Fall 2013

Report of the Commissioner of the Environment and Sustainable Development

CHAPTER 1

Backgrounder on Biological Diversity

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CHAPTER 1

Backgrounder on Biological Diversity

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Backgrounder on Biological Diversity

Main Points

Biological diversity is the variability among living organisms from all sources, which includes diversity within species, between species, and of ecosystems of which they are a part—the millions of animals, plants, and smaller organisms that live on the planet. Canada is home to over 70,000 species of plants, mammals, birds, fish, amphibians, reptiles, insects, and other organisms. While Canadian biodiversity is dispersed across landscapes and ecosystems ranging from forests to grasslands and from lakes and rivers to oceans, the greatest diversity is found in the southern areas and river valleys where most Canadians live.

Why it's important

A diverse mix of plants and animals is essential to produce the ecosystem services that make human survival possible. These services arise from the naturally occurring processes and functions of ecosystems, which depend on biological diversity to maintain their ability to respond to stresses. Ecosystem services include

- provisioning services that provide goods consumed directly or used to produce food, fresh water, and timber;
- regulating services that help to maintain air and water quality, and mitigate storms and flooding;
- cultural services that support recreation, aesthetic enjoyment, and spiritual fulfillment; and
- supporting services, such as soil formation, nutrient cycling, and photosynthesis, that make all other benefits possible.

Biodiversity is a prerequisite underpinning each of these services that are important to maintaining human societies, including human health. Some ecosystem services, such as the pollination performed by insects and birds, provide important economic benefits that would be extremely costly and perhaps impossible to replace if lost.

Key messages

Canada's social and economic prosperity relies on biological diversity and on the goods and services provided by a diverse natural environment. The use of plants and animals currently contributes billions of dollars to key sectors of the Canadian economy, including agriculture, forestry, ecotourism, fishing, and pharmaceuticals. Biodiversity is important to people's health, as many of our medications are derived from natural sources. For example, over half of the pharmaceutical drugs used to treat cancer are derived from plants.

Globally, growing human populations, urbanization, and increased consumption continue to intensify the direct threats to biodiversity. Similar trends exist within Canada. The area of urbanized land has nearly doubled over the past 50 years. Urbanization, economic growth, and a continuing reliance on natural resources puts pressure on our biodiversity. A key challenge for all stakeholders will be to balance the conservation of biodiversity while pursuing economic development.

As a result of human dependencies on biodiversity and the rate at which it is being lost, there is growing acceptance that the value provided by a biologically diverse environment needs to be determined and managed as an asset. While it is difficult to estimate, initial economic valuations suggest that the world's natural capital is in the trillions of dollars.

Based on our review of the literature and interviews conducted, we have identified a number of management approaches that support protecting and restoring biodiversity. These include the importance of

- proactive approaches to conserving biodiversity in order to reduce the impacts of various threats to biodiversity and the potential costs of its restoration in the future;
- integrating scientific data and information into decision making in order to allow for informed choices that support sustainable development;
- long-term commitments and strategies recognizing that it can take generations for habitats to be restored or species at risk to rebound;
- partnerships and cooperation among multiple stakeholders and often multiple jurisdictions; and
- an integrated approach that considers various aspects of an ecosystem, such as land, air, water, plants, animals, humans, and their interactions—including the social and economic factors relevant to the state of the ecosystem and its recovery.

Introduction

1.1 Nature and the benefits that nature provides affect our everyday lives. The agricultural crops we produce and consume, some of the ingredients in our medicines, the aesthetic beauty of our landscapes, lakes, rivers, and coastal waters—all depend on a natural and biologically diverse environment.

1.2 Biological diversity is the variability among living organisms from all sources, which includes diversity within species, between species, and of **ecosystems**.

Ecosystem—A system of interrelationships, interactions, and processes between species (such as plants, animals, and humans) and their physical and chemical environment.

1.3 Canada has committed to conserving biological diversity and using its components sustainably. Doing this requires the participation of multiple stakeholders, including governments; businesses; academia; First Nations, Métis, and Inuit communities; and individual Canadians.

1.4 Several chapters in the 2013 Fall Report of the Commissioner of the Environment and Sustainable Development explore different facets of biological diversity.

1.5 This backgrounder examines the nature and importance of biological diversity, the threats to it and their underlying causes, ways of measuring biodiversity, and key elements for managing it. The purpose is to provide readers with additional background information on the topic of biodiversity to complement information provided in the other chapters of the Commissioner's 2013 Report.

1.6 This backgrounder is not an audit report. For this reason, readers should not interpret the analysis in it as being an assessment of the federal government's current practices in managing or protecting biodiversity. The backgrounder has been prepared based on research, interviews, and a review of current academic literature and research.

Biological Diversity—The Variety Among Living Things

Biological diversity defined

1.7 Biological diversity, or biodiversity, is the variety among living things—the millions of species of mammals, reptiles, birds, fish, insects, plants, and bacteria on our planet, as well as the genetic differences within these species. It is a way of describing the many different ecosystems and habitats where species interact with one another and their surrounding environments.

1.8 Biodiversity operates at three fundamental levels: genes, species, and ecosystems.

- Genetic diversity is the variety within the gene pool of a species. Each individual in a species has its own particular genetic makeup, accounting for differences in behaviour and appearance. The more genetically diverse a species or population is, the greater will be its ability to adapt to changes in the environment. Lack of diversity—for example, in the monocultures on which modern farming often relies—increases vulnerability to disease, parasites, and other threats.
- Species diversity is the number of different species in a given area, along with how many there are of each species. Scientists have formally described approximately 1.7 million living species. Scientists with the United Nations Environment Programme's World Conservation Monitoring Centre suggest that these represent less than 20 percent of the species on our planet.
- Ecosystem diversity is the variety of ecosystems in a particular place. How the boundaries of ecosystems are defined depends on the issue under consideration. For example, the relevant ecosystem for a frog population may be defined as the pond and shore habitats inhabited by the frogs, while the relevant ecosystem for a population of woodland caribou may include the same pond and vast areas of surrounding forest, wetlands, and other freshwater bodies frequented by the caribou.

