

# Canadian biodiversity: ecosystem status and trends 2010



Prepared by Federal, Provincial and Territorial governments

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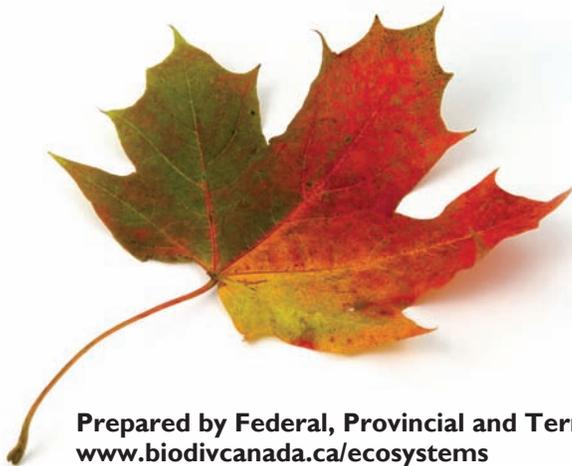
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### **Canadian Biodiversity: Ecosystem Status and Trends 2010**

is a collaborative effort of the federal, provincial, and territorial governments of Canada. It was prepared by Joan Eamer, Trish Hayes, and Risa Smith under the guidance of the Steering Committee and two secretariats. Information was drawn from technical reports prepared for each ecozone<sup>+</sup> and for national cross-cutting themes. A list of these reports and their authors is provided on page 112 of this document.

