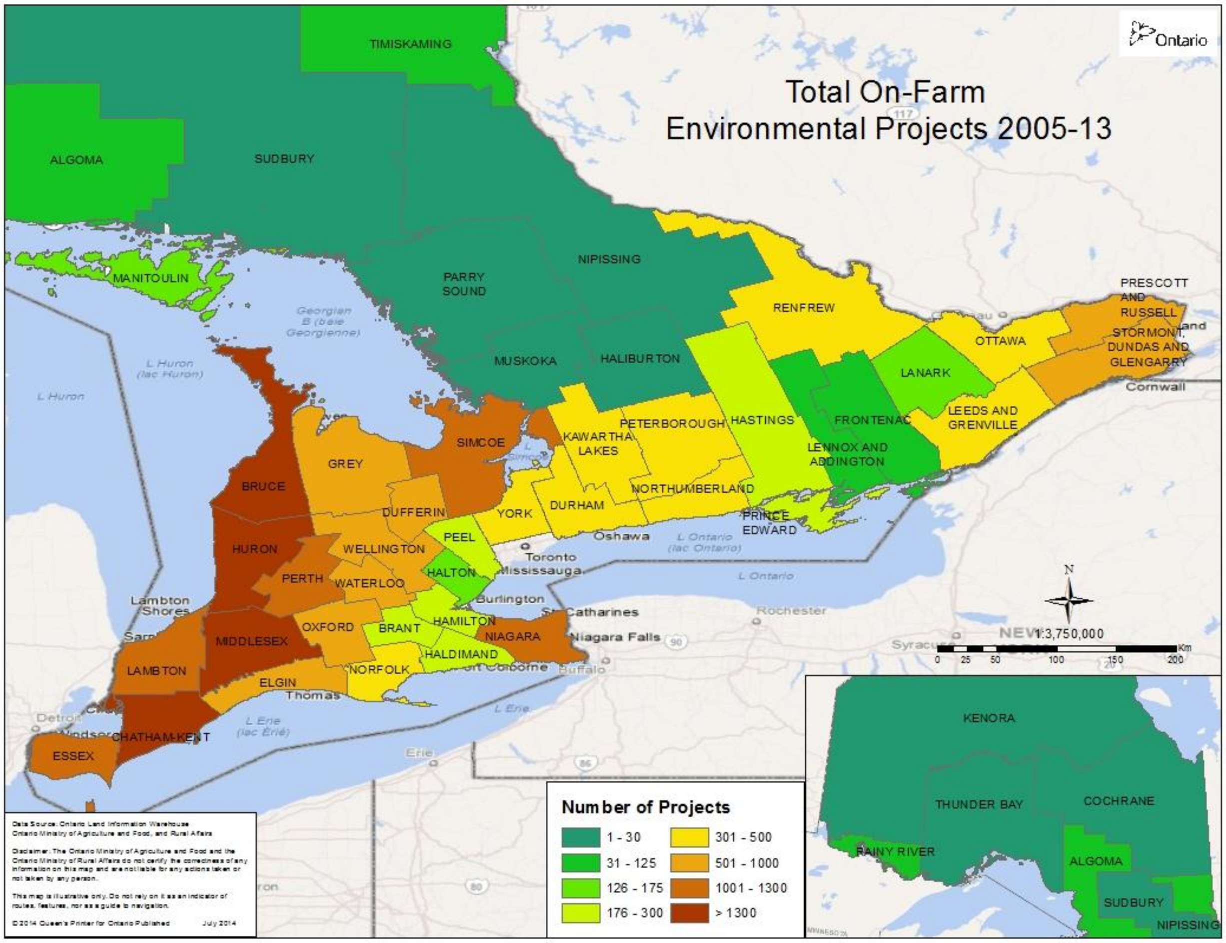

Figure 2. Number of completed On-farm Environmental Projects by County, Region and District (2005-13) (source: OMAFRA, Guelph, Ontario).

Status:

- An estimated 37,000 farms (about 70% of farms) participated in the Environmental Farm Plan program during 1992-2013 (Figure 1). That is about 2,000 additional farms since 2009, as reported in the State of Ontario's Biodiversity 2010.
- An estimated 37% of farm businesses had an up-to-date 3rd or 4th edition of the EFP in 2013.
- Between 2005 and 2013, farmers implemented 24,200 on-farm projects to achieve environmental outcomes (Figure 2), investing $365,000,000. That is 6,700 additional environmental projects since 2009 and the last report, the State of Ontario's Biodiversity 2010.
- The Species at Risk Farm Incentive Program (SARFIP) helped fund almost 1000 of the projects mentioned above specifically to improve biodiversity and species at risk habitat. Examples include wetland creation, streambank vegetation buffers, nest boxes, pollinator habitat establishment and invasive species removal.

- The proportion of private lands in agricultural areas managed to be more "biodiversity friendly" has increased since 2009. Participation in the Environmental Farm Plan continues to grow, but at less than 25% level in the OBS target.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Canada-Ontario Farm Plan http://www.omafra.gov.on.ca/english/environment/efp/efp.htm
http://www.ontariosoilcrop.org/en/programs/environmental_farm_plan.htm

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Ontario Soil and Crop Improvement Association. 2012. Environmental farm plan: right actions in the right places. Guelph, ON. [Available at: http://www.ontariosoilcrop.org/docs/2012_efp_brochure_revised_for_web.pdf]

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Indicator: Forest Certification

Strategic Direction: Conservation and Sustainable Use

Target: N/A

Theme: Conservation Response – Sustainable Management

Background Information:

Forest certification is an internationally recognized program that provides independent "third party" verification that a forest is well-managed. For this program, a well-managed forest is one that meets the audited forest certification standards that allows for trees to be harvested for a number of uses while protecting rare species, wildlife habitat, water quality and other factors that make up a healthy ecosystem.

Forestry is an important industry in Ontario. The *Crown Forest Sustainability Act* (CFSA) and other policies and regulations require that forests are sustainably managed and conserve biodiversity. Most of Ontario's managed forests are found in the Ontario Shield Ecozone and are divided into geographic planning areas known as management units. The majority of these forests are publicly owned but are managed by forest companies holding Sustainable Forest Licences. Ontario's regulated forest management system for Crown lands provides a good basis for forest companies to pursue third party certification.

Forest certification is a tool that promotes well-managed forests in the market place. Certification is granted by independent auditors, is voluntary, and can apply to public or private lands. Forest certification is generally market driven, with demand for certified products coming from consumers and retailers. A lack of certification does not mean a forest is poorly managed in Ontario as companies are still subject to the CFSA and management of Crown forests is highly regulated by the Ontario government to provide for the sustainable management and use of forest resources.

In Ontario, there are three types of forest certification:

- Canadian Standards Association (CSA) - Based on six criteria to assess environmental, social and economic benefits: biological diversity, ecosystem condition and productivity, soil and water, role in global ecological cycles, economic and social benefits, and society's responsibility;
- Forest Stewardship Council (FSC) - Evaluates forests against ten principles of forest management appropriate to local social, ecological and economic conditions. Some of the principles include: compliance with laws, indigenous people's rights, and environmental values and impacts; and
- Sustainable Forestry Initiative (SFI) - Uses 14 principles and 20 objectives to certify well-managed forests. Some of the principles are: sustainable forestry; protection of biological diversity; public involvement; and transparency.

Some Crown forests are being certified for the first time but economic challenges in the forestry industry has resulted in a slight net loss of certified forests. Levels of certification and interest in the program may increase as forest certification becomes a more integral part of the Ontario forest industry's business practice (OMNR 2014).

Data Analysis:

Forest Certification in Ontario is calculated by tracking the area of Crown forest in the AOU certified under a forest certification management standard.

All three of the forest certification systems have accredited third party auditors that perform on-site audits to verify that standards are being met. The audit organizations act as the registrars of the program. Source data for the status of Forest Certification come from the audit organizations.

The information presented for this indicator represents a summary of the *State of Resource Reporting: Forest Certification in Ontario* report (OMNR 2014).

Results:

Trend: Deterioration **Data Confidence:** High **Geographic Extent:** Area of Crown Forests