Biodiversity in Canada

1.9 According to Wild Species 2010 (see paragraph 1.46), Canada is home to more than 70,000 species, including well-known mammals, birds, fish, and plants, as well as lesser-known amphibians, reptiles, insects, and others. The caribou, polar bear, beaver, and Canada goose are among the most widely recognized species found in the country. The Canadian Arctic is home to about 60 percent of the world's population of polar bears. Canada supports the largest woodland caribou population in the world, and provides breeding grounds for two populations of monarch butterflies that migrate north every year.

1.10 Plants and animals in Canada are dispersed across various landscapes and ecosystems (Exhibit 1.1). The greatest diversity of species is in the southern areas, where most Canadians live. However, other areas of Canada maintain extensive intact habitats of global significance. Canada has 24 percent of the world's boreal forests and 15 percent of the world's temperate forests. Canada's 1.5 million square kilometres of wetlands represent about 25 percent of the world's remaining wetlands. Canada also has the world's longest coastline, 2 million lakes, and the third-largest area of glaciers in the world.

Exhibit 1.1 Canada has a wide range of landscapes and ecosystems

Photo: Chad Zuber/Shutterstock.com

Forests

Forests provide a home to everything from micro-organisms to large mammals. There are two main types of forest in Canada: boreal and temperate. Spruce trees dominate Canada's boreal forests, which form the largest continuous and connected forest ecosystem on earth, covering 25 percent of the country's landscape. Temperate forests contain a greater variety of tree species than boreal forests. For example, they may feature maple, pine, hemlock, and spruce.

Photo: BGSmith/Shutterstock.com

Grasslands

Grasslands are open ecosystems populated mainly by grasses or other leafy vegetation. They are typically found in areas of low moisture where winters are cold, and soils are deep and fertile. They provide habitat for many species.

Photo: Elena Elisseeva/Shutterstock.com

Wetlands

Wetlands are saturated with water all or most of the time, as indicated by poorly drained soils and vegetation and biological activity adapted to wet environments. Different types of wetlands include bogs, fens, marshes, and shallow water areas. Representing about 16 percent of Canada's land mass, wetlands support migratory birds, fish, amphibians, and a wide range of plants and other species.

(Continued on next page)

Exhibit 1.1 Canada has a wide range of landscapes and ecosystems (Continued)

Photo: Pi-Lens/Shutterstock.com

Lakes and rivers

Over 8,500 rivers and 2 million lakes cover almost 900,000 square kilometers or 9 percent of Canada's total area, and are home to a variety of plants, fish, amphibians, reptiles, and birds.

Photo: GVictoria/Shutterstock.com

Coastal ecosystems

Coastal ecosystems occur at the boundary between land and sea. They support many marine and terrestrial species, including approximately 1,100 species of fish and numerous marine mammals, birds, and plants.

Photo: Protasov AN/Shutterstock.com

Marine ecosystems

Canada has jurisdiction over 6.5 million square kilometres of marine waters in three oceans. Marine ecosystems are constantly in motion, carrying nutrients, dissolved oxygen, carbon, and water as well as bacteria, algae, plants, and animals. Millions of marine species live in a wide range of habitats, including the open ocean, the sea floor, corals, and continental shelves.

Photo: Achim Baque/Shutterstock.com

Ice ecosystems

Ice is a defining feature of Canada's landscapes. Permafrost (frozen subsoil) underlies almost half of the country. Sea ice extends across the North and along parts of the east coast. Most Canadian lakes and many rivers are seasonally frozen. Ice ecosystems provide critical habitat for a range of species adapted to living in, under, or on top of ice. They range from tiny one-celled organisms living in the ice to polar bears.

Source: Adapted from Canadian Biodiversity: Ecosystem Status and Trends 2010

Ecosystem services

1.11 Ecosystem services is a term used to communicate the benefits of biodiversity. A diverse mix of plants and animals is essential to produce the ecosystem services that make human survival possible. Ecosystem services arise from the naturally occurring processes and functions of ecosystems, which depend on biological diversity to maintain their resilience. While not an ecosystem service itself, biodiversity is a prerequisite underpinning each of these services:

- Provisioning services supply goods consumed directly or used as economic inputs, such as food, fresh water, and timber.
- Regulating services help to maintain air and water quality, and mitigate storms and flooding.
- Cultural services support recreation, aesthetic enjoyment, and spiritual fulfillment.
- Supporting services make all other benefits possible. These services include soil formation, nutrient cycling, and photosynthesis. For example, at least half of the oxygen we breathe comes from photosynthesis by marine plants.

Millennium Ecosystem Assessment—An international initiative, led by the United Nations Environment Programme, that assessed the consequences of ecosystem change for human well-being. From 2001 to 2005, the assessment involved the work of more than 1,360 experts worldwide. Their findings offer a scientific appraisal of the condition and trends in the world's ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably.

1.12 The **Millennium Ecosystem Assessment** found that, on a global basis, 60 percent of ecosystem services are being used unsustainably. Some ecosystem services, such as the pollination performed by insects and birds, would be extremely costly or perhaps impossible to replace (Exhibit 1.2).

Exhibit 1.2 Ecosystem services such as pollination are crucial to agriculture

Pollination is one of the many ecosystem services that make agriculture possible. It is the transfer of genetic material between flowering plants to fertilize them, allowing them to produce other edible parts such as seeds and fruits, flowers, and vegetables. Wind, water, or gravity can drive pollination, but more than 75 percent of flowering plants and one third of human crops depend on pollination by insects and other animals, including bees, butterflies, birds, and bats. Agriculture and Agri-Food Canada found that pollination by honeybees alone contributes more than $2.2 billion to the Canadian agricultural economy. Today, pollinator populations are in decline in Canada and worldwide because of habitat destruction, pesticide use, invasive alien species, and parasites. Collaborative national and international efforts have been launched to address the risk posed by the decline.

