Western Interior Basin Ecozone+ evidence for key findings summary

Canadian Biodiversity: Ecosystem Status and Trends 2010

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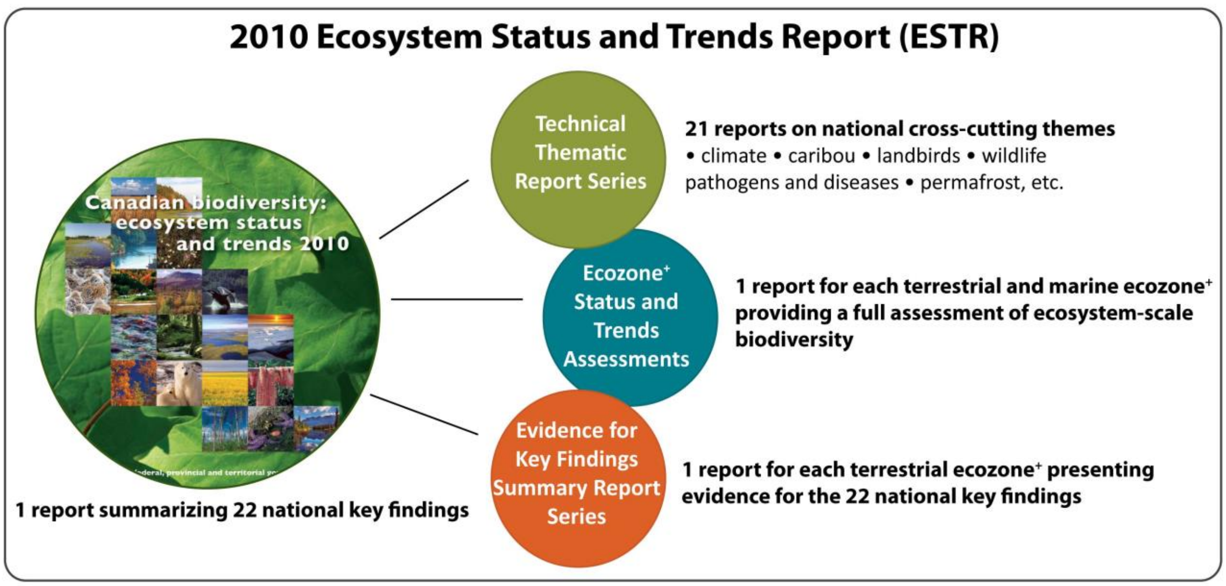
PREFACE

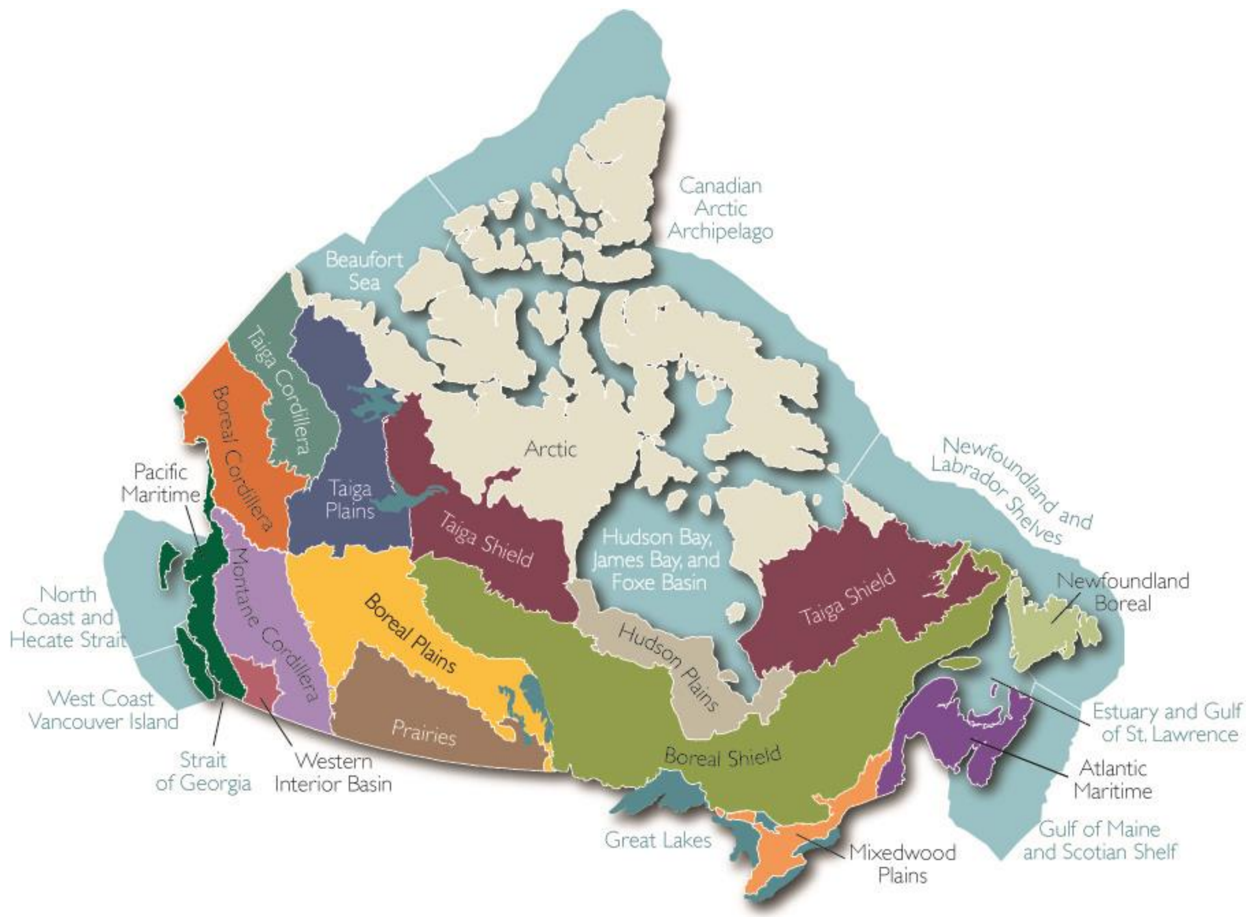
The Canadian Councils of Resource Ministers developed a Biodiversity Outcomes Framework[1] in 2006 to focus conservation and restoration actions under the *Canadian Biodiversity Strategy*.[2] *Canadian Biodiversity: Ecosystem Status and Trends 2010*[3] was the first report under this framework. It presents 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 Assessments). 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, *Western Interior Basin Ecozone+ Evidence for Key Findings Summary*, presents evidence from the Western Interior Basin Ecozone+ 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. 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*,[4] 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.[5] The boundary of the Western Interior Basin Ecozone+ is the same as the Southern Interior Ecoprovince of BC's Ecoregion Classification System.[6]



Acknowledgements

The ESTR Secretariat acknowledges Rowena Rae and Gregg Sheehy for the preparation of various drafts of the report. This report was overseen and edited by Trish Hayes and Emily Gonzales. Kelly Badger was the lead graphics designer. Additional support was provided by Jodi Frisk, Michelle Connolly, and others. It is based on the draft Western Interior Basin Ecozone+ Status and Trends Assessment. Other experts made significant contributions to that draft report and are listed below. Reviews were provided by scientists and resource managers from relevant provincial/territorial and federal government agencies. The Canadian Society of Ecology and Evolution also coordinated reviews with external experts.

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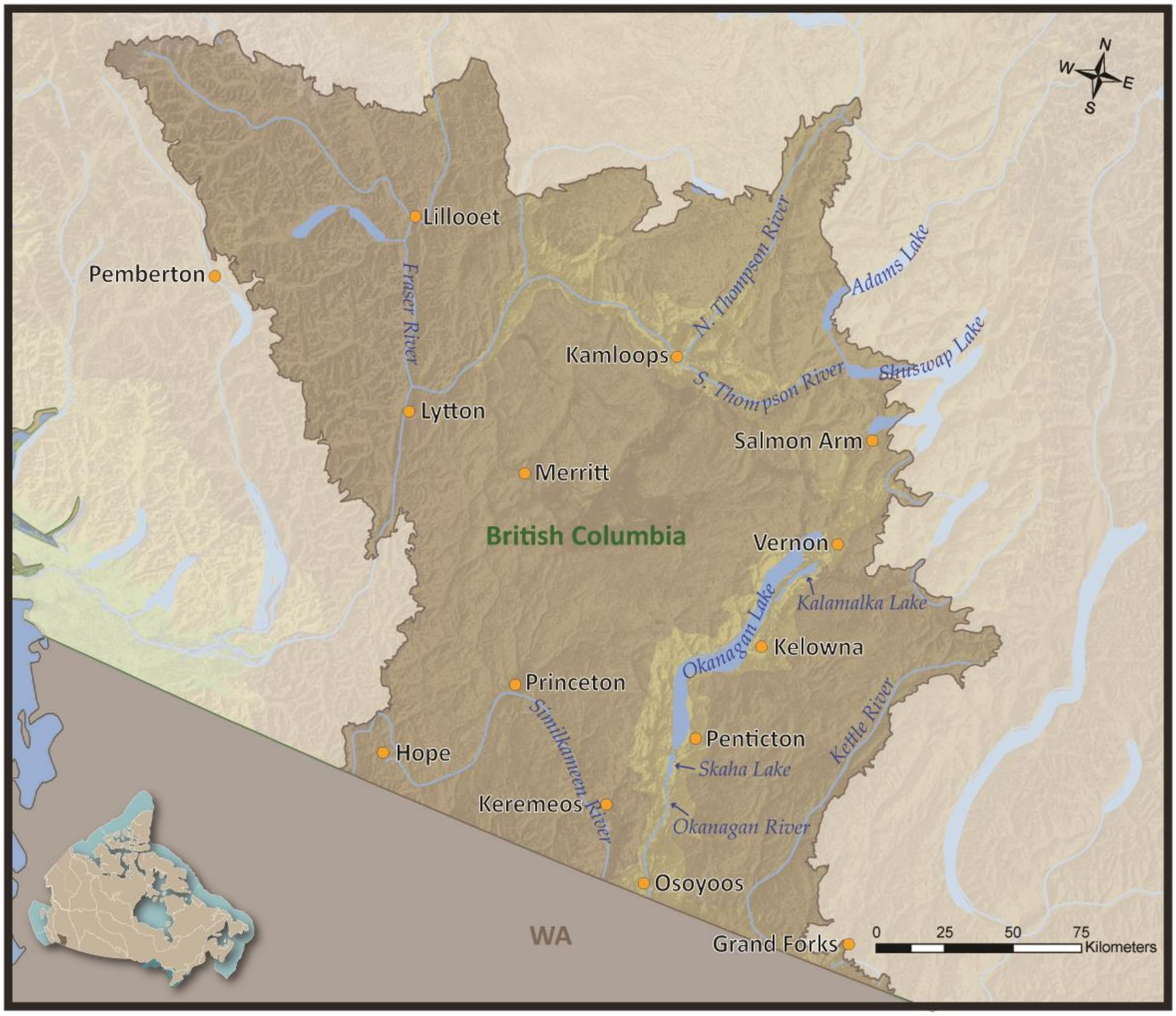


Figure 1. Overview map of the Western Interior Basin Ecozone+.

ECOZONE^{+} BASICS

The Western Interior Basin Ecozone^{+} (WIBE), shown in Figure 1 and summarized in Table 1, occupies the southern interior portion of British Columbia (BC) (see national map on page ii). The boundary of the WIBE is the same as the Southern Interior Ecoprovince of BC's Ecoregion Classification System.[6]

The WIBE includes a wide range of ecosystem types, including forests, grasslands, wetlands, large and small lakes, major rivers and small streams, and some alpine and glaciated areas. It is unique in Canada for representing the northern extent of the Great Basin desert and has very high species richness and species rarity.

The ecozone^{+} has hot, dry summers, moderate winters, and, because it is largely in the rain shadow of the coastal mountains, relatively low precipitation.

Table 1. Western Interior Basin Ecozone^{+} overview.

Area	57,071 km^2 (0.6% of Canada)
Topography	Generally rolling Created through mountain building, glaciation, and subsequent erosion Mountainous in the west and northwest regions
Climate	Dominated by the rain shadow effect of the coastal mountains, which limits precipitation Hot, dry summers and moderate winters
River basins	Thompson River draining to the Fraser River Fraser River draining to the Pacific Ocean Okanagan River draining to the Columbia River in Washington State Similkameen River draining to the Okanogan River in Washington State Kettle River draining to the Columbia River in Washington State
Geology	Surficial materials primarily till (70%) Contains the only significant concentration of black and brown chernozem soils in BC[7]
Settlement	Kamloops is the largest settlement in the Thompson region Lillooet is the largest settlement along the portion of the Fraser River within this ecozone^{+} Vernon, Kelowna, and Penticton are the largest settlements in the Okanagan region Princeton is the largest settlement in the Similkameen region Grand Forks is the largest settlement in the Kettle region From 1971 to 2006, the population of the ecozone^{+} more than doubled, principally due to growth in the Thompson and Okanagan regions
Economy	Services, agriculture, and forestry are major employers
Development	The central Okanagan (Kelowna and surroundings) and south Okanagan (Penticton and surroundings) are experiencing high growth rates
National/global significance	The WIBE includes many species at risk and is ecologically unique in Canada, because parts of the ecozone^{+} are the northward extension of the Great Basin sagebrush-dominated desert and its grasslands[8]

Jurisdictions: The WIBE is contained entirely within BC. The traditional territories for the Northern Shuswap Treaty Society (Northern Secwepemc te Qelmucw Nation), St'at'imc Nation, Tsilhqot'in Nation, Lil'wat Nation/Mount Currie, N'Quat'Qua, Sto:lo Tribal Council, Peters, Stó:lo Xwexwilmexw Treaty Association, Westbank, and Yale overlap the WIBE boundaries. Esk'etemc, In-SHUCK-ch Nation, Ktunaxa Kinbasket Treaty Council, Laich-Kwil-Tach Council of Chiefs, Stoney Indian Band, Union Bar, Chehalis, Skwah, Douglas, and Xwémalhkwu Nation are adjacent to the WIBE.

Human population growth is increasing rapidly in the ecozone+ (Figure 2), particularly in the north, central, and south Okanagan (Figure 3). Parts of the landscape have been substantially altered for urban development and agricultural conversion. Forestry is also a major industry.

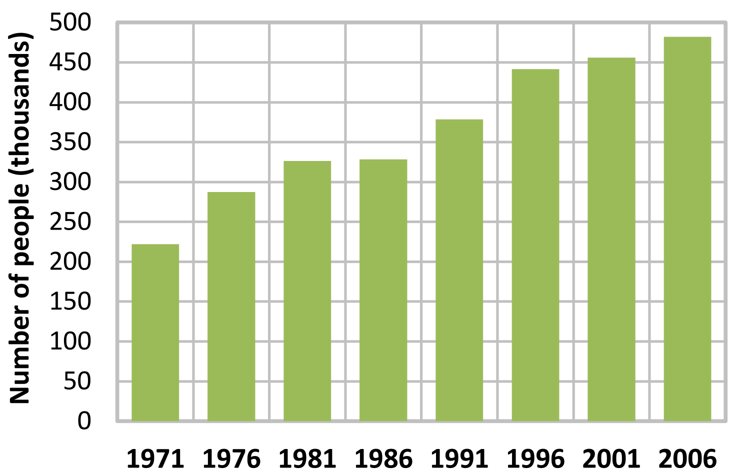


Figure 2. Human population from 1971 to 2006 in the Western Interior Basin Ecozone+.
For these data, the WIBE was approximated by the Southern Montane Cordillera Ecoprovince of the National Ecological Classification System. There are minor discrepancies between these borders, but no cities occur in the non-overlapping areas.
Source: compiled from Statistics Canada, 2000[9] and 2008[10]

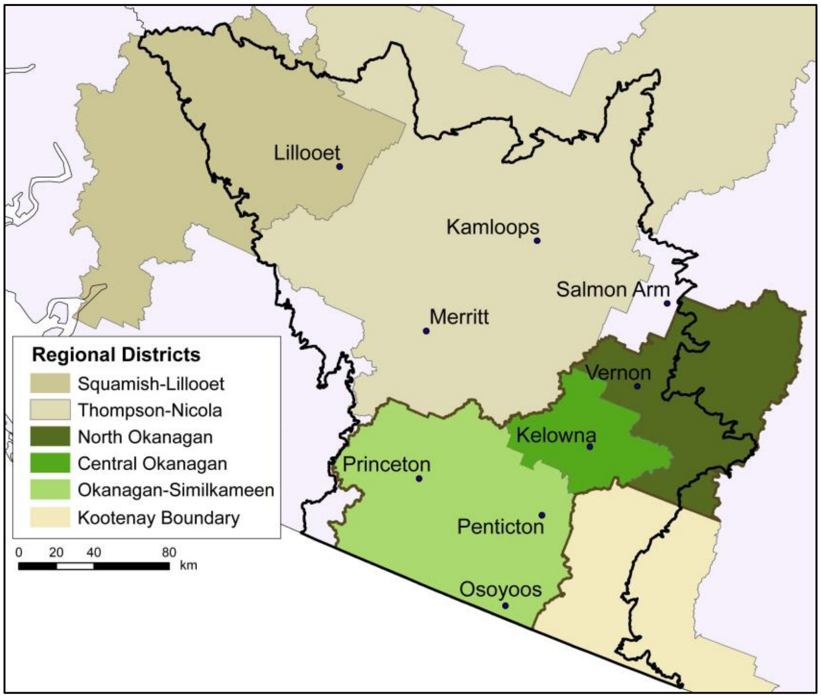


Figure 3. British Columbia regional districts in the Western Interior Basin Ecozone[+].
The Okanagan is comprised of the three districts in green.
Source: BC Ministry of Forests, Lands and Natural Resource Operations, 2007[11]

Based on 2005 remote sensing data, forest is the predominant land cover in the WIBE (Figure 4). Approximately 14% is covered by grassland/shrubland habitats, which support high biodiversity and provide corridors for animal movement from the Columbia Basin to the south into the shrub-steppe and interior forests to the north.

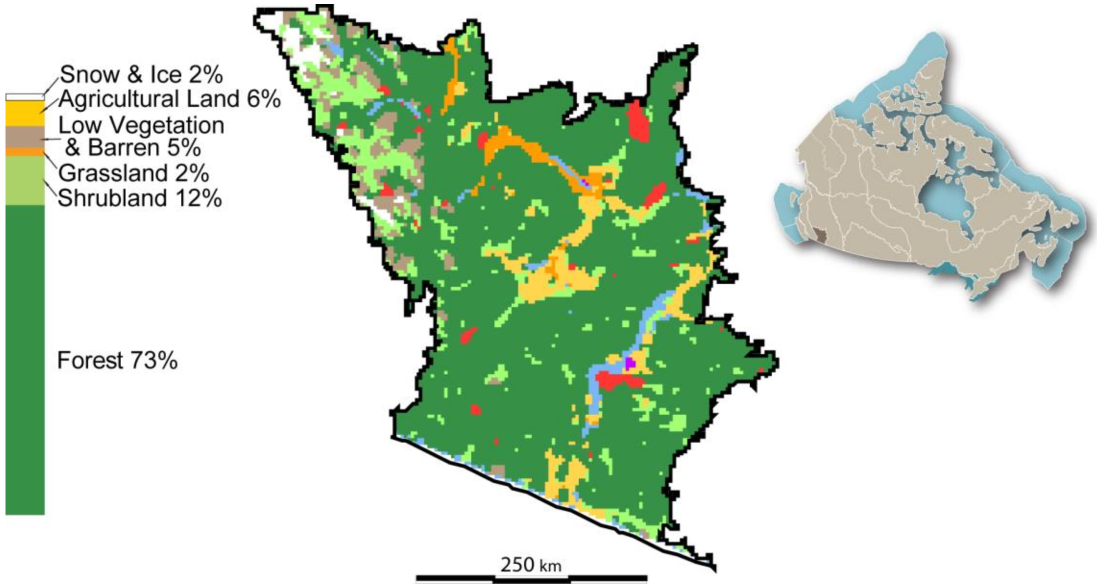


Figure 4. Distribution of major biomes in the Western Interior Basin Ecozone+ by remote sensing, 2005. Blue areas represent inland water bodies derived from the National Atlas of Canada; these were not included in the analyses.
Source: Ahern et al., 2011[12].

West Kettle River © R. Rae

Okanagan Lake shore, near Summerland © R. Rae

Landscape on Okanagan Mountain two years after the 2003 wildfire; Okanagan Lake beyond © R. Rae

Mountain goats, Cathedral Park © R. Rae

Ponderosa pine, near Summerland © R. Rae

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 WIBE. 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. See the Preface on page i.

Table 2. Key findings overview.

Themes and topics	Key findings: NATIONAL	Key findings: WESTERN INTERIOR BASIN 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 73% of the WIBE. Intact forests larger than 100 km^2 cover 22%, largely in the mountainous western portion. The extent of lower elevation forests declined between 1800 and 2005; for example, Douglas-fir ecosystems declined by 27% and ponderosa pine ecosystems by 53%.
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.	Grasslands cover 2% of the WIBE. Although the rate of loss has slowed since 1990, 16% of grasslands were lost to development between 1850 and 2005. Grasslands outside of protected areas are at risk of conversion to agricultural, commercial, and residential uses. Stressors that compromise grasslands in the WIBE include invasive species and fire suppression.
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 occupy <1% of the WIBE. Between 1800 and 2005, 85% of low-elevation wetlands were lost. Wetlands continue to be lost and degraded by urbanization, intensive agriculture, and, in some areas, heavy recreational use. In addition, invasive species and climate change pose serious threats.

Themes and topics	Key findings: NATIONAL	Key findings: WESTERN INTERIOR BASIN ECOZONE[+]
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.	Lakes, rivers, and streams cover 2% of the WIBE. There are high demands on scarce water supplies. Lake level fluctuations, tributary stream habitat loss, changes in nutrient levels, and an invasive shrimp have altered Okanagan Lake. Most Okanagan streams and headwater lakes have been dammed. Although 1 km is being restored, 93% of the Okanagan River was altered by channelization.
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.	Glaciers in the Bridge River Basin retreated by 8 km^2 (7%) between 1995 and 2005 and Place Glacier experienced a 37-metre reduction of ice thickness from 1964 to 2008.

Themes and topics	Key findings: NATIONAL	Key findings: WESTERN INTERIOR BASIN 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.	In 2009, 5,000 km^2 (9%) of the WIBE was federally or provincially protected. The Interior Dry Plateau natural region, characterized by the South Okanagan and Lower Similkameen, is unrepresented in the national park system.
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.	Many organizations, agencies, and groups are involved in stewardship activities in the WIBE. In the South Okanagan, covenants, conservation organizations, and landowners care for 13% of the shrub-steppe and wetland/riparian habitats that occur on private lands. There are no syntheses of participation rates or stewardship activities for the WIBE.
Ecosystem conversion*	Ecosystem conversion was initially identified as a nationally recurring key finding and information was subsequently compiled and assessed for the WIBE. 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 WIBE.	Ecosystem conversion and fragmentation are the primary threats to biodiversity in the WIBE. Historically, most high-value riparian and wetland ecosystems and a substantial portion of low elevation grassland/shrubland ecosystems were converted to other uses. From 1991–2001, >22% of low elevation habitats were converted. The WIBE also has the second highest road density (1.7 km of road/km^2) among the 10 regions of BC.
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.	Impacts of invasive non-native species in the WIBE include lowered real estate values, reduced quality of fish habitat, displaced native species, clogged irrigation pipes, decreased quality of forage for wildlife and livestock, and reduced recreational opportunities. Biological, chemical, and mechanical control are used to manage the priority invasives among the hundreds of non-native species that have been recorded in the WIBE.

* 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: WESTERN INTERIOR BASIN ECOZONE+
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.	In the 1990s, increased contaminant levels were detected in osprey downstream from a pulp mill and in American robins in orchards. In contrast, mercury and DDT were within concentrations considered safe for human consumption for fish from Okanagan Lake.
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.	The WIBE is the only agricultural ecozone+ in Canada where the residual soil nitrogen decreased from 1981 to 2006. Nutrient loading in several of the Okanagan Valley lakes, such as Skaha and Osoyoos, declined from the early 1970s to 2001 due to reductions in nutrient loading from agricultural sources and sewage treatment plants.
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.	The soils and lakes in the WIBE are thought to be at low risk of any small changes in rain pH, so acid deposition is 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, the temperature in the WIBE increased at most times of the year. Precipitation increased in spring and fall whereas snow decreased. The seasonality of stream flow changed, with earlier onsets of spring freshets, lower flows in late summer, and higher flows in winter.
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 WIBE include water, crop pollination, and nutrient cycling which are necessary for food production and potable water. Other services include forests, wildlife, and fish, which are harvested either commercially or recreationally. Although ecosystem services have not been quantified for the WIBE, a project to estimate the value of ecosystem services supported by the last remaining natural section of the Okanagan River was initiated in 2012/13.

Themes and topics	Key findings: NATIONAL	Key findings: WESTERN INTERIOR BASIN ECOZONE+
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.	Agricultural lands in the WIBE are dominated by Unimproved Pasture (67% in 2006), which provides breeding and feeding habitat for 80 species of wildlife. However, average wildlife habitat capacity on agricultural land declined from 70% to 61% between 1986 and 2006.
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.	The WIBE is ecologically unique in Canada as the northern extension of the Great Basin Desert. It has high species richness and assemblages of plants and animals that occur nowhere else in Canada. It also has a large number of species and ecosystems of conservation concern. Several bird and fish populations have declined over the past 30–40 years. Most ungulate and large carnivore populations are currently stable or increasing.
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.	Primary productivity increased for 16,713 km^2 (30.1%) and decreased for 1,035 km^2 (1.9%) of the WIBE between 1985 and 2006. The increases may be the result of regeneration in mixed forests; the reasons for the decreases are not known.
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.	In the 2000s, the burned area increased more than three-fold to >1,500 km^2 (2.6%) of the ecozone+, possibly due to changing climate, increased fuel loads due to fire suppression prior to the 1990s, and the interaction between forest fires and outbreaks of insects. Mountain pine beetles peaked in 2008 when they affected 8,100 km^2. In BC, western spruce budworms are found nearly exclusively in the WIBE where they peaked in 2007 affecting 3,800 km^2.

Themes and topics	Key findings: NATIONAL	Key findings: WESTERN INTERIOR BASIN ECOZONE+
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.	Over the past 40 years, an invasive non-native shrimp altered food web dynamics in Okanagan Lake and contributed to the decline of native salmonids. A temporary decline in mule deer resulted in increased cougar predation on mountain goat in the 1990s. Populations of deer recovered quickly but mountain goats were slow to recover.
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.	Ecosystem monitoring programs and research studies provide information on biodiversity for the WIBE. However, gaps include traditional and local ecological knowledge and data on contaminants. In addition, monitoring and research are unevenly distributed, with underrepresentation of the northern Okanagan.
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.	Population declines of birds and fish, the loss of plant communities such as grasslands, and changes in water availability are evidence or indicators of abrupt or unexpected ecological change.

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.

Forests cover 73% of the ecozone+.[12] Forests of the WIBE are classified into eight biogeoclimatic zones.[13] The Interior Douglas-fir, Montane Spruce, and Engelmann Spruce–Subalpine Fir zones —in that order of extent—comprised 84% of the total forested area in 2005 (Figure 5). The Ponderosa Pine zone covers 5% of the WIBE. This zone, along with the Bunchgrass zone, occupies lower elevations where land use is most intense and where habitat occurs for many species at risk. The WIBE includes three of the four zones identified in 2008 as areas of greatest conservation concern in BC (Bunchgrass, Ponderosa Pine, and the xeric site series of the Interior Douglas-fir zones).[14]

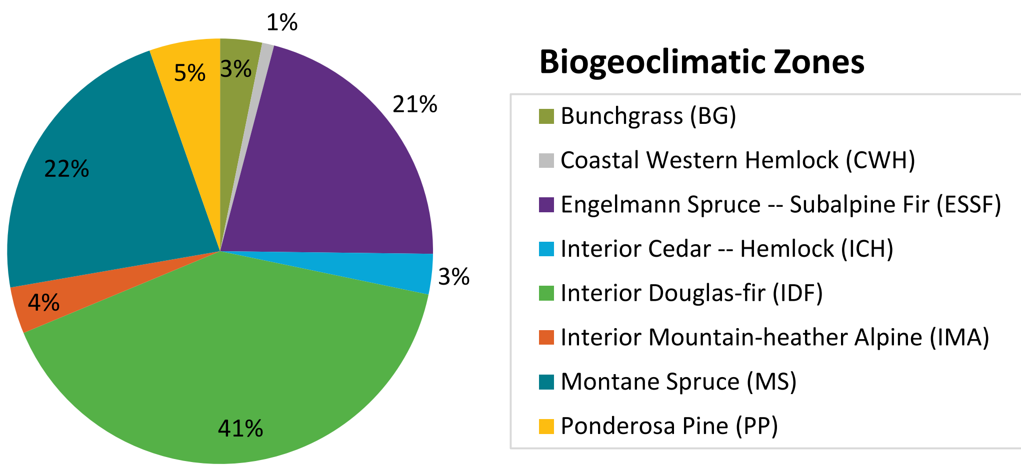


Figure 5. Biogeoclimatic zones of the Western Interior Basin Ecozone+, 2008.
Biogeoclimatic zones that make up <1% of the Western Interior Basin Ecozone+ are not shown.
Source: data from Hectares BC, 2009[13]

An analysis of forest density using remote sensing showed that in 2005 almost half of 1 km^2 cells within the WIBE were more than 80% forested.[12] Twenty-two percent of the WIBE area is covered by intact forest landscape fragments larger than 100 km^2 (Figure 6). A landscape fragment is defined as a contiguous mosaic, naturally occurring and essentially undisturbed by significant human influence. It is a mosaic of various natural ecosystems including forest, bog, water, tundra, and rock outcrops. These intact fragments are primarily located in the mountainous western part of the ecozone+.