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# overview

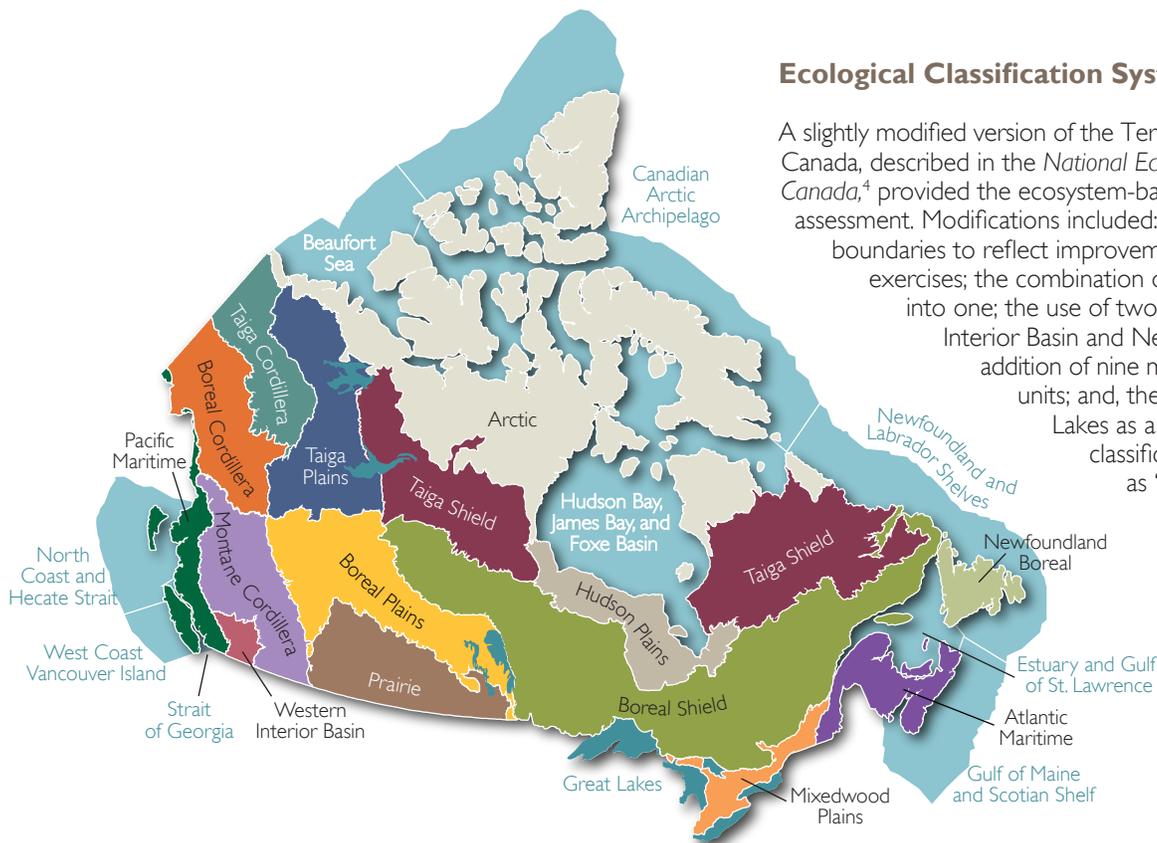


# ABOUT THIS ASSESSMENT

The Canadian Councils of Resource Ministers developed a Biodiversity Outcomes Framework in 2006<sup>1</sup> to focus conservation and restoration actions under the *Canadian Biodiversity Strategy*.<sup>2</sup> *Canadian Biodiversity: Ecosystem Status and Trends 2010*, is a first report under this framework. It assesses progress towards the framework's goal of "Healthy and Diverse Ecosystems" and the two desired conservation outcomes, i) productive, resilient, diverse ecosystems with the capacity to recover and adapt, and ii) damaged ecosystems restored. The results of this assessment will be used to inform the national biodiversity agenda, complement the historical focus on species, and help set biodiversity priorities.

This report was prepared under the guidance of a steering committee of federal, provincial, and territorial government representatives. Over 500 experts participated in the preparation of foundation technical reports (see Contributors). Twenty-two recurring key findings emerged from the technical information and are presented here, organized under four interrelated themes: biomes; human/ecosystem interactions; habitat, wildlife, and ecosystem processes; and science/policy interface.

2010 is the International Year of Biodiversity. It is the intention of the Canadian Councils of Resource Ministers to use this report as a partial assessment of Canada's progress towards the United Nations biodiversity target "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth."<sup>3</sup>



## Ecological Classification System – Ecozones+

A slightly modified version of the Terrestrial Ecozones of Canada, described in the *National Ecological Framework for Canada*,<sup>4</sup> provided the ecosystem-based units for this assessment. Modifications included: adjustments to terrestrial boundaries to reflect improvements from ground-truthing exercises; the combination of three Arctic ecozones into one; the use of two ecoprovinces – Western Interior Basin and Newfoundland Boreal; the addition of nine marine ecosystem-based units; and, the addition of the Great Lakes as a unit. This modified classification system is referred to as "ecozones+" throughout the assessment to avoid confusion with the more familiar "ecozones" of the original framework.<sup>5</sup>

# EXECUTIVE SUMMARY

*Canadian Biodiversity: Ecosystem Status and Trends 2010* is the first assessment of Canada's biodiversity from an ecosystem perspective. It presents 22 key findings derived from technical background reports. Some findings reveal that much of Canada's natural endowment remains healthy, including large tracts of undisturbed wilderness, internationally significant wetlands, and thriving estuaries, particularly in sparsely populated or less accessible areas. Forest area is fairly stable. Over half of Canada's landscape remains intact and relatively free from human infrastructure. Although much is in the more remote North, this also includes large tracts of boreal forest and coastal temperate rainforest. Canada maintains commercial and recreational freshwater and marine fisheries of significant economic and cultural importance.

Several stressors that impaired ecosystems in the past have been either removed or reduced. Some marine mammal populations are recovering from past overharvesting. Concentrations of contaminants now phased out of use, such as DDT and PCBs, are declining in wildlife. In the past 15 years, federal, provincial and territorial terrestrial protected areas have increased in number, area, and diversity of ecosystems represented. Canadians have demonstrated their commitment to biodiversity conservation through the growing number of individuals, groups, and businesses involved in stewardship initiatives.

Some key findings highlight areas of concern, where signals suggest that action is needed to maintain functioning ecosystems. These findings include loss of old forests, changes in river flows at critical times of the year, loss of wildlife habitat in agricultural landscapes, declines in certain bird populations, increases in wildfire, and significant shifts in marine, freshwater, and terrestrial food webs. Some contaminants recently detected in the environment are known to be increasing in wildlife. Plant communities and animal populations are responding to climate change. Temperature increases, shifting seasons, and changes in precipitation, ice cover, snowpack, and frozen ground are interacting to alter ecosystems, sometimes in unpredictable ways.

Some key findings identify ecosystems in which natural processes are compromised or increased stresses are reaching critical thresholds. Examples include: fish populations that have not recovered despite the removal of fishing pressure; declines in the area and condition of grasslands, where grassland bird populations are dropping sharply; and, fragmented forests that place forest-dwelling caribou at risk. The dramatic loss of sea ice in the Arctic has many current ecosystem impacts and is expected to trigger declines in ice-associated species such as polar bears. Nutrient



loading is on the rise in over 20% of the water bodies sampled, including some of the Great Lakes where, 20 years ago, regulations successfully reduced nutrient inputs. This time, causes are more complex and solutions will likely be more difficult. Lakes affected by acid deposition have been slow to recover, even when acidifying air emissions have been reduced. Invasive non-native species have reached critical levels in the Great Lakes and elsewhere.