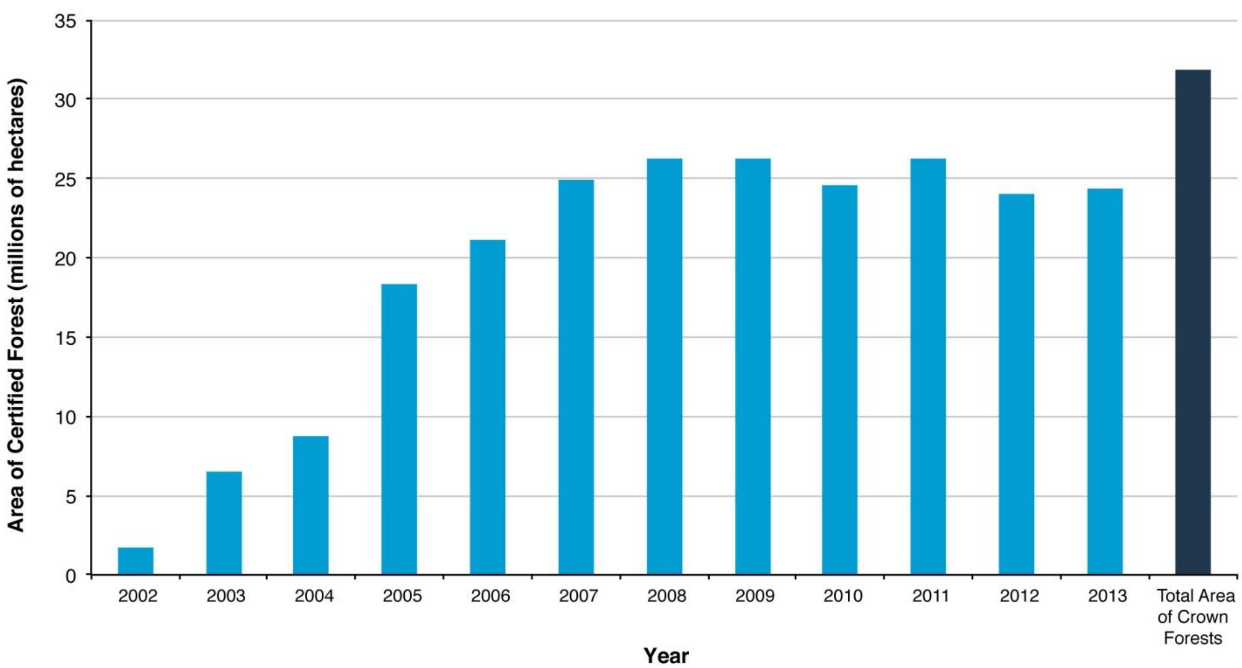

Figure 1. Area of managed forest under forest certification (2002 – 2013) compared with total area of licensed forest (OMNR 2014).

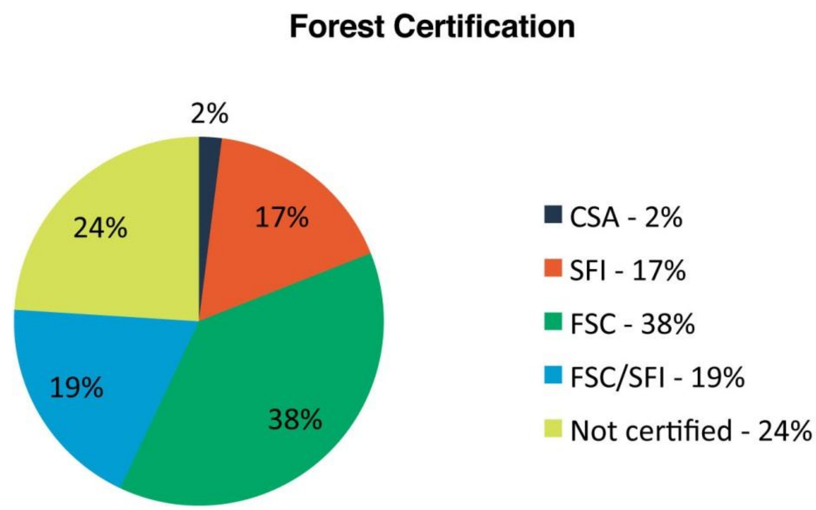

Figure 2. Percent of management units certified under each standard in 2013 (OMNR 2014).

Status:

- In 2013, 24 million ha of Ontario's 32 million ha of managed Crown forests were certified (76%). This is a 7% reduction in forest area certified since 2008.
- Forest certification increased dramatically between 2002 when programs were first available and 2008.
- The reduction in certified forests since 2008 is generally due to economic challenges faced by the Ontario forest industry in recent years, mainly as a result of company bankruptcies (OMNR 2014).

Links:

Related Targets: N/A

Related Themes: Conservation and Sustainable Use – Area under sustainable management systems

Web Links:

Forest Stewardship Council (FSC) https://ca.fsc.org

Sustainable Forestry Initiative (SFI) http://www.sfiprogram.org

Canadian Standards Association (CSA) http://www.csasfmforests.ca

Programme for the Endorsement of Forest Certification (PEFC) http://www.pefccanada.org

MNR – Forests http://www.mnr.gov.on.ca/en/Business/Forests/index.html

Forest Products Association of Canada - Forest Certification http://www.certificationcanada.org/english/index.php

Forest Products Association of Canada – Publications http://www.fpac.ca/index.php/en/publications

Sustainable Forest Management in Canada http://www.sfmcanada.org/

Ontario Wood http://www.mnr.gov.on.ca/en/Business/OntarioWood/index.html

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Ontario Ministry of Natural Resources (OMNR). 2014. State of resources reporting: Forest certification in Ontario. Ontario Ministry of Natural Resources, Peterborough, ON. [Available at: http://www.ontario.ca/document/forest-certification]

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INDICATOR: WALLEYE HARVEST IN INLAND LAKES

STRATEGIC DIRECTION: Enhance Resilience

TARGET: N/A

THEME: Conservation Response – Sustainable Management

Background Information:

In 2010, 1.2 million licenced anglers contributed $2.26 billion to the Ontario economy (OMNRF 2014a). Sustaining these economic and societal benefits relies on the effective management of the fish populations and aquatic ecosystems that support Ontario's fisheries. Ontario has a strong framework of legislation, regulations and policies that support a diversity of high quality, sustainable fisheries targeting a variety of species. Ongoing assessment and an adaptive management approach provide mechanisms to respond to fisheries status changes and ensure sustainability.

In 2004, Ontario introduced an Ecological Framework for Fisheries Management. The framework aims to manage healthy fisheries for the future through simplified regulations over larger, ecologically-based Fisheries Management Zones and providing more public involvement. In support of the framework, a Broad-Scale Monitoring Program of lakes (BSM) was established in 2008 to assess the current state of fishes and other aquatic resources, identify stresses on these resources, and report on changes over time. The program monitors a subset of lakes across the province on 5-year cycles to provide information critical to effective fisheries management.

This indicator uses information on Walleye populations from the Broad-Scale Monitoring Program to assess the level of fishing stress on Walleye across Ontario as an indicator of sustainable management. Walleye are widespread in Ontario and are one of the most sought after species and the most frequently captured species by Ontario anglers (OMNRF 2014a). Information on estimated recreational Walleye harvest and fishing intensity from the 2010 Survey of Recreational Fishing in Canada is used to supplement the data from the Broad-Scale Monitoring Program in this indicator. Together, these measures provide an index of the level of fishing pressure on Ontario's Walleye populations. This is the first time this indicator has been assessed. Future assessments will allow an analysis of trends as both the Broad-Scale Monitoring and Survey of Recreational Fishing are repeated every 5 years. Further details regarding the development of this indicator are available in a separate technical report (Dextrase et al. 2014).

Data Analysis:

Stress associated with fishing mortality – Estimates of Walleye fishing mortality were derived from the first cycle of BSM (2008-2012). Information to estimate mortality was available for 8% of Ontario's 4,242 known inland Walleye lakes greater than 50 ha in size (Table 1). Total adult mortality rate per year for each population was estimated from the number of individuals in each age class (OMNRF 2014b). Estimates of natural mortality for each population were calculated using climate information (Growing Degree Days > 5 ^{O}C) and estimates of growth rates and length at maturity (Lester et al. 2004a). Fishing mortality for each Walleye population was calculated as the total adult mortality minus natural mortality. The level of fishing stress was then assessed by comparing estimated fishing and natural mortalities – Walleye populations with estimated fishing mortality equal to or greater than estimated natural mortality were assessed as having a high level of fishing stress (Kolding and van Zwieten 2014). Such levels of fishing mortality are likely to be higher than the value that maximizes sustainable yield (Lester et al. 2014). For each inland Fisheries Management Zone with sufficient data, the percentage of sampled Walleye lakes with high fishing stress was calculated and mapped (Figure 1). Fishing mortality estimates include all types of fishing – recreational, commercial and subsistence.

Table 1. Sample size of inland Walleye lakes from Broad-Scale Monitoring used to estimate mortality in each Fisheries Management Zone (FMZ) compared with number of known Walleye populations in lakes > 50 ha.

FMZ	Sample size	Known Walleye populations	% of known lakes sampled
1	3	5	60
2	12	570	2
3	0	26	0
4	82	829	10
5	79	674	12
6	55	325	17
7	31	472	7
8	32	496	6
10	19	282	7
11	22	151	15
12	3	6	50
15	12	222	5
16	0	31	0
17	8	37	22
18	9	116	8
Total	**367**	**4242**	8

Harvest and fishing intensity – Estimates of recreational Walleye harvest and fishing intensity were based on Ontario respondents to the 2010 Survey of Recreational Fishing in Canada. Responses were received from 39.6% of 29,892 licenced anglers who received the mail-based survey (OMNRF 2014c). A follow-up phone survey of 10% of non-respondents was conducted to account for non-response bias. Estimates of the number of Walleye harvested in lakes in each of Ontario's Fisheries Management Zones were developed by applying appropriate weighting to geographically referenced responses (OMNRF 2014c). A standard measure of Walleye harvest for lakes in each Fisheries Management Zone (kg/hectare) was derived by multiplying the estimated number of harvested fish by 0.748 kg (mean weight of Walleye from historical creel survey data in Ontario) and dividing by the area of known Walleye lakes (Figure 2). Fishing intensity (person-hours of effort/hectare) for lakes in each Fisheries Management Zone was measured in a similar fashion based on survey responses (Figure 2). Fishing intensity is reported for all species combined as several respondents targeted multiple species or did not specify target species (OMNRF 2014c). Walleye is one of the most sought after and frequently captured fish species and therefore total fishing effort is a reliable index of fishing intensity directed at Walleye.

