



Prairies Ecozone⁺

evidence for key findings summary

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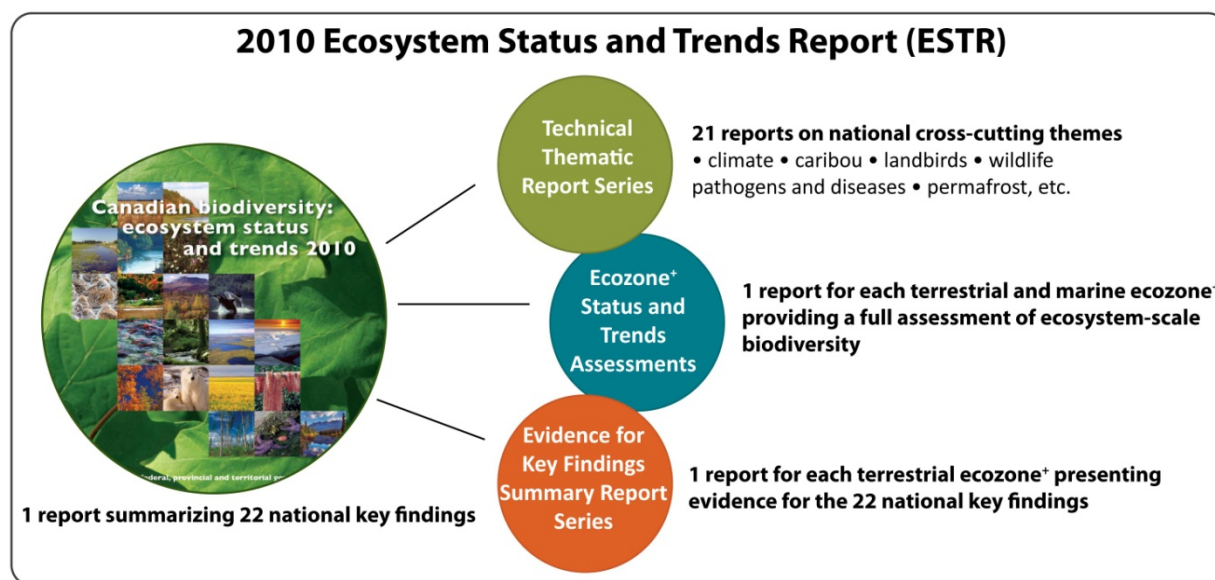
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PREFACE

The Canadian Councils of Resource Ministers developed a Biodiversity Outcomes Framework¹ in 2006 to focus conservation and restoration actions under the *Canadian Biodiversity Strategy*.² *Canadian Biodiversity: Ecosystem Status and Trends 2010*³ was the first report under this framework. It presents 22 key findings that emerged from synthesis and analysis of background technical reports prepared on the status and trends for many cross-cutting national themes (the Technical Thematic Report Series) and for individual terrestrial and marine ecozones⁺ of Canada (the Ecozone⁺ Status and Trends Assessment Report Series). More than 500 experts participated in data analysis, writing, and review of these foundation documents. Summary reports were also prepared for each terrestrial ecozone⁺ to present the ecozone⁺-specific evidence related to each of the 22 national key findings (the Evidence for Key Findings Summary Report Series). Together, the full complement of these products constitutes the 2010 Ecosystem Status and Trends Report (ESTR).



This report, *Prairies Ecozone⁺ Evidence for Key Findings Summary*, presents evidence from the *Prairies Ecozone⁺ Status and Trends Assessment*⁴ related to the 22 national key findings and highlights important trends specific to this ecozone⁺. It is not a comprehensive assessment of all ecosystem-related information. The level of detail presented on each key finding varies and important issues or datasets may have been missed. Although this is intended to be a comprehensive analysis, some issues may require further exploration. Some emphasis has been placed on information from the national Technical Thematic Report Series. As in all ESTR products, the time frames over which trends are assessed 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.

Ecological classification system – ecozones⁺

A slightly modified version of the Terrestrial Ecozones of Canada, described in the *National Ecological Framework for Canada*,⁵ provided the ecosystem-based units for all reports related to this project. Modifications from the original framework include: 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 these reports to avoid confusion with the more familiar “ecozones” of the original framework.⁶ The boundary for the Prairies is the same in both frameworks.



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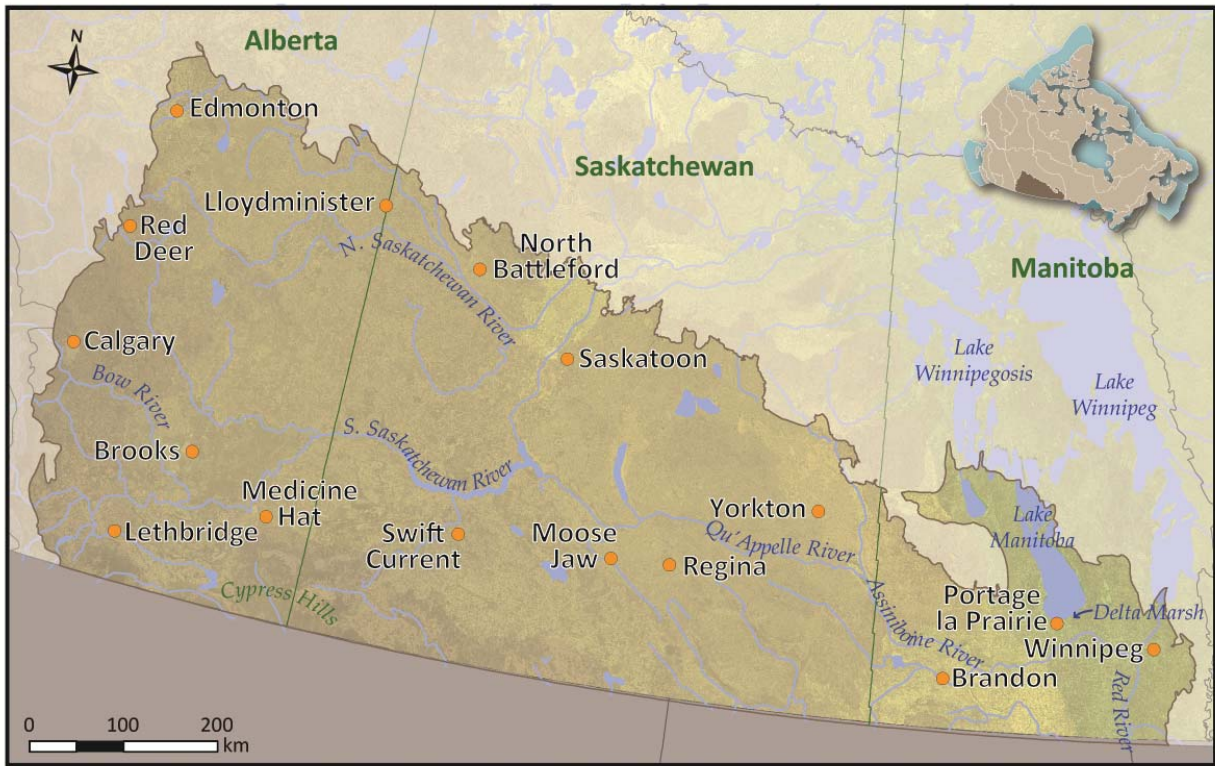


Figure 1. Overview map of the Prairies Ecozone[†].

ECOZONE⁺ BASICS

The Prairies Ecozone⁺, shown in Figure 1 and described in Table 1, is characterized by a semi-arid to sub-humid climate supporting vast, temperate grasslands. Most of the ecozone⁺ was glaciated and consequently much of the land surface is made up of glacial deposits of varying thicknesses. The predominant land use is agriculture (Figure 2), of which the primary use is cultivation of annual crops, with areas of remaining native and tame grasslands used for livestock grazing and hayland. Small areas of forest remain, mainly in the Aspen Parkland Ecoregion. The Prairies are known for the many wetlands, or potholes, across the landscape. Figure 3 shows the seven ecoregions that comprise the ecozone⁺.

Table 1. Prairies Ecozone⁺ overview.

Area	465,094 km ² (4.7% of Canada)
Topography	Modest relief, from 200 m above sea level in the east to 1,200 m in the west. Exceptions are the Cypress Hills on the Saskatchewan-Alberta border which rise almost 1,500 m above sea level and the Rocky Mountain foothills reaching 1,700 m above sea level. Part of the Great Plains.
Climate	Variable, with cool to very cold winters (average of -6 to -17°C), and warm, moist summers (average of 15 to 19°C). Precipitation varies from less than 280 mm/yr in the dry core area to 540 mm/yr in the east, with high number of cloud-free days.
River basins	Falls within 14 sub-drainages of the Nelson River Drainage and a small part of the Mississippi River Drainage. Major rivers include the North and South Saskatchewan, Bow, Red and Assiniboine.
Geology	Deposition directly from glacial ice creating rolling landscapes of medium-textured glacial till, with meltwater streams depositing sandy plains, and glacial lakes resulting in beds of clay soil. Underlain by horizontally bedded sandstones and shales of Tertiary and Cretaceous age, with some Paleozoic limestone in the east.
Settlement	Traditional territories for over a dozen Aboriginal groups. European influence began with the fur trade in the 18 th century, agricultural settlement beginning in the 19 th century. Major cities include Edmonton, Calgary, Regina, Saskatoon, Winnipeg, Brandon, and many other growing urban centres.
Economy	Agriculture, oil, natural gas, coal, and resource extraction such as potash.
Development	83 large dams, primarily for irrigation. Dense network of roads, both urban and rural; extensive network of drainage works in the east. Extensive oil and gas development in some areas. Potash and coal mining in some areas.

National/global significance

Two national parks: Elk Island and Grasslands.
One biosphere reserve: Redberry Lake (SK).
Five Ramsar sites (wetlands of international significance): Beaverhill Lake, Quill Lakes, Last Mountain Lake, Delta Marsh, and Oak Hammocks Marsh.
Four Western Hemisphere Shorebird Network Reserve sites: Quill Lakes, Chaplin-Old Wives-Reed Lakes, Beaverhill Lake, and Last Mountain Lake.
Two World Heritage sites: Head-Smashed-In Buffalo Jump (Aboriginal hunting) and Dinosaur Provincial Park (dinosaur fossils).
Northernmost extension of Great Plains of North America and largest area of grassland in Canada.
Most altered of all the ecozones⁺ in Canada as a result of widespread conversion of natural grasslands to agriculture.
Remaining remnant grasslands support a unique assemblage of prairie species, including several species at risk.

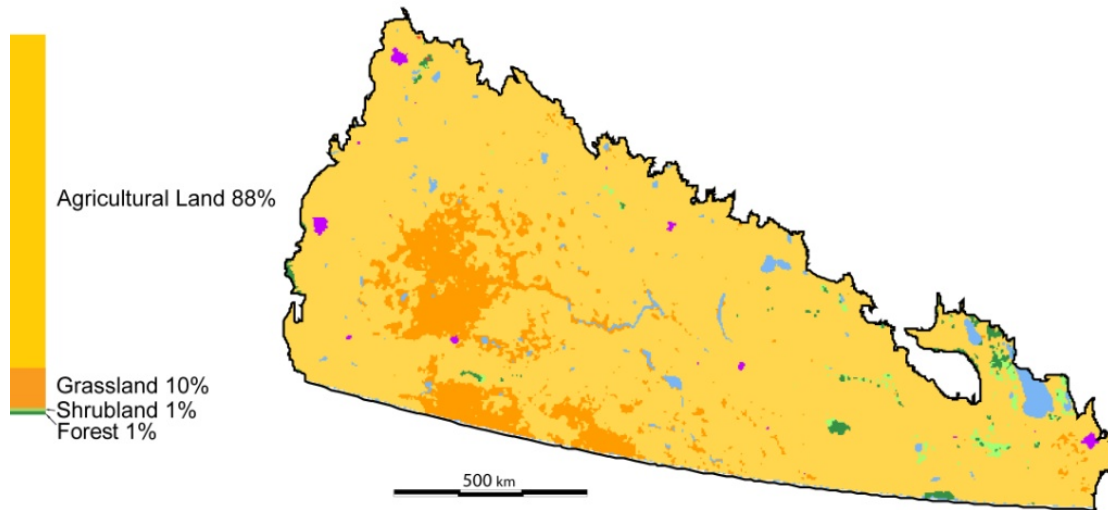


Figure 2. Land cover of the Prairies Ecozone⁺, 2005.

Source: Ahern et al., 2011⁷ using data from Latifovic and Pouliot, 2005⁸

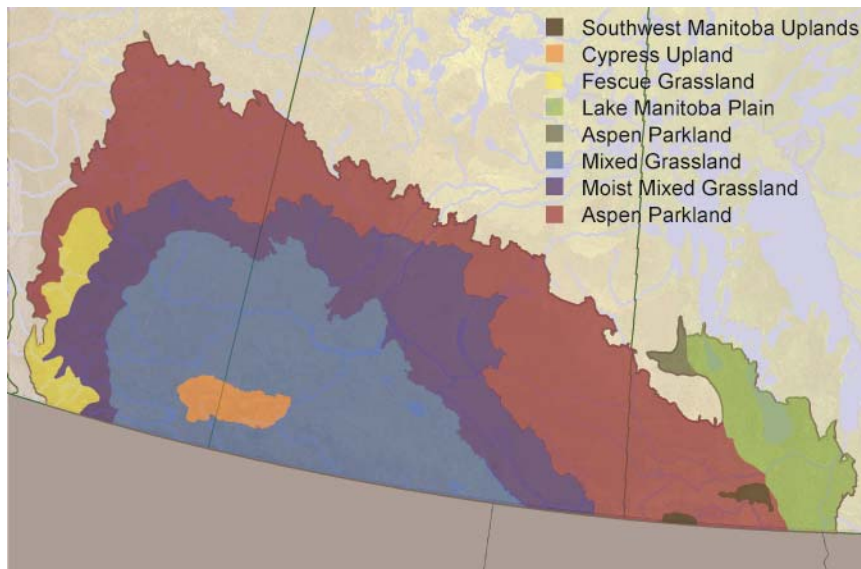


Figure 3. Ecoregions of the Prairies Ecozone⁺.
 Source: Ecological Stratification Working Group, 1995⁵

One of the most striking facts about the Prairies Ecozone⁺ is the extent of landscape alteration and the speed with which it was altered. Natural vegetation, which covered essentially all of the ecozone⁺ in the late 19th century, was reduced to about 30% (and much less in some areas) by the late 20th century, largely due to the conversion of natural grassland to agriculture. Conversion appears to have levelled off in the last few decades but threats from growing cities, residential and industrial development, drainage projects, and agriculture continue. Remaining areas are becoming increasingly fragmented by cultivated fields, roads, and energy developments.

Most of the natural biodiversity of the ecozone⁺ is embedded in and supported by the natural vegetation.

Jurisdictions: The Prairies Ecozone⁺ includes the southeast portion of Alberta (AB), the southern portion of Saskatchewan (SK), and the southwest portion of Manitoba (MB).

Population: The population of the Prairies Ecozone⁺ has been steadily increasing and reached 4.5 million in 2006 (Figure 4). It has shifted from being predominately rural to predominately urban.

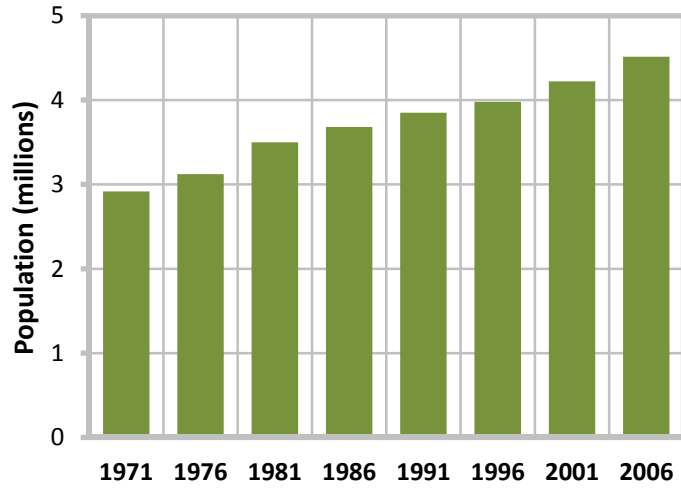


Figure 4. Human population in the Prairies Ecozone[†], 1971–2006.
Source: Environment Canada, 2009⁹



*Grasslands National Park, Saskatchewan
© istockphoto.com / 4loops*



Canola field, Manitoba © istockphoto.com / graphicjackson



*Example of closed-basin lakes in southern Saskatchewan
© dreamstime.com / A. Nantel*



Northern pintail © istockphoto.com / J. Lugo (lugo)

KEY FINDINGS AT A GLANCE: NATIONAL AND ECOZONE⁺ LEVEL

Table 2 presents the national key findings from *Canadian Biodiversity: Ecosystem Status and Trends 2010*³ together with a summary of the corresponding trends in the Prairies Ecozone⁺. Topic numbers refer to the national key findings in *Canadian Biodiversity: Ecosystem Status and Trends 2010*. Topics that are greyed out were identified as key findings at a national level but were either not relevant or not assessed for this ecozone⁺ and do not appear in the body of this document. Evidence for the statements that appear in this table is found in the subsequent text organized by key finding. For many topics, additional supporting information can also be found in the full *Prairies Ecozone⁺ Status and Trends Assessment*.⁴ See the Preface on page i.

Table 2. Key findings overview.

Themes and topics	Key findings: NATIONAL	Key findings: PRAIRIES ECOZONE ⁺
THEME: 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 a small proportion of the Prairies Ecozone ⁺ (1–5%). Between European settlement and the 1960s, tree cover expanded into grasslands in many parts of the Aspen Parkland Ecoregion, due in part to changes in the fire regime. Nevertheless, no changes in vegetation zones were detected. Between 1941 and 1981, tree cover in agricultural areas declined from 10 to 3%. From 1985 to 2001, there was a further 6% decline in naturally treed habitat but a 3% increase in tall shrubs. Variability in the growth rates of trees has been attributed to drought years and outbreaks of forest tent caterpillars.

Themes and topics	Key findings: NATIONAL	Key findings: PRAIRIES ECOZONE⁺
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.	Native grasslands cover less than 25% of the Prairies Ecozone ⁺ . An estimated 70% of native vegetation (mostly grasslands) was lost prior to the 1990s. Losses have slowed but not stopped; in some areas, 10% of remaining native grasslands were lost between 1985 and 2001. About 8% of the native rangelands and tame pastures assessed in Alberta and Saskatchewan were considered “unhealthy” as a result of overgrazing and invasion by non-native plants. Grassland birds declined by 35% as a group from the 1970s to 2000s with declines of greater than 60% for several species.
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.	Wetlands cover 3% or less of the Prairies Ecozone ⁺ . Estimates of historic wetland loss varied from 40 to 71%, depending on the region. At the ecozone scale ⁺ , 6% of wetland basins were lost between 1985 and 2001. Wetland drainage and filling remains an ongoing ecological stress, with impacts to continental waterfowl populations.
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.	Water availability is an important driver and issue in this ecozone ⁺ , with potential impacts to crop production, rangeland productivity, and wetland conditions for waterfowl. Between the 1940s and 2005, spring melt shifted earlier and seasonal (March–October) runoff volume and peak flows decreased. Average flow declined in several Prairie rivers over the past 50 to 100 years. Water levels in closed-basin lakes declined by four to ten metres from the 1920s to 2006. Construction of large dams peaked between the 1950s and 1970s and fragmentation of river and lake systems continues through small drainage and water control projects.

Themes and topics	Key findings: NATIONAL	Key findings: PRAIRIES ECOZONE⁺
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.	Not relevant
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.	Not relevant
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.	Lake and river ice break up has become earlier on particular lakes and rivers. Data on ice in the Prairies Ecozone ⁺ , however, was limited.
Dunes [*]	Dunes are a unique biome with a very limited distribution in Canada. As a result, information on dunes was not identified as a nationally recurring key finding nor was it included in one of the other key findings in the national report. ³ However, because of their significance to biodiversity in the Prairies Ecozone ⁺ , information on dunes is included as a separate ecozone ⁺ -specific key finding in this report.	Active (unstabalized) sand dune habitat declined from 1944 to 1991, although losses varied widely across the landscape. At least five species at risk are threatened by alteration of dune habitat.

^{*} This key finding is not numbered because it does not correspond to a key finding in the national report.³

Themes and topics	Key findings: NATIONAL	Key findings: PRAIRIES ECOZONE ⁺
THEME: HUMAN/ECOSYSTEM INTERACTIONS		
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.	Total area protected increased from between 0.4 and 3.8% in 1992 to 4.5% in 2009. This included 1.2% of the ecozone ⁺ in protected areas classified as IUCN categories I-IV, areas protected for natural and cultural conservation rather than sustainable use by established cultural tradition.
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.	Stewardship programs and initiatives, particularly those aimed at farmers and ranchers, grew rapidly in the 1990s and 2000s. The National Environmental Farm Plan Initiative and Habitat Stewardship Program for Species at Risk have helped to encourage stewardship activities on private lands. In 2007, approximately 90% of the land under conservation easements in Canada was in the Prairies Ecozone ⁺ . Under the Prairie Habitat Joint Venture, winter wheat seeding, which reduces disturbance and provides cover for early-nesting waterfowl species, increased over 600% from 1992 to 2007.
Ecosystem conversion*	Ecosystem conversion was initially identified as a nationally recurring key finding and information was subsequently compiled and assessed for the Prairies Ecozone ⁺ . In the final version of the national report, ³ information related to ecosystem conversion was incorporated into other key findings. This information is maintained as a separate key finding for the Prairies Ecozone ⁺ .	Approximately 70% of the ecozone ⁺ has been converted, mainly due to agriculture since European settlement. Wetlands, grasslands, and treed habitats all declined between 1985 and 2001. The landscape is highly fragmented and most remaining natural habitat fragments are less than 10 ha in size. Roads and infrastructure associated with energy development continue to increase fragmentation of the landscape.

Themes and topics	Key findings: NATIONAL	Key findings: PRAIRIES ECOZONE⁺
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.	Both numbers of invasive species and their geographic extent have increased. Native grasslands have been particularly altered by invasive non-native plants, with up to 95% non-native biomass in some areas. Non-native grasses and forbs have reduced native grassland diversity and cover and altered habitat for birds and species at risk. Aquatic ecosystems are also seriously threatened by invasive non-native fish, invertebrates, and plants.
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.	Herbicides use on agricultural land and the area treated increased rapidly from 1971 to 2006. Measurable pesticide residue was found in 92% of sampled wetlands in the Aspen Parkland Ecozone in 2002. No data on contaminants in wildlife is included at this time.
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.	Eutrophication in lakes and rivers accelerated in the 20 th century due to increased phosphorus and nitrogen inputs. Risk of residual soil nitrogen on agricultural land, however, remains the lowest in Canada and phosphorous levels in some rivers declined in response to improved sewage treatment.
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.	Not considered to be a concern for this ecozone ⁺
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.	From 1950 to 2007, spring temperature increased by 2.3°C and winter precipitation decreased by 18%. The number of days with snow cover decreased by 16 days. The growing season ended 6 days earlier and trembling aspen flowered 26 days earlier between 1901 and 1997. Some migratory bird species have shown earlier arrival dates of between 0.6 and 2.6 days per degree temperature increase.

Themes and topics	Key findings: NATIONAL	Key findings: PRAIRIES ECOZONE⁺
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.	Ecosystem services in the Prairies include water, crop pollination, and nutrient cycling which are necessary for food production and potable water. Important provisioning services include traditional food, fish, and wildlife. The majority of primary productivity is now being used for crop production, impairing the ability of ecosystems to deliver some of these services. Ecosystem services have not been systematically quantified for their economic value, although natural capital in the Upper Assiniboine River Basin was valued in 2004.
THEME: HABITAT, WILDLIFE, AND ECOSYSTEM PROCESSES		
16. Agricultural 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.	In 1986, 1996, and 2006, wildlife habitat capacity was low or very low on over 80% of the agricultural landscape (which covers 93% of the ecozone ⁺). From 1986 to 2006, wildlife habitat capacity on the agricultural landscape was constant on 92% of agricultural land, increased on 5%, and decreased on 3%. The dominance of cultivated land and the relatively small proportion of higher value habitat types was the primary reason for the low overall habitat capacity.
17. Species of special economic, cultural, or ecological interest	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.	Historic land conversion and human persecution has resulted in declines of many species including birds, freshwater fish, ungulates, and other mammals. Some species, including pronghorn, moose, and several raptors have recovered. Significant declines in grassland and open habitat birds and shorebirds have continued since the 1970s. In contrast, populations of some birds (e.g., Canada geese) have increased rapidly over the same period. Range shifts have been found for some ungulates as a result of changes in competition, tree cover, and hunting pressure.

Themes and topics	Key findings: NATIONAL	Key findings: PRAIRIES ECOZONE⁺
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.	From 1985–2006, primary productivity, as measured by the Normal Difference Vegetation Index (NDVI), increased for 157,491 km ² (35.1%) and decreased for 1,116 km ² (0.2%; in southeastern Alberta) of the Prairies. NDVI in this ecozone ⁺ is affected by precipitation and land cover change, thus the increasing trend is complicated by drought years and the large proportion of land area in cropland in which changes in cropping practices affect index and trend.
19. Natural disturbance	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.	Historically, the main agents of natural disturbance were fire, drought, heavy grazing, and insect infestations. Fire suppression and human-caused changes to the landscape resulted in a decline in fire leading to woody invasion of some grasslands. However, grassland productivity may have increased as a result. Outbreaks of two major insects, grasshoppers and forest tent caterpillar, were tied to warm, dry summers. Defoliation due to forest tent caterpillar increased in the 1980s and 1990s compared to the 1940s to 1970s.
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.	Patchy, variable grazing by free-roaming bison herds has been replaced by more uniform grazing by confined bison herds and domestic livestock. Large predators such as grey wolf and grizzly bear were nearly eliminated leading to an increase in mesopredators, such as coyotes.

Themes and topics	Key findings: NATIONAL	Key findings: PRAIRIES ECOZONE⁺
Wildlife diseases and parasites*	Wildlife diseases and parasites was initially identified as a nationally recurring key finding and information was subsequently compiled and assessed for the Prairies Ecozone ⁺ . In the final version of the national report, ³ information related to wildlife diseases and parasites was incorporated into other key findings. This information is maintained as a separate key finding for the Prairies Ecozone ⁺ .	A wide variety of diseases affect wildlife including waterfowl, cervids, rodents, carnivores, and amphibians. Chronic Wasting Disease is a serious threat to wild deer, elk and moose, and has also caused financial losses to game-farm operations. Type-C Botulism is a disease of waterfowl, especially ducks, which favours alkaline wetlands and dry summers. Dutch Elm Disease threatens the wild elm populations in the eastern part of the Prairies Ecozone ⁺ , as well as planted elms in most cities.
THEME: SCIENCE/POLICY INTERFACE		
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.	Biodiversity monitoring and research vary among provinces. Alberta has field monitoring programs for species diversity and rangeland productivity, but comparable programs are lacking in the other provinces. All provinces have targeted surveys for species of special interest and all provinces have Conservation Data Centres that list plant and animal species and maintain data on their occurrences.
22. Rapid change 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.	Climate change is predicted to lead to increased frequency of drought years, with major implications for agriculture, grassland productivity, and wetlands.

* This key finding is not numbered because it does not correspond to a key finding in the national report.³

THEME: BIOMES

Key finding 1

Theme Biomes

Forests

National key finding

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.

Woodlands make up a small percentage of the land cover in the Prairies Ecozone⁺, mainly in the Aspen Parkland Ecoregion and other moister ecoregions. Woody cover has increased within areas of natural vegetation, but has decreased overall. Compared to other ecozones⁺ in Canada, the Prairies have only a small amount of forest cover. The Canadian National Forest Inventory found that forests comprised approximately 195 km² (4.2%) of the area of the Prairies Ecozone⁺ in 2001. Based on 2005 remote sensing data, Ahern *et al.*⁷ estimated forest cover in the Prairies Ecozone⁺ at approximately 0.9%. Differences between the two estimates reflect different methodologies and definitions of forest rather than a change in the area of forest in the ecozone⁺.

Tree cover has expanded into grasslands in many parts of the Aspen Parkland Ecoregion between settlement and the 1960s.¹²⁻¹⁵ This expansion has usually been attributed to the reduction in fire frequency since European settlement,^{16, 17} although some authors have linked it to the extirpation of bison¹⁴ (*Bison bison*) and to nitrogen deposition.¹⁸ Tree cover expansion, primarily stands of trembling aspen (*Populus tremuloides*), has sometimes been interpreted as indicating southward shifts in vegetation zones since European settlement (e.g., the shift of Aspen Parkland into areas that were formerly continuous grassland).¹⁹ Thorpe,²⁰ however, reviewed historical sources from the 19th century and found that many of these sources clearly described parkland vegetation in places that now fall within the Aspen Parkland Ecoregion. For example, a map produced by the Palliser Expedition (1857–1860) shows the transition from the partially wooded “fertile belt” to the treeless “true prairie” near the same position as the southern edge of the Aspen Parkland on modern maps.²¹ Zoltai²² also concluded that the boundary between Boreal Forest and Aspen Parkland ecoregions has not shifted, based on range limits and ages of boreal conifers and peatlands. The key difference is that before European settlement, recurrent fires kept the aspen groves smaller in area and shorter in stature than at present.

ⁱ The Canadian National Forest Inventory^{10, 11} used inventory data from provincial, territorial, and other forest management agencies as well as remote sensing data to estimate forest cover. In contrast, Ahern *et al.*⁷ (see Figure 2) is based solely on remote sensing data (and defines Forest as areas with tree crown density >10%).