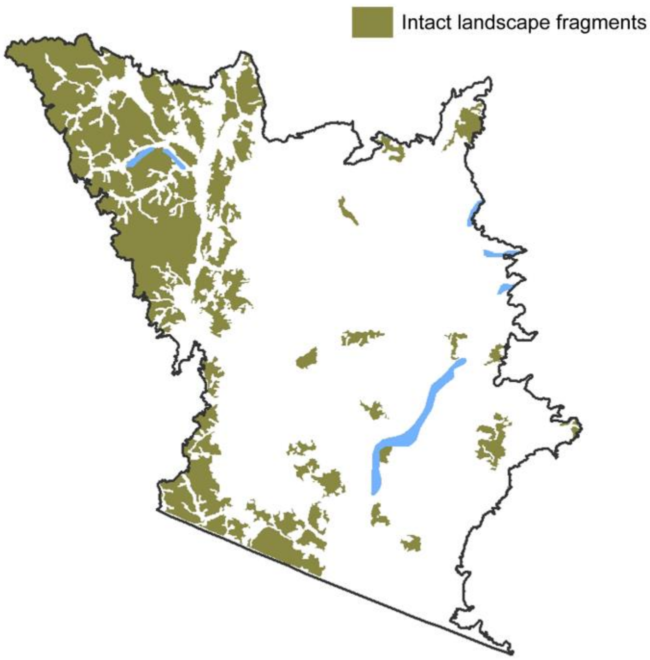


Figure 6. Intact forest landscape fragments larger than 100 km^2 in the Western Interior Basin Ecozone+, 2005.
Source: Lee et al., 2006[15]

Approximately one-third of the forests in the WIBE are younger than 100 years, another one-third are 101–140 years old, and the remaining one-third are older than 140 years (Figure 7).[16]

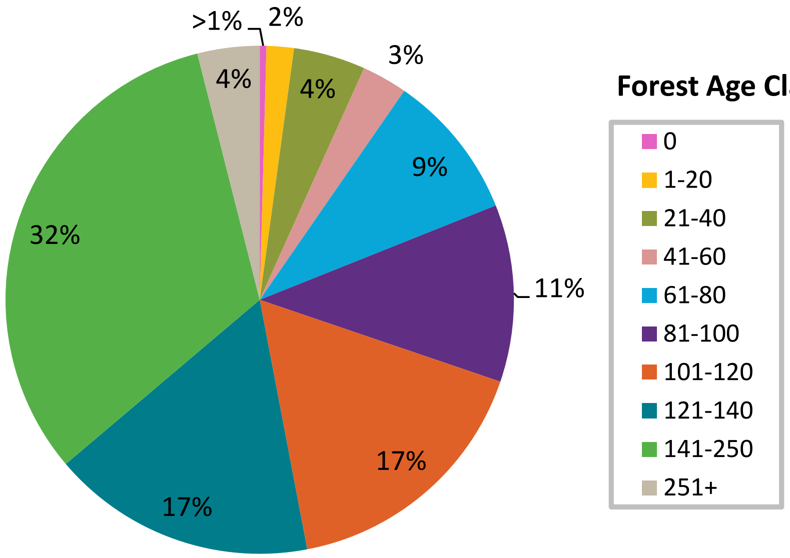


Figure 7. Forest age class distribution in the Western Interior Basin Ecozone+, 2008. Source: data from Hectares BC, 2009[13]

Forest harvest

The WIBE contains about 860 million m³ of wood in commercially harvested species.[13] The 2008 annual allowable harvest in the WIBE was approximately 7.3 million m³ (3.3 million m³ in the Okanagan-Shuswap Forest District and 4 million m³ in the Kamloops Forest District).[17]

Commercial harvest and planting have changed the tree composition of forests. The BC Ministry of Forests analyzed the change in forest composition in monocultures or mixed stands of conifers and deciduous trees. The report provides a comparison of the proportion of one tree species dominated stands (monocultures) and mixed tree species stands by addressing their species composition before and after harvest. There was no analysis of the variety of tree species present. The analysis distinguished, for example, whether a ponderosa pine-dominant stand had changed to a Douglas-fir-dominant stand, but it did not show a change in status for a spruce–pine stand that was converted to a nearly pure pine stand.[18]

The report also separated stands before and after harvest under pre-1987, 1987–1995, and 1995–2004 policy regimes. Prior to 1987, primary silvicultural obligation belonged to the provincial government. From 1987 to 1995, obligations fell to licensees. The years 1995 to 2004 coincide with the implementation of the Forest Practices Code and the *Forest and Range Practices Act*. Reforestation obligations commence at the time of harvest and end when the reforested stand of trees is declared “free growing.” Free growing obligations can be met either naturally (natural regeneration) or artificially (planting).[18]

Overall, forest stands with a single tree species (monoculture) declined in areas without timber harvest but increased in harvested areas. Approximately 39% of the non-harvested forest land base was monoculture prior to 1987. From 1987 to 2004, monocultures declined by 9%. However, the amount of monoculture at free growing has increased by about 9% post-1987, since licensees and BC Timber Sales had the primary silvicultural obligation (Figure 8). For deciduous stands at the free growing stage, the amount of mixed stands increased from 12 km^2 before harvest to 373 km^2 after harvest.

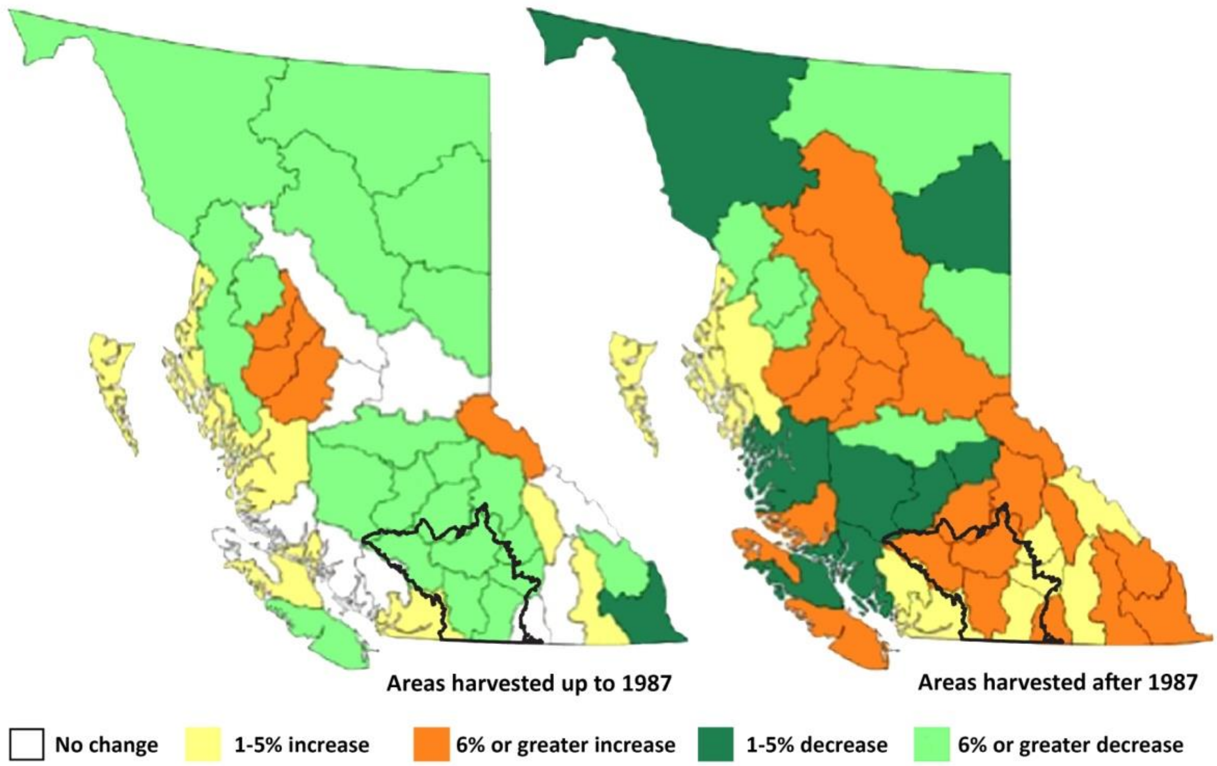


Figure 8. Change in area of monocultures before and after 1987.
Western Interior Basin Ecozone+ boundary is approximate.
Source: BC Ministry of Forests and Range, 2010[19]

Habitat loss

The extent of lower elevation forests declined from 1800 to 2005. An analysis of aerial photographs of the Okanagan and Lower Similkameen valleys from 1800, 1938, and 2005 illustrated losses of 27% for Douglas-fir–pinegrass gentle slope forest ecosystems (Figure 9) and 53% for ponderosa pine–bluebunch wheatgrass gentle slope forest ecosystems (Figure 10).[20]

Additional information about changes in forested ecosystems is in the Ecosystem conversion section on page 40 and in the Natural disturbance section on page 79.

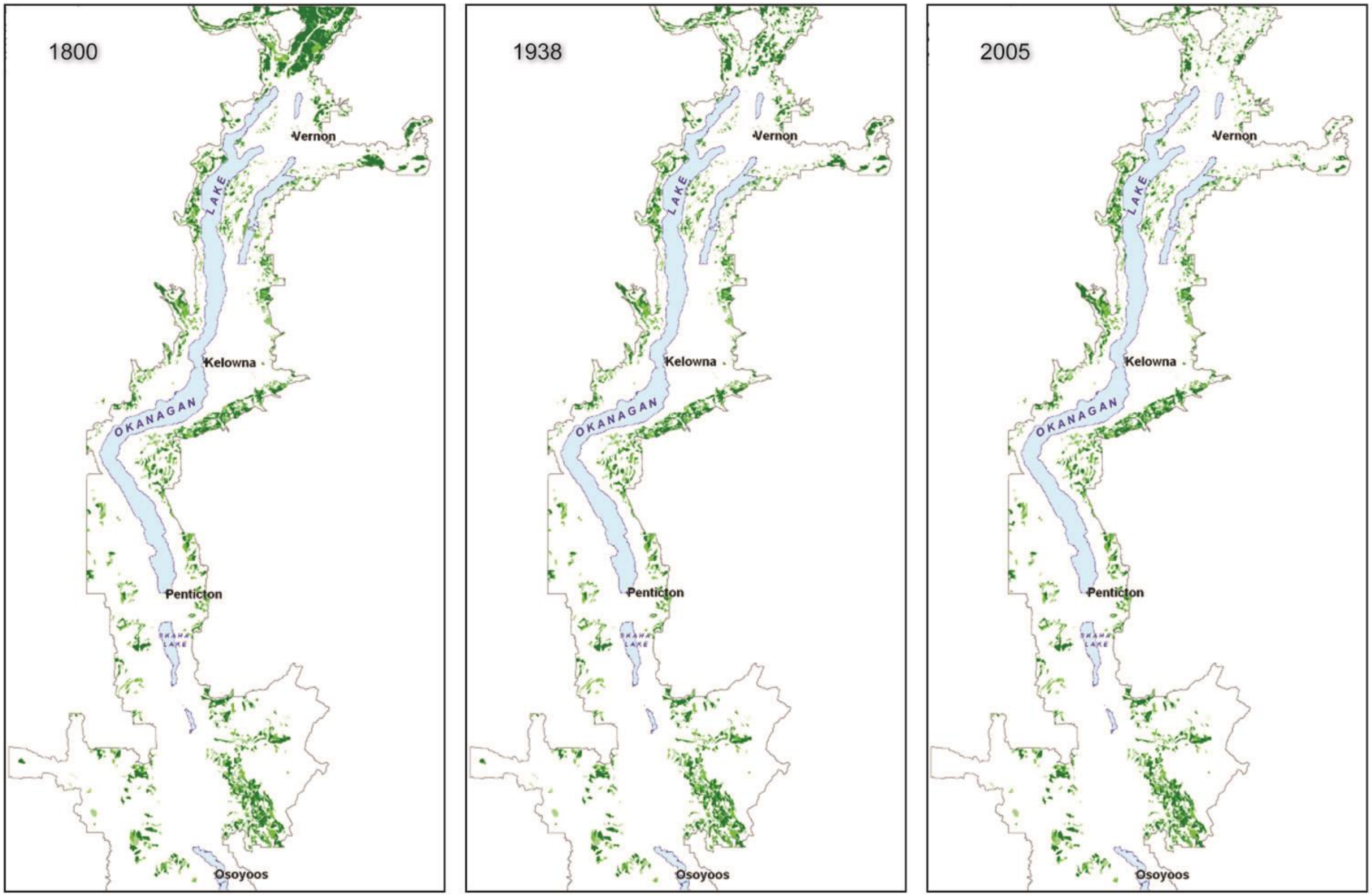


Figure 9. Changes in the Douglas-fir–pinegrass gentle slope forest ecosystem in 1800, 1938, and 2005. Source: Lea, 2008[20]

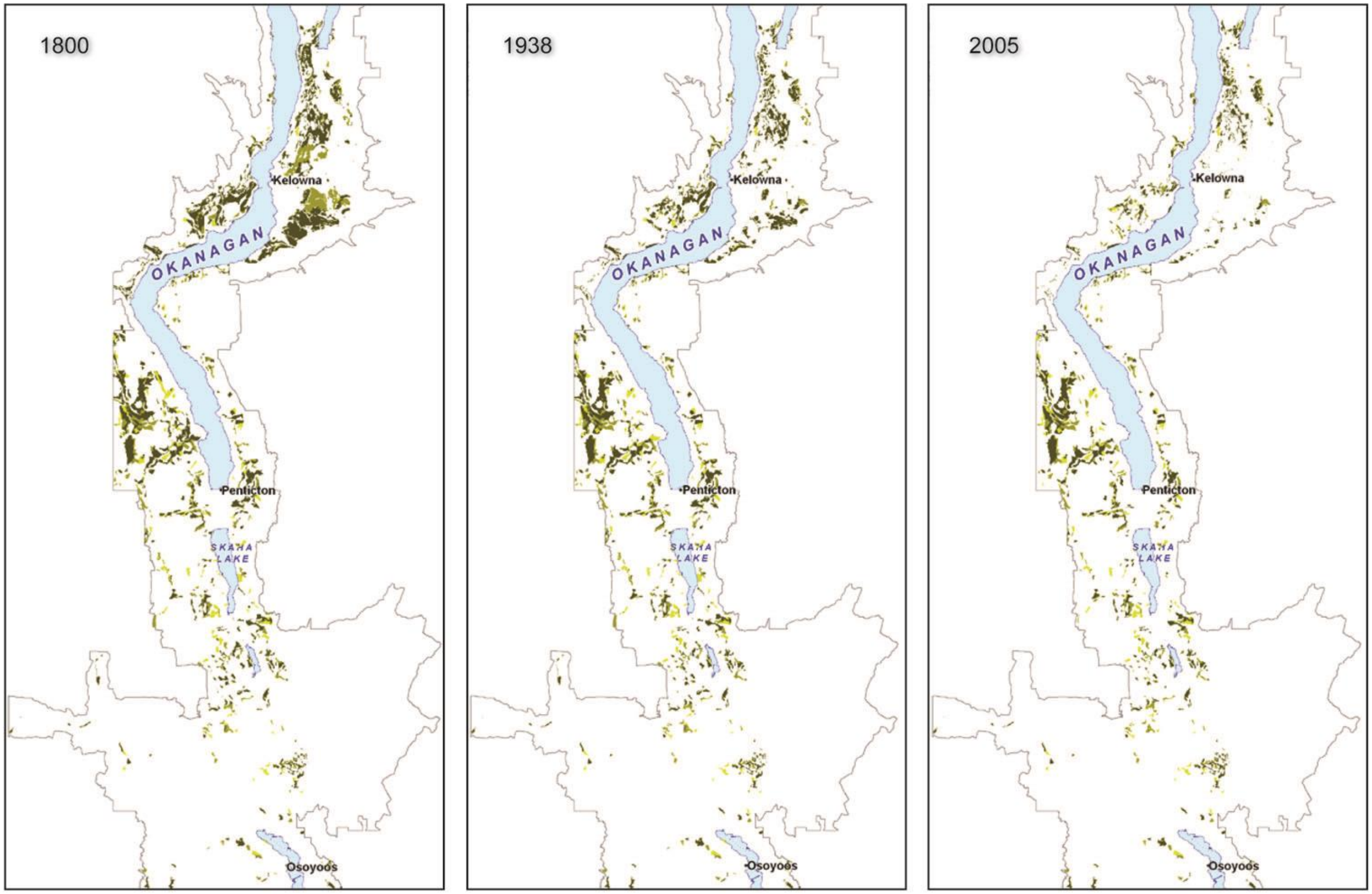


Figure 10. Changes in the ponderosa pine–bluebunch wheatgrass gentle slope forest ecosystem in 1800, 1938, and 2005. Source: Lea, 2008[20]

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.

Native grasslands comprised 2% of the WIBE in 2005. These grasslands are the northernmost extension of the Pacific Northwest Bunchgrass type,[21] also described as the Great Basin Sagebrush Desert Biome.[22] These grasslands are unique in Canada because they are dominated by bluebunch wheatgrass (*Pseudoreogneria spicata*), a species that rarely occurs east of the Rocky Mountains, and because they are differentiated from grasslands in Washington and Oregon due to a higher proportion of boreal species in their plant and animal communities.[8, 23]

BC's grasslands are one of Canada's most endangered ecosystems.[8, 24-27] Low-elevation grassland communities are the rarest land cover type in BC and are concentrated in three of BC's four biogeoclimatic zones of conservation concern (Interior Douglas-fir, Ponderosa Pine, and Bunchgrass).[14] Grasslands provide habitat for species at risk and contribute disproportionately to biodiversity.[24, 25] For example, over 30% of BC's species at risk including American badgers (*Taxidea taxus jeffersonii*), burrowing owls (*Athene cunicularia*), pallid bats (*Antrozous pallidus*), western rattlesnakes (*Crotalus oreganus*), and long-billed curlews (*Numenius americanus*) live in the grasslands of the WIBE.[28] Over 40% of BC's vascular plant flora are found in grasslands[26] even though grasslands cover less than 1% of BC.[26]

Habitat loss

Since 1850, 1,188 km^2 (16%) of the WIBE's grasslands have been converted to agriculture, high-density urban development, and low-density development (Figure 11).[26, 29] Although grasslands continue to be lost in some areas, most of the loss (15%, or 1,114 km^2) occurred before 1990 (Figure 12). The greatest losses prior to 1990 occurred in the Northern Okanagan Basin Ecosection, with 48% of its grasslands lost, and in the Southern Okanagan Highland Ecosection, with 39% lost (Figure 12).[30]

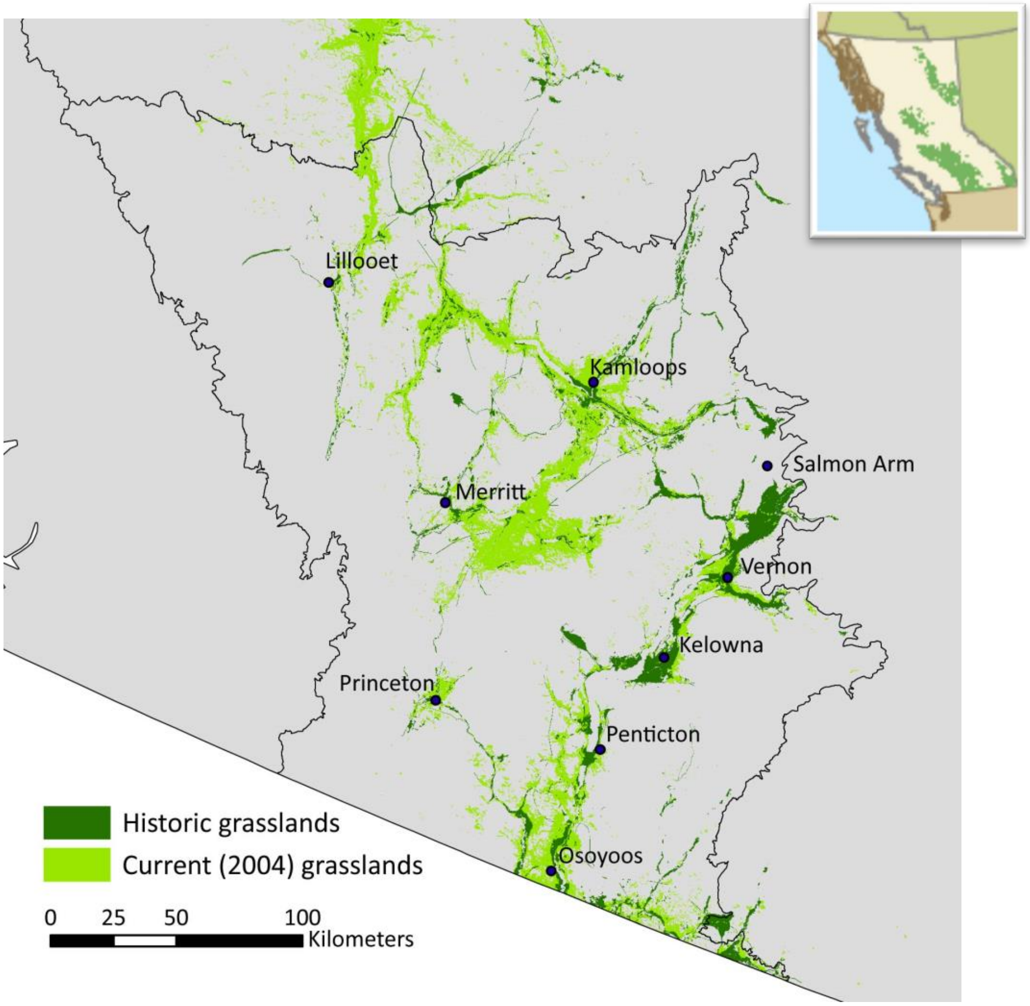


Figure 11. Distribution of historic and current (2004) grasslands in the Western Interior Basin Ecozone+.
Inset map shows the grassland regions of BC.
Source: updated from the Grasslands Conservation Council of British Columbia, 2004[30]

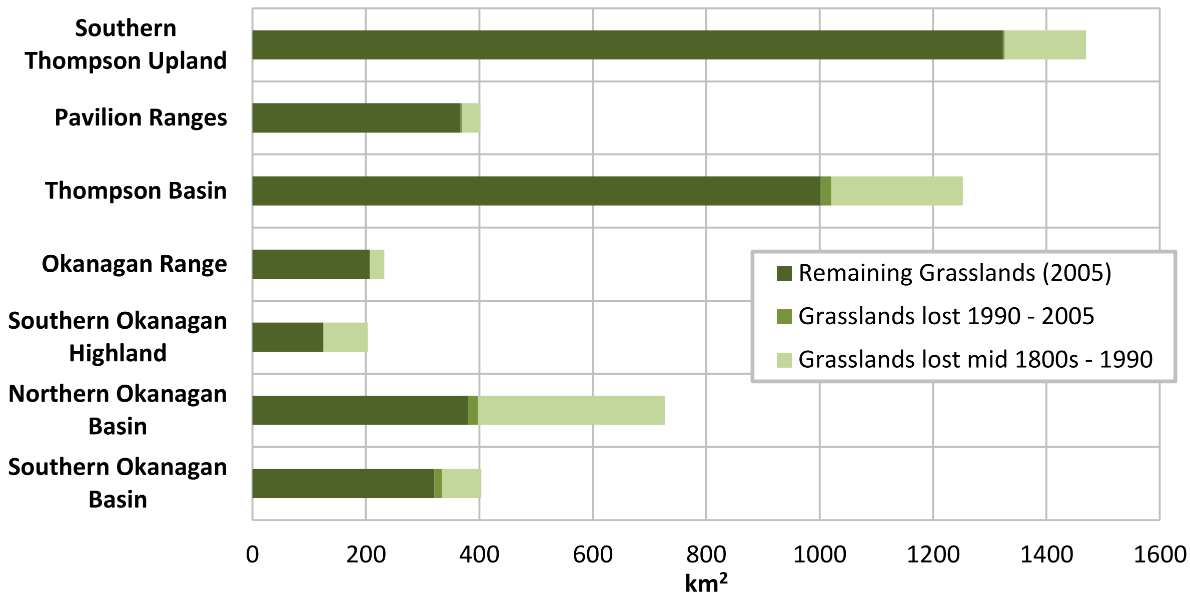


Figure 12. Amount of grassland from the mid-1800s to 2005 in the BC Southern Interior by ecosection. Source: BC Ministry of Environment, 2007a[29]; modified from data produced by the Grasslands Conservation Council of British Columbia, 2004, 2007.[28, 30] This information is provided by the Province of BC under the Open Government License for Government of BC Information v.BC1.0.

From 1800 to 2005 in the Okanagan and Lower Similkameen valleys, the antelope-brush–needle-and-thread grass shrub-steppe ecosystem declined by 68% (Figure 13), the big sagebrush shrub-steppe ecosystem declined by 33% (Figure 14), and the Idaho fescue–bluebunch wheatgrass grassland ecosystem declined by 77% (Figure 15).[20, 31] The loss of these ecosystems was mainly due to development at lower elevations.[20] These three ecosystems are presently in early seral stages and invaded by non-native species due to decades of intensive livestock grazing.[20] Further, many of the richest soils have been cultivated,[32, 33] leaving remaining grasslands on less productive soils.

Grasslands in the WIBE are at risk in and outside of protected areas. Grasslands outside of protected areas could be converted to agricultural, commercial, and residential uses. In 2004, 40% of grasslands were in private holdings whereas only 8% of grasslands were in protected areas.[29] The extent of grasslands, whether protected or not, can also be reduced by the alteration of natural disturbance regimes. For example, the suppression of wildfires in the Ponderosa Pine biogeoclimatic zone allowed forests to encroach into grasslands.[34-37] About 90% of all BC's grasslands are grazed by domestic livestock, degrading the ecosystems and facilitating the spread of invasive plants.[30] In a study of 17 grazed grassland sites in the Southern Interior, non-native plants covered 35% of the sites with some sites having 85% coverage of non-native species.[38] Increasing pressure from recreational activities, such as disturbances from off-road vehicles and conversion to golf courses, also threaten grasslands.[30] Additional information can be found in the Invasive non-native species section on page 44 and the Natural disturbance section on page 79.

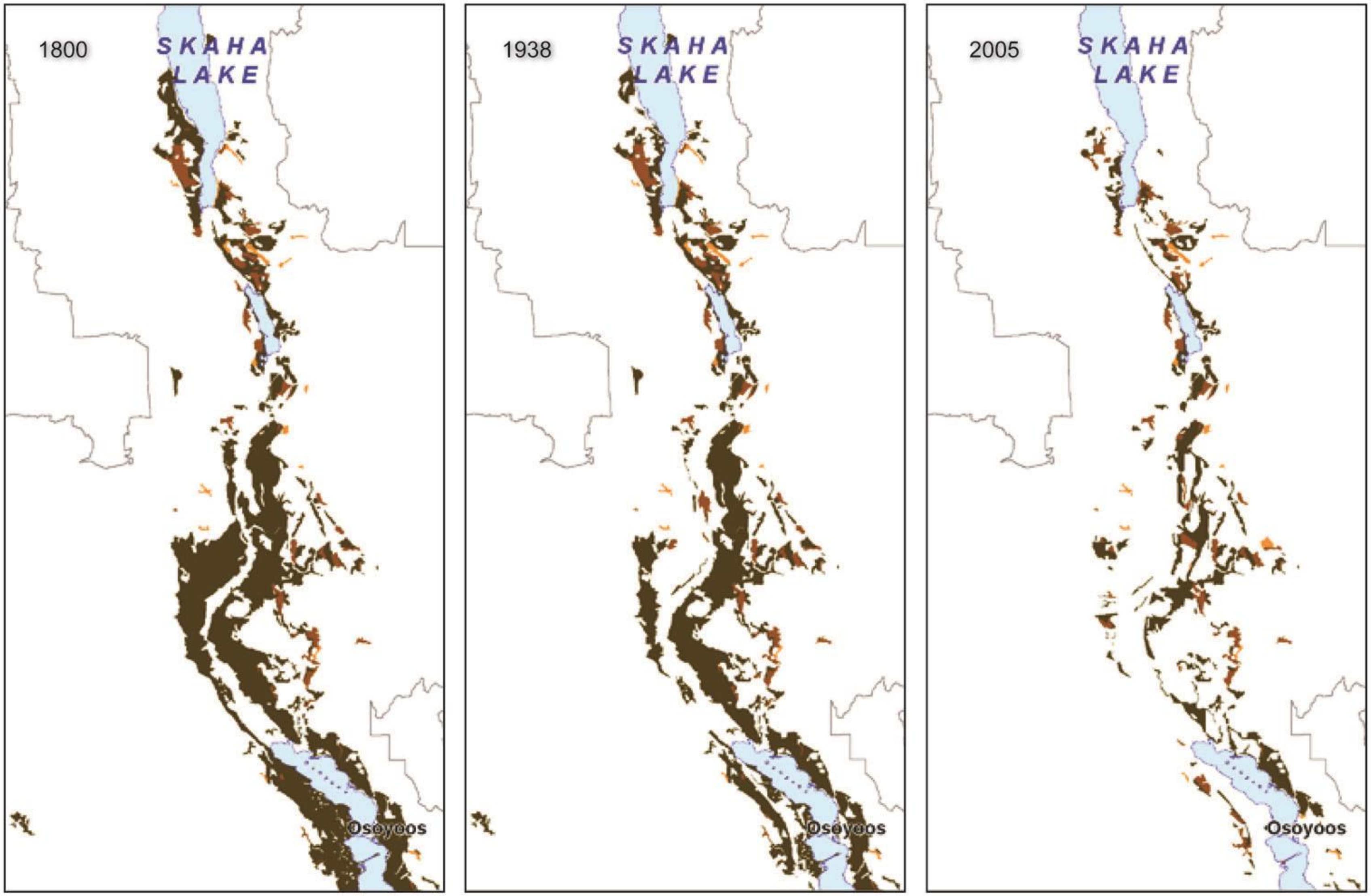


Figure 13. Changes in the antelope-brush–needle-and-thread grass shrub-steppe ecosystem in 1800, 1938, and 2005. Source: Lea, 2008[20]