In the more southern Fisheries Management Zones, a greater proportion of the total fishing effort is directed at other species such as Smallmouth Bass and Largemouth Bass.

- download Walleye fishing stress, Walleye harvest and fishing intensity data

Results:

Trend: Baseline	**Data Confidence:** Medium	**Geographic Extent:** Provincial

Stress Associated With Fishing Mortality

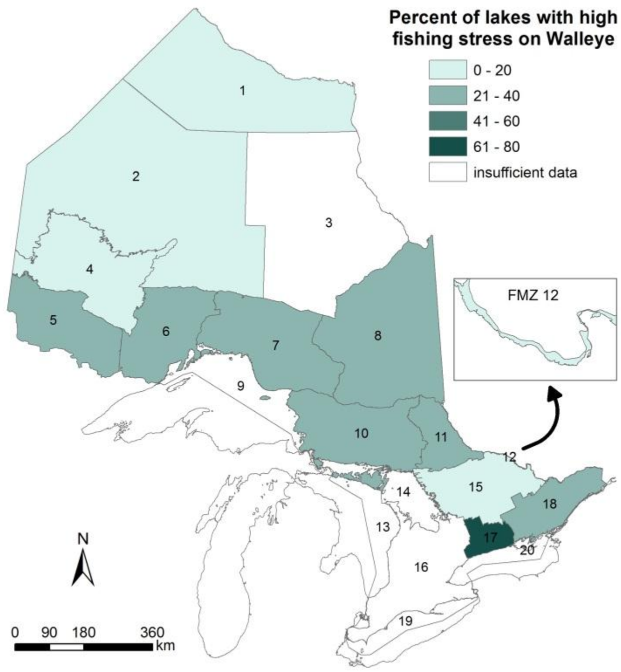

Figure 1. Proportion of sampled Walleye lakes in each inland Fisheries Management Zone with high fishing stress based on first 5-year cycle of Broad-scale Monitoring (Lakes with estimated Walleye fishing mortality equal to or greater than natural mortality were assessed as having high fishing stress on Walleye).

Status:

- Ninety-three of 367 Walleye lakes (25%) sampled in the first 5-year cycle of Ontario's Broad-scale Monitoring Program (2008-2012) were assessed as having high fishing stress on their Walleye populations based on estimates of fishing mortality.
- Fisheries Management Zones 17 in southern Ontario's Mixedwood Plains Ecozone has the greatest proportion of sampled lakes with high fishing stress on Walleye (63% of sampled lakes).
- Fisheries Management Zones in the Ontario Shield and Hudson Bay Lowlands ecozones have a relatively small proportion of sampled lakes with high fishing stress on walleye (all < 34%). None of

the sampled lakes from Fisheries Management Zones 1 and 2 in the Far North and Zone 12 in the southern Ontario Shield Ecozone were assessed as having high fishing stress on Walleye.

Harvest and Fishing Intensity

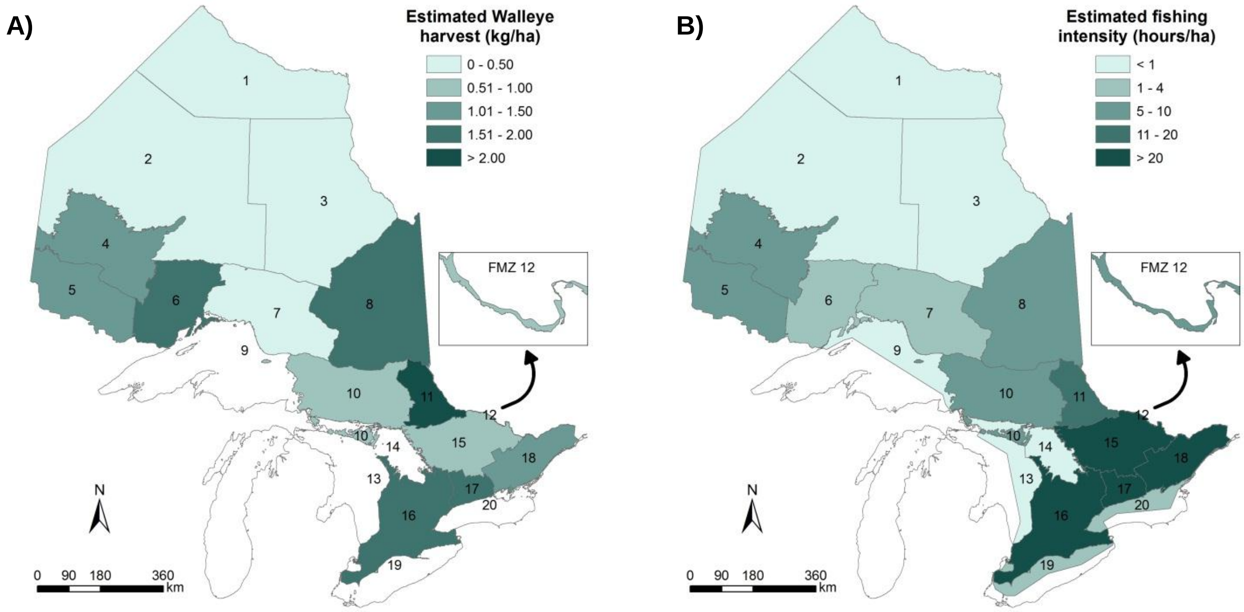

Figure 2. A) Estimated recreational fishing harvest of Walleye standardized by lake area (kg/ha) for lakes in inland Fisheries Management Zones in Ontario; B) Estimated recreational lake fishing intensity (person-hours/ha for all species combined) for lakes in Fisheries Management Zones in Ontario (Data for both panels are based on the 2010 Survey of Recreational Fishing in Canada [OMNRF 2014b]).

Status:

- Estimated Walleye harvest by lake area is highest (> 2.0 kg/ha) in Fisheries Management Zone 11 in the Ontario Shield Ecozone. Estimated harvest in Zones 6, 8, 16 and 17 is also relatively high (1.51 – 2.00 kg/ha). Because of a warmer climate, lakes in southern Ontario can generally sustain higher harvest levels than lakes in the north (Lester et al. 2004b).
- Recreational fishing intensity is high (> 20 hr/ha) in Fisheries Management Zones 16, 17, and 18 in the Mixedwood Plains Ecozone and in Zone 15 in the southern part of the Ontario Shield Ecozone. A greater proportion of fishing effort in these southern zones is directed at species other than Walleye.
- Fishing intensity decreases moving northward with very low levels of effort (< 1 hr/ha) in Fisheries Management Zones 1, 2 and 3 in the Far North. Recreational fishing intensity by lake area in the Great Lakes is relatively low, but much of this effort is concentrated in bays and nearshore areas.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

OMNRF – Management of Fish in Ontario [Management of Fish in Ontario]

Fish Ontario – Broad-scale Monitoring of lakes program https://www.ontario.ca/environment-and-energy/methods-monitoring-fish-populations

Fisheries and Oceans Canada - Survey of Recreational Fishing in Canada http://www.dfo-mpo.gc.ca/stats/rec/canada-rec-eng.htm

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Ontario Ministry of Natural Resources and Forestry (OMNRF). 2014b. Guide to lake synopsis: broad-scale monitoring. Science and Research Branch, Ontario Ministry of Natural Resources and Forestry, Peterborough, ON.

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INDICATOR: PROVINCIAL EXPENDITURE ON BIODIVERSITY AND CHARITABLE GIVING TO THE ENVIRONMENT

STRATEGIC DIRECTION: Engage People

TARGET: n/a

THEME: Conservation Response – Financing Biodiversity Conservation

Background Information:

Biodiversity 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.

This indicator assesses trends in the absolute and relative amounts of resources allocated to biodiversity conservation from three primary funding sources: the provincial public sector, conservation authorities and charitable giving of individuals. As the largest funder of the environmental not-for-profit sector in Ontario, environmental grants made by the Ontario Trillium Foundation (OTF) were also assessed (OTF 2007).

Data Analysis:

For the public sector, the Ontario Ministry of Natural Resources and Forestry and the Ministry of Environment and Climate Change were chosen because the majority of their programs align with activities relevant to biodiversity. Total expenditure estimates for these ministries and the Ontario government were obtained from estimates provided by the Ministry of Finance (OMOF 2014a). Most conservation authorities invest in a broad array of biodiversity conservation and monitoring programs across southern Ontario and parts of the north. Information on expenditures by conservation authorities was obtained from Conservation Ontario. Trends in charitable giving were assessed for environment-related donations based on Statistics Canada surveys conducted for 2004, 2007 and 2010 (Hall et al. 2006, 2009, Turcotte 2012). Information on OTF environmental grants was obtained from the Ontario Trillium Foundation.

To place the level of support for biodiversity conservation in context, trends in Ontario's Gross Domestic Product (GDP) were examined using the Ontario Economic Accounts (OMOF 2014b). To account for inflation all monetary values reported have been adjusted to 2002 dollars based on the Consumer Price Index (Bank of Canada 2014).

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. Some of the variability in the expenditures of the Ministry of Natural Resources and Forestry relate to evolving mandates (loss and inclusion of some forestry-related funding) and variation in forest fire fighting expenses. 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 Ontario's biodiversity. For these reasons, this indicator has been deliberately narrowly scoped, knowing that additional support for biodiversity management and conservation is provided through other means (e.g., businesses, academia, conservation organizations) and exists in the programs of other government ministries. Information on environment-related expenditures of federal ministries and agencies in Ontario was not available for inclusion in this indicator at this time.