While expansion of tree cover has been documented within areas of natural vegetation, tree cover has undoubtedly been lost in areas converted to cropland. Based on Census of Agriculture data for a portion of the Aspen Parkland, Coupland²³ showed that the percentage of woodland decreased from 10% in 1941 to 3% in 1981. Watmough and Schmoll²⁴ found a 6% decline in naturally treed habitats from 1985-2001 on 153 transects widely distributed across the ecozone⁺ (although more weighted towards more settled parts of the Prairies). Declines ranging from 1 to 12% were found in five ecoregions (Boreal Transition, Cypress Upland, Lake Manitoba Plain, Southwest Manitoba Uplands, and Interlake Plain) while increases were found in the other three ecoregions ranging from 13 to 18% (Southwest Manitoba Uplands, Cypress Upland, and Fescue Grassland). Tall shrub habitat increased by 3% overall, however, this was the result of regrowth of woody cover in wetland-upland transition areas and in cut blocks in the Aspen Parkland.²⁴

Hogg^{25, 26} showed that most of the variability in aspen growth between 1951 and 2002 could be attributed to climate variation (occurrence of drought years) and outbreaks of the forest tent caterpillar (*Malacosoma disstria*).

Climate change is predicted to result in increasing aridity that will cause expansion of the grasslands and a reduction in extent of Aspen Parkland vegetation. If the aridity results in increased fire frequency, this will also result in reductions to aspen grove area and extent (see Climate change key finding on page 52).

Key finding 2

Theme Biomes

Grasslands

National key finding

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.

Extent

Grasslands covered most of the Prairies Ecozone⁺ under natural conditions, and have decreased greatly since European settlement.

Based on an analysis of remote sensing data from Riley *et al.*,²⁷ an estimated 70% of the natural vegetation on the Canadian Prairies was lost prior to the 1990s²⁷ (see Ecosystem conversion key finding on page 39). Much of this would have been native grasslands and most of the loss occurred prior to the 1980s.²⁷ In the mid-1990s, a study of land cover by Agriculture and Agri-food Canada²⁸ based on satellite imagery found that native grasslands comprised 23% of the landscape while Riley *et al.*²⁷ found that native grasslands covered 25% of the ecozone⁺.²⁷ While the data from both studies have sources of error, there is strong agreement between their results.

Figure 5 shows the conversion of rangeland to cultivated land for selected areas of farmland in Alberta and Saskatchewan from 1941 to 2006 (excluding protected areas). Most of the native grassland in the Prairies Ecozone⁺ is “mixed prairie” with communities a mixture of mid-sized grasses and short grasses. The second broad type of grassland is “fescue prairie” which is much more restricted in area and of relatively greater conservation concern. Conversions were highest from the 1940s to 1970s. Losses were relatively more severe for fescue prairie compared to mixed prairie, and in Saskatchewan compared to Alberta.

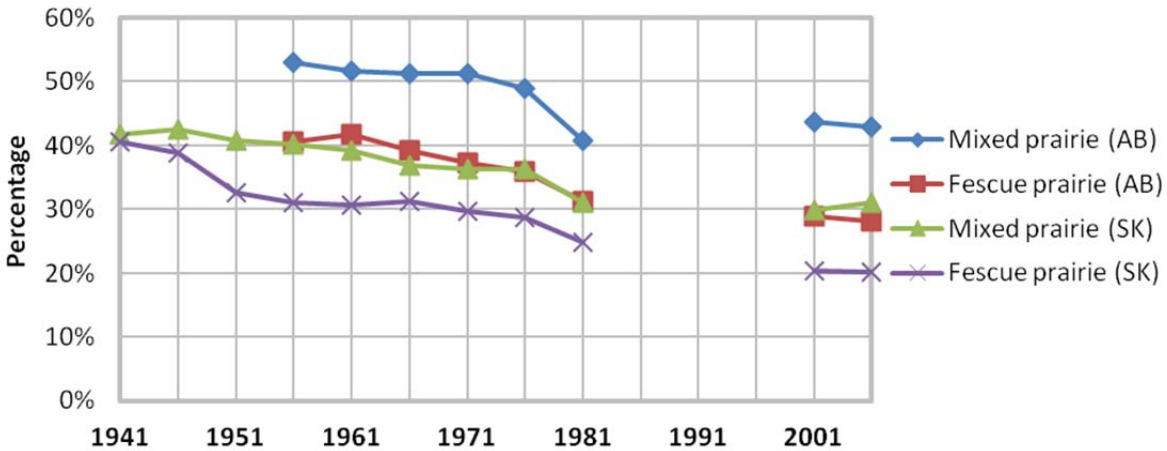


Figure 5. Trends in rangeland as a percentage of total farmland for parts of the Prairies Ecozone⁺, 1941–2006.

Source: Coupland, 1987²³ for 1941–1981 data, Statistics Canada, 2003²⁹ for 2001 data, and Statistics Canada, 2008³⁰ for 2006 data.

For the Prairies Ecozone⁺ as a whole, the loss of rangeland has levelled off in recent decades (Figure 6), with the percentage of rangeland declining from 27 to 24% from 1971 to 1986, and changing only slightly after that.

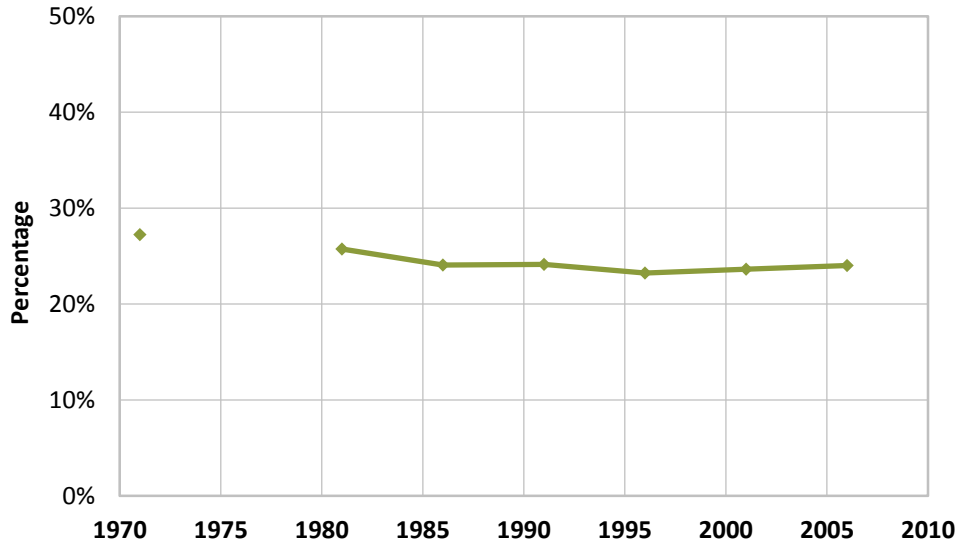


Figure 6. Trend in rangeland as a percentage of total farmland in the Prairies Ecozone⁺, 1971–2006. Source: adapted from Statistics Canada, 2008³⁰

However, in some parts of the Prairies Ecozone⁺, losses have continued. Along 153 sampling transects that were weighted to the more settled parts of the Prairies, Watmough and Schmol²⁴ found an overall 10% loss of native grasslands from 1985 to 2001. Area lost was greatest in the Aspen Parkland (15%), Fescue Grassland (13%), and Boreal Transition (13%) ecoregions (Figure 7). Most losses were remnant fragments on field margins (mean size was 2 ha; largest fragment lost was 64 ha). Forty-eight percent of the losses were to tame grass, 37% to annual crops, 10% to built cover (roads, houses, etc.), 4% to tree or shrub, and 1% to artificial water developments.²⁴

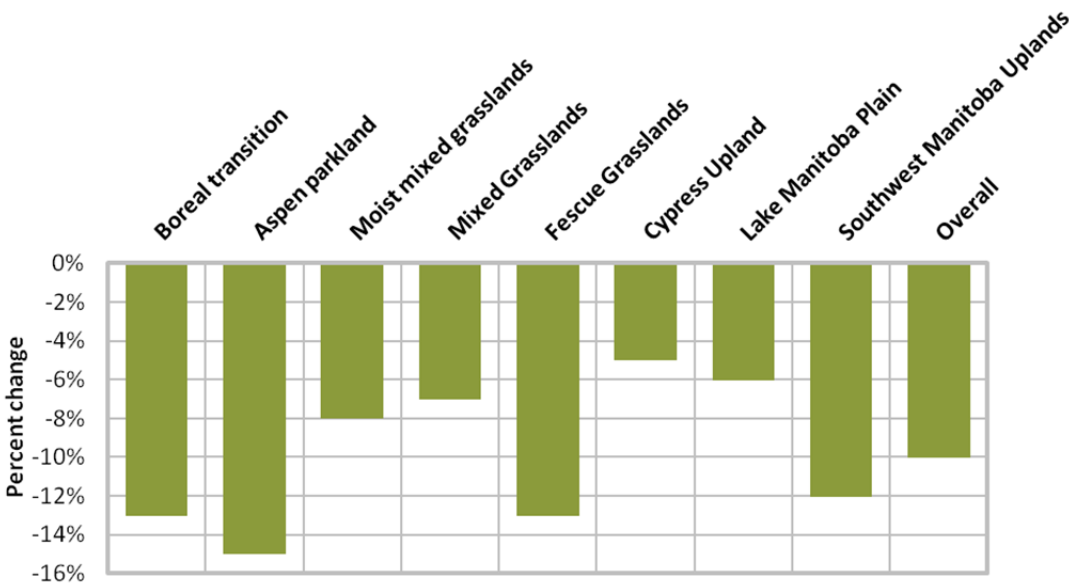


Figure 7. Percent change of native grasslands by ecoregion in the Prairies Ecozone⁺, 1985–2001. Source: Watmough and Schmol²⁴

Large areas of intact grasslands remain in some agricultural areas that are used for grazing. Agriculture and Agri-Food Canada's Prairie Farm Rehabilitation Administration, through its Community Pasture Program, has managed 9,390 km² of community pastures across the three Prairie provinces, 7,920 km² (84%) of which are in native vegetation. Originally created in the 1930s to reclaim land that was badly eroded by drought, the program has returned over 145,000 ha of poor-quality cultivated lands to grass cover.³¹ Saskatchewan also has 2,260 km² of existing provincial community pastures and Manitoba has 640 km² of pasture conservation lands.³² Alberta has provincial grazing reserves totalling 1,260 km².³³ While the primary use of these areas is to provide livestock grazing, many of them are located in the remaining areas of native vegetation and their management practices emphasize conservation. Starting in 2012, the federal Community Pasture Program is being phased out with management of pastures in the program returned to the provinces over a six-year period.³¹

Tallgrass prairie

A small but unique area of grassland is the tallgrass prairie, which occurs mostly in the United States (U.S.) but extends into Canada in the Lake Manitoba Plain Ecoregion (see Figure 3 on page 4). It is North America's most endangered grassland type. Tallgrass prairie provides habitat for a number of distinctive animals and plants including two endangered orchids—western prairie fringed orchid (*Platanthera praeclara*) and small white lady's slipper (*Cypripedium candidum*)—and a threatened butterfly—Poweshiek skipperling (*Oarisma poweshiek*).^{34, 35} Tallgrass prairie had been reduced to less than 1% of its original range in Manitoba by 1989.³⁶ Koper *et al.*³⁷ surveyed 65 remnant tallgrass prairie patches in 2007 and 2008 that had been previously surveyed in 1997 and 1998. They found that most patches, especially smaller ones, declined in quality. Furthermore, richness of native plants was negatively correlated with the cover and richness of non-native species. Also, 14% of prairie patches were so severely degraded by non-native species that they could no longer be recognized as tallgrass prairie.³⁷ Most remnant patches are unlikely to be sustained without active management.

Rangeland condition

Natural disturbance regimes that historically maintained grasslands are highly altered in the Prairies Ecozone⁺ (see Natural disturbance key finding on page 81), particularly from the suppression of fire and replacement of free-ranging bison with confined cattle. Historically, the Prairies were part of the plains bison's range,³⁸ and bison grazing was a significant driver of grassland composition and structure, maintaining short-grass prairie in areas climatically suitable for taller growth.³⁹ Bison impact was spatially and temporally patchy, with intense damage in some areas and years, and less in others, creating a mosaic of habitats.³⁹ Wild bison were extirpated by about 1870.¹⁴ Bison grazing has been replaced by domestic livestock grazing, mainly by beef cattle (*Bos taurus*). Although bison have certain advantages over cattle for open-range grazing,³⁸ Plumb and Dodd⁴⁰ argued that the biggest difference between bison and cattle impacts is that bison were free-roaming but cattle are confined in pastures and moved throughout the year to achieve a uniform level of grazing across the landscape. In confined pastures, both animals have similar impacts. Truett *et al.*³⁹ argued that the patchy impact that

occurred under historic bison grazing was better for prairie biodiversity than the uniform utilization sought by modern range managers and recommended recreating the earlier type of grazing regime for conservation purposes.

Grazing affects grassland biodiversity, but the relationship between the two is complex. Plant species diversity is usually higher in grazed grasslands compared to ungrazed grasslands, and may be highest at intermediate levels of range condition.⁴¹⁻⁴³ McCanny *et al.*⁴⁴ examined diversity of plants, songbirds, and large insects at Grasslands National Park and found that some species occur in grazed habitats and others in ungrazed ones. Similarly, in a review of Great Plains grasslands in the U.S., Bock *et al.*⁴⁵ found that nine species of birds respond positively to grazing and eight respond negatively. These results suggest that maximizing regional biodiversity requires the presence of a wide range of grazing intensities, while the least desirable situation is uniform grazing management.

Using data on species composition to indicate change, Thorpe⁴⁶ found that most Saskatchewan rangelands were similar to their potential composition or only moderately altered (Figure 8). However, 12% of plots overall were significantly or severely altered, mainly due to overgrazing and invasion by non-native plants. Rangelands were more altered in the Aspen Parkland Ecoregion than in the Mixed Grassland Ecoregion, because of higher levels of non-native invasion in the Aspen Parkland, and more conservative grazing management in the Mixed Grassland.

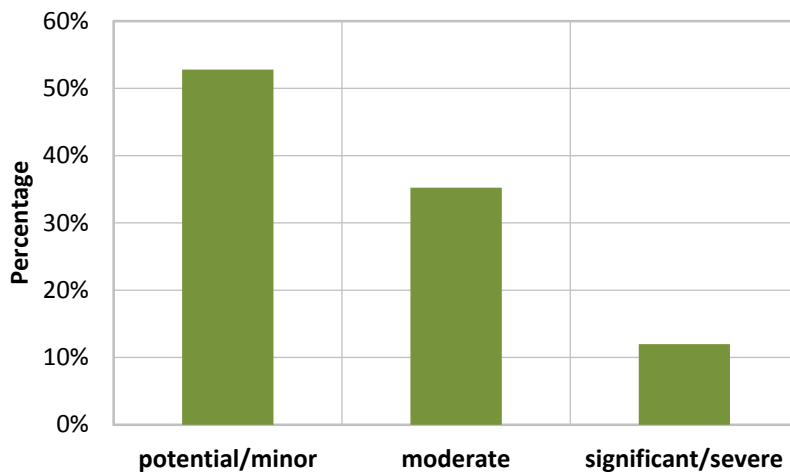


Figure 8. Degree of alteration of Saskatchewan grasslands from their potential composition as a result of grazing and non-native invasion (percentage of plots surveyed between 1980 and 2006).

Source: Thorpe, 2007⁴⁶

Health assessments for native rangelands and tame pastures in Saskatchewan⁴⁷ and Alberta³³ showed similar results. About 8% of rangelands were “unhealthy”, while another 43% were “healthy with problems”, indicating early warning signs of a negative trend (Figure 9). Native rangelands had similar results to tame pasture. The results for Saskatchewan were similar for all ecoregions, whereas the results for Alberta indicated a lower proportion of healthy scores in the

Aspen Parkland and Foothill Fescue ecoregions. Factors affecting range health include grazing intensity and invasion of non-native species.

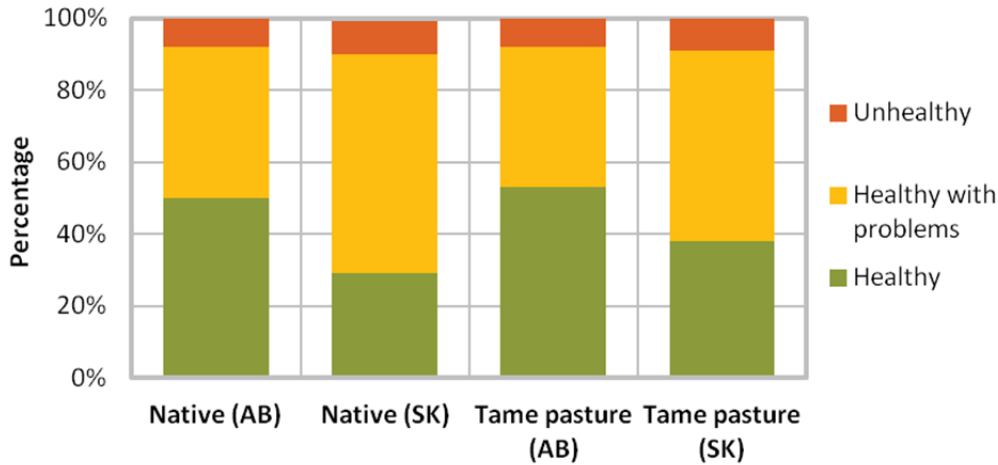


Figure 9. Percentage of native rangeland and tame pasture plots in each health category for Alberta and Saskatchewan, 2008.

Source: adapted from Alberta Sustainable Resource Development, 2008³³ (Alberta) and Saskatchewan Watershed Authority, 2008⁴⁷ (Saskatchewan)

As discussed under the Species of special economic, cultural, or ecological interest key finding on page 69, elk and moose populations are expanding as grassland areas experience woody vegetation expansion and reduction in hunter numbers.

Grassland birds

Loss of native grasslands affects grassland birds. Current landbird populations are also affected by habitat degradation caused by the intensification of grazing, expansion of woody cover due to fire suppression, continued fragmentation, and invasion of invasive non-native plants (see page 43).⁴⁸ There was an overall loss of 35% of grassland bird populations from the 1970s to 2000s.⁴⁹ (Figure 10) with several species showing declines of greater than 60%. Some species, however, also increased (Table 3). Some of the birds showing long-term declines—horned lark (*Eremophila alpestris*), McCown's longspur (*Rhynchophanes mccownii*), and upland sandpiper (*Bartramia longicauda*)—did not decline on recent (1996 to 2006) survey routes that have more than 50% grassland, but did decline on routes with less grassland. Habitat loss or fragmentation may be a major factor for these species as they are still doing well where habitat is common and in large blocks. Other species (e.g., Sprague's pipit) are showing greater declines where grassland is common, which may reflect decreased habitat quality.⁴⁹

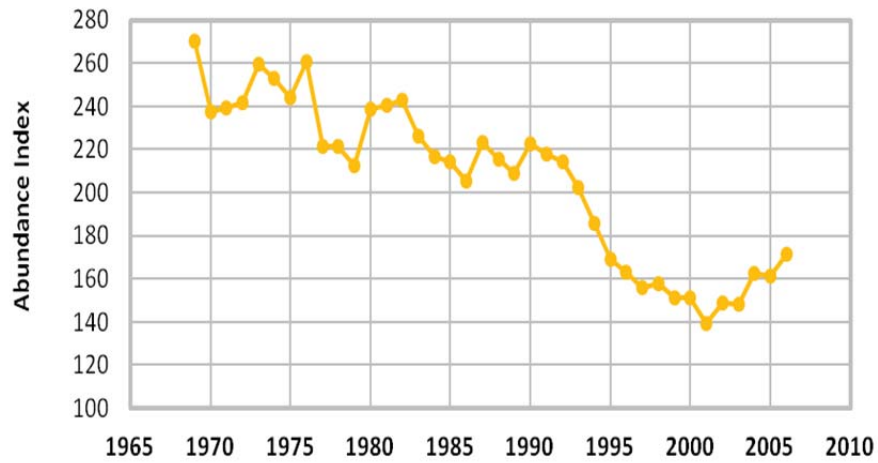


Figure 10. Annual indices of population change in grassland birds in the Prairies Ecozone⁺, 1969–2006. Source: Downes et al., 2011⁴⁹ using data from the Breeding Bird Survey⁵⁰

Table 3. Trends in abundance of grassland birds for the Prairies Ecozone⁺, 1970s to 2000s.

Grassland birds	Population		BBS abundance index				
	Trend (%/yr)	P	1970s	1980s	1990s	2000s	Change
McCown's longspur (<i>Rhynchophanes mccownii</i>)	-11.0%	*	6.10	2.05	0.77	0.24	-96%
Chestnut-collared longspur (<i>Calcarius ornatus</i>)	-5.4%	*	18.87	14.80	7.97	2.58	-86%
Short-eared owl (<i>Asio flammeus</i>)	-5.0%	n	0.47	0.21	0.09	0.10	-78%
Sharp-tailed grouse (<i>Tympanuchus phasianellus</i>)	-4.0%	*	1.49	1.73	0.47	0.53	-64%
Sprague's pipit (<i>Anthus spragueii</i>)	-3.8%	*	6.68	5.35	2.09	2.04	-69%
Horned lark (<i>Eremophila alpestris</i>)	-3.3%	*	81.15	77.03	48.81	31.38	-61%
Northern harrier (<i>Circus cyaneus</i>)	-3.0%	*	2.07	1.70	1.14	0.92	-55%
Western meadowlark (<i>Sturnella neglecta</i>)	-1.3%	*	60.21	49.25	43.23	43.67	-27%
Baird's sparrow (<i>Ammodramus bairdii</i>)	-1.1%		3.53	2.88	3.10	1.39	-61%
Vesper sparrow (<i>Pooecetes gramineus</i>)	0.8%		22.00	26.88	27.03	28.41	29%
Savannah sparrow (<i>Passerculus sandwichensis</i>)	1.0%	*	27.77	29.32	35.10	33.92	22%
Le Conte's sparrow (<i>Ammodramus leconteii</i>)	1.6%		1.14	1.22	2.01	1.26	11%
Sedge wren (<i>Cistothorus platensis</i>)	5.7%	*	0.31	0.23	0.70	0.94	199%

P is the Statistical significance: * indicates $P < 0.05$; n indicates $0.05 < P < 0.1$; no value indicates not significant
 Species are listed in order from those showing most severe declines to those showing the most positive increases
 "Change" is the percent change in the average index of abundance between the first decade for which there are results (1970s) and the 2000s (2000-2006)

Source: Downes et al., 2011⁴⁹ using data from the Breeding Bird Survey⁵⁰

The relative stability of the grassland guild as a whole in the past decade (Figure 10) reflects the strong influence of some common (vesper sparrow, savannah sparrow) or wet meadow-associated (LeConte's sparrow, sedge wren) grassland birds. These species are more widely distributed and may be tolerant of, or even helped by, tall non-native plant species associated with linear development and farm programs that plant tall non-native grasses on crop fields.⁵¹⁻⁵³ Declining species (e.g., Sprague's pipit, McCown's longspur, chestnut-collared longspur, Baird's sparrow) are those needing moderate or short, preferably native, cover and make little or no use of planted cover.⁵¹ Although some grassland birds will use hay-fields, 50–60% of ground nests, eggs, young, and fledglings are typically lost during a haying operation.^{54,55} One large study found 100% nest failure from haying operations as the remaining nests were abandoned.⁵⁶

Wetlands

National key finding

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.

Although wetlands only cover 3% of the Prairies Ecozone⁺, they contribute disproportionately to prairie biodiversity. The majority of wetlands in this ecozone⁺ are known as “potholes”, small, shallow seasonal wetlands that form every spring. Numbering in the millions, these wetlands are a result of the unique glacial history of the region combined with its cold semi-arid climate. Thus, conditions in these wetlands each year are determined by year-to-year variation in precipitation and snowmelt. Prairie potholes have the greatest capacity of all the wetland types to return water back to the soil and atmosphere, significantly reducing the impacts of floods.⁵⁷

The potholes and their surrounding uplands in both the U.S. and Canada form what is known as the Prairie Pothole Region, an area that is the most productive waterfowl breeding habitat in the world. The region supports 50% of annual continental duck production,^{58, 59} and between 50 to 88% of the North American breeding populations of several species.⁶⁰⁻⁶² Availability and condition of wetlands are primary factors determining the number and diversity of these waterfowl. Although these factors are influenced greatly by climate variation,⁶² land use change is also important.

Extensive areas and numbers of wetlands in the Prairies Ecozone⁺ have been drained although there are no comprehensive data on historic loss. There are many small studies that have examined loss but they are very localized, most are over 30 years old, and they vary in scale.^{24, 63-}
⁶⁵ As an example of a newer study, Ducks Unlimited Canada analyzed the watershed of Broughton’s Creek, a tributary of the Assiniboine River located northwest of Brandon, MB. From 1968 to 2005, 5,921 wetland basins or 70% of the total number in the watershed, were degraded or totally lost due to drainage (Figure 11). This resulted in the loss of 21% of the watershed’s wetland area and the loss of the various ecological functions played by those wetlands.⁶⁶

Portion of Broughton's Creek watershed

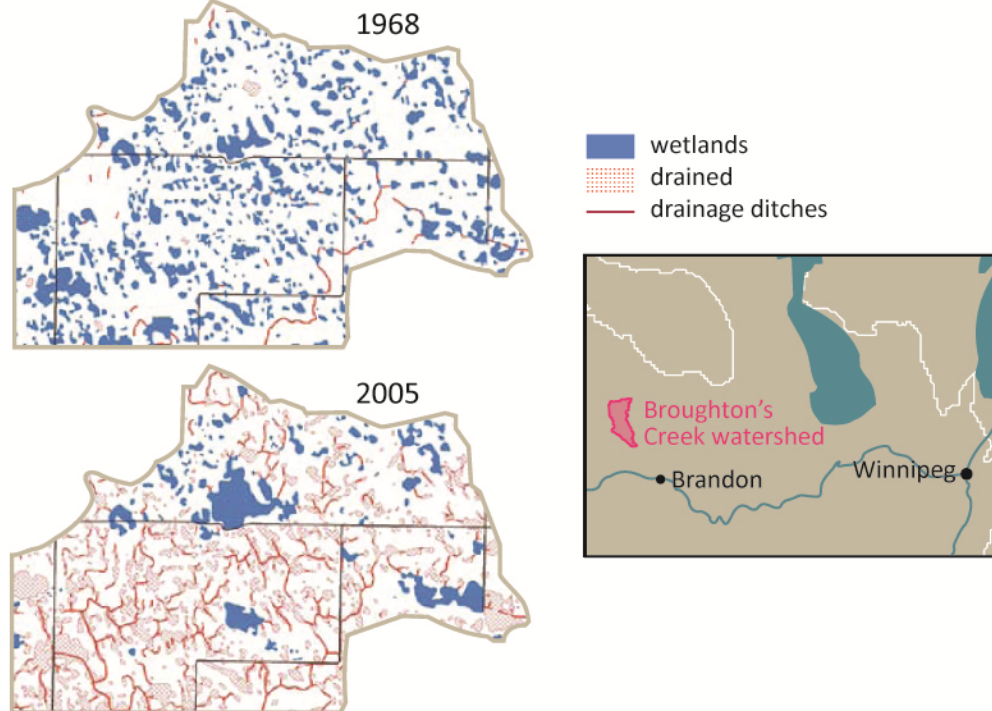


Figure 11. Changes in the extent of wetlands in a portion of Manitoba's Broughton's Creek watershed, 1968–2005.

Source: Ducks Unlimited, 2008⁶⁶

A review of these localized studies shows the high variability of wetland loss across the landscape and across time. Estimates for overall wetland loss since European settlement range from 40 to 71%.^{24, 67, 68} However, percent loss varies considerably between locations.^{24, 64} Some of the greatest losses were near major urban areas, with 76 to 96% lost by 1966 and a further 17% lost between 1966 and 1981.⁶⁹

Watmough and Schmall²⁴ provided the best estimate of the recent rate of wetland loss on a larger scale. Between 1985 and 2001, 6% of wetland basins were lost, representing 5% of the total estimated wetland area. Although all ecoregions showed declining trends, losses were not uniform (Figure 12). The Aspen Parkland Ecoregion accounted for 45% of wetland area lost and half the total number of basins lost. The Mixed Grassland Ecoregion had the highest relative area lost, however, at 7%. The average size of lost wetland basins was 0.2 ha, with 77% being less than 0.26 ha in size. Fifty percent of the total area of wetland lost was in the grass/sedge cover type, and 40% was within the cultivated landscape. Sixty-two percent of the area drained was used for cultivation, 21% for perennial grass, 6% for development, and 8% was in transition.²⁴

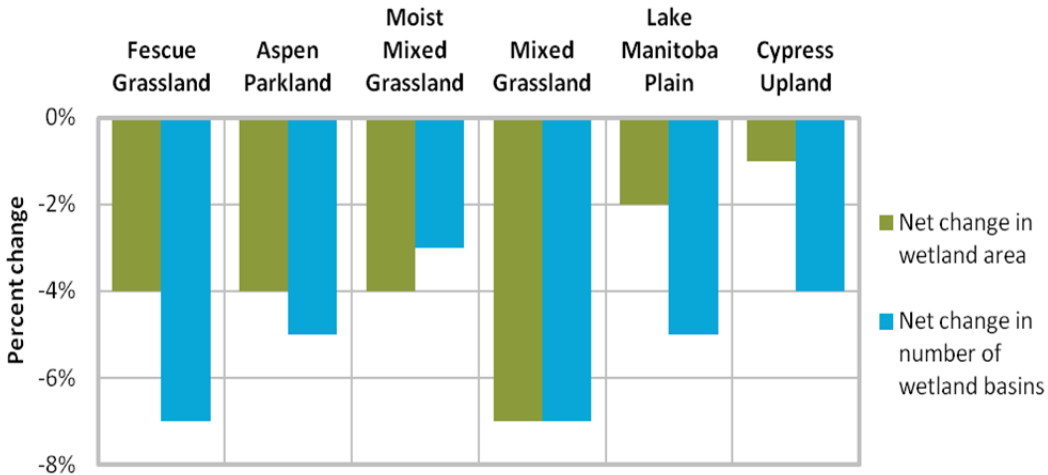


Figure 12. Percent change in wetland area and number of wetland basins for selected ecoregions in the Prairies Ecozone⁺, 1985–2001.