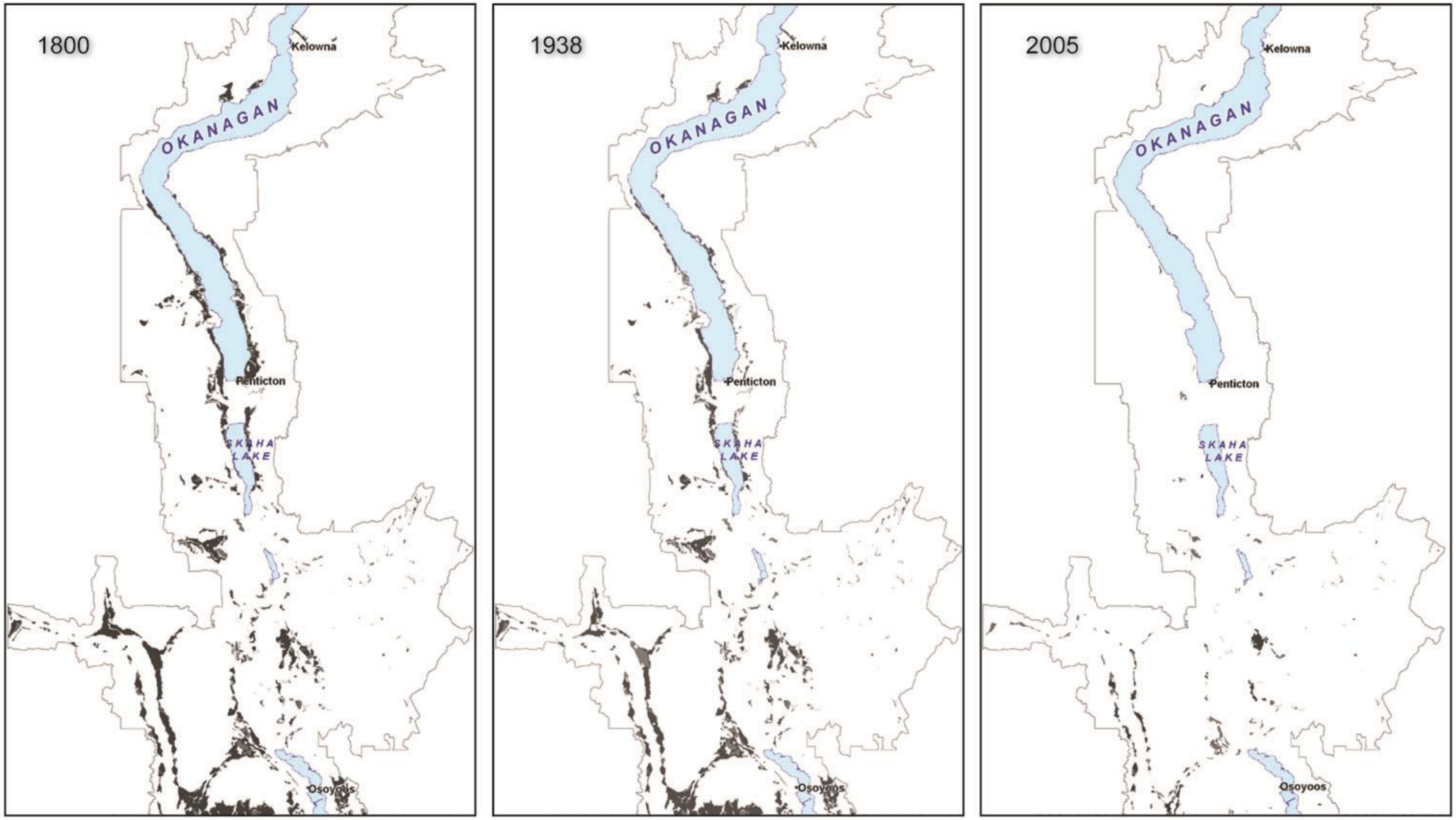


Figure 14. Changes in the big sagebrush shrub-steppe ecosystem in 1800, 1938, and 2005. Source: Lea, 2008[20]

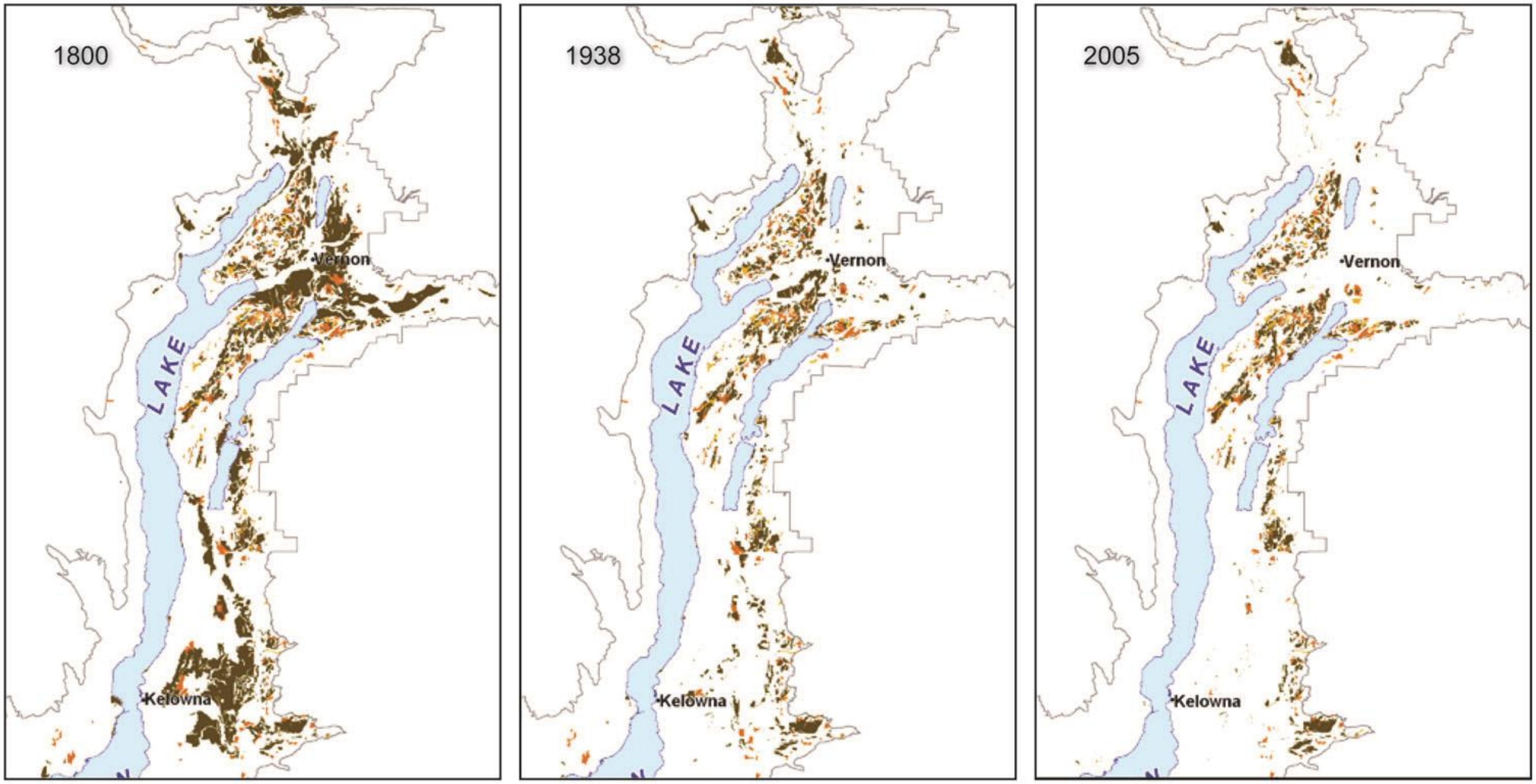


Figure 15. Changes in the Idaho fescue–bluebunch wheatgrass grassland ecosystem in 1800, 1938, and 2005. Source: Lea, 2008[20]

Key finding 3 **Theme** Biomes

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.

Wetlands occupy a small portion (<1%) of the WIBE due to the region's climate, soil, and topographic features.[39, 40] Nevertheless, they play a crucial ecological role particularly because wetlands in arid areas support more species than other ecosystems.[39, 41] Wetlands of the WIBE support many species at risk such as Wallis' dark saltflat tiger beetles (*Cicindela parowana wallisi*), Great Basin spadefoots (*Spea intermontana*), short-rayed alkali asters (*Symphyotrichum frondosum*), and small-flowered lipocarphas (*Lipocarpha micrantha*).[42]

Most wetlands in this area are located in valley bottoms where development is also concentrated and 85% of wetlands have been lost since European settlement—mainly due to conversion to agriculture and more recently for urban development.[2, 20] In 1800, the South Okanagan and Lower Similkameen valleys had 178 km^2 of wetlands, by 1938 the area had decreased to 69 km^2, and by 2005 there were fewer than 30 km^2 remaining.[20]

The loss among different wetland communities in the South Okanagan and Lower Similkameen valleys has varied. For example, from 1800 to 2005, shrubby water birch–red-osier dogwood riparian wetlands declined by 92% (Figure 16), black cottonwood–red-osier dogwood riparian floodplain by 63% (Figure 17), and cattail marshes by 41%.[20] Wetlands continue to be lost and degraded by urbanization, intensive agriculture, and, in some areas, heavy recreational use.[20, 42, 43] In addition, invasive species and climate change pose serious threats.[44]

Additional information can be found in the Ecosystem conversion section on page 40 and the Invasive non-native species section on page 44.

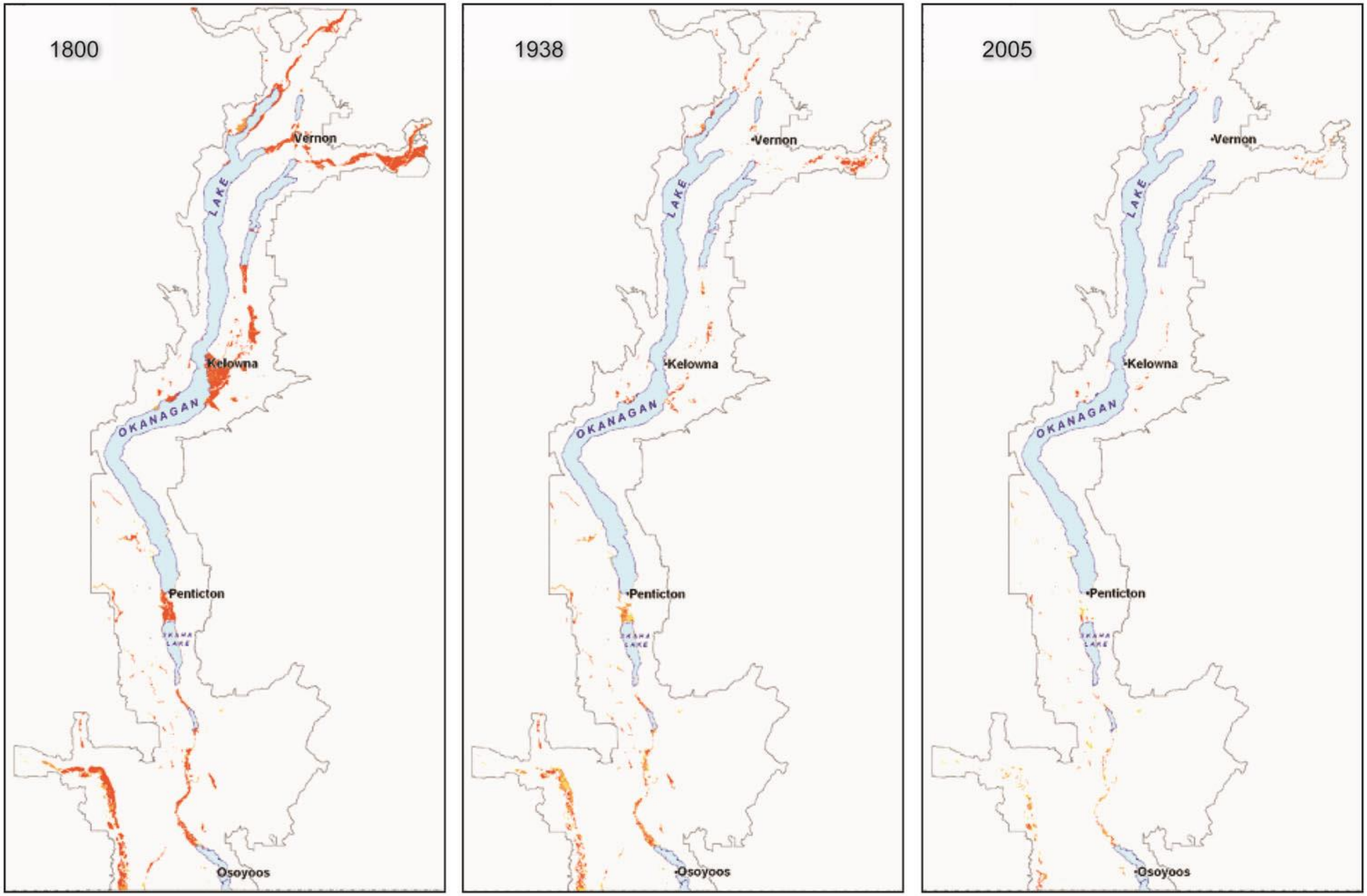


Figure 16.Changes in the water birch–red-osier dogwood riparian shrub swamp wetland ecosystem in 1800, 1938, and 2005. Source: Lea, 2008[20]

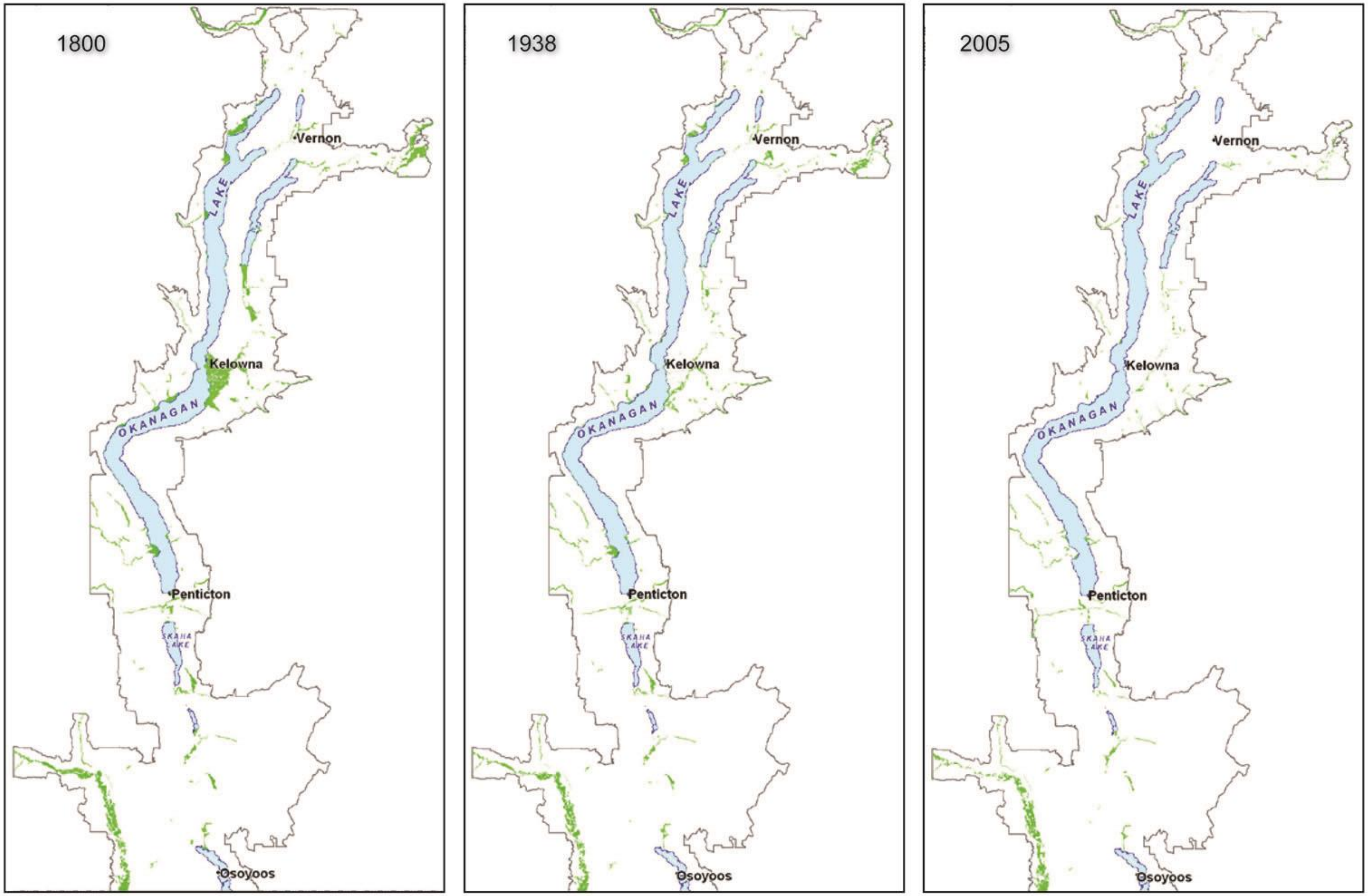


Figure 17. Changes in the black cottonwood–red-osier dogwood riparian floodplain ecosystem in 1800, 1938, and 2005. Source: Lea, 2008[20]

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.

Approximately 2% of the WIBE area is covered by lakes, rivers, and streams.[13] These support diverse aquatic communities including species at risk such as chiselmouth fish (*Acrocheilus alutaceus*) and Rocky Mountain ridged mussels (*Gonidea angulata*). Anadromous salmon migrate to parts of the Okanagan Basin and the Thompson Basin; the Adams River is also an important breeding area for sockeye salmon (*Oncorhynchus nerka*).

Large lakes

The Thompson Basin contains Kamloops and Nicola lakes as well as portions of Shuswap and Adams lakes. The Thompson River forms at the confluence of the North and South Thompson rivers and flows to the Fraser River. West of Lillooet and draining to the Fraser River are the Downton Lake and Carpenter Lake reservoirs and the Anderson Lake and Seton Lake reservoirs. A portion of the Fraser River mainstem is captured in the WIBE.

The WIBE also contains a chain of lakes along the Okanagan Valley floor that flow via the Okanagan/Okanogan River (Canadian and U.S. spellings, respectively) into the Columbia River in Washington State. Wood and Kalamalka lakes drain into Okanagan Lake, the largest in the series, and then Skaha, Vaseux, and Osoyoos lakes. Osoyoos Lake straddles the Canada–U.S. border.

Annual net inflow to Okanagan Lake is variable (Figure 18) and influences water levels (Figure 19), which affect the annual availability of spawning habitat for the shore-spawning variant of kokanee (*Oncorhynchus nerka kennerlyi*).[45] The loss of tributary streams and the establishment of mysis shrimp (*Mysis diluviana*, formerly *M. relicta*), an invasive non-native species, also reduced populations of kokanee. More information about mysis shrimp can be found in the Invasive non-native species section on page 44 and the Food webs section on page 85.

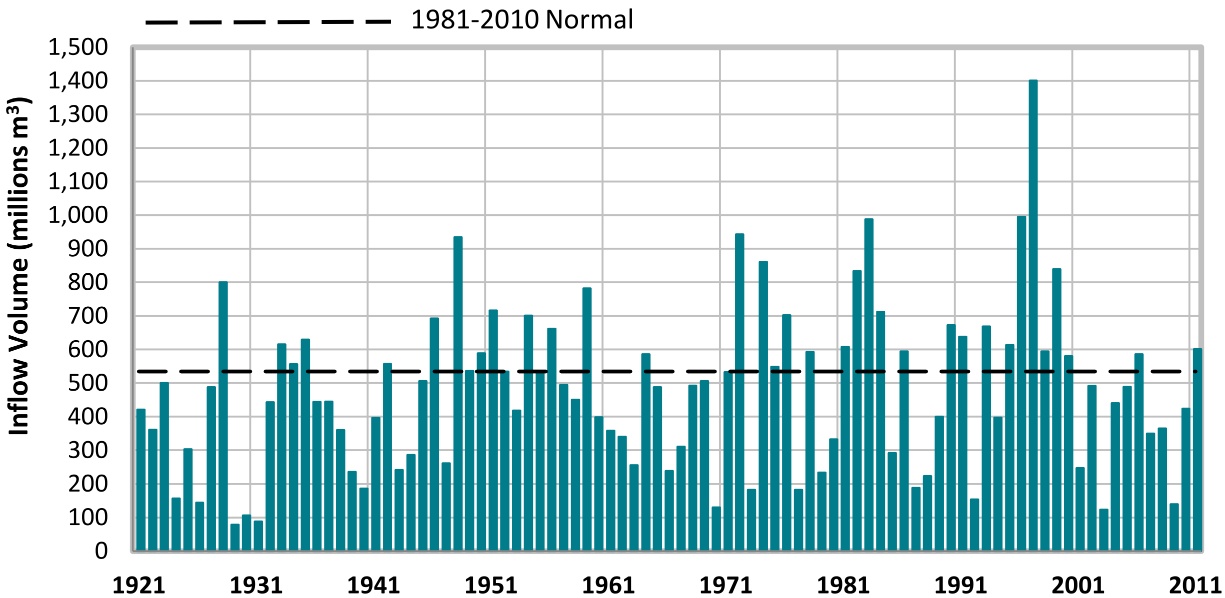


Figure 18. Annual net inflow volume for Okanagan Lake, 1921–2011.
Source: BC River Forecast Centre, 2011[46]

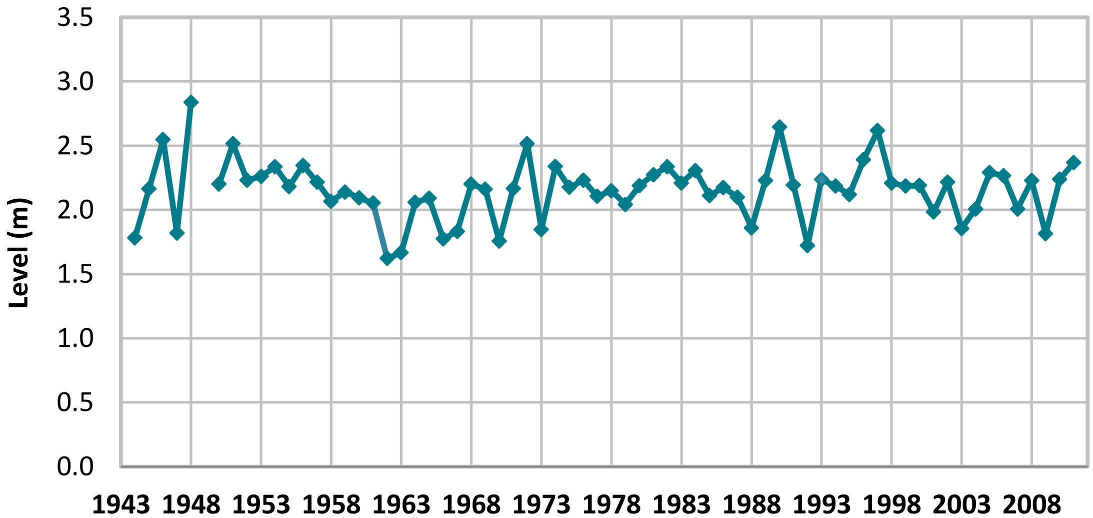


Figure 19. Annual peak water level for Okanagan Lake, measured at Kelowna from 1944 to 2011.
Source: Environment Canada, 2009[47]

From the mid-1970s to 2001, nutrient levels in Skaha and Osoyoos lakes (measured as total phosphorus concentration in spring) declined by 52% and 40% respectively.[48] These reductions are attributed to the implementation of sewage treatment plants and reduced nutrient inputs from agricultural sources. Nutrient reductions reduced the amount of phytoplankton and increased the concentration of oxygen in the lower (hypolimnetic) layer of these lakes, which benefits salmonids. Since 2001, the concentrations of phosphorus have remained relatively stable (see Figure 38 in the Nutrient loading and algal blooms section on page 52).

Rare features

Saline lakes and ponds in Kamloops and the southern Okanagan contain unique chemistry, non-vascular plants, and invertebrates.[49, 50] In addition, microbialites—large coral-like structures produced by cyanobacteria—occur in two lakes near Lillooet.[14]

Streams

Most of the watersheds in the WIBE are snowmelt-driven systems with high spring freshets. The spring freshet, from April to June, can account for as much as 90% of annual stream flow.[51] After the freshet, water flow generally remains low for the summer, fall, and winter. Changes in streamflow associated with climate change have been recorded in the Similkameen and Kettle rivers and are discussed in the Climate change section on page 55.

The BC Ministry of Environment sets water quality objectives for streams (and other waterbodies) that are or may be affected by human activities.[52] All of the major rivers and many of the smaller streams in the WIBE are monitored regularly for physical, chemical, and biological characteristics to ensure that they meet the water quality objectives. For select sites, a Water Quality Index[53] was calculated in 2002–2004 to assess the overall quality for the end uses of the water, such as drinking water, recreation, irrigation, or habitat for aquatic life.[54] Water quality varied from marginal to good at eight sites from 2002 to 2004 (Table 3). For example, the water quality of the Fraser River at Hope improved through reductions of adsorbable organohalogens (AOX) and chloride from 1979–2004, due to abatement of pulp mill waste entering the river. The water quality of the Okanagan River at Oliver declined from 1980–2002 due to agricultural runoff (Table 3).[54]

Table 3. Water Quality Index (WQI) in 2002–2004, rank, trend, concerns monitored, and the cause of the rank and trend for eight river sites in the WIBE.

Site (Years of Records)	WQI* Score	Rank*	Trend	Concerns monitored	Cause of Trend
Fraser River at Hope (1979–2004)	84.2	Good	Improving	Adsorbable orga-nohalogens (AOX), chloride	Pulp mill waste abatement
Kettle River at Carson (1980–2002)	71.0	Fair	Stable		No past trend
Kettle River at Midway (1980–2002)	76.7	Fair	Stable		No past trend
Okanagan River at Oliver (1980-2002)	70.8	Fair	Deteriorating	Chloride	Irrigation return flows
Salmon River at Salmon Arm (1985–2004)	45.8	Marginal	Stable	Fecal coliforms	Agricultural non-point source abatement
Similkameen River at Princeton (1989–1997)	83.2	Good	Stable		No past trend
Similkameen River near US Border (1979–2000)	82.7	Good	Stable	Arsenic	Unknown
Thompson River at Spences Bridge (1985–2004)	65.2	Fair	Stable	Chloride, dioxins, and furans in fish	Pulp mill waste abatement

**The scoring and ranks are based on the Canadian Council of Ministers of the Environment (CCME) Water Quality Index (WQI)[53]*
Source: BC Ministry of Environment, 2007[54]

Benthic invertebrates were collected from urban streams in the Okanagan for use as indicators of stream health. The benthic index of biological integrity (B-IBI) is a measure of the ability of streams to support biological communities including algae, invertebrates, fish, and aquatic mammals and birds. The B-IBI is a composite index based on a series of metrics characterizing the stream invertebrate community, including total taxa, number of plecoptera taxa, number of ephemeroptera taxa, number of intolerant taxa, and number of clinger taxa. These metrics responded predictably to cumulative watershed disturbance and clearly distinguished urban and highly altered sites from low impact sites.[55] Of 31 stream sites assessed, 68% were in fair, poor, or very poor condition, 16% were in good condition, and 16% were in excellent condition (Figure 20).[55] Low B-IBI scores suggest that these streams are subject to stressors such as the loss of riparian vegetation, channelization, stormwater inputs, and degraded water and sediment quality.

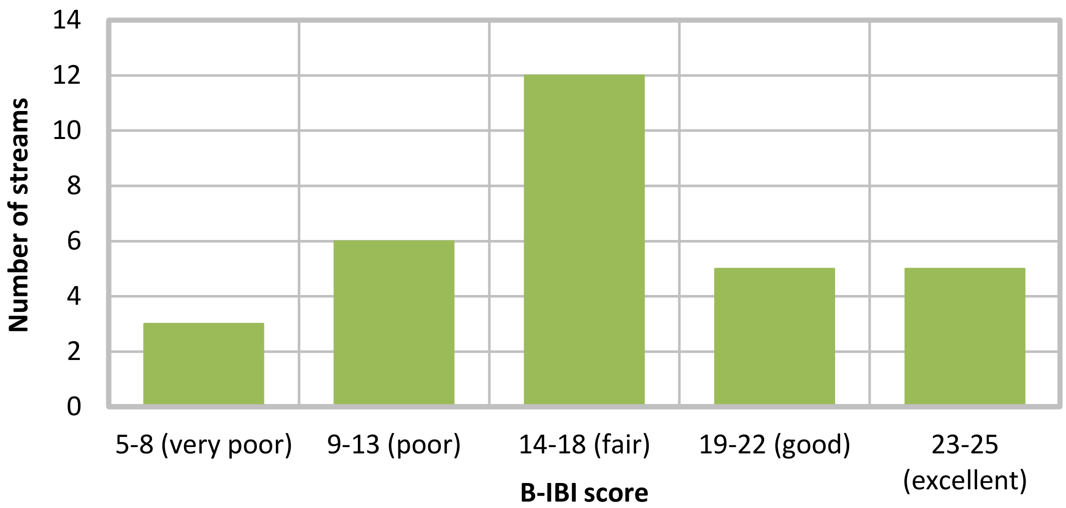


Figure 20. Okanagan Valley benthic index of biological integrity (B-IBI) from 1999 to 2004. The categories in parentheses indicate the estimated stream condition based on index score. Source: Jensen, 2006[55]

Habitat alteration and loss

Increasing human population, urbanization, and a history of changes to lake and stream systems will continue to alter the hydrology and availability of water in the WIBE. The Okanagan Basin has experienced the most substantial modifications to its hydrologic regime as a result of the construction of storage dams, withdrawals of water for residential, agricultural, and industrial uses, and channelization of the Okanagan River. These impacts include changes in the annual rate of flow and alteration or removal of floodplains and riparian areas of the Okanagan River.[20]

Dams

Most Okanagan streams and headwater lakes have been dammed; outlets of five of the six large Okanagan valley floor lakes are regulated, and there are reservoirs on many of the upstream tributaries.[56] From 1913 to 1998, the number of dams on inflows to the Okanagan Lake increased from 11 to 147.[57]

Portions of the land in the Thompson and Fraser basins within the WIBE are upstream of a dam (Figure 21). In addition, all the land area of the Okanagan, Similkameen, and Kettle watersheds is upstream of a dam. Okanagan, Skaha, Vaseux, and Osoyoos lakes all have outlet dams (Penticton, Skaha, McIntyre, and Zosel dams, respectively), and two of them are managed to allow the passage of fish upstream (Zosel Dam downstream of Osoyoos Lake and McIntyre Dam downstream of Vaseux Lake; the latter was modified in 2009).[58] The passage of fish upstream is barred on the Similkameen River by the Enloe Dam (in Washington State), which was built at the site of a natural barrier to the passage of fish. There are no dams on the mainstems of the Fraser, North and South Thompson, and Kettle rivers.