Photo: Klagyivik Viktor/Shutterstock.com

The importance of ecosystem services to the economy

1.13 Canada's social and economic prosperity depends on the goods and services provided by a biologically diverse natural environment for industries such as agriculture, ecotourism, fisheries, biotechnology, and pharmaceuticals. For instance, biotechnology is being used to address problems caused by **invasive alien species**, one example being the application of extracts from the African soapberry plant to control invasive zebra mussels in the Great Lakes. Equally important, biodiversity is a major source of ingredients for medications. For example, nearly half of all cancer drugs developed in the United States between the 1940s and 2010 were derived from **natural products**, directly or indirectly. Globally, about 50 percent of prescription drugs are based on a molecule that occurs naturally in a plant.

Invasive alien species—An organism whose introduction can threaten the environment, including native species and their habitat, the economy, society, or human health.

Natural product—A large and diverse group of substances produced from various sources, including marine organisms, animals, bacteria, fungi, and plants.

1.14 Provisioning services contribute directly to Canada's economy. In 2011, the Department of Fisheries and Oceans found that products and outputs of the commercial fishing, aquaculture, and fish processing industries were valued at approximately $7.4 billion and employed close to 85,000 people across Canada. In 2011, the Canadian forest service under Natural Resources Canada found that the forest industry accounted for about $23.7 billion in economic activity, or nearly 2 percent of Canada's gross domestic product, and employed almost 234,000 Canadians. In 2011, Parks Canada found that Canada's national parks and marine conservation areas generated nearly $3 billion in cultural services and close to 42,000 jobs.

1.15 While it is more difficult to put a value on regulating, supporting, and cultural services, a 2009 study conducted by the Ontario Ministry of Natural Resources examined an area in the province's southern region, consisting of the Lake Simcoe–Rideau and Lake Erie–Lake Ontario **ecoregions**, representing about 1.25 percent of Canada's territory. The study estimated that as of 2009, the area annually received approximately $84.4 billion worth of ecosystem services, including pollination, water filtration, waste regulation, and recreation.

Ecoregion—Ecoregions within Ontario are defined by the Ministry of Natural Resources according to the range and pattern in climatic variables, including temperature, precipitation, and humidity.

1.16 Economic development depends on the benefits derived from a biologically diverse environment; at the same time, it can have a significant impact on the ecosystems that provide these benefits, often resulting in a loss of biodiversity. To make the best development decisions possible, decision makers need to consider the trade-offs between development and conservation, the relative gains and losses, and their values. Biodiversity losses can jeopardize and degrade ecosystems that are essential to a broad range of economic sectors.

1.17 The relationship between the economy and biodiversity is more direct in certain sectors than others. For instance, the International Finance Corporation noted that the agri-food sector relies directly on fertile soils and a sustained supply of water, forestry companies depend on healthy trees, and portions of the tourism industry depend on wildlife and pristine ecosystems for travel destinations. In other sectors, the link is less obvious but equally important. In the retail sector, for example, consumers are increasingly looking for products such as seafood from sustainable sources and harvested in a manner that protects biodiversity.

1.18 As a result of these dependencies, many consider the physical natural environment, including ecosystem functions and processes, as a form of natural capital—an asset that needs to be managed. Much as a financial capital investment generates revenue in the form of interest, the planet produces renewable resources. Accordingly, it is important to use these resources sustainably to provide for future needs.

Valuation of ecosystem goods and services

1.19 Assigning an estimated economic value for features of the environment, including biodiversity, provides an opportunity to make more informed decisions considering the trade-offs between biodiversity preservation and economic development. Several national and international efforts are now under way to establish credible accounts of the value of ecosystem services. The European Union Biodiversity Strategy to 2020 requires all member states to assess their ecosystem services by 2014 and value them by 2020. The Economics of Ecosystems and Biodiversity study is an international joint initiative analyzing the global economic benefits of biodiversity and the costs of its loss. Within the federal government, Statistics Canada, Environment Canada, Natural Resources Canada, Parks Canada, and Agriculture and Agri-Food Canada have begun work to develop a system of accounts designed to help measure the value of ecosystem services. In addition, Environment Canada has developed models for valuing the economic benefits of ecosystem goods and services and has applied them in selected areas. (See Chapter 2—Meeting the Goals of the International Convention on Biological Diversity, in this report.)

1.20 There are many examples of local and regional ecosystems and species being valued in ways that contribute to decision making. Despite this, there is still a long way to go to reach comprehensive, widely used, and accepted accounts of values that can be maintained and updated, and integrated into all decisions.

Federal role in protecting biodiversity

International commitments

1.21 Canada is a signatory to several international conventions aimed at protecting biodiversity. The following provides some detail on some of the conventions that Canada is involved in.

1.22 **Convention on Biological Diversity.** This is a global commitment to conserve biological diversity, sustainably use its components, and fairly and equitably share the benefits arising from the use of genetic resources. Canada was an active participant in the negotiations leading up to the Convention and was the first major industrialized country to ratify it in 1992. In 2010, parties to the Convention agreed to a series of key targets for 2020, called the Aichi Biodiversity Targets. Organized under five strategic goals, the 20 targets form part of the Convention's Strategic Plan for Biodiversity 2011–2020. They range in nature and specificity. Examples include increasing awareness of the value of biodiversity, reducing the rate of all loss of natural habitat by at least 50 percent, and preventing the **extinction** of threatened species. (See Chapter 2—Meeting the Goals of the International Convention on Biological Diversity, in this report.)

Extinct species—A wildlife species that no longer exists anywhere in the world.

1.23 **Convention on the International Trade in Endangered Species of Wild Fauna and Flora.** This convention was ratified by Canada in 1975. It aims to ensure that international trade in wild animals and plants does not threaten their survival. For this purpose, the Convention sets controls on the movement of species that are, or may be, threatened. Approximately 5,000 animal species and 29,000 plant species are currently listed under this international convention.