Source: adapted from Watmough and Schmoll, 2007²⁴

When examined on a municipality-by-municipality basis, the highest rates of wetland loss between 1985 and 2011 were in parts of southeastern Saskatchewan (Figure 13). Areas of highest loss were generally correlated with areas of high wetland density.⁷⁰

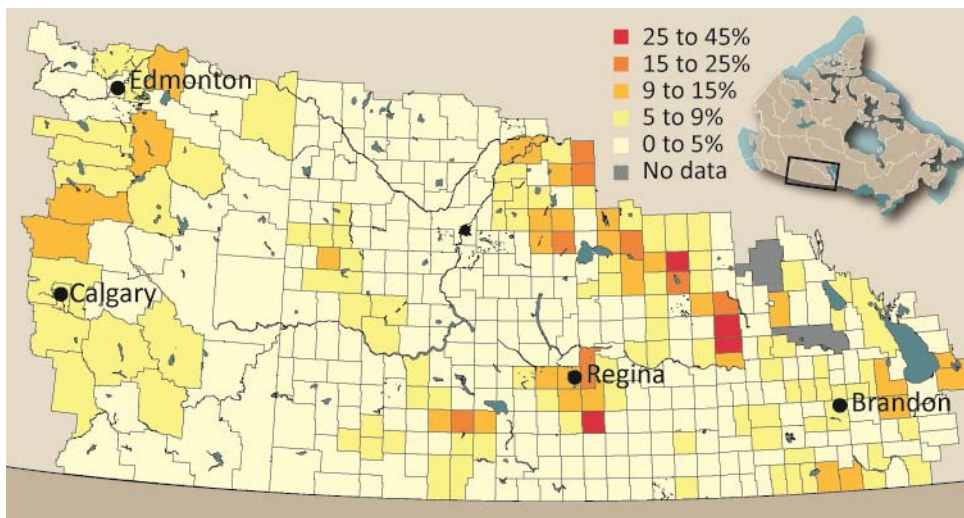


Figure 13. Estimated rates of wetland loss by municipality, 1985–2001.

Source: adapted from Prairie Habitat Joint Venture, 2008⁷⁰ and Watmough and Schmoll, 2007²⁴

Watmough and Schmoll's²⁴ study also recorded changes to wetlands that did not result in total loss, but that may have caused a loss of wetland function, such as partial drainage or limited filling. The percent of the wetland area affected by these factors was similar in 1985 (6%) and 2001 (7%), although results show a decline in wetlands affected in the Fescue Grassland Ecoregion and an increase in the Lake Manitoba Plain Ecoregion (Figure 14). The analysis also found that the edges of wetlands were impacted more than wetland basins. Although the rate of

impact for edges declined over the period, the rate of recovery was slower, indicating an increasing overall impact. The percent of edges impacted ranged between 82 and 97% in 1985, depending upon location, and stabilized in the early 1990s at between 90 and 95%.⁷¹

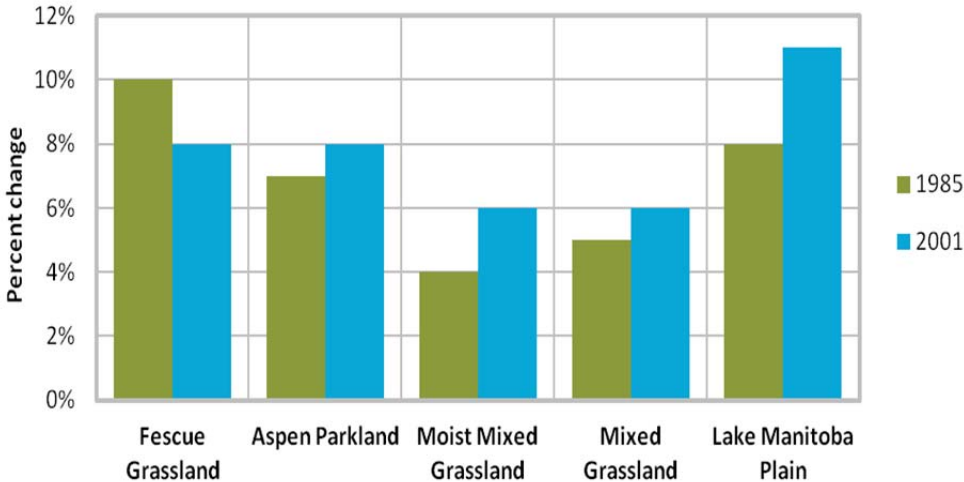


Figure 14. Percent of wetland area affected by partial drainage and limited filling for selected ecoregions in the Prairies Ecozone⁺, 1985 and 2001.

Source: adapted from Watmough and Schmoll, 2007²⁴

Through an analysis of other studies, Watmough and Schmoll²⁴ found that their results were consistent with estimates of the rate of loss from other localized studies from previous time periods. They concluded that wetland loss is variable across the landscape but that there has been a continuous slow decline overall with large losses in localized areas.

Trends in wetland distribution and abundance directly affect continental waterfowl populations and research indicates that, overall, smaller wetlands support a greater number of waterfowl than larger ones on a per area basis.⁵⁷ For example, data on waterfowl use of wetlands indicate that ten 1-ha wetlands will support approximately three times as many waterfowl as one 10-ha wetland.⁵⁷ A study of a representative sample of prairie wetlands found 91% were 1 ha or smaller²⁴ and these small wetlands also suffer the greatest losses. From 1985 to 2001, the average size of wetland basins lost was 0.2 ha, with 77% smaller than 2.6 ha.²⁴ Research also found that, between 1985 and 2005, shallow ephemeral wetlands located in agricultural fields had the highest rate of impact and slowest recovery rates relative to other wetland types.⁷¹ Wetland habitat, together with changes in the agricultural landscape, drive waterfowl populations. These trends are discussed in the Birds section of the Species of special economic, cultural, or ecological interest key finding on page 74.

As an example of the impacts of wetland loss on waterfowl populations and indirect impacts from upland habitat changes, a recent analysis estimated the deficit in waterfowl productivity for 1971 to 2006 relative to the 1970s. Results showed that while wetland loss resulted in an estimated decrease in waterfowl carrying capacity of just under 100,000 pairs from 2001 to 2006,

upland changes substantially reduced the hatched nest “deficit” from ~150,000 to ~113,000 hatched nests (Figure 15).

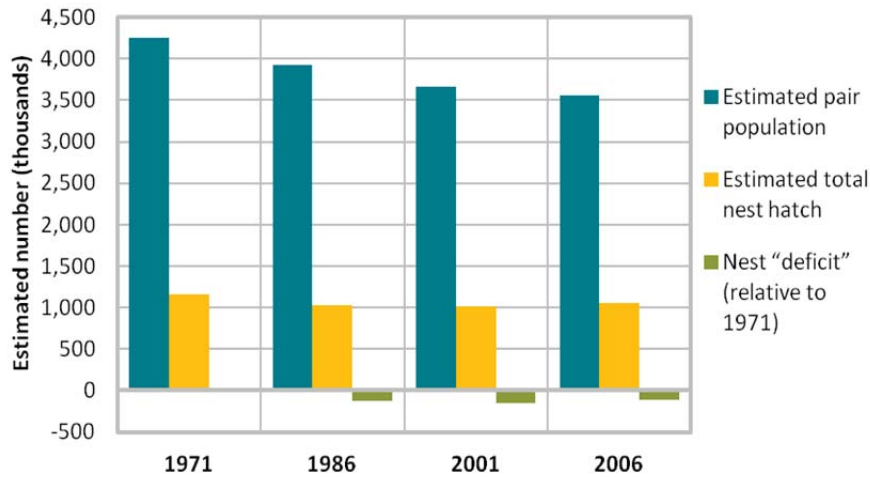


Figure 15. Estimated “deficit” in waterfowl productivity due to wetland and upland change as modelled by estimated carrying capacity (estimated pair population for five species) and estimated nests hatched, 1971–2006.

Note: Decline in pair population over time is based on model relating habitat changes to carrying capacity for waterfowl.

Source: updated from Devries, 2004⁷² with Ducks Unlimited Canada, unpublished data⁷³

Key finding 4

Theme Biomes

Lakes and rivers

National key finding

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.

Water availability is an important driver and issue in the Prairies Ecozone⁺ and the anticipated changes in moisture regimes as a result of climate change will exacerbate the challenges.

Streamflow

It is not possible to determine trends in streamflow for the Prairies Ecozone⁺ from the national hydrometric data because there are too few stations that are suitable. This is largely because many of the stations are only monitored seasonally.^{74,75} As discussed below, there are also a large number of Prairie streams that are dammed and channelized, altering their normal flow pattern making them unsuitable for the trend analysis on natural streamflow.

There are data from other analyses focused on the Prairie provinces. Gan⁷⁶ analyzed streamflow trends on streams in the Prairies that were unaffected by dams from the late 1940s or early 1950s to 1993 and found that significant decreases were much more common than increases (overall, 61 significant negative trends vs. 16 positive trends). Fifty-six percent of the positive trends were in March and were related to the earlier onset of spring melt. All other months showed greater declining trends, particularly May and June flow. Burn *et al.*⁷⁷ looked at 25 streams across the Prairies and also found decreasing trends in the spring snowmelt runoff volume and peak flow from 1966 to 2005. They found an earlier spring snowmelt peak and decreasing trends in seasonal (March–October) runoff volume.

Schindler and Donahue⁷⁸ also found a decline in average flow of Prairie rivers over the past 50 to 100 years, including (Figure 16):

- a 20% reduction from 1958 to 2003 for the Athabasca River at Fort McMurray, Alberta;
- a 42% reduction from 1915 to 2003 for the Peace River near Peace River, Alberta;
- a 57% reduction from 1912 to 2003 for the Oldman River at Lethbridge, Alberta; and
- an 84% reduction from 1912 to 2003 for the South Saskatchewan River at Saskatoon, Saskatchewan.

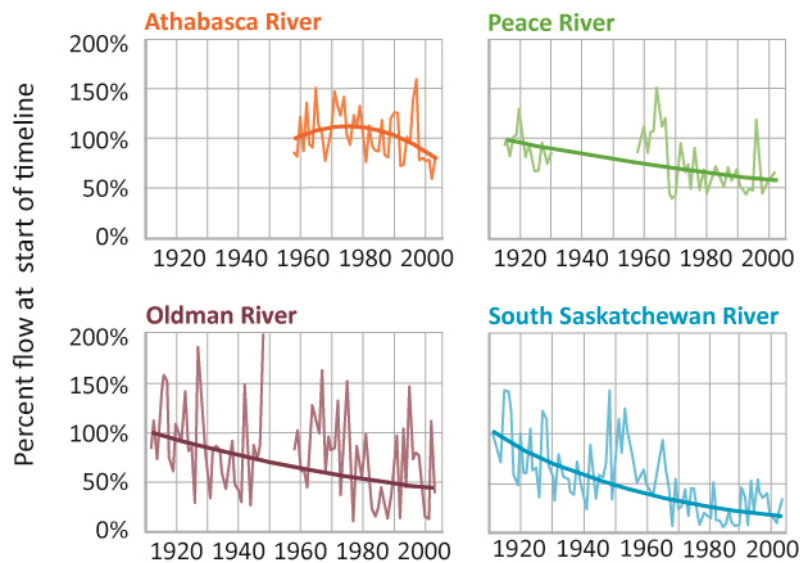


Figure 16. Trends in summer flows of four rivers in the Prairies Ecozone⁺, 1910–2006. Source: adapted from Schindler and Donahue, 2006⁷⁸

Lake levels

In the Prairies, the combination of glaciation and the dry climate has resulted in numerous closed-basin lakes (that is, lakes with no outlet). They are very sensitive to climate, with water levels and salinity driven by precipitation on the lake, local runoff to the lake, and evaporation off the lake. Changes in land use, such as water control structures that change the amount of water being delivered to the lake, also have significant effects on lake levels. Aquatic communities within these closed-basin lakes are sensitive to chemical changes that result from

changes in water levels. For example, water levels affect salinity and the diversity of aquatic species declines as salinity increases. When salinities reach very high values, species diversity becomes very low.⁷⁹

To provide a regional overview of lake level changes, van der Kamp *et al.*⁸⁰ analyzed long-term water level changes in 16 closed-basin lakes with little or no groundwater interactions and no strong influence by large water control structures. Their results show an overall decrease in most lake levels of approximately 4–10 m from ca. 1920 to 2006, with more rapid declines since the late 1970s (Figure 17). There was, however, a rise in the level of four lakes in the east-central area since the 1960s (three other lakes in this area had declining levels). These increases have been linked to either higher precipitation or lower evaporation, in addition to sensitivity to agricultural drainage and changing land use due to low-lying relief. No lakes were included in the study from the south-central part of the ecozone⁺ because all lakes with long-term data records were highly affected by water control structures and diversions. Oro Lake was included as an attempt to fill the gap and results show that water levels in this region may not have declined.

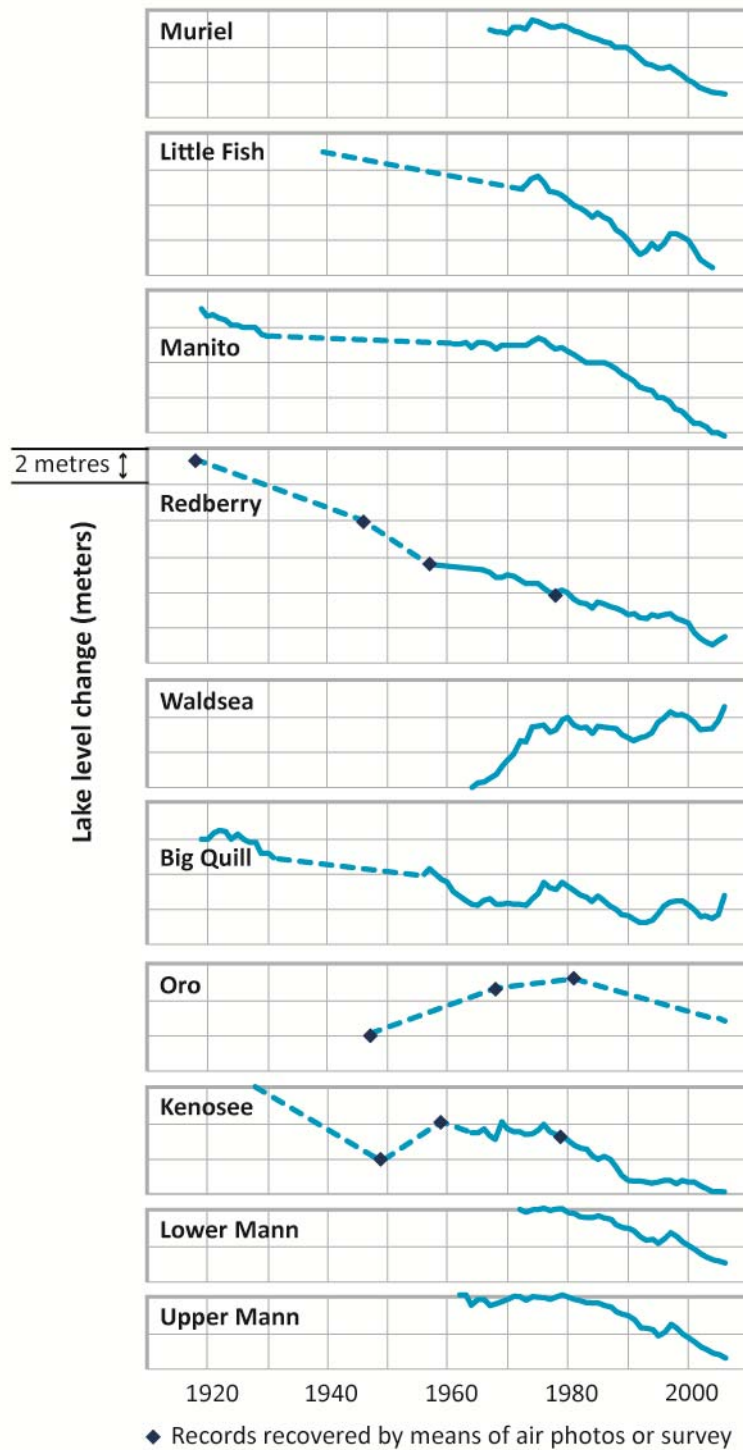


Figure 17. Water level changes in selected closed-basin lakes in the Prairies Ecozone⁺, 1910–2006.
Source: van der Kamp et al., 2008⁸⁰

The declines observed can be explained, at least in part, by climate. The early part of the 20th century was wet, contributing to the high lake levels.⁸⁰ Significant increases in spring temperatures from 1950 to 2007⁸¹ could have led to increased evaporation rates and declining

stream runoff⁸² could also have contributed. Nevertheless, the declines in lake levels were not completely consistent with climate. For example, with the exception of declines at two stations in south-central Saskatchewan, there was no significant change in precipitation from 1950 to 2007.⁸¹ Also, Zhang *et al.*⁸¹ found no significant change in Palmer Drought Severity Index from 1950 to 2007 to explain the recent declines, and Bonsal and Regier⁸³ found that most droughts over the past century were between 1915 and 1930, a time when lake levels were higher.

Other contributing factors that reduce surface runoff to the lakes include land use changes such as dams, ditches, wetland drainage and dugouts,⁸⁰ as well as changes in agricultural use and practices, such as the decline in summer fallow,⁸⁴ increased conservation tillage (see Agricultural landscapes as habitat key finding on page 63),⁸⁵ and increased continuous cropping.⁸⁰

Alteration of hydrology through water control structures

Water control structures are one of the greatest threats to freshwater ecosystems. In addition to being barriers to movement of fish and wildlife, they alter natural hydrological regimes, changing water depths and flows, and resulting in changes to the availability and distribution of habitat for in-stream communities.^{86,87} Disruption of the natural regime can occur as a result of both lateral barriers (such as dams, weirs, roads) or riparian barriers (such as gaps in riparian buffers).^{88,89}

Most major prairie streams are dammed. As of 2008, there were 83 large dams (greater than 10 m in height) in the ecozone⁺⁹⁰ – at least 73% of them with reservoirs less than 1,000,000 m³.⁹¹ Only two dams (those forming Lake Diefenbaker on the South Saskatchewan River) have reservoirs greater than 10,000,000 m³. The number of large dams is highest in the Mixed Grassland (34), Moist Mixed Grassland (22), and Aspen Parkland (18) ecoregions, with only one in the Cypress Uplands.^{90,91} In the Prairies Ecozone⁺, where agricultural production is limited by low rainfall, irrigation was the most common reason that dams were constructed. The majority of these large dams were built in the 1950s and 1960s (Figure 18).

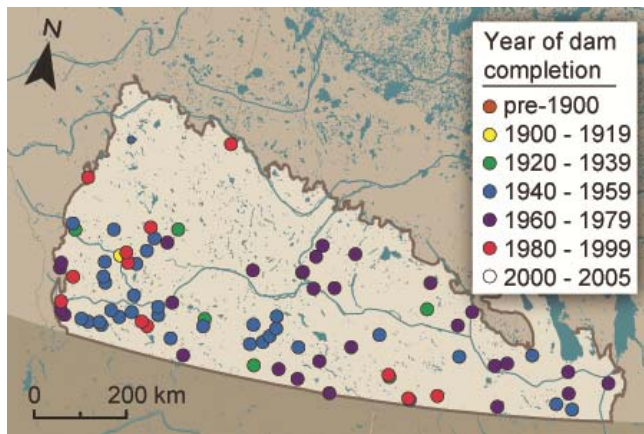


Figure 18. Distribution of dams greater than 10 m in height within the Prairies Ecozone⁺, grouped by year of completion, pre-1900 to 2005.

Source: adapted from Canadian Dam Association, 2003⁹⁰

While these large dams are the most visible, there are also a large number of smaller dams and water control structures. For example, the Prairie Farm Rehabilitation Administration constructed approximately 12,000 dams in the Prairie provinces although few new ones are being built due to the lack of suitable sites and because of environmental concerns.⁹²

Damming to create a reservoir also impacts terrestrial habitats in the flood zone. This impact is particularly important because it is concentrated on riparian zones, which contribute disproportionately to biodiversity. For example, the creation of Lake Diefenbaker flooded a significant area of riparian cottonwood (*Populus deltoides*) forest, an ecosystem that is relatively restricted in range in the Prairies Ecozone⁺. Damming can also have downstream effects on riparian ecosystems by eliminating flooding events that are important to these ecosystems. For example, it is thought that riparian cottonwoods are failing to regenerate on some dammed Prairie rivers because they require flood-deposited silt.⁹³

Another important cause of hydrological alteration and corresponding impacts on biodiversity is channelization, which is very common on the Prairies. However, data on the number of streams and the kilometres of channelization are not available.

Key finding 7

Theme Biomes

Ice across biomes

National key finding

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.

There is very little long term trend data on freeze-up and break-up of lake and river ice in the Prairies Ecozone⁺. What data there is shows mixed trends for freeze-up.⁷⁵ Some significant changes to earlier break-up were found—Duguay *et al.*⁹⁴ found that ice on Lake Diefenbaker broke up ten days earlier between 1971 and 2000, and Rannie⁹⁵ found that, from 1815 to 1981, ice on the Red River at Winnipeg broke-up 12 days earlier. Rannie⁹⁵ also found that the Red River froze ten days later.

Dunes

Dunes are a unique biome with a very limited distribution in Canada. As a result, information on dunes was not identified as a nationally recurring key finding nor was it included in one of the other key findings in the national report.³ However, because of their significance to biodiversity in the Prairies Ecozone⁺, information on dunes is included as a separate ecozone⁺-specific key finding in this report.

Sand dunes are important habitats in the Prairies Ecozone⁺, and in recent decades many of the active dunes have shifted to stabilized dunes as a result of vegetation growth. In southeastern Alberta's Middle Sand Hills, the total area of active sand dunes declined at a rate of 40% per decade and the number of active dunes declined by seven per decade since 1950; all dunes could become stabilized by 2014.⁹⁶ In southwestern Saskatchewan's Seward Sand Hills, a 70% decline in active dune area between 1944 and 1991 was documented;⁹⁷ however, while active sand area declined from 1944 to 1979 in part of Saskatchewan's Great Sand Hills, it increased from 1988 to 1991 to the extent that in 1991, the active area was equivalent to that of 1944.⁹⁷ The authors attributed this increase to the drier and hotter conditions of the mid- to late 1980s. In general, climate drives dune activity, which increases in dry periods (low ratio of precipitation to potential evapotranspiration) and decreases in moist periods.⁹⁸ Fire suppression may also contribute to sand-dune stabilization⁹⁹ (see Natural disturbance key finding on page 81).

The decline in active sand dunes poses a threat to the nationally Endangered Ord's kangaroo rat (*Dipodomys ordii*)⁹⁶, in addition to several other species that depend on dune activity, including western spiderwort (*Tradescantia occidentalis*) (Threatened),¹⁰⁰ small-flowered sand-verbena (*Tripterocalyx micranthus*) (Endangered),¹⁰¹ dusky dune moth (*Copablepharon longipenne*) (Endangered),¹⁰² and pale yellow dune moth (*Copablepharon grandis*) (Special Concern).¹⁰³

THEME: HUMAN/ECOSYSTEM INTERACTIONS

Protected areas

National key finding

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.

The amount of natural vegetation protected in parks and other designated conservation areas is relatively small, accounting for only about 4.5% of the Prairies Ecozone⁺ in 2009 (Figure 19). This included two national parks (Elk Island and Grasslands) totaling 1,100 km², and numerous provincial parks totaling 1,600 km². Prior to 1992 (the signing of the Convention on Biological

Diversity), between 0.4 and 3.8% of the ecozone⁺ was protectedⁱⁱ. By May 2009, the percentage of the ecozone⁺ protected had increased to 4.5% and included (Figure 20):

- 5,544 km² in 194 protected areas (1.2% of the ecozone⁺) classified as IUCN categories I-IV, categories that include nature reserves, wilderness areas, and other parks and reserves managed for conservation of ecosystems and natural and cultural features, as well as those managed mainly for habitat and wildlife conservation;¹⁰⁴ and
- 15,290 km² in 94 protected areas (3.3% of the ecozone⁺) classified as IUCN categories V-VI, categories that focus on sustainable use by established cultural tradition.¹⁰⁴

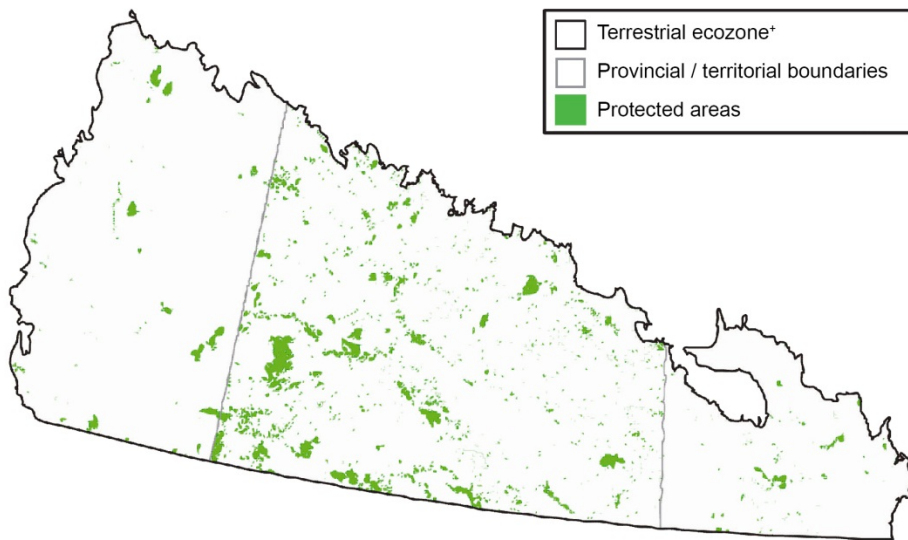


Figure 19. Distribution of protected areas in the Prairies Ecozone⁺, May 2009.

Source: Environment Canada, 2009¹⁰⁵ using data from the Conservation Areas Reporting and Tracking System (CARTS), v.2009.05, 2009;¹⁰⁶ data provided by federal, provincial, and territorial jurisdictions.

ⁱⁱ Note that there is 16,140 km² of protected land in the Prairies Ecozone⁺ with no information on the year established. If all of this land was protected prior to 1992, then 3.8% was protected prior to 1992.

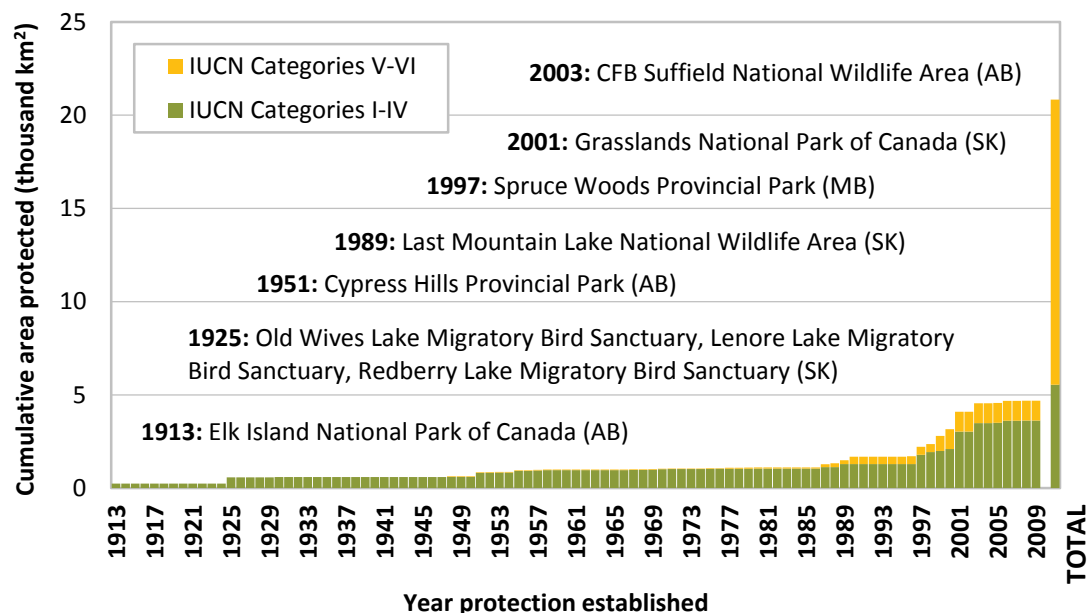


Figure 20. Growth of protected areas in the Prairies Ecozone⁺, 1913–2009. Data provided by federal and provincial jurisdictions, updated to May 2009. Only legally protected areas are included. IUCN (International Union for Conservation of Nature) categories of protected areas are based on primary management objectives (see text for more information). The last bar marked 'TOTAL' includes protected areas for which the year established was not provided. Source: Environment Canada, 2009¹⁰⁵ using data from the Conservation Areas Reporting and Tracking System (CARTS), v.2009.05, 2009¹⁰⁶; data provided by federal, provincial, and territorial jurisdictions.

Key finding 9

Theme Human/ecosystem interactions

Stewardship

National key finding

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.

While protected areas are often the most visible form of ecosystem conservation, they represent only a small fraction of the land base. Much of the habitat important to biodiversity in the Prairies Ecozone⁺ is found on land where the predominant use is agriculture, and much of it is privately held. Thus, stewardship is increasingly seen as an important complement to environmental regulation and policy, particularly to encourage conservation on privately managed land. Examples of stewardship initiatives in the Prairies include: managed crown grazing lands, major conservation initiatives such as the North American Waterfowl Management Plan and the Prairie Conservation Action Plan, integrated resource management plans, species at risk landowner contact programs, and several programs aimed at landowner stewardship.