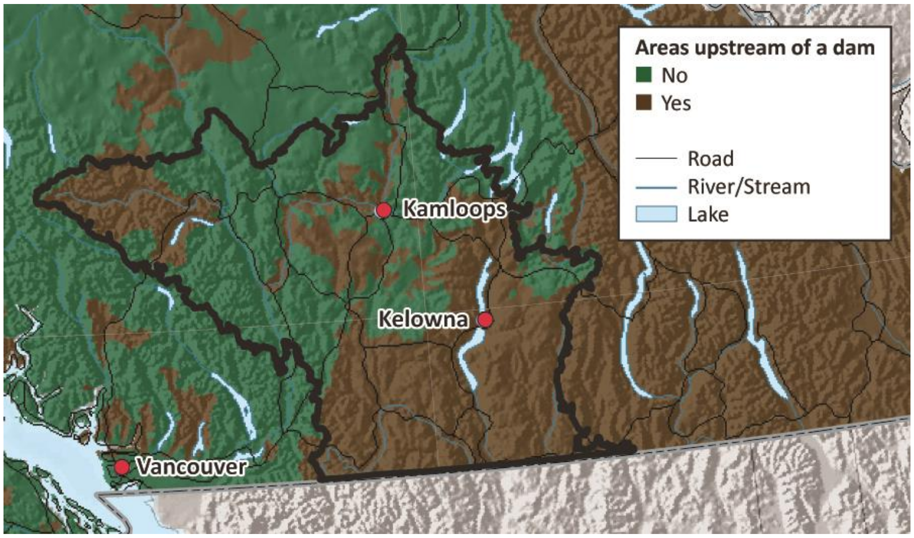


Figure 21. Areas upstream of a dam in the Western Interior Basin Ecozone+, 2008.
Source: Austin and Eriksson, 2009[49]

Water allocation and diversion

Water allocations and diversions from lakes and streams in the WIBE are primarily for residential, agricultural, commercial, industrial, water storage, and habitat conservation uses. Water may also be allocated to power production and mining. Many parts of the WIBE, especially in the Okanagan and Thompson basins, have high rates of water diversion (Figure 22). The majority of water use restrictions on streams in BC are located in the WIBE.[59]

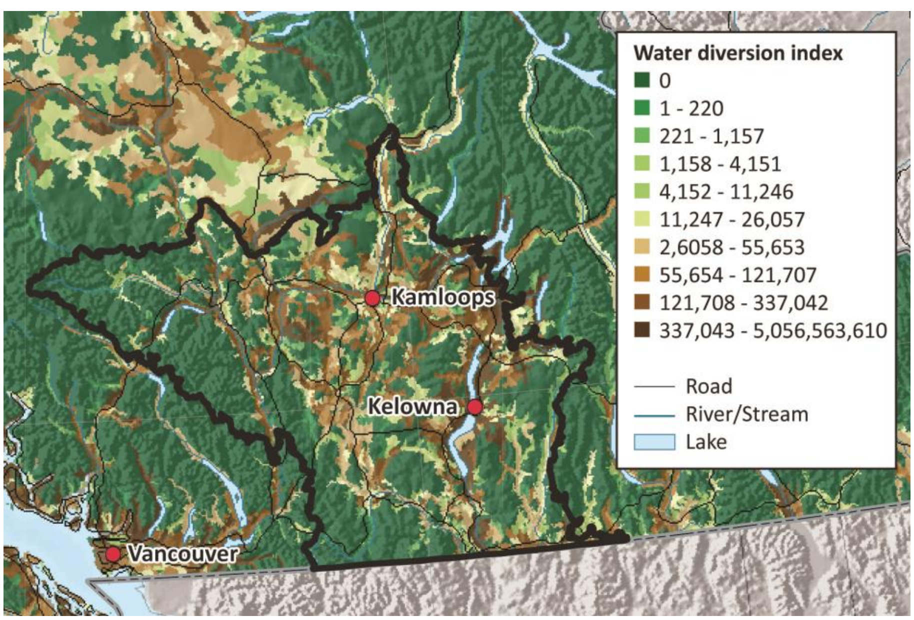


Figure 22. Water diversion index, 2008.
Higher index values indicate higher rates of diversion.
Source: Austin and Eriksson, 2009[49]

Water availability and use is well studied in the Okanagan Basin because of the Okanagan's growing population and arid conditions. The volume of surface water licensed for withdrawal per year is 443,000 megalitres (or 443 million m^3, equivalent to 177,200 Olympic-sized swimming pools).[60] An additional 351,000 megalitres per year are licensed for conservation and other non-consumptive uses.[60] In the Okanagan watershed, 235 streams are considered "fully recorded," meaning that there was no additional water available to allocate more water licences.[61]

Actual water use is not necessarily equivalent to water allocation in that water may be licensed for use but the licensee does not use the total volume allowed by the license. From 1996 to 2006, the average annual water use in the Okanagan Basin was 219,000 megalitres with 67% of this volume coming from surface water sources.[60] During that time period, water use was 187,000 megalitres in 1997 (a wet year) and 247,000 megalitres in 2003 (a dry year).[60] The increased use in 2003 was mainly due to agricultural and outdoor residential uses. Water use also varies throughout the year with the rate increasing in spring when irrigation begins and peaking in late July to mid-August. The largest annual users of water in the Okanagan Basin are the agricultural sector (55%) and residential users (31%).[60]

The Okanagan–Similkameen Basin has the lowest amount of water (measured as area, m^2) per capita in Canada.[62] Demand for water in this water-scarce region is rising with ongoing population, urban, and agricultural growth.[63] The consequence of a limited initial water supply in conjunction with human demands for water, increased evaporation, and climate change impacts on the seasonal rate of flow is a scarcity of water for aquatic and riparian ecosystems, especially during drought years.[64]

Channelization of Okanagan River

Sections of the Okanagan River were channelized for flood control and irrigation from 1949 to the mid-1950s (Figure 23).[65, 66] Before channelization, the Okanagan River regularly flooded communities within its floodplain; particularly large floods occurred in 1928, 1942, and 1948.[65] The channelization shortened the river from 61 km to 41 km and decreased the areal extent of its floodplain from 2.12 km^2 in 1800 to 0.15 km^2 in 2005.[20] A few sections of the river remain in a natural or semi-natural state,[67] but 93% of the natural river has been lost.[20]

The Okanagan River Restoration Initiative, sponsored by the Canadian Okanagan Basin Technical Working Group, is restoring part of the river to its original configuration. The 1-km section, just north of Oliver, will provide important habitat for salmon and trout, reduce the risk of flooding of lands adjacent to the floodplain, and allow riparian vegetation to re-establish.[68]

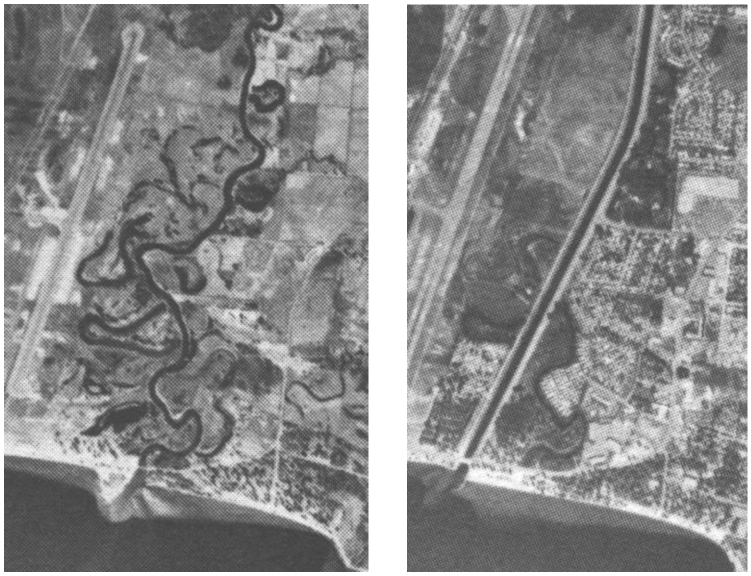


Figure 23. Photograph of Okanagan River where it drains into Skaha lake in 1949 (left) and 1982 (right). Photos are BC 800:31 and BC 82024:204.
Source: after Cannings 2003[69] Copyright © Province of BC. All rights reserved. Reprinted with permission of the Province of BC. www.ipp.gov.bc.ca

Additional information about habitat loss and fragmentation in lakes and rivers can be found in the Ecosystem conversion section on page 40.

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.

Over time, the loss of glaciers can reduce the amount of water in glacial streams in summer and lead to increased water temperatures.[70] Both streamflow and temperature are important factors for aquatic organisms, particularly cold-adapted species like salmonids.[70-72] Since the mid-1970s, the loss of ice in southwestern Canada's glaciers has accelerated.[73]

The World Glacier Monitoring Service recorded a 37 m reduction of ice thickness for Place Glacier, southwest of Lillooet near the western boundary of the WIBE, from 1964 to 2008 (Figure 24).[74] The Bridge Glacier, northwest of Lillooet, declined from 92 km^2 to 84 km^2 (7%) between 1995 and 2005 (Figure 25).[75]

Additional information related to glacier melt can be found in the Climate change section on page 55.

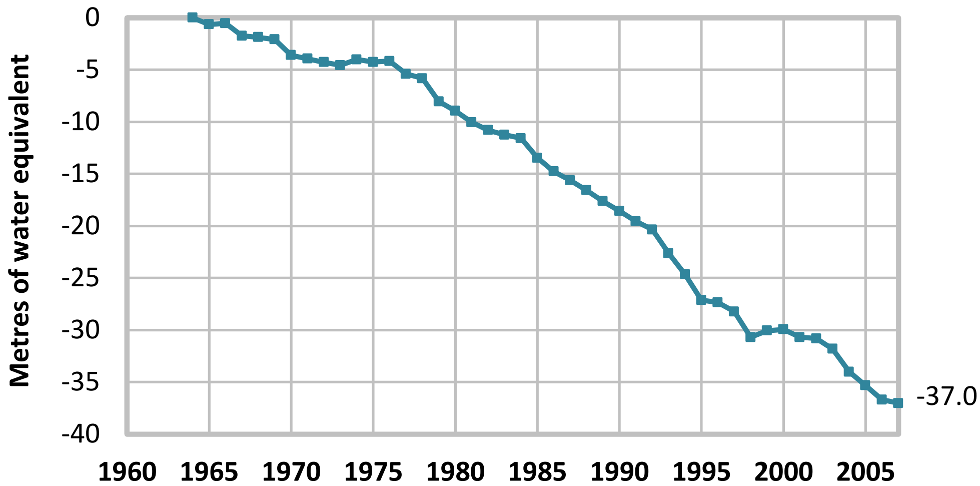


Figure 24. Cumulative average loss of ice thickness (cumulative sum of annual mass balances) for Place Glacier from 1964 to 2008.
Source: Demuth et al., 2009[74] *Data provided by World Glacier Monitoring Service.*

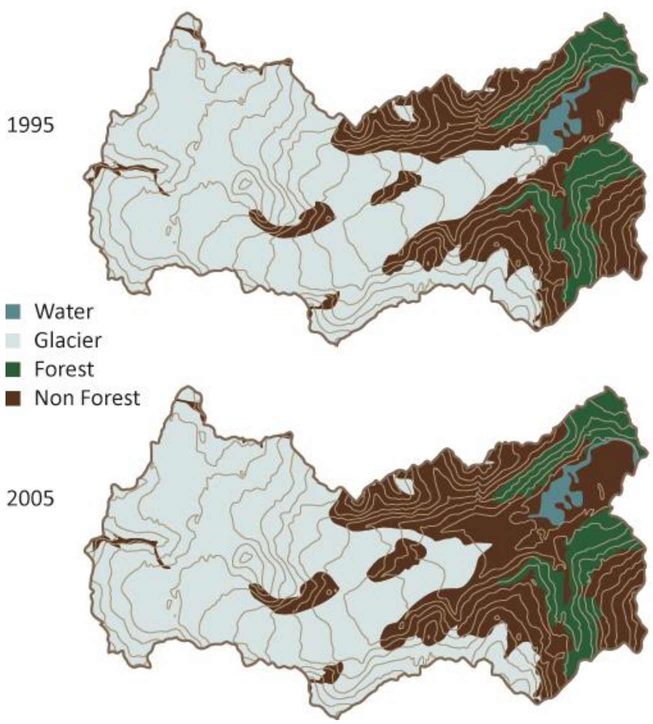


Figure 25. Change in the extent of Bridge Glacier from 1995 to 2005.
Note the westward recession of the main tongue of the glacier.
Source: Stahl et al., 2008[75] *This material is reproduced with permission of John Wiley & Sons, Inc.*

THEME: HUMAN/ECOSYSTEM INTERACTIONS

Key finding 8 **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.

Before 1940, four small protected areas totalling 5 km^2 were established in the WIBE by federal and provincial jurisdictions.[76] By 2009, 5,106 km^2 (9% of the WIBE) was in 111 protected areas in IUCN categories I–IV (Figure 26, Figure 27).[76] These categories 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.[77] In addition, 43 protected areas (0.07% of the WIBE) were in category VI for sustainable use by established cultural tradition.[77]

In 2003, Canada and BC signed a Memorandum of Understanding to assess the feasibility of establishing a national park reserve in the South Okanagan–Lower Similkameen. The proposed park would represent the Interior Dry Plateau natural region, which is one of Parks Canada's 39 distinct natural regions and a natural region not yet represented in the national park system. In early 2012, however, the BC government withdrew from the feasibility assessment due to concerns that there was insufficient local support. Consequently, Parks Canada is not conducting any further work on the proposal at this time.[78]

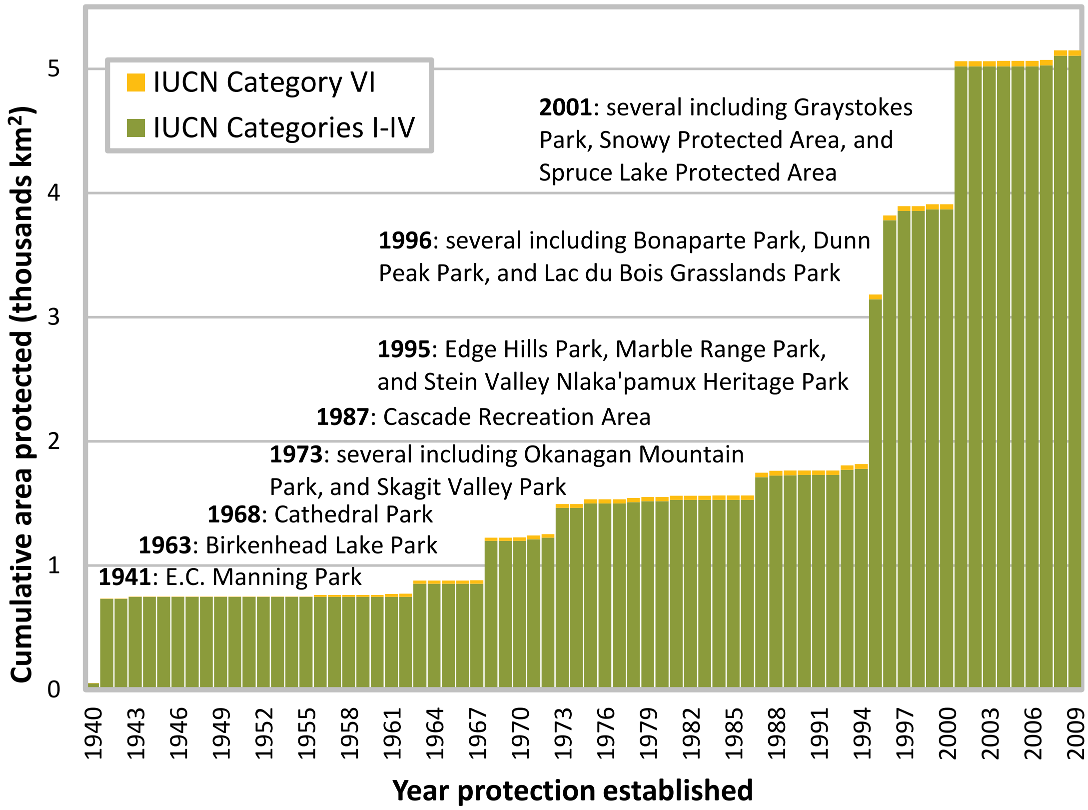


Figure 26. Area protected in the Western Interior Basin Ecozone+ from 1940 to 2009.
Data provided by federal and provincial jurisdictions, updated to May 2009.
Source: Environment Canada, 2009[79] using Conservation Areas Reporting and Tracking System (CARTS), v.2009.05, 2009;[76] data provided by federal, provincial, and territorial jurisdictions

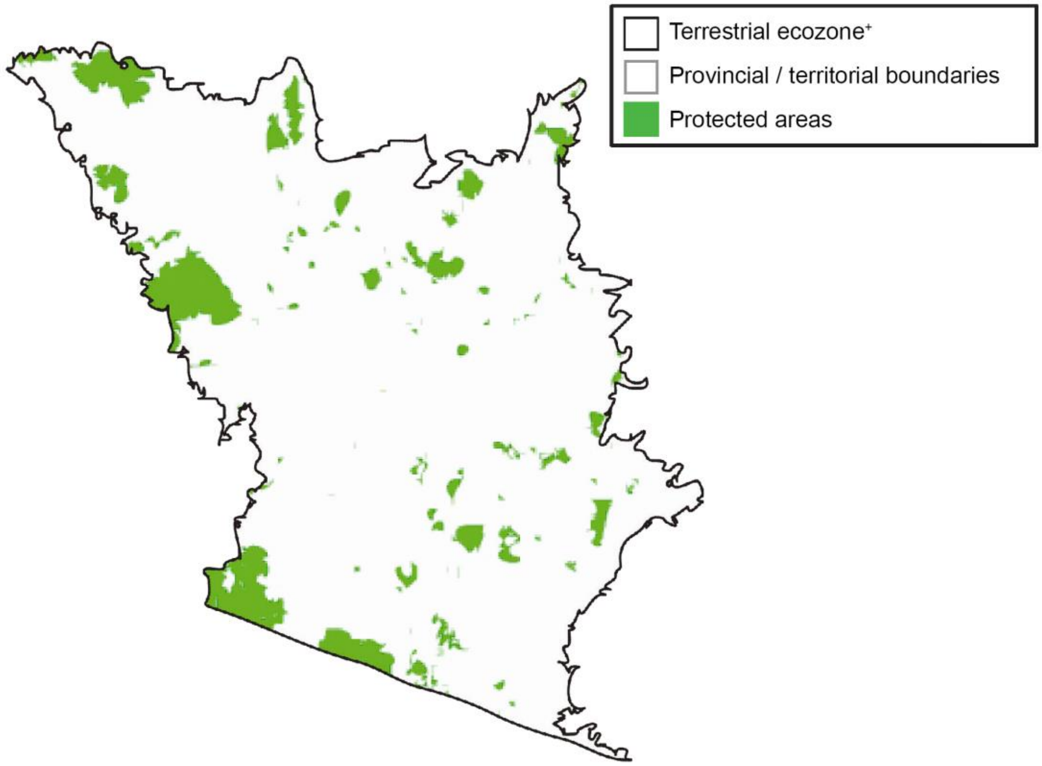


Figure 27. The distribution of protected areas in the Western Interior Basin Ecozone+, 2009. Not shown are four new provincial parks and one park expansion established in 2008. Source: Environment Canada, 2009[79] using Conservation Areas Reporting and Tracking System (CARTS), v.2009.05, 2009;[76] data 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.

The WIBE, particularly in the South Okanagan, has benefited from the conservation and restoration activities of non-governmental organizations (NGOs), federal and provincial government agencies, city councils, First Nations, stewardship groups, and thousands of individuals.

Several local and regional stewardship organizations in the south and southwest of the WIBE work under the umbrella of the South Okanagan–Similkameen Conservation Program and in the north and central Okanagan under the Okanagan Collaborative Conservation Program. Although the Thompson region lacks a similar coordinating body, stewardship groups are also active in this region. Many other local, provincial, and national initiatives and organizations also operate throughout the WIBE.

Stewardship can play a key role in augmenting government-protected habitats of conservation concern. In 2005, 156 km^2 of shrub-steppe and wetland/riparian habitats occurred on private land in the South Okanagan.[80] Of this, 7.5 km^2 (4.8%) had been acquired by The Nature Trust of BC, Ducks Unlimited Canada, The Land Conservancy of BC, or Nature Conservancy of Canada. An additional 12.6 km^2 (8.1%) were under covenant, in signed voluntary stewardship agreements, or were being actively stewarded by landowners without a signed agreement. Although there is no synthesis of stewardship activities and participation rates in the WIBE or across BC, information about stewardship projects can be obtained from the annual reports of many of the stewardship groups, as well as funders such as Environment Canada's Habitat Stewardship Program and the Habitat Conservation Trust Foundation.

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 WIBE. 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 WIBE.

Habitat loss

Ecosystem conversion resulting in habitat loss is the primary threat to biodiversity in the WIBE.[8, 81-83] Ecosystem conversion is the direct and complete conversion of natural landscapes such as forests, wetlands, or grasslands to landscapes of human uses (e.g., buildings, houses, parking lots, mines, reservoirs, and agricultural fields).[49] Although no significant change in the extent of the WIBE's major biomes between 1985 and 2005 was detected using remote sensing[12], conversion was detected using larger-scale maps.[49] Lower elevations had the highest rates (>22%) of terrestrial ecosystem conversion based on Baseline Thematic Mapping and Terrain Resource Information Management - Enhanced Base Maps from 1991–2001 (Figure 28).

Rates of ecosystem conversion in the WIBE were even greater historically. In the Okanagan and Lower Similkameen valleys, 12 ecosystems lost at least 33% of their area between 1800 and 2003, and 7 lost more than 60% (Figure 29).[20] Most high-value riparian and wetland ecosystems and a substantial portion of low elevation grassland/shrubland ecosystems have been converted to other uses.[84]

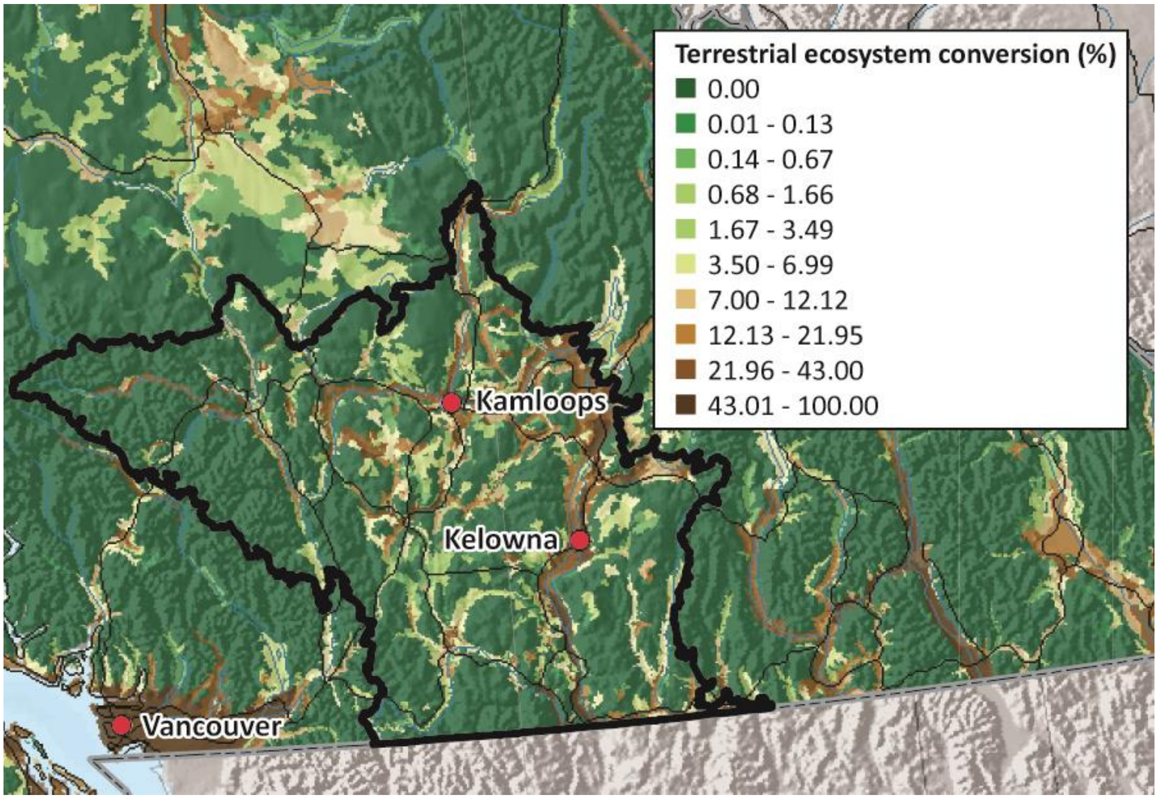


Figure 28. Percent of ecosystem conversion in the Western Interior Basin Ecozone+ from 1991 to 2001. Source: adapted from Austin and Eriksson, 2009[49] Original map by Caslys Consulting Ltd., produced for Biodiversity BC based on imagery taken between 1991 and 2001; ecosystem conversion that occurred after the images were taken is not included.

More information about habitat loss can be found in the Theme: Biomes (the Forests section on page 13, the Grasslands section on page 19, the Wetlands section on page 25, and the Lakes and rivers section on page 28).

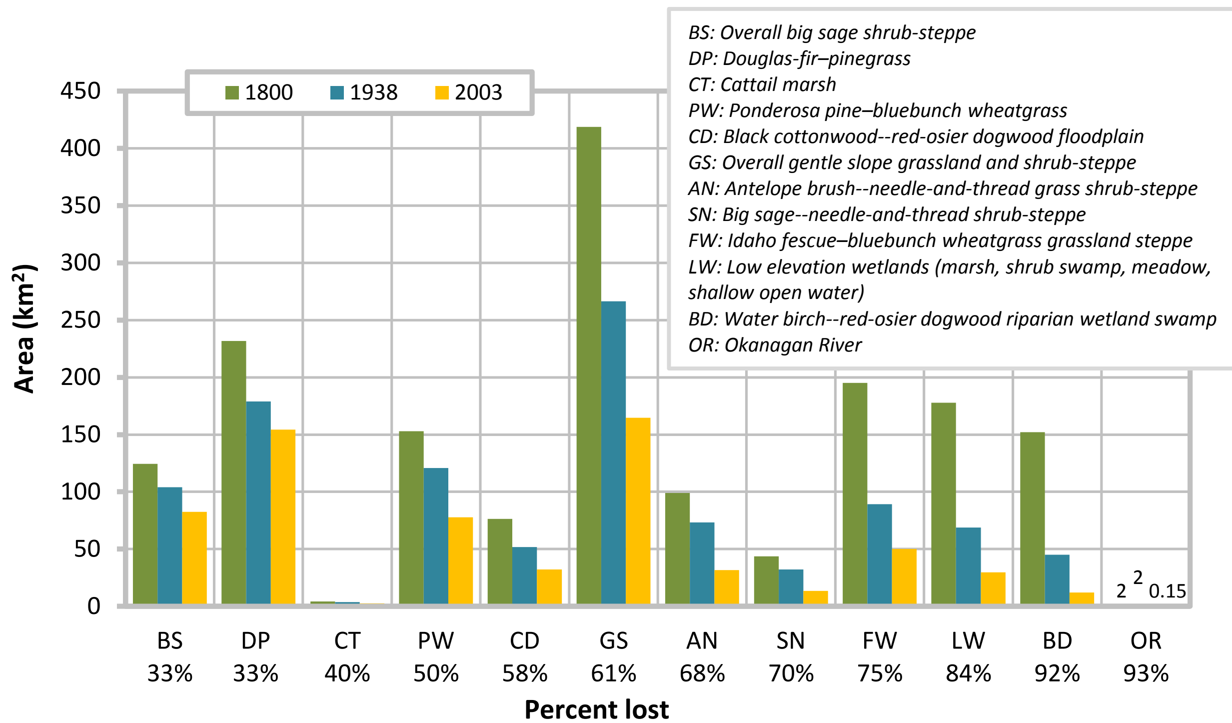


Figure 29. Extent of the major ecosystems in the Okanagan and Similkameen valleys in 1800, 1938, and 2003.
Source: data from Lea, 2008[20]

Habitat fragmentation

Much of the low-lying, highly productive areas have been logged and/or converted to high human density areas or agriculture, or flooded by hydroelectric dams. Therefore, remaining low-elevation forests are often highly fragmented by roads and forest harvesting.[14] In addition to the actual loss and fragmentation of habitat, land conversion for agriculture and suburban development creates a "halo zone" around the developed areas where roads, soil disturbance, domestic animals, and invasive species threaten native species and natural processes.

The density of roads can be used as an indicator of habitat fragmentation. Major roads and highways may restrict the movement of less mobile terrestrial species; for example, roads in the major valleys interrupt connectivity of grassland habitats and increase mortality for animals such as reptiles and amphibians.[85] In 2005, the WIBE had a road density of 1.7 km of road/km^2, the second highest among 10 regions of BC.[14] Road densities in the WIBE are increasing, particularly in the eastern regions of the ecozone+ (Figure 30).

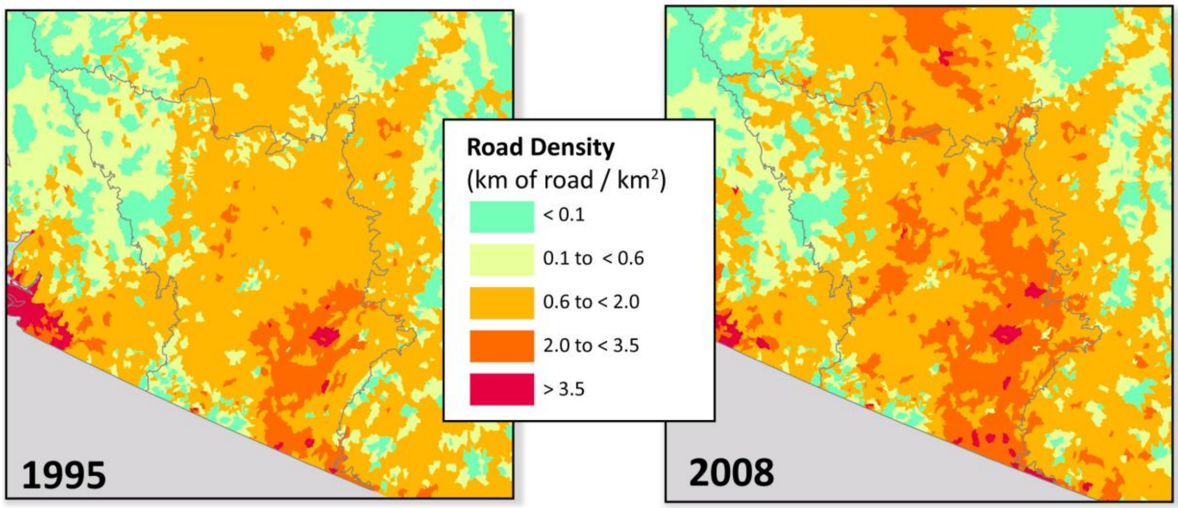


Figure 30. Road density and distribution in the Western Interior Basin Ecozone+ in 1995 and 2008. The road density categories shown represent areas that are (1-blue) undeveloped, without roads, (2-green) minimally affected by few roads, (3-yellow) moderately developed, (4-orange) rural areas, and (5-red) urban areas.
Source: adapted with permission from BC Ministry of Forests, Mines and Lands, 2010[19]

Urban, suburban, and agricultural development pressures will continue to fragment the WIBE's low elevation ecosystems. Ecosystem and habitat fragmentation is of particular concern in the southern Okanagan, which is the northern extension of the Great Basin desert of the United States. If well-managed, the southern Okanagan can provide a corridor for the north–south movement of species as the climate changes.[81, 86] The two main river systems, the Okanagan and the Fraser, also provide corridors for migration and dispersal of riparian and aquatic species. In addition to allowing movement of native species, however, these corridors may facilitate the invasion of non-native species.[87]

Urban areas

In 2010,[88] the four largest urban settlements in the WIBE were Kelowna (121,000), Kamloops (87,000), Vernon (39,000), and Penticton (33,000). This is one of the fastest growing regions in Canada, and population growth is expected to continue (Table 4).