Results:

Trend: No Change **Data Confidence:** Medium **Geographic Extent:** Provincial

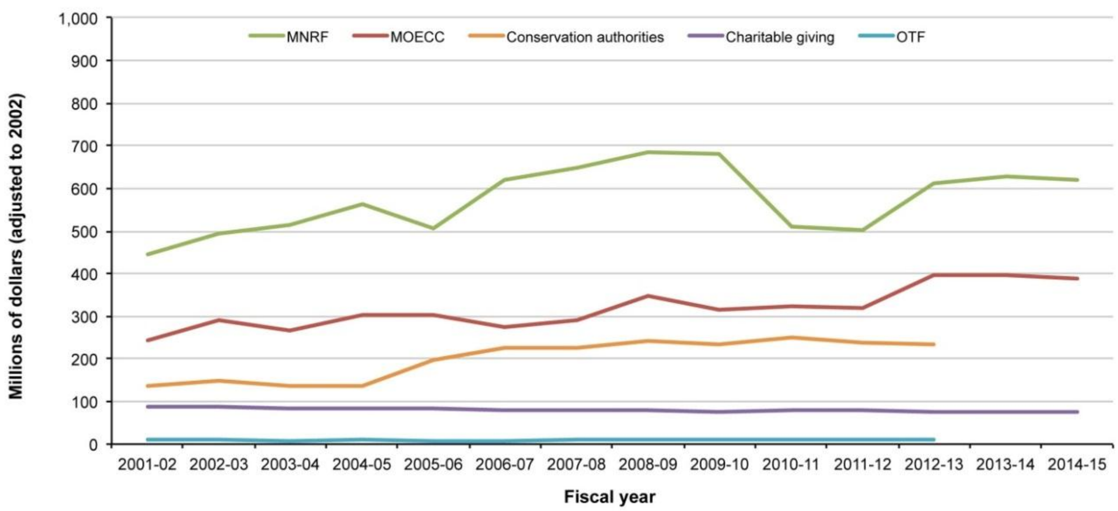

Figure 1. Provincial expenditures (adjusted to 2002 dollars) of Ontario ministries with biodiversity mandates, conservation authorities, charitable giving to the environment and environmental grants by the Ontario Trillium Foundation.

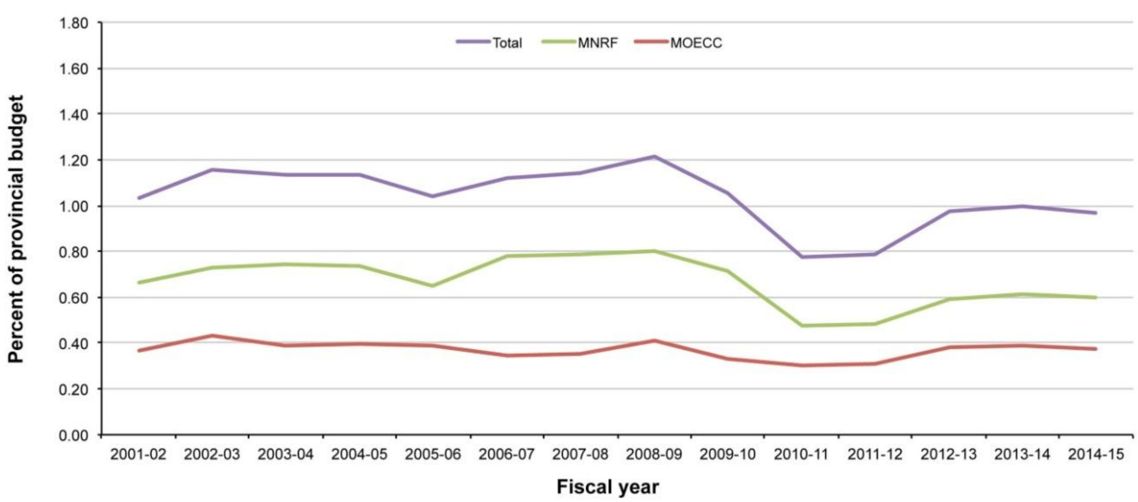

Figure 2. Percent of total provincial budget allocated to Ontario ministries with biodiversity mandates.

Status:

- From 2001-02 to 2014-15, expenditures of the biodiversity-related provincial ministries increased by 47% when adjusted to 2002 dollars. The total provincial budget increased by 57% during this period.
- Over the last 5 years, indexed expenditures of these ministries have decreased by 1.5% while the provincial budget has increased by 10%.
- Between 2001-02 and 2014-15, the provincial ministries most directly involved in biodiversity conservation and management were allocated 0.8 – 1.2% of the total provincial budget (average 1.0%). There has been a slight decrease over the last 5-year period.
- Total expenditures by conservation authorities increased by 71% between 2001 and 2012 and have remained relatively steady over the most recent 5-year period.
- Based on surveys conducted in 2004, 2007 and 2010, charitable donations by Ontarians to environmental activities amount to $88 to $95 million annually with a decrease in adjusted value in each successive survey. OTF environmental grants increased by 10% between 2001-02 and 2012-13 when indexed for inflation (from $9.9 million to $10.9 million).
- For perspective, it is important to note that over the period 2001 to 2013, Ontario's Gross Domestic Product (GDP) increased from $470 billion to $553 billion in constant (consumer inflation-adjusted) dollars. Allocation of resources to biodiversity management and conservation from the provincial public sector, conservation authorities, the OTF and charitable giving averaged 0.20% of Ontario's GDP over this period.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Ontario Ministry of the Environment and Climate Change http://www.ontario.ca/ministry-environment-and-climate-change

Ontario Ministry of Natural Resources and Forestry http://www.ontario.ca/ministry-natural-resources-forestry

Conservation Ontario http://www.conservation-ontario.on.ca/

Ontario Trillium Foundation http://www.otf.ca/en/

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OMOF (Ontario Ministry of Finance). 2014b. Ontario economic accounts. Ministry of Finance, Toronto, ON [available: http://www.fin.gov.on.ca/en/economy/ecaccts/ (date accessed: July 8, 2014)].

OTF (Ontario Trillium Foundation). 2007. The environment sector in Ontario. Ontario Trillium Foundation Research Brief – 104, Toronto, ON.

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Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: BIODIVERSITY IN ONTARIO'S ELEMENTARY AND SECONDARY SCHOOL CURRICULA

STRATEGIC DIRECTION: Engage People

TARGET: 1. By 2015, biodiversity is integrated into the elementary, secondary and postsecondary school curricula, including schools of business.

THEME: Conservation Response – Education and Awareness

Background Information:

Changes in the Earth's environment and its natural systems, including the loss of biodiversity, have emerged as a matter of increasing concern around the world. While the issues are complex and diverse, there is a shared recognition that solutions will arise only through committed action on a global, national, regional, local, and individual scale (Pooley and O'Connor 2000). Schools have a vital role to play in preparing young people to take their place as informed, engaged and empowered citizens who will be pivotal in shaping the future of our communities, our province, our country, and our global environment (Ontario Ministry of Education 2007).

In Ontario, the curriculum taught in elementary and secondary schools is mandated province-wide by the Ministry of Education. Environmental education, including learning about biodiversity, is recognized as an important part of Ontario's curriculum. In 2009 the Ontario government made a commitment that environmental education, as defined in *Acting Today, Shaping Tomorrow: A Policy Framework for Environmental Education in Ontario Schools,* would be part of every child's learning and that responsible environmental practices would be fostered across Ontario's education system (Ontario Ministry of Education 2009).

This indicator provides a narrative assessment of the integration of biodiversity into the elementary and secondary curricula.

Data Analysis:

Information about the integration of biodiversity into elementary and secondary school curricula was provided by the Ontario Ministry of Education. The Ontario curriculum consists of 8 elementary curriculum documents and 32 secondary curriculum documents. Elementary curriculum is standard from Grades 1-8. In secondary school, students generally work towards an Ontario Secondary School Diploma, which requires a combination of compulsory and optional credits from a variety of disciplines. Compulsory credit requirements include at least two credits in science and one credit in geography.

Results:

Trend: Improvement	**Data Confidence**: High	**Geographic Extent**: Provincial

Status:

- Biodiversity has been integrated into the elementary and secondary school curriculum and opportunities to learn about biodiversity have increased in revised curriculum. The Ministry of

Education continues to use the Standards for Environmental Education in the Curriculum to guide revisions, resulting in an increased focus on environmental issues such as biodiversity and related issues including habitat loss, invasive and endangered species, climate change and ecosystems.