The National Environmental Farm Plan Initiative, launched in 2003, included a set of nationally consistent principles and program elements for developing environmental farm plans (EFP). An EFP is a voluntarily prepared, formal written assessment of environmental issues or risks on a farm such as soil erosion, potential sources of water contamination, or pesticide drift. An EFP contains an action plan detailing the beneficial management practices (BMP) that should be put in place to mitigate or eliminate those risks. These potential on-farm agri-environmental risks and practices are identified by the farmer in consultation with agrologists, EFP facilitators/coordinators, and supporting materials (e.g., EFP workbooks and reference manuals). In 2011, 23% of farms in Alberta, 26% of farms in Saskatchewan, and 28% of farms in Manitoba had a formal Environmental Farm Plan. Of the farms with an EFP, more than 90% had either fully or partially implemented the practices recommended in their EFP.¹⁰⁷

The federal Habitat Stewardship Program (HSP) for Species at Risk fosters partnerships and provides funding for implementing activities that protect or conserve habitats for species at risk on private lands, provincial Crown lands, Aboriginal lands, or in aquatic and marine areas across Canada. For example, in the Prairies Ecozone⁺, HSP has supported actions to conserve species at risk in the tallgrass prairie and aspen parkland region of Manitoba, and habitat protection efforts benefiting plant and bird species at risk, such as the small white lady's-slipper (*Cypripedium candidum*) and Sprague's Pipit (*Anthus spragueii*). It has also funded educational activities of the Prairie Conservation Action Plan in Saskatchewan.

Over the last couple of decades, private conservation organizations have been increasingly involved in stewardship of private properties. One approach is through voluntary conservation easements registered on the land title that impose restrictions on current and future land uses. Of the approximately 1,200 km² of land under 1,400 conservation easements registered across Canada in 2007, approximately 90% of the land (and 70% of the number of easements) was in the Prairies Ecozone⁺. More than 90% of conservation easements in the ecozone⁺ are on agricultural land where some agricultural uses, such as grazing, continue under the easement. The number of conservation easements registered annually has increased steadily from 1996 to 2006 (Figure 21). Although the purchasing of easements has accelerated their registration within the Prairies Ecozone⁺, approximately 30% have been donated by the landowner.¹⁰⁸

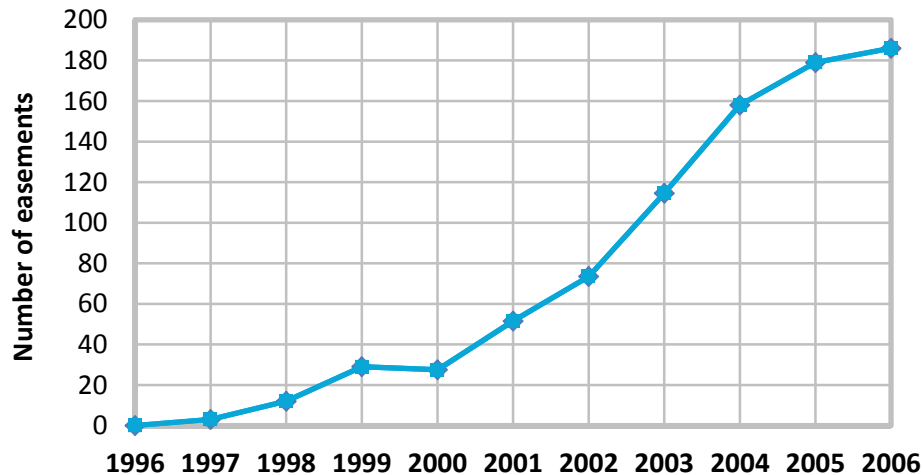


Figure 21. Number of conservation easements registered each year in the three Prairie provinces, 1996–2006.

Note: The total includes data for whole provinces, including areas outside of the Prairies Ecozone[†].

Source: Good and Michalsky, 2008¹⁰⁸

North American Waterfowl Management Plan

The North American Waterfowl Management Plan (the Plan) was established in 1986 in response to plummeting waterfowl numbers exacerbated by wetland drainage and drought. An initiative of Canada and the U.S., and joined in 1994 by Mexico, the Plan recognized that waterfowl populations could not be restored without continental cooperation across a broad landscape. Its goal is to restore waterfowl populations to average 1970s levels by conserving habitat through regional public-private partnerships called ‘Joint Ventures’ that are guided by the best available science and a continental landscape vision.¹⁰⁹ It includes a broad range of approaches with one focus on agriculture and forestry stewardship. For example, the Prairie Habitat Joint Venture works with farmers to encourage waterfowl-friendly cropping practices such as the planting of fall seeded cereals like winter wheat. Winter wheat reduces disturbance and provides cover for early-nesting species like northern pintail. The area seeded to winter wheat increased over 600% from 1992 to 2007 (Figure 22). Declines in the last two years are a result of a late fall harvest related to weather.

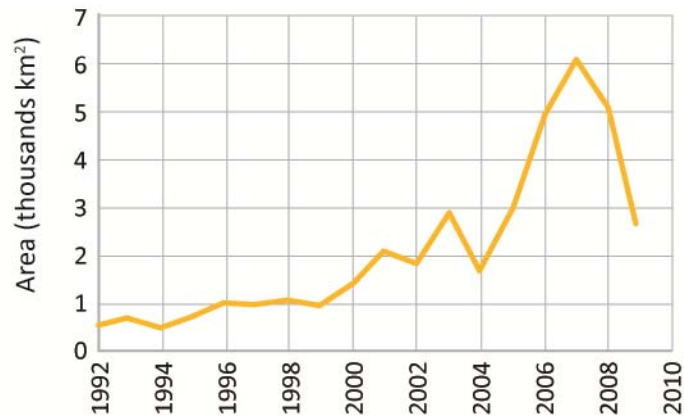


Figure 22. Area seeded to winter wheat in the Prairies Ecozone⁺, 1992–2009.
Source: Statistics Canada, 2010¹¹⁰

Theme Human/ecosystem interactions

Ecosystem conversion

Ecosystem conversion was initially identified as a nationally recurring key finding and information was subsequently compiled and assessed for the Prairies Ecozone⁺. In the final version of the national report,³ information related to ecosystem conversion was incorporated into other key findings. This information is maintained as a separate key finding for the Prairies Ecozone⁺.

Based on analysis of data from Riley *et al.*,²⁷ approximately 70% of the natural vegetation in the ecozone⁺ (excluding the Lake Manitoba Plain Ecoregion) had been converted to other uses, mainly agriculture, by the mid-1990s. Most land conversion is believed to have occurred between European settlement (mostly prior to 1885) and the 1980s.

Using air photos, digitized data, ground-truthing, and Census of Agriculture data, Watmough and Schmoll²⁴ analyzed changes in land cover from 1985 to 2001 along 153 transects, mainly in the more settled parts of Prairies Ecozone⁺. They found that all native habitats declined—wetlands (see page 24), grasslands (see page 16), and trees (see page 15)—except tall shrub (see page 15) (Figure 23). Much of this loss is small remnants that are not likely detected on broad scale analysis like remote sensing.

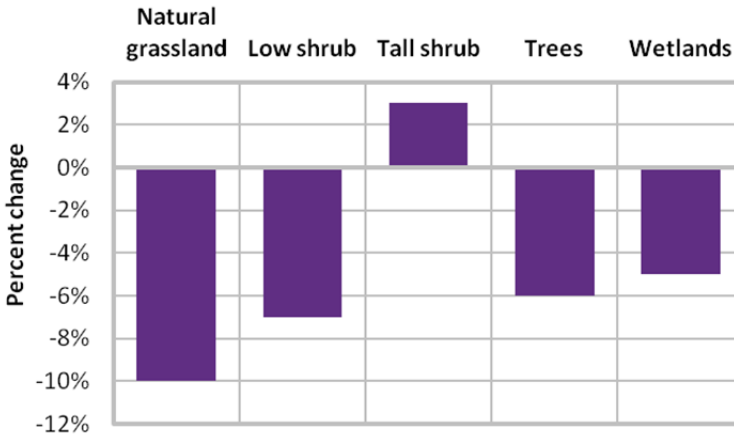


Figure 23. Percent change in land cover types in the Prairies Ecozone⁺, 1985–2001.
 Source: adapted from Watmough and Schmoll, 2007²⁴ Based on the same data from Riley et al,²⁷

Approximately 30% remaining natural habitat in the ecozone⁺ consisted of 25% grassland, 3% woodland, and 2% wetland, which varied among ecoregions (Figure 24). The percentage of natural vegetation remaining varies from 76% in the Cypress Upland Ecoregion to 22% in the Moist Mixed Grassland Ecoregion and 21% in the Aspen Parkland Ecoregion. The higher moisture balance in the latter two ecoregions makes cultivation viable over a greater proportion of the landscape, resulting in a high conversion rate.

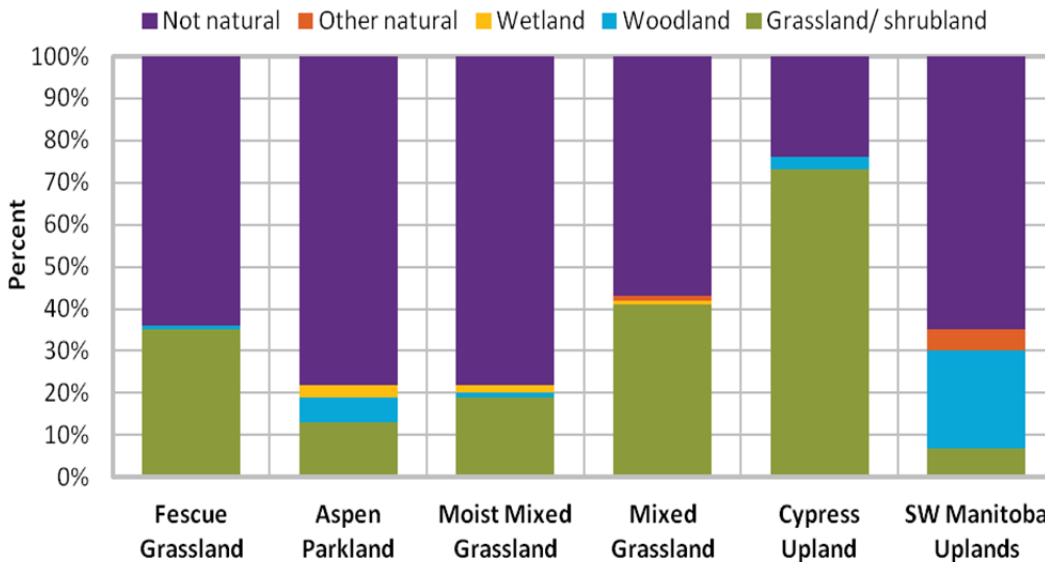


Figure 24. Percentage of the total area of each ecoregion covered by major vegetation types, 1990s.
 Note: Lake Manitoba Plains are not included as data were incomplete. “Other natural” includes small areas such as mud/sand and saline.
 Source: based on an analysis of data from Riley et al., 2007²⁷

Fragmentation

The remaining natural habitat in the Prairies Ecozone⁺ is highly fragmented, with most remaining patches in the smaller size classes. This is evident from a study in southern Saskatchewan that found 94% of habitat patches remaining in the late 20th century (the timespan was imprecise because this study used maps from a variety of dates) were less than 10 ha in size, with the trend most pronounced in the Aspen Parkland Ecoregion.¹¹¹ This represents a large change from the pre-European settlement condition of continuous grassland. The Aspen Parkland Ecoregion is particularly fragmented by agriculture because the climate and soils favour cultivation resulting in only a few remaining large patches. Changes in intact patch size also have impacts on birds. Koper and Schmiegelow¹¹² found that avian populations in southern Alberta responded to habitat characteristics at spatial scales similar to their home range and territory size (with the exception of northern pintail), suggesting that the effects of fragmentation may vary with home range or territory size of individual species.

One cause of fragmentation of the remaining habitat is linear developments such as roads. Even narrow unpaved roads through forest or grassland prevent the movement of some insect and small mammal species.¹¹³ Although no trend data, or comprehensive ecozone⁺-wide status data was available, an estimate from 1998 for the Saskatchewan portion of the ecozone⁺ found that roads accounted for 2% of the most densely populated ecoregions, and that Saskatchewan's municipal roads increased by almost 2% per four-year period from 1961 to 1996.¹¹⁴ Data for the Alberta portion of the ecozone⁺ showed almost 79,000 km of roads in 2008.¹¹⁵ The amount of roads within the Prairies is continuing to increase.

The infrastructure of energy development, such as the well pads, pipelines, roads, and powerlines, also results in fragmentation.¹¹⁶ Both oil and gas drilling activity has increased in the Prairie provinces from 1999 to 2006.¹¹⁷ For Saskatchewan, extensive oil drilling started after World War II and increased around 1980 at the same time that drilling for natural gas also increased (Figure 25).¹¹⁸ Studies in the U.S. and Saskatchewan have shown that impacts on animals include direct mortality from collisions on roads, disturbance due to noise, direct loss of habitat from the infrastructure,^{116, 119, 120} and perhaps most important, indirect loss of habitat due to avoidance.¹¹⁹ Natural gas well densities are typically higher than for oil wells (four to eight wells per section vs. two to four wells per section) and require more roads per area to service them.¹²¹

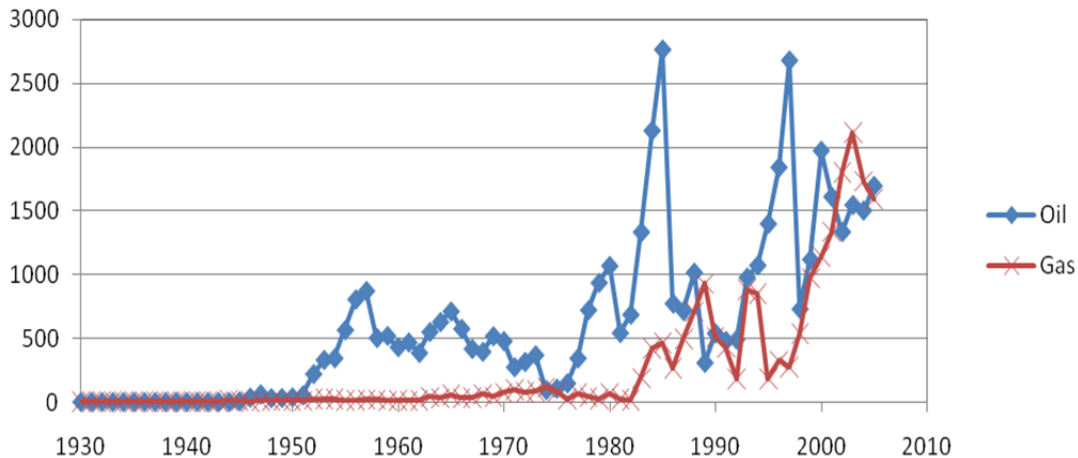


Figure 25. Trends in the number of oil and gas wells completed annually in Saskatchewan, 1930–2005. Source: adapted from Saskatchewan Industry and Resources, 2006¹¹⁸

The loss of intact habitats and the small patch size of remaining habitat leads to a reduction in the ability of the land to support wildlife (see the Wildlife habitat capacity on agricultural land section of the Agricultural landscapes as habitat key finding on page 65), loss of large predators (see Predators section of Food webs key finding on page 84), increases in invasive non-native species (see Invasive non-native species key finding on page 42), and decline in grassland endemic populations.¹²² James *et al.*¹¹¹ estimated the percentage of native flora and fauna lost due habitat loss and fragmentation in Saskatchewan in the late 20th century to be 21–34% in the Mixed Grassland Ecoregion, 33–50% in the Moist Mixed Grassland Ecoregion, and 25–39% in the Aspen Parkland Ecoregion.

Key finding 10

Theme Human/ecosystem interactions

Invasive non-native species

National key finding

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.

Species that inhabit areas outside their natural range are known as alien or non-native species. Most non-native species do not become established, are not detrimental, and can even be beneficial.¹²³ Invasive non-native species, however, cause considerable harm to the environment, the economy, or to society.¹²⁴ The ecological impacts of invasive non-native species are diverse. Non-native animals may outcompete, consume, or transmit diseases to native animals. Non-native plants can decrease the abundance of native plants, increase ecosystem productivity, change fire regimes, and alter the rate of nutrient cycling.¹²⁵ Economic impacts of invasive non-native species include lowered real estate values, reduced quality of fish habitat, clogged

irrigation pipes, decreased quality of forage by wildlife and livestock, and reduced recreational opportunities.¹²⁶ Some species have been introduced intentionally for specific reasons (e.g., agronomic grasses as forage for livestock, fish for recreational fishing) while others may have been introduced accidentally through human activity. Some may have spread into the area after introduction elsewhere.

Invasive non-native species are one of the greatest threats to biodiversity in the Prairies Ecozone⁺ and the threat is increasing. In some areas, some invasive non-native species, particularly plants, have become the dominant species and have altered composition of large tracts of native grasslands.

Invasive non-native plants

Thomas and Leeson¹²⁷ found that one-third of the 36 most abundant cropland “weed” species in the 2000s were not present in the early 1900s. The proportion of these “weed” species that were non-native climbed from 43% to close to 70% over the same time period.¹²⁷ However, from the 1970s to 2000s, the density of non-native species declined from approximately 100 to 30/m².¹²⁷ Patterns of invasion have been found to be correlated with proximity to agriculture. Godwin *et al.*¹²⁸ found that the percentage of non-native species in grassland remnants in Saskatchewan increases with proximity to the agricultural field edge.

Non-native species already dominate some habitats and a few non-native herbs have already altered large areas of native vegetation in some regions. Non-native plants most impacting native grasslands include Kentucky bluegrass (*Poa pratensis*) and smooth brome (*Bromus inermis*) in the more mesic grasslands, and leafy spurge (*Euphorbia esula*) and crested wheatgrass (*Agropyron cristatum*, *A. desertorum*) in the drier grasslands. Thorpe and Godwin^{129, 130} examined ungrazed areas at four locations along an east-west gradient across Saskatchewan’s Aspen Parkland Ecoregion. In general, grassland and Aspen forest habitat was similarly invaded. The proportion of biomass from non-native species varied from 10 to over 95%, with the invasion decreasing from east to west (Figure 26). Kentucky bluegrass was the major invader in these areas, but elsewhere other non-native species—usually grasses—are also important invaders.¹³⁰

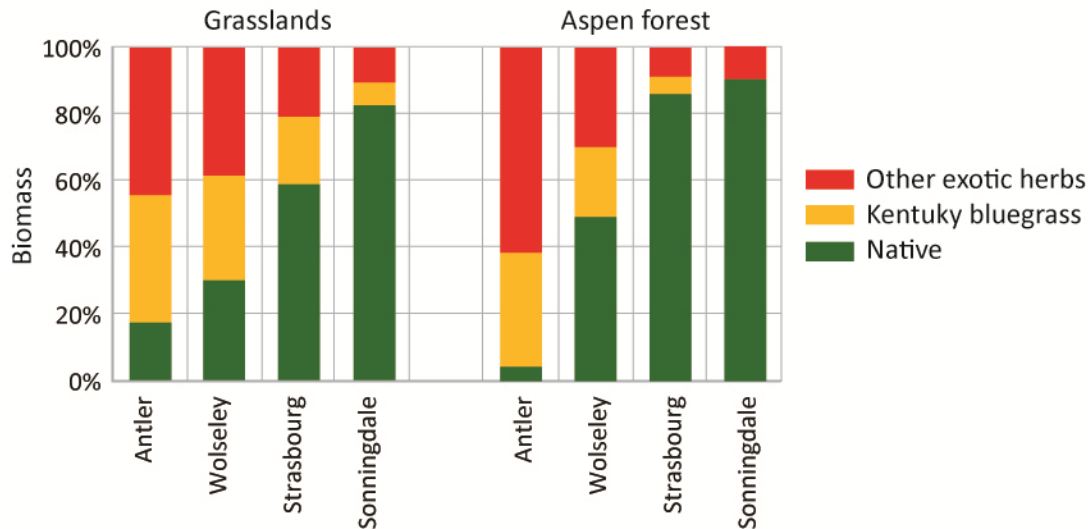


Figure 26. Proportion of herbaceous biomass from different sources (native plants species, Kentucky bluegrass, and exotic herbs) in grasslands and Aspen forest at four locations in the Aspen Parkland Ecoregion, 2000/2001.

Locations are listed on the bar chart from east to west.

Source: Thorpe and Godwin, 2001¹²⁹ and Thorpe and Godwin, 2002¹³⁰

In the Moist Mixed Grassland Ecoregion, Godwin *et al.*¹²⁸ found that non-native grasses invade from the edges of grassland patches, smaller remnant grasslands are altered more than larger grassland remnants, and non-native species become highly dominant, reducing the number of native plant species. Remaining native grasslands in the Prairies Ecozone⁺ are, therefore, particularly vulnerable to invasion as most of what remains is highly fragmented into small patches (see Fragmentation section of Ecosystem conversion key finding on page 41).

In addition to herbs, there are several non-native woody species that have the potential to become major invaders, including common buckthorn (*Rhamnus cathartica*), caragana (*Caragana arborescens*), and Russian olive (*Elaeagnus angustifolia*). Purple loosestrife (*Lythrum salicaria*) is a significant non-native invader of wetlands.

Many of these non-native species appear to spread along road ditches, so the extensive fragmentation by roads is a major concern.

Kentucky bluegrass

Kentucky bluegrass became established in the southeast portion of the ecozone⁺ during early European settlement and is probably still expanding in areas further west.¹³⁰ Kentucky bluegrass was not recorded in native grasslands northeast of Saskatoon in the 1950s but by 1993 it was well established in a grassland reserve in this area.¹³¹ Ten years later as the expansion continued, the percentage of the herbaceous biomass that was Kentucky bluegrass had increased from 17 to 43% and was having a significant negative impact on the diversity of herbaceous species.¹³² Kentucky bluegrass has expanded into the high elevation benchlands of Cypress Hills as well, increasing from 0.2% of above ground graminoid biomass in 1957,¹³³ to

5.5% in 1993,¹³⁴ to 21% in 2000,¹³⁵ then decreasing to 17% in 2005.¹³⁶ It may still be in the process of becoming established as a dominant species there.

Smooth brome

Smooth brome, desired by hay producers due to its productivity,¹³⁷ is considered one of the greatest threats to the moister regions of the ecozone[†]. It invades heavily grazed or disturbed fescue grasslands,¹³⁸ and it, together with crested wheatgrass, suppresses native grasses more than other non-native species sown into disturbed native stands.¹³⁹ Wilson and Belcher¹⁴⁰ found that common native grassland species were present in non-native invaded vegetation, but at reduced levels of cover, and that species richness was only half that of areas with only native vegetation. Romo *et al.*¹⁴¹ found that fescue grasslands invaded by smooth brome were almost devoid of native species. In the Aspen Parkland Ecoregion, Godwin *et al.*¹²⁸ reported that no rough fescue (*Festuca hallii*) plants became re-established in an old smooth brome stand even though rough fescue completely surrounded the stand. In Saskatchewan, roadsides have been traditionally revegetated using smooth brome or crested wheatgrass.¹⁴² In the Aspen Parkland Ecoregion, smooth brome has spread to become the dominant grass cover on roadsides, railway rights-of-way, and abandoned or otherwise disturbed lands,¹⁴¹ and it continues to be a problem.¹⁴³ There were no data on the total area invaded.

Leafy spurge

Leafy spurge, first noted in Saskatchewan in 1928, has become a prevalent non-native species in native grasslands.¹⁴⁴⁻¹⁴⁶ Belcher and Wilson¹⁴⁷ found that cover of all common native plant species was negatively correlated with leafy spurge cover and that most native species were absent in areas with the greatest leafy spurge abundance. Leafy spurge is particularly aggressive on sandy soils and is a threat to dune species at risk such as western spiderwort (*Tradescantia occidentalis*)^{146, 148} and hairy prairie-clover (*Dalea villosa*).¹⁴⁹ It is also believed to be a threat to two orchids listed as Endangered in Canada, small white lady's-slipper (*Cypripedium candidum*) and western prairie fringed orchid (*Platanthera praeclara*) in Manitoba's Tall Grass Prairie Reserve.¹⁴⁹ In a related study, Scheiman *et al.*¹⁴⁷ found that high levels of leafy spurge invasion lowered the density of some grassland birds but improved nesting success for one species. Leafy spurge is one invasive species for which biological control methods have had some success.

Crested wheatgrass

Introduced in the 1930s, crested wheatgrass was promoted as superior to native grasses for cattle grazing because of higher production.¹⁵⁰ By 2002, it covered 40,466 km² of the Prairies.¹⁴⁹ When road ditches seeded to crested wheatgrass are included, there is an extensive network of seed sources for invasion throughout the Mixed and Moist Mixed Grassland ecoregions. Crested wheatgrass is a threat to the habitat of some species at risk including hairy prairie-clover (by stabilizing the semi-active dunes)¹⁵¹ and Sprague's pipit (*Anthus spraguei*).¹⁵² Sprague's pipit was significantly less common in crested wheatgrass than in native pastures in Saskatchewan.¹⁵³ Chestnut-collared longspurs (*Calcarius ornatus*) were equally common in

native and crested wheatgrass sites in Montana but had significantly lower productivity in the invaded sites.¹⁵⁴

Purple loosestrife

Purple loosestrife is an example of an invasive plant species threatening aquatic ecosystems across the Prairies Ecozone⁺ as its abundance continues to increase. It has invaded every major river system in southern Manitoba and has spread as far north as The Pas. Saskatchewan first reported it in 1971 and it is now widespread in the ecozone⁺¹⁵⁵ with heavy infestations near urban areas.

Invasive fish

There were 58 native fish species and 11 non-native fish species known from Saskatchewan lakes and rivers in 2006.¹⁵⁶ One, the common carp (*Cyprinus carpeo*), first recorded in 1938 in Manitoba's Red River, likely invaded from North Dakota.¹⁵⁷ The other ten non-natives were intentionally introduced through stocking for sport fishing.¹⁵⁶ Fish stocking has been a common practice across the ecozone⁺. In 2007, 154 water bodies over the three provinces were stocked with three species (and one hybrid) of introduced trout species and 58 were stocked with native species (mainly walleye).¹⁵⁸⁻¹⁶⁰ In addition to invasive fish, aquatic invertebrates can also be invasive. The zebra mussel (*Dreissena polymorpha*) is a fast-spreading invasive species which forms dense monotypic colonies on the undersides of boats, docks, and other structures. They also clog intake pipes and water treatment plants. A huge problem in the Great Lakes, zebra mussels were detected in 2009 in a tributary of the Red River that flows into Lake Winnipeg.¹⁶¹

Other non-native species

Several non-native bird species have become established in the Prairies Ecozone⁺ including ring-necked pheasant (*Phasianus colchicus*) and gray partridge (*Perdix perdix*), which were introduced to provide hunting opportunities.

Feral swine (*Sus scrofa*), also called wild boar, can cause serious ecological impacts due to rooting,¹⁶² which disrupts plant communities, successional patterns, forest-floor habitat, and nutrient cycling. They also frequently concentrate their feeding activity on wetland habitats where they can also cause extensive damage.¹⁶³ The provinces have combatted this problem through culling the animals and, as a result, their populations are declining and they are no longer a concern in some areas.^{164, 165}

A study of native grasslands in Saskatchewan found that 12 of 157 beetle species were non-native.¹⁶⁶ The best known non-native invertebrate is the seven-spotted lady beetle (*Coccinella septempunctata*). Introduced to control aphids, it has become the dominant lady beetle in the southern Prairies, probably displacing native lady beetle species.¹⁶⁷

Contaminants

National key finding

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.

Pesticides

Pesticides, mostly herbicides, are widely used in Prairie agriculture. The area of land to which herbicides are applied increased rapidly from 1971 to 1986 and more gradually after that (Figure 27). The Aspen Parkland Ecoregion accounted for the largest area of herbicide application. Goldsborough¹⁶⁸ showed that use of phenoxy herbicides such as 2,4-Dichlorophenoxyacetic acid and methylchlorophenoxyacetic acid began after World War II and increased rapidly in the Prairies in the 1950s and 1960s. Use of specialty herbicides, such as those to control grassy vegetation, increased in the 1970s. Anderson *et al.*¹⁶⁹ sampled wetlands in Alberta's Aspen Parkland Ecoregion in 2002 and found measurable pesticide residues in 92% of them. The most frequently occurring chemicals were 2,4-Dichlorophenoxyacetic acid and methylchlorophenoxyacetic acid, but glyphosate and picloram were found at higher concentrations. Concentrations were lower than previously found in Saskatchewan prairie wetlands.

Areas treated with insecticides and fungicides are smaller and appear to have been stable from 1996 to 2006 (Figure 27). Usher and Johnson¹⁷⁰ found that the geographic pattern of insecticide purchase and application in the Prairies Ecozone⁺ was positively correlated with the distribution and abundance of grasshoppers. Spray intensity was greatest in the grassland ecoregions (1–5%) and less in the Aspen Parkland Ecoregion (<1%).

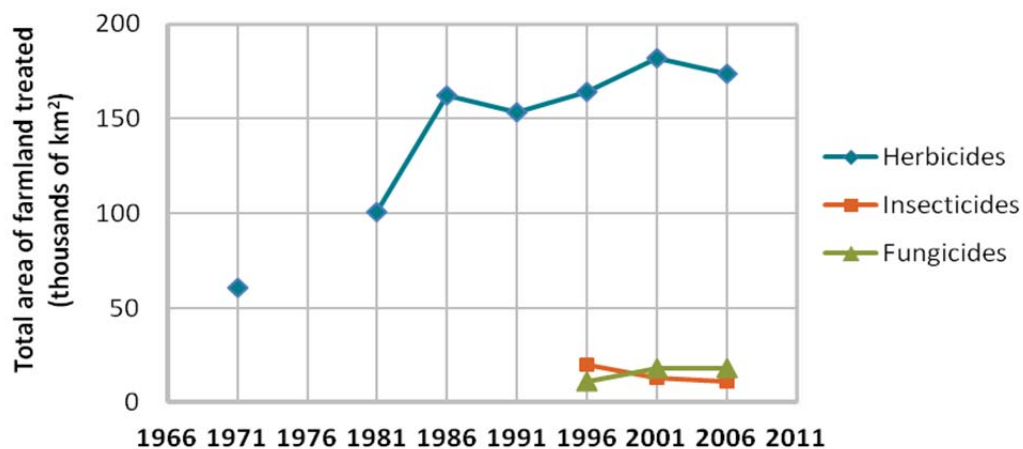


Figure 27. Trends in farmland area treated with herbicides, insecticides, and fungicides in the Prairies Ecozone⁺, 1971–2006.