Table 4. Projected population growth in four regional districts in the Western Interior Basin Ecozone+.

Regional district	2008	2035 (projected)	Percent growth
Thompson-Nicola*	130,132	163,681	20.5%
Okanagan-Similkameen	82,436	92,160	10.5%
Central Okanagan	180,114	263,892	31.7%
North Okanagan	81,932	103,005	20.5%

**Thompson-Nicola Regional District is partially in the WIBE and partially in the Montane Cordillera Ecozone+.*
Source: BC Statistics[88] *and Statistics Canada, 2007*[89]

Ecosystems in these cities have been dramatically altered. Overall loss was highest in Kelowna (Figure 31) and 100% of water birch–red-osier dogwood ecosystems were lost in Vernon.[20]

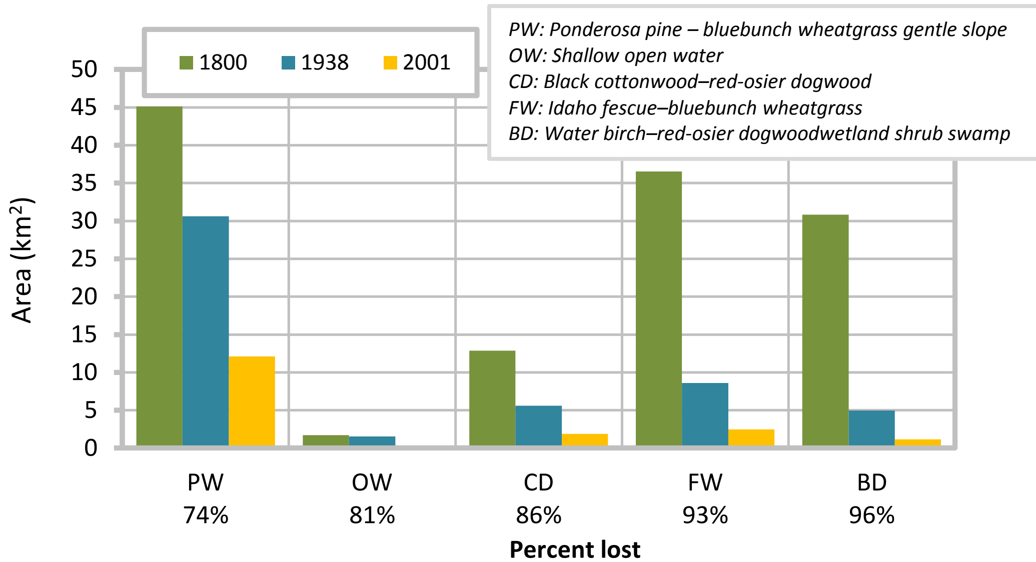


Figure 31. Extent and loss of ecosystems in the City of Kelowna in 1800, 1938, and 2001.
Source: Lea, 2008[20]

Conversion of native habitats to urban uses is also discussed in the Grasslands section on page 19 and the Wetlands section on page 25.

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.[90] *Invasive* non-native species, however, cause considerable harm to our environment, the economy, or to society.[91] 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.[92] 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.[93] The costs can be substantial. For example, six invasive plant species in BC had a combined economic impact of $65 million in 2008 and this was projected to increase to $139 million by 2020.[93] Invasive non-native species can also be harmful to human health and to domestic animals, such as hound's tongue (*Cynoglossum officinale*) which can cause liver damage to livestock.

Biocontrol programs use select non-native species to control other non-native species. By 1994, 103 non-native insects, 5 protozoans, 1 fungus, and 2 viruses were introduced to BC to control insect pests, as well as 59 species of insects, fungi, and nematodes to control weeds.[94] Other species have been introduced in biocontrol programs since then.[95, 96] A lengthy research process that includes quarantines and controlled trials precedes the introduction of biocontrol agents.[97]

The WIBE has a substantial number of non-native terrestrial and aquatic plants and animals (Figure 32). The three biogeoclimatic zones identified as of conservation concern each have more than 100 non-native species associated with them (Table 5).

Table 5. The proportion of each biogeoclimatic zone in the Western Interior Basin Ecozone[+] and the number of terrestrial non-native plant and animal species associated with each zone.

Biogeoclimatic zone	Proportion of each zone in WIBE	Terrestrial non-native species throughout BC associated with each zone
Interior Douglas-fir*	41%	335
Montane Spruce	22%	182
Engelmann Spruce—Subalpine Fir	21%	232
Ponderosa Pine*	5%	187
Interior Mountain-heather Alpine	4%	44
Bunchgrass*	3%	148
Interior Cedar–Hemlock	3%	265
Coastal Western Hemlock	1%	579

**Zones identified as being of conservation concern[14]*
Source: adapted from Austin and Eriksson, 2009[49] and BC Ministry of Forests, Mines and Lands, 2010[98]

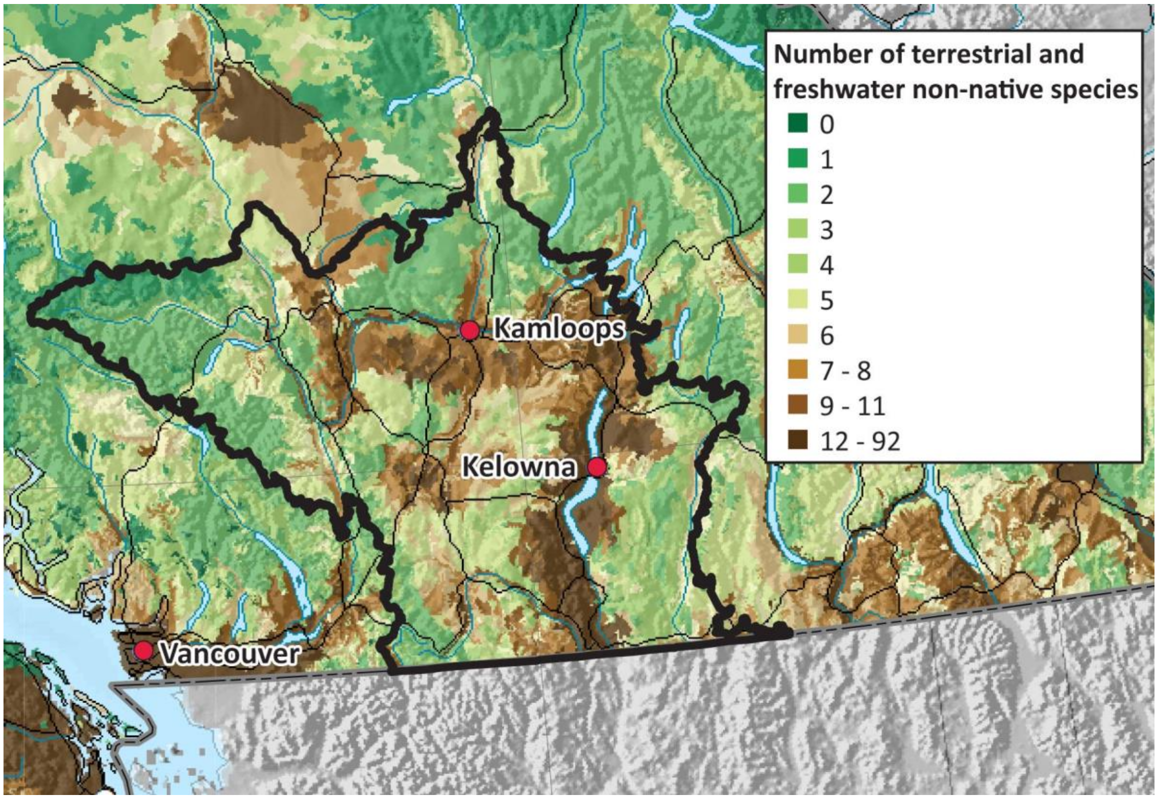


Figure 32. Number of terrestrial and freshwater non-native species in Western Interior Basin Ecozone+, 2008.
Source: adapted from Austin and Eriksson, 2009[49] Original map by Caslys Consulting Ltd., produced for Biodiversity BC.

Invasive terrestrial plants

In 2009, the provincial Invasive Alien Plant Program (IAPP) listed 83 invasive plants in the WIBE,[99] a conservative estimate because invasive plant inventories have not been conducted throughout the ecozone+.[100]

Many of these invasive plants became established in the WIBE 50–100 years ago (Table 6).[101] Species such as Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), cheatgrass (*B. tectorum*), yellow salsify (*Tragopogon dubius*), diffuse and spotted knapweed (*Centaurea* spp.), sulfur cinquefoil (*Potentilla recta*), and others are widespread throughout WIBE grasslands.[38, 102-104] Purple loosestrife (*Lythrum salicaria*), yellow iris (*Iris pseudacorus*), and common reed (*Phragmites australis* ssp. *australis*) have invaded wetlands and marshes.[105, 106]

Biological, chemical and mechanical control are used to manage invasive terrestrial plants. For example, knapweed seedhead weevils (*Larinus obtusus*) introduced as biocontrol agents in the early 1990s decreased the number of knapweed flower stems per area in the southern Okanagan.[96] In the Thompson–Nicola region, the Southern Interior Weed Management Committee encourages chemical control of invasive species by sharing the treatment costs.[107] Organizations throughout the region organize stewardship activities that include the mechanical removal of invasive species and the regional districts of the Okanagan–

Similkameen, North Okanagan, and Central Okanagan have by-laws supporting the management of invasive species.

Table 6. Date of first records of selected non-native plant arrivals in BC and in the Okanagan.

Scientific name	Common name	Earliest record in BC	Earliest record in the Okanagan
Arctium lappa	Great burdock	1895	1933
Arctium minus	Common burdock	1909	1917
Bromus tectorum	Cheatgrass	1890	1912
Centaurea diffusa	Diffuse knapweed	1936	1939
Centaurea maculosa	Spotted knapweed	1893	1944
Cirsium arvense	Canada thistle	1894	1913
Cuscuta pentagona	Dodder	1911	Late 1970s
Cynoglossum officinale	Hound's tongue	1922	1922
Echium vulgare	Blueweed	1917	1918
Hypericum perforatum	St. John's wort	1913	1950
Linaria genistifolia var. *dalmatica*	Dalmatian toadflax	1940	1952
Lythrum salicaria	Purple loosestrife	1897	1963
Potentilla recta	Sulphur cinquefoil	1914	1940
Senecio jacobaea	Tansy ragwort	1913	1991
Tribulus terrestris	Puncturevine	1974	1974

Source: Lea, 2007[20, 31]

Invasive terrestrial animals

Many invasive terrestrial animals were intentionally introduced. Ring-necked pheasants (*Phasianus colchicus*), grey (Hungarian) partridges (*Perdix perdix*), California quail (*Callipepla californica*), wild turkeys (*Melagris gallopavo),* and chuckar partridges (*Alectoris chukar*) were introduced for hunting and have established stable populations in the WIBE.[108] Eastern grey squirrels (*Sciurus carolinensis*), feral horses (*Equus caballus*), and feral cats (*Felis domesticus*) have also invaded the sensitive ecosystems of the WIBE.[109]

Invasive aquatic species

Sixteen species of non-native fish have been introduced to the rivers and lakes of the WIBE.[110] The introductions began in 1929 with the greatest number of introductions occurring in the 1940s (Figure 34). Some non-native fish were introduced to BC for angling and others were stocked in Washington State and later invaded BC waters. Osoyoos Lake has the largest number of non-native fish species (10 species confirmed and 3 possibly present) of the Okanagan valley floor lakes.[111] Other lakes in the WIBE, such as Shuswap Lake, have introduced yellow perch (*Perca flavescens*).[112]

The Freshwater Fisheries Society of BC regularly stocks some lakes with strains of rainbow trout that are not native to the particular lake.[113] Their effect on native fish has not been well studied in the WIBE, but rainbow trout stocking in previously fishless lakes caused amphibians [long-toed salamander (*Ambystoma macrodactylum*), Columbia spotted frog (*Rana luteiventris*), and Pacific treefrog (*Hyla regilla*)] to decline by 64% in the Thompson–Nicola region.[114]

Mysis shrimp (also known as mysids) are small, freshwater shrimp that were introduced to Okanagan Lake in 1966 to provide a food source for rainbow trout (*Oncorhynchus mykiss*) and kokanee.[45] Kokanee declined, however, due to the loss of kokanee spawning habitat, nutrient imbalances in the lake that led to a decline in lake productivity, overfishing, and competition between mysids and kokanee for preferred cladoceran zooplankton (e.g., *Daphnia*).[115-117] Mysids have a daily migration pattern through the water column that limits the amount of time they are available for consumption by kokanee.[45] Mysids live near the bottom of the lake during the day (100–120 m), move upward after dark to feed on zooplankton near the surface (20 m), and then migrate back down before dawn. Whether the consumption of daphnia by mysids is substantial enough to explain the long-term decline in kokanee salmon stocks in Okanagan Lake, however, remains unresolved.[118] Mysids also moved downstream to Skaha and Osoyoos lakes. In shallower lakes, like Skaha Lake, kokanee have more opportunities to eat mysids.[45]

Mysid biomass estimates in Okanagan Lake have ranged from 2,700 to 5,700 tonnes.[119] A fishery was opened in 1999 to provide mysids for the aquarium and aquaculture industries.[45] The efficiency of capturing mysids improved from 2000 to 2004 and harvest levels peaked at 78 tonnes in 2001 (Figure 33). To impact the population, however, harvest needs to exceed 1,000 tonnes and so new markets for mysids are needed before the WIBE shrimp fishery can expand.[117]

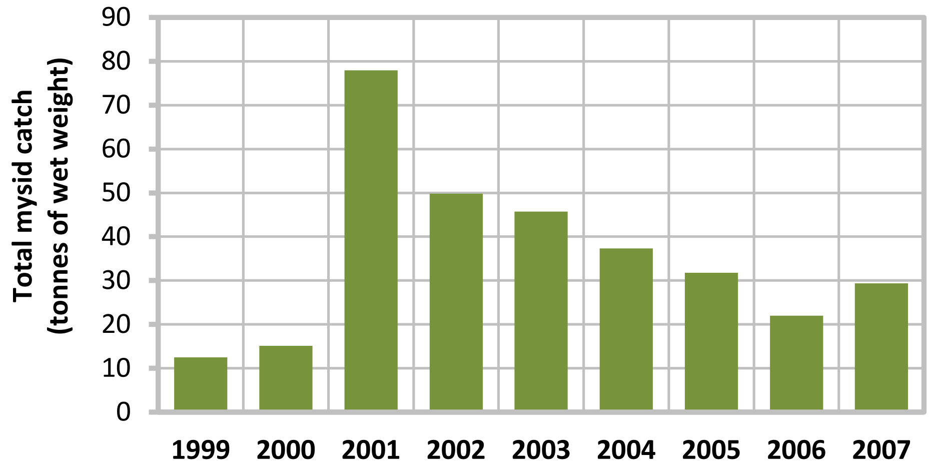


Figure 33. The total mysid catch (metric tonnes of wet weight) from the shrimp fishery in Okanagan Lake from 1999 to 2005.
Source: Rae and Andrusak, 2006[45] and Andrusak and White, 2008[119]

Since the early 1900s, 30 non-native aquatic plant species are known to have been introduced to the WIBE (Figure 34).[110] In the 1970s, one of the most problematic aquatic plants for the large Okanagan lakes was Eurasian water-milfoil (*Myriophyllum spicatum*).[120] Some plants included in Figure 34 are terrestrial species that can affect aquatic environments. For example, saltcedar (*Tamarix ramosissima*) has deep taproots that consume large amounts of water and leaves that excrete salt, which inhibit native riparian plants. Although saltcedar was not considered a problem in the WIBE in 2010, some BC nurseries sell it as an ornamental and it was identified at a site near Penticton.[121]

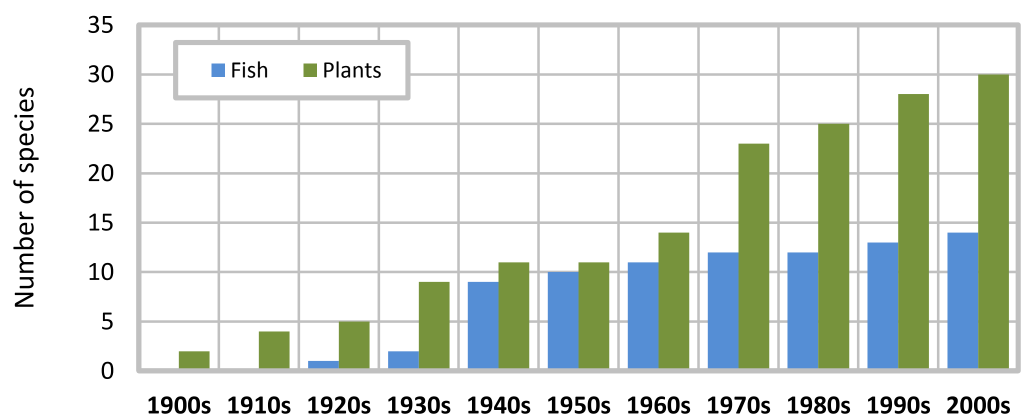


Figure 34. The cumulative number of fish and aquatic plants introduced to the Western Interior Basin Ecozone+ from the 1900s to 2000s.
Source: Herborg, 2011[110]

Invasive pathogens and disease

Similar to non-native plants and animals, non-native pathogens are species that have been moved from their native range and introduced to a new area. Non-native pathogens include bacteria, fungi, nematodes, other microscopic eukaryotes, and viruses, which can cause sickness or death in other species. This can alter the species composition of ecosystems. For example, white pine blister rust (*Cronartium ribicola*) arrived in BC around 1910, reached the interior about 1930, and is responsible for the severe reduction of western white pine (*Pinus monticola*) in the WIBE. Efforts to eradicate the rust's intermediate hosts—currants and gooseberries—did not control the blister rust.[122]

Key finding 11 **Theme** Human/ecosystem interactions

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.

There were no ecozone$^+$-level monitoring programs for contaminants in the WIBE, only localized research studies in birds [ospreys (*Pandion haliaetus*) and American robins (*Turdus migratorius*)] and fish. For example, in the Thompson region in the early 1990s, organochlorine pesticides, polychlorinated biphenyls (PCBs), and mercury residues in the eggs and blood of ospreys were higher downstream than upstream of a pulp mill.[123] Also in the 1990s, American robins nesting in orchards had higher DDT residue levels to those outside of orchards, even 20 years after the banning of DDT. However, reproduction by orchard robins was unaffected.[124, 125] In contrast, concentrations of mercury and DDT declined in rainbow trout in Okanagan Lake in the 2000s (Figure 35).[126] Of four fish species sampled from 2000 to 2006, lake trout (*Salvelinus namaycush*) had DDT concentrations ranging from 1 to 16 parts per million (ppm), and rainbow trout, kokanee, and largemouth bass (*Micropterus salmoides*) all had concentrations less than 1 ppm. Health Canada's human consumption guidelines are less than 0.5 ppm for both mercury and DDT.[126]

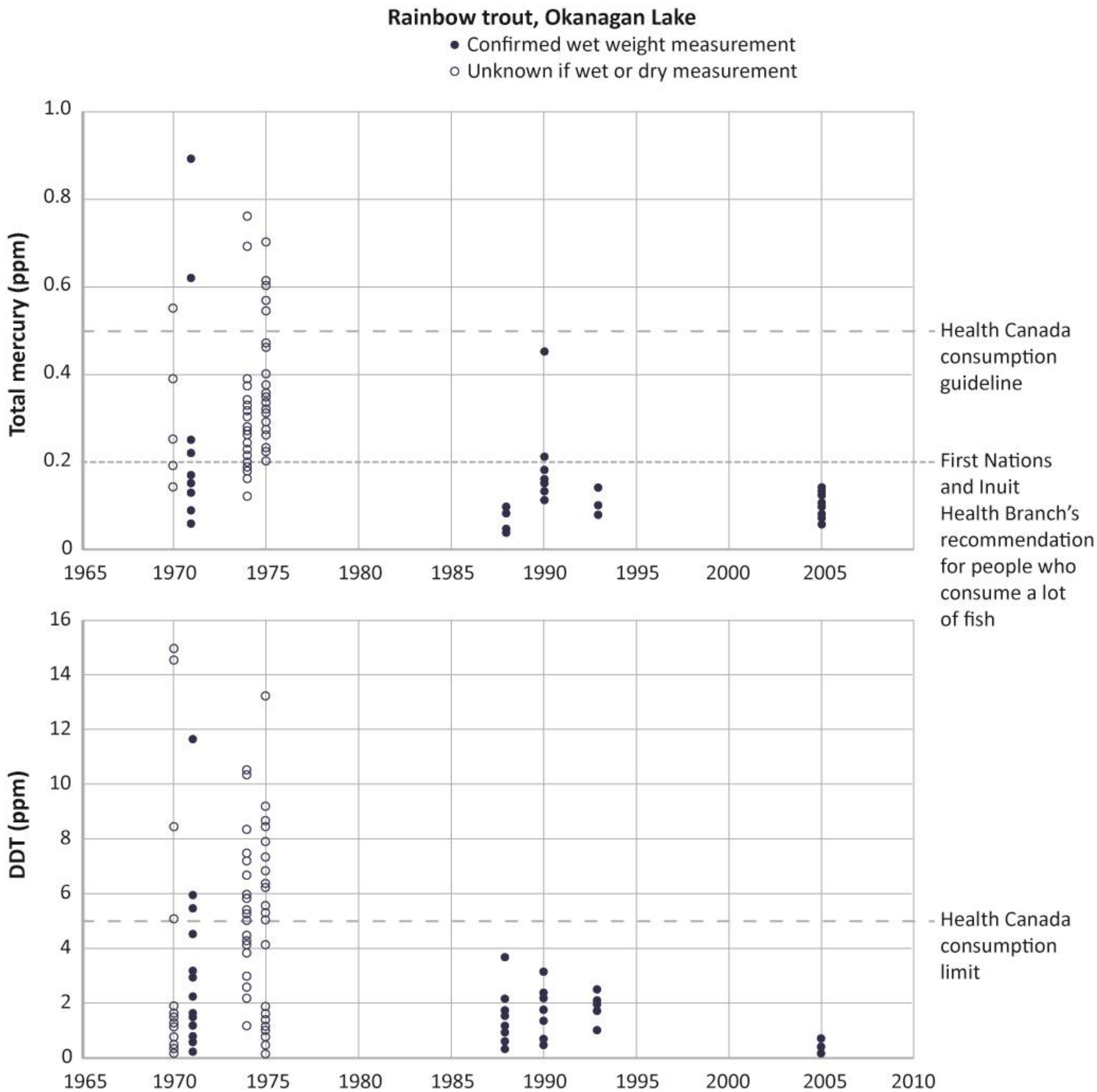


Figure 35. Total mercury and DDT in individual Okanagan Lake rainbow trout from 1970 to 2005. Source: Rae and Jensen, 2007[126]

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.

Residual soil nitrogen on agricultural lands

The WIBE is classed as having low residual soil nitrogen (Figure 36), which is an indicator of "unused" nitrogen in the soil at the end of an agricultural crop season.[127] Nitrogen inputs to the soil generally decreased from 1981 to 2006, although they increased in 2001. The decline from 2001 to 2006 was due to fewer livestock and less nitrogen from manure, decreased use of nitrogen fertilizers, and decreased nitrogen fixation by legumes. Nitrogen outputs, which include crop removal, ammonia volatilization, and denitrification, also decreased over this period due to changing crop acreages and decreasing hay yields. The net result was that the WIBE was the only agricultural ecozone+ in Canada where residual soil nitrogen decreased(20.6 kg N ha^{-1} in 1981 to 16.5 kg N ha^{-1} in 2006), although some local areas were stable or increased within the WIBE (Figure 37).[127]

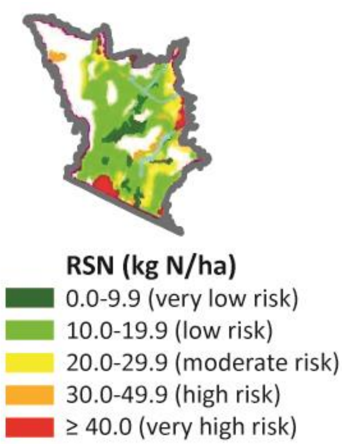


Figure 36. Residual soil nitrogen (RSN) classes in 2006.
Source: Drury et al., 2011[127]

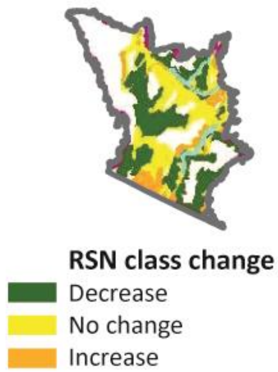


Figure 37. Change in residual soil nitrogen (RSN) class for the Western Interior Basin Ecozone+ and parts of adjacent ecozones+ between 1981 and 2006.
Source: Drury et al., 2011[127]

Nutrient loading to lakes

Pollution due to nutrient loading caused algal blooms in some of the large Okanagan Valley lakes in the 1960s and 1970s.[128] Due to reductions in phosphorus inputs from agricultural sources, the total phosphorus load to Okanagan Lake has decreased by 30% and improved sewage treatment resulted in a 95% reduction of the point source phosphorus load between 1970 and 2001.[128] The nutrient load was also reduced in Skaha Lake (Figure 38) and Osoyoos Lake (data not shown) with a concomitant decrease in chlorophyll *a* (a measure of the phytoplankton concentration) and increase in dissolved oxygen (which improves conditions for salmonids and other species).[48] More information about lakes and fish populations can be found in the Lakes and rivers section on page 28 and the Fish section on page 75.

There was deterioration near towns such as Salmon Arm by 2001.[129] In 2002, a new liquid waste management plan was ordered to improve sewage treatment. Annual nutrient loads are increasing in Mara Lake due to anthropogenic changes in the Shuswap River drainage basin. Forestry, agriculture, and urbanization have increased total phosphorus and nitrogen in the lake.[130] The federal and provincial governments announced a drinking water treatment plant for Sicamous and Mara lakes in 2013.[131]

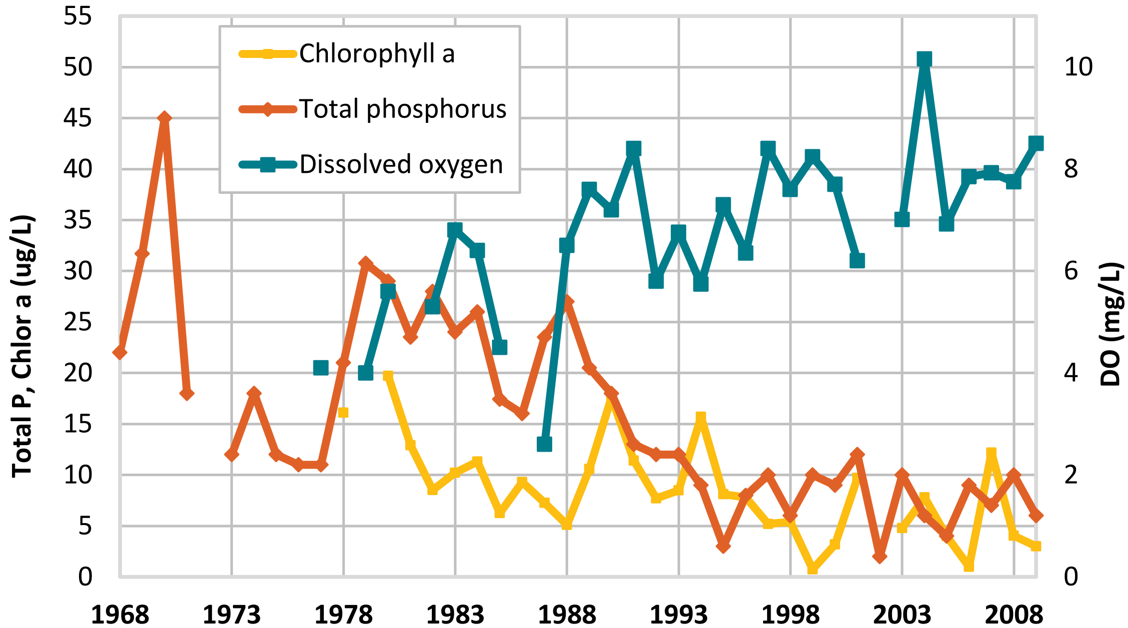


Figure 38. Changes in nutrient loading in Skaha Lake, 1968–2009.
Left axis is total phosphorus (total P) and chlorophyll a *(chlor* a*); right axis is dissolved oxygen (DO).*
Source: updated from Jensen and Epp, 2002[48]

Key finding 13 **Theme** Human/ecosystem interactions

Acid deposition

National key finding

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

Acid deposition was an issue of interest in BC in the 1980s; precipitation chemistry and data on acid levels were collected for several years at monitoring stations in Kamloops and Kelowna. The soils and lakes in the WIBE are considered at low risk from small changes in rain pH.[132] Coastal BC lakes were monitored from 1984 to 1994 and acidity did not change,[133] so it is probable that lakes in the WIBE did not change either.

Key finding 14 **Theme** Human/ecosystem interactions

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.

Climatic variables

Spring, summer, and winter temperatures increased from 1950 to 2007 across the WIBE (Table 7, Figure 39). Spring and fall precipitation increased, with some variability around the ecozone+, and winter precipitation decreased throughout the ecozone+ (Figure 40). The duration of snow cover (Figure 41) and the amount of precipitation falling as snow decreased. With these changes, the growing season also started earlier and was longer at some stations.

Table 7. Summary of changes in climatic variables in the WIBE, 1950–2007.