1.24 **Convention on Wetlands of International Importance (Ramsar Convention).** This convention, which was ratified by Canada in 1981, commits members to designating and making sustainable use of wetlands of international importance within their territories and maintaining their ecological character. Canada has designated 37 sites under the Convention, 17 of which are national wildlife areas or migratory bird sanctuaries.

1.25 **Migratory Birds Convention.** Signed in 1916, this was the first environmental treaty signed by Canada and the United States in an effort to cooperate on protecting birds that migrate across the two countries' common border. In 1917, the treaty led to the enactment of Canada's *Migratory Birds Convention Act*. With its accompanying regulations, the Act prohibits the possession or

harming of migratory birds and the disturbance, destruction, or taking of their nests and eggs. (See Chapter 3—Conservation of Migratory Birds, in this report.)

Responsibilities for protecting biodiversity

1.26 Protecting biodiversity in Canada is a joint effort that requires the collaboration of many different stakeholders. The federal, provincial, and territorial governments share primary responsibility for conserving biodiversity and ensuring the sustainable use of biological resources. Also playing an essential role are private property owners; businesses; First Nations, Métis, and Inuit communities; conservation organizations; research institutions; foundations; and other groups.

1.27 The federal government is responsible for protecting, preserving, and rehabilitating the biodiversity of oceans, lands, and waters under its jurisdiction. Included is responsibility for aquatic species, migratory birds, and federally listed species at risk.

1.28 Provincial and territorial governments are the primary custodians of the natural resources within their boundaries, and some have developed their own biodiversity strategies. They have responsibility for wildlife management, overseeing resource development, and land use planning.

1.29 First Nations, Métis, and Inuit communities, as well as wildlife management boards, play an important role by contributing their traditional knowledge to the process of determining how to manage biodiversity and natural resources on their lands. Both the Convention on Biological Diversity and the *Species at Risk Act* call for the preservation, maintenance, and consideration of traditional knowledge in the conservation of wildlife and biodiversity.

Threats to biodiversity

Principal threats to biodiversity

1.30 Threats to biodiversity have implications for human health because biodiversity supports the ecosystems on which humans depend and the overall state of the environment. The following paragraphs summarize the five principal threats to global biodiversity.

1.31 **Habitat loss.** Habitat loss can be the result of conversion of an area to new uses; its unsustainable use; or other infrastructure, residential, or commercial developments. Whatever the cause, the habitat becomes less able to support the various species that depend on it. This can be due to the complete loss of the habitat, its fragmentation into multiple smaller habitats that can support only

smaller populations, or the long-term decline of an ecosystem's productivity and its capacity to support native species. Habitat loss is the largest threat to species in Canada and globally. For example, a sub-species of Northern Goshawk living on British Columbia's Queen Charlotte Islands is listed as threatened in Canada. According to the Committee on the Status of Endangered Wildlife in Canada's assessment report on the sub-species, one of the most significant threats to its long-term viability is habitat loss and degradation, mainly resulting from logging of the forests that the birds inhabit.

1.32 **Invasive alien species.** Invasive alien species can destroy or alter habitat, reduce crop yields, and introduce parasites and disease. They can reduce populations of native species through predation and competition for use of the habitat. When they affect commercially valuable native species, they can hurt local economies and livelihoods. An example is the Asian Long-horned Beetle, introduced to Canada from China in wood packaging materials. This insect threatened maple trees, which are important to Canada's tourism and maple syrup industries. According to the Canadian Food Inspection Agency, this invasive alien species has now been eradicated from Canada. In contrast, the Emerald Ash Borer (discussed in the Commissioner's 2005 September Report, Chapter 3—Canadian Biodiversity Strategy: A Follow-Up Audit) continues to threaten wide areas of Ontario and Quebec.

1.33 **Overexploitation.** Overexploitation can threaten a species by reducing population size, in some cases to a point where there are too few individuals to successfully reproduce. In addition to the risk of extinction, overexploitation can lead to changes in population characteristics, such as smaller average sizes. Overexploitation is a particularly significant threat to marine fish. For example, it led to the **extirpation** of striped bass in the St. Lawrence Estuary in the late 1960s and contributed to the collapse of Atlantic Canada's cod fishery in the 1990s.

Extirpated species—A wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.

1.34 **Pollution.** Pollution has long been recognized as a threat to biodiversity. In recent decades, international agreements have limited the use of some hazardous substances, reducing the negative effects of some pollutants, such as DDT, on plants, animals, and humans. Nonetheless, according to Canada's most recent report to the Convention on Biological Diversity, concentrations of some pollutants have continued to rise in Canadian wildlife, potentially threatening the survival of some species. At the same time, there have been increases in the amount of nutrients released into the environment through sewage and agricultural runoff. This organic pollution

can cause changes in the mix of plant species. It promotes the growth of algae and bacteria, which in turn can affect water quality and resource availability. (The effect of this on the Great Lakes is described on page 23.)

1.35 **Climate change.** Climate change affects biodiversity by altering the environmental conditions faced by plants and animals. The consequences vary, depending on the region and the ability of individual species to adapt to changing conditions. Higher regional temperatures may lead to shifts in the area within which a species can be found. As noted in the Commissioner's 2010 Fall Report, Chapter 3—Adapting to Climate Impacts, warmer summers and milder winters in British Columbia have contributed to the infestation of the Mountain Pine Beetle, which destroyed large areas of the forest in the central part of the province. This has had drastic consequences for other animals and plants in those forest ecosystems, as well as for the forest industry. Climate-induced changes to the timing of plant flowering may also affect food availability and migration patterns. For instance, as a result of earlier growing seasons, caribou in the Canadian Arctic can arrive at their calving grounds after the vegetation on which they rely has passed its nutritional peak. In the oceans, carbon dioxide emissions lead to climate change–related alterations in marine habitats and species ranges. At the same time, the emissions cause ocean acidification, which is responsible for thinning the calcium-based shells of certain marine organisms.

1.36 **In summary.** These five principal threats to biodiversity largely result from human activities. Globally, factors such as growing populations, increasing urbanization, and increased consumption will intensify the pressures exerted by the direct threats to biodiversity. In Canada, urbanization, economic growth, and a continuing reliance on natural resource extraction will continue to put pressure on biodiversity.