A strategy of detecting ecosystem change and acting before thresholds are crossed has the greatest likelihood of preventing biodiversity loss. Examples throughout the assessment demonstrate the excellent return on investment from early response and prevention. Restoration, although more costly than prevention, has also had successes.

Lessons have been learned from preparing this assessment. Canada's long-term climate and hydrological monitoring programs ensure the reliability and relevance of climate and water trends in areas where station coverage is good. Equivalent monitoring of biodiversity and ecosystems is rare. Local and regional trends are helpful but usually cannot be extrapolated to a wider scale. Information collected for other purposes is often not useful for understanding changes in biodiversity and ecosystems. Relevant ecosystem-level information is less available than decision-makers may realize. Finally, this assessment would not have been possible without the combined efforts of federal, provincial, and territorial governments in sharing data, knowledge, and perspectives.

# KEY FINDINGS AT A GLANCE

## THEME: BIOMES

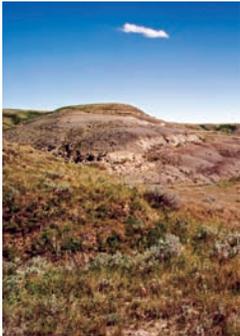
A biome is a large community of plants and animals that occupies a distinct type of environment. This section reports on six biomes and a seventh category of particular importance to Canadian ecosystems – ice across biomes.



### 1. FORESTS

**At a national level, the extent of forests has changed little since 1990; at a regional level, loss of forest extent is significant in some places. The structure of some Canadian forests, including species composition, age classes, and size of intact patches of forest, has changed over longer time frames.**

Forests cover 3.5 million km<sup>2</sup> (60%) of Canada's landscape. Of this, about 70% is boreal forest. The northern boreal forest has relatively little human imprint, but the southern boreal forest is fragmented by human disturbance. Only 0.01 to 0.02 % of Canada's forest is lost annually to other types of land cover. Although old forests have shifted to young forests in some areas, old forests still make up 40% of both Newfoundland and Labrador's boreal forest and British Columbia's coastal rainforest. Ecosystems near northern and mountain treelines are changing. For example, trees are expanding northward along the Labrador coast and tree growth and density are increasing near treelines in the Yukon and northern Québec.



### 2. GRASSLANDS

**Native grasslands have been reduced to a fraction of their original extent. Although at a slower pace, declines continue in some areas. The health of many existing grasslands has also been compromised by a variety of stressors.**

Grassland losses exceed those of other major biomes in North America. Most loss in Canada occurred before the 1930s as the result of conversion for cropland. Estimates of total loss prior to the 1990s include 97% of tallgrass/savannah in southern Ontario, 70% of prairie grasslands (by far the largest of Canada's grasslands), and 19% of bunchgrass/sagebrush in British Columbia. Losses continue in some areas, particularly small, remnant patches. Grassland health has also suffered. Over the long term, changes in natural disturbance regimes due to factors like fire suppression and confined cattle grazing have had negative impacts on grasslands. Sound stewardship practices in some areas are helping to address the problem. Other stressors include invasive non-native species, forest encroachment, fragmentation, and intensification of agriculture.



### 3. WETLANDS

**High loss of wetlands has occurred in southern Canada; loss and degradation continue due to a wide range of stressors. Some wetlands have been or are being restored.**

Approximately 16% of Canada's land area is covered by freshwater wetlands, making the country steward to about a quarter of the world's remaining wetlands. Wetland conversion was rapid in southern Canada post-settlement, with an estimated 200,000 km<sup>2</sup> lost prior to 1990. Despite significant efforts to conserve and restore wetlands in some areas, overall loss and degradation continue. Wetlands near urban areas are particularly threatened, with 80 to 98% of original wetlands converted to other uses in or near Canada's large urban centres. Current threats include conversion to other land uses, water regulation, pollution, and invasive non-native species. Climate change poses a significant threat to wetlands. In the North, wetland changes due to permafrost thaw and greater evaporation during warmer summers are already apparent.

Caroline Savage, EC



Environment Canada

#### 4. LAKES AND RIVERS

Trends over the past 40 years influencing biodiversity in lakes and rivers include seasonal changes in magnitude of stream flows, increases in river and lake temperatures, decreases in lake levels, and habitat loss and fragmentation.