Climatic variable	Overall ecozone+ trend (1950–2007)	Comments and regional variation
Temperature	↑ of 1.9°C in spring, 1.7°C in summer, and 2.1°C in winter	Trends are consistent across ecozone+
Precipitation	↑ of 40% in spring precipitation and 42% in fall precipitation ↓ of 22% in winter precipitation	↑ in spring precipitation at a majority of the stations ↑ in fall precipitation concentrated in the southeast ↑ in summer precipitation at three stations in the central east ↓ in winter precipitation spread throughout the ecozone+
Snow	↓ in the amount of precipitation falling as snow (9.8% ↓ in the absolute ratio) ↓ in snow duration in the late-winter and spring (February to July) No overall trend in snow depth	↓ in precipitation falling as snow across the ecozone+ ↓ in snow duration in the late-winter and spring (February to July) by >20 days at three of six stations ↑ in maximum snow depth at Grand Forks
Growing season	No overall trend in growing season	Growing season was longer at two of four stations (16.6 and 22.1 days) Growing season started 16 days earlier in Kamloops

Only significant trends ($p<0.05$) are included
Source: Zhang et al., 2011[134] and supplementary data provided by the authors

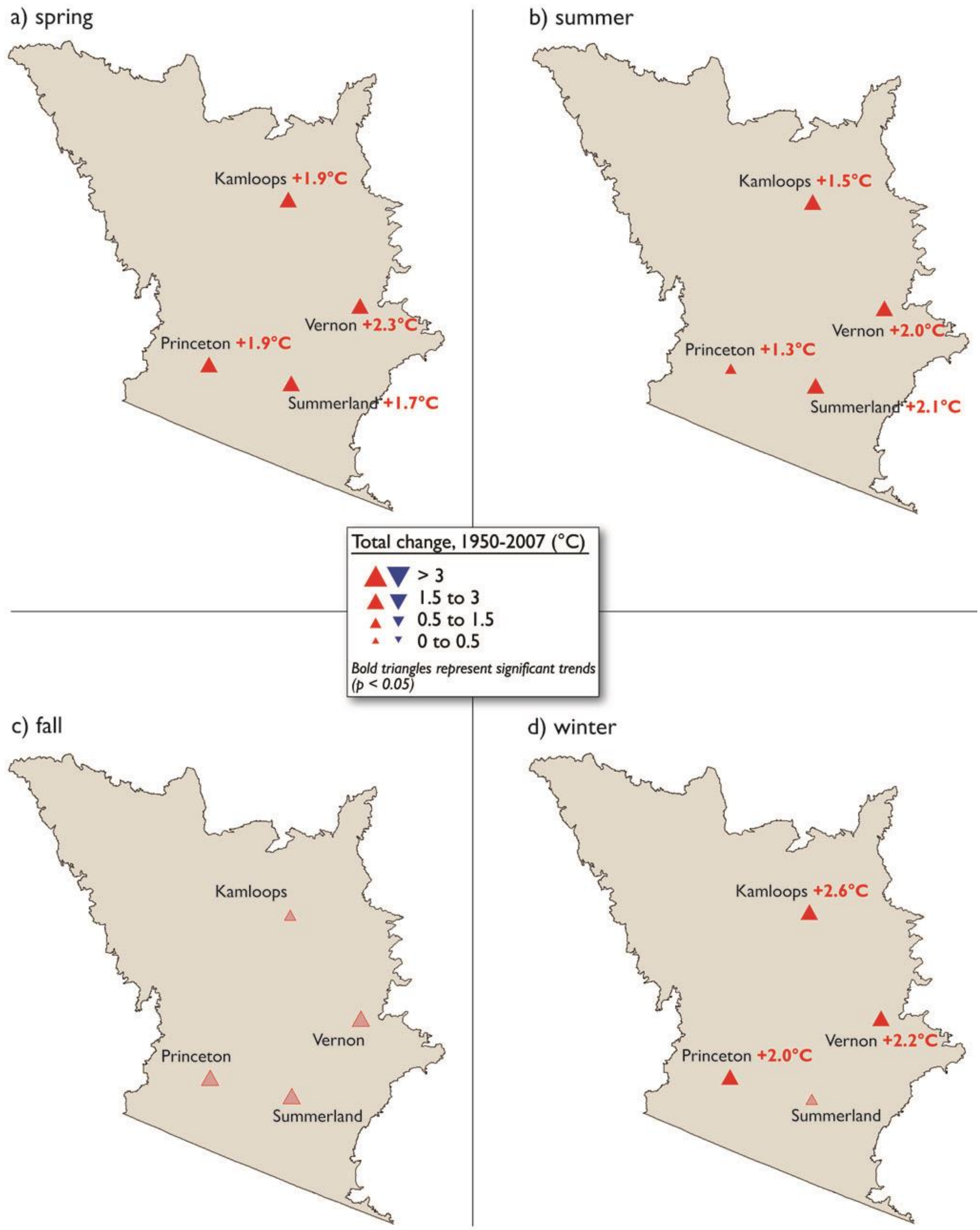


Figure 39. Change in mean temperature, 1950–2007 for a) spring (March–May), b) summer (June–August), c) fall (September–November), and d) winter (December–February).
Source: Zhang et al., 2011[134] and supplementary data provided by the authors

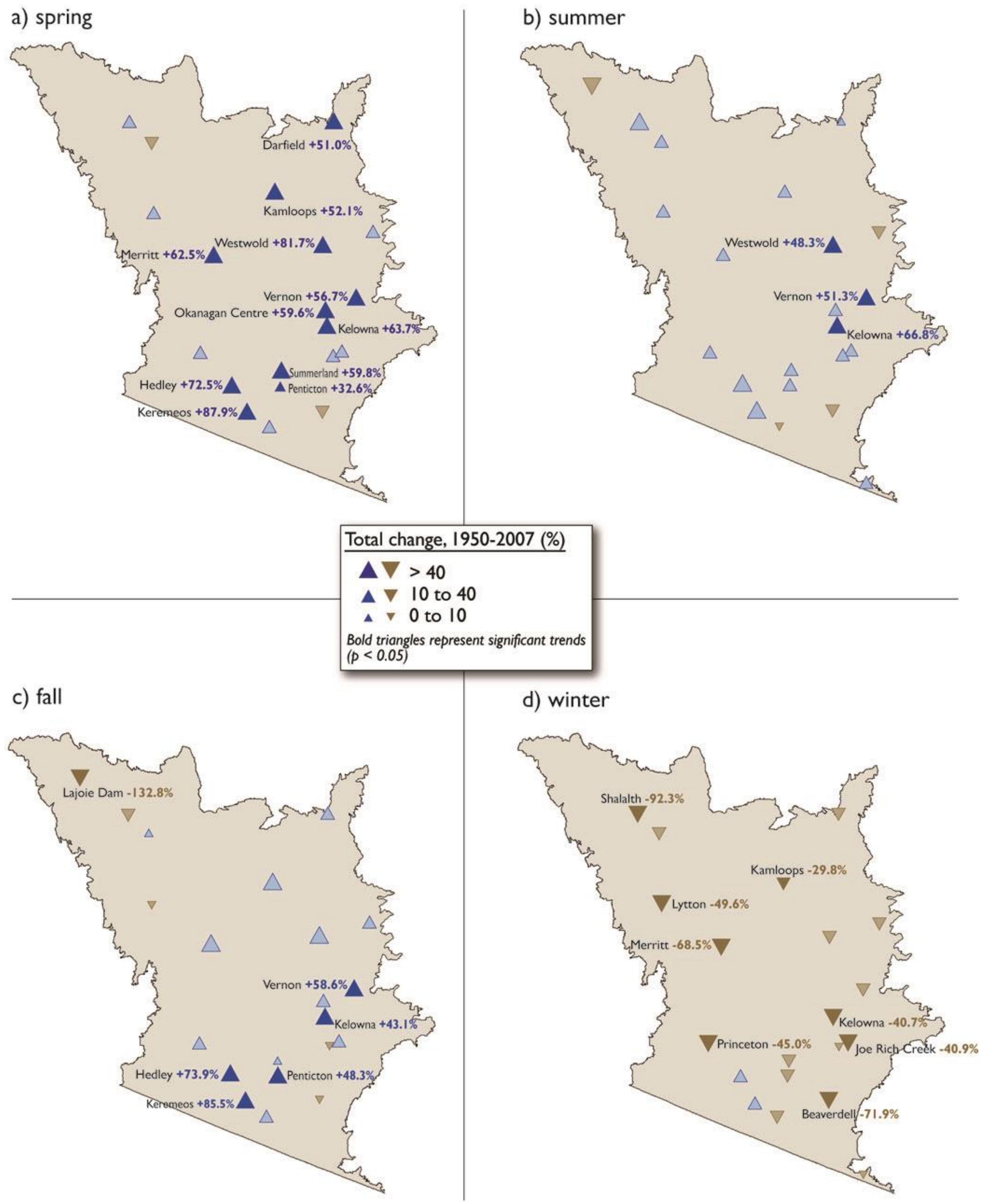
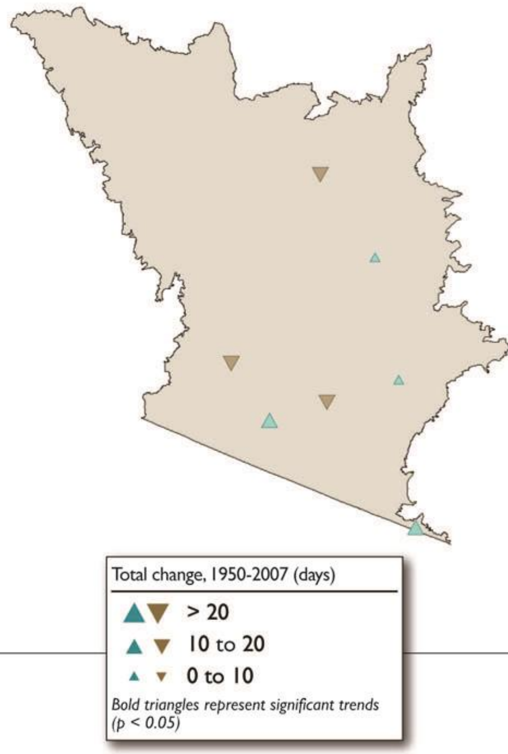


Figure 40. Change in the amount of precipitation, 1950–2007 for a) spring (March–May), b) summer (June–August), c) fall (September–November), and d) winter (December–February). Expressed as a percentage of the 1961–1990 mean. Source: Zhang et al., 2011[134] and supplementary data provided by the authors

a) August to January



b) February to July

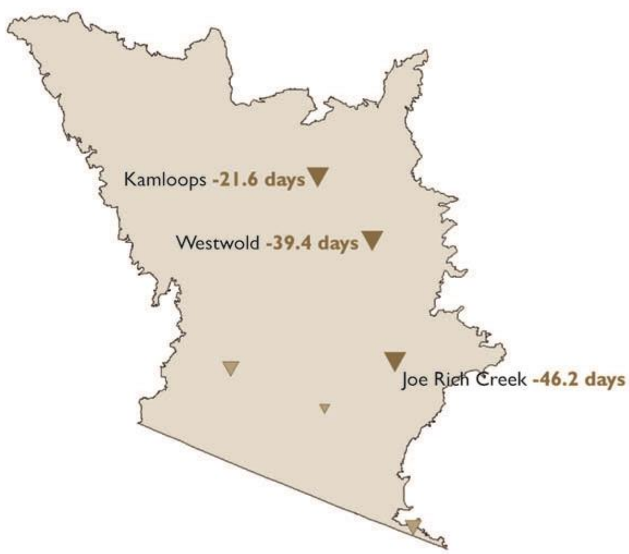


Figure 41. Change in snow duration, the number of days with ≥2 cm of snow on the ground, 1950–2007 in a) the first half of the snow season (August–January), which indicates changes in the start date of snow cover, and b) the second half of the snow season (February–July), which indicates changes in the end date of snow cover.
Source: Zhang et al., 2011[134] *and supplementary data provided by the authors*

Hydrology and climate analyses

Stream flow, temperature, and precipitation have changed between 1961–1982 and 1983–2003. These changes were analyzed using data from five hydrology stations clustered in the south of the WIBE.[135] There were stations located in the northern sections of the WIBE, but they were classified to the Montane Cordillera Ecozone+ because membership was based on watershed areas, rather than station location.[135] The results from the Similkameen and Kettle rivers are provided as representative examples of the southwest and southeast, respectively. Both stations recorded earlier onsets of spring freshet, lower flows in late summer, and higher flows in early winter (Figure 42, Figure 43). The Kettle River station also recorded lower flows in early fall (Figure 43). These changes are driven by climate change as well as land alteration and conversion.[135] See also the Large lakes and Streams sections on pages 28 and 30, respectively.

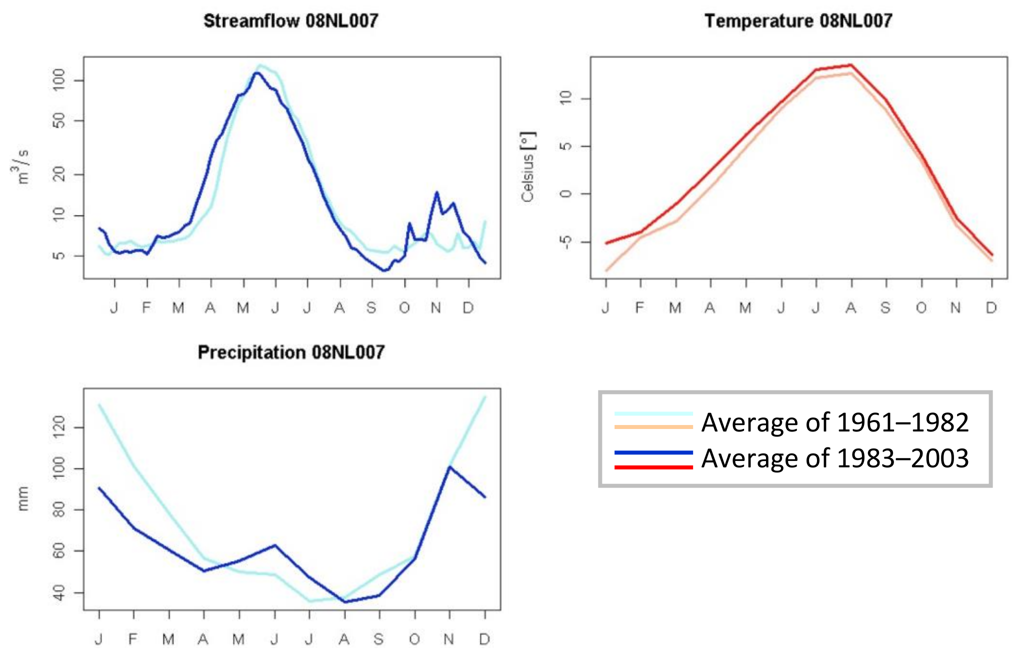


Figure 42. Average annual stream flow, temperature, and precipitation for 1961–1982 and 1983–2003 for the Similkameen River at Princeton (Station 08NL007).
Source: Cannon et al., 2011[135]

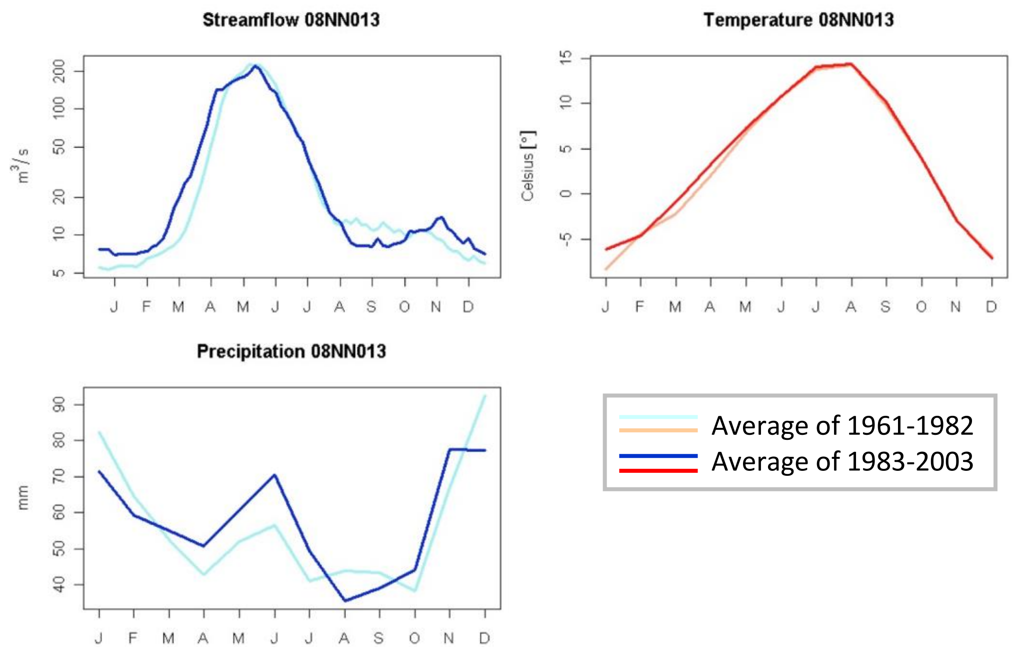


Figure 43. Average annual stream flow, temperature, and precipitation for 1961–1982 and 1983–2003 for the Kettle River at Ferry (Station 08NN013).
Source: Cannon et al., 2011[135]

Future climate predictions

Climate change in the WIBE is expected to have a range of effects on ecosystems and species such as:

- the alteration of the distribution, extent, and composition of forests;[136]
- the loss of some ecosystems including some wetland and alpine areas;[137]
- a general expansion of species' ranges northwards and upslope;[137]
- an increase in growing days;[137] and
- a more rain-dominated stream flow for the Okanagan Basin with earlier peak runoff and an extended period of low flows in summer.[138-140]

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 WIBE 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. Other provisioning services harvested commercially or recreationally including forests, wildlife, and fish. The WIBE's ecosystems also provide cultural services, which include educational, recreational, and spiritual experiences.

Ecosystem services in the WIBE have not been systematically quantified for their economic value. However, a project initiated in 2012–13 will estimate the value of ecosystem services supported by the last remaining natural (unchannelled) section of the Okanagan River.[141]

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 Province of BC zones agricultural land as part of the Agricultural Land Reserve (ALR). These lands are designated with agriculture as the primary use; other uses are controlled.[142] There is pressure to remove land from the ALR for other uses such as urban development.

Most of the agricultural lands (81%) in the WIBE are in the northeast region of the ecozone⁺ (Figure 44).[143] Between 1986 and 2006, the agricultural land base in the WIBE expanded from 4,810 to 5,690 km^2, approximately 10% of the ecozone⁺. At lower elevations, grazing, forage production, and orchards were common; grazing in woodlands was associated with middle elevations.

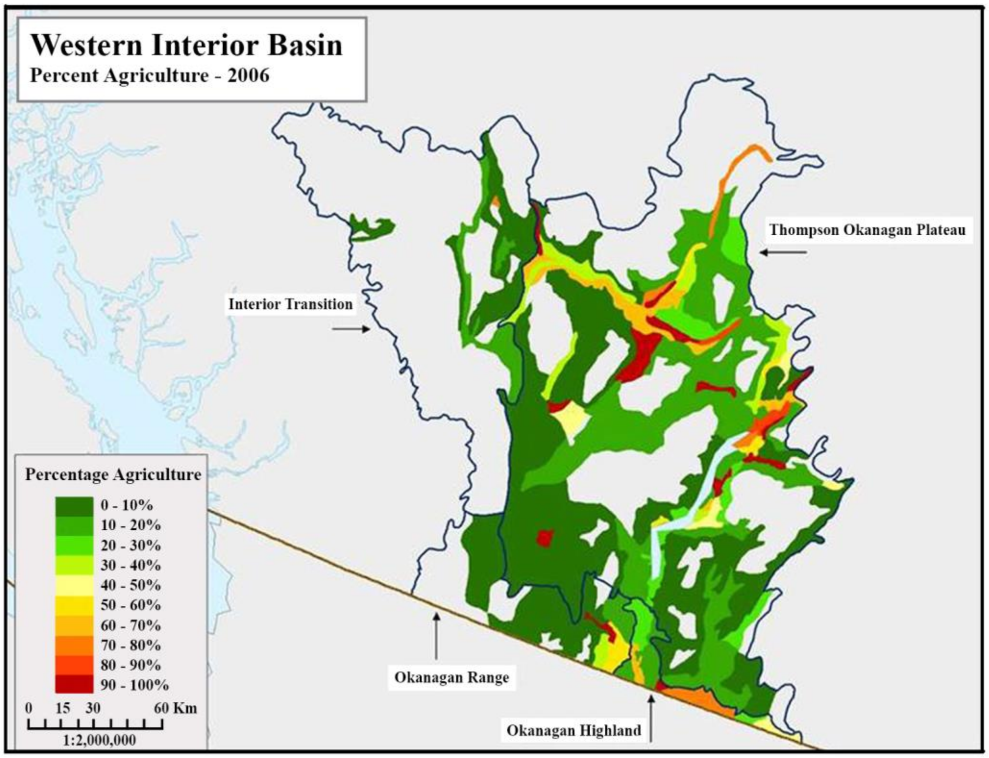
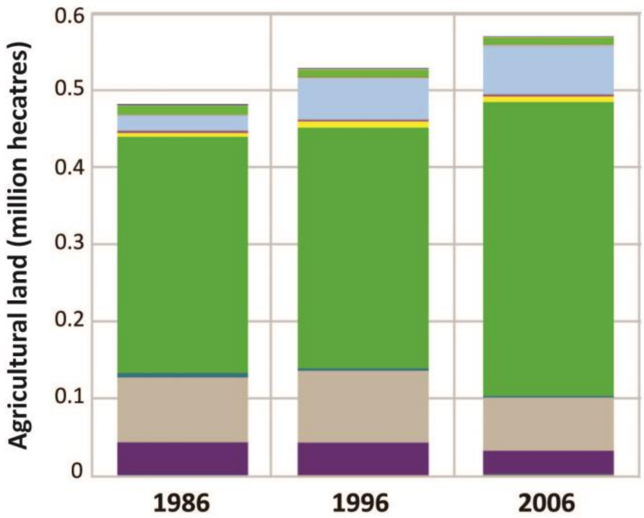


Figure 44. Percentage of land defined as agricultural in the Western Interior Basin Ecozone+, 2006. Source: Javorek and Grant, 2011[143]

Unimproved Pasture, which included pasture lands that have not been cultivated or managed such as native pasture, rangeland, and grazeable bush, was the most common agricultural land cover in the WIBE and increased from 64% to 67% from 1986 to 2006 (Figure 45).[143] In contrast, Improved Pasture declined from 9% to 5% (Figure 45).[143] Cropland, which included all agricultural land except for All Other Land, Unimproved Pasture, Improved Pasture, and Summerfallow, expanded by 6% to make up 15% of agricultural land (Figure 45).[143] The category Fruit Trees, an important cover type in the WIBE, contained trees such as apple, peach, plum, cherry, apricot, pear, and other tree fruits or nuts, as well as grapes (vineyards). Fruit Trees declined from 2.4% to 1.6% between 1986 and 2006 (Figure 45).[143]



Percentage of agricultural land

Cover type	1986	1996	2006
Winter Cereals	0.3	0.2	0.1
Vegetables	0.2	0.2	0.1
Fruit Trees	2.4	1.8	1.6
Other Crops	0.1	0.1	0.1
Tame Hay	4.3	10.3	11.3
Corn	0.5	0.3	0.4
Cereals	1.1	1.6	1.3
Unimproved Pasture	63.5	59.1	66.9
Summerfallow	1.2	0.6	0.4
All Other Land	17.5	17.7	12.1
Improved Pasture	8.7	8.0	5.4
Berries	0.0	0.0	0.0
Soybeans	0.0	0.0	0.0
Pulses	0.0	0.0	0.1
Oilseeds	0.1	0.0	0.1

Figure 45. Total agricultural area and the amount of land per cover type (bar chart) and the relative percentage of cover types for the Western Interior Basin Ecozone$^+$ in 1986, 1996, and 2006.
To convert hectares to km^2, divide by 100.
Source: Javorek and Grant, 2011[143]

Wildlife habitat capacity on agricultural land

A total of 323 terrestrial vertebrates (232 birds, 72 mammals, 10 reptiles, 9 amphibians) are associated with agricultural lands in the WIBE. The All Other Land cover type was the most species rich with 85% of these species using it for both breeding and feeding habitat. The most common agricultural land cover type, Unimproved Pasture, fulfilled breeding and feeding requirements of 25% of these species and provided a single habitat requirement (breeding or feeding) for 44% of these species. Only 12% of these species were able to use Cropland for both breeding and feeding habitat, whereas 25% were able to obtain a single habitat requirement from Cropland.[143]

Wildlife habitat capacity was calculated for each species using a model that incorporated breeding and feeding requirements in terms of cover type and habitat value to the species.[143] The "status" of habitat capacity on agricultural land in Canada for 1986, 1996, and 2006 was determined by generating ten categories (Very Low: <20, 20–30, Low: 30–40, 40–50, Moderate: 50–60, 60–70, High: 70–80, 80–90 and Very High: 90–100, >100) based on the national distribution of habitat capacity scores from all reporting Soil Landscapes of Canada polygons.[143] Average wildlife habitat capacity on agricultural land in the WIBE declined from high capacity in 1986 to moderate capacity in 2006 (Figure 46). Over this time period, habitat capacity decreased on 35%, increased on 7%, and remained stable on 58% of agricultural lands (Figure 47).

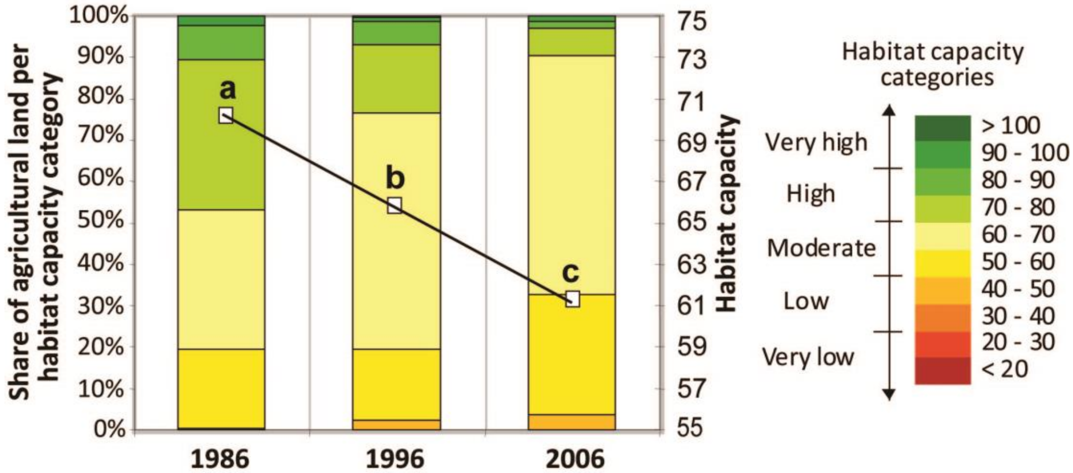


Figure 46. The share of agricultural land in each habitat capacity category (left axis, stacked bars) and the average habitat capacity (right axis, symbols) for the Western Interior Basin Ecozone+ in 1986, 1996, and 2006.
Letters indicate a statistically significant difference.
Source: Javorek and Grant, 2011[143]

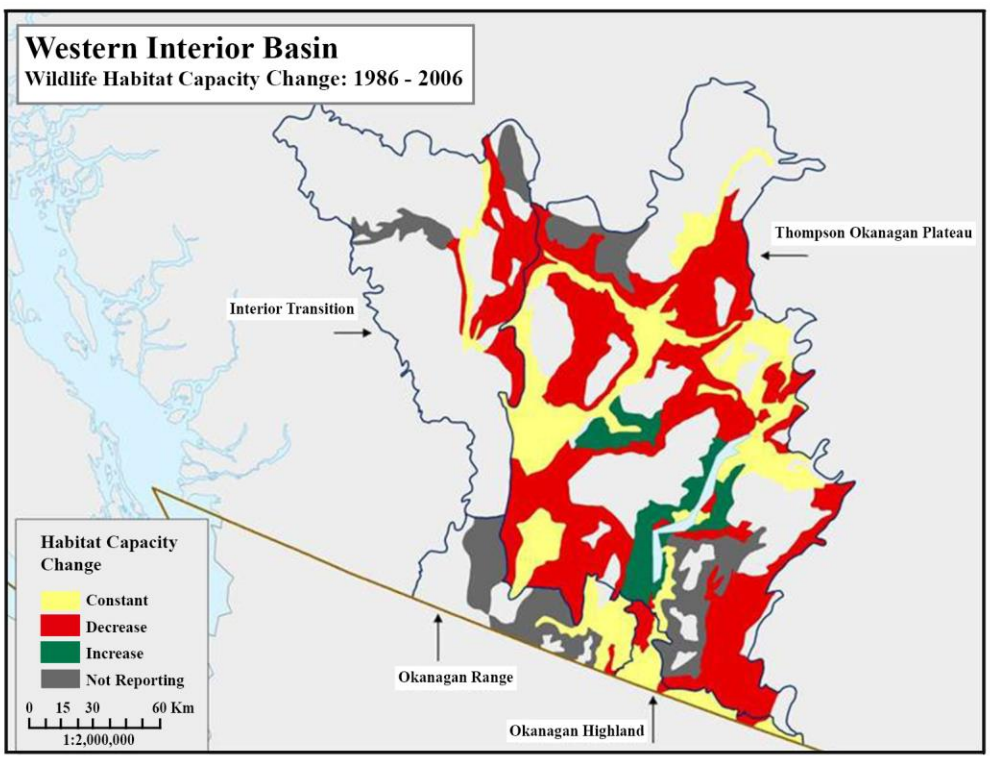


Figure 47. Changes in wildlife habitat capacity on agricultural lands in the Western Interior Basin Ecozone+, 1986–2006.
Source: Javorek and Grant, 2011[143]

Soil erosion

Due to the dry climate, the risk of soil erosion by water is generally low in the WIBE except on tilled complex slopes where tillage erosion is important (Figure 48).[144]

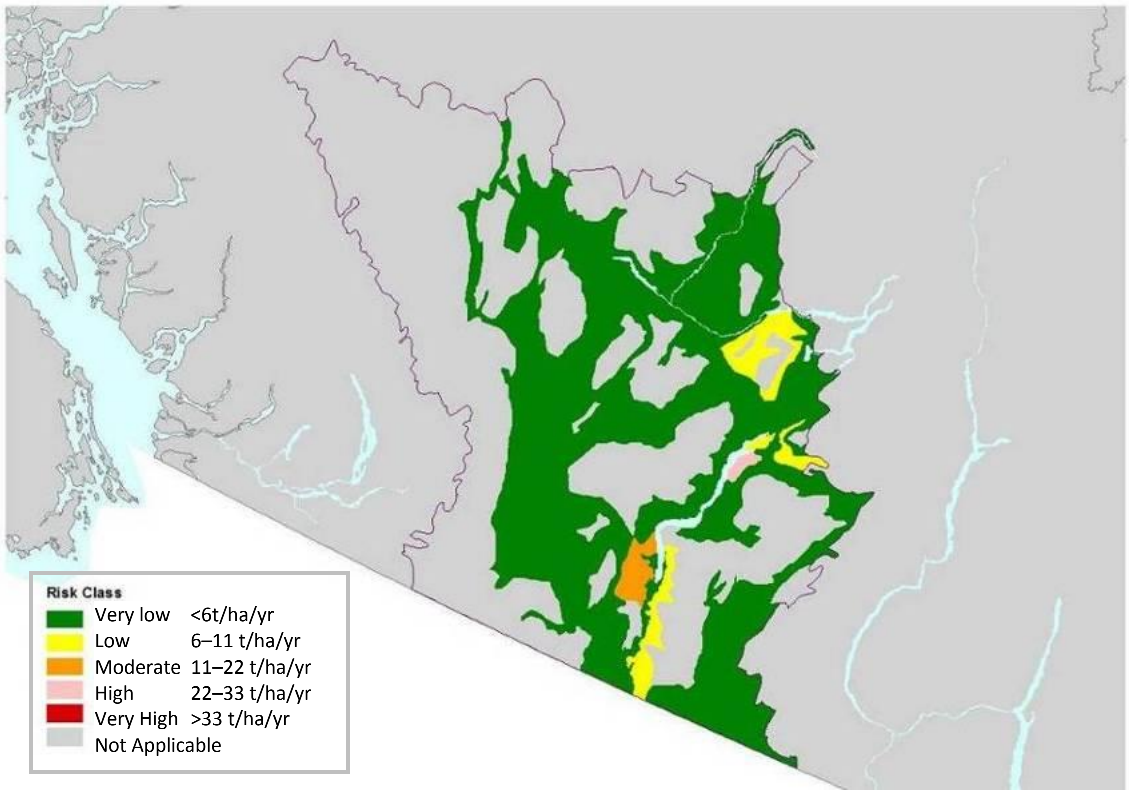


Figure 48. Soil erosion risk classes of agricultural land in the Western Interior Basin Ecozone+, 2006. Source: McConkey et al., 2011[144]

Additional information related to agricultural landscapes can be found in the Grasslands section on page 19 and the Species of special economic, cultural, or ecological interest section on page 66.