1.37 These threats to biodiversity do not exist or act in isolation. In most cases, multiple threats exert pressure on biodiversity in a region, affecting many species in varying ways. When threats coincide, they can intensify or multiply the impact each might have individually. Consequently, the most effective and efficient recovery strategies target multiple threats and species simultaneously by addressing the underlying causes.

Measures of the state of biodiversity

1.38 There are many challenges to summarizing the state of biodiversity or simply explaining trends. One challenge in accurately describing the state of biodiversity is the availability of information. For example, although scientists have formally described about 1.7 million species, that number may represent less than 20 percent of the species on earth. Most measures indicate that the state of biodiversity globally and in Canada is in decline. Here we examine three indicators of the state of biodiversity: habitat loss, extinction rate, and species at risk.

Habitat loss

1.39 According to the Millennium Ecosystem Assessment, humans had more impact on ecosystems in the second half of the 20th century than in any other period of human history, mainly through conversion of areas to cropland. The assessment also found that the habitat loss resulting from the conversion led to local extirpations and global extinctions.

1.40 In 2008, the United Nations' Food and Agriculture Organization published the Global Assessment of Land Degradation and Improvement. The study found that 24 percent of the world's land area was undergoing degradation, affecting 1.5 billion people. The report defined degradation as long-term loss of ecosystem function and productivity, caused by disturbances from which land cannot recover unaided. The analysis found that areas subject to degradation included about 30 percent of all forests, 20 percent of cultivated areas, and 15 percent of grasslands. In Canada, the study identified almost 2 million square kilometres—nearly 20 percent of the country's territory—as undergoing degradation, affecting 17.7 percent of the population (5.5 million people) between 1981 and 2003. This degradation results in loss of biodiversity.

1.41 The Government of Canada has developed an index that measures the capacity of agricultural land to provide habitat for terrestrial vertebrates. Results indicate that natural lands including woodlands, wetlands, and riparian areas—the land area bordering water bodies—support higher capacity to provide suitable habitat for these species than croplands. Agricultural landscapes cover 7 percent of Canada's land area and provide important habitat for over 550 species of terrestrial vertebrates, including about half of the species assessed as being at risk nationally. The extent of agricultural land in Canada has remained stable for more than 70 years. However, the proportion classified as cropland has risen from 1986 to 2006, and the

capacity of Canada's agricultural land to support wildlife has declined over this period because of the intensification of agriculture and the loss of natural and semi-natural land cover. The result has been a reduction in suitable habitat available for terrestrial vertebrates.

1.42 In addition to the expansion of cropland, other indicators suggest negative trends in habitat across Canada:

- The area of urbanized land nearly doubled between 1971 and 2001, and the total settled area (population centres) increased by 14 percent between 2001 and 2006.
- Canada has lost large proportions of its wetlands: up to 68 percent in southern Ontario, up to 88 percent in the lower Fraser Valley of British Columbia, and up to 96 percent around urban areas in the Prairies. Canada's 2009 report to the Convention on Biological Diversity suggests that these losses are going to continue. In 1991, it was estimated that the total wetland loss for Canada since the 1800s was 200,000 square kilometres, or one seventh of Canada's total wetland base.
- According to the report **Canadian Biodiversity: Ecosystem Status and Trends 2010**, deforestation in Canada is low and stable. Regional studies indicate that changes in mixes of tree species might be shifting habitats and that these trees have become more vulnerable to outbreaks of pests and disease with the rise in winter temperatures. For example, an unprecedented outbreak of the Mountain Pine Beetle has devastated more than 110,000 square kilometres of forest in Canada and the western United States since the late 1990s.

Canadian Biodiversity: Ecosystem Status and Trends 2010—A collaborative project of Canada's federal, provincial, and territorial governments, based on 21 national thematic reports. It provided baseline information, highlighted threats to biodiversity, identified trends, and helped to measure progress in achieving healthy and diverse ecosystems. Authors and reviewers included hundreds of experts from across Canada.

Extinction rate

1.43 Species extinction is a natural occurrence, part of the evolution of life on earth. Under normal circumstances, extinctions occur infrequently, at what is referred to as the background rate. The geological record shows that there have been five mass extinctions, that is, times when extinction rates spiked because of a particular event or a confluence of unusual global conditions. The most recent mass extinction happened about 65 million years ago. At average historical rates, observations of extinction on human time scales should be relatively rare. Globally, the International Union for Conservation of Nature (IUCN) Red List of Threatened Species has identified nearly 800 species that have become extinct since AD 1500. The Millennium Ecosystem Assessment noted that approximately 100 species became extinct globally in the last century.

1.44 While the absolute number of observed species extinctions may seem small, scientists have noted that current extinction rates may be 100 to 1,000 times higher than the background rate. Current estimates of the proportion of species at risk appeared in the Millennium Ecosystem Assessment, which projected in the coming centuries that future extinction rates will be more than 10 times higher than the current rate of extinction.

Species at risk

1.45 The IUCN Red List of Threatened Species is a globally recognized effort to determine the risks of extinction of plant, animal, and fungal species as a way to evaluate their conservation status and the extent to which they are under threat. In July 2013, the Red List assessment included more than 70,000 species globally, representing fewer than 5 percent of all described species. Of the 70,000 species, nearly 30 percent are categorized as threatened.

1.46 The Wild Species assessment is a similar evaluation carried out in Canada every five years by the National General Status Working Group, a joint federal–provincial/territorial body. The aim is to provide an overview of which species occur in Canada and where, as well as their status. In 2010, 11,950 species were assessed. Of these, 2 percent were found to be at risk and an additional 7 percent were ranked as "may be at risk" of being extirpated or becoming extinct.