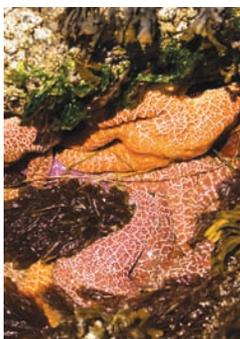
Annual low flows in natural streams decreased at many sites in southern Canada and increased at sites in the west and northwest. Annual peak flows decreased at many sites across Canada, but increased in the Atlantic Maritime. Other trends, such as changes in seasonal average flows, were also specific to regions and types of streams. Changes in stream flow affect aquatic life. For example, decreased low flows can cause problems for late-spawning fish and increase heat stress and predation for all fish. Trends in lakes include decreases in seasonal and year-to-year water-level fluctuations in some of the Great Lakes. In Lake Ontario, since 1960, water-level regulation has reduced plant diversity and altered habitat for animals living along the shoreline.



#### 5. COASTAL

Coastal ecosystems, such as estuaries, salt marshes, and mud flats, are believed to be healthy in less-developed coastal areas, although there are exceptions. In developed areas, extent and quality of coastal ecosystems are declining as a result of habitat modification, erosion, and sea-level rise.

On the Atlantic coast, wetlands, dunes, and beaches are at risk from coastal development and increased erosion – and are known to be declining in some areas. The erosion results from several interacting factors: changes from development make the shoreline more vulnerable, and rising sea level combines with more intense storm surges. On the Pacific coast, development in the early 20<sup>th</sup> century resulted in loss of intertidal wetlands, mudflats, and estuarine habitat. Losses continue today, with increasing human populations. Eelgrass meadows are internationally recognized as productive, at-risk coastal ecosystems. There is evidence of recent rapid declines in eelgrass in areas of James Bay, the Atlantic Coast, and the Gulf of St. Lawrence.



#### 6. MARINE

Observed changes in marine biodiversity over the past 50 years have been driven by a combination of physical factors and human activities, such as oceanographic and climate variability, and overexploitation. While certain marine mammals have recovered from past overharvesting, many commercial fisheries have not.

Management efforts to reverse long-term fisheries declines have been largely unsuccessful, hampered by shifts in ocean regimes and loss of habitat for spawning and rearing fish. Food webs in waters off all three of Canada's coasts are changing. The most dramatic example is the increase in invertebrates, such as shrimp, following the collapse of Atlantic ground fish. Ocean changes include shifts to warmer, less salty seawater over the past few decades, a result of natural climate oscillations and, possibly, climate change. Ocean acidification, caused by the oceans absorbing the increased atmospheric carbon dioxide, is already occurring in Canada's oceans, with severe consequences for marine biodiversity predicted by the end of this century.



#### 7. ICE ACROSS BIOMES

Declining extent and thickness of sea ice, warming and thawing of permafrost, accelerating loss of glacier mass, and shortening of lake-ice seasons are detected across Canada's biomes. Impacts, apparent now in some areas and likely to spread, include effects on species and food webs.

Ice is a defining feature of much of the Canadian landscape and many plants and animals are adapted to seasonally or permanently frozen environments. Loss of ice alters entire biomes – thawing permafrost is already changing frozen peatland ecosystems to wetlands in some areas. Over the long term, thawing permafrost will lead to shifts in plant and animal communities across the current permafrost zone. Sea ice has undergone the most dramatic, large-scale decline, especially in the last few years. There are direct impacts on species, including seals, polar bears, Arctic cod and Arctic foxes. Indirect effects include changes in coastal climate and impacts on Arctic food webs, including the range expansion of killer whales into ice-free areas.

# KEY FINDINGS AT A GLANCE

## THEME: HUMAN ECOSYSTEM INTERACTIONS

Humans now dominate most ecosystems on Earth. In Canada, with more wilderness than most countries, this dominance is not always obvious – but even in remote areas, human influence is increasingly apparent. This section examines the status and trends of some of the actions Canadians are taking to conserve ecosystems, some ecosystem stressors that are by-products of human activity, and trends in services provided by healthy and diverse ecosystems.



### 8. PROTECTED AREAS

Both the extent and representativeness of the protected areas network have increased in recent years. In many places, the area protected is well above the United Nations 10% target. It is below the target in highly developed areas and the oceans.