Source: Agriculture and Agri-Food Canada, 2009¹⁷¹

Mercury

Mercury is a pollutant of concern due to potential neurotoxicological effects on humans at environmentally relevant concentrations.¹⁷²⁻¹⁷⁷ Anthropogenic activity during the 20th century has tripled the amount of mercury in the environment compared to the global background level.¹⁷⁸ In the Prairies, pollution from the pulp and paper industry, coal burning, paint and battery wastes, and seed treatments used in agriculture have added to natural mercury levels.^{179, 180} In waterbodies, mercury can bioaccumulate in fish tissues, with higher concentrations found in older, larger fish and fish that consume other fish, such as walleye and northern pike.¹⁸⁰ Testing found that levels were high enough to warrant consumption advisories for recreationally-angled fish on several major Prairie waterbodies.^{179, 180} No information on trends in mercury concentrations was available.

Key finding 12

Theme Human/ecosystem interactions

Nutrient loading and algal blooms

National key finding

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.

Eutrophication has accelerated in lakes and rivers in the Prairies Ecozone⁺ over the 20th century due to increased phosphorus and nitrogen inputs. The large rivers running out of the Rocky Mountains generally have good water quality. However, the rivers and lakes receiving runoff from the Prairie landscape tend to be eutrophic, with naturally high nitrogen and phosphorus concentrations that are further elevated by inputs from municipal effluent and agriculture.¹⁸¹ Some improvement is evident. Phosphorus has decreased in some areas with improved sewage treatment and residual soil nitrogen on agricultural lands remains low.

The lakes along the Qu'Appelle River in east-central Saskatchewan are well-studied examples of both natural and anthropogenic eutrophication.¹⁸² Historical trends show a continuous increase in the urban population throughout the 20th century, a steady increase in livestock biomass, and a rapid increase of cultivation of field crops between 1900 and 1920, with more gradual increases thereafter. While the Qu'Appelle Lakes are naturally eutrophic, they have become more so from European settlement to the 1990s, with huge blooms of blue-green algae and fish kills.¹⁸³

Away from the Qu'Appelle system, Pham *et al.*¹⁸⁴ analyzed nitrogen isotopes in sediments in 21 lakes across southern Saskatchewan, and concluded that lakes showed substantial increases in nitrogen input during the 20th century as a result of agricultural intensification and, in one case, because of sewage effluent. These lakes showed increases in blue-green algae, consistent with the process of eutrophication.

Residual soil nitrogen on agricultural lands

High levels of the nitrate ion can adversely affect freshwater biodiversity, both directly through toxicity and indirectly through eutrophication. Guy¹⁸⁵ found that levels of nitrate in freshwater in excess of 4.7 mg N/L have impacts on development rates and mortality of insects, fish, and amphibians. Carmargo *et al.*¹⁸⁶ found that levels above even 2 mg N/L can affect many freshwater species. Nitrate concentrations of 6.25 and 25 mg N/L have been found to impact the rate of embryo development as well as the fry body size of lake trout (*Salvelinus namaycush*) and lake whitefish (*Coregonus clupeaformis*).¹⁸⁷ These concentrations are in the range found in runoff being released from agricultural land in Canada.^{188, 189}

The extent to which accelerated lake eutrophication is related to agriculture depends in part on the nutrient status of farm soils. A useful way of determining the risk of increased nitrogen loading to receiving waters is to look at nitrate accumulation in soils. Although the presence of nitrogen in the soil beyond crop requirements increases the probability of its export into water bodies, the risk depends on the volume of water leaving fields through overland flow or leaching. The dry prairie climate means that there is less surplus water compared to British Columbia and eastern Canada, so the risk of nutrient export is comparatively less.¹⁸¹

Although the Prairies Ecozone⁺ contained the largest amount of agricultural land in Canada in 2006 (65%; almost 400,000 km²), it had the lowest residual soil nitrogen levels of all ecozones⁺ with agriculture. The residual soil nitrogen increased from 3.3 kg N/ha in 1981 to 18.0 kg N/ha in 2001, and back to 11.8 kg N/ha in 2006.¹⁹⁰ Most of the land in the ecozone⁺ remained in the same risk class between 1981 and 2006 (Figure 28), although there was an increase in the eastern regions by at least one risk class. Despite this increase, this still represents very low to low risk. The nitrogen inputs, while increasing substantially from 1981 to 2006, remained lower than all other ecozones⁺ on average. The major nitrogen input in the Prairies Ecozone⁺ was fertilizers (44% of the total in 2006), followed by legume fixation (37%), which also increased,¹⁹⁰ particularly in Saskatchewan.¹⁹¹ Manure was the lowest of these nitrogen sources (15%) but also increased. Nitrogen outputs also increased, although slower than the inputs, due to a combination of increased crop yields as well as decreased areas of summerfallow.¹⁹⁰

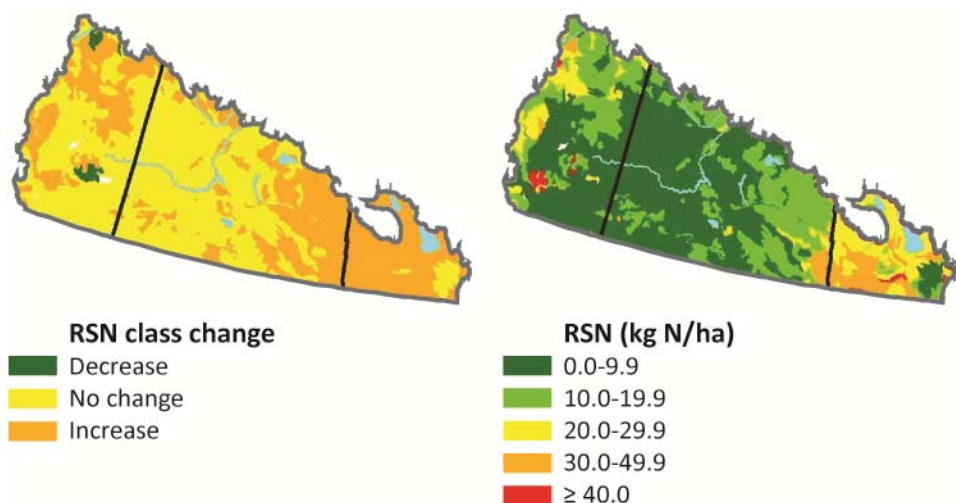


Figure 28. Change in Residual Soil Nitrogen (RSN) risk class from 1981 to 2006 (left) and risk classes in 2006 (right) for agricultural land in the Prairies Ecozone[†].

Agricultural land shown in this figure includes the Cropland, Improved Pasture, and Summerfallow categories from Canadian Census of Agriculture.

0.0-9.9 represents a very low risk class and ≥ 40 represents a very high risk class.

Source: Drury *et al.*, 2011¹⁹⁰

Phosphorus loading to rivers

Together with nitrogen, the other significant cause of eutrophication is high levels of phosphorus. The primary point source of phosphorous in lakes and rivers in Canada is sewage discharges.¹⁸¹ Many Prairie cities have secondary sewage treatment and a few have tertiary treatment.¹⁸¹ Glozier *et al.*¹⁹²⁻¹⁹⁴ quantified trends in phosphorous concentrations at five monitoring stations on the Bow, North Saskatchewan, and Athabasca rivers to assess the effectiveness of an upgrade to tertiary treatment in communities whose sewage treatment plants discharge into these rivers. Results showed dramatic improvements in concentrations of nutrient and bacteriological parameters observed at downstream sites with phosphorous concentrations in the Bow and Athabasca rivers restored to levels similar to upstream, naturally occurring concentrations by 2007 (Figure 29).

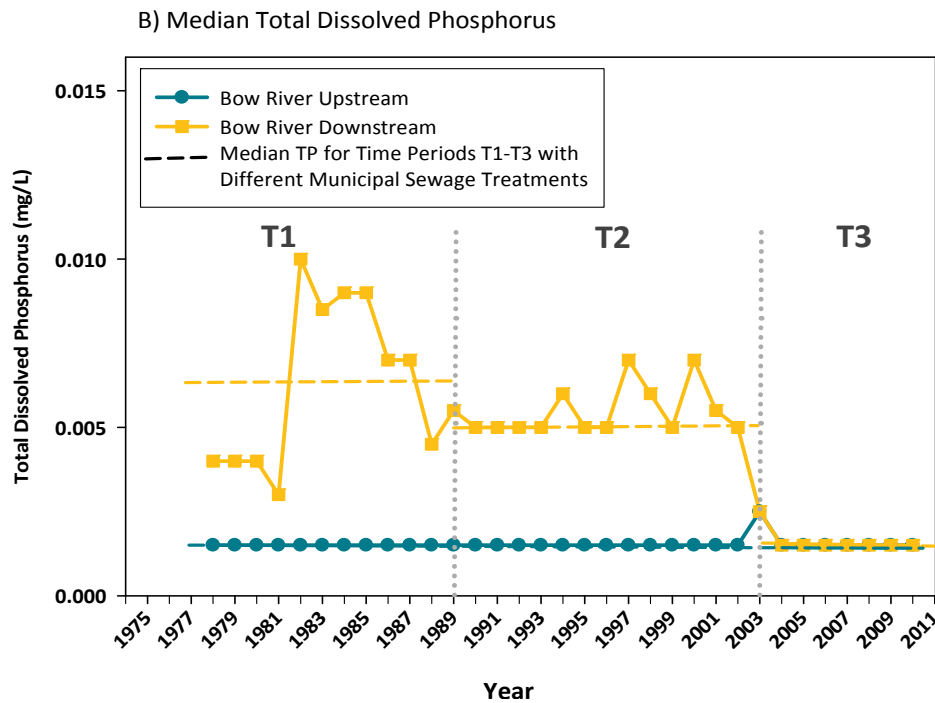
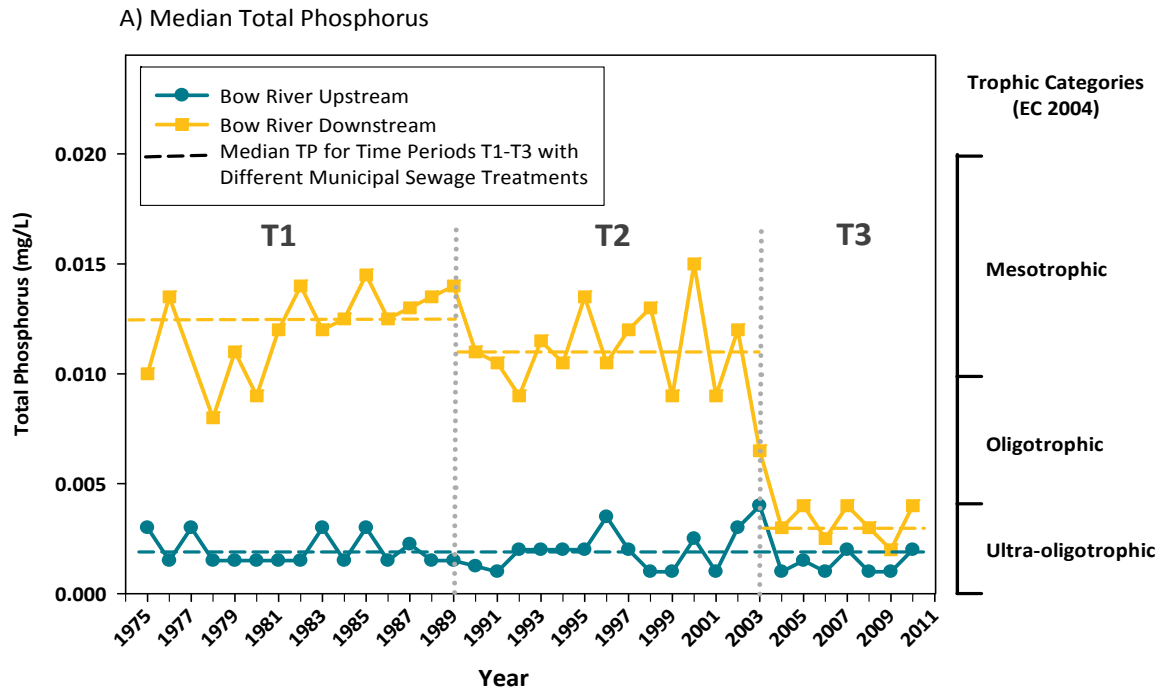


Figure 29. A) Median total phosphorus and B) median total dissolved phosphorus concentrations in the Bow River, 1975–2010.

Three distinct municipal treatment regimes through the period of record are indicated as: T1–secondary treatment and settling aeration, T2–high rate activated sludge plant with UV disinfection, and T3–tertiary treatment including phosphorus removal.

Source: Glozier, 2004¹⁹⁴ and updated by Glozier with unpublished data

Climate change

National key finding

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.

Trends in climatic variables

Table 4 summarizes significant trends in climatic variables in the Prairies Ecozone⁺ from 1950 to 2007. Across the ecozone⁺ as a whole, spring was warmer by 2.3°C and winter had less precipitation (18%). The number of days with snow cover in the spring decreased by 16 days. Although drought is a recurring characteristic of the Prairies, there was no trend in the Palmer Drought Severity Index from 1950 to 2007. Climate stations are well distributed across the ecozone⁺ and trends at individual stations are generally reflected in the overall ecozone⁺ results. While some variables had no overall trends for the ecozone⁺, individual stations showed trends when analyzed individually. For example, mean temperature in winter (December–February) increased at eight stations in the ecozone⁺ while there was no overall trend (see Table 4, Figure 30, Figure 31, and Figure 32).⁸¹

Table 4. Summary of changes in climate variables in the Prairies Ecozone⁺, 1950–2007.

Climate variable	Overall ecozone ⁺ trend (1950–2007)	Comments and regional variation
Temperature	<ul style="list-style-type: none"> • ↑ of 2.3°C in spring relative to 1961–1990 mean • No decreasing trends in any station in any season 	<ul style="list-style-type: none"> • ↑s of >3°C at several stations, particularly in western half of ecozone⁺ in spring • ↑ at 8 stations throughout ecozone⁺ in winter
Precipitation	<ul style="list-style-type: none"> • ↓ of 18% in winter relative to 1961–1990 mean 	<ul style="list-style-type: none"> • ↓ing trends in winter were at stations concentrated in western part of the ecozone⁺, 8 stations have ↓ of >40%; 2 stations in eastern end of the ecozone⁺ showed ↑ of >40% in winter
Snow	<ul style="list-style-type: none"> • No change in snow to total precipitation ratio • No change in maximum snow depth • ↓ by 16.3 days in the number of days with snow cover from February to July 	<ul style="list-style-type: none"> • ↓ in precipitation that fell as snow at some stations • ↓ in maximum snow depth for 6 stations, primarily along the northeast border of the ecozone⁺; ↑ for 2 stations in eastern Saskatchewan • Trends in snow cover duration consistent across ecozone⁺
Drought Severity Index	<ul style="list-style-type: none"> • No change • Moderate drought in 1980 and 1984; severe drought in 1961 and 1988 	<ul style="list-style-type: none"> • No trend at any station
Growing season	<ul style="list-style-type: none"> • End to growing season was 6 days earlier • No trend in length or start 	<ul style="list-style-type: none"> • 4 stations showed an earlier start of the growing season • 3 stations in southeast and 1 station in northwest showed ↑ in growing degree days

Only significant trends ($p < 0.05$) are shown

Source: Zhang et al., 2011⁸¹ and supplementary data provided by the authors

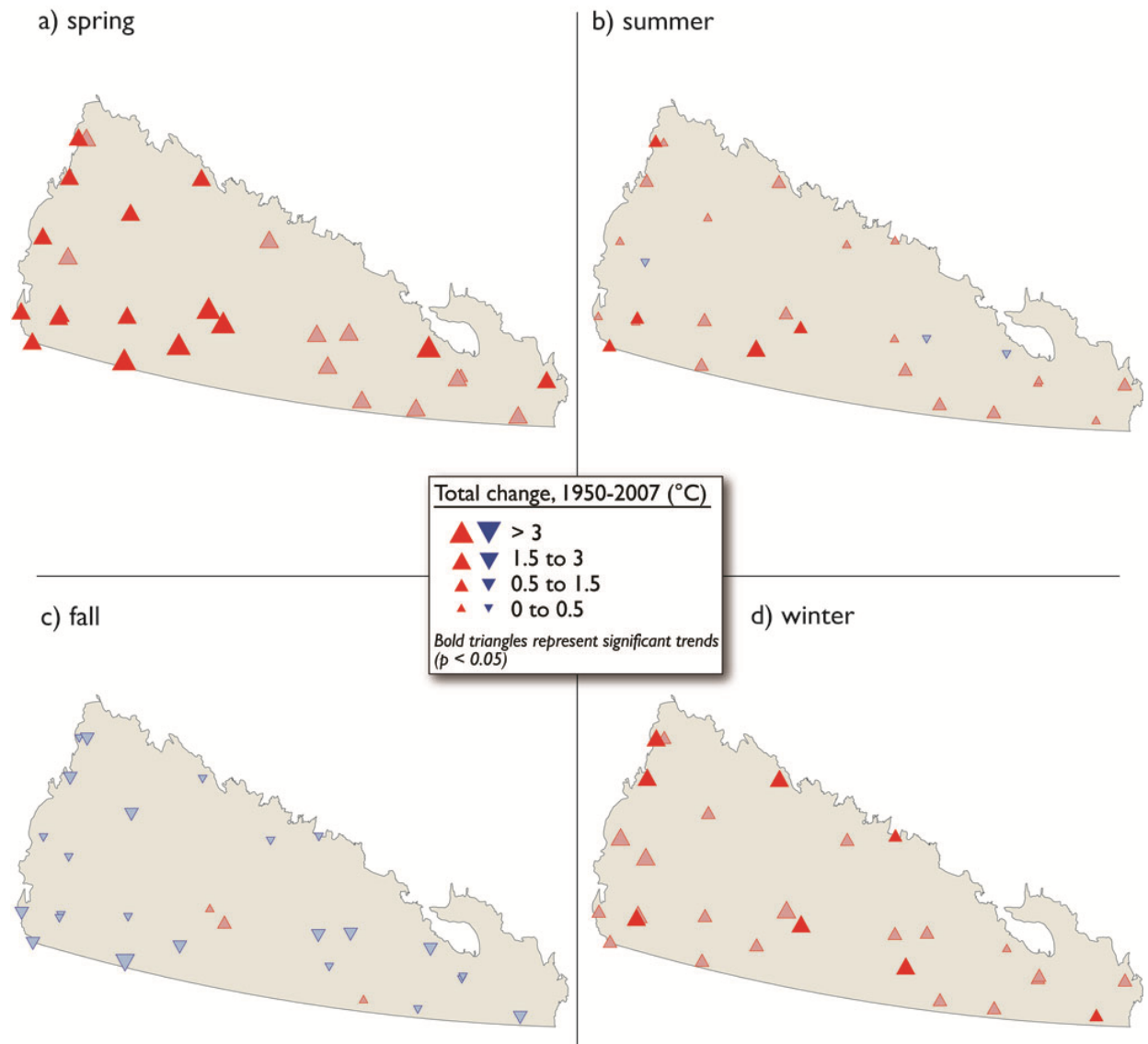


Figure 30. Change in mean temperatures in the Prairies Ecozone⁺, 1950–2007, for: a) spring (March–May), b) summer (June–August), c) fall (September–November), and d) winter (December–February). Source: Zhang et al., 2011⁸¹ and supplementary data provided by the authors

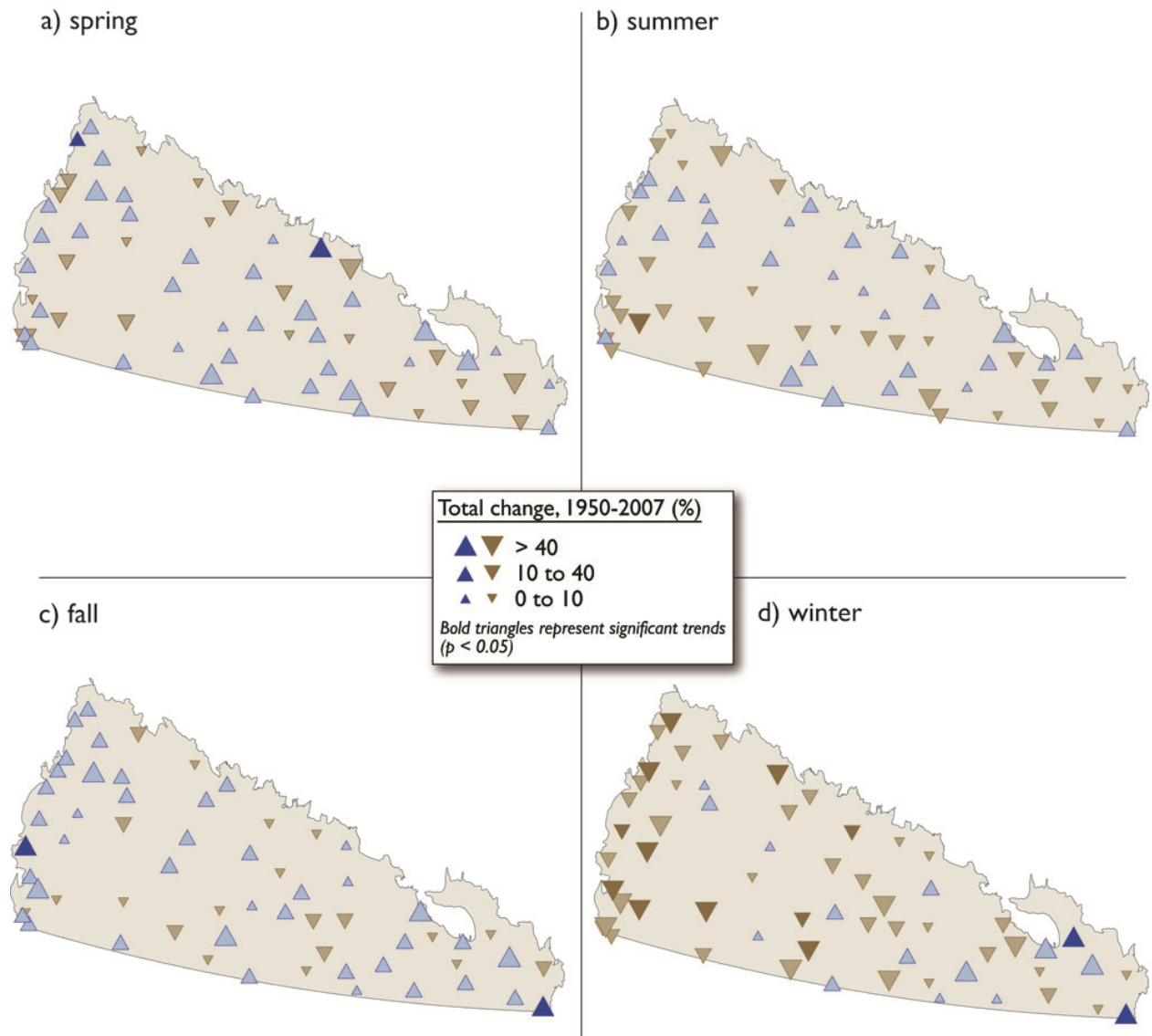
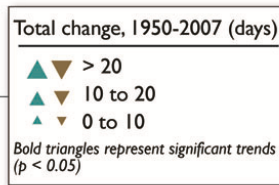
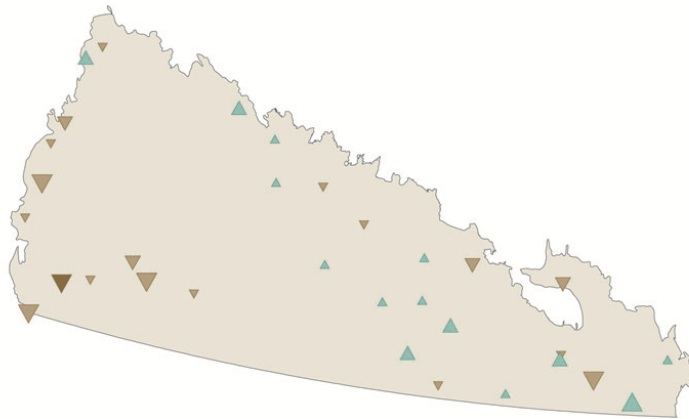


Figure 31. Change in the amounts of precipitation in the Prairies Ecozone⁺, 1950–2007, for: a) spring (March–May), b) summer (June–August), c) fall (September–November), and d) winter (December–February).

Expressed as a percentage of the 1961–1990 mean.

Source: Zhang et al., 2011⁸¹ and supplementary data provided by the authors

a) August to January



b) February to July



Figure 32. Change in snow durations (the number of days with ≥ 2 cm of snow on the ground) in the Prairies Ecozone⁺, 1950–2007, in: a) the first half of the snow season (August–January), which indicates change in the start date of snow cover, and b) the second half of the snow season (February–July), which indicates changes in the end date of snow cover.

Source: Zhang et al., 2011⁸¹ and supplementary data provided by the authors

Changes in phenology

Between 1950 and 2007, there was no change in the start date or length of the growing season for the ecozone⁺ when measured as days over 5°C, although the season ended 6 days earlier on average.⁸¹ The growing season did start earlier at four individual stations (Table 4). Growing season is specific to individual species, however, and some changes in phenology were noted for this ecozone⁺. Based on data from the Plantwatch Program,¹⁹⁵ in Edmonton, the first flowering date of trembling aspen advanced by 26 days from 1901 to 1997 which suggests that spring is occurring earlier.¹⁹⁶ Spring flowering of aspen and prairie crocus (*Anemone patens*) in Alberta's Aspen Parkland Ecoregion also advanced by two weeks from 1936 to 2006.¹⁹⁷

Changes in spring temperature can also impact arrival dates for migratory birds. For example, Murphy-Klassen *et al.*¹⁹⁸ analyzed spring arrival dates of 96 migratory bird species at Delta Marsh, Manitoba from 1939 to 2001 and their relationship to temperature. They found that 25 species (26%) had significantly earlier arrival dates (between 6 and 32 days) while only two arrived significantly later. Monthly mean spring temperature increased by 0.6 (in April) to 3.8°C (in February) over the same time period (measured at Winnipeg International Airport). Forty-six percent of the 96 species had arrival dates significantly related to temperature, and 98% of these arrived earlier with increasing temperature. This translated to arrival dates ranging from 0.6 to 2.6 days earlier for every 1°C increase in temperature. Changes in temperature on the breeding grounds and along migration routes, in addition to other factors, also influence arrival date (e.g., Figure 33).¹⁹⁸

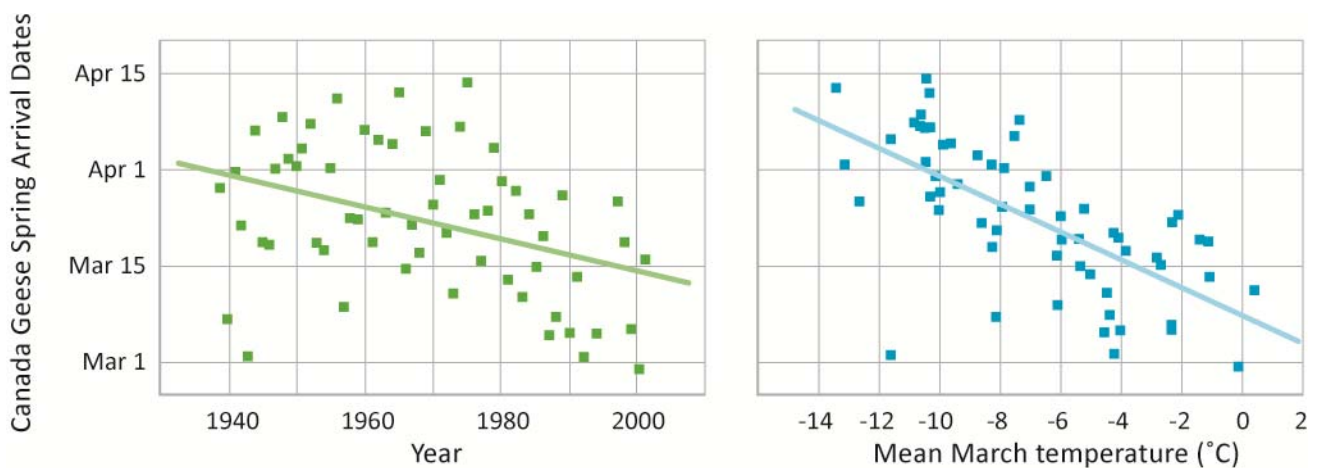


Figure 33. Trends in spring arrival date (left) and relationship between spring arrival date and mean monthly temperature (right) for Canada goose (*Branta canadensis*) at Delta Marsh, 1939–2001. Source: adapted from Murphy-Klassen *et al.*, 2005¹⁹⁸

Future climate predictions

Global climate models predict that the Prairies Ecozone⁺ will become significantly warmer and somewhat drier over the coming century. The ecosystems and biodiversity found in the Prairies Ecozone⁺ are strongly controlled by climate. Thorpe¹⁹⁹ modelled the shifts in vegetation zones in the southern part of the Prairie provinces resulting from climate change scenarios up to the 2080s. All scenarios show the grassland environment currently found in the Prairies Ecozone⁺ expanding northward into areas currently covered by forest. Canadian grassland types may be replaced by types found in the Montana, Wyoming, and the Dakotas, with the warmest scenario showing the southern margin of the ecozone⁺ shifting to the shortgrass prairie type found in Colorado.¹⁹⁹ However, many species, particularly plants, have limited dispersal abilities and will not be able to adjust their ranges northward as fast as the climate is changing, leading to . . . The analysis suggested the following trends for the coming century:¹⁹⁹

- Declines in tree and shrub cover;
- Reduced invasion of grassland patches by shrubs and poplar sprouts;

- An increase in open vegetation suitable for livestock grazing;
- Declines in animal species dependent on woody cover;
- Increases in animal species dependent on open grassland;
- Shifts in the structure of grasslands, particularly a decrease in midgrasses and an increase in shortgrasses;
- A decrease in cool-season grasses and an increase in warm-season grasses;
- Northward shift in the ranges of plants and animals found in the U.S. into Canada;
- New community types caused by differences in rates of northward migration;
- Increased invasion by non-native plants;
- Moderate decreases in average grass production and grazing capacity per unit area, depending on the climate scenario (however, the increase in open vegetation types associated with declining woody cover could increase the total area of rangeland); and
- More frequent drought years with low production, but possibly also more frequent extreme wet years with flooding of low-lying pastures.