1.47 Species that are ranked as "may be at risk" are prioritized for assessment by the Committee on the Status of Endangered Wildlife in Canada, which advises the federal government about species that should be listed under the *Species at Risk Act*. There are 676 Canadian species currently identified as at risk by the Committee. Of these, 518 species were recommended by the Minister of the Environment for protection under the Act. More detailed discussions on species at risk can be found in Chapter 5—Funding Programs for Species at Risk, and Chapter 6—Recovery Planning for Species at Risk, both in this report.

Selected practices for managing biodiversity

1.48 Managing biodiversity is a complex undertaking that can present many challenges. For this backgrounder, we sought to identify and explain some critical elements of managing biodiversity. We identified examples from Canada and abroad that show how some of the related challenges are being addressed. They are

- conservation of biodiversity,
- information management,

- long-term commitment and strategy,
- partnerships and cooperation, and
- use of an ecosystem approach.

Conservation of biodiversity

1.49 As noted, biodiversity is important to our way of life—from the benefits it provides to humans, to the contribution it makes to economic well-being, to the development of medicines, and for its intrinsic value.

1.50 The cost of repairing or restoring biodiversity once it has degraded or is in need of recovery can far outweigh the costs to preserve it in the present. This underscores the importance of a proactive approach to the conservation and protection of biodiversity.

1.51 A variety of strategies are commonly used to conserve biodiversity. Examples include the protection and preservation of habitats, species, and ecosystems, and may also include the development of protected areas, the use of wildlife corridors, and public education programs. There are over 4,000 publicly and privately managed **protected areas** in Canada. Common types of federal protected areas include national wildlife areas, migratory bird sanctuaries, *Oceans Act* marine protected areas, and national parks. (See Chapter 3—Conservation of Migratory Birds, in this report.)

Protected area—A clearly defined geographical space, recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Source: International Union for Conservation of Nature

1.52 One of Canada's main approaches to protecting its biodiversity is through the establishment of protected areas. In 2010, under the Convention on Biological Diversity, Canada agreed to an international target to conserve, by 2020, at least 17 percent of its terrestrial and inland water area, as well as 10 percent of its coastal and marine areas, by establishing a well-connected network of protected areas and undertaking other effective area-based conservation measures. As of 2012, Canada's terrestrial protected areas covered just over 1 million square kilometres, or about 10 percent of the country's land area. Canada's marine protected areas covered almost 50,000 square kilometres, or about 1 percent of the country's marine territory. The combined protected areas approximate the area of Ontario, and almost half are under federal jurisdiction.

Information management

1.53 As noted in the Commissioner's 2011 December Report, Chapter 2—Environmental Science, science is a key factor that informs decisions about legislation, regulations, policies, and programs that may contribute to sustainable development in Canada. Policy makers and

managers require appropriate scientific data and information to make decisions about how to manage biodiversity. Researchers have gathered much data on the various aspects and areas of biodiversity. However, they have also noted that different data sets are often not integrated or analyzed to provide information that can be used effectively by decision makers. What is needed is to efficiently consolidate the data into comparable, measurable, and meaningful information.

1.54 Even with the large amount of data that has been collected, gaps remain. For many species and ecosystems, the information simply does not exist. The report Canadian Biodiversity: Ecosystem Status and Trends 2010 found that the country's ecosystems were monitored using varying parameters, space and time scales, and protocols for data collection and analysis. According to the report, this mix of information created gaps that interfered with efforts to make comparisons and understand the data; assessments had to be completed by piecing together information from disparate sources. The report found a need for better data management, standardization, and coordination.

1.55 These concerns around information management are not unique to Canada. Internationally, several systems have been put in place to consolidate biodiversity information. Here are two:

- The Global Biodiversity Information Facility was established in 2001 through a Memorandum of Understanding between member states as a scientific infrastructure designed to facilitate and support free and open access to the world's biodiversity data over the Internet. The Facility currently brings together more than 400 million data records for specimens and observations of different species, which are available for reuse in many different scientific fields, including biodiversity assessments and projections of future trends.
- The Biodiversity Information System for Europe is a single entry point for all biodiversity data and information in the European Union. It links together the related policies, environmental data, assessments, and research findings on biodiversity and ecosystem services from various sources. The aim is to strengthen the knowledge base and support decision making on biodiversity in Europe.

1.56 In Canada, initiatives such as the Canadian Centre for DNA Barcoding are trying to address data issues. Housed at the Biodiversity Institute of Ontario within the University of Guelph, the Centre seeks to advance species identification and discovery through the analysis of DNA, using tissue samples from collected specimens. Under the International Barcode of Life Project, the Centre is using barcode technology to record and catalogue this information. In addition, it is leading the process of extending the barcode reference library for species from around the world.

1.57 Another approach being used internationally is remote sensing technology, that is, the use of satellites to collect data to assess and monitor elements of biodiversity. This technology is a way of addressing the limitations associated with the field-based collection of data. With remote sensing, scientists can collect information on species habitat, predict species distribution, develop information on species richness, and detect the impacts of human interactions.

Long-term commitments and strategies

1.58 Biodiversity recovery takes time, whether it involves remediating habitat, protecting ecosystem services, or rebuilding populations. For example, in marine protected areas, the time required to achieve these ecological benefits can range from a couple of years to decades. It is therefore essential to make a long-term commitment of time and resources to protecting and conserving biodiversity by exercising stewardship. Long-term strategic plans need to be designed to achieve long-term results, while taking into consideration the effects on the environment, economy, and society over time.

1.59 There are many factors that limit the pace of biodiversity recovery. It may take generations for a species in decline to rebound once the decline is arrested, and in some cases restoration may not be possible. Moreover, a species that is at risk might begin recovering only after remediation of the habitat or resources on which it depends. Sometimes the remediation may itself depend on the recovery of other species that contribute to ecosystem functions.

1.60 For example, more than 20 years have passed since a moratorium was imposed on fishing of depleted Atlantic cod stocks in Canada. So far, however, the species has been slow to recover. Many factors may contribute to the slow recovery of cod. They include changes to ocean conditions that might adversely affect the stock's productivity, as well as the residual impacts of overfishing in the past. Recovery will depend on the commitment of the federal government and

resource users to implement their long-term recovery plan in partnership with provinces and the fishing industry. In addition, future changes in environmental conditions could affect productivity and the likelihood of recovery.