As of May 2009, 9.4% of Canada's land area and 0.64% of its ocean area had provincial, territorial, or federal protected-area designation. Large and small protected areas have a role to play in biodiversity conservation. Thirty-six protected areas in Canada are larger than 5,000 km<sup>2</sup>, making up 59% of the total area protected. In several places, adjacent protected areas create large protected-area complexes. At the other end of the scale, 3,464 protected areas smaller than 10 km<sup>2</sup>, which make up less than 1% of the total area protected, play an important role in protecting rare species and habitats. Progress has been made in identifying potential sites for marine protected areas, although designation of marine areas has been slow.



### 9. STEWARDSHIP

Stewardship activity in Canada is increasing, both in number and types of initiatives and in participation rates. The overall effectiveness of these activities in conserving and improving biodiversity and ecosystem health has not been fully assessed.

Over a million people and a thousand stewardship groups participate in stewardship activities in Canada – everything from community projects to government initiatives. Tax incentives, conservation easements, and the growth of land trusts have helped facilitate stewardship on private land. Also important are large, landscape-level initiatives. For example, the North American Waterfowl Management Plan has influenced the stewardship of over 70,000 km<sup>2</sup> of wetland, grassland, and agricultural habitat across Canada in the 2000s alone. Standards and codes of practice, such as forest and marine certification, are important tools in the stewardship of public and private lands and waters. Participation in all forms of stewardship has increased substantially since the 1980s.



Jim Moyes, EC

## 10. INVASIVE NON-NATIVE SPECIES

**Invasive non-native species are a significant stressor on ecosystem functions, processes, and structure in terrestrial, freshwater, and marine environments. This impact is increasing as numbers of invasive non-native species continue to rise and their distributions continue to expand.**

Invasive non-native species are considered the second greatest threat to biodiversity world-wide, after habitat destruction. Ecosystems that are already altered or degraded are more vulnerable to colonization by aggressive non-native species. Non-native species are destroying valuable wetland and grassland habitat, are invading marine intertidal areas, and dominate the Great Lakes. Economic and ecological losses caused by invasive non-native species have been estimated at \$5.7 billion annually in the Great Lakes alone. Wildlife diseases caused by non-native pathogens, such as West Nile virus, have killed thousands of birds and potentially threaten many different wildlife species.



## 11. CONTAMINANTS

**Concentrations of legacy contaminants in terrestrial, freshwater, and marine systems have generally declined over the past 10 to 40 years. Concentrations of many emerging contaminants are increasing in wildlife; mercury is increasing in some wildlife in some areas.**

Levels of legacy contaminants – banned or restricted chemicals, such as PCBs – have declined in wildlife in the Strait of Georgia, St Lawrence Estuary, Great Lakes, Bay of Fundy, and the Arctic since the 1970s, although rates of decline in some areas have slowed in recent years. The recovery of peregrine falcons after the banning of DDT demonstrates that some species can rebound after the contaminant stress has been lifted. Flame retardants (PBDEs) are examples of emerging contaminants, which have more recently been found to spread through and accumulate in ecosystems. PBDE levels have increased since the 1980s in fish, birds, whales, and polar bears. Contaminants can directly affect wildlife health and reproduction and increase vulnerability to other stressors.



Greg McCullough

## 12. NUTRIENT LOADING AND ALGAL BLOOMS

**Inputs of nutrients to both freshwater and marine systems, particularly in urban and agriculture-dominated landscapes, have led to algal blooms that may be a nuisance and/or may be harmful. Nutrient inputs have been increasing in some places and decreasing in others.**

Fertilizers from agriculture, phosphates from detergents and industry, and sewage from towns and cities add nutrients to aquatic systems, sometimes causing algal blooms. In recent years, algal blooms have been reported in lakes, reservoirs, ponds, rivers, swamps, and estuaries across the southern half of the country. Some past successes in nutrient reductions, particularly in the Great Lakes, are now being reversed. Over the past 16 years, nitrogen has increased in 28% of water bodies sampled and decreased in 12%, while phosphorus has increased in 21% and decreased in 29%. Although harmful marine algal blooms occur naturally, they appear to be increasing in the oceans off Canada's coasts.

# KEY FINDINGS AT A GLANCE



## 13. ACID DEPOSITION

Thresholds related to ecological impact of acid deposition, including acid rain, are exceeded in some areas, acidifying emissions are increasing in some areas, and biological recovery has not kept pace with emission reductions in other areas.