- The Standards for Environmental Education in the Curriculum (2008) help curriculum writers incorporate environmental education expectations and opportunities, such as learning about biodiversity, across the curriculum. The standards frame learning around four themes – community, knowledge, perspectives, and action – and are designed to prepare students to support environmental sustainability by bridging the gap between their awareness of issues and their ability to take action.
- In elementary curriculum, which is mandatory, students learn about biodiversity in subject areas such as Social Studies, History and Geography and Science and Technology, as appropriate. In secondary schools, students learn about biodiversity in the mandatory courses in Gr. 9 Geography and Gr. 10 Science. Other opportunities to learn about biodiversity exist in courses in Science, Geography, Technological Education, and in other disciplines where biodiversity is used as the context for learning.
- In Social Studies, Grades 1-6; History and Geography, Grades 7 and 8 students learn about the human-created and natural world and gradually delve into impacts of human activities on the natural world. As students mature, they learn about how they can make choices that minimize the negative impacts of their actions and they learn how environmental stewardship can take place at the personal, national and international level. In this curriculum, concepts and issues such as respect for natural systems, land use, pollution, habitat loss, resource extraction, and action plans to reduce environmental impacts are introduced and students' learning deepens and expands as they progress through the grades. Biodiversity is the focus of a strand in Grade 6 Science. Students learn to:
    - Assess human impacts on biodiversity, and identify ways of preserving biodiversity;
    - Investigate the characteristics of living things, and classify diverse organisms according to specific characteristics; and
    - Demonstrate an understanding of biodiversity, its contributions to the stability of natural systems, and its benefits to humans.
- In Grade 10 Science, the Biology strand focuses on sustainable ecosystems and human activity. Students learn to:
    - Analyse the impact of human activity on terrestrial or aquatic ecosystems, and assess the effectiveness of selected initiatives related to environmental sustainability;
    - Investigate some factors related to human activity that affect terrestrial or aquatic ecosystems, and describe the consequences that these factors have for the sustainability of these ecosystems; and
    - Demonstrate an understanding of the characteristics of terrestrial and aquatic ecosystems, the interdependence within and between ecosystems, and the impact humans have on the sustainability of these ecosystems.
- Canadian and World Studies, Grades 9-10 contains curricula for Gr. 9 Geography, Grade 10 History and Gr. 10 Civics and Citizenship. These courses are a mandatory component of the Ontario

Secondary School Diploma. In these courses, students develop the skills they need to solve problems and communicate ideas and decisions about significant developments, events and issues. Biodiversity and related issues such as pollution, climate change, impacts of consumption, land use and issues of civic importance such as environmental responsibility are explored extensively.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Ontario Ministry of Education. 2008. Standards for Environmental Education in the Curriculum http://www.edu.gov.on.ca/eng/teachers/enviroed/standards.html

Ontario Ministry of Education. The Ontario Curriculum, Social Studies, Grades 1-6; History and Geography, Grades 7-8, 2013. http://www.edu.gov.on.ca/eng/curriculum/elementary/sshg18curr2013.pdf

Ontario Ministry of Education. The Ontario Curriculum Grades 1-8: Science and Technology, 2007. http://www.edu.gov.on.ca/eng/curriculum/elementary/scientec18currb.pdf

Ontario Ministry of Education. The Ontario Curriculum, Grades 9 and 10: Canadian and World Studies, 2013. http://www.edu.gov.on.ca/eng/curriculum/secondary/canworld910curr2013.pdf

Ontario Ministry of Education. The Ontario Curriculum, Grades 9 and 10: Science, 2008. http://www.edu.gov.on.ca/eng/curriculum/secondary/science910_2008.pdf

Ontario Ministry of Education. The Ontario Curriculum, Grades 9 and 10: Technological Education, 2009. http://www.edu.gov.on.ca/eng/curriculum/secondary/teched910curr09.pdf

Ontario Ministry of Education. The Ontario Curriculum, Grades 11 and 12: Technological Education, 2009. http://www.edu.gov.on.ca/eng/curriculum/secondary/2009teched1112curr.pdf

References:

Ontario Ministry of Education. 2009. Acting Today, Shaping Tomorrow: A Policy Framework for Environmental Education in Ontario Schools. Queens Printer for Ontario, Toronto, Ontario.

Pooley, J. A., and M. O'Connor. 2000. Environmental education and attitudes: Emotions and beliefs are what is needed. Environment and Behavior 32:711-723.

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Citation

Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: BIODIVERSITY IN ONTARIO'S POSTSECONDARY CURRICULA

STRATEGIC DIRECTION: Engage People

TARGET: 1. By 2015, biodiversity is integrated into the elementary, secondary and postsecondary curricula, including schools of business.

THEME: Conservation Response – Education and Awareness

Background Information:

As countries around the world face complex environmental issues, there is a growing recognition that education has a key role to play. Environmental education, including an awareness of the importance of biodiversity, is a vital tool to help people understand the nature and complexity of environmental challenges and build their capacity to take appropriate action (Pooley and O'Connor 2000; Smith et al. 2011).

At the postsecondary level, an assessment of how and to what degree biodiversity has been incorporated into university education has not previously been conducted in Ontario. This indicator provides an assessment of the extent to which biodiversity has been incorporated into the curriculum of select Ontario universities.

Data Analysis:

A detailed review of the curricula of six Ontario universities was conducted to develop an index of the degree to which biodiversity has been incorporated into university undergraduate and graduate education, with a focus on business schools. The universities in the index included: Carleton University, University of Guelph, Lakehead University, the University of Toronto, Trent University and the University Of Ontario Institute Of Technology. These universities were considered a representative selection as they included small, medium and large universities covering a wide geographic scale. The universities within this index represent 30% of the 20 universities in Ontario. In 2013 there was a total population of nearly 158,000 students enrolled at these six universities.

The course descriptions within 386 undergraduate and 327 graduate programs were assessed to determine whether or not the concept of biodiversity was included in core or elective courses (Table 1). An estimated 13,500 courses were assessed at the undergraduate level, and 4,000 courses at the graduate level. Programs that were offered only as 'minors' were excluded from the assessment. A list of keywords associated with the concept of biodiversity (Table 2) was generated and a keyword search was conducted on university academic calendars in PDF format, using the program Mendeley©. If a keyword was present within core or elective courses for a particular program, that program was considered to include biodiversity content.

Table 1. Definitions of university programs and core and elective courses.

Program	An assortment of courses that lead toward a degree at the undergraduate or graduate level. Programs consist of a certain number of core and elective courses.
Core course	A course that is required within a particular undergraduate or graduate program.
Elective course	A course that is not required, but is optional to take within a particular program.

Within academic calendars the keyword with greatest frequency was "environment". Some courses that included keywords were excluded, because the course descriptions did not suggest biodiversity content. For example, education courses that discussed learning in a "seminar environment", or computer courses about the "ecology of online learning" were not considered to have biodiversity content. Further details on analyses and results are available in a companion technical report (McCallum et al. 2014).

Table 2. List of keywords used to search university academic calendars for biodiversity education content.

Biodiversity/biological diversity/diversity	Invasive alien species
Biodiversity threats	Nature
Biosphere	Nature education
Climate change	Natural resource(s)
Composition, structure and function of biological systems	Preservation
Conservation/conservation biology	Pollution
Ecology/ecological	Species diversity
Ecosphere/ecospheric security	Species extinction
Ecosystem/ecosystem diversity/ecosystem health or integrity	Stewardship
Endangered species/species at risk	Sustainability
Environment/environmental	Taxonomy
Evolution	Value of nature
Genetic diversity	Wilderness
Human impacts on the environment	Wildlife

Results:

Trend: Baseline **Data Confidence**: Medium **Geographic Extent**: Provincial

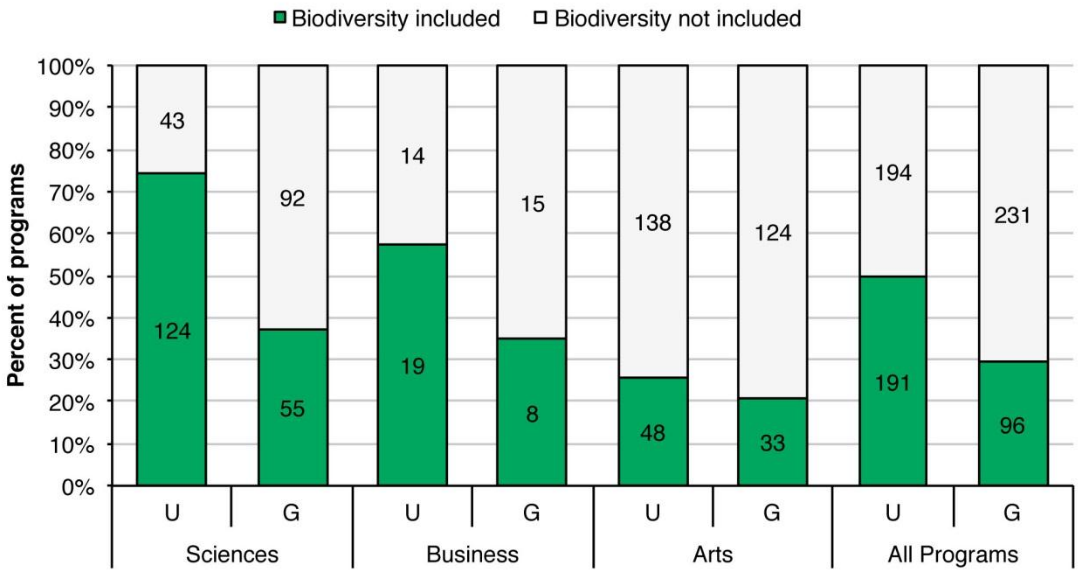

Figure 2. Summary of university biodiversity content overall (all programs) and by category (sciences, business and arts) within undergraduate (U) and graduate (G) programs.