1.61 Another example is the acidification and subsequent remediation of Canadian lakes and rivers. Concern about acidification became common in the 1970s due to the loss of biodiversity as a result of the acidification. To address the issue, Canada and the United States launched regulatory interventions. The water quality of affected lakes improved by the beginning of this century, some 30 years later, but the recovery of the aquatic species in those lakes has taken longer. This led the government to note in Canada's most recent report to the Convention on Biological Diversity that it is important to manage societal expectations of rapid improvements, underscoring the time frames it can take for remediation programs to achieve the intended results.

1.62 In Canada and abroad, an important component in the conservation and sustainable use of biodiversity is a long-term commitment to its stewardship, in partnership with multiple stakeholders (Exhibit 1.3).

Partnerships and cooperation

1.63 Animals, plants, and ecosystems do not follow lines drawn on the map by humans, and consequently neither do most issues and threats related to biodiversity. The successful conservation of biodiversity will often involve the collaboration of many jurisdictions and stakeholders that share responsibility.

1.64 Collaborative approaches that involve various levels of government as well as non-governmental organizations and community groups have yielded results. For example, declining waterfowl populations reached record lows across North America in 1985. The year 1986 saw the establishment of stewardship agreements, community-based urban planning, and conservation programs that included landowners and non-governmental organizations. These contributed to the protection of grasslands and wetlands to help with waterfowl recovery. To date, these efforts have played an important role in the recovery of some waterfowl. (See Chapter 3—Conservation of Migratory Birds, in this report.)

1.65 Ontario's Conservation Authorities are community-based watershed management agencies that illustrate the benefits of working in partnership with all levels of government, as well as landowners and other interest groups. The Authorities' mandate is to conserve, restore, and manage Ontario's water, land, and natural habitat, while balancing environmental, human, and economic needs. Programs include source water protection, watershed management and stewardship,

Exhibit 1.3 **Partnerships and long-term strategies are key to ecosystem recovery**

Rangeland management in western Canada

Hundreds of thousands of hectares of western Canadian rangeland have been restored to their native state in a collaborative management effort that began nearly 80 years ago. Its long-term focus and commitment have resulted in rehabilitation, productivity increases, and significant public and private benefits for lands affected by drought and soil drifting in the provinces of Manitoba, Saskatchewan, and Alberta.

Photo: Agriculture and Agri-Food Canada

Until the end of the 1800s, the Prairies were dominated by grasslands that provided grazing for millions of bison. Beginning in the late 19th century, hunting destroyed most of the bison population, and much of the land was settled and converted to cropland. By the 1930s, some areas had become dry and eroded as a result of years of growing crops in grassland ecosystems that were naturally unsuited to cultivation. The problem was compounded by drought conditions, significantly reducing crop yields. In addition, depressed wheat prices left many farmers on the degraded lands unable to support themselves.

The federal, provincial, and municipal governments joined with residents, farmers, and ranchers to find a solution. In partnership, they designed and implemented long-term programs that permanently returned the lands to their natural grassy state, for use as pastures for ranching. Over the following decades, productivity increased to the point that the lands were able to support more than 230,000 head of cattle a year. By the late 2000s, significant expanses of the lands were dominated by native vegetation, and were classified as being in good or excellent condition. In other words, they had been returned to high levels of biodiversity, while optimizing forage production for livestock.

The Great Fen Project in the United Kingdom

The Great Fen Project officially started in 2001 and is a 50-year project that seeks to address biodiversity issues in the Fens, a peatland area that has been devastated biologically by draining the area for farming ever since the 19th century. More than 99 percent of this habitat disappeared, along with many rare species of plants and animals. The Fens region is very important for biodiversity; it contains thousands of species, some of which are threatened or are found only in the region.

The project is a multi-stakeholder partnership supported by individuals, businesses, charities and trusts, and five organizations. The aim is to link two fragmented national nature reserves together, create 3,700 hectares of wildlife landscape, and provide opportunities for education, recreation, and business. The land will be protected by permanently covering the bare soil with grassland, fen, and reedbed. Another goal is to create a few smaller areas where winter floodwaters can be stored, preventing the release of huge amounts of carbon dioxide each year.

Photo: Alan Bowley

environmental education, natural heritage planning and monitoring, research, and land acquisition. The aim is to deliver community-based solutions to the various challenges facing Ontario's biodiversity. Approximately 90 percent of Ontario residents live in a watershed managed by a Conservation Authority.

The ecosystem approach

1.66 Those tasked with protecting biodiversity face the question of how they can effectively manage the many threats to an ecosystem, which may affect many species within the ecosystem and their interactions. The ecosystem approach is an integrated approach to natural resource and environmental management. When addressing critical environmental issues such as biodiversity loss, the approach considers various aspects of an ecosystem, including land, air, water, plants, animals, humans, and their interactions. The ecosystem approach also considers the social and economic factors relevant to the state of the ecosystem and its recovery.

1.67 The Convention on Biological Diversity has recognized the ecosystem approach as the primary framework for action under the Convention. It stresses, for example, the benefits of ecosystem-based approaches that integrate biodiversity and the provision of ecosystem services into overall strategies for adapting to climate change. Such approaches can be cost-effective; they can generate social, economic, and cultural benefits; and they help to maintain resilient ecosystems.

1.68 The Great Lakes Water Quality Agreement of 1978 calls for such an approach to the management of the various ecosystems within the Great Lakes Basin. Each of these ecosystems involves a different set of environmental conditions, stakeholders, and legislative frameworks. The approach requires stakeholders to look at the interaction of physical, chemical, and biological components of the Great Lakes Basin, and to use adaptive environmental planning and management.

1.69 Various organizations have incorporated the better practices discussed in this backgrounder—conservation, information management, long-term commitment, partnerships, and the ecosystem approach—to address issues associated with biodiversity loss in the Great Lakes (Exhibit 1.4).