Acid deposition occurs when sulphur and nitrogen-based air pollutants react with water and settle to Earth. In aquatic systems, the survival of many species is threatened by the acidification of their habitat. Emissions have declined since 1980, but improvements in lake acidity have been slow to follow. Some areas, such as parts of the Boreal Shield, have acid deposition levels beyond the ability of the ecosystem to cope. The Atlantic Maritime has some of the most acidic waters and heavily affected fish habitat in North America. Although acidification is often considered an eastern issue, it is an increasing concern in parts of the West. In northwest Saskatchewan, for example, many lakes downwind of oil and gas development emissions are sensitive to acid deposition.



## 14. CLIMATE CHANGE

Rising temperatures across Canada, along with changes in other climatic variables over the past 50 years, have had both direct and indirect impacts on biodiversity in terrestrial, freshwater, and marine systems.

Canada's climate has changed significantly since the 1950s. Temperatures have increased across the country, especially in winter and spring. Spring now arrives earlier, meaning snow melts earlier and growing seasons are longer. Precipitation has generally increased, especially in the North. The average annual temperature has increased by 1.4°C. No significant cooling trend has occurred at any location in any season. Changes in climate have led to widespread environmental changes, such as loss of sea ice. Some currently localized changes are likely to increase and become more widespread with continued warming. These include rising sea levels, higher seawater temperatures, and increases in wildfires. Ecosystems and species are affected by all of these changes, often in complex and unexpected ways that interact with other stressors, such as habitat fragmentation.



## 15. ECOSYSTEM SERVICES

Canada is well endowed with a natural environment that provides ecosystem services upon which our quality of life depends. In some areas where stressors have impaired ecosystem function, the cost of maintaining ecosystem services is high and deterioration in quantity, quality, and access to ecosystem services is evident.

Many of Canada's vast wetlands, coastal ecosystems, and forests are healthy and provide billions of dollars in ecosystem services annually. Services include commercial, recreational, and subsistence food gathering, flood and drought control, sediment filtering, nutrient cycling, erosion control, and climate regulation. There are also signs of loss of ecosystem services. Increased erosion, spread of wildlife diseases, and less predictable river flows have been documented. Several commercial fisheries are declining. Subsistence opportunities are hampered by wildlife population declines, contaminants in culturally important species, and, in the North, by altered access to harvesting due to changes in ice and permafrost. Recreational opportunities are affected by closed beaches, fouled fishing equipment, and invasive non-native species.

## THEME: HABITAT, WILDLIFE, AND ECOSYSTEM PROCESSES

The key findings in this section are related to aspects of abundance and diversity of wildlife. First, the capacity of agricultural lands to support wildlife is considered. Trends are then assessed for selected species groups of high economic, cultural, or ecological significance. Three aspects of ecosystem processes are examined: primary productivity, relations of predators and prey through food webs and population cycles, and the role of natural disturbance in forested ecosystems.



### 16. AGRICULTURE LANDSCAPES AS HABITAT

The potential capacity of agricultural landscapes to support wildlife in Canada has declined over the past 20 years, largely due to the intensification of agriculture and the loss of natural and semi-natural land cover.

Agricultural landscapes cover 7% of Canada's land area and provide important habitat for over 550 species of terrestrial vertebrates, including about half of the species assessed as at risk nationally. Natural areas, including wetlands, woodlands, and unimproved pasture, provide the highest biodiversity values, while croplands provide the lowest. Between 1986 and 2006 the capacity of agricultural landscapes to provide habitat for wildlife declined significantly across Canada. The main causes are the conversion of natural areas to cropland and more intensive use of agricultural land. The proportion of agricultural land classified as cropland increased from 46 to 53% over this period.

### 17. SPECIES OF SPECIAL INTEREST: ECONOMIC, CULTURAL, OR ECOLOGICAL

Many species of amphibians, fish, birds, and large mammals are of special economic, cultural, or ecological interest to Canadians. Some of these are declining in number and distribution, some are stable, and others are healthy or recovering.



**Amphibians** Twenty percent of native amphibians – frogs, toads and salamanders – are considered at risk of extinction in Canada. Declines of several amphibian populations since the mid-1990s have been documented in the Great Lakes Basin and the St. Lawrence River corridor. Trends for western Canada are not well documented. Habitat degradation and loss are the main causes of amphibian declines in Canada.



**Fishes using freshwater habitat** Freshwater species are at a high risk of extinction worldwide. In Canada 18% of freshwater and diadromous fish are Endangered or Threatened in all of parts of their ranges. The number of Endangered or Threatened fishes has been increasing since the 1980s. The causes of declines vary across the country and include invasive non-native species, habitat loss, degradation, and fragmentation, overharvesting, pollution, and climate change.