Status:

- Biodiversity has been partially integrated into postsecondary curricula in Ontario, including schools of business.
- At the undergraduate level, 386 program descriptions were reviewed for inclusion of biodiversity keywords. Reference to the concept of biodiversity was indicated in nearly half (49.5%) of undergraduate programs. At the graduate level, 327 programs were reviewed, 29.4% of which included biodiversity keywords.
- The concept of biodiversity was most prevalent within undergraduate science programs. Of the 167 undergraduate science programs reviewed across the six universities, 74.3% included biodiversity keywords, mostly within life sciences. At the graduate level, 37.4% of the 147 science programs included biodiversity keywords, again, most commonly within life sciences.
- Of the 33 undergraduate business programs reviewed, 57.5% included biodiversity keywords. Meanwhile, 34.8% of the 23 graduate-level business programs included the concept of biodiversity.
- Undergraduate arts programs showed fewer references to biodiversity. Of the 186 programs assessed, only 25.8% included relevant keywords. Programs in Anthropology and Geography had the highest degree of inclusion. One-fifth (21%) of the 147 arts programs at the graduate level included biodiversity key terms.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Carleton University. 2014. Graduate calendar. http://calendar.carleton.ca/grad/ [Accessed August 2014]

Carleton University. 2014. 2013-2014 Undergraduate calendar. http://calendar.carleton.ca/archives/ [Accessed August 2014]

Carleton University. (no date). About Carleton. http://carleton.ca/about/ [Accessed October 2014]

Lakehead University. 2014. Academic programs information 2014-2015. http://navigator.lakeheadu.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=20&chapterid=3276&loaduseredits=False [Accessed September 2014]

Lakehead University. 2012. About Lakehead University. https://www.lakeheadu.ca/about/overview [Accessed October2014]

Trent University. 2014. Academic calendar 2014-2015 undergraduate and graduate programs. *https://www.trentu.ca/calendar/past.php* [Accessed May 2014]

Trent University. (no date). Trent facts. http://www.trentu.ca/about/facts.php [Accessed October 2014]

University of Guelph. 2014. Academic calendars. http://www.uoguelph.ca/academics/calendars/ [Accessed July 2014]

University of Guelph. (no date). How many students are enrolled in the University? http://askgryph.registrar.uoguelph.ca/?requestType=NormalRequest&source=4&id=53&question=How+many+students+are+enrolled+in+the+University [Accessed October 2014]

University of Ontario Institute of Technology. 2014. Fact sheet. http://uoit.ca/footer/about/uoit_info/fact-sheet.php [Accessed October 2014]

University of Ontario Institute of Technology. 2014. Undergraduate and graduate calendars. http://www.uoit.ca/main/current-students/academics-and-programs/academic-calendars/?utm_source=redirect&utm_medium=web&utm_campaign=calendar/ [Accessed May 2014]

University of Toronto. 2014. Faculty of Arts and Science 2013-2014 calendar. http://www.artsandscience.utoronto.ca/ofr/calendar/ [Accessed June 2014]

University of Toronto. 2014. School of Graduate Studies academic calendar 2013-2014. http://www.sgs.utoronto.ca/calendar/Pages/default.aspx [Accessed June 2014]

University of Toronto. 2014. Quick facts. http://www.utoronto.ca/about-uoft/quickfacts [Accessed October 2014]

References:

McCallum, J., P. Elliot, and T. McIntosh. 2014. Integration of biodiversity into the curricula of select Ontario universities. State of Ontario's Biodiversity Technical Report Series, Report #SOBTR-01. Ontario Biodiversity Council, Peterborough, ON. [Available at: http://sobr.ca/_biosite/wp-content/uploads/SOBTR-01-Final1.pdf]

Pooley, J. A., and M. O'Connor. 2000. Environmental education and attitudes: Emotions and beliefs are what is needed. Environment and Behavior 32: 711-723.

Smith, A. L., D.R. Bazely and N.D. Yan. 2011. Missing the boat on invasive alien species: A review of post-secondary curricula in Canada. Canadian Journal of Higher Education 41:34-47.

Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR: AWARENESS OF BIODIVERSITY AND ITS IMPORTANCE TO HUMAN HEALTH

STRATEGIC DIRECTION: Engage People

TARGET: 2. By 2015, 50% of Ontarians understand biodiversity and its role in maintaining their health and well-being.

THEME: Conservation Response – Education and Awareness

Background Information:

It has long been recognized that biodiversity plays an important role in the health and well-being of humans. "Our personal health, and the health of our economy and human society, depends on the continuous supply of various ecological services that would be extremely costly or impossible to replace" (CBD 2010). Clean air and water, access to outdoor recreational opportunities, and medical research are just a few of the ways that biodiversity impacts human health and well-being.

People are more likely to take actions to conserve biodiversity if they understand the concept and its importance to their lives. *Ontario's Biodiversity Strategy, 2011*, (OBC 2011) includes the key action that the relevance of biodiversity be communicated to the public and the vision that "people value, protect and enhance biodiversity and the ecosystem services essential for human health and well-being."

The recent Canadian Nature Survey (FPTGC 2014) found that 71% of the 1,011 Ontario mail-in survey respondents had heard of the term 'biodiversity' and around the same number were familiar with the term 'ecosystem services'. Respondents were provided with the definition of biodiversity and were not asked questions regarding their understanding of the term. Because Target 2 of the Ontario Biodiversity Strategy relates specifically to Ontarians' understanding of biodiversity and its importance to human health, the Ontario Biodiversity Council commissioned a telephone survey to report on this target.

This indicator presents the results from the Biodiversity Awareness Survey, conducted in October 2014.

Data Analysis:

Data about Ontarian's understanding of biodiversity was collected as part of a phone survey done on behalf of the Ontario Biodiversity Council by ECO Environmental Communication Options and Oracle Poll Research in October 2014 (ECO 2014). Respondents were asked 10 questions related to biodiversity. This indicator uses data from four of the survey's questions related to understanding of the term biodiversity and its relationship to our health and well-being.

Survey questions related to this indicator:

1. Are you aware of the term biodiversity?
   - Yes
   - No
   - Don't know
2. Which of the following definitions best fit your understanding of biodiversity?
   - The environment and nature

- The variety of life on earth
- Sustainable development
- Human, religious and cultural variety
- Don't know

3. Biodiversity plays an important role in maintaining my health and well-being.
    - Strongly disagree
    - Disagree
    - Neither agree nor disagree
    - Agree
    - Strongly agree
    - Don't know
4. In your opinion, what aspect of biodiversity has the greatest impact on your health? (pick one)
    - Medicines sourced from wild species
    - Prevention of diseases
    - Availability of healthy food
    - Cleaner air and water
    - Improved physical and mental health from outdoor experiences
    - Climate regulation
    - Don't know

The poll was administered to 1,000 people aged 18 years or older. The margin of error is +/- 3.1%, 19/20 times.

Results from the Ontario survey are reviewed against data collected for select countries around the world for comparative purposes.

Results:

Trend: Baseline	**Data Confidence**: High	**Geographic Extent**: Provincial

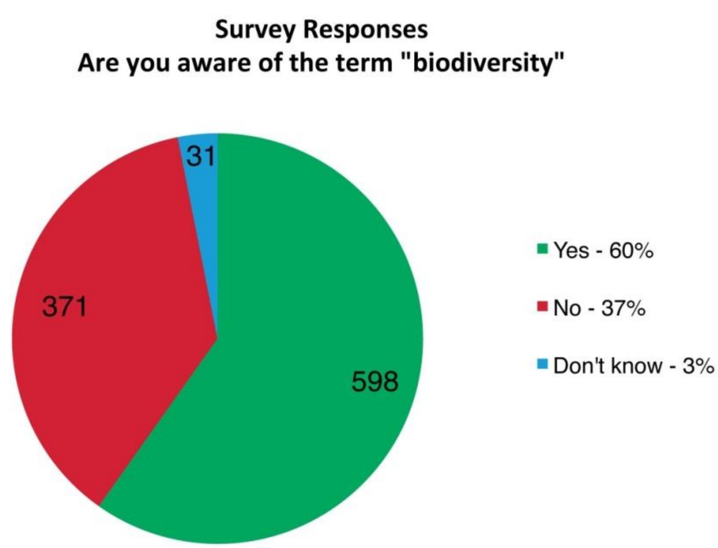

Figure 1. Biodiversity awareness survey responses by percentage (*n* = 1,000).

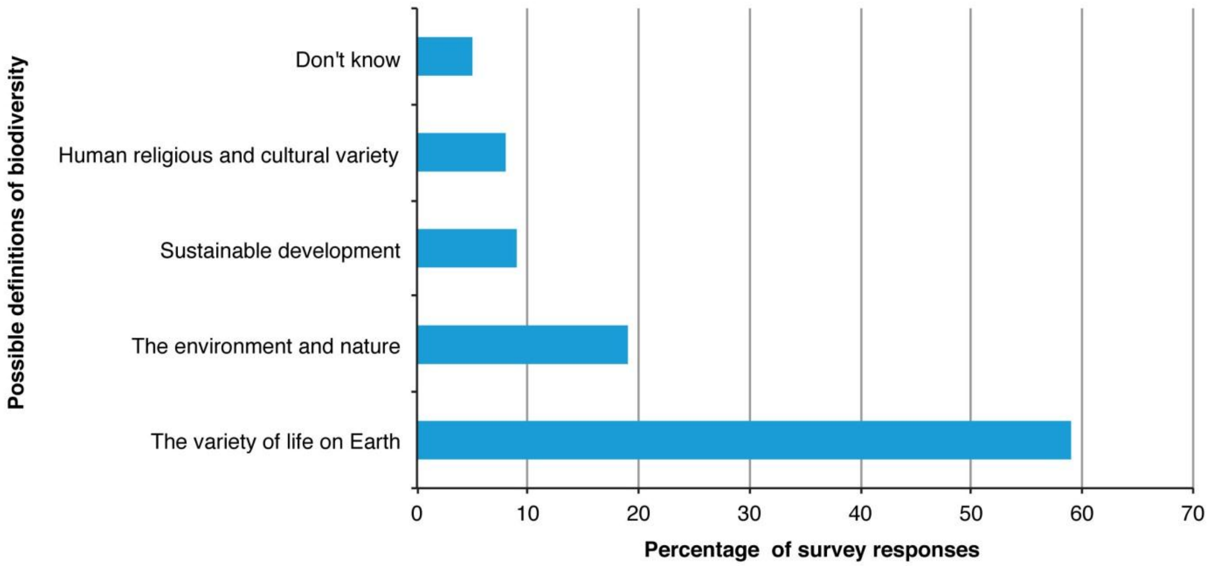

Figure 2. Survey respondent's definitions of biodiversity (only respondents that were aware of the term biodiversity were asked this question) (*n* = 598).