Wetlands, and the waterfowl populations that depend on them, are particularly sensitive to climatic moisture balance. Between 1955 and 1989, waterfowl productivity increased in wet years and decreased in dry years, a result of precipitation-driven changes in the extent and quality of wetland breeding habitats.²⁰⁰ For the Prairie Pothole Region, which includes the Prairies Ecozone⁺, researchers have predicted that the number of ponds and number of ducks will decrease with climate change.^{62, 201-203} The most productive areas in southeastern Saskatchewan and southwestern Manitoba will become a more episodic source of waterfowl production, similar to the drier areas in the western part of the Prairies Ecozone⁺.²⁰³

Warmer and drier conditions, with a possible increase in salinity and turbidity, are expected to stress aquatic ecosystems.^{78, 204} For the Prairies, Schindler and Donahue⁷⁸ predicted larger algal blooms, accelerated eutrophication, and serious impacts on fish species owing to a combination of climate change, increasing nutrient runoff, and ever more human use of natural water systems.

Key finding 15

Theme Human/ecosystem interactions

Ecosystem services

National key finding

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.

Ecosystem services in the Prairies include water (a provisioning service), crop pollination (a regulating service), and nutrient cycling (a supporting service). These are necessary for food production and potable water. The conversion of over 70% of the natural vegetation to agricultural production, and the increasing fragmentation and alteration of remaining

ecosystems, has altered the ability of the ecosystems in the Prairies Ecozone⁺ to deliver some ecosystem goods and services. Channeling of primary production into agricultural crops and secondary production into livestock has increased provisioning services but decreased many regulating and supporting services (as is evident from the trends presented throughout this report). Despite the extent of human modification to the landscape, the remaining biodiversity still provides services such as hunting, fishing, and other forms of outdoor recreation (e.g., hiking and camping, bird watching). Most native grasslands also support livestock grazing which, under proper management, is highly compatible with conservation goals. This section provides four examples of ecosystem services: three provisioning services related to food and a study in ecosystem valuation.

Food

Although primary productivity has shifted from wild species harvested for food to cultivated sources of food, ecosystems in the Prairies Ecozone⁺ provide several other important food sources, including traditional country foods, fish, and wildlife for hunting. Overall, production of food has steadily increased.

Traditional country foods

Prior to their extirpation in the late 1800s, plains bison were the foundation of the Aboriginal economy²⁰⁵⁻²¹⁰ and the preferred meat source in the Prairies Ecozone⁺.^{206, 210} Bison figure prominently in the structure, spirituality, and rituals of present-day Plains Aboriginal societies. The loss of the bison represented a significant impairment of the cultural services provided to Aboriginal people by this ecozone⁺.²¹¹

Similarly, although not eaten as frequently by present-day Aboriginal groups, prairie turnip (*Psoralea esculenta*) (other names include tipsin, teepsenee, breadroot, breadroot scurf pea, and pomme blanche) is particularly prevalent in Blackfoot legend and language, indicating that it once ranked as a species of particular importance.^{205, 212, 213} The prairie turnip is a key component of the Natoas, or “holy turnip” bundle, featured in the Sundance, the most important ceremony in Blackfoot culture.^{205, 214}

Fish

There is a limited amount of commercial fishing in the Prairies Ecozone⁺, but Lake Manitoba has a significant fishery.²¹⁵ From 1997/1998 to 2006/2007, the annual harvest varied from 1,000 to 2,500 tonnes per year (Figure 34). The most important commercial species harvested by weight are carp (*Cyprinus carpio*) and mullet (*Catostomus commersoni*).²¹⁵

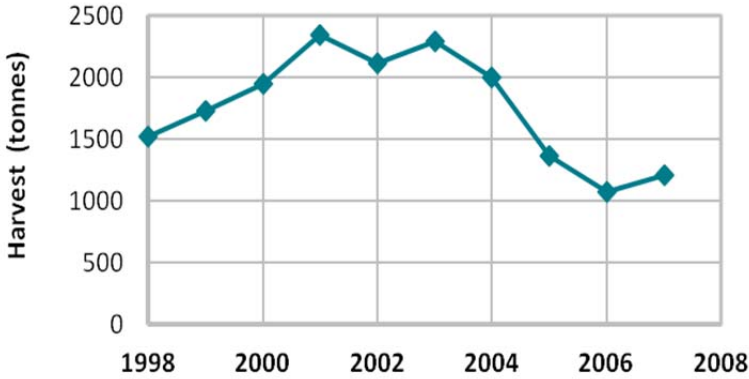


Figure 34. Trend in annual commercial harvest of fish from Lake Manitoba, 1997/1998 to 2006/2007. Source: Manitoba Conservation and Water Stewardship, 2008²¹⁵

Hunting

Sport hunting is an important recreational use associated with prairie biodiversity. Intact Prairie grasslands support several game species that are frequently hunted for sport.

White-tailed deer (*Odocoileus virginianus*) is the most important big game species, with tens of thousands of animals harvested per year (Figure 35).

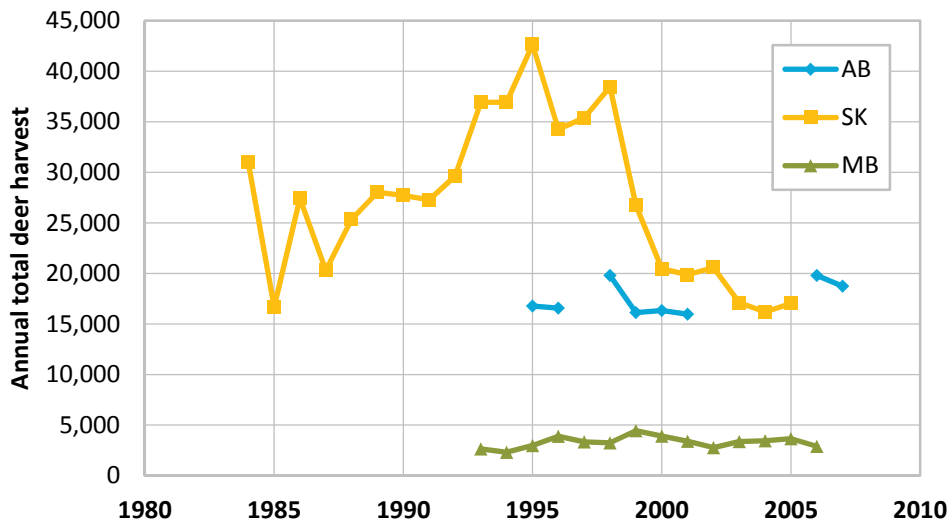


Figure 35. Trends in harvest of white-tailed deer by sport hunters in the three Prairie provinces, 1984–2007.

Data shown are for whole provinces and include areas outside of the Prairies Ecozone⁺.

Sources: Alberta: My Wild Alberta, 2008;²¹⁶; Saskatchewan: Saskatchewan Environment, unpublished data;²¹⁷ Manitoba: Manitoba Conservation, unpublished data²¹⁸

The duck harvest in the Prairies Ecozone⁺ declined steeply from the mid-1970s to the mid-1980s (Figure 36), mirroring the decline in breeding duck populations (see Figure 49 in Wetlands key

finding on page 78). Since the early 1990s, the duck harvest has increased, again related to gradual recovery of the duck population. However, by the 2000s, duck populations remained low compared to the levels of the 1970s. In contrast, the goose harvest was relatively stable from 1975 to 2006 (Figure 36). The slight increase since the early 1990s corresponded to the significantly higher numbers of geese, both locally nesting Canada geese,²¹⁹ and geese of several species that breed in the Arctic and migrate through the Prairies Ecozone⁺ in fall.

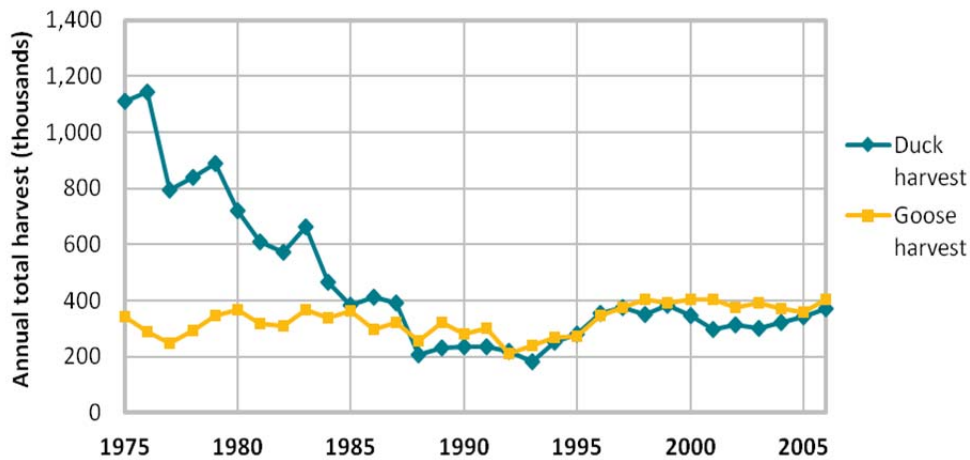


Figure 36. Trends in the number of ducks and geese harvested in the southern parts of the Prairie provinces, 1975–2006.

Source: Canadian Wildlife Service, 2008²²⁰

In general, the Prairie provinces, like other jurisdictions in North America, have experienced a decline in hunting participation,²²¹ in part due to a shift to increasingly urban populations. This may also be contributing to declining trends in some harvest rates.

Ecosystem valuation

Ecosystem services in the Prairies have not been systematically quantified for their economic value. However, Olewiler²²² examined the “natural capital” of the Upper Assiniboine River Basin, a 21,000 km² area in the Aspen Parkland Ecoregion, to place a value on the ecological services provided by the Basin to people. The study identified the major threats to natural capital as the loss of wetlands and riparian habitat due to agricultural use, increased danger of flooding due to wetland loss, soil erosion leading to sedimentation of surface waters, and a decline in water quality due to increasing livestock density. Their best estimate of the net value of conserving natural capital in this area was \$66/ha/yr (

Table 5).

Table 5. Estimates of net value of services provided by conserving natural capital in the Upper Assiniboine River Basin, 2004.

Service	Value (\$/ha/yr)
Saved government payments	\$12.83
Saved crop insurance premiums	\$3.51
Improved water quality – decreased sediment	\$4.62
Water-based recreation	\$0.91
Reduced wind erosion	\$2.67
Reduced GHG emissions	\$9.38
Carbon sequestration	\$19.60
Increased wildlife hunting	\$10.71
Increased wildlife viewing	\$4.16
Gross benefits	\$68.39
Program administration costs	(\$2.08)
Compensation for wildlife depredation	(\$0.64)
Net benefits	\$65.67

Source: adapted from Olewiler, 2004²²² Case study: Implications of wetland loss for the provision of ecosystem services

Another example of the ecosystem services in the Prairies Ecozone⁺ is the improvement to water quality provided by wetlands. Ducks Unlimited Canada worked in partnership with the University of Guelph to develop a hydrologic modeling system to estimate water quantity and quality impacts of wetland drainage in the Broughton’s Creek watershed in Manitoba. Between 1968 and 2005, 21% of wetland area was lost and 69% of the wetland basins (almost 6,000 wetlands) were negatively impacted (see also Wetlands key finding on page 24).⁶⁶ Wetland drainage since 1968 resulted in an additional 32 km² of the watershed draining into streams. These changes resulted in the following environmental impacts:

- A 31% increase in nitrogen and phosphorus export from the watershed;
- A 41% increase in average annual sediment loading;
- A 30% increase in the average annual flow;
- A 18% increase in the peak flow; and
- A 28% decrease in habitat capacity for waterfowl.⁶⁶

THEME: HABITAT, WILDLIFE, AND ECOSYSTEM PROCESSES

Key finding 16

Theme Habitat, wildlife, and ecosystem processes

Agricultural landscapes as habitat

National key finding

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.

The agricultural landscapes of Canada include a variety of land cover types: native rangeland, tame pasture, summerfallow, and 24 types of cropland, as well as woodlots, wetlands, windbreaks, and other non-farmed areas.^{30, 223} The agricultural landscape of the Prairie provinces increased from 35 to 55 million km² between 1921 and the early 1970s. Javorek and Grant,⁸⁴ in a more detailed analysis of recent trends for this report, found that the agricultural landscape expanded by 13,000 km² between 1986 and 1996, then remained generally stable through to 2006. They found that close to 93% of the ecozone⁺ in 2006 was used for some form of agriculture (Figure 37). Approximately 55% of this was cropland, with the most common crops being wheat, cereal, oilseed, and pulses (chickpeas, dry beans, dry peas, and lentils). The area of land seeded to annual crops has increased steadily since 1921 (Figure 38) and cropland increased from 42% in 1971 to 55% in 2006.⁸⁴

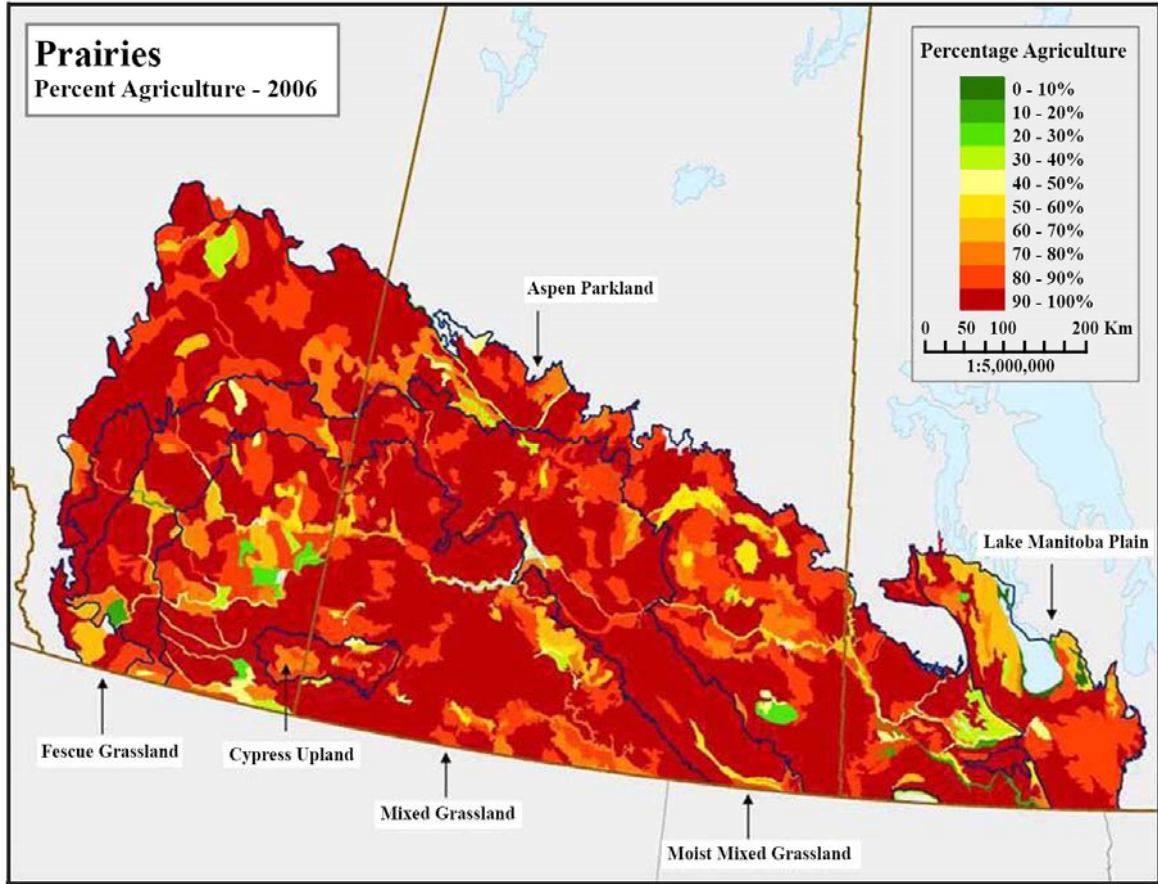


Figure 37. Percentage of land defined as agricultural in the Prairies Ecozone[†], 2006. Soil Landscapes of Canada polygons were the base unit used for this analysis. Source: Javorek and Grant, 2011⁸⁴

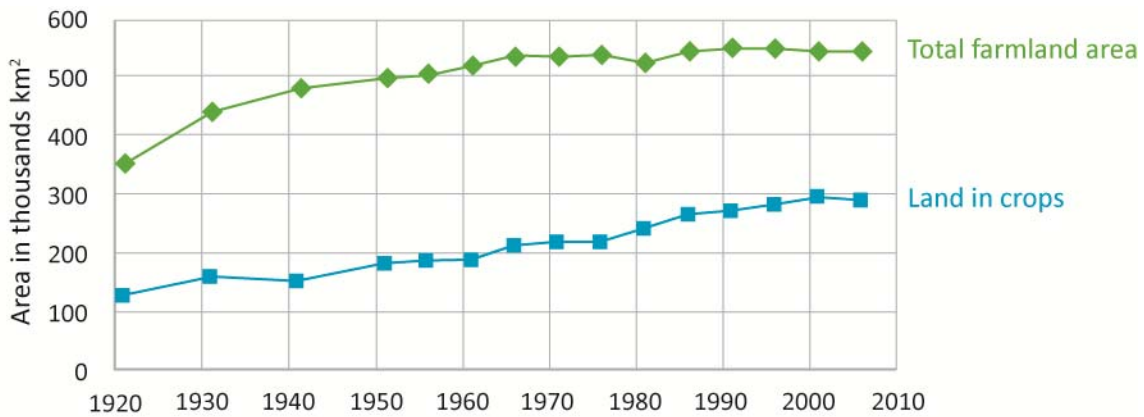


Figure 38. Trends in total farmland area and of land seeded to annual crops in the three Prairie provinces, 1921–2006. Data shown are for whole provinces and include areas outside of the Prairies Ecozone[†]. Source: Statistics Canada, 2007²²⁴

Wildlife habitat capacity on agricultural land

The capacity of agricultural landscapes to provide habitat for wildlife depends upon the land cover type and management. Agricultural land in the Prairies Ecozone⁺ consists mainly of cultivated cropland with some extensive areas of tame pasture and native rangeland (Figure 39).⁸⁴ With agriculture as the dominant land use, the population viability and persistence of many species depends upon the availability of suitable habitat on agricultural land. One way to measure the potential of these lands to support wildlife is through the Wildlife Habitat Capacity on Agricultural Land Indicator developed by Agriculture and Agri-Food Canada.^{84, 225} The indicator ranks potential capacity of 15 “habitat categories” for terrestrial vertebrates based on the percent of the agricultural landscape occupied by 31 land cover types (e.g., cereal crops, summerfallow, tame hay, improved pasture, unimproved pasture, natural lands) and a rating of the value of each cover type as habitat to 588 species of birds, mammals, reptiles, and amphibians.⁸⁴

Using the index, Javorek and Grant⁸⁴ found that 340 species (245 birds, 71 mammals, 13 reptiles, 11 amphibians) could use agricultural land in the Prairies. Of these, 78% could use the All Other Land category (natural and semi-natural land including wetlands, riparian vegetation, and wooded areas within the agricultural landscape) for breeding and feeding, and 30% could use Unimproved Pasture (that is native rangeland) for both breeding and feeding. In contrast, only 4% were able to utilize cropland for breeding and feeding. However, when other suitable habitat was present to provide for partial life history requirements, 32% could use cropland. Godwin *et al.*¹²⁸ showed the greatly reduced diversity in several taxonomic groups on cultivated land compared to even small remnants of native prairie.

The biggest change in land use has been the increase in area seeded to annual crops from 1971 to 2006, linked to the decrease in area of summerfallow (Figure 39). The total area of annually cultivated land, including both crops and summerfallow, declined from 66 to 62% of the agricultural landscape from 1986 to 2006, largely due to a shift of some cropland to seeded pasture (Figure 39).⁸⁴ Cultivated land, offering comparatively little wildlife habitat, still represented the dominant portion of the agricultural landscape in 2006. Natural land for pasture (also known as unimproved pasture) was the second most abundant cover type and remained stable from 1971 to 2006 at about 25% of the agricultural landscape. The all other land category was also stable over that time period at about 5% of the landscape. The latter two cover types play a crucial role in determining the viability of wildlife populations in this ecozone⁺. It is the lower proportions of these cover types that are the primary reason for the overall low habitat capacity.

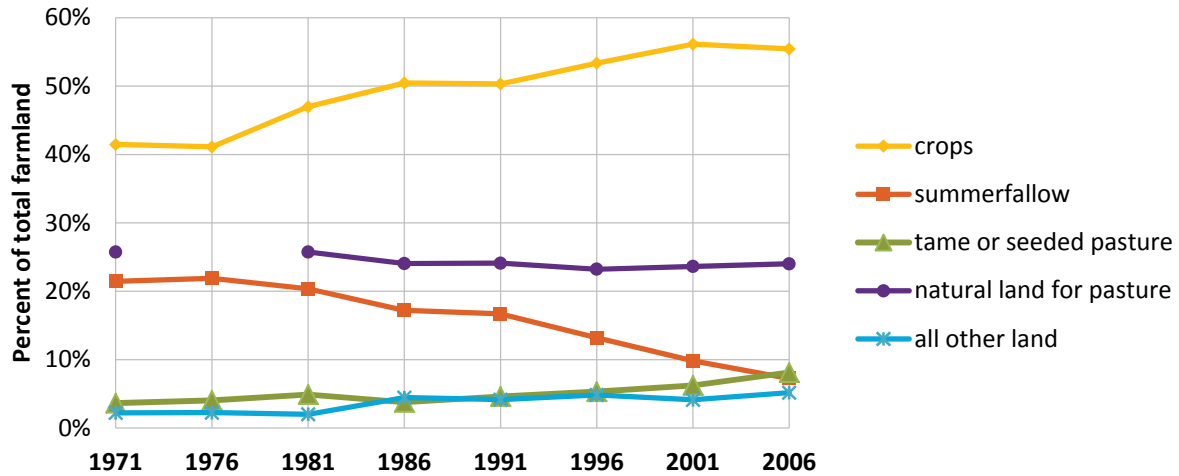


Figure 39. Trends in land cover types on agricultural land in the Prairies Ecozone⁺, 1971–2006. Percentages were calculated as percentage of total agricultural land. Source: Agriculture and Agri-Food Canada, 2009²²⁶

In 1986, 1996, and 2006, the average wildlife habitat capacity was “low” or “very low” on over 80% of the farmland in the Prairies Ecozone⁺ (over 10% of this was ranked as “very low”) (Figure 40). Despite slight shifts in the relative percentage among habitat capacity categories, there was no significant change in habitat capacity at the ecozone⁺ level.⁸⁴ Wildlife habitat capacity was constant on 92% of farmland, increased on 5%, and decreased on 3%. However, conversion of small parcels, such as grasslands on field margins and small wetlands in the Prairies,²⁴ can represent significant degradation of habitat capacity even when little change is detected at broader scales as was found here⁸⁴ (see Grasslands key finding on page 16 and Wetlands key finding on page 24 for discussion of loss of these habitats). Wildlife habitat capacity among ecoregions varied considerably; Moist Mixed Grassland Ecoregion had the lowest capacity and Cypress Upland Ecoregion had the highest, which was moderate capacity (Figure 40).⁸⁴

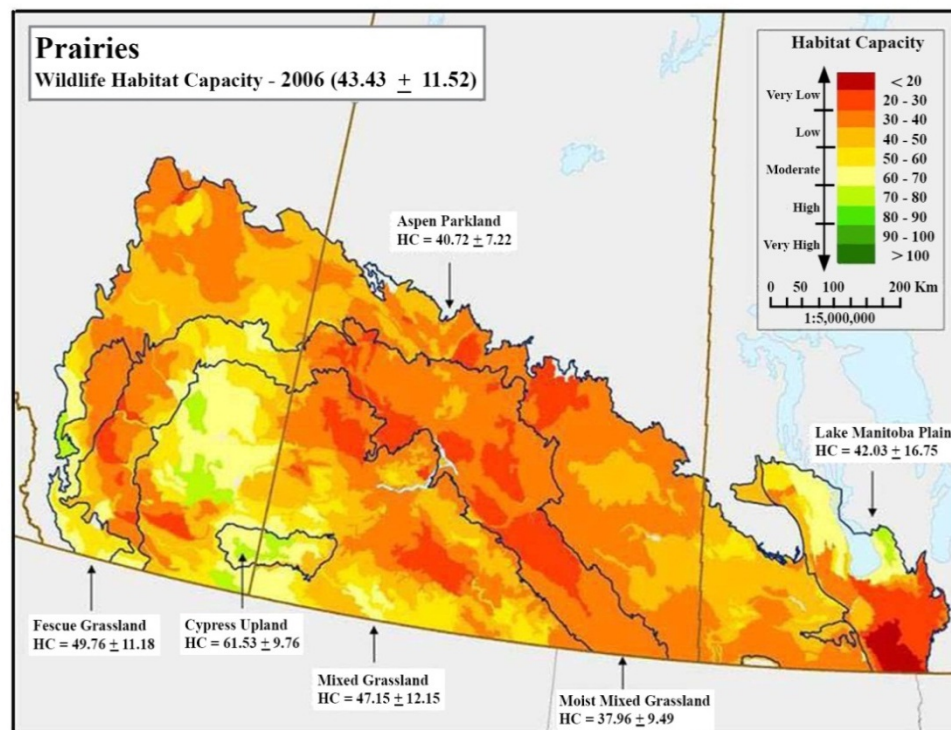
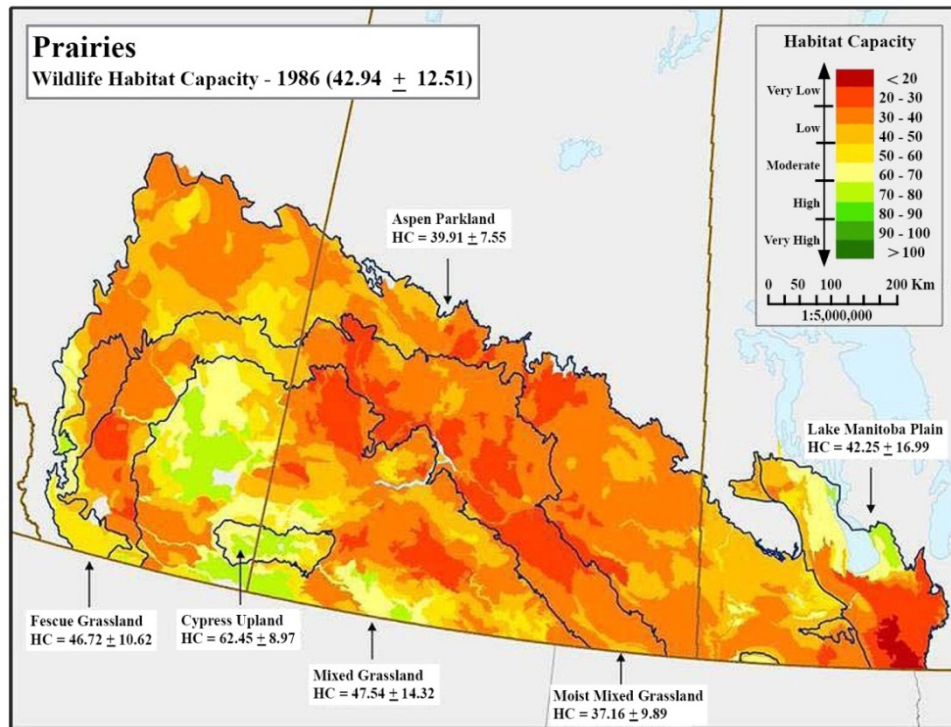


Figure 40. Wildlife habitat capacity on agricultural land in the Prairies Ecozone⁺ in 1986 (top) and 2006 (bottom).

HC means average Habitat Capacity for the ecoregion. All Soil Landscapes of Canada polygons with >5% agricultural land were included in the analysis.

Source: Javorek and Grant, 2011⁸⁴

Habitat capacity is a key indicator of an ecozone's ability to support biodiversity and can act as an umbrella indicator of how well overall ecological processes are functioning. Management practices also influence the ability of the land to support wildlife. The development of best management practices and stewardship initiatives has had positive results in some regions and for some cover types (see Stewardship key finding on page 36).

Soil erosion on cropland

Between 1981 and 2006, the proportion of croplandⁱⁱⁱ with very low risk of erosion increased from 64 to 84%, and the amount of land with moderate to very high erosion risk decreased from 18 to 7% (Figure 41).²²⁷ The reasons for these decreases in erosion risk are a combination of widespread adoption of conservation tillage, especially zero-till seeding, and a marked reduction in summerfallow. Further, some of the more erodible land has been converted from annual crops to perennial forages and tame pasture with associated dramatic reductions in erosion risk.²²⁷ Many of these changes are beneficial for biodiversity.