**Birds** Since the 1970s, overall population declines have affected all landbird groups except forest birds. Birds of grassland and other open habitats exhibited the most marked declines, losing over 40% of their populations. Some common landbird species are also showing declines. Half of the 35 shorebird species assessed in 2000 showed a decline somewhere in their ranges. Trends for seabirds are mixed, but the number of populations in decline has increased since the 1980s. Waterfowl are generally healthy, although some species are in decline.



**Caribou** The range of caribou has contracted. Most northern herds are declining, some precipitously. Causes are not well understood and might include natural population cycles, climate change, increased impacts from human activity, changes in predation, and over-harvesting. Forest-dwelling woodland caribou are Threatened in the boreal forest, with many herds declining. The status of most herds in the northern mountain population is not well understood, while most herds in the southern mountain population are in decline. Woodland caribou are declining primarily because of loss and fragmentation of habitat.

# KEY FINDINGS AT A GLANCE



## 18. PRIMARY PRODUCTIVITY

Primary productivity has increased on more than 20% of the vegetated land area of Canada over the past 20 years, as well as in some freshwater systems. The magnitude and timing of primary productivity are changing throughout the marine system.

The North, where temperature rise is highest, has experienced the largest increases in production of green vegetation. Productivity increases in southern Canada are likely related more to changes in land use than to changes in climate. Vegetation changes that correspond with northern Canada's greening trend include a shift to shrubs and grasses where lichens and mosses once dominated. In Arctic lakes and ponds, a longer growing season for algae, due to earlier melting of lake ice in spring, is considered the strongest factor driving the observed increase in productivity. Marine primary productivity, however, shows long-term declines in most of the world's ocean regions, including the Arctic, North Pacific and North Atlantic oceans.



## 19. NATURAL DISTURBANCES

The dynamics of natural disturbance regimes, such as fire and native insect outbreaks, are changing and this is reshaping the landscape. The direction and degree of change vary.

Natural disturbance regimes, such as fire and native insect outbreaks, are important drivers of biodiversity in forest and grassland ecosystems. Large fires, greater than 2 km<sup>2</sup>, account for over 95% of the area burned, and over 90% of them occur in the boreal forest. Although highly variable, the annual area burned has increased since the 1960s. At the same time, fire is no longer a significant disturbance agent in parts of the country such as southern Ontario and the Prairies. No overall trend in native insect outbreaks is evident, although some insects, such as the mountain pine beetle, show significant change. The infestation of mountain pine beetle over the last decade was of unprecedented intensity, damaging over 163,000 km<sup>2</sup> of forest. Fire and insects affect each other and both are influenced by climate and management practices.



## 20. FOOD WEBS

Fundamental changes in relationships among species have been observed in marine, freshwater, and terrestrial environments. The loss or reduction of important components of food webs has greatly altered some ecosystems.

An example of the impact from a major reduction in one food web component is the decline of *Diporeia*, a small relative of shrimp and historically the dominant invertebrate in most of the Great Lakes. This decline has had major consequences for Great Lakes fish populations and commercial fisheries. Reduction in predators also affects the whole food web. Most large native carnivore populations have declined severely in southern and eastern Canada, affecting abundance and diversity of prey species and small predators. Population cycles are important features of boreal forest and tundra ecosystems. Herbivores – especially the snowshoe hare in forests and small rodents in tundra – are at the heart of these cycles. There is emerging evidence that these population cycles are weakening at several locations in northern Canada.

## THEME: SCIENCE/POLICY INTERFACE

Although the interface between science and policy was not the focus of this assessment, themes and ideas recurred throughout the development and review process and have been grouped into two categories. The first deals with the nature and quality of information available for assessing ecosystem status and trends in Canada. The second deals with the policy implications resulting from rapid and unexpected change and the crossing of ecological thresholds, especially in the context of a changing climate.



### 21. BIODIVERSITY MONITORING, RESEARCH, INFORMATION MANAGEMENT, AND REPORTING

Long-term, standardized, spatially complete, and readily accessible monitoring information, complemented by ecosystem research, provides the most useful findings for policy-relevant assessments of status and trends. The lack of this type of information in many areas has hindered development of this assessment.