Microbiotic soil crust

The grazing of introduced livestock has altered the structure of the Bunchgrass and Ponderosa Pine zones of the WIBE from dominance by native bunchgrasses to increasing cover of native shrubs such as big sage (*Artemesia tridentata*) as well as non-native species.[145] Natural grasslands in semi-arid environments, including those in the WIBE, often have lichen-dominated microbiotic soil crusts that provide important ecological functions including soil formation and soil surface stabilization, nutrient cycling, seed germination, food and shelter, and moisture retention.[146] These have been extensively damaged in the WIBE by livestock trampling.[147] Loss of the soil crust results in a decrease in water retention. For example, five days after rain, soils covered by microbiotic crust in antelope-brush shrub-steppe habitats of South Okanagan retained an average of 31% of the moisture that was present in the soil on day 1, while bare soils retained only 9.5%.[148] This is particularly important for healthy plant development in semi-arid environments.

Loss of soil crust also encourages the spread of invasive alien plant species by providing suitable beds for germination of their seeds and the WIBE is more affected by invasive alien plants than any other part of BC.[145] The result is a major loss of rangeland productivity for livestock and degradation of the native grassland plant communities.[93,104] See also the Invasive terrestrial plants section on page 46.

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.

Sagebrush-dominated ecosystems are rare in Canada and, as the northern extension of the sagebrush-dominated Great Basin Desert of the US,[8] the WIBE contains assemblages of plants and animals that occur nowhere else in Canada.[26] The species richness is high throughout much of this ecozone+ (Figure 49), including a large number of species and ecosystems of conservation concern.

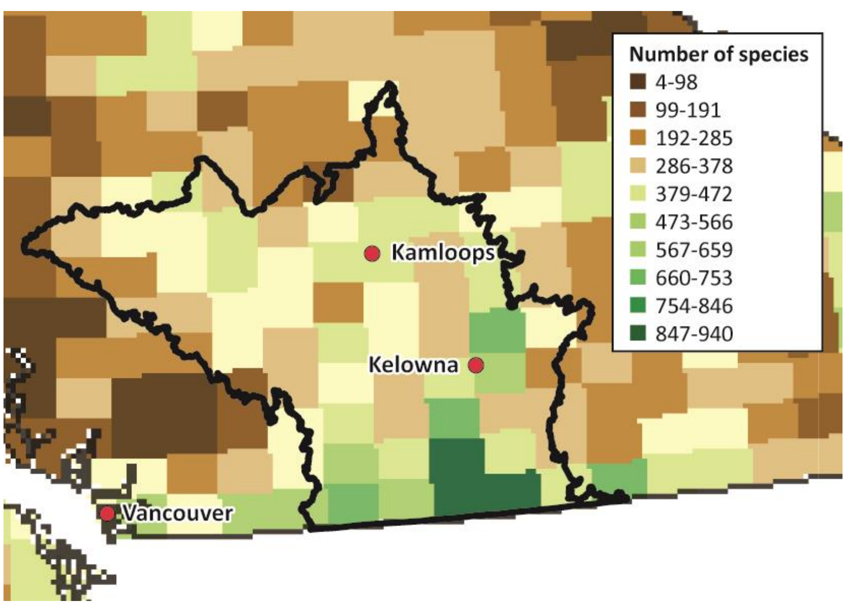


Figure 49. Distribution of species richness of vascular plants, vertebrates, butterflies, and dragonflies in the Western Interior Basin Ecozone+, 2008.
Source: Austin and Eriksson, 2009[49]

Species of conservation concern

NatureServe is a conservation organization that identifies animals and plants in North America according to global conservation concern.[149] The BC Conservation Data Centre performs the same function for BC.[150] The WIBE has 7 species of animals and 48 species of plants of global conservation concern and 131 species of animals and 305 species of plants of provincial conservation concern (Table 8 and Table 9); some of these rankings are for subspecies. A species' ranking changes between geographic levels because a species may be secure throughout its entire range (global or G-rank) but of conservation concern in the portion of its range that occurs in BC (provincial or S-rank). At both levels, species are classified as critically imperilled, imperilled, vulnerable, apparently secure, and secure. In addition, S-ranks for birds include the qualifiers of breeding, non-breeding, and migrant populations.

Many of the Great Basin Desert-associated plants and animals of the WIBE are at the northern limit of their range. Therefore, many species in the WIBE are ranked for conservation concern at the provincial level but not at the global level. These *peripheral populations* have special importance for biological conservation and the long-term persistence of these species. Peripheral populations may have unique genetic or behavioural attributes relative to the core population. These attributes can provide the species with resilience to changing environmental conditions as well as providing a source of individuals for reintroductions and translocations.[151, 152]

Table 8. Number of animal species and subspecies assessed for global conservation concern (G-rank, left number) and provincial conservation concern (S-rank, right number) in the Thompson and Okanagan regions.

Conservation Status Rank	Amphibians	Breeding Birds	Gastropods and bivalves	Insects	Mammals	Ray-finned fish	Reptiles and turtles	Totals
Extinct or Extirpated	0; 0	0; 0	0; 0	0; 1	0; 0	0; 0	0; 1	0; 2
Historical	0; 0	0; 0	0; 1	0; 0	1; 1	0; 0	0; 0	1;2
Critically Imperilled	0; 1	0; 9	0; 1	0; 10	0; 6	0; 0	0; 1	0; 28
Imperilled	0; 1	0; 9	1; 2	0; 6	0; 7	0; 7	0; 3	1; 35
Vulnerable	0; 3	1; 18	3; 6	0; 18	0; 9	1; 6	0; 4	5; 64
Total species and subspecies of conservation concern	0; 5	1; 36	4; 10	0; 35	1; 23	1; 13	0; 9	7; 131
Apparently secure or secure	7; 2	43; 8	6; 0	35; 0	25; 3	18; 6	12; 3	146; 22
Not ranked or unrankable	0; 0	0; 0	0; 0	0; 0	0; 0	0; 0	0; 0	0; 0
Total number of species assessed	7	44	10	35	26	19	12	153

These data include subspecies separately when they are ranked separately.
If there is uncertainty about a species' conservation status, it may be ranked with a range, such as S2S3. In these cases, species were included in the totals for the first ranking of the range (S2 in the example).
Data for birds indicate provincial ranking for breeding populations.
The Thompson and Okanagan regions are BC Ministry of Environment boundaries that together approximate the WIBE.
Source: BC Ministry of Environment, 2011[153]

Table 9. Number of plant species assessed for global conservation concern (G-rank, left number) and provincial conservation concern (S-rank, right number) in the Thompson and Okanagan regions.

Conservation Status Rank	Vascular	Non-vascular	Totals
Extinct or Extirpated	0; 0	0; 0	0; 0
Historical	0; 7	0; 0	0; 7
Critically Imperilled	0; 101	1; 15	1; 116
Imperilled	8; 119	5; 24	13; 143
Vulnerable	15; 26	19; 13	34; 39
Total species of conservation concern	*23; 253*	*25; 52*	*48; 305*
Apparently secure or secure	226; 1	22; 0	248; 1
Not ranked or unrankable	5; 0	5; 0	10; 0
Total number of species assessed	*254*	*52*	*306*

If there is uncertainty about a species' conservation status, it may be ranked with a range, such as S2S3. In these cases, species were included in the totals for the first ranking of the range (S2 in the example). The Thompson and Okanagan regions are BC Ministry of Environment boundaries that together approximate the WIBE.
Source: BC Ministry of Environment, 2011[153]

At the national level, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses species to determine if they are at risk of extinction or extirpation. Species designated by COSEWIC as being at risk may qualify for legal protection and recovery efforts under the *Species at Risk Act*.[154] In the WIBE, 93 animal species, subspecies, or populations have been assessed or are candidates for assessment by COSEWIC, and 54 of these are under *Species at Risk Act* protection (Table 10). Of plant species occurring in the WIBE, 28 have been assessed or are candidates for assessment by COSEWIC and 20 are under *Species at Risk Act* protection (Table 11).

Table 10. Number of animal species, subspecies, and populations assessed by the Committee on the Status of Endangered Species in Canada (COSEWIC)[155] in the Thompson and Okanagan regions.

COSEWIC Status	Amphibians	Breeding Birds	Gastropods and bivalves	Insects	Mammals	Ray-finned fish	Reptiles and turtles	Totals
Extinct or Extirpated	--	--	--	--	--	--	1	1
Endangered	2	8	1	4	1	6	2	24
Threatened	1	6	--	2	2	2	2	15
Special Concern	2	7	--	2	8	5	5	29
Not at Risk	2	9	--	--	2	2	2	17
Candidate for Assessment	--	2	--	1	--	1	--	4
Data Deficient	--	--	--	--	2	1	--	3
Number assessed by COSEWIC	7	32	1	9	15	17	12	93
Number protected by the *Species at Risk Act*	5	18	1	6	10	6	8	54

These data include subspecies and populations separately when they are ranked separately.
The Thompson and Okanagan regions are BC Ministry of Environment boundaries that together approximate the WIBE.
Source: BC Ministry of Environment, 2011[153]

Table 11. Number of plant species assessed by the Committee on the Status of Endangered Species in Canada (COSEWIC)[155] in the Thompson and Okanagan regions.

Conservation Status Rank	Vascular	Non-vascular	Totals
Extinct or Extirpated	--	--	--
Endangered	11	2	13
Threatened	4	1	5
Special Concern	2	1	3
Not at Risk	4	--	4
Candidate for Assessment	1	1	2
Data Deficient	1	--	1
Number assessed by COSEWIC	23	5	28
Number protected by the *Species at Risk Act*	16	4	20

The Thompson and Okanagan regions are BC Ministry of Environment boundaries that together approximate the WIBE.
Source: BC Ministry of Environment, 2011[153]

Ecosystems of conservation concern

NatureServe and the BC Conservation Data Centre also identify and rank the conservation concern of ecological communities, or ecosystems, in North America and BC, respectively. The identification of ecological communities in BC is ongoing.[150] The WIBE has 54 ecosystems of global conservation concern and 185 ecosystems of provincial conservation concern (Table 12). More information about individual ecosystems can be found in the Forests section on page 13, the Grasslands section on page 19, the Wetlands section on page 25, the Lakes and rivers section on page 28, and in the Ecosystem conversion section on page 40.

Table 12. Number of ecosystems (ecological communities) assessed for global conservation concern (G-rank, left number) and provincial conservation concern (S-rank, right number) in the Thompson and Okanagan regions.

Conservation status rank	Alpine	Forest and woodland	Grassland, herbaceous, and shrub	Wetland and riparian	Totals
Extinct or Extirpated	0; 0	0; 0	0; 0	0; 0	0; 0
Historical	0; 0	0; 0	0; 0	0; 0	0; 0
Critically Imperilled	0; 0	1; 6	1; 5	3; 11	5; 22
Imperilled	1; 0	6; 31	6; 13	5; 18	18; 62
Vulnerable	0; 0	7; 67	2; 3	22; 31	31; 101
Total ecosystems of conservation concern	*1; 0*	*14; 104*	*9; 21*	*30; 60*	*54; 185*
Apparently secure or secure	2; 1	6; 82	8; 4	10; 7	26; 94
Not ranked or unrankable	45; 47	167; 1	30; 22	27; 0	269; 70
Total number of ecosystems assessed	*48*	*187*	*47*	*67*	*349*

Some ecosystems are identified in more than one group (e.g., the Betula occidentalis/Rosa *spp. (water birch/roses) ecosystem is classified first in the riparian group and second in the shrub group). For this analysis, each ecosystem was placed with its primary group.*
The Thompson and Okanagan regions are BC Ministry of Environment boundaries that together approximate the WIBE.
Source: BC Ministry of Environment, 2011[153]

Species of special interest

Birds

From 1973 to 2006, the abundance of landbirds in the WIBE declined significantly ($p<0.05$) in all habitats except shrub/successional habitats, where they increased (Figure 50).[156] Declines in bird populations have been attributed to the cumulative impacts of ecosystem conversion to agricultural lands, overgrazing by livestock, forest harvest, insect outbreaks that affect bird habitats, habitat fragmentation, urban development, altered fire regimes, and invasion of non-native plants.[157-160]

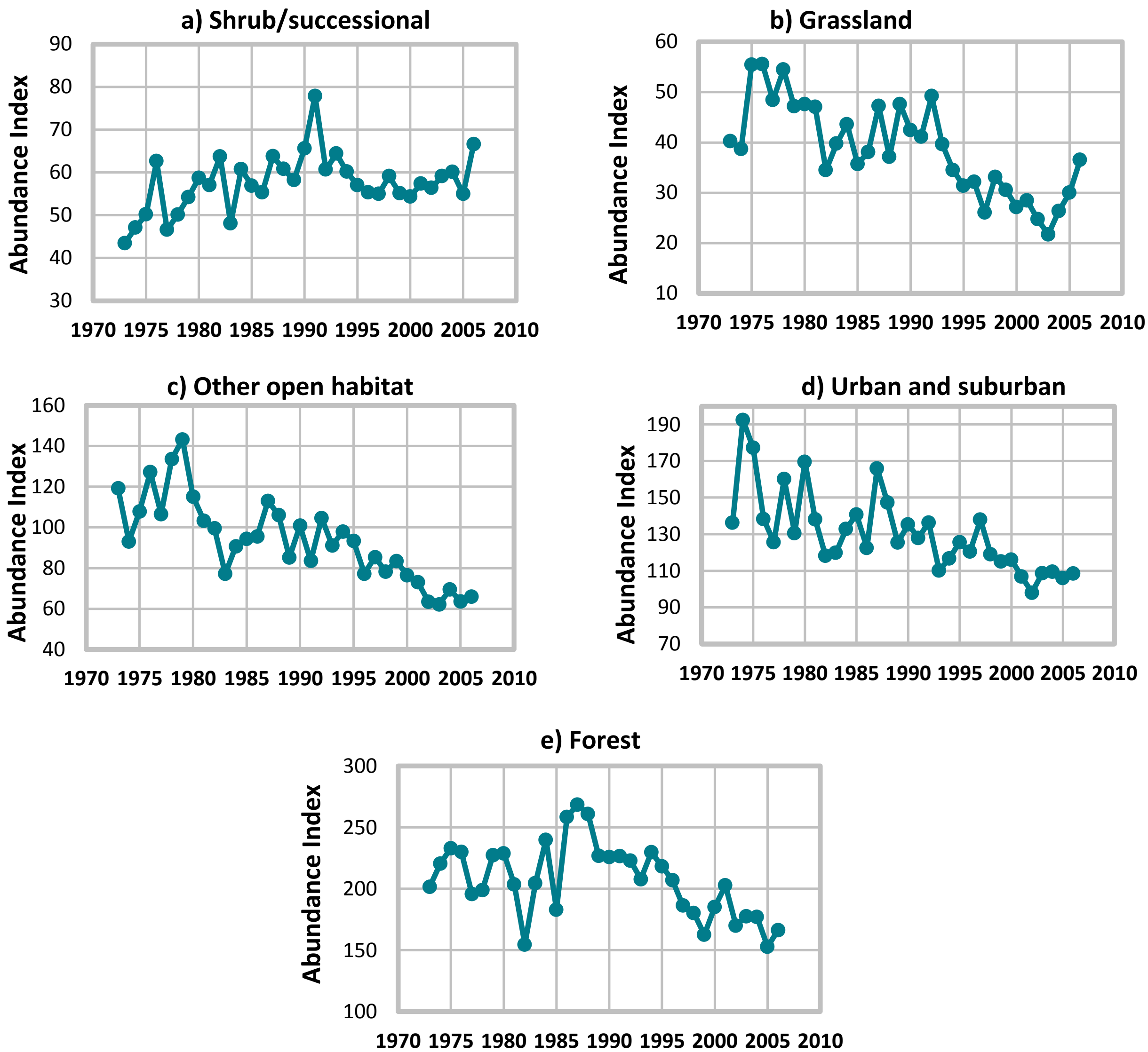


Figure 50. Annual indices of population change in bird assemblages for five habitat categories in the Western Interior Basin Ecozone⁺, 1973–2006.
The index is an estimate of the average number of individual birds that would be counted on a randomly selected route by an average observer in a given year.
Source: Downes et al., 2011[156]

Burrowing owls

Burrowing owls are ground-dwelling birds that use burrows created by ground squirrels, prairie dogs, and badgers for nesting and roosting. They are losing habitat as shortgrass prairies are converted to agricultural crop production.[161] Moreover, the use of pesticides has reduced the availability of food for the owls.[162] From 1990 to 2000, the number of owls declined by 90%[162] and the species was designated as Endangered in 1995.[162] The wild BC population has been augmented through a captive breeding program since 1992.[163]

Sage thrashers

Sage thrashers (*Oreoscoptes montanus*) are one of Canada's rarest bird species. They are found in mature sagebrush habitats, which are under threat from conversion to intensive agriculture, housing, and golf courses.[164] In the southern Okanagan and Similkameen valleys, habitat loss has reduced the number of breeding adults to fewer than 30 individuals.[164] Sage thrashers were designated as Endangered in 1992.[153]

Williamson's sapsuckers

Williamson's sapsuckers (*Sphyrapicus thyroideus*) are losing their habitat, old-growth western larch (*Larix occidentalis*), to timber harvest and land clearing.[165] The 2005 population was estimated to be 430 breeding adults with 85% of these individuals in the southern Okanagan (the Okanagan–Greenwood population).[165] They were designated as Endangered in 2005.[153]

Ungulates

First Nations and recreational hunters harvest many of the ungulate species in the WIBE. Most ungulate populations in the WIBE were stable or increasing from 2008 to 2011 with the exceptions of caribou (*Rangifer tarandus*) and mountain goats (*Oreamnos americanus*) (Table 13).[166]

Table 13. The status and trends (2008–2011) of ungulate populations in the Western Interior Basin Ecozone+.

Species	Estimated population and trend	
	Thompson region	Okanagan region
Mule deer (*Odocoileus hemionus*)	35,000–55,000; Increasing	28,000–42,000; Increasing
White-tailed deer (*Odocoileus virginianus*)	5,000–8,000; Increasing	31,000–44,000; Increasing
Black-tailed deer (*Odocoileus hemionus columbianus*)	1,000–2,000; Increasing	None
Moose (*Alces alces*)	8,000-12,000; Increasing	2,000-3,000; Stable
Elk (*Cervus canadensis*)	300-400; Stable/Increasing	1,000-1,500; Increasing
Caribou	200–300; Declining	5–15; Stable
Bighorn sheep*	2,000-2,500; Increasing	1,000-1,200; Stable/Increasing
Mountain goat	1,400-2,000; Declining	200-300; Stable

**Thompson region includes both California and Rocky Mountain bighorn sheep; the Okanagan region has only California bighorn sheep.*
Population trends: Declining is >20% decline; Stable is <20% change; Increasing is >20% increase. The Thompson and Okanagan regions are BC Ministry of Environment boundaries that together approximate the WIBE.
Source: BC Ministry of Forests, Lands and Natural Resource Operations, 2011[166]

Bighorn sheep (*Ovis canadensis californiana* and *O. c. canadensis*) are iconic ungulates for the ecozone+. In BC, the range of California bighorn sheep is largely restricted to the WIBE. Bighorn sheep are habitat specialists, inhabiting steep, open terrain. Overharvested historically, populations of California bighorn sheep were increasing until 1999 when pneumonia killed 70% of the southern Okanagan population (Figure 51).[22, 167] More information can be found in the ESTR technical thematic report *Wildlife pathogens and disease in Canada*.[168]

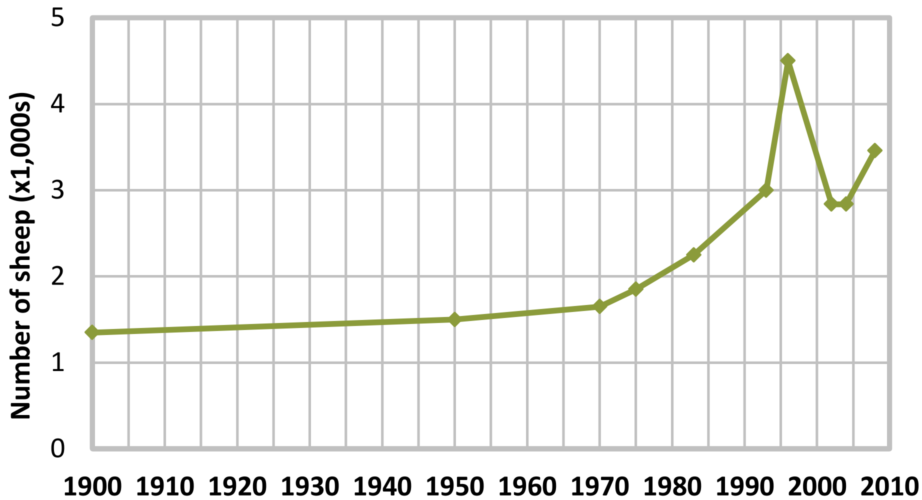


Figure 51. Population of California bighorn sheep in the Western Interior Basin Ecozone+, 1900–2008. Source: data from Demarchi et al., 2000;[167] BC Ministry of Forests, Lands and Natural Resource Operations, 2011;[166] and BC Ministry of Forests, Lands and Natural Resource Operations, unpublished data

Carnivores

The North American range of large carnivores retracted as Europeans settled the landscape and persecuted predators (Figure 52).[169] For example, badgers and wolverine (*Gulo gulo*) were persecuted, trapped, and, until the 1950s, poisoned by bait intended for wolves.[170]

Grey wolves (*Canis lupus*) were intentionally killed and possibly extirpated in the WIBE by 1968.[171] However, wolves have recolonized the Thompson region at a density of 2.8–3.1 per 1,000 km^2.[172] Wolves have also returned to the southern Okanagan,[173] although their densities are unknown. Wolf populations have also been increasing in the Kootenays,[174] east of the WIBE.

Grizzly bears (*Ursus arctos*) were extirpated in most of the ecozone+ (Figure 53).[175] Grizzlies are directly affected by disturbance and fragmentation associated with roads and off-road access.[176] Other large carnivores in the WIBE include lynx (*Lynx canadensis*), cougars (*Puma concolor*), and black bears (*Ursus americanus*).

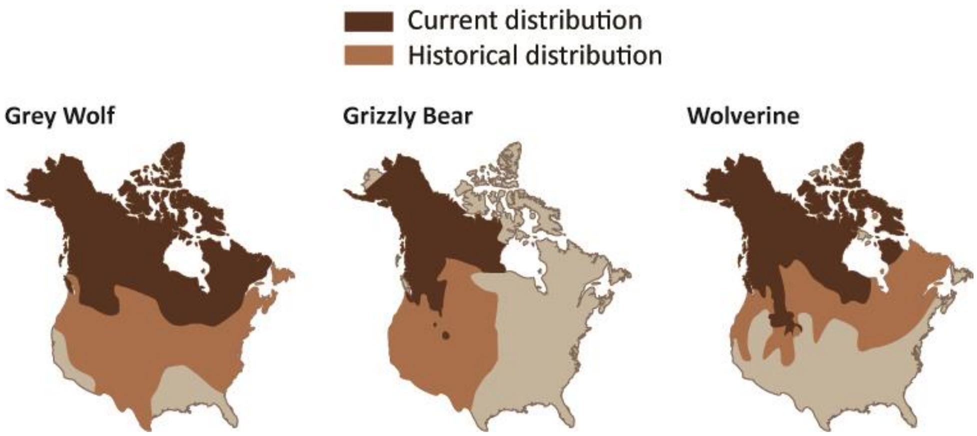


Figure 52. Reduction in the ranges of large carnivores in North America.
Source: Hummel and Ray, 2008[169]

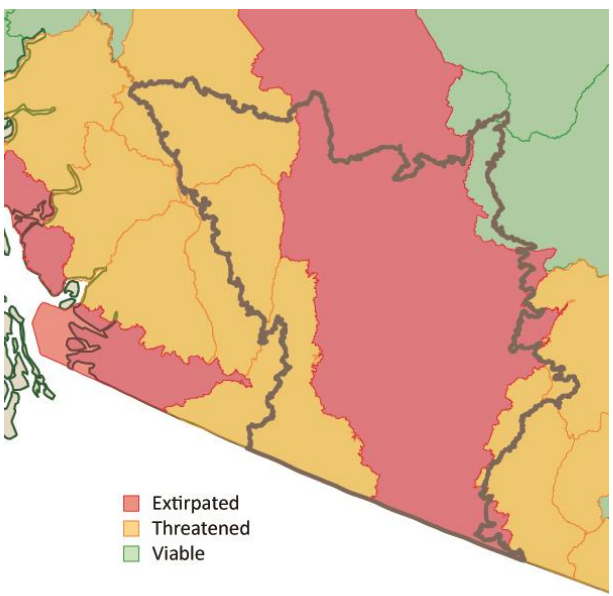


Figure 53. Grizzly bear range in the Western Interior Basin Ecozone[+], 2004.
Source: BC Ministry of Environment, 2010[177] This information is provided by the Province of BC under the Open Government License for Government of BC Information v.BC1.0.

Fish

Coho

Although the species is not listed provincially as a species at risk, the Interior Fraser River population of coho salmon (*Oncorhynchus kisutch*) has been ranked as Endangered by COSEWIC since 2002.[178] The population declined by 60% between 1990 and 2000 (Figure 54) because of habitat changes and overexploitation.[178]

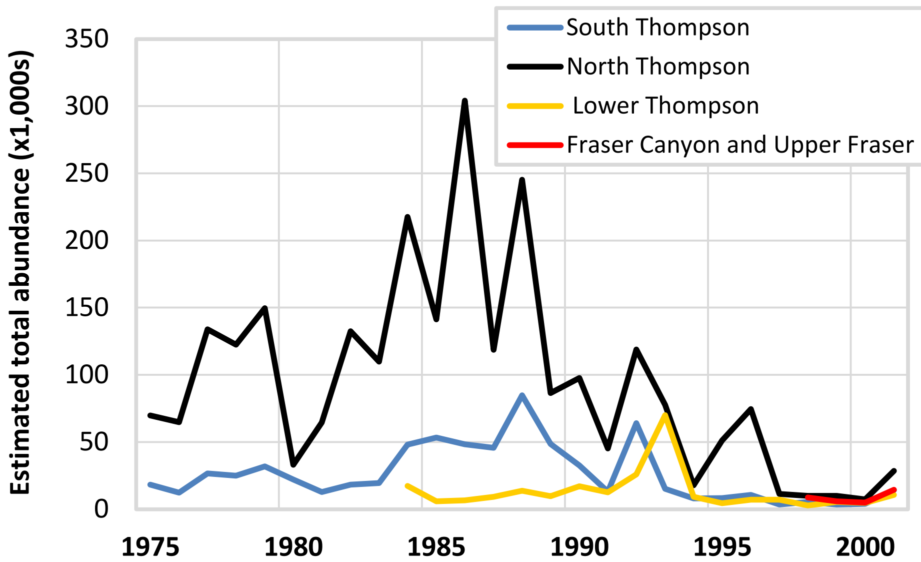


Figure 54. Estimated total abundance from fishery exploitation rates, escapements, and marine fishery catches of Interior Fraser coho salmon for major rivers in the Western Interior Basin Ecozone+, 1976–2001.
Data for the Fraser Canyon and Upper Fraser available since 1998.
Source: data from COSEWIC, 2002[178] updated from Irvine et al., 2001[179]

Kokanee

Kokanee are sockeye salmon that live and reproduce in lakes. In the WIBE, kokanee were historically harvested by First Nations[180] and used to support recreational fishing. Okanagan Lake kokanee have two genetically distinct stocks, stream spawners and shore spawners.[181, 182] Both stocks declined from over 450,000 spawners each in the early 1970s to fewer than 50,000 shore spawners and fewer than 10,000 stream spawners in the mid- to late 1990s. As a result, the recreational fishery was closed.[45] In 2011, population estimates were 276,000 shore spawners and 17,700 stream spawners.[183] Declines have been attributed to decreasing lake productivity due to nutrient reduction initiatives, degraded shoreline habitat due to development, forestry, and recreational activities, drops in lake water levels for flood control, and competition for food with mysis shrimp.[184] See the Habitat alteration and loss, Nutrient loading to lakes and Invasive aquatic species sections on pages 32, 53, and 48, respectively.