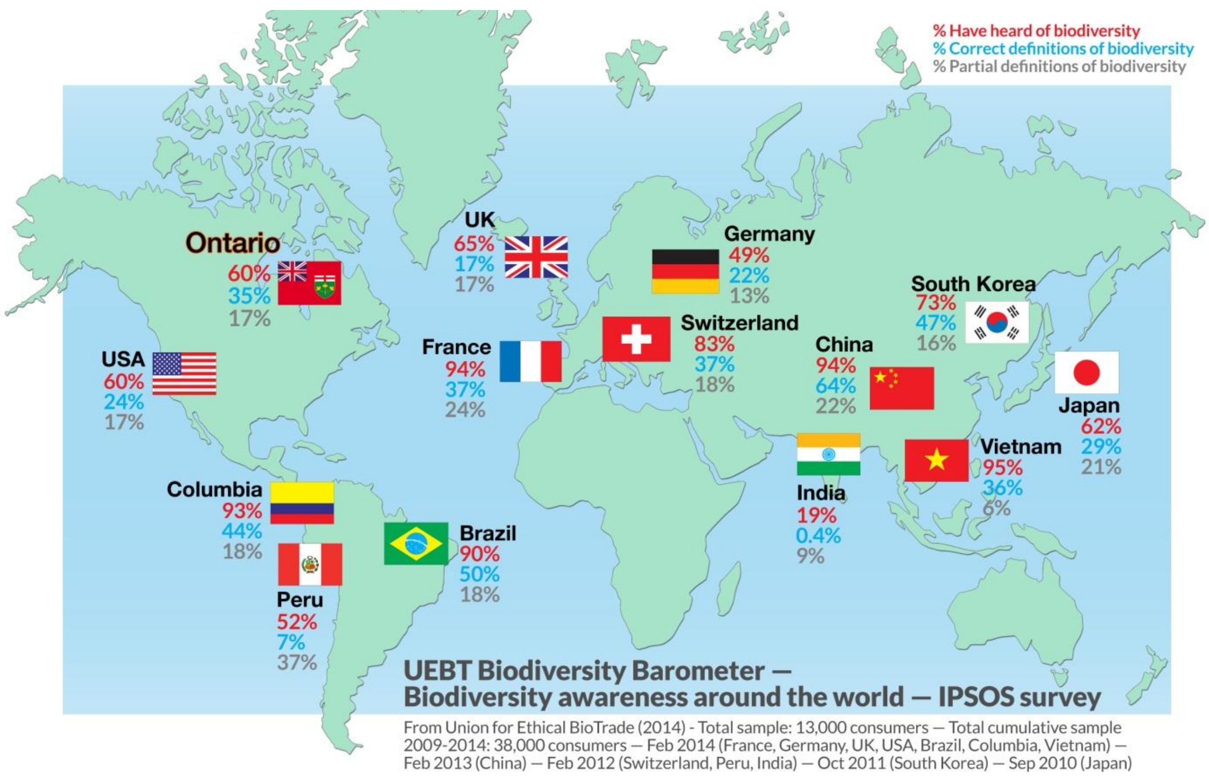

Figure 3. Ontario biodiversity awareness levels compared to countries around the world. Image courtesy Union for Ethical BioTrade.

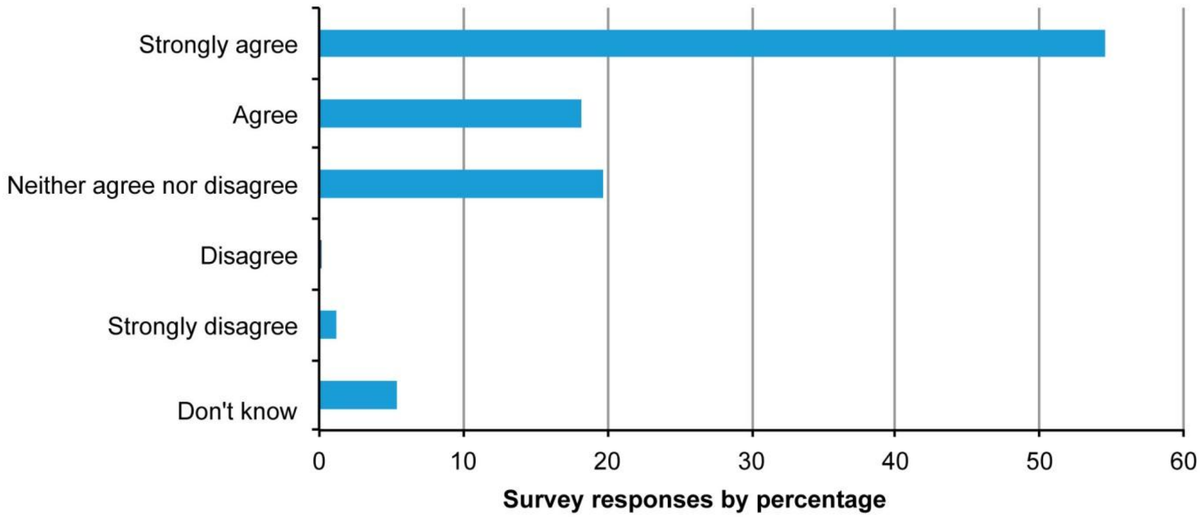

Figure 4. Percentage of survey responses to the statement, 'Biodiversity plays an important role in maintaining my health and well-being,' (n = 1,000).

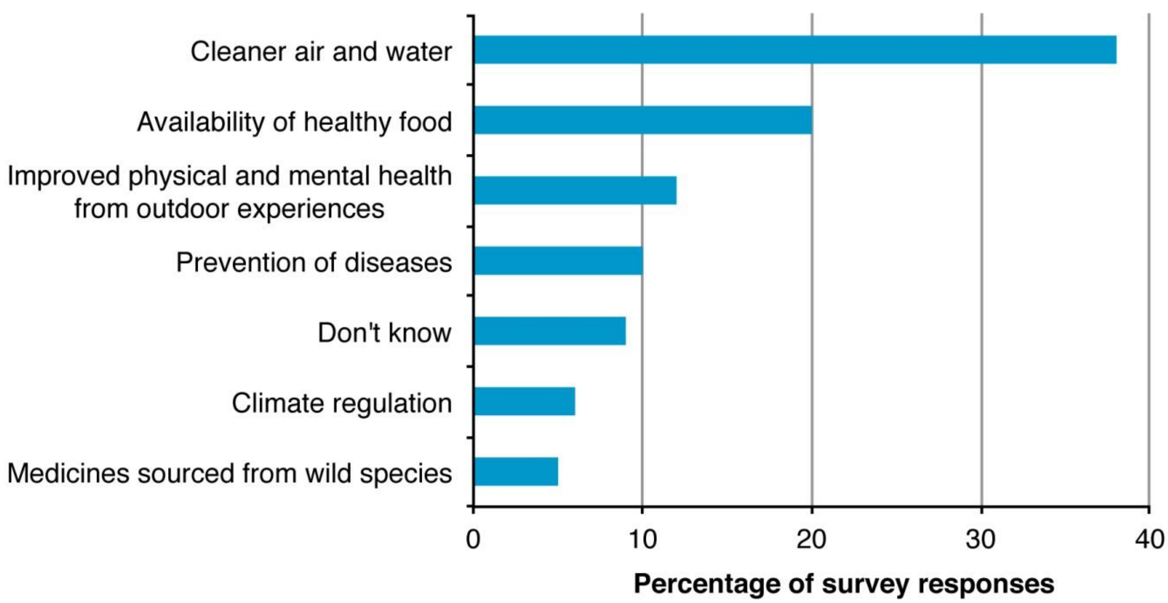

Figure 5. Percentage of survey participants' responses regarding which aspect of biodiversity has the greatest impact on their health (n = 1,000).

Status:

- 60% of respondents were aware of the term biodiversity.
- Of the respondents aware of biodiversity, 59% defined it correctly and another 28% chose a partial definition of the term.

- 73% of respondents agreed that biodiversity plays an important role in maintaining their health and well-being (54.6 strongly agree, 18.2% agree).
- Cleaner air and water was chosen as the aspect of biodiversity with the greatest impact on human health (38%), followed by availability of healthy food (20%), and improved physical and mental health from outdoor experiences (12%).
- The survey results suggest that Ontarian's awareness about biodiversity and its importance to their health is approaching the 50% target outlined in Ontario's Biodiversity Strategy, 2011.