Piecing together information from disparate sources is currently the only way to assess status and trends of Canada's ecosystems. In some cases, there are good data sets backed by long-term monitoring programs. Information is sometimes available for status but not trends, or trend information is limited to a small geographic area over a short time interval. Often, information critical to the assessment of ecosystem health is missing. Reporting on status and trends requires more than monitoring results. The context, cause-and-effect linkages, and knowledge of ecosystem functioning that will tell a coherent story is drawn from ecological research. Improved collaboration among Canada's ecological research, monitoring, and policy communities and institutions, focused on identifying and addressing policy-relevant questions would enhance future assessments of status and trends.



### 22. RAPID CHANGES AND THRESHOLDS

Growing understanding of rapid and unexpected changes, interactions, and thresholds, especially in relation to climate change, points to a need for policy that responds and adapts quickly to signals of environmental change in order to avert major and irreversible biodiversity losses.

When thresholds have been crossed, ecosystems shift irrevocably from one state to another. Options for action are usually limited, expensive, and have a low probability of success. Taking earlier action, when ecosystem changes have been detected but thresholds have not yet been crossed, creates more options and a greater probability of reversing or stabilizing impacts. In some cases, early warning signals appear in a few locations or in a few individuals in a population. When it is possible to take preventative action in response to early warnings, the probability of success is greatest and the long-term costs are usually lower.

# SYNTHESIS OF KEY FINDINGS

This diagram presents the status and trends of the key findings, as well as confidence in the conclusions drawn. The key findings are grouped in themes, each occupying a quarter of the diagram. They are presented as parts of a circle to highlight the holistic nature of ecosystems – these key findings are interrelated and their common, central focus is the health and diversity of ecosystems.

 The topics in the left half of the circle are aspects of the ecosystems themselves – biomes, habitat, wildlife, and ecosystem processes.

 The topics in the right half of the circle are human activities – alteration of ecosystems and actions taken to understand and conserve ecosystems.

By necessity, the time frames over which the ratings of status and trends are made vary – both because time frames that are meaningful for these diverse aspects of ecosystems vary and because the assessment is based on the best available information, which is over a range of time periods.

 Beside each topic is a coloured circle indicating the status associated with the key finding. Within each circle is an arrow that shows both the direction and the rate of change. Beside some topics there are two circle/arrow combinations to represent a range or a dichotomy of status and trends.

 The height of the stack of papers beside each key finding represents confidence in the finding, based on an evaluation of the adequacy of the supporting evidence. Confidence is lowered when the ecosystem aspect is not well understood or when data are inadequate in spatial or temporal coverage.

In the body of the report, at the beginning of each key finding section, these symbols are repeated, along with short phrases summarizing the basis for the ratings.

 The red flags in some key finding sections are used to highlight aspects of the findings that may be early warning signs of significant ecological change.

## LEGEND

### STATUS

	 ECOSYSTEM ASPECTS	 HUMAN ACTIVITIES
 HEALTHY	likely to persist and likely able to recover from disturbances	actions adequate for conservation or showing good progress, or stressor not causing major impacts
 CONCERN	showing signs of stress	showing signs of insufficient actions, or signs of major impacts from stressor
 IMPAIRED	outside of range of natural variation, unstable, or likely not recovering	poor progress or insufficient actions, or stressors causing major impacts

### TREND

 IMPROVING AT A RAPID RATE
 IMPROVING AT A SLOW TO MODERATE RATE
 LITTLE CHANGE
 GETTING WORSE AT A SLOW TO MODERATE RATE
 GETTING WORSE AT A RAPID RATE
 UNKNOWN

### CONFIDENCE IN FINDING

 LOW	limits in temporal and/or spatial extent of data, or gaps in understanding of the topic, making interpretation difficult
 MEDIUM	data coverage only fair and/or understanding of the topic poor
 HIGH	sufficient evidence and adequate understanding of the topic

## Biomes

  	Forests
 	Grasslands
 	Wetlands
 	Lakes and rivers
  	Coastal
  	Marine
 	Ice across biomes

## Human/Ecosystem Interactions

Protected areas	  
Stewardship	 
Invasive non-native species	 
Contaminants	  
Nutrient loading and algal blooms	  
Acid deposition	 
Climate change	 
Ecosystem services	 

# HEALTHY AND DIVERSE ECOSYSTEMS

## Habitat, Wildlife, and Ecosystem Processes

 	Agricultural landscapes as habitat
 	Species of special interest: economic, cultural, or ecological
 	Primary productivity
 	Natural disturbances
 	Food webs

## Science/Policy Interface

Biodiversity monitoring, research, information management, and reporting	
Rapid changes and thresholds	

# REFERENCES

## OVERVIEW

### About this Assessment

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