Exhibit 1.4 The Great Lakes—an example of an integrative, collaborative approach to biodiversity management

The Great Lakes are the largest freshwater reservoir on earth, providing drinking water to 24 million people (including 8.5 million Canadians) and habitat for more than 150 species at risk. They contribute as much as $9 billion a year to the Canadian tourism and fishing industries, and support 25 percent of Canada's agricultural capacity. The Great Lakes are a unique area, critical to Canada's economy and environment.

In the past hundred years, the Great Lakes saw collapse and recovery of species and their environment, faced a multitude of threats, and have been the subject of cooperation and collaboration across borders and jurisdictions.

One of the longest-enduring examples of binational cooperation is the Boundary Waters Treaty, signed by Canada and the United States in 1909 to guide the use and management of shared waters. As well, the Convention on Great Lakes Fisheries was signed by the two countries in 1954 to guide the use and management of shared fishery resources. Beginning in the 1920s, the invasion of the sea lamprey (an alien species), together with new pollution problems and overexploitation, caused the collapse of lake trout and other fish populations, which had supported an important commercial fishery. This led to the creation of the Great Lakes Fishery Commission, primarily tasked with addressing the sea lamprey problem and facilitating cross-border collaboration. By the late 1950s, the discovery of an effective pesticide and coordinated management efforts were leading to progress in controlling the sea lamprey population. The Commission also established lake committees and A Joint Strategic Plan for the Management of Great Lakes Fisheries to help many jurisdictions work across borders—at an ecosystem level—to establish and implement shared fish community objectives.

In the 1960s, a new problem emerged in Lake Erie, the most biologically productive of the Great Lakes, as increasing organic pollution caused the growth of algae and oxygen-depleted "dead zones." In the early 1970s, the Government of Canada signed agreements with the United States and the Province of Ontario, committing to targets and agreeing on actions to restore and protect the Great Lakes. Both agreements have been renewed many times since.

Through ballast water regulations, improved sewage treatment, and other collaborative efforts, many of the issues threatening the lakes have been addressed. The sea lamprey is under control (although it still requires millions of dollars in control measures a year), and the lake trout has largely been restocked. In the late 1980s, the amount of pollution declined significantly.

Today, the Great Lakes are recovering but are subject to new and growing threats, as well as the risk that threats addressed in the past will recur. There are over 180 invasive alien species in the lakes, and the Asian carp is a pending threat, although control measures are being taken. Zebra and other invasive mussels have had a significant impact on food webs, along with climate change and new forms of nutrients, which may be contributing to a resurgence of dead zones in Lake Erie and elsewhere. The year 2011 saw the Lake Erie dead zone at its largest since the 1960s. In 2012, a rapid growth of algae in Lake Superior resulted in its first-ever algal bloom, which is a main factor in the development of a dead zone.

The Great Lakes are vital but sensitive ecosystems. Given the many jurisdictions involved, no one group or country has the ability to manage the lakes alone. If these ecosystems are to maintain their key functions, stakeholders must continue to emphasize cooperation and collaboration to obtain the most up-to-date information, science, and data, as well as long-term commitments and constant vigilance.

Questions Parliamentarians Could Ask

1.70 Parliament has a crucial role in ensuring that Canada's biodiversity is properly managed. It passes legislation that sets the basic ground rules for the federal government, and it oversees the government's activities. This backgrounder provides information to help members of Parliament understand the core issues related to biodiversity. Based on the analysis in this backgrounder, we have identified several questions that members of Parliament may wish to ask when holding the government to account for its stewardship of the environment and the preservation of biodiversity.

Legislative oversight

- Members of Parliament may wish to examine whether existing legislation, regulations, and other federal actions are working and what changes may be needed. For example, what are the most cost-effective measures to protect and conserve biodiversity?

Biodiversity and the economy

- In what ways and to what extent is the Canadian economy exposed to the loss of ecosystem services and natural resources?
- What mechanisms are currently in place to incorporate the economic values of ecosystem services into decision making?

Knowledge gaps

- What are the most pressing knowledge gaps with respect to biodiversity and ecosystem services, and what is being done to address these gaps?

Comparison with other jurisdictions

- How does Canada compare with other jurisdictions in terms of the strength of its biodiversity legislation and its implementation?
- What can we learn from others?

Conclusion

1.71 Canada's social and economic prosperity relies on biological diversity and on the goods and services provided by a diverse natural environment. The use of plants and animals currently contributes billions of dollars to key sectors of the Canadian economy, including agriculture, forestry, ecotourism, fishing, and pharmaceuticals. Biodiversity is also important to people's health, since many of our medications are derived from natural sources.

1.72 Globally, human population growth, urbanization, and increased consumption continue to intensify the direct threats to biodiversity. Similar trends exist within Canada. The area of urbanized land has nearly doubled over the past 50 years. Urbanization, economic growth, and a continuing reliance on natural resources put pressure on our biodiversity. A key challenge for all stakeholders will be to balance the conservation of biodiversity with the pursuit of economic development.

1.73 As a result of human dependencies on biodiversity and the rate at which it is being lost, there is growing acceptance that the value provided by a biologically diverse environment needs to be determined and managed as an asset. While the value of this natural capital is difficult to estimate, initial economic valuations suggest that the world's natural capital is in the trillions of dollars.

1.74 Based on our review of the literature and interviews conducted, we have identified a number of management approaches that support protecting and restoring biodiversity. These include the importance of

- proactive approaches to conserving biodiversity in order to reduce the impacts of various threats to biodiversity and the potential costs of its restoration in the future;
- the integration of scientific data and information into decision making to allow for informed choices that support sustainable development;
- long-term commitments and strategies recognizing that it can take generations for habitats to be restored or species at risk to rebound;
- partnerships and cooperation involving multiple stakeholders and often multiple jurisdictions; and
- an integrated approach that considers various aspects of an ecosystem—such as land, air, water, plants, animals, humans, and their interactions—including the social and economic factors relevant to the state of the ecosystem and its recovery.

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