Links:

Related Targets: N/A

Related Themes: N/A

Web Links:

Union for Ethical BioTrade http://ethicalbiotrade.org/

Canadian federal, provincial and territorial working group on biodiversity http://www.biodivcanada.ca

References:

Convention on Biological Diversity (CBD). 2010. United Nations. [Available at: http://cbd.int/2010/biodiversity/].

Ontario Biodiversity Council. 2011. Ontario's biodiversity strategy, 2011: renewing our commitment to protecting what sustains Us. Ontario Biodiversity Council, Peterborough, ON.

Environmental Communication Options and Oracle Poll Research (ECO). 2014. Biodiversity awareness survey. Ontario Biodiversity Council, Peterborough, ON. [Available at: http://sobr.ca/_biosite/wp-content/uploads/Ontario-Biodiversity-Awareness-Report-October-2014.pdf]

Federal, Provincial and Territorial Governments of Canada (FPTGC). 2014. 2012 Canadian nature survey: awareness, participation and expenditures in nature-based recreation, conservation and subsistence activities. Canadian Council of Resource Ministers, Ottawa, ON. [Available at: www.biodivcanada.ca]

Union for Ethical BioTrade. 2014. UEBT Biodiversity Barometer – Biodiversity Awareness Around the World. [Available at: http://ethicalbiotrade.org/dl/barometer/UEBT_Biodiversity_Barometer_2014.pdf].

Citation
Ontario Biodiversity Council. 2015. State of Ontario's Biodiversity [web application]. Ontario Biodiversity Council, Peterborough, Ontario. [Available at: **http://ontariobiodiversitycouncil.ca/sobr** (Date Accessed: May 19, 2015)].

INDICATOR OUTLINE: MONITORING AND REPORTING ON ONTARIO'S BIODIVERSITY

STRATEGIC DIRECTION: Improve Knowledge

TARGET: 15. By 2015, a long-term monitoring and reporting system for assessing the state of Ontario's biodiversity is established and operating.

THEME: All

Background Information:

Implementing a monitoring and reporting system to regularly assess the state of the province's biodiversity, identify threats and track the success of conservation actions is critical to ensure Ontario's efforts are making a difference for biodiversity. Well-designed monitoring activities provide the foundation for effective indicators of biodiversity patterns and changes. Reporting on biodiversity provides important information to support decision making, including prioritization of actions for biodiversity conservation.

A full suite of indicators to assess the state of Ontario's biodiversity was developed for the State of Ontario's Biodiversity 2010 Report. Through this exercise, the absence of standardized, province-wide 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 portions of Ontario's biodiversity were identified as obstacles. Although there are many monitoring and research projects that contribute to knowledge about Ontario's biodiversity and its effective management, these projects are often not at the appropriate geographic or time scale to support reporting at the provincial level.

This indicator presents a review of monitoring programs, datasets, and the reporting system currently used to assess the state of Ontario's biodiversity. This indicator also presents observations about the strengths and weaknesses of Ontario's biodiversity information and its availability for assessing and reporting on the state of the province's biodiversity.

Data Analysis:

Data for this indicator were collected through a comprehensive review of monitoring programs, data sets and the reporting system currently used by the Ontario Biodiversity Council to assess the state of Ontario's biodiversity. Additional research was also completed to gather information on monitoring programs and data sets that may be used in future assessments of Ontario's biodiversity. It is important to note that the focus of this list is provincial-scale monitoring programs and that this list does not include the many monitoring and reporting programs that are done at the local, regional and watershed scale.

Results:

Trend: Baseline	**Data Confidence**: Medium	**Geographic Extent:** Provincial

Table 1. Monitoring programs and data sets used to assess the state of Ontario's biodiversity in 2015.

Surveys
Ontario Biodiversity Council Biodiversity Awareness Survey; conducted every 2 years
National Survey of Recreational Fishing; conducted every 5 years
Ontario Public Service Biodiversity Network Survey of Biodiversity Programs and Policies; conducted every 5 years
Ontario Invasive Plant Council Survey of Invasive Species Plans; updated every 5 years
Canadian Survey of Household Spending; updated annually
Ongoing Monitoring Programs
Canada's National Inventory Report on Emissions; updated annually
National Oceanic and Atmospheric Administration Great Lakes Environmental Research Database; updated regularly
Canadian Ice Services Seasonal Summaries of Great Lakes Ice Cover; reported seasonally
Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS); updated regularly
Ontario Ministry of Natural Resources and Forestry Broad-scale Monitoring Program of Lakes; monitoring cycle completed every 5 years
Provincial Water Quality Monitoring Network; updated regularly
Provincial Air Quality Monitoring Program, updated regularly
Ontario Ministry of Natural Resources and Forestry Natural Heritage Information Centre Database (species ranks and rare ecosystems element occurrences); updated regularly
National General Status of Wild Species Report; updated every 5 years
Ontario Ministry of Municipal Affairs and Housing Provincial Policy Statement, 2005: Performance Monitoring Framework and Indicator Results Report; updated every 5 years
Conservation Areas Tracking and Reporting System (CARTS); updated regularly
HYDAT Regional Stream Flow Monitoring Database; ongoing remote monitoring, regularly updated
State of the Great Lakes Technical Report (SOLEC); updated every 2 years
Committee on the Status of Species at Risk in Ontario (COSSARO) Reports; new assessments annually, reports updates every 5 years
Individual Program Area Data Sets
Ontario Ministry of Natural Resources and Forestry Conservation Land Tax Incentive Program Database; updated annually
Ontario Ministry of Natural Resources and Forestry Managed Forest Tax Incentive Program Database; updated annually
Ontario Ministry of Agriculture, Food and Rural Affairs Canada-Ontario Environmental Farm Plan Database; updated annually
Ontario Ministry of Finance Annual Provincial Expenditure data; updated annually
Biodiversity stewardship data from individual organizations (i.e., Ducks Unlimited Canada, Conservation Ontario, Nature Conservancy of Canada, Ontario Federation of Anglers and Hunters, Ontario Power Generation and Ontario Ministry of Natural Resources Stewardship Program) ; updated regularly
Biodiversity volunteer data from individual organizations (i.e., Nature Conservancy of Canada, Ducks Unlimited Canada, Conservation Ontario, Ontario Nature, Ontario Federation of Anglers and Hunters, and Ontario Stewardship) ; updated regularly
Specific Research Projects
Ontario Land Cover Data (SOLRIS, Far North, AOU)
Analysis of Normalized Difference Vegetation Index (NDVI) data set
Assessment of Polar Bear populations and their characteristics
Assessment of current knowledge about the genetic diversity of Ontario species
Assessment of the integration of biodiversity into elementary, secondary and post-secondary curricula
Assessment of the integration of biodiversity into business
Analysis of terrestrial representation in protected areas using GapTool and land cover data

Note: links to data sets used in the development of indicators are provided on individual indicator pages.

Table 2. Monitoring programs and data sets that may be used in future assessments of Ontario's biodiversity.

Biodiversity Monitoring Programs and Data Sets
Conservation Authority Watershed Report Cards
Early Detection and Distribution Mapping System for Invasive Species in Ontario (EDDMapS)
Ontario Ministry of Natural Resources and Forestry Species at Risk Targeted Monitoring
Ontario Ministry of Natural Resources and Forestry Far North Biodiversity Project
Ontario Ministry of Natural Resources and Forestry Multi-species Monitoring Program
Ontario Parks Inventory and Monitoring Program
Binational Cooperative Science Monitoring Initiative
Ontario Ministry of Natural Resources and Forestry and Canadian Forest Service Forest Health Monitoring
Ontario Ministry of Natural Resources and Forestry Great Lakes Fish Community Monitoring
Canadian Wildlife Service Ontario Forest Bird Monitoring Program
Bird Studies Canada Migration Monitoring Program
Bird Studies Canada Shorebird Survey Ontario
Canadian Wildlife Service and U.S. Fish and Wildlife Service Great Lakes Colonial Waterbird Survey
Great Lakes Commission Great Lakes Coastal Wetland Monitoring Program
Canadian Wildlife Service and U.S. Fish and Wildlife Service Waterfowl Breeding Population and Habitat Survey
Canadian Wildlife Service Southern Ontario Waterfowl Ground Survey
eBird Canada
eButterfly
Ontario Benthos Biomonitoring Network
Ontario Stream Assessment Protocol Monitoring and Flowing Waters Information System
Ontario Ministry of the Environment and Climate Change Lake Partner Program

Status:

- A comprehensive and mature suite of indicators has been developed to assess the state of Ontario's biodiversity (OBC 2010, 2015) and progress on targets in Ontario's Biodiversity Strategy, 2011. These indicators are communicated through a web-based reporting framework which is updated as new information becomes available.
- Efforts to assess Ontario's biodiversity currently rely on several independent environmental monitoring programs, individual program area data sets and specific research projects. State of Ontario's biodiversity reporting is an opportunity to regularly review, synthesize and share monitoring information and trends.
- There have been some improvements in monitoring since the 2010 report. For example, data from the first cycle of the Broad-scale Monitoring of Lakes Program was used to develop three indicators for this report.
- The further development of a standardized broad-scale monitoring program to assess status and trends of Ontario's species and ecosystems is essential for the effective conservation of biodiversity. Of particular importance is regularly updated land cover data for Ontario.

Links:

Related Targets: N/A

Related Themes: N/A

References:

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