Sockeye

Returns of Okanagan sockeye salmon have fluctuated greatly, from over 200,000 fish in 1967 to fewer than 5,000 in each of 1963, 1994, 1995, and 1998. Precipitous declines in Okanagan sockeye returns in the early to mid-1960s coincided with the construction of five dams on the Columbia River.[185] Presently, there are nine dams on the Columbia River and as well as the Zosel Dam at the outlet of Osoyoos Lake that block upstream migration of sockeye salmon. In 2009, the McIntyre Dam was modified to allow sockeye to pass.[58] In 2004, the Okanagan Nation Alliance began an experimental reintroduction program by releasing sockeye fry into Okanagan River upstream of Skaha Lake.[111, 186]

Steelhead

Steelhead are sea-run rainbow trout that return to freshwater to spawn. Thompson River steelhead have been declining (Figure 55) primarily because of bycatch during commercial salmon fishing.[187]

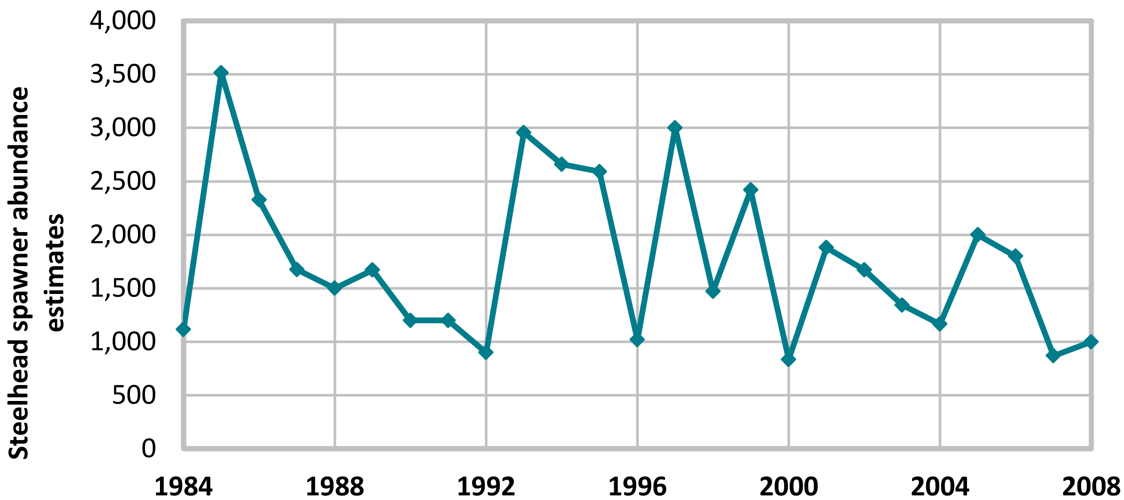


Figure 55. Thompson River Basin steelhead spawner abundance estimates, 1984–2008.
Source: BC Ministry of Environment, unpublished data

Sturgeon

White sturgeon (*Acipenser transmontanus*), the largest freshwater fish in Canada, is ranked as imperilled in BC and Endangered by COSEWIC.[153, 188] One of the six BC populations, the Middle Fraser population, lives in the WIBE where a catch-and-release recreational fishery is permitted.[189] The Middle Fraser population was estimated at 3,800 adult fish (fish that measured >50 cm from the tip of the nose to the fork in the tail) in 2003; population trends are unknown.[190] White sturgeon are slow growing and slow maturing, so they are particularly vulnerable to overharvesting, habitat degradation and loss, and a developing aquaculture industry.[190]

Plants

The WIBE contains numerous rare and distinctive plants such as alkaline wing-nerved moss (*Pterygoneurum kozlovii*), Columbian carpet moss (*Bryoerythrophyllum columbianum*), dwarf woolly-heads (*Psilocarphus brevissimus* var. *brevissimus*), Grand Coulee owl-clovers (*Orthocarpus barbatus*), Lemmon's holly ferns (*Polystichum lemmonii*), Lyall's mariposa lilies (*Calochortus lyallii*), Mexican mosquito ferns (*Azolla mexicana*), mountain holly ferns (*Polystichum lonchitis*), nugget moss (*Microbryum vlassovii*), rusty cord-moss (*Entosthodon rubiginosus*), scarlet ammannias (*Ammannia robusta*), short-rayed asters (*Symphyotrichum frondosum*), slender collomias (*Collomia tenella*), small-flowered lipocarphas, stoloniferous pussytoes (*Antennaria flagellaris*), and toothcups (*Rotala ramosior*). Most of these species are provincially and federally listed and more information can be found with their associated recovery plans and strategies.

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, indicates the amount and vigour of green vegetation—an indirect measure of primary productivity. Significance of the trend analyses was assessed at the 95% confidence level using the Mann-Kendall test.[191] From 1985 to 2006, this index increased for 16,713 km^2 (30.1%) and decreased for 1,035 km^2 (1.3%) of the WIBE (Figure 56). The increases were associated with areas of mixed forest and may indicate regeneration following extensive forest harvesting. The decreases were scattered throughout the ecozone+ in areas that were primarily classified as conifer forest. The reasons for the decreases in the WIBE are not known.[12]

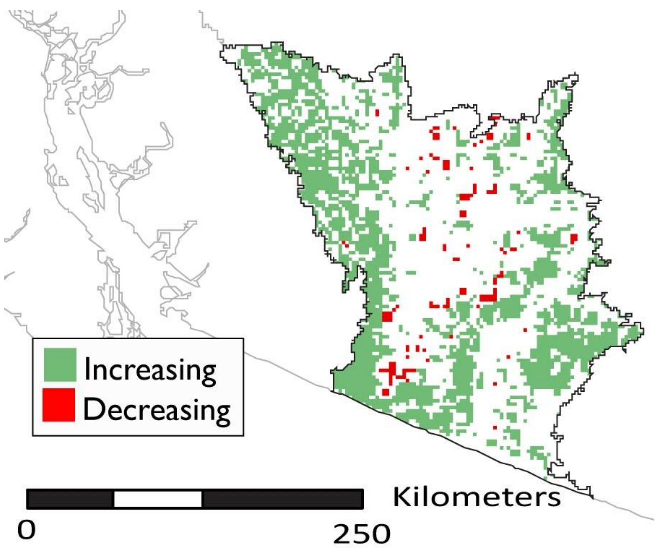


Figure 56. Change in the Normalized Difference Vegetation Index for the Western Interior Basin Ecozone+, 1985–2006.
Source: Ahern et al., 2011[12]

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 ecosystems of the WIBE have been shaped by several interacting factors including climate, extensive fires coincident with European settlement, harvesting, fire suppression, and insect attack. Although the nature of disturbance has changed from one largely dominated by fire and insect attack historically to harvesting and insect attack since 1950, the area disturbed annually has not diminished.[192]

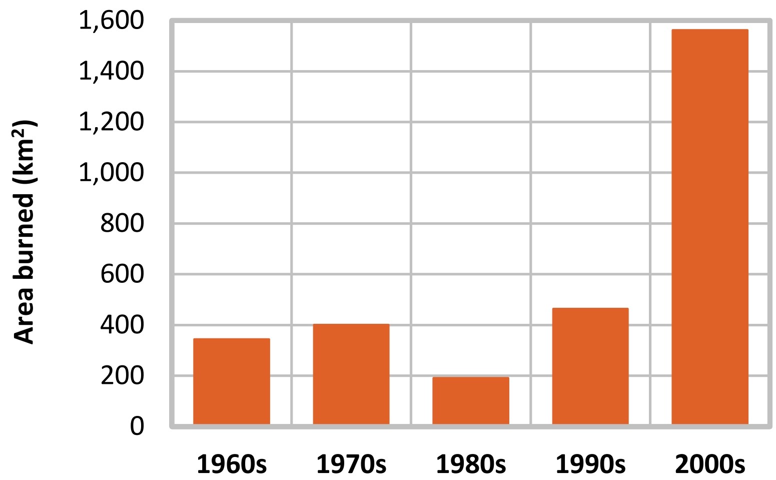
Fire

Fire is of fundamental importance to the ecosystems of the WIBE, particularly the Bunchgrass, Ponderosa Pine, and dry portions of the Interior Douglas-fir biogeoclimatic zones. Historic natural disturbances were likely diverse and episodic at multiple spatial and temporal scales.[192] High seasonal and annual variability in weather coupled with lightning strikes in complex topography likely resulted in a mixed-severity disturbance regime.[192]

Large fires as natural disturbance

From the 1960s to the 1990s, there were fewer fires in south-central BC because of vigorous fire protection by the BC Forest Service (Figure 57).[193] The suppression of normal fire cycles and the subsequent accumulation of woody fuels create an environment for more intense, stand-replacing wildfires.[194-197] Fire suppression increases the length of the fire cycle which allows pine stands to age thereby increasing their susceptibility to mountain pine beetle attack.[198, 199] Large-scale outbreaks of native insects are discussed on page 81. Fire suppression also allows forests to encroach into grasslands and ponderosa pine forests,[197] reducing habitat for species that require open landscapes.[14] In the South Okanagan and Lower Similkameen valleys, conifer densities increased in unburned landscapes between 1938–1985 and 1985–1996.[195]

On average, only 54 km2 (0.1%) of the forested areas burn each year. For 2000–2007, the average area burned by large fires increased to over 156 km2 (Figure 58),[200] possibly due to changing climate,[201] increased fuel loads due to long-term suppression,[202, 203] and a positive interaction between forest fires and the mountain pine beetle epidemic.[204]



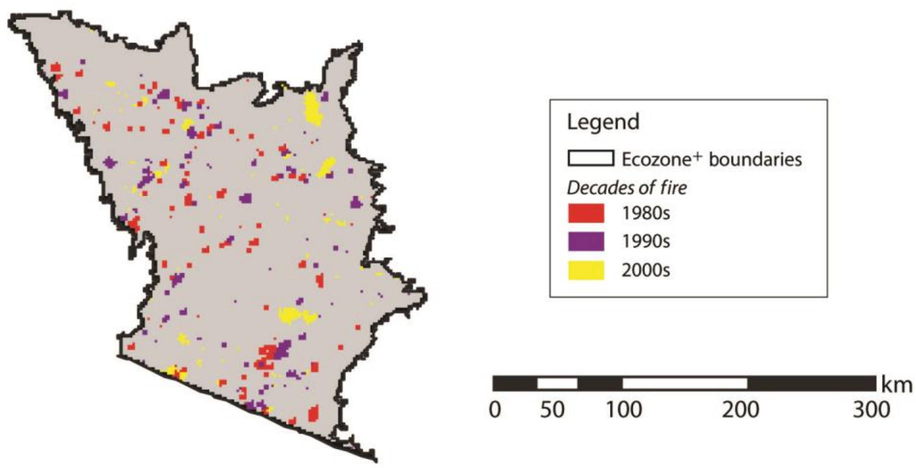


Figure 57. Total area burned per decade by large fires (>2 km^2 in size) (top) and the distribution of large fires (bottom) in the Western Interior Basin Ecozone$^+$, 1960s–2000s.
The value for the 2000s decade was pro-rated over 10 years based on the average from 2000–2007.
Source: Krezek-Hanes et al., 2011[200]

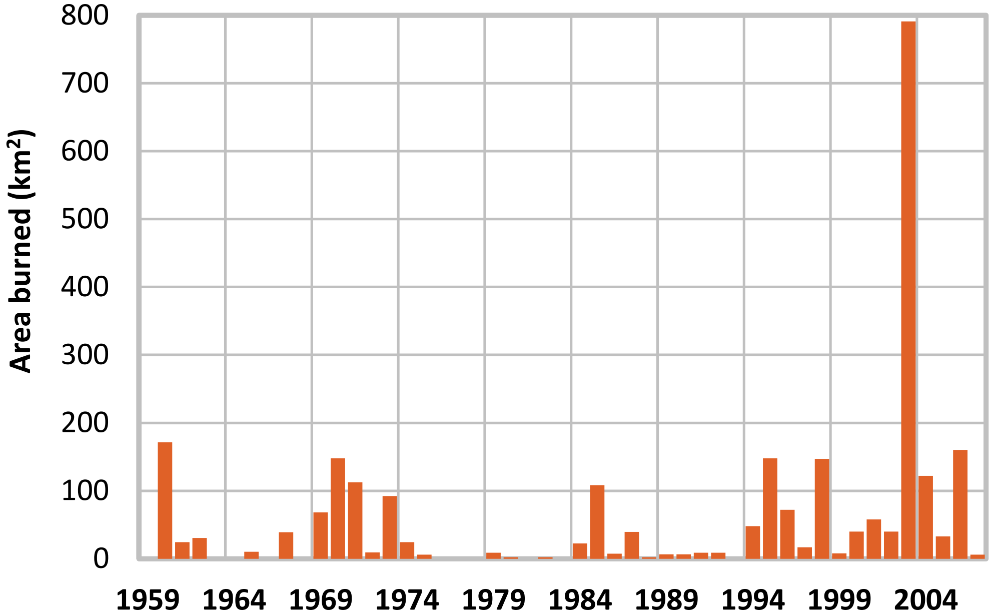


Figure 58. Annual area burned by large fires (>2 km^2 in size) in the Western Interior Basin Ecozone+, 1960–2007.
Source: Krezek-Hanes et al., 2011[200]

Large-scale outbreaks of native insects

Large-scale outbreaks of native insects play a major role in the functioning of ecosystems.[205] By 1994, about two dozen insect pests, primarily moth and beetle species, had degraded commercially valuable forests and horticultural operations in the WIBE.[206] In addition, the change in forest cover from tree death and salvage harvesting can increase the flood risk and threaten fisheries and aquatic ecosystems.[207]

The predominant insect pests in the WIBE are mountain pine beetles *(Dendroctonus ponderosae)* and western spruce budworms (*Choristoneura occidentalis*), which together accounted for >90% of the insect damage in this ecozone+ in 2009.[208] Other insects that damage forests in the WIBE are western balsam bark beetles (*Dryocetes confusus*), spruce beetles (*Dendroctonus rufipennis*), Douglas-fir tussock moths (*Orgyia pseudotsugata*), and aspen leaf miners (*Phyllocnistis populiella*).

Mountain pine beetle

The extent of mountain pine beetles increased between 1999 and 2009 in BC (Figure 59). Specifically, the area affected by mountain pine beetle in the WIBE increased from 500 km^2 in 2003 to a peak of 8,100 km^2 in 2008 (Figure 60).

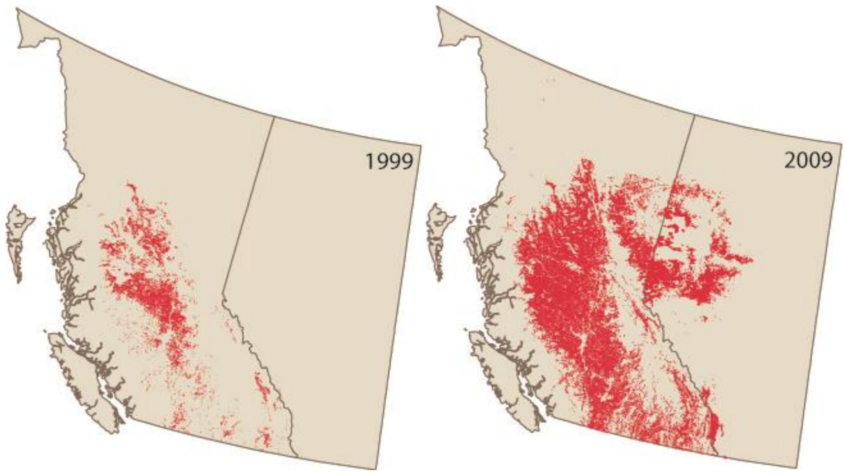


Figure 59. Area infested by mountain pine beetle in BC and Alberta, 1999 and 2009.
Source: data from BC Ministry of Forests, Lands and Natural Resource Operations, 2011[209]

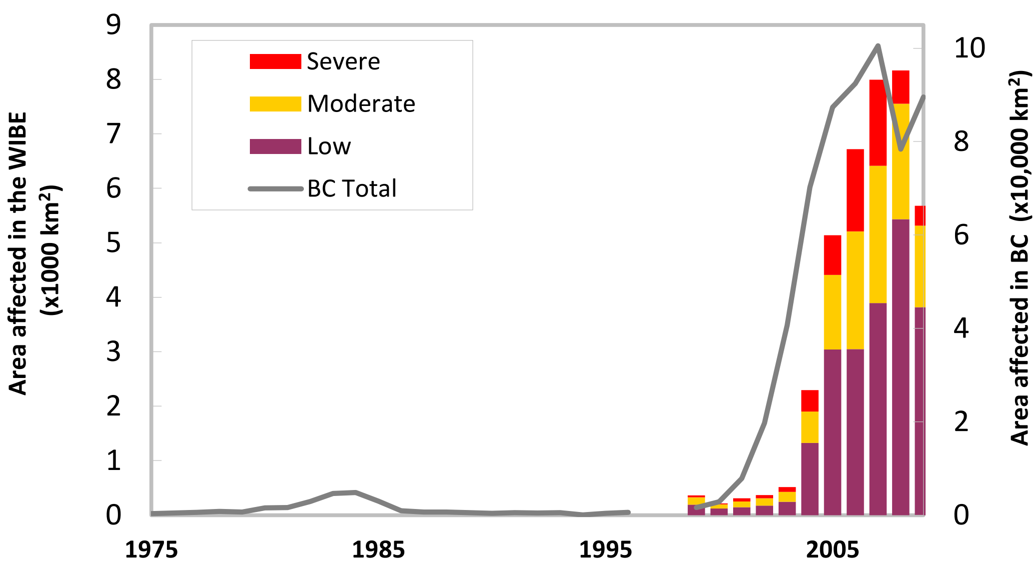


Figure 60. Area of forest affected by mountain pine beetle in the Western Interior Basin Ecozone[+] *(left axis, bars) and all of BC (right axis, line), 1975–2009.*
"Low" includes both "Trace" and "Light" areas.
Source: Analysis based on data from the BC Ministry of Forests and Range, 2010[208] *and the National Forestry Database, 2010*[210]

Western spruce budworm

Western spruce budworms favour dry, low-elevation Douglas-fir zones and therefore the majority of their BC range is in the WIBE (Figure 61). Annual defoliation by spruce budworm in the WIBE increased to peak of 3,800 km^2 in 2007 (Figure 62). Most of the defoliation was considered low or moderate.[208]

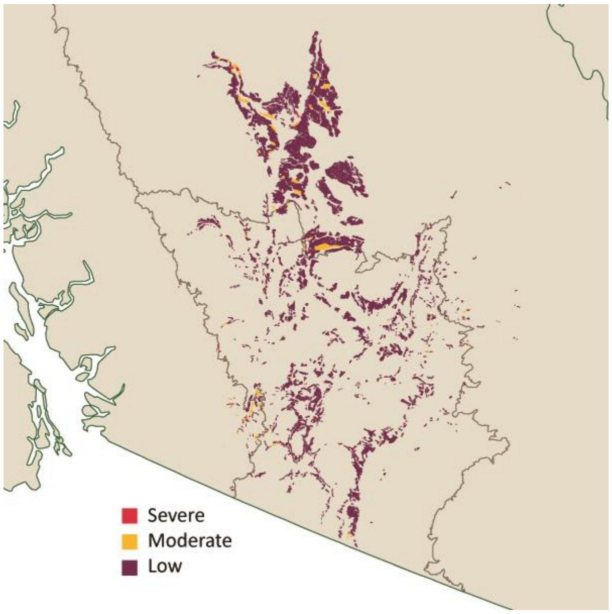


Figure 61. Areas of the Western Interior Basin Ecozone+ defoliated by western spruce budworm in 2008. Source: data from BC Ministry of Forests and Range, 2010[208]

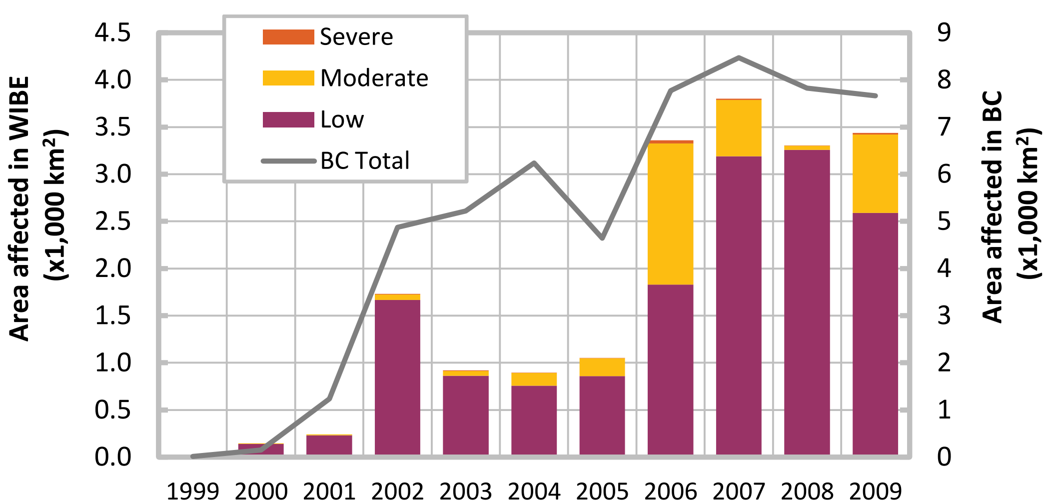


Figure 62. Area of forest defoliated by western spruce budworm in the Western Interior Basin Ecozone+ (left axis, bars) and all of BC (right axis, line), 1999–2009.
"Low" includes both "Trace" and "Light" areas.
Source: analysis based on data from the BC Ministry of Forests and Range, 2010[208]

Western balsam bark beetle

Western balsam bark beetles attack true firs in the genus *Abies*, which grow at mid- to high elevations. Figure 63 shows the area of forest affected annually by western balsam bark beetle from 1999 to 2009 in the WIBE and in BC overall. Most forest affected by balsam bark beetles is in the cooler Montane Cordillera Ecozone+ to the north and east of the WIBE. This insect tends to affect the same stands year after year with chronic, low-level, scattered attacks.[211]

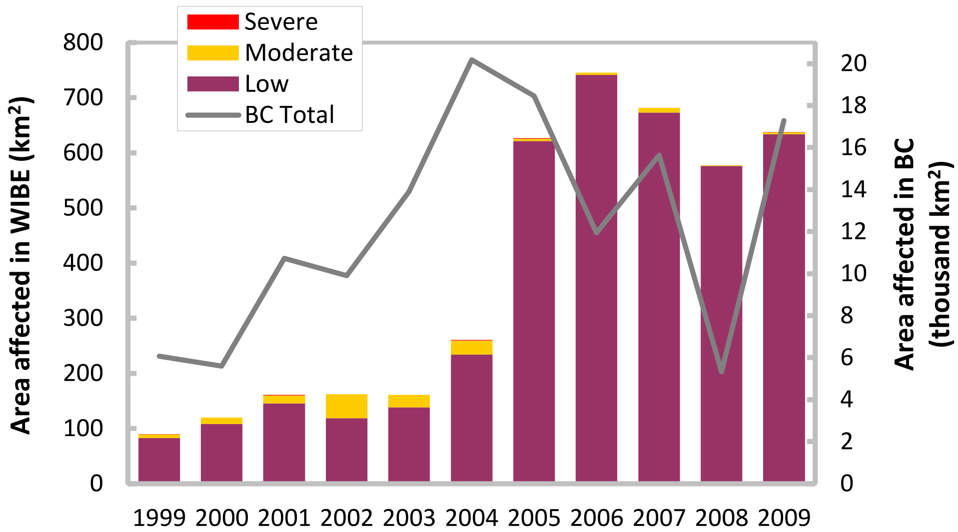


Figure 63. Area of forest affected by the western balsam bark beetle in the Western Interior Basin Ecozone+ (left axis, bars) and all of BC (right axis, line), 1999–2009.
"Low" includes both "Trace" and "Light" areas.
Source: analysis based on data from the BC Ministry of Forests and Range, 2010[208]

Spruce beetle

Spruce beetles (or spruce bark beetles) account for a relatively small proportion of insect damage in the WIBE, but areas affected by spruce beetles in the WIBE are not consistent with provincial trends. In BC, spruce beetle peaked in 2003 and then declined; in the WIBE, the area affected has continued to increase (Figure 64). The WIBE's proportion of the total area damaged in BC increased from 0.1% in 1999 to 47% in 2009.[211]

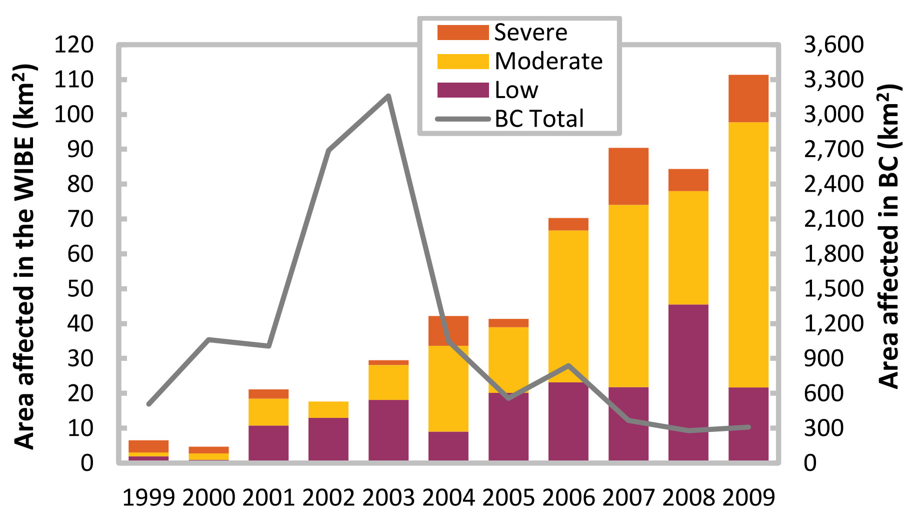


Figure 64. Area of forest by the spruce beetle in the Western Interior Basin Ecozone+ (left axis, bars) and all of BC (right axis, line), 1999–2009.
"Low" includes both "Trace" and "Light" areas.
Source: analysis based on data from the BC Ministry of Forests and Range, 2010[208]

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.

Non-native invasive species disrupt food webs by consuming, destroying, or otherwise removing food sources for native species. Introduced to Okanagan Lake in 1966, non-native mysis shrimp facilitated declines of kokanee and rainbow trout by consuming cladoceran zooplankton, a shared food resource.[45] Due to their diurnal migration pattern, mysis shrimp are rarely preyed upon by fish, so they effectively have no predators in the lake. More information can be found about mysis shrimp in the Invasive aquatic species section on page 48 and about Kokanee on page 76.

Predator-prey dynamics can be disrupted when the abundances of multiple prey species change. That is, less common prey species ("alternate prey") such as mountain goats can decline when there are shifts in the abundance of a primary prey species, such as deer. In the mid-1990s, poor winters resulted in mule deer populations that were half their previous size. Cougars may have preyed upon mountain goats as an alternate food source, which reduced the mountain goat population.[212] Since cougars and mule deer have returned to their previous population sizes, mountain goats have gradually been increasing again although recovery has been slow due to their relatively late reproductive maturity.[213]

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 programs and research studies have provided information on ecosystem status and trends for the WIBE, however, much of this information was not long-term, standardized, or spatially complete. Monitoring and research were unevenly distributed, with substantially more information available in the South Okanagan than in the west and northwest of the ecozone+. To determine trends in ecosystem processes, methods and analyses must be consistent through time and the results should be publicly accessible.[214] The maintenance and management of information can be a challenge, although excellent "clearing house" tools exist such as the BC government's Cross-Linked Information Resources (CLIR) that allows users to search for environmental and natural resource information (www.env.gov.bc.ca/clir/).

Frequently, status or trends must be pieced together from a variety of sources and/or methods. Often, only a patchwork of data can be reported. Ecozone+-wide data is not always available as the boundaries of a particular monitoring program may not match the boundaries of the ecozone+. This may be less of a problem for the WIBE than with other ecozones+ because WIBE boundaries are those of the Southern Interior Ecoprovince. Nevertheless, some datasets do not report data by ecoprovince.

Gaps

- Traditional and local ecological knowledge are rarely incorporated into monitoring programs.
- There is little information and no regular monitoring of contaminants in wildlife, despite the amount of agricultural activity in the WIBE where potential contaminants may be in use.
- Ecosystem services have not been systematically quantified for the WIBE.
- Although many stewardship groups and organizations are active in the WIBE, their contributions have not been quantified, so it is difficult to assess the impacts of stewardship.

Notable initiatives

- The 10-year Okanagan Lake Action Plan (1996–2005) measured the characteristics of the water (limnology) and the algae, zooplankton, and kokanee populations to better understand the food web of the lake.
- The Okanagan sockeye reintroduction program of the Okanagan Nation Alliance (www.syilx.org/fisheries-and-aquatics/).
- The Shuswap Lake Integrated Planning Process (www.fraserbasin.bc.ca/programs/shuswap.html).
- Report-A-Weed, an online application to report invasive non-native plants from the BC Ministry of Forests, Lands and Natural Resource Operations (www.for.gov.bc.ca/hra/Plants/raw.htm).

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.

Several of the key findings in this report include evidence or early-warning indications of environmental change that could lead to major and irreversible losses of biodiversity:

- The loss of plant communities including grasslands (see the Grasslands section on page 19), wetlands (see the Wetlands section on page 25), and ponderosa pine forests (see the Forests section on page 13). Ecosystem conversion on page 40 also has information related to these ecosystems.
- The channelization of Okanagan River resulting in the loss of riparian/floodplain area (see the Lakes and rivers section on page 28).
- Declines in the abundance of birds in grasslands, forests, and open habitats (see the Species of special economic, cultural, or ecological interest section on page 66).
- Declines in anadromous fish such as Fraser River coho, Thompson River steelhead, and Okanagan River sockeye (see the Species of special economic, cultural, or ecological interest section on page 66).
- The melting of glaciers (see the Ice across biomes section on page 35).
- Changes in the seasonal flow of streams in the southern portions of the ecozone+ (see the Climate change section on page 55)
- More than 200 streams in the Okanagan watershed with no additional water available to allocate more water licences (see the Lakes and rivers section on page 28)
- Invasive species, which disrupt food webs and outcompete, consume, or transmit diseases to native species, are widespread in most ecosystems in the WIBE (see the Invasive non-native species see section on page 44)

CONCLUSION: HUMAN WELL-BEING AND BIODIVERSITY

Many of the WIBE's ecosystem challenges are driven by continued human population growth, land conversion, and land fragmentation. The WIBE is an ecologically unique area of Canada due to its species richness and the significant number of species that occur nowhere else in the country. As the northern extent of the Great Basin Desert, the WIBE is an especially important corridor (and a potential bottleneck if poorly managed) for the northward migration of species as the climate changes.

In the biodiverse southern Okanagan, considerable human/ecosystem interactions have occurred with conversion of the original landscape to urban and agricultural areas. Some types of agriculture are more compatible with ecosystem processes and so pressures to transfer land out of the Agricultural Land Reserve are another threat to ecosystems and biodiversity. In addition, land fragmentation, habitat alteration, and the introduction of invasive species have increased the vulnerability of ecosystems and their capacity to provide ecosystem services.

The growing human population will continue to put pressure on surface water ecosystems that provide irrigation and drinking water. Climate change also threatens water availability in this already water scarce area. This threat will be particularly acute at certain times of year, such as the summer and fall when climate-induced shifts in stream flow result in reduced water availability during seasons when water needs for agricultural are the greatest.

Many of the animals present in the WIBE are iconic species for BC with high value to First Nations for food and ceremonial activities. BC residents also value the animals of the WIBE for wildlife viewing, angling, and hunting. Several large mammal populations are stable but many bird and fish populations are in serious decline. In some instances, there is also cause for optimism as conservation and restoration efforts improve habitat conditions in an effort to reverse these declines.

Despite the impacts of human modifications, some parts of the WIBE remain relatively natural and intact, especially in the west and northwest of the ecozone+. Protected areas have increased in number and area over the past 70 years and provide valuable cultural services as well as habitat conservation. However, the distinct Interior Dry Plateau natural region lacks federal protection.

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