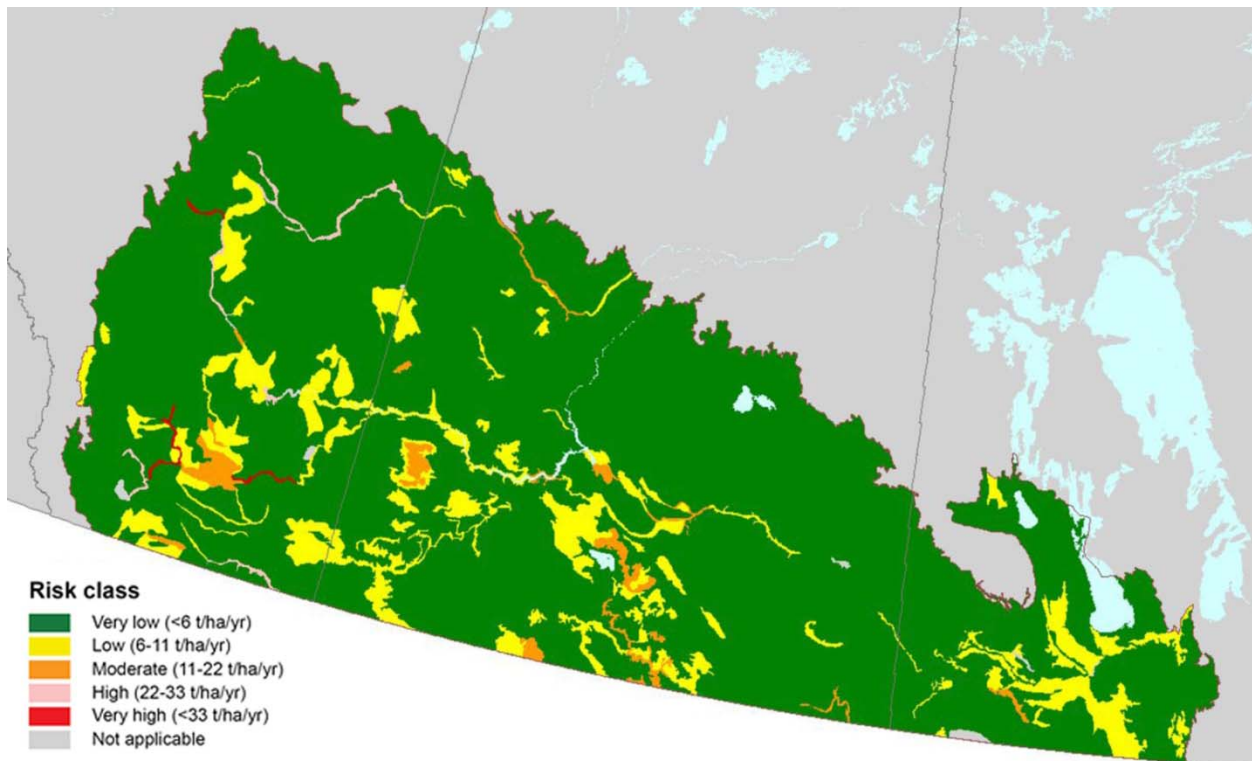


Figure 41. Soil erosion risk classes for cropland in the Prairies Ecozone⁺, 2006. All Soil Landscape of Canada polygons containing >5% cropland were included in the analysis and entire polygons are shown on the map. Source: McConkey et al., 2011²²⁷

ⁱⁱⁱ Cropland in this analysis also includes areas defined as Improved Pasture and Summerfallow in the Census of Agriculture. See McConkey et al., 2011²²⁷ for more information.

Conservation tillage

Farmers have been working with conservation agencies to reduce the impact of tillage operations on soil erosion. Conservation tillage is the practice of minimizing plowing and retaining protective crop residues to reduce soil erosion. Conservation tillage practices can also benefit waterfowl. The planting of winter wheat in the fall in a zero-till seeding practice eliminates the need for spring tillage thereby reducing disruption to nesting ducks. Application of these practices has increased since the early 1990s (Figure 42).^{110, 228}

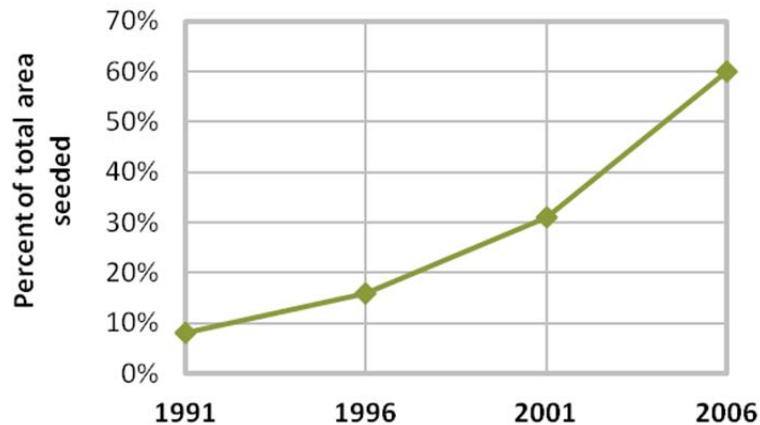


Figure 42. Application of zero-till seeding practices in Saskatchewan, 1991–2006.

Source: Prairie Habitat Joint Venture, 2006²²⁸

Key finding 17

Theme Habitat, wildlife, and ecosystem processes

Species of special economic, cultural, or ecological interest

National key finding

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.

Species at risk

As of 2014, 66 federally-listed species at risk were found in the Prairies Ecozone⁺: 25 listed as Endangered, 26 as Threatened, and 15 as Species of Special Concern.²²⁹ The list is dominated by birds (20 species), plants (16 species) and insects (15 species) and many of these species are unique to the ecozone⁺. Most of them are found in small, localized areas, but a few are grassland endemics whose populations are steadily declining, although they are still relatively widespread at present. Many of the plants and several vertebrates are associated with open or sparsely vegetated sand environments (see Dunes key finding on page 34). Some are “peripheral” species, occurring at the edge of their range, while others may have a significant

portion of their population in Canada but their numbers are declining, making them of global conservation concern.

Sprague’s pipit

Sprague’s pipit (*Anthus spragueii*) is listed as Threatened under Canada’s *Species at Risk Act*.²³⁰ It is a native grassland bird²³¹ and could be considered an indicator of grassland health for the Prairies Ecozone⁺. It breeds strictly in North America’s northern Great Plains, with most of the population in Canada. Sprague’s pipit has declined steadily over the past 45 years (Figure 43).²³² Habitat loss and habitat degradation (due to human disturbance, invasion by shrubs and non-native plants, and area and edge effects), and climate change are among the principal threats to Sprague’s pipit.¹⁵²

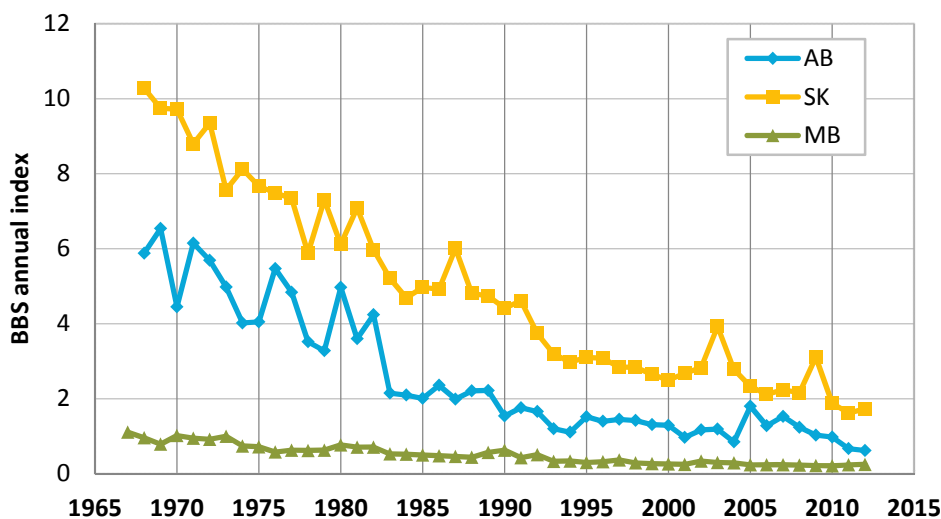


Figure 43. Trends in abundance of Sprague’s pipit as measured by the Breeding Bird Survey (BBS) in the Prairies Ecozone⁺ by province, 1967–2012.

The BBS annual index is a predicted number of birds per BBS transect based on a statistical model.

Source: Sauer et al., 2014²³²

Greater sage-grouse

Greater sage-grouse (*Centrocercus urophasianus*) is an indigenous North American grouse species that occurs in Canada and eleven western U.S. states. Canada’s population is the sub-species *C. u. urophasianus*, which occupies the silver sagebrush (*Artemisia cana*) grassland communities of southeastern Alberta and southwestern Saskatchewan, at the northern edge of the North American sage-grouse range.²³³ Greater sage-grouse is listed as Endangered under Canada’s *Species at Risk Act* because the very small population has declined substantially.²³³ In 2012, based on counts of male birds at leks (areas used for courtship displays), the population was estimated at 39–58 adults in Alberta and 54–80 adults in Saskatchewan (Figure 44).²³³ Populations have declined by 98% since their highest recorded population estimates in Alberta (1968) and Saskatchewan (1988). The number of active leks has also decreased by 76% in Alberta

and 93% in Saskatchewan. In 2012, there were only 5 active leks in Alberta and 3 in Saskatchewan.²³³

The main current and future threats to this species include drought and extreme weather conditions, West Nile virus, sensory disturbance from vertical structures and chronic noise, increased predator pressure, habitat loss and degradation, alteration of natural hydrology, and threats inherent to small populations.²³³

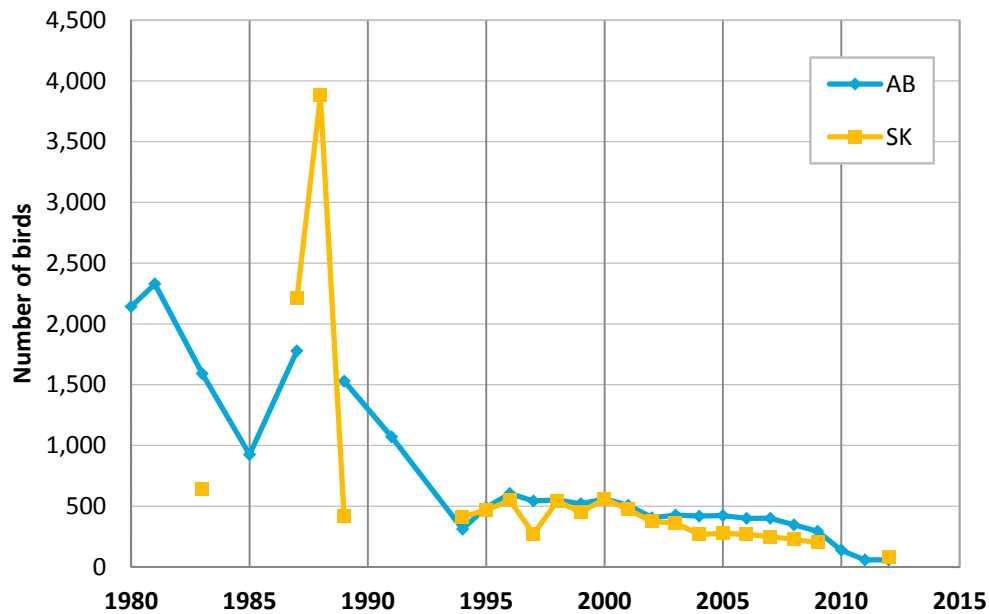


Figure 44. Population estimates for greater sage-grouse in Alberta and Saskatchewan, 1980s–2012. Estimates reported above are considered high estimates and use the high count of males on leks, assume a sex ratio of 2 females: 1 male, and also that only 90% of leks are known and only 75% of males attend leks. Only estimates for years in which surveys for a province were considered complete are shown. Source: Environment Canada, 2013²³³

In 2013, the Government of Canada published an Emergency Order to protect the greater sage-grouse on crown lands in southeastern Alberta and southwestern Saskatchewan.²³⁴ The Order, which came into force on February 18, 2014, prohibits activities that are known to be harmful to the birds and their habitat. In addition to the Order, private landowners are being encouraged to undertake voluntary stewardship measures and a captive breeding program has been initiated in partnership with the Calgary Zoo.

Burrowing owl

Burrowing owl (*Athene cunicularia*; Endangered²³⁰) is found across the Prairies Ecozone+ where it represents the northern limit of the species’ range. Its population in Canada declined strongly from the 1960s to 2007 (Figure 45). The Canadian population of burrowing owl in 2004 was estimated at 498 birds in Saskatchewan, and 288 in Alberta, but this estimate might be low by as much as 50%.²³⁵ A variety of causes for this decline have been suggested: loss of grassland habitat (the initial cause of the decline), greater emigration than immigration of birds from

Canada to the U.S., loss of burrows from declining burrowing animal populations, increased predation resulting from habitat changes, reduction in invertebrate food sources through the use of chemical pesticides, and vehicle collisions.²³⁵



Figure 45. Abundance of burrowing owls, 1969–2007.

Source: Canadian Wildlife Service, 2007²³⁶

Swift fox

The swift fox (*Vulpes velox*; Threatened²³⁰) is an example of a conservation success story. Originally occurring across the Prairies from Manitoba’s Pembina Hills to the foothills of the Rocky Mountains in Alberta, it was extirpated from Canada by the late 1930s.²³⁷ Attempts to reintroduce it started in 1983. Carbyn²³⁸ documented the release of 768 foxes from 1987 to 1995 and in 1996/1997, the Canadian population was estimated at 281 animals, of which 17% had been released and the rest were wild-born animals.²³⁹ By 2005/2006, the population had increased to an estimated 647 animals, with an additional 500 animals thought to be established in the adjacent region of Montana as a result of the Canadian reintroduction program. Although a success story so far, the population currently occupies only a small proportion of its original range, amounting to less than 300 km along the Canada-U.S. border in Alberta and Saskatchewan.

Freshwater fish

Based on data from the American Fisheries Society,²⁴⁰ the number of freshwater and diadromous fish taxa in this ecozone+ classified as imperilled has increased from two in 1979 to five in 2008. However, the assessment for lake sturgeon (*Acipenser fulvescens*) and shortjaw cisco (*Coregonus zenithicus*) improved between 1989 and 2008; they were downlisted to Vulnerable and Threatened, respectively.

Ungulates

Large ungulate populations have shown varying patterns of abundance and distribution, with some species increasing and others decreasing. Hunting is now regulated to prevent overharvesting, but populations continue to vary with weather fluctuations and habitat change.

Pronghorn

The pronghorn (*Antilocapra americana*) is a small-sized, fast-moving ungulate with two-pointed horns that is native to interior western and central North America.²⁴¹ Historically found from Manitoba's Red River to the edge of the Rocky Mountains in Alberta,²⁴² numbers were thought to equal or exceed those of bison on the Great Plains prior to European settlement. Conversion of grassland to cropland reduced pronghorn distribution to peripheral ranges, which historically supported low-density populations.²⁴³ Pronghorn numbers at the northern end of their range in Canada have always fluctuated widely because of mass emigration across the border or high winter mortality²⁴⁴ and were lowest at the beginning of the 20th century (Figure 46). They have recovered somewhat since then, although their range is still restricted. Sheriff²⁴¹ found that pronghorn abundance was strongly positively associated with native prairie. They are also highly dependent on sagebrush communities. The largest populations coincide with large expanses of remaining natural habitat. Threats include loss of movement corridors, barriers such as fences, and roads that can increase mortality risk.²⁴³

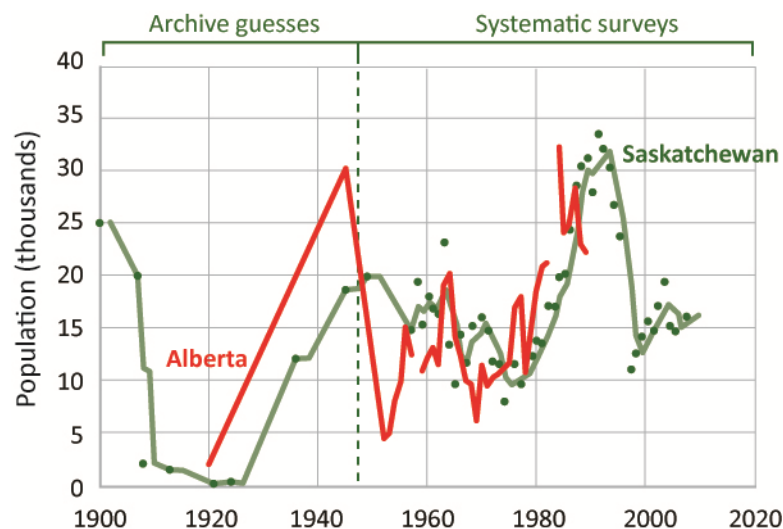


Figure 46. Pronghorn population trends in Saskatchewan (green line) and Alberta (red line), 1900–2008. Source: adapted from Arsenault, 2008²⁴³ (Saskatchewan) and Alberta Forestry, Lands and Wildlife, 1990²⁴² (Alberta)

Elk

Abundant in the Prairies prior to settlement, elk (*Cervus elaphus*) became largely restricted to pockets of forest²⁴⁵ but, since the 1990s, have begun to rapidly re-occupy non-forest habitats.^{108,}

164, 217, 246, 247

Moose

Moose (*Alces alces*), which typically occur in the Boreal Forest, have increased and extended their range into the Prairies since the late 1970s to mid-1980s.^{164, 217, 246} This expansion was likely a result of a reduction in hunter numbers, reduction or elimination of predators such as wolves and bears, and increasing amounts of woody vegetation.

Deer

Mule deer (*Odocoileus hemionus*) were the more common deer in the Prairies prior to European settlement, but are currently less abundant, being more restricted to open habitats with rougher topography.^{248, 249} White-tailed deer (*O. virginianus*) may have been largely absent from the Prairies Ecozone⁺ before European settlement.^{245, 248} They are very common, especially in the Aspen Parkland Ecoregion. Populations expanded rapidly in the 1940s and 1950s and have generally continued to expand.²⁵⁰⁻²⁵² Because the Prairies Ecozone⁺ is near the north end of the white-tailed deer's range, winter weather is the main factor limiting current populations, with fluctuations closely linked to severe winters.²⁵² The main reasons for expansion over the last 50 years have been reduced competition with mule deer, high quality and abundance of food provided by agriculture, and expansion of aspen.^{250, 253}

Birds

Landbirds

The Prairies Ecozone⁺ includes more grassland than any other ecozone⁺ and is the heart of range of many grassland birds in Canada. Grassland birds declined more rapidly than any other group of birds in North America since the 1970s,^{50, 50, 254, 255} and this is reflected in the results for the Prairies Ecozone⁺ (Figure 47) (see the Grasslands key finding on page 16).

In contrast, forest birds in the Prairies Ecozone⁺ increased by 35% in overall abundance since the 1970s (Figure 47). This assemblage benefitted from increased forest habitat as a result of tree planting on farms and in other settlements as well as the increased tree cover in areas of Aspen Parkland Ecoregion (see Forests key finding on page 15).^{17, 256} Birds of other open and shrub/early successional habitats were relatively stable and urban/suburban birds decreased as a group (Figure 47). Birds of forest, urban, and shrub/early successional habitats are a relatively small component of prairie avifauna.⁴⁹

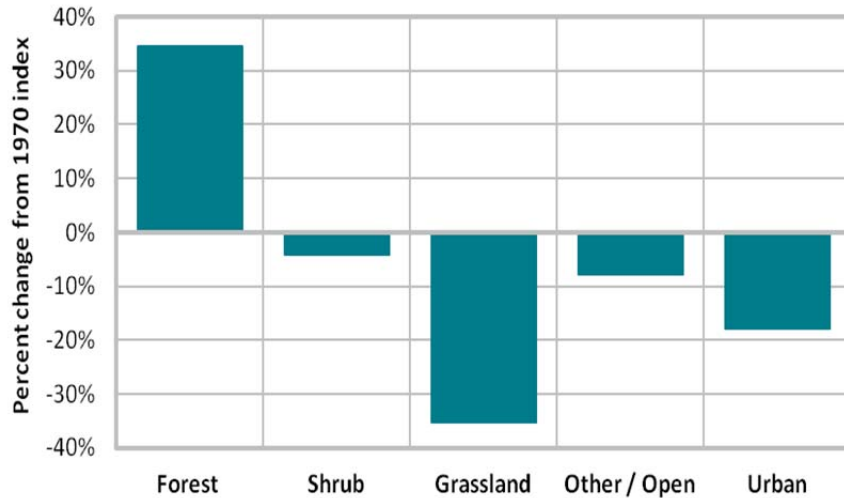


Figure 47. Change in abundance of landbirds by habitat for the Prairies Ecozone⁺ from 1970s to 2000s. Source: adapted from Downes et al., 2011⁴⁹ using data from the Breeding Bird Survey⁵⁰

Raptors

Because of their position high in the food web, raptors are indicators of ecosystem health. Data from the Breeding Bird Survey was analyzed to look at trends in raptor populations in the Prairies Ecozone⁺. Of the four species showing statistically significant trends, three were positive, while one, short-eared owl (*Asio flammeus*), was negative (Figure 48). Red-tailed hawk (*Buteo jamaicensis*) has increased 3.3%/yr, and it has replaced Swainson’s hawk (*Buteo swainsoni*) as the dominant *Buteo* and most abundant raptor in the ecozone⁺.²⁵⁷ This is probably due to the gradual expansion of tree cover.^{258, 259}

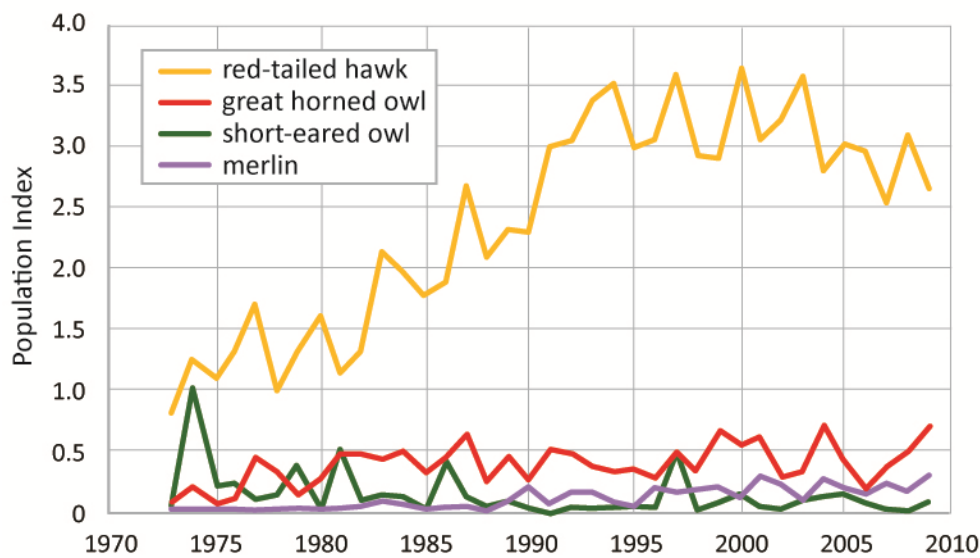


Figure 48. Population trends for raptors showing significant change in the Prairies Ecozone⁺, 1973–2009. Only raptors with significant trends ($p < 0.05$) are shown. Source: Environment Canada, 2010²⁶⁰

Waterfowl

The waterfowl found in the Prairies Ecozone⁺ are diverse, with a variety of different habitat requirements and migratory strategies. Some species winter on Canadian coasts while the majority winter in the U.S. and Mexico.⁵⁸ The Prairie Pothole Region (U.S. and Canada) is the world's most productive waterfowl habitat⁶² and, although it only covers 10% of the available breeding habitat in North America, it supports the highest densities of breeding waterfowl and can account for greater than 50% of annual continental duck production.^{58, 59} The Canadian Prairies produce 50–80% of the Prairie Pothole Region's duck population.²⁶¹ The Prairies Ecozone⁺ is also an important area for migrating waterfowl. Many ducks and geese that nest in the Arctic, sub-Arctic, and boreal forest pass through this area during migration, stopping in staging areas.

Some waterfowl species are showing long-term population increases. For example, Canada geese populations have increased by 765% since the 1970s due to their ability to adapt to a variety of habitats including farmland and urban areas.^{219, 262} Some species have declined significantly, such as northern pintail (*Anas acuta*) and American wigeon (*A. americana*). Other species, such as blue-winged teal (*A. discors*) and canvasback (*Aythya valisineria*), have shown little long-term change in their population size since the 1970s (Table 6).

Table 6. Abundance trends for selected breeding waterfowl species in the Prairies Ecozone[†], 1970s to 2000s.

Common name	Nesting habitat	Trend (%/yr)	P	Annual abundance index (in 1000s)				
				1970s	1980s	1990s	2000s	% Change
Canvasback (<i>Aythya valisineria</i>)	Overwater	0.3		198	146.7	192.7	206.2	4.2
Redhead (<i>Aythya americana</i>)	Overwater	0.7	*	279.2	202	285.1	307.5	10.1
Ring-necked duck (<i>Aythya collaris</i>)	Overwater	0.6	n	47.4	55.2	44.1	57.3	20.8
Ruddy duck (<i>Oxyura jamaicensis</i>)	Overwater	1.6	*	145.5	152.7	196.7	234.8	61.3
Bufflehead (<i>Bucephala albeola</i>)	Cavity	2.7	*	59.4	55.5	92.9	112.7	89.9
Northern pintail (<i>Anas acuta</i>)	Ground	-4.1	*	2795.3	944.8	816.8	835.5	-70.1
American wigeon (<i>Anas americana</i>)	Ground	-3.6	*	908.6	398.3	356.7	299.6	-67
Green-winged teal (<i>Anas crecca</i>)	Ground	-1.5	*	561.3	220.7	346.7	323.8	-42.3
Mallard (<i>Anas platyrhynchos</i>)	Ground	-1.1	*	3180.1	1801	2156.9	2221.2	-30.2
Blue-winged teal (<i>Anas discors</i>)	Ground	-0.1		2024.5	1242.2	1636.8	1835	-9.4
Gadwall (<i>Anas strepera</i>)	Ground	1.1	*	814.6	585.2	968.4	986.6	21.1
Northern shoveler (<i>Anas clypeata</i>)	Ground	1.2	*	899.9	654.7	1022.9	1254	39.3
Canada goose (<i>Branta canadensis</i>)	Ground	7.9	*	47.7	107.9	238.6	412.4	765.4

P is the statistical significance: * indicates $P < 0.05$; n indicates $0.05 < P < 0.1$; no value indicates not significant
 Source: Fast et al., 2011²¹⁹, using data from CWS and USFWS Waterfowl Breeding Population and Habitat Survey⁵⁹

Increased conversion of marginal land to cropland over the last four decades (see Agricultural landscapes as habitat key finding on page 63) has likely had continuing negative impacts on many breeding waterfowl on the Prairies through habitat loss and changes in predation patterns. For example, nest success for mallard (*Anas platyrhynchos*), northern pintail, northern shoveler (*A. clypeata*), blue-winged teal, and gadwall (*A. strepera*) is negatively associated with proportion of cropland.²⁶³

Climatic conditions, such as drought in the 1980s, also had a large impact on waterfowl populations; many populations steadily increased after the drought (Table 6). Wetland abundance and distribution affects several prairie breeding ducks (see Wetlands key finding on page 24).²⁶³⁻²⁶⁹ Northern pintail, blue-winged teal, mallard, and northern shoveler breeding

densities fluctuate with numbers of prairie ponds suggesting that these species fly over the prairies in drought years and settle in more northern ecozones²⁶⁸. These species, along with green-winged teal (*Anas crecca*), are dabbling ducks that are typically associated with shallow temporary and seasonal wetlands (i.e., ephemeral habitats). Consequently, some of these species may be more sensitive to fluctuating water conditions (which influences wetland densities) and wetland destruction than other species such as gadwall and diving ducks (e.g., canvasback, ruddy ducks), which are more associated with semi-permanent and permanent wetlands that are less susceptible to drought conditions and drainage.²⁶⁸ As such, duck species that use small wetlands prone to agricultural modification or destruction and climate fluctuations are generally the species that are declining (Table 6).

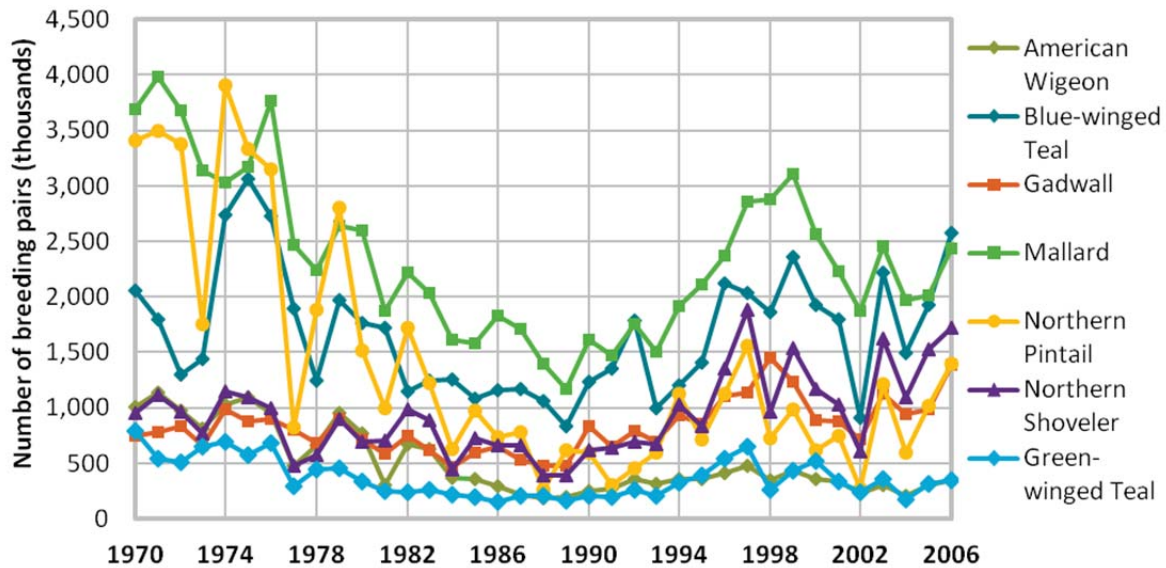


Figure 49. Population trends of selected ground nesting ducks in the Prairies Ecozone[†], 1970–2006. Source: Fast et al., 2011²¹⁹ using data from CWS and USFWS Waterfowl Breeding Population and Habitat Survey⁵⁹

Case study: northern pintail

Unlike most other waterfowl species, the northern pintail population in North America has remained well below the North American Waterfowl Management Plan goal of 5.6 million birds. In 2007, the population was 40% below the plan’s goal and 19% below the long-term average (Figure 50).²⁷⁰ Typically, the number of pintails that settled on the Prairie Pothole Region had a consistent and positive relationship with numbers of wetlands counted during May surveys. Since the early 1980s, however, the strength of this relationship had weakened²⁷¹ and there was no relationship between pintails and wetlands in the mid-1990s when water conditions were excellent. Comparison of population trends between the Canadian and U.S. portions of the Prairie Pothole Region indicate that most of the decline occurred in the southern Canadian portion of the region. A primary cause for the decline is the tendency of northern pintail to nest in standing stubble, mulched stubble, or fallow fields early in the season often

prior to seeding. The reduction of summerfallow and increase of spring seeding since the 1970s⁸⁴ has been linked to reduced nest success and a decline in the northern pintail population in the Canadian portion of the region.^{272, 273}

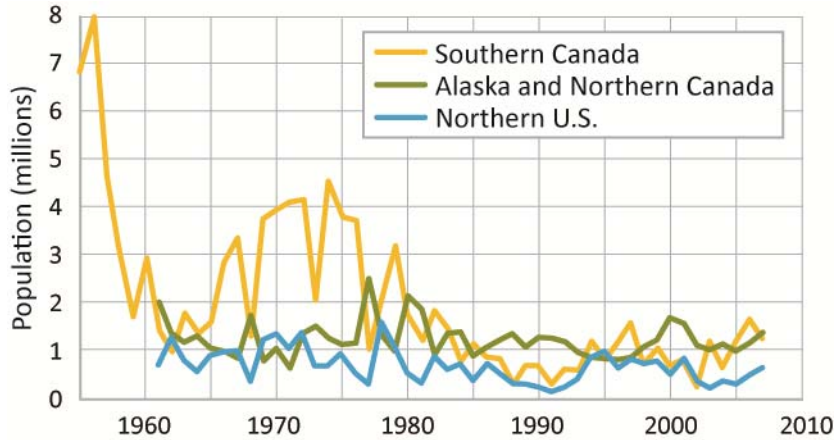


Figure 50. Comparison of northern pintail population trends in Alaska/northern Canada, southern Canada, and the northern U.S., 1961–2007.

Source: U.S. Fish and Wildlife Service, 2007⁵⁹ and Canadian Wildlife Service Waterfowl Committee, 2008²²⁰

Shorebirds

The Prairies Ecozone⁺ provides important habitat for both breeding and migrant shorebirds. This includes eight species whose breeding range in Canada is primarily or entirely in the Prairies: American avocet (*Recurvirostra americana*), marbled godwit (*Limosa fedoa*), piping plover (*Charadrius melodus*), Wilson’s phalarope (*Phalaropus lobatus*), black-necked stilt (*Himantopus mexicanus*), willet (*Tringa semipalmata*), long-billed curlew (*Numenius americanus*) and upland sandpiper (*Bartramia longicauda*). Data for these species was limited to the Breeding Bird Survey. Population totals of shorebird species tend to number in the tens to hundreds of thousands, with a few in the millions.²⁷⁴ The only species with a significant trend was marbled godwit, which declined by 1.1% per year since the 1970s.²⁷⁵ This is important as approximately 60% of the world’s population breeds in the Canadian Prairies.²⁷⁶ There is little information on population trends for the 31 species of shorebirds that regularly migrate through the Prairies in the spring and fall.²⁷⁷⁻²⁷⁹

Range changes

Major range shifts have occurred in a number of native species including white-tailed deer (see Deer on page 74), moose (see Moose on page 74), red-tailed hawk (see Raptors on page 75), and raccoon (*Procyon lotor*).²⁸⁰ Larivière²⁸⁰ documented the increase in raccoons in the Prairie provinces by examining fur sale records for each of the provinces. Sales of raccoon pelts in Manitoba climbed from near zero in 1960 to almost 1,000 in 1969, peaking at over 7,000 in the early 1970s. The increase in Saskatchewan occurred slightly later, starting in 1970, and numbers in Alberta showed little fluctuation above a low baseline through to 1985.

Climate change will also enable more warm water fish species to expand their ranges. The channel catfish (*Ictalurus punctatus*) is a native species that has increased its range, moving up the Qu'appelle River from Manitoba into Saskatchewan.¹¹⁴ Rainbow smelt (*Osmerus mordax*), an anadromous species of North America's east and west coasts, has appeared in Manitoba with the first report occurring in Lake Winnipeg in 1975. White bass (*Morone chrysops*), introduced to North Dakota in 1953, appeared in Lake Winnipeg 10 years later and by 1994 had become the most abundant spiny-rayed fish in the Lake's south basin.¹⁵⁷

Key finding 18

Theme Habitat, wildlife, and ecosystem processes

Primary productivity

National key finding

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 Normalized Difference Vegetation Index (NDVI), calculated from remote sensing data, is an indicator of the amount and vigour of green vegetation present on a landscape. Changes in NDVI are a proxy for changes in primary productivity. Trends in annual peak NDVI values over a 22-year period (1985–2006) were analyzed by Pouliot *et al.*²⁸¹ The significant results were then summarized by ecozone⁺ and visually compared to 1995 land cover (derived from Advanced Very High Resolution Radiometer data by the Canadian Centre for Remote Sensing²⁸²) by Ahern *et al.* (2011).⁷ Results show that, between 1985 and 2006, NDVI values increased for 157,491 km² (35.1%) of the Prairies Ecozone⁺ and decreased for 1,116 km² (0.2%) (Figure 51). Increases were distributed widely while decreases in NDVI were confined to a small area in southeastern Alberta. Broad increases in NDVI in this ecozone⁺ have also been shown by Slayback *et al.*,²⁸³ Zhou *et al.*,²⁸⁴ and Tateishi and Ebata.²⁸⁵

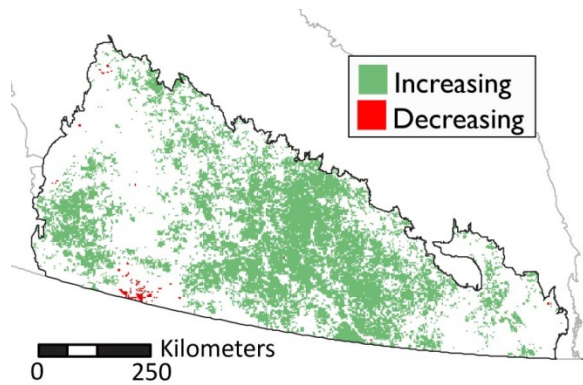


Figure 51. Change in the Normalized Difference Vegetation Index for the Prairies Ecozone⁺, 1985–2006. Trends are in annual peak NDVI, measured as the average of the three highest values from 10-day composite images taken during July and August of each year. Spatial resolution is 1 km, averaged to 3 km for analysis. Only points with statistically significant changes ($p < 0.05$) are shown. Source: adapted from Pouliot et al., 2009²⁸¹ by Ahern et al., 2011⁷

In an arid area like the Prairies Ecozone⁺, NDVI values are very sensitive to the amount and timing of precipitation.²⁸¹ It is possible that the increase in greenness that followed the drought of 2000 to 2002⁸³ may be responsible for the increases in NDVI. Increases in NDVI in the Saskatchewan portion of the ecozone⁺ were found to be highly correlated with changes in cropland area, suggesting that land cover is an important driver of NDVI trends.²⁸¹ Trend analysis is also complicated by the large proportion of land area in cropland; changes in agricultural practices will change NDVI values. For example, the decline in summerfallow will result in an increase in the average index.

Key finding 19

Theme Habitat, wildlife, and ecosystem processes

Natural disturbance

National key finding

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.

The main natural disturbance regimes that have historically shaped the Prairies include fire, drought, bison grazing, and large-scale native insect outbreaks.

Fire

Under pre-European settlement conditions, frequent fires were the predominant disturbance regime of grasslands in the Prairies Ecozone⁺. In addition to natural fires caused by lightning,²⁸⁶ some burning was anthropogenic.^{205, 287-289} There is no way to measure historic fire frequency, but 5–10 years is a “reasonable” estimate of the natural fire-return interval.¹⁶ Under modern conditions, prairie fires still start under dry conditions,¹⁶ sometimes ignited by lightning.²⁹⁰ They do not travel as far as they did historically, however, as a network of firebreaks in the form of

roads and cultivated fields break up the grassland,¹⁶ and accidental grass fires are aggressively suppressed to reduce damage to forage and facilities. No quantitative data were available for the extent or frequency of fires across the ecozone⁺.

In a review of threats to native areas in the Northern Great Plains of the U.S. and Canada, the Nature Conservancy²⁹¹ rated “loss of fire regime” as the second-most serious threat to this region. Fire is a natural and essential process which, like grazing, creates and maintains variety in the prairie landscape. In tallgrass prairie, however, Collins and Smith²⁹² found that frequently repeated burns reduce spatial variability and diversity, increasing the dominance of a few C4 grass species. In the mixed prairie, which covers most of this ecozone⁺, productivity is probably higher now than before European settlement, because fire causes a reduction in productivity that lasts for three years or more.^{16, 17, 293-295} In moister parts of the ecozone⁺, the reduction in fire frequency has led to increases in shrub and tree cover, because frequent fire tends to suppress woody plants and favour grasses.^{12, 13, 16, 17} In some areas, woody invasion threatens native grassland communities, such as the northern fescue prairie. Fire suppression may also contribute to sand dune stabilization, reducing habitat for certain rare species associated with active dunes.⁹⁹ Pylypec²⁹⁶ found that some birds such as horned lark increase after grassland fire, while others such as Sprague’s pipit, Baird’s sparrow (*Ammodramus bairdii*), and western meadowlark (*Sturnella neglecta*) decrease after fire.

Large-scale native insect outbreaks

Insect herbivores are an integral part of prairie ecosystems, with outbreaks of some native species functioning as disturbance agents. Grasshoppers (order *Orthoptera*) are the most significant insect pests to grasslands and cereal crops in many parts of the Prairies.²⁹⁷ Their populations increase when late summers are dry and warm,^{298, 299} and major grasshopper outbreaks occur after several consecutive years of warm, dry weather.²⁹⁷ No data were available on trends in the pattern of grasshopper outbreaks.

Forest tent caterpillars (*Malacosoma disstria*) and other insects can significantly defoliate trembling aspen in the Aspen Parkland Ecoregion in some years,³⁰⁰ and like the grasshoppers, outbreaks occur more frequently in warm, dry summers.³⁰¹ Outbreaks were much more frequent and severe in the Aspen Parkland in the 1980s and 1990s than in the 1940s to 1970s. They peaked in the early 1980s before severity declined in the early part of the 2000s (Figure 52).³⁰²

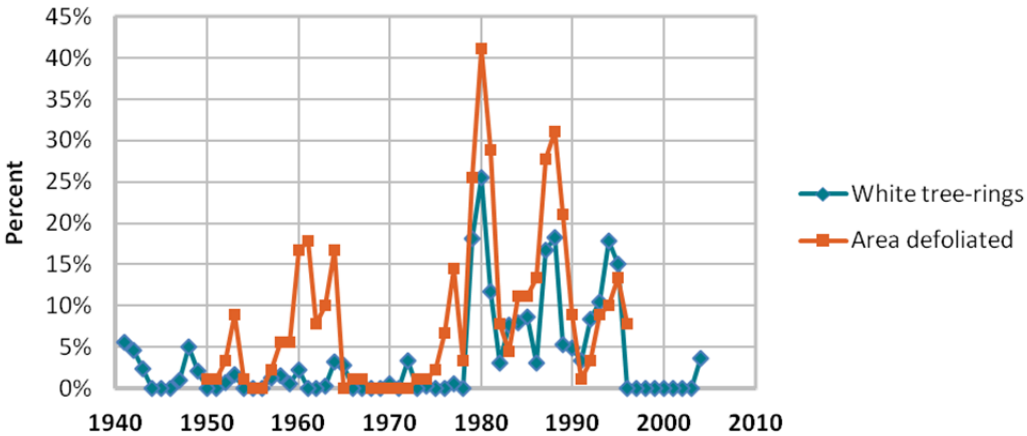


Figure 52. Trend in estimated percentage of area of aspen defoliated in the Aspen Parkland Ecoregion, based on plots monitored by the Canadian Forest Service, 1940–2005. The mean percent white rings from tree-ring analysis (blue line above) indicate years of severe insect defoliation. The orange line shows the estimated percent area with moderate to severe defoliation. The proportion of defoliated area is based on estimates from insect surveys of the area surrounding the plots. Defoliated aspen may have lower subsequent survival, potentially leading to underestimates of defoliation in early years based on white tree-ring method. Source: Canadian Forest Service, unpublished data³⁰²

Another insect disturbance agent of the Prairies Ecozone+ is the mountain pine beetle (*Dendroctonus ponderosae*), which is native to the unique lodgepole pine (*Pinus contorta*) forests of Cypress Hills. A significant outbreak occurred in the 1980s³⁰³ and the population was beginning to increase again in 2008.³⁰⁴

Key finding 20

Theme Habitat, wildlife, and ecosystem processes

Food webs

National key finding

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.

Changes to the food webs and trophic dynamics in the Prairies Ecozone+ have included changes in herbivore grazing patterns and intensity due to the replacement of bison herds with domestic livestock and the loss of large predators.

Herbivores

As discussed in the Grasslands key finding on page 16, the historic impacts of free-roaming bison on grasslands were thought to be very different from the impacts of confined bison herds and domestic beef cattle today. Although the relationships among grazing, grassland biodiversity, and invasive non-native plants are complex, the presence of a wide range of

grazing intensities appears better for maintaining prairie biodiversity than uniform grazing management.^{44, 45} In some areas, grazing regimes more similar to historic patterns have been implemented for conservation purposes (e.g., Grasslands National Park).³⁰⁵

Predators

Large predators, such as the grey wolf (*Canis lupus*) and grizzly bear (*Ursus arctos*), have been eliminated or substantially reduced as a result of European settlement (Figure 53).³⁰⁶ The decline of the grey wolf began with the extirpation of the plains bison in the late 1800s and continued due to over-hunting of ungulate prey and predator control.³⁰⁷ Across North America, the loss of the wolf has, among other impacts, resulted in increased abundances of ungulates, leading to increased browsing on vegetation.³⁰⁸ Although hunting has played a role similar to ungulate predation, it can also be selective based on age, sex, or other characteristics, leading to demographic effects on the overall population and decreased fecundity,³⁰⁹ or unintentional evolutionary consequences (e.g., selection for small antler size).³¹⁰ However, studies showing these effects have not been carried out in the ecozone[†].



Figure 53. Reduction in the ranges of three large carnivores in North America.
Source: after Hummel and Ray, 2008³⁰⁶

Because wolves tend to dominate other carnivores,³⁰⁷ the loss of wolves has probably contributed to increased coyote (*Canis latrans*) populations.³¹¹ In southeastern Alberta, coyote abundance increased 135% between 1977–1989 and 1995–1996.³¹¹ Coyotes eat a wide variety of foods including rodents, rabbits, woodchucks, songbirds, fruits, and domestic livestock (especially sheep). Although they do prey upon wild ungulates, much of the ungulate meat coyotes consume is from carrion.³¹² The shift in top predators from wolves, that mainly hunted ungulates, to coyotes, shifted the abundance and distribution of prey species. Coyotes are also a major predator of duck nests.³¹³ Coyotes, along with golden eagles (*Aquila chrysaetos*), are also the main predators of the reintroduced swift fox.^{311, 314-316}

Wildlife diseases and parasites

Wildlife diseases and parasites was initially identified as a nationally recurring key finding and information was subsequently compiled and assessed for the Prairies Ecozone⁺. In the final version of the national report,³ information related to wildlife diseases and parasites was incorporated into other key findings. This information is maintained as a separate key finding for the Prairies Ecozone⁺.

A wide variety of diseases affect wildlife in the Prairies Ecozone⁺:³¹⁷

- Avian influenza in wild ducks;
- Botulism in waterfowl;
- Avian cholera in migrating geese;
- Newcastle disease virus in double-crested cormorants (*Phalacrocorax auritus*);
- Ranavirus in amphibians;
- Chytrid fungus in amphibians;
- Epizootic hemorrhagic disease and Bluetongue virus in deer and pronghorns;
- Chronic wasting disease in deer and elk;
- Brainworm (*Parelaphostrongylus tenuis*) in deer, elk, and moose;
- Winter tick in moose;
- Tuberculosis in elk;
- Lyme disease in deer;
- Morbillivirus in carnivores such as the reintroduced swift fox and black-footed ferret (*Mustela nigripes*); and
- Plague bacterium in colonial ground squirrels and prairie dogs, which could also spread to black-footed ferret.

One disease (chronic wasting disease) and one parasite (botulism) are described in more detail below as examples of the known and potential impacts on native wildlife populations, along with an example of a disease impacting tree populations (Dutch elm disease).

Chronic wasting disease

Chronic wasting disease (CWD) is a fatal disease to members of the deer family (cervids; family *Cervidae*) resulting from ingestion of a misfolded version of a normal body protein called the prion protein.^{318, 319} CWD was first recognized as a clinical disease in 1967 in mule deer housed at a research station in Colorado.³¹⁹ The disease has spread widely in the U.S. and Canada (Figure 54), often in association with the sale and transport of farmed cervids. CWD was first reported in Canada in 1996 in captive elk on game farms in Saskatchewan.³²⁰ In 2000 it was detected in a wild mule deer and has since been detected in four separate geographical areas of the Prairies Ecozone⁺ in mule deer, white-tailed deer, and elk. CWD is a serious ecological and economic concern to Canada. The approximately 1.8 million white-tailed deer, 350,000 mule deer, 100,000 elk, and 900,000 moose in Canada are susceptible to CWD and there are no natural

barriers to prevent its spread from its current locations to the rest of the country.³²¹ A CWD disease control and eradication policy was implemented by the Canadian Food Inspection Agency (CFIA) in October 2000. Testing is mandatory in Manitoba, Saskatchewan, Alberta and the Yukon. Where captive animals have tested positive, exposed herds have usually been destroyed to minimize the risk of spread.³²²

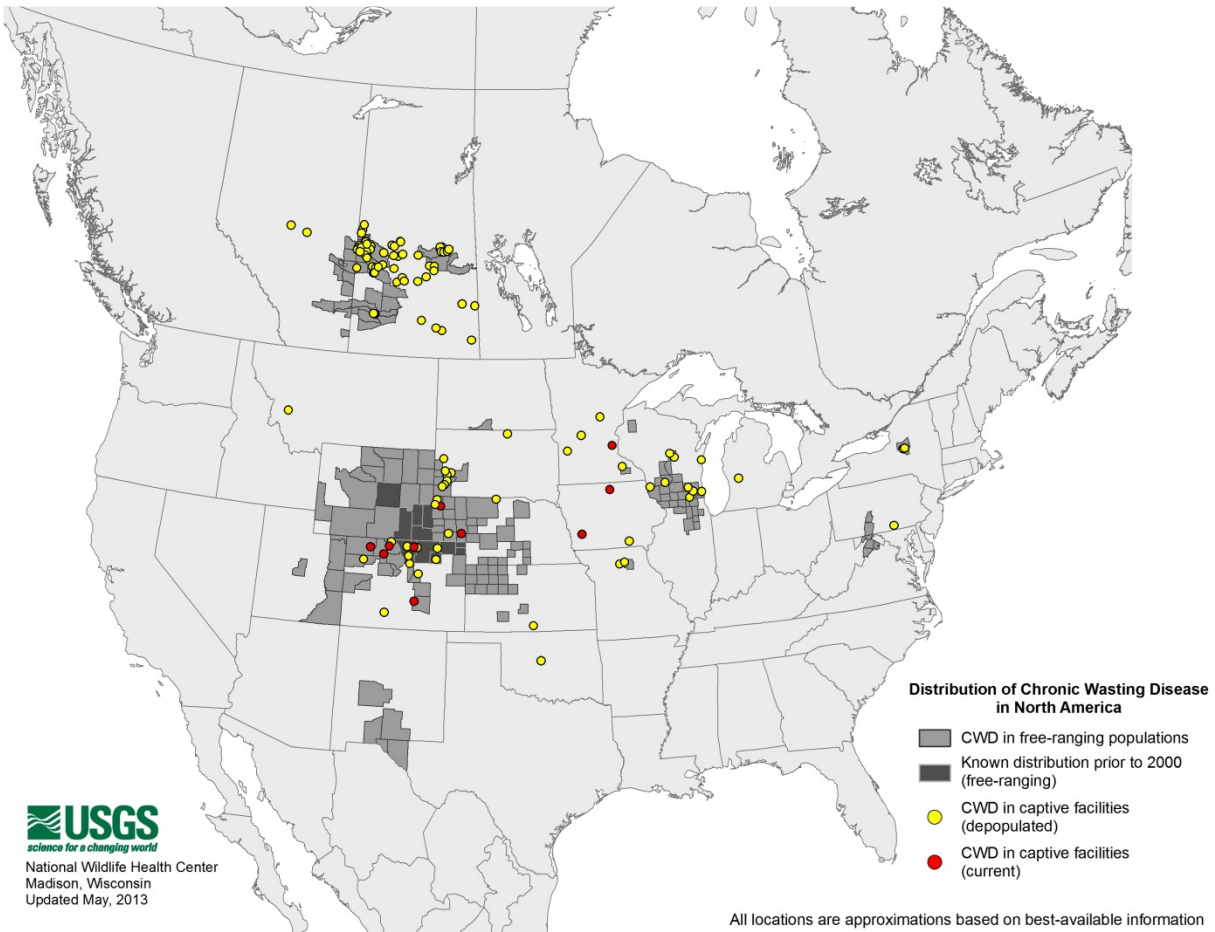


Figure 54. Distribution of Chronic Wasting Disease in North America, 2013.

“Depopulated” means that all cervids on the farm were killed by government authorities as per the North American response to CWD.

Source: USGS National Wildlife Health Center, 2013³²³

Botulism

Botulism is a form of food poisoning associated with the ingestion of powerful toxins produced by various strains of the bacterium *Clostridium botulinum*. Although it has occurred in other ecozones⁺, type-C botulism has caused large and recurrent epidemics only in the Prairies Ecozone⁺, affecting waterfowl, especially ducks. The alkaline wetlands of the Prairies Ecozone⁺ are habitats favourable to type-C botulism. In the mid-1990s, repeated years of high mortality occurred in southern Alberta, Saskatchewan, and Manitoba. For example, over 100,000 ducks

died in late fall at Old Wives' Lake in southern Saskatchewan in 1996, and total mortality from June to October was approximately one million birds.^{324, 325} These outbreaks were associated with summer drought conditions during which many of the small wetlands used by waterfowl for nesting were dry and large numbers of birds were concentrated on a small number of large wetlands where suitable habitat remained available. There was a marked reduction in mortality from botulism in subsequent years when precipitation relieved drought conditions.³²⁵

Dutch elm disease

Dutch elm disease is a fungal disease of elm trees. Since its introduction to Canada in Quebec in about 1940, it has spread quickly, invading Ontario by 1946, the Maritimes by 1957, Manitoba by 1975, and Saskatchewan by 1981.³²⁶ Control measures have generally focused on urban areas and as a result, wild trees have suffered high mortality rates. In Saskatchewan, mortality rates exceeded 80%.³²⁷ In Winnipeg, 40,000 city elms were lost over the past 20 years, with 200,000 remaining.³²⁸ Isolated pockets of wild trees occur as far west as Saskatoon and Assiniboia and these are probably the only natural populations in Canada that remain uninfected.³²⁷

THEME: SCIENCE/POLICY INTERFACE

Key finding 21

Theme Science/policy interface

Biodiversity monitoring, research, information management, and reporting

National key finding

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.

Monitoring, research, information management, and reporting on biodiversity vary widely in the provinces comprising the Prairies Ecozone⁺.

The Alberta Biodiversity Monitoring Program was initiated in the late 1990s, with the goal of linking policy development, resource management, and science using appropriate measures of biodiversity.³²⁹ A regular grid of sample points at 20 km intervals covers the entire province. At approximately five-year intervals, biological surveys are conducted for vascular plants, mosses, lichens, birds, mammals, fish, invertebrates, and algae.³³⁰ These data will measure trends in these taxa and relate them to land use. No other province has a comparable program. However, although the program has established a regular grid across Alberta, sampling has not been initiated in most of the Alberta portion of the Prairies Ecozone⁺ at this time.

Since the 1970s, Alberta has also maintained a Rangeland Reference Area Program to monitor trends in productivity and species composition in a network of plots (183 plots in 2004) representing different types of rangeland.³³¹ Similar programs initiated in Saskatchewan and

Manitoba have fewer numbers of plots. Alberta³³² and Saskatchewan³³³ also developed standardized rangeland health assessment methods, although these have not yet been applied to a monitoring program for the Prairies Ecozone⁺.

The Breeding Bird Survey⁵⁰ provides the most complete information on non-game and non-colonial bird populations for the Prairies Ecozone⁺. Because the transects are randomly selected in one-degree blocks (within the constraint of using roads as routes), the results are relatively representative of common habitats in the region and therefore representative of the most common bird species. The results are best used as an index of population trends rather than for estimating actual numbers of individuals.

Breeding Bird Survey routes in the Prairies tend to be located in agricultural areas where there is a good road network and where there has been substantial loss of native grassland. The remaining areas of extensive grassland in the prairies are concentrated in a relatively small area, often with poor road access, and so there is sparse Breeding Bird Survey coverage in areas where the grassland bird density is high. The Grassland Bird Monitoring program,⁵³ which began in 1996, provides supplemental data to the Breeding Bird Survey. Surveys are located in areas of southeastern Alberta and southwestern Saskatchewan where grassland is still common.

The best data on waterfowl species distribution, abundance, and community composition come from the joint Canadian Wildlife Service and U.S. Fish and Wildlife Service Waterfowl Breeding Population, and Habitat Survey.⁵⁹

The provinces also conduct targeted surveys for big game animals and other species of special concern, while both provincial and federal agencies are involved in targeted surveys for individual species at risk.

All three Prairie provinces have conservation data centres under the umbrella of NatureServe Canada. These centres develop lists of plant and animal species for their jurisdictions, maintain data on recorded occurrences of these species, and assign conservation status ranks.³³⁴⁻³³⁶

Key finding 22

Theme Science/policy interface

Rapid change and thresholds

National key finding

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.

Predictions of future climate change (see Climate change key finding on page 57) focus on trends in average climate. However, changes in climatic variability may be of even greater concern. The Prairies Ecozone⁺ is characterized by wide fluctuations in precipitation from year to year, and multi-year droughts occurred in the 1890s, 1910s, 1930s, 1960s, 1980s, and 2001 and 2002. Drought in the mixed prairie causes an immediate reduction in grass growth, while multi-year drought causes a shift in composition from taller to shorter grass species.¹⁹⁹ The result is

poorer habitat for those species that require taller vegetation. Research in North Dakota has shown that most grassland birds are less abundant in dry years, with species such as grasshopper sparrow (*Ammodramus savannarum*), Sprague's pipit, clay-coloured sparrow (*Spizella pallida*), and Baird's sparrow being most likely to decline.^{337, 338} Drought also reduces the area of shallow lakes and wetlands, resulting in reduced waterfowl populations. Climate change over the coming century is predicted to increase the frequency and severity of droughts.³³⁹ If droughts occur often enough to prevent complete recovery of species and ecosystems in the intervening moist years, this could lead to more rapid ecological changes than implied by the average trends. In addition, it could also threaten the viability of prairie agriculture.

CONCLUSION: HUMAN WELL-BEING AND BIODIVERSITY

Human/ecosystem interactions have been a the key driver of changes in this ecozone[†], with over 70% of the original landscape converted from natural vegetation to cropland over a span of about a century. Remaining natural areas are fragmented and, in many cases, have been further altered by changes to natural disturbance regimes. This has altered the capacity of the landscape to support biodiversity and deliver ecosystem goods and services. Channeling of primary production into agricultural crops and of secondary production into livestock has increased provisioning services but decreased many regulating and cultural services. Superimposed on this structural change has been change in community composition resulting particularly from invasion of non-native species, with more subtle effects on the delivery of ecosystem goods and services.

The addition of fertilizers has altered nutrient cycling on agricultural land. Nutrient loading from agricultural runoff and municipal effluents has accelerated the eutrophication of water bodies, causing algal blooms and reducing habitat for some fish and other biota. Habitat capacity has been reduced through fragmentation and large-scale land conversion. The reduction in this capacity is manifested in the decline of grassland birds in general, and of many species at risk.

Accelerated climate change threatens the productivity of the landscape. Primary productivity has been harnessed for the benefit of humans, but those benefits do not translate positively for all biodiversity. As a result, ecosystems have been converted in their composition and structure to ones that support human life in a way much different from pre-European settlement. One consequence these interactions have on biodiversity is a reduction in the landscape's resiliency to disturbance.

Despite the extent of human modification to the landscape, the remaining natural areas, including grasslands, woodlands, and wetlands, are still significant for biodiversity, supporting important and unique flora and fauna. Many grasslands continue to support both biodiversity and livestock grazing, which under proper management can be highly compatible with conservation goals. The landscape also provides services such as water, crop pollination, nutrient cycling, traditional foods, hunting, fishing, and outdoor recreation.

The key to conserving biodiversity and preventing further fragmentation, loss, and degradation of habitats and ecosystems will be continued application and strengthening of federal and provincial regulations and policies complemented by work with landowners and industry to increase stewardship activities. With respect to stewardship, advances have been made in this area, particularly with agricultural producers; nevertheless, losses and degradation continue.

It is difficult to gauge the impacts to biodiversity, natural disturbances, and ecological processes due to the lack of an adequate monitoring network.

The Prairies Ecozone⁺ represents a unique challenge to find methods to conserve biodiversity in a region so important to human food production. The two are inextricably linked, as without the supporting services of healthy ecosystems, food production is not sustainable.

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